

NATIONAL WEATHER SERVICE INSTRUCTION 80-301

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Office of Planning and Programming for Service Delivery

SYSTEMS ENGINEERING PROCESS AND LIFE CYCLE

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SUMMARY OF REVISIONS:

This is a new document in the 80-3 directive family. The document describes the NWS Systems Engineering Life cycle framework.

Signed

10/28/2019

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Date

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1 Introduction

The National Weather Service (NWS) has a multitude of systems that have to communicate and process data together in order to provide the country and other users with information critical to human survival and property preservation. As service functions continue to evolve, new systems and new services will have to be developed, along with improvements to legacy systems. To accommodate these activities, NWS has created its own Systems Engineering (SE) instruction that will help accomplish the following:

- Improve communications among NWS systems
- Provide for more efficient use of resources
- Improve the design, development, integration, testing, and validation of new systems
- Realize cost and time savings
- Improve the operations, maintenance, and logistics support of fielded systems

2 Objective

The objective of this instruction is to establish the requirement and framework for SE practices in developing systems and applications. This instruction establishes a structured, disciplined approach for planning, designing, and implementing systems within NWS. However, this instruction is not meant to be prescriptive and rigid, instead, project teams can further tailor the information in the instruction to meet the project specific needs, requirements, constraints, environment, schedule, budget and situation. As an example, activities of the first three stages of life cycle (“Need & Definition Stage”, “Design and Development Stage”, and “Operations Validation Stage”) can be simplified, grouped and iterated to support an Iterative and Incremental Development approach for a large and loose coupled system development effort.

3 NWS Systems Engineering Life Cycle Approach

The NWS has created a Five Stage SE life cycle model, shown in Figure 1, to establish a repeatable process for new and existing systems and ensure the NWS continues to meet its operational mission goals and obligations. This life cycle model and SE framework establish a number of processes to help ensure that systems meet required functionality throughout the life cycle. All NWS systems should follow this common set of life cycle stages in which the systems are conceived, developed, updated, produced, utilized, supported, and retired.

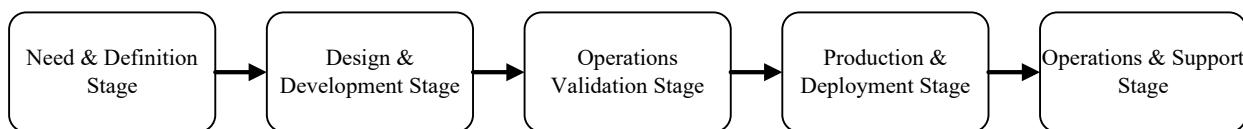


Figure 1: NWS Life Cycle Model

The NWS life cycle model consists of the following stages:

- Need and Definition Stage: This first stage is the conceptual stage that presents the Statement of Need (SON) and/or business case for the new system (or modification to a current system), identifies relevant stakeholders and their high-level operational requirements, analyzes how the new system will impact NWS and communicates how NWS operations will be impacted in a Concept of Operations (ConOps) Document.
- Design and Development Stage: This second stage is where the concepts and operational requirements of the first stage are designed and realized. A design of the system is created based on the operational requirements of the stakeholders and those requirements in the design are analyzed and decomposed to create specifications for the development of the required system.
- Operations Validation Stage: This third stage is where a structured series of tests and validation is performed to ensure that the system meets requirements and has the necessary support resources prepared to the extent required to authorize production.
- Production and Deployment Stage: This fourth stage is where the system is produced and deployed and, in case of improvements to legacy systems, incorporated into the current system architecture.
- Operations and Support Stage: In this final stage, the system has been commissioned into operations and is being maintained and upgraded, as appropriate, as well as decommissioned.

The remainder of this section defines the five life cycle stages of the SE process for NWS. Each stage takes certain inputs, encompasses specific activities, and generates particular outputs consisting of various artifacts and/or deliverables. As the NWS Life Cycle model progresses, the outputs of each stage become the inputs to the subsequent stage. This instruction gives an overview of the stages and their inputs, activities, and outputs. More detailed information on how the activities are performed and the outputs generated is provided in the supporting series of NWS Instructions including 80-303 *Systems Engineering for New Development*, 80-304 *Systems Engineering for Software Development*, 80-305 *Test and Evaluation* 80-307, *Operational Test and Evaluation Process* and 80-308, *Security Test and Evaluation Process*.

It should be noted that, in general, the activities identified herein occur in the order presented. However, some activities will likely overlap and in certain circumstances may need to follow a somewhat different order of execution.

3.1 Need and Definition Stage

The SE process starts with the need for a new or modified System of Interest. Figure 2 below illustrates the inputs, activities and outputs of this stage.

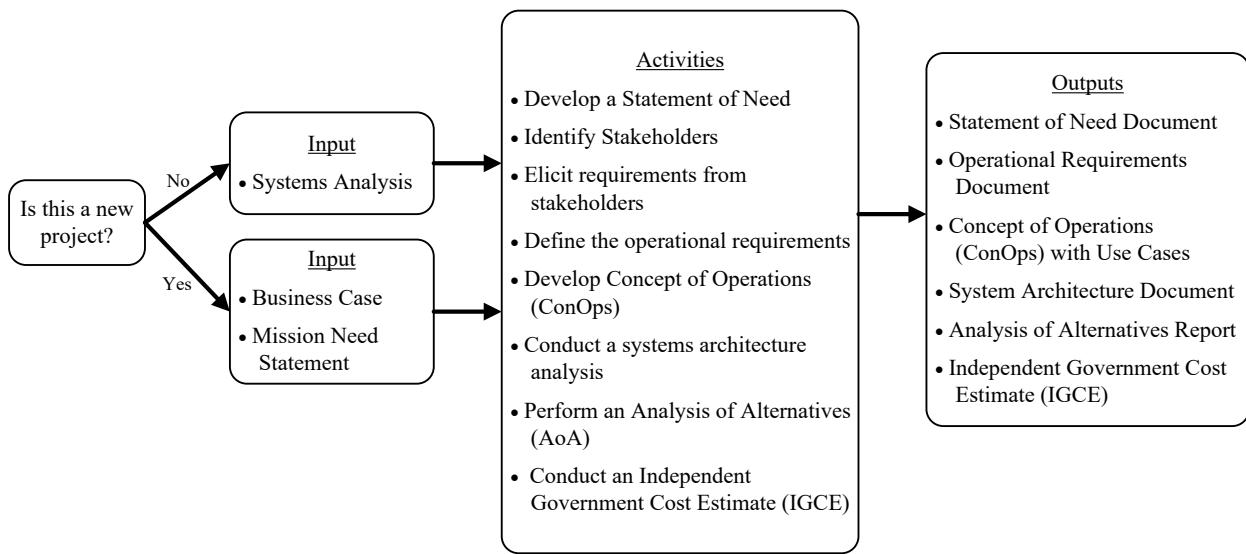


Figure 2: Need and Definition Stage

One of the first questions to address in this stage is: “Is this a project that requires a new system of interest or is the project for the development of upgrades to an existing system?” If the question is “No”, then the required input for this stage is a systems analysis that contrasts the current technical capabilities versus current and future needs. If the answer is “Yes”, then the required inputs for this stage are a business case and/or a mission need statement. A third case, not represented above, is the situation where an existing, already deployed system or capability requires a relatively minor change. Requirements that fit this category proceed through the processes governed by the submission of an [NWS Request for Change Form \(RC\)](#). Although there is some commonality between the NWS RC and SE Life Cycle processes, they should be considered as distinct entities based on the magnitude of the project.

Once the proper inputs are identified, the first activity is to develop a SON to document the reasons for the new system or modifications required for an existing system. Emphasis needs to be placed on the identification of stakeholders and elicit their requirements for the system. These requirements form the basis for the operational requirements, which are statements that identify the essential capabilities, performance, supported end-user processes, and/or other stakeholder needs required to address new operational needs, mission area deficiencies, evolving applications, and/or system cost improvements.

After the SON is created, the next activity is to develop a Concept of Operations document (ConOps) which presents the operational view and functional characteristics of a required capability from the perspective of those whose performance of duties intersects with its operations, such as end users, trainers, managers, maintenance personnel, and the overall organization. It includes a summary of the anticipated impacts associated with a new system and describes user scenarios to illustrate how the system will perform, allowing stakeholders to assess solution alternatives in the context of operational environments. The ConOps should also start to define the data management plan if the system is observing or managing environmental data. The ConOps feed the system architecture analysis, which describes the

system's basic technical concepts, structure, functional elements, and interfaces. Next, an "Analysis of Alternatives" (AoA) is created, which identifies and analyzes possible solutions for achieving the required capability. It includes evaluation of the effectiveness of the alternative solutions, as well as rough estimates of their life cycle costs. After the various alternatives are analyzed, and a particular solution has been recommended, an Independent Government Costs Estimate (IGCE) is needed. An IGCE is an independently developed estimate of the resources and the estimated cost of those resources that would be incurred in the acquisition of the recommended solution.

More details about the activities and outputs in the Needs and Definition stage can be found in NWS Instruction 80-303 *Systems Engineering for New System Development*.

3.2 Design and Development Stage

The Design and Development Stage defines, validates, and realizes that a System of Interest meets stakeholder requirements and can be produced, deployed, operated, and supported. This stage uses the outputs of the Need and Definition Stage as inputs, with the primary output of this stage being the System of Interest approved for entering Operational Test & Evaluation. Figure 3 illustrates the inputs, activities and outputs of this stage.

It should be noted that in parallel with the SE life cycle processes, an acquisition strategy will be developed that will describe how the System of Interest will be acquired. Some portion or all of that acquisition may be performed by one or more commercial vendors under contract to the Government.

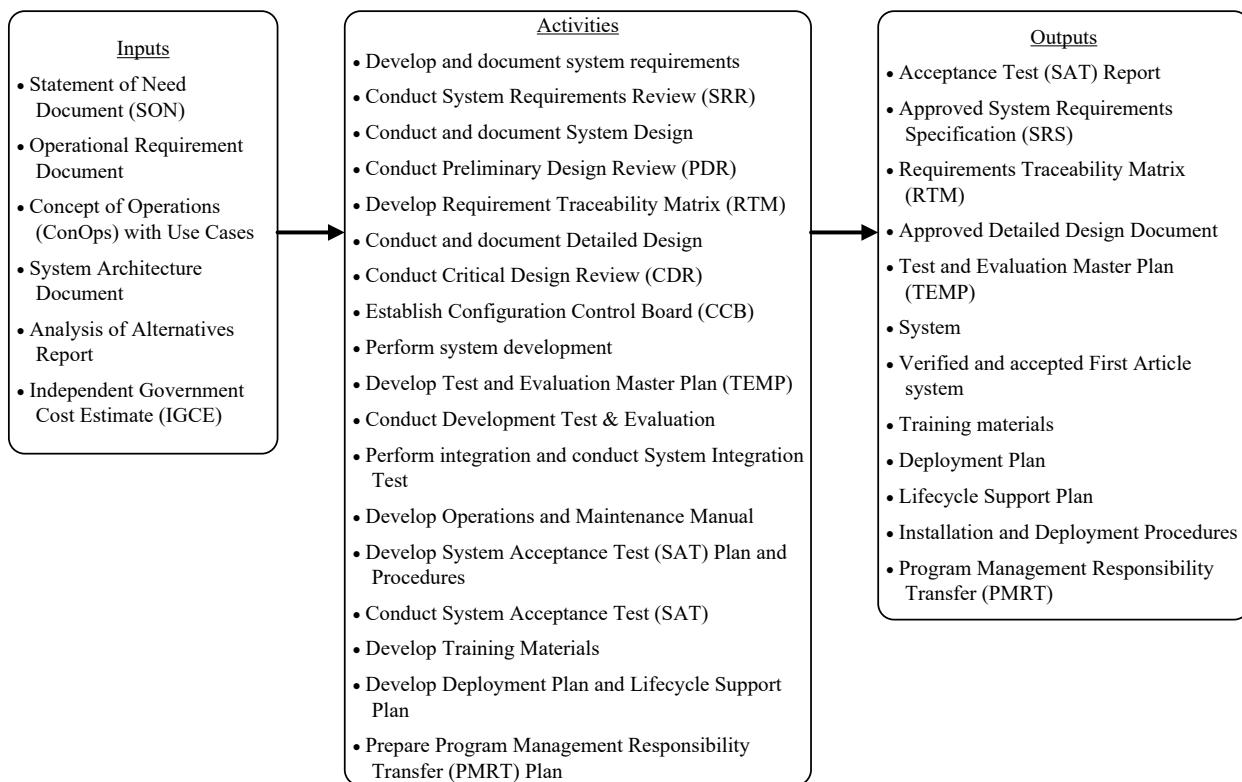


Figure 3: Design and Development Stage

The first activity of the Design and Development Stage is to develop and document system requirements. The stakeholder needs and operational requirements are used to develop functional and technical system requirements for the System of Interest. Once the requirements are developed and documented, a System Requirements Review (SRR) is conducted, which is a technical review of the system requirements to ensure that they are accurate, complete, and achievable. Once the SRR is completed, a system design document is generated, which is a high-level design defining the overall framework of the system and describe how its structure satisfies the requirements. The system design is used in the Preliminary Design Review (PDR). The PDR is used to demonstrate that an acceptable preliminary design is in place that will account for system requirements, fulfilling the operational requirements.

Once the PDR is complete, a Requirements Traceability Matrix (RTM) is developed to document the life of a requirement and providing bi-directional traceability between various associated requirements. After the RTM is developed, a detailed design is generated, which provides a description of the system structure, subsystems, components, interfaces, and data required. The detailed design is used in a Critical Design Review (CDR). The CDR is required to ensure all system requirements are met and that it fulfills all operational requirements within the established cost and schedule constraints, with acceptable risk.

A Configuration Control Board (CCB) is then used to govern changes to and versioning of the approved CDR documentation. After approval from the CCB, system development can

commence for the hardware components, software units and/or modules, and required interface capabilities.

During system development, a test plan is formulated. The first aspect of test planning is to develop the Test and Evaluation Master Plan (TEMP), which establishes the overall testing philosophy and strategy to be followed from development through operational testing. The TEMP provides an integrated test program schedule and a description of the overall test and management process, and provide guidance on documentation and issue reporting requirements. After test planning, the team Conducts Development Test & Evaluation (DT&E) to verify system development against approved system requirements. The team also Perform Integration and Conduct System Integration Test to integrate the various system components and modules as a whole system within a controlled environment.

After system development, an Operations and Maintenance Manual is developed, which includes detailed system installation instructions and configuration procedures that are used in both the initial installation to support Operational Test and Evaluation (OT&E) and all subsequent field installations during full system deployment.

Once the system has been integrated, a System Acceptance Test (SAT) plan and procedures document is developed that accounts for test management, preconditions and test setup, mechanics of test performance, test schedule and required personnel, success criteria, and documentation requirements for the SAT. This plan is critical to verify that the design solution meets all of the system technical requirements and is prepared for successful (OT&E).

A success SAT enables the team to develop training materials to ensure that end-users and support personnel can be trained on how to use the system, and support personnel can be trained on how to support it. It also enables the Development of Deployment Plan and Life Cycle Support Plan which describes the strategy and logistics of how, when, and by whom the deployment of the system will be executed and the strategy and logistics planning for how the system will be supported and maintained throughout its operational life cycle. Finally, during this stage, a Program Management Responsibility Transfer (PMRT) Plan is prepared to transfer the system from development to an operations and maintenance organization.

More details about the activities and outputs in the Needs and Definition stage can be found in NWS Instruction 80-303 *Systems Engineering for New System Development*.

3.3 Operations Validation Stage

The Operations Validation Stage is the third stage in the life cycle. It uses the outputs of the (Design and Development Stage as inputs. The operations validation stage is where the Government formally validates system installation and operations in the target operational environment. This includes validating that all requirements are fulfilled in order for the Government to operate and maintain the system at all sites to which it will be deployed. This is done by conducting an Operational Test and Evaluation (OT&E) of the System and is the primary focus of the Operations Validation Stage in the SE life cycle depicted in Figure 4 below.

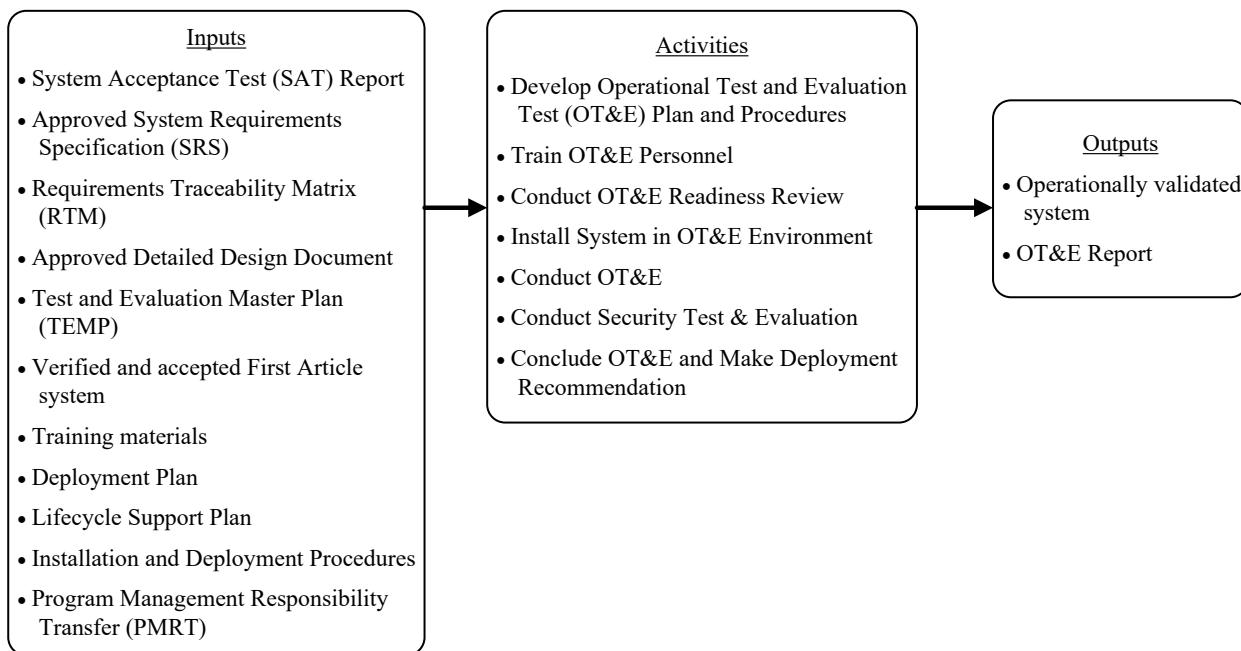


Figure 4: Operational Validation Stage

OT&E is a formal evaluation of a system that is conducted in an operational environment and is performed after the successful completion of the System Acceptance Test (SAT) or System Test (ST) and subsequent deployment of the system at the designated OT&E operational site(s). This is not limited to the operational compliance of the system itself, but includes all aspects of life cycle management of the system including: installation, documentation, performance, training, reliability, communications, information technology security, logistics, and maintenance support. OT&E must be successfully completed prior to full deployment of the System-Under-Test.

The first activity in this stage is to develop an OT&E plan and procedures, which establishes the testing objectives, strategy, scope, methodology, management, personnel and other resources, schedule, documentation, success criteria, trouble reporting guidelines, and approval and closeout requirements. Subordinate to the OT&E Plan are the OT&E procedures that describe the detailed test steps to be performed, the expected outcome, and pass/fail criteria for each test. Test procedures should cover operational testing as well as the validation of other supporting aspects such as documentation, installation, and training. Once the plan is developed, training of the OT&E personnel is required so that they can properly operate and maintain the system in the OT&E environment.

After personnel have been trained, the OT&E team conducts OT&E readiness review to confirm that all prerequisites for the OT&E have been properly satisfied prior to starting the testing. Once the readiness review has been satisfied, the team installs systems in OT&E environment and conducts OT&E. The OT&E typically runs for a period of 30 to 90 days to verify system performance, stability, reliability, and communications. After successful OT&E testing, the team conducts a Security Test & Evaluation to confirm that system security requirements have been appropriately addressed within system design, development, integration and implementation and

that the system is in compliance with NWS IT security policies. This will conclude OT&E and the team will make a deployment recommendation.

The subject matter presented in this section is covered in more detail in NWS Instruction 80-307 *Operational Test and Evaluation Process* and 80-308, *Security Test and Evaluation Process*.

3.4 Production and Deployment Stage

The Production and Deployment Stage is where the system is manufactured, deployed, and installed at all required operational field sites (beyond those sites involved in OT&E). The Production and Deployment Stage is depicted below in Figure 5.

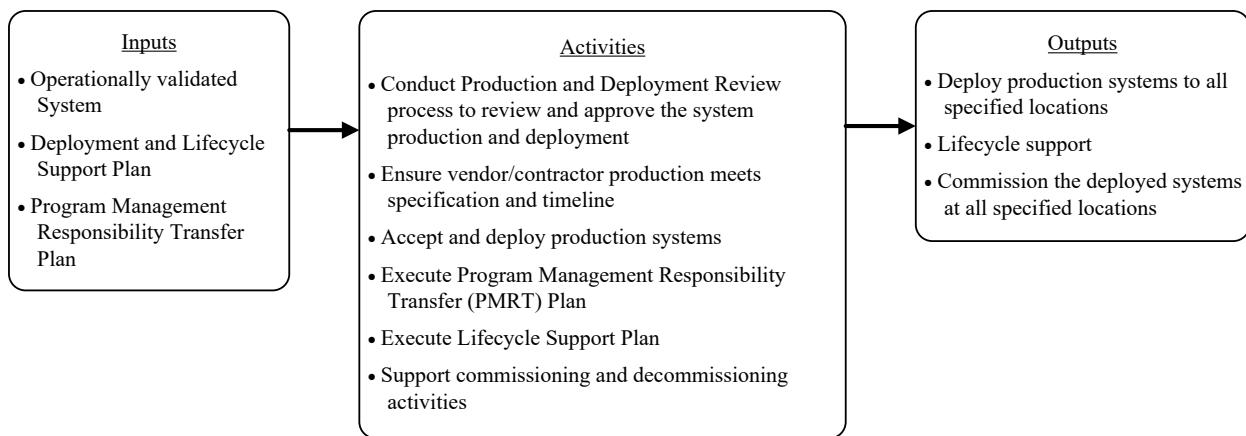


Figure 5: Production and Deployment Stage

The activities for this stage are as follows:

- Conduct Production and Deployment Review process to review and approved the system production and deployment
- Ensure vendor/contractor production meets specification and timeline
- Accept and deploy production systems
- Execute Program Management Responsibility Transfer (PMRT) Plan
- Execute Life Cycle Support Plan
- Support commissioning and decommissioning activities

3.4.1 Conduct Production and Deployment Review

Having a standardized procedure for reviewing production and deployment of the system developed is important to quality control. The Production and Deployment Review creates a mechanism whereby the production and deployment of the system can be reviewed and documented.

3.4.2 Ensure vendor/contractor production meets specification and timeline

Ensuring that vendor(s)/contractor(s) meet their production obligations can be as simple as creating a checklist or as complex and created a management board comprised of project managers and lawyers to ensure vendor compliance with the agreed upon contract. However, in the case of NWS, the Government Task Manager(s) will interface with vendors and monitor and track vendor's work product compared to the contractual agreement.

3.4.3 Accept and deploy production systems

After the system has been fully vetted through most of the aforementioned processes, a “green light” will be given to accept and deploy system into the current operations. Again, it should be noted that if there are any issues present that might affect the current operations of any subsystems, that those issues be documented and brought to the attention of the proper stakeholders. It is also important that during the acceptance and deployment of the system the SE team does not omit any knowledge that could be deemed critical in determining the acceptance and deployment of said system.

3.4.4 Execute Program Management Responsibility Transfer (PMRT) Plan

The transition of the system from development to operations is managed through coordination and approval of a Program Management Responsibility Transfer (PMRT). The System Program Manager may also serve as the primary focal point for the administration of the Planned Product Improvement process for the system. The System Program Manager reports to the PMC and may chair the CCB. The System Program Manager is a member of the Test Review Group (TRG) and presents the recommendations of the TRG to the CCB.

3.4.5 Execute Life Cycle Support Plan

Executing Life Cycle Support Plan is initially the plan that was agreed upon earlier in the life cycle development. While in the process of supporting the Life Cycle Support Plan, the SE team should ensure that the plan has no execution barriers that might have arisen since the support plan was initially developed. If there are issues present that might affect the execution of the support plan, then the SE has to alert and document those issues to the proper stakeholder in order to create a path for the issue.

3.4.6 Support Commissioning and Decommissioning Activities

System Commissioning

System Commissioning is the process of applying technical and administrative judgments quantitatively and qualitatively to:

- Determine when a major system, at an NWS site, can be used in the conduct of NWS operations in its fullest sense, i.e., critical evaluations criteria have been met.
- Evaluate the effectiveness of system support functions. An example of a support function is logistical support at the NWS depot.

When a surface weather observation system is commissioned, for example, its products are deemed acceptable for official use. A system can be used in the conduct of field operations for familiarization and training purposes before it is commissioned.

The NWS will produce commissioning plans for systems to be commissioned. The commissioning process shown in Figure 6 provides the framework for this plan.

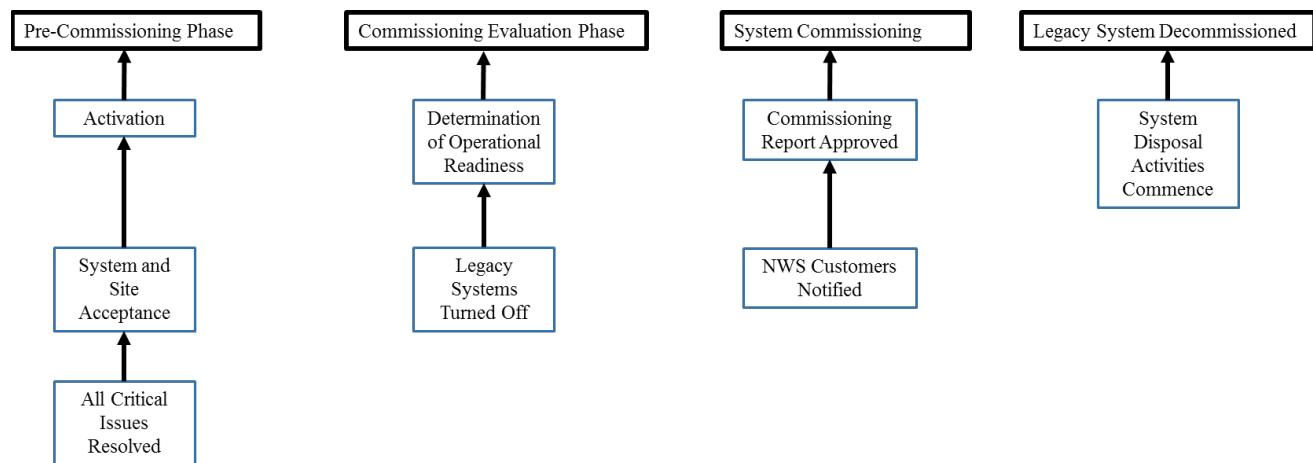


Figure 6: Commissioning Phases

There are four commissioning phases outlined in Figure 6:

- Pre-commissioning
- Commissioning evaluation
- System commissioning and implementation
- Decommissioning of the legacy system

Each phase will be delineated in the commissioning plan as applicable to the system being commissioned. However, some aspects of the phases may not be applicable because the function is not a part of the specific technology or may need to be modified from Figure 6 as specific conditions warrant. Furthermore, the commissioning of a system at a site is predicated on completing the commissioning report, getting it approved, and designating when the commissioning is to be implemented.

Please refer to NWSI 80-201 *System Commissioning Process* for further instruction.

Decommissioning

System Decommissioning is the process where technical and administrative judgments are applied quantitatively and qualitatively supporting the removal of a legacy system from official use. In most cases, one or more legacy systems will be decommissioned as a result of the system commissioning. In some cases, the legacy system must be removed before the new system can

be deployed and commissioned. In these cases, the legacy and new technology may reside side-by-side for a period of time before the legacy system is decommissioned after the new system has been commissioned. The System Commissioning Process (NWSI 80-201) for the new system will delineate the transition activities between the old and new technology.

For each system to be decommissioned, a decommissioning plan may be developed describing the system decommissioning activities, the process to be followed during the decommissioning phase, and the roles and responsibilities within NWS organizational components involved in the decommissioning activities. The Director, Office of Operational Systems, will be the authorizing official for this document. The decommissioning plan will include procedures to remove the system from the information system inventory.

Please refer to NWSI 80-202 *System Decommissioning Process* for further instruction.

3.4.7 Outputs of the Production and Deployment Stage

The outputs or artifacts produced from the activities in the Production and Deployment Stage of the SE life cycle are:

- Deploy production systems to all specified locations
- Life Cycle Support
- Commission the deployed systems at all specified locations

3.5 Operations and Support Stage

The Operations and Support Stage is where the system is operated in its intended environment to deliver its intended services, representing the “steady state” period that lasts until the system is retired or replaced. Figure 7 below illustrates the inputs, activities and outputs of this stage. The activities outlined in Figure 7 are to::

- Establish and maintain all Operations and Maintenance Procedures and Support
- Collect System Operational Data
- Plan and Implement the Required System Upgrade
- Maintain Configuration Control of System
- Plan System Retirement
- Decommission System

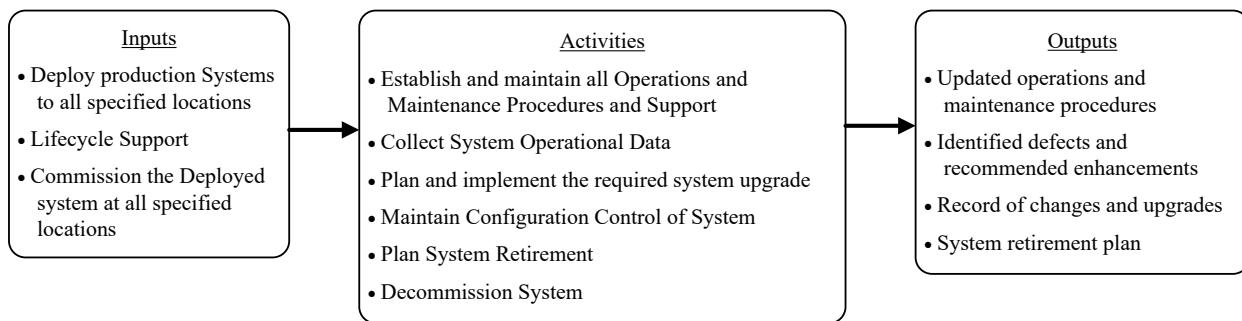


Figure 7: Operations and Support Stage

3.5.1 Establish and maintain all Operations and Maintenance Procedures and Support

Operations and maintenance procedures will have been established and approved during deployment. However, specific detailed procedures will be further developed and maintained as system efficiencies and issues are identified. All personnel will be trained in the updated procedures and are responsible for their use.

3.5.2 Collect System Operational Data

During operations and maintenance, sufficient performance data will be collected to support system analysis. This system analysis will determine how well the system is operating over time. In-process reviews will be held periodically to review collected metrics, assess system performance, and identify potential system improvements.

3.5.3 Plan and Implement the Required System Upgrade

Evolution of the system will occur as stakeholder priorities change and technology advances. Changes can also result from user-reported issues and recommendations and from system improvements identified from the review of operational data. These changes will need to be designed, developed, integrated, tested, and deployed.

3.5.4 Maintain Configuration Control of System

The deployed system will be under configuration control, so every time the system changes, even if only a minor software patch was added, the system baseline must be updated. This means that all documentation, databases, and any other operational data must also be updated. A project library should be established that includes the latest baseline versions of all project documentation.

3.5.5 Plan System Retirement

At some point, the system will need to be retired from service. The reasons for retirement could be the deployment of a newer system, a change in the Concept of Operations, or that the system is no longer needed. The retirement plan will include a complete inventory of all software and hardware, final system and documentation configurations, and other information that captures the final operational status of the system. It will also include how the system and documentation

will be disposed of, including an assessment and plan if special security measures should be in place or if there are environmental concerns that might dictate the site of disposal. The retirement plan will be reviewed and approved by all parties, including O&M team, the owner of the system (if different), and other key personnel.

3.5.6 Decommission System

The next activity is to execute the retirement plan and record the results. A “lessons learned” will be held meeting that includes suggested system improvements. All recommendations should be archived for reference in future system decommissions.

For systems which provide NWS products/services to external users (e.g., dissemination systems), NWSI 1-1003 must be followed to meet NOAA Partnership Policy requirements, if there will be a substantial change in service with the decommissioning of the system.

3.5.7 Outputs for Operations and Support Stage

The outputs or artifacts produced from the activities in the Operations and Support Stage of the SE life cycle are:

- Updated operations and maintenance procedures
- Identified defects and recommended enhancements
- Record of changes and upgrades
- System retirement plan

Attachment 1

REFERENCES AND GLOSSARY OF TERMS

References

- NWS Policy Directive 10-1, *NWS Requirements, Operations and Services Improvements*
NWS Instruction 10-103, *Operations and Services Improvement Process Implementation*
NWS Policy Directive 80-1, *Acquisition Program Management*
NWS Instruction 80-3, *Systems Engineering*
NWS Instruction 80-303, *Systems Engineering for New System Development*
NWS Instruction 80-304, *Systems Engineering for Software Development*
NWS Instruction 80-305, *Test and Evaluation*
NWS Instruction 80-306, *System Acceptance Test (SAT) Process*
NWS Instruction 80-307, *Operational Test and Evaluation (OT&E) Process*
NWS Policy Directive 80-4, *Science and Technology Planning and Programming*
NWS Policy Directive 80-5, *Science Review and Approval*
NWS Policy Directive 60-7, *Information Technology Security Policy*
NOAA Administrative Order 212-13, *Information Technology Security Management*
NIST Special Publication 800-37, *Guide for the Security Certification and Accreditation of Federal Information Systems*
NIST 800-53, *Recommended Security Controls for Federal Information Systems*
NIST 800-64, Revision 2, *Security Considerations in the System Development Life Cycle*
NIST 800-30, *Risk Management Guide for Information Technology Systems*

Glossary

The following is a list of common terms and acronyms used within the Systems Engineering industry. While many of these terms are not mentioned within the body of this document, they are nonetheless important to understanding this directive. These terms are taken from several sources, referenced sources contained from the directive.

Acceptance criteria - The criteria that a software component, product, or system must satisfy in order to be accepted by the system owner or other authorized acceptance authority.

Acceptance process - The process used to verify that a new or modified system is fully operational and meets the system owner's requirements. Successful completion of the acceptance process results in the formal transfer of the system responsibilities from development to maintenance personnel.

Acquisition - The acquiring by contract with appropriated funds of supplies or services (including construction) by and for the use of the Government through purchase or lease, whether the supplies or services are already in existence or must be created, developed, demonstrated, and evaluated.

Activity - A major unit of work to be completed in achieving the objectives of a project. An activity incorporates a set of tasks to be completed, consumes resources, and results in work products. An activity may contain other activities in a hierarchical manner. All project activities should be described in the Project Plan.

Allocated requirement - The subset of the system requirements that are to be implemented within the scope of a given project and forming the components of the system.

Analysis - Use of mathematical modeling and analytical techniques to predict the compliance of a design to its requirements based on calculated data or data derived from lower system structure end product validations.

Analysis of Alternatives (AOA) - A formal analysis method that compares alternative approaches by estimating their ability to satisfy mission requirements through an effectiveness analysis and by estimating their life-cycle costs through a cost analysis. The results of these two analyses are used together to produce a cost effectiveness comparison that allows decision makers to assess the relative value or potential programmatic returns of the alternatives.

Anomaly - Anything observed in the operation or documentation of software and systems that deviates from expectations based on previously verified system or software products, or documents.

Application - Software or systems products designed to fulfill specific needs.

Assumption - A condition that is taken to be true without proof or demonstration.

Audit - An independent examination of a work product to assess compliance with specifications, standards, quality or security requirements, contractual agreements, or other predetermined criteria.

Baseline - A set of configuration items (hardware, software, documents) that has been formally reviewed and agreed upon, that serves as the basis for further development, and that can be changed only through formal change control procedures.

Baselined requirements - The set of project requirements that have been approved and signed by the system owner.

Code - Computer instructions and data definitions expressed in a development language or in a form that is output by an assembler, compiler, or other translator.

Code review -A meeting at which software code is presented to project personnel, managers, users, or other functional areas for review, comment, or approval.

Component - One of the parts that make up a system. A component may be hardware, software, or firmware and may be subdivided into other components.

Concept of Operations (ConOps) -The ConOps describes how the system will be operated during the life-cycle phases to meet stake holder expectations. It describes the system characteristics from an operational perspective and helps facilitate an understanding of the system goals. It stimulates the development of the requirements and architecture related to the user elements of the system. It serves as the basis for subsequent definition documents and provides the foundation for the long-range operational planning activities

Configuration control - An element of configuration management consisting of the evaluation, coordination, approval/disapproval, and implementation of changes to configuration items after formal establishment of their configuration identification.

Configuration Control Board (CCB) - A group of people responsible for evaluating and approving/disapproving proposed changes to configuration items, and for ensuring implementation of approved changes.

Configuration item - An aggregate of hardware, software, or documentation components that are designated for configuration management and treated as a single entity in the configuration management process.

Configuration Management - A discipline that effectively controls and manages all modifications to system components, product, or system.

Constraint - A restriction, limit, or regulation that limits a given course of action or inaction.

Contract - A mutually binding legal relationship obligating the seller to furnish the supplies or services (including construction) and the buyer to pay for them. It includes all types of commitments that obligate the Government to an expenditure of appropriated funds and that, except as otherwise authorized, are in writing.

Contractor - An individual, partnership, company, corporation, association, or other service having a contract with the Agency for the design, development, manufacture, maintenance, modification, operation, or supply of items or services under the terms of a contract to a program or project.

Cost estimate - A formal estimate of the cost to develop and support a project.

Critical Design Review (CDR) - A review that demonstrates that the maturity of the design is appropriate to support proceeding with full-scale fabrication, assembly, integration, and test, and that the technical effort is on track to complete system development and operations in order to meet performance requirements within the identified cost and schedule constraints.

Deliverable - A work product that is identified in the Project Plan and is formally delivered to the system owner and other project stakeholders for review and approval.

Dependency - A relationship of one task to another where the start or end date of the second task is related to the start or end date of the first task.

Descope - Taken out of the scope of a project.

Design - The process of defining the architecture, components, interfaces, and other characteristics of a system, product, or component.

Design specification - A document that describes the design of a software component, product, or system. Typical contents include architecture, control logic, data structures, input/output formats, interface descriptions, and algorithms.

Enterprise - The aggregate of all functional elements, equipment, and processes which together accomplish a common mission.

Entry Criteria - Minimum accomplishments each project needs to fulfill to enter into the next life-cycle phase or level of technical maturity.

Feasibility - The degree to which the requirements, design, or plans for a software product or system can be implemented under existing constraints.

Function Test - Confirms that the logically-grouped modules function according to specifications. Developers write this test from a user's perspective. Testing is based on output only, without any knowledge of internal code or logic.

Functional area - Any formally organized group involved in the development and maintenance of systems or the support of development and maintenance efforts, or other group whose input is required to successfully implement a systems project.

Functional Decomposition - A sub-function under logical decomposition and design solution definition, it is the examination of a function to identify sub-functions necessary for the accomplishment of that function and functional relationships and interfaces.

Functional requirement - A requirement that specifies a function that a software component, product, or system must be able to perform.

Glueware - Integration software that provides the proper interface for the component (i.e., wrappers) being integrated and serves as a mediator for its interactions with other components.

Goal - Quantitative and qualitative guidance on such things as performance criteria, technology gaps, system context, effectiveness, cost, schedule, and risk.

Hardware - Physical computer and other equipment used to process, store, or transmit computer programs or data.

Hierarchy - A structure in which components are ranked into levels of subordination.

Independent Government Cost Estimate (IGCE) - Is the U.S. Government's estimate of costs that a contractor/recipient may incur in performing services and/or providing supplies to achieve the Government's objectives.

Implementation requirements - A requirement that supports the development and maintenance concepts and approaches in the areas of operating environment, conversion, installation, training, and documentation.

Incremental development - A development technique in which requirements definition, design, implementation, and testing occur in an overlapping, iterative (rather than sequential) manner, resulting in incremental completion of the overall system or product.

Information Security- The protection of information and information systems from unauthorized access, use, disclosure, disruption, modification, or destruction in order to provide confidentiality, integrity, and availability. [44 U.S.C., Sec. 3542(b)(1)(A)-(C)]

Information System - A discrete set of information resources organized for the collection, processing, maintenance, use, sharing, dissemination, or disposition of information. [44 U.S.C., Sec. 3502(8)]

Information Technology - Any equipment or interconnected system or subsystem of equipment that is used in the automatic acquisition, storage, manipulation, management, movement, control, display, switching, interchange, transmission, or reception of data or information. [40 U.S.C., Sec. 11101(6)(A)]

Inspection - A static analysis technique that relies on visual examination of development products to detect errors, violations of development standards, and other problems. Code inspection and design inspection are two types.

Integration Test - Verifies the system components are integrated and working as an application. The technical development team performs this test to uncover errors that occur in the interactions and interfaces between components.

Integrity - The degree to which a software component, product, or system prevents unauthorized access to, or modification of, computer programs or data.

Interface-A shared boundary between two functional units, defined by functional characteristics, common physical interconnection characteristics, signal characteristics, or other characteristics, as appropriate.

Interface requirement - A requirement that specifies an external item with which a software product or system must interact, or that sets forth constraints on formats, timing, or other factors caused by such an interaction.

Interview technique - A technique for the identification, analysis, and documentation of the project requirements.

Iterative - Application of a process to the same product or set of products to correct a discovered discrepancy or other variation from requirements. (See “Recursive” and “Repeatable.”)

Life Cycle - See Project Life Cycle.

Life-Cycle Cost - The total cost of ownership over the project's or system's life cycle from Formulation through Implementation, Operations/Support, and Disposal. The total of the direct, indirect, recurring, nonrecurring, and other related expenses incurred, or estimated to be incurred, in the design, development, verification, production, deployment, operation, maintenance, support, and disposal of a project.

Logistics - The management, engineering activities, and analysis associated with design requirements definition, material procurement and distribution, maintenance, supply replacement, transportation, and disposal that are identified by space flight and ground systems supportability objectives.

Maintainability - The measure of the ability of an item to be retained in or restored to specified conditions when

Maintenance -The process of supporting a software product or system after delivery to maintain operational status, correct faults, improve performance, implement updates/upgrades/enhancements or other attributes, or adapt to a changed environment.

Major Program/Project - Program/Project with total costs in excess of a predetermined threshold is deemed to be major program/project.

Margin - The allowances carried in budget, projected schedules, and technical performance parameters (e.g. weight, power, or memory) to account for uncertainties and risks.

Methodology - A collection of methods, procedures, and standards that defines an integrated synthesis of engineering approaches to the development of a work product.

Metric - The result of a measurement taken over a period of time that communicates vital information about the status or performance of a system, process, or activity. A metric should drive appropriate action.

Milestone - A scheduled event for which an individual or team is accountable and that is used to measure progress.

Mission - A major activity required to accomplish an Agency goal or to effectively pursue a scientific, technological, or engineering opportunity directly related to an Agency goal. Mission needs are independent of any particular system or technological solution.

Mission Critical System (MCS) - A system that is essential in the performance of a mission objective that if lost, would cause failure to meet or support the mission objective.

Module - A program unit that is discrete and identifiable with respect to compiling, combining with other units, and loading. A logically separable part of a program.

Operations -The provision of integrated systems and services that make the best use of existing systems in order to preserve and improve customer-related performance. This is done in anticipation of, or in response to, both recurring and non-recurring conditions.

Peer Review - Independent evaluation by internal or external subject matter experts who do not have a vested interest in the work product under review. Peer reviews can be planned, focused reviews conducted on selected work products by the producer's peers to identify defects and issues prior to that work product moving into a milestone review or approval cycle.

Performance requirement - A requirement that imposes conditions on a functional requirement (e.g., a requirement that specifies the speed, accuracy, or memory usage with which a given function must be performed).

Platform - A specific computer and operating system on which a software product or system is developed or operated.

Portability - The ease with which a software component, product, or system can be transferred from one hardware or software environment to another.

Preliminary Design Review (PDR) - A review that demonstrates that the preliminary design meets all system requirements with acceptable risk and within the cost and schedule constraints and establishes the basis for proceeding with detailed design. It will show that the correct design option has been selected, interfaces have been identified, and verification methods have been described.

Procedure - A written description of a course of action to be taken to perform a given task.

Process - An ordered set of steps performed for a given purpose. Processes define or control the development of the project work products. The use of processes will ensure a consistent methodology across all platforms in producing the life cycle deliverables.

Project - An undertaking requiring concerted effort that is focused on developing or maintaining a specific software product or system.

Project Life Cycle - Covers all activities conducted within the scope of an entire project, from project startup to project closeout.

Project Management Plan - See Project Plan. Synonymous with software development plan and project plan.

Project Manager - The individual with total responsibility for all activities of a project. The project manager plans, directs, controls, administers, and regulates a project.

Project Plan - A document that describes the technical and management approach to be followed for a project. The plan typically describes the work to be done, the resources required, the methods to be used, the procedures to be followed, the schedules to be met, and the way the project will be organized.

Project team - The project manager, analysts, developers, and other staff assigned as the core group for a project.

Prototyping - A technique for developing and testing a preliminary version of the software product (either as a whole or in modular units) in order to emulate functionality.

Pseudocode - A combination of development language constructs and natural language used to express a computer program design.

Quality assurance - A process designed to provide management with appropriate visibility into the work products being built and the systems engineering processes being used by the project team.

Rapid Prototyping - A type of prototyping in which emphasis is placed on developing prototypes earlier in the development process to permit early feedback and analysis in support of the development process.

Reference - A document(s) or other material that is useful in understanding more about an activity.

Regression Test - Re-execution of specific test cases to ensure defects are fixed, find new defects that may have been introduced, and confirm that module(s) are functioning properly.

Reliability - The ability of a software or system component to perform its required functions under stated conditions for a specified period of time.

Requirement - A condition or capability needed by a system owner/user to solve a problem or achieve an objective. A condition or capability that must be met or possessed by the software product or system to satisfy a contract, standard, specification, or other formally imposed documents.

Requirements analysis - The process of analyzing and understanding the scope and feasibility of identified requirements; of developing a preliminary plan to arrive at a detailed definition of system, hardware, or software requirements; and of crystallizing a preliminary system solution.

Requirements management - A process designed to establish a common understanding between the system owner/users and the project team regarding the system owner/users' software and system requirements. This understanding forms the basis for estimating, planning, performing, and tracking the project's activities throughout the life cycle.

Requirements Specification - A work product deliverable that specifies the requirements for a software product or system. Typically included are functional requirements, performance requirements, and interface requirements. Describes in detail what will be delivered in the product or system release.

Retirement - Permanent removal of a system or software product from its operational environment.

Reusability - The degree to which a software module or other work product or system component can be used in more than one computer program or software system.

Reverse Engineering - A development methodology in which the software development process is performed in reverse. The technique involves the examination of an existing software product that has characteristics that are similar to the desired product. Using the existing code as a guide, the requirements for the product are defined, analyzed, and abstracted all the way back to specifications.

Risk - The combination of the probability that a program or project will experience an undesired event (some examples include a cost overrun, schedule slippage, safety mishap, health problem, malicious activities, environmental impact, or failure to achieve a needed scientific or

technological breakthrough or mission success criteria) and the consequences, impact, or severity of the undesired event, were it to occur. Both the probability and consequences may have associated uncertainties.

Risk Assessment - An evaluation of a risk item that determines (1) what can go wrong, (2) how likely is it to occur, (3) what the consequences are, and (4) what are the uncertainties associated with the likelihood and consequences.

Risk Management - An organized, systematic decision making process that efficiently identifies, analyzes, plans, tracks, controls, communicates, and documents risk and establishes mitigation approaches and plans to increase the likelihood of achieving program/project goals.

Safeguards - Protective measures prescribed to meet the security requirements (i.e., confidentiality, integrity, and availability) specified for an information system.

Software - Computer programs, procedures, and associated documentation and data pertaining to the operation of a software product or system.

Specification - A document that specifies in a complete, precise, verifiable manner the requirements, design, behavior, and other characteristics of a software component, product, or system.

Spiral development model - A software development process in which the constituent activities, typically requirements analysis, design, coding, integration, and testing are performed iteratively until the software product is complete.

Stage - A partition of the project life cycle that reduces a project to manageable pieces and represents a meaningful and measurable set of related tasks that are performed to obtain specific work products.

Stakeholder - An individual, group, or organization, who may affect, be affected by, or perceive itself to be affected by a decision, activity, or outcome of a project.

Stakeholder Requirements - Requirements from various stakeholders that will govern the project, including required system capabilities, function, and/or services; quality standards; system constraints; and cost and schedule constraints. Stakeholder requirements may be captured in the Stakeholder Requirements Specification.

Standard - Mandatory requirements employed and enforced to prescribe a disciplined, uniform approach to software and systems development and maintenance.

State Diagram - A diagram that shows the flow in the system in response to varying inputs.

Structured analysis - An analysis technique that uses a graphical language to build models of software products or systems. The four basic features in structured analysis are data flow diagrams, data dictionaries, procedure logic representations, and data store structuring techniques.

System - 1) An integrated set of elements, subsystems, or assemblies that accomplish a define objective. These elements include products (hardware, software, firmware), processes, people, information, techniques, facilities, services, and other support elements. 2) A combination of interacting elements organized to achieve one or more stated purpose.

Systems Analysis - The analytical process by which a need is transformed into a realized, definitive product, able to support compatibility with all physical and functional requirements and support the operational scenarios in terms of reliability, maintainability, supportability, serviceability, and disposability, while maintaining performance and affordability.

System Architecture - The arrangement of elements and subsystems and the allocation of functions to them to meet system requirements.

System Design Document - A work product deliverable that describes the solution to the automation task as described by the requirements.

Systems Engineer - An engineer trained and experienced in the field of systems engineering.

Systems Engineering Processes - A logical, systematic set of processes selectively used to accomplish systems engineering tasks.

System Integration Test - An evaluation, examination or test of System Integration expectations, of or for one or more Assets, Systems, or Solutions.

System owner - The enterprise unit that funds and has approval authority for the project.

System of Interest - The system whose life cycle is under consideration.

System & Standards Test – Verifies functional business requirements, business processes, data flows and other system criteria are met.

Task - The smallest unit of work subject to management accountability. A task is a well-defined work assignment for one or more project team members. Related tasks are usually grouped to form activities. A task is the lowest level of work division typically included in the Project Plan and Work Breakdown Structure.

Telecommunications - The science and technology of communications by electronic transmission of impulses, as by telephone or email.

Test - The use of system, subsystem, or component operation to obtain detailed data to verify performance or to provide sufficient information to verify performance through further analysis. Testing is the detailed quantifying method of verification and is ultimately required in order to verify the system design.

Test bed - An environment containing the hardware, instrumentation, simulators, software tools, and other support elements needed to conduct a test.

Test case - A set of conditions or variables under which a tester determines whether or not an application or software system is working correctly. It is the mechanism for determining whether a software program or system has passed or failed

Test criteria - The criteria that a software product or system component must meet in order to pass a given test.

Test documentation - Documentation describing plans for, or results of, the testing of a system component or product. Documents typically include test case specifications, test incident reports, test logs, test plans, test procedures, and test reports.

Test item - A system component that is the object of testing.

Test log - A chronological record of all relevant details about the execution and results of a test.

Test plan - A document specifying the scope, approach, resources, and schedule of intended testing activities.

Testing - An activity in which a software or system component or product is executed under specified conditions, the results are observed and recorded, and an evaluation is made.

Traceability - The degree to which a relationship can be established between two or more products of the development process, especially products having a predecessor-successor relationship to one another.

Transition - The act of delivery or moving of a product from the location where the product has been implemented or integrated, as well as verified and validated, to a customer. This act can include packaging, handling, storing, moving, transporting, installing, and sustainment activities.

Unit - A separately testable element specified in the design of a computer system or software component.

Unit testing - Testing of individual hardware or software units or groups of related units. The isolated testing of each flowpath of code with each unit.

Usability - The ease with which a user can learn to operate, prepare inputs for, and interpret outputs of an IT product or system.

User - The general population of individuals who use a software product or system. User activities can include data entry; read only; add, change and delete capabilities; querying; and report generation.

User Acceptance Test (UAT) - Validates the system as a whole meets mutually agreed-upon requirements.

User interface - An interface that enables information to be passed between a user and hardware or software components of a computer system.

User manual - A document that presents the information necessary to use a software product or system to obtain desired results. Typically described are product or component capabilities, limitations, options, permitted inputs, expected outputs, possible error messages, and special instructions.

Validation - The process of evaluating software or systems at the end of the development process to assure compliance with established software and system requirements.

Verification - The process of evaluating a software product or system to determine whether or not the work products of a stage of the project life cycle fulfill the requirements established during the previous stage.

Walkthrough - An analysis technique in which a team of subject matter experts review a segment of code, documentation, or other work product, ask questions, and make comments about possible errors, violation of development standards, and other problems.