Series Editor
Jean-Paul Bourrières

Cybersecurity of Industrial Systems

Jean-Marie Flaus

Color section

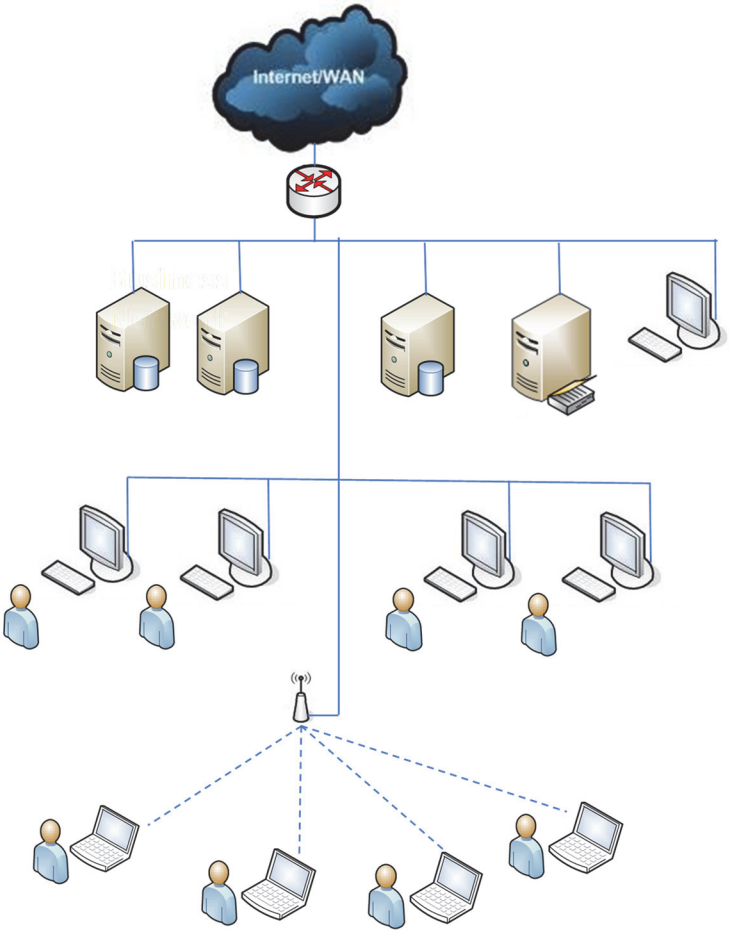


Figure 1.1. *Information system*

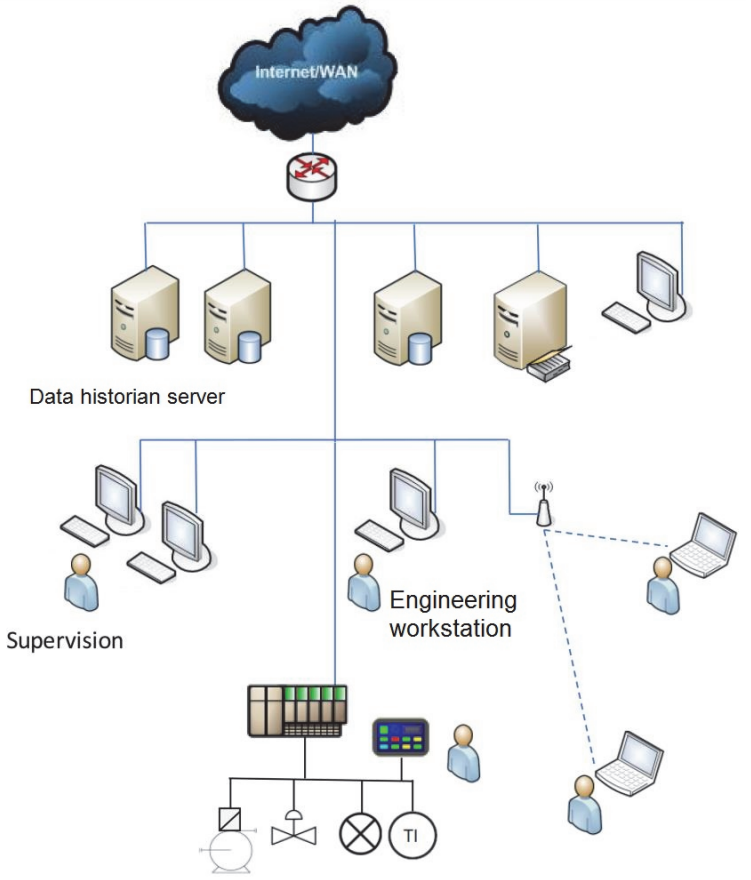


Figure 1.2. *Industrial information system*

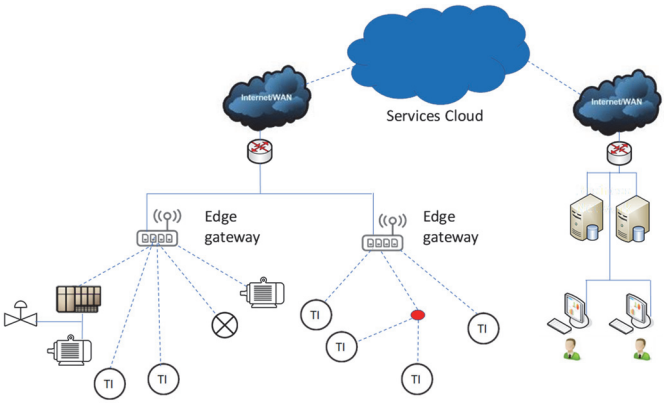


Figure 1.3. *IIoT information system*

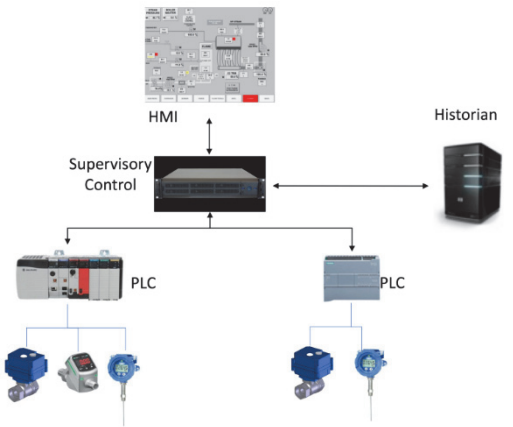


Figure 1.4. *The minimal functions of a SCADA*

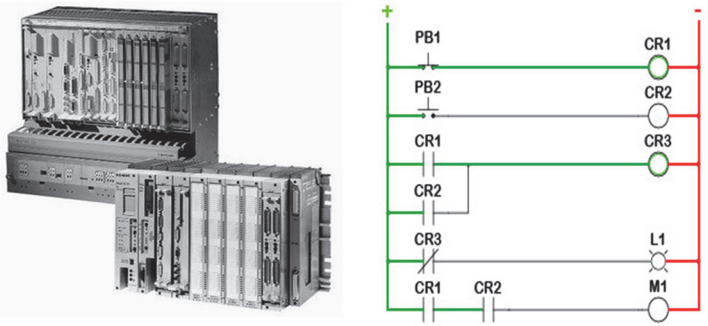


Figure 1.5. *Allen Bradley – Modicon 084*

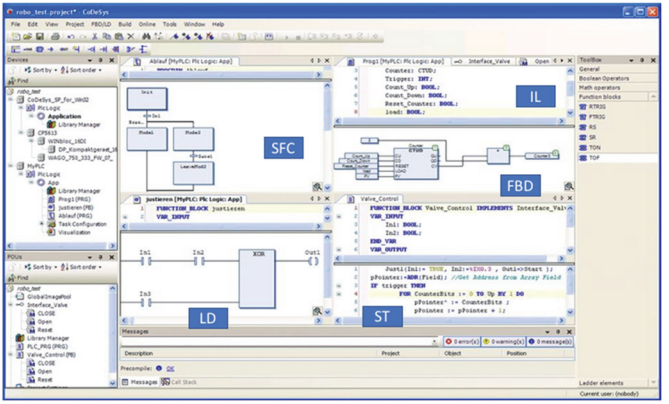


Figure 1.9. *Programming languages IEC 61131/3*

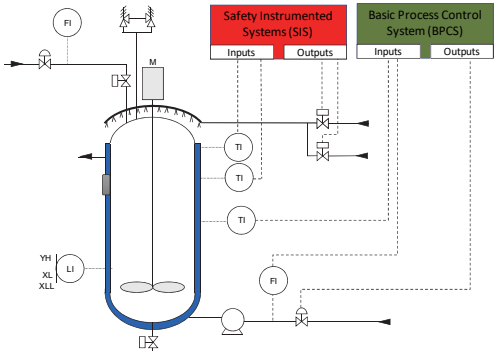


Figure 1.10. *Safety instrumented system (SIS)*

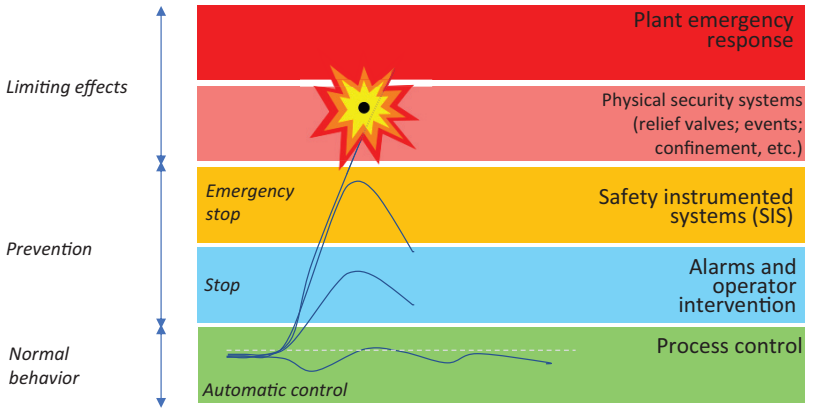


Figure 1.11. *The position of the SIS in terms of protection level*

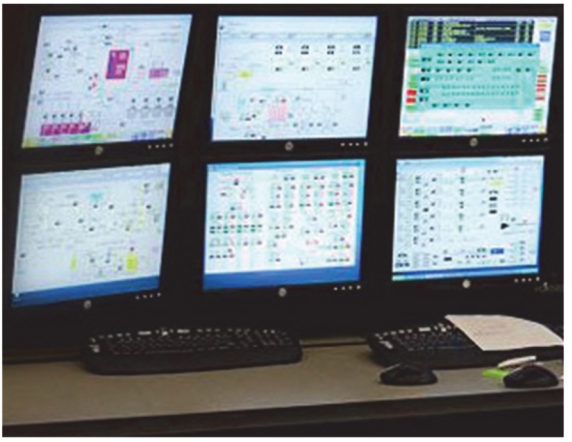


Figure 1.12. *HMI on PC*

Figure 1.13. *Dedicated unit for HMI*

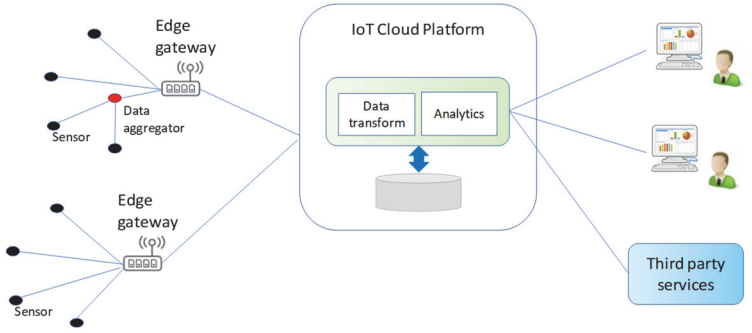


Figure 1.14. *IoT platform*

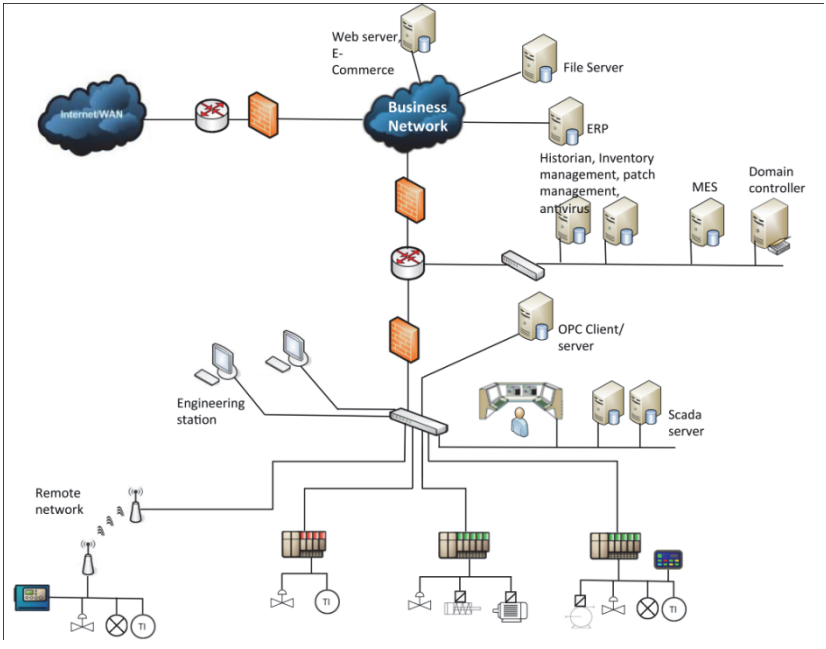


Figure 2.1. *Typical ICS architecture*

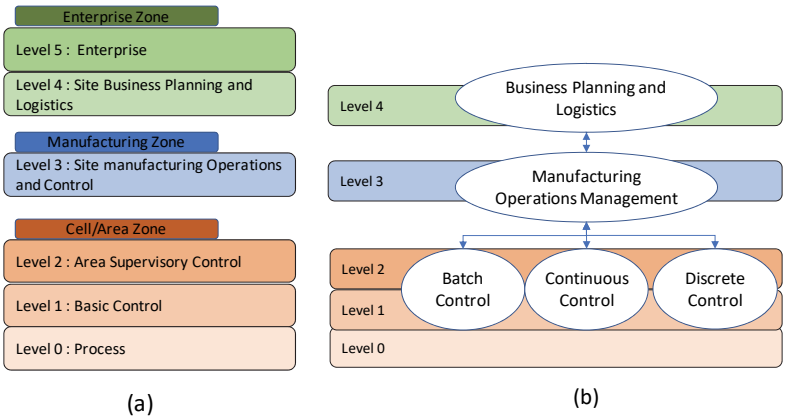


Figure 2.2. *(a) Purdue and (b) ISA85 models*

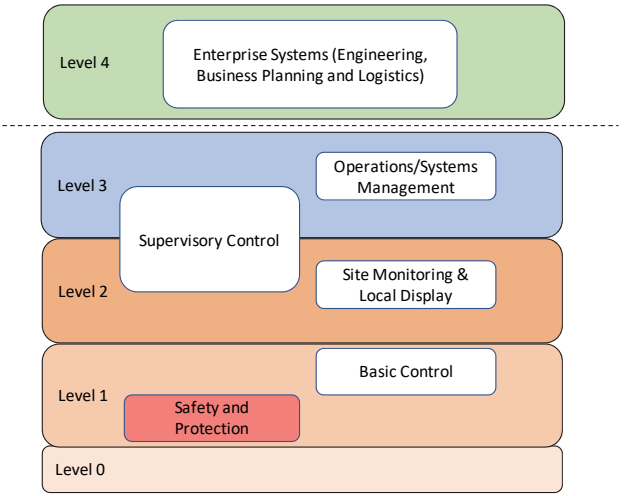


Figure 2.3. *IEC 62443 model*

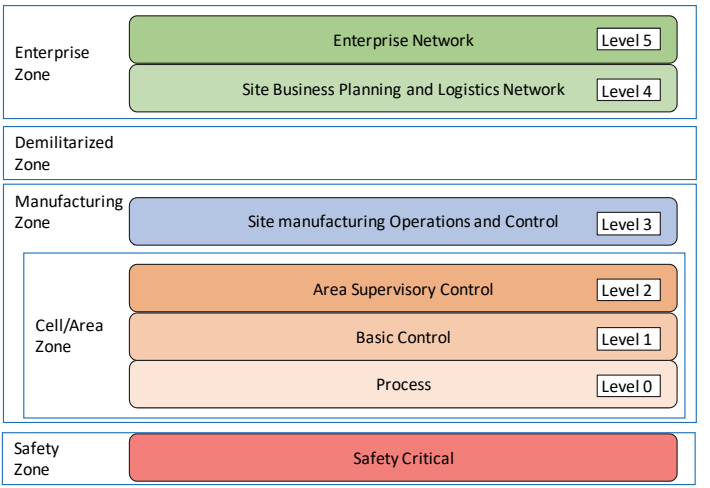


Figure 2.4. *Converged Plantwide Ethernet (CPwE) model*

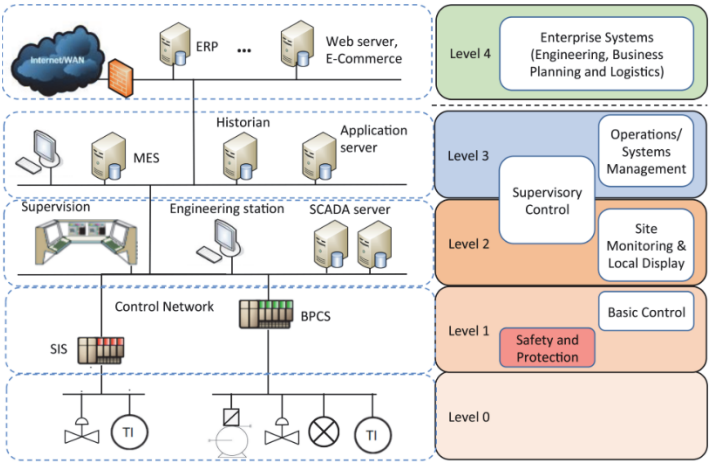


Figure 2.5. *Model of the previous installation according to the CIM architecture*

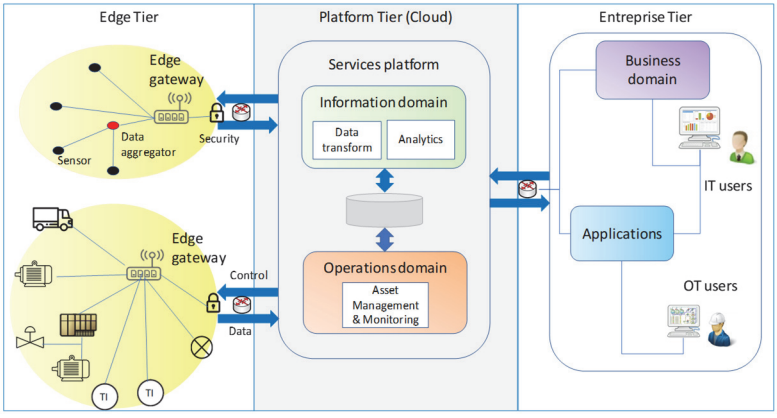


Figure 2.6. *IIoT architecture*

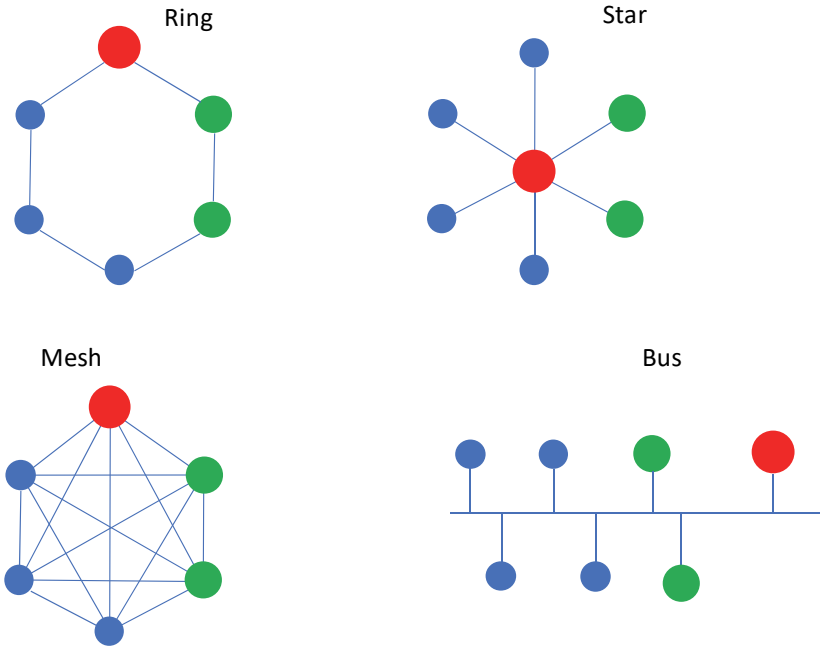


Figure 2.7. *Classic network topologies*

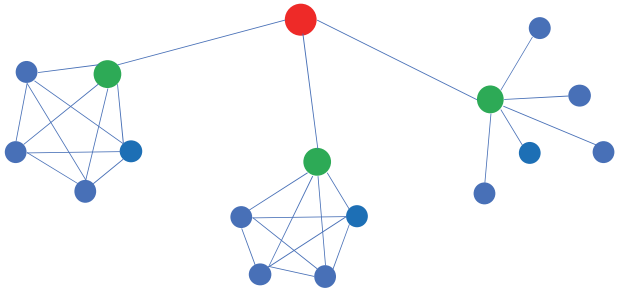
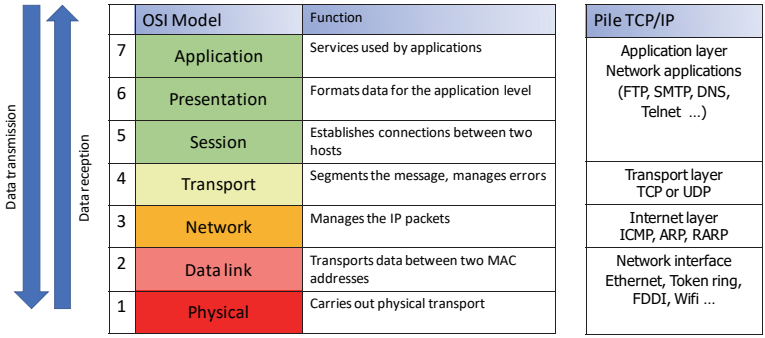


Figure 2.8. *Mixed network topology (IIoT)*



	OSI Model	Function
7	Application	Services used by applications
6	Presentation	Formats data for the application level
5	Session	Establishes connections between two hosts
4	Transport	Segments the message, manages errors
3	Network	Manages the IP packets
2	Data link	Transports data between two MAC addresses
1	Physical	Carries out physical transport

Pile TCP/IP
Application layer Network applications (FTP, SMTP, DNS, Telnet ...)
Transport layer TCP or UDP
Internet layer ICMP, ARP, RARP
Network interface Ethernet, Token ring, FDDI, Wifi ...

Figure 2.9. *OSI models and TCP/IP stack*

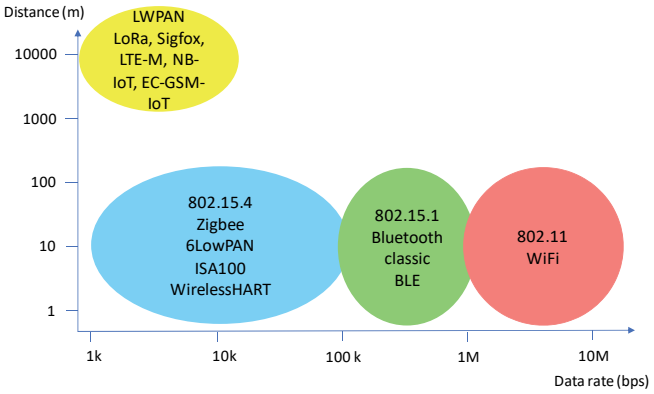


Figure 2.10. *Different wireless communication solutions*

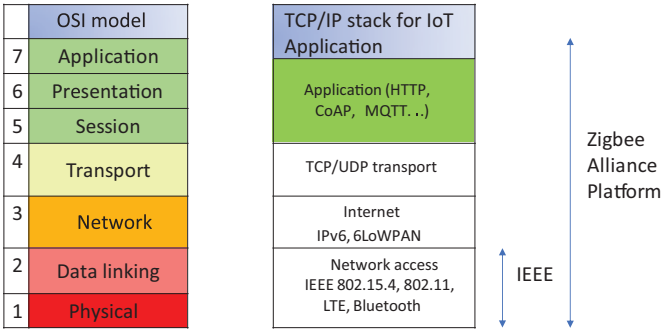


Figure 2.11. *IIoT protocols and OSI model*

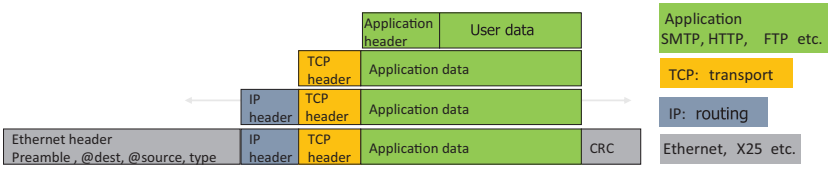


Figure 2.12. *Data packages*

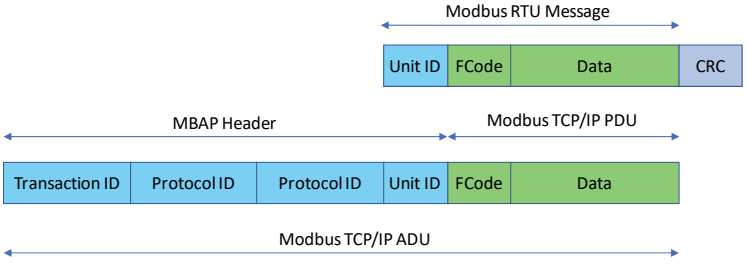


Figure 2.17. *Modbus frame*

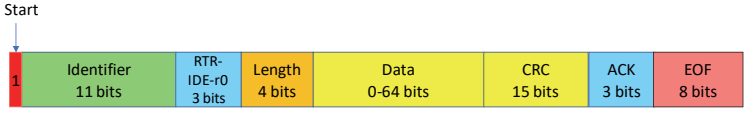


Figure 2.19. *CAN frame*

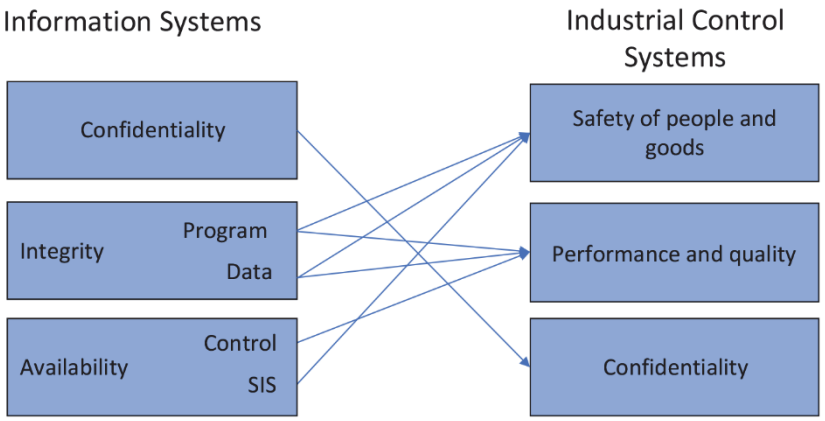


Figure 3.1. *Security needs of IS and ICS*

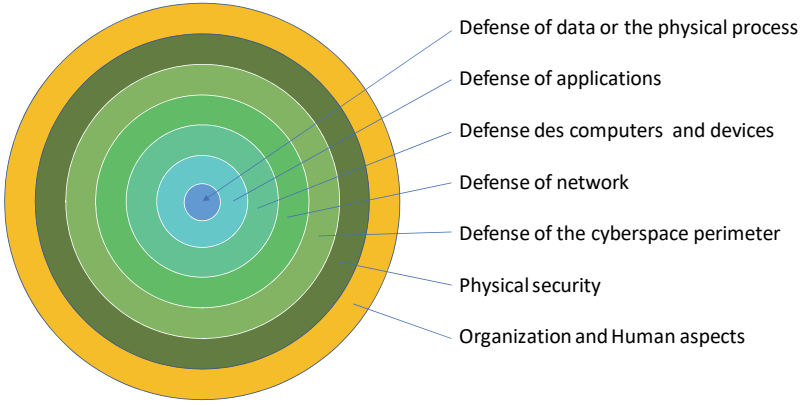


Figure 3.2. *The different layers of IT security*

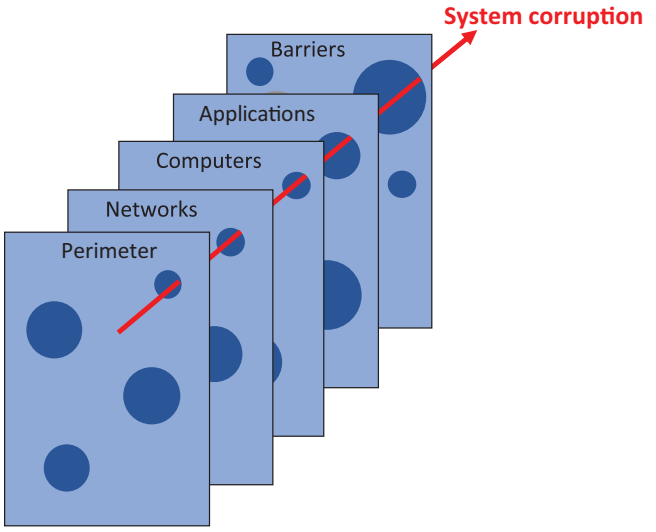


Figure 3.3. *Swiss cheese adapted to IT security*

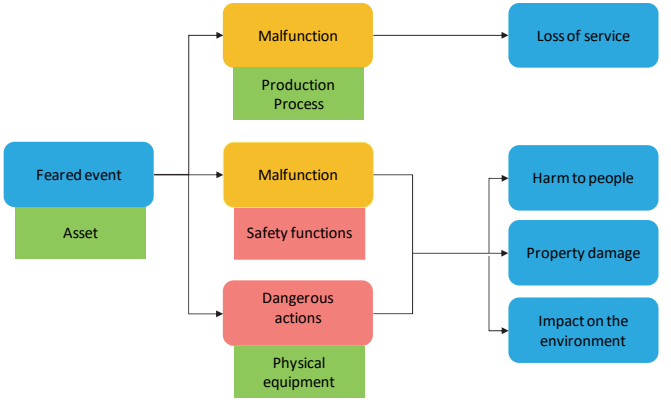


Figure 3.7. *Different types of impacts*

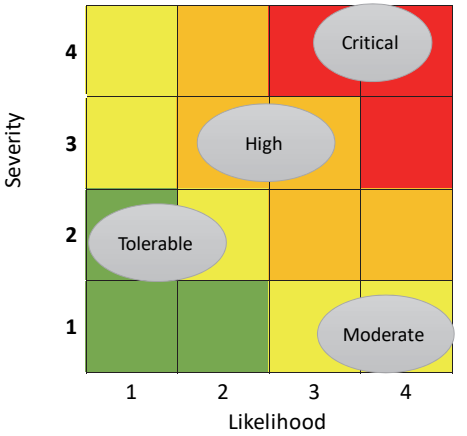


Figure 3.8. *Risk matrix or heat map*

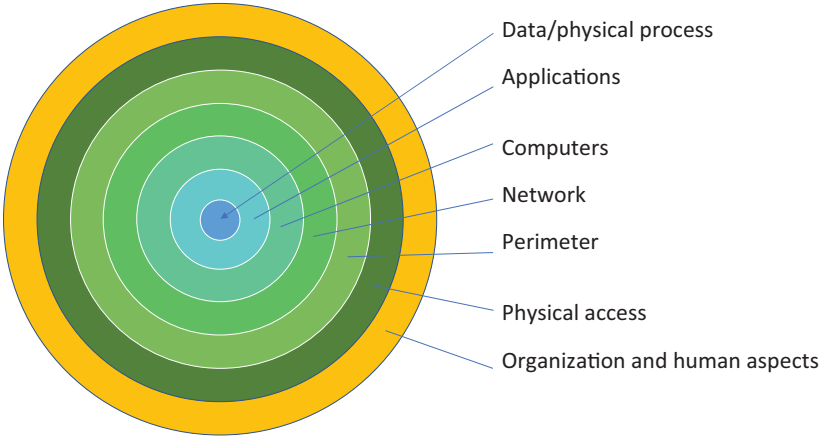


Figure 3.10. *Defense in depth*

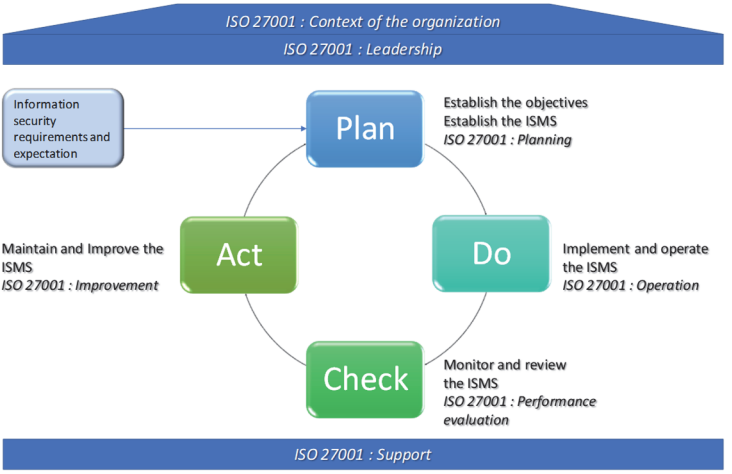


Figure 3.11. *Continuous improvement PDCA and ISO 27001:2013*

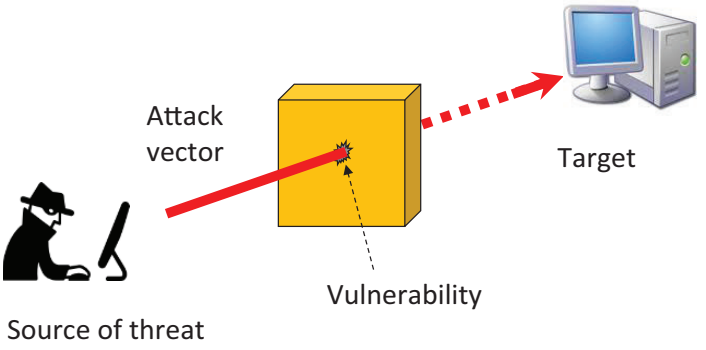


Figure 4.1. *Vector of attack and vulnerability*

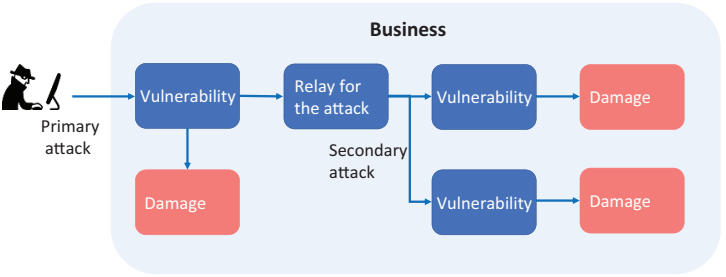


Figure 4.2. *Primary and secondary attacks*

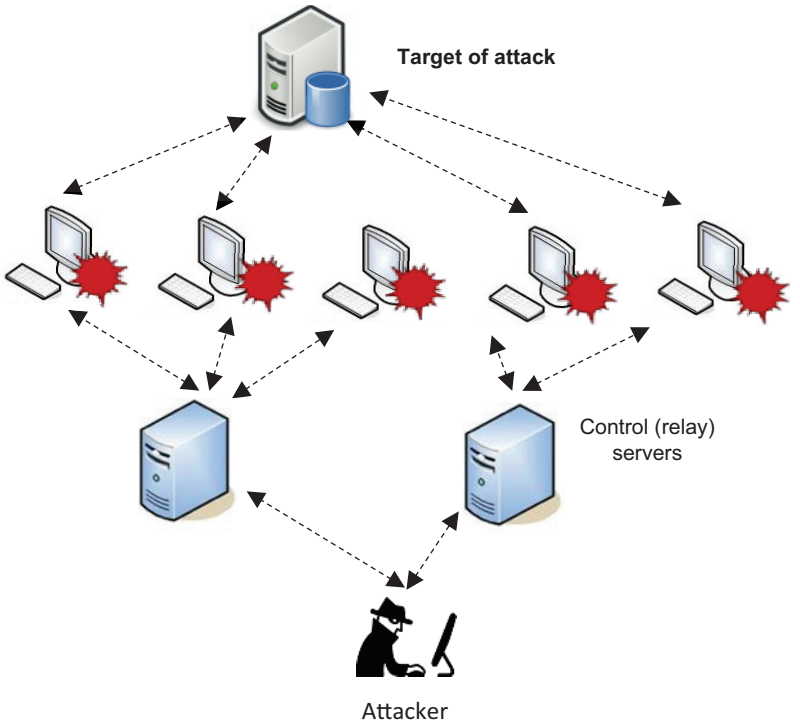


Figure 4.3. *DDoS attack by a botnet*

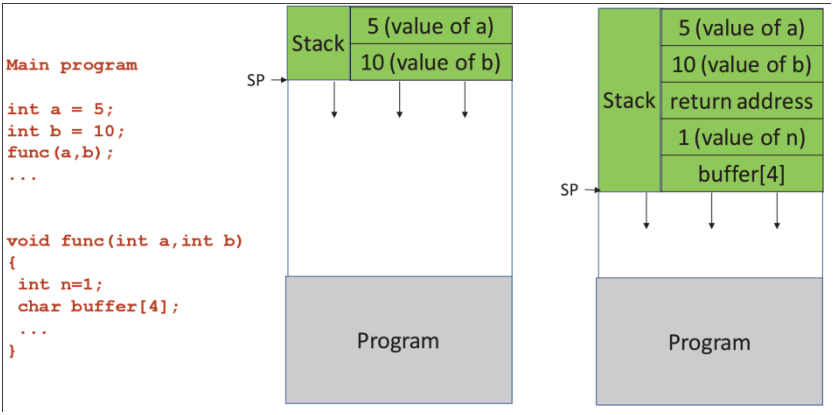


Figure 4.5. *Attack by buffer overflow*

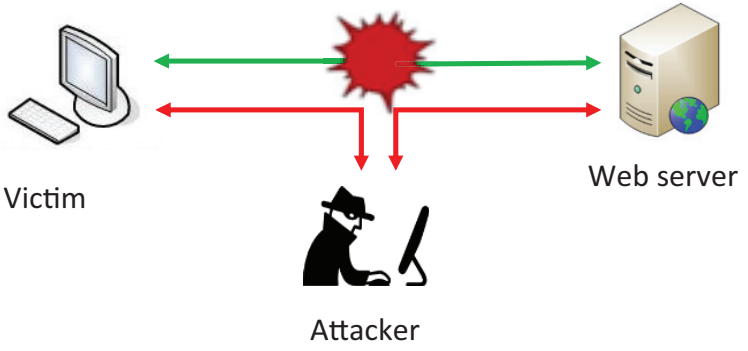


Figure 4.7. *MitM attack*

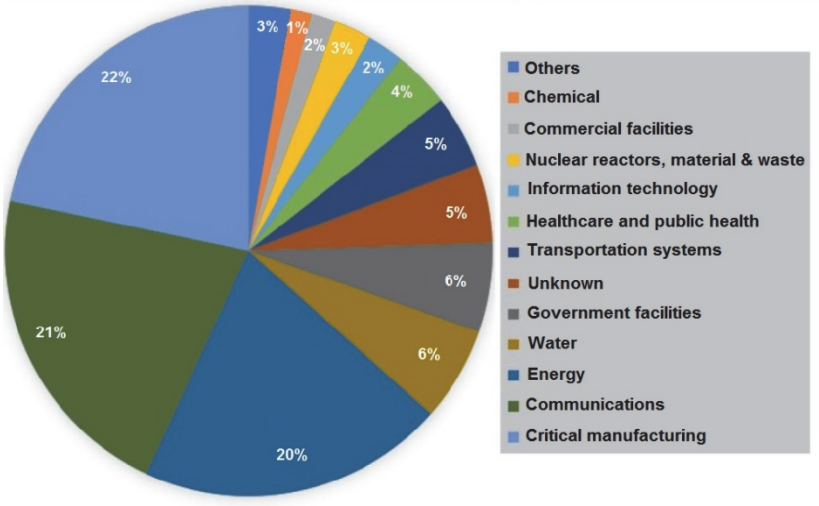


Figure 4.9. *Sectors affected by attacks*

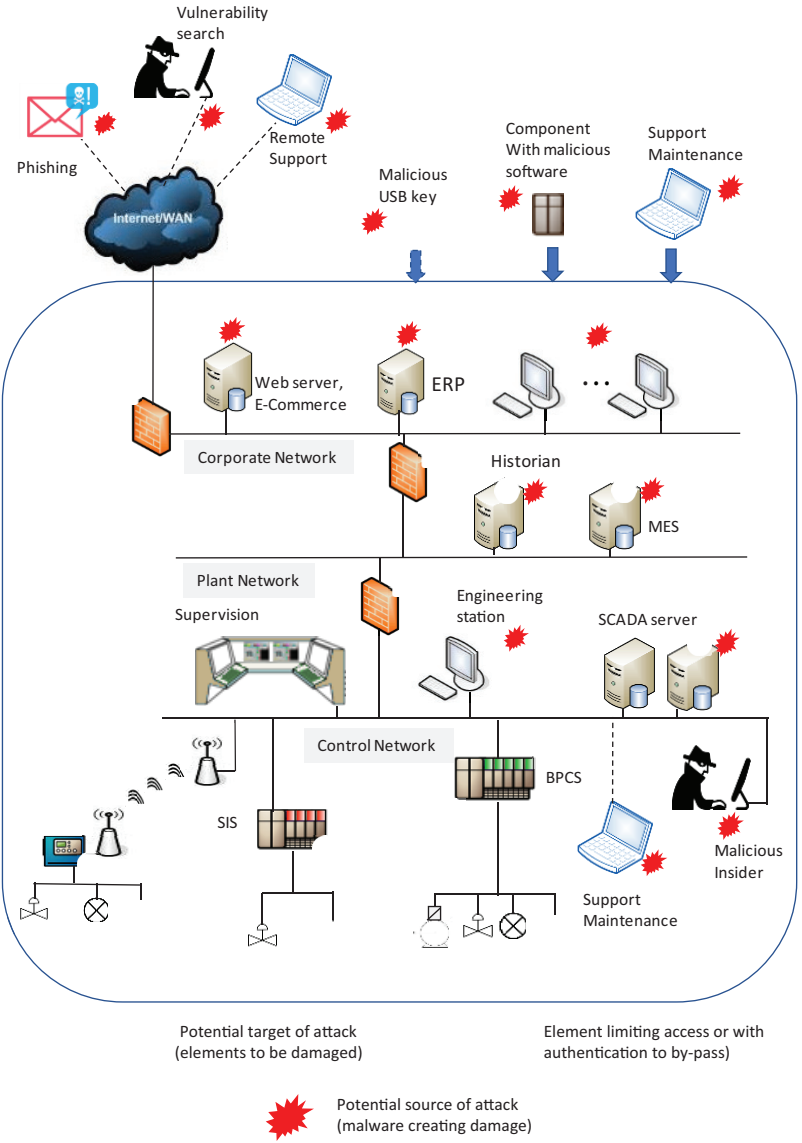


Figure 5.3. *Attack surface of an ICS*

Figure 5.6. *Answer to CSET questions screen*

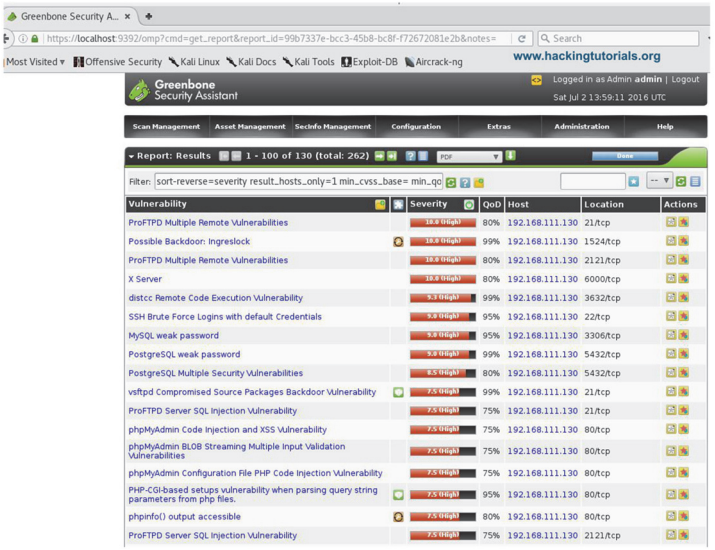


Figure 5.7. *Example of OpenVAS analysis*

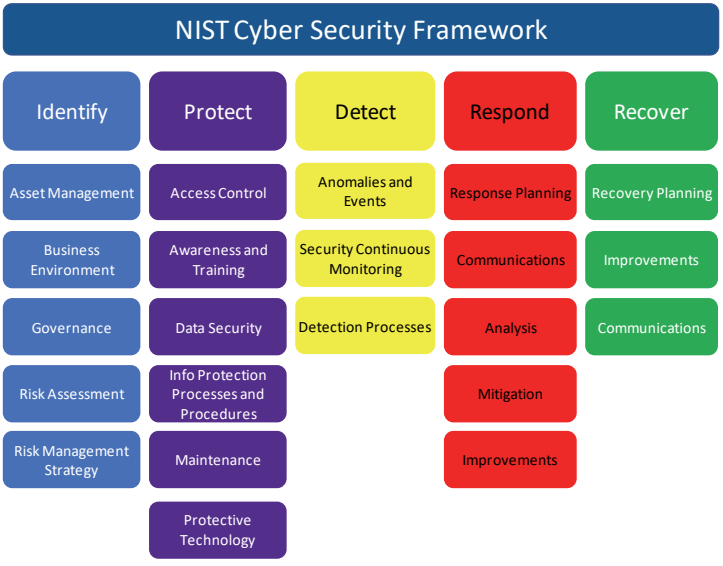


Figure 6.4. *Structure of the NIST framework*

IDENTIFY	ID.AM	Asset Management
	ID.BE	Business Environment
	ID.GV	Governance
	ID.RA	Risk Assessment
	ID.RM	Risk Management Strategy
	ID.SC	Supply Chain Risk Management
PROTECT (PR)	PR.AC	Identity Management, Authentication and Access Control
	PR.AT	Awareness and Training
	PR.DS	Data Security
	PR.IP	Information Protection Processes and Procedures
	PR.MA	Maintenance
	PR.PT	Protective Technology
DETECT (DE)	DE.AE	Anomalies and Events
	DE.CM	Security Continuous Monitoring
	DE.DP	Detection Processes
RESPOND (RS)	RS.RP	Response Planning
	RS.CO	Communications
	RS.AN	Analysis
	RS.MI	Mitigation
	RS.IM	Improvements
RECOVER (RC)	RC.RP	Recovery Planning
	RC.IM	Improvements
	RC.CO	Communications

Figure 6.5. *Structure of the NIST Framework*

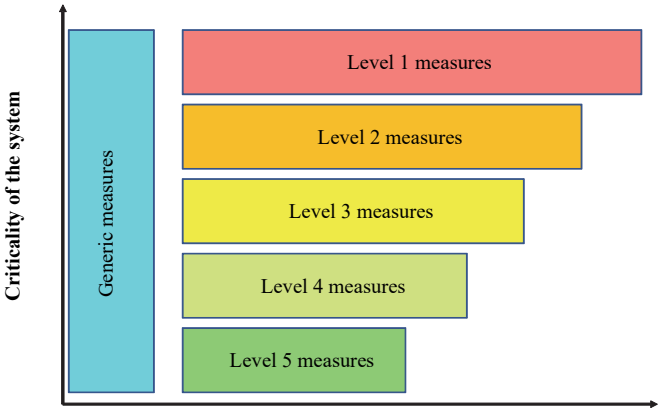


Figure 6.6. *Gradual approach*

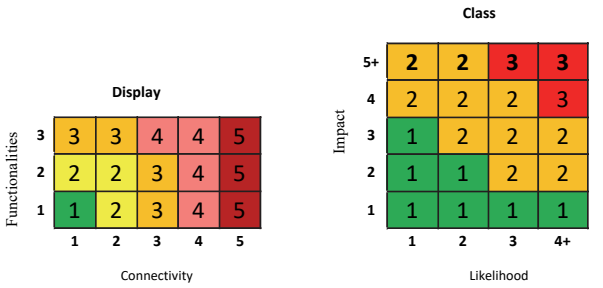


Figure 6.8. *Matrix to determine exposure level and class*

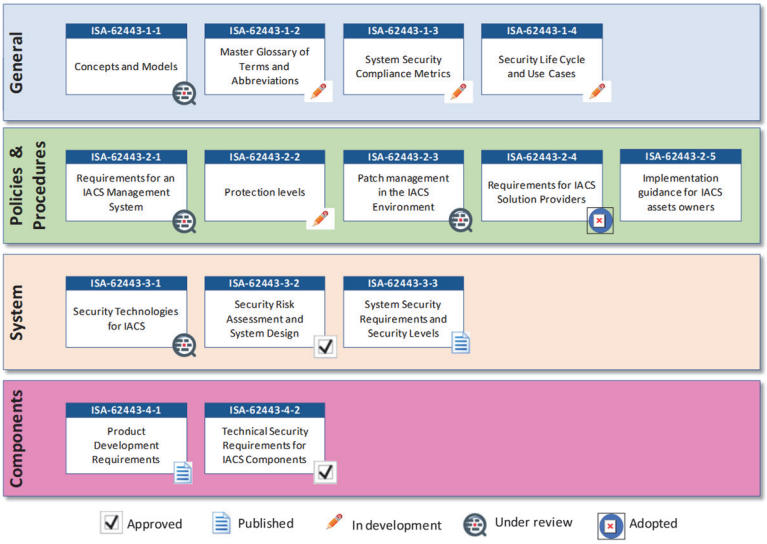


Figure 7.4. *Structure of the IEC 62443 (7/2018) standard*

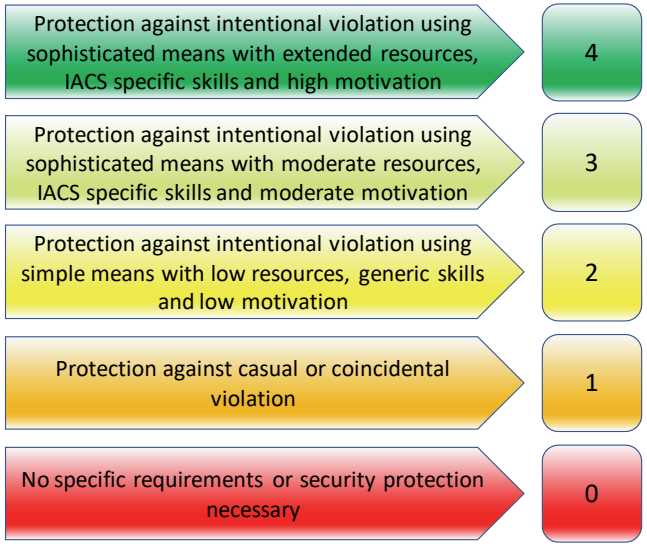


Figure 7.7. *Security levels*

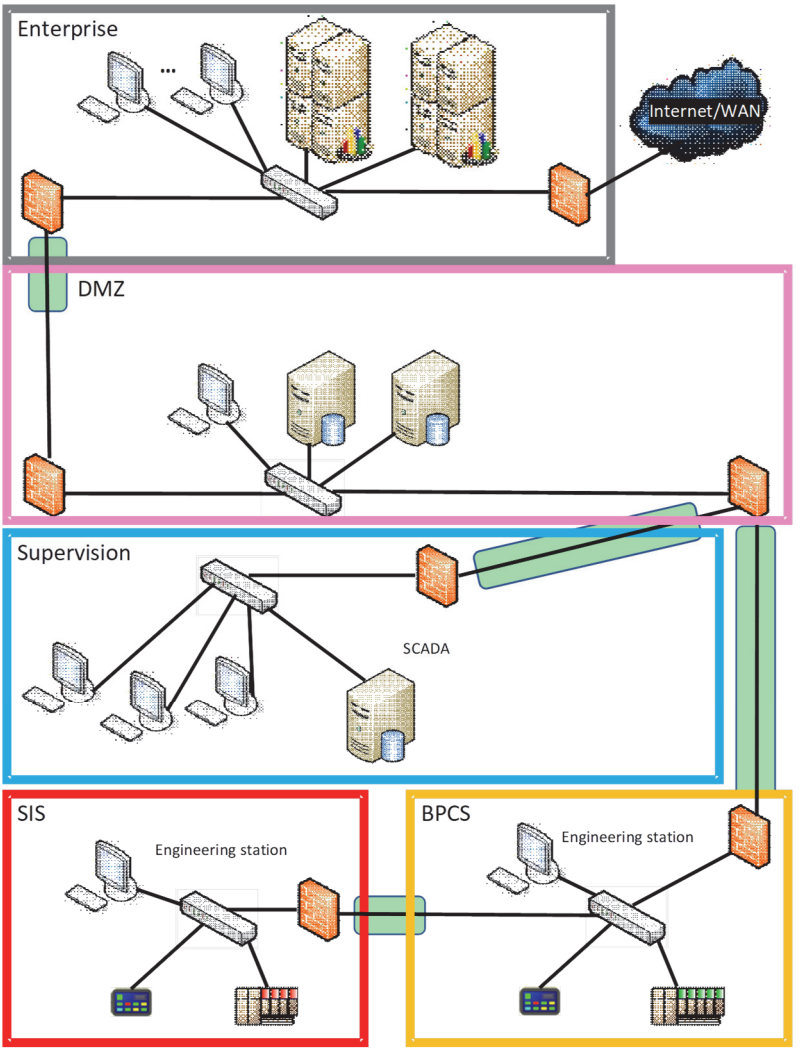


Figure 7.9. *Example of division into zones and conduits*

Figure 7.10. *Maturity levels*

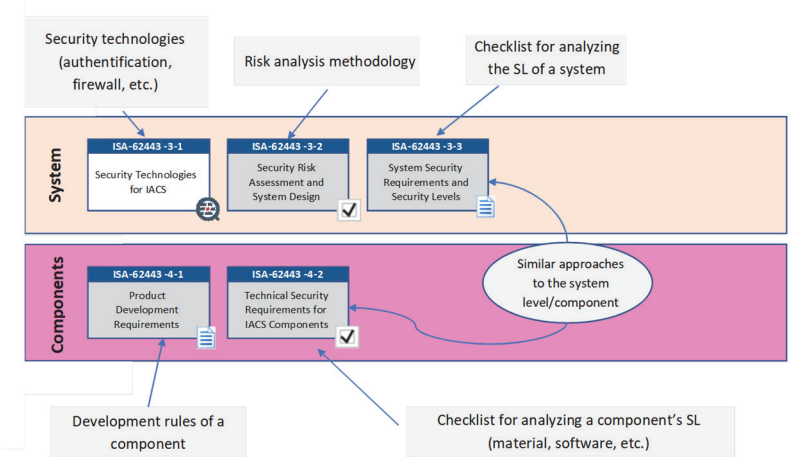


Figure 7.12. *Component and system level documents*

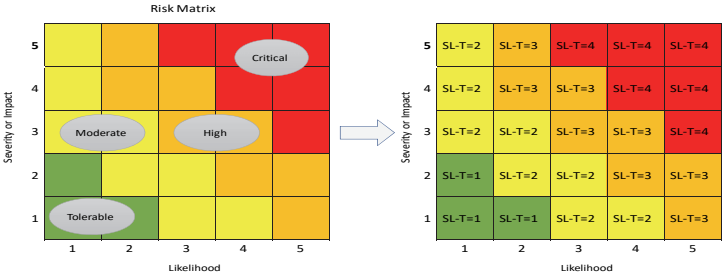


Figure 7.13. *Determination of SL-T from the risk matrix*

Tolerable Risk=4		
Risk	CRRF	SL-T
1	0,25	0
2	0,5	0
3	0,75	0
4	1	0
5	1,25	1
6	1,5	1
7	1,75	1
8	2	1
9	2,25	2
10	2,5	2
11	2,75	2
12	3	2
13	3,25	3
14	3,5	3
15	3,75	3

Tolerable Risk=4		
Risk	CRRF	SL-T
16	4	3
17	4,25	4
18	4,5	4
19	4,75	4
20	5	4
21	5,25	4
22	5,5	4
23	5,75	4
24	6	4
25	6,25	4

Figure 7.14. *Determination of SL-T with CRRF*

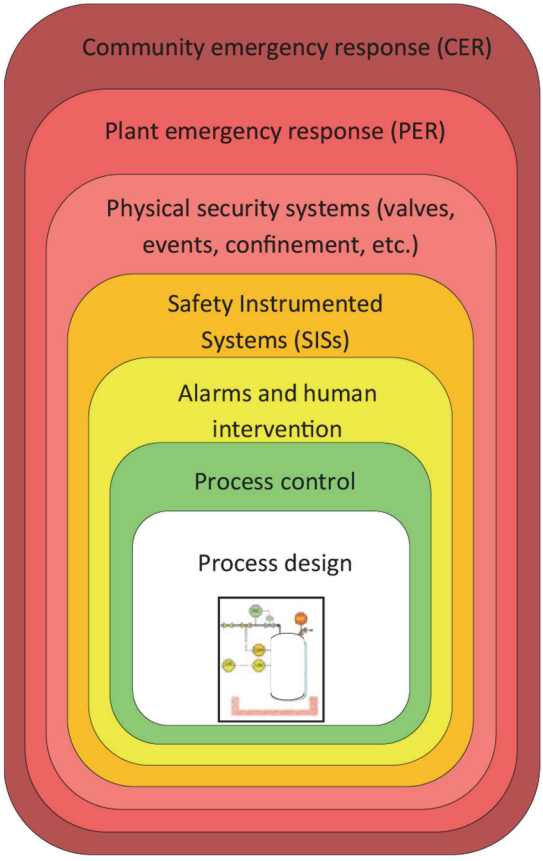


Figure 8.12. *Independent Protection Levels (IPL)*

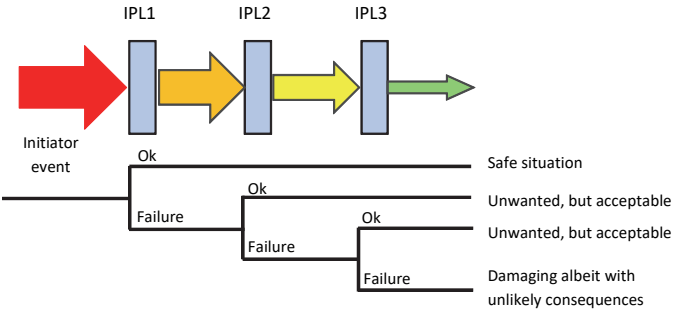


Figure 8.13. *IPL and risk management*

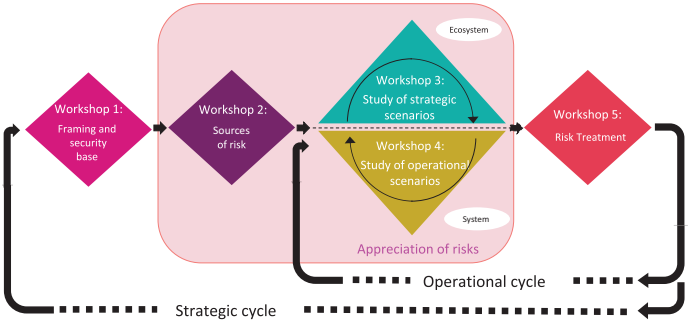


Figure 9.4. *Steps of the EBIOS method*

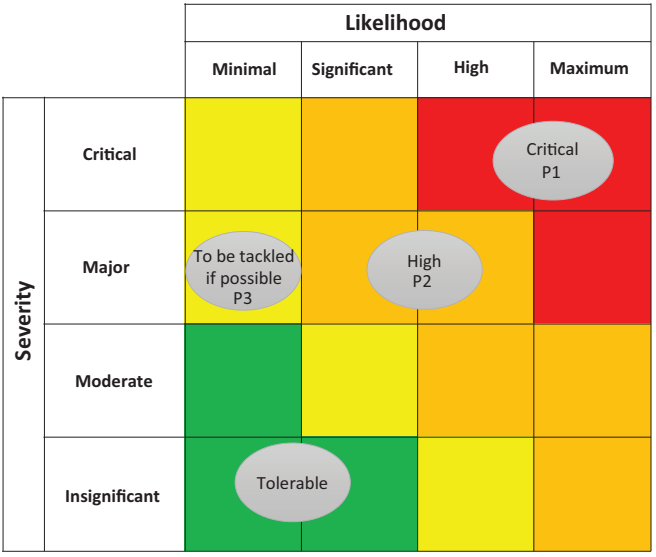


Figure 9.5. *Risk matrix*

Core assets	Feared event	Security requirement	Impacts	Threat sources	L (likelihood)	S (severity)
Supervision	Tampering of measured data	3. Integrity	Supervision screens out of step with real values Uncontrolled production	Internal human source, with malicious intent and limited capabilities External human source, with malicious intent and limited capabilities	3. High	3. Significant

Figure 9.6. *Example of an EBIOS analysis table*

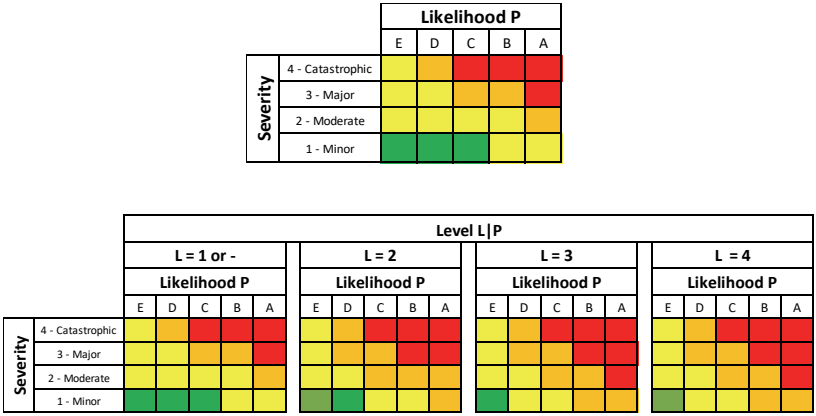


Figure 9.9. *Classic risk matrix (top) and scope*

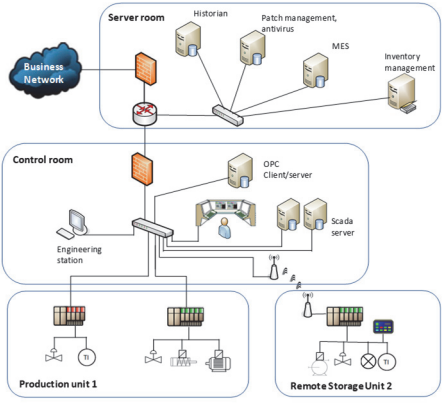


Figure 10.1. *Example of physical mapping*

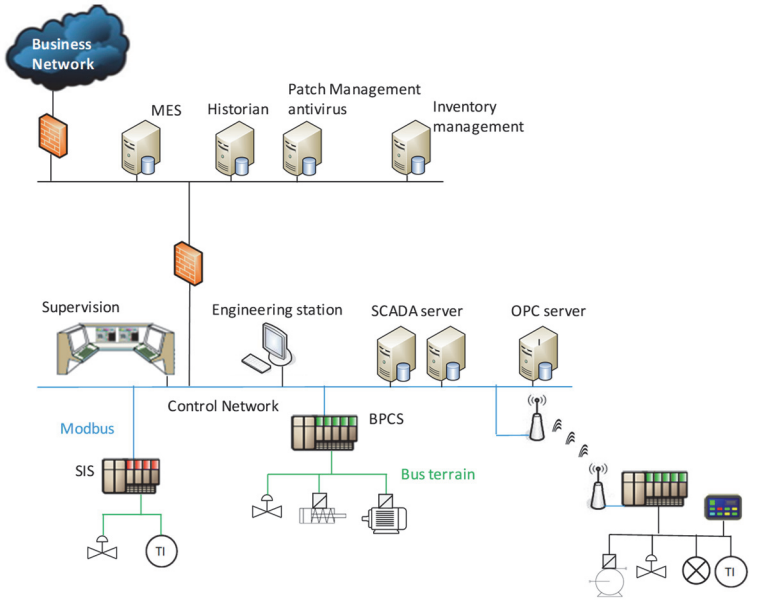


Figure 10.2. *Example of logical mapping*

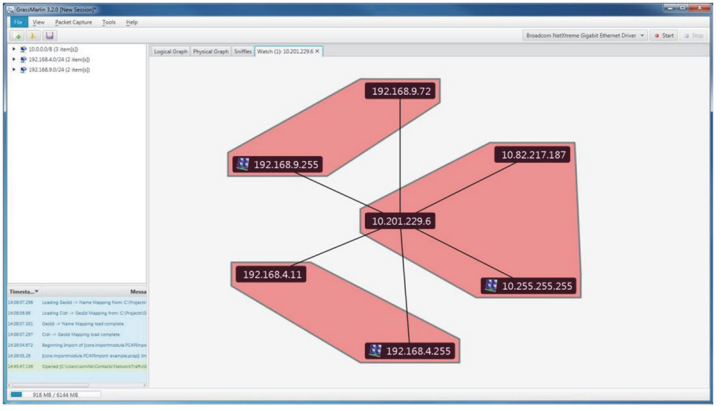


Figure 10.3. *Grassmarlin screenshot*

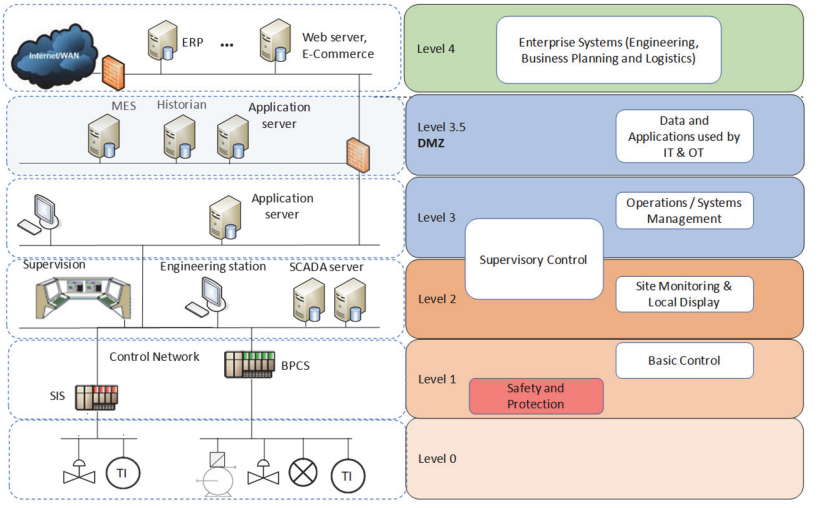


Figure 10.4. *Architecture with a DMZ*

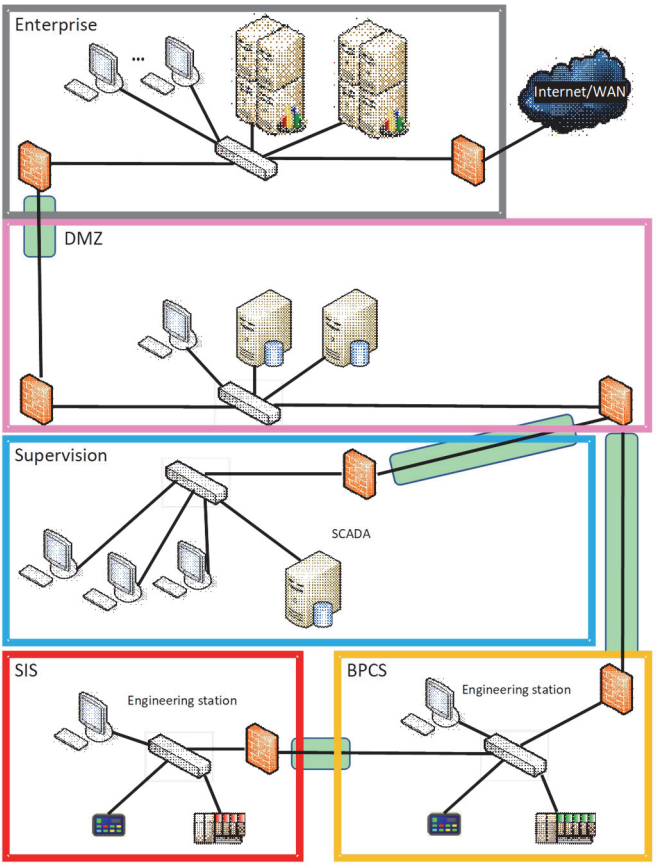


Figure 10.5. *Example of division into zones and conduits*

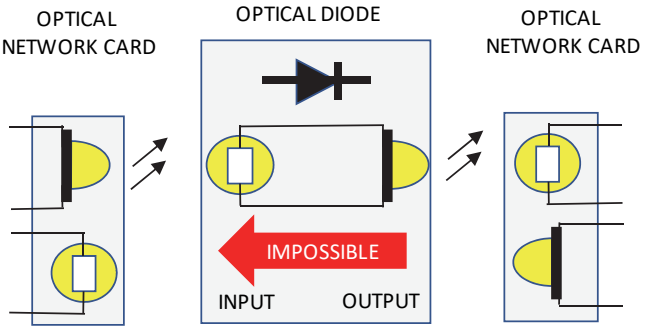


Figure 10.6. *Principle of a data diode*

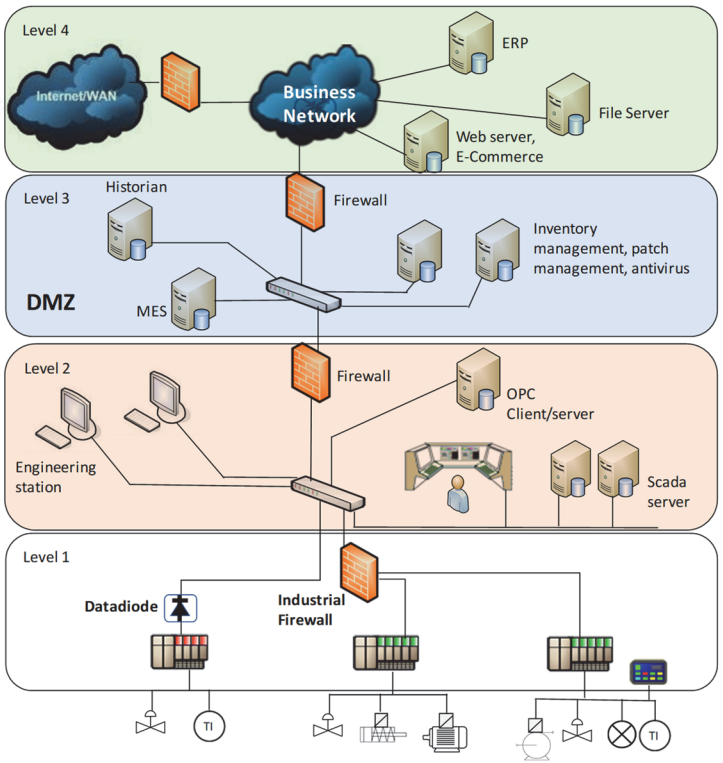


Figure 10.7. *Example of an architecture with data diode, firewall and industrial firewall*

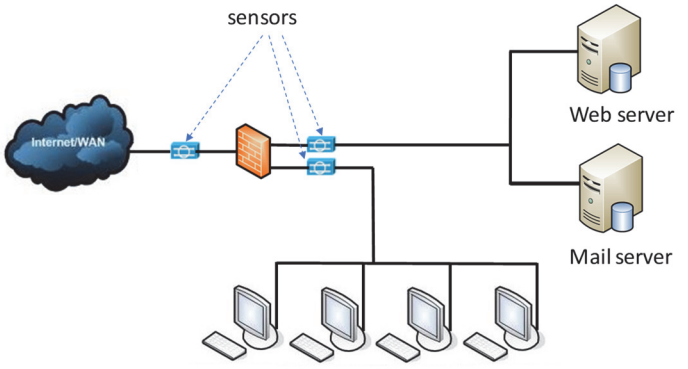


Figure 10.8. *NIDS*

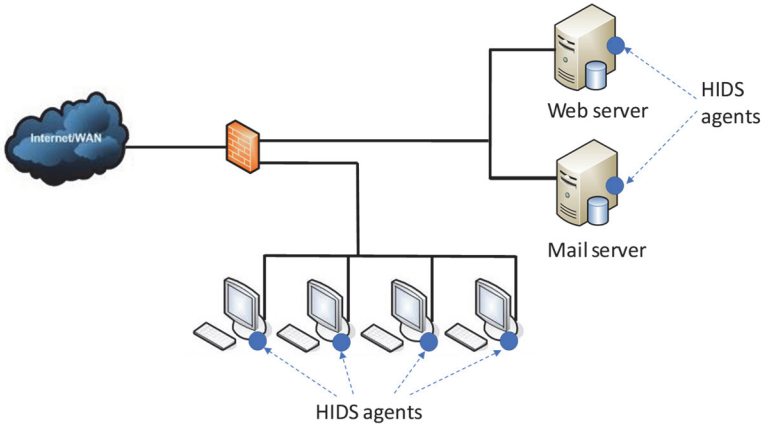


Figure 10.9. *HIDS*

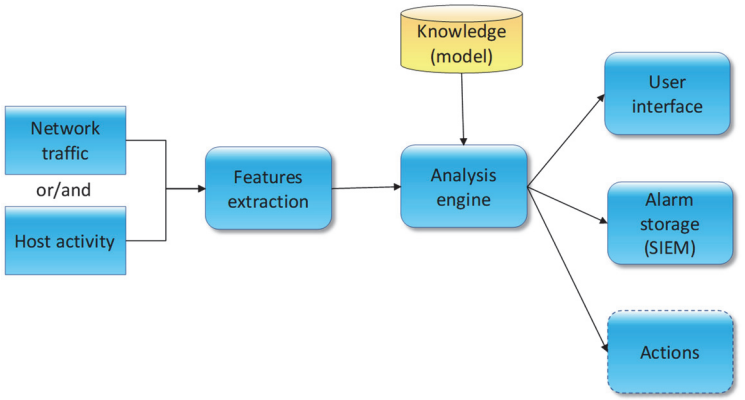


Figure 10.10. *Structure of an IDS*

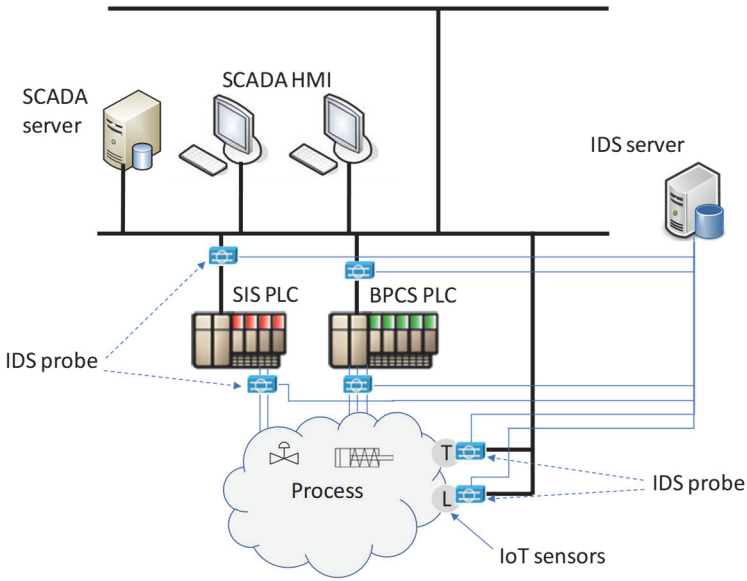


Figure 10.11. *Structure of an industrial IDS*

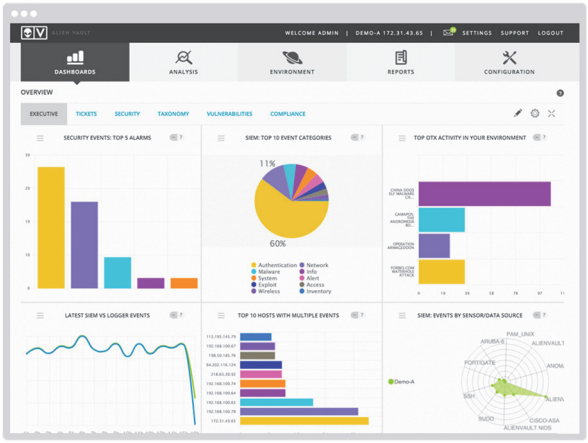


Figure 10.12. *SIEM screen*

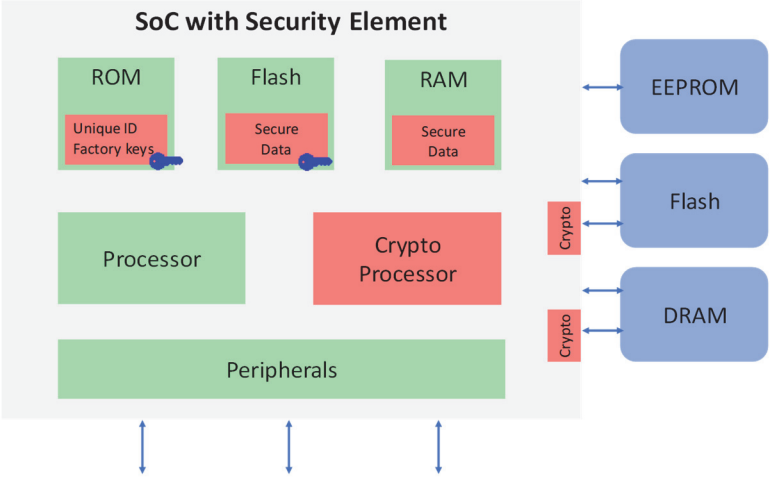


Figure 10.13. *SoC with security element*

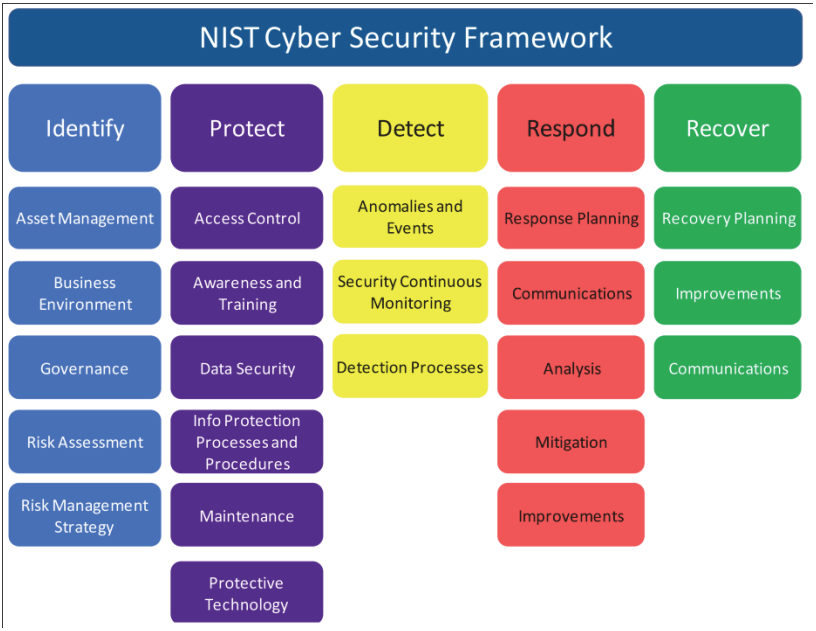


Figure 11.1. *Structure of the NIST framework*

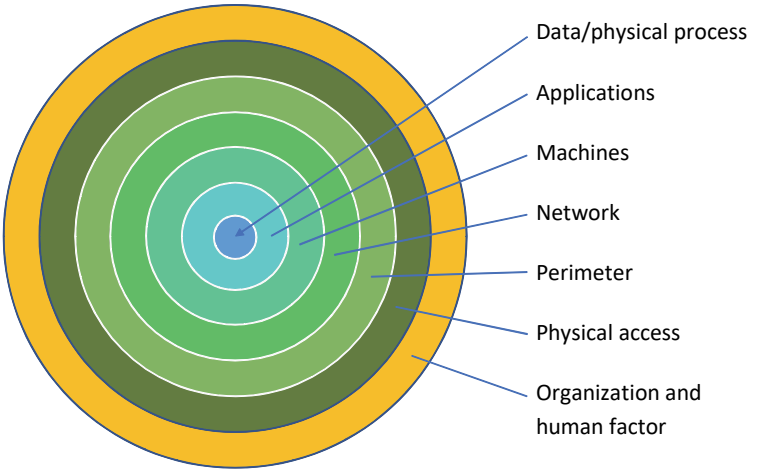


Figure 11.2. *Defense in depth*

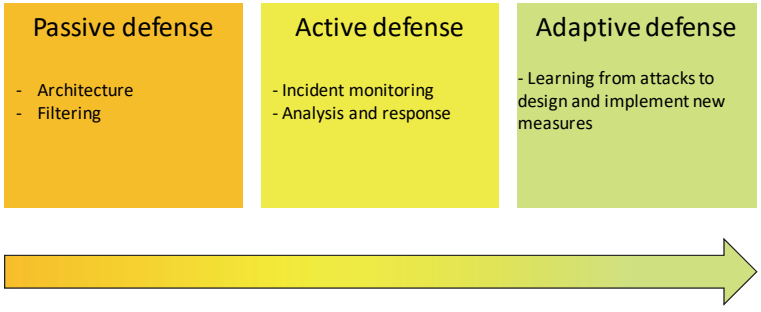


Figure 11.3. *Different levels of countermeasures*

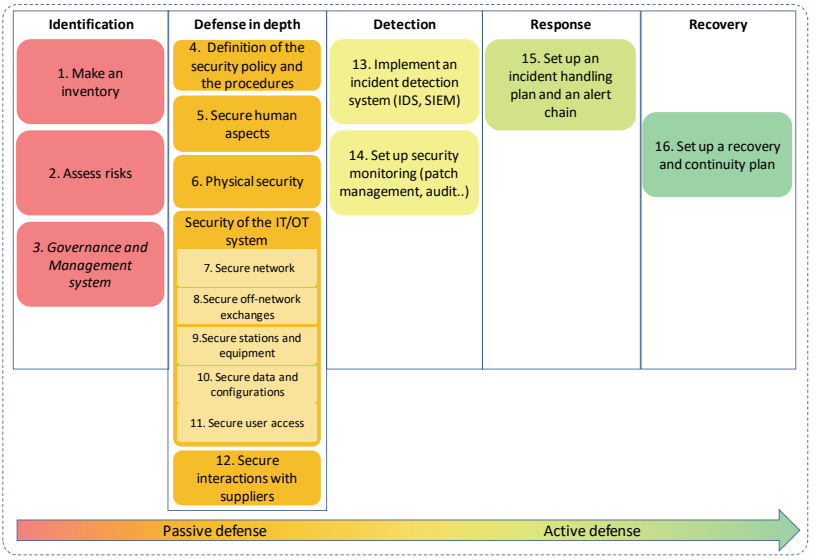


Figure 11.4. *Steps in the ICS security process*