Systems Engineering Tools for Rural Projects

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Agenda

- Overview of SE
- System Engineering Tools
- *Clarus* Multi-State Regional Demonstration
- VDOT ITS Architectures
- NTCIP
- Conclusion
Overview of SE

**Planning**
- Program/Budgets

**Project Initiation**
- Regional Architecture(s)
- Feasibility Study/Concept Exploration

**Preliminary Engineering**
- Concept of Operations
- System Requirements
- High-Level Design
- Detailed Design

**PS&E**
- Software/Hardware Development
- Field Installation

**Construction**
- System Validation
- System Verification & Deployment
- Subsystem Verification
- Unit/Device Testing

**Project Closeout**
- Operations and Maintenance
- Changes and Upgrades

**Ops & Maintain**
- Change & Upgrade

**Retire/Replace**
- Retirement/Replacement

**Time Line**
FHWA Rule 940.11

- 23 CFR 940.11 Project Implementation requires:
  - All ITS projects funded with highway trust funds shall be based on a systems engineering analysis
  - The analysis should be on a scale commensurate with project scope
23 CFR 940.11(c) defines “systems engineering analysis”

1. Identification of portions of the regional ITS architecture being implemented
2. Identification of participating agencies roles and responsibilities
3. Requirements definitions
4. Analysis of alternative system configurations and technology options to meet requirements
5. Procurement options
6. Identification of applicable ITS standards and testing procedures
7. Procedures and resources necessary for operations and management of the system

SE “V” covers all 7 requirements
SE Tools

- Advantages
  - Comprehensive Model
  - Sharing Components between Phases
  - Updates/Maintenance
  - Visual
  - Enables Easier Traceability

- Disadvantages
  - Need to Learn/Train
  - Can be Expensive
  - Models are Not Portable Between Tools
SE CASE Tools

- Some Tools Support Structured Analysis/Structured Design
- Examples:
  - IBM Rational Rose/Requisite Pro
  - IBM Rational System Architect
  - Sparx Enterprise Architect
  - Turbo Architecture
Sparx Enterprise Architect
Turbo Architecture
Clarus Multi-State Regional Demonstration – UML Use Case
Clarus Multi-State Regional Demonstration – UML Sequence
Clarus Multi-State Regional Demonstration – Traceability
VDOT ITS Architectures

VDOT Central Office
VDOT TEOC

VDOT Central Office
VDOT Statewide Environmental Sensor Stations (ESS)

VDOT Central Office
VDOT Surface Transportation Weather Platform

VDOT Central Office
VDOT ESS Weather Platform

FHWA
Clarus

National Oceanic and Atmospheric Administration
National Weather Service

Existing
NTCIP 1204 ESS Examples

Dialog for Capture Snapshot Image

The ESS will take a photographic image with camera x and save the image to the directory essSnapshotCameraStoragePath with the essSnapshotCameraFilename.
NTCIP 1204 ESS Examples

Pavement Treatment System State Machine Diagram
NTCIP 1204 ESS Examples

Sample Class Diagram for Temperature Sensors
NTCIP 1204 ESS Examples

ESS Characteristics Class Diagram

- SnmpInterface
- Controller
- ESS
  - category : code
  - siteDescription : text
  - typeOfStation : code
  - doorOpen : code
  - batteryCharge : quantity
  - lineVolts : quantity
  - stationMetaDataBlock : frame
  - weatherBlock : frame
  - latitude : quantity
  - longitude : quantity
  - referenceHeight : quantity
- MobilePlatform
  - mobileBlock : frame
  - speed : quantity
  - bearing : quantity
  - odometer : quantity
  - friction : quantity
  - observedGroundState : code
  - observedPavementState : code

See NTCIP 1201 for more details
NTCIP Traceability

• Protocol Requirements List
  • User Needs
  • Functional Requirements
  • Conformance
  • Project Requirement
• Requirements Traceability Matrix
  • Requirement
  • Dialog
  • Object ID
• Requirements to Test Case Traceability Table
Conclusion

- Many SE Tools out there
- SE Tools can help manage Rural Projects
- SE Tools help with a project’s SEA
- SE Tools help enforce the SE methodology
- SE Tools help visual the project
- It's not just the diagrams
- A common approach helps everyone understand the project
Thanks!

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