



W E L C O M E



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

# Welcome



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A screenshot of the website for the ITS Professional Capacity Building Program. The page has a blue header with the United States Department of Transportation logo and navigation links. The main content area features a large image of people in a classroom setting. A blue callout box contains a welcome message. Below this, there are sections for 'FREE TRAINING' and 'WHAT'S NEW' with various news items and links.

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**Welcome to ITS Professional Capacity Building**  
The ITS PCB Program is the U.S. Department of Transportation's leading program for delivering ITS training and learning resources to the nation's ITS workforce.

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**WHAT'S NEW**

**New Web-Based Training from ITS Joint Program Office**

- Connected Vehicle Reference Implementation Architecture Training now available

**New NHI Course**

- Systems Engineering for Signal Systems Including Adaptive Control (NHI-133123)

**New ITS Case Study Available**

- National ITS Architecture

**Added to T3 Archive**

- Learn from the Experts: Open Data Policy Guidelines for Transit - Maximizing Real Time and Schedule Data-Legalities, Evolutions, Customer Perspectives, Challenges, and Economic Opportunities - Part II Presented on August 7, 2014
- Saving Lives and Keeping Traffic Moving: Quantifying the Outcomes of Traffic Incident Management (TIM) Programs Presented on July 31, 2014

[www.pcb.its.dot.gov](http://www.pcb.its.dot.gov)

**T251:**

**Center-to-Center (C2C)  
Reference Implementation (RI)  
Introduction**



# Instructor



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Magnolia, TX, USA

# Learning Objectives

Recognize **purpose** of C2C Reference Implementation

Acknowledge **key capabilities and limitations**  
of the C2C RI

Follow process for **producing test documentation**  
that relies upon the C2C RI

Recognize **results** a tester might produce  
after using the C2C RI

# Learning Objective 1

Recognize purpose of C2C  
Reference Implementation

# Understand C2C Communications

## ITS: A complex network that needs proper analysis

### Real-time Data Capture and Management

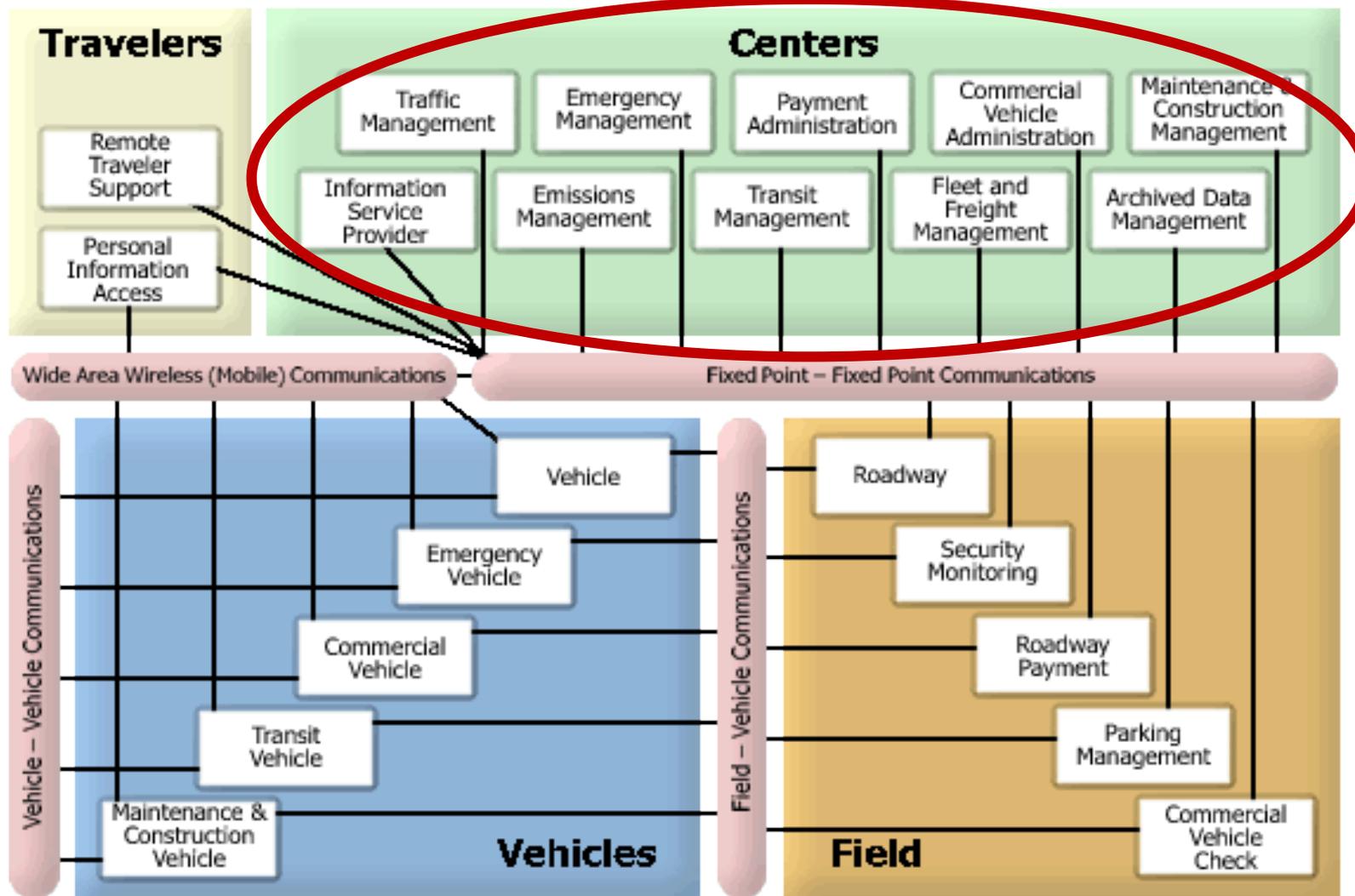


### Dynamic Mobility Applications



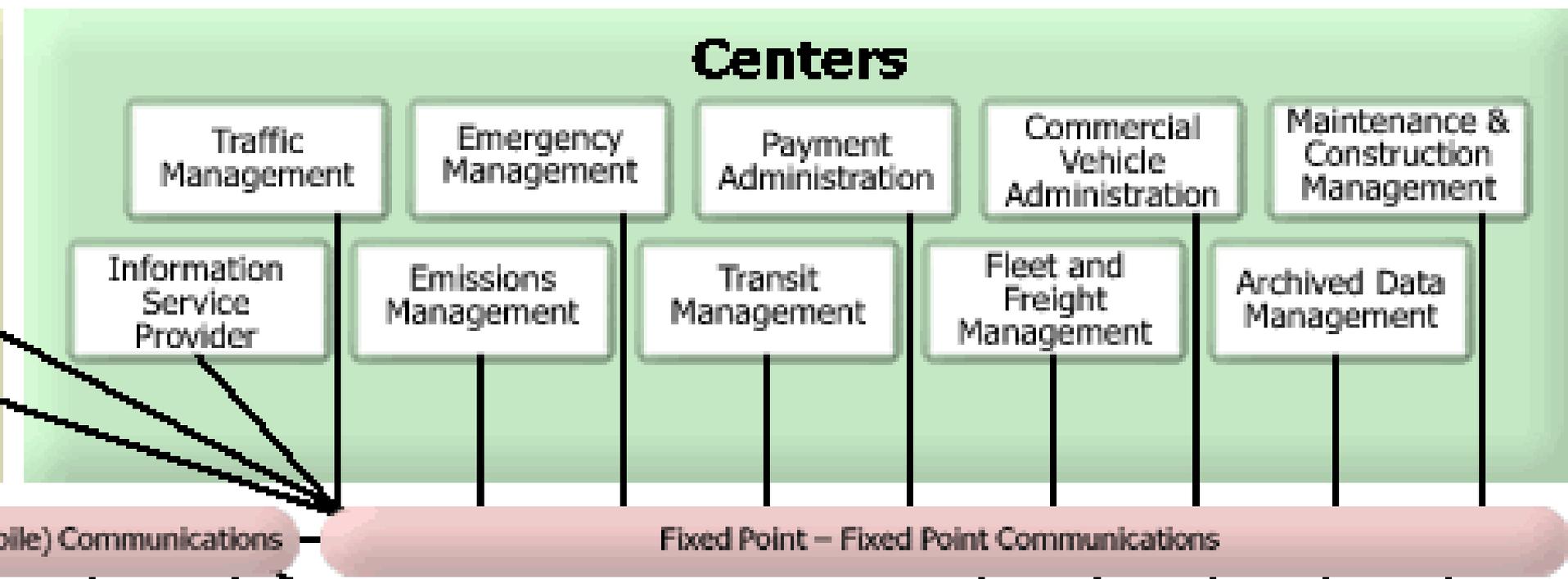
# Understand C2C Communications

National ITS Architecture is the result of the analysis



# Understand C2C Communications

This module focuses on center-to-center only



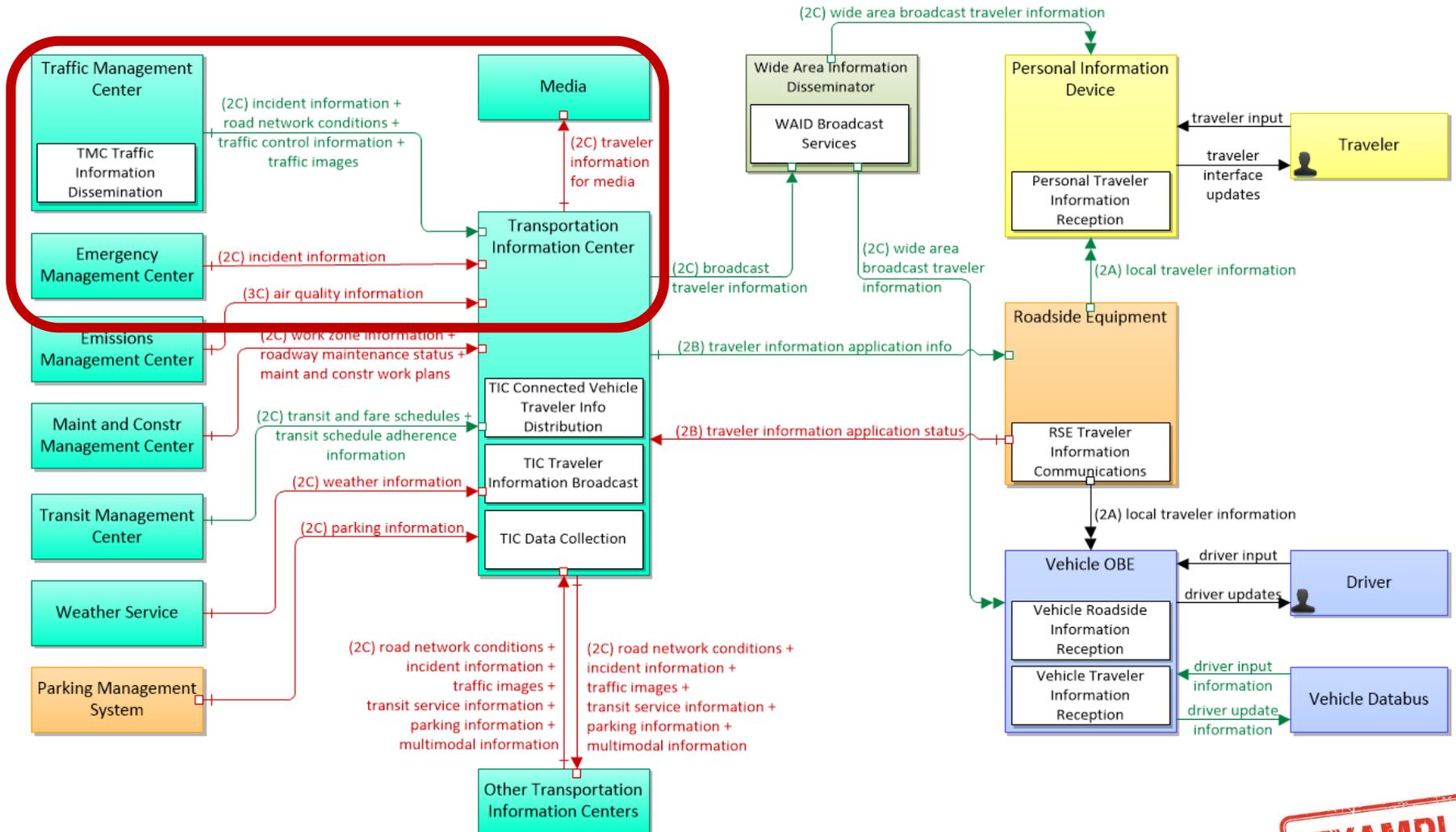
# Understand C2C Communications

## National ITS Architecture service packages (sample)

Group	Service Package Name
Traffic Signals	Emergency Vehicle Preemption
	Freight Signal Priority
	Intelligent Traffic Signal System
	Transit Signal Priority
Transit	Dynamic Ridesharing
	Dynamic Transit Operations
	Integrated Multi-Modal Electronic Payment
	Intermittent Bus Lanes
	Smart Park and Ride System
	Transit Connection Protection
	Transit Stop Request
Traveler Information	Advanced Traveler Information Systems
	Traveler Information – Smart Parking

# Understand C2C Communications

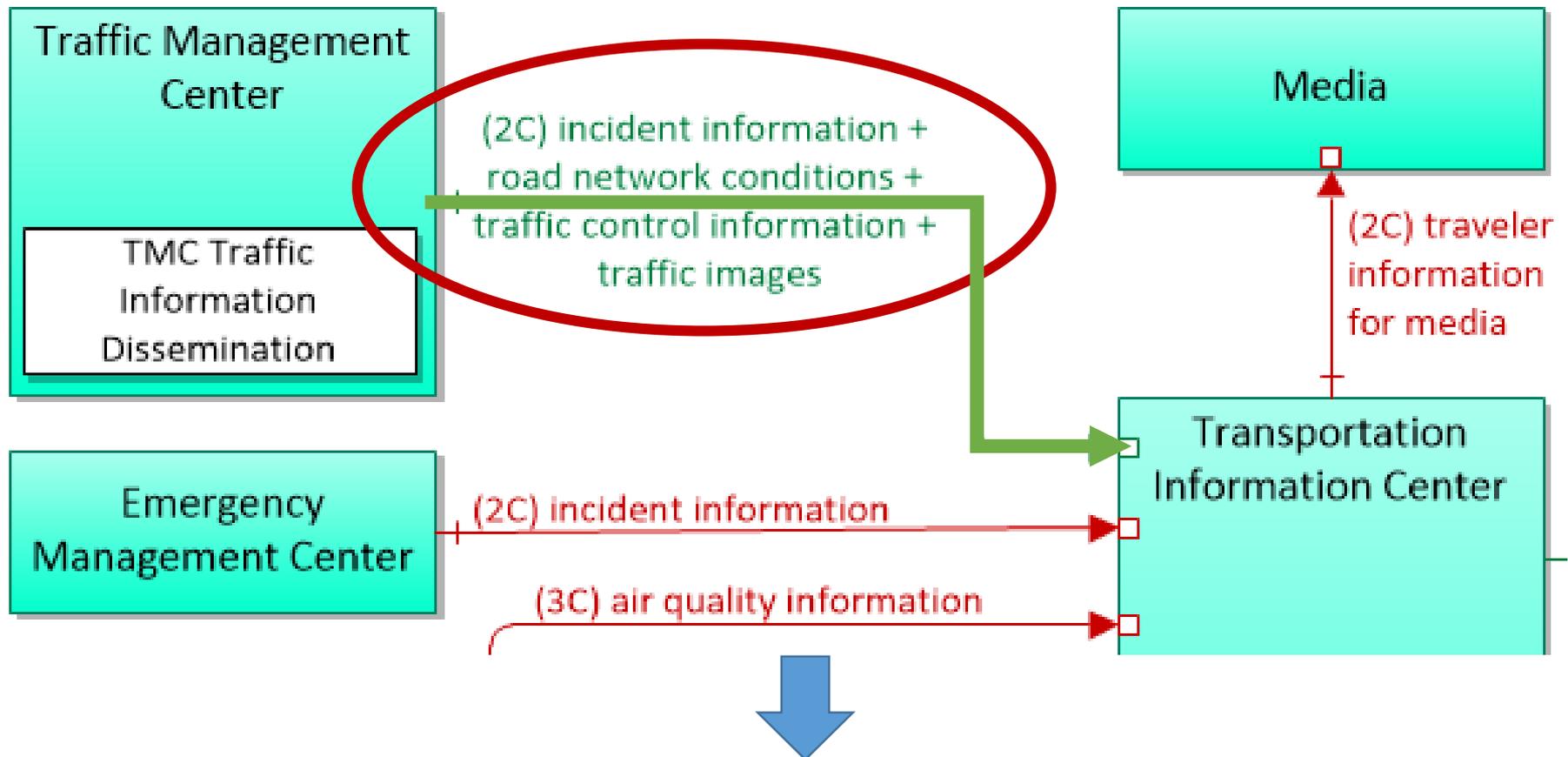
## Service packages depict information flows



**EXAMPLE**

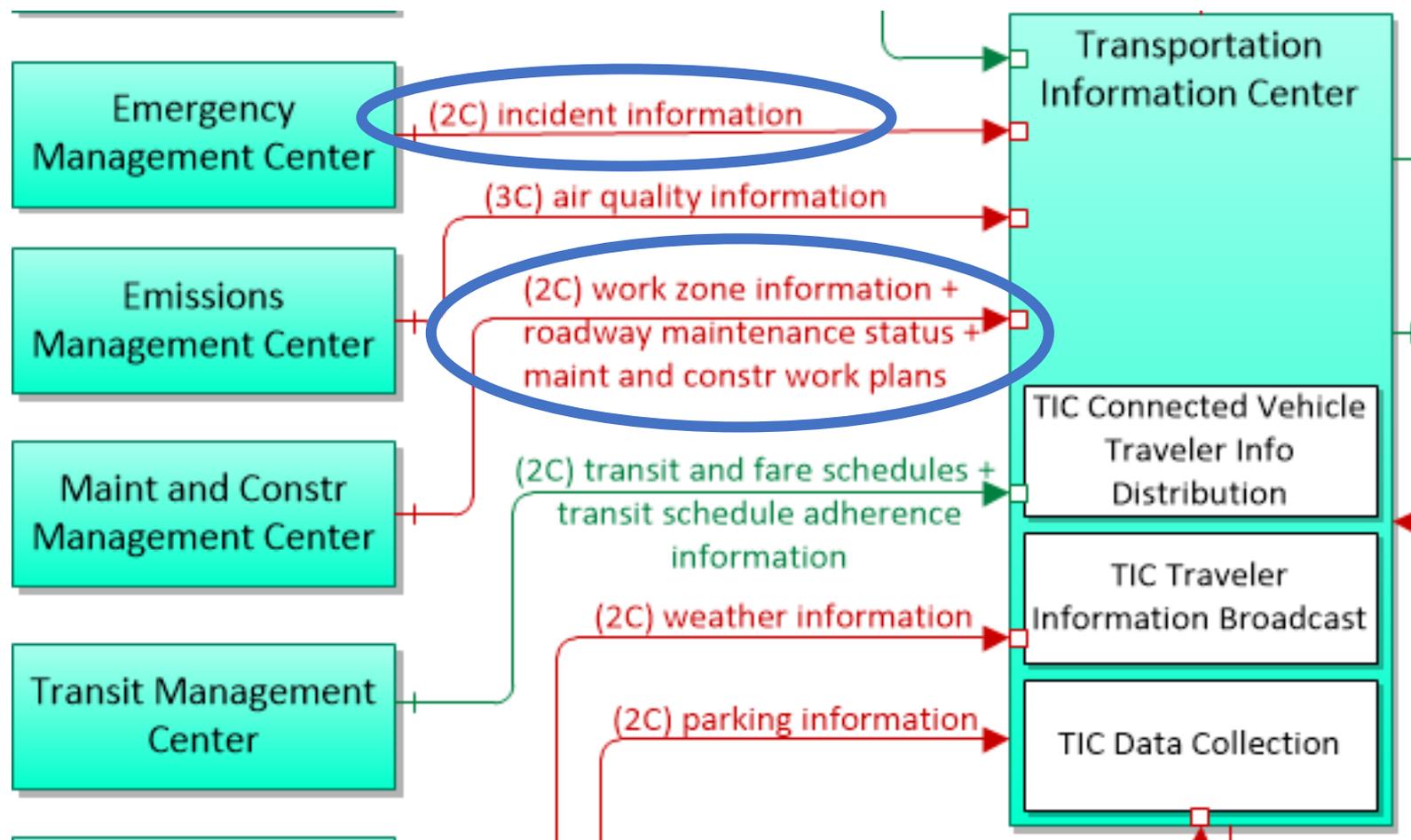
# Understand C2C Communications

## C2C RI focuses on Traffic Management flows



# Understand C2C Communications

Same flows may be provided by other centers



# Understand C2C Communications

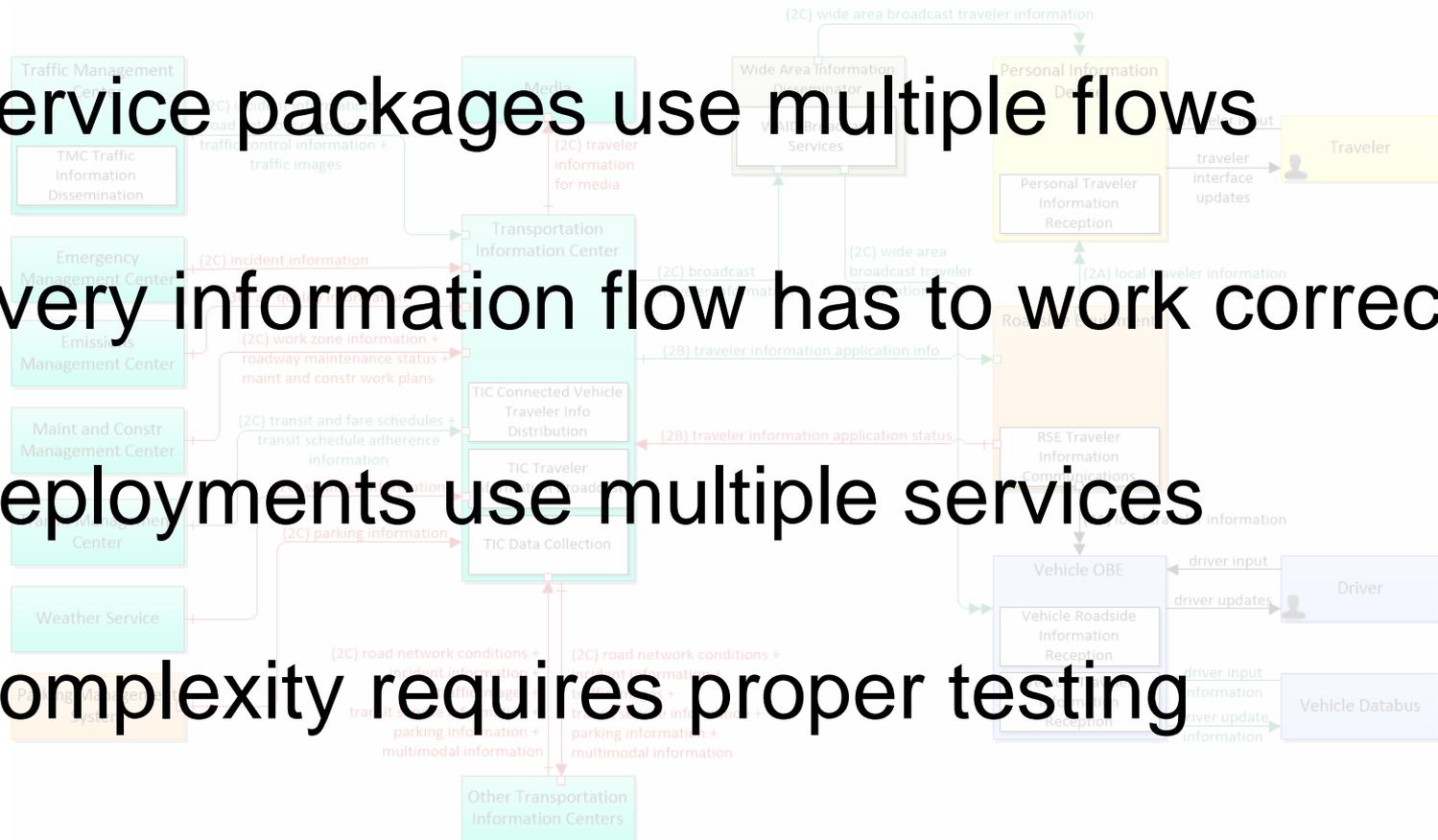
## Complex systems require proper testing

Service packages use multiple flows

Every information flow has to work correctly

Deployments use multiple services

Complexity requires proper testing



Advanced Traveler Information Systems		
7	Physical: Broadcast Traveler Information	Jul 8, 2015 NAT

# Purpose of the C2C RI

## Testing verifies interoperability

**Interoperability** is the main purpose of ITS Standards

*The ability of two or more systems or components to exchange information and use the information that has been exchanged* -- IEEE 610.12

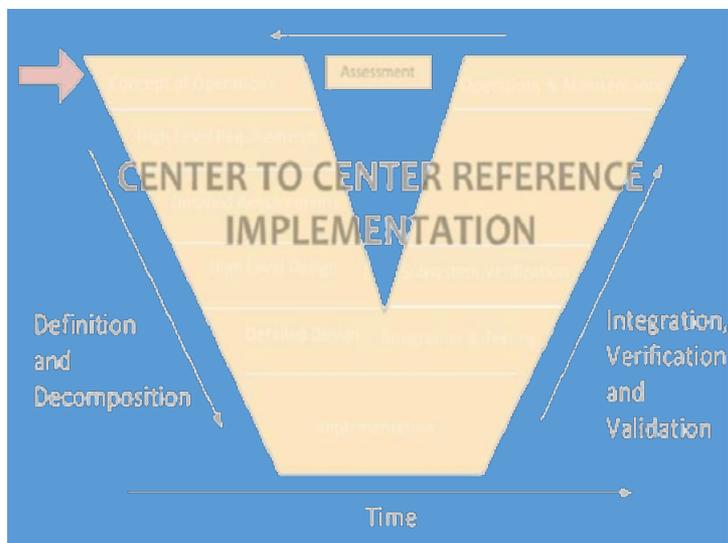
To realize interoperability, we need:

- User needs (Module A321a)
- Requirements (Module A321b)
- Design (TMDD Standard)
- Verification (Module T321)
- Validation (Module T321)

# Purpose of the C2C RI

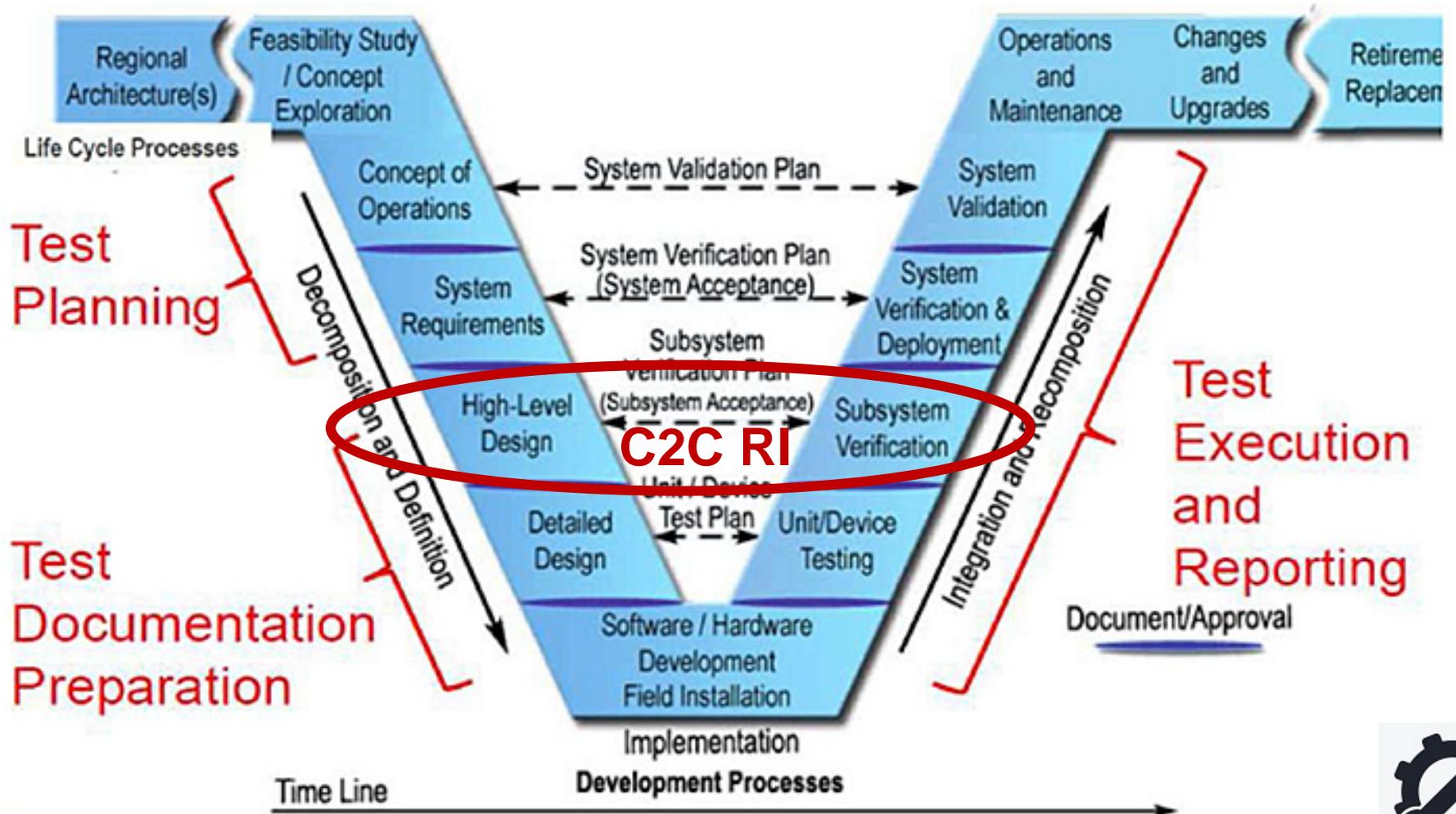
Verification is a key step in Systems Engineering

Version 2



# Purpose of the C2C RI

Subsystem verification is midway through right side



# Purpose of the C2C RI

**C2C RI is customizable to your project**

Three operational modes of the RI

- **Configure:** Define which flows are implemented, etc.
- **Test:** Verify that the flows are properly implemented
- **Report:** Tests performed and errors discovered

# C2C RI Communications Stack

Architecture, standards, and C2C RI work together

Traffic Management Center --> Transportation Information Center  
incident information

Definition

Included In

Communication Diagrams

Characteristics

Security

## Definitions

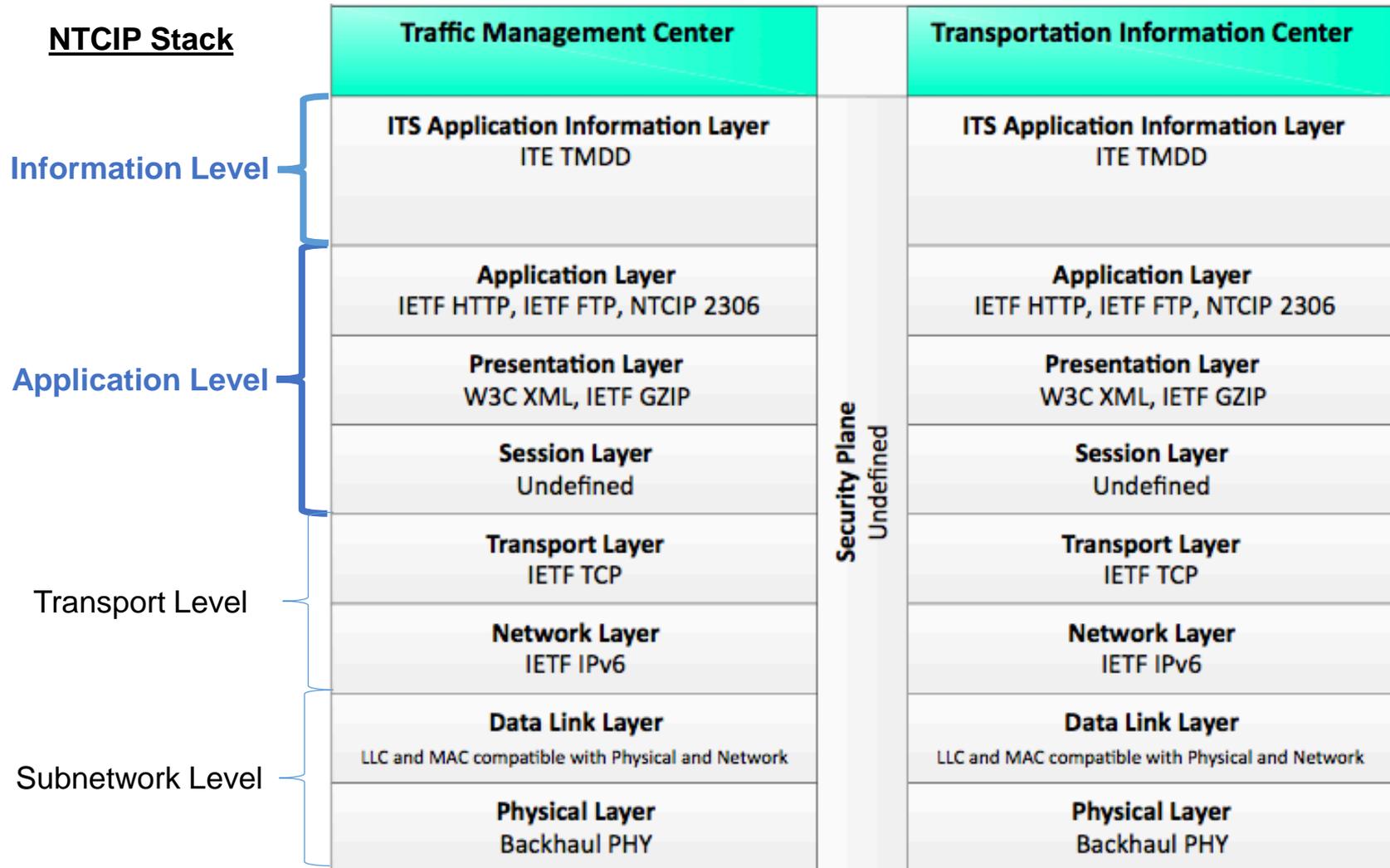
**incident information (Information Flow):** Notification of existence of incident and expected severity, location, and additional information is gathered and the incident evolves, updated incident information is provided. Incidents range from transportation system operation ranging from routine incidents (e.g., disabled vehicle at the side of the road) to major incidents caused disasters that involve loss of life, injuries, extensive property damage, and multi-jurisdictional response. Includes planned closures, and other planned events that may impact the transportation system.

**Traffic Management Center (Source Physical Object):** The 'Traffic Management Center' monitors and controls traffic flow and represents centers that manage a broad range of transportation facilities including freeway systems, rural and suburban traffic control systems. It communicates with ITS Roadway Equipment and Connected Vehicle Roadside Units to manage traffic flow and monitor the condition of the roadway, surrounding environmental conditions, and field emergency transportation resources to support allied agencies in responding to, and recovering from, incidents ranging from minor incidents to disasters.

**Transportation Information Center (Destination Physical Object):** The 'Transportation Information Center' receives and processes incident information and provides information to the Traffic Management Center.

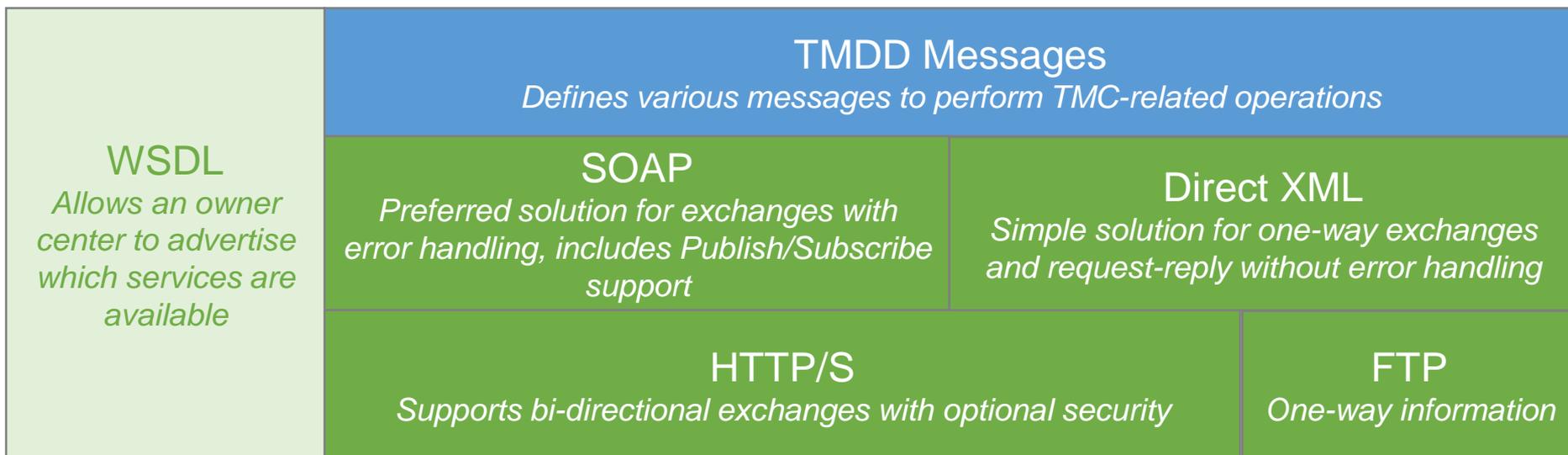
# C2C RI Communications Stack

## Architecture identifies the standards in the stack



# C2C RI Communications Stack

## Detailed view of the layers tested by C2C RI



■ **TMDD: Traffic Management Data Dictionary for C2C Communications**

■ **NTCIP 2306: XML Message Encoding and Transport in ITS C2C Communications**

TMDD – Traffic Management Data Dictionary

SOAP – Simple Object Access Protocol

XML – eXtensible Markup Language

HTTP/S – Hypertext Transfer Protocol with optional Security

FTP – File Transfer Protocol

WSDL – Web Services description Language

*See Supplement for full list of acronyms*

**SUPPLEMENT**

# C2C RI Communications Stack

## What does the C2C RI support?

C2C RI is able to **verify**:

- TMDD v3.03c
- NTCIP 2306 v1.69
- Over standard Internet stack

Others with user-customized test procedures

# C2C RI Communications Stack

## How do I obtain the C2C RI?

Download at:

<https://www.standards.its.dot.gov/DeploymentResources/Tools>

**FREE!**

User Manual is included in installation files

Technical support via e-mail at: [c2crisupport@transcore.com](mailto:c2crisupport@transcore.com)



# ACTIVITY



# Question

Which standard is not supported by the C2C RI (without customization)?

## Answer Choices

- a) Internet Protocol (v4)
- b) XML Center-to-Center Profile (NTCIP 2306 v1.69)
- c) Transit Communications Interface Profiles (TCIP v5.0)
- d) Traffic Management Data Dictionary (TMDD v3.03c)

# Review of Answers



a) Internet Protocol

*Incorrect. The C2C RI uses IP for all communications and allows the user to configure the IP address.*



b) XML Center-to-Center Profile (NTCIP 2306)

*Incorrect. The C2C RI includes a suite of tests to verify that a test system conforms to NTCIP 2306.*



c) Transit Communications Interface Profiles (TCIP)

***Correct! The C2C RI does not include a test suite for transit data; however, a custom test suite could be developed.***



d) Traffic Management Data Dictionary

*Incorrect. The C2C RI includes a suite of tests to verify that a test system conforms to the TMDD.*

# Learning Objectives

Recognize **purpose** of C2CReference Implementation

Acknowledge **key capabilities and limitations**  
of the C2C RI

## Learning Objective 2

Acknowledge  
**key capabilities and  
limitations**  
of the C2C RI

# Operational Environment Required

## Recommended Minimum System Requirements

- Windows 7 or 8
  - 64-bit Professional
- 2 GHz processor
- 4 GB RAM
- 1 GB Storage
- 1 Gbps Ethernet interface
- Java SE Runtime Environment (JRE) V7.17

# Capabilities and Limitations

## What are current limitations?

User needs **extensive skillset**

Information Layer limited to **TMDD**

Application Layer limited to **NTCIP 2306**

# Skills Required to Use C2C RI

## Skills Needed

-  Encoding languages
-  Protocols
-  Windows networking
-  ITS standards
-  Testing experience
-  Scripting language
-  System under test



# Skills Required to Use C2C RI

## Necessary encoding language skills

Basic understanding of:



- XML
  - eXtensible Markup Language
- XSD
  - XML Schema Definition
- WSDL
  - Web Services Description Language

Basic understanding means:

- Familiar with **basic structures** defined by standards
- Capable of **developing and inspecting** packets and/or documents, as needed

# Skills Required to Use C2C RI

## Necessary protocol skills

Basic understanding of:

- SOAP (if used)
  - Simple Object Access Protocol
  
- HTTP and/or FTP (as used)
  - Hypertext Transfer Protocol
  - File Transfer Protocol
  
- TCP/IP networking
  - Transport Control Protocol
  - Internet Protocol



# Skills Required to Use C2C RI

## Necessary IT networking skills

**Basic understanding** and **permissions** for configuring Windows:



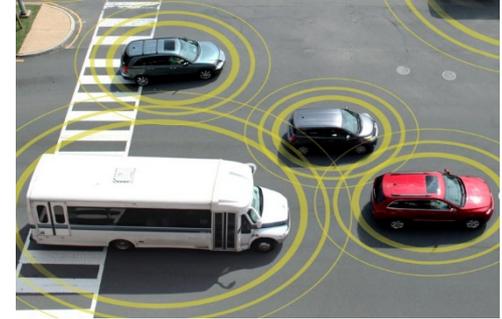
- Internet security

# Skills Required to Use C2C RI

## Necessary ITS standards skills

Thorough understanding of:

- **Information** Layer standards (e.g., TMDD v3.03c)
- **Application** Layer standards (e.g., NTCIP 2306 v1.69)



Thorough understanding means:

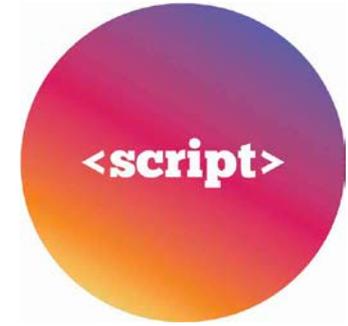
- Familiar with **basic structure** of standards
- Understand **conformance**
- Understand **compliance** (options)
- Understand **traceability** (NRTM and RTM)
- Capable of **quickly referencing** all details



# Skills Required to Use C2C RI

## Necessary programming skills

To create **custom test suites**, you also need to know how to:



- Define your custom **user needs**
- Define your custom **requirements**
- Write C2C test **script files**
- Combine this information into a **test suite** package

Detailed process will be included in the User Manual

# Skills Required to Use C2C RI

## Other necessary knowledge

### Knowledge of **System Under Test (SUT)**

- Custom **configuration** for each system
- Based on supported **user needs and requirements**



### **Permissions** to operate the SUT



C2C RI



SUT

Source: NYCDOT

# Skills Required to Use C2C RI

## Skill set summary

-  Encoding languages
-  Protocols
-  Windows networking
-  ITS standards
-  Testing experience
-  Scripting language
-  System under test



# What Functions Can Be Tested

## What does the C2C RI test?

- **Standards**

- NTCIP 2306 v1.69
- TMDD v3.03c

- **Center Type**

- Owner center emulation
- External center emulation

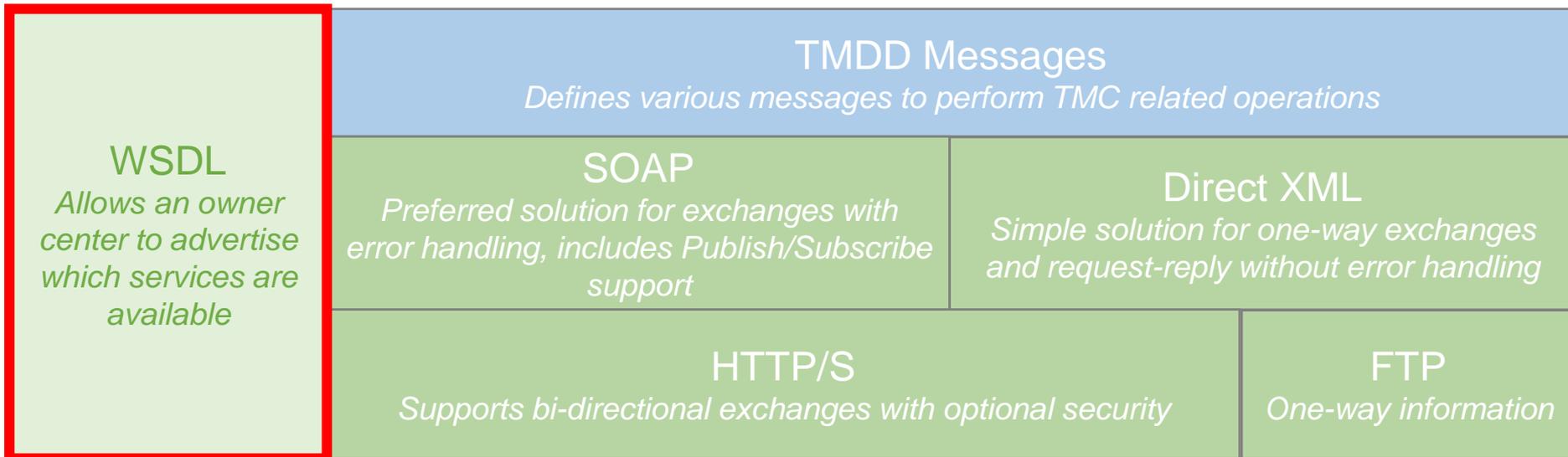
- **Types of Tests**

- Valid conditions
- Invalid conditions



# What Functions Can Be Tested

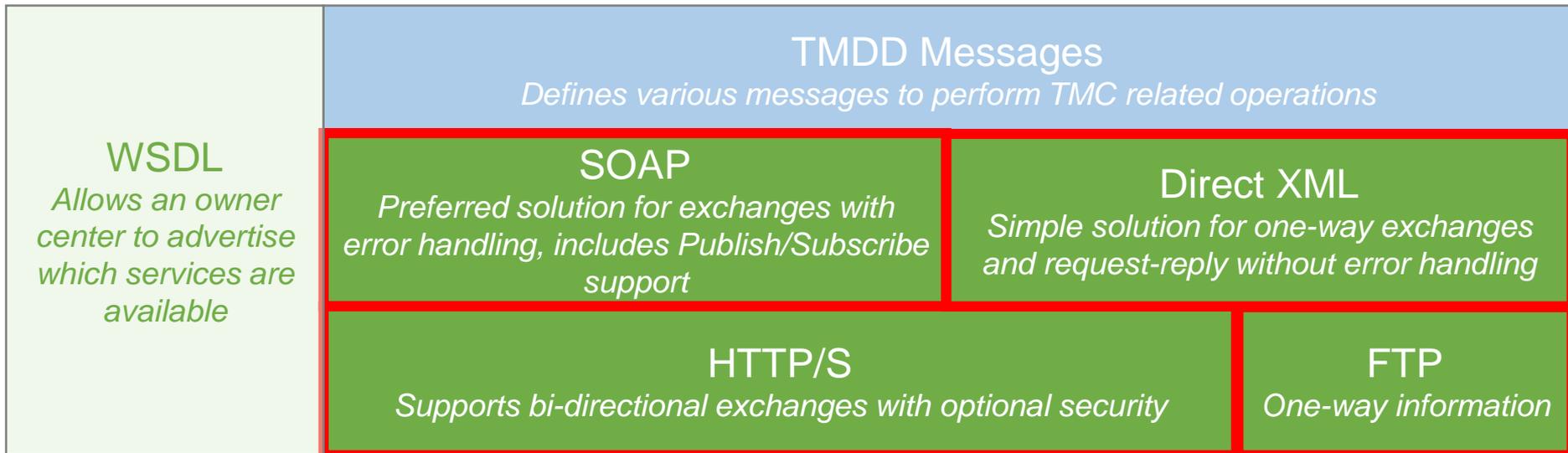
## Sample test cases for NTCIP 2306



- For **NTCIP 2306**, C2C RI verifies that a system:
  - **Advertises** its web services in a conformant manner
    - Ensures advertised file is conformant
    - Ensures advertised file supports the required interfaces

# What Functions Can Be Tested

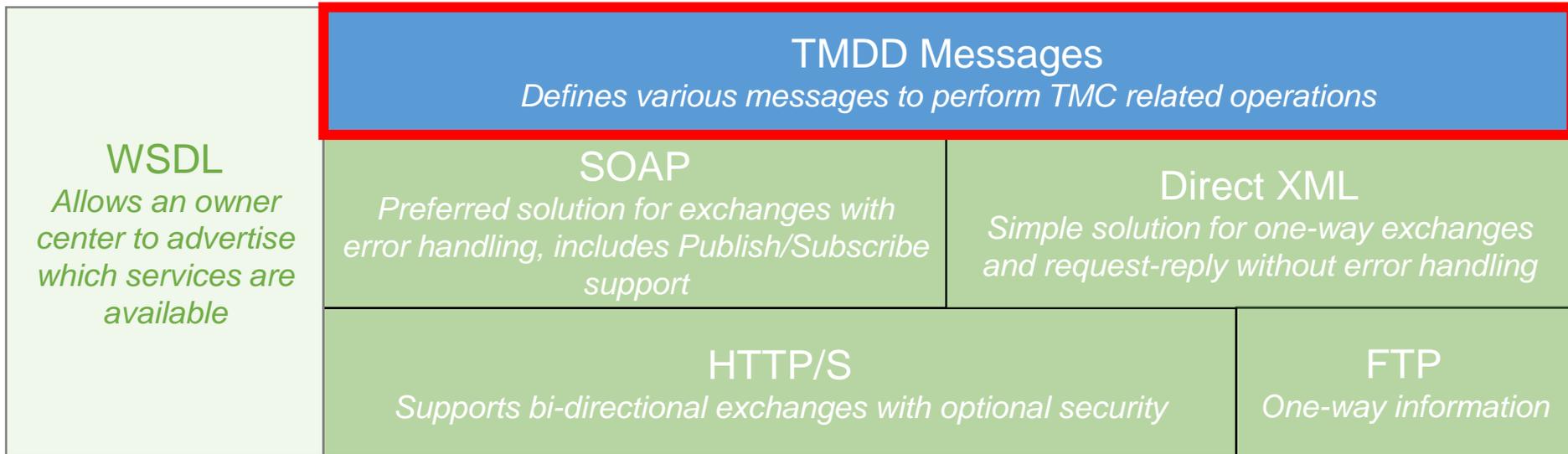
## Sample test cases for NTCIP 2306



- Is **able to connect** through the required and advertised interface(s)
  - Defined communication stacks
  - Defined exchange patterns
    - Request/Reply
    - Subscription/Publication
    - Publication only

# What Functions Can Be Tested

## Sample C2C RI test cases for TMDD



- For the **TMDD**, the C2C RI verifies that a system:
  - Supports a **valid request**
  - Properly handles **invalid requests**
    - Missing fields
    - Incorrect values
    - Etc.
  - Similar tests, **reversed**, when C2C RI acts as an Owner Center

# Unavailable/Planned Functions

## What are planned enhancements?

- Enhanced emulation
  - If RI is acting as Owner Center:
    - RI responds to EC requests, such as:
      - Inventory request
      - Status request
      - Information request
      - Control request

### Version 1

Response message is **statically** determined based on

- A user-defined configuration file

### Version 2

Response message is **dynamically** determined based on

- A user-defined configuration file and
- The contents of the request
  - E.g., if the request contains filters, the response may contain only a subset of the configuration file

# Unavailable/Planned Functions

## What are planned enhancements?

Version 2

- Verification for compliance to §1201 of SAFETEA-LU

Information Layer Standard Conformance Report

UN ID	User Need		Results	
2.3.1.1	Verify Connection Active		Passed	
		Requirement ID	Related DXFS Requirement	Results
		3.3.1.1.1	3.4.1.1.1	Passed
		3.3.1.1.2	3.4.1.1.2	Passed
		3.3.1.1.3	3.4.1.1.3	Passed
		3.3.1.1.4	3.4.1.1.4	No Test Cases Applicable in this Test Mode
		3.3.1.1.4.1	3.4.1.1.5	No Test Cases Applicable in this Test Mode
		3.3.1.1.5	3.4.1.1.6	Passed

Reference to Standard req'ts

Reference to §1201 req'ts

Results of testing each requirement

# ACTIVITY



# Question

What skill is not needed to use the C2C RI?

## Answer Choices

- a) Windows networking
- b) X.509 certificates
- c) HTTP
- d) WSDL

# Review of Answers



a) Windows networking

*Incorrect. The user needs to be able to configure the RI host to support incoming messages.*



b) X.509 certificates

***Correct! The user does not necessarily need to understand how X.509 certificates work as they are not required.***



c) HTTP

*Incorrect. The user needs to be aware of HTTP as this is often used as an underlying protocol for NTCIP 2306.*



d) WSDL

*Incorrect. The user needs to be familiar with WSDL as this is how the interface to the system is described.*

# Learning Objectives

Recognize **purpose** of C2C Reference Implementation

Acknowledge **key capabilities and limitations**  
of the C2C RI

Follow process for **producing test documentation**  
that relies upon the C2C RI

## Learning Objective 3

Follow process for  
**producing test documentation**  
that relies upon the C2C RI

# IEEE 829 Test Documentation

## Relationships of IEEE 829-2008 test documents



For more information see modules

- T101: Introduction to Standards Testing
- T201: How to Write a Test Plan
- T202: Test Design, Cases & Procedures
- T203: How to Develop Test Cases
- T204: How to Develop Test Procedures
- T321: Applying your Test Plan to TMDD



# Test Plan for C2C

## Test plan is a high level document



- Types
  - Master Test Plan
  - Level Test Plan
- Context
- Project management issues
- Reference to test design

# Test Plan for C2C

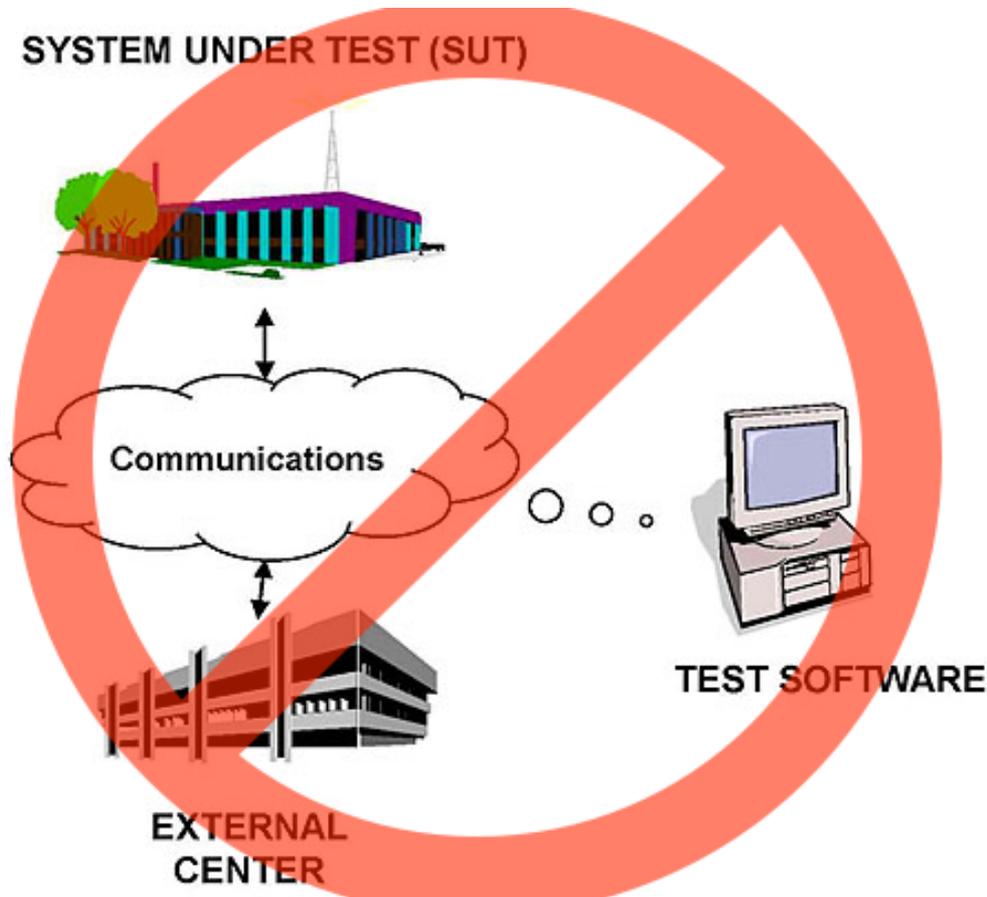
## Example C2C RI test plan context

### Test plan using C2C RI

- **Communications**/Functional/Environmental
- Factory/**Laboratory**/On-Site
- **Verification**/Validation
- **Component**/Integration
- **Acceptance**/Deployment
- Which standards? (**NTCIP 2306**, **TMDD**, any custom extensions)

# Test Plan for C2C

C2C RI is an active emulator, not just a sniffer



Example Test Environment in Module T321

# Test Plan for C2C

## C2C RI does not develop a test plan

Test plan is not covered by C2C RI

- Test plan is a management plan that should be defined before using C2C RI
- Outline defined by IEEE 829-2008 and provided in Student Supplement

SUPPLEMENT

# Test Design for C2C

## Test design defines traceability from requirements



Test Plan

- Context and reference to...

Test Design

- Specific requirements to be tested and reference to...

Test Cases

- Specific scenarios to test

# Test Design for C2C

## Test design example

### Test Plan

- Verify TMDD interface in a **laboratory environment** for approval of Stage 1 payment

### Test Design 1

- Verify that the system supports **SOAP message encodings**
  - Reference to appropriate test cases

### Test Design 2

- Verify that the system supports **connection active requests**
  - Reference to appropriate test cases

# Test Design for C2C

## Test Design Specifications for TMDD

Table 5: TMDD v3.03c Test Case to Requirements Mapping

Need ID	Test Case Identifier	Requirements
2.3.1.1	TCS-1-dlCenterActiveVerificationRequest-OC-Valid	3.3.1.1.1, 3.3.1.1.5, 3.3.1.1.5.1, 3.3.1.1.5.2.1
	TCS-1-dlCenterActiveVerificationRequest-OC-InValid-1	3.3.1.1.1, 3.3.1.4.1, 3.3.1.4.1.1, 3.3.1.4.1.2.1
	TCS-1-dlCenterActiveVerificationRequest-OC-InValid-2	3.3.1.1.1, 3.3.1.4.1, 3.3.1.4.1.1, 3.3.1.4.1.2.1
	TCS-1-dlCenterActiveVerificationRequest-OC-InValid-3	3.3.1.1.1, 3.3.1.4.1, 3.3.1.4.1.1, 3.3.1.4.1.2.1
	TCS-1-dlCenterActiveVerificationRequest-OC-InValid-4	3.3.1.1.1, 3.3.1.4.1, 3.3.1.4.1.1, 3.3.1.4.1.2.1
	TCS-1-dlCenterActiveVerificationRequest-OC-InValid-5	3.3.1.1.1, 3.3.1.4.1, 3.3.1.4.1.1, 3.3.1.4.1.2.1

**EXAMPLE**

# Test Design for C2C

## Test designs in the RI Reports

Complete traceability table available on request

### Version 1

- Includes a built-in traceability table
- Shows every test that traces to any selected requirement
- Allows user to select when to perform the tests

### Version 2

Also allows user-generated traceability report

# Test Case for C2C

## Role of test case



Test Design

- Specific requirements to be tested and reference to...

Test Cases

- Specific scenarios, including objective, inputs, outputs, and reference to...

Test Procedures

- Specific process used to test

# Test Case for C2C

## Test case example

### Test Design 1

- Verify that the system supports SOAP message encodings

### Test Case 1

- Ensure that the system accepts valid SOAP messages
  - Input: Valid TMDD file
  - Output: System accepts message without error
  - Procedure: <reference>

### Test Case 2

- Ensure that the system rejects an invalid SOAP message (type element)
  - Input: TMDD file with invalid type element
  - Output: System rejects message with distinct error code
  - Procedure: <reference>

# Test Case for C2C

## 2306 Test Case Specification

### 69.1 Test Case Specification Identifier

Identifier	Description
TCS-C2CRI-NTCIP2306-WSME-SUT-SHRR-OC	To verify that the SUT can communicate with the RI using the protocol stack for SOAP over HTTP with Request-Response defined in the SUT's WSDL document.

### 69.3 Input Specifications

Inputs	Procedures
The WSDL input file will be user defined for the owner center.	TPS-NTCIP2306-SOAP-RR-OC

### 69.4 Output Specifications

Outputs	Procedures
The input execution shall generate an RI Test Result Status of Passed or Failed associated with the matching expected result shown in the Test Case Data Variable Table in the appendix.	

**EXAMPLE**

# Test Case for C2C

## Test cases in the RI Reports

Supplement contains a complete example of the Test Case Specification

### Version 1

- Shows test case descriptions within tool

### Version 2

- Will also allow a user to print reports showing test cases

SUPPLEMENT

# Test Procedure for C2C

## Role of test procedure



Test Case

- Specific scenarios, including objective, inputs, outputs, and reference to...

Test Procedures

- Step-by-step process used to test

Test Steps

- Specific actions of tester

# Test Procedure for C2C

## Test procedure example

### Test Case

- Ensure that the system **accepts valid SOAP messages**
  - Input: Valid TMDD file
  - Output: System accepts message without error
  - Procedure: <reference>

### Test Procedure defines steps such as

- **Configure** the Application Layer standard to be used
- **Verify** that the specified WSDL file exists
- **If** the file is acceptable, **do** ...
- **Send** message ...

# Test Procedure for C2C

## TMDD Test Procedure

Test Step Number	Test Procedure	Results
1	<b>CONFIGURE:</b> Determine the Application Layer Standard that will be used for this test. RECORD this information as: ApplicationLayerStandard	NA
2	CONFIGURE: Determine the dialog performance requirement for Send Center Active Verification Upon Request (NRTM 3.3.1.1.1). RECORD this value as: TMDD_N1R1_Send_Center_Active_Verification_Upon_Request_Parameter	NA
3	CONFIGURE: Determine whether Restrictions - Center Active is required by the specification. (NRTM 3.3.1.1.5.2.1). RECORD this information as: TMDD_N1R8_Restrictions_Center_Active_Supported	NA
4	CONFIGURE: Determine whether Restrictions - Error Report is required by the specification. (NRTM 3.3.1.4.1.2.1). RECORD this information as: TMDD_N1R14_Restrictions_Error_Report_Supported	NA
5	CONFIGURE: Define the message that will be sent to the SUT. RECORD this information as: RequestMessage	NA
6	CONFIGURE: Determine whether an error response message is expected for this test. RECORD this information as: ErrorResponseExpected	NA
7	CONFIGURE: IF ErrorResponseExpected is true, determine the expected error code response for this test. RECORD this information as: ErrorTypeExpected	NA
8	<b>REQUEST-RESPONSE-EC</b> with the following parameters: DIALOG=dlCenterActiveVerificationRequest RESPONSETIMERREQUIRED=TMDD_N1R1_Send_Center_Active_Verification_Upon_Request_Parameter REQUESTMESSAGE = RequestMessage	PASS/FAIL (3.3.1.1.2, 3.4.2)

**EXAMPLE**

# Test Procedure for C2C

## Implemented test procedures

Supplement contains a complete example of this test procedure

### Version 1

- Built in procedures implemented in scripts

### Version 2

- Will allow a user to print test procedures

# ACTIVITY



# Question

**Which test document requires information from sources beyond the C2C RI?**

## Answer Choices

- a) Test plan
- b) Test design specification
- c) Test cases
- d) Test procedures

# Review of Answers



a) Test plan

**Correct! The test plan is a high-level document and contains management information beyond the scope of the the C2C RI.**



b) Test design specification

*Incorrect. The C2C RI Configuration Report allows the user to map between the requirements and associated test cases.*



c) Test cases

*Incorrect. The C2C RI Configuration Report identifies the test script used for each test case.*



d) Test procedures

*Incorrect. The C2C RI Test Script Report provides the test scripts as implemented in the C2C RI tool.*

# Learning Objectives

Recognize **purpose** of C2C Reference Implementation

Acknowledge **key capabilities and limitations**  
of the C2C RI

Follow process for **producing test documentation**  
that relies upon the C2C RI

Recognize **results** a tester might produce  
after using the C2C RI

## Learning Objective 4

Recognize **results**  
a tester might produce  
after using the C2C RI

# Hands-On Guidance

## Benefits of C2C RI



## C2C RI

- Largely automates testing
  - Simpler
  - More repeatable
  - Less prone to error
- Decreases costs
  - Labor
  - Schedule
- Increases thoroughness
  - Improves quality of product
  - Identifies bugs faster/earlier



See Module T351 for more information

# C2C RI Test Reports

## Types of Reports



Assist in developing formal test reports:

- Test logs
- Anomaly reports
- Test summary

C2C RI test reports

- Test logs
- Test summaries



# C2C RI Test Reports – Test Logs

## Purpose of Log

### Purpose of a Test Log

- Chronological record of details
- Assists in repeating process
- Assists in debugging

PURPOSE



# C2C RI Test Reports – Test Logs

## C2C RI Test Log Reports

- Test Case Detail Log Report
- Test Script Action Log Report
- Message Detail Report



# C2C RI Test Reports – Test Logs

## Test Case Detail Log

### Purpose of a Test Case Detail Log

- Logs test steps in order of execution
- Logs values used and calculations made
- Logs results of pass/fail steps
- Summarizes reason for failure
- Timestamp
- Script being executed

PURPOSE



# C2C RI Test Reports – Test Logs

## Test Case Detail Log Report

C2C RI Version: Version 1.0.7

Created by: MInsignares

Test Suites:

Application: NTCIP 2306 v1.69

Information: TMDD v3.03c

08/09/2016 11.20 AM

<b>Log File Name:</b>	C:\c2cri\TRANSCOM Stand-alone Test 2 Run 2.2016-08-09_10-31-35.xml
<b>Log File Creator:</b>	MInsignares
<b>Log File Creation Date:</b>	2016-08-09_10-31-35
<b>Log File Description:</b>	Second run of the TRANSCOM Stand-alone test 2, circumventing a problem discovered in the

Back-ground

Time	Test Case Name	Test Step Description	Pass/Fail	Fail Reason
09/08/2016 10.31.56.368	TCS-C2CRI-NTCIP2306-WSDL-SUT		FAILED	
09/08/2016 10.32.00.879		Step 1 CONFIGURE: Determine the URL for the WSDL file that will be used for this test. RECORD this information as: WSDLFile = http://standards2.xcmdata.org:8080/MiddlewareOutbound/wsd/XCM-TMDD.wsdl	PASSED	
09/08/2016		Step 2 CONFIGURE:	PASSED	

Detail

**EXAMPLE**

# C2C RI Test Reports – Test Logs

## Test Script Action Log

### Purpose of a Test Script Action Log

- Primarily a tool for debugging test scripts
- Chronological log of the start and end of each test script
- Logs results of the test script
- Filenames and line numbers
- Shows timestamps

PURPOSE



# C2C RI Test Reports – Test Logs

## Test Script Action Log Report

TimeStamp	Test Script Action	Results
09/08/2016 10.31.54.539	User Started the Test with selected Test Case Scripts:Application Layer: TCS-C2CRI-NTCIP2306-WSDL-SUT	
09/08/2016 10.31.56.352	testCase - Begin Script: jar:file:/C:/C2CRI/dist/RIGUI.jar!/org/fhwa/c2cri/testmodel/TestCaseLauncher.xml line: 14 column: 58	
09/08/2016 10.31.56.664	ri-execute-script - Begin Script: jar:file:/C:/C2CRI/dist/RIGUI.jar!/org/fhwa/c2cri/testmodel/TestCaseLauncher.xml line: 22 column: 79 functionId: TCS-C2CRI-NTCIP2306-WSDL-SUT	
09/08/2016 10.32.00.879	testStep - Begin Script: jar:file:/C:/C2CRI/./TestSuites/NTCIP2306v01_69Signed.jar!/AppLayer/Scripts/TPS-NTCIP2306-WSDL.xml line: 13 column: 187 functionId: Step 1 CONFIGURE: Determine the URL for the WSDL file that will be used for this test. RECORD this information as: WSDLFile =	
09/08/2016 10.32.00.895	testStep - End Script: jar:file:/C:/C2CRI/./TestSuites/NTCIP2306v01_69Signed.jar!/AppLayer/Scripts/TPS-NTCIP2306-WSDL.xml line: 13 column: 187 functionId: Step 1 CONFIGURE: Determine the URL for the WSDL file that will be used for this test. RECORD this information as: WSDLFile =	PASSED

**EXAMPLE**

# C2C RI Test Reports – Test Logs

## Message Detail Report

- Purpose of a Message Detail Report
  - Logs the messages that are transmitted/received
  - Source and destination
  - Shows complete details of contents
  - Shows timestamps

PURPOSE



# C2C RI Test Reports – Test Logs

## Message Detail Report

<b>Log File Name:</b>	C:\c2cri\TRANSCOM Stand-alone Test 2 Run 2.2016-08-09_10-31-35.xml
<b>Log File Creator:</b>	MInsignares
<b>Log File Creation Date:</b>	2016-08-09_10-31-35
<b>Log File Description:</b>	Second run of the TRANSCOM Stand-alone test 2, circumventing a problem discovered in the

Time	Message	Source	Destination
08/09/16 10:33:24.605	REQUEST(centerActiveVerificationRequestMsgErrorAddOn)	192.168.2.168:64673	160.79.9.145:8080
<pre>tmdd:centerActiveVerificationRequestMsgErrorAddOn.authentication.user-id = tmdd tmdd:centerActiveVerificationRequestMsgErrorAddOn.authentication.password = tmdd@123 tmdd:centerActiveVerificationRequestMsgErrorAddOn.authentication.operator-id = string tmdd:centerActiveVerificationRequestMsgErrorAddOn.organization-requesting.organization-id = agency.com tmdd:centerActiveVerificationRequestMsgErrorAddOn.organization-requesting.organization-name = string tmdd:centerActiveVerificationRequestMsgErrorAddOn.organization-requesting.organization-location = stringstri tmdd:centerActiveVerificationRequestMsgErrorAddOn.organization-requesting.organization-function = string tmdd:centerActiveVerificationRequestMsgErrorAddOn.organization-requesting.organization-contact-details.contact-id = string tmdd:centerActiveVerificationRequestMsgErrorAddOn.organization-requesting.organization-contact-details.person-name = string tmdd:centerActiveVerificationRequestMsgErrorAddOn.organization-requesting.organization-contact-details.person-title = string tmdd:centerActiveVerificationRequestMsgErrorAddOn.organization-requesting.organization-contact-details.phone-num string</pre>			



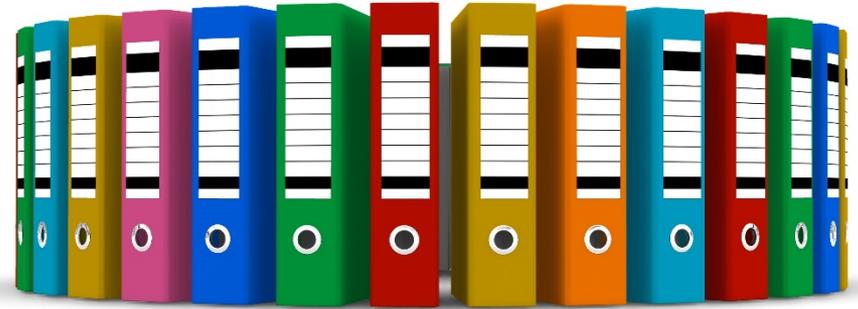
# C2C RI Test Reports – Test Summaries



# C2C RI Test Reports – Test Summaries

## C2C RI Test Summary Reports

- Test Case Summary
- Test Message Summary
- Test Conformance/Compliance



Version 2

- **Section 1201 Conformance/Compliance**

# C2C RI Test Reports – Test Summaries

## Test Case Summary Report

### Purpose of a Test Case Summary Report

- Identifies test cases performed, in order
- Identifies each performance as passed/failed
- Timestamp

PURPOSE



# C2C RI Test Reports – Test Summaries

## Test Case Summary Report

<b>Log File Name:</b>	C:\c2cr\TRANSCOM Stand-alone Test 2.2016-08-09_09-31-32.xml
<b>Log File Creator:</b>	MInsignares
<b>Log File Creation Date:</b>	2016-08-09_09-31-32
<b>Log File Description:</b>	TRANSCOM Stand-alone Test 2. Aug 9 2016. C2C RI 1.0.7.

<b>Time</b>	<b>Test Case Name</b>	<b>Pass/Fail</b>
Tue Aug 09 09:32:34 EDT 2016	TCS-1-dlCenterActiveVerificationRequest-OC-InValid-2	FAILED
Tue Aug 09 09:42:29 EDT 2016	TCS-1-dlCenterActiveVerificationRequest-OC-InValid-2	PASSED
Tue Aug 09 09:42:58 EDT 2016	TCS-1-dlCenterActiveVerificationRequest-OC-InValid-3	PASSED
Tue Aug 09 09:43:16 EDT 2016	TCS-1-dlCenterActiveVerificationRequest-OC-InValid-4	PASSED
Tue Aug 09 09:43:34 EDT 2016	TCS-1-dlCenterActiveVerificationRequest-OC-InValid-5	PASSED
Tue Aug 09 09:43:52 EDT 2016	TCS-1-dlCenterActiveVerificationRequest-OC-InValid-6	PASSED

**EXAMPLE**

# C2C RI Test Reports – Test Summaries

## Test Message Summary Report

### Purpose of a Test Message Summary Report

- Logs summary of messages transmitted/received
- Shows source and destination
- Shows timestamps

PURPOSE



# C2C RI Test Reports – Test Summaries

## Test Message Summary Report

<b>Log File Name:</b>	C:\c2cri\TRANSCOM Stand-alone Test 2 Run 2.2016-08-09_10-31-35.xml
<b>Log File Creator:</b>	MInsignares
<b>Log File Creation Date:</b>	2016-08-09_10-31-35
<b>Log File Description:</b>	Second run of the TRANSCOM Stand-alone test 2, circumventing a problem discovered in the

<b>Time</b>	<b>Message</b>	<b>Source</b>	<b>Destination</b>
08/09/16 10:33:24.605	REQUEST (centerActiveVerificationRequestMsgErrorAddOn)	192.168.2.168:64673	160.79.9.145:8080
08/09/16 10:33:24.605	RESPONSE (errorReportMsg)	160.79.9.145:8080	192.168.2.168:64673
08/09/16 10:33:43.315	REQUEST (centerActiveVerificationRequestMsg)	192.168.2.168:64683	160.79.9.145:8080
08/09/16 10:33:43.315	RESPONSE (errorReportMsg)	160.79.9.145:8080	192.168.2.168:64683
08/09/16 10:34:00.837	REQUEST (Unknown)	192.168.2.168:64693	160.79.9.145:8080
08/09/16 10:34:00.837	RESPONSE (errorReportMsg)	160.79.9.145:8080	192.168.2.168:64693



# C2C RI Test Reports – Test Summaries

## Test Conformance/Compliance Report

### Purpose of a Test Conformance/Compliance Report

- Summarizes results against tested requirements/needs
  - Using traceability tables discussed earlier
- Assists in identifying the practical impacts of failure

PURPOSE

# C2C RI Test Reports – Test Summaries

## Test Conformance/Compliance Report

### Information Layer Standard Conformance Report

UN ID	User Need			Results
2.3.1.1	Verify Connection Active			Passed
		Requirement ID	Other Requirements	Results
		3.3.1.1.1	The owner center shall respond within ____ (100 ms - 1 hour; Default = 1 minute) after receiving the request. See Section 3.4.2.	Passed
		3.3.1.1.4		No Test Cases Applicable in this Test Mode
		3.3.1.1.4.1		No Test Cases Applicable in this Test Mode
		3.3.1.1.5		Passed
		3.3.1.1.5.1		Passed
		3.3.1.4.1		Passed
		3.3.1.4.1.1		Passed

**EXAMPLE**

# C2C RI Test Reports – Test Summaries

## Section 1201 Conformance/Compliance Report

### Purpose of Section 1201 Report

- Summarizes results against
  - SAFETEA-LU Section 1201 requirements
  - CFR Title 23 Part 511 regulations
- An extension of the more basic conformance/compliance report
- Assists in identifying impacts related to Section 1201 compliance



# C2C RI Test Reports – Test Summaries

## Section 1201 Conformance/Compliance Report

### Information Layer Standard Conformance Report

UN ID	User Need			Results
2.3.1.1	Verify Connection Active			Passed
		Requirement ID	Related DXFS Requirement	Results
		3.3.1.1.1	3.4.1.1.1	Passed
		3.3.1.1.2	3.4.1.1.2	Passed
		3.3.1.1.3	3.4.1.1.3	Passed
		3.3.1.1.4	3.4.1.1.4	No Test Cases Applicable in this Test Mode
		3.3.1.1.4.1	3.4.1.1.5	No Test Cases Applicable in this Test Mode
		3.3.1.1.5	3.4.1.1.6	Passed
		3.3.1.1.5.1	3.4.1.1.7	Passed

**EXAMPLE**

# C2C RI Test Reports – Test Summaries

## Complete test summary

### Additional information for complete test summary

- Tester needs to compile data to prepare IEEE 829 summary
- These reports aid in that preparation
- Tester is ultimately responsible for analysis and recommendations



# Interpret Test Results

## Complete test summary

### C2C RI output is algorithmic

- May report false failures due to external problems
- Provides information about problem
- Does not judge severity or impact

Tester needs to analyze results

Ultimately needs to determine impact to project

# Limitations of Test Results

## What is not tested?

### C2C RI does not test

- Implied functionality of messages
- User interface
- Algorithms
- Reliability of the system

Master test plan should consider all aspects

# ACTIVITY



# Question

## Which is the best way to describe the C2C RI- generated test reports?

### Answer Choices

- a) The conformance report provides the final assessment of whether the implementation conforms to the communications interface
- b) When combined together, the various reports produce all of the elements of IEEE 829 test documentation
- c) The reports assist the tester in identifying potential issues for further analysis
- d) The reports fail to provide the information that they were intended to provide

# Review of Answers



a) Conformance report provides the final assessment

*Incorrect. The conformance report produces a formulaic result & may produce an erroneous result if an error was made in testing.*



b) When combined, the various reports produce all elements

*Incorrect. A proper test summary includes analysis that requires manual review.*



c) Reports assist the tester in identifying issues

***Correct! Issues identified in the reports should be investigated to determine why a failure was reported.***



d) Reports fail to provide what was intended

*Incorrect. The reports provide useful information, as intended, but require analysis before final conclusions are drawn.*

# Module Summary

Recognize **purpose** of C2C Reference Implementation

Acknowledge **key capabilities and limitations**  
of the C2C RI

Follow process for **producing test documentation**  
that relies upon the C2C RI

Recognize **results** a tester might produce  
after using the C2C RI

# TMDD Testing Curriculum



**Module T321:** Applying your **test plan** to the TMDD standard.



**Module T251:** Center-to-Center (C2C) **Reference Implementation (RI) – Introduction.**

**Curriculum complete for those not needing hands-on experience with C2C RI**

**Module T351:** Center-to-Center (C2C) Reference Implementation (RI) – **Applying the C2C Reference Implementation.**

## Next Course Module

### **T351: Center-to-Center (C2C) Reference Implementation (RI) – Applying the C2C Reference Implementation**

Concepts taught in next module (Learning Objectives):

- 1) Install and configure the C2C RI on a host system
- 2) Operate the C2C RI
- 3) Retrieve the C2C RI results from a test
- 4) Prepare a report based on the C2C RI results

**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!