Collaboration Infrastructure for Agile Model-Based Design
Steven Bankes

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Parallel process innovations promote agility

Emergent General Principles

- Emphasize Learning Velocity
  - "Fail early – Fail often"
  - Frequent Experimentation and Testing
  - Address the most important uncertainties early
- Short duty cycles
  - Frequent opportunities to test & pivot
  - "Bite size" development steps
  - Minimal initial versions incrementally improved
- Cross functional teams
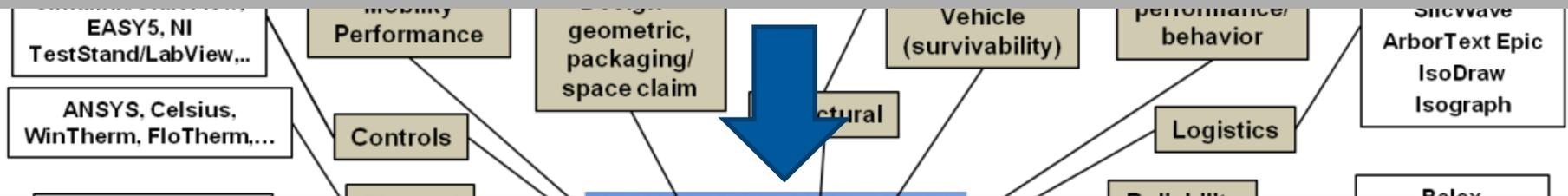 - Engage community of interest throughout development

Across Multiple Domains

- Agile Software Development
  - "Scrum – The Art of Doing Twice the Work in Half the Time" – Jeff Sutherland
- Discovery-Driven Planning
  - "Discovery-Driven Growth" – Rita Gunther-McGrath & Ian MacMillan
- Lean Manufacturing
  - "The Toyota Way" – Jeffrey Liker
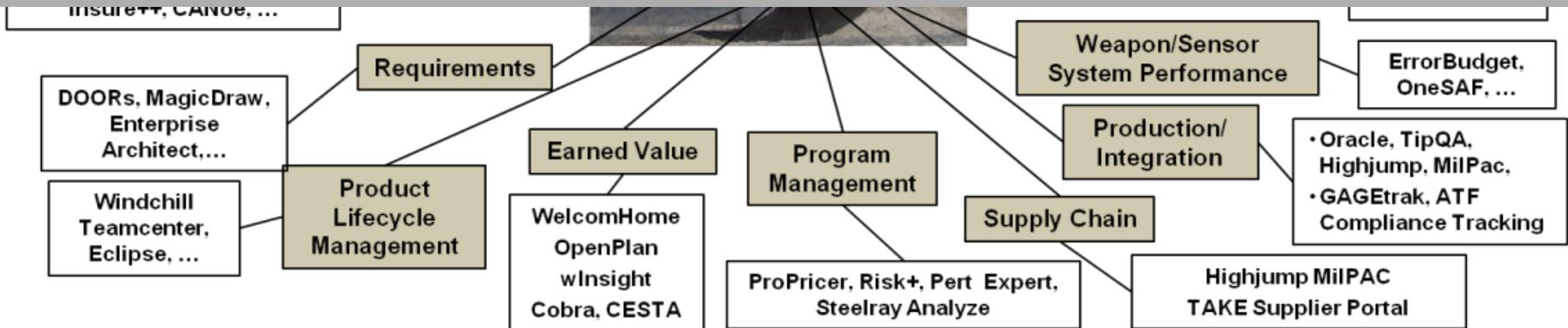- Lean Startups
  - "The Lean Startup" – Eric Ries

Process innovation in engineering complex systems requires infrastructure enabling broad interaction.

Collaboration needed among domains & tools

577 engineering tools & products in use at BAE Systems for Combat Vehicle System development (circa 2012).

EASY5, NI TestStand/LabView,...

ANSYS, Celsius, WinTherm, FloTherm,...

Mobility Performance

Design geometric, packaging/ space claim

Vehicle (survivability)

performance/ behavior

SilcWave ArborText Epic IsoDraw Isograph

Controls

Logistics

Need infrastructure for Agile Design Evaluation combining multiple tools/models

Insure++, CANoe, ...

Requirements

Weapon/Sensor System Performance

ErrorBudget, OneSAF, ...

DOORs, MagicDraw, Enterprise Architect,...

Earned Value

Program Management

Production/ Integration

• Oracle, TipQA, Highjump, MilPac,
• GAGEtrak, ATF Compliance Tracking

Windchill Teamcenter, Eclipse, ...

Product Lifecycle Management

WelcomHome OpenPlan wInsight Cobra, CESTA

ProPricer, Risk+, Pert Expert, Steelray Analyze

Supply Chain

Highjump MilPAC TAKE Supplier Portal

RSIDE: Resilient System Integrated Design Environment

Cross-Domain Coupling

Operational Context

Physical M&S

Analysis of Alternatives

Requirements, Analysis

Operational environment & Deep Red Team

Integrated Metrics

RSIDE Services

Flexible workflow enabled by: Lightweight, task-specific modeling framework which supports extensible professional tools, proprietary data and capturing expert knowledge to tame the complexity

- Distributed, multi-view shared infrastructure
- Facilitate shared vision for acquisition mangers, warfighters, & engineers

ECTo: concept exploration

Manufacturability analysis

Engineering analysis, integration with CAD tools

Plug-in tools & models (general & proprietary)

Trade study analysis of design geometry, system optimization

Tradespace Exploration

Provides Infrastructure to Connect Diverse Models & Tools

- Seamless Evolution from Conceptual Exploration to Detailed Design
- Support for proprietary models
- Commercial tools incorporated as needed
- Co-reasoning captures cascading effects
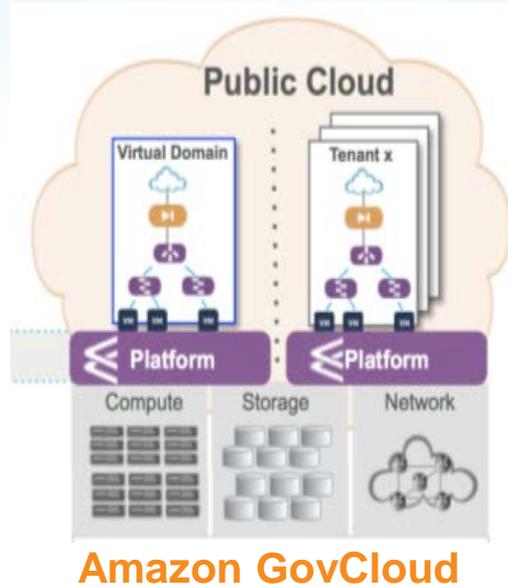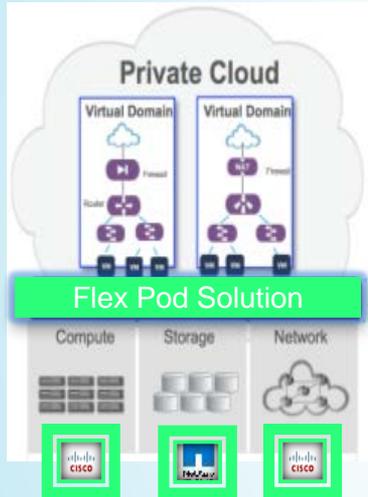- Distributed collaboration successfully demonstrated on Amazon cloud

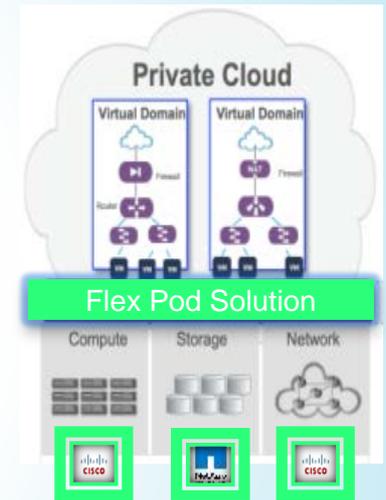# Tool & model relationships must be maintained

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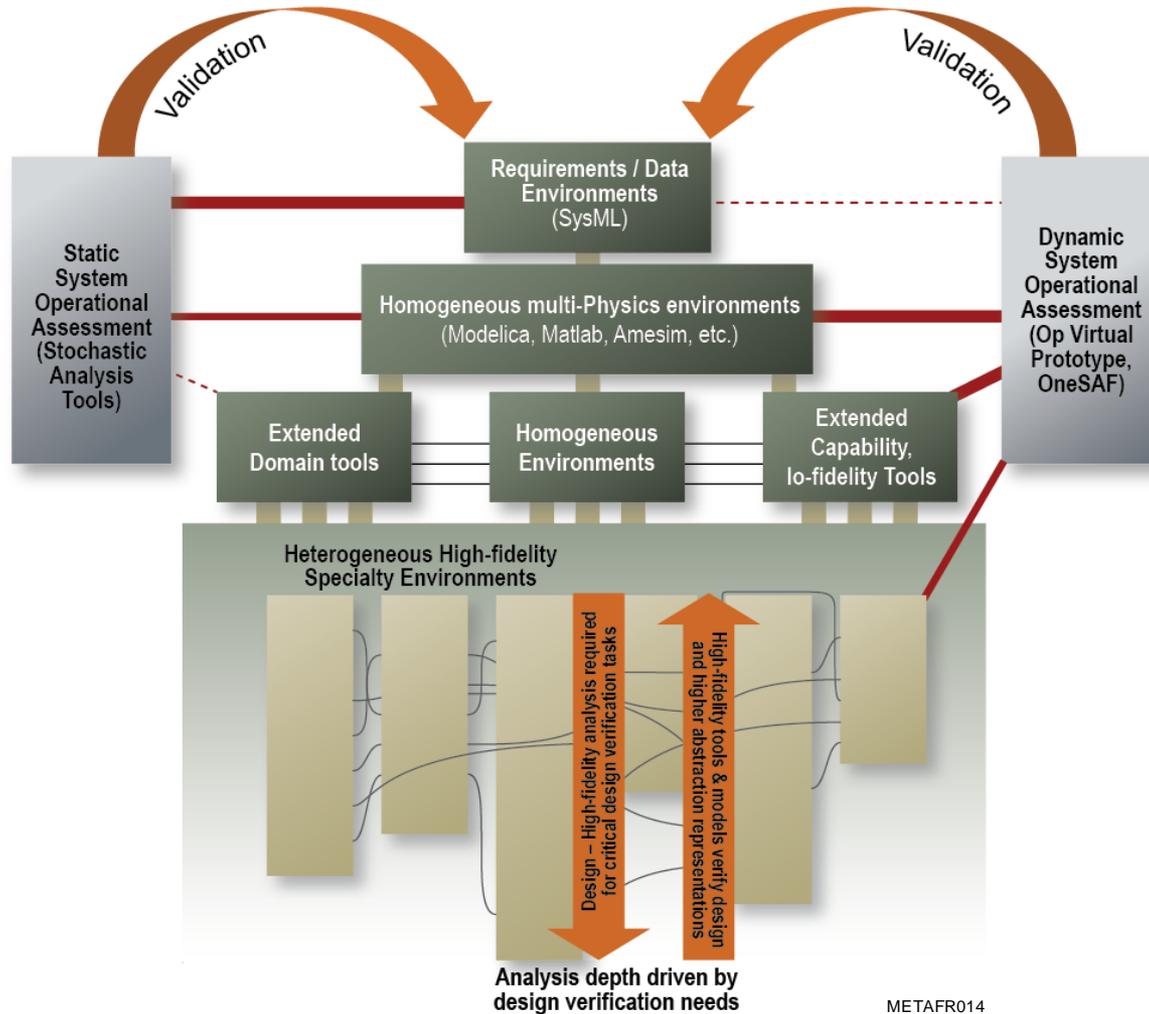
Infrastructure for engagement across locations & organizations
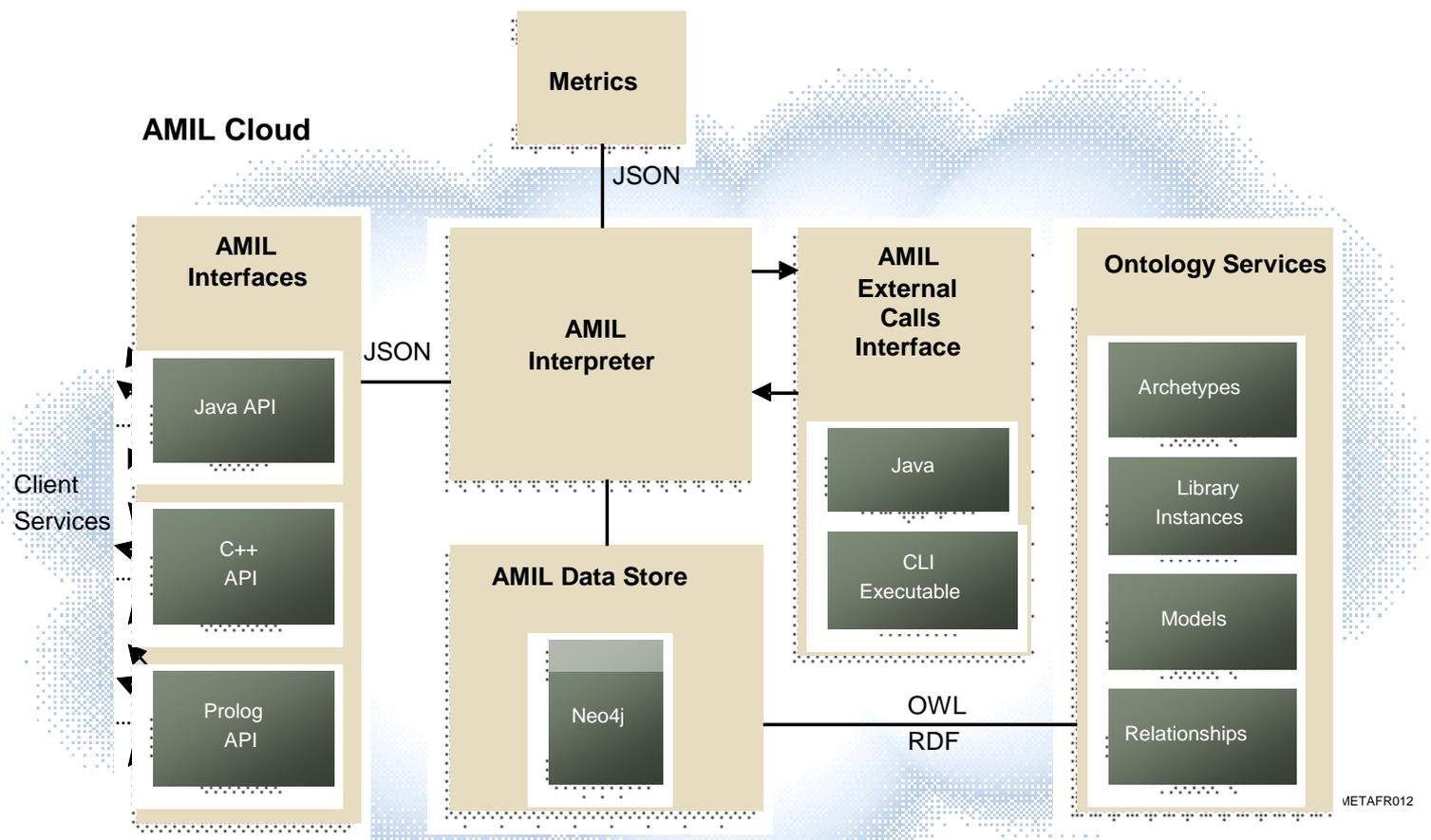

**BAE Systems
(VT Facility for example)**

**Other BAE Systems
facility/collaborating
industry/government**

Amazon GovCloud

- Provide Agile Interaction Between Distributed Models/Expertise
- Organizations Retain Control of What Is Exposed vs. Protected
- Virtual Prototype Evaluated Unconstrained By Location of Models/Tools

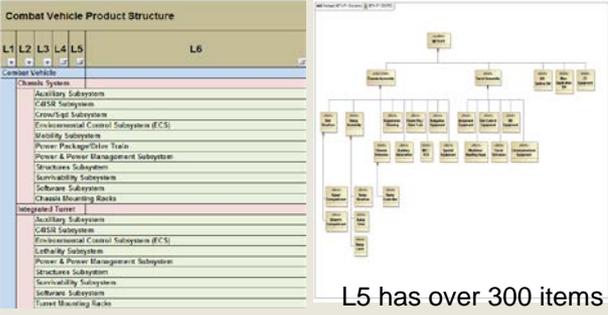# RSIDE Cloud Infrastructure

METAFR012

Firewalling of proprietary content enabled by RSIDE Cloud Infrastructure

- Dynamic Nodes Published Globally, Evaluated Locally

Sharing component model libraries via same infrastructure

Product Structure helps define Ontology

Combat Vehicle Product Structure

L5 has over 300 items

Common Parts Catalog (16)
C4ISR, Electrical Components, Crew Interface, Chemicals & Adhesives, Heating & Cooling, General Use Mechanical Systems Components, Weapon Systems, Fluid Flow & Seals, Vehicle Suspensions, Vehicle Propulsion & Braking, Standard Hardware, Vehicle Mission Equipment, Armor, Survivability Systems, Structure Components & Raw Materials, Engineering Documentation, Software

Mechanical Parts (64)
FASTENER, SPRING, BEARING

- Vendor supplied parts are already established
- Ontology based on Product structure to provide basis for establishing needs of product
- Need to find balance between top down design and component selection
- Iterative product inclusion in CML as products are analyzed and fielded

AMIL

Searchable Interface
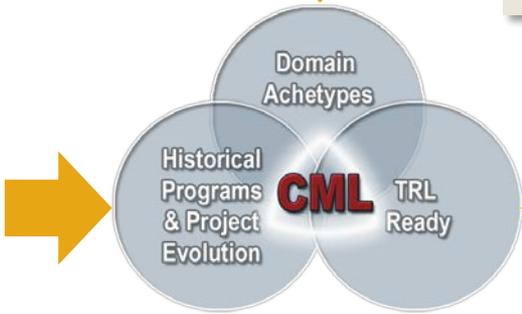
Domain Archetypes

Controls	Human Factors	Training
Schedule	Op Effectiveness	Production
Safety	Survivability	Structural
Finance	System Integration	Software
Reliability	Maintainability	Thermal
	Design	

- Experts use experience to build models with tools
- Domain experts use different views of the same data requiring filters
- Once models are applied to a specific product, they can be stored as a view of that product.

Domain Achetypes

Historical Programs & Project Evolution

CML

TRL Ready

Database

- Meta Data
- Software
- Part Data
- Models
- Archetypes
- Knowledge
- Configurations

Metrics framework provides extensible & composable metrics

Metrics Framework designed to support:

- **Distributed development** and use of metrics;

- **Agile creation** of new (derived) metrics from composition of models, metrics, and search, sampling, aggregation methods

    - Supports robustness, resiliency, and adaptability metric definition and evaluation

- **Customization** of metrics and dashboards to support individual user focus.

- Integrated into global environment as a Web Service

- Allows for easy access to all models being used to build and test design.
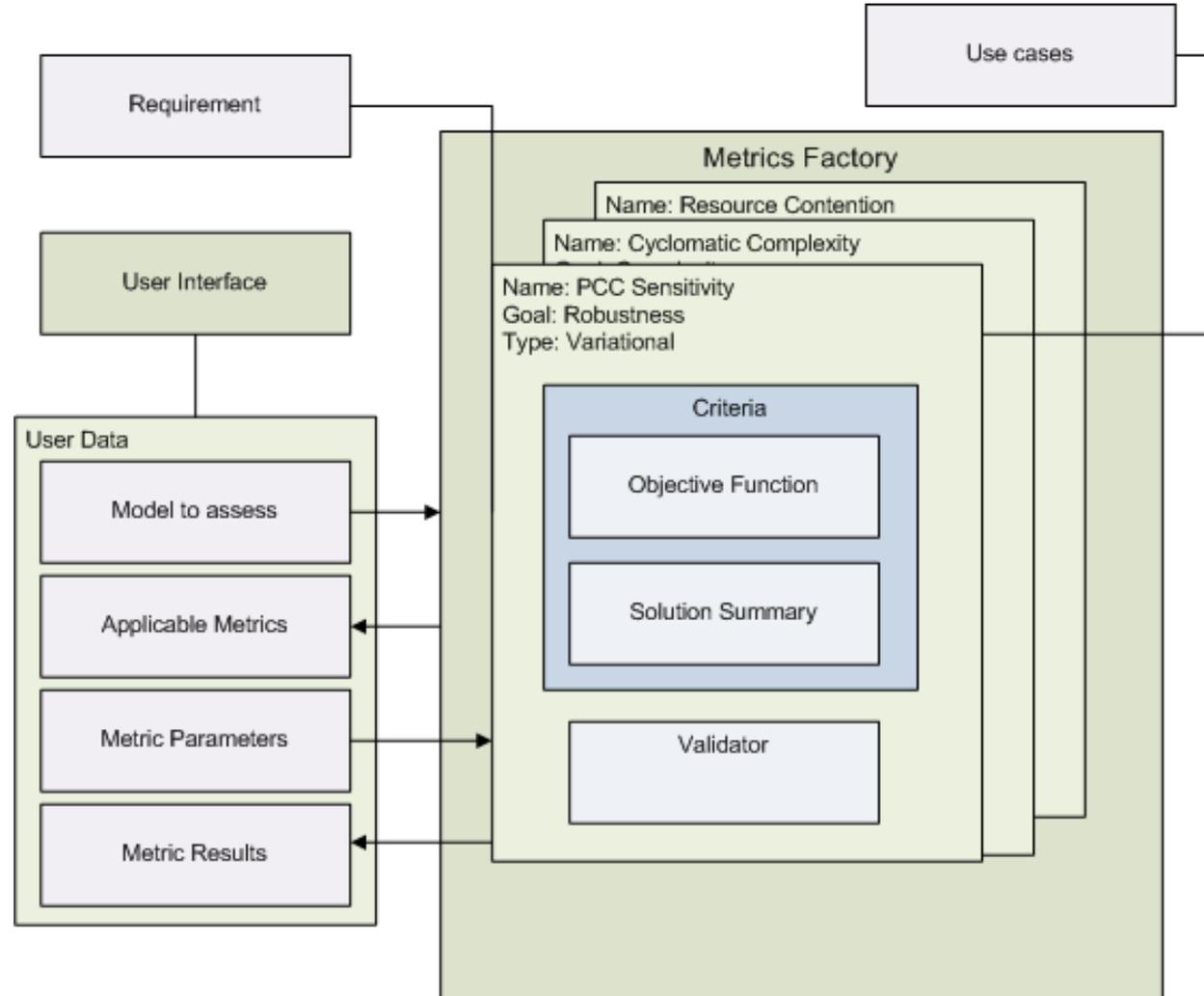
Summary

- Current uses of Model Based Engineering are limited by multiple issues
  - Significant labor required to establish data flows among tools and models
    - And to maintain/recreate these connections for each design change
  - Agile design exploration limited by communications barriers between individual contractors and government experts
  - Barriers to collaboration results in problems being discovered late with resulting cost and time penalties
- Prototype enabling infrastructure provides proof of principle demonstration and initial capabilities for agile collaborative design
  - Facilitate interaction among diverse and extensible collections of models and tools
  - Provide for collaboration between organization while allowing customized protection of IP and sensitive information
  - Create foundation for innovation in evaluation of advanced metrics for scoring alternatives in terms of robustness, resilience, and adaptability

Thank you