



AGENCY FOR HEALTHCARE RESEARCH AND QUALITY



November 2020 CDS Connect Work Group Call



CDS Connect

Agenda

Schedule	Topic
3:00 - 3:02	Roll Call, Michelle Lenox (MITRE)
3:02 - 3:05	Review of the Agenda, Maria Michaels (CDC)
3:05 - 3:50	Lessons Learned: Blockchain to Support Trust (EunoChains)
3:50 - 3:55	What's New with CDS Connect This Month (MITRE)
3:55 - 4:00	Open Discussion and Close Out, Maria Michaels (CDC) <ul style="list-style-type: none">• Open discussion and announcements• Concluding comments, review next steps and adjourn

Objectives

- Share lessons learned on use of CDS Connect
 - ▶ Blockchain as a potential means to support trust
- Share new features and resources available for CDS Connect
- Discuss topics of interest to members relating to opportunities for CDS Connect

Building an Accelerated and Participatory CDS Using Blockchain Technologies



Background



- In the 21st Century
 - Healthcare costs are going higher,
 - Health emergencies are becoming unpredictable, and
 - Response Times are becoming critical
- The Public Health Clinical Decision Support (CDS) has become very critical for ensuring public safety and quality of care
- *EunoChains*, is a tech startup focused on optimal architectures for Blockchain Networks, that can be overlaid upon industry standard frameworks like Hyperledger
- We are applying it to build Federated Blockchains for CDS Resource Provenance that will increase 'Trust' and reduce 'Frictions' within the 'Flow of Information' across CDS Stakeholders

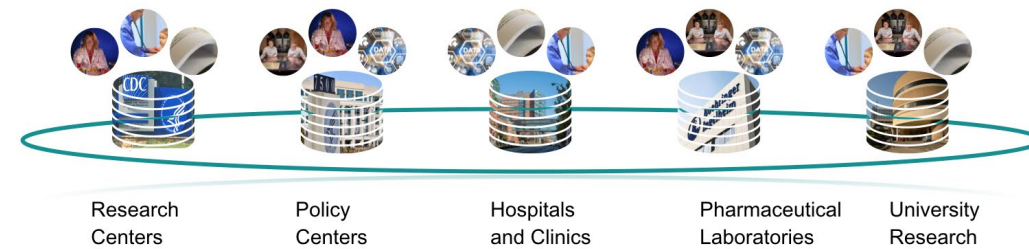


Figure: Accelerating the Flow of Information and Collaboration within the CDS ecosystem with Blockchains powered Assurances for Resource Provenance

Importance of Provenance of a Digital Resource

- HL7 FHIR defines Resource Provenance as
 - Provenance of a resource is a record that describes entities and processes involved in producing and delivering or otherwise influencing that resource. Provenance provides a critical foundation for assessing authenticity, enabling trust, and allowing reproducibility. Provenance assertions are a form of contextual metadata and can themselves become important records with their own provenance. **Provenance statement indicates clinical significance in terms of confidence in authenticity, reliability, and trustworthiness, integrity, and stage in lifecycle** (e.g. Document Completion - has the artifact been legally authenticated), all of which may impact security, privacy, and trust policies
- Types of information captured in Provenance Records depends upon the perspectives of use, e.g.
 - *agent-centered provenance*, that is, what people or organizations were involved in generating or manipulating the information in question.
 - *object-centered provenance*, by tracing the origins of portions of a document to other documents.
 - *process-centered provenance*, capturing the actions and steps taken to generate the information in question

source: HL7 FHIR Specifications

source: W3C PROV Documents

Challenges of recording Provenance information in CDS

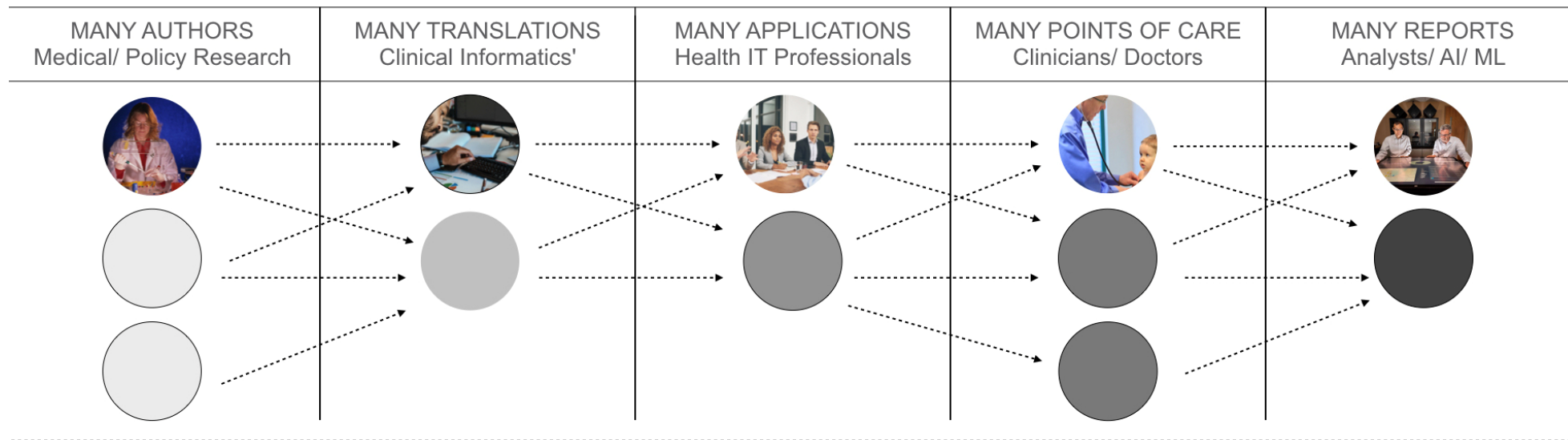
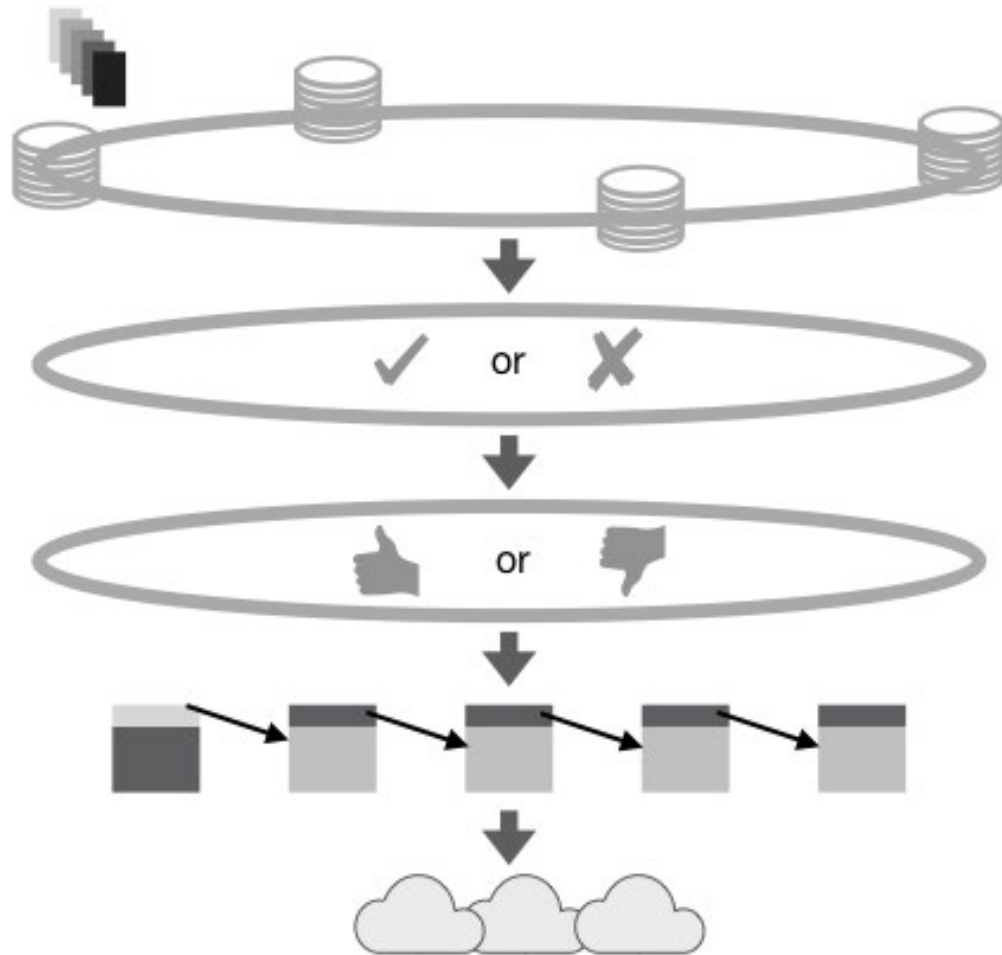


Figure: The Diverse and Complex Pathways for Producing and Exchanging of CDS Resources

- Digital resources, like Clinical Knowledge Artifacts, are 'produced and exchanged' as across a diverse set Actors, Activities and Organizations. Currently, its difficult to record and track their Provenance, along all the possible paths
- Today, the onus on managing the Provenance of such resources lies with Organizations acting as 'Curators'. Curators create and manage CDS Resource Repositories, and enforce '**Organization established**' policies and procedures to record the Provenance Information of the managed CDS Resources
- Such 'intermediated and brokered' mechanisms neither scale well, nor do they provide any 'autonomy or flexibility' for the CDS Stakeholders to organize and collaborate

Blockchains for Trust, Accountability and Auditability

Peer 2 Peer Protocols - Smart Contracts - Consensus Protocols - Cryptographically Secure Data - Broadcast Events



Participating Stakeholders organize themselves as a P2P network and set up Broadcast Channels

All Peers Independently Validate Transactions Using Agreed Upon Digitally Encoded Smart Contracts

All Peers Tabulate their Validation Results And Enter into a Consensus to Commit or NOT

All Peers Ledger and Commit Transactions on Cryptographically Secure Data Structures

All Peers Broadcast their Actions to the Cloud

Figure: Processes within Blockchains

Simplifying Provenance with Blockchains

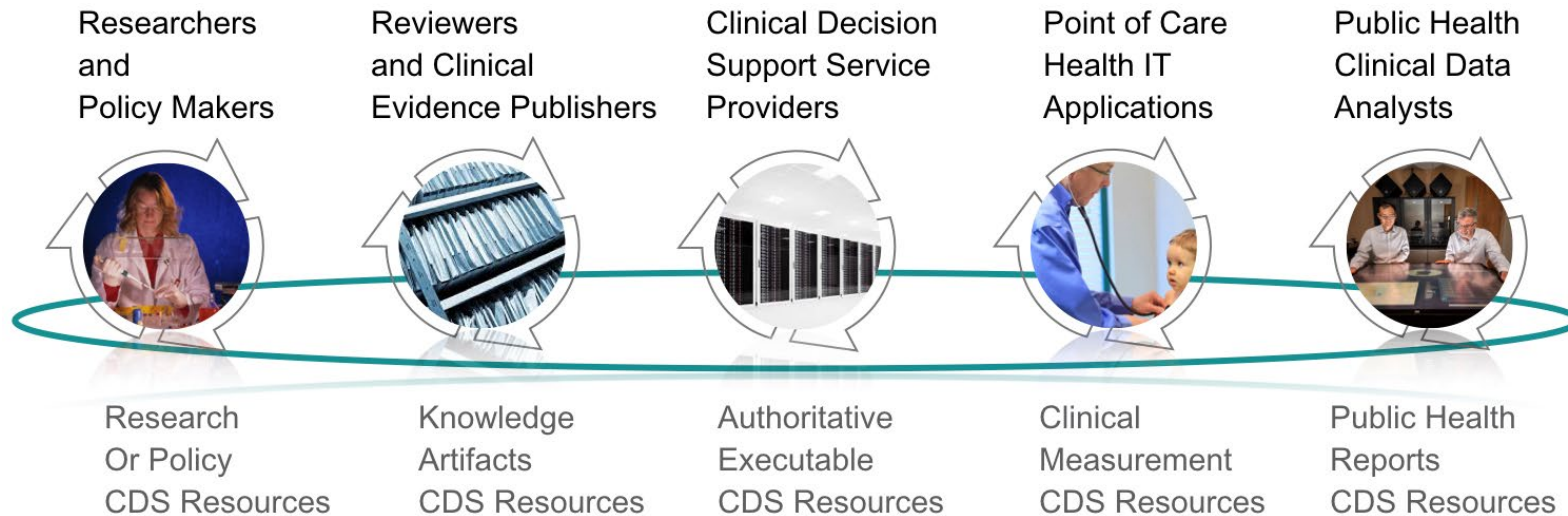


Figure: Distributed CDS Resource Repositories managed by Blockchains that enforce standardized Resource Provenance Policies

- Blockchains can provide alternate way to curate CDS artifacts with '**Stakeholder established**' policies and procedures of recording the Provenance of managed CDS Resources - enforced uniformly and transparently by Smart Contracts
- Provides dis-Intermediated CDS Resource repositories for stakeholders to collaborate by sharing Resources, Data, Expertise, Roles and Responsibilities - with Blockchain assurances of Trust, Accountability and Audit-ability
- Provides a scalable P2P Platform to accelerate the 'Speed of Dissemination' and reduce 'Response Times'

Presentation Agenda



- Share 'Lessons Learned' during EunoChains 'Discovery, Design and Prototype' Cycle
- Share thoughts of working together with the CDS Connect Work Group to reuse and build upon the the work done at AHRQ and the CDS Connect Program to create alternate Blockchain-based Channels for CDS Connect

EunoChains 'Discovery, Design and Prototype' Cycle

- DISCOVERY
 - VALUE OF BLOCKCHAIN TECHNOLOGIES IN CDS USE CASES
- DESIGN
 - CURRENT STATE OF STANDARDS & INDUSTRY INITIATIVES and BLOCKCHAIN ARCHITECTURES
- PROTOTYPE
 - CDS ENVIRONMENTS, OPEN SOURCE TECHNOLOGIES & TOOLS and BLOCKCHAIN I/F

Lessons Learnt: Discovery Phase

- Reviewed published CDS literature and documents
- Meeting with domain experts
- 8 Human-centered design sessions with Washington DC Metro area 'Blockchains/AI/ML in Healthcare' Working Group
- Rapid Prototyping
- Outcome:
 - ▶ Blockchain Value Proposition within CDS
 - ▶ Functional Use Cases and Technology Matrix

Blockchain Value Proposition within CDS

- Streamline the complex CDS Processes across Stakeholders, like managing
 - Provenance, Accuracy, Trust and Versioning
 - Attribution and Accountability
 - Privacy, Consent, Authorization & Access,
 - Accounting for Disclosures, and
 - Digital Rights Management
- Blockchains for Provenance will be important to support the CPG-on-FHIR Clinical Quality Lifecycle.
- Blockchains can be used to increase direct Participation of CDS Actors and Collaboration
- Conclusion
 - ▶ Blockchains are still new to the CDS Community and we found no comprehensive research available on Blockchain-enabled use cases for CDS

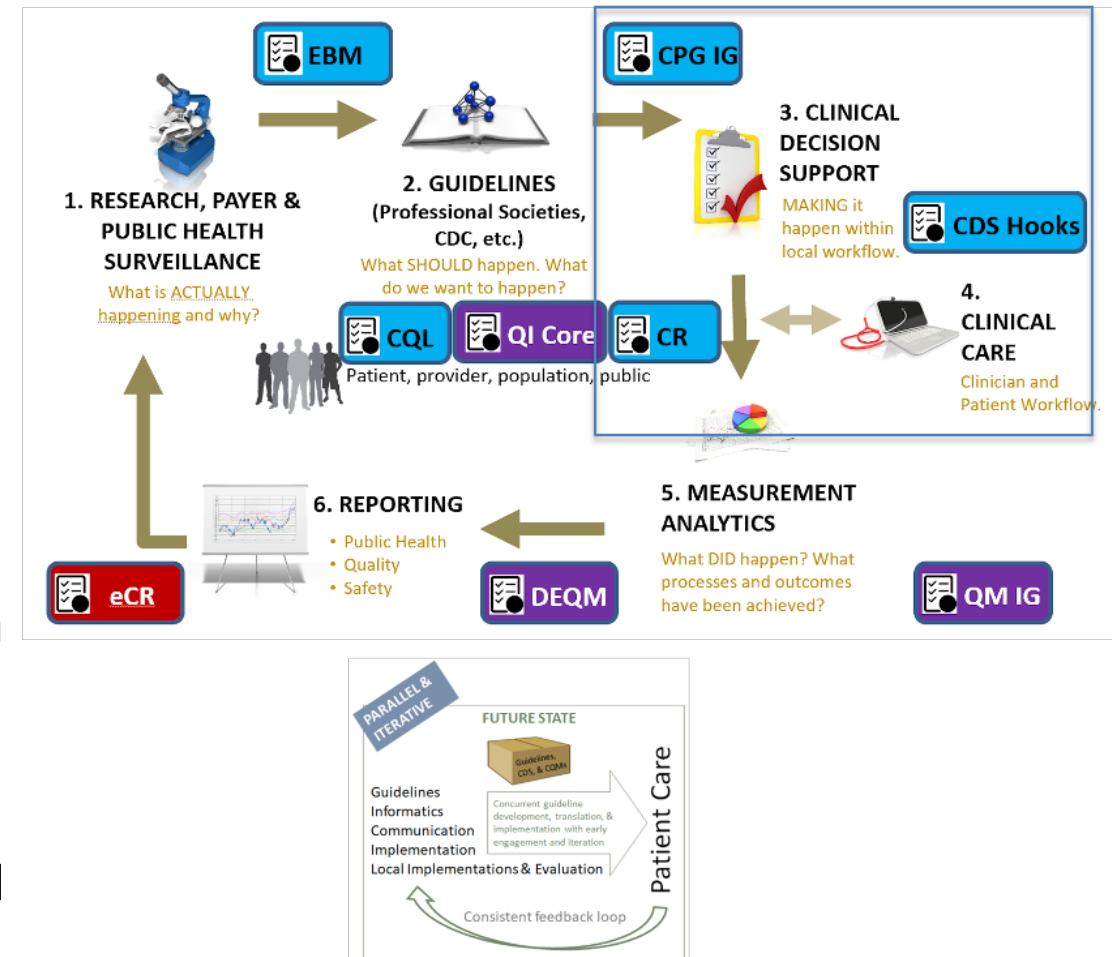


Figure: CPG-on-FHIR, Clinical Quality Lifecycle Feedback and Feedforward Loops

Functional CDS Use Cases & Tech Matrix (examples)

Objective	Benefits to CDS Stakeholders	Blockchain Technologies
Agility: Communities for Rapid Response	Communities can define their own Resources and Arrangements; while complying to common Procedures	Trust Framework, Programmable Smart Contracts and Pluggable Consensus
Rapid Response: Scalable and Reliable	Multiple Points of Presence for Dissemination and Measurement, Redundancy for Faults, Elastic Scaling	Peer to Peer Network built with all Parties participating in Consensus
Trust: Synthesis of Evidence	Verifiable Lineage, Records of Justification and Accountability of Work across CDS Resource Compositions	Smart Contracts enforced Provenance with Immutably Recorded Transactions
Interoperability: Streamlined and Frictionless Processes	Automation of Compliance and adherence to laid out Policy and Procedures	Cryptographically verified identities and roles. Digital Smart Contracts
Trust: Stakeholder Participation	Sharing of Data, Research and Quality Measurement with Transparency and Accountability, Patient Involvement	Digitally Enforced Contracts and Consistent Immutable Ledgers stored on many Nodes
Trust: Actionable Evidence	Verifiable Assurances of Trust like Provenance, Lineage, Integrity, Compliance and Quality; across Lifecycle	All Transactions are Crypto Signed, Verified by all, Timestamped and stored Immutably

Lessons Learnt: Design Phase

- Reviewed:
 - ▶ HL7 FHIR Standards and Work done in HL7 Accelerators
 - ▶ ONC - FHIR at Scale
 - ▶ CDC - CPG on FHIR
 - ▶ AHRQ - CDS Connect, PC-CDS, Knowledge/ Learning Networks
- Findings:
 - ▶ W3C PROV Model
 - ▶ Resource Model
 - ▶ Trust Model
 - ▶ Governance Model

W3C PROV Models for Provenance

Category	Dimension	Description
Content	Object	The artifact that a provenance statement is about.
	Attribution	The sources or entities that contributed to create the artifact in question.
	Process	The activities (or steps) that were carried out to generate or access the artifact at hand.
	Versioning	Records of changes to an artifact over time and what entities and processes were associated with those changes.
	Justification	Documentation recording why and how a particular decision is made.
	Entailment	Explanations showing how facts were derived from other facts.
Management	Publication	Making provenance available on the Web.
	Access	The ability to find the provenance for a particular artifact.
	Dissemination	Defining how provenance should be distributed and its access be controlled.
	Scale	Dealing with large amounts of provenance.
Use	Understanding	How to enable the end user consumption of provenance.
	Interoperability	Combining provenance produced by multiple different systems.
	Comparison	Comparing artifacts through their provenance.
	Accountability	Using provenance to assign credit or blame.
	Trust	Using provenance to make trust judgments.
	Imperfections	Dealing with imperfections in provenance records.
	Debugging	Using provenance to detect bugs or failures of processes.

Figure: Categories and Dimensions of Provenance (W3C PROV Wiki)

- When the CDS resources and records of their Provenance are maintained on blockchains it can enhance the CDS Information Interoperability to CDS Process Interoperability

AHRQ CDS Connect - Overview

- Many standardization efforts are in place to address CDS Artifacts and their Interoperability, Delivery and Use
 - But we couldn't find research or guidelines for the 'Provenance of CDS Resources'
- AHRQ has created Trust Requirements for CDS Artifacts with Attributes and Recommendations
 - It is broadly written and lacks supporting Implementation Guidelines
- Governance of CDS Ecosystems is still a new concept and still limited to Organizations playing a specific role like Curator of CDS Artifacts (AHRQ)
 - Needs more research and should be redefined as 'Governance as a Process'

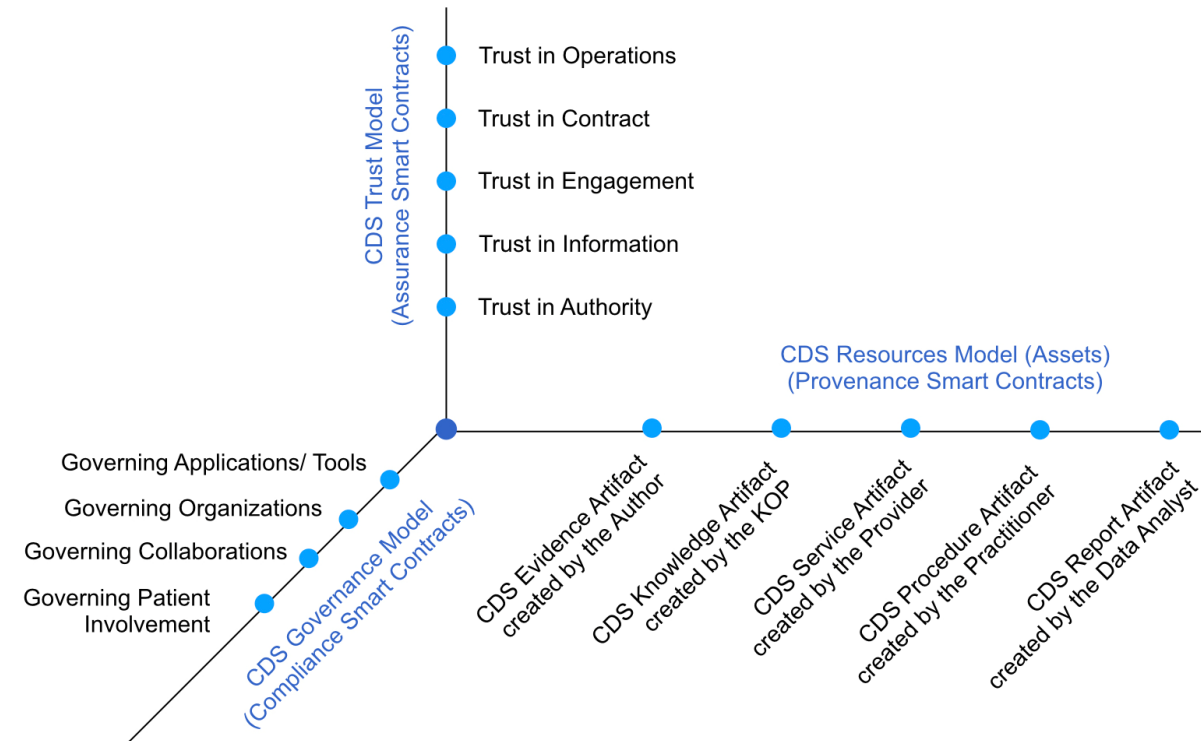


Figure: The Three Dimensions of Blockchain Engineering

AHRQ CDS Connect - Resources and Provenance

ARTIFACT CREATION AND USAGE

Steward

Agency for Healthcare Research and Quality
Contributors

Publisher

The MITRE Corporation

This artifact was developed by MITRE software engineers and clinical informaticists, in collaboration with clinical subject matter experts and leaders from the USPSTF.

Additional information about MITRE's health expertise is available [here](#).

Additional information about the USPSTF's preventive health expertise is available [here](#).

If you would like further information, would like to give us feedback, or have any questions about this artifact, please contact us at ClinicalDecisionSupport@ahrq.hhs.gov.

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Keywords

behavioral counseling USPSTF overweight obese blood glucose CVD risk Diabetes
patient-facing

MeSH Topics

☒ Diabetes Mellitus ☒ Endocrinology ☒ Cardiovascular System ☒ Primary Prevention

```
{
  "resourceType": "Provenance",
  // from Resource: id, meta, implicitRules, and language
  // from DomainResource: text, contained, extension, and modifierExtension
  "target": [{ Reference(Any) }], // R! Target Reference(s) (usually version specific)
  // occurred[x]: When the activity occurred. One of these 2:
  "occurredPeriod": { Period },
  "occurredDateTime": "<dateTime>",
  "recorded": "<instant>", // R! When the activity was recorded / updated
  "policy": ["<uri>"], // Policy or plan the activity was defined by
  "location": { Reference(Location) }, // Where the activity occurred, if relevant
  "reason": [{ CodeableConcept }], // Reason the activity is occurring
  "activity": { CodeableConcept }, // Activity that occurred
  "agent": [{ // R! Actor involved
    "type": { CodeableConcept }, // How the agent participated
    "role": [{ CodeableConcept }], // What the agents role was
    "who": { Reference(Practitioner|PractitionerRole|RelatedPerson|Patient|
      Device|Organization) }, // R! Who participated
    "onBehalfOf": { Reference(Practitioner|PractitionerRole|RelatedPerson|
      Patient|Device|Organization) } // Who the agent is representing
  }],
  "entity": [{ // An entity used in this activity
    "role": "<code>", // R! derivation | revision | quotation | source | removal
    "what": { Reference(Any) }, // R! Identity of entity
    "agent": [{ Content as for Provenance.agent }] // Entity is attributed to this agent
  }],
  "signature": [{ Signature }] // Signature on target
}
```

- Web Content Management to be adapted to FHIR Resource Management

AHRQ CDS Connect - Trust Requirements and Provenance

AHRQ TFWG Recommendations / EunoChains Trust Model Analysis

	Trust Attributes / Recommendations	Comments/ EunoChains Review
1	Competency	An actor is deemed to be competent in the role played in the CDS ecosystem. For example, an author of a knowledge artifact should be judged competent, qualified, and an appropriate authority to develop the artifact based on factors such as past performance, professional qualifications, or certifications.
1.1	Authors have descriptions with background information including affiliations, years participating, and frequency of participation.	CDS EUNOCHAINS & GLOBAL GOVERNANCE EUNOCHAINS
1.2	Authors promote respect and dignity when providing feedback.	CDS TOOLS/ WORKSPACES
1.3	Authors are credentialed by an agreed-upon entity through education or training, experience, and dependability.	CDS EUNOCHAINS
1.4	Knowledge professionals are certified that they are competent in the knowledge management lifecycle, competently interpret, encode, and execute knowledge, and are competent of issues in conflict of interest	CDS EUNOCHAINS & GLOBAL GOVERNANCE EUNOCHAINS
1.5	Competency should apply to both individuals and organizations	CDS EUNOCHAINS & CDS TOOLS/ WORKSPACES
2	Compliance	A knowledge artifact should conform to defined standards and criteria including copyright and intellectual property
2.1	Knowledge artifacts provide human-readable and machine-readable forms (whenever applicable) as well as supporting references.	CDS EUNOCHAINS & CDS TOOLS/ WORKSPACES
2.2	Knowledge artifacts are implemented in compliance with best practices for safe and effective implementation.	CDS TOOLS/ WORKSPACES
2.3	Knowledge artifacts are encoded using current standards for controlled medical terminologies, value sets, clinical data models, and knowledge representation formalisms.	CDS EUNOCHAINS
3	Consistency	A knowledge artifact should repeatedly generate expected results over time when given requisite inputs (e.g., patient data or supporting CDS triggers).
3.1	Authors take on responsibility of ensuring accurate knowledge translation and specification of a knowledge artifact.	CDS EUNOCHAINS & CDS TOOLS/ WORKSPACES

- Good first step
- Provides some baseline requirements for Resource Provenance
- Needs to be enhanced to standardize Provenance Framework for CDS Artifacts and its Ontology (HL7 FHIR)
- Needs to create supporting Implementation Guidelines

Lessons Learnt: Prototype Phase

- Reviewed:
 - ▶ Authoring Tools - CDS Artifacts & CQM
 - ▶ CQL Execution Engines
 - ▶ Smart on FHIR Application Frameworks
 - ▶ CDS Hooks Sandboxes
 - ▶ FHIR Resource Servers and OAuth
 - ▶ Use Cases developed in HL7 Accelerators
- Findings:
 - ▶ Test Beds and Prototype Blockchain powered Applications

Open Source Technologies for CDS

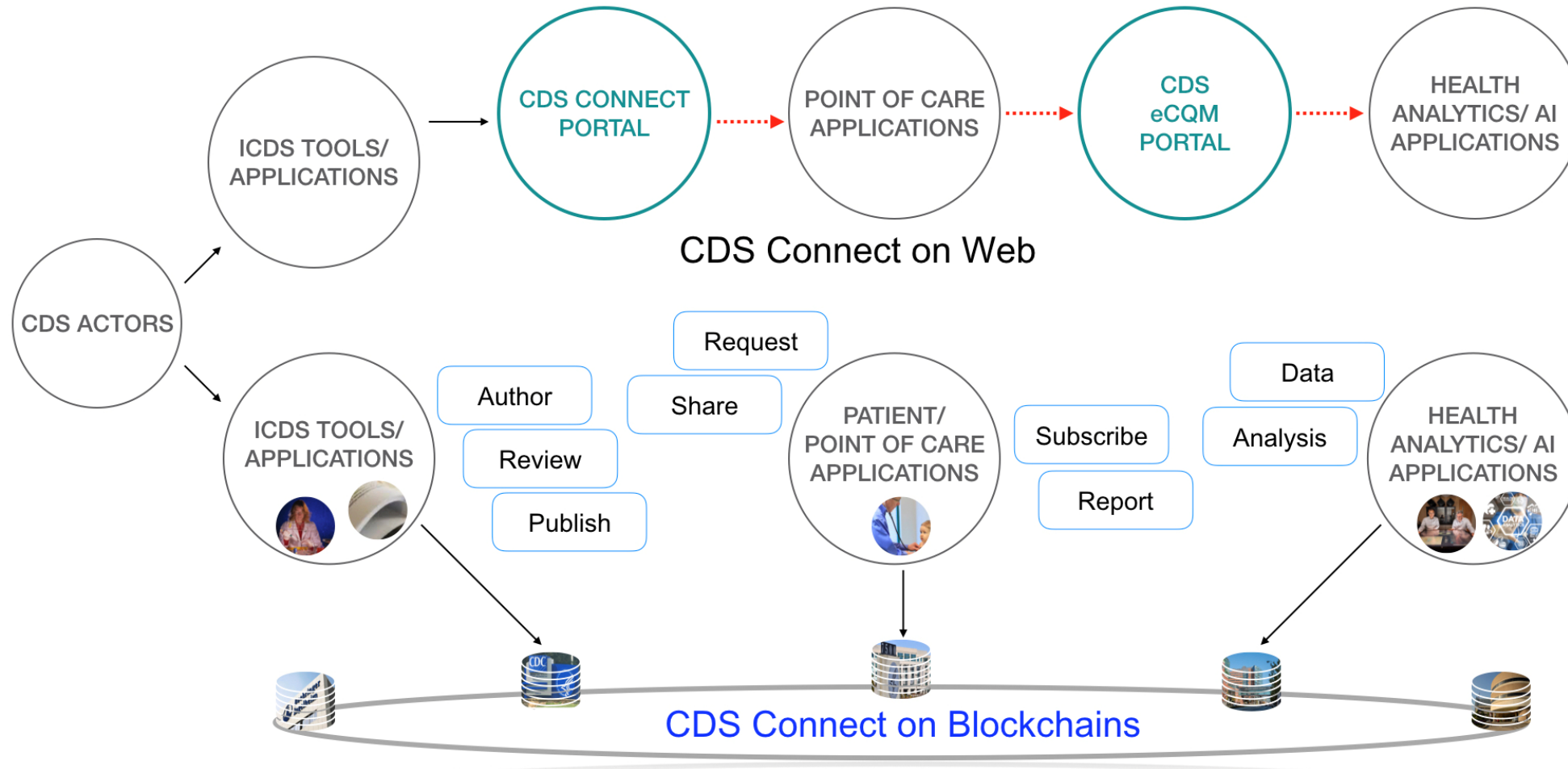
- Lots of Reference Implementations exists like CDS/ CQM Authoring Tools, CQL Translators, CQL Execution Environments, SMART on FHIR App Frameworks, CDS Hooks Sandboxes and Open Source FHIR Servers
- Some are supported by Open Forums
- Works well for Prototyping cycles only
- Other findings:
 - ▶ Not easily available as easily integrable Packages
 - ▶ Not maintained by Open Source Communities, no Long Term Support
 - ▶ Not broadly implemented across languages and environments;
 - ▶ Have to be customized and maintained in-house

Working With CDS Connect Workgroup



- Further Discussion
 - ▶ Reuse and build upon the work done at AHRQ & CDS Connect
 - ▶ How can we work together ?

Building upon the work done at AHRQ and CDS Connect



An Alternate Blockchain based Channel for CDS Artifacts Repositories
with Direct Participation of CDS Actors across Dis-intermediated Stakeholders' Infrastructure

How can we work together and move the chains ?

- **Discovery**
 - Research and Document CDS Use Cases with Blockchains
 - Research and Document CDS Requirements for Provenance and Accuracy, Authorization and Access, Privacy and Consent, Accounting for Disclosures and Digital Rights Management within CDS
- **Design**
 - Standardize CDS Provenance Attributes and their Implementation Guidelines (Stakeholder consensus for its Definitions, Ontology, FHIR standards)
 - Document current Governance Policies and Procedures
- **Prototype**
 - Long Term Support for existing CDS Tools and other Open Source
 - Community Based Development



WHAT'S NEW WITH CDS CONNECT

David Winters and Chris Moesel, MITRE

Updates and New Features



- Authoring Tool
 - ▶ CPG on FHIR Library export (now deployed to production)
 - ▶ Using external CQL functions as expression modifiers
 - ▶ CDS Authoring Tool dependency upgrades
 - ▶ Bug fixes
- Prototype Tools
 - ▶ CQL Services 1.7.0: Support for using UMLS API key authentication to VSAC
 - ▶ CQL Testing 2.2.0: Support for using UMLS API key authentication to VSAC
 - ▶ Alert: Delay migrating your UMLS account to identity providers until after VSAC “API Key” authentication support complete (December 2020)
- Repository
 - ▶ CPG-on-FHIR work is beginning early user testing
 - ▶ Process improvement: automated emails for server outages
 - ▶ FHIR® trademark references updated across site
 - ▶ User documentation update continues
 - ▶ Various bug fixes and software updates
 - ▶ Technical support for Repository contributors
- Link to CDS Connect: <https://cds.ahrq.gov/cdsconnect>

ANNOUNCEMENTS, OPEN DISCUSSION AND CLOSE-OUT

Maria Michaels

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