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# Software Configuration Management

Rovina D'britto[1], Pragyamani Sharma[2], Sejal D'mello[3], Reena Somani[4], Jyothi Arun[4]

[1](IT, University Of Mumbai, India)
[2](IT, University Of Mumbai, India)
[3](IT, University Of Mumbai, India)
[4](IT, University Of Mumbai, India)
[5](IT, University Of Mumbai, India)

***Abstract :*** *While Building Any Software, Changes Happen Throughout The Software Process And Changes Increases The Level Of Confusion Among The Software Engineers Who Are Working On That Project. Change Management, Also Known As Software Configuration Management Is A Set Of Activities Designed To Manage Change And Auditing And Reporting On The Changes Made. Everyone Involved In The Software Process Is Involved With Change Management. This Paper Is For Anyone Who Will Have Recently Detected Regarding Change Management And Desires To Grasp A Lot Of Regarding Software Configuration Management. During This Paper, We Described Software Configuration Management, The SCM Process, Different Tools For SCM, Different Features Of SCM, And Elements Of Configuration Management System.*

***Keywords -*** *Software, Scmprocess, SCM Tools, SCM Features.*

## I. Introduction

Software Configuration Management (SCM) Is A Software Engineering Discipline Consisting Of Standard Processes And Techniques Often Used By Organizations To Manage The Changes Introduced To Its Software Products. SCM Helps In Identifying Individual Elements And Configurations, Tracking Changes, And Version Selection, Control And Base Lining. SCM Is Also Known As Software Control Management. SCM Aims To Control Changes Introduced To Large Complex Software Systems Through Reliable Version Selection And Version Control. So The Purpose Of SCM Is Systematically Controls Changes To The Configuration And Maintains The Integrity And Traceability Of The Configuration Throughout The Systems Life Cycle.

### 1.1. Need For Software Configuration Management

Software Is A Collection Of Items Like Programs, Data, Documents Etc. That Can Be Changed Easily. Throughout The Software Development Cycle The Software Design Documents, Software Code Or Software Requirements Document Etc. Are Changed Often And It Is Very Important That The Changes Done In Software Are Done In A Controlled Manner. Software Configuration Management (SCM) Is The Discipline For Systematically Controlling The Changes In Software And Supporting Documents (Like Test Cases, Test Plan, Design Documents, SRS Etc.) During The Software Development Life Cycle.

### 1.2. Elements Of Software Configuration Management

The Four Important Elements When A Configuration Management Is Developed Are:

- Component Elements – Set Of Tools Coupled Within A File Management System To Enable Access To And Management Of Each Software Configuration Item.
- Process Elements – Collection Of Procedures And Tasks That Define An Effective Approach To Change Management For All Stakeholders.
- Construction Elements – Set Of Tools That Automate The Construction Of Software By Ensure A Set Of Validated Components Is Assembled.
- Human Elements – Team Uses A Set Of Tools And Process Features Encompassing Other CM Elements To Implement Effective SCM.

### 1.3. Goals Of Change Management

- Identify Changes In The Software
- Report Changes To The People Who Need To Know
- Control Change
- Ensure Change Is Properly Implemented

### 1.4 Baselines And Software Configuration Items

A Specification Or Product That Has Been Formally Reviewed And Agreed Upon, That There-After Serves As The Basis For Further Development, And That Can Be Changed Only Through Formal Change Control Procedures. Software Configuration Item Is Information That Is Created As Part Of The Software Engineering Process.Scis Is A Document, A Entire Suite Of Test Cases, Or A Named Program Component Either C++ Function Or A Java Applet.

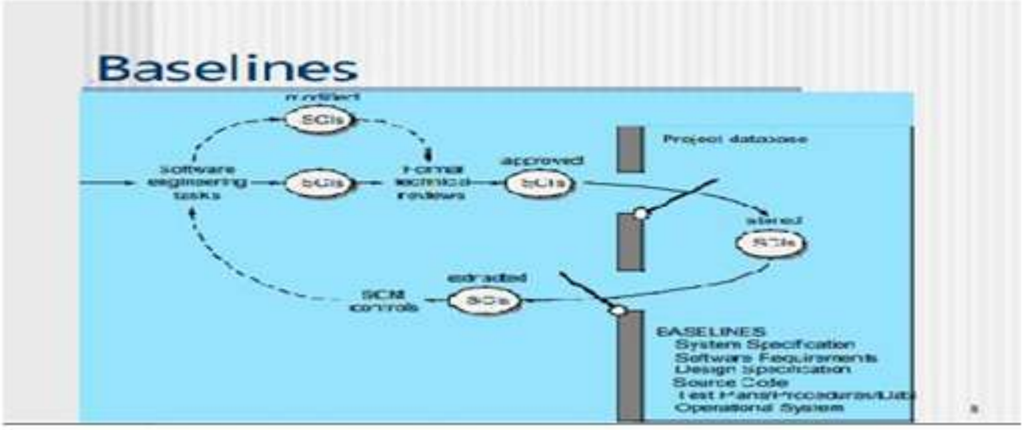

**Figure 1.**Baselined Scis

### 1.5. The SCM Repository And Role Of SCM

In Early Days Of Software Engineering, Software Configuration Items Were Maintained As Paper Documents, Placed In File Folders Or Three-Ring Binders And Stored In Metal Cabinets. This Approach Was Problematic For Many Reasons Such As Finding A Configuration Item When It Was Needed, Determining Which Items Were Changed. Today Scis Are Maintained In A Project Database Or Repository. The SCM Repository Is The Set Of Mechanisms And Data Structures That Allow A Software Team To Manage Change In An Effective Manner. The SCM Repository Performs The Following Functions:

- Data Integrity
- Information Sharing
- Tool Integration
- Data Integration
- Methodology Enforcement
- Document Standardization

## II. SOFTWARE CONFIGURATION MANAGEMENT FEATURES

To Support SCM, The Repository Must Have A Tool Set That Provides Support For The Following Features:

- Versioning
- Dependency Tracking And Change Management
- Requirements Tracing
- Configuration Management
- Audit Trails

**2.1. Versioning**

As A Project Progresses, Many Versions Of Work Products Will Get Created. The Repository Must Be Able To Save All These Versions And To Permit Developers To Go Back To Previous Versions During Testing And Debugging.

**2.2. Dependency Tracking And Change Management**

The Repository Manages A Wide Variety Of Relationships Among The Configuration Objects Stored In It. These Includes Relationships Between Enterprise Entities And Processes, Among The Parts Of An Application Design, Between Design Components And The Enterprise Information Architecture, Between Design Elements And Other Work Products, And So On. Some Of These Relationships Are Merely Associations, And Some Are Dependencies Or Mandatory Relationships. The Ability To Keep Track Of All These Relationships Is Crucial To The Integrity Of The Information Stored In The Repository And To The Generation Of Work Products Based On It. For Example If A Uml Class Diagram Is Modified, The Repository Can Detect Related Classes, Interface Definitions, And Code Components Also Require Modification And Can Bring Affected Scis To The Developer's Attention.

**2.3. Requirements Tracing**

This Special Function Provides The Ability To Track All The Design And Construction Components And Deliverables That Results From Software Requirement Specification (Forward Tracing) And To Identify Which Requirement Generated By Any Given Work Product (Backward Tracing)

## III. Software Configuration Management Process

The Software Configuration Management Process Defines A Series Of Task That Have Four Primary Objectives:

- To Identify All Items That Collectively Define The Software Configuration
- To Manage Changes To One Or More Of These Items
- To Facilitate The Construction Of Different Versions Of An Application
- To Ensure That Software Quality Is Maintained As Configuration Evolves Over Time

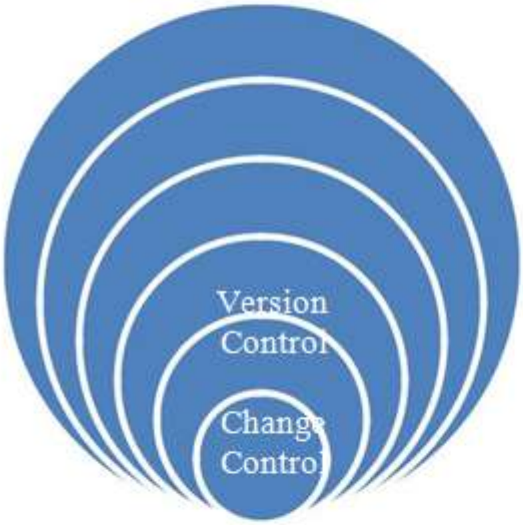

**Figure2.** Layers Of SCM Process

**3.1. Identification Of Objects In The Software Configuration**

To Control And Manage Software Configuration Items, Each Should Be Separately Named And Then Organized Using An Object Oriented Approach. Two Types Of Objects Can Be Identified: Basic Objects And Aggregate Objects

A Basic Object Is A Unit Of Information That Has Been Created By A Software Engineer During Analysis, Design, Code Or Test. For Example, A Basic Object Might Be A Section Of Requirements Specification, Part Of Design Model Or A Source Code Of Component.

An Aggregate Object Is A Collection Of Basic Objects. Each Object Has A Set Of Distinct Features That Identify It
Uniquely: A Name, A Description, A List Of Resources. Configuration Object Identification Can Also Consider The
Relationships That Exist Between Named Objects.
For Example, Using The Simple Notation:
Class Diagram <Part-Of> Analysis Model;
Analysis Model <Part-Of> Requirements Specification;

**3.2. Version Control**

Version Control Combines Procedures And Tools To Manage Different Versions Of Configuration Objects That Are Created During The Software Process. A Version Control System Implements Or Is Directly Integrated With Following Major Capabilities:

- A Project Database (Repository) That Stores All Relevant Configuration Objects
- A Version Management Capability That Stores All Versions Of Configuration Object.
- A Make Facility That Enables The Software Engineer To Collect All Relevant Configuration Objects And Construct A Specific Version Of The Software.
- In Addition, Version Control And Change Control Systems Often Implement An Issue Tracking (Also Called As Bug Tracking) Capability That Enables The Team To Record And Track The Status Of All Outstanding Issues Associated With Each Configuration Object.
- A Number Of Version Control Systems Establish A Change Set - A Collection Of All Changes (To Some Baseline Configuration) That Are Required To Create A Specific Version Of The Software.
- A Change Set Captures All Changes To All Files In The Configuration Along With The Reason For The Changes And Details Of Who Made The Changes And When.
- A Number Of Named Change Sets Can Be Identified For An Application Or System. A Number Of Different Automated Approaches To Version Control Have Been Proposed Over The Last Two Decades.

**3.3. Change Control**

In A Change Control Process, A Change Request Is Submitted And Evaluated To Assess Technical Merit, Potential Side Effects, Overall Impact On Other Configuration Objects And System Functions And The Projected Cost Of Change. The Results Of Evaluation Are Presented As A Change Report, Which Is Used By A Change Control Authority (CCA) – A Person Or A Group Who Makes The Final Decision On The Status And Priority Of The Change.

An Engineering Change Order (ECO) Is Generated For Each Approved Change. The ECO Describes The Change To Be Made, The Constraints That Must Be Respected And The Criteria For Review And Audit.

A Version Control System Updates The Original File Once The Change Has Been Made. As An Alternative, The Objects Can Be Checked Out Of The Project Database, The Change Is Made And Appropriate SQA Activities Are Applied. The Object Is Then Checked Into The Database And Appropriate Version Control Mechanisms Are Used To Create The Next Version Of The Software. These Version Control Mechanisms, Integrated Within The Change Control Process, Implement Two Important Elements Of Change Management – Access Control And Synchronization. Access Control Governs Which Software Engineers Have Authority To Access And Modify A Particular Configuration Object.
Synchronization Control Helps To Ensure That Parallel Changes, Performed By Two Different People Do Not Overwrite One Another.

### 3.4. Configuration Audit

A Software Configuration Audit Complements The Formal Technical Review By Addressing The Following Questions:

- Has The Change Specified In The ECO Been Made? Have Any Additional Modifications Been Incorporated?
- Has A Formal Technical Review Been Conducted To Assess Technical Correctness?
- Has The Software Process Been Followed, And Have Software Engineering Standards Been Properly Applied?
- Has The Change Been Highlighted In SCI? Have The Change Date And Change Author Been Specified? Do The Attributes Of The Configuration Object Reflect The Change?
- Have SCM Procedures For Noting The Change, Recording It, And Reporting It Been Followed?
- Have All The Software Configuration Items Been Properly Updated? Such Formal Configuration Audits Also Ensure That The Correct SCI's Have Been Incorporated Into A Specific Build And That All The Documentation Is Up To Date And Consistent With The Version That Has Been Built.

So Identification Of Objects In The Software Configuration, Version Control, Change Control, Configuration Audit And Reporting Are The Important Tasks In Software Configuration Management Process.

### 3.5. Status Reporting

Configuration Status Reporting Is A SCM Task That Answers The Following Questions

- What Happened?
- Who Did It?
- When Did It Happen?
- What Else Will Be Affected?

Each Time A SCI Is Assigned New Or Updated Identification, A Configuration Status Reporting (CSR) Entry Is Made. Each Time A Change Is Approved By The CCA, A CSR Entry Is Made. Each Time A Configuration Audit Is Conducted, The Results Are Reported As A Part Of CSR Task.

Output From CSR Can Be Placed In An Online Database Or Website, So That Software Developers Can Access Change Information By Keyword Category.

In Addition CSR Report Is Generated On A Regular Basis And Is Intended To Keep Management And Practitioners Appraised Of Important Changes.

## IV. DIFFERENT TOOLS FOR SOFTWARE CONFIGURATION MANAGEMENT

One Way Of Making Software Project Management Better Is By Implementing SCM Tool. SCM Tools Are Readily Available In The Market, And There Are Different Vendors Providing It. It Takes A Considerable Amount Of Time To Plan, Research, Select And Implement The Tool In The Company. It Is Not An Easy Task For Project Managers To Select A SCM Tool. The Selection Of SCM Tool Widely Depends On An Organizational Culture, Style Of Work, Amount Of Work, And So On.

### 4.1 Advantages Of SCM Tools

SCM Tools Are Beneficial In Many Aspects Such As Better Project Management, Productive Development, Excellent Customer Support, Company Certification, And Customer Satisfaction. Some Of The Major Advantages Of SCM Tools Are Project Information Is Shared Across Teams With Accurate And Reliable Information, Flexible In Supporting Parallel Development At Various Locations At The Same Time, Provide Better Decision-Making Capability Which Helps In Planning And Incorporates New Technology By Utilizing Latest And The Greatest In The IT Industry.

### 4.2. Functions Of SCM Tools

Many Companies Are Including SCM Tools In Their Strategic Plan To Automate The Manual Processes Which Are Prone To Human Errors. Automating Basic Tasks Such As Document Revision Management, Defect Tracking, And Code Management Is Now Done Using SCM Tools. Some Of The Features Included In SCM Tool Are Version Management, Change Management, Problem Tracking, Promotion

Management, System Building, Status Accounting (Querying And Reporting), Configuration Audits, Access And Security, Customization, Release Management, Graphical User Interfaces, Distributed Software Development, Client-Server Development Support, And Web Support.

Version Management Takes Care Of Versioning Different Configuration Items (CI) When Updates Are Made. Version Management Takes Care Of Versioning Different Configuration Items (CI) When Updates Are Made. Change Management Feature Usually Helps In Managing A Change Request. A Change Request Initiated By The Management Or Business Development Team Can Create A Change Request Item Into The SCM System. The Change Management Feature Usually Handles Communication Process Of Informing All The Required Personnel About The Change. In This Way, The Change Can Be Managed In A Better Way, Can Be Identified, And Implemented By The Development Team. Problem Tracking Feature Helps In Identifying, Documenting, Tracking, Resolving, And Managing The Problem. All The Related Details About The Problem Are Documented Into The SCM System Automatically. Problem Tracking Can Take Full Advantage Of Email Messaging System And Shot-Messaging System To Send Alert Emails And Smss To The Concerned People For Their Attention. Promotion Management Feature Tracks Various Different Phases Of Software Development Life Cycle. It Tracks The CI Based On The Phases. SCM Tool Tracks All The Details About The Event In Different Phases With The Start And End Date. This Feature Usually Helps In Testing The System. Testers Can Know What Exactly Happened During System Testing And Integration Testing. Testers And Developers Could Trace Back Using SCM Promotion Feature And Find The Root Cause Of The Issue.

### 4.3. Five Open Source Version Control Tools

The Five Most Popular Version Control Tools Are As Follows:

- CVS

CVS May Very Well Be Where Version Control Systems Started. Released Initially In 1986, Google Still Hosts The Original Usenet Post That Announced CVS. CVS Is Basically The Standard Here, And Is Used Just About Everywhere – However The Base For Codes Is Not As Feature Rich As Other Solutions Such As SVN. One Good Thing About CVS Is That It Is Not Too Difficult To Learn. It Comes With A Simple System That Ensures Revisions And Files Are Kept Updated. Given The Other Options, CVS May Be Regarded As An Older Form Of Technology, As It Has Been Around For Some Time, It Is Still Incredibly Useful For System Admins Who Want To Backup And Share Files.

- SVN

SVN, Or Subversion As It Is Sometimes Called, Is Generally The Version Control System That Has The Widest Adoption. Most Forms Of Open-Source Projects Will Use Subversion Because Many Other Large Products Such As Ruby, Python Apache, And More Use It Too. Google Code Even Uses SVN As A Way Of Exclusively Distributing Code. Because It Is So Popular, Many Different Clients For Subversion Are Available. If You Use Windows, Then Tortoise SVN May Be A Great Browser For Editing, Viewing And Modifying Subversion Code Bases. If You're Using A MAC, However, Then Versions Could Be Your Ideal Client.

- GIT

Git Is Considered To Be A Newer, And Faster Emerging Star When It Comes To Version Control Systems. First Developed By The Creator Of Linux Kernel, Linus Torvalds, Git Has Begun To Take The Community For Web Development And System Administration By Storm, Offering A Largely Different Form Of Control. Here, There Is No Singular Centralized Code Base That The Code Can Be Pulled From, And Different Branches Are Responsible For Hosting Different Areas Of The Code. Other Version Control Systems, Such As CVS And SVN, Use A Centralized Control, So That Only One Master Copy Of Software Is Used. As A Fast And Efficient System, Many System Administrators And Open-Source Projects Use Git To Power Their Repositories. However It Is Worth Noting That Git Is Not As Easy To Learn As SVN Or CVS Is, Which Means That Beginners May Need To Steer Clear If They're Not Willing To Invest Time To Learn The Tool.

- Mercurial

This Is Yet Another Form Of Version Control System, Similar To Git. It Was Designed Initially As A Source For Larger Development Programs, Often Outside Of The Scope Of Most System Admins, Independent

Web Developers And Designers. However, This Doesn't Mean That Smaller Teams And Individuals Can't Use It. Mercurial Is A Very

Fast And Efficient Application. The Creators Designed The Software With Performance As The Core Feature. Aside From Being Very Scalable, And Incredibly Fast, Mercurial Is A Far Simpler System To Use Than Things Such As Git, Which One Of The Reasons Why Certain System Admins And Developers Use It. There Aren't Quite Many Things To Learn, And The Functions Are Less Complicated, And More Comparable To Other CVS Systems. Mercurial Also Comes Alongside A Web-Interface And Various Extensive Documentation That Can Help You To Understand It Better.

- Bazaar

Similar To Git And Mercurial, Bazaar Is Distributed Version Control System, Which Also Provides A Great, Friendly User Experience. Bazaar Is Unique That It Can Be Deployed Either With A Central Code Base Or As A Distributed Code Base. It Is The Most Versatile Version Control System That Supports Various Different Forms Of Workflow, From Centralized To Decentralized, And With A Number Of Different Variations Acknowledged Throughout. . One Of The Greatest Features Of Bazaar Is That You Can Access A Very Detailed Level Of Control In Its Setup. Bazaar Can Be Used To Fit In With Almost Any Scenario And This Is Incredibly Useful For Most Projects And Admins Because It Is So Easy To Adapt And Deal With. It Can Also Be Easily Embedded Into Projects That Already Exist. At The Same Time, Bazaar Boasts A Large Community That Helps With The Maintenance Of Third-Party Tools And Plugins.

## V. Conclusion

This Paper On Software Configuration Management Describes About Software Configuration Management, Need Of Software Configuration Management, Its Features And Different SCM Tools Used For Tracking And Managing The Changes In Software.

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