PATENT ASSIGNMENT COVER SHEET

Electronic Version v1.1
Stylesheet Version v1.2

EPAS ID: PAT4394568

SUBMISSION TYPE:	NEW ASSIGNMENT
NATURE OF CONVEYANCE:	ASSIGNMENT

CONVEYING PARTY DATA

Name	Execution Date
MICHAEL SCOTT MARTIN	11/05/2010
CHAD ASHMORE	08/29/2016
ERIC A. DEINES	11/04/2016
GARY A. FREEMAN	08/24/2016
JOSEPH L. HELMICK	11/15/2016
THOMAS E. KAIB	11/01/2016
RICHARD A. RATTANNI	11/18/2016
C. SHANE REID	08/15/2016
JEREMY RYAN SOLLER	11/06/2016
SHANE S. VOLPE	11/01/2016
GARY RUGGIERO	10/28/2016
FREDERICK J. GEHEB	08/29/2016

RECEIVING PARTY DATA

Name:	ZOLL MEDICAL CORPORATION
Street Address:	269 MILL ROAD
City:	CHELMSFORD
State/Country:	MASSACHUSETTS
Postal Code:	01824

PROPERTY NUMBERS Total: 2

Property Type	Number
Application Number:	13647744
PCT Number:	US2011031868

CORRESPONDENCE DATA

Fax Number: (617)526-5000

Correspondence will be sent to the e-mail address first; if that is unsuccessful, it will be sent using a fax number, if provided; if that is unsuccessful, it will be sent via US Mail.

Phone: 617-526-6000
Email: lori.roman@wilmerhale.com
Correspondent Name: WILMERHALE
Address Line 1: 60 STATE STREET

Address Line 4:	BOSTON, MASSACHUSETTS 02109
ATTORNEY DOCKET NUMBER:	2211600.00171US4
NAME OF SUBMITTER:	LORI ROMAN
SIGNATURE:	/Lori Roman/
DATE SIGNED:	05/02/2017

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ZOLL®

11802 Ridge Parkway
Suite 400
Broomfield, Colorado 80021-5059

303 801 0000 (main)
303 801 0001 (fax)
www.zoll.com

February 17, 2011

Scott Martin
2727 S. Braun Court
Lakewood, Colorado 80228

Dear Scott:

Per your severance agreement (attached) we need you to sign the documents that are included. Attached you will find the two applications that were filed, along with that are six other documents that need your signature:

1. Declaration for Utility or Design Application Using an Application Data Sheet – 391929
2. Declaration for Utility or Design Application Using an Application Data Sheet – 391713
3. Assignment for Systems and Methods for Collection, Organization and Display of EMS Information – 387190
4. Assignment for Systems and Methods for EMS Device Communications Interface – 388096
5. Assignment for Systems and Methods for Collection, Organization and Display of EMS Information – 391713
6. Assignment for Systems and Methods for EMS Device Communications Interface – 391929

The two Declarations just need signatures and dates; while the Assignments need signatures and notarizations (Angie could notarize the documents if that would be easier for you). If you get them notarized on your own, please return to me in the prepaid FedEx envelope.

Sincerely,

David Brown
President

Employee Release and Settlement Agreement

The following is a Release and Waiver Agreement ("Agreement") between Scott Martin, the undersigned Employee (referred to as "you" or "your") and ZOLL ("ZOLL") together with its past and present officers. directors, employees, subsidiaries, predecessors, successors and assigns, regarding your employment with ZOLL and separation from employment.

1.0 Payments

ZOLL will, as consideration for your release and promises set forth in this Agreement, pay you additional compensation that you would not otherwise be entitled to. ZOLL, in entering this Agreement, does not admit that it is legally obligated to make any payment and denies that it is responsible or legally obligated for any claims or that it has engaged in any improper conduct or wrongdoing.

Employee's last day of employment will be **Tuesday, October 26, 2010**. Final paycheck (for today, **October 26, 2010**) will be paid via direct deposit on **November 5, 2010** unless otherwise requested by employee.

Employee will be paid out all vacation time **($19,260)** accrued as of **October 26, 2010** on **November 5, 2010.**

Employee will be paid 6 months of severance pay **($97,500)** following the execution of this Agreement so long as employee complies with all of the terms and conditions of this Agreement. The employee has up to 14 days to execute this Agreement and no payments will be made until employee signs and initializes this Agreement and faxes it to (303) 801-1834. In order for payments to be paid on the Pay Date, this Agreement must be received by ZOLL prior to the end of the Severance Period coinciding with that Pay Date. This severance pay will be paid out via direct deposit in accordance with the following schedule:

Pay Period	Work Days	Severance Days	Pay Date	Total Severance
10/17/10 - 10/30/10	10/17/10 - 10/26/10	10/26/10 - 10/30/10	11/5/2010	$2,250
10/31/10 - 11/13/10		10/31/10 - 11/13/10	11/19/2010	$7,500
11/14/10 - 11/27/10		11/14/10 - 11/27/10	12/3/2010	$7,500
11/28/10 - 12/11/10		11/28/10 - 12/11/10	12/17/2010	$7,500
12/12/10 - 12/25/10		12/12/10 - 12/25/10	12/31/2010	$7,500
12/26/10 - 1/8/11		12/26/10 - 1/8/11	1/14/2011	$7,500
1/9/11 - 1/22/11		1/9/11 - 1/22/11	1/28/2011	$7,500
1/23/11 - 2/5/11		1/23/11 - 2/5/11	2/11/2011	$7,500
2/6/11 - 2/19/11		2/6/11 - 2/19/11	2/25/2011	$7,500
2/20/11 - 3/5/11		2/20/11 - 3/5/11	3/11/2011	$7,500
3/6/11 - 3/19/11		3/6/11 - 3/19/11	3/25/2011	$7,500
3/20/11 - 4/2/11		3/20/11 - 4/2/11	4/8/2011	$7,500
4/3/11 - 4/16/11		4/3/11 - 4/16/11	4/22/2011	$7,500
4/17/11 - 4/30/11		4/17/11 - 4/26/11	5/6/2011	$5,2500
Total				$97,500

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Total severance will be **$97,500**. No severance will be paid out until the pay dates displayed above.

No severance payments will be released until the Employee has returned all Company property to the Company.

Employee's medical, dental, vision, life, and disability benefits will expire on the last day of employment (**October 26, 2010**). Employee has the right to elect continuation of medical, vision, and dental benefits through COBRA. In the event that the Employee elects COBRA coverage, ZOLL will pay for 4 months of premiums as part of this severance arrangement.

2.0 Other Arrangements

6 months per David Brown

ZOLL has agreed to the following additional arrangements concerning the termination of Employee's employment:

2.1 Cooperation the in Transfer of Intellectual Property and Other Knowledge

In consideration of the payments and other arrangements stated above, Employee agrees to actively participate in the transfer of all knowledge and intellectual property necessary for the Company to continue its operations with minimal disruption. This participation includes but is not limited to timely, accurate, and complete responses to questions and inquiries and full disclosure on all work projects on which the Employee was engaged. Failure to comply as described herein could be considered a breach of this Agreement and could result in the suspension and/or termination of severance benefits.

2.2 Acknowledgement of Confidentiality, Non-Competition, Non-Solicitation, Intellectual Property Ownership, Training, and Pre-Dispute Arbitration Agreement.

In consideration of the payments and other arrangements stated above, Employee acknowledges his obligations under the ZOLL Confidentiality, Non-Competition, Non-Solicitation, Intellectual Property Ownership, Training, and Pre-Dispute Arbitration Agreement and agrees to continue to be bound by its terms as specified within the Agreement itself. A copy is included as an Appendix to this Severance Agreement for reference.

2.3 Release by Employee

In consideration of the payments and other arrangements stated above, Employee agrees to forever, unequivocally and unconditionally release from and covenant not to sue or assert against ZOLL any and all causes of action, whether at law or in equity, pertaining to or arising from the employment relationship of the parties and the termination of such employment relationship based in whole or in part upon any act or omission occurring on or before the date of this Agreement, whether negligent or intentional without regard to your present actual knowledge of the act or omission. The Release does not affect your right to file a charge with or participate before the Equal Employment Opportunity Commission. However you agree that in the event you bring a claim covered by the foregoing release in which you seek damages or other remedies against ZOLL or in the event you seek to recover against ZOLL in any claim brought by a government agency on your behalf, this agreement shall serve as a complete defense to such claims and that you are expressly waiving the right to recover damages and attorney's fees from any such proceeding.

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Causes of actions as used in this section shall mean all claims, causes, judgments, damages, losses, liabilities and demands, of any kind and nature whatsoever, whether intentional or negligent, known or unknown, in law or in equity, individually or as part of a class action, occurring on or prior to the date of execution of this Agreement, arising under any constitution, federal, state, or local law(s) including but not limited to Title VII of the Civil Rights Act of 1964, as amended, the Colorado Anti-Discrimination in Employment Act, seq., and the Family and Medical Leave Act, or arising from any theory under common law such as breach of contract, express or implied promissory estoppel, wrongful discharge, tortious interference with contract rights, infliction of emotional distress, and defamation, excepting only vested retirement benefits (if any), COBRA rights, unemployment compensation, and workers' compensation.

2.4 Claims Excluded

Employee does not release or waive Employee's right to recovery under health, life or disability policies insuring Employee, and does not release or waive Claims for breach of this Agreement by ZOLL. Employees does not release or waive Employee's right to pursue a claim for Unemployment Insurance.

3.0 General Provisions

3.1 No ZOLL Admission

In entering into this Agreement, ZOLL does not admit any wrongdoing or liability. ZOLL has executed this Agreement to ease the transition of unemployment for the Employee.

3.2 Confidentiality

Employee will keep this Agreement strictly confidential, and will cause Employee's attorneys to do likewise, except to the extent disclosure is necessary for tax, insurance or banking purposes. Employee acknowledges that he has specifically agreed not to discuss the terms of this Agreement or the amount or duration of the severance amount with any other party except to the extent disclosure is necessary for tax, insurance, unemployment benefits, or banking purposes.

3.3 Confidences

Employee will maintain the confidentiality of ZOLL trade secrets, proprietary information, insider information, security procedures and other confidences that came into Employee's possession or knowledge during employment with ZOLL. Employee will not use information concerning ZOLL's business prospects or practices to profit Employee or others. Employee acknowledges that he has entered into a Confidentiality, Non-Competition, Non-Solicitation, Intellectual Property Ownership, Training, and Pre-Dispute Arbitration Agreement with ZOLL and agrees to honor that agreement in all regards. Employee further acknowledges that he has entered into an Insider Trading Agreement regarding SEC Regulations and disclosure of confidential information and agrees to be bound by the terms of that agreement.

3.4 Non-Disparagement

Employee, on behalf of himself and his agents and representatives, agrees that he will not orally or in writing criticize, disparage, deprecate, derogate, depreciate, discredit or vilify the ZOLL or any of its subsidiaries, affiliates, agents, representatives or employees.

3.5 Property

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Employee represents that Employee possesses no property of ZOLL. If any ZOLL' property comes into Employee's possession before departure from ZOLL' premises, or if the date of Employee's termination is in the future, Employee will return the ZOLL property to ZOLL prior to departure from the ZOLL' premises and without request or demand by ZOLL. The fair market value of any property that is in the possession of Employee but not returned will be deducted from the severance amount.

3.6 Entire Agreement

This is the entire Agreement concerning the termination of Employee's employment with ZOLL. Employee is not entitled to rely upon any other written or oral offer or agreement from ZOLL

3.7 Breach

Employee understands and agrees that, in exchange for these severance payments, he will be bound by all of the conditions of this Agreement and the Non Disclosure/Non Compete and Insider Trading Agreements referenced herein. In the event that Employee does not adhere to these agreements, Employee will be considered to be in breach and payments will cease. Additionally, breach of this Agreement by employee shall cause all amounts already paid to be payable back to the ZOLL.

3.8 Amendment

This Agreement can be modified only by a document signed by both parties.

3.9 Choice of Law

The Parties agree that this Agreement will be interpreted in accordance with the laws of the State of Colorado.

3.10 Severability.

If any provision of this Agreement is declared by any court of competent jurisdiction to be invalid for any reason, such invalidity shall not affect the remaining provisions. Such remaining provisions shall be fully severable, and this Agreement shall be construed and enforced as if such invalid provisions never had been inserted in the Agreement.

4.0 Signatures

I have carefully read the above and I execute it voluntarily, fully understanding and accepting the provisions of this Agreement in its entirety and without reservation after having had sufficient time and opportunity to consult with my legal advisors prior to executing this Agreement. I have been advised to consult with an attorney prior to executing this Agreement In agreeing to sign this Agreement I have not relied on any statements or explanation made by the Employer. I have had at twenty-one (21) days to consider this Agreement. I understand that if I do not return this Agreement signed by me to the ZOLL within the twenty-one (21) day consideration period this offer will expire. I understand that I may revoke and cancel the Agreement within seven (7) days after signing it by serving written notice upon ZOLL.

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ZOLL

By: _____

David Brown
President, ZOLL Data Products

Date: 10/26/10

EMPLOYEE

By: _____

Scott Martin

Date: 11/05/10

CONFIDENTIALITY, NON-COMPETITION, NON-SOLICITATION, INTELLECTUAL PROPERTY OWNERSHIP, TRAINING, AND PRE-DISPUTE ARBITRATION AGREEMENT

ZOLL

This Confidentiality and Non-Competition Agreement ("Agreement") is entered into this 25 day of October, 2010, between ZOLL ("the Company") and Scott Murphy ("the Employee").

1. Introduction.

By virtue of the Employee's position with the Company, the Employee has acquired or may from time to time in the future acquire knowledge of trade secrets or confidential and proprietary information relating to the Company's business. The Company uses its confidential information throughout the states in which it does, or will in the future do, business. Use of the Company's confidential information outside of the Company will injure the Company.

2. Definitions.

a. As used in this Agreement, the term "Confidential Information" shall mean information that is not generally known to the public and that is used, developed or obtained by the Company in connection with its business, including but not limited to:

(1) Products or services,
(2) Fees, costs and pricing structures,
(3) Analysis and designs
(4) Computer software, including operating systems, applications, program listings, flow charts, manuals, documentation, and databases
(5) Inventions, new developments, methods and processes, whether patentable or unpatentable and whether or not reduced to practice,
(6) Customers and clients, customer or client lists, and customer or client information,
(7) Other copyrightable works,
(8) All technology and trade secrets,
(9) Any similar or related information developed or obtained by the Company in connection with its business, and
(10) All information related to any employee of the Company, including, without limitation, information contained in personnel files, information concerning compensation, information concerning job performance, and information concerning discipline.

ZOLL Copy. Please initialize each Pg, Sign, and fax to 303 801-1834

b. "Prohibited Industry" means persons, companies, firms, partnerships, corporations, limited liability companies, and any other entities involved directly or indirectly in the Company's industry, developing, marketing, distributing and supporting software related to the collection, organization, handling or transmission of data or information in the emergency medical systems or services, or fire or rescue industries or a business in which Zoll Medical ("Parent") or the Company is engaged or is planning to be engaged (e.g. business plan or product in development) during the time employee is employed.

c. "Prohibited Territory" shall mean the geographic territory encompassing all areas in which the Company's customers are located or are anticipated to be located at the time of Employee's termination.

3. Confidential Information.

a. Employee acknowledges that during the term of his or her employment, Employee has or will be exposed to Confidential Information. The parties acknowledge and agree that all such Confidential Information is a trade secret as defined in C.R.S. §§ 7-74-102 and 8-2-113(2) and that the Company has taken adequate measures to prevent the Confidential Information from becoming available to those not selected by the Company.

b. Employee agrees to maintain the Confidential Information in the strictest of confidence and agrees not to disclose, directly or indirectly, to disseminate, disclose, misappropriate, use, copy, digest or summarize any Confidential Information, except to the extent necessary to carry out Employee's responsibilities as directed and/or authorized by the Company. All records in whatsoever form and in whatsoever medium recorded, and any copies thereof, relating to the Company's business shall be and remain the sole property of the Company and shall not be removed from the Company's premises except as necessary to carry out Employee's responsibilities as directed and authorized by the Company. In addition, any Confidential Information in the possession of or under the control of the Employee shall be returned promptly to the Company upon termination of Employee's relationship with the Company or upon the Company's request. Employee agrees that he or she will not use, misappropriate, disclose or disseminate any Confidential Information at any time during or after employment with the Company for the benefit of any person other than the Company.

4. ZOLL' Ownership of Intellectual Property

a. In the event that Employee as part of his or her activities on behalf of the Company generates, authors or contributes to any invention, design, new development, device, product, method or process (whether or not patentable or reduced to practice or comprising Confidential Information), any copyrightable work (whether or not comprising Confidential Information) or any other form of Confidential Information relating directly or indirectly to the Company's business as now or hereinafter conducted (collectively, "Intellectual Property"), Employee acknowledges that such Intellectual Property is the exclusive property of the Company and hereby assigns all right, title and interest in and to such Intellectual Property to the Company

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or its designees. Any copyrightable work prepared in whole or in part by Employee will be deemed "a work made for hire" under Section 201(b) of the 1976 Copyright Act, and the Company or its designees will own all of the rights comprised in the copyright therein. Employee will promptly and fully disclose all Intellectual Property to the Company and will cooperate with the Company to protect the Company's interests in and rights to such Intellectual Property (including, without limitation, providing reasonable assistance in securing patent protection and copyright and trademark registrations, in the defense in any judicial opposition or other proceeding in respect of such registrations, and executing all documents as reasonably requested by the Company, whether such requests occur prior to or after termination of Employee's employment with the Company.) In the event the Company is unable, after reasonable effort, to secure Employee's signature on any application for letters patent, copyright or trademark registration or other documents involving any legal protection relating to Intellectual Property, whether because of Employee's physical or mental incapacity or for any other reason whatsoever, Employee hereby irrevocably designates and appoints the Company and its duly authorized officers and agents as his or her agent and attorney-in-fact, to act for and in Employee's behalf and stead to execute and file any such applications or other documents and to do all other lawfully permitted acts to further the completion and issuance of letters patent, copyright or trademark registrations or any other legal protection thereon with the same legal force and effect as if executed by Employee.

b. Section 4(a) of this Agreement regarding the Company's ownership of Intellectual Property shall not apply to any invention for which no equipment, supplies, facilities or trade secret information of the Company was used and which was developed entirely on Employee's own time, unless:

1. The invention relates to the business of the Company or to the Company's actual or demonstrably anticipated research or development or

2. The invention results from any work performed by Employee for the Company.

c. Employee has attached hereto a complete list of inventions which have been made or conceived or first reduced to practice by Employee alone or jointly with others prior to Employee's employment with the Company which Employee desires to remove from the operation of this Agreement. If no such list is attached to this Agreement, Employee represents that Employee has not made, conceived or reduced to practice any such inventions and improvements at the time of signing this Agreement.

5. Non-Competition and Non-Solicitation

a. The parties acknowledge and agree that Employee's position with the Company is (check one or both):

☐ an executive or management position, or a position as a professional staff to executive or management personnel (as used in C.R.S. § 8-2-113(2)(d));

☐ a position in which Employee has been or may be exposed to Confidential Information and trade secrets.

b. The parties acknowledge and agree that this non-competition provision is necessary for the protection of the Company's Confidential Information and trade secrets.

c. In consideration of the employment of Employee by the Company, during employment with the Company and for two years after termination of employment, the Employee shall not do any of the following:

(1) Canvas, solicit or accept business in the Prohibited Industry;

(2) Aid or assist any other person, entity, partnership or corporation in any effort to canvas, solicit or accept any business in the Prohibited Industry;

(3) Directly or indirectly request or advise any past, present or possible future customer of the Company to withdraw, curtail, cancel or not undertake business in the Prohibited Industry with the Company, if the customer is located within the Prohibited Territory;

(4) Directly or indirectly disclose to any other person, entity, partnership or corporation the names of past or present customers of the Company. The parties agree that the names of these customers are confidential and proprietary and constitute trade secrets of the Company within the meaning of C.R.S. §§ 7-74-102(4) and 8-2-113(2);

(5) Suggest, solicit or encourage any employee of the Company to leave employment; or disclose to any other person, entity, partnership or corporation the names of employees of the Company;

(6) Provide any service, financing, aid or assistance of any kind for any person, entity, partnership, association or corporation which is

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competitive with any business conducted or service provided by the Company and which is in the Prohibited Industry and in the Prohibited Territory; and

(7) Work with a competitor or otherwise compete in any manner with any business which is conducted by the Company, and which business is in the Prohibited Industry and in the Prohibited Territory.

6. Cost of Training. Employee hereby acknowledges that The Company may invest a substantial amount of money in order to train The Employee on the installation, configuration, and use of The RescueNet Suite of products. This training is provided at significant expense to The Company and The Employee, upon accepting the training, agrees not to leverage that training to accept an offer of employment by a Client or any other Party to work as a Trainer or Administrator of The RescueNet Suite without the prior written consent of The Employer for a period of two (2) years following The Employee's date of employment.

7. Partial Invalidity. If any provision of this Agreement is found to be in violation of law, unenforceable, void or voidable, then that provision alone shall be deemed to be deleted from the agreement, and the balance of the agreement shall be enforced between the parties.

8. Association with Company. Nothing contained in this Agreement shall be construed as altering the at-will nature of employment of Employee, or as impairing Employee's right or the right of the Company to terminate Employee's employment with the Company, with or without notice or cause. Employee's obligations under this Agreement shall continue regardless of whether Employee's employment with the Company is terminated voluntarily or involuntarily, or with or without notice or cause.

9. Termination. Upon employee's termination, regardless of whether the termination is voluntary or involuntary, or with or without notice or cause, Employee agrees to submit to an exit interview, to return all confidential information at that time and to provide information concerning his or her next employer and duties for that employer.

10. Not an Employment Agreement. Employee and Company acknowledge and agree that this Agreement is not intended and should not be construed to grant Employee any right to continued employment with Company or to otherwise define the terms of Employee's employment with Company.

11. Prior Agreements in Employment. Employee represents and warrants that the services being rendered to the Company and its customers, and the terms of this Agreement, do not violate any other agreement of which Employee is a party, or violate or breach any obligation of confidentiality between Employee and any third party. Employee agrees to indemnify and hold the Company and its customers harmless from all damages, expenses, costs (including reasonable attorneys' fees) and liabilities incurred in connection with, or resulting from, any

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breach of this paragraph.

11. Remedy for Breach. The parties agree that any breach of the confidentiality or non-compete provisions of this Agreement by Employee will cause immediate and irreparable damage to the Company. The parties further agree that in the event of such breach, the Company shall have, in addition to any and all remedies at law, the right to a temporary restraining order and other injunctive relief, specific performance or other equitable relief to prevent the violation of Employee's obligations hereunder. The attorneys' fees and costs of the prevailing party shall be paid by the losing party.

12. Arbitration. Any dispute arising in connection with this Agreement or Employee's employment (except for equitable or injunction actions pursuant to paragraph 9 above, or claims by the employee for worker's compensation or unemployment compensation) shall be submitted to binding arbitration by an arbitrator with Judicial Arbiters Group (JAG) under the American Arbitration Association's rules for the resolution of employment disputes, in Boulder, Colorado. Judgment upon any award rendered by arbitration may be entered in any court having jurisdiction thereof. The attorneys' fees and costs of the prevailing party in connection with the arbitration, as well as any costs of AAA, JAG and the arbitrator, shall be assessed against the losing party.

13. Colorado Law. The Agreement shall be governed by and construed in accordance with the laws of the state of Colorado.

14. Acknowledgments. The parties acknowledge that all items of confidential information are important, material and confidential trade secrets of the Company and affect the successful conduct of the business of the Company and its good will. Employee acknowledges that Employee's covenants and agreements in this Agreement are reasonable and necessary to protect the legitimate interests and Confidential Information of the Company. Employee acknowledges that the restrictions in this Agreement are not so broad as to prevent Employee from earning a livelihood or practicing Employee's chosen profession after termination of Employee's duties for the Company.

15. Miscellaneous. No modification or changes in this Agreement shall be valid unless those modification or changes are in writing and signed by the parties hereto. Any waiver of any of the terms and conditions of this Agreement shall not operate as a waiver of any other breach of such terms or conditions, or any other term or condition, nor shall any failure to enforce the provision hereof operate as a waiver of such provision or any other provision hereof. The rights of the Company under this Agreement shall inure to its successors and assigns.

SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATIONS INTERFACE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application Serial Nos. 61/227,187, filed on July 21, 2009, and 61/322,675, filed on April 9, 2010, which are incorporated herein by reference in their entirety for all purposes.

TECHNICAL FIELD

[0002] Embodiments of the present invention relate generally to emergency medical services information management, and more particularly to collection, organization, and communication of information gathered from a device used in emergency medical services.

BACKGROUND

[0003] Devices that are used to gather patient monitoring information in emergency medical services ("EMS") applications, for example defibrillator devices, are often complex and expensive devices, primarily because they serve a very important purpose in an EMS setting, and must be durable, accurate, and reliable. The communications capabilities of such devices are often limited by their hardware, such that users must choose between buying a new defibrillator or continuing to use the same, often slower, communications interfaces available with an older defibrillator. A retrofit solution that involves changing the existing hardware or

SYSTEMS AND METHODS FOR COLLECTION, ORGANIZATION AND DISPLAY OF EMS INFORMATION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application Serial Nos. 61/227,187, filed on July 21, 2009, and 61/322,678, filed on April 9, 2010, which are incorporated herein by reference in their entirety for all purposes.

TECHNICAL FIELD

[0002] Embodiments of the present invention relate generally to emergency medical services information management, and more particularly to collection, organization, and display of information gathered from multiple different kinds of devices used in emergency medical services.

BACKGROUND

[0003] When an ambulance or other emergency medical services ("EMS") vehicle is dispatched to a medical emergency, the ambulance driver as well as the EMS technician typically rely on an array of devices in helping them locate, diagnose, treat, transport, chart information about, and deliver the patient. Although such devices typically facilitate particular aspects of the EMS experience, the manual interaction time for each device and the shifting of attention from device to device can in some cases increase transport time and/or shift valuable time away from patient care or can fail to give the crew a complete picture.

[0004] Sending certain data-intensive information from an ambulance to a hospital or other care provider often involves manually faxing or e-mailing such data between telephony devices. For example, an EMS technician attempting to convey 12-lead data from a

ASSIGNMENT

First Named Inventor: MARTIN, Michael Scott

Title: **SYSTEMS AND METHODS FOR COLLECTION, ORGANIZATION AND DISPLAY OF EMS INFORMATION**

WHEREAS, we, **Michael Scott Martin**, a United States citizen, residing at 2727 South Braun Court, Lakewood, Colorado 80228; **Chad Ashmore**, a United States citizen, residing at 6303 Taylor Street, Frederick, Colorado 80530; **C. Shane Reid**, a United States citizen, residing at 6453 East Floyd Avenue, Denver, Colorado 80222, Denver, Colorado 80222; **Joseph Lon Helmick**, a United States citizen, residing at 2556 West 110th Place, Westminster, Colorado 80234; **Mark Timmermann**, a United States citizen, residing in Boulder, Colorado; **Eric A. Deines**, a United States citizen, residing at 1052 Lilac Court, Broomfield, Colorado 80020; **Michael S. Erlich**, a United States citizen, residing in Erie, Colorado; **Thomas E. Kaib**, a United States citizen, residing at 2810 Ipnar Road, North Huntingdon, Pennsylvania 15642; **Shane S. Volpe**, a United States citizen, residing at 645 Oak Lane, Saltsburg, Pennsylvania 15681; **Richard A. Rattanni**, a United States citizen, residing at 215 Oak Street, New Stanton, Pennsylvania 15672; **Gary A. Freeman**, a United States citizen, residing at 47 Stearns Street, Newton Center, Massachusetts 02159;, **Gary Ruggiero**, a United States citizen, residing at 48 Sanderson Road, Lexington, Massachusetts 02402; and **Jeremy Ryan Soller**, a United States citizen, residing at 3307 Columbine Court, Broomfield, Colorado 80020, have invented certain new and useful improvements as described in a U.S. provisional patent application entitled **SYSTEMS AND METHODS FOR COLLECTION, ORGANIZATION AND DISPLAY OF EMS INFORMATION**, the application being identified in the United States Patent and Trademark Office by Application No. 61/322,678, filed April 9, 2010; and

WHEREAS, ZOLL Medical Corporation, a Massachusetts corporation having an address of 269 Mill Road, Chelmsford, Massachusetts 01824-4105 ("Assignee"), is desirous of acquiring the entire right, title and interest in and to the invention, the application, and any and all Letters Patent or similar legal protection, foreign or domestic, to be obtained therefor;

NOW, THEREFORE, for good and valuable consideration, the receipt and adequacy of which are hereby acknowledged, we transfer to Assignee, its successors and assigns, our entire right, title, and interest in and to the invention, the above-identified patent application, corresponding domestic applications (including original, non-provisional, divisional, continuation, and continuations-in-part, reexamination, or reissue patent or application), corresponding foreign applications, all Letters Patent or similar legal protection issuing thereon, and all rights and benefits under any applicable treaty or convention; and we authorize the Commissioner of Patents and Trademarks of the United States or foreign equivalent thereof to issue the Letters Patent or similar legal protection to the Assignee.

We authorize the Assignee, its successors and assigns, to insert in this instrument the filing date and application number of the application when ascertained. We authorize the Assignee, its successors and assigns, or anyone it may properly designate, to apply for Letters Patent or similar legal protection, in its own name if desired, in any and all foreign countries.

We represent to the Assignee, its successors and assigns, that we have not and shall not execute any writing or do any act whatsoever conflicting with this Assignment. We, or our executors or administrators, will at any time upon request, without additional consideration, but at the expense of the Assignee, its successors and assigns, execute such additional writings and do such additional acts as the Assignee, its successors and assigns, may deem desirable to perfect its enjoyment of this grant, and render all assistance in making application for and obtaining, maintaining, and enforcing the Letters Patent or similar legal protection on the invention in any and all countries.

IN WITNESS WHEREOF, we have hereunto set our hands and affixed our seals on the date indicated below:

_____

Michael Scott Martin

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Chad Ashmore

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

C. Shane Reid

Date

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Joseph Lon Helmick

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Mark Timmermann

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Eric A. Deines

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Michael S. Erlich

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Thomas E. Kaib

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Shane S. Volpe

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Richard A. Rattanni

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Gary A. Freeman

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Gary Ruggiero

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Jeremy Ryan Soller

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

ASSIGNMENT

First Named Inventor: MARTIN, Michael Scott

Title: **SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATIONS INTERFACE**

WHEREAS, we, **Michael Scott Martin**, a United States citizen, residing at 2727 South Braun Court, Lakewood, Colorado 80228; **Chad Ashmore**, a United States citizen, residing at 6303 Taylor Street, Frederick, Colorado 80530; **C. Shane Reid**, a United States citizen, residing at 6453 East Floyd Avenue, Denver, Colorado 80222; **Joseph Lon Helmick**, a United States citizen, residing at 2556 West 110th Place, Westminster, Colorado 80234; **Mark Timmermann**, a United States citizen, residing in Boulder, Colorado; **Eric A. Deines**, a United States citizen, residing at 1052 Lilac Court, Broomfield, Colorado 80020; **Michael S. Erlich**, a United States citizen, residing in Erie, Colorado; **Thomas E. Kaib**, a United States citizen, residing at 2810 Ipnar Road, North Huntingdon, Pennsylvania 15642; **Shane S. Volpe**, a United States citizen, residing at 645 Oak Lane, Saltsburg, Pennsylvania 15681; **Richard A. Rattanni**, a United States citizen, residing at 215 Oak Street, New Stanton, Pennsylvania 15672; **Gary A. Freeman**, a United States citizen, residing at 47 Stearns Street, Newton Center, Massachusetts 02159; and **Jeremy Ryan Soller**, a United States citizen, residing at 3307 Columbine Court, Broomfield, Colorado 80020 have invented certain new and useful improvements as described in a U.S. provisional patent application entitled **SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATIONS INTERFACE**, the application being identified in the United States Patent and Trademark Office by Application No. 61/322,675, filed April 9, 2010; and

WHEREAS, ZOLL Medical Corporation, a Massachusetts corporation having an address of 269 Mill Road, Chelmsford, Massachusetts 01824-4105 ("Assignee"), is desirous of acquiring the entire right, title and interest in and to the invention, the application, and any and all Letters Patent or similar legal protection, foreign or domestic, to be obtained therefor;

NOW, THEREFORE, for good and valuable consideration, the receipt and adequacy of which are hereby acknowledged, we transfer to Assignee, its successors and assigns, our entire right, title, and interest in and to the invention, the above-identified patent application, corresponding domestic applications (including original, non-provisional, divisional, continuation, and continuations-in-part, reexamination, or reissue patent or application), corresponding foreign applications, all Letters Patent or similar legal protection issuing thereon, and all rights and benefits under any applicable treaty or convention; and we authorize the Commissioner of Patents and Trademarks of the United States or foreign equivalent thereof to issue the Letters Patent or similar legal protection to the Assignee.

We authorize the Assignee, its successors and assigns, to insert in this instrument the filing date and application number of the application when ascertained. We authorize the Assignee, its successors and assigns, or anyone it may properly designate, to apply for Letters Patent or similar legal protection, in its own name if desired, in any and all foreign countries.

We represent to the Assignee, its successors and assigns, that we have not and shall not execute any writing or do any act whatsoever conflicting with this Assignment. We, or our executors or administrators, will at any time upon request, without additional consideration, but at the expense of the Assignee, its successors and assigns, execute such additional writings and do such additional acts as the Assignee, its successors and assigns, may deem desirable to perfect its enjoyment of this grant, and render all assistance in making application for and obtaining, maintaining, and enforcing the Letters Patent or similar legal protection on the invention in any and all countries.

IN WITNESS WHEREOF, we have hereunto set our hands and affixed our seals on the date indicated below:

_____

Michael Scott Martin

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Chad Ashmore

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

C. Shane Reid

Date

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Joseph Lon Helmick

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Mark Timmermann

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Eric A. Deines

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Michael S. Erlich

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Thomas E. Kaib

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Shane S. Volpe

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Richard A. Rattanni

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Gary A. Freeman

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Jeremy Ryan Soller

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public,
this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

ASSIGNMENT

First Named Inventor: REID, C. Shane

Title: SYSTEMS AND METHODS FOR COLLECTION, ORGANIZATION AND DISPLAY OF EMS INFORMATION

WHEREAS, we, **C. Shane Reid**, a United States citizen, residing at 6453 East Floyd Avenue, Denver, Colorado 80222; **Chad Ashmore**, a United States citizen, residing at 6303 Taylor Street, Frederick, Colorado 80530; **Eric A. Deines,** a United States citizen, residing at 1052 Lilac Court, Broomfield, Colorado 80020; **Gary A. Freeman**, a United States citizen, residing at 47 Stearns Street, Newton Center, Massachusetts 02159; **Michael Scott Martin**, a United States citizen, residing at 2727 South Braun Court, Lakewood, Colorado 80228; **Gary Ruggiero**, a United States Citizen, residing at 48 Sanderson Road, Lexington, Massachusetts 02402; **Jeremy Ryan Soller**, a United States citizen, residing at 3307 Columbine Court, Broomfield, Colorado 80020; **Mark Timmermann**, a United States Citizen residing at 6878 Roaring Fork Trail, Boulder, Colorado 80301; and **Michael S. Erlich**, a United States Citizen residing at 1726 Gordon Drive, Erie, Colorado 80516, have invented certain new and useful improvements as described in applications entitled **SYSTEMS AND METHODS FOR COLLECTION, ORGANIZATION AND DISPLAY OF EMS INFORMATION**, the applications being identified by U.S. Patent Application Serial No. 12/840,117, filed on July 20, 2010, and by Patent Cooperation Treaty Application No. PCT/US10/42655, filed on July 20, 2010; and

WHEREAS, ZOLL MEDICAL CORPORATION, having an address of 269 Mill Road, Chelmsford, Massachusetts 01824 ("Assignee"), is desirous of acquiring the entire right, title and interest in and to the invention, the application, and any and all Letters Patent or similar legal protection, foreign or domestic, to be obtained therefor;

NOW, THEREFORE, for good and valuable consideration, the receipt and adequacy of which are hereby acknowledged, we transfer to Assignee, its successors and assigns, our entire right, title, and interest in and to the invention, the above-identified patent applications, corresponding domestic applications (including provisionals, divisionals, continuations, and continuations-in-part), corresponding foreign applications, all Letters Patent or similar legal protection issuing thereon, and all rights and benefits under any applicable treaty or convention; and we authorize the Commissioner of Patents and Trademarks of the United States or foreign equivalent thereof to issue the Letters Patent or similar legal protection to the Assignee.

We authorize the Assignee, its successors and assigns, to insert in this instrument the filing date and application number of the application when ascertained. We authorize the Assignee, its successors and assigns, or anyone it may properly designate, to apply for Letters Patent or similar legal protection, in its own name if desired, in any and all foreign countries.

We represent to the Assignee, its successors and assigns, that we have not and shall not execute any writing or do any act whatsoever conflicting with this Assignment. We, or our executors or administrators, will at any time upon request, without additional consideration, but at the expense of the Assignee, its successors and assigns, execute such additional writings and do such additional acts as the Assignee, its successors and assigns, may deem desirable to perfect its enjoyment of this grant, and render all assistance in making application for and obtaining, maintaining, and enforcing the Letters Patent or similar legal protection on the invention in any and all countries.

_____

C.Shane Reid

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public, this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Chad Ashmore

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public, this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Eric A. Deines

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public, this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Gary A. Freeman

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public, this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Michael Scott Martin

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public, this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Gary Ruggiero

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public, this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Jeremy Ryan Soller

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public, this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Mark Timmermann

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public, this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Michael S. Erlich

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public, this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	SYSTEMS AND METHODS FOR COLLECTION, ORGANIZATION AND DISPLAY OF EMS INFORMATION

As the below named inventor(s), I/we declare that:

This declaration is directed to:

☐ The attached application, or

☒ Application No. 12/840,117, filed on July 20, 2010,

☐ as amended on _____ (if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the National or PCT International filing date of the continuation-in-part application.

I/we acknowledge that all statements made herein of my/our own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF INVENTOR(S)

Inventor one: C. Shane Reid _____ Date: _____

Signature: _____ Citizen of: US

Inventor two: Chad Ashmore _____ Date: _____

Signature: _____ Citizen of: US

Inventor three: Eric A. Deines _____ Date: _____

Signature: _____ Citizen of: US

Inventor four: Gary A. Freeman _____ Date: _____

Signature: _____ Citizen of: US

☒ Additional inventors or a legal representative are being named on 2 additional form(s) attached hereto.

SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	SYSTEMS AND METHODS FOR COLLECTION, ORGANIZATION AND DISPLAY OF EMS INFORMATION

As the below named inventor(s), I/we declare that:

This declaration is directed to:

☐ The attached application, or

☒ Application No. 12/840,117, filed on July 20, 2010,

☐ as amended on _____ (if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT International filing date of the continuation-in-part application.

I/we acknowledge that all statements made herein of my/our own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF INVENTOR(S)

Inventor five: Michael Scott Martin _____ Date: _____

Signature: _____ Citizen of: US

Inventor six: Gary Ruggiero _____ Date: _____

Signature: _____ Citizen of: US

Inventor seven: Jeremy Ryan Soller _____ Date: _____

Signature: _____ Citizen of: US

Inventor eight: Mark Timmermann _____ Date: _____

Signature: _____ Citizen of: US

☒ Additional inventors or a legal representative are being named on 1 additional form(s) attached hereto.

SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	SYSTEMS AND METHODS FOR COLLECTION, ORGANIZATION AND DISPLAY OF EMS INFORMATION

As the below named inventor(s), I/we declare that:

This declaration is directed to:

☐ The attached application, or

☒ Application No. 12/840,117, filed on July 20, 2010,

☐ as amended on _____ (if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT International filing date of the continuation-in-part application.

I/we acknowledge that all statements made herein of my/our own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF INVENTOR(S)

Inventor nine: Michael S. Erlich

Signature: _____ Date: _____

Citizen of: US

Inventor ten:

Signature: _____ Date: _____

Citizen of:

Inventor eleven:

Signature: _____ Date: _____

Citizen of:

Inventor twelve:

Signature: _____ Date: _____

Citizen of:

☐ Additional inventors or a legal representative are being named on ____ additional form(s) attached hereto.

SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

WHEREAS, we, **Michael Scott Martin**, a United States citizen, residing at 2727 South Braun Court, Lakewood, Colorado 80228; **Chad Ashmore**, a United States citizen, residing at 6303 Taylor Street, Frederick, Colorado 80530; **Eric A. Deines**, a United States citizen, residing at 1052 Lilac Court, Broomfield, Colorado 80020; **Gary A. Freeman**, a United States citizen, residing at 47 Stearns Street, Newton Center, Massachusetts 02159; **Joseph L. Helmick**, a United States citizen, residing at 2556 West 110th Place, Westminster, Colorado 80234; **Thomas E. Kaib**, a United States citizen, residing at 2810 Ipnar Road, North Huntingdon, Pennsylvania 15642; **Richard A. Rattanni**, a United States citizen, residing at 215 Oak Street, New Stanton, Pennsylvania 15672; **C. Shane Reid**, a United States citizen, residing at 6453 East Floyd Avenue, Denver, Colorado 80222; **Jeremy Ryan Soller**, a United States citizen, residing at 3307 Columbine Court, Broomfield, Colorado 80020; **Shane S. Volpe**, a United States citizen, residing at 645 Oak Lane, Saltsburg, Pennsylvania 15681; **Gary Ruggiero**, a United States citizen, residing at 48 Sanderson Road, Lexington, Massachusetts 02402; and **Frederick J. Geheb**, 18 Carolyn Drive, Danvers, Massachusetts 01923, have invented certain new and useful improvements as described in a patent application entitled **SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATIONS INTERFACE**, the application being identified in the United States Patent and Trademark Office by U.S. Application Serial No. 12/840,129, filed July 20, 2010; and

WHEREAS, ZOLL MEDICAL CORPORATION, a Massachusetts corporation having an address of 269 Mill Road, Chelmsford, Massachusetts 01824-4105 ("Assignee"), is desirous of acquiring the entire right, title and interest in and to the invention, the application, and any and all Letters Patent or similar legal protection, foreign or domestic, to be obtained therefor;

NOW, THEREFORE, for good and valuable consideration, the receipt and adequacy of which are hereby acknowledged, we transfer to Assignee, its successors and assigns, our entire right, title, and interest in and to the invention, the above-identified patent application, corresponding domestic applications (including original, provisional, non-provisional, divisional, continuation, and continuations-in-part, reexamination, or reissue patent or application), corresponding foreign applications, all Letters Patent or similar legal protection issuing thereon, and all rights and benefits under any applicable treaty or convention; and we authorize the Commissioner of Patents and Trademarks of the United States or foreign equivalent thereof to issue the Letters Patent or similar legal protection to the Assignee.

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maintaining, and enforcing the Letters Patent or similar legal protection on the invention in any and all countries.

IN WITNESS WHEREOF, we have hereunto set our hands and affixed our seals on the date indicated below:

_____
Michael Scott Martin

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public, this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____
Chad Ashmore

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public, this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Eric A. Deines

Date

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public, this _____ day of _____, 2011.

_____

Notary Public

(SEAL)

_____

Gary A. Freeman

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public, this _____ day of _____, 2011.

_____

Notary Public

(SEAL)

_____

Joseph L. Helmick

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public, this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Thomas E. Kaib

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public, this _____ day of _____, 2011.

_____
Notary Public

(SEAL)

_____

Richard A. Rattanni

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public, this _____ day of _____, 2011.

_____

Notary Public

(SEAL)

_____

C. Shane Reid

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public, this _____ day of _____, 2011.

_____

Notary Public

(SEAL)

_____

Jeremy Ryan Soller

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public, this _____ day of _____, 2011.

_____

Notary Public

(SEAL)

_____

Shane S. Volpe

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public, this _____ day of _____, 2011.

_____

Notary Public

(SEAL)

_____

Gary Ruggiero

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public, this _____ day of _____, 2011.

_____

Notary Public

(SEAL)

_____

Frederick J. Geheb

Date _____

CERTIFICATE OF ACKNOWLEDGMENT

STATE OF _____)
: SS.
COUNTY OF _____)

Subscribed and sworn to before me, a Notary Public, this _____ day of _____, 2011.

_____

Notary Public

(SEAL)

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATIONS INTERFACE

As the below named inventor(s), I/we declare that:

This declaration is directed to:

☐ The attached application, or

☒ Application No. 12/840,129, filed on July 20, 2010,

☐ as amended on _____ (if applicable);

I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the National or PCT International filing date of the continuation-in-part application.

I/we acknowledge that all statements made herein of my/our own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

FULL NAME OF INVENTOR(S)

Inventor one: Michael Scott Martin _____ Date: _____

Signature: _____ Citizen of: US

Inventor two: Chad Ashmore _____ Date: _____

Signature: _____ Citizen of: US

Inventor three: Eric A. Deines _____ Date: _____

Signature: _____ Citizen of: US

Inventor four: Gary A. Freeman _____ Date: _____

Signature: _____ Citizen of: US

☒ Additional inventors or a legal representative are being named on _2___ additional form(s) attached hereto.

SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATIONS INTERFACE

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FULL NAME OF INVENTOR(S)

Inventor five: Joseph L. Helmick _____ Date: _____

Signature: _____ Citizen of: US

Inventor six: Thomas E. Kaib _____ Date: _____

Signature: _____ Citizen of: US

Inventor seven: Richard A. Rattanni _____ Date: _____

Signature: _____ Citizen of: US

Inventor eight: C. Shane Reid _____ Date: _____

Signature: _____ Citizen of: US

☒ Additional inventors or a legal representative are being named on _1___ additional form(s) attached hereto.

SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

DECLARATION (37 CFR 1.63) FOR UTILITY OR DESIGN APPLICATION USING AN APPLICATION DATA SHEET (37 CFR 1.76)

Title of Invention	SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATIONS INTERFACE

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I/we believe that I/we am/are the original and first inventor(s) of the subject matter which is claimed and for which a patent is sought;

I/we have reviewed and understand the contents of the above-identified application, including the claims, as amended by any amendment specifically referred to above;

I/we acknowledge the duty to disclose to the United States Patent and Trademark Office all information known to me/us to be material to patentability as defined in 37 CFR 1.56, including for continuation-in-part applications, material information which became available between the filing date of the prior application and the national or PCT International filing date of the continuation-in-part application.

I/we acknowledge that all statements made herein of my/our own knowledge are true, all statements made herein on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like are punishable by fine or imprisonment, or both, under 18 U.S.C. 1001, and may jeopardize the validity of the application or any patent issuing thereon.

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SYSTEMS AND METHODS FOR COLLECTION, ORGANIZATION AND DISPLAY OF EMS INFORMATION

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application Serial Nos. 61/227,187, filed on July 21, 2009, and 61/322,678, filed on April 9, 2010, which are incorporated herein by reference in their entirety for all purposes.

TECHNICAL FIELD

[0002] Embodiments of the present invention relate generally to emergency medical services information management, and more particularly to collection, organization, and display of information gathered from multiple different kinds of devices used in emergency medical services.

BACKGROUND

[0003] When an ambulance or other emergency medical services ("EMS") vehicle is dispatched to a medical emergency, the ambulance driver as well as the EMS technician typically rely on an array of devices in helping them locate, diagnose, treat, transport, chart information about, and deliver the patient. Although such devices typically facilitate particular aspects of the EMS experience, the manual interaction time for each device and the shifting of attention from device to device can in some cases increase transport time and/or shift valuable time away from patient care or can fail to give the crew a complete picture.

[0004] Sending certain data-intensive information from an ambulance to a hospital or other care provider often involves manually faxing or e-mailing such data between telephony devices. For example, an EMS technician attempting to convey 12-lead data from a

defibrillator must often verbally describe her own assessment of the data, or spend the time e-mailing or faxing a snapshot of the 12-lead data to the hospital. This may delay patient care and/or result in the time-consuming transmission of a patient snapshot that may already be several minutes old by the time it reaches the hospital. In fact, transmission of information between an EMS technician in the back of an ambulance and a hospital emergency room ("ER") nurse often involves a mobile phone "patch" or call during which the EMS technician attempts to verbally convey the patient's status and treatment, and the vehicle location, while manually sorting through various data sources including the patient's chart, the defibrillator visual data, and/or the ambulance location data (e.g. looking out the window). This often results in inefficient and sometimes inaccurate communication between the EMS technician and the hospital.

SUMMARY

[0005] Embodiments of the present invention communicate with and gather relevant data from multiple EMS devices (including but not limited to a defibrillator monitoring a patient, a patient charting device, and a navigation device), organize and store the information, and display it in real-time on a screen in the back of an ambulance and to a hospital, or other location such as a physician's home, via a web browser interface. According to embodiments of the present invention, the display screen in the back of the ambulance is a touch-screen with various organizational options that instantly display different subsets of the EMS information for different uses.

[0006] A system for collecting and displaying emergency medical services information according to embodiments of the present invention includes a defibrillator device configured to monitor a patient, a navigation device, a patient charting device, a database, a display

device separate and distinct from the defibrillator device, the navigation device, and the patient charting device, and a processor in communication with the defibrillator, the navigation device, the patient charting device, the database, and the display device. According to embodiments of the present invention, the processor is configured to receive emergency medical services information from the defibrillator device, the navigation device, and the patient charting device, store the emergency medical services information in the database, and display the emergency medical services information on the display device according to an information template.

[0007] According to embodiments of the present invention, a system for collecting and displaying emergency medical services information, the system comprising: a patient monitoring device configured to monitor a patient and to make available patient monitoring information; a patient charting device configured to make available patient charting information, wherein emergency medical services information includes at least some of the patient monitoring information and at least some of the patient charting information; a database; a display device; and a processor communicably coupled to the patient monitoring device, the patient charting device, the database, and the display device, the processor configured to receive the emergency medical services information, store the emergency medical services information in the database, and display the emergency medical services information on the display device according to an information template.

[0008] The system of paragraph [0007], wherein the patient monitoring device is a defibrillator.

[0009] The system of any of paragraphs [0007] through [0008], wherein the information template is stored in the database.

[0010] The system of any of paragraphs [0007] through [0009], wherein the processor is configured to display at least some of the patient charting information and at least some of the patient monitoring information simultaneously on the display device.

[0011] The system of any of paragraphs [0007] through [0010], further comprising a navigation device configured to make available navigation information, wherein the processor is communicably coupled to the navigation device, and wherein the emergency medical services information further includes at least some of the navigation information.

[0012] The system of any of paragraphs [0007] through [0011], wherein the processor is configured to display at least some of the patient charting information, at least some of the patient monitoring information, and at least some of the navigation information simultaneously on the display device.

[0013] The system of any of paragraphs [0007] through [0012], wherein the navigation information is information about location of an emergency medical services vehicle.

[0014] The system of any of paragraphs [0007] through [0013] further comprising an emergency services vehicle, wherein the display device is mounted in the emergency services vehicle.

[0015] The system of any of paragraphs [0007] through [0014], wherein the emergency services vehicle is an ambulance, and wherein the display device is mounted in a back section of the ambulance.

[0016] The system of any of paragraphs [0007] through [0015], wherein the display device includes a touch screen input device for sending instructions to the processor.

[0017] The system of any of paragraphs [0007] through [0016], wherein the display device and the processor are part of a tablet PC.

[0018] The system of any of paragraphs [0007] through [0017], wherein the display device cycles display between an information template comprising primarily patient monitoring information and an information template comprising primarily patient charting information.

[0019] The system of any of paragraphs [0007] through [0018], wherein the display device cycles display between an information template comprising primarily patient monitoring information, an information template comprising primarily patient charting information, and a patch notes information template.

[0020] The system of any of paragraphs [0007] through [0019], further comprising: an enterprise server communicably coupled to the processor, the enterprise server configured to receive the emergency medical services information from the processor and send the emergency medical services information to an enterprise environment via a web browser interface.

[0021] The system of any of paragraphs [0007] through [0020], wherein the web browser interface is substantially similar to an interface displayed on the display device.

[0022] The system of any of paragraphs [0007] through [0021], wherein the database is a mobile database, the system further comprising an enterprise database on a storage medium, wherein the enterprise server is further configured to store at least a portion of the emergency medical services information in the enterprise database.

[0023] According to embodiments of the present invention, a system for collecting and displaying emergency medical services information, the system comprising: a patient monitoring device configured to monitor a patient and to make available patient monitoring information; a navigation device configured to make available navigation information about an emergency medical services vehicle, wherein emergency medical services information includes at

least some of the patient monitoring information and at least some of the navigation information; a database; a display device; and a processor communicably coupled to the patient monitoring device, the navigation device, the database, and the display device, the processor configured to receive the emergency medical services information, store the emergency medical services information in the database, and display the emergency medical services information on the display device according to an information template.

[0024] According to embodiments of the present invention, a system for collecting and displaying emergency medical services information, the system comprising: a patient monitoring device configured to monitor a patient in a medical emergency and to make available patient monitoring information; a display device configured for placement in a mobile environment for deployment in the medical emergency; an EMS device that does not monitor the patient but that records or observes information about the medical emergency, the EMS device configured to make available EMS information based on recorded or observed information; and a processor communicably coupled to the patient monitoring device, the EMS device, and the display device, the processor configured to display at least a portion of the patient monitoring information and the EMS information on the display device according to a data model.

[0025] The system of any of paragraphs [0007] through [0024], wherein the EMS device is a patient charting device, and wherein the EMS information is patient charting information.

[0026] The system of any of paragraphs [0007] through [0025], wherein the EMS device is a navigation device, and wherein the EMS information is navigation information about the mobile environment.

[0027] The system of any of paragraphs [0007] through [0026], wherein the patient monitoring device is a defibrillator.

[0028] The system of any of paragraphs [0007] through [0027], wherein the EMS device is a first EMS device and the EMS information is a first type of EMS information, the system further comprising: a second EMS device that does not monitor the patient but that records or observes information about the medical emergency, the second EMS device configured to make available a second type of EMS information different from the first type of EMS information, wherein the processor is communicably coupled to the second EMS device, and is configured to display at least a portion of the second type of EMS information on the display device.

[0029] The system of any of paragraphs [0007] through [0028], wherein the first EMS device is a patient charting device, wherein the first type of EMS information is patient charting information, wherein the second EMS device is a navigation device, and wherein the second type of EMS information is navigation information about the mobile environment.

[0030] The system of any of paragraphs [0007] through [0029], further comprising: an enterprise server communicably coupled to the processor, the enterprise server configured to receive the EMS information and the patient monitoring information from the processor and send the EMS information and patient monitoring information to an enterprise environment via a web browser interface.

[0031] The system of any of paragraphs [0007] through [0030], wherein the enterprise environment is a hospital.

[0032] According to embodiments of the present invention, a system for collecting and displaying emergency medical services information, the system comprising: a clinical device configured to gather clinical data related to a clinical encounter; a non-clinical device configured to gather non-clinical data related to a clinical encounter; wherein emergency medical services information includes at least

some of the clinical data and at least some of the non-clinical data; a database; a display device; and a processor communicably coupled to the clinical device, the non-clinical device, the database, and the display device, the processor configured to receive the emergency medical services information, store the emergency medical services information in the database, and display the emergency medical services information on the display device according to an information template.

[0033] The system of any of paragraphs [0007] through [0032], wherein the clinical device is a defibrillator.

[0034] The system of any of paragraphs [0007] through [0033], wherein processor is further configured to display on the display device a differential diagnosis indication based on the emergency medical services information.

[0035] The system of any of paragraphs [0007] through [0034], wherein the information template is stored in the database.

[0036] The system of any of paragraphs [0007] through [0035], wherein the processor is configured to display at least some of the clinical data and at least some of the non-clinical data simultaneously on the display device.

[0037] The system of any of paragraphs [0007] through [0036], wherein the non-clinical device is a navigation device configured to make available navigation information, and wherein the non-clinical data is the navigation information.

[0038] The system of any of paragraphs [0007] through [0037], wherein the non-clinical device is a patient charting device configured to make available patient charting information, and wherein the non-clinical data is the patient charting information.

[0039] The system of any of paragraphs [0007] through [0038] further comprising an emergency services vehicle, wherein the display device is mounted in the emergency services vehicle.

[0040] The system of any of paragraphs [0007] through [0039], wherein the emergency services vehicle is an ambulance, and wherein the display device is mounted in a back section of the ambulance.

[0041] The system of any of paragraphs [0007] through [0040], further comprising: an enterprise server communicably coupled to the processor, the enterprise server configured to receive the emergency medical services information from the processor and send the emergency medical services information to an enterprise environment via a web browser interface.

[0042] The system of any of paragraphs [0007] through [0041], wherein the web browser interface is substantially similar to an interface displayed on the display device.

[0043] The system of any of paragraphs [0007] through [0042], wherein the database is a mobile database, the system further comprising an enterprise database on a storage medium, wherein the enterprise server is further configured to store at least a portion of the emergency medical services information in the enterprise database.

[0044] While multiple embodiments are disclosed, still other embodiments of the present invention will become apparent to those skilled in the art from the following detailed description, which shows and describes illustrative embodiments of the invention. Accordingly, the drawings and detailed description are to be regarded as illustrative in nature and not restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

[0045] FIG. 1 illustrates a system for mobile and enterprise user real-time display of medical information collected from multiple different EMS devices, according to embodiments of the present invention.

[0046] FIG. 2 illustrates one example of a menu template for the display of a "back of ambulance" ("BOA") device, according to embodiments of the present invention.

[0047] FIG. 3 illustrates a display and graphical user interface displayed when the user selects the navigation button of the menu template, according to embodiments of the present invention.

[0048] FIG. 4 illustrates a display and graphical user interface displayed when the user selects the patient monitoring button of the menu template, according to embodiments of the present invention.

[0049] FIG. 5 illustrates a display and graphical user interface displayed when the user selects the patient charting button of the menu template, according to embodiments of the present invention.

[0050] FIG. 6 illustrates a display and graphical user interface displayed when the user selects the "patch notes" button of the menu template, according to embodiments of the present invention.

[0051] FIG. 7 illustrates a display and graphical user interface displayed when the user selects the protocols button of the menu template, according to embodiments of the present invention.

[0052] FIG. 8 illustrates an enterprise display and graphical user interface shown when the enterprise user selects the patient monitoring button, according to embodiments of the present invention.

[0053] FIG. 9 illustrates an enterprise display and graphical user interface shown when the enterprise user selects the navigation button, according to embodiments of the present invention.

[0054] FIG. 10 illustrates an enterprise display and graphical user interface shown when the enterprise user selects the patient charting button, according to embodiments of the present invention.

[0055] FIG. 11 illustrates a treatment domain system overview for real-time display of medical information collected from multiple different EMS devices, according to embodiments of the present invention.

[0056] FIG. 12 illustrates a device adapter / communication engine and medical device interface, according to embodiments of the present invention.

[0057] FIG. 13 illustrates an exemplary pipe, according to embodiments of the present invention.

[0058] FIG. 14 illustrates a method performed by a pipe of the device adapter that uses discovery supporting transport, according to embodiments of the present invention.

[0059] FIG. 15 illustrates a method performed by a pipe of the device adapter that uses non-discovery supporting transport, according to embodiments of the present invention.

[0060] FIG. 16 illustrates a method performed by a BOA module, according to embodiments of the present invention.

[0061] FIG. 17 illustrates a method performed by a BOA module, according to embodiments of the present invention.

[0062] FIG. 18 illustrates an exemplary computer system, according to embodiments of the present invention.

[0063] FIG. 19 illustrates a system for mobile and enterprise user real-time display of medical information collected from multiple different EMS devices, according to embodiments of the present invention.

[0064] FIG. 20 illustrates a carrier board design for an EMS communication interface device, according to embodiments of the present invention.

[0065] FIG. 21 illustrates a system overview for an EMS communication interface device, according to embodiments of the present invention.

[0066] FIG. 22 illustrates another system overview for an EMS communication interface device, according to embodiments of the present invention.

[0067] FIG. 23 illustrates a software logic diagram for an EMS communication interface device, according to embodiments of the present invention.

[0068] FIG. 24 illustrates a conventional mesh network.

[0069] FIG. 25 illustrates an indoor geolocation system.

[0070] FIG. 26 illustrates an example explanation of differential diagnosis of acute dyspnea in adults.

[0071] FIG. 27 illustrates an example explanation of clues to differential diagnosis of dyspnea.

[0072] FIG. 28 illustrates an example listing of physical exam findings in the diagnosis of acute dyspnea.

[0073] FIG. 29 shows an example treatment protocol for asthma, COPD, and acute decompensated heart failure.

[0074] FIG. 30 illustrates a data transmission interface, according to embodiments of the present invention.

[0075] FIG. 31 illustrates an EMS communication interface transmission processing block diagram, according to embodiments of the present invention.

[0076] FIG. 32 illustrates a EMS communications interface device client architecture, according to embodiments of the present invention.

[0077] FIG. 33 illustrates an enterprise display and graphical user interface shown when the enterprise user selects the patient monitoring button, according to embodiments of the present invention.

[0078] FIG. 34 illustrates an enterprise display and graphical user interface shown when the enterprise user selects the patient charting button, according to embodiments of the present invention.

[0079] FIG. 35 illustrates an enterprise display and graphical user interface shown when the enterprise user selects the navigation button, according to embodiments of the present invention.

[0080] FIG. 36 illustrates an alternative enterprise display and graphical user interface shown when the enterprise user selects the navigation button, according to embodiments of the present invention.

[0081] FIG. 37 illustrates an enterprise display and graphical user interface shown when the enterprise user selects the patch notes button, according to embodiments of the present invention.

[0082] FIG. 38 illustrates a display and graphical user interface displayed when the user selects the patient charting button of a BOA menu template, according to embodiments of the present invention.

[0083] FIG. 39 illustrates a display and graphical user interface displayed when the user selects the patient monitoring button of a BOA menu template, according to embodiments of the present invention.

[0084] FIG. 40 illustrates a display and graphical user interface displayed when the user selects the navigation button of a BOA menu template, according to embodiments of the present invention.

[0085] FIG. 41 illustrates an alternative display and graphical user interface displayed when the user selects the navigation button of a BOA menu template, according to embodiments of the present invention.

[0086] FIG. 42 illustrates a display and graphical user interface displayed when the user selects the shift start button of a BOA menu template, according to embodiments of the present invention.

[0087] FIG. 43 illustrates an alternative display and graphical user interface displayed when the user selects the navigation button of a BOA menu template, according to embodiments of the present invention.

[0088] FIG. 44 illustrates a display and graphical user interface displayed when the user selects the patch notes button of a BOA menu template, according to embodiments of the present invention.

[0089] FIG. 45 illustrates a display and graphical user interface displayed when the user selects a live patient data button of a BOA menu template, according to embodiments of the present invention.

[0090] FIG. 46 illustrates a start screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0091] FIG. 47 illustrates a role selection screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0092] FIG. 48 illustrates a lead medic quick log screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0093] FIG. 49 illustrates a lead medic ECG graph screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0094] FIG. 50 illustrates a lead medic patient data screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0095] FIG. 51 illustrates a lead medic chief complaint screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0096] FIG. 52 illustrates a drug medic quick log screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0097] FIG. 53 illustrates a drug medic ECG graph screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0098] FIG. 54 illustrates a role selection screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0099] FIG. 55 illustrates an airway medic ECG graph screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[00100] FIG. 56 illustrates an airway medic quick log screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[00101] FIG. 57 illustrates a CPR medic quick log screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[00102] FIG. 58 illustrates a CPR medic ECG graph screen during idle for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[00103] FIG. 59 illustrates a CPR medic ECG graph screen during administration of compressions for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

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[00104] FIG. 60 illustrates a CPR medic ECG graph screen during administration of compressions for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[00105] FIG. 61 illustrates a CPR medic ECG graph screen during administration of compressions for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[00106] FIG. 62 illustrates a system for role-based data feeds from a BOA device to EMS technician mobile devices, according to embodiments of the present invention.

[00107] While the invention is amenable to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and are described in detail below. The intention, however, is not to limit the invention to the particular embodiments described. On the contrary, the invention is intended to cover all modifications, equivalents, and alternatives falling within the scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION

[00108] As illustrated in FIG. 1, a system 100 according to embodiments of the present invention performs advanced data management, integration and presentation of EMS data from multiple different devices. System 100 includes a mobile environment 101, an enterprise environment 102, and an administration environment 103. Devices within the various environments 101, 102, 103 may be communicably coupled via a network 120, such as, for example, the Internet.

[00109] As used herein, the phrase "communicably coupled" is used in its broadest sense to refer to any coupling whereby information

may be passed. Thus, for example, communicably coupled includes electrically coupled by, for example, a wire; optically coupled by, for example, an optical cable; and/or wirelessly coupled by, for example, a radio frequency or other transmission media. "Communicably coupled" also includes, for example, indirect coupling, such as through a network, or direct coupling.

[00110] The network 120 may also take the form of an ad hoc, self-configuring, self-healing network 2400 such as a MESH network, as illustrated in FIG. 24, according to embodiments of the present invention. FIG. 24, as well as the following information about MESH networks in paragraphs [00109] to [00117], is taken directly from Poor, Robert; WIRELESS MESH NETWORKS; Sensors (Feb. 1, 2003), *available at* http://www.sensorsmag.com/networking-communications/standards-protocols/wireless-mesh-networks-968, which is incorporated herein by reference. Wireless systems for industry conventionally use cellular phone-style radio links, using point-to-point or point-to-multipoint transmission. But research at MIT's Media Lab in Cambridge, MA, indicated that traditional wireless formats have limitations in industrial applications. These include rigid structure, meticulous planning requirements, and dropped signals. This can pose an acute challenge in an EMS or mass casualty environment in which existing infrastructure may be either sparse (e.g. a rural environment) or dysfunctional (e.g. a mass casualty or disaster situation).

[00111] In contrast, wireless mesh networks 2400 are multihop systems in which devices assist each other in transmitting packets through the network, especially in adverse conditions. Such ad hoc networks may be implemented with minimal preparation, and they provide a reliable, flexible system that can be extended to thousands of devices, according to embodiments of the present invention.

[00112] The wireless mesh network topology developed at MIT for industrial control and sensing is a point-to-point-to-point, or peer-to-peer, system called an ad hoc, multihop network. A node can send and receive messages, and in a mesh network, a node also functions as a router and can relay messages for its neighbors. Through the relaying process, a packet of wireless data will find its way to its destination, passing through intermediate nodes with reliable communication links, as illustrated in FIG. 24.

[00113] In a wireless mesh network 2400, multiple nodes cooperate to relay a message to its destination. The mesh topology enhances the overall reliability of the network, which is particularly important when operating in harsh industrial environments. Like the Internet and other peer-to-peer router-based networks, a mesh network offers multiple redundant communications paths throughout the network. If one link fails for any reason (including the introduction of strong RF interference), the network automatically routes messages through alternate paths. In a mesh network 2400, the distance between nodes can be shortened, which dramatically increases the link quality. Reducing the distance by a factor of two, the resulting signal is at least four times more powerful at the receiver. This makes links more reliable without increasing transmitter power in individual nodes. The reach of a mesh network may be extended, redundancy added, and general reliability improved simply by adding more notes.

[00114] Network 2400 may be a self-configuring and self-healing network, according to embodiments of the present invention. According to embodiments of the present invention, a network 2400 does not require a system administrator to tell it how to get a message to its destination. A mesh network 2400 is self-organizing and does not require manual configuration. Because of this, adding new gear or relocating existing gear is as simple as plugging it in and turning it on,

according to embodiments of the present invention. The network discovers the new node and automatically incorporates it into the existing system, according to embodiments of the present invention.

[00115] A mesh network 2400 is not only inherently reliable, it is also highly adaptable, according to embodiments of the present invention. For example, if a tank-level sensor and data logger are placed too far apart for a robust RF communications link, one or more repeater nodes may be added to fill the gaps in the network 2400.

[00116] On the Internet, if one router goes down, messages are sent through an alternate path by other routers. Similarly, if a device or its link in a mesh network fails, messages are sent around it via other devices. Loss of one or more nodes does not necessarily affect the network's operation. A mesh network is self-healing because human intervention is not necessary for re-routing of messages. Such networks 2400 provide redundancy and scalability, according to embodiments of the present invention.

[00117] In a mesh network, the degree of redundancy is essentially a function of node density. A network can be deliberately over-designed for reliability simply by adding extra nodes, so each device has two or more paths for sending data. This is a simpler way of obtaining redundancy than is possible in most other types of systems. A mesh network is also scalable and can handle hundreds or thousands of nodes. Because the operation of network 2400 does not depend on a central control point, adding multiple data collection points or gateways may be convenient.

[00118] Reliability, adaptability, and scalability are notable attributes of a wireless network for industrial control and sensing applications, according to embodiments of the present invention. Point-to-point networks provide reliability, but they are often challenging to scale to handle more than one pair of end points. Point-

to-multipoint networks can handle more end points, but their reliability may depend on placement of the access point and end points. Mesh networks are inherently reliable, adapt easily to environmental or architectural constraints, and can scale to handle thousands of end points.

[00119] According to embodiments of the present invention, the mobile environment 101 is an ambulance or other EMS vehicle – for example a vehicular mobile environment (VME). The mobile environment may also be the local network of data entry devices as well as diagnostic and therapeutic devices established at time of treatment of a patient or patients in the field environment – the "At Scene Patient Mobile Environment" (ASPME). The mobile environment may also be a combination of one or more of VMEs and/or ASPMEs. The mobile environment may include a navigation device 110 used by the driver 112 to track the mobile environment's position 101, locate the mobile environment 101 and/or the emergency location, and locate the transport destination, according to embodiments of the present invention. The navigation device 110 may include a Global Positioning System ("GPS"), for example. The navigation device 110 may also be configured to perform calculations about vehicle speed, the travel time between locations, and estimated times of arrival. According to embodiments of the present invention, the navigation device 110 is located at the front of the ambulance to assist the driver 112 in navigating the vehicle. The navigation device 110 may be, for example, a RescueNet® Navigator onboard electronic data communication system available from Zoll Data Systems of Broomfield, Colorado.

[00120] FIG. 25, as well as the following information about geolocation in paragraphs [00119] through [00120], is taken directly from K. Pahlavan, *et al.,* "An Overview of Wireless Indoor

Geolocation," Mobile and Wireless Communications Networks IFIP-TC6/European Commission NETWORKING 2000 International Workshop, MWCN 2000 Paris, France, May 16–17, 2000, which is incorporated herein by reference. More generally, the mobile environment may include a geolocation sensor in one or more of the devices in the VME or ASPME. The geolocation sensor may be of a common type such as, for example, a Global Positioning System (GPS). GPS, though, may be subject to certain limitations: 1) line of sight to more than one GPS satellite, which may limit its performance in indoor environments; 2) in some urban environments, location accuracy is reduced due to signal reflections off of buildings; and 3) normal accuracy may be insufficient in the case of a mass casualty in which accuracies of better than +/- 5 feet may be required when there are multiple casualties and the locations of each victim needs to be integrated into a software mapping environment, according to embodiments of the present invention.

[00121] Therefore, additional locator base stations may be deployed on-scene outdoors, or within buildings, that may augment or replace the conventional GPS-based geolocator systems, according to embodiments of the present invention. Similar to the cellular geolocation system, the architecture of indoor geolocation systems may fall within one of two main categories: mobile-based architecture and network-based architecture. Most conventional indoor geolocation applications have been focused on network-based system architecture as shown in FIG. 25. The geolocation base stations (GBS) extract location metrics from the radio signals transmitted by the mobile station and relay the information to a geolocation control station (GCS). The connection between GBS and GCS can be either wired or wireless, according to embodiments of the present invention. Then the position of the mobile station may be estimated, in an indoor environment. As

a result, dedicated indoor geolocation systems provide accurate indoor geolocation services. This may be applied as well to a mobile environment such as a battlefield or other mass casualty situation in which base stations with better known accuracy based on landmarks or more sophisticated GPS systems such as differential GPS (DGPS) can be deployed to provide highly accurate and complete information about the patient status integrated into the navigation software or other mapping software, such as, for example, Google maps.

[00122] As illustrated in FIG. 1, a patient monitoring device 106 and a patient charting device 108 are also often used for patient care in the mobile environment 101, according to embodiments of the present invention. The EMS technician 114 attaches the patient monitoring device 106 to the patient 116 to monitor the patient 116. The patient monitoring device 106 may be, for example, a defibrillator device with electrodes and/or sensors configured for attachment to the patient 116 to monitor heart rate and/or to generate electrocardiographs ("ECG's"), according to embodiments of the present invention. The patient monitoring device 106 may also include sensors to detect or a processor to derive or calculate other patient conditions. For example, the patient monitoring device 106 may monitor, detect, treat and/or derive or calculate blood pressure, temperature, respiration rate, blood oxygen level, end-tidal carbon dioxide level, pulmonary function, blood glucose level, and/or weight, according to embodiments of the present invention. The patient monitoring device 106 may be a Zoll E-Series® defibrillator available from Zoll Medical Corporation of Chelmsford, Massachusetts, according to embodiments of the present invention. A patient monitoring device may also be a patient treatment device, or another kind of device that includes patient monitoring and/or patient treatment capabilities, according to embodiments of the present invention.

[00123] The patient charting device 108 is a device used by the EMS technician 114 to generate records and/or notes about the patient's 116 condition and/or treatments applied to the patient, according to embodiments of the present invention. For example, the patient charting device 108 may be used to note a dosage of medicine given to the patient 116 at a particular time. The patient charting device 108 and/or patient monitoring device 106 may have a clock, which may be synchronized with an external time source such as a network or a satellite to prevent the EMS technician from having to manually enter a time of treatment or observation (or having to attempt to estimate the time of treatment for charting purposes long after the treatment was administered), according to embodiments of the present invention. The patient charting device 108 may also be used to record biographic and/or demographic and/or historical information about a patient, for example the patient's name, identification number, height, weight, and/or medical history, according to embodiments of the present invention. According to embodiments of the present invention, the patient charting device 108 is a tablet PC, such as for example the TabletPCR component of the RescueNet® ePCR Suite available from Zoll Data Systems of Broomfield, Colorado. According to some embodiments of the present invention, the patient charting device 108 is a wristband or smart-phone such as an Apple iPhone or iPad with interactive data entry interface such as a touch screen or voice recognition data entry that may be communicably connected to the BOA device 104 and tapped to indicate what was done with the patient 116 and when it was done.

[00124] The navigation device 110, the charting device 108, and the monitoring device 106 are each separately very useful to the EMS drivers 112 and technicians 114 before, during, and after the patient transport. A "back of ambulance" ("BOA") device 104 receives,

organizes, stores, and displays data from each device 108, 110, 112 to further enhance the usefulness of each device 108, 110, 112 and to make it much easier for the EMS technician 114 to perform certain tasks that would normally require the EMS technician 114 to divert visual and manual attention to each device 108, 110, 112 separately, according to embodiments of the present invention. In other words, the BOA device centralizes and organizes information that would normally be de-centralized and disorganized, according to embodiments of the present invention.

[00125] Although device 104 is referred to herein as a "back of ambulance" device because the EMS technician 114 would normally benefit the most from having such a display device mounted in the back 152 of an ambulance, one of ordinary skill in the art, based on the disclosure provided herein, will recognize that some or all of the BOA device 104 may be located in any part of a mobile environment 101, EMS vehicle, and/or anywhere else useful to an EMS technician 114. For example, the BOA device 104 may be located in the front 150 of an ambulance, and/or may include components that are portable and can be carried into a patient residence, according to embodiments of the present invention.

[00126] The BOA device 104 is communicably coupled to the patient monitoring device 106, the patient charting device 108, and the navigation device 110, according to embodiments of the present invention. The BOA device 104 is also communicably coupled to a storage medium 118. The BOA device 104 may be a touch-screen, flat panel PC, and the storage medium 118 may be located within or external to the BOA device 104, according to embodiments of the present invention. The BOA device 104 may include a display template serving as a graphical user interface, which permits the user (e.g. EMS tech 114) to select different subsets and/or display modes of

the information gathered from and/or sent to devices 106, 108, 110, according to embodiments of the present invention.

[00127] FIG. 2 illustrates one example of a menu template 200 for the display of BOA device 104, according to embodiments of the present invention. The menu template 200 includes a navigation button 202, a patient monitoring device button 204, a patient charting device button 206, a "patch notes" button 208, and a protocols button 210, according to embodiments of the present invention. Pressing one of the buttons takes the user (e.g. EMS tech 114) to a particular page displaying all or a subset of information from devices 106, 108, 110. FIGS. 3-7 illustrate examples of particular information templates according to which information from the one or more EMS devices 106, 108, 110 is displayed, according to embodiments of the present invention. Based on the disclosure provided herein, one of ordinary skill in the art will recognize various other information templates according to which such information may be displayed.

[00128] FIG. 3 illustrates a graphical user interface displayed when the user selects the navigation button 202, according to embodiments of the present invention. One part of the display includes a status section 302 and another part of the display includes a map section 304, according to embodiments of the present invention. The status section 302 includes one or more fields identifying information about the EMS vehicle trip, according to embodiments of the present invention. For example, the fields of the status section 302 may include one or more of a Unit field 306 identifying the name of the EMS vehicle for which information is displayed, a Crew unit 308 identifying one or more crew members of the EMS vehicle, a Status unit 310 identifying the status of the trip (e.g. "transporting" or "en route to patient"), an ETA field 312 identifying an estimated time of arrival at the destination, a Destination field 314 identifying the destination of the

EMS vehicle (e.g. the hospital), and a Patch Info field 316 identifying a phone number or other information for contacting the EMS vehicle destination (e.g. the hospital), according to embodiments of the present invention.

[00129] The map section 304 may display street information along with the origin, destination, route identification, and/or progress information, according to embodiments of the present invention. The navigation device 110 may also supply vehicle status information for display, which may also be useful when a transport has not yet begun. A user may select a Cycle Feeds button 318 in order to continuously transition the display between one or more of the various displays of FIGS. 3-7, according to embodiments of the present invention. The information illustrated in FIG. 3 would normally be available only to the driver 112 in the front of the ambulance 101, but because BOA device 104 is communicably coupled to the navigation device 110, the BOA device 104 can display all or a selected subset of the information available to the navigation device 110.

[00130] FIG. 4 illustrates a graphical user interface displayed when the user selects the patient monitoring button 204 of the menu template, according to embodiments of the present invention. FIG. 4 displays information received by the BOA device 104 from a patient monitoring device 106 that is a Zoll E-Series® defibrillator. The display includes a vertical vital signs section 402, a horizontal vital signs summary section 404, a graphical section 406, and interpretation section 414, according to embodiments of the present invention. The vertical vital signs section 402 includes one or more fields indicating a condition of the patient 116 to which the device 106 is attached. For example, the vital signs section 402 includes a heart rate field, a respiration rate field, a blood pressure field, a blood oxygen level field, and an end-tidal carbon dioxide level field. Each field may include a

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visual indication of a further subset of information. For example, the heart rate field may include a numerical indication 408 of the heart rate, a time indication 410 reflecting the time that the measurement was taken or derived, and a historical graph 412 indicating generally how the heart rate has increased or decreased since the first measurement or a predetermined time, according to embodiments of the present invention. Other fields may include similar indicators, according to embodiments of the present invention. Vital sign trending may also be displayed.

[00131] A horizontal vital signs summary section 404 indicates, for example, the numerical values represented simultaneously in the vertical vital signs section 402, according to embodiments of the present invention. The graphical section 406 includes a visual representation of an electrocardiograph, such as that acquired from a twelve-lead sensor placement on the patient 116, according to embodiments of the present invention. Just above the ECG is an indication of when the ECG was acquired. As new vital signs information and/or new ECG information becomes available, the display of FIG. 4 is automatically refreshed to show the most recent data from the patient monitoring device 106, according to embodiments of the present invention. The interpretation section 414 includes automatically-generated information from the device 106, for example, indicating potential causes of the symptoms observed by the device 106, according to embodiments of the present invention.

[00132] FIG. 5 illustrates a graphical user interface displayed when the user selects the patient charting button 206 of the menu template, according to embodiments of the present invention. The display of FIG. 5 includes a biographical summary 502, an interventions section 504, and a vital signs section 506, according to embodiments of the present invention. The biographical summary 502

may display the patient's name, age, and gender as recorded by the EMS technician 114 with the patient charting device 108, according to embodiments of the present invention. The interventions section 504 displays the patient 116 interventions (e.g. treatments administered) recorded with the patient charting device 108, according to embodiments of the present invention. For example, the interventions section 504 includes a listing of each intervention made, the time of the intervention, a description of the intervention (e.g. name of the drug administered), and the name of the person administering the treatment, according to embodiments of the present invention.

[00133] The vital signs section 506 includes a historical listing of certain vital signs data observed by the EMS technician 114 and recorded in the patient charting device 108, and stored in the patient charting device 108 and/or the database 118, according to embodiments of the present invention. The historical listing of vital signs data in the vital signs section 506 includes a time stamp, heart rate, blood pressure, respiration rate, blood oxygen level, end-tidal carbon dioxide level, blood glucose level, Glasgow Coma Scale rating ("GCS"), and the name of the technician or device that observed or recorded the vital sign, according to embodiments of the present invention.

[00134] FIG. 6 illustrates a graphical user interface displayed when the user selects the "patch notes" button 208 of the menu template, according to embodiments of the present invention. Patch notes are notes used by an EMS technician 114 to place a call to a hospital or other treatment facility to confirm that the hospital will accept the patient 116 and/or to provide information about the patient 116 to help the hospital or treatment facility prepare for admission. Because time is typically of the essence for such phone calls (because placing the call can temporarily divert the EMS technician's 114

attention away from patient 116 care), the EMS technician typically consults and interacts with several different devices 106, 108, 110 and/or informal data sources to compile a list of notes to convey to the nurse or other responsible party at the hospital or treatment facility. Such patch notes often take considerable time to assemble, and are often hastily written on a glove, for example, which also results in inaccuracy and in some of the patch notes representing old information by the time the call is placed and the information conveyed to the hospital.

[00135] The BOA device 104, on the other hand, automatically creates a display of several different fields that would typically comprise patch notes, according to embodiments of the present invention. The display of FIG. 6 includes fields representing information from multiple different devices, such as, for example, devices 106, 108, 110. The patch notes display may organize the information into a predefined template, and/or may organize the information into a customized template associated with a particular EMS technician 114, according to embodiments of the present invention. Not only does the BOA device 104 automatically receive and display information from multiple different devices 106, 108, 110 in a single display summarized to function as patch notes, but it also automatically refreshes the display to reflect the most recent information, thus permitting real-time conveyance of patient information, according to embodiments of the present invention.

[00136] For example, without the BOA device 104, if a patient's heart rate rose from 75 to 115 over the course of three minutes, and if an EMS technician 114 wrote "HR 75" on his glove before consulting his patient chart for name and background information and the driver 112 for location information before calling the hospital three minutes later, the EMS technician 114 might report a heart rate of 75 to the

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hospital. With the BOA device 104, however, the patch notes are generated automatically and displayed as in FIG. 6, and the Defib Vitals section would list the current heart rate of 115 when the EMS technician 114 conveyed the patient status to the hospital.

[00137] In addition to one or more of a Hospital field 602 identifying the name and phone number of the hospital to which the patient 116 is en route and an age field 604 identifying the patient's age, the display of FIG. 6 may also include one or more of a History Present Illness field, an Interventions field, a Unit identification field (e.g. identifying the particular EMS vehicle), a Gender field, a Past Medical History Field, a patient charting device vital signs field, an Expected Time of Arrival field, a Chief Complaint field, an Assessments field, and a patient monitoring device vital signs field, according to embodiments of the present invention.

[00138] Each of the fields may be configured to display either past or current or derived content from one or more of the EMS devices (e.g. devices 106, 108, 110) which are communicably coupled with the BOA device 104, according to embodiments of the present invention. For example, the Hospital, Unit, and ETA fields may be based on information received from the navigation unit 110. The Age, Gender, Chief Complaint, History Present Illness, Past Medical History, and Interventions fields may be based on information received from the patient charting unit 108. The patient charting device vital signs field may be based on information received from the patient charting unit 108 (e.g. GCS score), and the patient monitoring device vital signs field may be based on information received from the patient monitoring device 106 (e.g. ECG), according to embodiments of the present invention. According to embodiments of the present invention, a BOA device 104 may be located in the front of the ambulance to permit the driver 112 or another EMS technician to place the call to the hospital

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based on the real-time patch notes, thereby providing the attending EMS technician 114 more time and attention for direct patient care.

[00139] According to embodiments of the present invention, the BOA device 104 receives information from at least one patient monitoring EMS device and at least one non-patient monitoring EMS device. The patch notes screen of FIG. 6 illustrates one example of EMS information (e.g. information related to an emergency medical encounter or transport) from at least one patient monitoring device and at least one other device that does not directly monitor a patient (e.g. a navigation device and/or a patient charting device) on the same display, according to embodiments of the present invention. Similarly, in another embodiment of the present invention, the BOA device 104 receives information from at least one patient clinical device and at least one non-clinical device, and analyzes, combines, stores, displays, and/or transmits the clinical and non-clinical information in a format useful to the user. As used herein, the term "clinical" is used in its broadest sense to refer to that which is directly implicated in monitoring or treatment or diagnosis of a patient. As used herein, the term "non-clinical" is used in its broadest sense to refer to that which is not directly implicated in monitoring or treatment or diagnosis of a patient. For example, a defibrillator is a clinical device, and a navigation device is a non-clinical device. As another example, a patient's ECG information or heart rate is clinical information, while a patient's address is non-clinical information.

[00140] FIG. 7 illustrates a graphical user interface displayed when the user selects the protocols button 210 of the menu template, according to embodiments of the present invention. The display of FIG. 7 includes an interactive guidelines manual for the particular locale where the medical emergency occurred, where the treatment occurs, and/or where the patient is delivered, according to

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embodiments of the present invention. Alternatively, the protocols button 210 may link to a manual or guideline document for the use of a particular device and/or the administration of a particular technique and/or information about a drug. For example, the display of FIG. 7 may include an interactive page listing of chapters in a county's protocol index, which may be a locally-stored protocol index and/or a protocol index accessed through an Internet connection. Clicking on one or more of the chapters or links opens a page containing more detail about the particular chapter or subject selected, for example.

[00141] Based on the disclosure provided herein, one of ordinary skill in the art will appreciate that the BOA device 104 may be configured to display additional or different subsets of information from one or more EMS devices and/or external data sources. According to embodiments of the present invention, the BOA device 104 not only seamlessly integrates information from a patient monitoring device 106, a patient charting device 108, and a navigation device 110 for display in mobile environment 101, but it also does so for display in a remote environment such as, for example, enterprise environment 102. Enterprise environment 102 may be a hospital and/or dispatch environment, for example.

[00142] Data from the BOA device 104 (and therefore data from the devices 106, 108, 110 communicably coupled with the BOA device 104) may be received by one or more enterprise storage servers 126 in an administration environment 103 and stored in an enterprise database 130, and the same information may be accessed and provided by one or more enterprise application servers 128 to a workstation 122 of an enterprise user 124, according to embodiments of the present invention. According to embodiments of the present invention, the BOA device 104 is communicably coupled to the storage server 126 which is communicably coupled to the database 130, and

the application server 128 is communicably coupled to the database and to the enterprise workstation 122. Such devices may be communicably coupled via a network 120 such as, for example, the Internet.

[00143] When the BOA device 104 receives updated information from one or more of the devices (e.g. devices 106, 108, 110) to which it is communicably coupled, the BOA device 104 sends the updated information to the enterprise storage server 126, which stores the updated information in a database which may be contained on a storage medium 130, according to embodiments of the present invention. Hence, information from one or more devices (e.g. devices 106, 108, 110) may be stored in mobile database 118, remote enterprise database 130, or both, according to embodiments of the present invention. An enterprise user 124, who may be an emergency room nurse monitoring and/or preparing for ambulance arrivals, an emergency room physician, and/or a medical director at home, for example, may access information similar to information displayed by the BOA device 104 by requesting the information via an enterprise workstation 122. For example, the enterprise workstation 122 accesses a web interface and/or thin client web browser application which requests the information over the network 120 from application server 128. Application server 128 queries the database 130 for the information, and returns a display to enterprise workstation 122 that looks the same as or similar to what the EMS technician 114 is currently seeing on the BOA device 104 display, according to embodiments of the present invention.

[00144] FIGS. 8-10 illustrate examples of user interface and display screens available to the enterprise user 124 via the enterprise workstation 122, according to embodiments of the present invention. FIG. 8 illustrates a web browser based client interface including, in one

portion of the display, a list of available EMS vehicles 802, 804 for which EMS device data is available, according to embodiments of the present invention. Clicking on ALS2 804, for example, brings up a screen similar to FIG. 8 which allows the enterprise user 124 to select one of the buttons, including but not limited to the patient monitoring button 806, the navigation button 808, and/or the patient charting button 810. When user 124 clicks on the patient monitoring button 806, the screen display of FIG. 8 is presented and includes current information from the patient monitoring device 106 of ambulance ALS2, according to embodiments of the present invention. According to embodiments of the present invention, the patient monitoring display of FIG. 8 is automatically updated continuously or semi-continuously; according to other embodiments of the present invention, the user 124 selects "get updates" or the browser's "refresh" button in order to obtain the most current information available. The enterprise display of FIG. 8 contains information similar to the mobile display of FIG. 4, according to embodiments of the present invention.

[00145] According to embodiments of the present invention, the website display in the enterprise environment 102 is accessed via a generic internet browser by a doctor waiting in the emergency room for the patient to arrive by ambulance. The website may be secured by logon username and password, for example. Each ambulance may be identified by a vehicle name; the doctor chooses from a list of incoming vehicle, after which the data for that patient is displayed. The data may be shown just as it appears on the mobile screen, also in "clinical time." According to embodiments of the present invention, the enterprise environment 102 website displays data only for those patients whose destination is the same as the destination logged on the user's facility.

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[00146] When the user 124 clicks on the navigator button 808, the screen display of FIG. 9 is presented and includes current information from the navigation device 110 of ambulance ALS2, according to embodiments of the present invention. The enterprise display of FIG. 9 contains information similar to the mobile display of FIG. 3, according to embodiments of the present invention.

[00147] When the user 124 clicks on the patient charting button 810, the screen display of FIG. 10 is presented and includes current information from the patient charting device 108 of ambulance ALS2, according to embodiments of the present invention. The enterprise display of FIG. 10 contains information similar to the mobile display of FIG. 5, according to embodiments of the present invention.

[00148] Although FIG. 1 depicts a single BOA device 104 in the mobile environment 101, more than one BOA device 104 may be used in the mobile environment 101 to communicably connect to the same or a different set of devices 106, 108, 110. And although FIG. 1 depicts one mobile environment 101, more than one mobile environment 101 and/or more than one BOA device 104 may be communicably coupled with the administration environment 103 and/or the enterprise storage server 126, according to embodiments of the present invention. According to embodiments of the present invention, the enterprise storage server 126 receives EMS device information from BOA device 104 and stores it in database 130 along with an authenticated time stamp and an identifier associating the information with a particular EMS device and/or a particular EMS vehicle. In this way, data from multiple vehicles and/or multiple devices may be accessed by the enterprise user 124.

[00149] Also, the enterprise storage server 130 may securely store the information received from one or more BOA devices 104 for longer periods of time to permit later use of the information. For

example, the BOA device 104 may receive patient-identifying information such as name, address, and/or social security number via the patient charting device 108 or directly through the BOA device 104, and then may convey some or all of the patient-identifying information to enterprise storage server 126 with a request for the enterprise storage server 126 to query the database 130 for past records involving the same patient 116. The enterprise storage server 126 may then forward any such records or portions of such records back to the BOA device 104 (e.g. for display in the patient charting screen or the Past Medical History in the patch notes screen) to assist the EMS technician 114 with the current emergency. Similarly, such past EMS encounter record information may also be accessed by the enterprise user 124, according to embodiments of the present invention. A system administrator 134 may access and/or monitor the data in database 130 and/or modify the instructions of the servers 126, 128 via administration workstation 132, which may be communicably coupled to the servers 126, 128, according to embodiments of the present invention.

[00150] According to some embodiments of the present invention, the BOA device 104 may connect with (e.g. automatically or manually or selectively) a wearable medical device, such as, for example, a Lifevest® wearable defibrillator, to receive and display patient monitoring information therefrom. The BOA device 104 may also be configured to receive patient-identifying information from such a wearable device, to permit the BOA device 104 to query an external database, for example across network 120, to retrieve additional information about the patient. The BOA device 104 may also be configured to connect with an implantable cardioverter-defibrillator ("ICD") in a similar fashion, according to embodiments of the present invention.

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[00151] FIG. 11 illustrates a treatment domain system 1100 overview for real-time display of medical information collected from multiple different EMS devices, according to embodiments of the present invention. System 1100 includes a patient monitoring device module 1102 communicably coupled with mobile domain modules 1126 communicably coupled with remote or enterprise domain modules 1128 communicably coupled with a thin client display module 1124, according to embodiments of the present invention. According to embodiments of the present invention, the database 130 may be accessed by multiple hospitals throughout a region, state, country, and/or the world.

[00152] The mobile domain modules 1126 includes the device adapter 1104, a mobile asset management module 1106 which may access a mobile database 1108, a BOA module 1110, a patient charting module 1112, a navigation module 1114, and a network adapter 1116, according to embodiments of the present invention. The remote/enterprise modules 1128 include the network adapter 1116, an enterprise asset management module 1118 which may access an enterprise database 1120, and an enterprise application server module 1122, according to embodiments of the present invention.

[00153] The patient monitoring device module 1102 operates the patient monitoring device 106 and generates one or more data pipes containing information about a patient 116 condition. The device adapter / communication interface module 1104 manages data communications between a computing device and one or more medical devices such as, for example, between the patient monitoring device module 1102 and the mobile asset management module 1106 and/or BOA module 1110. The device adapter module 1104 includes one or more of the following attributes, according to embodiments of the present invention:

- Supports multiple communications transports (e.g., devices can use Bluetooth, 802.11, Ethernet, Serial cable).
- Supports multiple data transfer protocols.
- Supports multiple medical device types.
- Supports multiple data storage profiles (e.g., storage to file system, storage by asset management module 1106 to database 1108).
- Allows administrator or user to associate transport, protocol, device and multiple storage profiles together to represent a communication "pipe" over which data can be exchanged with medical devices.
- Supports multiple pipes at the same time.
- Allows administrators or users to specify one or more specific medical devices to which it communicates in which case the module 1104 will use transport specific discovery protocols to find and attach to the devices.
- Allows administrators or users to specify ANY as a medical device in which case it will use transport specific discovery protocols to find and attach to any compatible medical device found.
- When a pipe is configured to use a protocol which does not support discovery (e.g. serial cable), module 1104 will allow the device to initiate the connection and then allow or deny it based on whether the specific medical device is selected or not.
- Supports multiple client applications (local or remote) by allowing them to connect to module 1104 and receive asynchronous notification of data arrival from medical devices and a means to retrieve the data.
- Maintains a communications 'pipe' should the medical device have a data asset to communicate, regardless of whether any application is running or ready to receive the data asset.

- A user may configure the medical device(s) applications communicate with, and such configuration may be persistent and easily changed.
- Communications policies may be configurable. For instance, Bluetooth may require pairing with a device before communications occur. A user may configure whether the pairing is 'automatic' or 'manual' or 'continuously reacquired', for example.
- Applications may access previously received data assets via a relatively simple, expressive API.
- Applications may be notified of newly received assets and may filter those notifications based on specific devices and/or asset type.
- Applications may query the communications layer for status, available devices, and the like, for customizable user interface elements.
- The communications layer may be controllable from a notification icon which also indicates status.
- Configurable items may be protected from malicious or erroneous alteration by common users through the use of a privileged 'admin' mode and a common user mode in the notification area icon applet.
- Configuration may be 'portable' and 'distributable,' such that one configuration may be created and copied to each device rather than having to actually configure each device through a notification applet.
- Particular features or limitations of the communications 'pipe' may be hidden from the application by default.
- The communications layer may itself be layered and support multiple plug-in style transport drivers for managing different communications transports and multiple plug-in style protocol drivers for handling the receipt of data assets from different devices and different asset types. This may allow for the rapid extension of

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the communications layer to new transports or to new protocols as they are developed.

[00154] FIG. 12 illustrates a diagram of the device adapter / communication module 1104, which includes one or more pipes 1202, 1204, 1206 each associated with a medical device 1208, 1210, 1212. The communication module 1104 may be a PELICAN™ communication interface available from Zoll Data Systems of Broomfield, Colorado, according to embodiments of the present invention. According to embodiments of the present invention, the communication engine 1104 is an "always on" operating system service which implements the communications pipes 1202, 1204, 1206 and handles the incoming data from medical devices 1208, 1210, 1212. Communication engine 1104 also includes an API 1216, which is a collection of objects and methods exposed by the communications engine 1104 which can be used by an application to configure and interact with the engine 1104 for tasks like getting data assets and configuring the engine 1104, according to embodiments of the present invention. For example, the mobile asset management module 1106 may interact with the API 1216 to receive medical device data.

[00155] FIG. 13 illustrates a diagram of pipe 1202, according to embodiments of the present invention. Pipe 1202 includes one or more storage plug-ins 1302, 1304, 1306 associated with one or more storage configurations 1312, 1314, 1316 of the medical device; a medical device plug-in 1308 associated with a medical device configuration 1318 of the medical device, and a transport plug-in 1310 associated with a transport configuration 1320 of the medical device, according to embodiments of the present invention. As used herein, a "transport" is an operating system supported underlying communications medium, for example TCP/IP, Bluetooth, and Serial. Some transports are packet oriented (e.g. TCP) while others are

stream oriented (e.g. Serial). Some support discovery, some do not. Some support pairing, some do not. Each transport may include unique configurations.

[00156] A transport plug-in may be a .NET assembly that is dynamically loaded by the communications engine 1104 and which provides data communications support for a specific transport (e.g. Serial Port, Bluetooth, TCP/IP, and File System). The communications engine 1104 may be configured for auto-pairing (e.g. for transports that support pairing, the engine 1104 uses rules specific to the transport to automatically create and maintain pairings with medical devices depending on configuration and user preference) and/or for auto-discovery (e.g. for transports that support discovery, the engine 1104 may be configured to automatically find new medical devices and enter them into the known device list), according to embodiments of the present invention.

[00157] A medical device plug-in may be a .NET assembly that is dynamically loaded by the communications engine 1104 which provides transport independent data communications services for a particular type of medical device, for example ZOLL M/E-Series ZOLLModem or ZOLL E-Series DUN. A storage plug-in may be a .NET assembly that is dynamically loaded by the communications engine 1104 which provides storage services to the engine.

[00158] As shown in FIG. 13, a pipe may be a combination of transport, medical device, and storage configurations which represent a medical device from which the user has indicated data will be received, and which allows communications to occur. Pipes may be configured by the user and/or may be predefined. For example, a pipe may specify Transport Serial Port with configuration (COM1, Baud=9600), Medical Device E/M Series ZOLLModem (Any Medical Device) and Storage (Local File System). This configuration would

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accept data assets from any device connected to COM1 at 9600 baud and store them to the local file system. As another example, a pipe may specify Transport Bluetooth (Baud=115200, Auto-Pair), Medical Device E/M Series ZollModem (ZOLL005611), Storage (Local File System) and Storage (Asset Management). This configuration would cause Bluetooth to pair to ZOLL005611, maintain that pairing even when broken and accept any data assets from that specific device and store them both to the local file system and submit them to Asset Management (e.g. mobile asset management module 1106 and/or enterprise asset management module 1118).

[00159] As yet another example, a pipe may specify Transport Bluetooth (Baud=115200, Auto-Pair), Medical Device E/M Series ZOLLModem (Any Device). This configuration would cause Bluetooth to automatically pair with any medical device found during periodic discovery and accept any data assets from any paired device and store them via all loaded and enabled storage plug-ins. As yet another example, a pipe may specify Transport TCP/IP (LocalIP=192.168.1.20, Port=7743), Medical Device E/M Series DUN (Any Device), Storage (Asset Management). This configuration would cause the engine 1104 to start listening on the specified IP address and port for DUN traffic and store it via Asset Management (e.g. by sending it to mobile asset management module 1106 and/or enterprise asset management module 1118), according to embodiments of the present invention.

[00160] For each "pipe" of device adapter 1104 that uses Discovery Supporting Transport, the adapter 1104 performs the method outlined in FIG. 14, and for each pipe of device adapter 1104 that uses Non-Discovery Supporting Transport, the adapter 1104 performs the method illustrated in FIG. 15, according to embodiments of the present invention.

[00161] As described above, the mobile asset management module 1106 receives medical device data from the device adapter and communications interface 1104, according to embodiments of the present invention. The mobile asset management module 1106 performs the secure storage, retrieval and management of medical device data together with asynchronous events informing other applications of the storage or modification of these data assets. The mobile asset management module 1106 supports local or remote service oriented API to store, retrieve and modify medical device data, and provides local or remote asynchronous message-based notification of events to applications which subscribe for them, according to embodiments of the present invention. These events may include notification of the arrival of medical device data.

[00162] The BOA module manages data feeds from multiple data providers (including but not limited to, the device adapter 1104, the patient charting module 1112, and the navigation module 1114) and presents these feeds on a touch-screen flat panel, according to embodiments of the present invention. The BOA module 1110 also communicates these aggregated data elements to a back-office module (e.g. the enterprise asset management module 1118). The patient charting module 1112 controls the patient charting device 108 and the information sent and received by it, and the navigation module 1114 controls the navigation device 110 and the information sent and received by it, according to embodiments of the present invention. The BOA module 1110 includes one or more of the following attributes, according to embodiments of the present invention:

- Allows the user to configure the device adapter / communication interface module 1104, including but not limited to selection of a medical device.

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- Allows the user to select a patient charting device from which it will receive a data feed containing medical record information as it is entered in patient charting device.
- Allows the user to select a navigation device from which it will receive a data feed containing navigational and dispatch information on a periodic basis.
- Receives notification from the communication interface module 1104 and/or the mobile asset management module 1106 about the arrival of new medical device data including but not limited to 12-lead ECG and vital trend records.
- Receives asynchronous messages from a selected patient charting device which contain data about the currently open patient record including but not limited to: patient demographics, medical history, current assessments, interventions performed and/or vital signs.
- Receives asynchronous messages from a selected navigation device which contains data about the current dispatch state, destination, crew, location, route and/or map of current position.
- Cyclically presents a graphic display of each of the received data feeds for viewing in the back of the ambulance on the flat panel, or elsewhere on another display device.
- Allows the caregiver or EMS technician 114 to temporarily freeze the cycling display on a feed for more careful examination of that particular data in that particular information template.
- Aggregates the data feeds into a data construct which is sent periodically to the enterprise asset management module 1118.
- Presents a customer customizable view of the aggregated data feed for the purpose of facilitating a verbal report to the receiving facility (e.g. a report in the Patch Notes information template displayed on the BOA device 104).

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- Presents the user with the ability to view the regional EMS protocols for reference.

[00163] FIG. 16 illustrates a logic flow chart 1600 executed by the BOA module 1110, according to embodiments of the present invention. The logic flow chart 1600 starts at block 1602. A user selects particular devices or selects a "read from" configuration to determine which devices' data will be read and displayed by the BOA device 104 (block 1604). A data model is prepared (block 1606), for example the current state of the system that will be displayed on the BOA device 104 and which may eventually be communicated to the enterprise environment 102 and/or enterprise application server 128. The data model may expand to contain other data elements as feeds are added, and may contract to eliminate container properties for unused data feeds (e.g. installations that do not include a patient charting device 108), according to embodiments of the present invention. The BOA module 1110 queries the mobile asset management module 1106 to determine whether new medical device data is available (block 1608) and, if so, updates the medical device data in the data model (block 1610). The BOA module 1110 queries the mobile asset management module 1106 to determine whether new patient charting data is available (block 1612) and, if so, updates the patient charting data in the data model (block 1614).

[00164] The BOA module 1110 queries the mobile asset management module 1106 to determine whether new navigation data is available (block 1616) and, if so, updates the navigation data in the data model (block 1618). The BOA module 1110 determines whether it is time to send updated information to the enterprise asset management module 1118 (block 1620) and, if so, sends the data model to the enterprise asset management module (block 1622) and generates an asynchronous message (block 1626). According to

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embodiments of the present invention, the asynchronous message generated at block 1626 is destined for the enterprise application server 128; according to alternative embodiments of the present invention, the asynchronous message generated at block 1626 is destined for the enterprise storage server 126 which, in turn, stores the data and notifies the enterprise application server 128 of the data's availability. The data model is then rendered (block 1624), for example in the form of a display update on the BOA device 104, according to embodiments of the present invention. According to embodiments of the present invention, the procedures indicated by blocks 1608, 1612, 1616, and 1620 are not executed as "stages" but are instead each events which trigger a different thread of execution that modifies a data model, which in turn triggers the update of the BOA device 104 display.

[00165] The network adapter / communication interface module 1116 is a communications channel that includes one or more of the following attributes, according to embodiments of the present invention:

- General purpose and data format independent. Each application may be responsible for the format of its messages.
- Message addressing may be by name rather than transport address (IP address for instance) so that messages can be sent to entities for which no route currently exists (e.g. when the sender is disconnected from the Internet). Name resolution into actual machine address may be deferred until a route actually exists.
- Tree relationship between entities that use communication interface module 1116, in which name information may be "percolated" up the tree but not down. As such, each node has a simple routing choice: if the name is the current device or below, route there, otherwise route to the current device's parent. The root of the tree may be the primary message broker and it accumulates all name

information. The primary message broker is the unique node in the communications tree which contains all name information and thus can perform routing from one sub-tree to another, according to embodiments of the present invention.

- Message delivery may be deferred until the recipient actually appears. Messages may be stored until the recipient becomes routable.
- Messages may be stored in a transaction safe database at each node so that even a node unexpectedly failing does not risk message loss.
- Full encryption of messages may be maintained until the recipient actually receives them. While stored in databases, the messages may remain encrypted.
- Robust operation over intermittently connected wireless connections. Messages may be stored until a connection is resumed. Within certain time-limits, if the connection is restored, message transmission may continue from where it left off rather than starting anew.
- Messages intended for machines or applications that are 'local' may be routed locally even when that segment of the tree is disconnected from the primary message broker.
- Messages may be sent with an expiration time after which the message will not be delivered and the sender may be notified of the expiration.

[00166] The communications interface 1116 may be a MERCURY^{TM} communication interface available from Zoll Data Systems of Broomfield, Colorado, according to embodiments of the present invention.

[00167] The messaging components for the BOA module 1110 may be implemented using the communication interface module 1116

as a channel. These messaging components implement one or more of the following characteristics, according to embodiments of the present invention:

- Publish-Subscribe Model: The data feed consumers (e.g. the BOA mobile module 1110) subscribe with the providers (e.g. the patient charting module 1112) to receive the data feed. The subscription request includes the duration of the subscription. As the providers modify the data feed items, the data feed items are sent to all subscribers. According to embodiments, the BOA module 1110 is a data feed consumer for feeds from the patient charting module 1112 and the navigation module 1114 but a data feed provider for the aggregated feed going to the enterprise asset management module 1118.
- Message Queue Throttling: Using the message expiration feature of the communications interface module 1116, all messages may be sent with a short expiration time and then a new, current copy is sent upon expiration notification. This keeps the system from having a large queue of stale data feed messages when components are disconnected; at most, one current message is in the system.
- Complex message format: The data feed messages include graphical, textual and binary data which may be turned into objects by the recipient for ease of use.

[00168] The enterprise asset management module 1118 receives an aggregated data feed from multiple BOA modules 1110 and provides presentation of those aggregated data feeds on displays remote from the originating ones. For example, such aggregated data feeds may be fetched from the database 1120 associated with the enterprise asset management module 1118 by the enterprise application server module 1122 and displayed to an enterprise user via

a thin client display application module 1124 running on a web browser, according to embodiments of the present invention. Such a web page may be secured, encrypted, password-protected, and/or HIPAA compliant, according to embodiments of the present invention. The enterprise asset management module 1118 includes one or more of the following attributes, according to embodiments of the present invention:

- Receives asynchronous messages from multiple BOA modules 1110 containing aggregated data feeds including but not limited to data feeds from patient charting modules 1112, navigation modules 1114, and medical devices.
- Uses destination data from the BOA module 1110, set either by the navigation module 1114 or manually by the user on the flat panel BOA device 104, creates a web page for each hospital destination containing the feeds from each BOA module 1110 with that hospital as the destination.
- Asynchronously updates the web page as new versions of the aggregated data feeds arrive for each BOA module 1110 sending data regarding a patient 116 en route to the hospital or treatment facility.
- Renders the aggregated data feeds with diagnostic resolution of the 12-Lead data.
- Prevents unauthorized access by employing hospital specific logins to the secured EMS data feed web page module 1124.

[00169] Although FIG. 1 illustrates the BOA device 104 communicably coupled with a patient monitoring device 106, a patient charting device 108, and a navigation device 110, in alternative embodiments of the present invention the BOA device 104 is communicably coupled with additional EMS-related devices not shown in FIG. 1, and/or is communicably coupled with multiple devices of the

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kind shown in FIG. 1, and/or is communicably coupled with different models or versions of the devices of the kind shown in FIG. 1. For example, the BOA module 1110 may be configured to communicate EMS-related device data to and from, either directly and/or indirectly via a device adapter/communication interface module 1104, one or more of the following devices: a defibrillator, a patient charting device, a navigation device, a GPS device, a pulse oximeter, an automatic cardiopulmonary resuscitation device (e.g. Autopulse® non-invasive cardiac support pump), a driver safety monitoring system, a standalone blood pressure monitor, a blood glucose measurement device, an inventory control system, a blood alcohol monitor, a breathalyzer instrument, and a crew scheduling system. A defibrillator or patient monitoring device may be one of a broad range of defibrillators or patient monitoring devices made and/or sold by a number of different manufacturers, according to embodiments of the present invention. The BOA device 104 may also be communicably coupled with, and configured to aggregate with patient data, data obtained from a CodeNet Writer™ device manufactured by Zoll Medical Corporation, or the like, according to embodiments of the present invention.

[00170] According to embodiments of the present invention, the BOA device 104 is communicably coupled to only one or two of the patient monitoring device 106, the patient charting device 108, and the navigation device 110, and is configured to organize and display EMS information from only the one or two such devices.

[00171] Although the modules and applications described with respect to FIG. 11 can roughly correspond to the hardware devices with similar designations in FIG. 1, one of ordinary skill in the art, based on the disclosure provided herein, will understand that the various modules and/or instructions for performing the described procedures may be located on different and various hardware devices

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and/or on hardware devices not depicted, in different combinations, according to embodiments of the present invention. For example, although the BOA device 104 may be a touch-screen PC including and configured to perform the tasks of the BOA module 1110, the BOA device 104 may alternatively be a simple display device such as a monitor, with the computational functions of the BOA module 1110 and/or mobile asset management module 1106 performed by other hardware, such that only the display information is communicated to the BOA device 104, according to embodiments of the present invention.

[00172] The BOA device 104 according to embodiments of the present invention may be configured to facilitate data entry via a touch screen device with software that permits rapid and easy data entry, similar to the Quicklog capability of the Zoll Data Systems RescueNet® ePCR Suite. In addition, the BOA device 104 may be configured to permit selection and display of patient monitoring data (e.g. 12-lead ECG data) from prior transports and/or other agencies retrieved from mobile database 118 and/or enterprise database 130, according to embodiments of the present invention. Such historical and/or shared patient data may also be made available to hospitals, and/or stored by hospitals or other care institutions as part of a data management program. The BOA device 104 may also be configured to display streaming ECG information similar to the "live" display of such information by a defibrillator device, for example. The BOA device 104 may also be configured to display feedback to the EMS technician 114 about cardiopulmonary resuscitation being performed, to evaluate the CPR technique during and/or after it is administered. According to embodiments of the present invention, the BOA device 104 may be configured to communicably couple with and receive information from an accelerometer and/or other CPR evaluation device, such as a

device configured to detect the presence of and/or the timing of and/or the depth/displacement of and/or the velocity of and/or the acceleration of chest compressions, for example the devices and methods described or referenced in U.S. Pat. No. 6,390,996 issued on May 21, 2002, U.S. Pat. No. 6,827,695 issued on December 7, 2004, U.S. Pat. No. 7,122,014 issued on October 17, 2006, and U.S. Pat. App. Pub. No. 2006/0009809 published on Jan. 12, 2006, which are incorporated by reference herein in their entireties.

[00173] FIG. 17 depicts a flow chart 1700 illustrating a method performed by BOA module 1110, according to embodiments of the present invention. The process begins at block 1701. The BOA module 1110 is initialized (block 1702), and the user may then select devices (block 1704) from which medical and/or EMS information will be received. For example, such device selection may involve generating an asynchronous message to be received by the patient monitoring module 1102 for establishing a connection (block 1706), an asynchronous message to be received by the navigation module 1114 for establishing a connection (block 1708), and/or an asynchronous message to be received by the patient charting module 1112 for establishing a connection (block 1710). A different subset of devices (different devices, fewer devices, or more devices) may be selected at any time when the user initiates an asynchronous event to select or change devices (block 1712).

[00174] Once devices have been selected, the BOA device 104 cycles through a series of different displays (block 1714). This cycling may be programmed to occur at preset intervals; for example, the BOA device 104 may be configured to cycle the display between different data models every seven seconds. For example, a navigation device data model may be displayed (block 1716), which may be similar to the data model depicted in FIG. 3, for example. After a preset time, the

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display may be switched to a patient monitoring device data model (block 1718), similar to the data model depicted in FIG. 4, for example. After another preset time, the display may be switched to a patient charting device data model (block 1720), similar to the data model depicted in FIG. 5, for example. Once the display has cycled through each data model, it may return to the first data model displayed and repeat the cycle, according to embodiments of the present invention. Such a cycling may be initiated or re-initiated during other tasks when the user initiates an asynchronous event (block 1722) by selecting the cycle feed button (similar to the button 318 of FIG. 3), for example.

[00175] When a user selects one of the "feed" buttons (block 1724), an asynchronous event is generated causing the data model corresponding to that feed to displayed (block 1726) for a longer predetermined period of time, for example one minute. As an example, if the user selects the patient charting button 206 (see FIG. 2), the patient charting data model similar to FIG. 5 will immediately be displayed and will remain displayed for a period of time longer than the default cycle time. When a user selects the patch notes button 208 (block 1728), an asynchronous event is generated causing the patch notes data model similar to FIG. 6 to be displayed (block 1730) until the user next selects the cycle feeds button 318 or a particular feed button 202, 204, 206, according to embodiments of the present invention. When a user selects the protocols button (block 1732), an asynchronous event is generated causing the protocols data model similar to FIG. 7 to be displayed (block 1734) until the user next selects the cycle feeds button 318 or a particular feed button 202, 204, 206, according to embodiments of the present invention.

[00176] When one of the EMS devices receives or generates new data, it may be configured to generate an asynchronous notification to be received by the BOA module 1110, according to embodiments of

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the present invention. For example, the patient charting module 1112 may generate an asynchronous message when it has new information to share (block 1736), the patient monitoring module 1102 may generate an asynchronous message when it has new information to share (block 1738), and the navigation module 1114 may generate an asynchronous message when it has new information to share (block 1740), according to embodiments of the present invention. These asynchronous messages may include within them the new or updated data itself. When the BOA module 1110 receives one or more of these notifications, it updates the data model or data models that correspond to the particular device and/or information received (block 1742). For example, if new patient charting information is received from the patient charting module 1112 (which may be running on the patient charting device 108), the BOA module 1110 will update the patient charting data model to reflect the most recent data. The BOA module 1110 then refreshes its display (block 1744), which results in the currently displayed data model being replaced with the new data model immediately if any data in the data model was updated in block 1742. The data model update may then be sent to the BOA enterprise module which may reside on enterprise application server 128 (block 1746), which may result in an asynchronous message being generated to the BOA enterprise module (block 1748), according to embodiments of the present invention.

[00177] Some embodiments of the present invention include various steps, some of which may be performed by hardware components or may be embodied in machine-executable instructions. These machine-executable instructions may be used to cause a general-purpose or a special-purpose processor programmed with the instructions to perform the steps. Alternatively, the steps may be performed by a combination of hardware, software, and/or firmware. In

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addition, some embodiments of the present invention may be performed or implemented, at least in part (e.g., one or more modules), on one or more computer systems, mainframes (e.g., IBM mainframes such as the IBM zSeries, Unisys ClearPath Mainframes, HP Integrity NonStop servers, NEC Express series, and others), or client-server type systems. In addition, specific hardware aspects of embodiments of the present invention may incorporate one or more of these systems, or portions thereof.

[00178] As such, Fig. 18 is an example of a computer system 1800 with which embodiments of the present invention may be utilized. According to the present example, the computer system includes a bus 1801, at least one processor 1802, at least one communication port 1803, a main memory 1804, a removable storage media 1805, a read only memory 1806, and a mass storage 1807.

[00179] Processor(s) 1802 can be any known processor, such as, but not limited to, an Intel® Itanium® or Itanium 2® processor(s), or AMD® Opteron® or Athlon MP® processor(s), or Motorola ® lines of processors. Communication port(s) 1803 can be any of an RS-232 port for use with a modem based dialup connection, a 10/100 Ethernet port, or a Gigabit port using copper or fiber, for example. Communication port(s) 1803 may be chosen depending on a network such a Local Area Network (LAN), Wide Area Network (WAN), or any network to which the computer system 1800 connects. Main memory 1804 can be Random Access Memory (RAM), or any other dynamic storage device(s) commonly known to one of ordinary skill in the art. Read only memory 1806 can be any static storage device(s) such as Programmable Read Only Memory (PROM) chips for storing static information such as instructions for processor 1802, for example.

[00180] Mass storage 1807 can be used to store information and instructions. For example, hard disks such as the Adaptec® family of

SCSI drives, an optical disc, an array of disks such as RAID (e.g. the Adaptec family of RAID drives), or any other mass storage devices may be used, for example. Bus 1801 communicably couples processor(s) 1802 with the other memory, storage and communication blocks. Bus 1801 can be a PCI /PCI-X or SCSI based system bus depending on the storage devices used, for example. Removable storage media 1805 can be any kind of external hard-drives, floppy drives, flash drives, IOMEGA® Zip Drives, Compact Disc – Read Only Memory (CD-ROM), Compact Disc – Re-Writable (CD-RW), or Digital Video Disk – Read Only Memory (DVD-ROM), for example. The components described above are meant to exemplify some types of possibilities. In no way should the aforementioned examples limit the scope of the invention, as they are only exemplary embodiments.

[00181] Embodiments of the present invention may be configured to achieve various other solutions in an emergency medical services environment. For example, the BOA device 104, in communication with the navigation device 110, may be configured to provide additional mapping and/or navigation information. The BOA device 104 may display status information about a hospital destination, and may indicate diversion or alternative destinations to direct the ambulance 101 to an appropriate destination, according to embodiments of the present invention. The BOA device 104 may also display characteristics about hospitals and/or other destinations, such as the hospital's capabilities (e.g. heart specialty, burn specialty), insurance accepted, patient capacity and current patient capacity status, according to embodiments of the present invention. The BOA device 104 may also be in communication with the enterprise workstation 122 of the hospital or other destination to permit preregistration or partial preregistration of the patient 116. According to embodiments of the present invention, a hospital without availability shows up for the

ambulance driver 112 as not available. The BOA device 104 may be configured to display such information simultaneously with a map and/or during navigation, to facilitate destination selection. This information may be obtained over the network 120 from an enterprise server 126 or 128 and/or from an enterprise workstation 122 and/or from the navigation device 110, according to embodiments of the present invention.

[00182] The BOA device 104 may also be configured to communicate in various ways with the user, including with the EMS driver 112 and/or the EMS technician 114, according to embodiments of the present invention. For example, the BOA device 104 may be configured to provide audio prompts, alarms, scheduling, timing, and/or audio streams to EMS users. The BOA device 104 may be configured with Bluetooth ® connectivity or capability, such that a user may connect or pair a unique Bluetooth ® device with BOA 104 to receive audio information and/or to communicate voice prompts. An alarm may be configured to sound or to display visually upon a triggering event, for example upon receipt by the BOA device 104 of an asynchronous event signal from a sensor indicating that a detected parameter is outside an acceptable range or value, according to embodiments of the present invention. Audio and/or visual cues may be used to alert a user to a particular dosage schedule, for example beeping when a certain amount of time has elapsed since a first administration of a drug. Such alarms and/or schedules may be set or customized by the users, or may be selected from a predetermined set of alarm and scheduling options, according to embodiments of the present invention.

[00183] According to embodiments of the present invention, the BOA device 104 may provide role-based data and/or audio streams; for example, a technician administering CPR may receive audio and/or

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visual information about the patient's cardiac condition, but the BOA device 104 may filter out other information such as mapping and/or routing information for that user. Private, customized feedback and/or information may be provided to EMS users based on their roles, according to embodiments of the present invention.

[00184] The BOA device 104 may further provide decision support for an EMS technician, according to embodiments of the present invention. Based on information entered by the technician 114 (e.g. via a patient charting device 108) and/or information received from a patient monitoring device 106, BOA device 104 may compare the information with internal or external databases to display or otherwise convey a differential diagnosis, and/or predictive diagnosis (e.g. based on vectors or EKG information), according to embodiments of the present invention. For example, the BOA device 104 may present the EMS technician 114 with a decision matrix based on symptoms and/or responses to treatments to help the EMS technician 114 determine, for example in an interactive format, a potential diagnosis. The BOA device 104 may provide protocols or links to protocols based on the information received, either from the technician 114 or from one of the devices with which it is in communication.

[00185] In one embodiment, the data for the patient's history may be entered via the BOA device 104 with patient physiological measures via the monitor of BOA device 104. As the differential diagnosis requires both patient history, patient examination findings, and measures of the patient's physiological state via such monitoring as ECG, capnography and pulse oximetry, these data elements are integrated into a user interface that automatically or semi-automatically integrates the various data elements on a single differential diagnosis screen within the application on the BOA device 104, according to embodiments of the present invention. The interface of BOA 104

begins by asking the rescuer to choose from a list of common presenting symptoms or complaints by the patient, e.g. dyspnea or respiratory distress. The information such as on the screens illustrated in FIGS. 26-28 (taken directly from Am Fam Physician 2003; 68:1803-10, which is incorporated by reference herein) and FIG. 29 (taken directly from the Collier County Common Medical Protocol, revised 02/01/08), provides a structured approach for rescuers to obtain information. As patient history and physical examination findings are entered into the BOA device 104, the differential diagnosis page may gradually narrow down the possible diagnoses. Heart sound measurement and detection may be incorporated into the monitoring device 106 for the detection of S3 and S4 heart sounds and automatically narrow the differential, or suggest for the rescuer to confirm agreement with the software diagnosis, of heart failure or pulmonary edema. A flowchart for incorporating heart sounds is shown in FIGS. 26-29. Pulse oximetry and capnography are also very helpful measures and may be automatically incorporated into the algorithm for more accurate diagnosis.

[00186] In one embodiment, rescuers may be able to simply touch the cursor to the history or physical exam findings listed as possible from the screen-displayed lists of FIGS. 26-29, thereby minimizing unnecessary keying inputs. At the bottom of each list of possible findings or history is a data entry position for "Other", for those findings or history which are not normally consistent with the presenting condition. In one embodiment, these additional findings, history or physiological measurements can be compared with a larger differential diagnosis database to suggest other possibilities to the rescuer based on a calculated probability or if the other possible causes have been ruled out, according to embodiments of the present invention.

[00187] In much the same way that twelve-lead data and other BOA 104 device data may be sent to an enterprise environment 102 and displayed and/or retrieved on an enterprise workstation 122 or web-based environment, the BOA device 104 may also be configured to receive, display, and/or store similar information from an enterprise environment 102, according to embodiments of the present invention. For example, in a situation in which a patient is being transported from one hospital to another to receive specialized care, the hospital may send to the BOA device 104 information about the patient's vitals and/or health history and/or physician recommendations. Alternatively, the hospital may grant electronic authorization for the remote EMS technician to query its database or databases where such information is kept, to enable the EMS technician 114 to select, using the BOA device 104 interface, which and how much information he would like to receive. In this way, technicians in an ambulance 101 can see what is happening to a patient at the hospital, for example.

[00188] The BOA device 104 may also include speech recognition software and/or text-to-speech software, according to embodiments of the present invention. As such, the BOA device 104 may provide an audio signal that reads text or numeric data received from one or more devices, to convey the data to the EMS technician 114 audibly, such that the EMS technician 114 need not divert visual attention from the patient or from another task, according to embodiments of the present invention. The BOA device 104 may also recognize voice command prompts, to enable the user to operate the BOA device 104 by voice instead of having to divert manual attention from the patient or the task at hand, according to embodiments of the present invention.

[00189] The BOA device 104 also be configured to retrieve audio data stored on a device, such as a patient monitoring device 106, to

help the EMS technician 114 in treatment or diagnosis, and/or for storage, technician evaluation, quality control, or later playback. For example, the patient monitoring device 114 may be a defibrillator that records a continuous audio stream; the BOA device 104 may access the continuous audio stream and permit selective play back of certain portions and/or transmit the audio stream or audio file for remote access or storage, according to embodiments of the present invention. The BOA device 104 may also be configured to receive audio information from a patient monitoring device 106 or other device even before the EMS technician 114 has reached the patient, to help the EMS technician 114 to prepare for the scene.

[00190] The BOA device 104 may be configured to connect with a video monitoring device, for example a webcam, or a standalone video camera, and/or a video capture device that is mounted on or part of another device to which the BOA device 104 connects, according to embodiments of the present invention. For example, a video or still camera mounted in the back of an ambulance 101 may provide visual data to BOA 104 for storage and/or transmission and/or retransmission to the enterprise environment 102 and/or the administration environment 103. Such a video feed may permit a physician waiting at a hospital to view the patient's status before the patient arrives, for example.

[00191] With an ability to connect with and interface multiple EMS-related devices, both clinical and non-clinical, and aggregate such EMS-information (both clinical and non-clinical) from multiple devices, the BOA device 104 may also be configured for inventory monitoring and control. For example, the BOA device 104 may be communicably coupled with a bar code scanner, a radio frequency identification ("RFID") receiver or transceiver, or other inventory monitoring device. The BOA device 104 may maintain or

communicate with a database that tracks a particular set of inventoried items, whether they be medical devices, supplies, drugs, personnel, or the like.

[00192] For example, the BOA device 104 may include a database that tracks the inventory of devices, supplies, and drugs on board a particular ambulance 101. When a new device is placed on the ambulance 101, the new device is equipped with a tag or bar code or some other unique identifier, and the BOA device 104 may be configured to automatically sense, or to be instructed to sense (e.g. by scanning a bar code with the bar code scanner), the presence of a new inventory item. The BOA device 104 may also prompt the user with a status update request, for example: new item, item being removed, item being dispensed, item destroyed, item transferred. Hence, at the beginning of an ambulance 101 shift, the crew may query the BOA device 104 to display the inventory of devices, supplies, and/or drugs on board, and may supplement the inventory for any deficient item. When a drug is administered, it may be scanned into the BOA device 104 system with an indication that it has been dispensed and should be replaced. At the end of a shift, the crew may check the inventory via the BOA device 104 and restock necessary supplies and/or transmit the inventory situation to a third party for any appropriate restocking, monitoring, and/or verification activity.

[00193] Such inventory information may also be conveyed by BOA 104 for remote use and/or storage. For example, a defibrillator patient monitoring device 106 may be checked out to each crew of each ambulance 101, and this information may be sent by BOA device 104 through network 120 to the enterprise storage server 126, which may aggregate such information across multiple ambulances 101. A shift supervisor using a remote enterprise workstation 122 may query such database to determine which defibrillators are out in the field on

which ambulances 101, according to embodiments of the present invention. In this way, the BOA device 104 may auto-upload inventory information to a central system.

[00194] The BOA device 104 may also be configured to connect with devices (clinical and/or non-clinical) that track EMS technician 114 and patient 116 safety, according to embodiments of the present invention. For example, the BOA device 104 may be configured to connect with accelerometer and/or tire pressure sensors, and/or other vehicle-relate sensors to track driving conditions, driving behavior, safety level, and/or event occurrences, according to embodiments of the present invention. According to one embodiment of the present invention, the BOA device 104 may be configured to connect with a breathalyzer device, which may be used to sense and/or estimate the blood alcohol content of the driver and/or patient. The BOA device 104 may collect such data and display it to the user in a feedback format, and/or may send such data through the network 120 for storage and/or remote evaluation, according to embodiments of the present invention. The BOA device 104 may also monitor a vehicle's maintenance schedule and alert the user when maintenance is needed or recommended, according to embodiments of the present invention.

[00195] Due to its connection with the network 120 and also with other devices 106, 108, 110, the BOA device 104 may also serve as an ambulance headquarters and/or a type of "repeater" in a trauma or disaster situation, according to embodiments of the present invention. For example, the BOA device 104 may be configured to connect with multiple devices including devices outside the ambulance 101 and/or in a different ambulance 101, to permit the BOA device 104 user to view and manage response treatments, for example. Such a configuration also permits data from multiple devices (e.g. multiple defibrillators or other patient monitoring devices) to be conveyed through the network

120 to an enterprise environment 102 and/or administration environment 103, according to embodiments of the present invention. In another example, a single ambulance 101 equipped with a BOA device 104 system as described above may be deployed to a disaster or trauma situation, and the BOA device 104 may be connected to and aggregating information from multiple patient monitoring devices 106. A supervisor or situation manager may use the BOA device 104 to monitor treatment status, prioritize patient medical needs, transmit relevant information to selected outside caregivers, hospitals, and/or treatment centers, and to distribute resources accordingly.

[00196] According to some embodiments of the present invention, the BOA device 104 is configured to perform diagnostics on and/or to initiate self-diagnostics for devices with which it is connected. The BOA device 104 may also be used for training and/or education of EMS technicians 114, by making downloaded protocols available for display, and/or by simulating a medical emergency (e.g. simulating the device feeds from multiple clinical and non-clinical devices during a medical emergency or transport).

[00197] According to some embodiments of the present invention, the BOA device 104 provides a visual indication of whether its connection with the navigation device 110 (or other predetermined device) is online or offline. According to some embodiments, the user can select to view historical rather than current patient information; for example, the user may select to view thumbnails of previous twelve-leads, and can send a collection of twelve-lead data snapshots to an enterprise environment 102 (e.g. a hospital), each with a unique serial number, for example. The enterprise user 124 may also view the patch notes from the BOA device 104, so that the EMS technician 114 need not convey them telephonically, according to embodiments of the present invention.

[00198] The BOA device 104 may also include a drop-down menu interface, listing each device to which the BOA device 104 is connected and its connection status, according to embodiments of the present invention. The BOA device 104 may also be connected with a biometric device such as a fingerprint reader or a retinal scanner, or a non-biometric device such as a keypad, to assist in verifying the identity of a patient and/or in authorizing access to patient medical records. Such records may be stored in remote databases and/or stored by different entities, for example.

[00199] FIGS. 20-23 illustrate an EMS communication interface device 2000, configured to facilitate communication between a patient monitoring module 1102 and a device adapter / communication interface 1104 (see FIG. 11). Not all patient monitoring devices 106 include the hardware necessary for certain kinds of communication (e.g. wireless communication), either with BOA device 104 or with other enterprise environments 103. An EMS communication interface device 2000 may be added as an accessory to the patient monitoring device 106 in order to supplement its communication capability, as well as provide additional functionality, according to embodiments of the present invention.

[00200] The EMS communication interface device 2000 may be configured to interface with the patient monitoring device 106 via an existing hardware interface, such as, for example, via a PCMCIA card slot, a USB slot, or the like, according to embodiments of the present invention. The following example illustrates an EMS communication interface device 2000 that interfaces with a patient monitoring device 106 via a PCMCIA card slot in the device 106, according to embodiments of the present invention.

[00201] FIG. 20 illustrates a carrier board 2010 design for an EMS communication interface device 2000, according to embodiments

of the present invention. The carrier board 2010 may be a custom carrier board for a systems-on-module ("SOM") hosting of various subsystems. The carrier board 2010 may host a PCMCIA edge connector 2030, PCMCIA address and control transceivers 2012, PCMCIA data transceivers 2014, a board power supply 2016, a first-in-first-out ("FIFO") co-processor input memory buffer 2018, a flash memory common memory plane ("CMP") 2020, a complex programmable logic device ("CPLD") attribute memory plane ("AMP") spoof shifter 2022; a universal serial bus ("USB") universal asynchronous receiver-transmitter ("UART") bridge 2024, a CPLD programming interface 2026, and a reset push button 2028. The power supplies for 3.3V, 1.8V, and 1.5V levels may be derived from PCMCIA 5V and possibly 12V inputs, according to embodiments of the present invention. Device 2000 may further include a USB 2.0 port.

[00202] The carrier board 2010 may also include a SOM coprocessor subsystem 2040 such as, for example, a Gumstix Overo Air SOM or a LogicPD xxxSOM. SOM 2040 may include a Bluetooth ("BT") radio and/or antenna and/or a WiFi (e.g. 802.11a/g) radio and/or antenna 2042. The 802.11 a/g subsystem may be initialized and configured during boot, and may also be configured via terminal session, according to embodiments of the present invention. SOM 2040 may also include a storage device 2044, such as, for example, a removable micro SD storage/memory slot. A micro SD card may be used in such a slot as random access storage as well as a source of the boot strap code to initialize the co-processor subsystem 2040. SOM 2040 may also include a power management integrated circuit ("IC") 2048, such as, for example, a Texas Instruments TPS65950 integrated power management IC. SOM 2040 may also include a processor 2046 such as, for example, a TI Open Multimedia Applications Platform ("OMAP") 3503 processor with 256MB of random

access memory ("RAM") and 256 MB of non-volatile RAM ("NVRAM") in a package-on-package ("POP") package. The coprocessor subsystem 2040 may be communicably coupled to the carrier board 2010 via dual 70-pin headers, according to embodiments of the present invention. The carrier board 2010 may also include a Joint Test Action Group ("JTAG") interface for programming, according to embodiments of the present invention.

[00203] The device 2000 may include CPLD firmware, such as, for example, Actel Igloo Nano AGL250V2-VQG100_0. Such CPLD firmware may govern linear flash ("LF") control signals for read/write operations, may govern FIFO control signals for write and read operations in a manner of a FIFO dual-ported implementation, and may employ level shifted address and data buses for LF, FIFO, and the OMAP, according to embodiments of the present invention. The device 2000 may include an operating system, such as, for example, OE 2.6.x Open Embedded Linux. The device 2000 may employ the C# Common Language Runtime (2.6.2), for example the Mono common language runtime ("CLR"), according to embodiments of the present invention. The device 2000 may include persistent data storage using SQLite software library, according to embodiments of the present invention. The device 2000 may perform asset management patterned data storage for framed data, and/or asset management patterned services for parameterized frame retrieval, according to embodiments of the present invention. The device 2000 may accomplish WiFi communications using User Datagram Protocol/Internet Protocol ("UDP/IP") for streaming data output, a .NET remoting service bus, and/or a .NET remoting eventing bus, according to embodiments of the present invention.

[00204] FIG. 21 illustrates a system overview for an EMS communication interface device 200, according to embodiments of the

present invention. A patient monitoring module 1102 processes and sends patient monitoring data. The patient monitoring module 1102 may be implemented by a Zoll E-Series Defibrillator, according to embodiments of the present invention. Such patient monitoring module 1102 is configured to transmit streaming patient vital signs and twelve lead information, as well as full disclosure data, over a BT wireless connection 2110, to a BT plug-in 2112 that is part of a device adapter 1104, according to embodiments of the present invention. As used herein, the term "Full Disclosure Data" means all data recorded by a patient monitoring device 106, and includes, without limitation, patient vital signs, twelve-lead data, audio information, ECG information, lead type, gain, defibrillator shock information, system mode, paddle type, heart rate alarm status, heart rate, configuration information, code marker information, non-invasive blood pressure measurements, patient name, patient identification, biphasic defibrillator data, invasive blood pressure information, invasive blood pressure waveform data, temperature data, SpO_2 information, SpO_2 waveform, sample number information, accelerometer information, accelerometer waveform, impedance waveform, CPR field data, APLS waveform, and/or APLS compression detection.

[00205] A WiFi wireless connection has a much higher bandwidth for the transfer of information than a BT wireless connection. However, in some cases, the patient monitoring device 106 on which the patient monitoring module 1102 runs may not include WiFi capabilities, but it may include a personal computer memory card international association ("PCMCIA") card slot with a PCMCIA interface 2114. A PCMCIA card may also be referred to as a PC card. The EMS communication interface device 2000 may be plugged in to the PCMCIA card slot 2114. The device 2000 may include a linear flash memory card 2122 or other memory element for recording full

disclosure data from the patient monitoring device 106, according to embodiments of the present invention. The memory card 2122 may be used to replicate all existing memory card functionality of the patient monitoring device 106, by storing in linear flash memory 2122 all data written to the patient monitoring device 106 data slot, by permitting a utility mode user-initiated retrieval of stored data from linear flash memory 2122, and/or by permitting a utility mode user-initiated erasure of the linear flash memory 2122, according to embodiments of the present invention.

[00206] The full disclosure data stream from the patient monitoring module 1102 may also be received through the PCMCIA slot 2114 by an EMS communication interface module 2116, which transforms the full disclosure data into incident data, and provides the incident data over a WiFi connection 2118 to a WiFi plug-in 2120 that is part of the communication interface 1104, according to embodiments of the present invention.

[00207] FIG. 22 illustrates another system overview for an EMS communication interface device 2000, according to embodiments of the present invention. As illustrated in FIG. 21, full disclosure data is recorded in a memory module 2122, for example a flash linear analog memory module 2122, according to embodiments of the present invention. The flash analog module 2122 may be read, written, and/or erased by the patient monitoring module 1102 similarly to the fashion in which any memory element permanently associated with the patient monitoring device 106 may be read, written, and/or erased by via the device 106, according to embodiments of the present invention. This may be accomplished by using a utility mode of the device 106, for example. As such, the flash analog 2122 is not interfaced to the SOM (e.g. to microprocessor 2204), but only to the patient monitoring module 1102 in write/read/erase fashion.

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[00208] According to embodiments of the present invention, the flash analog memory 2122 is designed to resemble the linear flash card that is normally associated with, and which may be embedded within, the patient monitoring device 106. Certain information may be stored in a non-volatile memory area, for example in the attribute memory plane, and certain other information may be stored in the first series of bytes of the common memory plane, to make the memory 2122 resemble the internal memory of the patient monitoring device 106. The communications interface 2116 may be a FIFO buffer 2202, which may receive full disclosure data from the patient monitoring module 1102 via the PCMCIA interface 2114, and pass the full disclosure data to a microprocessor 2204. The FIFO 2202 is uni-directional from the patient monitoring module 106 to the microprocessor 2204, according to embodiments of the present invention. Incident data sent may also be persisted in the asset management database 2314.

[00209] According to embodiments of the present invention, the FIFO buffer 2202 and/or the flash analog memory module 2122 are hardware-only solutions that function even when the SOM 2040 is non-operational. This functionality permits data protection in the case in which the SOM 2040 is not functional, and permits data buffering for the SOM 2040 to initialize (e.g. to boot and start the EMS communication interface services), according to embodiments of the present invention. During therapy mode data capture to the card 2122, if the SOM 2040 were to be disabled, device 106 data would not be lost, according to embodiments of the present invention. This also permits users who have been trained on utility modes of a patient monitoring device 106 related to the storage of data on a memory module to continue using such utility modes, even with the data being

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stored on memory module 2122 instead of a memory module internal to device 106, according to embodiments of the present invention.

[00210] Using a plug-in 2120 that is part of the communication interface 1104, incident data ("ID") may be streamed from the microprocessor 2204 over a WiFi connection 2118. Such information may be received and displayed by BOA device 104, for example, and may be displayed in real time and/or in clinically significant time (e.g. with a delay not larger than that which permits a medically accurate and timely observation, diagnosis, and/or treatment decision to be made). According to embodiments of the present invention, the incident data may be streamed on a BOA device 104 with no more than a one-second delay. For example, twelve-lead data generated by a defibrillator patient monitoring device 106 may be updated at least once each second, according to embodiments of the present invention.

[00211] The microprocessor 2204 may also be programmed to generate asynchronous (e.g. event based) notifications via an eventing bus, over the WiFi connection 2118, according to embodiments of the present invention. For example, if a patient vital sign falls outside of present parameters, the microprocessor 2204 may be programmed to send an alarm event via eventing bus across the communication interface 1104.

[00212] In addition, the microprocessor 2204 may be programmed to permit a two-way service bus / service interface, to permit the requesting of incident data related specific incidents, according to embodiments of the present invention. For example, after a treatment incident, the user may request, via a service bus, from microprocessor 2204 all information associated with the particular incident (using a unique incident identifier, such as a case number, patient name, or the like). The microprocessor 2204 would then query the asset management module 2314 and retrieve any records

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associated with the particular incident, and send them back out through service bus, according to embodiments of the present invention. In this way, users may retrieve specific incident data rather than having to download all of the card file data (which in many cases will relate to multiple incidents, or information beyond the specific subset of information sought). This is made possible by the conversion of full disclosure data into incident data by the microprocessor 2204 prior to storage and/or forwarding. In some cases, users may wish to request all data stored by asset management module 2314, which would be a similar operation to the request for the card file directly from the patient monitoring module 1102.

[00213] FIG. 23 illustrates a software logic diagram for an EMS communication interface device 2000, according to embodiments of the present invention. A Linux Kernel 2302 may include a general purpose input/output ("GPIO") module 2304 configured to receive the data stream (e.g. the full disclosure data) 2301 from the patient monitoring device 106. The data stream 2301 is interfaced to the system 2000 through the FIFO module 2202 which is controlled with several GPIO 2304 lines, according to embodiments of the present invention. The FIFO is read to the SOM using GPIO status, control and eight bits of data, according to embodiments of the present invention. The byte stream driver 2308 may be implemented in user space rather than a device driver to facilitate debugging, in some embodiments. The byte stream driver 2308 may keep the FIFO 2202 drained by monitoring the FIFO 2202 empty flag (which may be polled as opposed to interrupt driven for debugging efficiency in one embodiment).

[00214] Bytes read from the FIFO by the byte stream driver 2308 are re-assembled as blocks similar to those delivered by the patient monitoring device 106 and framed in the data formatter 2310,

according to embodiments of the present invention. This results in a frame event stream 2303 from the data formatter 2310. The frame event stream is then sent to an asset management module 2312, which saves the frames to the database 2314 and forwards them out the WiFi channel to the TCP/IP module 2306 of the Linux Kernel 2302. According to some embodiments of the present invention, the frame event stream 2303 is sent over the WiFi connection via an encrypted UDP broadcast, so that it may be received by a wide range of clients (e.g. an iPhone may be configured to receive the UDP broadcast). The frame event stream 2303 may also be received by a clinical time feed plug-in 2316 of the communications interface module 1104, according to embodiments of the present invention.

[00215] Asynchronous requests for incident data stored in the database 2314 may be made by authorized external clients, such as via an incident plug-in 2318 of the communications interface module 1104, according to embodiments of the present invention. Such incident service calls are shown in dashed lines in FIG. 23. Although database 2314 is shown as an SQLite database, one of ordinary skill in the art will appreciate, based on the disclosure provided herein, that other database formats may be employed by asset management module 2312, according to embodiments of the present invention.

[00216] According to embodiments of the present invention, the byte stream is formatted by data formatter 2310 into blocks of data resembling device 106 data blocks, and these full data blocks are broadcast in a WiFi format upon construction (e.g. as a block is made, it is sent over the WiFi interface). According to embodiments of the present invention, the asset management module 2312 frames the byte stream into consistent blocks of time, for example one second per frame, and each frame is saved into the asset management patterned data storage (e.g. database 2314).

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[00217] Although FIGS. 21-22 show full disclosure data as two separate feeds, a single full disclosure data feed may be bifurcated and sent to both the flash analog module 2122 and the FIFO 2202 simultaneously, according to embodiments of the present invention.

[00218] A user may query the device 2000 to request health information, for example, running time, exceptions detected, and other information from the patient monitoring device 106, according to embodiments of the present invention. A user may also request specific incident-based data from the device 2000; for example, a user may send a query that says "send all of the cases," or "send data relating to a specific case" or "send all twelve-lead data from a specific case." The device 2000 may also stream delivery of case data so as to permit multiple authorized receivers (e.g. multiple BOA devices 104) to obtain the data simultaneously, according to embodiments of the present invention. According to some embodiments of the present invention, device 2000 facilitates data sharing between the patient monitoring device 106 and the enterprise environment 103.

[00219] On power up, the device 106 interrogates the occupant of the PCMCIA slot 2114 to ascertain if a valid linear flash card 2122 is present. The validity test may consist of reading a series of bytes from the LF AMP and validating the values against sets of acceptable cards or an acceptable card. If a valid card is found, the device 106 reads a series of bytes from the CMP to test for validity and to determine if the card has been "formatted" according to the requirements of the device 106. In the absence of such a series of bytes, the device 106 may write such information to the card 2122, according to embodiments of the present invention. Once the card 2122 is validated, the device 106 begins to write the device data to the LF card 2122 as byte streams that are formatted into blocks as described, above.

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[00220] Although the device 2000 is depicted as interacting with device 106 in a one-way fashion, the device 2000 may also be configured to interact bi-directionally with device 2000. For example, the device 2000 may be configured to provide a WiFi user interface similar to the user interface observed directly on the patient monitoring device 106, to permit total or partial remote control of the patient monitoring device 106, according to embodiments of the present invention.

[00221] Packaged in a PCMCIA type x housing, each card 2010 contains a connector 2030, an array of flash memories packaged in thin small outline packages ("TSOP") and card control logic. The card control logic provides the system interface and controls the internal flash memories as well as the input FIFO to the SOM, according to embodiments of the present invention. Level shifters are present to adapt PCMCIA logic voltages to card logic voltages.

[00222] Card logic voltages of 3.3V, 1.8V, and 1.5V may be derived from the PCMCIA VCC voltage (TTL, +5V, possibly +12V). A single stage for 3.3V and 5V conversions is built using three discrete transceivers. A CPLD is used to perform 3.3V and 1.8V conversions.

Part	Logic Voltages	Power	Notes
J1	+5V	+5V, +12V	2X34 PCMCIA connector
U5, U6, U7	+5V : +3.3V	+5V, +3.3V	Level Shifters
U3	+3.3V	+3.3V	Flash Memory
U7	+3.3V	+3.3V	FIFO
U1	+3.3V : +1.8V	+3.3V, +1.8V	CPLD
MCU	+1.8V	+4.0V	OMAP SOM

[00223] Data enters FIFO at 3.3V from the PCMCIA byte stream. Reading the FIFO is clocked an 8bit byte at a time on the read clock shifted between 3.3 and 1.8 to OMAP, through the CPLD. OMAP control and status interface bits may be converted in a similar fashion.

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Each carrier card 2010 may have a USB2.0 port. OMAP UART signals are connected to a USB to UART serial bridge 2024, according to embodiments of the present invention.

[00224] A JTAG interface for programming the CPLD may be provided. A 2X34, A and B sided PCMCIA Connector (J1) may be used, that inter-connects I/O, status and power signals between the device and the card, according to embodiments of the present invention. For the device signals that the card interface is interested in, there is a group of three transceivers (U5, U6, and U7) that inter-convert PCMCIA voltage (VCC) and board voltage (3V3), according to embodiments of the present invention. Device 2000 is interested in 26 address bits, 8 data bits, and 6 control signals that are intended to be level-shifted, according to embodiments of the present invention. U5 and U6 are uni-directional 16b input shifters from device to card for address and control information, according to embodiments of the present invention.. U7 is a bi-directional 8b level shifter for 8 bits of data.

[00225] According to embodiments of the present invention, the device 2000 reads and writes data through this interface to LF memory. U5 shifting 16 address bits [PCA0:PCA15] to [A0:A15]. U6 shifting 10 address bits [PC16:PC25] to [A16:A25], and 6 control signals { PC_REGn, PC_RESET, PC_CE1n, PC_CE2n, PC_OEn, PC_BWEn} to { REGn, RESET, CE1n, CE2n, OEn, BWEn }.

Sig	Description	Active
REGn	Attribute Memory Select	Low
CE1n	Card enable 1	Low
CE2n	Card enable 2	Low
OEn	Output enable	Low
BWEn	Write enable	Low
RESET	Reset	High

[00226] [PCD0:PCD7] 8 data bits (U2). Address shifters may be input only, in which case the card does not generate address information to the device 2000, only outbound addressing (device to card) is exposed, according to embodiments of the present invention. The data shifter is bi-directional as the device can read and write data to and from the card, according to embodiments of the present invention. U5 shifts 16 bits of address and U6 shifts 8 control signals and the upper 8 bits of the address and control signals from PCMCIA VCC to 3V3.

[00227] Device 2000 is configured to permit streaming data transmission via WiFi during therapy mode operations of the device 106, as well as post-case upload of device data. The device 2000 has hardware components as well as programmable elements using both firmware and embedded software, including an embedded operating system as described, above. According to some embodiments, the EMS communication interface device 2000 is thicker than a standard Type III PCMCIA card.

[00228] An embodiment of the present invention may include one of more of the following features and/or characteristics:

- The carrier may be a PCMCIA card
- The carrier may be inserted into a patient monitoring device PCMCIA data slot.
- The card 2000 interfaces to the patient monitoring device 106 in such a way as to appear to the patient monitoring device 106 as a valid LF card ("linear flash analog") 2122.
- The card 2000 presents the PCMCIA byte stream, written by the patient monitoring device 106, via a buffered hardware interface, to a SOM processor.

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- The carrier stores the received PCMCIA byte stream to a non-volatile storage subsystem ("linear flash analog") such that all of the patient monitoring device 106 read/write/erase functionality is preserved in all device 106 modes of operation supporting these operations.
- The SOM provides IEEE 802.11. b/g wireless communications capability.
- The SOM provides Bluetooth V2.0 + EDR wireless communications capability.
- The SOM provides a micro SD card slot.
- The SOM supports watchdog type monitoring to provide for automatic reset if the SOM becomes non-functional.
- During patient monitoring device 106 or SOM reset or initialization, data is captured to flash analog memory.
- Data capture continues uninterrupted during SOM reset.
- The system 5000 is designed such that data being written by the patient monitoring device 106 is saved to the flash analog regardless of SOM state
- The SOM is able to access data saved while the SOM was unavailable.
- The carrier board provides a USB connector.
- The carrier SOM combination supports USB 2.0 On-The-Go ("OTG").
- Device 2000 form factor includes PCMCIA standard dimensions in width and height.
- Device 2000 form factor includes a width of 85.6mm X 54.0mm X a thickness (in some cases, this thickness is greater than type III which is 10.5 mm)
- Device 2000 thickness is no larger than permitted by device 106 PCMCIA slot.

- All carrier board components are mounted on one side of the carrier card.
- The interface to the patient monitoring device 106 is via slot bay via 68-pin PCMCIA card edge connector.
- Device 2000 is encapsulated to meet medical device requirements for EMC/RFI.
- The SOM is mounted on the carrier using 2 AVX 5602 70 pin connectors.
- Device 2000 is powered from the PCMCIA data slot, which may be on the order of 2.5W continuous with peak current not exceeding 600 mA.
- Device 2000 may utilize 15 GPIO pins to control reading FIFO byte stream buffer.
- Device 2000 may utilize 3 UART lines from the SOM connected and a USB bridge on the carrier.
- Device 2000 may include an antenna for WiFi.
- Device 2000 may include an antenna for BT.
- Device 2000 may use an Angstrom Open Embedded Linux operating system ("O/S").
- The device 2000 O/S may include Mono for the purposes of running code implemented in C#.
- The device 2000 O/S may include SQLite.
- The device 2000 may support the use of USB for bidirectional serial communications.
- The device 2000 provides secure wireless communications, including end-point authentication, confidentiality, integrity, and/or delivery confirmation.
- External data recipients (external processes to the device 2000) are able to request streaming data delivery.

- Data recipients are able to request complete incident data delivery by incident identifier, e.g. post-incident data.
- Device 2000 software is upgradeable via wireless interface.
- Device 2000 software is verified at run time using a cyclic redundancy code ("CRC")-like mechanism.

[00229] A device 2000 according to an embodiment of the present invention may permit individual screens for different receiving devices (e.g. different receiving devices using the communications interface 1104) to permit different users to obtain different data. For example, one user's settings could be configured to receive and display the frame event stream data relating to a patient's twelve-lead data, while an administrative technician user's settings could be configured to periodically request only frames associated with error codes generated by the patient monitoring device 106, according to embodiments of the present invention. Similarly, the same data may be received by and/or displayed by multiple users simultaneously over a WiFi connection, according to embodiments of the present invention.

[00230] In this way, the data from a patient monitoring device 106 may be streamed, e.g. over a wireless WiFi connection, from a patient's house to or from an ambulance, and/or from an ambulance to or from a hospital. Various frames in the event stream may be filtered and/or requested, such that a specific subset of data may be obtained. For example, respiration data may be included in a frame event stream generated by device 2000, according to embodiments of the present invention.

[00231] A device 2000 according to an embodiment of the present invention may be combined with other types of patient monitoring devices 106, for example an automatic external defibrillator ("AED"). The device 2000 may thus be configured to send status

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information from the AED, to facilitate software updates for the AED, and/or to remotely test the AED, according to embodiments of the present invention. Such a device 2000 may also be used with a patient charting device, for example to combine the patient charting device 108 information from one vendor/platform with the patient monitoring device 106 information from another vendor/platform, according to embodiments of the present invention. The device 2000 may also function as a data aggregator, to parse, organize, and place streams of information into discrete frames information that are more easily sorted, queried, and supplied at a later, post-incident time frame, according to embodiments of the present invention.

[00232] According to embodiments of the present invention, the patient monitoring device 106 (e.g. defibrillator) sends data to the device 2000 in data blocks, for example ECG data, or patient's current heart rate. A collection of data blocks corresponding to one incident may be referred to as incident data. Full disclosure data is the concatenation of data associated with all incidents, and may be broken into sequences of data blocks corresponding to each individual/patient. When a service request is received for an incident, all of the frames stored on device 2000 for that incident are collected and put together in sequence. According to embodiments of the present invention, each ECG block corresponds to 100ms of ECG data, which provides ten data blocks per second. The defibrillator may add to each data block an incident identifier, time information about when the data block was recorded, and/or a computing hash for data integrity purposes, according to embodiments of the present invention.

[00233] Device 2000 (which is referred to in some figures as a "Zango" device) and BOA device 104 (which is referred to in some figures as a RescueNet Link, or RNL, device) work together, according to embodiments of the present invention. Device 2000, by virtue of its

embedded computer, embodies a powerful processing engine. This processing engine is used to manage sophisticated data, communications, and applications operations on behalf of BOA device 104 users, according to embodiments of the present invention. According to one embodiment of the present invention, the device 2000 does not have input/output user interfaces (e.g., no keyboard, or display), so it works in conjunction with BOA device 104 to provide users access to the communications and data management services it supports, according to embodiments of the present invention.

[00234] FIGS. 20 and 23 illustrate the logical and functional architecture of the EMS communications interface card 2000 processing and the BOA device 104 processing, respectively. When device 2000 is not connected to device 104, device 2000 stores all device data and can transmit it to device 104 when a connection is established or restored.

[00235] FIG. 30 illustrates a data transmission interface, according to embodiments of the present invention. Zango device (1a), can be configured to perform a number of functions, according to embodiments of the present invention:

- Frame defibrillator incident data blocks.
- Stream framed incident data.
- Save incident data frames to Zango database.
- Host a set of data management services upon the Zango database.
    - In one embodiment, data management services are read/erase only. Services to modify incident data are not supplied.

[00236] The "EMS communications interface channel" (1a, 1b, 1c) provides a means to transmit patient monitoring data (e.g. E Series data) to the BOA device 104. This channel uses the device 2000 to connect to BOA 104.

[00237] The RNL Zango Client (1c) can be configured to perform a number of functions:

- Receive streamed incident frame data (1b).
- Present incident frame data on the Mobile Link Display (1e) (parse, render, 1d).
- Store incident frame data into the Mobile Link database (1f)
- Host a set of data management services upon the Mobile Link database (1f).
    - In some embodiments, data management services are read/erase only; and services to modify incident data are not supplied.
- Forward 12 lead ecg and vitals data to Field Link. (1g)
- Consume Zango data management services (1b).

[00238] The following table lists and describes various elements of FIG. 30, described with respect to one embodiment of the present invention.

Notation (Figure 30)	Description	Notes
1a	Zango accessory	Data management accessory for ZOLL E Series. Captures, stores, and transmits E Series data written to the E Series data slot to connect the E Series data to RNL.
1b	Zango UDP/IP transmissions over WPA2 secured 802.11.	
1b	Zango TCP/IP service invocation response transactions over WPA2 secured 802.11.	
1c	RNL Zango Client	RNL receiver of Zango transmissions.
1a, 1b, 1c	Zango channel	
1d	Zango parsing and rendering engine	Zango messages from the E Series are parsed and rendered for acute medical viewing.
1e	Mobile Link Display	

Notation (Figure 30)	Description	Notes
1f	Mobile Link Storage	
1g	RNL Protocol: Reliable UDP/IP over secured cellular networks.	
1h	RNL Field Link Server	Mobile link message receiver in Field Link environment.
1c, 1g, 1h	RNL Mobile Link to Field Link Communications Channel	The RNL Mobile Link to Field Link Channel connects Mobile Link to Field Link using reliable UDP/IP over secured cellular networks.
1j	Field Link Storage	
1i	Field Link parsing and rendering engine	
1k	Field Link web server	
1l	Secured connection to Field Link users	
1m	Field Link web viewer	

[00239] FIG. 31 illustrates an EMS communication interface transmission processing block diagram, according to embodiments of the present invention. The E Series writes a continuous byte stream of data to the PCMCIA Data Slot. The byte stream consists of E Series data block messages some of which are sent periodically and some of which are sent episodically. An example a periodic message is the ecg message. The E Series writes the ecg values for the currently displayed lead once per 100 ms, the message contains 25 data values (250 Hz samples, 4ms apart), according to embodiments of the present invention.

[00240] Examples of episodic messages are the vital sign messages. The E Series sends a particular vital sign message when a particular vital sign parameter value has changed; asynchronous messages are sent with no particular frequency, according to embodiments of the present invention.

[00241] The byte stream is bifurcated at the input to the Zango card. One branch stores data into an on board (16MB) linear flash, replicating all of the E Series linear flash operations. All data written is stored in the linear flash subsystem. The interface is hardware level, instant on prepared to receive and save the E Series byte stream to flash subsystem.

[00242] The second byte stream branch goes into the processor side of the Zango card. The processor side of the Zango card functions to process the byte stream performing the logical operations illustrated in FIG. 31. In the non-faulted case the byte stream receiver passes bytes to the byte block factory. The byte block factory re-constructs E Series data block messages from the byte stream. In this operation, 12 lead ecg data blocks are reconstructed and managed on a separate path to the incident path (sets of 12 lead data blocks are collected into entire 12 lead messages). The 12 lead data is entirely preserved in the case stream. One of the reasons for storing them separately is to permit a service user to request to see a 12 lead record on the service channel, rather than uploading the entire incident to get the 12 lead data, according to embodiments of the present invention.

[00243] Blocks are then framed into a configurable time interval's worth of data blocks. For example, frames of one second in size might have on the order of 15 data blocks in the one second frame. Frames are collected into constructs of cases or incidents. Frames are stored in the Zango database. Complete incidents are marked (collection of all incident frames) and managed as incidents as they are completed. Frames are also streamed on WiFi where they can be received by authorized client applications, such as the RNL Zango Client described, below, with respect to FIG. 32.

[00244] The upper row of boxes in Figure 31 identify detection and error handling processes for risk control of compromised data faults, according to embodiments of the present invention. Byte stream, block, framing, 12 Lead, or incident error all result in the following behaviors, according to embodiments of the present invention:

- Data is marked as invalid.
- Invalid data is not rendered for a user to view during the acute treatment phase of an incident
- Data is stored marked as invalid for forensic analysis.
- Any one of these faults will cause the incident to be marked invalid.
- Acute medical personnel are informed of data faults, assuming connectivity to RNL.

[00245] These are the control measures and behaviors that trace directly to the hazard analysis for data compromised faults, in one embodiment of the present invention.

[00246] FIG. 32 illustrates a EMS communications interface device client architecture, according to embodiments of the present invention. In some cases, Zango connectivity to RNL may be volatile as a result of the nature of wireless communications in mobile environments. For example, an E Series equipped with a Zango card may be moved out of range of the wireless access point to which it had been connected. When the device is back in range and reconnects, processing resumes as illustrated. Data written by the E Series while not connected to RNL is persisted in the Zango database and can be obtained in RNL upon re-connect, according to embodiments of the present invention.

[00247] The upper row of boxes in FIG. 32 identify detection and error handling processes for risk control of compromised data faults and communications faults. Integrity or framing faults detected on the

streamed data result in the following behaviors, according to embodiments of the present invention:

- Data is marked as invalid.
- Invalid data is not rendered for a user to view during the acute treatment phase of an incident
- Data is stored marked as invalid for forensic analysis.
- Either of these faults will cause the incident to marked invalid.
- Acute medical personnel are informed of data faults for either 12 leads or case frames.
- Acute medical personnel are informed of communications faults.
- Acute medical personnel are informed of service faults.

[00248] Service responses are validated and invalid service responses are notified to the user and invalid data is not displayed, according to embodiments of the present invention. Connectivity status between Zango and the Zango Stream Channel Receiver is monitored and reported to users on the Mobile Link Display. Lost connectivity between Zango and RNL does not result in lost data as Zango stores data in the Zango database regardless of connection status. Service channel connectivity is not continuously monitored, service requests will fail (response invalid) if service connectivity is not present.

[00249] FIGS. 33-37 illustrate various embodiments of screen shots available as viewed by the enterprise user 124 via the enterprise workstation 122, according to embodiments of the present invention. FIG. 33 illustrates an enterprise display and graphical user interface shown when the enterprise user selects the patient monitoring button (e.g. the "Zoll Defib" button), according to embodiments of the present invention. FIG. 34 illustrates an enterprise display and graphical user interface shown when the enterprise user selects the patient charting button (e.g. the "ePCR" button), according to embodiments of the present invention. FIG. 35 illustrates an enterprise display and

graphical user interface shown when the enterprise user selects the navigation button, according to embodiments of the present invention.

[00250] FIG. 36 illustrates an alternative enterprise display and graphical user interface shown when the enterprise user selects the navigation button, according to embodiments of the present invention. The display of FIG. 36 would correspond to a display created when the BOA device 104 is not communicably coupled with a navigation device; hence, in this situation, the enterprise display lists the positional and/or navigation information as input by the BOA 104 user. FIG. 37 illustrates an enterprise display and graphical user interface shown when the enterprise user selects the patch notes button, according to embodiments of the present invention. According to some embodiments of the present invention, the EMS technician 114 who is interacting with the BOA device 104 need not select the patch notes screen and relay the information to the enterprise user 124; instead, the enterprise user may select the patch notes button via the enterprise workstation 122 to observe the same information.

[00251] FIGS. 38-44 illustrate additional examples of screen shots displayed by BOA device 104, according to embodiments of the present invention. FIG. 38 illustrates a display and graphical user interface displayed when the user selects the patient charting button of a BOA menu template, according to embodiments of the present invention. FIG. 39 illustrates a display and graphical user interface displayed when the user selects the patient monitoring button of a BOA menu template, according to embodiments of the present invention. As illustrated by the thumbnail twelve-lead image in the bottom left corner, this BOA device 104 may be configured to display historical snapshots of past twelve-lead data, according to embodiments of the present invention.

[00252] FIG. 40 illustrates a display and graphical user interface displayed when the user selects the navigation button of a BOA menu template, according to embodiments of the present invention. FIG. 41 illustrates an alternative display and graphical user interface displayed when the user selects the navigation button of a BOA menu template, in situations in which a navigation device 110 is not communicably coupled to the BOA device 104. In such situations, the screen of FIG. 41 is configured to permit a user to manually select a destination, as well as select an estimated time of arrival, according to embodiments of the present invention. This information may be replicated or otherwise transmitted to the corresponding enterprise view (e.g. FIG. 36), according to embodiments of the present invention.

[00253] FIGS. 38-44 illustrate that a "shift start" button maybe included on the BOA device 104 interface. The shift start button may be used, for example, at the beginning of a shift, in order to permit the EMS technician or other user to communicably couple the BOA device 104 with other devices, according to embodiments of the present invention. FIG. 42 illustrates a display and graphical user interface displayed when the user selects the shift start button of a BOA menu template, according to embodiments of the present invention. In this screen, the user is permitted to select a navigation device, a defibrillator device, and a patient charting device; in this screen, the user is also able to confirm the identities of the devices to which the BOA device 104 is already communicably coupled, as indicated in this particular example by a checkmark next to the device name, according to embodiments of the present invention.

[00254] FIG. 43 illustrates an alternative display and graphical user interface displayed when the user selects the shift start button of a BOA menu template, according to embodiments of the present invention. In this alternative display, the BOA device 104 has sensed

that a navigation device 110 is not available or is disconnected, and thus prompts the user to identify the EMS transport unit and/or the crew members present with the unit. This information may be used in the corresponding navigation screens for the BOA device (FIG. 41) and the enterprise environment 102 (FIG. 36). FIG. 44 illustrates a display and graphical user interface displayed when the user selects the patch notes button of a BOA menu template, according to embodiments of the present invention.

[00255] FIG. 62 illustrates a system for role-based data feeds from a BOA device to EMS technician mobile devices, according to embodiments of the present invention. BOA device 104 receives streaming ECG data and other data from the patient monitoring device 106, which may be accomplished wirelessly via an EMS communications interface device 2000 as described above, according to embodiments of the present invention. The BOA device 104 displays such information on a screen such as the screen illustrated in FIG. 45.

[00256] FIG. 45 illustrates a display and graphical user interface displayed when the user selects a live patient data button of a BOA menu template, according to embodiments of the present invention. This display includes a list of interventions, a display of patient information, a display of chief complaint, an ECG wave form and/or an SpO2 waveform, as well as a button console (shown as extending vertically on the right side of the screen) listing buttons for available patient interventions, according to embodiments of the present invention. The intervention button console may be dynamic and/or color-coded. The intervention button console may also include timers.

[00257] For example, when a patient's airway is checked, the EMS technician activates (e.g. pushes or touches) the "patient airway" button on the intervention button console. The button activates and

displays a timer, which counts down to the next time when the patient's airways should be checked. This amount of time may be customized by the user and/or preprogrammed into the BOA module operating the BOA device 104 based on established treatment protocols for the locale in which the patient is treated. Color may also be used; for example, the buttons of the intervention button console may be normally gray, and the "patient airway" button may turn yellow as soon as the button is pushed and the timer activated. The button may turn red within a predetermined amount of time before expiry of the timer, for example one minute before the expiration of the time period being timed. For example, a user may look at the intervention button console of FIG. 45 and see that doses of Epi and Atropine have recently been administered, because those buttons are yellow and their timers activated, while also seeing that the patient's airway was previously checked and is about ready to be checked again, because that button is red. This permits the EMS technician to rapidly visually assess which interventions have been made, as well as which interventions should (or may, according to protocol) be considered in the near future, for any point in time.

[00258] Different EMS technicians may have different roles to play in an EMS scenario, based on their training or qualifications, the number of available technicians, and the status of the patient. In the same way, a single EMS technician may need to play multiple roles in an EMS encounter. Such EMS technicians may more effectively and efficiently perform their corresponding tasks if they are presented only with the information related to their particular role, such that they do not see extraneous information which they must mentally process and filter, and such that they are not presented with decision-making or data input options that do not apply to their role. One way in which such role-based information delivery may be accomplished is by

providing each EMS technician with a mobile device with software configured to permit an interface with a BOA device 104 based on the user's role.

[00259] FIG. 62 illustrates examples of such mobile devices communicably coupled to BOA device 104, including a lead medic mobile device 620, drug medic mobile device 622, airway medic mobile device 624, and CPR medic mobile device 626, according to embodiments of the present invention. According to embodiments of the present invention, each mobile device 620, 622, 624, 626 includes a WiFi transceiver that communicates wirelessly with a WiFi transceiver of BOA device 104.

[00260] FIG. 46 illustrates a start screen for a role-based EMS technician mobile device 620 in communication with a BOA device 104, according to embodiments of the present invention. The software instructions contained on the mobile device render this start screen to permit the medic to identify the IP Address, send port, receive port, medic name, and medic role, according to embodiments of the present invention. FIG. 47 illustrates a role selection screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention. A checkmark next to the "Medic – Lead" listing indicates that the user of the mobile device is the lead medic. According to embodiments of the present invention, a password or other authentication may be required in order to restrict role based on identity.

[00261] FIG. 48 illustrates a lead medic quick log screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention. The mobile device may be configured to display a list of menu options, for example the menu options shown extending horizontally along the bottom of the screen of FIG. 48 permit the lead medic to choose Quick

Log, ECG Graph, Patient Data, Chief Complaint, and Medic Role. These options may differ based the user's role. When the lead medic clicks on the Quick Log tab, the lead medic is presented with an intervention button panel, according to embodiments of the present invention. The quick log tab display replicates the intervention button console of the BOA live ECG display of FIG. 45, such that when a lead medic pushes an intervention button on the mobile device via the screen of FIG. 48, the same button (and corresponding timer and/or color) is indicated as being activated in the BOA display screen of FIG. 45, and vice versa, according to embodiments of the present invention.

[00262] FIG. 49 illustrates a lead medic ECG graph screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention, which is displayed for the lead medic when the lead medic selects the ECG graph menu button. Because the lead medic's role typically requires a broad swath of patient information, the lead medic ECG graph screen essentially recreates the patient data display screen of the BOA device 104 of FIG. 45, according to embodiments of the present invention. FIG. 50 illustrates a lead medic patient data screen, which permits the lead medic to enter patient information, including the patient's name and gender, according to embodiments of the present invention. FIG. 51 illustrates a lead medic chief complaint screen which permits the lead medic to identify the patient's chief complaint, according to embodiments of the present invention.

[00263] FIG. 52 illustrates a drug medic quick log screen and FIG. 53 illustrates a drug medic ECG graph screen for a medic who has identified his or her role as drug medic, according to embodiments of the present invention. Because the medic has identified a role of drug medic, the quick log screen presents only a subset of the interventions which relate to drugs, according to embodiments of the

present invention. Although the drug medic role accesses only a subset of the full set of intervention buttons, the same intervention buttons are tied together across the entire platform, according to embodiments of the present invention. For example, if the drug medic indicates that a dose of atropine has been given by tapping the atropine intervention button on his mobile device 622, the atropine button will turn yellow as activated, and begin a timer, not only on his mobile device 622, but also on atropine buttons of the quick log screen of the lead medic device 620 and on the intervention button console of the BOA device 104 display, as well as any other devices whose quick log screens include the atropine intervention button, according to embodiments of the present invention.

[00264] FIG. 54 illustrates a role selection screen in which an airway medic role has been identified (e.g. by tapping or otherwise selecting that option on the mobile device 624). FIG. 55 illustrates an airway medic ECG graph screen, and FIG. 56 illustrates an airway medic quick log screen listing the subset of interventions that relate to the airway medic's role, according to embodiments of the present invention.

[00265] FIG. 57 illustrates a CPR medic quick log screen illustrating a subset of interventions that relate to the CPR medic's role, according to embodiments of the present invention. FIG. 58 illustrates a CPR medic ECG graph screen during idle for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention. FIGS. 59-61 illustrate a CPR medic ECG graph screen during administration of compressions, which do not show the ECG wave form but instead show measurement and/or evaluation of chest compressions (because the CPR medic is concerned primarily with resuscitation), according to embodiments of the present invention. The CPR feedback provided by

PATENT
REEL: 042387 FRAME: 0400

the screen interface of FIGS. 58-61 may take many different forms. For example, as illustrated in FIG. 59, vertically descending bars may be used to represent depth of each chest compression, spaced horizontally in a manner along a time axis. The chest compression bars descend from an axis toward another set of axes, which specify the desirable or optimal range of depth for each chest compression. A qualitative indicator bar, shown in the upper right, gives the user a combined visual feedback relating to depth and rate of chest compressions; a full box means that both the rate and depth are within desired limits. The letter "R" on FIG. 58 indicates a potential alert regarding the rate of the chest compressions, and the letter "D" on FIG. 61 indicates a potential alert regarding the depth of chest compressions, according to embodiments of the present invention. According to embodiments of the present invention, the CPR feedback screen of device 626 provides information about the rate and volume of patient ventilation.

[00266] According to embodiments of the present invention, the patient monitoring device 106 and/or EMS communications interface device 2000 and/or the BOA device 104 includes a filtering mechanism (e.g. a circuit or processing instructions) that filters or removes chest compression interference from ECG signal data. Embodiments of the present invention may include a device or utilize a method similar to those described in U.S. Patent No. 7,295,871, issued Nov. 13, 2007, which is incorporated by reference herein. Embodiments of the present invention may also employ Real CPR Help ® technology available from Zoll Medical Corporation.

[00267] The use of role-based information delivery and intervention tracking permits a more efficient EMS treatment scenario by filtering data based on role, according to embodiments of the present invention. For example, the drug medic, airway medic, and

CPR medic do not have menu tab selections available for patient data entry or for chief complaint entry, while the lead medic has those options.

[00268] Although only four mobile devices 620, 622, 624, and 626 are shown in FIG. 62, the BOA device 104 may communicably couple with a greater or fewer number of role-based mobile devices. Also, although particular intervention options and data feed displays are shown as being related to particular roles, one of ordinary skill in the art, based on the present disclosure, will appreciate the numerous different roles that may be identified and implemented, as well as the numerous different data feeds and/or options that may be associated with each role. Further, mobile devices (e.g. 620) may be configured to communicably couple with multiple BOA devices 104 and/or to receive information for multiple patients from the same BOA device 104, to permit the medic to toggle between various patient data feeds and/or to treat different patients, possibly in different roles, according to embodiments of the present invention.

[00269] According to embodiments of the present invention, the software modules and hardware contained within the BOA device 104 for feeding the data to and from the mobile devices 620 may be consolidated into an EMS communications interface device 2000, and/or directly into a patient monitoring device 106.

[00270] Various modifications and additions can be made to the exemplary embodiments discussed without departing from the scope of the present invention. For example, while the embodiments described above refer to particular features, the scope of this invention also includes embodiments having different combinations of features and embodiments that do not include all of the described features. Accordingly, the scope of the present invention is intended to embrace

all such alternatives, modifications, and variations as fall within the scope of the claims, together with all equivalents thereof.

CLAIMS

What is claimed is:

1. A system for collecting and displaying emergency medical services information, the system comprising:

a clinical device configured to gather clinical data related to a clinical encounter;

a non-clinical device configured to gather non-clinical data related to the clinical encounter; wherein emergency medical services information includes at least some of the clinical data and at least some of the non-clinical data;

a database;

a display device; and

a processor communicably coupled to the clinical device, the non-clinical device, the database, and the display device, the processor configured to receive the emergency medical services information, store the emergency medical services information in the database, and display the emergency medical services information on the display device according to an information template.

2. The system of claim 1, wherein the clinical device is a defibrillator.

3. The system of claim 1, wherein the processor is further configured to display on the display device a differential diagnosis indication based on the emergency medical services information.

4. The system of claim 1, wherein the information template is stored in the database.

5. The system of claim 1, wherein the processor is configured to display at least some of the clinical data and at least some of the non-clinical data simultaneously on the display device.

6. The system of claim 1, wherein the non-clinical device is a navigation device configured to make available navigation information, and wherein the non-clinical data is the navigation information.

7. The system of claim 1, wherein the non-clinical device is a patient charting device configured to make available patient charting information, and wherein the non-clinical data is the patient charting information.

8. The system of claim 1 further comprising an emergency services vehicle, wherein the display device is mounted in the emergency services vehicle.

9. The system of claim 8, wherein the emergency services vehicle is an ambulance, and wherein the display device is mounted in a back section of the ambulance.

10. The system of claim 8, further comprising:

an enterprise server communicably coupled to the processor, the enterprise server configured to receive

the emergency medical services information from the processor and send the emergency medical services information to an enterprise environment via a web browser interface.

11. The system of claim 10, wherein the web browser interface is substantially similar to an interface displayed on the display device.

12. The system of claim 10, wherein the database is a mobile database, the system further comprising an enterprise database on a storage medium, wherein the enterprise server is further configured to store at least a portion of the emergency medical services information in the enterprise database.

13. A system for collecting and displaying emergency medical services information, the system comprising:

a patient monitoring device configured to monitor a patient and to make available patient monitoring information;

a patient charting device configured to make available patient charting information, wherein emergency medical services information includes at least some of the patient monitoring information and at least some of the patient charting information;

a database;

a display device; and

a processor communicably coupled to the patient monitoring device, the patient charting device, the database, and the display device, the processor configured to receive

the emergency medical services information, store the emergency medical services information in the database, and display the emergency medical services information on the display device according to an information template.

14. The system of claim 13, wherein the patient monitoring device is a defibrillator.

15. The system of claim 13, wherein the information template is stored in the database.

16. The system of claim 13, wherein processor is further configured to display on the display device a differential diagnosis indication based on the emergency medical services information.

17. The system of claim 13, wherein the processor is configured to display at least some of the patient charting information and at least some of the patient monitoring information simultaneously on the display device.

18. The system of claim 13, further comprising a navigation device configured to make available navigation information, wherein the processor is communicably coupled to the navigation device, and wherein the emergency medical services information further includes at least some of the navigation information.

19. The system of claim 18, wherein the processor is configured to display at least some of the patient charting information, at least some of the patient monitoring information, and at least some of the navigation information simultaneously on the display device.

20. The system of claim 18, wherein the navigation information is information about location of an emergency medical services vehicle.

21. The system of claim 13 further comprising an emergency services vehicle, wherein the display device is mounted in the emergency services vehicle.

22. The system of claim 21, wherein the emergency services vehicle is an ambulance, and wherein the display device is mounted in a back section of the ambulance.

23. The system of claim 13, wherein the display device includes a touch screen input device for sending instructions to the processor.

24. The system of claim 13, wherein the display device and the processor are part of a tablet PC.

25. The system of claim 13, wherein the display device cycles display between an information template comprising primarily patient monitoring information and an information template comprising primarily patient charting information.

26. The system of claim 13, wherein the display device cycles display between an information template comprising primarily patient monitoring information, an information template comprising primarily patient charting information, and a patch notes information template.

27. The system of claim 13, further comprising:

an enterprise server communicably coupled to the processor, the enterprise server configured to receive the emergency medical services information from the

processor and send the emergency medical services information to an enterprise environment via a web browser interface.

28. The system of claim 27, wherein the web browser interface is substantially similar to an interface displayed on the display device.

29. The system of claim 27, wherein the database is a mobile database, the system further comprising an enterprise database on a storage medium, wherein the enterprise server is further configured to store at least a portion of the emergency medical services information in the enterprise database.

30. A system for collecting and displaying emergency medical services information, the system comprising:

a patient monitoring device configured to monitor a patient and to make available patient monitoring information;

a navigation device configured to make available navigation information about an emergency medical services vehicle, wherein emergency medical services information includes at least some of the patient monitoring information and at least some of the navigation information;

a database;

a display device; and

a processor communicably coupled to the patient monitoring device, the navigation device, the database, and the display device, the processor configured to receive the

emergency medical services information, store the emergency medical services information in the database, and display the emergency medical services information on the display device according to an information template.

31. A system for collecting and displaying emergency medical services information, the system comprising:

a patient monitoring device configured to monitor a patient in a medical emergency and to make available patient monitoring information;

a display device configured for placement in a mobile environment for deployment in the medical emergency;

an EMS device that does not monitor the patient but that records or observes information about the medical emergency, the EMS device configured to make available EMS information based on recorded or observed information; and

a processor communicably coupled to the patient monitoring device, the EMS device, and the display device, the processor configured to display at least a portion of the patient monitoring information and the EMS information on the display device according to a data model.

32. The system of claim 31, wherein the EMS device is a patient charting device, and wherein the EMS information is patient charting information.

33. The system of claim 31, wherein the EMS device is a navigation device, and wherein the EMS information is navigation information about the mobile environment.

34. The system of claim 31, wherein the patient monitoring device is a defibrillator.

35. The system of claim 31, wherein the EMS device is a first EMS device and the EMS information is a first type of EMS information, the system further comprising:

a second EMS device that does not monitor the patient but that records or observes information about the medical emergency, the second EMS device configured to make available a second type of EMS information different from the first type of EMS information,

wherein the processor is communicably coupled to the second EMS device, and is configured to display at least a portion of the second type of EMS information on the display device.

36. The system of claim 35, wherein the first EMS device is a patient charting device, wherein the first type of EMS information is patient charting information, wherein the second EMS device is a navigation device, and wherein the second type of EMS information is navigation information about the mobile environment.

37. The system of claim 31, further comprising:

an enterprise server communicably coupled to the processor, the enterprise server configured to receive

the EMS information and the patient monitoring information from the processor and send the EMS information and patient monitoring information to an enterprise environment via a web browser interface.

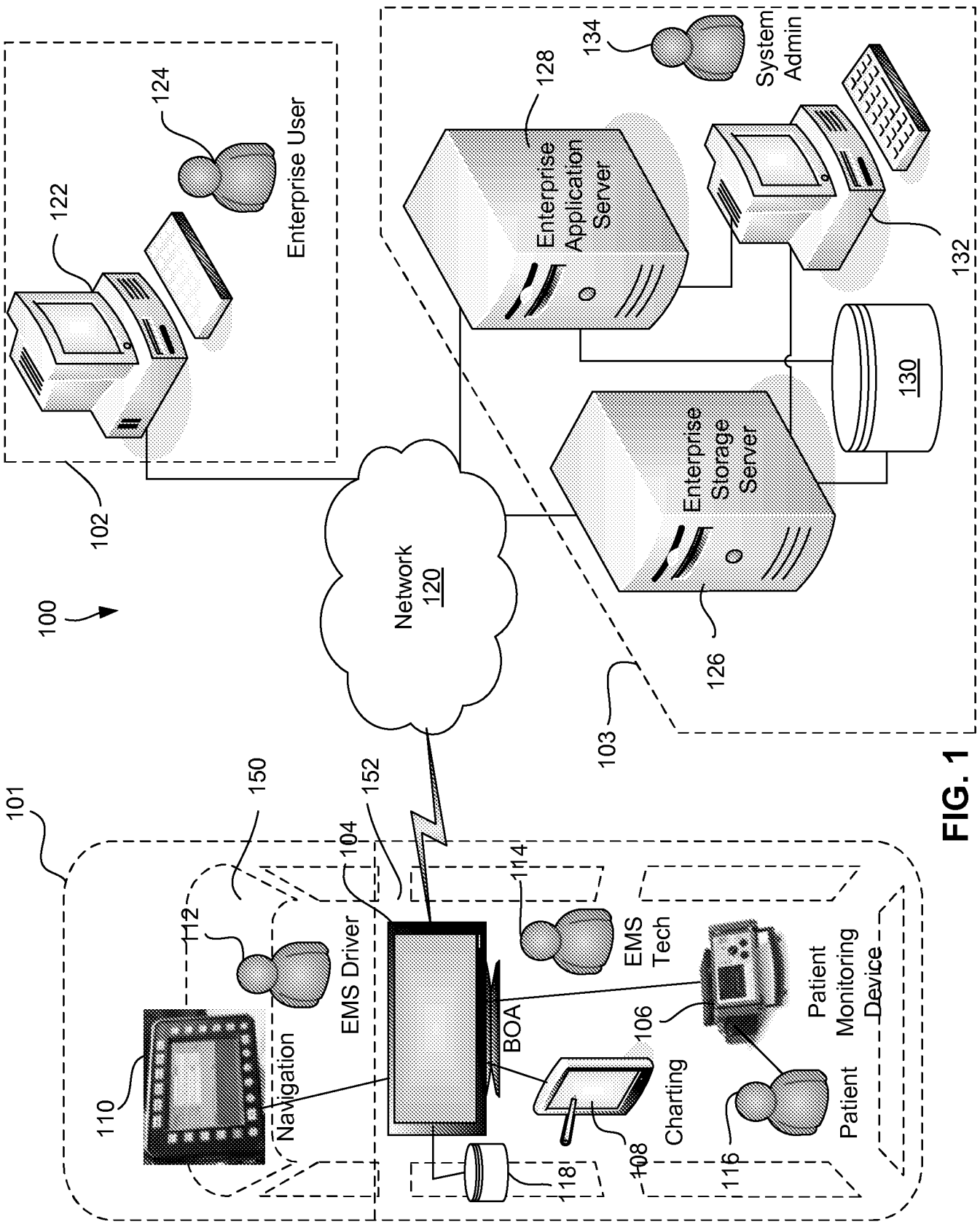
38. The system of claim 37, wherein the enterprise environment is a hospital.

SYSTEMS AND METHODS FOR COLLECTION, ORGANIZATION AND DISPLAY OF EMS INFORMATION

ABSTRACT

A system for collecting and displaying emergency medical services information according to embodiments of the present invention includes a patient monitoring device configured to monitor a patient, a navigation device, a patient charting device, a database, a display device, and a processor communicably coupled to the defibrillator, the navigation device, the patient charting device, the database, and the display device. According to embodiments of the present invention, the processor is configured to receive emergency medical services information from the defibrillator device, the navigation device, and the patient charting device, store the emergency medical services information in the database, and display the emergency medical services information on the display device according to an information template. According to some embodiments, aggregated data feeds from one or more such processors are stored in a remote server and available to remote enterprise users via a secure web interface.

fb.us.5462654.01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152
Enterprise User
Network
120
Enterprise
Application
Server
Enterprise
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Server
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Admin
EMS Driver
Navigation
BOA
EMS
Tech
Charting
Patient
Patient
Monitoring
Device

FIG. 1

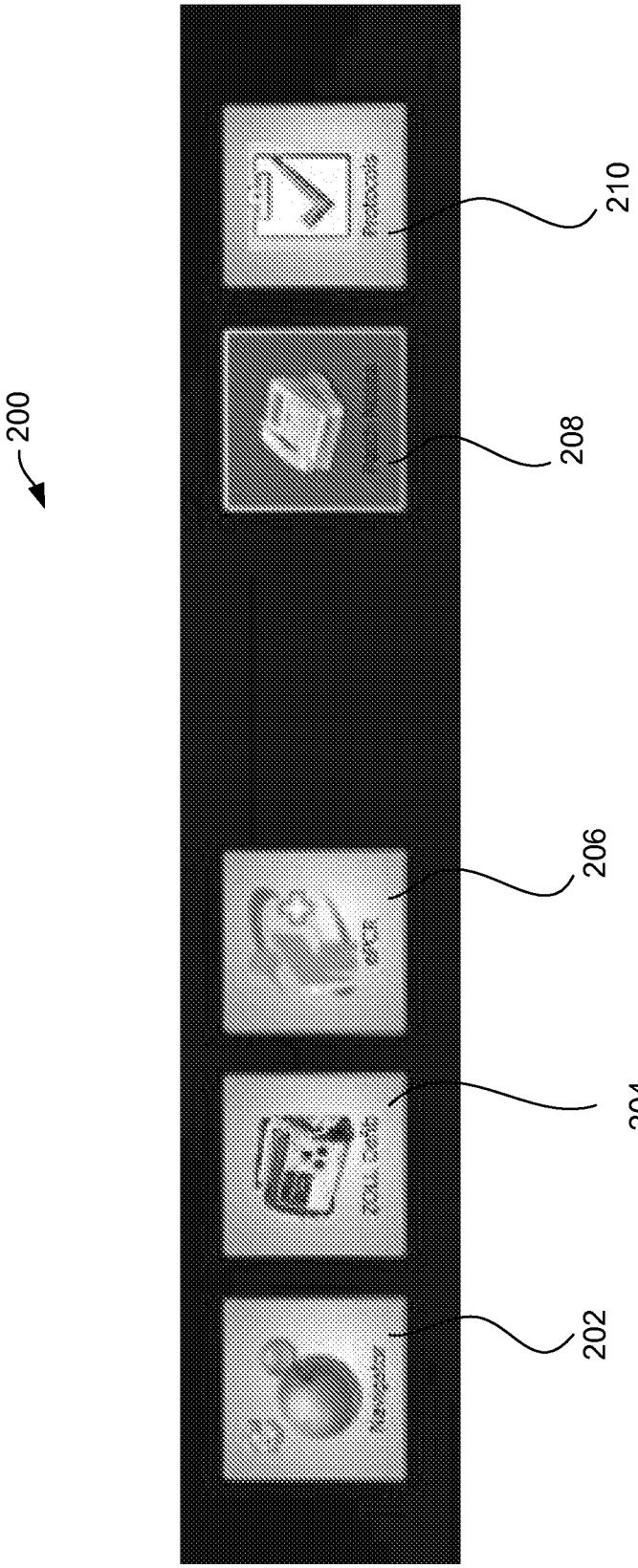
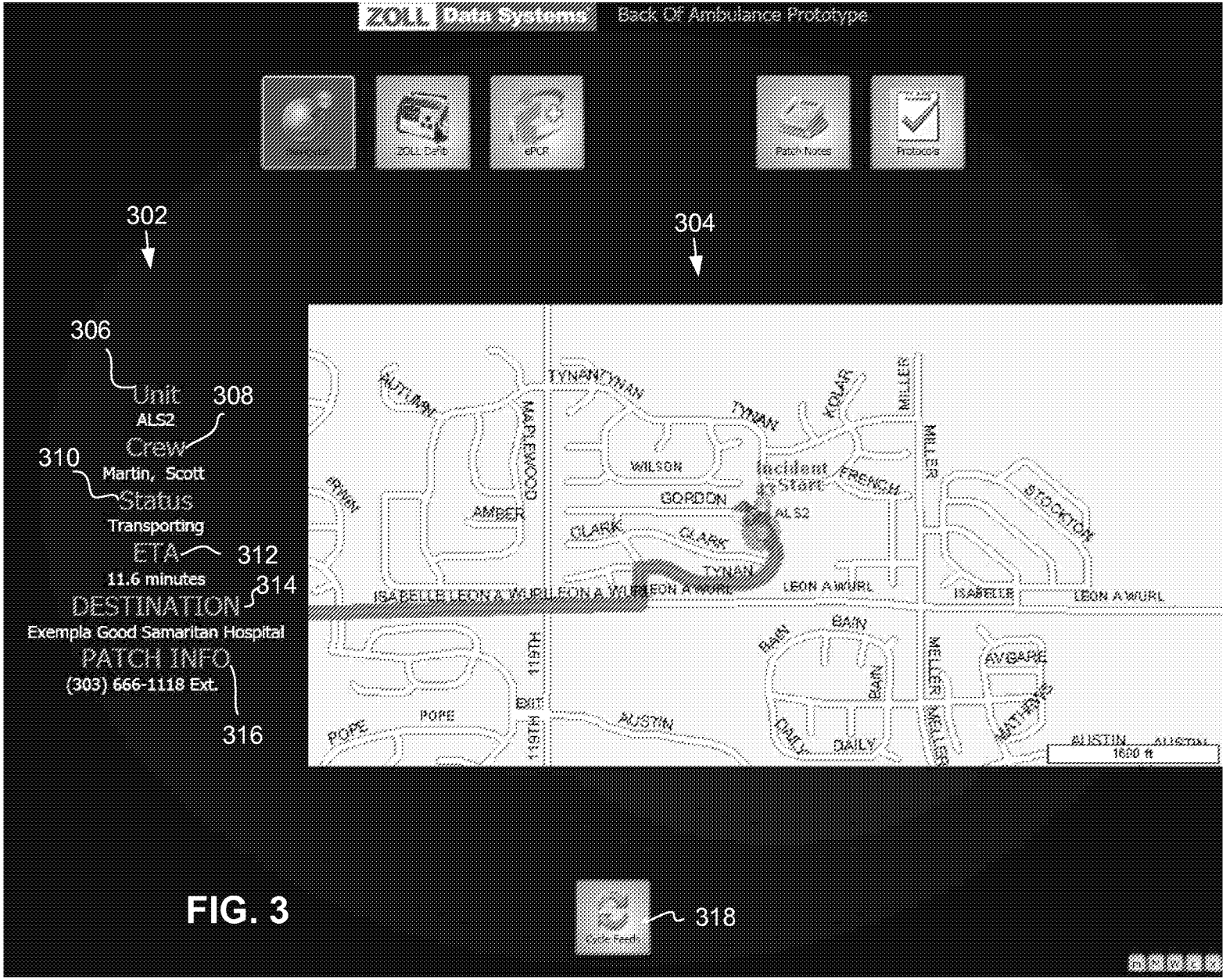


FIG. 2


ZOLL Data Systems
Back Of Ambulance Prototype
ZOLL Defib
ePCR
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Status
Transporting
ETA
312
11.6 minutes
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DESTINATION
Exempla Good Samaritan Hospital
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318
TYNAN
WILSON
GORDON
CLARK
AMBER
MAPLEWOOD
AUTUMN
KOLAR
MILLER
FRENCH
STOCKTON
ISABELLE
LEON A WURL
BAIN
DAILY
AVGARE
MATHEWS
AUSTIN
POPE
119TH
EXIT
1600 ft

FIG. 3

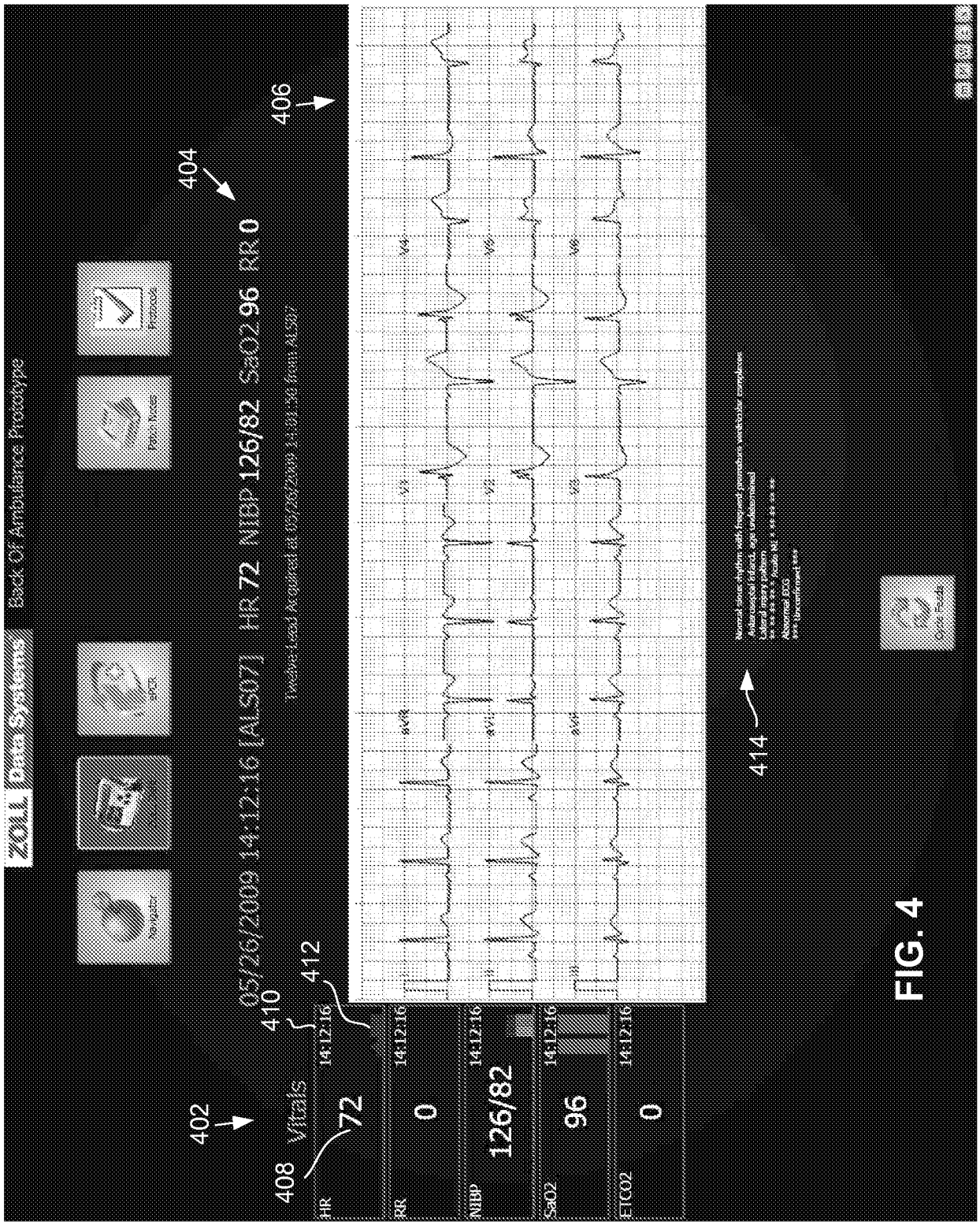

ZOLL Data Systems
Back Of Ambulance Prototype
05/26/2009 14:12:16 [ALS07] HR 72 NIBP 126/82 SaO2 96 RR 0
Vitals
HR
72
RR
0
NIBP
126/82
SaO2
96
ETCO2
0
14:12:16
402
404
406
408
410
412
414

FIG. 4

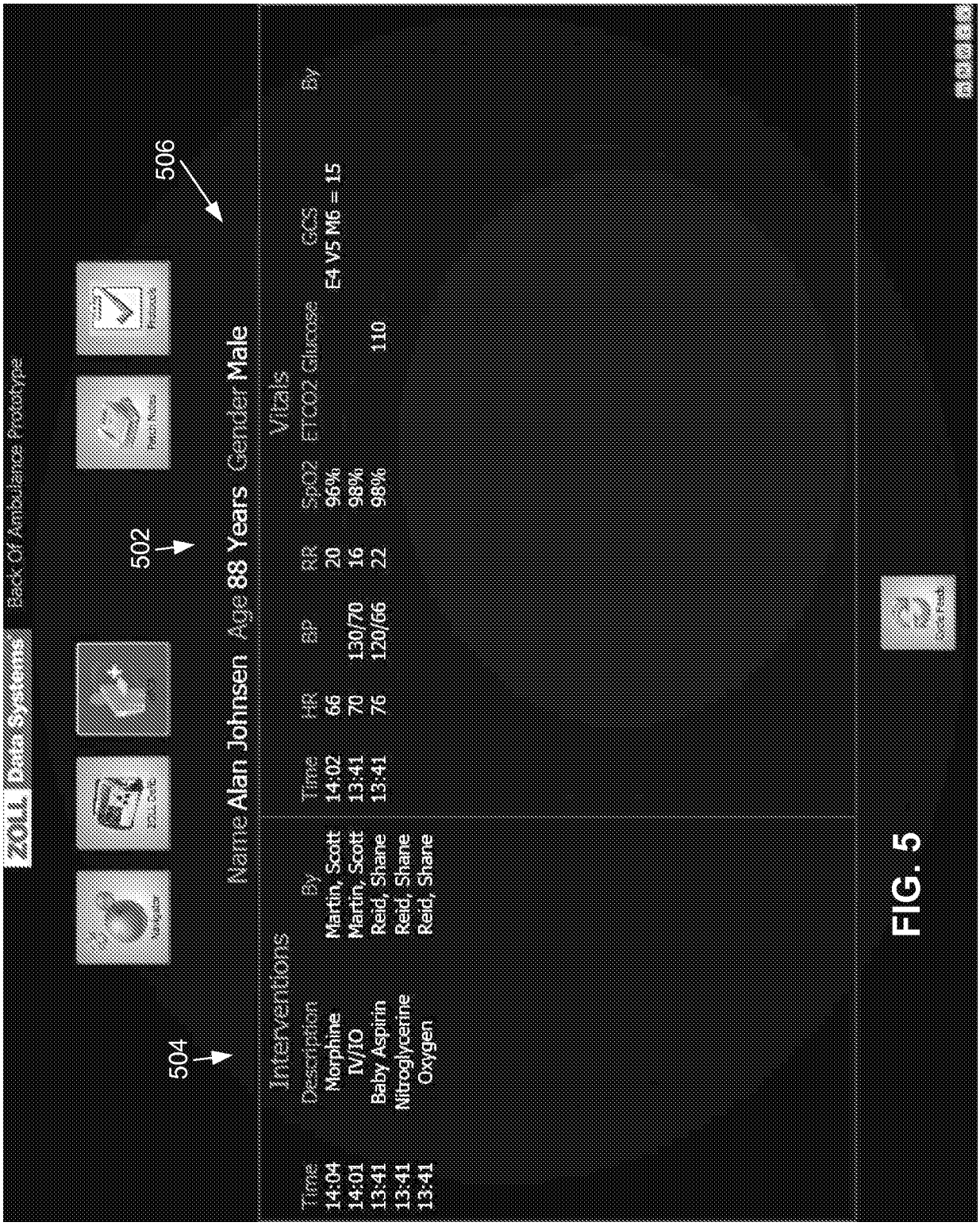

ZOLL Data Systems
Back Of Ambulance Prototype
Name Alan Johnsen Age 88 Years Gender Male
504
502
506
Interventions
Time
By
Description
14:04
Martin, Scott
Morphine
14:01
Martin, Scott
IV/IO
13:41
Reid, Shane
Baby Aspirin
13:41
Reid, Shane
Nitroglycerine
13:41
Reid, Shane
Oxygen
Vitals
Time
HR
BP
RR
SpO2
ETCO2
Glucose
GCS
By
14:02
66
20
96%
E4 V5 M6 = 15
13:41
70
130/70
16
98%
13:41
76
120/66
22
98%
110

FIG. 5

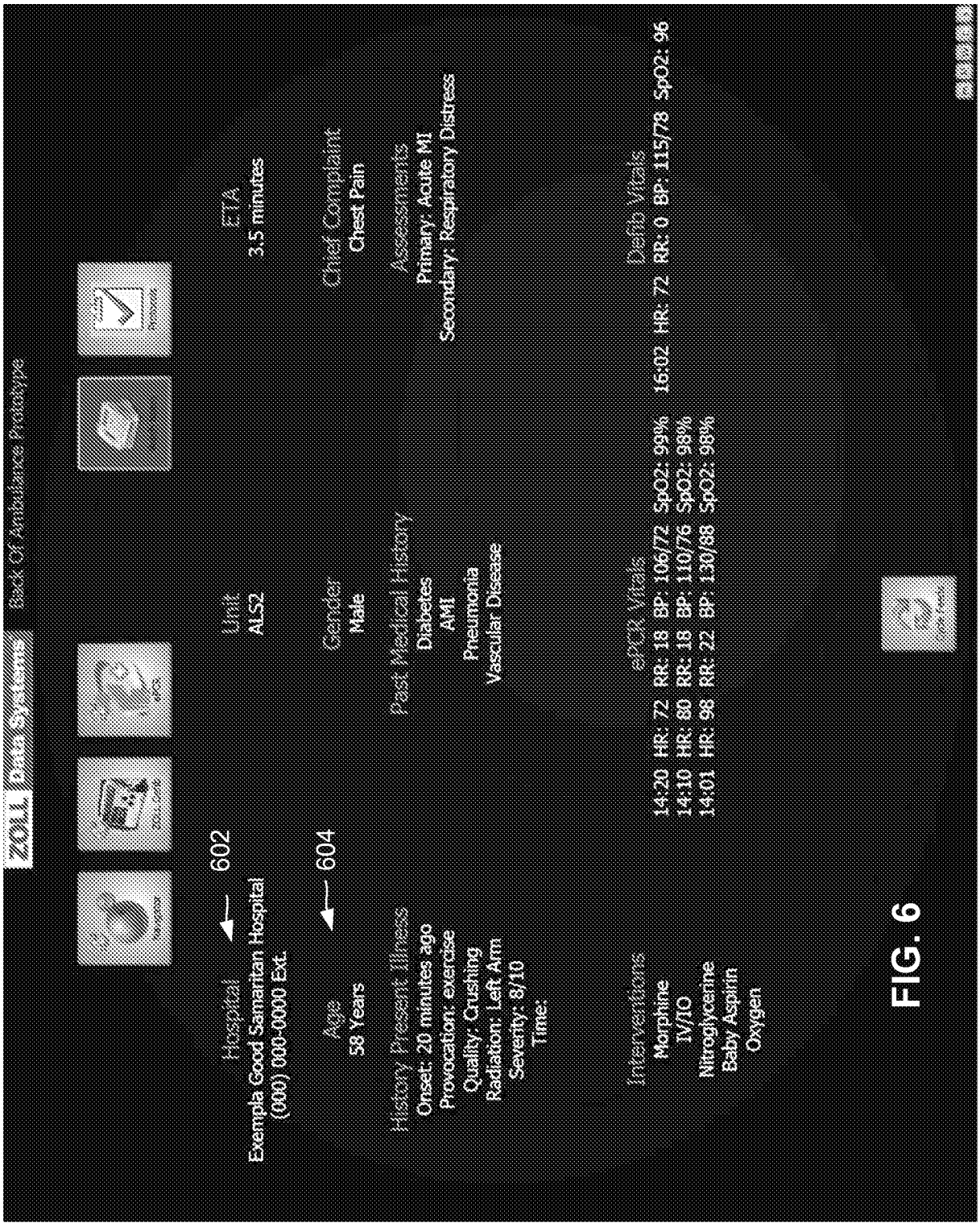

ZOLL Data Systems
Back Of Ambulance Prototype
602
604
Hospital
Exempla Good Samaritan Hospital
(000) 000-0000 Ext.
Unit
ALS2
ETA
3.5 minutes
Age
58 Years
Gender
Male
Chief Complaint
Chest Pain
History Present Illness
Onset: 20 minutes ago
Provocation: exercise
Quality: Crushing
Radiation: Left Arm
Severity: 8/10
Time:
Past Medical History
Diabetes
AMI
Pneumonia
Vascular Disease
Assessments
Primary: Acute MI
Secondary: Respiratory Distress
Interventions
Morphine
IV/IO
Nitroglycerine
Baby Aspirin
Oxygen
ePCR Vitals
14:20 HR: 72 RR: 18 BP: 106/72 SpO2: 99%
14:10 HR: 80 RR: 18 BP: 110/76 SpO2: 98%
14:01 HR: 98 RR: 22 BP: 130/88 SpO2: 98%
Defib Vitals
16:02 HR: 72 RR: 0 BP: 115/78 SpO2: 96

FIG. 6

ZOLL
Back Of Ambulance Prototype
El Paso County Protocol Index
El Paso County Guidelines
Chapter 1 : Assessment
Chapter 2 : Medical
Chapter 3 : Pediatric
Chapter 4 : Trauma
Chapter 5 : Environmental
Chapter 6 : HazMat
Chapter 7 : Procedures
Chapter 8 : Medications
Chapter 9 : Operations

FIG. 7

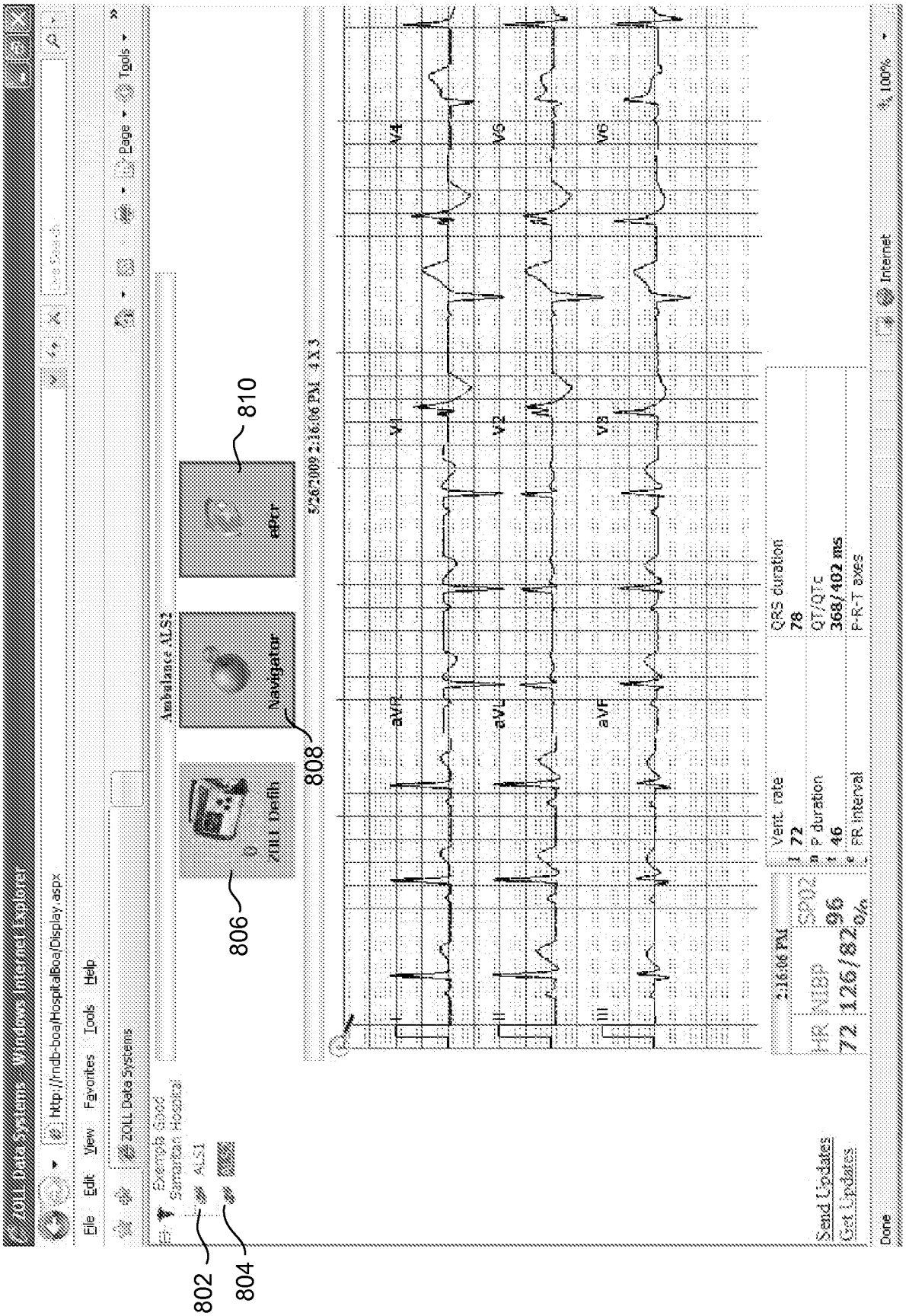

ZOLL Data Systems - Windows Internet Explorer
http://rndb-boa/HospitalBoa/Display.aspx
File Edit View Favorites Tools Help
ZOLL Data Systems
Exemplo Good Samaritan Hospital
ALS1
Ambulance ALS2
ZOLL Defib
Navigator
ePCR
5/26/2009 2:16:06 PM 4 X 3
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
Vent. rate
72
P duration
46
PR interval
QRS duration
78
QT/QTc
368/402 ms
P-R-T axes
2:16:06 PM
HR
NIBP
SPO2
72
126/82
96
Send Updates
Get Updates
Done
Internet
100%
802
804
806
808
810

FIG. 8

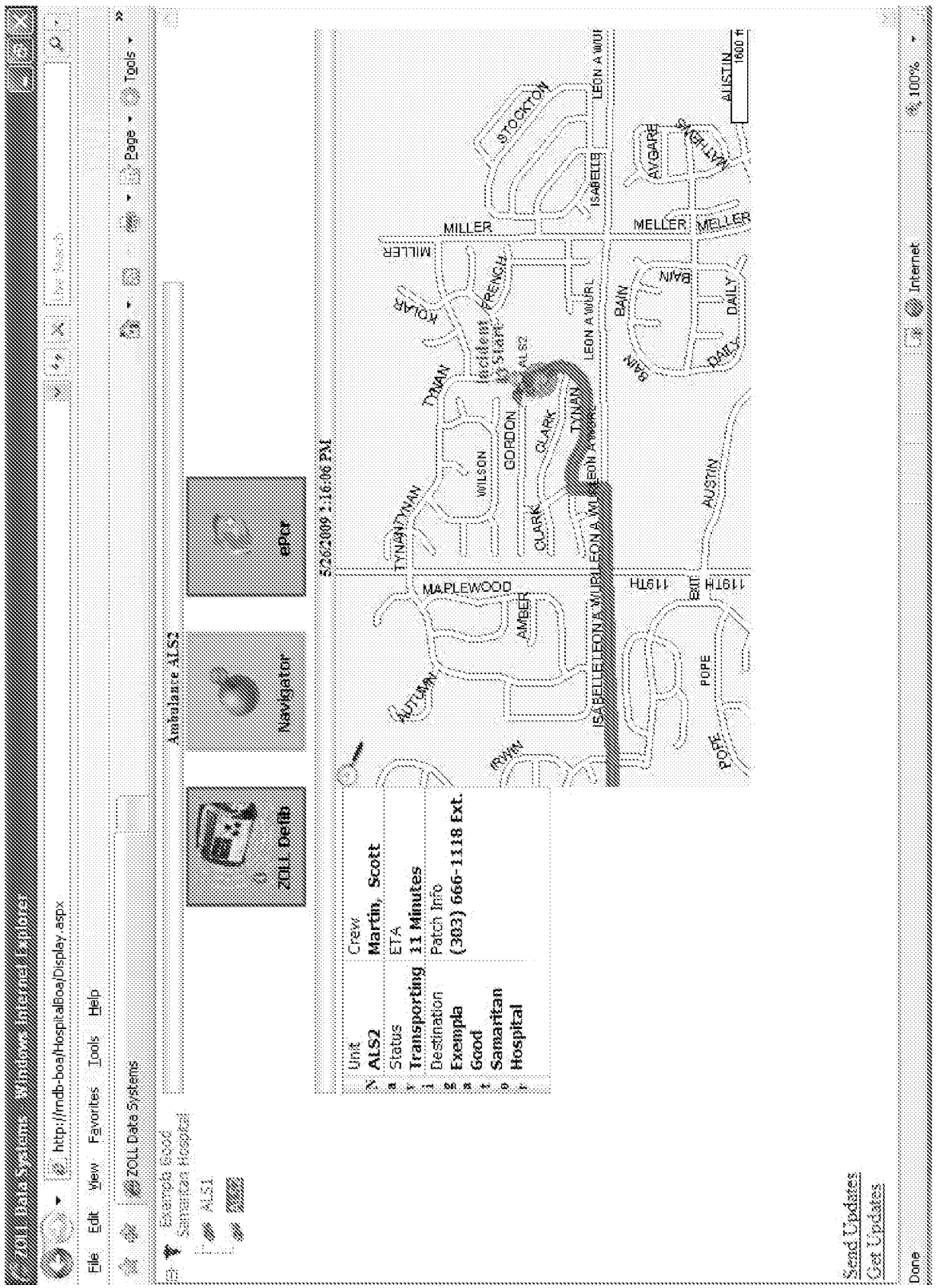

ZOLL Data Systems - Windows Internet Explorer
http://rmdb-boa/HospitalBoa/Display.aspx
File Edit View Favorites Tools Help
ZOLL Data Systems
Page Tools
Example Good Samaritan Hospital
ALS1
ALS2
Ambulance ALS2
ZOLL Defib
Navigator
ePCR
5/26/2009 2:16:06 PM
Unit ALS2
Crew Martin, Scott
Status Transporting
ETA 11 Minutes
Destination Example Good Samaritan Hospital
Patch Info (303) 666-1118 Ext.
Send Updates
Get Updates
Done
Internet
100%
MAPLEWOOD
AUTUMN
AMBER
IRWIN
TYNAN
WILSON
GORDON
CLARK
LEON A WURL
ISABELLE
MILLER
STOCKTON
FRENCH
BAIN
DAILY
AVGARE
MARTIN
AUSTIN
POPE
119TH
EXIT
MELLER
1600 ft

FIG. 9

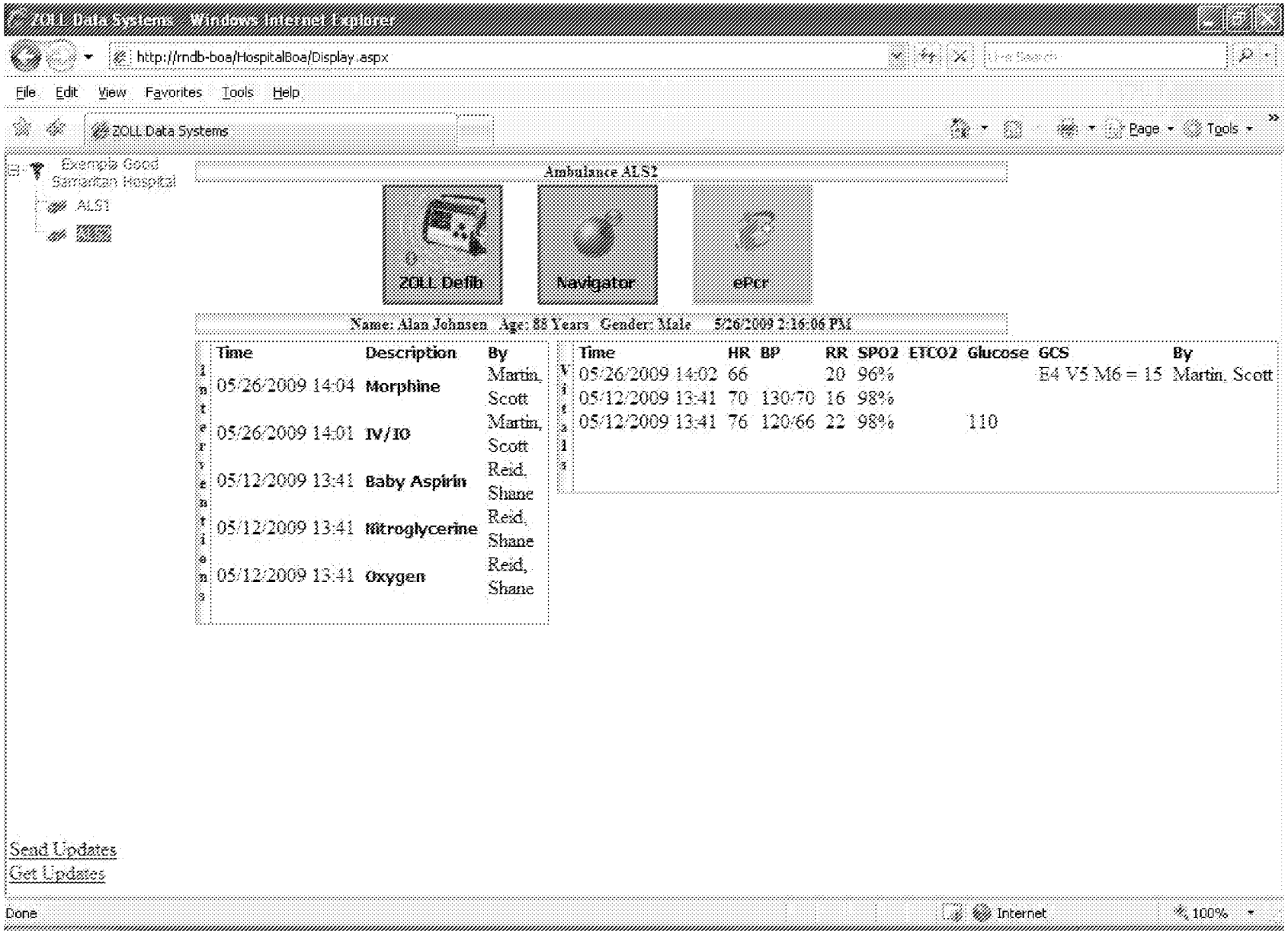

ZOLL Data Systems - Windows Internet Explorer
http://rndb-boa/HospitalBoa/Display.aspx
File Edit View Favorites Tools Help
ZOLL Data Systems
Page Tools
Example Good Samaritan Hospital
ALS1
Ambulance ALS2
ZOLL Defib
Navigator
ePcr
Name: Alan Johnsen Age: 88 Years Gender: Male 5/26/2009 2:16:06 PM
Interventions
Time Description By
05/26/2009 14:04 Morphine Martin, Scott
05/26/2009 14:01 IV/IO Martin, Scott
05/12/2009 13:41 Baby Aspirin Reid, Shane
05/12/2009 13:41 Nitroglycerine Reid, Shane
05/12/2009 13:41 Oxygen Reid, Shane
Vitals
Time HR BP RR SPO2 ETCO2 Glucose GCS By
05/26/2009 14:02 66 20 96% E4 V5 M6 = 15 Martin, Scott
05/12/2009 13:41 70 130/70 16 98%
05/12/2009 13:41 76 120/66 22 98% 110
Send Updates
Get Updates
Done
Internet
100%

FIG. 10

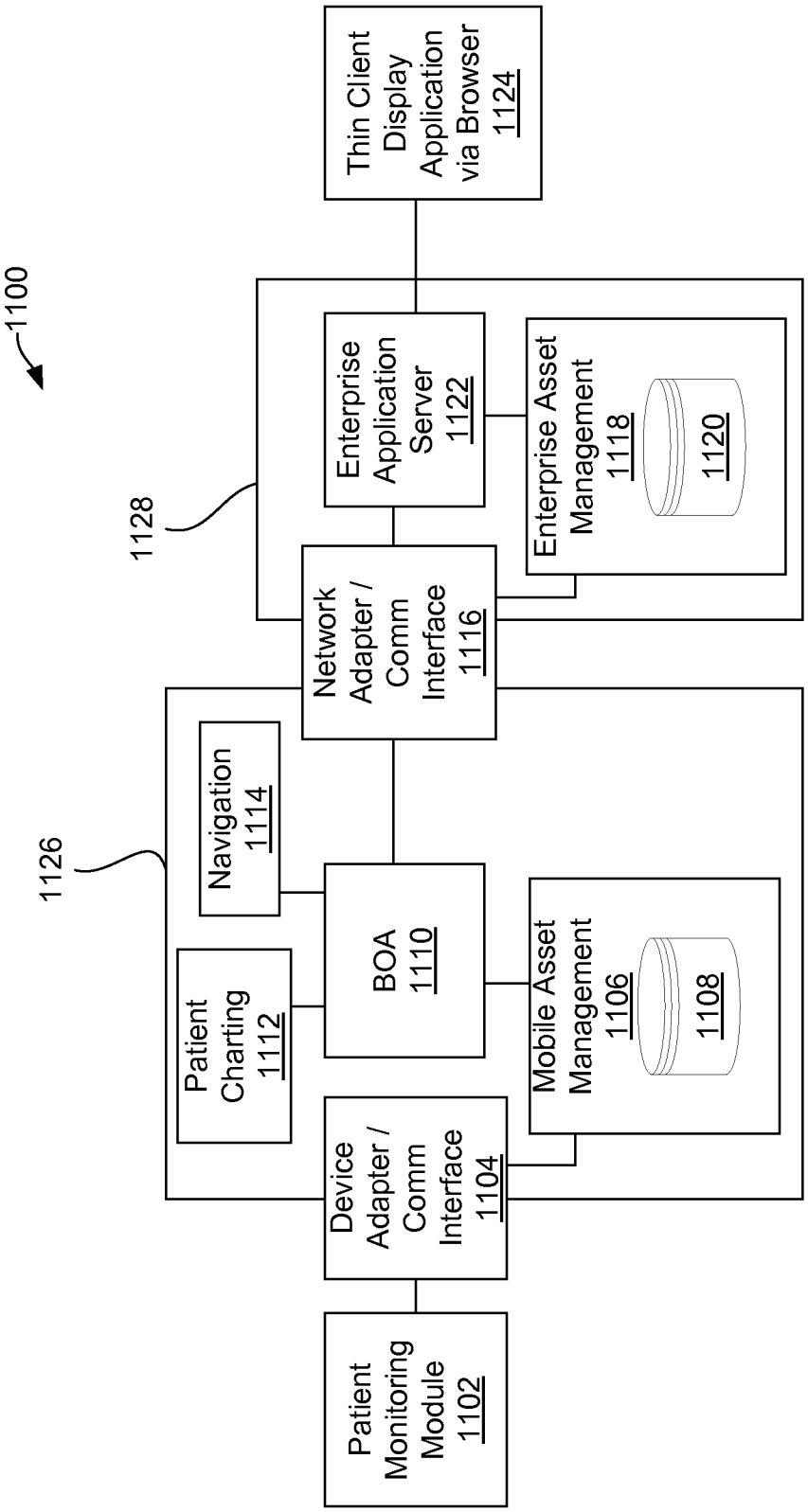

1100
Thin Client Display Application via Browser 1124
Enterprise Application Server 1122
Enterprise Asset Management 1118
1120
1128
Network Adapter / Comm Interface 1116
Navigation 1114
1126
Patient Charting 1112
BOA 1110
Mobile Asset Management 1106
1108
Device Adapter / Comm Interface 1104
Patient Monitoring Module 1102

FIG. 11

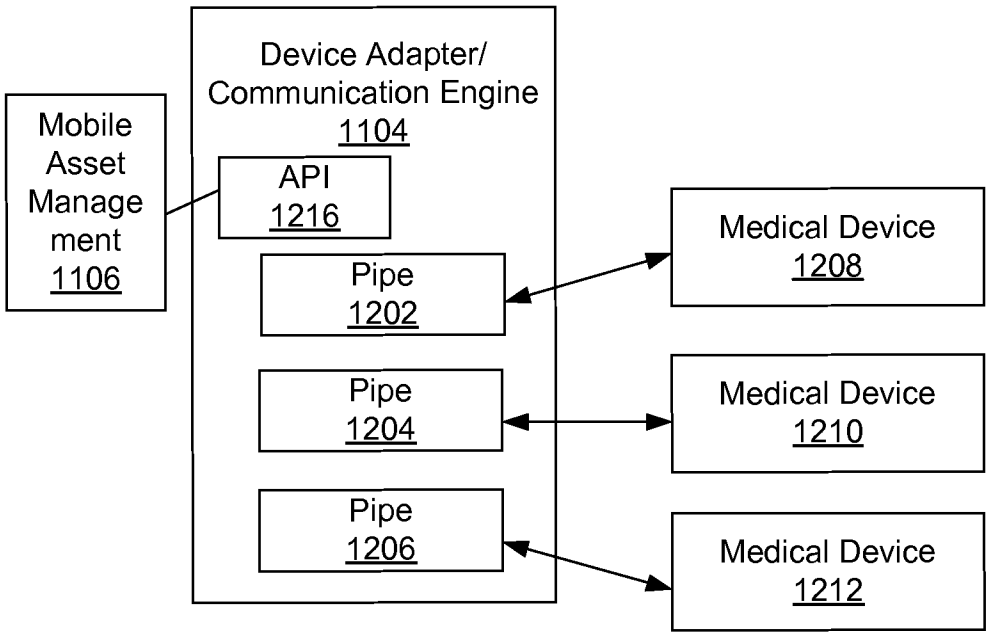

Device Adapter/
Communication Engine
1104
Mobile
Asset
Manage
ment
1106
API
1216
Pipe
1202
Pipe
1204
Pipe
1206
Medical Device
1208
Medical Device
1210
Medical Device
1212

FIG. 12

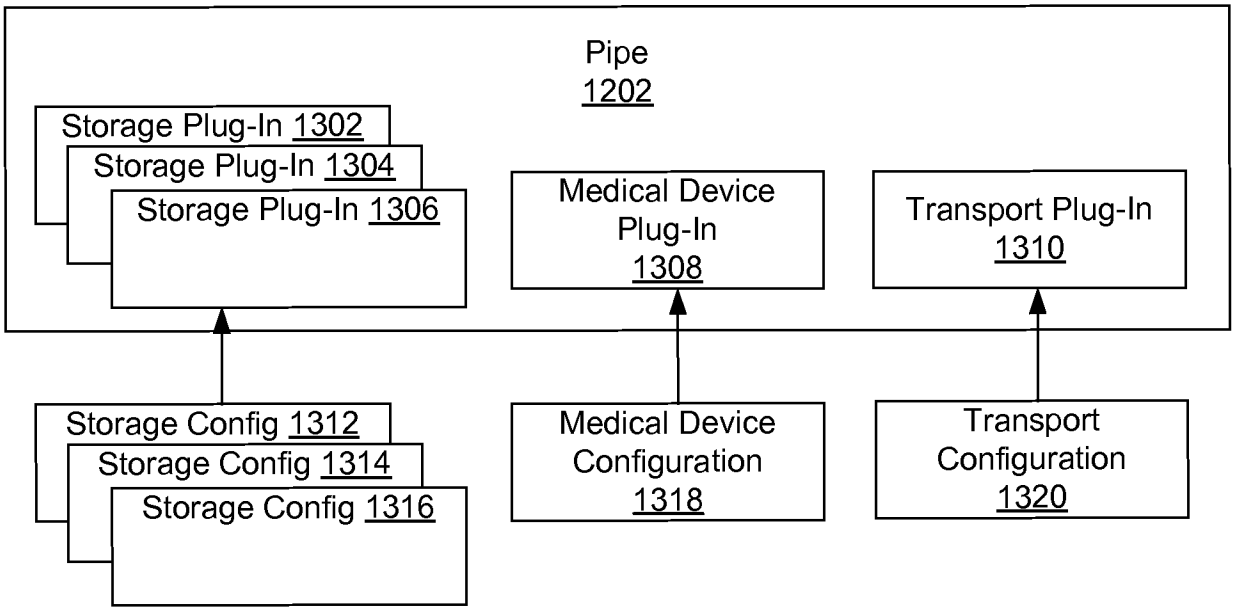

Pipe
1202
Storage Plug-In 1302
Storage Plug-In 1304
Storage Plug-In 1306
Medical Device
Plug-In
1308
Transport Plug-In
1310
Storage Config 1312
Storage Config 1314
Storage Config 1316
Medical Device
Configuration
1318
Transport
Configuration
1320

FIG. 13

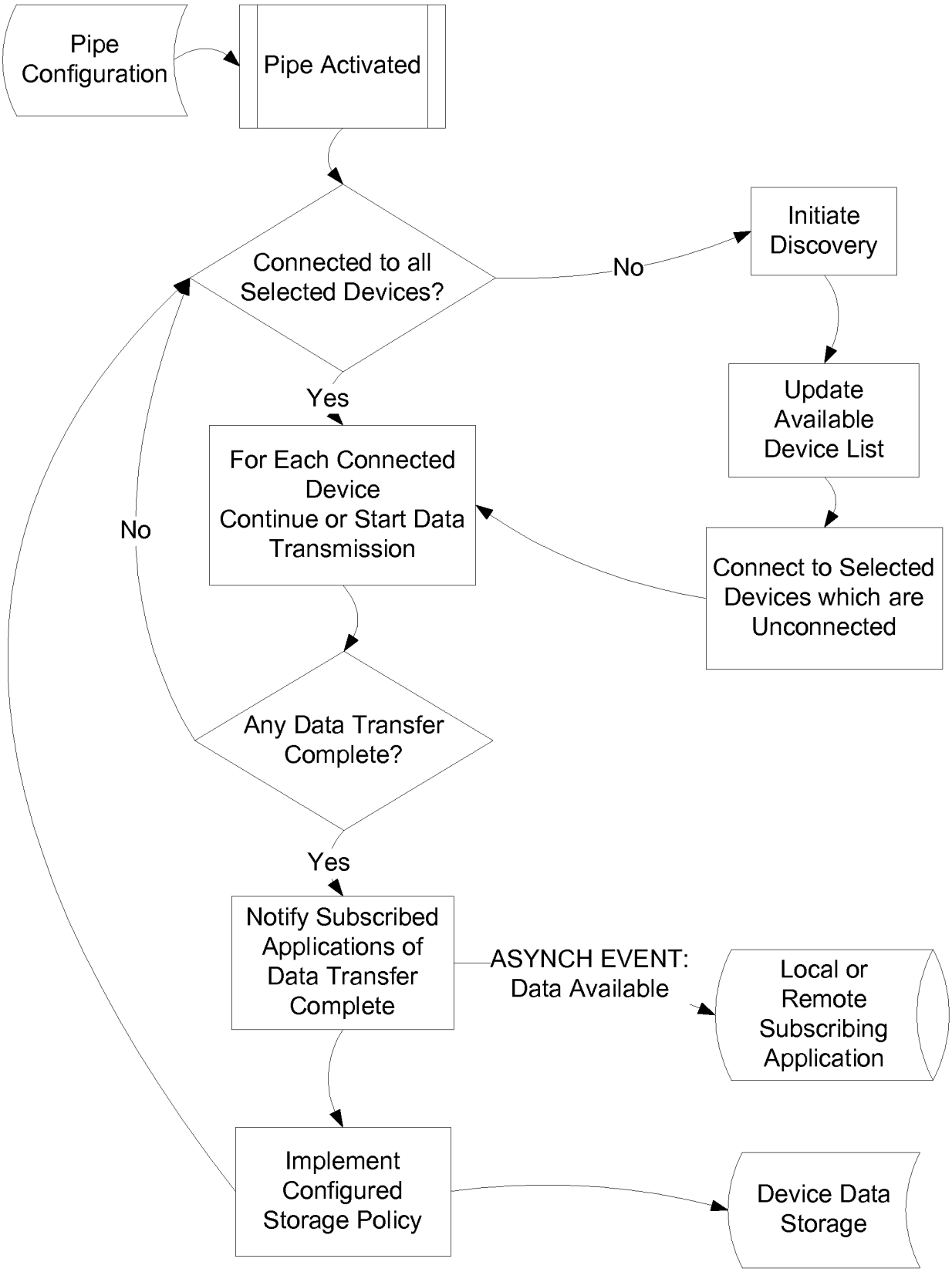

Pipe Configuration
Pipe Activated
Connected to all Selected Devices?
No
Initiate Discovery
Update Available Device List
Yes
For Each Connected Device Continue or Start Data Transmission
No
Connect to Selected Devices which are Unconnected
Any Data Transfer Complete?
Yes
Notify Subscribed Applications of Data Transfer Complete
ASYNCH EVENT: Data Available
Local or Remote Subscribing Application
Implement Configured Storage Policy
Device Data Storage

FIG. 14

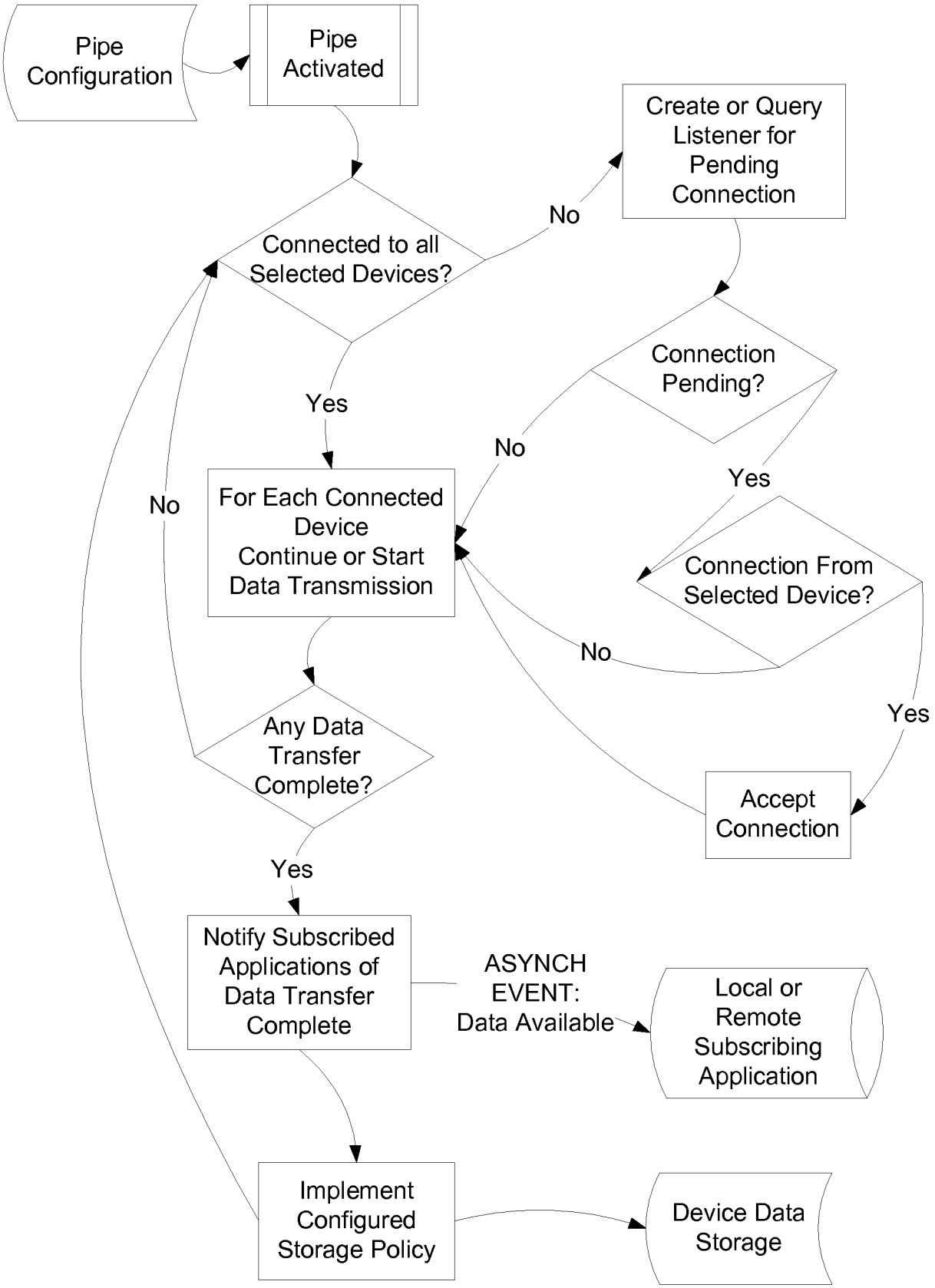

Pipe Configuration
Pipe Activated
Create or Query Listener for Pending Connection
No
Connected to all Selected Devices?
Yes
Connection Pending?
No
Yes
For Each Connected Device Continue or Start Data Transmission
No
Connection From Selected Device?
No
Yes
Any Data Transfer Complete?
Accept Connection
Yes
Notify Subscribed Applications of Data Transfer Complete
ASYNCH EVENT: Data Available
Local or Remote Subscribing Application
Implement Configured Storage Policy
Device Data Storage

FIG. 15

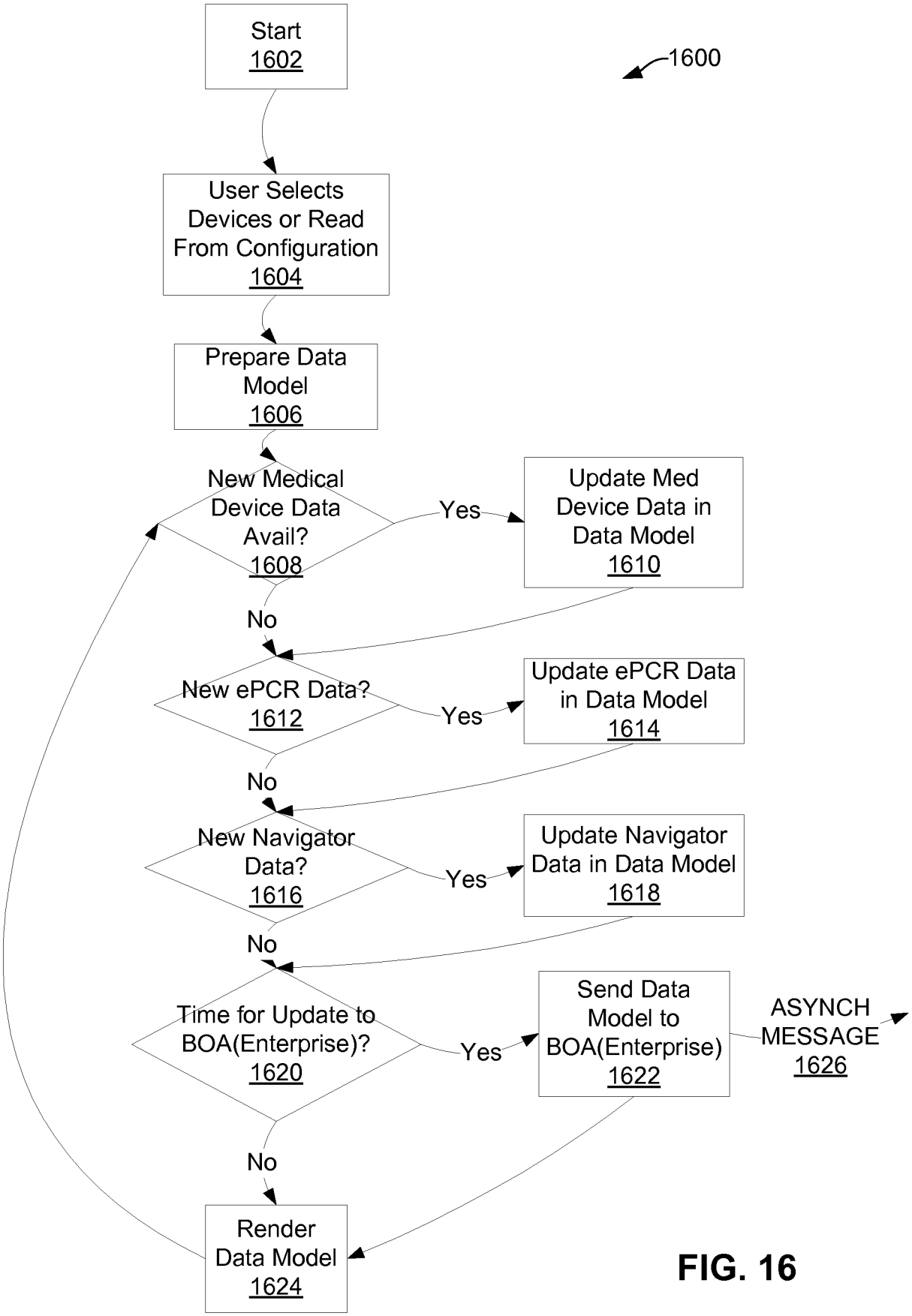

Start
1602
1600
User Selects Devices or Read From Configuration
1604
Prepare Data Model
1606
New Medical Device Data Avail?
1608
Yes
Update Med Device Data in Data Model
1610
No
New ePCR Data?
1612
Yes
Update ePCR Data in Data Model
1614
No
New Navigator Data?
1616
Yes
Update Navigator Data in Data Model
1618
No
Time for Update to BOA(Enterprise)?
1620
Yes
Send Data Model to BOA(Enterprise)
1622
ASYNCH MESSAGE
1626
No
Render Data Model
1624

FIG. 16

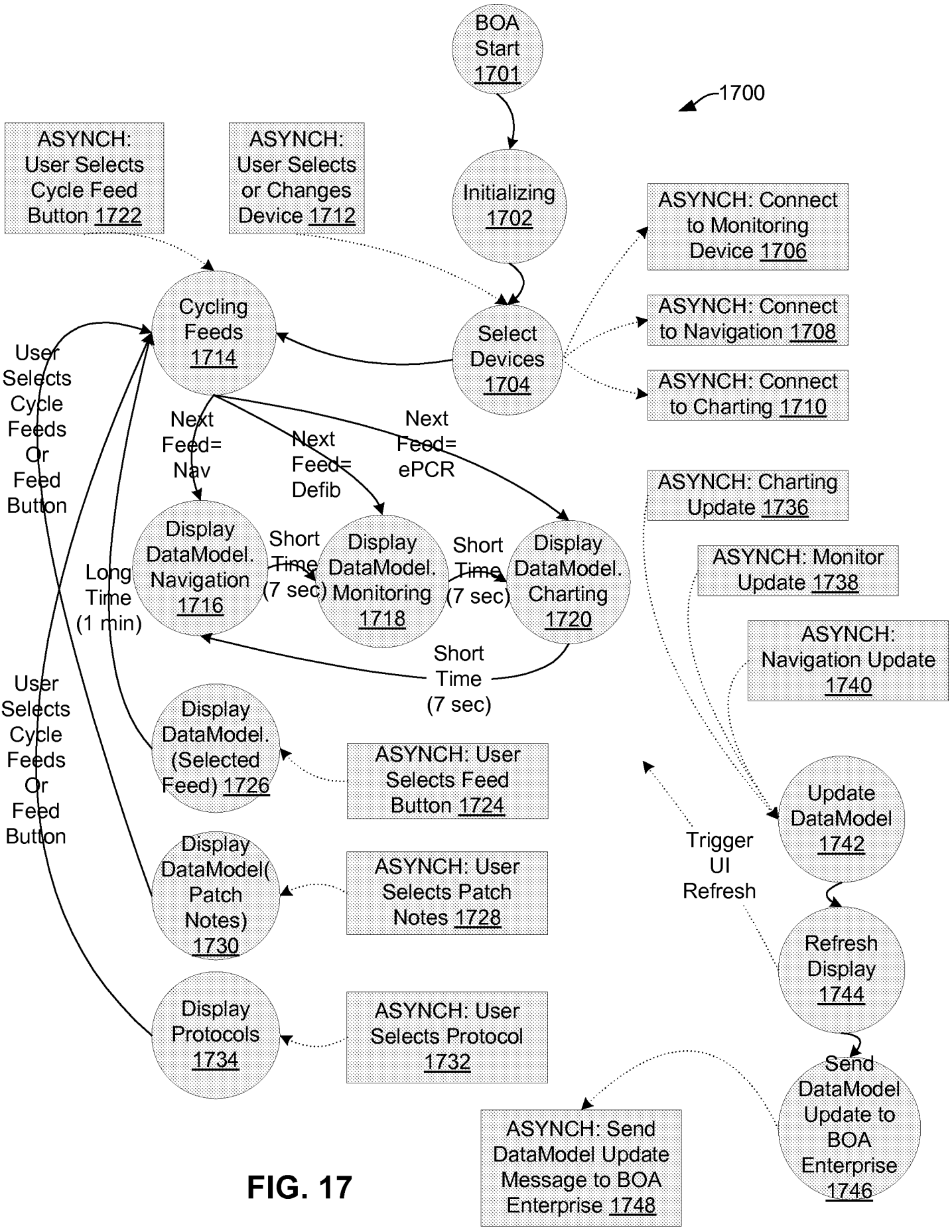

BOA Start 1701
1700
ASYNCH: User Selects Cycle Feed Button 1722
ASYNCH: User Selects or Changes Device 1712
Initializing 1702
ASYNCH: Connect to Monitoring Device 1706
Cycling Feeds 1714
Select Devices 1704
ASYNCH: Connect to Navigation 1708
ASYNCH: Connect to Charting 1710
User Selects Cycle Feeds Or Feed Button
Next Feed= Nav
Next Feed= Defib
Next Feed= ePCR
ASYNCH: Charting Update 1736
Display DataModel. Navigation 1716
Short Time (7 sec)
Display DataModel. Monitoring 1718
Short Time (7 sec)
Display DataModel. Charting 1720
ASYNCH: Monitor Update 1738
Long Time (1 min)
Short Time (7 sec)
ASYNCH: Navigation Update 1740
User Selects Cycle Feeds Or Feed Button
Display DataModel. (Selected Feed) 1726
ASYNCH: User Selects Feed Button 1724
Update DataModel 1742
Trigger UI Refresh
Display DataModel(Patch Notes) 1730
ASYNCH: User Selects Patch Notes 1728
Refresh Display 1744
Display Protocols 1734
ASYNCH: User Selects Protocol 1732
Send DataModel Update to BOA Enterprise 1746
ASYNCH: Send DataModel Update Message to BOA Enterprise 1748

FIG. 17

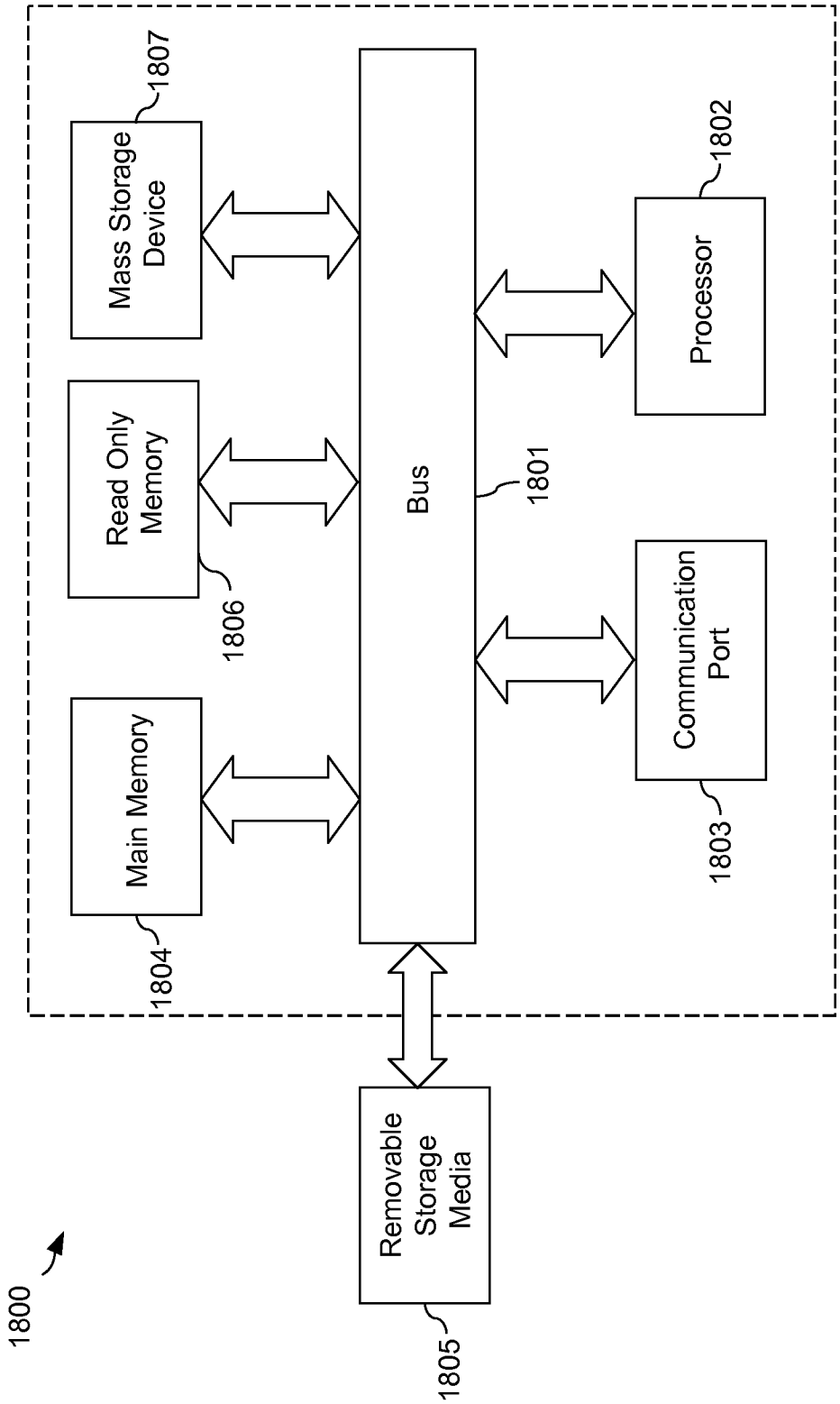

1800
Mass Storage Device
1807
Read Only Memory
1806
Main Memory
1804
Bus
1801
Processor
1802
Communication Port
1803
Removable Storage Media
1805

FIG. 18

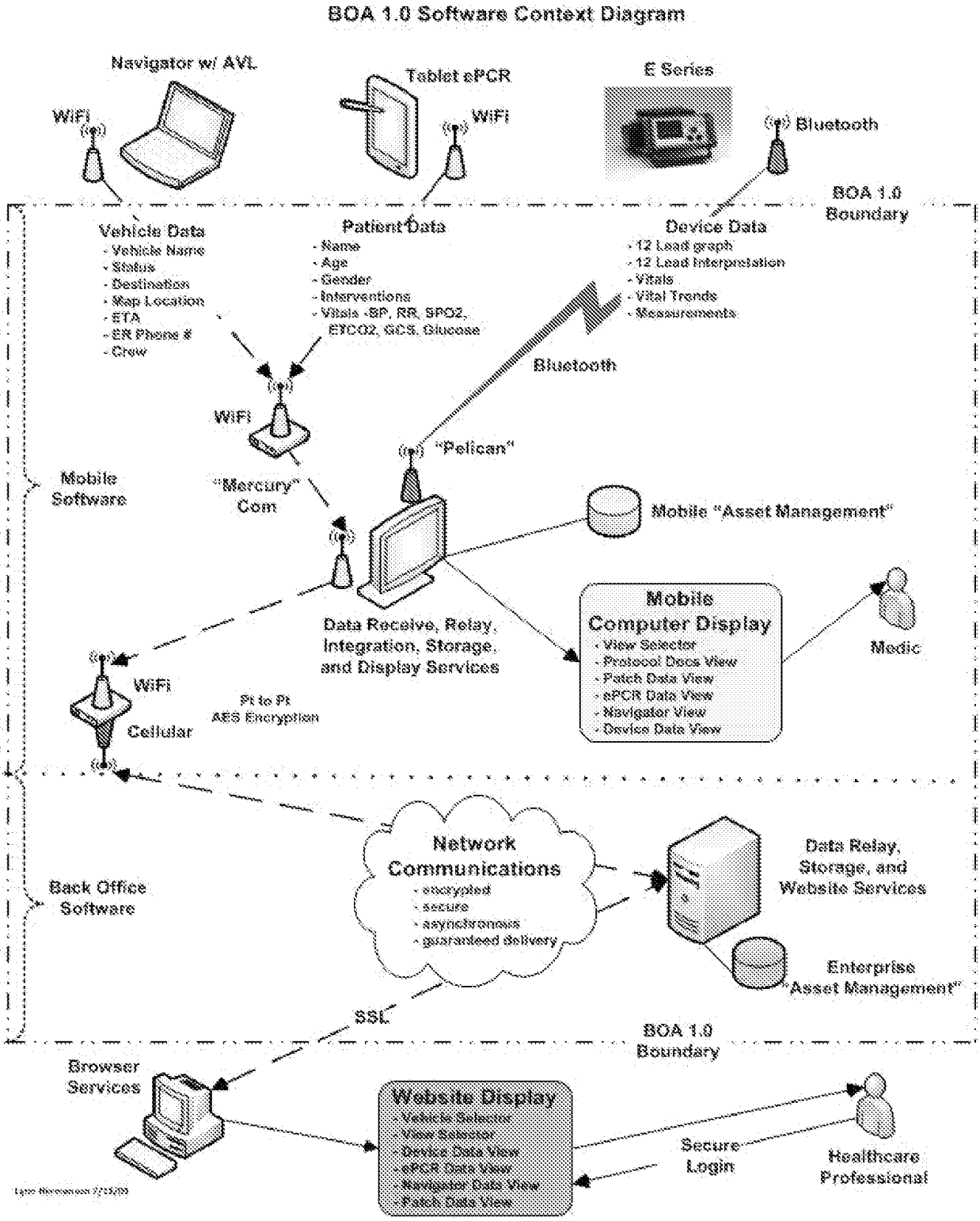

BOA 1.0 Software Context Diagram
Navigator w/ AVL
WiFi
Tablet ePCR
WiFi
E Series
Bluetooth
BOA 1.0 Boundary
Vehicle Data
- Vehicle Name
- Status
- Destination
- Map Location
- ETA
- ER Phone #
- Crew
Patient Data
- Name
- Age
- Gender
- Interventions
- Vitals -BP, RR, SPO2, ETCO2, GCS, Glucose
Device Data
- 12 Lead graph
- 12 Lead Interpretation
- Vitals
- Vital Trends
- Measurements
Bluetooth
WiFi
"Mercury" Com
"Pelican"
Mobile Software
Mobile "Asset Management"
Data Receive, Relay, Integration, Storage, and Display Services
Mobile Computer Display
- View Selector
- Protocol Docs View
- Patch Data View
- ePCR Data View
- Navigator View
- Device Data View
Medic
WiFi
Cellular
Pt to Pt AES Encryption
Network Communications
- encrypted
- secure
- asynchronous
- guaranteed delivery
Back Office Software
Data Relay, Storage, and Website Services
Enterprise "Asset Management"
SSL
BOA 1.0 Boundary
Browser Services
Website Display
- Vehicle Selector
- View Selector
- Device Data View
- ePCR Data View
- Navigator Data View
- Patch Data View
Secure Login
Healthcare Professional

FIG. 19

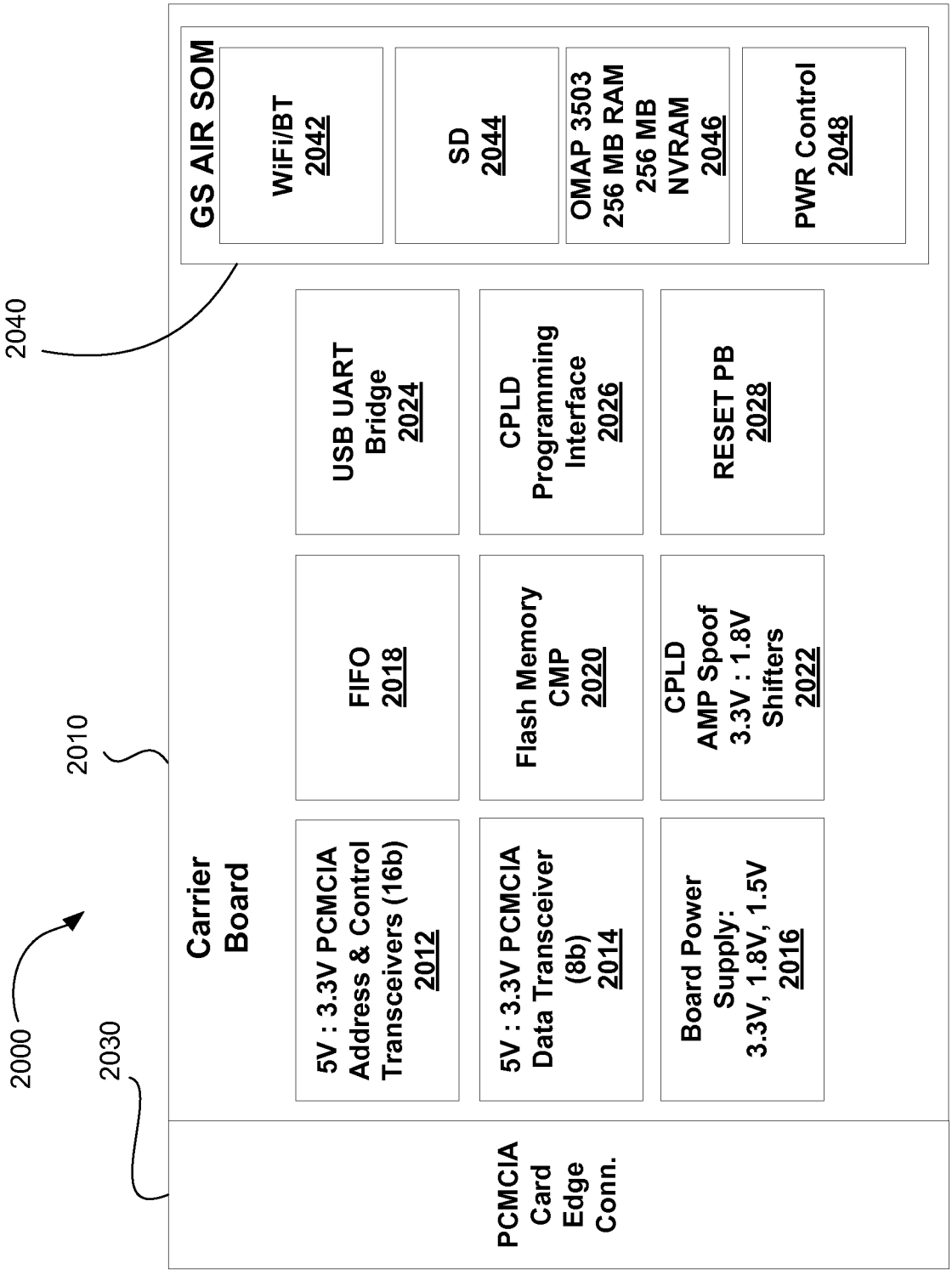

2000
2030
2010
2040
PCMCIA Card Edge Conn.
Carrier Board
5V : 3.3V PCMCIA Address & Control Transceivers (16b) 2012
5V : 3.3V PCMCIA Data Transceiver (8b) 2014
Board Power Supply: 3.3V, 1.8V, 1.5V 2016
FIFO 2018
Flash Memory CMP 2020
CPLD AMP Spoof 3.3V : 1.8V Shifters 2022
USB UART Bridge 2024
CPLD Programming Interface 2026
RESET PB 2028
GS AIR SOM
WiFi/BT 2042
SD 2044
OMAP 3503 256 MB RAM 256 MB NVRAM 2046
PWR Control 2048

FIG. 20

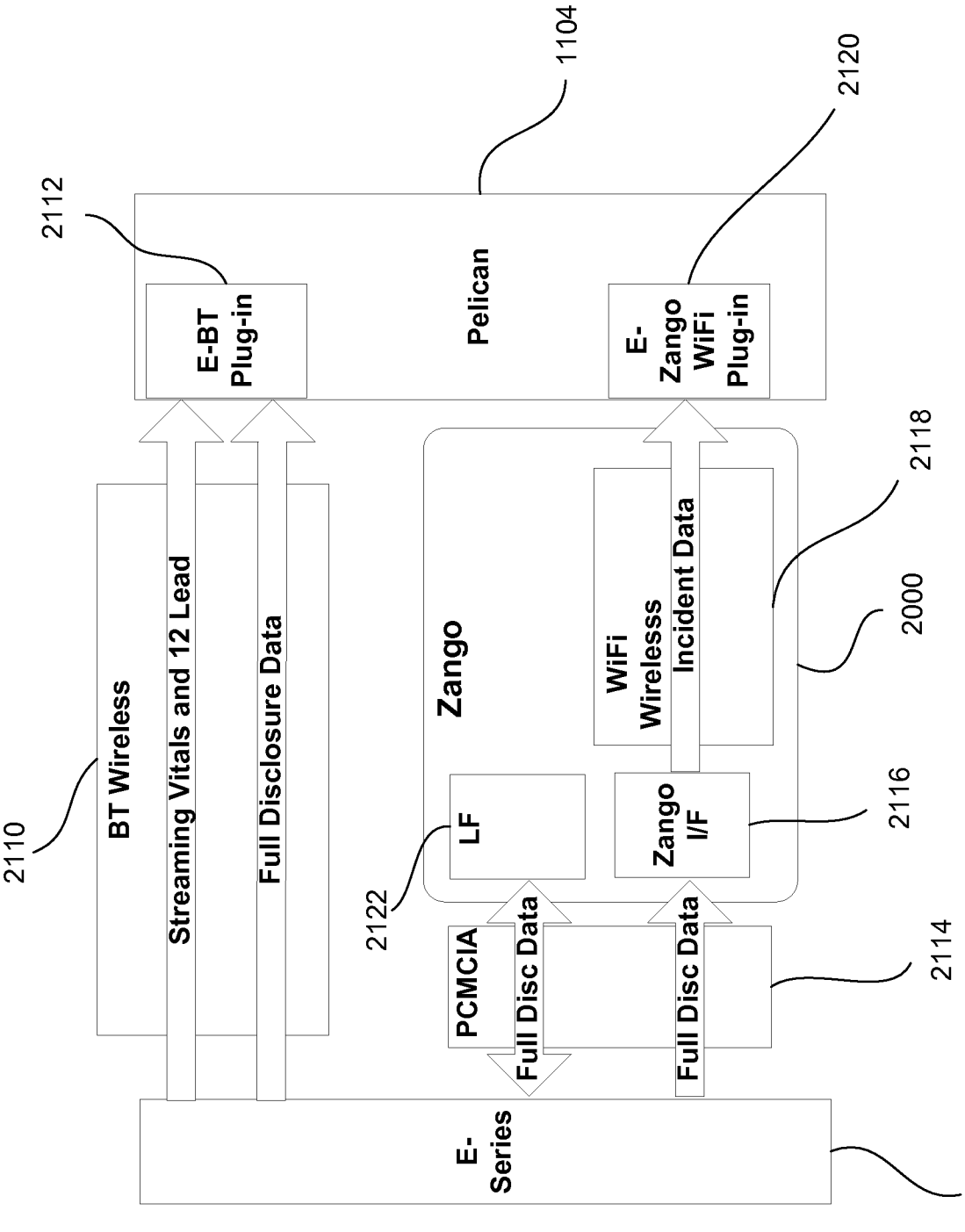

2110
BT Wireless
Streaming Vitals and 12 Lead
Full Disclosure Data
2112
E-BT Plug-in
1104
Pelican
2120
E- Zango WiFi Plug-in
2118
2000
Zango
WiFi Wirelesss
Incident Data
2122
LF
Zango I/F
2116
PCMCIA
Full Disc Data
Full Disc Data
2114
E- Series
1102

FIG. 21

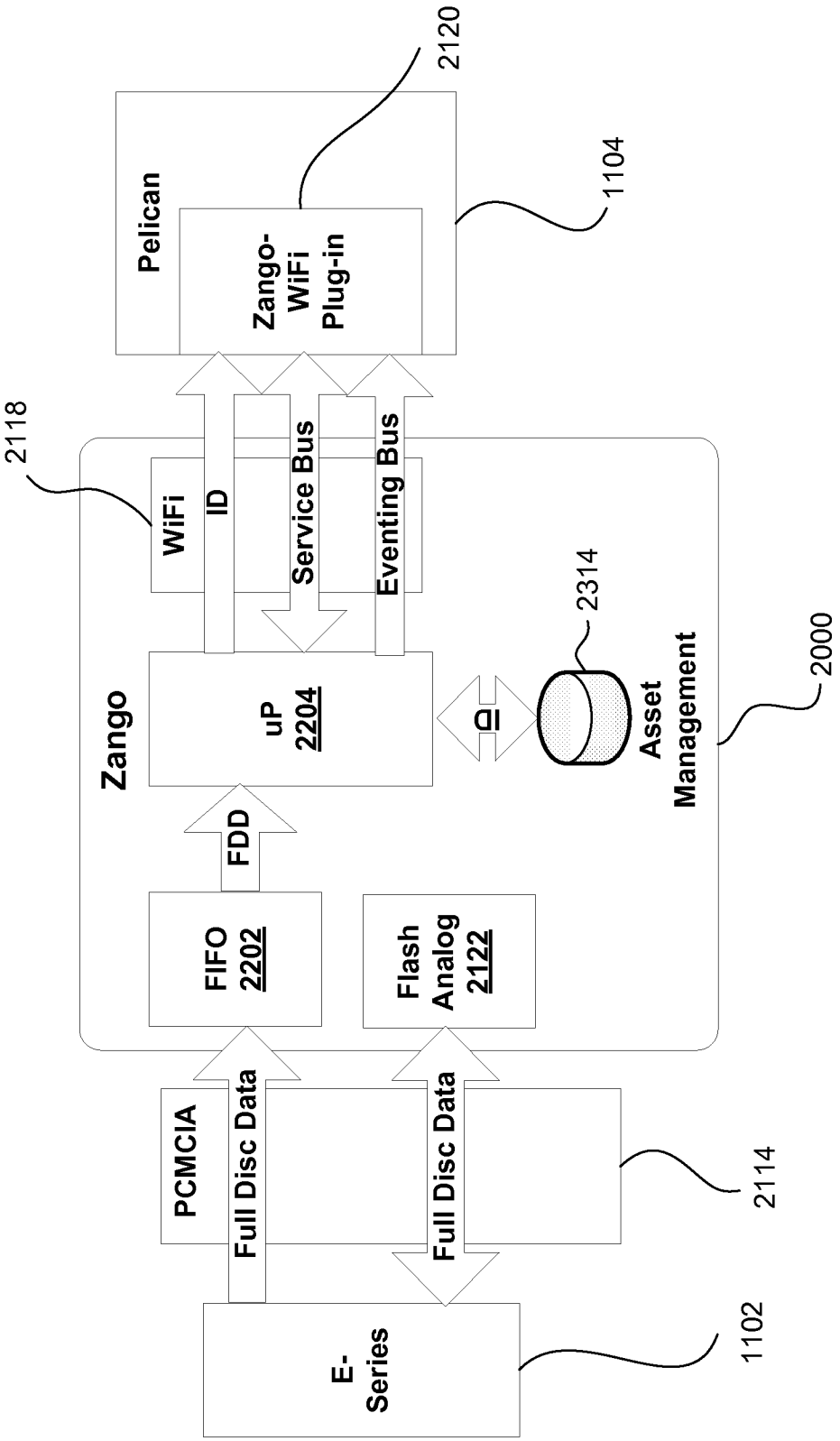

2120
Pelican
Zango-
WiFi
Plug-in
1104
2118
WiFi
ID
Service Bus
Eventing Bus
2314
Zango
uP
2204
ID
Asset
Management
2000
FDD
FIFO
2202
Flash
Analog
2122
PCMCIA
Full Disc Data
Full Disc Data
2114
E-
Series
1102

FIG. 22

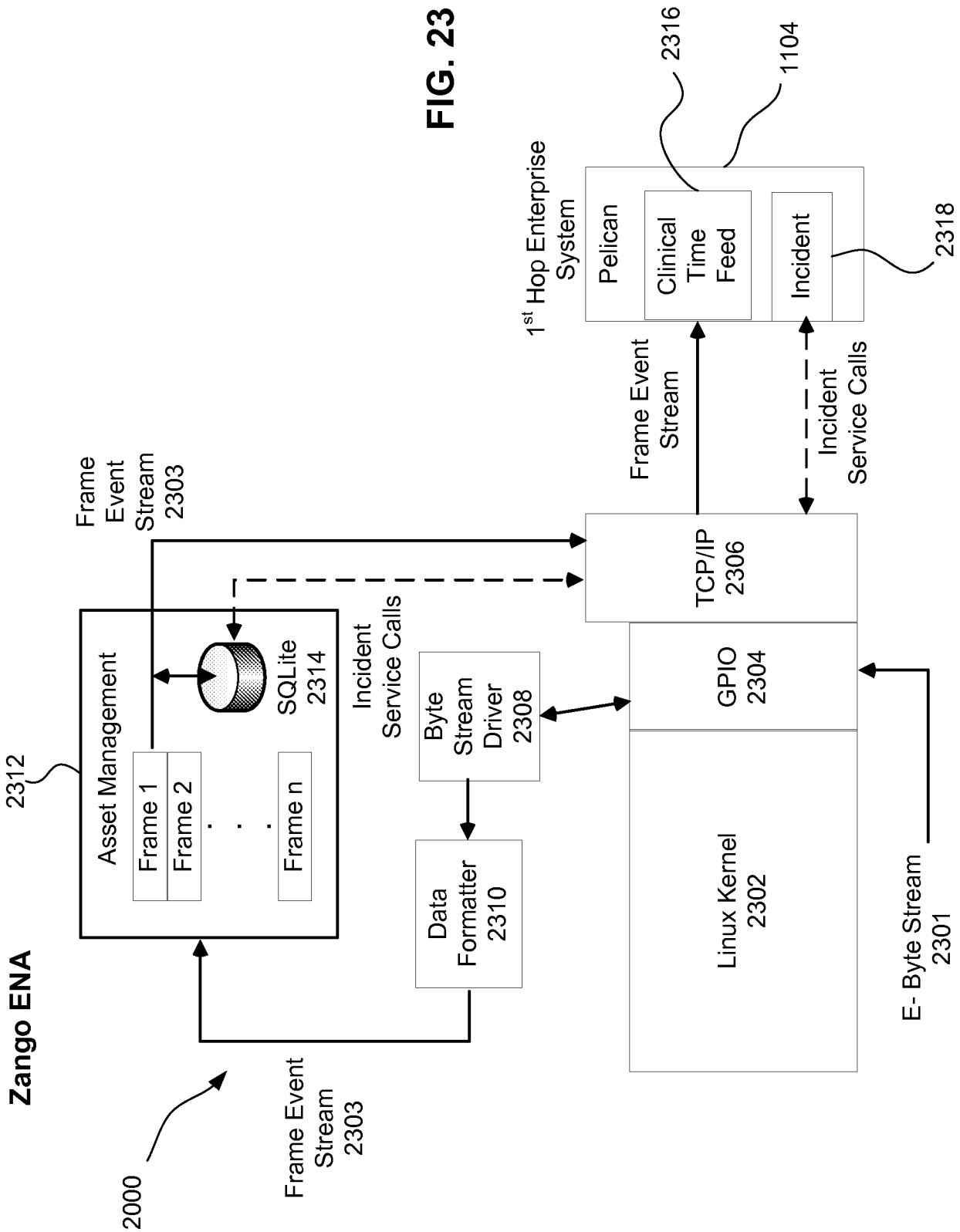

Zango ENA
2000
Frame Event Stream 2303
2312
Asset Management
Frame 1
Frame 2
Frame n
SQLite 2314
Frame Event Stream 2303
Incident Service Calls
Byte Stream Driver 2308
Data Formatter 2310
TCP/IP 2306
GPIO 2304
Linux Kernel 2302
E- Byte Stream 2301
Frame Event Stream
Incident Service Calls
1st Hop Enterprise System
Pelican
Clinical Time Feed
Incident
2316
1104
2318

FIG. 23

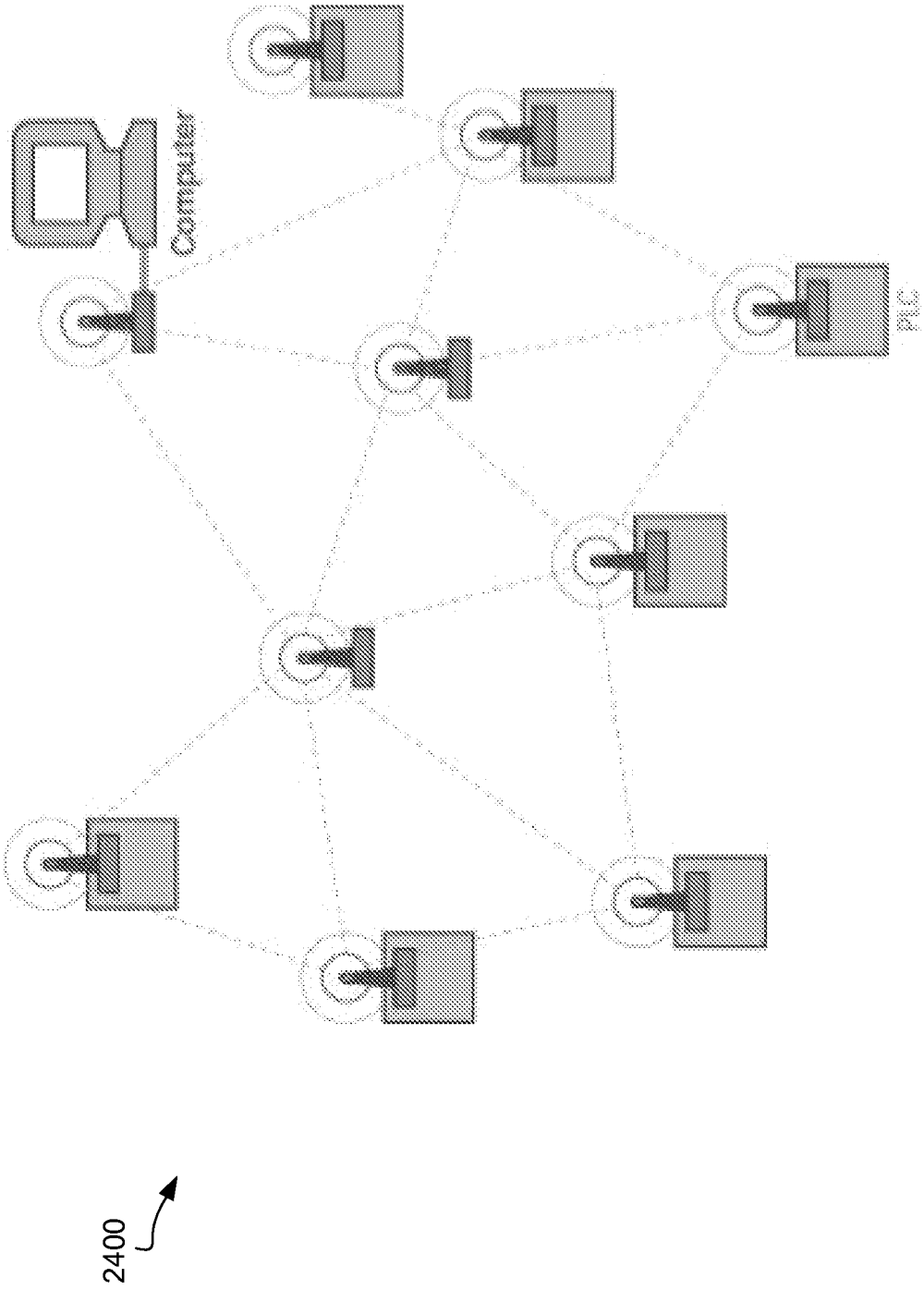


FIG. 24

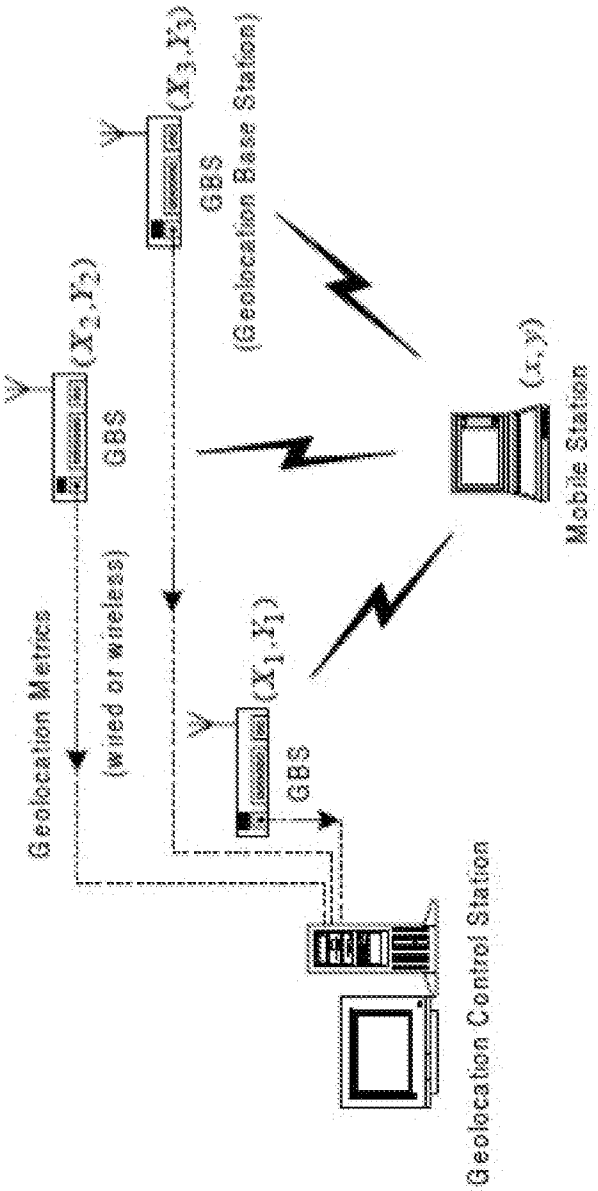


FIG. 25 Overall architecture of indoor geolocation system.

Differential Diagnosis of Acute Dyspnea in Adults

Cardiac: congestive heart failure, coronary artery disease, arrhythmia, pericarditis, acute myocardial infarction, anemia

Pulmonary: chronic obstructive pulmonary disease, asthma, pneumonia, pneumothorax, pulmonary embolism, pleural effusion, metastatic disease, pulmonary edema, gastroesophageal reflux disease with aspiration, restrictive lung disease

Psychogenic: panic attacks, hyperventilation, pain, anxiety

Upper airway obstruction: epiglottitis, foreign body, croup, Epstein-Barr virus

Endocrine: metabolic acidosis, medications

Central: neuromuscular disorders, pain, aspirin overdose

Pediatric: bronchiolitis, croup, epiglottitis, foreign body aspiration, myocarditis

FIG. 26

391713

PATENT
REEL: 042387 FRAME: 0438

Clues to the Diagnosis of Dyspnea

Symptoms or features in the history	*Possible diagnosis*
Cough	Asthma, pneumonia
Severe sore throat	Epiglottitis
Pleuritic chest pain	Pericarditis, pulmonary embolism, pneumothorax, pneumonia
Orthopnea, nocturnal paroxysmal dyspnea, edema	Congestive heart failure
Tobacco use	Chronic obstructive pulmonary disease, congestive heart failure, pulmonary embolism
Indigestion, dysphagia	Gastroesophageal reflux disease, aspiration
Barking cough	Croup

FIG. 27

Physical Examination Findings in the Diagnosis of Acute Dyspnea

Findings	*Possible diagnosis*
Wheezing, pulsus paradoxus, accessory muscle use	Acute asthma, COPD exacerbation
Wheezing, clubbing, barrel chest, decreased breath sounds	COPD exacerbation
Fever, crackles, increased fremitus	Pneumonia
Edema, neck vein distension, S_3 or S_4 hepatojugular reflux, murmurs, rales, hypertension, wheezing	Congestive heart failure, pulmonary edema
Wheezing, friction rub, lower extremity swelling	Pulmonary embolism
Absent breath sounds, hyperresonance	Pneumothorax
Inspiratory stridor, rhonchi, retractions	Croup
Stridor, drooling, fever	Epiglottitis
Stridor, wheezing, persistent pneumonia	Foreign body aspiration
Wheezing, flaring, intercostal retractions, apnea	Bronchiolitis
Sighing	Hyperventilation

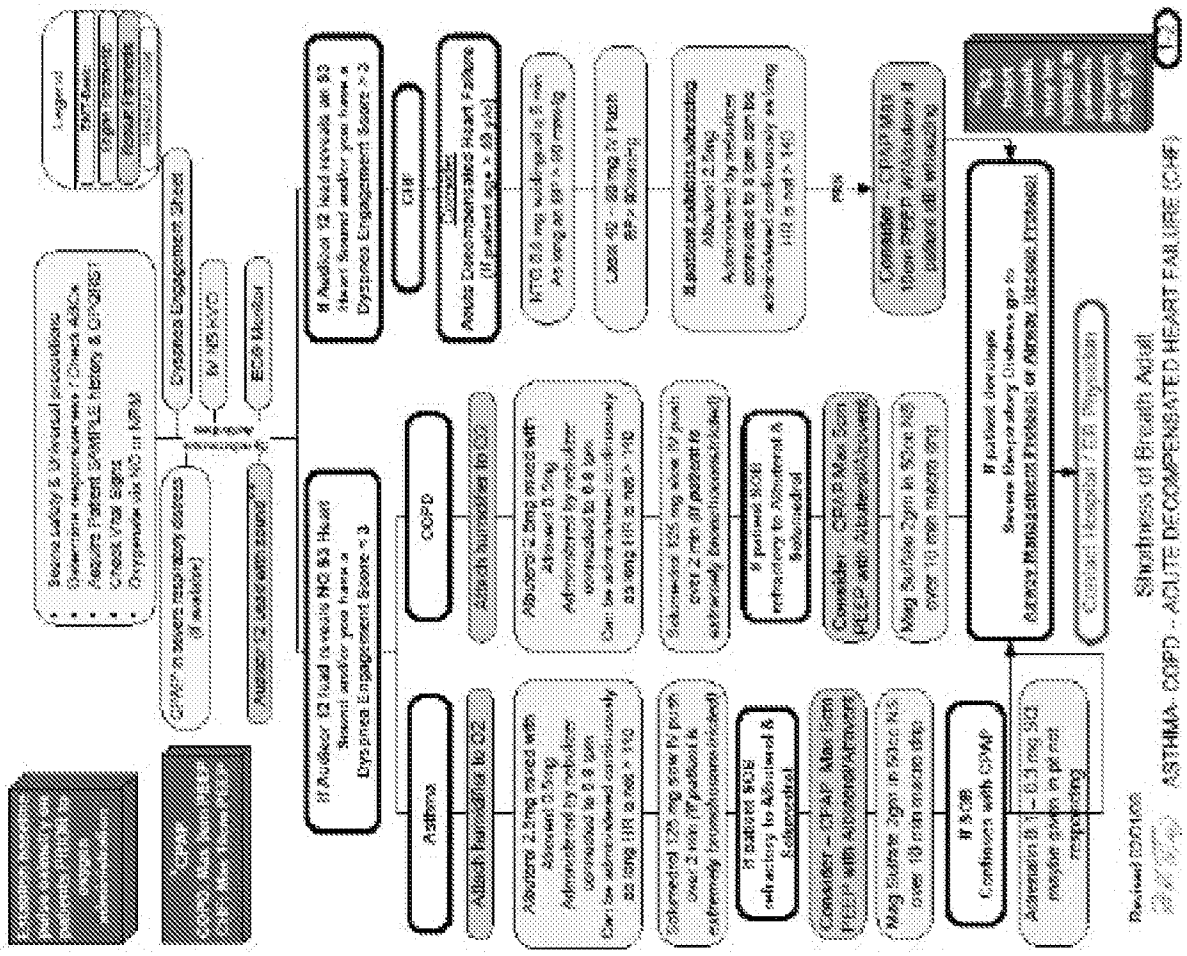
COPD = chronic obstructive pulmonary disease.

FIG. 28

391713

PATENT
REEL: 042387 FRAME: 0439

FIG. 29


Collier County Common Medical Protocol
ASTHMA - COPD – ACUTE DECOMPENSATED HEART FAILURE (CHF)
Legend
Shortness of Breath Adult
ASTHMA - COPD – ACUTE DECOMPENSATED HEART FAILURE (CHF)

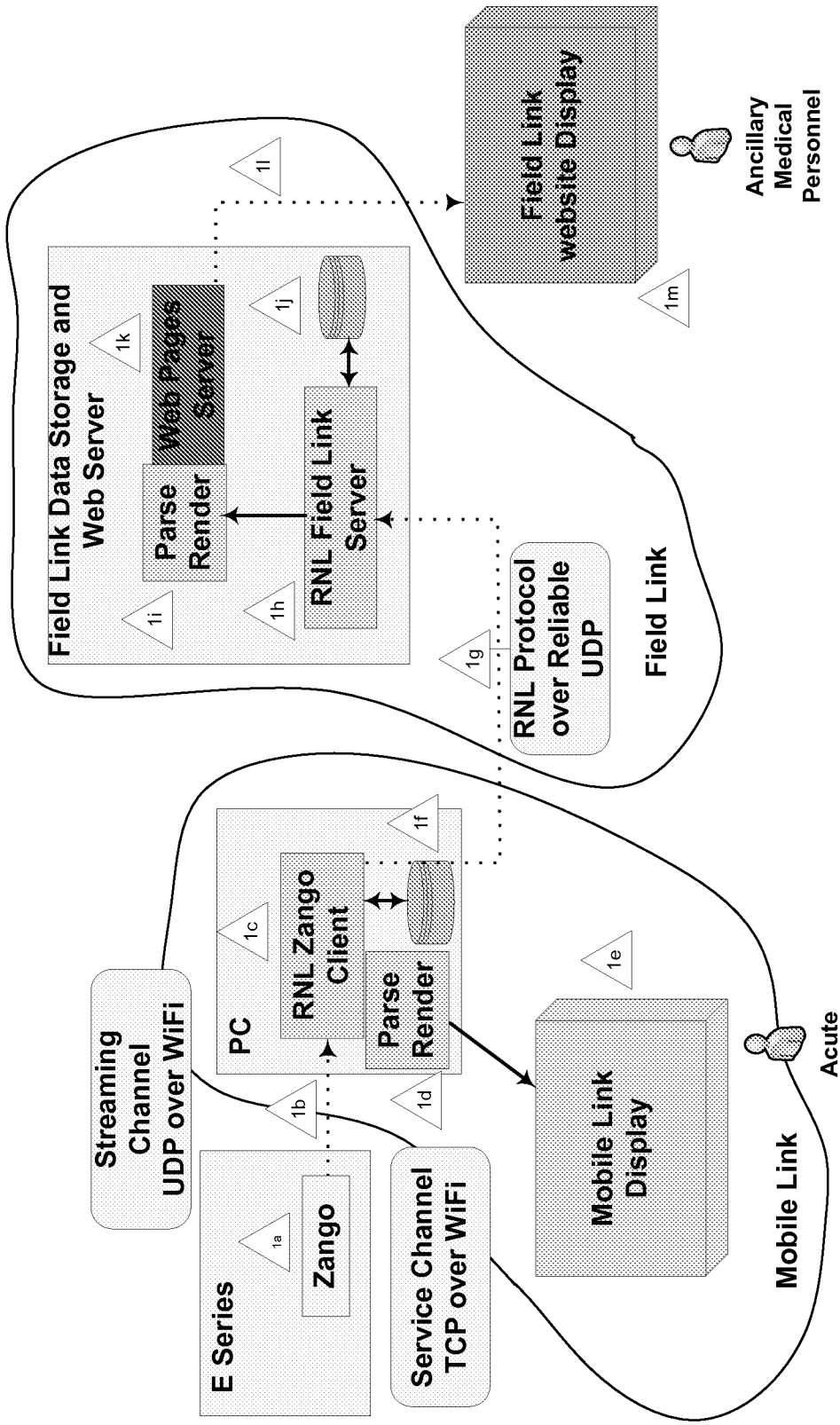

Field Link Data Storage and Web Server
Web Pages Server
Parse Render
RNL Field Link Server
Field Link website Display
Ancillary Medical Personnel
Field Link
RNL Protocol over Reliable UDP
PC
RNL Zango Client
Parse Render
Streaming Channel UDP over WiFi
E Series
Zango
Service Channel TCP over WiFi
Mobile Link Display
Mobile Link
Acute Medical Personnel
1a
1b
1c
1d
1e
1f
1g
1h
1i
1j
1k
1l
1m

FIG. 30

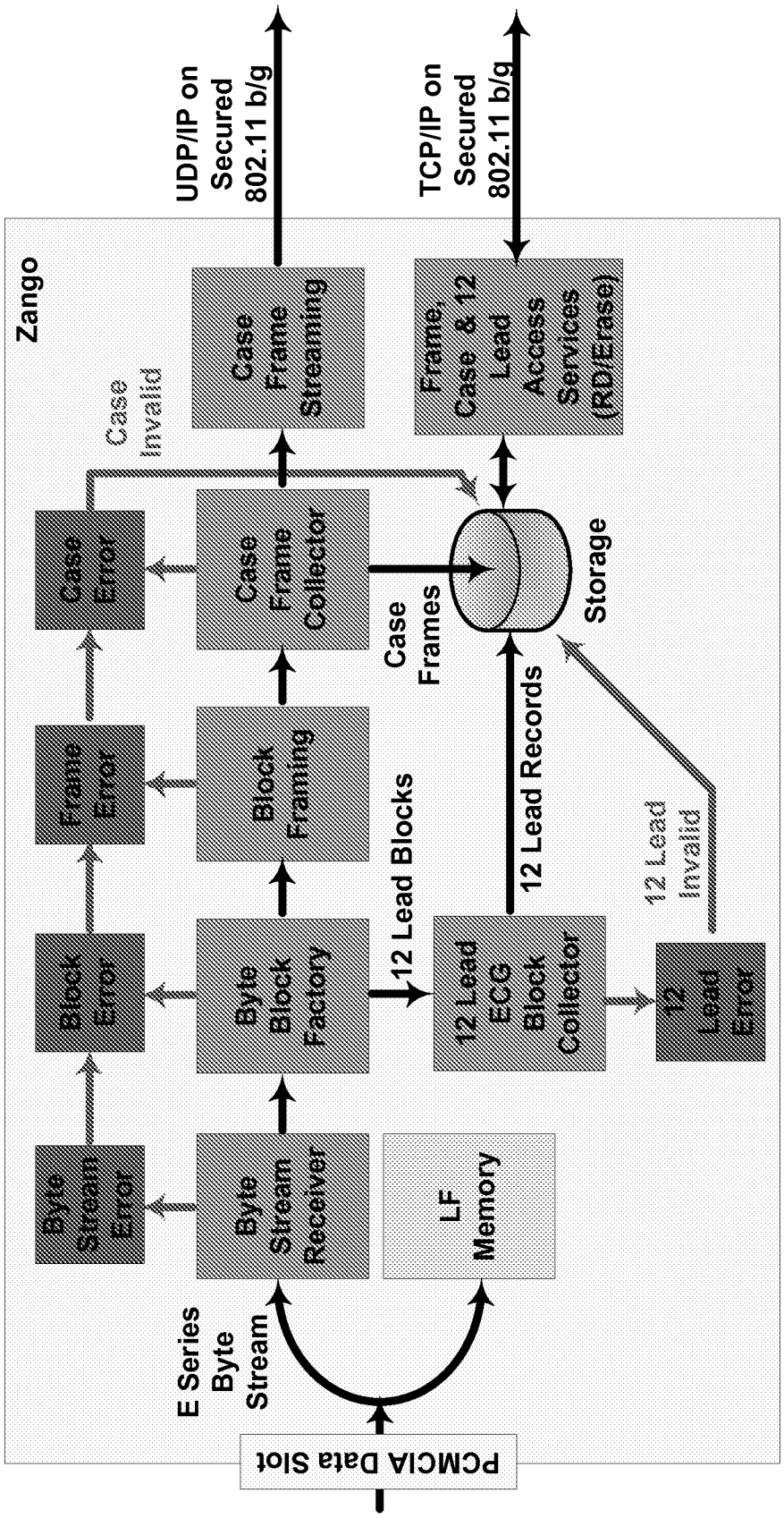

Zango
UDP/IP on Secured 802.11 b/g
TCP/IP on Secured 802.11 b/g
Case Frame Streaming
Frame, Case & 12 Lead Access Services (RD/Erase)
Case Invalid
Case Error
Case Frame Collector
Case Frames
Storage
Frame Error
Block Framing
12 Lead Blocks
12 Lead Records
12 Lead Invalid
Block Error
Byte Block Factory
12 Lead ECG Block Collector
12 Lead Error
Byte Stream Error
Byte Stream Receiver
LF Memory
E Series Byte Stream
PCMCIA Data Slot

FIG. 31

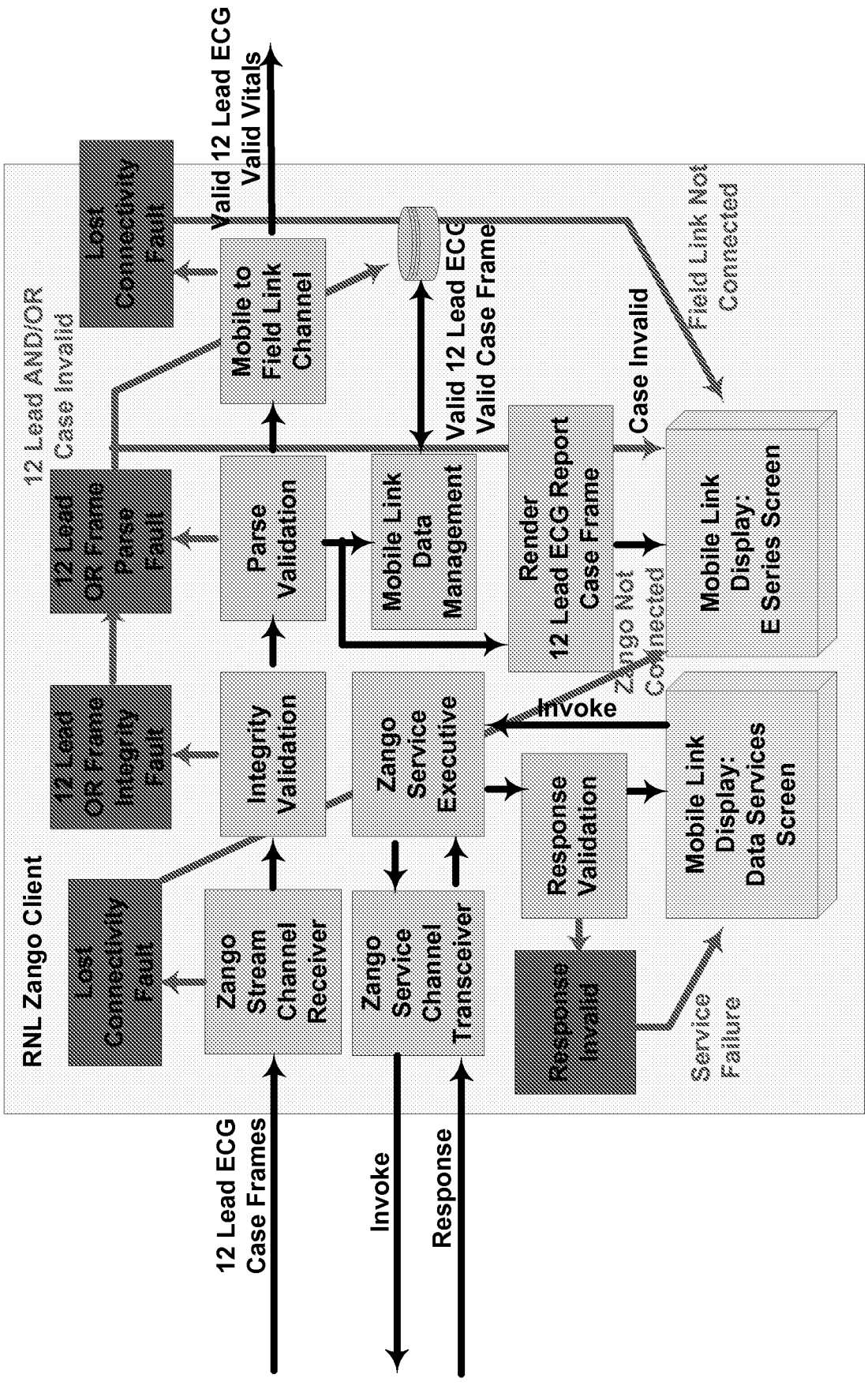

RNL Zango Client
12 Lead AND/OR Case Invalid
Lost Connectivity Fault
Zango Stream Channel Receiver
Zango Service Channel Transceiver
12 Lead OR Frame Integrity Fault
Integrity Validation
12 Lead OR Frame Parse Fault
Parse Validation
Mobile to Field Link Channel
Lost Connectivity Fault
Valid 12 Lead ECG Valid Vitals
Zango Service Executive
Mobile Link Data Management
Valid 12 Lead ECG Valid Case Frame
Response Validation
Response Invalid
Render 12 Lead ECG Report Case Frame
Case Invalid
Field Link Not Connected
Zango Not Connected
Invoke
Mobile Link Display: E Series Screen
Mobile Link Display: Data Services Screen
Service Failure
12 Lead ECG Case Frames
Invoke
Response

FIG. 32

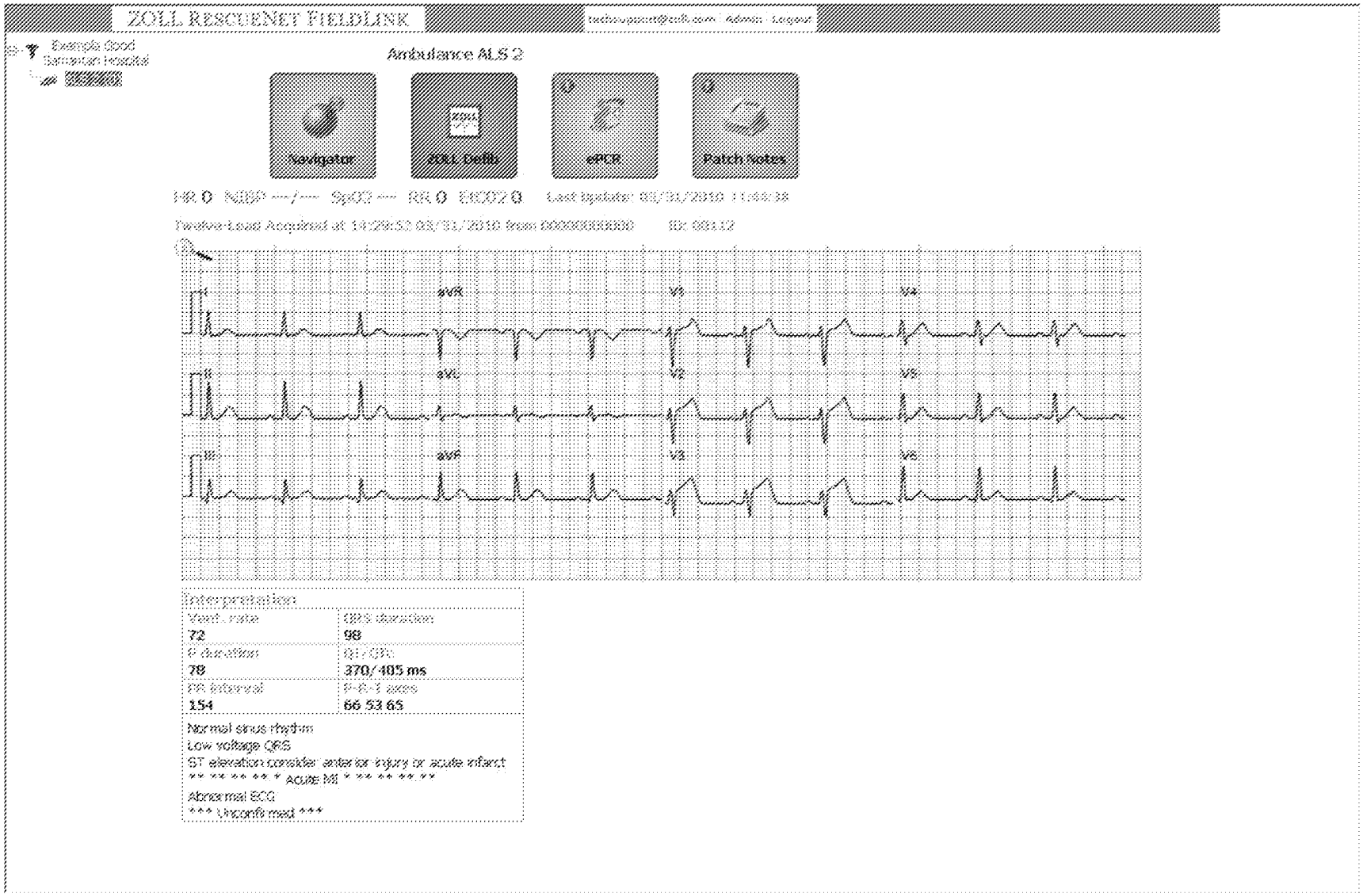

ZOLL RESCUENET FIELDLINK
Example Good Samaritan Hospital
Ambulance ALS 2
Navigator
ZOLL Defib
ePCR
Patch Notes
HR 0 NIBP —/— SpO2 — RR 0 EtCO2 0
Twelve-Lead Acquired at 14:29:52 03/31/2010 from 00000000000
I
aVR
V1
V4
II
aVL
V2
V5
III
aVF
V3
V6
Interpretation
Vent. rate
72
QRS duration
98
P duration
78
QT/QTc
370/405 ms
PR interval
154
P-R-T axes
66 53 65
Normal sinus rhythm
Low voltage QRS
ST elevation consider anterior injury or acute infarct
** ** ** ** * Acute MI * ** ** ** **
Abnormal ECG
*** Unconfirmed ***

FIG. 33

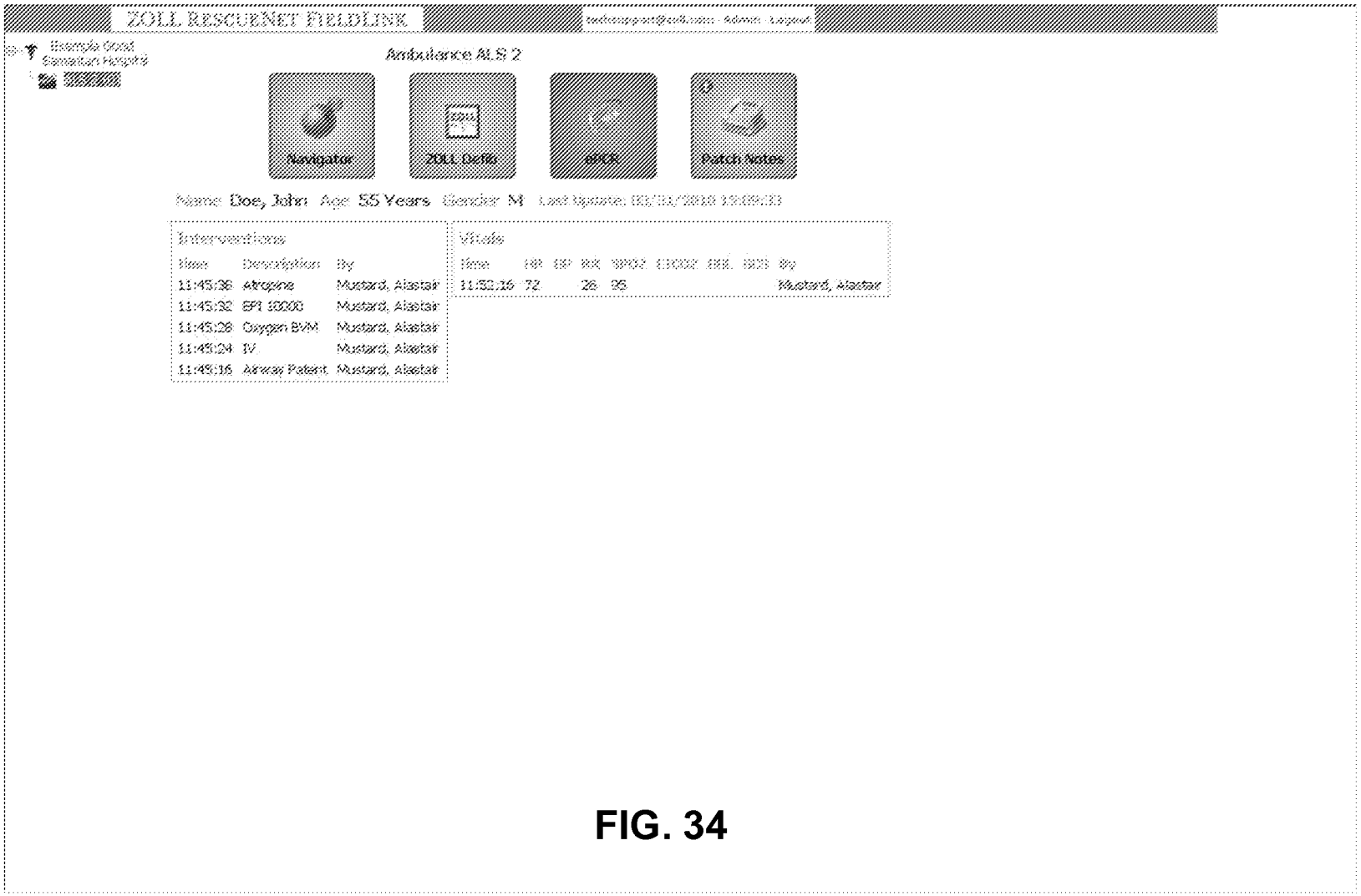

ZOLL RESCUENET FIELDLINK
Ambulance ALS 2
Navigator
ZOLL Defib
ePCR
Patch Notes
Name Doe, John Age 55 Years Gender M
Interventions
Time Description By
11:45:36 Atropine Mustard, Alastair
11:45:32 EPI 10000 Mustard, Alastair
11:45:28 Oxygen BVM Mustard, Alastair
11:45:24 IV Mustard, Alastair
11:45:16 Airway Patent Mustard, Alastair
Vitals
Time HR BP RR SPO2 ETCO2 BBL BCS By
11:52:16 72 26 95 Mustard, Alastair

FIG. 34

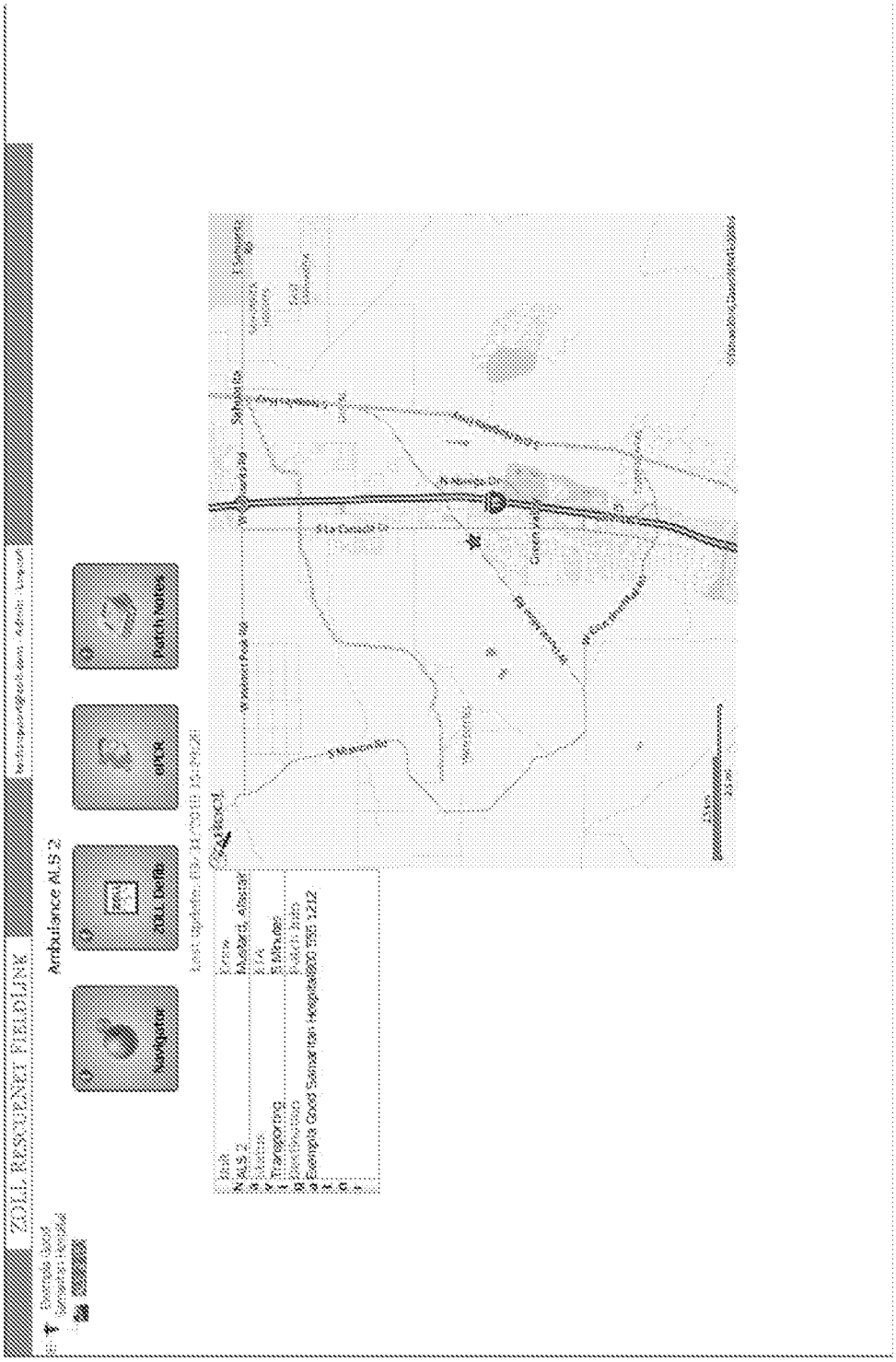

ZOLL RESCUENET FIELDLINK
Ambulance ALS 2
Navigator
ZOLL Defib
ePCR
Patch Notes

FIG. 35

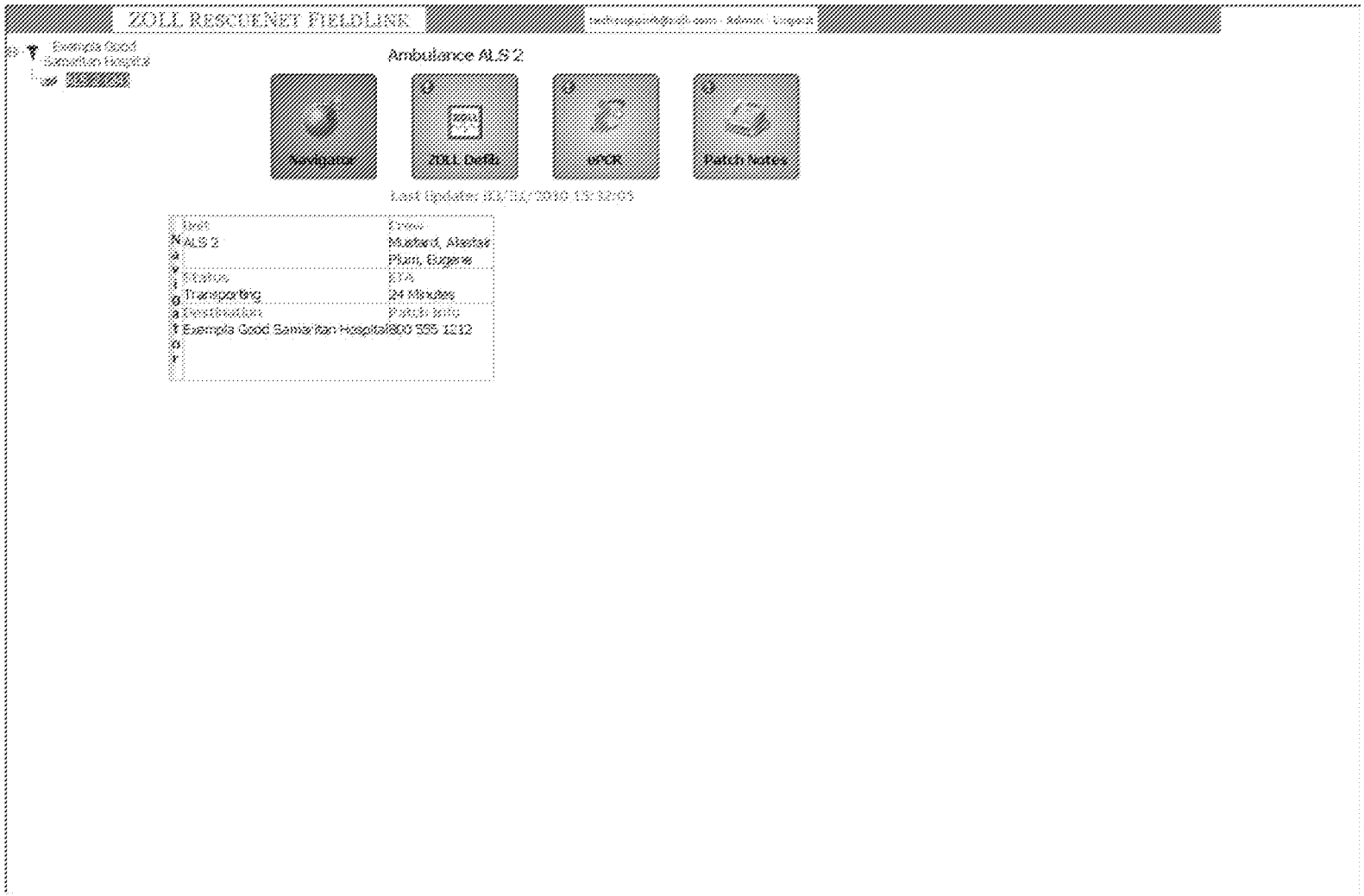

ZOLL RESCUENET FIELDLINK
Ambulance ALS 2
Navigator
ZOLL Defib
uPCR
Patch Notes
Navigator
Unit
ALS 2
Crew
Mustard, Alastair
Plum, Eugene
Status
Transporting
ETA
24 Minutes
Destination
Exempla Good Samaritan Hospital
Patch Info
800 555 1212

FIG. 36

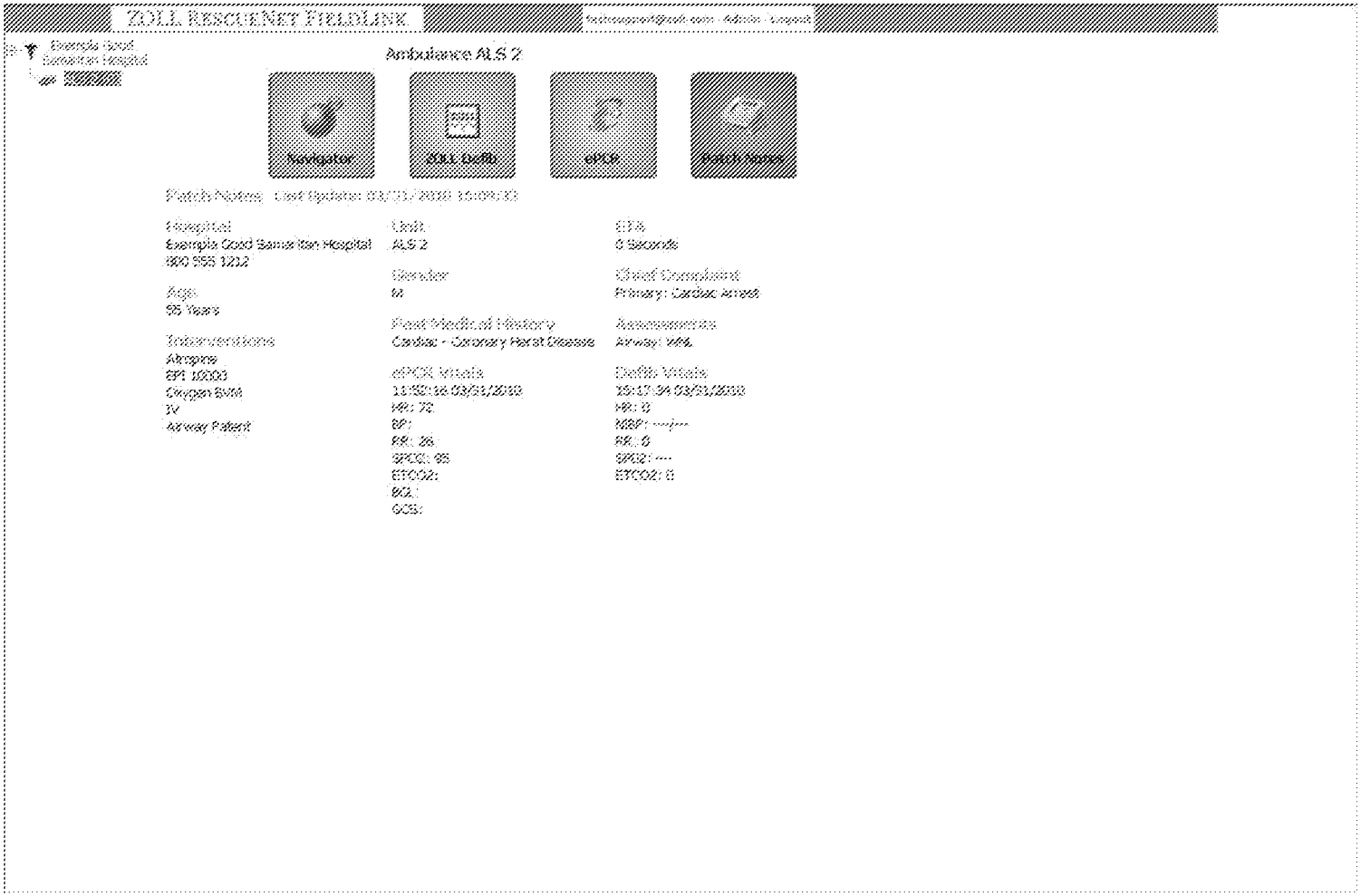

ZOLL RESCUENET FIELDLINK
Ambulance ALS 2
Navigator
ZOLL Defib
ePCR
Patch Notes
Patch Notes
Hospital
Exemplo Good Samaritan Hospital
800 555 1212
Age
55 Years
Interventions
Atropine
EPI 10000
Oxygen BVM
IV
Airway Patent
Unit
ALS 2
Gender
M
Past Medical History
Cardiac - Coronary Herat Disease
ePCR Vitals
11:52:16 03/31/2010
HR: 72
BP:
RR: 26
SPO2: 95
ETCO2:
BGL:
GCS:
ETA
0 Seconds
Chief Complaint
Primary: Cardiac Arrest
Assessments
Airway: WNL
Defib Vitals
15:17:34 03/31/2010
HR: 0
MBP: ---/---
RR: 0
SPO2: ---
ETCO2: 0

FIG. 37

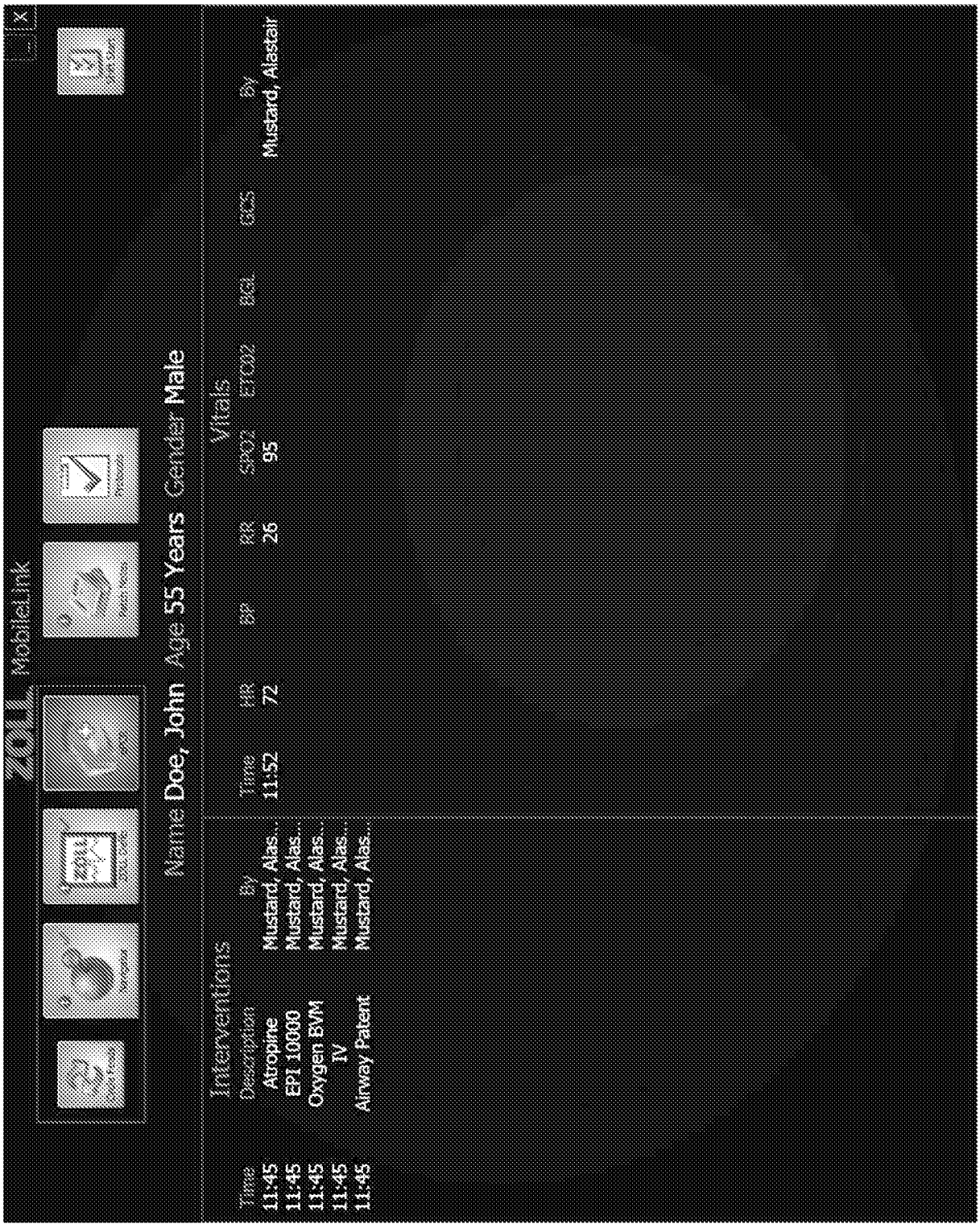

MobileLink
Name Doe, John Age 55 Years Gender Male
Interventions
Time Description By
11:45 Atropine Mustard, Alas...
11:45 EPI 10000 Mustard, Alas...
11:45 Oxygen BVM Mustard, Alas...
11:45 IV Mustard, Alas...
11:45 Airway Patent Mustard, Alas...
Vitals
Time HR BP RR SPO2 ETCO2 BGL GCS By
11:52 72 26 95 Mustard, Alastair

FIG. 38

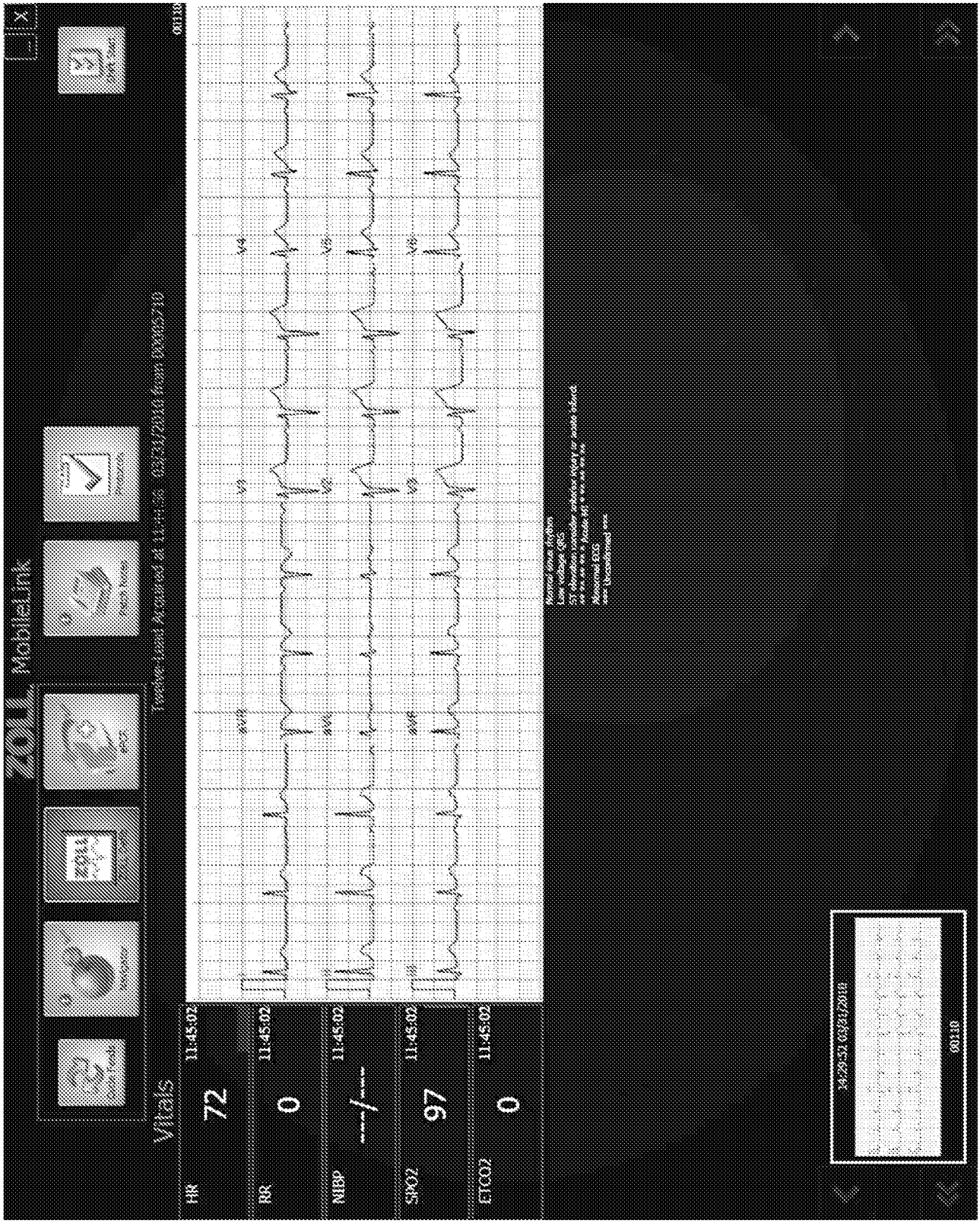

ZOLL MobileLink
Vitals
HR
72
11:45:02
RR
0
11:45:02
NIBP
---/---
11:45:02
SPO2
97
11:45:02
ETCO2
0
11:45:02

FIG. 39

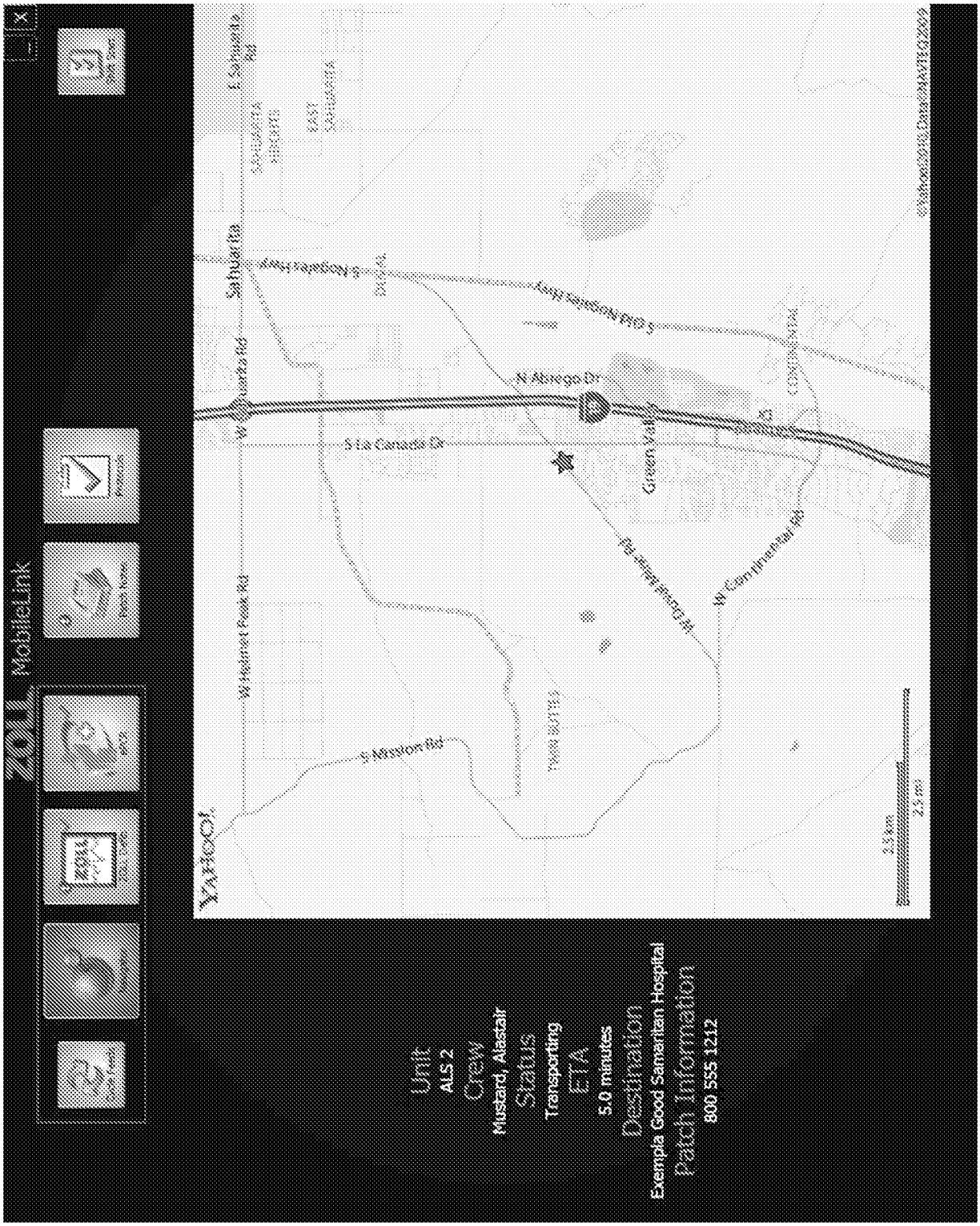

MobileLink
Unit
ALS 2
Crew
Mustard, Alastair
Status
Transporting
ETA
5.0 minutes
Destination
Exempla Good Samaritan Hospital
Patch Information
800 555 1212
Sahuarita
S Nogales Hwy
N Abrego Dr
S La Canada Dr
W Helmet Peak Rd
S Mission Rd
W Continental Rd
Green Valley
TWIN BUTTES
CONTINENTAL
2.5 km
2.5 mi

FIG. 40

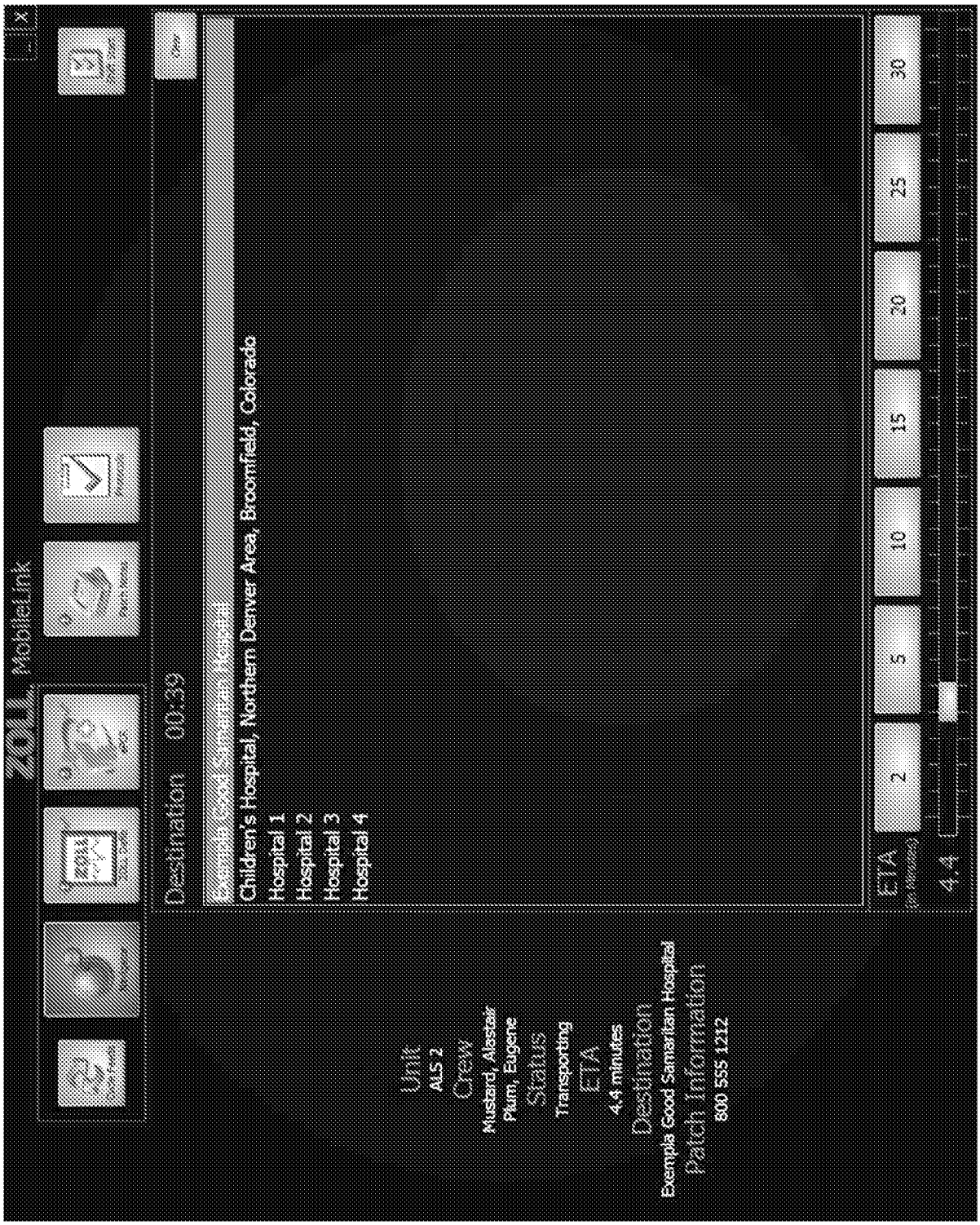

ZOLL MobileLink
Destination 00:39
Children's Hospital, Northern Denver Area, Broomfield, Colorado
Hospital 1
Hospital 2
Hospital 3
Hospital 4
Unit
ALS 2
Crew
Mustard, Alastair
Plum, Eugene
Status
Transporting
ETA
4.4 minutes
Destination
Exemplia Good Samaritan Hospital
Patch Information
800 555 1212
ETA
2
5
10
15
20
25
30
4.4

FIG. 41

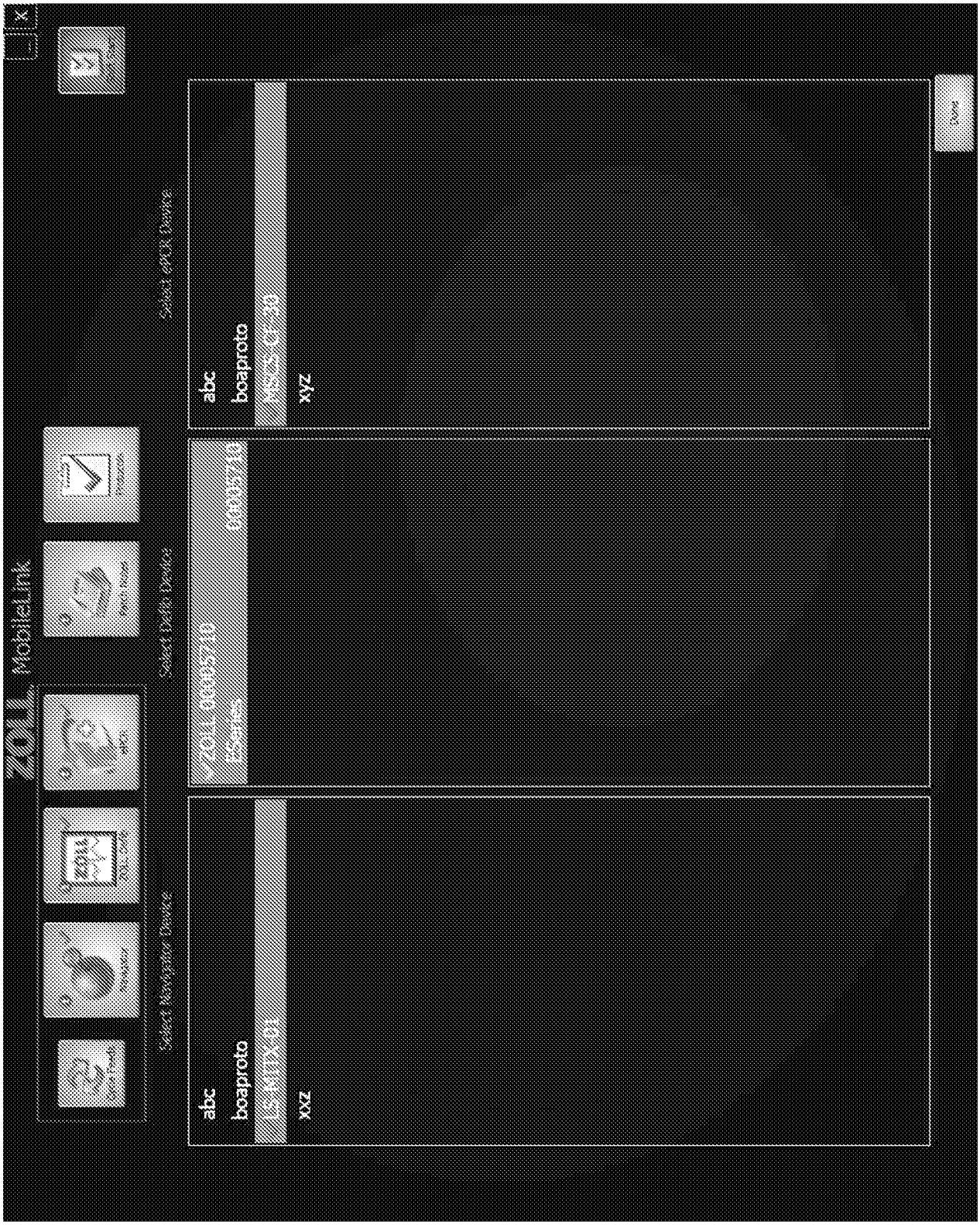

MobileLink
Select Navigator Device
Select Delta Device
Select ePCR Device
abc
boaproto
LS-MTTX-01
xxz
ZOLL 00005710
ESeries
00005710
abc
boaproto
MS ZS-CF-30
xyz

FIG. 42

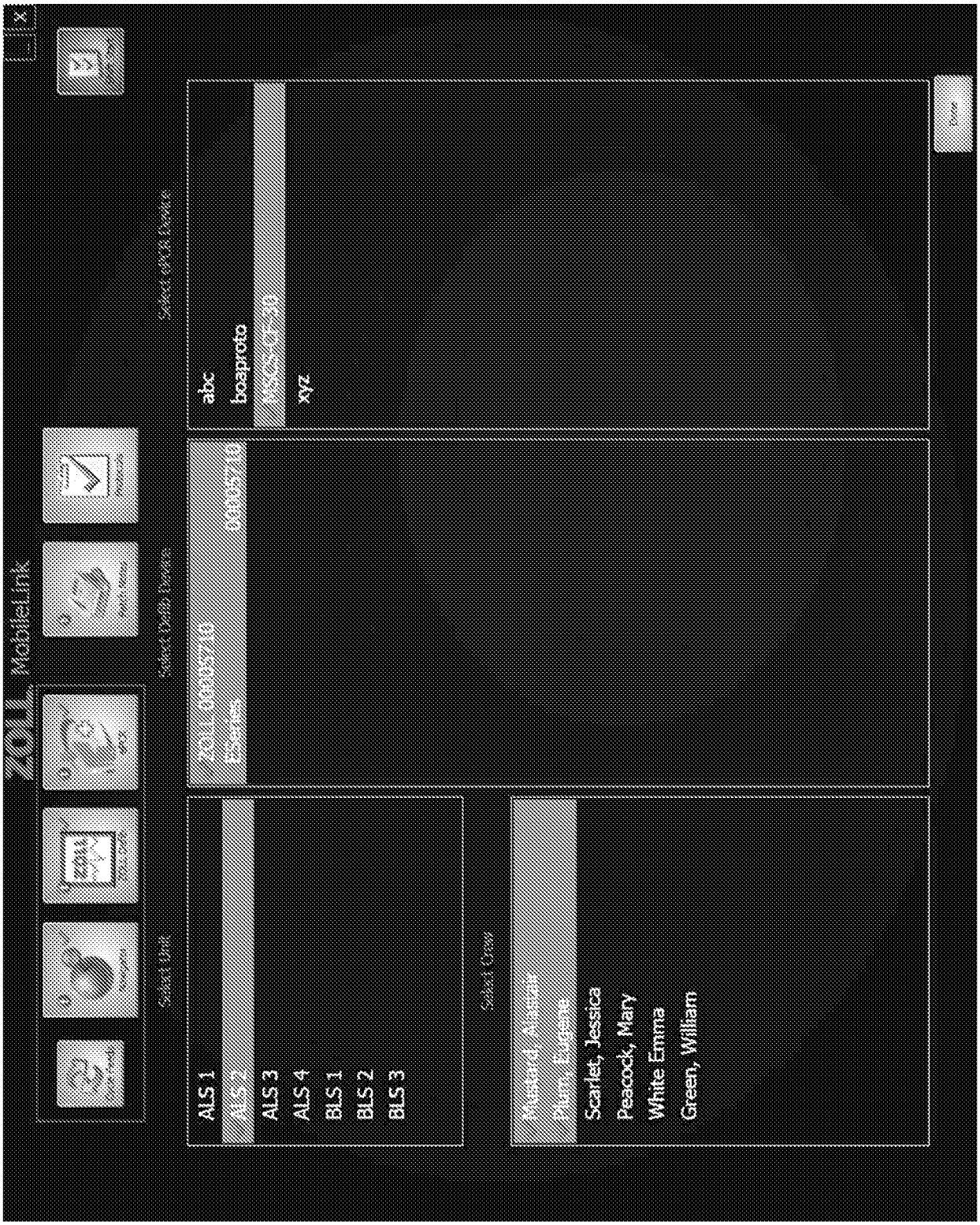

MobileLink
Select Unit
ALS 1
ALS 2
ALS 3
ALS 4
BLS 1
BLS 2
BLS 3
Select Crew
Mustard, Alastair
Plum, Eugene
Scarlet, Jessica
Peacock, Mary
White Emma
Green, William
Select Radio Device
ZOLL 00005710
ESeries
00005710
Select ePCR Device
abc
boaproto
xyz

FIG. 43

MobileLink
Destination
Exempla Good Samaritan Hospital
800 555 1212
Unit
ALS 2
ETA
1.3 minutes
Age
55 Years
Gender
Male
Chief Complaint
Primary: Cardiac Arrest
Medical History
Cardiac - Coronary Herat Disease
Airway: WNL
Assessments
Interventions
Atropine
EPI 10000
Oxygen BVM
IV
Airway Patent
ePCR Vitals
11:52:16 03/31/2010
HR: 72
BP:
RR: 26
SPO2: 95
ETCO2:
BGL:
GCS:
Defib Vitals
15:09:36 03/31/2010
HR: 0
MAP: —/—
RR: 17
SPO2: 95
ETCO2: 34

FIG. 44

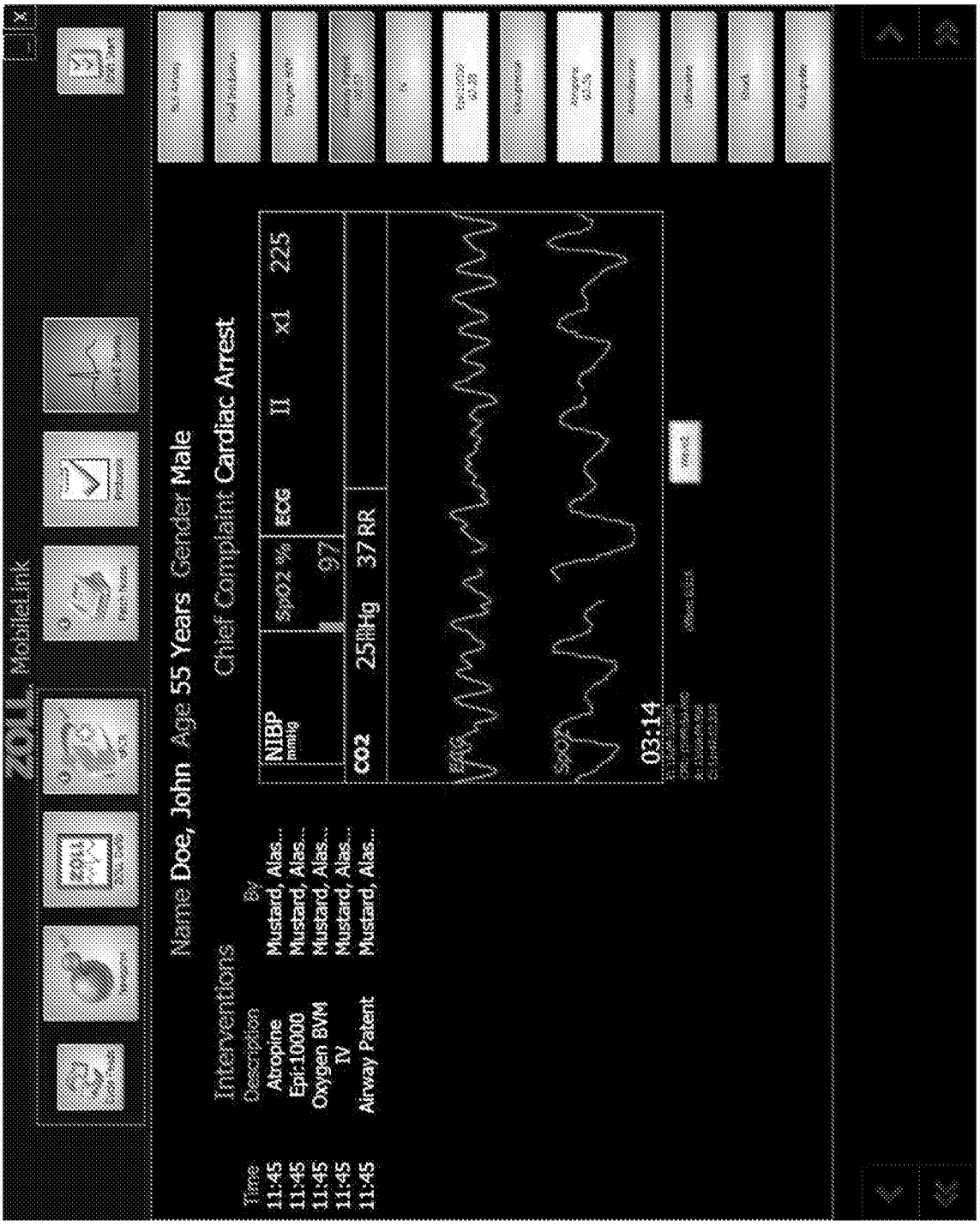

MobileLink
Name Doe, John Age 55 Years Gender Male
Chief Complaint Cardiac Arrest
Interventions
Time
Description
By
11:45 Atropine Mustard, Alas...
11:45 Epi-10000 Mustard, Alas...
11:45 Oxygen BVM Mustard, Alas...
11:45 IV Mustard, Alas...
11:45 Airway Patent Mustard, Alas...
NIBP
mmHg
SpO2 %
97
ECG
II
x1
225
CO2
25mmHg
37 RR
03:14

FIG. 45

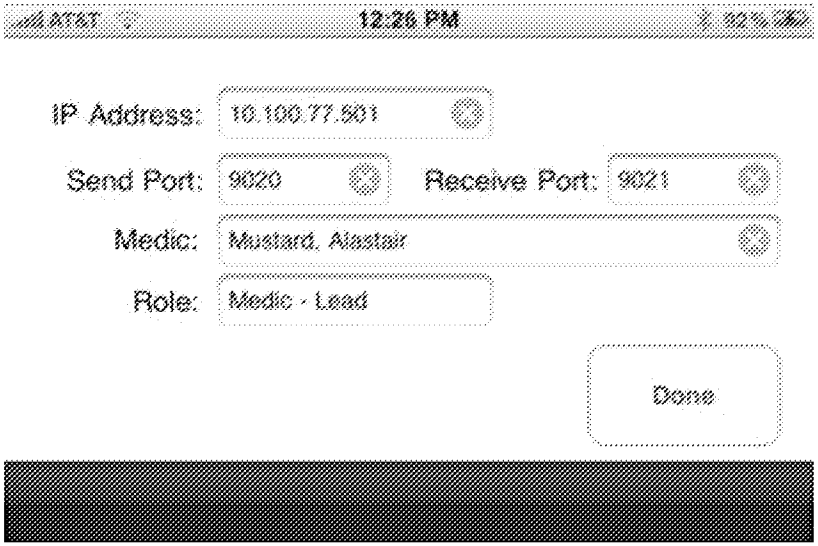


FIG. 46

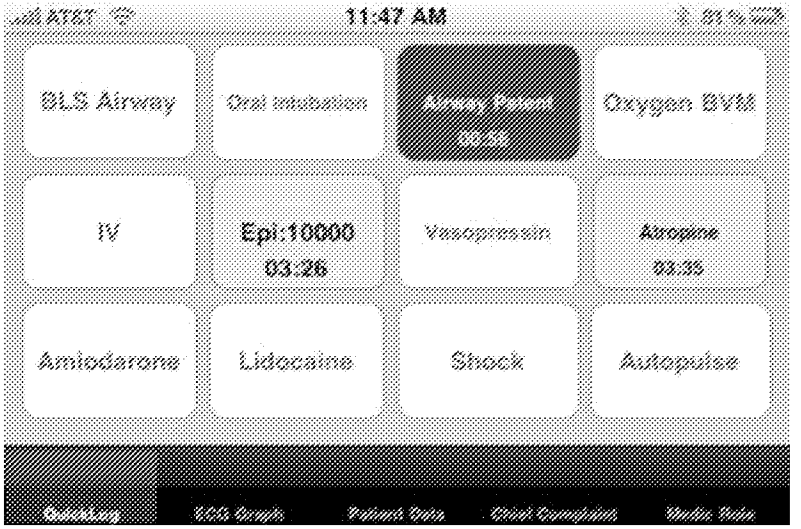


FIG. 48

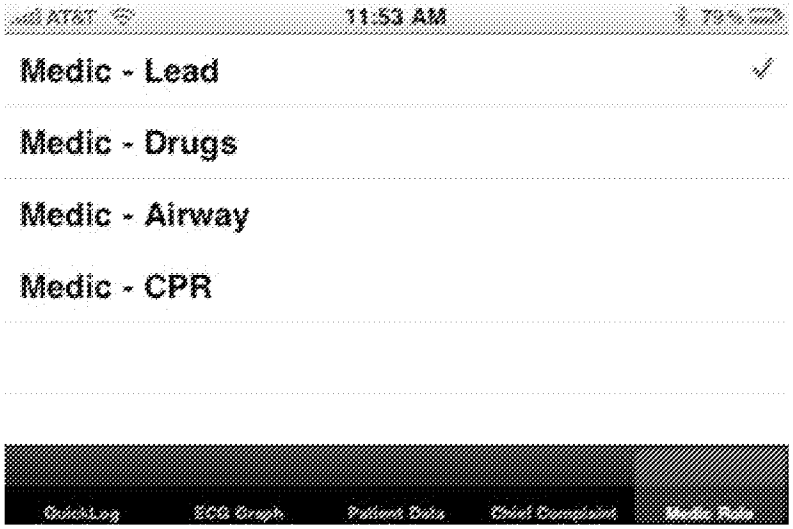


FIG. 47

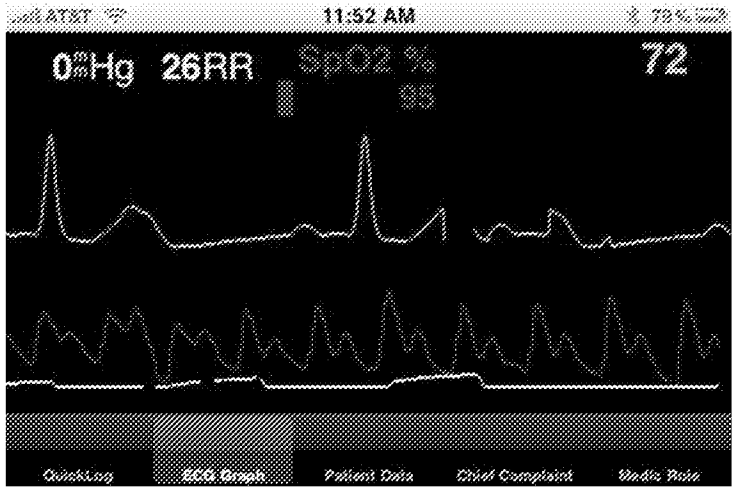


FIG. 49

PATENT
REEL: 042387 FRAME: 0457

AT&T
11:53 AM
79%
Patient Name:
Doe, John
Gender:
Male
Female

FIG. 50

AT&T
11:53 AM
79%
Chest Pain
Cardiac Arrest
Headache
Difficulty Breathing
Psych
Altered Mental Status

FIG. 51

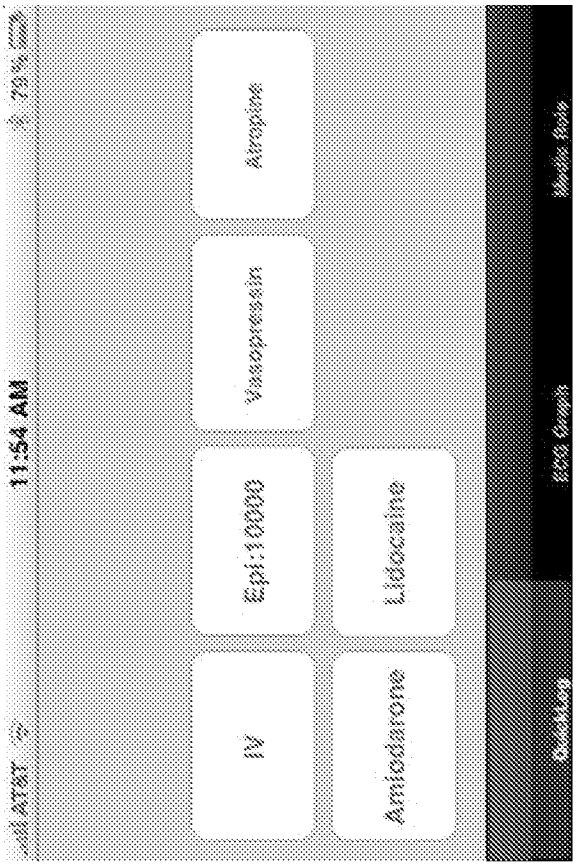

AT&T
11:54 AM
IV
Epi:1000
Vasopressin
Atropine
Amiodarone
Lidocaine
Cardiology
ECG Graph
Radio Rate

FIG. 52

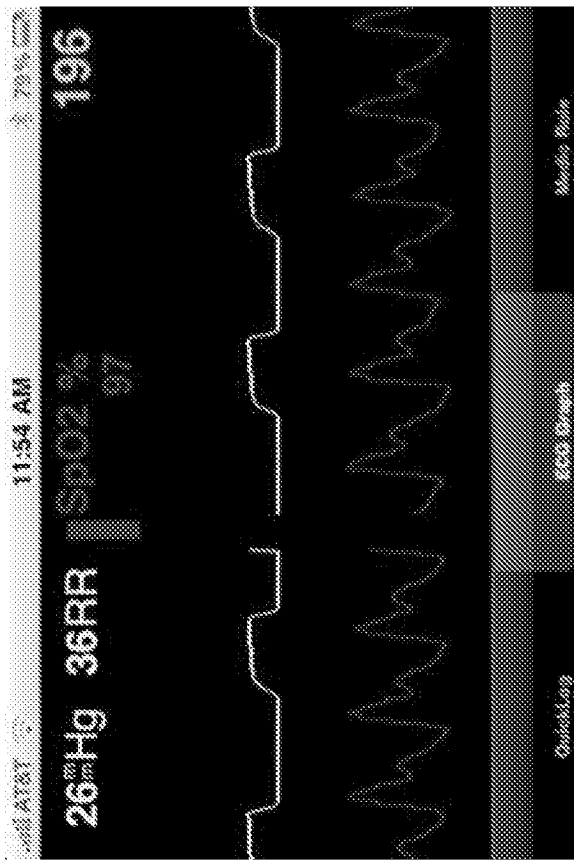

AT&T
11:54 AM
26 mHg
36RR
SpO2 %
87
196
Cardiology
ECG Graph
Radio Rate

FIG. 53

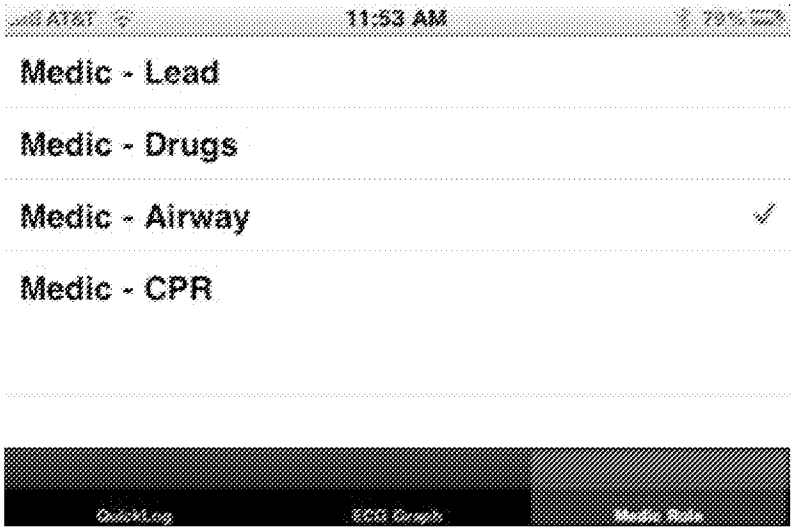


FIG. 54

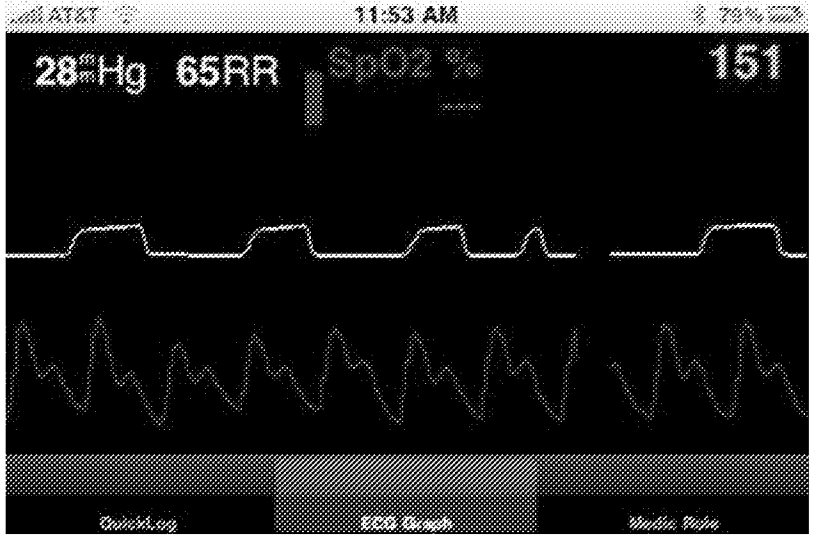


FIG. 55

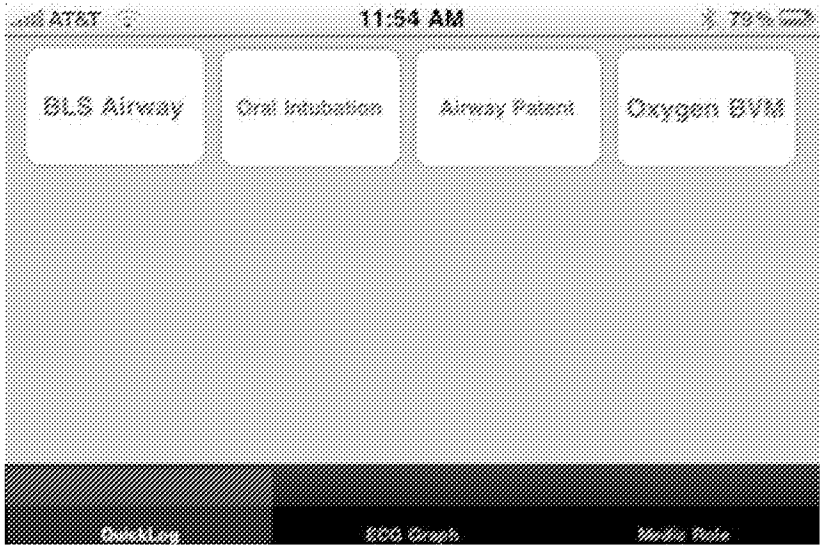


FIG. 56

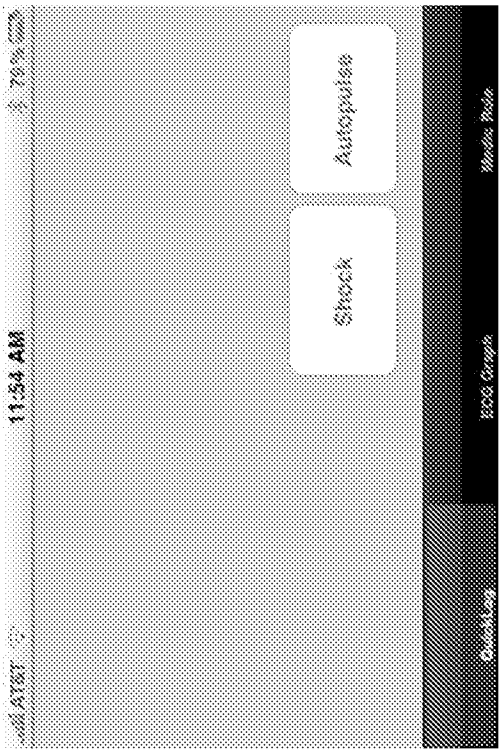


FIG. 57

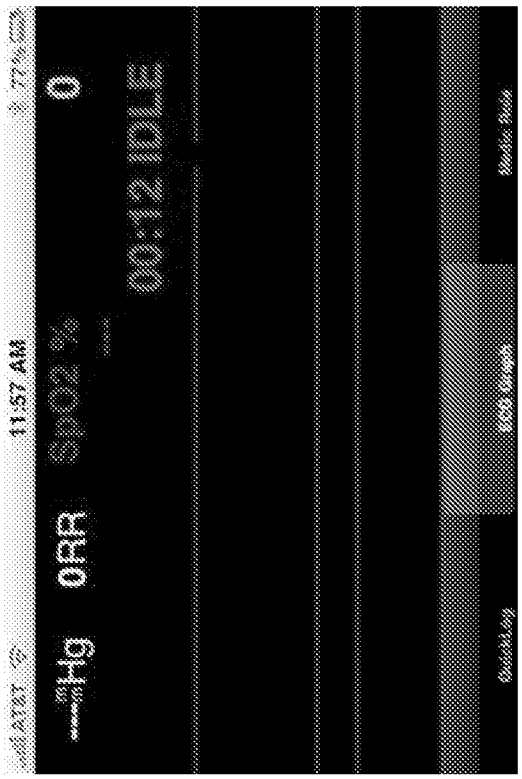


FIG. 58

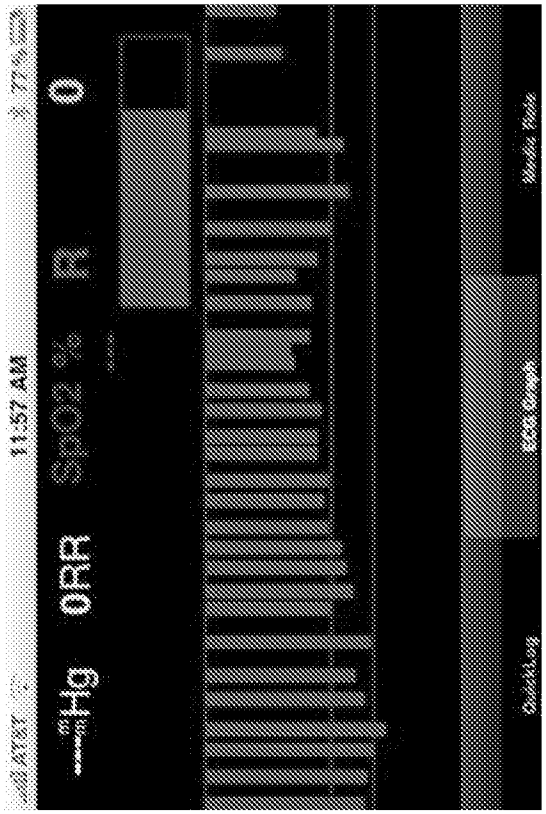


FIG. 59

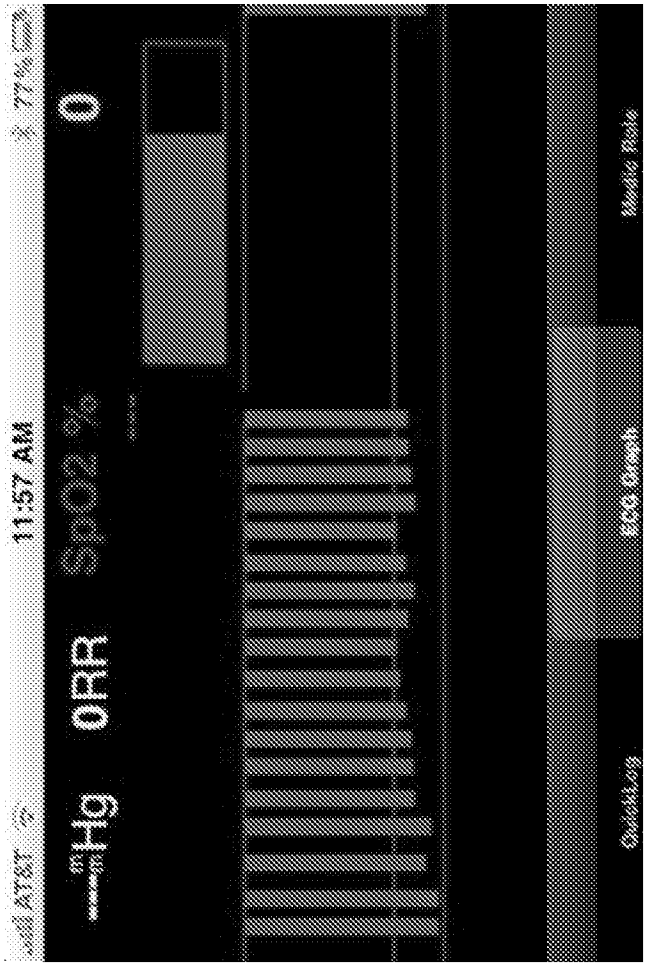

AT&T
11:57 AM
77%
mmHg
0RR
SpO2 %
0
ECG Graph
Waste Rate

FIG. 60

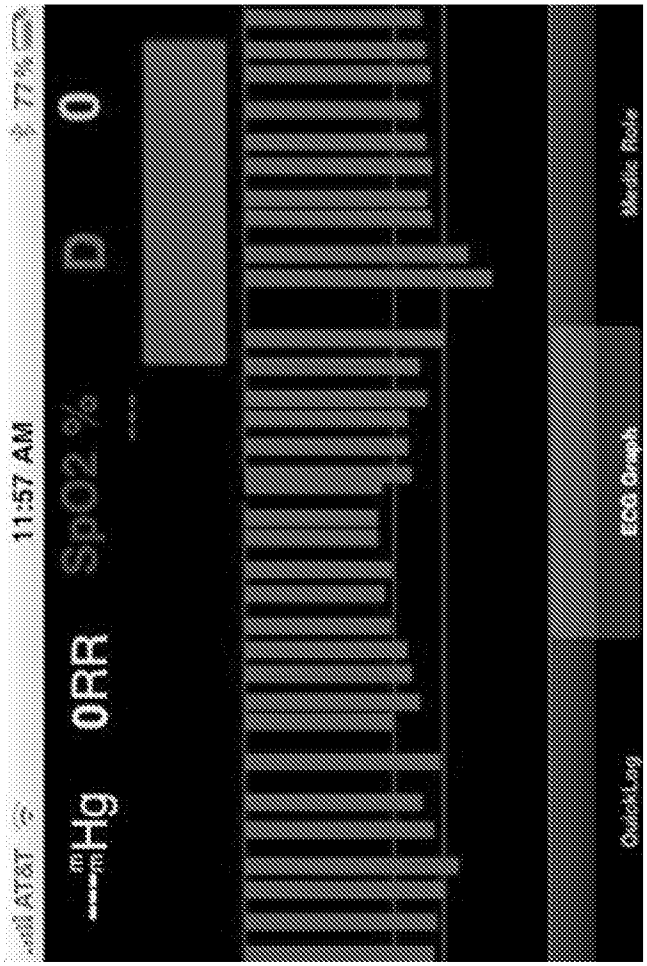

AT&T
11:57 AM
77%
mmHg
0RR
SpO2 %
0
0
ECG Graph
Waste Rate

FIG. 61

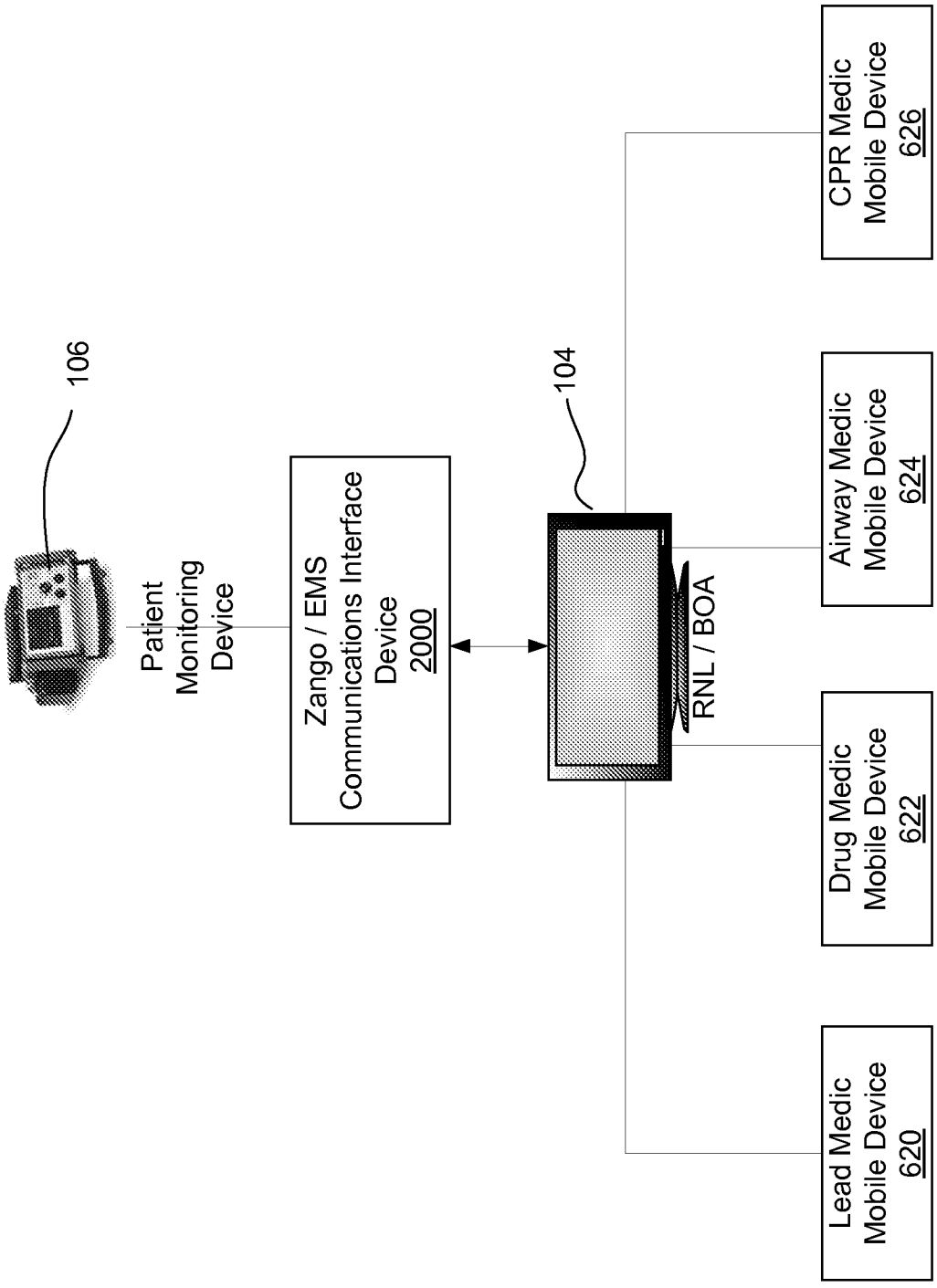

106
Patient Monitoring Device
Zango / EMS Communications Interface Device 2000
104
RNL / BOA
CPR Medic Mobile Device 626
Airway Medic Mobile Device 624
Drug Medic Mobile Device 622
Lead Medic Mobile Device 620

FIG. 62

PTO/SB/14 (11-08)
Approved for use through 09/30/2010. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	391713
	Application Number	
Title of Invention	SYSTEMS AND METHODS FOR COLLECTION, ORGANIZATION AND DISPLAY OF EMS INFORMATION	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Applicant Information:

Applicant 1 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	C.	Shane	REID	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Denver	State/Province	CO	Country of Residence[i]	US

Citizenship under 37 CFR 1.41(b)[i] US

Mailing Address of Applicant:

Address 1	3050 South Elm Street		
Address 2			
City	Denver	State/Province	CO
Postal Code	80222	Country[i]	US

Applicant 2 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Chad		ASHMORE	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Frederick	State/Province	CO	Country of Residence[i]	US

Citizenship under 37 CFR 1.41(b)[i] US

Mailing Address of Applicant:

Address 1	6303 Taylor Street		
Address 2			
City	Frederick	State/Province	CO
Postal Code	80530	Country[i]	US

Applicant 3 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Eric	A.	DEINES	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Broomfield	State/Province	CO	Country of Residence[i]	US

PTO/SB/14 (11-08)
Approved for use through 09/30/2010. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	391713
	Application Number	
Title of Invention	SYSTEMS AND METHODS FOR COLLECTION, ORGANIZATION AND DISPLAY OF EMS INFORMATION	

Citizenship under 37 CFR 1.41(b) i	US				
Mailing Address of Applicant:					
Address 1	1052 Lilac Court				
Address 2					
City	Broomfield	**State/Province**	CO		
Postal Code	80020	**Country**i	US		

Applicant 4 Remove

Applicant Authority (•) Inventor	( ) Legal Representative under 35 U.S.C. 117	( ) Party of Interest under 35 U.S.C. 118			
Prefix	**Given Name**	**Middle Name**	**Family Name**		**Suffix**
	Gary	A.	FREEMAN		
Residence Information (Select One) (•) US Residency	( ) Non US Residency	( ) Active US Military Service			
City	Newton Center	**State/Province**	MA	**Country of Residence** i	US
Citizenship under 37 CFR 1.41(b) i	US				
Mailing Address of Applicant:					
Address 1	47 Stearns Street				
Address 2					
City	Newton Center	**State/Province**	MA		
Postal Code	02159	**Country**i	US		

Applicant 5 Remove

Applicant Authority (•) Inventor	( ) Legal Representative under 35 U.S.C. 117	( ) Party of Interest under 35 U.S.C. 118			
Prefix	**Given Name**	**Middle Name**	**Family Name**		**Suffix**
	Michael	Scott	MARTIN		
Residence Information (Select One) (•) US Residency	( ) Non US Residency	( ) Active US Military Service			
City	Lakewood	**State/Province**	CO	**Country of Residence** i	US
Citizenship under 37 CFR 1.41(b) i	US				
Mailing Address of Applicant:					
Address 1	2727 South Braun Court				
Address 2					
City	Lakewood	**State/Province**	CO		
Postal Code	80228	**Country**i	US		

Applicant 6 Remove

Applicant Authority (•) Inventor	( ) Legal Representative under 35 U.S.C. 117	( ) Party of Interest under 35 U.S.C. 118			
Prefix	**Given Name**	**Middle Name**	**Family Name**		**Suffix**
	Gary		RUGGIERO		
Residence Information (Select One) (•) US Residency	( ) Non US Residency	( ) Active US Military Service			
City	Lexington	**State/Province**	MA	**Country of Residence** i	US
Citizenship under 37 CFR 1.41(b) i	US				

PTO/SB/14 (11-08)
Approved for use through 09/30/2010. OMB 0651-0032
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	391713
	Application Number	
Title of Invention	SYSTEMS AND METHODS FOR COLLECTION, ORGANIZATION AND DISPLAY OF EMS INFORMATION	

Mailing Address of Applicant:			
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Application Information:

Title of the Invention	SYSTEMS AND METHODS FOR COLLECTION, ORGANIZATION AND DISPLAY OF EMS INFORMATION		
Attorney Docket Number	391713	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Suggested Class (if any)		Sub Class (if any)	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)	50	Suggested Figure for Publication (if any)	1

PTO/SB/14 (11-08)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	391713
	Application Number	
Title of Invention	SYSTEMS AND METHODS FOR COLLECTION, ORGANIZATION AND DISPLAY OF EMS INFORMATION	

Publication Information:

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Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	non provisional of	61227187	2009-07-21
Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	non provisional of	61322678	2010-04-09

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	391713
	Application Number	
Title of Invention	SYSTEMS AND METHODS FOR COLLECTION, ORGANIZATION AND DISPLAY OF EMS INFORMATION	

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Signature	/Benjamin S. Fernandez/			Date (YYYY-MM-DD)	2010-07-20
First Name	Benjamin	Last Name	Fernandez	Registration Number	55172

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Application Number:	
Filing Date:	
Title of Invention:	SYSTEMS AND METHODS FOR COLLECTION, ORGANIZATION AND DISPLAY OF EMS INFORMATION
First Named Inventor/Applicant Name:	C. Shane REID
Filer:	Benjamin S. Fernandez
Attorney Docket Number:	391713

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility application filing	1011	1	330	330
Utility Search Fee	1111	1	540	540
Utility Examination Fee	1311	1	220	220
Pages:				
Utility Appl Size fee per 50 sheets >100	1081	1	270	270
Claims:				
Claims in excess of 20	1202	18	52	936
Independent claims in excess of 3	1201	1	220	220

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Miscellaneous-Filing:				
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**2516**

Electronic Acknowledgement Receipt

EFS ID:	8054023
Application Number:	12840117
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Confirmation Number:	9513
Title of Invention:	SYSTEMS AND METHODS FOR COLLECTION, ORGANIZATION AND DISPLAY OF EMS INFORMATION
First Named Inventor/Applicant Name:	C. Shane REID
Customer Number:	35657
Filer:	Benjamin S. Fernandez/Aimee Miller
Filer Authorized By:	Benjamin S. Fernandez
Attorney Docket Number:	391713
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Application Type:	Utility under 35 USC 111(a)

Payment information:

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Payment Type	Credit Card
Payment was successfully received in RAM	$2516
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Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		20100720-391713-Specification.pdf	292622 a54501241cff9eedd0f91be7cf6efdd18083a06a	yes	107

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	97
Claims	98	106
Abstract	107	107

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2	Drawings-other than black and white line drawings	20100720-391713-Drawings.pdf	2881261 16fe62e5c47c2eed47d77c6979b05ca8518b5ea9	no	50

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3	Application Data Sheet	391713-ADS.pdf	1032273 784246d33c2eca8e187ee7a96e110a577975a32d	no	6

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4	Fee Worksheet (PTO-875)	fee-info.pdf	39814 6155ee999d2243d1ae5a40d24f8b2c84d8ad074e	no	2

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SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATIONS INTERFACE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Patent Application Serial Nos. 61/227,187, filed on July 21, 2009, and 61/322,675, filed on April 9, 2010, which are incorporated herein by reference in their entirety for all purposes.

TECHNICAL FIELD

[0002] Embodiments of the present invention relate generally to emergency medical services information management, and more particularly to collection, organization, and communication of information gathered from a device used in emergency medical services.

BACKGROUND

[0003] Devices that are used to gather patient monitoring information in emergency medical services ("EMS") applications, for example defibrillator devices, are often complex and expensive devices, primarily because they serve a very important purpose in an EMS setting, and must be durable, accurate, and reliable. The communications capabilities of such devices are often limited by their hardware, such that users must choose between buying a new defibrillator or continuing to use the same, often slower, communications interfaces available with an older defibrillator. A retrofit solution that involves changing the existing hardware or

software of the device may be almost as costly and time-consuming to implement as device replacement itself.

[0004] Existing patient monitoring devices store various kinds of information during use. Users wishing to upload or download such information, typically after an incident or after a certain period of time (e.g. at the end of the day or end of the week), are often limited to retrieving only the entire content of the device's memory card, regardless of whether the user is interested in only a specific subset of the entire card's contents. This increases the time necessary for data transfer, as well as the time necessary to sort the data and/or identify the desired subset of the data.

SUMMARY

[0005] A system for supplementing communications capabilities of a patient monitoring device configured to monitor a patient and to make available patient monitoring information according to embodiments of the present invention includes a communications interface slot, the system including a card configured to fit within the communications interface slot and to receive the patient monitoring information from the patient monitoring device via the communications interface slot, a memory device hosted by the card and configured to store the patient monitoring information, a wireless transceiver hosted by the card, an asset management database hosted by the card, and a processor communicably coupled to the wireless transceiver and the asset management database, the processor configured to format the patient monitoring information into a stream of one or more frames, each of the one or more frames associated with an EMS incident during which the patient monitoring information was gathered, the processor further configured to store the one or more frames to the asset management database and to transmit the stream of one or

more frames with the wireless transceiver. In such a system, the processor may be further configured to receive, via the wireless transceiver, a request for frames associated with a specific EMS incident, query the asset management database to retrieve all frames associated with the specific EMS incident, and to transmit the frames associated with the specific EMS incident with the wireless transceiver.

[0006] A method for supplementing communications capabilities of a patient monitoring device configured to monitor a patient and to make available patient monitoring information according to embodiments of the present invention includes receiving the patient monitoring information from the patient monitoring device to an EMS communication interface device via a communications interface slot, storing the patient monitoring information to a memory hosted by the EMS communication interface device, formatting the patient monitoring information into a stream of one or more frames, each of the one or more frames associated with an EMS incident during which the patient monitoring information was gathered, storing the one or more frames to an asset management database hosted by the EMS communication interface device, and transmitting the stream of one or more frames via a wireless transceiver of the EMS communication interface device.

[0007] According to embodiments of the present invention, a system for supplementing communications capabilities of a patient monitoring device configured to monitor a patient and to make available patient monitoring information, the patient monitoring device having a communications interface slot, the system comprising: a card configured to fit within the communications interface slot and to receive the patient monitoring information from the patient monitoring device via the communications interface slot; a memory device hosted by the card and configured to store the patient monitoring information; a wireless transceiver hosted by the card; an asset management

database hosted by the card; and a processor communicably coupled to the wireless transceiver and the asset management database, the processor configured to format the patient monitoring information into a stream of one or more frames, each of the one or more frames associated with an EMS incident during which the patient monitoring information was gathered, the processor further configured to store the one or more frames to the asset management database and to transmit the stream of one or more frames with the wireless transceiver.

[0008] The system of paragraph [0007], wherein the processor is further configured to receive, via the wireless transceiver, a request for frames associated with a specific EMS incident, query the asset management database to retrieve all frames associated with the specific EMS incident, and to transmit the frames associated with the specific EMS incident with the wireless transceiver.

[0009] The system of any of paragraphs [0007] through [0008], wherein the processor is restricted from editing the patient monitoring information on the memory device.

[0010] The system of any of paragraphs [0007] through [0009], wherein the patient monitoring device is configured to edit the patient monitoring information on the memory device.

[0011] The system of any of paragraphs [0007] through [0010], wherein patient monitoring information from the patient monitoring device is bifurcated into a first stream and a second stream, wherein the memory card is configured to store the first stream, and wherein the processor is configured to receive the second stream.

[0012] According to embodiments of the present invention, a method for streaming patient information from a clinical device, comprising: establishing a wireless data connection with the clinical device; receiving patient information from the clinical device via the

wireless data connection at least once every five seconds; and displaying at least a portion of the patient information in an emergency medical services mobile environment.

[0013] The method of any of paragraphs [0007] through [0012], wherein the clinical device is a defibrillator.

[0014] The method of any of paragraphs [0007] through [0013], wherein receiving the patient information comprises receiving the patient information from the clinical device via the wireless data connection at least once every second.

[0015] The method of any of paragraphs [0007] through [0014], wherein the wireless data connection is a secure WiFi connection.

[0016] The method of any of paragraphs [0007] through [0015], wherein the patient information is clinical information, the method further comprising receiving non-clinical information and displaying the clinical information and the non-clinical information simultaneously in the emergency medical services mobile environment.

[0017] The method of any of paragraphs [0007] through [0016], wherein the patient information comprises an ECG waveform.

[0018] The method of any of paragraphs [0007] through [0017], wherein the patient information comprises a heart rate.

[0019] The method of any of paragraphs [0007] through [0018], wherein the patient information comprises an ECG waveform.

[0020] The method of any of paragraphs [0007] through [0019], further comprising: receiving full disclosure data from the clinical device; formatting the full disclosure data into a frame event stream, wherein the frame event stream comprises a plurality of frames in chronological order, wherein each of the plurality of frames comprises a time identifier, an incident identifier, and clinical information associated with a time identified by the time identifier and an incident

identified by the incident identifier; and sending the frame event stream over the wireless data connection as the patient information.

[0021] The method of any of paragraphs [0007] through [0020], further comprising storing the plurality of frames in a computer readable medium.

[0022] The method of any of paragraphs [0007] through [0021], further comprising: sending a request over the wireless data connection, the request including a particular incident identifier; retrieving from the computer readable medium and adding to a response set each of the plurality of frames for which the incident identifier corresponds to the particular incident identifier of the request; and sending the response set over the wireless data connection.

[0023] The method of any of paragraphs [0007] through [0022], further comprising displaying at least a portion of the response set in the emergency medical services mobile environment.

[0024] The method of any of paragraphs [0007] through [0023], wherein the wireless data connection is a first wireless data connection, the method further comprising: transmitting the patient information via a second wireless data connection; receiving the patient information with a personal mobile device via the second wireless data connection; receiving, via the personal mobile device, a role indication; and determining a portion of the patient information for display on the mobile device based on the role indication.

[0025] The method of any of paragraphs [0007] through [0024], wherein the role indication is CPR medic, and wherein the portion of the patient information comprises chest compression measurement data.

[0026] The method of any of paragraphs [0007] through [0025], further comprising: receiving a patient intervention indication via the second wireless data connection from the personal mobile device; and

displaying at least a portion of the patient information simultaneously with information associated with the patient intervention indication in the emergency medical services mobile environment.

[0027] The method of any of paragraphs [0007] through [0026], wherein the patient intervention indication is one of a plurality of patient intervention indications, and wherein the plurality of patient intervention indications displayed on the personal mobile device is determined based on the role indication.

[0028] The method of any of paragraphs [0007] through [0027], wherein the wireless data connection is a first wireless data connection, the method further comprising: transmitting the patient information via a second wireless data connection; receiving the patient information with a personal mobile device via the second wireless data connection; receiving, via the personal mobile device, a role indication; and filtering the patient information for display on the mobile device based on the role indication.

[0029] According to embodiments of the present invention, a method for supplementing communications capabilities of a patient monitoring device configured to monitor a patient and to make available patient monitoring information, the patient monitoring device having a communications interface slot, the method comprising: receiving the patient monitoring information from the patient monitoring device to an EMS communication interface device via the communications interface slot; storing the patient monitoring information to a memory hosted by the EMS communication interface device; formatting the patient monitoring information into a stream of one or more frames, each of the one or more frames associated with an EMS incident during which the patient monitoring information was gathered; storing the one or more frames to an asset management database hosted by the EMS communication interface device; and

transmitting the stream of one or more frames via a wireless transceiver of the EMS communication interface device.

[0030] While multiple embodiments are disclosed, still other embodiments of the present invention will become apparent to those skilled in the art from the following detailed description, which shows and describes illustrative embodiments of the invention. Accordingly, the drawings and detailed description are to be regarded as illustrative in nature and not restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

[0031] FIG. 1 illustrates a system for mobile and enterprise user real-time display of medical information collected from multiple different EMS devices, according to embodiments of the present invention.

[0032] FIG. 2 illustrates one example of a menu template for the display of a "back of ambulance" ("BOA") device, according to embodiments of the present invention.

[0033] FIG. 3 illustrates a display and graphical user interface displayed when the user selects the navigation button of the menu template, according to embodiments of the present invention.

[0034] FIG. 4 illustrates a display and graphical user interface displayed when the user selects the patient monitoring button of the menu template, according to embodiments of the present invention.

[0035] FIG. 5 illustrates a display and graphical user interface displayed when the user selects the patient charting button of the menu template, according to embodiments of the present invention.

[0036] FIG. 6 illustrates a display and graphical user interface displayed when the user selects the "patch notes" button of the menu template, according to embodiments of the present invention.

[0037] FIG. 7 illustrates a display and graphical user interface displayed when the user selects the protocols button of the menu template, according to embodiments of the present invention.

[0038] FIG. 8 illustrates an enterprise display and graphical user interface shown when the enterprise user selects the patient monitoring button, according to embodiments of the present invention.

[0039] FIG. 9 illustrates an enterprise display and graphical user interface shown when the enterprise user selects the navigation button, according to embodiments of the present invention.

[0040] FIG. 10 illustrates an enterprise display and graphical user interface shown when the enterprise user selects the patient charting button, according to embodiments of the present invention.

[0041] FIG. 11 illustrates a treatment domain system overview for real-time display of medical information collected from multiple different EMS devices, according to embodiments of the present invention.

[0042] FIG. 12 illustrates a device adapter / communication engine and medical device interface, according to embodiments of the present invention.

[0043] FIG. 13 illustrates an exemplary pipe, according to embodiments of the present invention.

[0044] FIG. 14 illustrates a method performed by a pipe of the device adapter that uses discovery supporting transport, according to embodiments of the present invention.

[0045] FIG. 15 illustrates a method performed by a pipe of the device adapter that uses non-discovery supporting transport, according to embodiments of the present invention.

[0046] FIG. 16 illustrates a method performed by a BOA module, according to embodiments of the present invention.

[0047] FIG. 17 illustrates a method performed by a BOA module, according to embodiments of the present invention.

[0048] FIG. 18 illustrates an exemplary computer system, according to embodiments of the present invention.

[0049] FIG. 19 illustrates a system for mobile and enterprise user real-time display of medical information collected from multiple different EMS devices, according to embodiments of the present invention.

[0050] FIG. 20 illustrates a carrier board design for an EMS communication interface device, according to embodiments of the present invention.

[0051] FIG. 21 illustrates a system overview for an EMS communication interface device, according to embodiments of the present invention.

[0052] FIG. 22 illustrates another system overview for an EMS communication interface device, according to embodiments of the present invention.

[0053] FIG. 23 illustrates a software logic diagram for an EMS communication interface device, according to embodiments of the present invention.

[0054] FIG. 24 illustrates a conventional mesh network.

[0055] FIG. 25 illustrates an indoor geolocation system.

[0056] FIG. 26 illustrates an example explanation of differential diagnosis of acute dyspnea in adults.

[0057] FIG. 27 illustrates an example explanation of clues to differential diagnosis of dyspnea.

[0058] FIG. 28 illustrates an example listing of physical exam findings in the diagnosis of acute dyspnea.

[0059] FIG. 29 shows an example treatment protocol for asthma, COPD, and acute decompensated heart failure.

[0060] FIG. 30 illustrates a data transmission interface, according to embodiments of the present invention.

[0061] FIG. 31 illustrates an EMS communication interface transmission processing block diagram, according to embodiments of the present invention.

[0062] FIG. 32 illustrates a EMS communications interface device client architecture, according to embodiments of the present invention.

[0063] FIG. 33 illustrates an enterprise display and graphical user interface shown when the enterprise user selects the patient monitoring button, according to embodiments of the present invention.

[0064] FIG. 34 illustrates an enterprise display and graphical user interface shown when the enterprise user selects the patient charting button, according to embodiments of the present invention.

[0065] FIG. 35 illustrates an enterprise display and graphical user interface shown when the enterprise user selects the navigation button, according to embodiments of the present invention.

[0066] FIG. 36 illustrates an alternative enterprise display and graphical user interface shown when the enterprise user selects the navigation button, according to embodiments of the present invention.

[0067] FIG. 37 illustrates an enterprise display and graphical user interface shown when the enterprise user selects the patch notes button, according to embodiments of the present invention.

[0068] FIG. 38 illustrates a display and graphical user interface displayed when the user selects the patient charting button of a BOA menu template, according to embodiments of the present invention.

[0069] FIG. 39 illustrates a display and graphical user interface displayed when the user selects the patient monitoring button of a BOA menu template, according to embodiments of the present invention.

[0070] FIG. 40 illustrates a display and graphical user interface displayed when the user selects the navigation button of a BOA menu template, according to embodiments of the present invention.

[0071] FIG. 41 illustrates an alternative display and graphical user interface displayed when the user selects the navigation button of a BOA menu template, according to embodiments of the present invention.

[0072] FIG. 42 illustrates a display and graphical user interface displayed when the user selects the shift start button of a BOA menu template, according to embodiments of the present invention.

[0073] FIG. 43 illustrates an alternative display and graphical user interface displayed when the user selects the navigation button of a BOA menu template, according to embodiments of the present invention.

[0074] FIG. 44 illustrates a display and graphical user interface displayed when the user selects the patch notes button of a BOA menu template, according to embodiments of the present invention.

[0075] FIG. 45 illustrates a display and graphical user interface displayed when the user selects a live patient data button of a BOA menu template, according to embodiments of the present invention.

[0076] FIG. 46 illustrates a start screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0077] FIG. 47 illustrates a role selection screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0078] FIG. 48 illustrates a lead medic quick log screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0079] FIG. 49 illustrates a lead medic ECG graph screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0080] FIG. 50 illustrates a lead medic patient data screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0081] FIG. 51 illustrates a lead medic chief complaint screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0082] FIG. 52 illustrates a drug medic quick log screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0083] FIG. 53 illustrates a drug medic ECG graph screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0084] FIG. 54 illustrates a role selection screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0085] FIG. 55 illustrates an airway medic ECG graph screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0086] FIG. 56 illustrates an airway medic quick log screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0087] FIG. 57 illustrates a CPR medic quick log screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0088] FIG. 58 illustrates a CPR medic ECG graph screen during idle for a role-based EMS technician mobile device in

communication with a BOA device, according to embodiments of the present invention.

[0089] FIG. 59 illustrates a CPR medic ECG graph screen during administration of compressions for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0090] FIG. 60 illustrates a CPR medic ECG graph screen during administration of compressions for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0091] FIG. 61 illustrates a CPR medic ECG graph screen during administration of compressions for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention.

[0092] FIG. 62 illustrates a system for role-based data feeds from a BOA device to EMS technician mobile devices, according to embodiments of the present invention.

[0093] While the invention is amenable to various modifications and alternative forms, specific embodiments have been shown by way of example in the drawings and are described in detail below. The intention, however, is not to limit the invention to the particular embodiments described. On the contrary, the invention is intended to cover all modifications, equivalents, and alternatives falling within the scope of the invention as defined by the appended claims.

DETAILED DESCRIPTION

[0094] As illustrated in FIG. 1, a system 100 according to embodiments of the present invention performs advanced data management, integration and presentation of EMS data from multiple different devices. System 100 includes a mobile environment 101, an

enterprise environment 102, and an administration environment 103. Devices within the various environments 101, 102, 103 may be communicably coupled via a network 120, such as, for example, the Internet.

[0095] As used herein, the phrase "communicably coupled" is used in its broadest sense to refer to any coupling whereby information may be passed. Thus, for example, communicably coupled includes electrically coupled by, for example, a wire; optically coupled by, for example, an optical cable; and/or wirelessly coupled by, for example, a radio frequency or other transmission media. "Communicably coupled" also includes, for example, indirect coupling, such as through a network, or direct coupling.

[0096] The network 120 may also take the form of an ad hoc, self-configuring, self-healing network 2400 such as a MESH network, as illustrated in FIG. 24, according to embodiments of the present invention. FIG. 24, as well as the following information about MESH networks in paragraphs [00109] to [00117], is taken directly from Poor, Robert; WIRELESS MESH NETWORKS; Sensors (Feb. 1, 2003), *available at* http://www.sensorsmag.com/networking-communications/standards-protocols/wireless-mesh-networks-968, which is incorporated herein by reference. Wireless systems for industry conventionally use cellular phone-style radio links, using point-to-point or point-to-multipoint transmission. But research at MIT's Media Lab in Cambridge, MA, indicated that traditional wireless formats have limitations in industrial applications. These include rigid structure, meticulous planning requirements, and dropped signals. This can pose an acute challenge in an EMS or mass casualty environment in which existing infrastructure may be either sparse (e.g. a rural environment) or dysfunctional (e.g. a mass casualty or disaster situation).

[0097] In contrast, wireless mesh networks 2400 are multihop systems in which devices assist each other in transmitting packets through the network, especially in adverse conditions. Such ad hoc networks may be implemented with minimal preparation, and they provide a reliable, flexible system that can be extended to thousands of devices, according to embodiments of the present invention.

[0098] The wireless mesh network topology developed at MIT for industrial control and sensing is a point-to-point-to-point, or peer-to-peer, system called an ad hoc, multihop network. A node can send and receive messages, and in a mesh network, a node also functions as a router and can relay messages for its neighbors. Through the relaying process, a packet of wireless data will find its way to its destination, passing through intermediate nodes with reliable communication links, as illustrated in FIG. 24.

[0099] In a wireless mesh network 2400, multiple nodes cooperate to relay a message to its destination. The mesh topology enhances the overall reliability of the network, which is particularly important when operating in harsh industrial environments. Like the Internet and other peer-to-peer router-based networks, a mesh network offers multiple redundant communications paths throughout the network. If one link fails for any reason (including the introduction of strong RF interference), the network automatically routes messages through alternate paths. In a mesh network 2400, the distance between nodes can be shortened, which dramatically increases the link quality. Reducing the distance by a factor of two, the resulting signal is at least four times more powerful at the receiver. This makes links more reliable without increasing transmitter power in individual nodes. The reach of a mesh network may be extended, redundancy added, and general reliability improved simply by adding more notes.

[00100] Network 2400 may be a self-configuring and self-healing network, according to embodiments of the present invention. According to embodiments of the present invention, a network 2400 does not require a system administrator to tell it how to get a message to its destination. A mesh network 2400 is self-organizing and does not require manual configuration. Because of this, adding new gear or relocating existing gear is as simple as plugging it in and turning it on, according to embodiments of the present invention. The network discovers the new node and automatically incorporates it into the existing system, according to embodiments of the present invention.

[00101] A mesh network 2400 is not only inherently reliable, it is also highly adaptable, according to embodiments of the present invention. For example, if a tank-level sensor and data logger are placed too far apart for a robust RF communications link, one or more repeater nodes may be added to fill the gaps in the network 2400.

[00102] On the Internet, if one router goes down, messages are sent through an alternate path by other routers. Similarly, if a device or its link in a mesh network fails, messages are sent around it via other devices. Loss of one or more nodes does not necessarily affect the network's operation. A mesh network is self-healing because human intervention is not necessary for re-routing of messages. Such networks 2400 provide redundancy and scalability, according to embodiments of the present invention.

[00103] In a mesh network, the degree of redundancy is essentially a function of node density. A network can be deliberately over-designed for reliability simply by adding extra nodes, so each device has two or more paths for sending data. This is a simpler way of obtaining redundancy than is possible in most other types of systems. A mesh network is also scalable and can handle hundreds or thousands of nodes. Because the operation of network 2400 does not

depend on a central control point, adding multiple data collection points or gateways may be convenient.

[00104] Reliability, adaptability, and scalability are notable attributes of a wireless network for industrial control and sensing applications, according to embodiments of the present invention. Point-to-point networks provide reliability, but they are often challenging to scale to handle more than one pair of end points. Point-to-multipoint networks can handle more end points, but their reliability may depend on placement of the access point and end points. Mesh networks are inherently reliable, adapt easily to environmental or architectural constraints, and can scale to handle thousands of end points.

[00105] According to embodiments of the present invention, the mobile environment 101 is an ambulance or other EMS vehicle – for example a vehicular mobile environment (VME). The mobile environment may also be the local network of data entry devices as well as diagnostic and therapeutic devices established at time of treatment of a patient or patients in the field environment – the "At Scene Patient Mobile Environment" (ASPME). The mobile environment may also be a combination of one or more of VMEs and/or ASPMEs. The mobile environment may include a navigation device 110 used by the driver 112 to track the mobile environment's position 101, locate the mobile environment 101 and/or the emergency location, and locate the transport destination, according to embodiments of the present invention. The navigation device 110 may include a Global Positioning System ("GPS"), for example. The navigation device 110 may also be configured to perform calculations about vehicle speed, the travel time between locations, and estimated times of arrival. According to embodiments of the present invention, the navigation device 110 is located at the front of the ambulance to

assist the driver 112 in navigating the vehicle. The navigation device 110 may be, for example, a RescueNet® Navigator onboard electronic data communication system available from Zoll Data Systems of Broomfield, Colorado.

[00106] FIG. 25, as well as the following information about geolocation in paragraphs [00119] through [00120], is taken directly from K. Pahlavan, *et al.,* "An Overview of Wireless Indoor Geolocation," Mobile and Wireless Communications Networks IFIP-TC6/European Commission NETWORKING 2000 International Workshop, MWCN 2000 Paris, France, May 16–17, 2000, which is incorporated herein by reference. More generally, the mobile environment may include a geolocation sensor in one or more of the devices in the VME or ASPME. The geolocation sensor may be of a common type such as, for example, a Global Positioning System (GPS). GPS, though, may be subject to certain limitations: 1) line of sight to more than one GPS satellite, which may limit its performance in indoor environments; 2) in some urban environments, location accuracy is reduced due to signal reflections off of buildings; and 3) normal accuracy may be insufficient in the case of a mass casualty in which accuracies of better than +/- 5 feet may be required when there are multiple casualties and the locations of each victim needs to be integrated into a software mapping environment, according to embodiments of the present invention.

[00107] Therefore, additional locator base stations may be deployed on-scene outdoors, or within buildings, that may augment or replace the conventional GPS-based geolocator systems, according to embodiments of the present invention. Similar to the cellular geolocation system, the architecture of indoor geolocation systems may fall within one of two main categories: mobile-based architecture and network-based architecture. Most conventional indoor geolocation

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applications have been focused on network-based system architecture as shown in FIG. 25. The geolocation base stations (GBS) extract location metrics from the radio signals transmitted by the mobile station and relay the information to a geolocation control station (GCS). The connection between GBS and GCS can be either wired or wireless, according to embodiments of the present invention. Then the position of the mobile station may be estimated, in an indoor environment. As a result, dedicated indoor geolocation systems provide accurate indoor geolocation services. This may be applied as well to a mobile environment such as a battlefield or other mass casualty situation in which base stations with better known accuracy based on landmarks or more sophisticated GPS systems such as differential GPS (DGPS) can be deployed to provide highly accurate and complete information about the patient status integrated into the navigation software or other mapping software, such as, for example, Google maps.

[00108] As illustrated in FIG. 1, a patient monitoring device 106 and a patient charting device 108 are also often used for patient care in the mobile environment 101, according to embodiments of the present invention. The EMS technician 114 attaches the patient monitoring device 106 to the patient 116 to monitor the patient 116. The patient monitoring device 106 may be, for example, a defibrillator device with electrodes and/or sensors configured for attachment to the patient 116 to monitor heart rate and/or to generate electrocardiographs ("ECG's"), according to embodiments of the present invention. The patient monitoring device 106 may also include sensors to detect or a processor to derive or calculate other patient conditions. For example, the patient monitoring device 106 may monitor, detect, treat and/or derive or calculate blood pressure, temperature, respiration rate, blood oxygen level, end-tidal carbon dioxide level, pulmonary function, blood glucose level, and/or weight,

according to embodiments of the present invention. The patient monitoring device 106 may be a Zoll E-Series® defibrillator available from Zoll Medical Corporation of Chelmsford, Massachusetts, according to embodiments of the present invention. A patient monitoring device may also be a patient treatment device, or another kind of device that includes patient monitoring and/or patient treatment capabilities, according to embodiments of the present invention.

[00109] The patient charting device 108 is a device used by the EMS technician 114 to generate records and/or notes about the patient's 116 condition and/or treatments applied to the patient, according to embodiments of the present invention. For example, the patient charting device 108 may be used to note a dosage of medicine given to the patient 116 at a particular time. The patient charting device 108 and/or patient monitoring device 106 may have a clock, which may be synchronized with an external time source such as a network or a satellite to prevent the EMS technician from having to manually enter a time of treatment or observation (or having to attempt to estimate the time of treatment for charting purposes long after the treatment was administered), according to embodiments of the present invention. The patient charting device 108 may also be used to record biographic and/or demographic and/or historical information about a patient, for example the patient's name, identification number, height, weight, and/or medical history, according to embodiments of the present invention. According to embodiments of the present invention, the patient charting device 108 is a tablet PC, such as for example the TabletPCR component of the RescueNet® ePCR Suite available from Zoll Data Systems of Broomfield, Colorado. According to some embodiments of the present invention, the patient charting device 108 is a wristband or smart-phone such as an Apple iPhone or iPad with interactive data entry interface such as a touch screen or voice

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recognition data entry that may be communicably connected to the BOA device 104 and tapped to indicate what was done with the patient 116 and when it was done.

[00110] The navigation device 110, the charting device 108, and the monitoring device 106 are each separately very useful to the EMS drivers 112 and technicians 114 before, during, and after the patient transport. A "back of ambulance" ("BOA") device 104 receives, organizes, stores, and displays data from each device 108, 110, 112 to further enhance the usefulness of each device 108, 110, 112 and to make it much easier for the EMS technician 114 to perform certain tasks that would normally require the EMS technician 114 to divert visual and manual attention to each device 108, 110, 112 separately, according to embodiments of the present invention. In other words, the BOA device centralizes and organizes information that would normally be de-centralized and disorganized, according to embodiments of the present invention.

[00111] Although device 104 is referred to herein as a "back of ambulance" device because the EMS technician 114 would normally benefit the most from having such a display device mounted in the back 152 of an ambulance, one of ordinary skill in the art, based on the disclosure provided herein, will recognize that some or all of the BOA device 104 may be located in any part of a mobile environment 101, EMS vehicle, and/or anywhere else useful to an EMS technician 114. For example, the BOA device 104 may be located in the front 150 of an ambulance, and/or may include components that are portable and can be carried into a patient residence, according to embodiments of the present invention.

[00112] The BOA device 104 is communicably coupled to the patient monitoring device 106, the patient charting device 108, and the navigation device 110, according to embodiments of the present

invention. The BOA device 104 is also communicably coupled to a storage medium 118. The BOA device 104 may be a touch-screen, flat panel PC, and the storage medium 118 may be located within or external to the BOA device 104, according to embodiments of the present invention. The BOA device 104 may include a display template serving as a graphical user interface, which permits the user (e.g. EMS tech 114) to select different subsets and/or display modes of the information gathered from and/or sent to devices 106, 108, 110, according to embodiments of the present invention.

[00113] FIG. 2 illustrates one example of a menu template 200 for the display of BOA device 104, according to embodiments of the present invention. The menu template 200 includes a navigation button 202, a patient monitoring device button 204, a patient charting device button 206, a "patch notes" button 208, and a protocols button 210, according to embodiments of the present invention. Pressing one of the buttons takes the user (e.g. EMS tech 114) to a particular page displaying all or a subset of information from devices 106, 108, 110. FIGS. 3-7 illustrate examples of particular information templates according to which information from the one or more EMS devices 106, 108, 110 is displayed, according to embodiments of the present invention. Based on the disclosure provided herein, one of ordinary skill in the art will recognize various other information templates according to which such information may be displayed.

[00114] FIG. 3 illustrates a graphical user interface displayed when the user selects the navigation button 202, according to embodiments of the present invention. One part of the display includes a status section 302 and another part of the display includes a map section 304, according to embodiments of the present invention. The status section 302 includes one or more fields identifying information about the EMS vehicle trip, according to embodiments of

the present invention. For example, the fields of the status section 302 may include one or more of a Unit field 306 identifying the name of the EMS vehicle for which information is displayed, a Crew unit 308 identifying one or more crew members of the EMS vehicle, a Status unit 310 identifying the status of the trip (e.g. "transporting" or "en route to patient"), an ETA field 312 identifying an estimated time of arrival at the destination, a Destination field 314 identifying the destination of the EMS vehicle (e.g. the hospital), and a Patch Info field 316 identifying a phone number or other information for contacting the EMS vehicle destination (e.g. the hospital), according to embodiments of the present invention.

[00115] The map section 304 may display street information along with the origin, destination, route identification, and/or progress information, according to embodiments of the present invention. The navigation device 110 may also supply vehicle status information for display, which may also be useful when a transport has not yet begun. A user may select a Cycle Feeds button 318 in order to continuously transition the display between one or more of the various displays of FIGS. 3-7, according to embodiments of the present invention. The information illustrated in FIG. 3 would normally be available only to the driver 112 in the front of the ambulance 101, but because BOA device 104 is communicably coupled to the navigation device 110, the BOA device 104 can display all or a selected subset of the information available to the navigation device 110.

[00116] FIG. 4 illustrates a graphical user interface displayed when the user selects the patient monitoring button 204 of the menu template, according to embodiments of the present invention. FIG. 4 displays information received by the BOA device 104 from a patient monitoring device 106 that is a Zoll E-Series® defibrillator. The display includes a vertical vital signs section 402, a horizontal vital signs

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summary section 404, a graphical section 406, and interpretation section 414, according to embodiments of the present invention. The vertical vital signs section 402 includes one or more fields indicating a condition of the patient 116 to which the device 106 is attached. For example, the vital signs section 402 includes a heart rate field, a respiration rate field, a blood pressure field, a blood oxygen level field, and an end-tidal carbon dioxide level field. Each field may include a visual indication of a further subset of information. For example, the heart rate field may include a numerical indication 408 of the heart rate, a time indication 410 reflecting the time that the measurement was taken or derived, and a historical graph 412 indicating generally how the heart rate has increased or decreased since the first measurement or a predetermined time, according to embodiments of the present invention. Other fields may include similar indicators, according to embodiments of the present invention. Vital sign trending may also be displayed.

[00117] A horizontal vital signs summary section 404 indicates, for example, the numerical values represented simultaneously in the vertical vital signs section 402, according to embodiments of the present invention. The graphical section 406 includes a visual representation of an electrocardiograph, such as that acquired from a twelve-lead sensor placement on the patient 116, according to embodiments of the present invention. Just above the ECG is an indication of when the ECG was acquired. As new vital signs information and/or new ECG information becomes available, the display of FIG. 4 is automatically refreshed to show the most recent data from the patient monitoring device 106, according to embodiments of the present invention. The interpretation section 414 includes automatically-generated information from the device 106, for

example, indicating potential causes of the symptoms observed by the device 106, according to embodiments of the present invention.

[00118] FIG. 5 illustrates a graphical user interface displayed when the user selects the patient charting button 206 of the menu template, according to embodiments of the present invention. The display of FIG. 5 includes a biographical summary 502, an interventions section 504, and a vital signs section 506, according to embodiments of the present invention. The biographical summary 502 may display the patient's name, age, and gender as recorded by the EMS technician 114 with the patient charting device 108, according to embodiments of the present invention. The interventions section 504 displays the patient 116 interventions (e.g. treatments administered) recorded with the patient charting device 108, according to embodiments of the present invention. For example, the interventions section 504 includes a listing of each intervention made, the time of the intervention, a description of the intervention (e.g. name of the drug administered), and the name of the person administering the treatment, according to embodiments of the present invention.

[00119] The vital signs section 506 includes a historical listing of certain vital signs data observed by the EMS technician 114 and recorded in the patient charting device 108, and stored in the patient charting device 108 and/or the database 118, according to embodiments of the present invention. The historical listing of vital signs data in the vital signs section 506 includes a time stamp, heart rate, blood pressure, respiration rate, blood oxygen level, end-tidal carbon dioxide level, blood glucose level, Glasgow Coma Scale rating ("GCS"), and the name of the technician or device that observed or recorded the vital sign, according to embodiments of the present invention.

[00120] FIG. 6 illustrates a graphical user interface displayed when the user selects the "patch notes" button 208 of the menu template, according to embodiments of the present invention. Patch notes are notes used by an EMS technician 114 to place a call to a hospital or other treatment facility to confirm that the hospital will accept the patient 116 and/or to provide information about the patient 116 to help the hospital or treatment facility prepare for admission. Because time is typically of the essence for such phone calls (because placing the call can temporarily divert the EMS technician's 114 attention away from patient 116 care), the EMS technician typically consults and interacts with several different devices 106, 108, 110 and/or informal data sources to compile a list of notes to convey to the nurse or other responsible party at the hospital or treatment facility. Such patch notes often take considerable time to assemble, and are often hastily written on a glove, for example, which also results in inaccuracy and in some of the patch notes representing old information by the time the call is placed and the information conveyed to the hospital.

[00121] The BOA device 104, on the other hand, automatically creates a display of several different fields that would typically comprise patch notes, according to embodiments of the present invention. The display of FIG. 6 includes fields representing information from multiple different devices, such as, for example, devices 106, 108, 110. The patch notes display may organize the information into a predefined template, and/or may organize the information into a customized template associated with a particular EMS technician 114, according to embodiments of the present invention. Not only does the BOA device 104 automatically receive and display information from multiple different devices 106, 108, 110 in a single display summarized to function as patch notes, but it also

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automatically refreshes the display to reflect the most recent information, thus permitting real-time conveyance of patient information, according to embodiments of the present invention.

[00122] For example, without the BOA device 104, if a patient's heart rate rose from 75 to 115 over the course of three minutes, and if an EMS technician 114 wrote "HR 75" on his glove before consulting his patient chart for name and background information and the driver 112 for location information before calling the hospital three minutes later, the EMS technician 114 might report a heart rate of 75 to the hospital. With the BOA device 104, however, the patch notes are generated automatically and displayed as in FIG. 6, and the Defib Vitals section would list the current heart rate of 115 when the EMS technician 114 conveyed the patient status to the hospital.

[00123] In addition to one or more of a Hospital field 602 identifying the name and phone number of the hospital to which the patient 116 is en route and an age field 604 identifying the patient's age, the display of FIG. 6 may also include one or more of a History Present Illness field, an Interventions field, a Unit identification field (e.g. identifying the particular EMS vehicle), a Gender field, a Past Medical History Field, a patient charting device vital signs field, an Expected Time of Arrival field, a Chief Complaint field, an Assessments field, and a patient monitoring device vital signs field, according to embodiments of the present invention.

[00124] Each of the fields may be configured to display either past or current or derived content from one or more of the EMS devices (e.g. devices 106, 108, 110) which are communicably coupled with the BOA device 104, according to embodiments of the present invention. For example, the Hospital, Unit, and ETA fields may be based on information received from the navigation unit 110. The Age, Gender, Chief Complaint, History Present Illness, Past Medical History,

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and Interventions fields may be based on information received from the patient charting unit 108. The patient charting device vital signs field may be based on information received from the patient charting unit 108 (e.g. GCS score), and the patient monitoring device vital signs field may be based on information received from the patient monitoring device 106 (e.g. ECG), according to embodiments of the present invention. According to embodiments of the present invention, a BOA device 104 may be located in the front of the ambulance to permit the driver 112 or another EMS technician to place the call to the hospital based on the real-time patch notes, thereby providing the attending EMS technician 114 more time and attention for direct patient care.

[00125] According to embodiments of the present invention, the BOA device 104 receives information from at least one patient monitoring EMS device and at least one non-patient monitoring EMS device. The patch notes screen of FIG. 6 illustrates one example of EMS information (e.g. information related to an emergency medical encounter or transport) from at least one patient monitoring device and at least one other device that does not directly monitor a patient (e.g. a navigation device and/or a patient charting device) on the same display, according to embodiments of the present invention. Similarly, in another embodiment of the present invention, the BOA device 104 receives information from at least one patient clinical device and at least one non-clinical device, and analyzes, combines, stores, displays, and/or transmits the clinical and non-clinical information in a format useful to the user. As used herein, the term "clinical" is used in its broadest sense to refer to that which is directly implicated in monitoring or treatment or diagnosis of a patient. As used herein, the term "non-clinical" is used in its broadest sense to refer to that which is not directly implicated in monitoring or treatment or diagnosis of a patient. For example, a defibrillator is a clinical device, and a

navigation device is a non-clinical device. As another example, a patient's ECG information or heart rate is clinical information, while a patient's address is non-clinical information.

[00126] FIG. 7 illustrates a graphical user interface displayed when the user selects the protocols button 210 of the menu template, according to embodiments of the present invention. The display of FIG. 7 includes an interactive guidelines manual for the particular locale where the medical emergency occurred, where the treatment occurs, and/or where the patient is delivered, according to embodiments of the present invention. Alternatively, the protocols button 210 may link to a manual or guideline document for the use of a particular device and/or the administration of a particular technique and/or information about a drug. For example, the display of FIG. 7 may include an interactive page listing of chapters in a county's protocol index, which may be a locally-stored protocol index and/or a protocol index accessed through an Internet connection. Clicking on one or more of the chapters or links opens a page containing more detail about the particular chapter or subject selected, for example.

[00127] Based on the disclosure provided herein, one of ordinary skill in the art will appreciate that the BOA device 104 may be configured to display additional or different subsets of information from one or more EMS devices and/or external data sources. According to embodiments of the present invention, the BOA device 104 not only seamlessly integrates information from a patient monitoring device 106, a patient charting device 108, and a navigation device 110 for display in mobile environment 101, but it also does so for display in a remote environment such as, for example, enterprise environment 102. Enterprise environment 102 may be a hospital and/or dispatch environment, for example.

[00128] Data from the BOA device 104 (and therefore data from the devices 106, 108, 110 communicably coupled with the BOA device 104) may be received by one or more enterprise storage servers 126 in an administration environment 103 and stored in an enterprise database 130, and the same information may be accessed and provided by one or more enterprise application servers 128 to a workstation 122 of an enterprise user 124, according to embodiments of the present invention. According to embodiments of the present invention, the BOA device 104 is communicably coupled to the storage server 126 which is communicably coupled to the database 130, and the application server 128 is communicably coupled to the database and to the enterprise workstation 122. Such devices may be communicably coupled via a network 120 such as, for example, the Internet.

[00129] When the BOA device 104 receives updated information from one or more of the devices (e.g. devices 106, 108, 110) to which it is communicably coupled, the BOA device 104 sends the updated information to the enterprise storage server 126, which stores the updated information in a database which may be contained on a storage medium 130, according to embodiments of the present invention. Hence, information from one or more devices (e.g. devices 106, 108, 110) may be stored in mobile database 118, remote enterprise database 130, or both, according to embodiments of the present invention. An enterprise user 124, who may be an emergency room nurse monitoring and/or preparing for ambulance arrivals, an emergency room physician, and/or a medical director at home, for example, may access information similar to information displayed by the BOA device 104 by requesting the information via an enterprise workstation 122. For example, the enterprise workstation 122 accesses a web interface and/or thin client web browser application

which requests the information over the network 120 from application server 128. Application server 128 queries the database 130 for the information, and returns a display to enterprise workstation 122 that looks the same as or similar to what the EMS technician 114 is currently seeing on the BOA device 104 display, according to embodiments of the present invention.

[00130] FIGS. 8-10 illustrate examples of user interface and display screens available to the enterprise user 124 via the enterprise workstation 122, according to embodiments of the present invention. FIG. 8 illustrates a web browser based client interface including, in one portion of the display, a list of available EMS vehicles 802, 804 for which EMS device data is available, according to embodiments of the present invention. Clicking on ALS2 804, for example, brings up a screen similar to FIG. 8 which allows the enterprise user 124 to select one of the buttons, including but not limited to the patient monitoring button 806, the navigation button 808, and/or the patient charting button 810. When user 124 clicks on the patient monitoring button 806, the screen display of FIG. 8 is presented and includes current information from the patient monitoring device 106 of ambulance ALS2, according to embodiments of the present invention. According to embodiments of the present invention, the patient monitoring display of FIG. 8 is automatically updated continuously or semi-continuously; according to other embodiments of the present invention, the user 124 selects "get updates" or the browser's "refresh" button in order to obtain the most current information available. The enterprise display of FIG. 8 contains information similar to the mobile display of FIG. 4, according to embodiments of the present invention.

[00131] According to embodiments of the present invention, the website display in the enterprise environment 102 is accessed via a generic internet browser by a doctor waiting in the emergency room for

the patient to arrive by ambulance. The website may be secured by logon username and password, for example. Each ambulance may be identified by a vehicle name; the doctor chooses from a list of incoming vehicle, after which the data for that patient is displayed. The data may be shown just as it appears on the mobile screen, also in "clinical time." According to embodiments of the present invention, the enterprise environment 102 website displays data only for those patients whose destination is the same as the destination logged on the user's facility.

[00132] When the user 124 clicks on the navigator button 808, the screen display of FIG. 9 is presented and includes current information from the navigation device 110 of ambulance ALS2, according to embodiments of the present invention. The enterprise display of FIG. 9 contains information similar to the mobile display of FIG. 3, according to embodiments of the present invention.

[00133] When the user 124 clicks on the patient charting button 810, the screen display of FIG. 10 is presented and includes current information from the patient charting device 108 of ambulance ALS2, according to embodiments of the present invention. The enterprise display of FIG. 10 contains information similar to the mobile display of FIG. 5, according to embodiments of the present invention.

[00134] Although FIG. 1 depicts a single BOA device 104 in the mobile environment 101, more than one BOA device 104 may be used in the mobile environment 101 to communicably connect to the same or a different set of devices 106, 108, 110. And although FIG. 1 depicts one mobile environment 101, more than one mobile environment 101 and/or more than one BOA device 104 may be communicably coupled with the administration environment 103 and/or the enterprise storage server 126, according to embodiments of the present invention. According to embodiments of the present invention,

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the enterprise storage server 126 receives EMS device information from BOA device 104 and stores it in database 130 along with an authenticated time stamp and an identifier associating the information with a particular EMS device and/or a particular EMS vehicle. In this way, data from multiple vehicles and/or multiple devices may be accessed by the enterprise user 124.

[00135] Also, the enterprise storage server 130 may securely store the information received from one or more BOA devices 104 for longer periods of time to permit later use of the information. For example, the BOA device 104 may receive patient-identifying information such as name, address, and/or social security number via the patient charting device 108 or directly through the BOA device 104, and then may convey some or all of the patient-identifying information to enterprise storage server 126 with a request for the enterprise storage server 126 to query the database 130 for past records involving the same patient 116. The enterprise storage server 126 may then forward any such records or portions of such records back to the BOA device 104 (e.g. for display in the patient charting screen or the Past Medical History in the patch notes screen) to assist the EMS technician 114 with the current emergency. Similarly, such past EMS encounter record information may also be accessed by the enterprise user 124, according to embodiments of the present invention. A system administrator 134 may access and/or monitor the data in database 130 and/or modify the instructions of the servers 126, 128 via administration workstation 132, which may be communicably coupled to the servers 126, 128, according to embodiments of the present invention.

[00136] According to some embodiments of the present invention, the BOA device 104 may connect with (e.g. automatically or manually or selectively) a wearable medical device, such as, for

example, a Lifevest® wearable defibrillator, to receive and display patient monitoring information therefrom. The BOA device 104 may also be configured to receive patient-identifying information from such a wearable device, to permit the BOA device 104 to query an external database, for example across network 120, to retrieve additional information about the patient. The BOA device 104 may also be configured to connect with an implantable cardioverter-defibrillator ("ICD") in a similar fashion, according to embodiments of the present invention.

[00137] FIG. 11 illustrates a treatment domain system 1100 overview for real-time display of medical information collected from multiple different EMS devices, according to embodiments of the present invention. System 1100 includes a patient monitoring device module 1102 communicably coupled with mobile domain modules 1126 communicably coupled with remote or enterprise domain modules 1128 communicably coupled with a thin client display module 1124, according to embodiments of the present invention. According to embodiments of the present invention, the database 130 may be accessed by multiple hospitals throughout a region, state, country, and/or the world.

[00138] The mobile domain modules 1126 includes the device adapter 1104, a mobile asset management module 1106 which may access a mobile database 1108, a BOA module 1110, a patient charting module 1112, a navigation module 1114, and a network adapter 1116, according to embodiments of the present invention. The remote/enterprise modules 1128 include the network adapter 1116, an enterprise asset management module 1118 which may access an enterprise database 1120, and an enterprise application server module 1122, according to embodiments of the present invention.

[00139] The patient monitoring device module 1102 operates the patient monitoring device 106 and generates one or more data pipes containing information about a patient 116 condition. The device adapter / communication interface module 1104 manages data communications between a computing device and one or more medical devices such as, for example, between the patient monitoring device module 1102 and the mobile asset management module 1106 and/or BOA module 1110. The device adapter module 1104 includes one or more of the following attributes, according to embodiments of the present invention:

- Supports multiple communications transports (e.g., devices can use Bluetooth, 802.11, Ethernet, Serial cable).
- Supports multiple data transfer protocols.
- Supports multiple medical device types.
- Supports multiple data storage profiles (e.g., storage to file system, storage by asset management module 1106 to database 1108).
- Allows administrator or user to associate transport, protocol, device and multiple storage profiles together to represent a communication "pipe" over which data can be exchanged with medical devices.
- Supports multiple pipes at the same time.
- Allows administrators or users to specify one or more specific medical devices to which it communicates in which case the module 1104 will use transport specific discovery protocols to find and attach to the devices.
- Allows administrators or users to specify ANY as a medical device in which case it will use transport specific discovery protocols to find and attach to any compatible medical device found.
- When a pipe is configured to use a protocol which does not support discovery (e.g. serial cable), module 1104 will allow the device to

initiate the connection and then allow or deny it based on whether the specific medical device is selected or not.

- Supports multiple client applications (local or remote) by allowing them to connect to module 1104 and receive asynchronous notification of data arrival from medical devices and a means to retrieve the data.
- Maintains a communications 'pipe' should the medical device have a data asset to communicate, regardless of whether any application is running or ready to receive the data asset.
- A user may configure the medical device(s) applications communicate with, and such configuration may be persistent and easily changed.
- Communications policies may be configurable. For instance, Bluetooth may require pairing with a device before communications occur. A user may configure whether the pairing is 'automatic' or 'manual' or 'continuously reacquired', for example.
- Applications may access previously received data assets via a relatively simple, expressive API.
- Applications may be notified of newly received assets and may filter those notifications based on specific devices and/or asset type.
- Applications may query the communications layer for status, available devices, and the like, for customizable user interface elements.
- The communications layer may be controllable from a notification icon which also indicates status.
- Configurable items may be protected from malicious or erroneous alteration by common users through the use of a privileged 'admin' mode and a common user mode in the notification area icon applet.
- Configuration may be 'portable' and 'distributable,' such that one configuration may be created and copied to each device rather than

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having to actually configure each device through a notification applet.

- Particular features or limitations of the communications 'pipe' may be hidden from the application by default.
- The communications layer may itself be layered and support multiple plug-in style transport drivers for managing different communications transports and multiple plug-in style protocol drivers for handling the receipt of data assets from different devices and different asset types. This may allow for the rapid extension of the communications layer to new transports or to new protocols as they are developed.

[00140] FIG. 12 illustrates a diagram of the device adapter / communication module 1104, which includes one or more pipes 1202, 1204, 1206 each associated with a medical device 1208, 1210, 1212. The communication module 1104 may be a PELICAN™ communication interface available from Zoll Data Systems of Broomfield, Colorado, according to embodiments of the present invention. According to embodiments of the present invention, the communication engine 1104 is an "always on" operating system service which implements the communications pipes 1202, 1204, 1206 and handles the incoming data from medical devices 1208, 1210, 1212. Communication engine 1104 also includes an API 1216, which is a collection of objects and methods exposed by the communications engine 1104 which can be used by an application to configure and interact with the engine 1104 for tasks like getting data assets and configuring the engine 1104, according to embodiments of the present invention. For example, the mobile asset management module 1106 may interact with the API 1216 to receive medical device data.

[00141] FIG. 13 illustrates a diagram of pipe 1202, according to embodiments of the present invention. Pipe 1202 includes one or

more storage plug-ins 1302, 1304, 1306 associated with one or more storage configurations 1312, 1314, 1316 of the medical device; a medical device plug-in 1308 associated with a medical device configuration 1318 of the medical device, and a transport plug-in 1310 associated with a transport configuration 1320 of the medical device, according to embodiments of the present invention. As used herein, a "transport" is an operating system supported underlying communications medium, for example TCP/IP, Bluetooth, and Serial. Some transports are packet oriented (e.g. TCP) while others are stream oriented (e.g. Serial). Some support discovery, some do not. Some support pairing, some do not. Each transport may include unique configurations.

[00142] A transport plug-in may be a .NET assembly that is dynamically loaded by the communications engine 1104 and which provides data communications support for a specific transport (e.g. Serial Port, Bluetooth, TCP/IP, and File System). The communications engine 1104 may be configured for auto-pairing (e.g. for transports that support pairing, the engine 1104 uses rules specific to the transport to automatically create and maintain pairings with medical devices depending on configuration and user preference) and/or for auto-discovery (e.g. for transports that support discovery, the engine 1104 may be configured to automatically find new medical devices and enter them into the known device list), according to embodiments of the present invention.

[00143] A medical device plug-in may be a .NET assembly that is dynamically loaded by the communications engine 1104 which provides transport independent data communications services for a particular type of medical device, for example ZOLL M/E-Series ZOLLModem or ZOLL E-Series DUN. A storage plug-in may be a

.NET assembly that is dynamically loaded by the communications engine 1104 which provides storage services to the engine.

[00144] As shown in FIG. 13, a pipe may be a combination of transport, medical device, and storage configurations which represent a medical device from which the user has indicated data will be received, and which allows communications to occur. Pipes may be configured by the user and/or may be predefined. For example, a pipe may specify Transport Serial Port with configuration (COM1, Baud=9600), Medical Device E/M Series ZOLLModem (Any Medical Device) and Storage (Local File System). This configuration would accept data assets from any device connected to COM1 at 9600 baud and store them to the local file system. As another example, a pipe may specify Transport Bluetooth (Baud=115200, Auto-Pair), Medical Device E/M Series ZollModem (ZOLL005611), Storage (Local File System) and Storage (Asset Management). This configuration would cause Bluetooth to pair to ZOLL005611, maintain that pairing even when broken and accept any data assets from that specific device and store them both to the local file system and submit them to Asset Management (e.g. mobile asset management module 1106 and/or enterprise asset management module 1118).

[00145] As yet another example, a pipe may specify Transport Bluetooth (Baud=115200, Auto-Pair), Medical Device E/M Series ZOLLModem (Any Device). This configuration would cause Bluetooth to automatically pair with any medical device found during periodic discovery and accept any data assets from any paired device and store them via all loaded and enabled storage plug-ins. As yet another example, a pipe may specify Transport TCP/IP (LocalIP=192.168.1.20, Port=7743), Medical Device E/M Series DUN (Any Device), Storage (Asset Management). This configuration would cause the engine 1104 to start listening on the specified IP address and port for DUN traffic

and store it via Asset Management (e.g. by sending it to mobile asset management module 1106 and/or enterprise asset management module 1118), according to embodiments of the present invention.

[00146] For each "pipe" of device adapter 1104 that uses Discovery Supporting Transport, the adapter 1104 performs the method outlined in FIG. 14, and for each pipe of device adapter 1104 that uses Non-Discovery Supporting Transport, the adapter 1104 performs the method illustrated in FIG. 15, according to embodiments of the present invention.

[00147] As described above, the mobile asset management module 1106 receives medical device data from the device adapter and communications interface 1104, according to embodiments of the present invention. The mobile asset management module 1106 performs the secure storage, retrieval and management of medical device data together with asynchronous events informing other applications of the storage or modification of these data assets. The mobile asset management module 1106 supports local or remote service oriented API to store, retrieve and modify medical device data, and provides local or remote asynchronous message-based notification of events to applications which subscribe for them, according to embodiments of the present invention. These events may include notification of the arrival of medical device data.

[00148] The BOA module manages data feeds from multiple data providers (including but not limited to, the device adapter 1104, the patient charting module 1112, and the navigation module 1114) and presents these feeds on a touch-screen flat panel, according to embodiments of the present invention. The BOA module 1110 also communicates these aggregated data elements to a back-office module (e.g. the enterprise asset management module 1118). The patient charting module 1112 controls the patient charting device 108

and the information sent and received by it, and the navigation module 1114 controls the navigation device 110 and the information sent and received by it, according to embodiments of the present invention. The BOA module 1110 includes one or more of the following attributes, according to embodiments of the present invention:

- Allows the user to configure the device adapter / communication interface module 1104, including but not limited to selection of a medical device.
- Allows the user to select a patient charting device from which it will receive a data feed containing medical record information as it is entered in patient charting device.
- Allows the user to select a navigation device from which it will receive a data feed containing navigational and dispatch information on a periodic basis.
- Receives notification from the communication interface module 1104 and/or the mobile asset management module 1106 about the arrival of new medical device data including but not limited to 12-lead ECG and vital trend records.
- Receives asynchronous messages from a selected patient charting device which contain data about the currently open patient record including but not limited to: patient demographics, medical history, current assessments, interventions performed and/or vital signs.
- Receives asynchronous messages from a selected navigation device which contains data about the current dispatch state, destination, crew, location, route and/or map of current position.
- Cyclically presents a graphic display of each of the received data feeds for viewing in the back of the ambulance on the flat panel, or elsewhere on another display device.

- Allows the caregiver or EMS technician 114 to temporarily freeze the cycling display on a feed for more careful examination of that particular data in that particular information template.
- Aggregates the data feeds into a data construct which is sent periodically to the enterprise asset management module 1118.
- Presents a customer customizable view of the aggregated data feed for the purpose of facilitating a verbal report to the receiving facility (e.g. a report in the Patch Notes information template displayed on the BOA device 104).
- Presents the user with the ability to view the regional EMS protocols for reference.

[00149] FIG. 16 illustrates a logic flow chart 1600 executed by the BOA module 1110, according to embodiments of the present invention. The logic flow chart 1600 starts at block 1602. A user selects particular devices or selects a "read from" configuration to determine which devices' data will be read and displayed by the BOA device 104 (block 1604). A data model is prepared (block 1606), for example the current state of the system that will be displayed on the BOA device 104 and which may eventually be communicated to the enterprise environment 102 and/or enterprise application server 128. The data model may expand to contain other data elements as feeds are added, and may contract to eliminate container properties for unused data feeds (e.g. installations that do not include a patient charting device 108), according to embodiments of the present invention. The BOA module 1110 queries the mobile asset management module 1106 to determine whether new medical device data is available (block 1608) and, if so, updates the medical device data in the data model (block 1610). The BOA module 1110 queries the mobile asset management module 1106 to determine whether new patient charting data is

available (block 1612) and, if so, updates the patient charting data in the data model (block 1614).

[00150] The BOA module 1110 queries the mobile asset management module 1106 to determine whether new navigation data is available (block 1616) and, if so, updates the navigation data in the data model (block 1618). The BOA module 1110 determines whether it is time to send updated information to the enterprise asset management module 1118 (block 1620) and, if so, sends the data model to the enterprise asset management module (block 1622) and generates an asynchronous message (block 1626). According to embodiments of the present invention, the asynchronous message generated at block 1626 is destined for the enterprise application server 128; according to alternative embodiments of the present invention, the asynchronous message generated at block 1626 is destined for the enterprise storage server 126 which, in turn, stores the data and notifies the enterprise application server 128 of the data's availability. The data model is then rendered (block 1624), for example in the form of a display update on the BOA device 104, according to embodiments of the present invention. According to embodiments of the present invention, the procedures indicated by blocks 1608, 1612, 1616, and 1620 are not executed as "stages" but are instead each events which trigger a different thread of execution that modifies a data model, which in turn triggers the update of the BOA device 104 display.

[00151] The network adapter / communication interface module 1116 is a communications channel that includes one or more of the following attributes, according to embodiments of the present invention:

- General purpose and data format independent. Each application may be responsible for the format of its messages.

- Message addressing may be by name rather than transport address (IP address for instance) so that messages can be sent to entities for which no route currently exists (e.g. when the sender is disconnected from the Internet). Name resolution into actual machine address may be deferred until a route actually exists.
- Tree relationship between entities that use communication interface module 1116, in which name information may be "percolated" up the tree but not down. As such, each node has a simple routing choice: if the name is the current device or below, route there, otherwise route to the current device's parent. The root of the tree may be the primary message broker and it accumulates all name information. The primary message broker is the unique node in the communications tree which contains all name information and thus can perform routing from one sub-tree to another, according to embodiments of the present invention.
- Message delivery may be deferred until the recipient actually appears. Messages may be stored until the recipient becomes routable.
- Messages may be stored in a transaction safe database at each node so that even a node unexpectedly failing does not risk message loss.
- Full encryption of messages may be maintained until the recipient actually receives them. While stored in databases, the messages may remain encrypted.
- Robust operation over intermittently connected wireless connections. Messages may be stored until a connection is resumed. Within certain time-limits, if the connection is restored, message transmission may continue from where it left off rather than starting anew.

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- Messages intended for machines or applications that are 'local' may be routed locally even when that segment of the tree is disconnected from the primary message broker.
- Messages may be sent with an expiration time after which the message will not be delivered and the sender may be notified of the expiration.

[00152] The communications interface 1116 may be a MERCURY™ communication interface available from Zoll Data Systems of Broomfield, Colorado, according to embodiments of the present invention.

[00153] The messaging components for the BOA module 1110 may be implemented using the communication interface module 1116 as a channel. These messaging components implement one or more of the following characteristics, according to embodiments of the present invention:

- Publish-Subscribe Model: The data feed consumers (e.g. the BOA mobile module 1110) subscribe with the providers (e.g. the patient charting module 1112) to receive the data feed. The subscription request includes the duration of the subscription. As the providers modify the data feed items, the data feed items are sent to all subscribers. According to embodiments, the BOA module 1110 is a data feed consumer for feeds from the patient charting module 1112 and the navigation module 1114 but a data feed provider for the aggregated feed going to the enterprise asset management module 1118.
- Message Queue Throttling: Using the message expiration feature of the communications interface module 1116, all messages may be sent with a short expiration time and then a new, current copy is sent upon expiration notification. This keeps the system from having a large queue of stale data feed messages when

components are disconnected; at most, one current message is in the system.

- Complex message format: The data feed messages include graphical, textual and binary data which may be turned into objects by the recipient for ease of use.

[00154] The enterprise asset management module 1118 receives an aggregated data feed from multiple BOA modules 1110 and provides presentation of those aggregated data feeds on displays remote from the originating ones. For example, such aggregated data feeds may be fetched from the database 1120 associated with the enterprise asset management module 1118 by the enterprise application server module 1122 and displayed to an enterprise user via a thin client display application module 1124 running on a web browser, according to embodiments of the present invention. Such a web page may be secured, encrypted, password-protected, and/or HIPAA compliant, according to embodiments of the present invention. The enterprise asset management module 1118 includes one or more of the following attributes, according to embodiments of the present invention:

- Receives asynchronous messages from multiple BOA modules 1110 containing aggregated data feeds including but not limited to data feeds from patient charting modules 1112, navigation modules 1114, and medical devices.
- Uses destination data from the BOA module 1110, set either by the navigation module 1114 or manually by the user on the flat panel BOA device 104, creates a web page for each hospital destination containing the feeds from each BOA module 1110 with that hospital as the destination.
- Asynchronously updates the web page as new versions of the aggregated data feeds arrive for each BOA module 1110 sending

data regarding a patient 116 en route to the hospital or treatment facility.

- Renders the aggregated data feeds with diagnostic resolution of the 12-Lead data.
- Prevents unauthorized access by employing hospital specific logins to the secured EMS data feed web page module 1124.

[00155] Although FIG. 1 illustrates the BOA device 104 communicably coupled with a patient monitoring device 106, a patient charting device 108, and a navigation device 110, in alternative embodiments of the present invention the BOA device 104 is communicably coupled with additional EMS-related devices not shown in FIG. 1, and/or is communicably coupled with multiple devices of the kind shown in FIG. 1, and/or is communicably coupled with different models or versions of the devices of the kind shown in FIG. 1. For example, the BOA module 1110 may be configured to communicate EMS-related device data to and from, either directly and/or indirectly via a device adapter/communication interface module 1104, one or more of the following devices: a defibrillator, a patient charting device, a navigation device, a GPS device, a pulse oximeter, an automatic cardiopulmonary resuscitation device (e.g. Autopulse® non-invasive cardiac support pump), a driver safety monitoring system, a standalone blood pressure monitor, a blood glucose measurement device, an inventory control system, a blood alcohol monitor, a breathalyzer instrument, and a crew scheduling system. A defibrillator or patient monitoring device may be one of a broad range of defibrillators or patient monitoring devices made and/or sold by a number of different manufacturers, according to embodiments of the present invention. The BOA device 104 may also be communicably coupled with, and configured to aggregate with patient data, data obtained from a

CodeNet Writer™ device manufactured by Zoll Medical Corporation, or the like, according to embodiments of the present invention.

[00156] According to embodiments of the present invention, the BOA device 104 is communicably coupled to only one or two of the patient monitoring device 106, the patient charting device 108, and the navigation device 110, and is configured to organize and display EMS information from only the one or two such devices.

[00157] Although the modules and applications described with respect to FIG. 11 can roughly correspond to the hardware devices with similar designations in FIG. 1, one of ordinary skill in the art, based on the disclosure provided herein, will understand that the various modules and/or instructions for performing the described procedures may be located on different and various hardware devices and/or on hardware devices not depicted, in different combinations, according to embodiments of the present invention. For example, although the BOA device 104 may be a touch-screen PC including and configured to perform the tasks of the BOA module 1110, the BOA device 104 may alternatively be a simple display device such as a monitor, with the computational functions of the BOA module 1110 and/or mobile asset management module 1106 performed by other hardware, such that only the display information is communicated to the BOA device 104, according to embodiments of the present invention.

[00158] The BOA device 104 according to embodiments of the present invention may be configured to facilitate data entry via a touch screen device with software that permits rapid and easy data entry, similar to the Quicklog capability of the Zoll Data Systems RescueNet® ePCR Suite. In addition, the BOA device 104 may be configured to permit selection and display of patient monitoring data (e.g. 12-lead ECG data) from prior transports and/or other agencies retrieved from

mobile database 118 and/or enterprise database 130, according to embodiments of the present invention. Such historical and/or shared patient data may also be made available to hospitals, and/or stored by hospitals or other care institutions as part of a data management program. The BOA device 104 may also be configured to display streaming ECG information similar to the "live" display of such information by a defibrillator device, for example. The BOA device 104 may also be configured to display feedback to the EMS technician 114 about cardiopulmonary resuscitation being performed, to evaluate the CPR technique during and/or after it is administered. According to embodiments of the present invention, the BOA device 104 may be configured to communicably couple with and receive information from an accelerometer and/or other CPR evaluation device, such as a device configured to detect the presence of and/or the timing of and/or the depth/displacement of and/or the velocity of and/or the acceleration of chest compressions, for example the devices and methods described or referenced in U.S. Pat. No. 6,390,996 issued on May 21, 2002, U.S. Pat. No. 6,827,695 issued on December 7, 2004, U.S. Pat. No. 7,122,014 issued on October 17, 2006, and U.S. Pat. App. Pub. No. 2006/0009809 published on Jan. 12, 2006, which are incorporated by reference herein in their entireties.

[00159] FIG. 17 depicts a flow chart 1700 illustrating a method performed by BOA module 1110, according to embodiments of the present invention. The process begins at block 1701. The BOA module 1110 is initialized (block 1702), and the user may then select devices (block 1704) from which medical and/or EMS information will be received. For example, such device selection may involve generating an asynchronous message to be received by the patient monitoring module 1102 for establishing a connection (block 1706), an asynchronous message to be received by the navigation module 1114

for establishing a connection (block 1708), and/or an asynchronous message to be received by the patient charting module 1112 for establishing a connection (block 1710). A different subset of devices (different devices, fewer devices, or more devices) may be selected at any time when the user initiates an asynchronous event to select or change devices (block 1712).

[00160] Once devices have been selected, the BOA device 104 cycles through a series of different displays (block 1714). This cycling may be programmed to occur at preset intervals; for example, the BOA device 104 may be configured to cycle the display between different data models every seven seconds. For example, a navigation device data model may be displayed (block 1716), which may be similar to the data model depicted in FIG. 3, for example. After a preset time, the display may be switched to a patient monitoring device data model (block 1718), similar to the data model depicted in FIG. 4, for example. After another preset time, the display may be switched to a patient charting device data model (block 1720), similar to the data model depicted in FIG. 5, for example. Once the display has cycled through each data model, it may return to the first data model displayed and repeat the cycle, according to embodiments of the present invention. Such a cycling may be initiated or re-initiated during other tasks when the user initiates an asynchronous event (block 1722) by selecting the cycle feed button (similar to the button 318 of FIG. 3), for example.

[00161] When a user selects one of the "feed" buttons (block 1724), an asynchronous event is generated causing the data model corresponding to that feed to displayed (block 1726) for a longer predetermined period of time, for example one minute. As an example, if the user selects the patient charting button 206 (see FIG. 2), the patient charting data model similar to FIG. 5 will immediately be displayed and will remain displayed for a period of time longer than the

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default cycle time. When a user selects the patch notes button 208 (block 1728), an asynchronous event is generated causing the patch notes data model similar to FIG. 6 to be displayed (block 1730) until the user next selects the cycle feeds button 318 or a particular feed button 202, 204, 206, according to embodiments of the present invention. When a user selects the protocols button (block 1732), an asynchronous event is generated causing the protocols data model similar to FIG. 7 to be displayed (block 1734) until the user next selects the cycle feeds button 318 or a particular feed button 202, 204, 206, according to embodiments of the present invention.

[00162] When one of the EMS devices receives or generates new data, it may be configured to generate an asynchronous notification to be received by the BOA module 1110, according to embodiments of the present invention. For example, the patient charting module 1112 may generate an asynchronous message when it has new information to share (block 1736), the patient monitoring module 1102 may generate an asynchronous message when it has new information to share (block 1738), and the navigation module 1114 may generate an asynchronous message when it has new information to share (block 1740), according to embodiments of the present invention. These asynchronous messages may include within them the new or updated data itself. When the BOA module 1110 receives one or more of these notifications, it updates the data model or data models that correspond to the particular device and/or information received (block 1742). For example, if new patient charting information is received from the patient charting module 1112 (which may be running on the patient charting device 108), the BOA module 1110 will update the patient charting data model to reflect the most recent data. The BOA module 1110 then refreshes its display (block 1744), which results in the currently displayed data model being replaced with the new data model

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immediately if any data in the data model was updated in block 1742. The data model update may then be sent to the BOA enterprise module which may reside on enterprise application server 128 (block 1746), which may result in an asynchronous message being generated to the BOA enterprise module (block 1748), according to embodiments of the present invention.

[00163] Some embodiments of the present invention include various steps, some of which may be performed by hardware components or may be embodied in machine-executable instructions. These machine-executable instructions may be used to cause a general-purpose or a special-purpose processor programmed with the instructions to perform the steps. Alternatively, the steps may be performed by a combination of hardware, software, and/or firmware. In addition, some embodiments of the present invention may be performed or implemented, at least in part (e.g., one or more modules), on one or more computer systems, mainframes (e.g., IBM mainframes such as the IBM zSeries, Unisys ClearPath Mainframes, HP Integrity NonStop servers, NEC Express series, and others), or client-server type systems. In addition, specific hardware aspects of embodiments of the present invention may incorporate one or more of these systems, or portions thereof.

[00164] As such, Fig. 18 is an example of a computer system 1800 with which embodiments of the present invention may be utilized. According to the present example, the computer system includes a bus 1801, at least one processor 1802, at least one communication port 1803, a main memory 1804, a removable storage media 1805, a read only memory 1806, and a mass storage 1807.

[00165] Processor(s) 1802 can be any known processor, such as, but not limited to, an Intel® Itanium® or Itanium 2® processor(s), or AMD® Opteron® or Athlon MP® processor(s), or Motorola ® lines of

processors. Communication port(s) 1803 can be any of an RS-232 port for use with a modem based dialup connection, a 10/100 Ethernet port, or a Gigabit port using copper or fiber, for example. Communication port(s) 1803 may be chosen depending on a network such a Local Area Network (LAN), Wide Area Network (WAN), or any network to which the computer system 1800 connects. Main memory 1804 can be Random Access Memory (RAM), or any other dynamic storage device(s) commonly known to one of ordinary skill in the art. Read only memory 1806 can be any static storage device(s) such as Programmable Read Only Memory (PROM) chips for storing static information such as instructions for processor 1802, for example.

[00166] Mass storage 1807 can be used to store information and instructions. For example, hard disks such as the Adaptec® family of SCSI drives, an optical disc, an array of disks such as RAID (e.g. the Adaptec family of RAID drives), or any other mass storage devices may be used, for example. Bus 1801 communicably couples processor(s) 1802 with the other memory, storage and communication blocks. Bus 1801 can be a PCI /PCI-X or SCSI based system bus depending on the storage devices used, for example. Removable storage media 1805 can be any kind of external hard-drives, floppy drives, flash drives, IOMEGA® Zip Drives, Compact Disc – Read Only Memory (CD-ROM), Compact Disc – Re-Writable (CD-RW), or Digital Video Disk – Read Only Memory (DVD-ROM), for example. The components described above are meant to exemplify some types of possibilities. In no way should the aforementioned examples limit the scope of the invention, as they are only exemplary embodiments.

[00167] Embodiments of the present invention may be configured to achieve various other solutions in an emergency medical services environment. For example, the BOA device 104, in communication with the navigation device 110, may be configured to provide additional

mapping and/or navigation information. The BOA device 104 may display status information about a hospital destination, and may indicate diversion or alternative destinations to direct the ambulance 101 to an appropriate destination, according to embodiments of the present invention. The BOA device 104 may also display characteristics about hospitals and/or other destinations, such as the hospital's capabilities (e.g. heart specialty, burn specialty), insurance accepted, patient capacity and current patient capacity status, according to embodiments of the present invention. The BOA device 104 may also be in communication with the enterprise workstation 122 of the hospital or other destination to permit preregistration or partial preregistration of the patient 116. According to embodiments of the present invention, a hospital without availability shows up for the ambulance driver 112 as not available. The BOA device 104 may be configured to display such information simultaneously with a map and/or during navigation, to facilitate destination selection. This information may be obtained over the network 120 from an enterprise server 126 or 128 and/or from an enterprise workstation 122 and/or from the navigation device 110, according to embodiments of the present invention.

[00168] The BOA device 104 may also be configured to communicate in various ways with the user, including with the EMS driver 112 and/or the EMS technician 114, according to embodiments of the present invention. For example, the BOA device 104 may be configured to provide audio prompts, alarms, scheduling, timing, and/or audio streams to EMS users. The BOA device 104 may be configured with Bluetooth ® connectivity or capability, such that a user may connect or pair a unique Bluetooth ® device with BOA 104 to receive audio information and/or to communicate voice prompts. An alarm may be configured to sound or to display visually upon a triggering

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event, for example upon receipt by the BOA device 104 of an asynchronous event signal from a sensor indicating that a detected parameter is outside an acceptable range or value, according to embodiments of the present invention. Audio and/or visual cues may be used to alert a user to a particular dosage schedule, for example beeping when a certain amount of time has elapsed since a first administration of a drug. Such alarms and/or schedules may be set or customized by the users, or may be selected from a predetermined set of alarm and scheduling options, according to embodiments of the present invention.

[00169] According to embodiments of the present invention, the BOA device 104 may provide role-based data and/or audio streams; for example, a technician administering CPR may receive audio and/or visual information about the patient's cardiac condition, but the BOA device 104 may filter out other information such as mapping and/or routing information for that user. Private, customized feedback and/or information may be provided to EMS users based on their roles, according to embodiments of the present invention.

[00170] The BOA device 104 may further provide decision support for an EMS technician, according to embodiments of the present invention. Based on information entered by the technician 114 (e.g. via a patient charting device 108) and/or information received from a patient monitoring device 106, BOA device 104 may compare the information with internal or external databases to display or otherwise convey a differential diagnosis, and/or predictive diagnosis (e.g. based on vectors or EKG information), according to embodiments of the present invention. For example, the BOA device 104 may present the EMS technician 114 with a decision matrix based on symptoms and/or responses to treatments to help the EMS technician 114 determine, for example in an interactive format, a potential

diagnosis. The BOA device 104 may provide protocols or links to protocols based on the information received, either from the technician 114 or from one of the devices with which it is in communication.

[00171] In one embodiment, the data for the patient's history may be entered via the BOA device 104 with patient physiological measures via the monitor of BOA device 104. As the differential diagnosis requires both patient history, patient examination findings, and measures of the patient's physiological state via such monitoring as ECG, capnography and pulse oximetry, these data elements are integrated into a user interface that automatically or semi-automatically integrates the various data elements on a single differential diagnosis screen within the application on the BOA device 104, according to embodiments of the present invention. The interface of BOA 104 begins by asking the rescuer to choose from a list of common presenting symptoms or complaints by the patient, e.g. dyspnea or respiratory distress. The information such as on the screens illustrated in FIGS. 26-28 (taken directly from Am Fam Physician 2003; 68:1803-10, which is incorporated by reference herein) and FIG. 29 (taken directly from the Collier County Common Medical Protocol, revised 02/01/08), provides a structured approach for rescuers to obtain information. As patient history and physical examination findings are entered into the BOA device 104, the differential diagnosis page may gradually narrow down the possible diagnoses. Heart sound measurement and detection may be incorporated into the monitoring device 106 for the detection of S3 and S4 heart sounds and automatically narrow the differential, or suggest for the rescuer to confirm agreement with the software diagnosis, of heart failure or pulmonary edema. A flowchart for incorporating heart sounds is shown in FIGS. 26-29. Pulse oximetry and capnography are also very

helpful measures and may be automatically incorporated into the algorithm for more accurate diagnosis.

[00172] In one embodiment, rescuers may be able to simply touch the cursor to the history or physical exam findings listed as possible from the screen-displayed lists of FIGS. 26-29, thereby minimizing unnecessary keying inputs. At the bottom of each list of possible findings or history is a data entry position for "Other", for those findings or history which are not normally consistent with the presenting condition. In one embodiment, these additional findings, history or physiological measurements can be compared with a larger differential diagnosis database to suggest other possibilities to the rescuer based on a calculated probability or if the other possible causes have been ruled out, according to embodiments of the present invention.

[00173] In much the same way that twelve-lead data and other BOA 104 device data may be sent to an enterprise environment 102 and displayed and/or retrieved on an enterprise workstation 122 or web-based environment, the BOA device 104 may also be configured to receive, display, and/or store similar information from an enterprise environment 102, according to embodiments of the present invention. For example, in a situation in which a patient is being transported from one hospital to another to receive specialized care, the hospital may send to the BOA device 104 information about the patient's vitals and/or health history and/or physician recommendations. Alternatively, the hospital may grant electronic authorization for the remote EMS technician to query its database or databases where such information is kept, to enable the EMS technician 114 to select, using the BOA device 104 interface, which and how much information he would like to receive. In this way, technicians in an ambulance 101 can see what is happening to a patient at the hospital, for example.

[00174] The BOA device 104 may also include speech recognition software and/or text-to-speech software, according to embodiments of the present invention. As such, the BOA device 104 may provide an audio signal that reads text or numeric data received from one or more devices, to convey the data to the EMS technician 114 audibly, such that the EMS technician 114 need not divert visual attention from the patient or from another task, according to embodiments of the present invention. The BOA device 104 may also recognize voice command prompts, to enable the user to operate the BOA device 104 by voice instead of having to divert manual attention from the patient or the task at hand, according to embodiments of the present invention.

[00175] The BOA device 104 also be configured to retrieve audio data stored on a device, such as a patient monitoring device 106, to help the EMS technician 114 in treatment or diagnosis, and/or for storage, technician evaluation, quality control, or later playback. For example, the patient monitoring device 114 may be a defibrillator that records a continuous audio stream; the BOA device 104 may access the continuous audio stream and permit selective play back of certain portions and/or transmit the audio stream or audio file for remote access or storage, according to embodiments of the present invention. The BOA device 104 may also be configured to receive audio information from a patient monitoring device 106 or other device even before the EMS technician 114 has reached the patient, to help the EMS technician 114 to prepare for the scene.

[00176] The BOA device 104 may be configured to connect with a video monitoring device, for example a webcam, or a standalone video camera, and/or a video capture device that is mounted on or part of another device to which the BOA device 104 connects, according to embodiments of the present invention. For example, a video or still

camera mounted in the back of an ambulance 101 may provide visual data to BOA 104 for storage and/or transmission and/or retransmission to the enterprise environment 102 and/or the administration environment 103. Such a video feed may permit a physician waiting at a hospital to view the patient's status before the patient arrives, for example.

[00177] With an ability to connect with and interface multiple EMS-related devices, both clinical and non-clinical, and aggregate such EMS-information (both clinical and non-clinical) from multiple devices, the BOA device 104 may also be configured for inventory monitoring and control. For example, the BOA device 104 may be communicably coupled with a bar code scanner, a radio frequency identification ("RFID") receiver or transceiver, or other inventory monitoring device. The BOA device 104 may maintain or communicate with a database that tracks a particular set of inventoried items, whether they be medical devices, supplies, drugs, personnel, or the like.

[00178] For example, the BOA device 104 may include a database that tracks the inventory of devices, supplies, and drugs on board a particular ambulance 101. When a new device is placed on the ambulance 101, the new device is equipped with a tag or bar code or some other unique identifier, and the BOA device 104 may be configured to automatically sense, or to be instructed to sense (e.g. by scanning a bar code with the bar code scanner), the presence of a new inventory item. The BOA device 104 may also prompt the user with a status update request, for example: new item, item being removed, item being dispensed, item destroyed, item transferred. Hence, at the beginning of an ambulance 101 shift, the crew may query the BOA device 104 to display the inventory of devices, supplies, and/or drugs on board, and may supplement the inventory for any deficient item.

When a drug is administered, it may be scanned into the BOA device 104 system with an indication that it has been dispensed and should be replaced. At the end of a shift, the crew may check the inventory via the BOA device 104 and restock necessary supplies and/or transmit the inventory situation to a third party for any appropriate restocking, monitoring, and/or verification activity.

[00179] Such inventory information may also be conveyed by BOA 104 for remote use and/or storage. For example, a defibrillator patient monitoring device 106 may be checked out to each crew of each ambulance 101, and this information may be sent by BOA device 104 through network 120 to the enterprise storage server 126, which may aggregate such information across multiple ambulances 101. A shift supervisor using a remote enterprise workstation 122 may query such database to determine which defibrillators are out in the field on which ambulances 101, according to embodiments of the present invention. In this way, the BOA device 104 may auto-upload inventory information to a central system.

[00180] The BOA device 104 may also be configured to connect with devices (clinical and/or non-clinical) that track EMS technician 114 and patient 116 safety, according to embodiments of the present invention. For example, the BOA device 104 may be configured to connect with accelerometer and/or tire pressure sensors, and/or other vehicle-relate sensors to track driving conditions, driving behavior, safety level, and/or event occurrences, according to embodiments of the present invention. According to one embodiment of the present invention, the BOA device 104 may be configured to connect with a breathalyzer device, which may be used to sense and/or estimate the blood alcohol content of the driver and/or patient. The BOA device 104 may collect such data and display it to the user in a feedback format, and/or may send such data through the network 120 for storage and/or

remote evaluation, according to embodiments of the present invention. The BOA device 104 may also monitor a vehicle's maintenance schedule and alert the user when maintenance is needed or recommended, according to embodiments of the present invention.

[00181] Due to its connection with the network 120 and also with other devices 106, 108, 110, the BOA device 104 may also serve as an ambulance headquarters and/or a type of "repeater" in a trauma or disaster situation, according to embodiments of the present invention. For example, the BOA device 104 may be configured to connect with multiple devices including devices outside the ambulance 101 and/or in a different ambulance 101, to permit the BOA device 104 user to view and manage response treatments, for example. Such a configuration also permits data from multiple devices (e.g. multiple defibrillators or other patient monitoring devices) to be conveyed through the network 120 to an enterprise environment 102 and/or administration environment 103, according to embodiments of the present invention. In another example, a single ambulance 101 equipped with a BOA device 104 system as described above may be deployed to a disaster or trauma situation, and the BOA device 104 may be connected to and aggregating information from multiple patient monitoring devices 106. A supervisor or situation manager may use the BOA device 104 to monitor treatment status, prioritize patient medical needs, transmit relevant information to selected outside caregivers, hospitals, and/or treatment centers, and to distribute resources accordingly.

[00182] According to some embodiments of the present invention, the BOA device 104 is configured to perform diagnostics on and/or to initiate self-diagnostics for devices with which it is connected. The BOA device 104 may also be used for training and/or education of EMS technicians 114, by making downloaded protocols available for display, and/or by simulating a medical emergency (e.g. simulating the

device feeds from multiple clinical and non-clinical devices during a medical emergency or transport).

[00183] According to some embodiments of the present invention, the BOA device 104 provides a visual indication of whether its connection with the navigation device 110 (or other predetermined device) is online or offline. According to some embodiments, the user can select to view historical rather than current patient information; for example, the user may select to view thumbnails of previous twelve-leads, and can send a collection of twelve-lead data snapshots to an enterprise environment 102 (e.g. a hospital), each with a unique serial number, for example. The enterprise user 124 may also view the patch notes from the BOA device 104, so that the EMS technician 114 need not convey them telephonically, according to embodiments of the present invention.

[00184] The BOA device 104 may also include a drop-down menu interface, listing each device to which the BOA device 104 is connected and its connection status, according to embodiments of the present invention. The BOA device 104 may also be connected with a biometric device such as a fingerprint reader or a retinal scanner, or a non-biometric device such as a keypad, to assist in verifying the identity of a patient and/or in authorizing access to patient medical records. Such records may be stored in remote databases and/or stored by different entities, for example.

[00185] FIGS. 20-23 illustrate an EMS communication interface device 2000, configured to facilitate communication between a patient monitoring module 1102 and a device adapter / communication interface 1104 (see FIG. 11). Not all patient monitoring devices 106 include the hardware necessary for certain kinds of communication (e.g. wireless communication), either with BOA device 104 or with other enterprise environments 103. An EMS communication interface

device 2000 may be added as an accessory to the patient monitoring device 106 in order to supplement its communication capability, as well as provide additional functionality, according to embodiments of the present invention.

[00186] The EMS communication interface device 2000 may be configured to interface with the patient monitoring device 106 via an existing hardware interface, such as, for example, via a PCMCIA card slot, a USB slot, or the like, according to embodiments of the present invention. The following example illustrates an EMS communication interface device 2000 that interfaces with a patient monitoring device 106 via a PCMCIA card slot in the device 106, according to embodiments of the present invention.

[00187] FIG. 20 illustrates a carrier board 2010 design for an EMS communication interface device 2000, according to embodiments of the present invention. The carrier board 2010 may be a custom carrier board for a systems-on-module ("SOM") hosting of various subsystems. The carrier board 2010 may host a PCMCIA edge connector 2030, PCMCIA address and control transceivers 2012, PCMCIA data transceivers 2014, a board power supply 2016, a first-in-first-out ("FIFO") co-processor input memory buffer 2018, a flash memory common memory plane ("CMP") 2020, a complex programmable logic device ("CPLD") attribute memory plane ("AMP") spoof shifter 2022; a universal serial bus ("USB") universal asynchronous receiver-transmitter ("UART") bridge 2024, a CPLD programming interface 2026, and a reset push button 2028. The power supplies for 3.3V, 1.8V, and 1.5V levels may be derived from PCMCIA 5V and possibly 12V inputs, according to embodiments of the present invention. Device 2000 may further include a USB 2.0 port.

[00188] The carrier board 2010 may also include a SOM coprocessor subsystem 2040 such as, for example, a Gumstix Overo

Air SOM or a LogicPD xxxSOM. SOM 2040 may include a Bluetooth ("BT") radio and/or antenna and/or a WiFi (e.g. 802.11a/g) radio and/or antenna 2042. The 802.11 a/g subsystem may be initialized and configured during boot, and may also be configured via terminal session, according to embodiments of the present invention. SOM 2040 may also include a storage device 2044, such as, for example, a removable micro SD storage/memory slot. A micro SD card may be used in such a slot as random access storage as well as a source of the boot strap code to initialize the co-processor subsystem 2040. SOM 2040 may also include a power management integrated circuit ("IC") 2048, such as, for example, a Texas Instruments TPS65950 integrated power management IC. SOM 2040 may also include a processor 2046 such as, for example, a TI Open Multimedia Applications Platform ("OMAP") 3503 processor with 256MB of random access memory ("RAM") and 256 MB of non-volatile RAM ("NVRAM") in a package-on-package ("POP") package. The coprocessor subsystem 2040 may be communicably coupled to the carrier board 2010 via dual 70-pin headers, according to embodiments of the present invention. The carrier board 2010 may also include a Joint Test Action Group ("JTAG") interface for programming, according to embodiments of the present invention.

[00189] The device 2000 may include CPLD firmware, such as, for example, Actel Igloo Nano AGL250V2-VQG100_0. Such CPLD firmware may govern linear flash ("LF") control signals for read/write operations, may govern FIFO control signals for write and read operations in a manner of a FIFO dual-ported implementation, and may employ level shifted address and data buses for LF, FIFO, and the OMAP, according to embodiments of the present invention. The device 2000 may include an operating system, such as, for example, OE 2.6.x Open Embedded Linux. The device 2000 may employ the

C# Common Language Runtime (2.6.2), for example the Mono common language runtime ("CLR"), according to embodiments of the present invention. The device 2000 may include persistent data storage using SQLite software library, according to embodiments of the present invention. The device 2000 may perform asset management patterned data storage for framed data, and/or asset management patterned services for parameterized frame retrieval, according to embodiments of the present invention. The device 2000 may accomplish WiFi communications using User Datagram Protocol/Internet Protocol ("UDP/IP") for streaming data output, a .NET remoting service bus, and/or a .NET remoting eventing bus, according to embodiments of the present invention.

[00190] FIG. 21 illustrates a system overview for an EMS communication interface device 200, according to embodiments of the present invention. A patient monitoring module 1102 processes and sends patient monitoring data. The patient monitoring module 1102 may be implemented by a Zoll E-Series Defibrillator, according to embodiments of the present invention. Such patient monitoring module 1102 is configured to transmit streaming patient vital signs and twelve lead information, as well as full disclosure data, over a BT wireless connection 2110, to a BT plug-in 2112 that is part of a device adapter 1104, according to embodiments of the present invention. As used herein, the term "Full Disclosure Data" means all data recorded by a patient monitoring device 106, and includes, without limitation, patient vital signs, twelve-lead data, audio information, ECG information, lead type, gain, defibrillator shock information, system mode, paddle type, heart rate alarm status, heart rate, configuration information, code marker information, non-invasive blood pressure measurements, patient name, patient identification, biphasic defibrillator data, invasive blood pressure information, invasive blood

pressure waveform data, temperature data, SpO_2 information, SpO_2 waveform, sample number information, accelerometer information, accelerometer waveform, impedance waveform, CPR field data, APLS waveform, and/or APLS compression detection.

[00191] A WiFi wireless connection has a much higher bandwidth for the transfer of information than a BT wireless connection. However, in some cases, the patient monitoring device 106 on which the patient monitoring module 1102 runs may not include WiFi capabilities, but it may include a personal computer memory card international association ("PCMCIA") card slot with a PCMCIA interface 2114. A PCMCIA card may also be referred to as a PC card. The EMS communication interface device 2000 may be plugged in to the PCMCIA card slot 2114. The device 2000 may include a linear flash memory card 2122 or other memory element for recording full disclosure data from the patient monitoring device 106, according to embodiments of the present invention. The memory card 2122 may be used to replicate all existing memory card functionality of the patient monitoring device 106, by storing in linear flash memory 2122 all data written to the patient monitoring device 106 data slot, by permitting a utility mode user-initiated retrieval of stored data from linear flash memory 2122, and/or by permitting a utility mode user-initiated erasure of the linear flash memory 2122, according to embodiments of the present invention.

[00192] The full disclosure data stream from the patient monitoring module 1102 may also be received through the PCMCIA slot 2114 by an EMS communication interface module 2116, which transforms the full disclosure data into incident data, and provides the incident data over a WiFi connection 2118 to a WiFi plug-in 2120 that is part of the communication interface 1104, according to embodiments of the present invention.

[00193] FIG. 22 illustrates another system overview for an EMS communication interface device 2000, according to embodiments of the present invention. As illustrated in FIG. 21, full disclosure data is recorded in a memory module 2122, for example a flash linear analog memory module 2122, according to embodiments of the present invention. The flash analog module 2122 may be read, written, and/or erased by the patient monitoring module 1102 similarly to the fashion in which any memory element permanently associated with the patient monitoring device 106 may be read, written, and/or erased by via the device 106, according to embodiments of the present invention. This may be accomplished by using a utility mode of the device 106, for example. As such, the flash analog 2122 is not interfaced to the SOM (e.g. to microprocessor 2204), but only to the patient monitoring module 1102 in write/read/erase fashion.

[00194] According to embodiments of the present invention, the flash analog memory 2122 is designed to resemble the linear flash card that is normally associated with, and which may be embedded within, the patient monitoring device 106. Certain information may be stored in a non-volatile memory area, for example in the attribute memory plane, and certain other information may be stored in the first series of bytes of the common memory plane, to make the memory 2122 resemble the internal memory of the patient monitoring device 106. The communications interface 2116 may be a FIFO buffer 2202, which may receive full disclosure data from the patient monitoring module 1102 via the PCMCIA interface 2114, and pass the full disclosure data to a microprocessor 2204. The FIFO 2202 is uni-directional from the patient monitoring module 106 to the microprocessor 2204, according to embodiments of the present invention. Incident data sent may also be persisted in the asset management database 2314.

[00195] According to embodiments of the present invention, the FIFO buffer 2202 and/or the flash analog memory module 2122 are hardware-only solutions that function even when the SOM 2040 is non-operational. This functionality permits data protection in the case in which the SOM 2040 is not functional, and permits data buffering for the SOM 2040 to initialize (e.g. to boot and start the EMS communication interface services), according to embodiments of the present invention. During therapy mode data capture to the card 2122, if the SOM 2040 were to be disabled, device 106 data would not be lost, according to embodiments of the present invention. This also permits users who have been trained on utility modes of a patient monitoring device 106 related to the storage of data on a memory module to continue using such utility modes, even with the data being stored on memory module 2122 instead of a memory module internal to device 106, according to embodiments of the present invention.

[00196] Using a plug-in 2120 that is part of the communication interface 1104, incident data ("ID") may be streamed from the microprocessor 2204 over a WiFi connection 2118. Such information may be received and displayed by BOA device 104, for example, and may be displayed in real time and/or in clinically significant time (e.g. with a delay not larger than that which permits a medically accurate and timely observation, diagnosis, and/or treatment decision to be made). According to embodiments of the present invention, the incident data may be streamed on a BOA device 104 with no more than a one-second delay. For example, twelve-lead data generated by a defibrillator patient monitoring device 106 may be updated at least once each second, according to embodiments of the present invention.

[00197] The microprocessor 2204 may also be programmed to generate asynchronous (e.g. event based) notifications via an eventing bus, over the WiFi connection 2118, according to embodiments of the

present invention. For example, if a patient vital sign falls outside of present parameters, the microprocessor 2204 may be programmed to send an alarm event via eventing bus across the communication interface 1104.

[00198] In addition, the microprocessor 2204 may be programmed to permit a two-way service bus / service interface, to permit the requesting of incident data related specific incidents, according to embodiments of the present invention. For example, after a treatment incident, the user may request, via a service bus, from microprocessor 2204 all information associated with the particular incident (using a unique incident identifier, such as a case number, patient name, or the like). The microprocessor 2204 would then query the asset management module 2314 and retrieve any records associated with the particular incident, and send them back out through service bus, according to embodiments of the present invention. In this way, users may retrieve specific incident data rather than having to download all of the card file data (which in many cases will relate to multiple incidents, or information beyond the specific subset of information sought). This is made possible by the conversion of full disclosure data into incident data by the microprocessor 2204 prior to storage and/or forwarding. In some cases, users may wish to request all data stored by asset management module 2314, which would be a similar operation to the request for the card file directly from the patient monitoring module 1102.

[00199] FIG. 23 illustrates a software logic diagram for an EMS communication interface device 2000, according to embodiments of the present invention. A Linux Kernel 2302 may include a general purpose input/output ("GPIO") module 2304 configured to receive the data stream (e.g. the full disclosure data) 2301 from the patient monitoring device 106. The data stream 2301 is interfaced to the

system 2000 through the FIFO module 2202 which is controlled with several GPIO 2304 lines, according to embodiments of the present invention. The FIFO is read to the SOM using GPIO status, control and eight bits of data, according to embodiments of the present invention. The byte stream driver 2308 may be implemented in user space rather than a device driver to facilitate debugging, in some embodiments. The byte stream driver 2308 may keep the FIFO 2202 drained by monitoring the FIFO 2202 empty flag (which may be polled as opposed to interrupt driven for debugging efficiency in one embodiment).

[00200] Bytes read from the FIFO by the byte stream driver 2308 are re-assembled as blocks similar to those delivered by the patient monitoring device 106 and framed in the data formatter 2310, according to embodiments of the present invention. This results in a frame event stream 2303 from the data formatter 2310. The frame event stream is then sent to an asset management module 2312, which saves the frames to the database 2314 and forwards them out the WiFi channel to the TCP/IP module 2306 of the Linux Kernel 2302. According to some embodiments of the present invention, the frame event stream 2303 is sent over the WiFi connection via an encrypted UDP broadcast, so that it may be received by a wide range of clients (e.g. an iPhone may be configured to receive the UDP broadcast). The frame event stream 2303 may also be received by a clinical time feed plug-in 2316 of the communications interface module 1104, according to embodiments of the present invention.

[00201] Asynchronous requests for incident data stored in the database 2314 may be made by authorized external clients, such as via an incident plug-in 2318 of the communications interface module 1104, according to embodiments of the present invention. Such incident service calls are shown in dashed lines in FIG. 23. Although

database 2314 is shown as an SQLite database, one of ordinary skill in the art will appreciate, based on the disclosure provided herein, that other database formats may be employed by asset management module 2312, according to embodiments of the present invention.

[00202] According to embodiments of the present invention, the byte stream is formatted by data formatter 2310 into blocks of data resembling device 106 data blocks, and these full data blocks are broadcast in a WiFi format upon construction (e.g. as a block is made, it is sent over the WiFi interface). According to embodiments of the present invention, the asset management module 2312 frames the byte stream into consistent blocks of time, for example one second per frame, and each frame is saved into the asset management patterned data storage (e.g. database 2314).

[00203] Although FIGS. 21-22 show full disclosure data as two separate feeds, a single full disclosure data feed may be bifurcated and sent to both the flash analog module 2122 and the FIFO 2202 simultaneously, according to embodiments of the present invention.

[00204] A user may query the device 2000 to request health information, for example, running time, exceptions detected, and other information from the patient monitoring device 106, according to embodiments of the present invention. A user may also request specific incident-based data from the device 2000; for example, a user may send a query that says "send all of the cases," or "send data relating to a specific case" or "send all twelve-lead data from a specific case." The device 2000 may also stream delivery of case data so as to permit multiple authorized receivers (e.g. multiple BOA devices 104) to obtain the data simultaneously, according to embodiments of the present invention. According to some embodiments of the present invention, device 2000 facilitates data sharing between the patient monitoring device 106 and the enterprise environment 103.

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[00205] On power up, the device 106 interrogates the occupant of the PCMCIA slot 2114 to ascertain if a valid linear flash card 2122 is present. The validity test may consist of reading a series of bytes from the LF AMP and validating the values against sets of acceptable cards or an acceptable card. If a valid card is found, the device 106 reads a series of bytes from the CMP to test for validity and to determine if the card has been "formatted" according to the requirements of the device 106. In the absence of such a series of bytes, the device 106 may write such information to the card 2122, according to embodiments of the present invention. Once the card 2122 is validated, the device 106 begins to write the device data to the LF card 2122 as byte streams that are formatted into blocks as described, above.

[00206] Although the device 2000 is depicted as interacting with device 106 in a one-way fashion, the device 2000 may also be configured to interact bi-directionally with device 2000. For example, the device 2000 may be configured to provide a WiFi user interface similar to the user interface observed directly on the patient monitoring device 106, to permit total or partial remote control of the patient monitoring device 106, according to embodiments of the present invention.

[00207] Packaged in a PCMCIA type x housing, each card 2010 contains a connector 2030, an array of flash memories packaged in thin small outline packages ("TSOP") and card control logic. The card control logic provides the system interface and controls the internal flash memories as well as the input FIFO to the SOM, according to embodiments of the present invention. Level shifters are present to adapt PCMCIA logic voltages to card logic voltages.

[00208] Card logic voltages of 3.3V, 1.8V, and 1.5V may be derived from the PCMCIA VCC voltage (TTL, +5V, possibly +12V). A

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single stage for 3.3V and 5V conversions is built using three discrete transceivers. A CPLD is used to perform 3.3V and 1.8V conversions.

Part	Logic Voltages	Power	Notes
J1	+5V	+5V, +12V	2X34 PCMCIA connector
U5, U6, U7	+5V : +3.3V	+5V, +3.3V	Level Shifters
U3	+3.3V	+3.3V	Flash Memory
U7	+3.3V	+3.3V	FIFO
U1	+3.3V : +1.8V	+3.3V, +1.8V	CPLD
MCU	+1.8V	+4.0V	OMAP SOM

[00209] Data enters FIFO at 3.3V from the PCMCIA byte stream. Reading the FIFO is clocked an 8bit byte at a time on the read clock shifted between 3.3 and 1.8 to OMAP, through the CPLD. OMAP control and status interface bits may be converted in a similar fashion. Each carrier card 2010 may have a USB2.0 port. OMAP UART signals are connected to a USB to UART serial bridge 2024, according to embodiments of the present invention.

[00210] A JTAG interface for programming the CPLD may be provided. A 2X34, A and B sided PCMCIA Connector (J1) may be used, that inter-connects I/O, status and power signals between the device and the card, according to embodiments of the present invention. For the device signals that the card interface is interested in, there is a group of three transceivers (U5, U6, and U7) that inter-convert PCMCIA voltage (VCC) and board voltage (3V3), according to embodiments of the present invention. Device 2000 is interested in 26 address bits, 8 data bits, and 6 control signals that are intended to be level-shifted, according to embodiments of the present invention. U5 and U6 are uni-directional 16b input shifters from device to card for address and control information, according to embodiments of the present invention.. U7 is a bi-directional 8b level shifter for 8 bits of data.

[00211] According to embodiments of the present invention, the device 2000 reads and writes data through this interface to LF memory. U5 shifting 16 address bits [PCA0:PCA15] to [A0:A15]. U6 shifting 10 address bits [PC16:PC25] to [A16:A25], and 6 control signals { PC_REGn, PC_RESET, PC_CE1n, PC_CE2n, PC_OEn, PC_BWEn} to { REGn, RESET, CE1n, CE2n, OEn, BWEn }.

Sig	Description	Active
REGn	Attribute Memory Select	Low
CE1n	Card enable 1	Low
CE2n	Card enable 2	Low
OEn	Output enable	Low
BWEn	Write enable	Low
RESET	Reset	High

[00212] [PCD0:PCD7] 8 data bits (U2). Address shifters may be input only, in which case the card does not generate address information to the device 2000, only outbound addressing (device to card) is exposed, according to embodiments of the present invention. The data shifter is bi-directional as the device can read and write data to and from the card, according to embodiments of the present invention. U5 shifts 16 bits of address and U6 shifts 8 control signals and the upper 8 bits of the address and control signals from PCMCIA VCC to 3V3.

[00213] Device 2000 is configured to permit streaming data transmission via WiFi during therapy mode operations of the device 106, as well as post-case upload of device data. The device 2000 has hardware components as well as programmable elements using both firmware and embedded software, including an embedded operating system as described, above. According to some embodiments, the EMS communication interface device 2000 is thicker than a standard Type III PCMCIA card.

[00214] An embodiment of the present invention may include one of more of the following features and/or characteristics:

- The carrier may be a PCMCIA card
- The carrier may be inserted into a patient monitoring device PCMCIA data slot.
- The card 2000 interfaces to the patient monitoring device 106 in such a way as to appear to the patient monitoring device 106 as a valid LF card ("linear flash analog") 2122.
- The card 2000 presents the PCMCIA byte stream, written by the patient monitoring device 106, via a buffered hardware interface, to a SOM processor.
- The carrier stores the received PCMCIA byte stream to a non-volatile storage subsystem ("linear flash analog") such that all of the patient monitoring device 106 read/write/erase functionality is preserved in all device 106 modes of operation supporting these operations.
- The SOM provides IEEE 802.11. b/g wireless communications capability.
- The SOM provides Bluetooth V2.0 + EDR wireless communications capability.
- The SOM provides a micro SD card slot.
- The SOM supports watchdog type monitoring to provide for automatic reset if the SOM becomes non-functional.
- During patient monitoring device 106 or SOM reset or initialization, data is captured to flash analog memory.
- Data capture continues uninterrupted during SOM reset.
- The system 5000 is designed such that data being written by the patient monitoring device 106 is saved to the flash analog regardless of SOM state

- The SOM is able to access data saved while the SOM was unavailable.
- The carrier board provides a USB connector.
- The carrier SOM combination supports USB 2.0 On-The-Go ("OTG").
- Device 2000 form factor includes PCMCIA standard dimensions in width and height.
- Device 2000 form factor includes a width of 85.6mm X 54.0mm X a thickness (in some cases, this thickness is greater than type III which is 10.5 mm)
- Device 2000 thickness is no larger than permitted by device 106 PCMCIA slot.
- All carrier board components are mounted on one side of the carrier card.
- The interface to the patient monitoring device 106 is via slot bay via 68-pin PCMCIA card edge connector.
- Device 2000 is encapsulated to meet medical device requirements for EMC/RFI.
- The SOM is mounted on the carrier using 2 AVX 5602 70 pin connectors.
- Device 2000 is powered from the PCMCIA data slot, which may be on the order of 2.5W continuous with peak current not exceeding 600 mA.
- Device 2000 may utilize 15 GPIO pins to control reading FIFO byte stream buffer.
- Device 2000 may utilize 3 UART lines from the SOM connected and a USB bridge on the carrier.
- Device 2000 may include an antenna for WiFi.
- Device 2000 may include an antenna for BT.

- Device 2000 may use an Angstrom Open Embedded Linux operating system ("O/S").
- The device 2000 O/S may include Mono for the purposes of running code implemented in C#.
- The device 2000 O/S may include SQLite.
- The device 2000 may support the use of USB for bidirectional serial communications.
- The device 2000 provides secure wireless communications, including end-point authentication, confidentiality, integrity, and/or delivery confirmation.
- External data recipients (external processes to the device 2000) are able to request streaming data delivery.
- Data recipients are able to request complete incident data delivery by incident identifier, e.g. post-incident data.
- Device 2000 software is upgradeable via wireless interface.
- Device 2000 software is verified at run time using a cyclic redundancy code ("CRC")-like mechanism.

[00215] A device 2000 according to an embodiment of the present invention may permit individual screens for different receiving devices (e.g. different receiving devices using the communications interface 1104) to permit different users to obtain different data. For example, one user's settings could be configured to receive and display the frame event stream data relating to a patient's twelve-lead data, while an administrative technician user's settings could be configured to periodically request only frames associated with error codes generated by the patient monitoring device 106, according to embodiments of the present invention. Similarly, the same data may be received by and/or displayed by multiple users simultaneously over a WiFi connection, according to embodiments of the present invention.

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[00216] In this way, the data from a patient monitoring device 106 may be streamed, e.g. over a wireless WiFi connection, from a patient's house to or from an ambulance, and/or from an ambulance to or from a hospital. Various frames in the event stream may be filtered and/or requested, such that a specific subset of data may be obtained. For example, respiration data may be included in a frame event stream generated by device 2000, according to embodiments of the present invention.

[00217] A device 2000 according to an embodiment of the present invention may be combined with other types of patient monitoring devices 106, for example an automatic external defibrillator ("AED"). The device 2000 may thus be configured to send status information from the AED, to facilitate software updates for the AED, and/or to remotely test the AED, according to embodiments of the present invention. Such a device 2000 may also be used with a patient charting device, for example to combine the patient charting device 108 information from one vendor/platform with the patient monitoring device 106 information from another vendor/platform, according to embodiments of the present invention. The device 2000 may also function as a data aggregator, to parse, organize, and place streams of information into discrete frames information that are more easily sorted, queried, and supplied at a later, post-incident time frame, according to embodiments of the present invention.

[00218] According to embodiments of the present invention, the patient monitoring device 106 (e.g. defibrillator) sends data to the device 2000 in data blocks, for example ECG data, or patient's current heart rate. A collection of data blocks corresponding to one incident may be referred to as incident data. Full disclosure data is the concatenation of data associated with all incidents, and may be broken into sequences of data blocks corresponding to each individual/patient.

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When a service request is received for an incident, all of the frames stored on device 2000 for that incident are collected and put together in sequence. According to embodiments of the present invention, each ECG block corresponds to 100ms of ECG data, which provides ten data blocks per second. The defibrillator may add to each data block an incident identifier, time information about when the data block was recorded, and/or a computing hash for data integrity purposes, according to embodiments of the present invention.

[00219] Device 2000 (which is referred to in some figures as a "Zango" device) and BOA device 104 (which is referred to in some figures as a RescueNet Link, or RNL, device) work together, according to embodiments of the present invention. Device 2000, by virtue of its embedded computer, embodies a powerful processing engine. This processing engine is used to manage sophisticated data, communications, and applications operations on behalf of BOA device 104 users, according to embodiments of the present invention. According to one embodiment of the present invention, the device 2000 does not have input/output user interfaces (e.g., no keyboard, or display), so it works in conjunction with BOA device 104 to provide users access to the communications and data management services it supports, according to embodiments of the present invention.

[00220] FIGS. 20 and 23 illustrate the logical and functional architecture of the EMS communications interface card 2000 processing and the BOA device 104 processing, respectively. When device 2000 is not connected to device 104, device 2000 stores all device data and can transmit it to device 104 when a connection is established or restored.

[00221] FIG. 30 illustrates a data transmission interface, according to embodiments of the present invention. Zango device

(1a), can be configured to perform a number of functions, according to embodiments of the present invention:

- Frame defibrillator incident data blocks.
- Stream framed incident data.
- Save incident data frames to Zango database.
- Host a set of data management services upon the Zango database.
    - In one embodiment, data management services are read/erase only. Services to modify incident data are not supplied.

[00222] The "EMS communications interface channel" (1a, 1b, 1c) provides a means to transmit patient monitoring data (e.g. E Series data) to the BOA device 104. This channel uses the device 2000 to connect to BOA 104.

[00223] The RNL Zango Client (1c) can be configured to perform a number of functions:

- Receive streamed incident frame data (1b).
- Present incident frame data on the Mobile Link Display (1e) (parse, render, 1d).
- Store incident frame data into the Mobile Link database (1f)
- Host a set of data management services upon the Mobile Link database (1f).
    - In some embodiments, data management services are read/erase only; and services to modify incident data are not supplied.
- Forward 12 lead ecg and vitals data to Field Link. (1g)
- Consume Zango data management services (1b).

[00224] The following table lists and describes various elements of FIG. 30, described with respect to one embodiment of the present invention.

Notation (Figure 30)	Description	Notes
1a	Zango accessory	Data management accessory for ZOLL E Series. Captures, stores, and transmits E Series data written to

Notation (Figure 30)	Description	Notes
		the E Series data slot to connect the E Series data to RNL.
1b	Zango UDP/IP transmissions over WPA2 secured 802.11.	
1b	Zango TCP/IP service invocation response transactions over WPA2 secured 802.11.	
1c	RNL Zango Client	RNL receiver of Zango transmissions.
1a, 1b, 1c	Zango channel	
1d	Zango parsing and rendering engine	Zango messages from the E Series are parsed and rendered for acute medical viewing.
1e	Mobile Link Display	
1f	Mobile Link Storage	
1g	RNL Protocol: Reliable UDP/IP over secured cellular networks.	
1h	RNL Field Link Server	Mobile link message receiver in Field Link environment.
1c, 1g, 1h	RNL Mobile Link to Field Link Communications Channel	The RNL Mobile Link to Field Link Channel connects Mobile Link to Field Link using reliable UDP/IP over secured cellular networks.
1j	Field Link Storage	
1i	Field Link parsing and rendering engine	
1k	Field Link web server	
1l	Secured connection to Field Link users	
1m	Field Link web viewer	

[00225] FIG. 31 illustrates an EMS communication interface transmission processing block diagram, according to embodiments of the present invention. The E Series writes a continuous byte stream of

data to the PCMCIA Data Slot. The byte stream consists of E Series data block messages some of which are sent periodically and some of which are sent episodically. An example a periodic message is the ecg message. The E Series writes the ecg values for the currently displayed lead once per 100 ms, the message contains 25 data values (250 Hz samples, 4ms apart), according to embodiments of the present invention.

[00226] Examples of episodic messages are the vital sign messages. The E Series sends a particular vital sign message when a particular vital sign parameter value has changed; asynchronous messages are sent with no particular frequency, according to embodiments of the present invention.

[00227] The byte stream is bifurcated at the input to the Zango card. One branch stores data into an on board (16MB) linear flash, replicating all of the E Series linear flash operations. All data written is stored in the linear flash subsystem. The interface is hardware level, instant on prepared to receive and save the E Series byte stream to flash subsystem.

[00228] The second byte stream branch goes into the processor side of the Zango card. The processor side of the Zango card functions to process the byte stream performing the logical operations illustrated in FIG. 31. In the non-faulted case the byte stream receiver passes bytes to the byte block factory. The byte block factory re-constructs E Series data block messages from the byte stream. In this operation, 12 lead ecg data blocks are reconstructed and managed on a separate path to the incident path (sets of 12 lead data blocks are collected into entire 12 lead messages). The 12 lead data is entirely preserved in the case stream. One of the reasons for storing them separately is to permit a service user to request to see a 12 lead record on the service channel, rather than uploading the entire incident

to get the 12 lead data, according to embodiments of the present invention.

[00229] Blocks are then framed into a configurable time interval's worth of data blocks. For example, frames of one second in size might have on the order of 15 data blocks in the one second frame. Frames are collected into constructs of cases or incidents. Frames are stored in the Zango database. Complete incidents are marked (collection of all incident frames) and managed as incidents as they are completed. Frames are also streamed on WiFi where they can be received by authorized client applications, such as the RNL Zango Client described, below, with respect to FIG. 32.

[00230] The upper row of boxes in Figure 31 identify detection and error handling processes for risk control of compromised data faults, according to embodiments of the present invention. Byte stream, block, framing, 12 Lead, or incident error all result in the following behaviors, according to embodiments of the present invention:

- Data is marked as invalid.
- Invalid data is not rendered for a user to view during the acute treatment phase of an incident
- Data is stored marked as invalid for forensic analysis.
- Any one of these faults will cause the incident to be marked invalid.
- Acute medical personnel are informed of data faults, assuming connectivity to RNL.

[00231] These are the control measures and behaviors that trace directly to the hazard analysis for data compromised faults, in one embodiment of the present invention.

[00232] FIG. 32 illustrates a EMS communications interface device client architecture, according to embodiments of the present invention. In some cases, Zango connectivity to RNL may be volatile as a result of the nature of wireless communications in mobile

environments. For example, an E Series equipped with a Zango card may be moved out of range of the wireless access point to which it had been connected. When the device is back in range and reconnects, processing resumes as illustrated. Data written by the E Series while not connected to RNL is persisted in the Zango database and can be obtained in RNL upon re-connect, according to embodiments of the present invention.

[00233] The upper row of boxes in FIG. 32 identify detection and error handling processes for risk control of compromised data faults and communications faults. Integrity or framing faults detected on the streamed data result in the following behaviors, according to embodiments of the present invention:

- Data is marked as invalid.
- Invalid data is not rendered for a user to view during the acute treatment phase of an incident
- Data is stored marked as invalid for forensic analysis.
- Either of these faults will cause the incident to marked invalid.
- Acute medical personnel are informed of data faults for either 12 leads or case frames.
- Acute medical personnel are informed of communications faults.
- Acute medical personnel are informed of service faults.

[00234] Service responses are validated and invalid service responses are notified to the user and invalid data is not displayed, according to embodiments of the present invention. Connectivity status between Zango and the Zango Stream Channel Receiver is monitored and reported to users on the Mobile Link Display. Lost connectivity between Zango and RNL does not result in lost data as Zango stores data in the Zango database regardless of connection status. Service channel connectivity is not continuously monitored, service requests will fail (response invalid) if service connectivity is not present.

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[00235] FIGS. 33-37 illustrate various embodiments of screen shots available as viewed by the enterprise user 124 via the enterprise workstation 122, according to embodiments of the present invention. FIG. 33 illustrates an enterprise display and graphical user interface shown when the enterprise user selects the patient monitoring button (e.g. the "Zoll Defib" button), according to embodiments of the present invention. FIG. 34 illustrates an enterprise display and graphical user interface shown when the enterprise user selects the patient charting button (e.g. the "ePCR" button), according to embodiments of the present invention. FIG. 35 illustrates an enterprise display and graphical user interface shown when the enterprise user selects the navigation button, according to embodiments of the present invention.

[00236] FIG. 36 illustrates an alternative enterprise display and graphical user interface shown when the enterprise user selects the navigation button, according to embodiments of the present invention. The display of FIG. 36 would correspond to a display created when the BOA device 104 is not communicably coupled with a navigation device; hence, in this situation, the enterprise display lists the positional and/or navigation information as input by the BOA 104 user. FIG. 37 illustrates an enterprise display and graphical user interface shown when the enterprise user selects the patch notes button, according to embodiments of the present invention. According to some embodiments of the present invention, the EMS technician 114 who is interacting with the BOA device 104 need not select the patch notes screen and relay the information to the enterprise user 124; instead, the enterprise user may select the patch notes button via the enterprise workstation 122 to observe the same information.

[00237] FIGS. 38-44 illustrate additional examples of screen shots displayed by BOA device 104, according to embodiments of the present invention. FIG. 38 illustrates a display and graphical user

interface displayed when the user selects the patient charting button of a BOA menu template, according to embodiments of the present invention. FIG. 39 illustrates a display and graphical user interface displayed when the user selects the patient monitoring button of a BOA menu template, according to embodiments of the present invention. As illustrated by the thumbnail twelve-lead image in the bottom left corner, this BOA device 104 may be configured to display historical snapshots of past twelve-lead data, according to embodiments of the present invention.

[00238] FIG. 40 illustrates a display and graphical user interface displayed when the user selects the navigation button of a BOA menu template, according to embodiments of the present invention. FIG. 41 illustrates an alternative display and graphical user interface displayed when the user selects the navigation button of a BOA menu template, in situations in which a navigation device 110 is not communicably coupled to the BOA device 104. In such situations, the screen of FIG. 41 is configured to permit a user to manually select a destination, as well as select an estimated time of arrival, according to embodiments of the present invention. This information may be replicated or otherwise transmitted to the corresponding enterprise view (e.g. FIG. 36), according to embodiments of the present invention.

[00239] FIGS. 38-44 illustrate that a "shift start" button maybe included on the BOA device 104 interface. The shift start button may be used, for example, at the beginning of a shift, in order to permit the EMS technician or other user to communicably couple the BOA device 104 with other devices, according to embodiments of the present invention. FIG. 42 illustrates a display and graphical user interface displayed when the user selects the shift start button of a BOA menu template, according to embodiments of the present invention. In this screen, the user is permitted to select a navigation device, a

defibrillator device, and a patient charting device; in this screen, the user is also able to confirm the identities of the devices to which the BOA device 104 is already communicably coupled, as indicated in this particular example by a checkmark next to the device name, according to embodiments of the present invention.

[00240] FIG. 43 illustrates an alternative display and graphical user interface displayed when the user selects the shift start button of a BOA menu template, according to embodiments of the present invention. In this alternative display, the BOA device 104 has sensed that a navigation device 110 is not available or is disconnected, and thus prompts the user to identify the EMS transport unit and/or the crew members present with the unit. This information may be used in the corresponding navigation screens for the BOA device (FIG. 41) and the enterprise environment 102 (FIG. 36). FIG. 44 illustrates a display and graphical user interface displayed when the user selects the patch notes button of a BOA menu template, according to embodiments of the present invention.

[00241] FIG. 62 illustrates a system for role-based data feeds from a BOA device to EMS technician mobile devices, according to embodiments of the present invention. BOA device 104 receives streaming ECG data and other data from the patient monitoring device 106, which may be accomplished wirelessly via an EMS communications interface device 2000 as described above, according to embodiments of the present invention. The BOA device 104 displays such information on a screen such as the screen illustrated in FIG. 45.

[00242] FIG. 45 illustrates a display and graphical user interface displayed when the user selects a live patient data button of a BOA menu template, according to embodiments of the present invention. This display includes a list of interventions, a display of patient

information, a display of chief complaint, an ECG wave form and/or an SpO2 waveform, as well as a button console (shown as extending vertically on the right side of the screen) listing buttons for available patient interventions, according to embodiments of the present invention. The intervention button console may be dynamic and/or color-coded. The intervention button console may also include timers.

[00243] For example, when a patient's airway is checked, the EMS technician activates (e.g. pushes or touches) the "patient airway" button on the intervention button console. The button activates and displays a timer, which counts down to the next time when the patient's airways should be checked. This amount of time may be customized by the user and/or preprogrammed into the BOA module operating the BOA device 104 based on established treatment protocols for the locale in which the patient is treated. Color may also be used; for example, the buttons of the intervention button console may be normally gray, and the "patient airway" button may turn yellow as soon as the button is pushed and the timer activated. The button may turn red within a predetermined amount of time before expiry of the timer, for example one minute before the expiration of the time period being timed. For example, a user may look at the intervention button console of FIG. 45 and see that doses of Epi and Atropine have recently been administered, because those buttons are yellow and their timers activated, while also seeing that the patient's airway was previously checked and is about ready to be checked again, because that button is red. This permits the EMS technician to rapidly visually assess which interventions have been made, as well as which interventions should (or may, according to protocol) be considered in the near future, for any point in time.

[00244] Different EMS technicians may have different roles to play in an EMS scenario, based on their training or qualifications, the

number of available technicians, and the status of the patient. In the same way, a single EMS technician may need to play multiple roles in an EMS encounter. Such EMS technicians may more effectively and efficiently perform their corresponding tasks if they are presented only with the information related to their particular role, such that they do not see extraneous information which they must mentally process and filter, and such that they are not presented with decision-making or data input options that do not apply to their role. One way in which such role-based information delivery may be accomplished is by providing each EMS technician with a mobile device with software configured to permit an interface with a BOA device 104 based on the user's role.

[00245] FIG. 62 illustrates examples of such mobile devices communicably coupled to BOA device 104, including a lead medic mobile device 620, drug medic mobile device 622, airway medic mobile device 624, and CPR medic mobile device 626, according to embodiments of the present invention. According to embodiments of the present invention, each mobile device 620, 622, 624, 626 includes a WiFi transceiver that communicates wirelessly with a WiFi transceiver of BOA device 104.

[00246] FIG. 46 illustrates a start screen for a role-based EMS technician mobile device 620 in communication with a BOA device 104, according to embodiments of the present invention. The software instructions contained on the mobile device render this start screen to permit the medic to identify the IP Address, send port, receive port, medic name, and medic role, according to embodiments of the present invention. FIG. 47 illustrates a role selection screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention. A checkmark next to the "Medic – Lead" listing indicates that the user of the mobile

device is the lead medic. According to embodiments of the present invention, a password or other authentication may be required in order to restrict role based on identity.

[00247] FIG. 48 illustrates a lead medic quick log screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention. The mobile device may be configured to display a list of menu options, for example the menu options shown extending horizontally along the bottom of the screen of FIG. 48 permit the lead medic to choose Quick Log, ECG Graph, Patient Data, Chief Complaint, and Medic Role. These options may differ based the user's role. When the lead medic clicks on the Quick Log tab, the lead medic is presented with an intervention button panel, according to embodiments of the present invention. The quick log tab display replicates the intervention button console of the BOA live ECG display of FIG. 45, such that when a lead medic pushes an intervention button on the mobile device via the screen of FIG. 48, the same button (and corresponding timer and/or color) is indicated as being activated in the BOA display screen of FIG. 45, and vice versa, according to embodiments of the present invention.

[00248] FIG. 49 illustrates a lead medic ECG graph screen for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention, which is displayed for the lead medic when the lead medic selects the ECG graph menu button. Because the lead medic's role typically requires a broad swath of patient information, the lead medic ECG graph screen essentially recreates the patient data display screen of the BOA device 104 of FIG. 45, according to embodiments of the present invention. FIG. 50 illustrates a lead medic patient data screen, which permits the lead medic to enter patient information, including the patient's name and gender, according to embodiments of the present invention. FIG.

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51 illustrates a lead medic chief complaint screen which permits the lead medic to identify the patient's chief complaint, according to embodiments of the present invention.

[00249] FIG. 52 illustrates a drug medic quick log screen and FIG. 53 illustrates a drug medic ECG graph screen for a medic who has identified his or her role as drug medic, according to embodiments of the present invention. Because the medic has identified a role of drug medic, the quick log screen presents only a subset of the interventions which relate to drugs, according to embodiments of the present invention. Although the drug medic role accesses only a subset of the full set of intervention buttons, the same intervention buttons are tied together across the entire platform, according to embodiments of the present invention. For example, if the drug medic indicates that a dose of atropine has been given by tapping the atropine intervention button on his mobile device 622, the atropine button will turn yellow as activated, and begin a timer, not only on his mobile device 622, but also on atropine buttons of the quick log screen of the lead medic device 620 and on the intervention button console of the BOA device 104 display, as well as any other devices whose quick log screens include the atropine intervention button, according to embodiments of the present invention.

[00250] FIG. 54 illustrates a role selection screen in which an airway medic role has been identified (e.g. by tapping or otherwise selecting that option on the mobile device 624). FIG. 55 illustrates an airway medic ECG graph screen, and FIG. 56 illustrates an airway medic quick log screen listing the subset of interventions that relate to the airway medic's role, according to embodiments of the present invention.

[00251] FIG. 57 illustrates a CPR medic quick log screen illustrating a subset of interventions that relate to the CPR medic's role,

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according to embodiments of the present invention. FIG. 58 illustrates a CPR medic ECG graph screen during idle for a role-based EMS technician mobile device in communication with a BOA device, according to embodiments of the present invention. FIGS. 59-61 illustrate a CPR medic ECG graph screen during administration of compressions, which do not show the ECG wave form but instead show measurement and/or evaluation of chest compressions (because the CPR medic is concerned primarily with resuscitation), according to embodiments of the present invention. The CPR feedback provided by the screen interface of FIGS. 58-61 may take many different forms. For example, as illustrated in FIG. 59, vertically descending bars may be used to represent depth of each chest compression, spaced horizontally in a manner along a time axis. The chest compression bars descend from an axis toward another set of axes, which specify the desirable or optimal range of depth for each chest compression. A qualitative indicator bar, shown in the upper right, gives the user a combined visual feedback relating to depth and rate of chest compressions; a full box means that both the rate and depth are within desired limits. The letter "R" on FIG. 58 indicates a potential alert regarding the rate of the chest compressions, and the letter "D" on FIG. 61 indicates a potential alert regarding the depth of chest compressions, according to embodiments of the present invention. According to embodiments of the present invention, the CPR feedback screen of device 626 provides information about the rate and volume of patient ventilation.

[00252] According to embodiments of the present invention, the patient monitoring device 106 and/or EMS communications interface device 2000 and/or the BOA device 104 includes a filtering mechanism (e.g. a circuit or processing instructions) that filters or removes chest compression interference from ECG signal data. Embodiments of the

present invention may include a device or utilize a method similar to those described in U.S. Patent No. 7,295,871, issued Nov. 13, 2007, which is incorporated by reference herein. Embodiments of the present invention may also employ Real CPR Help ® technology available from Zoll Medical Corporation.

[00253] The use of role-based information delivery and intervention tracking permits a more efficient EMS treatment scenario by filtering data based on role, according to embodiments of the present invention. For example, the drug medic, airway medic, and CPR medic do not have menu tab selections available for patient data entry or for chief complaint entry, while the lead medic has those options.

[00254] Although only four mobile devices 620, 622, 624, and 626 are shown in FIG. 62, the BOA device 104 may communicably couple with a greater or fewer number of role-based mobile devices. Also, although particular intervention options and data feed displays are shown as being related to particular roles, one of ordinary skill in the art, based on the present disclosure, will appreciate the numerous different roles that may be identified and implemented, as well as the numerous different data feeds and/or options that may be associated with each role. Further, mobile devices (e.g. 620) may be configured to communicably couple with multiple BOA devices 104 and/or to receive information for multiple patients from the same BOA device 104, to permit the medic to toggle between various patient data feeds and/or to treat different patients, possibly in different roles, according to embodiments of the present invention.

[00255] According to embodiments of the present invention, the software modules and hardware contained within the BOA device 104 for feeding the data to and from the mobile devices 620 may be

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consolidated into an EMS communications interface device 2000, and/or directly into a patient monitoring device 106.

[00256] Various modifications and additions can be made to the exemplary embodiments discussed without departing from the scope of the present invention. For example, while the embodiments described above refer to particular features, the scope of this invention also includes embodiments having different combinations of features and embodiments that do not include all of the described features. Accordingly, the scope of the present invention is intended to embrace all such alternatives, modifications, and variations as fall within the scope of the claims, together with all equivalents thereof.

CLAIMS

What is claimed is:

1. A system for supplementing communications capabilities of a patient monitoring device configured to monitor a patient and to make available patient monitoring information, the patient monitoring device having a communications interface slot, the system comprising:

a card configured to fit within the communications interface slot and to receive the patient monitoring information from the patient monitoring device via the communications interface slot;

a memory device hosted by the card and configured to store the patient monitoring information;

a wireless transceiver hosted by the card;

an asset management database hosted by the card; and

a processor communicably coupled to the wireless transceiver and the asset management database, the processor configured to format the patient monitoring information into a stream of one or more frames, each of the one or more frames associated with an EMS incident during which the patient monitoring information was gathered, the processor further configured to store the one or more frames to the asset management database and to transmit the stream of one or more frames with the wireless transceiver.

2. The system of claim 1, wherein the processor is further configured to receive, via the wireless transceiver, a request for frames associated with a specific EMS incident, query the asset management database to retrieve all frames associated with the specific EMS incident, and to transmit the frames associated with the specific EMS incident with the wireless transceiver.

3. The system of claim 1, wherein the processor is restricted from editing the patient monitoring information on the memory device.

4. The system of claim 3, wherein the patient monitoring device is configured to edit the patient monitoring information on the memory device.

5. The system of claim 1, wherein patient monitoring information from the patient monitoring device is bifurcated into a first stream and a second stream, wherein the memory card is configured to store the first stream, and wherein the processor is configured to receive the second stream.

6. A method for streaming patient information from a clinical device, comprising:

establishing a wireless data connection with the clinical device;

receiving patient information from the clinical device via the wireless data connection at least once every five seconds; and

displaying at least a portion of the patient information in an emergency medical services mobile environment.

7. The method of claim 6, wherein the clinical device is a defibrillator.

8. The method of claim 6, wherein receiving the patient information comprises receiving the patient information from the clinical device via the wireless data connection at least once every second.

9. The method of claim 6, wherein the wireless data connection is a secure WiFi connection.

10. The method of claim 6, wherein the patient information is clinical information, the method further comprising receiving non-clinical information and displaying the clinical information and the non-clinical information simultaneously in the emergency medical services mobile environment.

11. The method of claim 6, wherein the patient information comprises an ECG waveform.

12. The method of claim 6, wherein the patient information comprises a heart rate.

13. The method of claim 8, wherein the patient information comprises an ECG waveform.

14. The method of claim 6, further comprising:

receiving full disclosure data from the clinical device;

formatting the full disclosure data into a frame event stream, wherein the frame event stream comprises a plurality of frames in chronological order, wherein each of the

plurality of frames comprises a time identifier, an incident identifier, and clinical information associated with a time identified by the time identifier and an incident identified by the incident identifier; and

sending the frame event stream over the wireless data connection as the patient information.

15. The method of claim 14, further comprising storing the plurality of frames in a computer readable medium.

16. The method of claim 15, further comprising:

sending a request over the wireless data connection, the request including a particular incident identifier;

retrieving from the computer readable medium and adding to a response set each of the plurality of frames for which the incident identifier corresponds to the particular incident identifier of the request; and

sending the response set over the wireless data connection.

17. The method of claim 16, further comprising displaying at least a portion of the response set in the emergency medical services mobile environment.

18. The method of claim 6, wherein the wireless data connection is a first wireless data connection, the method further comprising:

transmitting the patient information via a second wireless data connection;

receiving the patient information with a personal mobile device via the second wireless data connection;

receiving, via the personal mobile device, a role indication; and

determining a portion of the patient information for display on the mobile device based on the role indication.

19. The method of claim 18, wherein the role indication is CPR medic, and wherein the portion of the patient information comprises chest compression measurement data.

20. The method of claim 18, further comprising:

receiving a patient intervention indication via the second wireless data connection from the personal mobile device; and

displaying at least a portion of the patient information simultaneously with information associated with the patient intervention indication in the emergency medical services mobile environment.

21. The method of claim 20, wherein the patient intervention indication is one of a plurality of patient intervention indications, and wherein the plurality of patient intervention indications displayed on the personal mobile device is determined based on the role indication.

22. The method of claim 6, wherein the wireless data connection is a first wireless data connection, the method further comprising:

transmitting the patient information via a second wireless data connection;

receiving the patient information with a personal mobile device via the second wireless data connection;

receiving, via the personal mobile device, a role indication; and

filtering the patient information for display on the mobile device based on the role indication.

23. A method for supplementing communications capabilities of a patient monitoring device configured to monitor a patient and to make available patient monitoring information, the patient monitoring device having a communications interface slot, the method comprising:

receiving the patient monitoring information from the patient monitoring device to an EMS communication interface device via the communications interface slot;

storing the patient monitoring information to a memory hosted by the EMS communication interface device;

formatting the patient monitoring information into a stream of one or more frames, each of the one or more frames associated with an EMS incident during which the patient monitoring information was gathered;

storing the one or more frames to an asset management database hosted by the EMS communication interface device; and

transmitting the stream of one or more frames via a wireless transceiver of the EMS communication interface device.

SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATIONS INTERFACE

ABSTRACT

A system for supplementing communications capabilities of a patient monitoring device, the system including a card fitting within a device slot and configured to receive patient monitoring information from the device via the interface slot; a memory device hosted by the card and configured to store patient monitoring information; a wireless transceiver hosted by the card; an asset management database hosted by the card; and a processor communicably coupled to the wireless transceiver and the asset management database, the processor configured to format the patient monitoring information into a stream of one or more frames, each of the one or more frames associated with an EMS incident during which the patient monitoring information was gathered, the processor further configured to store the one or more frames to the asset management database and to transmit the stream of one or more frames with the wireless transceiver.

fb.us.5463435.01

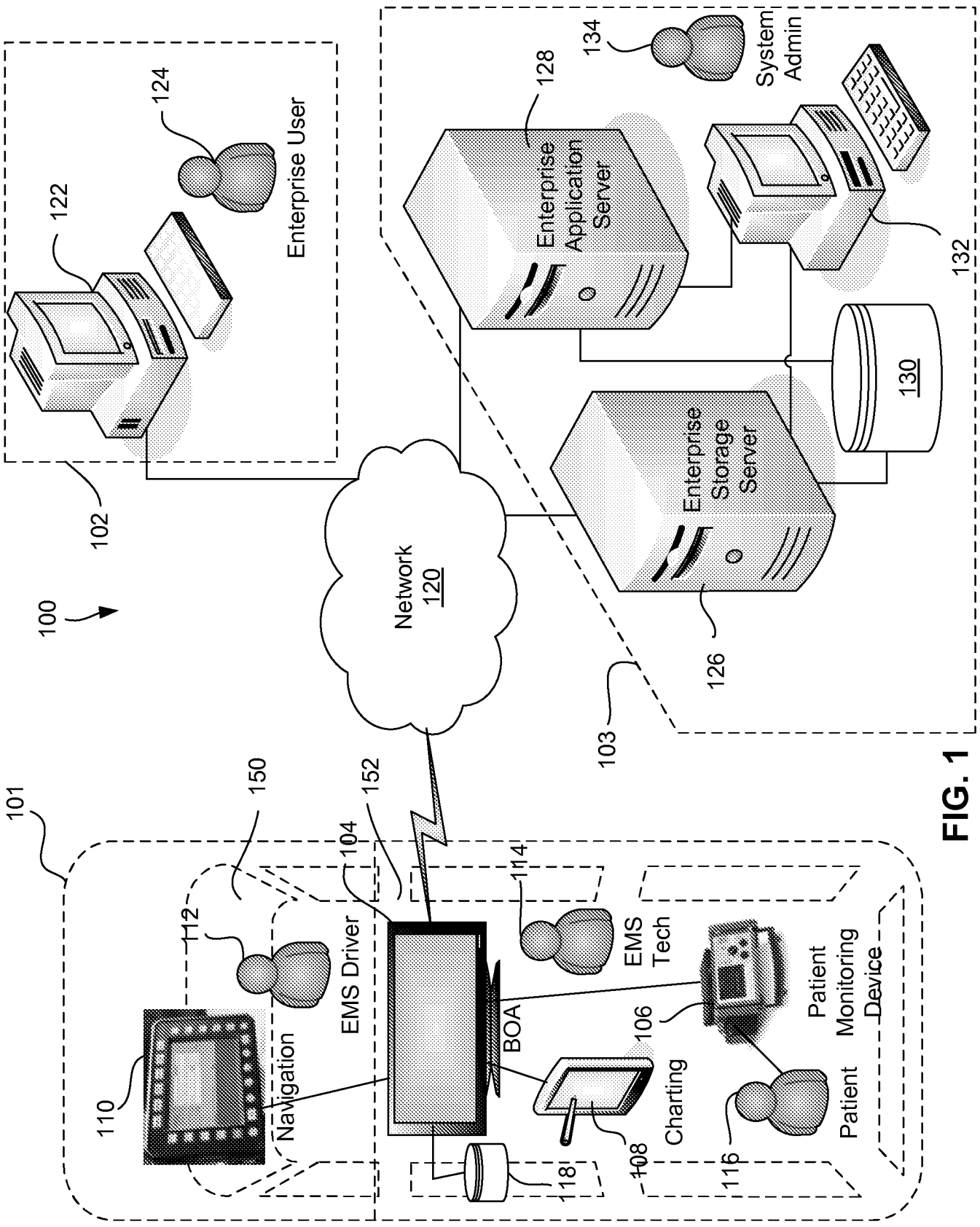

100
101
102
103
104
106
108
110
112
114
116
118
120
122
124
126
128
130
132
134
150
152
Enterprise User
Network
120
Enterprise
Application
Server
Enterprise
Storage
Server
System
Admin
EMS Driver
Navigation
BOA
EMS
Tech
Charting
Patient
Patient
Monitoring
Device

FIG. 1

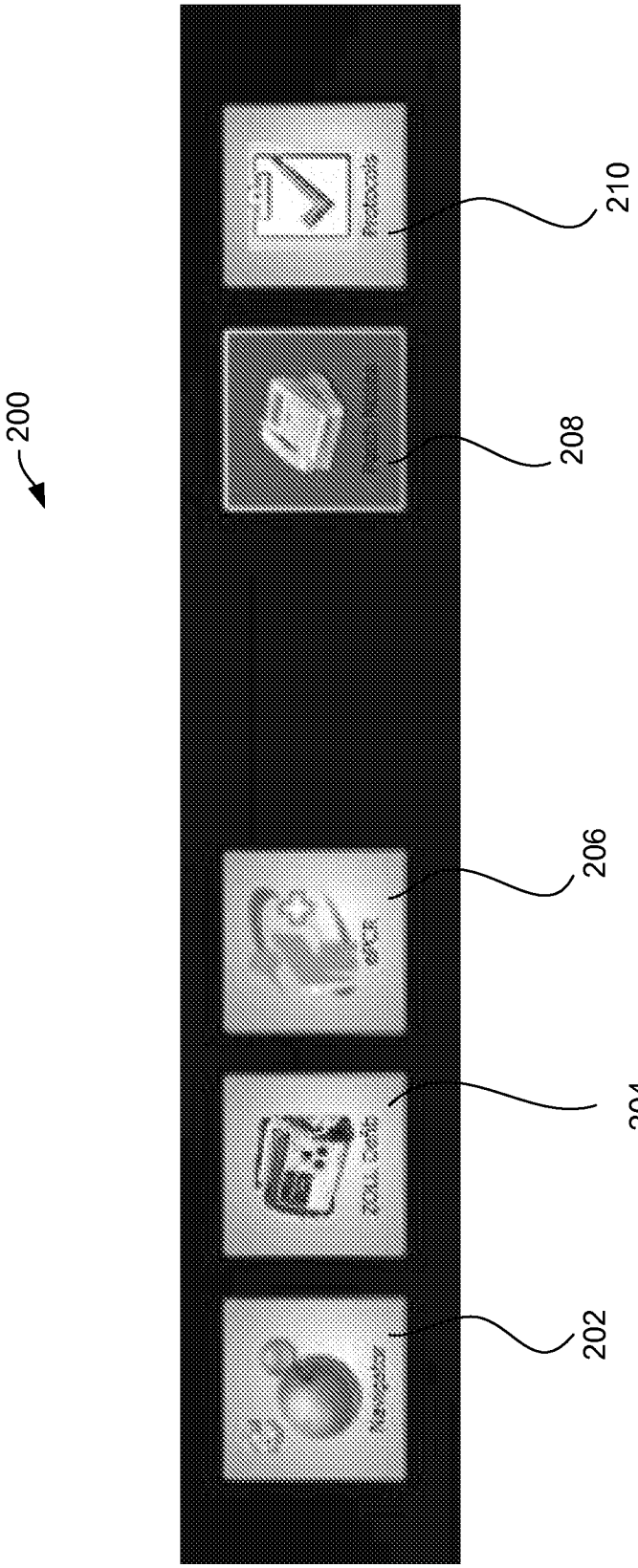


FIG. 2

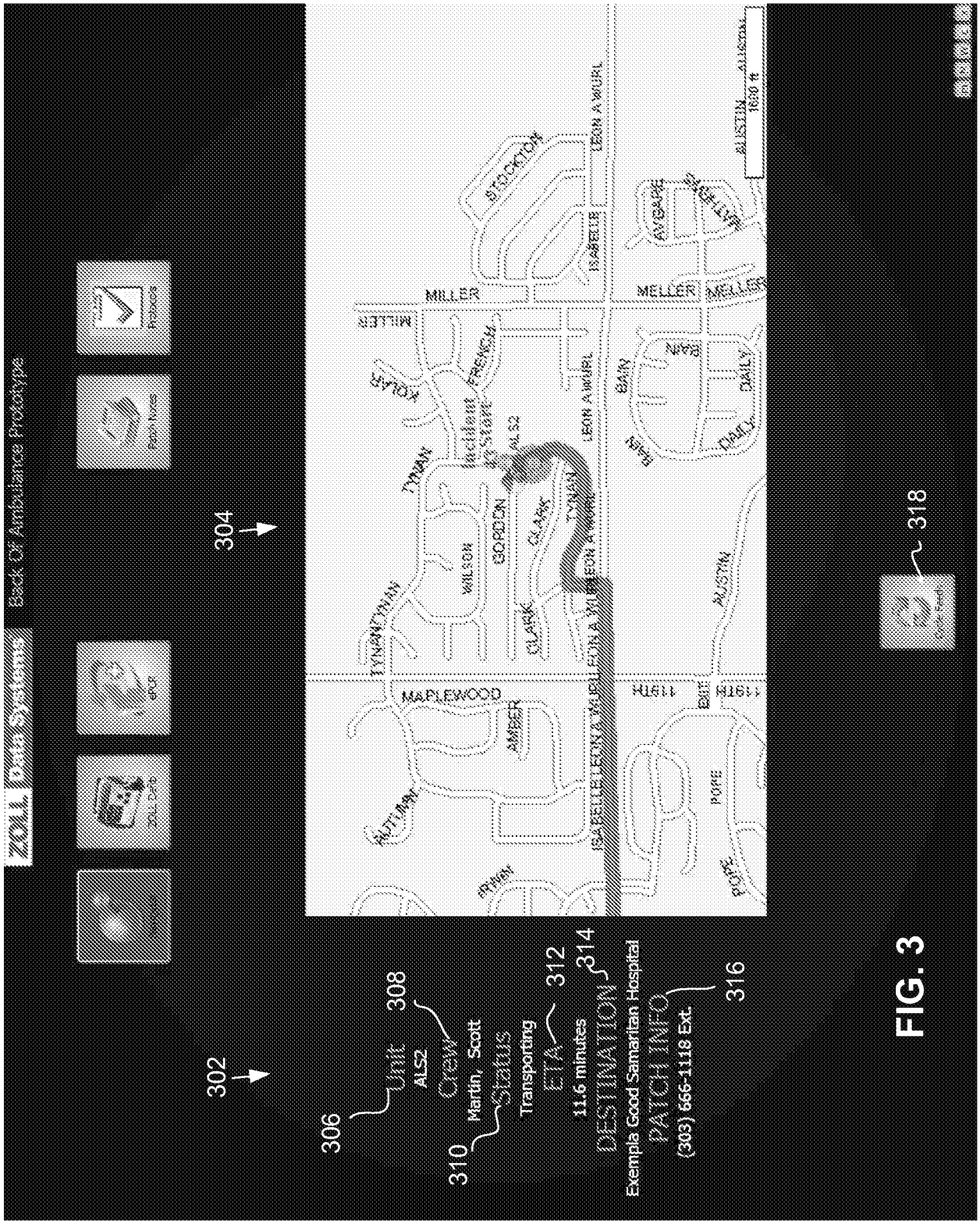

ZOLL Data Systems
Back Of Ambulance Prototype
302
304
306
Unit
ALS2
308
Crew
Martin, Scott
310
Status
Transporting
312
ETA
11.6 minutes
314
DESTINATION
Exempla Good Samaritan Hospital
316
PATCH INFO
(303) 666-1118 Ext.
318
MILLER
MAPLEWOOD
STOCKTON
LEON A WURL
ISABELLE
FRENCH
TYNAN
WILSON
GORDON
CLARK
AMBER
AUSTIN
POPE
BAIN
DAILY
AVGAPE
1600 ft

FIG. 3

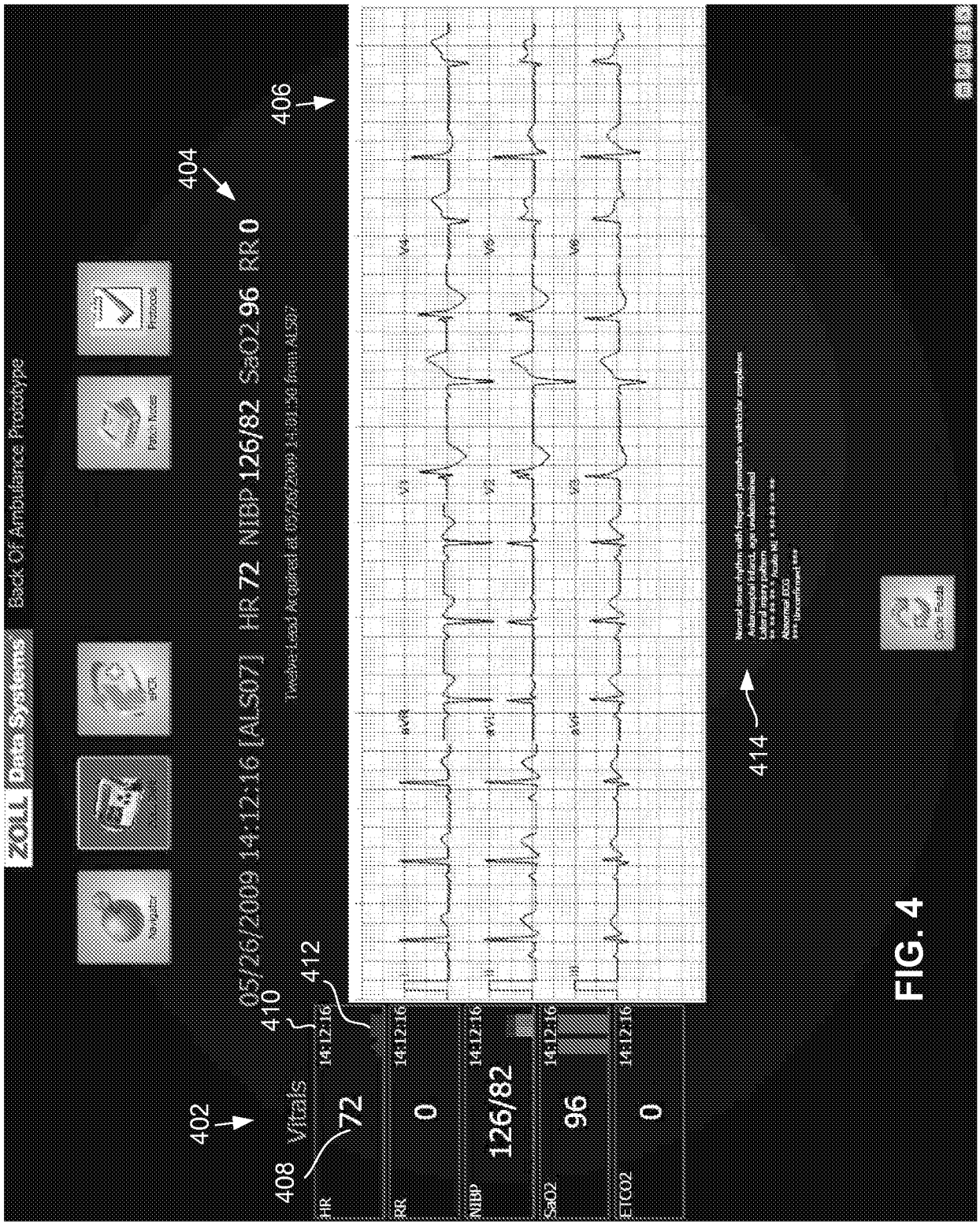

ZOLL Data Systems
Back Of Ambulance Prototype
05/26/2009 14:12:16 [ALS07] HR 72 NIBP 126/82 SaO2 96 RR 0
Twelve-Lead Acquired at 05/26/2009 14:31:30 from ALS07
402
404
406
408
410
412
414
Vitals
HR
72
RR
0
NIBP
126/82
SaO2
96
ETCO2
0
14:12:16

FIG. 4

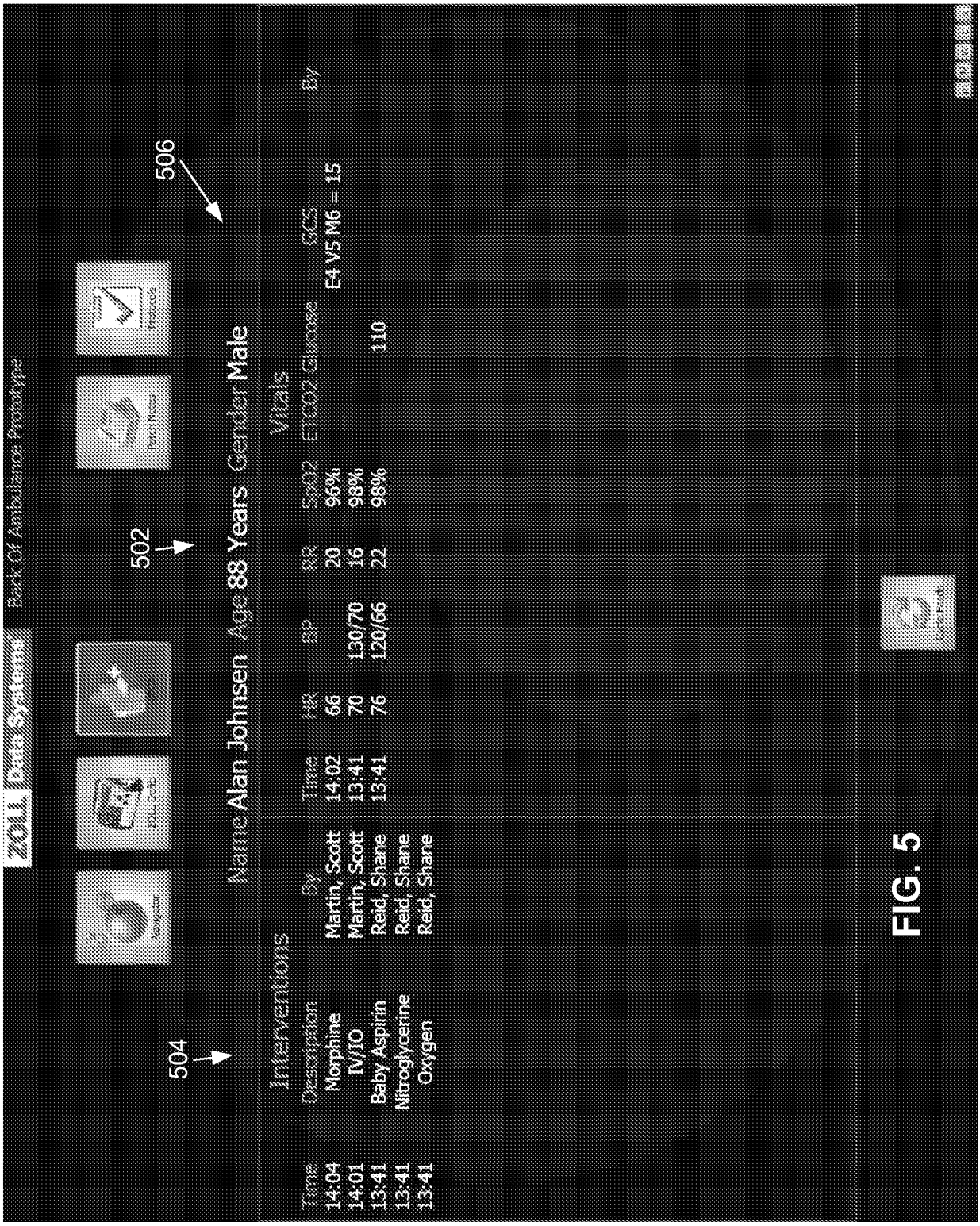

ZOLL Data Systems
Back Of Ambulance Prototype
Name Alan Johnsen Age 88 Years Gender Male
504
502
506
Interventions
Time
By
Description
14:04
Martin, Scott
Morphine
14:01
Martin, Scott
IV/IO
13:41
Reid, Shane
Baby Aspirin
13:41
Reid, Shane
Nitroglycerine
13:41
Reid, Shane
Oxygen
Vitals
Time
HR
BP
RR
SpO2
ETCO2
Glucose
GCS
By
14:02
66
20
96%
E4 V5 M6 = 15
13:41
70
130/70
16
98%
13:41
76
120/66
22
98%
110

FIG. 5

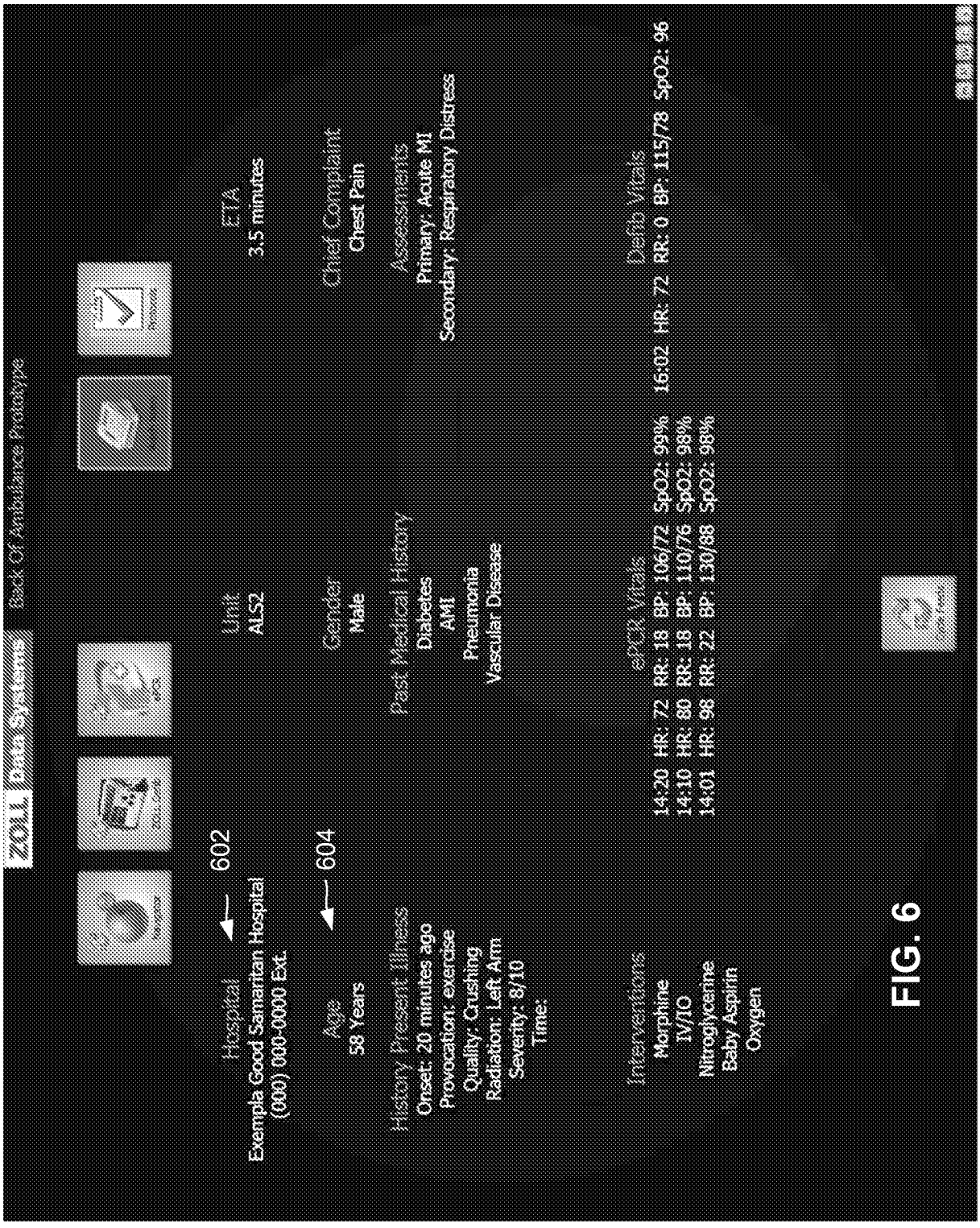

ZOLL Data Systems
Back Of Ambulance Prototype
602
604
Hospital
Exempla Good Samaritan Hospital
(000) 000-0000 Ext.
Unit
ALS2
ETA
3.5 minutes
Age
58 Years
Gender
Male
Chief Complaint
Chest Pain
History Present Illness
Onset: 20 minutes ago
Provocation: exercise
Quality: Crushing
Radiation: Left Arm
Severity: 8/10
Time:
Past Medical History
Diabetes
AMI
Pneumonia
Vascular Disease
Assessments
Primary: Acute MI
Secondary: Respiratory Distress
Interventions
Morphine
IV/IO
Nitroglycerine
Baby Aspirin
Oxygen
ePCR Vitals
14:20 HR: 72 RR: 18 BP: 106/72 SpO2: 99%
14:10 HR: 80 RR: 18 BP: 110/76 SpO2: 98%
14:01 HR: 98 RR: 22 BP: 130/88 SpO2: 98%
Defib Vitals
16:02 HR: 72 RR: 0 BP: 115/78 SpO2: 96

FIG. 6

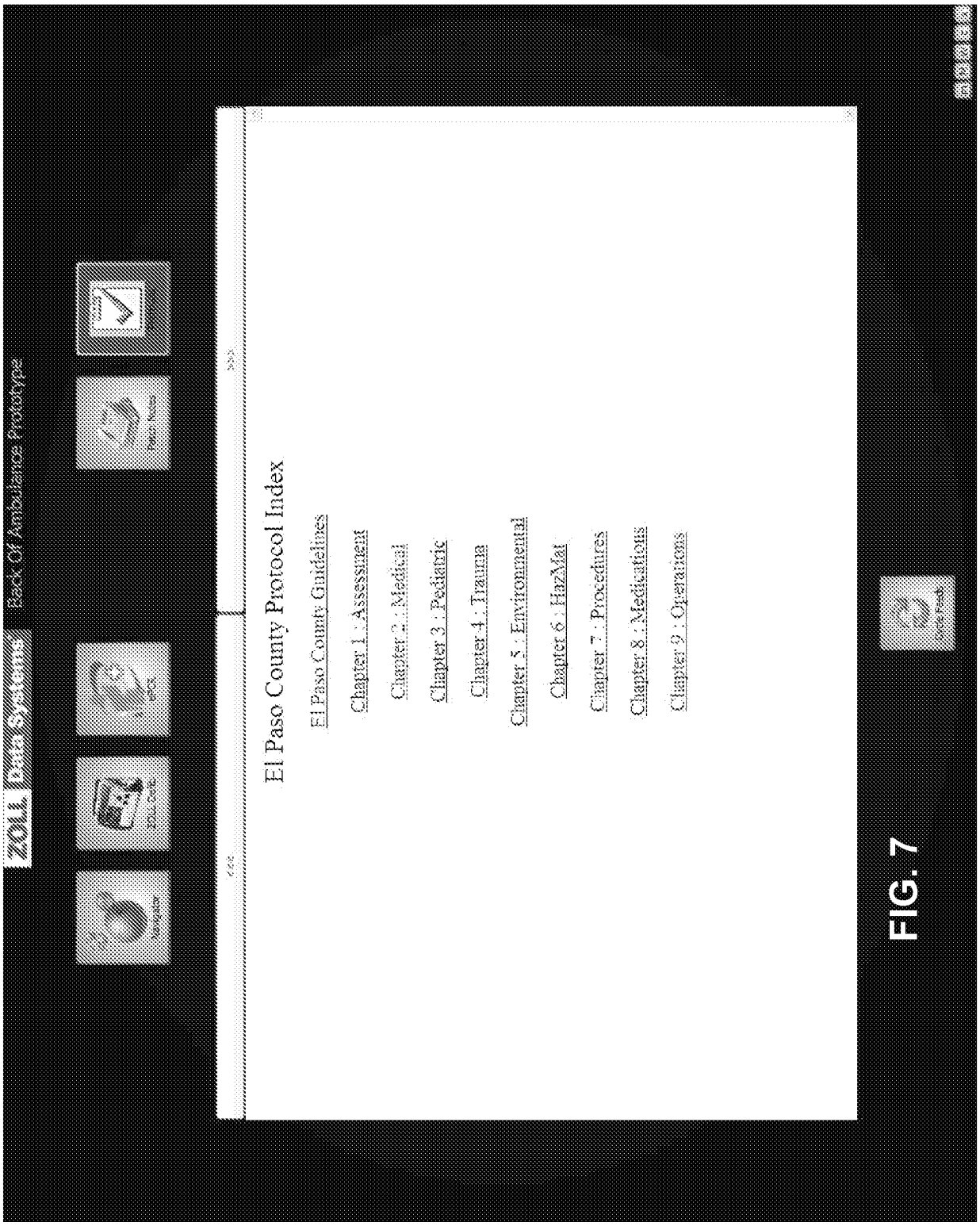

ZOLL
Back Of Ambulance Prototype
El Paso County Protocol Index
El Paso County Guidelines
Chapter 1 : Assessment
Chapter 2 : Medical
Chapter 3 : Pediatric
Chapter 4 : Trauma
Chapter 5 : Environmental
Chapter 6 : HazMat
Chapter 7 : Procedures
Chapter 8 : Medications
Chapter 9 : Operations

FIG. 7

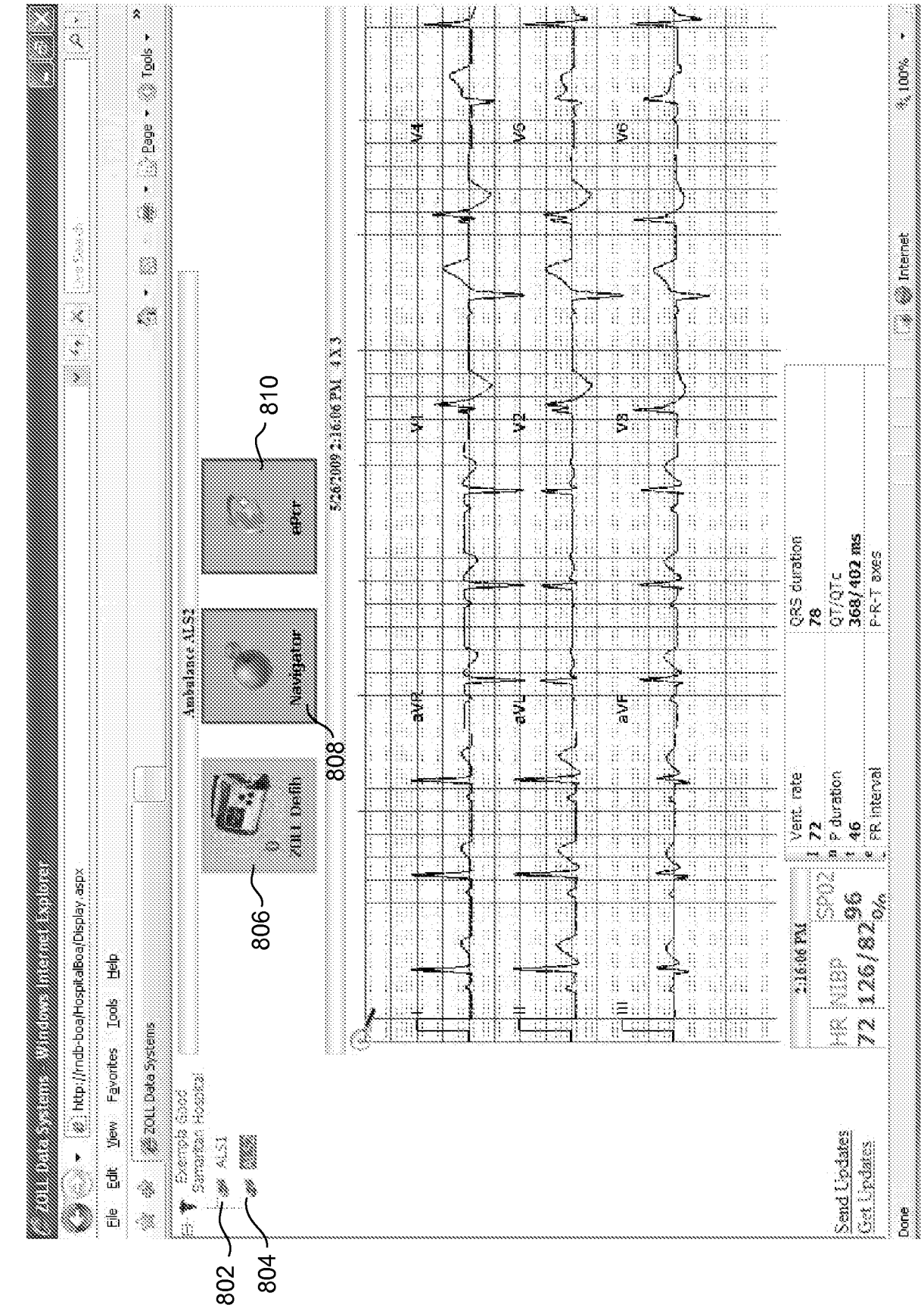

ZOLL Data Systems - Windows Internet Explorer
http://rndb-boa/HospitalBoa/Display.aspx
File Edit View Favorites Tools Help
ZOLL Data Systems
Exemplo Good Samaritan Hospital
ALS1
Ambulance ALS2
ZOLL Defib
Navigator
ePCR
5/26/2009 2:16:06 PM 4 X 3
aVR
aVL
aVF
V1
V2
V3
V4
V5
V6
Vent. rate
72
P duration
46
PR interval
QRS duration
78
QT/QTc
368/402 ms
P-R-T axes
2:16:06 PM
HR
NIBP
SPO2
72
126/82
96
Send Updates
Get Updates
Done
Internet
100%
802
804
806
808
810

FIG. 8

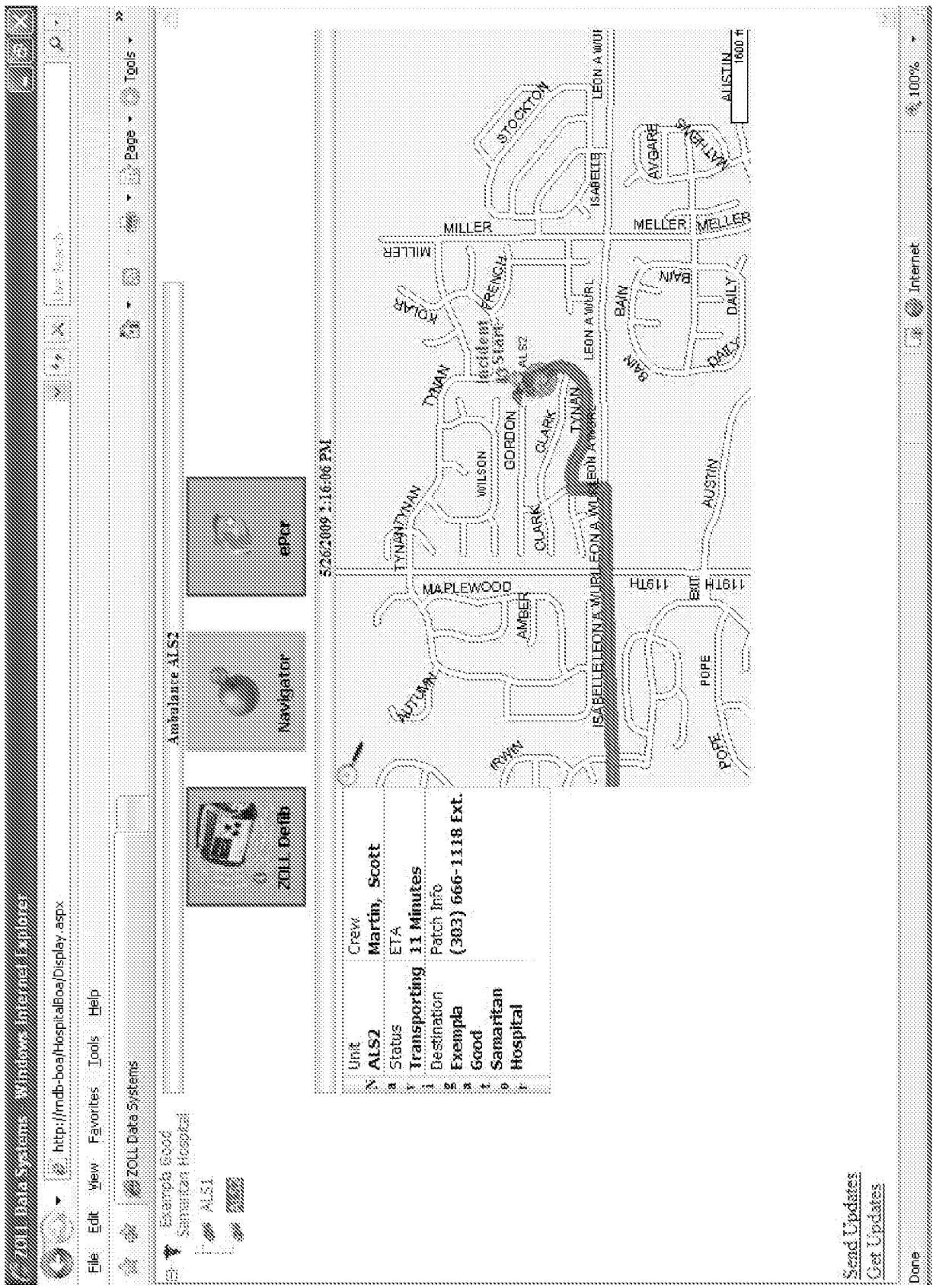

ZOLL Data Systems - Windows Internet Explorer
http://rndb-boa/HospitalBoa/Display.aspx
File Edit View Favorites Tools Help
ZOLL Data Systems
Page Tools
Exempla Good Samaritan Hospital
ALS1
Ambulance ALS2
ZOLL Defib
Navigator
ePcr
5/26/2009 2:16:06 PM
Unit
ALS2
Status
Transporting
Destination
Exempla Good Samaritan Hospital
Crew
Martin, Scott
ETA
11 Minutes
Patch Info
(303) 666-1118 Ext.
MILLER
MELLER
STOCKTON
ISABELLE
AVGARE
MATHEWS
KOLAR
FRENCH
TYNAN
WILSON
GORDON
CLARK
LEON A WURL
BAIN
DAILY
AUSTIN
MAPLEWOOD
AMBER
AUTUMN
IRWIN
ISABELLE LEON A WURL
119TH
EXIT
POPE
Send Updates
Get Updates
Done
Internet
100%

FIG. 9

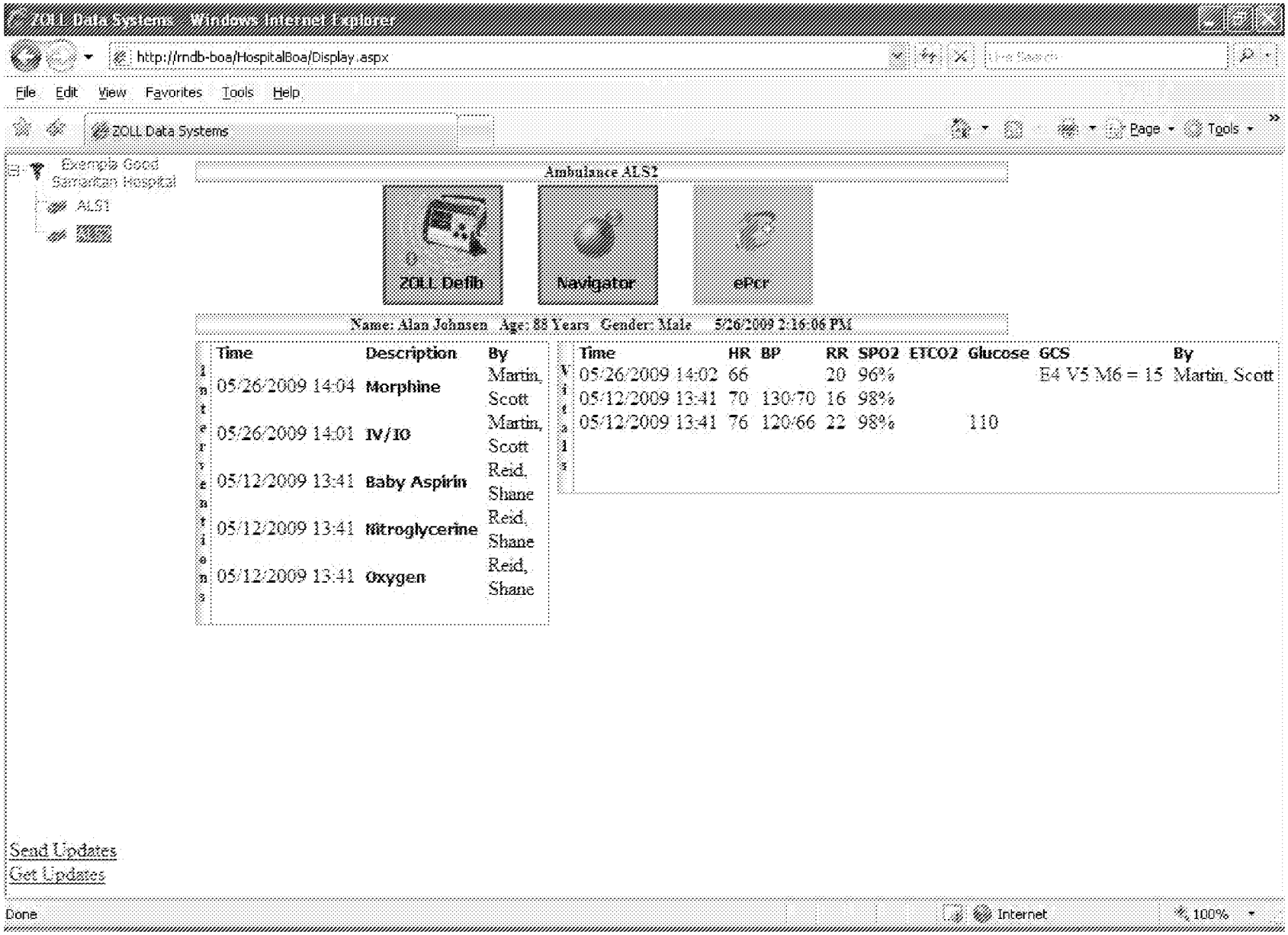


FIG. 10

PATENT
REEL: 042387 FRAME: 0587

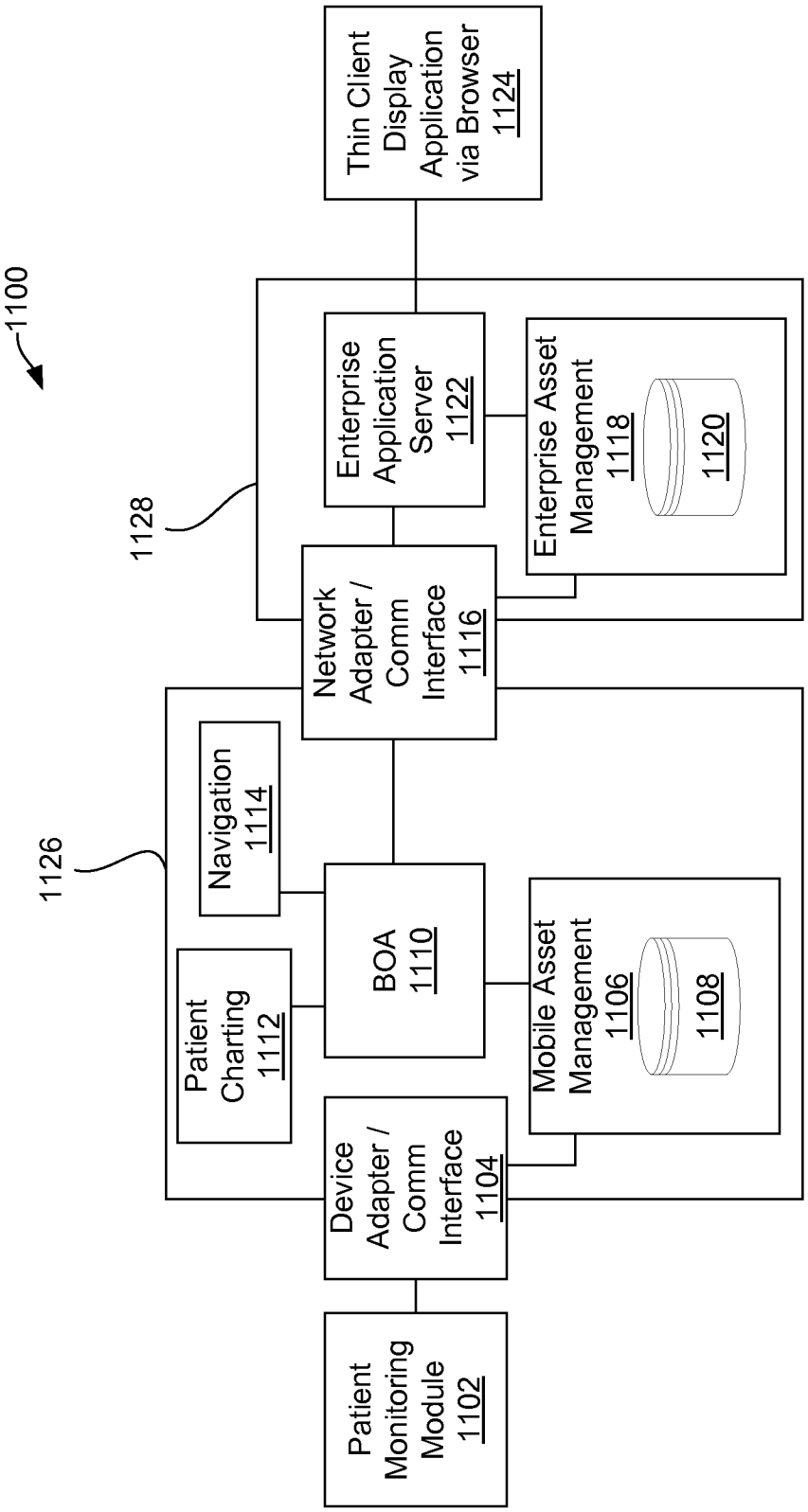

1100
Thin Client Display Application via Browser 1124
Enterprise Application Server 1122
Enterprise Asset Management 1118
1120
1128
Network Adapter / Comm Interface 1116
Navigation 1114
1126
Patient Charting 1112
BOA 1110
Mobile Asset Management 1106
1108
Device Adapter / Comm Interface 1104
Patient Monitoring Module 1102

FIG. 11

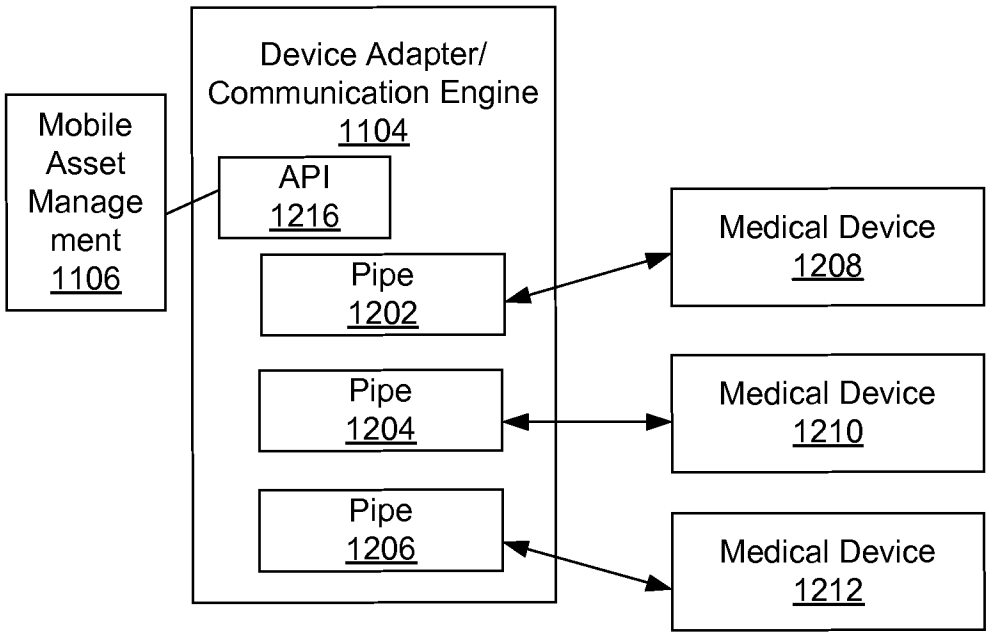

Device Adapter/
Communication Engine
1104
Mobile
Asset
Manage
ment
1106
API
1216
Pipe
1202
Pipe
1204
Pipe
1206
Medical Device
1208
Medical Device
1210
Medical Device
1212

FIG. 12

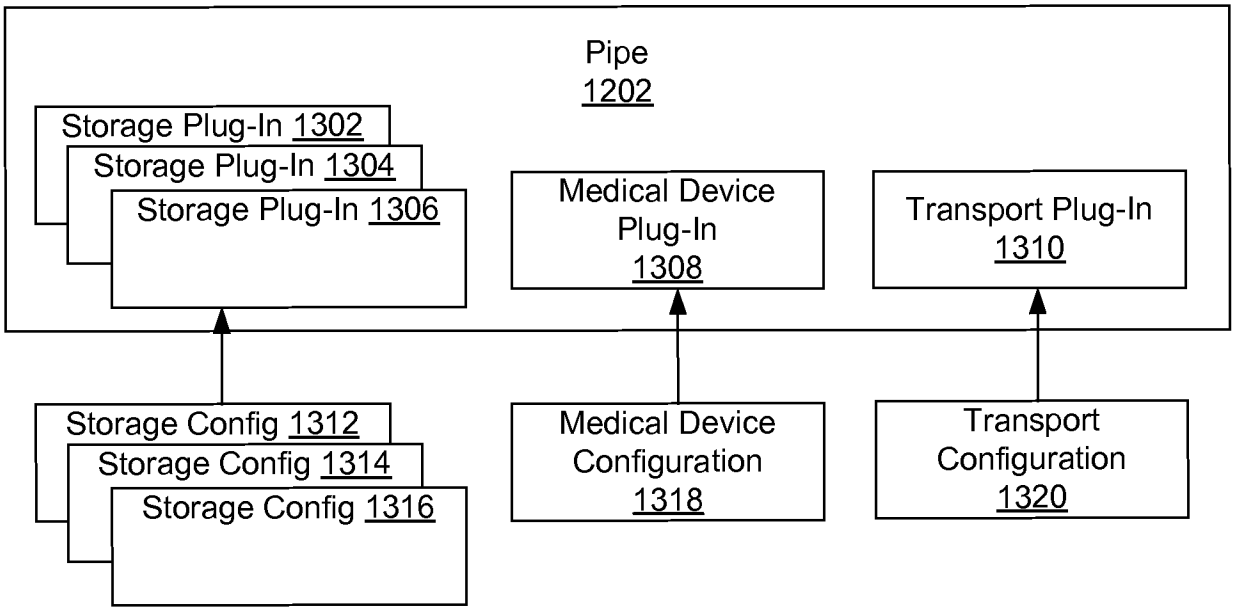

Pipe
1202
Storage Plug-In 1302
Storage Plug-In 1304
Storage Plug-In 1306
Medical Device
Plug-In
1308
Transport Plug-In
1310
Storage Config 1312
Storage Config 1314
Storage Config 1316
Medical Device
Configuration
1318
Transport
Configuration
1320

FIG. 13

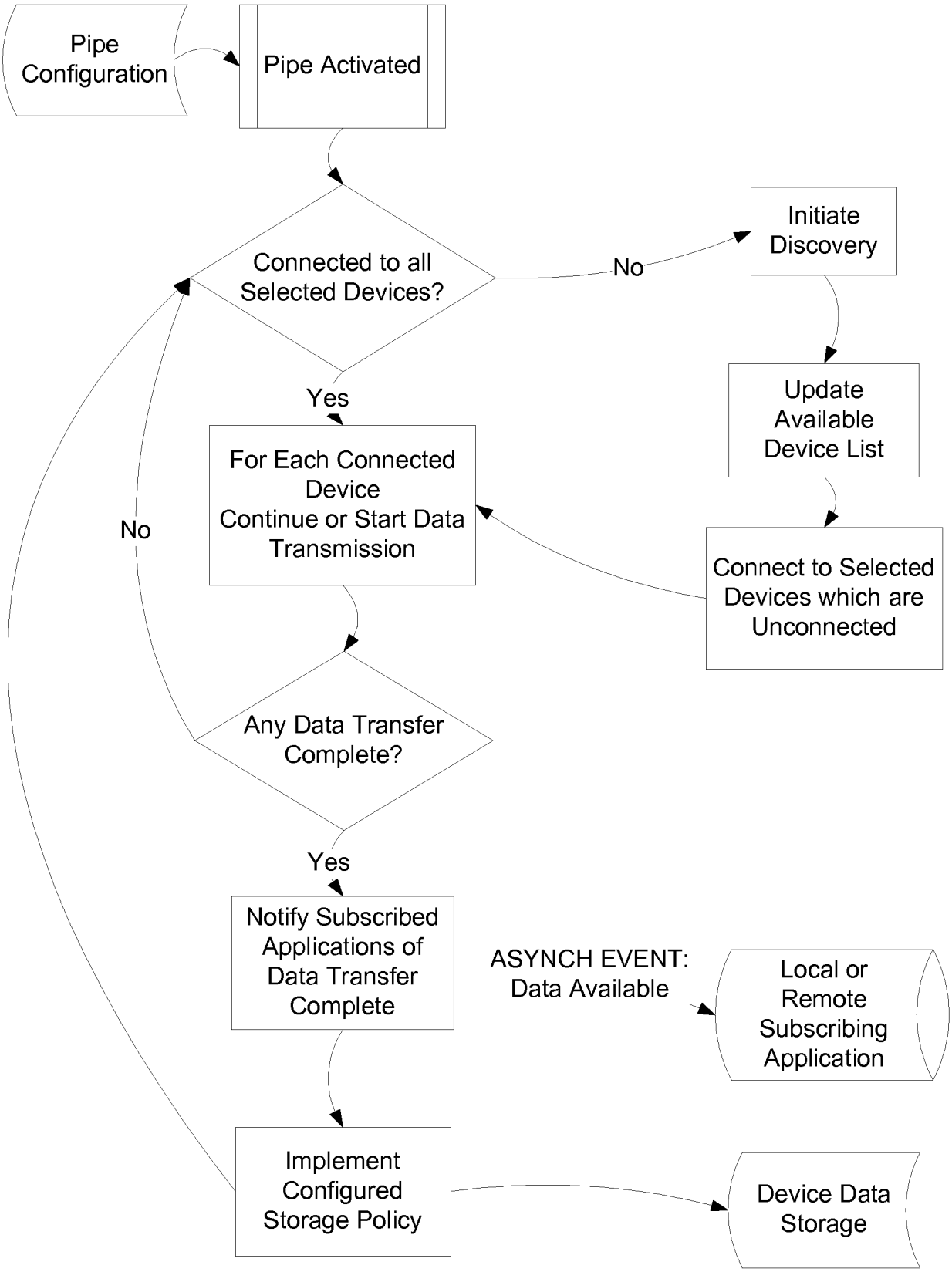

Pipe Configuration
Pipe Activated
Connected to all Selected Devices?
No
Initiate Discovery
Update Available Device List
Connect to Selected Devices which are Unconnected
Yes
For Each Connected Device Continue or Start Data Transmission
No
Any Data Transfer Complete?
Yes
Notify Subscribed Applications of Data Transfer Complete
ASYNCH EVENT: Data Available
Local or Remote Subscribing Application
Implement Configured Storage Policy
Device Data Storage

FIG. 14

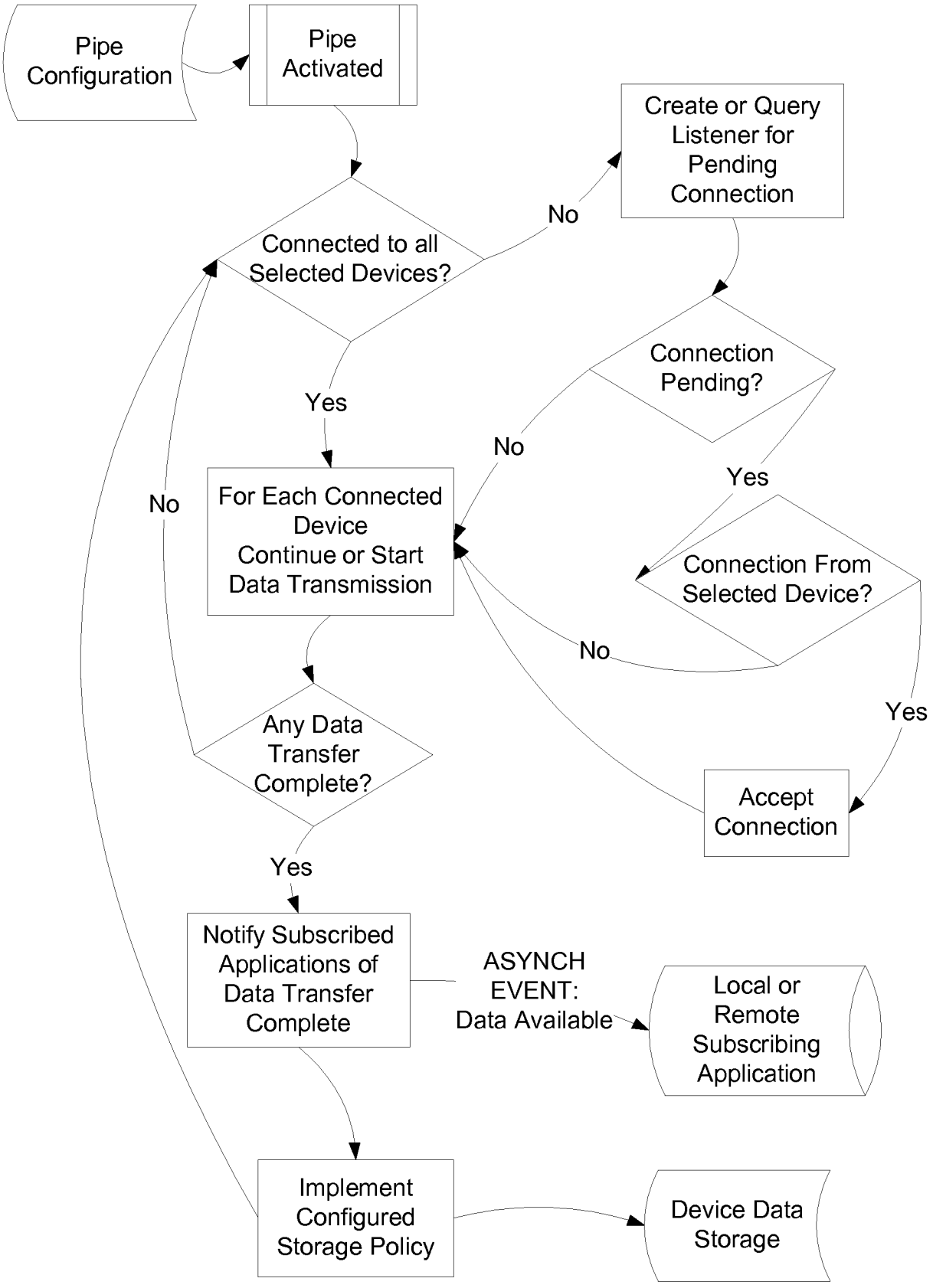

Pipe Configuration
Pipe Activated
Create or Query Listener for Pending Connection
No
Connected to all Selected Devices?
Connection Pending?
Yes
No
Yes
For Each Connected Device Continue or Start Data Transmission
No
Connection From Selected Device?
No
Yes
Any Data Transfer Complete?
Accept Connection
Yes
Notify Subscribed Applications of Data Transfer Complete
ASYNCH EVENT: Data Available
Local or Remote Subscribing Application
Implement Configured Storage Policy
Device Data Storage

FIG. 15

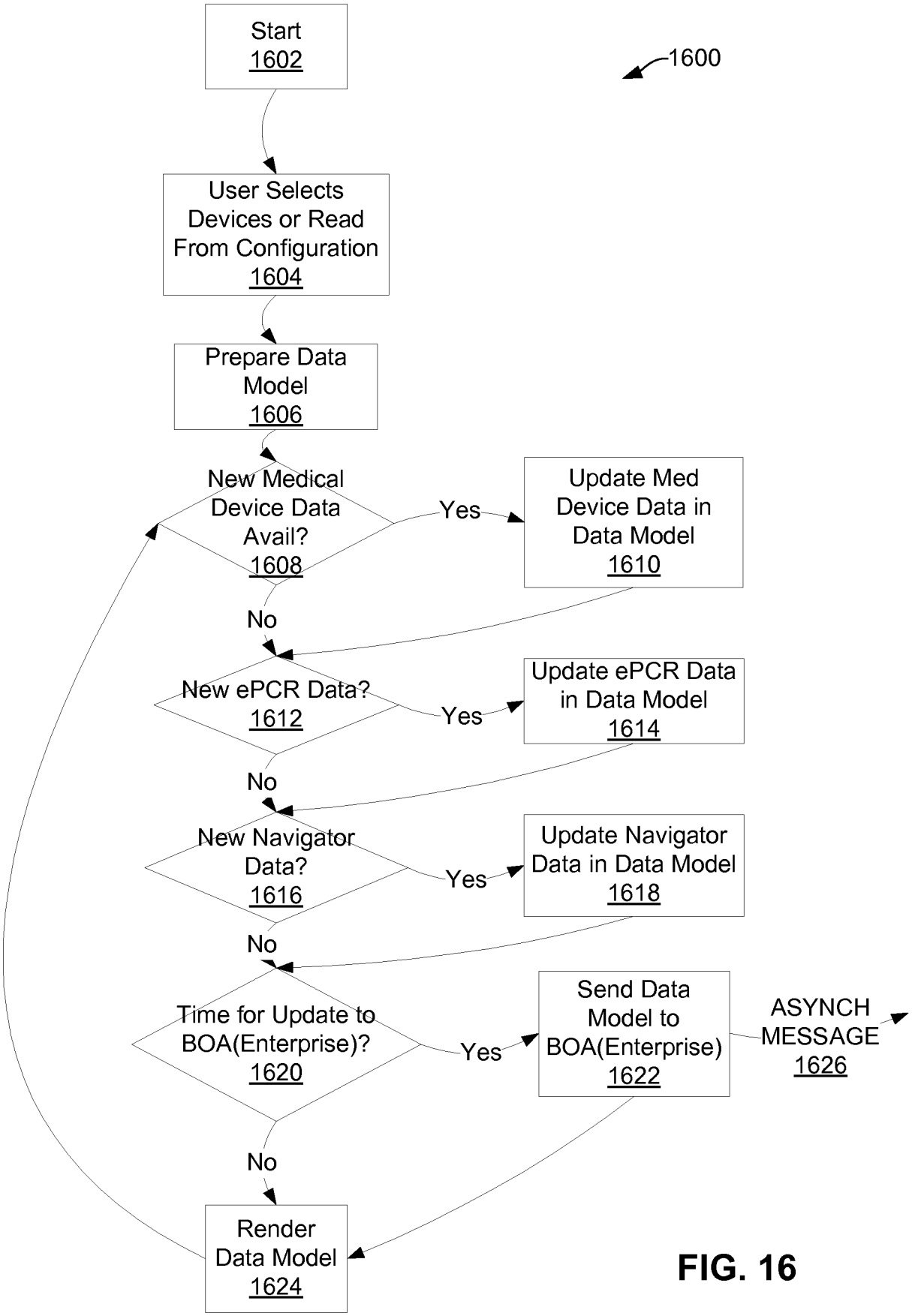

Start
1602
1600
User Selects Devices or Read From Configuration
1604
Prepare Data Model
1606
New Medical Device Data Avail?
1608
Yes
Update Med Device Data in Data Model
1610
No
New ePCR Data?
1612
Yes
Update ePCR Data in Data Model
1614
No
New Navigator Data?
1616
Yes
Update Navigator Data in Data Model
1618
No
Time for Update to BOA(Enterprise)?
1620
Yes
Send Data Model to BOA(Enterprise)
1622
ASYNCH MESSAGE
1626
No
Render Data Model
1624

FIG. 16

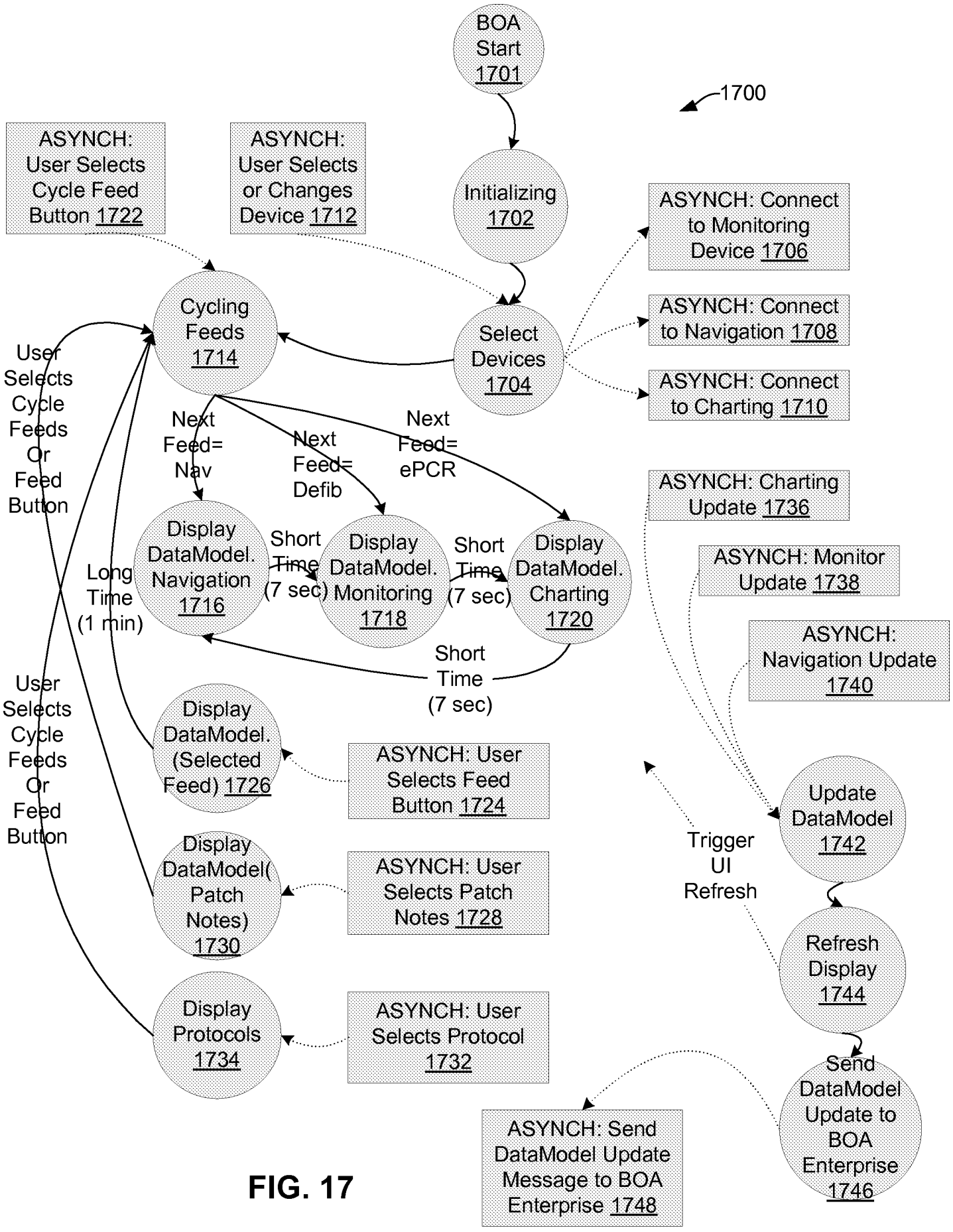

BOA Start 1701
1700
ASYNCH: User Selects Cycle Feed Button 1722
ASYNCH: User Selects or Changes Device 1712
Initializing 1702
ASYNCH: Connect to Monitoring Device 1706
Cycling Feeds 1714
Select Devices 1704
ASYNCH: Connect to Navigation 1708
ASYNCH: Connect to Charting 1710
User Selects Cycle Feeds Or Feed Button
Next Feed= Nav
Next Feed= Defib
Next Feed= ePCR
ASYNCH: Charting Update 1736
Display DataModel. Navigation 1716
Short Time (7 sec)
Display DataModel. Monitoring 1718
Short Time (7 sec)
Display DataModel. Charting 1720
ASYNCH: Monitor Update 1738
Long Time (1 min)
Short Time (7 sec)
ASYNCH: Navigation Update 1740
User Selects Cycle Feeds Or Feed Button
Display DataModel. (Selected Feed) 1726
ASYNCH: User Selects Feed Button 1724
Update DataModel 1742
Trigger UI Refresh
Display DataModel(Patch Notes) 1730
ASYNCH: User Selects Patch Notes 1728
Refresh Display 1744
Display Protocols 1734
ASYNCH: User Selects Protocol 1732
Send DataModel Update to BOA Enterprise 1746
ASYNCH: Send DataModel Update Message to BOA Enterprise 1748

FIG. 17

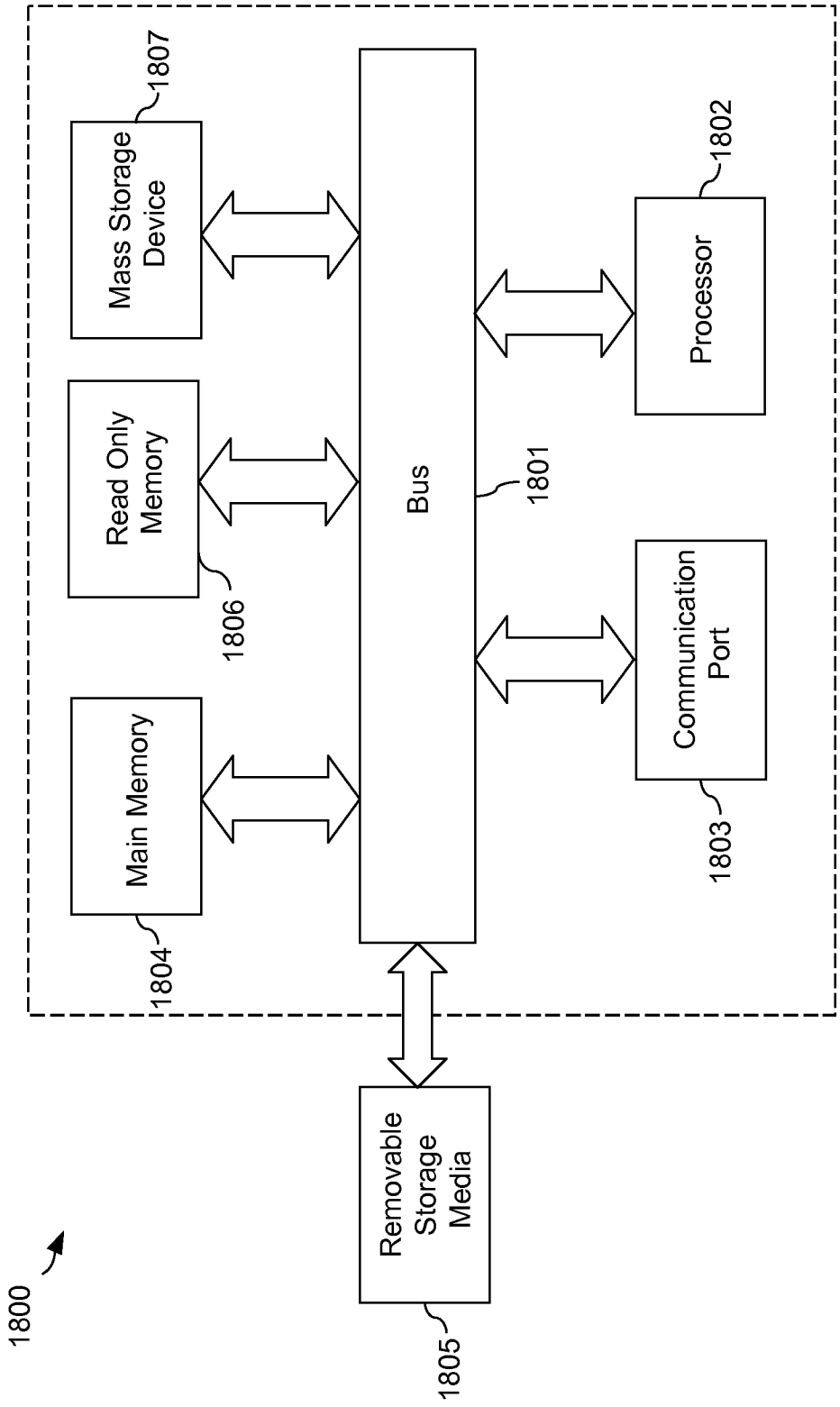

1800
Mass Storage Device
1807
Read Only Memory
1806
Main Memory
1804
Bus
1801
Processor
1802
Communication Port
1803
Removable Storage Media
1805

FIG. 18

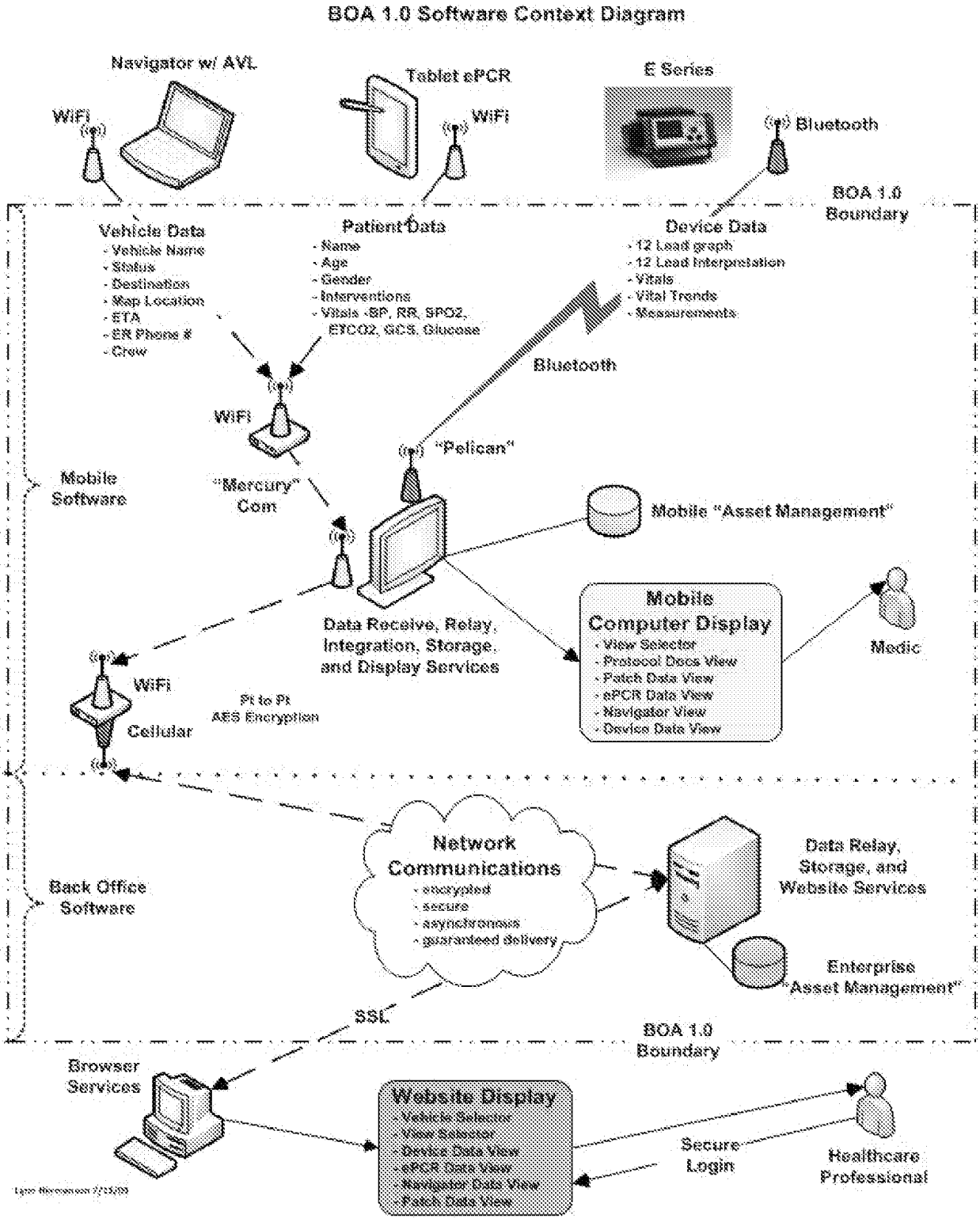

BOA 1.0 Software Context Diagram
Navigator w/ AVL
WiFi
Tablet ePCR
WiFi
E Series
Bluetooth
BOA 1.0 Boundary
Vehicle Data
- Vehicle Name
- Status
- Destination
- Map Location
- ETA
- ER Phone #
- Crew
Patient Data
- Name
- Age
- Gender
- Interventions
- Vitals -BP, RR, SPO2, ETCO2, GCS, Glucose
Device Data
- 12 Lead graph
- 12 Lead Interpretation
- Vitals
- Vital Trends
- Measurements
Bluetooth
WiFi
"Mercury" Com
"Pelican"
Mobile Software
Mobile "Asset Management"
Data Receive, Relay, Integration, Storage, and Display Services
Mobile Computer Display
- View Selector
- Protocol Docs View
- Patch Data View
- ePCR Data View
- Navigator View
- Device Data View
Medic
WiFi
Cellular
Pt to Pt AES Encryption
Network Communications
- encrypted
- secure
- asynchronous
- guaranteed delivery
Back Office Software
Data Relay, Storage, and Website Services
Enterprise "Asset Management"
SSL
BOA 1.0 Boundary
Browser Services
Website Display
- Vehicle Selector
- View Selector
- Device Data View
- ePCR Data View
- Navigator Data View
- Patch Data View
Secure Login
Healthcare Professional

FIG. 19

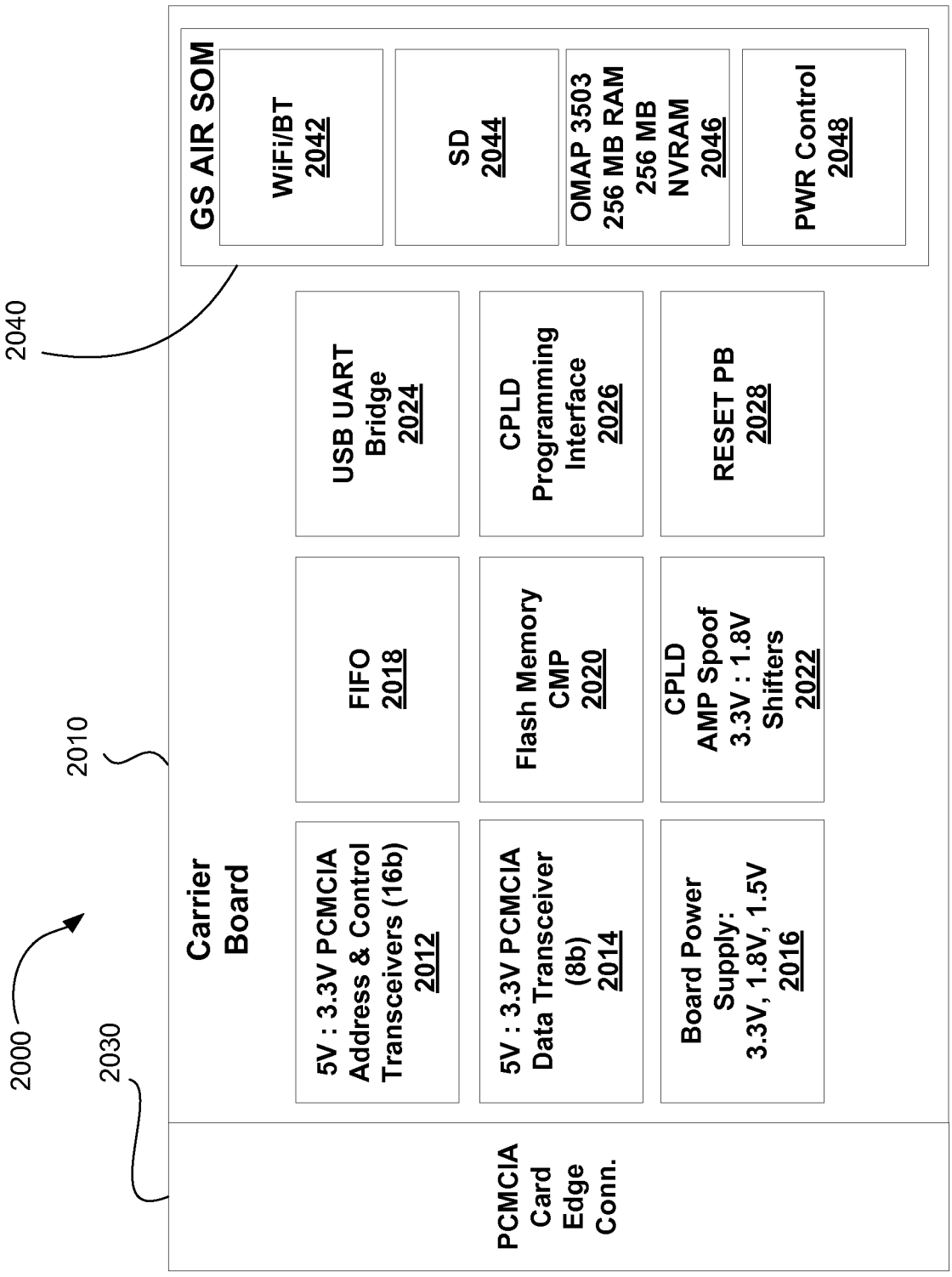

2000
2030
2010
2040
PCMCIA Card Edge Conn.
Carrier Board
5V : 3.3V PCMCIA Address & Control Transceivers (16b) 2012
5V : 3.3V PCMCIA Data Transceiver (8b) 2014
Board Power Supply: 3.3V, 1.8V, 1.5V 2016
FIFO 2018
Flash Memory CMP 2020
CPLD AMP Spoof 3.3V : 1.8V Shifters 2022
USB UART Bridge 2024
CPLD Programming Interface 2026
RESET PB 2028
GS AIR SOM
WiFi/BT 2042
SD 2044
OMAP 3503 256 MB RAM 256 MB NVRAM 2046
PWR Control 2048

FIG. 20

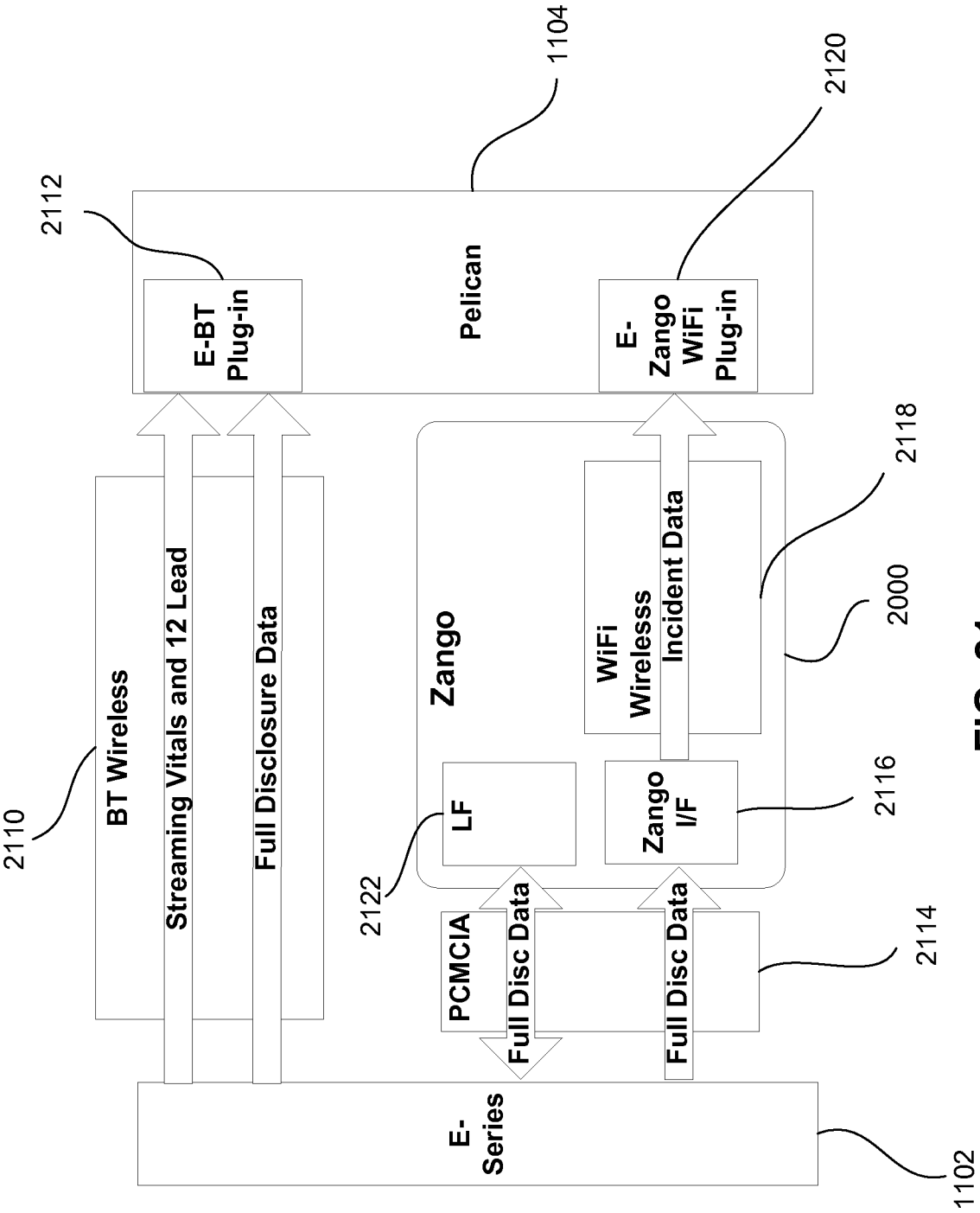

2110
BT Wireless
Streaming Vitals and 12 Lead
Full Disclosure Data
2112
E-BT Plug-in
1104
Pelican
2120
E- Zango WiFi Plug-in
2118
2000
Zango
WiFi Wirelesss
Incident Data
2122
LF
Zango I/F
2116
PCMCIA
Full Disc Data
Full Disc Data
2114
E- Series
1102

FIG. 21

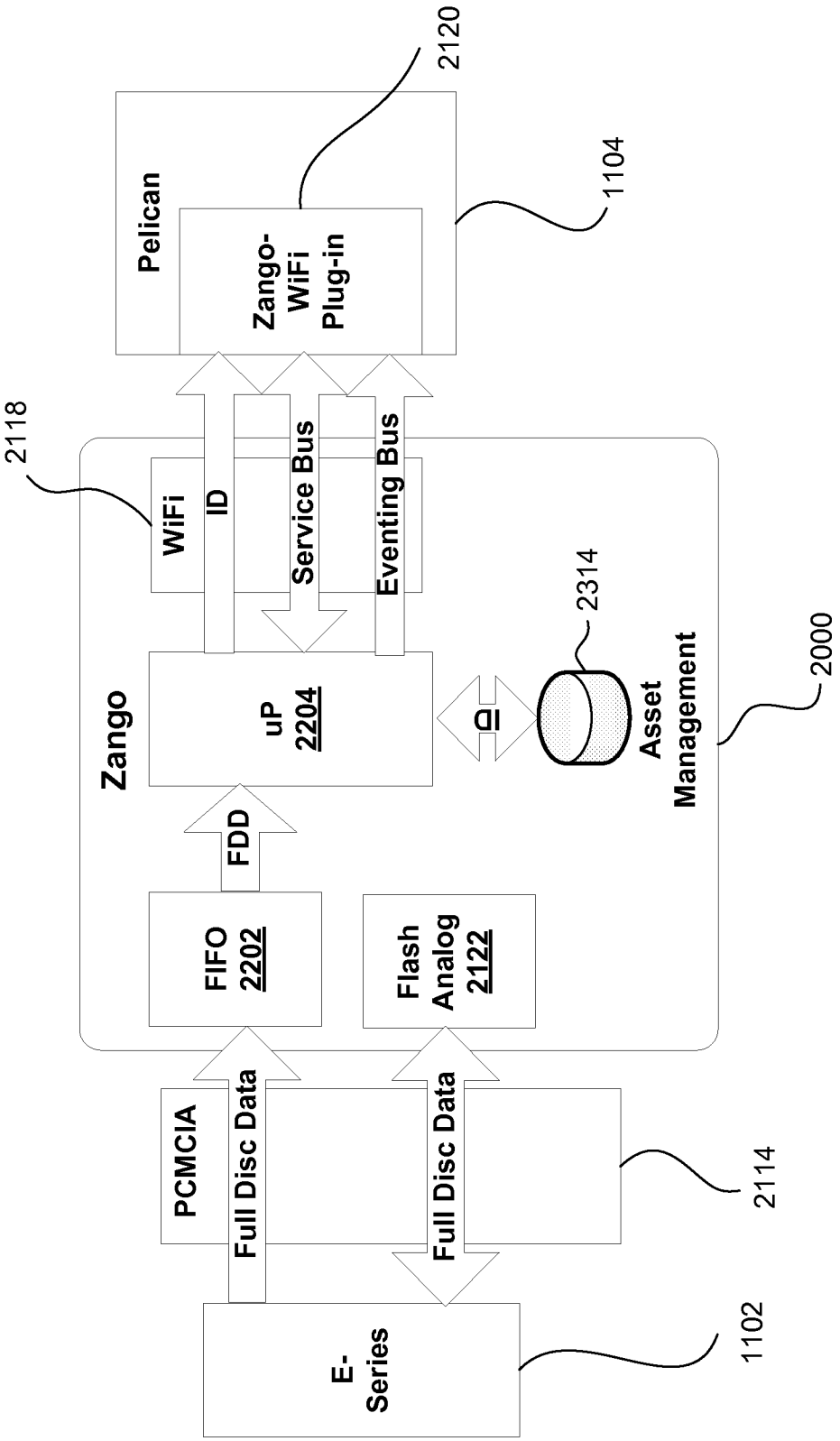

2120
Pelican
Zango-
WiFi
Plug-in
1104
2118
WiFi
ID
Service Bus
Eventing Bus
2314
Zango
uP
2204
ID
Asset
Management
2000
FDD
FIFO
2202
Flash
Analog
2122
PCMCIA
Full Disc Data
Full Disc Data
2114
E-
Series
1102

FIG. 22

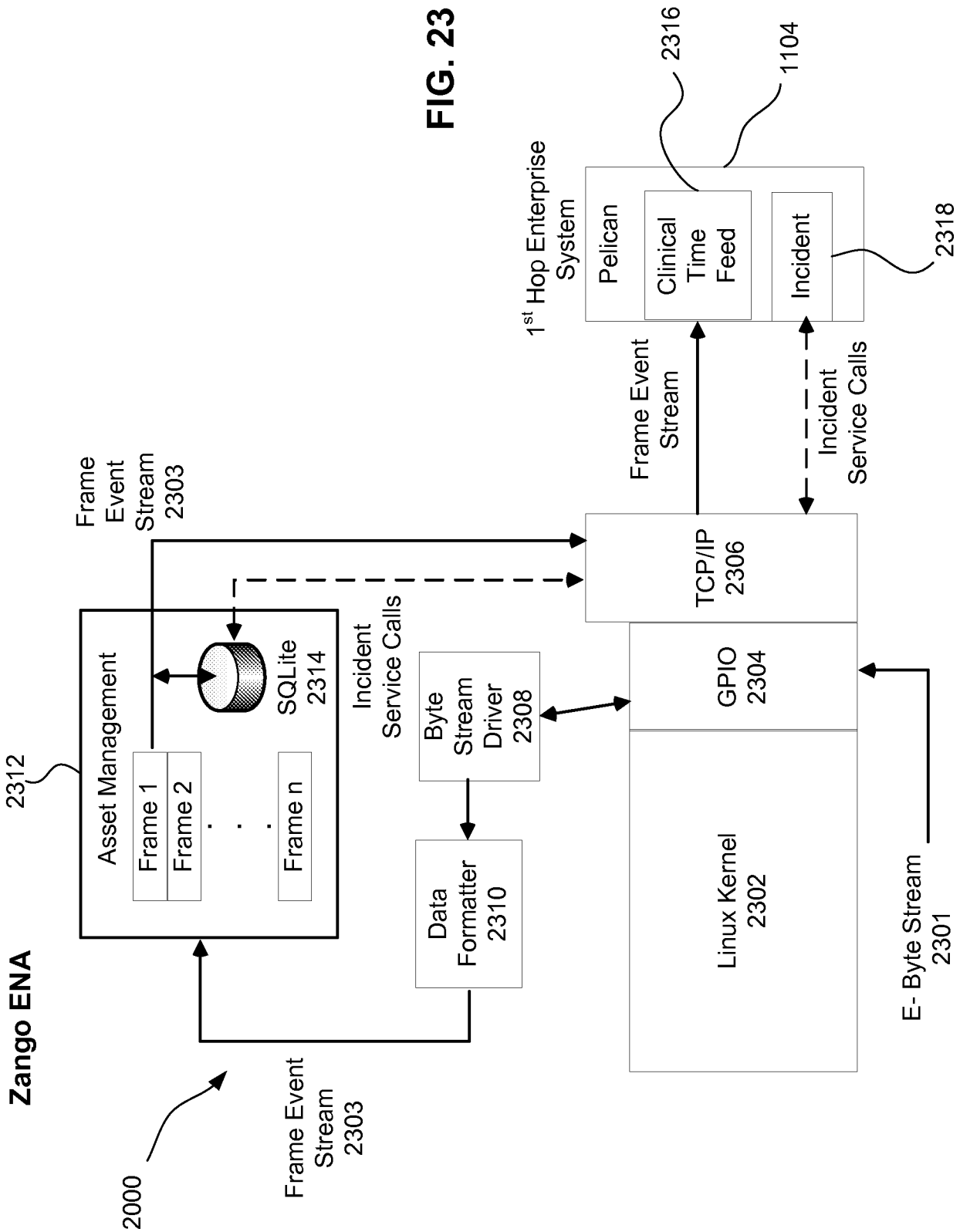

Zango ENA
2000
Frame Event Stream 2303
2312
Asset Management
Frame 1
Frame 2
Frame n
SQLite 2314
Frame Event Stream 2303
Incident Service Calls
Byte Stream Driver 2308
Data Formatter 2310
TCP/IP 2306
GPIO 2304
Linux Kernel 2302
E- Byte Stream 2301
Frame Event Stream
Incident Service Calls
1st Hop Enterprise System
Pelican
Clinical Time Feed
Incident
2316
1104
2318

FIG. 23

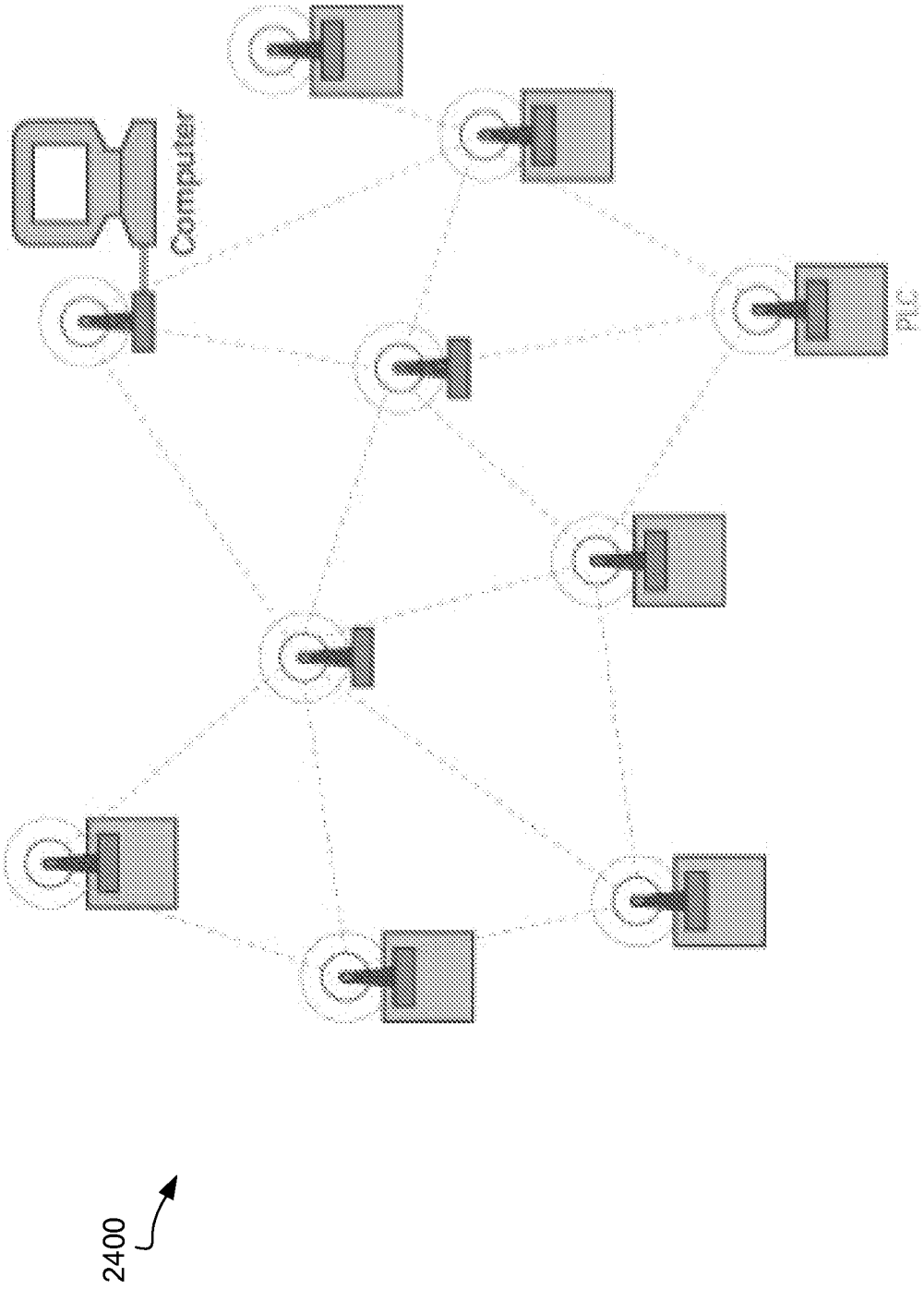


FIG. 24

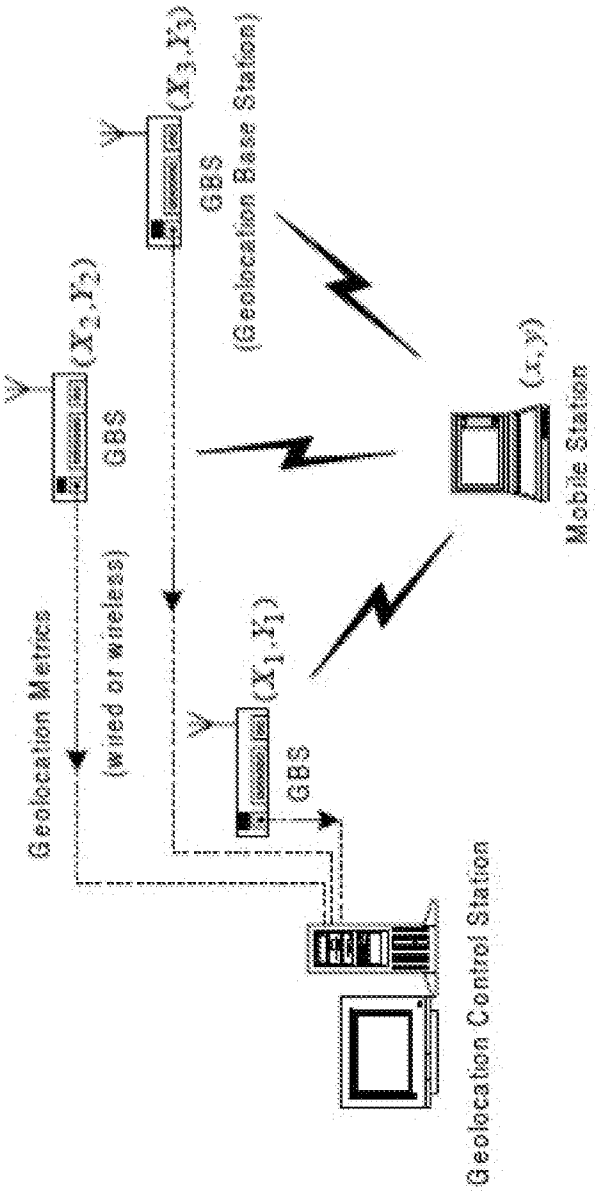


FIG. 25 Overall architecture of indoor geolocation system.

Differential Diagnosis of Acute Dyspnea in Adults

Cardiac: congestive heart failure, coronary artery disease, arrhythmia, pericarditis, acute myocardial infarction, anemia

Pulmonary: chronic obstructive pulmonary disease, asthma, pneumonia, pneumothorax, pulmonary embolism, pleural effusion, metastatic disease, pulmonary edema, gastroesophageal reflux disease with aspiration, restrictive lung disease

Psychogenic: panic attacks, hyperventilation, pain, anxiety

Upper airway obstruction: epiglottitis, foreign body, croup, Epstein-Barr virus

Endocrine: metabolic acidosis, medications

Central: neuromuscular disorders, pain, aspirin overdose

Pediatric: bronchiolitis, croup, epiglottitis, foreign body aspiration, myocarditis

FIG. 26

391929

PATENT
REEL: 042387 FRAME: 0602

Clues to the Diagnosis of Dyspnea

Symptoms or features in the history	*Possible diagnosis*
Cough	Asthma, pneumonia
Severe sore throat	Epiglottitis
Pleuritic chest pain	Pericarditis, pulmonary embolism, pneumothorax, pneumonia
Orthopnea, nocturnal paroxysmal dyspnea, edema	Congestive heart failure
Tobacco use	Chronic obstructive pulmonary disease, congestive heart failure, pulmonary embolism
Indigestion, dysphagia	Gastroesophageal reflux disease, aspiration
Barking cough	Croup

FIG. 27

Physical Examination Findings in the Diagnosis of Acute Dyspnea

Findings	*Possible diagnosis*
Wheezing, pulsus paradoxus, accessory muscle use	Acute asthma, COPD exacerbation
Wheezing, clubbing, barrel chest, decreased breath sounds	COPD exacerbation
Fever, crackles, increased fremitus	Pneumonia
Edema, neck vein distension, S_3 or S_4 hepatojugular reflux, murmurs, rales, hypertension, wheezing	Congestive heart failure, pulmonary edema
Wheezing, friction rub, lower extremity swelling	Pulmonary embolism
Absent breath sounds, hyperresonance	Pneumothorax
Inspiratory stridor, rhonchi, retractions	Croup
Stridor, drooling, fever	Epiglottitis
Stridor, wheezing, persistent pneumonia	Foreign body aspiration
Wheezing, flaring, intercostal retractions, apnea	Bronchiolitis
Sighing	Hyperventilation

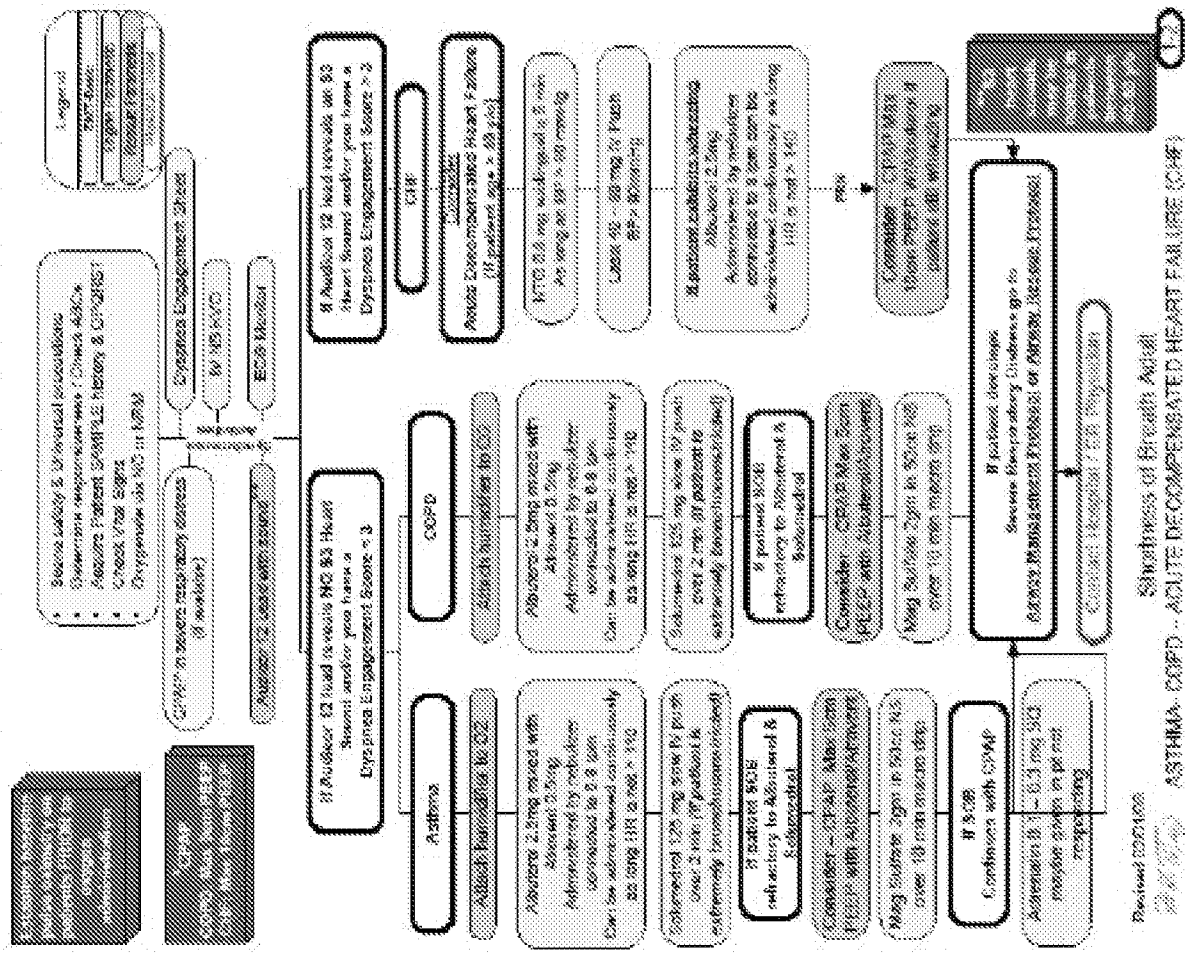
COPD = chronic obstructive pulmonary disease.

FIG. 28

391929

PATENT
REEL: 042387 FRAME: 0603

FIG. 29


Collier County Common Medical Protocol
ASTHMA - COPD – ACUTE DECOMPENSATED HEART FAILURE (CHF)
Legend
Shortness of Breath Adult
ASTHMA - COPD – ACUTE DECOMPENSATED HEART FAILURE (CHF)

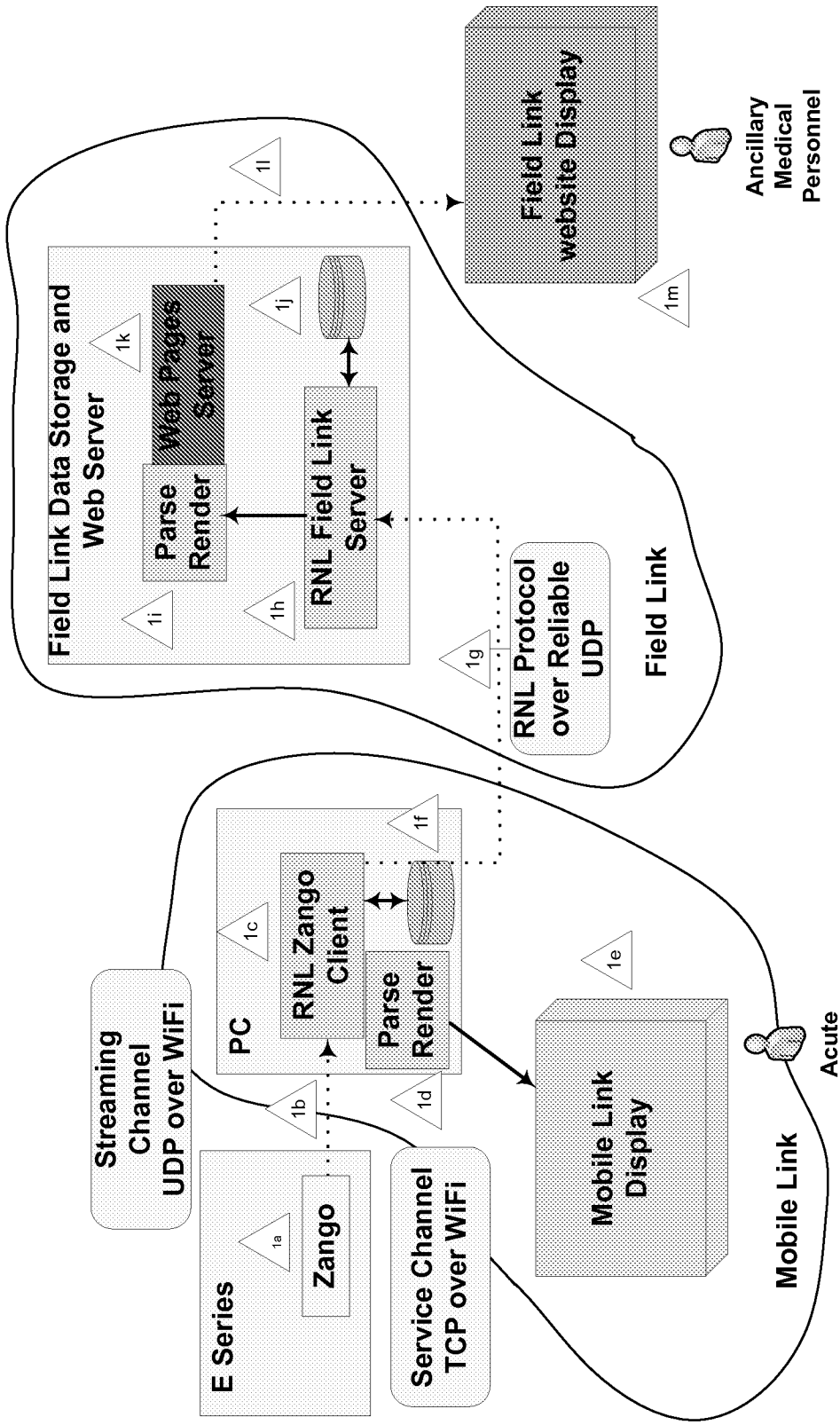

Field Link Data Storage and Web Server
Web Pages Server
Parse Render
RNL Field Link Server
Field Link website Display
Ancillary Medical Personnel
Field Link
RNL Protocol over Reliable UDP
PC
RNL Zango Client
Parse Render
Streaming Channel UDP over WiFi
E Series
Zango
Service Channel TCP over WiFi
Mobile Link Display
Mobile Link
Acute Medical Personnel
1a
1b
1c
1d
1e
1f
1g
1h
1i
1j
1k
1l
1m

FIG. 30

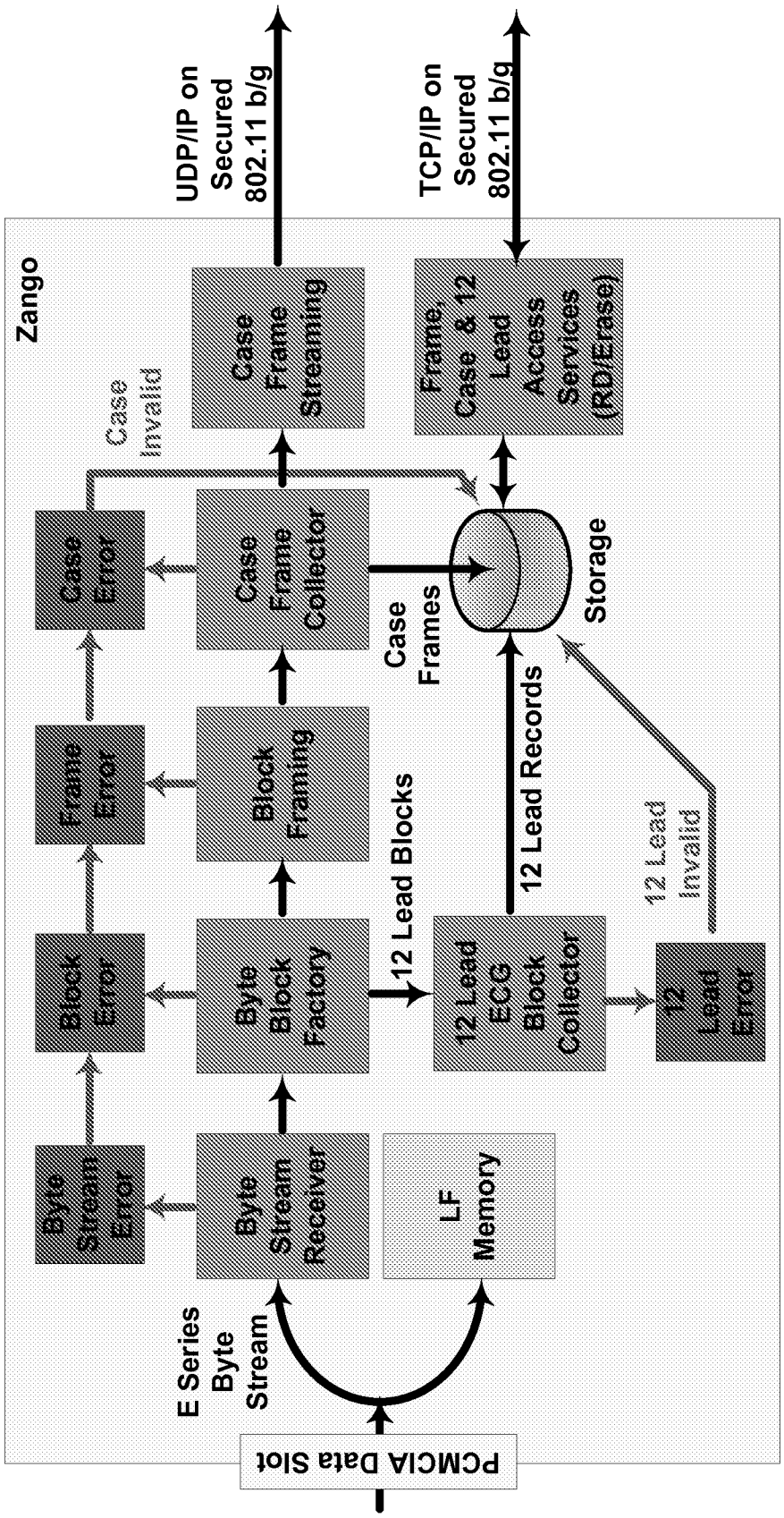

Zango
PCMCIA Data Slot
E Series Byte Stream
Byte Stream Receiver
LF Memory
Byte Stream Error
Block Error
Frame Error
Case Error
Byte Block Factory
Block Framing
Case Frame Collector
12 Lead Blocks
12 Lead ECG Block Collector
12 Lead Error
12 Lead Records
12 Lead Invalid
Case Frames
Storage
Case Invalid
Case Frame Streaming
Frame, Case & 12 Lead Access Services (RD/Erase)
UDP/IP on Secured 802.11 b/g
TCP/IP on Secured 802.11 b/g

FIG. 31

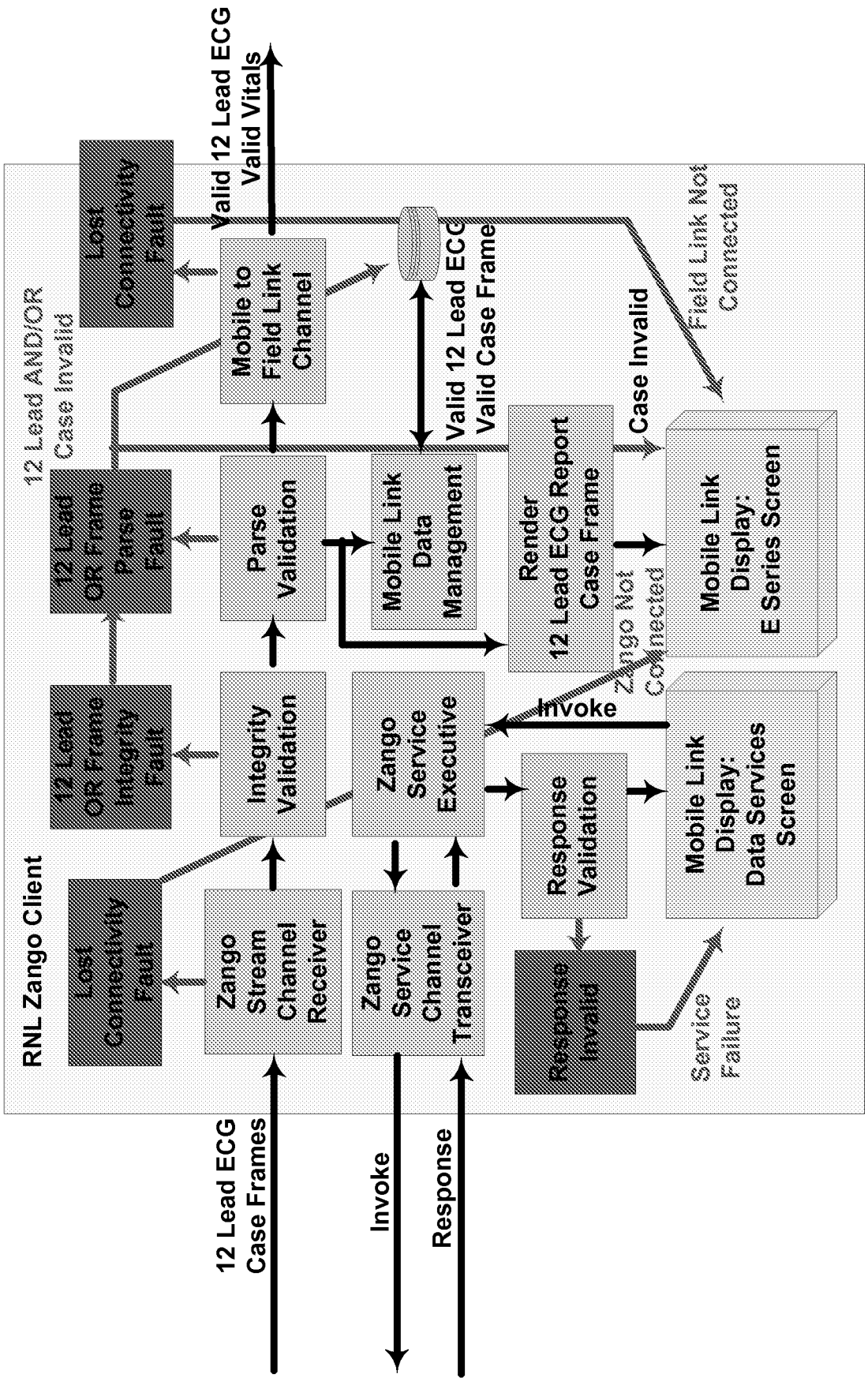

RNL Zango Client
12 Lead AND/OR Case Invalid
Lost Connectivity Fault
Zango Stream Channel Receiver
Zango Service Channel Transceiver
12 Lead ECG Case Frames
Invoke
Response
12 Lead OR Frame Integrity Fault
Integrity Validation
Zango Service Executive
Response Validation
Response Invalid
Service Failure
12 Lead OR Frame Parse Fault
Parse Validation
Mobile Link Data Management
Render 12 Lead ECG Report Case Frame
Zango Not Connected
Invoke
Case Invalid
Mobile Link Display: Data Services Screen
Mobile Link Display: E Series Screen
Mobile to Field Link Channel
Valid 12 Lead ECG Valid Case Frame
Field Link Not Connected
Lost Connectivity Fault
Valid 12 Lead ECG Valid Vitals

FIG. 32

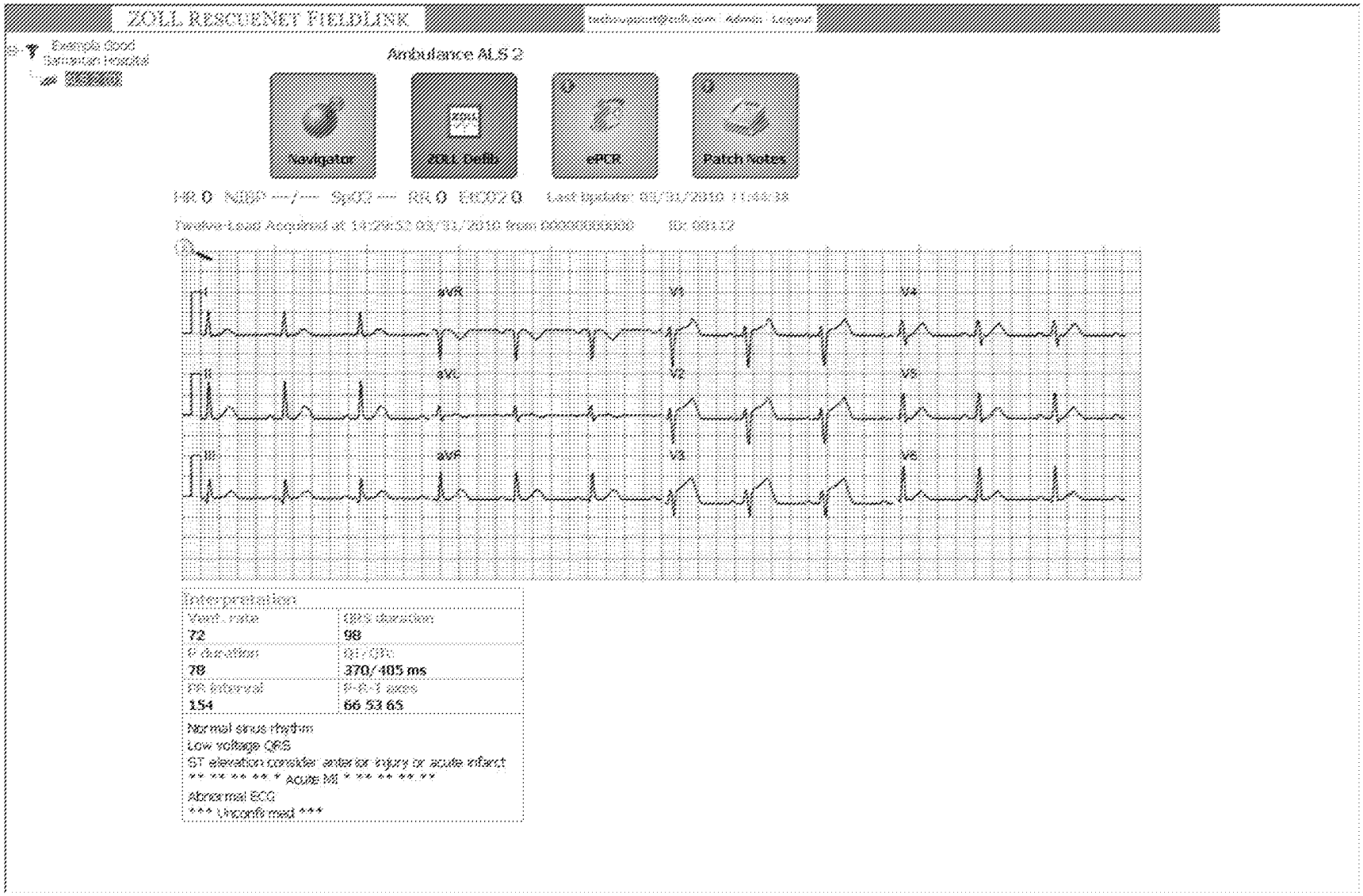

ZOLL RESCUENET FIELDLINK
Ambulance ALS 2
Navigator
ZOLL Defib
ePCR
Patch Notes
Interpretation
Vent. rate
72
QRS duration
98
P duration
78
QT/QTc
370/405 ms
PR interval
154
P-R-T axes
66 53 65
Normal sinus rhythm
Low voltage QRS
ST elevation consider anterior injury or acute infarct
** ** ** ** * Acute MI * ** ** ** **
Abnormal ECG
*** Unconfirmed ***

FIG. 33

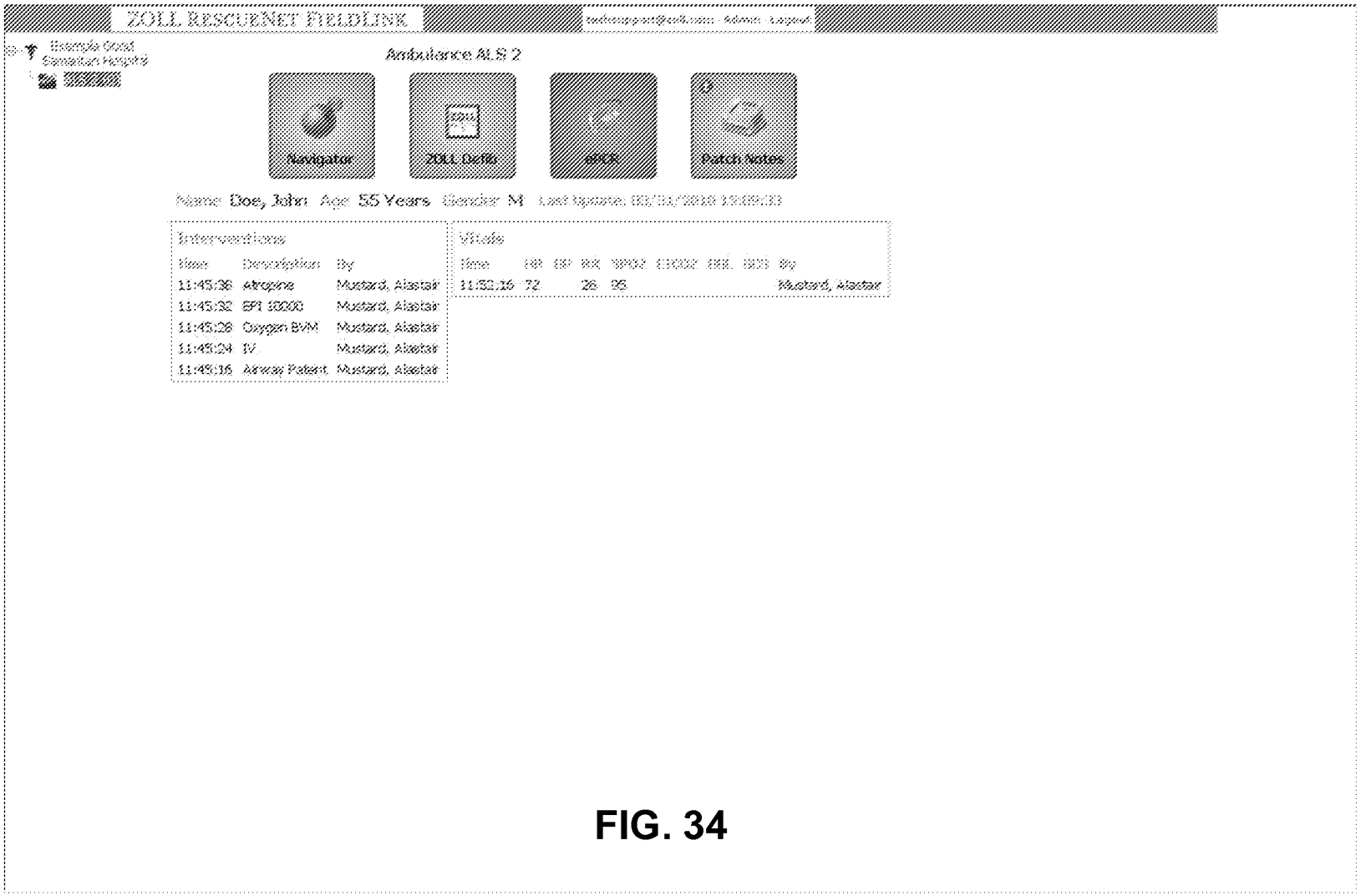

ZOLL RESCUENET FIELDLINK
Ambulance ALS 2
Navigator
ZOLL Defib
ePCR
Patch Notes
Name Doe, John Age 55 Years Gender M
Interventions
Time Description By
11:45:36 Atropine Mustard, Alastair
11:45:32 EPI 10000 Mustard, Alastair
11:45:28 Oxygen BVM Mustard, Alastair
11:45:24 IV Mustard, Alastair
11:45:16 Airway Patent Mustard, Alastair
Vitals
Time HR BP RR SPO2 ETCO2 BBL BO3 By
11:52:16 72 26 95 Mustard, Alastair

FIG. 34

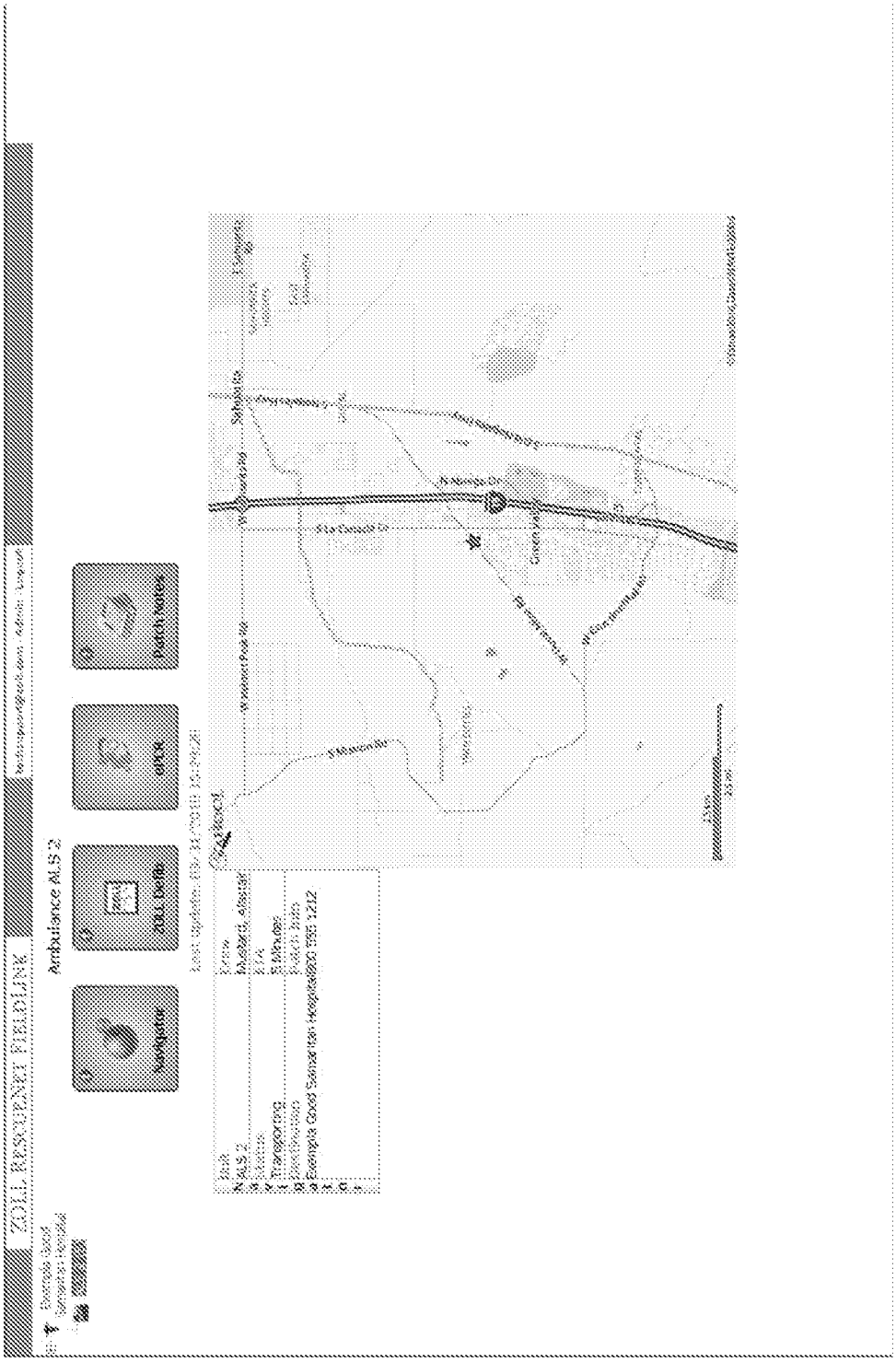

ZOLL RESCUENET FIELDLINK
Ambulance ALS 2
Navigator
ZOLL Defib
ePCR
Patch Notes

FIG. 35

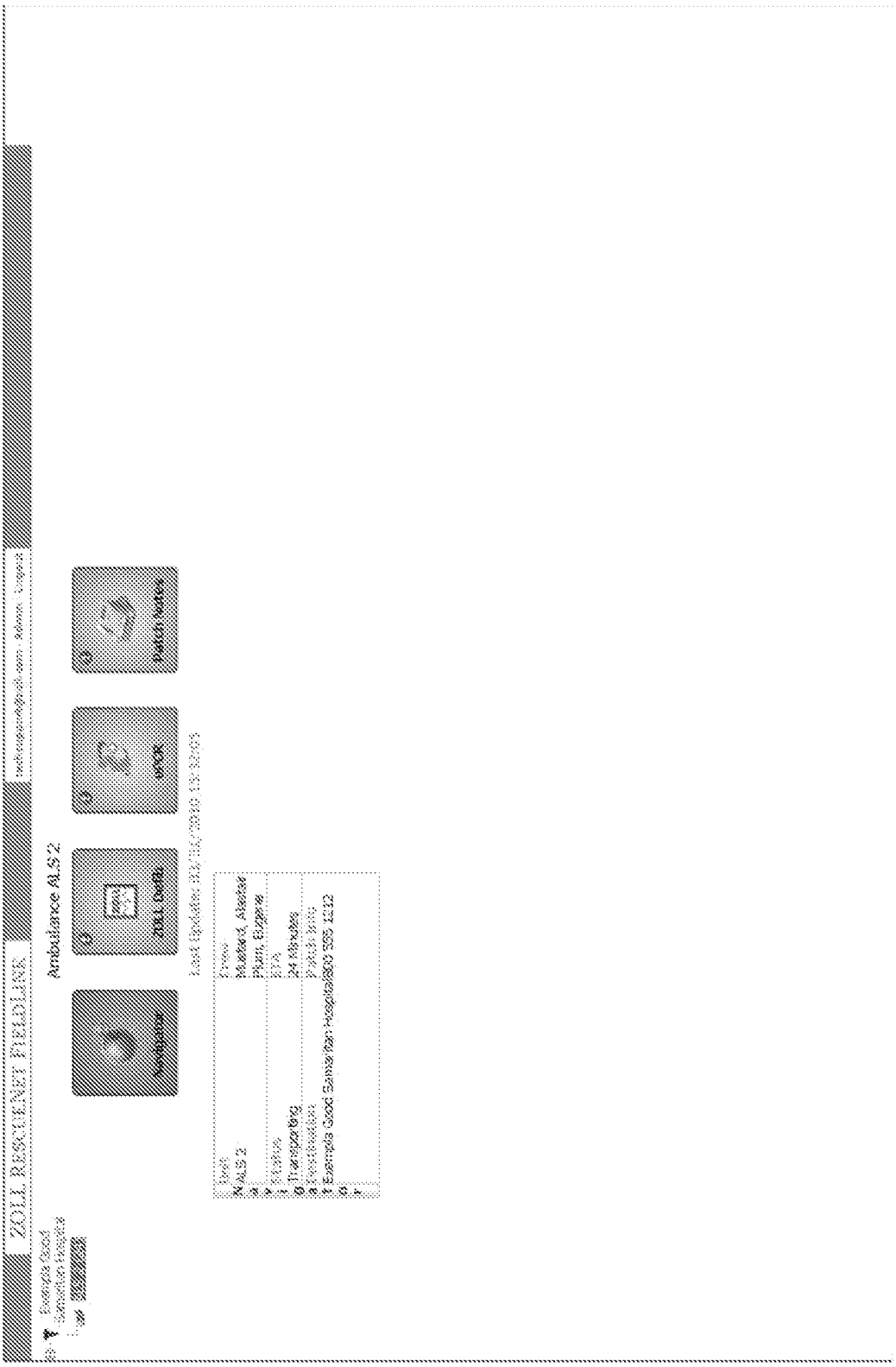

ZOLL RESCUENET FIELDLINK
Ambulance ALS 2
Navigator
ZOLL Defib
uPCR
Patch Notes

FIG. 36

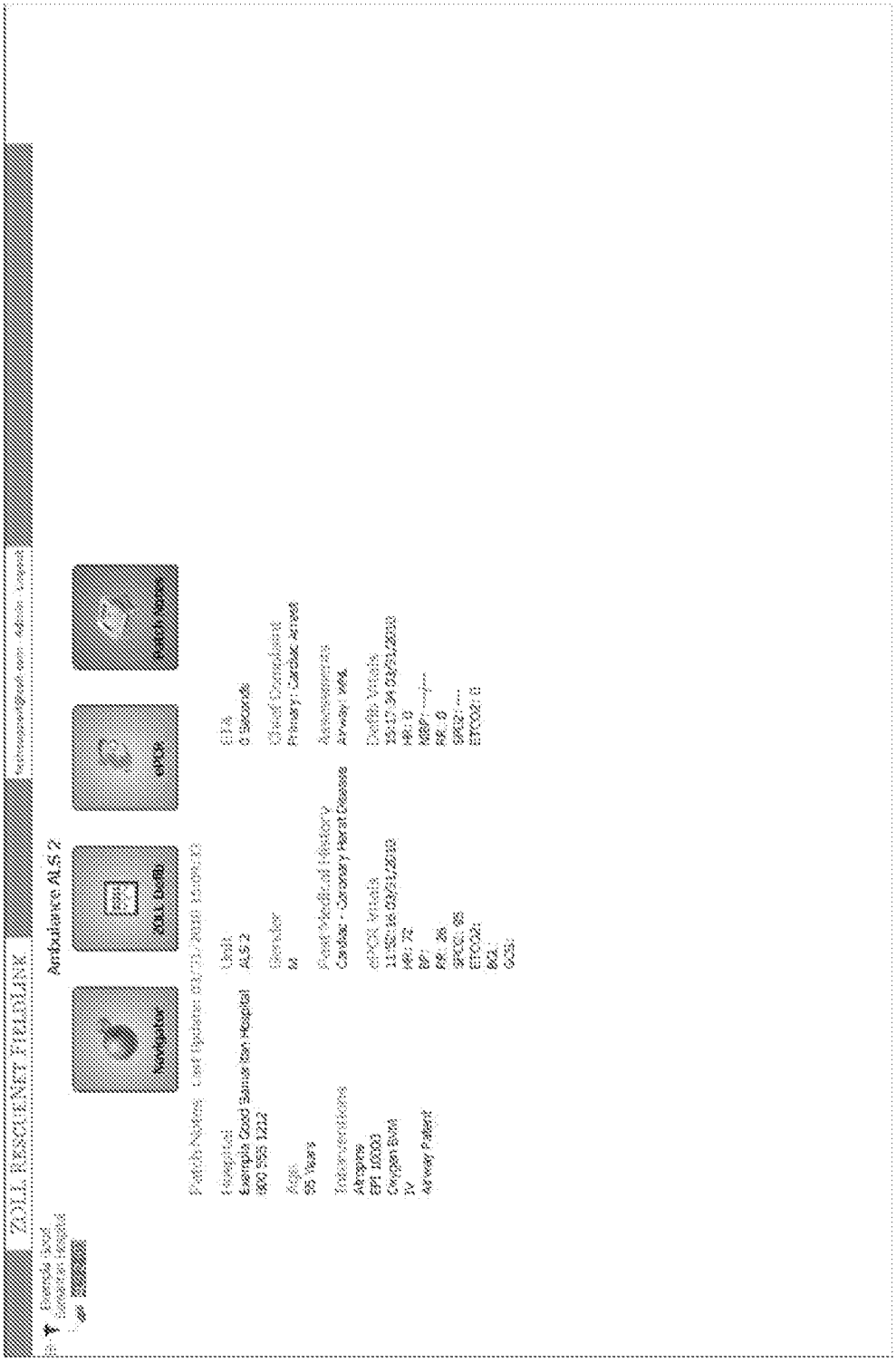

ZOLL RESCUENET FIELDLINK
Ambulance ALS 2
Navigator
ZOLL Defib
ePCR
Patch Notes
Hospital
Example Good Samaritan Hospital
800 555 1212
Age
95 Years
Interventions
Atropine
EPI 10000
Oxygen BVM
IV
Airway Patent
Unit
ALS 2
Gender
M
Fixed Medical History
Cardiac - Coronary Heart Disease
ePCR Vitals
11:52:16 03/31/2010
HR: 72
BP:
RR: 26
SPO2: 95
ETCO2:
BG:
GCS:
ETA
0 Seconds
Chief Complaint
Primary: Cardiac Arrest
Assessments
Airway: WNL
Defib Vitals
15:17:34 03/31/2010
HR: 0
MBP: ---/---
RR: 0
SPO2: ---
ETCO2: 0

FIG. 37

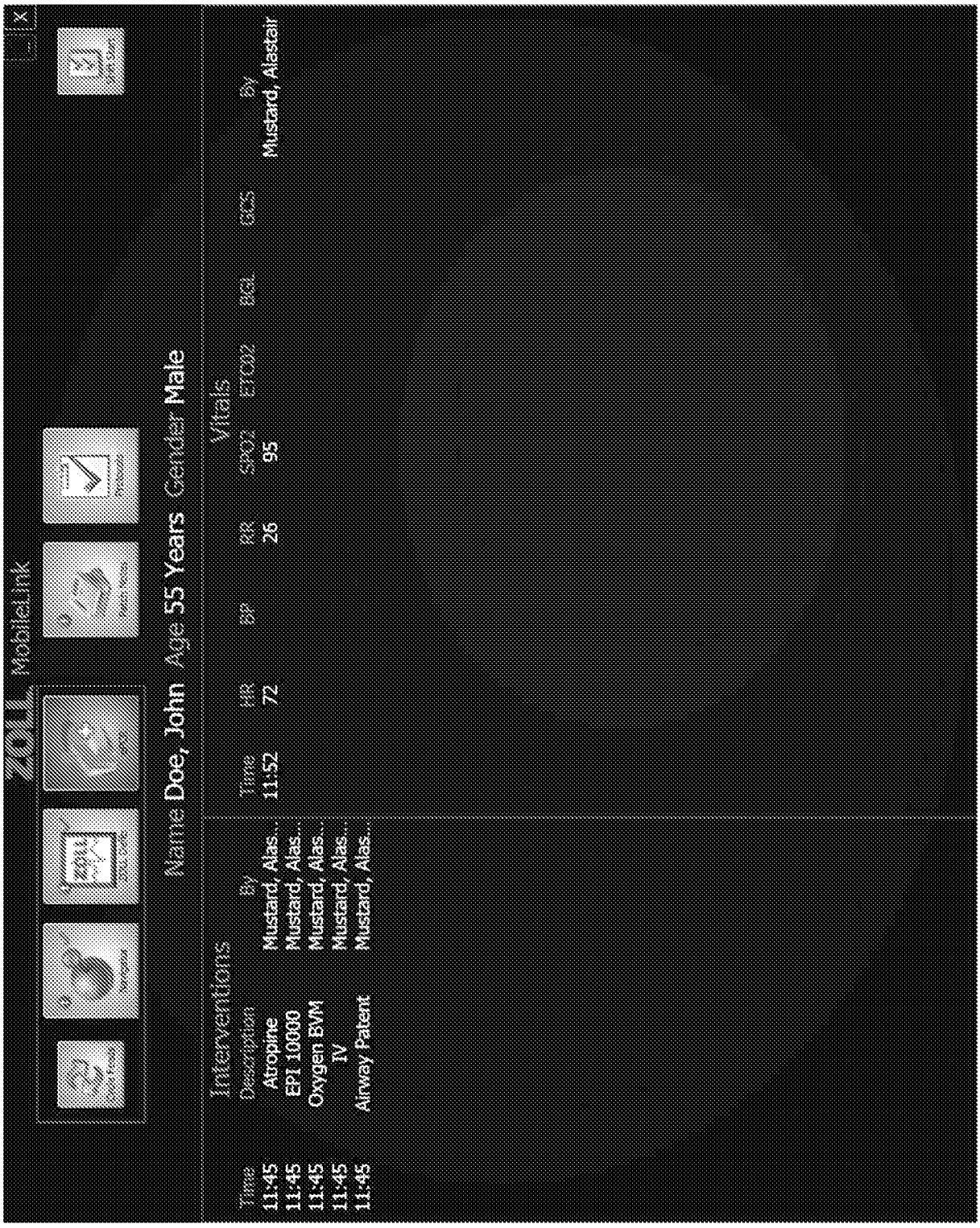

MobileLink
Name Doe, John Age 55 Years Gender Male
Interventions
Time Description By
11:45 Atropine Mustard, Alas...
11:45 EPI 10000 Mustard, Alas...
11:45 Oxygen BVM Mustard, Alas...
11:45 IV Mustard, Alas...
11:45 Airway Patent Mustard, Alas...
Vitals
Time HR BP RR SPO2 ETCO2 BGL GCS By
11:52 72 26 95 Mustard, Alastair

FIG. 38

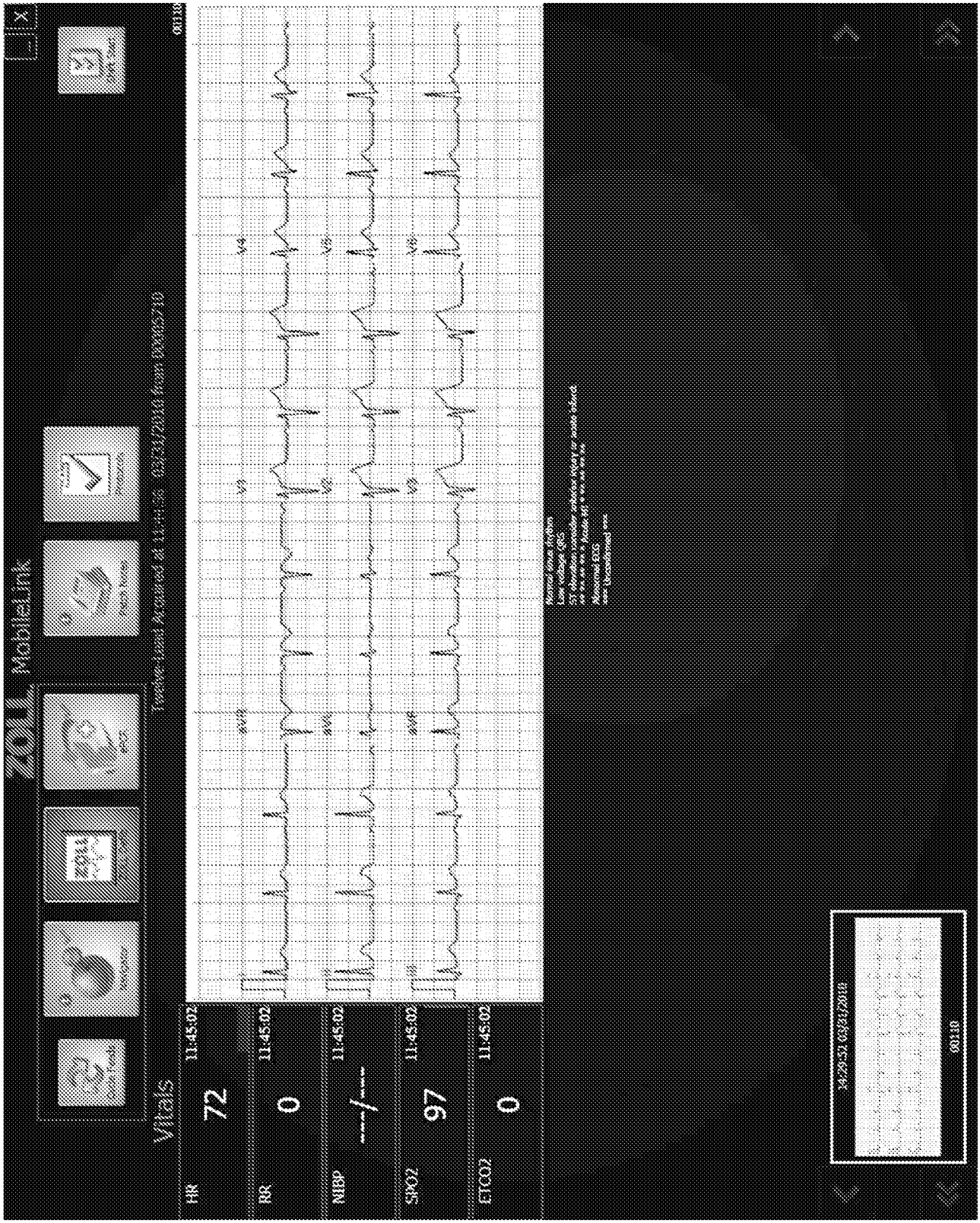

ZOLL MobileLink
Vitals
HR
72
11:45:02
RR
0
11:45:02
NIBP
---/---
11:45:02
SPO2
97
11:45:02
ETCO2
0
11:45:02

FIG. 39

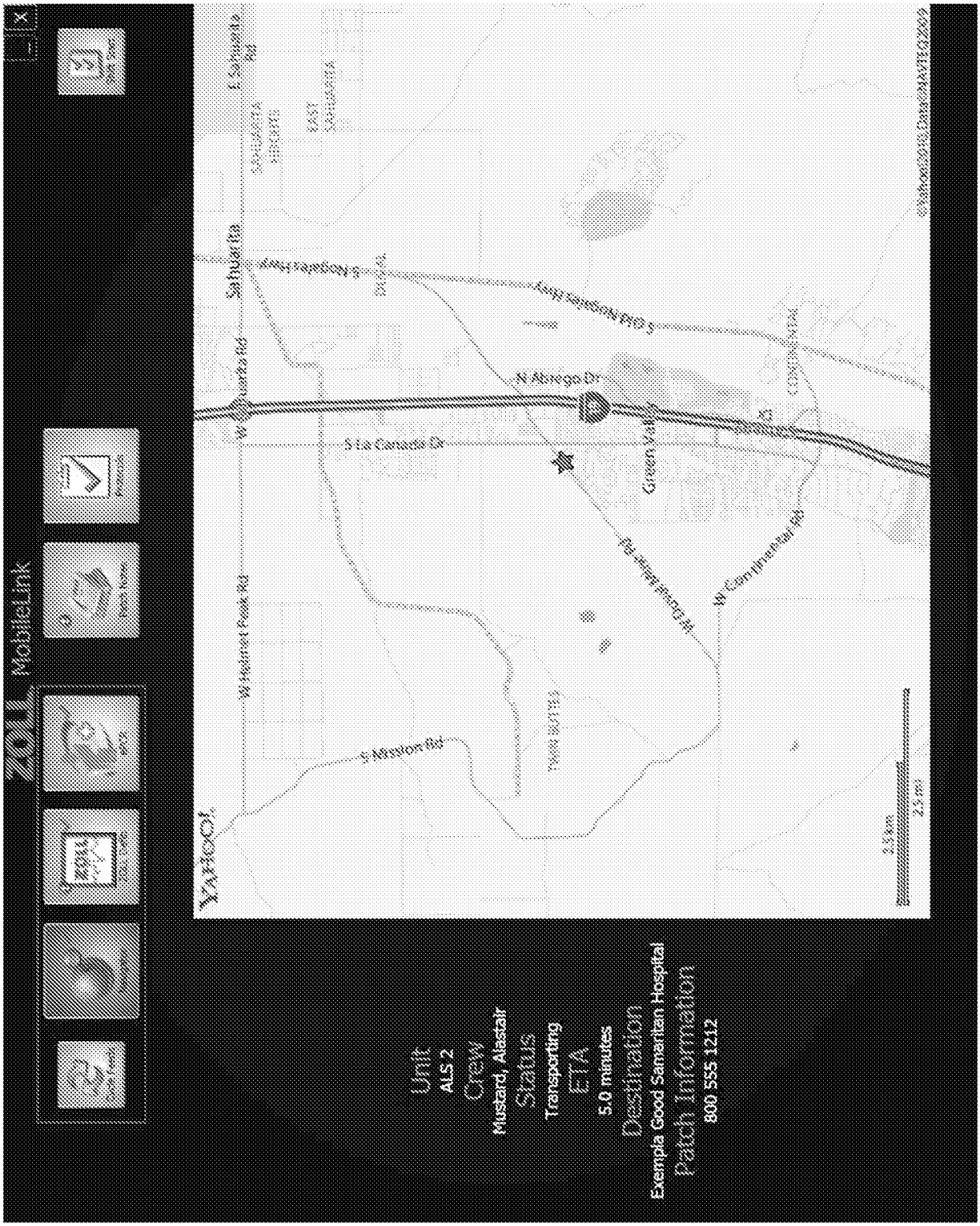

MobileLink
Unit
ALS 2
Crew
Mustard, Alastair
Status
Transporting
ETA
5.0 minutes
Destination
Exempla Good Samaritan Hospital
Patch Information
800 555 1212
Sahuarita
N Abrego Dr
S La Canada Dr
Green Valley
W Helmet Peak Rd
S Mission Rd
W Continental Rd
S Old Nogales Hwy
E Sahuarita Rd
YAHOO!

FIG. 40

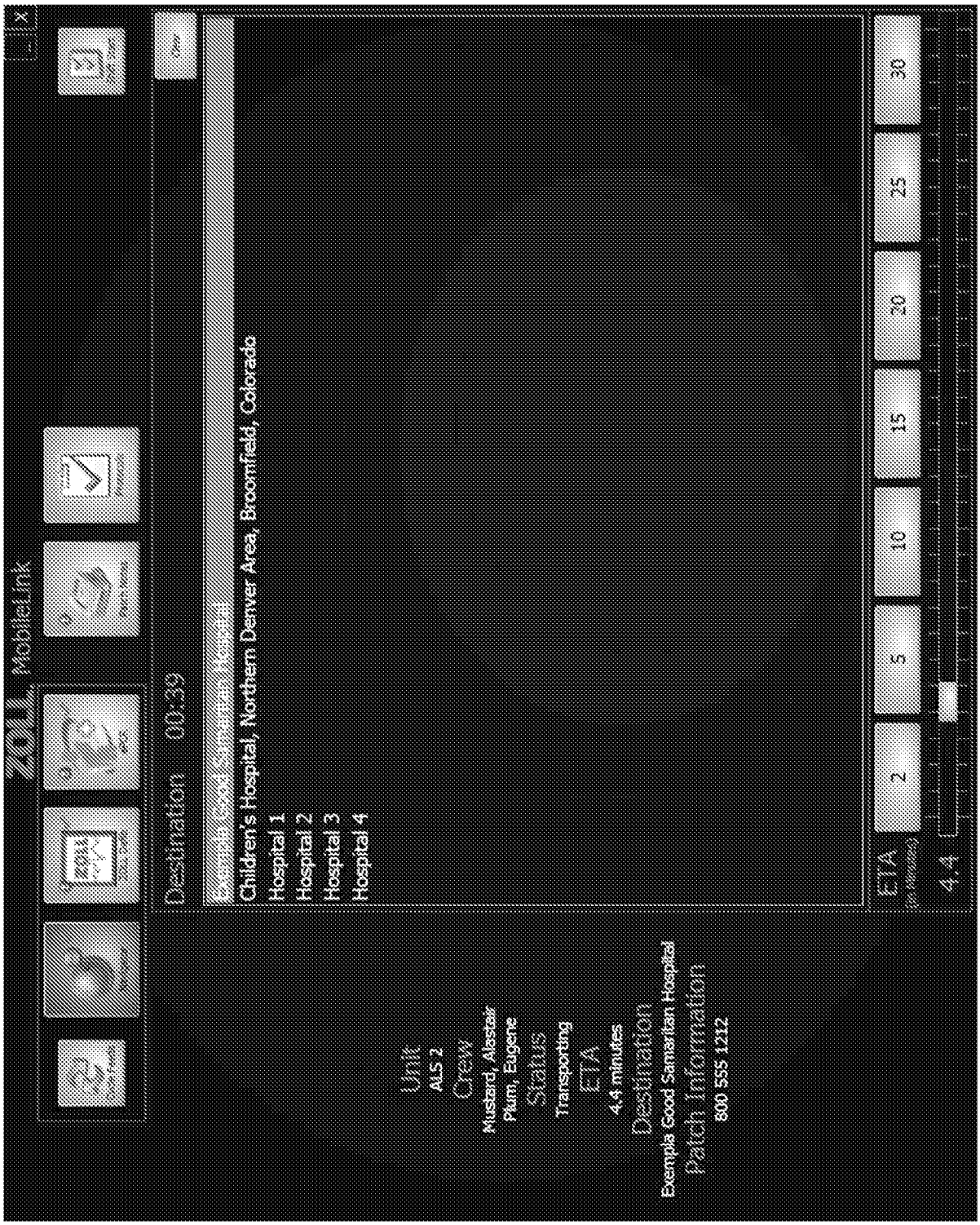

ZOLL MobileLink
Destination 00:39
Children's Hospital, Northern Denver Area, Broomfield, Colorado
Hospital 1
Hospital 2
Hospital 3
Hospital 4
Unit
ALS 2
Crew
Mustard, Alastair
Plum, Eugene
Status
Transporting
ETA
4.4 minutes
Destination
Exemplia Good Samaritan Hospital
Patch Information
800 555 1212
ETA
2
5
10
15
20
25
30
4.4

FIG. 41

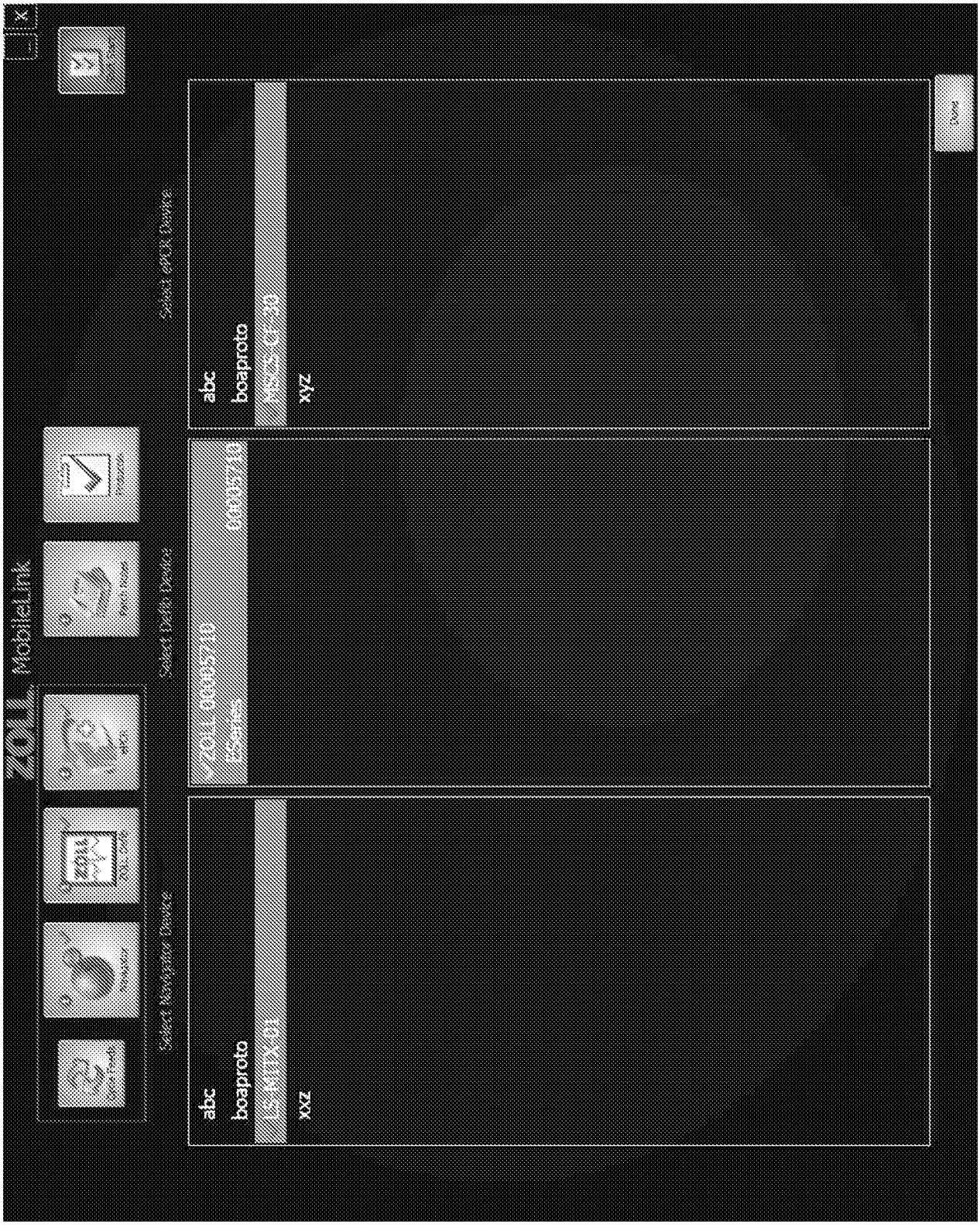

MobileLink
Select Navigator Device
Select Delta Device
Select ePCR Device
abc
boaproto
xxz
abc
boaproto
xyz

FIG. 42

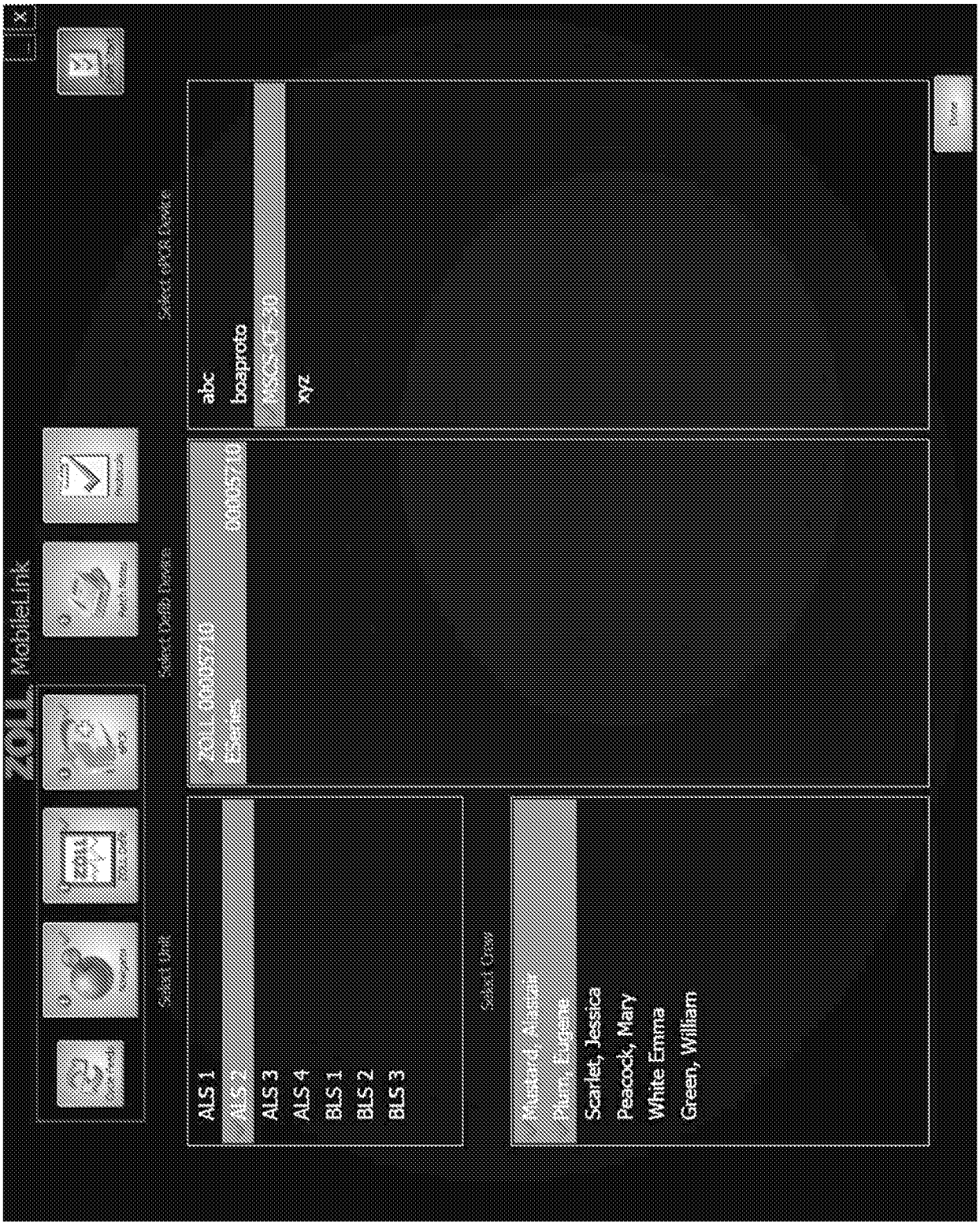

MobileLink
Select Unit
ALS 1
ALS 2
ALS 3
ALS 4
BLS 1
BLS 2
BLS 3
Select Crew
Mustard, Alastair
Plum, Eugene
Scarlet, Jessica
Peacock, Mary
White Emma
Green, William
Select Radio Device
ZOLL 00005710
ESeries
00005710
Select ePCR Device
abc
boaproto
xyz

FIG. 43

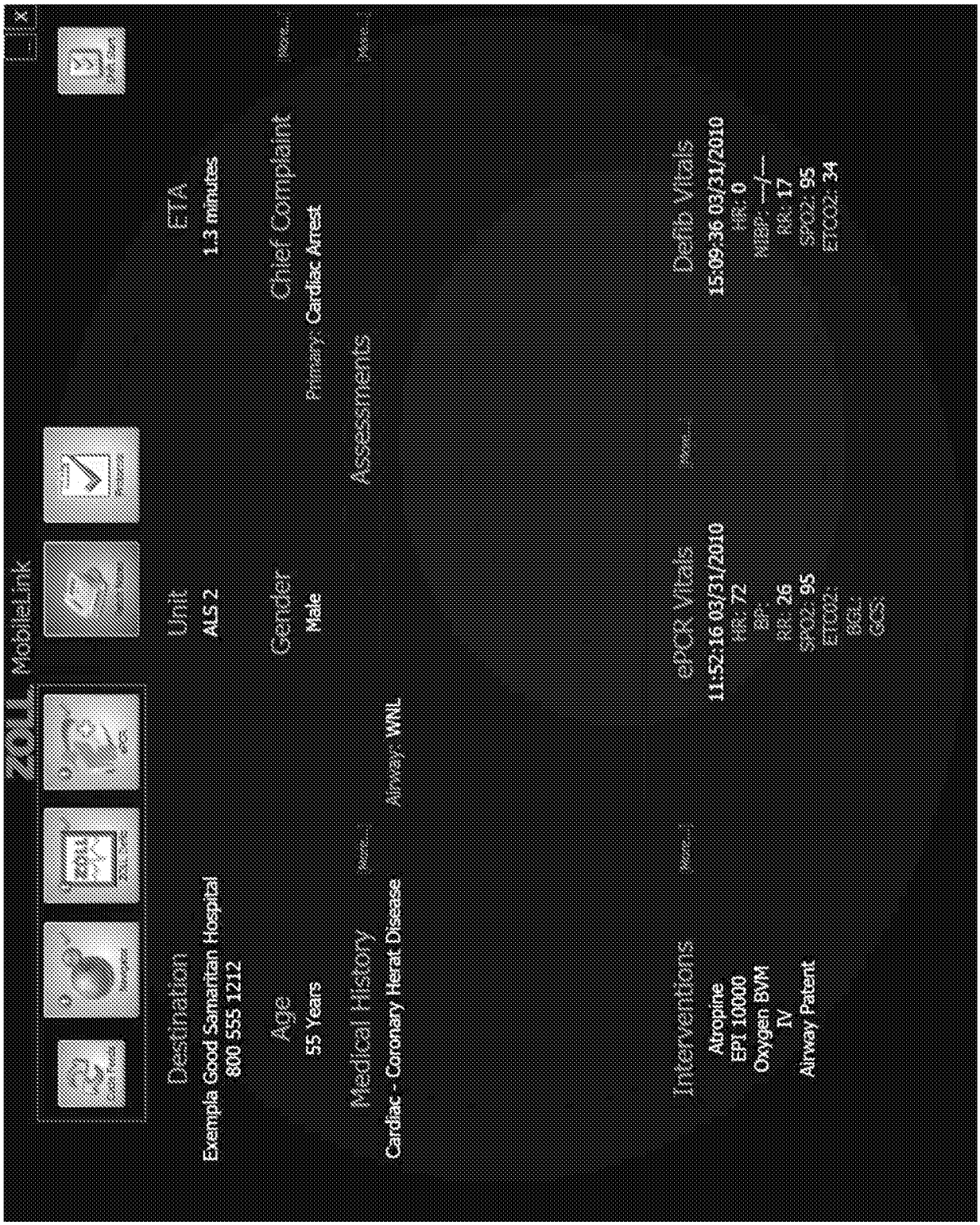

MobileLink
Destination
Exempla Good Samaritan Hospital
800 555 1212
Unit
ALS 2
ETA
1.3 minutes
Age
55 Years
Gender
Male
Chief Complaint
Primary: Cardiac Arrest
Medical History
Cardiac - Coronary Herat Disease
Airway: WNL
Assessments
Interventions
Atropine
EPI 10000
Oxygen BVM
IV
Airway Patent
ePCR Vitals
11:52:16 03/31/2010
HR: 72
BP:
RR: 26
SPO2: 95
ETCO2:
BGL:
GCS:
Defib Vitals
15:09:36 03/31/2010
HR: 0
MAP: —/—
RR: 17
SPO2: 95
ETCO2: 34

FIG. 44

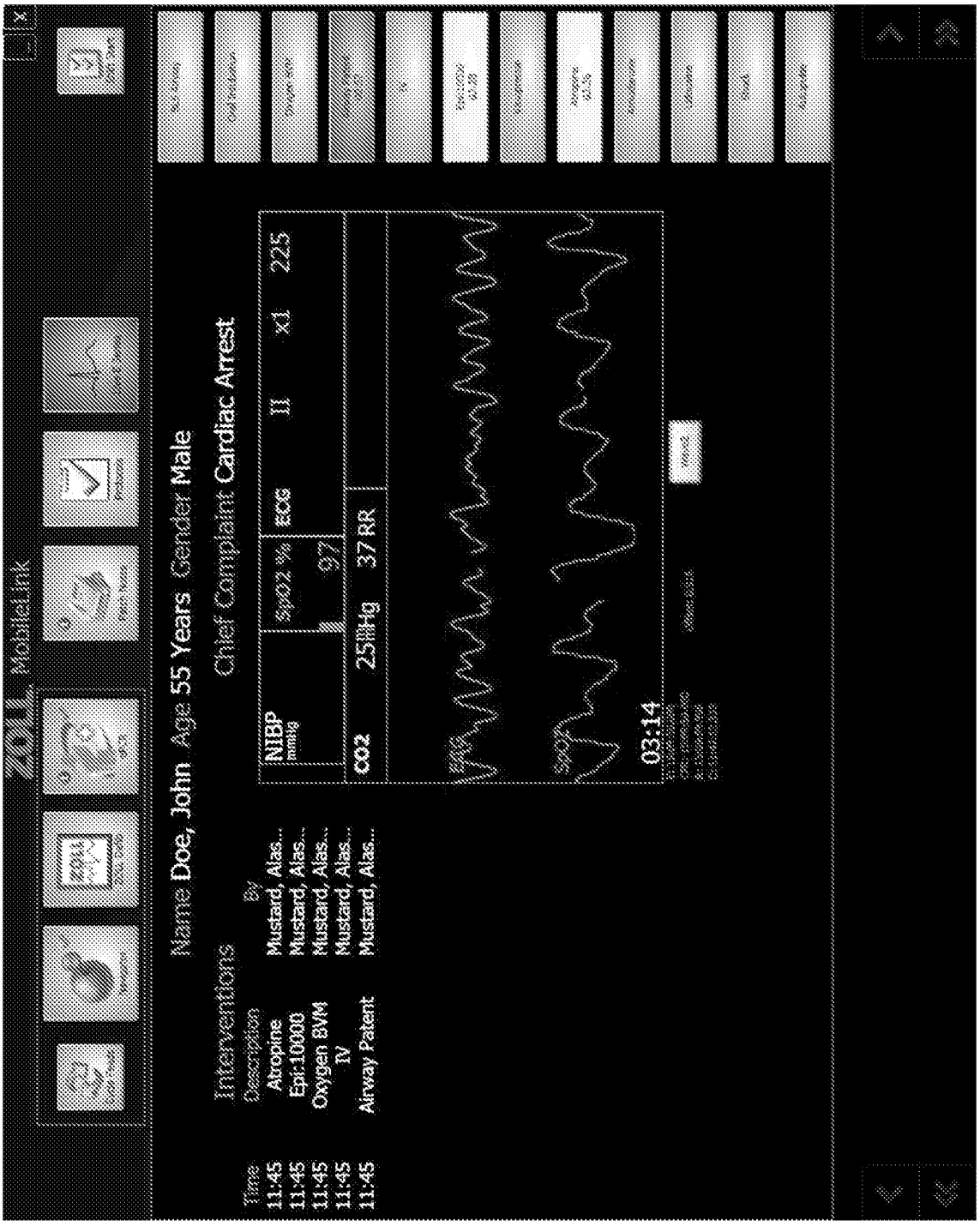

MobileLink
Name Doe, John Age 55 Years Gender Male
Chief Complaint Cardiac Arrest
Interventions
Time
Description
By
11:45 Atropine Mustard, Alas...
11:45 Epi-10000 Mustard, Alas...
11:45 Oxygen BVM Mustard, Alas...
11:45 IV Mustard, Alas...
11:45 Airway Patent Mustard, Alas...
NIBP
mmHg
SpO2 %
97
ECG
II
x1
225
CO2
25mHg
37 RR
03:14

FIG. 45

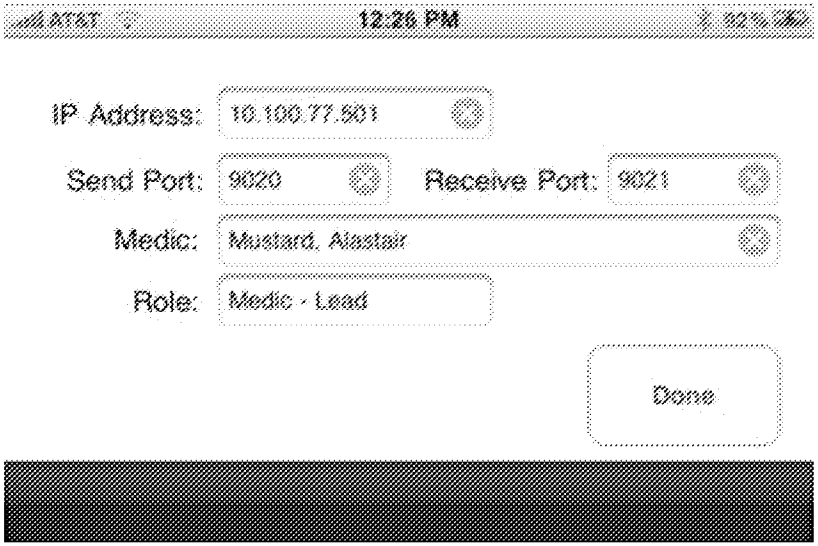


FIG. 46

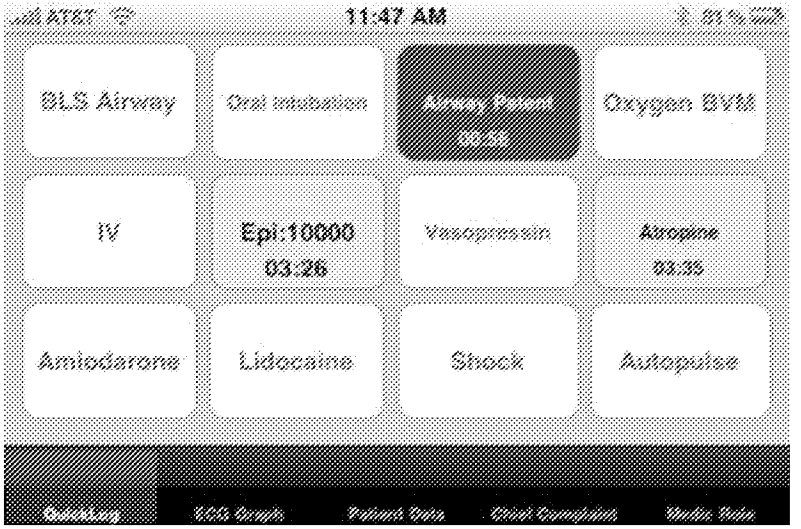


FIG. 48

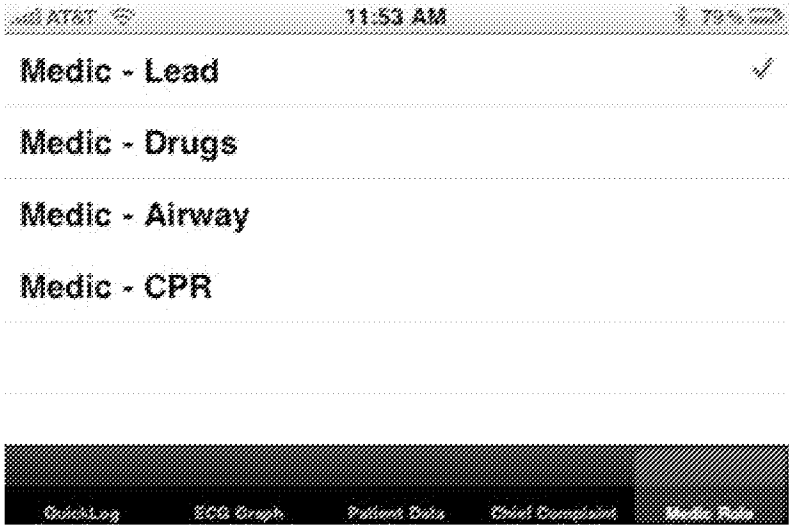


FIG. 47

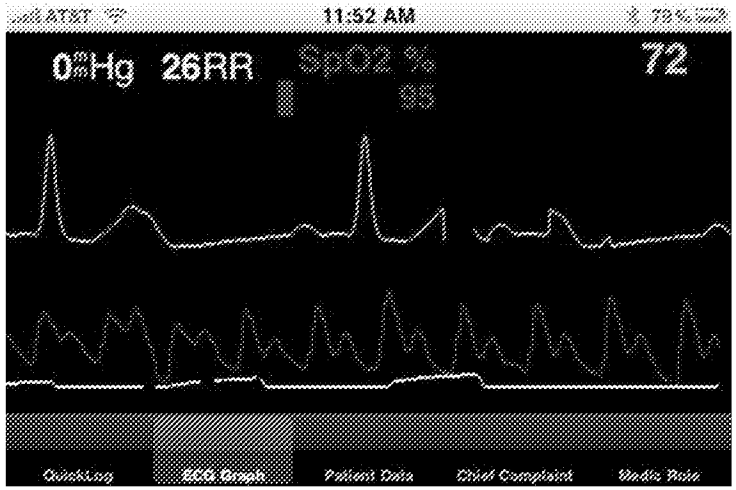


FIG. 49

PATENT
REEL: 042387 FRAME: 0621

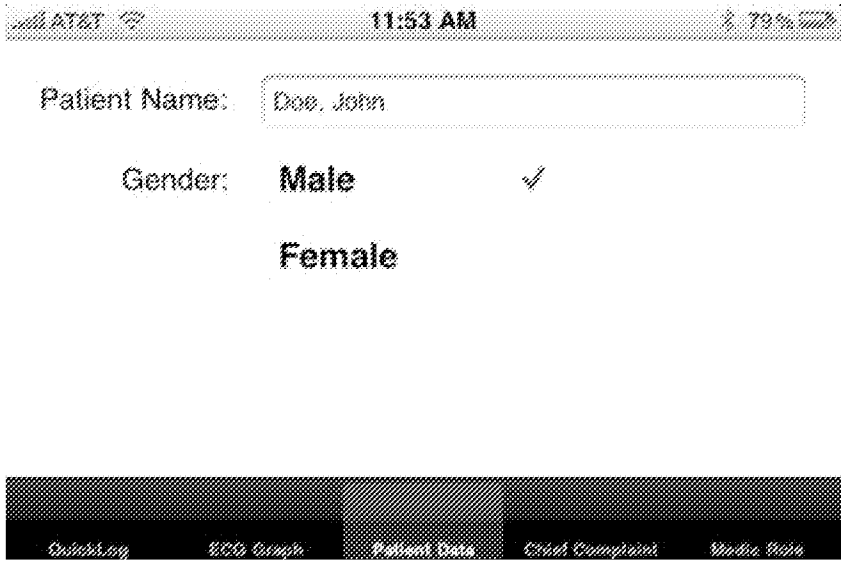

AT&T
11:53 AM
79 %
Patient Name:
Doe, John
Gender:
Male
Female

FIG. 50

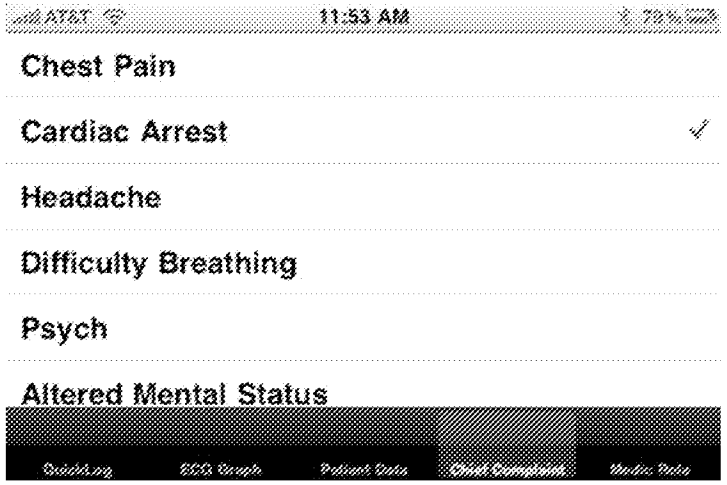

AT&T
11:53 AM
79 %
Chest Pain
Cardiac Arrest
Headache
Difficulty Breathing
Psych
Altered Mental Status

FIG. 51

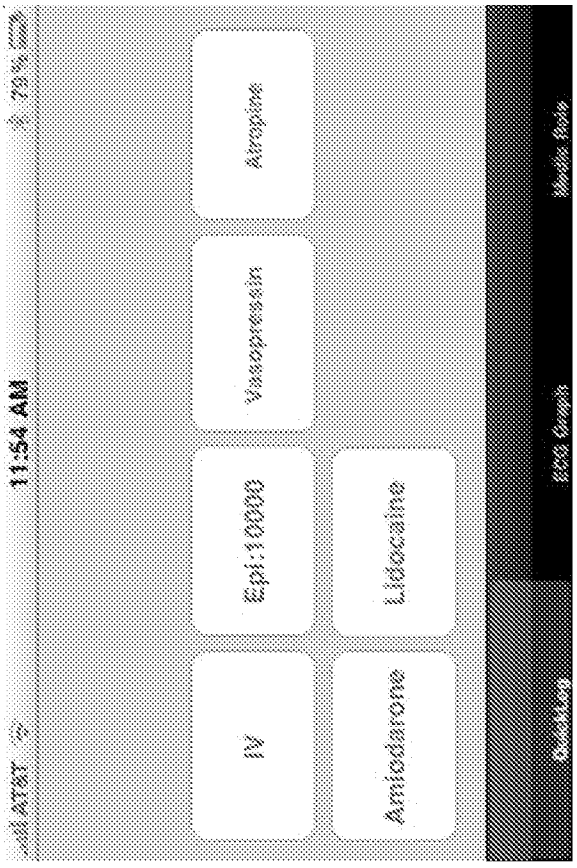

AT&T
11:54 AM
IV
Epi:10000
Vasopressin
Atropine
Amiodarone
Lidocaine
ECG Graph
Radio Rate

FIG. 52

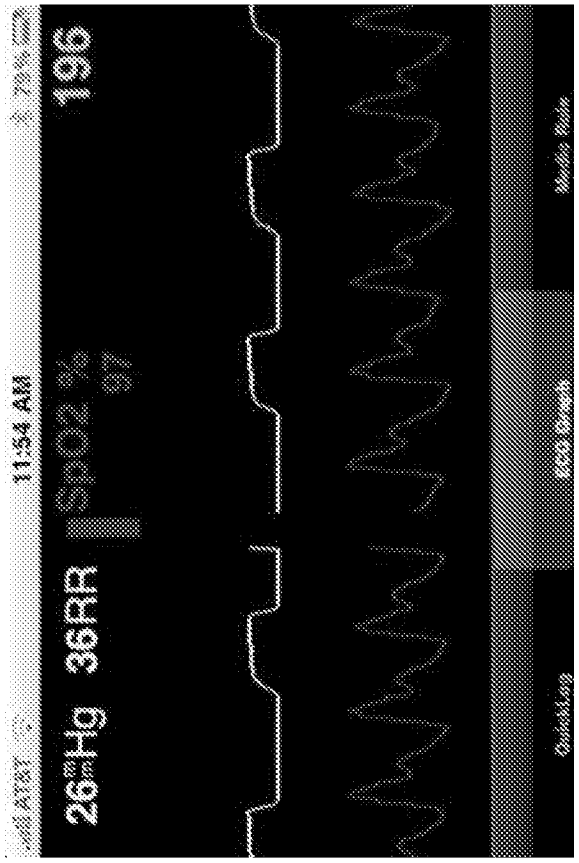

AT&T
11:54 AM
26 mHg
36RR
SpO2 %
87
196
ECG Graph
Radio Rate

FIG. 53

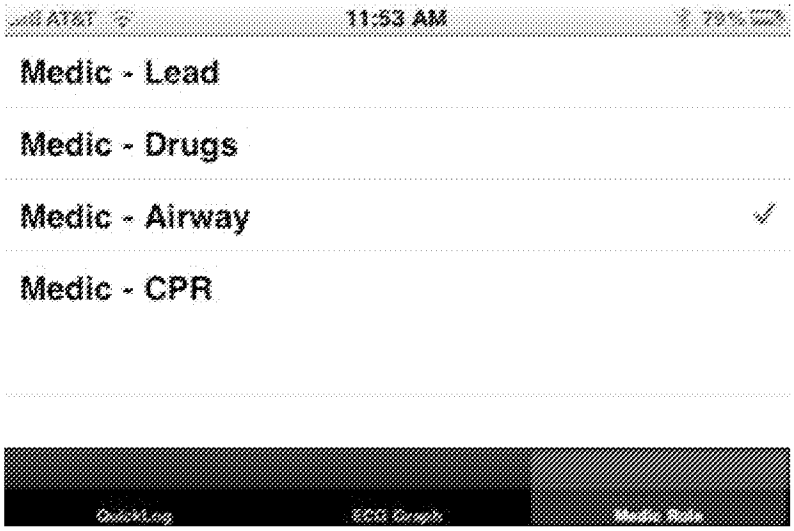


FIG. 54

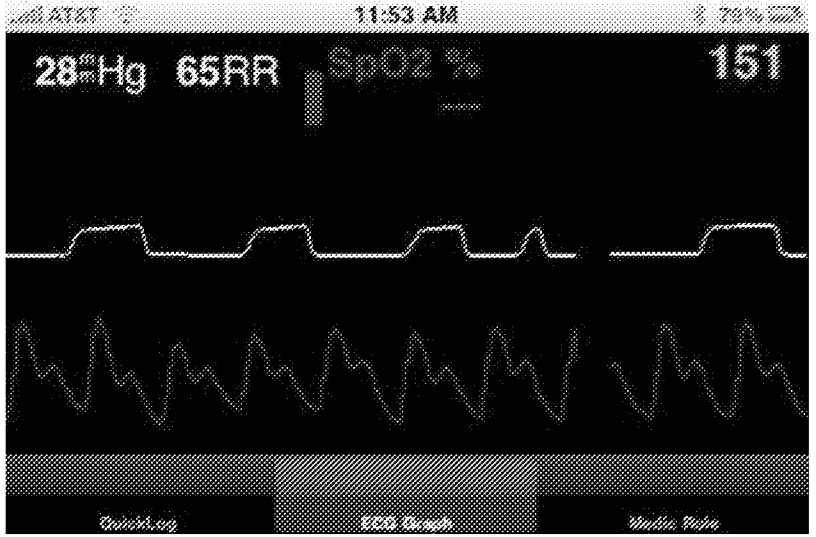


FIG. 55

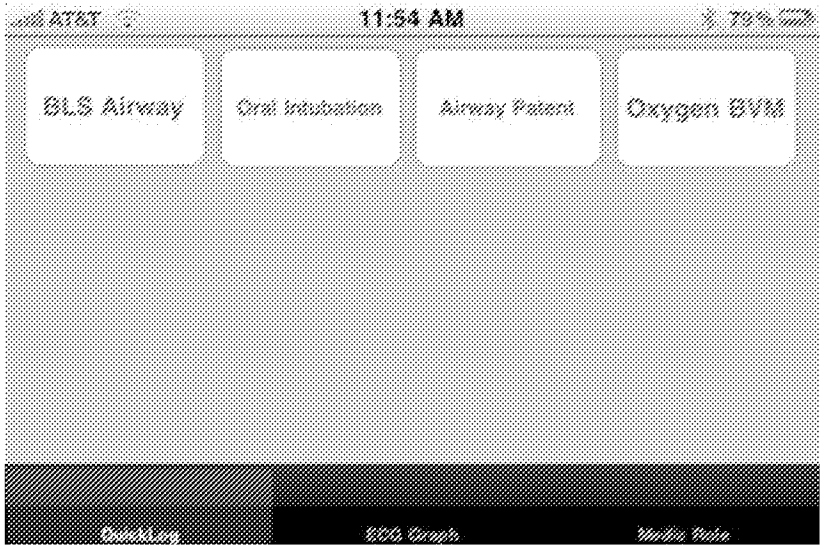


FIG. 56

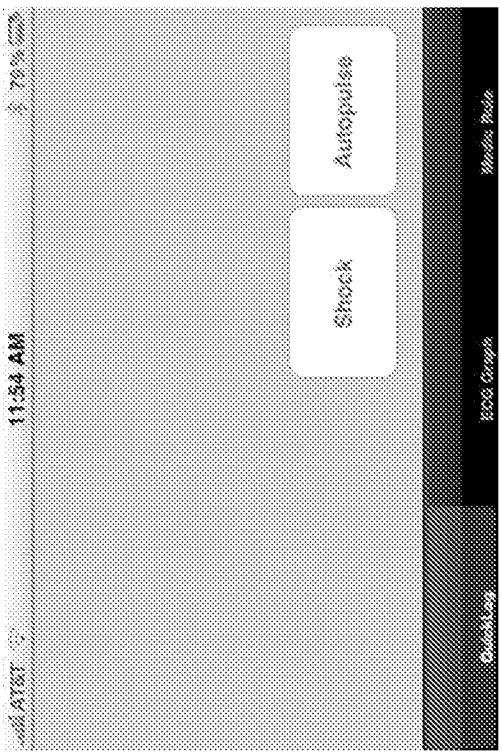


FIG. 57

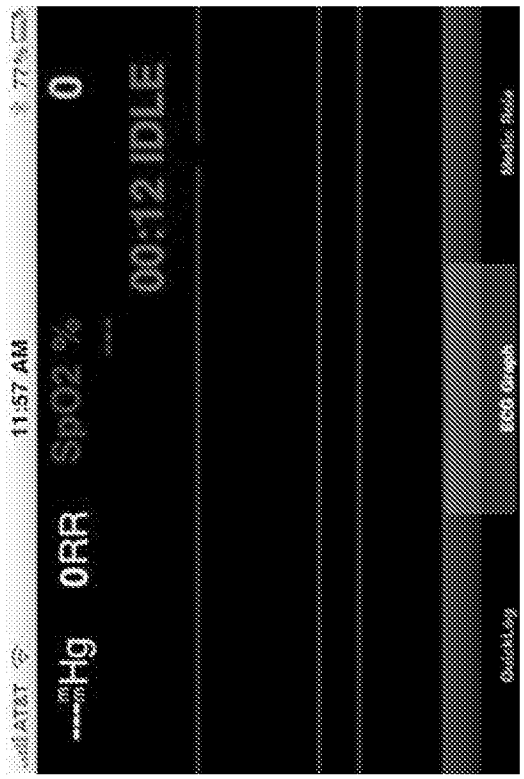


FIG. 58

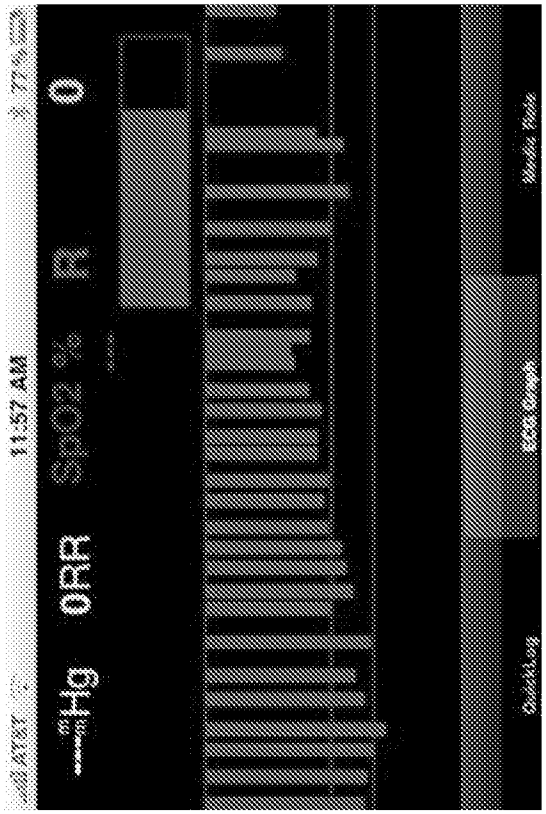


FIG. 59

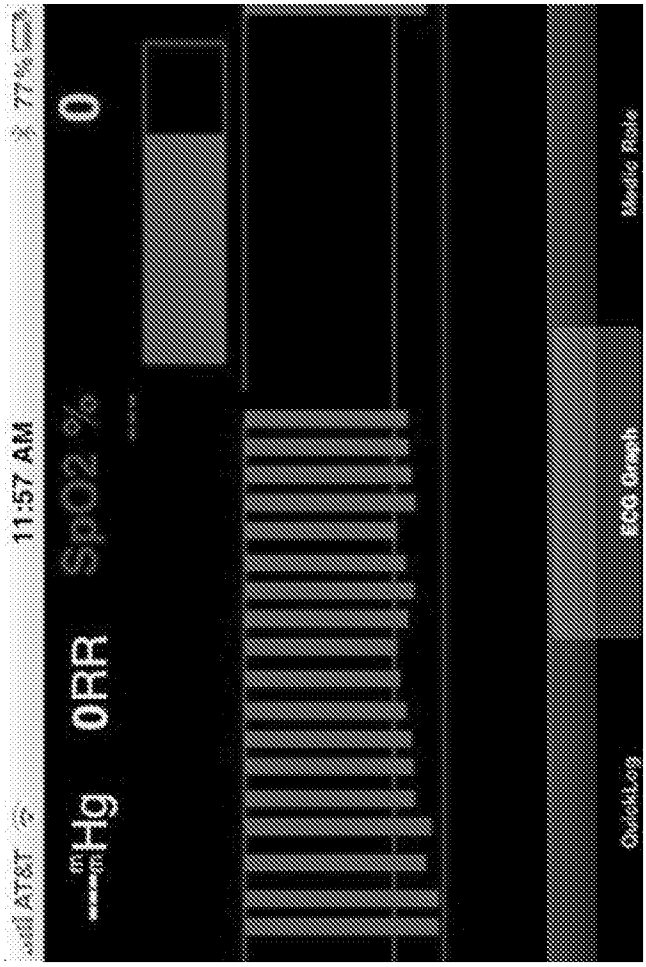

AT&T
11:57 AM
77%
mmHg
0RR
SpO2 %
0
Quick Log
ECG Graph
Media Rate

FIG. 60

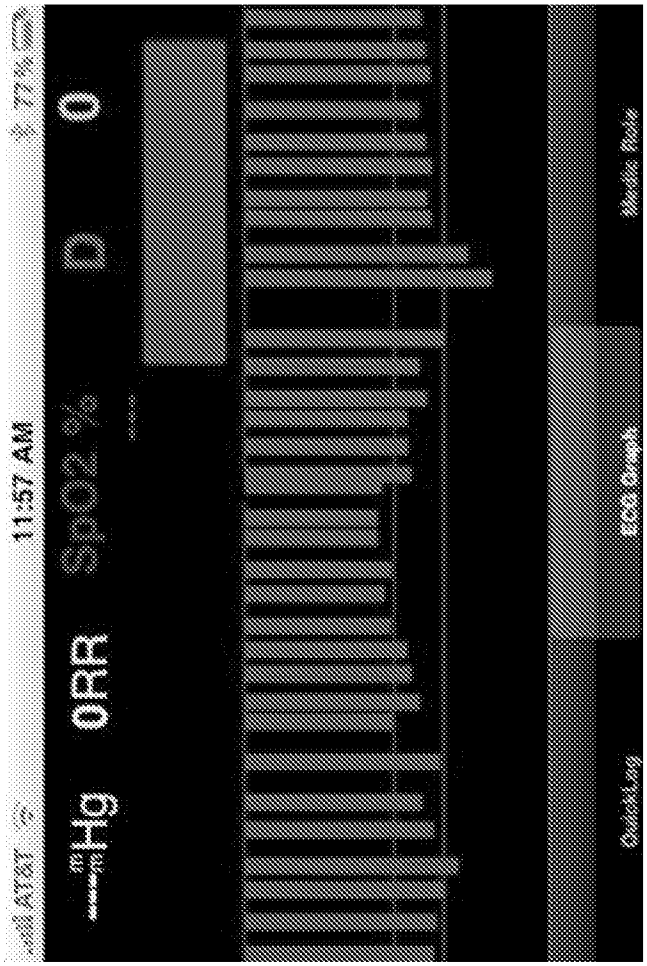

AT&T
11:57 AM
77%
mmHg
0RR
SpO2 %
0
0
Quick Log
ECG Graph
Media Rate

FIG. 61

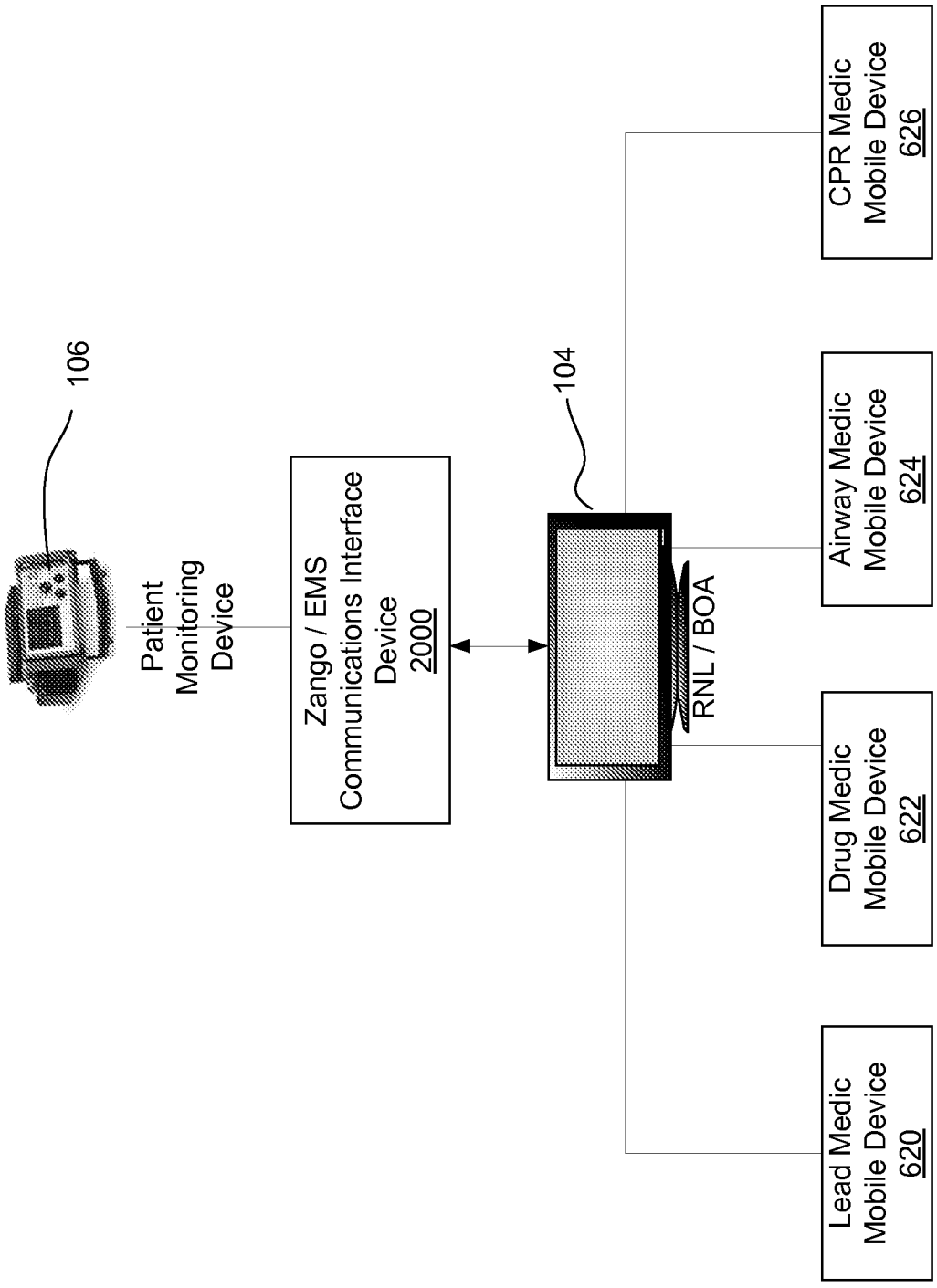

106
Patient Monitoring Device
Zango / EMS Communications Interface Device 2000
104
RNL / BOA
Lead Medic Mobile Device 620
Drug Medic Mobile Device 622
Airway Medic Mobile Device 624
CPR Medic Mobile Device 626

FIG. 62

PTO/SB/14 (11-08)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	391929
	Application Number	
Title of Invention	USPA: SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATION INTERFACE	

The application data sheet is part of the provisional or nonprovisional application for which it is being submitted. The following form contains the bibliographic data arranged in a format specified by the United States Patent and Trademark Office as outlined in 37 CFR 1.76.
This document may be completed electronically and submitted to the Office in electronic format using the Electronic Filing System (EFS) or the document may be printed and included in a paper filed application.

Secrecy Order 37 CFR 5.2

☐ Portions or all of the application associated with this Application Data Sheet may fall under a Secrecy Order pursuant to 37 CFR 5.2 (Paper filers only. Applications that fall under Secrecy Order may not be filed electronically.)

Applicant Information:

Applicant 1 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Michael	Scott	MARTIN	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Lakewood	State/Province	CO	Country of Residence i	US

Citizenship under 37 CFR 1.41(b) i: US

Mailing Address of Applicant:

Address 1	2727 South Braun Court		
Address 2			
City	Lakewood	State/Province	CO
Postal Code	80228	Country i	US

Applicant 2 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Chad		ASHMORE	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Frederick	State/Province	CO	Country of Residence i	US

Citizenship under 37 CFR 1.41(b) i: US

Mailing Address of Applicant:

Address 1	6303 Taylor Street		
Address 2			
City	Frederick	State/Province	CO
Postal Code	80530	Country i	US

Applicant 3 Remove

Applicant Authority ◉ Inventor ○ Legal Representative under 35 U.S.C. 117 ○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Eric	A.	DEINES	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Broomfield	State/Province	CO	Country of Residence i	US

PATENT
REEL: 042387 FRAME: 0628

PTO/SB/14 (11-08)
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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	391929
	Application Number	
Title of Invention	USPA: SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATION INTERFACE	

Citizenship under 37 CFR 1.41(b) i	US				
Mailing Address of Applicant:					
Address 1	1052 Lilac Court				
Address 2					
City	Broomfield	**State/Province**	CO		
Postal Code	80020	**Country**i	US		

Applicant 4 Remove

Applicant Authority (•) Inventor	( ) Legal Representative under 35 U.S.C. 117	( ) Party of Interest under 35 U.S.C. 118			
Prefix	**Given Name**	**Middle Name**	**Family Name**		**Suffix**
	Gary	A.	FREEMAN		
Residence Information (Select One)	(•) US Residency	( ) Non US Residency	( ) Active US Military Service		
City	Newton Center	**State/Province**	MA	**Country of Residence** i	US
Citizenship under 37 CFR 1.41(b) i	US				
Mailing Address of Applicant:					
Address 1	47 Stearns Street				
Address 2					
City	Newton Center	**State/Province**	MA		
Postal Code	02159	**Country**i	US		

Applicant 5 Remove

Applicant Authority (•) Inventor	( ) Legal Representative under 35 U.S.C. 117	( ) Party of Interest under 35 U.S.C. 118			
Prefix	**Given Name**	**Middle Name**	**Family Name**		**Suffix**
	Joseph	L.	HELMICK		
Residence Information (Select One)	(•) US Residency	( ) Non US Residency	( ) Active US Military Service		
City	Westminster	**State/Province**	CO	**Country of Residence** i	US
Citizenship under 37 CFR 1.41(b) i	US				
Mailing Address of Applicant:					
Address 1	2556 West 110th Place				
Address 2					
City	Westminster	**State/Province**	CO		
Postal Code	80234	**Country**i	US		

Applicant 6 Remove

Applicant Authority (•) Inventor	( ) Legal Representative under 35 U.S.C. 117	( ) Party of Interest under 35 U.S.C. 118			
Prefix	**Given Name**	**Middle Name**	**Family Name**		**Suffix**
	Thomas	E.	KAIB		
Residence Information (Select One)	(•) US Residency	( ) Non US Residency	( ) Active US Military Service		
City	North Huntingdon	**State/Province**	PA	**Country of Residence** i	US
Citizenship under 37 CFR 1.41(b) i	US				

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	391929
	Application Number	
Title of Invention	USPA: SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATION INTERFACE	

Mailing Address of Applicant:			
Address 1	2810 Ipnar Road		
Address 2			
City	North Huntingdon	State/Province	PA
Postal Code	15642	Country[i]	US

Applicant 7 — Remove

Applicant Authority	◉ Inventor	○ Legal Representative under 35 U.S.C. 117	○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Richard	A.	RATTANNI	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	New Stanton	State/Province	PA	Country of Residence [i]	US

Citizenship under 37 CFR 1.41(b) [i]: US

Mailing Address of Applicant:			
Address 1	215 Oak Street		
Address 2			
City	New Stanton	State/Province	PA
Postal Code	15672	Country[i]	US

Applicant 8 — Remove

Applicant Authority	◉ Inventor	○ Legal Representative under 35 U.S.C. 117	○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	C.	Shane	REID	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Denver	State/Province	CO	Country of Residence [i]	US

Citizenship under 37 CFR 1.41(b) [i]: US

Mailing Address of Applicant:			
Address 1	3050 South Elm Street		
Address 2			
City	Denver	State/Province	CO
Postal Code	80222	Country[i]	US

Applicant 9 — Remove

Applicant Authority	◉ Inventor	○ Legal Representative under 35 U.S.C. 117	○ Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Jeremy	Ryan	SOLLER	

Residence Information (Select One) ◉ US Residency ○ Non US Residency ○ Active US Military Service

City	Broomfield	State/Province	CO	Country of Residence [i]	US

Citizenship under 37 CFR 1.41(b) [i]: US

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	391929
	Application Number	
Title of Invention	USPA: SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATION INTERFACE	

Mailing Address of Applicant:			
Address 1	3307 Columbine Court		
Address 2			
City	Broomfield	State/Province	CO
Postal Code	80020	Country[i]	US

Applicant 10 — Remove

Applicant Authority: (•) Inventor ( ) Legal Representative under 35 U.S.C. 117 ( ) Party of Interest under 35 U.S.C. 118

Prefix	Given Name	Middle Name	Family Name	Suffix
	Shane	S.	VOLPE	

Residence Information (Select One): (•) US Residency ( ) Non US Residency ( ) Active US Military Service

City	Saltsburg	State/Province	PA	Country of Residence [i]	US
Citizenship under 37 CFR 1.41(b) [i]	US				

Mailing Address of Applicant:			
Address 1	645 Oak Lane		
Address 2			
City	Saltsburg	State/Province	PA
Postal Code	15681	Country[i]	US

All Inventors Must Be Listed - Additional Inventor Information blocks may be generated within this form by selecting the **Add** button. Add

Correspondence Information:

Enter either Customer Number or complete the Correspondence Information section below.
For further information see 37 CFR 1.33(a).

☐ **An Address is being provided for the correspondence Information of this application.**

Customer Number	35657		
Email Address	patentdocketing@faegre.com	Add Email	Remove Email

Application Information:

Title of the Invention	USPA: SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATION INTERFACE		
Attorney Docket Number	391929	Small Entity Status Claimed	☐
Application Type	Nonprovisional		
Subject Matter	Utility		
Suggested Class (if any)		Sub Class (if any)	
Suggested Technology Center (if any)			
Total Number of Drawing Sheets (if any)	50	Suggested Figure for Publication (if any)	23

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Application Data Sheet 37 CFR 1.76	Attorney Docket Number	391929
	Application Number	
Title of Invention	USPA: SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATION INTERFACE	

Publication Information:

☐	Request Early Publication (Fee required at time of Request 37 CFR 1.219)
☐	**Request Not to Publish.** I hereby request that the attached application not be published under 35 U.S.C. 122(b) and certify that the invention disclosed in the attached application **has not and will not** be the subject of an application filed in another country, or under a multilateral international agreement, that requires publication at eighteen months after filing.

Representative Information:

Representative information should be provided for all practitioners having a power of attorney in the application. Providing this information in the Application Data Sheet does not constitute a power of attorney in the application (see 37 CFR 1.32).
Enter either Customer Number or complete the Representative Name section below. If both sections are completed the Customer Number will be used for the Representative Information during processing.

Please Select One:	◉ Customer Number	○ US Patent Practitioner	○ Limited Recognition (37 CFR 11.9)
Customer Number	35657		

Domestic Benefit/National Stage Information:

This section allows for the applicant to either claim benefit under 35 U.S.C. 119(e), 120, 121, or 365(c) or indicate National Stage entry from a PCT application. Providing this information in the application data sheet constitutes the specific reference required by 35 U.S.C. 119(e) or 120, and 37 CFR 1.78(a)(2) or CFR 1.78(a)(4), and need not otherwise be made part of the specification.

Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	non provisional of	61227187	2009-07-21
Prior Application Status	Pending		Remove
Application Number	Continuity Type	Prior Application Number	Filing Date (YYYY-MM-DD)
	non provisional of	61322675	2010-04-09

Additional Domestic Benefit/National Stage Data may be generated within this form by selecting the **Add** button. Add

Foreign Priority Information:

This section allows for the applicant to claim benefit of foreign priority and to identify any prior foreign application for which priority is not claimed. Providing this information in the application data sheet constitutes the claim for priority as required by 35 U.S.C. 119(b) and 37 CFR 1.55(a).

Remove

Application Number	Country [i]	Parent Filing Date (YYYY-MM-DD)	Priority Claimed
			◉ Yes ○ No

Additional Foreign Priority Data may be generated within this form by selecting the **Add** button. Add

PTO/SB/14 (11-08)
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U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
Under the Paperwork Reduction Act of 1995, no persons are required to respond to a collection of information unless it contains a valid OMB control number.

Application Data Sheet 37 CFR 1.76	Attorney Docket Number	391929
	Application Number	
Title of Invention	USPA: SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATION INTERFACE	

Assignee Information:

Providing this information in the application data sheet does not substitute for compliance with any requirement of part 3 of Title 37 of the CFR to have an assignment recorded in the Office.

Assignee 1 Remove

If the Assignee is an Organization check here. ☐

Prefix	**Given Name**	Middle Name	**Family Name**	Suffix

Mailing Address Information:

Address 1			
Address 2			
City		**State/Province**	
Country [i]		Postal Code	
Phone Number		Fax Number	
Email Address			

Additional Assignee Data may be generated within this form by selecting the **Add** button. Add

Signature:

A signature of the applicant or representative is required in accordance with 37 CFR 1.33 and 10.18. Please see 37 CFR 1.4(d) for the form of the signature.

Signature	/Benjamin S. Fernandez/			Date (YYYY-MM-DD)	2010-07-20
First Name	Benjamin	Last Name	Fernandez	Registration Number	55172

This collection of information is required by 37 CFR 1.76. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 23 minutes to complete, including gathering, preparing, and submitting the completed application data sheet form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. **SEND TO: Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.**

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1. The information on this form will be treated confidentially to the extent allowed under the Freedom of Information Act (5 U.S.C. 552) and the Privacy Act (5 U.S.C. 552a). Records from this system of records may be disclosed to the Department of Justice to determine whether the Freedom of Information Act requires disclosure of these records.

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3. A record in this system of records may be disclosed, as a routine use, to a Member of Congress submitting a request involving an individual, to whom the record pertains, when the individual has requested assistance from the Member with respect to the subject matter of the record.

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5. A record related to an International Application filed under the Patent Cooperation Treaty in this system of records may be disclosed, as a routine use, to the International Bureau of the World Intellectual Property Organization, pursuant to the Patent Cooperation Treaty.

6. A record in this system of records may be disclosed, as a routine use, to another federal agency for purposes of National Security review (35 U.S.C. 181) and for review pursuant to the Atomic Energy Act (42 U.S.C. 218(c)).

7. A record from this system of records may be disclosed, as a routine use, to the Administrator, General Services, or his/her designee, during an inspection of records conducted by GSA as part of that agency's responsibility to recommend improvements in records management practices and programs, under authority of 44 U.S.C. 2904 and 2906. Such disclosure shall be made in accordance with the GSA regulations governing inspection of records for this purpose, and any other relevant (i.e., GSA or Commerce) directive. Such disclosure shall not be used to make determinations about individuals.

8. A record from this system of records may be disclosed, as a routine use, to the public after either publication of the application pursuant to 35 U.S.C. 122(b) or issuance of a patent pursuant to 35 U.S.C. 151. Further, a record may be disclosed, subject to the limitations of 37 CFR 1.14, as a routine use, to the public if the record was filed in an application which became abandoned or in which the proceedings were terminated and which application is referenced by either a published application, an application open to public inspections or an issued patent.

9. A record from this system of records may be disclosed, as a routine use, to a Federal, State, or local law enforcement agency, if the USPTO becomes aware of a violation or potential violation of law or regulation.

Electronic Patent Application Fee Transmittal

Application Number:	
Filing Date:	
Title of Invention:	SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATIONS INTERFACE
First Named Inventor/Applicant Name:	Michael Scott MARTIN
Filer:	Benjamin S. Fernandez/Aimee Miller
Attorney Docket Number:	391929

Filed as Large Entity

Utility under 35 USC 111(a) Filing Fees

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Basic Filing:				
Utility application filing	1011	1	330	330
Utility Search Fee	1111	1	540	540
Utility Examination Fee	1311	1	220	220
Pages:				
Utility Appl Size fee per 50 sheets >100	1081	1	270	270
Claims:				
Claims in excess of 20	1202	3	52	156
Miscellaneous-Filing:				

Description	Fee Code	Quantity	Amount	Sub-Total in USD($)
Petition:				
Patent-Appeals-and-Interference:				
Post-Allowance-and-Post-Issuance:				
Extension-of-Time:				
Miscellaneous:				
		Total in USD ($)		**1516**

Electronic Acknowledgement Receipt

EFS ID:	8053638
Application Number:	12840129
International Application Number:	
Confirmation Number:	9536
Title of Invention:	SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATIONS INTERFACE
First Named Inventor/Applicant Name:	Michael Scott MARTIN
Customer Number:	35657
Filer:	Benjamin S. Fernandez/Aimee Miller
Filer Authorized By:	Benjamin S. Fernandez
Attorney Docket Number:	391929
Receipt Date:	20-JUL-2010
Filing Date:	
Time Stamp:	18:44:43
Application Type:	Utility under 35 USC 111(a)

Payment information:

Submitted with Payment	yes
Payment Type	Credit Card
Payment was successfully received in RAM	$1516
RAM confirmation Number	4860
Deposit Account	060029
Authorized User	FERNANDEZ,BENJAMIN

The Director of the USPTO is hereby authorized to charge indicated fees and credit any overpayment as follows:

Charge any Additional Fees required under 37 C.F.R. Section 1.16 (National application filing, search, and examination fees)

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Charge any Additional Fees required under 37 C.F.R. Section 1.19 (Document supply fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.20 (Post Issuance fees)

Charge any Additional Fees required under 37 C.F.R. Section 1.21 (Miscellaneous fees and charges)

File Listing:

Document Number	Document Description	File Name	File Size(Bytes)/ Message Digest	Multi Part /.zip	Pages (if appl.)
1		20100720-391929-Specification.pdf	285485 cd81b31719e1a3a8f2e9aaae4532cadccff3ee0c	yes	103

Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	95
Claims	96	102
Abstract	103	103

Warnings:

Information:

2	Drawings-other than black and white line drawings	20100720-391929-Drawings.pdf	2880827 5763bd9ade44c1dbbea502c34ec3d51371819502	no	50

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Information:

3	Application Data Sheet	391929-ADS.pdf	1032602 a24b0470e01e81123814cdb11fdf76917ddd9d2c	no	7

Warnings:

Information:

4	Fee Worksheet (PTO-875)	fee-info.pdf	38032 ca02cd11bb2528cbe6dc0594304e92c267a19ede	no	2

Warnings:

Information:

Total Files Size (in bytes):	4236946

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New Applications Under 35 U.S.C. 111

If a new application is being filed and the application includes the necessary components for a filing date (see 37 CFR 1.53(b)-(d) and MPEP 506), a Filing Receipt (37 CFR 1.54) will be issued in due course and the date shown on this Acknowledgement Receipt will establish the filing date of the application.

National Stage of an International Application under 35 U.S.C. 371

If a timely submission to enter the national stage of an international application is compliant with the conditions of 35 U.S.C. 371 and other applicable requirements a Form PCT/DO/EO/903 indicating acceptance of the application as a national stage submission under 35 U.S.C. 371 will be issued in addition to the Filing Receipt, in due course.

New International Application Filed with the USPTO as a Receiving Office

If a new international application is being filed and the international application includes the necessary components for an international filing date (see PCT Article 11 and MPEP 1810), a Notification of the International Application Number and of the International Filing Date (Form PCT/RO/105) will be issued in due course, subject to prescriptions concerning national security, and the date shown on this Acknowledgement Receipt will establish the international filing date of the application.

ASSIGNMENT

WHEREAS, the undersigned, to wit:

- Michael Scott MARTIN residing at 2727 South Braun Court, Lakewood, Colorado 80228;
- Chad ASHMORE residing at 6303 Taylor Street, Frederick, Colorado 80530;
- Eric A. DEINES residing at 1052 Lilac Court, Broomfield, Colorado 80020;
- Gary A. FREEMAN residing at 185 Crescent Street, Apt. 423, Waltham, Massachusetts 02453;
- Joseph L. HELMICK residing at ~~2556 West 110th Place, Westminster, Colorado 80234~~; 15464 E POWERS DR. CENTENNIAL CO 80015
- Thomas E. KAIB residing at 2810 Ipnar Road, North Huntingdon, Pennsylvania 15642;
- Richard A. RATTANNI residing at 215 Oak Street, New Stanton, Pennsylvania 15672;
- C. Shane REID residing at 6453 East Floyd Avenue, Denver, Colorado 80222;
- Jeremy Ryan SOLLER residing at 3307 Columbine Court, Broomfield, Colorado 80020;
- Shane S. VOLPE residing at 645 Oak Lane, Saltsburg, Pennsylvania 15681;
- Gary RUGGIERO residing at 48 Sanderson Road, Lexington, Massachusetts 02420;
- Frederick J. GEHEB residing at 18 Carolyn Drive, Danvers, Massachusetts 01923

(hereinafter collectively ASSIGNORS), have made a certain new and useful invention as set forth the following applications:

International Application No. PCT/US11/31868, filed April 9, 2011, entitled:
"SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATIONS INTERFACE"

U.S. Patent Application No. 13/647,744, filed October 9, 2012, entitled:
"SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATIONS INTERFACE"

AND WHEREAS, ZOLL Medical Corporation (hereinafter ASSIGNEE), a corporation organized and existing under the laws of the Commonwealth of Massachusetts, and having its principal place of business at 269 Mill Road, Chelmsford, Massachusetts 01824, is desirous of acquiring the entire right, title, and interest in and to said invention and any and all patents that may be obtained therefor, and in and to said application and any and all patents that may issue therefrom;

ActiveUS 155697461v.1

NOW, THEREFORE, for good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, ASSIGNORS do hereby sell, assign, transfer, and set over unto said ASSIGNEE, its successors, assigns, and legal representatives, all right, title, and interest in and to said invention throughout the world, and any and all patents of the United States and foreign countries that may be obtained therefor, including the right to sue for past infringement and obtain past damages, and in and to said applications, including any and all non-provisionals, continuations, continuations-in-part, divisionals, reissues, re-examinations, substitutions, and extensions thereof, and any and all patents of the United States and foreign countries that may issue therefrom, such right, title, and interest including the right to file applications and obtain patents, utility models, industrial models, and designs for said invention in the name of said ASSIGNEE, its successors, assigns, and legal representatives, throughout the world, including all rights of priority, all rights to publish cautionary notices reserving ownership of said invention, and all rights to register said invention in appropriate registries;

ASSIGNORS also do hereby covenant that they have the full right to convey the entire right, title, and interest herein assigned, and that they have not and will not execute any agreement in conflict herewith;

ASSIGNORS also do hereby authorize and request the Commissioner of Patents and Trademarks to issue any and all Letters Patent of the United States on said invention or resulting from said application, including any continuations, continuations-in-part, divisions, reissues, re-examinations, substitutions, and extensions thereof, to said ASSIGNEE, its successors, assigns, and legal representatives as the ASSIGNEE of the entire right, title, and interest herein assigned;

ASSIGNORS also do hereby agree to, at any time, upon request, without further or additional consideration but at the expense of said ASSIGNEE, its successors, assigns, or legal representatives, execute and deliver any and all papers, make all rightful oaths, and do all lawful acts that may be necessary or desirable to perfect the entire right, title, and interest in said application, including any and all continuations, continuations-in-part, divisionals, reissues, re-examinations, substitutions, and extensions thereof, and any and all patents of the United States and foreign countries that may issue therefrom said ASSIGNEE, its successors, assigns, and legal representatives, and generally do everything possible to vest the entire right, title, and interest herein assigned in said ASSIGNEE, its successors, assigns, and legal representatives;

ASSIGNOR also does hereby grant to ASSIGNEE, its successors and assigns, and legal representatives thereof, the power to insert on this Assignment any further identification which may be necessary or desirable in order to comply with the rules of the United States Patent and Trademark Office or foreign equivalent thereof for recordation of this document.

This ASSIGNMENT is effective as of April 9, 2011.

ActiveUS 155697461v.1

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign:_____
Name:Michael Scott Martin
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Michael Scott Martin, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this 29th day of August, 2016.

Sign: _____

Name: Chad Ashmore
ASSIGNOR

Date: 8-29-16

United States of America)
State of Colorado) ss.:
County of Broomfield)

On this 29th day of August, 2016, before me personally came Chad Ashmore, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

Angela Lee Rossback
Notary Public

ANGELA LEE ROSSBACK
NOTARY PUBLIC
STATE OF COLORADO
NOTARY ID 20024024129
MY COMMISSION EXPIRES JULY 29, 2018

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign: _____
Name:Eric A. Deines
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Eric A. Deines, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this 24th day of August, 2016.

Sign: Gary A Freeman
Name: Gary A. Freeman
ASSIGNOR

Date: August 24, 2016

United States of America)
State of Massachusetts) ss.:
County of Middlesex)

On this 24th day of August, 2016, before me personally came Gary A. Freeman, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

Helen D. Leary
Notary Public

HELEN D. LEARY
Notary Public
Massachusetts
Commission Expires Jul 11, 2019

IN WITNESS WHEREOF, I have hereunto set my hand and seal this 15 day of NOVEMBER, 2016.

Sign: _____
Name: Joseph L. Helmick
ASSIGNOR

Date: November 15, 2016

United States of America)
State of Colorado) ss.:
County of Arapahoe)

On this 15 day of November, 2016, before me personally came Joseph L. Helmick, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

HEIDI SIMONIS
NOTARY PUBLIC
STATE OF COLORADO
NOTARY ID 20164000689
MY COMMISSION EXPIRES 02/25/20

IN WITNESS WHEREOF, I have hereunto set my hand and seal this 1st day of NOVEMBER, 2016.

Sign: Thomas E Kaib
Name: Thomas E. Kaib
ASSIGNOR

Date: NOVEMBER 1, 2016

United States of America)
State of PENNSYLVANIA) ss.:
County of ALLEGHENY)

On this 1st day of NOVEMBER, 2016, before me personally came Thomas E. Kaib, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

Teresa L Mrazik
Notary Public

COMMONWEALTH OF PENNSYLVANIA
NOTARIAL SEAL
TERESA L MRAZIK
Notary Public
O'HARA TWP, ALLEGHENY COUNTY
My Commission Expires Mar 7, 2020

IN WITNESS WHEREOF, I have hereunto set my hand and seal this 18 day of NOVEMBER, 2016.

Sign: _____
Name: Richard A. Rattanni
ASSIGNOR

Date: NOVEMBER 18, 2016

United States of America)
State of PENNSYLVANIA) ss.:
County of ALLEGHENY)

On this 18 day of NOVEMBER, 2016, before me personally came Richard A. Rattanni, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

COMMONWEALTH OF PENNSYLVANIA
NOTARIAL SEAL
TERESA L MRAZIK
Notary Public
O'HARA TWP, ALLEGHENY COUNTY
My Commission Expires Mar 7, 2020

IN WITNESS WHEREOF, I have hereunto set my hand and seal this 15th day of August, 2016.

Sign: C. Shane Reid
Name: C. Shane Reid
ASSIGNOR

Date: 8-15-2016

United States of America)
State of Colorado) ss.:
County of Broomfield)

On this 15th day of August, 2016, before me personally came C. Shane Reid, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

Angela Lee Rossback
Notary Public

ANGELA LEE ROSSBACK
NOTARY PUBLIC
STATE OF COLORADO
NOTARY ID 20024024129
MY COMMISSION EXPIRES JULY 26, 2018

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign: _____
Name:Jeremy Ryan Soller
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Jeremy Ryan Soller, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this 1st day of NOVEMBER, 2016.

Sign: _____

Name:Shane S. Volpe
ASSIGNOR

Date: NOVEMBER 1, 2016

United States of America)
State of PENNSYLVANIA) ss.:
County of ALLEGHENY)

On this 1st day of NOVEMBER, 2016, before me personally came Shane S. Volpe, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

COMMONWEALTH OF PENNSYLVANIA
NOTARIAL SEAL
TERESA L MRAZIK
Notary Public
O'HARA TWP, ALLEGHENY COUNTY
My Commission Expires Mar 7, 2020

IN WITNESS WHEREOF, I have hereunto set my hand and seal this 28 day of October, 2016.

Sign: Gary Ruggiero
Name: Gary Ruggiero
ASSIGNOR

Date: October 28, 2016

United States of America)
State of Massachusetts) ss.:
County of Worcester)

On this 28 day of October, 2016, before me personally came Gary Ruggiero, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

Notary Public

MICHAEL J. DAMON
Notary Public
Commonwealth of Massachusetts
My Commission Expires September 10, 2021

IN WITNESS WHEREOF, I have hereunto set my hand and seal this 29th day of August, 2016.

Sign: Frederick J. Geheb
Name: Frederick J. Geheb
ASSIGNOR

Date: August 29th

United States of America
State of Massachusetts)ss.:
County of Middlesex)

On this 29th day of August, 2016, before me personally came Frederick J. Geheb, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

Notary Public

HELEN D. LEARY
Notary Public
Massachusetts
Commission Expires Jul 11, 2019

ASSIGNMENT

WHEREAS, the undersigned, to wit:

- Michael Scott MARTIN residing at 2727 South Braun Court, Lakewood, Colorado 80228;
- Chad ASHMORE residing at 6303 Taylor Street, Frederick, Colorado 80530;
- Eric A. DEINES residing at ~~1052 Lilac Court~~, Broomfield, Colorado 80020; EO 11/4/2016
  355 Peregrine Cir
- Gary A. FREEMAN residing at 185 Crescent Street, Apt. 423, Waltham, Massachusetts 02453;
- Joseph L. HELMICK residing at 2556 West 110th Place, Westminster, Colorado 80234;
- Thomas E. KAIB residing at 2810 Ipnar Road, North Huntingdon, Pennsylvania 15642;
- Richard A. RATTANNI residing at 215 Oak Street, New Stanton, Pennsylvania 15672;
- C. Shane REID residing at 6453 East Floyd Avenue, Denver, Colorado 80222;
- Jeremy Ryan SOLLER residing at 3307 Columbine Court, Broomfield, Colorado 80020;
- Shane S. VOLPE residing at 645 Oak Lane, Saltsburg, Pennsylvania 15681;
- Gary RUGGIERO residing at 48 Sanderson Road, Lexington, Massachusetts 02420;
- Frederick J. GEHEB residing at 18 Carolyn Drive, Danvers, Massachusetts 01923

(hereinafter collectively ASSIGNORS), have made a certain new and useful invention as set forth the following applications:

International Application No. PCT/US11/31868, filed April 9, 2011, entitled:
"SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATIONS INTERFACE"

U.S. Patent Application No. 13/647,744, filed October 9, 2012, entitled:
"SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATIONS INTERFACE"

AND WHEREAS, ZOLL Medical Corporation (hereinafter ASSIGNEE), a corporation organized and existing under the laws of the Commonwealth of Massachusetts, and having its principal place of business at 269 Mill Road, Chelmsford, Massachusetts 01824, is desirous of acquiring the entire right, title, and interest in and to said invention and any and all patents that may be obtained therefor, and in and to said application and any and all patents that may issue therefrom;

ActiveUS 155697461v.1

NOW, THEREFORE, for good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, ASSIGNORS do hereby sell, assign, transfer, and set over unto said ASSIGNEE, its successors, assigns, and legal representatives, all right, title, and interest in and to said invention throughout the world, and any and all patents of the United States and foreign countries that may be obtained therefor, including the right to sue for past infringement and obtain past damages, and in and to said applications, including any and all non-provisionals, continuations, continuations-in-part, divisionals, reissues, re-examinations, substitutions, and extensions thereof, and any and all patents of the United States and foreign countries that may issue therefrom, such right, title, and interest including the right to file applications and obtain patents, utility models, industrial models, and designs for said invention in the name of said ASSIGNEE, its successors, assigns, and legal representatives, throughout the world, including all rights of priority, all rights to publish cautionary notices reserving ownership of said invention, and all rights to register said invention in appropriate registries;

ASSIGNORS also do hereby covenant that they have the full right to convey the entire right, title, and interest herein assigned, and that they have not and will not execute any agreement in conflict herewith;

ASSIGNORS also do hereby authorize and request the Commissioner of Patents and Trademarks to issue any and all Letters Patent of the United States on said invention or resulting from said application, including any continuations, continuations-in-part, divisions, reissues, re-examinations, substitutions, and extensions thereof, to said ASSIGNEE, its successors, assigns, and legal representatives as the ASSIGNEE of the entire right, title, and interest herein assigned;

ASSIGNORS also do hereby agree to, at any time, upon request, without further or additional consideration but at the expense of said ASSIGNEE, its successors, assigns, or legal representatives, execute and deliver any and all papers, make all rightful oaths, and do all lawful acts that may be necessary or desirable to perfect the entire right, title, and interest in said application, including any and all continuations, continuations-in-part, divisionals, reissues, re-examinations, substitutions, and extensions thereof, and any and all patents of the United States and foreign countries that may issue therefrom said ASSIGNEE, its successors, assigns, and legal representatives, and generally do everything possible to vest the entire right, title, and interest herein assigned in said ASSIGNEE, its successors, assigns, and legal representatives;

ASSIGNOR also does hereby grant to ASSIGNEE, its successors and assigns, and legal representatives thereof, the power to insert on this Assignment any further identification which may be necessary or desirable in order to comply with the rules of the United States Patent and Trademark Office or foreign equivalent thereof for recordation of this document.

This ASSIGNMENT is effective as of April 9, 2011.

ActiveUS 155697461v.1

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign: _____
Name: Michael Scott Martin
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Michael Scott Martin, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign:_____
Name:Chad Ashmore
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Chad Ashmore, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this 4 day of November, 2016.

Sign: Eric A. Deines
Name: Eric A. Deines
ASSIGNOR

Date: 11/04/16

United States of America)
State of Colorado) ss.:
County of Summit)

On this 4 day of November, 2016, before me personally came Eric A. Deines, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

Notary Public

LELAND G FRANK
NOTARY PUBLIC
STATE OF COLORADO
NOTARY ID 20124049584
MY COMMISSION EXPIRES AUGUST 7, 2020

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign: _____
Name:Gary A. Freeman
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Gary A. Freeman, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign: _____
Name:Joseph L. Helmick
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Joseph L. Helmick, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign: _____
Name: Thomas E. Kaib
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Thomas E. Kaib, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign: _____
Name:Richard A. Rattanni
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Richard A. Rattanni, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign: _____
Name:C. Shane Reid
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came C. Shane Reid, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign: _____
Name: Jeremy Ryan Soller
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Jeremy Ryan Soller, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign: _____
Name: Shane S. Volpe
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Shane S. Volpe, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign: _____
Name:Gary Ruggiero
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Gary Ruggiero, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign: _____
Name:Frederick J. Geheb
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Frederick J. Geheb, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

ASSIGNMENT

WHEREAS, the undersigned, to wit:

- Michael Scott MARTIN residing at 2727 South Braun Court, Lakewood, Colorado 80228;
- Chad ASHMORE residing at 6303 Taylor Street, Frederick, Colorado 80530;
- Eric A. DEINES residing at 1052 Lilac Court, Broomfield, Colorado 80020;
- Gary A. FREEMAN residing at 185 Crescent Street, Apt. 423, Waltham, Massachusetts 02453;
- Joseph L. HELMICK residing at 2556 West 110th Place, Westminster, Colorado 80234;
- Thomas E. KAIB residing at 2810 Ipnar Road, North Huntingdon, Pennsylvania 15642;
- Richard A. RATTANNI residing at 215 Oak Street, New Stanton, Pennsylvania 15672;
- C. Shane REID residing at 6453 East Floyd Avenue, Denver, Colorado 80222;
- Jeremy Ryan SOLLER residing at ~~3307 Columbine Court, Broomfield, Colorado 80020~~; 4803 S Eagle Circle, Aurora, CO 80015 Jeremy Soller Nov. 6, 2016
- Shane S. VOLPE residing at 645 Oak Lane, Saltsburg, Pennsylvania 15681;
- Gary RUGGIERO residing at 48 Sanderson Road, Lexington, Massachusetts 02420;
- Frederick J. GEHEB residing at 18 Carolyn Drive, Danvers, Massachusetts 01923

(hereinafter collectively ASSIGNORS), have made a certain new and useful invention as set forth the following applications:

International Application No. PCT/US11/31868, filed April 9, 2011, entitled:
"SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATIONS INTERFACE"

U.S. Patent Application No. 13/647,744, filed October 9, 2012, entitled:
"SYSTEMS AND METHODS FOR EMS DEVICE COMMUNICATIONS INTERFACE"

AND WHEREAS, ZOLL Medical Corporation (hereinafter ASSIGNEE), a corporation organized and existing under the laws of the Commonwealth of Massachusetts, and having its principal place of business at 269 Mill Road, Chelmsford, Massachusetts 01824, is desirous of acquiring the entire right, title, and interest in and to said invention and any and all patents that may be obtained therefor, and in and to said application and any and all patents that may issue therefrom;

ActiveUS 155697461v.1

NOW, THEREFORE, for good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, ASSIGNORS do hereby sell, assign, transfer, and set over unto said ASSIGNEE, its successors, assigns, and legal representatives, all right, title, and interest in and to said invention throughout the world, and any and all patents of the United States and foreign countries that may be obtained therefor, including the right to sue for past infringement and obtain past damages, and in and to said applications, including any and all non-provisionals, continuations, continuations-in-part, divisionals, reissues, re-examinations, substitutions, and extensions thereof, and any and all patents of the United States and foreign countries that may issue therefrom, such right, title, and interest including the right to file applications and obtain patents, utility models, industrial models, and designs for said invention in the name of said ASSIGNEE, its successors, assigns, and legal representatives, throughout the world, including all rights of priority, all rights to publish cautionary notices reserving ownership of said invention, and all rights to register said invention in appropriate registries;

ASSIGNORS also do hereby covenant that they have the full right to convey the entire right, title, and interest herein assigned, and that they have not and will not execute any agreement in conflict herewith;

ASSIGNORS also do hereby authorize and request the Commissioner of Patents and Trademarks to issue any and all Letters Patent of the United States on said invention or resulting from said application, including any continuations, continuations-in-part, divisions, reissues, re-examinations, substitutions, and extensions thereof, to said ASSIGNEE, its successors, assigns, and legal representatives as the ASSIGNEE of the entire right, title, and interest herein assigned;

ASSIGNORS also do hereby agree to, at any time, upon request, without further or additional consideration but at the expense of said ASSIGNEE, its successors, assigns, or legal representatives, execute and deliver any and all papers, make all rightful oaths, and do all lawful acts that may be necessary or desirable to perfect the entire right, title, and interest in said application, including any and all continuations, continuations-in-part, divisionals, reissues, re-examinations, substitutions, and extensions thereof, and any and all patents of the United States and foreign countries that may issue therefrom said ASSIGNEE, its successors, assigns, and legal representatives, and generally do everything possible to vest the entire right, title, and interest herein assigned in said ASSIGNEE, its successors, assigns, and legal representatives;

ASSIGNOR also does hereby grant to ASSIGNEE, its successors and assigns, and legal representatives thereof, the power to insert on this Assignment any further identification which may be necessary or desirable in order to comply with the rules of the United States Patent and Trademark Office or foreign equivalent thereof for recordation of this document.

This ASSIGNMENT is effective as of April 9, 2011.

ActiveUS 155697461v.1

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign: _____
Name: Michael Scott Martin
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Michael Scott Martin, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign: _____
Name: Chad Ashmore
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Chad Ashmore, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign: _____
Name: Eric A. Deines
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Eric A. Deines, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign: _____
Name: Gary A. Freeman
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Gary A. Freeman, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign: _____
Name:Joseph L. Helmick
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Joseph L. Helmick, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign: _____
Name: Thomas E. Kaib
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Thomas E. Kaib, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign: _____
Name: Richard A. Rattanni
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Richard A. Rattanni, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign:_____
Name:C. Shane Reid
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came C. Shane Reid, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this 6th day of November, 2016.

Sign: Jeremy Ryan Soller
Name: Jeremy Ryan Soller
ASSIGNOR

Date: Nov. 6, 2016

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Jeremy Ryan Soller, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign: _____
Name:Shane S. Volpe
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Shane S. Volpe, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign: _____
Name:Gary Ruggiero
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Gary Ruggiero, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public

IN WITNESS WHEREOF, I have hereunto set my hand and seal this _____ day of _____, _____.

Sign: _____
Name: Frederick J. Geheb
ASSIGNOR

Date: _____

United States of America)
State of _____) ss.:
County of _____)

On this _____ day of _____, _____, before me personally came Frederick J. Geheb, to me known to described in and who executed the foregoing instrument, and acknowledged execution of the same.

_____
Notary Public