Integrity - Service - Excellence

Product Lifecycle Management (PLM) for Systems Engineering support within Expeditionary Combat Support System (ECSS)

NDIA 13th Annual Systems Engineering Conference
27 Oct 2010

Ms. Segrid Harris-Wright, AF/A4IT
Com: 937-904-0855
E-mail: segrid.harris-wright@wpafb.af.mil
Mr. Ron Krugman, CSC
Mr. Edwin W. Kincaid, OC-ALC/ENSN

U.S. AIR FORCE

U.S. AIR FORCE

Outline

- **AF System Engineering Drivers**
- ECSS and PLM Overview
- PLM and SE Sustainment Challenges
- ECSS Blueprinting
- Configuration Management and CMII
- Problem Reporting
- Engineering BP Processes
- System Engineering Benefits/Summary

The Total Weapon System Lifecycle

U.S. AIR FORCE

AF Acquisition Improvement Plan (AIP) & WSARA

U.S. AIR FORCE

Acquisition Improvement Plan

- **Revitalize the Air Force acquisition workforce**
- **Improve requirements generation process**
- Establish clear lines of authority and accountability within acquisition organizations
- **Instill budget and financial discipline**
- **Improve Air Force major systems source selections**

Weapon System Acquisition Reform Act (PL 111-23) Sec. 102 Directors of Developmental Test and Evaluation and Systems Engineering

(a) In General

§ 139d. (b) (5) Director of Systems Engineering shall

(D) provide advocacy, oversight, and guidance to elements of the acquisition workforce responsible for systems engineering, development planning, and lifecycle management and sustainability functions;

(E) provide input on the inclusion of systems engineering requirements in the process for consideration of joint military requirements by the Joint Requirements Oversight Council …

(b) Developmental Test and Evaluation and Systems Engineering in the Military Departments

(1) Plans. -- The(SAE) … shall develop and implement plans to ensure the military department … has provided appropriate resources for …

(B) Development planning and systems engineering organizations with adequate numbers of trained personnel in order to

(i) support key requirements, acquisition, and budget decisions made for each major defense acquisition program prior to Milestone A approval and Milestone B approval through a rigorous systems analysis and systems engineering process; …

(iii) identify systems engineering requirements, including reliability, availability, maintainability, and lifecycle management and sustainability requirements, during the Joint Capabilities Integration Development System process, and incorporate …into contract requirements …

Secretary of Defense Direction

U.S. AIR FORCE

Chief among institutional challenges facing the Department is acquisition."

"First, this department must consistently demonstrate the commitment and leadership to stop programs that significantly exceed their budget or which spend limited tax dollars to buy more capability than the nation needs…

Second, we must ensure that requirements are reasonable and technology is adequately mature to allow the department to successfully execute the programs…

Third, realistically estimate program costs, provide budget stability for the programs we initiate, adequately staff the government acquisition team, and provide disciplined and constant oversight.

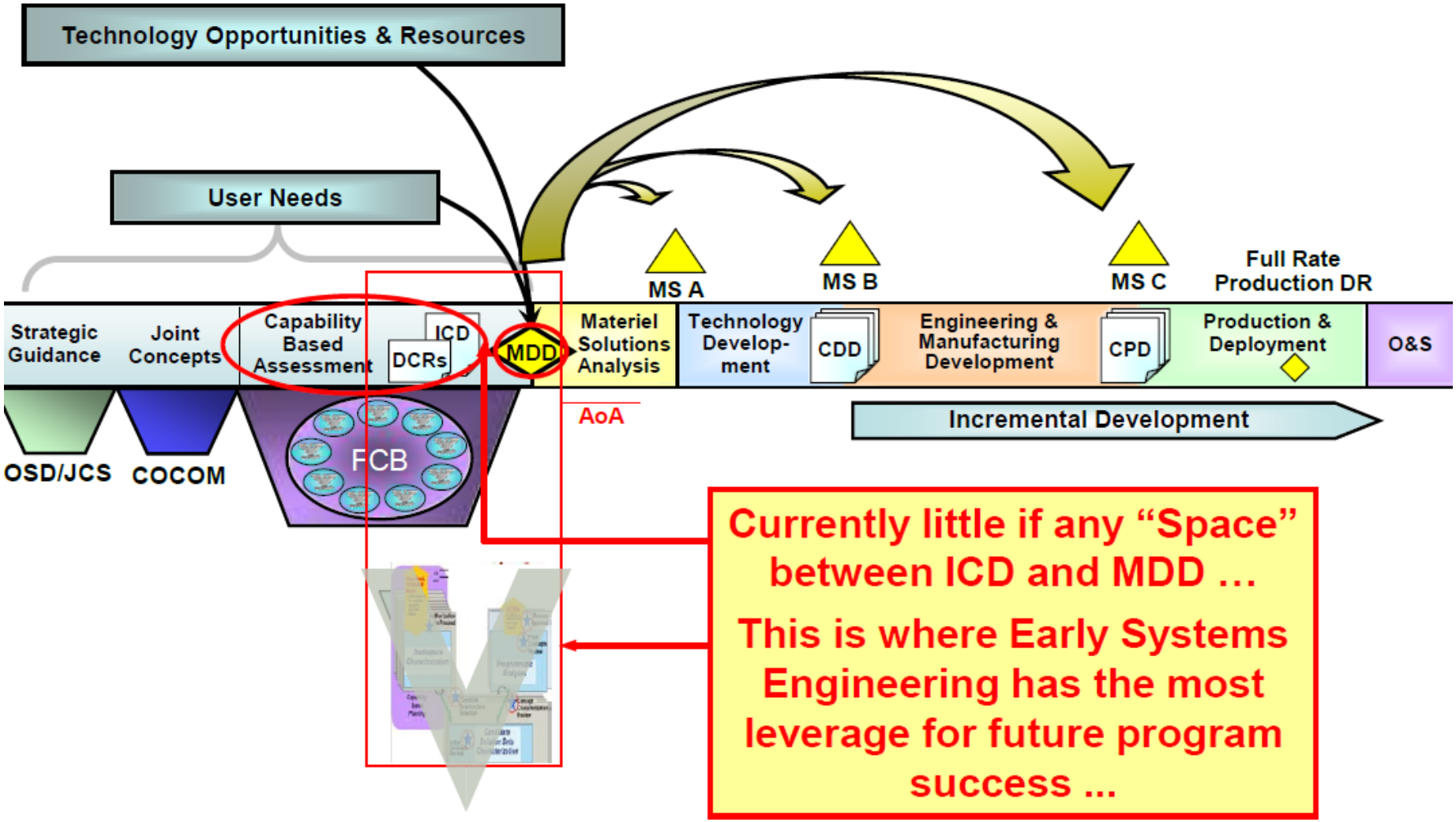
We must constantly guard against so-called "requirements creep," validate the maturity of technology at milestones, fund programs to independent cost estimates, and demand stricter contract terms and conditions."

Secretary of Defense Robert M. Gates

U.S. AIR FORCE

Current State

Filling the Gap Between CBA and MDD



Currently little if any "Space" between ICD and MDD …

This is where Early Systems Engineering has the most leverage for future program success …

U.S. AIR FORCE

Outline

- AF System Engineering Drivers
- **ECSS and PLM Overview**
- PLM and SE Sustainment Challenges
- ECSS Blueprinting
- Configuration Management and CMII
- Problem Reporting
- Engineering BP Processes
- System Engineering Benefits/Summary

U.S. AIR FORCE

What is ECSS?

- **ECSS and PLM initiatives are part of the eLog21 transformation campaign that will integrate Air Force supply chain operations**

eLog21:

Expeditionary Logistics for the 21st Century (eLog21) campaign, will transform Air Force Logistics to improve support of the War fighter.

ECSS:

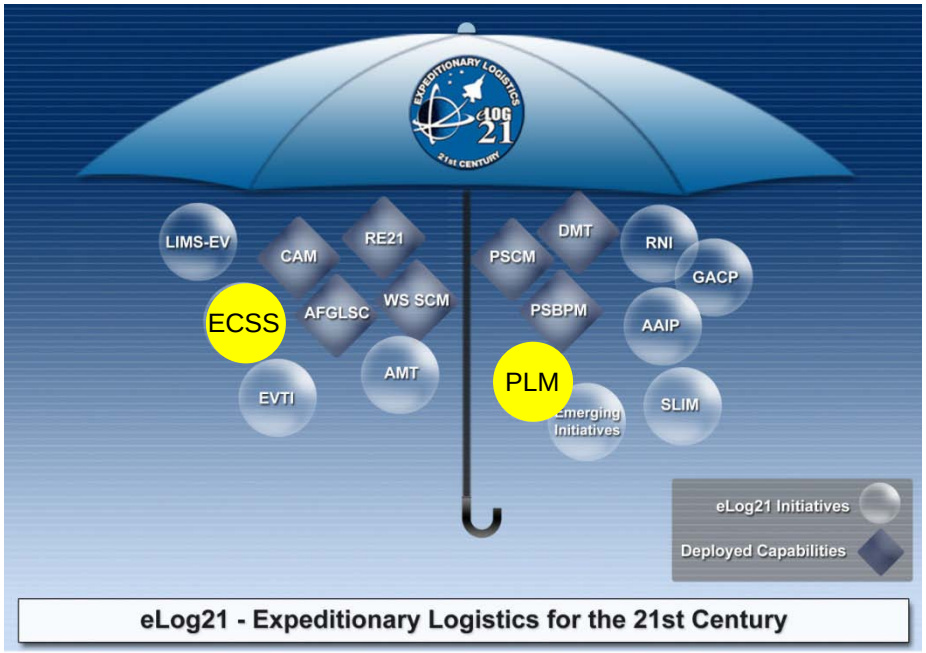
Cornerstone for eLog21. The eLog21 initiatives will be enabled by ECSS not just because ECSS provides a common IT infrastructure, but because ECSS will transform the way the Air Force Logistics community does business

Enterprise Resource Planning (ERP):

ECSS is AF Logistics ERP. A commercial, off-the-shelf (COTS) software product for horizontal integration of business operations

Product Lifecycle Management (PLM):

Process of managing the entire lifecycle of a product from its conception, through design and manufacture, to service and disposal



eLog21 - Expeditionary Logistics for the 21st Century

U.S. AIR FORCE

ECSS PLM Overview

- Is an enabling technology based on **industry's best practices** to support total lifecycle systems management
- Provides a closed loop, **CMII compliant process**
- Provides a **single authoritative source** with effective configuration management of product information
- **Tracks configurations** and attributes of a weapon system and its subassemblies and components
- Accurately **captures the design** from initial concepts to the as-built, as-operated and as-maintained configurations
- Assures the **data is available** for all users facilitating cost effective sustainment of USAF combat capabilities
- Facilitates **reuse of information** for future acquisition efforts such as major system modifications

U.S. AIR FORCE

PLM's Roles

D&SWS Business Intelligence

Weapon System/Program Performance Scorecards

Service Requests

AQ

- DOD 5K
- Programs
- Budgets
- Quality
- Schedule
- Cost

- Requirements
- DODAF
- Capabilities
- Testing
- Life cycle Plans
- Re-use
- Performance
- Compliance
- RISK

Source

- Contracts
- Purchase order
- Purchase Request
- Indirect sourcing

- Technical Specs
- Manufacture Sources
- **Technical Packages**
- Product Quality
- KPP/KPA

Del/Rtn

- Inventory
- Warehousing
- Distribution
- Logistics
- Transport

- **Supplier integration**
- Warranty
- Materials Handling
- Storage Specs
- Kitting

Make/Repair

- Asset Configuration
- Work Order Planning
- Resource Mgmt
- Maintenance History
- Serialization
- Equipment & Facilities
- Asset mgmt.
- Work Plan & Execute

- Bills of Material
- Maintenance Programs
- Engineering Drawings
- Engineering Specs
- **Technical Orders & TCTO's**

- Assistance Request
- **Configurations & Modifications**
- Job Standards & Controls

Plan

- Demand Plan
- Supply Plan
- Deployment Planning
- Resource & Equipment Planning

- **Obsolescence**
- Resources,
- Facilities, & Equipment
- Capacity Factors

SLIM

- Structures
- Engines
- Electronics
- RCM
- CBM+

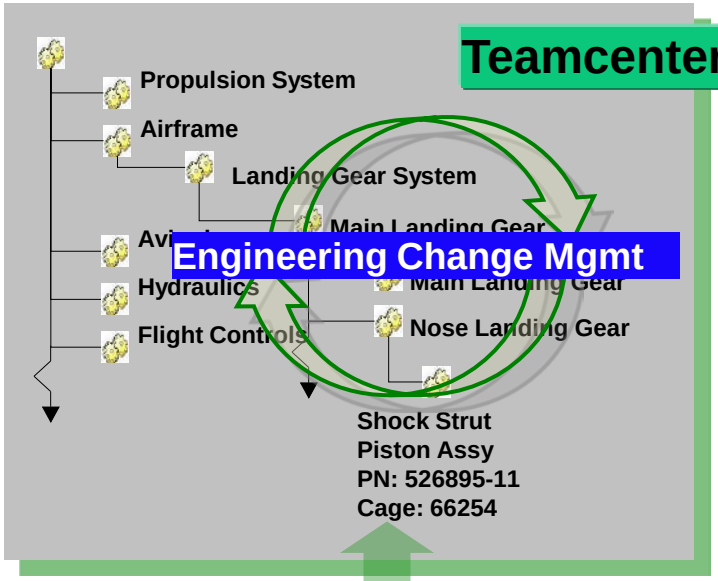
- Root-Cause
- **Reliability**
- **Performance**

Core ERP Processes

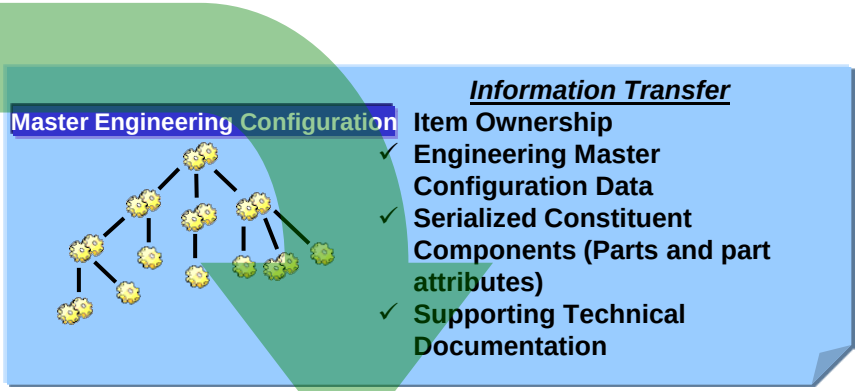
PLM

ECSS Operational Model

U.S. AIR FORCE



SIEMENS



Configuration Change Request

Oracle Product Suite

Maintenance Planning and Execution

Enterprise Resource Planning/Execution

Advanced Planning and Scheduling

ORACLE

Outline

- AF System Engineering Drivers
- ECSS and PLM Overview
- **PLM and SE Sustainment Challenges**
- ECSS Blueprinting
- Configuration Management and CMII
- Problem Reporting
- Engineering BP Processes
- System Engineering Benefits/Summary

U.S. AIR FORCE

Bottom Line Up Front

- The Air Force requires new end-to-end Sustainment Engineering capabilities within the core ECSS functionality
- The architecture for PLM will use a two-system approach
  - Engineering community Teamcenter
  - Logistics community Oracle
- The scope of PLM covers activities after Milestone C
- ECSS Planning and Maintenance require Bills of Materials
  - PLM provides configuration management of BOMs

PLM & SE Challenges Today

U.S. AIR FORCE

Lack of Enterprise Config Mgmt Process

- Each weapon system has unique configuration management processes

No Common Intelligent Product Data Formats

- Product data formats and systems to manage product data are not standardized

Not Buying the Correct Data

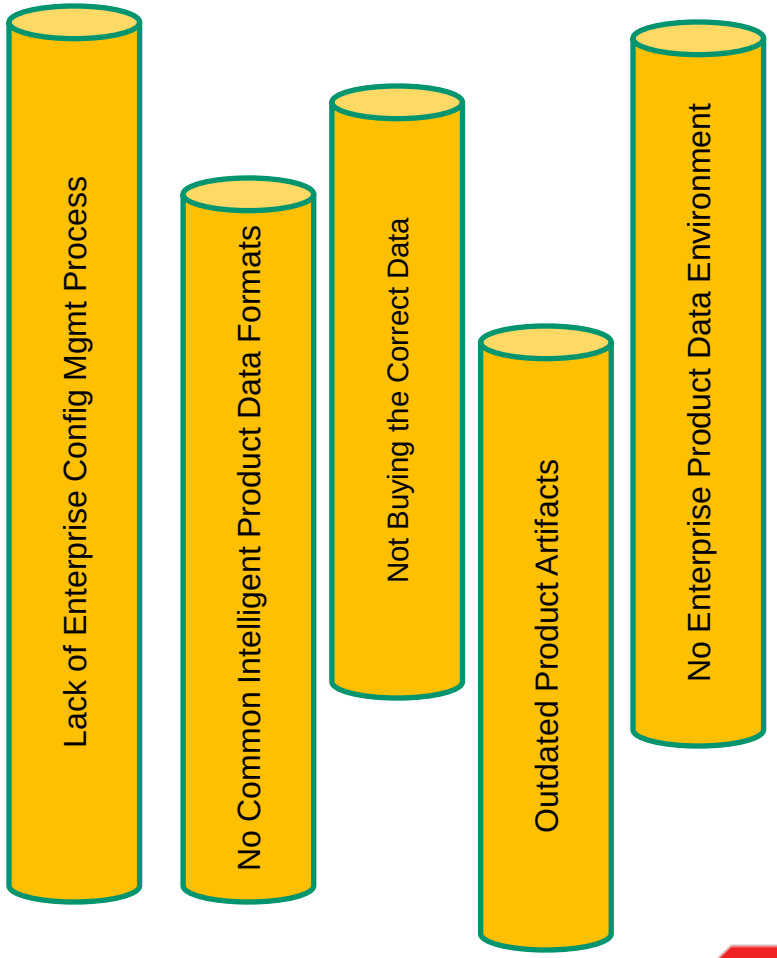
- Rights to technical data are not considered to reduce lifecycle costs
- Not buying complete data

Outdated Product Artifacts

- Product data is primarily image-based formats even when OEMs are utilizing 3D CAD models and structured content

No Enterprise Product Data Environment

- Silos of data exist; no enterprise visibility



ECSS PLM SE for the Future

U.S. AIR FORCE

Common Config Mgmt Process

- Single CMII Based Product Management Process
- Standardized Practices and procedures

Standard Product Data Formats

- Common Product Data Exchange with Vendors
- Standardized Data across Weapon Systems

Buying the Correct Data

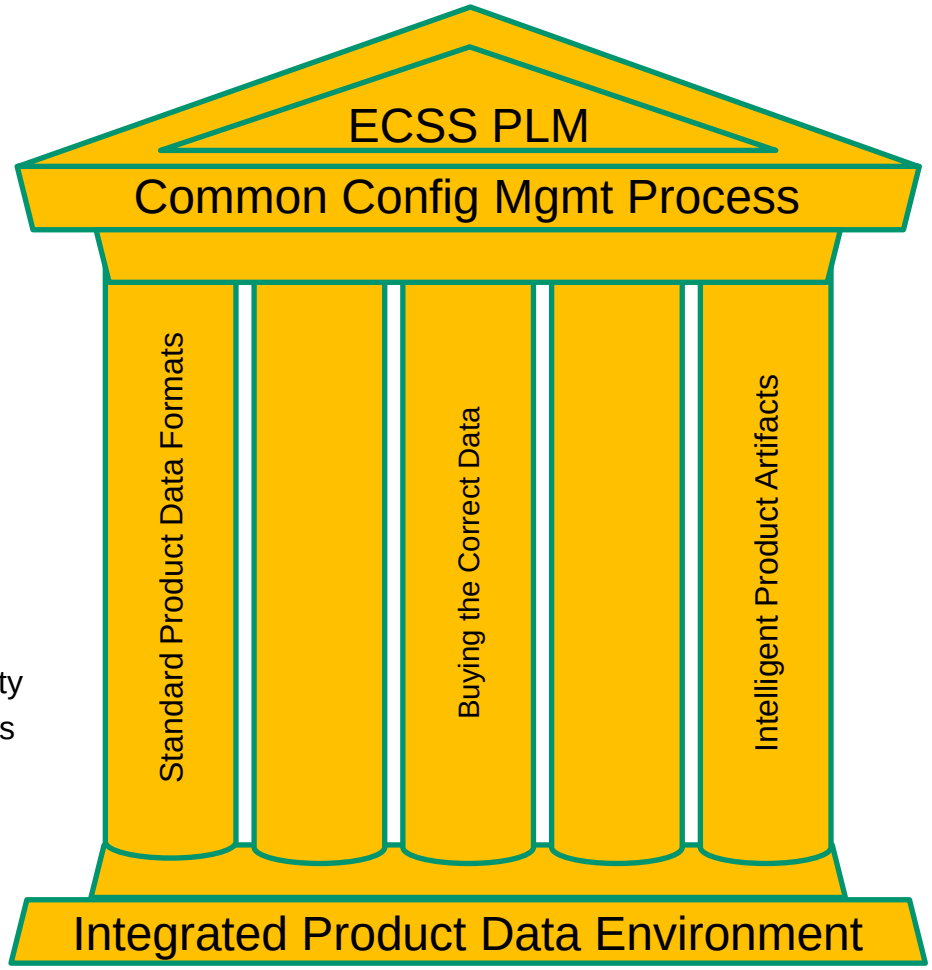
- Adopt A&D industry standards
- Reduction in OSS&E Costs

Intelligent Product Artifacts

- Database driven Functional Capability
- Integrated Artifact Data Relationships

Integrated Product Data Environment

- Accurate, timely and efficient data management
- Product Data (CAx, BOM, and Content)
- Common Functional Interface



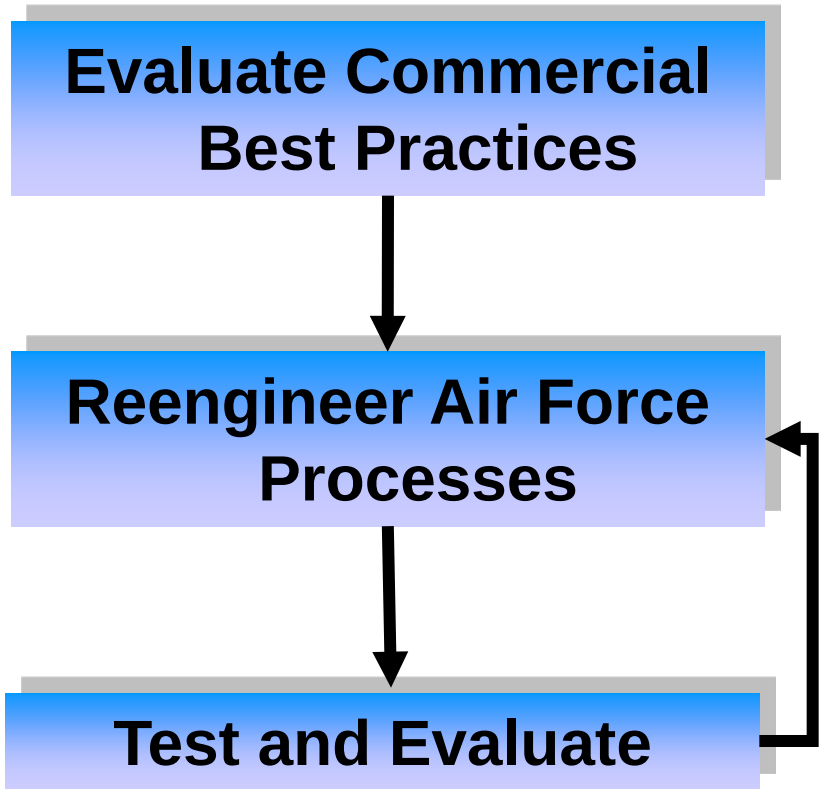
U.S. AIR FORCE

Outline

- AF System Engineering Drivers
- ECSS and PLM Overview
- PLM and SE Sustainment Challenges
- **ECSS Blueprinting**
- Configuration Management and CMII
- Problem Reporting
- Engineering BP Processes
- System Engineering Benefits/Summary

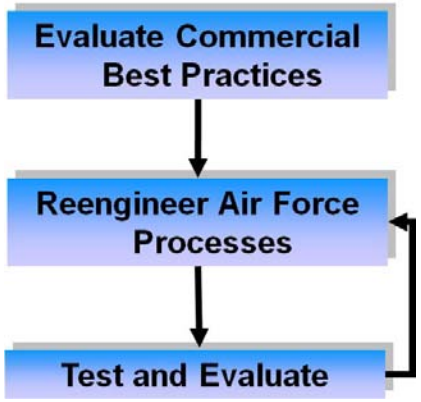
ECSS Blueprinting Process

U.S. AIR FORCE



ECSS Blueprinting Process

U.S. AIR FORCE



Objectives:

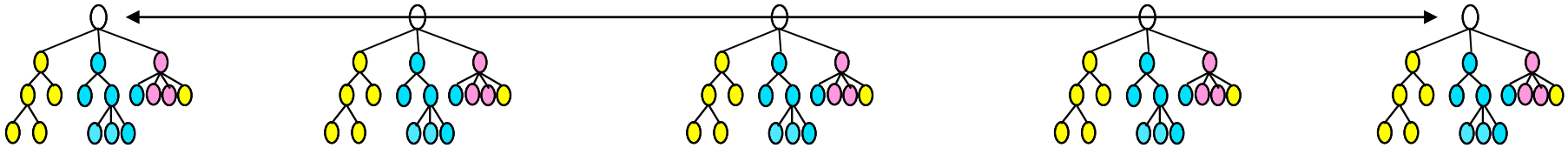
- Core SE Processes in Place and Practiced
  - Requirements
  - Project Management
  - SE "V" Model
- Provide Repeatable SE "Best Practices" Process
- Improve Program Performance & Reduce Technical Risk
- Implement Industry Best Practices
  - CMMI
  - CMII
  - ISO/IEEE
  - INCOSE
  - Defense Acquisition Guidebook
  - PMBOK
- Incorporate US Government SE and related Standards
  - AFI 63-1201 Life Cycle Systems Engineering & OSS&E
  - MIL-STD 499B Systems Engineering
  - AF SEAM

U.S. AIR FORCE

PLM Premise

– *The primary objective of PLM in the logistics domain is to establish a single-source of authoritive product data via integrated Bill of Material Configuration Management through the product lifecycle.*

Engineering | Provisioning | Advanced Planning And Scheduling | Supply Chain Management | Maint/Repair and Overhaul



Integrated Engineering Change Control Process

Revision-controlled weapon system documentation

- Engineering Drawings
- System Specifications
- Technical Orders
- Product Support Documentation
- Parts and Items Data
- Deficiency Reports
- Maintenance Plans
- Safety Data
- Operational Requirements
- Acquisition Documentation
- Air Worthiness Documentation
- OSS&E Documentation

U.S. AIR FORCE

Outline

- AF System Engineering Drivers
- ECSS and PLM Overview
- PLM and SE Sustainment Challenges
- ECSS Blueprinting
- **Configuration Management and CMII**
- Problem Reporting
- Engineering BP Processes
- System Engineering Benefits/Summary

U.S. AIR FORCE

PLM And Derived Configurations

Derivative Configurations (BOMs)

Engineering/Master Configuration
(Supports Engineering)

Product Structure Breakdown

C-130

- Propulsion System
- Airframe
- Landing Gear System
  - Main Landing Gear
  - Main Landing Gear
  - Nose Landing Gear
    - Shock Strut Piston Assy
- Avionics
- Hydraulics
- Flight Controls

PLM

Model/Serialized Specific Configuration
(Supports Provisioning, APS, SCM)

Product Structure Breakdown

C-130H

- Propulsion System
- Airframe
- Landing Gear System
  - Main Landing Gear
  - Main Landing Gear
  - Nose Landing Gear
    - Shock Strut Piston Assy
      PN: 526895-11
      Cage: 66254
- Avionics
- Hydraulics
- Flight Controls

Aircraft/Tail Number Specific Configuration
(Supports MRO)

Product Structure Breakdown

C-130H Tail Number 2245

- Propulsion System
- Airframe
- Landing Gear System
  - Main Landing Gear
  - Main Landing Gear
  - Nose Landing Gear
    - Shock Strut Piston Assy
      PN: 526895-11
      Cage: 66254
      SERNO: 114245
- Avionics
- Hydraulics
- Flight Controls

ERP/MRO/APS

Increased Granularity

What is in CMII?

CMII is an integration of configuration management and other closely related activities as shown below.

CMII

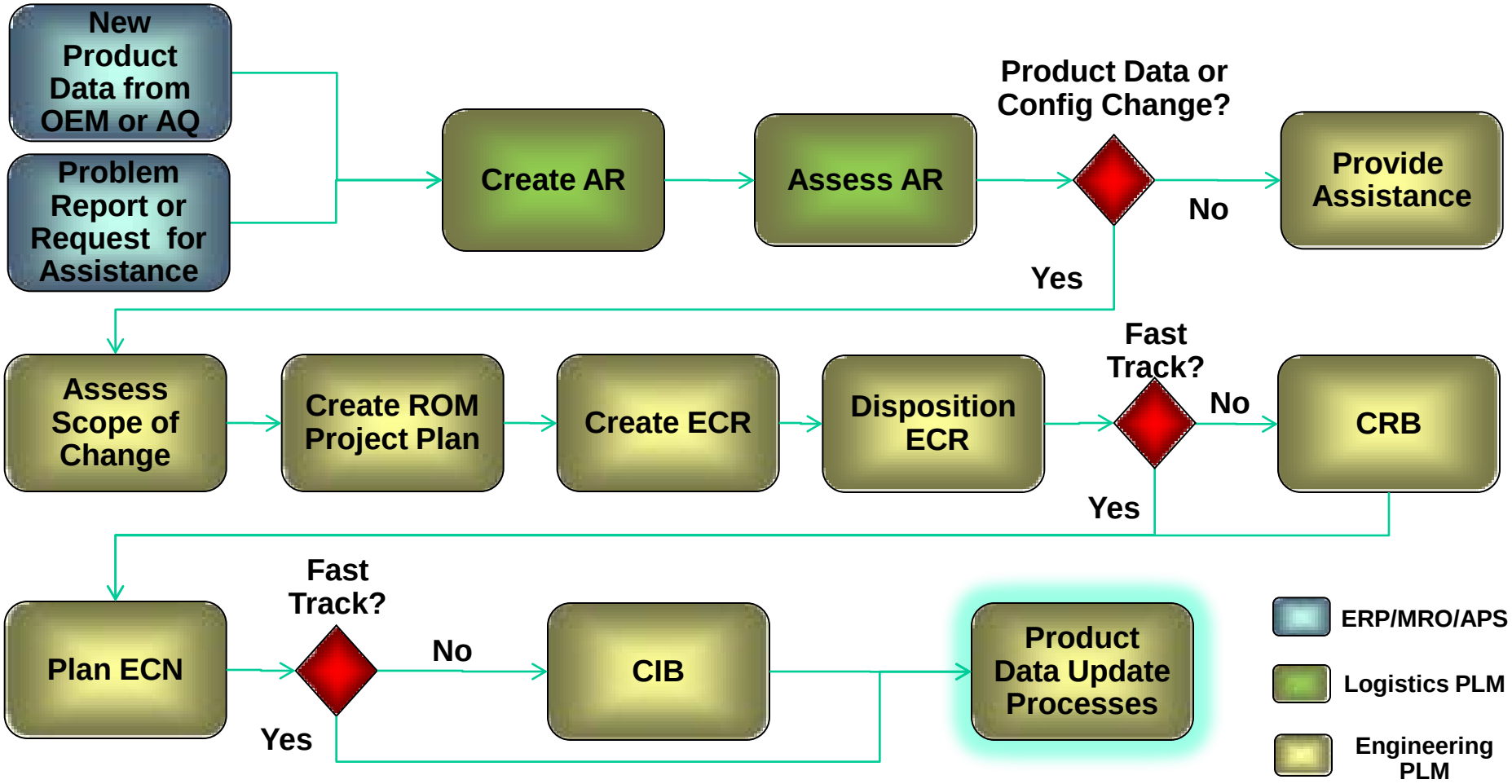
Configuration Management:	*Ensures that configurations conform to released requirements;*
Requirements Management:	*Ensures that documented requirements are clear, concise and valid;*
Release Management:	*Ensures that documents are authorized and released prior to use;*
Change Management:	*Keeps released documents and data up to date;*
Data Management:	*Ensures data bases are accurate and deliverable data is secure;*
Records Management:	*Retains traceability of work and proof that work products conform;*
Document & Library Control:	*Protects knowledge assets and prevents unauthorized changes;*
Enabling Software Tools:	*Serve to enhance overall process reliability and efficiency.*

Outline

- AF System Engineering Drivers
- ECSS and PLM Overview
- PLM and SE Sustainment Challenges
- ECSS Blueprinting
- Configuration Management and CMII
- **Problem Reporting**
- Engineering BP Processes
- System Engineering Benefits/Summary

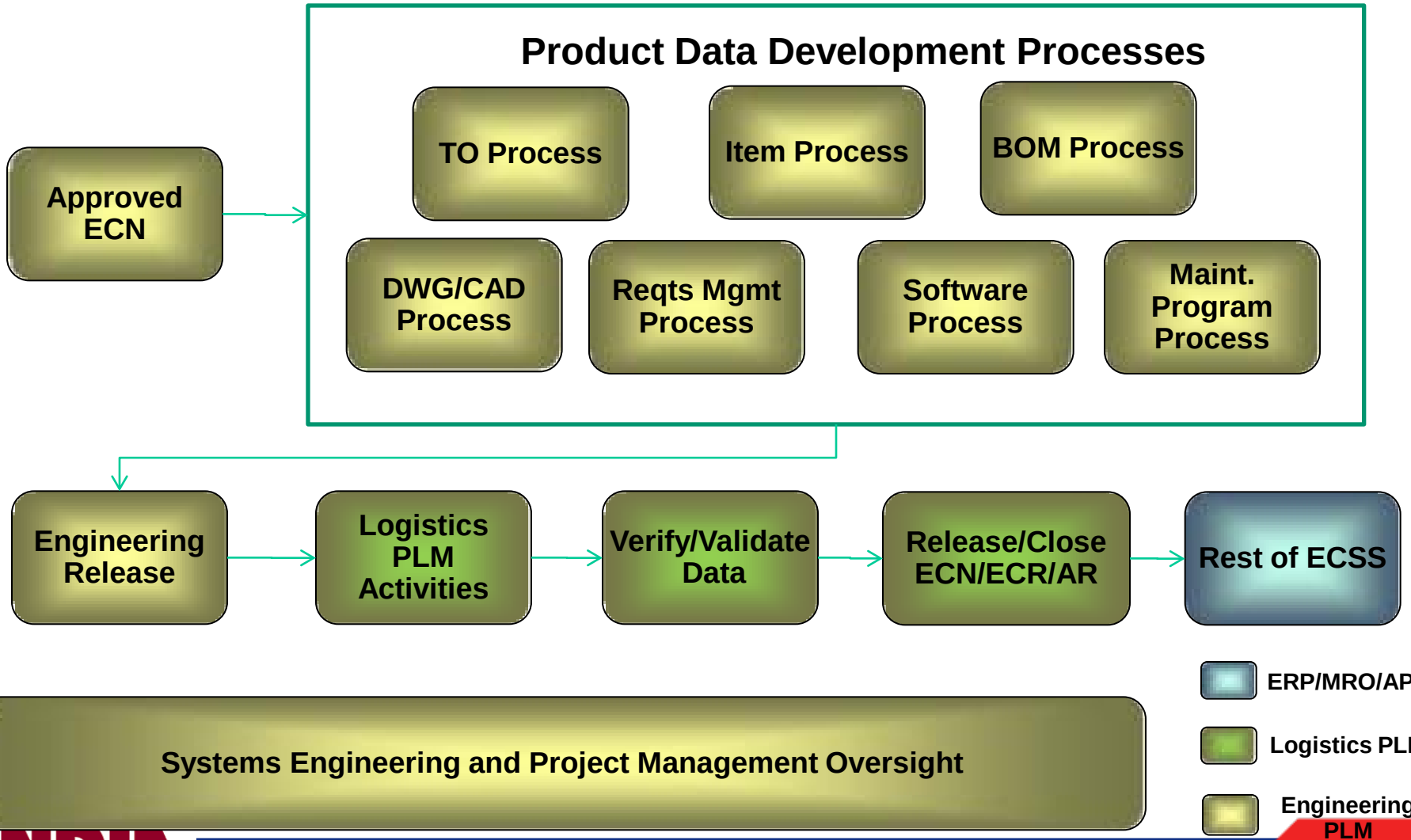
U.S. AIR FORCE

PLM Process Model: Change Management



U.S. AIR FORCE

PLM Process Model
Product Data Update and Release



U.S. AIR FORCE

Outline

- AF System Engineering Drivers
- ECSS and PLM Overview
- PLM and SE Sustainment Challenges
- ECSS Blueprinting
- Configuration Management and CMII
- Problem Reporting
- **Engineering BP Processes**
- System Engineering Benefits/Summary

U.S. AIR FORCE

Ensure SE Processes & Techniques

- Implement Weapon Systems Acquisition Reform Act 2009
  - Focus is on AF Sustainment (After Milestone C)
  - Some ALC Engineering Projects will be supported pre Milestone C
    - Local and AFRL collaborated R&D Projects
    - ALC Managed implementing Major Command Modification directed Projects
- Provide SE Processes tailored as needed to support sustainment activities
  - Maintenance Requests
  - Deficiency Reports
  - Airworthiness
  - Product Improvements

U.S. AIR FORCE

Ensure OSS&E

- **Implementation of AFMCI 63-1201 (OSS&E and Life Cycle Systems Engineering)**
  - ***Operational Safety*, *Suitability* and *Effectiveness* (OSS&E) defines a process for establishing and preserving the safety, suitability, and effectiveness of Air Force systems and end-items over their entire operational life by preserving technical integrity via prudent use of disciplined engineering practices**
  - ***Disciplined Engineering Process* - A disciplined engineering process must be implemented to ensure that activities such as operational use, configuration changes, maintenance repairs, and part/software substitutions or upgrades do not degrade OSS&E characteristics over the operational life of the system or end-item**

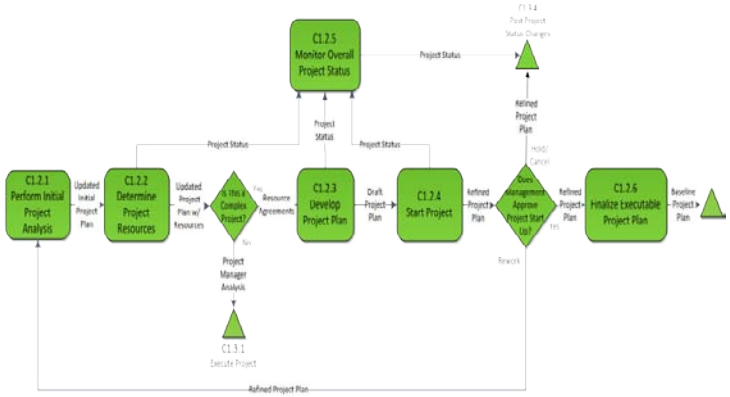
U.S. AIR FORCE

AF Systems Engineering Assessment Model (SEAM)

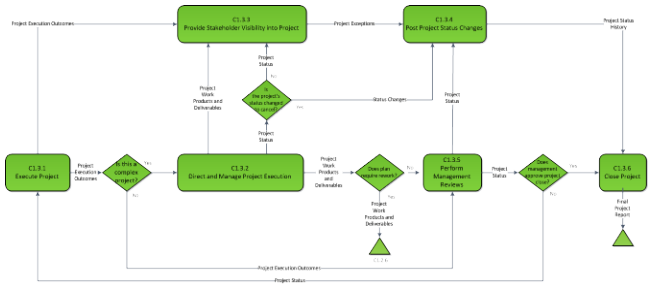
- **Definition of AF Systems Engineering Assessment Model:**
  - **A single AF-wide tool which can be used for the assessment and improvement of systems engineering processes in a program/project.**
- **Applying SEAM Model Goals**
  - **Ensure a Consistent Understanding of SE**
  - **Ensure Core SE Processes are in Place and Being Practiced**
  - **Document repeatable SE "Best Practices" across AF**
  - **Identify Opportunities for Continuous Improvement**
  - **Clarify Roles and Responsibilities**
  - **Improve Program Performance & Reduce Technical Risk**

Supporting SE Processes

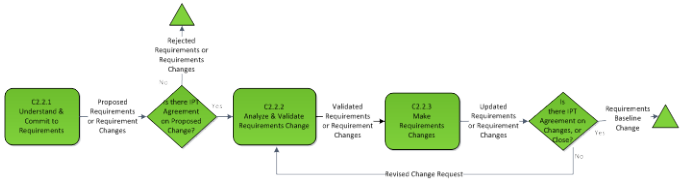
U.S. AIR FORCE



- Project Management – Planning
  - Scope
  - WBS
  - Cost Estimates

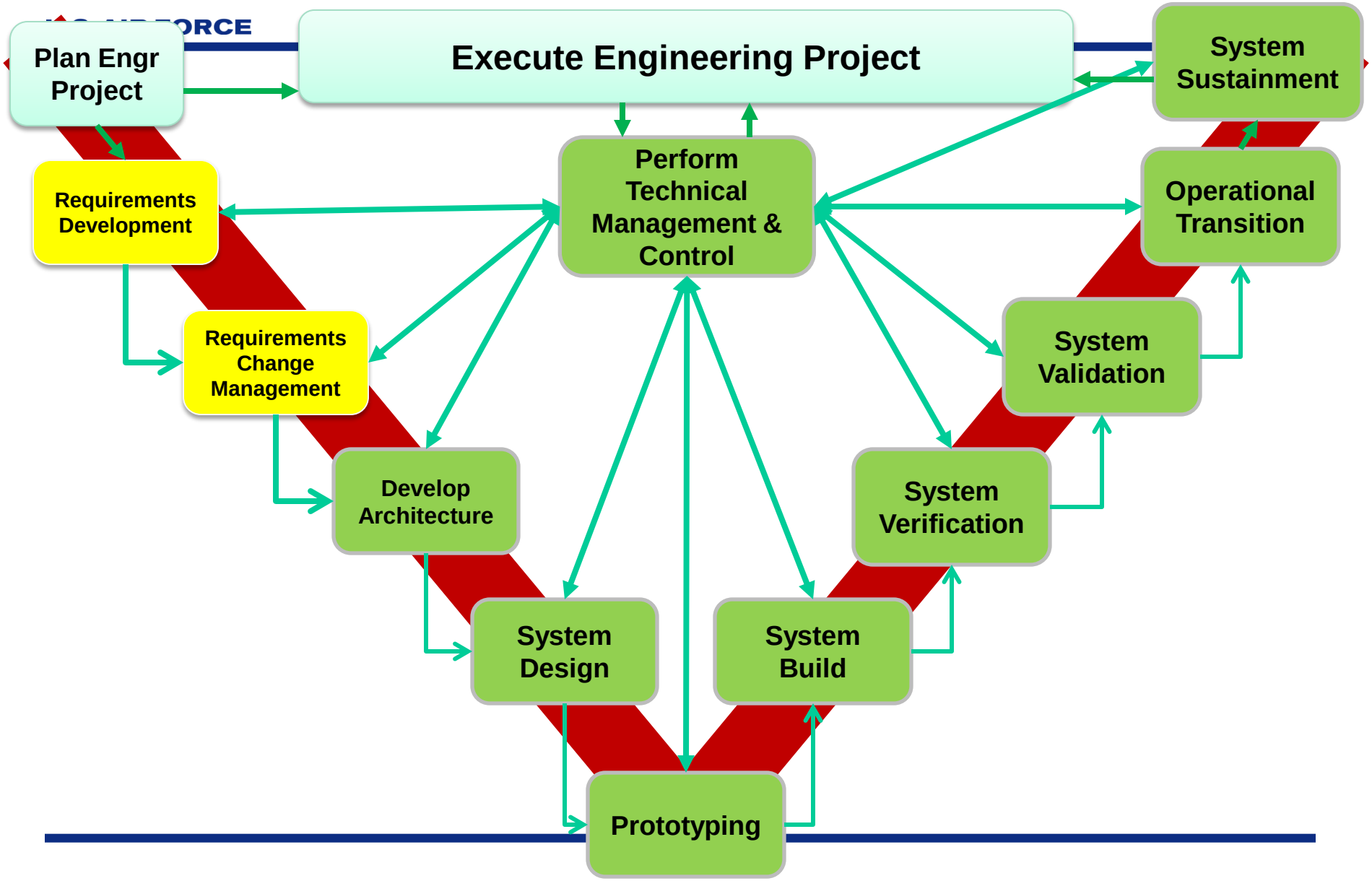


- Project Management – Execute
  - Monitor
  - Schedule
  - Performance



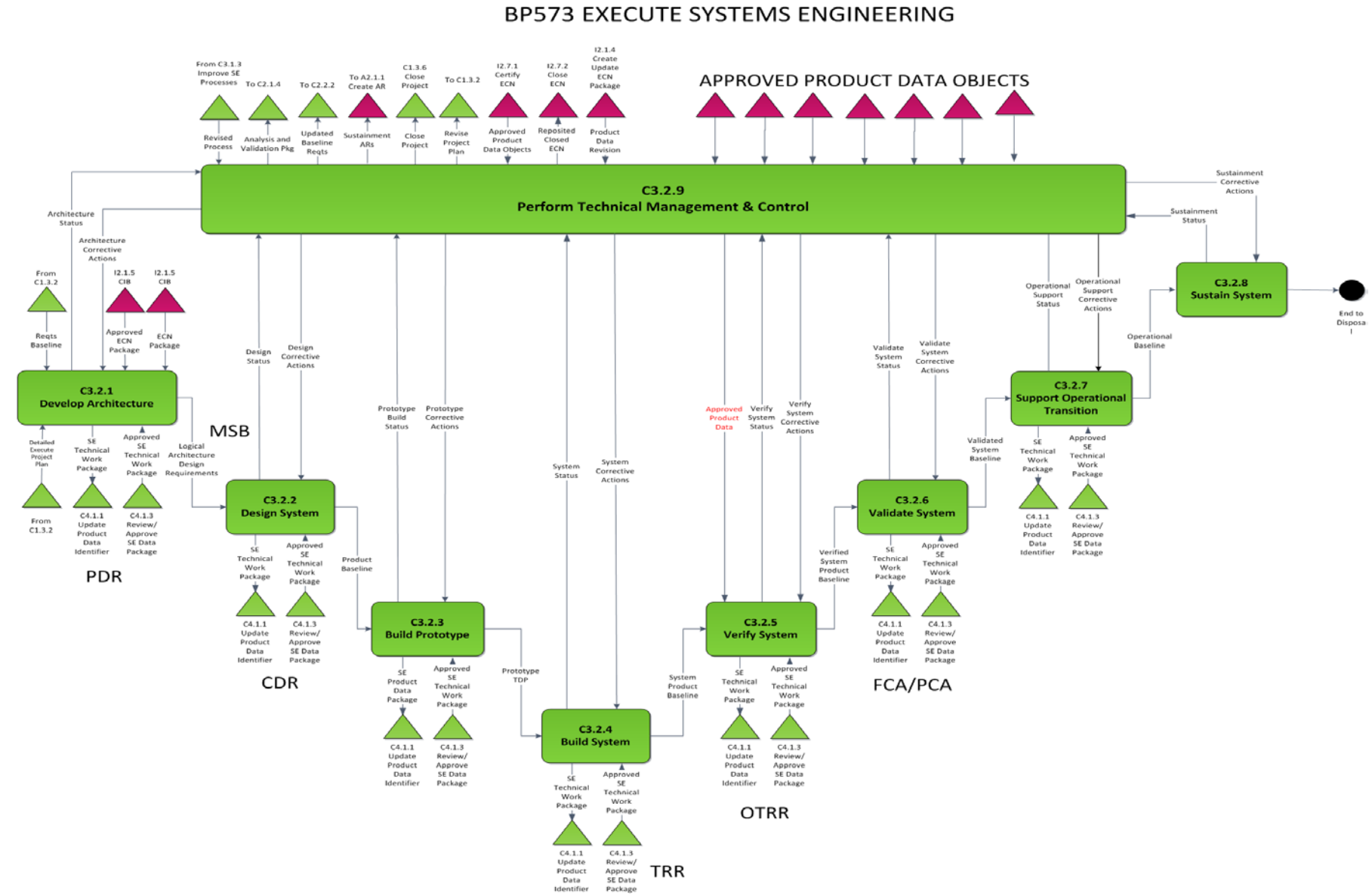
- Requirements Change Management
  - Manage Requirements Baseline
  - Traceability
  - Change Rational

ECSS PLM System Engineering "V"



U.S. AIR FORCE

Execute System Engineering



ECSS PLM System Engineering "V"

U.S. AIR FORCE

ECSS/PLM SE Process focus is on Sustainment Support

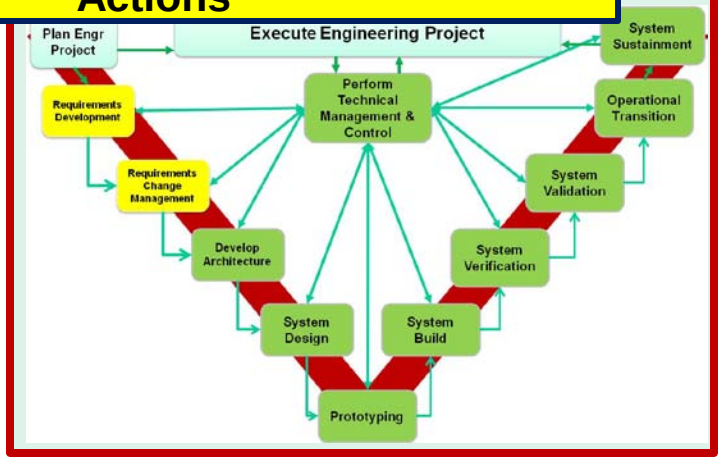
A | B | C | IOC | FOC

Materiel Solution Analysis	Technology Development	Engineering and Manufacturing Development	Production & Deployment	Operations & Support

Tech Insertion and R&D Projects

Can Support → Support to MAJCOM on Major Mods

Primary Focus → ALC SPO Managed Mods/Corrective Actions

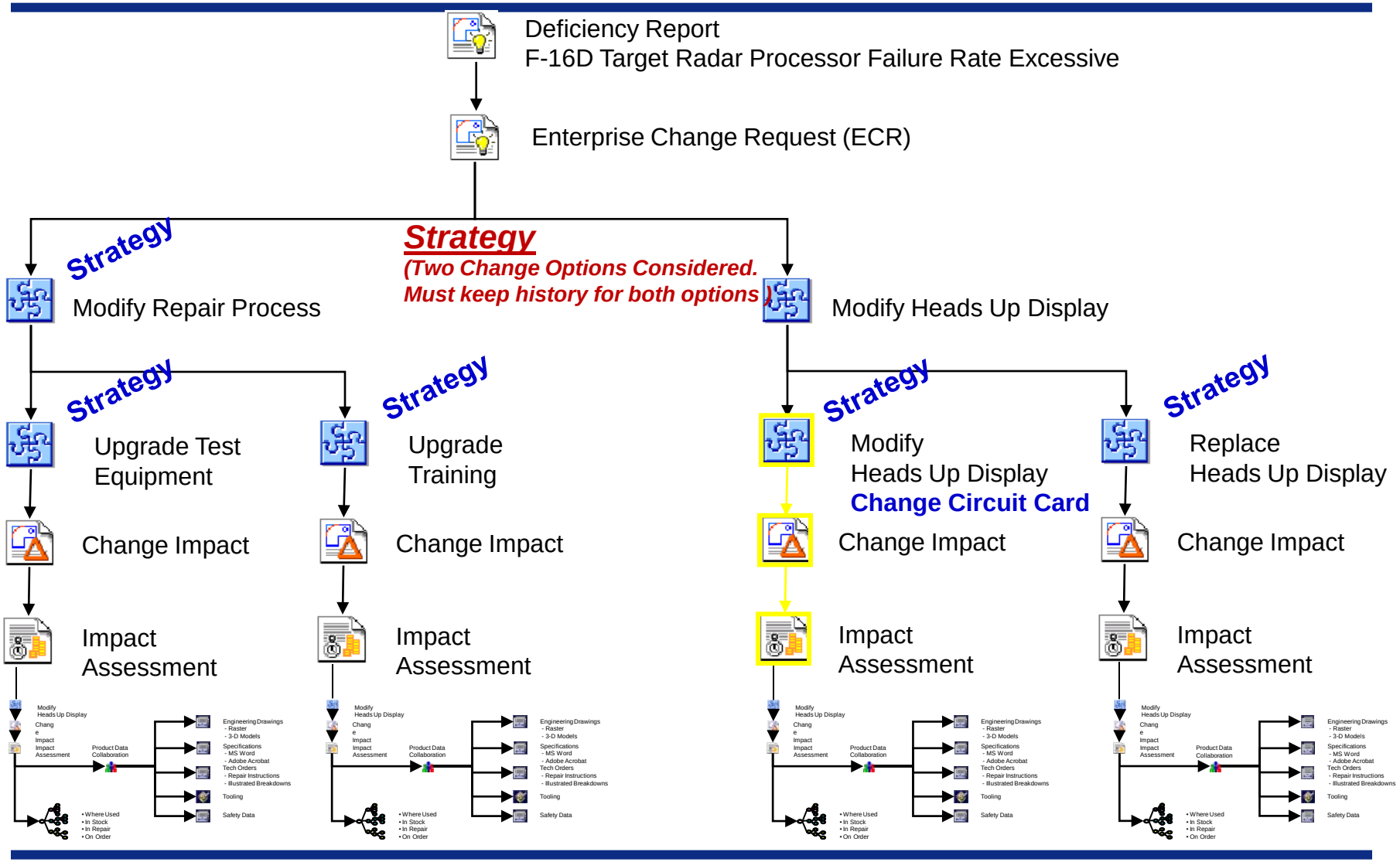


SE Sustainment "V" Supports Product Data examples below:

- Initial Technical Review (ITR)
- Alternative Systems Review (ASR)
- Systems Requirements Review (SRR)
- System Functional Review (SFR)
- Preliminary Design Review (PDR)
- Critical Design Review (CDR)
- Post-PDR Assessment (Post-PDRA)
- Post-CDR Assessment (PCDRA)
- Test Readiness Review (TRR)
- System Verification Review (SVR)
- Functional Configuration Audit (FCA)
- Production Readiness Review (PDR)
- Operational Test Readiness Review
- Physical Configuration Audit (PCA)

U.S. AIR FORCE

Example: Repair or Modify Enterprise Change Request



U.S. AIR FORCE

Example: Enterprise Change Notice (ECN)

Deficiency Report
F-15E Strike Eagle Heads Up Display Failure Rate Excessive

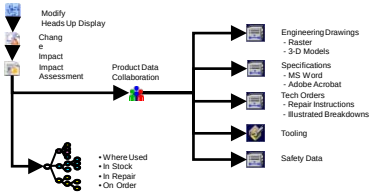
Enterprise Change Notice

Strategy Selected

Modify
Heads Up Display
Change Circuit Card

Change Impact

Impact
Assessment



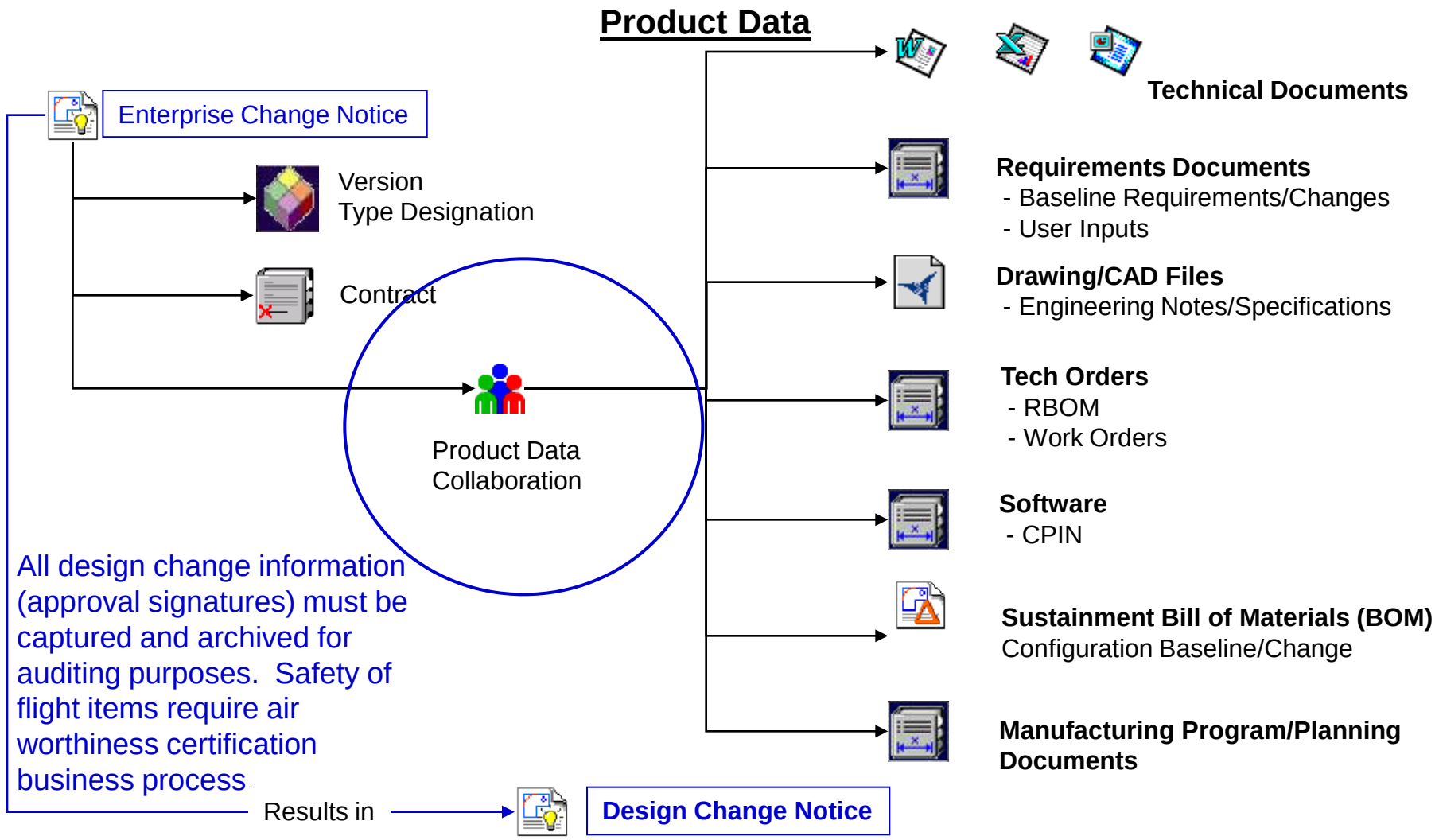
It is crucial to capture the change decision process for reuse in implementing the change, future change considerations and configuration auditing purposes.

Results in

Enterprise
Change Notice
Product Data for Release

U.S. AIR FORCE

Example: Enterprise Change Notice (ECN)



U.S. AIR FORCE

Outline

- AF System Engineering Drivers
- ECSS and PLM Overview
- PLM and SE Sustainment Challenges
- ECSS Blueprinting
- Configuration Management and CMII
- Problem Reporting
- Engineering BP Processes
- **System Engineering Benefits/Summary**

U.S. AIR FORCE

Benefits of ECSS/PLM SE Implementation

- Accumulation of accurate project execution history data (cost, performance, etc.) facilitates improved budgeting and financial management of future projects.
- Overall, better engineering project execution control will contribute to higher weapon systems availability.
- Standard documented process support for formal training (vs. on-the-job learning) will improve the quality of the workforce and reduce worker training time.
- Capability to track product design and build results to the customer requirements baseline.
- Capability to link specific requirement elements to their specific engineering project plan tasks, work products and related technical artifacts.

U.S. AIR FORCE

Benefits of ECSS/PLM SE Implementation

- Collaborative stakeholder interaction, feedback and conflict resolution over warfighter needs, expectations, constraints, and limitations.
- Continuous process improvement and implementation of standardized, common, and repeatable processes across the Air Force organization.
- Reduced overall systems engineering work effort and costs with an optimal balance of performance and total ownership cost will be achieved.
- Standard processes will provide improved performance metrics, cross organizational visibility and accountability for OSS&E results.

U.S. AIR FORCE

Summary

- ECSS and PLM initiatives are part of the eLog21 transformation campaign that will integrate Air Force supply chain operations
- The scope of PLM covers activities after Milestone C
- The primary value provided by PLM is a comprehensive, single source of authoritative product data that supports Provisioning, Planning, and Repair activities
- PLM SE Implementation meet the goals/objectives of
  - WSARA
  - AF SEAM
  - AFMCI 63-1201

U.S. AIR FORCE

Questions & Answers

Questions

U.S. AIR FORCE


LEADING EDGE TECHNOLOGY
WORLD CLASS SUSTAINMENT
WAR-WINNING SYSTEMS