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ARCHITECTURE – ENABLED SYSTEMS ENGINEERING

KIHOMAC®
System Acquisition Excellence

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Agenda

- Incorporating Architecture Processes in System Engineering
- The Architecture Roadmap Process
- Applying DoDAF 2
- Challenges
  - Tools
  - Processes
- Questions

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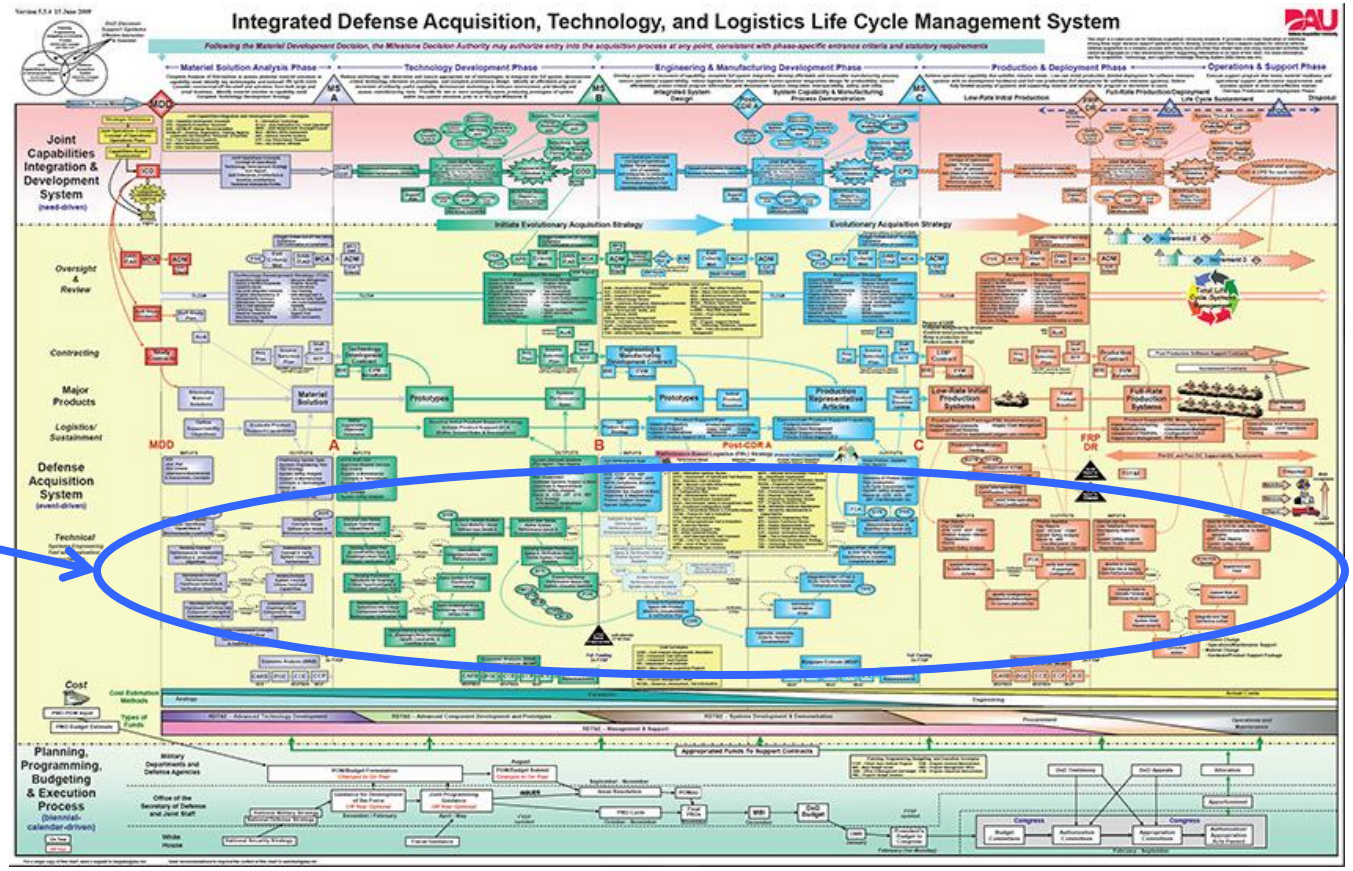
Incorporating Architectures in Systems Engineering

DoD Systems Engineering

Systems Engineering Processes



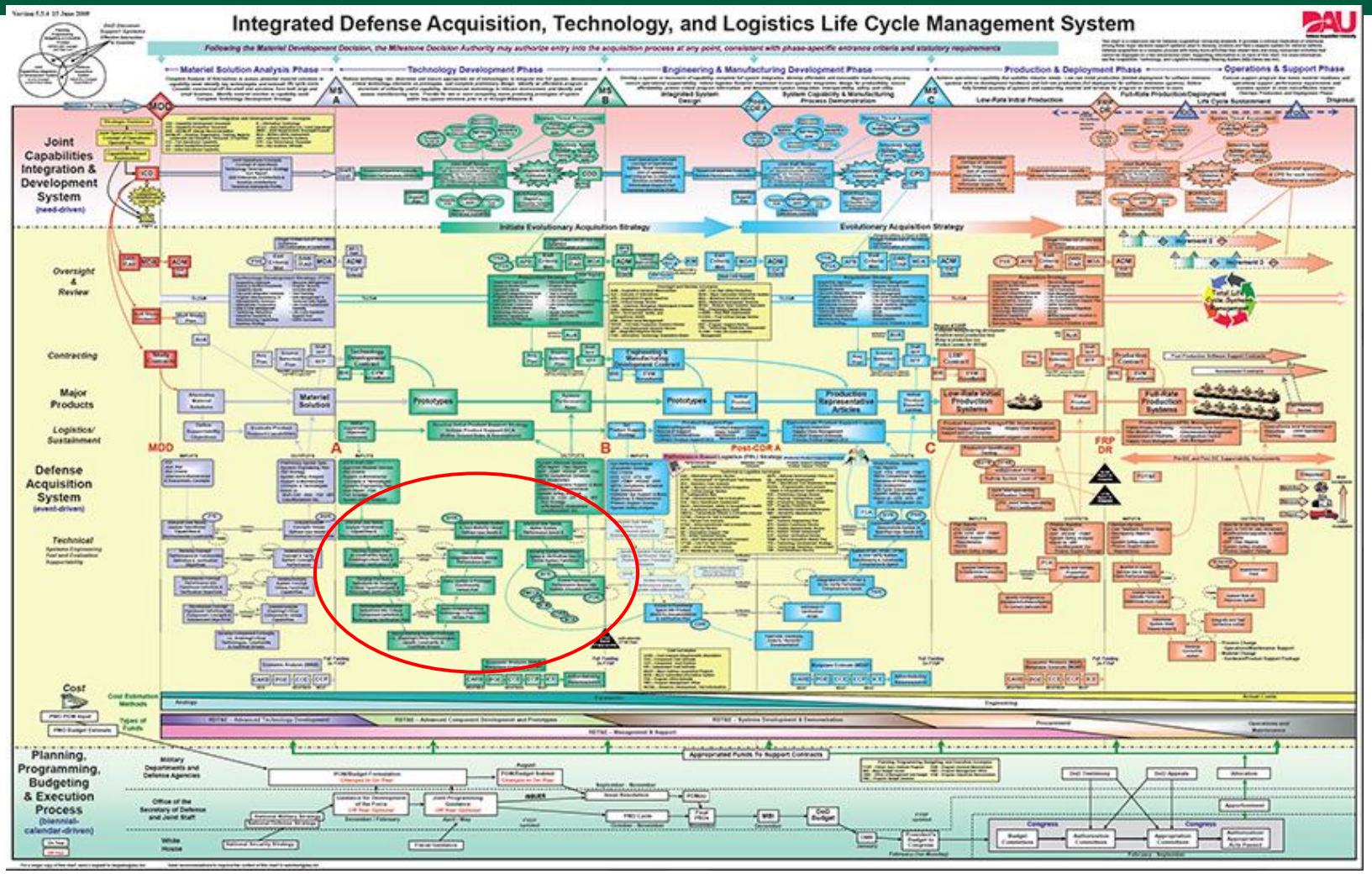
OSS&E Systems Engineering

- OSS&E: Operational Safety, Suitability and Effectiveness
  - Defined in AFI 63-1201 and refined in AFMCI 63-1201
  - From AFI 63-1201:

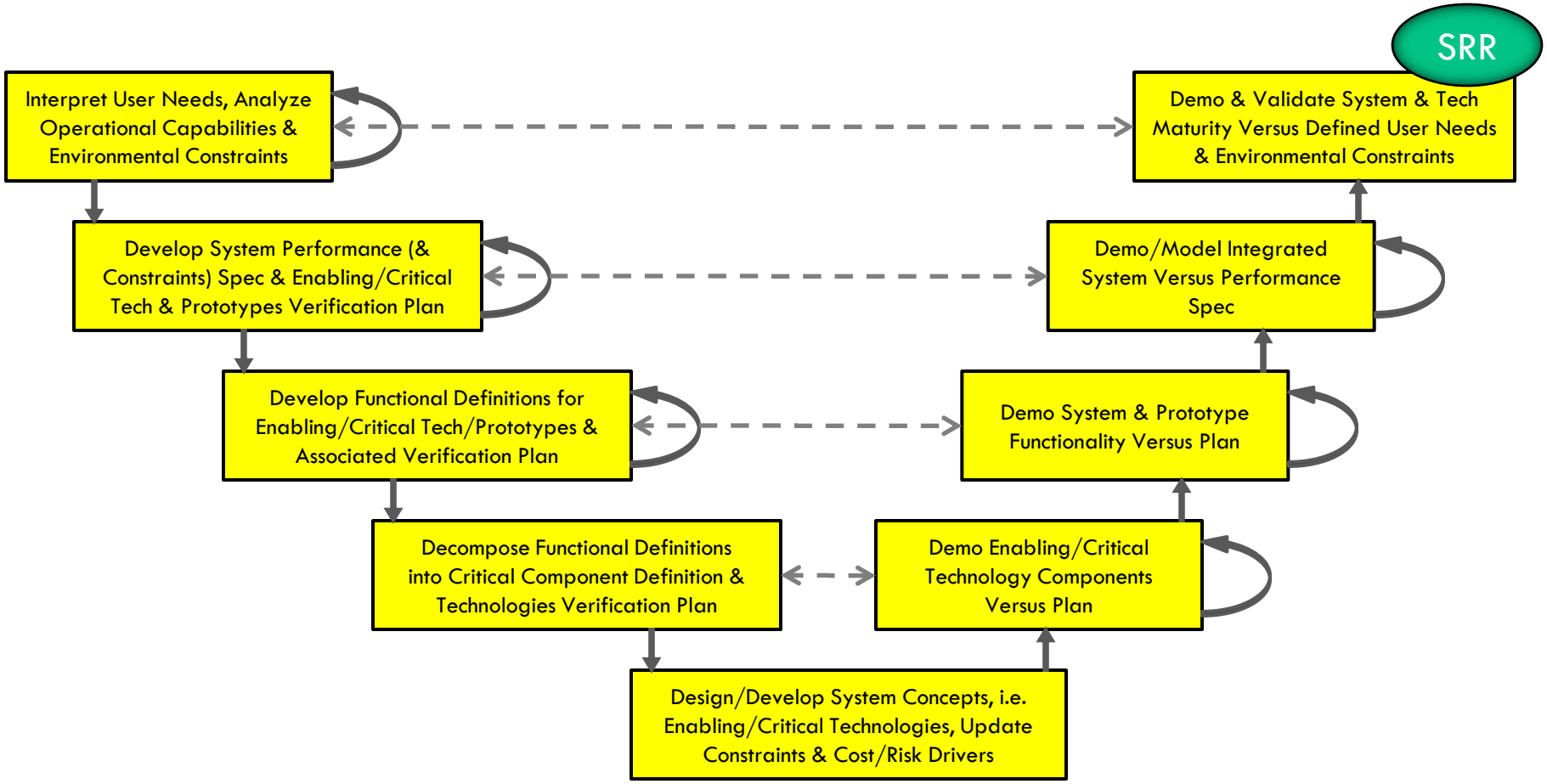
    "… identifies elements of Air Force systems engineering (SE) practice and management required to provide and sustain, in a timely manner, cost-effective products and systems that are operationally safe, suitable, and effective."

- Challenge: How to execute both sustainment and modernization in a cost-constrained environment?
  - Sustainment modifications (F^3-type) alone do not address new capabilities or reduction in overall ownership cost.
  - Modernization (new capabilities) modifications alone do not address A_O or current sustainment costs.
    - Can provide opportunities to address related sustainment issues.
    - This requires a broader vision of 'modernization'.

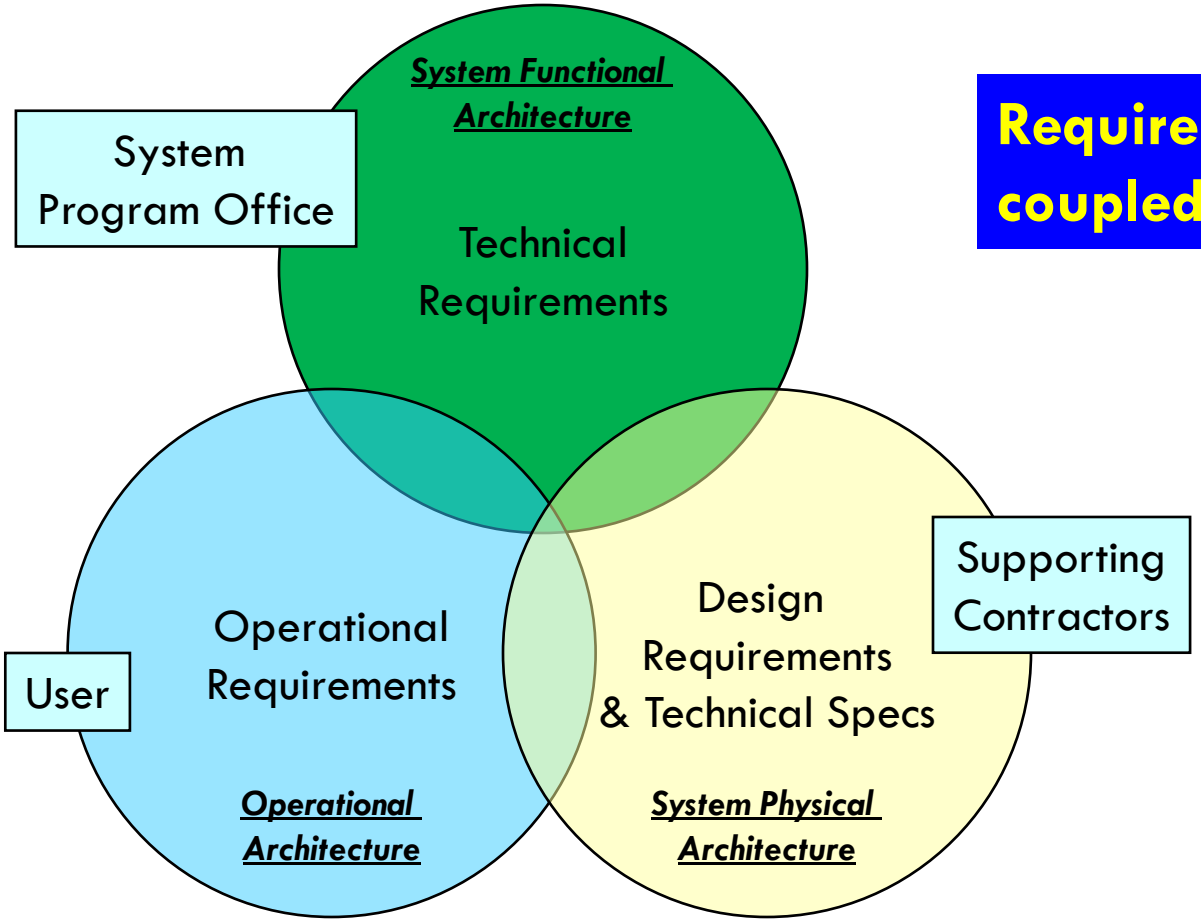
Technology Development Phase



Technology Development Phase



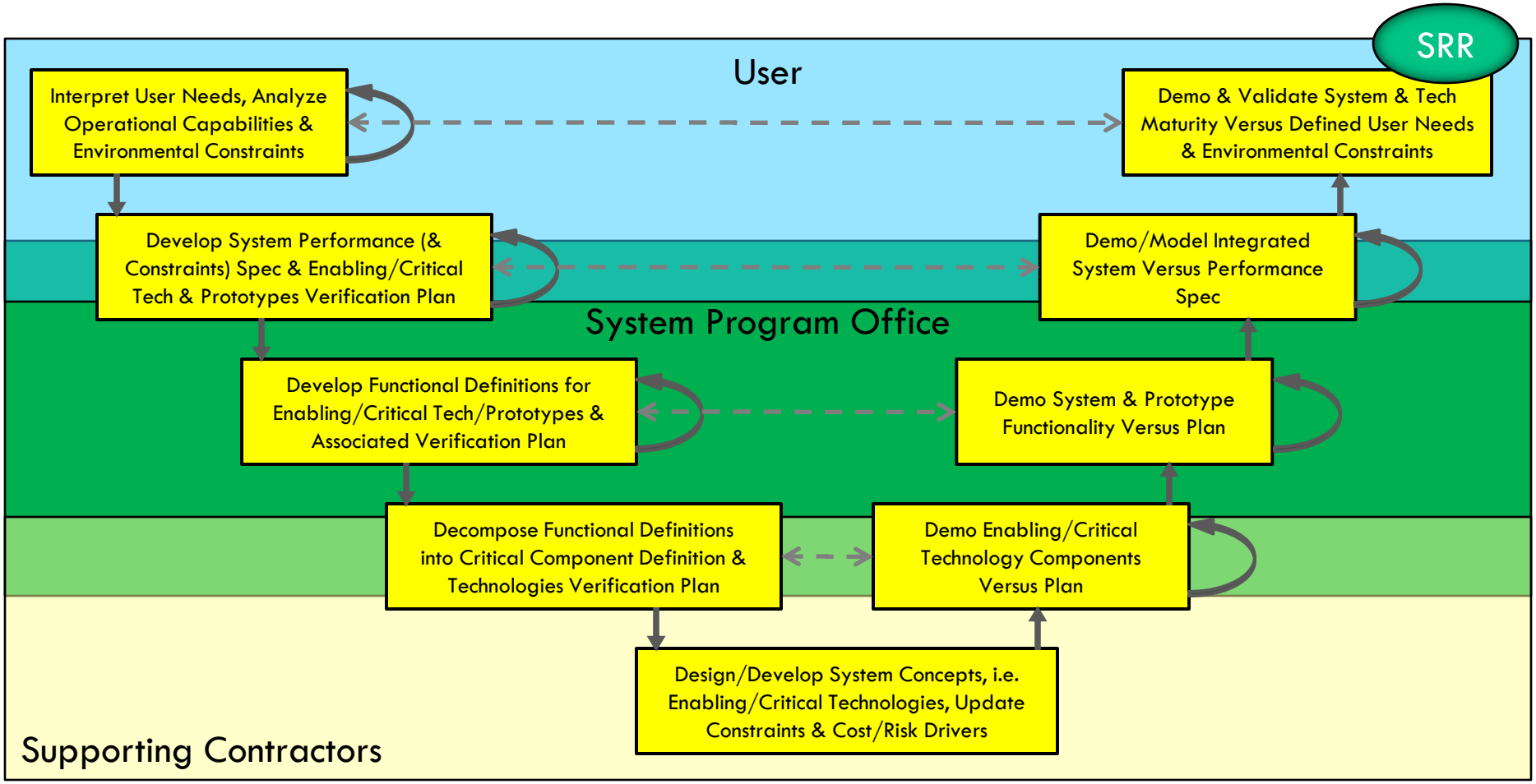
Primary Stakeholders



Requirements are tightly coupled to Architectures!!

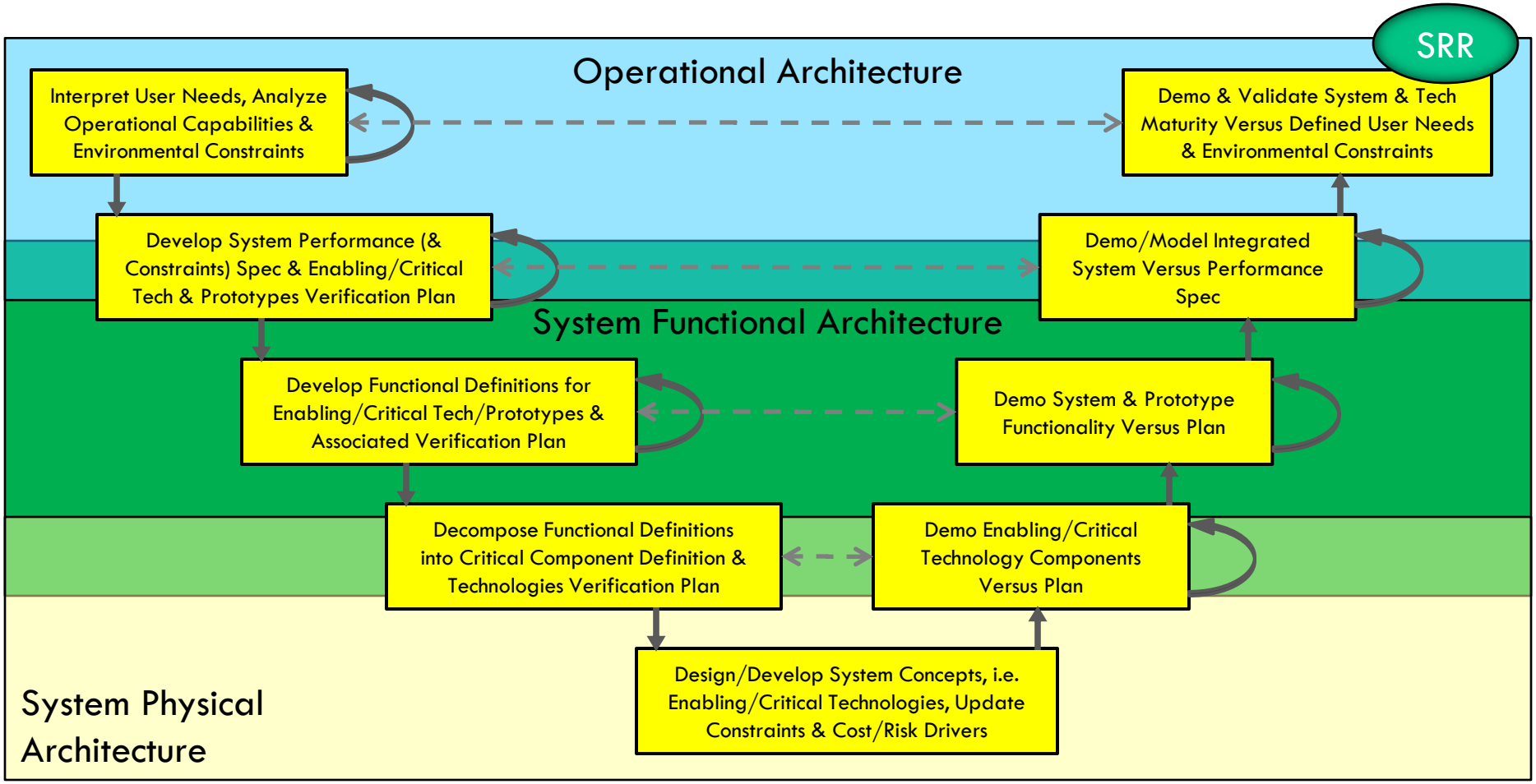
Technology Development

- Participation



Technology Development

- Architecture Aspects



Technology Development

- Architecture Products

- At System Requirements Review:
  - Updates to Operational Architecture:
    - OV-1 - High-Level Operational Concept Graphic
    - OV-2 - Operational Node Connectivity Description
    - OV-3 - Operational Information Exchange Matrix
    - OV-5a - Operational Activity Decomposition Model
    - OV-5b – Operational Activity Model
    - OV-6a - Operational Rules Model
    - OV-6b - Operational State Transition Description
    - OV-6c - Operational Event-Trace Description
    - DIV-2 – Logical Data Model

Optional, depends on program scope

EMD Phase

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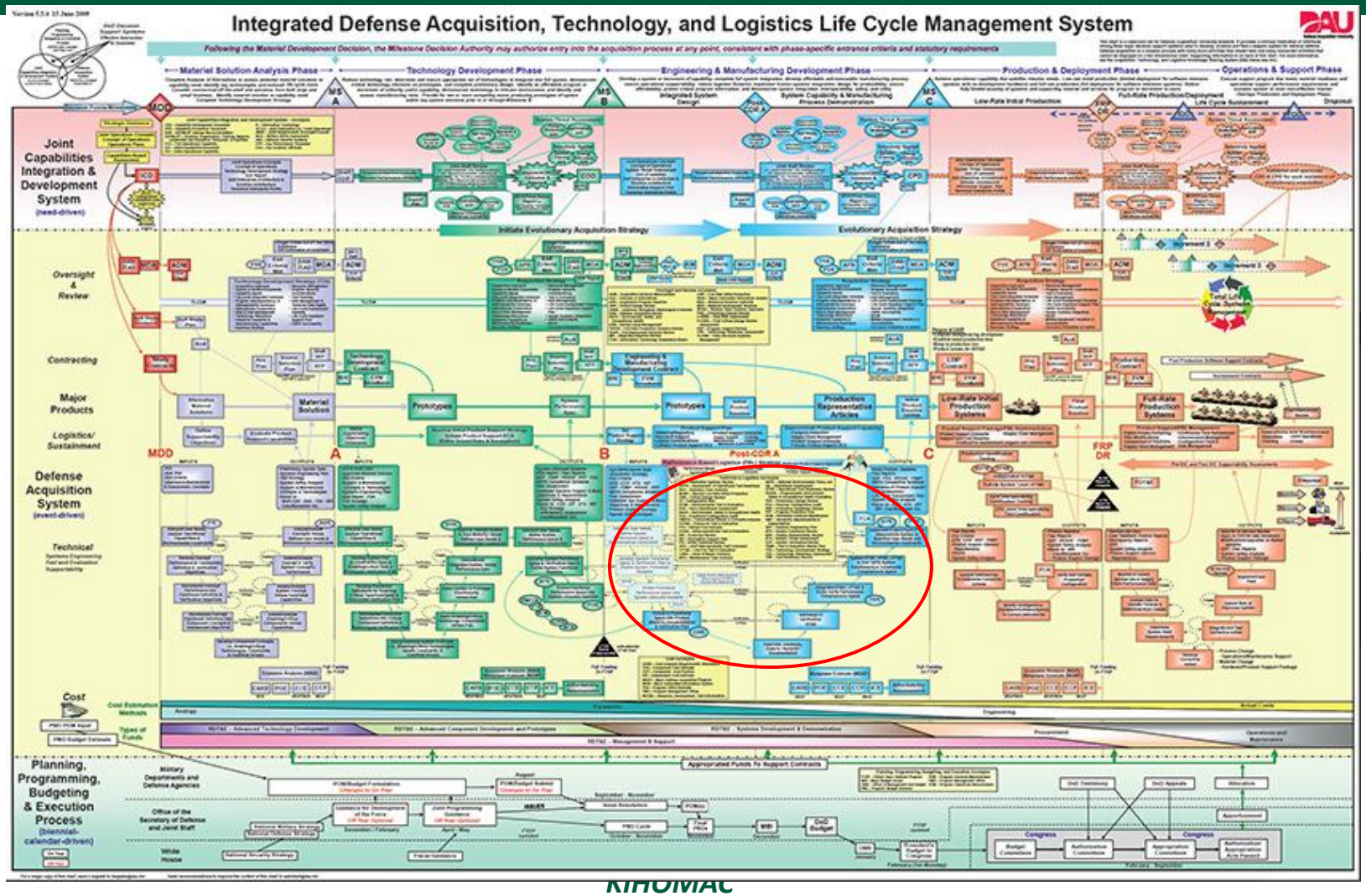
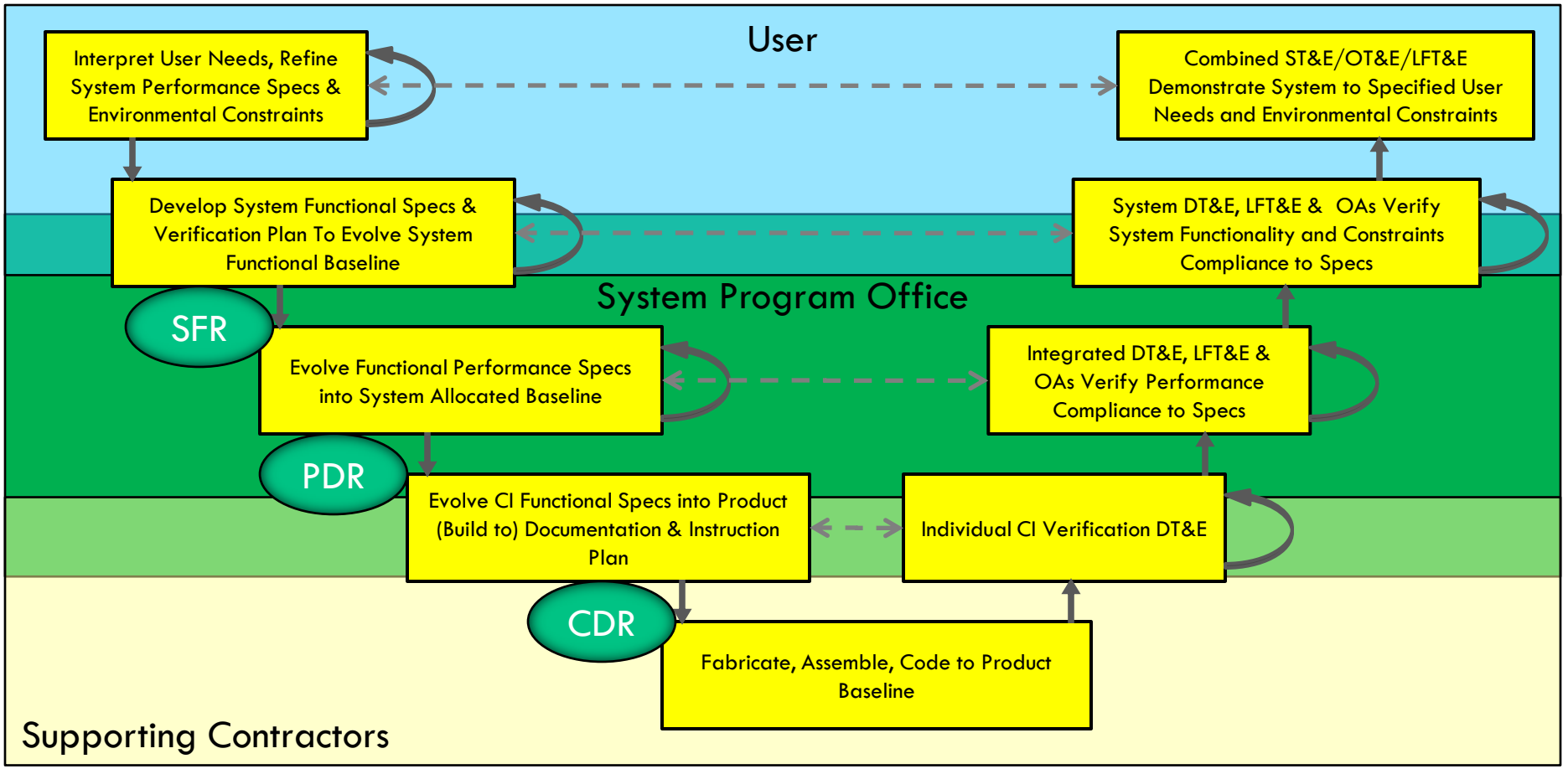
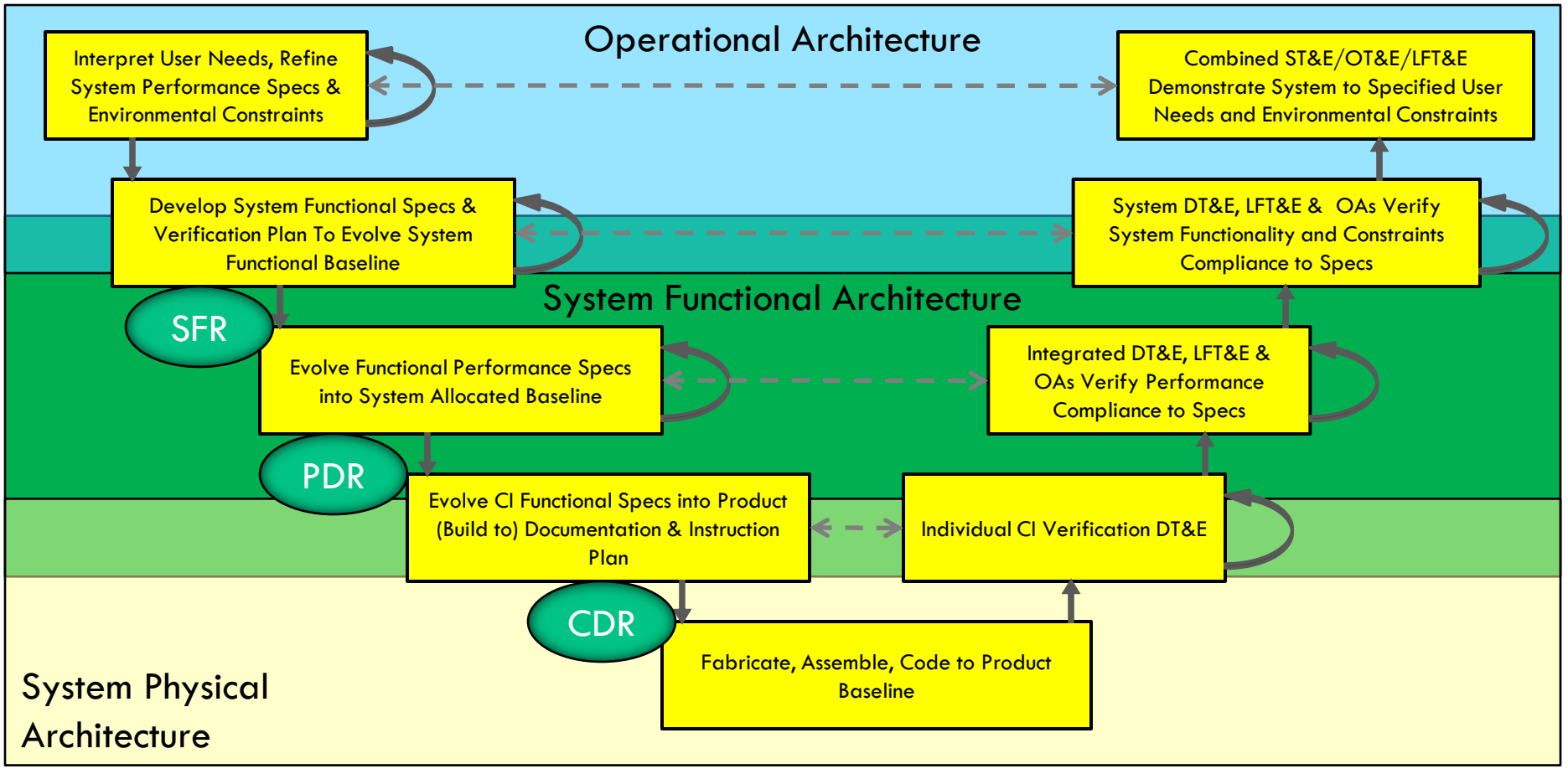


EMD Phase - Participation



EMD Phase - Architecture Aspects



EMD Phase - Architecture Products

- At System Functional Review:
  - Updates to System Functional Architecture:
    - SV-4 (preliminary) - Systems Functionality Description
    - SvcV-4 (preliminary) - Services Functionality Description
    - SV-5a (preliminary) - Operational Activity to Systems Function Traceability Matrix
    - SvcV-5 (preliminary) - Operational Activity to Services Traceability Matrix

Optional, depends on program scope

EMD Phase - Architecture Products

- At Preliminary Design Review:
  - Updates to System Physical Architecture:
    - SV-1 (preliminary) - Systems Interface Description
    - SvcV-1 (preliminary) - Services Context Description
    - SV-2 (preliminary) - Systems Resource Flow Description
    - SvcV-2 (preliminary) - Services Resource Flow Description
    - SV-4 (final) - Systems Functionality Description
    - SvcV-4 (final) - Services Functionality Description
    - SV-5a (final) - Operational Activity to Systems Function Traceability Matrix
    - SV-5b (preliminary) - Operational Activity to Systems Traceability Matrix
    - SvcV-5 (preliminary) - Operational Activity to Services Traceability Matrix

Optional, depends on program scope

EMD Phase - Architecture Products

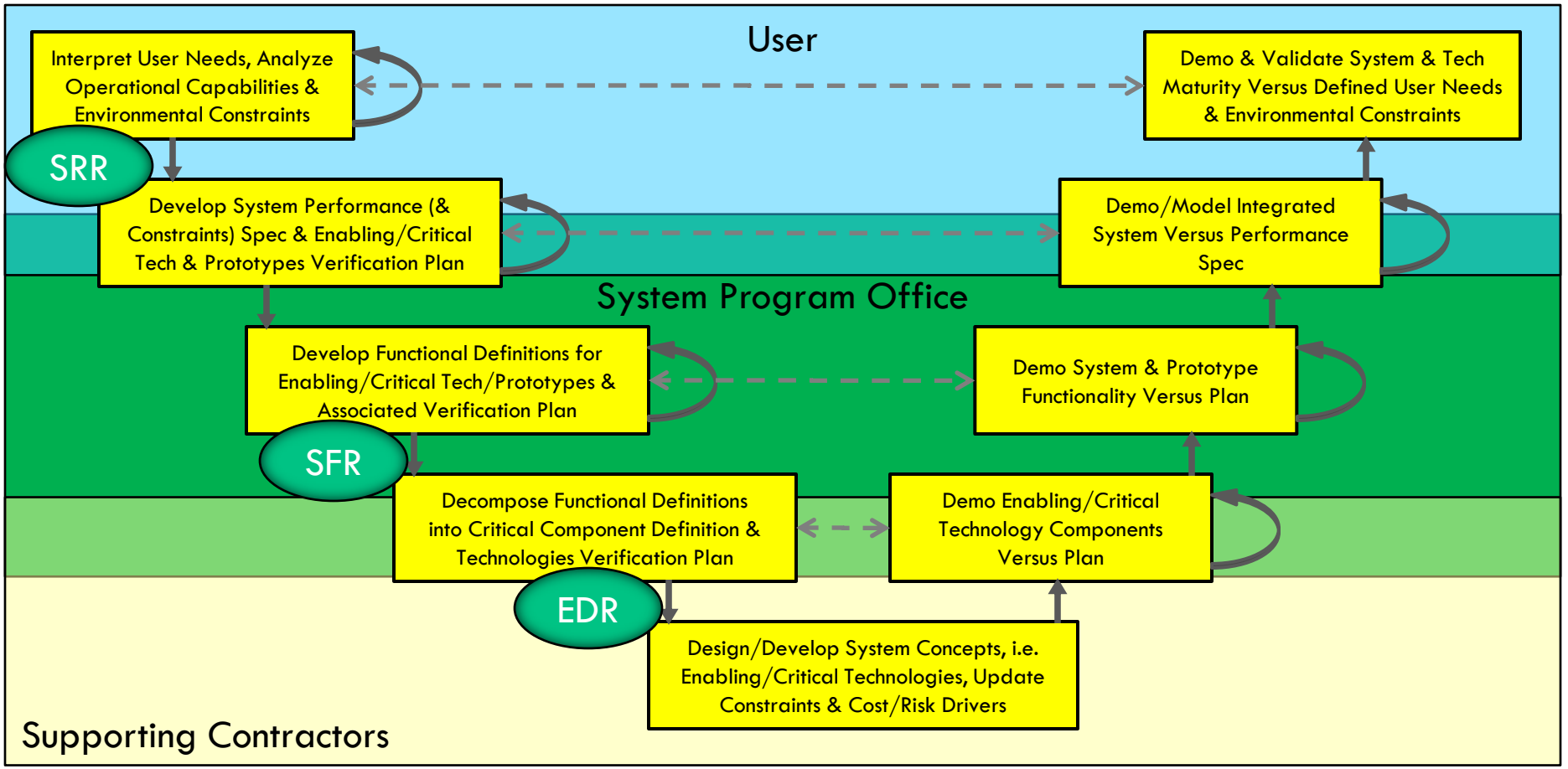
- At Critical Design Review:
  - Updates to System Physical Architecture:
    - SV-1 (final) - Systems Interface Description
    - SvcV-1 (final) - Services Context Description
    - SV-2 (final) - Systems Communications Description
    - SvcV-2 (final) - Services Resource Flow Description
    - SV-3 - Systems-Systems Matrix
    - SvcV-3a - Services-Services Matrix
    - SvcV-3b - Systems-Services Matrix
    - SV-5a (final) - Operational Activity to Systems Function Traceability Matrix
    - SV-5b (final) - Operational Activity to Systems Traceability Matrix
    - SvcV-5 (final) - Operational Activity to Services Traceability Matrix

Optional, depends on program scope

OA's/OUE's

- Operational Assessments (OA's) / Operational Utility Evaluations (OUE's)
  - Gain deep insight into operational problem space.
    - Opportunity to assess existing operational architecture.
    - Better understanding of operational requirements
  - Early system engineering opportunity
    - Dry-run for technology development & EMD phases
  - Refine operational & implementation requirements

Operational Assessments



Operational Assessments - Architecture Products

- At System Requirements Review:
  - Updates to Operational Architecture:
    - OV-1(s) - High-Level Operational Concept Graphic
    - OV-2 - Operational Node Connectivity Description
    - OV-3 - Operational Information Exchange Matrix
    - OV-5 - Operational Activity Model
    - OV-6a - Operational Rules Model
    - OV-6b - Operational State Transition Description
    - OV-6c - Operational Event-Trace Description
    - OV-7 - Logical Data Model

Optional, depends on program scope

Operational Assessments - Architecture Products

- At System Functional Review:
  - Updates to System Functional Architecture:
    - *SV-4a (preliminary) - Systems Functionality Description
    - *SV-4b (preliminary) - Services Functionality Description
    - *SV-5a (preliminary) - Operational Activity to Systems Function Traceability Matrix

  * - Deliver final at EDR

Optional, depends on program scope

Operational Assessments - Architecture Products

- At Engineering Design Review:
  - Updates to System Physical Architecture:
    - SV-1 (preliminary) - Systems Interface Description
    - SvcV-1 (preliminary) - Services Context Description
    - SV-2 (preliminary) - Systems Communications Description
    - SvcV-2 (preliminary) - Services Resource Flow Description
    - SV-5a (preliminary) - Operational Activity to Systems Function Traceability Matrix
    - SvcV-5 (preliminary) - Operational Activity to Services Traceability Matrix
    - SV-6 (preliminary) - Systems Resource Flow Matrix
    - SV-7 (preliminary) - Systems Measures Matrix
    - SV-10a (preliminary) - Systems Rules Model
    - SV-10b (preliminary) - Systems State Transition Description
    - SV-10c (preliminary) - Systems Event-Trace Description

Optional, depends on program scope

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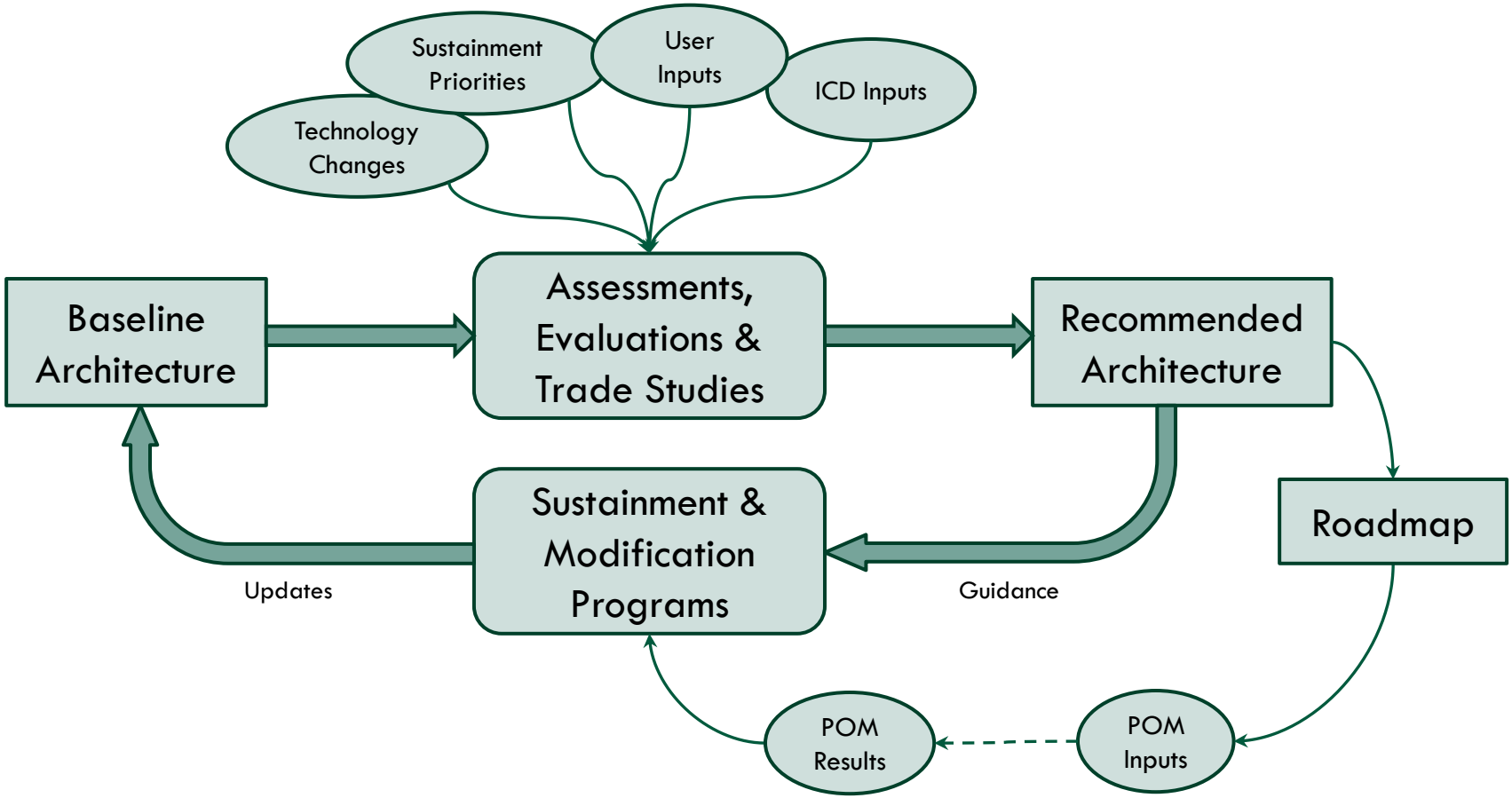
The Architecture Roadmap Process

Roadmap Process



Technology Changes

- Two forms:
  - Technology refreshment
    - i.e. replace legacy analog with digital components/systems
  - Technology enablers (examples)
    - New technical solutions to existing implementations
    - New technical solutions to previously unsolved areas
      - Think : requirements in the 'Too-Hard' box
    - Technology maturity brings cost-to-implement within the acheivable
      - Think: requirements in the 'Too-Expensive' box

Sustainment Priorities

- Diminishing Manufacturing Sources (DMS)
  - Think: I can't buy the parts anymore
- Cost Of Ownership drivers
  - Think: I can continue to fix it, but it is getting more expensive to fix all the time
- Availability drivers
  - Think: It always works – vs. – It is always broken
    - OK, so… what is causing the 'broken'?

User Inputs

- Changing scope within the bounds of established requirements
  - “I need it to do _____”

ICD Changes

- New and revised ICD's (and other guidance)

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Applying DoDAF 2

DoDAF 2 New Views of Interest

- Capability Views:
  - CV-1 Vision
  - CV-2 Capability Taxonomy
  - **CV-3 Capability Phasing**
  - **CV-4 Capability Dependencies**
  - CV-5 Capability to Organizational Development Mapping
  - CV-6 Capability to Operational Activities Mapping
  - CV-7 Capability to Services Mapping

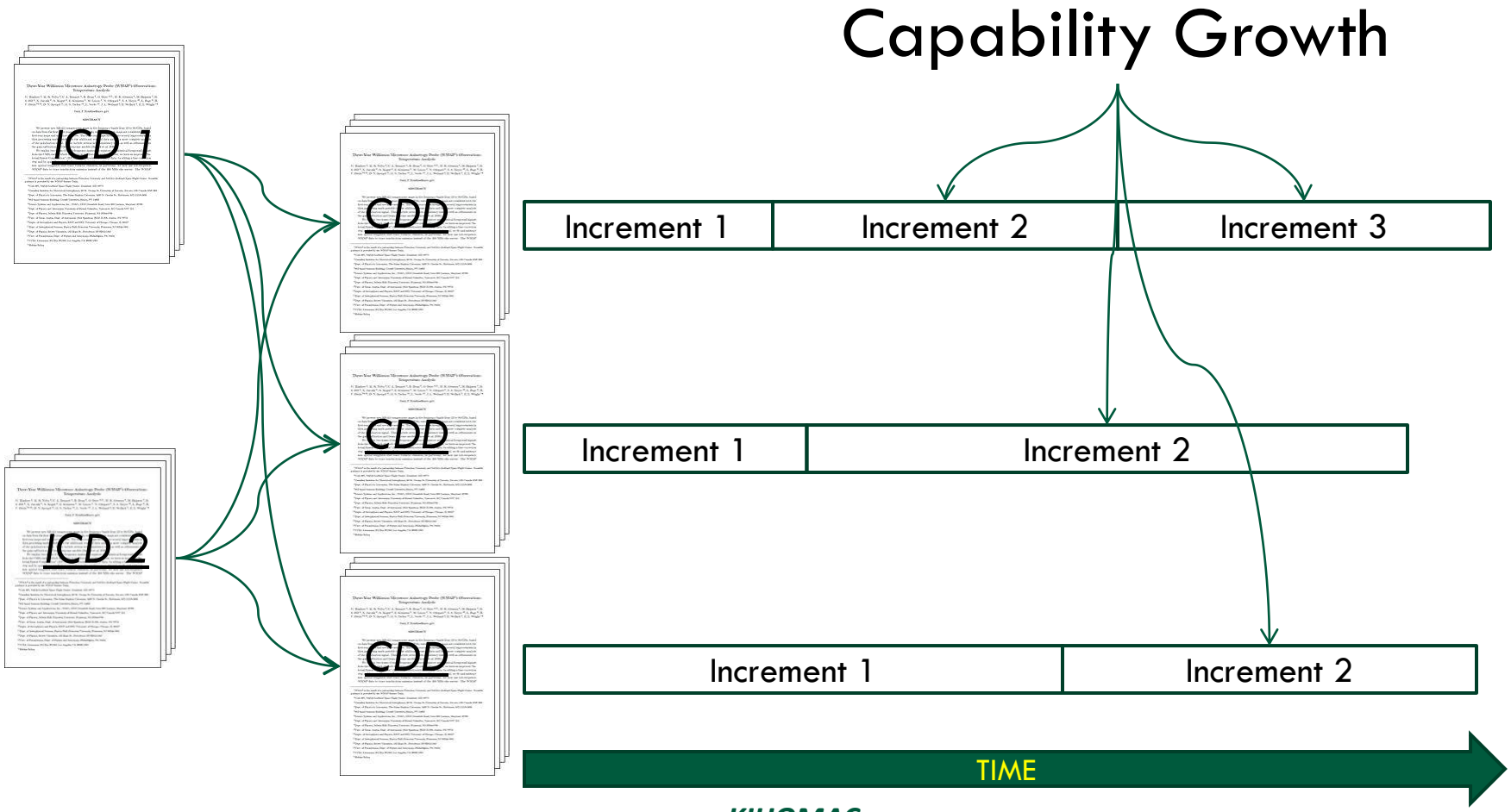
- Project Views:
  - PV-1 Project Portfolio Relationships
  - **PV-2 Project Timelines**
  - **PV-3 Project to Capability Mapping**

DoDAF 2 Improvements

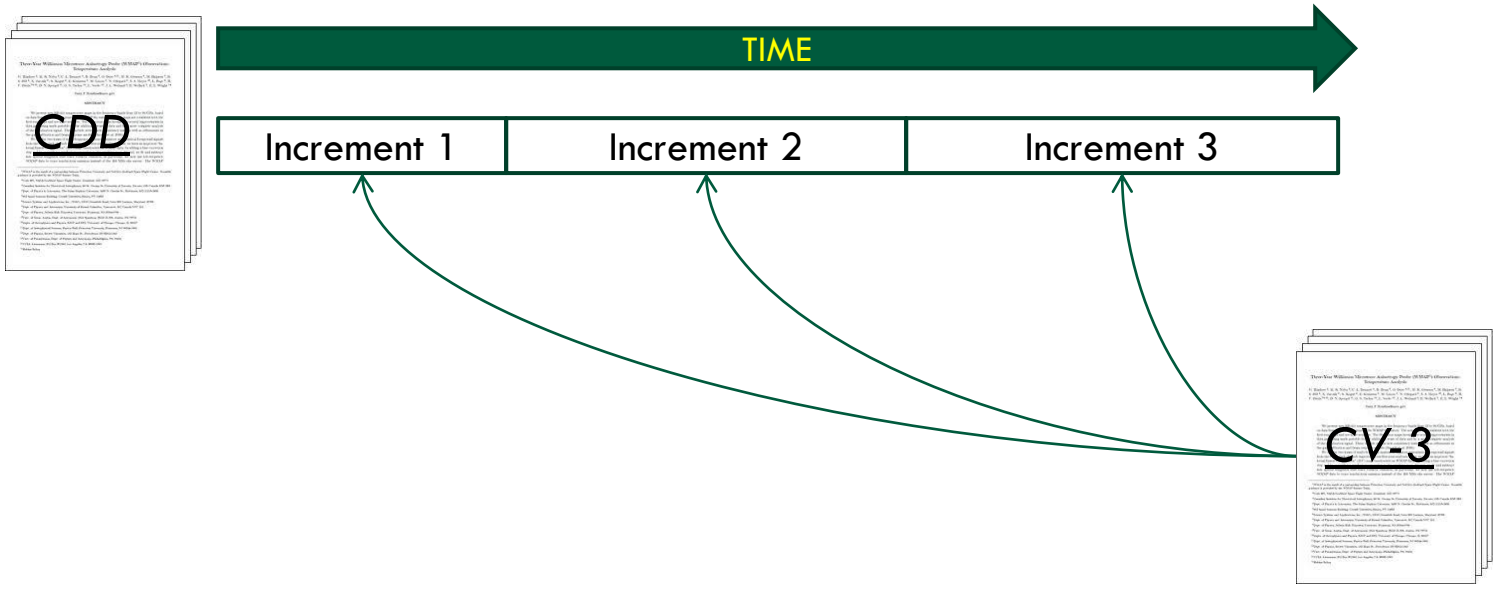
- Capability Views
  - Provide the ability to work with the warfighter to better socialize and prioritize their needs and expectations.

- Project Views
  - Coupled to Capability Views [via PV-3], produces broad awareness to current & planned future activities and their relationship to forecasted capabilities.
    - Great way to socialize future planning

Capability Growth

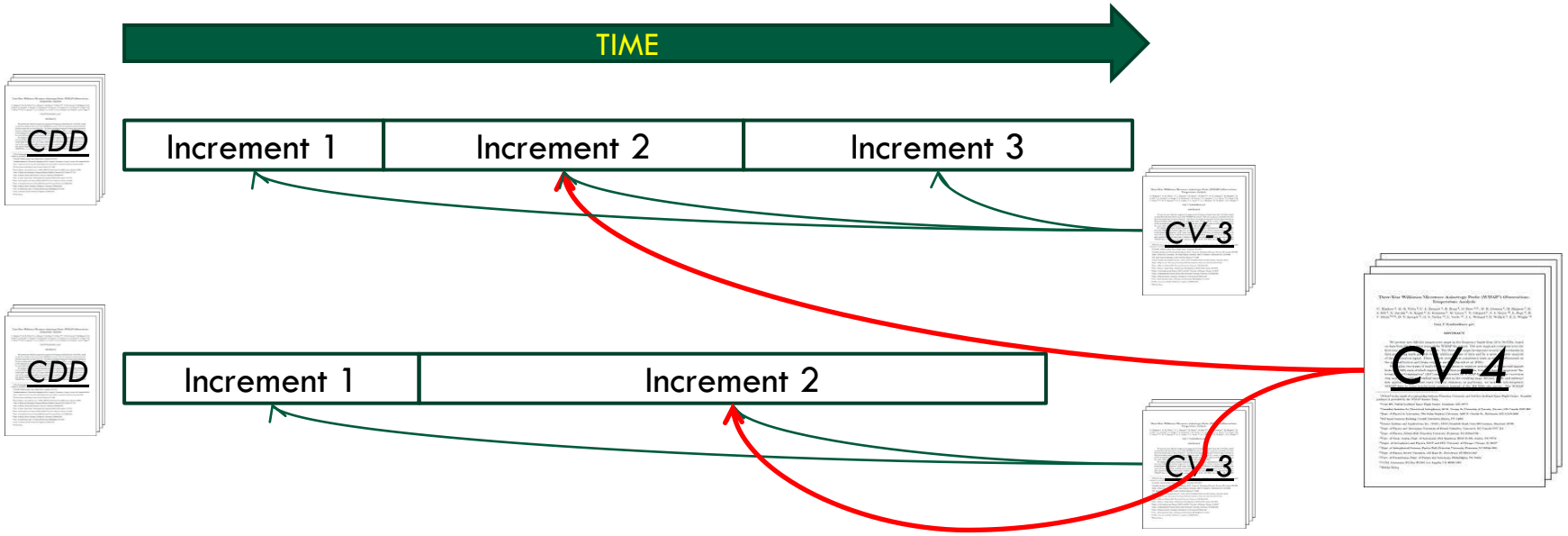


CV-3 – Capability Phasing



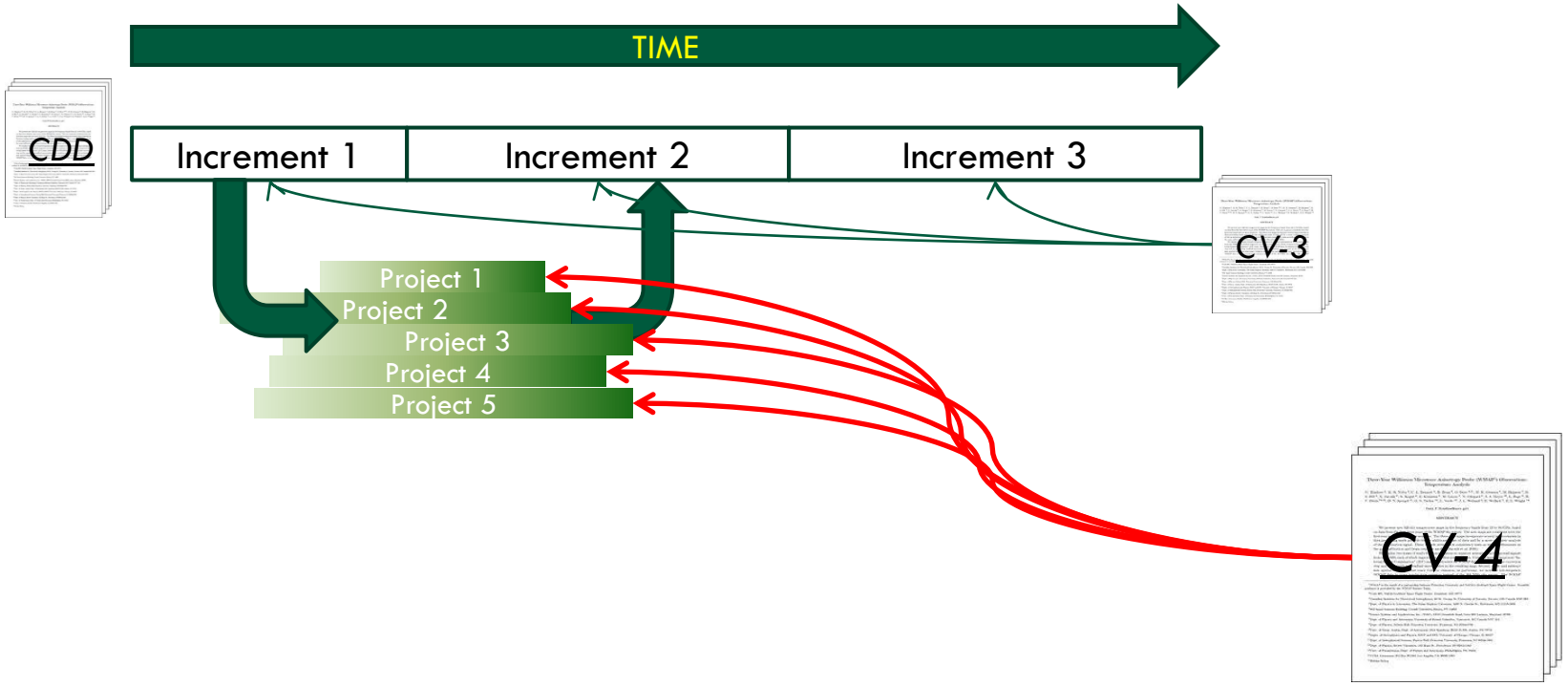
CV-3 Articulates the capabilities added /removed/modified over time

CV-4 Capability Dependencies



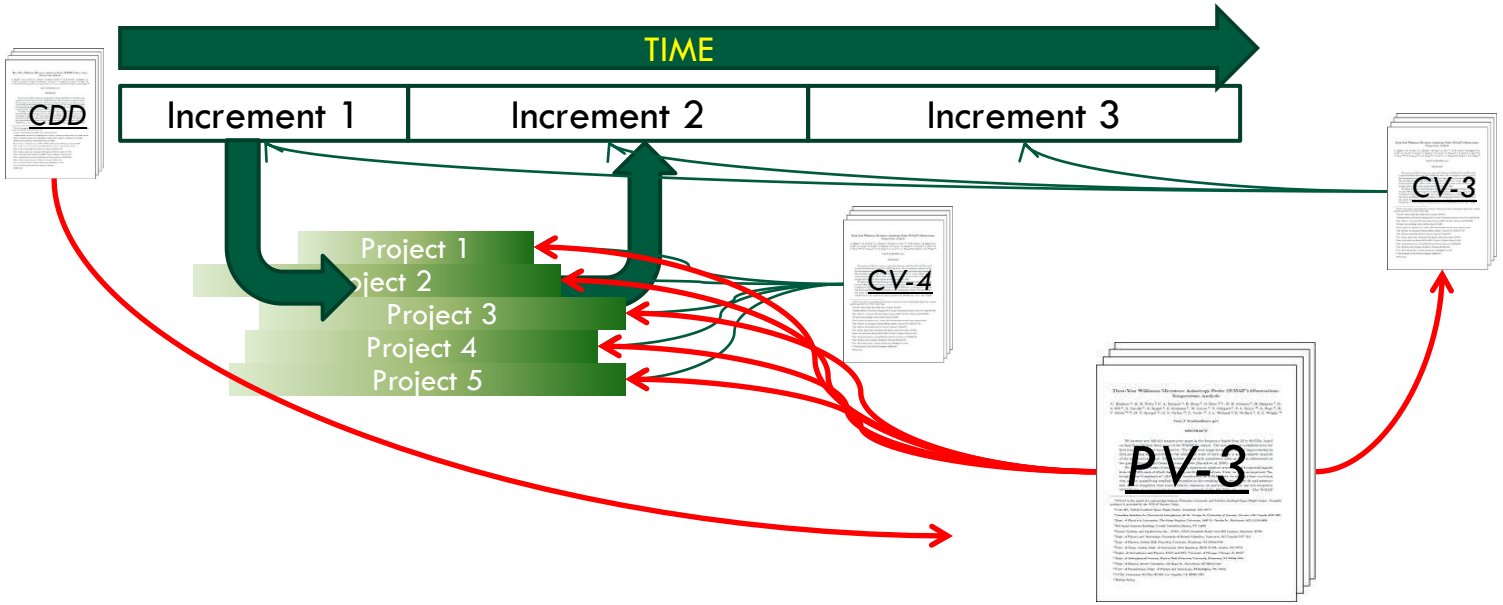
CV-4 articulates those aspects that require multiple efforts (dependencies between parallel efforts)

CV-4 Capability Dependencies



CV-4 is also used to articulate those aspects that cross multiple projects to develop a capability

PV-3 Project to Capability Mapping



PV-3 provides the traceability between a set of projects and a defined capability increment – used in acquisition planning

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Challenges:

- *Tools*
- *Processes*

Tools

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- Varying levels of tool maturity
  - Pictures?
  - Databases?
  - Ability to support broad stakeholder socialization?
    - This is a HARD problem to solve!! Some stakeholders want pretty pictures with little technical detail and others want highly detailed (and multi-dimensional) technical content made simple.
  - Ability to accurately describe operational & systems architectures
- Lack of integration
  - Not just element-to-element but also across methodologies
- 'Requirements'
  - In a separate repository or embedded in the architecture tools?

Processes

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- Varying levels of process maturity
  - Architectures as a check-the-box exercise?
  - Architectures as an interesting problem but not connected to systems engineering and ultimately design?
  - Architectures as an integral part of systems engineering & design?

- Lack of integration - both tools and processes!
  - Difficult to mature processes when we can't get the tools to integrate into the larger processes!

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Questions??

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