



## **CIP Network Conformance Testing**

ODVA Conformance Authority  
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# CIP Network Conformance Testing

## Today's Topics:

- **Conformance Testing Process**
- **New Conformance Test Changes**
- **Common Conformance Testing Errors**
- **Questions**

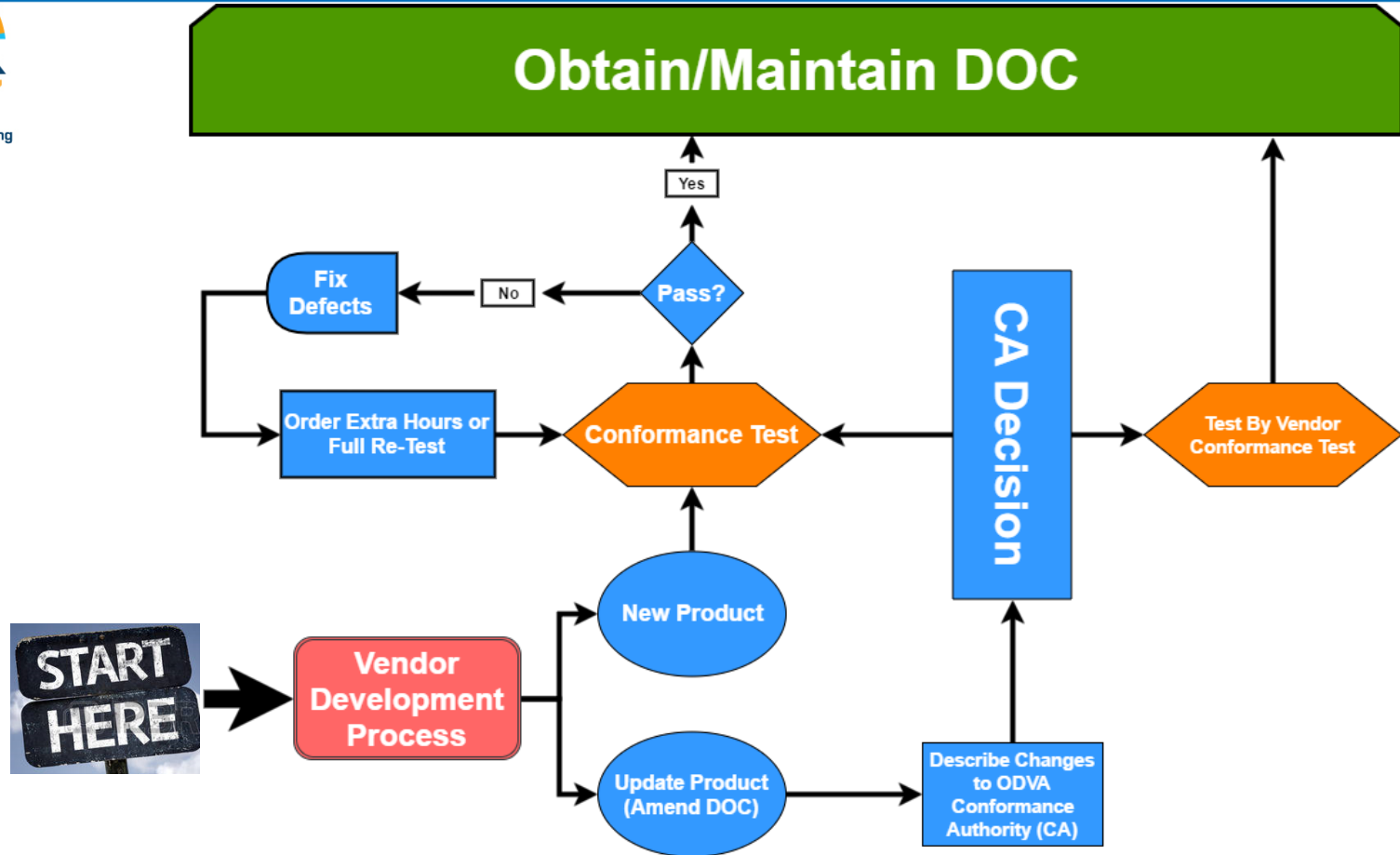


# Conformance Testing Process

## Conformance Testing Purpose

- Because You Have To (TOU)
- Better Products at Release
- Benefits Your Customers and Ultimately You





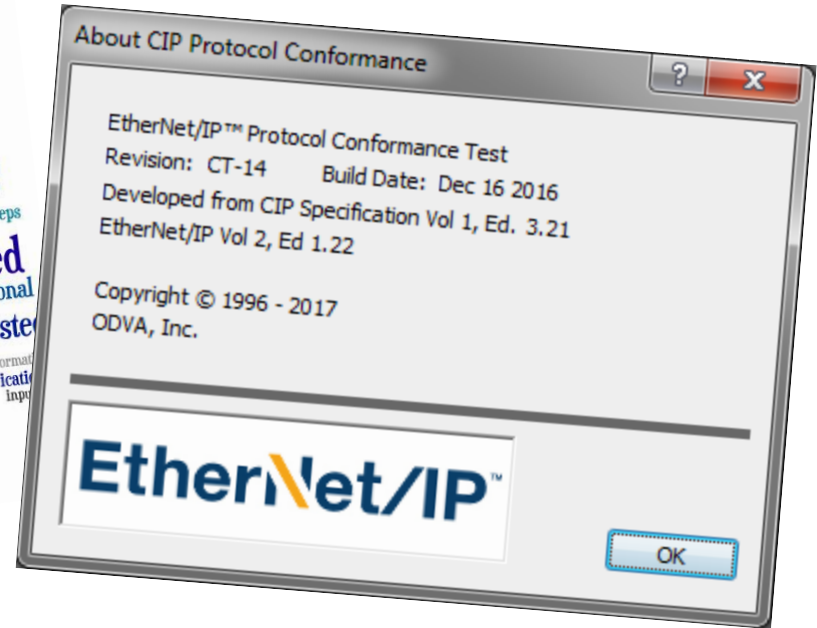
# Conformance Testing Process

## Updates to ODVA Test Guidelines

- Read the ODVA Test Guidelines in the ***Conformance Test Details Form***
  - Updates to the DUT firmware testing will require repeating all tests
  - Order extra hours in advance
  - Send in the required documents on time



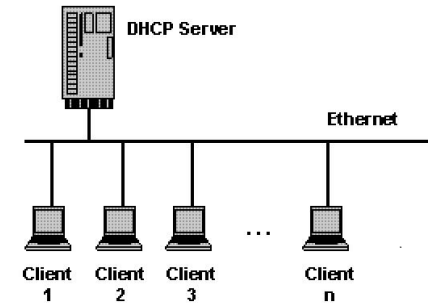
# New Tests in EtherNet/IP™ CT14



# New Tests in EtherNet/IP™ CT14

## ➤ MS/NS LED Behavior

- Vendor specific LED behavior must be documented.
- MS/NS LEDs not required for Industrial Performance Level
  - But if implemented must conform to requirements
    - or documented
- Special LED behavior before DHCP / BOOTP server configuration.
  - MS = flashing green, NS = dark

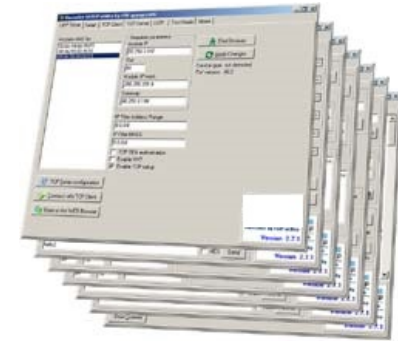




# New Tests in EtherNet/IP™ CT14

## ➤ TCP/IP Interface Object Test

- Multiple Instances Test
  - CT tool probes all instances of TCP/IP Object
  - Need as many STC files as instances
    - *unless some or all instances configured same*
- IANA Port Admin attribute test
  - At minimum, all EtherNet/IP-related ports supported by the DUT shall be exposed.



## New Tests in EtherNet/IP™ CT14

### ➤ Point-to-Point I/O on non-default port

- Point-to-Point **consumer** can specify alternate port number
- Default UDP port is 2222. **Sockaddr Info** item specifies other UDP port.
- Forward\_Open Request - T->O Item – Originator as Consumer, **determines the port**
- Forward\_Open Reply - O->T Item – Target as Consumer, **determines the port**

## New Tests in EtherNet/IP™ CT14

### ➤ T->O multicast matching rules test (return error code)

*Test for the rule “For multicast, if an established T->O producer exists on the **same port\***, the T->O parameters listed in the Table 3-6.4 below shall match. If not, the device shall return the indicated error.”*

**\* Same port**  
means same  
UDP port 2222  
*and same  
T->O path*

Table 3-6.4 T→O Parameter Matching Error Codes

T→O parameter	General Status	Extended Status
T→O RPI	0x01	0x0112
T→O Network Connection Parameters – Size	0x01	0x0134
T→O Network Connection Parameters – Fixed/Variable	0x01	0x0135
T→O Network Connection Parameters – Priority	0x01	0x0136
Transport Class	0x01	0x0137
T→O Production Trigger	0x01	0x0138
T→O Production Inhibit Time	0x01	0x0139

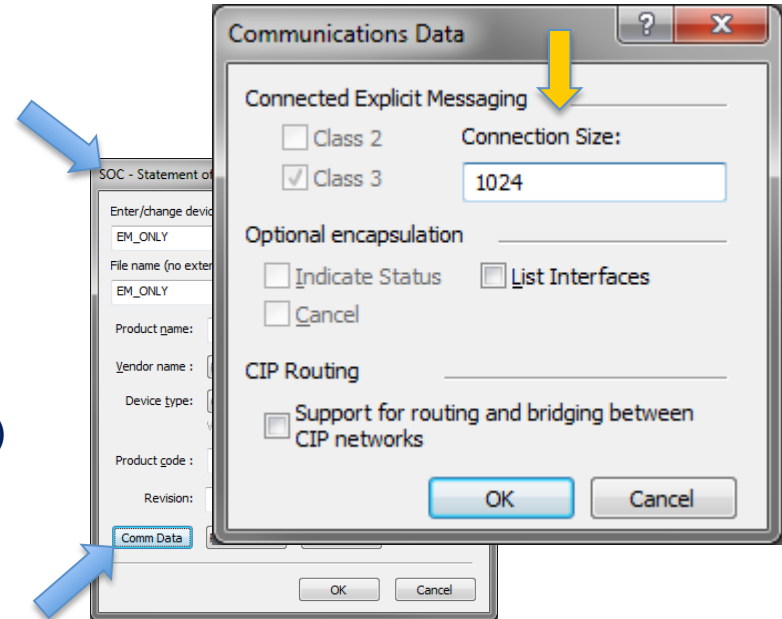
## New Tests in EtherNet/IP™ CT14

- **T->O multicast matching rules, test cases in CT tool software**
  - Transport Class mismatch
  - T->O Production Trigger mismatch
  - T->O Production Inhibit Time mismatch
  - T->O Network Connection Parameters Size mismatch
  - T->O Network Connection Parameters Fixed/Variable mismatch
  - T->O Network Connection Parameters Priority mismatch
  - T->O parameters totally match
  - See also CIP PCTS PUB 166 for details of these tests

## New Tests in EtherNet/IP™ CT14

### ➤ Run CT

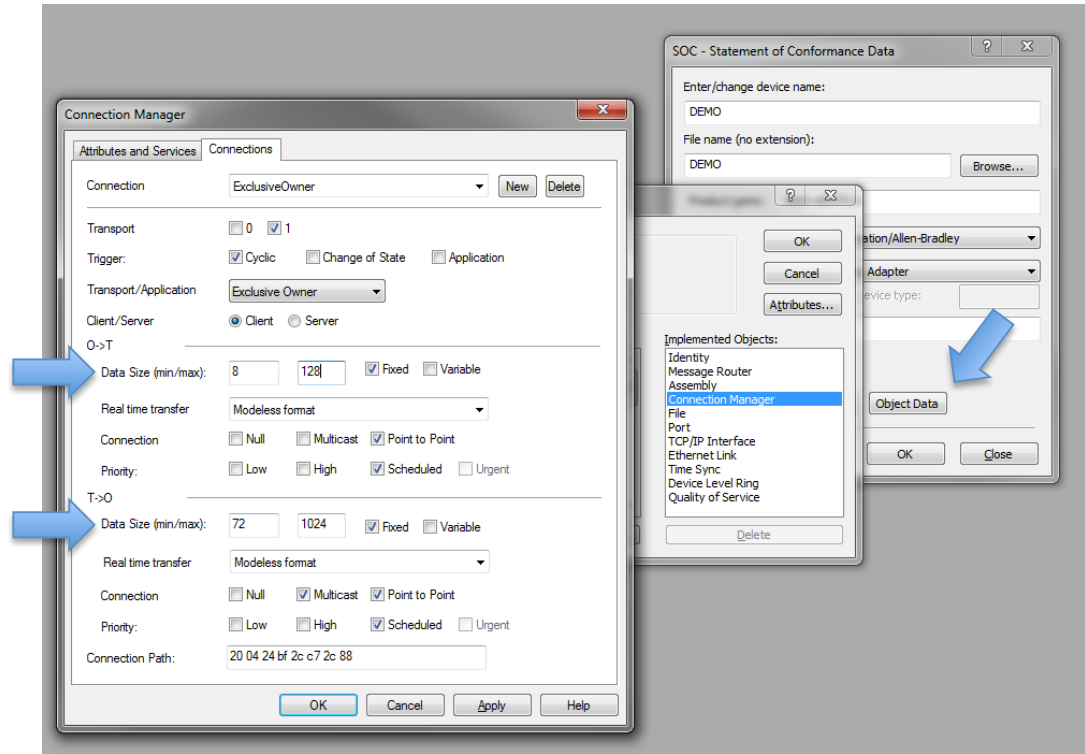
- for each supported Configuration Method: Hardware, DHCP, Static IP Mode...
- again for Large\_Forward\_Open if supported. Set Connection Size to > 511 For Class 3 Connection (Explicit Messages)



# New Tests in EtherNet/IP™ CT14

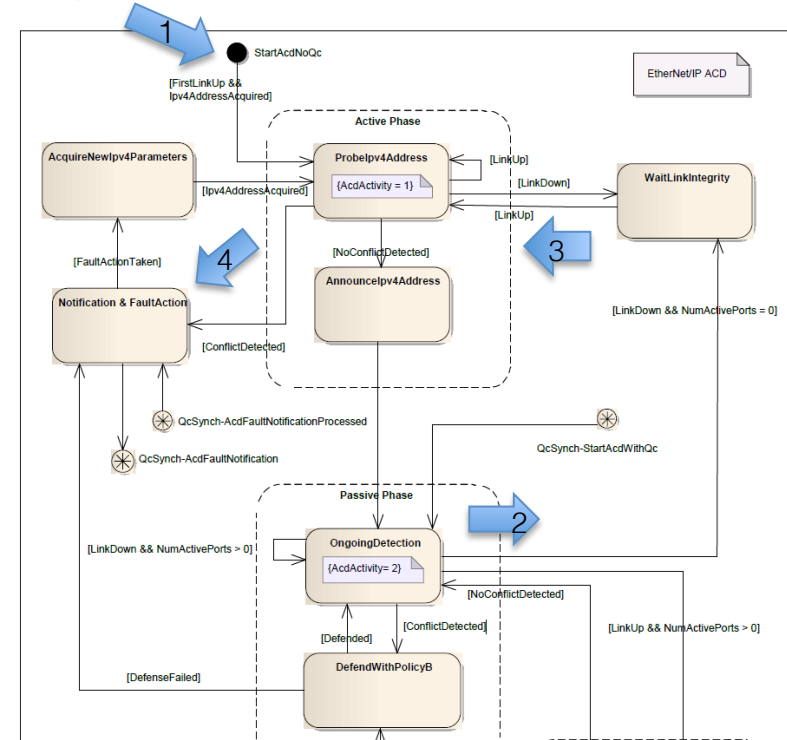
## ➤ Large\_Forward\_Open (LFO)

- Class 1 Connection
  - Tested by Connection Manager Size Max
  - Either T->O or O->T now generates LFO when Max Size > 511



# New Tests in EtherNet/IP™ CT14

### Figure F-1.1 ACD Behavior



## ➤ ACD Behavior Test of WaitLinkIntegrity

1. DUT Initialization → Ongoing Detection
2. DUT LinkDown (only port)
3. Transition to *Probelpv4Address* (LinkUp)
4. Reference Node creates Conflict
  - ***DUT shall not defend***

# New Tests in EtherNet/IP™ CT14

## ➤ DLR

- AutoMDIX in Auto-Negotiation and ***Forced Mode***.
  - Use appropriate PHY
- Neighbor\_Status on Ring Fault (notifies Supervisor)
  - 0x01 Port 1 Active (bit 0)
  - 0x02 Port 2 Active (bit 1)
  - 0x80 Neighbor Status (bit 7)
  - Indicates Unresponsive Neighbor





# New Tests in EtherNet/IP™ CT14

## ➤ DLR

- Multiple Instances (DLR Switch)
  - Manual verification, each instance operates independently
  - CT tool probes each instance
  - Ring Port 1 and 2 Ethernet Link Object Instance Attributes
    - Allow Ethernet Link Object Instances to be mapped to DLR instance
  - DLR Enable
    - Allows the DLR instance to be disabled



# Common Conformance Testing Errors



# Common Conformance Testing Errors

## ➤ TCP/IP Interface Object Test

- Report correct status or value during **mode switch** for following attributes:

- Attribute 1 (Status) accurately reports Configuration Status
- Attribute 2 (Configuration Capability) reflects correct DUT capabilities

Status (attr 1)

Interface Configuration Status

☐ Not configured

☐ Obtained by BOOTP, DHCP or Stored Value

☐ Valid conf obtained by hardware settings

☐ Mcast Pending    ☐ I/F Configuration Pending

☐ Acd Status

Configuration Capability (attr 2)

☐ BOOTP Client    ☐ DNS Client

☐ DHCP Client    ☐ DHCP-DNS Update

☐ Config. Settable    ☐ Hardware Configurable

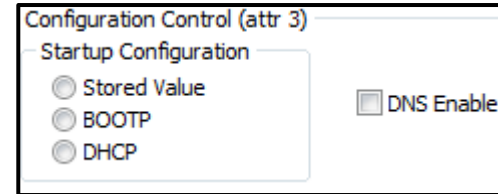
☐ Interface Configuration change requires reset

☐ Acd Capable

# Common Conformance Testing Errors

## ➤ TCP/IP Interface Object Test – Cont'd

- Attribute 3 (Configuration Control) shows current mode of DUT
- Attribute 5 (Interface Configuration) maintains proper values
- In DHCP mode, attributes 5 & 6 should get the Domain Name and Host Name from the DHCP server if they are in the DHCPOFFER\*.



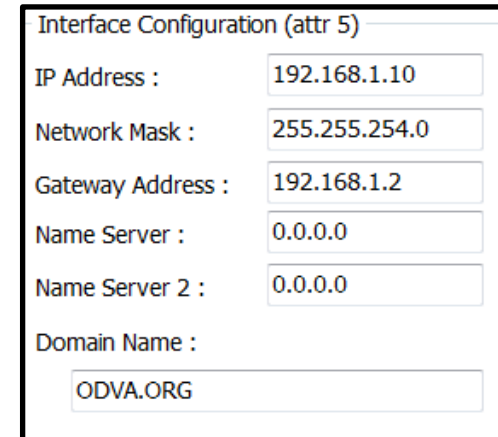
Configuration Control (attr 3)

Startup Configuration

☒ Stored Value ☐ DNS Enable

☐ BOOTP

☐ DHCP



Interface Configuration (attr 5)

IP Address : 192.168.1.10

Network Mask : 255.255.254.0

Gateway Address : 192.168.1.2

Name Server : 0.0.0.0

Name Server 2 : 0.0.0.0

Domain Name : ODVA.ORG

Status (attr 1)

Interface Configuration Status

☐ Not configured

☐ Obtained by BOOTP, DHCP or Stored Value

☐ Valid conf obtained by hardware settings

☐ Mcast Pending

☐ I/F Configuration Pending

☐ Acd Status

Configuration Capability (attr 2)

☐ BOOTP Client

☐ DNS Client

☐ DHCP Client

☐ DHCP-DNS Update

☐ Config. Settable

☐ Hardware Configurable

☐ Interface Configuration change requires reset

☐ Acd Capable

Configuration Control (attr 3)

Startup Configuration

☐ Stored Value

☐ BOOTP

☐ DHCP

☐ DNS Enable

Interface Configuration (attr 5)

IP Address : 192.168.1.10

Network Mask : 255.255.254.0

Gateway Address : 192.168.1.2

Name Server : 0.0.0.0

Name Server 2 : 0.0.0.0

Domain Name :

ODVA.ORG

# Common Conformance Testing Errors

## ➤ Ethernet Link Object Test

- Attribute 2 (Interface Flags) shall report correct status and configuration about the physical interface.
- Attribute 9 (Admin State) should not allow you to disable the last port\*.

Interface Flags (attr 2)

☒ Link Status

☒ Half/Full Duplex

Negotiation Status

☐ Auto-negotiation in progress

☐ Auto-negotiation and speed detection failed

☒ Auto-negotiation failed but detected speed

☐ Successfully negotiated speed and duplex

☐ Auto-negotiation not attempted

☐ Manual Setting / Requires Reset

☐ Local Hardware Fault

# Common Conformance Testing Errors

## ➤ Ethernet Link Object Test

- Attribute 11 (Interface Capability) shall indicate the exact capabilities of that instance.
  - Ensure this matches the capabilities reported in other Ethernet link object attributes (attribute 2)

Attribute 11- Interface Capabilities Verification			DUT Reports		Result
Attribute 11 Get_AttributeSingle Value (Hex):	0A 00 00 00 04 0A 00 00 0A 00 01 64 00 00	1010			
Verify - DUT requires reset to apply changes made to Interface Control (Attr 6):			No		
Verify - DUT supports link Auto-Negotiate:			Yes		
Verify - DUT supports Auto MDIX operation:			No		
Verify - DUT is capable of Manual Speed/Duplex Via Interface Control (Attr 6):			Yes		
Verify - Number of elements:			04		
Formatted Hex Value:	0A000000040A00000A0001640000640001		Speed	Duplex	Result
	Element Pair #1:		10	Half	
	Element Pair #2:		10	Full	
	Element Pair #3:		100	Half	
	Element Pair #4:		100	Full	
	Element Pair #5:		None	None	
	Element Pair #6:		None	None	

# Common Conformance Testing Errors

## ➤ DLR Object Test

- Sign\_On Frame is received and transmitted upon power up. Test with all Configurations (BOOTP,DHCP, Static)
- Be sure to check for consistent results on LinkDown (Ring Fault) at least three times, for all DLR Frames.

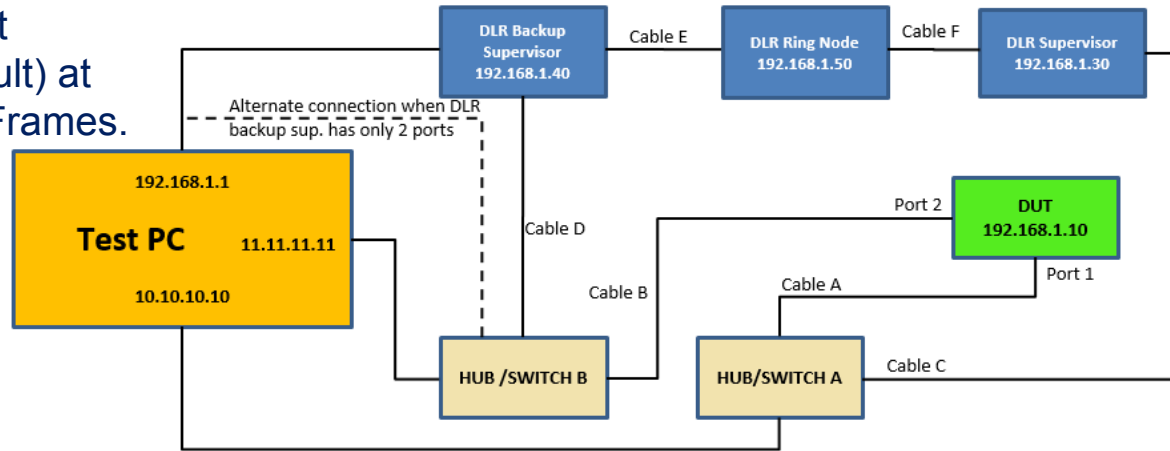


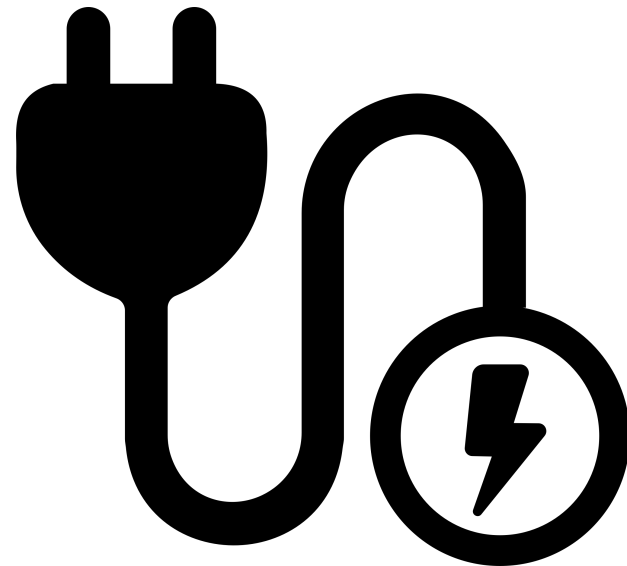
Figure 1: DLR Ring Node Conformance Test Setup



# Common Conformance Testing 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.



# Common Conformance Testing Errors

## ➤ NV (Non-Volatile) Attributes Behavior

- Take effect immediately. e.g. *PTPEnable in Time Sync Object*
- Take effect after power cycle or a Type 0 Reset.  
e.g. *QoS Object attributes. ACD Enable*
- Take effect immediately or after a reset. Tend to have a pending reset bit. e.g. *Interface Configuration, TTL/Mcast attributes*

# Common Conformance Testing Errors

## ➤ Honorable Mentions

- DUT unable to acquire Interface Configuration after ACD conflict, upon link up.
- DUT only able to pass CT with a single TCP/IP configuration.
- DUT having Memory leak/buffer issues.





**QUESTIONS?**



**THANK YOU**