Mac Lister

**Program Manager Knowledge and Technology Transfer
ITS Joint Program Office
Mac.Lister@dot.gov**

www.pcb.its.dot.gov

Jeffrey Spencer

ITS Team Leader
Federal Transit Administration
Office of Research, Demonstration and Innovation
Jeffrey.Spencer@dot.gov

www.pcb.its.dot.gov

ITS Transit Standards
Professional Capacity Building Program

Module 1:
Introduction to Intelligent Transportation Systems (ITS) Transit Standards

ACTIVITY

U.S. Department of Transportation
Office of the Assistant Secretary for
Research and Technology

Instructor
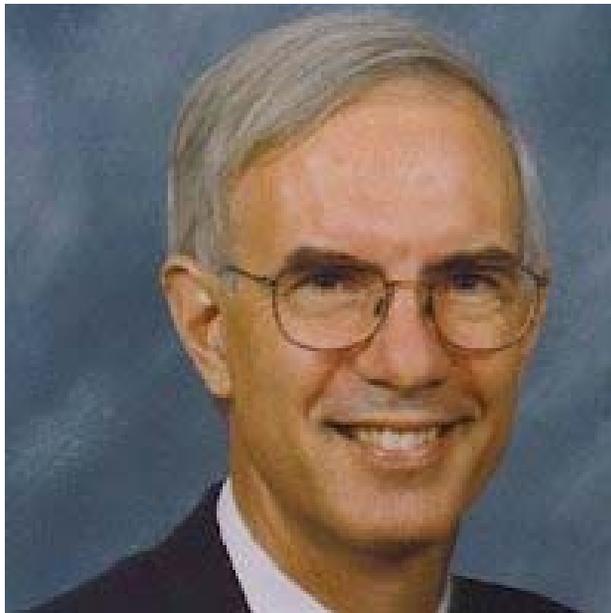
Bruce S. Eisenhart

Vice President, Operations

Consensus Systems Technologies

Centreville, VA, USA

Target Audience

- Transit management staff;

- Transit planning, operations, and maintenance staff;

- Transit procurement staff;

- Transit ITS staff;

- Transit ITS contractors and consultants;

- Transit technology vendors;

- Vehicle manufacturers; and

- Transit IT staff.

Recommended Prerequisite(s)

- None. This is the Introductory Module in the series of Transit Standards modules.

Curriculum Path (Decision-maker)

Introduction to ITS Transit Standards — Module 1

Transit Management, Part 1 of 2 — Module 2

TCIP, Part 1 of 2 — Module 3

Traveler Information, Part 1 of 2 — Module 6

Electronic Fare Payment Systems — Module 10

Transit and the Connected Vehicle Environment/Emerging Technologies, Applications, and Future Platforms — Module 11

Recommended Prerequisite Modules

Optional Modules

U.S. Department of Transportation
Office of the Assistant Secretary for
Research and Technology

Curriculum Path (Project Manager)

Introduction to ITS Transit Standards — Module 1

Transit Management, Part 1 of 2 — Module 2 | Transit Management, Part 2 of 2 — Module 5

TCIP, Part 1 of 2 — Module 3 | TCIP, Part 2 of 2 — Module 4

Traveler Information, Part 1 of 2 — Module 6 | Arterial Management & Transit Signal Priority, Part 1 of 2 — Module 8 | Electronic Fare Payment Systems — Module 10 | Transit and the Connected Vehicle Environment/Emerging Technologies, Applications, and Future Platforms — Module 11

Traveler Information, Part 2 of 2 — Module 7 | Arterial Management & Transit Signal Priority, Part 2 of 2 — Module 9

Recommended Prerequisite Modules

Optional Modules

U.S. Department of Transportation
Office of the Assistant Secretary for
Research and Technology

Curriculum Path (Project Engineer)

Introduction to ITS Transit Standards — Module 1

Transit Management, Part 1 of 2 — Module 2 | Transit Management, Part 2 of 2 — Module 5

TCIP, Part 1 of 2 — Module 3 | TCIP, Part 2 of 2 — Module 4

Traveler Information, Part 1 of 2 — Module 6 | Arterial Management & Transit Signal Priority, Part 1 of 2 — Module 8 | Electronic Fare Payment Systems — Module 10 | Transit and the Connected Vehicle Environment/Emerging Technologies, Applications, and Future Platforms — Module 11

Traveler Information, Part 2 of 2 — Module 7 | Arterial Management & Transit Signal Priority, Part 2 of 2 — Module 9

Recommended Prerequisite Modules

Optional Modules

Learning Objectives

1. Define ITS transit standards and examine the benefits and costs of using ITS transit standards

2. Introduce the use of the Systems Engineering Process (SEP) and articulate benefits of SEP in ITS transit projects

3. Define high level technical and institutional challenges

4. Identify the role of ITS Standards in Transit ITS applications

5. Describe Roadmap for Transit Standards Modules

Learning Objective #1: Define ITS Transit Standards and Examine the Benefits and Costs of Using ITS Transit Standards

- What are ITS transit standards?

- Standards development process

- Benefits of using standards as part of transit deployments

- Costs of using (or not using)

U.S. Department of Transportation
Office of the Assistant Secretary for
Research and Technology

What are ITS Transit Standards?

- What is a standard?

  - Established norm or requirement about technical systems that establishes:

    - Uniform engineering or technical criteria, methods, processes, and practices

- What are Intelligent Transportation Systems (ITS) Standards?

  - Defines how ITS systems, products, and components can interconnect, exchange information, and interact to deliver services within a transportation network

- Types of ITS Standards

  - Data transferred on an interface

  - Communications protocols used to send data

  - Hardware definition

Standards Development Process

- Standards Development Organizations (SDO)
  - Voluntary
  - Consensus based
  - Open
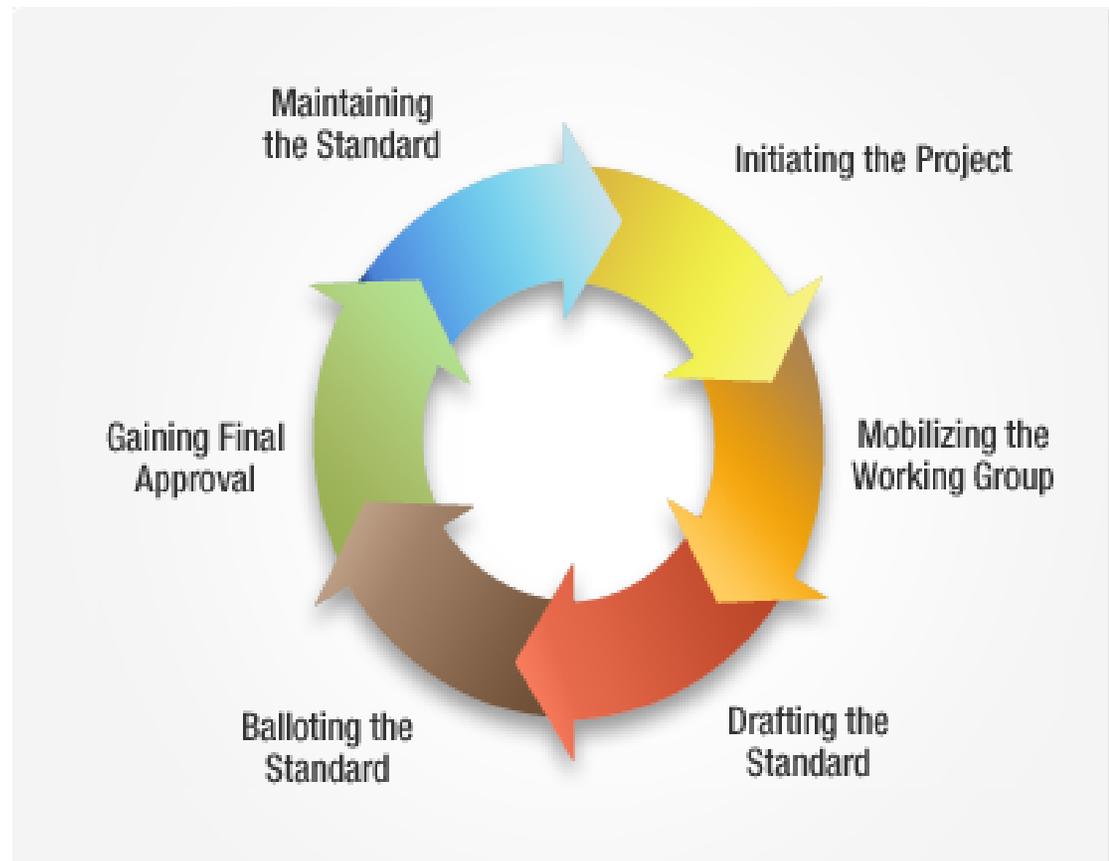
Benefits of Using Standards

- Facilitates regional interoperability

- Supports compliance to Federal Transit Agency (FTA) Policy on ITS Architecture and Standards

- Facilitates systems integration

- Reduces future integration costs

- Reduces operating and maintenance costs

- Easier to apply boilerplate specifications and copy similar procurements from other agencies

Benefits - Interoperability

- The ability of an ITS system to:

  - Provide information and services to other systems

  - Use exchanged information and services to operate together effectively

- Analogy: home theater system
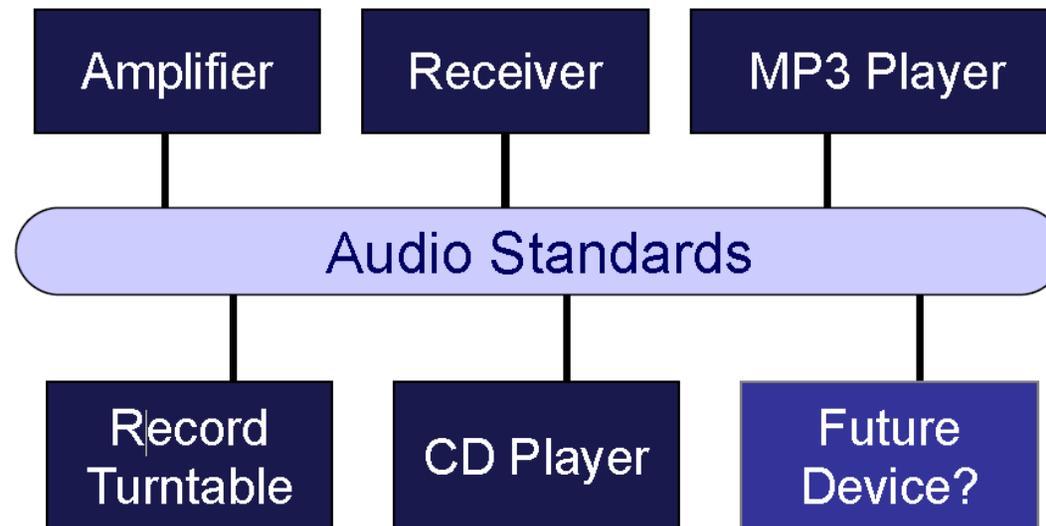
Interoperability in Transit

- The interoperability with standards support regional information sharing
    - E.g. sharing of real-time bus information
- Supports Code of Federal Regulations (CFR) 23 Rule 511 - Real-time System Management Information Program (RTSMIP)
    - Requires states and metropolitan regions to collect and share real-time traffic and **travel conditions**
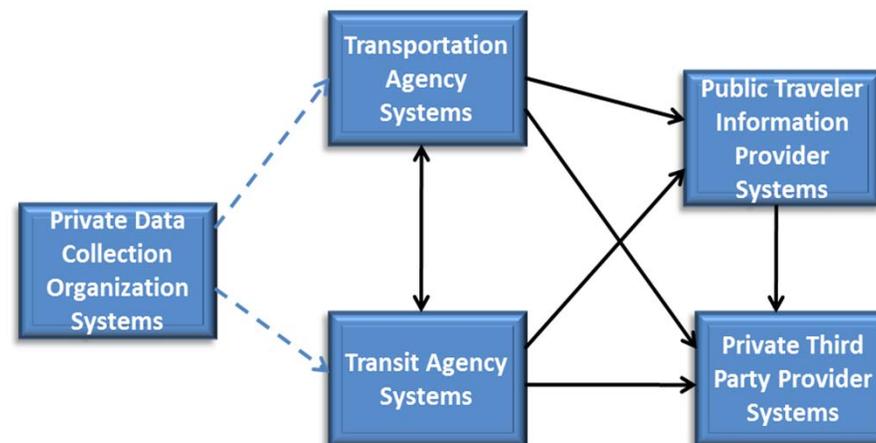
Figure Key

→ Interfaces that are the subject of the DXFS

- - → Additional interfaces relevant to an overall RTSMIP

Supports Compliance to FTA Policy on ITS Architecture and Standards

- FTA Policy enacted on January 8, 2001

- "Requires" a systems engineering analysis for ITS projects using highway trust funds

- Seven requirements included in the Systems Engineering (SE) analysis (see supplemental materials)

  - #6 states: Identification of applicable ITS standards and testing procedures

Facilitates Systems Integration

- Standards facilitate integration of systems within an agency

    - Between services (e.g. fixed route and paratransit)

    - Between modes (e.g. bus and rail)

    - Between departments (e.g. between operations and maintenance)

- How is systems integration made easier?

    - Data created by one part of the agency can be input and used directly by another part of the agency

    - Removes the need for costly translation from one form to another

Reduces Costs for Integration and O&M

- Reduced Integration Costs

  - Not locked into proprietary systems

  - Expansion is easier

  - Still allows for innovation

  - Reduced risk

  - Increased flexibility

- Reduced Operations and Maintenance (O&M) Costs

  - Documented standards-based interfaces are easier to maintain and update

Simplifies Procurement

- Easier to apply boilerplate specifications and copy similar procurements from other agencies

    □ Use of commonly deployed standards means that others have already gone through procurements using the standard

    □ They have created specifications and technical procurement packages

    □ Can borrow and customize for your particular procurement

- Lowers implementation risks

Costs Associated with Standards Use

- Using ITS standards may have a cost

  - Agency must do the upfront work to understand and define use of the standard but these costs will be offset by cost advantages for future upgrades and deployments

  - Decision makers must support increased cost of extra time to support initial (upfront) development costs

- Not using ITS standards will also have a cost

  - Being locked into proprietary systems costs more for upgrades and additional deployments

STANDARDS ITS TRAINING

U.S. Department of Transportation
Office of the Assistant Secretary for
Research and Technology

ACTIVITY

U.S. Department of Transportation
Office of the Assistant Secretary for
Research and Technology

What are some benefits of using ITS Standards?

Answer Choices

○ A) Facilitates regional interoperability

○ B) Supports compliance to FTA Policy on ITS Architecture and Standards

○ C) Facilitates systems integration

● D) All of the above

Your answer:

The correct answer is:

You must answer the question before continuing

question completely

Submit   Clear

STANDARDS ITS TRAINING

Review of Answers

a) Facilitates regional interoperability

Incorrect. Including information sharing across agencies.

b) Supports compliance to FTA Policy on ITS Architecture and Standards

Incorrect. Identifying standards used is one part of policy requirement for systems engineering analysis.

c) Facilitates systems integration

Incorrect. Data created by one part of the agency can be input and used directly by another part of the agency.

d) All of the above

Correct! Each of the above are key benefits of using standards.

Summary of Learning Objective #1

Define ITS Transit Standards and Examine the Benefits and Costs of Using ITS Transit Standards

- ITS Standards define how ITS systems exchange information to deliver services within a transportation network

- Using ITS Transit Standards

    - Facilitates regional interoperability, which allows agencies to share information

    - Supports compliance to FTA Policy on ITS Architecture and Standards

- However, the agency must do the upfront work to understand and define how the standard will be used.

Learning Objective #2: Introduce the Use of the Systems Engineering Process (SEP) and Articulate Benefits of SEP in ITS Transit Projects

- Explain SEP and its benefits

- Recognize how standards fit into SEP

SEP and its Benefits

- Define Systems Engineering and explain the Systems Engineering Process (SEP)

- List key benefits of using SEP

- Discuss ITS Architectures- National and Regional

U.S. Department of Transportation
Office of the Assistant Secretary for
Research and Technology

What is Systems Engineering?

- Interdisciplinary approach

- Structured development process

- Focuses on defining customer needs (business and technical) and required functionality

- Final design selected from alternatives that accomplish objectives and considers technical merits and costs

- Addresses the problem throughout the process

What is the "Vee" Model?
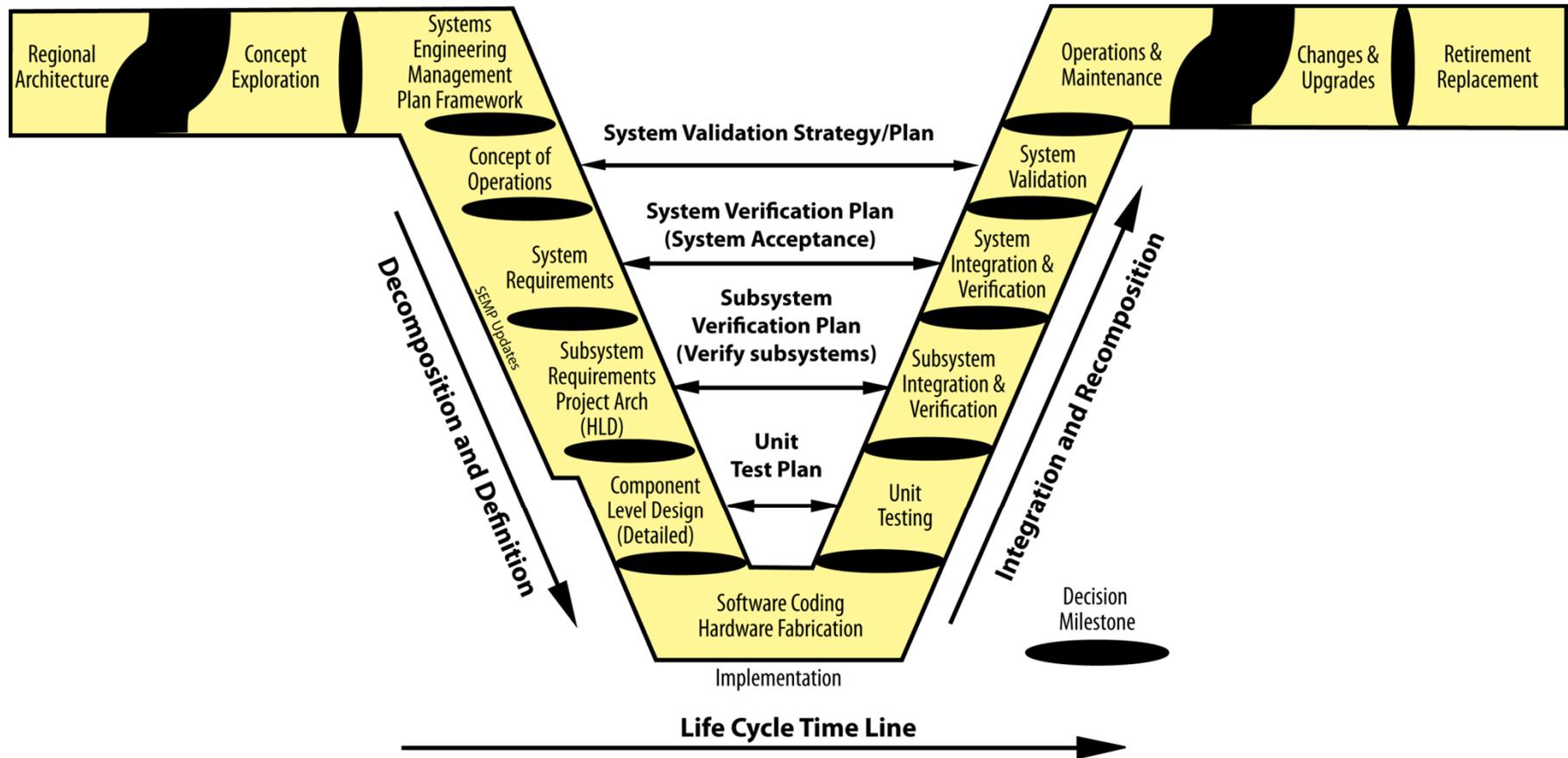
Connecting Left and Right Sides

- Vee symmetry reflects the relationship between the steps on the left and right

- Definition generated on the left is ultimately used to verify the system on the right

  - e.g., user needs and performance measures in ConOps are the basis for System Validation Plan

Detailed "Vee" Diagram with Relationship to Project Life Cycle
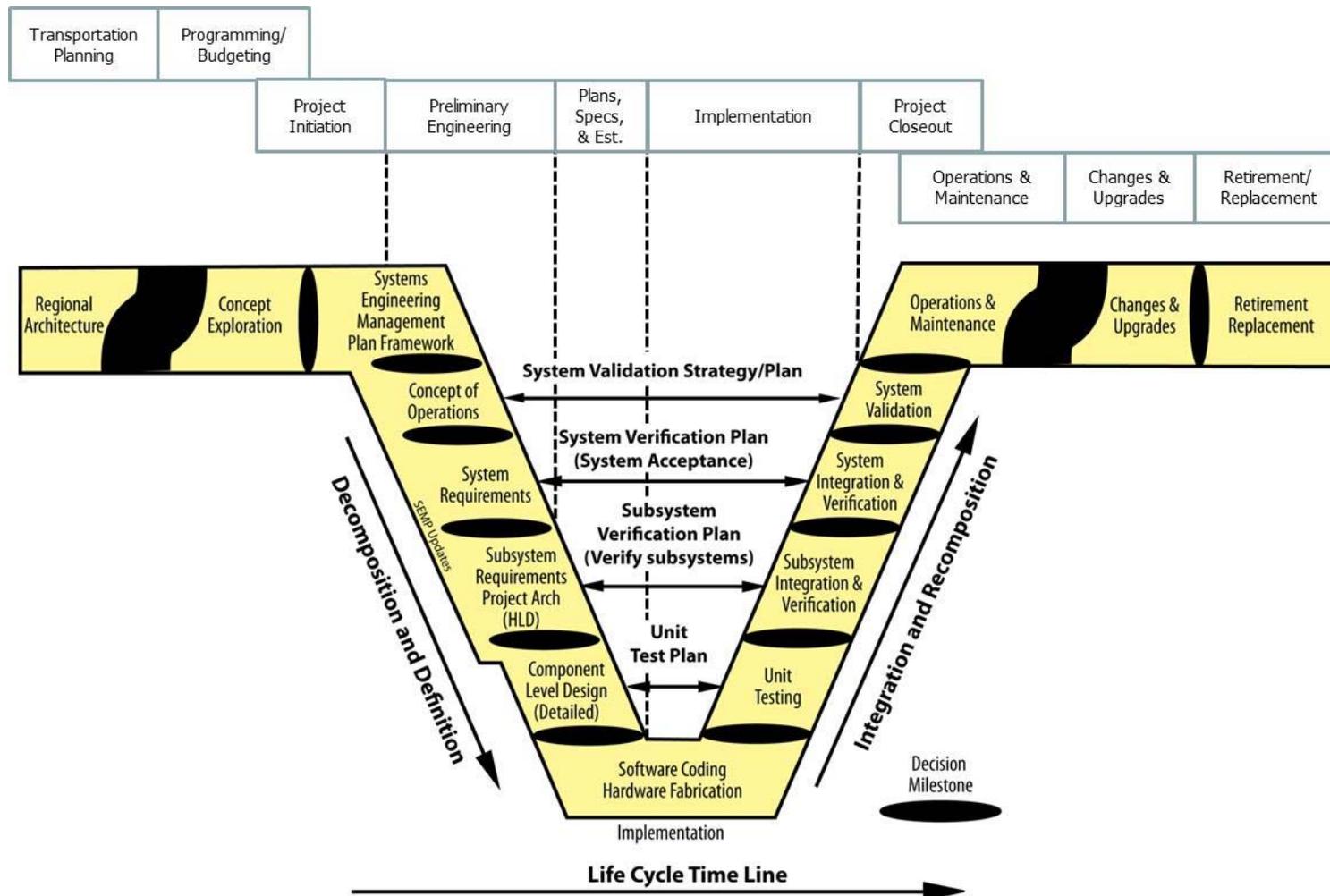
SEP Decision Points

- Project reviews:

  - Provide structured and organized approach to reviewing project products to determine if fit for intended use

  - Are a primary method of communicating progress, monitoring risk, and transferring products and knowledge

  - Often occur at completion of "Vee" process step

  - Represent decision points that must be passed successfully before moving on to next step

- In addition to formal decision-point reviews, many less formal reviews may be conducted

Benefits of SEP

- Improve quality of products created by the project

- Reduce the risk of schedule and cost overruns

- Increase the likelihood that user needs will be met

- Improve stakeholder participation

- Provide better documentation

- Reduce operational costs

Regional ITS Architecture

- First step in the SEP, occurring before project initiation

- Regional ITS Architecture is defined as:
  - "A regional framework for ensuring institutional agreement and technical integration for the implementation of ITS projects in a particular region" [1]

- Regional ITS Architecture is a plan for deployment of ITS in the region
  - Used to support transportation planning and
  - ITS project development
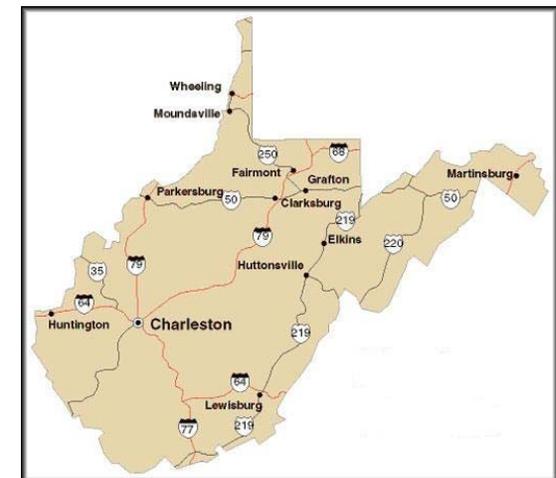
[1] FTA Policy on Architecture and Standards, 2001

National ITS Architecture

- Provides a common framework for planning, defining, and integrating ITS.
- The architecture defines:
  - The functions that are required for ITS
  - The physical entities or subsystems where these functions reside
  - The information flows that connect these physical subsystems

View at http://www.iteris.com/itsarch/index.htm
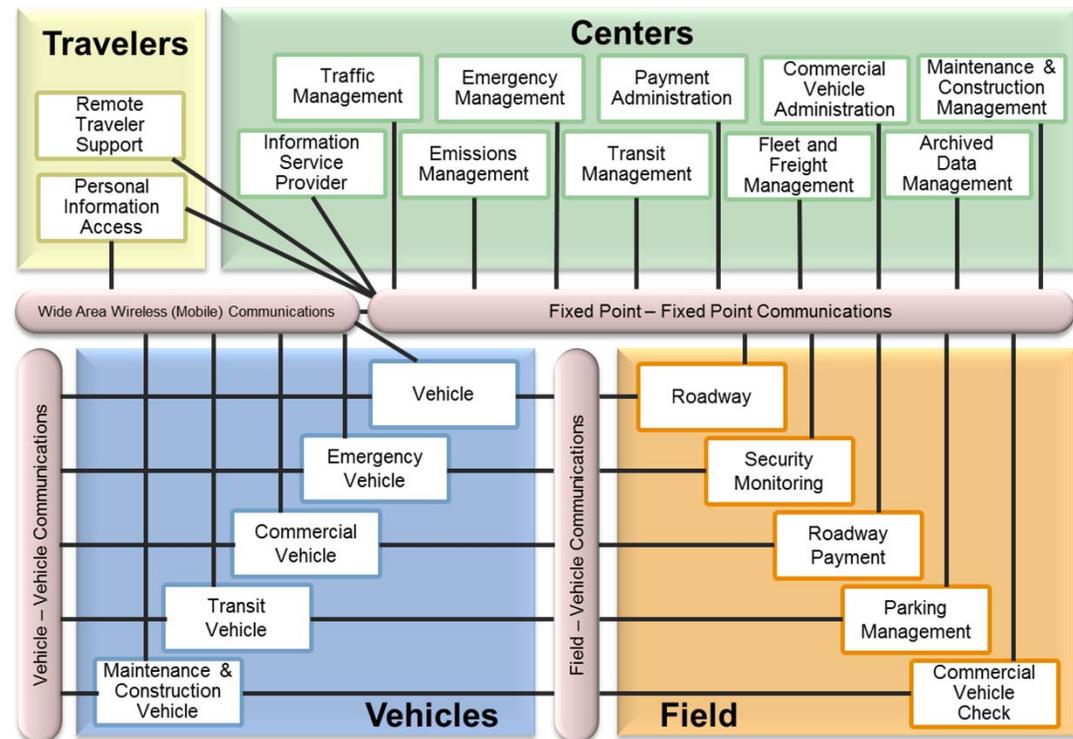
How Standards Fit into SEP

- Standards to be used are defined as part of High Level Design (HLD)

- Key output of HLD is definition of Interfaces- where standards are used

- During Detailed Design the use of standards is fully defined via tailoring of the standards
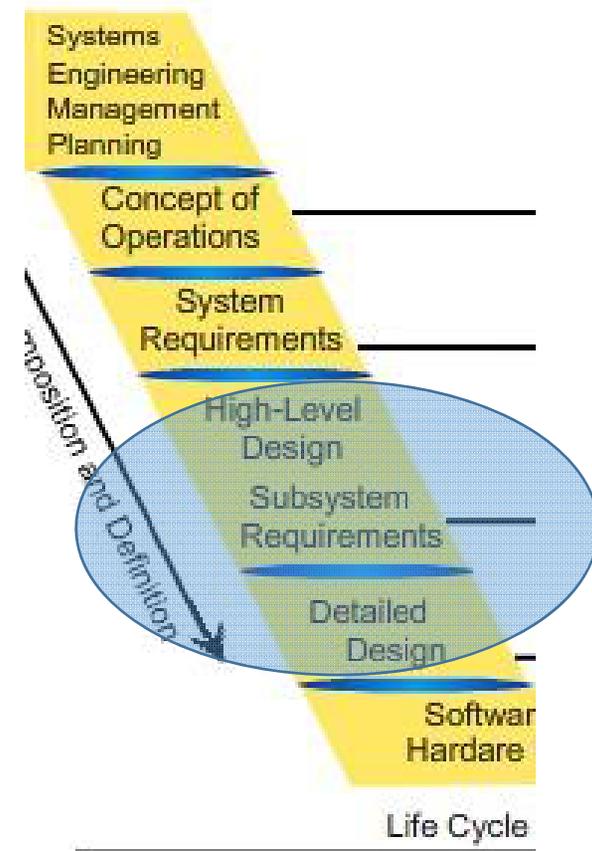
ACTIVITY

U.S. Department of Transportation
Office of the Assistant Secretary for
Research and Technology

What is the relationship between the steps on the left of the Vee and the right?

Answer Choices

○ A) No relationship between left and right

⦿ B) System definition on left used to verify system on right

○ C) Items on the left are performed after items on right

Correct - Clic Your answer:
pr The cor You must answer the question
before continuing

You did not answer this
question completely

Submit   Clear

U.S. Department of Transportation
Office of the Assistant Secretary for
Research and Technology

STANDARDS
ITS
TRAINING

Review of Answers

a) No relationship between left and right

Incorrect. There is a relationship between items on the left and items on the right.

b) System definition on left used to verify system on right

Correct! Definition generated on the left is ultimately used to verify the system on the right. See Slide 33.

c) Items on left performed after items on right

Incorrect. Items on the left are performed first and used to verify items on the right.

ITS Standards are typically first used in what step in the SE Process?

Answer Choices

○ A) Concept of Operations

○ B) Requirements

● C) Design – High level and Detailed

○ D) HW and SW development

Correct - Click press ControlY

The correct answer is:

You must answer the question before continuing

Submit   Clear

Review of Answers

a) Concept of Operations

   Incorrect. Defines user needs.

b) System Requirements

   Incorrect. Defines functional, performance, and other requirements (may be able to pull requirements from standards).

c) Design- High Level and Detailed

   Correct! Standards are identified in High Level Design and specified in Detailed Design.

d) HW and SW development

   Incorrect. Implemented based on the standards defined.

Summary of Learning Objective #2

Introduce the Use of the Systems Engineering Process (SEP) and Articulate Benefits of SEP in ITS Transit Projects

- SEP for Transportation Projects—the Vee Diagram
  - Project Planning and Concept of Operations
  - System Requirements
  - System Definition and Design
  - System Development and Implementation
  - Integration, Testing, and Validation
- Using SEP can reduce the risks and improve the quality of ITS projects
- Regional ITS Architectures provide a plan for regional deployment of ITS
- Standards are defined in the Design steps of SEP (High Level Design and Detailed Design)

Learning Objective #3: Define High Level Technical and Institutional Challenges

- Technical Challenges

- Institutional Challenges

Technical Challenges

- Inconsistent industry support for standards (some vendors don't support standards)

- What to do when standards are piecemeal and only partially developed

  - EXISTING GAPS—not all potential standards defined

  - There are some key areas that do not have mature standards

- Paradigm shift from non-standards based to standards based

- Paradigm shift from non-SEP-based to SEP-based

Technical Challenges – Industry Support

- Inconsistent industry support for standards

  - Many transit vendors provide custom solutions

  - They don't support standards

- Ownership of data is sometimes an issue

  - So the data can be shared as part of regional integration (key benefit of standards)

Technical Challenges – Gaps

- Gaps in standards coverage exist in some interfaces that have been standardized

  - Some only partially developed

  - Some standards that do exist are not yet mature

- Not many deployments have used the standard

  - Actual deployments uncover and resolve bugs or issues resulting in a mature standard

Technical Challenges – Paradigm Shifts

- From non-standards based to standards based

  - In past decade extensive progress made toward development of Transit ITS Standards

    - Options now exist for standards based procurements

- From non-SEP-based to SEP-based

  - FTA pushing SEP-based deployment

    - Part of FTA Policy on Architecture and Standards

    - Use of standards is a key aspect of SEP

- Paradigm shifts can meet with resistance—not business as usual

Institutional Challenges

- Resistance to change

- Gaps in existing skills

- Training (having the skills to use the standard)

Institutional Challenges – Resistance to Change

- Agency leadership has comfort with "business as usual"

- May be bigger issue if agency is not aggressive in applying technology since ITS deployments are technology based

- To overcome this resistance, the case for change must be strong

  - SEP can actually help this by defining user needs and scenarios based on standards that can meet the needs

Institutional Challenges – Gaps in Skills/Training

- Standards knowledge gaps make use of standards more difficult

- Systems Engineering knowledge gaps also make its use difficult

- Training for agency staff is important to address the gaps

- The set of ITS Transit Standards Modules are a valuable training resource
  - What standards to consider
  - How to tailor these standards

- Alternative is contracting for skills

ACTIVITY

U.S. Department of Transportation
Office of the Assistant Secretary for
Research and Technology

Agencies have found which of the following to be a technical challenge of using ITS Standards?

Answer Choices

- ○ A) Inconsistent industry support
- ○ B) Needed standards are not mature
- ○ C) Using standards is a paradigm shift for agency
- ● D) All of the above

Your answer:

The correct answer is:

You must answer the question before continuing

anywhere or continue

Submit   Clear

U.S. Department of Transportation
Office of the Assistant Secretary for
Research and Technology

Review of Answers

a) Inconsistent industry support

Incorrect. Specifying standards may incur pushback from vendors who do not support them.

b) Needed standards are not mature

Incorrect. May have some gaps in coverage.

c) Using standards is a paradigm shift for agency

Incorrect. Technical skills are needed to properly specify standards in procurements.

d) All of the above

Correct! Each of the above are potential technical challenges to using standards.

Summary of Learning Objective #3

Define High Level Technical and Institutional Challenges

- Technical Challenges

    - Some transit standards are not mature and some key industry vendors don't support those that are mature

- Institutional Challenges

    - Gaps in agency skills can make it harder to implement standards

    - This can be overcome with training, which is the goal of these ITS Transit Standards modules

U.S. Department of Transportation
Office of the Assistant Secretary for
Research and Technology

Learning Objective #4: Identify the Role of ITS Standards in Transit ITS Applications

- Standards applicability
  - What are specific ITS applications for which standards can be applied?
  - What are some of the key standards that address these applications?
- Procurement link
  - How to specify an ITS standard in a procurement
- Other Issues to consider
  - Addressing changing technologies
  - Interfacing with legacy systems
- What transit agency staff will need to know to implement standards

What are Specific ITS Applications for which Standards can be Applied

- ITS Standards can be used to address a wide array of ITS Applications for transit:

  - Automated Vehicle Location (AVL)

  - Computer Aided Dispatch (CAD)

  - Automatic Passenger Counters (APCs)

  - Scheduling Software and Systems

  - Traveler Information and Trip Planning

  - Transit Signal Priority (TSP)

  - Electronic Fare Payment

How do the Standards Apply to the Applications?

- The later modules in this series will discuss the general areas of transit where these ITS applications are employed such as:

  - Transit Management

  - Traveler Information

  - Electronic Fare Payment

- In each module the ITS standards relevant to the area will be addressed

How do the Standards Apply to the Applications? (cont.)

- Some of the key standards that will be discussed include

  - Transit Communications Interface Profiles (TCIP)

  - SAE Data Bus Standards

  - TransXChange

  - Service Interface for Real Time Information (SIRI)

  - National Transportation Communications for ITS Protocol (NTCIP) 1211

  - Contactless Fare Media System (CFMS) Standard

Procurement Link to Standards

- To include an ITS standard in a project it must be included in the procurement package

- How to specify an ITS standard in a procurement?

  - Cannot just put in a procurement—"comply with standard xyz"

  - Must tailor or customize the standard to cover just those aspects needed by the specific deployment

- Customizing standards for individual procurements will be a recurring topic in many of the modules in this series

Addressing Changing Technologies

- But doesn't technology change quickly?

    - Changing technologies often offer different ways to provide similar system functionality

    - Properly standardized Interfaces will work well no matter the underlying technology that creates the functionality.

    - Standards reduce your vulnerability to technology changes

Interfacing with Legacy Systems

- Interfacing with legacy systems

    - Deployments don't get to start with a "clean slate"

    - They build upon existing systems

- How to handle this when specifying ITS standards?

    - Consider all the interfaces in the project

        - If new, is it covered by a standard?

        - If legacy, does it need to be revised for project?

    - Use standards where possible, keep legacy definitions as needed

What Transit Agency Staff will Need to Know to Implement Standards

- Which standards to consider

- How to specify standards as part of procurement

- How to test standards when deployed

Summary of Learning Objective #4

- ITS standards apply to many of the common transit applications including CAD, AVL, and Electronic Payment Systems

- To deploy projects using ITS standards, consideration must begin in the procurement package

- Agencies need to decide:

  - which standards;

  - how they will be tailored; and

  - how they will be tested

# Learning Objective #5: Describe Roadmap for Transit Standards Modules

- Roadmaps for the following
  - Transit Decision Maker
  - Transit Project Managers
 - Transit Project Engineering Staff

Roadmap for Transit Decision-makers
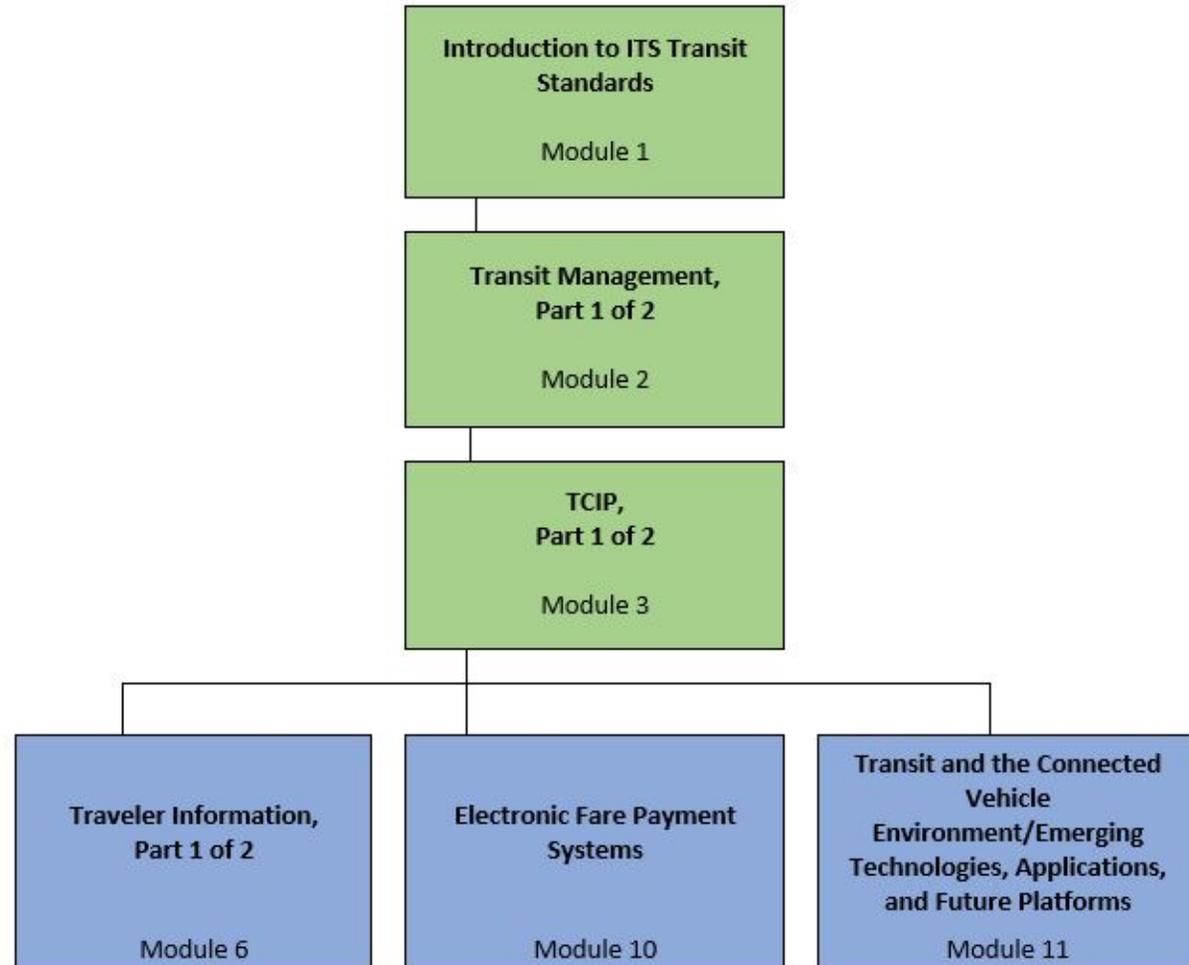
Roadmap for Transit Project Managers
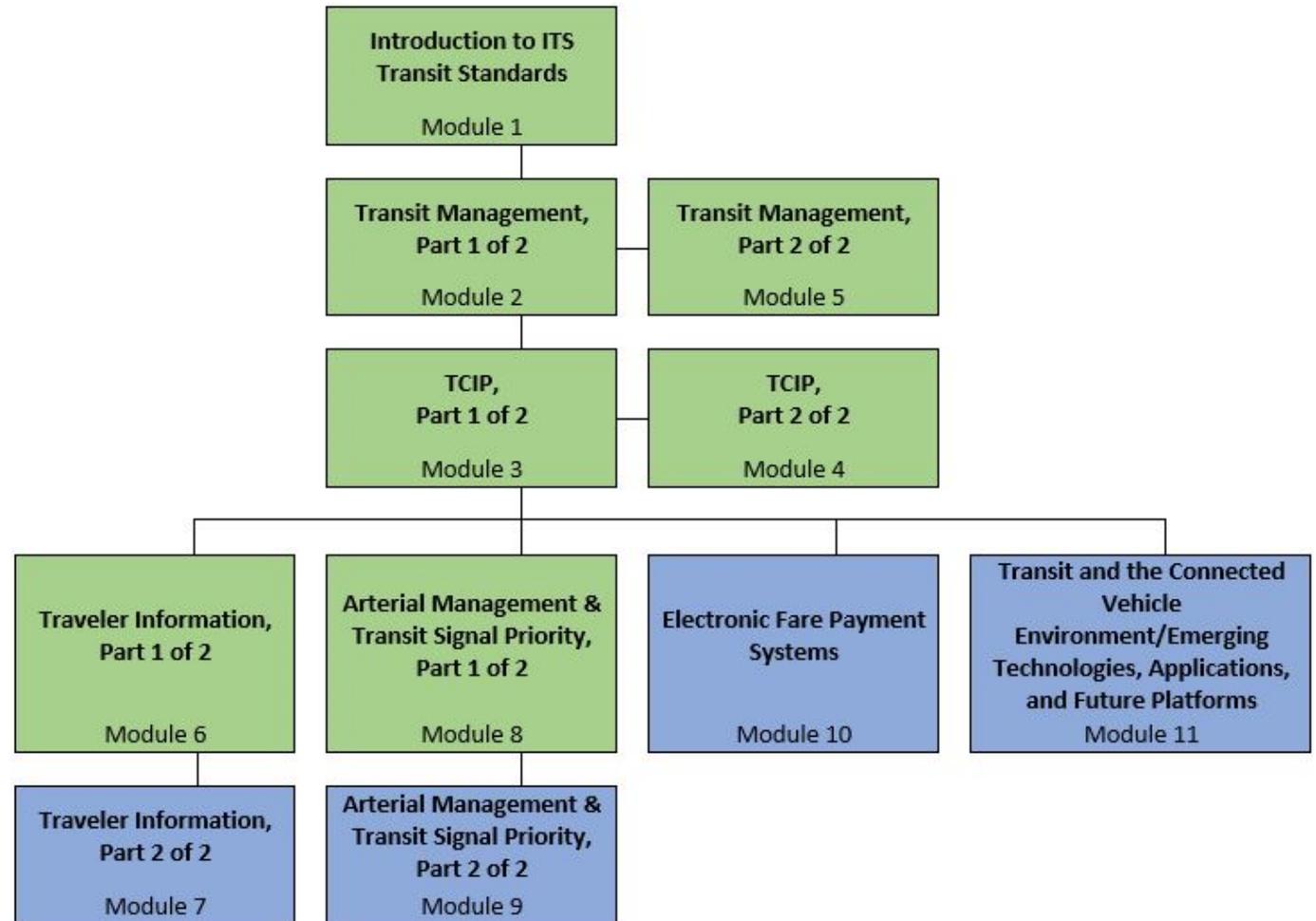
Roadmap for Project Engineering Staff
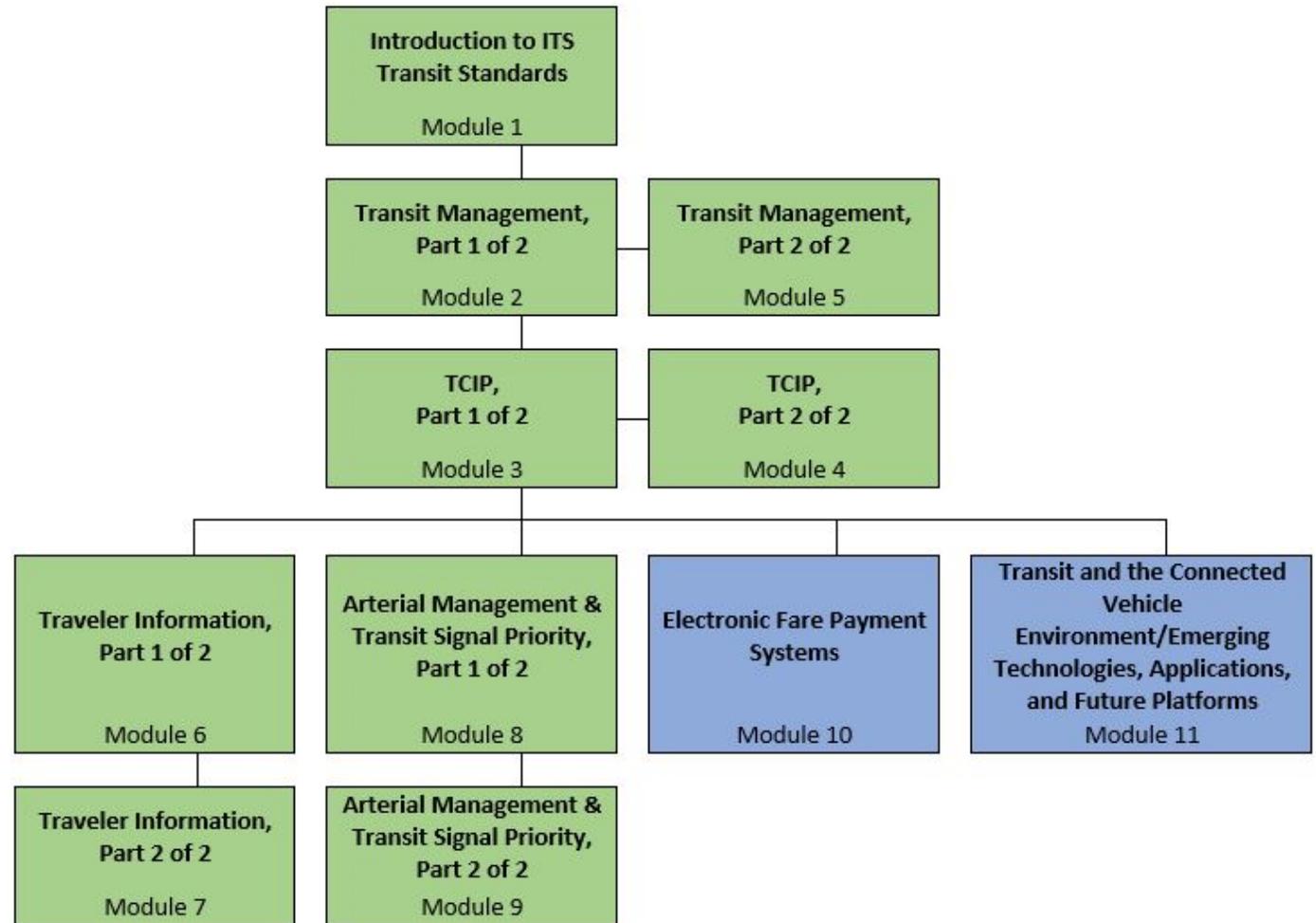
Summary of Learning Objective #5

Describe Roadmap for Transit Standards Modules

- Recommended for <u>all</u> groups of students

  - □ Module 2: Transit Management Part 1

  - □ Module 3: TCIP Part 1

- Remaining modules are optional depending on the types of person's role in the organization and the type of deployments being considered

U.S. Department of Transportation
Office of the Assistant Secretary for
Research and Technology

What We Have Learned

1) ITS Standards define how ITS systems, products, and components can interconnect, <u>exchange information</u>, and interact to deliver services within a transportation network.

2) ITS Standards can facilitate Regional <u>interoperability</u>.

3) Standards can be used as part of the <u>Systems Engineering</u> Process.

4) There are challenges to using ITS Transit standards that are both:

   a) <u>Technical</u> and

   b) <u>Institutional</u>

5) ITS Transit standards can be used to support a wide array of transit <u>applications</u>, including AVL, CAD, traveler information, TSP, and Electronic Fare Payment.

Resources

- ITS Standards Program:

  http://www.standards.its.dot.gov

- SEP FHWA Guidance:

  http://ops.fhwa.dot.gov/int_its_deployment/sys_eng.htm

- Regional ITS Architecture:

  http://ops.fhwa.dot.gov/its_arch_imp/index.htm

- ITS ePrimer Module 7: Public Transportation:
  http://www.pcb.its.dot.gov/eprimer/module7.aspx#opsmgmt

- ITS ePrimer Module 2: Systems Engineering

  http://www.pcb.its.dot.gov/eprimer/module2.aspx#opsmgmt

- FTA Transit Intelligent Transportation System Architecture Consistency Review – 2010 Update

  http://www.fta.dot.gov/documents/2010TransitITSArchRvw_-_08.29.2011.pdf

Next Course Module

Module 2: Transit Management Standards,
Part 1 of 2

- Module 2 covers technologies and systems that facilitate and automate operations, planning, management, safety, security and data management functions of public transit systems.

Thank you for completing this module.

Feedback

Please use the Feedback link below to provide us with your thoughts and comments about the value of the training

Thank you.