Welcome

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T251:

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

Introduction
Instructor

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President
Trevilon LLC
Magnolia, TX, USA
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

- Vehicle Status Data
- Infrastructure Status Data
- Weather Data
- Truck Data
- Transit Data
- Data from mobile devices

Dynamic Mobility Applications

- Reduce Speed 35 MPH
- Transit Signal Priority
- Weather Application
- Real-Time Travel Info
- Fleet Management/Dynamic Route Guidance
- Real-Time Signal Phase and Timing Optimization
- Safety Alert and Advisories
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)

<table>
<thead>
<tr>
<th>Group</th>
<th>Service Package Name</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Traffic Signals</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Emergency Vehicle Preemption</td>
</tr>
<tr>
<td></td>
<td>Freight Signal Priority</td>
</tr>
<tr>
<td></td>
<td>Intelligent Traffic Signal System</td>
</tr>
<tr>
<td></td>
<td>Transit Signal Priority</td>
</tr>
<tr>
<td><strong>Transit</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dynamic Ridesharing</td>
</tr>
<tr>
<td></td>
<td>Dynamic Transit Operations</td>
</tr>
<tr>
<td></td>
<td>Integrated Multi-Modal Electronic Payment</td>
</tr>
<tr>
<td></td>
<td>Intermittent Bus Lanes</td>
</tr>
<tr>
<td></td>
<td>Smart Park and Ride System</td>
</tr>
<tr>
<td></td>
<td>Transit Connection Protection</td>
</tr>
<tr>
<td></td>
<td>Transit Stop Request</td>
</tr>
<tr>
<td><strong>Traveler Information</strong></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Advanced Traveler Information Systems</td>
</tr>
<tr>
<td></td>
<td>Traveler Information – Smart Parking</td>
</tr>
</tbody>
</table>
Understand C2C Communications

Service packages depict information flows
Understand C2C Communications

C2C RI focuses on Traffic Management flows

Traffic Management Center
- TMC Traffic Information Dissemination

Emergency Management Center

(2C) incident information + road network conditions + traffic control information + traffic images

Media
- (2C) traveler information for media

Transportation Information Center
- (2C) incident information
- (3C) air quality information
Understand C2C Communications

Same flows may be provided by other centers

- Emergency Management Center
- Emissions Management Center
- Maint and Constr Management Center
- Transit Management Center

- Transportation Information Center
  - (2C) incident information
  - (3C) air quality information
  - (2C) work zone information + roadway maintenance status + maint and constr work plans
  - (2C) transit and fare schedules + transit schedule adherence information
  - (2C) weather information
  - (2C) parking information

- TIC Connected Vehicle Traveler Info Distribution
- TIC Traveler Information Broadcast
- TIC Data Collection
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
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
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
incident information

Definitions

incident information (Information Flow): Notification of existence of incident and expected severity, location, additional information is gathered and the incident evolves, updated incident information is provided. Incidents can cause disasters that involve loss of life, injuries, extensive property damage, and multi-jurisdictional response and closures, and other planned events that may impact the transportation system.

Traffic Management Center (Source Physical Object): The 'Traffic Management Center' monitors and controls 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 manage traffic flow and monitor the condition of the roadway, surrounding environmental conditions, and field transportation resources to support allied agencies in responding to, and recovering from, incidents ranging from disasters.

Transportation Information Center (Destination Physical Object): The 'Transportation Information Center'...
C2C RI Communications Stack

Architecture identifies the standards in the stack

<table>
<thead>
<tr>
<th>NTCIP Stack</th>
<th>Traffic Management Center</th>
<th>Transportation Information Center</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Information Level</strong></td>
<td>ITS Application Information Layer</td>
<td>ITS Application Information Layer</td>
</tr>
<tr>
<td></td>
<td>ITE TMDD</td>
<td>ITE TMDD</td>
</tr>
<tr>
<td><strong>Application Level</strong></td>
<td>Application Layer</td>
<td>Application Layer</td>
</tr>
<tr>
<td></td>
<td>IETF HTTP, IETF FTP, NTCIP 2306</td>
<td>IETF HTTP, IETF FTP, NTCIP 2306</td>
</tr>
<tr>
<td></td>
<td>Presentation Layer</td>
<td>Presentation Layer</td>
</tr>
<tr>
<td></td>
<td>W3C XML, IETF GZIP</td>
<td>W3C XML, IETF GZIP</td>
</tr>
<tr>
<td></td>
<td>Session Layer</td>
<td>Session Layer</td>
</tr>
<tr>
<td></td>
<td>Undefined</td>
<td>Undefined</td>
</tr>
<tr>
<td><strong>Transport Level</strong></td>
<td>Transport Layer</td>
<td>Transport Layer</td>
</tr>
<tr>
<td></td>
<td>IETF TCP</td>
<td>IETF TCP</td>
</tr>
<tr>
<td></td>
<td>Network Layer</td>
<td>Network Layer</td>
</tr>
<tr>
<td></td>
<td>IETF IPv6</td>
<td>IETF IPv6</td>
</tr>
<tr>
<td><strong>Subnetwork Level</strong></td>
<td>Data Link Layer</td>
<td>Data Link Layer</td>
</tr>
<tr>
<td></td>
<td>LLC and MAC compatible with Physical and Network</td>
<td>LLC and MAC compatible with Physical and Network</td>
</tr>
<tr>
<td></td>
<td>Physical Layer</td>
<td>Physical Layer</td>
</tr>
<tr>
<td></td>
<td>Backhaul PHY</td>
<td>Backhaul PHY</td>
</tr>
</tbody>
</table>
# C2C RI Communications Stack

## Detailed view of the layers tested by C2C RI

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMDD</td>
<td>Defines various messages to perform TMC-related operations</td>
</tr>
<tr>
<td>SOAP</td>
<td>Preferred solution for exchanges with error handling, includes Publish/Subscribe support</td>
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<td>FTP</td>
<td>One-way information</td>
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</table>

**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
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
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
ACTIVITY
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 C2C Reference 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 systems engineering skills

Experience in:

- Preparing and understanding test documentation

- Using a Needs to Requirements Traceability Matrix (NRTM)

- Using a Requirements (to design) Traceability Matrix (RTM)

- Using a Requirements to Test Case Traceability Matrix (RTCTM)
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

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

- **WSDL**
  - Allows an owner center to advertise which services are available

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</table>

- 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

<table>
<thead>
<tr>
<th>WSDL</th>
<th>TMDD Messages</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>
What Functions Can Be Tested

Sample C2C RI test cases for TMDD

<table>
<thead>
<tr>
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<th>SOAP</th>
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<td>One-way information</td>
</tr>
</tbody>
</table>

TMDD Messages
Defines various messages to perform TMC related operations

- 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
What are planned enhancements?

- Verification for compliance to §1201 of SAFETEA-LU
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
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)
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
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 Procedures

- Execute

- Test Reports
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>
<thead>
<tr>
<th>Need ID</th>
<th>Test Case Identifier</th>
<th>Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3.1.1</td>
<td>TCS-1-dlCenterActiveVerificationRequest-OC-Valid</td>
<td>3.3.1.1.1, 3.3.1.1.5, 3.3.1.1.5.1, 3.3.1.1.5.2.1</td>
</tr>
<tr>
<td></td>
<td>TCS-1-dlCenterActiveVerificationRequest-OC-Invalid-1</td>
<td>3.3.1.1.1, 3.3.1.4.1, 3.3.1.4.1.1, 3.3.1.4.1.2.1</td>
</tr>
<tr>
<td></td>
<td>TCS-1-dlCenterActiveVerificationRequest-OC-Invalid-2</td>
<td>3.3.1.1.1, 3.3.1.4.1, 3.3.1.4.1.1, 3.3.1.4.1.2.1</td>
</tr>
<tr>
<td></td>
<td>TCS-1-dlCenterActiveVerificationRequest-OC-Invalid-3</td>
<td>3.3.1.1.1, 3.3.1.4.1, 3.3.1.4.1.1, 3.3.1.4.1.2.1</td>
</tr>
<tr>
<td></td>
<td>TCS-1-dlCenterActiveVerificationRequest-OC-Invalid-4</td>
<td>3.3.1.1.1, 3.3.1.4.1, 3.3.1.4.1.1, 3.3.1.4.1.2.1</td>
</tr>
<tr>
<td></td>
<td>TCS-1-dlCenterActiveVerificationRequest-OC-Invalid-5</td>
<td>3.3.1.1.1, 3.3.1.4.1, 3.3.1.4.1.1, 3.3.1.4.1.2.1</td>
</tr>
</tbody>
</table>
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 Plan**: Specific requirements to be tested and reference to...
- **Test Design**: Specific scenarios, including objective, inputs, outputs, and reference to...
- **Test Procedures**: Specific process used to test
- **Execute**: Test Reports
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>
### 2306 Test Case Specification

#### 69.1 Test Case Specification Identifier

<table>
<thead>
<tr>
<th>Identifier</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>TCS-C2CRI-NTCIP2306-WSME-SUT-SHRR-OC</td>
<td>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.</td>
</tr>
</tbody>
</table>

#### 69.3 Input Specifications

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>The WSDL input file will be user defined for the owner center.</td>
<td>TPS-NTCIP2306-SOAP-RR-OC</td>
</tr>
</tbody>
</table>

#### 69.4 Output Specifications

<table>
<thead>
<tr>
<th>Outputs</th>
<th>Procedures</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
<td></td>
</tr>
</tbody>
</table>
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
Test Procedure for C2C

Role of test procedure

- Test Plan
- Test Design
- Test Cases
- Test Procedures
- Execute
- Test Reports

- Specific scenarios, including objective, inputs, outputs, and reference to...
- Step-by-step process used to test
- 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

<table>
<thead>
<tr>
<th>Test Step Number</th>
<th>Test Procedure</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>CONFIGURE:</strong> determine the Application Layer Standard that will be used for this test. RECORD this information as: ApplicationLayerStandard</td>
<td>NA</td>
</tr>
<tr>
<td>2</td>
<td><strong>CONFIGURE:</strong> 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</td>
<td>NA</td>
</tr>
<tr>
<td>3</td>
<td><strong>CONFIGURE:</strong> 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</td>
<td>NA</td>
</tr>
<tr>
<td>4</td>
<td><strong>CONFIGURE:</strong> 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</td>
<td>NA</td>
</tr>
<tr>
<td>5</td>
<td><strong>CONFIGURE:</strong> Define the message that will be sent to the SUT. RECORD this information as: RequestMessage</td>
<td>NA</td>
</tr>
<tr>
<td>6</td>
<td><strong>CONFIGURE:</strong> Determine whether an error response message is expected for this test. RECORD this information as: ErrorResponseExpected</td>
<td>NA</td>
</tr>
<tr>
<td>7</td>
<td><strong>CONFIGURE:</strong> IF ErrorResponseExpected is true, determine the expected error code response for this test. RECORD this information as: ErrorTypeExpected</td>
<td>NA</td>
</tr>
<tr>
<td>8</td>
<td><strong>REQUEST-RESPONSE-EC</strong> with the following parameters: DIALOG=dICenterActiveVerificationRequest; RESPONSETIMEREQUIRED=TMDD_N1R1_Send_Center_Active_Verification_Upon_Request_Parameter; REQUESTMESSAGE = RequestMessage</td>
<td>PASS/FAIL (3.3.1.1.2, 3.4.2)</td>
</tr>
</tbody>
</table>
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
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 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
Benefits of 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

- Test Plan
- Test Design
- Test Cases
- Test Procedures
- Execute
- Test Reports

Assist in developing formal test reports:
- Test logs
- Anomaly reports
- Test summary

C2C RI test reports
- Test logs
- Test summaries
Purpose of a Test Log

- Chronological record of details
- Assists in repeating process
- Assists in debugging
C2C RI Test Reports – Test Logs

C2C RI Test Log Reports

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

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

## Test Case Name: TCS-C2CRI-NTCIP2306-WSDL-SUT

<table>
<thead>
<tr>
<th>Time</th>
<th>Test Case Name</th>
<th>Test Step Description</th>
<th>Pass/Fail</th>
<th>Fail Reason</th>
</tr>
</thead>
<tbody>
<tr>
<td>09/08/2016</td>
<td>TCS-C2CRI-NTCIP2306-WSDL-SUT</td>
<td>Step 1 CONFIGURE: Determine the URL for the WSDL file that will be used for this test. RECORD this information as: WSDLFile = <a href="http://standards2.xcmdata.org:8080/MiddlewareOutbound/wsd1/XCM-TMDD.wsdl">http://standards2.xcmdata.org:8080/MiddlewareOutbound/wsd1/XCM-TMDD.wsdl</a></td>
<td>FAILED</td>
<td></td>
</tr>
<tr>
<td>09/08/2016</td>
<td></td>
<td>Step 2 CONFIGURE:</td>
<td>PASSED</td>
<td></td>
</tr>
</tbody>
</table>

---

**Back-ground**

**Detail**
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
## Test Script Action Log Report

<table>
<thead>
<tr>
<th>TimeStamp</th>
<th>Test Script Action</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>09/08/2016 10:31:54.539</td>
<td>User Started the Test with selected Test Case Scripts: Application Layer: TCS-C2CRI-NTCIP2306-WSDL-SUT</td>
<td></td>
</tr>
<tr>
<td>09/08/2016 10:32:00.879</td>
<td>testStep - Begin &lt;br&gt;Script: jar:file:/C:/C2CRI//.TestSuites/NTCIP2306v01_69Signed.jar!/AppLayer/Scripts/TPS-NTCIP2306-WSDL.xml &lt;br&gt;line: 13 column: 187 &lt;br&gt;functionId: Step 1 CONFIGURE: Determine the URL for the WSDL file that will be used for this test. RECORD this information as: WSDLFile =</td>
<td></td>
</tr>
<tr>
<td>09/08/2016 10:32:00.895</td>
<td>testStep - End &lt;br&gt;Script: jar:file:/C:/C2CRI//.TestSuites/NTCIP2306v01_69Signed.jar!/AppLayer/Scripts/TPS-NTCIP2306-WSDL.xml &lt;br&gt;line: 13 column: 187 &lt;br&gt;functionId: Step 1 CONFIGURE: Determine the URL for the WSDL file that will be used for this test. RECORD this information as: WSDLFile =</td>
<td>PASSED</td>
</tr>
</tbody>
</table>
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
C2C RI Test Reports – Test Logs

Message Detail Report

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

<table>
<thead>
<tr>
<th>Time</th>
<th>Message</th>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
</table>

```plaintext
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 = string
```

EXAMPLE
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
## Test Case Summary Report

<table>
<thead>
<tr>
<th>Log File Name:</th>
<th>C:\c2cri\TRANSCOM Stand-alone Test 2.2016-08-09_09-31-32.xml</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log File Creator:</td>
<td>MInsignares</td>
</tr>
<tr>
<td>Log File Creation Date:</td>
<td>2016-08-09_09-31-32</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Time</th>
<th>Test Case Name</th>
<th>Pass/Fail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tue Aug 09 09:32:34 EDT 2016</td>
<td>TCS-1-dICenterActiveVerificationRequest-OC-InValid-2</td>
<td>FAILED</td>
</tr>
<tr>
<td>Tue Aug 09 09:42:29 EDT 2016</td>
<td>TCS-1-dICenterActiveVerificationRequest-OC-InValid-2</td>
<td>PASSED</td>
</tr>
<tr>
<td>Tue Aug 09 09:42:58 EDT 2016</td>
<td>TCS-1-dICenterActiveVerificationRequest-OC-InValid-3</td>
<td>PASSED</td>
</tr>
<tr>
<td>Tue Aug 09 09:43:16 EDT 2016</td>
<td>TCS-1-dICenterActiveVerificationRequest-OC-InValid-4</td>
<td>PASSED</td>
</tr>
<tr>
<td>Tue Aug 09 09:43:34 EDT 2016</td>
<td>TCS-1-dICenterActiveVerificationRequest-OC-InValid-5</td>
<td>PASSED</td>
</tr>
<tr>
<td>Tue Aug 09 09:43:52 EDT 2016</td>
<td>TCS-1-dICenterActiveVerificationRequest-OC-InValid-6</td>
<td>PASSED</td>
</tr>
</tbody>
</table>
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
### Test Message Summary Report

<table>
<thead>
<tr>
<th>Time</th>
<th>Message</th>
<th>Source</th>
<th>Destination</th>
</tr>
</thead>
<tbody>
<tr>
<td>08/09/16 10:33:43.315</td>
<td>REQUEST (centerActiveVerificationRequestMsg)</td>
<td>192.168.2.168:64683</td>
<td>160.79.9.145:8080</td>
</tr>
<tr>
<td>08/09/16 10:34:00.837</td>
<td>REQUEST (Unknown)</td>
<td>192.168.2.168:64693</td>
<td>160.79.9.145:8080</td>
</tr>
<tr>
<td>08/09/16 10:34:00.837</td>
<td>RESPONSE (errorReportMsg)</td>
<td>160.79.9.145:8080</td>
<td>192.168.2.168:64693</td>
</tr>
</tbody>
</table>
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
## Information Layer Standard Conformance Report

<table>
<thead>
<tr>
<th>UN ID</th>
<th>User Need</th>
<th>Requirement ID</th>
<th>Other Requirements</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3.1.1</td>
<td>Verify Connection Active</td>
<td>3.3.1.1.1.1</td>
<td>The owner center shall respond within ___ (100 ms - 1 hour; Default = 1 minute) after receiving the request. See Section 3.4.2.</td>
<td>Passed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.3.1.1.4</td>
<td></td>
<td>No Test Cases Applicable in this Test Mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.3.1.1.4.1</td>
<td></td>
<td>No Test Cases Applicable in this Test Mode</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.3.1.1.5</td>
<td></td>
<td>Passed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.3.1.1.5.1</td>
<td></td>
<td>Passed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.3.1.4.1</td>
<td></td>
<td>Passed</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3.3.1.4.1.1</td>
<td></td>
<td>Passed</td>
</tr>
</tbody>
</table>
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
## Information Layer Standard Conformance Report

<table>
<thead>
<tr>
<th>UN ID</th>
<th>User Need</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.3.1.1</td>
<td>Verify Connection Active</td>
<td>Passed</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Requirement ID</th>
<th>Related DXFS Requirement</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.3.1.1.1</td>
<td>3.4.1.1.1</td>
<td>Passed</td>
</tr>
<tr>
<td>3.3.1.1.2</td>
<td>3.4.1.1.2</td>
<td>Passed</td>
</tr>
<tr>
<td>3.3.1.1.3</td>
<td>3.4.1.1.3</td>
<td>Passed</td>
</tr>
<tr>
<td>3.3.1.1.4</td>
<td>3.4.1.1.4</td>
<td>No Test Cases Applicable in this Test Mode</td>
</tr>
<tr>
<td>3.3.1.1.4.1</td>
<td>3.4.1.1.5</td>
<td>No Test Cases Applicable in this Test Mode</td>
</tr>
<tr>
<td>3.3.1.1.5</td>
<td>3.4.1.1.6</td>
<td>Passed</td>
</tr>
<tr>
<td>3.3.1.1.5.1</td>
<td>3.4.1.1.7</td>
<td>Passed</td>
</tr>
</tbody>
</table>
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
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.*
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!