

ONC Validated Healthcare Directory Implementation Workshop

The Sequoia Project® Healthcare Directory
Overview and Lessons Learned

Eric Heflin, CTO/CISO The Sequoia Project



The Sequoia Project's Role

The Sequoia Project is a trusted, independent convener of private sector healthcare and governmental stakeholders

We work to address the challenges of secure, interoperable nationwide health information exchange (HIE).



SECURE



INTEROPERABLE



NATIONWIDE

The Sequoia Project Provides Support Services to:



Carequality operates a nationwide interoperability framework to link health information networks



eHealth Exchange is a nationwide public-private health information network



RSNA Image Share Validation Program is an interoperability testing program to enable seamless sharing of medical images

Current Sequoia Project Initiatives



PULSE is a system which provides disaster healthcare volunteers access to information to treat individuals injured or displaced by disasters

Interoperability Matters

Interoperability Matters is a leadership forum of public and private stakeholders who work together to solve mission critical interoperability challenges

Directory Production Status

HL7[®] and FHIR[®] are registered trademarks of HL7 and are used with permission

eHealth Exchange Directory Experience

- Have been in production with a Directory since inception (under the ONC until 2012)
- Primary use case is electronic services endpoint discovery
- Over 300 entries representing over 150m patients connected today in production
- Directory is based on the UDDI v3 standard, organized by business entities (primary search key), then by metadata such as contacts, then by services and end points.
- Migrating to FHIR
- Moved from Java to a Ruby coded version that now supports UDDI and moving to FHIR with the same directory instances

Carequality Directory Experience

- Live since Feb 2017 (first to deploy the Argonaut Directory specification in production)
- Approaching 15k entries representing live Carequality end points supporting 19m clinical document exchanges per month
- Approaching 95% coverage of all US practices and clinics and 90% of all US hospitals (source: Implementers)
- Written in Ruby using an in-memory database supporting a FHIR API

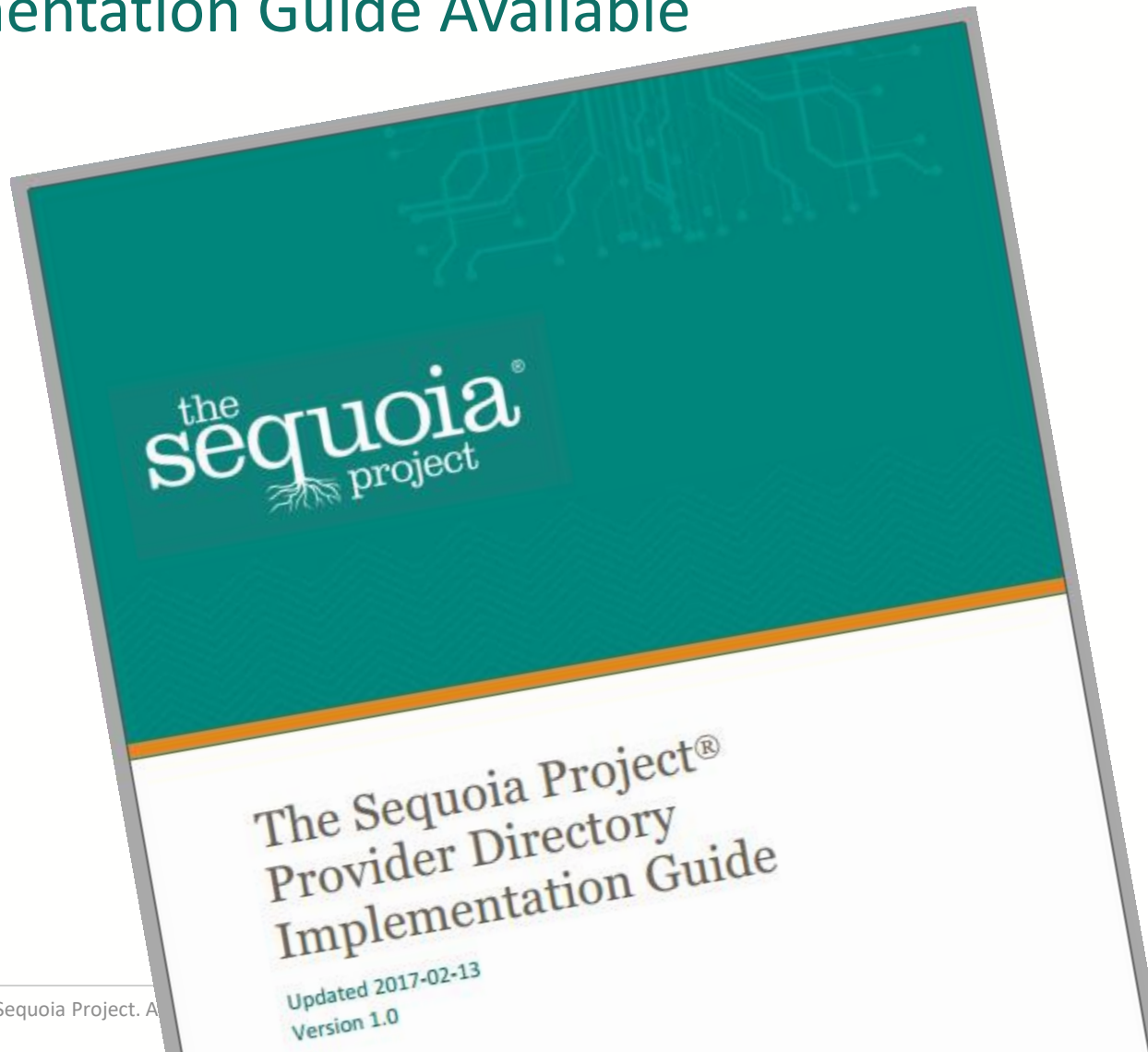
PULSE Directory Experience

- FHIR based directory drives PULSE queries
- Enables Geographic awareness and future features such as searching for hospitals servicing specific regions



Existing Directory Lessons Learned

Implementation Guide Available



Lessons: Overall

- Directories were expected to provide significant value and they've proven to be strategically important
- New use cases were discovered
 - Getting participant administrative status
 - Communicating test patient demographics
 - Sharing of organizational scheduled maintenance windows
 - And many more as discussed in the “Extension” slide

Lessons: Data Quality

- Moving from manually maintained data elements to programmatically maintained required multiple iterations. Required multiple manual QA reviews which then allowed subsequent automation.
- Data quality automation is essential for efficiency and consistency
- Interoperability of each key data element is important, including all components of address, types of contacts, versions of services supported.
- Some FHIR data elements seem like they are ignored by client applications initially (such as address) resulting in lax data quality adherence and then later used by client applications resulting in consistency problems.
- GeolP required additional constraints (programmatically enforced now) to allow the map API to function. We constrained the USPS further. Note: International addresses will be a challenge with GeolP! Some countries don't offer carrier delivery to residences or offices for example.

Lessons: Workflow

- Sequoia maintains now over 20 directory instances for the companies we offer directory services for and some of these directories are interdependent.
- One example workflow was to reconcile entries from a (now retired) manual directory, with a client maintained directory (client applications use the FHIR API). And then publishing that reconciled directory to the main API cluster of servers, and a web site interactive search map cluster of servers.
- We've invested heavily in automating this workflow and find the ROI to be extremely high.

Lessons: Operational (Part 1)

- Keeping in lock-step with HL7 and ONC work
 - Suggest publishing a directory roadmap with periodic phases to resynchronize FHIR versions
- Clients move at their own pace
 - Requires planned overlap period between versions of the directory to allow for migration
- Clients used production directories for development work.
 - Examples: bad HCIDs, infinite loops (twice!)
 - API keys can be an easy way to track issues
 - Recommend you deploy DEV, STAGE and PROD directories and enforce use of those by client applications
- Clients need to use gzip http header to avoid timeouts on their side and servers must support this esp. if they allow bulk operations
- Needed to export
- Bulk data operations

Lessons: Operational (Part 2)

- Requires working examples to get dev teams into production and usually a mini virtual Connectathon
- Found using CURL examples was extraordinarily helpful as it was a minimal working case
- Needed to publish full round trip operations
- Client application expectation setting
 - bulk download vs real-time query
 - download frequency
 - incremental update frequency
- Need to support clients and servers to both support gzip encoding (90% compression is typical) to avoid client time outs
- Need to balance stability of the directory API so that client applications have a stable target, vs the desire to keep current with FHIR as it matures. Example: Use of HAPI and .NET reference implementation code. Requires the use of a non-validating client for now.

Lessons: Access Control

- Access control model
 - Our model has is simple and seems sufficient
 - Designed to provide for:
 - Accountability
 - Delegated administration
 - Partitioning of admin domains
 - API key linked to CRUD rights and managedBy attribute
 - Full CRUD operations are heavily used
 - Some attributes are now locked down and not available for clients including last updated, managed by, and soon admin status.
 - All clients with an API key are granted at least read-only access

Lessons: The Human Element

- We had several surprises as far as non-API directory access
- Interactive map
 - <https://carequality.org/active-sites-search/>
 - Implemented using the Carequality directory data
 - Uses a custom Word Press template
 - Was a surprise “hit” with hundreds to thousands of queries per day
 - We had to create a custom, extremely optimized, response to allow quick client rendering of nearly 15k endpoints
- Administrators needed a “meaningful summary” of directory changes
 - We created a directory diff tool and publish a list of directory changes such as “added a new organization” or “changed end points”

Search By
Name:

Search By City:

Search By
State:

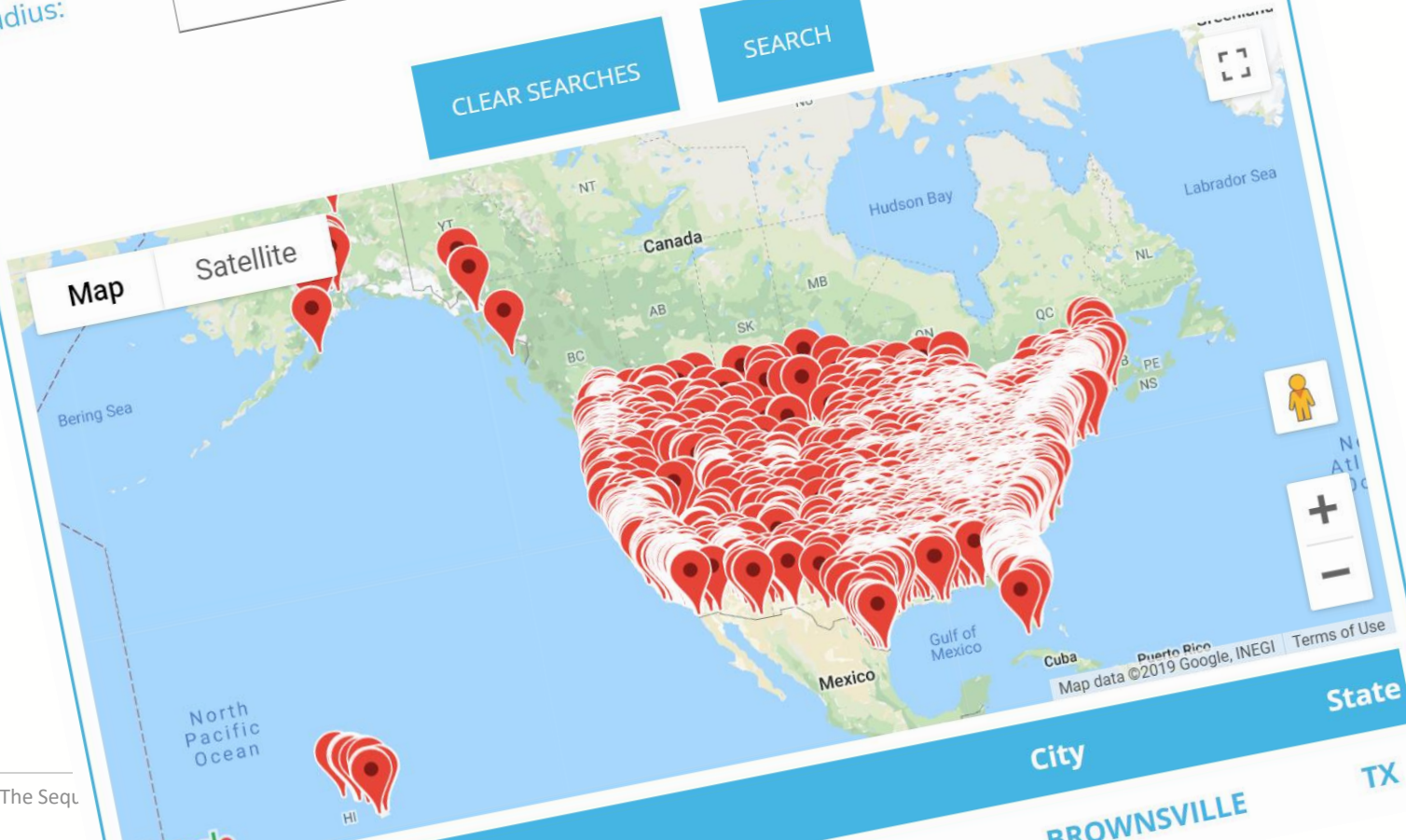
No State

Search By Zip:

Radius:

CLEAR SEARCHES

SEARCH



Lessons: Federation

- We are combining two of our directories
 - The eHealth Exchange is becoming a Carequality Implementer resulting in the need to combine these two directory trees
 - Federation has been a challenge when combining directories resulting in the need for a 35 page spec focused on this topic
 - Where an organization entry persists after the merge is complex and both a policy and technical issue with routing implications

Lessons: Current FHIR Extensions

- Sequoia extended the FHIR data model to include key extensions driven by business use cases, largely designed to allow for more automation
 - Use case compatibility
 - Clinical content compatibility
 - More specific technical transaction version number
 - The purpose of the transaction such as treatment, disaster response, disability determination, or patient authorized
- Extensions are mission-critical as they can allow automated partner onboarding

Lessons: New FHIR Extensions in Process Now

- Adding administrative status such suspended, in testing state, or full nominal production
- Routing options (if there are multiple ways to reach a single organization)
- Timeouts for response from responding gateways
- Adding scheduled maintenance windows (hard to express using existing FHIR data types). Used by partners and op analytics metrics
- Used for eHealth Exchange Hub operational analytics so that only the HCID OID is logged, every other org attribute is obtained from the directory (such as the org name)
- Domain; the structural location in the directory is insufficient so we needed to add a new attribute
- New attribute to further describe routing status such as “initiator only” or “both initiator and responder”
- Needed to document state transitions

For More Information

- The Sequoia Project
 - www.sequoiaproject.org
- Argonauts
 - [http://argonautwiki.hl7.org/index.php?title=Main Page](http://argonautwiki.hl7.org/index.php?title=Main_Page)
- HL7[®] FHIR[®]
 - <http://wiki.hl7.org/index.php?title=FHIR>

Thank You!

Eric Heflin

eheflin –at- sequoiaproject –dot- org

Appendix

Detailed Requirements

- Support query, retrieve, and bulk operations for electronic end points
- Access control model
- Delegated self administration
- Expression of relationships between entities (legal and administrative)
- Extensible to express implementation-specific required elements such as:
 - Purpose of use, Role
 - Use case(s) supported
 - Content types supported (CCDA 2.1, FHIR4, etc.)
 - Admin status of the organization (suspended, nominal, etc.)
- UDDI and FHIR API support simultaneously
- Full FHIR create, read, update, delete operations
- Master/slave replication
- Supports “part of” and “member of” relationships
- Open source

The Sequoia Project® Healthcare Directory

- Use case A.1 (electronic end point discovery)
- Based on the Argonauts workgroup
- Went live February 2017
- EndPoint is a contained resource of Organization resources
- Extensions include additional EndPoint data elements for
 - Use cases supported
 - Technical transaction information
 - Version
 - PurposeOfUse
 - Role
 - IPA
 - More
- Supports JSON and XML
















Sequoia Implementation Overview/Use Cases













- Sequoia has deployed the Argonaut Provider Directory specification
- Sequoia Project advocated for key use cases:
 - Endpoint discovery
 - Relationships between orgs and orgs
 - Relationships between people and orgs
 - Attributes required by eHealth Exchange and Carequality were added as an extension (discussed next)
 - Efficient retrieval of full directory contents



Technical Drill-Down

Standard FHIR® Directory Data (Org and Endpoint)

Name	Flags	Card.	Type
 Organization	I		DomainResource
 identifier	Σ I	0..*	Identifier
 active	?! Σ	0..1	boolean
 type	Σ	0..*	CodeableConcept
 name	Σ I	0..1	string
 alias		0..*	string
 telecom	I	0..*	ContactPoint
 address	I	0..*	Address
 partOf	Σ	0..1	Reference(Organization)
 contact		0..*	BackboneElement
 purpose		0..1	CodeableConcept
 name		0..1	HumanName
 telecom		0..*	ContactPoint
 address		0..1	Address
 endpoint		0..*	Reference(Endpoint)

Name	Flags	Card.	Type
 Endpoint			DomainResource
 identifier	Σ	0..*	Identifier
 status	?! Σ	1..1	code
 connectionType	Σ	1..1	Coding
 name	Σ	0..1	string
 managingOrganization	Σ	0..1	Reference(Organization)
 contact		0..*	ContactPoint
 period	Σ	0..1	Period
 payloadType	Σ	1..*	CodeableConcept
 payloadMimeType	Σ	0..*	code
 address	Σ	1..1	uri
 header		0..*	string

Sequoia Extensions

- Purpose:
 - Implement additional fields to reduce connectivity costs and effort
 - Based on 10 years of production directory lessons learned
 - Included significant community guidance
- Version of the service
- Actor (initiator/responder)
- IHE ITI transactions
- Use cases supported
- Content details (generated/accepted)
- Purpose of use
- Role

Example Directory Entry

```
<Organization>
  <!--The ID value is subject to change-->
  <id value="Organization-1"/>
  <meta>
    <versionId value="1"/>
    <lastUpdated value="2017-02-19T11:27:06-06:00"/>
  </meta>
  <!--This is the XCA/XCPD HomeCommunityID OID in URN format-->
  <identifier>
    <use value="official"/>
    <system value="http://www.hl7.org/oid"/>
    <value value="Org-Identifier"/>
  </identifier>
  <active value="Org-Status"/>
  <name value="Org-DisplayName"/>
  <alias value="Org-OtherNames"/>
  <!--The contact object is repeated for each person listed in
the directory-->
  <contact>
```

Example Directory Entry (Cont.)

```
<partOf>  
  <Reference>  
    <!--Home Community ID of parent org, if any-->  
    <identifier>  
      <use value="official"/>  
      <type value="HCID"/>  
      <system value="http://www.hl7.org/oid"/>  
      <value value="1.2.3.4.1"/>  
    </identifier>  
  </Reference>  
</partOf>
```


Example Directory Entry (Cont.)

```
<Endpoint>
  <!--Home Community ID-->
  <identifier>
    <use value="official"/>
    <type value="HCID"/>
    <system value="http://www.hl7.org/oid"/>
    <value value="Endpoint01-HomeCommunityID"/>
  </identifier>
  <!--Assigning Authority ID-->
  <identifier>
    <use value="official"/>
    <type type="AAID"/>
    <system value="http://www.hl7.org/oid"/>
    <value value="Endpoint01-AssigningAuthorityID"/>
  </identifier>
  <connectionType>
    <system value="http://hl7.org/fhir/subscription-channel-type"/>
    <code value="IHE-XCA"/>
  </connectionType>
  <name value="Endpoint01-DisplayName"/>
  <managingOrganization/>
  <address value="Endpoint01-URL"/>
  <payloadMimeType value="text/xml"/>
  <payloadType>
```

Example Directory Entry (Cont.)

```
<payloadType>
  <coding>
    <system value="urn:oid:1.3.6.1.4.1.19376.1.2.3"/>
    <code value="Endpoint01-ContentTypesSupported"/>
  </coding>
</payloadType>
<extension url="https://sequoiaproject.org/StructureDefinition/Endpoint/main/1.3.6.1.4.1.19376.1.2.3" base="http://hl7.org/fhir/StructureDefinition/Endpoint" />
  <extension url="Transaction">
    <valueString value="Endpoint01-SupportedTransactions"/>
  </extension>
  <!--Is this gateway an initiator or responder actor-->
  <extension url="Actor">
    <valueCodeableConcept>
      <coding>
        <system value="https://sequoiaproject.org/StructureDefinition/Endpoint/main/1.3.6.1.4.1.19376.1.2.3" />
        <value value="Responding Gateway"/>
      </coding>
    </valueCodeableConcept>
  </extension>
</extension>
```

Example Directory Entry (Cont.)

```
<extension url="Version">
  <valueCodeableConcept>
    <coding>
      <system value="https://sequoiaproject.org/StructureDefinition/Endpoint/Version/1.0.0"/>
      <value value="2.0"/>
    </coding>
  </valueCodeableConcept>
</extension>
<!--Initiative specific list of use cases supported-->
<extension url="UseCases">
  <valueCodeableConcept>
    <coding>
      <system value="https://sequoiaproject.org/StructureDefinition/Endpoint/UseCases/1.0.0"/>
      <value value="Endpoint01-UseCasesSupported"/>
    </coding>
  </valueCodeableConcept>
</extension>
```

Example Directory Entry (Cont.)

```
<!--PurposesOfUse Value Set for SAML header and/or access control-->
<extension url="PurposesOfUse">
  <valueCodeableConcept>
    <coding>
      <system value="https://sequoiaproject.org/StructureDefinition/Endpoint/PurposesOfUse/1.0.0"/>
      <value value="Endpoint01-PurposeOfUseAllowed"/>
    </coding>
  </valueCodeableConcept>
</extension>
<!--Roles Value Set for SAML header and/or access control-->
<extension url="Roles">
  <valueCodeableConcept>
    <coding>
      <system value="https://sequoiaproject.org/StructureDefinition/Endpoint/Roles/1.0.0"/>
      <value value="Endpoint01-RolesAllowed"/>
    </coding>
  </valueCodeableConcept>
</extension>
```