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SOFTWARE ENGINEERING

CS 487

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Computer Science

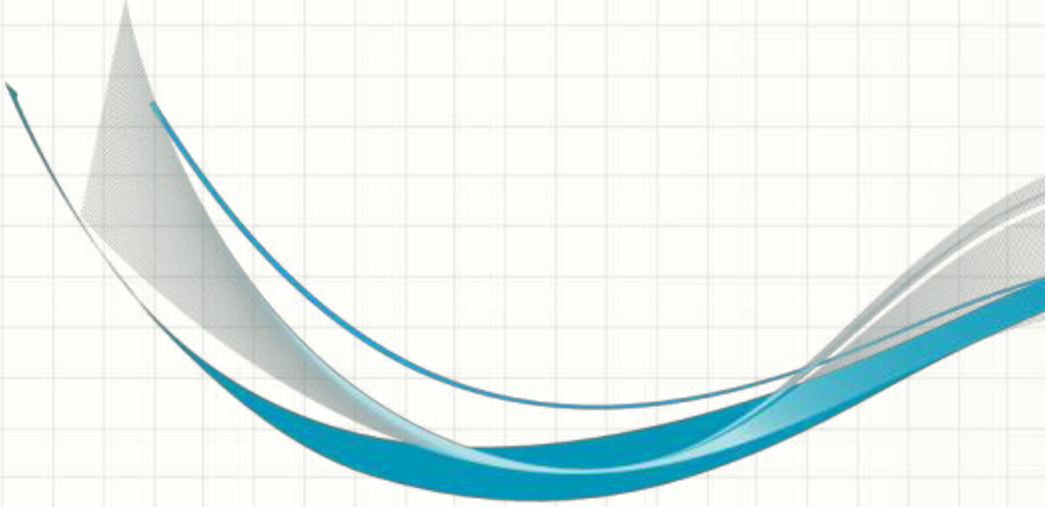
Summer ‘19

Lesson Overview

- Testing and Quality Management
- Reading
  - Ch. 8 – Software Testing
  - Ch. 24 – Quality Management
- Objectives
  - Analyze testing as a critical life-cycle phase and quality as a critical goal of software engineering
  - Explore both the reactive (testing) and proactive (quality management) approaches for maximizing quality and likelihood of success

Homework #2

- Consider an automated lecturer
  1. Rewrite each of the following student needs as an unambiguous system requirement
     a. "We must be able to ask the instructor questions."
     b. "The instructor must respond to questions quickly."
     c. "The instructor must teach me the subject matter."
  2. Document tests to *prove* success for each requirement
  3. Propose a "defensive design" to allow a student to interrupt with a question – explain how your design minimizes the possibility of "false alarms"
- Submit to Blackboard by 7/20/19



Lecture 4
Testing and Quality Management

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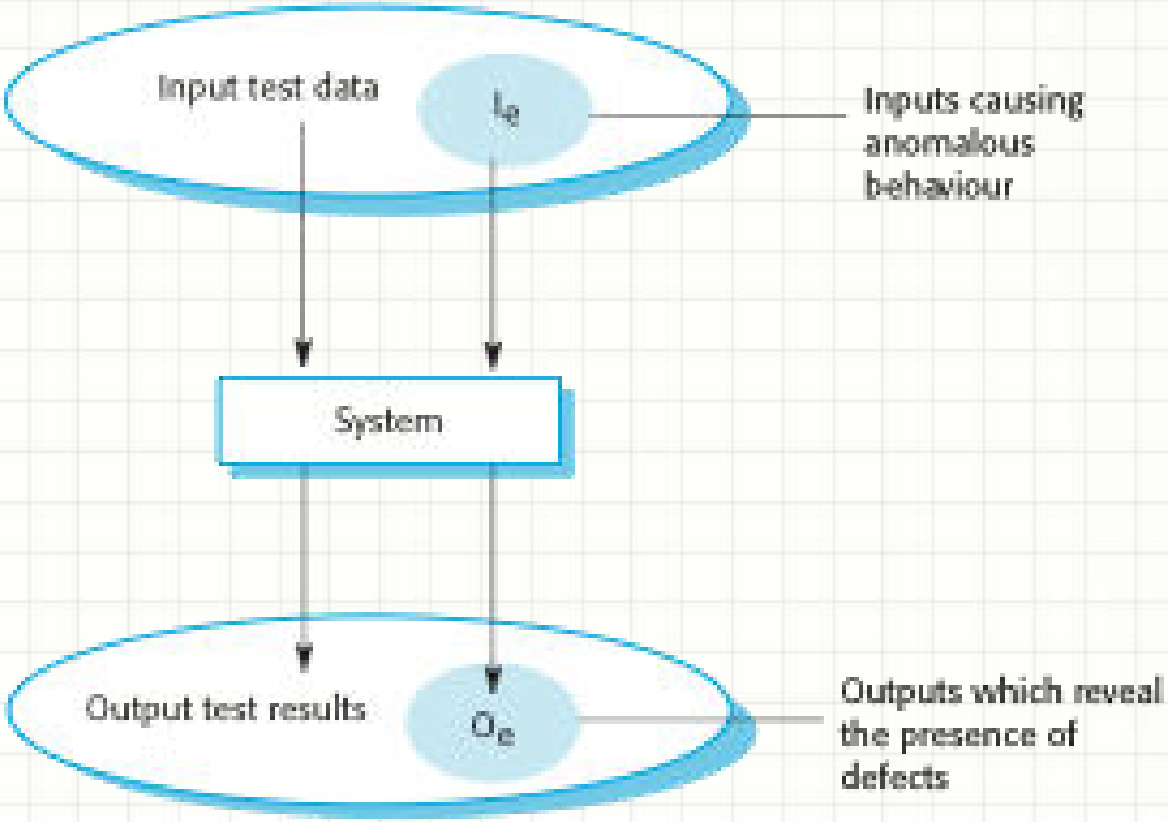
The Role of Testing

- Goals
  - Demonstrate correctness, completeness, etc.
    - At least one test per requirement
    - Tests to fully exercise features
  - Discover any defects
    - Or at least gain confidence that all have been discovered
- V&V
  - Validate that we are building the right product
  - Verify that we are building it right

Testing Model



Fit for Purpose

- The system is good enough for its intended use
- Software purpose – the more critical the system, the more important that it is reliable
- User expectations
  - Tolerance for defects
  - Sense of value in the system's capabilities
- Marketing environment
  - Competition can both drive organization's to strive for greater quality OR motivate them to release systems without fully testing
  - User expectations of quality are related to price

Inspections

- Static review of “readable” representations of the system
  - “Executability” is not a pre-condition
  - Source code, design documents, etc.
  - Inspected for adherence to specification and standards
- Inspections vs. Testing
  - In testing, defects can “hide beneath” other defects
  - Testing requires a certain degree of completeness
  - Inspections can look at other important factors beyond correctness, such as portability, maintainability, efficiency, etc.

Inspection Checks

- Variable management
- Flow control management
- Input/output management
- Interface management
- Memory management
- Exception handling

Development Testing

- Testing done local to the development effort
  - Often done informally by the developer
  - Primarily for defect detection – “debugging”
- Levels of granularity
  - Unit testing – exercise the functionality of logical units of the system
  - Component testing – verify proper operation of interacting entities such as objects
  - System testing – exercise the system as a whole for proper operation, exception handling, tolerance of load, etc.

Test-driven Development

- Interleave testing and code development
  - Develop a portion of code and its associated test(s)
  - Move onto the next increment of code only when current increment passes testing
- TDD approach
  - Forces partitioning of system into portions
  - Ensures “clean” code (in portions)
  - Utilize automated testing
  - Facilitates deeper understanding of the system
  - Provides a level of documentation
  - Needs to be supported by occasional “big picture” assessment

Release Testing

- Establish a “fit for use” version of the system
  - Requires independent verification
  - Focus is on validation more than defect discovery
  - Usually “black-box” in nature (ins and outs)
- Requirements testing
  - Requirements should be testable
  - Demonstrate proper implementation of system requirements
- Scenario testing
  - Verify “realistic” operation
- Performance or load testing

User Testing

- User acceptance is the ultimate goal of systems development
- User involvement is critical to successful development
- Users should be involved in test planning and execution
- Approaches
  - Alpha – within development process
  - Beta – "field" testing of a preliminary release
  - Acceptance – users determine "fitness"

Test Cases

- Effectiveness
  - Efficiently discover defects
  - Credibly show proper operation
- Efficiency
  - Repeatable
  - Self-documenting
  - Easy to develop and maintain
- Strategies
  - Test normal AND abnormal
  - Use realistic data
  - Test boundaries

Interface Testing

- Exercise the interface
  - Parameter passing
  - Return values and types
  - Synchronization
  - State management
- Box testing
  - Predictable output for given input
  - “Correctly incorrect” output for given improper input

Test Planning

- Testing process description
- Requirements traceability
- Items to be tested
- Schedule
- Results recording procedures
- Required hardware and software
- Constraints

Cleanroom Software Development

- Target is zero-defect software
- Keep the development environment “ultra clean”
- Approach
  - Formally specify the system showing system response to stimuli (state transitions)
  - Utilize incremental development with significant user involvement
  - Rely on structured programming and limit the use of control and data abstraction
  - Rigorous software inspections
  - Statistical testing to determine reliability

Quality Defined

- Quality
  - The degree to which the project fulfills requirements
  - A degree of excellence
  - A critical yet understated requirement
- Quality Management
  - Creating policies and procedures
  - Enforcing them to ensure compliance with project requirements

QA vs. QC

- Quality Assurance
  - Prevent defects
  - Improve the level of quality through an efficient set of activities performed throughout the life cycle
- Quality Control
  - Eliminate defective products
  - Improve the rate of acceptable product delivery through an efficient set of defect detection activities, primarily late in the life cycle

Quality Goals

- Prevent, discover and eliminate defects
- Deliver customer satisfaction by representing the user in design and development
- Enforce standards and process
- Mind the gate
- Improve processes
- Review, audit, monitor, verify, validate and inspect

The Value of Quality

- Quality increases customer satisfaction
  - Credibility lasts and attracts new business
- Lack of quality leads to rework
  - Unscheduled work means unplanned expense and slipping schedules
  - Work under duress increases the likelihood of more mistakes
- Uptime and performance are largely determined by quality
  - Lack of quality drives the need to change

The QA Environment

- Contractual conditions
  - Scope, time, budget, etc.
- Customer-supplier relationship
  - Change management, acceptance, etc.
- Teamwork
  - Variety of skills, parallel activities, etc.
- Multiple project support
- HCI / usability concerns
- Turnover management
- Maintenance
  - Enhancement and release management, troubleshooting, etc.

Defect Classification

- Incorrect specification of requirements
- Misunderstanding of client's needs
- Deviation from requirements
  - Gold-plating, short-cutting, etc.
- Design errors
- Implementation errors
- Violation of standards
- Poor test coverage
- User interface / usability errors
- Documentation errors

Planning for Quality

- Checkpoints supporting milestones
- Independent verification
- Build-test-fix-retest
- Make it measurable/testable
- Inspire the delivery of high-quality deliverables
  - Establish quality goals
  - Obtain commitment
  - Motivate performance
- Collect the data/information required to improve over time

Perform Quality Control

- Feedback loops
  - Measure the output of a process
  - As compared to expected
  - Understand the results (both good and bad)
  - Use that knowledge to improve the process
- Root-cause analysis
  - Ask yourself what caused a problem to occur,
  - then ask what caused that cause, and so on
- Histograms and Pareto Charts
  - Frequency of problems by problem category
  - 80% of the problems are due to 20% of the causes
  - Invest in eliminating the most problematic causes

Focus on Quality

- Commitment to quality must be part of the organizational culture
- Improvement frameworks
  - Process maturity models
    - Six-Sigma, CMMI
  - The agile approach
    - Rapid delivery of functionality
    - Customer responsiveness
- Assess the quality of all deliverables and reward practices and behaviors that lead to high-quality results
  - Attention to detail
  - Extra effort
  - Defect removal
  - Proactive communication, etc.

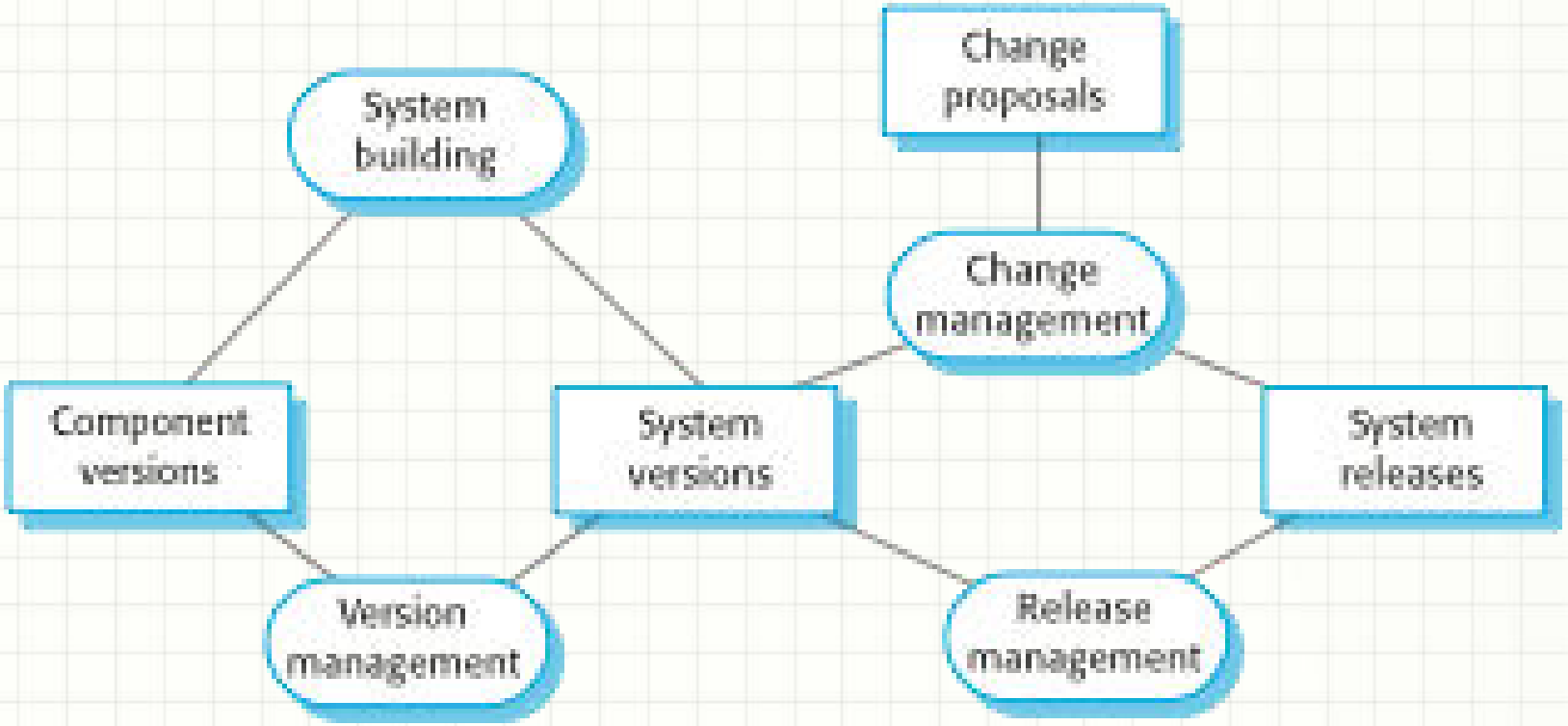
Variability of Process

- Variety
  - The spice of life, but death to a production line
  - Managing variability requires knowledge of
    - The desired output and the degree of tolerance
  - Reducing variability (increasing predictability) takes effort ($)
  - Side benefits can be significant
- Focus on improvement
  - A focal point is essential to achieving significant, sustainable improvement
- Feedback provides the mechanism for assessment

Configuration Management

- Configuration Management (CM) supports the evolution of software systems through a progression of versions
- Policies, processes and tools
- CM activities
  - Change management
  - Version management
  - System building
  - Release management

CM Activities



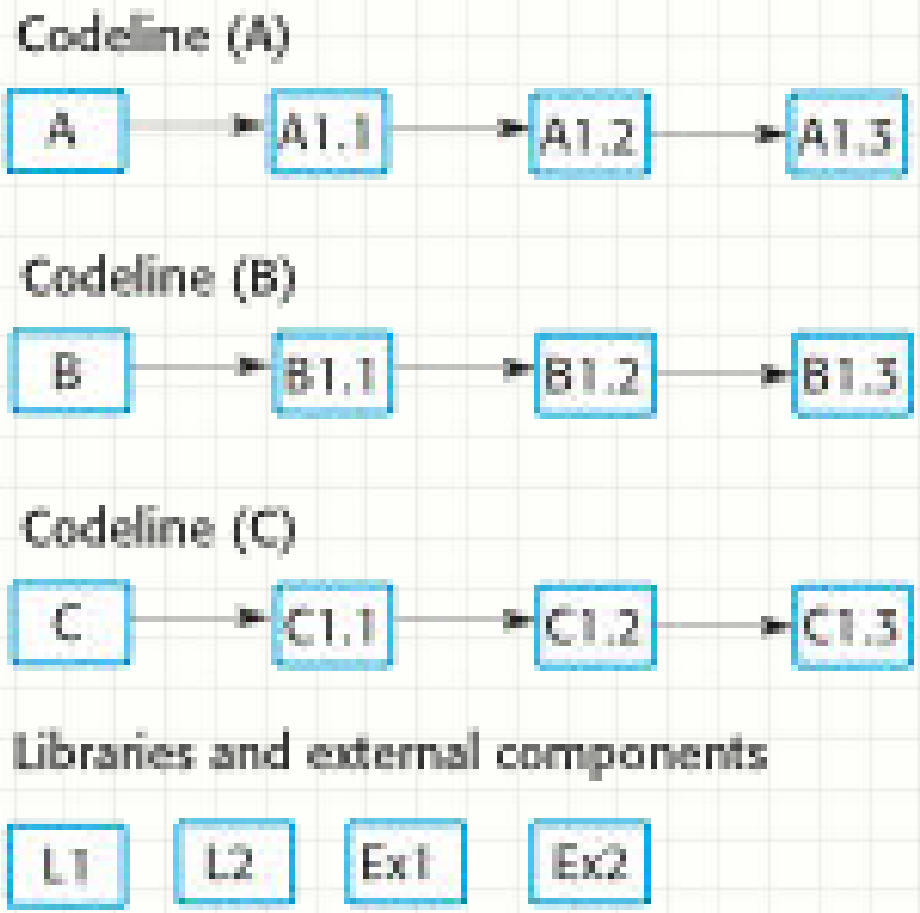
Change Management

- Change happens, mainly for good
- Change requests
  - Formality reduces risk (and dampens change)
  - Impact (time, effort, cost, risk, value, etc.)
- Decision making
  - Change control board (CCB)
- Implementation
  - Project planning and documentation
  - Timing
  - Cutover and rollback

Version Management (VM)

- Inevitable evolution often results of multiple "supported" versions
- VM responsibilities
  - Version and release identification
  - Storage management
  - Tracking change history
  - Check out – modify – check in
  - Shared component modification management
- Branching and merging
  - Branching allows for parallel development
  - Merging brings changes together

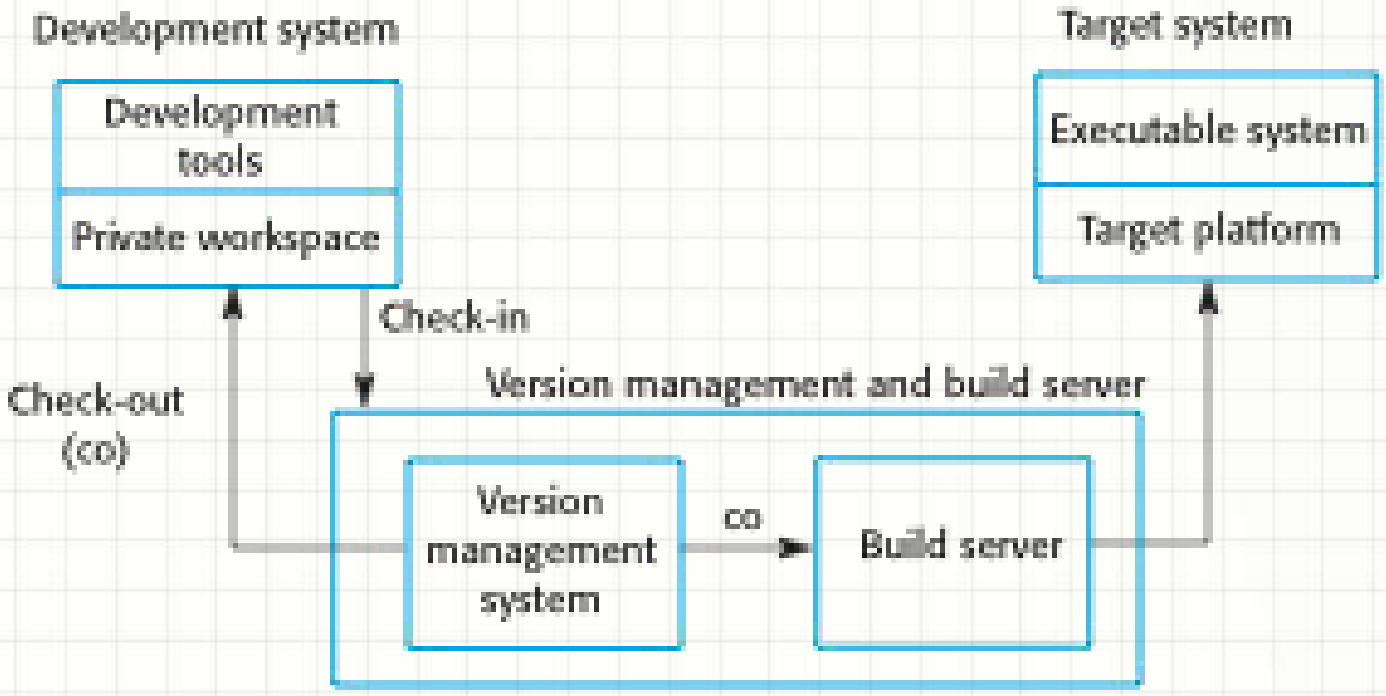
Baselines


Codeline (A)
A
A1.1
A1.2
A1.3
Codeline (B)
B
B1.1
B1.2
B1.3
Codeline (C)
C
C1.1
C1.2
C1.3
Libraries and external components
L1
L2
Ex1
Ex2

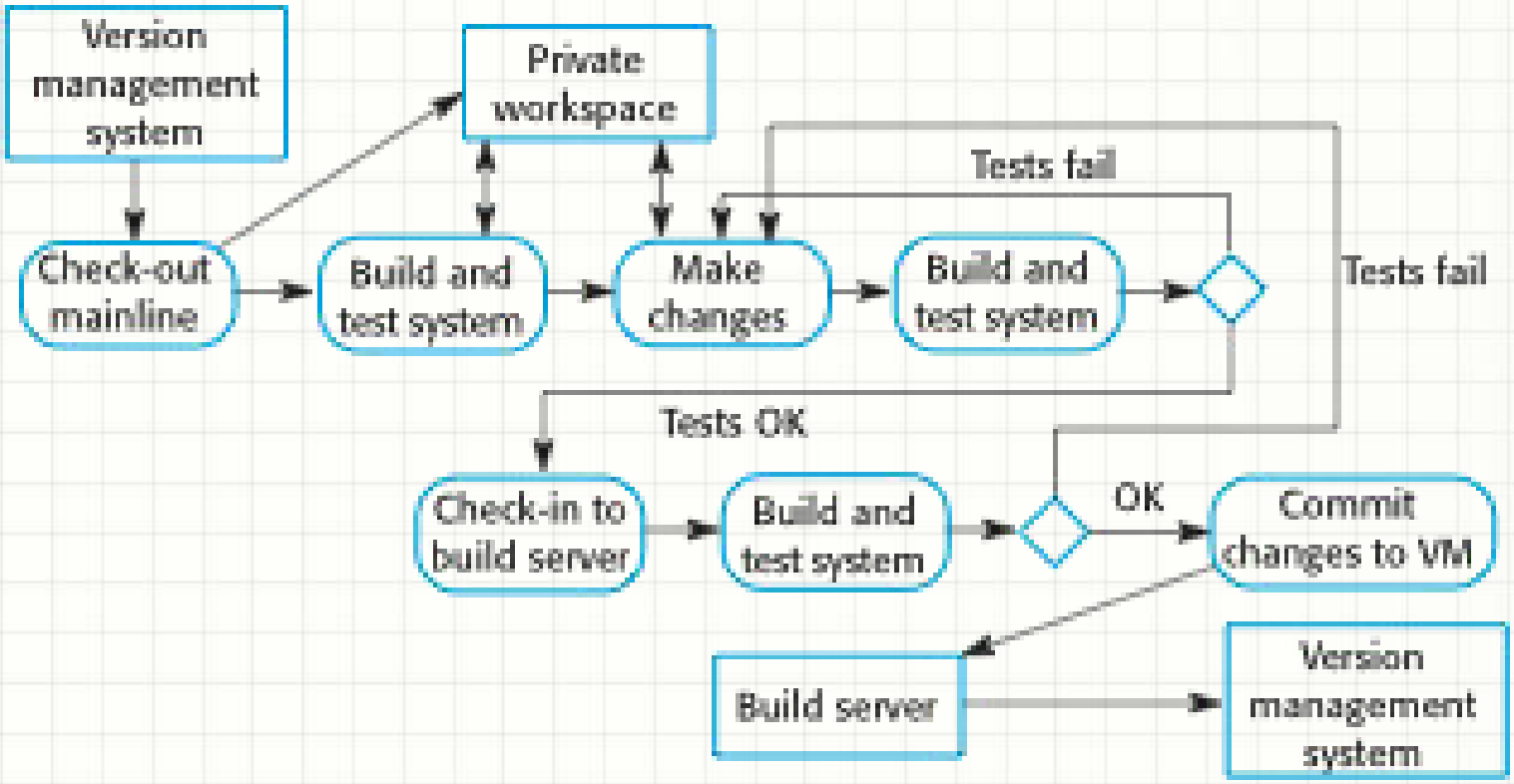

Baseline - V1
A
B1.2
C1.1
L1
L2
Ex1
Baseline - V2
A1.3
B1.2
C1.2
L1
L2
Ex2
Mainline

System Building

- Compiling and linking the latest checked-in components into a version of the system
- Tool support
  - Build script generation
  - VM system integration
  - Minimal recompilation
  - Executable system creation
  - Test automation
  - Reporting
  - Documentation generation


Development system
Development tools
Private workspace
Target system
Executable system
Target platform
Check-in
Check-out (co)
Version management and build server
Version management system
co
Build server

Continuous Integration



Release Management

- A package for distribution
  - Major – significant new functionality
  - Minor – patches / fixes
- Release planning
  - Current system quality
  - Platform changes
  - New-feature release followed by bug-fix release
  - Competition
  - Marketing commitments
  - Custom changes