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

www.pcb.its.dot.gov
Module 4:
Transit Communications Interface Profiles (TCIP), Part 2 of 2: Structure and Elements of TCIP—Accessing TCIP via TIRCE and TCIP Tools
Acknowledgments

- Ayers Electronic Systems, LLC
- Critical Link, LLC
- National Transit Institute
Instructor

Jerome M. Lutin, Ph.D., P.E., AICP
Senior Director (Retired)
New Jersey Transit
South Brunswick, NJ, USA
**Target Audience**

- Transit procurements staff;
- Transit IT staff;
- Metropolitan Planning Organizations (MPO) staff;
- Department of Transportation (DOT)/ITS staff;
- Transit ITS contractors and consultants;
- Transit technology vendors;
- Transit Traveler Information System managers; and
- Traffic Management Center (TMC) / Traffic Operation Center (TOC) managers.
# Recommended Prerequisite(s)

<table>
<thead>
<tr>
<th>Module</th>
<th>Decision-Maker</th>
<th>Project Manager</th>
<th>Project Engineer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module 1:</td>
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<tr>
<td>Introduction to ITS Transit Standards</td>
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<td>Module 2:</td>
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<td>Module 3:</td>
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<tr>
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<td>✓</td>
<td>✓</td>
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<tr>
<td>Module 5:</td>
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<td></td>
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<tr>
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Curriculum Path (Project Manager)

- **Introduction to ITS Transit Standards**
  - Module 1

- **Transit Management, Part 1 of 2**
  - Module 2

- **TCIP, Part 1 of 2**
  - Module 3

- **Transit Management, Part 2 of 2**
  - Module 5

- **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 7

- **Electronic Fare Payment Systems**
  - Module 8

- **Traveler Information, Part 2 of 2**
  - Module 9

- **Arterial Management & Transit Signal Priority, Part 2 of 2**
  - Module 10

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

**Recommended Prerequisite Modules**

**Optional Modules**
Curriculum Path (Project Engineer)

- Introduction to ITS Transit Standards
  - Module 1

- Transit Management, Part 1 of 2
  - Module 2

- TCIP, Part 1 of 2
  - Module 3

- Transit Management, Part 2 of 2
  - Module 5

- 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

- Traveler Information, Part 2 of 2
  - Module 7

- Arterial Management & Transit Signal Priority, Part 2 of 2
  - Module 9

- 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
Learning Objectives

1. Illustrate the “communications stack” and show how it relates to TCIP.
2. Describe the TCIP Implementation, Requirements and Capabilities Editor (TIRCE) and how it is used as the key to TCIP.
3. Identify and provide examples of data elements, data frames, messages, and dialogs.
4. Describe how data are organized in TCIP data exchanges
5. Define a Profile Requirements List (PRL) and explain how it is used to specify TCIP requirements in a transit ITS project.
6. Articulate and describe the uses of each tool in the TCIP suite of tools.
7. Summarize the range of TCIP applications, implementation tools, and additional training.
Learning Objective #1: Illustrate the “Communications Stack” and Show How It Relates to TCIP

- Communications layers
- TCIP model for data exchange
- File transfer and real time
<table>
<thead>
<tr>
<th>Open Systems Interconnection (OSI) Model</th>
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<tbody>
<tr>
<td>7. Application Layer – Message Format – TCIP is used in this layer</td>
</tr>
<tr>
<td>6. Presentation Layer – Encryption/decryption – XML is used in this layer</td>
</tr>
<tr>
<td>5. Session Layer – Manages connection between computers</td>
</tr>
<tr>
<td>4. Transport Layer – Creates segments or “packets” of data</td>
</tr>
<tr>
<td>3. Network Layer – Addressing and routing</td>
</tr>
<tr>
<td>2. Data Link Layer – Access to physical layer, error detection</td>
</tr>
<tr>
<td>1. Physical Layer – Electrical properties of connection</td>
</tr>
</tbody>
</table>
TCIP Model for Data Exchange

Transit Subsystem “A”
(e.g., Data Repository)

TCIP Standard

Dialogs
File Transfers

Messages

Communication Link

Transit Subsystem “B”
(e.g., Scheduling System)
TCIP Building Blocks

This graphic illustrates the distinction between what data are transferred, which is shown below the blue line; and how the data are transferred, which is shown above the blue line.

Learning Objective #1
How Data Are Transferred – File-Based Exchange

**Transfer Data Without the Use of Dialogs in a Non-Real-Time Manner**

- Computer application saves data in a file
- File is transferred to another system
- File is loaded and read by another computer application
  - Sometimes involves human interaction
- This interaction requires an agreed-upon description for the files
  - TCIP messages provide this description
Dialogs

Specify the Operational Purpose, Dialog Pattern, Messages, and Other Special Conditions/Constraints

Publication Dialog Definition – Refer to Section 7.1

<table>
<thead>
<tr>
<th>Dialog Name: Publish Fleet Locations</th>
<th>Business Area: CC</th>
</tr>
</thead>
</table>

Dialog Purpose:
Allows a subscriber to obtain PTV locations by subscribing through a single business system (e.g. CAD/AVL) rather than subscribing to each PTV individually.

Publication Type: Event

Row Updates Supported: None

<table>
<thead>
<tr>
<th>Publication Request and Response Messages:</th>
<th>Name</th>
<th>Identifier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Request: [CcFleetLocationSub]</td>
<td>[CcFleetLocation]</td>
<td>Cc 2063</td>
</tr>
<tr>
<td>Response: [CcFleetLocation]</td>
<td>[CptSubErrorNotice]</td>
<td>Cc 2064</td>
</tr>
<tr>
<td>Error response:</td>
<td></td>
<td>Cpt 2000</td>
</tr>
</tbody>
</table>
Dialog-Based Transfer

Real-Time Transfer (Machine-to-Machine) Using Dialogs

- Does not define:
  - How data are stored, translated, and manipulated
  - How data are formatted and presented to human users
  - How systems/components trigger or initiate dialogs
  - Details of the interactions with human users
Dialog Patterns

- Defines the sequence of actions for a dialog
- Can be reused for multiple purposes
Which of the following is defined in a TCIP dialog?

Answer Choices

a) How data are stored and translated
b) How data are formatted
c) How systems present data to human users
d) How messages are sequenced
Review of Answers

a) How data are stored and translated

*Incorrect. Dialogs do not determine how data are stored and translated.*

b) How data are formatted

*Incorrect. Dialogs do not determine how data are formatted.*

c) How systems present data to human users

*Incorrect. Dialogs do not determine how data are presented to human users.*

d) How messages are sequenced

*Correct! Dialogs specify the sequential order of messages.*
Summary of Learning Objective #1

Illustrate the “Communications Stack” and Show How It Relates to TCIP

- There are seven layers in the OSI model “communications stack”
- TCIP model for data exchange includes the “what,” which are data elements, data frames, and messages, and the “how,” which are file transfers, dialogs, and dialog patterns
- TCIP can exchange data in both file transfer and real time
Learning Objective #2: Describe the TCIP Implementation, Requirements and Capabilities Editor (TIRCE) and How It Is Used as the Key to TCIP

- Interface specification
- Agency perspective – defining business applications by creating a Profile Requirements List (PRL)
- Vendor perspective – testing product compliance using a Profile Implementation Conformance Statement (PICS)
Interface Specification

Detailed Interface Specifications Are Critical for Success

- Ability to understand (and specify) exactly what information is to be exchanged across the interface (both the “how” and the “what”)
- Minimizes opportunities for agency/vendor technical disconnects
- Provides verification test criteria
- Maintenance and future upgrades
Interface Specification (cont.)

TIRCE – for Interface Specification

- Guides user through a step-by-step process of converting an agency’s functional requirements into a TCIP-compliant specification
- A top-down systems engineering approach to defining the data exchange interfaces between transit components
  - Information that will be exchanged
  - Manner in which information is exchanged
Interface Specification (cont.)
The Five Tabs of TIRCE

- Profile Information
- Component Selection
- Interface Definition
- Interface Tailoring
- Document Creation

Easily Specify TCIP interfaces for your project
PRL and PICS

Profile Requirements List (PRL)
Profile Implementation Conformance Statement (PICS)

- PRL and PICS are very similar in structure
  - PRL defines the interface from the agency’s perspective
  - PICS defines the interface from the vendor’s perspective
- Both define the TCIP dialogs and messages for each interface in the system
TIRCE – Agency Perspective

Profile Requirements List (PRL)

- Generates detailed interface requirements
  - Top-down systems engineering approach
  - Interface requirements embodied in the PRL
- Allows an agency to define a project incrementally over time
- Quickly compare vendor responses to RFP requirements as stated in the PICS
TIRCE – Vendor Perspective

Profile Implementation Conformance Statement (PICS)

- Provides TCIP-compliance “spec-sheet” for vendors’ products (PICS)
- Provides a structured, precise response to interface requirements in a PRL
- Quickly evaluate RFPs against existing product capabilities (Diff)
- Software development support
  - Tailored XML Schema
TIRCE – Agency and Vendor Perspective

- TIRCE includes a Diff function to compare the PRL and PICS
Which statement best characterizes a Profile Requirements List (PRL)?

**Answer Choices**

a) A PRL includes a Diff function  
b) A PRL is developed by the vendor  
c) A PRL specifies the size of the files in the data exchange  
d) A PRL is developed by the agency
Review of Answers

a) A PRL includes a Diff function

*Incorrect. The Diff function is used to compare the PRL and PICS.*

b) A PRL is developed by the vendor

*Incorrect. The PRL is developed by the procuring agency.*

c) A PRL specifies the size of the files in the data exchange

*Incorrect. The PRL does not specify the size of the files.*

d) A PRL is developed by the agency

*Correct! The PRL is developed by the procuring agency.*
Summary of Learning Objective #2: Describe the TCIP Implementation, Requirements and Capabilities Editor (TIRCE), and How It Is Used as the Key to TCIP

- **Interface specification**: TIRCE provides detailed specifications and XML schema for interfaces between machines that are exchanging data.

- **Agency perspective**: Create a PRL that defines the components to be connected, the interfaces needed, and the dialogs to be implemented to facilitate the data exchange.

- **Vendor perspective**: Create a PICS document that allows a vendor’s product to be compared with an agency’s requirements.
Learning Objective #3: Identify and Provide Examples of Data Elements, Data Frames, Messages, and Dialogs

- Data elements
- Data frames
- Messages
- Dialogs
- Dialog patterns
Data Element

- An atomic piece of information related to a person, place, thing, or concept
  
  - Examples:
    - SCH-TimepointID – a timepoint alphanumeric identifier
    - SCH-TimepointName – a timepoint name
    - LRMS.Latitude – latitude in microdegrees
Data Elements (cont.)

- TCIP Data Types are based on Abstract Syntax Notation (ASN.1)
  - BOOLEAN
  - ENUMERATED
  - INTEGER
  - UTF8String
  - Numeric String
  - OCTET String

- TCIP has extended ASN.1 – created subtypes
  - Integer subtypes
  - Date and Time subtypes
  - String, Name, and Identifier subtypes
Data Frames

- Groupings of data elements and other data frames to describe more complex concepts
- The groupings help organize information to describe or identify objects or concepts in the real world

Examples:

- SCHTimepointIden identifies a timepoint
  - Contains the data element with its unique alphanumeric identifier (SCH-TimepointID) and can also contain optional data elements including agency number and name

- SCHTimepointInfo describes a timepoint
  - Contains its identifier and location
TCIP Messages

- Aggregations of data elements and data frames into a larger, more complex structure
- A complete, understandable, one-way communication that consists of data elements and data frames conveying metadata and information
- For example, CptStoppointList is a message transmitting a list of all stop points
TCIP Message Example “SchTimepointList”

C.319 Message SchTimepointList {Sch 2007}

Use:
Provide a specified version of timepoint information

Remarks:
A timepoint may be used in more than one pattern.

An agency may decide to include all timepoints for the agency within a timepoint version, or to limit a version to the timepoints included on a route or group of routes, however all timepoints referenced in a pattern list (SchPatternList message) must be included in the version of the timepoints referenced by that pattern list. The update-thru field that the information provided reflects all updates thru the indicated date/time. This message can be used to convey changes to a timepoint list version since a specified time. In such a case, the update-since field indicates the date/time from which updates are provided. The deleted-timepoints field indicate timepoints deleted from the list since update-begin.

ASN1:

```
SchTimepointList ::= SEQUENCE {
    subscriptionInfo          CPTSubscriptionHeader,
    languages                 CPTLanguageList OPTIONAL,
    update-since              CPT-DateTime OPTIONAL,
    timepointVersion          SCH-TimetableVersionID OPTIONAL,
    effective                 CPT-DateTime,
    expires                   CPT-DateTime OPTIONAL,
    timepoints                SEQUENCE (SIZE(1..10000)) OF SCHTimepointInfo OPTIONAL,
    deleted-timepoints        SEQUENCE (SIZE(1..10000)) OF SCHTimepointIden OPTIONAL
}
```

The following dialogs use this message:

Publish Timepoint List
TCIP Dialogs

- Dialogs specify:
  - The operational purpose of the exchange of information
  - Dialog pattern
  - Messages included in the dialog
  - Special conditions/constraints
  - Relationships with other dialogs
TCIP Dialog Example: “Publish Timepoint List”

**D.147 Dialog Publish Timepoint List**

*Use:*

Allows a subscriber to obtain timepoint information by effective datetime or version number. The subscriber can determine the required timepoint effective date/version number using the Publish Master Schedule Version dialog.

*Remarks:*

The dialog may be used to request updates to a timepoint list since a specified date/time if the subscriber has previously obtained the complete timepoint list with the specified effective date or version number.

**Dialog Contents**

<table>
<thead>
<tr>
<th>Message</th>
<th>Role</th>
<th>File Transfer</th>
</tr>
</thead>
<tbody>
<tr>
<td>SchTimepointListSub</td>
<td>Request</td>
<td>No</td>
</tr>
<tr>
<td>SchTimepointList</td>
<td>Response</td>
<td>Yes</td>
</tr>
<tr>
<td>CptSubErrorNotice</td>
<td>ErrorResponse</td>
<td>No</td>
</tr>
</tbody>
</table>

**Dialog Row Updates**

<table>
<thead>
<tr>
<th>Message</th>
<th>Field</th>
<th>Data Frame</th>
</tr>
</thead>
<tbody>
<tr>
<td>SchTimepointList</td>
<td>timepoints</td>
<td>SCHTimepointInfo</td>
</tr>
</tbody>
</table>
TCIP Has 11 Types of Dialog Patterns

1. Publication (query, periodic, and event)
2. Command-Response
3. Report
4. Silent alarm
5. Load
6. Unload
7. Voice radio call
   - Operator-initiated
   - Dispatch-initiated
8. Signal control and prioritization
9. Blind notification
10. Push
11. Traveler service request
TCIP Dialog Patterns 1 - 4

1. Publication (query, periodic, and event)
2. Command-Response
3. Report
4. Silent alarm
TCIP Dialog Patterns 5 - 8

5. Load

6. Unload

7. Voice radio call
   - Operator-initiated
   - Dispatch-initiated

8. Signal control and prioritization
TCIP Dialog Patterns 9 - 11

9. Blind notification

10. Push

11. Traveler service request
TCIP Dialog Pattern Example

Periodic Variations of Publication Dialog
ACTIVITY
Which of the following statements about data elements is correct?

**Answer Choices**

a) A data element can include a data frame
b) A data element can only include integers
c) A data element cannot be used to identify a person
d) A data element can be used to represent a concept
Review of Answers

a) A data element can include a data frame

Incorrect. A data frame can include a data element, but a data element cannot include a data frame.

b) A data element can only include integers

Incorrect. A data element can include several types of ASN.1 representations.

c) A data element cannot be used to identify a person

Incorrect. A data element can be a person’s name or other identifier.

d) A data element can be used to represent a concept

Correct! A data element can represent a person, place, thing, or concept.
Summary of Learning Objective #3: Identify and Provide Examples of Data Elements, Data Frames, Messages, and Dialogs

- **Data Element**: An atomic piece of information related to a person, place, thing, or concept

- **Data Frame**: Groupings of data elements and other data frames to describe more complex concepts

- **Message**: Aggregations of data elements and data frames into a complete, understandable, one-way communication conveying metadata and information

- **Dialog**: Specified sequence of messages for an operational purpose including any special conditions

- **Dialog Pattern**: Common forms of dialogs that can be used repeatedly for multiple purposes
Learning Objective #4: Describe How Data Are Organized in TCIP Data Exchanges

- TCIP identifiers
- Optional items (fields)
- Versioning
- Row updates
- Applicability
- Local extensions
- Multilanguage support
TCIP Identifiers

- Allow an agency to provide information about items (e.g., bus stop inventory, timepoint inventory) to an application once, and then refer to the item in subsequent messages
  - For example, if we want to associate passenger count information with a bus stop, we can associate it with the identifier, and not send a complete description of the bus stop with each set of passenger counts
TCIP Identifiers (cont.)

TCIP Identifiers

- Allow items to be uniquely identified across all transit agencies in the US

- Employees
- Intersections
- Operator bases
- Operators
- Organizational units
- Shelters
- Stop points
- Transfer clusters
- Transit facilities

- Vehicles
- Fare policies
- Fare zones
- Trips
- Incidents
- Amenities
- Announcements
- Geographic zones
- Service bulletins

- Travelers
- Blocks
- Notes
- Patterns
- Pattern segments
- Routes
- Runs
- Timepoints
- Trains
TCIP Identifiers (cont.)

- TCIP Iden Frames ALWAYS contain:
  - Alphanumeric identifier (e.g., vehicle_id)

- TCIP Iden Frames MAY contain:
  - Optional agency number
  - Optional string designator that uniquely represents the item within the agency (e.g., route_designator)
  - Zero or more optional string name fields for the identified item (e.g., first-name, last-name, VIN)
Optional Items (Fields)

- Support a functional requirement that is not common to all agencies (e.g., an announcement can be text, audio, or both)
- Support a capability that is only required in certain contexts (e.g., a warning in a message)
- Convey information that may or may not be available (e.g., photographs of a stoppoint)

Annex B.79 Data Frame: CPTStoppointIden {CPT 1016}

Use: Uniquely identify a stoppoint whether in a single, or multi agency environment.

ASN.1 Representation:

```
CPTStoppointIden ::= SEQUENCE{
  stoppoint-id       CPT-StoppointID,
  agency-id          CPT-AgencyID OPTIONAL,
  name               CPT-StoppointName OPTIONAL,
  nameLangs          CPTAdditionalLanguageContents OPTIONAL,
  designator         CPT-StoppointDesignator OPTIONAL,
  designatorLangs    CPTAdditionalLanguageContents OPTIONAL,
  agencyDesignator   CPT-AgencyDesignator OPTIONAL,
  agencyDesignatorLangs CPTAdditionalLanguageContents OPTIONAL
}
```
Versioning

- Data items in TCIP need to be updated from time to time
- TCIP’s primary means of tracking versions of these items is by updating the effective date-time
- Some TCIP data items also have optional integer-based version numbers to provide backward compatibility with legacy business systems

ASN.1 Representation:

```
SchPatternList ::= SEQUENCE {
    subscriptionInfo       CPTSubscriptionHeader, OPTIONAL,
    languages              CPTLanguageList, OPTIONAL,
    patternVersion         SCH-TimetableVersionID, OPTIONAL,
    effective              CPT-DateTime, OPTIONAL,
    update-since           CPT-DateTime, OPTIONAL,
    update-thru            CPT-DateTime, OPTIONAL,
    stoppointVersion       CPT-StoppointVersion, OPTIONAL,
    stoppointEffective     CPT-DateTime, OPTIONAL,
    timepointVersion       SCH-TimetableVersionID, OPTIONAL,
    timepointEffective     CPT-DateTime, OPTIONAL,
}
```
Row Updates

- Many TCIP messages provide lists of items that can be lengthy
  - Bus stops
  - Timepoints
  - Employees
  - Vehicles

- Row updates allow changes to be sent to previously provided lists
Row Updates

Example

Stoppoint 234

- Stoppoint 132
- Stoppoint 146
- Stoppoint 149
- Stoppoint 200
- Stoppoint 211
- Stoppoint 245
- Stoppoint 249
- Stoppoint 288
- Stoppoint 291
- Stoppoint 310

Stoppoint 132
- Stoppoint 146
- Stoppoint 149
- Stoppoint 200
- Stoppoint 211
- Stoppoint 234
- Stoppoint 245
- Stoppoint 249
- Stoppoint 288
- Stoppoint 291
- Stoppoint 310
Row Updates (cont.)

- A message requesting row updates includes a field indicating the date-time when changes are requested.
- A message providing row updates contains a field indicating the date-time that changes are provided.
- A row update message may contain rows to be added, rows that replace old rows, or rows to be deleted.
**Applicability**

- A TCIP message may contain an Applicability Field indicating the scope of the information requested or provided by that message.
- Applicability Field (if present) usually occurs in the message application header.

**Affected by**
- Brake recall

**Wirelessly load maps**
- Bus 212
- Bus 1232
- Bus 834
- Bus 559
- Bus 712
- Bus 933
Local Extensions – Two Types

Type 1 – Code Extension

- Adds a value to a specified enumerated list of values
  - Data Element: SCH-ServiceType {SCH-41}
    - Describes the type of transit service provided
  - Local use example:
    - BayFerryConnector (128) – ongoing service
    - SuperBowl (129) – one time event
Local Extensions – Type 1

SCH-ServiceType ::= ENUMERATED {
  regular   (1),   -- Regular,
  express   (2),   -- Express,
  circular  (3),   -- Circular,
  radial    (4),   -- Radial,
  feeder    (5),   -- Feeder,
  jitney    (6),   -- Jitney,
  limited   (7),   -- Limited,
  nonRevenue(8), -- Non-revenue,
  unknown   (9),   -- Unknown,
  charter   (10),  -- Charter Service,
  school    (11),  -- School Service,
  special   (12),  -- Special Service,
  operatorTraining (13), -- Operator Training,
  maintenance (14), -- Maintenance Service,
  noService (15), -- No Service,
  standBy   (16),  -- Stand-by,
  extra     (17),  -- Extra,
  -- 18-127 reserved
  -- 128-255 local use
  ...
  -- # LOCAL_CONTENT
}
Local Extensions (cont.)

Type 2 – Frame/Message Extension

Type 2 - Frame/message extensions – add locally specified data to the sequence Data Frame: CCBlockWorkRecord

- Describe events related to work done by a PTV

CCBlockWorkRecord ::= SEQUENCE {
  block          SCHBlockIden, OPTIONAL,
  begin-time     CPT-DateTime, OPTIONAL,
  end-time       CPT-DateTime, OPTIONAL,
  timepoints     SEQUENCE (SIZE(1..15000)) OF CCTimepointHistory, OPTIONAL,
  stoppoints     SEQUENCE (SIZE(1..15000)) OF OBOStoppointRecord, OPTIONAL,
  deviations     SEQUENCE (SIZE(1..1000)) OF CCRouteDeviationRecord, OPTIONAL,
  passenger-miles CC-PassengerMiles, OPTIONAL,
... -- # LOCAL_CONTENT
}

- Local use example:
  dailySamples     SEQUENCE(SIZE(1..1000)) OF ABCAirQualitySample, OPTIONAL
Multilanguage Support

- TCIP can support multiple languages, beginning with TCIP version 3.0.4
- Languages are specified using ISO 639 codes
- “CPTLanguageList” data frame specifies the default and additional languages
  - Optional item
  - Where string content appears in a message, “CPTAdditionalLanguageContent” data frames provide the information in the additional languages

Learning Objective #4
ACTIVITY
Which statement best characterizes a TCIP identifier?

**Answer Choices**

a) Uses a shorthand code to represent an item
b) Identifies a TCIP-generated message
c) Identifies a unique data frame
d) Always includes a string designator to identify an item
Review of Answers

a) Uses a shorthand code to represent an item

Correct! A TCIP identifier can be used to represent an item that may have a longer description.

b) Identifies a TCIP-generated message

Incorrect. A TCIP identifier represents items in the real world, not TCIP elements.

c) Identifies a unique data frame

Incorrect. A TCIP identifier would not be used to represent a TCIP data frame. An identifier is a data element.

d) Always includes a string designator to identify an item

Incorrect. String designators are optional types of identifiers; alpha-numeric identifiers are mandatory.
Summary of Learning Objective #4: Describe How Data Are Organized in TCIP Data Exchanges

TCIP Provides a Way To:

- Create unique identifiers for information across all transit agencies
- Identify version of information provided
- Incrementally update large data sets
- Define and use groups of items/entities
- Include locally defined data in TCIP messages
Learning Objective #5: Define a Profile Requirements List (PRL) and Explain How It Is Used to Specify TCIP Requirements in a Transit ITS Project

- Profile Information
- Component selection
- Interface definition
- Interface tailoring
- Document creation
Profile Information

TIPCE 3.0.6 - Project PIL

Profile Information
- Project Component
- External Components
- Interfaces
- Create Document

Please enter your project information below. If you are unsure what to enter, hover your cursor over the field for details.

Project Name: 

Agency/Company Name: 
Agency/Company ID: 
Agency Model: Unknown

Will languages other than English be used? 
- Yes 
- No

Will agency-defined applicability groups be used? 
- Yes 
- No (Answer "Yes" if unsure)

TCIP Version: 3.0.6

Learning Objective #5
TIRCE Example – Component Selection

TIRCE Example

- Transferring fleet location information between a CAD/AVL system and a Traveler Information System
TIRCE Example – Component Selection

Fleet Location Transfer Example
Learning Objective #5

TIRCE Example – Interface Definition and Tailoring

Fleet Location Example

Project Component

- CAD/AVL System

Dialog: Publish Fleet Locations

- Message: CcFleetLocationSub
- Message: CcFleetLocation
- Message: CptSubErrorNotice

External Component

- Traveler Information System

Information Flow
Learning Objective #5

TIRCE Example – Document Creation

<table>
<thead>
<tr>
<th>Profile Requirements List (PRL)</th>
<th>Cover Sheet</th>
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<tbody>
<tr>
<td><strong>Project Name:</strong></td>
<td>abc</td>
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<tr>
<td><strong>Creation Date:</strong></td>
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<tr>
<td><strong>External Component(s):</strong></td>
<td>Traveler Information System</td>
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<table>
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<td><strong>Agency ID:</strong></td>
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<tr>
<td><strong>Project Component:</strong></td>
<td>IP/Network Address:</td>
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<td><strong>Location:</strong></td>
<td>Port/Transport Address:</td>
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<td>IP/Network Address:</td>
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<td><strong>Location:</strong></td>
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<td><strong>Exceptions to TCIP Requirements:</strong></td>
<td>Conformance Class 1A: Supported Dialogs</td>
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<td><strong>Location:</strong></td>
<td>Computer Aided Dispatch/Automatic Vehicle Location</td>
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<td><strong>External Component:</strong></td>
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<tr>
<td><strong>Location:</strong></td>
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<td><strong>Traveler Information System:</strong></td>
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<td>Publish Fleet Locations</td>
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**Conformance Class 2A: TCIP Message Files Accepted**

**Project Component:**

Computer Aided Dispatch/Automatic Vehicle Location

**External Component:**

Traveler Information System

**File Attributes & Limitations:**
Learning Objective #5

Example of XML-Encoded TCIP Message Produced by TIRCE for a PRL

```xml
  <request-id>4001</request-id>
  <status-info>3</status-info>
  <time-reported>2016-01-07T13:10:23</time-reported>
  <altitude>31000000</altitude>
  <longitude>-89000000</longitude>
  <direction>
    <deg>90</deg>
    <rad>0</rad>
    <cdeg>0</cdeg>
  </direction>
  <speed>50</speed>
</tcip:ccLocationReport>
```
ACTIVITY
Which of the following is not included in the preparation of a Profile Requirements List (PRL)?

**Answer Choices**

a) Profile information  
b) Component selection  
c) Vendor conformance  
d) Interface tailoring
Review of Answers

a) Profile information
Correct! Profile information is included in a PRL.

b) Component selection
Incorrect. Component selection is included in a PRL.

c) Vendor conformance
Correct! Vendor conformance is not included in preparing a PRL. The DIFF function would be used.

d) Interface tailoring
Incorrect. Interface tailoring is used in preparation of a PRL.
Summary of Learning Objective #5: Define a Profile Requirements List (PRL) and Explain How It Is Used to Specify TCIP Requirements in a Transit ITS Project

- Profile information includes entering data to describe the project and identify the agency developing the profile
- Component selection involves choosing the subsystems that will exchange data
- Interface definition involves selecting the file transfers and dialogs
- Tailoring involves selecting specific messages to be exchanged
- Document creation involves producing the Profile Requirements List (PRL) specifications and XML schema
Learning Objective #6: Articulate and Describe the Uses of Each Tool in the TCIP Suite of Tools

- Interface Definition – TIRCE
- Procurement – TIRCE
- Development – Message Builder, Interrogator, Responder
- Verification – Interrogator, Responder
TCIP Tool Suite

**Interface Definition**
- TIRCE
- Requirements Definition
- Interface Specification
- TCIP Compliant Documentation

**Procurement**
- TIRCE
- Automated Comparison of Vendor Responses to RFP Requirements

**Development**
- TCIP Message Builder
- Simulation Capability
- TCIP Message Generation
- Data Logging / Viewing

**Verification**
- TCIP Interrogator
- TCIP Responder
- Automated TCIP Compliance Verification
Uses of TCIP Tools: Interface Definition – TIRCE

TIRCE Allows a User to Specify an Interface in Five Steps

- Specify profile information
- Select components
- Define interfaces
- Tailor interfaces
- Produce documents
Uses of TCIP Tools: Procurement – TIRCE

TIRCE Produces Two Key Documents to Facilitate ITS Procurements

- Profile Requirements List (PRL)
- Profile Implementation Conformance Statement (PICS)
- TIRCE provides a Diff function:
  - To compare agency requirements (PRL)
  - With vendor product specifications (PICS)
Uses of TCIP Tools – Development

TCIP Message Builder

- Enables user to generate XML-encoded TCIP messages
- Messages are used by the TCIP Test Console applications
- Load / save / view / edit TCIP messages
TCIP Message Builder – Example

Learning Objective #6
Uses of TCIP Tools – Verification

TCIP Test Console

- Provides capability to simulate one, or both, ends of a TCIP interface
- Consists of two functions:
  - TCIP Interrogator → requests TCIP data
  - TCIP Responder → supplies TCIP data
Uses of TCIP Tools – Verification (cont.)

TCIP Interrogator

- Simulates a TCIP-compliant device
  - Client side of interface
  - Subscribes to a provider (publisher) of TCIP data
- Establishes a TCIP communications link with a TCIP device under development or test
- Transmits/receives TCIP messages
- View/log TCIP messages
- Automated TCIP message verification
Uses of TCIP Tools – Verification (cont.)

TCIP Responder

- Simulates a TCIP-compliant device
  - Server side of interface
  - Provides TCIP data upon receipt of a subscription request
- Data are preloaded
  - Previously created (via TCIP Message Builder) or recorded TCIP messages
Learning Objective #6

TCIP Tool Suite – Test Console

Testing a Component
TCIP Tool Suite – Test Console

Testing a Simulated Component
Which of the following statements about the underlined TCIP tool function is FALSE?

**Answer Choices**

a) Interrogator simulates a client component requesting data
b) Responder simulates a server providing data
c) Test Console corrects errors in XML schema
d) TIRCE (Diff function) compares a PICS with a PRL
Review of Answers

a) **Interrogator** simulates a client component requesting data

*Incorrect. This statement is true.*

b) **Responder** simulates a server providing data

*Incorrect. This statement is true.*

c) **Test Console** corrects errors in XML schema

*Correct! This statement is false. The test console does not correct XML errors.*

d) **TIRCE (Diff function)** compares a PICS with a PRL

*Incorrect. This statement is true.*
Summary of Learning Objective #6: Articulate and Describe the Uses of Each Tool in the TCIP Suite of Tools

- **TCIP Implementation, Requirements and Capabilities Editor (TIRCE)** can be used to specify interfaces between components.

- **TIRCE** also can be used to prepare procurement documents representing the agency view, Profile Requirements List (PRL), and vendor’s view, Profile Implementation Conformance Statement (PICS).

- **TCIP Message Builder** can be used to construct TCIP-compliant messages using XML. Messages can be saved, viewed, and edited.

- **TCIP Test Console** can simulate one or both ends of a TCIP interface. It includes an interrogator, which simulates the client side of the data exchange, and a responder to simulate the server side of the data exchange.
Learning Objective #7: Summarize the Range of TCIP Applications, Implementation Tools, and Additional Training

- Non-normative TCIP content – model architecture and concept of operations
- Normative TCIP content – building blocks, data elements to dialogs
- Implementation tools
- Examples of TCIP implementation at transit agencies
- Overview of National Transit Institute (NTI) on-site training for TCIP
Non-Normative TCIP Content – Model Architecture and Concept of Operations

- TCIP contains non-normative material that has not been balloted but is useful as context for applying the standard. The following items are non-normative:
  - TCIP Model Architecture
  - TCIP Concept of Operations
Non-Normative TCIP Content – Model Architecture and Concept of Operations (cont.)

Where do I find it?

- American Public Transportation Association (APTA)
  - Transit Communications Interface Profiles (TCIP) Standard Development Program
  - APTA-TCIP-S-01 4.0 Volume I

How do I get it?

- Download FREE from:
  - http://www.aptatcip.com/APTA-TCIP-S-01%204.0.htm
Normative TCIP Content – Building Blocks, Data Elements to Dialogs

Where do I find it?

- TCIP 4.0 Volume I - Basis for conformance
- TCIP 4.0 Volume II - Data and Dialog Definitions
  - Annex A - TCIP Data Elements
  - Annex B - TCIP Data Frames
  - Annex C - TCIP Messages
  - Annex D - TCIP Dialogs
- TCIP 4.0 Volume III - TCIP XML Schema
  - Annex E – TCIP XML Schema
TCIP Implementation Tools

- TIRCE
- Message Builder
- Test Console

Where do I get them?

- Transit Communications Interface Profiles (TCIP) Standard Development Program APTA-TCIP TIRCE & Support Tools and Support Tool Installation Instructions

Download FREE from:

TCIP Tools Download - Implementation Tools

Learning Objective #7
TCIP Tools Download – Implementation Tools

TIRCE Icon

TCIP Message Builder Icon

TCIP Test Console Icon
Who Is Using TCIP?
Examples and Real World Applications

Current TCIP Projects

- LYNX (Orlando)
- King County Metro (Seattle)
- New York MTA (NYC)
- AMT (Montreal)
- WMATA (Washington DC)
- DART (Dallas)
Examples of TCIP Implementation at Transit Agencies

Learning Objective #7
Examples of TCIP Implementation at Transit Agencies (cont.)

King County Transit ITS Architecture

TCIP: Notify Onboard PRG Inputs
Examples of TCIP Implementation at Transit Agencies (cont.)

MTA Bus CIS Concept Architecture

- Real-time and historical data consumers (e.g., operations, planning)
- Wireless Data Networks (e.g., Verizon)
- Payment Terminal
- Operator Login Information
- 3G Wireless Modem
- Enhanced GPS
- MTA Back Office/Internet
- MTA, The Market
- App Developers
- Digital Displays
- Customer PCs
- Customer Smart Phones
- Customer Cell Phones
- Web
- SMS
- Open API
- TCIP-JSON-HTTP

MTA Metropolitan Transportation Authority
Examples of TCIP Implementation at Transit Agencies (cont.)

AMT (Montreal)

Center to center data exchange
Examples of TCIP Implementation at Transit Agencies (cont.)

AMT (Montreal)

Two TCIP dialogs utilized:
- Publish Stop Point ETA
- Publish Service Bulletin List
Examples of TCIP Implementation at Transit Agencies (cont.)

Learning Objective #7
National Transit Institute Course

Integrating Transit Applications: Defining Data Interfaces Using TCIP

- The National Transit Institute offers a two-day course
- Covers material presented in both TCIP online modules
- Provides hands-on instruction
- Register at www.ntionline.com
ACTIVITY
Which one of the following lists includes only normative elements of TCIP?

**Answer Choices**

a) Dialogs, TIRCE, model architecture
b) TIRCE, dialogs, XML schema
c) Dialogs, XML schema, data elements
d) Model architecture, dialogs, XML schema
Review of Answers

a) Dialogs, TIRCE, model architecture
   *Incorrect. Model architecture is non-normative.*

b) TIRCE, dialogs, XML schema
   *Incorrect. TIRCE is non-normative.*

c) Dialogs, XML schema, data elements
   *Correct! Dialogs, XML schema, and data elements are all normative.*

d) Model architecture, dialogs, XML schema
   *Incorrect. Model architecture is non-normative.*
Summary of Learning Objective #7:
Summarize the Range of TCIP Applications, Implementation Tools, and Additional Training

- TCIP contains both normative and non-normative information in four volumes
- TCIP includes a set of tools to implement the standard using XML schema
- TCIP documents and tools can be downloaded FREE from APTA’s website
- A number of transit agencies are using TCIP in a variety of ways
- National Transit Institute (NTI) offers a two-day on-site TCIP training course
What We Have Learned

1. TCIP is used in the top layer of the “__________________communications stack__________________.”

2. The __________ TCIP Implementation, Requirements and Capabilities Editor (TIRCE)__________ is a key tool for use in transit ITS procurements.

3. TCIP building blocks include ______________ data elements, data frames, messages, and dialogs___________________.

4. Messages are the highest level for TCIP-encoded data in ______________ file transfers__________ and ______________ dialogs_______________.

5. A __________ Profile Requirements List (PRL)______________ is used to specify an agency’s TCIP requirements in a transit ITS project.

6. The TCIP suite of tools includes: __________ TIRCE__________, ______________ message builder______________, __________ interrogator__________, and __________ responder______________.
Resources


- Concept of operations - Wikipedia, the free encyclopedia en.wikipedia.org/wiki/Concept_of_operations

- ITS PCB T3 Webinars on ITS Transit Standards http://www.pcb.its.dot.gov/t3_archives.asp


Next Course Modules

Students who have completed Module 4 may delve into the following PCB modules:

- Module 5: Transit Management Standards, Part 2 of 2
- Module 7: Traveler Information, Part 2 of 2
- Module 9: Arterial Management & Transit Signal Priority, Part 2 of 2
- Module 10: Electronic Fare Payment Systems
- Module 11: Transit and the Connected Vehicle Environment / Emerging Technologies, Applications, and Future Platforms
Thank you for completing this module.

Click [here](http://www.pcb.its.dot.gov/stds_training.aspx) to open the feedback form

OR

Please provide us your feedback:


(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)