

5 November 2025
14:00-16:00 (CET)

UIC WEBINAR

Safety Webinar « ETCS & HOF : Return of Experience 2025 »

INTERNATIONAL UNION
OF RAILWAYS

The speakers



Eric Pebret

Train driving and safety specialist

SNCF Voyageurs



Jean-Emmanuel Leroy

Train driving and safety specialist

SNCF Voyageurs



John Gunnell

Principal Human Factors Consultant

Atkins Realis



Nora Balfe

Head of Human Factors

Iarnród Éireann Irish Rail

The speakers



Richard Bye

Head of Ergonomics and Human Factors

Network Rail



Frederik Calleeuw

Safety Culture Specialist

Infrabel



Bernard Penners

Safety Culture Specialist

Infrabel



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BACKGROUND TO THE ETCS HOF RETURN ON EXPERIENCE

Nora Balfe

INTERNATIONAL UNION
OF RAILWAYS

Genesis

Feb 2024

Discussion at UIC HOFWG on shared experiences of ETCS

Nov 2024

UIC HOFWG propose a workshop to consolidate experiences

Feb 2025

Invitations issued to experts with knowledge of both ETCS & HOF

Jun 2025

2-day workshop at UIC Headquarters in Paris on 11/12 June



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Workshop objectives

1. To create a community of practice for HOF aspects of design and implementation of ETCS
2. To share knowledge and understanding of HOF issues with ETCS
3. To identify common HOF issues with ETCS
4. To share best practices in resolving ETCS HOF issues
5. To identify proposals for improvements to the ETCS specification to be promoted to ERA

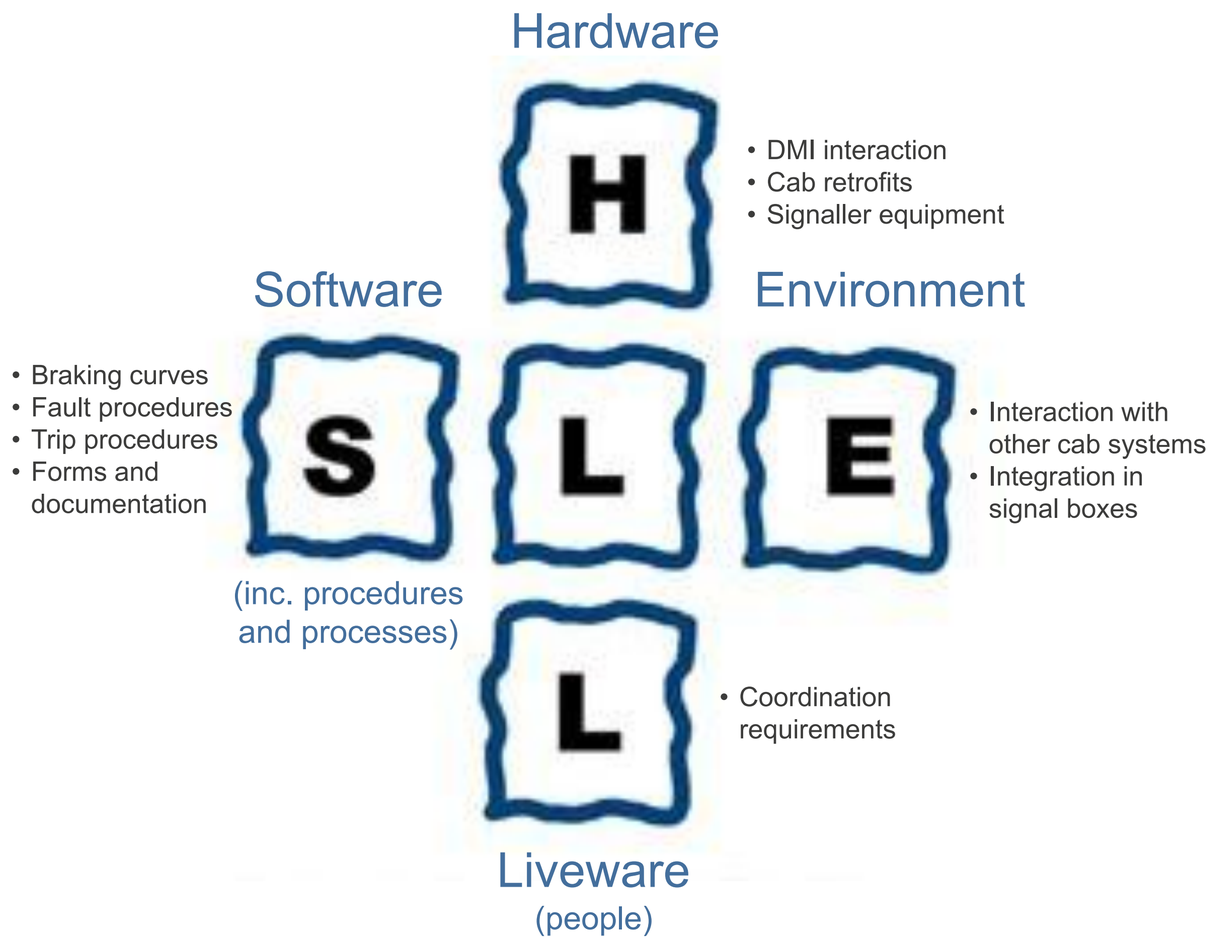
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A short note about HOF

Systems focussed

Looks at the interactions between people (L) and other parts of a socio-technical system

Design discipline – looks at supporting human performance firstly through human centred design



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Workshop structure and topics

Participants asked to prepare and bring their identified issues to the workshop

Brainstorm and prioritisation on five topic areas:

- DMI issues
- Onboard behaviour issues
- Signalling and trackside issues
- Training issues
- Migration issues

Group discussion on the highest priority issues, resulting in 13 documented issues

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Today’s webinar

Some caveats:

- We are not systems engineers!
- We have incorporated our knowledge of the ETCS specification and why ETCS has been designed in a certain way, but our focus is on the human performance implications of that
- The mitigations we present are suggestions – they may not all be suitable in practice

Today we will present on 6 topics, and our suggested mitigations

We aim to start a conversation

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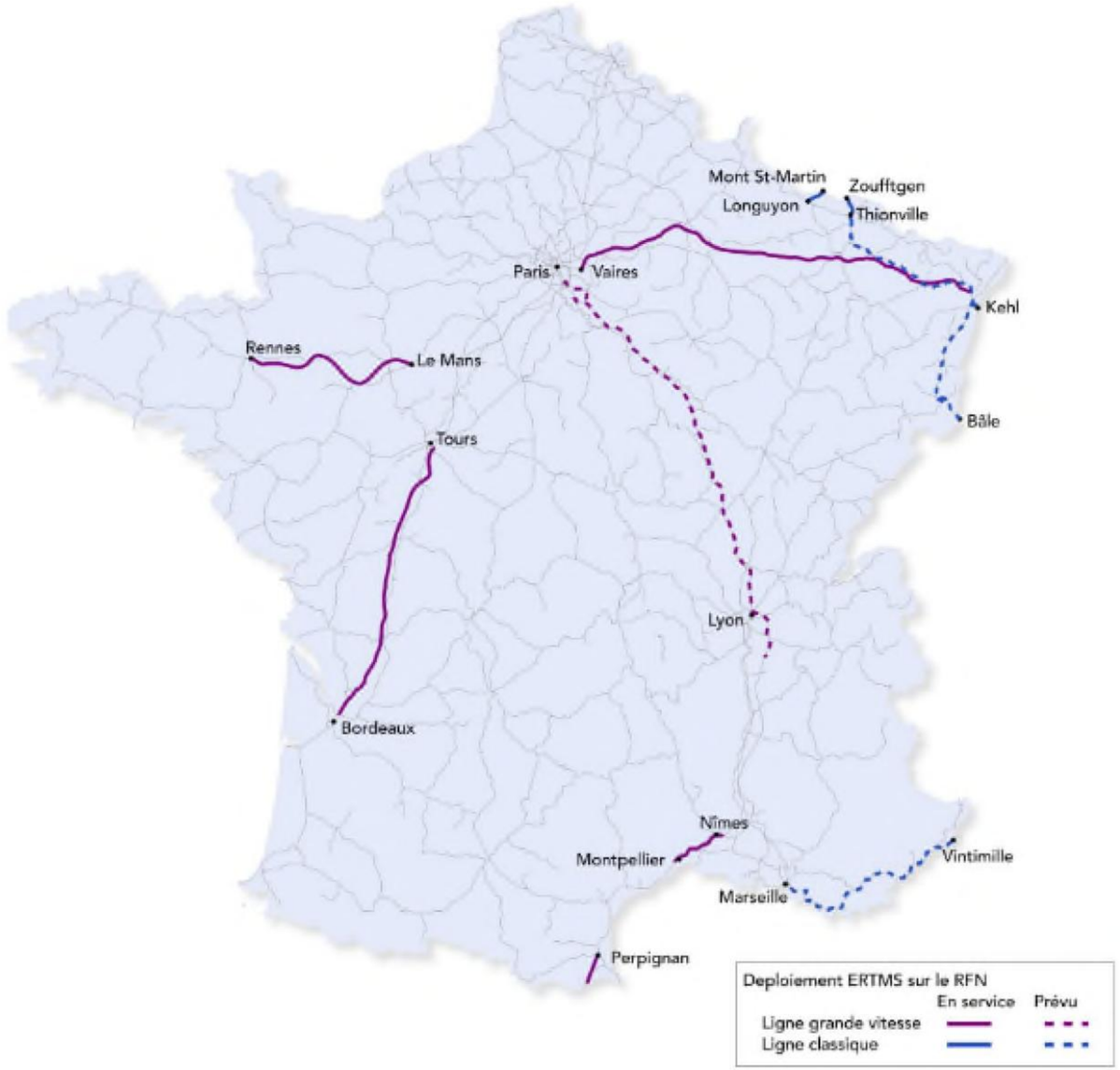
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LANGUAGE ISSUES

Eric Pebret &
Jean-Emmanuel
Leroy

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French network : ETCS lines



Interne

ETCS text messages: variability & language issues

Text messages on the DMI are displayed here



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ETCS text messages: variability issues

STI CCS Appendix E:

97	Unauthorized passing of EOA/LOA

	English	French
CCS TSI 2023	Unauthorized passing of EOA/LOA	Franchissement LOA/EOA non autorisé
TGV SNCF (SRS 3.4.0)	Unauthorized passing of EOA/LOA	ETCS : Franchissement EOA
Z 24500 SNCF (SRS 3.4.0)	Unauthorized passing of EOA/LOA	ETCS : Franchissement EOA
Z 26500 SNCF (SRS 3.6.0)	Unauthorized passing of EOA/LOA	ETCS : Franchissement EOA
Ae 2200 CFL (Alstom bsl 2)	EOA or LOA crossed	Dépassement EOA ou LOA

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ETCS text messages: variability issues

Example from Ouigo Spain TGVs :

Alstom Label ID	English	Español	French	ETCS ID
289	Unauthorized passing of EOA / LOA	Modo TRIP - EOA o LOA rebasado	ETCS : Franchissement EOA	**151**
290	Unauthorized passing of EOA / LOA	Modo TRIP - Anterior EOA o LOA rebasado	ETCS : Franchissement EOA	**153**
291	Unauthorized passing of EOA / LOA	Sobrepasado grupo balizas de señal en rojo	ETCS : Franchissement EOA	**155**
293	SR distance exceeded	Máxima distancia en SR excedida	ETCS : Franchissement EOA	**159**
294	No MA received at level transition	Entrada en Nivel 1 o 2 sin MA	ETCS : Franchissement EOA	**161**

Example from Ae 2200 CFL :

151	EOA_LOA_CROSSED	EOA or LOA crossed	Dépassement EOA ou LOA	Entry in TR mode due to an EOA or a LOA crossed
152	EOA_LOA_CROSSED_TR_ACK	EOA or LOA crossed	Dépassement EOA ou LOA	Same meaning as the id 151 message, but this message requests an acknowledgement. This latter gives the opportunity to memorise the entry in TR mode reason.
153	FORMER_EOA_LOA_CROSSED	Former EOA or LOA crossed	EOA/LOA précédente dépassée	Entry in TR mode due to a Former EOA or LOA crossed
154	FORMER_EOA_LOA_CROSSED_TR_ACK	Former EOA or LOA crossed	EOA/LOA précédente dépassée	Same meaning as the id 153 message, but this message requests an acknowledgement. This latter gives the opportunity to memorise the entry in TR mode reason.
155	RED_SIGNAL_BG_CROSSED	Red signal balise group crossed	Dépassement EOA	Entry in TR mode due to a red signal balise crossed
156	RED_SIGNAL_BG_CROSSED_TR_ACK	Red signal balise group crossed	Dépassement EOA	Same meaning as the id 155 message, but this message requests an acknowledgement. This latter gives the opportunity to memorise the entry in TR mode reason.

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ETCS text messages variability in written procedures

Extracts from ground failure procedures in ETCS L2 (TGV, high speed lines)

➢ Text variations and their combinations are highlighted in yellow

DRIVER REFERENCE & TRAINING DOCUMENT :

Certaines anomalies peuvent déclencher un freinage d'urgence avec affichage du symbole [ ] ou [ ].

À l'arrêt le freinage d'urgence est levé et suivant l'équipement de l'EM :

- Bi-Standard ERTMS/TVM :

version 7 :

un EOA est positionné par le système bord au niveau de la tête du train avec affichage du message :

- « **MA raccourcie** » lorsque le train est en mode FS ou OS ;
- « **Allocation SR raccourcie** » lorsque le train est en mode SR.

version 9 :

un EOA est positionné par le système bord au niveau de la tête du train avec affichage du message « **MA raccourcie** » lorsque le train est en mode FS ou OS ; en mode SR, le conducteur peut reprendre sa marche.

- Bi-Standard ERTMS/KVB et BR407 ETCS :

un EOA est positionné par le système bord au niveau de la tête du train en mode FS ou OS (sans affichage de message) ;
en mode SR, le conducteur peut reprendre sa marche.

1 - Le conducteur constate l'affichage du message textuel « **Défaut équipement sol** » ou « **ETCS : Défaut sol** » ou « **Défaut liaison balise x** » ou « **Défaut LEU x** », sans freinage d'urgence

➢ Signaler l'anomalie à l'agent-circulation.

2 - Le conducteur constate un freinage d'urgence ([ ] ou [ ]) associé au message textuel « **Défaut équipement sol** » ou « **Défaut informations balises** » ou « **ETCS : Défaut sol** »

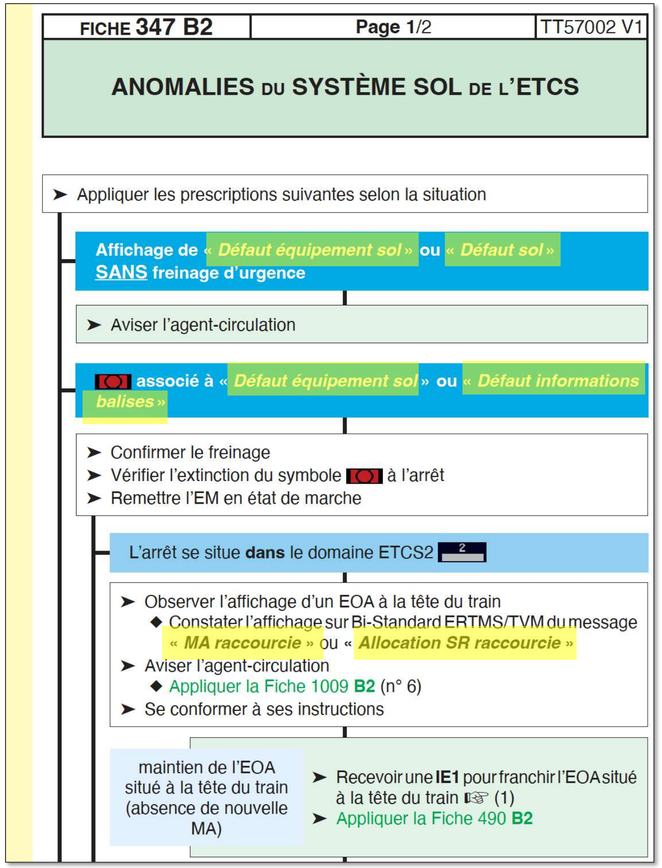
⇨ *Ces messages peuvent être accompagnés des messages « **Défaut liaison balise x** » ou « **Défaut LEU x** »*

➢ Confirmer le freinage.

➢ Vérifier l'effacement du symbole [ ] ou [ ].

⇨ *Ce freinage d'urgence est irréversible jusqu'à l'arrêt du train.*

DRIVER OPERATIONAL DOCUMENT :



FICHE 347 B2 | **Page 1/2** | TT57002 V1

ANOMALIES DU SYSTÈME SOL DE L'ETCS

➢ Appliquer les prescriptions suivantes selon la situation

Affichage de « *Défaut équipement sol* » ou « *Défaut sol* » SANS freinage d'urgence

➢ Aviser l'agent-circulation

[ ] associé à « *Défaut équipement sol* » ou « *Défaut informations balises* »

➢ Confirmer le freinage
➢ Vérifier l'extinction du symbole [ ] à l'arrêt
➢ Remettre l'EM en état de marche

L'arrêt se situe **dans** le domaine ETCS2 2

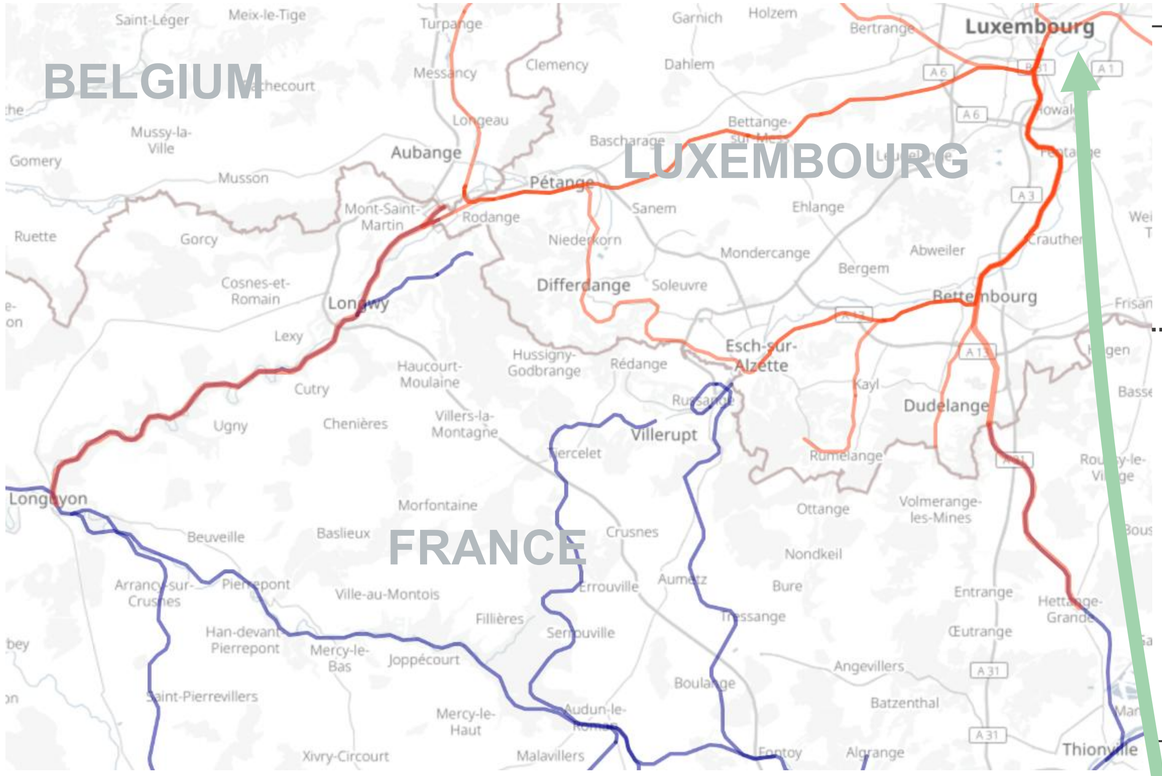
➢ Observer l'affichage d'un EOA à la tête du train
◆ Constater l'affichage sur Bi-Standard ERTMS/TVM du message « ***MA raccourcie*** » ou « ***Allocation SR raccourcie*** »
➢ Aviser l'agent-circulation
◆ Appliquer la Fiche 1009 **B2** (n° 6)
➢ Se conformer à ses instructions

maintien de l'EOA situé à la tête du train (absence de nouvelle MA)

➢ Recevoir une **IE1** pour franchir l'EOA situé à la tête du train ☞ (1)
➢ Appliquer la Fiche 490 **B2**

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The case of France <> Luxembourg regional traffic



Luxembourg

ETCS L1 Lux

FR/Lux border

ETCS L1 FR

Class B system (KVB)

Thionville

Metz



Ae 2200 CFL



Z 24500 SNCF

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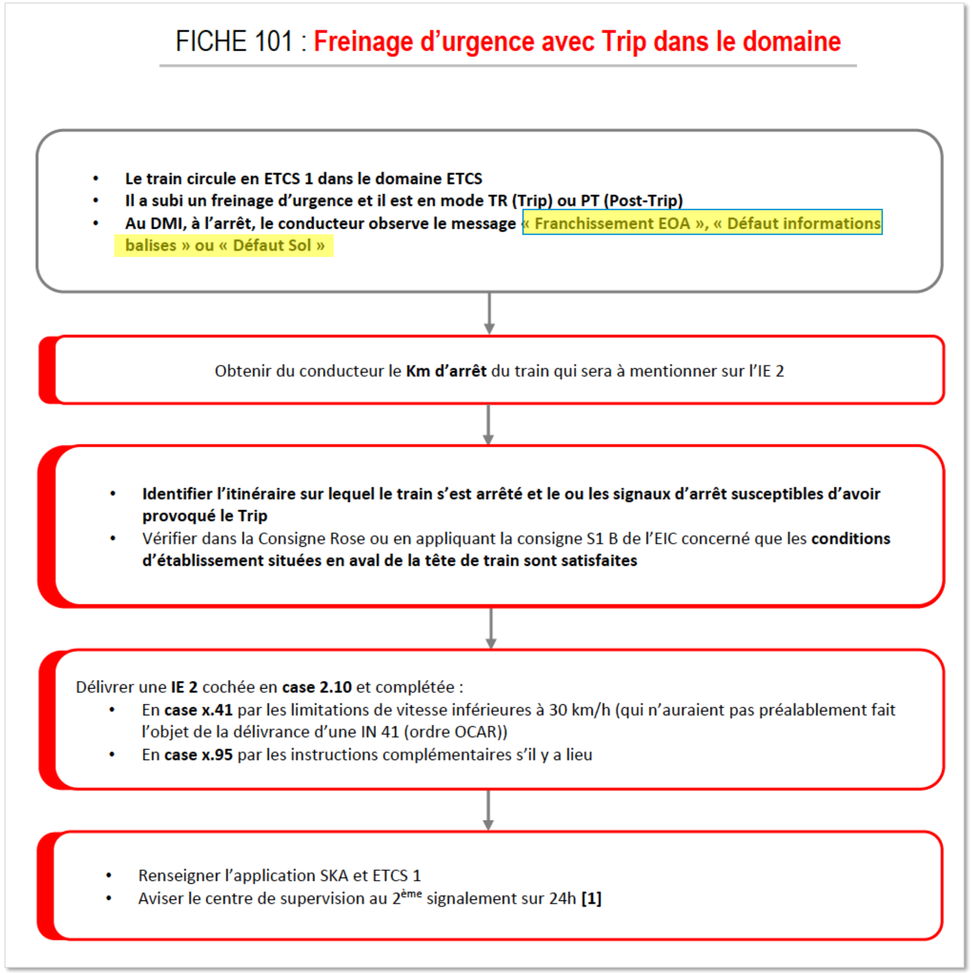
Signaller / driver communications

SIGNALLER OPERATIONAL DOCUMENT :

5.Signification des messages textuels

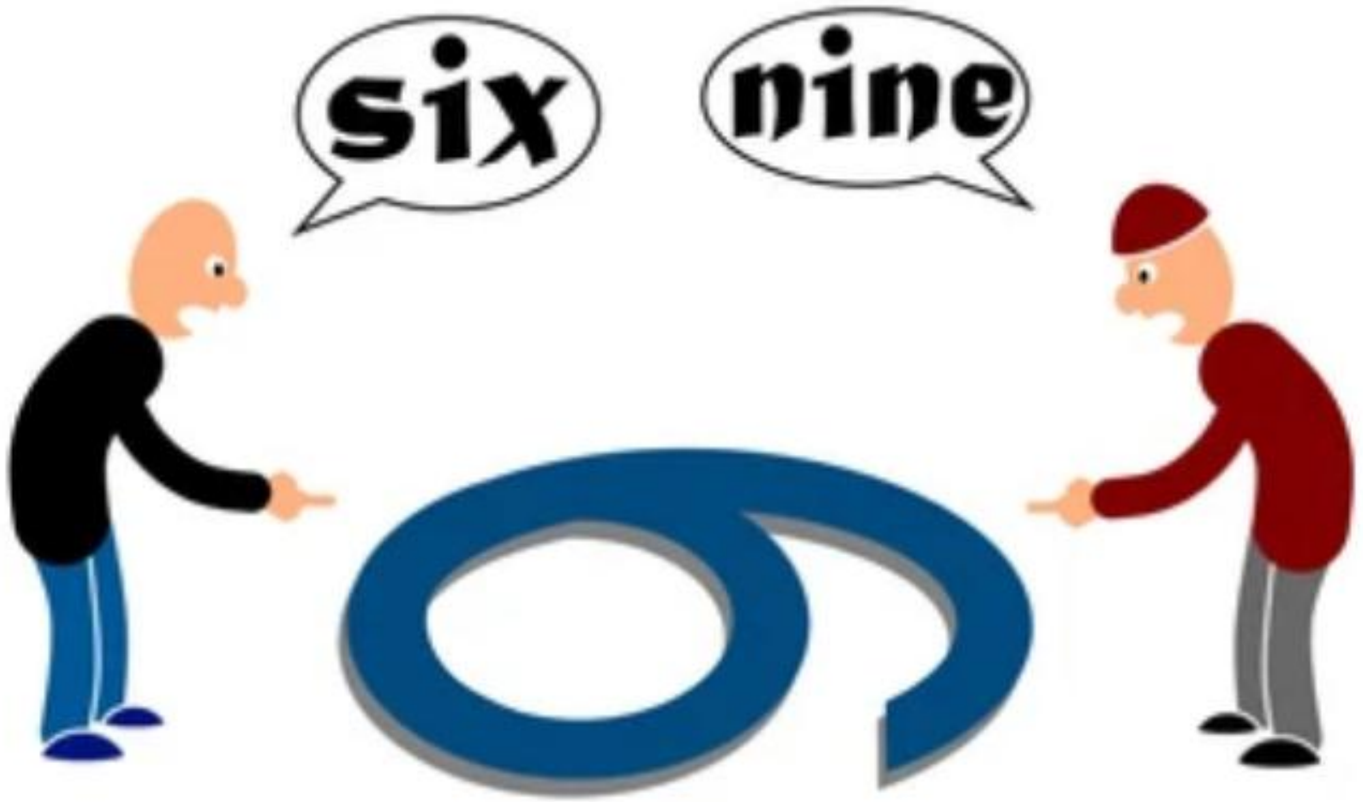
En raison de la diversité du matériel roulant, la liste des messages ci-dessous n'est pas exhaustive.

- **« Franchissement EOA » / « *Unauthorized passing of EOA* »** :
  - Dans le domaine ETCS, le train supervisé a franchi une EOA.
  - En entrée de domaine ETCS, le train en cours de transition n'a pas reçu de MA au franchissement du PLD. Dans ce cas, le message **« Franchissement EOA »** équivaut au message **« Pas de MA reçue au point de transition »**.



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Signaller / driver communications



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Text messages variability issues – Mitigations

Preventing variations through standardisation

- Ideally, at European network level:
  - ✓ ERA ETCS Workgroup : in progress for a future version of CCS TSI
- In the meantime, at Infrastructure Manager level:
  - ✓ Designing national rules with all interested parties

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France > Luxembourg transition

Transition KVB > ETCS

Signal
(eventually annoucing a red aspect)

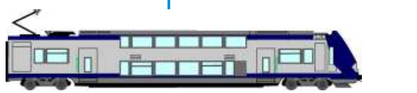
Current switching
(or pantograph lowering if multiple units)

Signal
(eventually at red aspect)

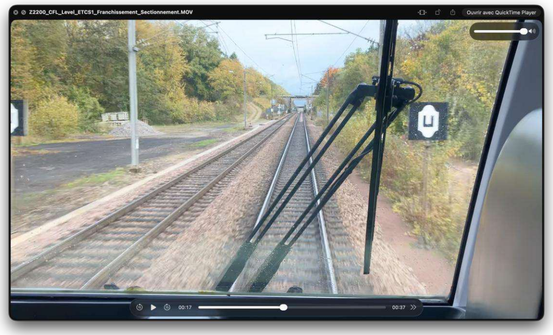
GSM-R switching

Time sheet switching

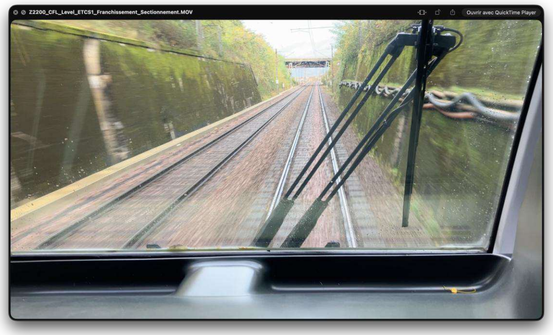
Language switching











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DMI Language selection



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Language switch issues - Mitigations

- Message from a balise (L1) or RBC (L2) to display a language switch request to the driver

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RELEASE SPEED MANAGEMENT

John Gunnell

INTERNATIONAL UNION
OF RAILWAYS

Release Speed Management

To enable the driver to pull forward to an EoA at a system defined maximum controlled speed

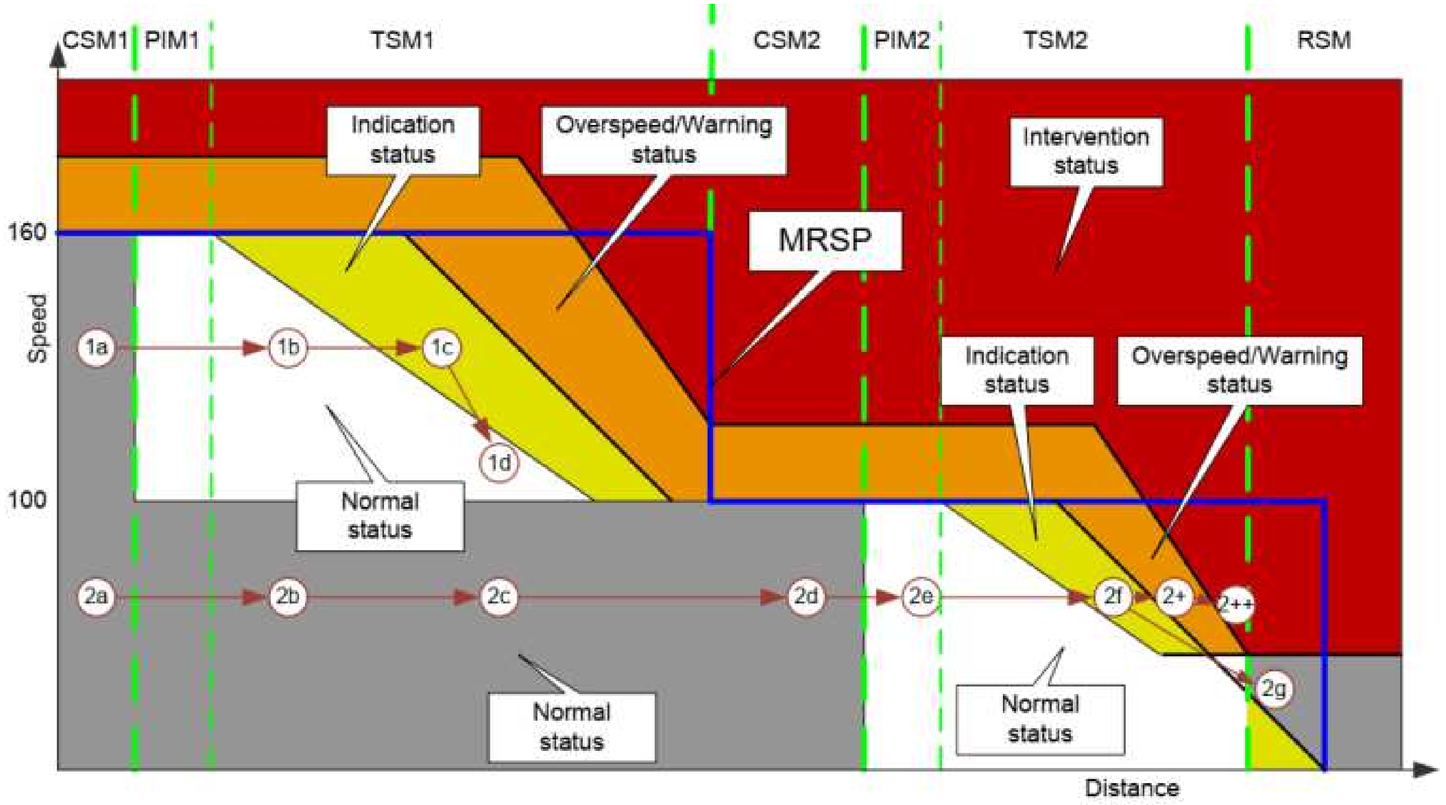


Figure 47 – Release speed, when $V_{perm} > V_{relea}$



Figure 48 – Release speed, when $V_{perm} < V_{release}$

A grey indication and speed presented



- Risk #1 Sudden emergency brake application used if actual speed is above release speed
- Risk #2 Conservative driving profile impact on operational performance

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Release Speed Management

Impact on human and system performance

- Divided attention - ‘Heads Up’ to monitor approaching stopping point
  - ‘Heads Down’ within cab to monitor RSM prompts

- Driver RSM awareness - Generic ‘S_info’ audible alert provided when entering RSM
  - No overspeed status info. If RSM exceeded, then straight to EBI
  - Confusion with Ceiling Speed (grey shaded bar on speed hook)

Release Speed Monitoring (light grey bar)



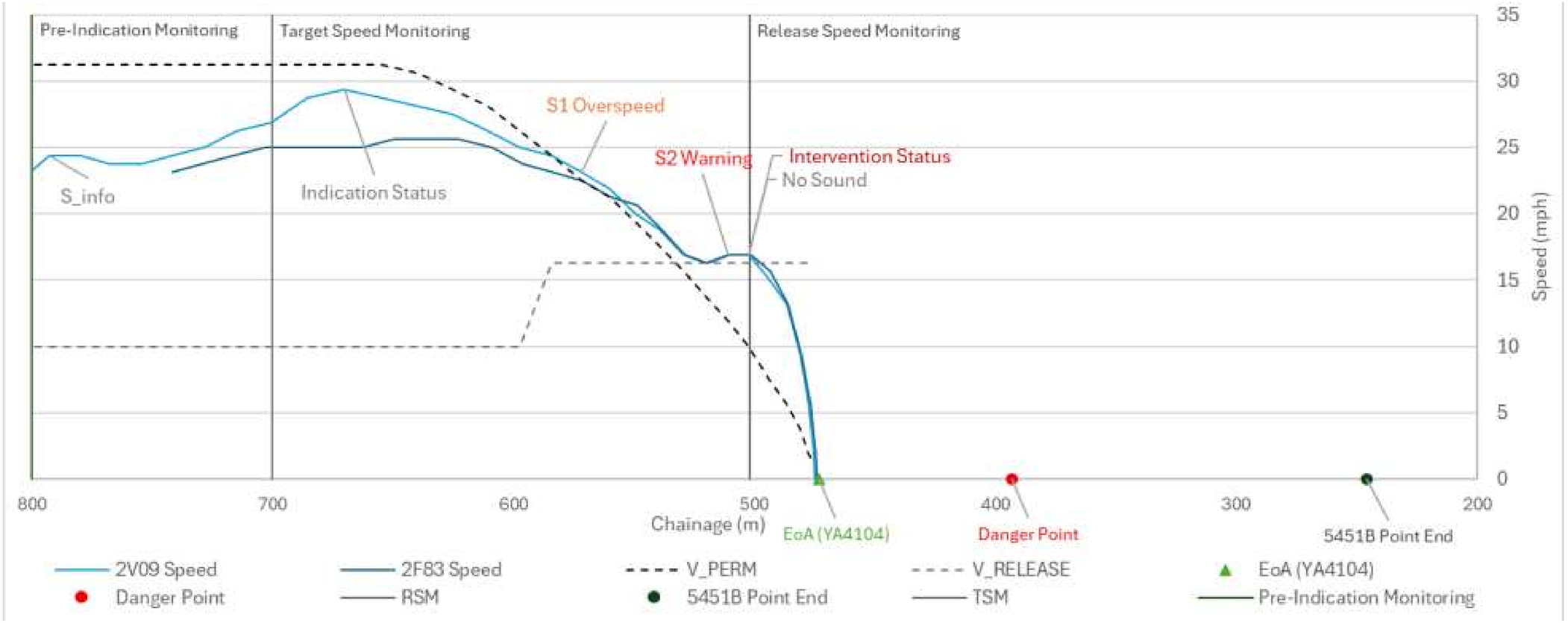


Ceiling Speed Monitoring (dark grey bar)

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Release Speed Management

Driver RSM Awareness – ECDP Events



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Release Speed Management

Proposed Design Mitigations

Support Drivers with RSM information improvements. For instance:

- Visual representation of RSM to provide clear distinction from ceiling speed design
- RSM warning audible alert tones designed to best prepare the driver

Application Engineering Opportunities

- Analysis of the operational needs and constraints in the design to ensure that the release speed is set at an appropriate level for Driveability / Usability.

- Test and refine the release speed design before entering operational service, with relevant driver representatives.

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SYSTEM DIVERSITY AND BUGS

Nora Balfe

INTERNATIONAL UNION
OF RAILWAYS

System diversity and bugs

There can exist multiple ETCS systems on a train or across a route, depending on the combination of level, baseline, and supplier.

- Differences in system behaviour
- E.g. Calculation and display of braking curves
- E.g. Presentation of alarms and messages

Some organisations have different versions installed on the same fleet

- Meaning trains can be driven in one direction with one system version, and a different system version and behaviour for the opposite direction

Some suppliers have released versions of ETCS software with known ‘bugs’

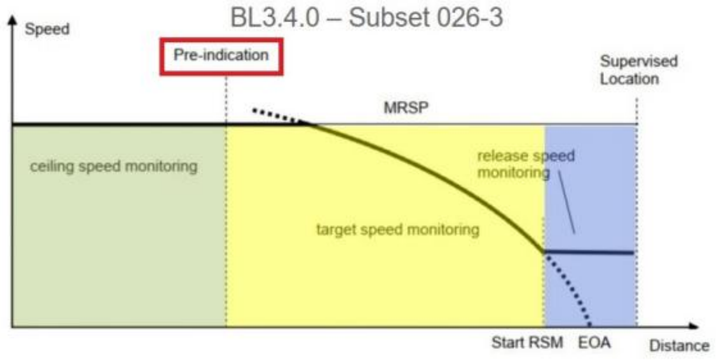
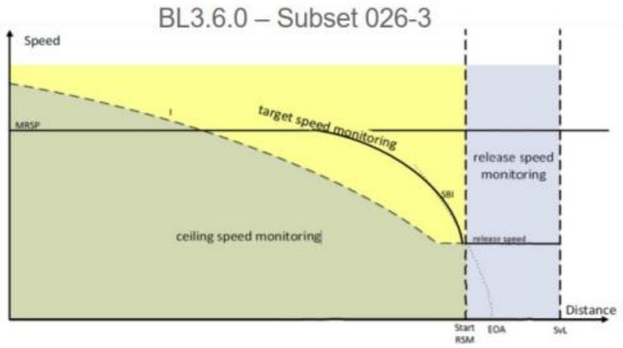
These are planned to be updated and rectified during future updates

This means that the behaviour of the system can also change over time

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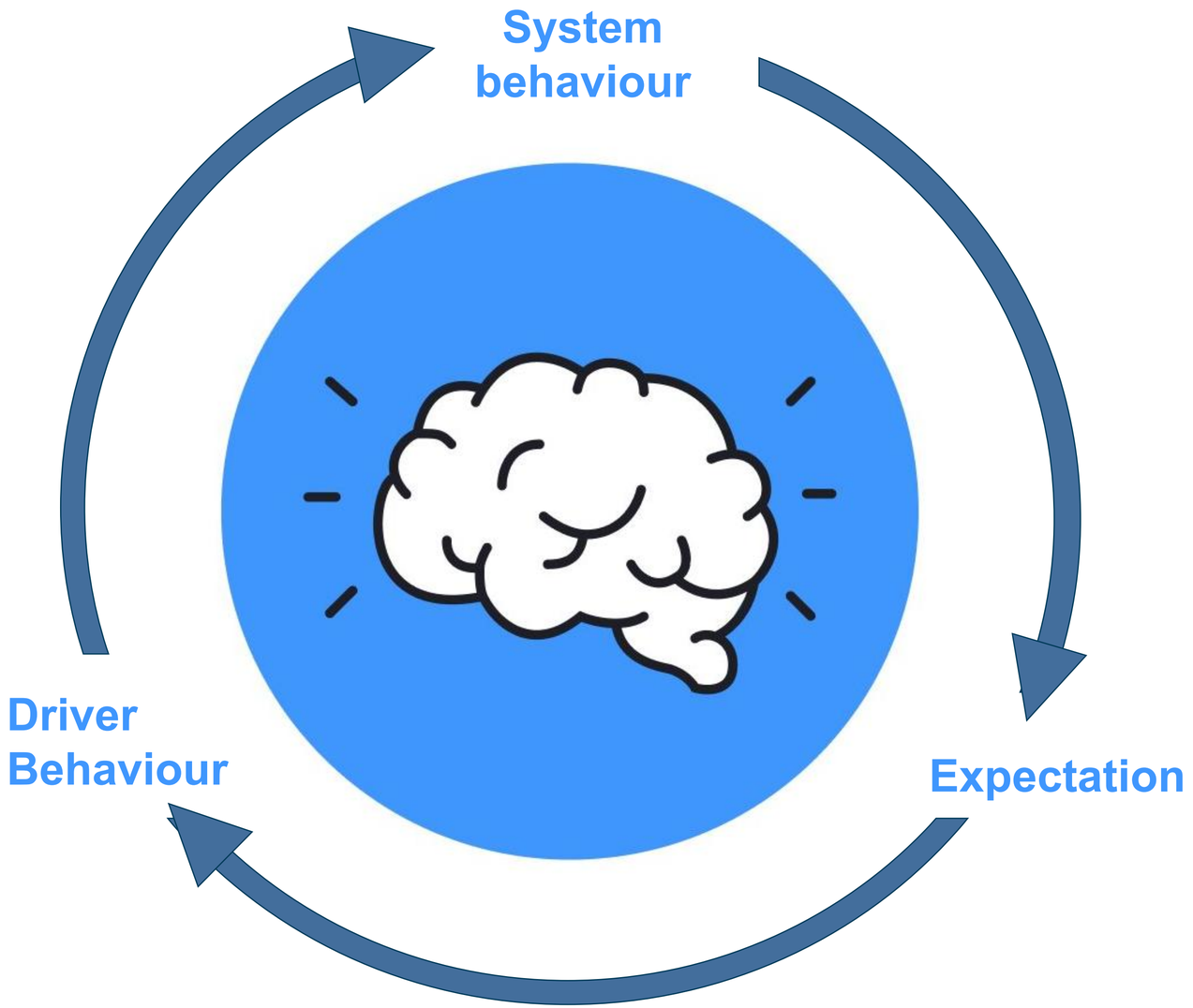
Example of change in system behaviour

In Baseline 3.6.0, the transitions between Ceiling Speed Monitoring (CSM), Target Speed Monitoring (TSM) and Release Speed Monitoring (RSM) no longer depend primarily on the distance to a target, but on the speed currently travelled.

SRS 2.3.0d und 3.4.0	SRS 3.6.0
	
Baseline 3.4.0	Baseline 3.6.0

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Why does it matter?



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Workarounds





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System and human performance implications

- The amount of training needed → more system versions means more training for drivers on the differences between them
- The driver’s ability and confidence to correctly interpret situations and system behaviour → having to choose between mental models introduces the potential for drivers to select the incorrect one and be surprised by the eventual result
- Timeframes when dealing with faults → choosing the correct mental model may take longer and slow down responses to faults
- Volume and complexity of documentation → multiple system versions means more procedures and variations on procedures

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Suggested mitigations

Human error analysis of proposed changes in system versions

- Understand how ‘visible’ the differences are to drivers
- Reduce reliance on mental models by making the system more transparent
- Understand if the differences are incompatible with previous versions

Clearly show the system version on the DMI home screen at all times

- Reduces memory burden
- Navigating to the system menu is onerous
- Avoid meaningless ‘names’, e.g. Android operating systems

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Q&A SESSION

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SIGNALLER-DRIVER COMMUNICATION

Frederik Calleeuw

INTERNATIONAL UNION
OF RAILWAYS

Topic: Signaller and driver communication

Issue Description:

Differences in the formats, terminology and symbology between driver and signaller interfaces can lead to confusion in communications.



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ETCS

- New vocabulary (trip, SR, FS, OS, E.I. 1, …)
- New symbolic (DMI) train driver
- Difference in DMI’s (Different manufacturers)
- Different baselines, different ETCS levels

- Old vocabulary remains
- Old signalling remains (class B systems)
- Difference in national instructions forms (countries)

- Driver and signaller rely on each other for information sharing

- European Instructions
- National Instructions



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Examples Of Safety Events

- Incorrect localisation train (train driver, control room)
- Train departs without authorization
- Technical issues that lead to human error
- Passing on the wrong traction code in safety communication
- Communicating an incorrect signal or stop marker in safety communication
- Even with the use of the NATO phonetic alphabet, incorrect data entries were made on the forms
- SPAD during a shunting movement due to poor communication with the shunter
- Applying incorrect national instructions
- Misinterpretation of ETCS Level 1 and Level 2 (signaller)
- …

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HOF in communication

- Cognitive load, stress, and fatigue lead to errors in passing safety information.
- Poor information exchange can lead to a lack of situational awareness, which is crucial for decision-making during operations,
- Human errors, such as misinterpreting messages or forgetting protocols, pose a significant safety risk.
- The social relationships
- Complex (communication) technology can be confusing or work inefficiently, especially in stressful situations.
- Cultural and language differences lead to misunderstandings in communication.
- ...

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HOF in communication

Organisational Influences

- Culture, lack of training, and complex instructions increase the risk of communication problems.
- In the working environment, working instructions and rules come from several sources, this means prioritizing these potentially contradictory instructions.

Technical and System Factors

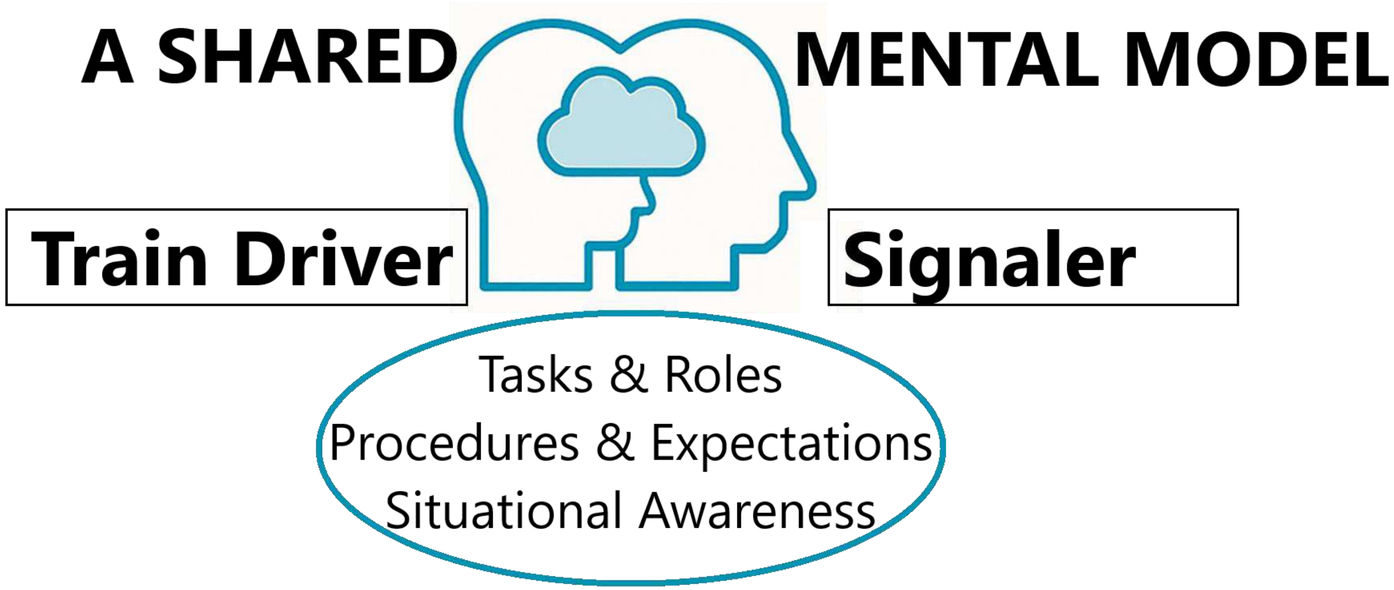
- Paper-based processes and lack of feedback mechanisms create additional safety risks.

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Signaller and driver communication

Human Performance Implications

For effective communication between the driver and signaller there is a need for a shared mental model



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Signaller and driver communication

Possible mitigations

Specification update: List of signaller information needs for HMIs providing a basis for IMs to specify what should be shown and how.



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FAULT MANAGEMENT

Richard Bye

INTERNATIONAL UNION
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Definitions

Fault

fɑːlt

-A broken part or weakness in a machine or system.

Management

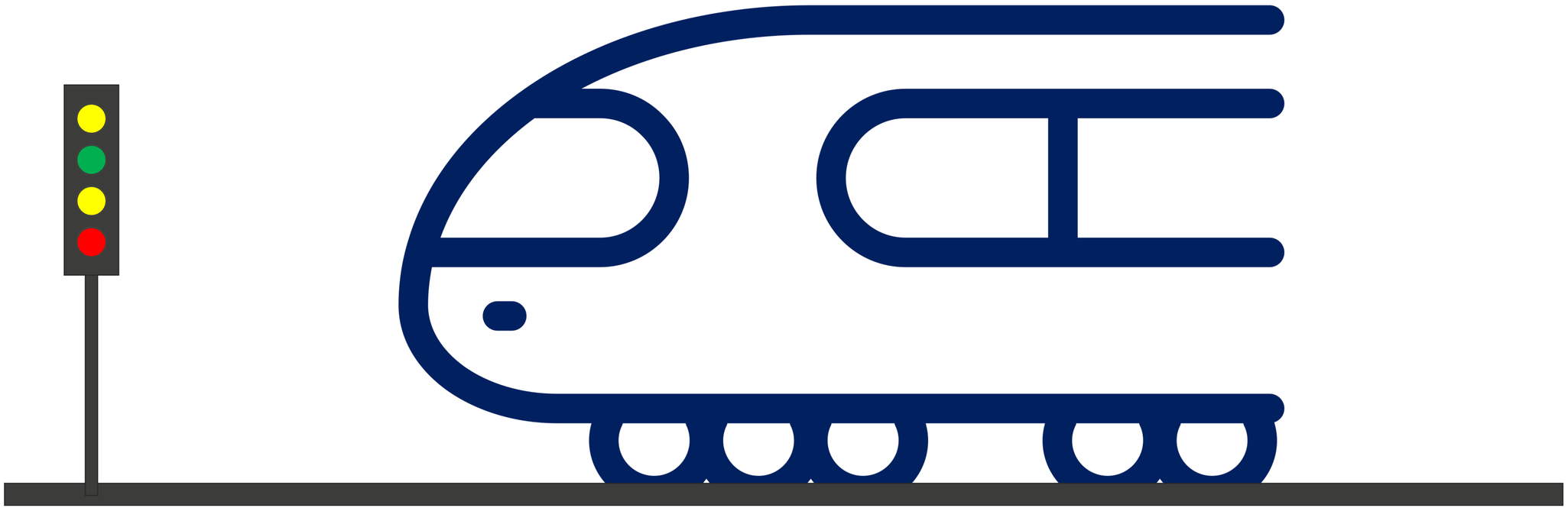
mæn.ɪdʒ.mənt

-The activity of controlling something, or of using or dealing with something in a way that is effective.

https://dictionary.cambridge.org

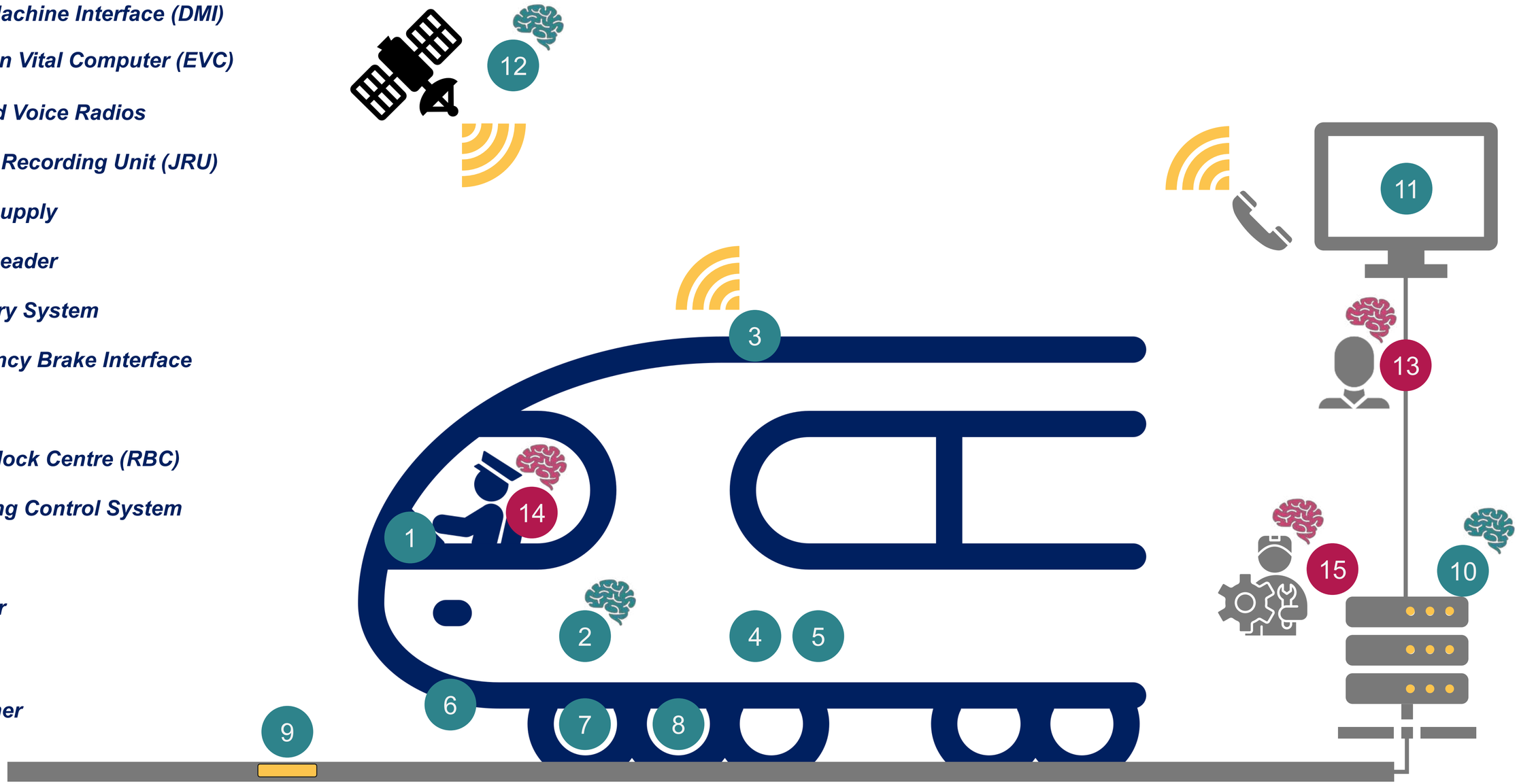
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European Train Control System



European Train Control System

1. *Driver Machine Interface (DMI)*
2. *European Vital Computer (EVC)*
3. *Data and Voice Radios*
4. *Judicial Recording Unit (JRU)*
5. *Power Supply*
6. *Balise Reader*
7. *Odometry System*
8. *Emergency Brake Interface*
9. *Balise*
10. *Radio Block Centre (RBC)*
11. *Signalling Control System*
12. *GSM-R*
13. *Signaller*
14. *Driver*
15. *Maintainer*



European Train Control System

1 *Driver Machine Interface (DMI)*

~~2~~ *European Vital Computer (EVC)*

3 *Data and Voice Radios*

4 *Judicial Recording Unit (JRU)*

5 *Power Supply*

~~6~~ *Balise Reader*

7 *Odometry System*

~~8~~ *Emergency Brake Interface*

~~9~~ *Balise*

~~10~~ *Radio Block Centre (RBC)*

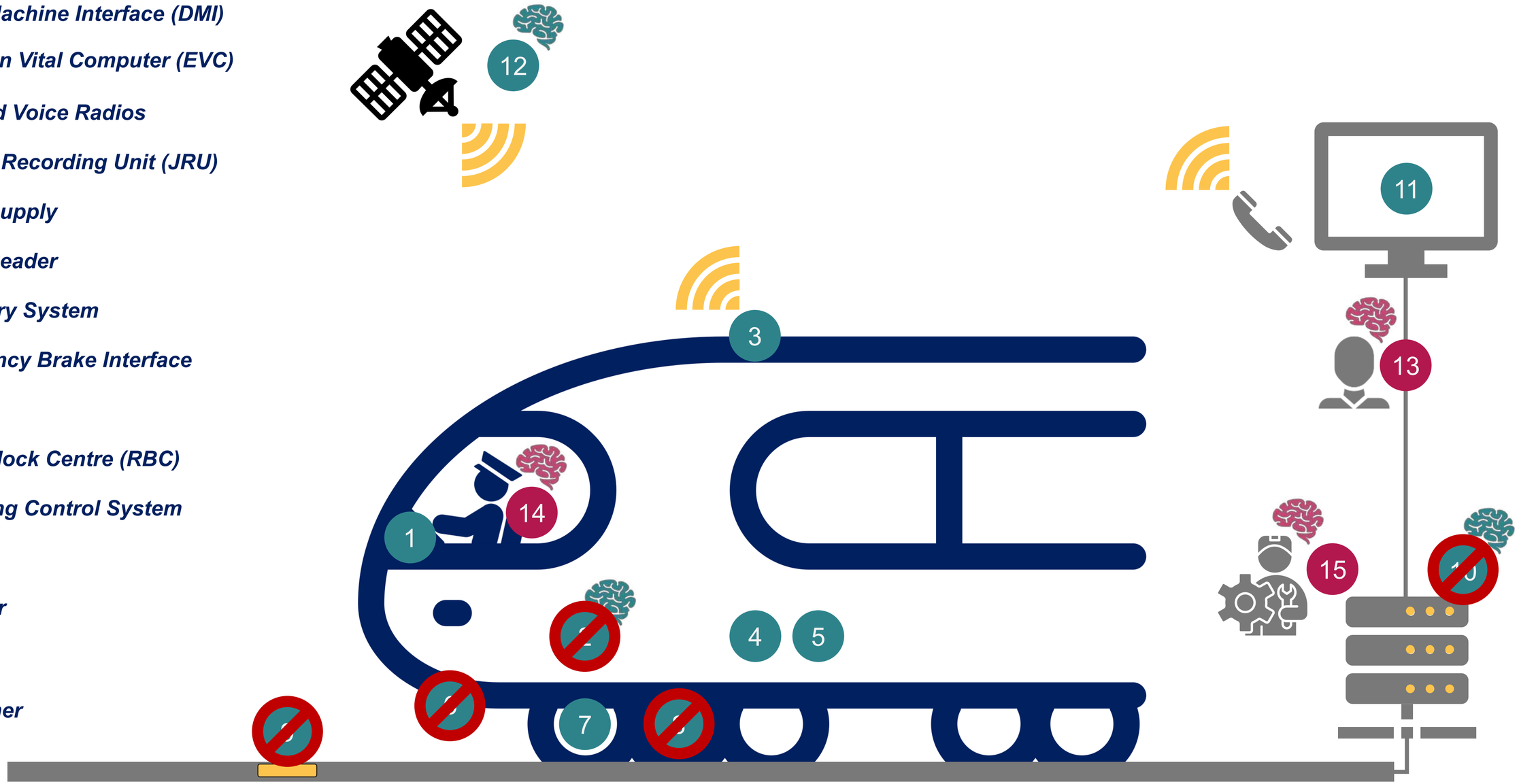
11 *Signalling Control System*

12 *GSM-R*

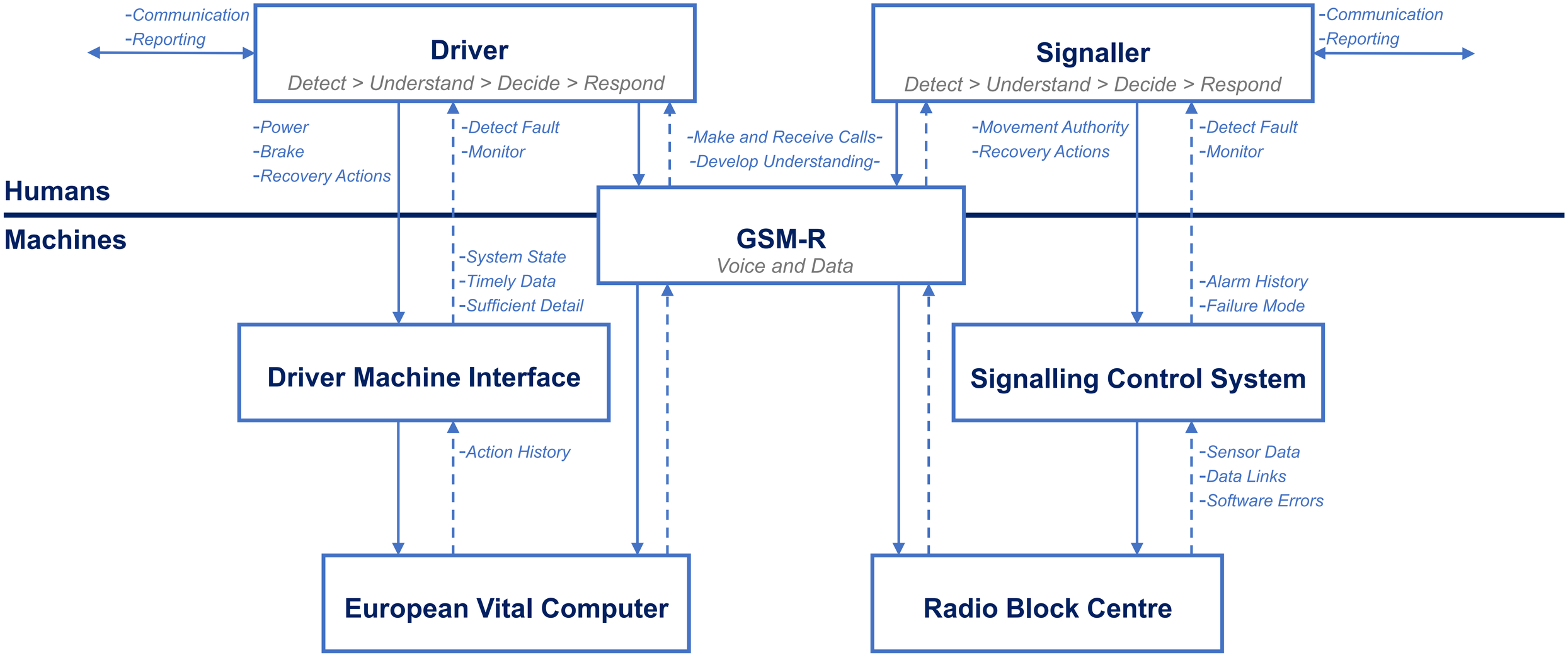
13 *Signaller*

14 *Driver*

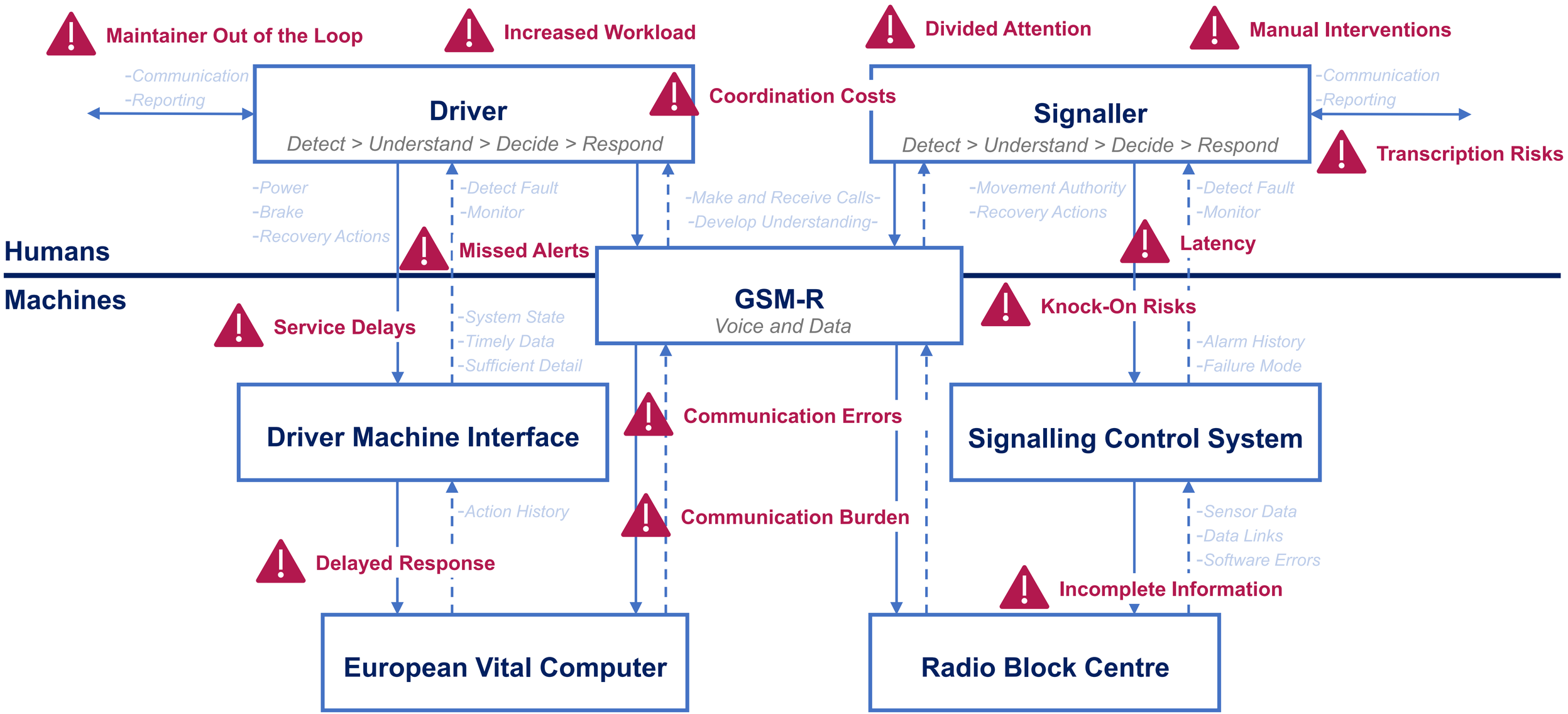
15 *Maintainer*



ETCS Fault Management Control Structure



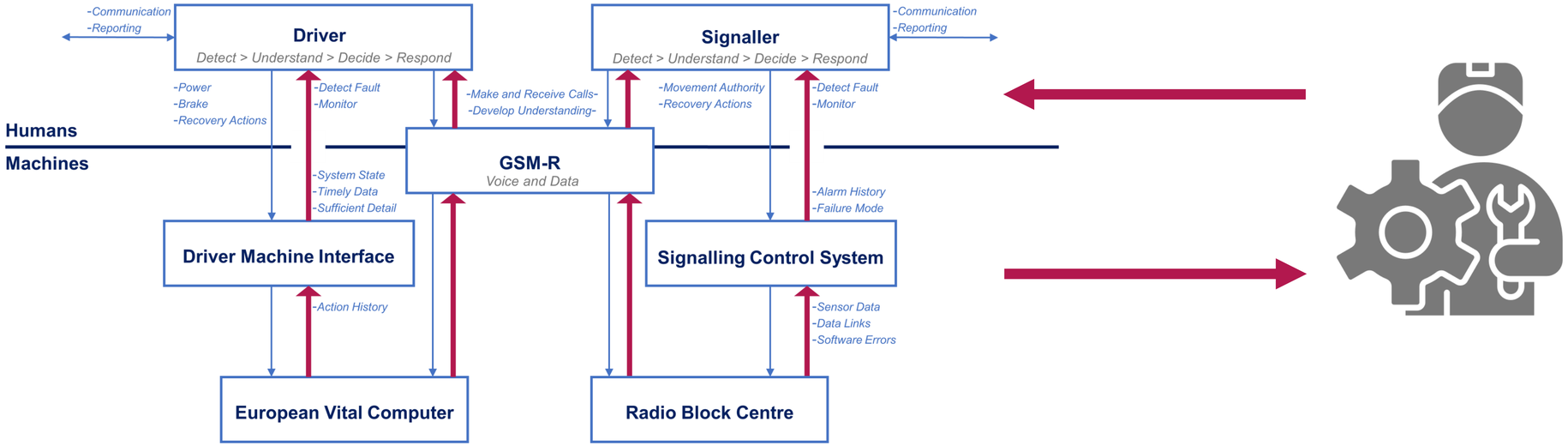
ETCS Fault Management Control Structure



Suggestions for Improved Fault Management

Update standardised ETCS message protocol specifications to:

- Provide rich real-time diagnostic data and trend analysis for maintainers.
- Bypass the need to access multiple systems and proprietary data.
- Enable fault detection and diagnosis to be semi-automated, thereby reducing reliance on driver, signaller and maintainer communications.
- Allow European Instruction forms to be partially auto-populated.

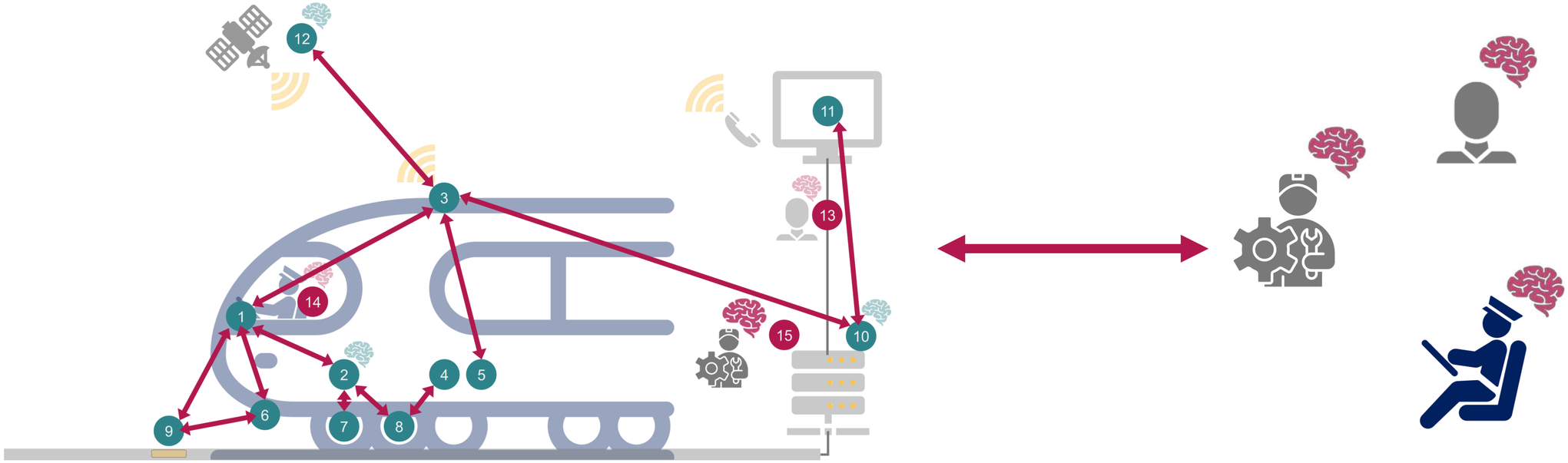


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Suggestions for Improved Fault Management

Develop a system-wide alarm management strategy to:

- Describe system information and end-to-end data flows.
- Detail actions and decisions for operational and maintenance staff.
- Drive contractual requirements between RUs and IMs to share information for fault detection and diagnosis.



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5 November 2025
14:00-16:00 (CET)

TRAINING STANDARDISATION

Bernard Penners

INTERNATIONAL UNION
OF RAILWAYS

Training is a pillar of good safety management

ERA proposes the ETCS Driver's handbook

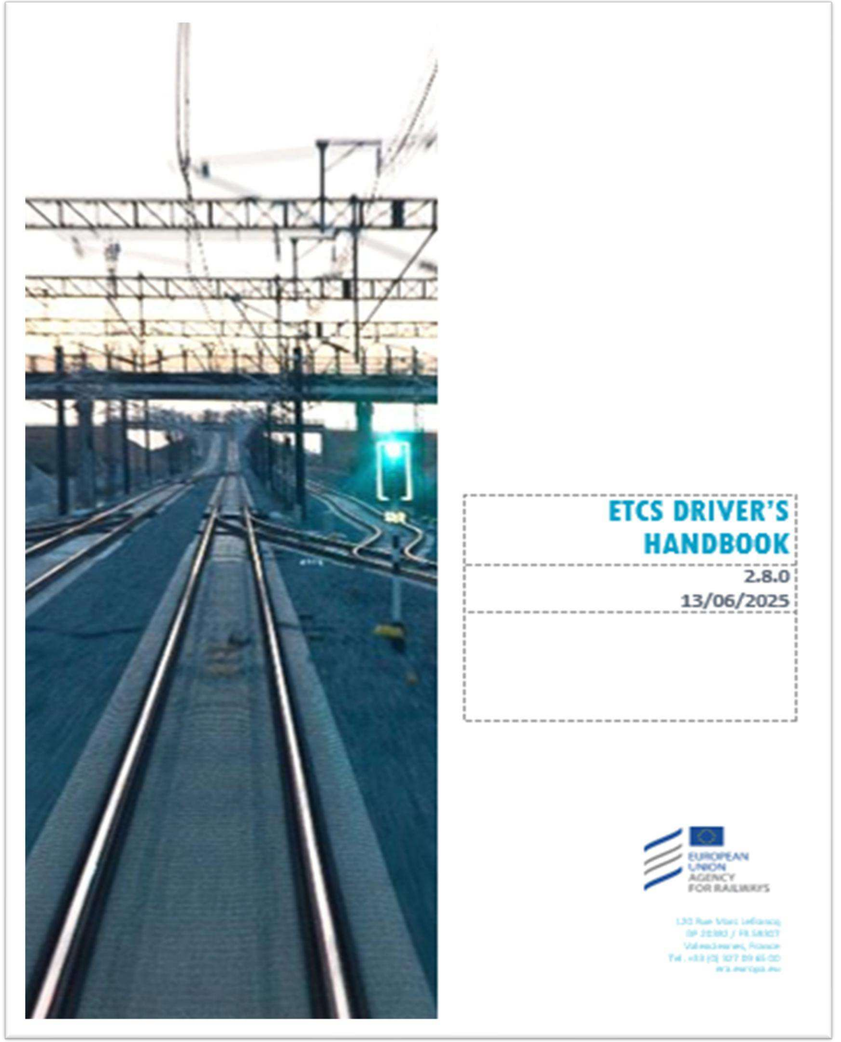
A training course consists of :

- content,
- a pedagogical method,
- Assessments,
- competency reviews and update.

The how is already proposed with precious and essential information, the why can be improved.

The advantage of giving the reason

- **Boosts motivation**
- **Enhances retention**
- **Supports autonomy**
- **Improves application**
- **Encourages prioritisation**
- **Connects to experience**



https://www.era.europa.eu/domains/european-rail-traffic-management-system-ertms/generic-etcs-drivers-handbook

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knowledge



DO

+

why



DO

The reality of training ETCS on the field

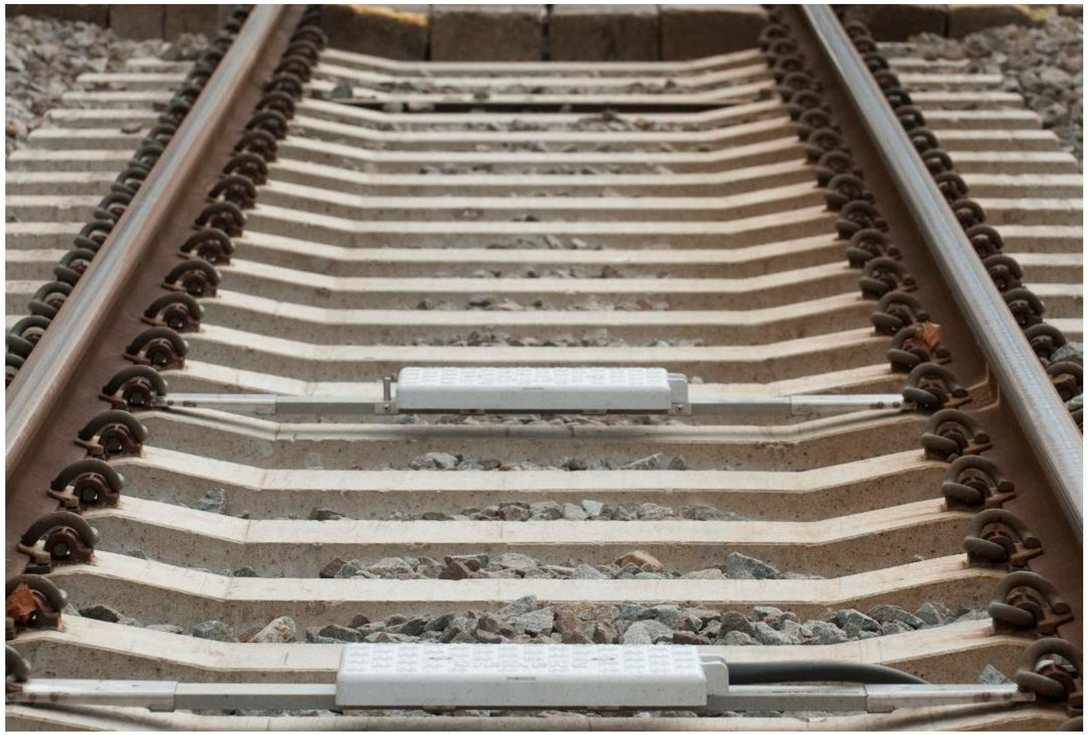
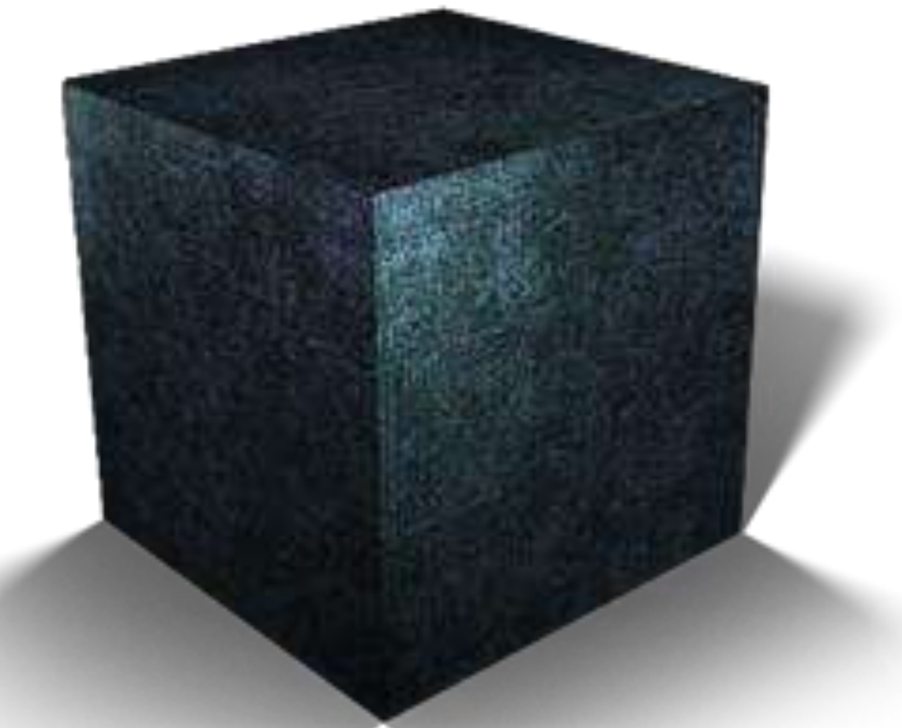


Photo: Infrabel

- It’s difficult to know who should be trained on ETCS and to what level.
- There is variation across Europe on the duration and content of training.
- Variability in the training may come from the identification of the needs, the competence’s availabilities…
- ETCS project implementation teams may focus on the technical aspects and leave training to existing operational departments who may not have an in-depth understanding of the system.
- The time between learning and using skills can be long. Skills may decline.

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Consequences on human performance



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ETCS is a complex system with multiple affected end user groups.

Different risks are identified:

- Frustration, mistrust in the ETCS system.
- A lack of understanding can affect the efficiency of the implementation.

Skills are acquired through practice and repetition. If they do not have the opportunity, drivers may find it more difficult to acquire and practise the skills needed to use ETCS.

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Possible mitigation measures



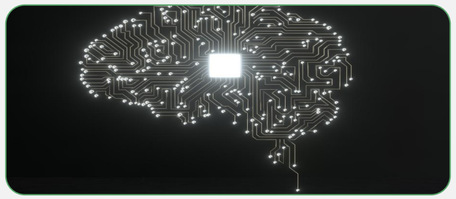
Documentation implementation:

Supplement generic materials with information about the implementation of generic materials in the sector.



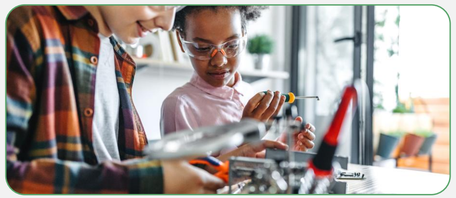
Training specification update

- Minimum training times, maximum times between training and application
- Criteria for a continuous training programme



Content specifications update:

Add information explaining the concepts and operation of ETCS to the existing material.



Training tools:

Job shadowing or “Live my life”

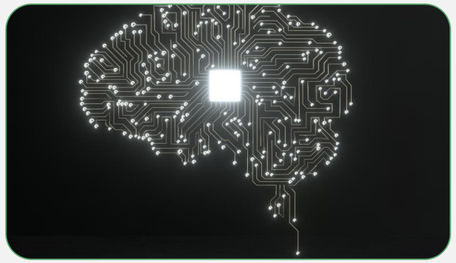
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Possible mitigation measures



Who is this training for?

Drivers, signalers, trackside maintainers, rolling stock maintainers, project teams, operational management



Who delivers the training?

Minimum trainer competency requirements



Simulation-based learning

Use to develop practical skills for managing degraded operations and unexpected scenarios

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5 November 2025
14:00-16:00 (CET)

Q&A SESSION

INTERNATIONAL UNION
OF RAILWAYS



5 November 2025
14:00-16:00 (CET)

NEXT STEPS

Nora Balfe

INTERNATIONAL UNION
OF RAILWAYS

Objectives for the workshop

1. To create a community of practice for HOF aspects of design and implementation of ETCS
2. To share knowledge and understanding of HOF issues with ETCS
3. To identify common HOF issues with ETCS
4. To share best practices in resolving ETCS HOF issues
5. To identify proposals for improvements to the ETCS specification to be promoted to ERA

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Next steps

Workshop report will be published

- Email Virginie Papillault (papillault@uic.org) for a copy
- Will soon be able to download from www.railhof.org

Progress change requests via ERA

Enlarging our network

- Members should have a working knowledge of both HOF and ETCS
- Email Virginie Papillault (papillault@uic.org) to request to join

Another workshop is planned in 2026, and outputs will again be circulated

- Topics may include: ETCS migration, number and presentation of text messages, ETCS tones, use of simulation in design and evaluation
- New topics are welcome!

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5 November 2025
14:00-16:00 (CET)

UIC WEBINAR

Safety Webinar « ETCS & HOF : Return of Experience 2025 »

THANK YOU FOR YOUR PARTICIPATION!