AsIf: Asset Interface Analysis of Industrial Automation Devices

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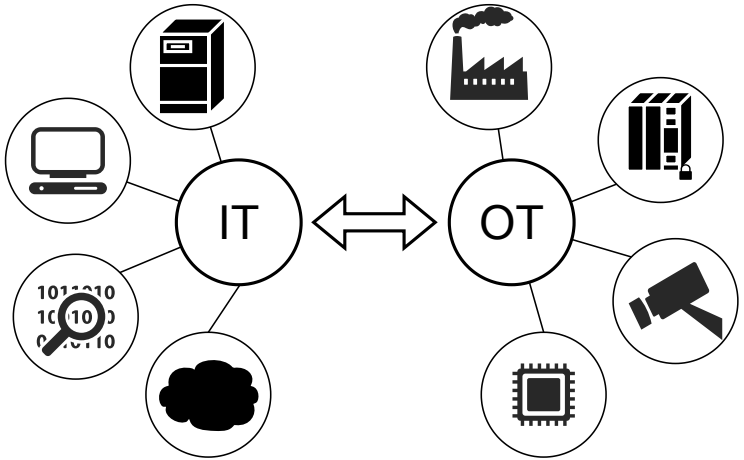
OT is not IT

Information Technology

- is for the cyber space
- examples are personal computer, office

Operational Technology

- is for the physical space
- examples are chemical, transportation, manufacturing, defense, ...



OT is about distributed, realtime, embedded, cyber-physical systems

Industrial Automation Systems


Internet, Cloud

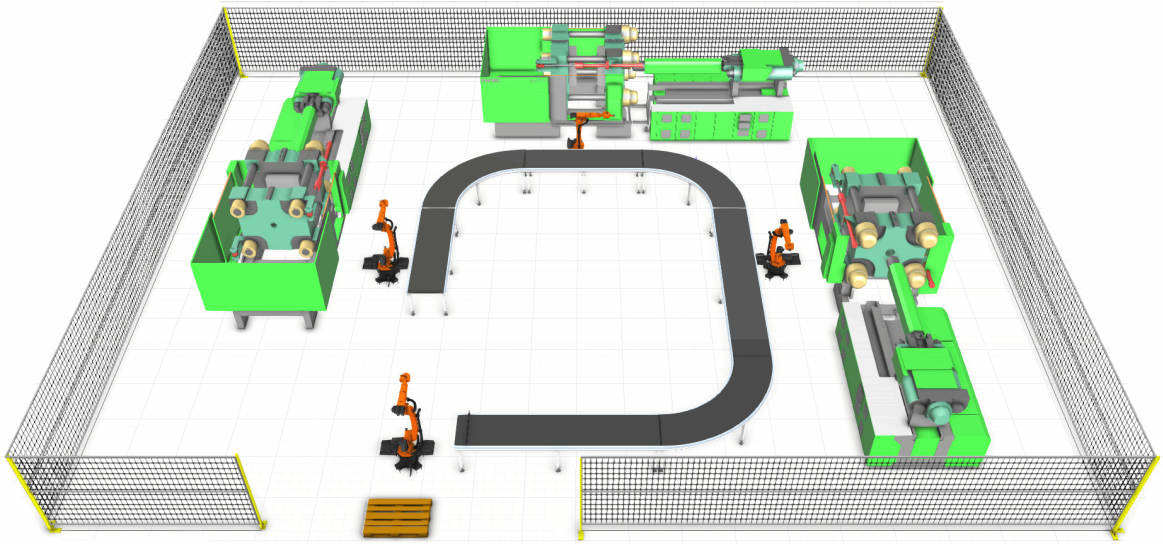

Business Planning


Plant DMZ


Monitoring & Control

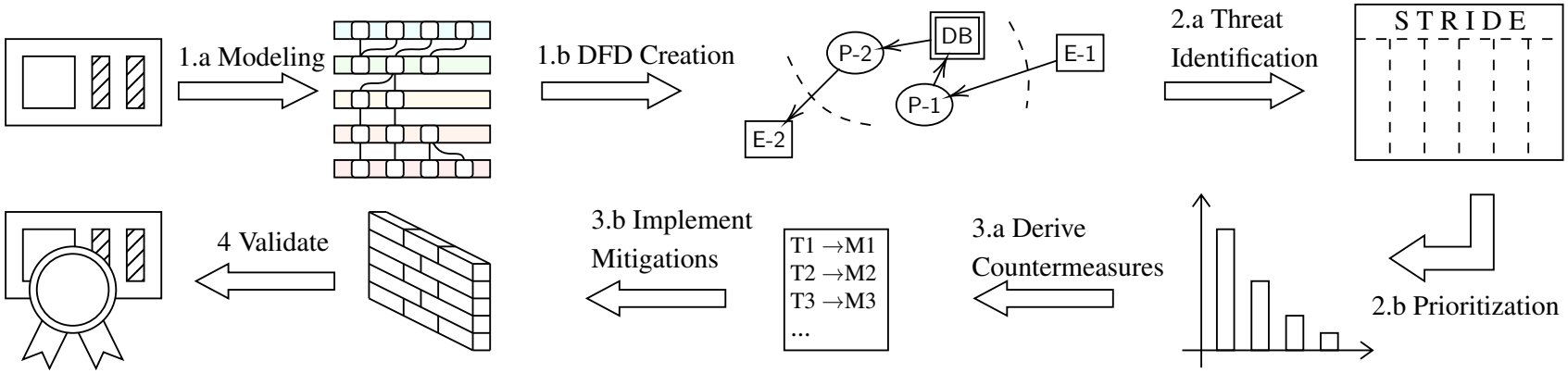

Programmable Logic Controllers


Sensors, Actuators



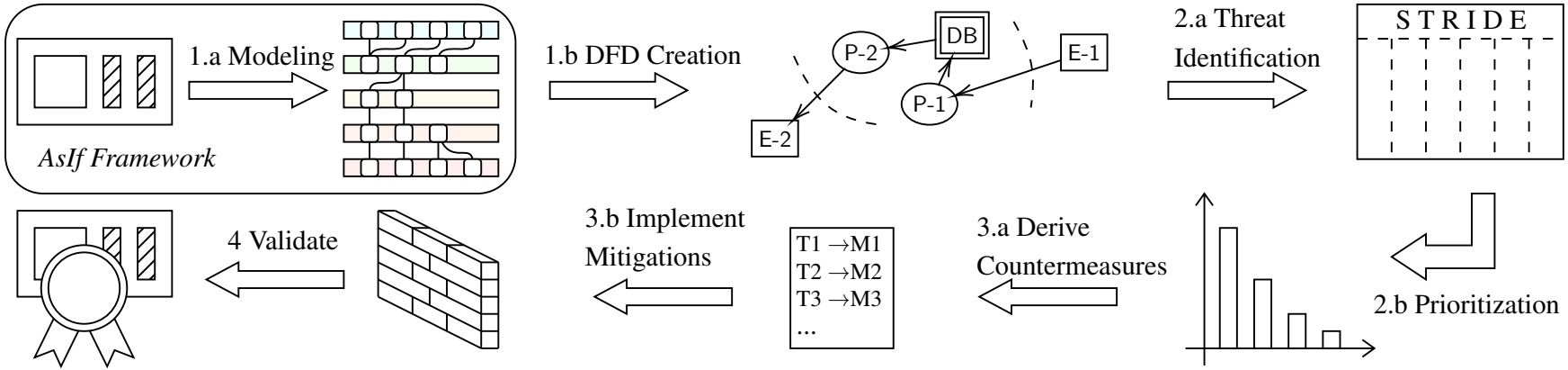
With Industry 4.0, CPS are more connected and have become viable targets for cyber attacks.

Threat modeling supports threat identification (detection)

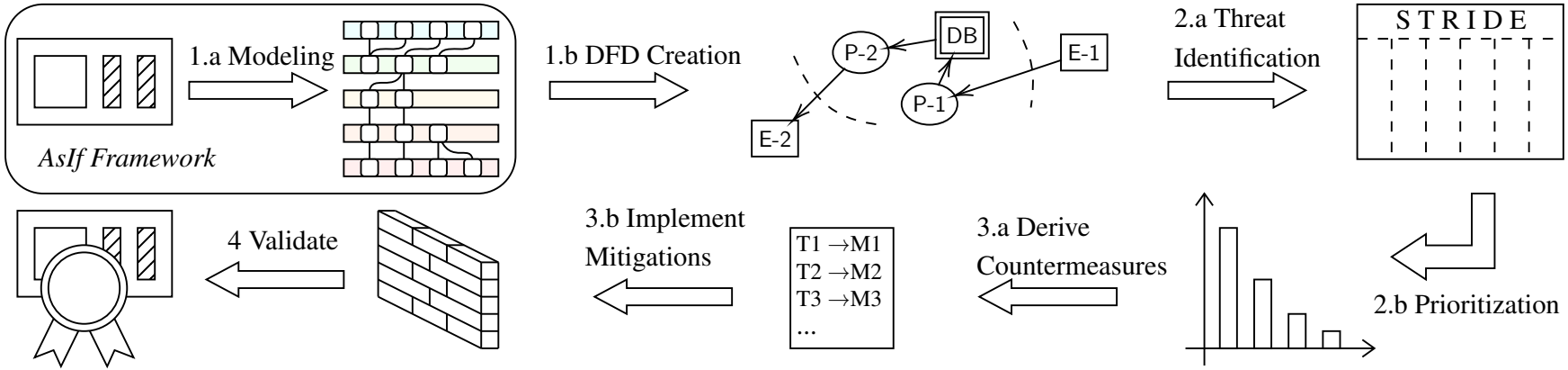


- Modeling and asset identification is often done through semi-structured meetings and brainstorming [Ysk+20]; [Sho14]
- Studies using STRIDE used different ways to model the system [Saß+24]

Threat modeling supports threat identification (detection)



Threat modeling supports threat identification (detection)



- **RQ.1** How can we effectively address the challenges of exhaustively modeling OT systems?
- **RQ.2** What are the current industrial perspectives on threat modeling practices and their impact on security posture?

- ISO/OSI model as guidance for modeling
- Identify assets in a bottom-up approach
- Visualise dependencies between interfaces – (*Interface Tree*)
- Infer data flow diagrams (DFDs) from the interface trees

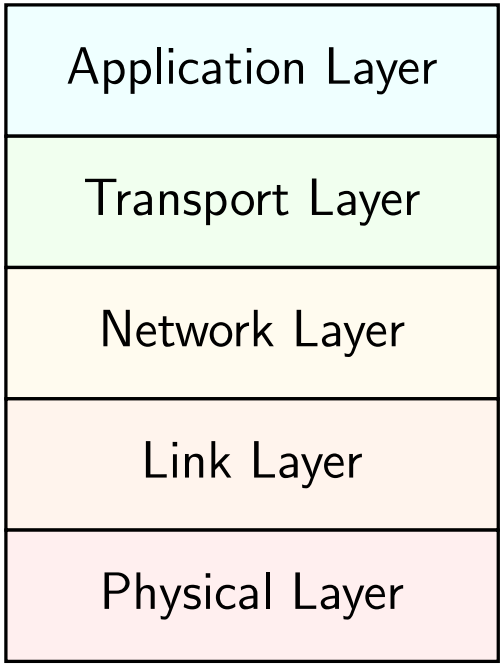


Figure: Hybrid TCP/IP model by Tanenbaum [TW10].

- step-by-step methodology
- offers systematic and exhaustive analysis
- provides a better understanding of the system
- physical interfaces will not be overlooked

This is important, as

- interconnection of machines is a central aspect of modern, industrial automation[1].
- interfaces are typically entry points for attacks

[1] Interconnection is also a central aspect of *Industry 4.0* [HPO16]

Aslf Interface Analysis

Interfaces are identified layer-by-layer:

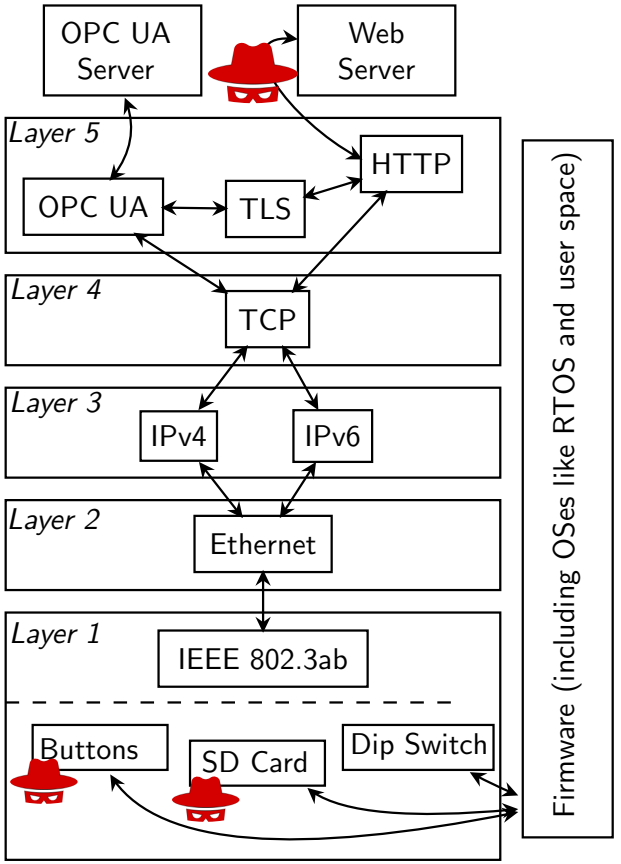
Layer	**Exemplary Methods***
Application Layer	Individually, based on the transport layer results from `Nmap` scan and `tcpdump` for open TCP & UDP ports
Transport Layer	`Nmap` scan for supported IP protocols
Network Layer	`Wireshark` and `tcpdump` traffic analysis
Link Layer	Derived from Physical Layer
Physical Layer	Physical inspection

*Note, based on the environment, further methods may be useful.

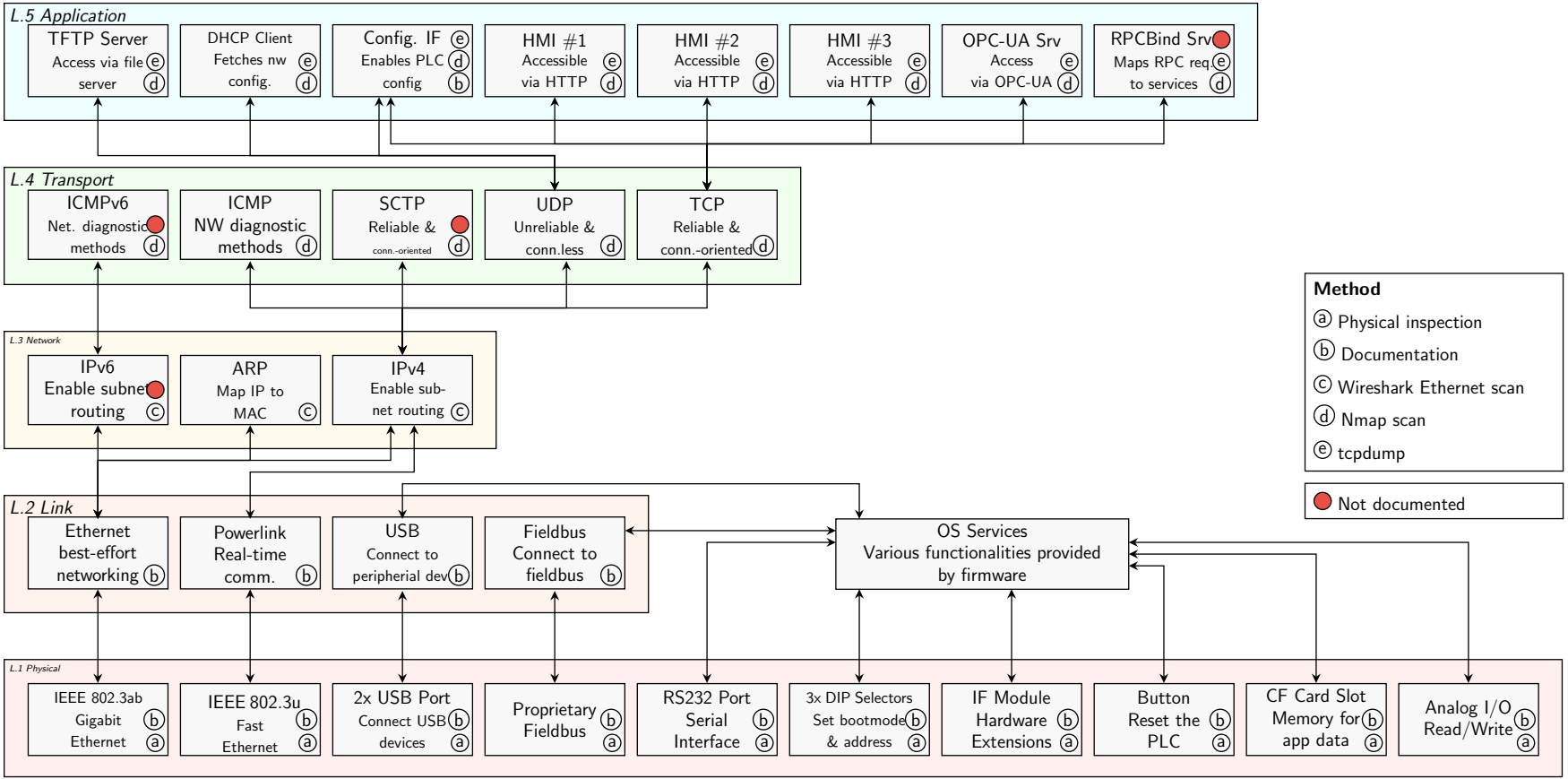
- Results are visualised as **Interface Tree**.

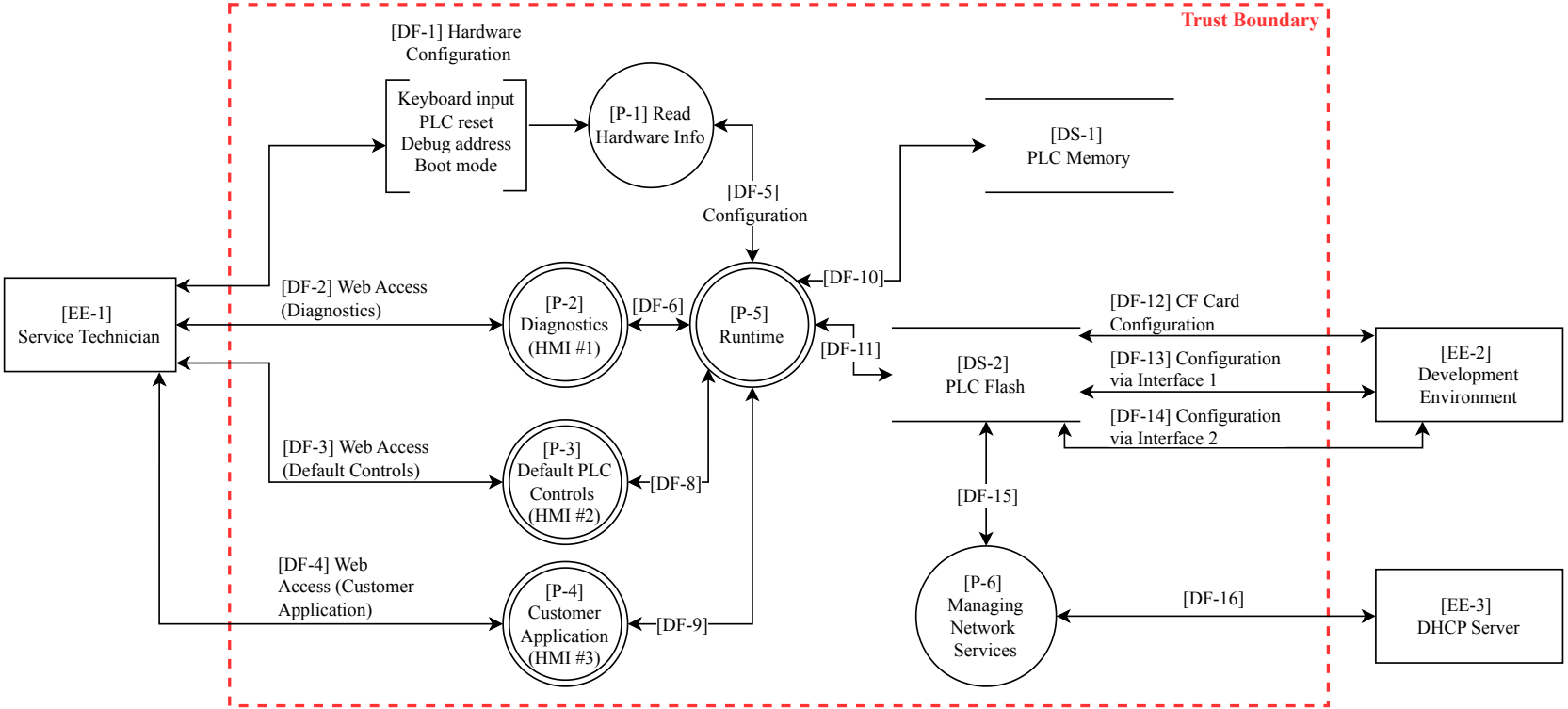
Aslf Interface Tree

- Start with the lowest level
- Identify accessible hardware interfaces, e.g., buttons, storage media, debug interfaces
- connect the interfaces, e.g., Ethernet enables IPv4 and IPv6 in the upper layer
- on top, an OPC UA server and web servers are running



Aslf Interface Tree




Trust Boundary
[DF-1] Hardware Configuration
Keyboard input
PLC reset
Debug address
Boot mode
[P-1] Read Hardware Info
[DS-1] PLC Memory
[DF-5] Configuration
[EE-1] Service Technician
[DF-2] Web Access (Diagnostics)
[P-2] Diagnostics (HMI #1)
[DF-6]
[P-5] Runtime
[DF-10]
[DF-11]
[DF-12] CF Card Configuration
[DF-13] Configuration via Interface 1
[DF-14] Configuration via Interface 2
[DS-2] PLC Flash
[EE-2] Development Environment
[DF-3] Web Access (Default Controls)
[P-3] Default PLC Controls (HMI #2)
[DF-8]
[DF-15]
[DF-4] Web Access (Customer Application)
[P-4] Customer Application (HMI #3)
[DF-9]
[P-6] Managing Network Services
[DF-16]
[EE-3] DHCP Server

How is Industry Perceiving Threat Modeling?

Facts about the questionnaire:

- Video[2] introducing Aslf
- 22 Questions[3]
- three parts: (i) background of participants, (ii) security in industrial systems, (iii) Aslf evaluation
- target group works in R&D at a company within the industrial systems domain

[2] https://www.youtube.com/watch?v=2GpFI3XDmgA

[3] https://doi.org/10.5281/zenodo.11201810

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- three parts: (i) background of participants, (ii) security in industrial systems, (iii) AsIf evaluation
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- 12 respondents ranging from automation, research, security consulting, and production
- Overwhelmingly positive feedback

[2] https://www.youtube.com/watch?v=2GpFI3XDmgA

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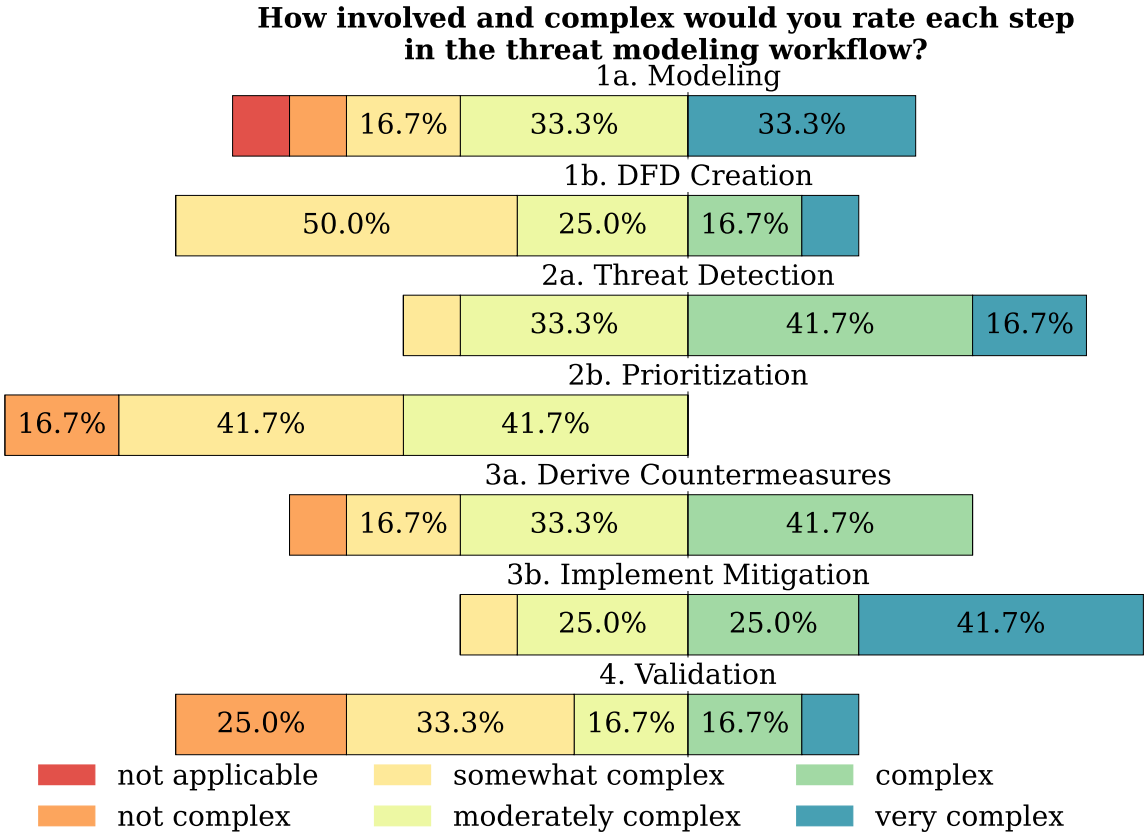
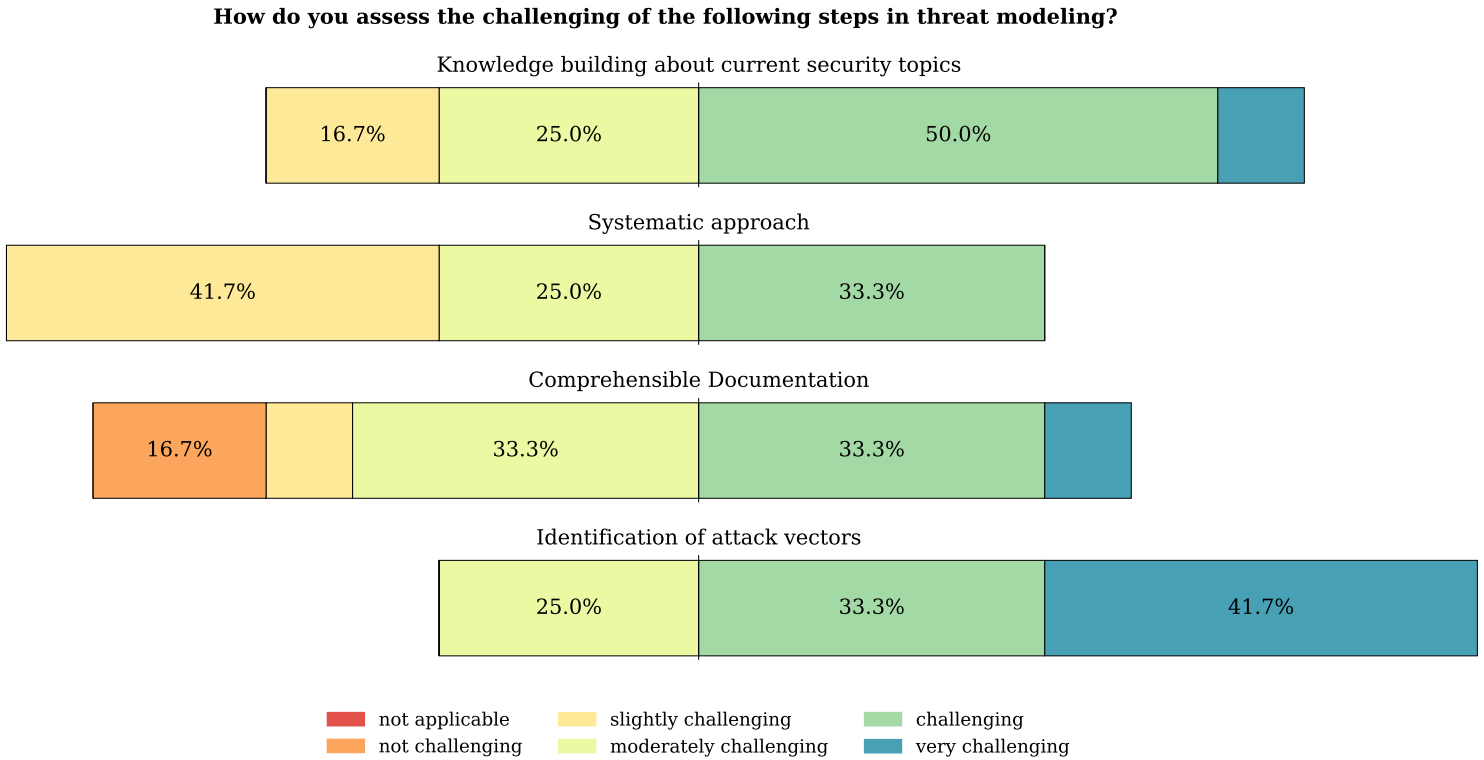
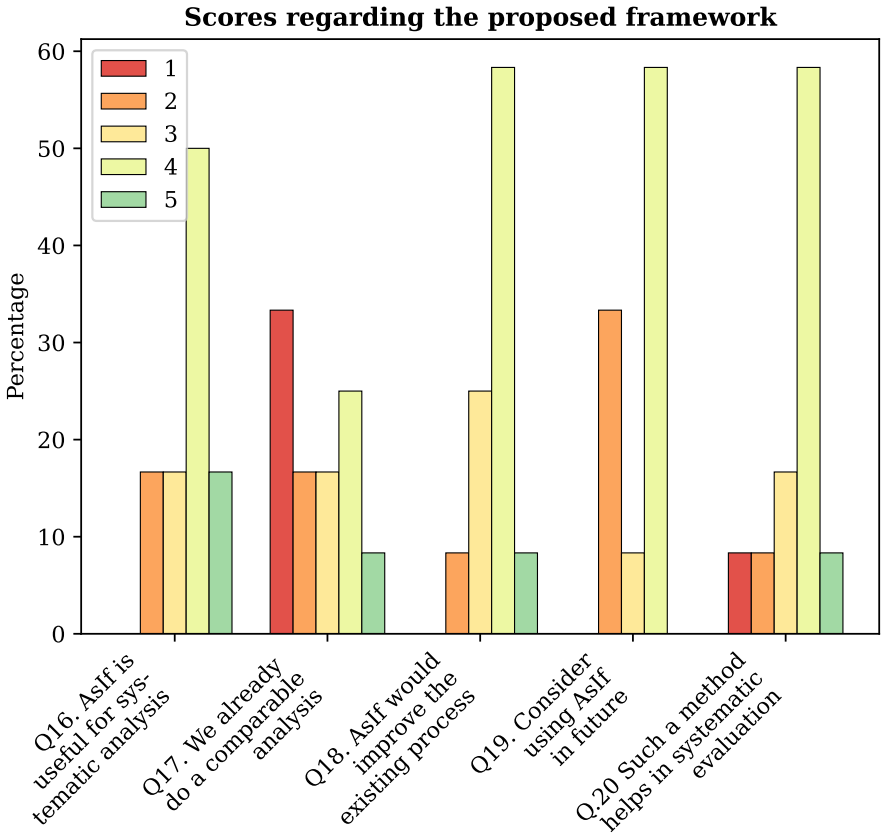

How involved and complex would you rate each step in the threat modeling workflow?
1a. Modeling
16.7%
33.3%
33.3%
1b. DFD Creation
50.0%
25.0%
16.7%
2a. Threat Detection
33.3%
41.7%
16.7%
2b. Prioritization
16.7%
41.7%
41.7%
3a. Derive Countermeasures
16.7%
33.3%
41.7%
3b. Implement Mitigation
25.0%
25.0%
41.7%
4. Validation
25.0%
33.3%
16.7%
16.7%
not applicable
not complex
somewhat complex
moderately complex
complex
very complex

How is Industry Perceiving Threat Modeling?

Where the challenges lie

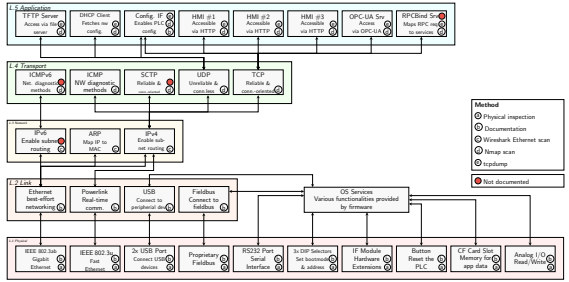


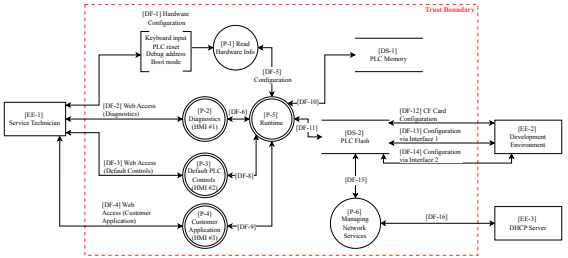
Response to the AsIf Framework



Asset Interface Identification (ASIF)

- method to find and model interfaces (physical & virtual)
- the hybrid TCP/IP model supports a structured approach
- layer-by-layer collection of the interfaces and their dependencies
- visualisation of dependencies between interfaces (*Interface Tree*)
- interface trees as a platform for discussions, and
- foundation for data flow diagrams (DFDs)





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