Maintenance Processes

Idaho State University | Computer Science

Isaac Griffith

CS 4423 and CS 5523
Department of Computer Science
Idaho State University

ROAR

Outcomes

After today's lecture you will:

- IEEE/EIA 1219 Maintenance Process
- ISO/IEC 14764 Maintenance Process

Maintenance Standards

CS 4423/5523

ROAR

Software Maintenance Standard

- IEEE and ISO have both addressed software maintenance processes
- IEEE/EIA 1219 and ISO/IEC 14764 as a part of ISO/IEC 12207 (life cycle processes)
- IEEE/EIA 1219 organizes the maintenance process in seven phases:
  - **problem identification**, **analysis**, **design**, **implementation**, **system test**, **acceptance test** and **delivery**
- ISO/IEC 14764 describes software maintenance as an iterative process for managing and executing software maintenance activities
- The activities which comprise the maintenance process are:
  - **process implementation**, **problem and modification analysis**, **modification implementation**, **maintenance review/acceptance**, **migration** and **retirement**
- Each of these maintenance activities is made up of tasks. Each task describes a specific action with inputs and outputs.

ROAR
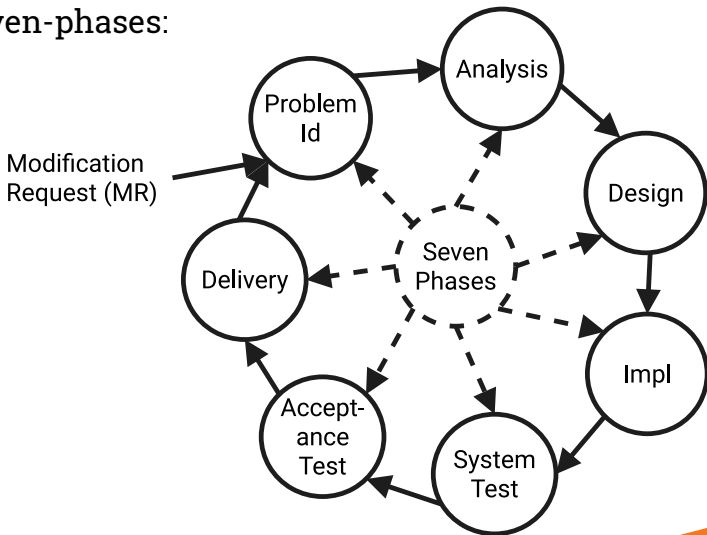
IEEE/EIA 1219

CS 4423/5523

ROAR

IEEE/EIA 1219 Maintenance Process

The standard focuses on seven-phases:

- Problem Identification
- Analysis
- Design
- Implementation
- System Test
- Acceptance Test
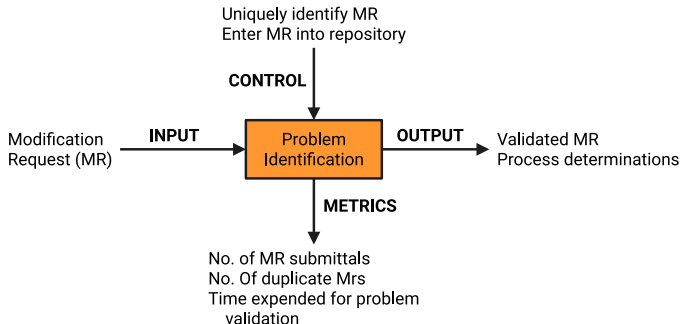- Delivery

IEEE/EIA 1219 Maintenance Process

Each of the seven activities has five associated attributes as follows:

- **Activity definition:** This refers to the implementation process of the activity

- **Input:** This refers to the items that are required as input to the activity

- **Output:** This refers to the items that are produced by the activity

- **Control:** This refers to those items that provide control over the activity

- **Metrics:** This refers to the items that are measured during the execution of the activity

Problem Identification Phase

- A request for change to the software is normally made by the users of the software system or the customers, and it starts the maintenance process

- The change request (CR) is submitted in the form of a modification requires (MR) for a correction or for an enhancement.
  - MR & CR are used interchangeably

Uniquely identify MR
Enter MR into repository

CONTROL

Modification Request (MR)   **INPUT** →   Problem Identification   **OUTPUT** →   Validated MR
Process determinations

METRICS

No. of MR submittals
No. Of duplicate Mrs
Time expended for problem
    validation

- Activities included in this phase are as follows:
  ❶ reject or accept the MR
  ❷ identify and estimate the resources needed to change the system
  ❸ put the MR in a batch of changes scheduled for implementation

ROAR

Analysis Phase

The process is viewed to have two major components:

❶ feasibility analysis

❷ detailed analysis

Conduct technical review
Verify that documentation is updated
Verify test strategy
Identify safety and security issues

CONTROL

Validate MR
Project documentation
Repository information

INPUT → Analysis → **OUTPUT**

Feasibility report for MR
Deltailed analysis report
Test strategy
Implementation plan

METRICS

Requirement changes
Documentation error rates
Effort per function area
Elapsed time (schedule)
Error rates generated by priority and type

Feasibility analysis is performed to:

❶ determine the impact of the change

❷ investigate other possible solutions including prototyping

❸ assess both short-term and long-term costs

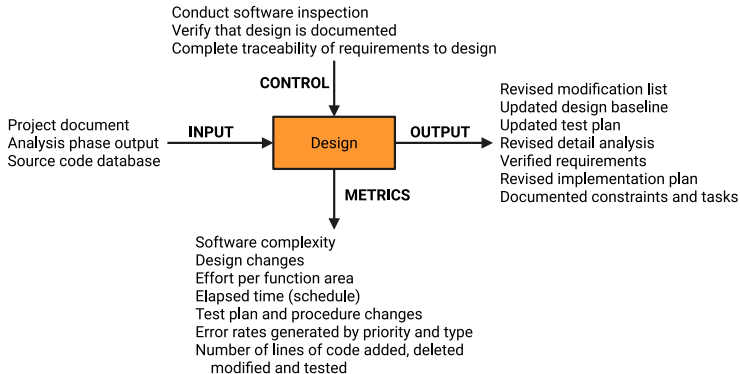❹ determine the benefits of making the change
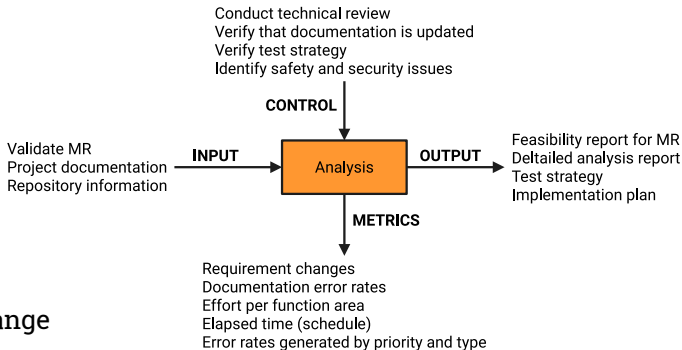
Detailed analysis determines

❶ firm modification requirements

❷ the software components involved

❸ an overall test strategy

❹ an implementation plan

ROAR

Design Phase

Activities:

❶ identify the affected software components

❷ modify the software components

❸ document the changes

❹ create a test suite for the new design

❺ select test cases for regression testing

Conduct software inspection
Verify that design is documented
Complete traceability of requirements to design

CONTROL

Project document
Analysis phase output
Source code database

INPUT → Design → **OUTPUT**

METRICS

Revised modification list
Updated design baseline
Updated test plan
Revised detail analysis
Verified requirements
Revised implementation plan
Documented constraints and tasks

Software complexity
Design changes
Effort per function area
Elapsed time (schedule)
Test plan and procedure changes
Error rates generated by priority and type
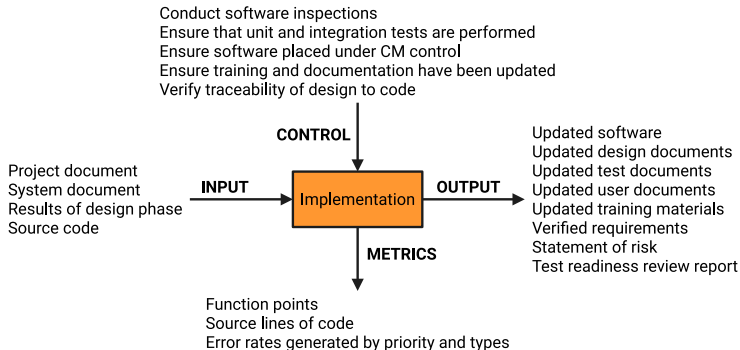Number of lines of code added, deleted
   modified and tested

ROAR

Implementation Phase

Activities:

- Writing new code and performing unit testing

- Integrating changed code

- Conducting integration and regression testing

- Performing risk analysis

- Reviewing the system for test-readiness

Conduct software inspections
Ensure that unit and integration tests are performed
Ensure software placed under CM control
Ensure training and documentation have been updated
Verify traceability of design to code

CONTROL

Project document
System document
Results of design phase
Source code

INPUT → Implementation **OUTPUT** →

Updated software
Updated design documents
Updated test documents
Updated user documents
Updated training materials
Verified requirements
Statement of risk
Test readiness review report

METRICS

Function points
Source lines of code
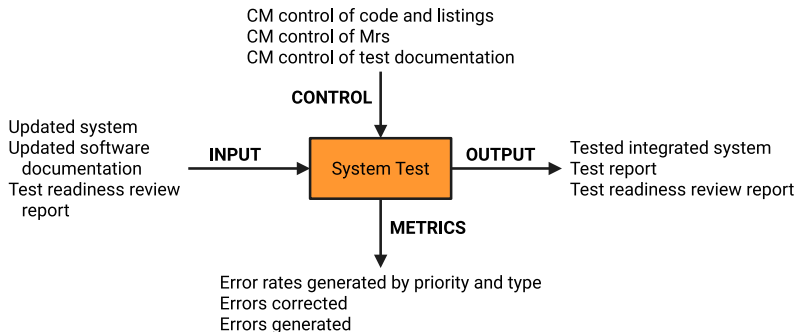Error rates generated by priority and types

System Test Phase

Tests are performed on the full system to ensure that the modified system complies with the original requirements as well as the new modifications.
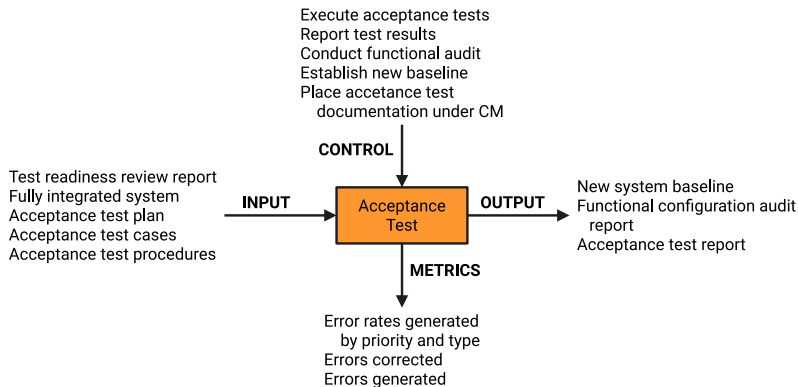
Activities

- functionality testing
- robustness testing
- stability testing
- load testing
- performance testing
- security testing
- regression testing

CM control of code and listings
CM control of Mrs
CM control of test documentation

CONTROL

Updated system
Updated software
  documentation
Test readiness review
  report

INPUT

System Test

OUTPUT

Tested integrated system
Test report
Test readiness review report

METRICS

Error rates generated by priority and type
Errors corrected
Errors generated

ROAR

Acceptance Test Phase

Testing is performed on a completely integrated system, and it involves customers, users, or their representatives

- **Main objective:** assess the overall quality of the system, rather than actively identify defects

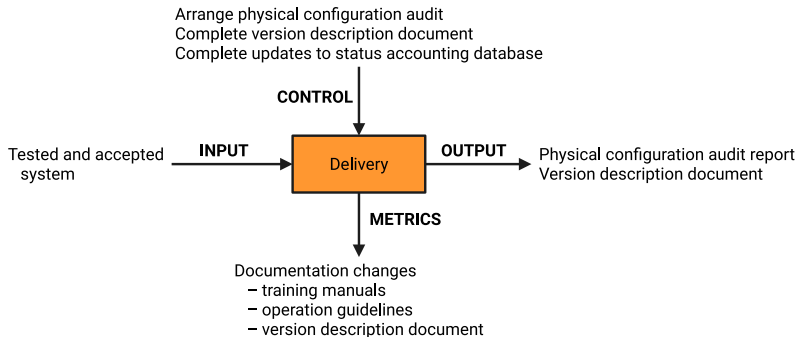- Based on the customer's expectation from the system

Execute acceptance tests
Report test results
Conduct functional audit
Establish new baseline
Place accetance test
   documentation under CM

CONTROL

Test readiness review report
Fully integrated system
Acceptance test plan
Acceptance test cases
Acceptance test procedures

INPUT → Acceptance Test **OUTPUT** →

New system baseline
Functional configuration audit
   report
Acceptance test report

METRICS

Error rates generated
   by priority and type
Errors corrected
Errors generated

ROAR

Delivery Phase

In this phase the changed system is released to customers for installation and operation

Activities:

- notify the user community

- perform installation and training

- develop an archival version of the system for backup

Arrange physical configuration audit
Complete version description document
Complete updates to status accounting database

CONTROL

Tested and accepted system → **INPUT** → Delivery → **OUTPUT** → Physical configuration audit report
Version description document

METRICS

Documentation changes
– training manuals
– operation guidelines
– version description document

ISO/IEC 14764
CS 4423/5523

ROAR

ISO/IEC 14764 Maintenance Process

- ISO/IEC 14764 is an international standard for software maintenance
- It describes maintenance using the same concepts as IEEE/EIA 1219 except that they are depicted slightly differently.
- The basic structure of an ISO process is made up of activities, and an activity is made up of tasks.
- Upon an activation of the maintenance process, plans and procedures are developed and resources are allocated to carry out maintenance.
- In response to a changed request, code is modified in conjunction with the relevant documentation.
- Modification of the running software without losing the system's integrity is considered to be the overall objective of maintenance

ROAR

Iterative Maintenance Process

The maintenance process comprises the following high level activities:

❶ Process Implementation

❷ Problem and Modification Analysis

❸ Modification Implementation

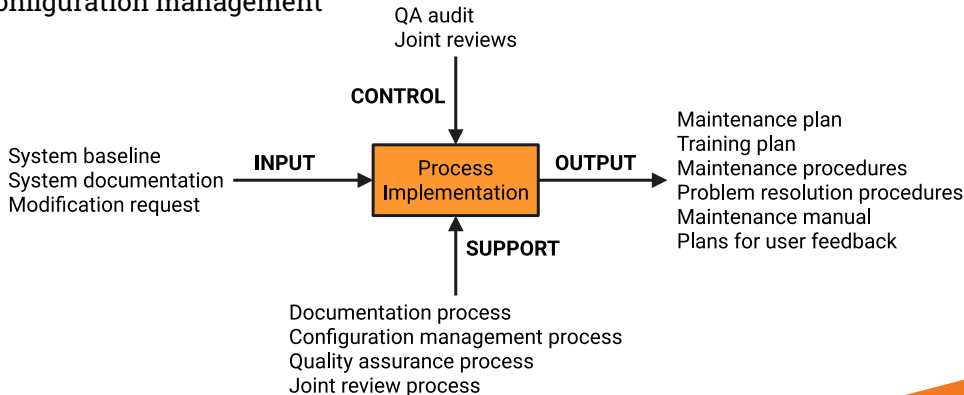❹ Maintenance Review and Acceptance

❺ Migration

❻ Retirement
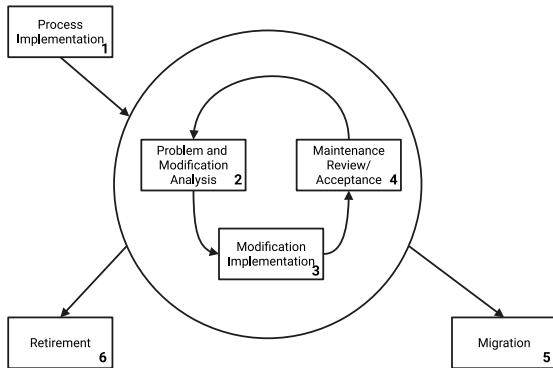
Process Implementation Activity

The process implementation activity consists of three major tasks:

- Maintenance plan
- Modification requests (MR/CR)
- Configuration management

Maintenance Plan Template

❶ Introduction

This section outlines the goals, purpose, and general scope of the maintenance effort. Also, deviations from the standard are identified.

❷ References

The documents that impose constraints on the maintenance effort are identified in this section.

In addition, other documents supporting maintenance activities are identified.

❸ Definitions

All terms required to understand the maintenance plan are defined in this section.

If some terms are already defined in other documents, then references are provided to those documents.

Maintenance Plan Template

❹ Software Maintenance Overview

This section briefly describes the following aspects of the maintenance process:

4.1. Organization

4.2. Scheduling Priorities

4.3. Resource Summary

4.4. Responsibilities

4.5. Tools, Techniques, and Methods

Maintenance Plan Template

❺ Software Maintenance Process

This section describes the actions to be executed in each phase of the maintenance process.

Each action is described in the form of input, output, process, and control

5.1. Problem Identification/Classification and Prioritization

5.2. Analysis

5.3. Design

5.4. Implementation

5.5. System Testing

5.6. Acceptance Testing

5.7. Delivery

❻ Software Maintenance Reporting Requirements

This section briefly describes the process for gathering information and disseminating it to members of the maintenance organization

Maintenance Plan Template

❼ **Software Maintenance Administrative Requirements**

Describes the standard practices and rules for anomaly resolution and reporting

7.1. Anomaly Resolution and Reporting

7.2. Deviation Policy

7.3. Control Procedures

7.4. Standards, Practices, and Conventions

7.5. Performance Tracking

7.6. Quality Control Plan

❽ **Software Maintenance Documentation Requirements**

Describes the procedures to be followed in recording and presenting the outputs of the maintenance process

Modification Request Task Steps

❶ Decide whether or not the maintainer is adequately staffed to make the proposed changes

❷ Decide whether or not the maintenance program has received adequate budget

❸ Decide whether or not enough resources are available and whether the proposed change will effect some current or future projects

❹ Determine the operational issues to be considered

❺ Determine handling priority

❻ Classify the type of maintenance

❼ Determine the impact to current and future users

❽ Determine safety and security implications

❾ Identify ripple effects

ROAR

Modification Request Task Steps
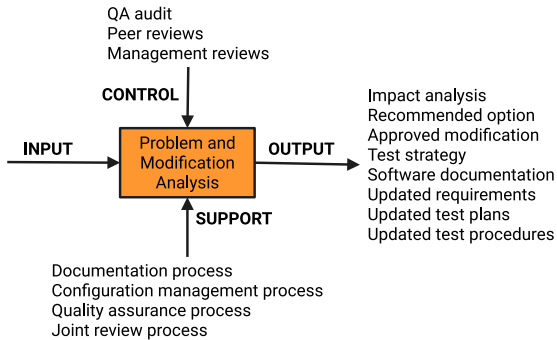
⑩ Determine any hardware or software constraints that may result from the proposed changes

⑪ Estimate the values of the benefits of making the changes

⑫ Determine the impact on existing schedules

⑬ Document the risks resulting from the impact analysis

⑭ Estimate the evaluation to be performed

⑮ Estimate the cost of management to execute the modification

⑯ Place developed artifacts under CM

Modification Analysis

Tasks:

- Modification request analysis
- Verification
- Options
- Documentation
- Approval

System baseline
System repository
Modification request
Functional requirements
Interface requirements
Configuration status information
Project planning data
Outputs from process implementation activity

QA audit
Peer reviews
Management reviews

CONTROL

INPUT

Problem and Modification Analysis

OUTPUT

SUPPORT

Documentation process
Configuration management process
Quality assurance process
Joint review process

Impact analysis
Recommended option
Approved modification
Test strategy
Software documentation
Updated requirements
Updated test plans
Updated test procedures

ROAR

Option Tasks

Option Task Steps

❶ The MR is assigned a work priority

❷ Explore a work-around for the problem. If a work-around exits, provide it to the user

❸ Identify concrete requirements for the planned modification

❹ Calculate the magnitude and size of the planned modification

❺ Identify a variety of options to execute the planned modification

❻ Estimate the impacts of the options on the users and system hardware

❼ Analyze the risks of each option

❽ Document the outcomes of risk analysis for each of the proposed options

❾ Develop a widely acceptable plan to implement the modification

ROAR

Documentation Tasks

Documentation Task Steps

❶ Ensure result analyses have been completed and documentation updated. If documentation does not exist, develop new documentation

❷ For accuracy, review the planned strategy to perform tests and review the schedule

❸ Review resource estimates for accuracy

❹ Revise the database for storing accounting status

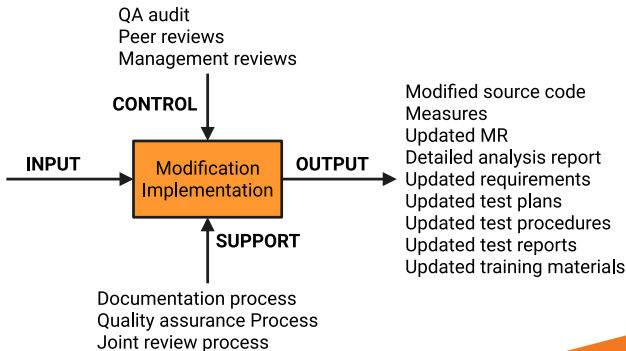❺ Describe a procedure to decide whether or not to approve the MR

Modification Implementation Activity

In this activity, maintainers;

❶ Identify the items to be modified

❷ Execute a development process to actually implement the modifications

QA audit
Peer reviews
Management reviews

CONTROL

System architecture definitions
Modification request record
Approved MR
Source code
Impact analysis report
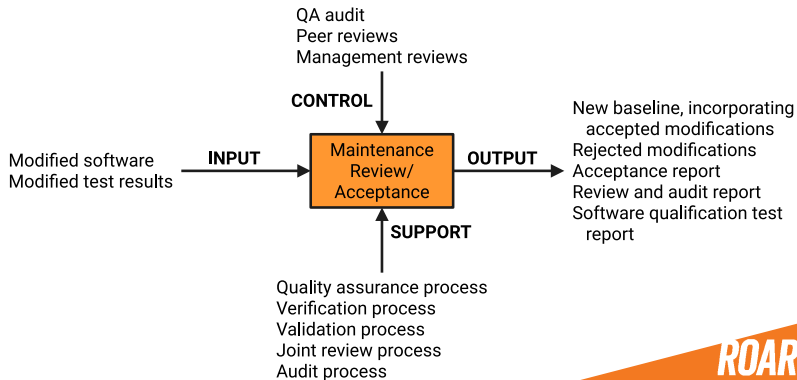Outputs from problem and modification
   analysis activity

INPUT → Modification Implementation → **OUTPUT**

Modified source code
Measures
Updated MR
Detailed analysis report
Updated requirements
Updated test plans
Updated test procedures
Updated test reports
Updated training materials

SUPPORT

Documentation process
Quality assurance Process
Joint review process

Maint Review/Acceptance Activity

By means of this activity it is ensured that:

1. the changes made to the software are correct
2. changes are made to the software according to accepted standards and methodologies

The activity is augmented with the following processes

1. quality management
2. product verification
3. product validation
4. product review

QA audit
Peer reviews
Management reviews

CONTROL

Modified software
Modified test results

INPUT → Maintenance Review/ Acceptance → **OUTPUT**

New baseline, incorporating accepted modifications
Rejected modifications
Acceptance report
Review and audit report
Software qualification test report

SUPPORT

Quality assurance process
Verification process
Validation process
Joint review process
Audit process

ROAR

Review Task

Review Task Steps

❶ Track the MRs from requirement specification to coding

❷ Ensure that the code is testable

❸ Ensure that the code conforms to coding standards

❹ Ensure that only the required software components were changed

❺ Ensure that the new code is correctly integrated with the system

❻ Ensure that documentation is accurately updated

❼ CM personnel build software items for testing

❽ Perform testing by an independent test organization

❾ Perform system test on a fully integrated system
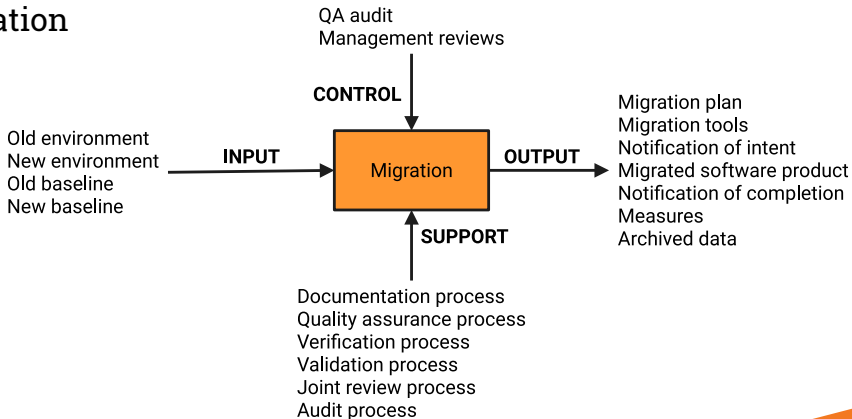
❿ Develop test report

ROAR

Approval Task

Approval Task Steps

❶ Obtain quality assurance approval

❷ Verify that the process has been followed

❸ CM prepares the delivery package

❹ Conduct functional and physical configuration audit

❺ Notify operators

❻ Perform installation and training at the operator's facility

Migration Activity

Migration is effected in two broad phases

❶ identify the actions required to achieve migration

❷ design and document the concrete steps to be execute to effect migration

QA audit
Management reviews

CONTROL

Old environment
New environment
Old baseline
New baseline

INPUT

Migration

OUTPUT

Migration plan
Migration tools
Notification of intent
Migrated software product
Notification of completion
Measures
Archived data

SUPPORT

Documentation process
Quality assurance process
Verification process
Validation process
Joint review process
Audit process

Migration Plan Task

1. Analyze the requirements for migration
2. Perform an impact analysis of migrating the software system
3. Make a schedule to execute migration
4. Determine all requirements for data collection to perform post-operation review
5. Identify and record the migration effort
6. Identify and reduce risks
7. Identify the required tools to support migration
8. Determine how the old environment is going to be supported

Migration Plan Task

⑨ Acquire and/or design new tools to support migration

⑩ Partition software products and data for conversion in an incremental manner

⑪ Prioritize the activities involving data conversion and software products

⑫ Execute software products and data conversions

⑬ Perform migration of software products and data to the new environment

⑭ Operate the migrated system and the old system in parallel as much as possible

⑮ Perform testing to ensure the success of migration

⑯ Should there be a need, continue to provide support for the old environment

ROAR

Operation Task

Parallel Operations Task Steps

❶ Survey the site

❷ Install hardware equipment

❸ Install the software system

❹ Run basic tests to ensure that hardware and software have been correctly installed

❺ Run both the new and old systems in parallel, under the desired operational load.

❻ Gather data from the old and the new systems.
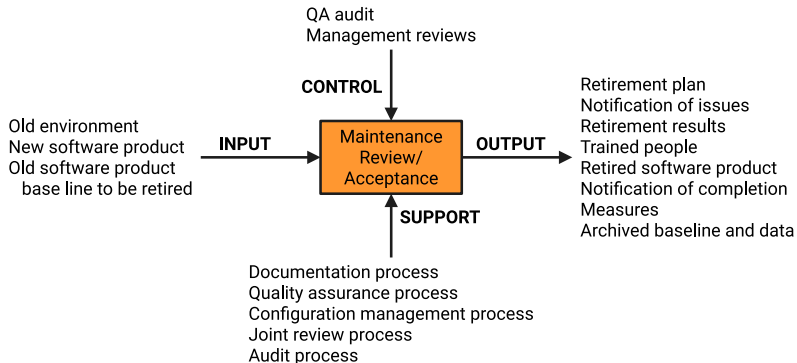
❼ Analyze the collected data

Training Task

Training Task Steps

❶ Identify the requirements for migration training

❷ Schedule the requirements for migration training

❸ Review the migration training

❹ Update the plan to provide training

ROAR

Retirement Activity

Tasks:

- Retirement plan
- Notification of intent
- Implement parallel operations and training
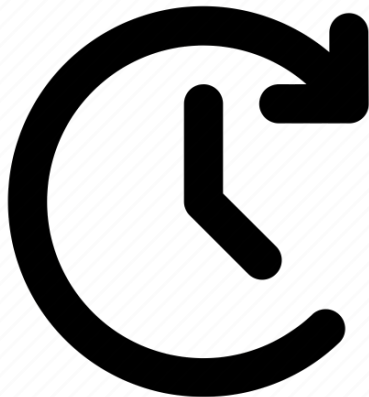- Notification of completion
- Data archival

QA audit
Management reviews

CONTROL

Old environment
New software product
Old software product
   base line to be retired

INPUT

Maintenance
Review/
Acceptance

OUTPUT

Retirement plan
Notification of issues
Retirement results
Trained people
Retired software product
Notification of completion
Measures
Archived baseline and data

SUPPORT

Documentation process
Quality assurance process
Configuration management process
Joint review process
Audit process

Retirement Plan Task

❶ Analyze the requirements to retire the systems

❷ Determine what impacts that retiring the software will have

❸ Identify a product that will replace the software to be retired

❹ Make a schedule to retire the software

❺ Determine the need for residual support in the future

❻ Identify and describe the retirement effort

For Next Time

- Review EVO Chapter 3.6 and 3.7
- Read EVO Chapter 3.8 - 3.9
- Watch Lecture 06
- Continue working on Homework 01
- **4423: Course Project Part 1: Team Selection is due Friday at 11:00 pm**
- **4423: Work on Homework 01**

ROAR

Are there any questions?

ROAR