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U.S. Department of Transportation

Office of the Assistant Secretary for
Research and Technology

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ITS Transit Standards
Professional Capacity Building Program

Module 7:
Traveler Information Standards, Part 2 of 2

Instructor

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Target Audience

- Transit agency technical staff from the planning, customer information, and information technology areas/departments
- Regional (multi-modal) Traveler Information System technical manager (at transit, State Department of Transportation, Metropolitan Planning Organization, etc.)
- Technology vendors and consultants
- Application developer community
- Transit or transportation agency procurement and grants staff (optional)

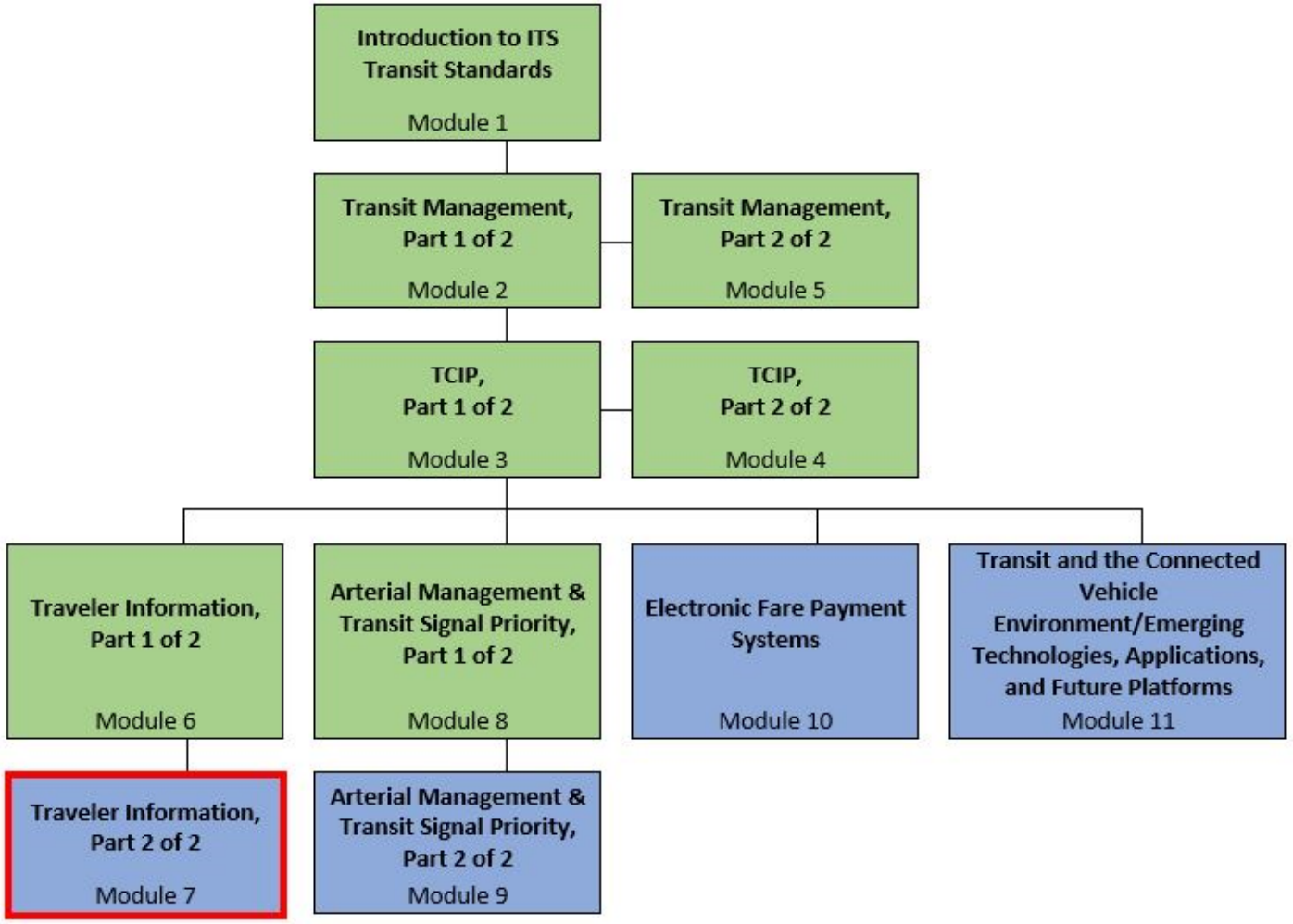
Recommended Prerequisite(s)

	Decision-Maker	Project Manager	Project Engineer
Module 1: Introduction to ITS Transit Standards	N/A	✔	✔
Module 2: Transit Management Standards, Part 1 of 2	N/A	✔	✔
Module 3: Transit Communications Interface Profiles (TCIP), Part 1 of 2	N/A	✔	✔
Module 4: Transit Communications Interface Profiles (TCIP), Part 2 of 2	N/A	✔	✔
Module 5: Transit Management Standards, Part 2 of 2	N/A	✔	✔
Module 6: Traveler Information, Part 1 of 2	N/A	✔	✔

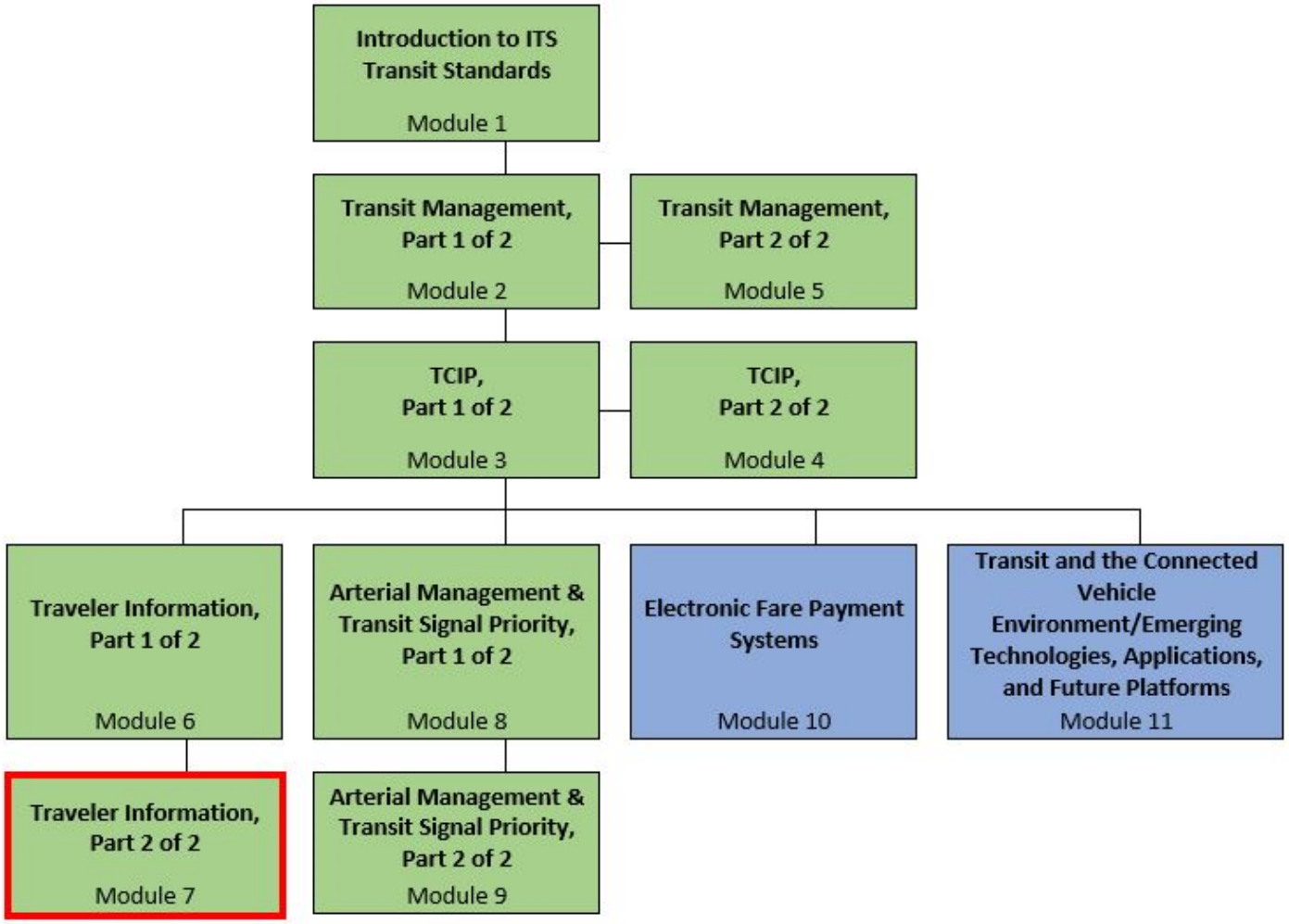
Recommended Prior Knowledge

- Basic understanding of transit-related portions of the National ITS Architecture
- Detailed understanding of how traveler information is generated and disseminated
- Detailed understanding of the technology that is used in providing traveler information
- Basic knowledge of systems engineering, which can be obtained from NTI's course entitled *Systems Engineering for Transit ITS Projects*

Curriculum Path (Project Manager)



Curriculum Path (Project Engineer)



Learning Objectives

1. Summarize key concepts from Module 6: Traveler Information Standards, Part 1 of 2
2. Illustrate the structure and use of data exchange standards for traveler information systems
3. Select appropriate ITS standards for data exchange among traveler information systems, and between transit management systems and traveler information, and other systems (e.g., traffic management systems)
4. Illustrate how to apply standards to the development of procurement specifications

Learning Objective #1: Summarize Key Concepts from Traveler Information Standards, Part 1 of 2

- Traveler information taxonomy and technologies
- Relationships and information exchanges between transit management and traveler information technologies
- Using systems engineering (SE)
- National ITS Architecture service packages related to traveler information

Traveler Information Taxonomy

- Pre-trip systems provide information before taking a trip:
  - Proactive information provided regardless of user needs
  - Interactive information provided based on user needs upon request
- On-board systems provide static and real-time information
- Wayside systems provide static and real-time information at stops/ stations
- Third-party applications and social media:
  - Third-party applications use either open data or internal transit operations data
  - Social media is a way to disseminate mostly real-time traveler information

Traveler Information

Category	System/Technology	Dependent on
Traveler Information	On-board automated voice announcements (AVA)	• AVL system • Route and vehicle schedule data
	En route/wayside traveler information, including real-time arrival/departure information in a variety of dissemination media	• Route and vehicle schedule data • AVL system • CAD system • Data communications technologies
	On-board Internet access for passengers	Data communications technologies
	511, 311, and 211 systems, and Google Transit	Open data
	Third-party smartphone applications	Open data

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On-board automated voice announcements (AVA) are dependent upon which of these?

Answer Choices

a) Automatic vehicle location (AVL) system

b) Automatic passenger counting (APC) system

c) Route and vehicle schedule data

d) All of the above

e) A and C

Review of Answers

a) AVL System

It is one of technologies on which an AVA system is dependent.

b) APC System

APC systems are not used in on-board automated voice announcements (AVA). APCs are used to count boarding and alighting passengers.

c) Route and vehicle schedule data

It is one of technologies on which an AVA system is dependent.

d) All of the above

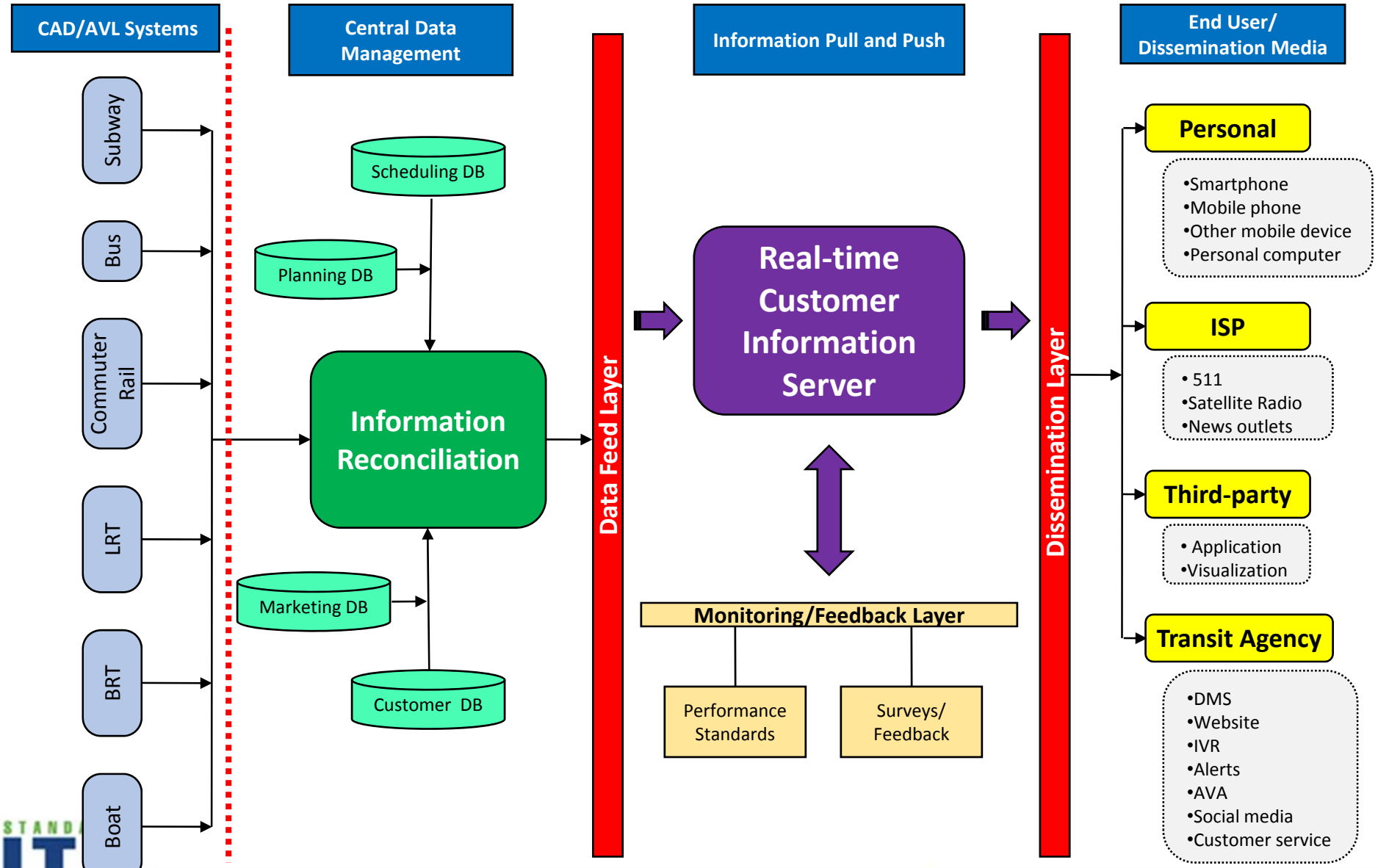
An AVA system is dependent on A and C only.

e) A and C

Correct! On-board automated voice announcements (AVA) are dependent upon an AVL system, and route and vehicle schedule data.

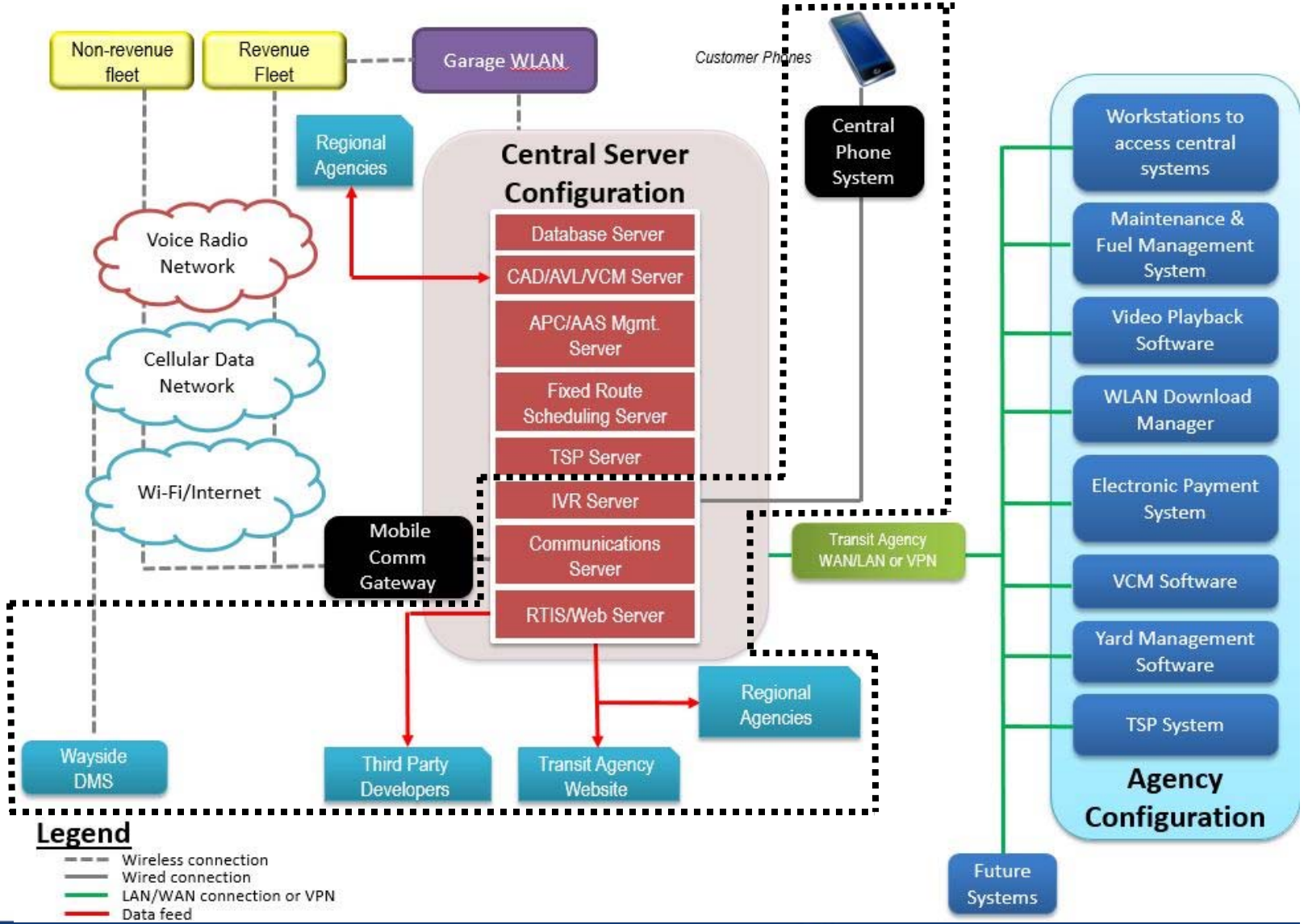
Traveler Information Data Exchanges

Learning Objective #1



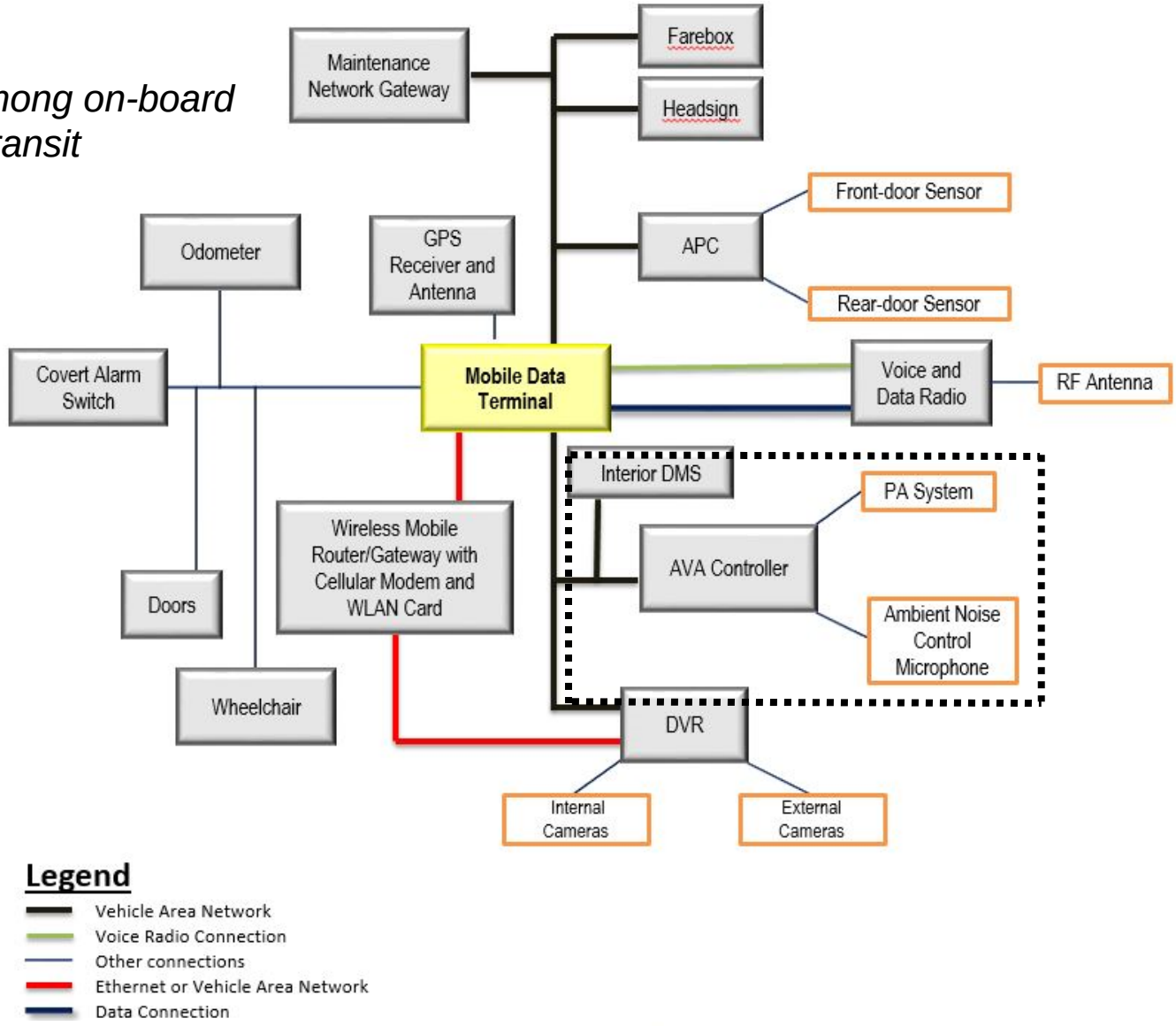
Example of Central System Technology Relationships

Main Point: *Shows the relationships among central Traveler Information and other transit ITS technologies*



Example of Onboard Technology Relationships

Main Point:
Shows the relationships among on-board Traveler Information and Transit Management technologies.

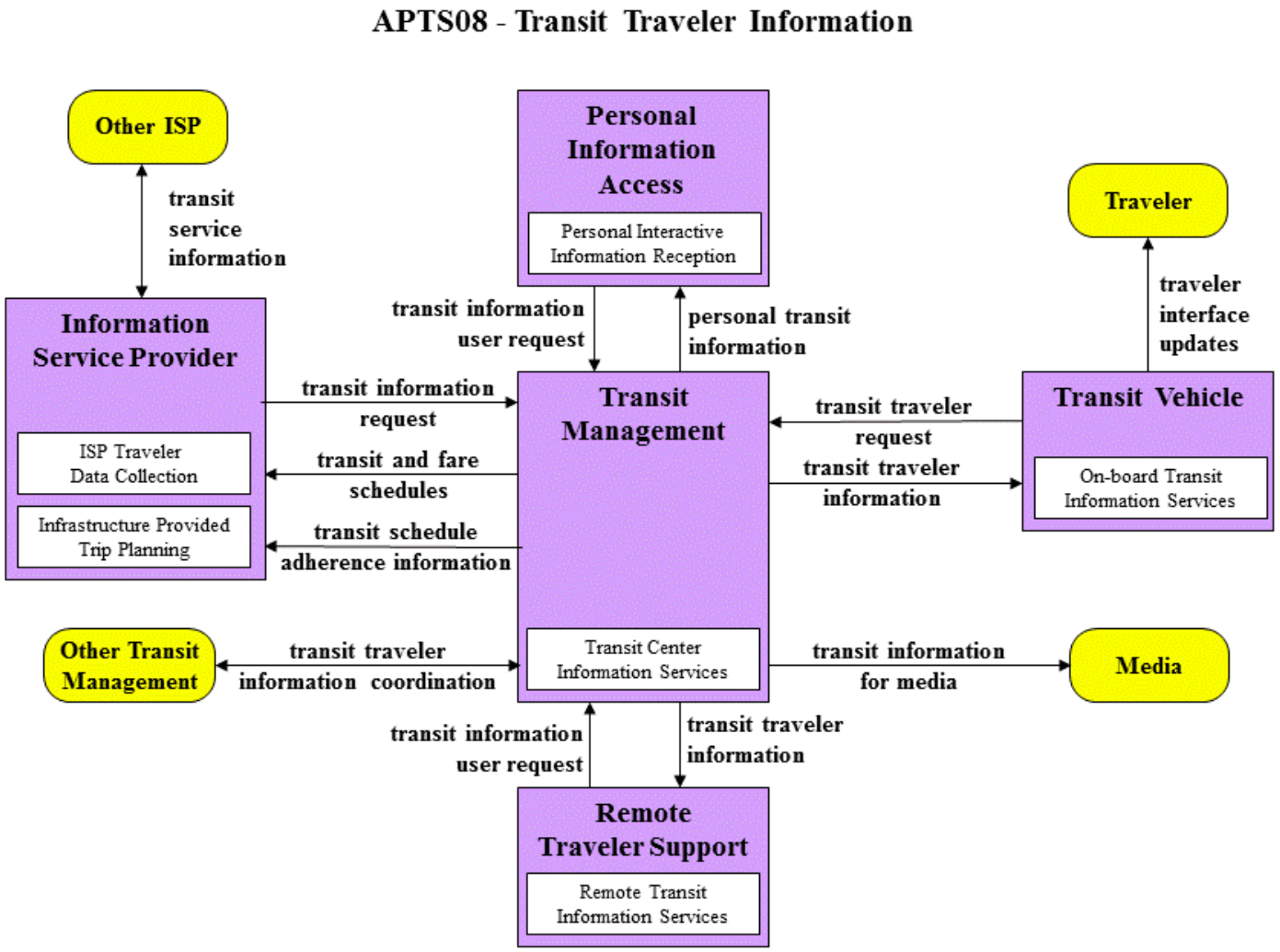


Service Packages (SPs)

- Represent slices of physical architecture
- Collects subsystems, equipment packages, and architecture flows that provide desired service
- There are 12 traveler information-related SPs
- The most relevant SP to this module is Transit Traveler Information

Transit Traveler Information Service Package Example

Main Point: *An example of one traveler information SP diagram.*



Summary of Learning Objective #1

Summarize Key Concepts from Traveler Information Standards, Part 1 of 2

- All traveler information technologies are dependent upon other technologies
- "Vee" model is the systems engineering process (SEP) that facilitates system development and deployment, including the identification and incorporation of ITS standards
- 12 Traveler Information Service Packages (SPs)

Learning Objective #2: Illustrate the Structure and Use of Data Exchange Standards for Traveler Information Systems

- How to meet user needs by using standards
- Structure of standards in addition to Transit Communications Interface Profiles (TCIP)
  - For example, General Transit Feed Specification (GTFS) and TransXChange

Standards Facilitate Meeting User Needs

- User need:
  - Requirement for system to solve problem experienced by user
  - Part of the systems engineering process (SEP)
  - FTA National ITS Architecture Policy includes identification of applicable ITS standards
  - May be satisfied by applying or adhering to standards
- Standards being applied to meet user needs:
  - Users may avoid costly customization
  - Data exchanges facilitated among applications and entities
  - Can choose most suitable and cost-effective applications, knowing they use common standards

Standards Facilitate Meeting User Needs (cont.)

- Benefits from using standards:
  - Reducing complexity and cost in procurement, development, and management
  - Ensuring wider choice of suppliers
  - Enhancing economic performance of systems due to certain types of standards

Standards Facilitate Meeting User Needs: Example

- Transit agency provides real-time data to developers for creation of mobile applications
- Data provided in standards-defined format to make it easier for developers to create application
- Automatic vehicle location (AVL) system required to generate information in General Transit Feed Specification (GTFS)-realtime format (considered de facto standard)
- AVL data could be provided in any format to meet user need, but greatly facilitated by use of GTFS-realtime format/standard

Standards Facilitate Meeting User Needs: Value

- Protection of investment:
  - Modularization and incremental deployment
  - Choice of suppliers
  - Reuse

Standards Facilitate Meeting User Needs: Value (cont.)

- Interoperability:
  - Roadmap for evolution
  - Data management

Standards Facilitate Meeting User Needs: Value (concluded)

- Improved quality and value:
  - Risk reduction
  - Better abstraction
  - Better testing
  - Process and tool support
  - Modularization
  - Reuse

Standards Facilitate Meeting User Needs: Criteria for Evaluating a Standard

- Technical:
  - How well it represents a problem
  - What technologies does it use
- Organizational:
  - How mature it is
  - If it is actively supported and adopted by industry
  - How long it will last

Standards Facilitate Meeting User Needs: Starting Point for Identifying Standards

- National ITS Architecture divided into interface classes
- Interface classes:
  - Defined by type of system at each end of communications path: center, field (a.k.a. infrastructure), vehicle, and traveler
  - Subdivided into application areas
  - Public transit management interface classes (all bi-directional) are:
    - Center-to-infrastructure (C2I)
    - Center-to-vehicle/traveler (C2V)
    - Center-to-center (C2C)
- Example: Application area within C2I includes bi-directional communication between transit dispatch center and dynamic message signs at transit stop

Center-to-Infrastructure (C2I) Application Area Capabilities Related to Transit

- Covers interface between transit management center and specific type of infrastructure: transit signal priority (TSP) and dynamic message signs (DMS)
- DMS:
  - Provides information to travelers
  - May use various technologies capable of displaying messages using any combination of characters
- TSP:
  - Provides intersection control through local traffic signal controller
  - Provides interface between traffic management center and on-street master controller
  - Based on analysis of transit vehicle's conditions (e.g., schedule adherence) and traffic characteristics for a given time and type of day
  - Center invokes appropriate pre-configured traffic signal control system timing plan

Center-to-Vehicle/Traveler (C2V) Application Area Capabilities Related to Transit: Vehicle

Covers interface between transit management center and transit or paratransit vehicles

- Collecting automated vehicle location information
- Collecting operational and maintenance data
- Providing transit vehicle driver with electronic dispatch and routing instructions
- Providing traveler information to vehicle
- Providing schedule information used to develop corrective actions on-board
- Providing fare management information, including invalid traveler credit identities, to transit vehicles
- Supporting transit vehicle operator authentication and ability to remotely disable vehicle in emergency situations

Center-to-Vehicle/Traveler (C2V) Application Area Capabilities Related to Transit: Traveler

Covers interfaces between traveler information providers and devices used by traveling public

- General traveler information, including traffic information, transit information (fares, real-time schedules, and transactions), incident information, event information, and parking information
- Emergency traveler information, including alerts and advisories, and evacuation information
- Traveler services information (e.g., dining, lodging, etc.)
- Trip planning, using various modes of surface transportation and route options
- Route guidance

Center-to-Center (C2C) Application Area Capabilities Related to Transit

- Multimodal coordination between transit agencies and other public transportation modes
- Transit incident information, schedules, and fare and pricing information
- Transit information suitable for media use
- Emergency transit schedule information to other operations centers
- Transit system information to traffic management centers
- Personalized transit routes requested by travelers
- Financial institution approval and status of electronic fare payments
- Law enforcement regarding the notification of violations

Identifying Appropriate Standards

- Application Areas provide a starting point for identifying appropriate ITS standards
- Use USDOT's ITS Standards website
- Example: Transit Traveler Information, which is in the C2C Interface Class

Applicable Standards

In general, the following standards are applicable to Traveler Information deployments. To determine which specific standards are applicable for a deployment you will need to determine which architecture flows will be needed for the Traveler Information piece of your deployment. Contact your local FHWA ITS Division Specialist or an ITS Standards Program Field Support Team contact

Standard	Development Status
NTCIP 1102 Octet Encoding Rules (OER) Base Protocol;	Published
NTCIP 1104 Center-to-Center Naming Convention Specification;	Published
NTCIP 2104 Ethernet Subnetwork Profile;	Published
NTCIP 2202 Internet (TCP/IP and UDP/IP) Transport Profile;	Published
NTCIP 2303 File Transfer Protocol (FTP) Application Profile;	Published
NTCIP 2304 Application Profile for DATEX-ASN (AP-DATEX);	Published
NTCIP 2306 Application Profile for XML Message Encoding and Transport in ITS Center-to-Center Communications (C2C XML);	Published
NTCIP 8003 Profile Framework;	Published
NTCIP 9001 NTCIP Guide;	Published
SAE J2266 Location Referencing Message Specification (LRMS);	Published
SAE J2354 Message Set for Advanced Traveler Information System (ATIS);	Published
SAE J2540 Messages for Handling Strings and Look-Up Tables in ATIS Standards;	Published
SAE J2540/1 RDS (Radio Data System) Phrase Lists;	Published
SAE J2540/2 ITIS (International Traveler Information Systems) Phrase Lists;	Published
SAE J2540/3 National Names Phrase List;	Published

Structure of Standards: GTFS

- General Transit Feed Specification (GTFS):
  - Defines common format for public transportation schedules and associated geographic information
  - "Feeds" allow public transit agencies to publish their transit data and developers to write applications that consume that data in an interoperable way
- Structure: Comma-delimited text files
  - Six mandatory files: agency information, stops, routes, trips, stops times, and calendar
  - Seven optional files: calendar dates, fare attributes, fare rules, shapes, frequencies, transfers and feed info
- Considered "de facto" standard
- Adoption substantially outpaced TCIP and Service Interface for Real Time Information (SIRI) standards in North America

Structure of Standards: GTFS-realtime

- Feed specification that provides real-time updates about public transit fleet to application developers
- Developed by Google as extension to GTFS and designed around:
  - Ease of implementation
  - GTFS interoperability
  - Focus on passenger information
- Currently supports the following types of information:
  - Trip updates - delays, cancellations, changed routes
  - Service alerts - stop moved, unforeseen events affecting a station, route, or entire network
  - Vehicle positions - information about vehicles including location and congestion level
- Updates of each type provided in separate feed. Feeds served via HTTP and updated frequently
- Format based on protocol buffers

Structure of Standards: SIRI

- CEN/TS 15531-1: Public Transport - Part 1: Context and framework
- CEN/TS 15531-2: Public Transport - Part 2: Communications infrastructure
- CEN/TS 15531-3: Public Transport - Part 3: Functional service interfaces
- CEN/TS 15531-4: Public Transport - Part 4: Functional service interfaces: Facility Monitoring
- CEN/TS 15531-5: Public Transport - Part 5: Functional service interfaces: Situation Exchange

Structure of Standards: SIRI (cont.)

- Uses eXtensible Markup Language (XML) – two layers:
  - Transport (how the data is transported)
  - Payload (the domain data exchanged), wrapped in Mediation layer, which:
    - Provides common management functions
    - Describes policies associated with exchange behavior
- SIRI messages exchanged as either:
  - XML documents with http POST
  - Simple Object Access Protocol (SOAP)

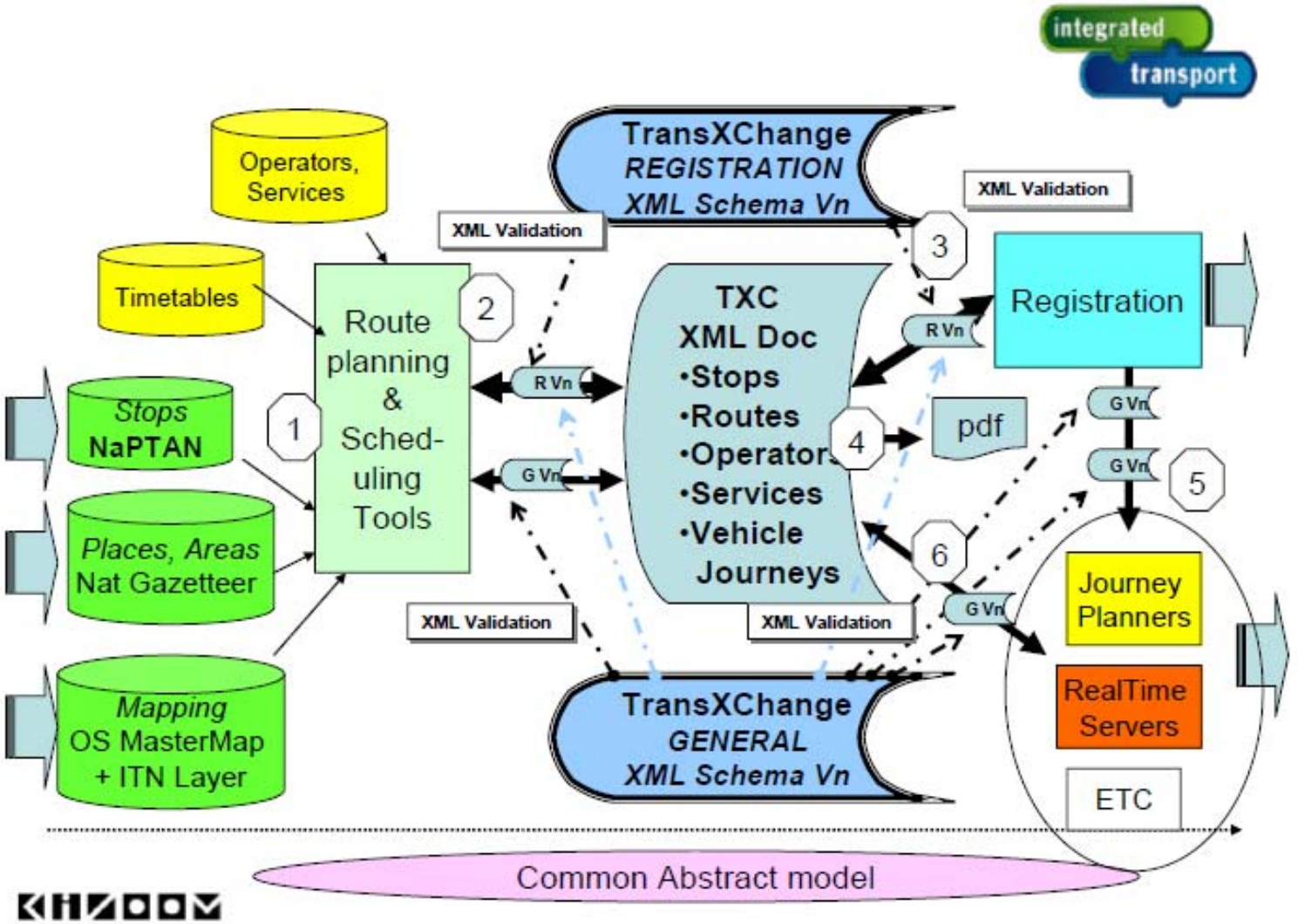
Structure of Standards: SIRI (concluded)

- Uses consistent general communication protocols to exchange information between client and server, using following patterns:
  - Request/Response allows for ad hoc exchange of data on demand from client
  - Publish/Subscribe allows for repeated asynchronous push of notifications and data to distribute events and situations
- Websites: http://user47094.vs.easily.co.uk/siri/index.htm and https://www.vdv.de/siri.aspx

Structure of Standards: TransXChange

- Two main variants:
  - Registration schema: Defines XML document for registering bus services with VOSA
  - General schema: Defines XML document for exchanging bus timetables and related information
- Three components:
  - TransXChange Schema: Model and formal XML schema (and variants) for describing and encoding bus schedules as XML documents
  - TransXChange Documents and Process: Description and explanation of standard, including rules for creating, managing, and using TransXChange documents with software tools
  - TransXChange Publisher: Free tool issued along with TransXChange, schemas which allows users to render TransXChange XML documents into readable timetable-like layout

Overview of TransXChange Use



Structure of Standards: Other Relevant Standards/Formats

- JavaScript Object Notation (JSON)
- Protocol Buffers
- Representational state transfer (REST)
- Simple Object Access Protocol (SOAP)
- eXtensible Markup Language (XML)

- Other standards for traveler information exist in:
  - International Organization for Standardization (ISO)
  - Comité Européen de Normalisation (CEN) (French for European Committee for Standardization)
  - UK (e.g., TransXChange)

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Which one of these standards is not a traveler information standard?

Answer Choices

a) Service Interface for Real Time Information (SIRI)

b) Society of Automotive Engineers (SAE) J1939

c) TransXChange

d) GTFS

Review of Answers

a) SIRI

Incorrect. SIRI is an XML protocol for exchange of public transport real-time information.

b) SAE J1939

Correct! This is an on-board Vehicle Area Network (VAN) standard.

c) TransXChange

Incorrect. TransXChange is a UK national data standard for the exchange of bus route and timetable information.

d) GTFS

Incorrect. GTFS defines a common format for public transportation schedules and associated geographic information.

Summary of Learning Objective #2

Illustrate the Structure and Use of Data Exchange Standards for Transit Management Systems

- Three interface classes: C2C, C2I, and C2V
- Other standards are in a variety of formats:
  - GTFS and GTFS-realtime
  - SIRI
  - TransXChange
  - JavaScript Object Notation (JSON)
  - Protocol Buffers
  - Representational State Transfer (REST)
  - Simple Object Access Protocol (SOAP)
  - eXtensible Markup Language (XML)

Learning Objective #3:
Select Appropriate ITS Standards for Data Exchange Among Traveler Information Systems, and Between Transit Management Systems and Traveler Information, and Other Systems (e.g., Traffic Management Systems)

- Life-cycle cost considerations
- Case study for selection of standards
- Case study for standards use
- Using standards to facilitate integration with legacy systems

Life-Cycle Cost Considerations

- **Standards-based products should**:
  - Be available from a number of suppliers at lower cost
  - Have a longer lifetime providing specific advantages
- **Modularization and incremental deployment**:
  - Provides technical advantages
  - Allows for incremental approach to adoption, meaning users spread investment over extended period
- **Choice of suppliers** – Systems using interfaces based on standards can be implemented as discrete pluggable modules that can be chosen from wide variety of suppliers in competitive market
- **Reuse** – Significantly reduce costs of specifying, procuring, and integrating system

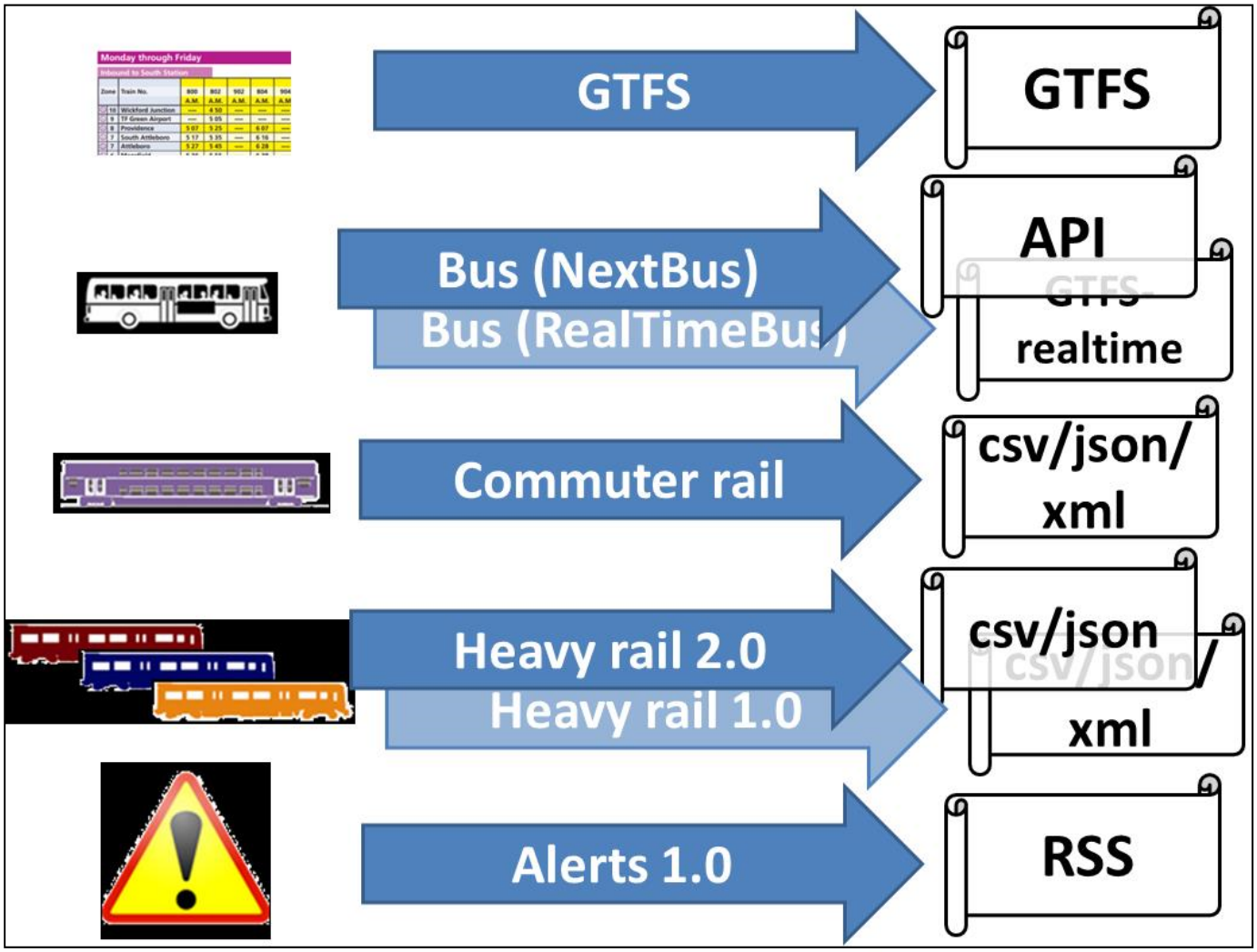
Life-Cycle Cost Considerations (cont.)

- **Development** – Standards complex and expertise needed to develop and validate
- **Availability** – Must wait for standard to be published and confirm widespread adoption
- **Maintenance** – If standard changes, there can be additional costs to users
- **Procurement** – If standard not used, costs associated with additional technical and marketplace complexity
- **Adaptation** – Standard or organization may need to be adapted to meet specific requirements
- **Certification** – When required, formal certification of compliance may add costs
- **Gold-plating** – Using standards may give organization items that it does not need

Case Study for Selection of Standards: Massachusetts Bay Transportation Authority (MBTA), Boston, MA

- MBTA: 1.3 million daily riders; 75 member cities and towns; heavy rail, light rail, commuter rail, bus, trackless trolley, ferry and paratransit
- MBTA's open data program:
  - Started in 2009
  - Added real-time data in 2010
  - Integrated social media
- Rapid development of open data program:
  - Underlying systems providing data independently
  - Data feeds incompatible due to variety of standards and formats
- Choice of standards based on what was:
  - Needed within Application Programming Interface (API)
  - Available in marketplace

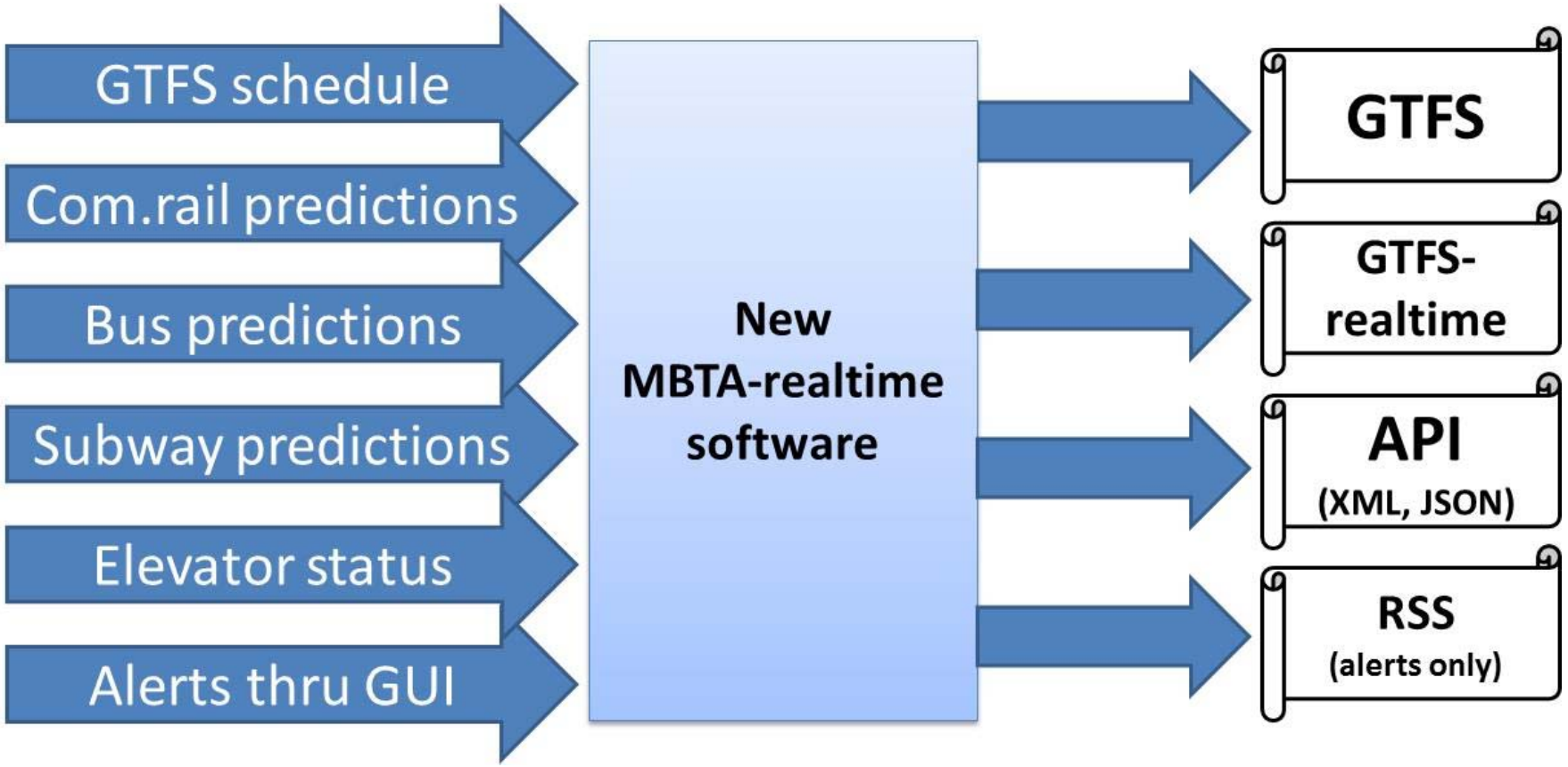
Case Study for Selection of Standards: MBTA (cont.)



Case Study for Selection of Standards: MBTA (cont.)

- Staff wanted to support GTFS-realtime and be on Google Maps
- Found SIRI verbose and somewhat complicated, so not selected
- TCIP well-suited for communications within agency, but not for communications with developers, so not selected
- Developed API to:
  - Retrieve smaller sets of information than what contained in GTFS-realtime (GTFS-RT)
  - Include some information not in GTFS-RT
- Selected XML format for its API because it is industry standard for APIs

Case Study for Selection of Standards: MBTA (cont.)



Case Study for Selection of Standards: MBTA (concluded)

- Re-organized feeds by developing new MBTA-realtime software:
  - C# application with Microsoft SQL Server back-end on two Amazon cloud servers
  - Based around foundation of GTFS data
  - Feeds, MBTA website, subscription service
  - Email and SMS sent by GovDelivery
  - Phase 1 launched 2013, Phase 2 launched Spring 2014
- GTFS, GTFS-realtime and their API popular with developers
- No requests for TCIP or SIRI from developers to date

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Which standard is not being used by the MBTA for their open data program?

Answer Choices

a) General Transit Feed Specification (GTFS)

b) eXtensible Markup Language (XML)

c) JavaScript Object Notation (JSON)

d) Service Interface for Real Time Information (SIRI)

Review of Answers

a) GTFS

Incorrect. GTFS is one of the standards used by the MBTA.

b) XML

Incorrect. The MBTA selected XML format for its API.

c) JSON

Incorrect. JSON is also used in the MBTA API.

d) SIRI

Correct. The MBTA determined that SIRI was somewhat complicated, so they chose not to use it.

Case Study for Changing Traveler Information Standards: Metropolitan Transportation Authority (MTA), New York, NY

- Metropolitan Transportation Authority (MTA) in New York City:
  - Provides free real-time developer APIs to MTA Bus Time system
  - Identified and use SIRI standard
  - Represented first public-facing and free to access SIRI implementation
- SIRI did not cover “distance away” but MTA added it
- SIRI requests are typically SOAP requests sent via HTTP POST, but MTA implemented RESTful interface using HTTP GET requests
- SIRI web service calls implemented:
  - VehicleMonitoring
  - StopMonitoring

Case Study for Changing Traveler Information Standards: MTA (cont.)

- MTA Bus Time provides both XML and JSON versions of API
- Two SIRI calls use MTA's GTFS data as a reference
- OneBusAway software powering MTA Bus Time comes with free utility to strip down GTFS file to only data relevant to given route
- Committee managing SIRI adopted changes/extension MTA made
- MTA Bus Time exposes modified version of OneBusAway RESTful API
- OneBusAway is open source platform for real-time transit information

Open Source Software Criteria

- Free redistribution
- Program must include source code
- Allow modifications and derived works
- Permit distribution of software built from modified source code
- No discrimination against persons or groups

- Rights must apply to all to whom the program is redistributed without the need for execution of an additional license by those parties
- License must not be specific to a product
- License must not restrict other software
- License must be technology-neutral

Using Standards to Facilitate Integration with Legacy Systems: Portland TriMet Case Study

- TriMet: 888 vehicles operating in max service/ approx. 461 million annual passenger miles
- Use ITS standards when developing systems to maximize vendor flexibility, and data exchange compatibility
- Functional integration example:
  - No Transmission Control Protocol/Internet Protocol (TCP/IP) standards for LED sign interface at time of DMS procurement
  - Forced to consider sign vendors that had proprietary protocols
  - TriMet required sign vendors to interface with TCP/IP protocols
  - Advantage to using TCP/IP and standard protocols that would enable use of different communication methods, yet retain same applications

Using Standards to Facilitate Integration with Legacy Systems: Portland TriMet Case Study

- New traveler information systems should be designed to support integration of data from existing legacy systems
- New real-time bus arrival estimation system built upon same platform as TriMet's existing AVL bus dispatch and rail central control systems
- Saved software development time and system costs
- Few minor changes needed to meet different requirements necessary for reporting information to passengers (versus dispatchers)

Summary of Learning Objective #3

Select Appropriate ITS Standards for Data Exchange Among Transit Management Systems and Between Other Systems

- Six main areas of life-cycle cost considerations:
  - Development
  - Availability
  - Maintenance
  - Procurement
  - Adaptation
  - Gold-plating
- MBTA, MTA and TriMet examples
- Issues associated with integration with legacy systems:
  - Comply with standards and select proven commercial off-the-shelf technology
  - Plan on adequate development time and thorough system testing

Learning Objective #4: Illustrate How to Apply Standards to the Development of Procurement Specifications

- Read a standard
- Rigidity, flexibility and change in the application of standards
- Incorporate a standard into a specification for procuring a Traveler Information system
- Test and determine conformance with a standard
- Standards and intellectual property

Read a Standard

- Traveler information standards not structured the same way:
  - GTFS is a series of comma-delimited text files
  - GTFS-realtime format based on protocol buffers
  - SIRI is in XML format
  - TransXChange is in XML format
- Need to understand enough to:
  - Identify appropriate standard(s) based on aforementioned criteria
  - Define use of standard(s) in functional requirements/specifications
  - Define how compliance with standard(s) can be tested

Read a Standard: GTFS

Filename	Required	Defines
agency.txt	**Required**	One or more transit agencies that provide the data in this feed.
stops.txt	**Required**	Individual locations where vehicles pick up or drop off passengers.
routes.txt	**Required**	Transit routes. A route is a group of trips that are displayed to riders as a single service.
trips.txt	**Required**	Trips for each route. A trip is a sequence of two or more stops that occurs at specific time.
stop_times.txt	**Required**	Times that a vehicle arrives at and departs from individual stops for each trip.
calendar.txt	**Required**	Dates for service IDs using a weekly schedule. Specify when service starts and ends, as well as days of the week where service is available.
calendar_dates.txt	Optional	Exceptions for the service IDs defined in the calendar.txt file. If calendar_dates.txt includes ALL dates of service, this file may be specified instead of calendar.txt.
fare_attributes.txt	Optional	Fare information for a transit organization's routes.
fare_rules.txt	Optional	Rules for applying fare information for a transit organization's routes.
shapes.txt	Optional	Rules for drawing lines on a map to represent a transit organization's routes.
frequencies.txt	Optional	Headway (time between trips) for routes with variable frequency of service.
transfers.txt	Optional	Rules for making connections at transfer points between routes.
feed_info.txt	Optional	Additional information about the feed itself, including publisher, version, and expiration information.

Read a Standard: GTFS (cont.)

agency.txt

```
agency_id, agency_name,agency_url,agency_timezone,agency_phone,agency_lang
FunBus,The Fun Bus,http://www.thefunbus.org,America/Los_Angeles,(310) 555-0222,en
```

stops.txt

```
stop_id,stop_name,stop_desc,stop_lat,stop_lon,stop_url,location_type,parent_station
S1,Mission St. & Silver Ave.,The stop is located at the southwest corner of the intersection.,37.728631,-122.431282,,,
S2,Mission St. & Cortland Ave.,The stop is located 20 feet south of Mission St.,37.74103,-122.422482,,,
S3,Mission St. & 24th St.,The stop is located at the southwest corner of the intersection.,37.75223,-122.418581,,,
S4,Mission St. & 21st St.,The stop is located at the northwest corner of the intersection.,37.75713,-122.418982,,,
S5,Mission St. & 18th St.,The stop is located 25 feet west of 18th St.,37.761829,-122.419382,,,
S6,Mission St. & 15th St.,The stop is located 10 feet north of Mission St.,37.766629,-122.419782,,,
S7,24th St. Mission Station,,37.752240,-122.418450,,,S8
S8,24th St. Mission Station,,37.752240,-122.418450,http://www.bart.gov/stations/stationguide/stationoverview_24st.asp,1,
```

routes.txt

```
route_id,route_short_name,route_long_name,route_desc,route_type
A,17,Mission,"The ""A"" route travels from lower Mission to Downtown.",3
```

GTFS-realtime

- GTFS-realtime format based on protocol buffers, language- and platform-neutral mechanism for serializing structured data
- Data structure defined in gtfs-realtime.proto file, used to generate source code to read and write structured data from and to variety of data streams using variety of languages
- Hierarchy of elements and their type definitions specified in gtfs-realtime.proto file, used to generate necessary libraries in choice of programming language
- https://developers.google.com/transit/gtfs-realtime/

SIRI

- General communications architecture, supporting two patterns of interchange:
  - Synchronous request/response protocol
  - Asynchronous subscribe/publish protocol
- Specific services operating within that architecture
- Primary content of messages consist of XML document
- Two different patterns of message exchange:
  - Direct delivery protocol
  - Fetched delivery protocol
- Identify appropriate standard(s) based on aforementioned criteria

SIRI: Example of StopMonitoringRequest

- Request consists of:
  - Standard header (similar for all SIRI requests)
  - Topics and Policies specific to SIRI-SM functional service
- Request asks for departures for stop “HLTST011”
- Response contains up to seven vehicle journeys at stop, as set by policy. If there are more than seven available, then only the first two for each line will be shown

SIRI: Example of StopMonitoringRequest (cont.)

```
<ServiceRequest>
        <RequestorRef>NADER</RequestorRef>
        <RequestTimestamp>2004-12-17T09:30:47-05:00</RequestTimestamp>
        <StopMonitoringRequest version="1.0">
        <!-- All LINE77services from stop EH00001to destination PLACE457 in the next 30 minutes-->
                <RequestTimestamp>2004-12-17T09:30:47-05:00</RequestTimestamp>
                <MessageIdentifier>NDR06756</MessageIdentifier>
                <!--=======TOPIC ==================================== -->
                <PreviewInterval>P30M</PreviewInterval>
                <MonitoringRef> HLTST011</MonitoringRef>
                <!--=======POLICY=========================================-->
                <MaximumStopVisits>7</MaximumStopVisits>
                <MinimumStopVisitsPerLine>2</MinimumStopVisitsPerLine>
                <StopMonitoringDetailLevel>normal</StopMonitoringDetailLevel>
        </StopMonitoringRequest>
</ServiceRequest>
```

TransXChange

- TransXChange major components:
  - XML schema
  - Publisher
  - Schema documentation
  - Examples of schedules
- TransXChange XML schemas:
  - Registration – registering bus timetable
  - General – exchanging bus timetable and ancillary data

TransXChange Schemas

- Modularized into functional packages
- Share common set of base modules with National Public Transport Access Nodes (NaPTAN)
- Used to exchange:
  - Bus schedules
  - Days of service
  - School holidays
  - Service registration
  - Bus operator information
  - Operational information
  - Accessibility information

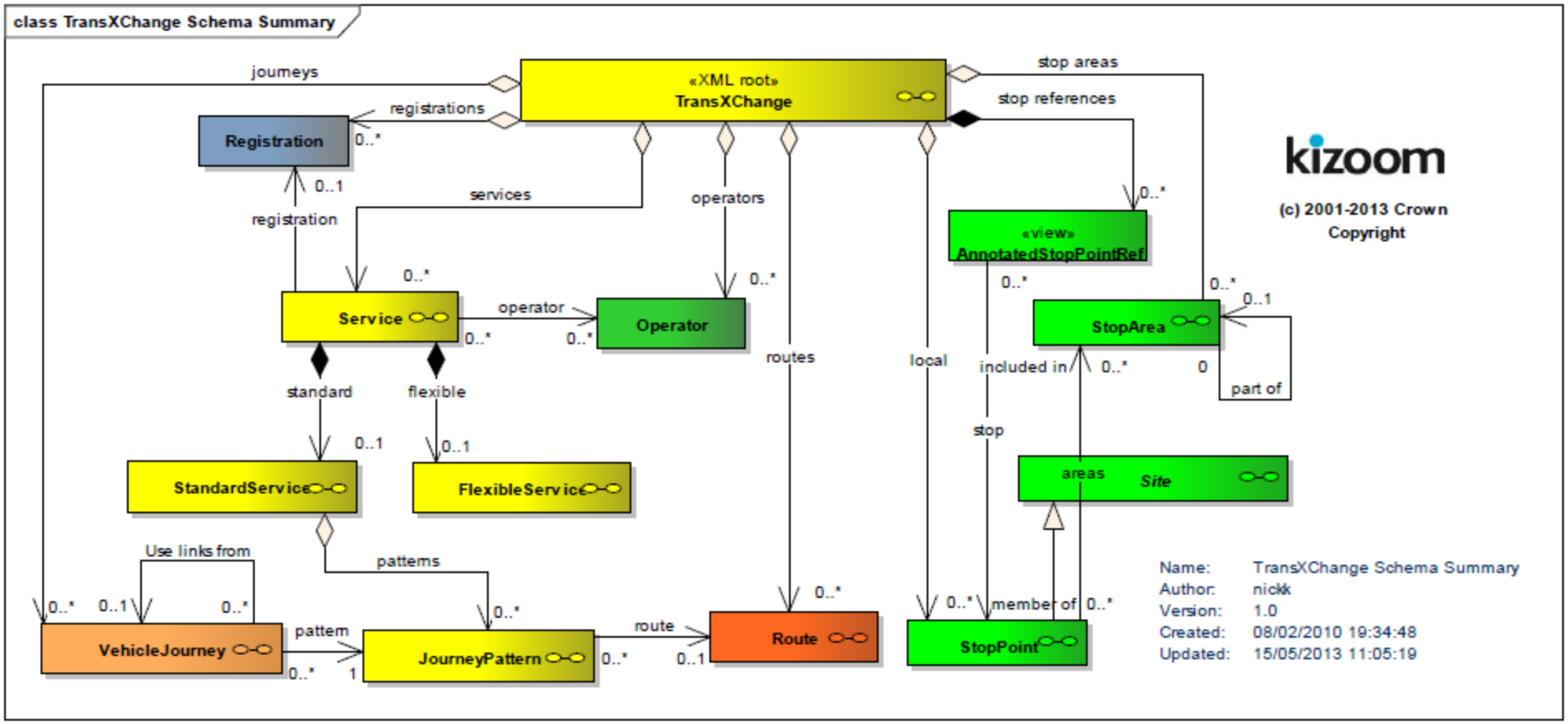
TransXChange Model

- **Service** brings together information about registered bus service, and may contain two types of component service: Standard or Flexible
- **StandardService** describes normal bus schedule. **Route** describes physical path taken by buses as set of route links
- **FlexibleService** describes bus service that does not have fixed route, but only catchment area or variable stops with no prescribed pattern of use
- StandardService has one or more **JourneyPattern** elements to describe logical path of traversal of stops of Route as:
  - Sequence of timing links
  - One or more **VehicleJourney** elements

TransXChange Model (cont.)

- Both types of service have registered **Operator**, who runs the service
- Route, JourneyPattern and VehicleJourney follow sequence of NaPTAN **StopPoints**
- StopPoints used in JourneyPattern or Route are either declared locally or by referenced to an external definition using an **AnnotatedStopRef**
- **Registration** specifies registration details for service. It is mandatory in registration schema.

TransXChange Model (cont.)



Rigidity, Flexibility, and Change in the Application of Standards

- Standards are not perfect
- Extending standards are acceptable but:
  - Must be well-documented
  - Follow prescribed procedures
- Vendors may claim “conformance to standards” but may not provide all features and value ranges allowed
- Beware of “cherry picking” from manufacturers datasheets
- Stick to functions needed to meet Concept of Operations (ConOps)

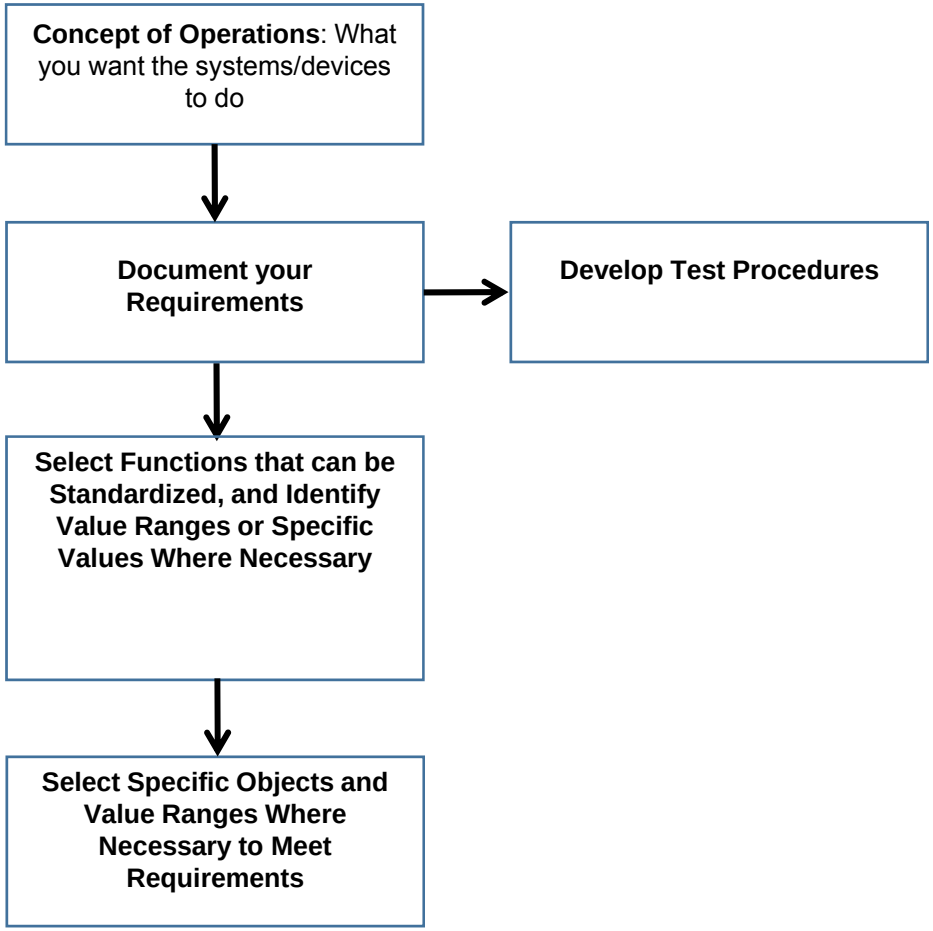
Rigidity, Flexibility and Change in the Application of Standards (cont.)

- Avoid specifying proprietary features and objects:
  - Both will result in non-standard, non-interoperable solutions
  - If you must have a new or different “feature,” document thoroughly for all to use

Incorporate a Standard into a Specification for Procuring a Traveler Information System

- Discussion of Concept of Operations (ConOps)
- Components/devices you expect to be supplied in system
- Functions to be supported, value ranges and optional capabilities required
- Detailed listing of requirements
- Language requiring use of standardized dialogs
- Testing program

Incorporate a Standard into a Specification for Procuring a Traveler Information System



Structure of Standards: Excerpts from Functional Specification Using GTFS

- Real Time Information System (RTIS)
  - General Transit Feed Specifications Export (GTFS Feed) for Google Transit Trip Planner:
    - The system shall provide an interface to Google Transit using the GTFS. The interface shall allow for the export and delivery of data fields necessary (per the agency's needs) for fixed-route trip planning on Google[1]. The contractor shall work with the agency…
    - The contractor shall perform or help the agency with the following processes required to deliver its fixed-route data to Google Transit:
      - Shall prepare transit data as a zip file in GTFS format.
      - Shall test the GTFS zip file using FieldValidator and ScheduleViewer tools…; and
      - Shall review and perform a quality assurance check of Google's preview data (beta website)...

[1] GTFS guidelines for transit feeds are available at: http://code.google.com/transit/spec/transit_feed_specification.html

Test and Determine Conformance with a Standard

- Conformance: testing to determine if implementation meets requirements of standard or specification
- Testing for:
  - Performance
  - Robustness
  - Behavior
  - Functions
  - Interoperability
- Conformance testing is different – requirements or criteria for conformance must be specified in standard/specification
- If criteria or requirements for conformance not specified, there can be no conformance testing

Test and Determine Conformance with a Standard (cont.)

- Prove that implementation is correct, consistent, and complete with respect to specification
- Alternative is falsification testing, which:
  - Subjects implementation to combinations of legal and illegal inputs
  - Compares resulting output to set of corresponding "expected results"
    - If errors found, implementation does not conform to specification
    - If no errors, does not necessarily imply converse
  - Can only demonstrate non-conformance
  - The larger and more varied the inputs, the more confidence can be placed when testing generates no errors

Test and Determine Conformance with a Standard: Conformance Clause

- High-level description of what is required of implementers and application developers
- May specify:
  - Sets of functions
  - Minimal requirements for certain functions and implementation-dependent values
  - Permissibility of extensions, options and alternative approaches and how they are to be handled

Test and Determine Conformance with a Standard: Conformance Testing

- Ensure that “standard-based” products are implemented
- Conformance involves two major components:
  - Test tool/suite
  - Testing program (e.g., certification or branding) for those specifications/standards for:
    - Critical applications
    - Interoperability with other applications
    - Security of systems
- Decision to establish program based on risk of nonconformance versus costs of creating and running program

Test and Determine Conformance with a Standard: Conformance Testing (cont.)

- Conformance testing program usually includes:
  - Standard or specification
  - Test tool (e.g., tool, suite) and/or reference implementation
  - Procedures for testing
  - Organization(s) to do testing, issue certificates of validation, and arbitrate disputes

ACTIVITY

STANDARDS ITS TRAINING

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

Which of the following elements are included in a conformance testing program?

Answer Choices

a) Standard or specification

b) Procedures for testing

c) Organization(s) to test/issue certificates of validation

d) All of the above

Review of Answers

a) Standard or specification

This is included in a conformance testing program.

b) Procedures for testing

This is included in a conformance testing program.

c) Organization(s) to test/issue certificates of validation

This is included in a conformance testing program.

d) All of the above

Correct! All three are part of a conformance testing program.

Standards and Intellectual Property

- Best technology for technical standard could be proprietary technology, protected by one or more patents
- Standards development more frequently anticipates technology rather than following it
- Leads to conflicts between standards and patents
- If patented technology is incorporated into standard without patent holder's agreement to share its patent rights, then patent holder may be the only entity able to comply with the standard

Standards and Intellectual Property (cont.)

- Agency should verify if "essential" patent for which license is required, and broad terms and conditions under which license will be granted
- Information generally available from relevant Standards Development Organization (SDO)
- If license obtained directly from patent holder:
  - Patent holder should be contacted
  - Licensing agreement negotiated and signed prior to adopting standard
- Agency may have option of choosing from alternative technologies to comply with a given standard
- May include use of protected or patented technology

Standards and Intellectual Property (concluded)

- In all such cases, patents would not be considered to be “essential patents” but “useful patents”
- Essential patents may be pooled by patent holders
- Compliance with given standard or technical regulation may require using one or more patented technologies. In all such cases:
  - Required to obtain license from patent holder
  - Must be done prior to using patented technology to conform to requirements of standard
- Know rules so you are able to negotiate best possible terms and conditions for use of proprietary or patented technology

Summary of Learning Objective #4

Illustrate How to Apply Standards to the Development of Procurement Specifications

- Different standards have different structures
- Standards not static and can change. Standard extensions can be used, but:
  - Must be well-documented
  - Follow prescribed procedures
- Five components to incorporate standard into procurement
- Conformance testing program includes:
  - Standard or specification
  - Test tool
  - Procedures for testing
  - Organization(s) to do testing, issue certificates of validation, and arbitrate disputes
- Agency that plans to adopt standard should verify if any “essential” patent(s) for which a license is required

What We Have Learned

1) Service packages represent slices of the physical architecture that address specific services like surface street control.
2) The use of standards is desirable for both business and technical reasons. The principal benefits of standards are as follows:
   a) protection of investment
   b) interoperability
   c) improved quality and value
3) Application areas provide a starting point for identifying the ITS standards and other resources, and are deployment-oriented categories that focus on commonly deployed ITS services or systems.
4) Using standards in a deployment can greatly reduce component development costs, especially if standardized off-the-shelf components are available.
5) The requirements or criteria for conformance must be specified in the standard or specification.

Resources

- ITS ePrimer: Module 7: Public Transportation, http://www.pcb.its.dot.gov/eprimer/documents/module7p.pdf
- Transit Traveler Information Service Package, http://www.iteris.com/itsarch/html/mp/mpapts08.htm
- Transport Direct, "Guide on the use of standards for travel information and retailing," https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/4360/standards-guide.pdf
- ITS Standards Program, About ITS Standards: Application Areas, http://www.standards.its.dot.gov/LearnAboutStandards/ApplicationAreas
- General Transit Feed Specification (GTFS): https://developers.google.com/transit/gtfs/
- General Transit Feed Specification (GTFS)-realtime: https://developers.google.com/transit/gtfs-realtime/
- Service Interface for Real Time Information (SIRI), CEN/TS 15531 (prCEN/TS-OO278181), http://user47094.vs.easily.co.uk/siri/
- Gov.UK, "TransXChange," https://www.gov.uk/government/collections/transxchange

Next Course Modules

Students who have completed Module 7 may delve into the following PCB modules:

- Module 8: Arterial Management & Transit Signal Priority, Part 1 of 2
- Module 9: Arterial Management & Transit Signal Priority, Part 2 of 2
- Module 10: Electronic Fare Payment Systems
- Module 11: Transit and Connected Vehicle Environment / Emerging Technologies, Applications, and Future Platforms

Thank you for completing this module.

Click here to open the feedback form

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Please provide us your feedback:

http://www.pcb.its.dot.gov/stds_training.aspx

(insert exact location for feedback for each module as well as link to Transit ITS Standards – page to be developed as part of standards training site)

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