UIC

INTERNATIONAL UNION OF RAILWAYS

INTERNATIONAL CONFERENCE ON RELIABILITY, SAFETY AND SECURITY OF RAILWAY SYSTEMS

new methods for safety demonstration in the frame of railway system

Frédéric HENON
Head of Operations and Safety

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INTRODUCTION

Frédéric Hénon – Head of Operations and Safety - UIC

- 1991-2005 - Eurotunnel (Channel Tunnel Rail Link, railway system commissioning phase, and start of operations in may 1994). Successively « French Railway Planning Officer », « Train Crew Leader », « Duty Operations Manager », and « Head of Infrastructure Maintenance Logistics »
- 2005-2009 - RFF (Reseau Ferré de France) as Operations and Maintenance Manager
- 2009-2013 - EPSF (French National Safety Agency), as Interoperability and Safety Officer, working mainly with French Transport Ministry and ERA for the development of TSI's and CSM's. Was at this time Railway Inspector for the IGC (intergovernmental commission) for the Channel Tunnel.
- 2013-2017 - Eurostar HS, deputy Head of Safety / Head of Railway Operations Planning and Performance.
- 2017-2020 - SNCF Safety Directorate, working on the settlement of a reformatted safety culture with the SNCF group. SNCF delegate, ex. UIC Safety Platform Steering group, ERA and other bodies for the development of safety culture , safety leadership, risk model, etc.
- July 2020 - Head of Operations and Safety – UIC

entitled with a Mathematics Degree, and a Master in Transportation's Economy

UIC: A LONG HISTORY OF SERVING MEMBER RAILWAYS AND FACILITATING INTERNATIONAL RAILWAY COOPERATION

1921

Intergovernmental (diplomatic) conference in Portorož, Slovenia (formerly in Italy)

1922

Intergovernmental (diplomatic) conference in Genoa, Italy

October 1922

Constitutive Assembly of UIC (Paris):
UIC statutes adopted by 51 railway administrations in 29 countries (Europe, Asia)

2022

200 member railways in 95 countries

100th anniversary

100 YEARS ANNIVERSARY UIC
INTERNATIONAL UNION OF RAILWAYS

3 fora

9 platforms

23 sectors

136 working groups

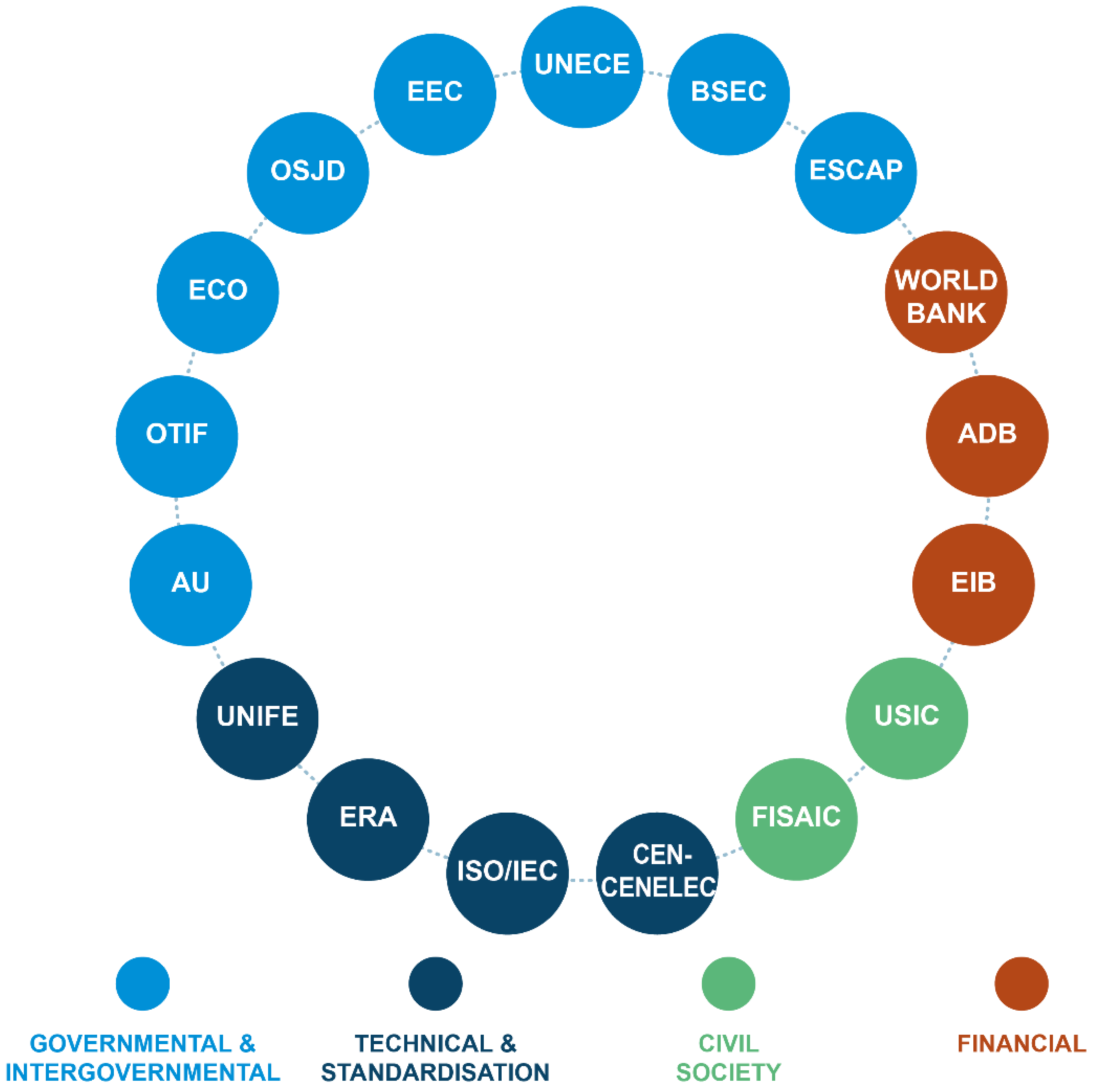
9 special groups

95 countries

200 members

2000 experts

SYNERGIES WITH LEADING INSTITUTIONS DEVELOPED BY UIC



ADB: Asian Development Bank

AU: African Union

BSEC: Black Sea Economic Cooperation

CEN: Comité européen de normalisation

CENELEC: Comité européen de normalisation en électronique et en électrotechnique

EEC: Eurasian Economic Commission

ECO: Economic Cooperation Organization

EIB: European Investment Bank

ERA: European Railway Agency

ESCAP: The Economic and Social Commission for Asia and the Pacific

FISAIC: Fédération Internationale des Sociétés Artistiques et Intellectuelles de Cheminots

ISO: International Organization for Standardization

OSJD: Organisation for Cooperation between Railways

OTIF: Intergovernmental Organisation for International Carriage by Rail

UNECE: United Nations Economic Commission for Europe

UNIFE: Union des Industries Ferroviaires Européennes

USIC: International Railway Sports Association

VISION OF RAIL IN 2030

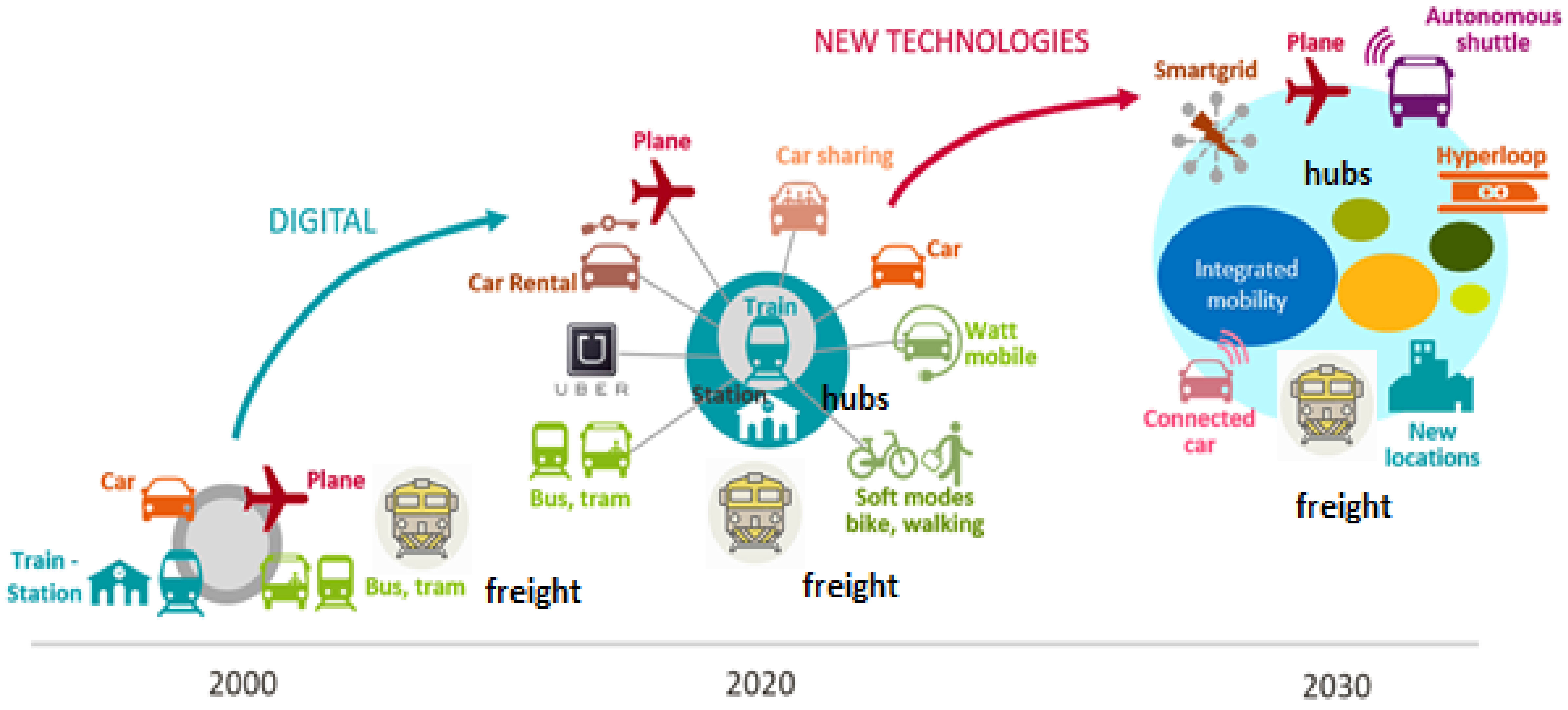
- Transport modal shift
- Increase of the railway capacity
- CCS & FRMCS
- Automation
- Lighter trains
- Railway Digital Modelling
- Frugal eco-design
- Reduction of railway noise
- Biodiversity
- Green energy, hydrogen and batteries
- Digitisation in rail freight
- Green logistics
- Resilience of railway infrastructures and rolling stock to climate change
- Operational resilience to climate change
- Predictive maintenance
- Multimodal e-tickets
- Inclusivity
- Accessibility
- Acceleration of the cycle of innovation

“Operations & Safety” encompass all the processes and responsibilities required to operate a train with passengers or freight, from “service design” to “return of experience”

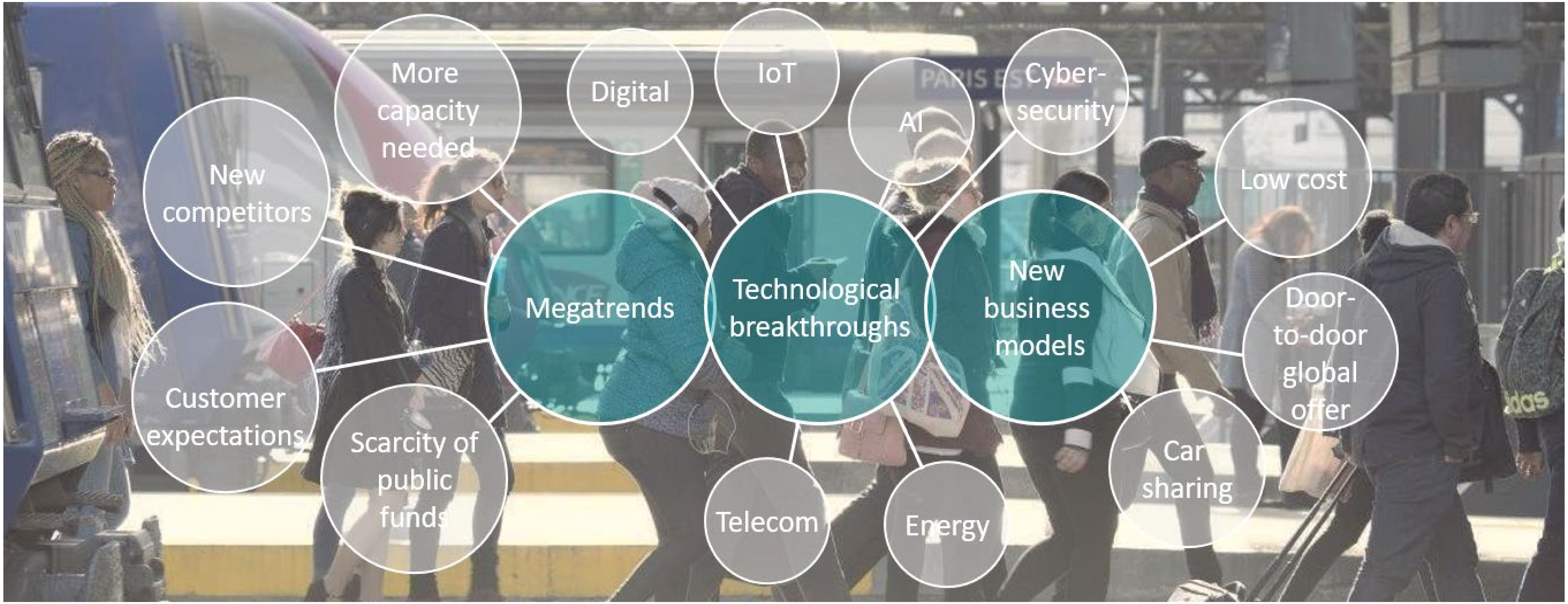
DNA of UIC Operations & Safety - Roadmap 2022-2025

- Achieve with an **efficient and practicable « Return of Experience »** through **Common Railway Risk Models,** based on a **confidential & competent international processes for data sharing / data interoperability**
- **Deliver UIC technical solutions** (procedures, guidances, tools, etc.), as **Risk Control Measures (RCM) and Means of Performance and Compliance for « Integrated Safety and Performance of Operations » (AMOC)**
- Deliver **Trainings and Tools (Academy + Clusters/Hubs)**
- **Deliver Assistance to Members (Audits / Change Management/Peer Reviews)**

FROM DIGITAL TO INTEGRATED MOBILITY



THE RAILWAY SYSTEM MUST RE-INVENT



⟶ The new paradigm for railway engineers and safety engineers is not future, but already actual and real.
⟶ The different new technologies involved, such as AI, Video Content Analysis, etc., solve problems, but remain rather opaque about “how” they actually solve them. Interpretability of results is therefore a “key” question.

HOW and WHAT ? INNOVATION FIELDS

MAINTENANCE

OPTIMISATION OF RESOURCES AND OPERATIONS

SERVICES AND PASSENGER EXPERIENCE

ENERGY

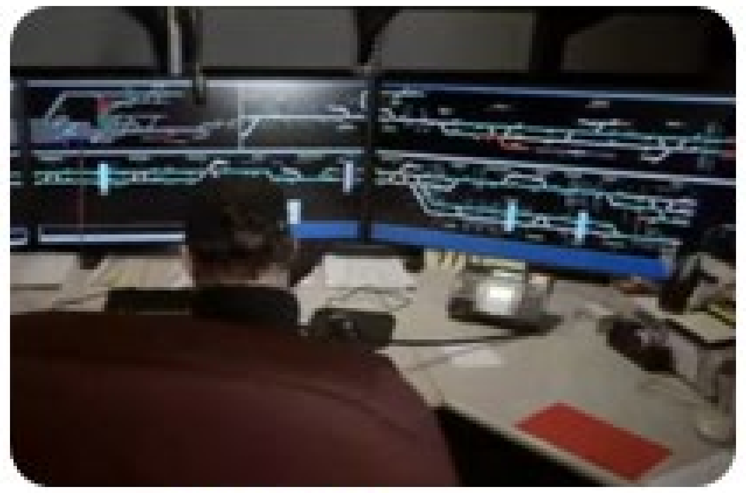
DATA AND MOBILITIES

SYSTEM SAFETY

SUSTAINABLE DEVELOPMENT

Increased RUNNING

Improved PUNCTUALITY



Greater FLEXIBILITY

Better ENERGY SAVINGS

SAFETY

EU Regulations and Standardisation Process

EU Regulatory Framework

MANDATORY

Interoperability & Safety Directives + ERA regulation

6 essential requirements (1)

Mandatory Rules

- TSIs (2): EN standards and UIC documents (as specifications or technical documents) are referenced /quoted in TSIs
- National rules: some UIC documents are also referenced in national rules

VOLUNTARY

Level of details

Presumption of Conformity

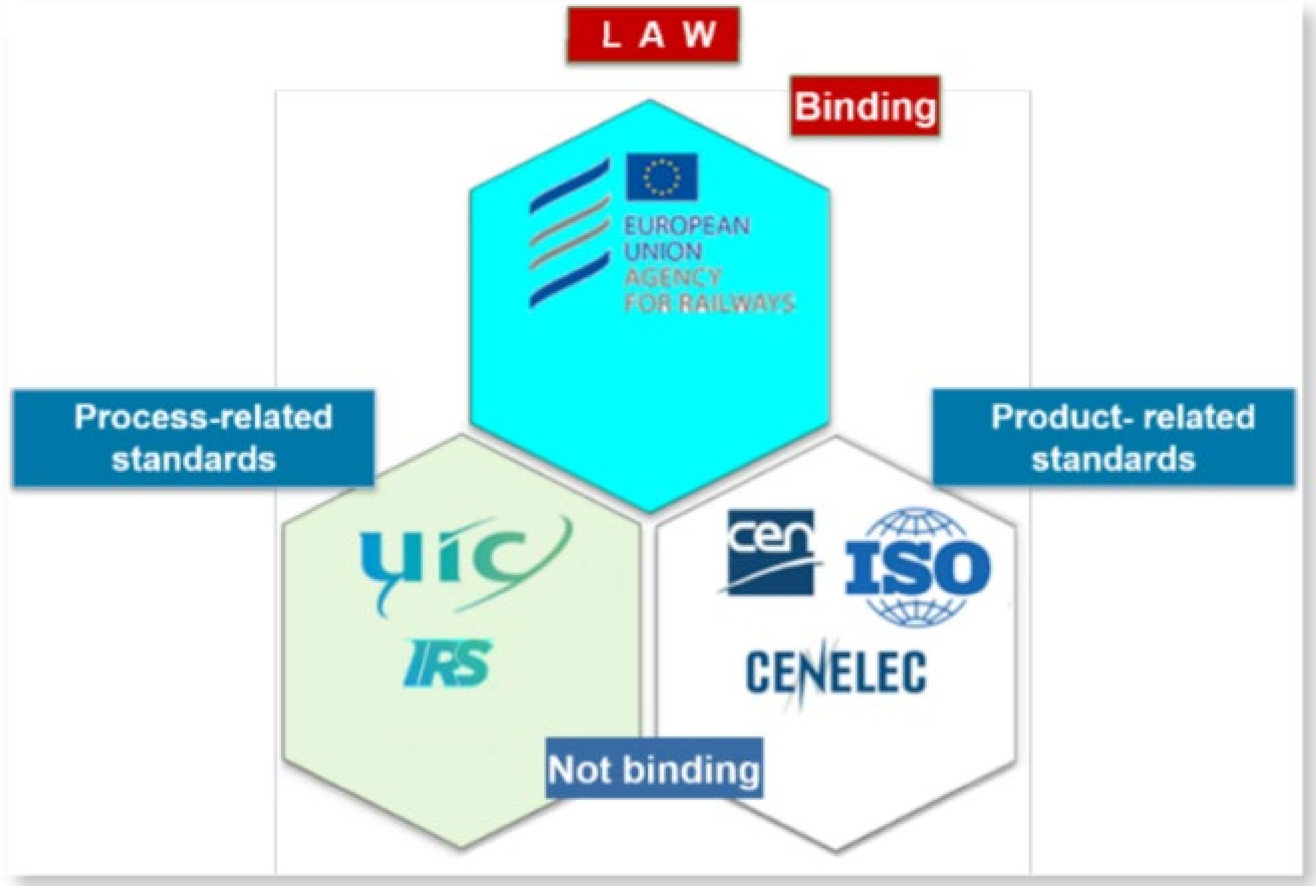
- Harmonised EN standards (3): many EN standards are UIC based and must respect copyrights
- AMoCs (4) : may be used for the assessment of projects (5)
- Guidelines (6)

AMoCs and Guidelines can be drafted by UIC, and then approved and published by ERA

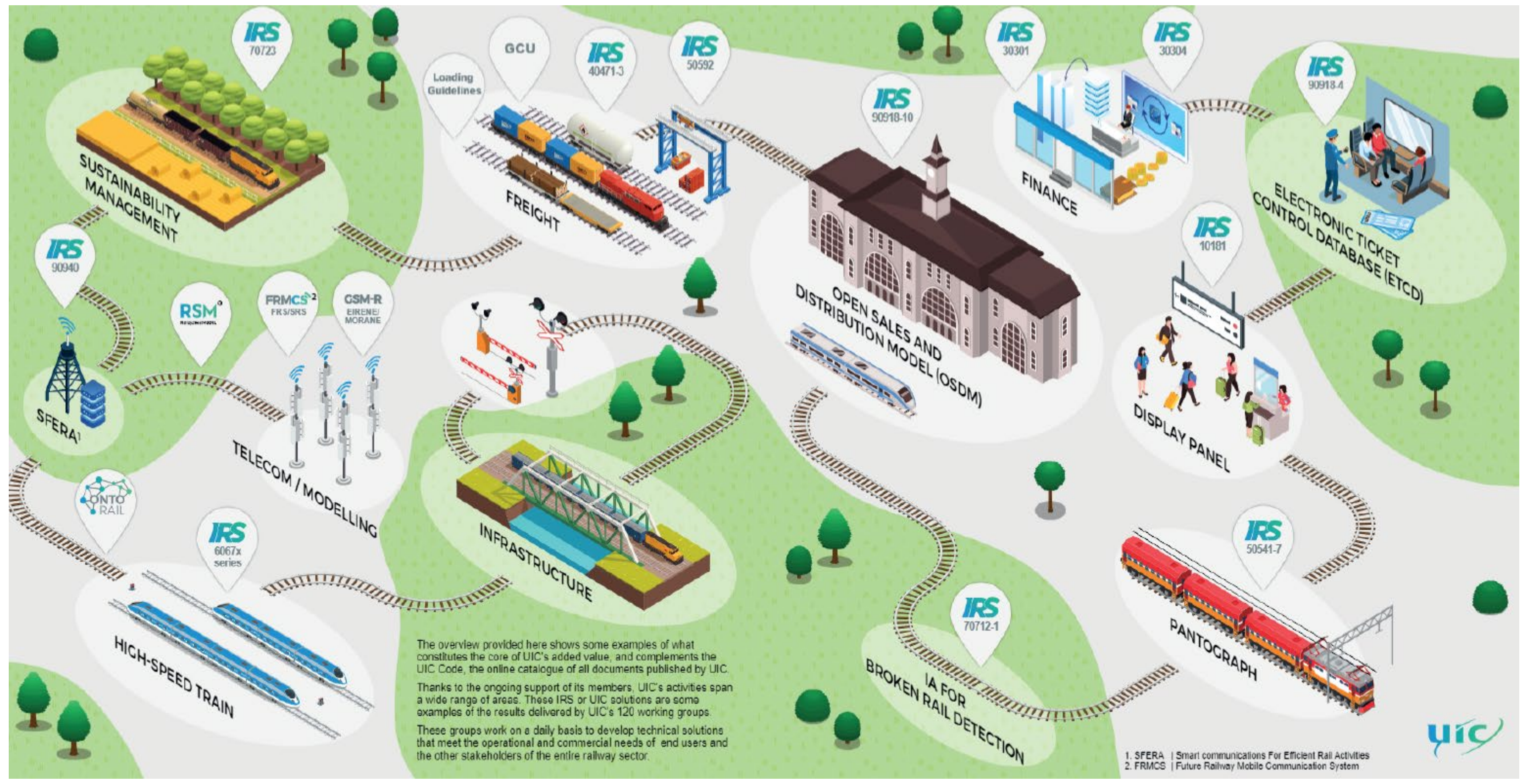
Voluntary 'Sector Standards'

- EN standards, ISO, IEC Standards
- Some UIC Leaflets / IRSs are used by manufacturers on a voluntary basis
- Some UIC Leaflets / IRSs are adopted by railway operators (SMS)

Other company standards

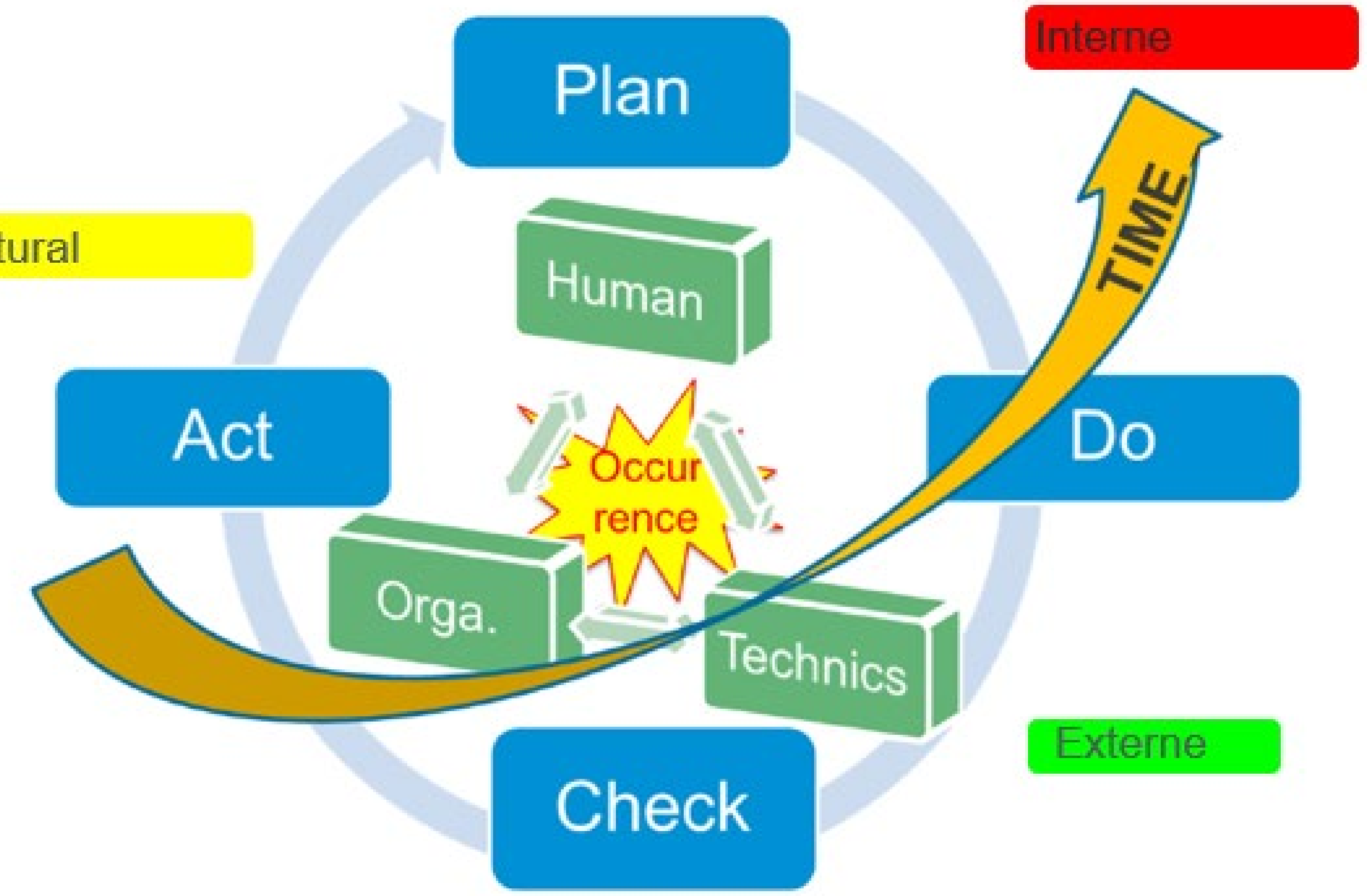


Summary diagram of voluntary and mandatory application in Europe



https://uic.org/IMG/pdf/uic_guide_to_standardisation_21062019.pdf

INSPIRATION SOURCES IN EU RAILWAY SAFETY MANAGEMENT



- ISO 9000: 2005
- ISO 9001: 2008
- ISO 14001: 2004
- OHSAS 18001: 2007
- ISO 45001: 2018
- Etc.

4TH RAILWAY PACKAGE

4RP Technical Pillar

Regulation (EU) 2016/796 ('The Agency' Regulation)	Directive (EU) 2016/797 (Recast Interoperability Directive)	Directive (EU) 2016/798 (Recast Safety Directive)

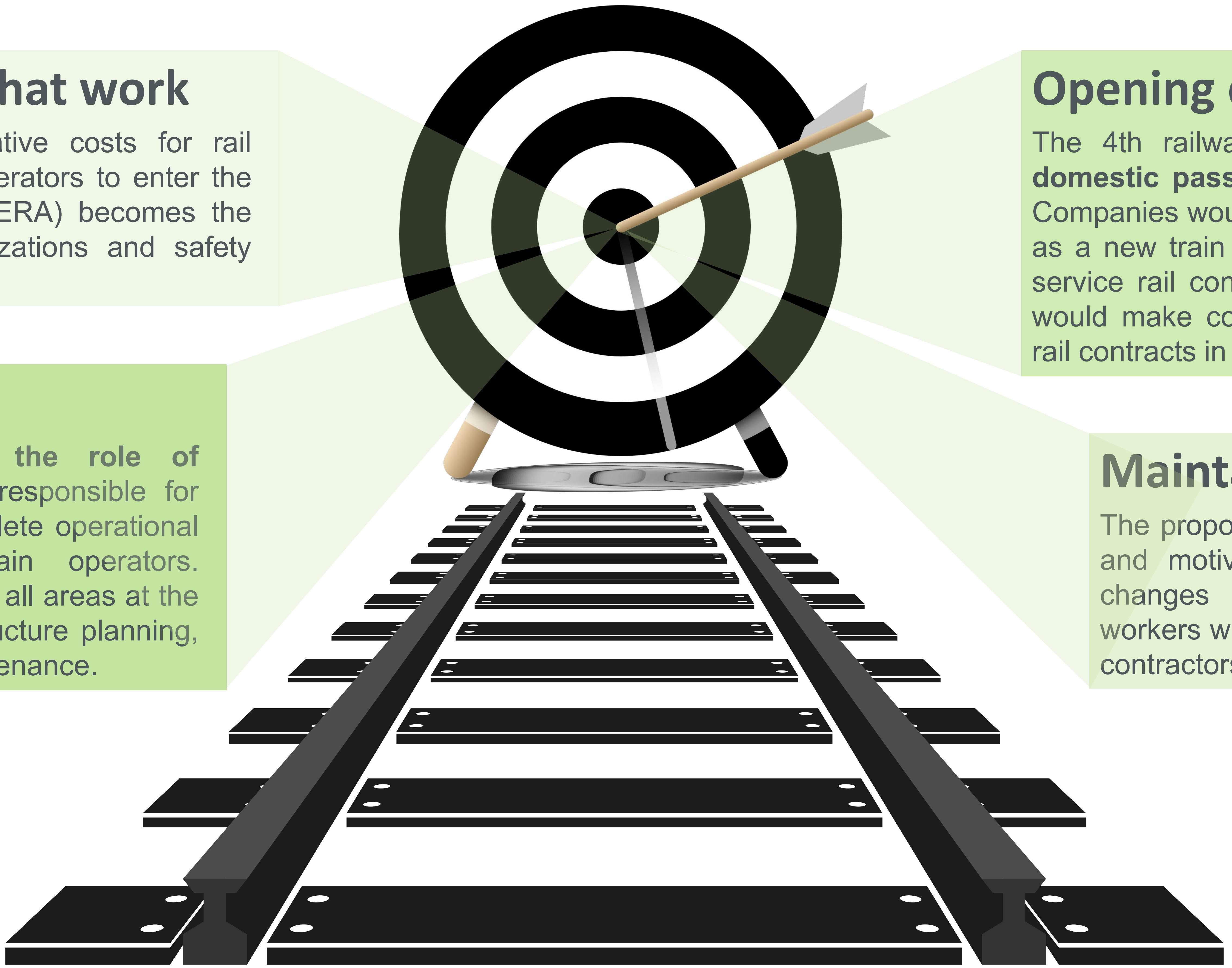
4th railway package have four main aims

Standards and approvals that work

The changes aim to cut the administrative costs for rail companies and make it easier for new operators to enter the market. The European Railway Agency (ERA) becomes the single place of issue for vehicle authorizations and safety certificates for operators.

A structure that delivers

The proposed changes strengthen the role of infrastructure managers - the people responsible for running tracks - ensuring they have complete operational and financial independence from train operators. Infrastructure managers would also control all areas at the heart of the rail network, such as infrastructure planning, timetabling, and daily operations and maintenance.



Opening domestic passenger markets

The 4th railway package includes the proposal to **open-up domestic passenger railways to new entrants and services.** Companies would be able either to offer competing services, such as a new train service on a particular route, or to bid for public service rail contracts through tendering. The proposed changes would make competitive tendering mandatory for public service rail contracts in the EU.

Maintaining a skilled rail workforce

The proposals recognize the importance of attracting skilled and motivated staff to the rail sector. In particular, the changes would allow member states to better protect workers when public service contracts are transferred to new contractors.

Changes brought by the technical pillar of the 4RP will affect anyone who

Manufactures or modifies Railway Vehicles

Authorises vehicles and fixed installations, and grants safety certificates

Who will be affected by the changes

Regulates railway Safety and Interoperability

Operates Trains

Manages Infrastructure

MAIN ACTORS IN SAFETY MANAGEMENT OF OPERATIONS

Trains are operated by ***Railway Undertakings (RU)*** *(safety certificate is needed)*

ECM are performing the maintenance of vehicles (accreditation/recognition scheme)

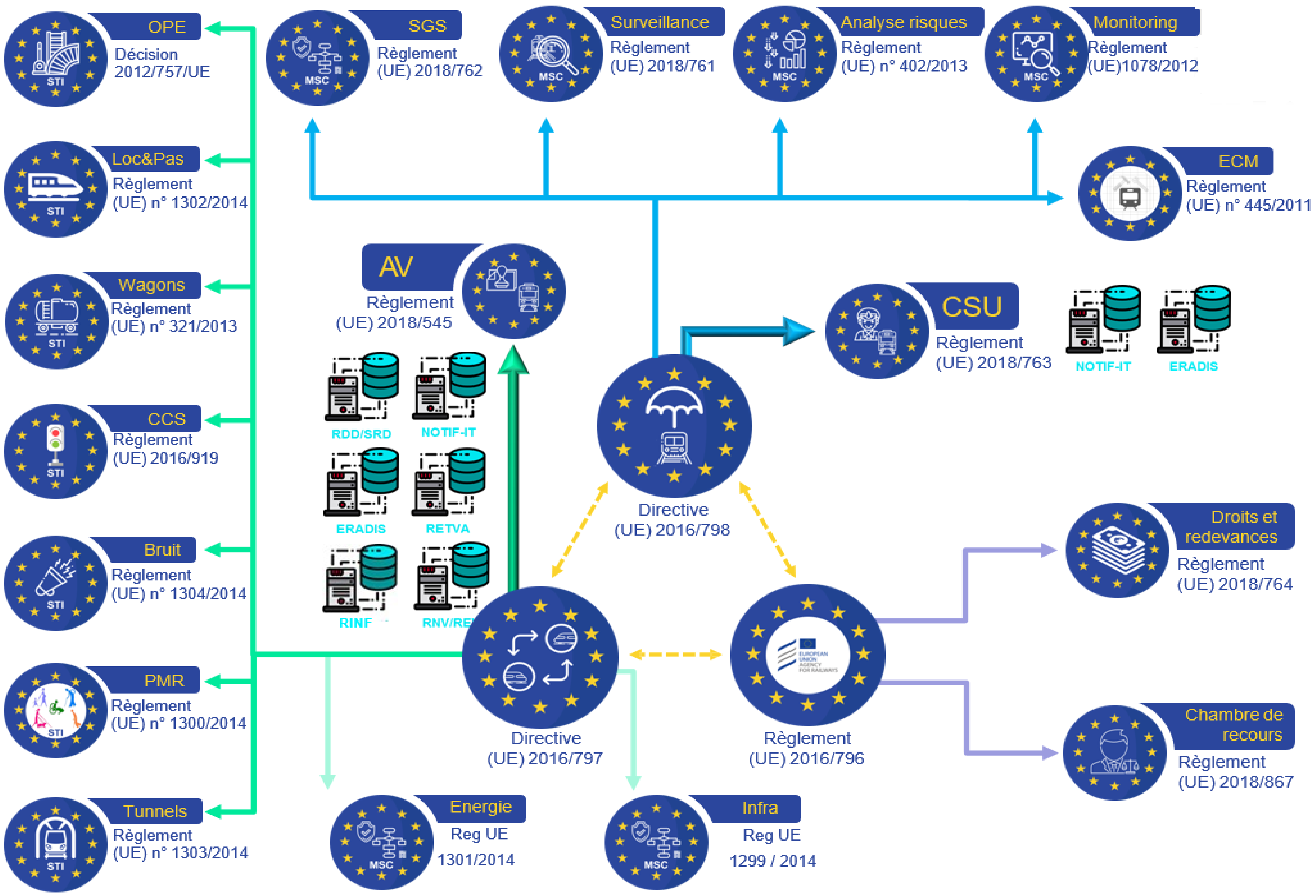
NSAs:

- *Supervise RUs/IMs,*
- *Issue safety authorization,*
- *With ERA, participate to single safety certificate issuing to RU*

Fixed installations: are operated by ***Infrastructure Manager (IM)*** *(safety authorisation is needed)*

https://en.wikipedia.org/wiki/Railway_signal#/media/File:Finnish_distant_signal_displaying_Expect_Stop.jpg

Relationship with TSI and CSM + other regulations for Railway Safety Management System in 4th railway package



TSI's – CSM's – SMS

- Technical Specifications for Interoperability (TSIs) define the technical and operational standards that must be met by each subsystem or part of subsystem in order to meet the essential requirements and ensure the interoperability of the railway system of the European Union.

- Safety Management System (SMS) to ensure that the organisation achieves its business objectives in a safe manner and complies with all of the safety obligations that apply to it.

- Common Safety Methods (CSMs) describe how should be fulfilled the safety levels, the achievement of safety targets and compliance with other safety requirements.

CSM, TSI, HOW DO THEY RELATE?

TSIs contain essential requirements related to safety <u>when necessary for interoperability</u>

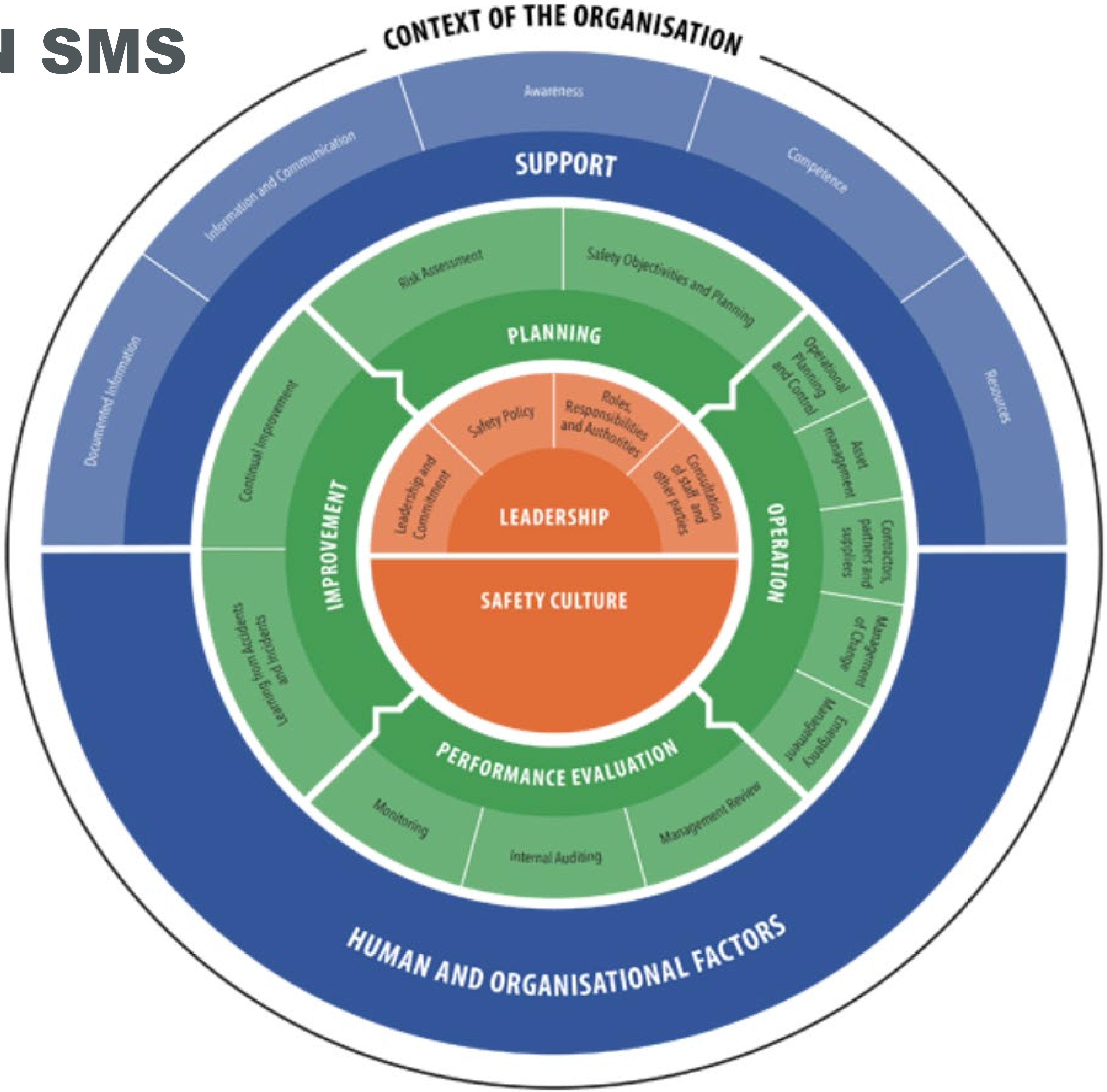
TSIs request application of specific part(s) of CSM-RA <u>where necessary for interoperability</u>

However, sole compliance with TSIs is not sufficient to ensure that safety is fully covered
CSM RA *must be applied to demonstrate safety is fully controlled*

ERA MODEL ON SMS

The SMS should be a **living set of arrangements** which **grows in maturity** and develops as the organization which it serves does so.

The elements of the SMS can be observed to apply a **Plan-Do-Check-Act (PDCA)** cycle.



The set of standards referred as the pillar of the related safety system to railways are

- EN 50126.1. Railway Applications - The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS) - **Part 1: Generic RAMS Process**

- EN 50126-2. Railway Applications - The Specification and Demonstration of Reliability, Availability, Maintainability and Safety (RAMS) - **Part 2: Systems Approach to Safety**

It is the most generic and significant for the railway as applied on all the subsystems of the rail system. The edition of the standard in 2018 (EN 50126-1 and EN 50126-2) changes and extends some concepts that will play a key role in the development of new products, such as, for instance, the concept of **Safety Integrity Level.**

But other relevant standards for the safety are

- EN 50128. Railway applications - Communication, signalling and processing systems. Software for railway control and protection systems. It should be applied to the development, implementation and maintenance of **any software related with safety,** aimed to applications of control and protection of the railways. **The central concept in this European standard are the five levels of safety integrity of the software (0 being the minimum level and 4 the maximum).** The more dangerous consequences of a software failure, the higher level of safety integrity would be required. The current version is EN 50128:2012.

- EN 50129. Railway applications. Communication, signalling and processing systems - **Safety related electronic systems for signalling. It is applicable to the phases of specification, design, construction, deployment, acceptance, operating, maintaining and codification/extension of comprehensive signalling systems**, and it also applies to subsystems and individual products included in a comprehensive system. Its application is usually considered in the development of the hardware, but new edition of EN 50126 is fully aligned in the current edition EN 50129:2020.

- EN 50657. Railways Applications. **Rolling stock applications. Software on Board**. EN 50567 does not specify the requirements for the development, implementation, maintenance and / or operation of security policies, or protection services. In this sense, since the protection of Information Technology (IT) can affect not only the operation, but also the functional safety of the system, to ensure the protection of Information Technology, specific rules must be applied of IT protection (ISO / IEC standards of the 27000 series, ISO / IEC / TR 19791, as well as the IEC 62443 series). These standards, exclusively applicable in the railway field, are based on the international standards IEC UNE-EN 61508 Functional Safety of Electrical/Electronic/Programmable Electronic Safety-related Systems.

- EN 50155. Railway applications. **Electronic equipment used on rolling stock. Sets requirements related to aspects such as environmental operating conditions, electrical conditions, electromagnetic compatibility, reliability and maintainability, design, components, construction, safety, documentation, tests, etc.** This standard can be used as a code of good practice to cover the “technical safety requirements”

- EN 50122. Railway applications - **Fixed installations - Electrical safety, earthing and the return circuit**. This standard is in three parts. Part 1: Protective provisions against electric shock; part 2: Provisions against the effects of stray currents caused by DC traction systems and part 3: Mutual Interaction of AC and DC traction systems.

NoBo – DeBo – AsBo - NSA

- What is a NoBo (Notified Body)?

A **NoBo** is an independent body (normally a private company) that is authorized to carry out EC verification process of interoperability of railway systems and equipment, as well as to assess the conformity or suitability for using such systems or equipment.

- What is a DeBo (Designated Body)?

A **DeBo** is an independent body (normally a private company) that is authorized to carry out the procedure for verification of subsystems in the case of **national implementation standards**. In the case of Spain, it would be, for example, the independent evaluator of the ADIF railway product validation processes.

- What is a AssBo (Risk Assessment Body) ?

AssBo is an independent body (normally a private company) authorized to carry out the analysis and the evaluation of the risk according to Implementing Regulation **402/2013** concerning the adoption of a common method on safety and the evaluation of risk and Regulation **2015/1136** according to ISO 17020.

- ***NSA - national safety authority*** means the authority responsible for the railway safety regulations and supervision of the Infrastructure Managers, Railway Operators and the Traffic Control Authority

WHY THE CSM RA

History of railways:

Multiple historical Railway Undertakings in Europe (more than 100 years of railway history)

Typically one “big” historical Railway Undertaking per country (Public Company, due to merging of multiple private companies which where not always economically self-sufficient)

Each company was responsible for its safety (self validation / acceptance of modifications, including new trains)

European Union => European Railways:

Creation of the European Railway Agency to promote/ensure Interoperability between the countries of Europe : 4th Railway Package

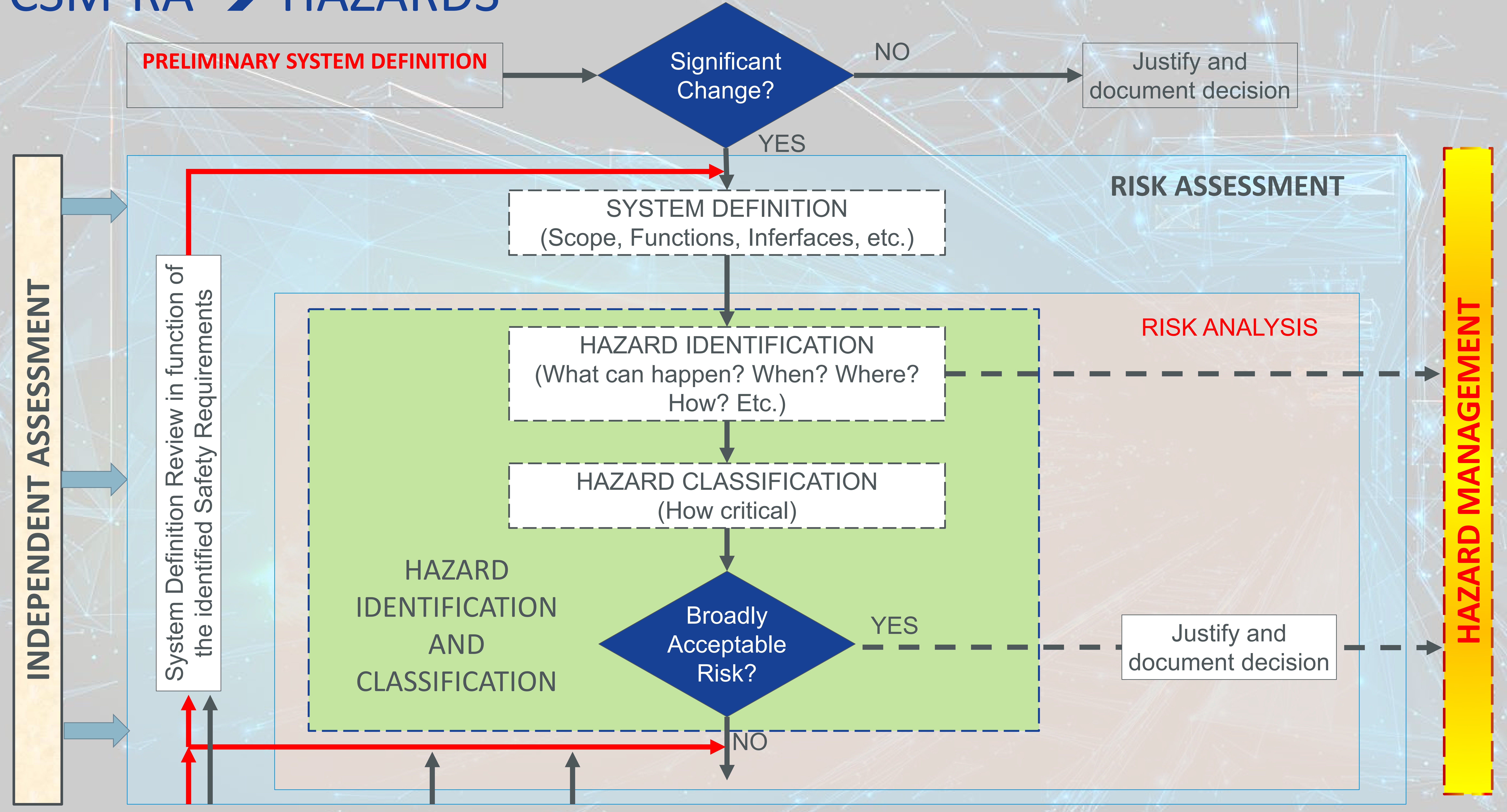
- Creation of a National Safety Authority for each country to ensure independence between the operator and the authorisation (and thus ensure fairness in authorisation for other operators)
- Creation of Technical Specifications for Interoperability to provide the essential requirements to ensure interoperability (these requirements are common to all countries, and out of the scope of NSAs => fairness in authorisation for other operators)

However:

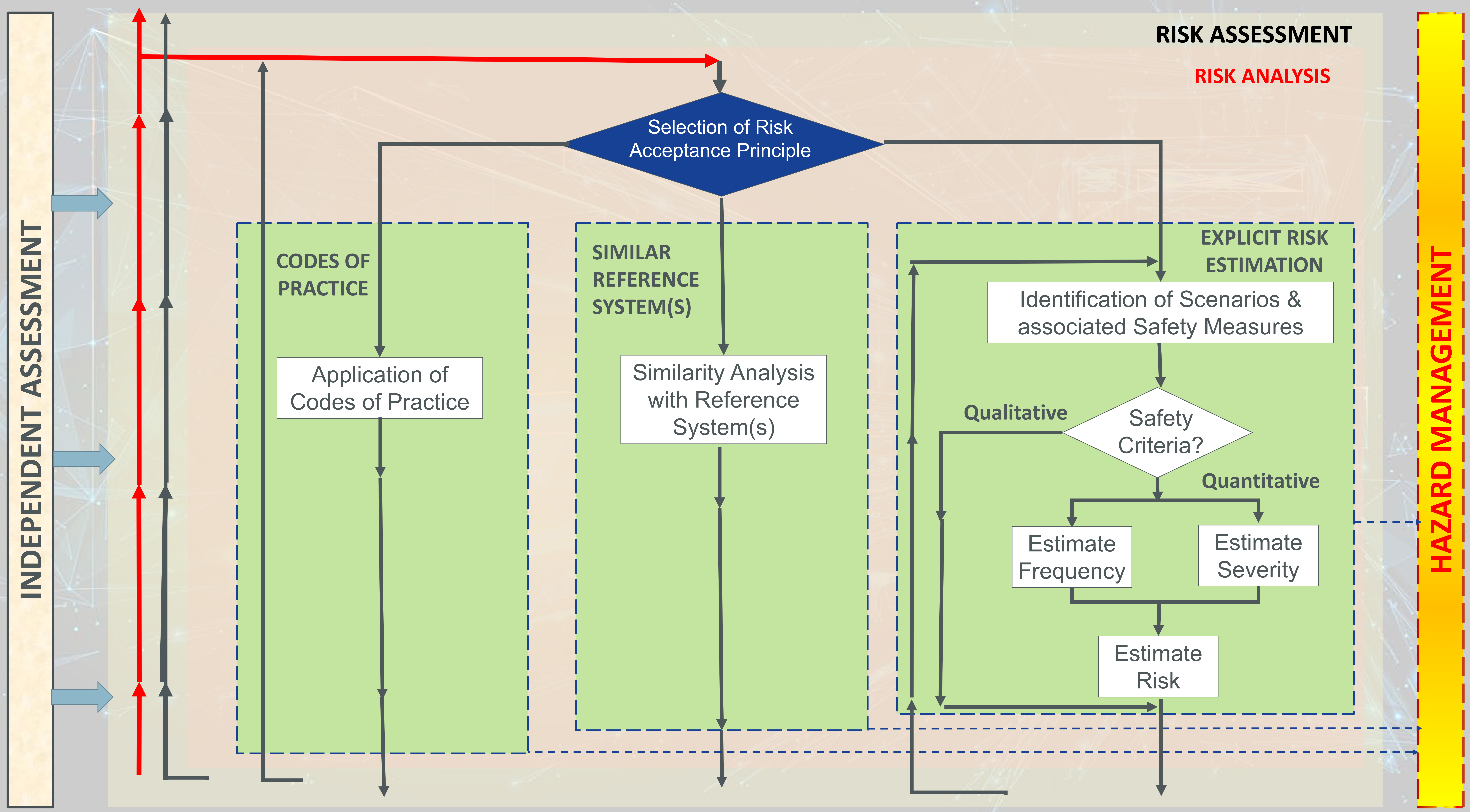
- **Ensuring interoperability does not ensure a coherent level of safety (mostly out of the scope of TSIs**)
- Each Railway Undertaking & each NSA have different means of achieving safety (e.g. different documents to be conform to, different numerical criteria, …)

Creation of the Common Safety Method on Risk Acceptance to <u>ensure that a safety</u> <u>demonstration will be valid in all countries</u>

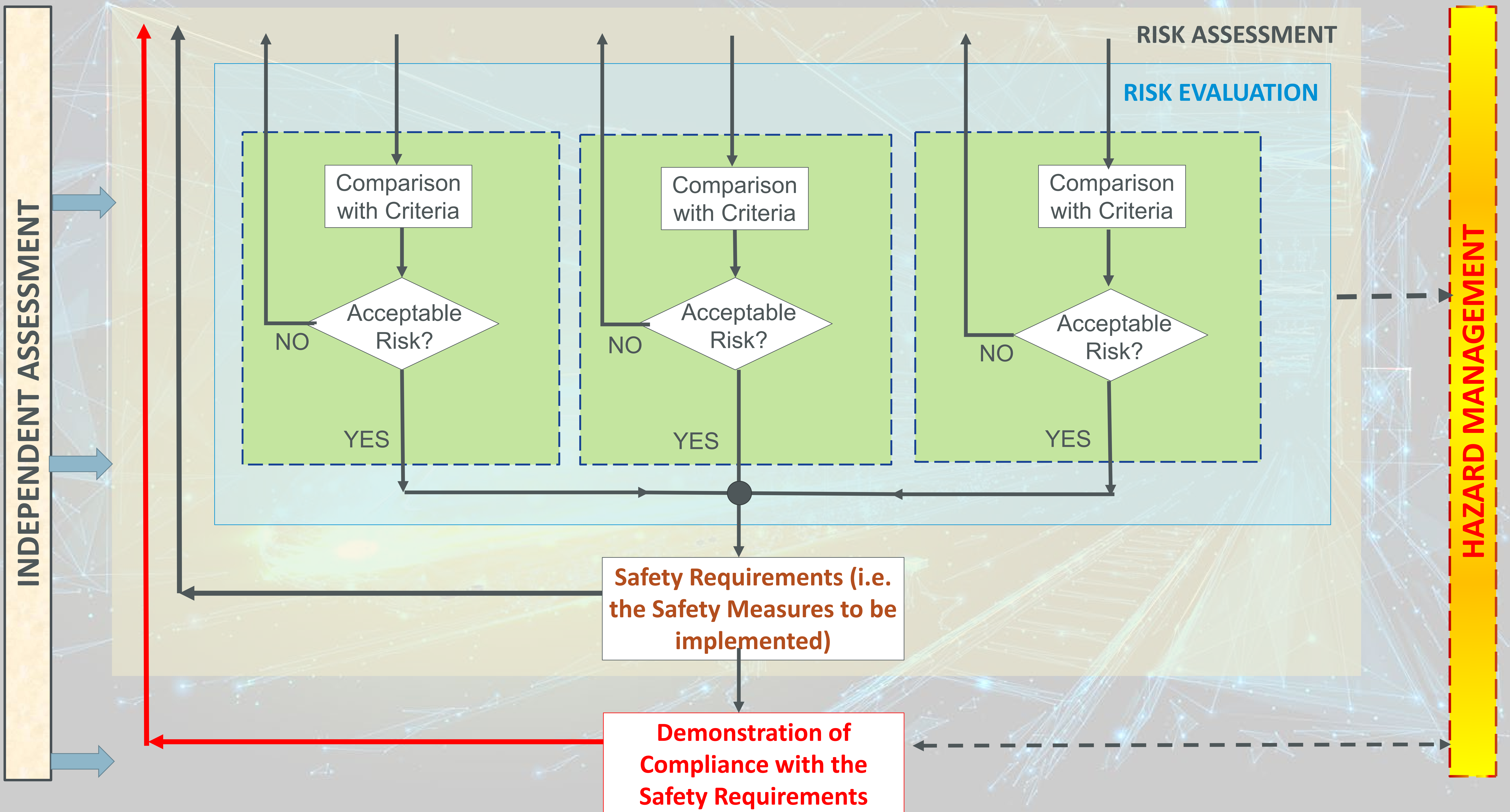
CSM-RA → HAZARDS



CSM-RA ➔ RAP


RISK ASSESSMENT
RISK ANALYSIS
INDEPENDENT ASSESSMENT
HAZARD MANAGEMENT
Selection of Risk Acceptance Principle
CODES OF PRACTICE
Application of Codes of Practice
SIMILAR REFERENCE SYSTEM(S)
Similarity Analysis with Reference System(s)
EXPLICIT RISK ESTIMATION
Identification of Scenarios & associated Safety Measures
Safety Criteria?
Qualitative
Quantitative
Estimate Frequency
Estimate Severity
Estimate Risk

CSM-RA ➔ RISK EVALUATION & SAFETY REQUIREMENTS



ACTUAL WEAKNESSES

Formalization of hazard analysis (necessary for new systems / new technologies)

If no innovation, then you are capable to provide the hazards, the contrary is …

Generally provided by the supplier, but need of the Railway Undertaking for its knowledge of operation (i.e. what are the potential consequences of this failure on my network/system ?)

Introduction of Risk Acceptance Principles:

Codes of Practice & Similar Reference for "keep working as we do", but **mutual recognition not assured**

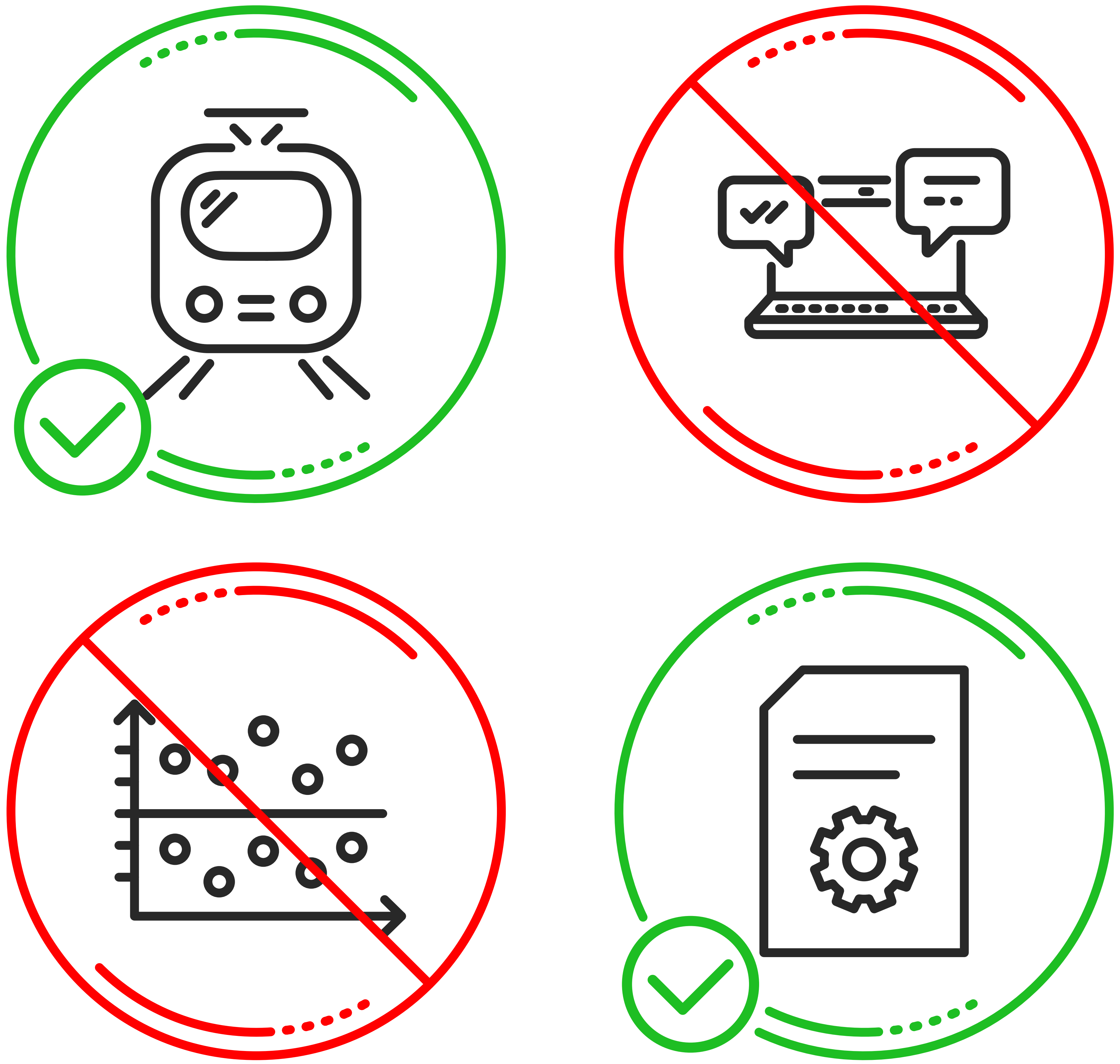
Explicit Risk Estimation have no undisputable common ground for mutual recognition

Traceability of safety requirement to ensure that they are put in place (e.g. speed limit in case of failure detection, access denied on certain lines, etc.)

Independent assessment to provide good confidence on the results of safety studies (and thus facilitate mutual recognition & interoperability)

EXPLICIT RISK ESTIMATION

WHAT IF USED INCORRECTLY / NOT USED ?



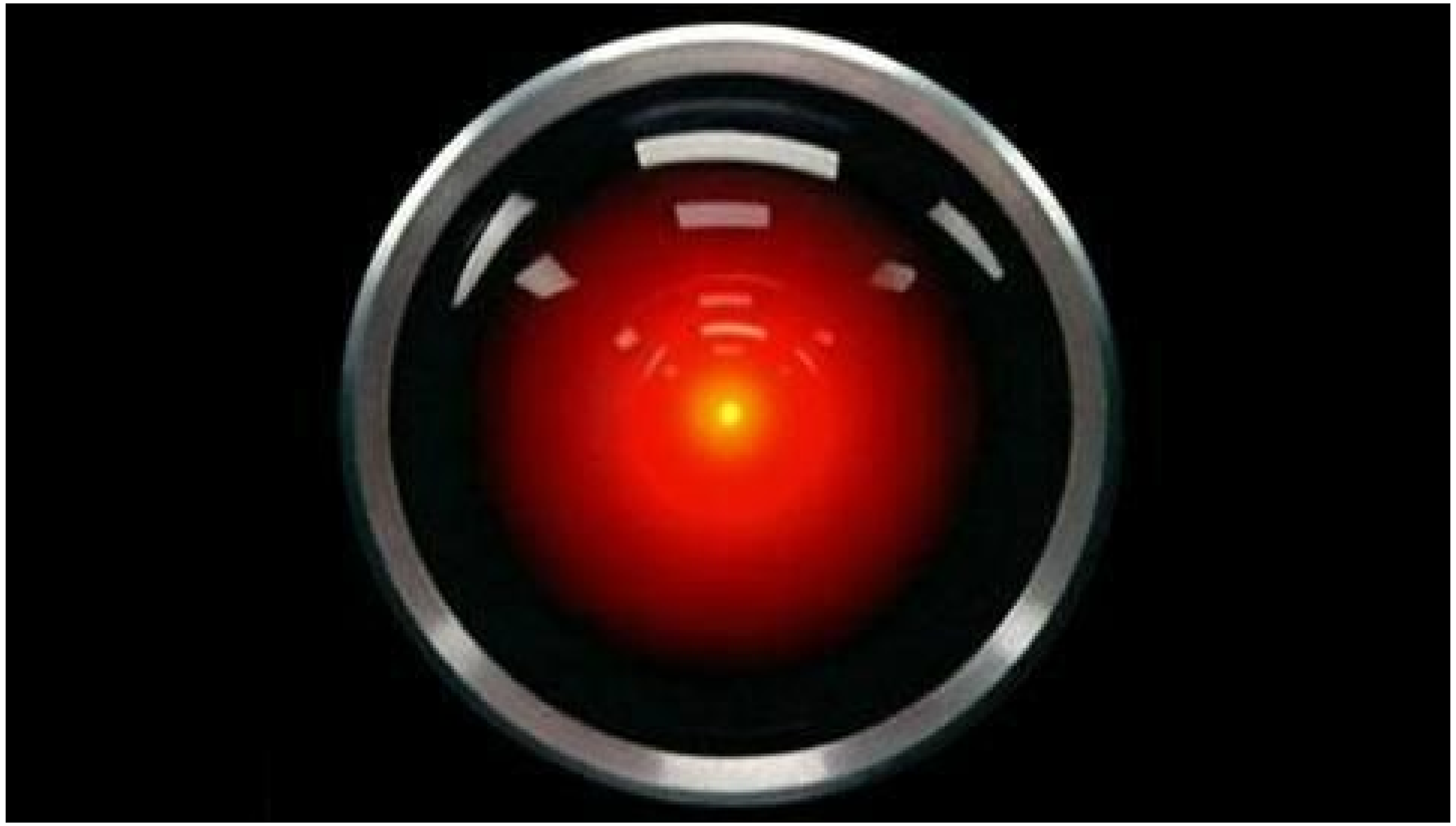
Independent assessment not achieved -> a failure will trigger another failure, thus the safety target is not reached -> system not accepted by NSA, redesign necessary -> costs & delays

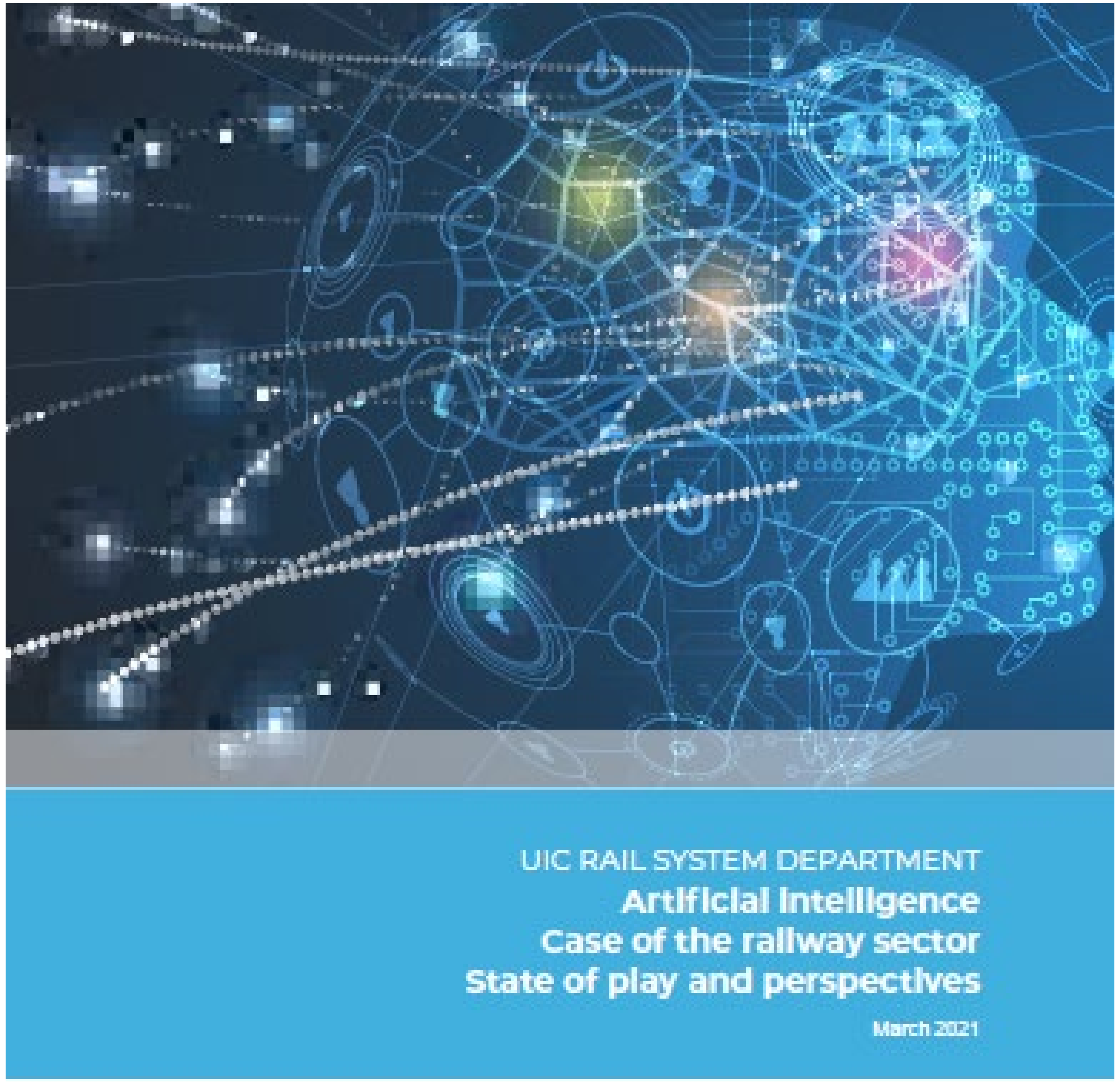
Failure rates / probabilities for component's failure not realistic -> number of accidents higher than expected -> risk of losing the "autorisation" for the system

Safety study built on the functional description rather than on the schematics -> wrong results -> number of accidents higher than expected -> risk of losing the authorisation for the system

Non application of Explicit Risk Estimation -> **risk of no mutual recognition of the study**

What about innovations, new technologies & AI ?





INTERNATIONAL UNION
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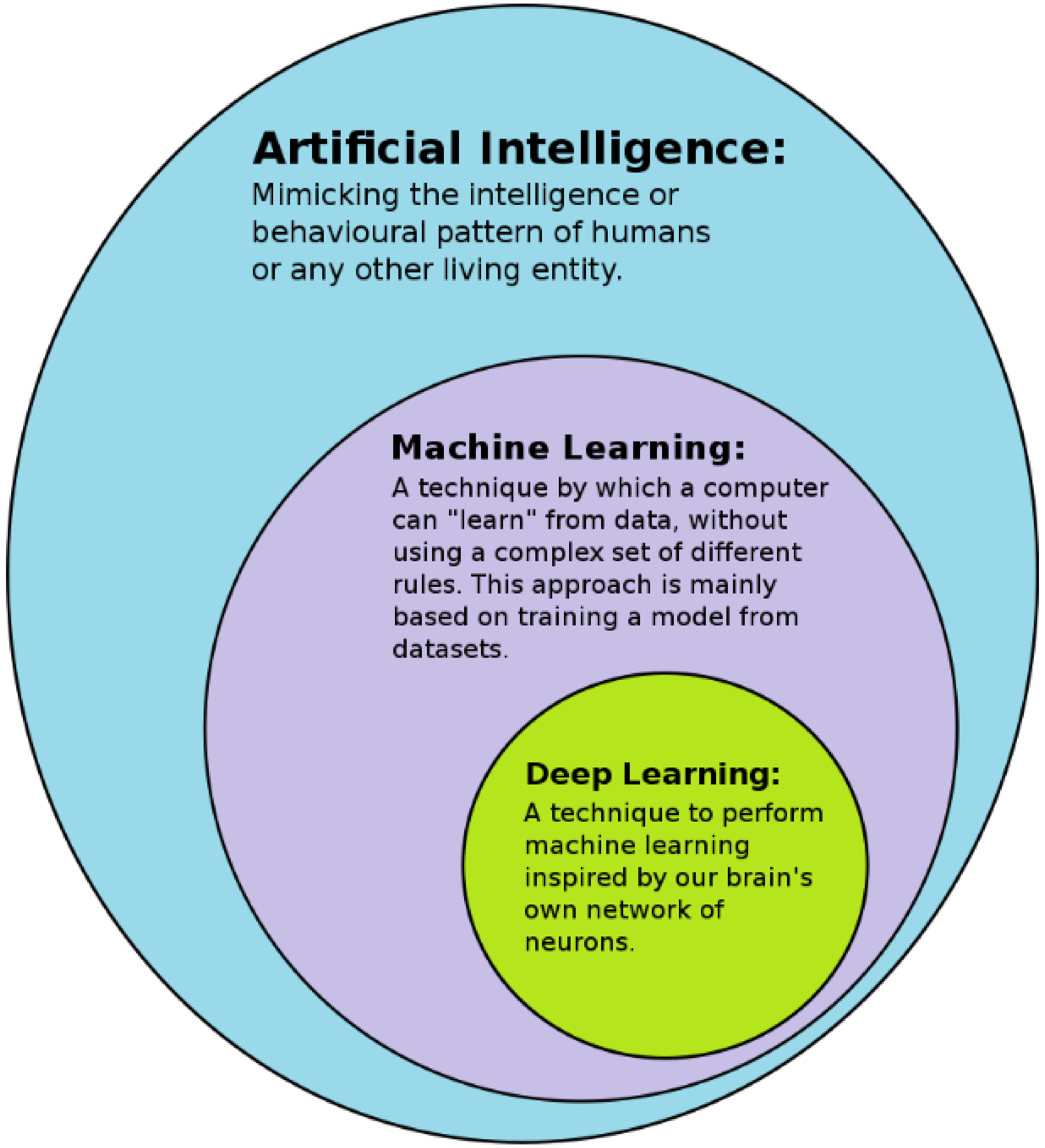
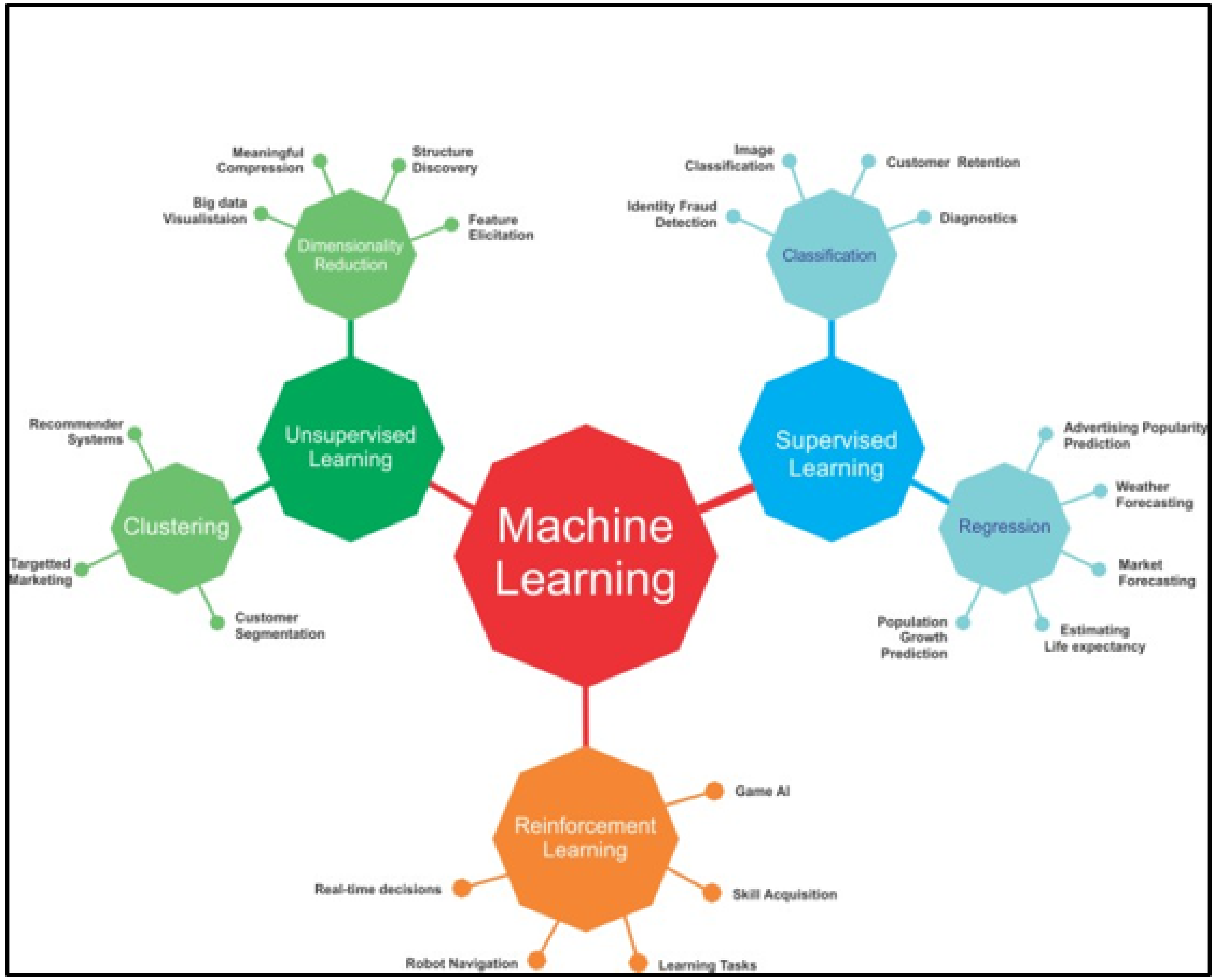
French :
https://uic.org/IMG/pdf/intelligence_artificielle_implications_pour_le_secteur_ferroviaire_europeen_etat_des_lieux_et_perspectives.pdf

English :
https://uic.org/IMG/pdf/artificial_intelligence_case_of_the_railway_sector_state_of_play_and_perspectives.pdf

German :
https://uic.org/IMG/pdf/kunstliche_intelligenz_auswirkungen_auf_den_europaischen_bahnsektor_aktueller_stand_und_perspektiven.pdf

WHAT IS AI ?





Skilllx (2020) 'List of Machine Learning Algorithms', disponible le 20 juillet 2020 sur : https://skilllx.com/list-of-machinelearning-algorithms/

Source: Wikipedia (2021), 'How deep learning is a subset of machine learning and how machine learning is a subset of artificial intelligence (AI)' disponible le 3 février 2021 sur : https://en.wikipedia.org/wiki/Deep_learning#/media/File:AIML-DL.svg

Today, AI is <u>**not intelligent, not artificial**</u> ...

Inside

$$\left|\begin{matrix}\mathrm{RDFT\text{-}1}_n\\ \mathrm{RDFT\text{-}2}_n\\ \mathrm{DHT\text{-}1}_n\\ \mathrm{DHT\text{-}2}_n\\ \overline{\mathrm{RDFT\text{-}1}}_n\\ \overline{\mathrm{RDFT\text{-}2}}_n\end{matrix}\right| = P_m^n \left(\left|\begin{matrix}\mathrm{RDFT\text{-}1}_m\\ \mathrm{RDFT\text{-}2}_m\\ \mathrm{DHT\text{-}1}_m\\ \mathrm{DHT\text{-}2}_m\\ \overline{\mathrm{RDFT\text{-}1}}_m\\ \overline{\mathrm{RDFT\text{-}2}}_m\end{matrix}\right| \oplus \left|\begin{matrix}\mathrm{RDFT\text{-}3}_m\\ \mathrm{RDFT\text{-}4}_m\\ \mathrm{DHT\text{-}3}_m\\ \mathrm{DHT\text{-}4}_m\\ \overline{\mathrm{RDFT\text{-}3}}_m\\ \overline{\mathrm{RDFT\text{-}4}}_m\end{matrix}\right| \oplus \left(\bigoplus_{1\le i<k/2} \left|\begin{matrix}\mathrm{rDFT}_{2m}(i/k)\\ \mathrm{rDFT\text{-}2}_{2m}(i/k)\\ \mathrm{rDHT}_{2m}(i/k)\\ \mathrm{rDHT\text{-}2}_{2m}(i/k)\\ \overline{\mathrm{RDFT}}_{2m}(i/k)\\ \overline{\mathrm{RDFT\text{-}2}}_{2m}(i/k)\end{matrix}\right| \right)\right) \left(\left|\begin{matrix}\mathrm{RDFT\text{-}1}_k\\ \mathrm{RDFT\text{-}2}_k\\ \mathrm{DHT\text{-}1}_k\\ \mathrm{DHT\text{-}2}_k\\ \overline{\mathrm{RDFT\text{-}1}}_k\\ \overline{\mathrm{RDFT\text{-}2}}_k\end{matrix}\right| \otimes I_m \right), \quad k \text{ even},$$

$$\left|\begin{matrix}\mathrm{RDFT\text{-}1}_n\\ \mathrm{RDFT\text{-}2}_n\\ \mathrm{DHT\text{-}1}_n\\ \mathrm{DHT\text{-}2}_n\\ \overline{\mathrm{RDFT\text{-}1}}_n\\ \overline{\mathrm{RDFT\text{-}2}}_n\end{matrix}\right| = P_m^n \left(\left|\begin{matrix}\mathrm{RDFT\text{-}1}_m\\ \mathrm{RDFT\text{-}2}_m\\ \mathrm{DHT\text{-}1}_m\\ \mathrm{DHT\text{-}2}_m\\ \overline{\mathrm{RDFT\text{-}1}}_m\\ \overline{\mathrm{RDFT\text{-}2}}_m\end{matrix}\right| \oplus \left(\bigoplus_{1\le i\le\lfloor k/2\rfloor} \left|\begin{matrix}\mathrm{rDFT}_{2m}(i/k)\\ \mathrm{rDFT\text{-}2}_{2m}(i/k)\\ \mathrm{rDHT}_{2m}(i/k)\\ \mathrm{rDHT\text{-}2}_{2m}(i/k)\\ \overline{\mathrm{RDFT}}_{2m}(i/k)\\ \overline{\mathrm{RDFT\text{-}2}}_{2m}(i/k)\end{matrix}\right| \right)\right) \left(\left|\begin{matrix}\mathrm{RDFT\text{-}1}_k\\ \mathrm{RDFT\text{-}2}_k\\ \mathrm{DHT\text{-}1}_k\\ \mathrm{DHT\text{-}2}_k\\ \overline{\mathrm{RDFT\text{-}1}}_k\\ \overline{\mathrm{RDFT\text{-}2}}_k\end{matrix}\right| \otimes I_m \right), \quad k \text{ odd},$$

$$\left|\begin{matrix}\mathrm{RDFT\text{-}3}_n\\ \mathrm{RDFT\text{-}4}_n\\ \mathrm{DHT\text{-}3}_n\\ \mathrm{DHT\text{-}4}_n\\ \overline{\mathrm{RDFT\text{-}3}}_n\\ \overline{\mathrm{RDFT\text{-}4}}_n\end{matrix}\right| = Q_m^n \left(\bigoplus_{0\le i<k} \left|\begin{matrix}\mathrm{rDFT}_{2m}(U(k,i,1/4))\\ \mathrm{rDFT\text{-}2}_{2m}(U(k,i,1/4))\\ \mathrm{rDHT}_{2m}(U(k,i,1/4))\\ \mathrm{rDHT\text{-}2}_{2m}(U(k,i,1/4))\\ \overline{\mathrm{RDFT}}_{2m}(U(k,i,1/4))\\ \overline{\mathrm{RDFT\text{-}2}}_{2m}(U(k,i,1/4))\end{matrix}\right| \right) \left(\left|\begin{matrix}\mathrm{RDFT\text{-}3}_k\\ \mathrm{RDFT\text{-}4}_k\\ \mathrm{DHT\text{-}3}_k\\ \mathrm{DHT\text{-}4}_k\\ \overline{\mathrm{RDFT\text{-}3}}_k\\ \overline{\mathrm{RDFT\text{-}4}}_k\end{matrix}\right| \otimes I_m \right), \quad k \text{ even},$$

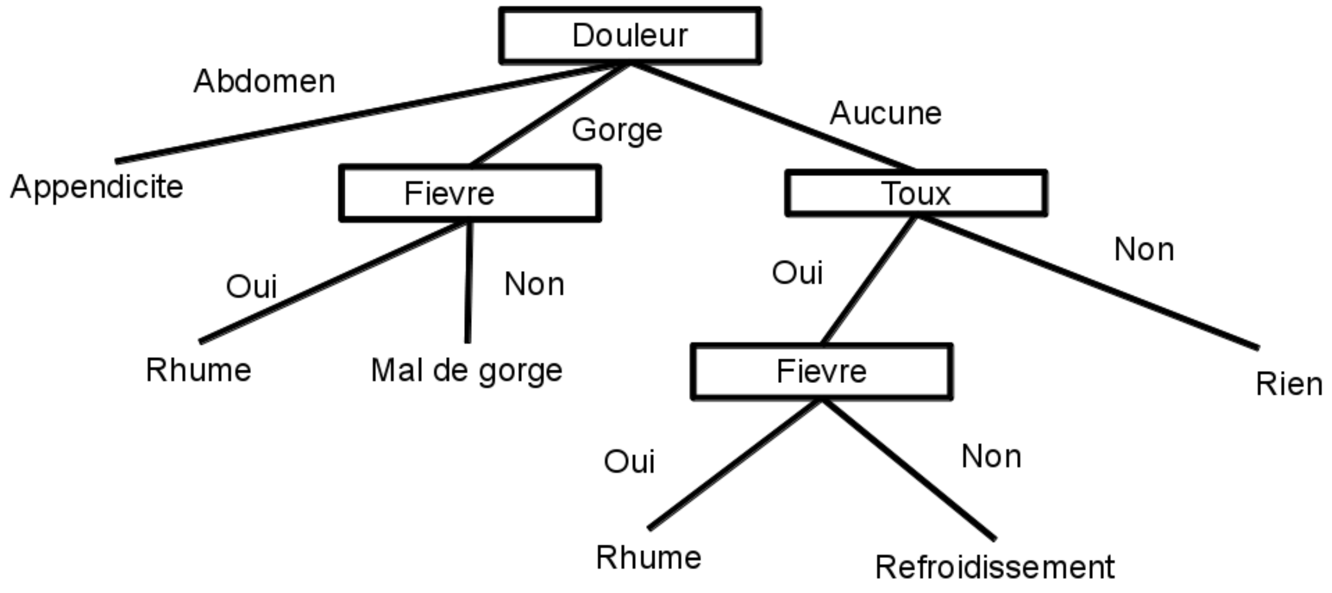
$$\left|\begin{matrix}\mathrm{RDFT\text{-}3}_n\\ \mathrm{RDFT\text{-}4}_n\\ \mathrm{DHT\text{-}3}_n\\ \mathrm{DHT\text{-}4}_n\\ \overline{\mathrm{RDFT\text{-}3}}_n\\ \overline{\mathrm{RDFT\text{-}4}}_n\end{matrix}\right| = Q_m^n \left(\left(\bigoplus_{0\le i<\lfloor k/2\rfloor} \left|\begin{matrix}\mathrm{rDFT}_{2m}(U(k,i,1/4))\\ \mathrm{rDFT\text{-}2}_{2m}(U(k,i,1/4))\\ \mathrm{rDHT}_{2m}(U(k,i,1/4))\\ \mathrm{rDHT\text{-}2}_{2m}(U(k,i,1/4))\\ \overline{\mathrm{RDFT}}_{2m}(U(k,i,1/4))\\ \overline{\mathrm{RDFT\text{-}2}}_{2m}(U(k,i,1/4))\end{matrix}\right| \right) \oplus \left|\begin{matrix}\mathrm{RDFT\text{-}3}_m\\ \mathrm{RDFT\text{-}4}_m\\ \mathrm{DHT\text{-}3}_m\\ \mathrm{DHT\text{-}4}_m\\ \overline{\mathrm{RDFT\text{-}3}}_m\\ \overline{\mathrm{RDFT\text{-}4}}_m\end{matrix}\right| \right) \left(\left|\begin{matrix}\mathrm{RDFT\text{-}3}_k\\ \mathrm{RDFT\text{-}4}_k\\ \mathrm{DHT\text{-}3}_k\\ \mathrm{DHT\text{-}4}_k\\ \overline{\mathrm{RDFT\text{-}3}}_k\\ \overline{\mathrm{RDFT\text{-}4}}_k\end{matrix}\right| \otimes I_m \right), \quad k \text{ odd},$$

$$\left|\begin{matrix}\mathrm{rDFT}_{2n}(u)\\ \mathrm{rDFT\text{-}2}_{2n}(u)\\ \mathrm{rDHT}_{2n}(u)\\ \mathrm{rDHT\text{-}2}_{2n}(u)\\ \overline{\mathrm{RDFT}}_{2n}(u)\\ \overline{\mathrm{RDFT\text{-}2}}_{2n}(u)\end{matrix}\right| = Q_m^{2n} \left(\bigoplus_{0\le i<k} \left|\begin{matrix}\mathrm{rDFT}_{2m}(U(k,i,u))\\ \mathrm{rDFT\text{-}2}_{2m}(U(k,i,u))\\ \mathrm{rDHT}_{2m}(U(k,i,u))\\ \mathrm{rDHT\text{-}2}_{2m}(U(k,i,u))\\ \overline{\mathrm{RDFT}}_{2m}(U(k,i,u))\\ \overline{\mathrm{RDFT\text{-}2}}_{2m}(U(k,i,u))\end{matrix}\right| \right) \left(\left|\begin{matrix}\mathrm{rDFT}_{2k}(u)\\ \mathrm{rDFT\text{-}2}_{2k}(u)\\ \mathrm{rDHT}_{2k}(u)\\ \mathrm{rDHT\text{-}2}_{2k}(u)\\ \overline{\mathrm{RDFT}}_{2k}(u)\\ \overline{\mathrm{RDFT\text{-}2}}_{2k}(u)\end{matrix}\right| \otimes I_m \right).$$

with

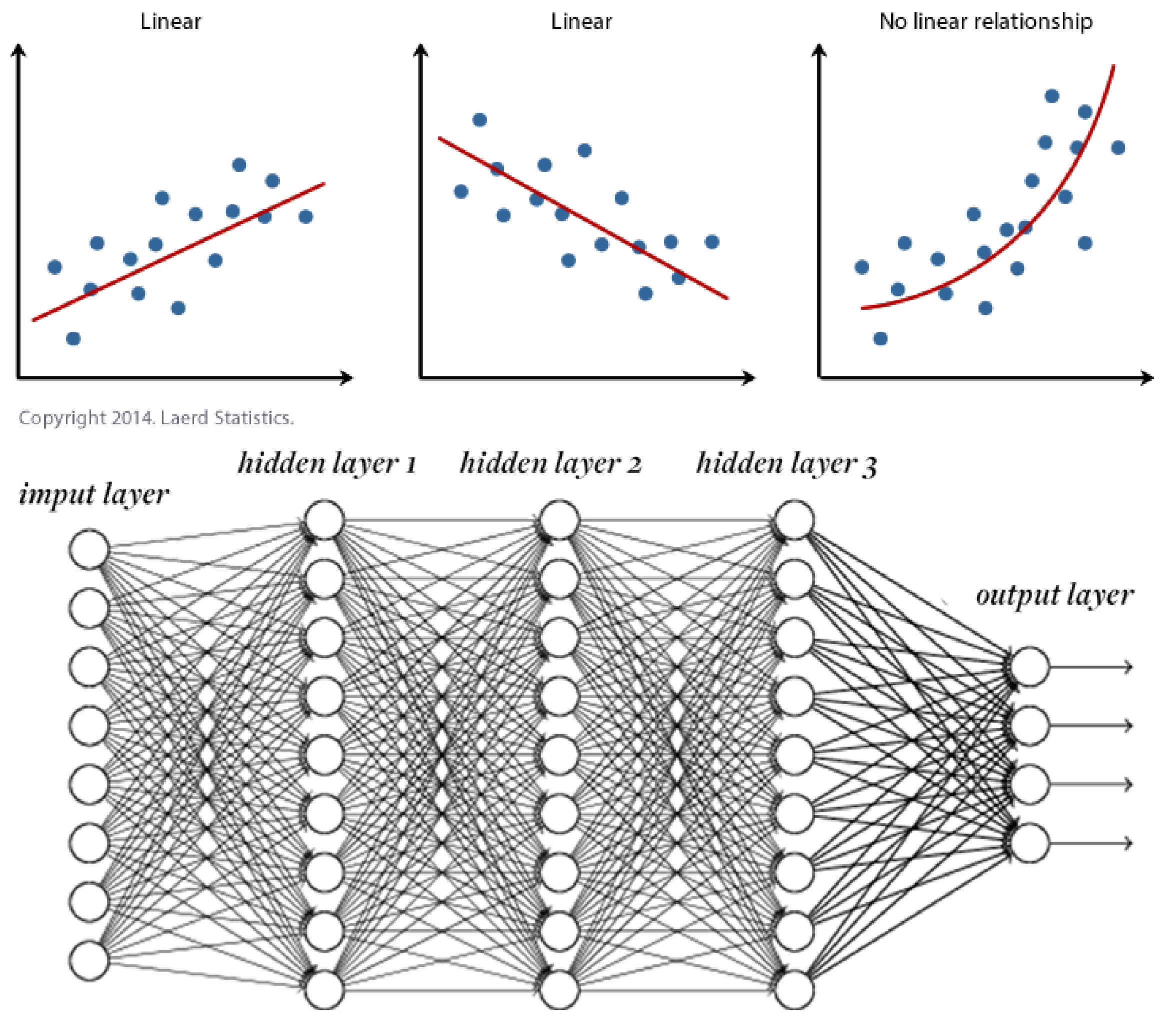
AI TODAY

« reasoning » automation



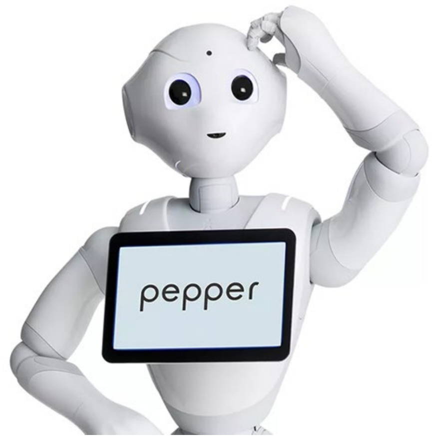
Use-cases, logic, optimisation with constraints , ...

Machin Learning (statistical learnings ...)



regressions, gradient boosting, neuronal network, ...

Agents and Networks

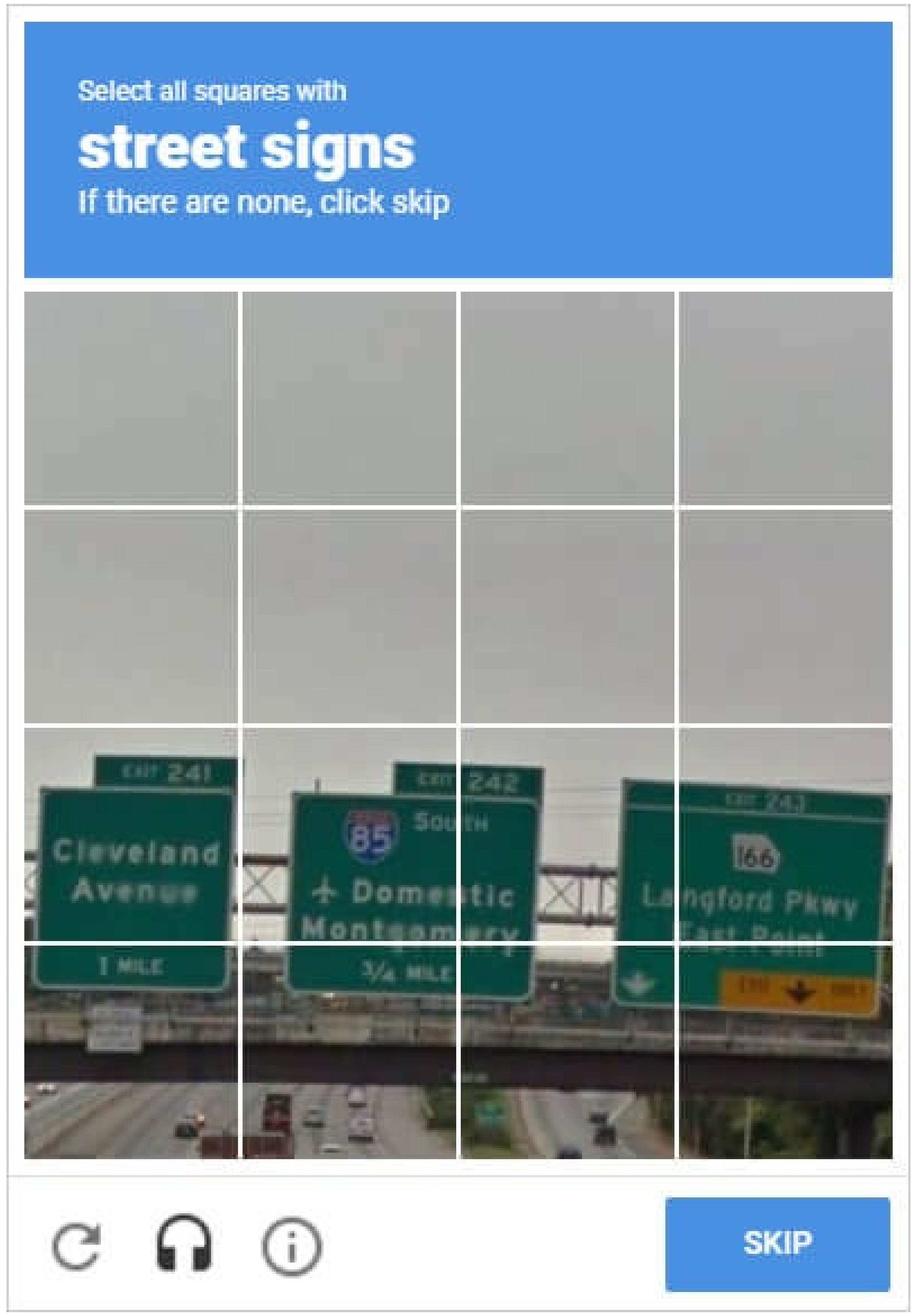


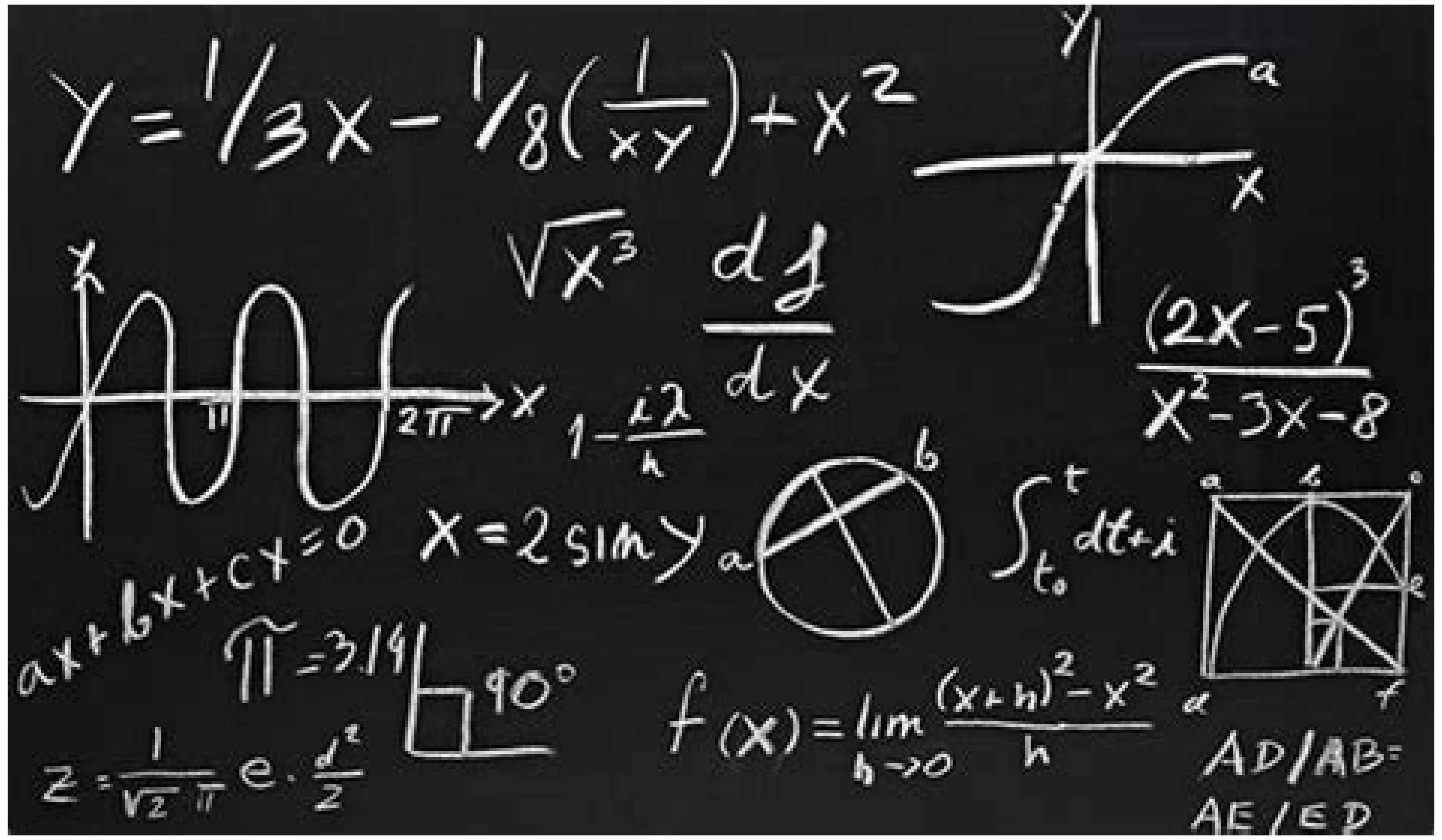
bots, robotic, deep learning, ...

Requires : lot of jobs knowledge, capacity to describe the matter in « equation »

Requires : a lot of big data, labellised and certified

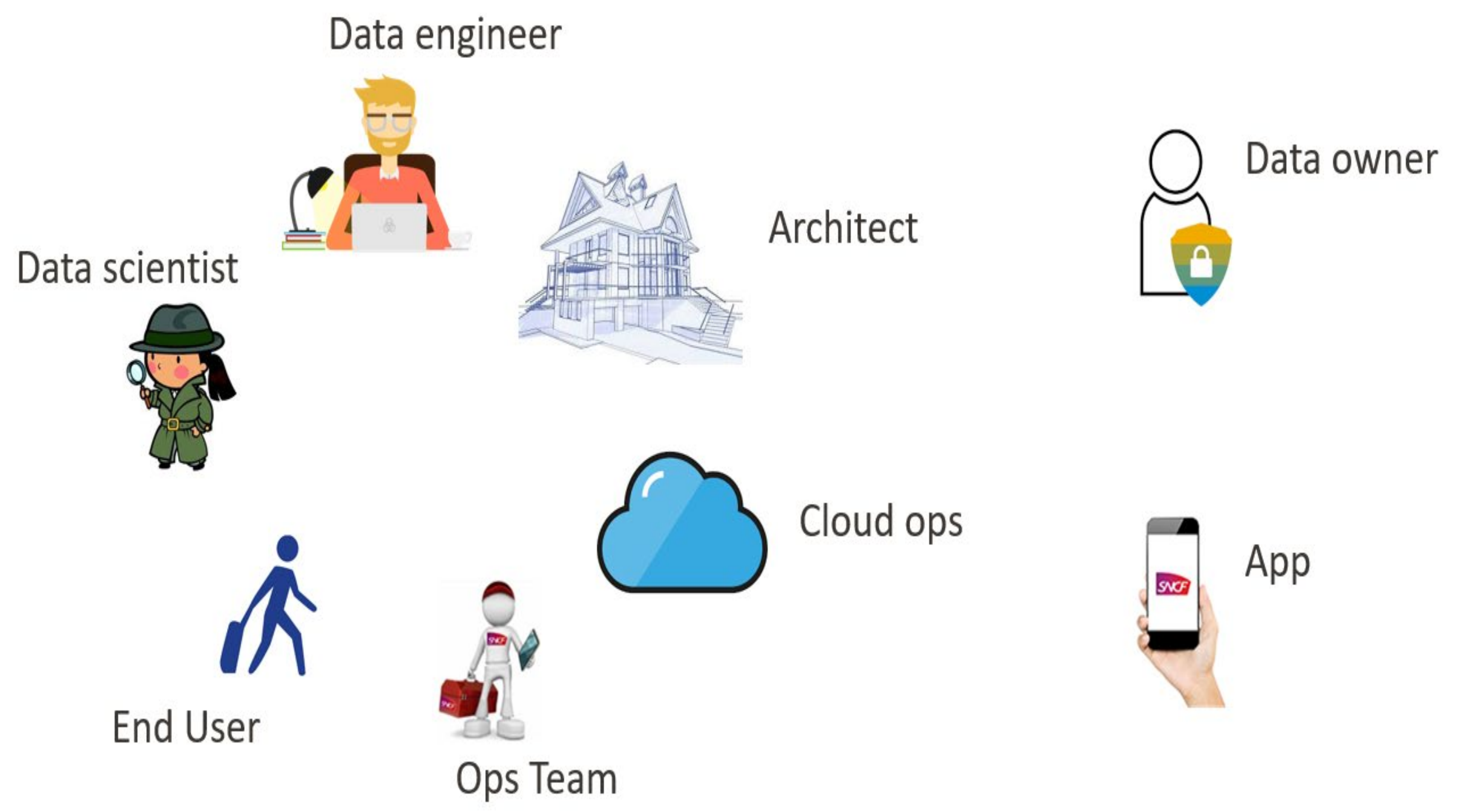
Requires : a lot of data, capacity to test or simulate some actions


Select all squares with
street signs
If there are none, click skip
SKIP

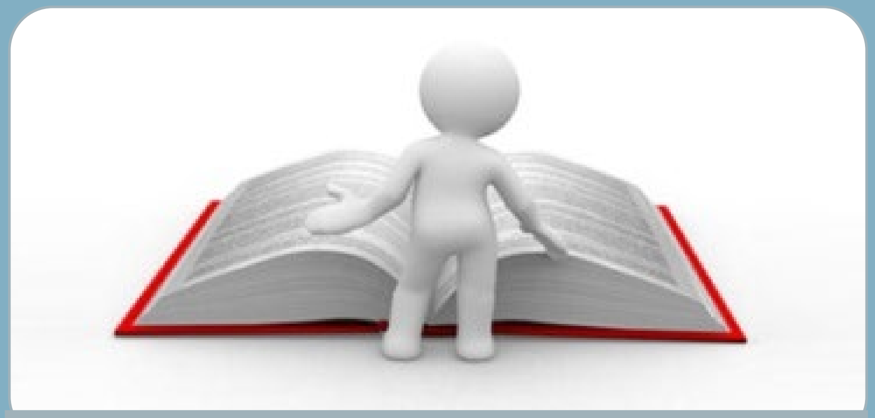


AI MUST BE TAKEN IN A SYSTEMIC APPROCACH, WITH END-USERS VIEW

DATA SCIENTISTS ALONE



THE MORE MATURE A COMPANY IS IN ITS USE OF DATA, THE RICHER THE BUSINESS ISSUES ADDRESSED WILL BE



know

What happened

passé

Understand

why

Predict

What will

Prescribe

What must be

EUROPEAN POLITICAL CONTEXT

- **The European Year of Rail 2021** is *"shining a light on one of the most sustainable, innovative and safest transport modes we have!"* (European Commission, 2020a).

- The '**Sustainable and smart mobility strategy**' of the European Commission (European Commission, 2020b) stresses the need to double high-speed railway traffic by 2030 and railway freight traffic by 2050 and to promote collective travel. In addition, the European Commission (EC) insists upon the need to stimulate innovation and the use of data and AI for smarter mobility.

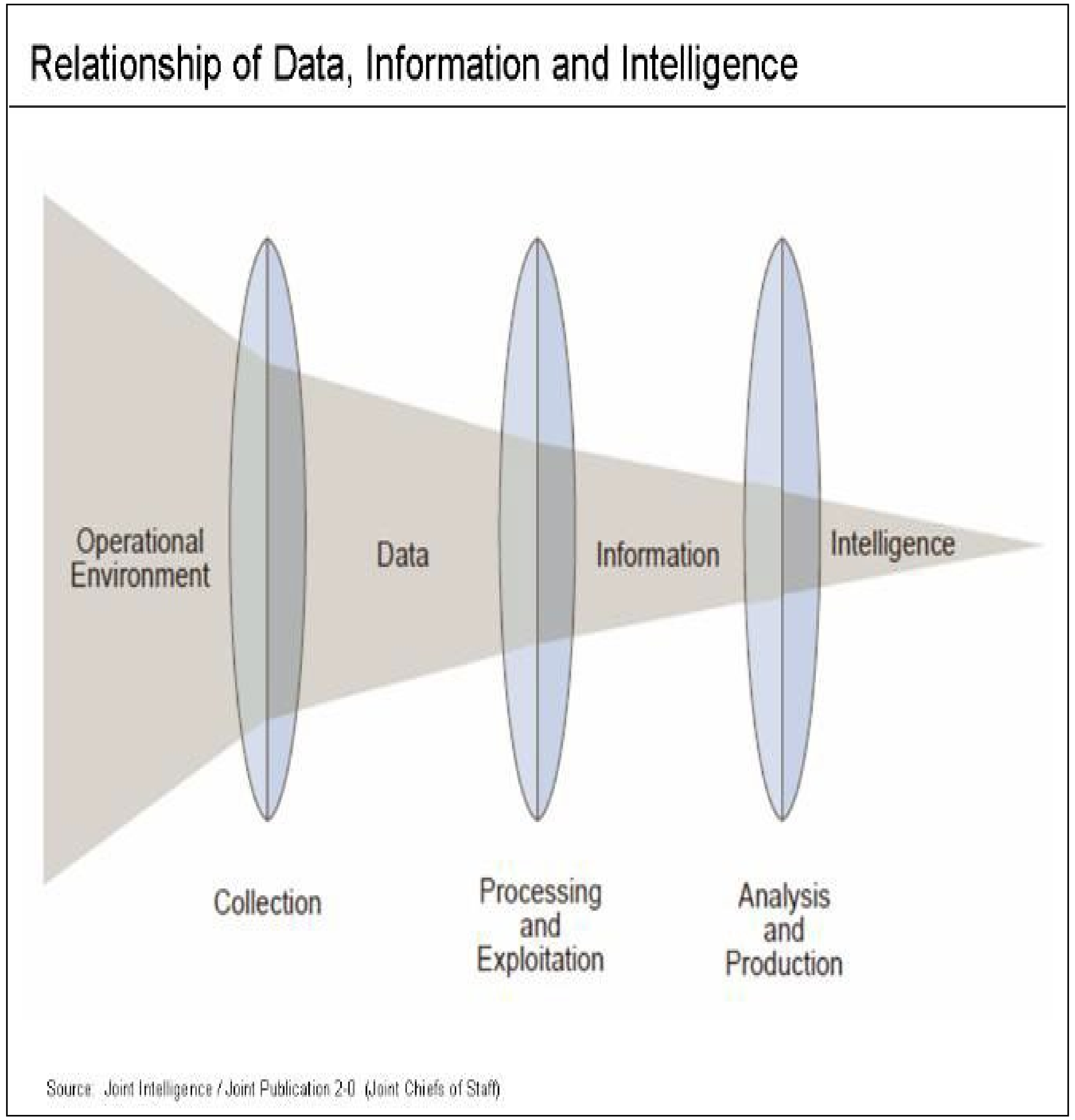
- This impetus is in line with the **European strategy on AI and data** (European Commission, 2020c), which aims to make Europe a leader in trustworthy AI and in the data economy. Thus, the European Commission will implement rules and a legal framework, notably for transport:

  - For high-risk cases, **AI systems** must be transparent, traceable and guarantee human oversight. Authorities must be able to test and certify the data used by algorithms. Unbiased data is necessary to train high-risk systems to perform properly and to ensure respect for fundamental rights, in particular non-discrimination.

  - The EC will establish a true **European data space**. First, the EC will put in place a regulatory framework for data governance (access and re-use between businesses, between businesses and government, and within administrations). Second, the EC will support the development of technological systems and the next generation of infrastructures, such as clouds. Finally, the EC will launch sector-specific actions to create European data spaces, for example in the fields of industrial manufacturing, the green deal, mobility or health.

ANALYSIS AND DECISION MAKING

Experts will keep being key players in Safety



US Defense (2020), 'Relationship of Data, Information and Intelligence'

disponible le 3 juin 2020 sur : https://media.defense.gov/2020/Jun/03/2002310219/-1/-1/0/200602-F-YT915-010.PNG

Role of the experts:

- **Selection of relevant data to be collected**
- **Assisting megadata experts**
- **Assisting data engineers in transforming data into information**
- **Providing the right tools to the humans in charge of analysing this information and making the decision**
- **In the field of safety, authorizations for placing on the market , for systems with AI, will only be granted if the human/machine system is kept understood in its entirety**

ALGORITHM CAN MAKE MISTAKES

INPUTS

IA + diagnostic

OUTPUTS

Prediction IA + complementary infos + human intelligent

AI tells me "that" but I know my job, and it must be taken into account ... Last month, we had the same situation, ...

Preventive measures

Context for “new safety demonstrations” in the field of railway

- Rapidly evolving technologies
- Safety demonstrations by restriction to “known solutions”, is no longer feasible
- Safety demonstrations by limiting the amount of innovations is not suitable
- New contextual elements:
  - Deep interconnexion
  - Decentralized computing
  - Artificial Intelligence is offering progress
  - Smart sensing & sensor fusion

Goal of the study

- ➢ Optimized Safety Demonstration for innovative systems
- ➢ But innovative systems shall not become a premise for (new) dangers !
- ➢ Today’s methods (EN 50126 / 50129 / 50128):
  - Risk assessments
  - Organizational precautions
  - Technical demonstrations:
    - Addressing systematic errors (methods, proofs, tools, tests, etc.)
    - Addressing random failures (redundancies & architecture, failure rates, etc.)
  - In documented & verifiable way: specifications / design / implementation / testing / integration and validation canvas

for IoT, IA, etc. technologies: difficult to frame in this canvas

Black box vs White box

Black box AI is where AI produces insights based on a data set, but the end-user doesn't know how. Machine learning programs reach conclusions from the data inputted, but it's not clear how the program came to them. These approaches used to be the industry standard for machine learning, but things must change

In contrast, white box AI is transparent about how it comes to its conclusions. A data scientist can look at an algorithm and understand how it behaves and which factors influence its decision-making. As people have grown increasingly suspicious of black box AI, these models have risen in popularity.

Ensuring safety based on extensive external testing ? (black box)

- But there are famous examples of catastrophic failures after many years without problem…
  - 1986's Hotel New World collapse in Singapore
- without inner view, one never knows what latent defect may be waiting for conditions to activate

Inner view: difficult in particular for artificial intelligence (white box)

- Even more if learning phases occur during service
- Know examples of pitfalls in image recognition:
  - "adverse images" could fake a car to be recognized as an ostrich (2014, C. Szegedy et al.)
- What are the criteria chosen by an automatic learning process?

Cybersecurity / Monitoring

- Deep interconnexion, decentralized computing: cybersecurity?
  - Deliberate attacks change the limits of what is considered improbable in traditional safety studies
  - New attacks related to new technologies & automation
    - Example: luring train signal image recognition as an attack to trains

- Automated monitoring for unexpected conditions / possible attacks?
  - But what safety level for such systems ?

To sum up

➢Causes of accidents:

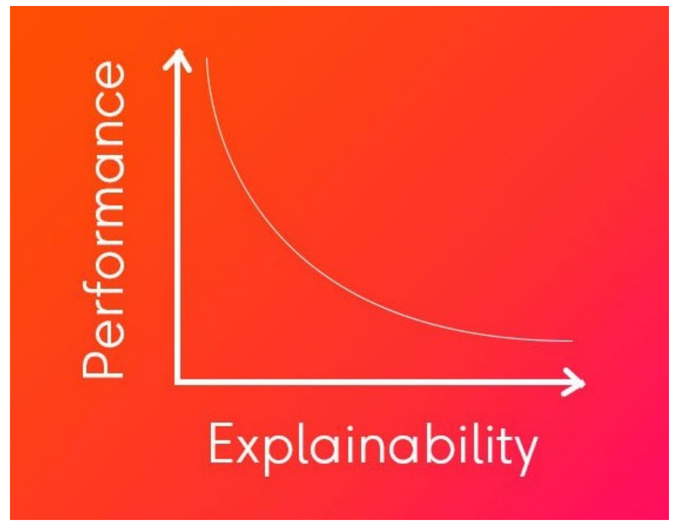
- Technical errors

- Unexpected events

- Organizational pitfalls

➢ Optimized safety demonstrations: action on the root causes

In a way that is adapted not to a set of technologies, but to innovation itself



In the field of new technologies, the more performance increases, the more explainability tends to decrease. What is desired in the future, is to increase the explainability without affecting the performance of the model.

Planned deliverables and strategy for implementation

➢ What will be the outcome(s) of the project

To accelerate innovation and migration of rail technologies, more open and agile methods must be implemented. The use of demonstrators, "tests and learn“, simulations, etc. will allow us to assess the potential of the technologies but also the conditions for their industrialization (investments, transitions between technologies, industrial transformations).

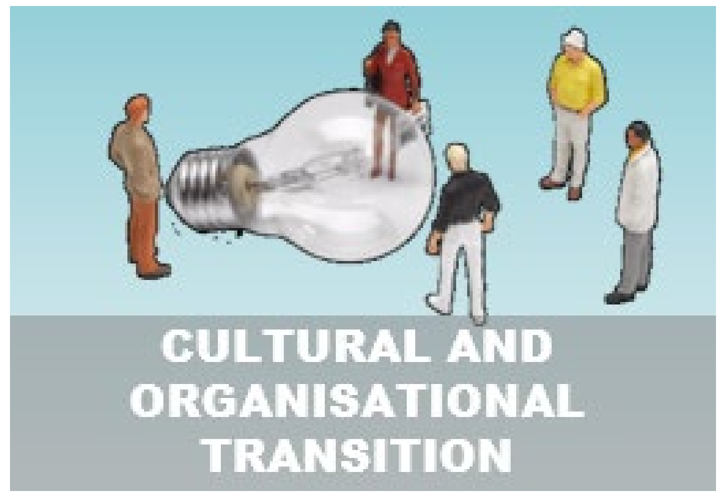
The development, testing and use of algorithms must be supervised. In other words, it is necessary to encourage, not to say impose, actors to build a relevant and efficient algorithmic governance to ensure the proper functioning of their tools. This requires, among other things, methods of explicability calculation (numerical calculations to extract part of the algorithm's logic) which allow a better understanding of the tools in order to highlight biases or malfunctions, and thus to repair them quickly before damage is caused to users.

➢ How will these outcomes be taken forward ?

UIC Worldwide practical arrangements and methods, articulated with regulations, that allow for:

- the achievement of safety demonstrations integrating innovative solutions, interoperable
- the authorization processes that allow regulators/independent assessors/etc., to accompany the safety demonstration, without shifting “ownership and responsibilities”

There can be no global regulation in the strict sense for the simple reason that we do not all have the same way of constructing and applying laws, not to mention cultural differences. That being said, we can have agreements between nations or an influence of texts on other countries. This was the case with the European RGPD, which inspired the Californian text.



Preparing railway staff and organisations for cultural changes linked to digital and technical innovations

- **Anticipating** the digital and technological future of safety in railways

- Integrating **digital** technologies into **safety/Quality** management

- **Rethinking** operations and management, where "operating principles" **lead** "innovation processes"

- Prepare staff, managers and leaders for digital innovations through **cultural change**

- **Accompany** the digital and technical innovations with a real cultural changes

- **Inspire** a change of mentality and cultural practices in the way employees are trained and learn

- **design methods for** workplaces as spaces of learning per excellence

TO CONCLUDE

Can we resist algorithms? And should we resist them?

Why resist ? The term "resist" assumes that algorithms are fundamentally bad. Algorithmic science is not manichean. **Let's remember that algorithms are neither sexist nor racist, nor guilty of any fault; the only ones responsible are those who design them and who feed them with their data through their sometimes biased uses**. We need to understand more - within our means - how they work in order to decide how to use them or simply refuse to use certain technologies. It is a question of balance, and future AI regulations must succeed in protecting the individual while encouraging innovation.

We need to understand how these tools work so that we are able to question the use of one tool over another, or even reject the algorithmic suggestion.

The owners of these **tools need to educate people about their technologies**. Scientists and engineers need to **explain algorithmic science and data science over and over again.**

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Thank you for your attention.