Engineered Resilient Systems (ERS) Architecture

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Distribution A: Cleared for Public Release

Presentation Outline

1. Architecture Goals
2. Software Engineering Team
3. Product Vision and Requirements
4. Architecture Framework and Standards
5. Workflow
6. Product Delivery

Architecture Goals

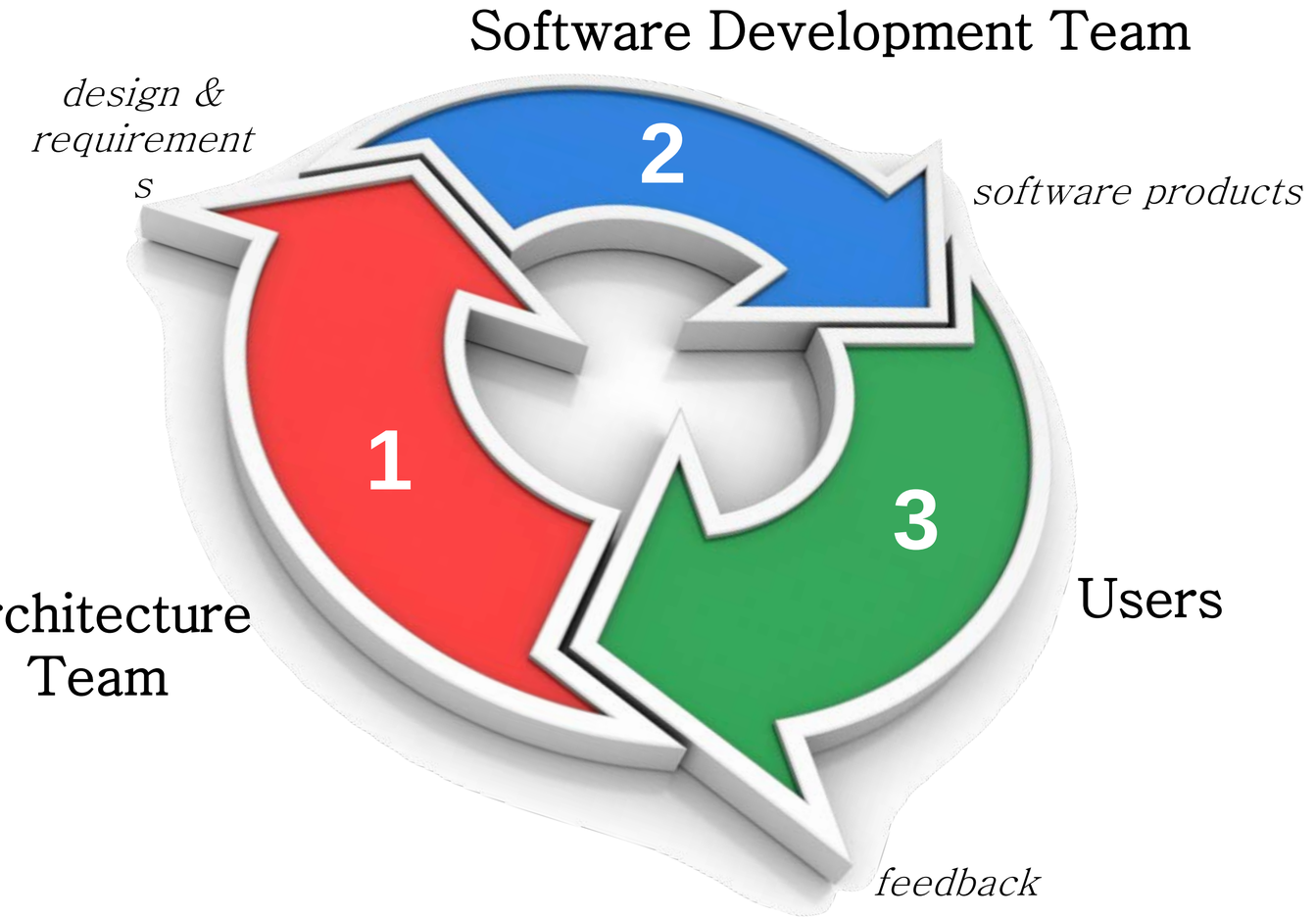
1. Focuses software development on delivering value-oriented business outcomes

2. Optimizes quality attributes such as performance, security, maintenance, usability, reuse, and aesthetics

3. Divides the software into distinct (but related) descriptions that helps the design, analysis, and communication processes by allowing focus on each aspect separately

4. Ties business workflows into the system

5. Provides artifacts to the development team for implementation

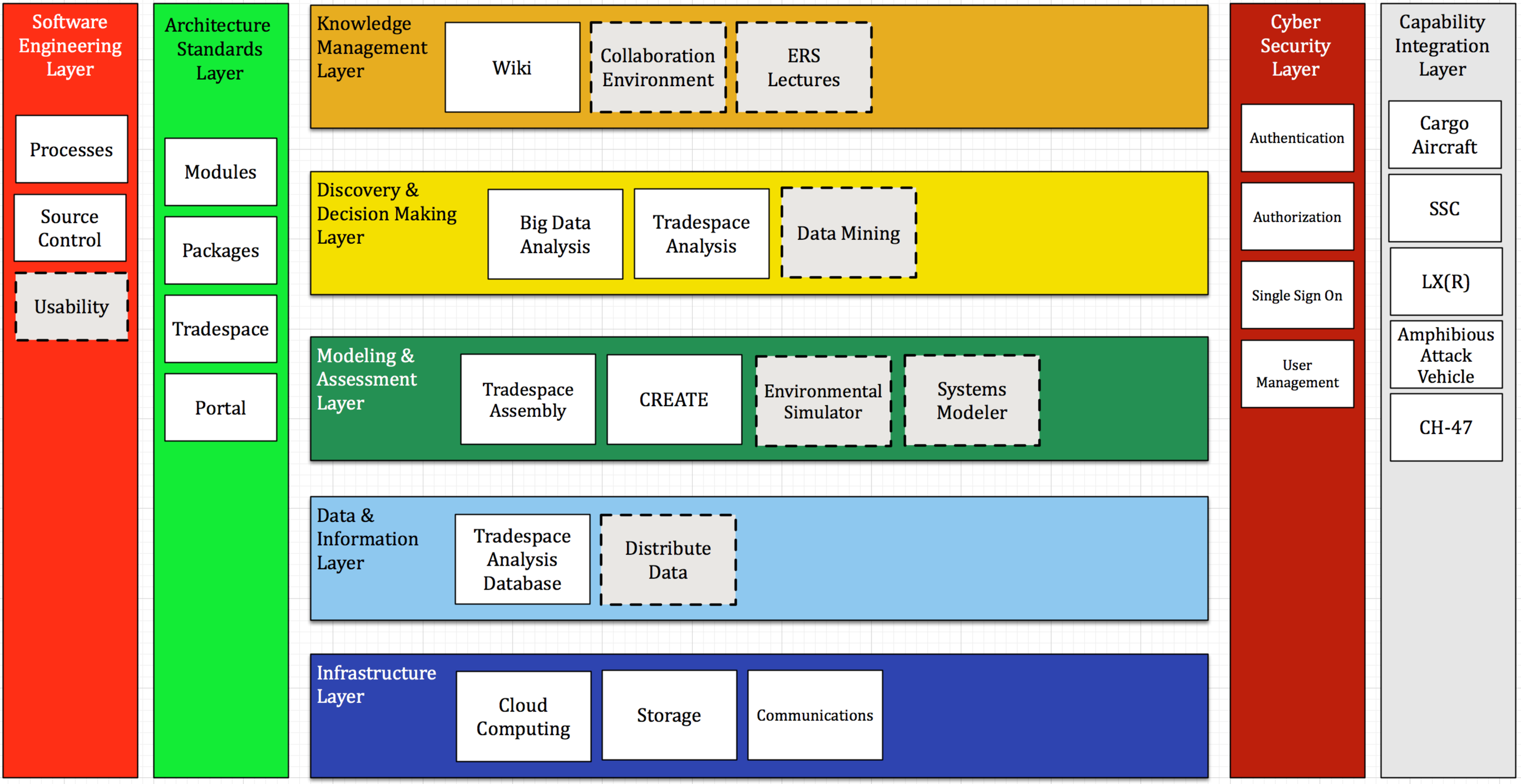


Software Engineering Team

- ERDC
  - *Systems Architecture*
  - *Software Engineering*
  - *Software Development*
- Georgia Tech Research Institute (GTRI)
  - *Systems Engineering*
  - *Software Development*
- Software Engineering Institute (SEI)
  - *Software Engineering*
  - *Human Factors and Usability*
- Kitware
  - *High Performance Web-based Visualization*
  - *Big Data Analysis*

Initial Product Requirements

1. Provide a suite of **web-based tools** with easy workflow (requires no installation, access with a browser)
2. Quickly assemble tradespace from simulation sets generated on **HPC** and non-HPC resources
3. Provide secure hosting capabilities with access from **users outside the .mil network**
4. Increase the number of design alternatives analyzed from thousands to **millions**
5. Enable an **"Open" computing framework** that allows software to plug-and-play
6. Provide "what if" drills to assess alternatives and eliminate Tradespace candidates
7. **Simplify the delivery** of capabilities to users
8. Support a **broad user community** (S&T, PEOs, and Industry)
9. Manage and analyze **extremely large data sets**
10. Leverage/interoperate with existing capabilities (models, tools, libraries, etc.) when possible


Software Engineering Layer
Processes
Source Control
Usability
Architecture Standards Layer
Modules
Packages
Tradespace
Portal
Knowledge Management Layer
Wiki
Collaboration Environment
ERS Lectures
Discovery & Decision Making Layer
Big Data Analysis
Tradespace Analysis
Data Mining
Modeling & Assessment Layer
Tradespace Assembly
CREATE
Environmental Simulator
Systems Modeler
Data & Information Layer
Tradespace Analysis Database
Distribute Data
Infrastructure Layer
Cloud Computing
Storage
Communications
Cyber Security Layer
Authentication
Authorization
Single Sign On
User Management
Capability Integration Layer
Cargo Aircraft
SSC
LX(R)
Amphibious Attack Vehicle
CH-47

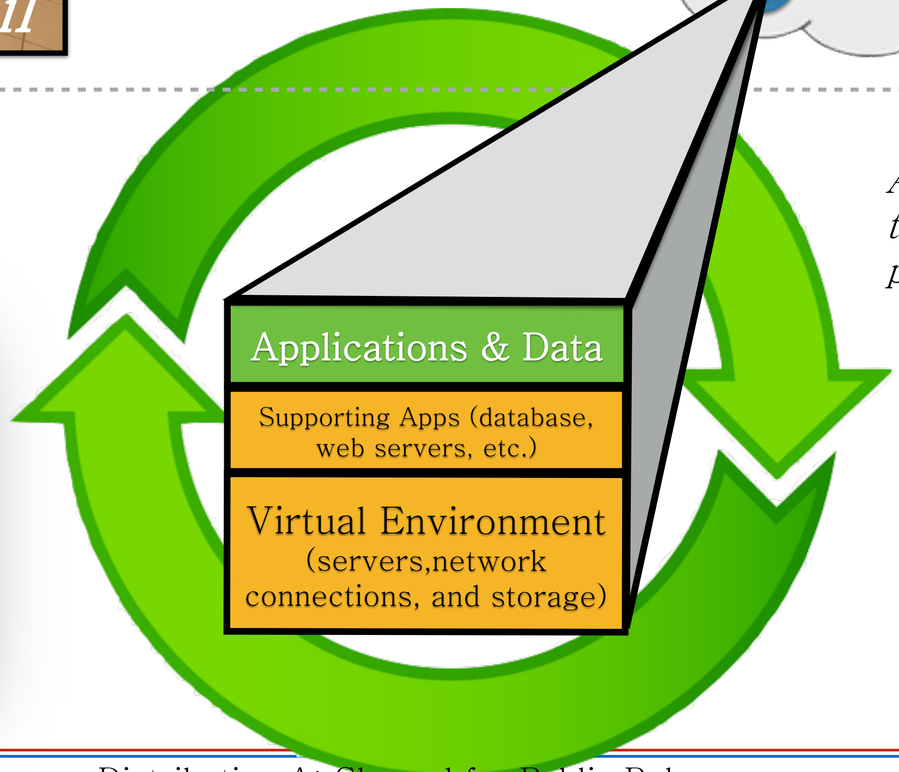
ERS Infrastructure

Infrastructure

10-Gigabit

ers.hpc.mil

ERS Shared Computing Environment



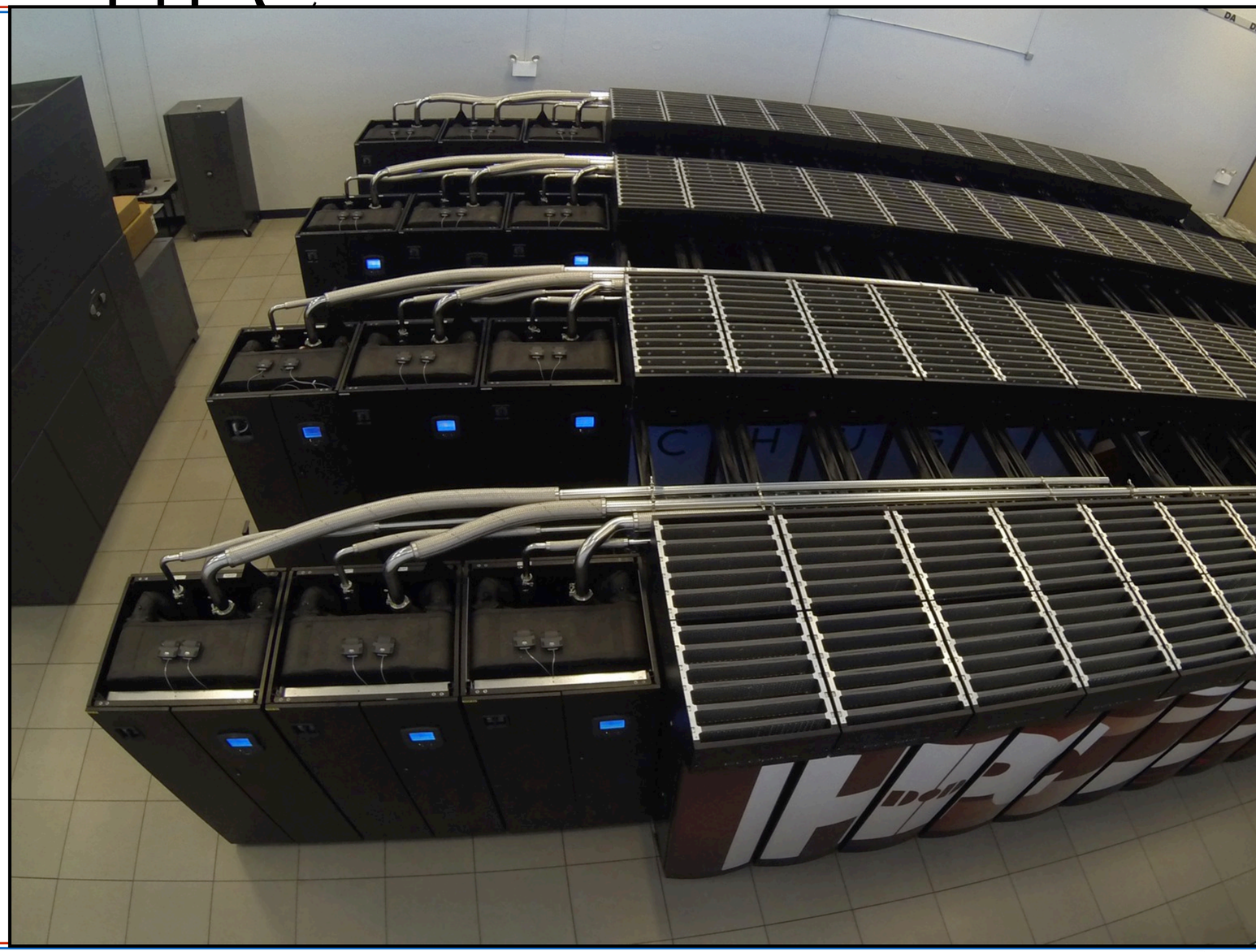
Users

Systems team assembles source code, models, databases, and information to configure the ERS tools for a specific domain.

Acquisition and design teams leverage the ERS tools to identify the best possible design alternatives.

Reducing Barriers Through HPC

- **Improves ability to assess system performance** – *simple models are replaced by high-fidelity simulations*
- **Scales with needs** – *transition from analyzing thousands of alternatives to millions*
- **Provides faster results** – *calculations that normally take hours are reduced to seconds*
- **Increases ability to perform large-scale data analysis and data mining** - *TBs of information can produce new insights*



Architecture Standards

1. **Portal**: Serves as a web-based front page to system

2. **Modules**: Provides ability to incorporate capabilities that are accessible directly from the portal
   - *Front-end:*
     - *Provides user interface to modules*
     - *Implemented in AngularJS*
   - *Back-end:*
     - *Implemented in NodeJS and accessed via an AJAX interface*
     - *Supports the ability to integrate legacy code*

3. **Data Packaging**: Provides a method to encapsulate data for common access

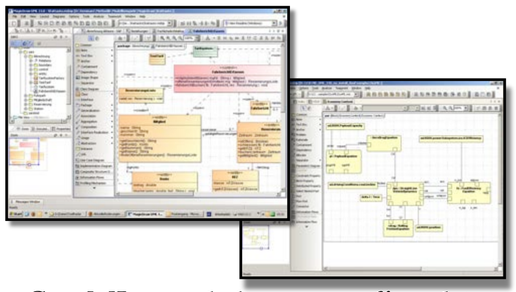
4. **Tradespace**: Organizes all design trades in multi-dimensional data structure along with the parameters that describe each design

5. **Authentication and Authorization**: Manages access controls to programs and data

Workflow

Requirements & Systems Modeling

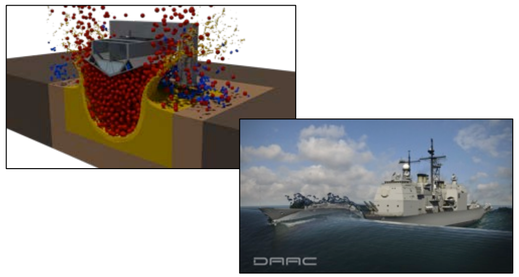
Requirements and system concepts are captured in SysML



SysML models are refined to include the baseline design, performance metrics, models, and methods to create the Tradespace

Tradespace Creation

High fidelity models assess performance aspects of the system

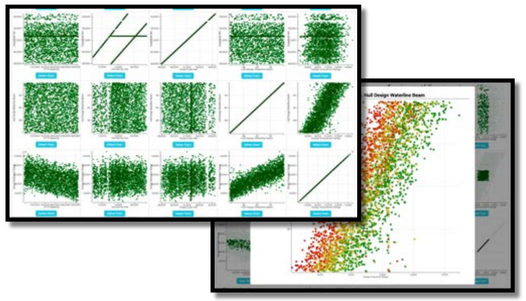


Parameter sweeps introduce design variations into the Tradespace

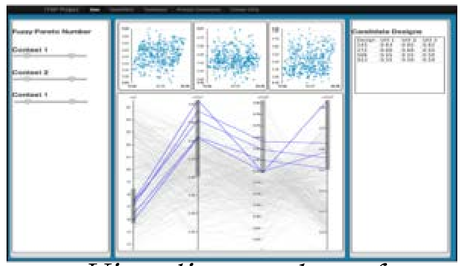
Performance metrics are identified and assessed on each design

Tradespace Analysis

Collaborative, interactive Tradespace exploration



Statistical analysis helps reduce visualization burden



Visualize trades of numerous designs in far less time

Alternative Analysis

Tradespace is reduced to a small set of alternatives

Design alternatives are compared

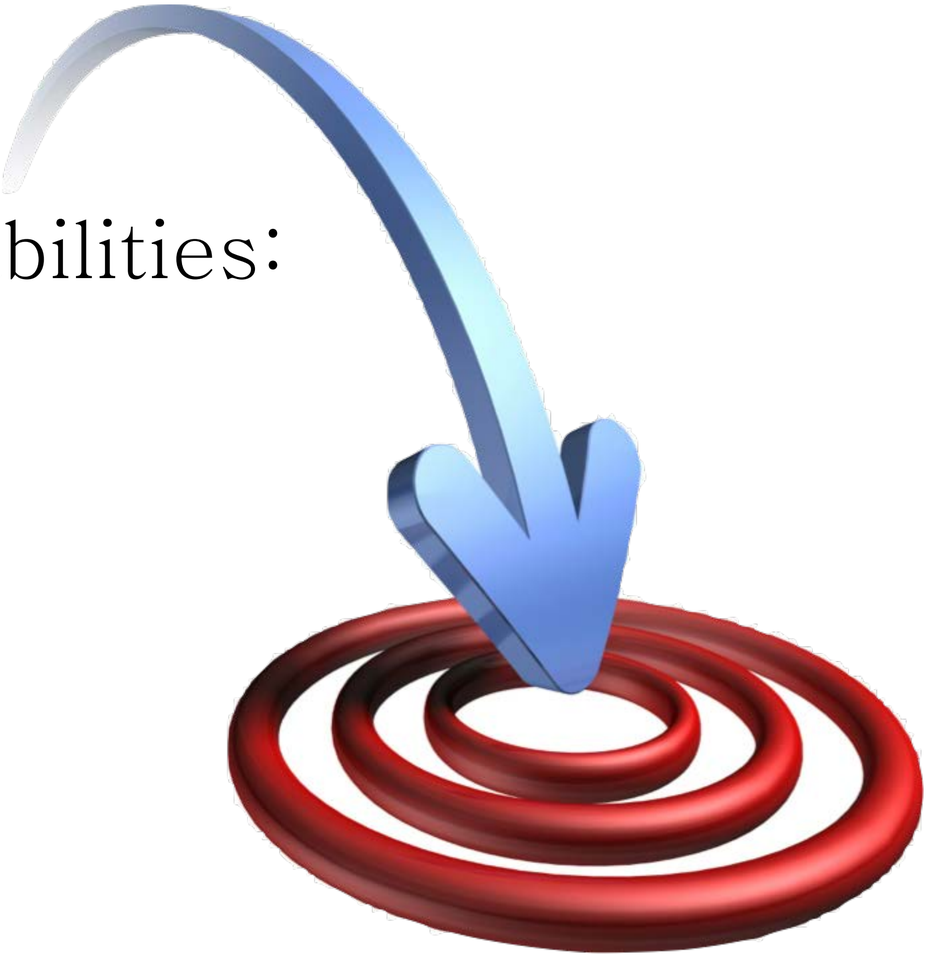
Modeling & Simulations are used to assess designs in context of a mission

Insights are used to refine requirements

Transitioning Capabilities to Users

Four ways to transition ERS capabilities:

1. Tools and Models
2. Data
3. Virtualized Environment
4. Hosted Services



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