

MODEL-BASED HUMAN SYSTEM INTEGRATION (MB-HSI)

YANG SUN

MERCREDI 23 NOVEMBRE 2022



+ 01.

RESEARCH BACKGROUND

+ 02.

SCENARIO-BASED DESIGN & HUMAN-IN-THE-LOOP SIMULATION

+ 03.

BPMN (BUSINESS PROCESS MANAGEMENT NOTATION) PROCESSES

+ 04.

ACCIDENTS ANALYSES

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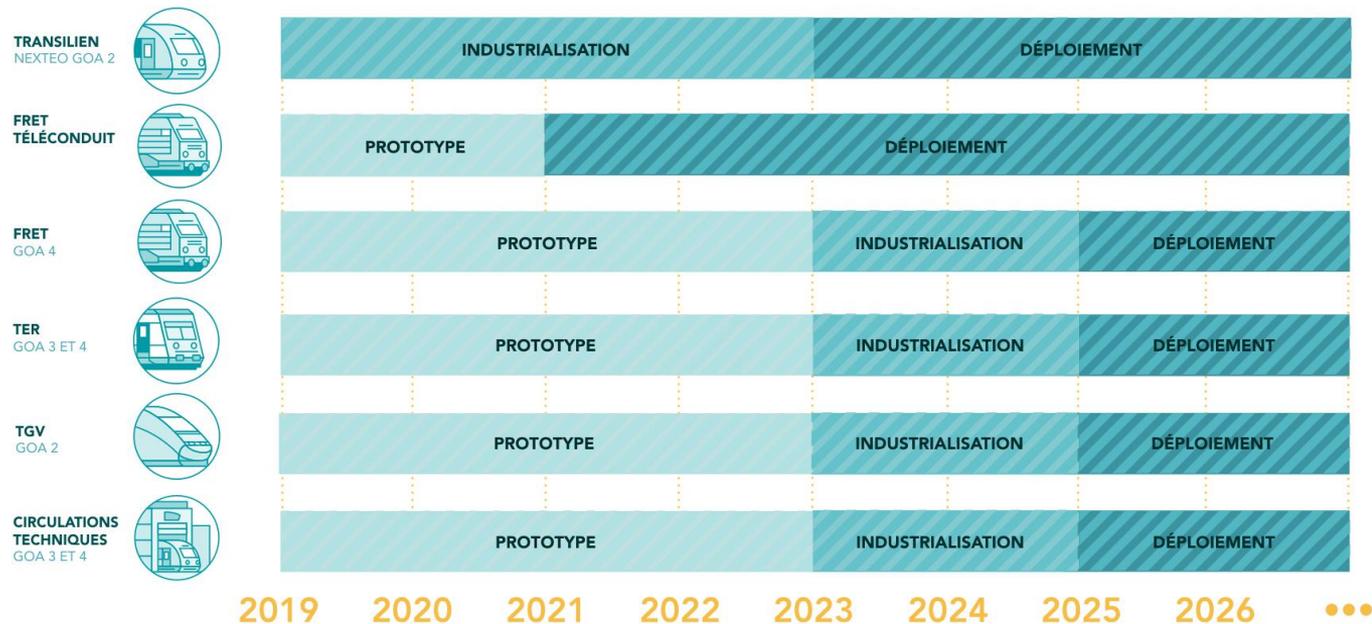
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ACCIDENTS ANALYSES

AUTOMATED TRAIN - VISION SNCF

#TrainAutonome

Les grands jalons



RESEARCH QUESTION

- SNCF aims to develop automated trains. How does the role of people evolve in railway systems during automation change?
- How does the train driver collaborate with the automatic driving system (Human-Machine Teaming)? What about unexpected situations? Who is in charge of safety?
- Under emergencies, what are the 'best' decisions the driver can make to guarantee safety?



AUTOMATIC TRAIN OPERATION(ATO)

Different train operation's automation levels



GoA2 is an intermediate level of automation that provides the service of acceleration and deceleration. It is supervised by the **Automatic Train Protection** system (ATP). The conductor is always in charge of the exchanges with passengers, door control and unexpected situations.

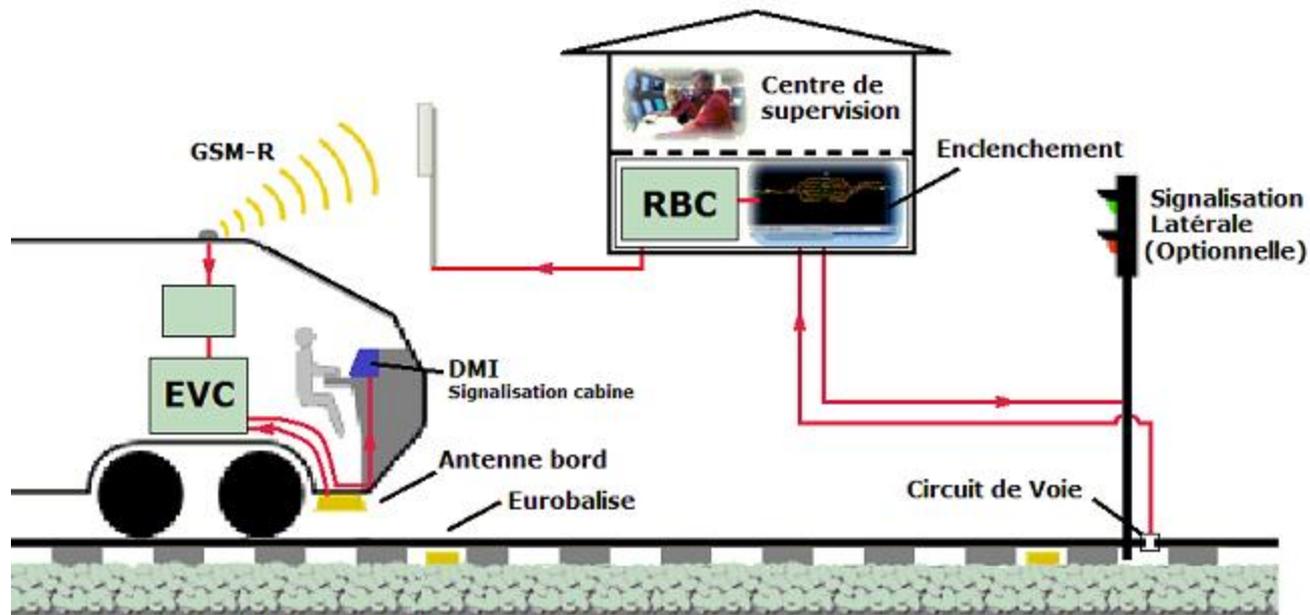
Source: <https://www.digital.sncf.com/actualites/train-autonome-ou-comment-trouver-une-reponse-aux-mobilites-le-demain>

AUTOMATIC TRAIN OPERATION(ATO)

Different train operation's automation levels

GoA	GoA Name	Train Operator	Description
GoA1	Non automated train operation	Train driver in the cab	The train is driven manually; but protected by automatic train protection (ATP). This GoA can also include providing advisory information to assist manual driving.
GoA2	Semi-automated train operation	Train driver in the cab	The train is driven automatically, stopping is automated but a driver in the cab is required to start automatic driving of the train, the driver can operate the doors (although this can also be done automatically), the driver is still in the cab to check the track ahead is clear and carry out other manual functions. The driver can take over in emergency or degraded situations.
GoA3	Driverless train operation	Train attendant on-board the train	The train is operated automatically including automatic departure, a train attendant has some operational tasks, e.g. operating the train doors (although this can also be done automatically) and can assume control in case of emergency or degraded situations.
GoA4	Unattended train operation	No staff on-board competent to operate the train	Unattended train operation; all functions of train operation are automatic with no staff on-board to assume control in case of emergencies or degraded situations.

EUROPEAN RAIL TRAFFIC MANAGEMENT SYSTEMS (ERTMS)

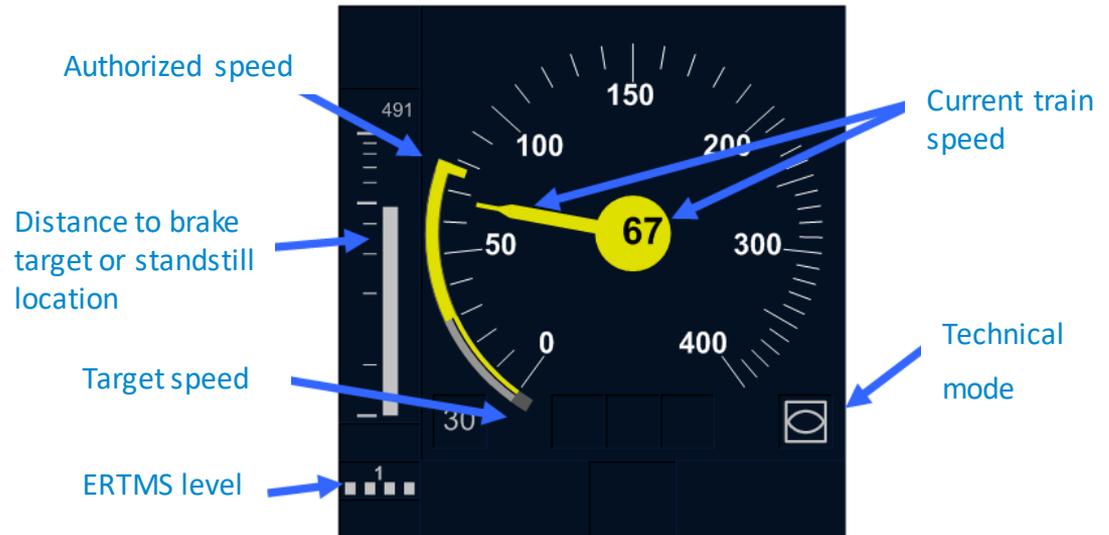


EVC = European Vital Computer (ordinateur embarqué)

RBC = Radio Block Center

EUROPEAN RAIL TRAFFIC MANAGEMENT SYSTEMS (ERTMS)

Driver Machine Interface (DMI) in cabin



Source: <https://www.lettreducheminot.fr/ertms-ecran-regio2n/>;
<http://transportrail.canalblog.com/pages/ertms---les-grands-principes-techniques/38926569.htm>

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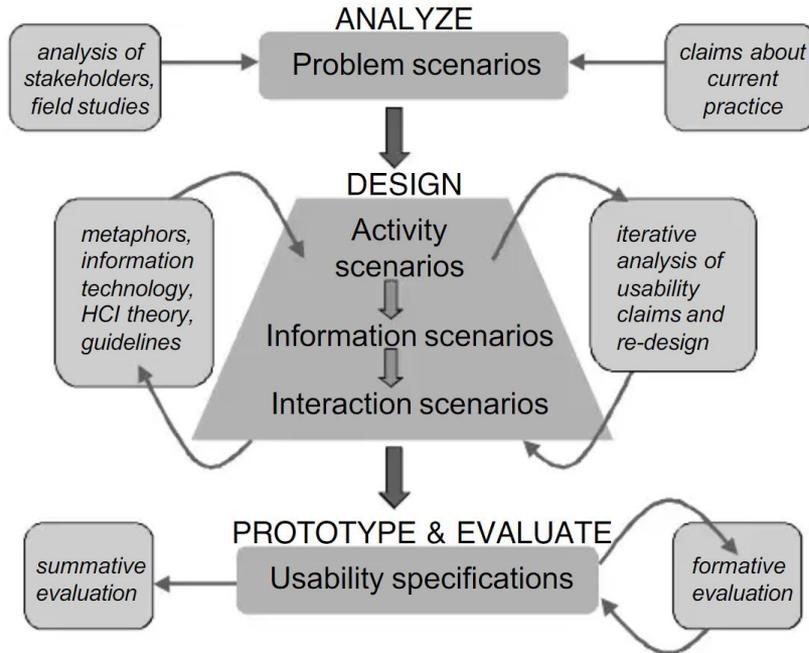
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A FRAMEWORK FOR SCENARIO-BASED DESIGN



Scenarios serve as a central representation throughout the development cycle, first describing the goals and concerns of current use, and then being successively transformed and refined through an iterative design and evaluation process

HUMAN-IN-THE-LOOP SIMULATION

SNCF Train Simulators for training(Lito)



HUMAN-IN-THE-LOOP SIMULATION

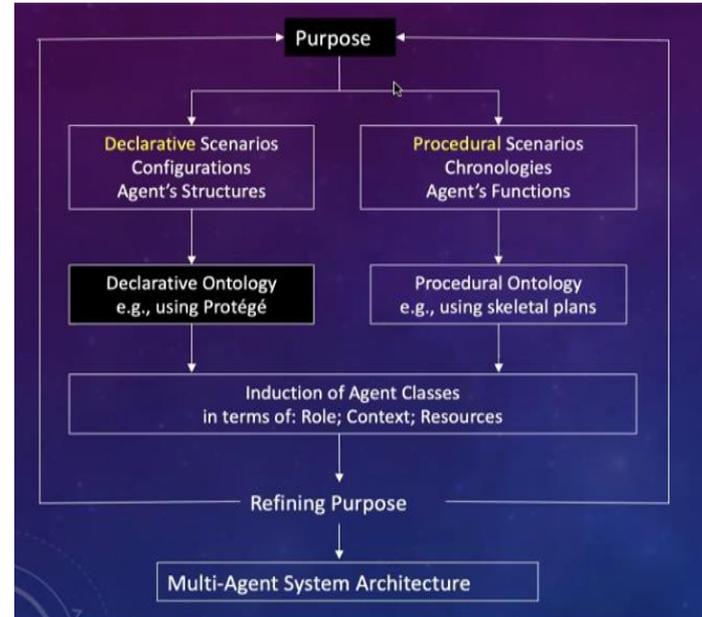
SNCF Train Simulators for training (Simbox)



HUMAN-IN-THE-LOOP SIMULATION



A cognitive function as a transformation of a **task** into an **activity**.

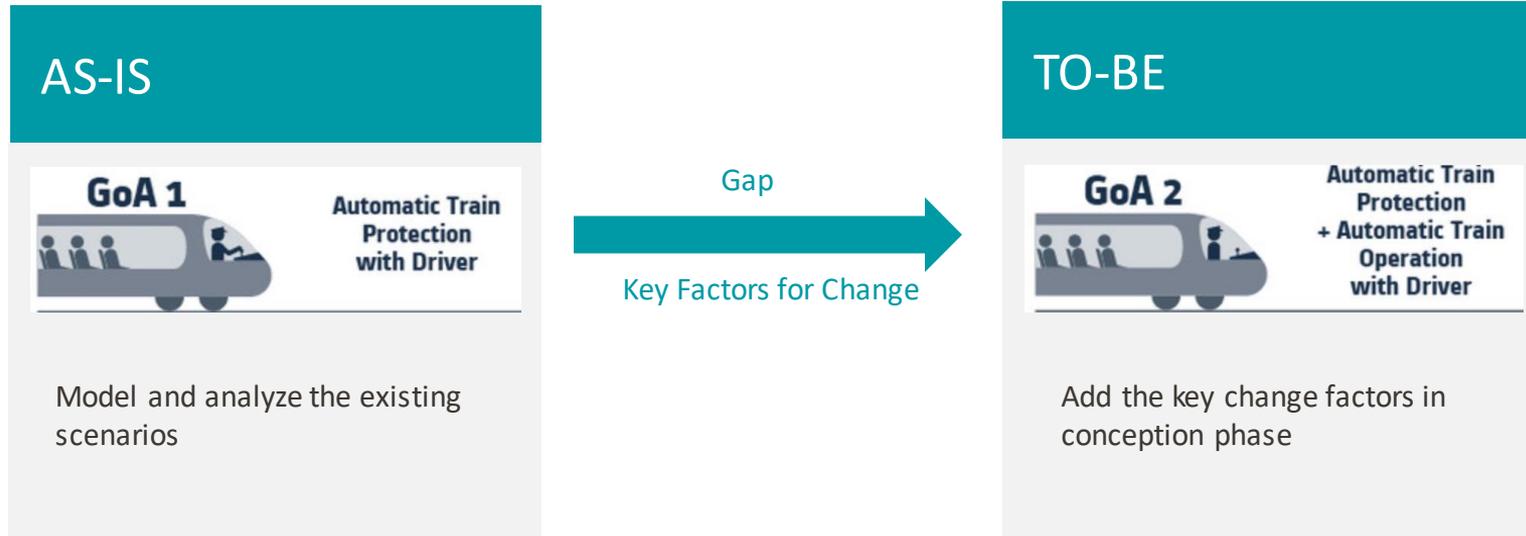


PRODEC method

Source: Guy A. BOY - The Role of People in Large Interconnected Systems (2022)

AS-IS TO-BE ANALYSIS

Project the future application on GoA2 by analysing the existing scenarios



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BASIC BPMN

Business Process Management notation

Basic BPMN is useful for modeling when details have not been worked out.

Activities, events, gateways, and sequence flow all have Basic BPMN level versions.



Abstract activity

No specific execution, acts as a placeholder for documentation purposes.



Start event

Begins a process flow.



End event

Ends a process flow.



Parallel gateway

All inputs must be received (in any order) before the process can continue.

All outputs are activated – process continues in parallel.



Exclusive gateway

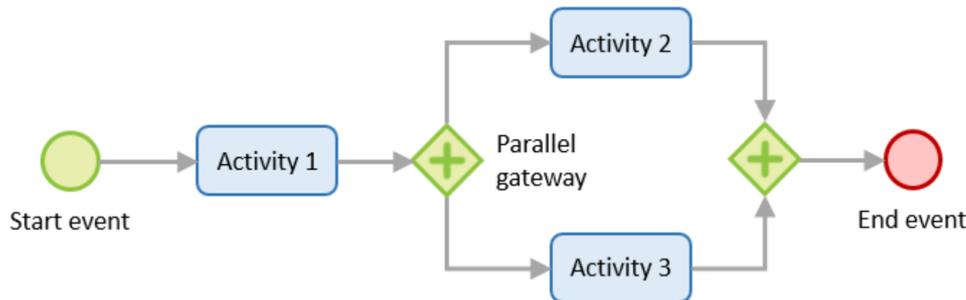
Only one input is needed for the process to continue.

Only one output is activated – a condition is needed to determine which one.



Sequence flow

Directs process flow from activity to activity.



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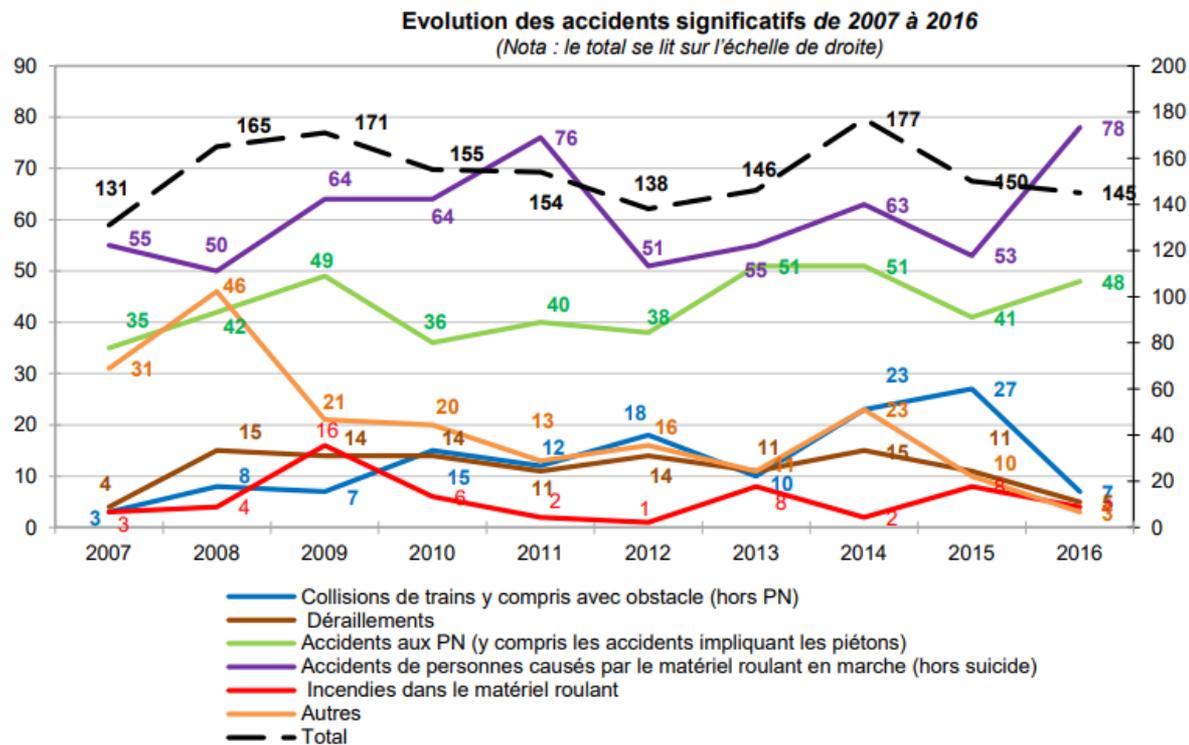
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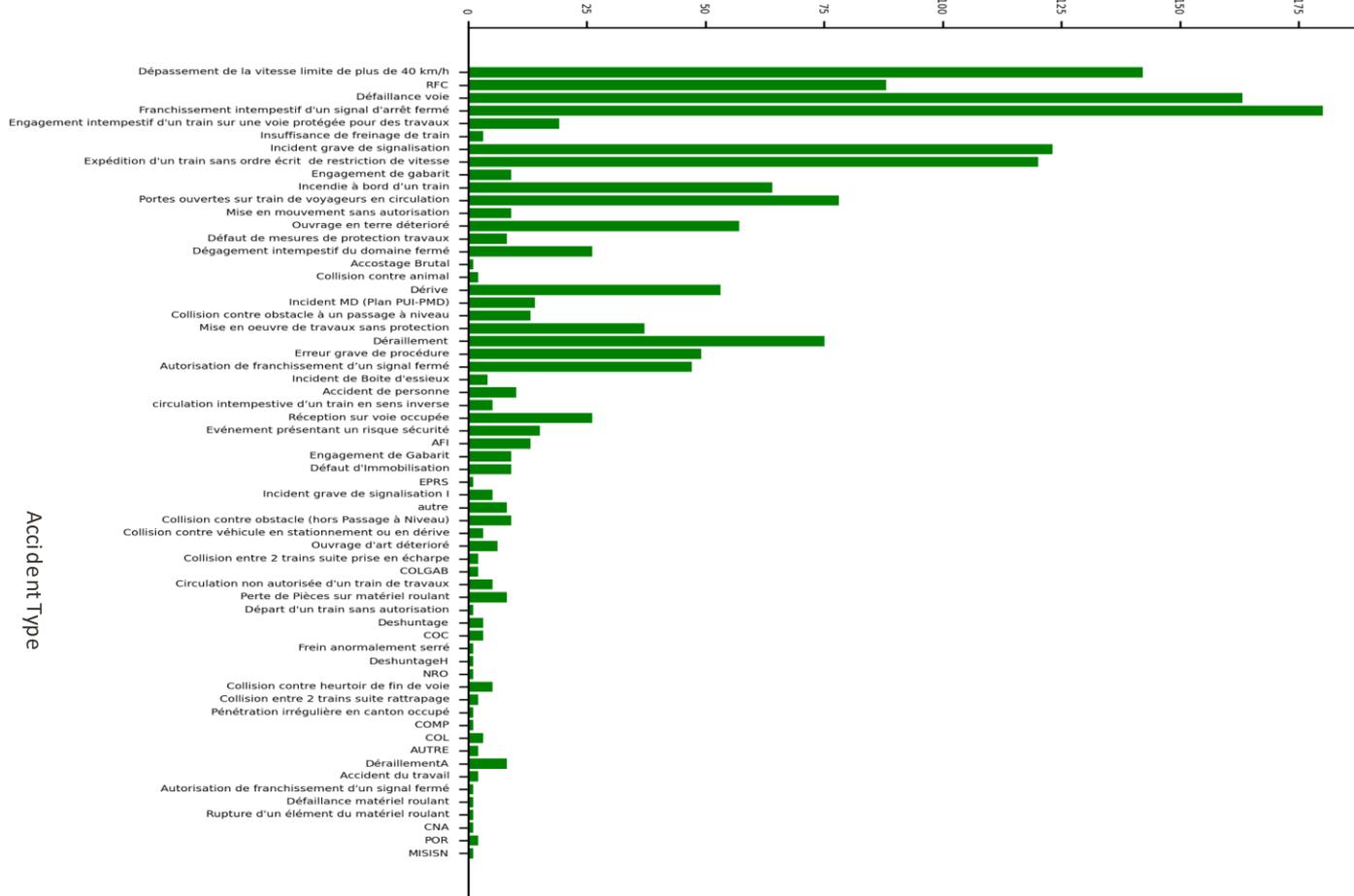
NUMBERS IN REPORT



Source: [SNCF RÉSEAU RAPPORT ANNUEL SÉCURITÉ 2016](#)

DATA ANALYSES BASED ON SNCF OPEN SOURCE DATA

Total number Janvier 2015 – May 2022



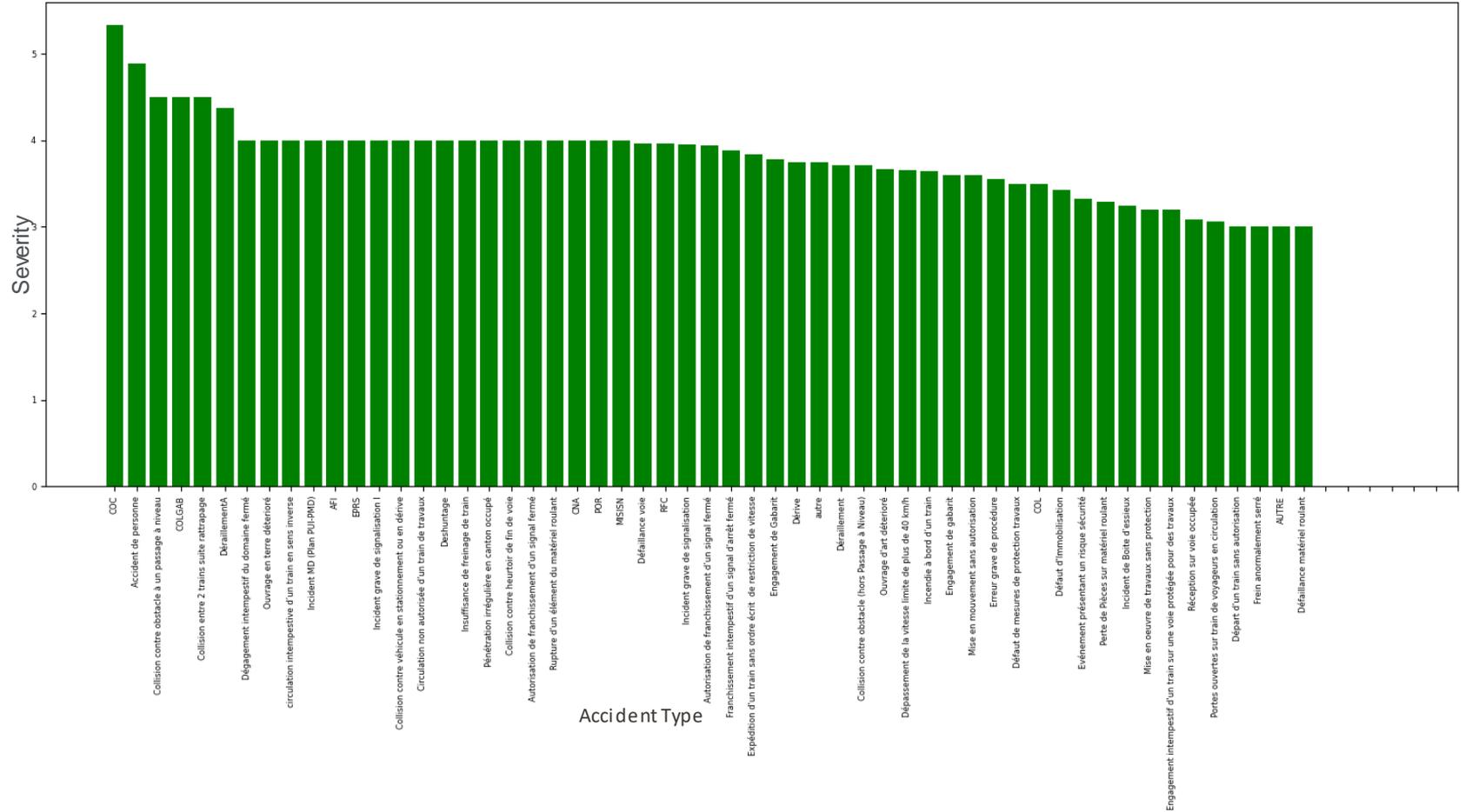
CLASSIFICATION BY SEVERITY EPSF

EPSF(Établissement public de sécurité ferroviaire) is the national railway security authority



Source : Guide pour la détermination des CCS des installations fixes – Version 1 – Applicable au 31 janvier 2018 (EPSF)

DATA ANALYSES BASED ON SNCF OPEN SOURCE DATA



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