



# Development of a Configuration Management Standard for a Government Agency

## Software SIG - October 2013

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The MITRE Corporation*

*Note: Al Florence was not  
able to attend but will tune in  
remotely but not as speaker.*

This presenters' affiliation with the MITRE Corporation is provided for identification purposes only and is not intended to convey or imply MITRE's concurrence with or support for the positions, opinions or view points expressed by these presenters

# Presentation

This tutorial is in two parts:

- Part 1 presents a generic Configuration Management
  - Presented by AI Florence
- Part 2 presents applying the generic Configuration Management principles to the development of a Configuration Management Standard for a large Federal Government organization
  - Presented by Ron Perrella

# Presentation Contents (Part 1)

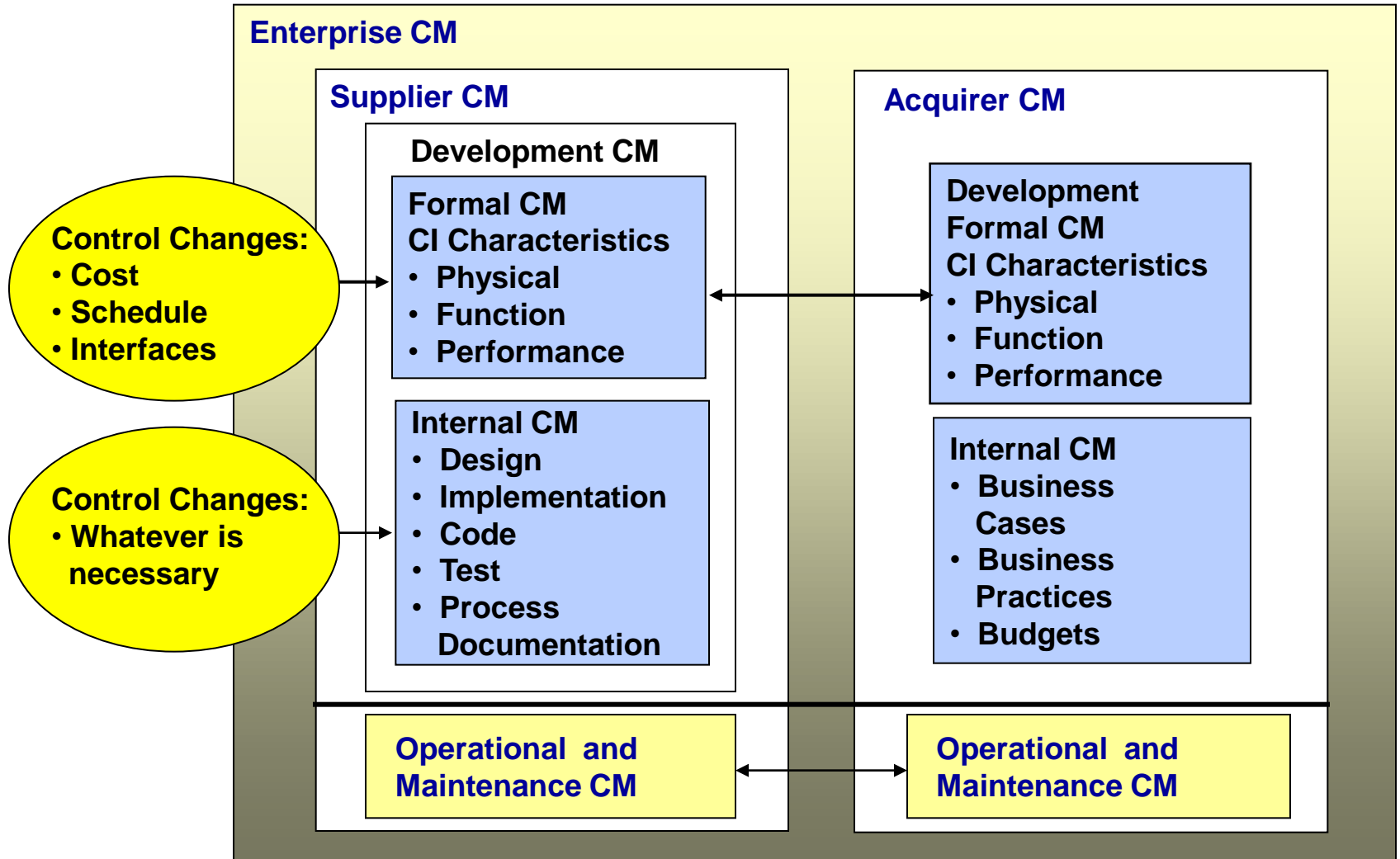
## AI Florence

- ➔ ■ Introduction
  - CM Concepts
- Formal CM
  - Formal Baselines and Configuration Items (CIs)
  - Configuration Control Boards (CCBs)
    - Supported with Technical Review Boards (TRBs)
  - Change Control
  - CM Audits and Status Accounting
- Internal CM
  - Internal Baselines
  - CM of Design, Code, Hardware Items, Test Articles
- Operation CM
  - During Operation / Maintenance

# What is CM?

- CM is a discipline applying technical and administrative direction and surveillance to:
  - Identifying and documenting the physical, functional, and performance characteristics of items
  - Baselining those characteristics
  - Controlling changes to those characteristic
  - Providing status on those characteristics
  - Conducting audits on those characteristics
  
- The CM tasks that produce these results are:
  - Configuration Management Planning
  - Configuration Identification
  - Configuration Control
  - Configuration Status Accounting
  - Configuration Management Audits

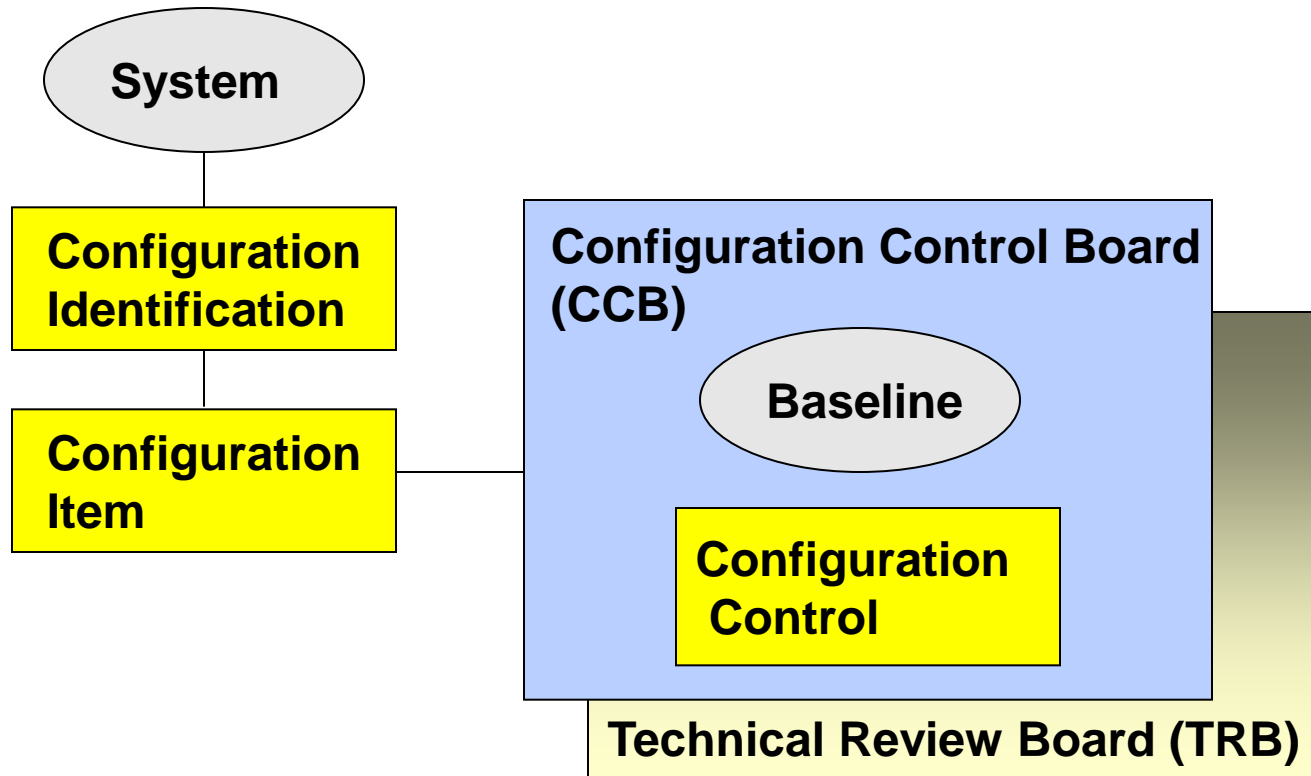
# Some Levels of CM



# Presentation Contents (Part 1)

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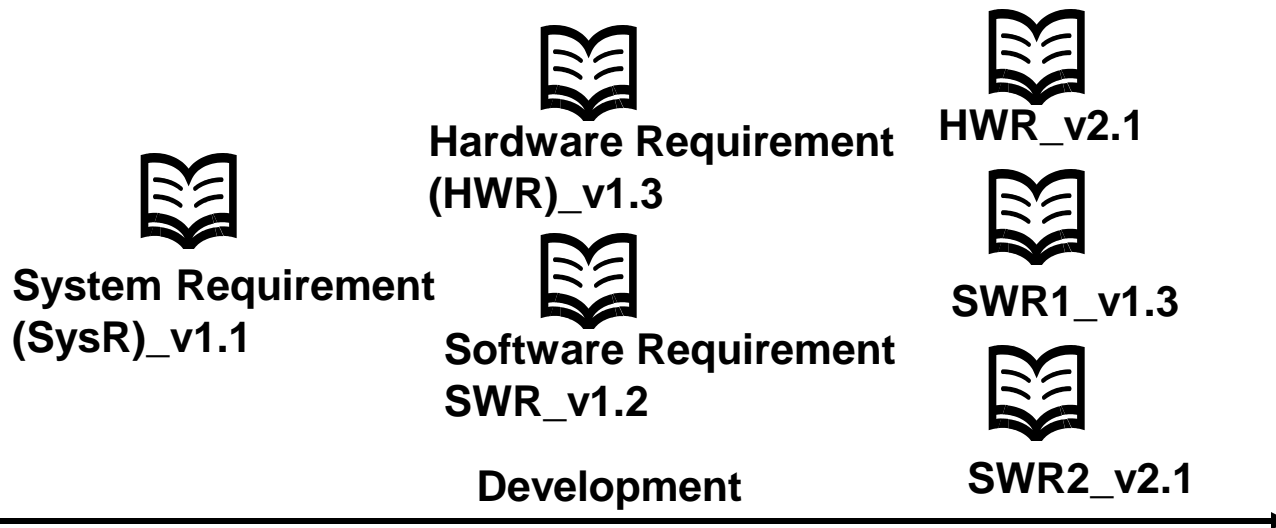
# Formal CM - Configuration Management Overview



**Configuration Management Audits – Configuration Status Accounting**

# Configuration Identification

- Configuration Identification is established in the form of documentation of items that becomes more detailed as development proceeds
- Items represent sets of functionally related capabilities
- It is important to assign unique identifiers to items
  - Supports version identification and control





# Configuration Identification continued

- Three levels of Configuration Identification are established

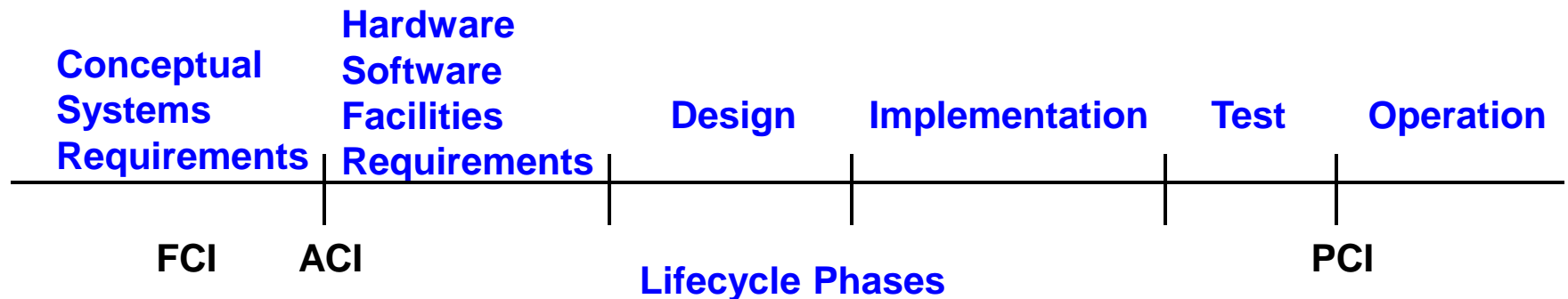
- Functional Configuration Identification (FCI)



- Allocated Configuration Identification (ACI)



- Physical Configuration Identification (PCI)  
of the products

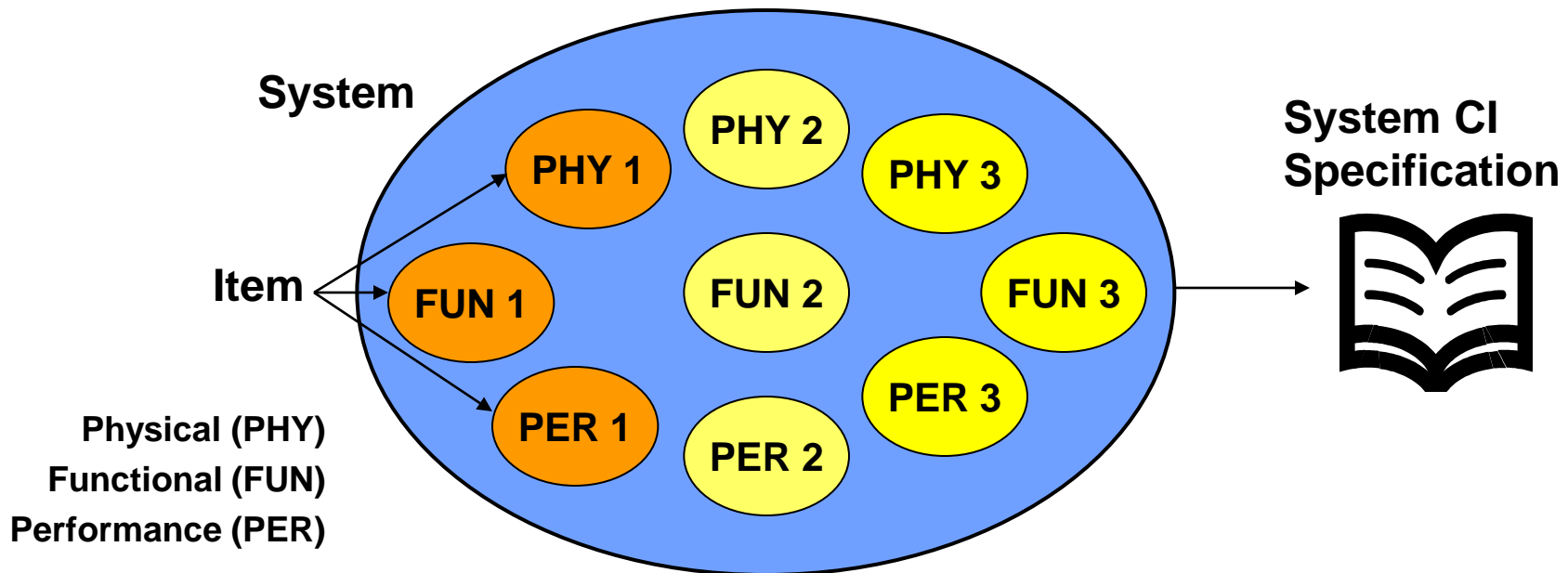


# Functional Configuration Identification

## Functional Configuration Identification (FCI)

The identified system and system items and their physical, functional, and performance characteristics which are documented in a System CI Specification for requirements

*Established as the Functional Baseline (FBL)*

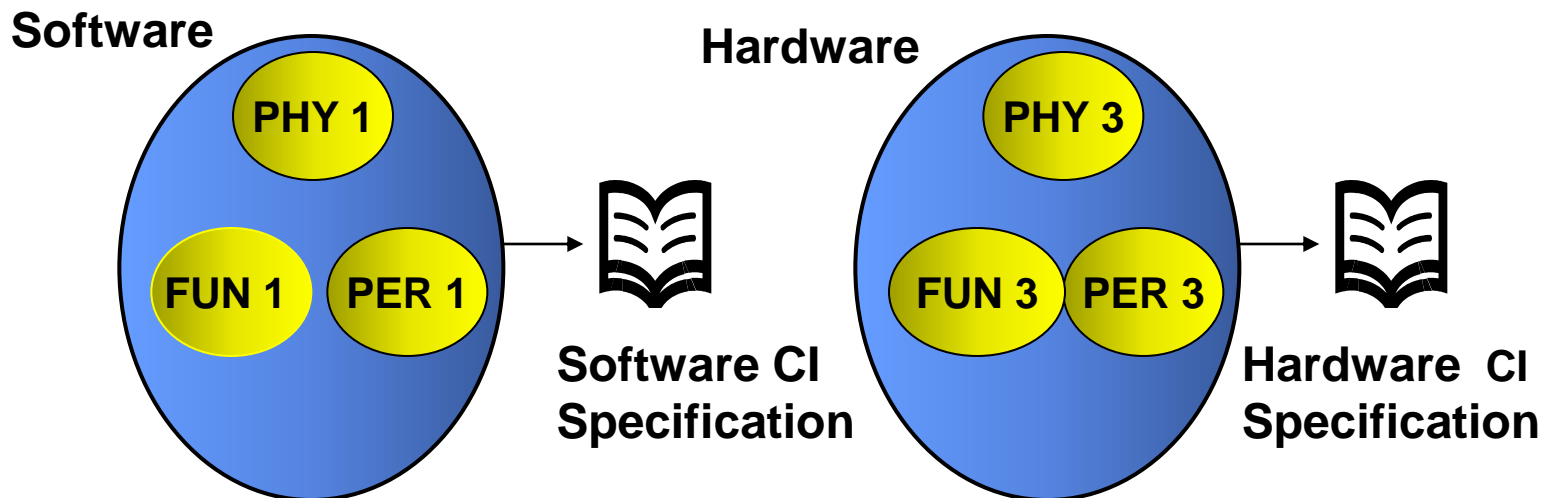


# Allocated Configuration Identification

## Allocated Configuration Identification (ACI)

Later in development the physical, functional, and performance characteristics of the system are allocated to lower level entities: software, hardware, facilities, and are documented as CI Specifications for requirements

*Established as the Allocated Baseline (ABL)*



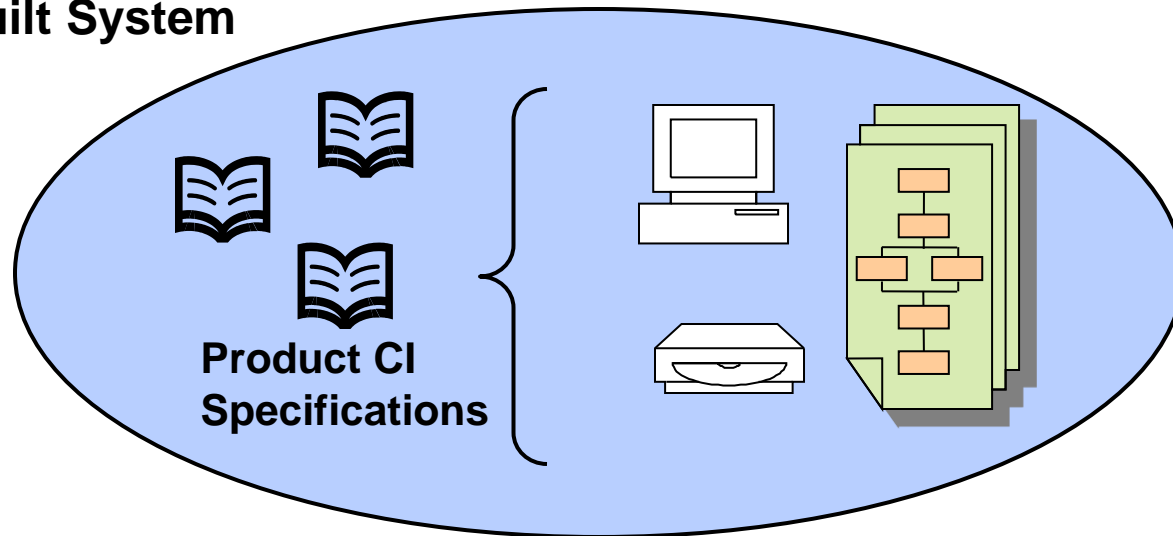
# Physical Configuration Identification

## Physical Configuration Identification (PCI)

Finally, the products of the developed system: software, hardware, facilities are defined in a series of Product CI Specifications that describe the as-built system including requirements

*Established as the Product Baseline (PBL)*

**As-built System**



# Other Baselines – covered in more detail later in the presentation

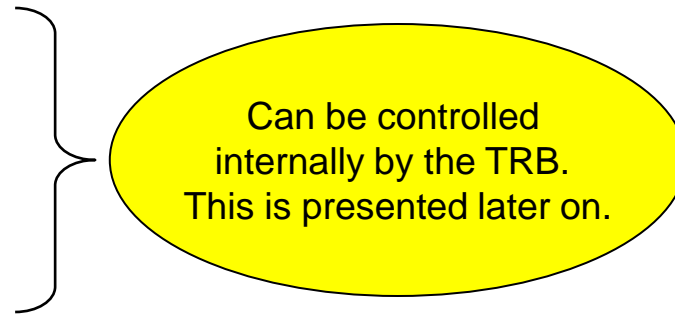
It gets more complex:

■ As development progresses CIs evolve and include more detail:

– Initially the CIs are represented as requirements documented in CI Requirements Specifications

– Later the CIs are represented in:

- Design documents
- Test plans
- Code (for software)
- Test procedures
- Test results



– \*During development only CIs that have achieved the Functional Baseline and the Allocated Baseline for the CI Specifications are designated for formal CCB control

**\* As described for this presentation and as reflected in references**

# Configuration Control

- The systematic

- evaluation
- coordination
- approval or disapproval, and
- implementation

of changes to the physical, functional, and performance characteristics of a baselined CI

- Changes are requested with a Change Request (CR) form

# Configuration Control Board (CCB)

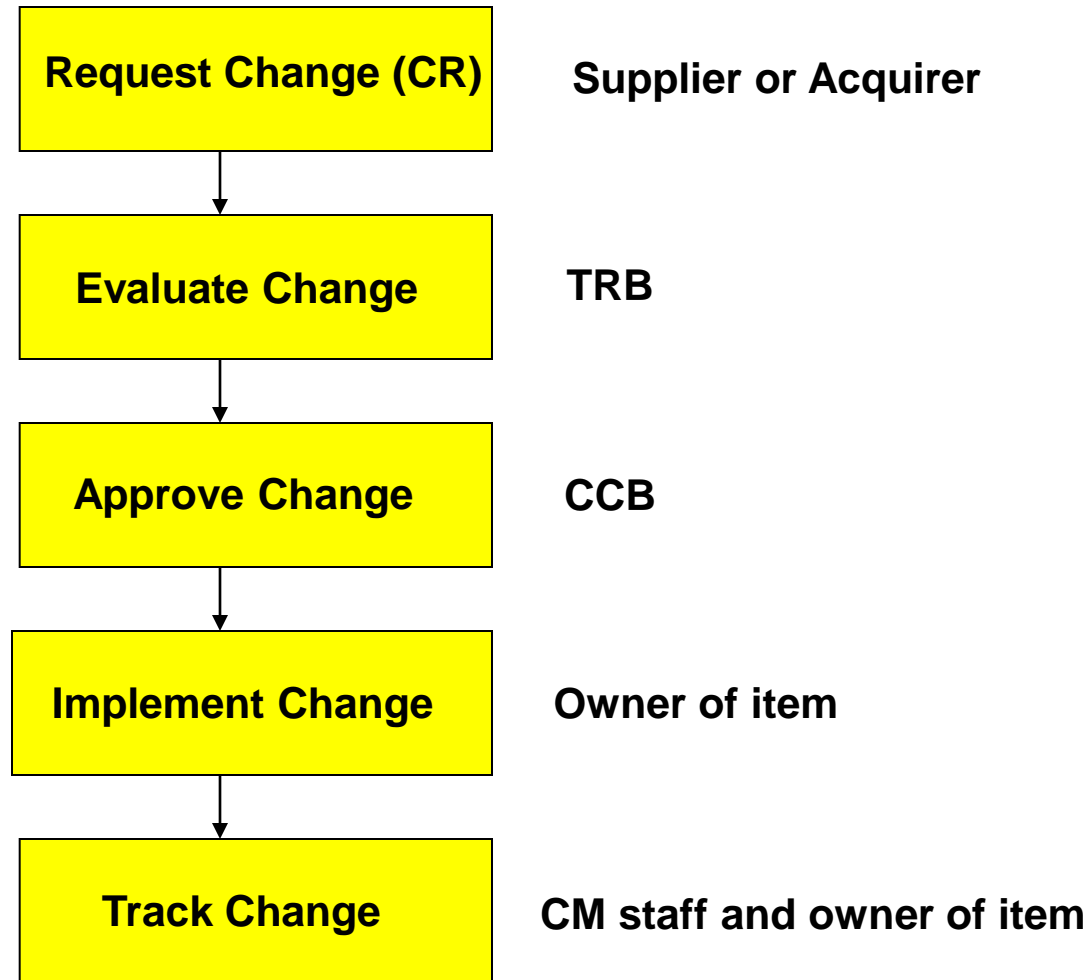
- Establishes baselines for CIs
- Reviews and approves / disapproves / defers Change Requests to CIs
- Membership comprised of management, and other stakeholders and supported by the subject matter experts
  - Project Management
  - Systems Engineering
  - Software/Hardware Engineering
  - Test Engineering
  - Quality Assurance
  - Configuration Management
- Chaired by the program / project manager or designee

# Technical Review Board (TRB)

- Provides technical and programmatic support to the CCB
  - Conducts impact assessment on CRs to baselined CIs
  - Makes approval / disapproval recommendations to the CCB
- Membership comprised of program / project personnel and subject matter experts
- Chaired by a technical manager



# Change Flow



# Impact Assessments

- Impact assessments need to be conducted by all stakeholders:
  - Systems
  - Hardware
  - Software
  - Test
  - Configuration Management
  - Quality Assurance
  - Contracts
  - Others
  
- On CI characteristics:
  - Physical
  - Functional
  - Performance
  
- Against their interests:
  - Cost
  - Schedule
  - Interface

# Classification of Changes

At least two types of changes can be defined:

- Class I—affects the Acquirer's interest in one or more of these factors:
  - Physical characteristics
  - Functional characteristics
  - Performance characteristics
  - External interfaces
  - Cost
  - Schedule

**Supplier must submit change to the Acquirer  
for approval before implementation**

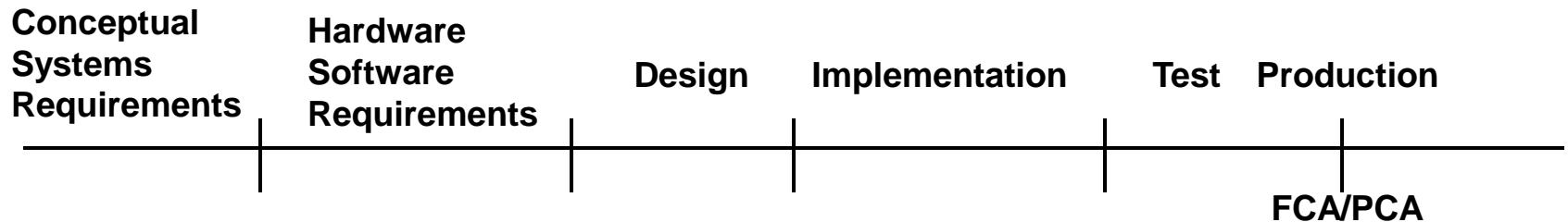
# Classification of Changes concluded

- Class II— Does not affect any of the Class I factors
  - Affects changes such as:
    - Addition of clarifying comments
    - Spelling or typographical errors
    - Changes that do not affect external interfaces change functionality or degrade performance

**Supplier may implement it without Acquirer's approval  
but must inform Acquirer of change**

# CM Audits

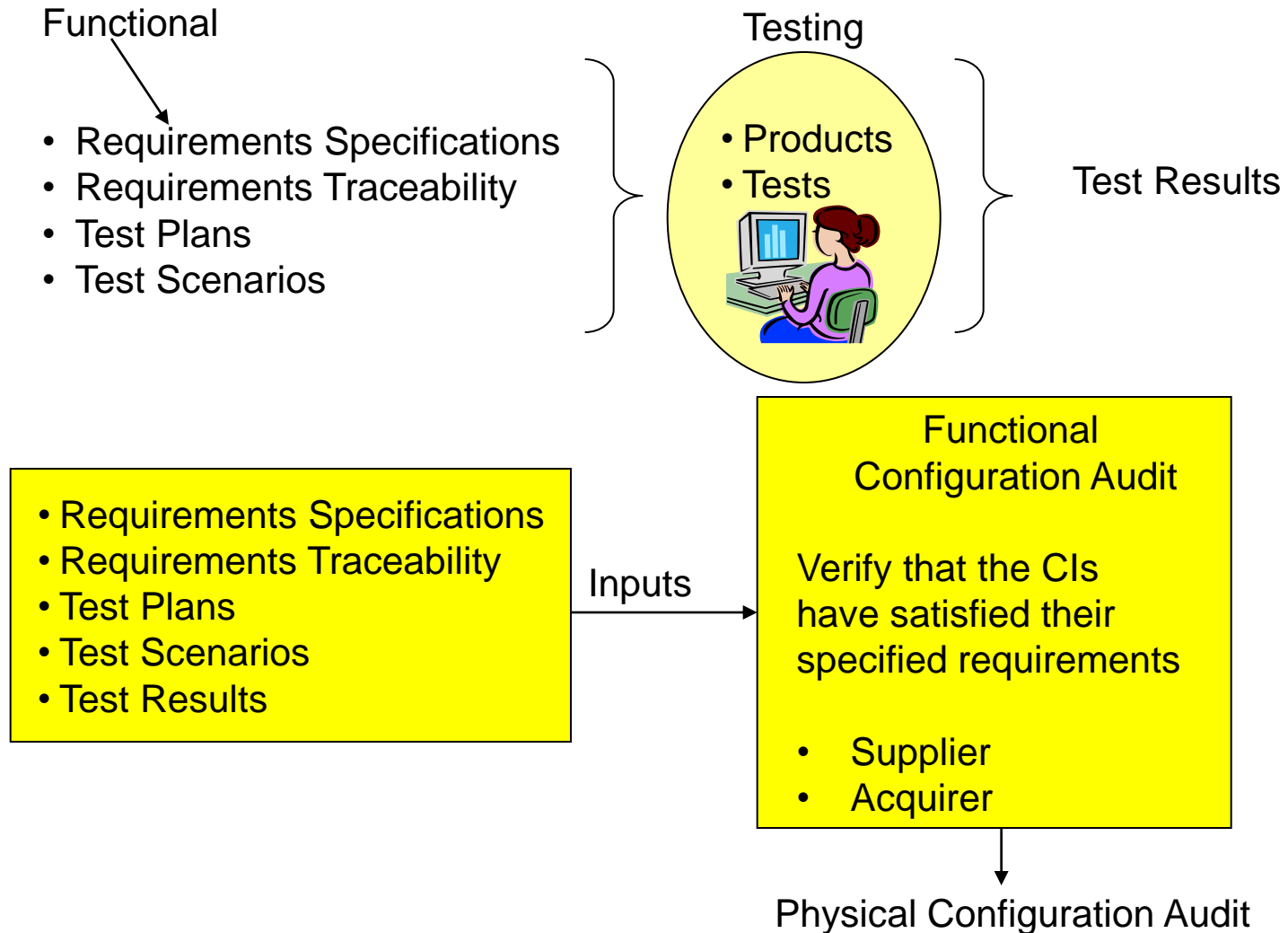
- Functional Configuration Audits (FCA) and Physical Configuration Audits (PCA) are conducted by Engineering and facilitated by CM and/or Quality Assurance (QA)
- Other audits conducted by QA and CM may include:
  - Audits of CM Repository that contains CM records, documentation, processes, procedures, artifacts, etc.
  - Audits of Program/Project organizations to ensure CM process is being followed
  - Audits of status of approved CRs
  - Audits to ensure that CIs are consistent with CM records



# Functional Configuration Audit (FCA)

- A formal examination of test results of the as-built functional configuration of CIs, prior to acceptance, to verify that the CIs have satisfied their specified requirements
- This audit is conducted by either the *Supplier or Acquirer* for the benefit of the Acquirer and attended by
  - Management
  - System Engineering
  - Hardware / Software Engineering
  - Test Engineering
  - QA and CM
  - Contractsof both the Acquirer and Supplier

# Functional Configuration Audit continued

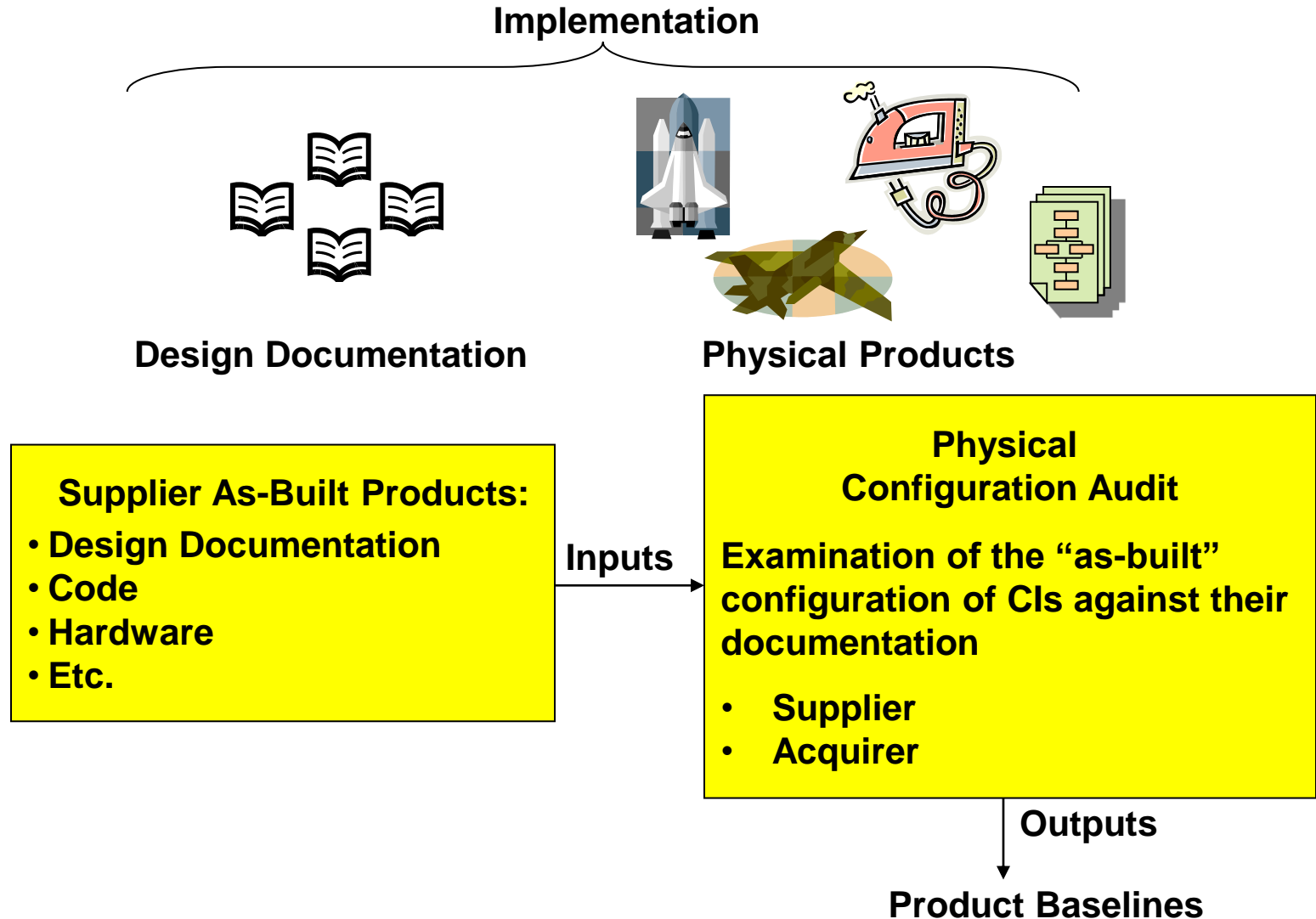


# Physical Configuration Audit (PCA)

- A formal examination of the as-built physical configuration of CI products against their design documentation
- This establishes the Product Baseline
- This audit is conducted by either the *Supplier or Acquirer* for the benefit of the Acquirer and attended by both
  - Management
  - System Engineering
  - Hardware / Software Engineering
  - Test Engineering
  - QA and CM
  - Contractsof both the Acquirer and Supplier

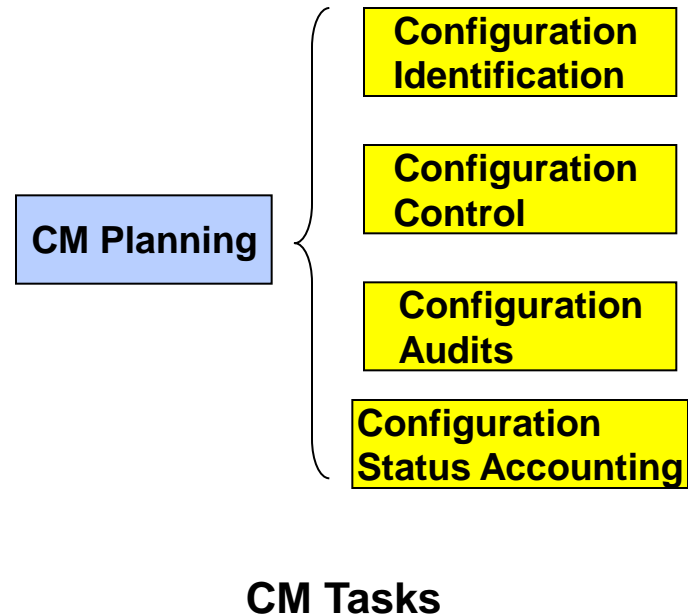
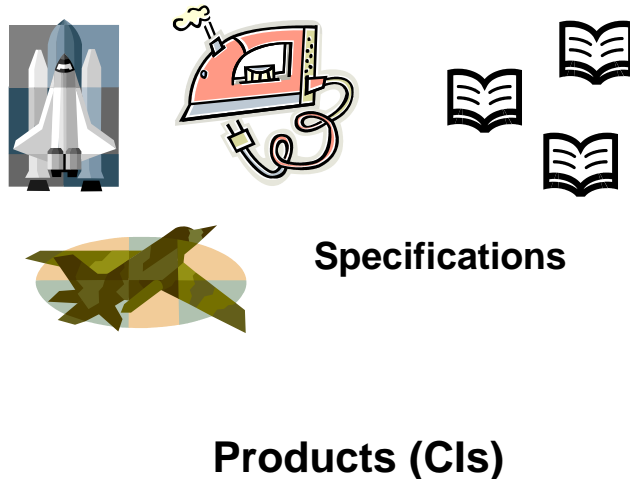


# Physical Configuration Audit continued



# Configuration Status Accounting (CSA)

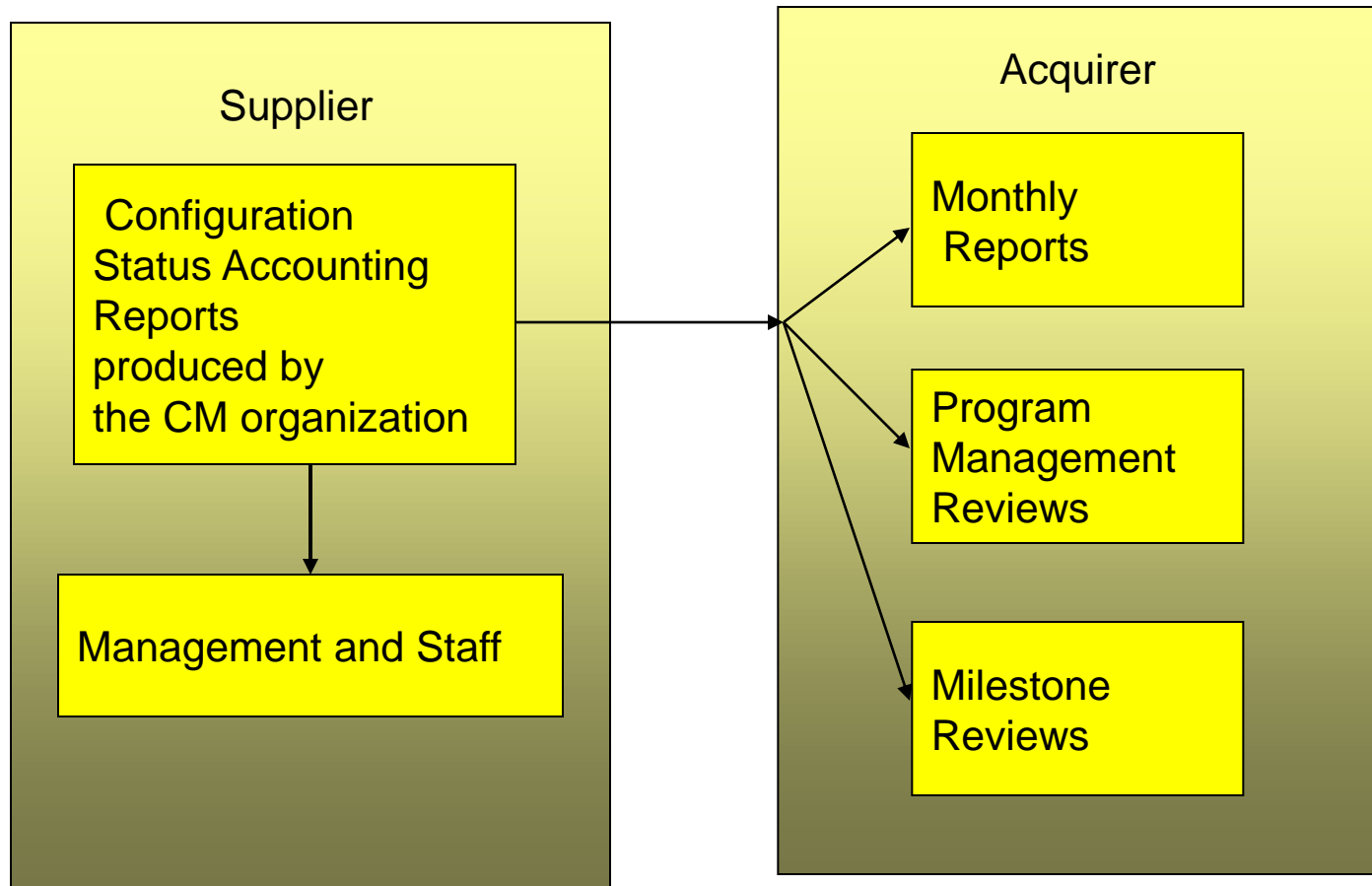
- CSA is performed to gather, correlate, maintain and provide status on CM controlled products (CIs), and on CM tasks



# Configuration Status Accounting continued

- Provides the means for reporting status on:
  - Configurations
    - FCI
    - ACI
    - PCI
  - Baselines
    - FBL
    - ABL
    - PBL
  - Other
    - CM metrics
    - CM activities
    - CM audits

# Configuration Status Accounting concluded



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# Internal CM Under Technical Review Board (TRB)

- Chaired by Deputy PM or Lead Systems Engineer
  - Systems
  - Software
  - Hardware
  - Test
  - CM
  - QA
  - Etc.

# Internal CM versus Formal CM

- Formal CM is concerned with
  - High Level baselines
    - FBL
    - ABL
    - PBL
  - Master Schedules
  - Project Costs
  - Contractual Items
- Internal CM is concerned with
  - Design BL
  - Code BL
  - Hardware component BL
  - Test BL
  - COTS BL
  - Etc.

# Internal CM Concerns

## ■ Documents

- Database
- Test procedures
- Analysis that drive requirements and design
- Etc.

## ■ Plans

- Project plans
- CM plans
- QA plans
- Risk Management plans
- Test plans
- Etc.



# Internal CM Concerns continued

- Internal CM is concerned with
  - Version Control
    - Documents
    - Code
    - Hardware items
    - COTS
  - Data Management
    - Documents
    - Plans
    - Process Documentation
    - Procedures
    - Metrics
    - Action Items
    - Etc.

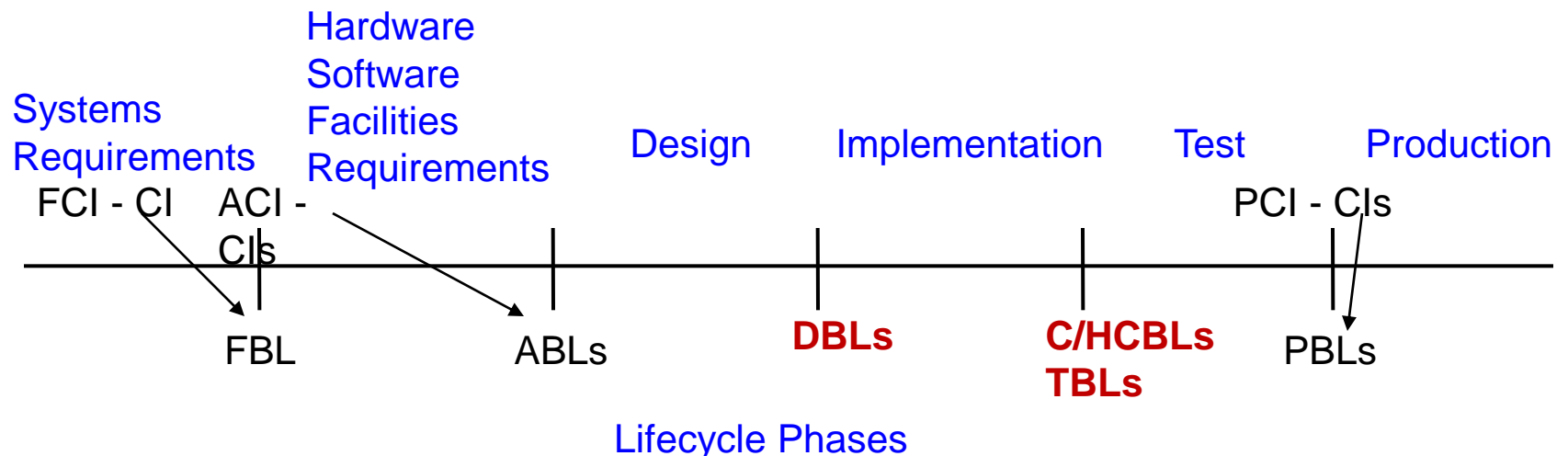
# Internal CM & Testing

- Internal CM during testing is concerned with
  - Code changes (TRB)
  - Design changes (TRB)
  - Test case changes (TRB)
  - Requirements changes (Require escalation to CCB)

# Internal Baselines

Internal baselines are established at strategic points in a system lifecycle. Three internal baselines may be defined

- Design Baseline (DBLs)
- Code/Hardware Components Baseline (C/HCBLs)
- Test Baseline (TBLs)



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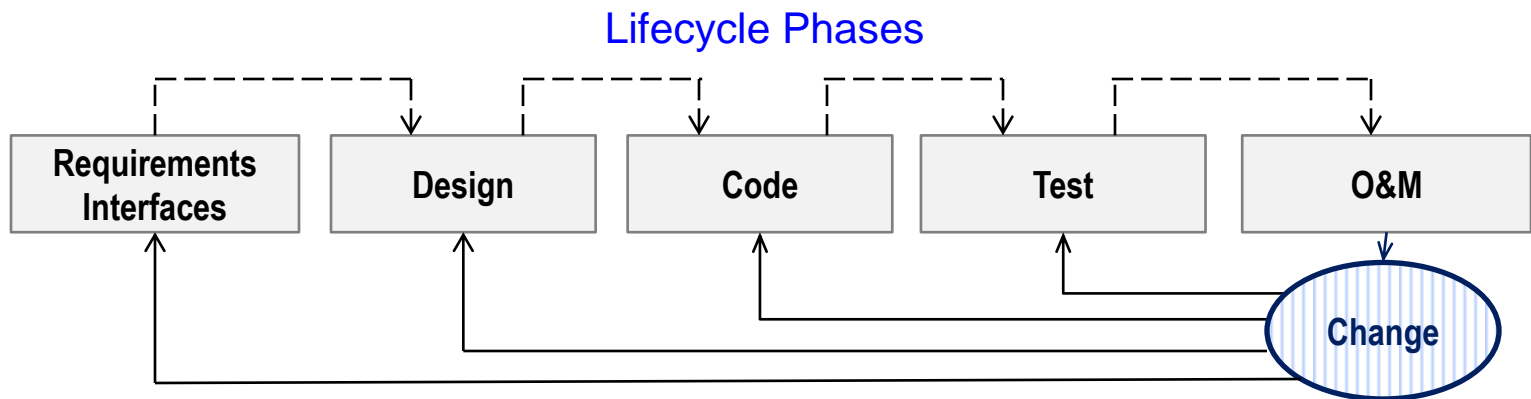
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# CM During Operation & Maintained

- Operation and Maintenance (O&M) CM does not differ from CM conducted during development
  - Formal CM
  - Internal CM
- The players may change
  - A different O&M contractor
  - A different O&M agency
    - Acquisition Agency vs. O&M Agency
- The O&M Baseline has been established

# CM During Operation & Maintained continued

- If a problem or change affects test activities the test is fixed and retested
- If a problem or change affects code, the code is repaired and tested
- If a problem or change affects design, the design is fixed, coded, and tested
- If a problem or change affects requirements or interfaces, the requirement or interface is fixed and the design is fixed, coded, and tested
- In all cases the results are returned to O&M



**CM process and CCB activities continue**

# End of Part 1

# Part 2 Presented by Ron Perrella

- Part 2 presents the application of the CM concepts in Part 1 in the development of a CM Standard for a large Federal Government Agency
- The Standard presents “WHAT” must be accomplished when applying CM to programs and projects and does not address “How” CM needs to be done.
- Although the Standard was developed for a specific agency the approach presented can be applied to any organization
- The organization had a CM process in place along with a CM Policy but needed a CM Standard tailored to their needs to guide projects in applying consistent CM
  - In developing the standard we had to abide by their way of applying CM which may be somewhat different in some CM areas described in Part 1

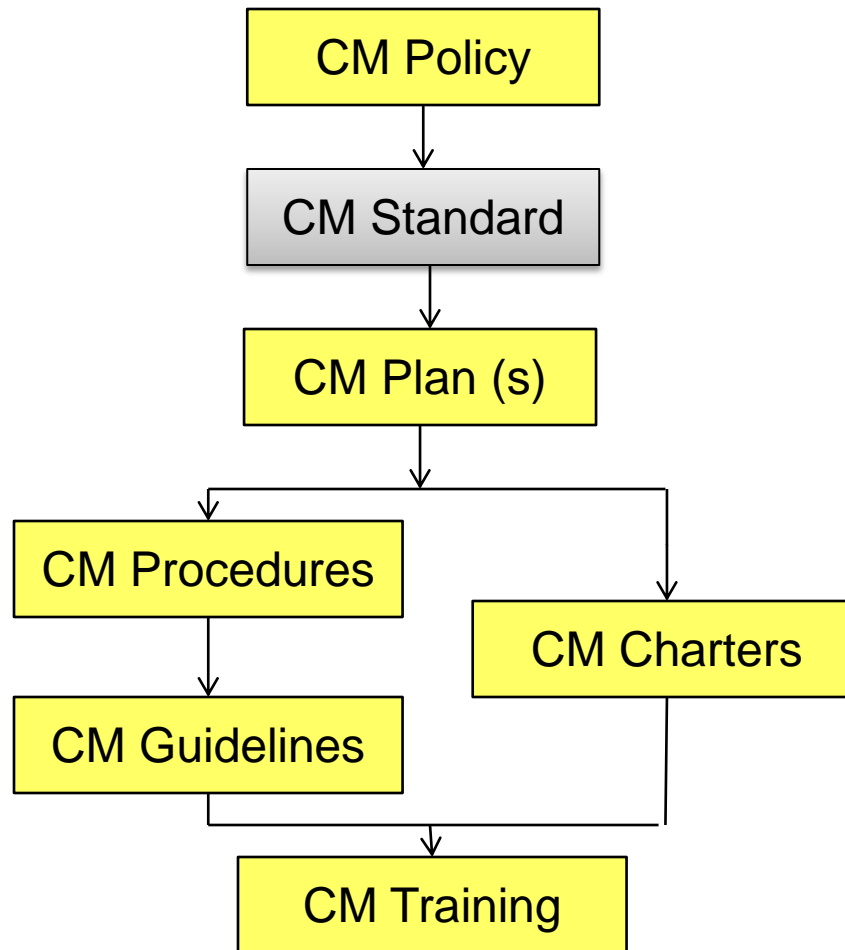


# Background

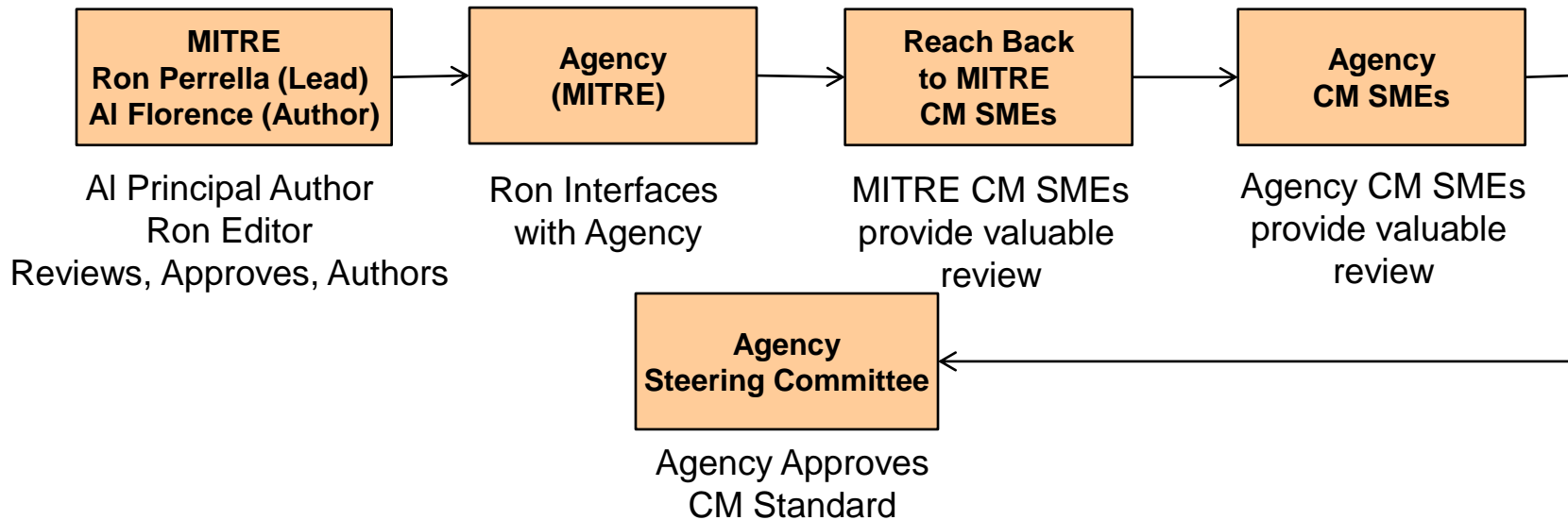
- A Federal Government agency asked MITRE to develop a Configuration Management (CM) Standard for the agency's use
- The standard needs to reflect the way the agency does business
- Adoption of a commercial CM standard, such as IEEE CM Standards, will not suffice
  - Although the standard should be in compliance with industry best CM practices as described in:
    - IEEE CM Standards
    - ITIL CM Standards
    - CMMI CM processes
    - NIST Security CM process
    - Etc.
- The standard needs to reflect “WHAT” needs to be accomplished with CM not “HOW” CM is applied
  - CM Plans, procedures, guidelines, etc. describe the “HOW”

# Application of Standard

## CM Documentation Tree



# Approach to Development of the Standard



# Presentation Contents (Part 2)

- ➔ ■ Introduction
- The Standard
  - Executive Summary
  - Introduction
  - Configuration Management Objectives
  - Configuration Management
  - Configuration Management during O&M
  - Appendix A, Configuration Management Tailoring Guide
  - Appendix B, CM Roles and Responsibilities
  - Appendix C, CM Resources and Tools
  - Appendix D, CM controlled items
  - Acronyms
  - Glossary
- Review of Standard/Acceptance of Standard
- Application of Standard
- Contact Information
- References/Suggested Reading

# Introduction

## Outline of the Standard

**Presents the Standard  
summarized in  
the following slides**

**Not all sections will be  
discussed**

### **Executive Summary**

#### **1. Introduction**

- 1.1 Background
- 1.2 Purpose
- 1.3 Scope
- 1.4 Disclosure
- 1.5 Audience
- 1.6 Document Organization

#### **2. Configuration Management Objectives**

- 2.1 CMO 1 Plan CM
- 2.2 CMO 2 Identify CIs
- 2.3 CMO 3 Control Changes
- 2.4 CMO 4 Provide Status
- 2.5 CMO 5 Conduct Audits

#### **3. Configuration Management**

- 3.1 Configuration Management Planning
- 3.2 Configuration Identification
  - 3.2.1 Configuration Items
  - 3.2.2 Identifying Configuration Items
- 3.3 Configuration Control
  - 3.3.1 Establish Baselines
  - 3.3.2 Configuration Control Board
  - 3.3.3 Change Requests
  - 3.3.4 Impact Assessment
  - 3.3.5 Updated Baselines
- 3.4 Configuration Status Accounting
- 3.5 Configuration Audits

#### **4. Configuration Management during O&M**

**Appendix A, Configuration Management Tailoring Guide**

**Appendix B, CM Roles and Responsibilities**

**Appendix C, CM Resources and Tools**

**Appendix D, CM controlled items**

**Acronyms**

**Glossary**

**List of References**

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# Executive Summary

- The Agency recognizes the necessity of managing its inventory of Information Technology (IT) assets to ensure the integrity and availability of these assets to support its missions
- The Standard reflects the use of industry best CM practices:
  - Information Technology Infrastructure Library (ITIL)
  - Software Engineering Institute Capability Maturity Model Integration (CMMI®)
  - Institute of Electrical and Electronics Engineers (IEEE) 828-2012 Standard for Configuration Management in Systems and Software Engineering
  - ISO/IEC 12207, Software Life Cycle Processes
- The practice of CM affects all phases of IT system development from requirements through design, integration and test, implementation, and Operations and Maintenance (O&M) of hardware and software

# 1. Introduction

## ■ Background:

- The Agency is undertaking the development of a large-scale Information Technology (IT) Modernization initiative to improve the quality and delivery of services to stakeholders.

## ■ Purpose

- This Standard establishes standards for CM of the agencies' enterprise, including automated systems, software applications and products, supporting hardware and software infrastructure as well as contactor deliverables and associated documentation.

## ■ Scope

- This document represents the required standards for conduct of CM activities performed by the agency, partners in development, integration, test and validation, processing, and Operations and Maintenance (O&M) environments.



## 2. Business Rules

- The Agency has established the following Configuration Management Objectives (CMO) for governing CM activities.
- CMO 1
  - Projects must plan for Configuration Management
- CMO 2
  - Projects must identify items to be placed under Configuration Control
- CMO 3
  - Projects must provide control of Items placed under Configuration Control
- CMO 4
  - Projects must provide status of CM activities and products
- CMO 5
  - Projects must conduct audits of CM activities and products

# 3. Configuration Management

- The discipline of CM applies technical and administrative direction and surveillance to:
  - Identify and document the physical, functional, and performance characteristics of items
  - Identify which items need to be controlled by CM
  - Baseline those items and their characteristics
  - Control changes to items and their characteristics
  - Provide status on those characteristics
  - Conduct audits on items and their characteristics
- Configuration Management employs a structure that performs the functions of policy, plans, charters, processes, procedures, guidelines, and training. Each layer in the structure provides an increasing level of detail.

# 3.1 Configuration Management Planning

- The purpose of CM planning is to produce and communicate effective and workable CM Plans (CMP) whether for a project or for ongoing CM services to an organization
- CMPs establish and provide the basis for uniform and concise CM practices and activities for:
  - Configuration Identification – identifies items for CM control
  - Configuration Control – provides control of items that have been selected and baselined for CM control
  - Configuration Status Accounting – provides status of CM activities and controlled items
  - Configuration Audits – provides evaluation and assessment on CM activities and controlled items

## 3.2 Configuration Identification

- Configuration Identification involves identifying the configuration of items such as hardware, software, and documentation within a system as well as their physical, functional, and performance characteristics
- Examples of these configurations:
  - Requirements
  - Architecture, software, hardware designs
  - System, subsystem and product interfaces
  - Test plans
  - Test procedures
  - Code
  - Hardware infrastructure
  - Security configurations
  - Schedules
  - Budgets

## 3.2.1 Configuration Items

- A Configuration Item (CI) is the identified configuration of an item, or a portion of its parts, that is designated for CM and change control
- CIs are important program or project items that are subject to change during their life
- The identification of CIs includes:
  - Assigning unique identifiers to each CI
  - Technical documentation describing each item's configuration
  - Establishing naming conventions for CIs
  - Establishing and maintaining associations between CIs and their descriptive information
  - Describing the product structure through the selection of CIs and identification of their internal and external relationships

## 3.3 Configuration Control

- Configuration control is the systematic evaluation, coordination, approval or disapproval, and implementation of changes to CIs
- Change control is the process of making changes in a planned fashion, the objective is to:
  - correct defects
  - add capability
  - more effectively implement new and improved methods and systems on a project or in an enterprise
- Changes may be initiated by a Change Request (CR), which may originate as a Problem Report (PR) or an Engineering Change Proposal (ECP)
- CIs need to be stored in a repository to support their control

## 3.3.1 Establish Baselines

- A baseline (BL) is the approved and fixed configuration of a collection or set of one or more CIs at a specific time in its life cycle that serves as a reference point for change control
  - A specification or product that has been formally reviewed and agreed upon, that thereafter serves as the basis for further development
  - A specific version of a single CI by itself or a set of functionally related CIs can be established as a baseline
  - A baseline is established at the proper time
    - When the CI is mature, stable, and has been reviewed and agreed upon by all stakeholders
    - BLs can only be changed through formal change control procedures
    - A BL change requires a CR, which ensures that implications to cost schedule, and technical baselines are addressed

## 3.3.2 Configuration Control Boards

- Configuration Control Boards (CCBs)
  - establish baselines – although the recommendation is provided by the technical staff
  - manages and controls changes to baselines
- CCBs review, approve, disapprove, defer to a later time, escalate to higher authority, CRs for CIs
- CCB membership comprises management and stakeholders, and is supported by Technical Advisors (TAs)
- An Acquirer CCB may exist at the enterprise and/or project level, with an approved charter and operating procedures
- A Supplier CCB may exist at the
  - Program level
  - Project level
  - Sub Contractor level



## 3.3.3 Change Requests

- A CR should contain the following fields, at a minimum:
  - CR requester
  - CI to be changed
  - Class of change
  - Description and reason of proposed change, rationale, and purpose
  - Affected baseline
  - Analysis of impact on the project and other entities
  - Approval or disapproval
  - State of the change (e.g., open, approved/rejected, implemented, tested)
  - Date closed

## 3.3.4 Impact Assessment

- All stakeholders need to assess impacts against requested CRs
- The assessments should include at least the following:
  - Physical, functional, performance characteristics
  - System, subsystem, and product interfaces
  - Security issues
  - Cost (may be against a cost threshold)
  - Schedule (Master Schedule or equivalent)
  - Shared data by systems
  - Environmental impact

A CR can be generated for non-existing capabilities that require the start of a new program. Additionally, a CR can be used to add or change capabilities or make changes or corrections to existing programs whether in development or in operation.

## 3.3.5 Updated Baselines

- The CCB establishes an initial baseline for a CI once it is deemed mature and the stakeholders have approved it
- Any update of the baseline requires
  - submission of a CR
  - completion of an impact assessment
  - CCB approval of requested change
  - implementation of the change
- The process for updating a baseline may take days, weeks, or even months depending on the complexity and degree of anticipated impact

## 3.4 Configuration Status Accounting

- Configuration Status Accounting (CSA) focuses on recording and reporting information needed to maintain integrity and traceability of CIs, CM activities, and associated CM documentation
- Status is provided to executives, project managers, CCBs, and team members which can aid in:
  - Determining the results of project work during a given period and developing estimates-to-complete at any point in the project
  - Ascertaining the developing product's status with regard to stability and functional completion
  - Verifying control over assets
  - Satisfying CM compliance

## 3.5 Configuration Audits

- The purpose of configuration auditing is to objectively assess the integrity of the product both from a:
  - Functional perspective; how the different technical processes of product development—from requirements to testing—were performed
  - Physical perspective; how the product was built and changes were applied
- Functional Audits are formal examinations of test results of the as-built functional configuration of CIs prior to acceptance
  - verify that the CIs have satisfied their specified requirements
- Physical Audits are formal examinations of the as-built physical configuration of CI products against their design documentation
  - verify that they have met their design specifications

# 4. Configuration Management During O&M

- Configuration Management continues during O&M.
- The main emphasis during O&M is on change control, although other CM processes are important.
- The following baselines migrate to the O&M phase after development is complete and comprise the O&M Baseline:
  - Requirements Specification Baseline
  - Interface Control Document Baseline
  - System Design Document Baseline
  - Business/Product Code Baseline
  - Test Plan Baseline
  - O&M Manual Baseline
  - Version Description Document Baseline
  - Other baseline such as security IT assets baselines

# References/Suggested Reading

- *IEEE Std. 828-1998 IEEE Standard for Software Configuration Management Plans*
- *IEEE 1042, Guide to Software Configuration Management*
- *ANSI/EIA-649-1998 National Consensus Standard for Configuration Management*
- *IEEE 828-2005 – Standard for Software CM plans*
- *MIL-STD-973 Military Standard for Configuration Management (cancelled, but still good reference)*
- *CM Today Yellow Pages, Your Source for Daily CM News, [www.cmtoday.com/yp/configuration\\_management.html](http://www.cmtoday.com/yp/configuration_management.html)*
- *CM BoK – Configuration Management Body of Knowledge. [www.cmcrossroads.com/cgi-bin/cmwiki/bin/view.cgi/CM/](http://www.cmcrossroads.com/cgi-bin/cmwiki/bin/view.cgi/CM/) CMBoK, CM Crossroads, CM Community Forums*
- *Capability Maturity Model® Integration (CMMI), Version 1.3. Software Engineering Institute*
- *NIST, SP 800-53, Revision 4, Recommended Security Controls for Federal Information Systems and Organizations, April 30, 2013.*

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