Department of Commerce • National Oceanic & Atmospheric Administration • National Weather Service

NATIONAL WEATHER SERVICE INSTRUCTION 80-303

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Science and Technology

Systems Engineering

SYSTEMS ENGINEERING FOR NEW DEVELOPMENT

NOTICE: This publication is available at: http://www.nws.noaa.gov/directives/

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Type of Issuance: Routine

SUMMARY OF REVISIONS: This directive supersedes NWS Instruction 80-303, dated October 28, 2004. Changes were made to (1) update the names of certification and approval officials to reflect the personnel changes; (2) change type of issuance from Initial to Routine and provide Summary of Revisions information; (3) update Section 1 to include coordination activity for systems engineer and information system security officer to address security requirements; (4) update Section 1 and 3.1 to add system maintenance as part of system life cycle requirements; (5) update Section 3.3 and 3.4 to add OSIP Stage 5 activities to address the deployment, transition to operation, and maintenance support; (6) modify Table 1 to update OSIP Gate 2 systems engineering evaluation criteria; and (7) revise Appendix B to update the references of NWS policy directives and instruction.

SUMMARY: This instruction specifies the functions and evaluation criteria for the systems engineering associated with new development and relates to NWS Policy Directive 80-3 *Systems Engineering*. The instruction is intended to apply to the NWS Operations and Services Improvement Process (OSIP) established by NWS, although one may recognize standard systems engineering principles that could be applied to other processes.

signed April 7, 2009

Donald H. Berchoff Date

Director, Office of Science and Technology

Systems Engineering for New Development

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Systems Engineering for New Development

1. Introduction

The systems engineering function provides:

- System functional and performance requirements analysis
- Architecture and system analyses
- Tradeoff analyses between effectiveness and cost
- Analysis of technical support throughout the system life cycle

Outcomes of an effective systems engineering process provide efficient functionality, performance, and process-related specifications for a complete solution. The resulting complete solution reflects the requirements to support efficient management, planning, maintenance and execution of the program. The program or project encompasses the design, development, test and evaluation of the solution and associated systems.

New development comprises major and visible changes to the enterprise architecture that affect the performance of existing mission critical systems, or adds a new mission critical system to the enterprise. Mission critical systems are those systems that are essential in the performance of a mission objective that if lost, would cause failure to meet or support the mission objective. Systems engineering is required in all stages of new development of mission critical systems.

This instruction provides guidance on systems engineering for new development.

The following references pertain to this instruction:

- Systems Engineering Fundamentals, Defense Acquisition University Press, January 2001
- IEEE Std. 1220-1998 Standard for Application and Management of the Systems Engineering Process, 2005
- INCOSE, Systems Engineering Handbook: A Guide for System Life Cycle Processes and Activities, Version 3.0, June 2006

Additional NIST Special Publications related to information security topics may apply to the development of a specific system. The systems engineer, in conjunction with the Information System Security Officer assigned for the development system, will determine the applicability of specific NIST guidance to the system under development.

2. Purpose and Scope

This instruction specifies the functions and evaluation criteria for the systems engineering associated with new development. An overview of a systems engineering process is shown in

Appendix A, Figure 1. This instruction focuses on creating and operating effective systems analysis and control functions; the other functions are specified in other procedural directives.

3. Program Product Standards

This section provides the following:

- A definition of the systems engineering approach (per INCOSE)
- A definition of the systems engineering role
- Systems engineer's role associated with Operations and Services Improvement Process (OSIP) (refer to Appendix B – Reference 1 and 2)
- OSIP Gate Criteria with associated systems engineering evaluation criteria

3.1 Systems Engineering Approach

The systems engineering approach is an interdisciplinary approach intended to enable the realization of successful systems. Systems engineering:

- Encompasses the scientific and engineering efforts related to the development, manufacturing, verification, deployment, operations, support, maintenance, and disposal of system products and processes
- Develops or incorporates system security safeguards to protect the confidentiality, integrity, and availability of information systems
- Develops user training equipments, procedures, and data
- Establishes and maintains configuration management of the system
- Develops work breakdown structures and statements of work
- Provides information for management decision making

3.2 Systems Engineer's Role

The systems engineer's role includes:

- Providing support to defining, clarifying, and documenting requirements
- Performing (or insuring his/her team performs) the necessary parametric analysis and tradeoffs
- Recognizing when interface impacts might occur and taking early action to avoid problems.

The systems engineer should have a thorough understanding of the new system in the context of system requirements, system architecture, interfaces to external systems, and the Enterprise Architecture.

3.3 Systems Engineer's Role as Related to OSIP Gate Criteria and Stage Activities

The systems engineer's primary role starts at OSIP Stage 1- Collection and Validation of Needs. The systems engineering roles in support of OSIP Gates 1, 2, 3, 4, and Stage 5 are as follows:

Gate1 - Need & Validation Approval, and Concept Exploration & Definition Resourcing

- Develops or participates in development and review of statements of need, particularly needs associated with technology opportunity

Gate 2 - Concept Exploration and Definition Approval, and Research & Analysis Resourcing

- Develops or participates in development and review of operational requirements
- Develops or participates in development of the conceptual architecture
- Conducts initial trade-off analysis
- Conducts risk identification, including preliminary information security risk analysis

Gate 3 - Research & Analysis Approval, and Operational Development Resourcing

- Uses a systems engineering perspective
- Leads the decomposition of operational requirements
- Develops the system architecture
- Conducts trade-off analyses and develop a business case
- Conducts risk identification and mitigation, including information security risk analysis
- Coordinates security categorization of system with the Information System Security Officer

Gate 4 – Operational Development Approval, and Deployment Decision & Resourcing

- Identifies and utilizes a systems engineering process
- Assures that a product is built that adequately meets the requirements
- Oversees the development test and evaluation effort
- Supports the security test and evaluation effort
- Supports the operational test and evaluation effort
- Assure the system lifecycle support is planned and in place
- Ensure necessary documentation is produced to support information security certification and accreditation

Stage 5 (following Gate 4) - Deployment, Assessment, and Lifecycle Support

- Support deployment execution
- Support transition to operations and maintenance

3.4 Systems Engineering Evaluation Criteria Associated with OSIP Gates

Table 1 specifies the OSIP gate products and the associated systems engineering gate evaluation criteria. The OSIP gate products are documents that are to be completed as gate criteria. The systems engineering evaluation criteria specify what will be used to evaluate the gate documents. For example, the Gate 2 Concept of Operations / Operational Requirements Document (ConOps/ORD) will be evaluated and analyzed to ensure that the requirements listed in the ConOps/ORD are both feasible and achievable. Continuing with the example, the Gate 3 Technical Requirements will be evaluated to ensure that the operational requirements are adequately decomposed to technical requirements such that a product may be built.

Table 1 - OSIP Gate Products and associated Systems Engineering Evaluation Criteria

OSIP Gate Products	Systems Engineering Evaluation Criteria
G1 Criteria:	
1. Statement of Need (SON)	(1) Evaluate SON (2) Identify alternative or associated SONs
2. Project Plan (Initial – based on the information known at that time, and developed to the extent possible)	(1) Review the plan to support Stage 2 activities and beyond
G2 Criteria:	
1. SON	(1) Evaluate and analyze SON to support requirements formulation
2. Concept of Operations / Operational Requirements Document (ConOps/ORD)	(1) Evaluate and analyze ConOps to support operational requirements formation (2) Evaluate and analyze ORD for feasibility and achievability (2) Identify trade-offs (3) Identify risk areas
3. Project Plan (Update)	(1) Review the plan to support Stage 3 activities and beyond
G3 Criteria:	
1. Exploratory Research	(1) Assist in and evaluate exploratory research results to ensure consistency with the approved SON and with available technology (2) Identify alternative enterprise architecture approaches or solutions

OSIP Gate Products	Systems Engineering Evaluation Criteria
2. ConOps/ORD	(1) Evaluate and analyze ConOps/ORD to support requirements formulation (2) Refine and revise ConOps/ORD as needed
3. Technical Requirements	(1) Develop system requirements (first cut) (2) Evaluate and analyze for feasibility and achievability (3) Identify trade-offs (4) Identify risk areas, risks, and mitigation approaches
4. Business Case Analysis (BCA)	(1) Support business case development including assessments of alignment to goals, current and future states, gaps, alternatives, benefits, costs, architecture, risks, acquisition strategy, regulatory compliance, schedule development, and requirements baseline
5. Operational Development Plan (ODP), as needed	(1) Support detailed project planning (2) Support requirements allocation (3) Support alternative selection (4) Select development approach, e.g. - Incremental - Spiral - Prototyping (5) Support critical milestone definition (6) Support schedule definition (7) Identify schedule trade-offs (8) Develop ODP
6. Project Plan (Update)	(1) Review the plan to support Stage 4 activities and beyond
G4 Criteria:	
1. Operational Development Evaluation	(1) Lead operational development evaluation (2) Establish verification program
2. Deployment, Assessment, and Lifecycle Support (DALS) plan	(1) Support DALS plan development
3. Deployment Decision Document	(1) Support development of the Deployment Decision Document
4. Program Management Responsibility Transfer (PMRT) plan	(1) Support responsibility transfer planning
5. Project Plan (Update)	(1) Review the plan to support Stage 5 activities
Stage 5 (following Gate 4):	
Deployment, Assessment, and Lifecycle Support	(1) Support deployment execution (2) Support transition to operations and maintenance

Appendix A – Systems Engineering Process

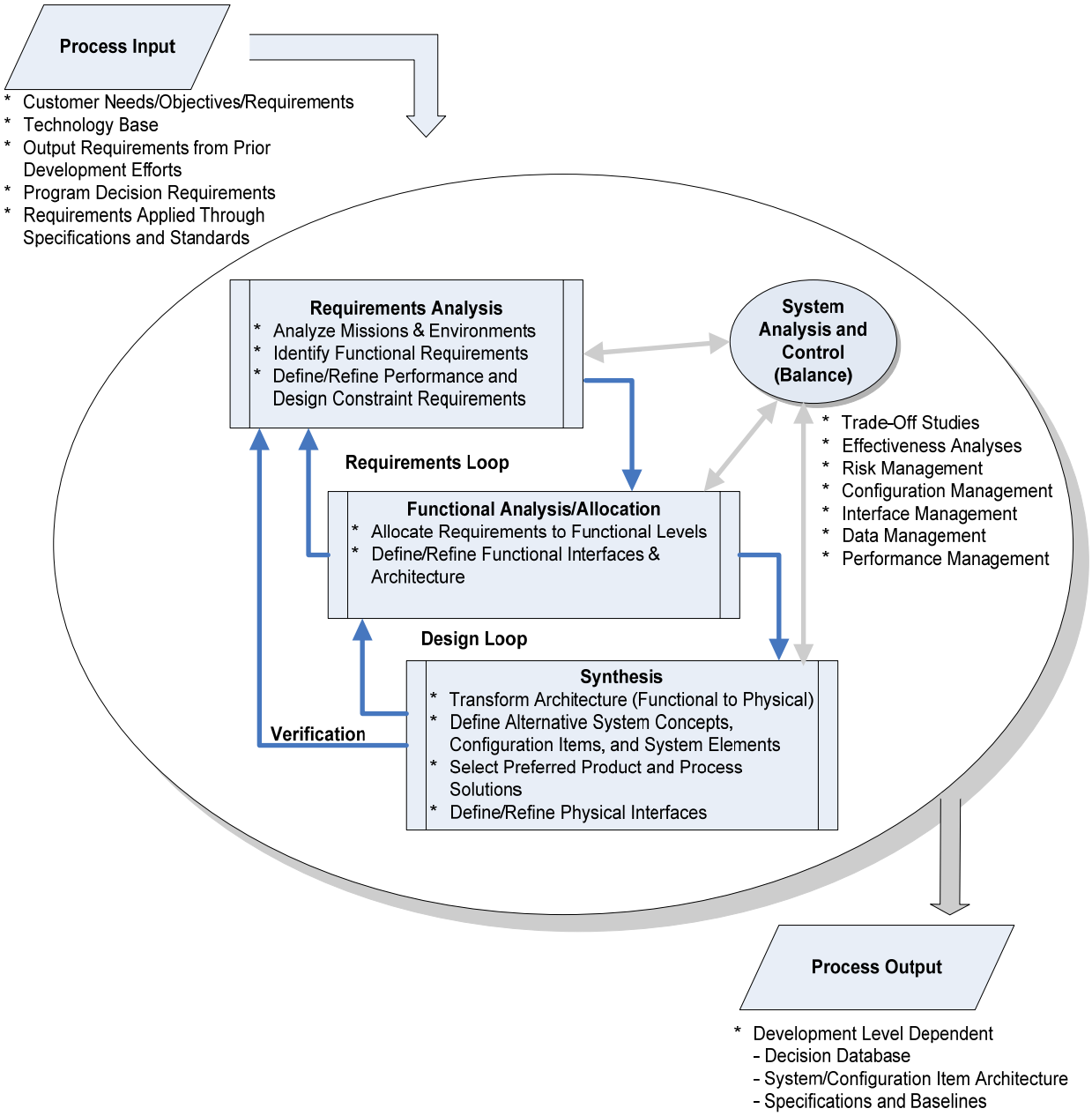

Figure 1. The Systems Engineering Process, Excerpt from *Systems Engineering Fundamentals*, p 31

Appendix B - References

1. NWS Policy Directive 10-1, *NWS Requirements, Operations and Services Improvements*
2. NWS Instruction 10-103, *Operations and Services Improvement Process Implementation*
3. NWS Policy Directive 80-3, *Systems Engineering*
4. NWS Policy Directive 60-7, *Information Technology Security Policy*