





Integrity **★** Service **★** Excellence





- Introduce ICE
- Review integration case
- Present a vision for the future of ICE and like systems





- The Federated Architecture allows for self-governance of connected systems
- Systems may be COTS tools, in-house developed applications, or any hybrid thereof
- Systems do not talk directly to each other ICE "brokers" all transactions between connected systems



Architectural Solution

- ICE Core Collaboration platform (Hub), Common Service Bus and Apps(Django), advanced visualization (Plotly)
- ICE Extended Material properties database (Granta), MTS Echo, Dream.3D
- Persistent identification, triple-based metadata, data type registration and SSO
- Graphical workflow design tools, item management, file management, advanced search tools







Case 1: PID Store Case 3: Searching/Querying Data PID Linked to Local ID







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- Test case U of M's Materials Commons
- Add Materials Commons API to ICE.Search
 - ICE delegates search mechanism to Materials Commons
 - Materials Commons relies on Elasticsearch (full text) vs object search (ICE.Search)
- Connection established after 4 hours of collaboration
 - RESTful call with authentication token and search string
 - JSON returned, shaped into search result format





Search Extended to Materials Commons

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- Persistent Problem how to treat workflow processes, participants, and items (physical and digital) as first class objects?
- Begin to register various data types object "classes"
- Ex. Tension test, titanium specimen, etc.
- Invoke registered data types wherever possible
- Index all metadata assignments based on object type





- Data Model Builder open up the DTR to certain users
- Graphical interface for defining data models and linkages/nesting
- DTR is implemented with OO principles of inheritance
- Use a NoSQL structure to define "parent" classes (casting) and child classes (investment casting)
- Restrict instantiation of new objects (even metadata) to those entries in the DTR.





- Still not "semantic" how do we relate classes?
- We need a simple way (baby steps) to start building vocabularies, taxonomies, and domain-specific ontologies
- Our users are overwhelmed at the utterance of "ontology"
- Enter the Basic Formal Ontology



BFO High Level



- Try to abstract objects from processes (test frame from the test for example) and use "occurents" only as needed
- Most things can and should be described as continuants
- Separate objects from qualities/properties





Approach



- Whiteboard a concept
- Build a taxonomy
- Define relationships
- Construct domain ontology from taxonomy and relational elements
- Continuously refine the ontology
- Propagate into other domains





- Engage SMEs and flesh out the mechanical test domain
- Build into BFO domain ontology in Protégé
- Flatten out the taxonomy and ontology
- Build an inferencing engine for determining identities based solely on qualities, similar to a graph-based templating search.
- Implement common domain elements in partnering systems







- First stab not perfect, but gives plenty of elements to start fitting into a taxonomy
- Key point the SME must be involved and be comfortable with the flow





Taxonomy and Relationships



- Materials
 - Metals
 - Stainless Steel
 - Non-Metals
 -
- Quality
 - Porosity
 - Density
 - Transmittance
 -
- Relationships
 - Participates in
 - Contains

- Systems like Granta do this pretty well already
- Downside is that the qualities are dependent

- Object instances pull from all tiers:
- -Ex: Sample of Stainless Steel has qualities X, Y, Z, and was part of Test A
- Qualities are only invoked in the instance, not the class





- System integration is greatly enhanced by using common schema/vocabulary/ontology
- Eases total ecosystem burden with standard models/classes
- Existing schema/ontology momentum in many S&T communities