ODVA INDUSTRY CONFERENCE 20TH ANNUAL MEETING

CIP Security and IEC-62443-4-2

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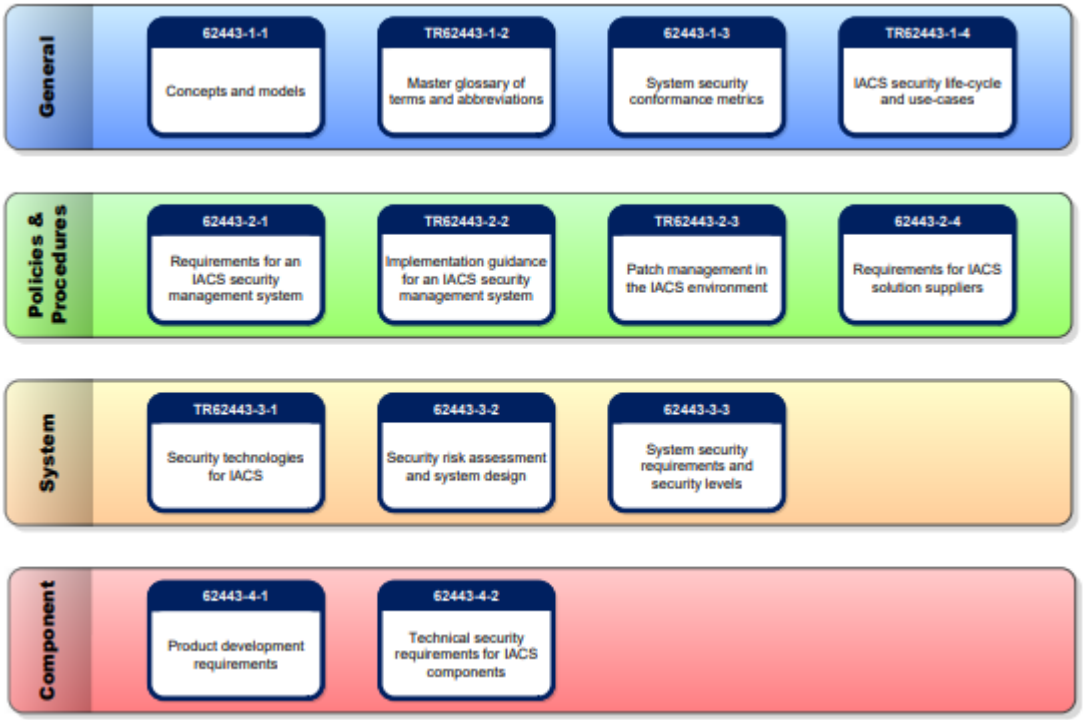
Introduction

- CIP Security is the ODVA standard for securing CIP and EtherNet/IP
- How does CIP Security fit in with IEC 62443?
  - First, some background on IEC 62443
  - Then some background on CIP Security Profiles
  - Discussion on how CIP Security meets some 62443 requirements

IEC 62443

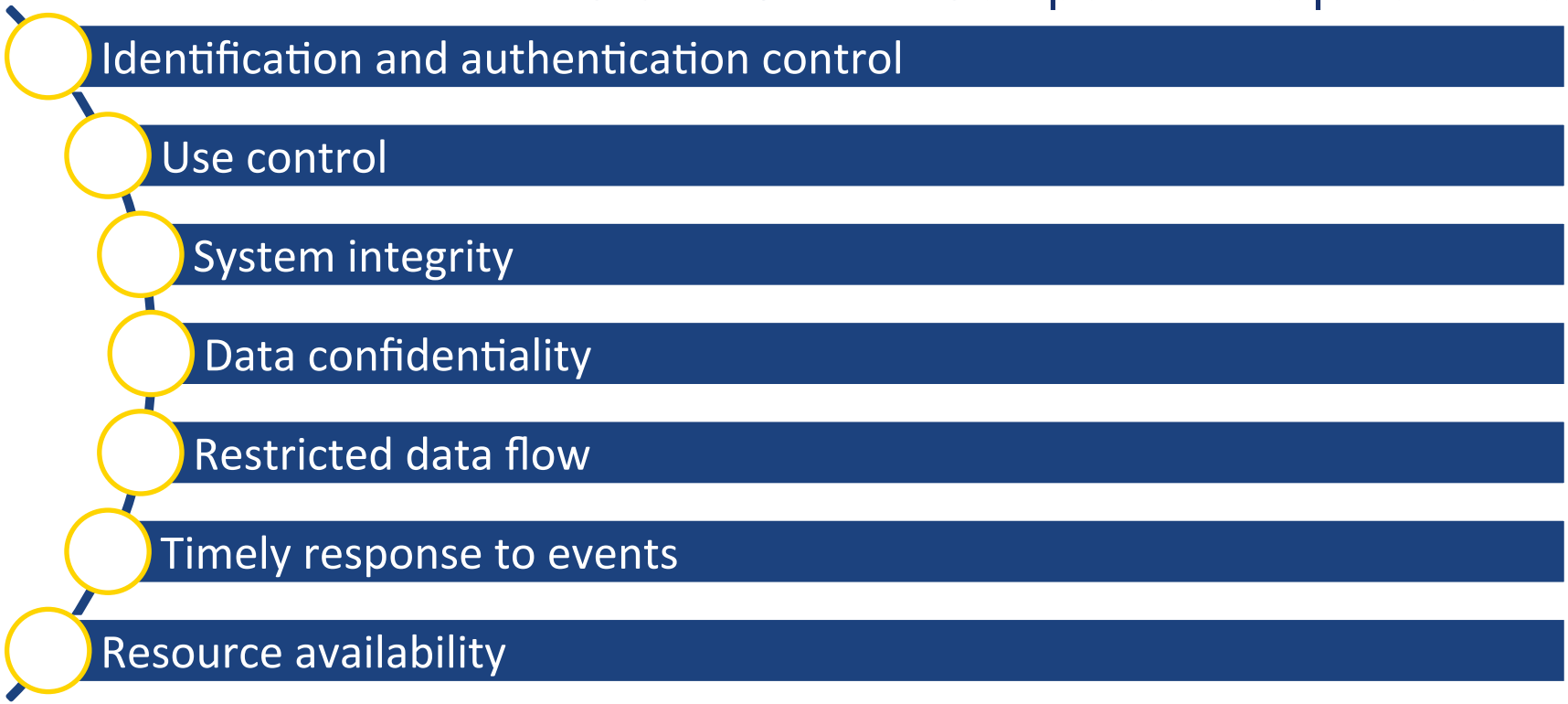
- International standard that is gaining a lot of traction within the industry
- Focus is on security of industrial automation systems
- Many parts, covers a wide variety of areas
- Focus for us is on component requirements



IEC 62443

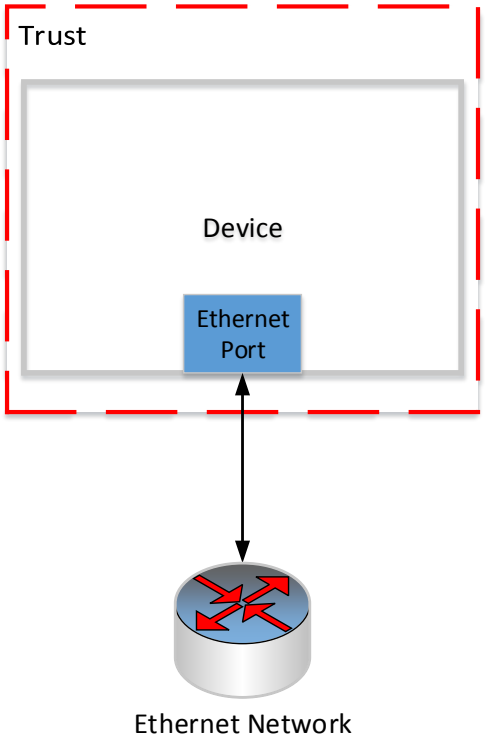
- For a component, IEC 62443-4-1 defines how a product is developed
  - Important, but out of the scope of the paper
- IEC 62443-4-2 defines functional requirements for a component
  - Here a component could be a device, software, product, etc…
- IEC 62443 contains levels of security, one through four
  - SL 1 – Focused on actors who unintentionally cause security events
  - SL 2 – Focused on attackers with basic skills and resources
  - SL 3 – Focused on advanced attackers with moderate resources
  - SL 4 – Focused on the highest level of attackers with significant skills and resources
- **IEC 62443 defines *what* you have to do, not *how* you have to do it**

IEC 62443-4-2 – Component Requirements



CIP Security as an answer for IEC 62443

- CIP Security can be used to meet a number of the IEC 62443 requirements
- What is meant by CIP Security? Well, we have to make some assumptions
  - Assume a simple device, one Ethernet port, implements CIP Security EtherNet/IP Confidentiality Profile and CIP Security User Authentication Profile
  - Let's draw the trust boundary like shown
    - Data coming in/going out the Ethernet port is crossing a trust boundary
  - Small changes in product structure can have a big effect on the security case, take note that **careful, individual analysis is needed**



CIP Security: EtherNet/IP Confidentiality Profile

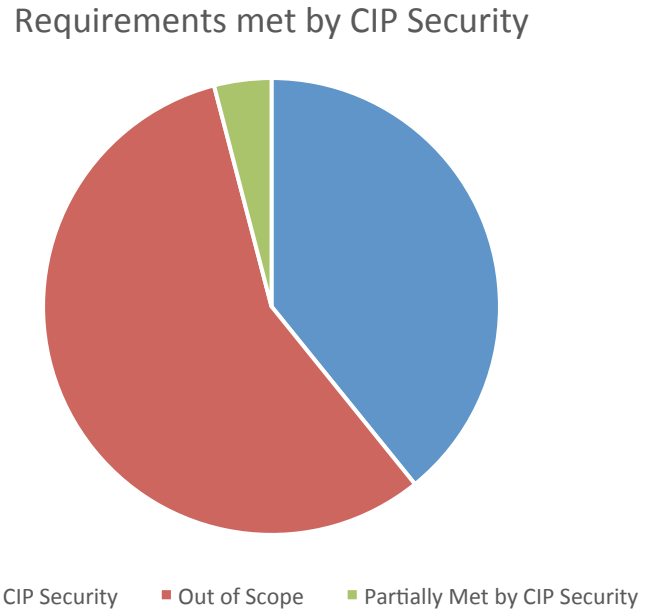
- Built on IETF standard technologies, ubiquitous in communication sec
  - Secure communications via TLS (messaging) and DTLS (I/O)
  - Certificate management via CIP and EST
- Security Properties:
  - Authentication of the endpoints – ensuring that the target and originator are both trusted entities. End point authentication is accomplished using X.509 certificates or pre-shared keys.
  - Message integrity and authentication – ensuring 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.

CIP Security User Authentication Profile

- Again, built on standard technologies
  - OAuth 2.0, JWTs, and OpenID Connect
- Authentication and Authorization of humans, devices, and software processes
- Central identity management for integration with IT system, local identity management for simple OT systems
- Supports multifactor authentication and various workflows via OpenID Connect

Coverage

- With these two profiles, many items are covered
  - Nearly 50% of the total requirements are either fully met or partially met
  - Many items out of scope cannot be covered by a communications protocol



Wait, so CIP Security is less than 50% Coverage?

- Although we are showing requirements coverage, not all requirements are "equal work items"
  - A given requirement might be very complex or fairly straightforward
  - Many requirements are in disparate areas (e.g. internal structure of the hardware versus integration with software tools)
- It would not be realistic to expect a communication protocol to cover all 62443 requirements
  - Despite this, CIP Security provides significant coverage
  - CIP Security provides a strong solution for relevant requirements

Some Examples

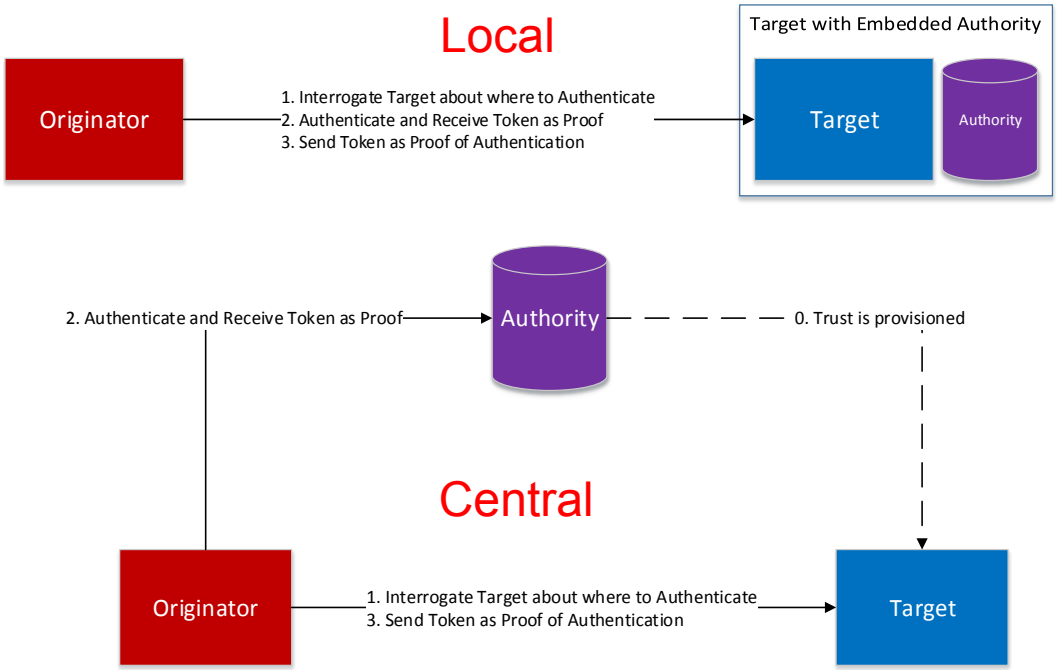
- Given the number of requirements, we can't go through all of them in the allotted time
- However, we have chosen a few that we felt were illustrative and/or interesting for the audience
- You can always read our paper if you want to know about a specific requirement or all the requirements ☺

CR 1.1 – Human user identification and authentication

- Requirement deals with identification of humans using industrial equipment
- Met via CIP Security User Authentication Profile
  - Authentication for humans and non-humans via tokens (JWT)
- Two Requirement Enhancements:
  - Unique identification and authentication
    - With User Authentication Profile, each user has a unique identity via the ‘sub’ claim of the JWT
  - Multifactor authentication on all interfaces
    - Integrating with an OpenID Connect system provides for multifactor authentication

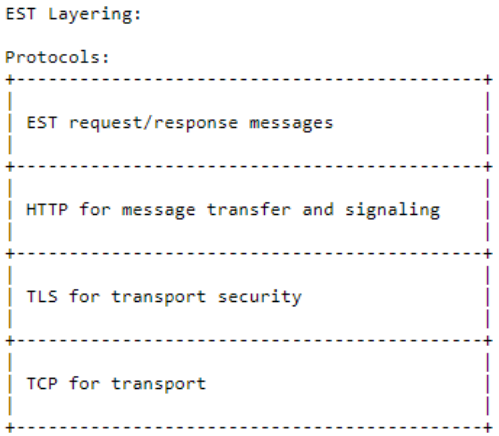
CR 1.3 – Account management

- Accounts can be managed centrally or locally with CIP Security User Authentication Profile
  - Locally involves just the device managing the accounts
  - Centrally involves integrating into a 3rd party identity management system



CR 1.8 – Public Key Infrastructure and Certificates

- Certificates can be managed over CIP, or via EST
- EST allows native integration with IT certificate management
- Certificates are standard X.509, used for TLS and DTLS, furthering the IT/OT integration
- CIP Security fully integrates into a PKI for certificate management

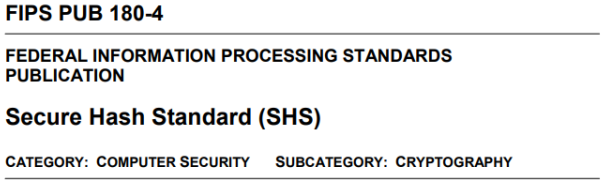


CR 2.1 – Authorization enforcement

- CIP Security User Authentication Profile implements access policy via standard roles
  - These can be extended with general “claims” within the JWT
  - Standard roles can also be extended if necessary
  - Groups for policy enforcement also supported (via ‘aud’ claim)
- Two Requirement Enhancements
  - Authorization enforcement for all users
    - Once User Authentication is set up it is enforced for all users
  - Permission mapping to role
    - Specification gives mandatory permissions and suggested permissions for roles
      - Spec would not be able to mandate access to all attributes and services for all products, given the wide range of CIP products

CR 3.1 – Communication integrity

- TLS and DTLS cipher suites use Message Authentication Code via SHA-2 HMACs for protection of the data
- One requirement enhancement
  - Communication authentication
    - Same reasoning, HMACs from TLS and DTLS protect the authenticity of the data
- SHA-2 suite is widely recognized as a best-in-class algorithm for data protection



FIPS PUB 180-4

FEDERAL INFORMATION PROCESSING STANDARDS PUBLICATION

Secure Hash Standard (SHS)

CATEGORY: COMPUTER SECURITY SUBCATEGORY: CRYPTOGRAPHY

CR 3.12 – Provisioning product supplier roots of trust

- CIP Security provides the option of including a “Vendor Certificate”, that is, a unique cryptographic identity signed by the vendor with the associated root of trust for the signing CA
  - This is an 802.1AR IDevID
- This partially meets the CR 3.12 requirement
  - It is up to the vendor to store this securely within the product, ODVA does not “conformance test” hardware secure key storage
  - It is up to the vendor to use the Vendor Certificate and root of trust for enabling security functions beyond just CIP Security (e.g. secure updates)

CR 4.1 – Information confidentiality

- Confidentiality of information in transit over EtherNet/IP is covered by CIP Security EtherNet/IP Confidentiality Profile
  - TLS and DTLS provide the option to encrypt the data
  - Mandatory to support cipher suites for CIP Security use AES CBC for data protection
- However, CIP Security only covers the data while in transit
  - While at rest the data may also need to have confidentiality applied, this aspect is outside the scope of CIP Security

CR 4.3 – Use of cryptography

- CIP Security is built on open, well-used, and well-vetted standards like TLS, DTLS, EST, OAuth 2.0, OpenID Connect
- Cryptography from these technologies includes algorithms recognized by international standards bodies and best-in-class
  - AES
  - SHA
  - ECC
  - RSA

Out of Scope

- What are some of the things that are out of scope?
  - Logging is a big item; there are a number of requirements around logging
  - EtherNet/IP System Architecture SIG has discussed possible standardization of Syslog
    - This would be in line with the strategy to use well-known, well-vetted technologies
    - With the addition of Syslog support several other requirements would also be covered
    - SIG will be investigating this in the coming year
- Internal product structure
  - E.g. Secure Boot, Secure Storage, Physical Interface Management, etc.)
  - These items are not possible for a communications standard to cover
- DoS protections
  - This deals with internal product structure and communications layers below CIP and EtherNet/IP (e.g. IP Storm)

Summary of mappings

- CIP Security uses best in class security technology to meet a number of IEC 62443 requirements
- Our hope is that this paper is an aid to ODVA members wanting to certify to IEC 62443 products/systems that implement CIP Security

Met by CIP Security	• 29
Partially Met by CIP	• 3
Out of scope for CIP Security	• 42

Questions?

- **Are there any questions or further discussion?**
- **You can contact us later if questions arise, through the SIG forum or other means**
    - If you are a vendor interested in security, consider joining the EtherNet/IP System Architecture SIG and the CIP Security Working Group

THANK YOU!!!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