# 4. Safety and Cyber-security 1

http://www.gipsa-lab.grenoble-inp.fr/~jean-marc.thiriet/asean/asean.html

**Asean-Factori 4.0 project**

**Grenoble, 9th May, 20th May 2022**

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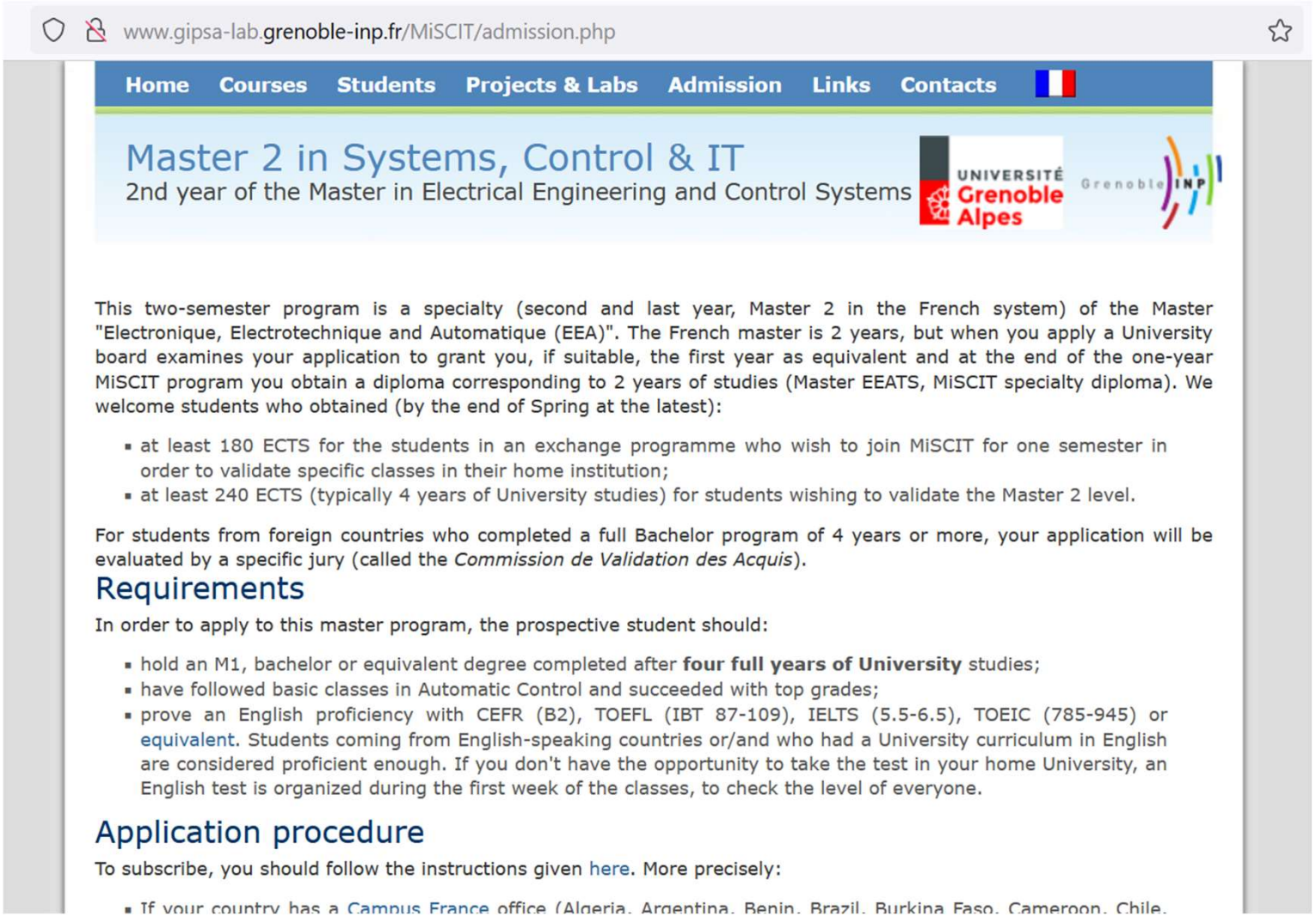

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# Master 2 in Systems, Control & IT

2nd year of the Master in Electrical Engineering and Control Systems

This two-semester program is a specialty (second and last year, Master 2 in the French system) of the Master "Electronique, Electrotechnique and Automatique (EEA)". The French master is 2 years, but when you apply a University board examines your application to grant you, if suitable, the first year as equivalent and at the end of the one-year MiSCIT program you obtain a diploma corresponding to 2 years of studies (Master EEATS, MiSCIT specialty diploma). We welcome students who obtained (by the end of Spring at the latest):

- at least 180 ECTS for the students in an exchange programme who wish to join MiSCIT for one semester in order to validate specific classes in their home institution;
- at least 240 ECTS (typically 4 years of University studies) for students wishing to validate the Master 2 level.

For students from foreign countries who completed a full Bachelor program of 4 years or more, your application will be evaluated by a specific jury (called the *Commission de Validation des Acquis*).

## Requirements

In order to apply to this master program, the prospective student should:

- hold an M1, bachelor or equivalent degree completed after **four full years of University** studies;
- have followed basic classes in Automatic Control and succeeded with top grades;
- prove an English proficiency with CEFR (B2), TOEFL (IBT 87-109), IELTS (5.5-6.5), TOEIC (785-945) or equivalent. Students coming from English-speaking countries or/and who had a University curriculum in English are considered proficient enough. If you don't have the opportunity to take the test in your home University, an English test is organized during the first week of the classes, to check the level of everyone.

## Application procedure

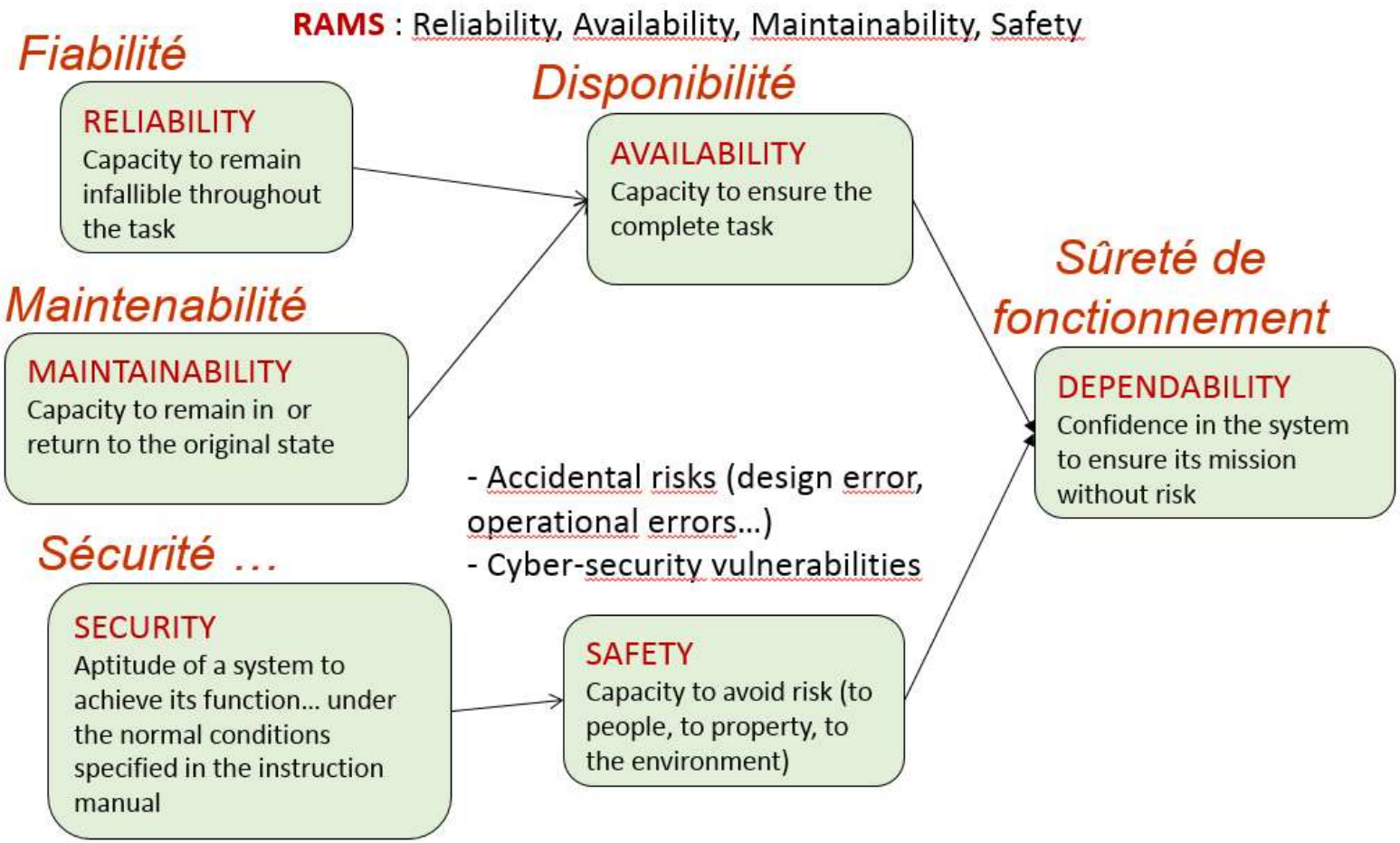
To subscribe, you should follow the instructions given here. More precisely:

- If your country has a Campus France office (Algeria, Argentina, Benin, Brazil, Burkina Faso, Cameroon, Chile,

Emmanuel Witrant <emmanuel.witrant@gipsa-lab.grenoble-inp.fr>

# Some Challenges: Safety & Cyber-security

# Dependability



# Some dependability parameters

MTTF: Mean Time To Failure: average duration before a failure occurs ; mathematical expectation of the operating time before failure

MTBF: Mean Time Between Failures, average uptime ; mathematical expectation of the service life

MTTR: Mean Time To Repair (Recovery, Restoration), average downtime or average time to restore to working order ; mathematical expectation of downtime

$$MTTF = \int_0^\infty R(t)dt \qquad MTTR = \int_0^\infty [1 - M(t)]dt$$

R(t) : probability that the system stays in the operating state without failure over the entire time interval (0,t>.

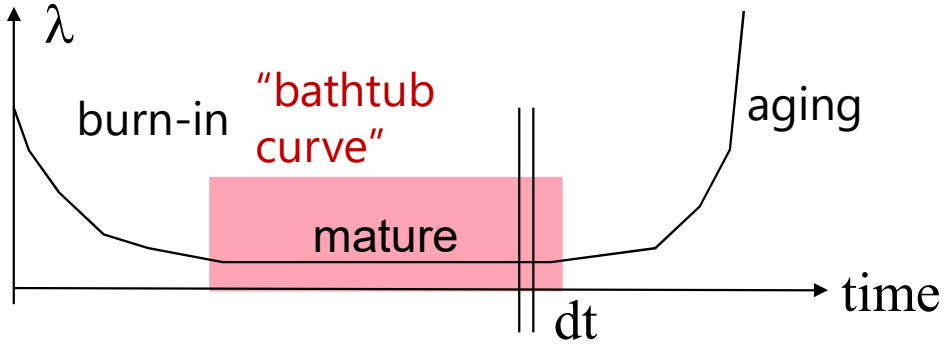
M(t) : probability that the system will be restored within a specified period of time *t*.

# Ex: Reliability

Reliability **R(t)** = probability of one (initially good element) of not having failed until time t

Experiment: How many bulbs fail per time unit ?

$$\lambda(t) = -\frac{dR(t) / dt}{R(t)}$$

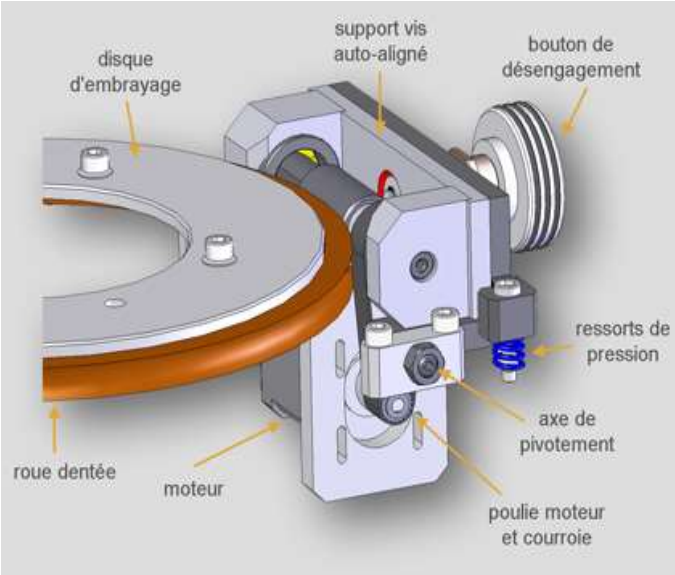



Failure rate **λ(t)** = probability that a (good) element fails during the next time unit dt

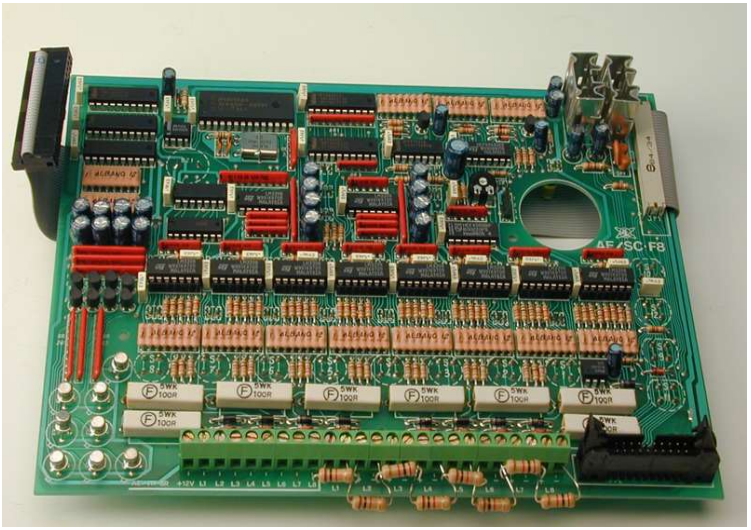
# Dependability of classical Components

- System wear-out
- Topology (architecture) of the system
- « Average » use
- Permanent failures

Mechanical systems

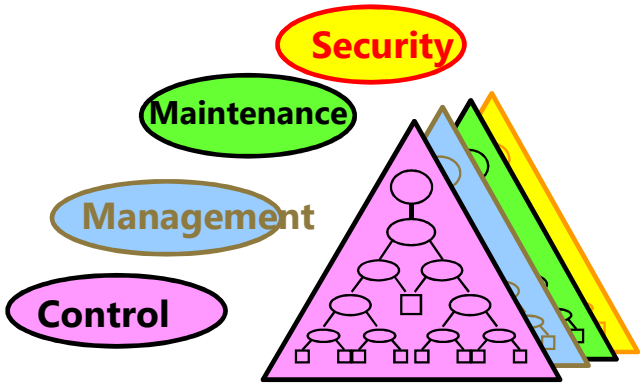



• Electronic systems



# Context: Automation system evolution

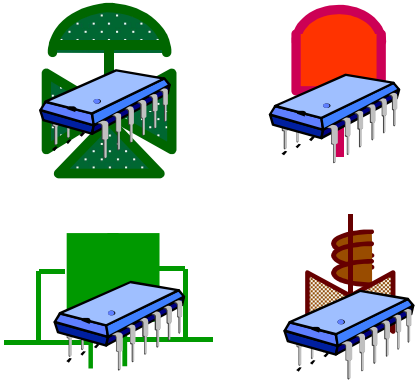
## Needs:




Increased number of services

More complex architectures

## Components :

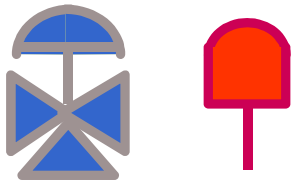


Various capacities and functionalities availability

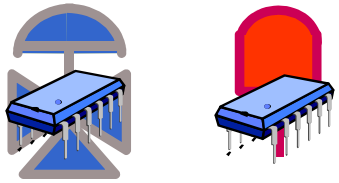
Dependability hard to evaluate and to qualify

# From analog to digital and from smart to intelligent…

- Analog sensors and actuators
  - Hardware and analytical Redundancies
  - « Classiques" studies of dependability

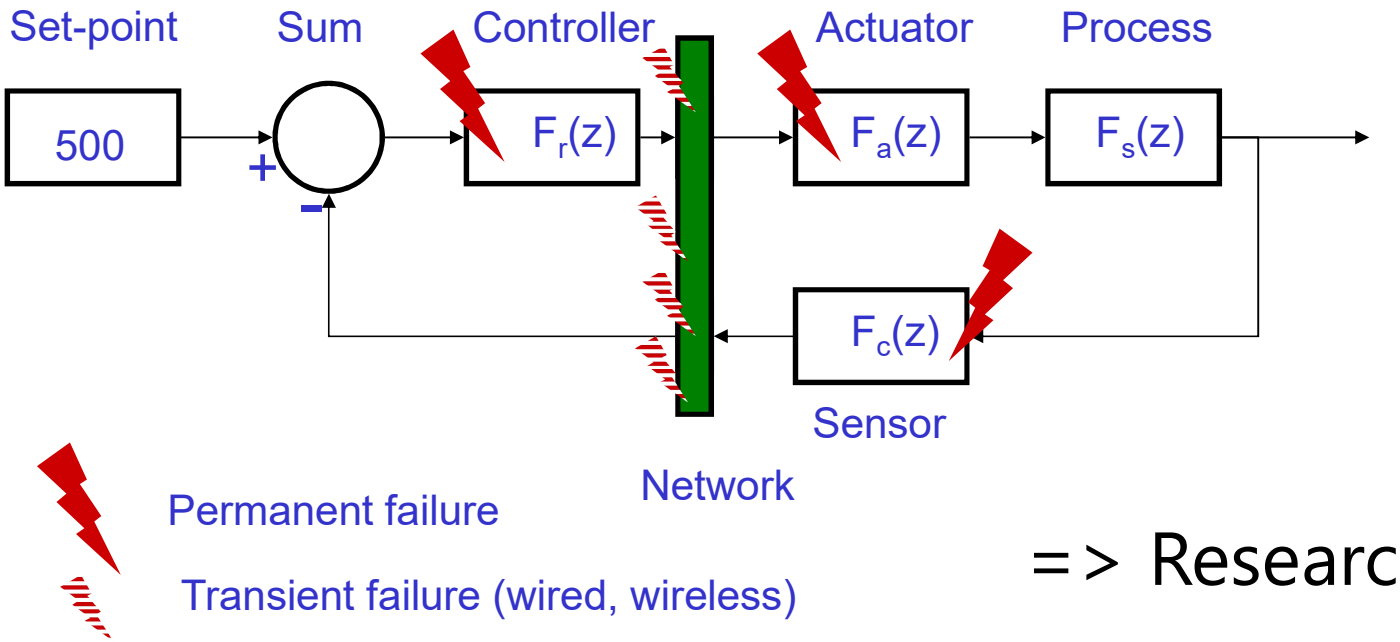


- Digital sensors and actuators
  - A/D Interfaces, processing units, delays…
  - Software, implementation



- « Smart » sensors and actuators
  - Embedded intelligence, local decision
- « Intelligent » sensors and actuators
  - Communicating Interface
  - Diagnosic, monitoring, checking, embedded decision
  - Instrument contributing of the global « intelligence » of the system
- Intelligence vs. Complexity => consequences on Dependability ?

# Failures integration




=> Research aspects

Failure Modes
- Continuous/sampled
- Discrete events

***Time scales***
***-Speed (modulation rate, throughput) of the networks***
***-System time constant***
***-Time between failures***

# Safety Integrated Level (SIL)

- Generic standard IEC-**61508**/IEC-61511

  **Functional safety** of electrical/electronic/programmable electronic safety-related systems

- SIL (*Safety Integrated Level*)

| **Prescriptions of a security system and corresponding SIL levels** | | |
|---|---|---|
| **SIL** | Demand operation<br>Average **probability of failure on demand (PFD)**<br>Failure rate per year | Continuous operation<br>$\lambda$<br>Failure rate<br>per hour |
| **SIL4** | $10^{-4} < PFDavg < 10^{-5}$ | $10^{-8} < \lambda < 10^{-9}$ |
| **SIL3** | $10^{-3} < PFDavg < 10^{-4}$ | $10^{-7} < \lambda < 10^{-8}$ |
| **SIL2** | $10^{-2} < PFDavg < 10^{-3}$ | $10^{-6} < \lambda < 10^{-7}$ |
| **SIL1** | $10^{-1} < PFDavg < 10^{-2}$ | $10^{-5} < \lambda < 10^{-6}$ |

Problems:
- SIL of a component
- SIL of physical architecture
- SIL of a functional architecture
- SIL of a computer and network-based architecture

# Safety
# = the Science of Failures

- Failure: interruption of the capacity of an entity to carry out a necessary function
  - The function concerned should be defined
    - ex 1: to ensure communication between two sites
    - ex 2: to ensure the accessibility of data (locally and remotely)
  - the criterion of interruption of this function must be specified
    - ex 1: QUANTITATIVE: the flow is ≤ a certain %age of a reference value
    - ex 2: QUALITATIVE: the loss, or irremediable destruction of strategic data for the company

# Safety

# = Risks Analysis => Risk Management

- **To Identify** failures in a more exhaustive manner
  - Crashing of hardware disks
  - Burning down, or flooding of premises containing backups
  - Open ports on a network
- **To evaluate the severity** of each failure (level of risk)
- **To envisage** the failures (use of evolution models)
  - 'Outdatedness' of the data-processing components
  - Probability of attacks by third parties on vulnerable ports
- At each **observation** of a failure, we should associate the appropriate **measurement** (statistical) => to improve the forecasting models
- **To control the** failures
  - Reduction of their frequency
  - Preventive measures against the consequences (reduction of the impact)
  - Tolerance

# Elements of risks (Asset)

- Asset (*actif*)
  - Represented by monetary value
  - Anything of worth that can be damaged, compromised, or destroyed by an accidental or deliberate action
  - A asset's worth is generally far more than the simple costs of replacement (image, legal issues…)

# Elements of risks (Threat)

- Threat (*menace*)
  - Potential event that, if realized, would cause an undesirable impact
  - Two factors plays in the severity of a threat: degree of loss and likelihood of occurrence
    - Exposure factor: degree of loss (percentage of asset loss if a threat is realized) – ex: if we estimate that a fire will cause a 70 % loss of asset values if it occurs, the exposure factor is 70 % or 0.7
    - Annual rate of occurrence: likelihood that a given threat would be realized in a single year in the event of a complete absence of control – ex : if we estimate that a fire will occur every three years, the annual rate of occurrence will be 33 %, or 0.33
    - => A threat can be calculated as a percentage by multiplying the exposure factor by the annual rate of occurrence. Ex : 0.7*0.33 = 0.231 or 23.1 %

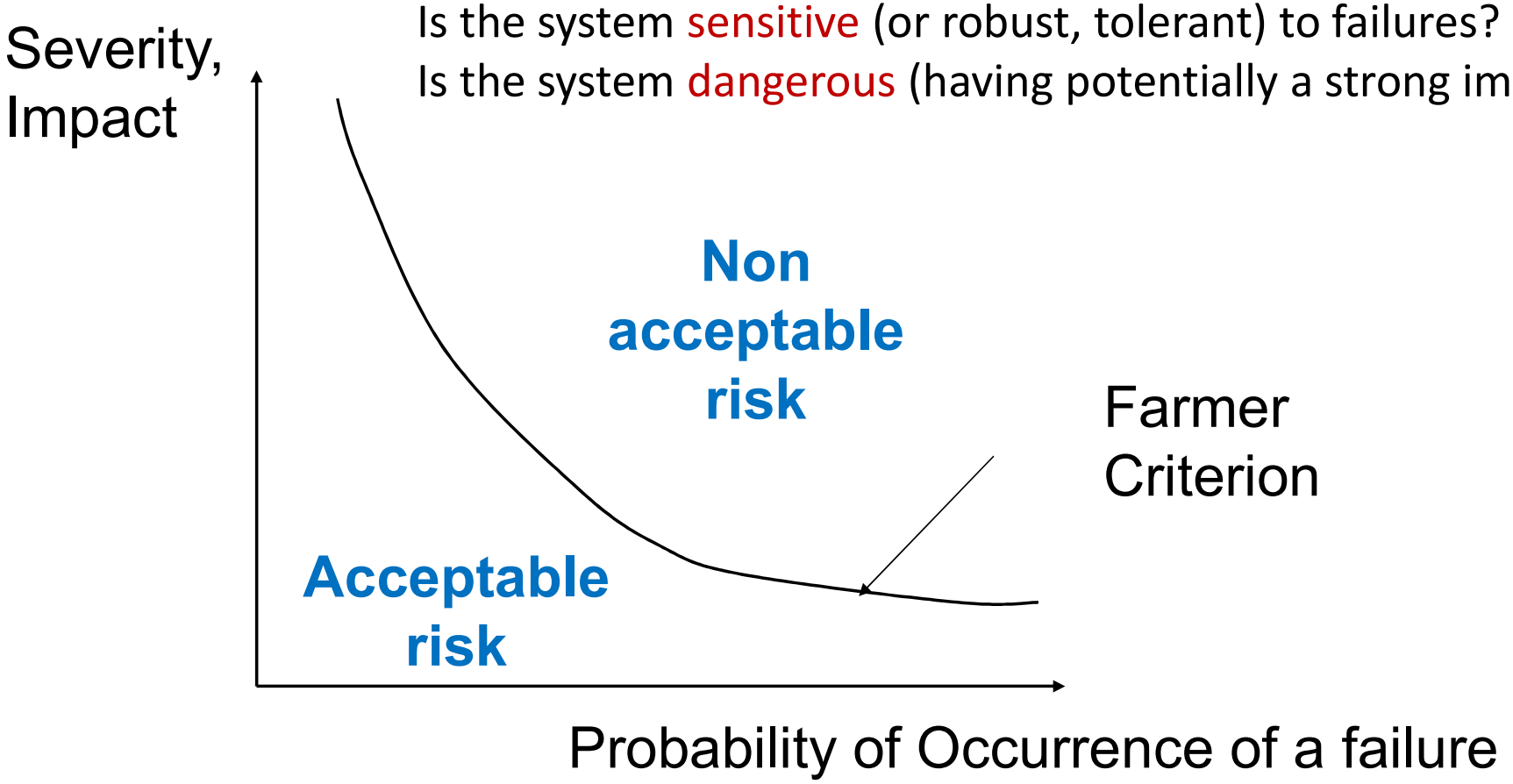
# Elements of risks (Vulnerability)

- Vulnerability (*vulnérabilité*)
  - Absence or weakness of cumulative controls protection in a particular asset
  - Estimated as percentages based on the level of control weakness
  - Control Deficiency (cd) is calculated by subtracting the effectiveness of the control by 100% - ex : if we estimate that our industrial espionage controls are 70 % effective, so 100 % - 70 % = 30 % (CD)

  - Most of the time, more than one control is employed to protect an asset.
  - Ex : the threat is an employee stealing trade secrets and selling them to the competitor
  - To address this threat, we may:
    - implement an information classification policy,
    - monitor outgoing e-mails,
    - prohibit the use of portable storage devices,
    - …

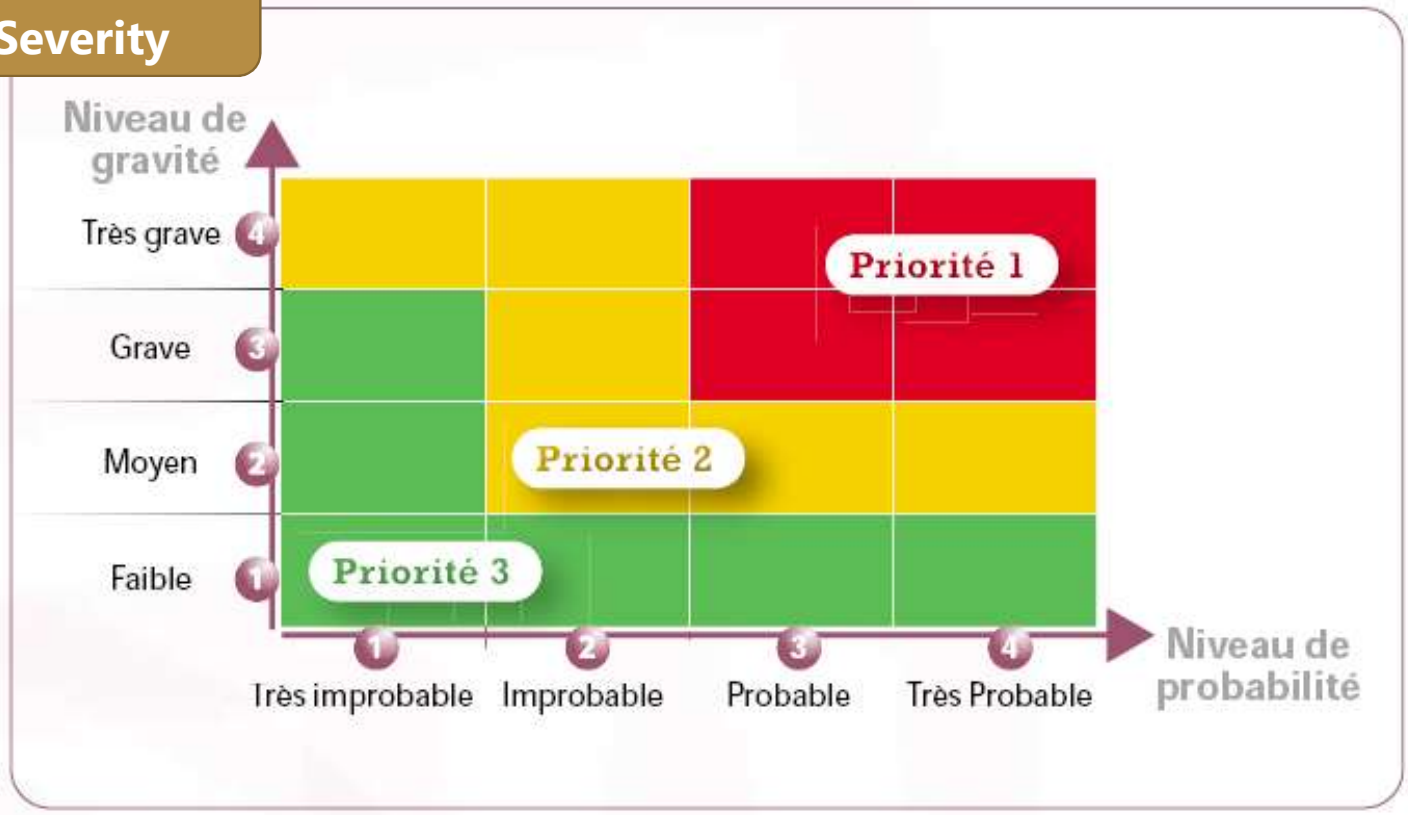
# Severity-probability law

Is the system sensitive (or robust, tolerant) to failures?
Is the system dangerous (having potentially a strong impact) ?



# Risks evaluation, evaluation of the severity

**Gravité = Severity**



# Example

| Danger (cause) | Dange-rous situa-tion | Dangerous event | Risk of… | Consequence | Severity | Probability | Priorities | Observations |
|---|---|---|---|---|---|---|---|---|
| Explo-sion of a tyre | Car sliding | Screw in the tyre | Accident | Killing people in the car | 4 (high) | 1 (low) | 2 (int.) | Having a sparewheel … |

# Prescriptions, Methods for risk analysis

- **Methods**

1. FMEA (Failure Mode and Effect Analysis)/AMDE
2. HAZOP (Hazard and Operability Study)
3. Preliminary Hazard Analysis
4. MEHARI (Method for Harmonized Analysis of Risk) (FR, CLUSIF)
5. EBIOS (Expression des Besoins et Identification des Objectifs de Sécurité, FR, ANSSI)
6. OCTAVE (Operationally Critical Threat, Asset and Vulnerability Evaluation, US-CERT)
7. CRAMM (CCTA Risk Analysis and Management Method, UK CCTA (Central Communication and Telecommunication Agency))

- **Prescriptions**

1. US standard NERC-CIP-002-3 Critical Cyber Asset Identification
2. US standard NIST.IR 7628 Guidelines for smart grid security
3. ISA/IEC 62443 Security for Industrial Automation and Control Systems
4. EU efforts about smart grid security
5. ANSSI Classification method and key measures

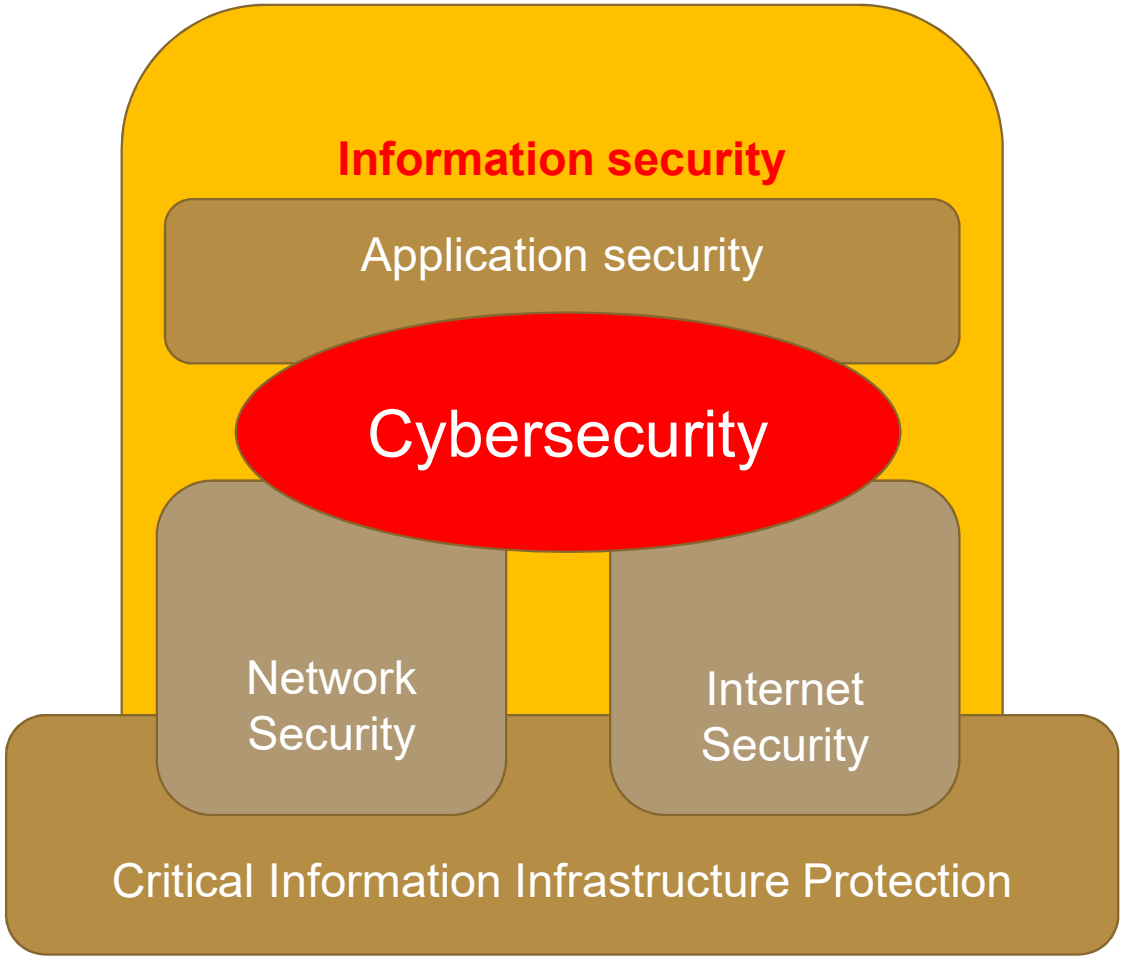
# Cyber-Security

*UGA Grenoble – May 2022*

# Some preliminary questions about cybersecurity (from Stéphane)

- What do you have to secure ?
  - Physical process, computers, networks, applications, data, people ?
- What do you mean by secure ?
  - Have to define a policy.
- Against which threats ?
  - There is no “absolute security”.
    - Vulnerabilities
    - Threat available resources
- What to do ? (choice of controls)
- How to do ? (security management)

# General cybersecurity guidelines – ISO 27032




- CIIP : protection of critical industrial systems
- IS : General information security
- Application security : manage risk associated with application use (code, data, users)
- Network security : secure external and internal communication within organizations
- Internet security : protection of Internet-related services

# Basic information security

- ISO 27000
- Information security : preservation of confidentiality ,integrity and availability of information CIA Triad
- In addition, other properties, such as authenticity, accountability, non-repudiation and reliability can also be involved

- Resilience may also be of interest

# CIA Triad

- Confidentiality: property that information is not made available or disclosed to unauthorized individuals, entities, or processes
  - Preserving authorized restrictions on information access and disclosure, including means for protecting personal privacy and proprietary information
- Integrity : property of accuracy and completeness
  - Guarding against improper information modification or destruction, and includes ensuring information non-repudiation and authenticity
- Availability property of being accessible and usable on demand by an authorized entity
  - Ensuring timely and reliable access to and use of information.

- Proof :
- Authenticity property that an entity is what it claims to be
- Non-repudiation : ability to prove the occurrence of a claimed event or action and its originating entities
- Reliability property of consistent intended behavior and results

# Cyber-security

**Cybernetics** from Greek κῠβερνήτης (*kubernêtês*) => Used 19th and 20 century => ideas of control and communication

**Cyber** : Greek *kubernân,* to govern

Today used for everything relative to the « digital » world (internet, web…)

**Cyber-security**:

- Cyber security comprises technologies, processes and controls that are designed to protect systems, networks and data from cyber attacks. Effective cyber security reduces the risk of cyber attacks, and protects organisations and individuals from the unauthorised exploitation of systems, networks and technologies (https://www.itgovernance.co.uk/what-is-cybersecurity)
- État recherché pour un système d'information lui permettant de résister à des événements issus du cyberespace susceptibles de compromettre la disponibilité, l'intégrité ou la confidentialité des données stockées, traitées ou transmises et des services connexes que ces systèmes offrent ou qu'ils rendent accessibles. La cybersécurité fait appel à des techniques de sécurité des systèmes d'information et s'appuie sur la lutte contre la cybercriminalité et sur la mise en place d'une cyberdéfense. (ANSSI, https://www.ssi.gouv.fr/entreprise/glossaire/c/)

# Convergence between IT and cyber-physical systems (CPS)


US Black-out, 2003

**INFRASTRUCTURE**

Industrial
Control
Systems (ICS)

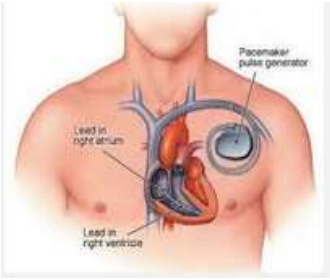
Smart grids

Cyber attack ukrainian power network, Dec. 2015

- Integrity of the information and communication infrastructure

→ Challenge: DEPENDABILITY (RAMS Reliability, Availability, Security & Safety, Maintainability)

**EMBEDDED SYSTEMS**
Drones
Autonomous vehicles
Connected objects




**Maroochy shire, Stuxnet, CrashOverride**

# Overview of cyber attacks against ICS systems (from PhD Peter Matousek)

| Year | Attack | Place |
|---|---|---|
| 1982 | Explosion of Siberian gas pipeline caused by a trojan which reset pump speeds and valve settings | Soviet Union |
| 1997 | Knock out of Worcester air traffic control communication | MA, USA |
| 2000 | Maroochy shire sewage spill | Australia |
| 2003 | Crash of the Safety Parameter Display System in Davis-Bess nuclear power plant by Slammer worm | OH, USA |
| 2003 | Shutting down of CSX train signaling system by Sobig virus | FL, USA |
| 2005 | Zotob virus knocked 13 of Daimler-Chrysler's manufacturing plants | USA |
| 2010 | Stuxnet virus damaged Iranian centrifuges by increasing and decreasing their speed and pressure beyond normal levels | Iran |
| 2014 | Disrupted control system in German steel mill | Germany |
| 2015 | Power outage off Ukrainian power plant distribution caused by BlackEnergy malware | Ukraine |
| 2016 | Industroyer malware attack on Ukrainian power grid | Ukraine |
| 2017 | Cyber-espionage attack against aerospace and energy industry by APT33 group | USA |
| 2019 | Cyber attack against chemical giant Bayer | Germany |
| 2019 | Intrusion attack against U.S. Energy sector by KAMACITE group | USA |
| 2019 | Cyber attack against Kudankulam nuclear power plant | India |
| 2020 | Compromising supply chain of Solarwinds software used in industrial environment | USA |
| 2021 | Ransomware attack against oil distribution company Colonial Pipeline | USA |

## FIREWALLS DÉDIÉS AUX RÉSEAUX INDUSTRIELS

Une cyber-attaque peut impacter l'outil de production et provoquer :

- Une marche irrégulière ou dégradée
- Des arrêts intempestifs
- L'activation d'actions dangereuses pour les biens et les personnes
- Un arrêt complet avec rançon pour pouvoir redémarrer
- Le vol de données de fonctionnement pour utilisation ultérieure

# Comparison between ICS and classical IT systems

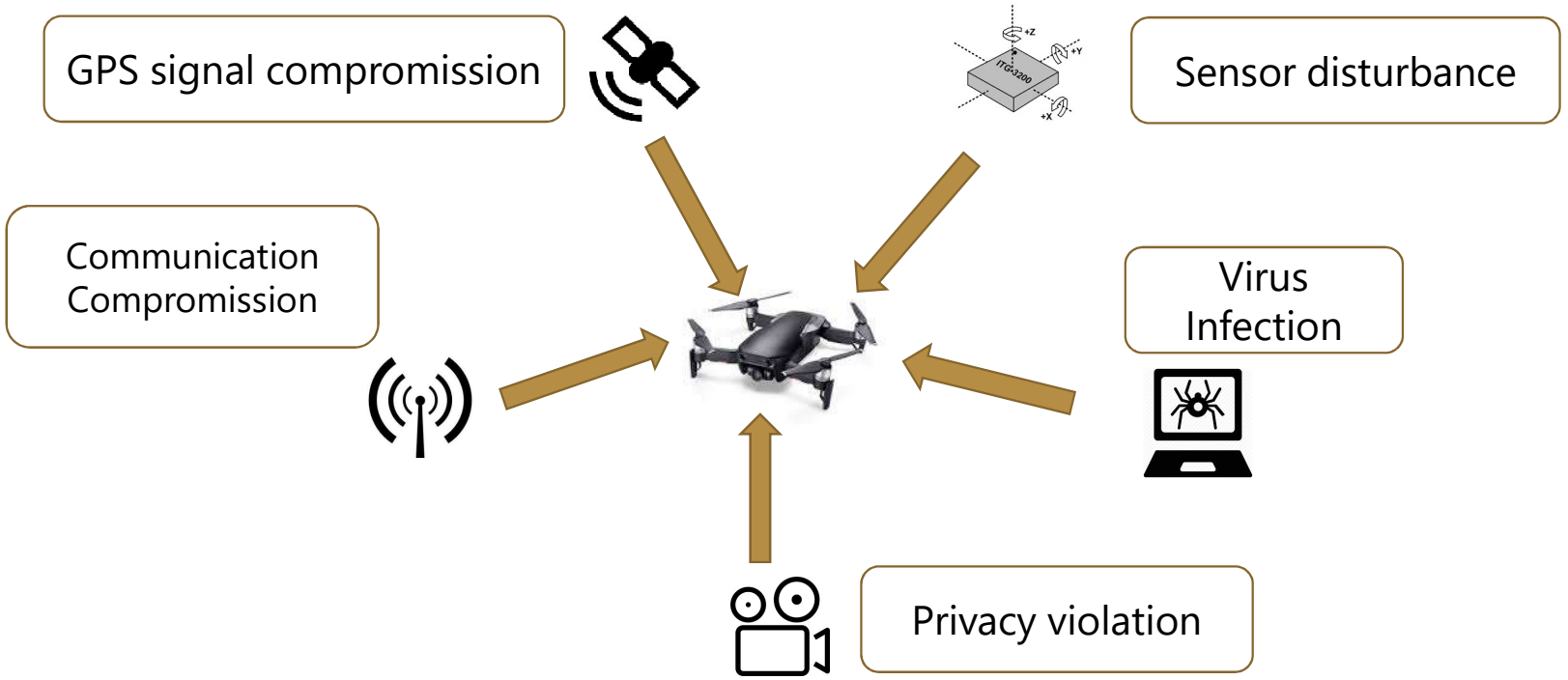
**IT Information Technogy**

**ICS Industrial Control System**

| Category | IT systems | ICS systems |
|---|---|---|
| **Cyber security culture** | Awareness of risks<br>Methods and tools | Recent |
| **Life duration** | 3-5 years | > 20 years |
| **Performance** | Throughput | Latency<br>Real-time constraints |
| **Resources** | Abundant | Limited |
| **Networks Protocols topologies** | Numerous connection points<br>Dynamic topologies | Fixed topologies<br>“Simple” protocols<br>Defined communication strategy, scheduling |
| **Performances** | Delays and jigs acceptable | Real time, critical time<br>Strict time constraints |
| **Availability** | Some tolerance on degradations, depending on situations | High availability<br>Inacceptable loss of connection (depends)<br>Advance planning |
| **Resource constraints** | Available resources | Design for industrial processes<br>Limited processing and memory resources |
| **Targeted properties** | Confidentiality<br>Integrity<br>Availability | Timeliness<br>Availability<br>Integrity<br>Confidentiality |

# Cyber-security of flying drones

**Vulnerability of the drone:**



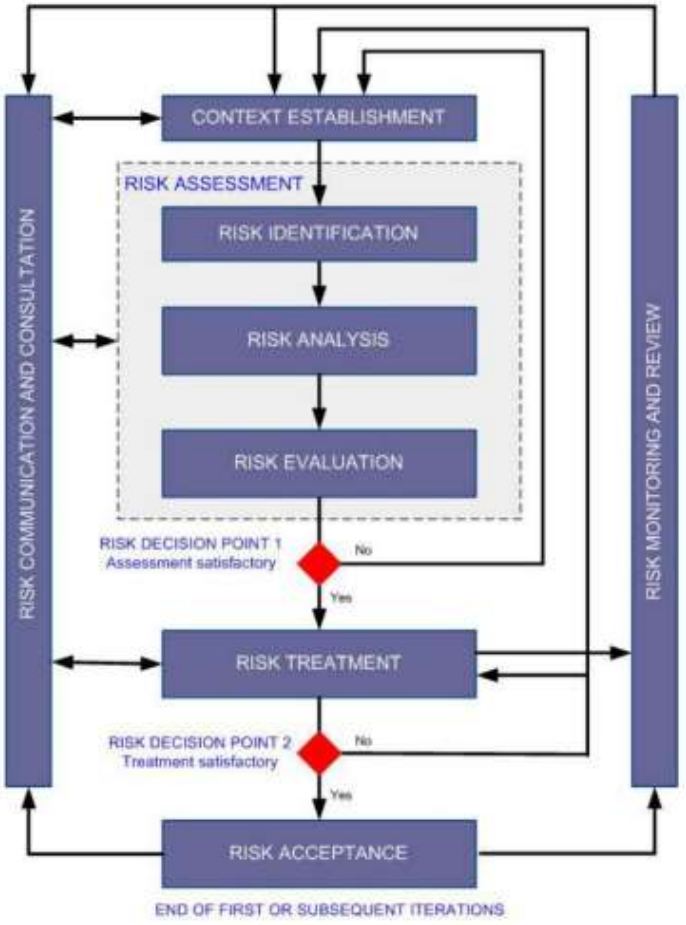

Need of a methodology to get a cartography of the drone security in a systematic way and to ensure completude

# Ex: methodologies in the industrial domain

- **ISO27005 Standard**: Information security risk management
  Propose a work-flow

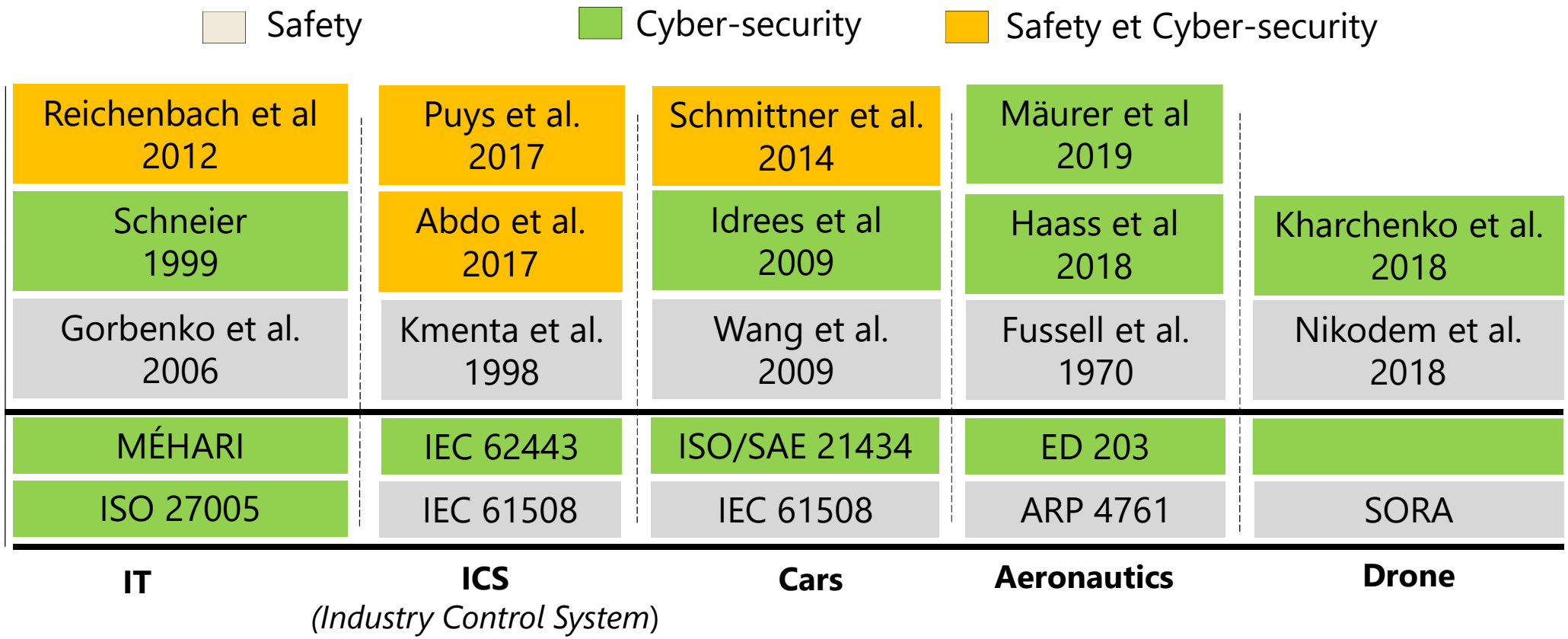
- **MEHARI[12]:**
  - IT Security in companies
  - Databases
  - Security Evaluation Tools

- **ED202A/DO326A Standard:**
  - Avionics security
  - During the processus of aircraft development



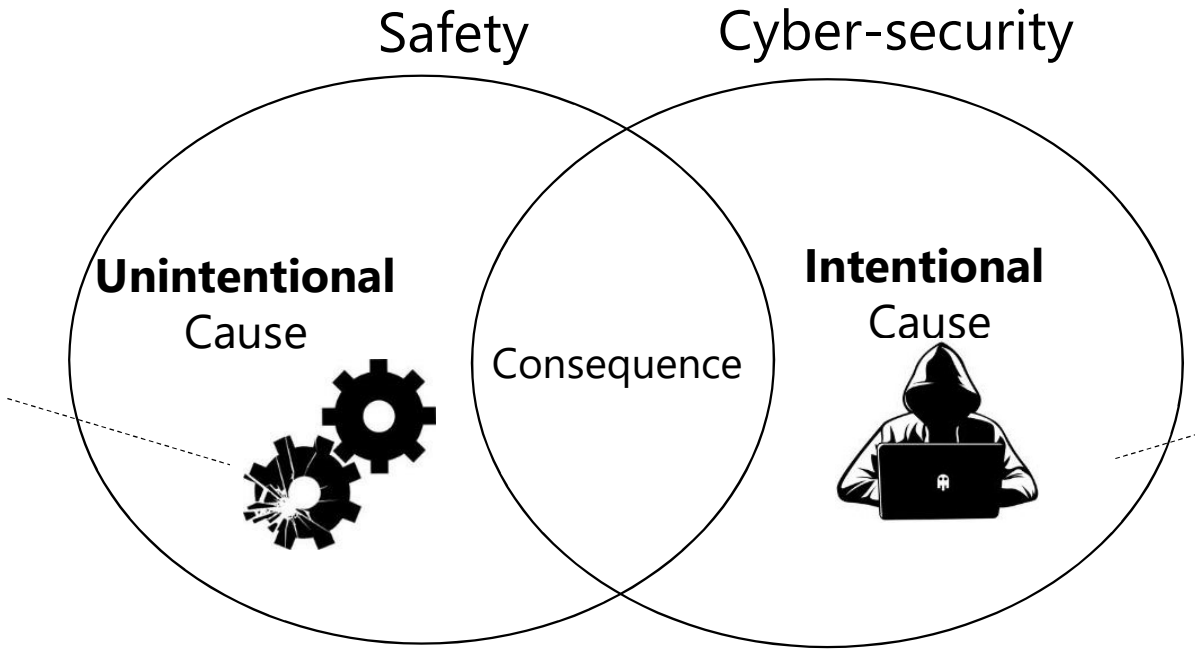
# Risk Assessment: Safety and Cyber-security

[Phd TRAN Trung Duc 2021]



# Safety and Cyber-security

[Phd TRAN Trung Duc 2021]




No one wants the "consequences" to happen

Someone wants the "consequences" to happen

Different **causes**, same **consequences**

# Attacks?

# Why do pirates take an interest in organizations IT or individuals computers ?

- Motivations change
  - 80s and 90s: lots of enthusiastic hackers
  - Nowadays: Mostly organized and thoughtful actions

# Why do pirates take an interest in organizations IT or individuals computers ?

- Cyber Delinquency:
  - Individuals attracted by the lure of gain
  - The "hacktivists“
  - Political, religious, etc.
  - Direct competitors of a targeted organization
  - Civil servants in the service of a country
  - Mercenaries acting for the account of sponsors...

# Types of targets

- Convenient target *(cible opportune)*
  - By “chance”: detected by the pirates in the search of least protected machines or servers
  - What to do?: update the systems
  - To test the system (try to find faults)
- Chosen target *(cible de choix)*
  - Precise Target: strategic interest of the company …

# Types of attacks (1/3)

- DoS (Denial of service) : To decrease the system capabilities
  - DDoS (Distributed DoS) : idem but with an attack coming from several sites (http://grc.com/dos/grcdos.htm)
  - SYN Flood: the attacker floods a system with SYN synchronization packets in order to initiate connection requests (these requests are never finished) => strong exploitation of the processor resources, memory, network cards => Denial of service
  - UDP Flood: attack which submerges a system with UDP packets => prevent it from treating the valid requests for connection (often on the DNS port 53) (ICMP Flood: idem to submerge a system with ICMP messages (Internet Control Message Protocol) by using the Ping utility)
  - Ping of Death: possibility to "ping" with a too huge packet which can cause a whole range of uncontrolled reactions on the targeted system: Denial of service, shut down, freezing or restarting

# Types of attacks (2/3)

- Scan of ports: Packets sent by using the port numbers in order to scan available services, hoping that a port answers
- Eavesdropping: the goal is to violate the confidentiality of the communication (by sniffing packets on the local area network or by intercepting wireless communications)
- Man-in-the-middle: the attacker acts between the two ends of the communication as if he were the awaited interlocutor: harmful effects on the confidentiality and possibly the integrity

# Types of attacks (3/3)

- Java/ActiveX/ZIP/EXE: dangerous Java components or Active X hidden in Web pages, Trojan dissimulated in a ZIP/TAR or EXE file
- Breaking into a system: by violating the authentication or the access control, the attacker obtains the possibility of controlling the communication: effects on the confidentiality and the integrity
- Virus: shortcuts the authentication and the access control with the aim of carrying out destroying code: effects on the availability of the machine and/or the network
- Trojan: virus hidden in a function usually used, program being carried out on the pirated machine to send information to the pirate
- Worm *(ver)*: explore and automatically exploits the faults of a system, without action of the user => problems of availability

# Detection of attacks

- By human beings (culture)
- By specialised software or hardware (anti-virus, firewalls)
- By ports normally non open (alert scans)
- By abnormal reactions
  - During connections, when you are absent
  - Of the applications (slow, double validation)
- By abnormal overloads
  - Network resources
  - Processor, disk, memory resources
- By invalid data
- By data losses

Every abnormal event should incitate to remain very "attentive" !

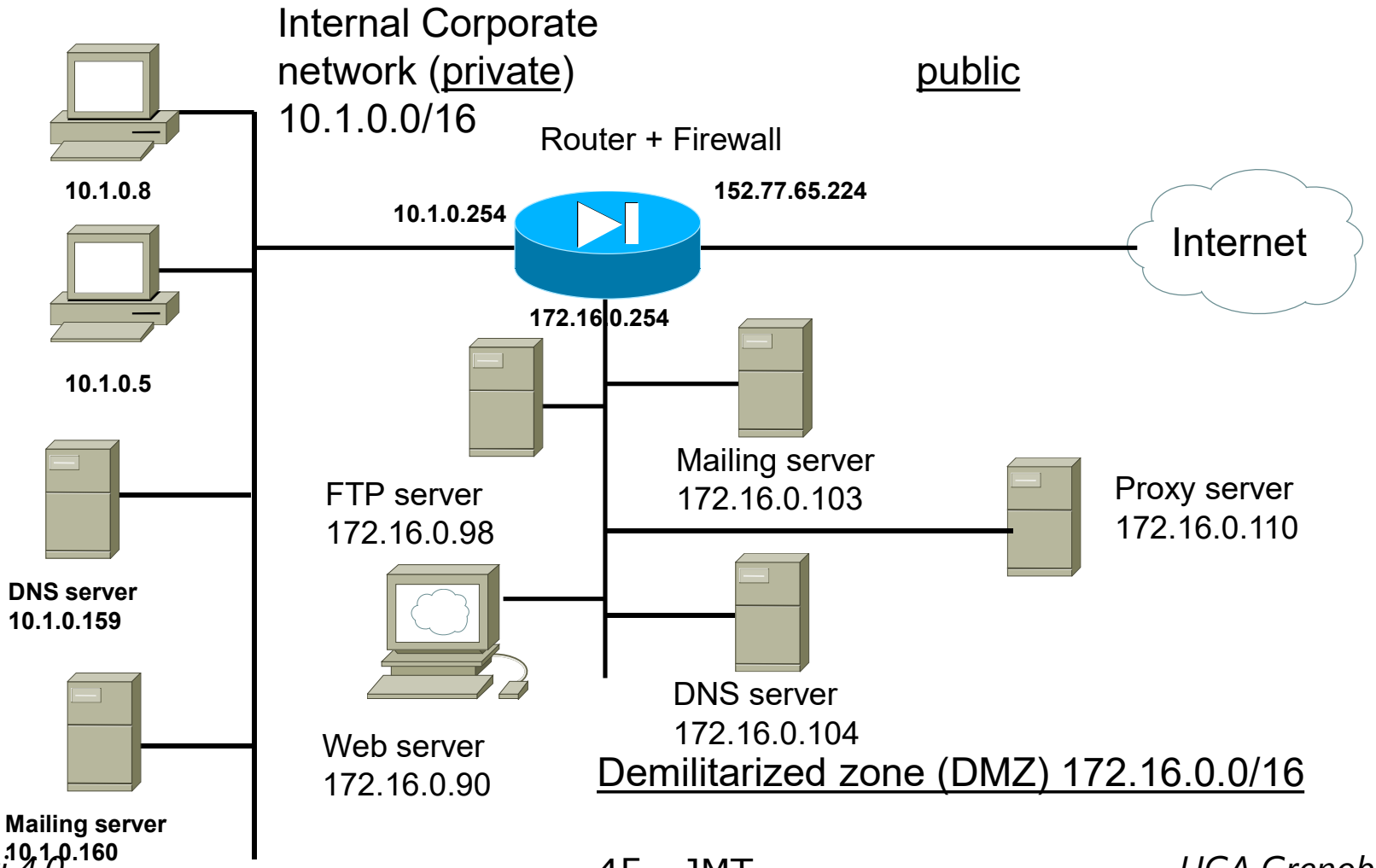
# Organizations for security

- CERTA (Centre d'Expertise gouvernemental de Réponses et de Traitements des Attaques Informatiques / French governmental Center of Expertise for Answers and Treatments of the Data-processing Attacks)
  - www.certa.ssi.gouv.fr
- SANS (SysAdmin, Audit, Network, Security)
  - www.sans.org
  - Research on information security
- SCORE (Security Consensus Operational Readiness Evaluation)
  - www.sans.org/score
  - Community of professionals in security
- ISC (Internet storm center)
  - http://isc.sans.org
  - Logs (journal) concerning detections of intrusion
- ANSSI
  - www.ssi.gouv.fr
  - Agence Nationale de Sécurité des Systèmes d'Information

# Firewalls,
# Demilitarized Zone

*UGA Grenoble – May 2022*

# A network with a firewall/router…



# ***Stateful firewall:*** Dynamic ACL

- Dynamic filtering
  - **Stateful inspection firewall**: packet filters that take into consideration OSI-layer 4 (particularly TCP) => if a connection is authorized, every packet within this exchange will be implicitely accepted
  - Dynamic entries for responses to the TCP, UDP, ICMP requests
  - Does not require to keep open the static ports (the ports remain open only during the time of the session)
- Follow-up/monitoring of the TCP sequence numbers
  - Monitoring of the sequence numbers of the input and output packets to follow-up communication flows
  - Protection against “man in the middle” attacks and session hackings

# Dynamic ACL

- Follow-up of specific applications (example of protocols)
  - Cu-SeeMe (port 7648): PTP videoconference
  - FTP (port 21)
  - HTTP (port 80 or 8080)
  - HTTPS (port 443)
  - DNS (Domain Name Server): port 53
  - H.323 (port 1720): multi-media communication (VoIP, video, audio)
  - ICMP: repairing of problems (administrator) + used by the pirates => to let pass only ICMP messages generated inside the network
  - MCGP (Media Control Gateway Protocol, port 2427): VoIP
  - MSRPC (Microsoft Remote Procedure Call Protocol, port 135): communication of inter-systems process

# Example

- ACL (Access Control List)
- Access-list list_number Order (Permit/Pass or Deny/Block) Protocol (4th, 3rd, 2nd layer) source (machine or a network) Destination (machine or a network) port number (application)

- Access-list 121 Permit TCP/UDP 10.10.10.0/24 any http
- Access-list 121 Permit TCP/UDP 10.10.10.0/24 DNS_SERVER dns
- Access-list 121 Deny any any any any

- Access-list 121 Permit TCP/UDP 10.10.10.0/24 any 80
- Access-list 121 Permit TCP/UDP 10.10.10.0/24 DNS_SERVER 53
- Access-list 121 Deny any any any any

# Cryptography basics

### *a. Definitions*

**Encryption**

Transform data such that it became unreadable. Only authorized entitiesmay read the ecrypted data.


**decryption**

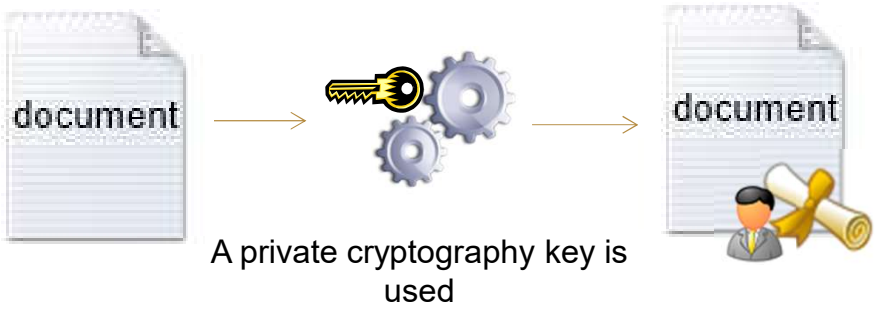
Transform data previousy encrypted such that it became readable. Only authorized entities may decrypt data

# Cryptography basics

## *a. Definitions*

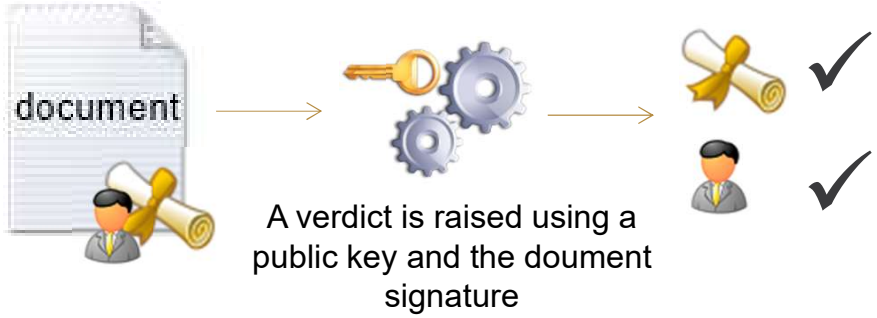
**Sign**

Create an electronic signature that uniquely identifyies data and sender.




**Signature check**

Checks that the data was not tampered and the sender is genuine.



# Cryptography basics

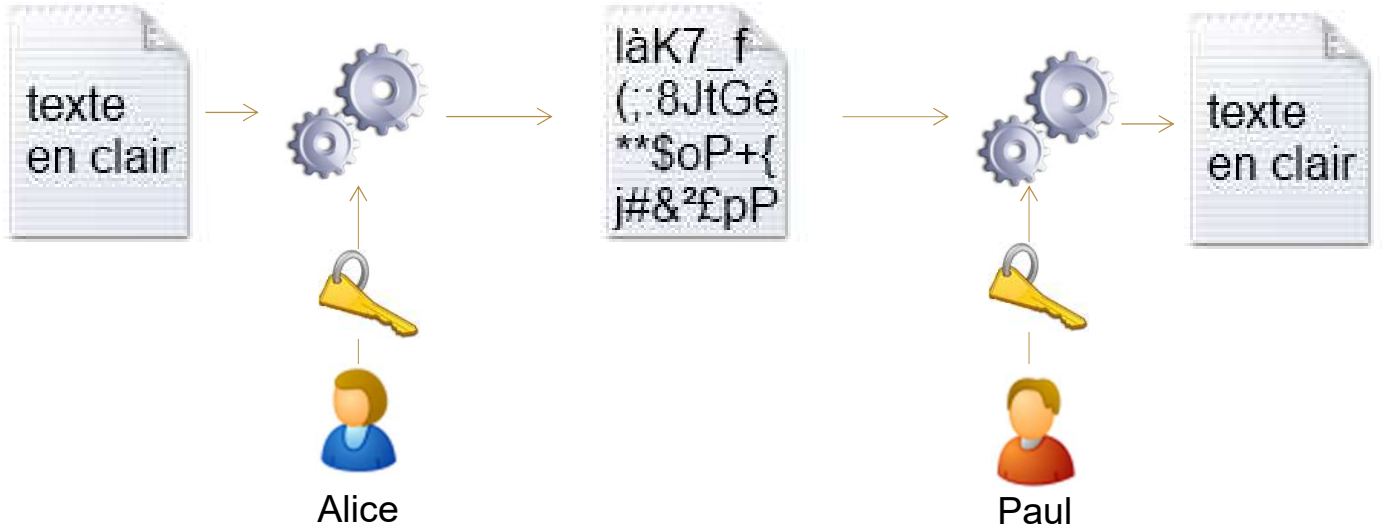
***Symmetric encryption***

- The same key is used to encrypt and decrypt the document
- The weak point is that key has to be kept secret !
- Faster than the asymmetric encryption

# Cryptography basics

***Symmetric encryption***

- Alice wants to send a secure message to Paul





Shared secret key

# Cryptography basics

***Asymmetric encryption***

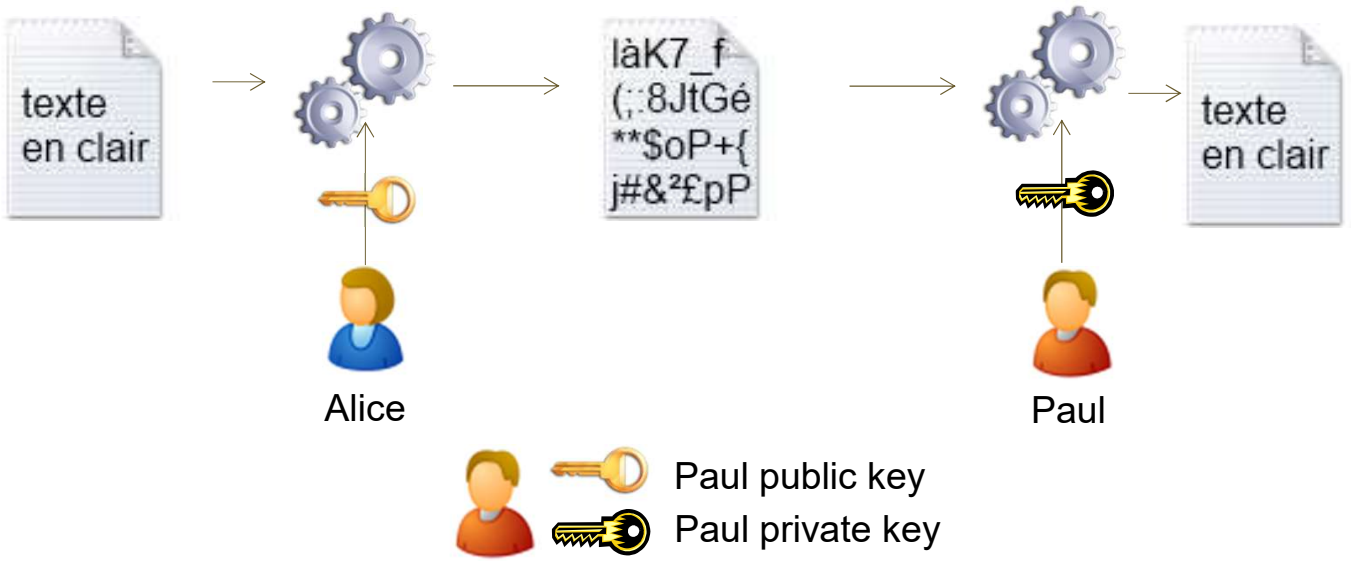
- Two different keys are used, one to encrypt the second one to decrypt:
  - Public key : anyone can obtain this key ;
  - Private key : only the owner has access, it has to be kept secret

- The two keys are mathematically related
  - Knowing the public key does not allow effective calculation of the private key
  - Each use owns two key : the private that must not be communicated and the public key which can be given to anyone.

# Cryptography basics

### *Asymmetric encryption*

- Alice wants to send an encrypted message to Paul
  - Alice encrypts the massage with Paul public key ;
  - Only Paul may decrypt the message using his private key;
  - Notes :
    - Alice never needs (and she cannot) use Paul's private key !
    - Alice does not need to use her own keys in this example while she does not sign the message.



# Cryptography basics

***Symmetric vs asymmetric encryption***

| Symmetric encryption | Asymmetric encryption |
|---|---|
| **Advantages** | |
| • Faster (XOR functions, logical functions)<br>• Short keys (512 bits are enough) | • Keys are ease exchanged. Ony public keys hve to be exchanged<br>• A Public Key Infrastructure can ba managed |
| **Disadvantages** | |
| • Keys are difficult to be exchanged as secrecy has to be kept.<br>• It is not possible to manage the secret shared keys guaranteeing the secrecy… | • Operations are long (modulo exponential)<br>• Needs longer keys (at least 4096 bits) ; |
| **Some well known algorithms** | |
| • AES. | • RSA. |

# Cryptography basics

***Electronic signature***

**Insures that data was not tampered and the sender is genuine**. If the signature is not valid that means that the sender identity is missused or the the data was modifyed

Note :

- **Electronic signature does not insure confidentiality**, but integrity and proof;
- **When one encrypts a message it is recommended to sign it also** in order to grant the sender identity

# Cryptography basics

***Electronic signature***

1. A hash (fixed size code) is generated from the message.;
   - Hash computing algorithm are public. The hash is not a secret. ;
   - The chance to obtain the same hash from two different message is very small.
2. The signature algorithm uses the hash and the private key to generate the authentication key (the actual signature) ;
3. The sender will send the message and the signature ;
4. The receiver computes the hash;
5. The receiver checks the authenticity using the public key of the sender, the hash and the signature

# Cryptography basics

***Security certificates***

An important issue is related to the autheticity of the keys themselves


Anyone can obtain the public key of everybody using key servers. How may one be sure **that « Public key of Paul » actually belongs to Paul** and it was not generated by someone who missused Paul identity ?

Another point : when visiting a web site (a bank) how can one be sure that the web site is genuine and not a fake ?

- Solution : security certificates.

# Cryptography basics

***Security certificates***

A security certificate (digital certificate, public key certificate, identity certificate) is **a file** containing :

- The **Public key** of a person (corporate of web site) ;
- Identity details of the owner (name, address) . ;
- The **digital signature** of a trusted entity that issued the certificate.;
- Information related to the validity of the key, allowed usage etc.

The trusted entity will :

- **Check the identity** of the person asking for the certificate;
- **Creates the certificate** after verification, **and digitally signs it** (with the private key of the trusted entity) ;
- **Keeps up to date a list of certificates which were retired** (for example if the key was compromised).

# Cryptography basics

### *Security certificates*

How to recognize a trusted entity ?

- Directly integrated by the editors in the operating system and browsers;
- User may add new certificates if it chooses to trust them.

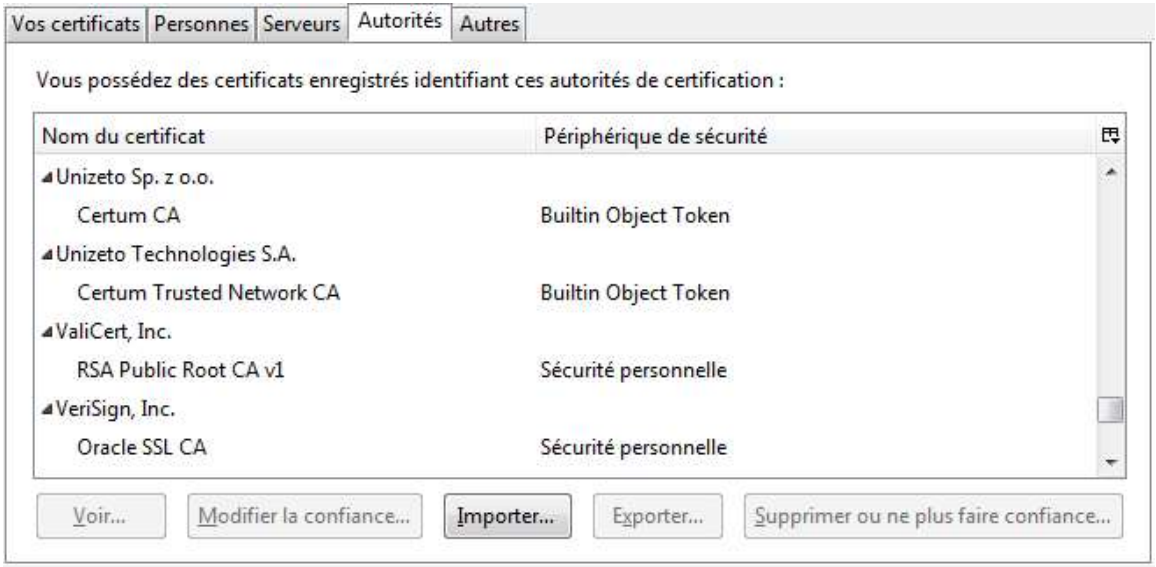



Image : magasin de certificats de Firefox

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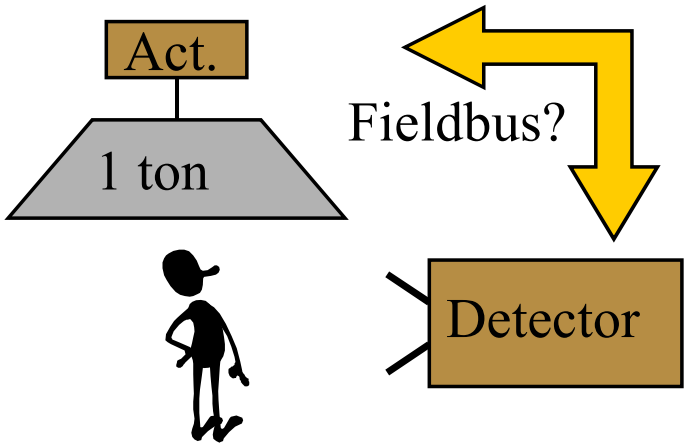
# Safety Networks

*UGA Grenoble – May 2022*

# Safety networks

- 2 aspects of operational safety (see also IEC 61508)
  - Reliability, Maintainability, Availability
- For networks:
  - Offer network monitoring and administration services
  - Allow the implementation of redundancy mechanisms (master, medium…), watchdog…

- Safety
  - Ensure the non-occurrence of dangerous events



# Safety and networks

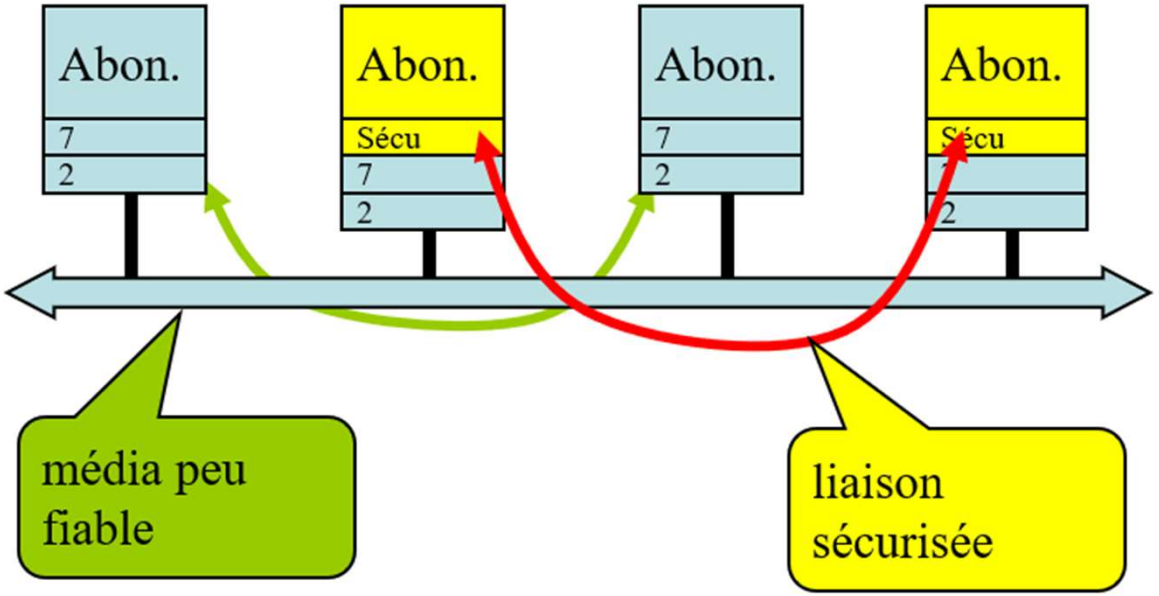
- Objective
  - Extend networks from the « control" function to the "safety" function.
- Interests
  - Gain of implementation
  - Easy detection and localization of faults
- Obstacles
  - Technical: response time required is often shorter than for the control function
  - Constraint: for any fault the system should switch to a safe mode…
  - Regulations: compliance with normative aspects, need for certification

# Safety by levels (EN 954)

| Cat. | Prescriptions / Behaviour |
|---|---|
| B | a fault can lead to the loss of the safety function |
| A1 | idem but with a lower probability thanks to proven principles |
| A2 | a fault → loss of the safety function between control intervals |
| A3 | for a single fault, the safety function is assured |
| A4 | for several faults, the safety function is assured |

# Safety and networks

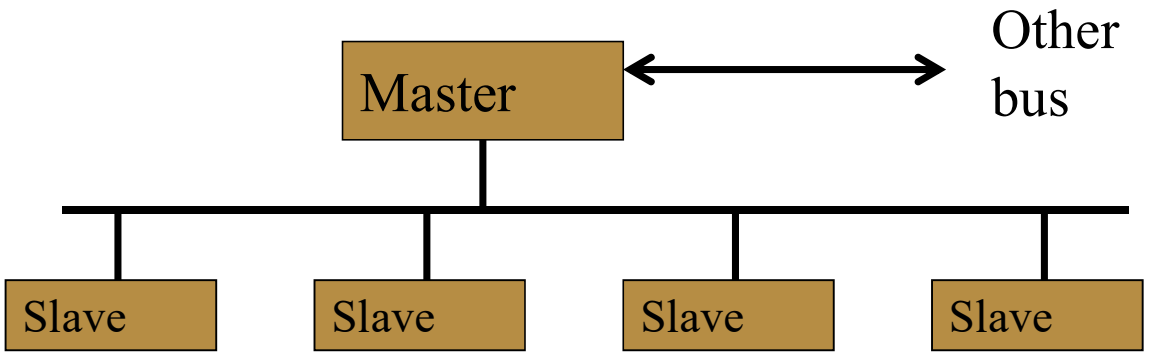
Commonly used principle :
- secure overlay



# Safety Bus

General information:

- Developed by the companies SICK and PILZ
- 1 master / several slaves (up to 60)
- Standard cable (2 conductors)
- Tree topology (500m at 125Kb, 100m at 500kb)
- Response time between 20 and 100ms

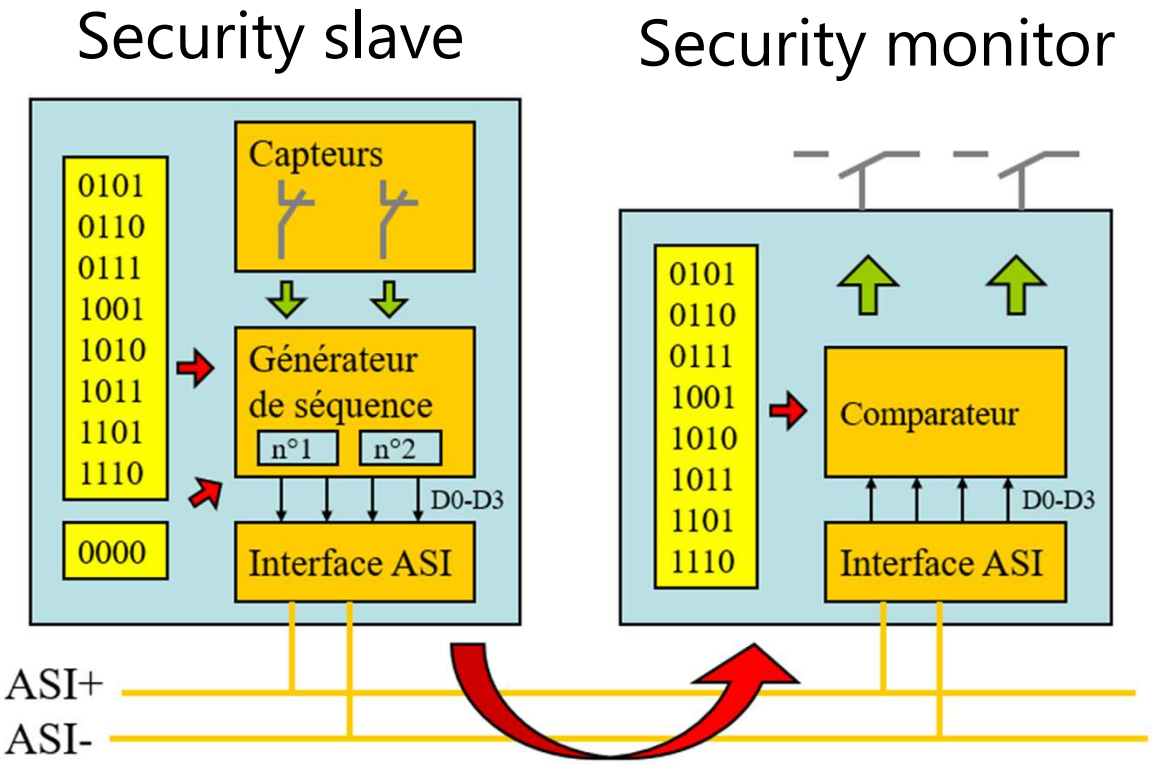


# ASI Safety at Works

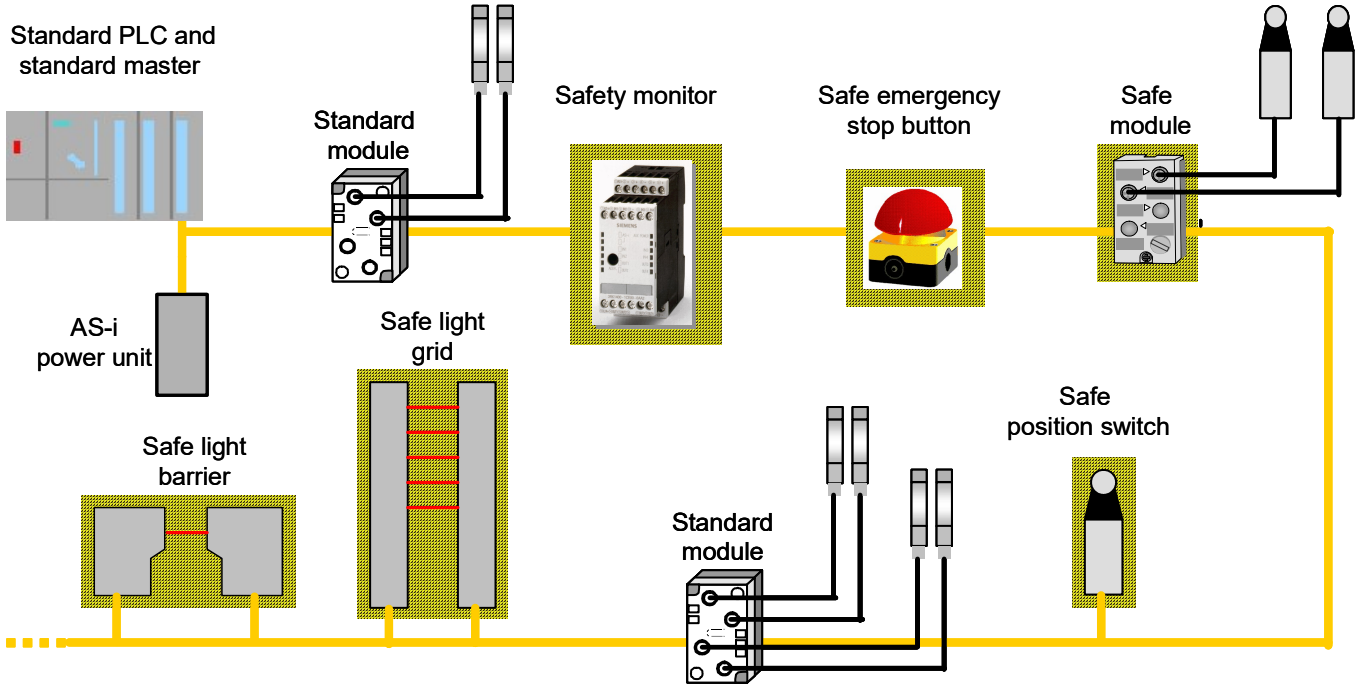
## ASI Safety at Works: transmission sequence

### Principle

- extension to the classical AS-i protocol
- A safety monitor added – continuous monitoring
- Specific safety code table for each slave
- Power supply stop by the monitor (safety relay)
(stop, com. interruption, mess. corrupt, response delay)



# ASI Safety at Works




## Advantages

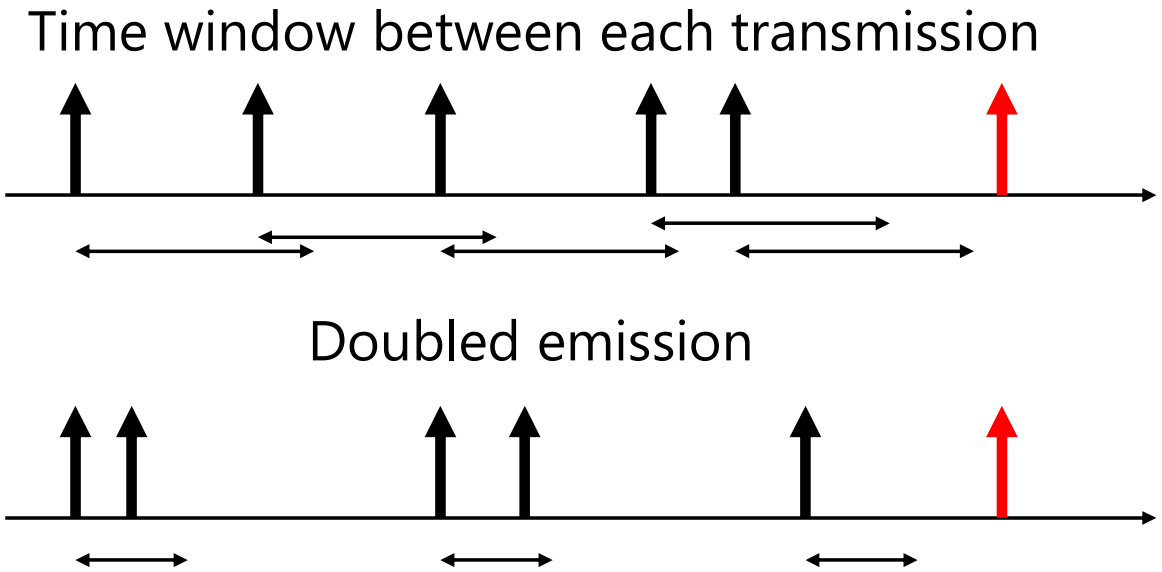
- cabling reduction
- Safety and non-safety on one bus
- Groups of safety signals
- EN 954 – 1 category 4 compliant
- Certified: TUV and BIA
- No AS-i wiring changes needed

# ASI Safety at Works

- ASI is a standard communication bus with finite and fast response times, dedicated to sensors-actuators: it contains error detection and recognition mechanisms (see chapter 5) [SCH 01], [LET 02]. The idea of "ASI Safety at work" is to extend the capabilities of ASI in order to add properties to make it safe and to mix operation traffic with safety traffic on the same bus; users can thus extend their existing installation with safety components.
- The principle is based on the co-existence, on the same network, of conventional components and safety components. A monitor is used to evaluate both safety-related signals and safety-related systems such as emergency stop devices and light curtains.
- This monitor is passive, it does not transmit any communication. The role of the monitor is to listen to all safety traffic and to detect consecutive sequences of four zero bits. Four consecutive zeros indicate that something has gone wrong, either a user has triggered a safety system and pressed an emergency stop, or faults have been detected on the communication bus or on one of the components. Without worrying about the cause of the error, as soon as four consecutive bits are detected at zero, the monitor puts the system in the fallback position that has been programmed. It is possible to have several monitors on the network, each controlling a part of the automation system.
- The safety components can be connected to the ASI Safety at work network via a safety slave. The ASI Safety at work network has been certified by TüV and BIA as category 4 in accordance with EN 954-1 [Std 954].Translated with www.DeepL.com/Translator (free version)

# CAN Open Safety

Security CANOpen:
- Difficulties related to non-deterministic access, but arbitration → estimated maximum time
- Use of 2 watch dogs:



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Merci pour votre attention

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**ຂອບໃຈຫຼາຍໆ ສຳ ລັບຄວາມສົນໃຈຂອງ ທ່ານ (LAO)**

**ขอบคุณมากสำหรับความสนใจของคุณ (TH)**

**Merci pour votre attention**

**Thank you for your attention**