# Linking Patient Records
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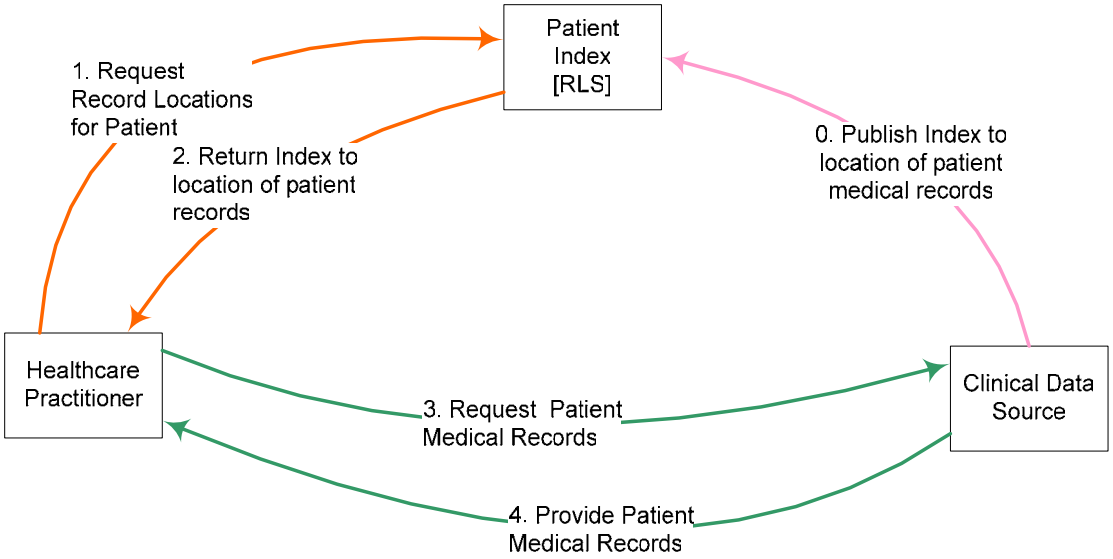
# Agenda

- RLS Architecture
- Security Architecture
- Prototype Demonstration Screen shots
- Patient Linking and Matching

# High Level Functional Architecture

- Publish patient index (record location) from local data source to central registry
- Acquire address (record location) of EHR system and local patient index from central registry
- Retrieve medical data directly from data source on peer-to-peer basis [***Not RLS function***]
- Conforms to Web-services interop pattern: Publish/Find/Bind




✦ Adapted from: Linking Healthcare Information: Proposed Methods for Improving Care and Protecting Privacy, Carol Diamond, Connecting for Health, Markle Foundation, HIMSS 2005

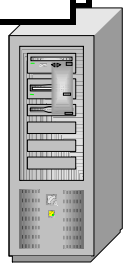
# Use case scenario / workflow

**1**
1. Patient visits physician / practitioner and person / visit-related information is entered into local clinical system
2. Patient consents for (selective) release of information to others
3. System produces a record of the person / visit
4. Person / visit record is "published" for other utility users

**Source Clinical Data System Gateway**

**Clinical Data Exchange**

**2**
1. Patient index entry is created at community level
2. Index = Patient demographics + source system address + patient source system identifier



**4**
1. Exchange receives patient lookup request
2. Reads previously populated patient index to determine where medical records may reside
3. Patient is identified in patient index and matching patient index information with record locations returned
4. Returned data logged

Secure Internet / Leased Private Network

**6**
1. Source with releasable medical records (of type requested) receives request for records
2. Request is authenticated and checked for release consent
3. Cached or source records are retrieved and formatted to standards
4. Request and return are logged for auditability
5. Records are returned to requestor
6. Returned data logged

**3**
1. Patient visits another utility user
2. Utility user logs on, is authenticated and queries patient index: enters patient demographics to search for and retrieve electronic medical records
3. Request is logged for auditability

**Requesting Clinical Data System Gateway**

**5**
1. One or more patients with releasable records are presented to user for selection
2. User selects patient records (if human disambiguation is required and allowed), or record requests are automatically sent to source systems
3. Request logged

**7**
1. Returned records are aggregated, if required
2. Business logic is applied to records
3. Records are presented for viewing or formatted for other purposes (integration with legacy / core systems, use in business process, additional workflow, etc.)
4. Returned data logged

= Publish patient index

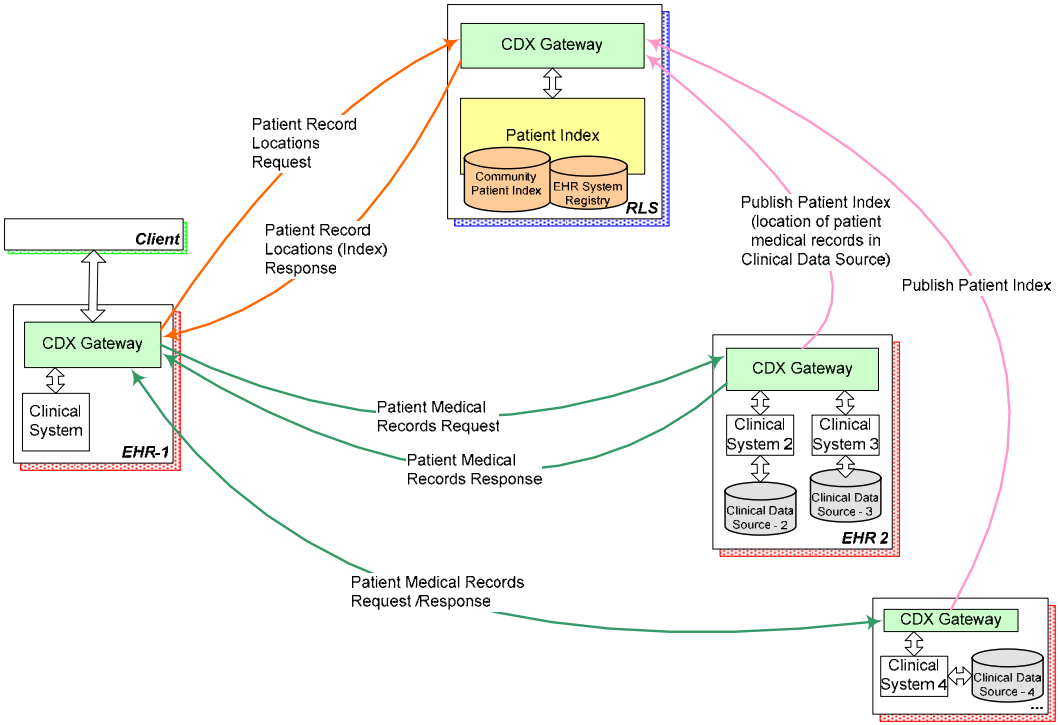
= Locate patient records

= Retrieve patient records

Supporting processes are required for:
- Security administration
- Registration and identity administration
- Consent management, access control, logging, and audit - tracking inquiry, access and use

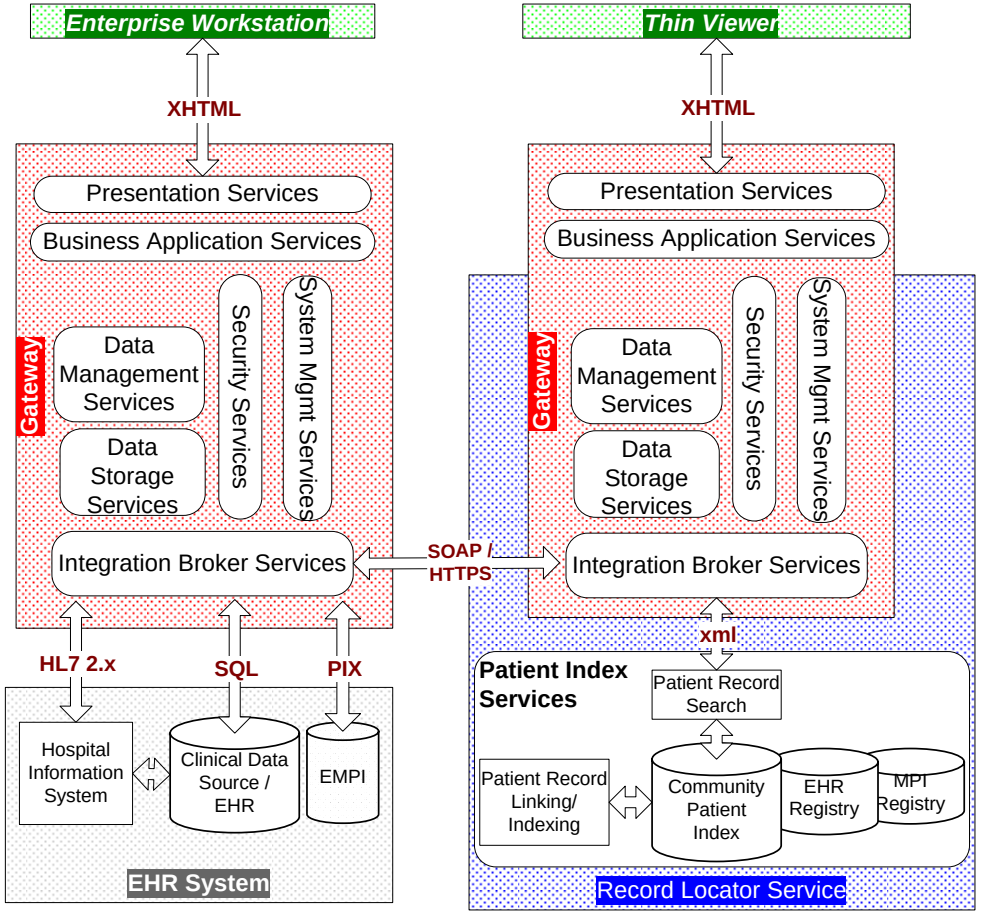
# RLS Technical Architecture using Gateway

- RLS: index and registry
  - Returns record locations of patients matching demographics search criteria entered by authorized healthcare practitioner
  - Maintains contract between providers & consumers
  - CMPI with record linking algorithm matches patients from different EHRs
- Gateway: secure, standards based data interchange
  - Encapsulate:
    - Service gateway (agent) to consume web services without changing consuming application
    - Service interface to wrap disparate legacy applications with web service interface
    - Mapping service to transform message formats
    - Security and Systems Management Services
  - Abstract both RLS and EHR (legacy) systems to enable standards based communication between disparate systems
  - Extensible to clinical data exchange (CDX)



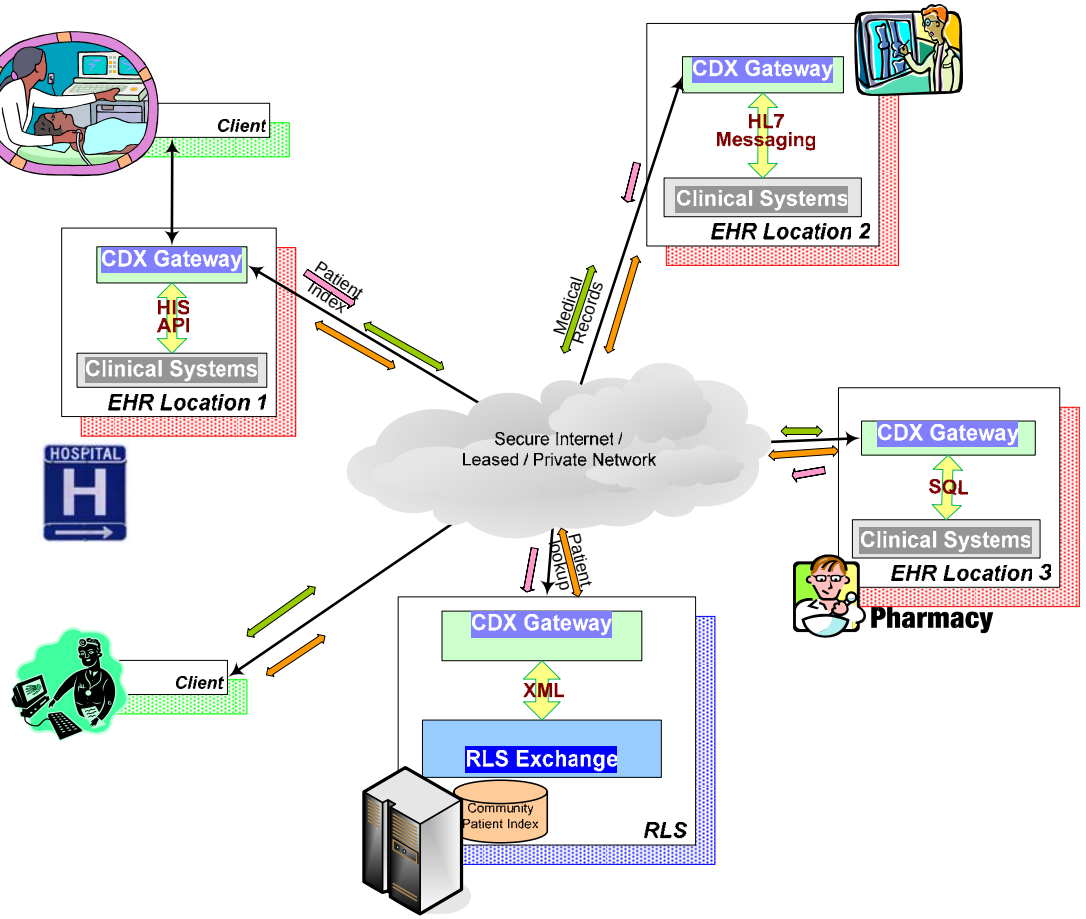
# Service-Oriented Application Architecture

- RLS: composite application made up of loosely coupled, coarse grained services
  - Core Service: Patient Index Service
  - Central registry of distributed EHR systems and other CMPIs / EMPIs
- Gateway: provides common infrastructural (plumbing) services
  - Systems management including logging, auditing, service management
  - Security: authentication, policy, consent management
  - Integration services: messaging, transformation, orchestration, adaptor
  - Presentation/Business services for user interface
- Common services reused across RLS and Gateway



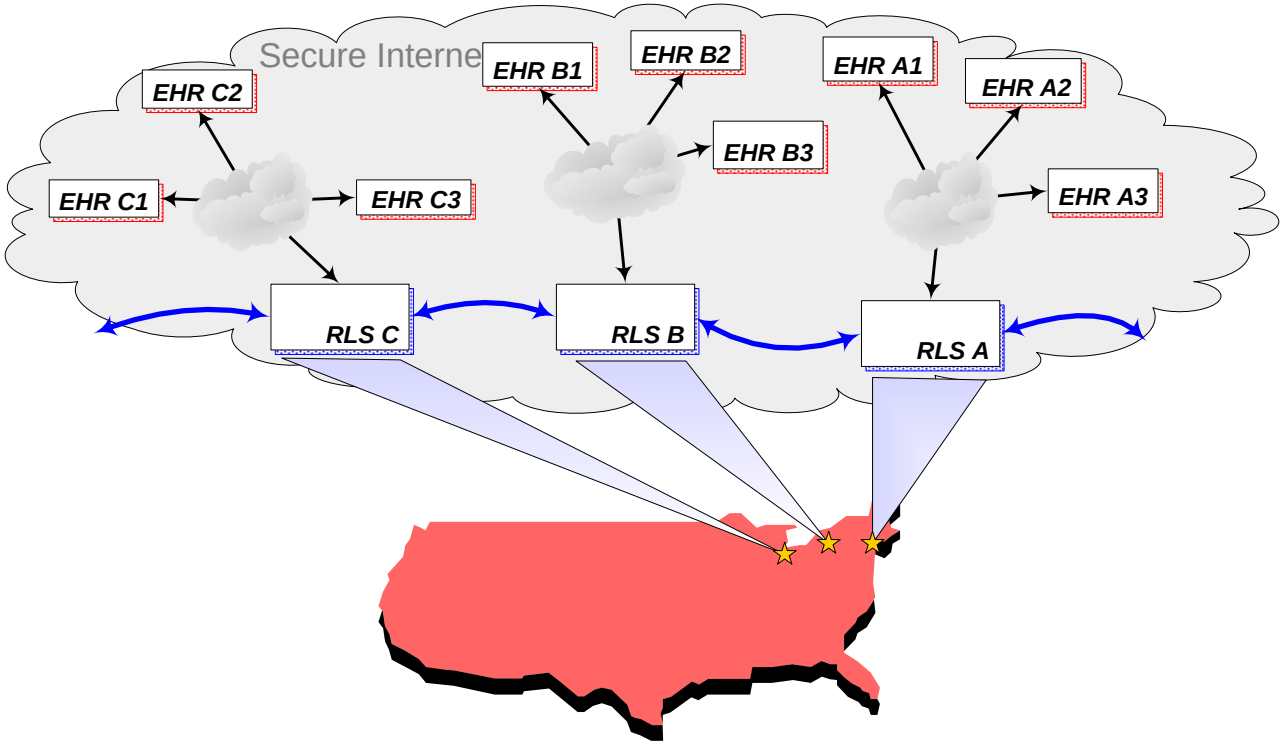
# Gateway Web-service enables legacy systems

- Gateway provides interface layer between clinical systems using
  - HL7
  - SOAP
  - XML
  - https
- Abstracts differences between application interfaces
- Gateway at RLS
  - Hosted Gateway implementation
  - Enables direct client access to remote clinical systems
  - Low cost solution for small providers
  - Minimal requirement: Web browser



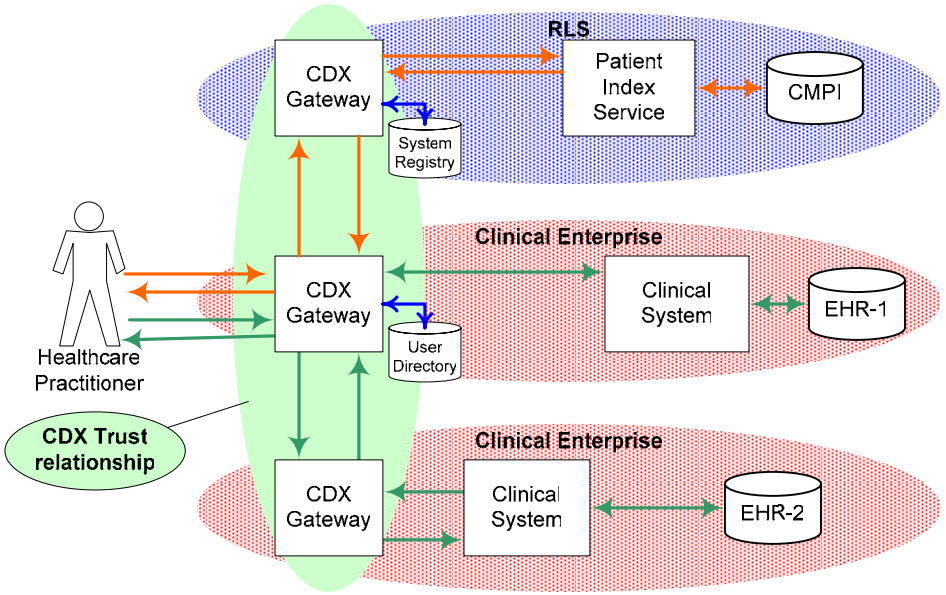
# Architecture supports communication between RLSs

- RLS maintains registry of other MPIs and can pass on patient lookup request to other RLSs
  - Enabling a network of RLS communities / RHIOs
- Data sharing possible between EHRs attached to different RLSs
  - EHRs are 'web-addressable' via Internet
- Security and contracts coordination more direct through RLS



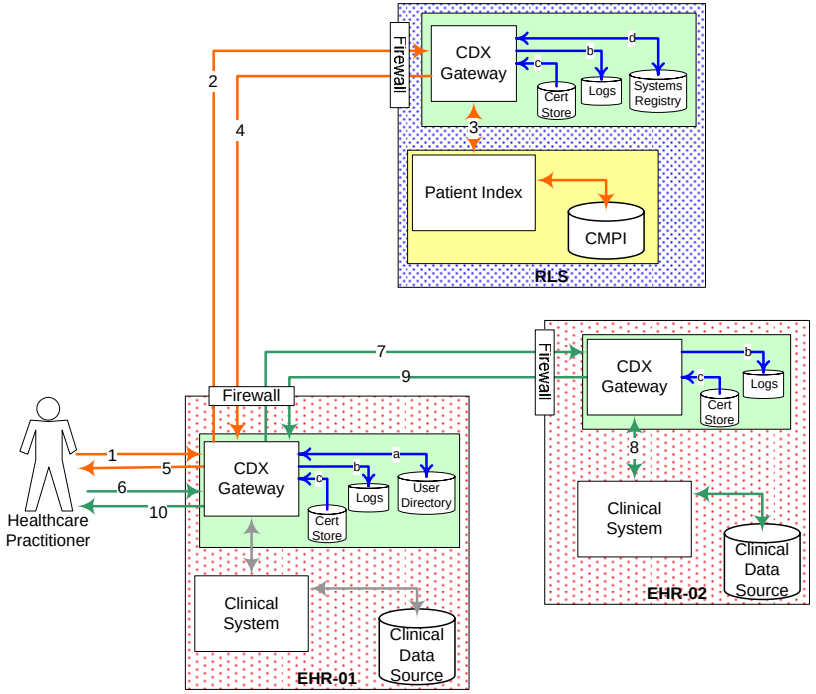
# RLS Prototype Security Architecture

- Overlapping Trust Relationships
  - Security services embedded in CDX Gateway
  - Gateway is part of local Enterprise Application security architecture
    - Enterprise integration enables coordinated identity provisioning and single sign-on
  - User identities authenticated locally
    - Username communicated in each message but are not authenticated by message receiver
  - Local user roles to be mapped to common (RLS/CDX) roles and messaged along with user credentials
  - Gateway to Gateway trust relationships
    - Technologies and standards exist
    - Implementation challenges remain with distributed credentials management to support secure peer-to-peer data exchange
  - Comprehensive message logging at each gateway supports auditing of all data access



# Distributed Authentication / Authorization in RLS Prototype

- Human users authenticated at edge
  - Follow enterprise security standards
- Direct trust relationship between Gateways using security tokens
  - SSL/TLS uses server-side X.509 certificates to authenticate receiver and encrypt data traffic
  - Sender authentication possible with security tokens:
    - Username / password
    - Digital certificates (X.509) with private/public keys
    - Kerberos ticket
  - Certificate management overhead in real world
  - Use application firewall to block access by unknown network entities
- Position architecture to leverage SAML / Federation standards as they mature




**Patient Lookup**

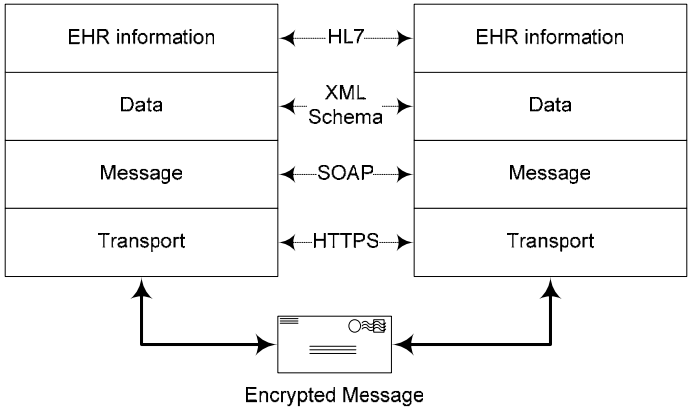
1. User logs in / enters patient lookup query (demographics)
   ***a. authenticated against directory***
   ***b. access logged***
2. Request for patient record locations in SOAP envelope with user identity / roles over
   ***c. sender-side certificate used to sign message and receiver certificate used to establish SSL/TLS connection***
3. Matching patient record locations looked up
   ***d. remote system authenticated against registry***
   ***b. access logged***
4. Matching records from CMPI returned
   ***c. sender-side certificate used to sign message and receiver certificate used to establish SSL/TLS connection***
5. Patient record locations displayed for user selection

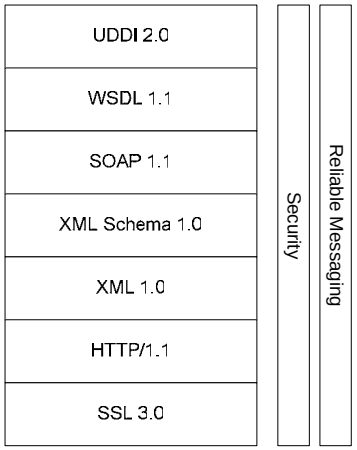
**Medical Records Retrieval**

6. Patient clinical records query entered
7. Request for patient medical records request in SOAP envelope with user identity / roles, and server key
   ***d. remote system authenticated against registry***
   ***b. access logged***
8. Patient clinical records retrieved
9. Clinical records returned to user
   ***c. sender-side certificate used to sign message and receiver certificate used to establish SSL/TLS connection***
10. Clinical records aggregated and displayed to user

# Data, Messaging, Transport Standards

- HL7
  - HL7 RIM 2 based data standards
  - HL7 Version 3.0 versus 2.x
    - XML notation recommended over EDI style
    - Canonical message format between gateways reduces many-to-many translation load
    - Version 3.0 offers semantic interoperability benefits
- Web services
  - Follow WS-I Basic Profile interop standards
    - SOAP 1.1 / WSDL 1.2 / UDDI 2.0
  - ebXML based messaging has some advantages over WS-*
    - Interoperation with DoD and CDC PHIN
    - RLS architecture does not preclude data interchange with eb-Message Services
- Security
  - Distributed user authentication and SSL based server authentication and transport level encryption
  - Message-based security in future releases using SAML, XML Signatures etc.



# Prototype Components / Layers Platforms

- Prototype platform choices based on expediency and rapid development capabilities
  - Post-prototype Implementation / deployment on alternate platforms
- Interoperability through adherence to open standards
  - HL7
  - SOAP
  - WSDL
  - XML

| *Service Layer* | *Prototype Platform* | *Alternatives* |
|---|---|---|
| Presentation Services | ASP.NET | * JSP<br>* PHP |
| Business Application Services | .NET components | * Java Servlets<br>* EJB Session Beans<br>* PHP / Python / Perl |
| Data Management Services | ADO.NET using .NET framework services | * EJB Entity Beans<br>* PHP / Python / Perl |
| Data Storage Services | Microsoft SQL Server 2000 | * Oracle / DB2<br>* MySQL / PostgreSQL |
| Integration Broker Services (includes messaging, orchestration, transformation and adaptor services) | Microsoft BizTalk Server 2004 | * BEA WebLogic Integrator<br>* IBM WebSphere / Mercator<br>* InterSystems Ensemble<br>* Orion Symphonia<br>* SeeBeyond eGate<br>* A combination of an Enterprise Service Bus (Sonic MQ) and an XML utility (Altova XML Suite) |
| | Custom components built on BizTalk framework | * Packaged adaptors from Integration broker vendors |
| | Microsoft BizTalk Server 2004, which uses MSMQ | * IBM WebSphere MQ |
| Systems Management Services | Custom .NET components using .NET framework | * CA Unicenter<br>* IBM Tivoli<br>* Microsoft Management Services |
| Security Services | Custom .NET components using simple database table for user identities / credentials | * Novell Odyssey<br>* Sun ONE<br>* CA eTrust |

# Screen Flow

CONNECTING FOR HEALTH℠

MARKLE FOUNDATION *A Public-Private Collaborative*

**Record Locator Service - DEMO**

## Log In

User Name: jcalladi

Password: ••••••••

Security Disclaimer:

Access to this website is for authorized users only. All access (including time and IP address) is tracked, logged and monitored. If you do not have permission to be here, you should leave immediately. This information is made available to the users by other healthcare entities. Any unauthorized use may result in hospital discipline and/or legal repercussions.

Log In: Enter

Forgot login? Contact your administrator.

Use and disclosure of this information must comply with all applicable State and Federal privacy and security laws and regulations.



Powered by: CSC

5/3/2005 3:39 PM | Version Strawman 0.20

# Screen Flow

Hello **jcalladi**
User at Boston Hospital

CONNECTING FOR HEALTH℠
MARKLE FOUNDATION *A Public-Private Collaborative*

Log off

## Record Locator Service - DEMO

### Patient Identification

**Required Data:**

Name [ ] * First [ ] * Last

Gender ○ Male ◉ Female

DOB [ ] / [ ] / [ ] * mm / dd / yyyy

ZIP Code [ ] *

Search Cancel

Enter data to search.

Required Fields when empty marked *

# Screen Flow

Hello **jcalladi**
Administrator at
General Hospital

CONNECTING FOR HEALTH℠
MARKLE FOUNDATION — *A Public-Private Collaborative*

Record Locator Service - DEMO

Log off
Gateway :
General Hospital

Patient Search | Publish

## Patient Identification

Prefill: John Clark

**Required Data:**

Name: John (First) Clark (Last)

Gender: Male / Female

DOB: 4 / 1 / 1927 (mm / dd / yyyy)

ZIP Code: 02139

Search | Cancel

Enter data to search.

# Screen Flow – Exact Match

Patient Search | Publish

## Patient Identification

Prefill: James Abate

**Required Data:**

Name: John (First) Clark (Last)

Gender: (•) Male ( ) Female

DOB: 1 / 4 / 1927 (mm / dd / yyyy)

ZIP Code: 02139

Search | Cancel

...search complete.

1 record(s) found. Elapsed Time: 3 seconds.

| Select | Gateway Location | MRN | Name | Gender | Birthdate | Zipcode |
|---|---|---|---|---|---|---|
| ☐ | General Hospital | 41188 | JOHN CLARK | M | 1/4/1927 | 02139 |

Get Summary Records

# Screen Flow – Probabilistic Match with Score

Patient Search | Publish

## Patient Identification

Prefill: John Clark

**Required Data:**

Name: John (First) Clark (Last)

Gender: Male Female

DOB: 4 / 1 / 1927 (mm / dd / yyyy)

ZIP Code: 02139

Search | Cancel

...search complete.

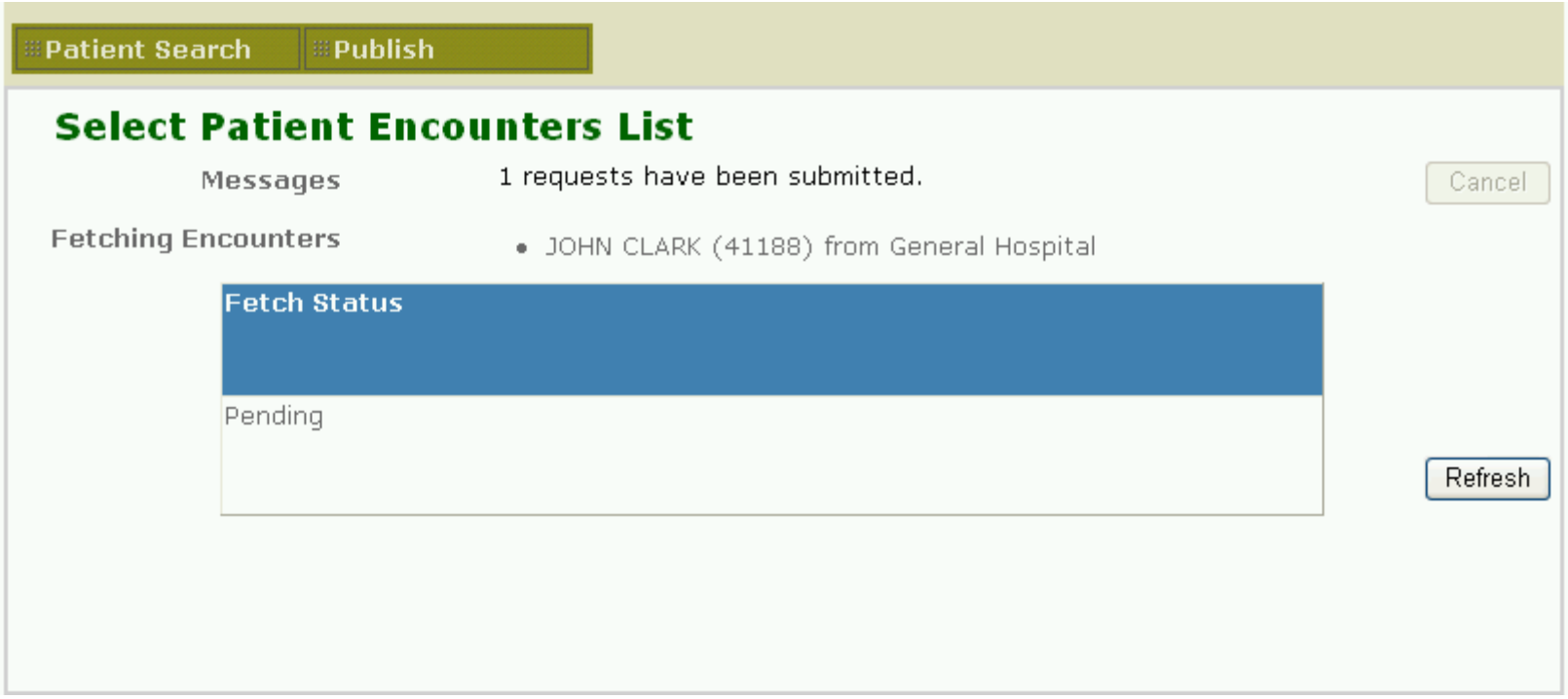
5 record(s) found. Elapsed Time: 2.35 seconds.

| Select | Gateway Location | MRN | Name | Gender | Birthdate | Zipcode | Score |
|---|---|---|---|---|---|---|---|
| ☐ | General Hospital | 41188 | JOHN CLARK | M | 1/4/1927 | 02139 | 6.2 |
| ☐ | General Hospital | 406611 | JOHN CLARK | M | 1/1/1906 | 02128 | 1.7 |
| ☐ | General Hospital | 24913 | JOHN CLARK | M | 12/4/1992 | 02126 | 1.7 |
| ☐ | General Hospital | 196314 | JOHN CLARK | M | 1/30/1938 | | 1.2 |
| ☐ | General Hospital | 433763 | JENNY CLARK | F | | 02124 | 1.1 |

Get Summary Records

*Threshold set low*

# Fetching Patient Encounters - pending



# Fetching Patient Encounters - found

Patient Search | Publish

## Select Patient Encounters List

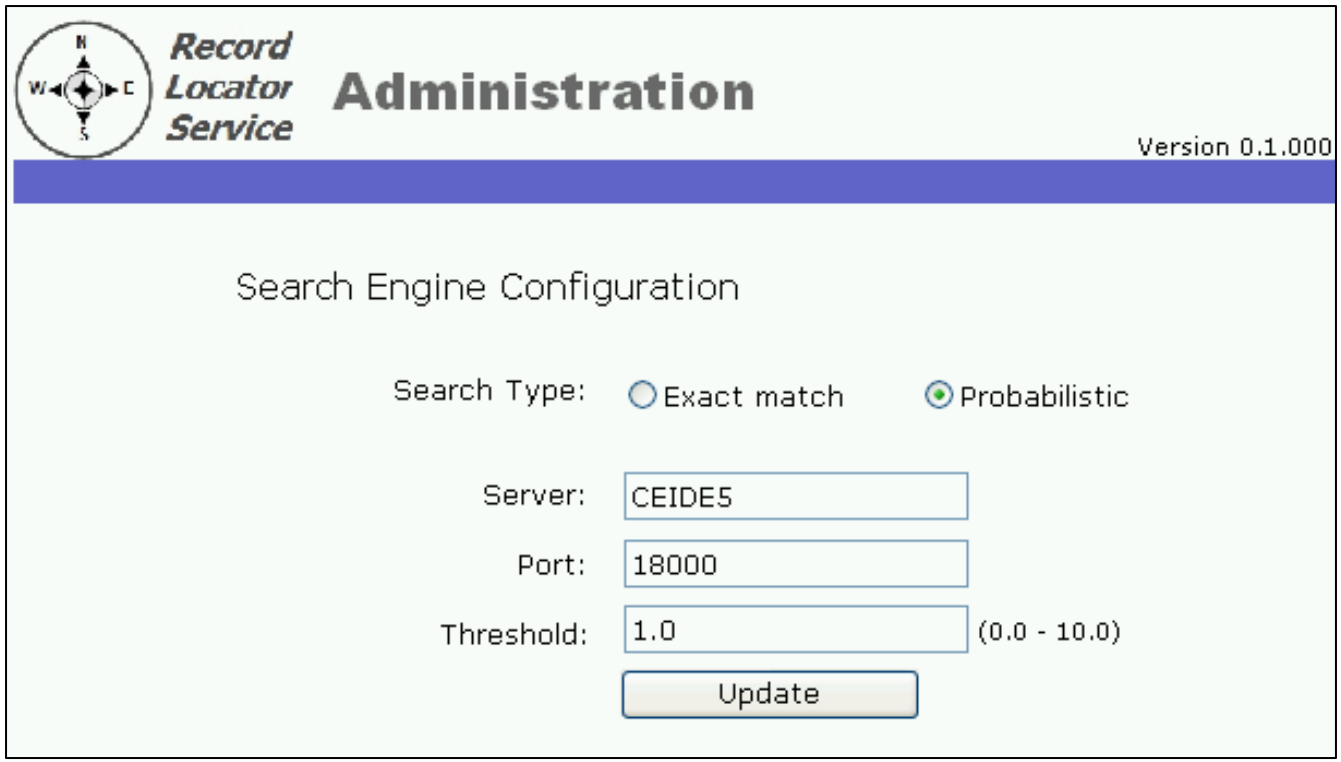
**Messages** 37 encounters were found.

**Fetching Encounters**

- BOY BOYKINS (294474) from General Hospital

| Select | Act Id | Act Type | Act Date | Fetch Status |
|---|---|---|---|---|
| ☐ | 246251 | SPECIMENS | 5/5/2000 | Completed |
| ☐ | 178940 | SPECIMENS | | Completed |
| ☐ | 237690 | SPECIMENS | | Completed |
| ☐ | 246250 | SPECIMENS | 5/5/2000 | Completed |
| ☐ | 170796 | SPECIMENS | | Completed |
| ☐ | 178938 | SPECIMENS | | Completed |
| ☐ | 178939 | SPECIMENS | | Completed |
| ☐ | 151066 | SPECIMENS | | Completed |
| ☐ | 2339698 | ORDER | 3/31/2005 | Completed |
| ☐ | 2339699 | ORDER | 3/31/2005 | Completed |
| ☐ | 48192 | OR_CASE | 3/15/2001 | Completed |
| ☐ | 2339695 | ORDER | 3/31/2005 | Completed |
| ☐ | 2339696 | ORDER | 3/31/2005 | Completed |
| ☐ | 2339697 | ORDER | 3/31/2005 | Completed |
| ☐ | 2339692 | ORDER | 3/31/2005 | Completed |
| ☐ | 2339693 | ORDER | 3/31/2005 | Completed |
| ☐ | 2339694 | ORDER | 3/31/2005 | Completed |

# Screen Flow – Configure Search Engine
# ADMIN Site



# Screen Flow – Publish Add

Patient Search | Publish

- New Patient
- Edit Exisiting
- Delete

**Publish Add**

**Required Data:**

MRN 999888777 — Medical record number for patient

URI cdxgw.chicagohope.org — Web address of institution where record is stored. (exludes Web Service name, but include path: e.g. https://medical.institution.org/public)

Name Michael (First) Clark (Last)

Gender ◉ Male ○ Female

DOB 1 / 6 / 1958 — Date Of Birth

mm / dd / yyyy

ZIP Code 02125 — Five digit ZIP

Add | Cancel

Enter data to Add.

*Deliberate typing error*
*Transposed mm /dd*

# Screen Flow – Search found newly added record

Patient Search | Publish

## Patient Identification

**Required Data:**

Name: Michael (First) Clark (Last)

Gender: (•) Male ( ) Female

DOB: 6 / 1 / 1958 (mm / dd / yyyy)

ZIP Code: 02125

Search | Cancel

...search complete.

7 record(s) found. Elapsed Time: 4.58 seconds.

| Select | URI | MRN | Name | Gender | Birthdate | Zipcode | Score |
|---|---|---|---|---|---|---|---|
| ☐ | www.csc.com | 21 | MICHAEL CLARK | M | 6/1/1958 | 02125 | 8.9 |
| ☐ | cdxgw.chicagohope.org | 999888777 | Michael Clark | M | 1/6/1958 | 02125 | 5.6 |
| ☐ | www.csc.com | 491482 | MICHAEL CLARK | M | 6/21/1945 | | 4.5 |
| ☐ | www.csc.com | 250153 | MICHAEL CLARK | M | 9/1/1941 | 02131 | 1.8 |
| ☐ | www.csc.com | 291590 | MICHAEL CLARK | M | 8/5/1965 | 02126 | 1.8 |
| ☐ | www.csc.com | 253112 | MICHAEL CLARK | M | 2/20/1931 | 02131 | 1.8 |
| ☐ | www.csc.com | 195926 | JEFFREY CLARK | M | 5/22/1958 | 02125 | 1.7 |

*Newly added record*

# Patient Linking / Matching Component

- Prototype includes two “swappable” components (configurable via Admin screen or XML config file)
  - **Exact match** (custom built)
    - Compares demographics entered to fields in CMPI table
    - All fields must match exactly.
      - First Name
      - Last Name
      - DOB
      - Gender
      - Zip
  - **Probabilistic match** (using Initiate Systems Identity Hub)
    - NYSIIS soundex (“whyte” and “white”)
    - Allows transpositions (01234 and 01243)
    - Scores based on weighted closeness to original data
    - If total score above a threshold – patient data is returned
    - Threshold is configurable (central admin config file)

# Initiate Search Engine – Scoring / Setting Thresholds

| **Comparison Scoring** | | *part of Initiate's Identity Hub Software* | | | www.initiatesystems.com | |
|---|---|---|---|---|---|---|
| | | This example from their literature | | | | |
| **Rec#** | **Name** | **Address** | **Phone** | **DOB** | **SSN** | **Example Score** |
| 101 | **John Q Public** | **1043 W. Easy St, Phoenix, AZ.85535** | **5556060** | **10-24-1950** | **482891822** | **20.0** |
| 102 | **Jon Public** | **1043 W. Easy St, Phoenix, AZ.85535** | **5556060** | **10-24-1950** | **482891822** | 18.0 |
| 103 | J **Public** | | 5553232 | **10**-25-**1950** | **482891822** | 11.0 |
| 104 | John Q Long | 552 Green Dr, **Phoenix, AZ**.85535 | | 11-15-1962 | 57265225 | 5.0 |
| 105 | Danny Smith | | 5552745 | **10-24-1950** | 48289244 | 5.0 |
| 106 | Kevin Dohert | 1028 **W. Easy** Ave, **Phoenix, AZ** .85535 | 5554289 | | 48224857 | 4.0 |

- Matching threshold is set by RLS implementing organization (e.g. RHIO)
  - Threshold is an installation time parameter, based on security policies re: “false positives” and human disambiguation.
  - Architecture does not preclude specific matching requirements

# Discussion

- Questions / follow-up
  - jhalamka@caregroup.harvard.edu