Engineered Resilient Systems (ERS) Overview

December 2013

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Engineered Resilient Systems

ERS

Engineered Resilient Systems

Integrated Lifecycle Engineering

What is a "Resilient" System?

A Resilient System…

- ***is trusted and effective in a wide range of contexts,***
- ***is easily adapted to many others through reconfiguration or replacement, and***
- ***has predictable degradation of function.***

C-130 Hercules

AC-130A
Drone Control

EC-130E
Airborne battlefield command and control & electronic warfare

HC-130H
Maritime and Ice Patrol

JC-130
Mid-air Retrieval

ERS: Part of DoD S&T Portfolio

Defense Strategy

1. Mitigate new and emerging capabilities

- Electronic Warfare
- Cyber
- Counter Space
- Counter-WMD

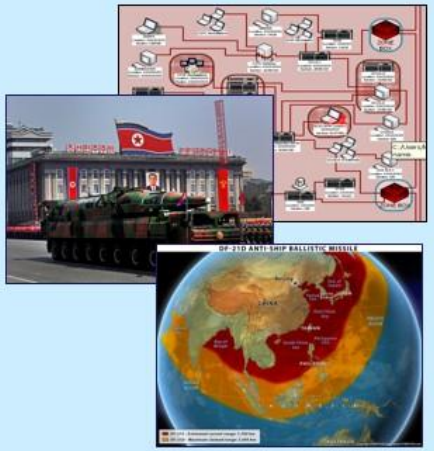
2. Affordably enable new or extended capabilities in existing military systems

- Systems Engineering
- Data Reuse
- Engineered Resilient Systems
- Developmental Test & Evaluation

3. Develop technology surprise through science and engineering

- Autonomy
- Basic Research
- Data-to-Decisions
- Human Systems

Technology Needs



- Middle East Instability
- North Korean Nuclear Ambitions
- Anti-Access/Area Denial
- Cyber Attacks
- Electronic Warfare

Mr. Al Shaffer, Principal Deputy, ASD Research and Engineering
October 29, 2013

ERS Addressing the Acquisition Challenge

Integrated Defense Acquisition, Technology, and Logistics Life Cycle Management System

Pre-Milestone A

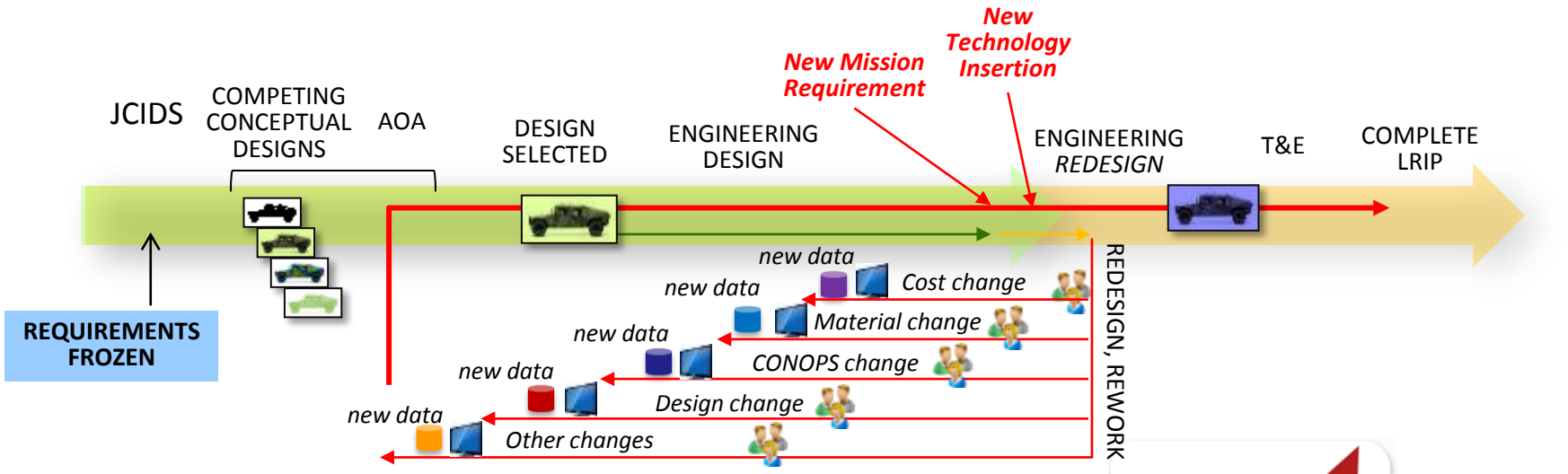
ERS will empower Pre-materiel analysis with significant impact on

- ***Requirements Generation***
- ***Analysis of Alternatives***
- ***Lifecycle Intelligence***

"We need to continually move forward with designing an acquisition system that responds more efficiently, effectively and quickly to the needs of troops and commanders in the field. "

Secretary of Defense Chuck Hagel, April 3, 2013

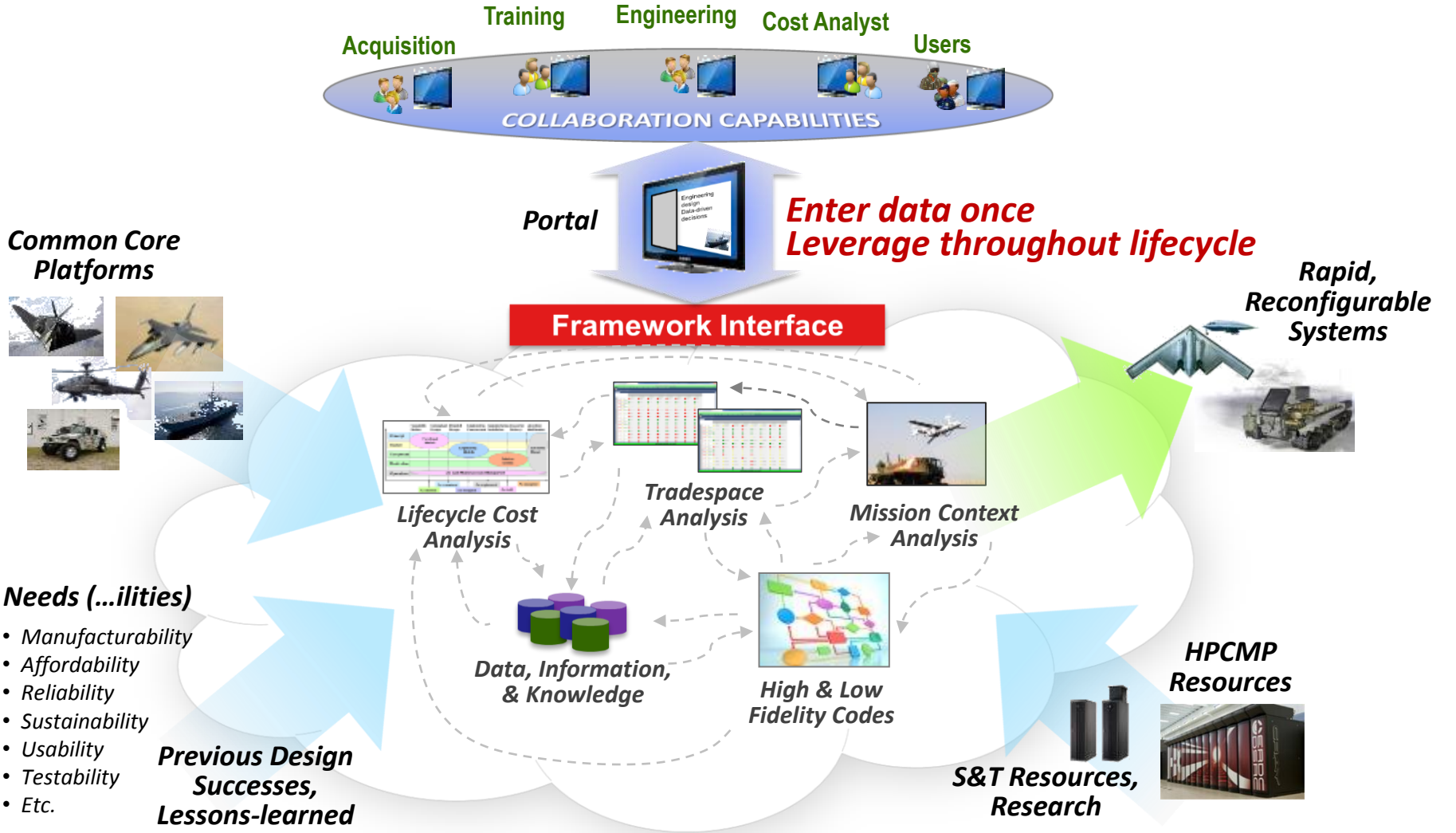
Today: Process-driven



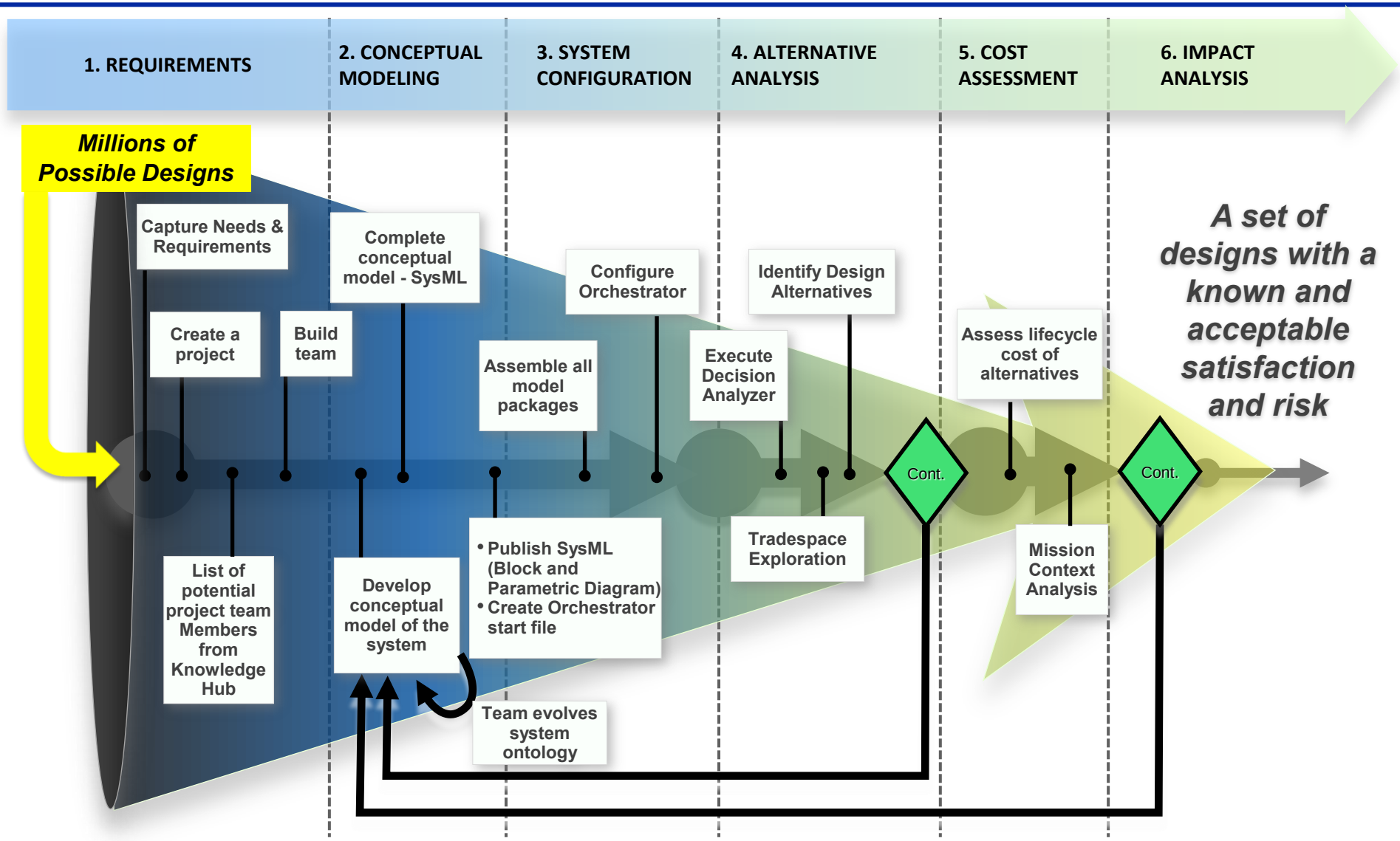
Negative time and cost impact

- ***Stove-piped workforce and data sources***
- ***Redundant processes***
- ***Little data reuse***
- ***Inefficient: both time and cost***
- ***Lacks adaptability to new requirements/missions***

ERS: *Data*-driven



Data-driven Decisions



ERS Framework Concept

Needs/Requirements

Army
Tools, Information & Infrastructure

Air Force
Tools, Information & Infrastructure

Navy
Tools, Information, & Infrastructure

Pre-Milestone A
Systems Engineering

Framework Standards

ERS Framework

Open Architecture
Common Environment
Shared Capabilities
Enables Collaboration

Framework Interface

Acquisition

- Acquisition Program
- Acquisition Program
- Acquisition Program

Acquisition teams leverage ERS capabilities throughout the systems lifecycle

Major ERS Components

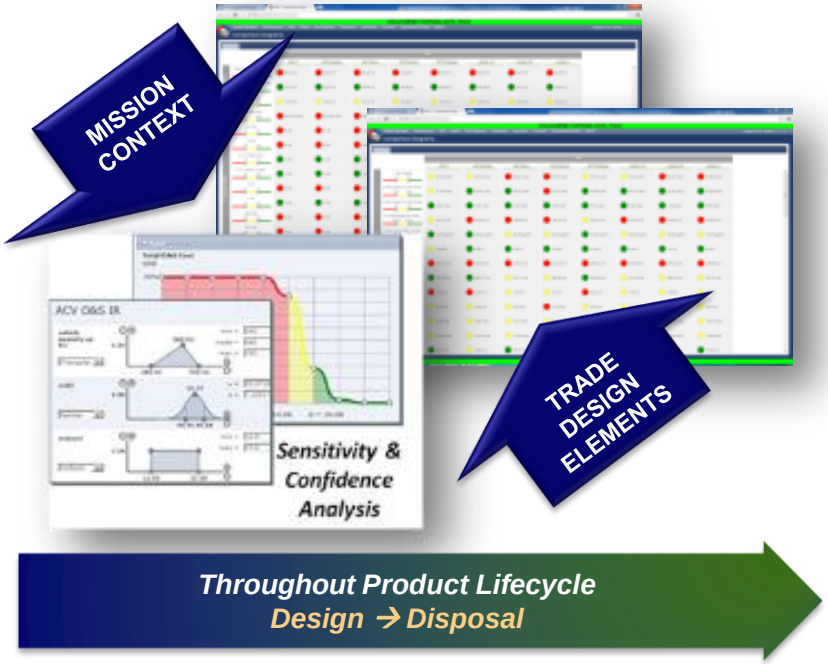
ERS Technology Anchors

ERS Framework and Open Architecture

- Connects existing tools, information, and data in a **common framework**
- Acquisition teams leverage ERS capabilities **throughout the system lifecycle**

Tradespace Analysis

- Enables **informed decisions**
- **Empowers AoA** and Requirements Generation
- **"Visualizes" trades** of many more designs in far less time

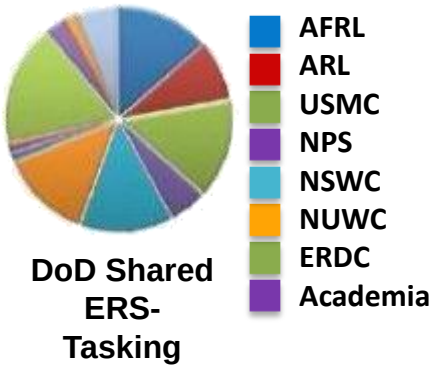


FY13 Tasks and Results

Architecture

Technology Development

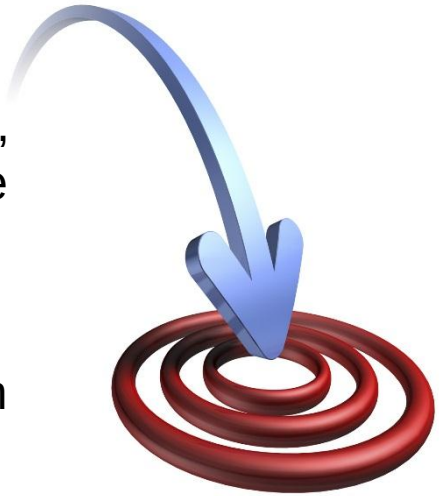
Demonstrations and Results



Architecture Development Goals

Build a cohesive framework to share, leverage and reuse capabilities.

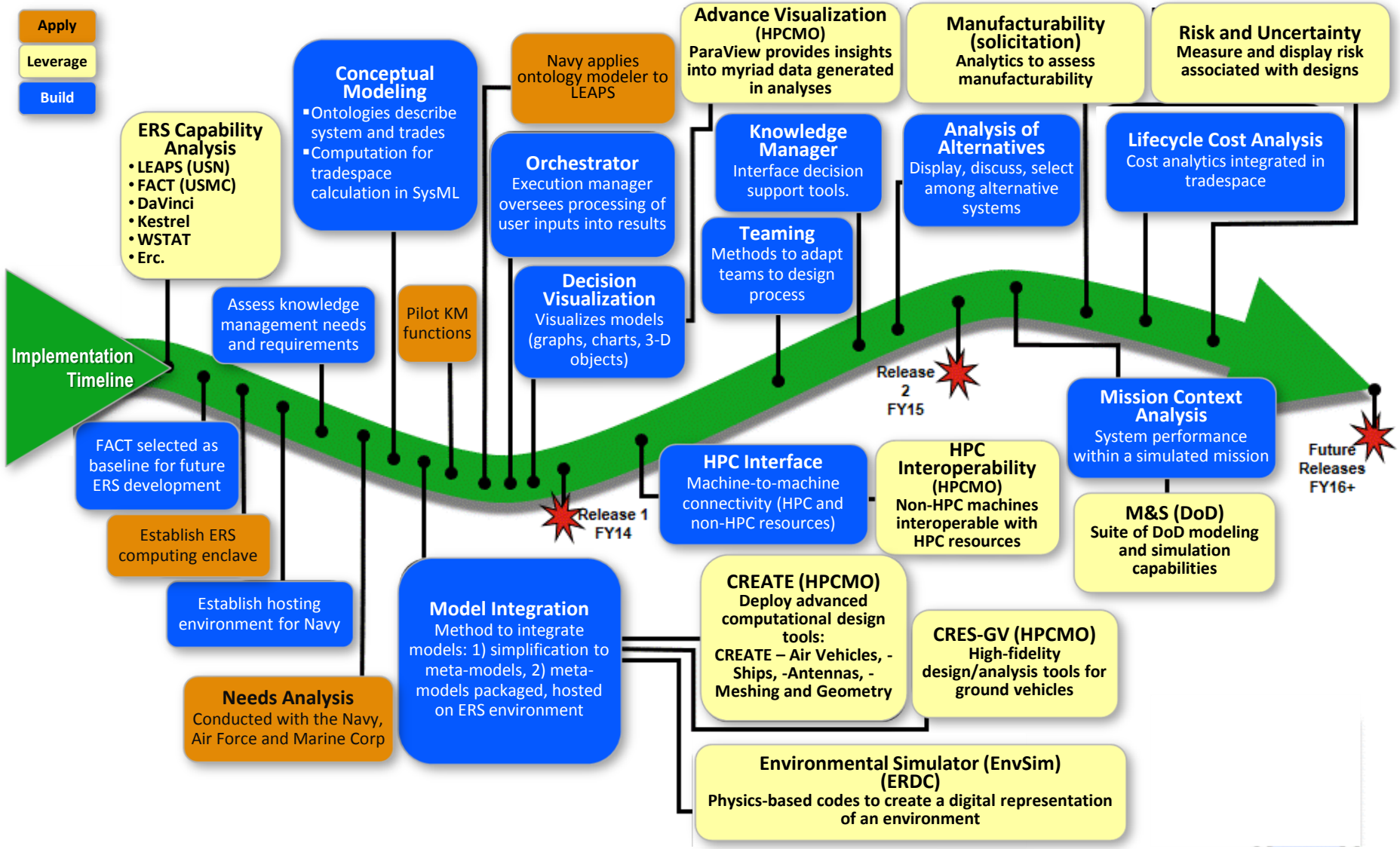
- **Current State in DoD:**
  - Investments in ERS-like projects are currently made across the DoD (estimated $120M+)
  - *Yet, **no overarching framework exists*** to share and reuse capabilities (tools, models, algorithms, data, etc.)
- **Goals of ERS Architecture:**
  - Leverage technical standards that support a modular, loosely coupled and highly cohesive system structure
  - Enable an "Open" computing framework that allows software to plug-and-play
  - Openness drives opportunities to enhance innovation across government, academia and industry



FY13/14 Accomplishments
Architecture Development

- **FY13 Accomplishments**
  - Assessment of existing, ERS-relevant software products (Gov't & commercial)
  - Established ERS Enclave - segregated network to host ERS products – **ers.hpc.mil**
  - Developed Ontological Modeling (DOM) - set of concepts defining a system
    - shared vocabulary to denote the types,
    - properties, and
    - interrelationships among components of a system.
- **FY14 Currently in Progress**
  - **Knowledge Environment (KE)** - installed a suite of knowledge products as the initial knowledge management environment for ERS
  - **Model Packages** – software standards to encapsulate models that support system analysis
  - **Connectors** – software standards for communicating with ERS Model Packages
  - **SysMLGen** – software that translates ontologies into SysML block and parametric diagrams
  - **Architecture COI** – Online community of interest to connect those interested in ERS architecture

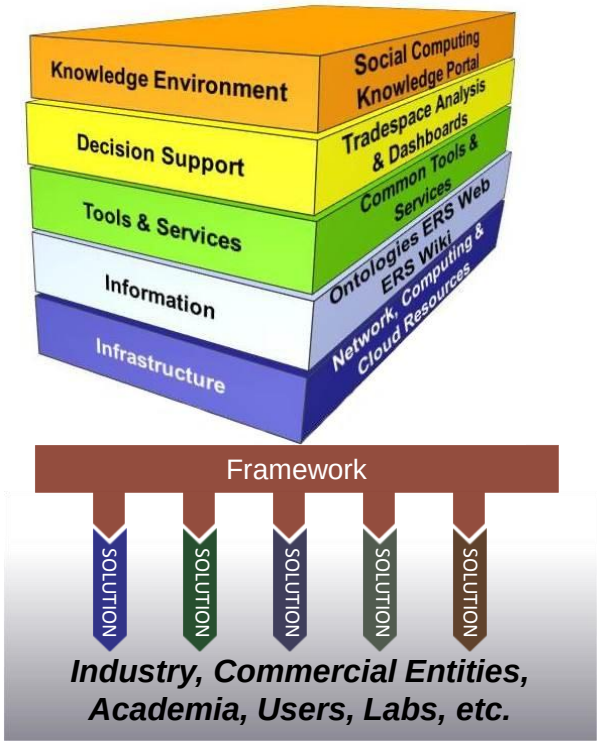
Architecture Roadmap



ERS Architecture Attributes

"Open System Architecture is a key contributor to Resilient Design."
Mr. Stephen P. Welby, Deputy Assistant Secretary of Defense for Systems Engineering

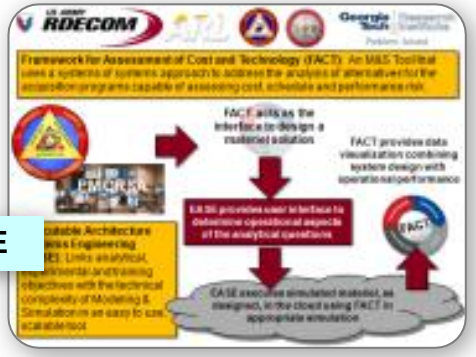
- **Non-proprietary, open framework**
- **Interactive with outside entities (API)**
- **Platform agnostic**
- **System—not Service—centric**
- **Multi-fidelity analysis**
- **Legacy system compatibility**
- **Shares benefit of R&D among users**



Tradespace Analysis Goals

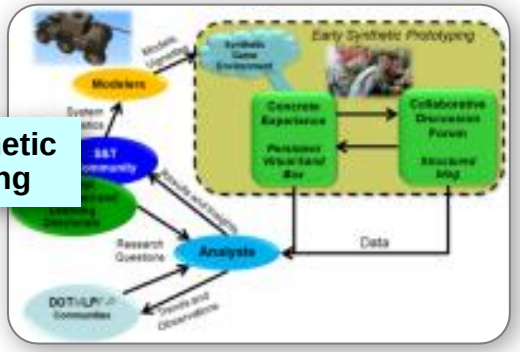
Develop a prototype tool linking Mission Context and Tradespace tools into a combined system

FACT-EASE



Demonstrate collection and validation of capabilities requirements in virtual and synthetic environments

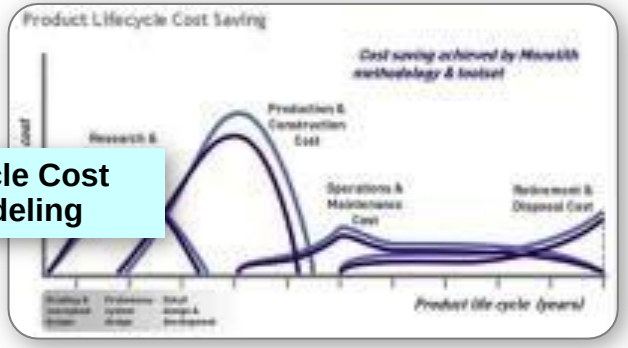
Early Synthetic Prototyping



Map the current lifecycle cost mythologies to more fully understand the process, and

Draft a strategy and lifecycle cost model(s) based on stakeholder values

Lifecycle Cost Modeling



FY13/14 Accomplishments
Tradespace Analysis

- **Tradespace Tool Survey** ARL
  - **Review of tradespace methodologies, techniques and tools**
  - **Provided input for initial requirements document (CDD) for the ERS Tradespace Analysis Tool**

- **Expanded Capability of FACT (Framework for Assessing Cost and Technology) for ERS:** Georgia Tech Research Institute
  - **Used by USMC in AVM program for tradespace visualization (2013)**
  - **Enhanced capabilities for tradespace visualization of multiple parameters with FY13 ERS Ships Demo (FACT-Ship)**
  - **Requirements for tool modification for generic use (land, air and sea systems)**
  - **Initial linking of tradespace tool with combat simulation(s) for inclusion of mission context (FACT-EASE)**

Richly Informed Decisions

Tradespace Analysis

- Mission data
- Mission context
- Lifecycle data
- Physics-based models
- Other data sources…

100X

# of parameters and scenarios considered in setting requirements

Space spanned by completely enumerated design variables

HPCMP & S&T Resources

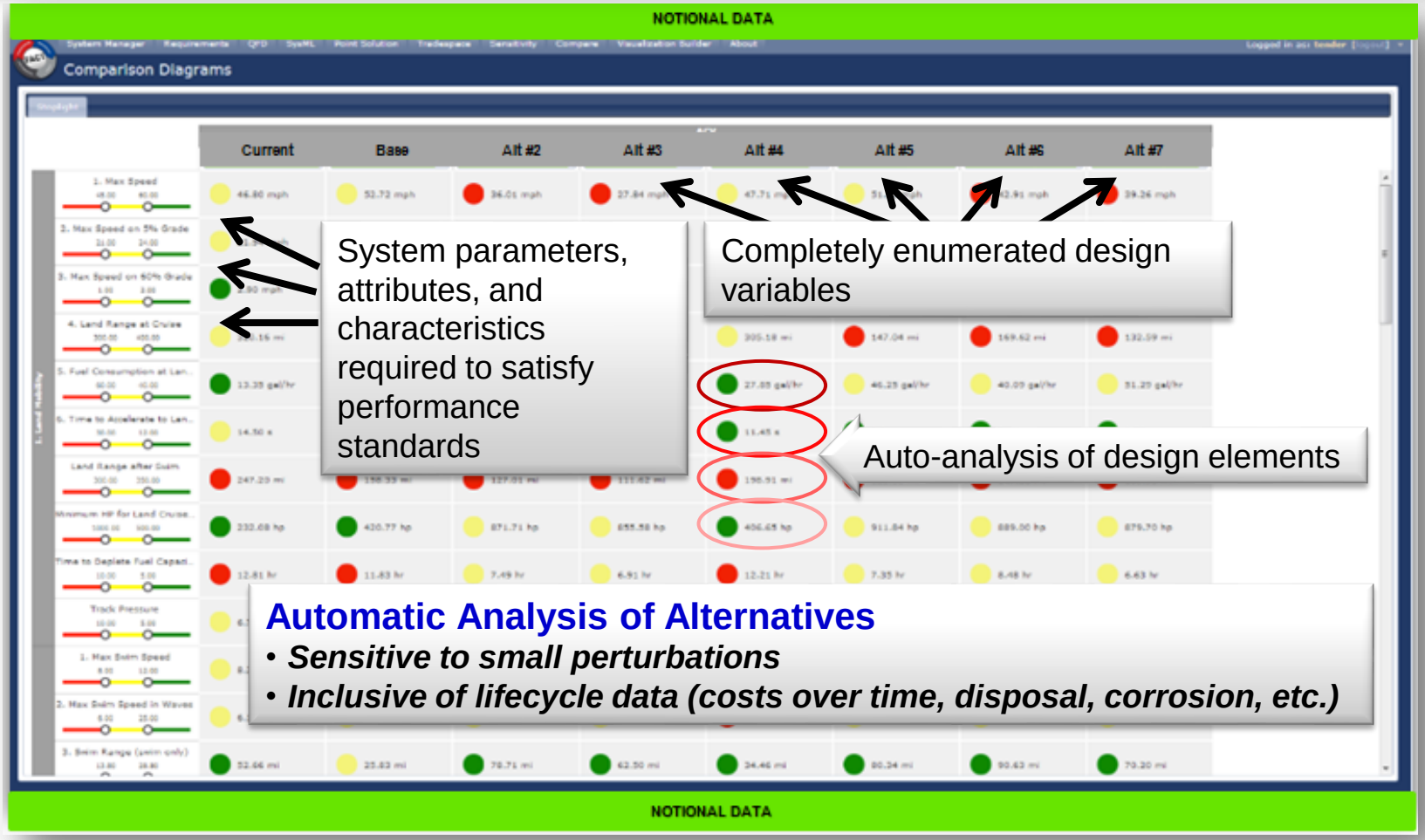
75% reduction in time to complete systems by reducing rework

Much faster computation; Ample data storage

Data and lessons-learned retained for rework

Multi-dimensional Data Analysis

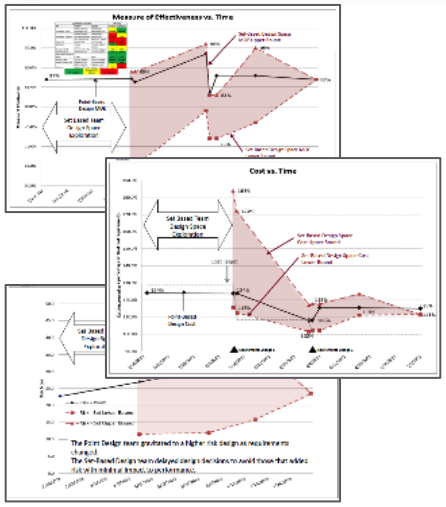
"If only we had this last year." Center for Army Analysis, Sep 2013



Ship Design Experiment

- **Point-based vs. Set-based design teams**
  - 3 requirements changes introduced during design phase:

Task	Point-based Design	Set-based Design
Measure of Effectiveness	Complete design iteration with requirements changes.	Required no design re-work for requirements changes.
Cost vs. Time	Necessary to guess in cost analysis	Analysis from data-driven knowledge
Risk	Gravitated to higher-risk design over time	Developed lower-risk design Delayed decisions to avoid higher-risk options

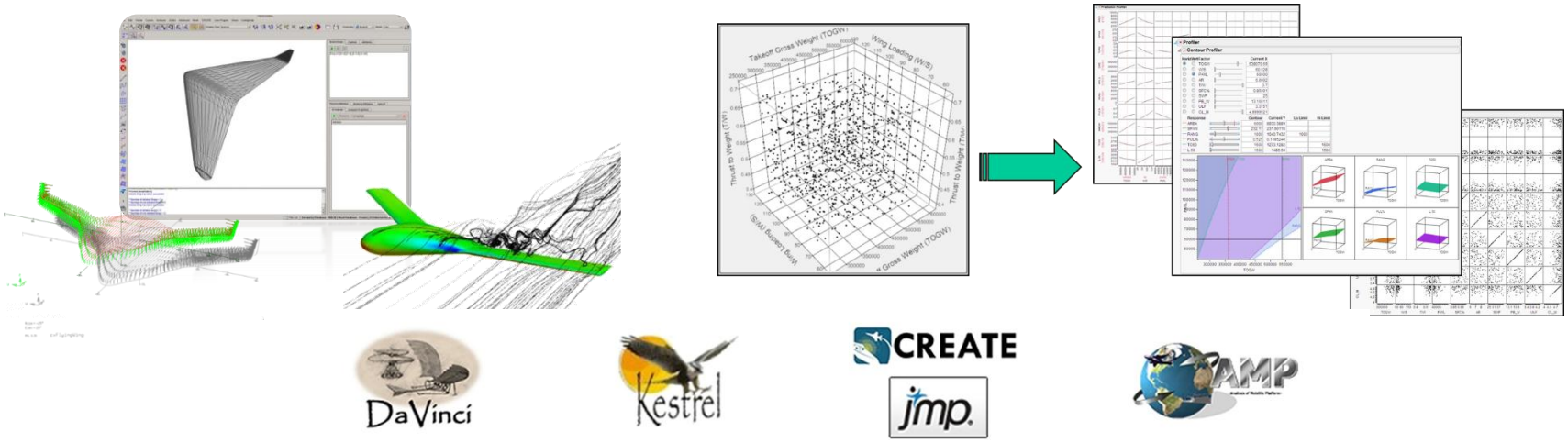


- **Physics-based analysis tools** provide information for early ID of sub-optimal requirements
- **Tradespace information** enables identification of risk-reducing technologies
- **Systems of Systems (SoS)** insights are more deeply understood and utilized

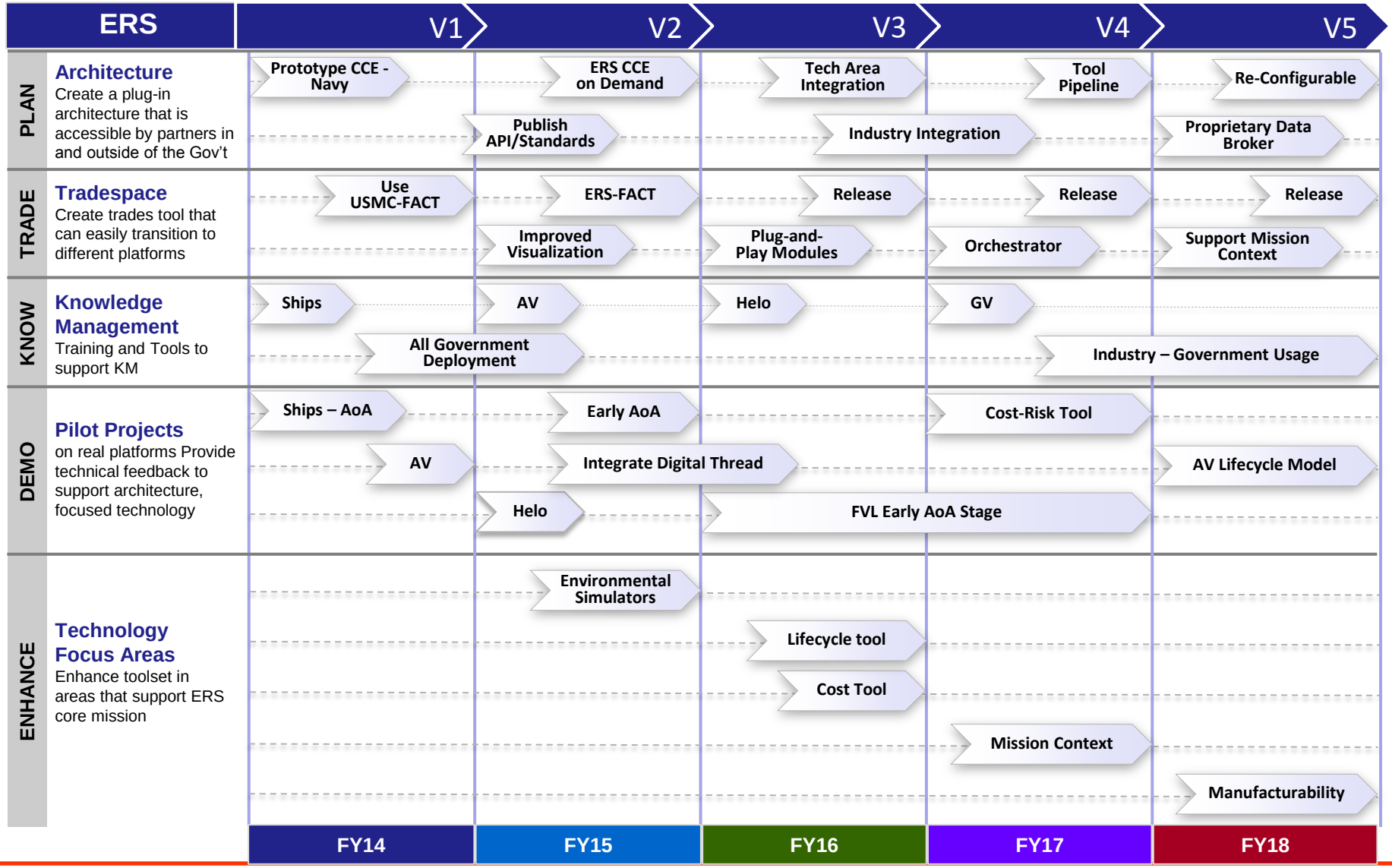
Aircraft Design Experiment

Mission context metrics can feed into the design loop and enable physics-based analysis: visual, quantifiable assessments

- **CREATE-AV tools (DaVinci): efficient, rapid, comprehensive evaluation of design space**
- **Surrogate design: Enables interface with operational (mission) models – assess requirements against cost & risk**
- **Probability-based analysis: Visualizes quantified assessment of feasibility/affordability for decision-makers**



ERS Roadmap (FY14 - FY18)



FY14-15 Technical Milestones

Building Components & Integrating

Quarter	Description of Milestone	Status
3QFY13	Pilot Projects: ERS Ships and AV, Phase 1	Completed
1QFY14	ERS Ships and Air Vehicle, Phase 2	In Progress
1QFY14	Initial Release: ERS Integrating Architecture (corresponds to ERS V0.1)	Planned
4QFY14	ERS V1.0 Release (Major Milestone)	Planned
4QFY15	ERS V2.0 Release (Major Milestone)	Planned

Technical Goals:

- Capture and simulate essential components of the DoD acquisition and operational analysis processes;
- Integrate M&S, collaborative tools, tradespace analysis, engineering design processes into single architecture;
- Express lessons learned and create communities of interest through DoD social media exploitation;
- Demonstrate ERS for various platforms, such as Ships, Fixed-Wing Air Vehicles, and Helicopters; and
- Provide the technical basis for improvements to DoD policy.

FY14-15 Program Milestones

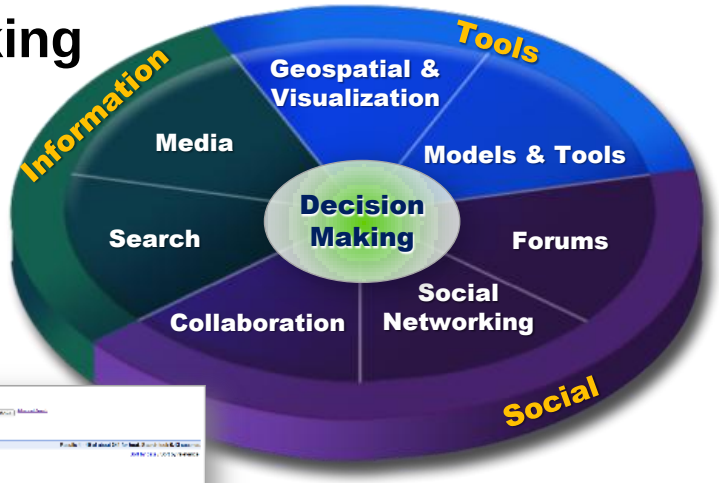
Quarter	Description of Milestone	Status
1QFY13	PSC Transition of Leadership – R. Neches to J. Holland	Completed
2QFY14	Outreach/engagement of Academia and Industry (e.g., GTRI, SERC, Lockheed Martin ATL, BAE Systems, etc.)	Complete/Task Ongoing
4QFY13	Annual General PSC Meeting to discuss FY14 Activities	Complete
1QFY14	Continue Industrial Outreach (Boeing, Northrop, Raytheon, etc.)	Planned
2QFY14	Deliver priority research topics to the SERC	Planned
2QFY14	Virtual ERS-wide Technical Workshop (VTW)	Planned
3QFY14	Hold Senior Advisory Meeting to discuss FY15 Activities	Planned
4QFY14	Annual Technical/Program Review	Planned

- The ERS Program Management team is actively engaging the Services, the DoD's industrial base, commercial tool-makers, academia and research institutes. Technical exchange between Government and industry is built into the ERS management goals.

- Engineered Resilient Systems (ERS) has developed three levels of Government engagement and support:
  - OSD serves as a surrogate for the Services and DoD in general.
  - A joint-services, Senior Advisory body will provide technical direction, guide service engagements, provides insights and opportunities related to the Services, and assist with enlistment of relevant projects.
  - ERS Working Groups will identify technical needs and gaps related to policy, standards, data and training (and issues that arise), and draft working plans to address issues.

ERS Knowledge Hub

- Critical outreach tool for multiple communities of interest (COI)
- Prototype framework for decision-making
- Cloud-based collaboration system
- Connect, leverage and share data



Capture/engage COIs

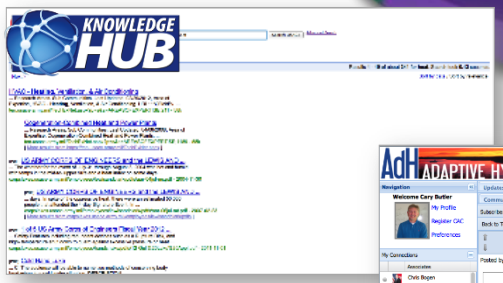
- *Government, Non-government, stakeholders, academia, etc.*

Host behind-the-firewall search

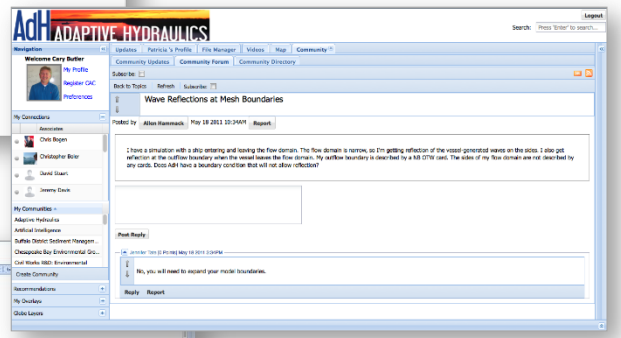
- *Smart search of millions of documents*
- *Avoid recreation, redundancy, etc.*

Locator of experts

- *Cross-divisions, communities*
- *Leverage remote communities of practice (COPs)Individual management of information*
- *Foster interaction and sharing*



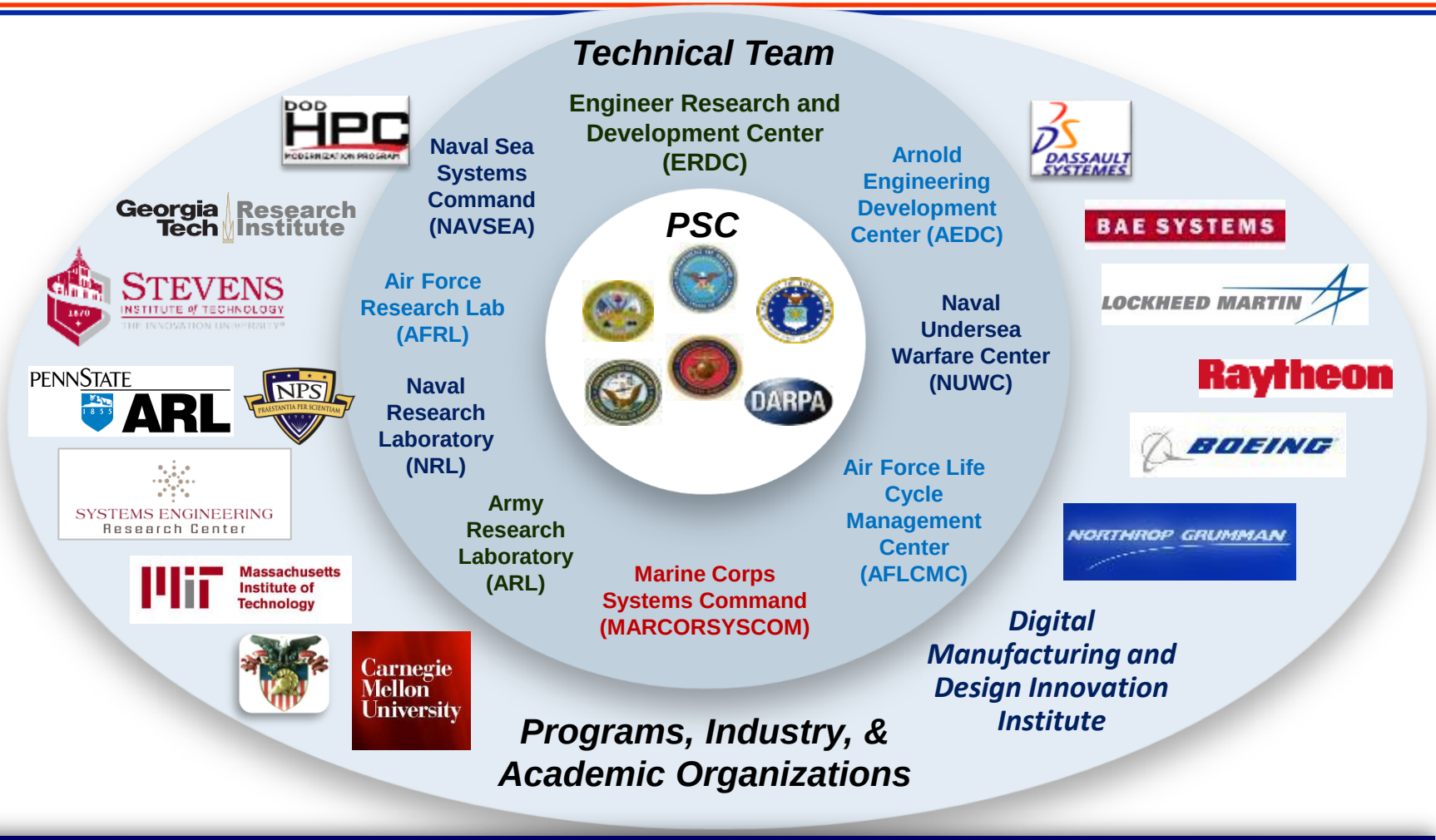
"Google" search



Wiki Pages

Experts

ERS Technical Team & Partners



Partnering with and Leveraging Key Program Executive Offices (PEOs), Program Managers (PMs), Industry and Academia