

Systems Engineering for ITS Deployments From Conception to Completion

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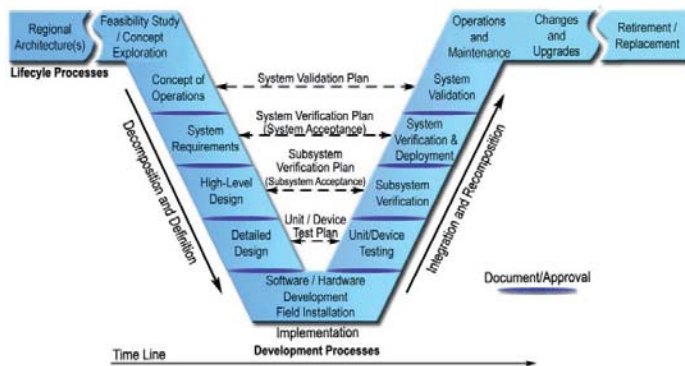
Why do ITS Projects Need Systems Engineering?



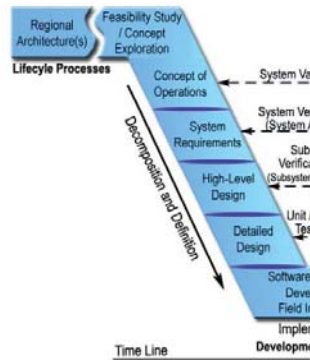
- Some products and solutions are technology based
 - Most new technologies are not programmatic
- Ensures that the investment meets the needs
- All federally funded ITS projects require a Systems Engineering analysis
 - Programmatic – Systems Engineering Review Form (SERF)
 - Development and deployment of standard ITS systems
 - Non-Programmatic – Concept of Operations
 - ITS systems not previously used nor in current use by the Agency

Systems Engineering

The "V" Model



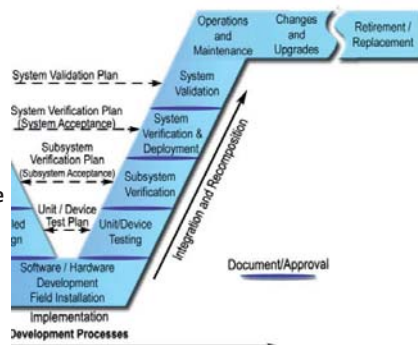
Systems Engineering Documents



- Concept of Operations
 - Non-technical description of how the system will be used
 - *System needs, goals, and objectives*
 - *Stakeholder Outreach*
- System Requirements
 - What needs to be achieved by the system

Systems Engineering Documents

- System Verification
 - How the system will be tested to ensure that it meets the requirements
 - Confirms system meets its specified requirements
- System Validation
 - How the performance of the system will be measured to determine whether or not the needs have been met
 - Confirms system fulfills its intended use



Example Statements

- Concept of Operations Needs
 - *The system needs to prevent queues forming at user-specified locations.*
- System Requirements
 - *When queues are detected at user-specified locations, the ASCT shall execute user-specified timing plan/operational mode.*
 - *The ASCT shall detect the presence of queues at pre-configured locations.*
 - *When queues are detected at user-specified locations, the ASCT shall execute user-specified adaptive operation strategy.*
- Verification
 - *Test Case/Demonstration: Length of queues, detector data,*
- Validation
 - *Performance Measure: Delay*

Traceability

Need Statement Reference Number	Concept of Operations Need Statement	System Requirements Reference Numbers			
4.1.0-1.0-1	Maximize the throughput on coordinated routes.	2.1.1.0-7	2.1.1.0-7.0-1	2.2.0-1	2.2.0-2
4.1.0-1.0-2	Provide smooth flow along coordinated routes.	2.1.1.0-7.0-4	2.2.0-1	2.2.0-2	2.2.0-5
4.1.0-1.0-3	Distribute phase times in an equitable fashion.	2.1.1.0-7	2.1.1.0-7.0-3	2.1.1.0-7.0-4	2.1.1.0-8
4.1.0-1.0-4	Manage the length of queues.	2.1.1.0-7.0-2	2.1.3.0-1	2.1.3.0-2	2.1.3.0-3
4.1.0-1.0-5	Manage the locations of queues within the network.	2.1.3.0-1	2.1.3.0-2	2.1.3.0-3	2.1.3.0-4
4.1.0-1.0-6	At an isolated intersection, optimize operation with a minimum of phase failures (based on the optimization objectives).	2.1.1.0-8	2.1.1.0-8.0-1	2.1.1.0-8.0-1.0-1	2.1.1.0-8.0-2
4.1.0-3	The system needs the ability to change the operational strategy (for example, from smooth flow to maximizing throughput or managing queues) based on changing traffic conditions.	2.1.1.0-7	2.1.1.0-7.0-3	2.1.1.0-7.0-2	
4.1.0-4	The system needs the ability to detect repeated phase failures and control signal timing to prevent phase failures building up queues.	2.1.1.0-9	2.1.1.0-9.0-1	2.1.3.0-1	2.2.0-3
4.1.0-5	The system needs to minimize the chance that a queue forms at a specified location.	2.2.0-5.0-5	2.5.0-6	2.5.0-7	2.5.0-8
4.1.0-6	The system needs the ability to fix the sequence of phases at any specified location.	2.1.2.0-11			
4.1.0-7	The system needs the ability to designate the coordinated route based on traffic conditions and the selected operational strategy.	2.1.1.0-10	2.1.1.0-10.0-1	2.1.1.0-10.0-2	2.1.1.0-10.0-3
4.1.0-8	The system needs the ability to set signal timing parameters to comply with agency policies.	2.1.1.0-11	9.0-4		
4.2.0-1	The system needs the ability to eventually adaptively control up to XX miles from the Traffic Management Center (TMC) (or specified location).	1.0-1			
4.2.0-2	The system needs the ability to be able to eventually adaptively control up to XX independent groups of signalized intersections.	1.0-2	1.0-2.0-2		
4.2.0-3	The system needs the ability to vary the number of signals in an adaptively controlled group to accommodate the prevailing traffic conditions.	1.0-2	1.0-2.0-3	1.0-2.0-5	1.0-2.0-5.0-1

Systems Engineering & Contract Documents

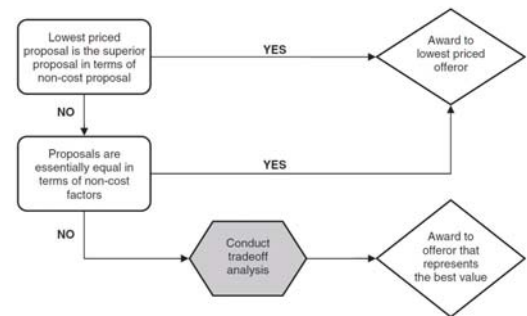
- Benefits of incorporating Systems Engineering requirements into bid documents
- Verification Plan
 - Traceability
- Submittal Acceptance
 - Require contractors/vendors demonstrate how they fulfill the system requirements before awarding contract
- Definition of responsibilities



Procurement Plan

- Sole Source (Highest Cost, Least Risk)
 - Only allowed in certain circumstances
 - Direct selection of a contractor without competition
 - 23 CFR 635.411 provides the regulatory authority for FHWA's participation in the cost of a patented or proprietary product
- Low Bid (Least Cost, Highest Risk)
 - Based on the lowest price offered
 - "Competitive procurement does not mandate low bid" - FHWA Model SE
 - "rarely satisfactory method of procuring a complex system such as ASCT" - FHWA Model SE
- Proposal Based Selection (Best Value, Negotiated, Price and other factors)
 - Based on the evaluation a technical proposal
 - Weighted combination low-bid and negotiated methods of award
- Design-Build

NCHRP REPORT 560: Guide to Contracting ITS Projects NCHRP REPORT 561: Best-Value Procurement Methods for Highway Construction Projects

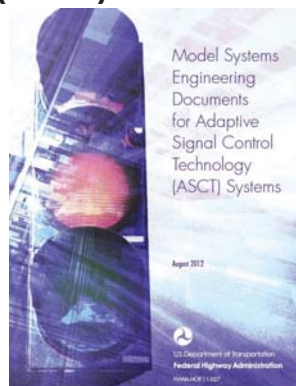


Proposal Based Selection

Model SE for Adaptive Signal Control Technology (ASCT)

Documents:

- Concept of Operations
 - How it will be used
- System Requirements
 - What it will do
- Verification Plan
 - How it will be tested
- Validation Plan
 - How it will be measured



Important Constraints for ASCT

- System Cost
 - Capital
 - Operations
 - Maintenance
- Procurement
 - Low-Bid
 - Price and Other Factors
- Agency Resources
 - Operational objectives
 - Staff skills
- Site Suitability
 - Arterial vs grid
 - Congestion
 - Objectives
- Existing Infrastructure
 - Closed Loop
 - Centrally Managed
 - Communications
 - Detection



Operations & Maintenance



Q&A

Questions?

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