Configuration Management

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Software Special Interest Group (SSIG)

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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
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

Enterprise CM

Supplier CM

Development CM
- Formal CM
  - CI Characteristics
    - Physical
    - Function
    - Performance

Internal CM
- Design
- Implementation
- Code
- Test
- Process Documentation

Control Changes:
- Cost
- Schedule
- Interfaces

Acquirer CM

Development
- Formal CM
  - CI Characteristics
    - Physical
    - Function
    - Performance

Internal CM
- Business Cases
- Business Practices
- Budgets

Control Changes:
- Whatever is necessary

Operational and Maintenance CM

Operational and Maintenance CM
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Configuration Management Overview

- System
  - Configuration Identification
  - Configuration Item
  - Configuration Control Board (CCB)
  - Baseline
  - Configuration Control
  - Technical Review Board (TRB)

- 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)
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.

System

Item

Physical (PHY)
Functional (FUN)
Performance (PER)
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.

Software

Hardware

Software CI Specification

Hardware CI Specification
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

Lifecycle Phases

Systems Requirements
- FCI - CI
- ACI - CIs

Hardware
- Design

Software
- Implementation

Facilities
- Test
- Operation

Requirements
- FBL
- ABLs
- PCI - CIs
- PBLs
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.
Configuration Item

Represents the characteristics (requirements) of a Configuration Item

- **Functional and performance characteristics**
  - Rolls down hill at 10 mph

- **Physical characteristic**
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
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

Acquirer CCB

Supplier Program CCB

Supplier Project CCB

Subcontractor CCB

Acquirer (Customer)

Supplier (Contractor)
Configuration Control

Configuration Item

Less than 3 mph wind

Physical characteristic

Rolls down hill at 10 mph

Functional and performance characteristic

Constraint

3% Grade

Gravel

Requirements Change Request

Need to control the configuration of physical, functional, and performance characteristic

Slides down hill at 15 mph

If not we might get something really dumb or suffer a catastrophic failure

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Change Request

<table>
<thead>
<tr>
<th>CR #</th>
<th>Date: 12/4/2003</th>
<th>Requestor: ET</th>
<th>Class:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Problem:</strong></td>
<td>A requirement to deploy the probe’s parachute does not exist</td>
<td></td>
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<tr>
<td><strong>Change:</strong></td>
<td>Add the following requirement: The probe’s parachute shall be deployed .01 seconds after the heat shield has been jettisoned</td>
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<tr>
<td><strong>Impacts:</strong></td>
<td>Enter figures for cost and schedule and list affected interfaces or “None” and attach impact assessments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Systems:</td>
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<td></td>
</tr>
<tr>
<td>Hardware:</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Software:</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Test:</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Configuration Management:</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Quality Assurance:</td>
<td></td>
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<tr>
<td>Contracts:</td>
<td></td>
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<tr>
<td>Other [Specify]:</td>
<td></td>
<td></td>
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</table>

**Approve:**
TRB Date: 
CCB Date: 
Chair: 

**Disapprove:**
TRB Date: 
CCB Date: 
Chair: 

**Assignee:**

**Due Date:**
Change Flow

- **Request Change (CR)**
  - Supplier or Acquirer: TRB

- **Evaluate Change**
  - TRB

- **Approve Change**
  - CCB

- **Implement Change**
  - Owner of item

- **Track Change**
  - CM staff and owner of item
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

<table>
<thead>
<tr>
<th>Conceptual Systems Requirements</th>
<th>Hardware Requirements</th>
<th>Design</th>
<th>Implementation</th>
<th>Test</th>
<th>Operation</th>
<th>FCA/PCA</th>
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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

Functional Configuration Audit
Verify that the CIs have satisfied their specified requirements

Inputs

Supplier
Acquirer

Physical Configuration Audit
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
Configuration Status Accounting (CSA)

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

**Supplier**
- Configuration Status Accounting Reports produced by the CM organization
- Management and Staff

**Acquirer**
- Monthly Reports
- Program Management Reviews
- Milestone Reviews
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■ 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)
Internal CM During Design

Design not yet Baselined

Design Defect is identified

Design Team fixes Design

CCB processes change request (CR) to fix the Requirement & update the baseline

Design Defect

Requirement Defect
Internal CM During Coding
Design Baselined, Code not Baselined

- TRB Design Team fixes Design Defect
- Coding/Hardware Defect Identified
  - CCB processes CR to fix Requirement & update the baseline
  - Requirement Defect
  - Code/Hardware Defect
- Coding/Hardware Team fixes defect
Internal CM During Testing
Design, Code & Test Cases Baselined

TRB Code/Hardware Team fixes defect

Code/Hardware Defect

Testing Defect identified

Requirement Defect

Test Case Defect

TRB fixes Test Case

CCB processes CR to fix Requirement & update the baseline

TRB Design Team fixes Design
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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.

Lifecycle Phases

- Systems Requirements
  - FCI - CI
  - ACI - CI
  - Hardware
  - Software
  - Facilities
  - Requirements
- Design
- Implementation
- Test
- Operation
- FBL
- ABLs
- DBLs
- CBLs
- TBLs
- PCI - CI
- PBLs
References/Suggested Reading

- MIL-STD-973 Military Standard for Configuration Management (cancelled, but still good reference)
- Capability Maturity Model® Integration (CMMI), Version 1.3. Software Engineering Institute
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