Systems Engineering (SE) Analysis & Control: Configuration Management (CM) & Technical Reviews

TOPIC LEARNING OBJECTIVES

Upon successful completion of this topic, the student will be able to:

1. Identify the purpose and functions of Configuration Management.
2. Recognize the reasons and impacts of designating items as Configuration Items.
3. Identify the three types of configuration baselines (functional, allocated & product).
4. Identify the relationship between configuration baselines, specifications, and configuration management planning.
5. Identify the three types of changes (engineering change, deviation & waiver).
6. Recognize what constitutes the current approved configuration.
7. Identify the roles, responsibilities, and methods for interface control and technical data management.
8. Identify the purpose of specific technical reviews and their relationship to the acquisition process.
9. Relate the different types of program-unique specifications to their appropriate configuration baselines and technical review requirements.
10. Identify how instability of requirements, design, and production processes impact program cost and schedule.
11. Identify how participants should prepare, conduct and follow-up technical reviews.
12. Identify the impact of configuration management on test, logistics and manufacturing disciplines.
13. Identify the impact on configuration management when commercial items are used in the system.

STUDENT PREPARATION

Student Support Material

1. DAU Acq notes (http://acqnotes.com/)
2. DAU Systems Engineering Fundamentals (Chapters 10-11) highlighted portions on CM and Reviews
3. Systems Engineering Configuration Baseline
4. Configuration Management

Primary References

1. DoD 5000 Series
2. SECNAV 5000 Series
3. DAU guidance (https://aaf.dau.edu/guidebooks/)
4. DAU Glossary
5. Configuration Management Standard, SAE EIA-649B
6. Configuration Management Standard Implementation Guide, GEIA-Handbook-649
7. Configuration Management Guidebook, MIL-Handbook-61B
8. MIL-STD-961 Defense and Program-Unique Specifications Format and Content

Additional References

1. A Guide to the Project Management Body of Knowledge (PMBOK Guide)

Overview

- Configuration Management
- Interface Control & Technical Data Management
- Technical Reviews

Configuration Management (CM)

- CM Definition
  - Configuration management is a technical and management process applying appropriate resources, processes, and tools to establish and maintain consistency between the product requirements, the product, and associated product configuration information
  - Configuration Management implements sound practices to establish and maintain consistency of a product's or system's attributes with its requirements and evolving technical baselines, to include the Functional Baseline, Allocated Baseline, and the Product Baseline over its life-cycle

- CM Implementation
  - The technical and administrative direction and surveillance actions taken to identify and document the functional and physical characteristics of a Configuration Item (CI), to control changes to a CI and its characteristics, and to record and report change processing and implementation status. It provides a complete audit trail of decisions and design modifications

CM is a process to manage design information as the design changes

Why do we need CM?

- Provides
  - Measurable performance parameters
  - Common basis for acquisition and use of the product (for Gov't & KTR)
  - Basis for making changes and decisions with correct, current information
  - Managed-change process, minimizing avoidable cost occurrences
  - Retrieval of key information and relationships
- Correlates products with their requirements, design, and product information
  - ***Avoid guesswork***
- Verifies configuration against required attributes
- Achieves a high level of confidence in the product information

Effective CM helps avoid costs and reduces risk

Configuration Item (CI)

- CI definition
  - An aggregation of hardware, software, or both, that is designated for configuration management and treated as a single entity in the configuration management process. The entity within a configuration that satisfies an end use function and that can be uniquely identified at a given reference point

- Impact of designation as CI
  - Separate configuration control
    - Specifications, documentation
    - Formal approval of changes
    - User manuals
  - Individual design reviews
  - Separate qualification tests

Designation as a CI increases visibility and management control

Considerations for Designating CIs

- Level at which qualification conducted
- Integration of tested and untested components
- Interface with CIs whose configuration is controlled by someone else
- Requirement to know exact configuration during life-cycle
- High risk or safety concerns
- Uses new technology
- Newly developed
  - For each development contract, there should be at least one CI designated

Cost should not be a consideration when identifying a CI

CM's Four Functional Components

- Identification
  - Identify and document the functional and physical characteristics of configuration items
- Status Accounting
  - Recording and reporting of all the changes to the configuration items
- Control
  - Managing of the configuration items and related documentation throughout the life-cycle of the product
- Verification and Audits
  - Verify the correctness of the product and its components to ensure conformance to requirements, specifications, drawings, interface control documents, and other contract requirements
  - Also includes verifying correctness of status accounting information

IPPD and CM

- Configuration management ties requirement definition and specifications together through a collection of baselines, and then allows for control of those baselines
- CM is a multi-functional activity which leverages Integrated Product and Process Development (IPPD). Configuration changes (e.g., new requirements, design changes, etc.) can have impact across multiple areas:
  - Test & Evaluation
    - Impacts: Test planning, execution, verification, test equipment, calibration/settings
  - Manufacturing
    - Impacts: Production processes, tooling, materials
  - Logistics Support
    - Impacts: Documentation, spare parts, training, reliability, usability, correctness, etc.
  - Software Development
    - Impacts: Full design functionality
  - Technical Data Management
    - Maintained and available when needed

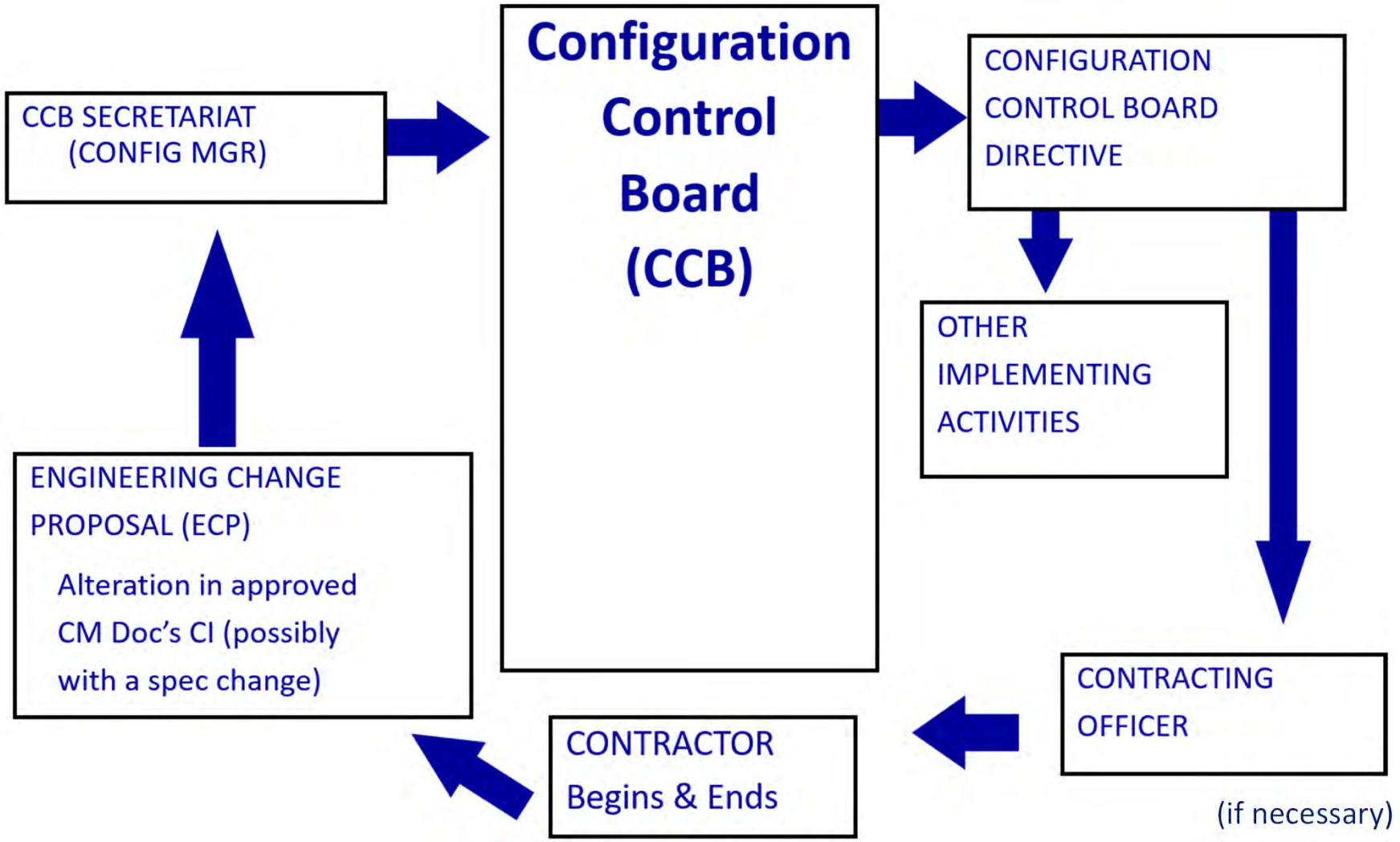
When the configuration of an item changes,
cost & schedule impacts may be felt across multiple disciplines

Commercial Item Impacts

- Commercial items are increasingly used in DoD acquisition
  - Open systems concepts
  - Reducing development cost and time
  - Government reliance on contractor research and development
- Impact to Configuration Management
  - Government does not control design details
  - Detailed technical data package may not be available
    - May make tech manuals difficult to draft and to maintain
  - Requires careful definition of interfaces
    - Interface requirements may constitute design requirements
  - Support strategies must address repairs and updates in commercial environment
  - Test strategies must ensure performance not only at item level, but in integrated units

Use of commercial items affects configuration, technical data and interface management, as well as logistics, test and evaluation

General Configuration Control Process



Configuration Control: Three Types of Baseline Changes

- Engineering Change
  - A change to an original item of equipment. The design or engineering change being incorporated into the article to modify, add to, delete, or supersede original parts
- Deviation (prior to manufacture)
  - A written authorization, granted prior to the manufacture of an item, to depart from a particular performance or design requirement of a specification, drawing, or other document for a specific number of units or a specified period of time
- Waiver (during or after manufacture)
  - A written authorization to accept a Configuration Item (CI) or other designated item, which, during production, or after having been submitted for inspection, is found to depart from specified requirements, but nevertheless is considered suitable "as is" or after rework by an approved method

*The current **approved configuration** is the **approved baseline plus approved changes** from that baseline*

Three Typical Baselines

- Functional Baseline
  - Overall system performance and functional characteristics
- Allocated Baseline
  - Performance requirements of Configuration Items (CIs) making up a system
- Product Baseline
  - Functional and physical characteristics of the CIs

Specifications, CM Planning, and Baselines

Specification	Configuration Management Planning	Configuration Baselines
System	- Defines mission/technical performance requirements - Allocates requirements to functional areas - Defines interfaces	Functional
Performance	- Defines performance characteristics of CIs (form, fit, function) - Details design requirements to the interfaces - "Design to"	Allocated
Detail	- Defines specific “how to” design requirements - Usually includes specific processes, procedures, logistics manuals and tech data packages - “Build to"	Product
Process	- Defines process performed during fabrication - Part of the tech data package	Product
Material	- Defines production of raw materials or semi-fabricated material used in fabrication - May also be part of the tech data package	Product

Overview

- Configuration Management
- Interface Control & Technical Data Management
- Technical Reviews

Interface Control

- Interfaces are:
  - Common boundary between CIs
  - Mechanical, electrical, operational, software, etc.
- Common examples are:
  - Boundaries within one Contractor's design
  - Boundaries between Contractor's items and GFE (Government Furnished Equipment)
  - Boundaries between multiple Contractors' items
  - Boundaries between systems
- Interface Control Working Group (ICWG):
  - Includes Government personnel, Contractor personnel (technical experts) & Configuration Management Team
  - Roles include identifying, documenting, & controlling all functional and physical characteristics of the interfaces
  - Produces ***Interface Control Documents (ICDs)***

Interface Control

- Common Government open systems strategy
  - Choose widely accepted interface standards
  - Require elements of systems be compatible at interfaces
    - Joint Technical Architecture defines standard IT Interfaces
    - Defense Information Systems Agency (DISA) approves Information System Architectures
- Results in systems that are more affordable and easier to update and support over their life-cycle

Government manages tech authority over the interface;
Contractor designs system to meet interface specs

Technical Data Management

- The disciplined processes and systems used to plan for, acquire, access, manage, protect, and use data of a technical nature to support the total life-cycle of the system
  - Extent of Government data requirements will be directly related to plans relative to baseline control
  - Based on acquisition management and logistics support strategies
  - Data requirements documented in the Contract Data Requirements List (CDRL)
  - Only minimum data required to execute and manage the program should be procured
  - Data should generally be ordered in Contractor format
- Technical Data Packages (TDPs) are provided and reviewed to support the technical reviews, including the FCA/PCA

FCA: Functional Configuration Audit
PCA: Physical Configuration Audit

CM facilitates disciplined maintenance of Technical Data

Technical Data Package (TDP)

- Government obtains the TDP as part of the contract solicitation
  - May decide ***not*** to include the full TDP
    - Lowers procurement cost
    - Considerations given to TDP maintenance and obsolescence
- Contractor responsible for technical data below system level
  - Maintains and updates TDP
- TDP includes
  - Engineering drawings
  - Associated lists
  - Specifications: function, performance, interfaces
  - Physical geometry, other constraints
  - Test data or analysis
  - Process descriptions
  - Material composition

Government must ensure the TDP is comprehensive and properly maintained

Configuration Management Strategy

- Government typically controls
  - Functional baseline
  - System level specification
  - External interfaces
  - System and major sub-system level technical review
- Contractor typically controls
  - Allocated and Product baselines
  - Item Performance and Item Detail specification
  - Internal interfaces
  - Component and vendor technical review
- Benefits of this strategy
  - Promotes Contractor design flexibility
  - Relieves PM from the burden of managing lower level ECPs
  - Allows for a smaller Government program office

CM strategy is tailored to individual programs based on many factors, including risk

Overview

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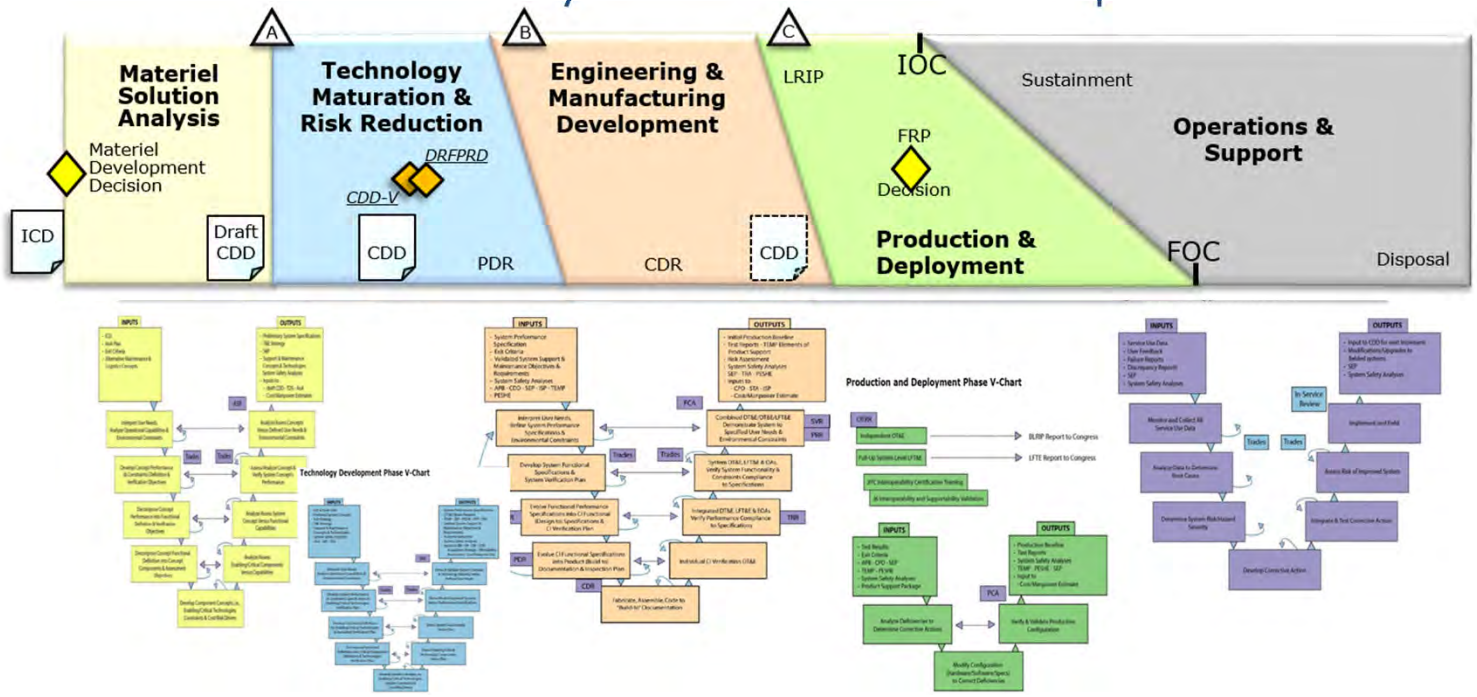
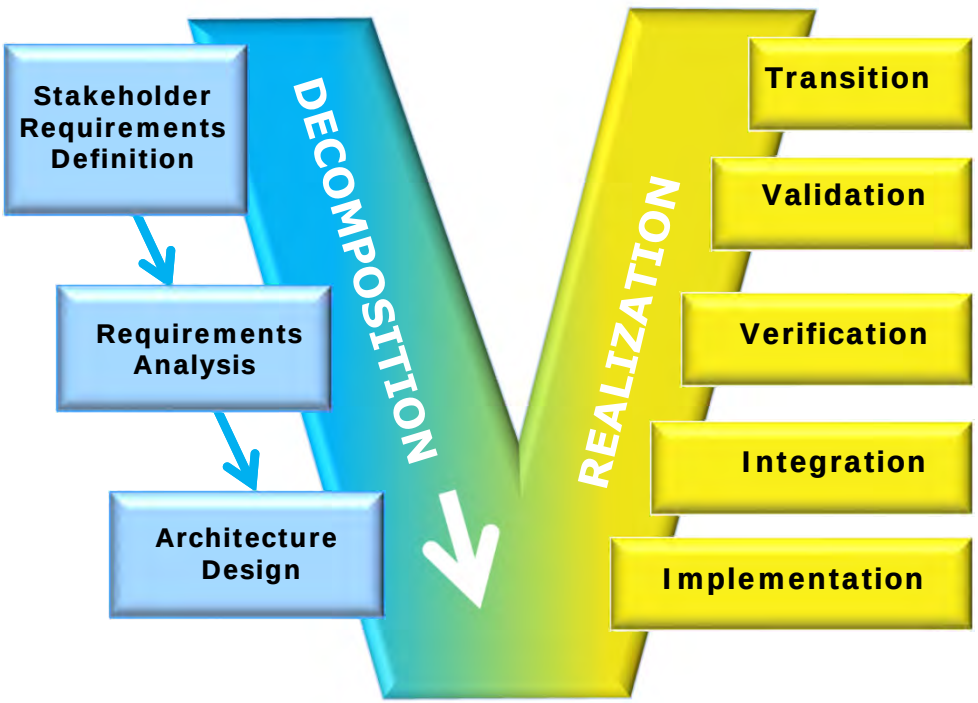
SE Process Across the Life-Cycle

- SE activities must be progressively integrated across all phases of the life-cycle
- Systems Engineering occurs both on a macro and micro level
  - Macro – SE occurs across the Defense Acquisition System (DAS) framework, as you'll see in the discussion of major technical reviews
  - Micro – SE occurs iteratively within each of the DAS phases

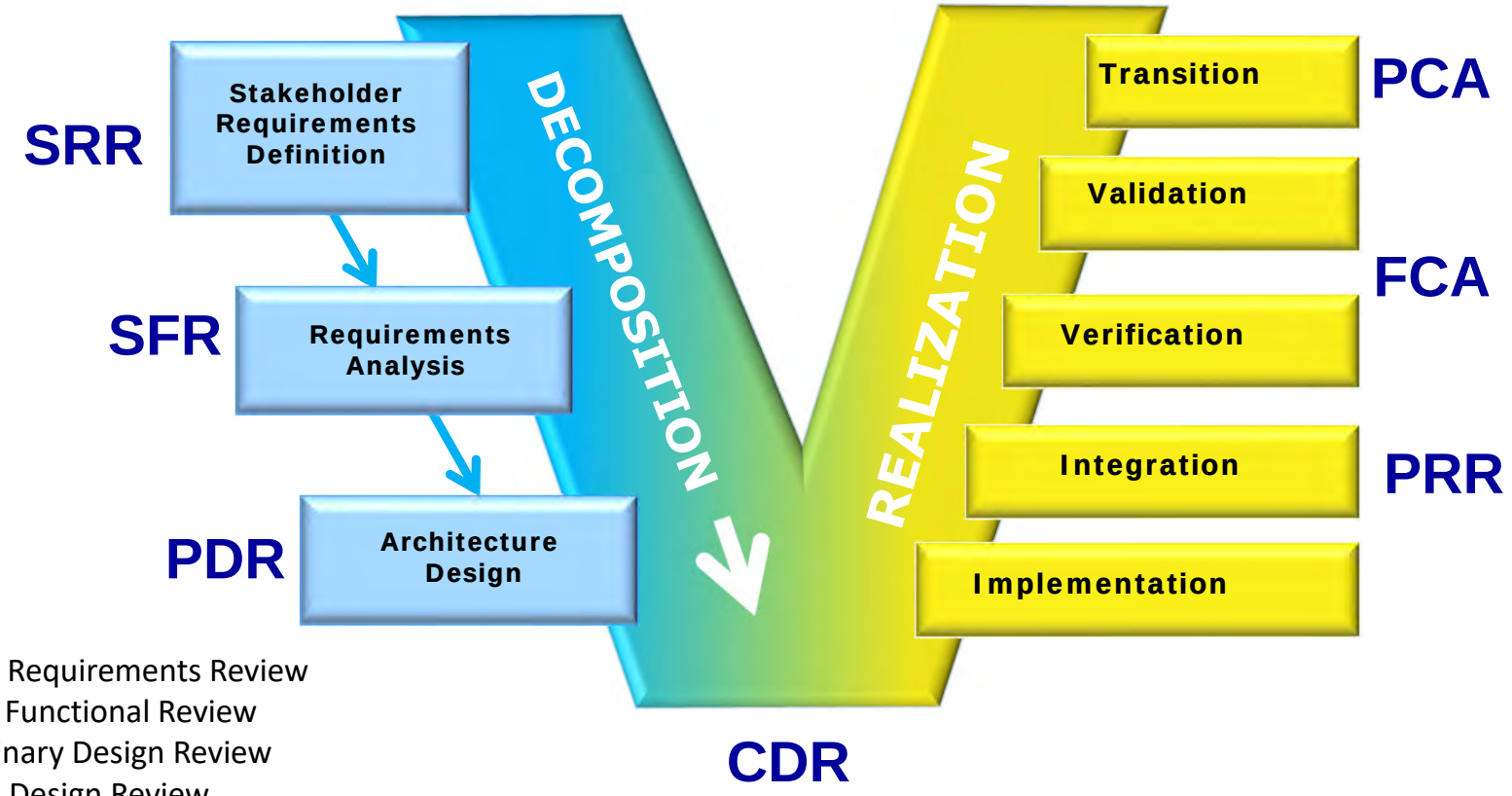


General Purpose of Technical Reviews



- Check design maturity
- Assess readiness to proceed to the next level of development
- Compliance with requirements
- Check each level of development
- Review technical risk
- Provide visibility into Contractor implementation statement of work

Technical Reviews: System Engineering "V" Model



SRR: System Requirements Review
SFR: System Functional Review
PDR: Preliminary Design Review
CDR: Critical Design Review
PRR: Production Readiness Review
FCA: Function Configuration Audit
PCA: Physical Configuration Audit

Select Technical Reviews

- SRR: System Requirements Review
  - Review of system technical requirements
  - Determines that requirements are identified
  - Ensures Government and Contractor mutually understand requirements
- SFR: System Functional Review
  - Ensures design has capability to meet requirements
  - Establishes functional baseline
- PDR: Preliminary Design Review
  - Ensures system is ready to proceed to detailed design
  - Establishes allocated baseline (usually)
- CDR: Critical Design Review
  - Assess readiness for fabrication (coding for software), demonstration and test
  - Establishes product baseline

Select Technical Reviews

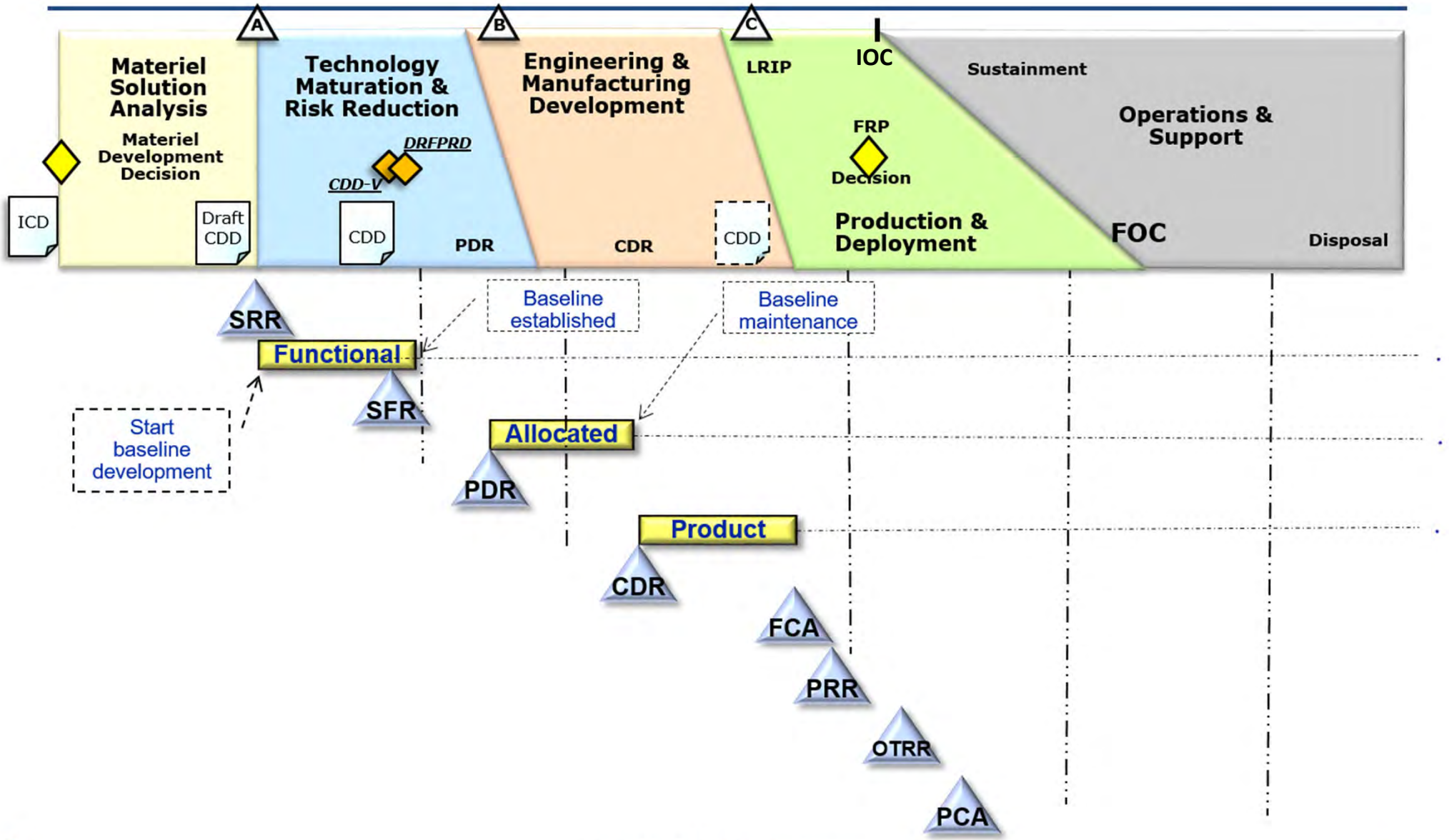
- TRR: Test Readiness Review
  - Ensures system under review is ready to proceed into formal test
- PRR: Production Readiness Review
  - Determines if the design is ready for production and the producer has adequate production planning without incurring unacceptable risks
- FCA/SVR: Functional Configuration Audit/System Verification Review
  - Serves as an audit trail from the CDR
  - Assesses that the system meets the functional requirements as derived from CDD
  - Ensures system under review can proceed into LRIP and FRP within cost, schedule, risk, and other system constraints
- OTRR: Operational Test Readiness Review
  - Ensures the production configuration system can proceed into Operational Testing (OT) with a high probability of success
- PCA: Physical Configuration Audit
  - Examines the actual configuration of production system to verify that the related design documentation matches contract specifications
  - Confirms that the manufacturing processes, quality control system, measurement and test equipment, and training are adequately planned, tracked, and controlled

Specifications, Baselines, and Reviews

Specification	Baseline	Review
System	Functional	System Requirement & Functional Reviews
Performance	Allocated	Preliminary Design Review
Item Detail/Process/ Material	Product	Critical Design Review Functional/Physical Configuration Audit

Instability of requirements, design, and production processes will have impacts across multiple levels of the system and may have major negative cost and schedule implications

Phases, Reviews, and Baselines



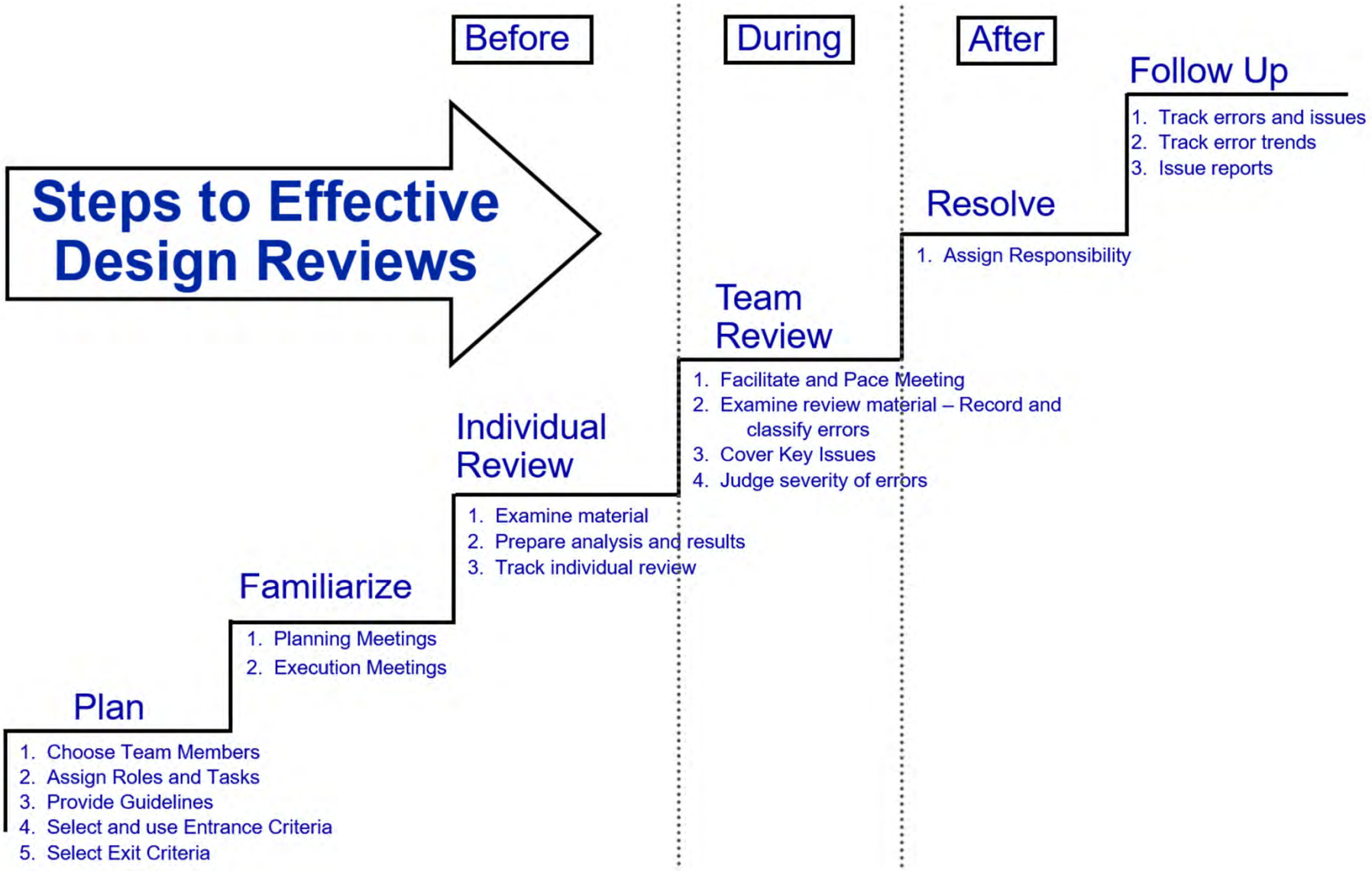
General Principles for Reviews

- Why do they occur?
  - Assess design maturity
  - Assess technical and programmatic risk
  - SE reviews ***are not*** a check-in-the-box for program reviews
- When do they occur?
  - Systems Engineering Plan (SEP) describes which technical reviews a program will conduct
  - Completion of a baseline (functional, allocated, and product)
  - Complete product
  - Preparation for operational testing
  - In support of upcoming milestone reviews

General Principles for Reviews, cont.

- Who conducts?
  - A Technical Review Board (TRB)
- TRB may include:
  - Chairperson: an experienced and independent technical person
  - PM (or representatives)
  - Program Engineer, SMEs as required
  - Independent Review Team
  - Logistician
  - Cost team representative
  - Legal Counsel
  - Contracting Officer
  - Resource sponsor (Requirements Officer)
  - User representatives
  - TRB recorder

Steps to Effective Design Reviews



Summary

- What is the purpose of CM?
- What are the 4 functions of CM?
- Designating items as Configuration Items requires more:
- What are the 3 types of configuration baselines?
- What are the 3 types of changes?
- The current approved configuration is the:

Summary

- What are the roles and responsibilities for the Interface Control Working Group (ICWG)?

- Changes to requirements, design, and production processes can have impacts across multiple levels of the system and have major negative implications to:

- What are the steps to an effective Design Review?

Summary

- What are the impacts to configuration management when commercial items are used?