Developments in Conformance Testing

ODVA Conformance Authority

Developments in Conformance Testing

Presenters

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Developments in Conformance Testing

Conformance Testing Process – Background

– Conformance Testing Purposes

- Provide vendor-independent **Quality Assurance** to industry – Product Conformance to CIP Specification
- Improve **Customer Satisfaction** with CIP technologies – Ensure Interoperability between products
- Drive **Growth of ODVA** – Increase the value proposition for ODVA membership

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Conformance Testing Process – Background

- ODVA Terms of Use Agreement (TOU) Requirements
  - Vendors must obtain and maintain Declaration of Conformity (DOC) for their devices
  - The Conformance Test process outcome is a DOC granted to a product

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Conformance Testing Process – Vendor development cycle

– Plan ahead for your product conformance test

- Follow the current CIP Specification to guide your development
- Order/maintain the protocol test software subscription and use it on a regular basis while developing your product
- Check the planned contents for the next CT to see what's up and coming.

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Conformance Testing Process – Vendor development cycle

- Plan ahead for your product conformance test

  - Integrate the conformance testing process into your product development process

  - Ann Arbor test lab is available on an hourly fee basis for pre-testing devices if needed

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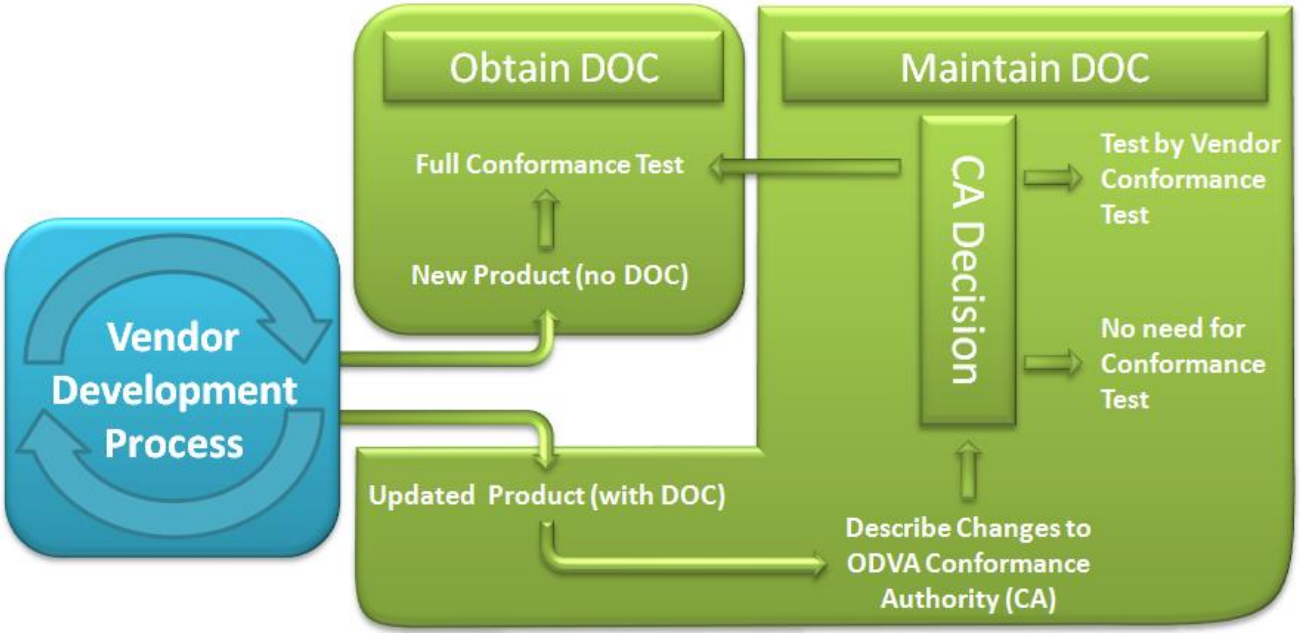
Conformance Testing Process – The process



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Conformance Testware – (Non-Safety), Current Releases:

- EtherNet/IP Conformance Composite Test CT12
- DeviceNet Conformance Composite Test CT26
- EZ-EDS 3.11.1.20151008

Find current CCT info at:
www.odva.org

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EtherNet/IP CT13 Testware (November 2015)

- *New features*
  - Originator Connection List Object Test
  - Target Connection List Object Test
  - Connection Configuration Object Test
  - Position Sensor Object Test

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EtherNet/IP CT13 Testware (November 2015)

- *New features*
  - Ethernet Link Object revision 4 and 1 Gbps support
  - Energy Objects revision 2 and ODOMETER data type support
  - CIP I/O connection timeout reconnect test and I/O injection test (Sequence Number Gap Test)
  - Port Object Revision 2 Routing Capability Test

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EtherNet/IP CT13 Testware (November 2015)

- *Improvements and Bug Fixes*
  - TCP/IP Interface Object revision 4 support required
  - Encapsulation Inactivity Timeout update
  - ForwardClose IP Check required
  - Connection ID Reuse Check required

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EtherNet/IP CT13 Testware (November 2015)

– *Improvements and Bug Fixes*

- Large_Forward_Open support for Class 1/ Class 3 Connection
- Type 2 Reset Test for EtherNet/IP devices
- RSTP Object available in any Device Profile for EtherNet/IP devices

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EtherNet/IP CT13 Testware (November 2015)

– *Bug Fixes for Existing Objects:*

- Assembly
- File
- Port

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EtherNet/IP CT13 Manual Test Changes (November 2015)

– *DLR Object Test update:*

a. Verify DUT does not learn MAC address of the active ring supervisor

b. DLR Link Speed 10 Mb and Half Duplex are now optional

c. Neighbor_Status Check

d. Unicast and Multicast I/O passing check

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EtherNet/IP CT13 Manual Test Changes (November 2015)

- ACD Direct ARP Test – in Automated Tool (ACDTEST.exe)
- IGMP support only required if implementing O->T multicast (NMAP)
- MS and NS LED indicator optional for Industrial Performance Level

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DeviceNet CT27 Testware (November 2015)

– *New features*

- Position Sensor Object Test
- Energy Objects: revision 2 and ODOMETER data type support
- Port Object Revision 2 Routing Capability Test
- *(Note: Vol 3 has Not changed since 2013)*

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DeviceNet CT27 Testware (November 2015)

– *Bug Fixes in Objects:*

- Assembly
- File
- Port

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CIP Safety Conformance Testing

- Implements Safety Test Plan (Volume 5 Appendix F)
- Includes all relevant sections of Standard Conformance Test
  - A standard test order IS needed for non-safety product variants
  - A standard test order is NOT needed for safety products

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CIP Safety Conformance Testing

- Safety Protocol Test
  - CIP object extensions for safety (Vol 5 chapters 5 & 6)
    - Safety-specific profiles and objects
    - Impact to existing objects SAFETY IMPACTS SOME OBJECTS
  - “Black Box” tests are automated (Vol 5 F-3)
  - “White Box” tests must be performed by Vendor (Vol 5 F-4)

CIP Safety Conformance Testing

- Refer to the Conformance Test User's Guide – Appendix E
  - CIP Safety Adaptation for Conformance Testing

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CIP Safety Conformance Software

- Current Composite Test Levels
  - CIP Safety on EtherNet/IP CT8 ES (CT12 EN)
  - CIP Safety on DeviceNet: CT7 DS (CT26 DN)
  - CT1 CIP Safety on Sercos III

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CIP Safety Conformance Software

- Planned for 2015-PC2
  - CIP Safety on EtherNet/IP CT9 ES (CT13 EN)
  - CIP Safety on DeviceNet: CT8 DS (CT27 DN)
  - CT2 CIP Safety on Sercos III

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CIP Safety Conformance Software

- Planned features
  - Improved test result auditing
  - Improved test coverage for non-SNCT DUTs
  - Improved support and guidance for Originator DUTs

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Conformance Testing Preparation – Common Errors

Developments in Conformance Testing

Conformance Testing Preparation – Common Errors

- TCP/IP Interface Object Test
  - DHCP: Following the correct DISCOVER/OFFER/REQUEST/ACK/ARP sequencing

No.	Time	Source	Destination	Protocol	Info
1	0.000000000	0.0.0.0	255.255.255.255	DHCP	DHCP Discover - Transaction ID 0x6ed06ce6
2	0.000558000	192.168.1.4	255.255.255.255	DHCP	DHCP Offer - Transaction ID 0x6ed06ce6
8	0.199802000	_ca:1c:cc	Broadcast	ARP	Who has 192.168.1.10? Tell 0.0.0.0
12	0.409770000	_ca:1c:cc	Broadcast	ARP	Who has 192.168.1.10? Tell 0.0.0.0
17	0.619804000	_ca:1c:cc	Broadcast	ARP	Who has 192.168.1.10? Tell 0.0.0.0
23	0.829819000	_ca:1c:cc	Broadcast	ARP	Who has 192.168.1.10? Tell 0.0.0.0
27	1.039984000	_ca:1c:cc	Broadcast	ARP	Gratuitous ARP for 192.168.1.10 (Request)
60	3.039870000	_ca:1c:cc	Broadcast	ARP	Gratuitous ARP for 192.168.1.10 (Request)
89	5.041213000	0.0.0.0	255.255.255.255	DHCP	DHCP Request - Transaction ID 0x6ed06ce6
90	5.041610000	169.254.56.34	255.255.255.255	DHCP	DHCP ACK - Transaction ID 0x6ed06ce6
91	5.042023000	_ca:1c:cc	Broadcast	ARP	Gratuitous ARP for 192.168.1.10 (Request)

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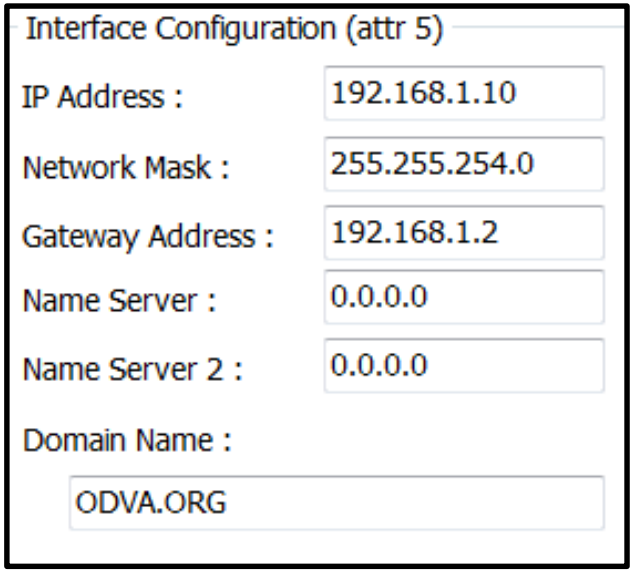
Conformance Testing Preparation – Common Errors

- TCP/IP Interface Object Test
  - Report correct status or value during **mode switch** for following attributes:
    a. Attribute 2 (Configuration Capability) reflects correct DUT capability
    b. Attribute 3 (Configuration Control) shows current mode of DUT
    c. Attribute 5 (Interface Configuration) maintains proper values



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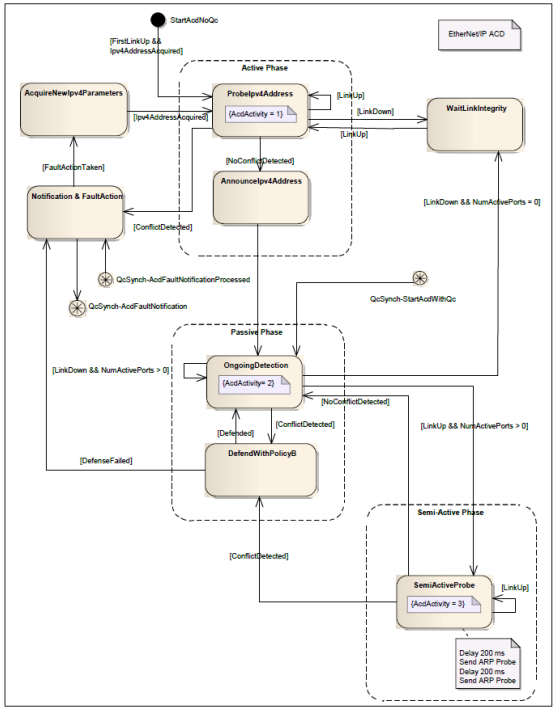
Conformance Testing Preparation – Common Errors

- ACD Test (ACD support is optional, but if implemented ensure it conforms to the CIP specification)
  - Report correct conflict information in attribute 11 (LastConflictDetected), especially AcdActivity and ArpPdu
  - Report correct AcdStatus (bit 6) in attribute 1 (Status) if DUT recovers from reconnecting the link cable
  - MS/NS LED behave correctly to the conflict if implemented
  - Pay close attention to the **Wireshark trace** while running Automatic ACD Test, make sure no extra frames are sent.
  - We run Automatic ACD Test under both fixed IP configuration mode and dynamic IP configuration mode.

Volume 2: EtherNet/IP Adaptation of CIP, Appendix F: Address Conflict Detection

Figure F-1.1 ACD Behavior



Conformance Testing Preparation – Common Errors

- Ethernet Link Object Test
  - Attribute 1 (Interface Speed) shall report current speed in use. 0 is only used to indicate the speed is indeterminate.
  - Attribute 2 (Interface Flags) shall report correct status and configuration about the physical interface.

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Conformance Testing Preparation – Common Errors

– Ethernet Link Object Test

- Attribute 6 (Interface Control) is a preferred CIP interface, if the DUT supports auto-negotiation and forced speed/duplex.
- Attribute 9 (Admin State) shall not allow you to disable the last port.
- Attribute11 (Interface Capability) shall indicate the exact capability for the interface.

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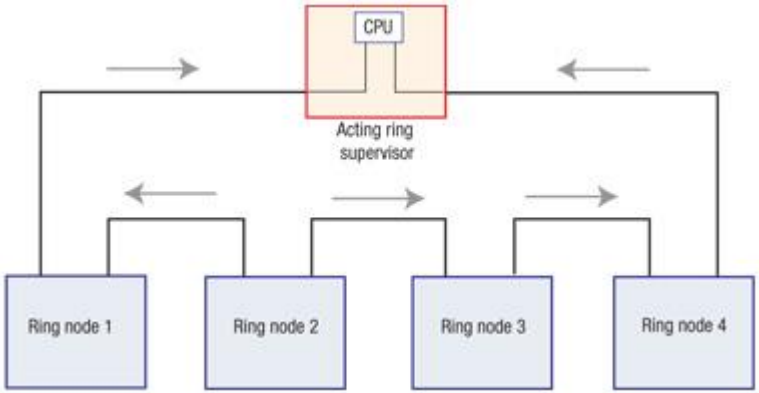
Conformance Testing Preparation – Common Errors

– DLR Object Test

- Auto MDIX support is required for both auto-negotiate and force speed/duplex modes.
- 100 Mbs and Full Duplex required; 10/1000 Mbs, Half-Duplex optional.
- Attribute 6 (Interface Control) is a preferred CIP interface since auto-negotiate and forced speed/duplex are required for DLR device.



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Conformance Testing Preparation – Common Errors

- DLR Object Test
  - No constant I/O packet loss during normal ring operation
  - When DUT passes on a Sign_On frame, the Source IP Address of the frame should be replaced with the DUT's IP address.

```
Device Level Ring
  Ring Sub-Type: 0x02
  Ring Protocol Version: 1
  Frame Type: Sign_On (0x07)
  Source Port: Port 1 (0x01)
  Source IP: 192.168.1.10 (192.168.1.10)
  Sequence Id: 0x00004b3a
  Num nodes: 4
  MAC Address: [redacted]
  IP Address: 192.168.1.30 (192.168.1.30)
  MAC Address: [redacted]
  IP Address: 192.168.1.50 (192.168.1.50)
  MAC Address: [redacted]
  IP Address: 192.168.1.40 (192.168.1.40)
  MAC Address: [redacted]
  IP Address: 192.168.1.10 (192.168.1.10)
```

Conformance Testing Preparation – Common Errors

– NV (Non-Volatile) Attributes Behavior

- NV attribute values shall be persistent after a power cycle or a Type 0 Reset.
- NV attribute values shall be restored to factory default values after a Type 1 Reset.

Conformance Testing Preparation – Common Errors

- NV (Non-Volatile) Attributes Behavior
  - Various NV attribute behavior after a Set_Attribute_Single request:
    a. Some NV attributes take effect immediately after a Set, such as PTPEnable in Time Sync Object, Admin State in Ethernet Link Object.
    b. Some NV attribute changes have to take effect after a power cycle or a Type 0 Reset, such as SelectAcd attribute in TCP/IP Object
    c. Some NV attributes can take effect immediately or after a reset, there's a pending bit to reflect such behavior, such as Interface Configuration, TTL/Mcast attributes of TCP/IP Object; Interface Control of Ethernet Link Object. If a reset is not needed, the DUT shall behave under the new value immediately.

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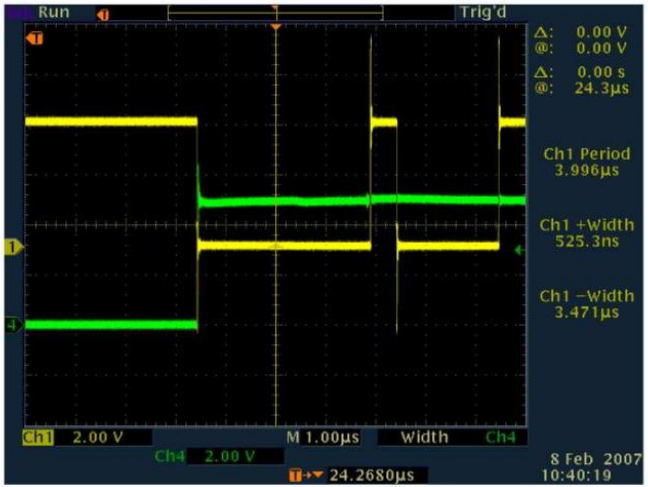
Conformance Testing Preparation – Common Errors

- DeviceNet physical layer propagation delay exceeds 312 ns
  - Many new CAN transceivers and isolation devices are available since the original introduction of DeviceNet.
  - Newer doesn't always mean better! Excessive propagation delay results in a sharp increase in the network CAN error rate.
  - Before choosing a transceiver and isolator, verify that the combined propagation delay does not exceed 120 ns for the CAN transmitter + isolator (isolator data in to CAN state out) and does not exceed 130 ns for the CAN receiver + isolator (CAN state in to isolator data out). Ref: *Vol 3, Ch8, Tables 8-2.2 and 8-2.3*

Conformance Testing Preparation – Common Errors

- DeviceNet physical layer propagation delay exceeds 312 ns
  - Confirm device performance using the bit sample time measurement described in the test report.



Dominant bit width near sample point

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Conformance Testing Preparation – Tips

- Access documents in the CT installation folder, see readme.htm

Sample Test Report

Provides guidance for the entire Composite Test. Similar to that used by ODVA Test Service Providers (TSPs), this test report template includes procedures for optional features such as ACD, DLR, and CIP Sync™.

CIP Conformance Test Software User Manual

Provides guidance for setting up and running the Protocol Conformance Test Software Tool.

CIP Protocol Conformance Test Specification (PCTS)

Provides detailed information about test procedures performed during the automated protocol test. PCTS documents explain what is being tested and how to interpret the test results. The CIP PCTS covers the common device behavior specified in *The CIP Networks Library Volume One: The Common Industrial Protocol*.

EtherNet/IP PCTS

Documents the CIP Network specific portion of the automated protocol test covering device behavior specified in *The CIP Networks Library Volume Two: EtherNet/IP Adaptation of CIP*.

EtherNet/IP Interoperability Conformance Test Specification

Documents the test procedure for the Interoperability test section. Refer to the Sample Test Report for additional guidance.

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Conformance Testing Preparation – Tips

- Check the latest Sample Test Report Template to get familiar with the expectation and test contents

5 Ethernet Link Object Tests	Object 0xF6 (246)		
Connect straight into the device for speed test cases(DO NOT USE A HUB - a crossover cable may be nee			
5.1 Ethernet Link Object Test Cases			**Result**
Speed test cases (Attribute 1) - Force PC NIC to 10Mbps (Full or Half) - Value reported OK			
Speed test cases (Attribute 1) - Force PC NIC to 100Mbps, Full Duplex - Value reported OK			
Interface Flags test cases (Attribute 2) - Force PC NIC to 100Mbps Full - Value reported OK			
Interface Flags test cases (Attribute 2) - Force PC NIC to 100Mbps Half - Value reported OK			
Force DUT and PC NIC to 100Mbps Full Duplex - DUT and PC communicate			
Force DUT and PC NIC to 100Mbps Half Duplex - DUT and PC communicate			
Force DUT and PC NIC to 10Mbps Full Duplex - DUT and PC communicate			
Force DUT and PC NIC to 10Mbps Half Duplex - DUT and PC communicate			
Physical Address test cases (attribute 3) - Match IEEE OUI listings - See wireshark capture			
5.2 Ethernet Link objects - Multiple Interfaces Tests			**Result**
Class Attribute 3 (Number of Instances)	Attribute 3 Value		
Class Attribute 2 (Max Instances)	Attribute 2 Value		
Class Attribute 1 (Revision)	Attribute 1 Value		
Instance 1 Attribute 10 (Interface Label)	Attribute 10 Value		
Instance 2 Attribute 10	Attribute 10 Value		
Admin State (Attribute 9) - Port Disable			
Admin State - Port Enable			
Admin State - Last Port not disabled			
Admin State - Enable all ports			

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Conformance Testing Preparation – Tips

- Self-testing with the latest CT release
- Understand manual test procedures and test tools from the Sample Test Report.
- If not sure about the errors according to the CIP specification, contact ODVA staff at conformance@odva.org

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Questions?


ODVA
2015
INDUSTRY CONFERENCE
AND 17TH ANNUAL MEETING
ODVA'S 20TH ANNIVERSARY 1995–2015

THANK YOU