# Configuration Management

## January 22, 2013
## American Society for Quality (ASQ)
## Washington, DC and Maryland Section 509
## Software Special Interest Group (SSIG)

*Russ Roseman and Al Florence*

This presenter's 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 this presenter.

MITRE

# Presentation Contents

- Introduction
  - Reasons for Configuration Management (CM)
  - 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
- References

# Presentation Contents

- This presentation was developed by Al Florence and Russ Roseman of The MITRE Corporation
- Unfortunately Al could not present due to conflicts with his schedule

# Why CM?

- CM ensures that the current configuration of items are known throughout their lifecycle
- CM ensures that changes to the configuration of evolving items are correct, controlled, managed, and documented
- CM helps manage complexity, interface dependencies, increases security, and recovery from errors

# 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 Planning
  - Configuration Identification
  - Configuration Control
  - Configuration Status Accounting
  - Configuration Management Audits

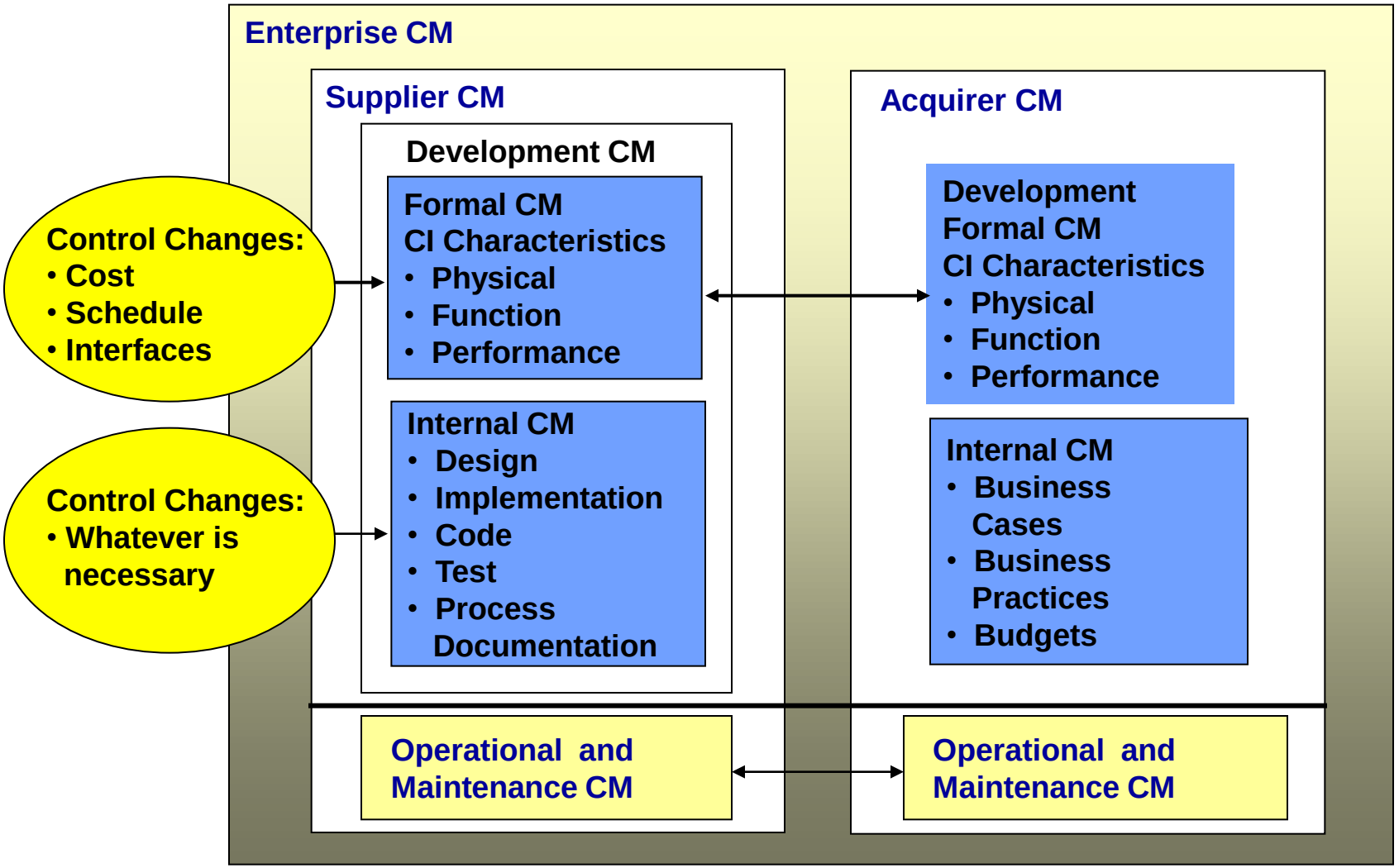
# Application of CM

- The CM concepts presented in this course can be applied to:
  - Hardware (H/W)
  - Software (S/W)
  - Facilities

  And their appropriate documentation

**During Development and Operation by the Acquirer and Supplier**

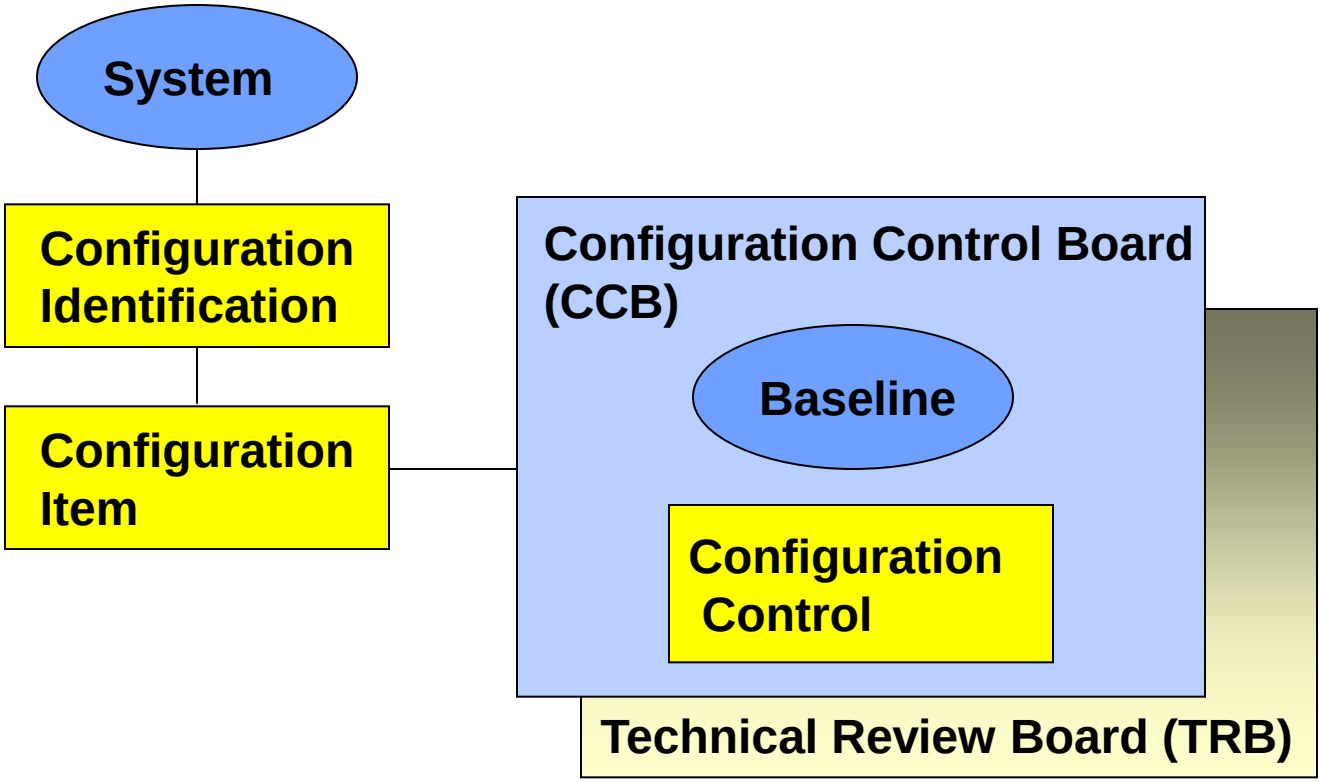
# Some Levels of CM



# Presentation Contents

- Introduction
  - Reasons for Configuration Management (CM)
  - 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
- References

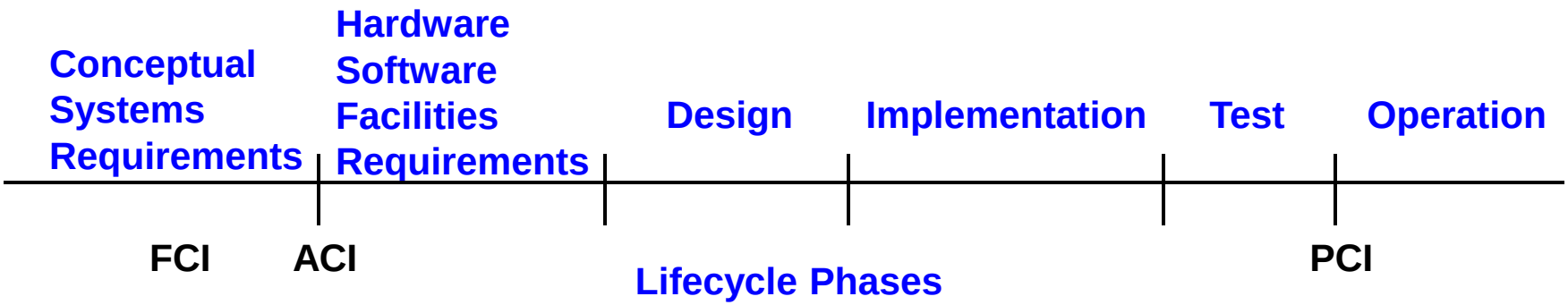
# Configuration Management Overview




**Configuration Management Audits – Configuration Status Accounting**

# Configuration Identification concluded

- Three levels of Configuration Identification are established
  - Functional Configuration Identification (FCI)
  - Allocated Configuration Identification (ACI)
  - Physical Configuration Identification (PCI)



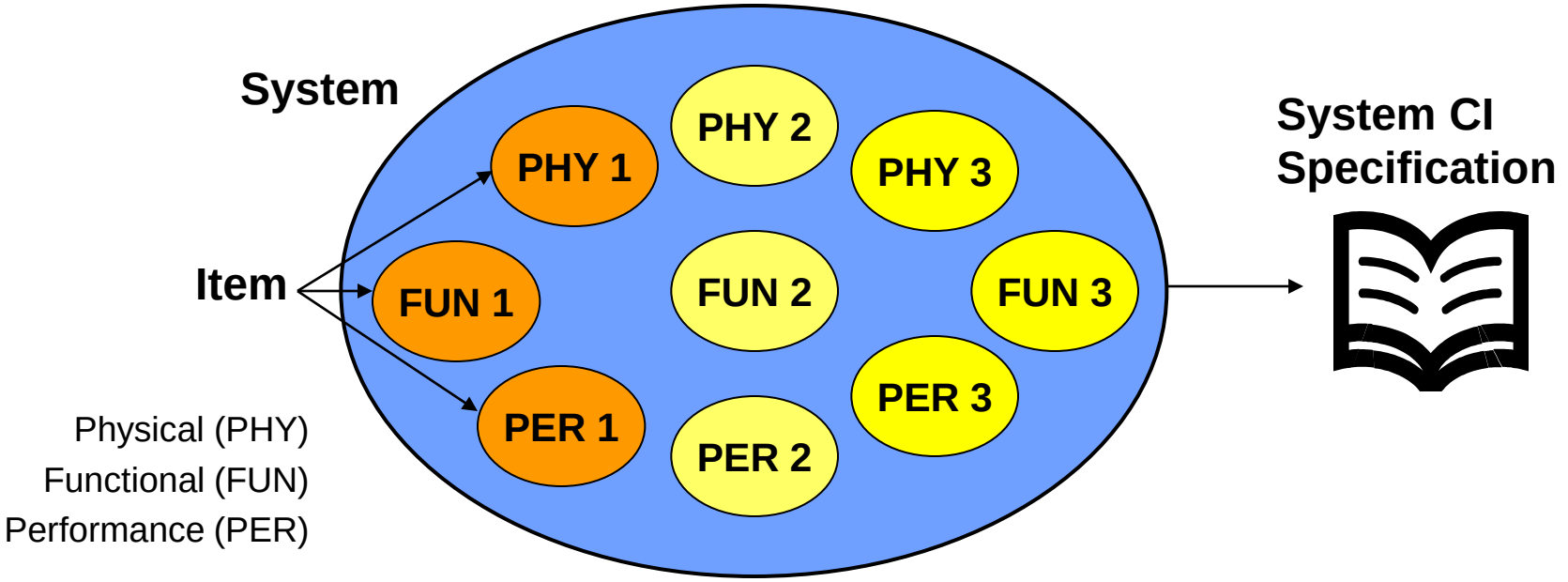



MITRE

# 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



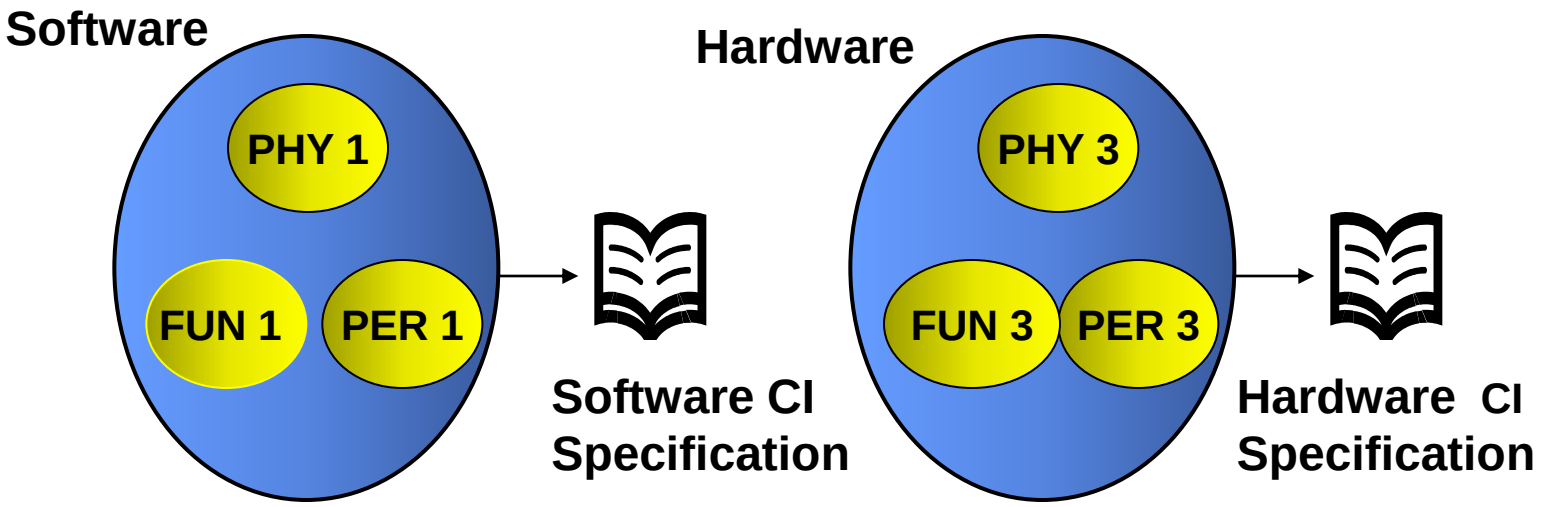



MITRE

# 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



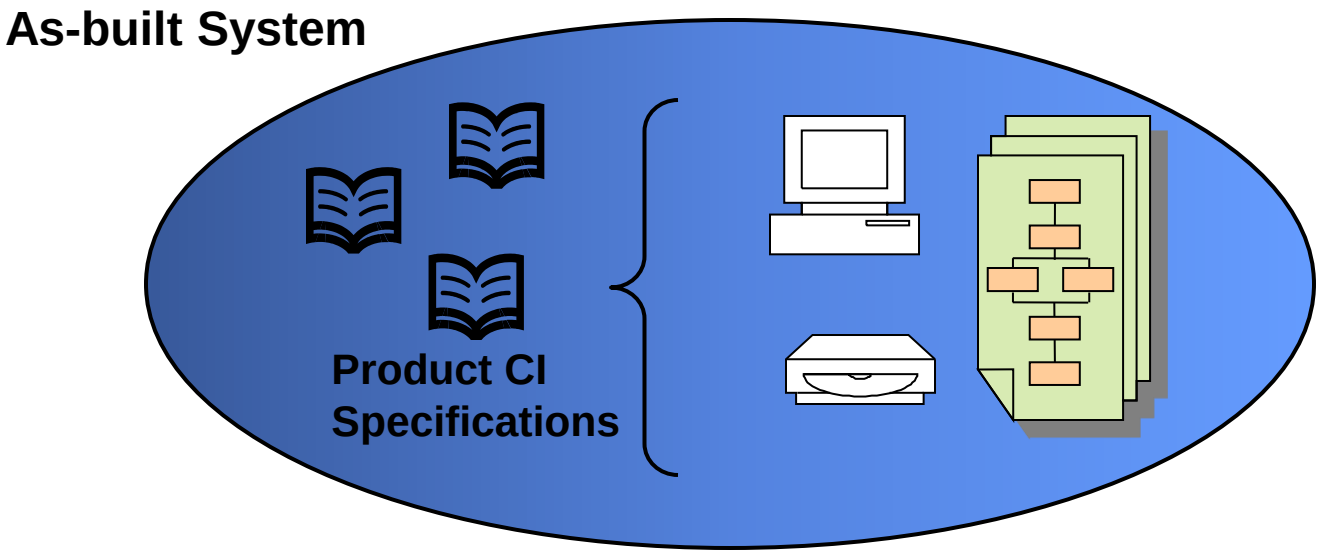



MITRE

# Physical Configuration Identification

## Physical Configuration Identification (PCI)

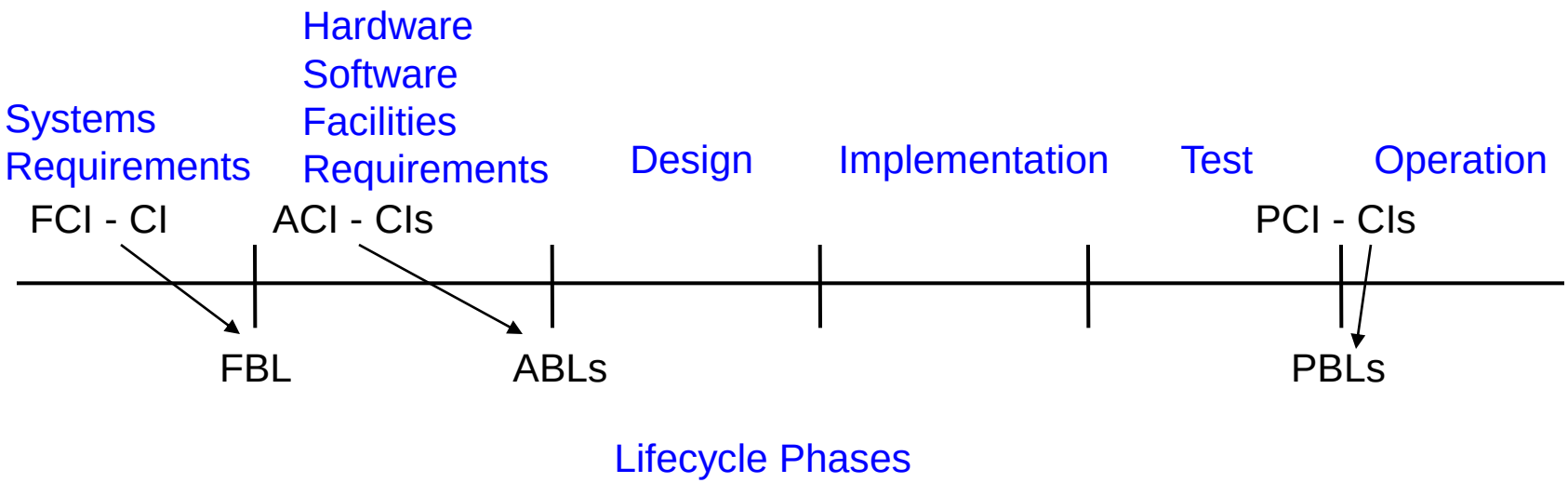
Finally, the products of the developed system: software, hardware, facilities are defined in a series of Product CI Specifications that describe the as-built system including requirements



# Formal Baselines

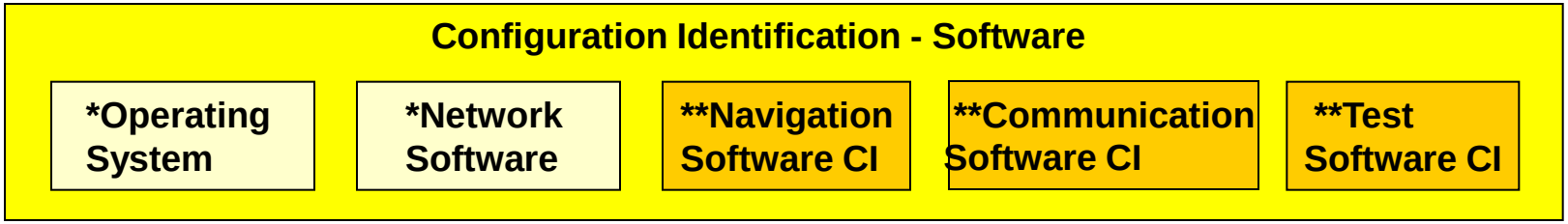
Baselines are established at strategic points in a system lifecycle. Three baselines may be defined:

- Functional Baseline (FBL) Requirements
- Allocated Baseline (ABL) Requirements
- Product Baseline (PBL) Including Requirements



# Configuration Identification and Configuration Items

- Configuration Identification is an activity that identifies items and their characteristics: physical, functional, and performance
- Not all items that are identified need be controlled at the same level of rigor
- Configuration Items are selected for formal change control from items identified, usually related to requirements



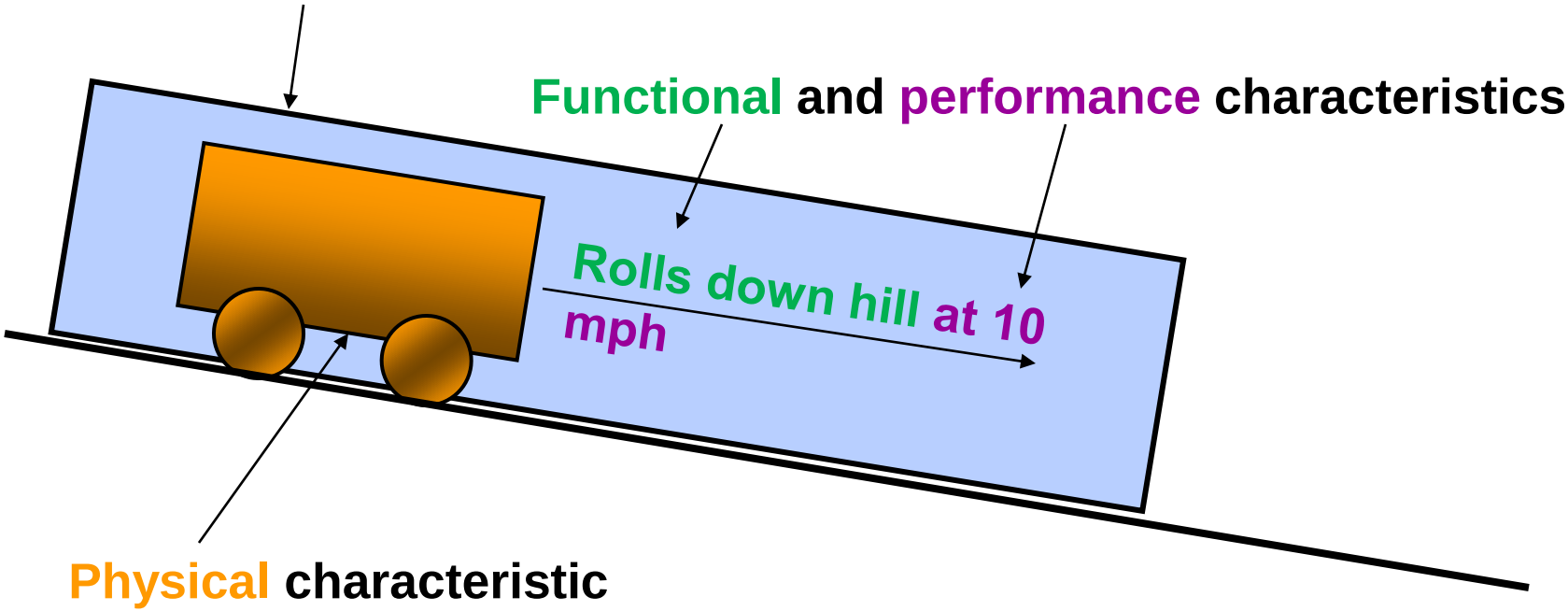

***Commercial products MAY not be subject to change – In operation (Operation) everything is under CM control**
****Applications software in development that is subject to change**



MITRE

# Configuration Item

**Represents the characteristics (requirements) of a Configuration Item**

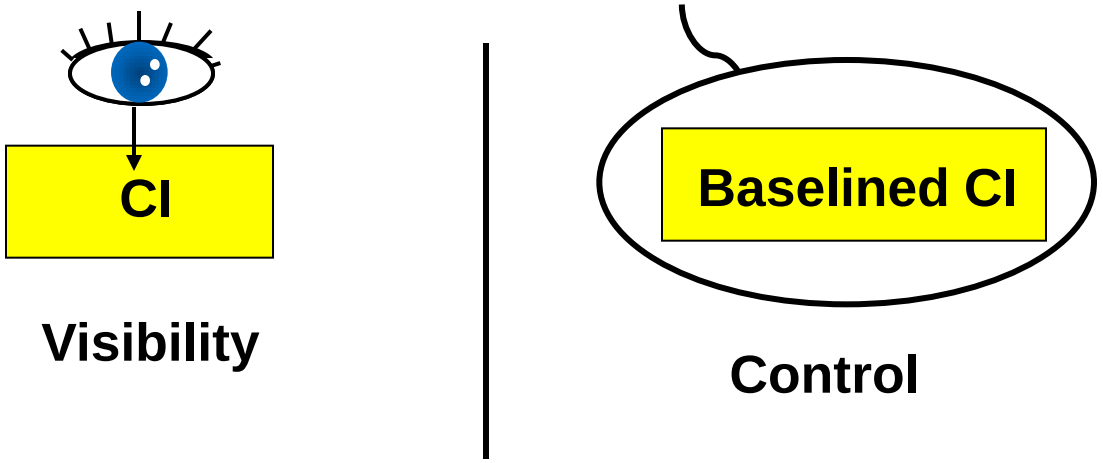





MITRE

# Baseline vs. Configuration Items

- **The approved and fixed (baselined) configuration of a CI at a specific time in its lifecycle that serves as a reference point for change control**
  - CIs are used for visibility
  - Baselines are used for control






MITRE

# 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

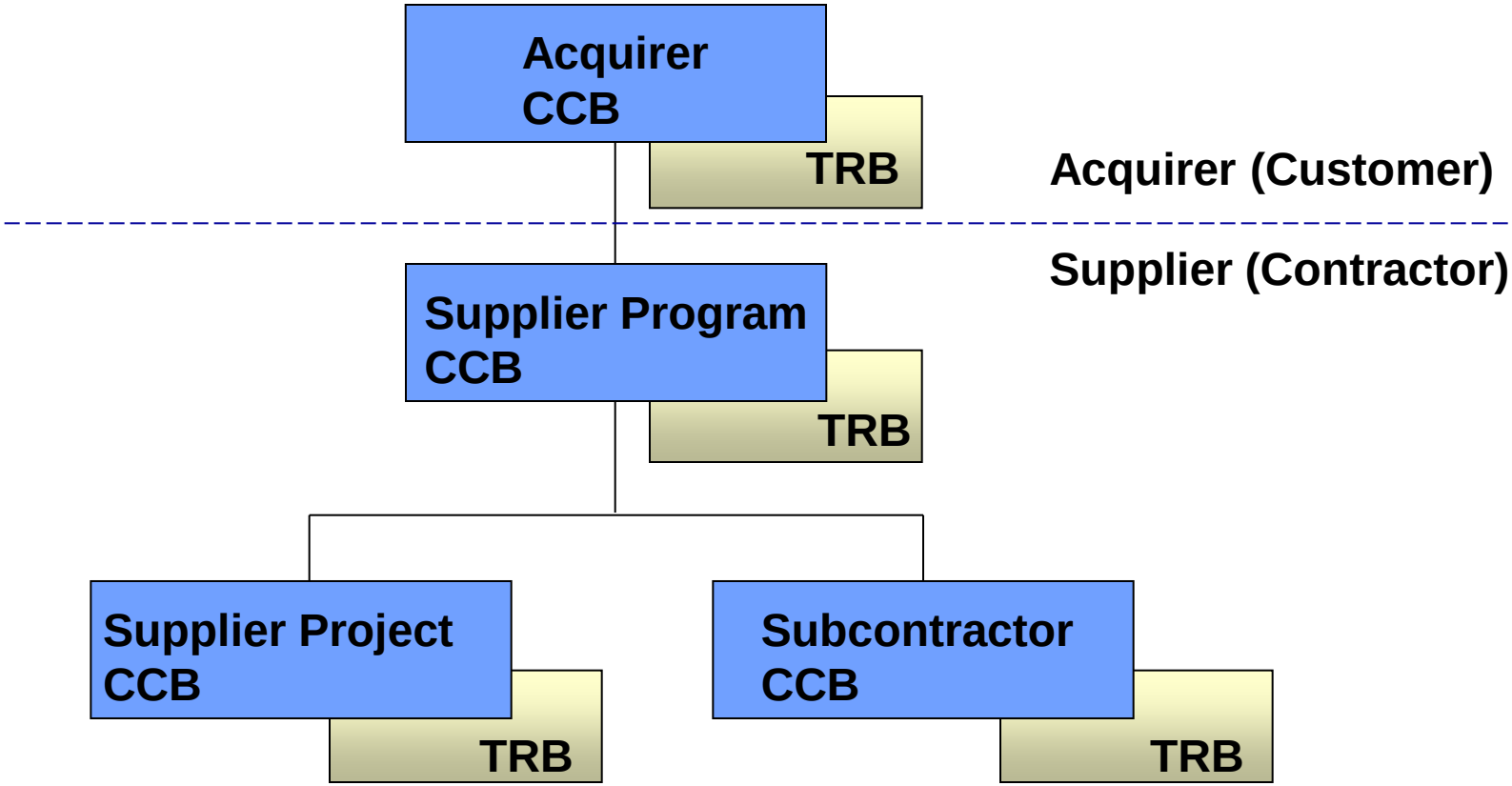
# Configuration Control Board (CCB)

- 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

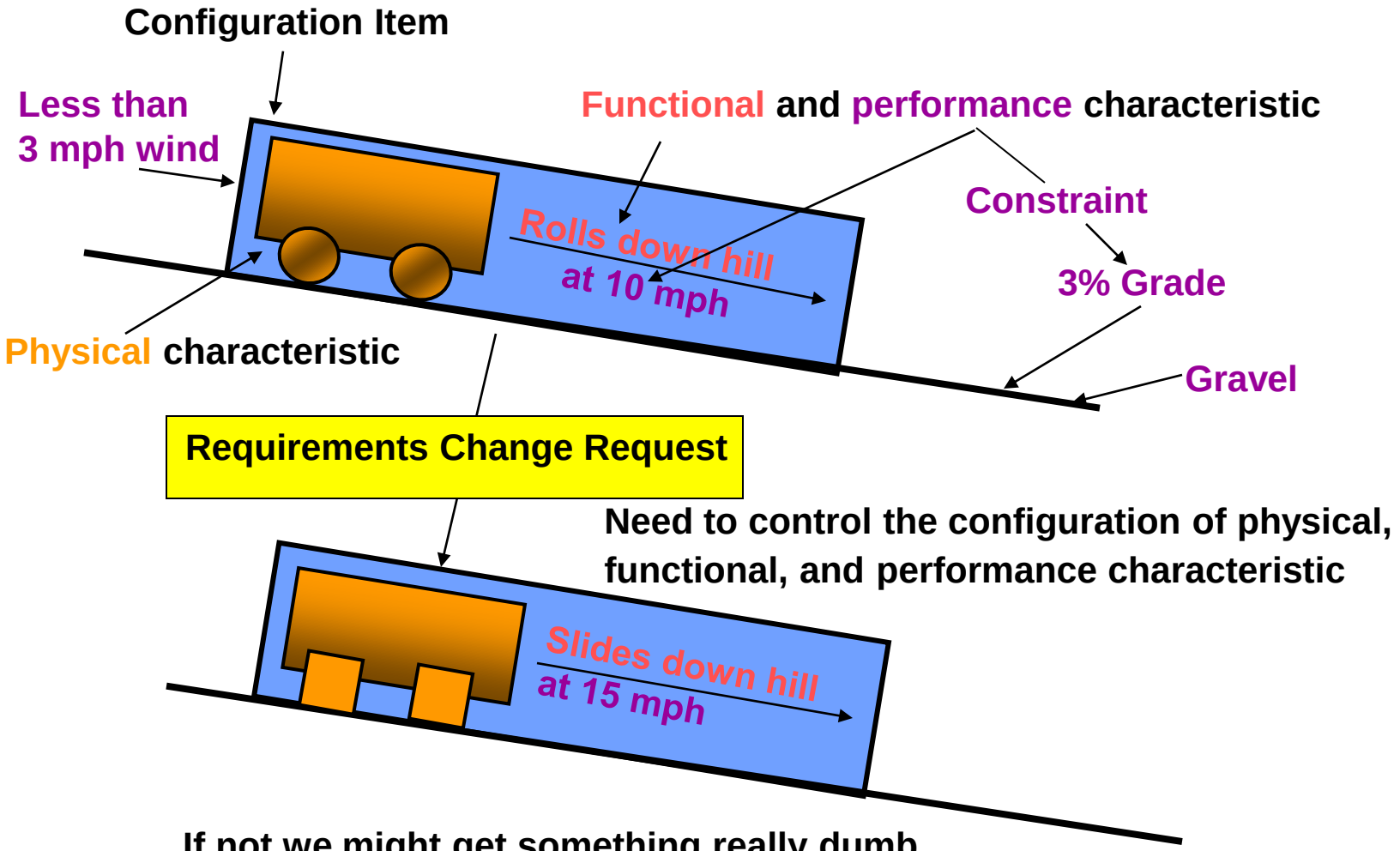
# CCB and TRB Hierarchy






MITRE

# Configuration Control





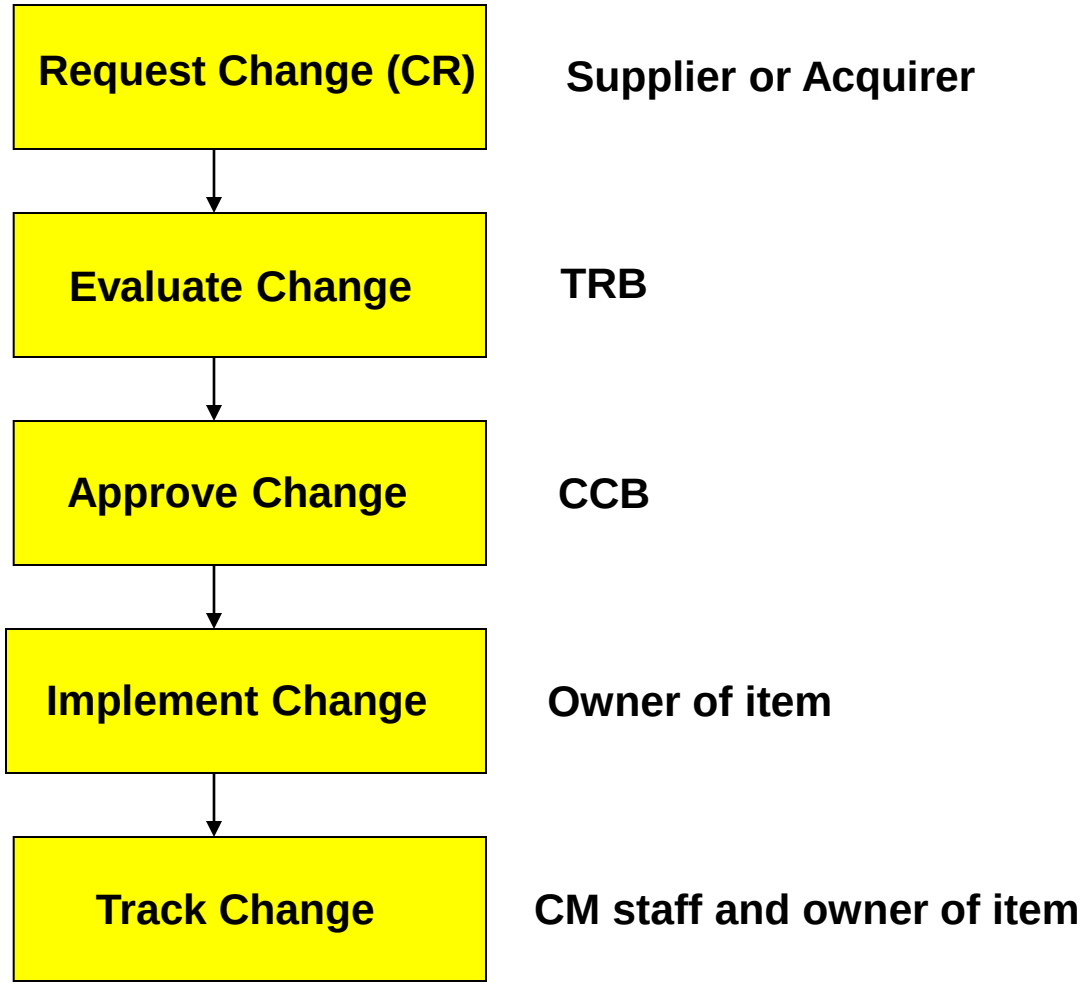

MITRE

# CR Example

Change Request

| | | | |
|---|---|---|---|
| **CR #** | **Date:** 12/4/2003 | **Requestor:** ET | **Class:** I ☐ II ☐ |
| **Problem:** A requirement to deploy the probe's parachute does not exist | | | |
| **Change:** Add the following requirement: The probe's parachute shall be deployed .01 seconds after the heat shield has been jettisoned | | | |
| **Impacts:** Enter figures for cost and schedule and list affected interfaces or "None" and attach impact assessments<br><br>Systems:<br>Hardware:<br>Software:<br>Test:<br>Configuration Management:<br>Quality Assurance:<br>Contracts:<br>Other [Specify]: | | | |
| **Approve:** | TRB Date:<br>CCB Date: | Chair:<br>Chair: | |
| **Disapprove:** | TRB Date:<br>CCB Date: | Chair:<br>Chair: | |
| **Assignee:** | | **Due Date:** | |

# 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 capability**
  - **Performance**
  - **External interfaces**
  - **Cost**
  - **Schedule**

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

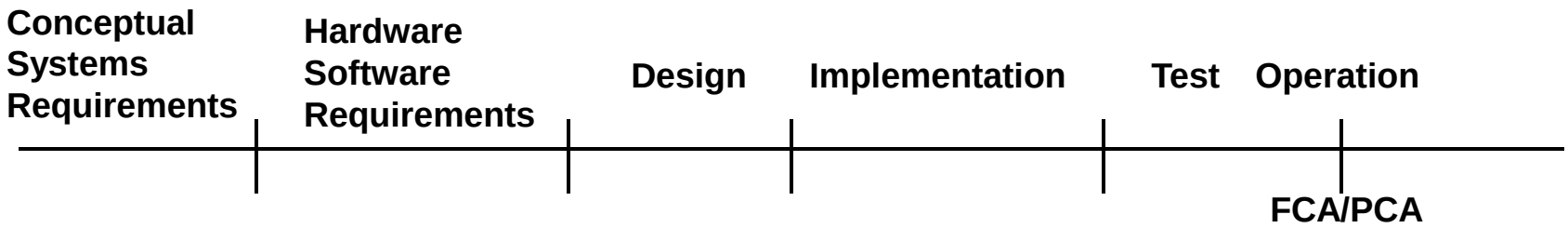
# Classification of Changes concluded

- **Class II -** Does not affect any of the Class I factors, affects changes such as:
  - Spelling or typographical errors
  - Addition of clarifying comments
  - 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






MITRE

# 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 the Supplier for the Acquirer and attended by
  - Management
  - System Engineering
  - Hardware / Software Engineering
  - Test Engineering
  - QA and CM
  - Contracts

  of both the Acquirer and Supplier

# Functional Configuration Audit concluded

Functional

- Requirements Specifications
- Requirements Traceability
- Test Plans
- Test Scenarios

Testing

- Products
- Tests

Test Results

- Requirements Specifications
- Requirements Traceability
- Test Plans
- Test Scenarios
- Test Results

Inputs

**Functional Configuration Audit**

Verify that the CIs have satisfied their specified requirements

Supplier
Acquirer

Physical Configuration Audit



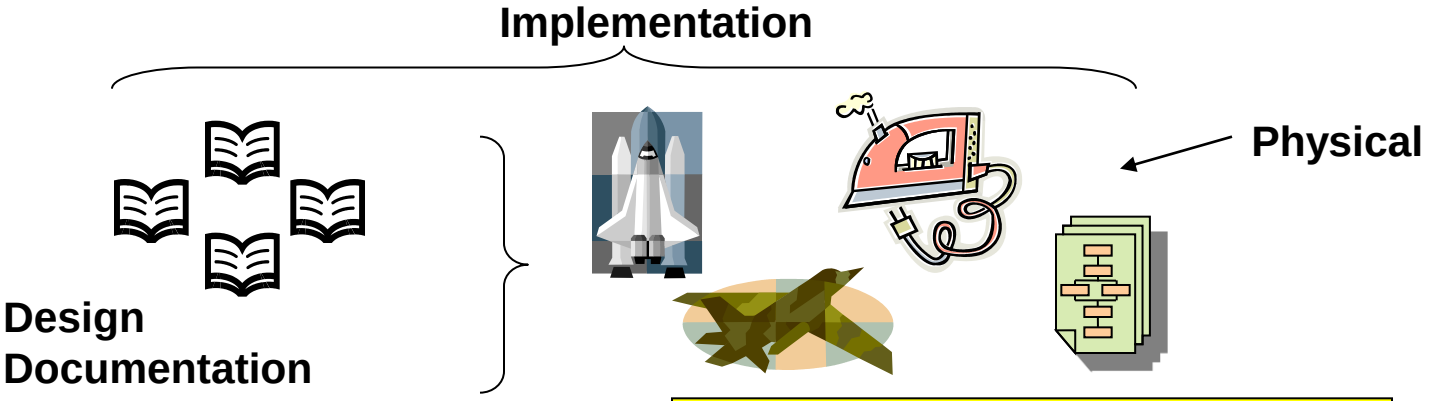
MITRE

# 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 the Supplier for the Acquirer and attended by
  - Management
  - System Engineering
  - Hardware / Software Engineering
  - Test Engineering
  - QA and CM
  - Contracts

  of both the Acquirer and Supplier

# Physical Configuration Audit concluded




**Supplier As-Built Products:**

- Design Documentation
- Code
- Hardware
- Etc.

Inputs

**Physical Configuration Audit**

**Examination of the "as-built" configuration of CIs against their documentation**

**Supplier**
**Acquirer**

Outputs

**Product Baselines**



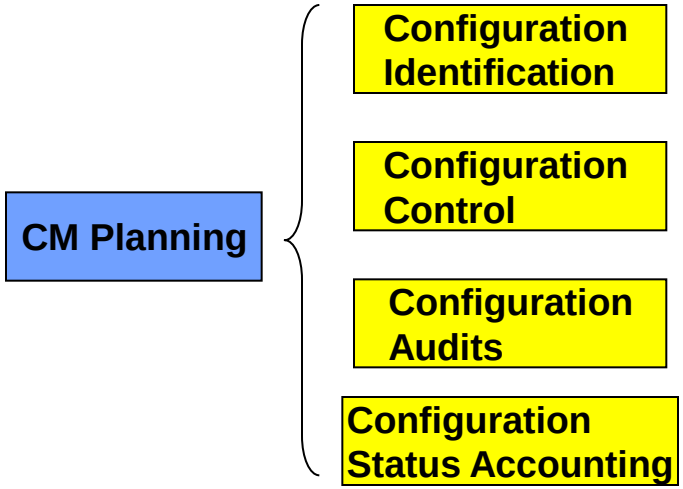
MITRE

# Configuration Status Accounting (CSA)

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

Specifications

Products (CIs)

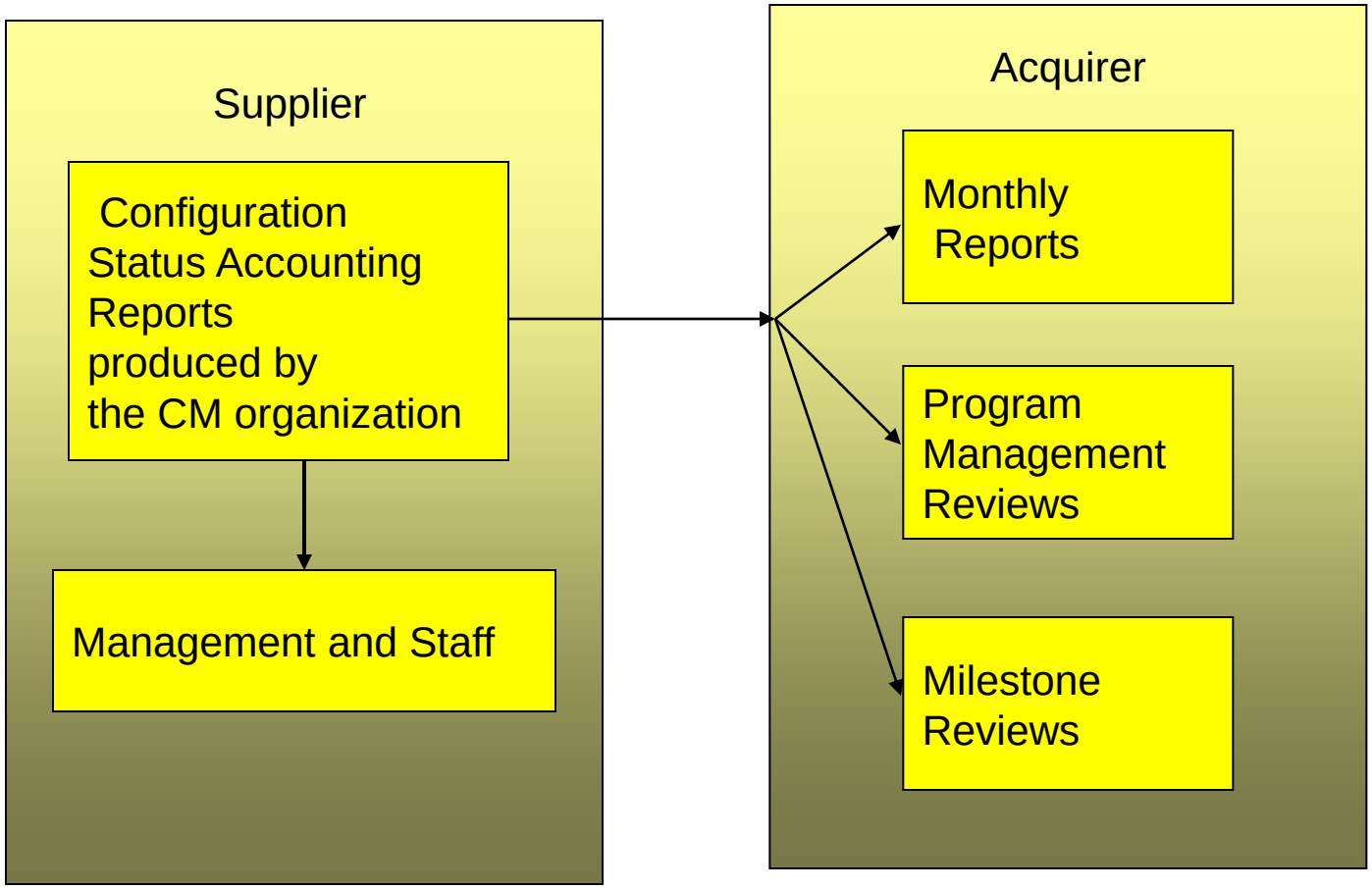



CM Tasks

# Configuration Status Accounting concluded

- The Configuration Status Accounting (CSA) task gathers, correlates, maintains, and provides status on CM controlled products and CM tasks
- 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






MITRE

# Presentation Contents

- Introduction
  - Reasons for Configuration Management (CM)
  - 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
- References

# Internal CM versus Formal CM

- Formal CM is concerned with
  - High Level baselines
    - FBL
    - ABL
    - PBL
  - Master Schedules
  - 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.

# Formal CM Under Configuration Control Board (CCB)

- Configuration Control Board is Chaired by PM
- Membership composed of management
  - Systems
  - Software
  - Hardware
  - Test
  - CM
  - QA
  - Etc.

# Internal CM Under Technical Review Board (TRB)

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

# Internal CM Concerns concluded

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

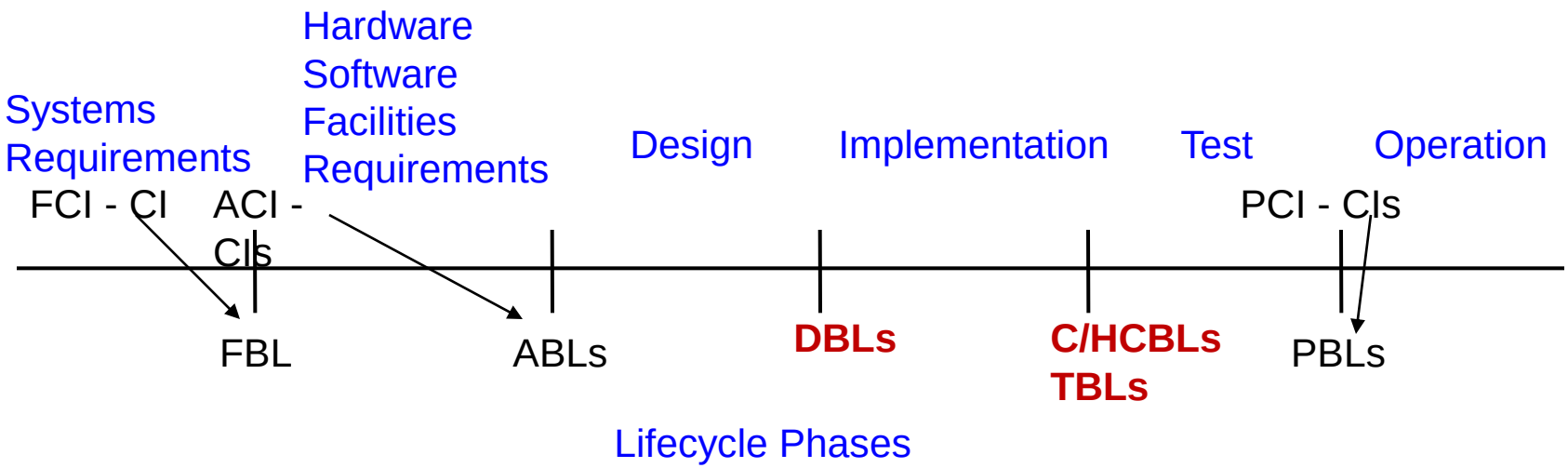
# Internal CM & Testing

- **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)

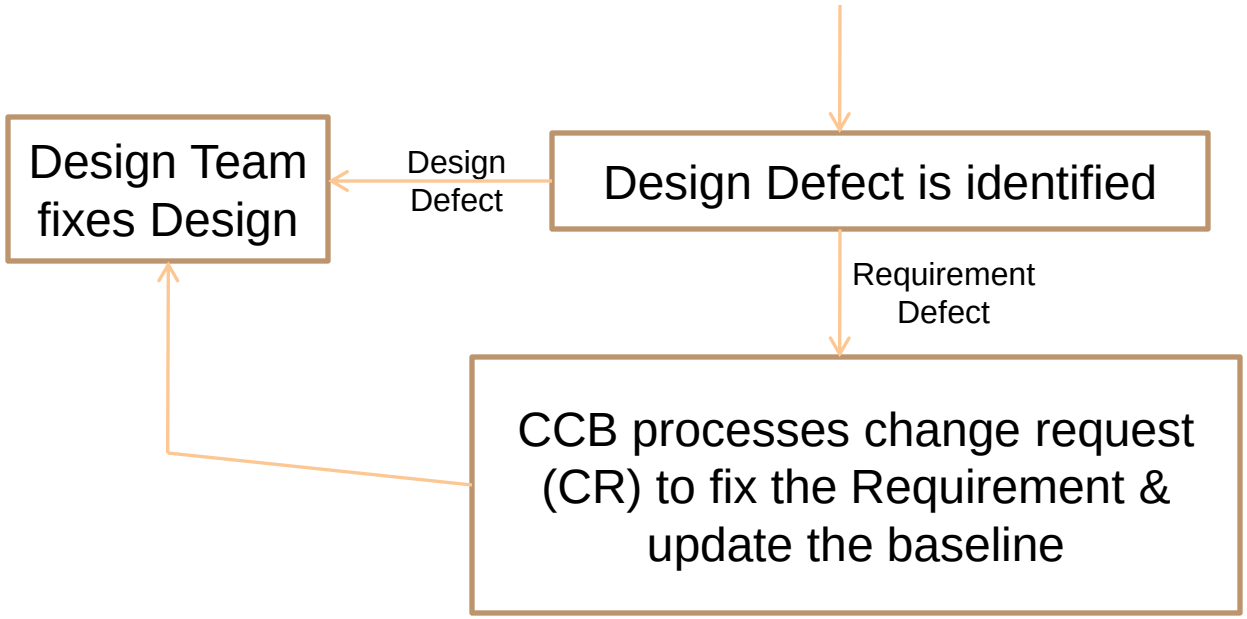





MITRE

# Internal CM During Design

## Design not yet Baselined

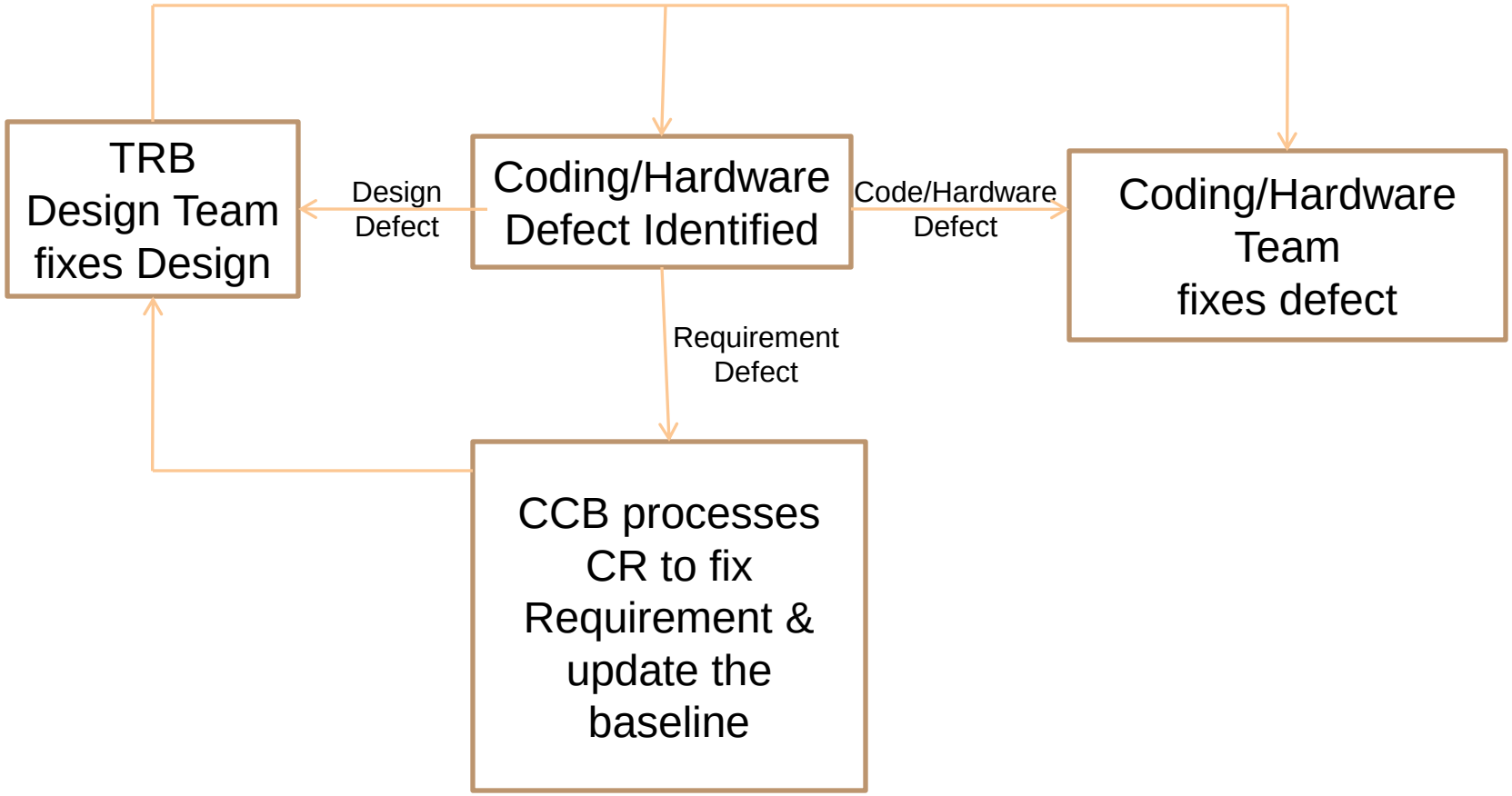





MITRE

# Internal CM During Coding

## Design Baselined, Code not Baselined

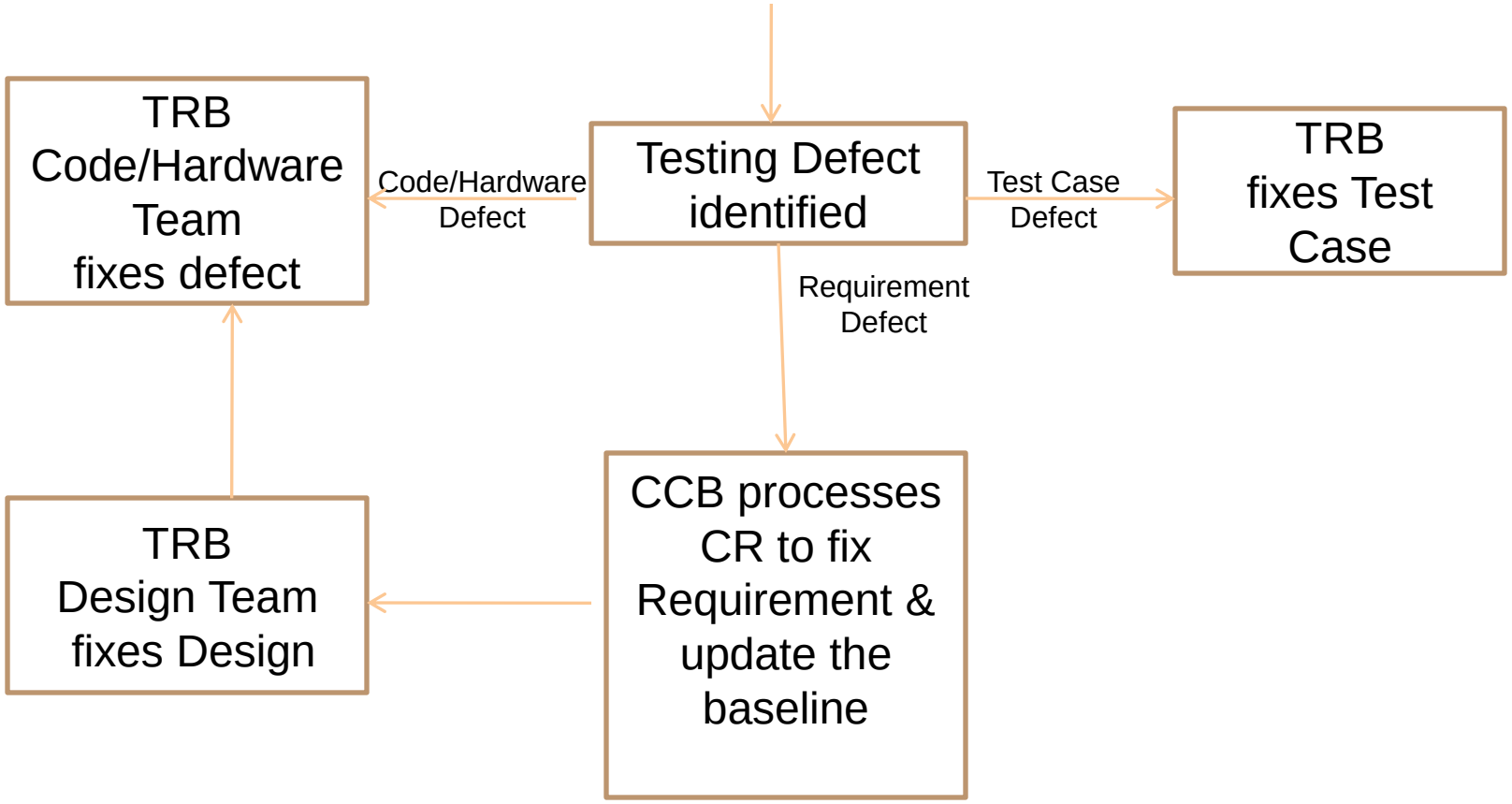





MITRE

# Internal CM During Testing

## Design, Code & Test Cases Baselined






MITRE

# Presentation Contents

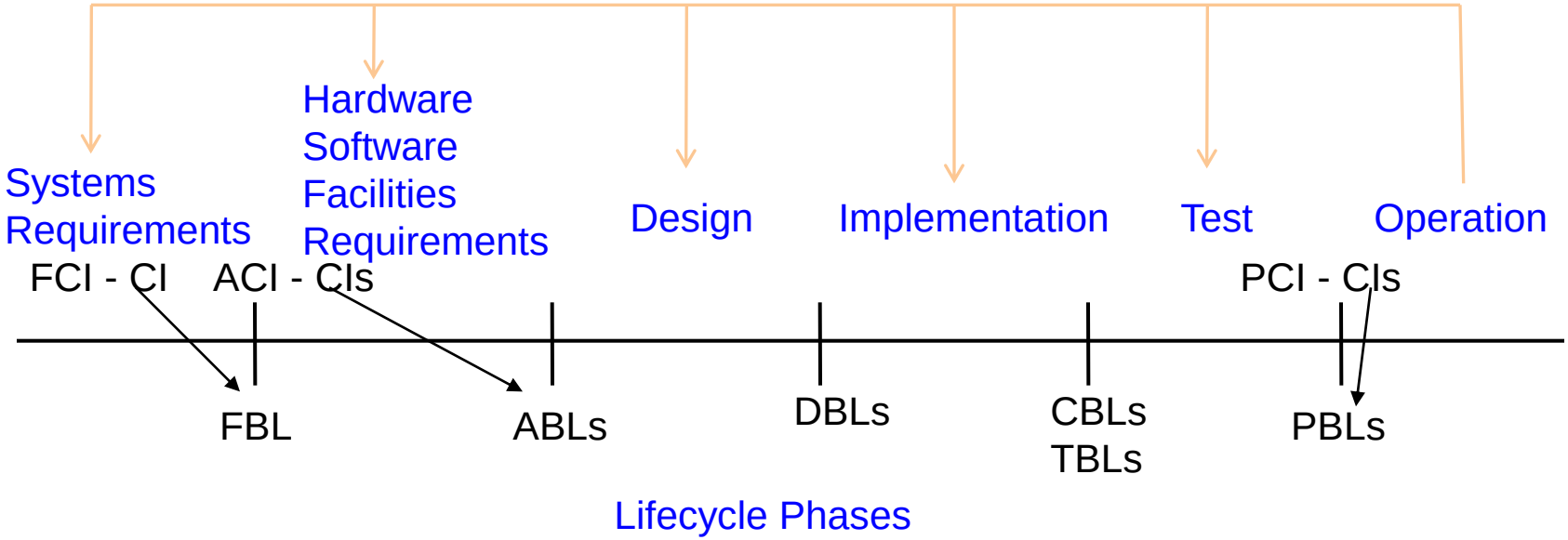
- Introduction
  - Reasons for Configuration Management (CM)
  - CM Concepts
- Formal CM
  - Formal Baselines and Configuration Items (CIs)
  - Configuration Control Boards (CCBs)
    - Supported with Technical Review Boards (TRBs)
  - Change Control
  - CM Audits and Status Accounting
- Internal CM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

# CM During Operation

- Operation CM does not differ from CM conducted during development
  - Formal CM
  - Internal CM
- The players may change
  - A different operation contractor
  - A different operation agency
    - Acquisition Agency vs. Operation Agency
- The Operation Baseline has been established

# CM During Operation concluded

Defects and changes during operation may require repeat of activities that were conducted during development and reestablishment of baselines as appropriate.



# References/Suggested Reading

- *IEEE Std. 828-2005 IEEE Standard for Software Configuration Management Plans*
- *IEEE 1042 - 1987, Guide to Software Configuration Management*
- *ANSI/EIA-649-B 2011 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)*
- *Capability Maturity Model® Integration (CMMI), Version 1.3.* Software Engineering Institute

# Contact Information

**Russ Roseman**

**rroseman@mitre.org**

**703 983 6193**

**Al Florence**

**florence@mitre.org**

**303-955-2286**