Headquarters U.S. Air Force

Integrity - Service - Excellence

Tailoring USAF Systems Engineering for the Life Cycle: One Shape, Multiple Dimensions

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Systems Engineering Conference
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What's Up

- Co-Authors:
  - Kevin Kemper, AFMC/EN
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- What is USAF SE ?
- Key USAF SE Interactions
- SE "V" Diagram and Applications
  - Basic
  - Complex System, Subsystem, and Platform
  - SoS / Architecture
  - Life Cycle
  - Incremental Acquisition
- Next ?

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What is USAF SE ?

Air Force Center for Systems Engineering (CSE) definition

Systems Engineering is the discipline encompassing the entire set of scientific, technical, and managerial processes needed to conceive, evolve, verify, deploy, and support an integrated system-of-systems (SoS) capability to meet user needs across the life cycle.

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What is USAF SE?
Implications for Practitioners

- **Breadth**
  - Knowledge across technical disciplines and engineering functions is required to ensure rigorous technical processes are applied
  - Must apply engineering capabilities, tools, and techniques to anticipate issues with requirements, acquisition, test, and sustainment of AF capabilities
  - Must ensure application of SE principles to families of systems (FoS), systems of systems (SoS), air platforms, weapons, command and control (C2), and space systems, as well as subsystems and components
- **Expertise (Depth)**
  - Capability, domain, or enterprise level engineering expertise
  - Requires focused technical management on joint/coalition capabilities; goes beyond standard interface engineering
- **Life Cycle Perspective**
  - Must apply systematic processes, technical processes, and measurements to promote mission assurance throughout the life cycle
  - Must not limit scope/range with respect to requirements development, science and technology (S&T), product/system development, or sustainment
  - Operational safety, suitability, and effectiveness (OSS&E) characteristics must be identified, maintained, assessed, and analyzed

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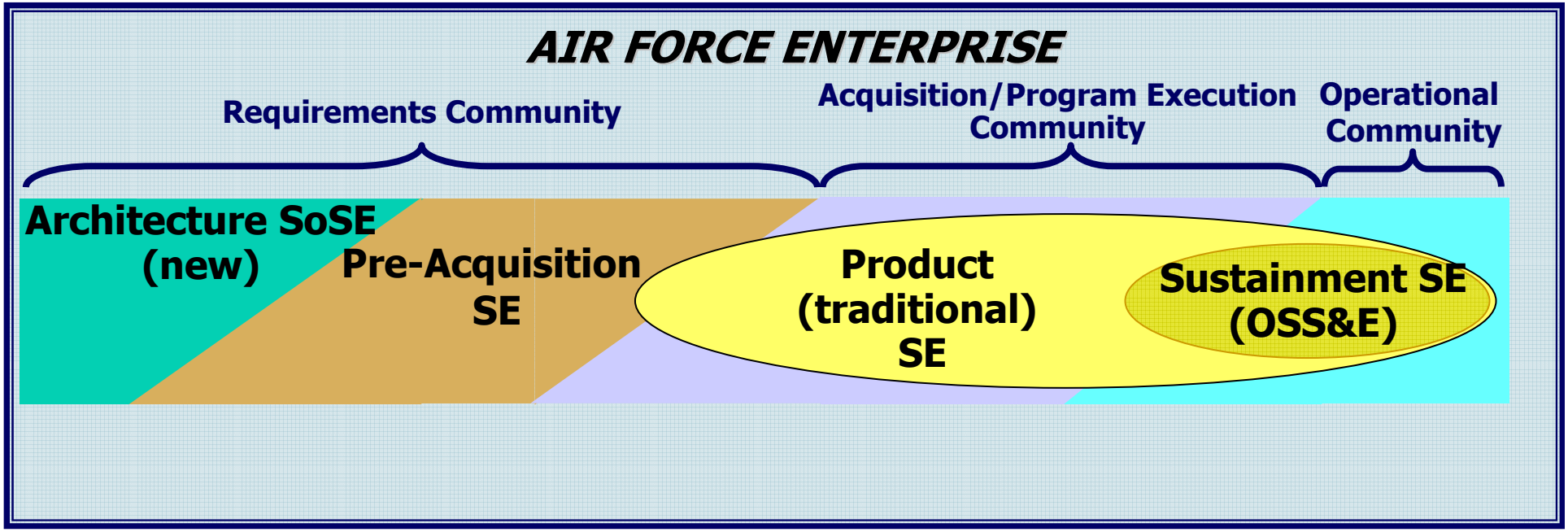
What is USAF SE?
A Management / Leadership Vision



Interfacing / integrating engineering and technical "threads" with architecture development, capabilities planning, science and technology, developmental (products / systems) engineering, and sustainment

INTEGRATED POLICY AND COLLABORATION REQUIRED ACROSS "ENGINEERING PROCESS THREADS"

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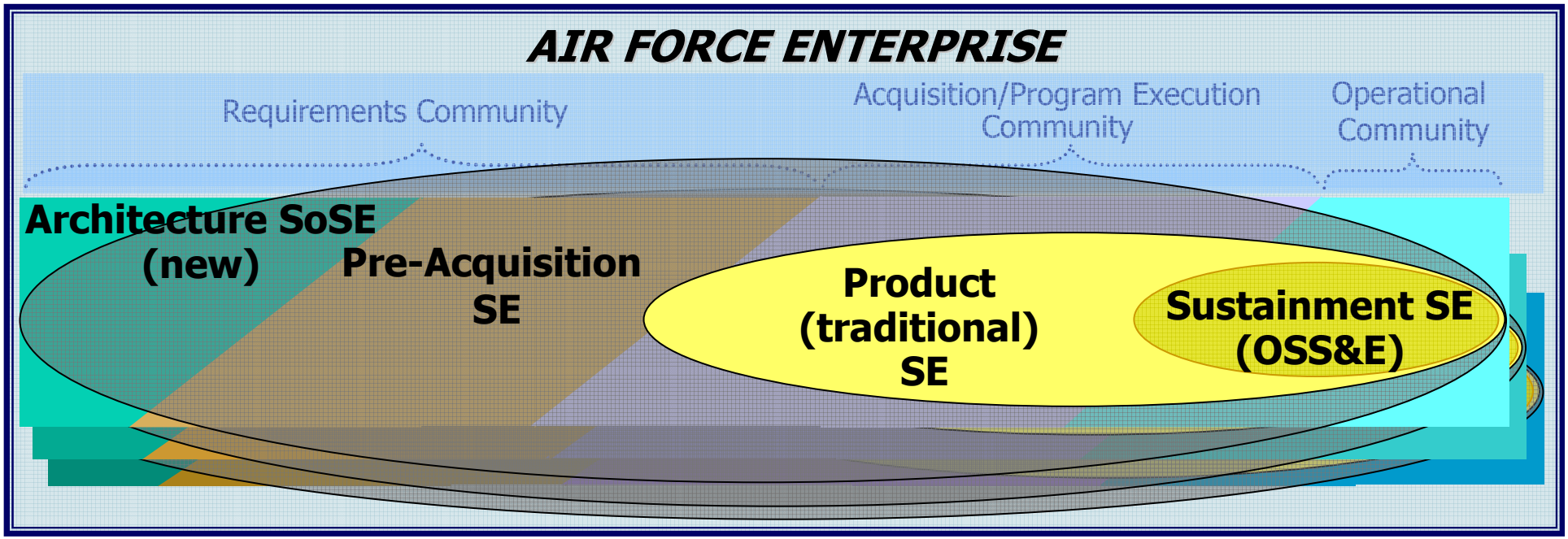

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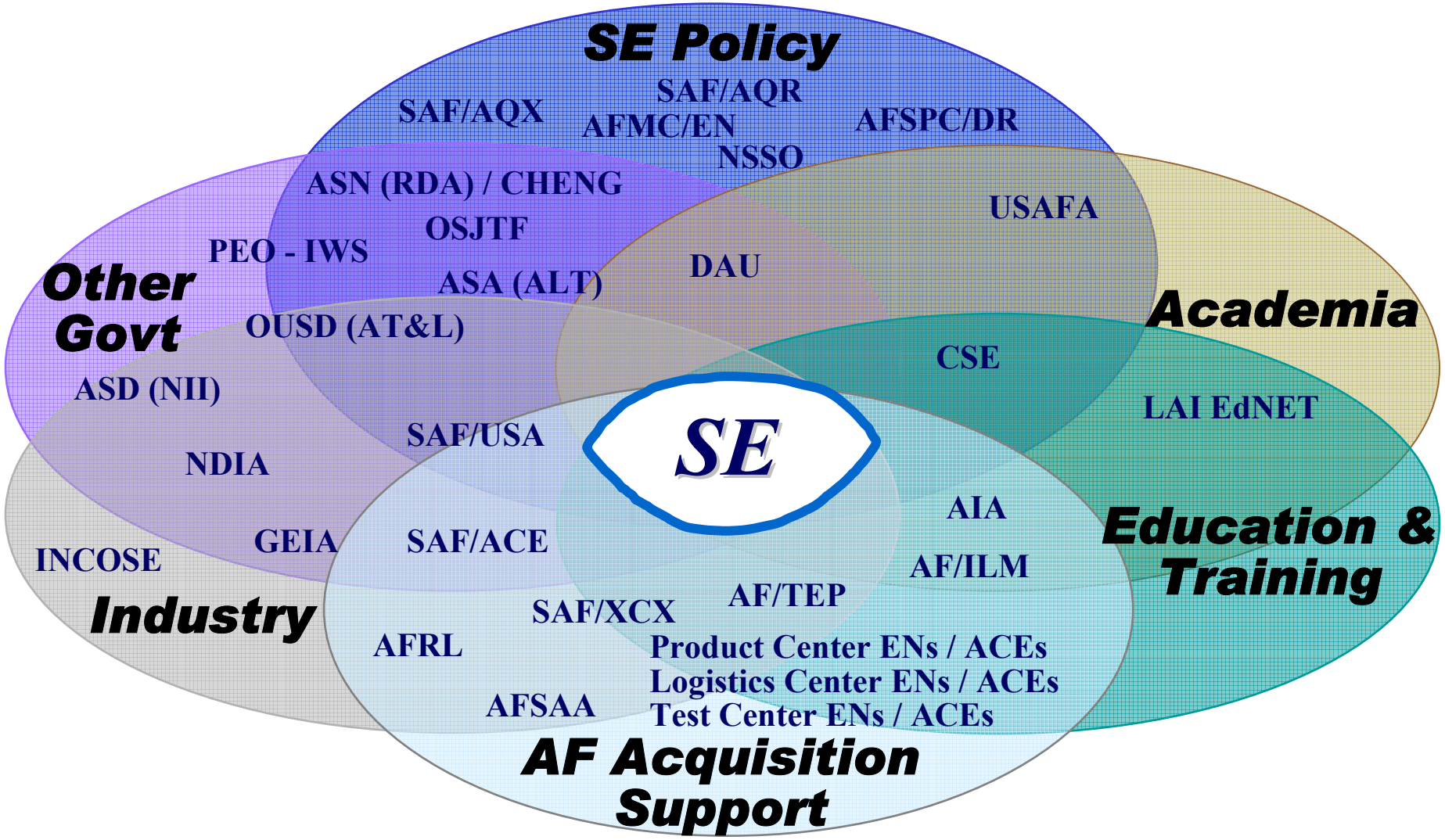
Key USAF SE Interactions



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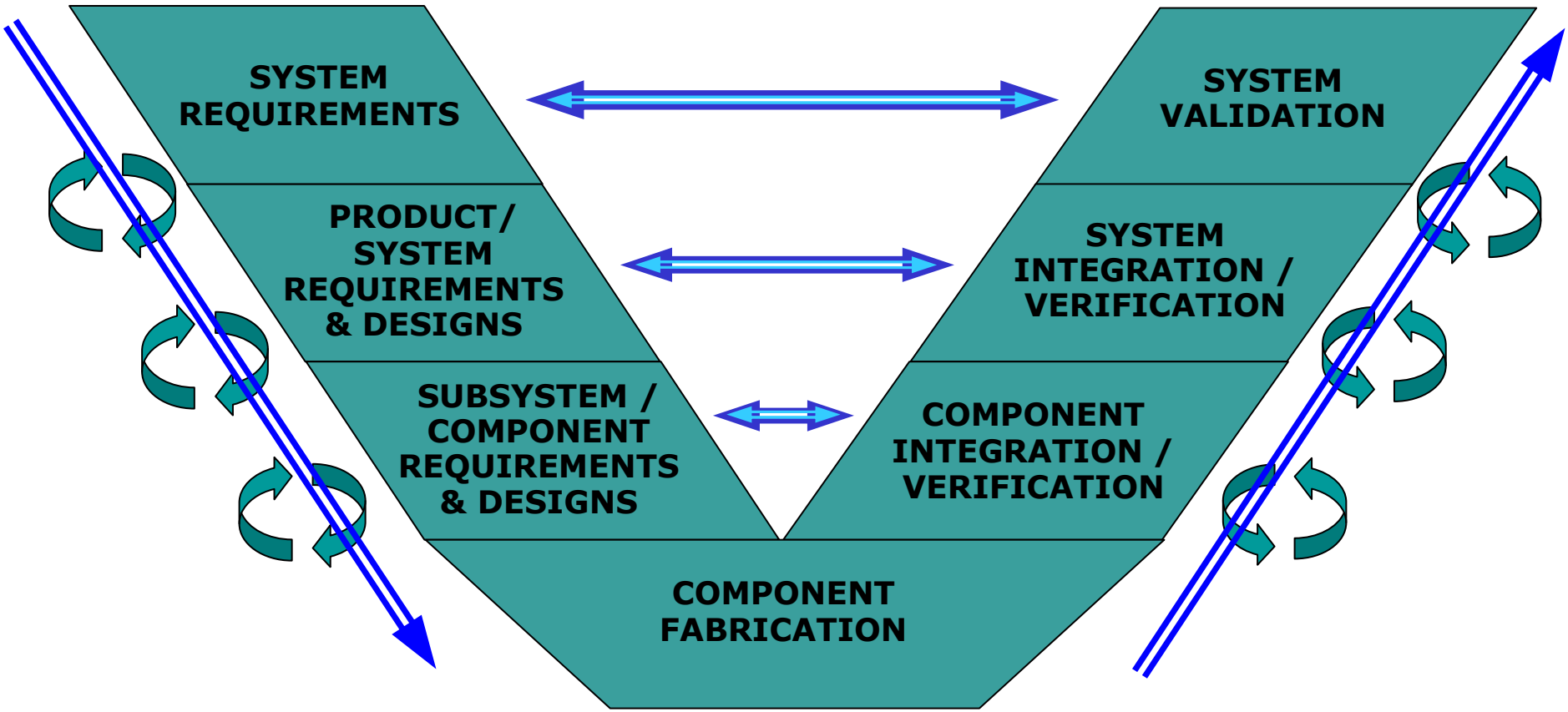
SE "V" Diagram



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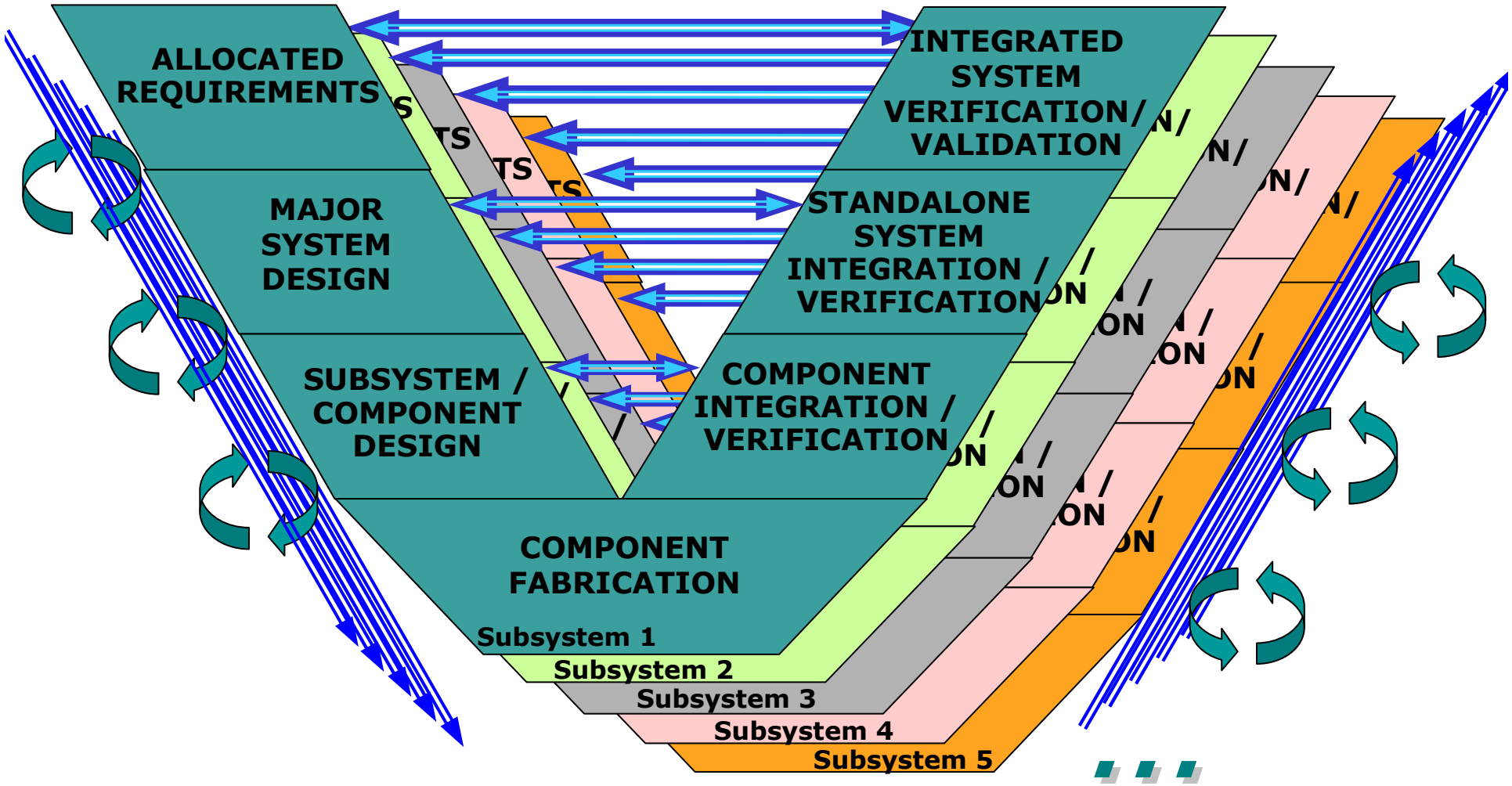
SE "V" Diagram Applied to a Complex System



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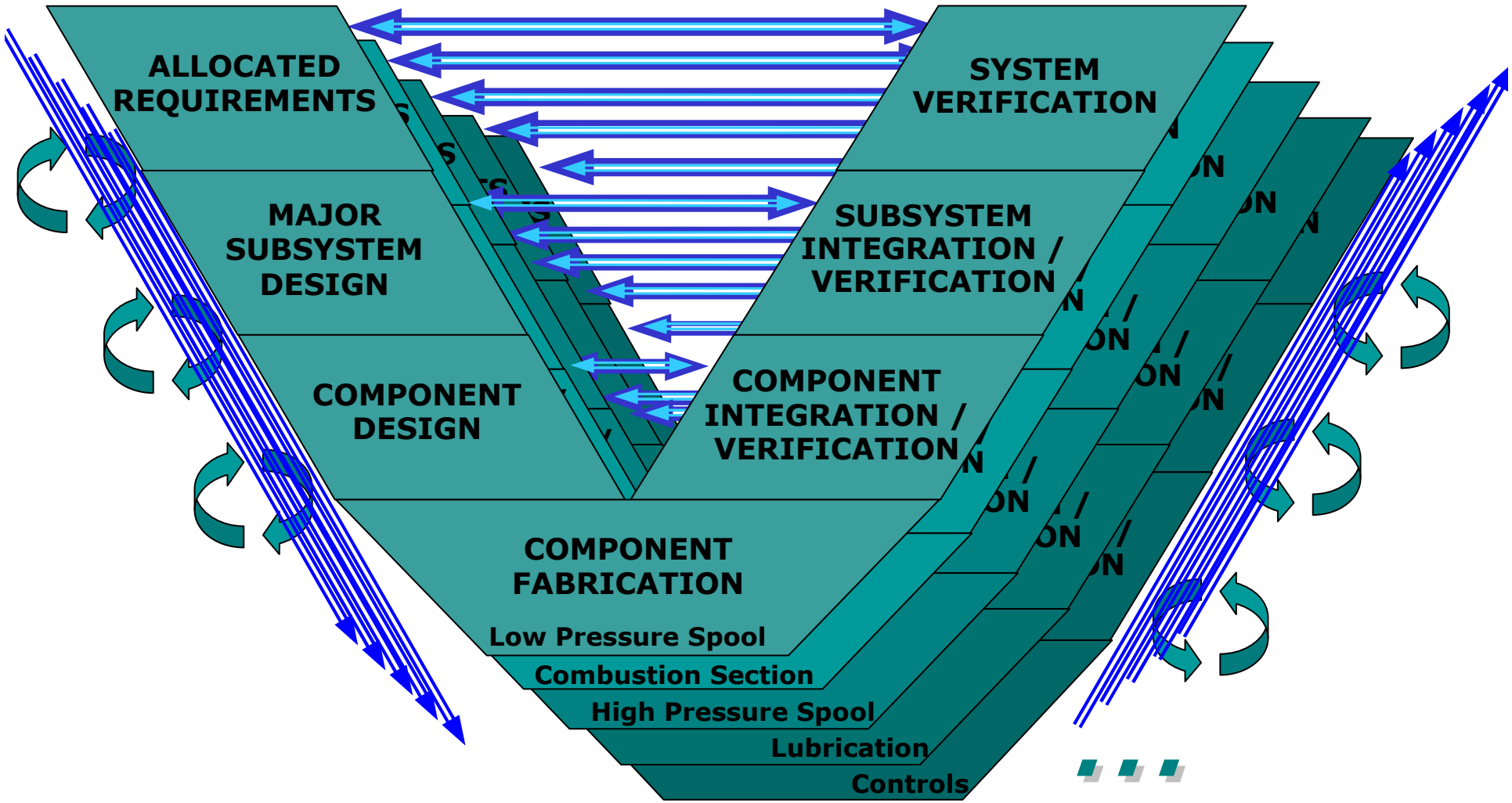
SE "V" Diagram Applied to a Major Vehicle System



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SE "V" Diagram Applied to a Weapon System (Platform)

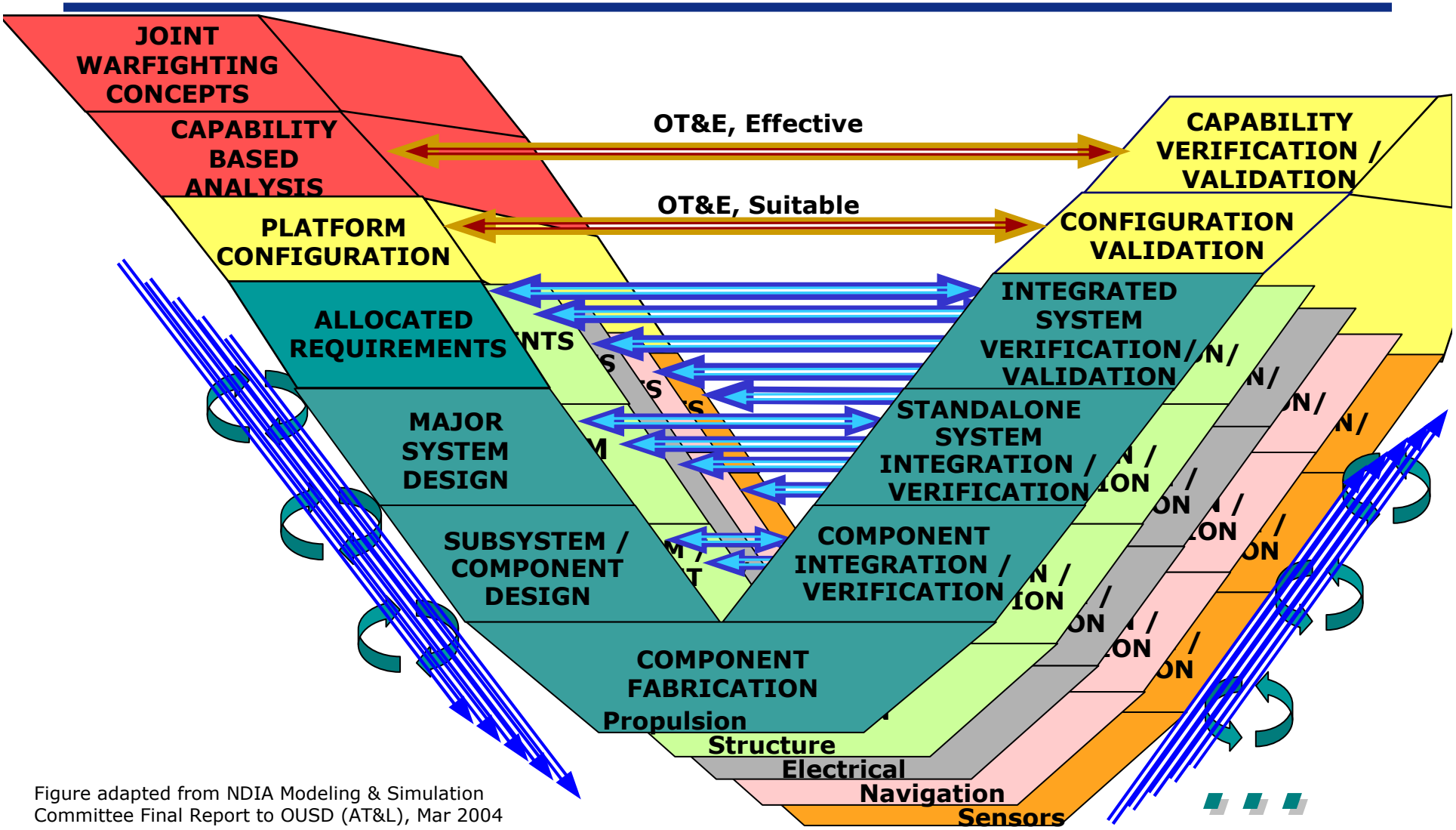

Figure adapted from NDIA Modeling & Simulation Committee Final Report to OUSD (AT&L), Mar 2004

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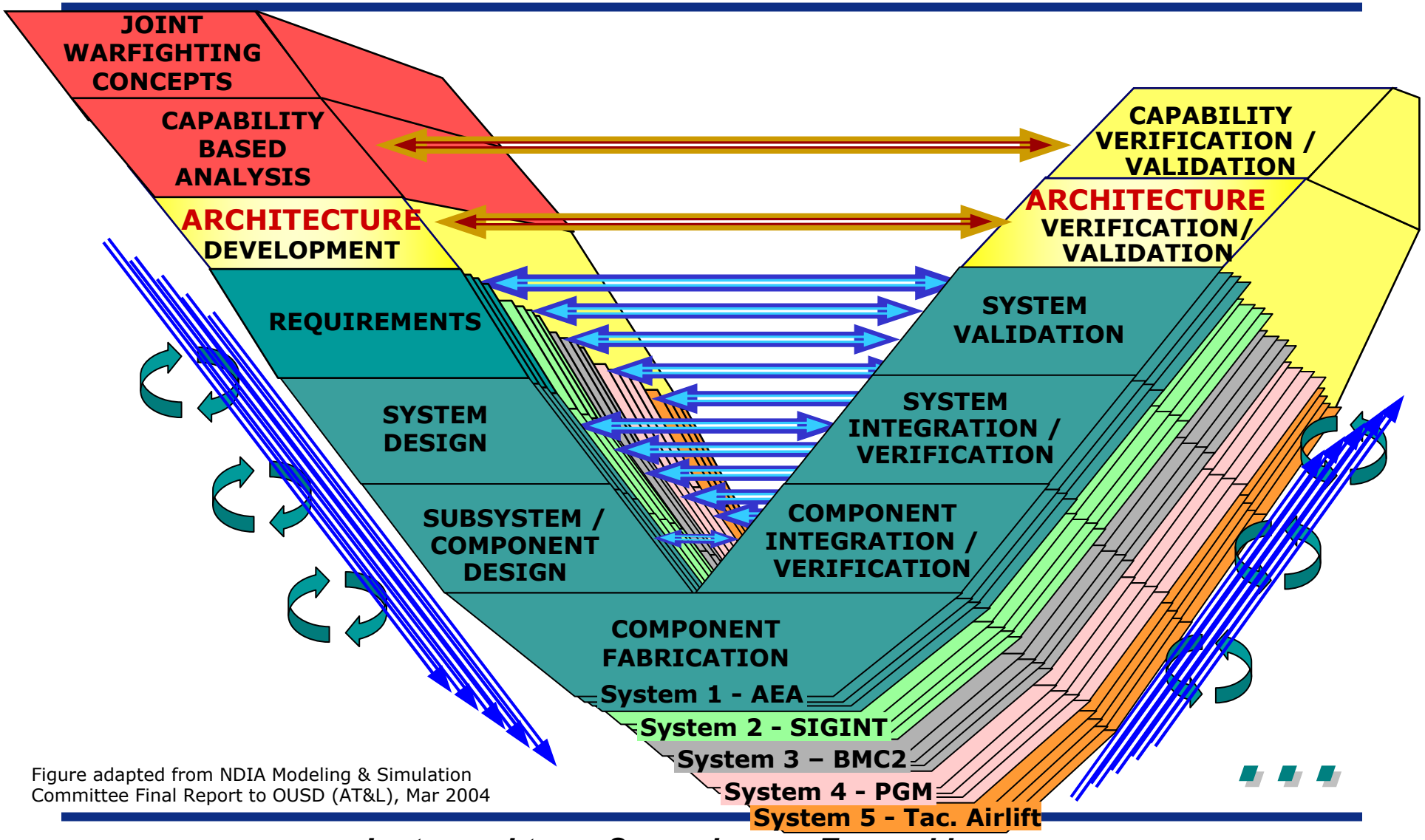
SE "V" Diagram with SoS and Architecture Perspective



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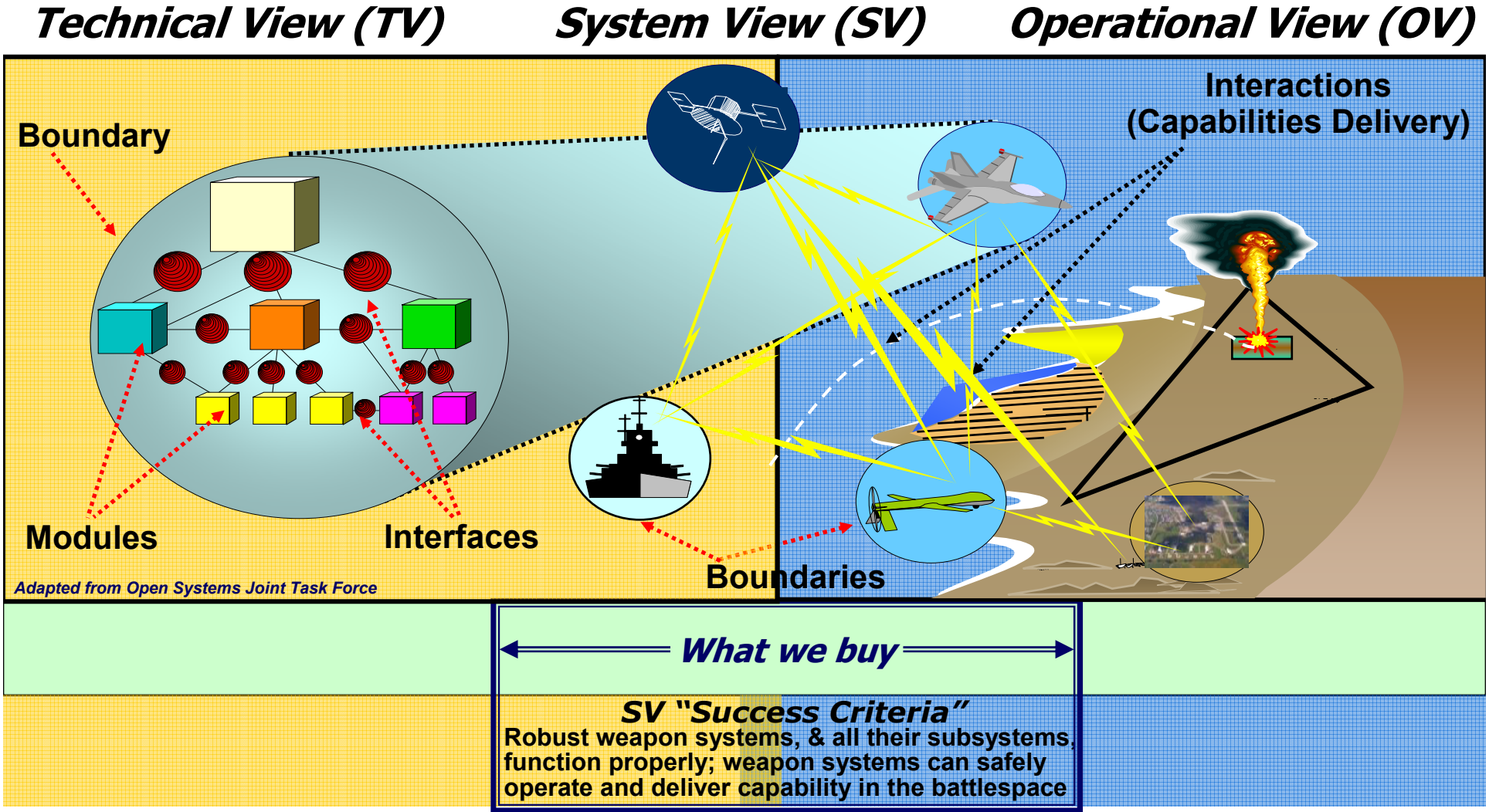
Views
Architecture, SoS, and SE



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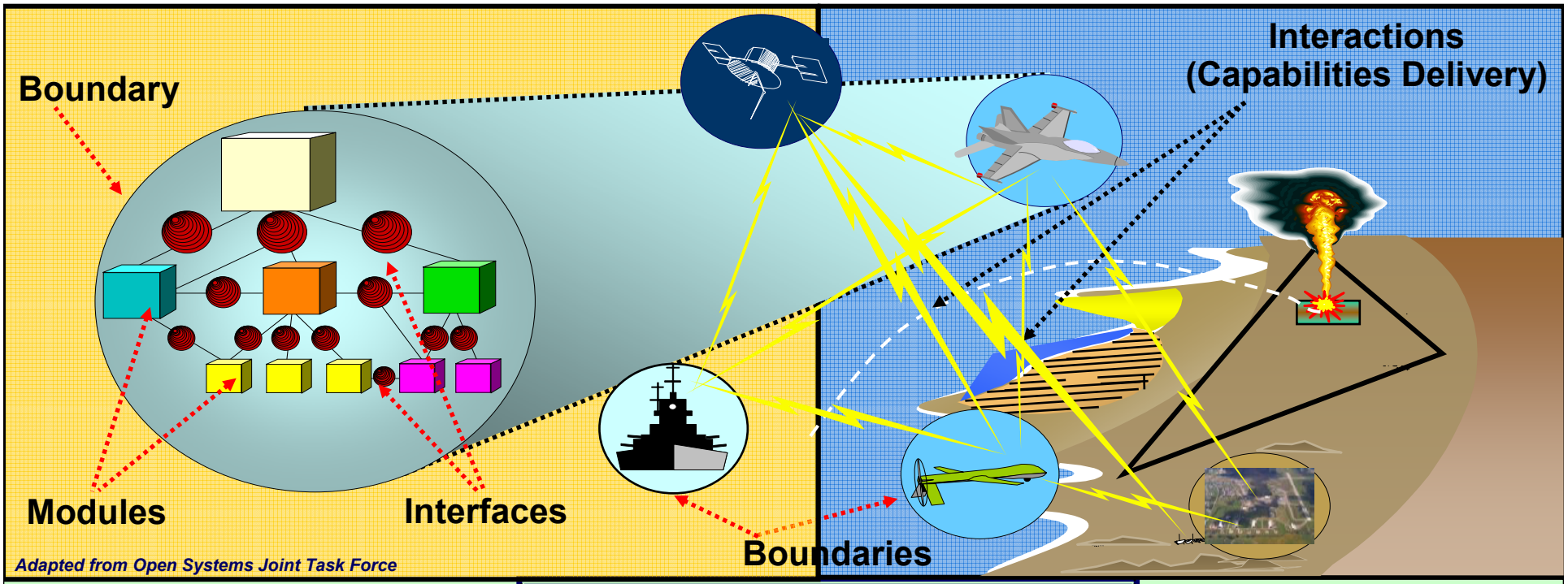
Views
Architecture, SoS, and SE

Technical View (TV) | System View (SV) | Operational View (OV)



How we support and maintain it	What we buy	Where and how it is used; where value/effectiveness/ success are determined
TV "Success Criteria"	**SV "Success Criteria"**	**OV "Success Criteria"**
System/subsystem components function properly; designs reflect "plug-and-play" open interfaces and industry standards	Robust weapon systems, & all their subsystems, function properly; weapon systems can safely operate and deliver capability in the battlespace	All players in the battlespace can interoperate; capability delivery is essentially "plug-and-fight"

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SoS Awareness

- **Ideally, individual systems and platforms are:**
  - Managed by competent program managers
  - Well understood by the major system integrators who have successfully developed, tested, fielded, and supported them
  - Regulated by robust acquisition processes
- **Systems-of-systems, and their corresponding mission capabilities, are often:**
  - Literally “assembled on-the-fly” by operational commanders in response to emerging threats or requirements
  - Of relatively short lifecycle when compared to traditional systems that remain “intact” for extended periods of time
  - Not managed or funded under a single or consolidated authority

Adapted from Open Systems Joint Task Force

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SoS Issues

- **SoS Engineering is not a defined / applied discipline**
  - **Long history of reasonable success, GIVEN pre-determined needs (explicit requirements) for interconnection / interoperability**
  - **Dynamic operational environments demand spontaneous interconnection / interoperability**
- **Lots of policy (even more guidance) on what *should be* done (e.g., net-ready KPP) … but few specifics on *how* to achieve**
  - **"On the network" doesn't necessarily mean "Interoperable in real time"**
  - **"Best Commercial Practices" don't always mesh well with unique military issues**
    - **Security**
    - **Commander's Intent**
    - **Resource prioritization and rapid reallocation**
    - **Unintended consequences**

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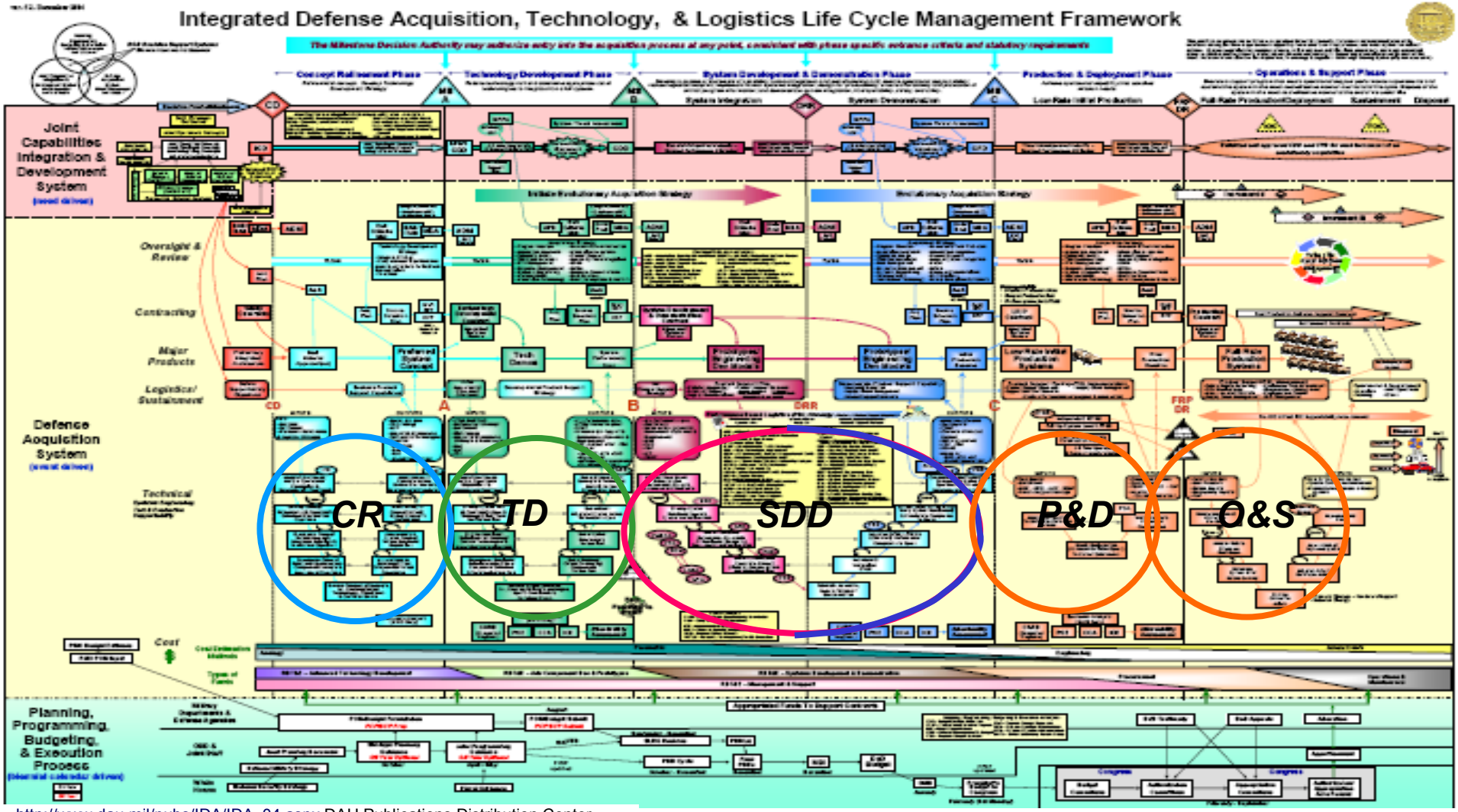
Integrated Defense Acquisition, Technology, & Logistics Life Cycle Management Framework (2004)



http://www.dau.mil/pubs/IDA/IDA_04.aspx DAU Publications Distribution Center

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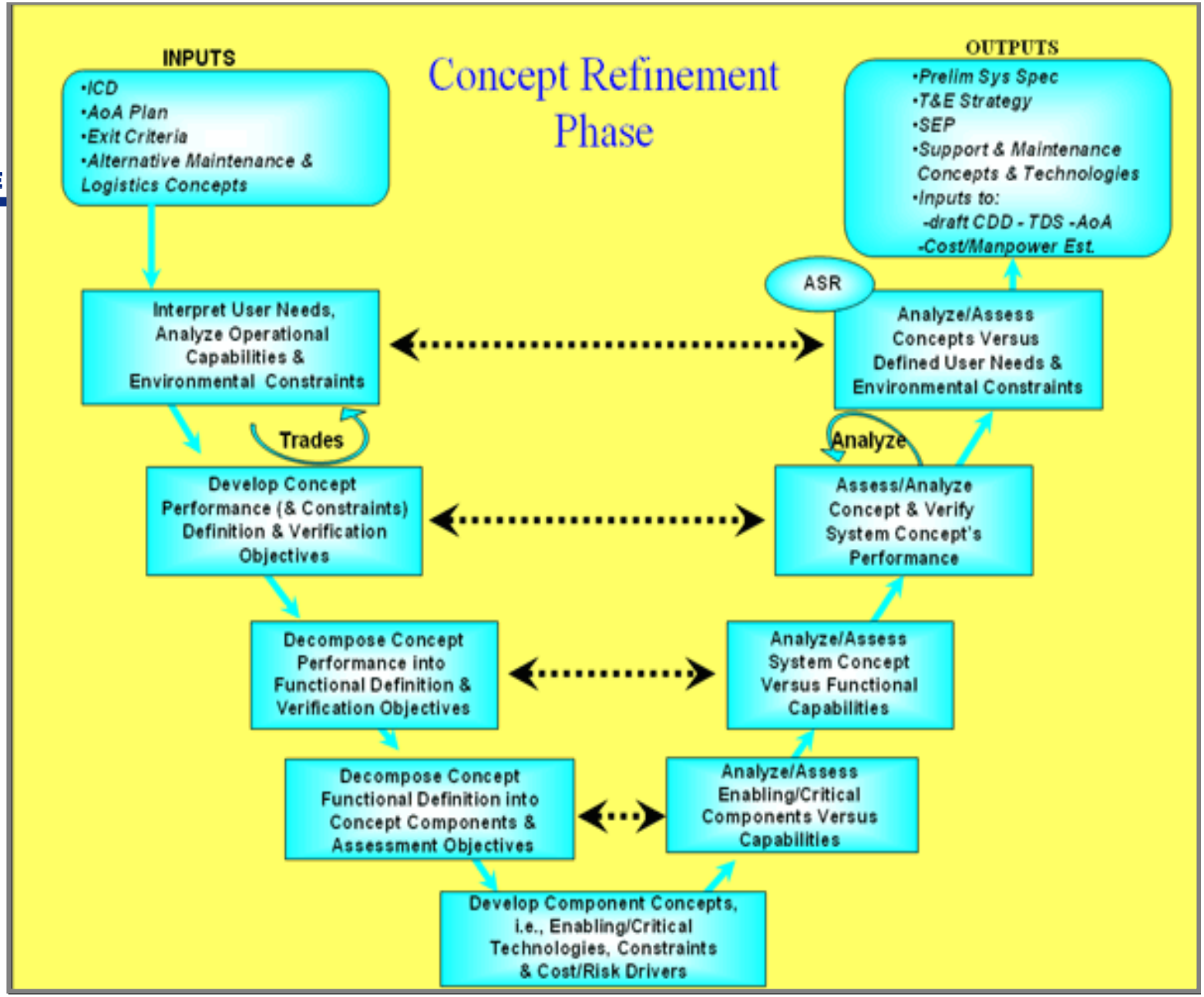
Govt performs most SE tasks

Efforts largely conducted at study / project level

Somewhat *ad hoc* use of tools and disciplines

Key objectives:

- Evaluate architecture
- Evaluate support capabilities



SE-related steps during Concept Refinement

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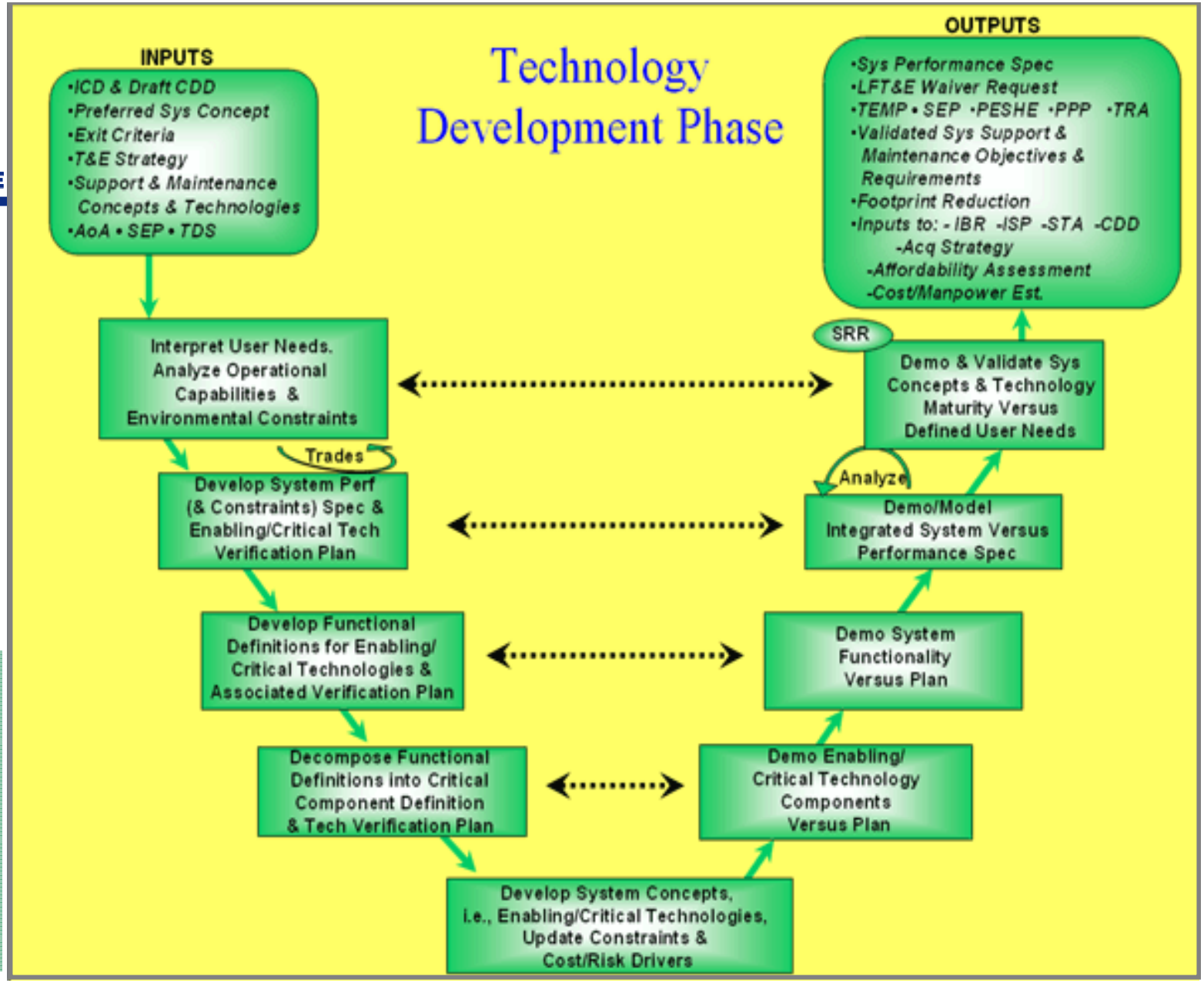
Some SE responsibilities transition from Govt to contractor

Efforts largely conducted as discrete projects or small programs

Key process areas employ selected tools & disciplines

Key objectives:

- Reduce technical risk
- Determine appropriate technologies to integrate



SE-related steps during Technology Development

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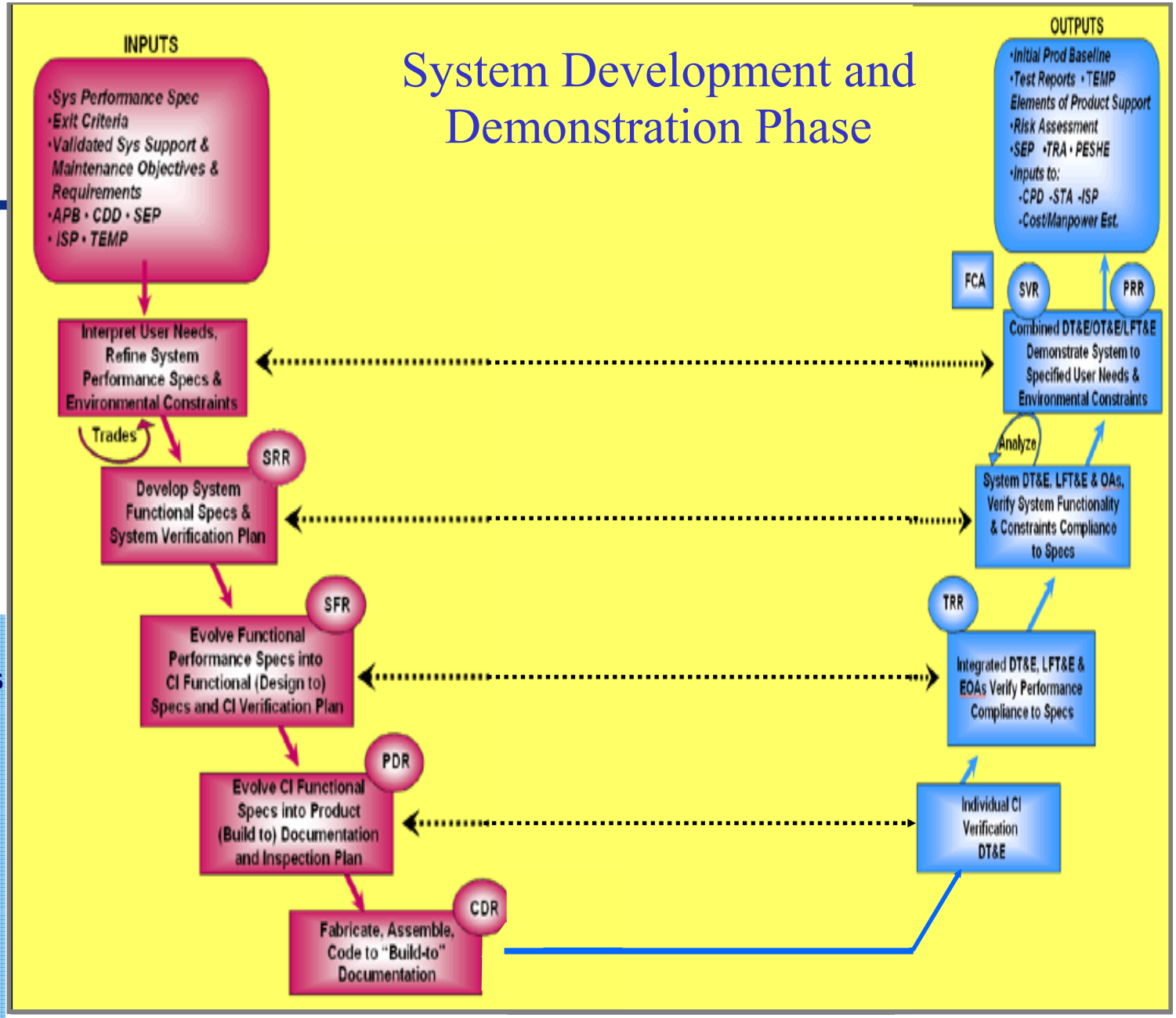
"Traditional" SE applications: Govt manages contractors who perform most SE tasks

Efforts generally conducted at program / capability level

All process areas employ key tools and disciplines

Key objectives:

- Finalize all levels of requirements
- Develop product & system details
- Produce hardware and software
- Integrate and verify product / system



SE-related steps during System Development & Demonstration

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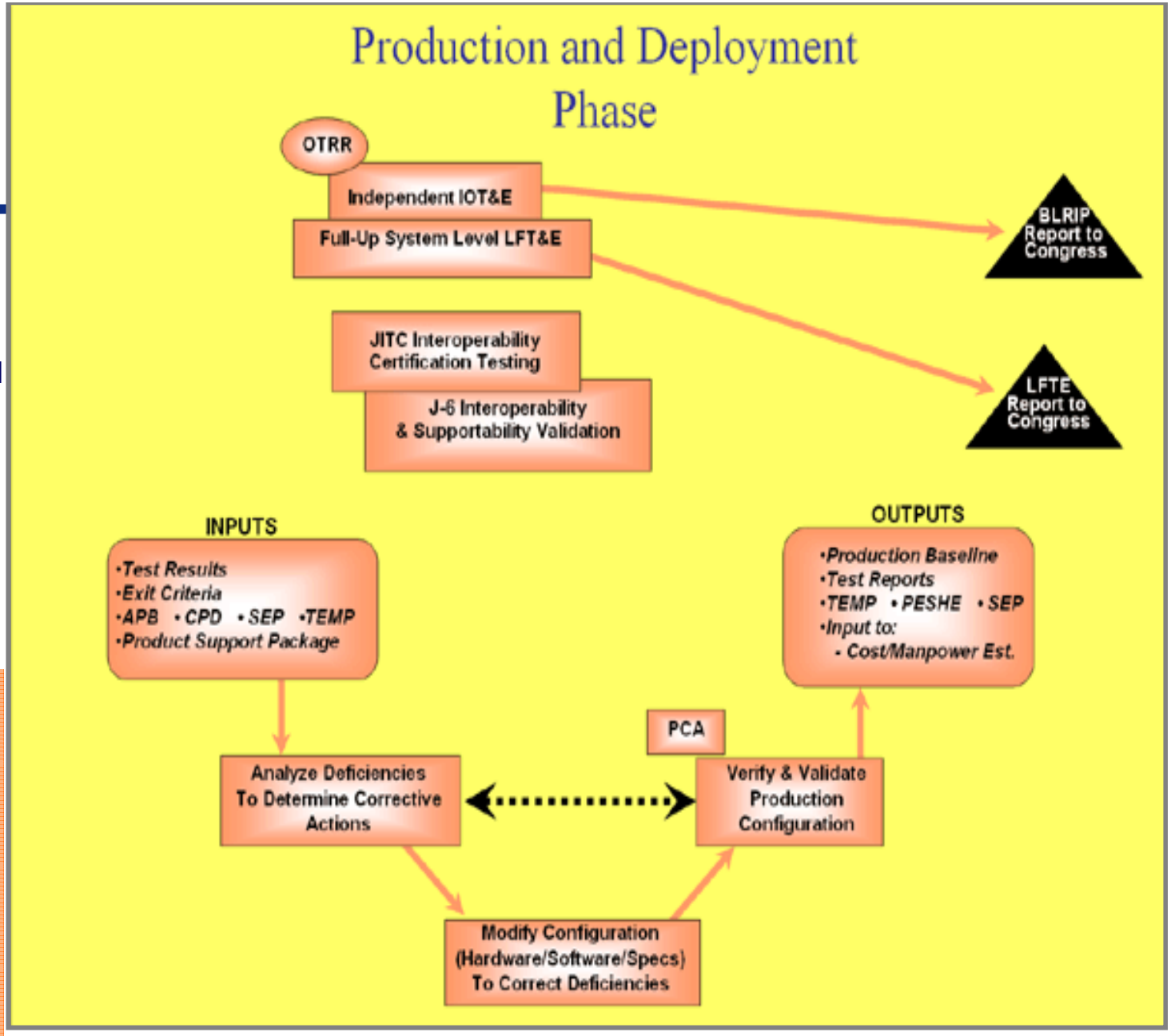
Some SE responsibilities transition from contractor back to Govt

Efforts largely conducted as discrete projects or small programs

Key process areas employ selected tools and disciplines

Key objectives:

- Verify that desired operational capability can be produced, delivered, and employed
- Ensure that the system continues to mission needs



SE-related steps during Production & Deployment

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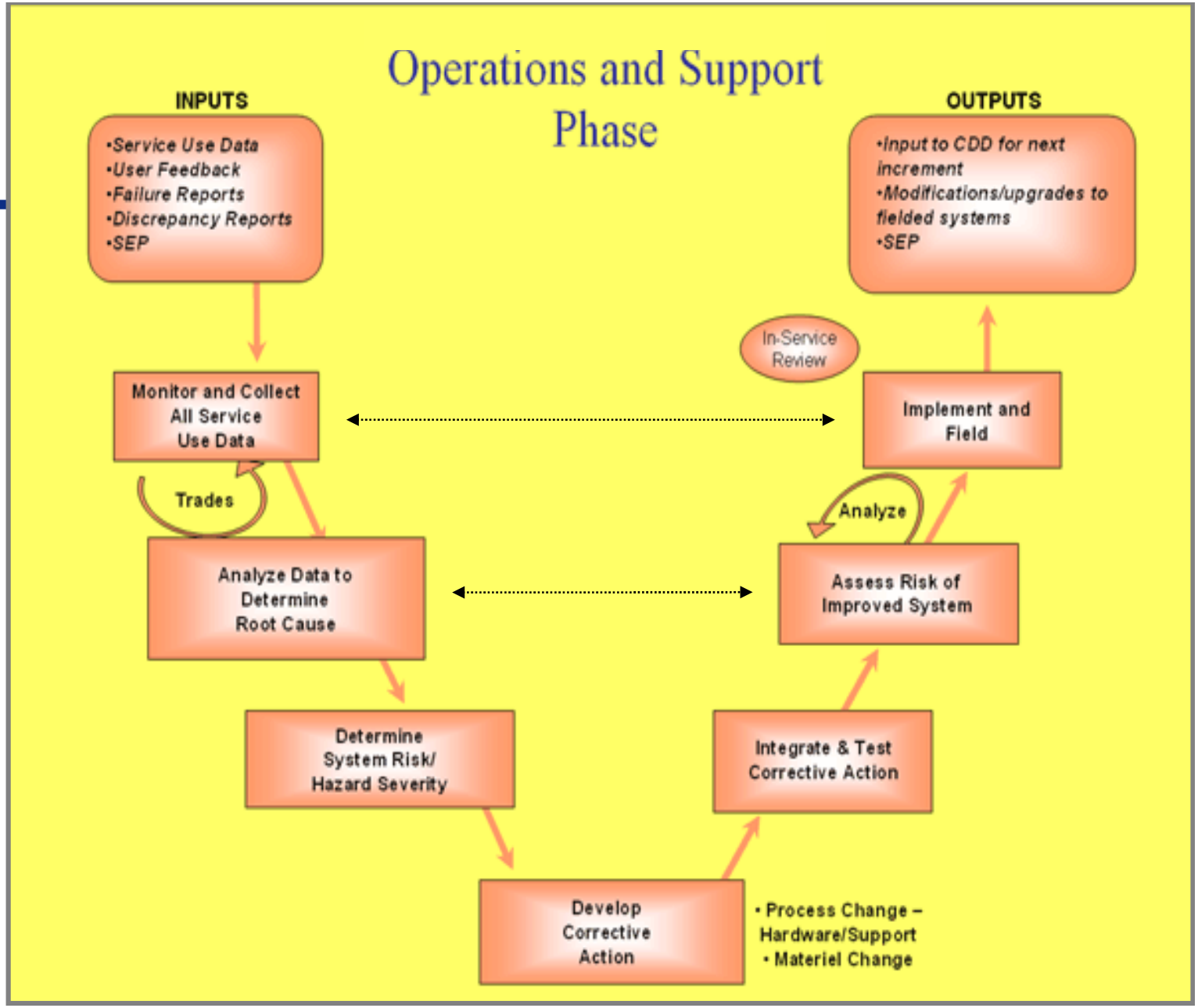
Govt performs most SE tasks

Efforts largely conducted at study / project level

Somewhat *ad hoc* use of tools and disciplines

Key objectives:

- **Ensure the system continues to meet performance requirements in the integrated architecture**
- **Cost-effective sustainment**



SE-related steps during Operations & Support

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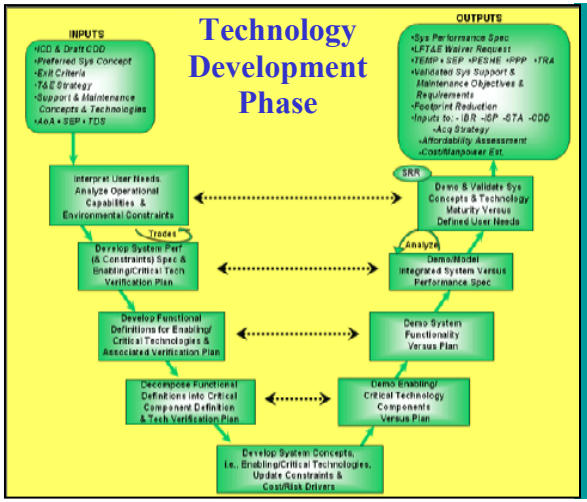


Some SE responsibilities transition to (TD) and from (P&D) contractor

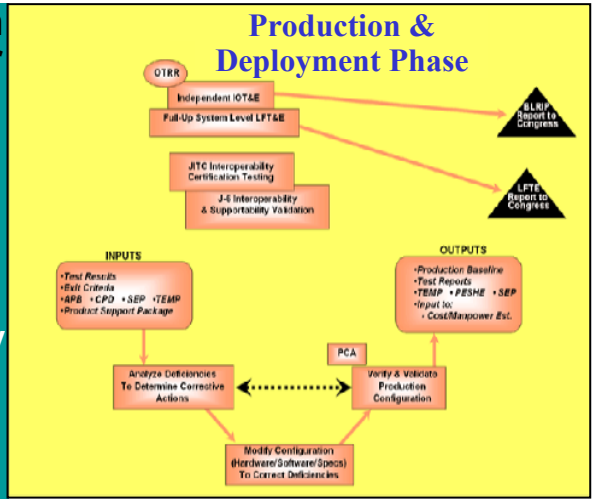
- **Project level**
- **Key process areas employ selected tools and disciplines**

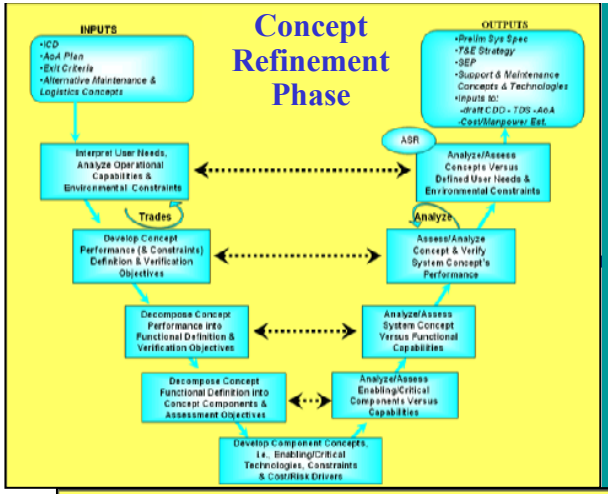
Reduce technical risk

Determine appropriate technologies to integrate

Provides operational capability

Meets mission needs





Govt performs most SE tasks

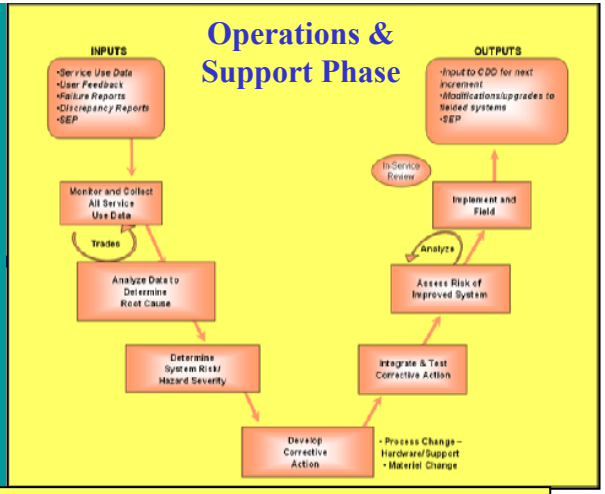
- Study / project level
- Use of tools and disciplines: somewhat ad hoc in CR; not SE-specific in O&S

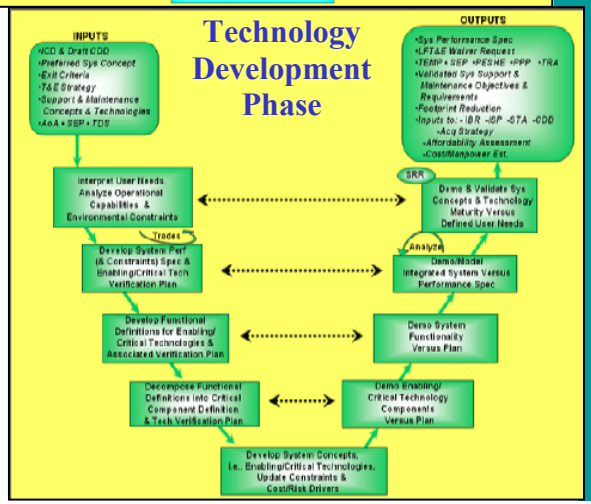
Evaluate architecture

Evaluate support capabilities

Meets performance requirements in the integrated architecture

Cost-effective sustainment





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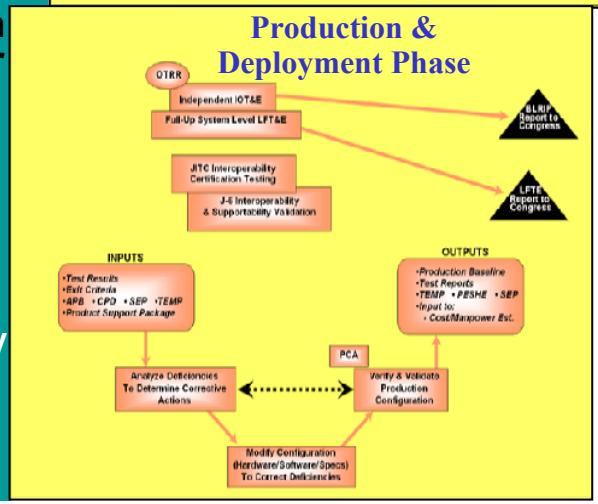

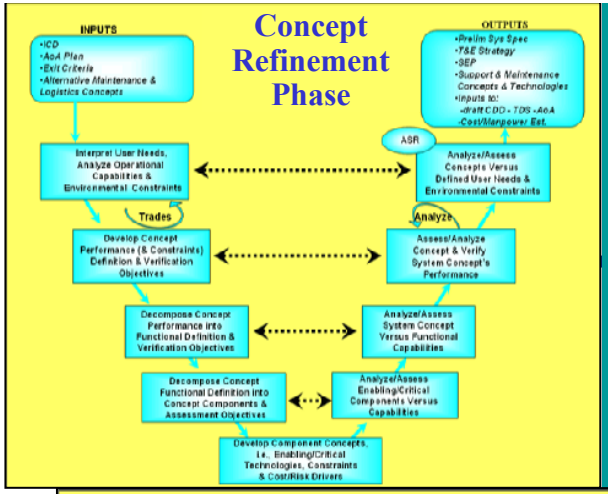

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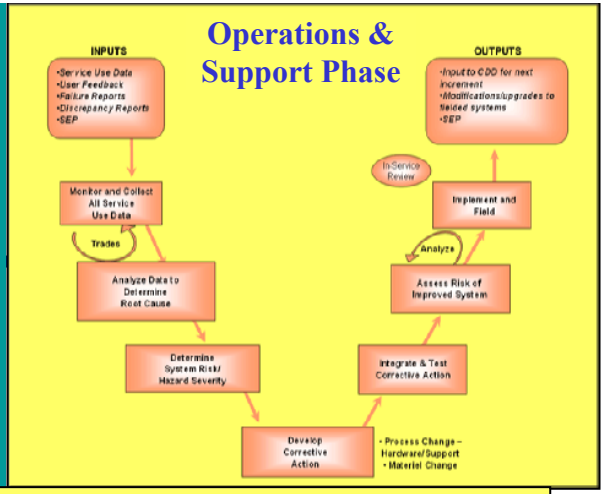

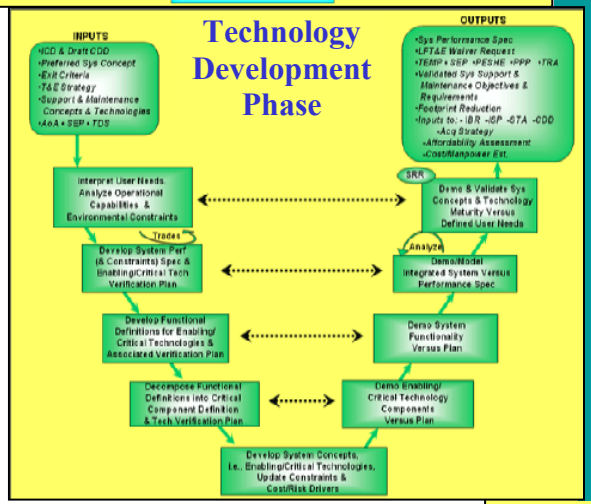

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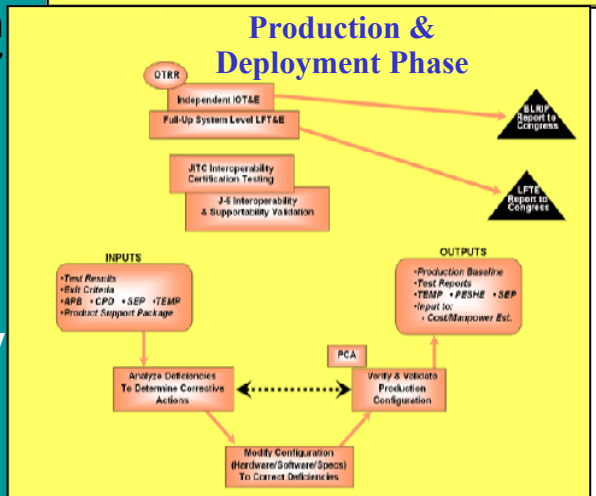
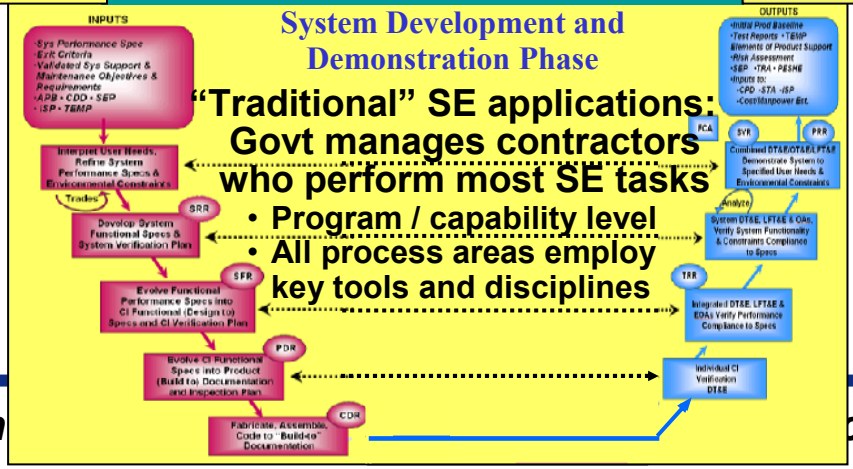
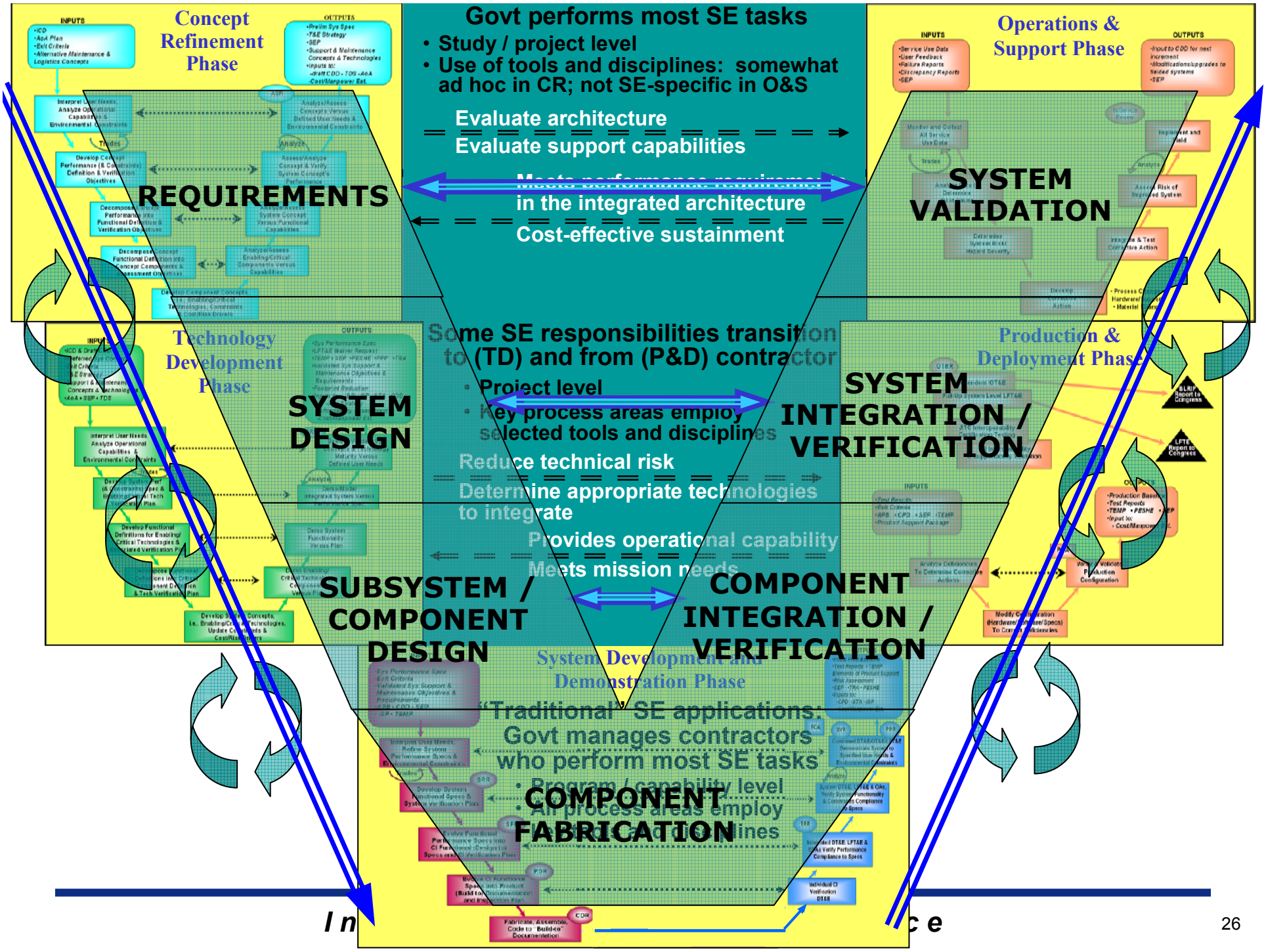




"Traditional" SE applications: Govt manages contractors who perform most SE tasks

- Program / capability level
- All process areas employ key tools and disciplines


Concept Refinement Phase
Technology Development Phase
System Development and Demonstration Phase
Production & Deployment Phase
Operations & Support Phase
REQUIREMENTS
SYSTEM DESIGN
SUBSYSTEM / COMPONENT DESIGN
COMPONENT FABRICATION
COMPONENT INTEGRATION / VERIFICATION
SYSTEM INTEGRATION / VERIFICATION
SYSTEM VALIDATION
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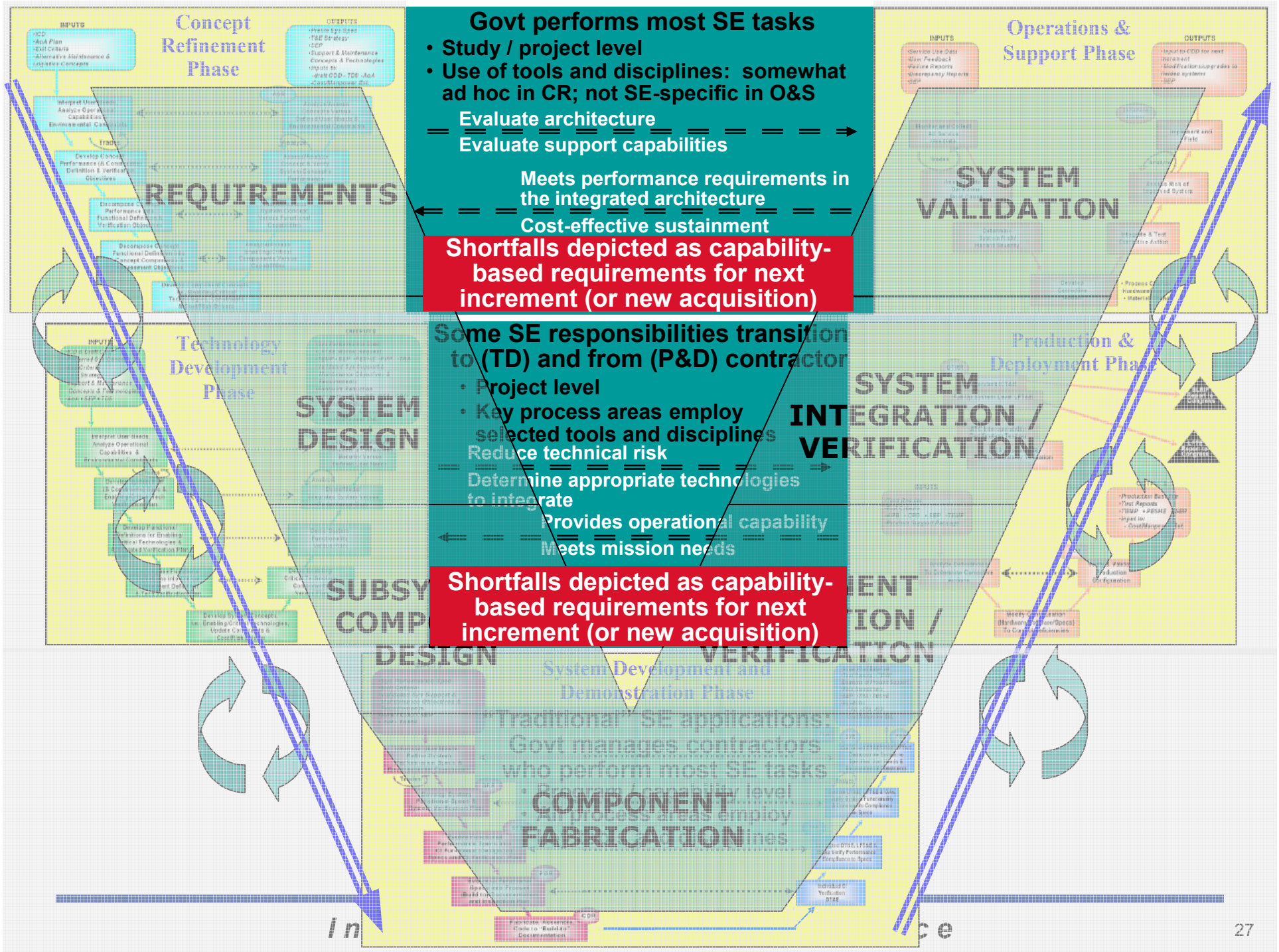
OUTPUTS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Linear View of Incremental System / Program Life Cycle