Patient Unified Lookup System for Emergencies (PULSE)
System Design

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Submitted to: California Emergency Medical Services Authority

Submitted by: California Association of Health Information Exchanges
PULSE +EMS Subject Matter Expert Advisor

The PULSE project was developed in collaboration with Office of the National Coordinator for Health Information Technology (ONC) staff to support nationwide health information exchange and care coordination efforts.
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1. Introduction

The California Emergency Medical Services Authority (EMSA) received a significant investment from the Office of the National Coordinator for Health Information Technology to support the integration of health information exchange with emergency medical services in California. This funding in part supports the development of a disaster response medical history portal called the Patient Unified Lookup System for Emergencies (PULSE) that is the subject of this document.

This document describes the high-level system design and architecture for PULSE; that is its structure, comprising system and software elements, the externally visible properties of those elements including external interfaces, and the relationship among the elements. This document also describes some elements of the hardware design for a cloud-based hosted implementation, and some elements of the software design.

1.1. System Overview

Natural or manmade disaster situations often force individuals to seek care outside of their usual facilities or provider networks. Additionally, the disaster area’s healthcare system is often stretched beyond its limits during a disaster, and volunteers must be placed into service to care for victims and evacuees. The result is that those delivering care may not have access to the primary systems holding the health information of the patients being received at their facility, leading to suboptimal outcomes and potential patient safety issues.

PULSE is intended to provide healthcare professionals with access to electronic health information for victims and evacuees during times of large-scale disaster – information that may be drawn from disparate systems within and outside of the affected region. Users of PULSE include disaster healthcare volunteers that will access health information through a web-based portal, and healthcare professionals that may use the capabilities of PULSE to search for and retrieve information from within the capabilities of their electronic health record systems or health information exchange systems. PULSE is not intended to be a replacement for an electronic health record, electronic patient care reporting system, or any other means for documenting care, but a supplement to existing electronic and paper-based systems designated for that purpose.

PULSE will be integrated with the existing California Disaster Healthcare Volunteers (DHV) database, California’s implementation of Emergency Service Advance Registry for Volunteer Healthcare Professionals (ESAR-VHP) that provides a registry for individuals who wish to volunteer to serve during an emergency or disaster. Healthcare professionals preregistered through DHV and activated for a disaster response will be able to access the PULSE portal, with DHV providing the means for authentication and authorization to access protected health information electronically.

PULSE will also be integrated with Directory Services, a component of the California Trusted Exchange Network (CTEN). Directory Services provides a services registry with the information PULSE requires to identify the healthcare organizations and facilities that participate in PULSE, and the means by which to search for and retrieve health information from them electronically.
There are five primary use cases envisioned for PULSE, which are retrieving health information to aid in caring for:

1. displaced patients evacuated from healthcare facilities in the disaster area for which a potential source of health records may be known
2. injured victims of the disaster transported by first responders for which little identifying information or prior healthcare history may be known
3. injured victims of the disaster transported by themselves, family, or neighbors for which more identifying information and healthcare history may be available
4. walking wounded victims and evacuees presenting to alternate care facilities with minor injuries requiring treatment
5. evacuees seeking primary care for chronic conditions or health issues unrelated to the disaster itself but unable to obtain it through their regular care providers or facilities

PULSE must support these potential use cases. It must be able to correctly match patient identities with varying amounts of input demographics or knowledge of organizations that have previously provided care, and be able retrieve health information suitable for the varying needs of the specific victim or evacuee.

See *Patient Unified Lookup System for Emergencies (PULSE)* for more information on the concepts for PULSE.

1.2. Scope
This document describes the system design and architecture for PULSE as is visible from outside the system and that may be necessary for:

- proper interfacing to Emergency System for Advance Registration of Volunteer Health Professionals (ESAR-VHP), which in California is called Disaster Healthcare Volunteers (DHV)
- proper interfacing to Directory Services
- proper interfacing to participating healthcare systems and health information exchanges

It also provides a high-level, systems view of the overall PULSE system that may be useful as an introduction to those ultimately needing more information on the software or hardware architecture of PULSE, DHV, and/or Directory Services that is documented elsewhere.

This document includes the architecture for the entire system, including some aspects of DHV and Directory Services.

This document does not describe the software design or architecture for PULSE beyond aspects that are visible from other system components.

1.3. Design Constraints
The following are constraints in the system design, including assumptions made by the project team in developing the system design.
1.4. Definitions, Acronyms, andAbbreviations
The following is a list of terms and their definitions as used in this document:

- **alternate care facility** – A location other than a dedicated healthcare facility, such as a triage center of field hospital, at which disaster victims or evacuees may be provided with health care during a widespread disaster.
- **California Trusted Exchange Network or CTEN** – A common set of policies, procedures, and lightweight technical infrastructure to create a trust environment for statewide health information exchange in California.
- **Carequality** – An initiative of The Sequoia Project that has developed a consensus-based process to enable interoperability and health information exchange across participating networks.
- **Directory Services** – When capitalized, an external electronic services registry containing information necessary for PULSE to execute queries and retrieve health information.
- **DHV (or Disaster Healthcare Volunteers)** – The California implementation of the Emergency System for Advance Registration of Volunteer Health Professionals (ESAR-VHP) operated by the California Emergency Medical Services Authority.
- **disaster healthcare volunteer(s)** – A PULSE user authenticated through DHV and authorized to retrieve health information via PULSE’s web-based portal.
- **electronic health record** – Software that manages a patient-centered, electronic version of a patient’s medical record, allowing authorized users to document encounters, and view and stored information.
- **external health system** – A health information system operated by a covered entity or its business associate participating in PULSE for the purpose of responding to queries for protected health information.
- **health information exchange** – The process of moving electronic health information among disparate healthcare information systems, or alternatively the technology or organization that enables this process.
- **healthcare professional** – A PULSE user that is a healthcare professional not acting as a disaster healthcare volunteer and not located at an alternate care facility and accessing PULSE through their existing EHR or HIE.
- **Unified Modeling Language** – A set of diagrams intended to provide a standardized way to visualize the design of a software system.

The following acronyms and abbreviations are used in this document:

- **ACF** – alternate care facility
- **CTEN** – California Trusted Exchange Network
- **DHV** – Disaster Healthcare Volunteers
- **EHR** – electronic health record
- **ESAR-VHP** – Emergency System for Advance Registration of Volunteer Health Professionals
• HIE – health information exchange
• PULSE – Patient Unified Lookup System for Emergencies
• SAML – Security Assertion Markup Language
• UML – Unified Modeling Language

1.5. Applicable Documents

The following document describes the system-level requirements for PULSE that are visible from outside the system and, like this document, forms part of the high-level system documentation for PULSE.

• Patient Unified Lookup System for Emergencies (PULSE) System Requirements Version 1.2 released 14 July 2017

The following documents describe technical standards used by PULSE and referenced within this document.

• Carequality Connected Agreement (CAA), approved 5 November 2015
• Carequality Query-Based Document Exchange Implementation Guide Version 1.0, adopted 5 November 2015
• HL7 CDA Release 2, CCD. Implementation specifications: HITSP Summary Documents Using HL7 CCD Component HITSP/C32
• HL7 FHIR® Standard for Trial Use 3 (STU3) Release 3, version 3.0.0, published 21 March 2017
• IHE IT Infrastructure Technical Framework Volume 2a (ITI TF-2a) Transactions Part A Revision 13.0, released 9 September 2016
• Nationwide Health Information Network Messaging Platform Specification Version 3.0, released 27 July 2011
• Nationwide Health Information Network (NHIN) Patient Discovery Web Service Interface Specification Version 2.0, released 27 July 2011
• Nationwide Health Information Network (NHIN) Query for Documents Web Service Interface Specification Version 3.0, released on 27 July 2011
• Nationwide Health Information Network (NHIN) Retrieve Documents Web Service Interface Specification Version 3.0, released 27 July 2011
• OASIS Security Assertion Markup Language (SAML) Version 2.0, released 15 March 2005

The following documents may be useful in understanding the purpose of PULSE and its intended use:

• Health Information Exchange Services in Support of Disaster Preparedness and Emergency Medical Response, prepared for the Office of the National Coordinator for Health IT Audacious Inquiry, published 21 April 2014
1.6. Revision History

Table 1 Revision history for the System Design Document

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<th>Date</th>
<th>Description</th>
</tr>
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<tr>
<td>1.1</td>
<td>14 July 2017</td>
<td>Modified to decouple the SAML assertion provided by DHV for single sign-on from the SAML assertion passed to External Health Systems to authorize disclosure of PHI, corresponding to changes to requirements 4.2.1 and 4.3.4 in version 1.2 of the Patient Unified Lookup System for Emergencies (PULSE) System Requirements</td>
</tr>
<tr>
<td>1.0</td>
<td>25 May 2017</td>
<td>Initial release</td>
</tr>
<tr>
<td>12</td>
<td>May 2017</td>
<td>Draft for initial review</td>
</tr>
</tbody>
</table>
2. System Architecture

This section describes the overall system architecture that is visible from outside the system. Where possible, Unified Modeling Language (UML) diagrams have been used as an aid to visualizing the system design.

The Patient Unified Lookup System for Emergencies (PULSE) System Requirements identified some requirements for PULSE at a lower priority that may not be implemented in the initial phase of development. Those requirements were considered and included in the system design and are described in this architecture.

2.1. System Software Architecture

2.1.1. PULSE System Actors and Interactions

Figure 1 shows the high-level conceptual architecture for PULSE, illustrating the major actors and their interactions.

![Conceptual architecture diagram](image)

**Figure 1** Conceptual architecture illustrating the components of the PULSE system, major actors, and their interactions

**Actors**

The **Disaster Healthcare Volunteer** is the primary user for PULSE. This user searches for patient matches corresponding to disaster victims or evacuees via PULSE, examines potential patient matches returned by PULSE, selects among potential matches for those corresponding to the victim or evacuee of interest, requests relevant health information from PULSE, and views and/or prints health information returned by PULSE.

All Disaster Healthcare Volunteers interact with PULSE securely over the Internet via a **Browser** using a web-based portal application exposed by PULSE.
Disaster Healthcare Volunteers gain access to PULSE by first authenticating to ESAR-VHP (DHV) (or simply DHV), California’s implementation of the Emergency System for Advance Registration of Volunteer Health Professionals operated by the California Emergency Medical Services Authority. DHV provides single sign-on to PULSE for all Disaster Healthcare Volunteers, and redirects the Browser to the PULSE web-based application. DHV interacts with PULSE securely over the Internet and uses SAML for single sign-on.

The Healthcare Professional is an alternate user of PULSE that may perform the same functions as the Disaster Healthcare Volunteer. Healthcare Professionals are distinct from Disaster Healthcare Volunteers in that they are not authenticated through DHV, nor do they use the web-based PULSE portal application.

Instead, the Healthcare Professional interacts with PULSE through an EHR or HIE operated by a healthcare delivery organization or health information exchange organization in which they participate. Healthcare Professionals are authenticated by the EHR or HIE, and are authorized to access health information provided by PULSE through their EHR or HIE. The EHR or HIE accesses PULSE securely over the Internet using accepted and widely-adopted national standards, optionally using the trust framework and specifications of Carequality.

Disaster Healthcare Volunteers and Healthcare Professionals use PULSE to request and review copies of health information obtained from External Health Systems. PULSE seeks patient matches for disaster victims or evacuees and requests health information on matched patients securely over the Internet using accepted and widely-adopted national standards, optionally using the trust framework and specifications of Carequality.

PULSE obtains a listing of the External Healthcare Systems participating in PULSE and the technical information it needs to interact with them using the services registry published by Directory Services, a component of the California Trusted Exchange Network (CTEN) operated by the California Association of Health Information Exchanges. PULSE requests information on External Healthcare System services from Directory Services over the Internet using emerging national standards for provider directories.

PULSE is the core software component of the PULSE system, and performs two logical functions.

1. It manages all interactions with the Disaster Healthcare Volunteers by exposing a web-based portal application used to search for patients, select among potential patient matches, request health information on matched patients, and view and/or print retrieved information.
2. It orchestrates all interactions with external systems, including single sign-on via DHV for Disaster Healthcare Professionals, health information exchange with an EHR or HIE used by Healthcare Professionals, retrieval of service information on External Health Systems from Directory Services, and health information exchange with External Health Systems.

PULSE interacts with all external systems over the Internet, using established national standards whenever possible.
2.1.2. PULSE Use Cases

Figure 2 illustrates the primary use cases implemented by the PULSE system. This figure includes only those use cases that involve Disaster Healthcare Volunteers and Healthcare Professionals. Administrative use cases for the PULSE software component or external systems are beyond the scope of this document.

![Use Case Diagram for PULSE](image)

**Figure 2** Use case diagram for the primary use cases implemented by PULSE for Disaster Healthcare Volunteers and Healthcare Professionals

The use cases in Figure 2 are based on a query/response health information exchange pattern described in the *Nationwide Health Information Network (NHIN) Patient Discovery Web Service Interface Specification*, *Nationwide Health Information Network (NHIN) Query for Documents Web Service Interface Specification*, and *Nationwide Health Information Network (NHIN) Retrieve Documents Web Service Interface Specification*. This exchange pattern retrieves health information in three distinct steps:

1. Discovering matches to an individual disaster victim or evacuee by querying External Health Systems for potential matches using demographics that describe them
2. Querying External Health Systems for documents containing health information on the matched patient
3. Retrieving documents from External Health Systems from the list of those available on a matched patient

While all three activities must be performed, it is the retrieval of health information in the final steps that is the goal of the overall use cases in Figure 2.

**Use Cases**

Disaster Healthcare Volunteers **Authenticate** to PULSE using DHV by entering their login credentials.

DHV **Checks If Active** to determine whether the PULSE system is active, and only allows Disaster Healthcare Volunteers to authenticate to PULSE if it is.
In response to user input, PULSE **Finds Matching Patients** that may have health information on External Healthcare Systems based on patient demographics, **Finds Documents** for those patients made available by External Healthcare Systems which it may retrieve, and **Retrieves Documents** from External Healthcare Systems selected from those available. The Retrieve Documents process requires and therefore includes the Finds Documents process which in turn requires and includes the Finds Matching Patients process.

Disaster Healthcare Volunteers **View / Print Documents** containing health information that PULSE retrieves from External Health Systems. They can only perform this task if they have already authenticated to PULSE using DHV. The View / Print Documents process is an extension of, and therefore requires, the Retrieve Documents process be performed by PULSE.

In order to View / Print Documents, Disaster Healthcare Volunteers **Select Patients** from potential matches to disaster victims or evacuees that PULSE retrieves from External Health Systems. The Select Patients process is an extension of, and therefore requires, the Find Matching Patients process be performed by PULSE.

PULSE **Finds Systems** from Directory Services to determine which External Healthcare Systems are participating in PULSE and to determine the service information necessary to retrieve information from them.

While PULSE implements the View / Print Document and Select Patients use cases for Disaster Healthcare Volunteers, Healthcare Professionals access Find Matching Patients, Finds Document, and Retrieve Documents processes of PULSE directly through their EHR or HIE systems, the details of which is beyond the scope of this document.

### 2.1.3. High-Level PULSE Components

Figure 3 shows a simplified UML component diagram for the PULSE system.
Components
The components in Figure 3 correspond to the Actors in Figure 1, and fulfill the functions and activities described in that section. Only a brief description of each component is included here.

**PULSE** is the core software component of the PULSE system. It manages interactions with Disaster Healthcare Volunteers through a web-based portal application and orchestrates interactions with all other components.

**Web Browser** is an external component operated by a Disaster Healthcare Volunteer that accesses the web-based portal application exposed by PULSE facilitating access to health information on disaster victims and evacuees.

**ESAR-VHP (DHV)** is California’s implementation of the Emergency System for Advance Registration of Volunteer Health Professionals, an external component operated by the California Emergency Medical Services Authority that provides single sign-on to PULSE for all Disaster Healthcare Volunteers.

**EHR or HIE** is zero or more external components operated by healthcare delivery organizations or health information exchange organizations facilitating access to health information on disaster victims and evacuees for Healthcare Professionals other than Disaster Healthcare Volunteers.

**Directory Services** is an external component of the CTEN operated by the California Association of Health Information Exchanges that publishes a services registry listing of the External Healthcare Systems participating in PULSE and the technical information needed to interact with them.

**External Health Systems** are one or more external components operated by healthcare delivery organizations or health information exchange organizations that respond to requests for health information on disaster victims and evacuees.

See Section 2.1.1, *PULSE System Actors and Interactions*, for more information on the activities of the actors that correspond to these high-level components.

Interfaces
The interfaces in Figure 3 are described in more detail in Section 3.3, *External Interfaces*. Only a brief description of each interface is included here.

**Request Status** is a proprietary but open RESTful web service that returns the status of PULSE as active or inactive.

**Query for Systems** is a standards-based RESTful web service that returns a list of the organizations and facilities participating in PULSE and the information required to request health information from the External Healthcare Systems associated with them.

**Patient Discovery** is a standards-based SOAP web service that allows PULSE to query External Health Systems for individuals matching disaster victims and evacuees based on demographic information.
**Query for Documents** is a standards-based SOAP web service that allows PULSE to retrieve a list of documents available for any matched patient identified through Patient Discovery.

**Retrieve Documents** is a standards-based SOAP web service that allows PULSE to retrieve specific documents identified through Query for Documents containing health information specific patients identified through Patient Discovery.

2.1.4. **PULSE Data Flow**

Figure 4 and Figure 5 outline the flow of data among to the *Actors* included in Figure 1 and necessary to fulfill the functions and activities described in that section. Like the *Use Cases* in Figure 2, Figure 4 and Figure 5 illustrate the primary data flow implemented by the PULSE system to support the retrieval of health information for disaster victims and evacuees by Disaster Healthcare Volunteers and Healthcare Professionals, respectively. Data flows to support administrative functions are beyond the scope of this document.

Figure 4 includes the data flow to support use cases for the Disaster Healthcare Volunteer.

Figure 5 illustrates the data flow to support use cases for the Healthcare Professional.
Functions

Authenticate and Authorize: A Disaster Healthcare Volunteer authenticates to DHV, which creates a SAML assertion that is passed to PULSE to authenticate the individual and authorize access to health information. The format of the assertion is described in the OASIS Security Assertion Markup Language (SAML). The content of the assertion provides information on the user as described in the Nationwide Health Information Network (NHIN) Authorization Framework Specification.

Authenticate and Authorize is a function of the data flow for Disaster Healthcare Volunteers access PULSE via the web-based portal application only.

Query for Participating Systems: PULSE generates a query to Directory Services, requesting a list of organizations and/or facilities participating in PULSE and the electronic service information required to request health information from them. Directory Services responds with organization, facility and electronic endpoint information. The query from PULSE and response from Directory Services is described in Section 3.3, External Interfaces.

PULSE may save and reuse information obtained from Directory Services for some period of time to reduce traffic on the interface. Frequency of the query is a configurable parameter in PULSE.

Discover Potential Patient Matches: A Disaster Healthcare Volunteer or Healthcare Professional enters demographic information for the disaster victim or evacuee in the web-based portal interface exposed by
PULSE or the EHR/HIE interface, respectively. PULSE creates a SAML assertion using user and other information obtained from DHV or the EHR/HIE, and sends a Patient Discovery request to identify potential matching patients to all External Health Systems simultaneously. Each External Health System responds with matches, which PULSE consolidates and presents to the Disaster Healthcare Volunteer or Healthcare Professional. The query from PULSE, SAML assertion, and responses from External Health systems are described in Section 3.3, External Interfaces.

**List Documents for Matched Patients:** A Disaster Healthcare Volunteer or Healthcare Professional reviews the list of potential patient matches and the organizations or facilities that contain health information for each potential match, and selects the matches and organizations/facilities corresponding to the disaster victim or evacuee of interest. PULSE takes the selected matches, creates a SAML assertion using user and other information obtained from DHV or the EHR/HIE, and sends a Query for Documents request to obtain a list of documents containing health information associated to each patient match to each corresponding External Health Systems simultaneously. Each External Health System responds with a list of available documents, which PULSE consolidates and presents to the Disaster Healthcare Volunteer or Healthcare Professional. The query from PULSE, SAML assertion, and responses from External Health systems are described in Section 3.3, External Interfaces.

For Disaster Healthcare Volunteers accessing PULSE through the web-based portal application, Discover Potential Patient Matches and List Documents for Matched Patients are functions of the “search” mode of PULSE.

**Retrieve Selected Documents:** A Disaster Healthcare Volunteer or Healthcare Professional reviews the list of available documents and selects those of interest. PULSE takes the list of selected documents, creates a SAML assertion using user and other information obtained from DHV or the EHR/HIE, and sends a Retrieve Documents request to obtain the selected documents containing health information to each corresponding External Health Systems simultaneously. Each External Health System responds with the requested documents, which PULSE saves temporarily and presents to the Disaster Healthcare Volunteer or Healthcare Professional. The query from PULSE, SAML assertion, and responses from External Health systems are described in Section 3.3, External Interfaces.

For Disaster Healthcare Volunteers accessing PULSE through the web-based portal application, Retrieve Selected Documents is a function of the “review” mode of PULSE.

**2.1.5. PULSE Interactions**

Figure 6 describes the sequence of interactions between the Disaster Healthcare Volunteer (using a web browser), DHV, and PULSE for authenticating to PULSE and authorizing access to health information.
**Login**: The Disaster Healthcare Volunteer directs their web browser to the DHV web site and logs in using the login credentials established for their use of DHV. The details of the standards and mechanisms used for this interaction are beyond the scope of this document.

**Request Status**: DHV queries PULSE for its current activation status using Request Status as described in Section 3.3, *External Interfaces*.

**Status**: If active, PULSE responds with a JSON object response to Request Status as described in Interfaces in Section 2.1.3 *High-Level PULSE Components* with the current status of PULSE. If not active, PULSE may not respond to the query, or may respond with a JSON object response that indicates an inactive state as described in Section 3.3, *External Interfaces*.

**Login Screen**: DHV presents the Disaster Healthcare Volunteer with a landing page that indicates the status of PULSE and, if PUSLE is active, and opportunity to log into PULSE. If the user chooses to log into PULSE, the following sequence of events apply. If not, the user may navigate away from this landing page and use DHV for some other purpose.

**Login**: The Disaster Healthcare Volunteer logs in again to confirm their identity using the login credentials established for their use of DHV.

The reminder of the interaction is a subset of the classic SAML use case for web browser single sign-on.

**XHTML response**: DHV validates the request and responds to the browser with a document containing a standardized XHTML form with a base64-encoding of a SAML assertion containing information about the authentication and the authorization to access PULSE.

**Request Service**: The browser issues a POST request to PULSE based on information in the XHTML form.
Redirect: If PULSE accepts the SAML assertion included in the POST request, the Disaster Healthcare Volunteer’s browser is redirected to the initial PULSE page.

(authorized access): Not actually a step in the interaction, (authorized access) represents a placeholder for the more complete interactions show in Figure 7 and Figure 8.

See Section 3.3, External Interfaces for a description of the interfaces that comprise these interactions.

Figure 7 describes the sequence of interactions between the Disaster Healthcare Volunteer (using a web browser), PULSE, Directory Services, and External Health Systems for the “search” mode of operation. Search mode is described in Section 4.1.2, Searching for Patient Matches.

Figure 7  High-level sequence diagram for a Disaster Healthcare Volunteer searching for patient matches for a victim or evacuee via the web-based portal application
Login through (authorized access): The Disaster Healthcare Volunteer logs into DHV and, if PULSE is active, is directed to PULSE through SAML web browser single sign-on. The abbreviated single sign-on process illustrated in Figure 7 is a reference to the full authentication and authorization process described in Figure 6 and the text that follows that figure. Please refer to Figure 6 for a complete description of the authentication and authorization process using SAML web browser single sign-on.

Select Search Function: The Disaster Healthcare Volunteer uses their browser to enter the Search mode. PULSE displays a form to enter demographic information.

The following sequence illustrates the normal activity of a Disaster Healthcare Volunteer using the Search mode of PULSE.

Enter Patient Demographics: The Disaster Healthcare Volunteer enters demographic information for a disaster victim or evacuee of interest using a web form presented by PULSE in their browser, and submits the form to PULSE.

Log Request: PULSE logs the request in the audit log.

Query for Systems: PULSE queries Directory Services for information on participating External Healthcare Systems as described in Section 3.3, External Interfaces. Directory Services responds with a list of External Healthcare Systems participating in PULSE and the information necessary to query them for information electronically.

Cache Results: PULSE saves the information returned by Directory Services for some configurable period of time for reuse in subsequent interactions with External Healthcare Systems.

Patient Discovery: PULSE queries all External Healthcare Systems identified by Directory Services for potential patient matches for the demographic information entered by the Disaster Healthcare Volunteer as described in Section 3.3, External Interfaces. All queries are placed in parallel. Each External Healthcare System in turn responds with a list of potential patient matches, if any.

Log Response: PULSE logs the response of each External Healthcare System in the audit log. PULSE then presents the list of potential matches to the Disaster Healthcare Volunteer via their web browser.

Select Patient(s) of Interest: The Disaster Healthcare Volunteer selects among the potential matches displayed by PULSE one or more matching the disaster victim or evacuee of interest.

Log Selection: PULSE logs the selection in the audit log.

Query for Documents: PULSE queries the appropriate External Healthcare Systems for a list of documents containing health information corresponding to the patient matches identified by the Disaster Healthcare Volunteer in as described in Section 3.3, External Interfaces. All queries are placed in parallel. Each External Healthcare System in turn responds with a list of documents corresponding to each matched patient, if any.

Log Response: PULSE logs the response of each External Healthcare System in the audit log.
See Section 3.3, *External Interfaces* for a description of the interfaces that comprise these interactions.

Figure 8 describes the sequence of interactions between the Disaster Healthcare Volunteer (using a web browser), PULSE, Directory Services, and External Health Systems for the “review” mode of operation. Review mode is described in Section 4.1.3, *Retrieving and Reviewing Health Information*.

![High-level sequence diagram for a Disaster Healthcare Volunteer retrieving and viewing health information for a disaster victim or evacuee via the web-based portal application](image)

**Figure 8** High-level sequence diagram for a Disaster Healthcare Volunteer retrieving and viewing health information for a disaster victim or evacuee via the web-based portal application

**Login through (authorized access):** The Disaster Healthcare Volunteer logs into DHV and, if PULSE is active, is directed to PULSE through SAML web browser single sign-on. The abbreviated single sign-on process illustrated in Figure 8 is a reference to the full authentication and authorization process described in Figure 6 and the text that follows that figure. Please refer to Figure 6 for a complete description of the authentication and authorization process using SAML web browser single sign-on.
Select **Review Function**: The Disaster Healthcare Volunteer uses their browser to enter the Review mode. PULSE displays a list of patients selected by a Disaster Healthcare Volunteer using Search mode.

The following sequence illustrates the normal activity of a Disaster Healthcare Volunteer using the Review mode of PULSE.

Select **Patient of Interest**: The Disaster Healthcare Volunteer selects from the list of patients the one corresponding to the disaster victim or evacuee of interest, and submits that information to PULSE. PULSE responds by displaying a list of available documents containing health information for the selected patient.

Select **Document(s) of Interest**: The Disaster Healthcare Volunteer selects from among potential documents containing health information to retrieve from External Healthcare Systems using their web browser, and submits that information to PULSE.

Log **Request**: PULSE logs the request in the audit log.

Query for **Systems**: PULSE queries Directory Services for information on participating External Healthcare Systems as described in Section 3.3, External Interfaces. Directory Services responds with a list of External Healthcare Systems participating in PULSE and the information necessary to query them for information electronically.

Cache Results: PULSE saves the information returned by Directory Services for some configurable period of time for reuse in subsequent interactions with External Healthcare Systems.

Both Query for Systems and Cache Results may be skipped if PULSE uses previously saved information on External Healthcare Systems participating in PULSE.

Retrieve Documents: PULSE requests the document(s) selected by the Disaster Healthcare Volunteer from the appropriate External Healthcare System(s) as described in Section 3.3, External Interfaces. If more than one document is requested, all requests are placed in parallel. Each External Healthcare System in turn responds with the requested document, if available.

Log Response: PULSE logs the response of each External Healthcare System in the audit log. PULSE then saves the retrieved documents for some configurable length of time, and presents the list of retrieved documents to the Disaster Healthcare Volunteer via their web browser. The Disaster Healthcare Volunteer may select and view any of the retrieved documents in their browser or choose to print them.

Both Retrieve Documents and Log Response may be skipped if PULSE has previously retrieved the selected documents. In this case, PULSE simply displays the list of retrieved documents to the Disaster Healthcare Volunteer in their browser.

Figure 9 describes the sequence of interactions between the Healthcare Professional, PULSE, Directory Services, and External Health Systems when using an EHR or HIE to retrieve health information. This scenario is described in Section 4.2, *Retrieving Health Information via an EHR or HIE*. 
Enter Patient Demographics: Demographic information for a disaster victim or evacuee of interest is identified in the EHR or HIE by the Healthcare Professional.

Patient Discovery (EHR or HIE to PULSE): The EHR or HIE queries PULSE for potential patient matches for the demographic information identified in the EHR or HIE as described in Section 3.3, External Interfaces.
Log Request: PULSE logs the query in the audit log.

Query for Systems: PULSE queries Directory Services for information on participating External Healthcare Systems as described in Section 3.3, External Interfaces. Directory Services responds with a list of External Healthcare Systems participating in PULSE and the information necessary to query them for information electronically.

Cache Results: PULSE saves the information returned by Directory Services for some configurable period of time for reuse in subsequent interactions with External Healthcare Systems.

Both Query for Systems and Cache Results may be skipped if PULSE uses previously saved information on External Healthcare Systems participating in PULSE.

Patient Discovery (PULSE to External Healthcare Systems): PULSE queries all External Healthcare Systems identified by Directory Services for potential patient matches for the demographic information identified in the EHR or HIE as described in Section 3.3, External Interfaces. All queries are placed in parallel. Each External Healthcare System in turn responds with a list of potential patient matches, if any.

Log Response: PULSE logs the response of each External Healthcare System in the audit log. PULSE then returns a consolidated list of all potential matches returned by all External Healthcare Systems to the EHR or HIE.

Query for Documents (EHR or HIE to PULSE): The EHR or HIE queries PULSE for a list of documents containing health information corresponding to patient matches identified by some process in the EHR or HIE in as described in Section 3.3, External Interfaces.

Log Selection: PULSE logs the query in the audit log.

Query for Documents (PULSE to External Healthcare Systems): PULSE queries the appropriate External Healthcare Systems for a list of documents containing health information corresponding to the patient matches identified in the EHR or HIE in as described in Section 3.3, External Interfaces. All queries are placed in parallel. Each External Healthcare System in turn responds with a list of documents corresponding to each matched patient, if any.

Log Response: PULSE logs the response of each External Healthcare System in the audit log.

Retrieve Documents (EHR or HIE to PULSE): The EHR or HIE requests the document(s) identified in the EHR or HIE from PULSE as described in Section 3.3, External Interfaces.

Log Request: PULSE logs the request in the audit log.

Retrieve Documents (PULSE to External Healthcare Systems): PULSE requests the document(s) identified by the EHR or HIE from the appropriate External Healthcare System(s) as described in Section 3.3, External Interfaces. If more than one document is requested, all requests are placed in parallel. Each External Healthcare System in turn responds with the requested document, if available.
Log Response: PULSE logs the response of each External Healthcare System in the audit log. PULSE then returns the retrieved documents to the EHR or HIE.

See Section 3.3, External Interfaces for a description of the interfaces that comprise these interactions.

2.2. System Hardware Architecture

Figure 10 shows the high-level component diagram, similar to Figure 3, but including some of the internal software structure of PULSE.

![Component diagram illustrating the major subsystems that comprise PULSE, including some minimal internal software structure of PULSE](image)

A detailed description of the software components that comprise the internal structure of PULSE is beyond the scope of this document, and are outlined only briefly to facilitate description of the “hardware” deployment.

Logically, PULSE comprises:

1. a “message broker” that orchestrates the exchange of health information
2. an “audit log” that records the activities of PULSE
3. “interface services” that implement the interfaces between PULSE and external components, and
4. a “web portal” that implements the web-based application used by Disaster Healthcare Volunteers.
Please refer to the detailed *Software Design Document* for PULSE for a complete description of the components that actually comprise PULSE.

Figure 11 shows the high-level “hardware” architecture for implementing PULSE in a cloud-based hosting environment as a deployment diagram.

![High-level hardware architecture for the PULSE system as a deployment diagram](image)

**Figure 11** High-level hardware architecture for the PULSE system as a deployment diagram

**DMZ:** Web Services and Interface Services are hosted in a logical sub-network that separates the Message Broker and Audit Log from other untrusted networks accessed through the Internet. All *External Interfaces* to DHV, Directory Services, EHRs or HIEs, and External Health Systems are implemented by PULSE components hosted in the DMZ.

**Private Network:** The Message Broker and Audit Log are hosted in a logical private network with no external connections save to the DMZ. All functions that are not related to external connections via untrusted networks are implemented by PULSE components hosted in the Private Network.

A full hardware bill of materials is beyond the scope of this document. Please refer to the detailed *Software Design Document* for PULSE for more information on the hardware design.
3. System Design

3.1. File and Database Design
This section describes the design of all database management system files and other files maintained or used by PULSE that have external visibility.

3.1.1. PULSE Audit Log
PULSE records information about queries it receives, queries and requests it places to external systems, responses to those requests, and other activities in an Audit Log implemented as a number of tables in a relational database management system.

PULSE does not expose the Audit Log through any interface, and the database is not visible externally. Access to the database is available only to administrators, and a description of that access is beyond the scope of this document. Please refer to the detailed Software Design Document for PULSE for a description of design of the Audit Log database.

3.1.2. PULSE Configuration Files
PULSE has a number of configurable parameters that may be specified in configuration files. PULSE does not expose the configuration files through any interface, including through any user interface or administration console, and the configuration files are not visible externally. Access to the configuration files is available only to administrators, and a description of that access is beyond the scope of this document. Please refer to the detailed Software Design Document for PULSE for a description of configuration files.

3.2. Human-Machine Interface

3.2.1. Interactions with Disaster Healthcare Volunteers
All interactions with Disaster Healthcare Volunteers occurs through DHV and a web-based portal application exposed by PULSE. The following sections describe the inputs requested by PULSE of a Disaster Healthcare Volunteer and outputs provided by PULSE in response to those inputs, organized along major phases of a Disaster Healthcare Volunteer user’s interaction with the system.

Authentication
Disaster Healthcare Volunteers gain access to PULSE by first logging into DHV. Figure 12 shows the landing page presented to the Disaster Healthcare Volunteer following successful log in. This figure shows the status of PULSE as “Active”.

If “Log In To PULSE” is selected, DHV presents the Disaster Healthcare Volunteer with the login form shown in Figure 13. The Disaster Healthcare Volunteer must confirm their login credentials for DHV in this form in order to gain access to PULSE.
Figure 12  Landing page presented by DHV informing the Disaster Healthcare Volunteer that PULSE is Active

Figure 13  Login form presented by DHV allowing the Disaster Healthcare Volunteer to authenticate to PULSE
Figure 14 shows the landing page presented by PULSE after successful authentication via DHV and redirection to the PULSE web-based portal application. The Disaster Healthcare Volunteer must select the county and location of the alternate care facility (ACF) to which the worker has reported. PULSE will associate patient matches for disaster victims and evacuees that with this ACF.

![Figure 14 Landing page and form presented by PULSE requesting the user to identify the Alternate Care Facility (ACF) in which they are working during this session](image)

**Searching for Matches for Disaster Victims and Evacuees**

Following selection of an ACF, PULSE defaults to the “Search” mode of operation and presents the Disaster Healthcare Volunteer with the form in Figure 15.

![Figure 15 Form presented by PULSE to request demographic information for a disaster victim or evacuee](image)

The Disaster Healthcare Volunteer can switch from the default to “Review” mode of operation by clicking on “Review”. Otherwise, the Disaster Healthcare Volunteer enters the first name, last name,
gender, date of birth (month, day, and year), and optionally the address and/or social security number for a disaster victim or evacuee in this form and clicks on “Search” at the bottom of the form to initiate a search for potential matches at all External Health Systems.

Once a search is initiated, the form is cleared and PULSE displays the ongoing status of the search on the right side of the form in Figure 15. PULSE can initiate multiple searches asynchronously, allowing the Disaster Healthcare Volunteer to fill in the form with demographic information for another disaster victim or evacuee and initiate a new search before the last one has completed.

Figure 16 shows the response from PULSE following a completed search, listing the name, date of birth, and gender entered by the Disaster Healthcare Volunteer, and the date and time that the search completed on the right side of the form in the area labeled “Queries”. It also indicates how many potential matches were returned by External Health Systems in response to the search request. The Disaster Healthcare Volunteer can repeat the search if desired by clicking on the button with the circling arrows.

Pending queries displayed on the right side of the form in Figure 16 are visible only to the specific Disaster Healthcare Volunteer that initiated the search.

Not shown in Figure 16, PULSE displays the list of facilities corresponding to the External Health Systems being searched for matching patients while a search in progress, updating the display as each External Health System responds to the request for a match or returns an error. The Disaster Healthcare Volunteer can request that a search at a specific facility be repeated as well.

**Staging Matched Patients**

Once a search is completed, the Disaster Healthcare Volunteer can review the potential matches and select those that should be associated with the disaster victim or evacuee. Figure 17 shows the form presented by PULSE, listing the name, gender, date of birth, and social security information for each
potential match returned by queried External Health Systems, along with the facility that returned that match.

The Disaster Healthcare Volunteer can view additional demographic detail that may have been returned with each potential match, and selects those that should be combined to represent the disaster victim or evacuee of interest, a process referred to as “staging” the patient. The Disaster Healthcare Volunteer can revise the name, gender, date of birth, or social security number of the staged patient based on information returned in potential matches if desired.

Once a patient is staged, the Disaster Healthcare Volunteer is returned to the search form in Figure 16, and the staged patient is removed from the list of Queries.

**Retrieving Health Information**

From the “Search” mode screen, the Disaster Healthcare Volunteer can click on “Review” to enter the “Review” mode of PULSE.

In “Review” mode, the Disaster Healthcare volunteer is presented with a list of all staged patients within the selected ACF. Figure 18 shows the form PULSE displays when the Disaster Healthcare Volunteer
selects a staged patient from the list. The display contains a list of the documents that are available along with some of the metadata returned by the External Health System to describe the document content.

If a document has not yet been retrieved from the External Health System, the Disaster Healthcare Volunteer may retrieve it by clicking the button with the download icon. PULSE displays the status of each requested document retrieval, and displays a button with an eye icon when retrieval is complete.

Figure 18  Form presented by PULSE to allow the Disaster Healthcare Volunteer to select documents for matched patients staged to retrieve from External Health Systems for review

Reviewing Health Information

Figure 19 shows a rendering of a document containing health information displayed when the Disaster Healthcare Volunteer clicks a button with an eye icon next to any retrieved document.
The Disaster Healthcare Volunteer can review the document within PULSE, or can print the document using the print functionality in the web browser.

Any Disaster Healthcare Volunteer can retrieve and view documents on any patient staged within the ACF, whether or not they performed the search and staged the patient. This allows various Disaster Healthcare Volunteers for fill different roles in the ACF, such as registration, triage, or treatment. PULSE will retain information on staged patients for some configurable length of time, after which time the staged patient information is deleted and the search would have to be repeated.

Any Disaster Healthcare Volunteer can also view any retrieved document on any patient staged within the ACF, whether or not they requested the document be retrieved. PULSE will retrain retrieved documents for some configurable length of time, after which time the document is deleted and would have to be retrieved again.

3.2.2. Interactions with Healthcare Professional
PULSE does not interact directly with Healthcare Professionals accessing PULSE through their EHR or HIE. Therefore, the interactions with Healthcare Professionals is not strictly defined in the PULSE system design.

PULSE does have information requirements that must be supplied through some interaction of the Healthcare Professional with their EHR or HIE, and responds to the EHR or HIE with information that may be presented to the Healthcare Professional. These requirements and responses are listed below.

Information Requirements from the Healthcare Professional
The Healthcare Professional, through interaction with their EHR or HIE, must provide sufficient demographic information for the disaster victim or evacuee to formulate a proper query as defined in Section 3.3.4, Interface to External Health Systems.
The Healthcare Professional may be required to select among potential matching patients returned by PULSE, or this function may be automated in some way by the EHR or HIE.

The Healthcare Professional may be required to select among available documents for matching patient to retrieve and review, or this function may be automated in some way by the EHR or HIE.

**Information Provided to the Healthcare Professional**

PULSE will respond to a request for matching patients with a list of potential matches as defined in Section 3.3.4, *Interface to External Health Systems*. The EHR or HIE may present that list to the Healthcare Professional.

PULSE will respond to a query for documents with a list of available documents as defined in Section 3.3.4, *Interface to External Health Systems*. The EHR or HIE may present the list of documents to the Healthcare Professional.

PULSE will respond to a request to retrieve one or more documents with the documents as defined in Section 3.3.4, *Interface to External Health Systems*. The EHR or HIE may render those documents or otherwise display content to the Healthcare Professional for viewing.

### 3.3. External Interfaces

This section describes the external interfaces implemented by PULSE. See Figure 3 for a high-level component diagram that shows how the various *Components* in PULSE interact through these Interfaces. See Figure 6, Figure 7, Figure 8, and Figure 9 for sequence diagrams that illustrate how PULSE uses these interfaces to retrieve health information from External Healthcare Systems. The interface names in bold below correspond to the names in these figures.

#### 3.3.1. Interface to Disaster Healthcare Volunteers (DHV)

**Request Status** is a proprietary but open RESTful web service that returns a JSON object describing the status of PULSE as follows:

```json
{
    "status": "UP",
    "broker": {
        "status": "UP"
    },
    "diskSpace": {
        "status": "UP",
        "total": <integer value>,
        "free": <integer value>,
        "threshold": <integer value>
    }
}
```

PULSE is considered in an active state if (1) the service responds and returns a valid JSON object, and (2) all three “status” values in the JSON object are set to “UP”.

---

Patient Unified Lookup System for Emergencies (PULSE)  
System Design 1.1
PULSE is authenticated via TLS with a digital certificate tied to the domain, and requires no authentication from DHV or any other client placing a query.

At the time of this writing, the production RESTful endpoint for the production interface to PULSE can be found at https://pulse.emsa.ca.gov/rest/health.

Not shown or named explicitly in Figure 3, the HTTPS interface between DHV, the Web Browser used by a Disaster Healthcare Volunteer, and PULSE implements a web browser-based single sign-on using a SAML 2.0 assertion created by DHV acting as the identity provider. The SAML assertion created by DHV contains information that is used by PULSE to construct a SAML assertion passed in the SOAP security header to External Healthcare Systems as part of Patient Discovery, Query for Documents, and Retrieve Documents. The format and requirements for the assertion created by PULSE are described in the Nationwide Health Information Network (NHIN) Authorization Framework Specification. PULSE conform to all aspects of the specification. The SAML assertion created by PULSE asserts:

- A purpose-for-use of Treatment
- A role of Consulting Provider for all authorized DHV occupations

3.3.2. Interface to Directory Services

**Query for Systems** is a standards-based RESTful web service described in *HL7 FHIR Standard for Trial Use 3 (STU3)* that returns a list of the organizations and facilities that are participating in PULSE, and the information necessary to retrieve information from them electronically. This interface implements the Organization, Location, and Endpoint resources described in *HL7 FHIR Standard for Trial Use 3 (STU3)* as follows:

- Health information exchange organizations, hospital systems, integrated delivery networks (IDNs), individual hospitals, clinics, and other healthcare delivery organizations are included in the registry as Organization resources
- Organizations that participate in a health information exchange have a child relationship to the exchange in which they participate
- Facilities involved in health care delivery, including hospitals and clinics, are also included in the registry as Location resources with details of the care delivery location

---

1 Stakeholders in California have agreed that the PULSE use case qualifies as treatment purposes. The Sequoia Project, which maintains the applicable specifications, has indicated that it may at some future time add specific purpose-for-use values for disaster response use cases.

2 Stakeholders in California have agreed to accept a value of Consulting Provider for all occupations approved by EMSA for accessing health information through PULSE. The Sequoia Project, which maintains the applicable standards, has indicated that it may at some future time revise the acceptable values for role to correspond to those specified in FHIR STU3.
• Facilities always have a child relationship to a single corresponding Organization (e.g., a hospital, clinic, or IDN)
• The electronic service information used by PULSE to retrieve health information from each participating External Healthcare System is described in the registry as an Endpoint resource
• Electronic services used for testing or demonstration purposes are marked with a status data element equal to “test” in the Endpoint resource, while those used for health information are marked with a status data element equal to “active”
• Endpoint resources included by reference in the corresponding Organization and Location resource(s) they serve
• Some Endpoint resources are included by reference in multiple Organizations and Locations, representing a single interface that serves multiple organizations or facilities such as one managed by a health information exchange organization or an IDN
• The organization managing the interface, usually a health information exchange organization, IDN, or hospital system, is identified in the Endpoint managingOrganization data element with a reference to a single Organization resource

Directory Services conforms to the specification as constrained above, except that the Endpoint resource contains the following additions:

1. A “connectionType” data element, a CodeableConcept, with potential values of “nwhin-xcpd” corresponding to Patient Discovery, “nwhin-xca-query” corresponding to Query for Documents, and “nwhin-xca-retrieve” corresponding to Retrieve Documents
2. A “publicKey” data element, a string containing the public key of the digital certificate used to secure the endpoint using TLS in PEM format

These additions are not implemented as FHIR extensions at this time, but instead are based on DSTU2.3

Directory Services is authenticated via TLS with a digital certificate tied to the domain, and requires no authentication from PULSE or any other client placing a query.

At the time of this writing, the production RESTful endpoint for the production services registry can be found at https://cten.ca-hie.net:8443/fhir.

3.3.3. Interface to EHR or HIE

The Patient Discovery, Query for Documents, and Retrieve Documents SOAP web services that comprise the interface to an EHR or HIE are the same as described in Section 3.3.4, Interface to External Health Systems that follows.

---

3 FHIR STU3 eliminated these elements upon which the services registry depends after implementation of Directory Services was complete.
3.3.4. Interface to External Health Systems

**Patient Discovery** is a standards-based SOAP web service described in the *Nationwide Health Information Network (NHIN) Patient Discovery Web Service Interface Specification*. This interface allows PULSE to query External Health Systems for individuals matching disaster victims and evacuees based on demographic information.

PULSE conforms to all aspects of the specification except that it further constrains the standard to require that month, day, and year be specified as part of a date of birth.

**Query for Documents** is a standards-based SOAP web service described in the *Nationwide Health Information Network (NHIN) Query for Documents Web Service Interface Specification*. This interface allows PULSE to retrieve a list of documents available for any matched patient identified through Patient Discovery.

PULSE conforms to all aspects of the specification.

**Retrieve Documents** is a standards-based SOAP web service described in the *Nationwide Health Information Network (NHIN) Retrieve Documents Web Service Interface Specification*. This interface allows PULSE to retrieve specific documents identified through Query for Documents containing health information on disaster victims and evacuees. PULSE conforms to all aspects of the specification.

PULSE uses the synchronous versions of Patient Discovery, Query for Documents, and Retrieve Documents.
4. Operational Scenarios

This section describes the general functionality of PULSE from the users’ perspective via operational scenarios that provide step-by-step descriptions of how PULSE operates and interacts with its users and other external systems. These scenarios tie together all parts of the system, the users, and other entities described in the preceding sections by describing how they interact.

4.1. Retrieving Health Information by a Disaster Healthcare Volunteer

PULSE has a single operational scenario with two potential roles for the Disaster Healthcare Volunteer:

1. Searching External Health Systems for patient matches associated with disaster victims or evacuees, and
2. Retrieving health information on disaster victims or evacuees from External Health Systems and reviewing it for the purposes of treatment during a disaster.

A single Disaster Healthcare Volunteer may fulfil both roles, searching for a patient match and then retrieving and reviewing health information for that single patient. Or a Disaster Healthcare Volunteer might switch from one role to the other to manage the workflow of disaster victims or evacuees arriving at the ACF and being registered, switching to triage and treat individuals after initiating the search and retrieval of information on all of them.

4.1.1. Authenticating to PULSE

Figure 20 shows an abbreviated flow diagram for the Disaster Healthcare Volunteer authenticating to PULSE, a sequence of events that must take place for every Disaster Healthcare Volunteer each time they access the system, independent of the role or function they fill within the ACF.

Authenticating to PULSE comprises the following steps:

1. The Disaster Healthcare Volunteer logs into DHV
2. DHV determines the status of PULSE using the interface described in Section 3.3.1, Interface to Disaster Healthcare Volunteers (DHV)
3. If PULSE is active, DHV displays its status as shown in Figure 12 and the Disaster Healthcare Volunteer may choose to log into PULSE
4. If the Disaster Healthcare Volunteer chooses to log into PULSE, DHV displays a login screen as shown in Figure 13
5. The Disaster Healthcare Volunteer enters their DHV credentials
6. DHV redirects the Disaster Healthcare Volunteer to PULSE, and PULSE displays the landing page as shown in Figure 14
7. The Disaster Healthcare Volunteer selects the ACF at which they have reported
8. PULSE displays the patient search form shown in Figure 15 for the default “Search” mode of operation

![Flow diagram for a Disaster Healthcare Volunteer authenticating to PULSE](image)

**Figure 20** Flow diagram for a Disaster Healthcare Volunteer authenticating to PULSE

4.1.2. Searching for Patient Matches

Figure 21 shows an abbreviated flow diagram for the Disaster Healthcare Volunteer searching for matching patients corresponding to disaster victims or evacuees at an ACF. This sequence describes the “Search” mode of operation and applies specifically to a Disaster Healthcare Volunteer searching for matching patients.

The process of searching External Health Systems for patient matches associated with disaster victims or evacuees comprises the following steps:

9. The Disaster Healthcare Volunteer enters demographic information for the disaster victim or evacuee of interest and requests PULSE to conduct a search for potential matches

10. PULSE searches all External Health Systems in parallel for potential matches to the patient demographics entered by the Disaster Healthcare Volunteer using the interface described in Section 3.3.4, Interface to External Health Systems

11. PULSE consolidates all responses to the search and displays them to the Disaster Healthcare Volunteer as shown in Figure 16

The Disaster Healthcare Volunteer may enter demographic information for another disaster victim or evacuee while waiting for the search to complete, or may wait for PULSE to complete the search.

12. The Disaster Healthcare Volunteer selects a patient from completed searches

13. PULSE displays information about the potential matches returned by External Health Systems as shown in Figure 17
14. The Disaster Healthcare Volunteer selects from among the potential matches and “stages” a patient.

15. PULSE removes the patient search for the staged patient from the search form.

16. PULSE queries the External Health Systems associated with selected patient matches for a list of available documents containing health information using the interface described in Section 3.3.4, *Interface to External Health Systems*.

---

**Figure 21**  
Flow diagram for a Disaster Healthcare Volunteer searching for patients corresponding to disaster victims or evacuees

The Disaster Healthcare Volunteer can continue to search for patients by returning to step 9, perhaps functioning to register disaster victims or evacuees as they arrive at the ACF, or may continue to review health information associated with the staged patient by continuing with step 17 below.

4.1.3. **Retrieving and Reviewing Health Information**

Figure 22 shows an abbreviated flow diagram for the Disaster Healthcare Volunteer retrieving and reviewing health information. This sequence describes the “Review” mode of operation and applies specifically to a Disaster Healthcare Volunteer reviewing health information for treating disaster victims or evacuees.

The process of retrieving health information from External Health Systems for disaster victims or evacuees and reviewing it to facilitate treatment comprises the following steps:

17. The Disaster Healthcare Volunteer enters the “Review” mode of PULSE by clicking the “Review” button at the top of the patient search form.
18. PULSE displays a list of patients at staged this ACF

19. The Disaster Healthcare Volunteer selects a patient based on the disaster victim or evacuee being evaluated or treated

20. PULSE displays the list of available documents for that patient as shown in Figure 18

21. The Disaster Healthcare Volunteer inspects the facility, document type, document date, and other displayed information about each document and decides which to review

22. If the selected documents have not already been retrieved, the Disaster Healthcare Volunteer requests PULSE to retrieve the documents

23. PULSE retrieves the selected documents from the appropriate External Health Systems using the interface described in Section 3.3.4, Interface to External Health Systems

24. The Disaster Healthcare Volunteer selects any retrieved document for review

25. PULSE renders the selected document as shown in Figure 19

Figure 22  Flow diagram for a Disaster Healthcare Volunteer retrieving and reviewing health information for disaster victims or evacuees

The Disaster Healthcare Volunteer can continue to select and review health information for other patients by returning to step 18.
4.2. Retrieving Health Information via an EHR or HIE

PULSE does not interact directly with Healthcare Professionals accessing PULSE through their EHR or HIE. Therefore, the functionality from the user perspective of Healthcare Professionals is not strictly defined in the PULSE system design.

See Section 3.2.2, Interactions with Healthcare Professional for a description of the possible interactions between PULSE and the Healthcare Professional via their EHR or HIE.
5. Appendices

Appendix A: Requirements Traceability

Table 2 lists the requirements identified in the *Patient Unified Lookup System for Emergencies (PULSE)* System Requirements Version 1.1. It includes absolute requirements that must be implemented and identified by SHALL and SHALL NOT statements, as well as goals to be addressed by the design team and identified by SHOULD and SHOULD NOT statements.

Table 2 Requirements traceability matrix mapping system requirements to components in the system design

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Design Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1 The system SHALL support separate production and a test/demonstration modes</td>
<td>Implementation detail not specific to system design</td>
</tr>
<tr>
<td>1.1.2 The production mode SHALL allow a user to search for and retrieve protected health information from external healthcare systems</td>
<td>Overall System Software Architecture, Section 2.1</td>
</tr>
<tr>
<td>1.1.3 The test/demonstration mode SHALL NOT allow a user to search for or retrieve actual protected health information from external healthcare systems</td>
<td>Implementation detail not specific to system design</td>
</tr>
<tr>
<td>1.1.5 If implemented as a separate instance of the system, the test/demonstration version SHALL integrate with test/demonstration versions of external systems to ensure that actual protected health information cannot be searched for or retrieved</td>
<td>Implementation detail not specific to system design</td>
</tr>
<tr>
<td>1.1.6 The test/demonstration mode SHALL allow a user to search for and retrieve fictitious health information for fictitious patients for testing and demonstration purposes</td>
<td>Overall System Software Architecture, Section 2.1</td>
</tr>
<tr>
<td>1.2 The system SHALL support separate “active” and “inactive” states</td>
<td>“Request Status” interface, Section 2.1.3</td>
</tr>
<tr>
<td>1.3 The system SHALL allow an administrator to determine its current state as active or inactive</td>
<td>Configuration file, Section 3.1.2</td>
</tr>
<tr>
<td>1.4 The system SHALL allow an administrator to change its state from active to inactive and from inactive to active</td>
<td>Configuration file, Section 3.1.2</td>
</tr>
<tr>
<td>1.5 The system SHALL NOT allow a user to search for or retrieve health information when in the inactive state</td>
<td>Software design detail</td>
</tr>
<tr>
<td>2.1 The system SHALL be available on the Internet</td>
<td>Implementation detail not specific to system design</td>
</tr>
<tr>
<td>2.2 The system SHALL be available 24 hours a day and 365 days a year</td>
<td>Implementation detail not specific to system design</td>
</tr>
<tr>
<td>2.3 The system SHALL be accessible by disaster healthcare volunteers via a web browser</td>
<td>“Web Browser” component, Section 2.1.3</td>
</tr>
<tr>
<td>2.3.1 The system SHALL support the web browser(s) included in a standardized bill-of-materiats for computers deployed by emergency medical services for use by disaster healthcare volunteers during a disaster, if any</td>
<td>No current bill of materials (i.e., no requirement)</td>
</tr>
<tr>
<td>Requirement</td>
<td>Design Component</td>
</tr>
<tr>
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</tr>
<tr>
<td>2.3.2</td>
<td>The system SHOULD support the major browsers in common use</td>
</tr>
<tr>
<td></td>
<td>Software design detail</td>
</tr>
<tr>
<td>2.4</td>
<td>The query capabilities of the system SHALL be accessible by healthcare works through their electronic health records (EHRs) or health information exchanges (HIEs)</td>
</tr>
<tr>
<td></td>
<td>“Patient Discovery”, “Query for Documents”, “Retrieve Documents” interfaces, Section 2.1.3</td>
</tr>
<tr>
<td>2.5</td>
<td>The query capabilities of the system SHALL be accessible by Carequality Connected Clients</td>
</tr>
<tr>
<td></td>
<td>“Patient Discovery”, “Query for Documents”, “Retrieve Documents” interfaces, Section 2.1.3</td>
</tr>
<tr>
<td>4.1</td>
<td>The system SHALL report its current active or inactive status to DHV via a programmatic interface</td>
</tr>
<tr>
<td></td>
<td>“Request Status” interface, Section 3.3.1</td>
</tr>
<tr>
<td>4.2</td>
<td>DHV SHALL authenticate disaster healthcare volunteers to the system using SAML single sign-on</td>
</tr>
<tr>
<td></td>
<td>Authentication sequence, Section 2.1.5, Figure 6</td>
</tr>
<tr>
<td>4.2.1</td>
<td>The SAML assertion SHALL be compliant with OASIS Security Assertion Markup Language (SAML) Version 2.0</td>
</tr>
<tr>
<td></td>
<td>“Patient Discovery”, “Query for Documents”, “Retrieve Documents” interfaces, Section 3.3.1</td>
</tr>
<tr>
<td>4.3</td>
<td>The system SHALL query external health systems using eHealth Exchange specifications</td>
</tr>
<tr>
<td></td>
<td>“Patient Discovery”, “Query for Documents”, “Retrieve Documents” interfaces, Section 3.3.1</td>
</tr>
<tr>
<td>4.3.1</td>
<td>The system SHALL query for patient matches in a manner compliant with the Nationwide Health Information Network (NHIN) Patient Discovery Web Service Interface Specification Version 2.0</td>
</tr>
<tr>
<td></td>
<td>“Patient Discovery” interface, Section 3.3.1</td>
</tr>
<tr>
<td>4.3.2</td>
<td>The system SHALL query for existing documents for a matched patient, if any, in a manner compliant with the Nationwide Health Information Network (NHIN) Query for Documents Web Service Interface Specification Version 3.0</td>
</tr>
<tr>
<td></td>
<td>“Query for Documents” interface, Section 3.3.1</td>
</tr>
<tr>
<td>4.3.3</td>
<td>The system SHALL retrieve existing documents for a matched patient, if any, in a manner compliant with the Nationwide Health Information Network (NHIN) Retrieve Documents Web Service Interface Specification Version 3.0</td>
</tr>
<tr>
<td></td>
<td>“Retrieve Documents” interface, Section 3.3.1</td>
</tr>
<tr>
<td>4.3.4</td>
<td>The system SHALL create a SAML assertion in a manner compliant with the Nationwide Health Information Network Messaging Platform Specification Version 3.0 using necessary information obtained from the SAML assertion for single sign-on provided by DHV</td>
</tr>
<tr>
<td></td>
<td>“Patient Discovery”, “Query for Documents”, “Retrieve Documents” interfaces, Section 3.3.1</td>
</tr>
<tr>
<td>4.3.5</td>
<td>When querying for matching patients, querying for existing documents, and retrieving existing documents, the system SHALL also be compliant with the Nationwide Health Information Network Messaging Platform Specification Version 3.0 and the Nationwide Health Information Network (NHIN) Authorization Framework Specification Version 3.0</td>
</tr>
<tr>
<td></td>
<td>“Patient Discovery”, “Query for Documents”, “Retrieve Documents” interfaces, Section 3.3.1</td>
</tr>
<tr>
<td>Requirement</td>
<td>Design Component</td>
</tr>
<tr>
<td>-------------</td>
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</tr>
<tr>
<td>4.4</td>
<td>The system SHALL query Directory Services using FHIR specifications</td>
</tr>
<tr>
<td>4.4.1</td>
<td>The system SHALL retrieve the list of participating external health systems and the connection information required for matching patients, querying for existing documents, and retrieving existing documents using a RESTful FHIR STU3 programmatic interface</td>
</tr>
<tr>
<td>4.5</td>
<td>The system SHALL respond to incoming queries from an external EHR or HIE using eHealth Exchange specifications</td>
</tr>
<tr>
<td>4.5.1</td>
<td>The system SHALL respond to incoming queries for patient matches in a manner compliant with the Nationwide Health Information Network (NHIN) Patient Discovery Web Service Interface Specification Version 2.0</td>
</tr>
<tr>
<td>4.5.2</td>
<td>The system SHALL respond to incoming queries for existing documents for a matched patient, if any, in a manner compliant with the Nationwide Health Information Network (NHIN) Query for Documents Web Service Interface Specification Version 3.0</td>
</tr>
<tr>
<td>4.5.3</td>
<td>The system SHALL provide retrieved existing documents for a matched patient, if any, in a manner compliant with the Nationwide Health Information Network (NHIN) Retrieve Documents Web Service Interface Specification Version 3.0</td>
</tr>
<tr>
<td>4.5.4</td>
<td>When responding to queries for matching patients, queries for existing documents, and requests to retrieve existing documents, the system SHALL also be compliant with the Nationwide Health Information Network Messaging Platform Specification Version 3.0 and the Nationwide Health Information Network (NHIN) Authorization Framework Specification Version 3.0</td>
</tr>
<tr>
<td>4.6</td>
<td>The system SHALL respond to incoming queries from an external EHR or HIE using Carequality specifications</td>
</tr>
<tr>
<td>4.6.1</td>
<td>When responding to queries for matching patients, queries for existing documents, and requests to retrieve existing documents, the system SHALL be compliant with the Carequality Query-Based Document Exchange Implementation Guide Version 1.0</td>
</tr>
<tr>
<td>5.1</td>
<td>The system SHALL allow access to disaster healthcare volunteers</td>
</tr>
<tr>
<td>5.1.3</td>
<td>The system SHALL allow disaster healthcare volunteers to search for matching patients, query for available health information on matched patients, and retrieve existing health information on matched patients</td>
</tr>
<tr>
<td>5.2</td>
<td>The system SHALL allow access to administrators</td>
</tr>
<tr>
<td>Requirement</td>
<td>Design Component</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>5.2.2  The system SHALL allow administrators to control, monitor, and configure the system</td>
<td>Audit log, Section 3.1.1, and configuration files, Section 3.1.2</td>
</tr>
<tr>
<td>5.2.3  The system SHALL NOT allow non-administrators to control, monitor, or configure the system</td>
<td>Implementation detail not specific to system design</td>
</tr>
<tr>
<td>5.3  The system SHALL allow access to healthcare professionals that are not acting as a disaster health care volunteer and not located at an alternate care facility</td>
<td>“EHR or HIE” component, Section 2.1.3</td>
</tr>
<tr>
<td>5.3.3  The system SHALL allow healthcare professionals that are not acting as a disaster health care volunteer and not located at an alternate care facility to search for matching patients, query for available health information on matched patients, and retrieve existing health information on matched patients</td>
<td>“Patient Discovery”, “Query for Documents”, “Retrieve Documents” interfaces, Section 2.1.3</td>
</tr>
<tr>
<td>6.1  The system SHALL maintain a list of alternate care facilities (ACFs)</td>
<td>Configuration files, Section 3.1.2</td>
</tr>
<tr>
<td>6.1.1  ACFs SHALL be identified by county name plus a two-digit number</td>
<td>Configuration files, Section 3.1.2</td>
</tr>
<tr>
<td>6.1.2  The administrator SHALL be able to configure the list of ACFs that can be selected by users</td>
<td>Configuration files, Section 3.1.2</td>
</tr>
<tr>
<td>6.1.4  A user SHALL be able to add demographic information on the location of each ACF once a disaster is cleared and PULSE will be or has been activated</td>
<td>Configuration files, Section 3.1.2</td>
</tr>
<tr>
<td>6.2  The system SHALL require the disaster healthcare volunteer to select an ACF upon entering the system</td>
<td>Human-machine interface design, Section 3.2.1</td>
</tr>
<tr>
<td>6.3  The system SHALL obtain a list of participating external health systems from Directory Services</td>
<td>“Query for Systems” interface, Section 3.3.2</td>
</tr>
<tr>
<td>6.4  The system SHALL obtain information about external health system interfaces from Directory Services sufficient to execute queries and retrieve health information</td>
<td>“Query for Systems” interface, Section 3.3.2</td>
</tr>
<tr>
<td>6.4.2  The system SHALL refresh any saved information obtained from Directory Services from time to time to obtain any changes made to the list of external health systems or their connection information</td>
<td>Patient search sequence, Section 2.1.5, Figure 7, and document retrieval sequence, Section 2.1.5, Figure 8</td>
</tr>
<tr>
<td>6.5  The system SHALL provide “search” and “review” modes</td>
<td>Human-machine interface design, Section 3.2.1</td>
</tr>
<tr>
<td>6.6  A disaster healthcare volunteer SHALL be able to designate use of search mode or review mode, and be able to switch between modes</td>
<td>Human-machine interface design, Section 3.2.1</td>
</tr>
<tr>
<td>6.7  A disaster healthcare volunteer SHALL be able to search for patient matches for an individual by specifying key demographic information on the individual</td>
<td>Human-machine interface design, Section 3.2.1</td>
</tr>
<tr>
<td>6.7.1  The system SHALL support all patient demographic information specified within the Nationwide Health Information Network (NHIN) Patient Discovery Web Service Interface Specification Version 2.0</td>
<td>“Patient Discovery” interface, Section 3.3.1</td>
</tr>
<tr>
<td>Requirement</td>
<td>Design Component</td>
</tr>
<tr>
<td>---------------------------------------------------------------------------</td>
<td>-----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>6.7.2 The system SHALL require only patient demographic information required by the <em>Nationwide Health Information Network (NHIN) Patient Discovery Web Service Interface Specification Version 2.0</em></td>
<td>“Patient Discovery” interface, Section 3.3.1</td>
</tr>
<tr>
<td>6.7.3 The system SHALL require a day, month, and year for the patient date of birth rather than the greatest degree of detail as is available as specified in the <em>Nationwide Health Information Network (NHIN) Patient Discovery Web Service Interface Specification Version 2.0</em></td>
<td>“Patient Discovery” interface, Section 3.3.1</td>
</tr>
<tr>
<td>6.7.4 The system SHOULD provide options for including demographic information in such a way as to support good workflow and not lead to user confusion</td>
<td>Software design detail</td>
</tr>
<tr>
<td>6.8 The system SHALL query external health systems for matching patients using search parameters entered by a disaster healthcare volunteer</td>
<td>Human-machine interface design, Section 3.2.1</td>
</tr>
<tr>
<td>6.8.1 The system SHALL provide feedback on the progress of each external health system in responding to a query for matching patients</td>
<td>Human-machine interface design, Section 3.2.1</td>
</tr>
<tr>
<td>6.9 The system SHALL display a list patient matches and the demographic information returned by each external health system returning a match</td>
<td>Human-machine interface design, Section 3.2.1</td>
</tr>
<tr>
<td>6.9.1 The system SHALL identity which external health systems returned matching patients</td>
<td>Human-machine interface design, Section 3.2.1</td>
</tr>
<tr>
<td>6.9.2 The system SHALL identity which external health systems completed the query but did not return matching patients</td>
<td>Human-machine interface design, Section 3.2.1</td>
</tr>
<tr>
<td>6.9.3 The system SHALL identity which external health systems failed to return a response to the query</td>
<td>Human-machine interface design, Section 3.2.1</td>
</tr>
<tr>
<td>6.10 The system SHALL display a list of all active patient searches for the disaster healthcare volunteer that initiated the search</td>
<td>Human-machine interface design, Section 3.2.1</td>
</tr>
<tr>
<td>6.10.1 The system SHALL NOT display patient searches initiated by other disaster healthcare volunteers</td>
<td>Human-machine interface design, Section 3.2.1</td>
</tr>
<tr>
<td>6.11 The disaster healthcare volunteer SHALL be able to cancel any active search</td>
<td>Human-machine interface design, Section 3.2.1</td>
</tr>
<tr>
<td>6.11.1 The disaster healthcare volunteer SHALL be able to cancel any active search for a specific external health system</td>
<td>Human-machine interface design, Section 3.2.1</td>
</tr>
<tr>
<td>6.11.2 The disaster healthcare volunteer SHALL be able to cancel any active search for all external health systems</td>
<td>Human-machine interface design, Section 3.2.1</td>
</tr>
<tr>
<td>6.12 The disaster healthcare volunteer SHALL be able to repeat any completed search</td>
<td>Human-machine interface design, Section 3.2.1</td>
</tr>
<tr>
<td>6.12.1 The disaster healthcare volunteer SHALL be able to repeat any search attempted by a specific external health system, whether or not it completed successfully or was cancelled</td>
<td>Human-machine interface design, Section 3.2.1</td>
</tr>
<tr>
<td>6.13 The disaster healthcare volunteer SHALL be able to delete any completed search</td>
<td>Human-machine interface design, Section 3.2.1</td>
</tr>
<tr>
<td>Requirement</td>
<td>Design Component</td>
</tr>
<tr>
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</tr>
<tr>
<td>6.14</td>
<td>The disaster healthcare volunteer SHALL be able to select among returned patient matches those that are to be associated with the specific patient of interest</td>
</tr>
<tr>
<td>6.14.1</td>
<td>The disaster healthcare volunteer SHALL be required to identify the name, gender, and date-of-birth to display for the patient in review mode</td>
</tr>
<tr>
<td>6.14.2</td>
<td>The system SHALL associate the patient with the ACF selected by the disaster healthcare volunteer when entering the system</td>
</tr>
<tr>
<td>6.14.3</td>
<td>The system SHALL query the appropriate external health system(s) for existing documents automatically so they are available for retrieval</td>
</tr>
<tr>
<td>6.14.4</td>
<td>The system SHALL remove the patient query and the results for all external health systems from the list of active patient searches after matching patients are selected</td>
</tr>
<tr>
<td>6.15</td>
<td>The system SHALL display a list of all patients with existing health information</td>
</tr>
<tr>
<td>6.15.1</td>
<td>The patient SHALL be identified by the name, gender, and date-of-birth designated by a disaster healthcare volunteer in search mode</td>
</tr>
<tr>
<td>6.15.2</td>
<td>The patient list SHALL include only those patients searched for within the ACF selected the disaster healthcare volunteer when entering the system</td>
</tr>
<tr>
<td>6.16</td>
<td>The system SHALL display the number of existing documents containing health information for each patient in the patient list</td>
</tr>
<tr>
<td>6.17</td>
<td>The disaster healthcare volunteer SHALL be able to view the metadata returned by the external health system for each existing document for each patient</td>
</tr>
<tr>
<td>6.17.1</td>
<td>The system SHALL support all metadata returned as specified within the Nationwide Health Information Network (NHIN) Query for Documents Web Service Interface Specification Version 3.0</td>
</tr>
<tr>
<td>6.17.2</td>
<td>The system SHOULD display only information to support good workflow and not lead to user confusion</td>
</tr>
<tr>
<td>6.18</td>
<td>The disaster healthcare volunteer SHALL be able to request retrieval of any document associated with a patient</td>
</tr>
<tr>
<td>6.18.1</td>
<td>The system SHALL provide feedback on the progress of each external health system in returning a requested document</td>
</tr>
<tr>
<td>6.18.2</td>
<td>The system SHALL identity which external health systems returned documents successfully</td>
</tr>
<tr>
<td>6.18.3</td>
<td>The system SHALL identity which external health systems failed to return the requested document</td>
</tr>
<tr>
<td>6.19</td>
<td>The disaster healthcare volunteer SHALL be able to cancel any active request for a specific document</td>
</tr>
<tr>
<td>6.20</td>
<td>The disaster healthcare volunteer SHALL be able to repeat a request for an existing document if cancelled or unsuccessful</td>
</tr>
<tr>
<td>Requirement</td>
<td>Design Component</td>
</tr>
<tr>
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</tr>
<tr>
<td>6.21</td>
<td>The disaster healthcare volunteer SHALL be able to view any retrieved document in the system</td>
</tr>
<tr>
<td>Human-machine interface design, Section 3.2.1</td>
<td></td>
</tr>
<tr>
<td>6.21.1</td>
<td>The system SHALL be able to display in human-readable form documents conforming to the HL7 CDA Release 2, CCD. Implementation specifications: HITSP Summary Documents Using HL7 CCD Component HITSP/C32</td>
</tr>
<tr>
<td>Human-machine interface design, Section 3.2.1</td>
<td></td>
</tr>
<tr>
<td>6.21.2</td>
<td>The system SHOULD be able to display other common document formats returned by external health systems</td>
</tr>
<tr>
<td>Human-machine interface design, Section 3.2.1</td>
<td></td>
</tr>
<tr>
<td>6.22</td>
<td>The disaster healthcare volunteer SHALL be able to print any retrieved document that can be displayed in the system</td>
</tr>
<tr>
<td>Human-machine interface design, Section 3.2.1</td>
<td></td>
</tr>
<tr>
<td>6.23</td>
<td>The disaster healthcare volunteer SHALL be able to delete any patient and their health information from the system</td>
</tr>
<tr>
<td>Human-machine interface design, Section 3.2.1</td>
<td></td>
</tr>
<tr>
<td>6.24</td>
<td>The system SHALL automatically delete a patient and their health information if not accessed within a configurable amount of time</td>
</tr>
<tr>
<td>Configuration files, Section 3.1.2</td>
<td></td>
</tr>
<tr>
<td>6.24.1</td>
<td>The administrator SHALL be able to configure the amount of time that a matched patient and their health information are retained without access by a disaster healthcare volunteer before being deleted</td>
</tr>
<tr>
<td>Configuration files, Section 3.1.2</td>
<td></td>
</tr>
<tr>
<td>6.24.2</td>
<td>The administrator SHALL be able to delete all matched patients and their health information</td>
</tr>
<tr>
<td>Implementation detail not specific to system design</td>
<td></td>
</tr>
<tr>
<td>6.25</td>
<td>A healthcare professional SHALL be able to search for patient matches via their EHR or HIE</td>
</tr>
<tr>
<td>Human-machine interface design, Section 3.2.2</td>
<td></td>
</tr>
<tr>
<td>6.25.1</td>
<td>The system SHALL support searches for matching patients via queries conforming to the Nationwide Health Information Network (NHN) Patient Discovery Web Service Interface Specification Version 2.0</td>
</tr>
<tr>
<td>“Patient Discovery” interface, Section 3.3.1</td>
<td></td>
</tr>
<tr>
<td>6.25.2</td>
<td>The system SHALL support searches for matching patients via queries conforming to the Carequality Query-Based Document Exchange Implementation Guide Version 1.0</td>
</tr>
<tr>
<td>“Patient Discovery” interface, Section 3.3.1</td>
<td></td>
</tr>
<tr>
<td>6.25.3</td>
<td>The system SHALL query all external health systems for the patient and return a consolidated result</td>
</tr>
<tr>
<td>Human-machine interface design, Section 3.2.2</td>
<td></td>
</tr>
<tr>
<td>6.26</td>
<td>A healthcare professional SHALL be able to search for existing documents for discovered patient matches via their EHR or HIE</td>
</tr>
<tr>
<td>Human-machine interface design, Section 3.2.2</td>
<td></td>
</tr>
<tr>
<td>6.26.1</td>
<td>The system SHALL support document searches via queries conforming to the Nationwide Health Information Network (NHN) Query for Documents Web Service Interface Specification Version 2.0</td>
</tr>
<tr>
<td>“Query for Documents” interface, Section 3.3.1</td>
<td></td>
</tr>
<tr>
<td>6.26.2</td>
<td>The system SHALL support document searches via queries conforming to the Carequality Query-Based Document Exchange Implementation Guide Version 1.0</td>
</tr>
<tr>
<td>“Query for Documents” interface, Section 3.3.1</td>
<td></td>
</tr>
<tr>
<td>6.26.3</td>
<td>The system SHALL query the external health systems with patient matches for documents and return a consolidated result</td>
</tr>
<tr>
<td>Human-machine interface design, Section 3.2.2</td>
<td></td>
</tr>
<tr>
<td>6.27</td>
<td>A healthcare professional SHALL be able to retrieve discovered documents via their EHR or HIE</td>
</tr>
<tr>
<td>Human-machine interface design, Section 3.2.2</td>
<td></td>
</tr>
<tr>
<td>Requirement</td>
<td>Design Component</td>
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</tr>
<tr>
<td>6.27.1</td>
<td>“Retrieve Documents” interface, Section 3.3.1</td>
</tr>
<tr>
<td>6.27.2</td>
<td>“Retrieve Documents” interface, Section 3.3.1</td>
</tr>
<tr>
<td>6.27.3</td>
<td>Human-machine interface design, Section 3.2.2</td>
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<td>7.5</td>
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<td>7.6</td>
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<td>9.1</td>
<td>Authentication sequence, Section 2.1.5, Figure 6</td>
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<td>9.2</td>
<td>Implementation detail</td>
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<td>9.3</td>
<td>Interface definitions, Section 3.3</td>
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<tr>
<td>9.3.1</td>
<td>Interface definitions, Section 3.3</td>
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<tr>
<td>9.4</td>
<td>Sequence diagrams, Section 2.1.5, Figure 7, Figure 8, and Figure 9</td>
</tr>
<tr>
<td>9.4.1</td>
<td>Software design detail</td>
</tr>
<tr>
<td>9.5</td>
<td>Sequence diagrams, Section 2.1.5, Figure 7, Figure 8, and Figure 9</td>
</tr>
<tr>
<td>Requirement</td>
<td>Design Component</td>
</tr>
<tr>
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<td>9.5.1 For queries for documents, the audit information SHALL include at least the date and time of the search for existing documents, the disaster healthcare volunteer imitating the search, the external health systems that were searched, which health systems responded to the query, which health systems reported that documents were available, and what documents they reported were available</td>
<td>Software design detail</td>
</tr>
<tr>
<td>9.5.2 For requests for existing documents, the audit information SHALL include at least the date and time of each request for an existing document, the disaster healthcare volunteer imitating the request, the external health systems from which the document was requested, and whether the external health system responded with the document</td>
<td>Software design detail</td>
</tr>
<tr>
<td>9.5.3 For all retrieved documents, the audit information SHALL include at least the date and time that a disaster healthcare volunteer viewed the document, if ever</td>
<td>Software design detail</td>
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<td>9.5.4 The audit information SHALL conform to the Audit Trail and Node Authentication (ATNA) profile in the <em>IHE IT Infrastructure Technical Framework Volume 2a (ITI TF-2a) Transactions Part A</em> Revision 13.0</td>
<td>Software design detail</td>
</tr>
<tr>
<td>9.6 The administrator SHALL be able to extract information from the audit logs upon authorized request</td>
<td>Audit log, Section 3.1.1</td>
</tr>
</tbody>
</table>