UGA
Université
Grenoble Alpes

# Security of information systems

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

Jean-Marc THIRIET

jean-marc.thiriet@univ-grenoble-alpes.fr

# Introduction to Network and Systems Security

- Security is increasingly important in Networks and Telecommunications
  - Today's networks are open rather than closed
    - IP VPN
    - Intranet
    - Extranet
    - IPSec
    - Wi-Fi

<u>Types of applications</u>
Web access
Mailing
Internet access
E-commerce

The use of the Internet in companies is widespread

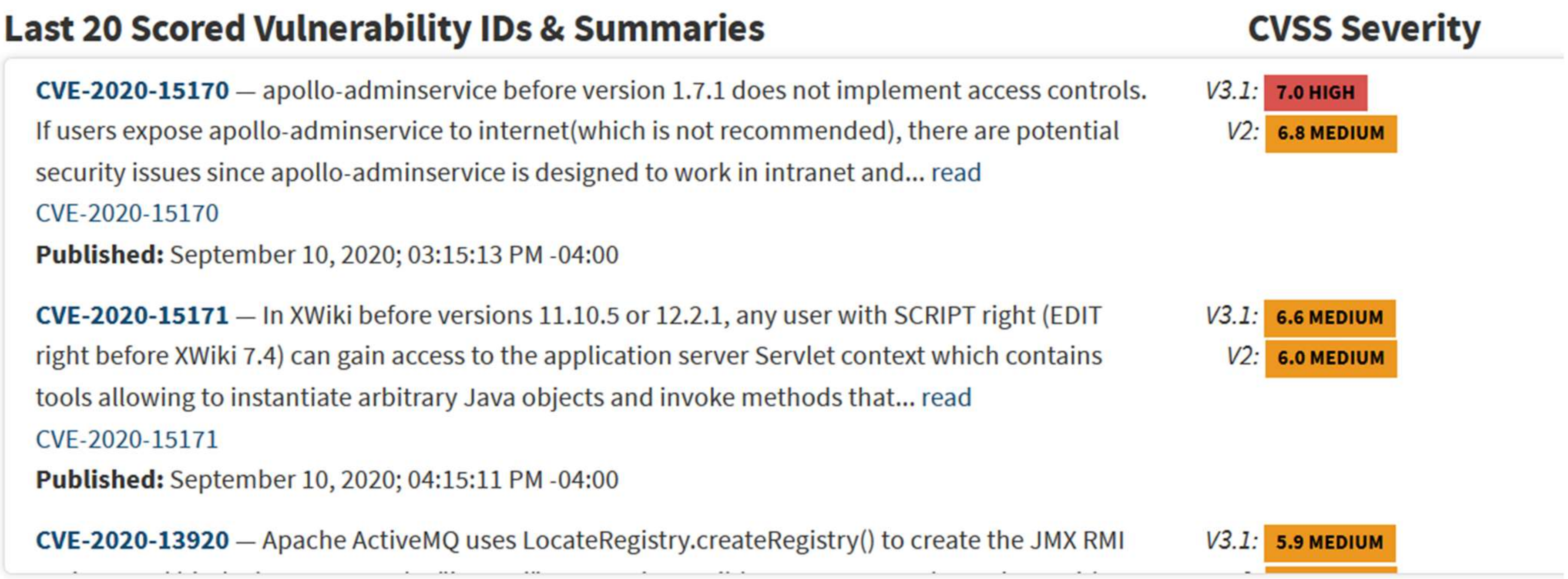
# Brainstorm

- Database access
- Read (confidentiality)/Write (integrity) authorization
- Privacy
- Integrity (data, transmissions, buildings)
- Quality and stability of the connection
  - Availability (Disponibilité)

- To forbide what is not useful

# Brainstorming

- Security risks around networks and information systems
- https://nvd.nist.gov/



## Last 20 Scored Vulnerability IDs & Summaries

## CVSS Severity

**CVE-2020-15170** — apollo-adminservice before version 1.7.1 does not implement access controls. If users expose apollo-adminservice to internet(which is not recommended), there are potential security issues since apollo-adminservice is designed to work in intranet and... read CVE-2020-15170

**Published:** September 10, 2020; 03:15:13 PM -04:00

*V3.1:* 7.0 HIGH
*V2:* 6.8 MEDIUM

**CVE-2020-15171** — In XWiki before versions 11.10.5 or 12.2.1, any user with SCRIPT right (EDIT right before XWiki 7.4) can gain access to the application server Servlet context which contains tools allowing to instantiate arbitrary Java objects and invoke methods that... read CVE-2020-15171

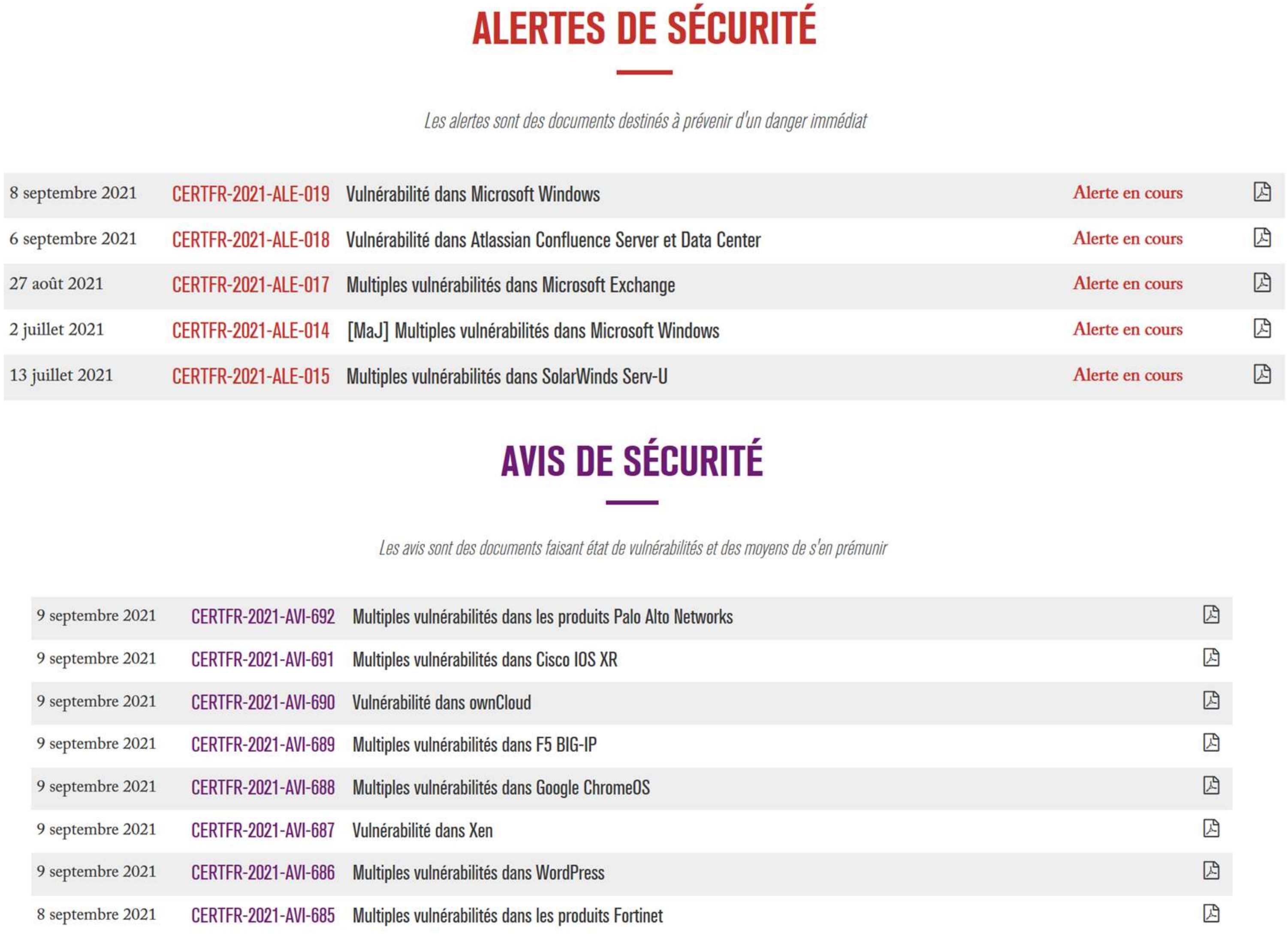
**Published:** September 10, 2020; 04:15:11 PM -04:00

*V3.1:* 6.6 MEDIUM
*V2:* 6.0 MEDIUM

**CVE-2020-13920** — Apache ActiveMQ uses LocateRegistry.createRegistry() to create the JMX RMI

*V3.1:* 5.9 MEDIUM

# Brainstorming: https://www.cert.ssi.gouv.fr/



## ALERTES DE SÉCURITÉ

*Les alertes sont des documents destinés à prévenir d'un danger immédiat*

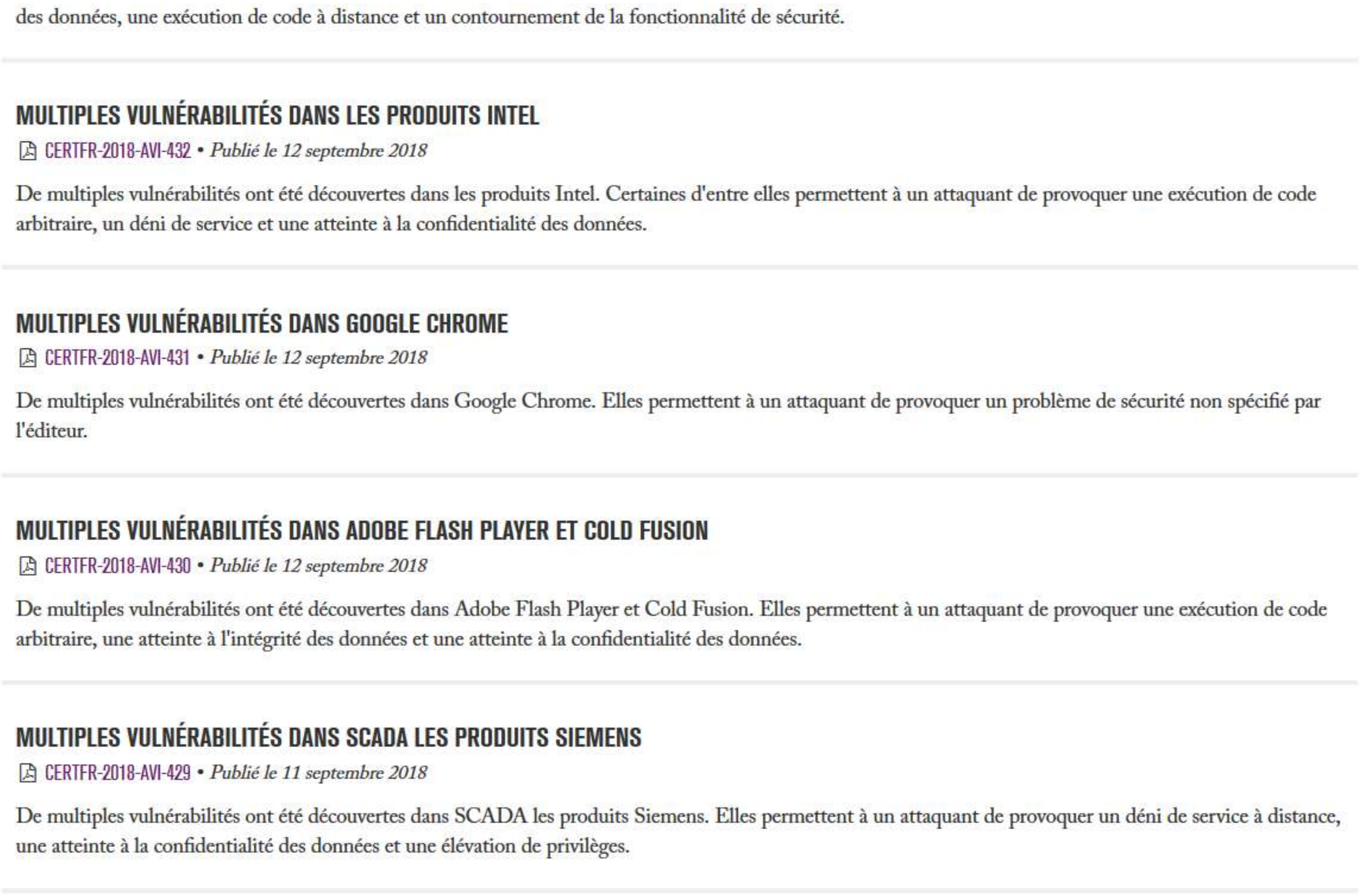
| | | | |
|---|---|---|---|
| 8 septembre 2021 | CERTFR-2021-ALE-019 | Vulnérabilité dans Microsoft Windows | Alerte en cours |
| 6 septembre 2021 | CERTFR-2021-ALE-018 | Vulnérabilité dans Atlassian Confluence Server et Data Center | Alerte en cours |
| 27 août 2021 | CERTFR-2021-ALE-017 | Multiples vulnérabilités dans Microsoft Exchange | Alerte en cours |
| 2 juillet 2021 | CERTFR-2021-ALE-014 | [MaJ] Multiples vulnérabilités dans Microsoft Windows | Alerte en cours |
| 13 juillet 2021 | CERTFR-2021-ALE-015 | Multiples vulnérabilités dans SolarWinds Serv-U | Alerte en cours |

## AVIS DE SÉCURITÉ

*Les avis sont des documents faisant état de vulnérabilités et des moyens de s'en prémunir*

| | | |
|---|---|---|
| 9 septembre 2021 | CERTFR-2021-AVI-692 | Multiples vulnérabilités dans les produits Palo Alto Networks |
| 9 septembre 2021 | CERTFR-2021-AVI-691 | Multiples vulnérabilités dans Cisco IOS XR |
| 9 septembre 2021 | CERTFR-2021-AVI-690 | Vulnérabilité dans ownCloud |
| 9 septembre 2021 | CERTFR-2021-AVI-689 | Multiples vulnérabilités dans F5 BIG-IP |
| 9 septembre 2021 | CERTFR-2021-AVI-688 | Multiples vulnérabilités dans Google ChromeOS |
| 9 septembre 2021 | CERTFR-2021-AVI-687 | Vulnérabilité dans Xen |
| 9 septembre 2021 | CERTFR-2021-AVI-686 | Multiples vulnérabilités dans WordPress |
| 8 septembre 2021 | CERTFR-2021-AVI-685 | Multiples vulnérabilités dans les produits Fortinet |

# Also Industrial systems…



des données, une exécution de code à distance et un contournement de la fonctionnalité de sécurité.

### MULTIPLES VULNÉRABILITÉS DANS LES PRODUITS INTEL

CERTFR-2018-AVI-432 • *Publié le 12 septembre 2018*

De multiples vulnérabilités ont été découvertes dans les produits Intel. Certaines d'entre elles permettent à un attaquant de provoquer une exécution de code arbitraire, un déni de service et une atteinte à la confidentialité des données.

### MULTIPLES VULNÉRABILITÉS DANS GOOGLE CHROME

CERTFR-2018-AVI-431 • *Publié le 12 septembre 2018*

De multiples vulnérabilités ont été découvertes dans Google Chrome. Elles permettent à un attaquant de provoquer un problème de sécurité non spécifié par l'éditeur.

### MULTIPLES VULNÉRABILITÉS DANS ADOBE FLASH PLAYER ET COLD FUSION

CERTFR-2018-AVI-430 • *Publié le 12 septembre 2018*

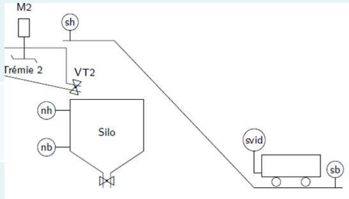
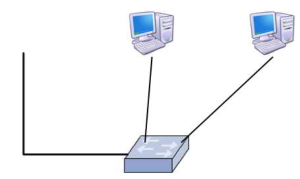
De multiples vulnérabilités ont été découvertes dans Adobe Flash Player et Cold Fusion. Elles permettent à un attaquant de provoquer une exécution de code arbitraire, une atteinte à l'intégrité des données et une atteinte à la confidentialité des données.

### MULTIPLES VULNÉRABILITÉS DANS SCADA LES PRODUITS SIEMENS

CERTFR-2018-AVI-429 • *Publié le 11 septembre 2018*

De multiples vulnérabilités ont été découvertes dans SCADA les produits Siemens. Elles permettent à un attaquant de provoquer un déni de service à distance, une atteinte à la confidentialité des données et une élévation de privilèges.

# Comparison between IT (Information Technology) and OT (Operational Technology, ex: ICS)

| Category | IT systems | ICS systems |
|---|---|---|
| **Cyber security culture** | Awareness of risks<br>Methods and tools | Recent   M2<br>sh<br>Trémie 2<br>VT2<br>nh<br>Silo<br>nb<br>svid<br>sb |
| **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 |

# Approaches for security

- Theoretic approach (cryptology, virology)
- In-depth security
- Organisational approach (security policy, human aspects (social engineering), saving policy)
- Methodological approach (firewall configuration, attacks strategies and defense…)
- Technological approach (network, topology, servers, hardware and software firewalls, security protocols)
- Testing (quality) approach (checking, testing, audit…)

# 3. Introduction to dependability, security principles

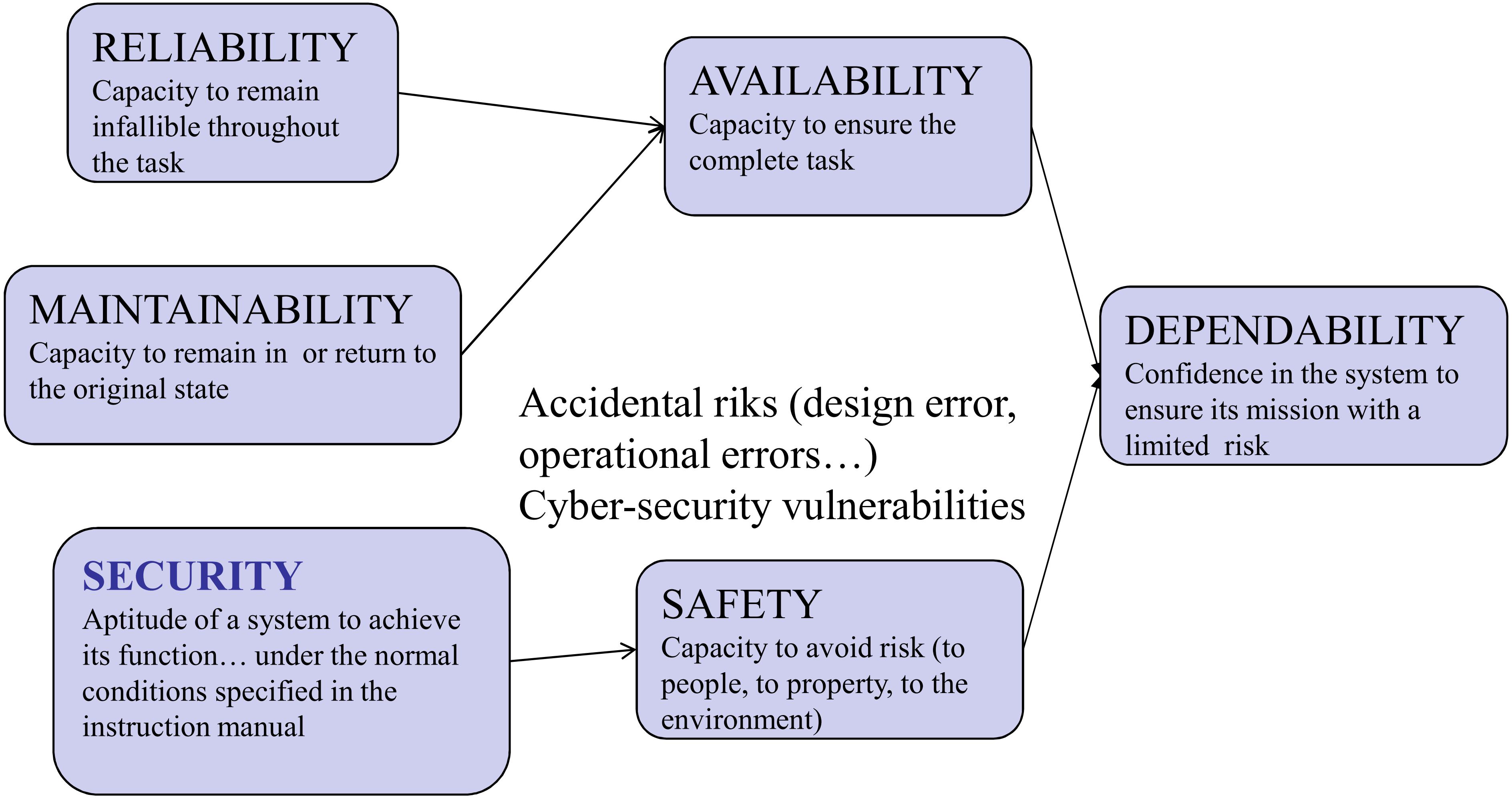
3.1 Dependability

3.2 Safety and security: definition

3.3 Safety and security principles

# Dependability

**RAMS** : Reliability, Availability, Maintainability, Safety



RELIABILITY
Capacity to remain infallible throughout the task

AVAILABILITY
Capacity to ensure the complete task

MAINTAINABILITY
Capacity to remain in  or return to the original state

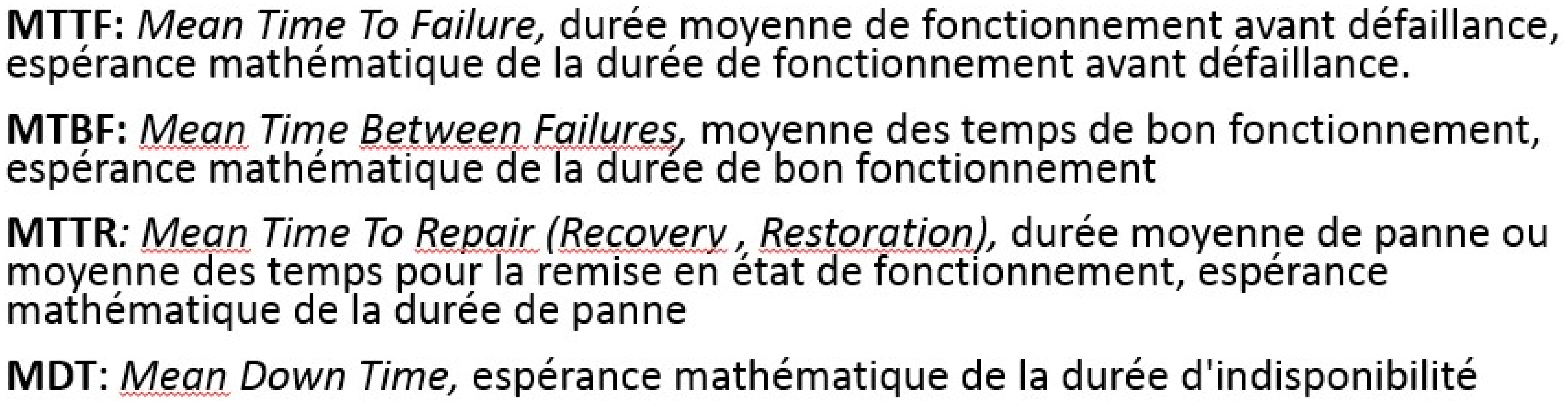
DEPENDABILITY
Confidence in the system to ensure its mission with a limited  risk

Accidental riks (design error, operational errors…)
Cyber-security vulnerabilities

SECURITY
Aptitude of a system to achieve its function… under the normal conditions specified in the instruction manual

SAFETY
Capacity to avoid risk (to people, to property, to the environment)

# Dependability parameters



**MTTF:** *Mean Time To Failure,* durée moyenne de fonctionnement avant défaillance, espérance mathématique de la durée de fonctionnement avant défaillance.

**MTBF:** *Mean Time Between Failures,* moyenne des temps de bon fonctionnement, espérance mathématique de la durée de bon fonctionnement

**MTTR**: *Mean Time To Repair (Recovery , Restoration),* durée moyenne de panne ou moyenne des temps pour la remise en état de fonctionnement, espérance mathématique de la durée de panne

**MDT**: *Mean Down Time,* espérance mathématique de la durée d'indisponibilité

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

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*.

# Safety
# = the Science of Failures

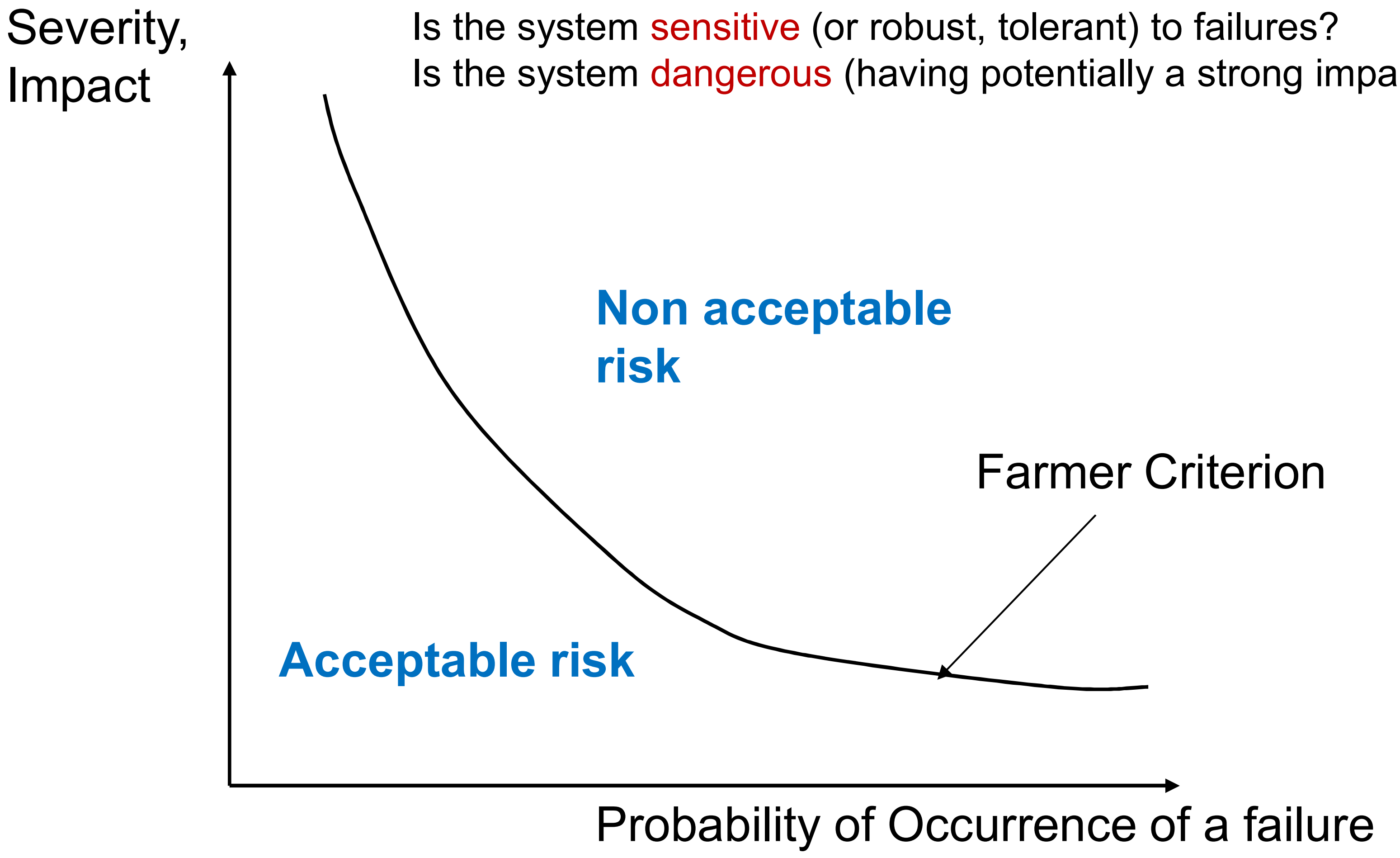
- Failure: interruption of the capacity of an entity to carry out a necessary function
  - The function concerned should be defined
    - ex 1: to ensure communication between two sites
    - ex 2: **to ensure the accessibility of data** (locally and remotely)
  - the criterion of interruption of this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

# Severity-probability law

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



# 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 %

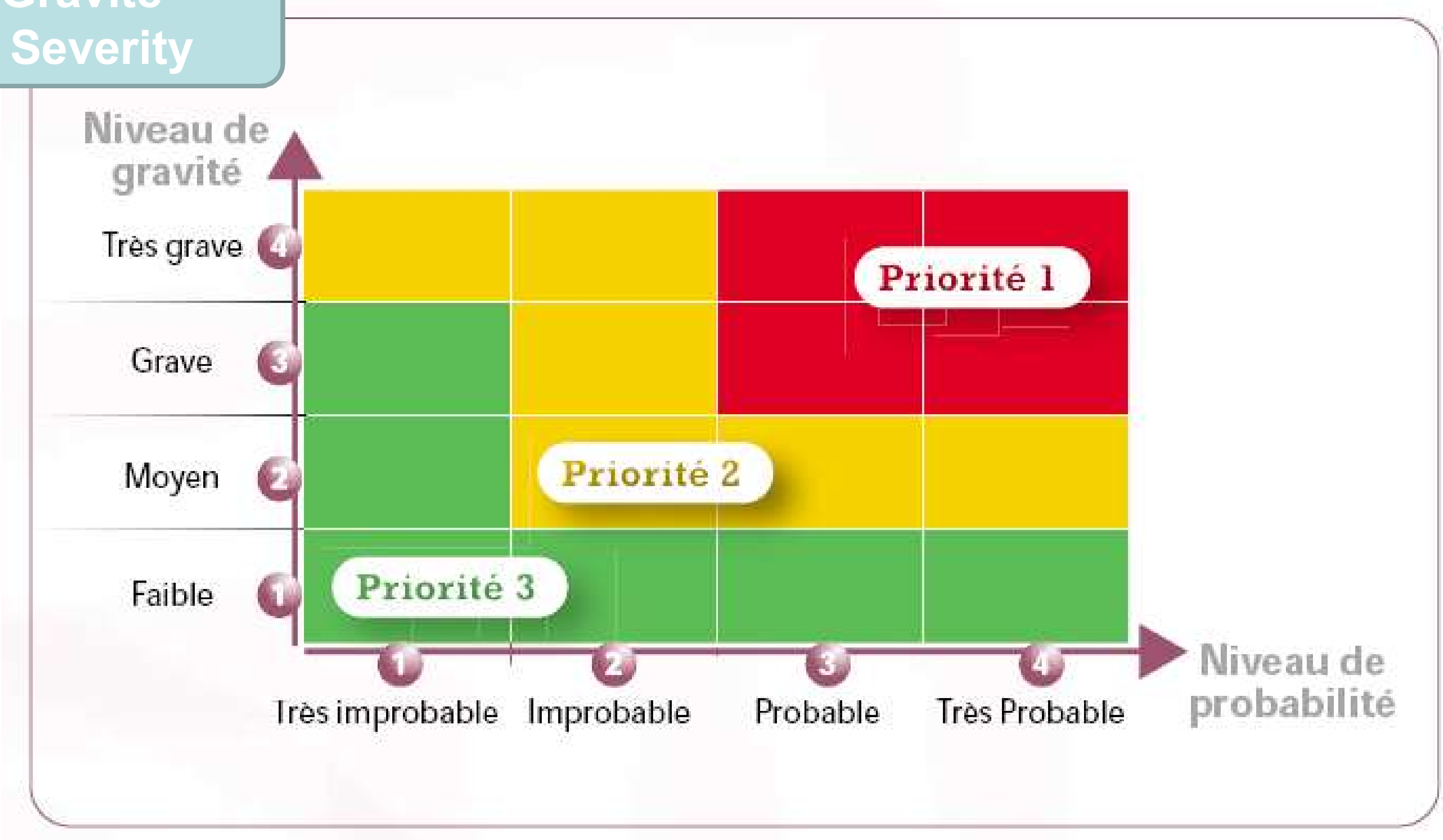
# Elements of risks (Vulnerability)

- 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,
    - …

# Risks evaluation, evaluation of the severity

**Gravité = Severity**



# Example

| Danger (cause) | Dangerous situation | Dangerous event | Risk of… | Consequence | Severity | Probability | Priorities | Observations |
|---|---|---|---|---|---|---|---|---|
| Explosion of a tyre | Car sliding | Screw in the tyre | Accident | Killing people in the car | 4 (high) | 1 (low) | 2 (int.) | Having a spare wheel … |

# 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 Industriel Automation and Control Systems
4. EU efforts about smart grid security
5. ANSSI Classification method and key measures

# 3.2 Safety and security: definition

- Security: definition (from EN 292 standards)
  - Aptitude of a system to achieve its function… under the normal conditions specified in the instruction manual…
- Safety
  - Aptitude of an entity to avoid revealing critical or catastrophic events => likely to affect people, equipment, the environment
- **Confidentiality & Integrity**
  - Aptitude of one entity to safeguard the confidentiality and the integrity of information

# 3.2 Definitions of terms related to the reliability and the security for applications such like data-processing networks (1/2)

Direct Properties of Security

- Confidentiality *(confidentialité)*: preventing the visualization of information by unauthorized persons
- Integrity *(intégrité)*: preventing the non-detection of modifications of information by unauthorized persons
- Authentication *(authentification)*: allowing the identity check of users

Property linked to security

- Availability *(disponibilité)*: *preventing* unauthorized persons

  access in order to guaranty the use by authorized users

# 3.2 Definitions of terms related to the reliability and the security for applications such like data-processing networks (2/2)

- Authorization *(autorisation)*: preventing access to the system by unauthorized persons
- Auditability *(auditabilité)*: possibility of rebuilding the complete history of the system from recordings of histories
- Non "repudiability" *(non répudiabilité)*: possibility of  providing irrefutable proof of the perpetrator of an action on the system
- Protection from third parties: preventing serious damage linked to an attack (pirating) by third parties.

# 3.3 Security principles

# Security principles

- 3.3.1 Physical security
- 3.3.2 Exploitation security
- 3.3.3 Logical security
- 3.3.4 Applicative security

# 3.3.1 Physical security

- Protection of energy sources (electricity (power supplies)…)
- Environmental protection (fire, temperature, moisture (humidity)…)
- Protection of access
  - Physical protection of the equipment
  - Distribution premises
  - Plugboards (electrical connections boards), cabled infrastructure,
  - Traceability of access on the premises
- Operational reliability and materials reliability
- Physical redundancy
- Marking (census) of the materials
- Preventive (tests…) and corrective (spare parts…), maintenance plans

# 3.3.2 Exploitation security

- Back up plan
- Emergency help plan
- Continuity plan
- Test plan
- Regular and if possible dynamic inventories
- Management of the computer park
- Management of the configurations and the updates
- Management of the incidents and follow-ups until resolution
- Automation, control and follow-up of the exploitation
- Analysis of accountancy and logging files
- Management of the maintenance contracts
- Separation of the environments of development, industrialization and production of add-ons
- Reliable and quality connectivity
- Protected infrastructure network

# 3.3.3 Logical security

- Mechanisms of security by software
  - Identification
  - Authentication
  - Authorization
- Devices set up to guarantee confidentiality and integrity
  - Cryptography
  - Effective password management
  - Antivirus
  - Backup of sensitive data
- Classification of data
  - Degree of sensitivity (normal, confidential…)

# 3.3.4 Applicative security

- Development Methodology (respect of the development standards suited to the technology employed)
- Robustness of the applications
- Programmed checks, tests
- security of the software packages (choice of the suppliers, interfaces security)
- Contracts with subcontractors (responsibility clauses)
- Migration plan of critical applications
- Validation and audit of programs
- Quality and relevance of data
- Security Insurance Plan

# Type d’Applications

1. Systèmes d’Exploitation
   - Windows W. Server, Linux, Mac OS (ordinateurs, serveurs)
   - Android, iOS (OS de téléphones portables)
   - Real Time OS (IoT, systèmes embarqués)
2. Applications classiques
   - Office software (Open Office, Microsoft Office)
   - Matlab
3. Applications métier
   - TIA Portal…
4. Logiciels « Faits-maison »
   - ???

# Example

- The management team of a company requires the following objectives:
  - Availability of the communication media of the Headquarters situated in Paris
  - Availability of the communication media for the Grenoble plant
  - Availability of the communication media with the suppliers or sub-contractors ABC
  - Availability of the mailing system
  - Production
  - Confidentiality and integrity of the company production « secrets »
  - Updates of the production programme

# Deontology

- Students

  => signing of a computer (informatics) charter

- Engineer with Security aspects

  **=> responsibility**

- The use of the methods described in this course engages the responsibility of the users!

# References

- J.F. Aubry – Cours de Sûreté de Fonctionnement, INPL Lorraine, 2005.
- J.C. Laprie & al. – Guide de la sûreté de fonctionnement – Cépaduès, 1995.
- A. Villemeur – *Sûreté de fonctionnement des systèmes industriels* – Editions Eyrolles, Paris, 1988.
- S. Ghernaouti-Helie – *Sécurité informatique et réseaux, 4*$^{\text{ème}}$ *édition* – Dunod, 2013
- C. Davis, M. Schiller, K. Wheeler - *IT Auditing: using control to protect assets* – 2007, Mc Graw Hill