Recommended Functionality for EtherNet/IP Devices

Version 10 PR001
November 28, 2018
PUB00070R10

Published by

Roundtable for EtherNet/IP Implementors

1 Introduction

1.1 Scope of Document

The purpose of this document is to recommend functionality related to the EtherNet/IP protocol implementation in EtherNet/IP devices. The recommendations are a result of work generated by the ongoing series of EtherNet/IP Implementors Workshops. The recommendations are being made to help ensure interoperability between devices and provide a minimum level of capability required for user applications.

1.2 Interpreting the Recommendations

The recommendations cannot be interpreted as “requirements” from the perspective of the EtherNet/IP specification. However from the perspective of the Implementors Workshop, it is useful to be able to state whether or not a device adheres to the Functionality Recommendations (and future workshop recommendations) for the type of device. Therefore, this document uses language similar to the EtherNet/IP specification to make clear what is required (specified with the use of "**shall"**) and what is optional (specified with the use of "recommended") in order for a device to adhere to the recommendations.

It should be understood that a device may be compliant to the EtherNet/IP specification yet not meet the minimum recommendations described in this document for the type of device. Such a device is a valid EtherNet/IP device; however, the vendor will not be able to state that the device meets the workshop recommendations.

1.3 Future Revisions of the Recommendations

Further revisions of the document are anticipated as work progresses in the Roundtable for EtherNet/IP Implementors and ODVA SIGs.

1.4 Organization of the Document

This document is primarily organized by EtherNet/IP device classification, and includes the following sections:

Common Device	This section includes EtherNet/IP functionality recommendations that are common across multiple types of devices. The sections for the specific types of devices will add recommendations to those described in this section.
Explicit Message Server Device	This section explains the functionality that is recommended for explicit message server devices over and above the Common Device section.
Explicit Message Client Device	This section explains the functionality that is recommended for explicit message client devices.
Adapter Device	This section explains the functionality that is recommended for Adapter class devices over and above that in the Common Device section.
Scanner Device	This section explains the functionality that is recommended for Scanner class devices over and above that in the Common Device and Adapter Device sections.

2 Common Device Recommendations

This section includes EtherNet/IP functionality recommendations that are common across multiple types of devices. The succeeding sections for the specific types of devices may add recommendations to those described in this section.

2.1 CIP

1. The device **shall**, at a minimum, provide support for:
    a) 3 concurrent Encapsulation sessions.
    b) 6 concurrent Transport Class 3 Explicit Messaging connections.
    c) More than 1 Transport Class 3 connection per Encapsulation session.

    Rationale: A server should be able to handle requests from 3 client nodes, 2 continuous and 1 transitory (e.g. controller, HMI, and commissioning tool). Some clients may require more than 1 CIP Class 3 connection on a given Encapsulation session.

2. The device **shall** support both unconnected and connected messaging concurrently in an Encapsulation session.

3. Use of Device Type Code 0x00 has been deprecated. New generic devices **shall** report the keyable Generic Device Type Code (0x2B).

4. Transport Class 3 connections **shall** support priorities Low and High. This applies to Class 3 servers only.

2.2 TCP/IP Suite

1. The device **shall** support the TCP/IP features required by the latest EtherNet/IP specification in Volume 2, Requirements for TCP/IP Support (e.g. section 9-3 in Ed. 1.20).

2. The device **shall** follow the recommendations put forth in the ODVA document Recommended IP Addressing Methods for EtherNet/IP Devices, Version 1.0, June 10, 2003 (PUB00028). In summary, this document specifies the following features in regards to IP addressing:
    a) The device **shall** by default issue BOOTP or DHCP requests at initial power up "out-of-box" (from the vendor).
    b) The device **shall** facilitate enabling and disabling BOOTP or DHCP via the TCP/IP Object (Class 0xF5).
    c) The device **shall** allow its IP address (and other IP parameters) to be set using the TCP/IP Object. This requirement does not prohibit the device from supporting other means of setting these parameters.
    d) The device **shall** allow the user to make a valid IP address persistently stored in non-volatile memory, via attributes and services of the TCP/IP Object.

3. The device **shall** reserve, at a minimum, 3 concurrent TCP connections for CIP. If other protocols (HTTP, FTP, etc.) are supported, the number of concurrent TCP connections supported should account for these protocols in addition to the connections reserved for CIP.

4. The device **shall** provide support for UDP requests. The List Identity command is typically transmitted as a UDP broadcast by network tools.

5. The device **shall** cease sending BootP/DHCP requests once an IP address has been obtained from the BootP/DHCP server and has been successfully applied. It is understood that a DHCP-configured device will attempt to renew its IP address at some point, but this requirement is for the initial requests.

6. The device **shall not** issue BootP/DHCP requests when configured to use a static IP address as indicated by the Startup Configuration bits being set to zero in the Configuration Control Attribute of the TCP/IP Object.

2.3 Ethernet and Physical

The following recommendations apply to each of the device's externally exposed EtherNet/IP interfaces.

1. The device **shall** support Full Duplex.

2. The device **shall** support 10/100Mbps.

3. The device **shall** provide auto negotiation of duplex and data rate with a configurable manual override. Auto Negotiation plus Manual Override provides support for the widest possible range of network infrastructure devices, e.g. switches. The device **shall** store the link settings (e.g. Auto-Negotiate, Fixed Speed & Duplex) in non-volatile memory such that they are persistent through a cycle of power to the device.

4. The device **shall** follow the recommendations put forth in the ODVA document Recommended IP Addressing Methods for EtherNet/IP Devices, Version 1.0, June 10, 2003 (PUB00028). In summary, this document specifies the following features in regards to Ethernet and Physical Layer:
    a) For 100Base-T devices, the device **shall** allow the user to select auto-negotiation or manual setting of duplex mode and port speed, per the Ethernet Link Object
    b) The Ethernet MAC address **shall** be visible on the device (e.g., on a label). Note that the address may be hidden after the device is installed.

5. It is recommended that the device physical layer conform to the EtherNet/IP Industrial Conformance Level. Note that this recommendation does not apply to PC-based or transitory devices. This includes:
    a) The latest EtherNet/IP industrial physical layer as specified in Volume 2, Performance Levels (e.g. section 8.7 in Ed. 1.20,).
    b) EtherNet/IP specific LED, or equivalent, indicators (Module Status, Network Status) as specified in Volume 2, Indicators (e.g. section 9.4 in Ed. 1.20).

6. It is recommended that the device have LED, or equivalent, indication for Ethernet Link Status, Transmit and Receive. It is recommended that LED behavior on all future development follow the behavior described below.
    a) Devices with a single indicator:

Indicator	Single Color LED		Bi-Color LED	
	State	Description	State	Description
Link Status	Off On Flashing	No link Link Port activity	Off Solid Green Solid Amber Flashing Green Flashing Amber Solid Red	No link Link Port disabled Port activity Collision Major NIC Fault e.g. POST error

b) Devices with a two Indicators:

Indicator	Single Color LED		Bi-Color LED	
	State	Description	State	Description
Link Status	Off On	No link Link	Off Solid Green Solid Amber Solid Red	No link Link Port disabled Major NIC Fault e.g. POST error
Activity	Off Flashing	No activity Port activity	Off Flashing Green Flashing Amber	No activity Port activity Collision

c) Devices with a three Indicators:

Indicator	Single Color LED		Bi-Color LED	
	State	Description	State	Description
Link Status	Off On	No link Link	Off Solid Green Solid Amber Solid Red	No link Link Port disabled Major NIC Fault e.g. POST error
Transmit	Off Flashing	No activity Port activity	Off Flashing Green Flashing Amber	No activity Port activity Collision
Receive	Off Flashing	No activity Port activity	Off Flashing Green	No activity Port activity

2.4 EDS File

The EDS file for the device **shall** include the [Capacity] section. This is used to declare the I/O Connection capacity supported by the device. Definitions per Volume 1, Capacity Section (e.g. section 7-3.6.13 in Ed. 3.19).

2.5 Performance

2.5.1 Response Times

The performance values in this section are based on benchmark procedures originally created by the Performance Working Group. The values listed below are recommendations based on an absence of significant background traffic.

List Identity Response/UDP	< 250ms
List Services Response/TCP (assuming existing TCP connection)	< 250ms
Unconnected explicit response - No TCP connection established (Specific internal object/attribute would be tested)	< 500ms
Unconnected explicit response - TCP connection established (Specific internal object/attribute would be tested)	< 100ms
Connected explicit response (Specific internal object/attribute would be tested)	< 100ms
Two back-to-back explicit message requests without dropping either	≥ 1ms

2.6 Duplicate IP Address Detection

The device **shall** support duplicate IP address detection as specified in the latest version of Volume 2, Appendix F.

2.7 Testing of Product Families

The same products that will be or were used for basic conformance testing of an ODVA Conformance-defined product family shall be submitted for PlugFest testing of the product family.

3 Explicit Messaging Server Device Recommendations

This section explains the functionality that is recommended for explicit message server devices over and above the Common Device section.

3.1 Example Devices

- Text Display device
- Data Acquisition Input devices
- Data Logger

3.2 CIP

No addition to Common Device Recommendations.

3.3 TCP/IP Suite

No addition to Common Device Recommendations.

3.4 Ethernet and Physical

No addition to Common Device Recommendations.

3.5 EDS File

No addition to Common Device Recommendations.

3.6 Performance

No addition to Common Device Recommendations.

4 Explicit Messaging Client Device Recommendations

This section explains the functionality that is recommended for explicit message client devices.

4.1 Example Devices

- Simple HMI
- Data Logger
- Diagnostic Tool

4.2 CIP

1. The device **shall** meet the minimum requirements defined in the CIP and EtherNet/IP specifications for a messaging client, which includes certain explicit server functionality such as Identity object support.

2. The device **shall** support the initiation of both connected and unconnected explicit messaging.

4.3 TCP/IP Suite

The device **shall** meet the minimum requirements defined in the CIP and EtherNet/IP specifications for a messaging client.

4.4 Ethernet and Physical

No addition to Common Device Recommendations.

4.5 EDS File

The device **shall** meet the minimum requirements defined in the CIP and EtherNet/IP specifications for a messaging client.

4.6 Performance

No addition to Common Device Recommendations.

5 Adapter Device Recommendations

This section explains the functionality that is recommended for Adapter class devices over and above that in the Common Device section.

There are several references in this section to "rack-based" devices. For the purpose of this document, a rack-based device is one that conforms to the Modular description in Volume 1 of the CIP specification (e.g., section 7-3.7 Modular EDS File Requirements in Ed. 3.19).

5.1 Example Devices

- Block I/O
- Weigh Scale
- AC Variable Frequency Drive

5.2 CIP

1. The device **shall** support all CIP recommendations described in the Common Device Recommendations section 2.1.

2. The device **shall** accept, at a minimum, 2 simultaneous Transport Class 1 I/O connections, in the combinations outlined in 3.d) below. (Rationale: 1 Exclusive Owner or Input Only connection for a controller and 1 Input Only or Listen Only connection for a monitoring device, each connected to the same T→O connection point.)
    a) The device **shall** support the Class 1 and Class 3 connection requirements simultaneously, i.e. the device must support 8 simultaneous connections (2 Class 1 + 6 Class 3)

3. The following recommendations pertain to Transport Class 1 connections supported by the device.
    a) The device **shall** support bi-directional connections, i.e. accept a Forward_Open with non-null O→T and T→O connection types. The device may also support uni-directional connections (with a null connection type in either O→T or T→O).
    b) The device **shall** support Cyclic trigger type.
    c) The device **shall** support the Change of State (COS) trigger type. Support for the COS trigger type is optional for non-discrete devices and for rack connections on rack-based devices.
    d) The device **shall** support all of the following connection combinations:
        i. a multicast T→O and unicast O→T Exclusive Owner connection with at least one multicast T→O Input Only or Listen Only connection for the same T→O connection point, simultaneously
        ii. a multicast T→O and unicast O→T Exclusive Owner connection with at least one unicast T→O Input Only or Listen Only connection for the same T→O connection point, simultaneously
        iii. a unicast T→O and unicast O→T Exclusive Owner connection with at least one multicast T→O Input Only or Listen Only connection for the same T→O connection point, simultaneously.
        iv. a unicast T→O and unicast O→T Exclusive Owner connection with at least one unicast T→O Input Only or Listen Only connection for the same T→O connection point, simultaneously.

    Input-only devices may substitute an Input Only connection for the Exclusive Owner connection.

e) The device **shall** support an Exclusive Owner connection if the device has output data.
f) The device **shall** support a Listen Only or Input Only connection supporting more than 1 listener if the device has input data. Note that this is necessary regardless of whether the device has output data or not.
g) The device **shall** provide a "heartbeat" connection path to be used for connection pairs where application data is only flowing in one direction. Note: Connections to the heartbeat connect path are configured with 0 data length and do not include a 32-bit Real-Time Header (Run/Idle Header).
h) The device **shall** support Electronic Keys in the Forward_Open connection path. The device **shall** also support a Null key segment and no key segment.
i) The device **shall** support the 32-bit Real-Time Header (Run/Idle Header) in the O→T connection data. Note that the device may also support other connection data formats as well.
j) The device **shall** support priorities High and Scheduled.

4. The device **shall** accept a Configuration path as part of the Forward_Open request. This is not a requirement for rack-based devices.

   Devices that support the data segment for configuration data **shall** accept Forward_Opens with all 3 types of data segments: None, Null, or Non-Null. Devices that choose not to support the data segment for configuration data **shall** still specify and accept a Configuration path. This unused configuration path may be the same as the "heartbeat" path associated with the I/O connection(s).

   Devices not requiring configuration data **shall only** accept Forward_Opens with Null or No data segments; Forward_Open requests containing Non-Null data segments **shall** be rejected.

   Examples of data segment types:

Non-Null	0x80 0x01 0x12 0x34
Null	0x80 0x00
None	-

   A device **shall** retain its configuration even if all connections are terminated. Devices may lose their configuration on a reset.

   Rationale: It is stated in Vol 1, 3-6.2 that "If no data segment is specified the existing configuration continues to be used." The device may require configuration data with the Forward_Open after initial power up. However, until the device is reset, the device must accept Forward_Opens with no configuration data, in which case it would continue to use the existing configuration.

5. The device **shall** support the Assembly object. Assembly object instances **shall** be used to specify connection paths for Transport Class 1 connections. Path segments in the Forward_Open **shall** use the compressed format in the following order: Configuration instance, Consumed Data connection point, Produced Data connection point, and data segment if present. This is not a requirement for rack-based devices.

6. The device **shall** provide access to configuration parameters/attributes via Explicit Messaging (e.g. web-only access is not acceptable). Note that it is not necessary to utilize the Parameter Object. This does not apply to rack-based, technology enabler devices, or devices with user-

defined I/O data content (e.g. EtherNet/IP to other network gateway, target connections of a PLC).

7. The device **shall** provide access to its I/O Data attribute(s) via unconnected and/or connected (Class3) explicit messaging, e.g. Assembly object, instance attribute 3. Write requests to Output data shall be rejected when the assembly is linked to an active I/O connection and succeed when the connection is not active. Explicit messaging-based access to I/O Data attribute(s) is not a requirement for rack-based devices. The I/O Data attributes **shall not** include the 32-bit Real-Time Header (Run/Idle Header).

8. The device **shall not** report the deprecated extended status codes of the Connection Manager object as specified in Volume 1, Connection Manager Object Instance Error Codes (e.g. section 3-5.6 in Ed. 3.19).

5.3 TCP/IP Suite

No addition to Common Device Recommendations.

5.4 Ethernet and Physical

No addition to Common Device Recommendations.

5.5 EDS File

1. The device **shall** support all EDS File recommendations described in the Common Device Recommendations section 2.4.

2. The format of the I/O connection data **shall** be detailed in the EDS [Assem] section. This does not apply to rack-based, technology enabler, or explicit messaging-only devices, or devices with user-defined I/O data content (e.g. EtherNet/IP to other network gateway, target connections of a PLC).

3. The EDS file **shall** include the [Connection Manager] section. This will allow easy configuration of connections from scanners supporting the Connection Configuration object.

4. If the device supports configuration data with the Fwd_Open, the format of the configuration data **shall** be detailed in the EDS [Assem] section and associated parameters **shall** be defined in the [Param] section.

5.6 Performance

1. The device **shall** support all Performance recommendations described in the Common Device Recommendations section 2.5.

2. The device **shall** conform to the following I/O performance measures under no background traffic for 60 seconds:

Minimum Supported Connection RPI	≤ 100ms
Mean measured packet interval (MPI) with respect to reported API	< ±10%
Standard Deviation of the MPI	< ±10%
Maximum jitter of the MPI	< ±50%

3. The device **shall** conform to the following I/O performance measures under a steady-state amount of background traffic for 30 seconds:

Mean MPI with respect to reported API	< ±10%
Standard Deviation of the MPI	< ±25%
Maximum jitter of the MPI	< ±100%

The background traffic will consist of the following:

ARP Request Broadcasts	180 packets/s
Gratuitous ARP Broadcasts	180 packets/s
DHCP Request Broadcasts	100 packets/s
ICMP (ping) Request Broadcasts	100 packets/s
NTP Multicasts	10 packets/s
EtherNet/IP ListIdentity Broadcast Requests	10 packets/s
EtherNet/IP Connected Class 1 Multicast I/O	1800 packets/s

The EtherNet/IP Connected Class 1 I/O only applies to the test cases where IGMP is disabled, representative of the use of unmanaged switches.

4. The device **shall** conform to the following I/O performance measures under a burst of background traffic during the same steady-state amount of background traffic:

Return to within this percentage of the mean MPI with respect to reported API within the test period	< ±10%
Maximum jitter of the MPI	< 400%

The burst of background traffic will consist of the following 240 ARP Request packets in a 60 ms period, for an effective rate of 4000 packets/s.

6 Scanner Device Recommendations

This section explains the functionality that is recommended for Scanner class devices over and above that in the Common Device section. The Scanner device recommendations are for any device that originates Transport Class 1 connections.

6.1 Example Devices

- Programmable Controller
- Soft Controllers
- Robot

6.2 CIP

1. The device **shall** support all CIP recommendations described in the Common Device Recommendations section 2.1.

2. The device **shall** support, at a minimum, origination of 8 Transport Class 1 I/O connections. Although the actual number of connections supported is application specific, support for 64 or more is recommended.

3. The following recommendations pertain to originated Transport Class 1 I/O connections.
    a) It is recommended that the device support the Change of State trigger type with Production Inhibit Timer (PIT).
    b) The device **shall** support the Cyclic trigger type.
    c) The device **shall** support the Listen Only and Input Only connection types.
    d) The device **shall** support the Exclusive Owner connection type.
    e) The device **shall** support multicast T→O and unicast O→T. The device **shall** also support unicast T→O.
    f) The device **shall** support the 32-bit Real-Time Header (Run/Idle Header) in the O→T connection data. O→T connections to the Heartbeat connection path with 0 data length **shall not** include the Real-Time Header. Support for connections without the Real-Time Header (according to specifications in [Connection Manager] section of the adapter's EDS file) is recommended.

4. The device **shall** be able to deliver a device Configuration Assembly (of ≤ 400 bytes) as part of Forward_Open/Large_Forward_Open.

5. The device **shall** provide access to I/O data collected as a result of its "scan list" via Explicit Messaging, e.g. Assembly object instance attribute 3. The I/O data collected **shall not** include the 32-bit Real-Time Headers (Run/Idle Header).

6. It is recommended that the Connection Configuration object be supported. This will provide a standard means of configuring the scanner.

7. It is recommended that the device accept (be a target of), at a minimum, 2 Transport Class 1 I/O connections. If this functionality is supported, the connections **shall** support the Transport Class 1 connection features defined for the Adapter class device (section 5.2, items 2-5).
8. It is recommended that the device support the Extended Symbolic path segment in the Forward_Open as an originator and a target. This would provide interoperable peer-to-peer communication with current EtherNet/IP scanners.

6.3 TCP/IP Suite

1. The device **shall** support all TCP/IP Suite recommendations described in the Common Device and Adapter Device Recommendations section 2.2.

2. The device **shall** support IGMP V2 with the following behavior:
    a) Upon receiving a Forward_Open response to a multicast connection request, an IGMP Membership Report **shall** be issued to join the multicast group.
    b) Upon closing the multicast connection, an IGMP Leave Group **shall** be issued.

6.4 Ethernet and Physical

No addition to Common Device and Adapter Device Recommendations.

6.5 EDS File

1. The device **shall** support all EDS File recommendations described in the Common Device Recommendations section 2.4.

2. If the device accepts Transport Class 1 connections from other devices, the EDS file **shall** include the [Connection Manager] section. This will allow easy configuration of connections from scanners supporting the Connection Configuration object.

6.6 Performance

1. The device **shall** support all Performance recommendations described in the Common Device Recommendations section 2.5.

2. If the device supports Adapter functionality, then the device **shall** support all the Performance recommendations described in the Adapter Device Recommendations section 5.6.

Document Revision Log

Revision	Sections	Remarks	Date	Author	RTS	TRB
0.3		Release for review in Workshop #11	3/15/2004	Perry Green		
0.4		Update after Workshop #11 comments	4/2/2004	Perry Green		
0.5		Update after comments received from group review	6/4/2004	Perry Green		
0.6, 0.7		Last minute updates.	6/7/2004	Perry Green		
0.8		Update after Workshop #12 comments	6/8/2004	Perry Green		
1.0		First release after Workshop acceptance	6/10/2004	Perry Green		
1.0a		Update after Workshop #16 discussion	9/27/2005	Perry Green		
1.0b		Further suggestions for change	09/29/2005	Viktor Schiffer		
1.1		Cleanup after review	10/12/2005	Perry Green		
1.2		Changes after Plug Fest #4	2/14/2006	Perry Green		
1.3		Updated after Workshop #24 discussion	8/12/2008	B Campbell		
2.0		Added Performance Recommendations	10/7/2008	Jim Gilsinn		
2.1	5.2 2.2 2.3, 2.4, 5 2.6 5.2 5.5 5.6 6.2 6.3	Clarification on how the I/O Data attribute can be accessed. Grammar correction Spec reference corrections Made(new) Appendix F version of ACD the preferred implementation. Clarified cross reference in item 1. Clarification of I/O Data in item 7. Clarified cross reference in item 1. Clarified cross reference in item 1. Clarified cross reference in item 1. Clarification re Large_Forward_Open in item 4. Clarification of I/O Data in item 5. Corrected cross reference. Replaced Fwd_Open with Forward_Open. Clarified cross reference in item 1. Clarified cross references.	3/1/2011	Joakim Wiberg/ Darren Klug		

	6.4					
2.2 PR001	5.2-2 & 5.2-3 2.1 5.2-4 5.2-4 2.1 2.6	1. Clarified that device must support multiple, unicast connections for the same connection point. 2. Added requirement that Generic devices report Device Type 0x2B. 3. Clarified that config rules apply to f_open-based config. 4. Clarified that a device may require a f_open with a non-null data segmentfor unowned targets. 5. Added proposals to require TaCL and recommend that deprecated f_open extended status codes no longer be used. 6. Removed reference to June 2006 IPv4 Address Conflict Detection for EtherNet/IP Devices document. 7. Updated spec references.	2/8/2012	Darren Klug		
3 PR001	2.1, 5.2, 6.2 2.1, 5.2 5.2-4 Throughout	1. Moved Target Connection List recommendation to Adapter and Scanner sections (vs. Common). 2. Moved updated status code recommendation to Adapter section (vs. Common). 3. Reversed item 4 in Rev 2.2 PR001. Clarified that a device shall retain its configuration even if all connections are terminated. 4. Cleaned up formatting.	2/23/2012	Darren Klug		
3 PR002	5.2 Throughout	1. Clarified combinations of multicast and unicast connections required. 2. Replaced "->" with "→"	3/2/2012	Darren Klug		
3 PR003	5.2	Further clarifications to mc/uc required cnxn combos.	5/23/2012	Darren Klug		
3 PR004	5.2	A few more tweaks based on internal RA feedback. Changed support for CoS from recommendation to requirement.	5/24/2012	Darren Klug		
3 PR005	Throughout	1. Changed spec reference format (so updates are not required every time spec is updated). 2. Clarified that Device Type 0x00 has been deprecated.	6/4/2012	Darren Klug		

	2.1 5.2 5.2, 6.2	3. Changed recommendation to requirement that deprecated f_open extended status codes no longer be used starting with PF#17 (spring 2013). 4. Removed recommendation that devices support TaCL (until at least a test is available).				
3	1.4, 2.5, 5.6 6.2	1. Clean up heading editing glitches reported by Quinton. 2. Applied "bold" face to a "shall" that lacked it.	7/2/2012	Darren Klug		
4 PR001	5.2	1. Added missing connection combination.	9/10/2012	Darren Klug		
4 PR002	1.3	1. Corrected document rev.	2/18/2013	Darren Klug		
4 PR003	 5.2.6 5.5.2	Updates during WS#37: 1. Clarified requirement for exp msg access to config params. 2. Clarified requirement for EDS I/O connection data member definition.	2/19/2013	Darren Klug		
4	-	As approved at WS#37; all changes accepted.	2/19/2013	Darren Klug		
5 PR001	- 1.3 2.5 5.2, item 7	Improved consistency of CIP spec references and verified section numbers vs. Apr 2013 spec release. Added future work item section with 1 item: TCP Socket Cleanup. Removed references to pending updates by Performance Working Group. Added Startup Behavior to Performance section. Clarified that explicit messaging access to I/O Data attribute(s) shall be limited to read access.	7/31/2013	Darren Klug		
5 PR002	1.3, 2.2, 5.2	Editorial cleanups.	8/5/2013	Joaakim Wiberg		
5 PR003	5.2-4	Made support for data segment-based configuration required for devices with less than 400 bytes of configuration data. Recommend use of multiple attributes/assemblies for devices with larger amounts of configuration data.	8/8/2013	Darren Klug		
5 PR004		Updates based on discussion at EIP WS#38:	8/30/2013	Darren Klug		

	1.3 2.5 2.7 5.2, item 7 5.2, item 4 5.6	Added 2 items for future consideration (DHCP, 10 Mbps). Removed (understood) startup behavior requirement; test to be incorporated in Network tests. Added rule re: testing of ODVA Conformance recognized product families. Reverted to allowing explicit write access I/O Data attributes. Reverted except for editorial changes. Updated Performance section to include test duration and traffic descriptions.				
5	1.3	Pre WS#40 Cleanup Removed future work item re: ESE-050-006 “TCP Socket Cleanup” (new Encapsulation Inactivity Timeout attribute (13) is required). Added future worked item re: improving Explicit Messasing Client/Scanner requirements.	3/10/2014	Darren Klug	X	X
6	2.2, item 3	Clarified that TCP connections for CIP are reserved not just supported.	10/22/1014	Perry Green	X	X
7	5.5, item 4 5.2, item 7	Added requirement for configuration assembly details in the EDS. Clarified behavior of explicit write to output data	2/17/2016	Perry Green	X	X
8	2.1 5.2, item 2 5.2, item 3 5.2, item 3 5.2, item 4	Added Class 3 priority support requirements Added simultaneous class 3/1 connection requirements Added Listen Only to Unicast connection options Added Class 1 priority support requirements Added rationale for no/null data segment in Fwd-Open Moved to end of document	3/30/2017	Perry Green	X	X

	This table					
9	2.3, item 1	Removed Half Duplex requirement	4/20/2018	Perry Green	X	X
10	1.3 2.3	Remove sentence with document version in it. Clarify that Ethernet requirements are for all devices regardless of interface count.	11/28/2018	Perry Green	X	X