PARIS
2 ▶ 7
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INTERNATIONAL
RAILWAY SAFETY COUNCIL

Shunting of track circuits: a prospective study

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Summary

→Signalling system : principles and track circuit

→Shunting malfunction : a system problem

→Innovative design method : presentation & application to the problem

→Roadmap of actual and future actions

Signalling principle: continuous train detection

➔ The continuous train detection is realized on the network with track circuits

➔ Role of track circuits :

→Track circuit is an electrical circuit which allows :

- To detect there is no traffic on a track section called zone
- To ensure mechanical continuity with control of electrical continuity
- Eventually transmit information on rolling stock

→ This information is used by most of automatism of railway operation.

This is an essential element for railway security.

The information is used for :

- Keeping distance between trains, Command of switches, Call at road crossing, The following of trains
- …

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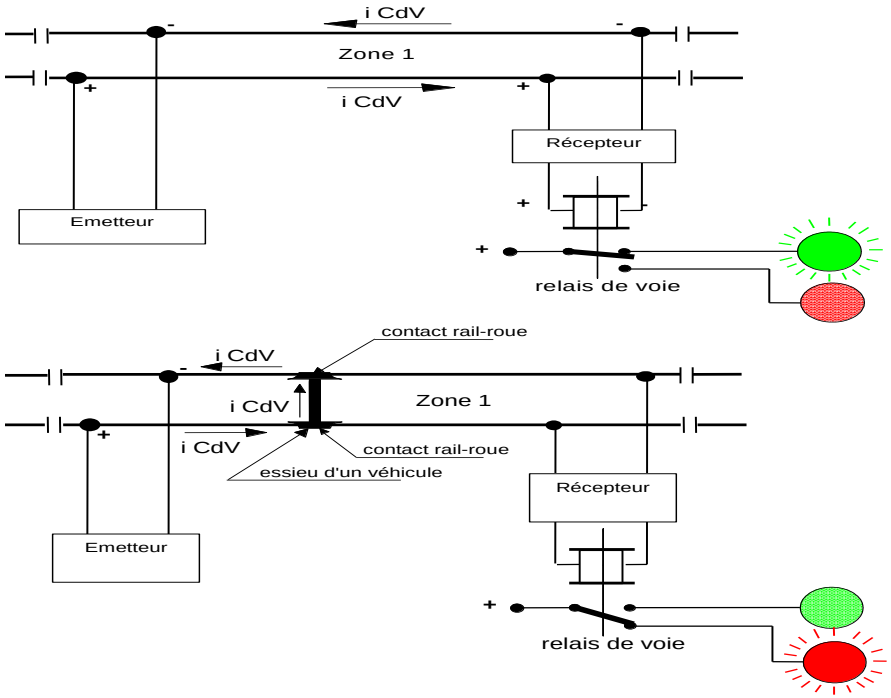
Signalling principle: continuous train detection

➔ Track circuit principle :

→The track is free :
Without train, current from emitter is sufficient to feed the receptor and maintain the track relay excited

→ The track is occupied:
When the train is on the track circuit, train axles are **shunting** the current from the generator. The receptor is not enougth feeded to maintain the track relay excited.



➔ 2 track circuits familly in France :
UM 71 for lines
ITE in stations zone

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Shunting malfunction : a system problem

➔ Conditions for good shunting :

- infrastructure specifications : optimized settings and maintenance of track circuits (and the track)
- Rolling stock specifications : TCA, sanding, axles specifications…
- A good quality of the wheel/rail contact in standard conditions (application of SAM S 004 to control the wheel/rail contact quality)
- A good quality of the wheel/rail contact in real conditions

There is still difficulties to understand wheel/rail electrical contact behaviour and to maintain good quality in real conditions

➔ **Shunting malfunction** : the track relay becomes excited whereas the train is still on the zone because of bad wheel/rail conditions.

Shunting malfunction : a system problem

➔ Main reasons for shunting malfunction
Pollution of rail (sand, grease, leaves)
Problem on the rolling stock (TCA, shoe problem, …)
Oxydation of rail
Specificity of certain rolling stocks (light, with disc brakes only) coming from 2004
Difficulty on tracks with low traffic flow

➔ **There is stopgap measures to control the consequences of shunting malfunction**

➔ **Need new ideas to manage the situation** ➔ **Innovative design method**

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Innovative design method

DISRUPTIVE INNOVATION // INCREMENTAL INNOVATION

Regular design

- Management by project
- Project management rules

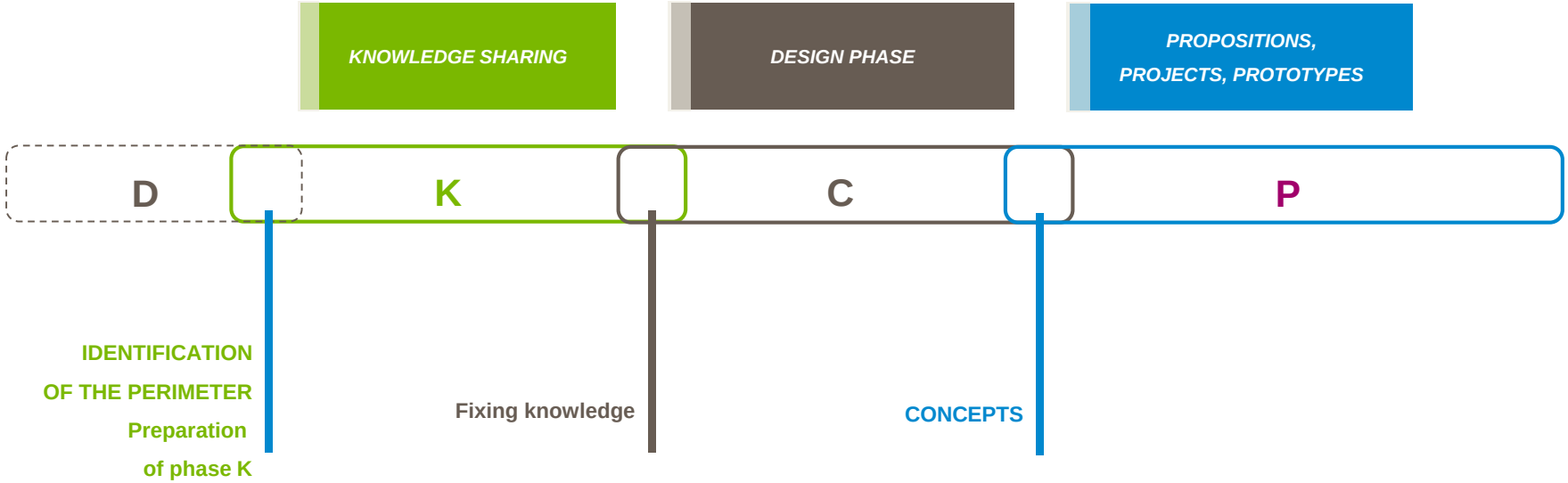
Innovative design approach

- New thinking
- New tools
- New management of activities
- at the end : Back to regular design

Applied by C. Brogard (SNCF I&R/INO)

Innovative design method

DKCP© METHOD



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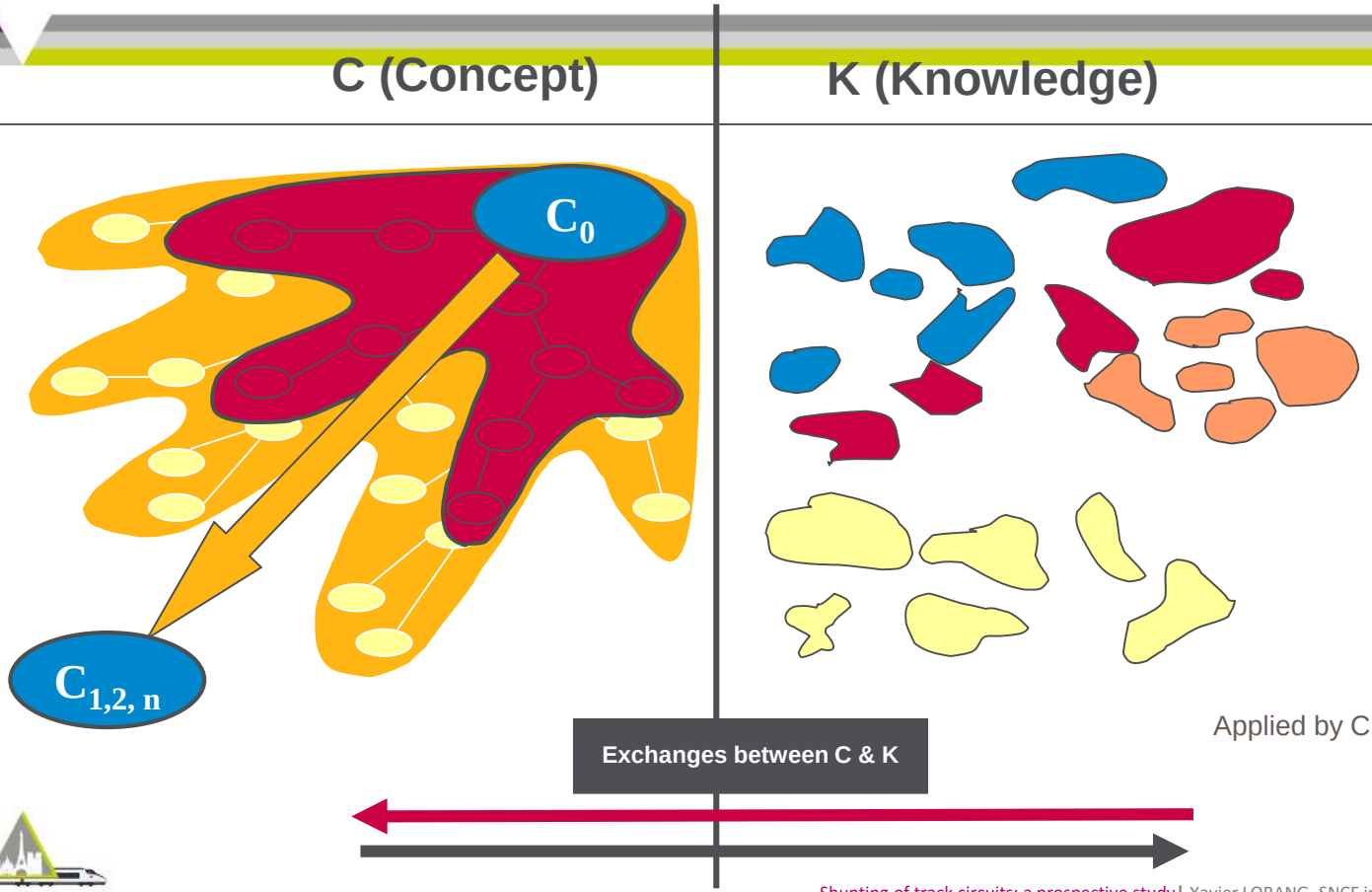
ECOLE DES MINES DE PARIS

Innovative design method



Applied by C. Brogard (SNCF I&R/INO)

Application on shunting malfunction

➔*A group of person at SNCF from :*

infrastructure department,

rolling stock department,

innovation and research department and operation department

as applied the method

➔*Proposition of the following target for the C0 concept :*

A rolling stock detected in all situations by track circuits

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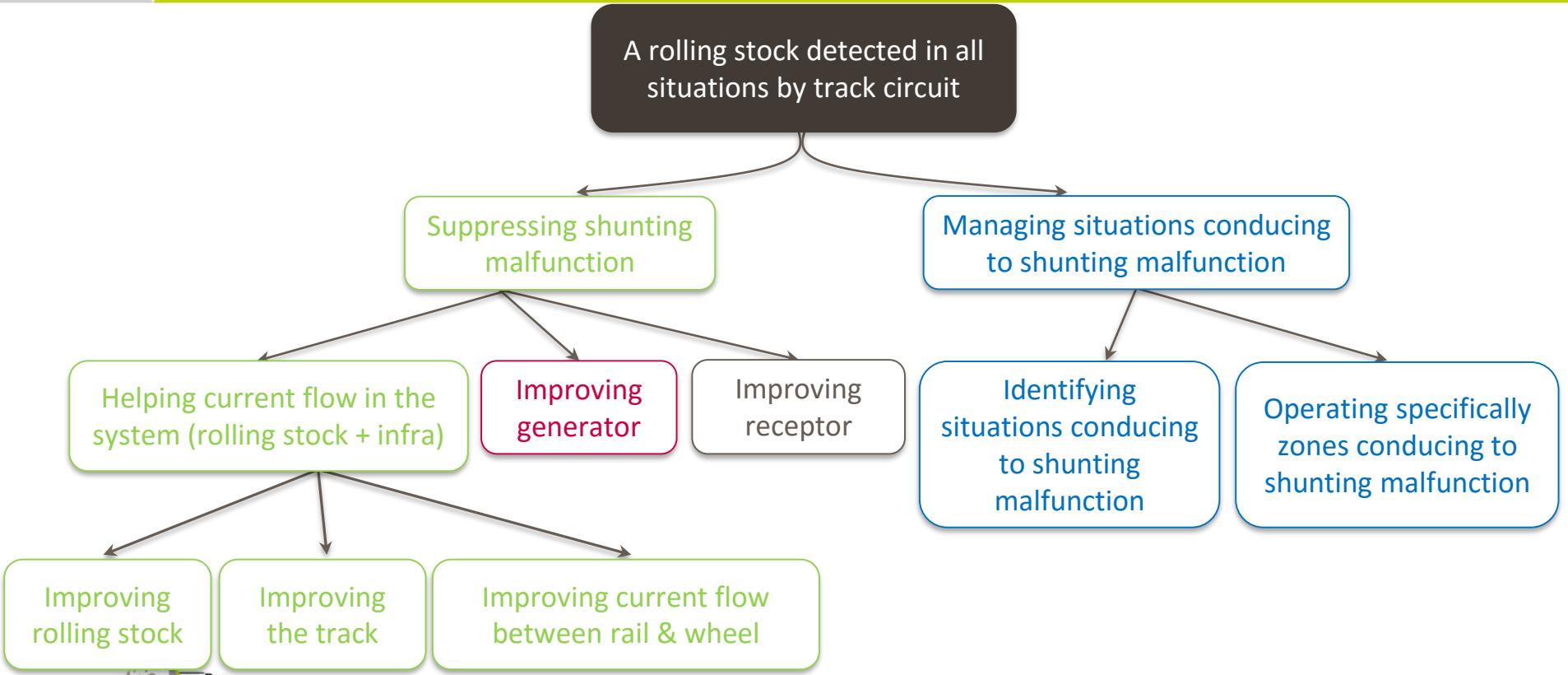
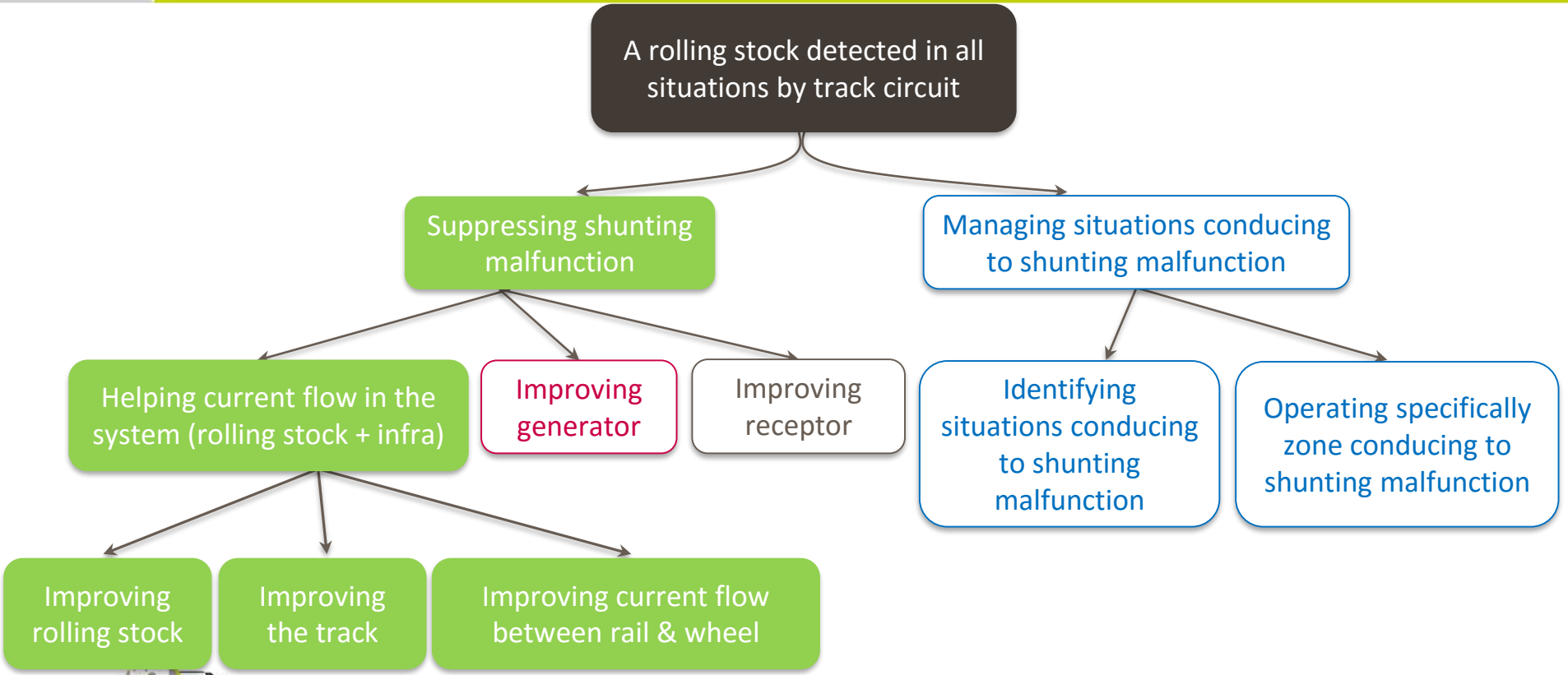
Concept tree



Roadmap

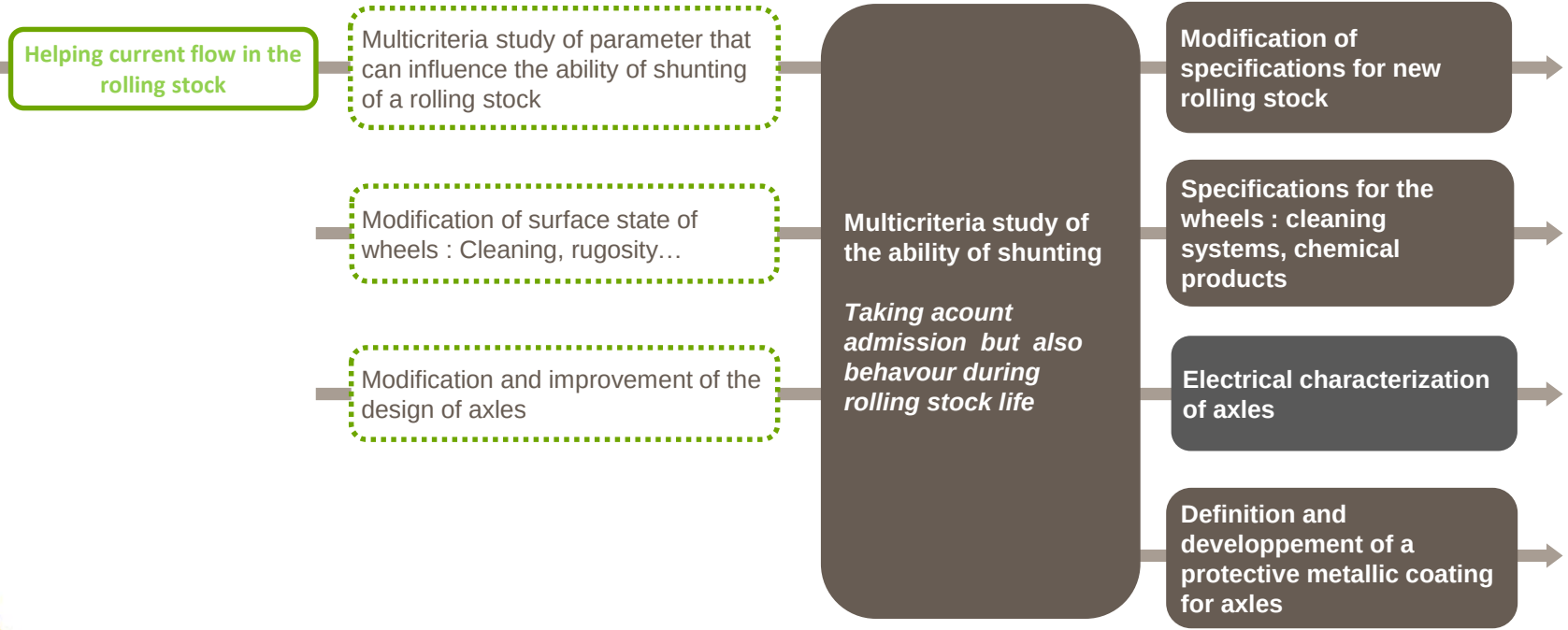

A rolling stock detected in all situations by track circuit
Suppressing shunting malfunction
Managing situations conducing to shunting malfunction
Helping current flow in the system (rolling stock + infra)
Improving generator
Improving receptor
Identifying situations conducing to shunting malfunction
Operating specifically zone conducing to shunting malfunction
Improving rolling stock
Improving the track
Improving current flow between rail & wheel

Roadmap

Finality

BRANCH 1 |

Suppressing shunting malfunction Helping current flow in the system (rolling stock + infra)



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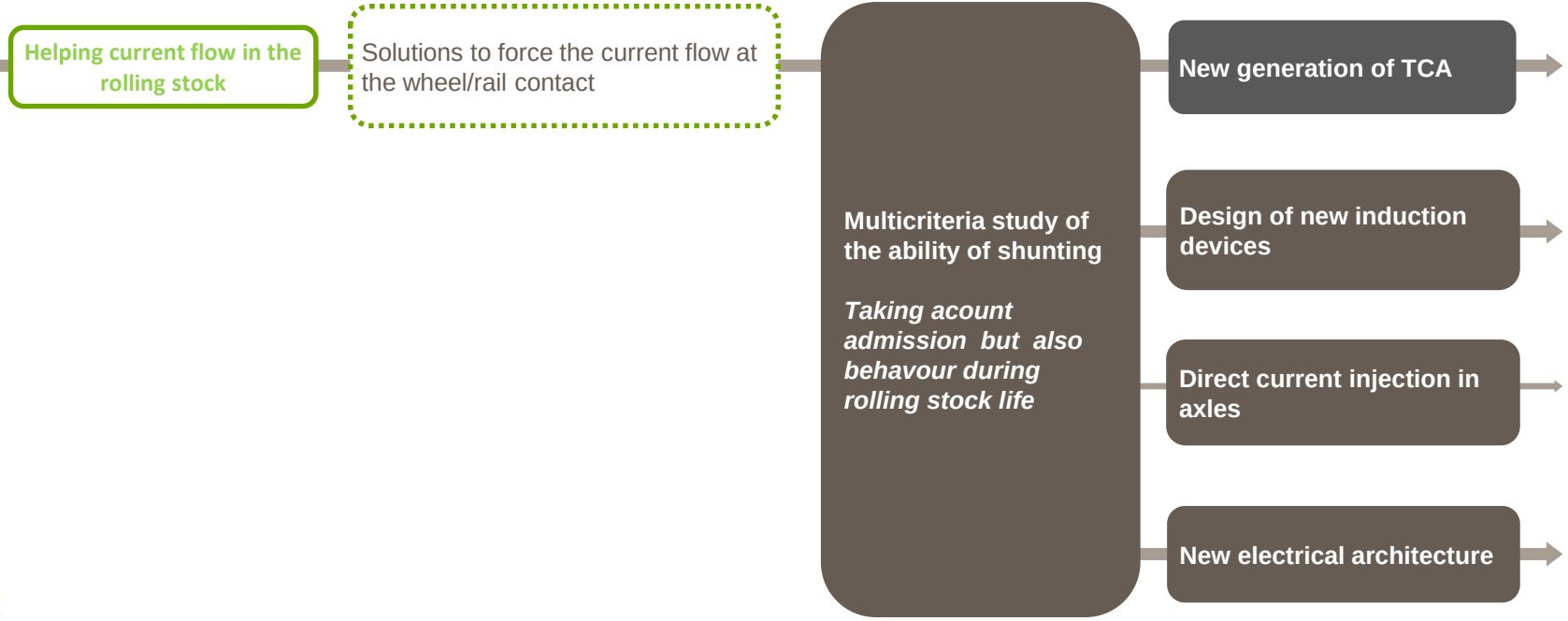

Roadmap

Finality

BRANCH 1 |

Suppressing shunting malfunction Helping current flow in the system (rolling stock + infra)

Improving current flow between rail & wheel

- Cleaning of rail : by trains or dedicated equipements, by commercial trains
  - ***Benchmark of cleaning solutions***
    - **Laser cleaning solutions, chemical products, heavy trains which cleans rust**
- Limitations of pollutions on rail (leaves, sand, …)
  - **Solutions for optimized sanding process as a function of velocity, type of sand…**
  - **Stick for lubrification of the wheel flange or for better electrical wheel/rail contact**
  - **Management of vegetation**
- Design of the track (impedance adaptation, …)
  - **Impedance adaptation of UM71**
  - **Modification of specifications for new tracks : ballast, rails, crosspiece…**

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Roadmap

Finality

BRANCH 1 |

Suppressing shunting malfunction Helping current flow in the system (rolling stock + infra)

Improving current flow between rail & wheel

Study of the mechanical wheel/rail contact to improve shunting (dynamic, adhesion…)

Optimization of the wheel/rail contact parameters (contact profile, size of the contact ellipse)

Correlation study between shunting malfunction phenomena and adhésion problems

Study of the impact of sliding zones in the wheel/rail contact surface on shunting

Electric characterization of 3rd body between wheel / rail

Characterization of 3rd body to find chemical and electrical solutions to eradicate it

Creation of a new contact between rail et rolling stock dedicated to shunting

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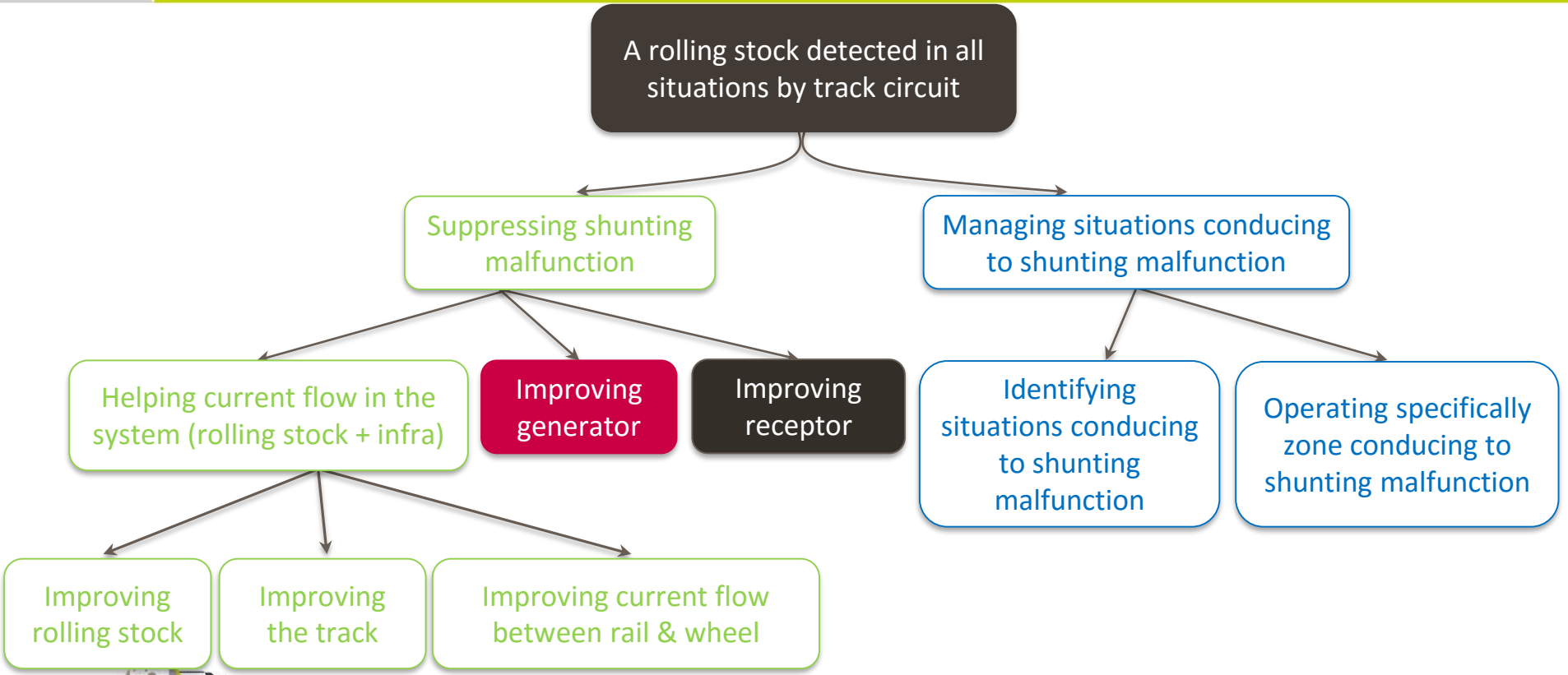
Roadmap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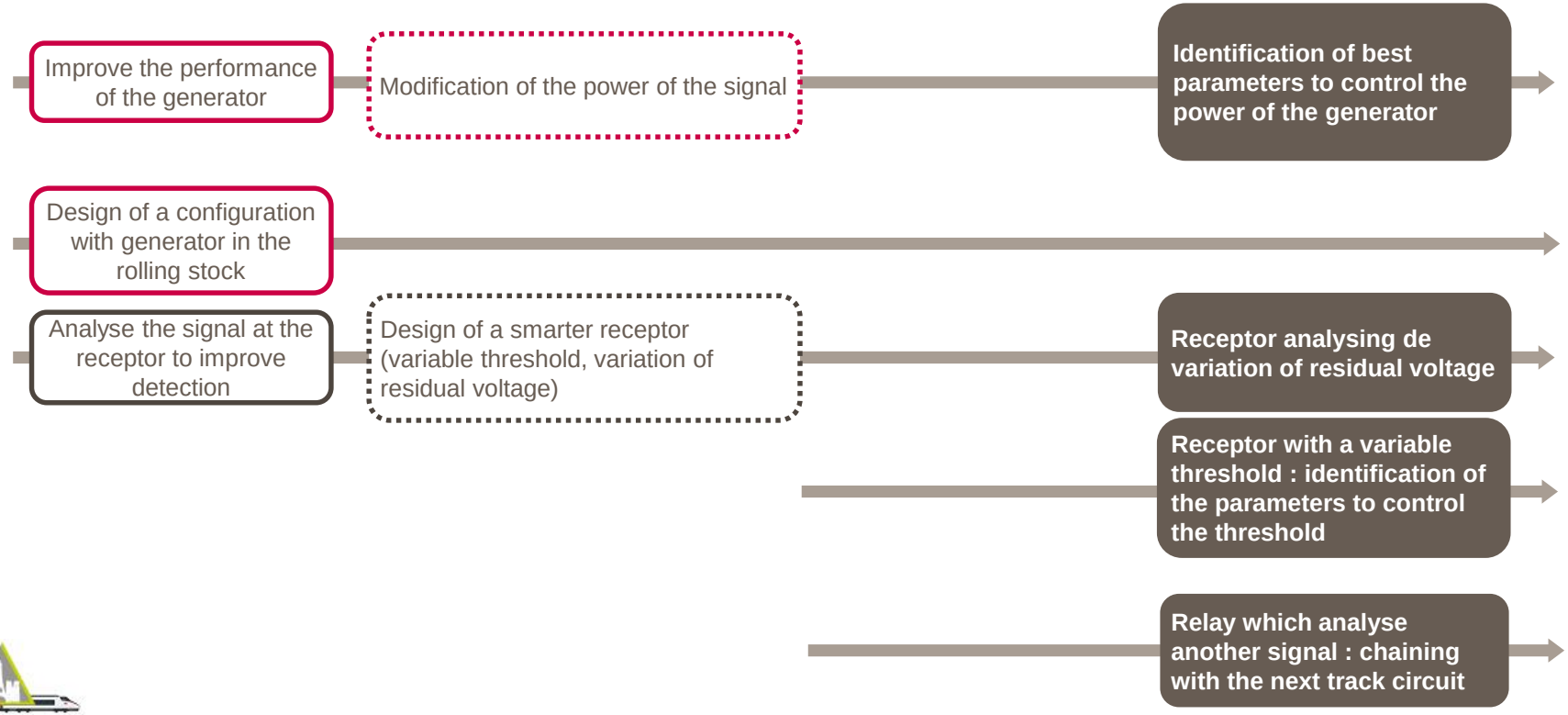
Roadmap

Finality

BRANCH 2 & 3 |

Suppressing shunting malfunction Improving the track circuit



Roadmap

Finality

Design rolling stock with receptor onboard

It implies suppression of Track circuit

Solution is not interoperable

BRANCH 2 & 3 |

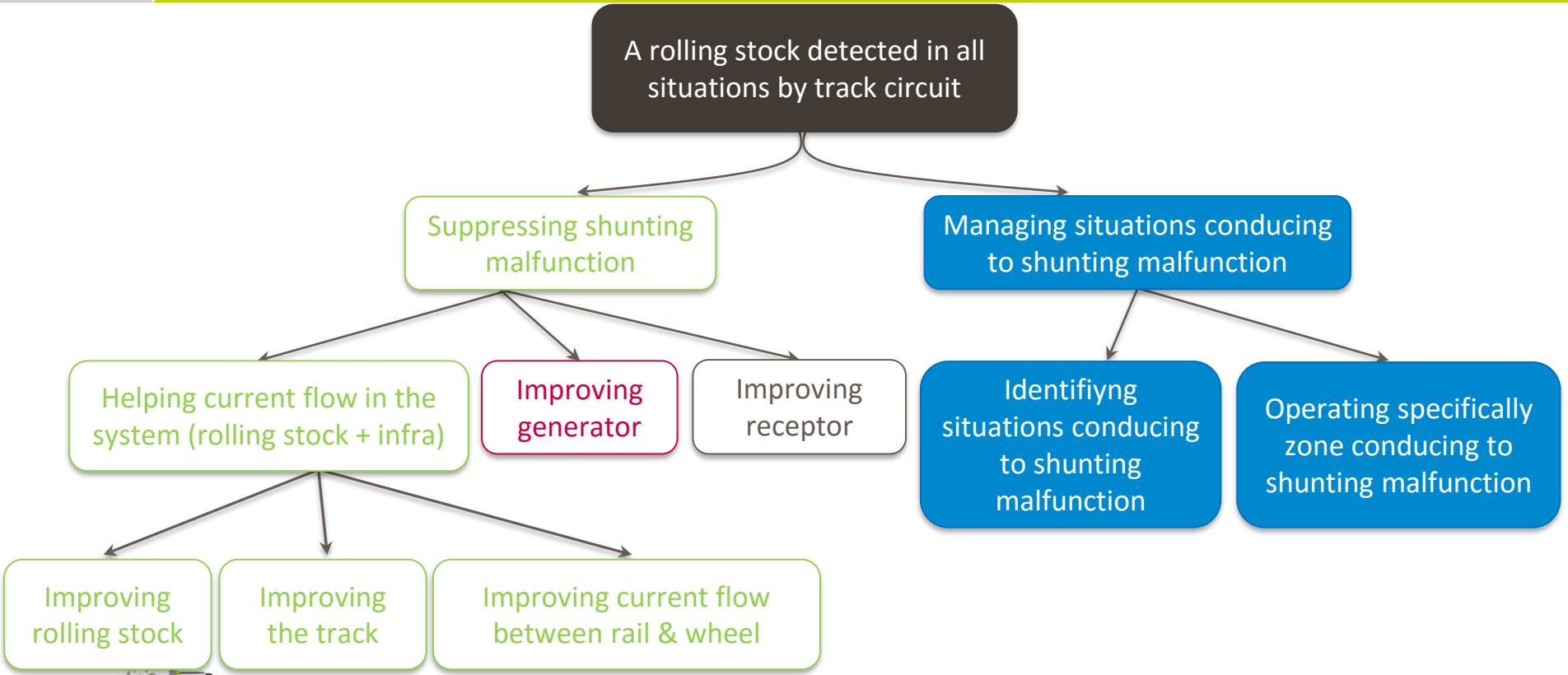
Suppressing shunting malfunction Improving the track circuit

Modify link between generator and receptor

Modification of the shape of the emitted signal

Frequency scanning

Roadmap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Roadmap

Finality

BRANCH 4 |

Managing situations with stopgap measures

Identify, in advance or in realtime, situations conducing to shunting malfunction

- Installation of equipements to improve the knowledge of the behaviour of rolling stocks
  - **Electric wheel/rail contact diagnostic on board**
  - **Electric wheel/rail contact diagnostic on track**
- Improving the knowledge of infrastructure
  - **infrastructure solutions : measurement of rail impedance, state of cleanliness of rail**
  - **Watch on traffic and real tonnage**
- Management of both together shunting malfunction and degraded adhesion
  - **Evaluation of wheel/rail adhesion by image analysis**
  - **Correlation analysis between shunting malfunction and degraded adhesion database**

Roadmap

Finality

Operating specifically zone conducing to shunting malfunction

Study on the rules for category of operating

Study on actual categories of rolling stocks

Creation of categories by line for some sensitive itinerary

BRANCH 4 |

Managing situations with stopgap measures

Installation of new equipements to make easier or to suppress operating procedures associated to bad shunting rolling stock

Creation of specific zones Redundancy with axle counter

Conclusions

→Shunting malfunction context has been briefly presented

→An innovative design method has been applied to the problem

→As a result, a Roadmap of actions has been proposed

→New ideas has been bringing and will help to manage the situation