Aerospace Digital Engineering Ecosystem: Architecture and Implementation

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Agenda

- **Background**
- **DE Ecosystem Architecture Approach**
- **Summary & Challenges**

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- **Background**
  - *Corporate DE strategy*
  - *Governance*
  - *Aerospace's DE Ecosystem*
- **DE Ecosystem Architecture Approach**
- **Summary & Challenges**

Aerospace Digital Engineering Strategy

Balanced investment approach to enable transformation of both Aerospace and our customers

DE Transformation of Aerospace

- *Ensures corporation remains relevant in the Digital Age*
- *Ensures corporation keeps pace w/ and fosters digital fluency*
- *Modernizes corporate IT infrastructure and environment to serve as DE ecosystem*
- *Modernizes corporate M&S capabilities to operate within a DE environment*

DE Transformation of Customers

- *Delivers near-term capabilities to meet immediate customer needs and solve their hardest problems*
- *Provides guidance & support to our customers' DE transformation efforts*
- *Supports the establishment of customer DE ecosystems*
- *Ensures Aerospace serves as a key tenant within customers' DE environments*

Aerospace must fully commit to the digital transformation of its own enterprise to make itself more competitive, to enable it to become the premier integrator of the space enterprise, and to give it the necessary knowledge, experience, and legitimacy to effectively advise its customers on their own digital transformations

Aerospace Digital Engineering Lines of Effort (LOEs)

- **LOE #1: Governance and Integration**
  - *Strategic planning, governance, & integration of DE activities across corporation and customers*
- **LOE #2: Infrastructure and Environments**
  - *Development and modernization of the Corporation's DE infrastructure and environment and the interoperability of the Aerospace DE ecosystem with customer DE ecosystems*
- **LOE #3: Authoritative Data and Models**
  - *Greater sharing of information and baselines to accelerate learning, facilitate knowledge management, and improve the accuracy, validity, and responsiveness of analyses*
- **LOE #4: Capability Development/Modernization**
  - *Development of capabilities required to implement DE processes and workflows and the modernization of legacy capabilities, including M&S, to be executable in a DE environment*
- **LOE #5: Workforce Education and Culture**
  - *Training and education of the Aerospace workforce to operate intuitively and effectively across the digital workspace and to champion the digital transformation of our customers*

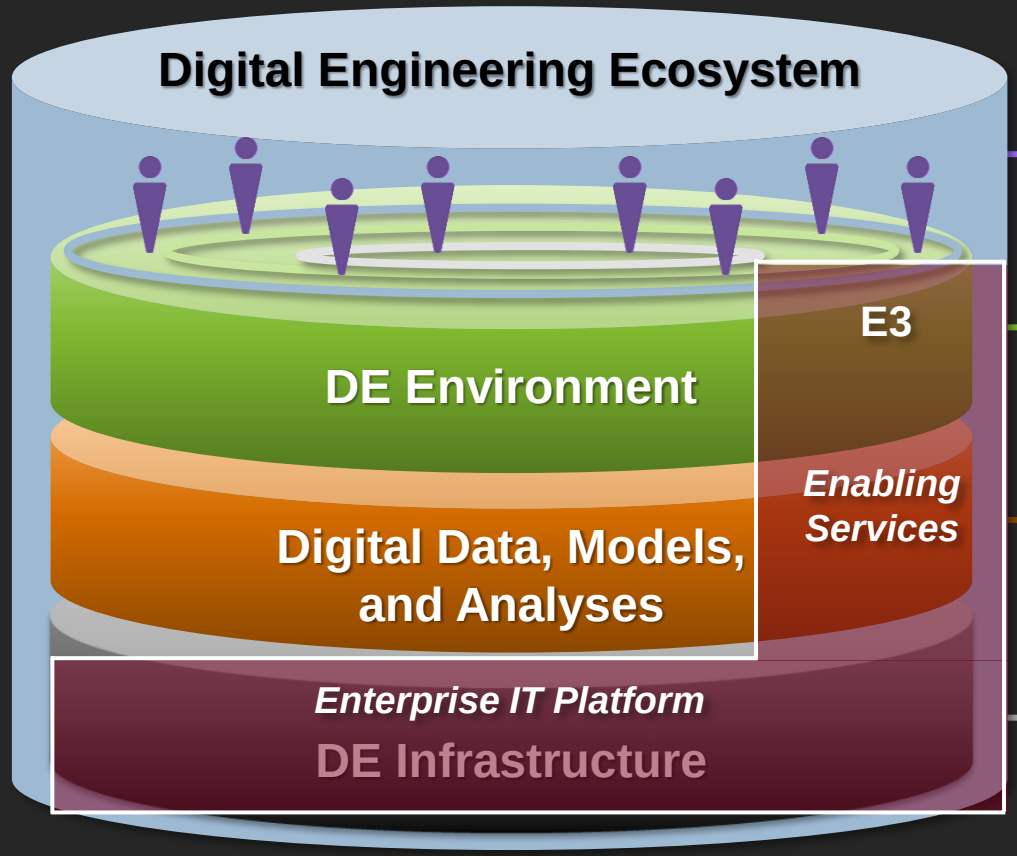
LOE #2: Infrastructure and Environments

- **LOE #2 Definition/Scope**
  - *The development and modernization of the Corporation's DE infrastructure and environment and the interoperability of the Aerospace DE ecosystem with customer DE ecosystems*
- **Key Takeaways**
  - *The DE ecosystem serves as the technological foundation for enabling DE across Aerospace and linkages to our customers*
  - *Knowledge management at this scale requires adoption of modern infrastructure, environment, and tools*
- **Ecosystem Implementation => Cloud Technologies**
  - *Ability to readily access shared pools of configurable HW and SW resources that can be rapidly provisioned w/ minimal management*
  - *On-prem OR commercial*
  - *Service-oriented: Compute, store, software development, databasing, AI/machine learning, analytics, collaboration, etc.*

LOE #2: Aerospace DE Ecosystem on E3 Foundation

Digital Engineering Ecosystem (DEE): Serves as the common, integrated workspace for users to support and execute all technical functions

Enterprise Engineering Ecosystem (E3): Enables digital solutions by providing enterprise cloud services, associated provisioning across the DEE, and the intuitive interfaces for users to access what they need



The people who interact with, manipulate, and govern the environment to deliver mission value (e.g., analysts, engineers, developers, managers)

Structured enclaves that provide ability to access and manipulate the data & models (e.g., via application tools, workflows, dashboards, software factory)

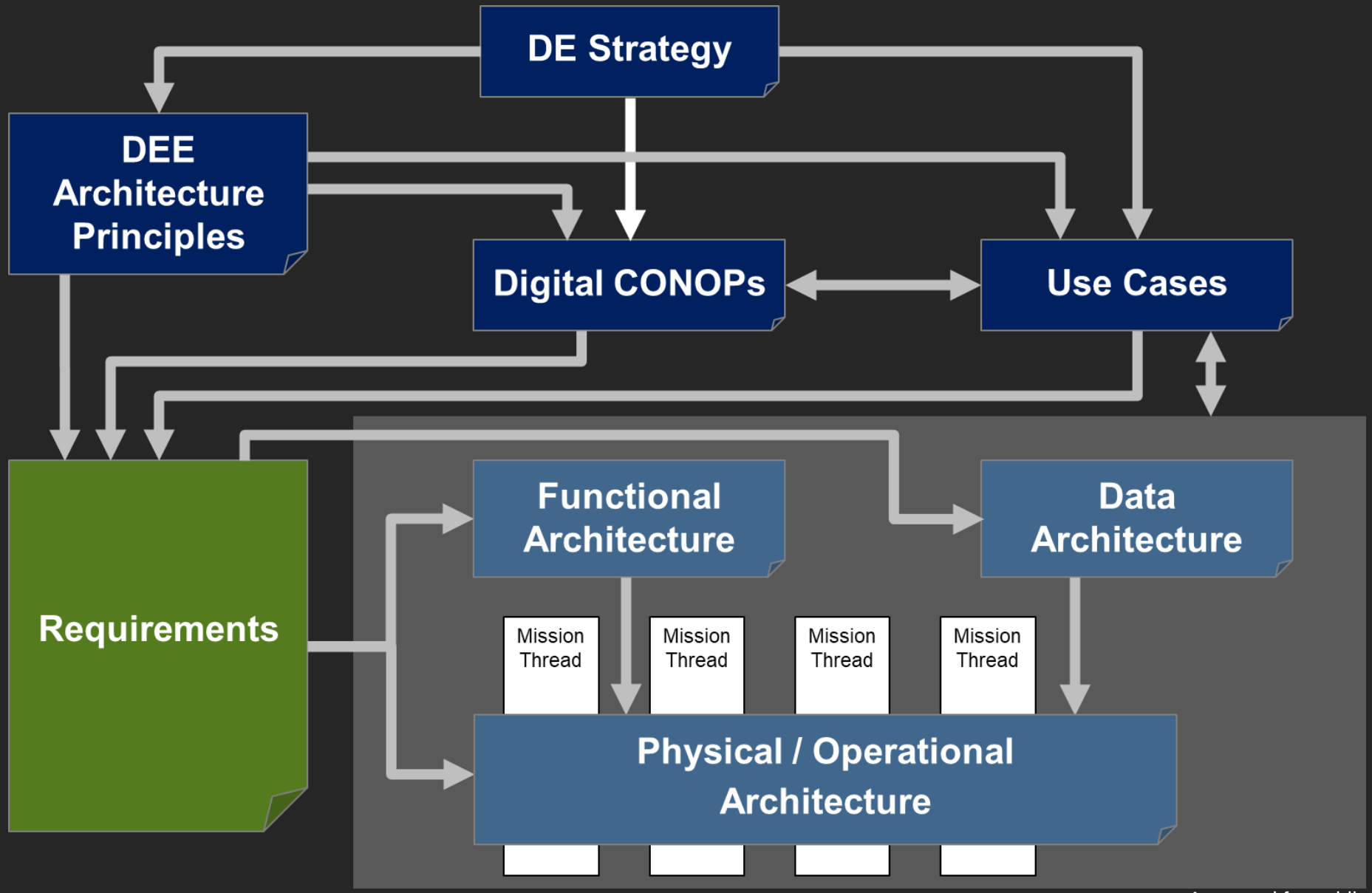
The core information layer that contains the data and models (and supporting structure) to be created and maintained across their lifecycle (e.g., ASOTs, databases, libraries, metadata, pedigree)

The foundational infrastructure elements needed to enable ecosystem capabilities (e.g., networks, storage, compute, security, and virtualization)

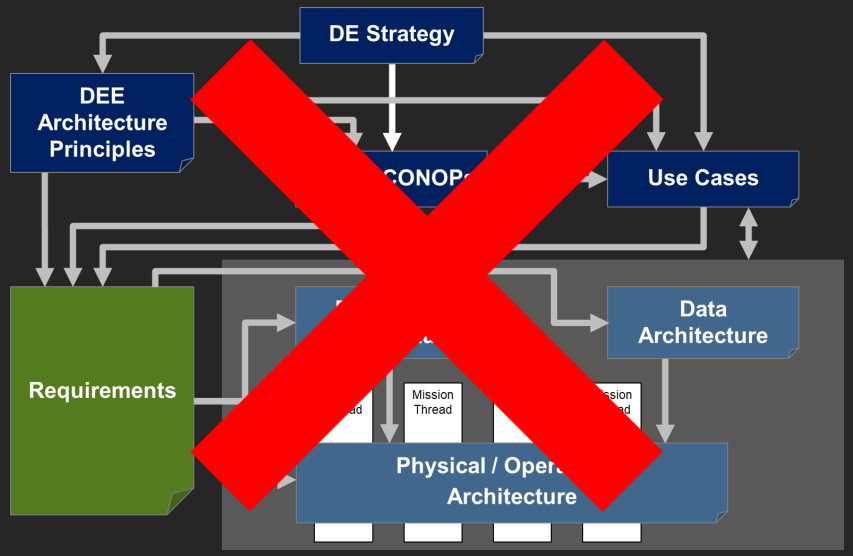
Agenda

- Background
- **DE Ecosystem Architecture Approach**
  - *Original Plan*
  - *Current Plan*
  - *Service-Oriented*
  - *Physical Architecture*
- Summary & Challenges

Original DE Ecosystem Implementation Approach



Several Factors Drove us to Revector



1. **Speed is Paramount**
   - *Must show value quickly to internal stakeholders; must learn quickly to credibly advise customers*

2. **Must Confront Cultural Barriers**
   - *Technical challenges hard, but people piece is harder—speed and results critical*

3. **DE is a Revolution**
   - *Today's use cases (rqmnts) are expected to be substantively different from tomorrow's use cases*

4. **Nature of Solution Known**
   - *We have a relatively firm understanding of rqmnts and architecture tradespace*

Pivoted to Agile/Incremental Approach

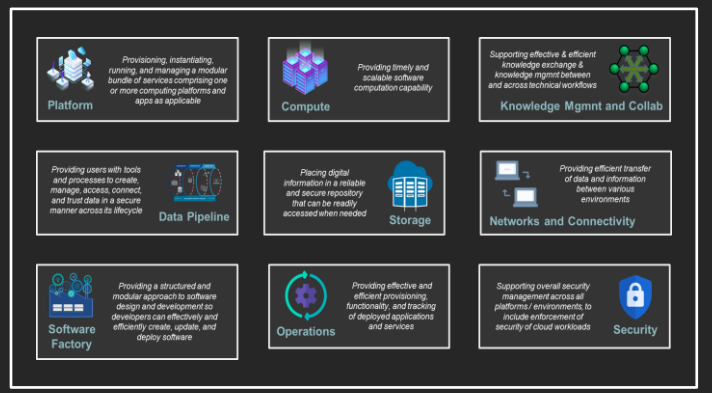
- **Establish Basic Principles for the DEE (vs. Hard Rqmnts)**

Principles

Elastic
Service-Oriented
Secure
Frictionless
Collaborative
Data-Centric

- **Attack via Middle-Out Design (vs. Exclusively Top-Down)**
  - *Service-centric (vs. use case-centric)*
  - *Workflow creation w/ users (vs. use case satisfaction by architects)*

- **Rapid Deployments of Working Capability**
  - *Early, ongoing engagements with users*
  - *Heavy reliance on pilots/MVPs to create "beachheads" and learn*
  - *Extensible: libraries of modeled workflows and "service patterns"*



Aerospace Service-Centric Approach: Top-Level ("Level 1") Services

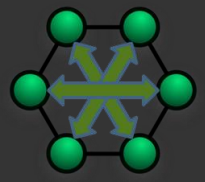
Platform

Provisioning, instantiating, running, and managing a modular bundle of services comprising one or more computing platforms and apps as applicable

Compute

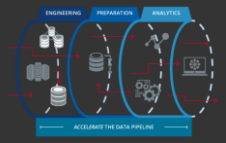
Providing timely and scalable software computation capability

Supporting effective & efficient knowledge exchange & knowledge mgmnt between and across technical workflows



Knowledge Mgmnt and Collab

Providing users with tools and processes to create, manage, access, connect, and trust data in a secure manner across its lifecycle



Data Pipeline

Placing digital information in a reliable and secure repository that can be readily accessed when needed

Storage

Providing efficient transfer of data and information between various environments

Networks and Connectivity

Software Factory

Providing a structured and modular approach to software design and development so developers can effectively and efficiently create, update, and deploy software

Operations

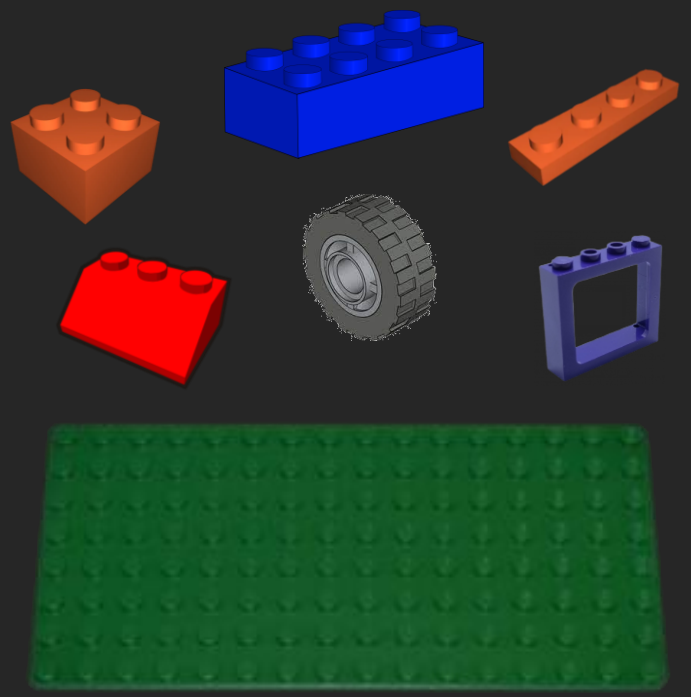
Providing effective and efficient provisioning, functionality, and tracking of deployed applications and services

Supporting overall security management across all platforms / environments, to include enforcement of security of cloud workloads

Security

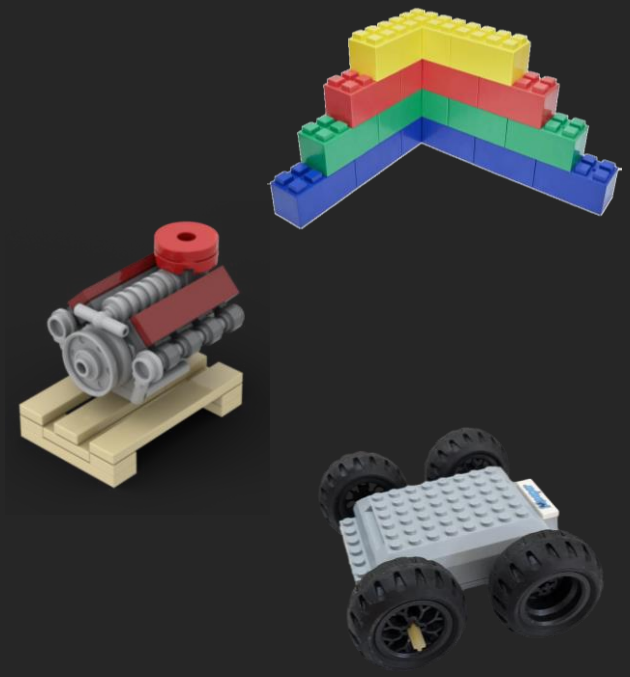
Legos Analogy

Lego Pieces



Atomic services that can be mixed and matched to satisfy user needs
(e.g., encryption, license mgmnt, code commit, data archival, data ingestion, web hosting)

Lego Modules

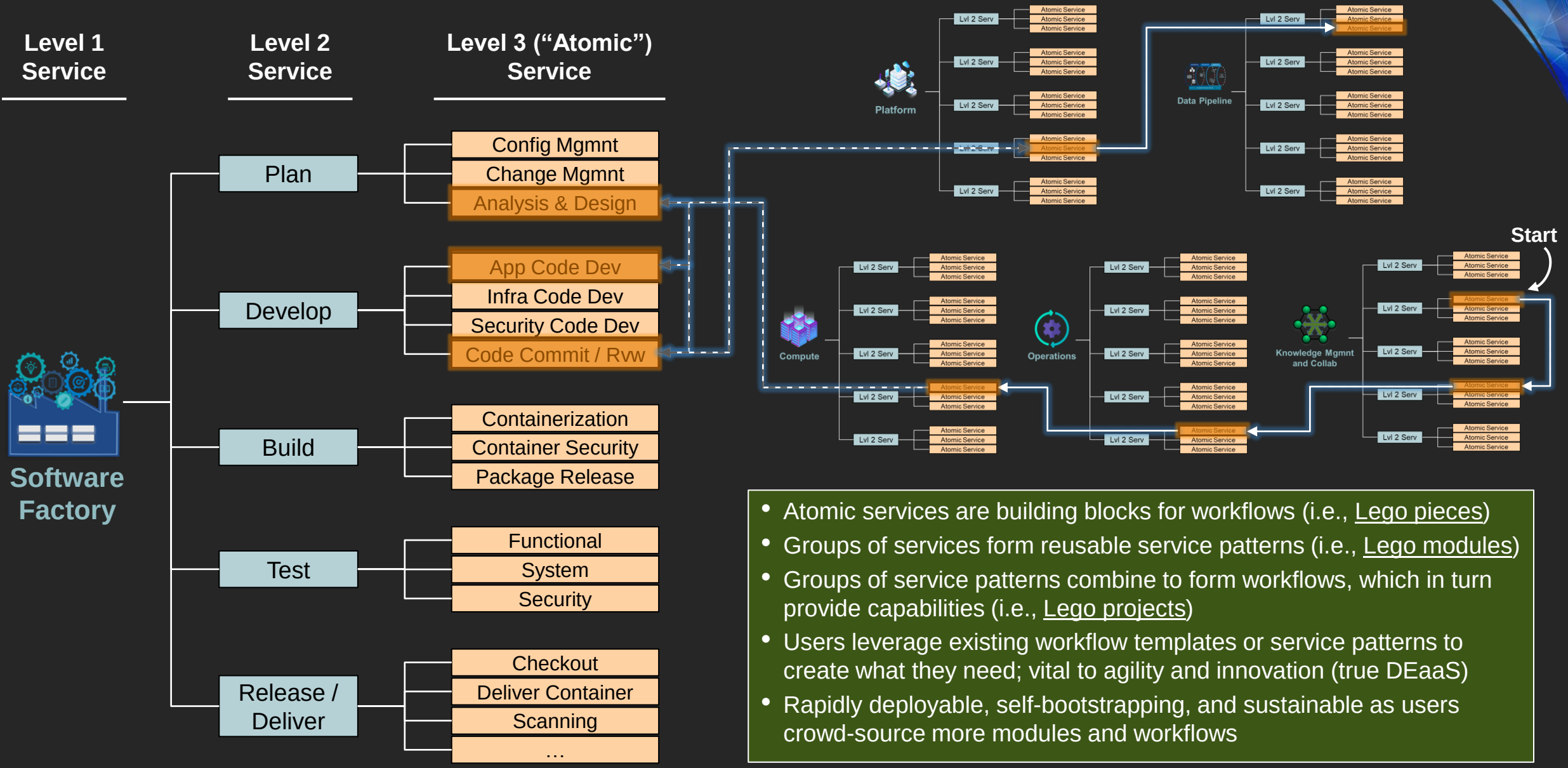


Common groupings of services (i.e., service patterns) that are readily reusable and extensible
(e.g., ETL, SW testing, health monitoring, structured repository)

Lego Project

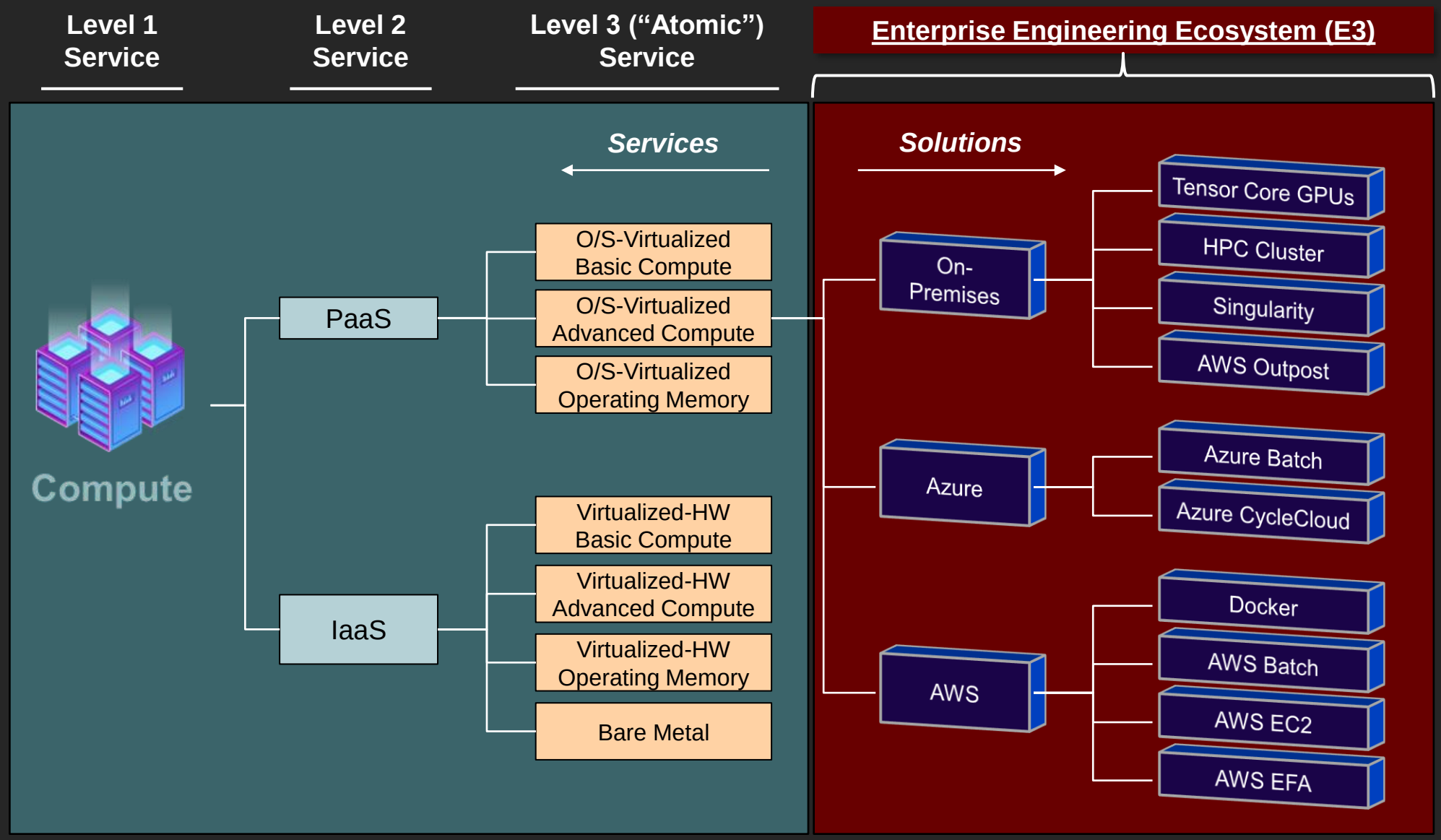
Sequenced combination of services that satisfy user needs via an end-to-end workflow
(e.g., rqmnts mgmnt, survivability analysis, discrepancy resolution)

Aerospace Service-Based DEE (Notional)



- Atomic services are building blocks for workflows (i.e., Lego pieces)
- Groups of services form reusable service patterns (i.e., Lego modules)
- Groups of service patterns combine to form workflows, which in turn provide capabilities (i.e., Lego projects)
- Users leverage existing workflow templates or service patterns to create what they need; vital to agility and innovation (true DEaaS)
- Rapidly deployable, self-bootstrapping, and sustainable as users crowd-source more modules and workflows

Aerospace DEE Physical Architecture



- Services are allocated down to specific resources
- CONOPS drives nature of solutions

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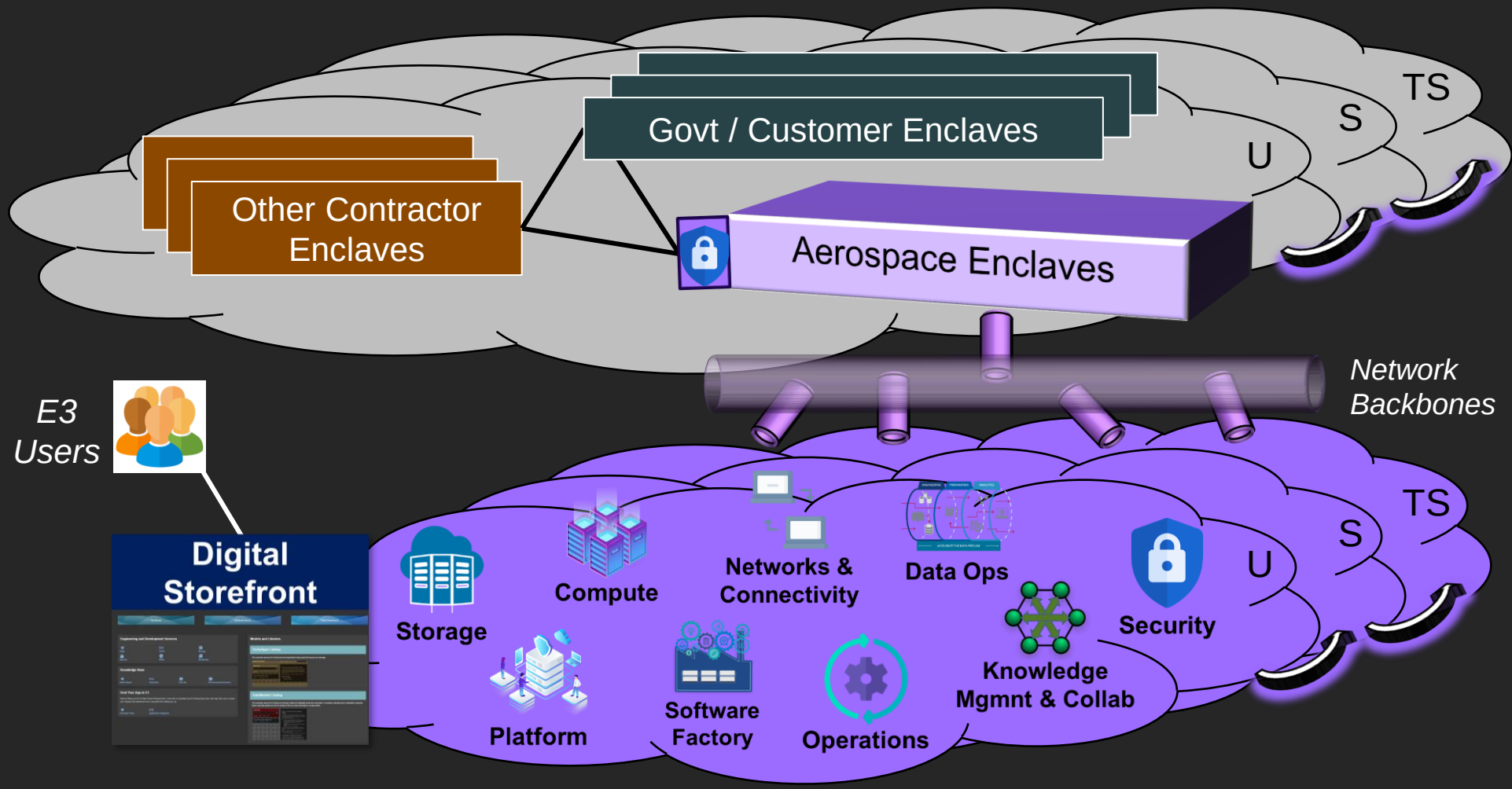
E3 “OV-1” Hybrid, Federated, and Cross-Domain



Biggest Near-Term Challenges / Opportunities to Collaborate?

- **Data-Centricity**
- **Hybrid CONOPs**
- **Cross-Domain CONOPs**
- **Transition Strategy**