Panelists

- **Dr. Tommi Karhela** (VTT Technical Research Centre, FI) - "Ontology based Integration Platform for Modelling and Simulation - Simantics"

- **Mr. Anatoly Levenchuk** (TechInvestLab, RU) - "Ontology-based Systems Federation"

- **Mr. Dennis Wisnosky** (DoD, US) - "Leveraging Semantic Technology across systems to meet the goal of having an 'executable, integrated, consumable, solution architecture'"

- **Mr. Cory Casanave** (Model Driven Solutions, US) - "Semantic Information Modeling for Federation“ (SIMF)
What is Federation and Integration?

• Federation
  – Combining multiple independently conceived data sources, services and/or systems and using them together for analytics, information sharing and other purposes
  – Applies to system of systems engineering
  – Systems Federation (bus) – a kind of network with interoperability
  – WIKIPEDIA: A Federation is multiple computing and/or network providers agreeing upon standards of operation in a collective fashion

• Integration:
  – Implies (but does not require) more control over the interacting components than does federation to achieve a composite system
  – Applies to systems engineering
  – Wikipedia: Systems integration, the engineering practices and procedures for assembling large and complicated systems from less-complicated units, especially subsystems
Business Case

• The ability to federate and integrate data, processes, services and systems components is at the foundation of the modern enterprise, business eco-system and open, collaborative government

• The cost of non-semantic approaches, that are largely coded transformations between fixed data structures, is high and introduces errors, inflexibility and risks

• Incremental improvements in our ability to integrate and federate with semantics can mean bottom-line profits for the enterprise and improved service to citizens for government at lower cost and reduced timeframes
Federation Semantics

• Federation and integration *always* involves semantic analysis, even if done informally

• Ontologies provide methodologies and tools for capturing and leveraging semantic analysis to reduce the cost, time, errors and risk associated with manual federation and integration

• Ontologies can help directly drive federation and integration solutions using inference, rules and model driven architecture
Primary Architectures

- **Structure**
  - Point-point
  - Via a reference ontology (e.g. conceptual model)

- **Runtime**
  - Extract Transform Load (ETL)
  - Semantic Bridges (Dynamic)

- Ontologies assist with any combination, but are particularly effective in avoiding point-point static integration. Semantic federation can be implemented as ETL or dynamic translation.
Reference Ontologies

- Represent the semantics of a domain
- Can map to multiple representations/systems/structures
- A lattice of reference ontologies avoids the “universal ontology” problems
Federation at all levels

• Federation and integration is required
  – At the “instance” level: data-data
  – At the model or ontology level: concept-concept
  – At the language or meta-model level: language-language

• To be most effective, ontologies are applied at all levels
Service Federation

- Service federation (SOA) encompasses information exchange, interacting roles, choreography, security & privacy
- Service viewpoints can also be modeled using ontologies
- Services utilize “information centric” ontologies
- Service and domain ontologies are required to support the full life-cycle of integration and federation
Standards targeted at federation

- ISO 15926, HDQM, Gellish, IDEAS, RDF/OWL, SIMF (in progress)
- Important capabilities of federation standards and languages
  - The broadest possible context
  - Extensible
  - Enable anything to be said that is valid (i.e. no artificial restrictions)
  - Explicit ontological commitments that are followed consistently
  - Strong methodology so that the same thing is represented in the same way by different analysts, including,
    - Choice of alternative approaches left open by ontological commitments,
    - Consistent representation so the same thing would get pretty much the same representation from different analysts.
  - FOL (Minimum), HOL is actually needed
  - General languages for specifying federation & conceptual models as well as the general programming languages used for federation
  - Stakeholder (business) friendly
Semantic Web

- Includes: Linked Data, RDF & OWL
- Seen as mainstream for web data representation and “lite” semantics
- Is being used in production (e.g. DoD BTA)
- There are questions about representational capability and suitability for widespread federation and integration
Federation/Integration Examples

• Product Lifecycle Management (PLM)
• Financial systems integration
• Federation of simulation systems
• Federation of modeling languages
• Space systems integration
• Enterprise architecture
• Federation of medical records
• Supply chains
• Information sharing to prevent terrorism
Difficulties

• Absence of authoritative reference ontologies
• Limited support for distributed ontology development: Versioning, granularity, provenance, etc.
• Performance issues, particular when using federated ontologies and advanced logics
• Different tools, languages and methodologies used by different practitioners
• No ontology of system federation/integration - leads to fragmentation of methods, models, tools & frameworks
Plug-in Architecture for Modelling and Simulation

**Simantics Platform**
- Eclipse based application framework
- SVG based 2D diagram framework
- OpenCASCADE and VTK based 3D geometry kernel
- ...
- Editors (text, 2D diagram, 3D geometry)
- Structural data handling and mapping
- Project/team management tools
- Distributed modelling and simulation facilities

**Simantics Core**
- Triplestore modelling database management

**Simantics Database**
- Simulation results and real time data management

For more information, visit: www.simantics.org

Dr. Tommi Karhela
Conceptual mapping (ISO 15926)

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Federation through Semantic Architecture

Investment Review Board
Dashboards
 Implemented by
Complies to

Electronic Health Record Enterprise Architecture (IEHR EA)

Human Resources Management Enterprise Architecture (HRM EA)

Defense Information Enterprise Architecture (DIEA)

Business Enterprise Architecture: BEA

Virtual Interactive Processing System Architecture (VIPS)

Service Integrated Personnel and Pay System Architecture (IPPS)

iEHR Services Architecture

Enterprise Architectures

Solution Architectures

Dennis Wisnosky
Semantic Information Modeling for Federation (SIMF) Architecture (OMG Standard in progress)

Subject focused conceptual models define the concepts, predicates, integrity rules and terms of a domain that can be related to each other.

Solution focused logical information elements represent information structures and integrity rules that can use and extend other information.

Technology focused physical data schema are grounded in logical data models which define their context and semantics.
Summary

• Ontologies are an emerging best practice for federation and integration
• Ontologies are part of a model driven architecture solution scenario – ontologies are models
• Standards and agreement on languages and reference ontologies are still emerging
• Semantic federation and integration improves agility while reducing time, cost and risk
• Current ontological tools and methods are sufficiently mature for use in production federation and integration projects