VVZE[1)]
CONCEPT DESIGN STATEMENT
(final version)

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TEMPORARY ON-TRAIN ETCS EQUIPMENT
"ETCS-Trolley"

Purpose

To provide an outline of the concept design and architecture, suitable for development into a FFFIS, for the temporary on-train ETCS equipment solution identified in the VVZE[1)] study.

[1] VVZE is the Dutch acronym for movement of vehicles without ETCS over ETCS routes

Use of temporary on-train ETCS equipment

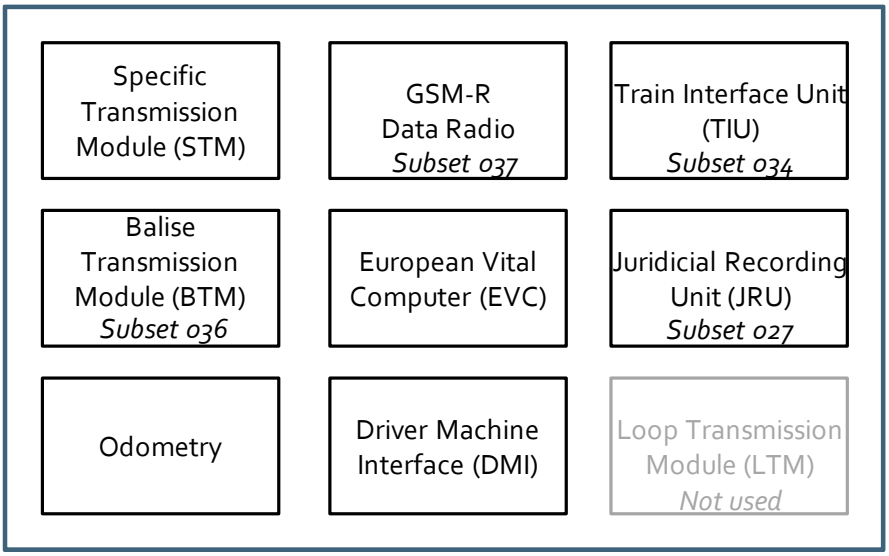
The purpose of the temporary on-train ETCS equipment is to provide a cost-effective solution to the incidental movement of trains that are not equipped with a full-fit ETCS solution over ETCS-only routes.

Such trains would not be equipped with a full-fit ETCS solution because in their normal operating area, ETCS is not (yet) installed, and/or the frequency of movements over ETCS-routes is low. In the Netherlands, the following (parts of the) fleets are involved:

- Trains operating under a regional concession agreement
- Yellow fleet (maintenance vehicles)
- Black fleet (historic vehicles)

ETCS Reference Architecture

To provide a reference architecture that can be used as a baseline to discuss the solution and options, the standard ETCS architecture given in Figure 1 will be used. This architecture is based on Subset 026-2 from the ERTMS requirements. The components are elaborated in Table 1.



LTM is not used because loops are not applied in NL within the boundaries of the assumptions

Figure 1 – ETCS Reference Architecture

Table 1 - Reference Components

Ab	Meaning	Function
EVC	European Vital Computer	Provides the vital computing power for the system
DMI	Driver Machine Interface	Provides for input from and information to the driver
TIU	Train Interface Unit	Provides the interface between the ETCS and the train circuits
BTM	Balise Transmission Module	Used to read the ETCS balise
JRU	Judicial Recording Unit	Data Recorder
STM	Specific Transmission Module	Unit that provides interface to National Notified Signalling Systems [for example ATB]
DR	(GSM-R) Data Radio	Provides the data channel to the wayside ETCS systems
OS	Odometry Sensors	Provides vehicle speed to the EVC

Current Assumptions for the alternative solution

The solution for the temporary on-train ETCS equipment is based on the following assumptions that will be validated or modified during the study as required.

Table 2 - Project Assumptions

Assumption	Justification
ETCS Baseline 3, release 2, is being used at Level 2 only [i.e. Level 3 is not supported and an interface at Euro-loop is not required]	ERTMS Programme starting point
The ETCS-solution functions on TSI compliant infrastructure	The use of the solution does not require additional or re-arranged infrastructure
The system architecture is designed to be as simple as possible: • The system does not support an integrated interface with National Systems [i.e. STM support by the ETCS is not required] • Only Emergency Brake control is provided at a vehicle level [i.e. it is not required to also control the service brake of the train] • Traction cut-off is assumed to be integral with Emergency Brake application in the train circuits • Only safety functions for train separation are supported [i.e. does not support factors such as neutral gap control] • The system will not be designed and assured for timetabled services	The solution is designed as a cost-effective solution for incidental movements This means that for the regional fleet, no passenger services are foreseen.

Relationship with legacy signalling system

A fully compliant system requires a functional connection between the ETCS and any notified national signalling system, ATB in the case of the Netherlands. This is accomplished by fitting an 'STM' that provides the ATB signalling as part of the ETCS system, where the STM operation and displays are controlled by and integrated with the ETCS system.

This is considered to be overly complex for the proposed architectural approach in line with the intended purpose. It is proposed that ATB and 'ETCS-trolley' are arranged such that only one unit can be powered at a time (see train interface section for justification).

This approach means that the transfer between ATB and ‘ETCS-trolley’ at the applicable boundary location will be completed manually using procedures, rather than automatically under the control of the ETCS as would be the case with a full permanent ETCS fitment.

Operationally the train would stop at a defined boundary location. The train operator would manually operate a switch on the 'ETCS-trolley' equipment (or train, tbd) that would result in ATB being powered down and 'ETCS-trolley' being powered up. On power up the 'ETCS-trolley’ will go to Staff Responsible (SR). Once the train has been localised and connected to the RBC the system will generate a Movement Authority under Full Supervision (FS).

ETCS-trolley technical description

The ETCS-trolley provides much of the ETCS functionality at a high level of safety [to be determined exactly which elements are SIL4] using mainly standard ETCS components, but arranged in a manner that they can be temporality fitted to ‘pre-prepared’ trains (refer to section *Required train modifications*).

The equipment is provided on two or three racks or in a trolley that can be loaded on to the train and connected up [rack or trolley are variants using the same modules]

As the study has developed the approach has been optimised to reduce the amount of equipment that is required to be included in the ETCS-trolley. Figure 2 shows the ETCS-trolley architecture.

Table 3 provides the rationale for the differences between the standard ETCS architecture given in Figure 1 and the concept ETCS-trolley architecture given in Figure 2.

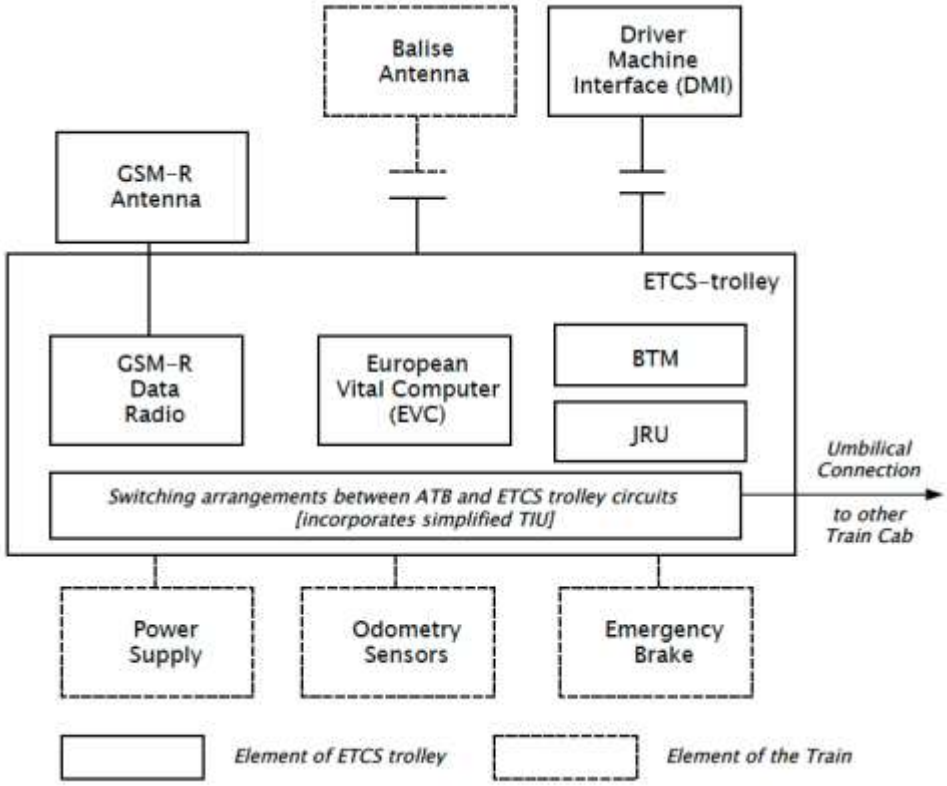


Figure 2 – Concept ETCS-trolley Architecture

Table 3 – ETCS-trolley Component Allocation

Block	Component allocation	Rational
EVC	Uses a standard EVC	
DMI	Uses a standard DMI but with bespoke temporary fit into driver's cab	The temporary fit is to minimise modifications to the train and to reinforce the difference between full-fit ETCS trains
TIU	Simplified interface	Provided by trolley design and approach to train interface
BTM	Uses a standard BTM, with antenna fitted to train	Assumed permanent fit of antenna on train
JRU	To be fitted with single end configuration	See 'Practical Application'
STM	Not fitted	See assumptions
DR	Uses standard GSM-R data radio	Provides the data channel to the wayside ETCS systems; GSM-R antenna mounted to trolley
Odometry	Uses available tacho+ optional augmentation	Minimise required modifications to the train

ETCS-trolley Packaging

Most of the standard ETCS modules provided by the major suppliers are designed to be mounted in an industry standard 19" rack. Any items that are not 'rack-ready' can be easily provided with secondary mounting to allow use in a 19" rack.

Following the technical workshop the space requirement has been refined as follows

- key ETCS components (EVC, BTM, JRU and data radio) should fit within a 9U high standard 19" rack space (1 3U rack for EVC, 2 x 3U rack for the other elements)
- an additional 1U above and below should be allowed for equipment ventilation, in case of instalment in a trolley

Thus a total of 11U high of 19" rack space is required. Each U is 44.5mm high, so 11 U requires a minimum of 490 mm available height.

Therefore it is proposed that the equipment is mounted in a commercial-off-the-shelf (COTS) enclosure, which are also provided with wheels to allow easy handling. Additional review has been completed of suitable enclosures and it appears that the most suitable units for this application is COTS flight/road cases as used largely for sound/light equipment. These units are suitably rugged and are easy to get with appropriate access (integral wheels can be fitted if desired to aid with movement).

A typical unit (suitable for up to 12 U of equipment, and thus sufficient for our purpose, is approximately 680mm (h) x 520mm (w) x 700mm (d) with the transit doors fitted and 680mm (h) x 520mm (w) x 520mm (d) with the transit doors removed. Note that approximately 100mm of the height is for the transport wheels. Note that each of the two transit doors provides 80mm depth for additional storage that should be sufficient to allow for the DMI and the local interface cables required. See Figure 3.

Three local cable connections are used to:

a. connect the ETCS-trolley to the vehicle power supply
b. connect the ETCS-trolley to the train circuits and/or ETCS equipment already mounted to the train such as the BTM
c. connect the 'temporary DMI' to the ETCS-trolley

For the practical application (see later) an umbilical cord (suitable to run the length of a 4-car train) is also required. This would be carried separate to the ETCS 'trolley'.

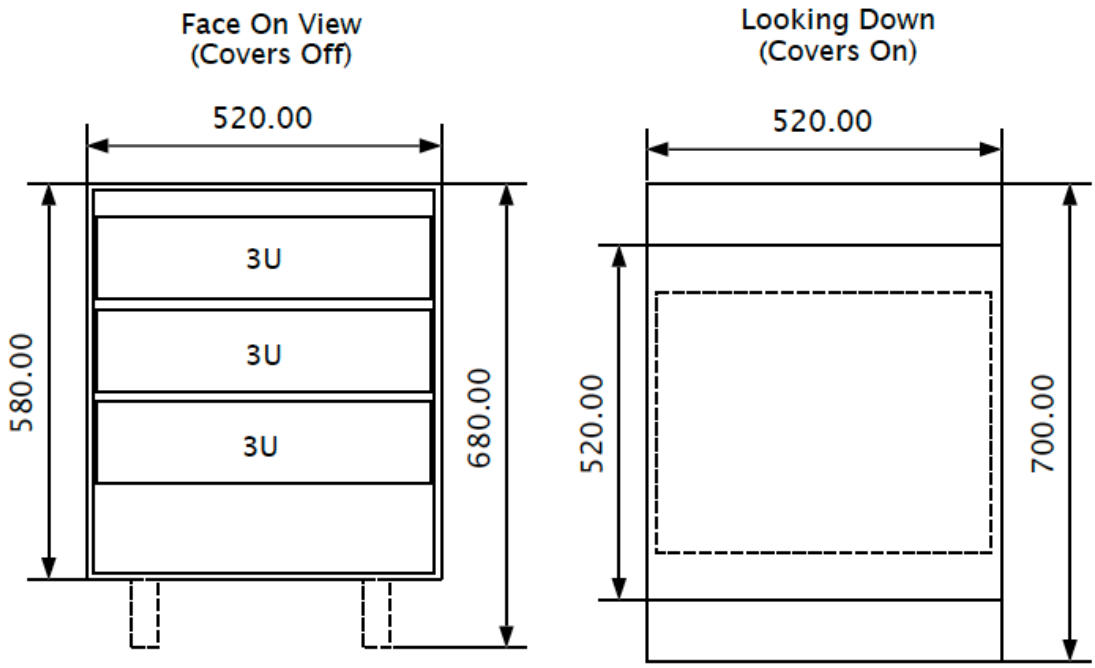


Figure 3 - ETCS-trolley Packaging

Alternatively, the rolling stock can be fitted with slides to fit three standard 3U 19” racks if there is sufficient free cabinet space with the unit. In this solution, the full trolley is not required. This would have to be determined after surveys of each vehicle type/

ETCS-trolley to train interface

Further review of the possible solutions for the train interface indicates that the simplest and most efficient way of achieving this will be by using the current connections used by the ATB signalling and 'diverting' them to the ETCS-trolley when operation with ETCS is required

This would involve switching at least the following circuits from the ATB unit to the ETCS-trolley, when the vehicle is stationary at the location you wish to move from ATB to ETCS protection:

- signalling power feed
- tachometer signal circuits
- emergency brake control circuits

Currently the conventional ATB-NL system requires about 200 watts of power to operate, and it is believed this should also be sufficient to operate the ETCS-trolley, but this requires confirmation. To allow maximum flexibility, the ETCS-trolley should be able to accommodate input voltages from 14 vdc to 160 vdc.

For Maintenance and Historic units that are fitted with ATBE the available power is much lower and an additional power feed will need to be provided. The approach to this will have to be assessed on a vehicle-by-vehicle basis.

Odometry

We have also considered the approach to gaining the optimal speed signals for the ETCS-trolley. The standard application requires that the speed sensor arrangement is able to detect slip and slide of the train wheels during acceleration and braking.

This is usually achieved by having two tachometers mounted on different axles, along with a secondary detection system (doppler radar, accelerometer etc) to detect synchronous spin/slide and provide infill speed detection when both axles are locked due to wheel slide.

Achieving this easily in the proposed application of the ETCS-trolley is difficult. But in the case where the ETCS-trolley is being used there are not the same time constraints (i.e. the train can be driven softly to limit any spin/slide) and as capacity is not key, greater variation in speed and distance tolerance can be accommodated, provided they remain within the system parameters.

For the above reasons the current working assumption is that it should be possible to justify the use of a single tachometer mounted on one axle (but with multiple channels), and this can be achieved by using the existing ATB tachometer.

GSM-R Data Antenna

Initial proposals included the installation of an additional antenna on the train roof for use with the ETCS-trolley.

Following the April workshop it was suggested that the GSM-R data radio antenna could be mounted on the ETCS-trolley housing, rather than requiring any extra train fitment.

As the train body provides a degree of electromagnetic shielded (although this is limited as evidenced by the ability to use mobile phones within trains) the best location for the antenna would have to be confirmed using some field trials.

As the antennas are freely available from multiple suppliers (and thus relatively inexpensive compared to the core ETCS equipment) and the on-train mounting is not particularly complex, this choice does not materially impact the implementation estimates.

Required train modifications

The ETCS-trolley solution aims to minimise the required changes to the rolling stock, however, some modifications are needed:

- Installation of balise antenna(s)
- Plug connection(s) to the relevant on board systems (power supply, odometry, balise antenna, dead-man); the train-side of this plug should include the required train parameters

- ATB/ETCS transfer switch (depending on train circuit configuration, it may be easier to include this as part of the trolley); figure 4 and 5 below depict possible circuits for emergency brake and odometry circuits
- Slides/frames to install racks (if applicable to the specific rolling stock type)
- Changes to support the temporary fit of the DMI screen in the cabin(s)

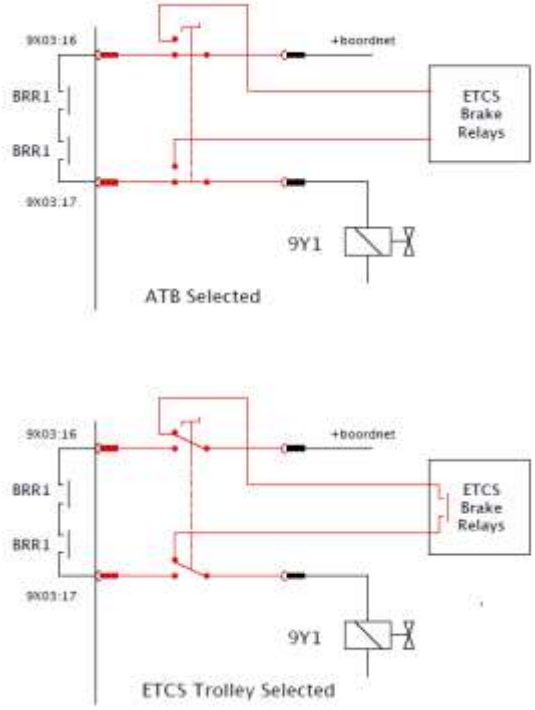


Figure 4 – example Emergency Brake circuit

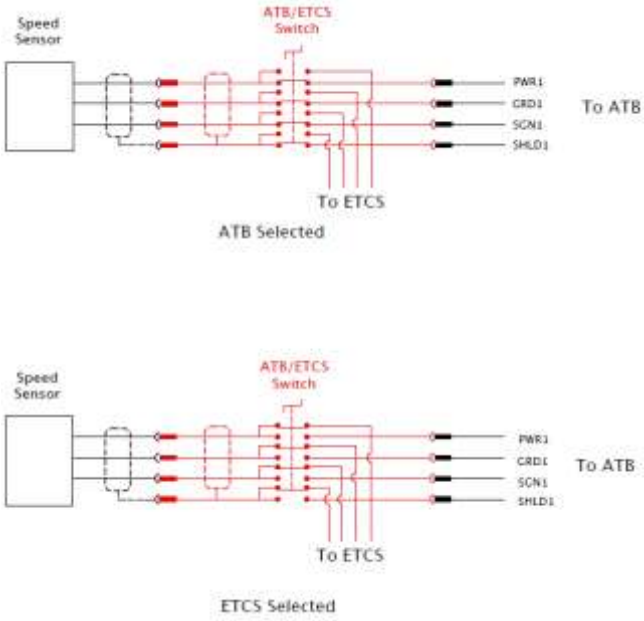


Figure 5 – example *tachometer circuit*

Practical Application

Where a single ATB control unit is used for the train (electronics unit installed in one cab only with control/display connections and antenna connections trainlined to the other end of the train) the application of the ETCS trolley is as follows:

- Cut in to existing circuits is only required at one end of the train
- The feed for the temporary ETCS display and the switched control between ETCS and ATB is carried down the length of the train to the second cab using an temporary 'umbilical' cord run down the length of the train in the passenger compartment (plugged into the ETCS trolley)
- A second BTM may be required at the non-trolley cab, feeding telegrams from the euro-balise to the trolley via the umbilical cord
- Addition of a JRU as the full power down of the single ATB unit results in the loss of logging when this is integrated into the ATB electronics.

In terms of cost and complexity the practical application can be treated the same as the initial concept for the following reasons:

- Only one cab end will require the existing train circuits to be cut into, significantly reducing the time and complexity of this task
- There will be a small increase in equipment cost due to the umbilical cord and the possible need for an extra BTM (although the BTM cost can be avoided by physically relocating the BTM from the trolley, the best trade off would required additional study on a train by train basis)
- A JRU compatible with ETCS logging requirements is available off the shelf from multiple (non-signalling) suppliers, these are essentially 'plug and play' (interface functional requirements defined in Subset-027) and are relatively cheap (circa < 15K euro per unit).

The most appropriate configuration, and of course the final installation details and functional allocation, would be determined as the result of a more detailed feasibility study completed for each train type.

Application/derogation to Subset 034

The main requirements to the train interface are included in subset 034. The below provides an overview of choices in or derogation of the application, itemised per section number.

2.2 Mode control

2.2.1 We do not need the sleep mode as the trolley will only be operated from the lead cab, so select 'sleeping not requested'

2.2.2 Starting point is no passive shunting under ETCS mode so select 'passive shunting not permitted'

2.2.3 Always put the trolley in the lead cab, so select 'non-leading not permitted'

2.3 Control of brakes

2.3.1 No support of service brakes only emergency brakes, as the sole purpose is to prevent a collision

2.3.2 Not needed because no service brakes

2.3.4 to 2.3.7 Not applicable

2.4 Train control functions

2.4.1 – 2.4.9 Not applicable

2.4.10 n/a (in NL; there are such sections in other countries, e.g. in the UK, also there it would not be needed on the trolley as we deal with non-loaded trains 'going easy' as part of operational rules)

2.5 Train status

2.5.1 we will have equivalent of cab active

2.5.2 direction controller always put in 'forward'

2.6 Train data

2.6.1.1 We go for 'switchable'

2.6.2 Use a coded plug in the connection train-Trolley

Process steps in using the ETCS-trolley

This section sets-out the proposed operational steps required to use the ETCS-trolley, from installation to transitioning between signalling systems.

Before departure

1. Plug-in the trolley
2. Install DMI
3. Configure the system (select train type)
4. System check (using the test button)
5. Confirm that the switch is in ATB position

After departure

6. Operation of vehicle under ATB

Transition ATB->ETCS

7. Stop before the transition to ETCS, in accordance with the operational rules
8. Move the switch into ETCS position
9. ATB screen goes black, ETCS screen powers up
10. Acknowledge type of train on DMI
11. Select RBC
12. Receive permission for movement from traffic control
13. Depart under L0
14. L2 is automatically selected (once train position is localised using the ETCS balises)

After transition to ETCS

15. Operation of vehicle under ETCS L2

Transition ETCS->ATB

16. Stop before the transition to ATB, in accordance with the operational rules
17. Move the switch into ATB position
18. ETCS screen goes black, ATB screen powers up
19. Receive permission for movement from traffic control
20. Depart

After transition to ATB

21. Operation of vehicle under ATB