Systems Engineering in S&T

A Bridge-Builder to Development Planning

Dr. Ken Barker
Chief Engineer

27 Oct 2010

AFRL
THE AIR FORCE RESEARCH LABORATORY
LEAD | DISCOVER | DEVELOP | DELIVER

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

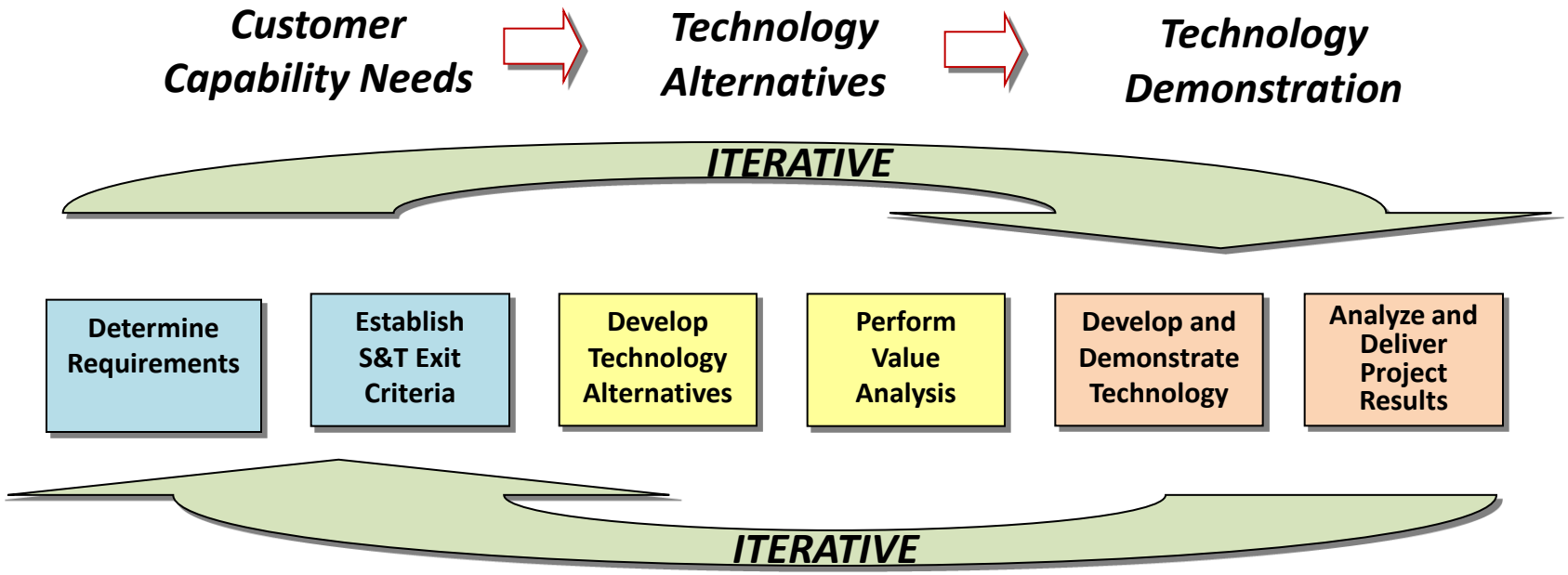
AFRL Leadership Committed to Strong SE in AFRL While Addressing These Challenges

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)

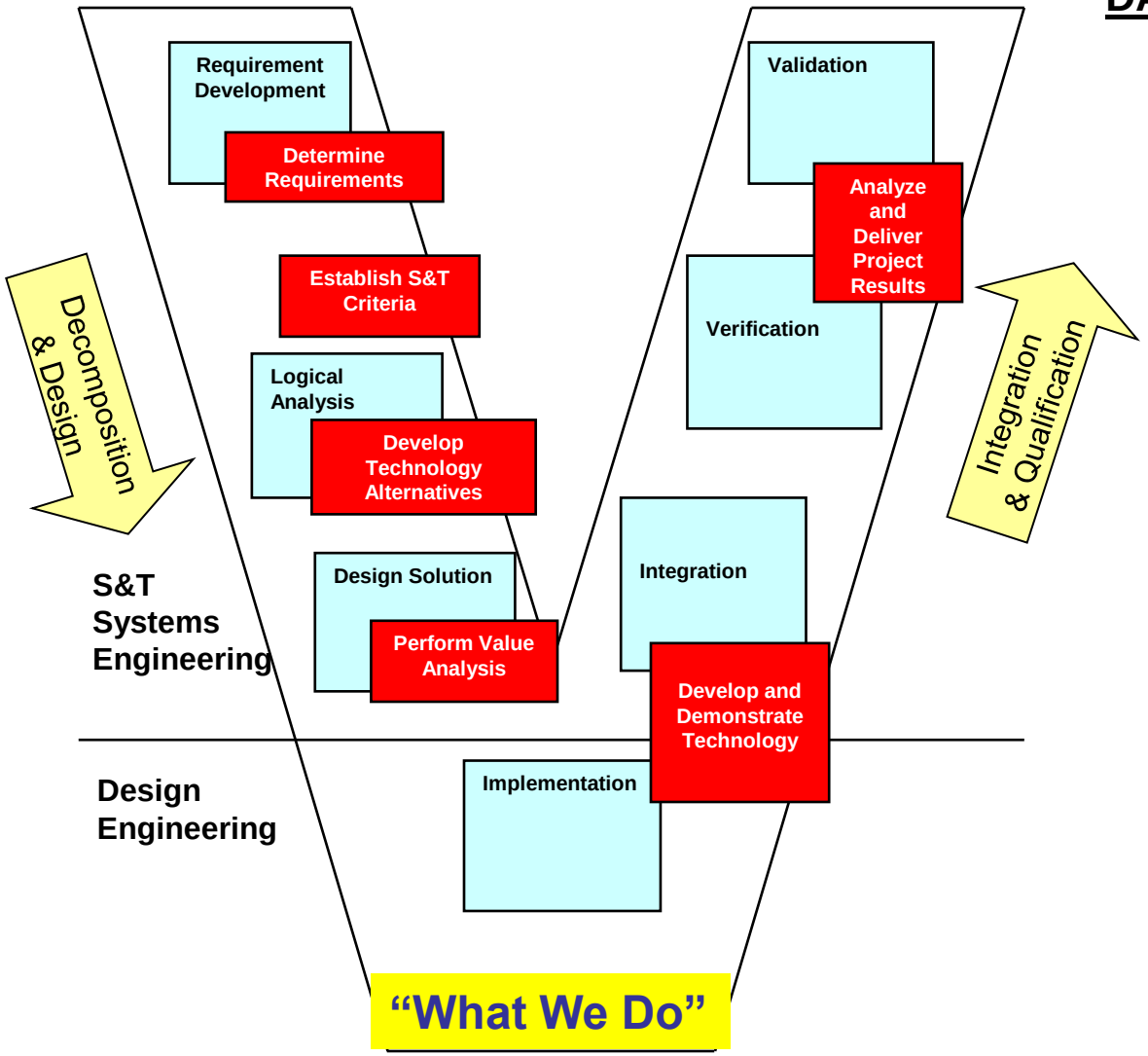
Appreciation for AFRL's Role & Responsibilities in SE Never Greater

AFRL's Systems Engineering Process



- **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



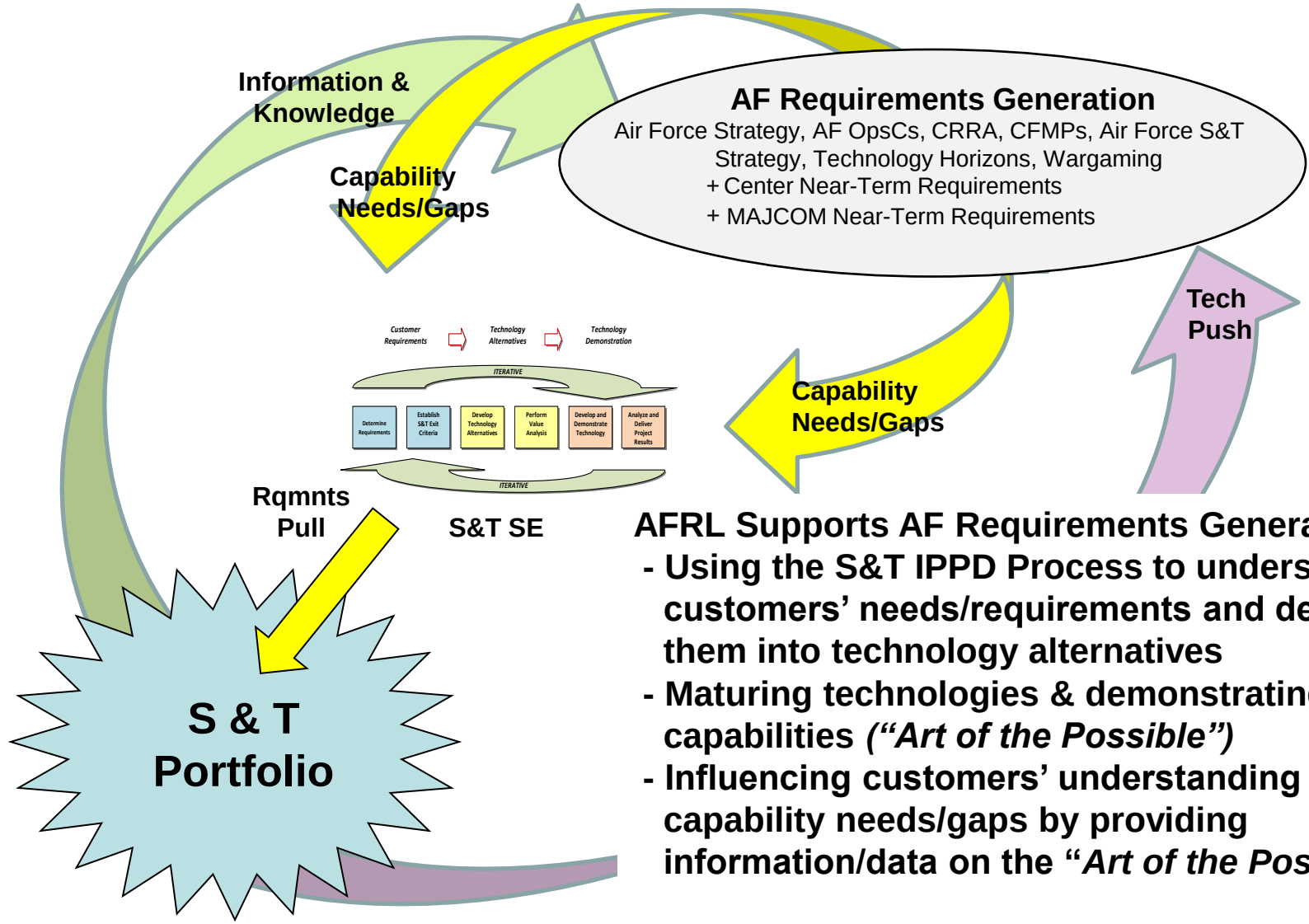
DAG Technical Mgmt Processes

- 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

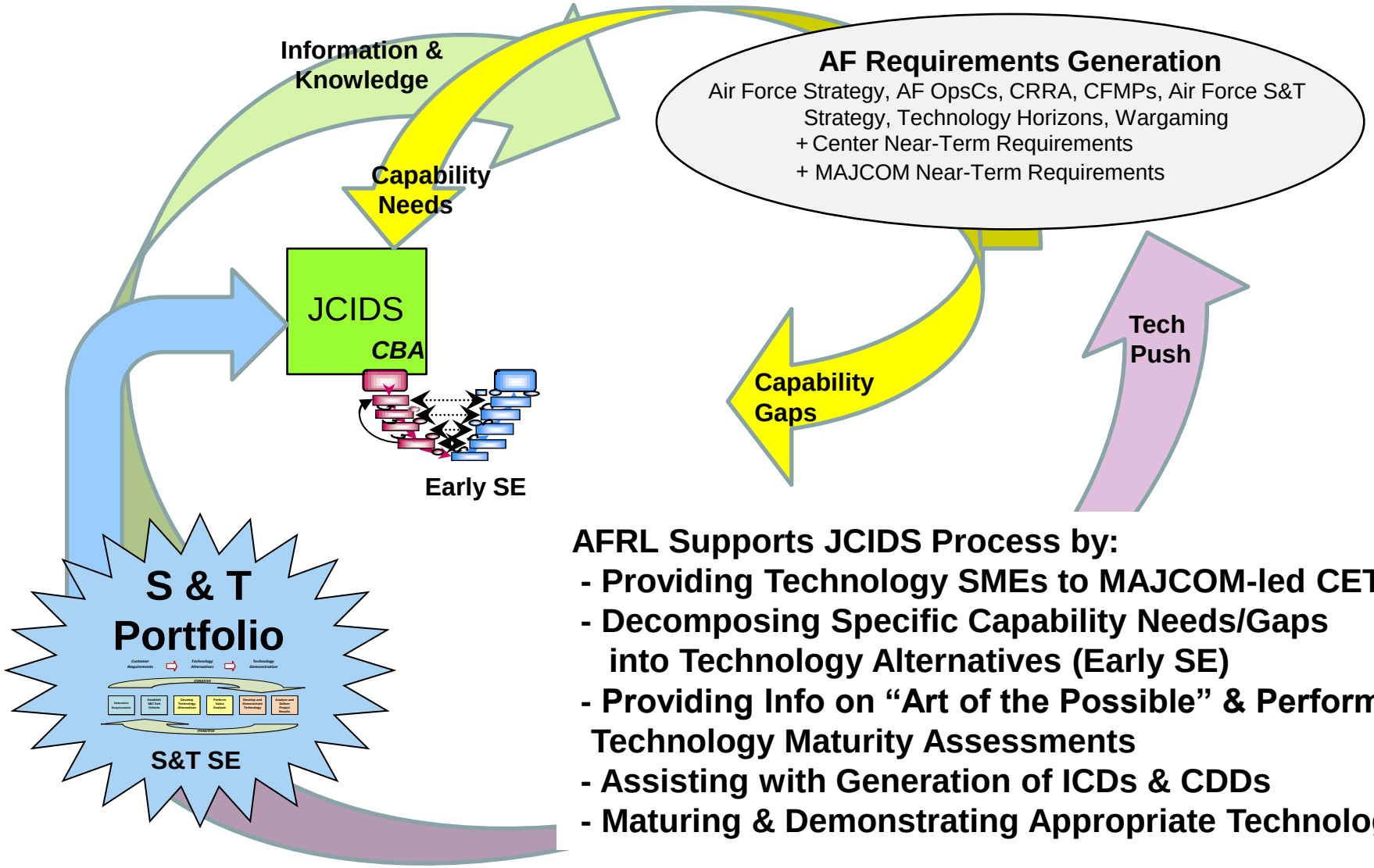
Warfighter Requirements Influence AFRL's S&T Portfolio



AFRL Supports AF Requirements Generation by:

- **Using the S&T IPPD Process to understand customers' needs/requirements and decompose them into technology alternatives**
- **Maturing technologies & demonstrating new capabilities *("Art of the Possible")***
- **Influencing customers' understanding of their capability needs/gaps by providing information/data on the "*Art of the Possible*"**

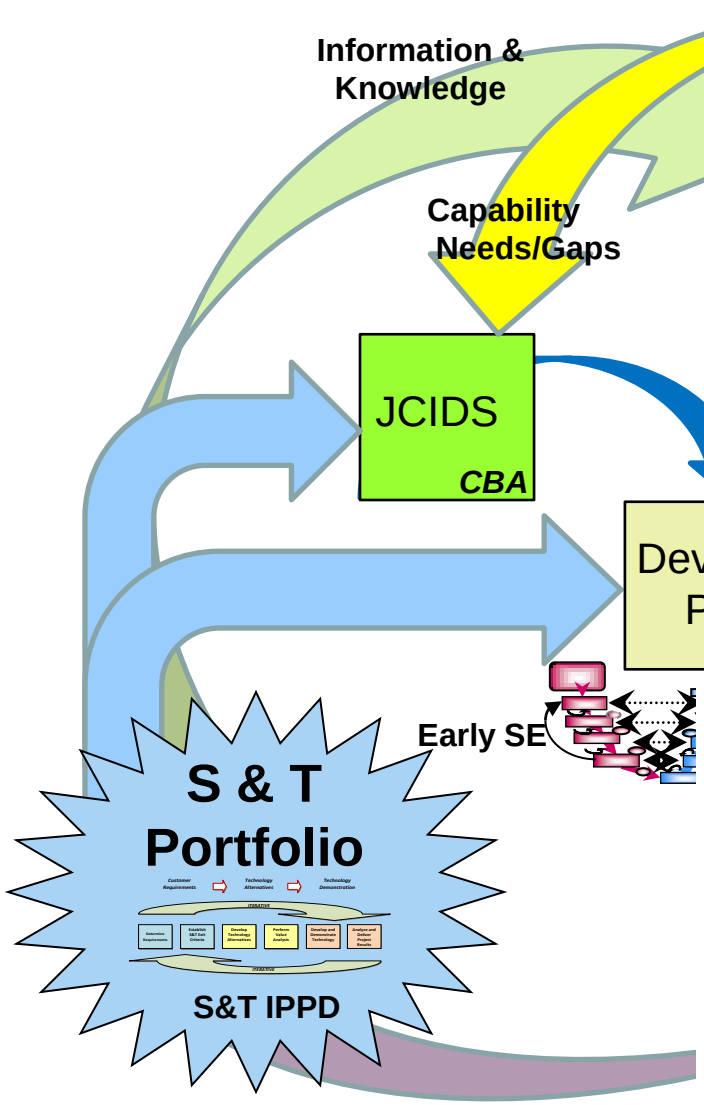
S&T SE: And The Acquisition Life Cycle



AFRL Supports JCIDS Process by:

- Providing Technology SMEs to MAJCOM-led CETs
- Decomposing Specific Capability Needs/Gaps into Technology Alternatives (Early SE)
- Providing Info on "Art of the Possible" & Performing Technology Maturity Assessments
- Assisting with Generation of ICDs & CDDs
- Maturing & Demonstrating Appropriate Technologies

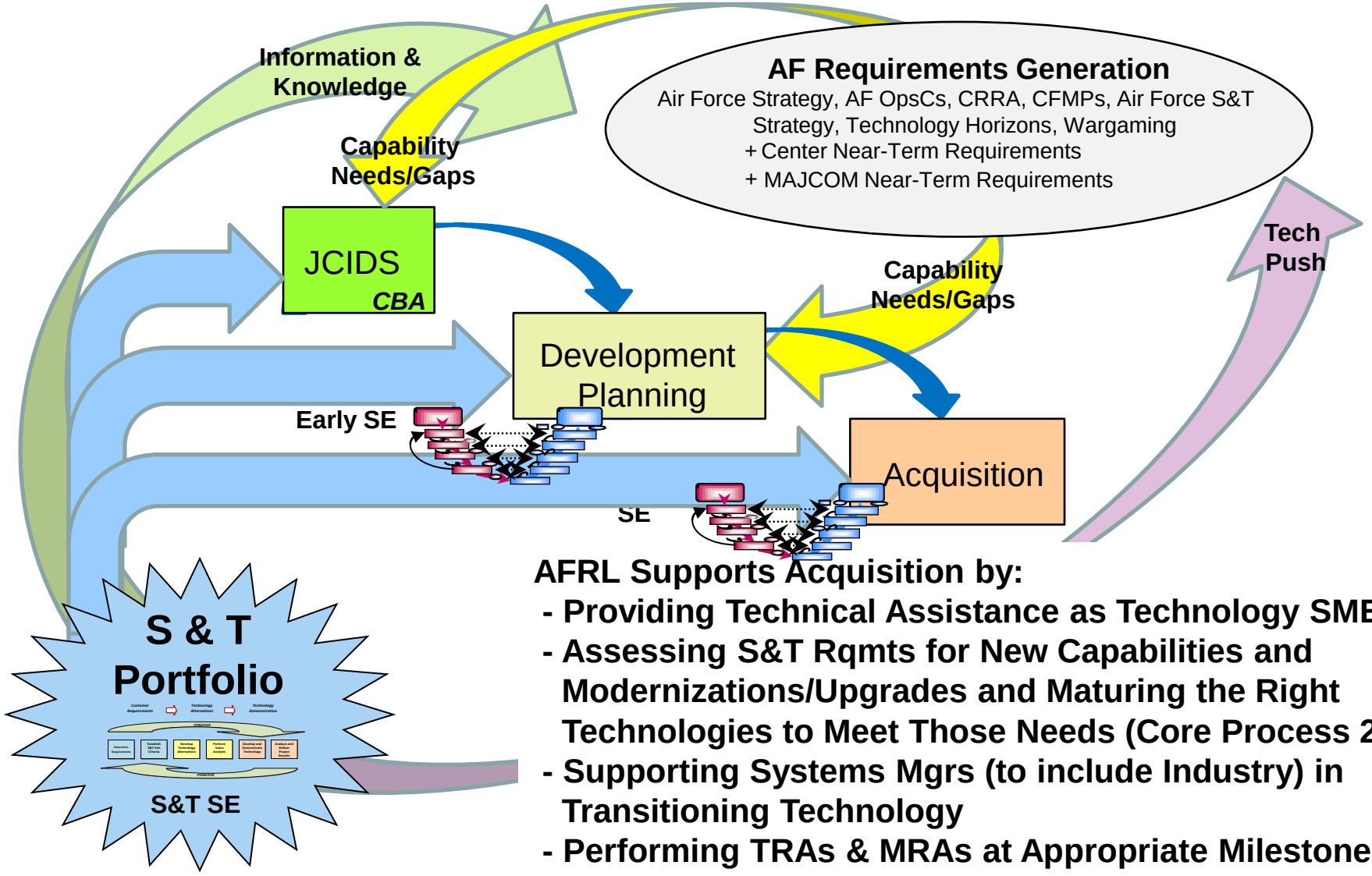
S&T IPPD: And The Acquisition Life Cycle



AFRL Supports DP by:

- **Providing Technology SMEs to XR-led DP Teams**
- **Further Decomposing Needs/Gaps into S&T Reqmts for Materiel Solutions**
- **Assisting with Analytical-Based Decision Assessments, Analysis of Alternatives, Studies and Strategies**
- **Performing Technology and Manufacturing Risk Assessments**
- **Helping Evolve the CCTD into the SRD**

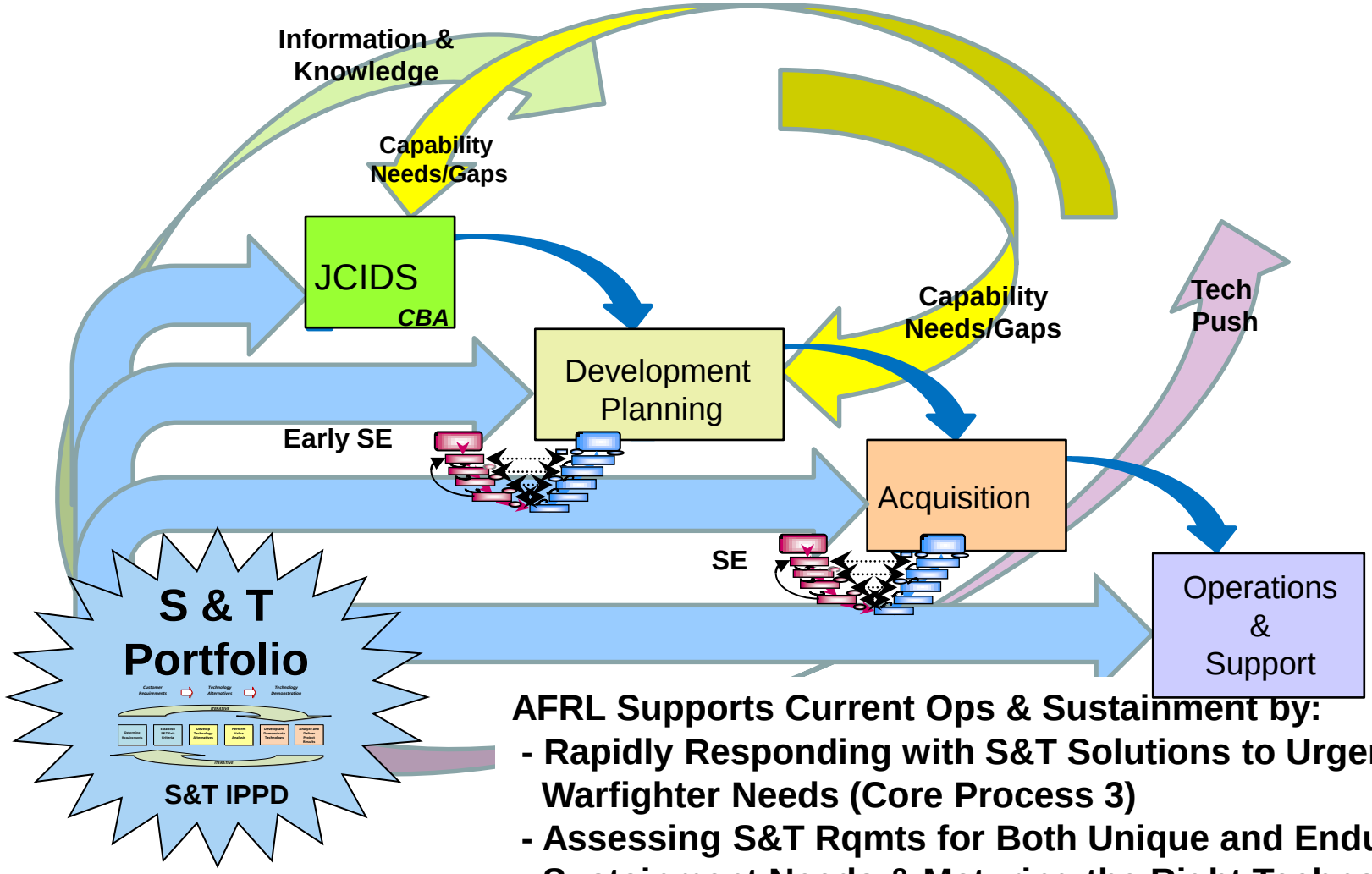
S&T IPPD: And The Acquisition Life Cycle



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

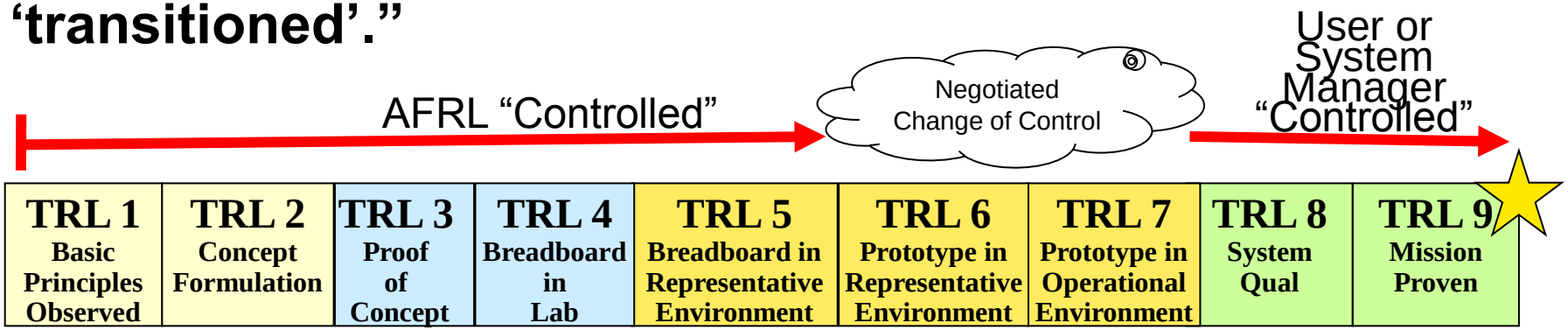


AFRL Supports Current Ops & Sustainment by:

- **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**

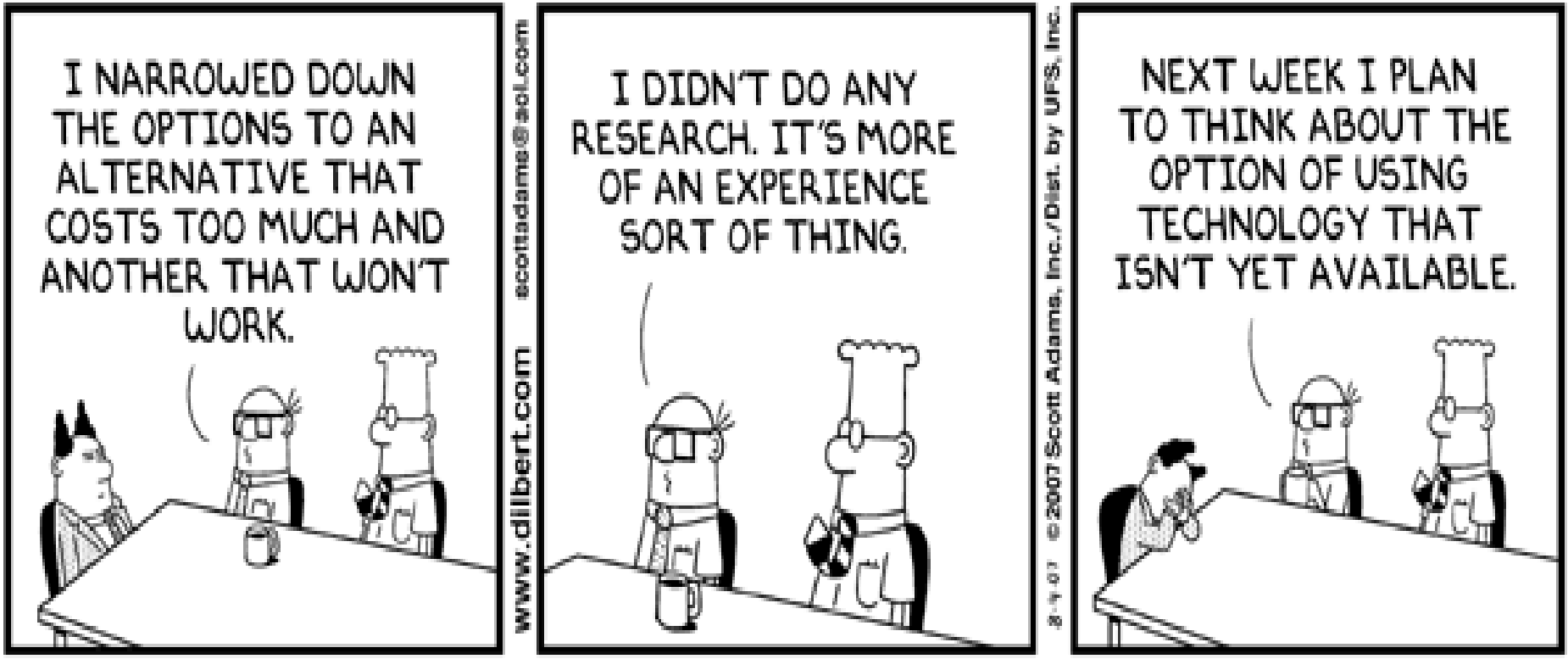
S&T SE:
Must Enable Transition

"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

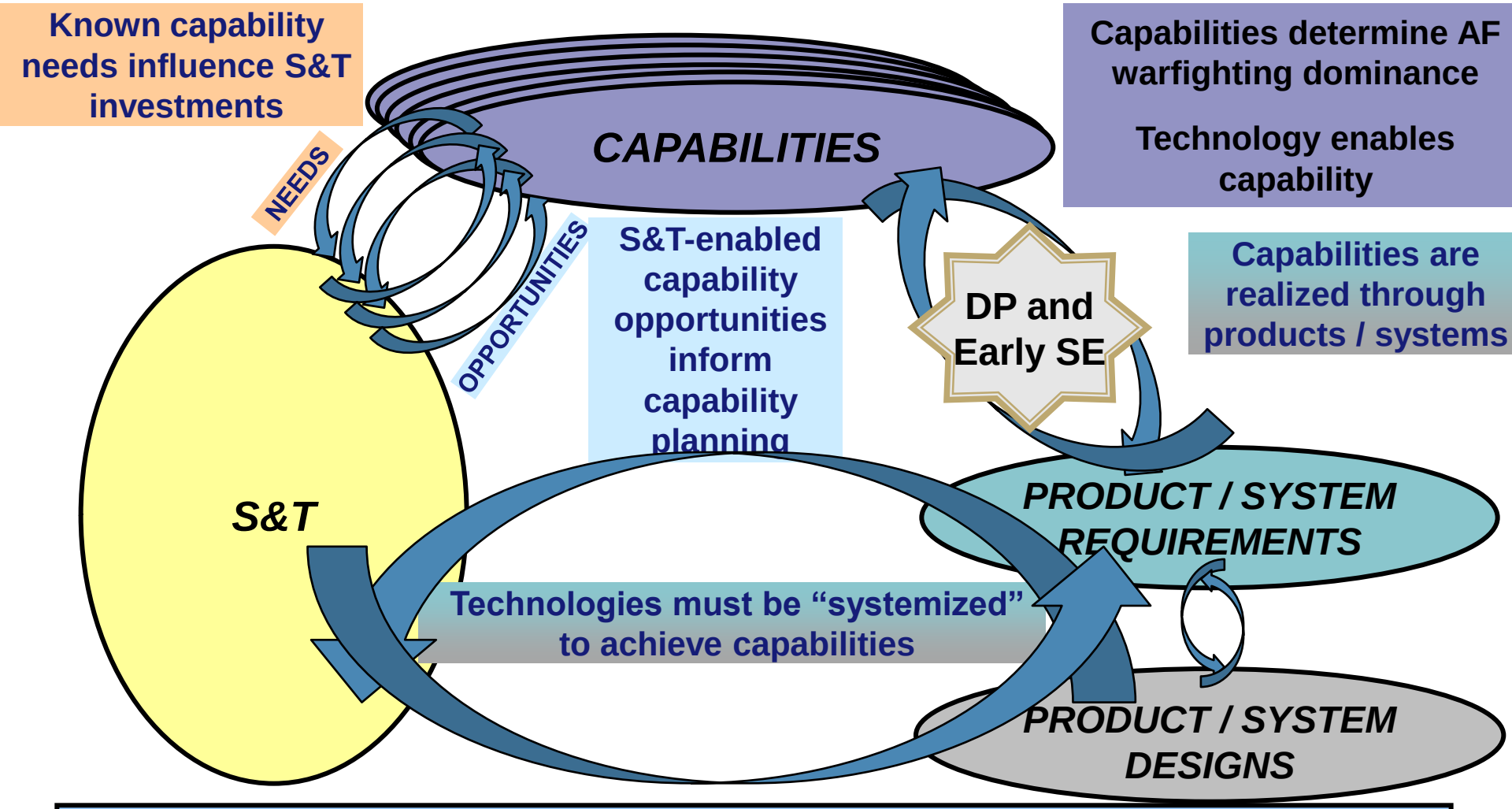
Truth Hurts?



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



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

Summary

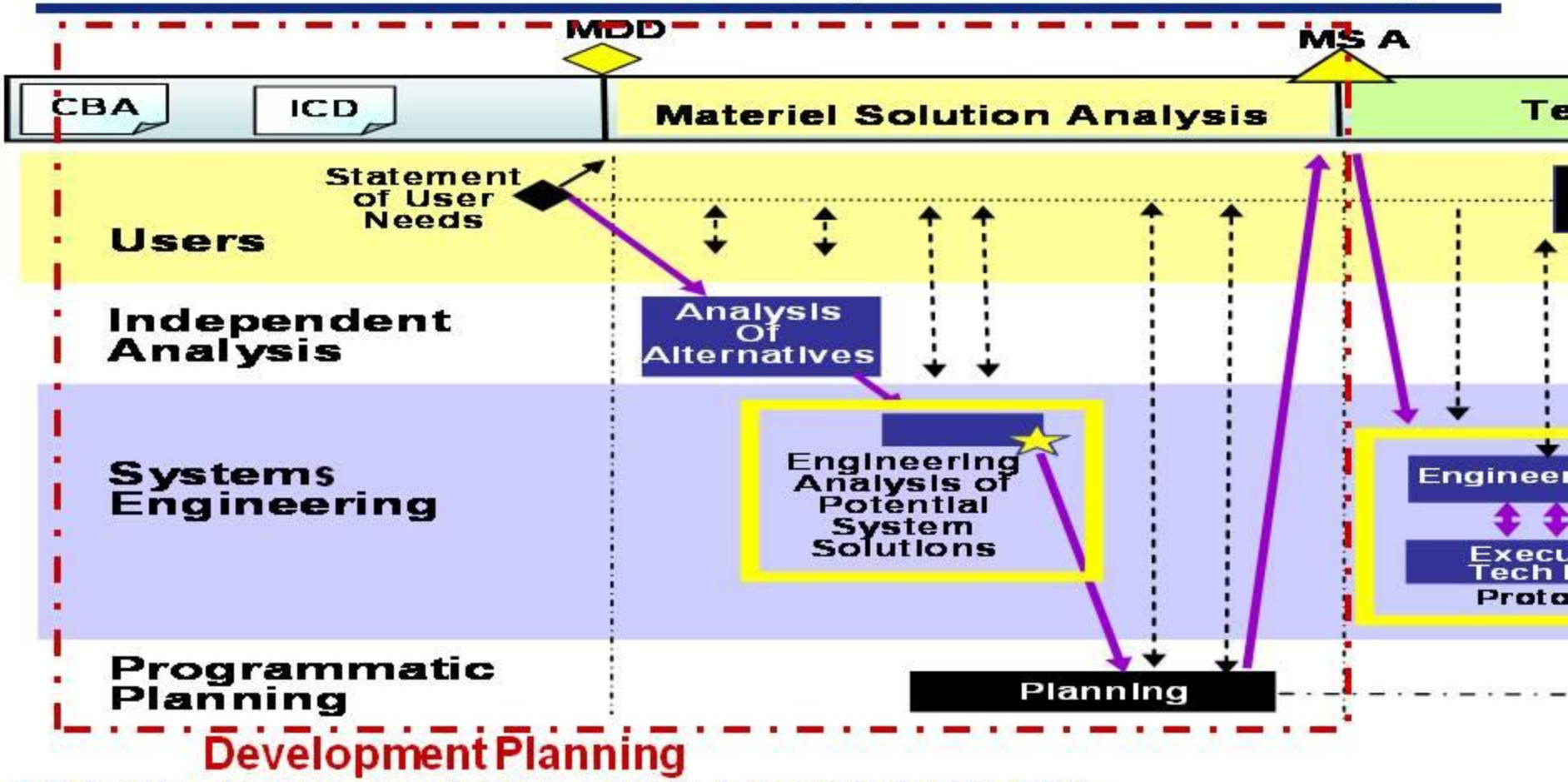
- Warfighters and end users want capability, not technology
- Capability is provided by platforms and systems
- Technology must be “systemized” to be useful
- DP ensures proper pre-acquisition analysis
- S&T informs and enables early SE
- Early SE facilitates DP
- SE facilitates technology transition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

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

Backups

Year of the Air Force
Family

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

- 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))

CCTD IS NOT A REQUIRED MS DECISION DOCUMENT

S&T CCTD

- 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

S&T CCTDs UNDER DEVELOPMENT in AFRL

QUESTIONS ?

Dr. Ken Barker
Chief Engineer
AFRL/XP
937-904-4409
Kenneth.barker@wpafb.af.mil

AFRL
THE AIR FORCE RESEARCH LABORATORY
LEAD | DISCOVER | DEVELOP | DELIVER