Deploying ITS Standards Using USDOT Testing Tools

Test Procedure Generator (TPG) and C2C Reference Implementation Tools

April 2019

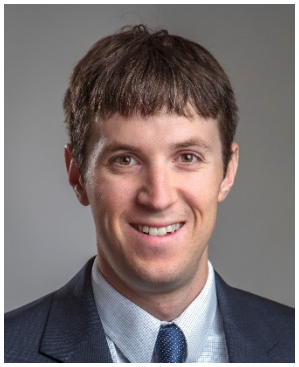
What you will learn

- What are Intelligent Transportation System Standards?
- Introduction to the Test Procedure Generator (TPG)
  - Why is it important and what are the benefits?
  - How to obtain the software and get support

- Introduction to the Center-to-Center (C2C) Reference Implementation (RI)
  - Why is it important and what are the benefits?
  - How to obtain the software and get support
  - A local Agency's experience with the RI

Today's Speakers

Kingsley Azubike, P.E., PTOE, Transportation Specialist, Office of Operations, FHWA HQ



Drennan Hicks, ASEP, PMP, Noblis

Walter Crear, Associate Vice President, TransCore

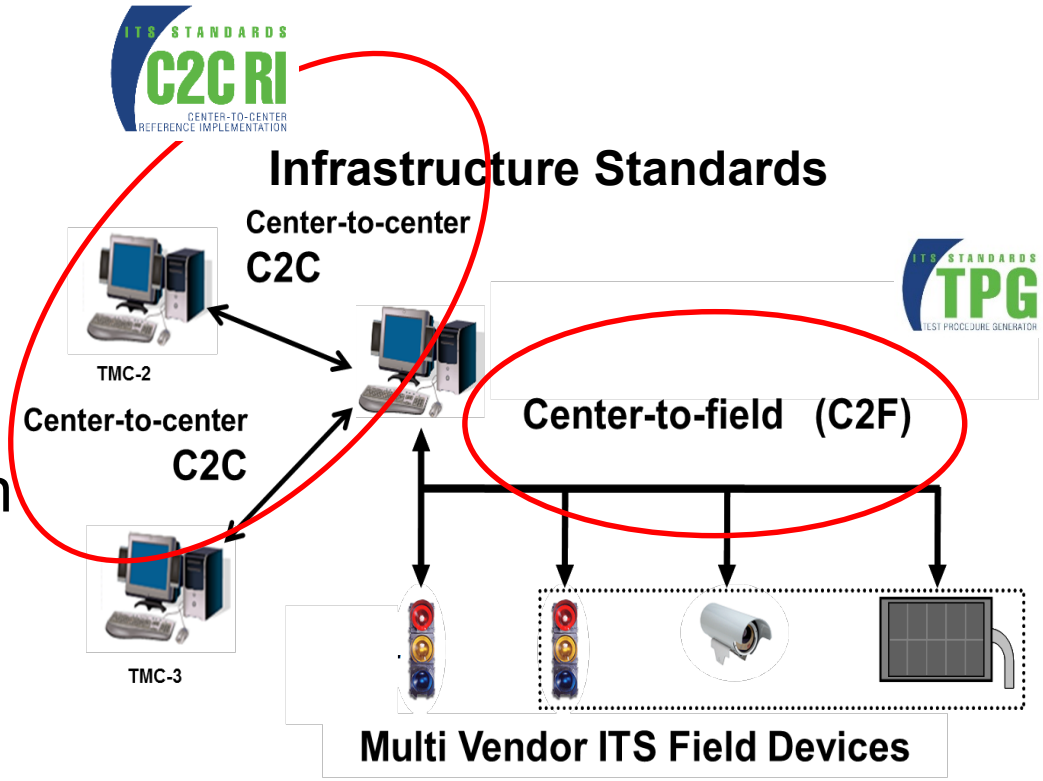
Manny Insignares, Vice President Technology, ConSysTec

What Are Standards?

- Established norm or requirement about technical systems that establishes:
  - Uniform engineering or
  - Technical criteria, methods, processes, and practices
- Most standards are:
  - Voluntary
  - Consensus-based
  - Open

What Are ITS Standards?

- Define how Intelligent Transportation Systems, products, and components:
  - Interconnect
  - Exchange information
  - Interact within a transportation network



Benefits

- Supports interoperability
- Supports Rule 940 compliance
- Minimizes future integration costs
- Facilitates regional integration
- Supports incremental measurable development
- Prevents technological obstacles
- Minimizes operations and maintenance costs
- Prepares for emerging technologies
- Makes procurements easier
- Easier and more robust test for conformance

Polling Question

Have you heard of the TPG or C2C RI tools?

- Yes, I have heard of the TPG
- Yes, I have heard of the C2C RI
- No, I have not heard about either tool

TEST PROCEDURE GENERATOR (TPG)

NTCIP Purpose

- National Transportation Communications for ITS Protocol (NTCIP) Standards provide:
  - Rules for communicating (protocols)
  - Vocabulary (objects and dialogs) for electronic traffic control equipment among different manufacturers to interoperate
- NTCIP Standards
  - Promote vendor independence
  - Reduce life-cycle costs
- NTCIP Standards address communication between
  - Field Devices
  - Management Centers and Field Devices
  - Two or more Management Centers

Test Procedure Generator (TPG)

- A survey of state and local transportation agencies in 2006-2007 indicated a need for assistance from the USDOT in developing procurement and testing documents when implementing ITS Standards.
- The ITS Standards Program determined one way to assist would be to develop a tool that generates test procedures for the center-to-field (C2F) ITS Standards in a consistent manner.
- To develop complete and correct test procedures, ITS Standards must contain requirements and other System Engineering content.

Standards with System Engineering Content

- **NTCIP 1203v03** Object Definitions for Dynamic Message Signs (DMS), September 2014*
- **NTCIP 1204v03** Environmental Sensor Station (ESS) Interface Standard – Version 03 with Errata, September 2014
- **NTCIP 1209v02** Data element Definitions for Transportation Sensor Systems (TSS) – Version 02, May 2014*
- **NTCIP 1210v01** Field Management Station (FMS) – Part 1: Object Definitions for Signal System Masters (SSM), September 2013
- **NTCIP 1211v02** Signal Control and Prioritization (SCP), Sept. 2014*
- **NTCIP 1213v02.20** Object Definitions for Electrical and Lighting Management Systems (ELMS), March 2011

**Standards with TPG Versions Published*
NTCIP 1203 and NTCIP 1204 Already have Published Test Procedures
NTCIP 1202 Actuated Signal Controller (ATC) Coming Soon

What is the TPG and How Does it Work?

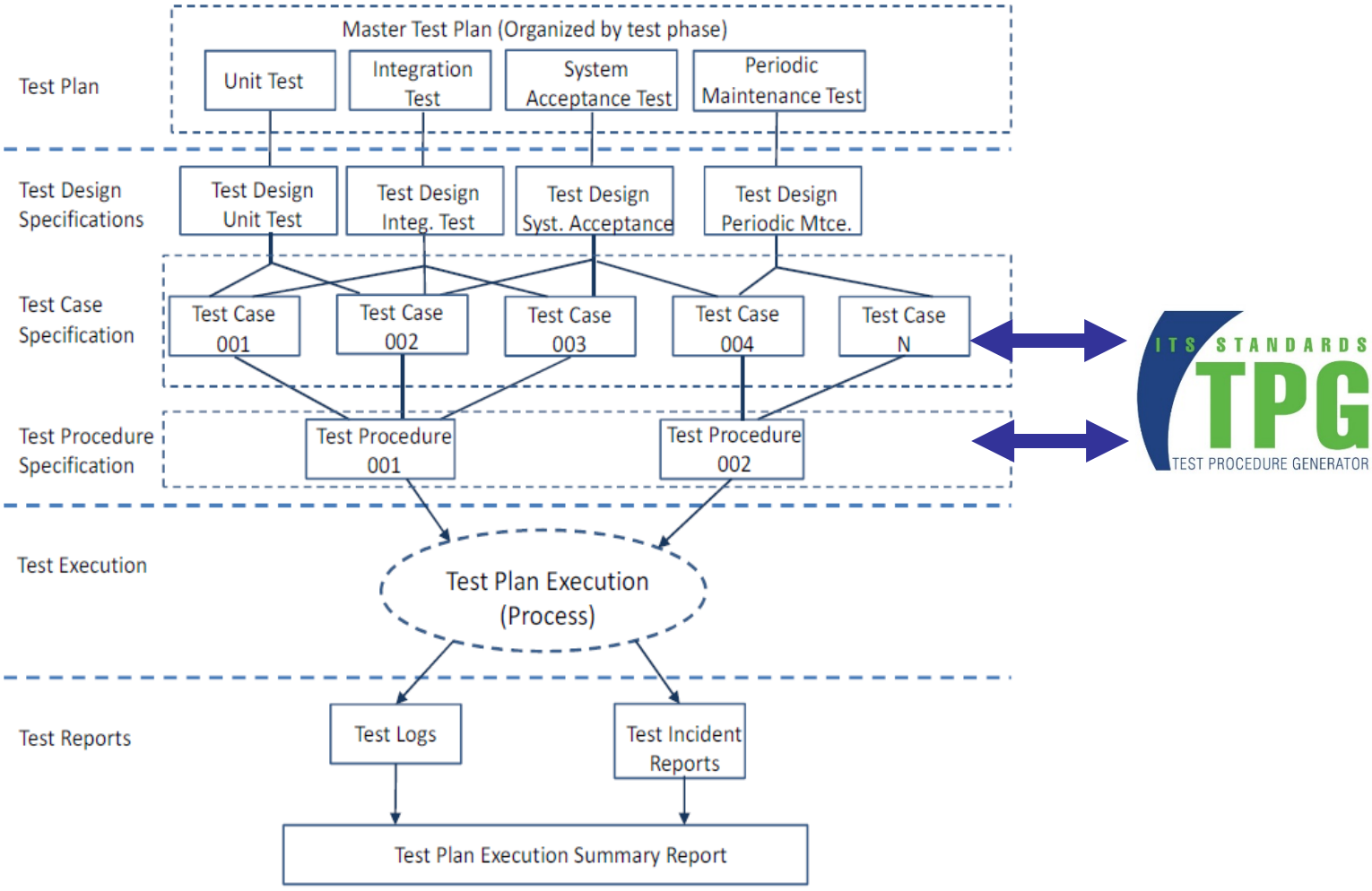
- Windows based software tool that processes NTCIP Standards and outputs Test Procedures.
- Supports ITS Standards developers as well as deployers (local and state agencies) of NTCIP C2F Standards.
- TPG guides the development of test procedures by:
  - Loading and processing standards to be implemented including requirements, dialogs, and objects
  - Basing Test Procedures on user selected requirements in NTCIP C2F Standard

What is the TPG and How Does it Work?

- Uses standardized and consistent language for Test Procedures development:
  - Standard keywords, variables, and object names imported from standards
- Outputs an XML file for consistent interpretation of test suites
- Standards Developers use the TPG to create consistent Test Procedures and verify standards

The TPG is not a testing tool!

NTCIP Testing

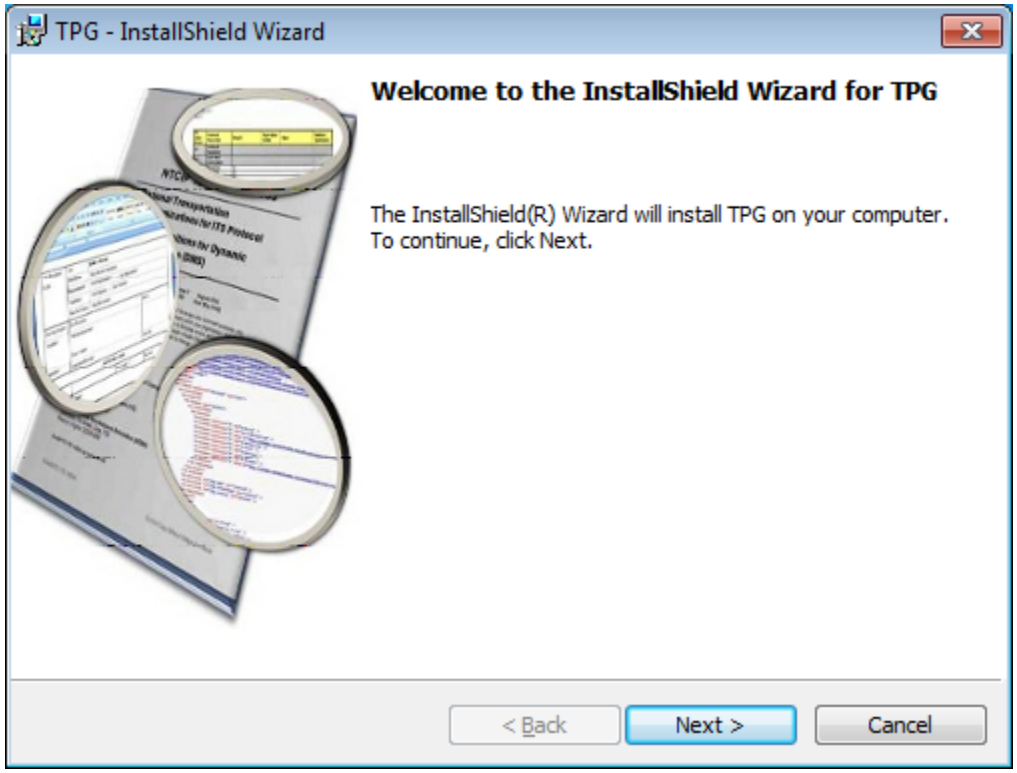


Role of the TPG in Testing

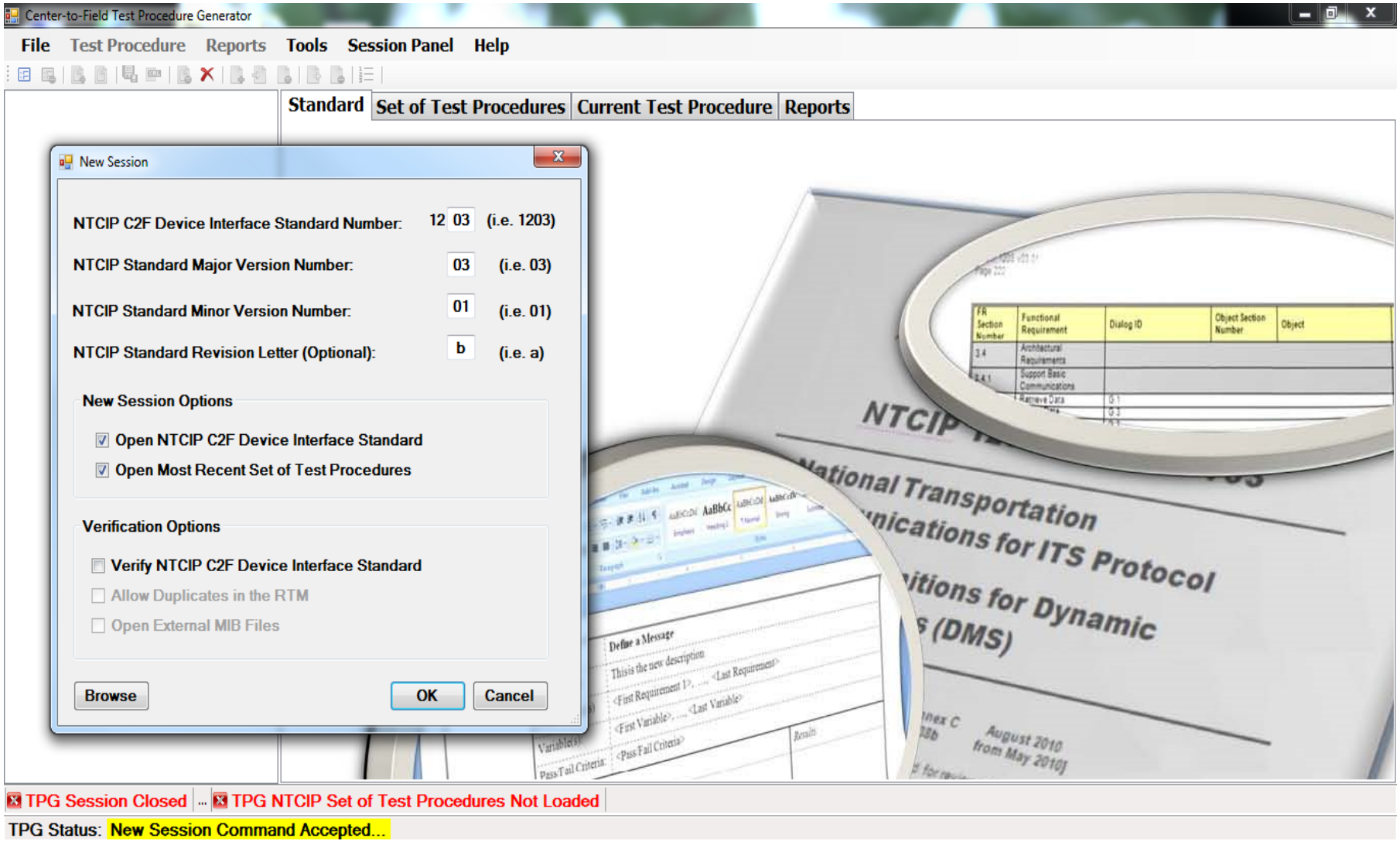
- Supports off-the-shelf interoperability
- Promotes the systems engineering process by giving users support in creating test procedures
- Standardized and easily available Test Procedures that are conformant to the standard helping to eliminating proprietary system elements

Using the TPG

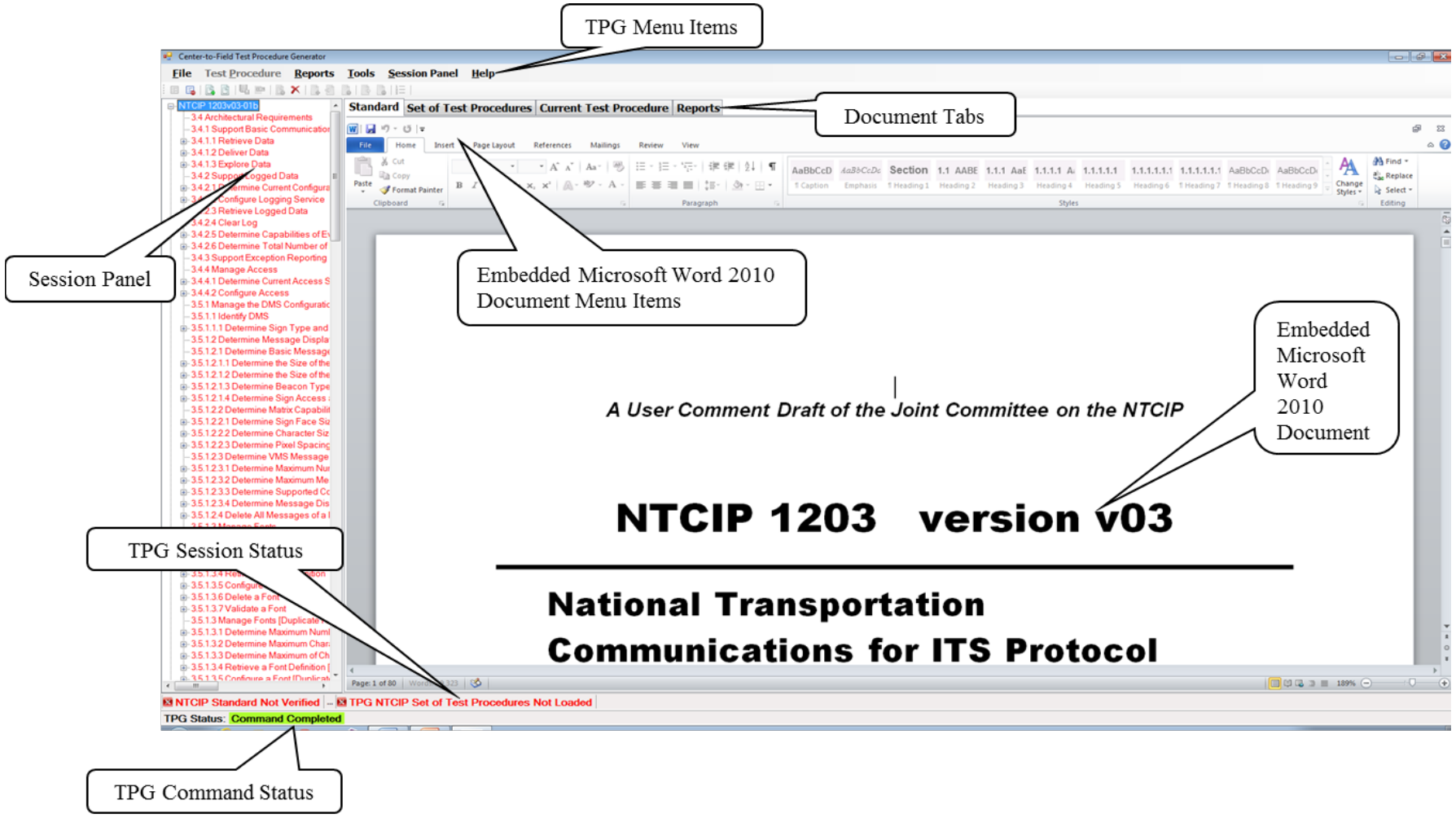
- Install the TPG



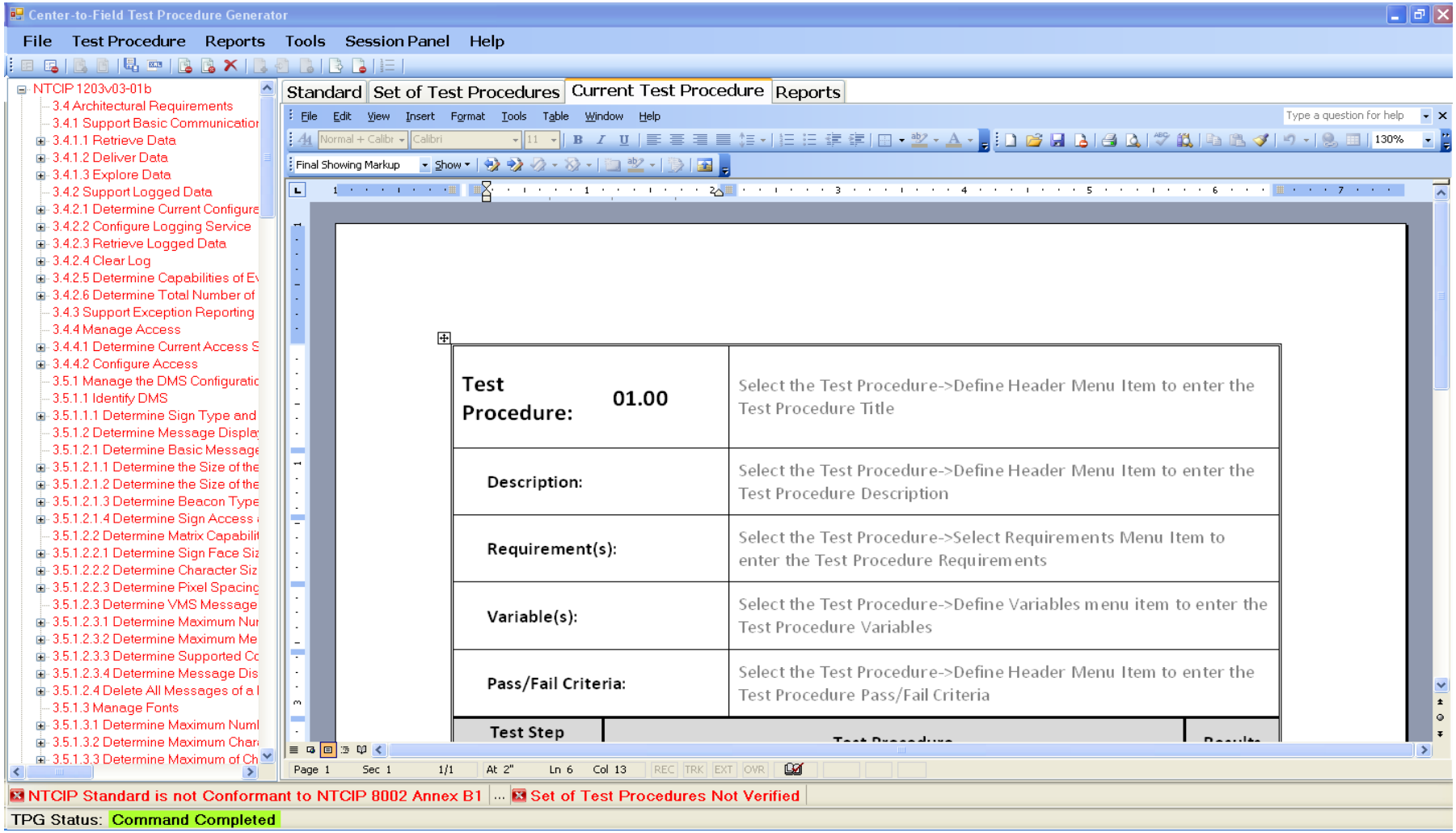
Using the TPG



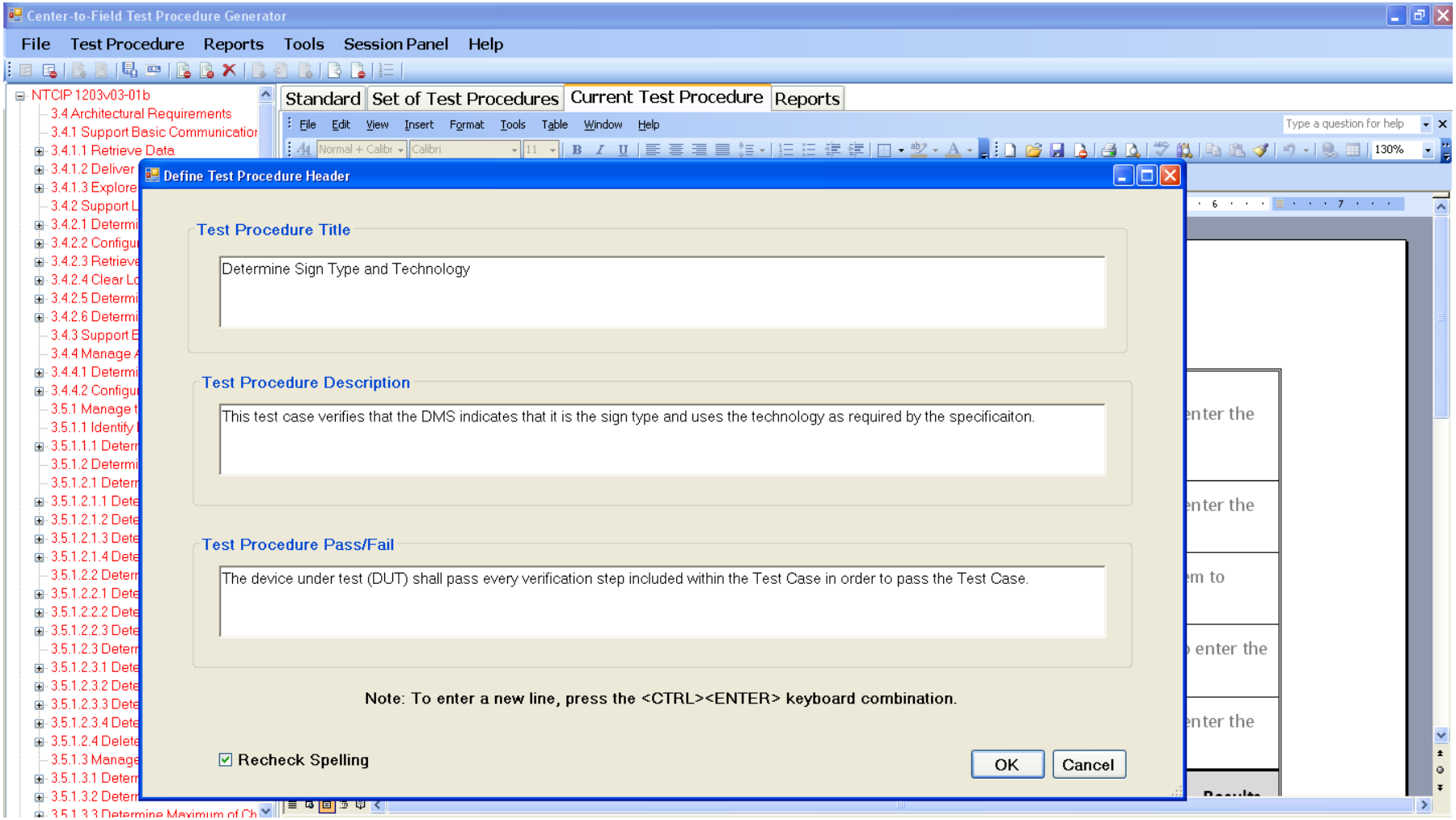
TPG Graphical User Interface



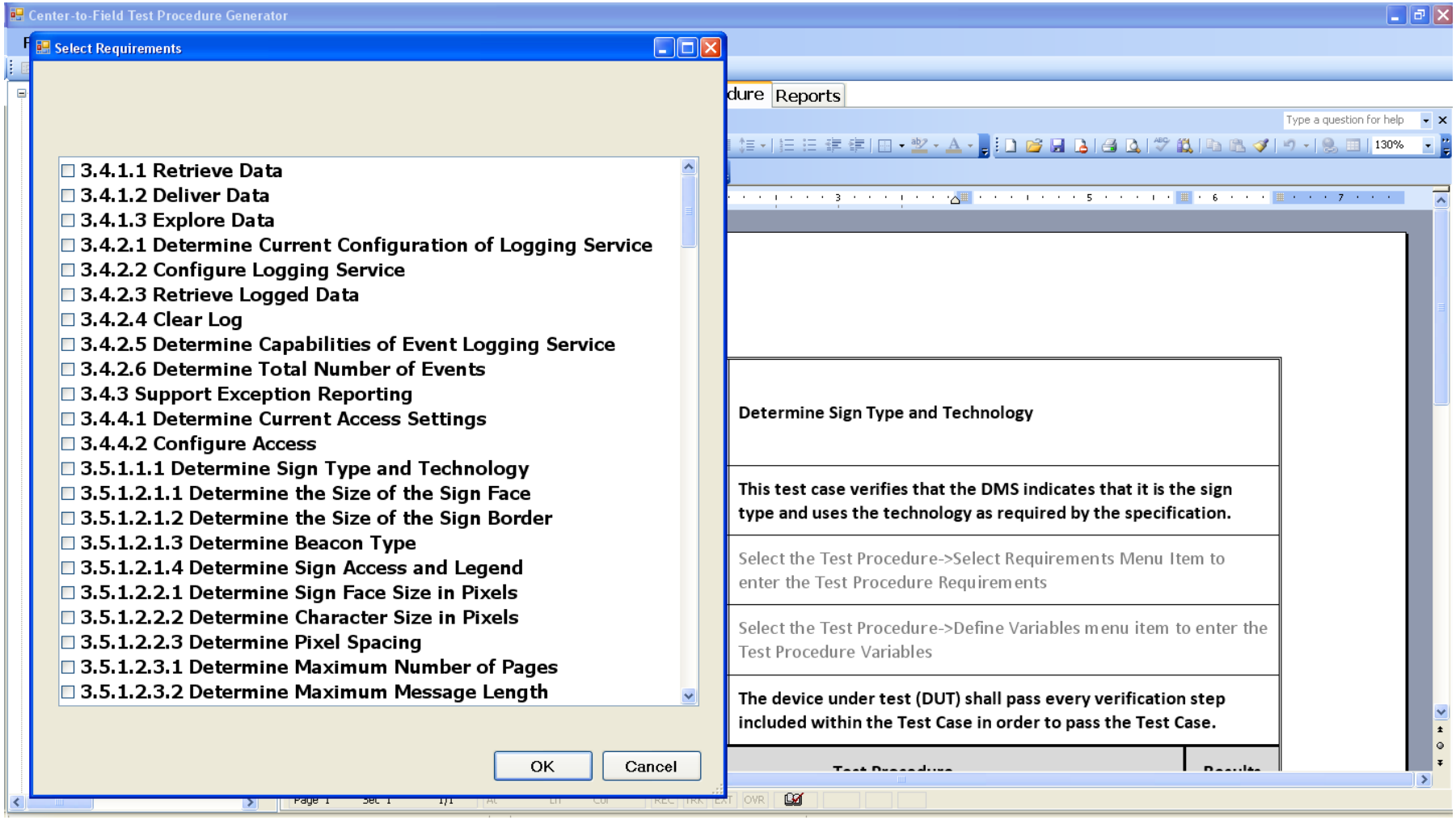
New Test Procedure



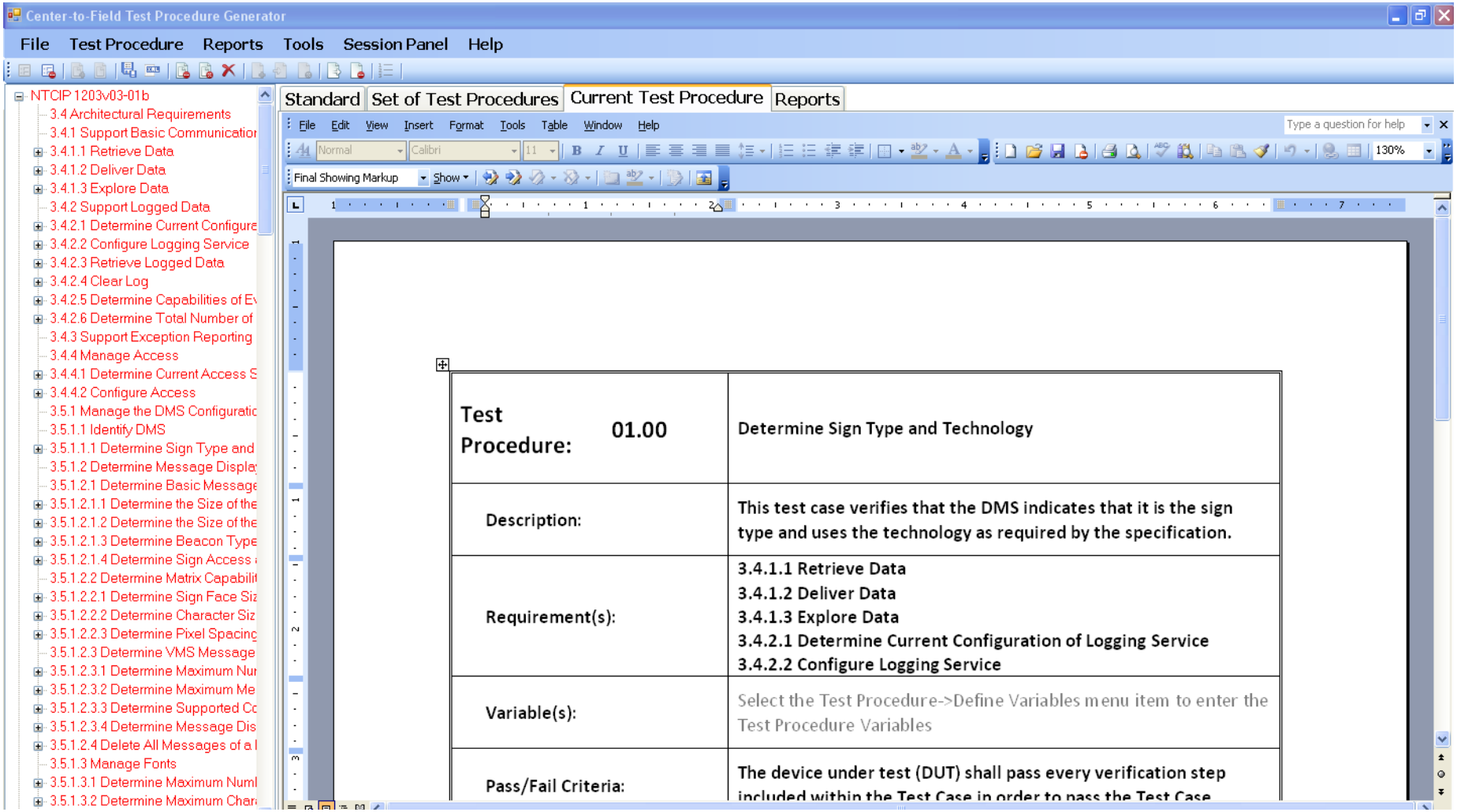
Define Header Information



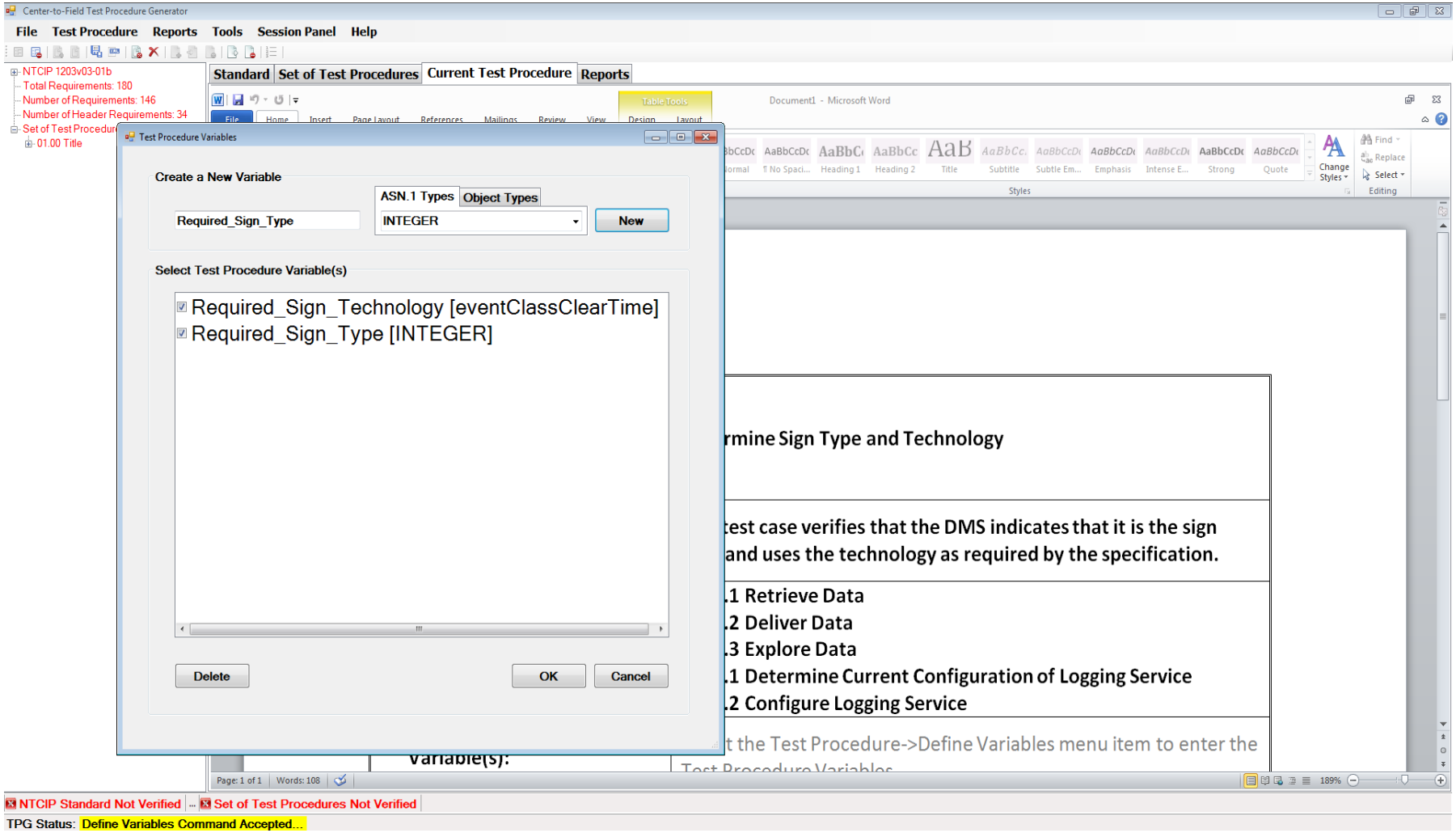
Select Requirements



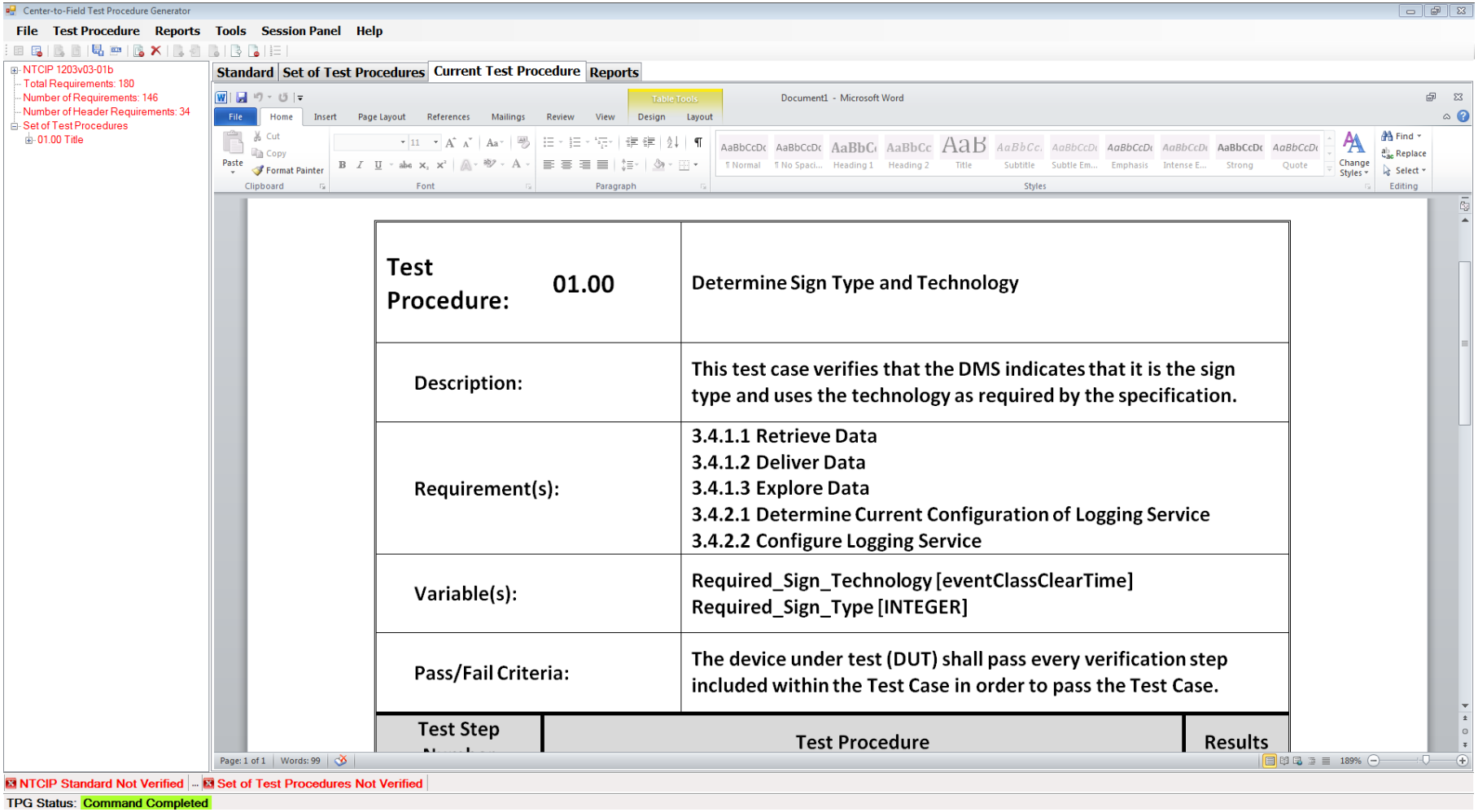
Test Procedure



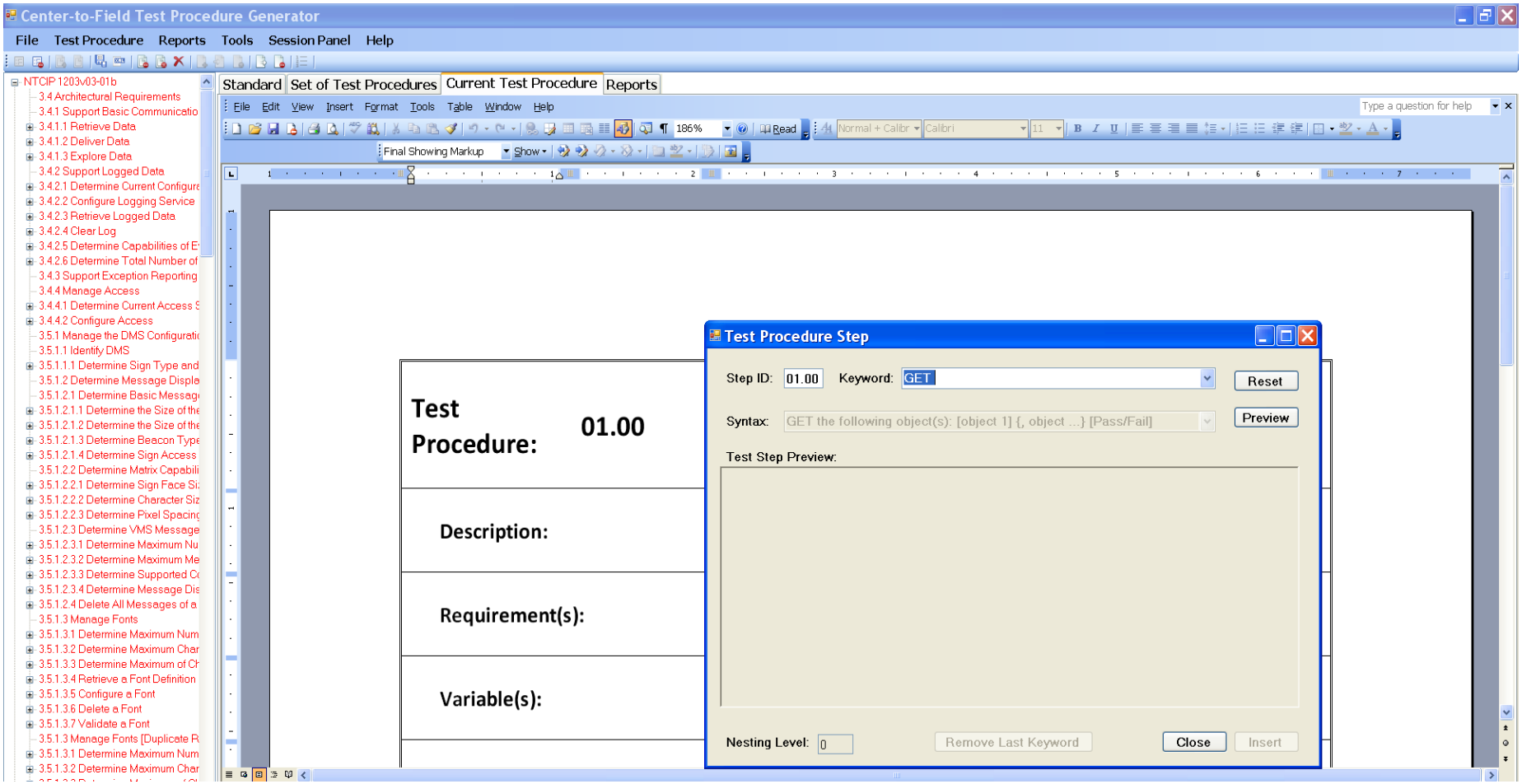
Create Variables



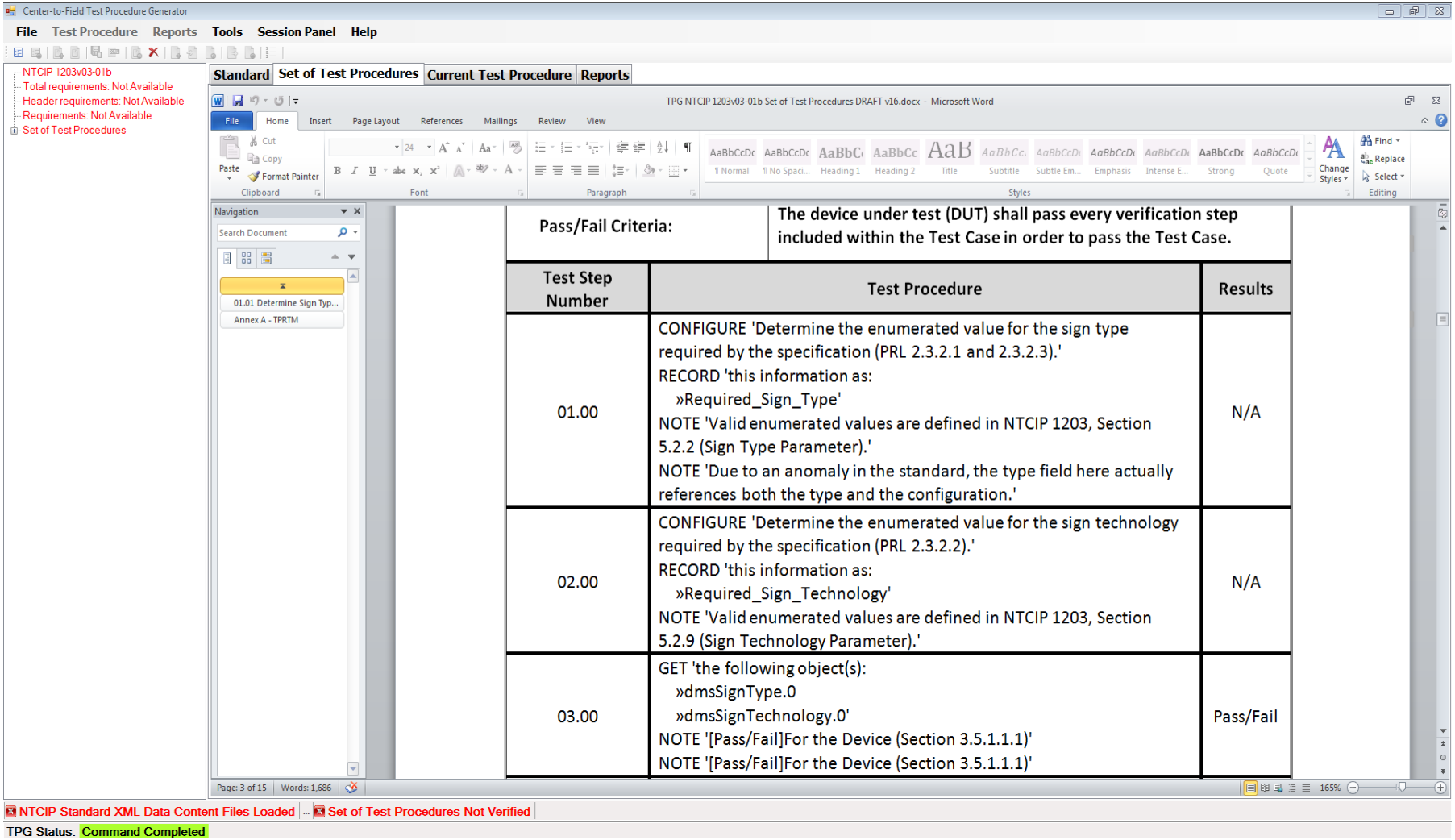
Test Procedure



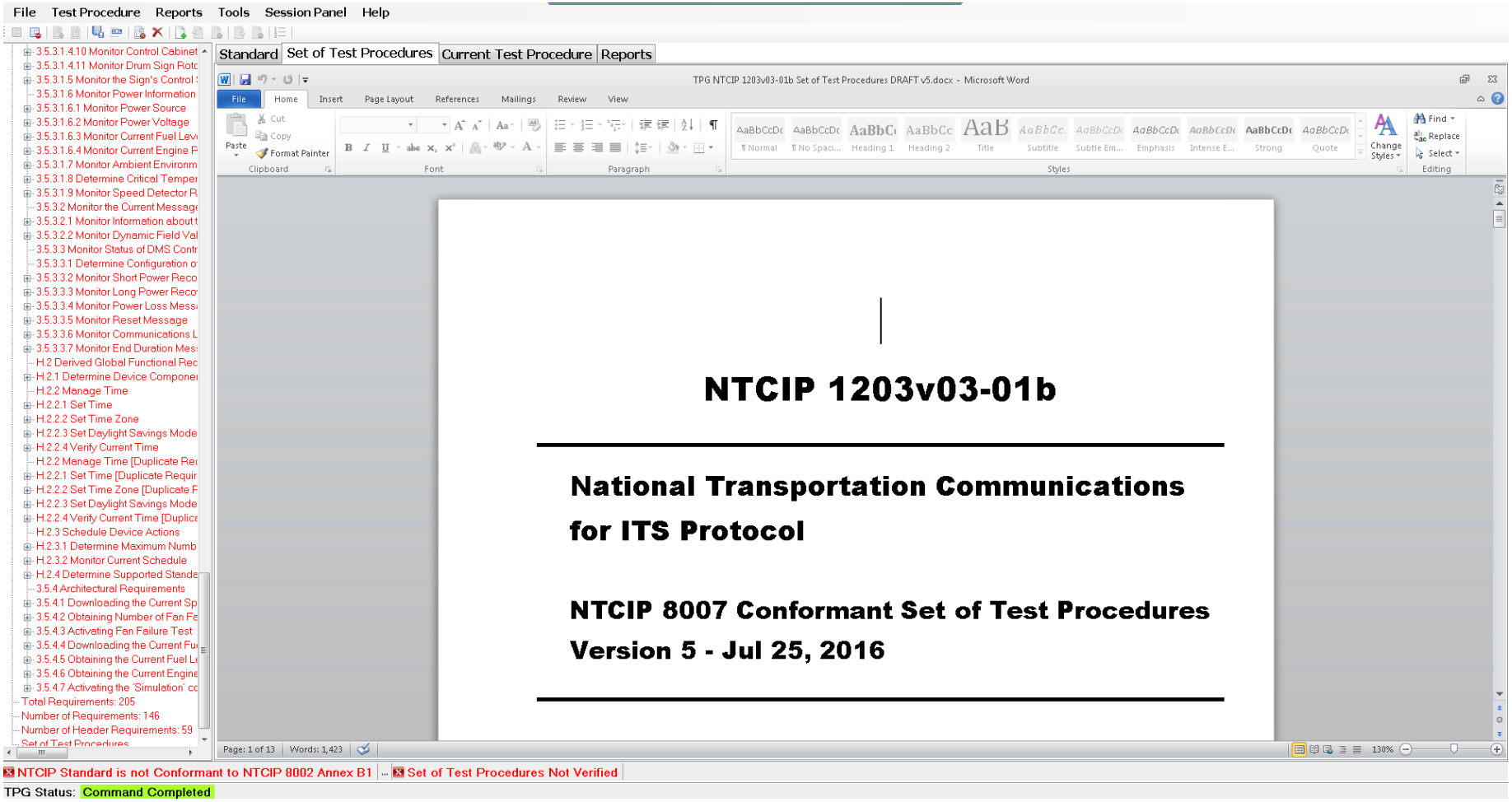
Create Test Step



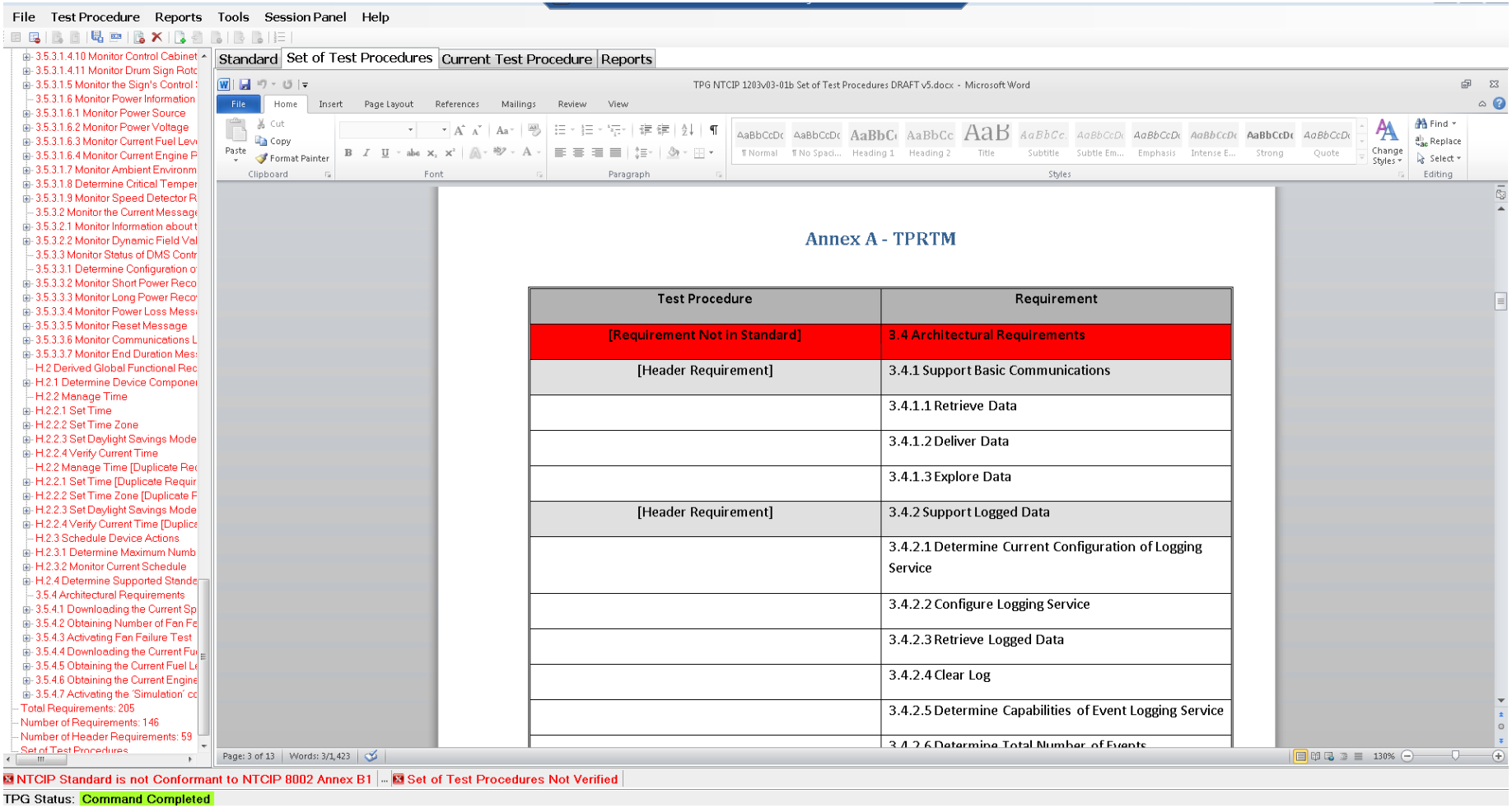
Test Procedure Results



Set of Test Procedures



Test Procedure to Requirements Traceability Matrix (TPRTM)



Summary

- Agencies can use the TPG to develop consistent and reusable test procedures for verifying conformance and compliance.
- Using the TPG tool will reduce risks, effort, and the cost of developing test procedures.
- Promotes off-the-shelf interoperability.
- USDOT is actively seeking local or state agencies partners to deploy a NTCIP C2F Standard using the TPG
  - Use the experience to make any necessary updates to the software
  - Get the tool into the hands of agencies to prove its worth in the field and encourage more agencies to use the software

How to obtain the Tools

- TPG v3 is now available updates include:
  - Compatibility with Windows 7 and 10 Professional
  - Compatibility with Microsoft Office 2010
- TPG Support: TPGSupport@noblis.org

For more information and to acquire the Tools please visit:
https://www.standards.its.dot.gov/DeploymentResources/Tools

CENTER-TO-CENTER (C2C) REFERENCE IMPLEMENTATION (RI)

Introduction

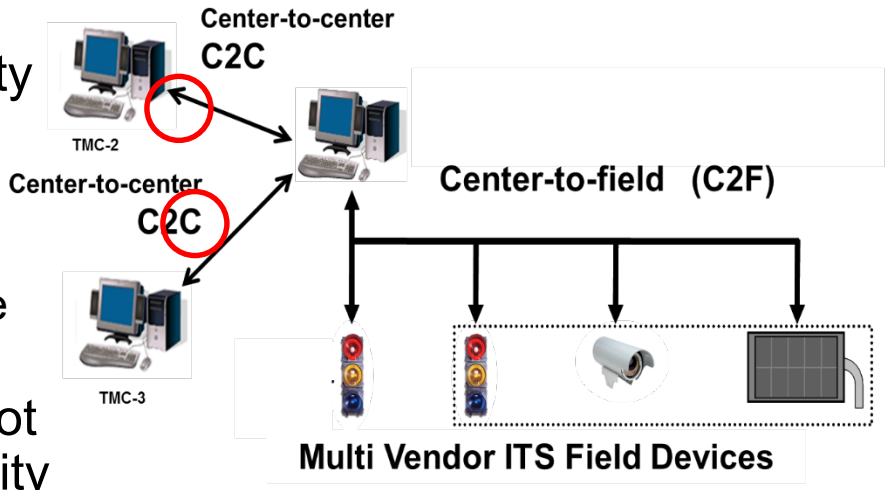
- The Center-to-Center Reference Implementation (C2C RI) is a test tool designed to test for conformance to ITS Standards for center to center communications
- Sponsored development and provided for free by USDOT to help promote implementation of center to center communications standards

What will you get from this session

- This session will provide:
  - An understanding of what the C2C RI test tool is and how it works
  - How to achieve interoperability using the C2C RI tool
  - Benefits of the C2C RI tool
  - How to obtain a copy from USDOT
  - How to receive technical support for the C2C RI tool

What is the C2C and Why is it Important?

- Center-to-Center (C2C) communications
- Coordination between centers
  - Incident management between agencies
  - Traffic coordination
  - Transit coordination
  - Status of network
- How do we achieve interoperability
  - Needed for exact and prompt coordination
  - Protocol must be the same
  - Message contents must have same meaning
- Proprietary implementations do not achieve off-the-shelf interoperability



Center-to-Center RI

- C2C identified in National ITS Architecture
- **Regional coordination is occurring (driven by congestion issues)**
- **No consistent means to verify conformance**
- The C2C standards were still a moving target
- Extensions common for C2C breaking standardized capabilities
- **Interoperability not being achieved**
- **Agencies asking how to test for conformance**
- USDOT sponsored development of C2C RI to encourage deployments and interoperability

High-Level Description of the C2C RI

- C2C RI currently works with:
  - Traffic Management Data Dictionary v3.03c and v3.03d
  - NTCIP 2306 v1.69
- Can verify both transmissions from owning centers and requests from external centers
- Emulates devices (version 2)
- Provides test for SAFETY-LU Section 1201
- Verifies formats, protocols, and performance requirements

High-Level Description of the C2C RI

- Can be configured to test for only your center's requirements
- Provides test reports and logs test results
- Can be used for debugging, conformance testing, and acceptance testing
- Version 2 available now

Benefits of the C2C RI

- Reduce the development risks and costs to achieve interoperable systems
- Easier and more robust test for conformance to standards
- Allows you to select the requirements you want to verify

Testing Process for C2C

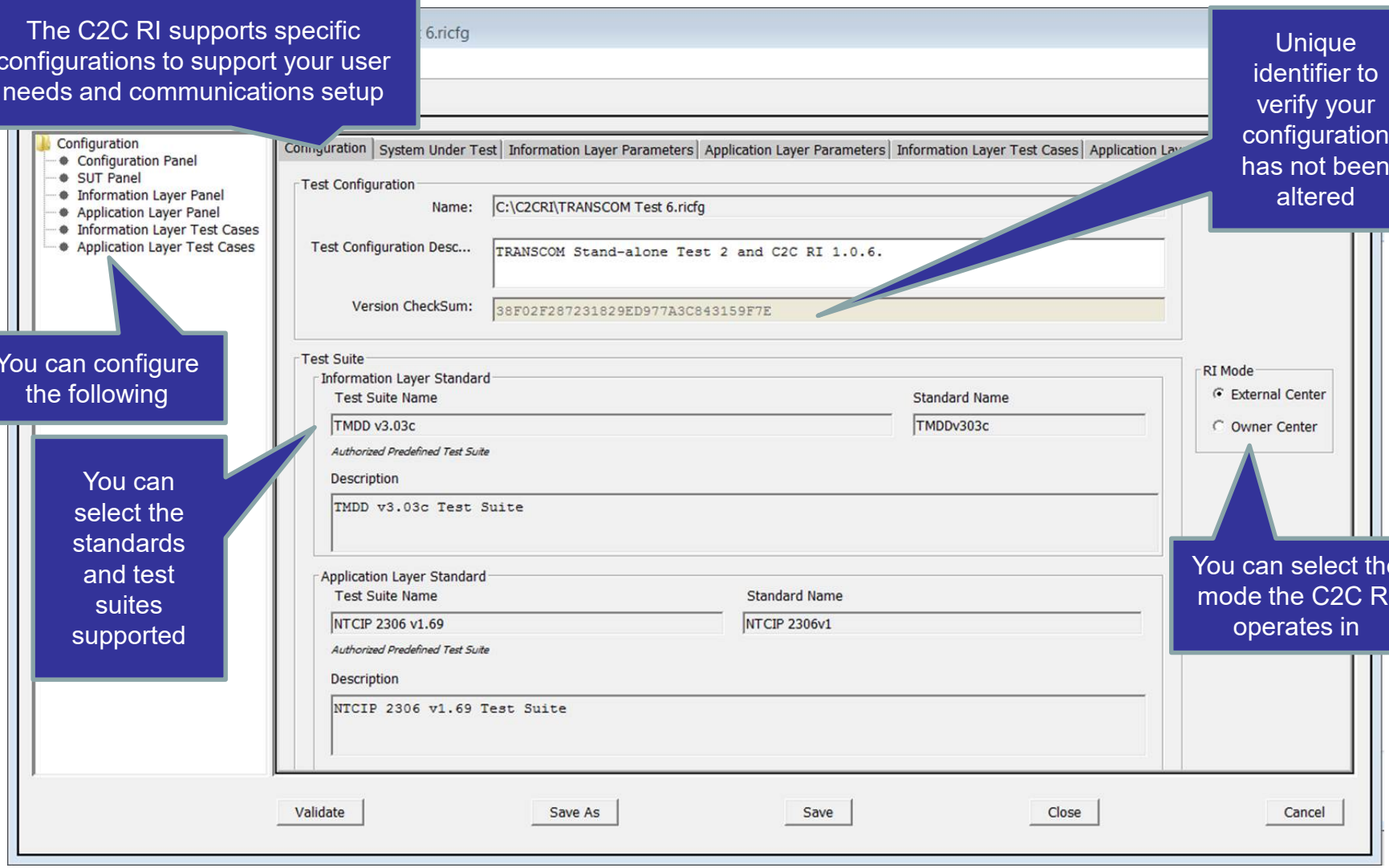
- Provide NRTM (system requirements)
- Configure C2C RI to communicate with the C2C system under test (SUT)
- Configure C2C RI to SUT requirements (from NRTM)
- C2C RI then selects the test cases
- Run test cases
  - Tester may verify results in some cases
  - C2C RI logs all test results and displays the results for the tester
- Request test reports and save test logs
- Verify all test cases passed

C2C RI capabilities summary

Table 1 - C2C RI Capabilities		
• Verifies TMDD v3.03c and 3.03d • Supports request/response operations • Supports Publication/Subscription operations • Provides Emulation of devices (DMS, ESS, Traffic Controller, Ramp Meter, CCTV control, Vehicle Detector, HAR, Lane Closure Gate, Lane Control Signal, Signal Section & Video Switch) • Provides Emulation of Events • Allows for local extensions as per TMDD v3.03c and 3.03d • Supports debugging and conformance	• Configures for project needs and requirements • Automatically selects test cases and procedures • Logs test activities and results • Provides tester the ability to confirm key content in an automated testing environment • Generates test reports for conformance • Generates SAFETEA-LU section 1201 conformance report • Provides test suspension and termination capabilities	• Verifies NTCIP 2306 v1.69 • Supports XML Text, GZIP, SOAP encoding • Supports XML over HTTP, XML over FTP, SOAP over HTTP • Supports WSDL & WSDL for SOAP Request-Response messaging • Supports WSDL & WSDL for SOAP Subscription-Publication messaging

Configuration screen

The C2C RI supports specific configurations to support your user needs and communications setup



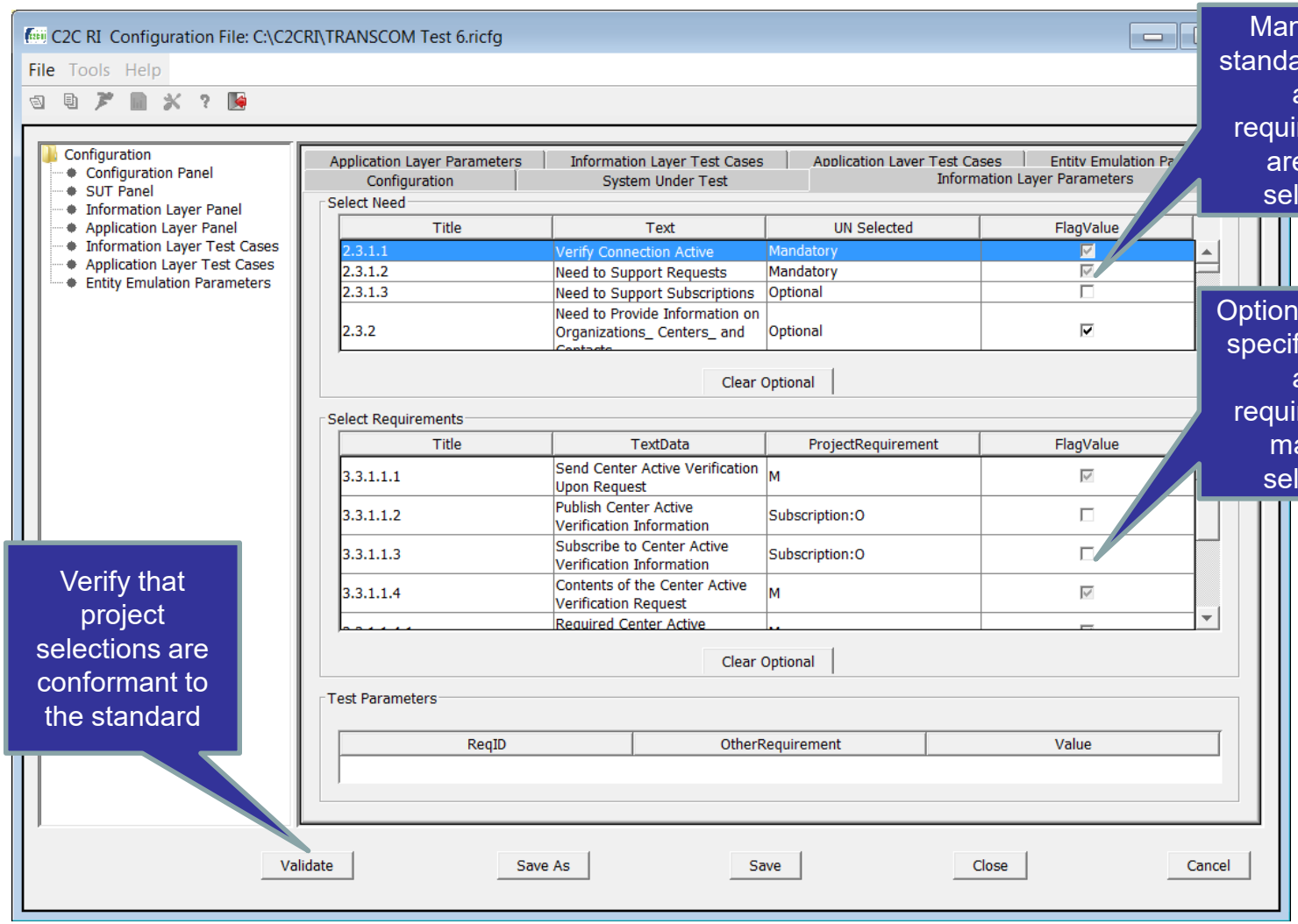
Unique identifier to verify your configuration has not been altered

You can configure the following

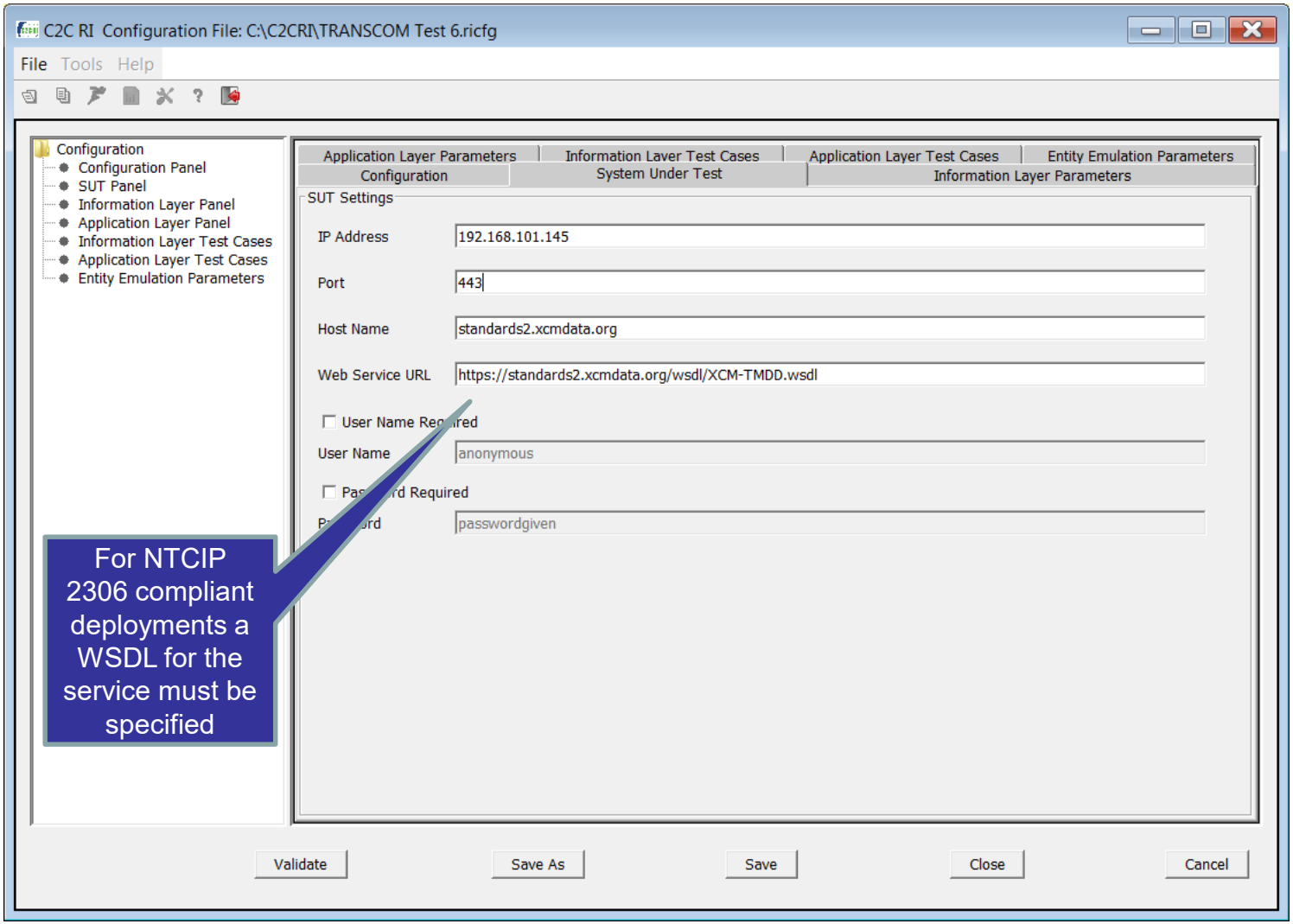
You can select the standards and test suites supported

You can select the mode the C2C RI operates in

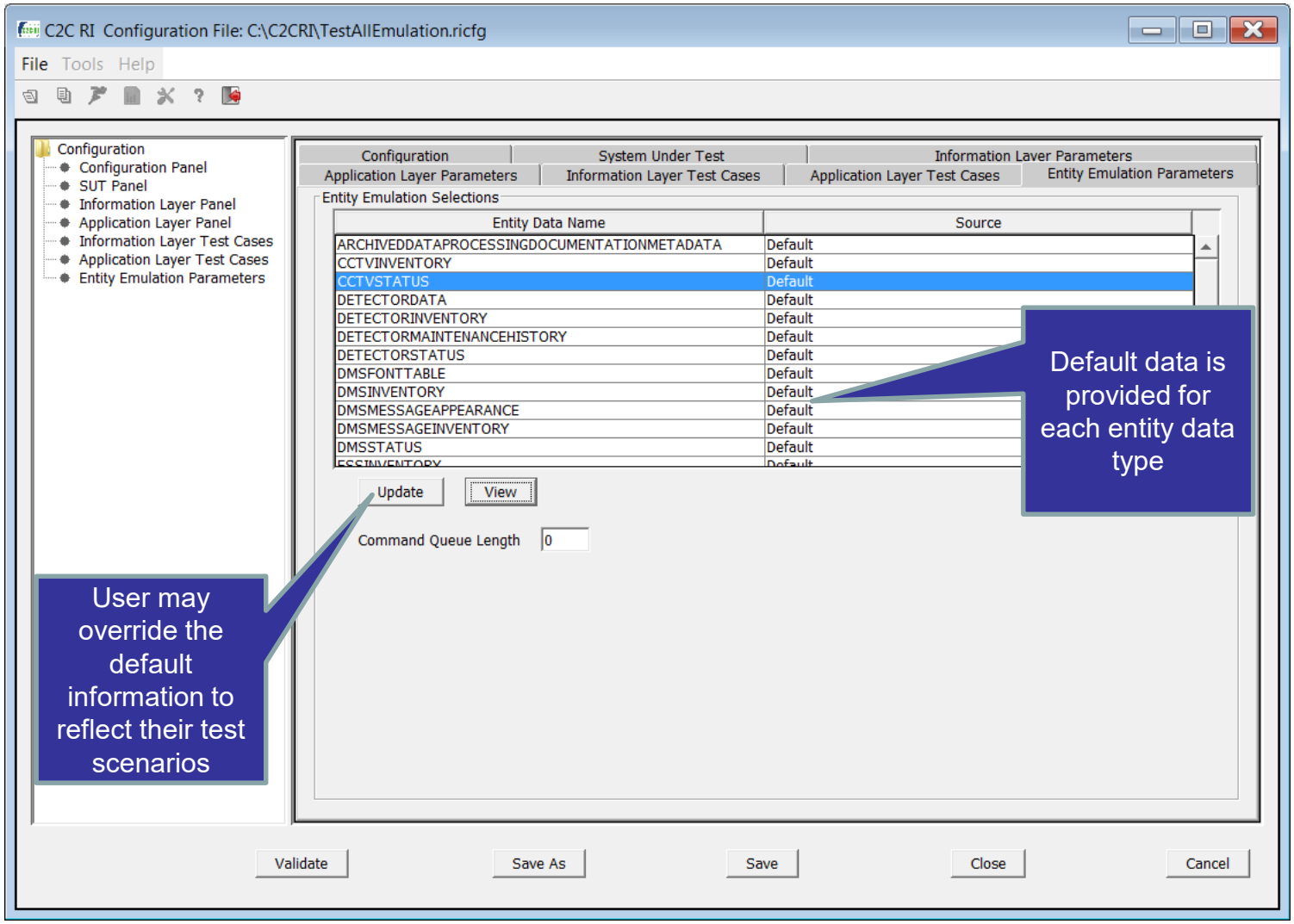
Configure Needs and Requirements



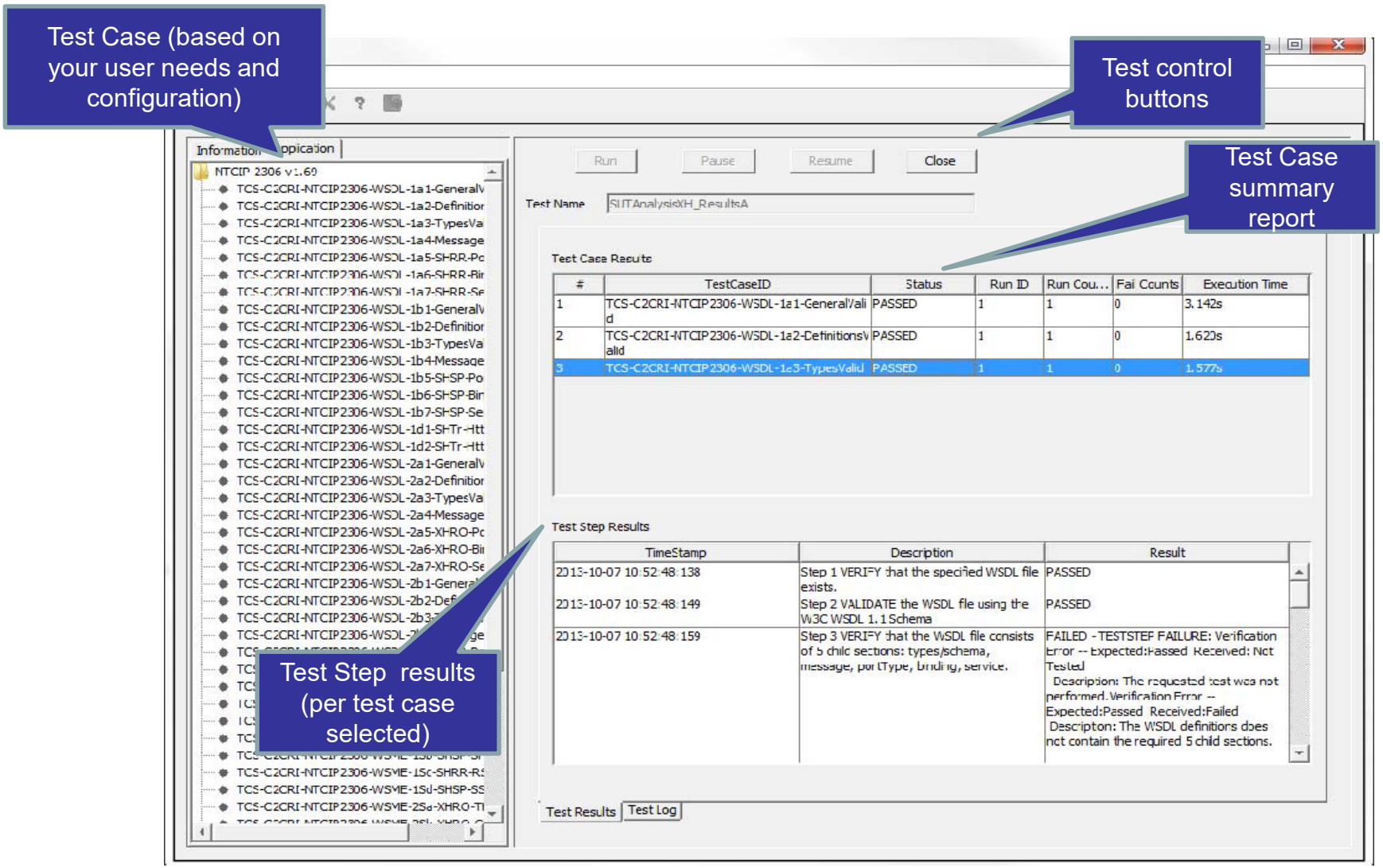
Configure System Under Test



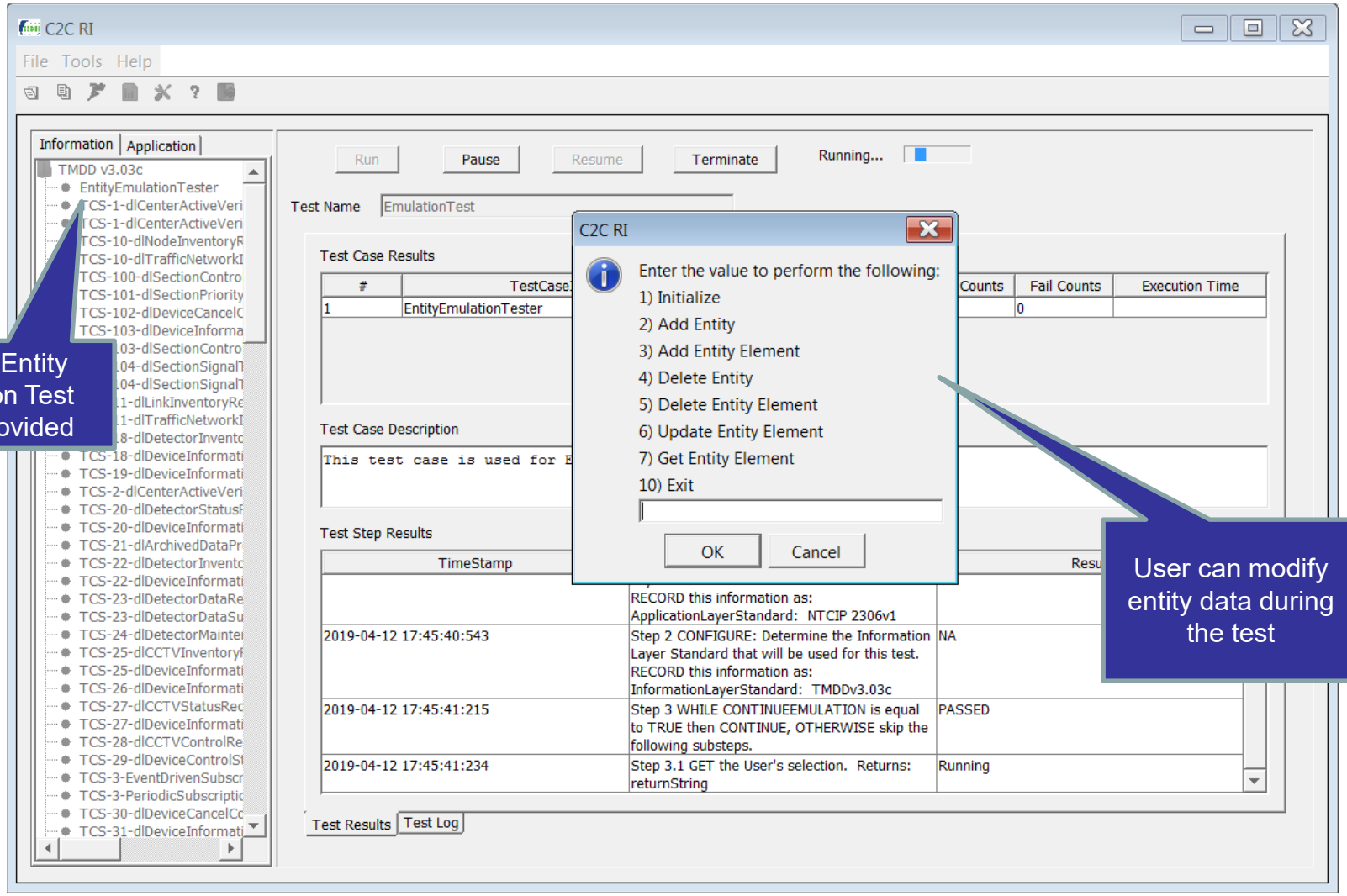
Configure Entity Emulation Data



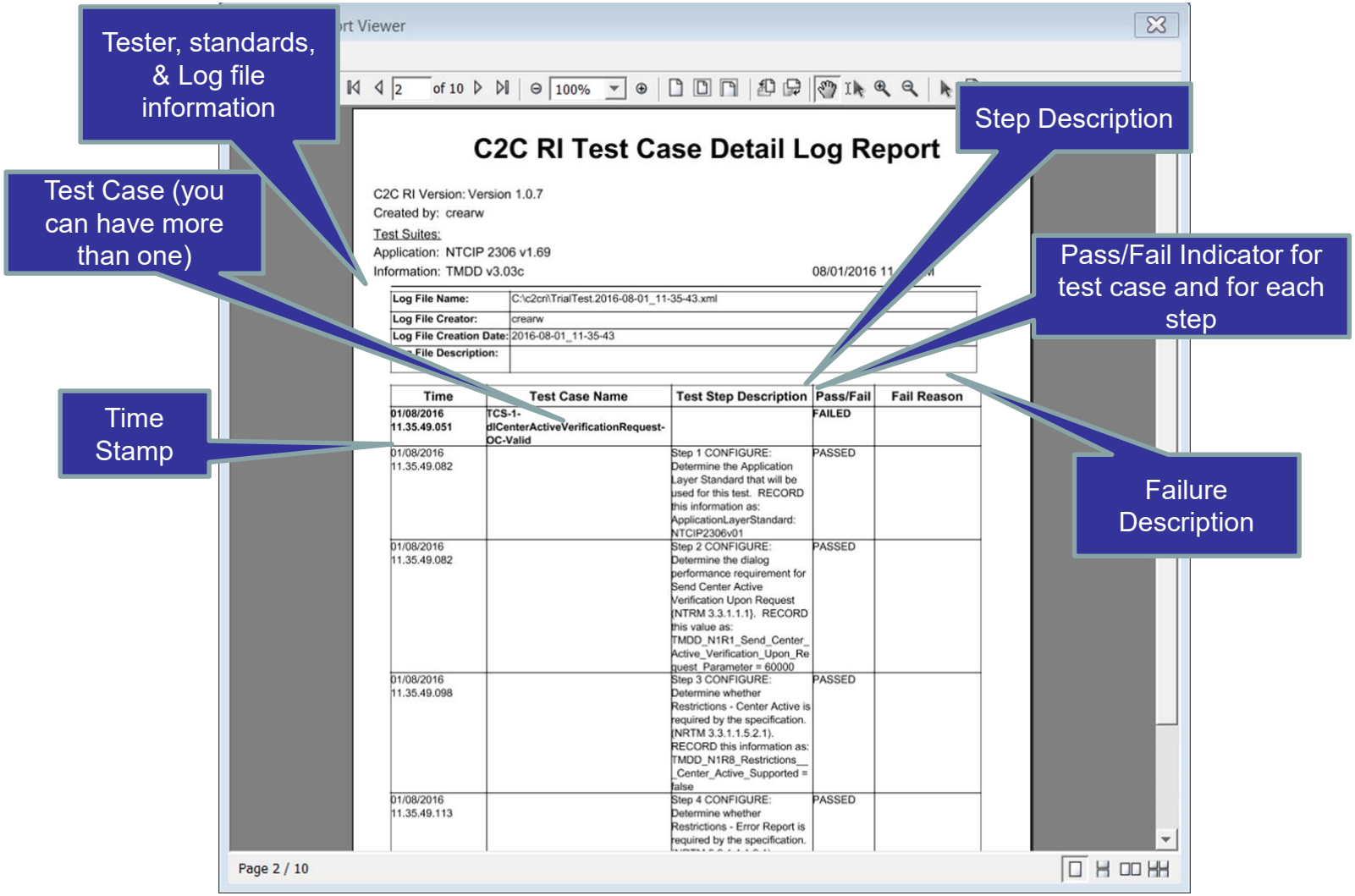
Run & test results screen



Run Entity Emulation Test

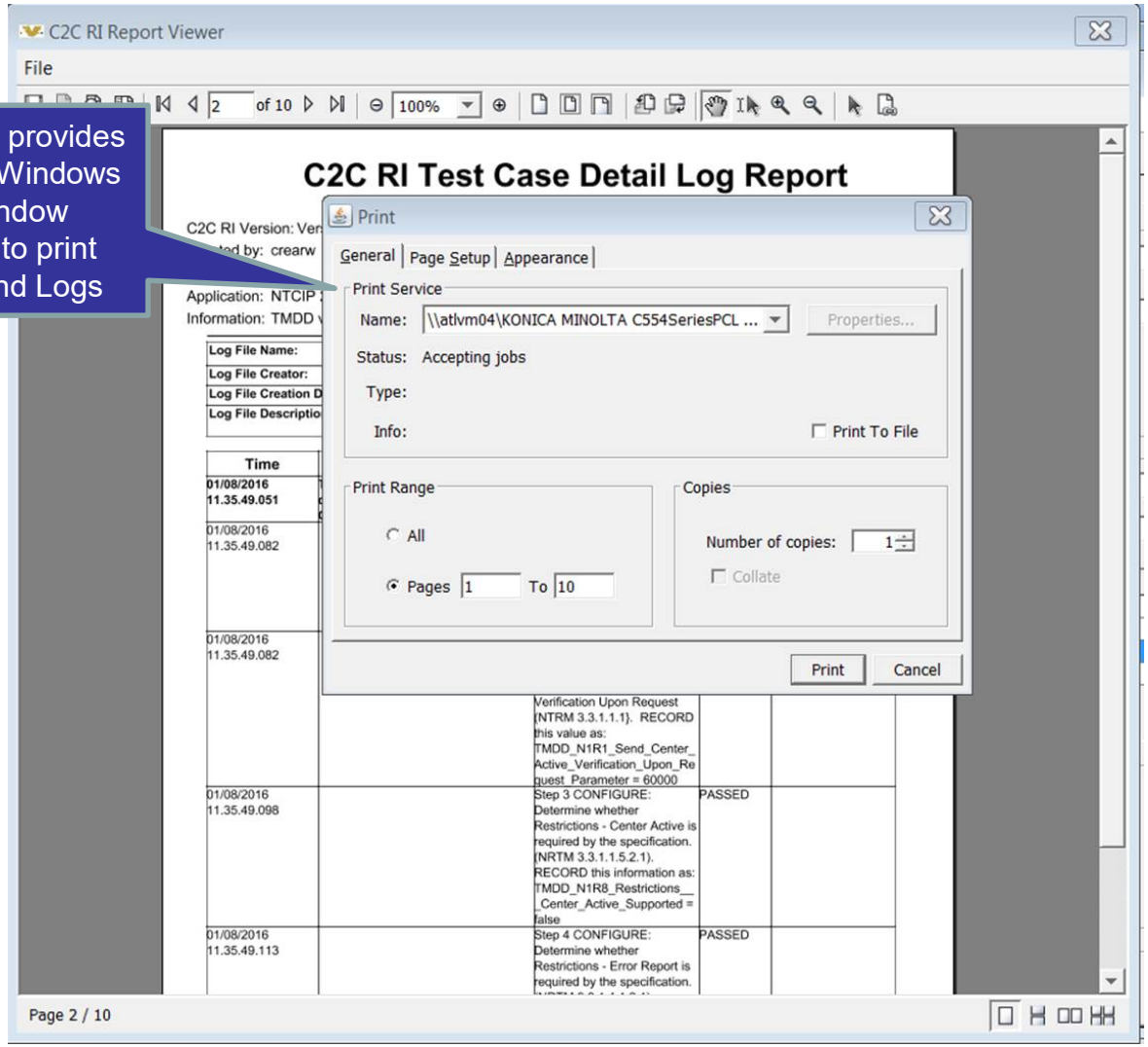


Test case result report



Print reports screen

The C2C RI provides a standard Windows Print window capability to print Reports and Logs



Role of C2C RI in Testing Process

- Selection of requirements
- C2C RI provides Test cases
- Run tests
- Provides Reports
  - Conformance to standards
  - Compliance to requirements
  - Verifies conformance to Section 1201
  - Provides Test Logs

Summary

- The C2C RI is a test tool that verifies conformance to C2C Standards
- It currently supports
  - TMDD v3.03c
  - TMDD v3.03d
  - NTCIP 2306 v1.69
- You can obtain a copy for free
- There is technical support for it

How to Obtain the C2C RI and Get Help

- The C2C RI and user manual can be downloaded at: https://www.standards.its.dot.gov/DeploymentResources/Tools

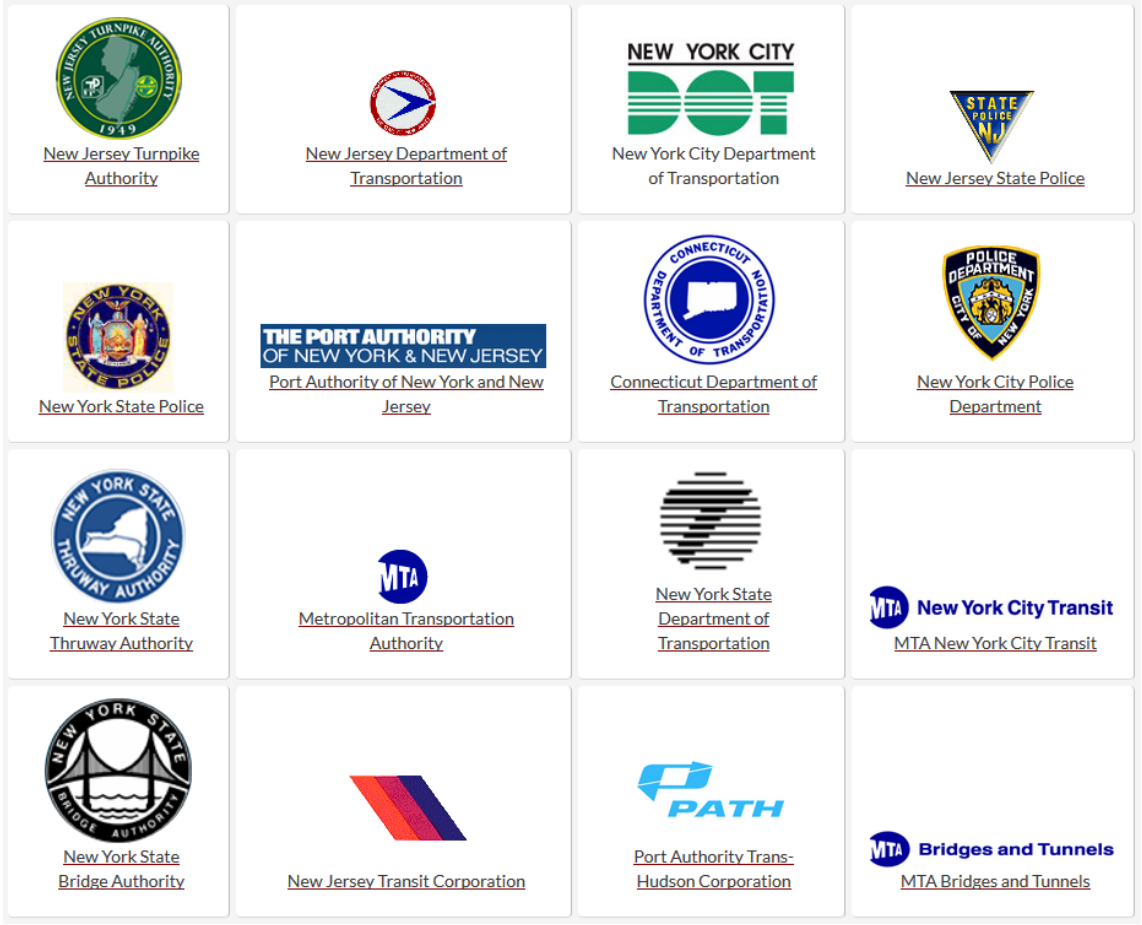
- You can get technical support help on the C2C RI at: c2crisupport@transcore.com

TRANSCOM Background

- TRANSCOM is a coalition of 16 transportation and public safety agencies in the New York – New Jersey – Connecticut metropolitan region. It was created in 1986 to provide a cooperative, coordinated approach to regional transportation management.
- *Video available at www.xcm.org*

TRANSCOM Member Agencies

TRANSCOM's systems are driven by the communications and information exchange needs of its member agencies.

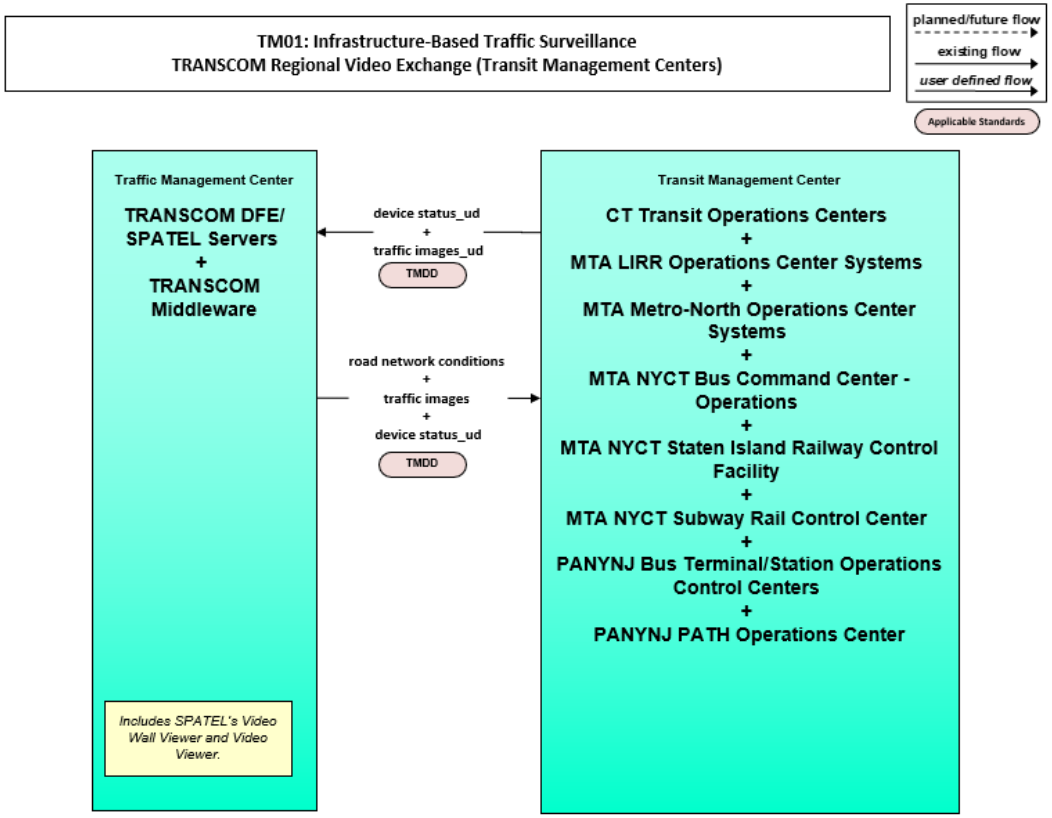


TRANSCOM Background

- TRANSCOM has achieved a level of success by demonstrating that 100+ operations centers can achieve an interoperability advantage and provide a real benefit at the operations level by conforming to these ITS standards.

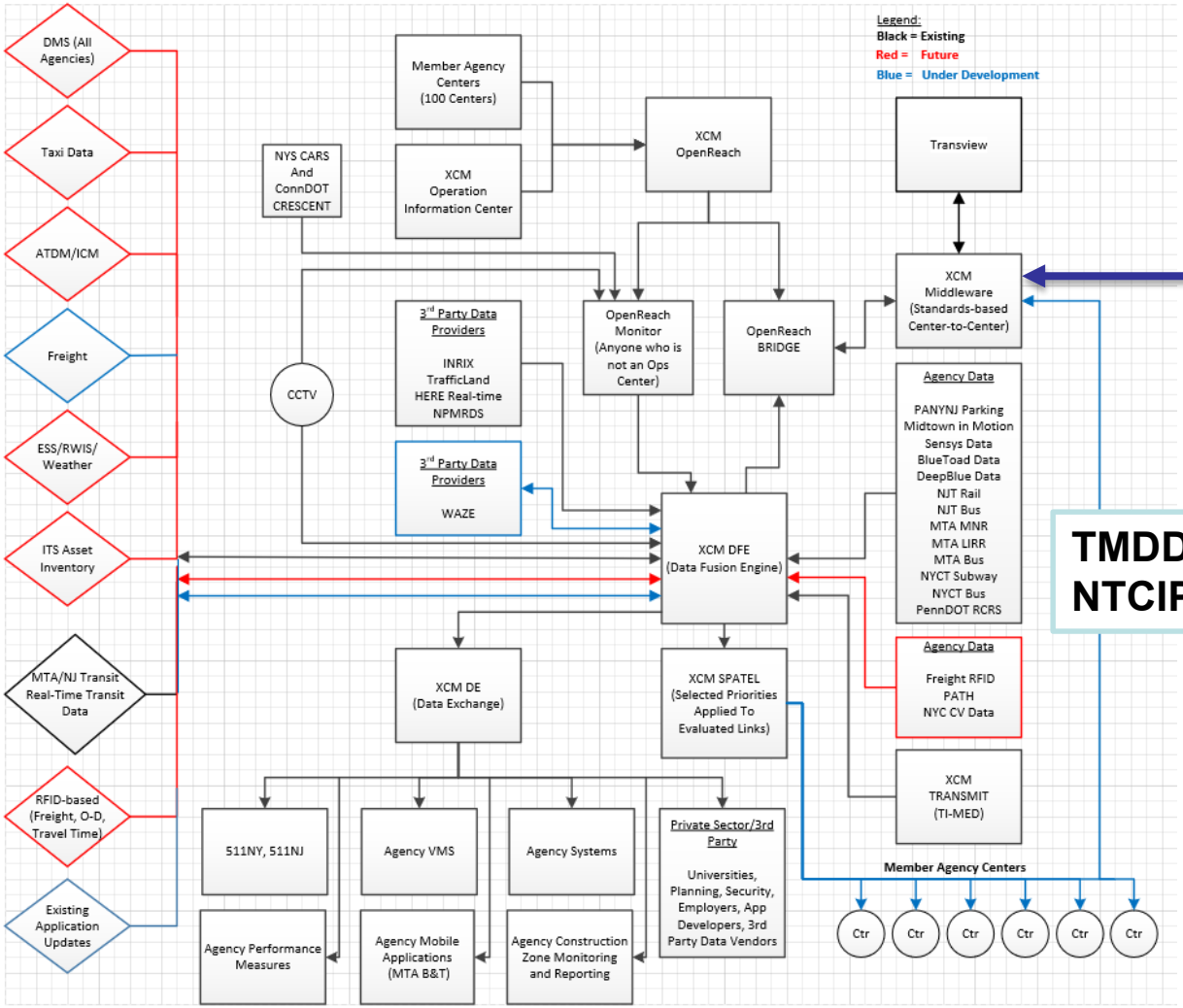
TRANSCOM and ITS Standards

- TRANSCOM integrates ITS Standards into it's systems planning. An example ITS Architecture service package diagram is shown below.



TRANSCOM's System Architecture

Middleware and other native systems.



Lessons Learned: General

- Using the C2C RI tool and testing TMDD conformance of a system is a process.
- It is recommended to take simple steps first, then build upon your successes.
- The project would have been very difficult to implement without TRANSCOM Middleware, TMDD, NTCIP 2306, and C2C RI expertise available.
  - Plus, system developer staff available to make necessary modifications to the software.
  - Plus, access to the C2C RI development staff who are thoroughly familiar with how the tool works.

Pre-Test Activities

- TRANSCOM had developed a specification for the system (called Middleware), based on the TMDD “Needs to Requirements Traceability Matrix”.
  - As a result, there were no problems configuring the C2C RI tool, which also uses the NRTM to determine TMDD XML message exchanges.
- Used an off-the-shelf tool called SOAP UI to assess and verify that the XML message structure is conformant with TMDD.
  - As a result, there were no problems with C2C RI verification of XML messages.

Pre-Test Activities

- Test Plan (Prepared by the Test Engineer)
- Test Case Specifications (Generated from the C2C RI tool)
- Test Procedure Specifications (Generated from the C2C RI tool)

Conformance Testing

- Pre-Test/Training Phase – Verified WSDL, ability to connect the systems and exchange messages. Two messages tested:
  - Connection Verification
  - Node Inventory

- Conformance Test Phase – Ensure the full set of requirements messages being sent from the center conform to TMDD v3.03c and NRTM.

- Anomaly Reports (Prepared by the Test Engineer)

Conclusion of Testing Process

- TRANSCOM had completed, using C2C RI version 1.0.7, testing conformance of the TRANSCOM Middleware with TMDD v3.03c and NTCIP 2306 v1.69 standards.

- The TRANSCOM Middleware system is conformant with TMDD v3.03c.

Lessons Learned: Specific

- Need C2C RI Tool Technical Support readily available!
- For project-specific extensions: only include extensions in response messages.
  - Changed the logic of Middleware so that request messages did not include mandatory elements nor extensions.
  - Changed the logic of Middleware to follow TMDD/C2C RI extension tag requirement.
- Configuring C2C RI to make modifications to messages sent (request messages) is time consuming.

Polling Question

After today's presentation are you or your agency likely to use the TPG or C2C RI?

- Yes, we are likely to use the TPG
- Yes, we are likely to use the C2C RI
- Need additional information before deciding
- No, we are not likely to use either tool

QUESTIONS?

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