

Systems Engineering in S&T

A Bridge-Builder to Development Planning

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Chief Engineer

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The logo for the Air Force Research Laboratory (AFRL) features the letters 'AFRL' in a bold, sans-serif font. The 'A' is grey, while 'F', 'R', and 'L' are blue. To the right of the letters is a stylized globe composed of a grid of blue dots, with a blue arrow pointing to the right, suggesting global reach and forward progress.

AFRL

THE AIR FORCE RESEARCH LABORATORY
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Overview



- **SE for AFRL's S&T Mission**
- **S&T Influences Across the Life Cycle**
 - **Emphasis on Development Planning**
- **SE Couples S&T and Development Planning**



Systems Engineering in AFRL



- Enjoys Strong Support from Senior Leadership; Support from S&T Workforce is Growing
- Uniquely Tailored to AFRL's S&T Mission
 - SE Rigor Appropriate to S&T Program
- Recognizes that Technology Must be “Systemized” to Enable Capability
- Facilitates Technology Transition -- Turning Technology into War Winning Capabilities
- Enables Necessary S&T Influence Across Acquisition Life Cycle
- Forcing Function for Development Planning Activity
 - Which is a Forcing Function for S&T



SE Challenges in AFRL

(probably true in any DoD S&T organization)



- Terminology
 - Policy & guidebooks focus on Weapon System SE - require translation to S&T Mission
- Culture – a concern that SE discipline & rigor will:
 - Stifle innovation & creativity
 - Inhibit freedom to “push” technology not being “pulled” by documented capability need/gap

**AFRL Leadership Committed to Strong SE in AFRL
While Addressing These Challenges**



Current AFRL Initiatives Support SE



- Formalized Role of Chief Engineer
 - AFRL-level and at each Technology Directorate
 - Responsible for Tailored SE in AFRL's Portfolio & Programs
 - Improved technology transition to AF systems
- Improved Responsiveness to Customer Needs
 - S&T Strategy...SES Capability Leads...Flagship Capability Concepts
- Consistent Participation on Development Planning (DP) & TRA Teams
- Relevant Training! (Lab 202, STM 303)

**Appreciation for AFRL's Role & Responsibilities in SE
Never Greater**

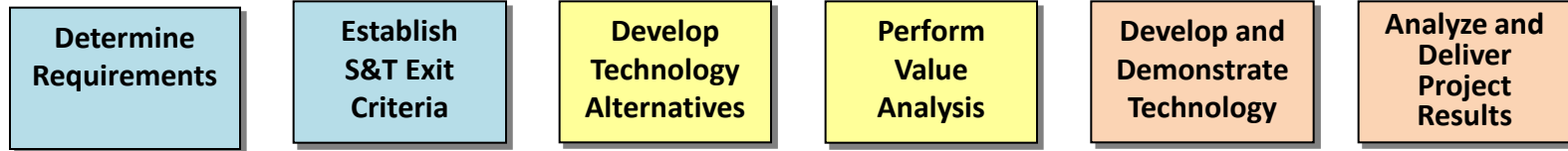


AFRL's Systems Engineering Process



Customer Capability Needs → *Technology Alternatives* → *Technology Demonstration*

ITERATIVE

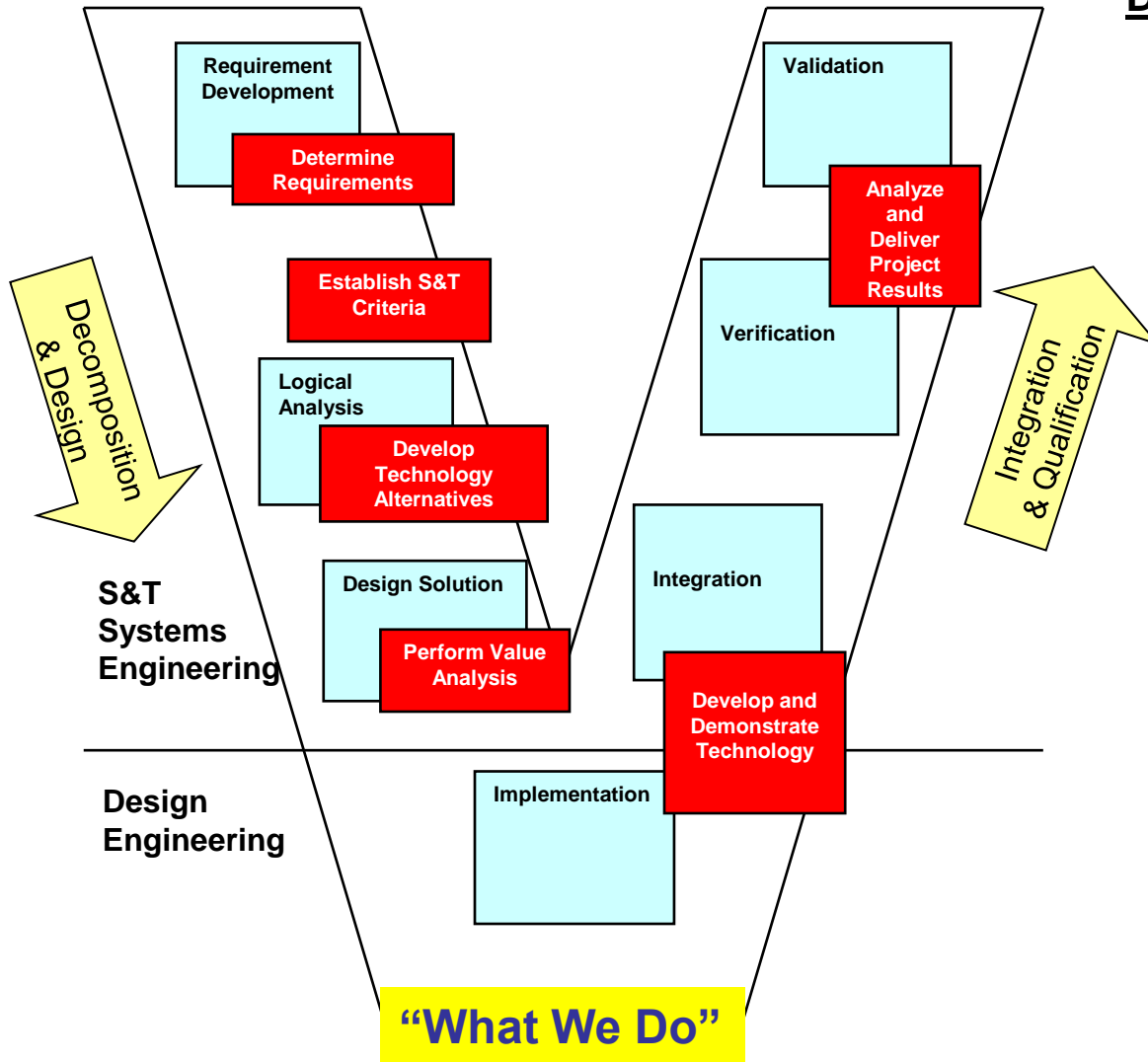


ITERATIVE

- **SE in S&T is fundamental to:**
 - Portfolio Development
 - Technology program planning, execution, transition



AFRL's S&T SE Process: Consistent With DAG SE Processes



DAG Technical Mgmt Processes

- Decision Analysis
- Tech Planning
- Tech Assessment
- Requirements Mgmt
- Risk Mgmt
- Configuration Mgmt
- Data mgmt
- Interface Mgmt

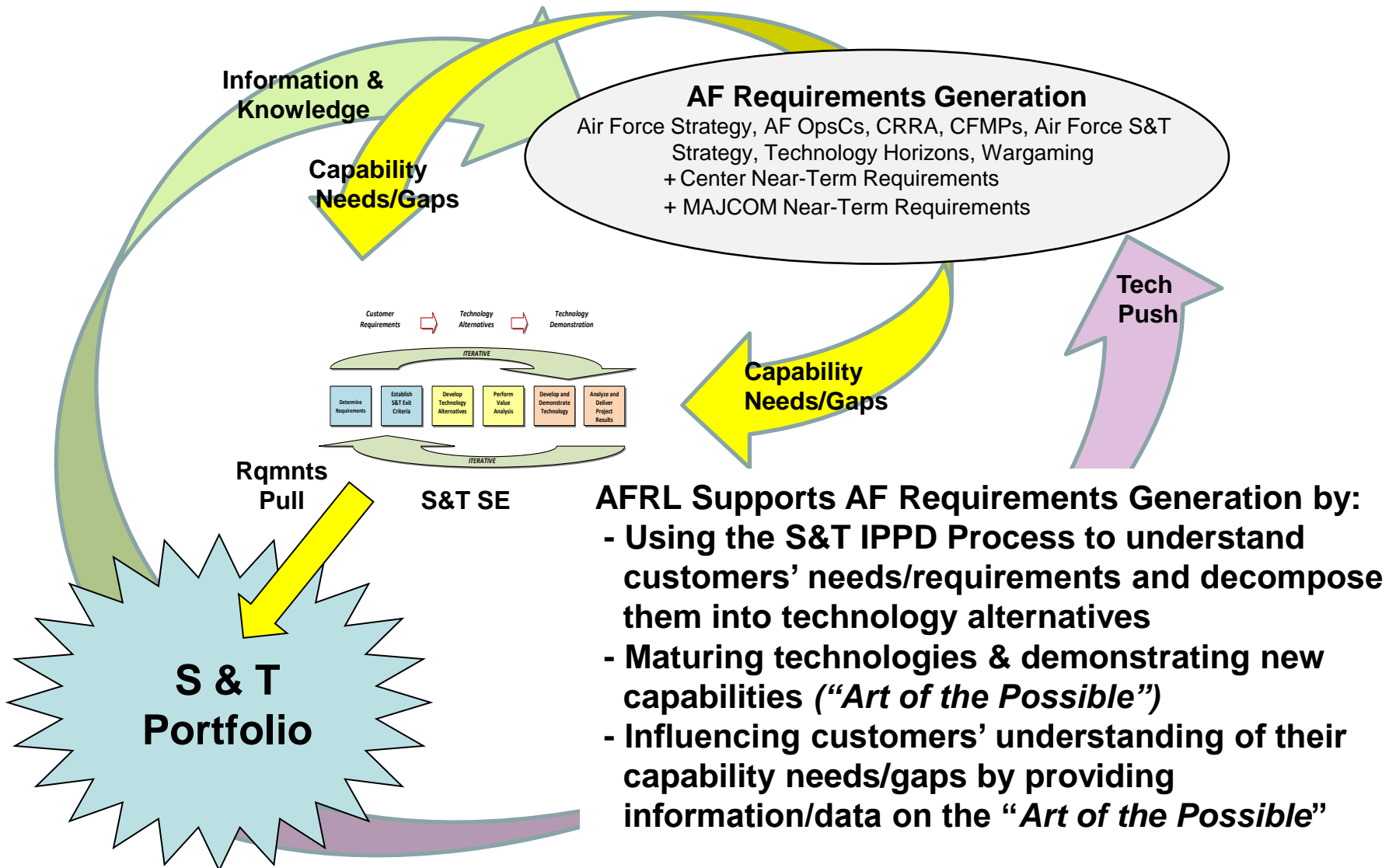
“How We Do It”



S&T SE: And The Acquisition Life Cycle

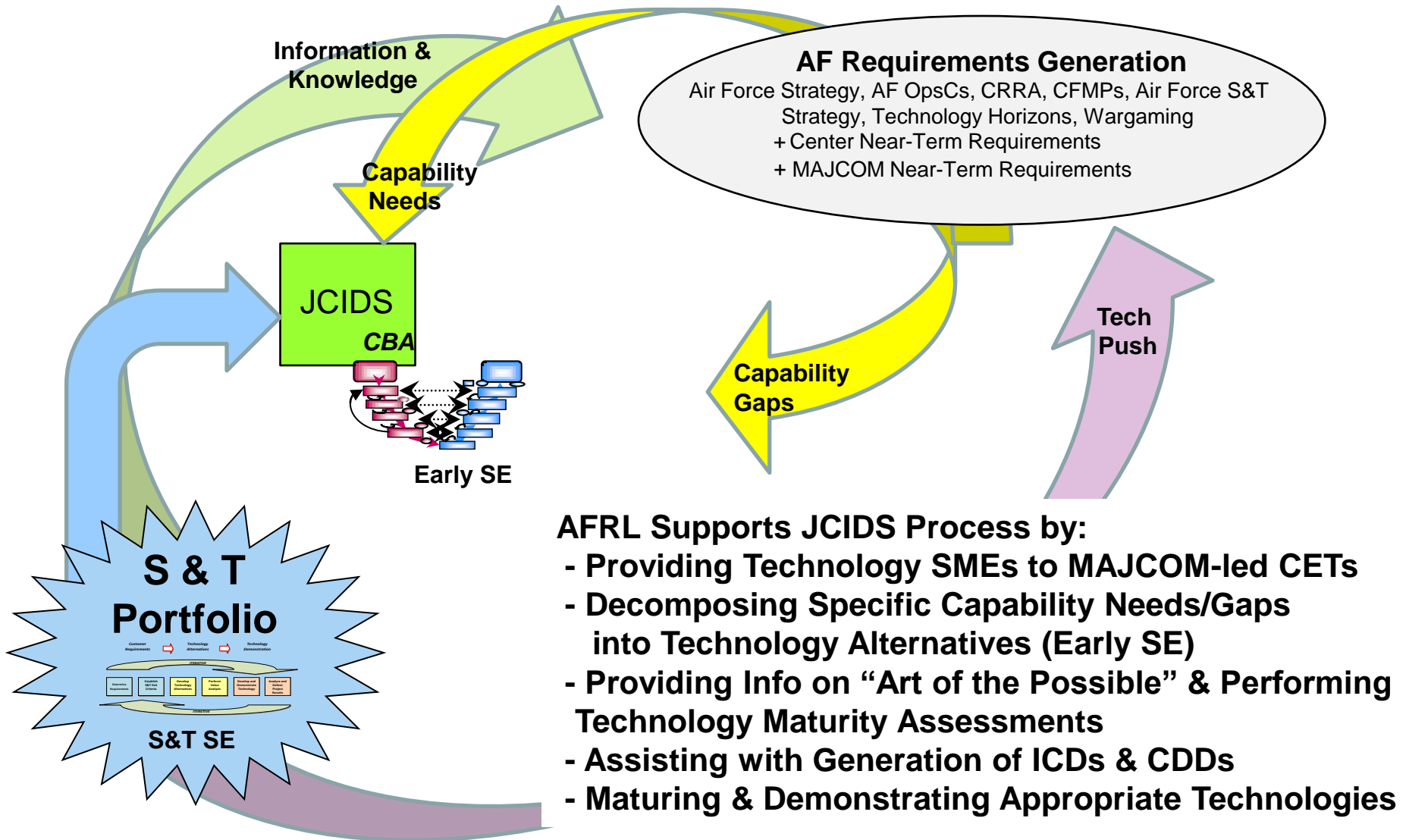


Warfighter Requirements Influence AFRL's S&T Portfolio



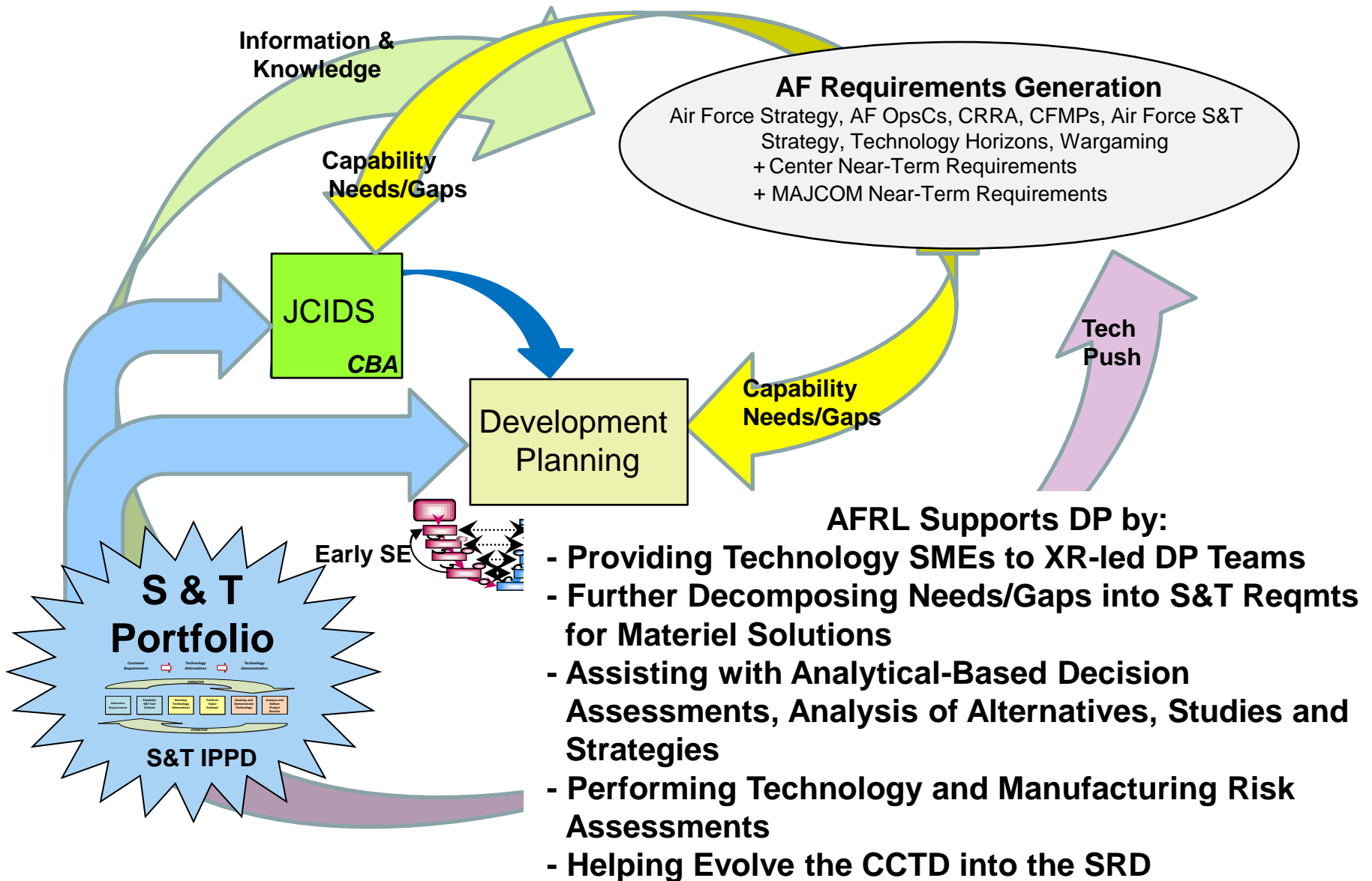


S&T SE: And The Acquisition Life Cycle





S&T IPPD: And The Acquisition Life Cycle



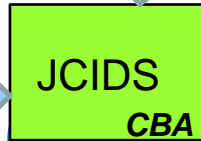


S&T IPPD: And The Acquisition Life Cycle

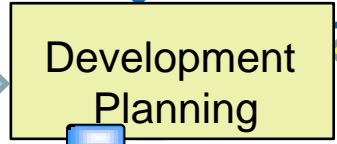


Information &
Knowledge

Capability
Needs/Gaps



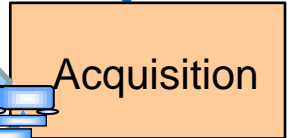
Capability
Needs/Gaps



Early SE



SE



Tech
Push

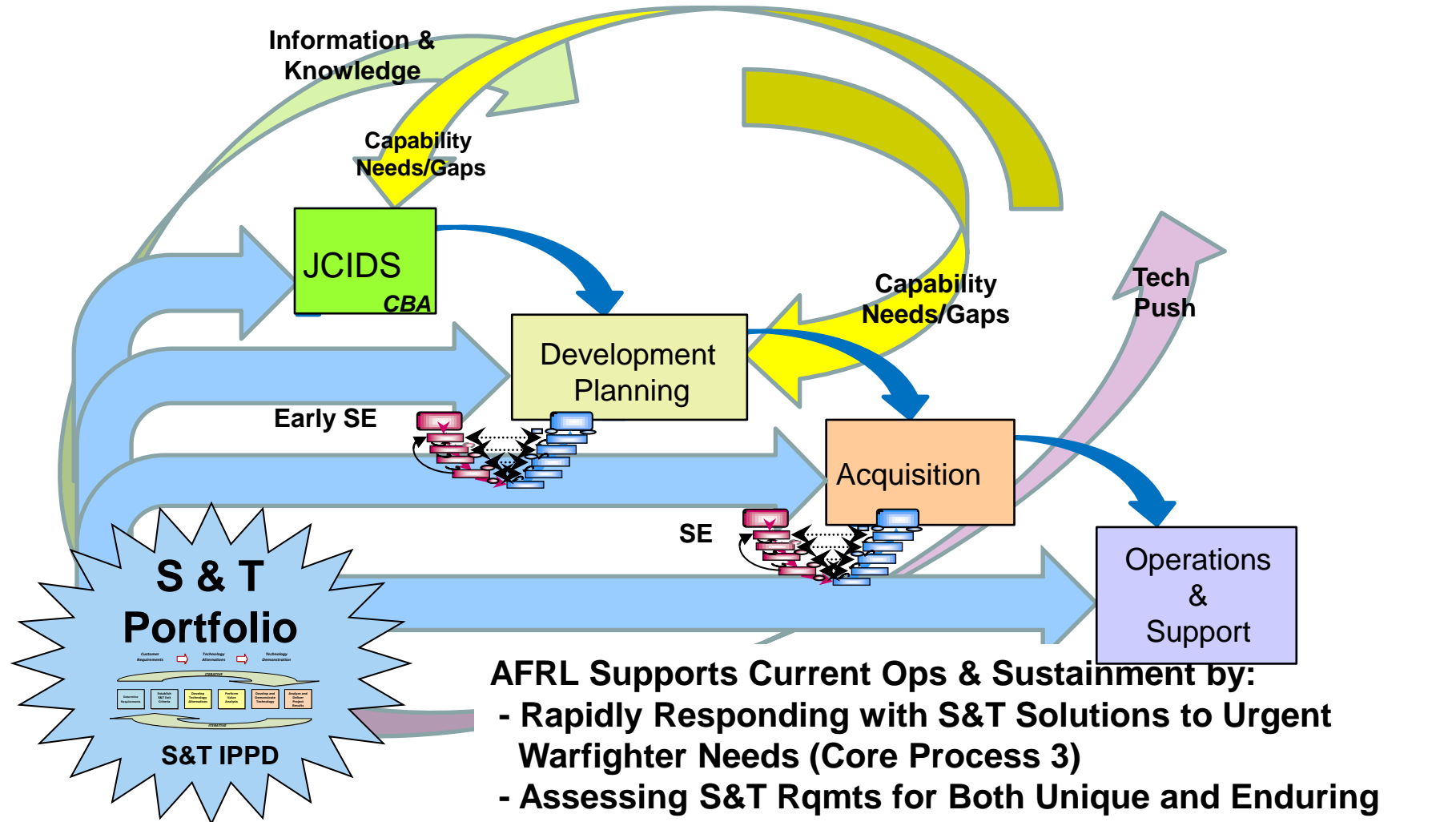


AFRL Supports Acquisition by:

- Providing Technical Assistance as Technology SMEs
- Assessing S&T Rqmts for New Capabilities and Modernizations/Upgrades and Maturing the Right Technologies to Meet Those Needs (Core Process 2)
- Supporting Systems Mgrs (to include Industry) in Transitioning Technology
- Performing TRAs & MRAs at Appropriate Milestones
- Maturing Manufacturing Processes



S&T IPPD: And The Acquisition Life Cycle



AFRL Supports Current Ops & Sustainment by:

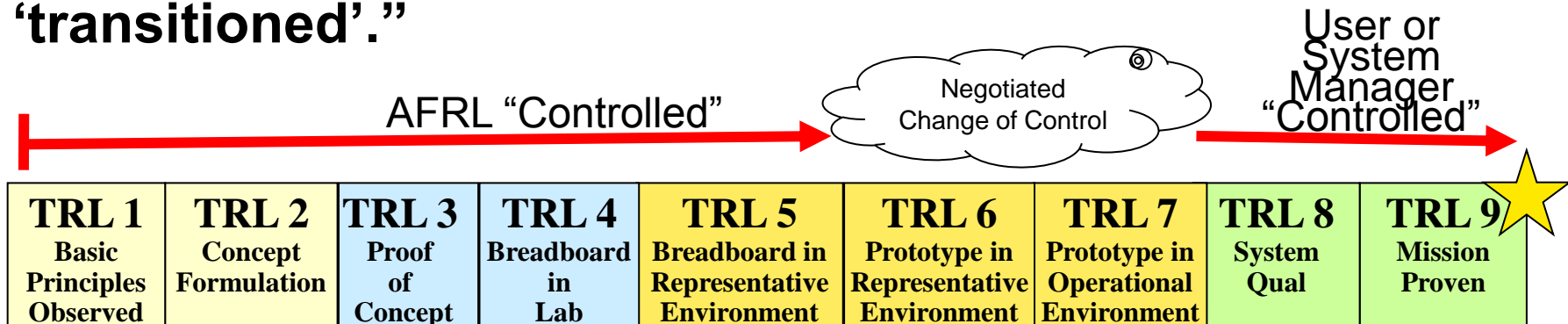
- Rapidly Responding with S&T Solutions to Urgent Warfighter Needs (Core Process 3)
- Assessing S&T Rqmts for Both Unique and Enduring Sustainment Needs & Maturing the Right Technologies to Meet Those Needs (Core Process 2)
- Providing Timely Forensic Analyses on Technical Issues



S&T SE: Must Enable Transition



“Technology transition is a **process** where technology is developed in strong **collaboration** with managers and users of systems* with the intent to insert the matured technology into that system. The process is complete when the technology is operational (**TRL 9**) and supportable. Only at that point has the technology ‘transitioned’.”

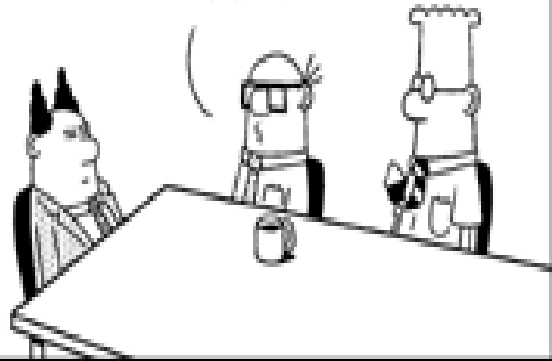


* Weapon systems, manufacturing processes, analysis tools, and other systems intended to provide capability to an end user



Truth Hurts?

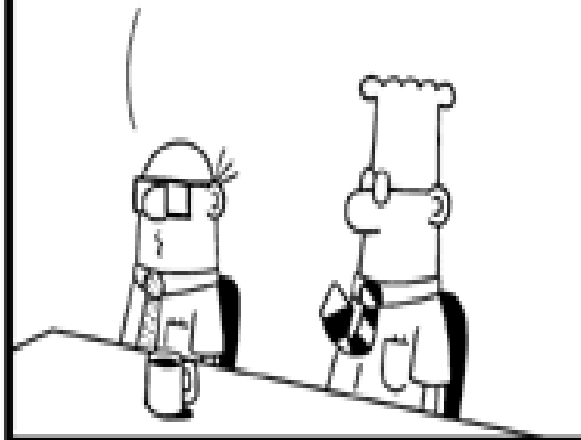
I NARROWED DOWN
THE OPTIONS TO AN
ALTERNATIVE THAT
COSTS TOO MUCH AND
ANOTHER THAT WON'T
WORK.



scottadams@aol.com

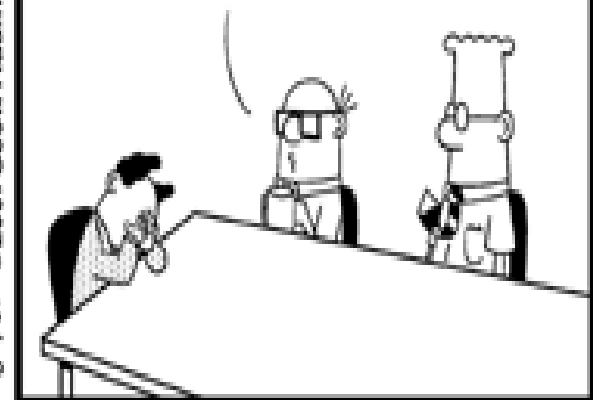
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I DIDN'T DO ANY
RESEARCH. IT'S MORE
OF AN EXPERIENCE
SORT OF THING.



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NEXT WEEK I PLAN
TO THINK ABOUT THE
OPTION OF USING
TECHNOLOGY THAT
ISN'T YET AVAILABLE.



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S&T Relationship to DP: SE is the “Coupler”



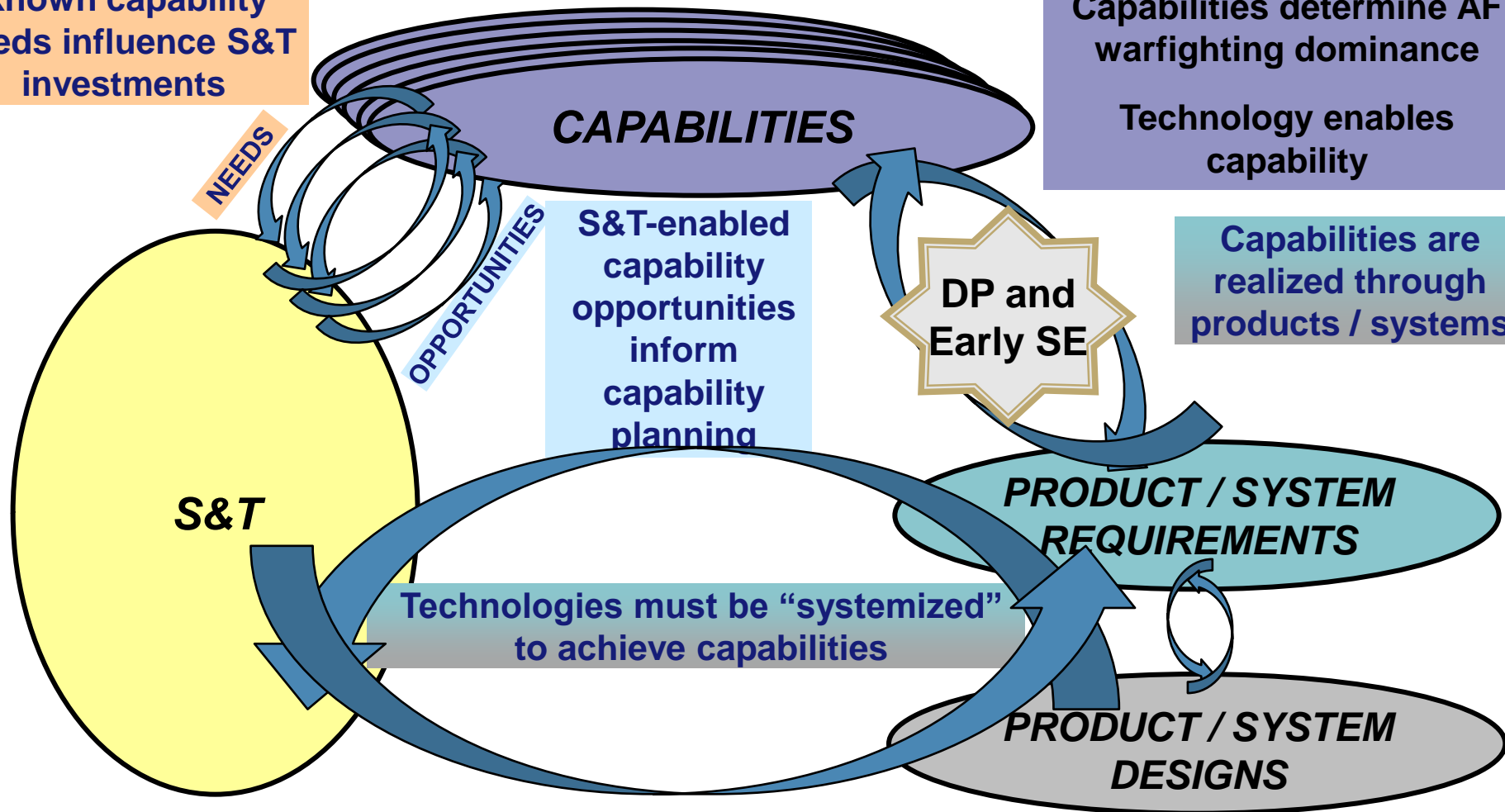
- Refine warfighters’ understanding of required capabilities
- Introduce warfighters to capability opportunities (often come from “Tech Push” efforts)
- Enable DP’s SE “V” via insight into technology’s “state-of-readiness” and risk of further maturing required technologies
- Focus S&T investments to ensure required technologies are properly mature for acquisition program (post MS A efforts)
- Ensure industry can respond to Program Office RFP with the necessary mature technologies



How It Works Together

Known capability needs influence S&T investments

Capabilities determine AF warfighting dominance
Technology enables capability



SE and technical planning establish the connections between capability planning and S&T strategy



Summary



- Warfighters and end users want capability, not technology
- Capability is provided by platforms and systems
- Technology must be “systemized” to be useful
- DP ensures proper pre-acquisition analysis
- S&T informs and enables early SE
- Early SE facilitates DP
- SE facilitates technology transition beyond that required of DP

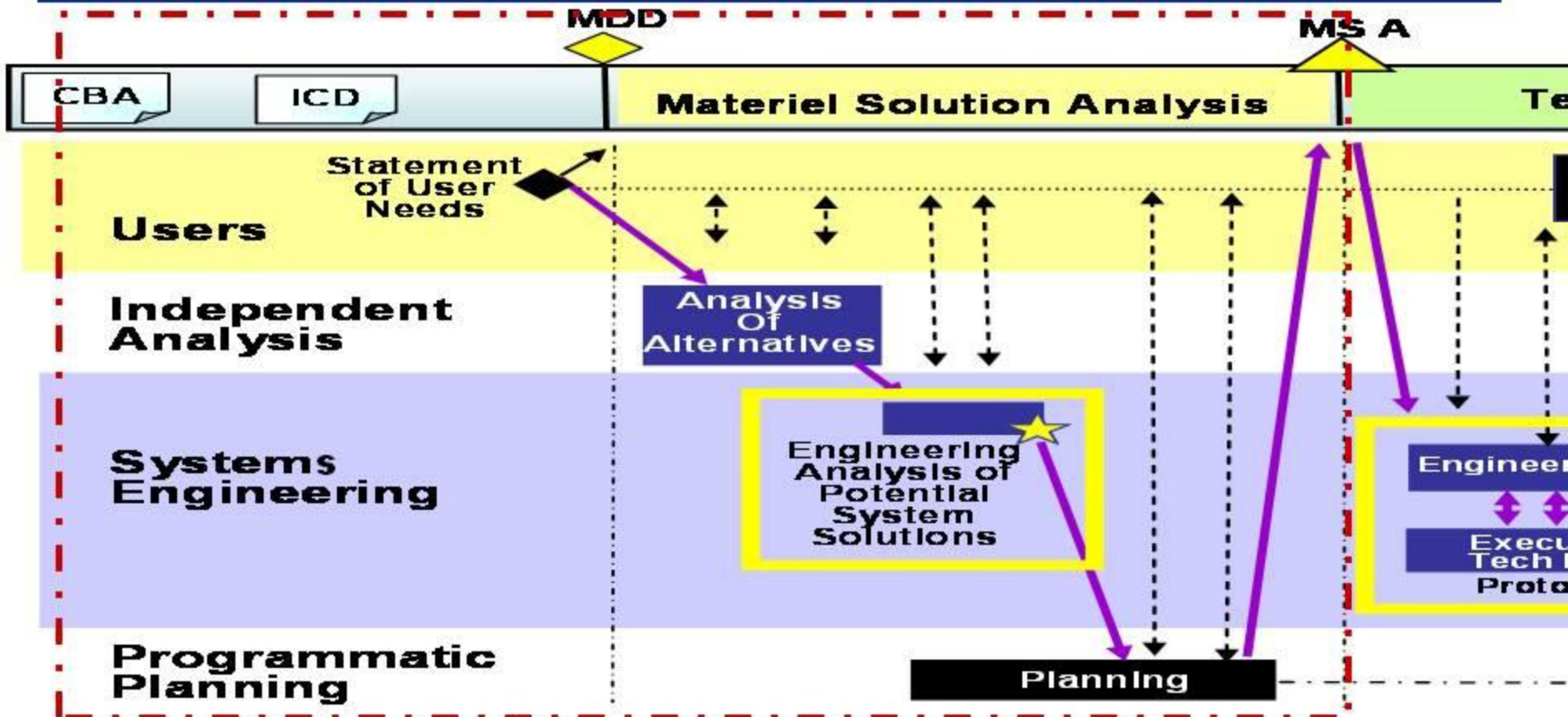
**SE Can “Mechanize” the Interrelationship
Between Development Planning and S&T**



Backups



Development Planning



Development Planning

- DP begins before acquisition, and is integrated with CBA
- DP is a natural application of Systems Engineering processes
- DP provides robust concepts/alternatives/approaches for evaluation during MSA



Concept Characterization and Technical Description (CCTD) Principal Elements



1. Mission / Capability Need Statement / CONOPS
2. Concept Overview
3. Trade Space Characterization
4. Evaluations (Studies, Analyses, Experiments)
5. Concept Characterization / Design **includes Critical Technology Elements**
6. Implementation Analyses **includes Critical Technologies and Technology Maturation Approach**
7. Risk Assessment and Decision-Certain Consequences
8. DOT_LPF Implications
9. Conclusions (Capability Description; Traceability to Need Statement)

Tailored to meet MDD information needs
Tailored to timeline needed to support decision



CCTD and S&T CCTD Comparison



CCTD	S&T CCTD
<ul style="list-style-type: none">■ Acquisition (system) Based – Constrained by requirements■ Technical and analytical knowledge base document that captures data about a concept (prospective materiel solution) developed in response to gaps or shortfalls in operational concepts■ Prepared by the concept development organization (e.g., XR) with stakeholder inputs (i.e., Program Office, user, AFRL, etc.)■ Documents the pedigree of development actions and decisions as concept matures■ Informs AF leadership for decision making (e.g., AF Review Board before MDD & MS A; AFROC approval of AoA Study Plan and Report)■ Becomes source data/information for AoA documentation (e.g., Alternative Description or Technical Description Document (TDD))	<ul style="list-style-type: none">■ Technology Based – Unconstrained (can be tech push)■ Technical and analytical knowledge base document which captures data about a Capability Concept as a technology-enabler for future Capabilities■ Prepared by the appropriate Future Long Term Challenge (FLTC) Team with AFRL Technology Directorate (TD) technical support■ Highlights maturity of FLTC Capability Concept■ Instrumental to FLTC Chief and Senior AFRL Leadership decision making (e.g., POM inputs, resource postures, Mid-/Far-Term Demonstrations, etc.)■ Becomes source data/information for JCIDS Candidate Solution Sets and/or DP Programs

CCTD IS NOT A REQUIRED MS DECISION DOCUMENT

S&T CCTDs UNDER DEVELOPMENT in AFRL



QUESTIONS ?

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