EtherNet/IP®

Quick Start for Vendors

ODVA®

Before We Begin

- Introductions
- All attendees are automatically muted with no video connection as a default.
- Please use the Q&A to ask questions, not the chat. We will address questions as they come in.
- At the end if there is time, we will take questions verbally from the attendees. We will advise if and when there is time for you to “raise your hand” if you have a question.
- Please complete the 4 question post session survey. The survey will launch when you close out of the webinar.

Review - Yesterday We Covered:

Technical Overview of CIP

- Device Profiles:
  - Object Model
  - I/O Data Format
  - Configuration Format
- Class, Instance
- Attributes, Services, Behaviors
- Implicit & Explicit Messaging
- Configuration

Review - Yesterday We Covered:

Technical Overview of EtherNet/IP

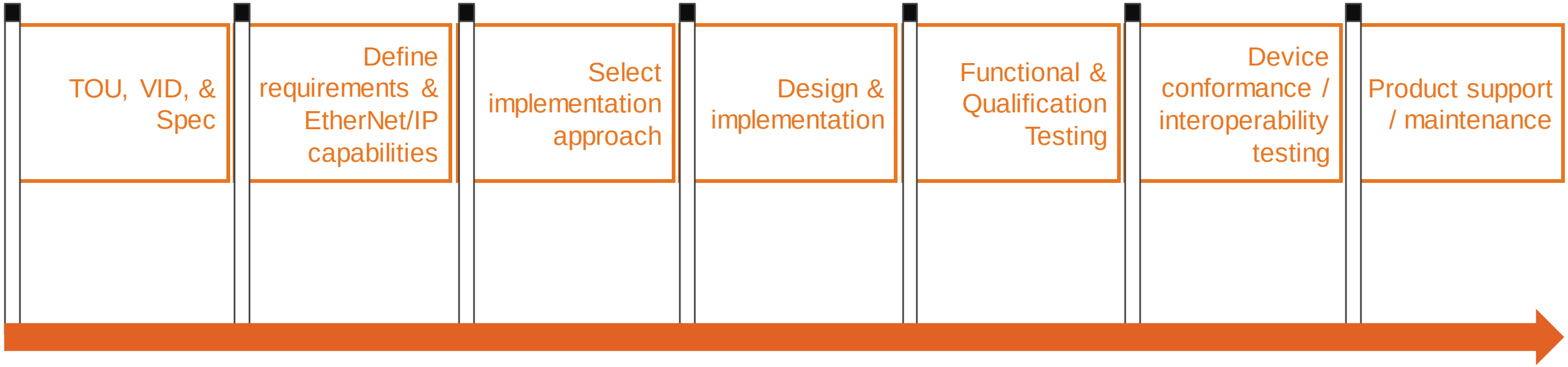
- EtherNet/IP Encapsulation
- Connected/Unconnected Explicit Messaging
- Implicit Messaging
- Connection Concepts:
  - Originator, Target
  - Point-to-point, Multicast
- Connection Types:
  - Exclusive Owner
  - Input Only
  - Listen Only

Getting Started with EtherNet/IP™ Development

Matthew Frazer
ODVA

Steps to Development

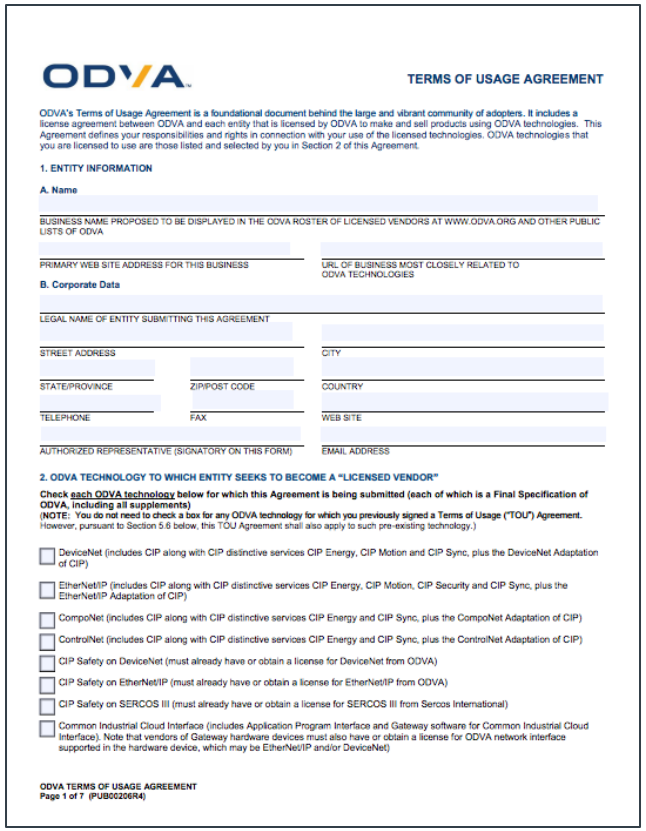
The EtherNet/IP Development Process



Terms of Usage Requirements:
Vendor ID, Specifications, Testing

Terms of Usage (TOU) and Vendor ID (VID)

Complete the TOU



ODVA

TERMS OF USAGE AGREEMENT

ODVA's Terms of Usage Agreement is a foundational document behind the large and vibrant community of adopters. It includes a license agreement between ODVA and each entity that is licensed by ODVA to make and sell products using ODVA technologies. This Agreement defines your responsibilities and rights in connection with your use of the licensed technologies. ODVA technologies that you are licensed to use are those listed and selected by you in Section 2 of this Agreement.

1. ENTITY INFORMATION

A. Name

BUSINESS NAME PROPOSED TO BE DISPLAYED IN THE ODVA ROSTER OF LICENSED VENDORS AT WWW.ODVA.ORG AND OTHER PUBLIC LISTS OF ODVA

PRIMARY WEB SITE ADDRESS FOR THIS BUSINESS

URL OF BUSINESS MOST CLOSELY RELATED TO ODVA TECHNOLOGIES

B. Corporate Data

LEGAL NAME OF ENTITY SUBMITTING THIS AGREEMENT

STREET ADDRESS

CITY

STATE/PROVINCE

ZIP/POST CODE

COUNTRY

TELEPHONE

FAX

WEB SITE

AUTHORIZED REPRESENTATIVE (SIGNATORY ON THIS FORM)

EMAIL ADDRESS

2. ODVA TECHNOLOGY TO WHICH ENTITY SEEKS TO BECOME A "LICENSED VENDOR"

Check each ODVA technology below for which this Agreement is being submitted (each of which is a Final Specification of ODVA, including all supplements)
(NOTE: You do not need to check a box for any ODVA technology for which you previously signed a Terms of Usage ("TOU") Agreement. However, pursuant to Section 5.6 below, this TOU Agreement shall also apply to such pre-existing technology.)

- ☐ DeviceNet (includes CIP along with CIP distinctive services CIP Energy, CIP Motion and CIP Sync, plus the DeviceNet Adaptation of CIP)
- ☐ EtherNet/IP (includes CIP along with CIP distinctive services CIP Energy, CIP Motion, CIP Security and CIP Sync, plus the EtherNet/IP Adaptation of CIP)
- ☐ CompoNet (includes CIP along with CIP distinctive services CIP Energy and CIP Sync, plus the CompoNet Adaptation of CIP)
- ☐ ControlNet (includes CIP along with CIP distinctive services CIP Energy and CIP Sync, plus the ControlNet Adaptation of CIP)
- ☐ CIP Safety on DeviceNet (must already have or obtain a license for DeviceNet from ODVA)
- ☐ CIP Safety on EtherNet/IP (must already have or obtain a license for EtherNet/IP from ODVA)
- ☐ CIP Safety on SERCOS III (must already have or obtain a license for SERCOS III from Sercos International)
- ☐ Common Industrial Cloud Interface (includes Application Program Interface and Gateway software for Common Industrial Cloud Interface). Note that vendors of Gateway hardware devices must also have or obtain a license for ODVA network interface supported in the hardware device, which may be EtherNet/IP and/or DeviceNet)

ODVA TERMS OF USAGE AGREEMENT
Page 1 of 7 (PUB00206R4)

Order Vendor ID & Specifications

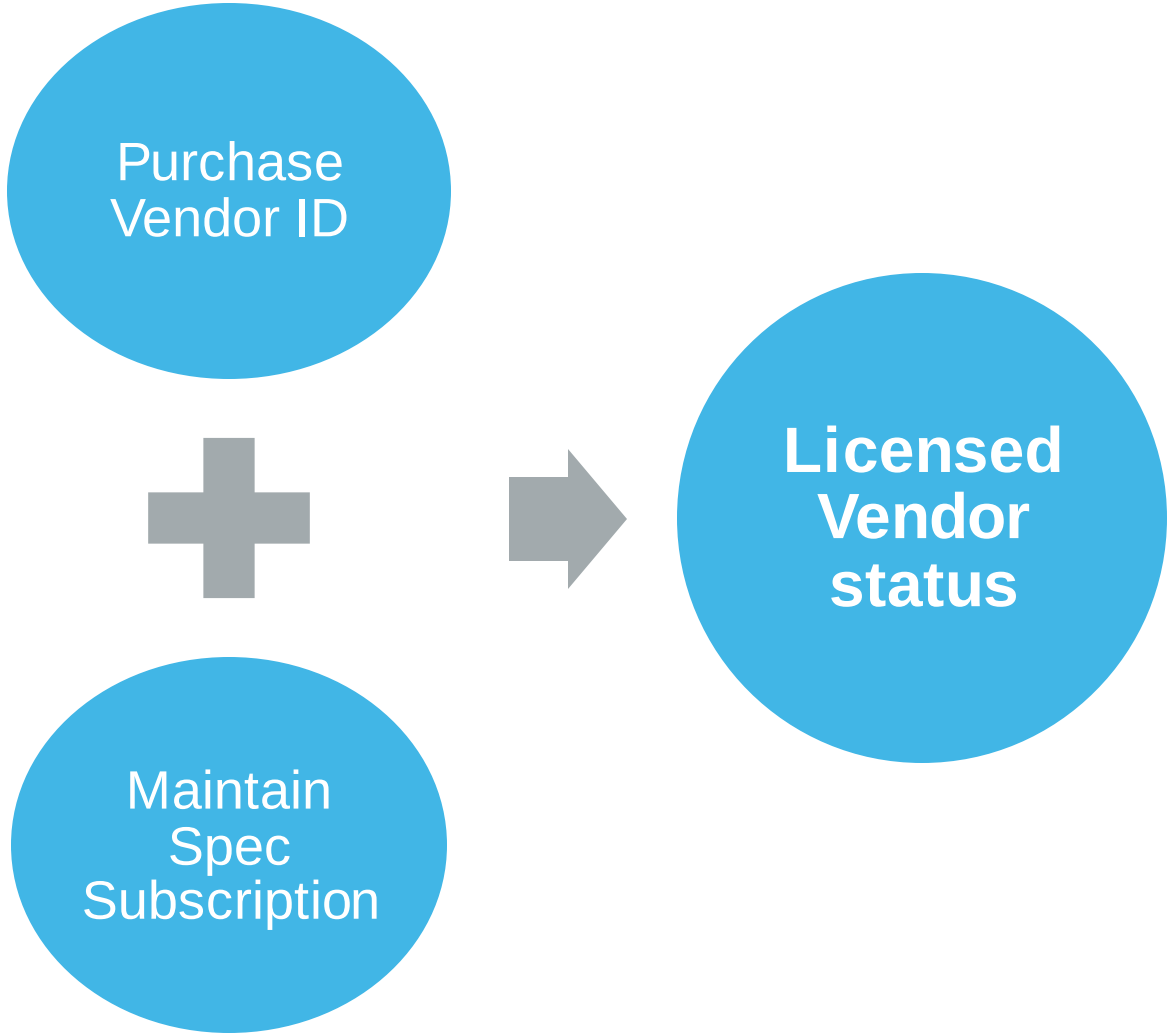
- ☐ DeviceNet
- ☐ EtherNet/IP
- ☐ CompoNet
- ☐ ControlNet

Submit Order

Available on: www.odva.org/technology-standards/document-library/

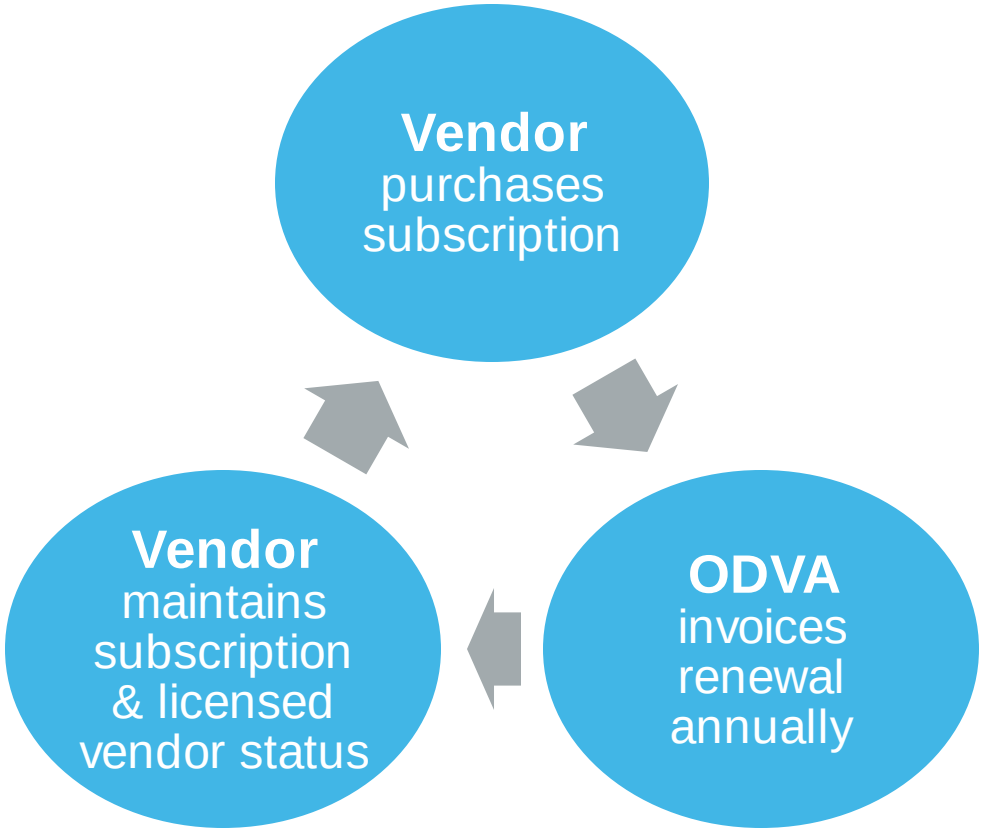
TOU Highlights: VID

- Maintain Vendor ID for each licensed technology (EtherNet/IP)
- Your company's VID is:
  - Unique
  - Same for all technologies
  - What identifies you as authorized vendor of EtherNet/IP Devices



TOU Highlights: Specifications

- Maintain subscription to The EtherNet/IP Specification



TOU Highlights: Declaration of Conformity (DOC)

- DOCs obtained via ODVA conformance testing
- Vendor-independent assurance of compliance
- Authorized Test Service Providers (TSPs) conduct testing in North America, Europe, China, and Japan
- ODVA CONFORMANT products:
  - Have passed conformance testing at a TSP
  - Hold a valid DOC

TOU Highlights: Trademarks

The EtherNet/IP™ network trademark

The ODVA CONFORMANT™ certification trademark (product holds valid DOC)

- Non-conformance = stop selling, advertising the product

Specifications: The CIP Networks Library

- Volume 1: Common Industrial Protocol (CIP™)
- Volume 2: EtherNet/IP™ Adaptation of CIP
- Volume 3: DeviceNet® Adaptation of CIP
- Volume 4: ControlNet ® Adaptation of CIP
- Volume 5: CIP Safety™
- Volume 6: CompoNet ® Adaptation of CIP
- Volume 7a: Integration of Modbus Devices into CIP
- Volume 7b: Integration of HART Devices into CIP
- Volume 8: CIP Security™
- Volume 9: CIP Motion™

What's in the Spec?

- Documentation of the Common Industrial Protocol and its specific network adaptations.
- NOT a "how-to" guide for developing an EtherNet/IP product

How Specs are Organized

- Each contains 10 chapters
- 4+ appendices
- Network adaption volumes:
  - Expand the scope of CIP (Vol. 1)
  - Narrow the scope of CIP

What to Read in Volume 1 CIP

CHAPTERS 1-4
All

CHAPTER 5
Only objects that will be implemented

CHAPTER 6
Only the profile that will be implemented

CHAPTER 7
Required later in the development phases

APPENDIX A
Only services that will be implemented

APPENDIX B
All

APPENDIX C
All

APPENDIX D
Reference

Tips for Chapter 3 of Volume 1 CIP

- Sections 2 & 3:
  - What goes on inside the device, independent of what happens with externally visible objects
- Connection Object
  - Not mandatory and typically not implemented
  - Transport and Trigger definitions **do** apply to EtherNet/IP, so read about Class 1 and Class 3 transports
- Connection Manager Object
  - Required for every EtherNet/IP device
  - Connection Messaging requires services Forward_Open, Forward Close
  - Unconnected_Send required only for routing / originating devices that send messages across routers

Tips for Appendix C of Volume 1 CIP

- Data Types
- Segment Encoding: powerful addressing method
  - Used in Forward_Open, Unconnected_Send messages
  - Used in EDSs
  - Key segment types to know:
    - Logical segments (class/instance/attribute and connection point addressing, keying)
    - Port segments (path description)
    - Symbolic segments
    - Electronic key segments (device identification)
    - Data segments (to send config data)

What to Read in Volume 2 EtherNet/IP Adaptation

CHAPTER 1
Reference material

CHAPTER 2
Encapsulation protocol

CHAPTER 3
CIP messaging and TCP/IP

CHAPTER 5
Two required EtherNet/IP-specific objects; optional DLR, QoS, SNMP

CHAPTER 6
Required set of objects

CHAPTER 7
EDS for EtherNet/IP devices

CHAPTER 8
Cables, connectors

CHAPTER 9
Indicators, labels, Device Level Ring (DLR)

APPENDIX F
Address conflict detection

Recommended Sequence for Reading

Vol. 1 CIP, Ch. 1 - 2

- Gain understanding of overall concepts

Vol. 1 CIP, Appx. C

- Gain understanding of Message Router Request Format
- Logical segments used in EPATH format

Vol 1 CIP, Ch. 4

- Overview of the CIP Object Model

Recommended Sequence for Reading

Vol. 2, Ch. 2 & Ch. 3

- Understand the Encapsulation & Common Packet Format Vol. 1 Chapter 3, Section 5.5

Vol. 2 Ch. 3-2.1 & Vol. 1, Ch. 2-4.1

- Understand how Unconnected Explicit Messaging works on EtherNet/IP

Vol. 1, Ch. 3, Section 5.5

- Understand creation of connections using Forward_Open service

Recommended Sequence for Reading

Vol. 1, Ch. 3-4.4.3	• I/O message formats: transports & triggers
Vol. 1, Ch. 3-6	• I/O message formats: data headers & application connection types
Vol. 2, Ch. 2-6	• I/O message encoding details

Recommended Sequence for Reading

Appx. E

- EtherNet/IP QuickConnect (if building device that must power up and get online quickly)

Vol. 1, Ch. 7 & Vol. 2, Ch. 7

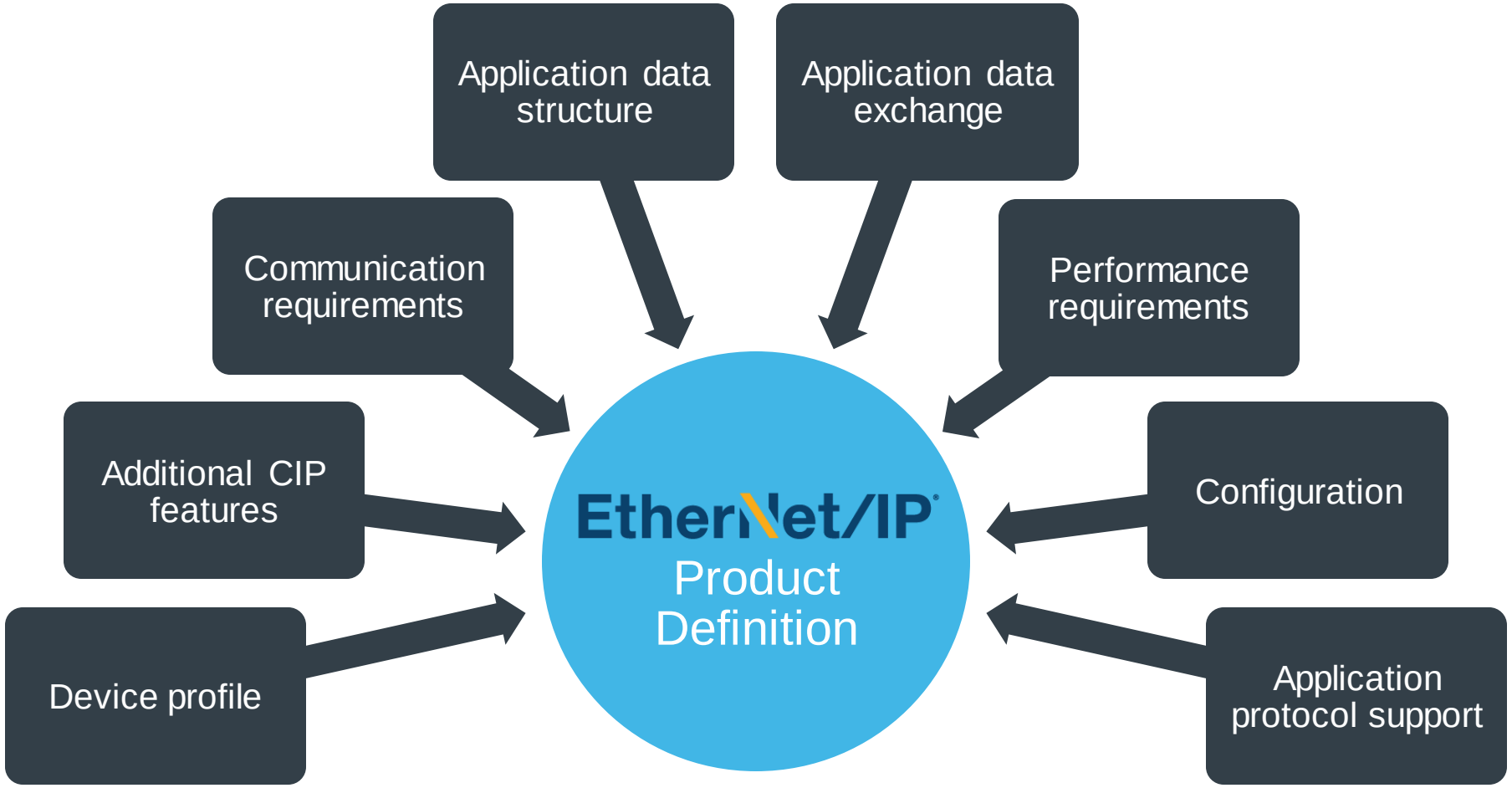
- After the product is functional, read these sections to understand how to create your EDS file

EtherNet/IP™ Functional Requirements

Chatrapathi GV
Utthunga

ODVA®

Defining Your Product Requirements

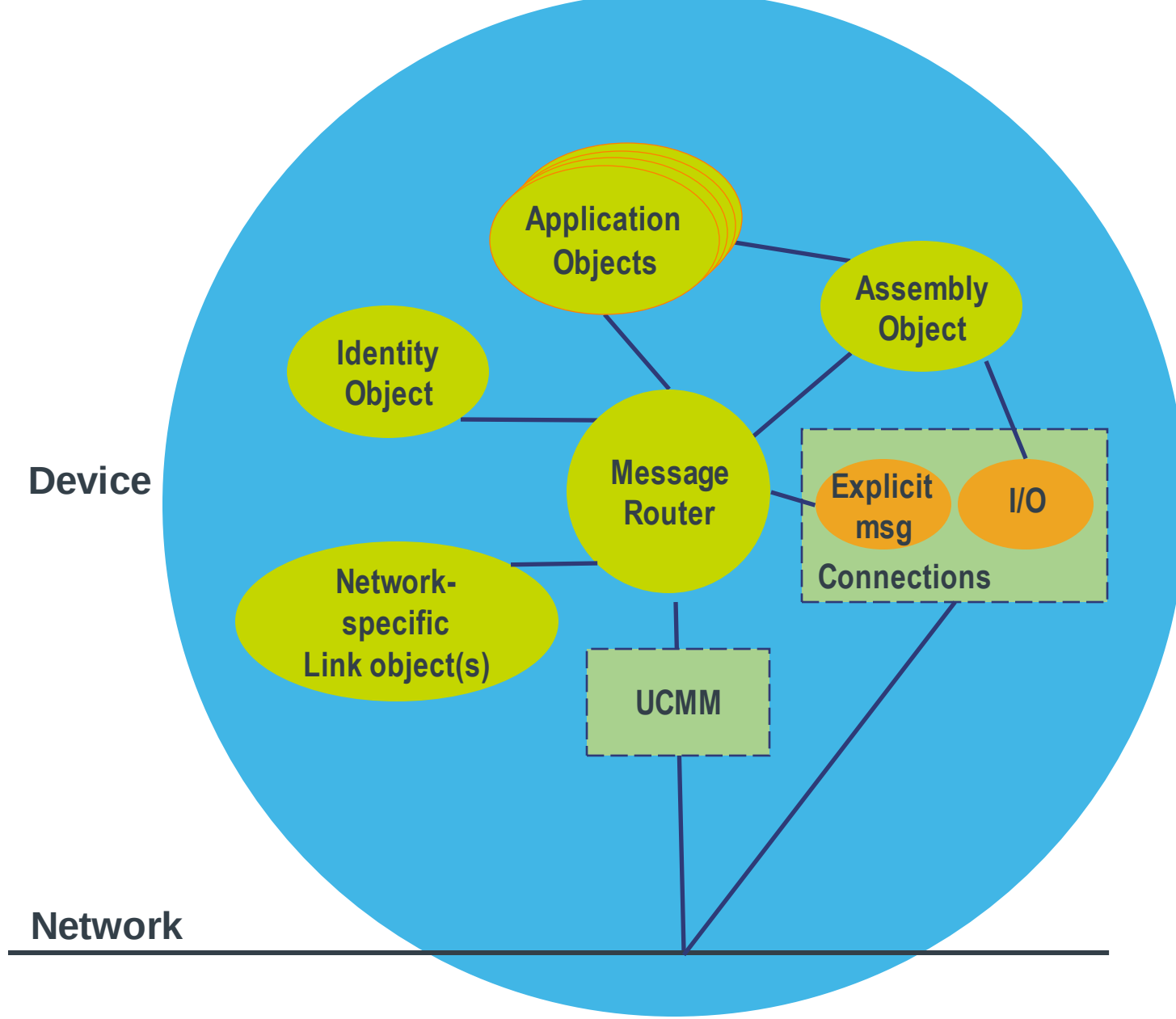


Defining Application Data within Device Objects

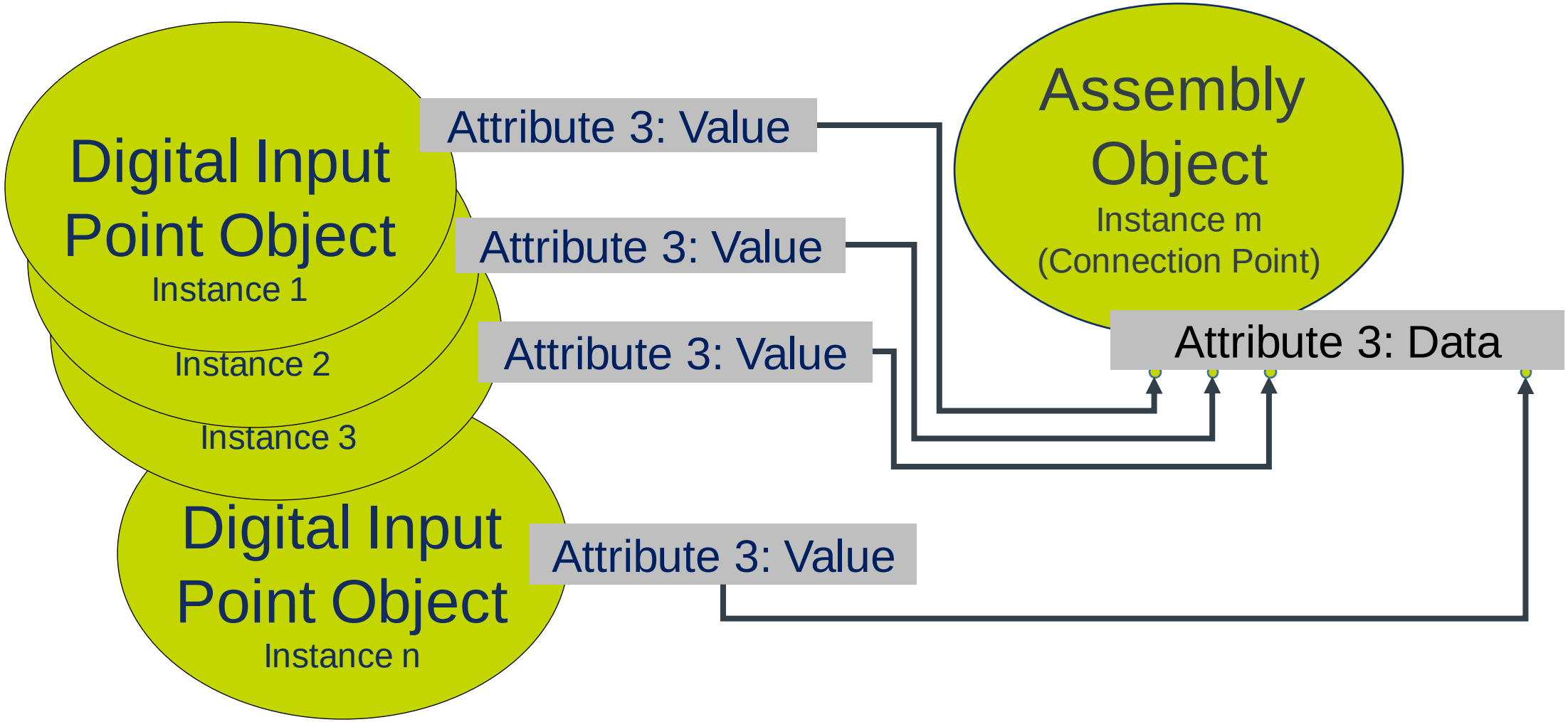
- Related data grouped together within single object
- Define data using Application Object or Vendor-specific Object
- Access data through explicit or implicit messages
- I/O Adapter class devices:
  - Use Assembly Object to define I/O data

Assembly Object

- Assembles data (attributes) from many places into a single object
  - Identity Objects, Application Objects, Vendor-specific, or Messaging
  - Aggregates data associated with I/O connections
  - Sent/received over single connection
  - Allows Vendor-specific assemblies



Example of an Assembly Object



Choosing the Best Device Profile

- Best fit for product functionality needed
- Best fit for intended application of product:

Digital I/O module	• General Purpose Discrete I/O Device profile
I/O Scanner	• Communications Adapter profile
No other CIP Network profile is application-appropriate?	• Use the Generic or Vendor-Specific profile

Electronic Data Sheet (EDS)

- Text file that allows a tool to learn about device's
  - Structure and meaning of I/O data
  - Available I/O data transfer types
  - Network accessible application configuration parameters
  - Modular constructs (for complex devices)
  - Network capacity capabilities
  - Optional supported attributes/services
  - Internalization strings for parameters
  - Identity

Basic Contents of an EDS

- Contains structure of I/O
- How to get access
- Distinguishes this product from all others
  - Tailored to individual product features
  - Describes multiple network interfaces to multiple CIP Networks
  - Identifies your product as an EtherNet/IP device, etc.

EDS [File] and [Device]

- [File] is for EDS revision control
- [Device] matches a device with the EDS file

```
[File]
        DescText = "New Description";
        CreateDate = 03-26-2008;
        CreateTime = 10:08:17;
        Revision = 1.1;
        HomeURL = "www.homeurl.com";
[Device]
        VendCode = 1;
        VendName = "XYZ";
        ProdType = 7;
        ProdTypeStr = "General Purpose Discrete I/O";
        ProdCode = 1;
        MajRev = 1;
        MinRev = 1;
        ProdName = "New Product";
        Catalog = "1234567890";
        Icon = "Device_icon.ico";
[Device Classification]
        Class1 = EtherNetIP;
```

Where to get more info about product

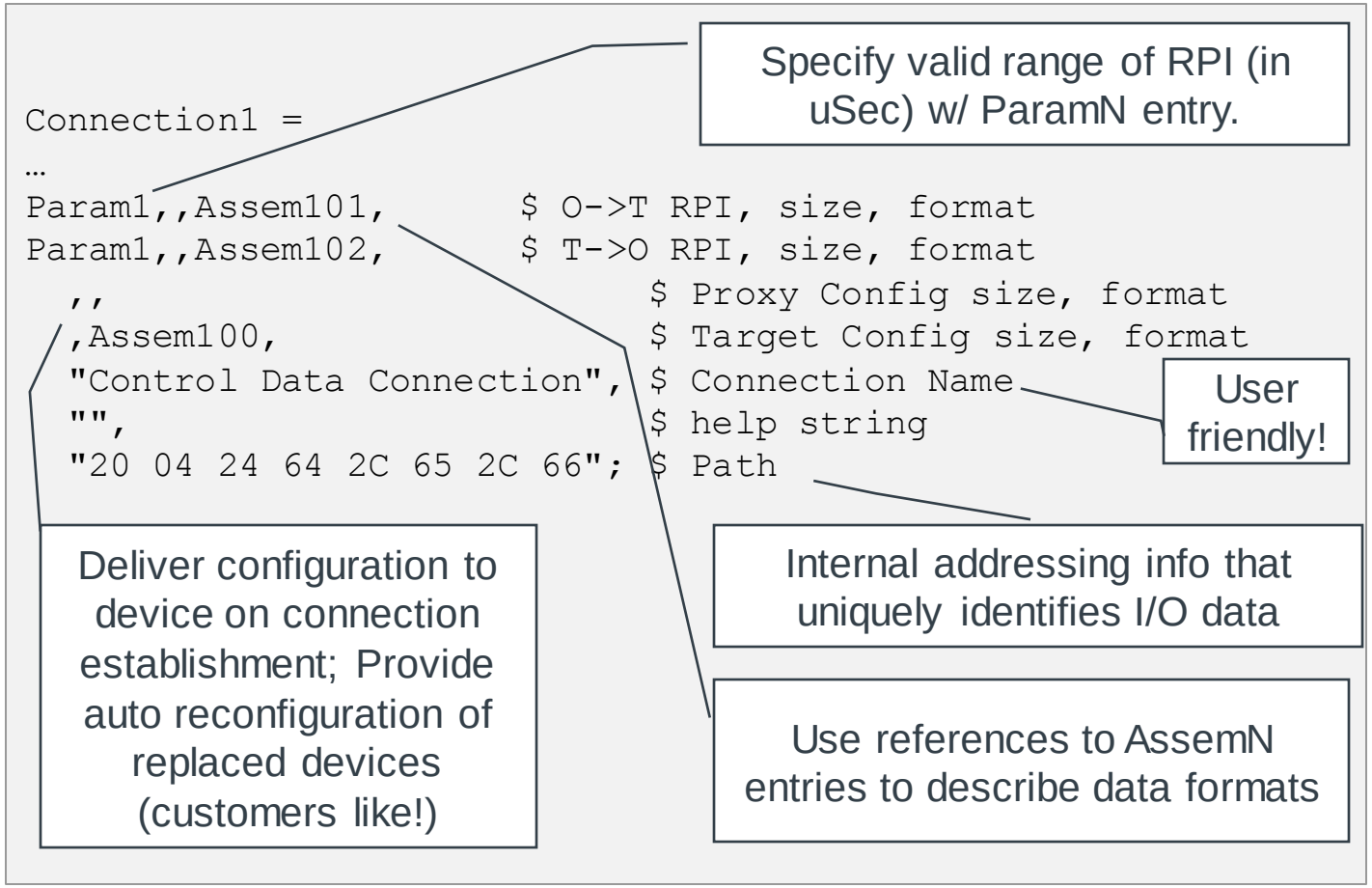
Most correlate to Identity Object attributes

Image to distinguish product from all others

Identifies product as EtherNet/IP device

EDS [Connection Manager]

- Contains entries describing all available connections



EDS [Params]

- Provide data entry and interpretation assistance

```
[Params]
 Param1 =
  0,                  $ reserved, shall equal 0
  ,,                  $ Link Path Size, Link Path
  0x0000,             $ Descriptor
  0xC8,               $ Data Type
  4,                  $ Data Size in bytes
  "RPI",              $ name
  "",                 $ units
  "",                 $ help string
  5000,50000,10000,   $ min, max, default data values
  ,,,,                $ mult, div, base, offset scaling
  ,,,,                $ mult, div, base, offset links
  ;                   $ decimal places
 Param2 =
  0,                  $ reserved, shall equal 0
  ,,                  $ Link Path Size, Link Path
  0x0200,             $ Descriptor
  0xC7,               $ Data Type
  2,                  $ Data Size in bytes
  "Input Data Size",  $ name
  "",                 $ units
  "",                 $ help string
  2,6,6,              $ min, max, default data values
  ,,,,                $ mult, div, base, offset scaling
  ,,,,                $ mult, div, base, offset links
  ;                   $ decimal places
```

Data type, size, parameter name aid configuration

Short help string can provide basic assistance

Valid range for value includes min, max, and default

Scaling factors can be specified and linked to other ParamN entries

EDS [Enum]

- Enumerate parameters to simplify data value interpretation

```
[Params]
 …
 Param7 =
  0,                    $ reserved, shall equal 0
  ,"",                  $ Link Path Size, Link Path (Class 7,
Instance 7
  0x0014,               $ Descriptor
  0xD2,                 $ Data Type
  2,                    $ Data Size in bytes
  "Status",             $ name
  "",                   $ units
  "Indicates current run status",                  $ help string
  0,8,0,                $ min, max, default data values
  ,,,,                  $ mult, div, base, offset scaling
  ,,,,                  $ mult, div, base, offset links
  ;                     $ decimal places

 Enum7 = 1, "Running/Stopped",
         2, "Forward/Reverse",
         4, "Torque Limit Exceeded"
         8, "Overspeed Detected"
```

Enumerate each valid value for this parameter. Names are displayed (instead of the raw number) when param is accessed

EDS [Groups]

- Create logically related parameter groupings

```
[Params]
 …
[Groups]
  Group1 = "Setup", 3, 1,2,6;     $ This group has Params 1, 2 and
6
  Group2 = "Monitor", 3, 3,4,10;  $ This one has Params 3, 4 and
10
  Group3 = "Maintenance", 6, 5,6,7,8,9,10;
```

Each GroupN keyword contains a Group Name, Number of Members, and a list of ParamN entry numbers that comprise the group

EDS [Assembly]

- Gives useful description of Assembly contents (usually input and output data for I/O connections)
- Mandatory

```
[Assembly]
 Assem3 =
  "Discrete Inputs, Process Status and Fault Bits",
  ,,
  0x0000,
  ,,
 16,Param15,
  5,Param25,
  3,Assem31,
  8,;              $ Pad bits
```

Name of the Assembly

Each member entry indicates size (in bits), followed by reference to another EDS construct (e.g., ParamN, AssemN) that describes the member

EDS [Capacity]

- Specifies how many connections and how much I/O traffic a device can tolerate
- Required to pass interoperability testing

```
[Capacity]
TSpec1 = TxRx, 2, 5000;       $ packets per sec @ 2 bytes
TSpec2 = TxRx, 128, 4700;     $ packets per sec @ 128 bytes
TSpec3 = TxRx, 256, 4200;     $ packets per sec @ 256 bytes
TSpec4 = TxRx, 508, 3400;     $ packets per sec @ 508 bytes

ConnOverhead = .002;          $ connection overhead

MaxCIPConnections = 128;      $ no more than 128 total
connections
MaxConsumersPerMCast = 64;    $ 64 consumers per multicast
connection
```

Using the EDS [Capacity] values, a tool can determine whether a given network will allow stable operation

EDS Summary

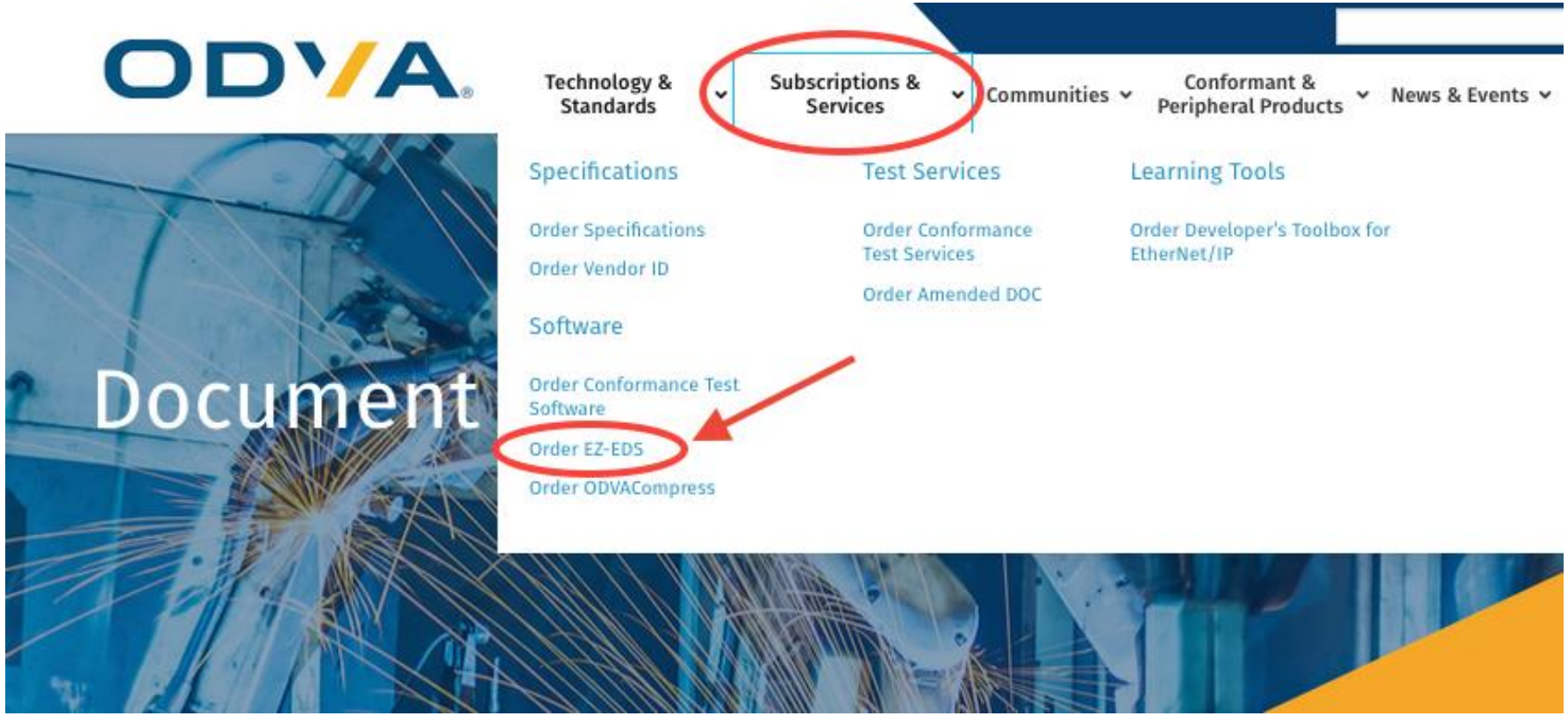
- Storage using the File Object:
  - Tightly links EDS to the device
  - Compression algorithm detailed in the spec
  - Customers like this approach!
- Call to action: develop good EDS – it provides BIG payback

EDS SECTIONS THAT DEAL WITH MODULARITY (RACK-BASED PRODUCTS)

- Ports
- Network Specific Sections
- Internalization

Recommended Tool: EZ-EDS

- Create and edit EDS files
- Free on odva.org



EtherNet/IP Functionality Considerations

- What other devices must my device interoperate with?
- How do I ensure interoperability?
- What capabilities and performance should my device have to allow users to create a functional system?
- Should I implement an embedded switch and DLR?

EtherNet/IP Functionality Recommendations

- Promote EtherNet/IP device interoperability through the definition of product functional requirements
- Defined in a set of two EtherNet/IP interoperability documents.
  - Validated by ODVA
  - Updated in ongoing PlugFest interoperability events
  - Published on odva.org

PUB 00070
Recommended Functionality for EtherNet/IP Devices

PUB 00028
Recommended IP Addressing Methods for EtherNet/IP Devices

ODVA EtherNet/IP Member Roundtables

- Promote:
  - Adoption
  - Technical leadership
  - Exploratory discussion
  - Collaboration of ODVA and industry peers
  - Ease of use of EtherNet/IP technology
  - Interoperability through PlugFest

Roundtable Purpose

Share	• Mission-relevant, real-world experiences in engineering design and field deployment of EtherNet/IP products
Enhance	• Best practices in making an EtherNet/IP product to improve interoperability and ease of use
Identify	• Technology barriers for user adoption
Develop	• Recommendations on how ODVA could address barriers to improve interoperability and ease of use

Required vs. Recommended Functionality

- Interoperability test is an *advisory* test administered at multi-vendor PlugFest events
- Elements of *advisory* test *will* become part of standard conformance test

Suggestions for Vendors

- Include interoperability recommendations in your functional specification
  - Adds value to your product
  - Reduces support needed later
  - Better end-user experience implementing your product in EtherNet/IP systems

- Attend a PlugFest!

Defining Device Performance

- # of connections and I/O traffic a device should allow (without overloading)
- RPI rates, total # of connections, connection types and sizes all interrelate and affect performance
- Publish capability in [Capacity] section of EDS

Defining Performance Variables

- Maximum # of CIP connections and connection types
  - Follow Recommended Functionality for EtherNet/IP Devices document
- Maximum throughput (application dependent)
  - Minimum allowable RPI (minimum 10ms RPI*)
  - Maximum packets/second throughput with minimum data size
  - Maximum packets/second throughput with maximum data size
- Consider robustness testing
  - Measures ability of device to sustain normal communications in presence of other multicast or broadcast traffic

*If unsure, consider minimum 10ms RPI, but do not support RPI rate faster than your product application needs to allow the best use of your product's internal resources

Additional Functional Considerations

IP Address Configuration	• DHCP recommended as “out-of-the-box” configuration method • If static addressing allowed, device vendors should provide mechanism for resetting configuration to factory defaults to allow the user to recover the device
Ethernet Physical Layer	• Choose appropriate performance level for physical layer design • Define industrial-grade physical layer design if appropriate • *The EtherNet/IP Specification* (Vol. 2, Chapter 8) defines requirements • Decide whether having an embedded switch with DLR is important to your target customers
Indicators and Diagnostics	• Aids in troubleshooting • *The EtherNet/IP Specification* (Vol. 2, Chapter 9) defines behavior and labeling for indicators

Additional Functional Considerations

Co-existence with other TCP/IP applications

- Modbus/TCP
- HTTP – Hypertext Transfer Protocol
- FTP – File Transfer Protocol
- SMTP – Simple Mail Transfer Protocol
- OPC – Open Platform Communications

Additional capabilities of TCP/IP applications

- Browser-based configuration, monitoring, and diagnostics
- Email notification on alarms or events
- Software update via network

CIP Security

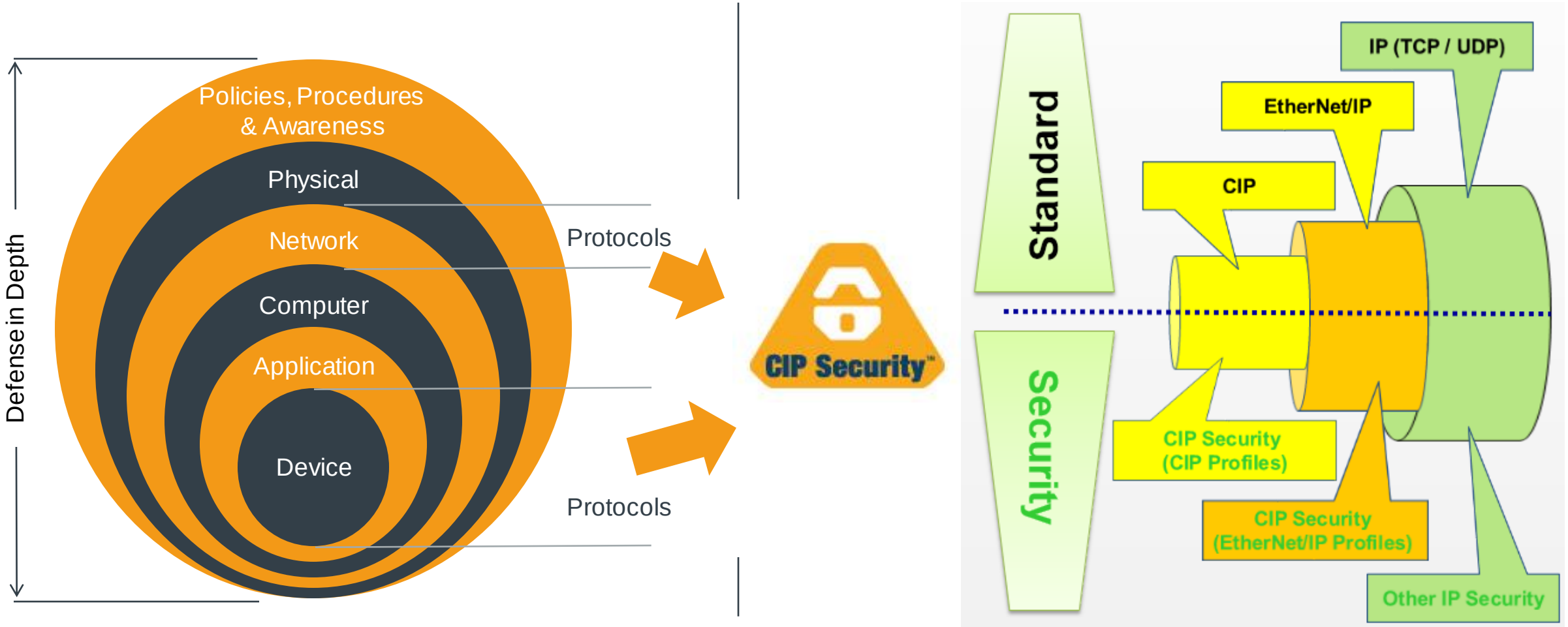
Industrial Security Considerations

- The use of network technologies grew out of the desire to share information between systems
  - Initially, they were proprietary, and access was limited
  - Today they are based on widely used technologies
- The value of connectivity is obvious, but there are risks
  - Theft of intellectual property
  - Tampering with plant systems
  - Disruption of plant operations
  - Damage to equipment

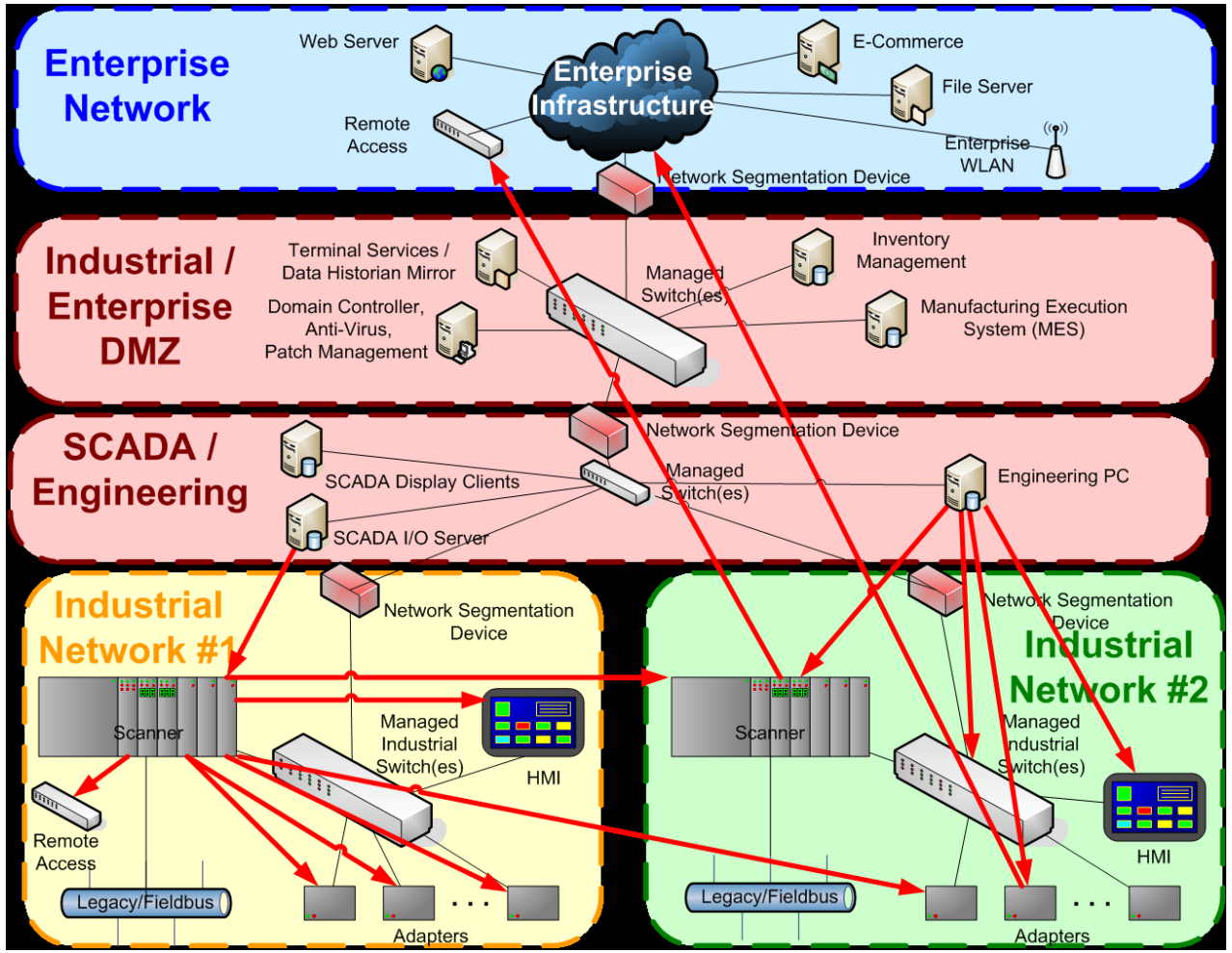
Introducing CIP Security

- The goal of CIP Security:
  - Improve the defensive capabilities of devices in a defense-in-depth architecture
  - Ultimately, build devices that defend themselves
- Today
  - Provides: Trust Domain, Device Authentication, Integrity and Confidentiality
- Future
  - Provides: User Authentication, Audit and Authorization

ODVA's Role in Security

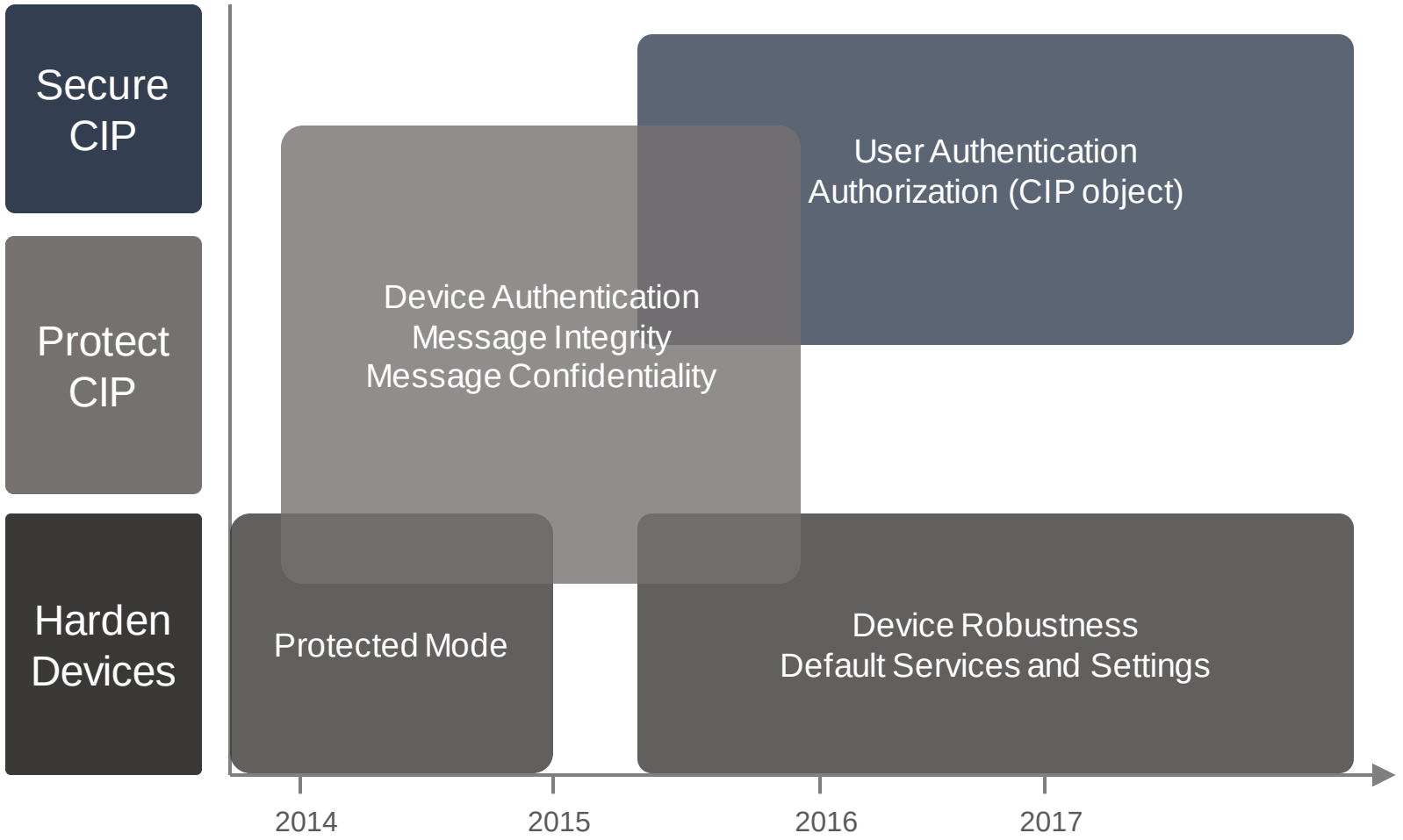


Key Data Flows to Secure



- Scanner to Adapter process data
- Scanner to Adapter configuration
- Scanner to adapter across zones
- SCADA and HMI to Adapter (PLC)
- Scanner to Scanner
- Engineering PC to Adapter, scanner, and HMI for configuration and diagnostics
- Enterprise to Adapter (e.g., Energy Object)
- Configuration tool to network infrastructure
- Local Machine Remote Access
- Enterprise remote access

Elements of CIP Security



Hardening Considerations

Protection Mode	• Attribute of the Identity Object • Rejects disruptive CIP services when attribute is set
Network Robustness	• Open port scanning (NMAP) • Vulnerability testing (Nessus) • Resource starvation eg: storm handling (Achilles) • Protocol robustness eg: fuzzing (Achilles)
System Level Resources	• Securing EtherNet/IP Networks guide • ODVA Conformance testing • Proprietary, vendor-specific usability & functional testing

CIP Security Mechanisms: Best Practices

- Utilize proven-in-use, open security standards wherever possible
- Provide security options and/or scalable properties compatible with different risk profiles and device capabilities (e.g., apply encryption for confidentiality if required)
- Maximize compatibility with existing network infrastructure (switches, routers, firewalls, etc.)
- Require no custom cryptography to maximize security and minimize any possible import and export restrictions
- Implementations should be available as both commercial and open-source supporting many different OS platforms (embedded, PC, Linux, etc.) where possible

CIP Security Technologies

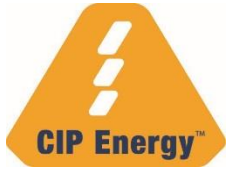
- X.509v3 Digital Certificates provide cryptographically secure device identities
  - Supports either default certificate (vendor or self-signed) or Local PKI (Push or Pull models)
- TLS (Transport Layer Security) and DTLS (Datagram Transport Layer Security) cryptographic protocols are used to provide secure transport of EtherNet/IP traffic
- Hashes or HMAC (keyed-Hash Message Authentication Code) provides data integrity and message authentication to EtherNet/IP traffic
- Encryption prevents reading or viewing of EtherNet/IP data by unauthorized parties

TLS and DTLS Security Attributes

- Authentication of the endpoints – ensuring that the target and originator are both trusted entities
  - End point authentication is accomplished using X.509 certificates or pre-shared keys
- Message integrity/authentication – ensures that the message was sent by the trusted endpoint and was not modified in transit
  - Message integrity and authentication is accomplished via TLS message authentication code (HMAC)
- Message encryption – optional capability to encrypt the communications
  - Provided by the encryption algorithm that is negotiated via the TLS handshake.

EtherNet/IP Security

- UCMM and Connected Explicit (transport Class 3) - EtherNet/IP over TLS (Port 2221/TCP)
- Implicit (transport Class 0/1) – EtherNet/IP over DTLS (Port 2221/UDP)
  - Forward_Open and Forward_Close moved to DTLS/UDP
- Identity and Integrity of communications in all use cases
  - Confidentiality of communications optional.
- Authorization based on possession of pre-shared key or trusted certificate

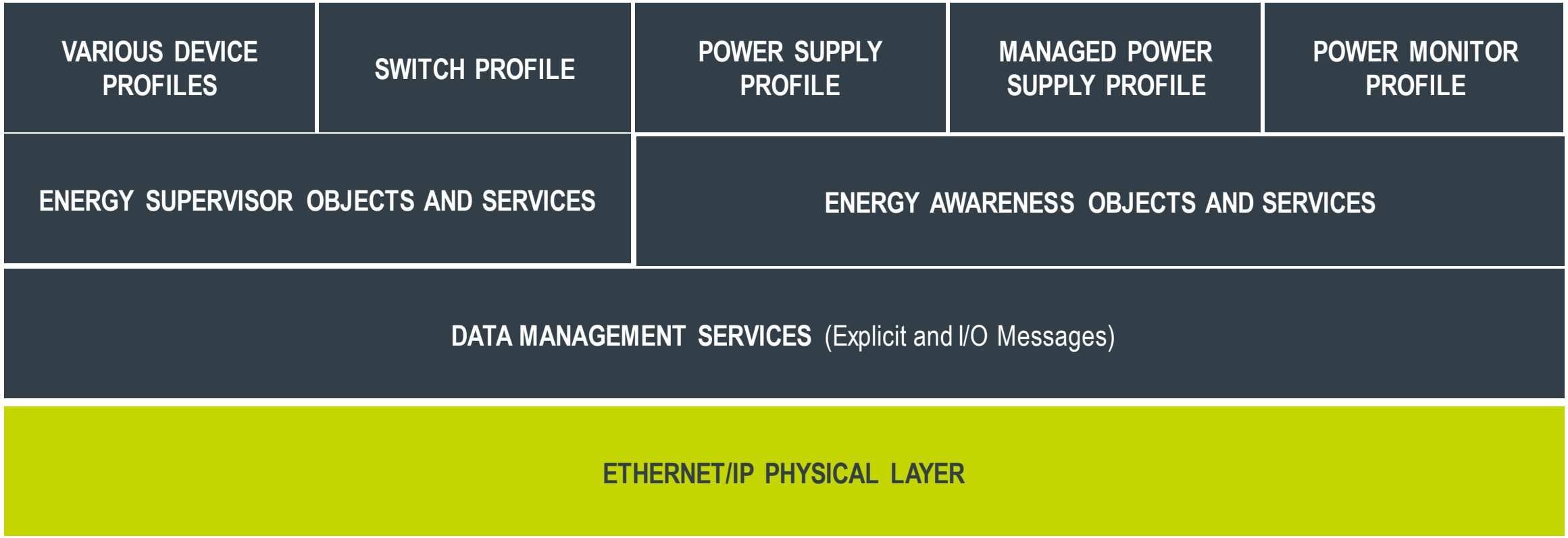


CIP Energy

CIP Energy Overview

- Awareness of energy usage
- Efficient energy consumption
- Transacting energy for best results

Energy Elements



CIP Energy Objects and Services

Objects

- ✓Base energy object
- ✓Electrical energy object
- ✓Non-electrical energy object
- ✓Power management object
- ✓Power curtailment object

Services

- ✓Pause
- ✓Sleep
- ✓Curtailment

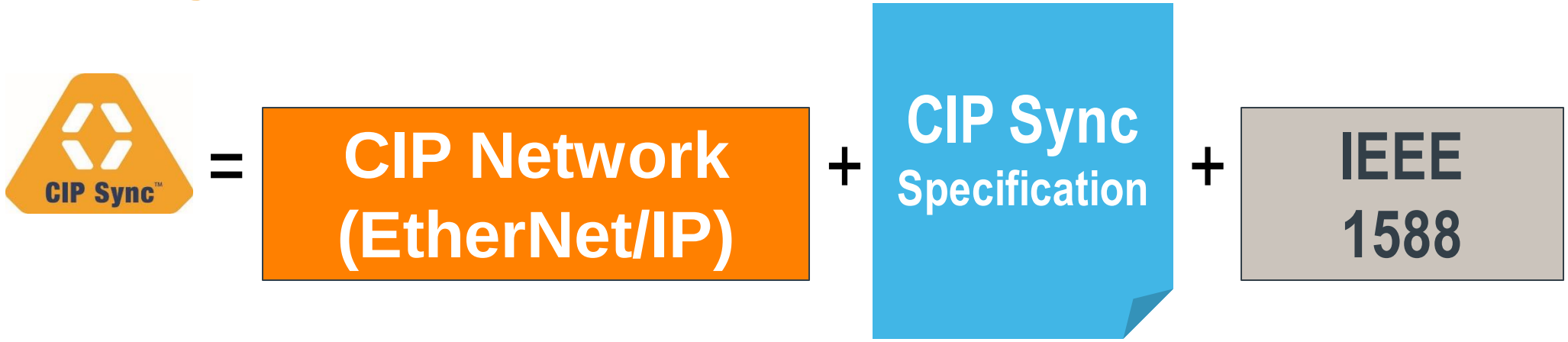
CIP Safety

CIP Safety Overview

- Allows safety devices to coexist with standard control devices on same CIP Network
- IEC 61508 certification for safety networks
- Integrity of safety control loop
- ODVA offers a one-day CIP Safety seminar

CIP Sync

CIP Sync Overview



- Provides time synchronization services
- Uses IEEE 1588 standard Precision Time Protocol (PTP)
- Syncs devices to within hundreds of nanoseconds of accuracy
- Allows distributed control components to share a common notion of time

CIP Motion

CIP Motion Overview

- Bandwidth and power
  - 100Mbps real-time data transfer via EtherNet/IP
  - Full duplex managed switches
  - Motion packets prioritized
- Common Interface
  - Device profiles support wide range of drive types
  - Control types: position, control, velocity, torque, feedback-only

CIP Motion Benefits

- Single network solution for control + motion
- High-performance motion control via standard Ethernet
- Flexible communications
- Motion device profile = superior drive interoperability
- Accurate time synchronization via CIP Sync

Choosing an Implementation Approach

Jamie Gallant
Hilscher

ODVA®

EtherNet/IP Implementation Options

- Develop your own hardware and software
- Purchase part of implementation from an enabler product vendor
- Purchase entire implementation from an enabler product vendor

Disclaimer: This section is most useful for those in the early stages of development.

EtherNet/IP Enabling Technologies

- Hardware
  - External gateway device (e.g., serial to EtherNet/IP)
  - Embedded board with complete EtherNet/IP implementation
  - Microprocessor/FPGA with integrated EtherNet/IP protocol stack implementation
  - Complete hardware implementation (internal or outsourced)
- Software
  - Integrate an EtherNet/IP stack solution
  - Develop your own EtherNet/IP stack
  - Complete outsourced software implementation

•Not intended to be a complete list

External Gateway Device

Self contained gateway with EtherNet/IP to serial or other network protocols

Advantages	Disadvantages	Best Suited to
• Quickest and easiest path to implementation • No product development required • Conformance certified	• Not an integrated solution; software tools see gateway not actual device • User must configure gateway • May have limited EtherNet/IP communications options (size, rate, type) • May have low throughput performance	• Low volume or situations needing a fast solution • Connecting legacy devices or EtherNet/IP backbone to other networks

Embedded Board

Embedded boards/modules with EtherNet/IP implementation

Advantages	Disadvantages	Best Suited to
• Complete EtherNet/IP hardware and software implementation • Integrated solution; vendor-specific customization • Fast time to market • Conformance tested embedded technology (finished product will still require conformance testing)	• Cost of embedded board may be decision factor • Performance may be an issue in the most demanding applications, such as motion control	• Typically low to mid volume solution, high volume solutions are available • When multiple fieldbus connectivity is needed

Microprocessor with Integrated EtherNet/IP

Chip-level solution with embedded EtherNet/IP

Advantages	Disadvantages	Best Suited to
• EtherNet/IP stack already integrated • Can be more easily customized for vendor-specific application • Some solutions allow application software to run on same microprocessor • Performance can be good (depending on hardware)	• Hardware development to integrate with application platform • Cost can be an issue versus off-the-shelf microprocessor	• Mid to high volume solution when vendor does not want to do complete hardware development and EtherNet/IP stack integration

Complete Hardware Implementation

In-house or outsourced

Advantages	Disadvantages	Best Suited to
• Can choose specific microprocessor, components, OS, TCP/IP stack and EtherNet/IP stack suited for product application • Can achieve high performance • More control over cost	• Most work and development expense to implement • Requires hardware, embedded design and Ethernet development expertise	• High volume applications or when product cost is critical

EtherNet/IP Stack Options for Developers

- Implement an EtherNet/IP stack yourself
  - Provides design control for special requirements
  - Requires more expertise; will need extensive testing
- Purchase a commercial EtherNet/IP stack
  - Generally a more robust and complete stack
  - Support, maintenance and consulting offered
- Purchase a hardware solution with embedded stack
  - Will need to integrate with your application

Integrate EtherNet/IP Stack

Onto existing or new hardware platform

Advantages	Disadvantages	Best Suited to
• Can use a proven EtherNet/IP stack, no need to develop a stack • Ability to choose a stack that meets your product application needs	• Still may need to select and integrate with a TCP/IP stack • Still may need to develop hardware platform • Might have large RAM/ROM requirements not tailored for the specific application	• Integration of EtherNet/IP onto existing Ethernet capable hardware • When vendor wants to develop hardware, but not develop an EtherNet/IP stack

Develop Your Own EtherNet/IP Stack

From specification or example code

Advantages	Disadvantages	Best Suited to
• Ability to implement specific features needed for product application • More control over performance, quality and maintenance • More control over RAM/ROM footprints • No licensing fees to a stack vendor	• Can be significant work to develop a full-featured stack • Likely to have errors in initial versions • Substantially more testing needed	• Simple explicit message clients and servers • Vendors with significant CIP and EtherNet/IP expertise • Larger vendors who will reuse the stack across multiple products

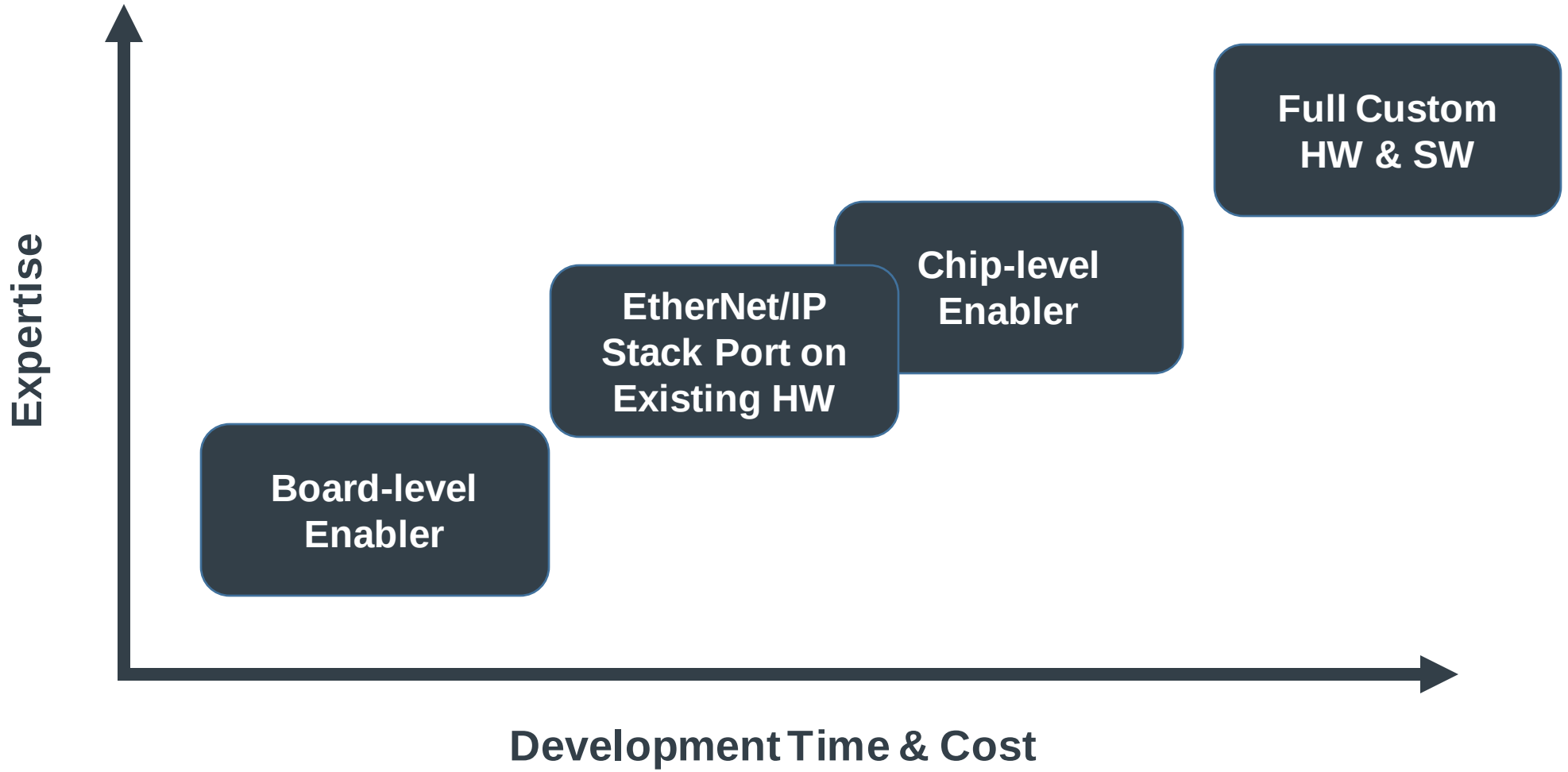
EtherNet/IP Stack Considerations

- When purchasing …
  - Ensure stack has features you require for your application
  - Ensure stack passes most recent version of EtherNet/IP conformance test
  - Ensure stack supports interoperability recommendations and passes PlugFest interoperability testing
  - Always get source code
  - Stacks are generally optimized for platform portability; ask how the stack can be optimized for performance
  - Ask for RAM/ROM footprints to make sure it fit your needs/limits
  - Ask for performance data; there are no benchmarks standards for EtherNet/IP stacks

Make vs. Buy Considerations

- How do you decide which implementation approach is most suitable?
  - Are your EtherNet/IP functional requirements general in nature or very specialized to your product's application
  - What is your time-to-market requirement?
  - What is your development budget?
  - What is your product cost target?
  - Do you have the relevant background and experience?
    - Hardware development
    - Ethernet communications
    - TCP/IP protocol suite
    - Embedded device development
    - CIP and EtherNet/IP knowledge
  - Do you have the resources to support and maintain the product?

Make vs. Buy Considerations



Enabler Product Selection Considerations

- Product must meet your cost and functional requirements
- Product should have passed conformance testing or is being used in a product that has passed conformance testing
- Vendor must have a proven field track record
- Product should have passed interoperability testing
- Vendor should be an ODVA Member and have made a commitment to supporting EtherNet/IP technology
  - Significant experience with CIP and EtherNet/IP
  - Participates in SIGs, Roundtables or seminars
  - Keeps the product current to the specification
  - Can assist you with end-user product support

EtherNet/IP Enabling Technologies

- Check the ODVA Marketplace online at marketplace.odva.org for EtherNet/IP enabling technology providers and products:
  - Developer training
  - Developer services
  - Development and testing tools
  - Embedded interface boards
  - Chip level solutions
  - I/O Adapter stack source code
  - I/O Scanner stack source code
  - Gateways
  - PCI cards
  - IP67 EtherNet/IP-compliant connectors

Thank you! Next session:

- EtherNet/IP Quick Start Session 3: Product Design and Testing: Tomorrow at 8:00 am – 10:00 am US Eastern

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