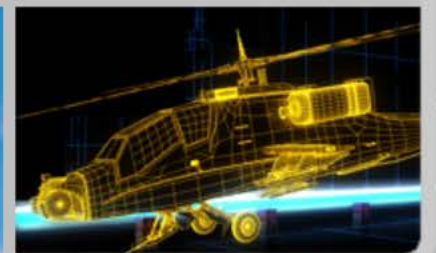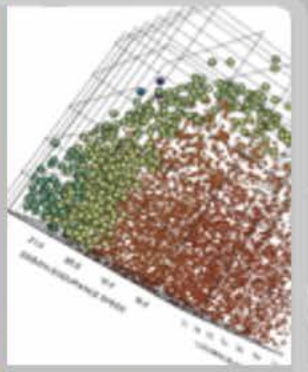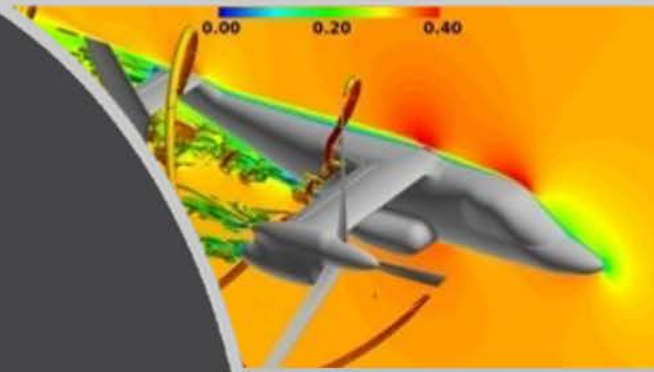**ERS**

Engineered Resilient Systems

Digital Engineering and Computational Testing

- **Robert Wallace, PhD, PE, SSTM**

  Technical Director

  US Army ERDC – Information Technology Laboratory

Distribution A: Approved for public release: distribution unlimited.

NDIA **Systems & Mission Engineering Conference**

US Army Corps of Engineers

ERDC ENGINEER RESEARCH & DEVELOPMENT CENTER

INFORMATION TECHNOLOGY LAB

ITL MAJOR PROGRAMS AND INITIATIVES

1 HIGH PERFORMANCE COMPUTING MODERNIZATION PROGRAM	2 ENGINEERED RESILIENT SYSTEMS	3 HIGH PERFORMANCE DATA ANALYTICS	4 DoD CYBERSECURITY	5 ENABLING THE REGIMENT
DoD HPC MODERNIZATION PROGRAM	**ERS** ENGINEERED RESILIENT SYSTEMS		DEPARTMENT OF DEFENSE UNITED STATES OF AMERICA	US Army Corps of Engineers
PROVIDING THE INFRASTRUCTURE AND SUPPORT NECESSARY TO PERFORM OUR RESEARCH	DELIVERING THE TOOLS NECESSARY TO MAKE INFORMED ACQUISITION DECISIONS FASTER	USING LARGE-SCALE DATA AND ADVANCED DATA ANALYTICS TECHNIQUES TO MAKE BETTER DECISIONS	ASSESSING AND SECURING DoD COMPUTING, AND RESEARCHING CUTTING-EDGE SECURITY SOLUTIONS	DEVELOPING PHYSICAL AND DIGITAL SOLUTIONS TO SUPPORT THE DoD

ITL INFORMATION TECHNOLOGY LABORATORY

ENGINEERED RESILIENT SYSTEMS

ENGINEERED RESILIENT SYSTEMS
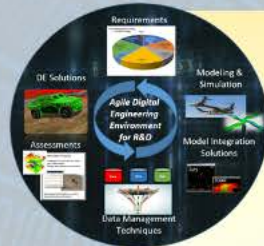
ERS SUPPORT FOR
DIGITAL ENGINEERING
Conceptual Design
Analysis of Alternatives
Value Engineering

COMPUTATIONAL PROTOTYPING
ENVIRONMENT
Prototyping Refinement
Manufacturing Modeling

USER-BASE
STAKE HOLDERS

WEB
INTERFACE

IP
PROTECTED

Industry
Commercial
Cloud

RMF
Compliant

- JCIDS
- ACQUISITION ENGINEERS
- ANALYSTS
- SMEs
- PEOs, MANAGERS

OUTPUT REPORTS

INPUT PROJECT DATA

CAPABILITIES GENERATION	TRADESPACE ANALYSIS
MISSION ENGINEERING	ENGINEERING ANALYSIS
ERS SYSTEM MANAGEMENT	TRADESPACE WORKFLOW PROCESS

FEASIBLE
ALTERNATIVE
DESIGNS

VIRTUAL
PROTOTYPING &
WAR GAMING

AN
ENGINEERED
RESILIENT
SYSTEM

VIRTUAL TESTING & EVALUATION

COMPUTATIONAL ENVIRONMENTS

ADVANCED COMPUTATIONAL METHODS
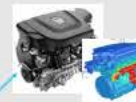
DECISION SCIENCE

WORKFLOW INTEGRATION

HIGH-PERFORMANCE DATA ANALYTICS

Science & Technology Areas

IMMERSIVE METHODS FOR IMPROVED UNDERSTANDING

KNOWLEDGE MANAGEMENT
SEMI-AUTOMATED DATA THREAD
SEARCH, STORAGE, DISTRIBUTION & RETRIEVAL

DIGITAL THREAD

DIGITAL TWIN

OBSERVATIONS AFTER 10 YEARS OF ERS

- ERS Concepts Work – They actually reduce time, risk, and cost

- No Single Solution works for every program/project – Bespoke

- Two Components of ERS
  - Digital Engineering – Conceptual Design, Analysis of Alternatives, Value Engineering
  - Computational Testing – Design Refinement, Manufacturing Modeling, System Integration

- ERS is now a Reimbursable Program
  - Cooperative Research Agreement (CRADA) – OEM Funded (wind tunnel)
  - Government Funded Equipment (GFE) – PEO Funded

TECHNICAL SOLUTIONS

- **Scalable solutions** on HPC resources
- Software integration and process automation for **increased efficiency**
- Multidisciplinary, integrated & collaborative approach to **reduce inefficient tech "silos"**

Speed   Risk

- **Fully coupled** codes that better identify failure modes
- Evaluate massive amounts of data **within decision cycles**; analyze more designs
- Incorporate **emerging simulation technologies**

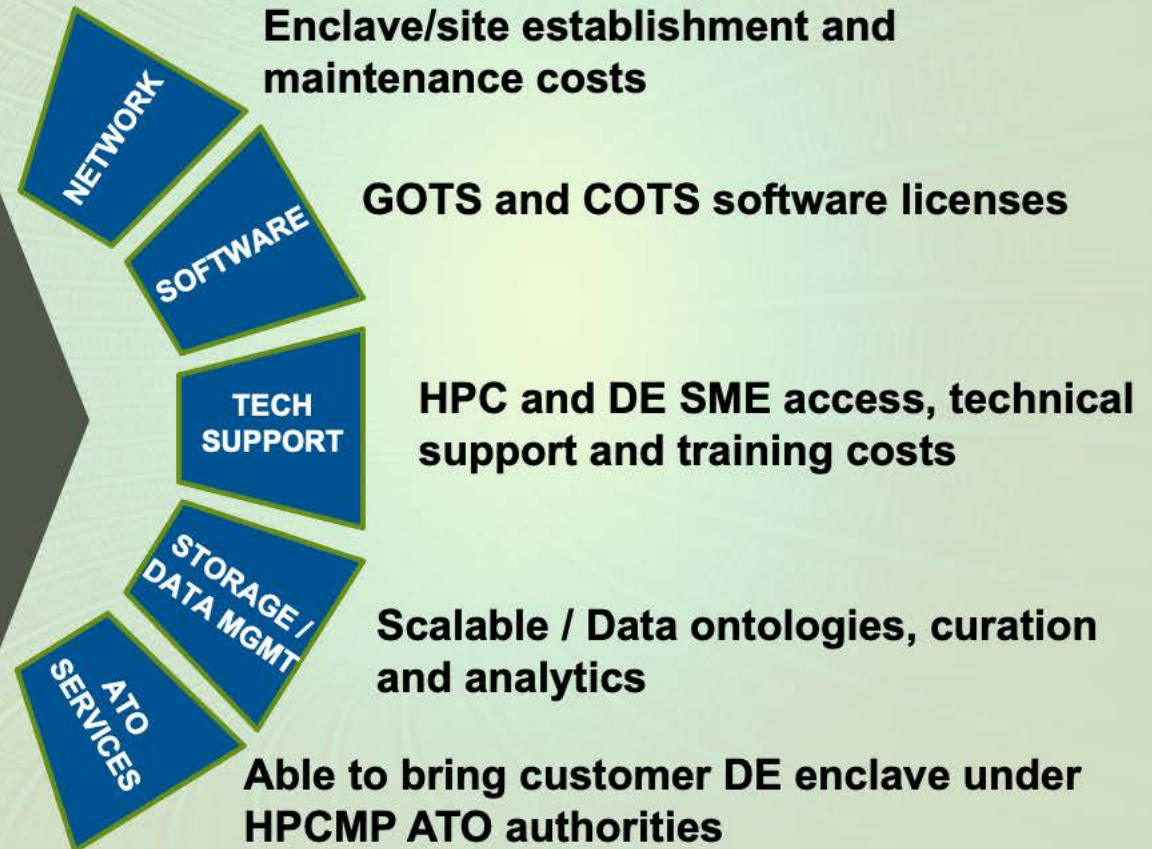*To achieve the best design, you must derive insights from your data.*

ERS NEXT - DIGITAL ENGINEERING SERVICES

2012 ⟶ 2021

ERS

OSD-sponsored R&D in multiple Digital Engineering Areas

MODELS
CREATE
Environmental Sims
Lifecycle Intel

DECISION SUPPORT & ANALYSES
TradeStudio
Analytic Tools

OPERATIONS
Mission
Doctrine

EMERGING RESEARCH
X-ARPAs
Research
Algorithms

KNOWLEDGE MGMT
Notebooks
Knowledge Hub
Wiki

- NETWORK
- SOFTWARE
- TECH SUPPORT
- STORAGE / DATA MGMT
- ATO SERVICES

Enclave/site establishment and maintenance costs

GOTS and COTS software licenses

HPC and DE SME access, technical support and training costs

Scalable / Data ontologies, curation and analytics

Able to bring customer DE enclave under HPCMP ATO authorities

ITL COMPUTATIONAL ENGINEERING SERVICES

Hardware/Software Resources

- Army DoD Supercomputing Resource Center
- DoD Cyber Expertise
- MS Azure Test Environment
- On-Premise Cloud Services
- DoD CREATE Software

Digital Engineering Project Experience

- Engineered Resilient Systems – OUSD
- B-52 CERP Environment – AF
- Nuclear Weapons Effects (NWE) Collaboratory – DTRA
- DoD Predictive Maintenance Data Lake – JAIC
- ERDC SEIR COVID Modeling – USACE
- EDGE Computing Lab – USACE

- **World-Class computational resources**
- **DoD leading software expertise**
- **Cloud computing integration**
- **Dashboard for rapid data dissemination**
- **Workflows for computational efficiency**

ITL COMPUTING FACILITIES
Combined computational resources available for ERS Activities

- New state-of-the-art facilities

- Access to 5 networks with top speed of 40Gbps (2 Unclassified, 2 Secret, 1 Top Secret)

- 29,000 sq ft, raised-floor computing space

- Additional 10,000 sq ft of raised floor space increasing classified and unclassified supercomputing capabilities

- Collaborative environment

- 8,000 sq ft conference center

Secure Computing Facility

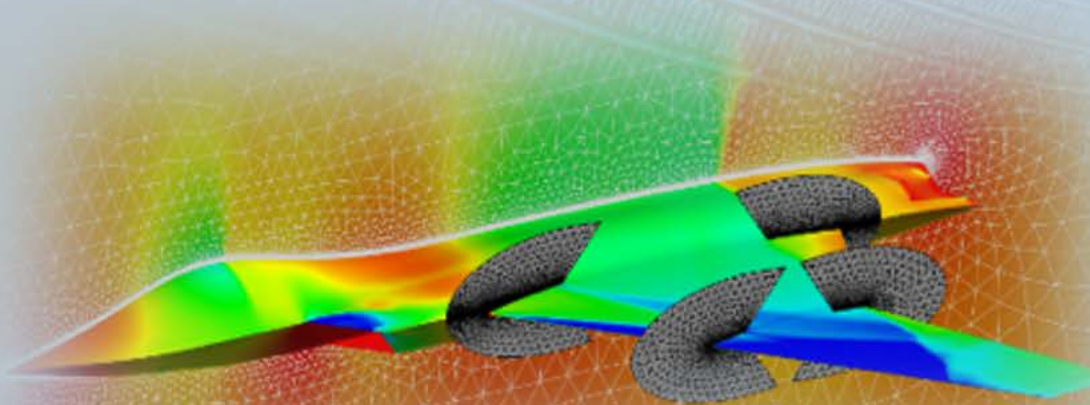Supercomputing Research Center

ITL HPC Resources

Jim	SGI ICE-X 2 sockets/node Intel Xeon	124,200	Unclassified
Thunder	SGI ICE-X 2 sockets/node Intel Xeon	152,676	TBD

COMPUTATIONAL TEST RANGE

Vision and Goal: Virtual Test that Supplements Physical Test

Computational Test Range Capability

Reduce the cost and time burden of conventional wind tunnel testing

- **Design analysis is often siloed:** *poor communication between disciplines.*

- **Simulation of DoD systems with highly complex, interdependent physical phenomenon.**

- **Capabilities:** *Augment computational resources and HPC experience*
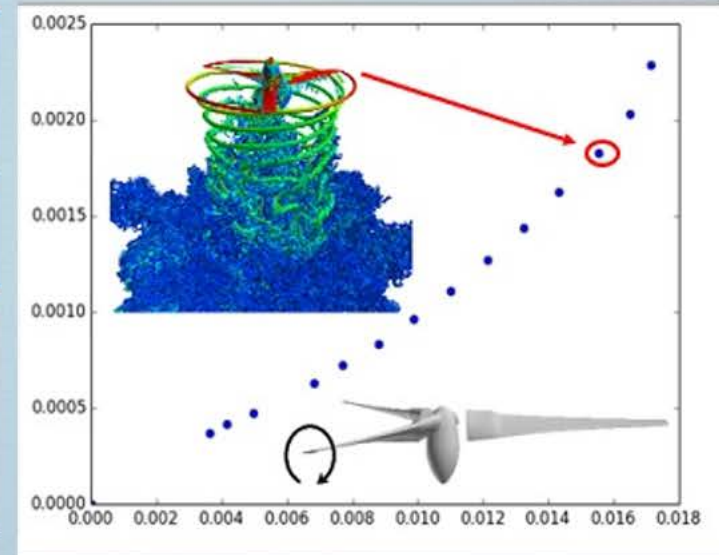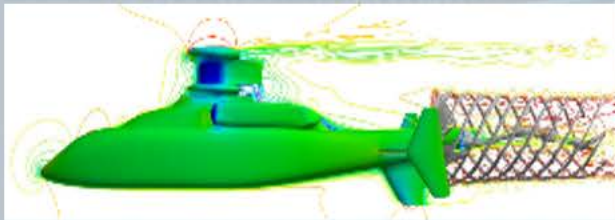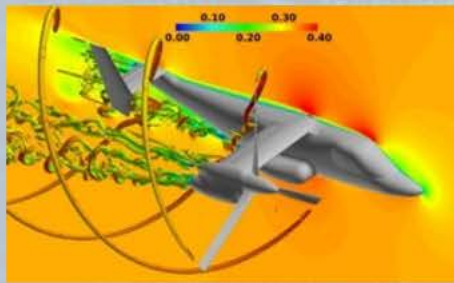
| HPC Expertise | Computational Engineering | Code Optimization |

FVL FARA/FLRAA DOWN SELECT

IMPACT: High-Fidelity Physics Speeds Down Select Decision Process

ERS dramatically reduced the time required (from months to days) to simulate each industry-proposed design, thus allowing results within acquisition timelines.

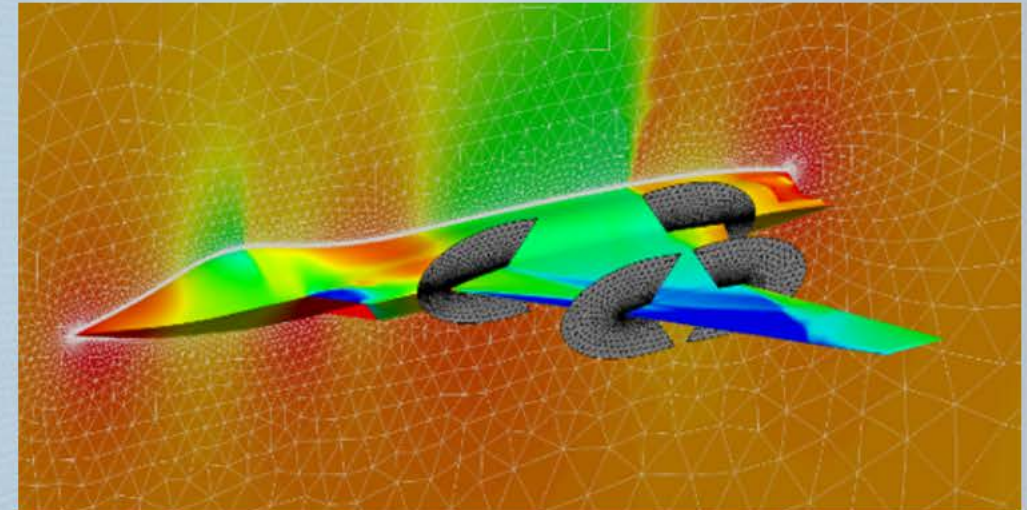

Project Title	Time/Money/Risk	Impact Statement
FVL FARA/FLAARA Down Select	20x time reduction per analysis	Time reduction allowed high-fidelity simulations to be used in FARA down select – never previously attempted

DARPA CRANE

IMPACT: Providing Expertise and Resources to DARPA and Industry Performers

Simulation of DoD systems with highly complex, interdependent physical phenomenon where design analysis is siloed with poor communication between system disciplines.

- **Augment computational resources and HPC experience for industry performers**

- **Technical Support:** *HPC migration, computational science,* and *computer science*

| Project Title	Time/Money/Risk	Impact Statement
DARPA CRANE X-Plane	$4.0M direct program savings / 10x increase in designs evaluated	Explore higher fidelity, more expansive, and more detailed design spaces of novel aircraft

B-52 CERP DIGITAL ENGINEERING ENVIRONMENT

IMPACT: Collaborative environment that reduced time, cost, and risk for design and development replacement engines

Problem: The USAF B-52 Special Project Office lacked the ability to rapidly ingest data from multiple sources, manage and reuse system models that leveraged a proven MBE framework, tools, and methods, and provided secure access to multiple stakeholders using a common interface.

Solution:

- **Shareable Data Access**

- **Virtual Desktop Interfaces (VDI)**

- **Government and OEM IP Protection**
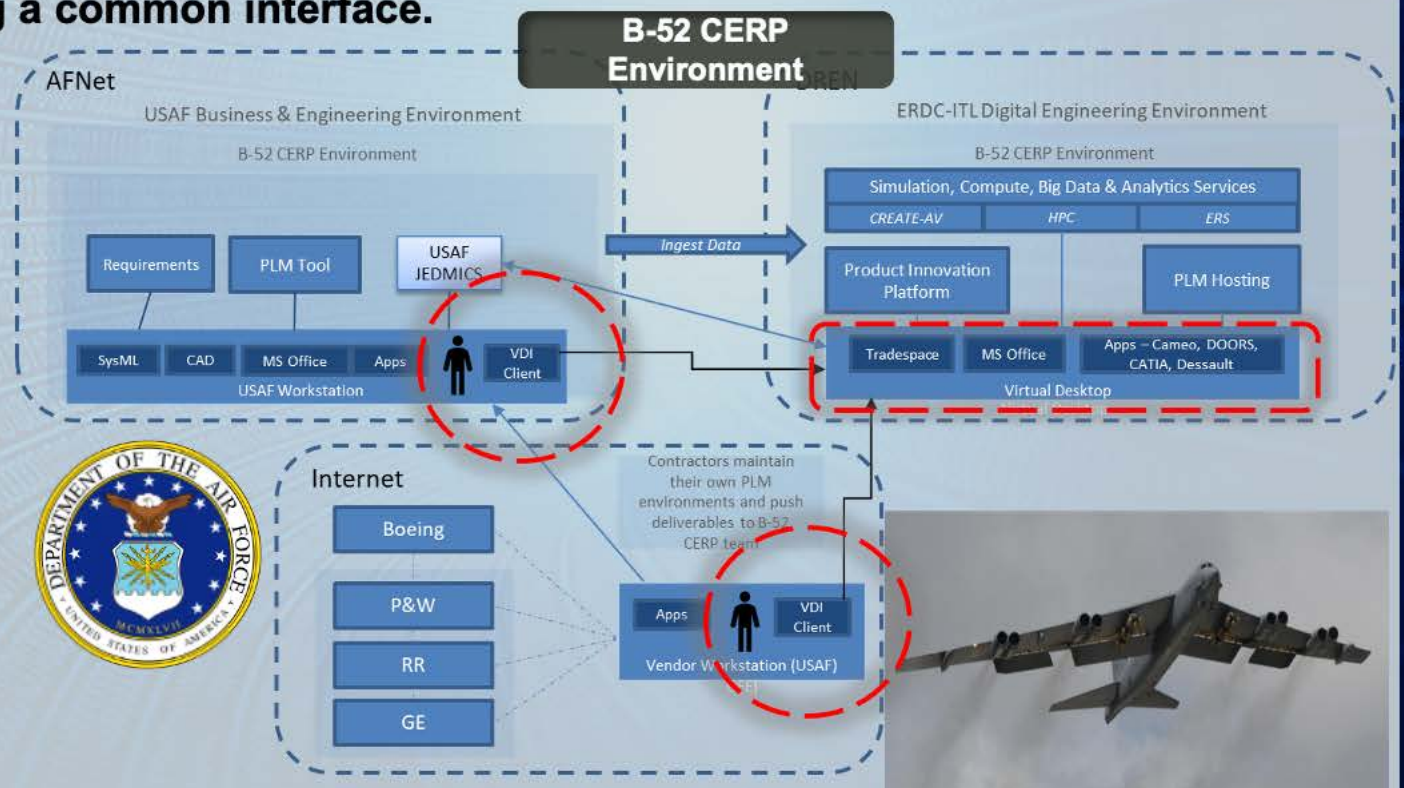
THE IMPACT

Government/Industry Acquisition Partnerships

GENERAL ATOMICS
DEVCOM

DARPA

B-52 CERP**	LOCKHEED HYPERSONIC SYSTEMS**	DARPA CRANE DESIGN PROJECT**
VDI's for shareable digital engineering infrastructure	Automating analyses process, expected time reduction per trajectory point from 6 months to 6 days	Reduced time for multi-discipline modeling, multi-domain s/w coupling, & tools for efficient computing
Speed of multiple design assessments increased by 100X – FARA	Reduced time in predicting probability of kill assessments for UAVs from weeks to hours	Fully-coupled aero/thermo/elastic simulation with control
FUTURE VERTICAL LIFT**	UAV Lethality Assessment*	RAYTHEON HYPERSONIC SYSTEMS**

DEVCOM

S3I Systems Simulation Software & Integration

Raytheon

ERS
ENGINEERED RESILIENT SYSTEMS

Transformational Engineering Processes for DoD Acquisition Projects
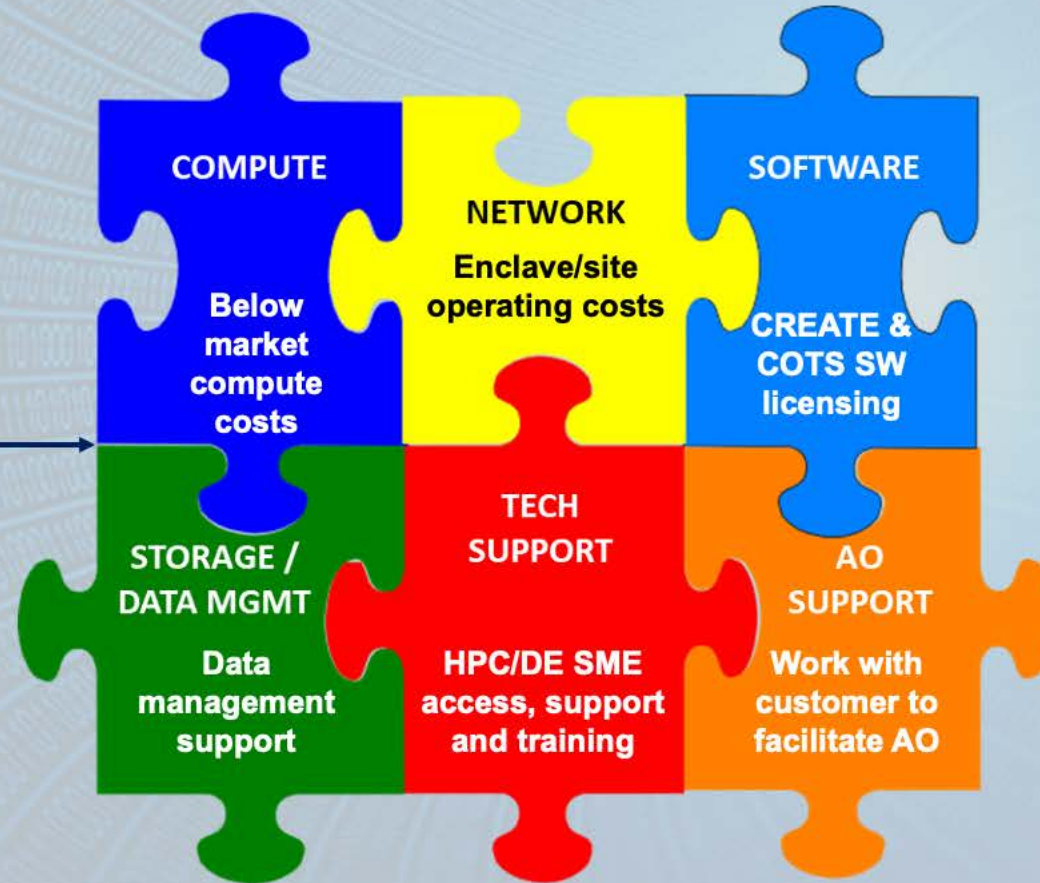
* completed
** in progress

Concurrent Hands-on Workforce Development

TRANSACTIONAL MODEL

DEMAND-DRIVEN SERVICES

Customer Identifies DE Challenge → ERS/customer plan a tailored DE solution →

COMPUTE
Below market compute costs

NETWORK
Enclave/site operating costs

SOFTWARE
CREATE & COTS SW licensing

STORAGE / DATA MGMT
Data management support

TECH SUPPORT
HPC/DE SME access, support and training

AO SUPPORT
Work with customer to facilitate AO

Funding

- Services provided are in line with **agreed upon Statement of Work and Services Agreement** between ITL and funding agency

- Reimbursable funds can be transferred via **MIPR or CRADA to ITL**

CONTACTS

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