



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.

United States Department of Transportation
OFFICE OF THE ASSISTANT SECRETARY FOR RESEARCH AND TECHNOLOGY
Intelligent Transportation Systems
Joint Program Office

ITS Professional Capacity Building Program / Advancing ITS Education

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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.

FREE TRAINING
The ITS PCB Program and partners offer many free ITS training courses.

- Web and Blended Courses from CITE
- ITS Standards Training
- Upcoming T3 Webinars

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

T351

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





Instructor



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Learning Objectives

Install and configure the C2C RI on a PC

Operate the C2C RI

Retrieve the C2C RI results from a test

Prepare a report based on the C2C RI results



Learning Objective 1

**Install and configure
the Center-to-Center (C2C)
Reference Implementation (RI)
on a personal computer**



Obtaining the C2C RI

Obtain the latest version

Download at:

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

FREE!

Site is updated with the latest version

User Manual is included

Technical support via e-mail at: c2crisupport@transcore.com





Review Requirements

Requirements to Run C2C RI

- System requirements
- Interoperability requirements
- Skillset requirements for operator



Review Requirements

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



Review Requirements

Interoperability Requirements

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



Review Requirements

Interoperability Requirements

C2C interoperability testing relies upon:

- User needs (Module A321a)
- Requirements (Module A321b)
- Design (TMDD and NTCIP 2306 Standards)
- Verification (Module T321)
- Validation (Module T321)
- C2C RI (Module T251 and T351)

Passing C2C RI does not guarantee full interoperability

- Requires user interaction
- Not exhaustive
- Standards may have ambiguities

Review Requirements

Required Skillset of Operator

See T251 for details



Encoding languages



Protocols



Windows networking



ITS standards



Testing experience



Scripting language



System under test



Basic Configuration

Understand C2C Environment

C2C RI tests Center-to-Center communications

One center is called the “owner”; the other is the “external”

Exchanges include discovery and data exchange



Source: TRANSCOM

Owner

Discover
Services



Exchange
Data



External

Source: NYCDOT

Basic Configuration

Understand C2C Environment

For the purpose of testing, either end (or both) can be replaced by C2C RI

A real test would replace only one end of system

Presentation connects two C2C RIs to demonstrate each mode



Source: TRANSCOM

Owner

Discover
Services



Exchange
Data



External

Source: NYCDOT



ACTIVITY



Question

Which of the following statements is untrue?

Answer Choices

- a) C2C standards define how services can be discovered
- b) A C2C exchange occurs between an “Owner center” and an “External center”
- c) The C2C RI software is available for free
- d) ITS standards only define how to exchange information

Review of Answers



a) C2C standards define how services can be discovered

Incorrect. The WSDL file allows an External center to discover the services offered by an Owner center.



b) A C2C exchange occurs between an “Owner center” and an “External center”

Incorrect. Exchanges occur between Owner and External centers.



c) The C2C RI software is available for free

Incorrect. The C2C RI can be downloaded for free from <https://www.standards.its.dot.gov/DeploymentResources/Tools>.



d) ITS standards only define how to exchange information

Correct! ITS standards also define how to use information,



Basic Configuration

Steps to Set Up the C2C RI

1. Install the C2C RI
2. Define initial configuration of C2C RI
3. Configure the service announcement file
4. Configure the C2C RI to reference the file
5. Identify applicable test cases





Basic Configuration

Installation and Initial C2C RI Configuration

1. Install using the supplied Windows installer
2. Start the C2C RI
3. Configure default directories, etc.



Basic Configuration

Initial C2C RI Configuration



All directories must exist on the local machine; changing the values is especially important if the C2C RI is not installed in the default location



Basic Configuration

Configure the Owner Center WSDL File

Discovery of Services

- NTCIP 2306 requires the use of a **Web Services Description Language (WSDL) file** to define supported services
- The **Owner Center should define** its own WSDL file properly configured
- WSDL is based on **XML**
- Primary purpose of WSDL is to **define supported services**
 - Also used to auto-configure the C2C RI



Basic Configuration

Configure the Owner Center WSDL File

WSDL Defines:

- Schema files that define data structures
- Messages using data structures
- Operations that define message sequences
- Ports on which the operations are available
- Bindings mapping operations to protocols
- Services mapping bindings to URLs

C2C RI does not automatically customize to your URL



Basic Configuration

Configure the Owner Center WSDL File

WSDL files are associated with the **Owner Center**

C2C RI as External Center:

- C2C RI will check the provided WSDL file for conformance
 - Some tools do not produce NTCIP 2306-conformant WSDL files

C2C RI as Owner Center:

- You'll need to customize the default WSDL files to use your URL
- All of the changes are in the last few lines of the file

C2C RI provides sample WSDL files; our example uses

<C2C RI Directory>/Test Files/release2+.wsdl



Basic Configuration

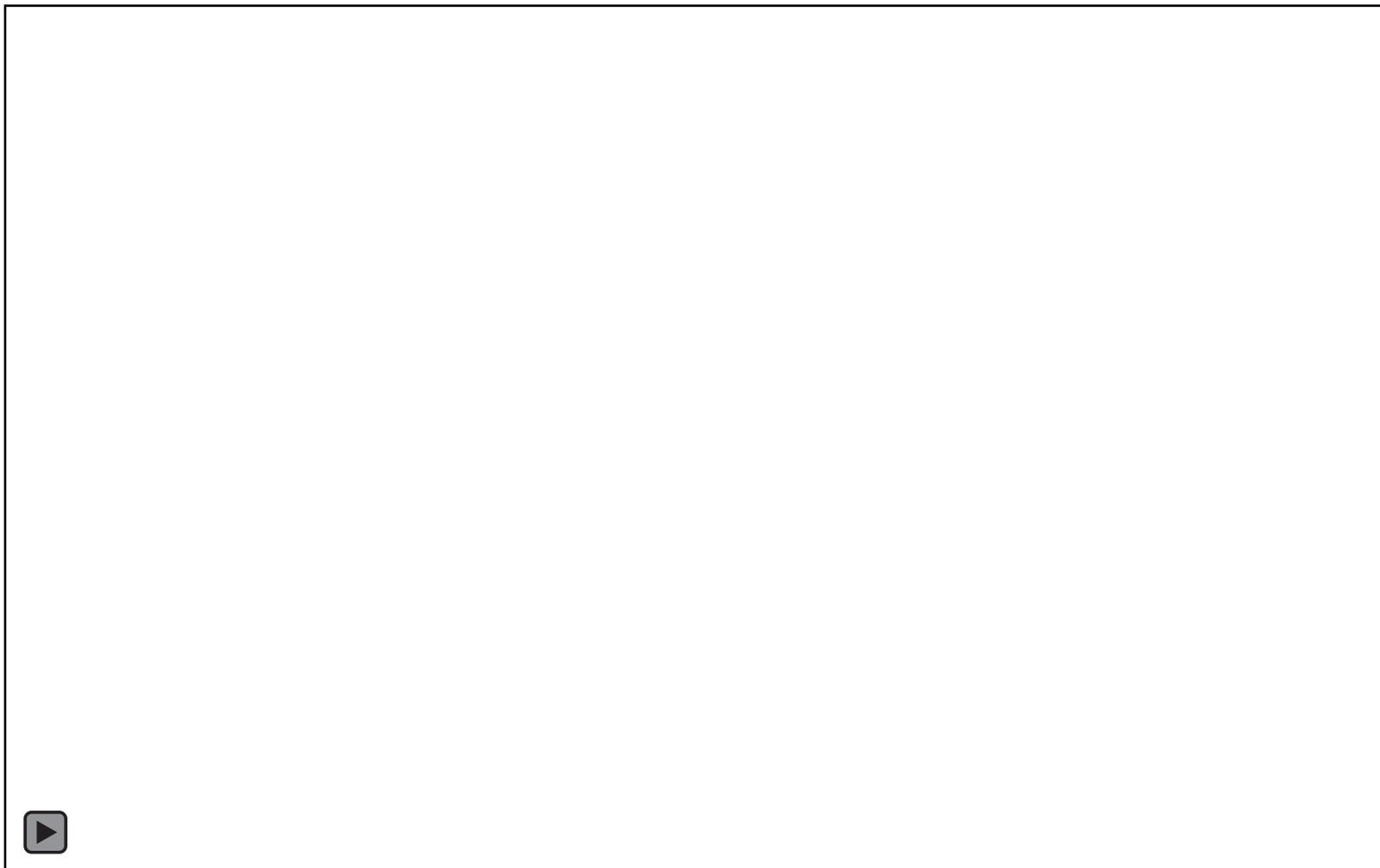
Configure the Owner Center WSDL File





Basic Configuration

Configure the C2C RI to Use WSDL File





Configuration for a Specific Test

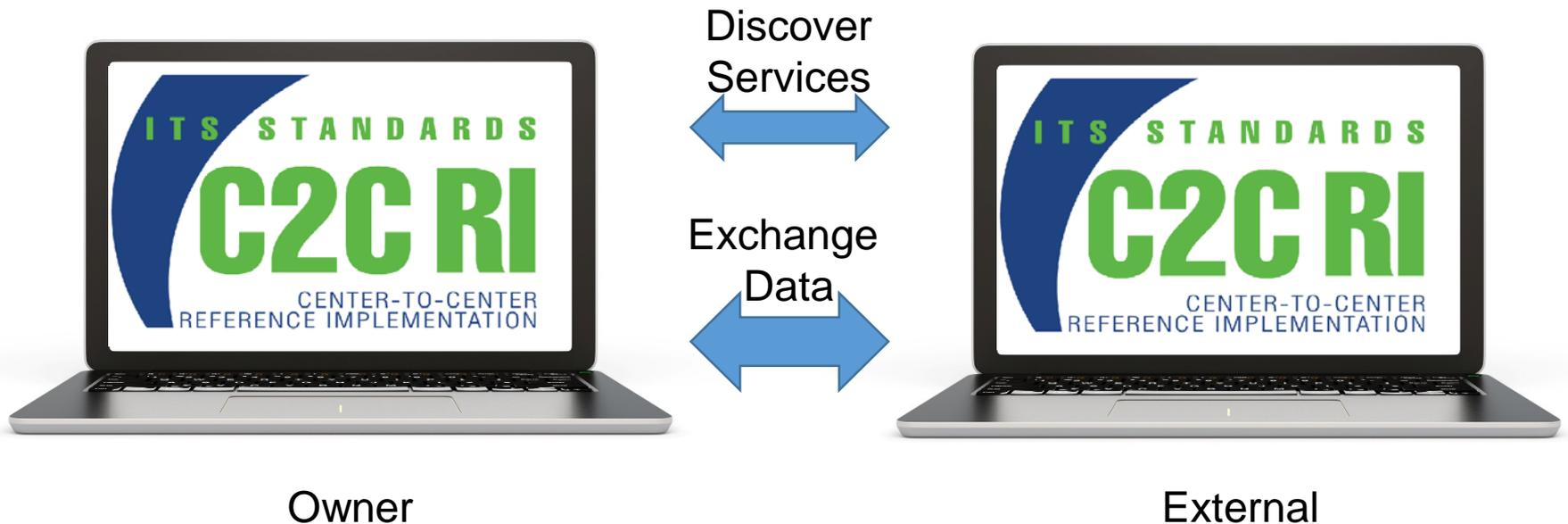
Configure the Needs and Requirements to Test



Configuration for a Specific Test

Ready to Test

Your test case is now ready to test





ACTIVITY



Question

What is the primary purpose of a WSDL file?

Answer Choices

- a) Configure the C2C RI
- b) Report errors to the user
- c) Define the services offered by the owner center
- d) All of the above

Review of Answers



a) Configure the C2C RI

Incorrect. While the C2C RI uses the WSDL file, the purpose of the file is much broader and includes operational deployment.



b) Report errors to the user

Incorrect. The WSDL file does not report errors.



c) Define the services offered by the owner center

Correct! The WSDL file defines the services offered by the owner center and how remote systems can access these services.



d) All of the above

Incorrect. Options A and B are incorrect.



Learning Objectives

Install and configure the C2C RI on a PC

Operate the C2C RI



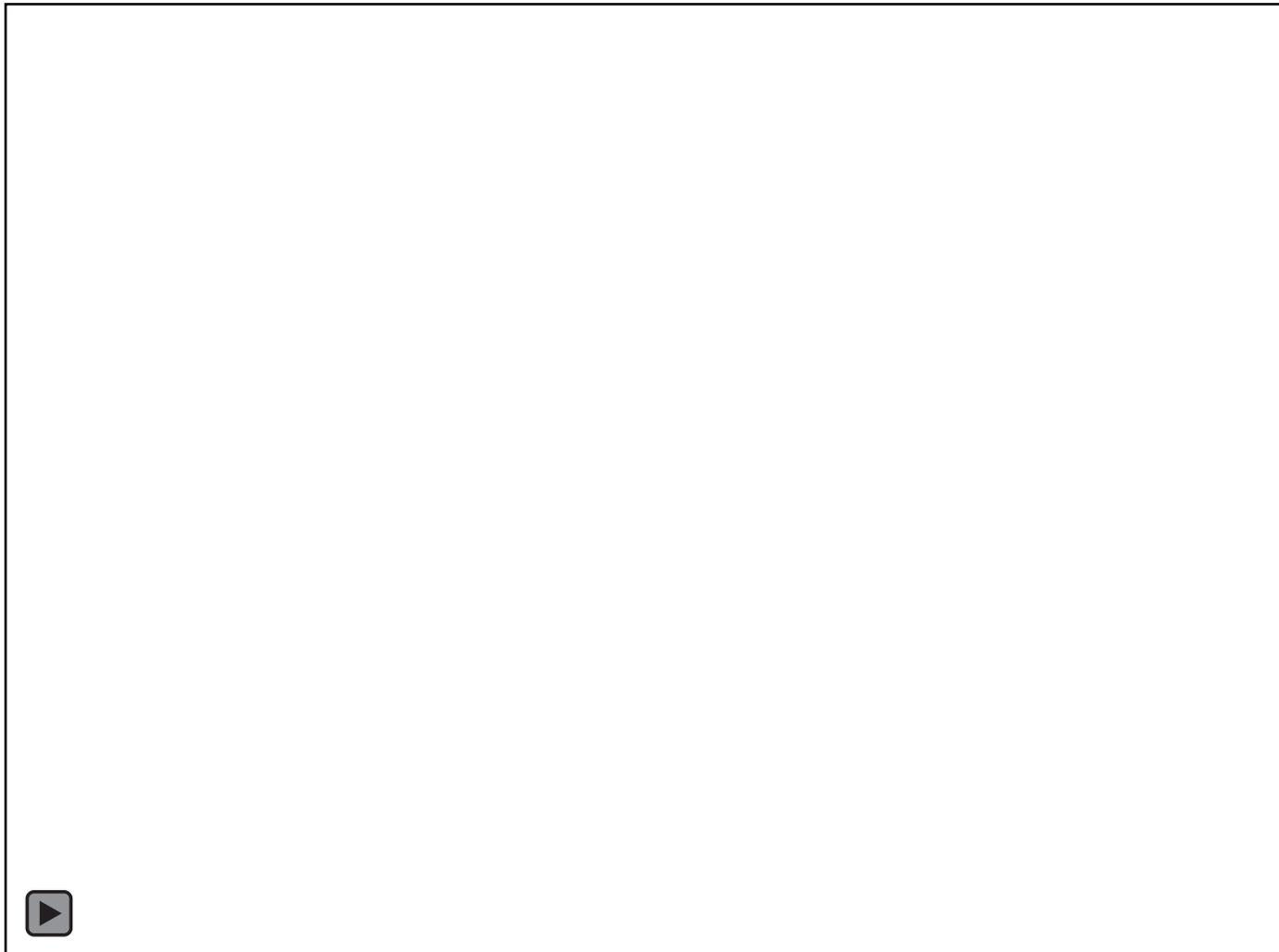
Learning Objective 2

**Operate
the C2C RI**



Request – Reply Exchange

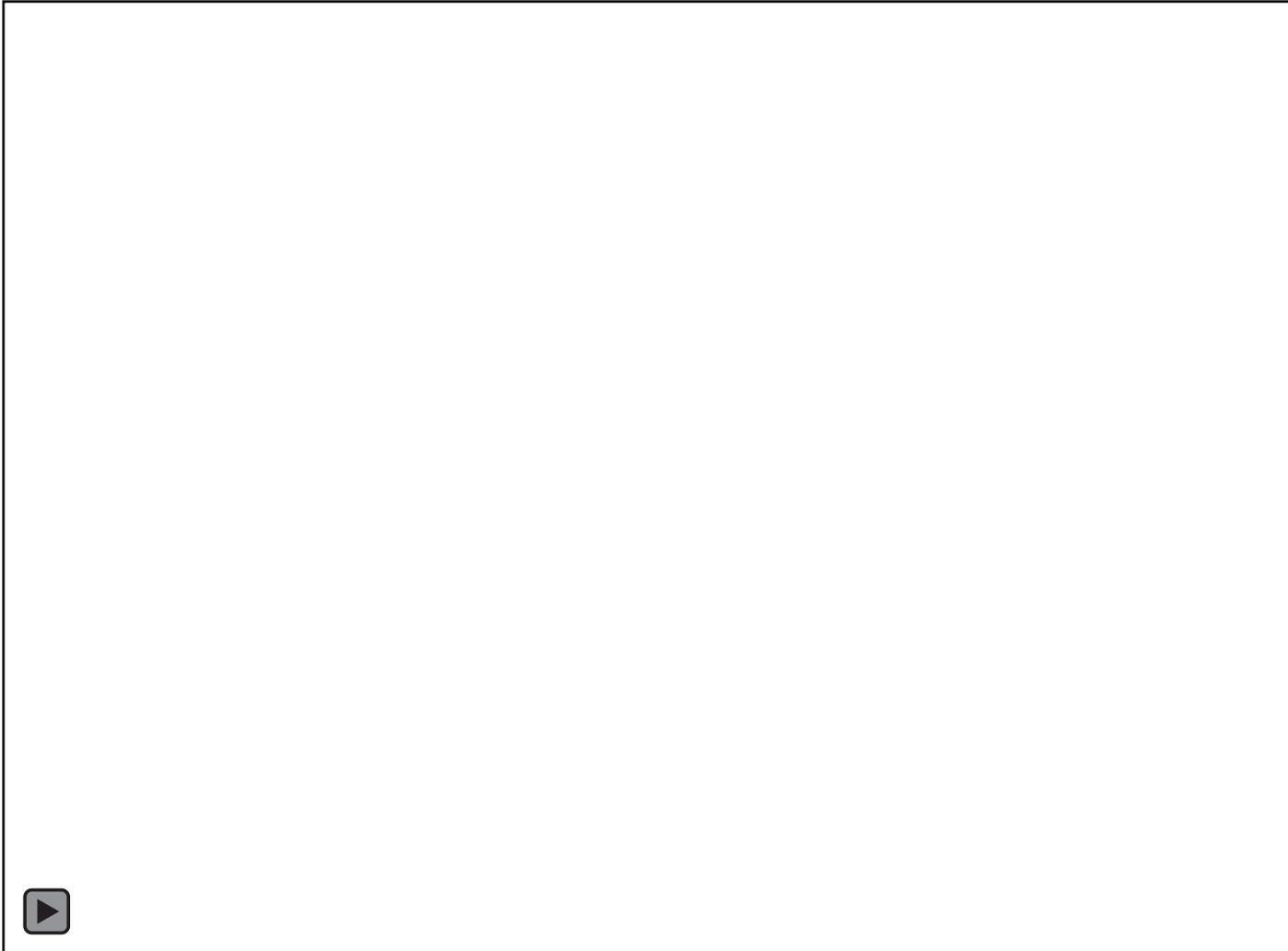
Start a Test – Owner Center





Request – Reply Exchange

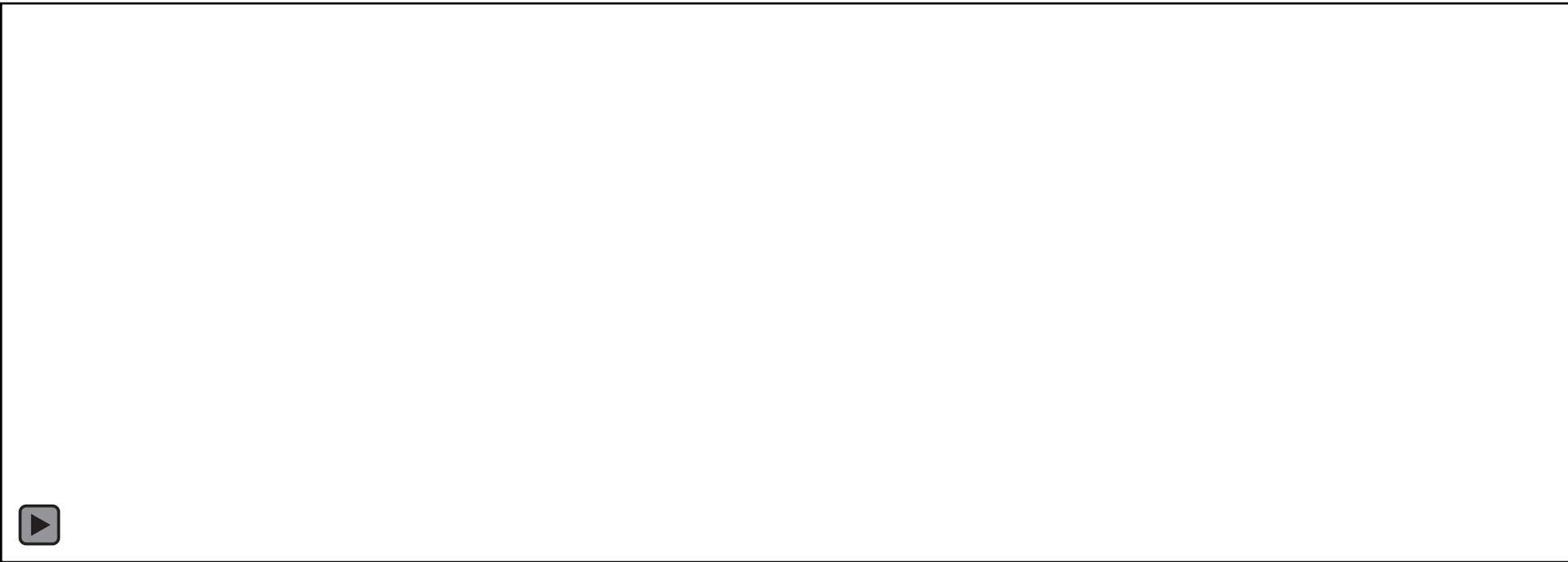
Start a Test – External Center





Request – Reply Exchange

Finish the Test





Request – Reply Exchange

Repeating a Test – Data Files

Entering data at prompts can become time consuming

Text entered for messages has to be precise

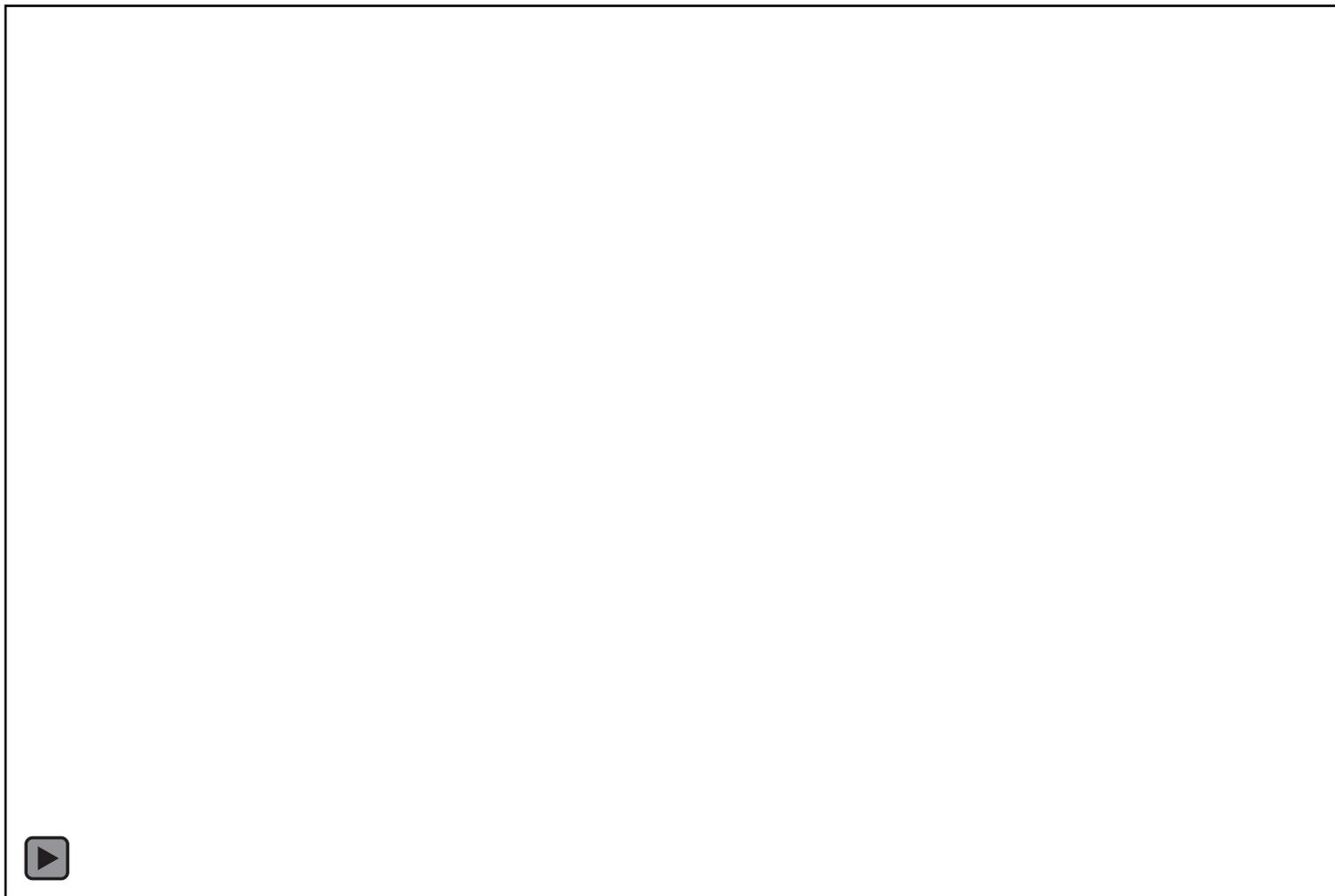
- Prompt provides little screen space to double-check entry
- Any error can cause the test case to fail

C2C RI allows the user to define data files to automate the process



Request – Reply Exchange

Testing with a Data File





Request – Reply Exchange

Data Files

You still have to know what values to enter

- Requires understanding of WSDL
- Requires understanding of XML
- Entries can be made once and saved

In version 1, the XML response message must be exact for the request

Version 2

In version 2, the XML response message may be a super-set

- An inventory response message may contain a list of all signs within the region. If a request is received for only part of the region, Version 2 will only transmit signs within requested area

Subscription-Publication Exchange

Running a Test with Multiple Publications

- For Publications, your **data** file will use multiple #ITERATION tags

```
1
2 #<!--
3 # dlDeviceInformationSubscription-EC-Valid
4 # Version/Date: 2011/11/15 22:59:44
5 #-->
6
7 #ITERATION NAME = One
8 PublicationServiceName = tmddECSoapHttpService
9 PublicationPortName = tmddECSoapHttpServicePort
10 PublicationOperationName = OP_DeviceInformationUpdate
11 PublicationMessage = <SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/
. -scheme>2</dms-color-scheme><dms-multi-tag-support>2</dms-multi-tag-support></dms-i
12
13 #ITERATION NAME = Two
14 PublicationServiceName = tmddECSoapHttpService
15 PublicationPortName = tmddECSoapHttpServicePort
16 PublicationOperationName = OP_DeviceInformationUpdate
17 PublicationMessage = <SOAP-ENV:Envelope xmlns:SOAP-ENV="http://schemas.xmlsoap.org/
. -scheme>2</dms-color-scheme><dms-multi-tag-support>2</dms-multi-tag-support></dms-i
```



ACTIVITY



Question

How can you get the C2C RI to publish multiple publications for one subscription?

Answer Choices

- a) Enter the number of publications in the configuration file
- b) Use the #ITERATION keyword in the associated data file
- c) Multiple publications are not supported by the C2C RI
- d) The C2C RI can receive but not publish multiple publications

Review of Answers



a) Enter the number of publications in the configuration file

Incorrect. The configuration file does not have a parameter like this.



b) Use the #ITERATION keyword in the associated data file

*Correct! The user uses the #ITERATION keyword in the *.data file.*



c) Multiple publications are not supported by the C2C RI

Incorrect. The C2C RI does support multiple publications with the #ITERATION keyword.



d) The C2C RI can only receive multiple publications

Incorrect. The C2C RI is able to both send and receive multiple publications.



Learning Objectives

Install and configure the C2C RI on a PC

Operate the C2C RI

Retrieve the C2C RI results from a test



Learning Objective 3

Retrieve the **C2C RI** results
from a test

Viewing Results

Real-Time Results

The C2C RI shows the results on-screen

Screen space is limited

Test Case Results

#	TestCaseID	Status	Run ID	Run C...	Fail C...	Execution Time
1	TCS-C2CRI-NTCIP2306-WSME-SUT-SHRR-OC	PASSED	1	1	0	22.022035s
2	TCS-C2CRI-NTCIP2306-WSME-SUT-XFRO-OC	FAILED - Errors NOT expected, but found!	1	1	1	17.488s

Test Case Description

the protocol stack for XML FTP Get defined in user provided WSDL document.

Test Step Results

TimeStamp	Description	Result
2016-12-20 19:22:57:264	Step 13 FTP-GET-EC with the following parameter(s): SERVICENAME = tmddOCSoapHttpService, PORTNAME = tmddOCFtpGetServicePort, OPERATIONNAME = OP_RIXMLFtpDMSInventory Returns: TRANSPORTERRORRESULT, TRANSPORTERRORTYPE, ENCODINGERRORRESULT, ENCODINGERRORTYPE, MESSAGEERRORRESULT, MESSAGEERRORTYPE	NA
2016-12-20 19:22:58:077	Step 14 VERIFY that TRANSPORTERRORRESULT = TransportErrorExpected	FAILED - TESTSTEP FAILURE: Error: TransportErrorExpected was false while TRANSPORTERRORRESULT was true. expected: <[fals]e> but



Viewing Results

Understanding Results

A reported failure may be due to:

1. System Under Test (SUT) implementation error
2. SUT configuration error
3. Network configuration error
4. User error
5. C2C RI configuration error
6. C2C RI implementation error
7. Ambiguity in the standard

Each reported failure has to be investigated to determine cause

Viewing Results

Understand Results

Description	Result
Step 13 FTP-GET-EC with the following parameter(s): SERVICENAME = tmddOCSoapHttpService, PORTNAME = tmddOCFtpGetServicePort, OPERATIONNAME = OP_RIXMLFtpDMSInventory Returns: TRANSPORTERRORRESULT, TRANSPORTERRORTYPE, ENCODINGERRORRESULT, ENCODINGERRORTYPE, MESSAGEERRORRESULT, MESSAGEERRORTYPE	NA
Step 14 VERIFY that TRANSPORTERRORRESULT = TransportErrorExpected	FAILED - TESTSTEP FAILURE: Error: TransportErrorExpected was false while TRANSPORTERRORRESULT was true. expected: <[fals]e> but



Viewing Results

Understand Results: Transport Error

1. SUT implementation error
 - Unlikely, as this tends to be off-the-shelf software
2. **SUT configuration error**
 - **We could be receiving on a different port**
3. **Improper network configuration**
 - **Perhaps the messages are not being routed**
4. User error
 - Probably would not result in a transport error
5. **C2C RI configuration error**
 - **Perhaps we are sending to the wrong IP address**
6. C2C RI implementation error
 - Unlikely, as this tends to be off-the-shelf software
7. Ambiguity in standard
 - Unlikely, as Transport Layer standards are well proven





Viewing Results

Understand Results: Transport Error

How do we isolate the error?

- Follow the logical flow of information
 - Did EC send request?
 - Did request appear on the wire?
 - Near the EC?
 - Near the OC?
 - Did OC receive the request?
 - Did OC log an error or send a response?
 - Did the response appear on the wire?
 - Did the EC receive the response?
 - Did the EC log an error?





Viewing Results

Capturing Results for Archives

Issues should be documented in anomaly reports

Once anomaly is identified, fix issue and repeat test

Correction may identify or even create new issues

A complete regression test should be performed at end



Viewing Results

Capturing Results for Archives

Results are captured to the log file during test

File is automatically saved and signed when closing test

File location can be specified when:

- Defining directory structure under options
- Starting test
- After test by moving file to desired location



ACTIVITY



Question

Which of the following might cause the C2C RI to report a failure?

Answer Choices

- a) Ambiguity in standard
- b) SUT configuration error
- c) C2C RI configuration error
- d) All of the above

Review of Answers



a) Ambiguity in standard

Incorrect. An ambiguity in the standard can cause a failure, but so can the other options.



b) SUT configuration error

Incorrect. An error in the SUT configuration can cause a failure, but so can the other options.



c) C2C RI configuration error

Incorrect. An error in the SUT configuration can cause a failure, but so can the other options.



d) All of the above

Correct! All three options can cause the C2C RI to report a failure.



Learning Objectives

Install and configure the C2C RI on a PC

Operate the C2C RI

Retrieve the C2C RI results from a test

Prepare a report based on the C2C RI results



Learning Objective 4

**Prepare a report
based on the
C2C RI results**



Preparing Reports

Preparing Reports



Preparing Reports

IEEE 829-2008 Report Formats

IEEE 829 Report	C2C RI Report
Test Log	Test Case Details
	Message Summary
	Message Details
	Script Log
	Configuration File Details
Anomaly Report	<Same as above>
Test Report	Conformance Compliance Report
	Test Case Summary
	Section 1201 Conformance (Version 2 only)



Preparing Reports

Test Log

- Chronological record of relevant details
- C2C RI provides four types of log reports
 - Test Case Details: step-by-step log
 - Message Summary: identifies each message sent/received with timestamp
 - Message Detail: complete contents of each message sent/received
 - Script Log: logs the start/end of each called script
- May include other non-C2C RI logs



Preparing Reports

Anomaly Report

- Any event that occurs during the testing process that requires investigation
 - Anomaly report documents
 - The problem
 - The impact
 - The corrective action needed
- All C2C RI test reports can assist in producing an anomaly report



Preparing Reports

Test Report

Summarize results and provide evaluation and recommendations

- Test Case Summary:
 - pass/fail for each test in chronological order
- Conformance Compliance Report:
 - pass/fail for each req't (reverse traceability)

Version 2

- Section 1201 Conformance:
 - pass/fail for each Section 1201 requirement

ACTIVITY



Question

Which C2C RI report will assist in developing an anomaly report?

Answer Choices

- a) Test Case Details
- b) Message Summary
- c) Message Details
- d) All of the above

Review of Answers



a) Test Case Details

Incorrect. The Test Case Details report will help identify the step where the error occurs, but other reports assist as well.



b) Message Summary

Incorrect. The Message Summary report will help identify if messages were sent/received, but other reports assist as well.



c) Message Details

Incorrect. The Message Details report will help identify if a message contained an error, but other reports assist as well.



d) All of the above

Correct! All of these reports assist in developing an Anomaly Report.



Module Summary

Install and configure the C2C RI on a PC

Operate the C2C RI

Retrieve the **C2C RI results** from a test

Prepare a report based on the C2C RI results



TMDD Testing Curriculum



Module A321a: Understanding **User Needs** for Traffic Management Systems Based on TMDD Standard.



Module A321b: Specifying **Requirements** for Traffic Management Systems Based on TMDD Standard.



Module T321: Applying Your **Test Plan** to the TMDD Standard.



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



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

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!