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ERTMS USERS GROUP - ENGINEERING GUIDELINE

76. Border Crossings

Ref: EUG_17E087
Version: 2.0
Date: 10/10/2019

Modification history

Version	Date	Modification / Description	Editor
0.1	26/06/2017	First draft based on ESG Topic – Border Crossing_V0 12 (Version 2)	Workshop Border Crossings
0.2	31/08/2017	Draft considering the output of the Border Crossing WS and ESG60	GR
0.3	12/09/2017	Review during ESG61	GR
0.4	30/09/2017	Remarks coming from ESG61	GR
0.5	06/10/2017	Update section 3.3.1 and 3.3.3	GR
0.6	12/10/2017	Remarks coming from ESG62 and following contributions from AJM, JA, AB, SMC, DC	GR
0.7	17/11/2017	Feedback from ESG63	GR/DC
0.8	23/11/2017	Figure 1 corrected, location of level transition table corrected	GR/DC
1.0	20/12/2017	Version 1.0	GR/DC
1.1	19/02/2019	Added issue about non-harmonised axle load speed restrictions	AJM
1.2	19/04/2019	Impact Art10SP (2017) incorporated Added issue about informing driver about border crossings	AJM
1.3	24/05/2019	Review during ESG75	AJM
1.4	25/06/2019	Review during ESG76 and remarks SMC, BK	AJM
2.0	10/10/2019	Release of version 2.0	ESG

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1 Introduction

1.1.1.1 Border crossings are a distinct part of ERTMS implementations; ERTMS being principally designed to act as a mobility enabler for cross border traffic to facilitate continued and harmonised operations across country borders, for example via the freight corridors across Europe. However, safely and efficiently interfacing ERTMS implementations across borders is potentially a complex and difficult implementation exercise, particularly because:

- often, critical initial situations/requirements at the borders are not available when the implementation on either side of the border are completed
- national borders, system borders (ERTMS, Telecommunications etc.) and IM Network borders are not congruent
- different national safety standards (NSAs), operational rules, and approval processes exist on either side of the border.

1.1.1.2 However, border crossings are not necessarily only related to crossing borders between countries. The complex technical and operational requirements of ERTMS, and the possibility of extended staged roll-out of ERTMS also introduce border crossing type issues within individual countries, for example at changes in system version or national values. For the definition of the “border” considered in the present document see § 2.1.

1.1.1.3 Authors of the document consider that the issues identified and tackled represent the status of the present knowledge and implementations concerning ERTMS border crossing.

1.2 Scope and Field of Application

1.2.1.1 The aim of this document is to collect and describe border crossing related issues already identified during implementation of, or specification of requirements for, ERTMS across Europe and provide a recommended trackside solution for the engineering of border crossings.

1.2.1.2 The objective is to support an efficient and safe implementation of ERTMS, from a technical and operational point of view, simplifying and harmonising future system implementations by taking advantage of the experience obtained from projects already in operation or under development.

1.2.1.3 This document provides recommendations concerning both strategy/process and technical choices to design (considerations to be made when specifying requirements), test, and authorise in commercial operation, an ERTMS border crossing.

1.2.1.4 The recommendations identified aim to provide specific border crossing provisions aiming to allow trains to cross border safely and seamlessly in spite of the potential change of rules, procedures, and safety principles occurring at a border.

1.2.1.5 The recommendations identified aim to minimise the impact on operation in a transparent way for all users (number of operational handlings by driver and traffic manager).

1.2.1.6 This document is based on ERTMS/ETCS Baseline 2 and 3 (including [OPINION ERA 2017-2]) and applicable for ETCS Levels 1, 2 and 3 on at least one side of the border.

Border crossing involving only national systems are not in scope of this document; provisions in this and other referenced EUG and ERA Guidelines may be applicable also to borders with National systems on both sides and trains equipped with ERTMS and both class B systems.

1.2.1.7 The recommendations identified consider also possible failures and degraded situations.

1.2.1.8 It is strongly recommended that any entity using ERTMS/ETCS follows the recommendations defined in this document.

1.2.1.9 To identify operational rules over borders is out of scope of this document.

1.2.1.10 This guideline only considers issues directly related to border crossings.

1.3 Applicable system versions

1.3.1.1 Table 1 describes which trackside and onboard system versions are managed by this guideline. It also describes in which guidelines other system version combinations are managed.

	Trackside System Version	
Onboard System Version	1.Y	2.Y
1.Y	This guideline	Not applicable
2.Y	This guideline	This guideline

Table 1: System version management

1.3.1.2 This guideline is applicable for a trackside where system version is 1.Y or 2.Y.

1.3.1.3 This guideline takes into consideration the following onboard systems:

– Onboard system with pure system version 1.Y (i.e.: they are not fitted with any other system version)

– Onboard system supporting version 1.Y and 2.Y, with active system version 1.Y or 2.Y (this includes onboards B3MR1, B3R2, B3R2+Art10SP(2017))

1.4 Document structure

1.4.1.1 Chapter 1 introduces the document, defines the scope and the field of application.

1.4.1.2 Chapter 2 provides definitions, references, terms and abbreviations used in this document and the list of Appendixes.

1.4.1.3 Chapter 3 provides considerations addressing strategy and process when dealing with a border crossing project.

1.4.1.4 Chapter 4 provides the issues to be addressed for engineering of Border Crossings.

1.4.1.5 Chapter 5 provides the recommended solutions to the issues addressed in chapter 4.

1.4.1.6 Chapter 6 provides Appendixes.

2 Definitions, Abbreviations and References

2.1 Definitions

2.1.1.1 ERTMS Border Crossing: A location where operational rules and/or functionality and/or juridical aspects change AND ERTMS/ETCS operation in Levels 1, 2 or 3 is available on at least one side of the border.

2.1.1.2 Border Zone: the smallest possible zone containing all ERTMS Border Crossing arrangements, including any preparation, connecting two areas.

2.1.1.3 Changes of Operational Rules: changes affecting National Values with Operational impact and changes affecting national rulebooks.

2.1.1.4 Changes in Functionality: changes of engineering rules, System Version, ETCS Level, NID_C and National Values with functional impact and changes affecting the communication system.

2.1.1.5 Changes in Juridical aspects: changes of users' responsibility, authorization (NSA) and National Law.

2.2 Abbreviations

Abbreviation	Description
ACC RBC	Accepting RBC
ATAF	Automatic Track Ahead Free
B	Baseline
CES	Conditional Emergency Stop
CR	Change request
DeBo	Designated Body
DMI	Driver Machine Interface
EDP	ERTMS Deployment Plan
ERA	European Union Agency for Railways
ESG	Engineering Support Group (working group @ ERTMS Users Group)
FS	Full Supervision (mode)
GPRS	General Packet Radio Service
GSM-R	Global System for Mobile communication – Railways
HOV RBC	Handing Over RBC
IM	Infrastructure Manager
IXL	Interlocking
KM	Key Management

KMAC	Authentication Key
KMC	Key Management Centre
LS	Limited Supervision (mode)
MA	Movement authority
MoU	Memorandum of Understanding
Mx	Message number x
NL	Non Leading (mode)
NoBo	Notified Body
NP	No Power (mode)
NSA	National Safety Authority
NTC	National Train Control
NTR	National Technical Rule
NV	National Value
OBU	ETCS Onboard Unit
OS	On Sight (mode)
PLMN	Public Land Mobile Network
PT	Post Trip (mode)
Px	Packet number x
RBC	Radio Block Centre
RIU	Radio Infill Unit
RRI	Route Related Information
RU	Railways Undertaking
SR	Staff Responsible (mode)
STM	Specific Transmission Module
SV	System Version
TBD	To Be Determined
TMS	Traffic Management System
TR	Trip (mode)
TRK	Trackside
TSR	Temporary Speed Restriction

2.3 References

The following documents and versions apply:

Ref. N°	Document Reference	Title	Version
[SS026]	SUBSET-026	System Requirements Specification	2.3.0 + [SS108] (B2) 3.4.0 (B3 MR1) 3.6.0 (B3 R2)
[SS108]	SUBSET-108	Interoperability-related consolidation on TSI annex A documents	1.2.0
[SS037]	SUBSET-037	EuroRadio FIS	2.3.0(B2) 3.1.0 (BR MR1) 3.2.0 (B3 R2
[SS038]	SUBSET-038	Off-line Key Management FIS	3.1.0
[SS039]	SUBSET-039	FIS for the RBC/RBC Handover	2.3.0(B2) 3.1.0 (BR MR1) 3.2.0 (B3 R2)
[SS040]	SUBSET-040	Dimensioning and Engineering rules	2.3.0 (B2) 3.3.0 (B3 MR1) 3.4.0 (B3 R2)
[SS093]	SUBSET-093	GSM-R Interfaces: Class 1 Requirements	2.3.0 (B2/B3 MR1)
[SS113]	SUBSET-113	ETCS Hazard Log	1.3.0
[SS114]	SUBSET-114	KMC-ETCS Entity Off-line KM FIS	1.0.0
[SS137]	SUBSET-137	On-line Key management FFFIS	1.0.0
[EUG74]	EUG_17E112	RBC/RBC Handover Guideline	1
[LSTM-1]	ERA_ERTMS_040058	Guideline, Level Transition from Level STM to Level 1	1.0
[LSTM-2]	ERA_ERTMS_040039	Guideline, Level Transition from Level STM to Level 2	2.0
[ERA_L1-2]		Guideline, Level Transition from Level 1 to Level 2	0.7
[ERA_L2-1]		Level transition from Level 2 to Level 1	0.5
[BCA B3 MR1]	EUG_UNISIG_BCA	Baseline Compatibility Assessment - Final Report	1.0.0
[BCA B3 R2]	ERA_BCA_B3R2	Baseline Compatibility Assessment Baseline 3 Release 2- Final Report	1.1.0

Ref. N°	Document Reference	Title	Version
[OPE HARM]		Minutes of the Operational Harmonisation of ERTMS WP meeting #49	
[EUG66]	EUG_17E114	Transition from SV 1.Y to SV 2.Y L1/2/3 with NTC fallback	1-
[EUG67]	EUG_67	Level transition from level NTC to Level 1 (System Version 2.y)	1-
[EUG70]	EUG_70	Level transition from Level 1 to Level STM	1-
[EUG71]	EUG_71	Level transition from Level 2 to Level STM	1-
[EUG72]	EUG_17E113	Level transition from Level STM to Level 1	1-
[CFC12]	CFC#12	EUG CFC#12: use of National Values	0.3
[OPINION ERA 2017-2]	Opinion ERA-OPI-2017-2	OPINION ERA/OPI/201 7-2 OF THE EUROPEAN UNION AGENCY FOR RAILWAYS for European Commission regarding CCS TSI Error Corrections	-
[AG TSA]	010TSA1068	Application guide for the ERTMS trackside approval	1.0
[2016/798]	2016/789 EU	DIRECTIVE (EU) 2016/798 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 11 May 2016 on railway safety	-

2.4 Appendixes

The following Appendixes apply and are attached at the present document:

Ref. N°	Title
[A.1]	List of National Values with functional and operational impact
[A.2]	List of operational Scenarios
[A.3]	List of implemented Border Crossing
[A.4]	SBB example of border crossing commissioning process
[A.5]	RBC – RBC border when RBC interfaces are not compatible
[A.6]	Methodology to identify the possible issues to be tackled when designing a border area
[A.7]	Template of the 2012 Agreement between RFI and SBB on Crossing Border Train Control System between Italy – Switzerland

3 Strategy, process, and general recommendations

3.1 General

Based on the projects experience these general recommendations shall be considered when engineering an ERTMS border:

3.1.1.1 Border crossing experience teaches that case by case study is required however it is fundamental to ensure appropriate and early identification of dialogue partners (ERA, IM, NSA, RU, NoBo/DeBo, suppliers etc.) across the national borders to guarantee a harmonised approach (share analysis and design documents).

3.1.1.2 Consider carefully if locating the system borders in a different location to the national border; in this case the early involvement of NSAs (and possibly of the Member State) is more important to have a clear identification of the responsibilities and rules to apply (different safety approaches, TSI CCS specific cases and NTRs influence ERTMS engineering rules).

3.1.1.3 Ensure aligning of implementation strategies (masterplan) on both sides of the border (may depend on Freight corridors, national implementation plan).

3.1.1.4 Consider the constraint to minimise the impact on existing operational rules of both sides of the border however, on the other hand, consider that different operational rules and principles may heavily affect technical solutions.

3.1.1.5 Consider the capacity requirements for cross border services as the capacity across a border may be lower than on the adjacent lines and thus not fulfil the requirements.

3.1.1.6 In case a border has to be located in a long tunnel/bridge, specific precautions/strategy to regulate the traffic /allow evacuation, have to be considered by both parties in case of incident/regularity problem.

3.1.1.7 Consider locating borders on plain lines not too close to nodes/large stations, if applicable, to simplify the engineering.

3.1.1.8 The characteristics (e.g. train categories, ETCS Baseline, non-mandatory CRs implemented onboard, possible OBU deviation to the standards due to NTRs) of the fleet involved have to be considered.

3.1.1.9 In case one party involved in the border crossing (including RUs) does a modification in its system, an impact analysis has to be performed to identify all possible issues arising from that modification and the relevant recommendations to be considered again.

3.1.1.10 When engineering a border crossing as part of a ERTMS implementation it should be considered that also the IXL-IXL interface and the TMS-TMS interface should be engineered. I.e. what minimum information is needed at these interfaces to facilitate continued and harmonised operations.

3.1.1.11 Differences in languages at national border crossings would need to be considered as part of any border crossing implementation. Drivers who cross national borders will need to communicate verbally with foreign signallers in some situations and will need to be able to interpret plain text messages received from a foreign trackside. Fixed text message content and system status messages (shown by the B3 DMI in the language chosen by the driver) may form part of the verbal communication between driver and signaller. To minimise the risk of misinterpretation or miscommunication the following language related issues should be considered:

- Competency of drivers and other railway staff to converse in the language applicable following a border crossing at an appropriate level
- Sharing of plain text messages and their meaning, and any translation of fixed text/ system status messages, between all parties that may be affected by them
- Whether it will be necessary for the driver to change the language used for display on the ERTMS/ETCS at the border crossing and if so where this change should be made and to what. This will require the necessary language configurations to be available onboard (potential issue for B2 OBU)
- Where the border crossing is between two countries that share the same, non-English, language it may be appropriate to harmonise the translation of fixed text/ system status messages displayed on the ERTMS/ETCS DMI into that language, and plain text messages transmitted by the trackside, to facilitate correct interpretation and communication in each country.

3.2 Radio

Based on the project experience these considerations shall be made when engineering a radio border (the following provisions are applicable also for the voice communication):

3.2.1.1 Ensure sufficient radio coverage across the border, if change of GSM-R network is required.

3.2.1.2 Ensure approval from foreign approval bodies according to the cross-border coverage of GSM-R (see above).

3.2.1.3 In case the border has to be located in the middle of a bridge, specific precautions have to be considered by both parties to avoid interferences (see also 3.2.3).

3.2.1.4 Note: previous requirement is based on experience from the Oeresund bridge connecting Denmark and Sweden, which is located very close to the Danish/Swedish signalling system border. It was found that equipping the Oeresund bridge, a large and high metal bridge, with two national GSM-R networks and avoiding interference was such a challenge that the GSM-R network on the bridge had to be completely redesigned.

3.2.1.5 In case of border between packet/circuit switch radio sessions, a detail analysis has to be performed by both parties to manage possible transition delays onboard.

3.2.2 GSM-R frequency planning

3.2.2.1 To avoid interference between different GSM-R systems on each side of a border, the frequencies/channels used by base stations has to be coordinated.

3.2.2.2 Poor coordination of frequency planning across the border may lead to interference between cells on each side of the border, causing lost communication and in the worst case brake application. Naturally, this issue is particularly important for border crossings where the topology allows radio signals to propagate a long distance. Examples of such topologies can be over water or in flat landscapes.

3.2.2.3 To mitigate this risk, it is highly recommended to coordinate or create common processes for frequency planning in border areas including the furthest theoretical propagation distance for radio signals from the neighbouring GSM-R system. Cooperation agreements should describe allowed propagation into the neighbouring territory and use of channels in this area.

3.2.3 Radio Interferences from commercial radio networks

3.2.3.1 GSM-R can be sensitive to interference from radio signals outside of the GSM-R domain. For example, there are known issues with public 3G or LTE networks in the 900MHz band interfering with GSM-R. During frequency planning in border areas, potential interference sources on both sides of the border should be mapped. Commercial radio networks can create two types of issues, Intermodulation and blocking.

3.2.3.2 Intermodulation will distort GSM-R signals leading to dropped packets. This can be mitigated by frequency hopping, but there are limited possibilities for that in the GSM-R frequency range and system properties. In many cases, the solution will be to build additional base stations for GSM-R to increase the signal/noise ratio.

3.2.3.3 Blocking will jam the GSM-R signal, leading to lost connection. GSM-R receivers have in general a wide range and are sensitive to unwanted signals. Terminals that are less sensitive to blocking have been developed, and partly mitigates the problem. Blocking can also be mitigated by installing bandpass filters. Filters on the onboard equipment can also be hard to implement if there are many trains from different operators running on the line in question. As with intermodulation, blocking problems can be avoided by increasing signal strength of the GSM-R signal. For example, by installing additional base stations.

3.3 Process

3.3.1.1 Border crossings typically involve a number of ETCS and other trackside systems, often from different suppliers, needing to operate in harmony. It is important that all parties have the same understanding of the interfaces, what each system will provide and what each system expects. It is recommended that a series of design reviews are undertaken with all the design authorities/suppliers present to ensure that all the issues are identified early in the process and there is clarity on the requirements.

3.3.1.2 There is no defined functional boundary between an interlocking and an RBC – indeed they may be combined. Each supplier has their own arrangements for sharing information at this interface and for making safe decisions based on that information. Linking the products of two suppliers at a border will nearly always be a bespoke application and will involve both suppliers to define and implement the interface.

3.3.1.3 The operational requirements in the vicinity of the border need to be clearly identified. The technical solution to some operational requirements may be very complex or expensive, it may be necessary to restrict operational flexibility on the approach, across and beyond the border (e.g. different policies for degraded operation: OS or SR). This may include a restriction on modes available from the trackside, the need to avoid a change of direction or start of mission, or requirements that the train must have two available radio mobile terminal.

3.3.1.4 The following steps summarise an example of harmonised process to commission a national border project:

1. Technical preliminary meetings with both IMs and NSAs: bilateral MoU identifying targets, constraints and responsibilities can be helpful
2. ERA joint involvement (see Application guide for the ERTMS trackside approval [AG TSA])
3. Create joint detailed operational, technical specifications and engineering data (values and format; e.g. BG locations, signal aspects, signal distances, gradient …) at border (see Appendix [A.2] as a possible check list) taking into consideration possible NTRs and specific cases
4. Supplier activities of product development, installation and data preparation can be performed separately but it needs to be reviewed through an integrated process
5. Create joint test plan
6. Execute tests together (IMs, RUs for field test, all suppliers involved, NoBo/DeBo)
7. Create joint maintenance specification when useful
8. Create joint TSR specification
9. Obtain Subsystems EC declaration of verification separately
10. Obtain ERA positive decision (according to the "Technical pillar" of the 4th Railways package) and NSA authorisation separately (but NSA having worked together)
11. Commission project together

3.3.1.5 Note: the above steps are based on the 4 different borders between Belgium and Luxemburg.

3.3.1.6 Note: Common safety methods should be used during the process, see directive on railway safety [2016/798].

3.3.1.7 The SBB process included in [A4] is an example of a harmonised process to commission a national border project.

3.3.1.8 An example of a methodology to identify the possible issues to be tackled when designing a border area is included in [A.6].

3.3.1.9 EU Regulation 2017/6 (EDP) article 2 comma 3 states that an agreement between IMs at national border is mandatory and it has to be notify to the Commission; in Appendix [A.7] you find the template of the agreement between RFI and SBB on Crossing Border Train Control System between Italy – Switzerland. Such template has to be considered as an example of successful bilateral cooperation however it was signed in a different legislative framework (2012) therefore it can only represent a possible starting point, to be necessarily updated to current legislation, for the definition of a new bilateral agreement.

3.4 Test & Commissioning Plans

3.4.1.1 The involved parties must consider the development of a joint test and commissioning plan covering the border area. The plan must be agreed by all parties and should consider any phased implementation or migration strategies, the testing and commissioning strategies and methodologies employed by all parties.

3.4.1.2 The joint development by the involved parties of operational scenarios covering the border crossing must include a full and detailed consideration of all normal, emergency, abnormal and degraded operations, for all relevant implementation phases, that may occur in the border crossing area. A full and complete set of operational scenarios will not only assist in the development of the border crossing requirements, but also in the mutual understanding of how different systems on each side of the border behave and the validation of any assumptions made in relation to that behaviour, and provides a basis against which sub-systems and system integration testing can be completed.

3.4.1.3 It is desirable to perform as much of the sub-system and system integration testing in a laboratory environment as possible – this reduces on-site testing work, provides the ability to conform bug fixes/upgrades before on-site implementation and supports flexibility of testing arrangements. For border crossing areas it could be considered to provide a joint test laboratory, or to provide an interface between separate test laboratories, to support cross border system integration and validation testing.

3.4.1.4 In [A.2] a list of possible operational scenarios is reported to be used as input for the definition of the possible test cases.

3.5 Cyber security

3.5.1.1 ETCS relies on data being available to the train and being shared between parts of the trackside. A border crossing requires all the relevant duty holders to share securely relevant data however each administration will have their own data security rules and constraints.

3.5.1.2 When connecting different data networks consideration needs to be given to the confidentiality of information. What restrictions need to be placed on access to data from systems on the other side of the border and can those systems comply with the host's security protocols?

3.5.1.3 There is a need for the trackside to communicate across the border and this may be by dedicated connections or by routing the information through secure gateways.

3.5.1.4 Trains need to be able connect to either GSM-R network which may require the two networks to be connected via secure networks.

3.5.1.5 On-line key management requires trains to be able to contact their host key management centres which requires gateways between different country's networks.

3.5.1.6 Each party needs to analyse the impact on the security and availability of their data networks of connecting them to another network and determine the acceptable secure management of the connection without impacting on availability.

4 Issues to be addressed

This chapter lists issues that need to be considered for engineering a Border Crossing. The relevant recommended solutions are recorded in the corresponding sections of chapter 5.

4.1 National Values

4.1.1 Location of Change of National Values (NID_C)

4.1.1.1 When a balise group message is received, the balise identity information referring to the country or region (NID_C) is used to ensure that the correct national values are used. If there are no national values stored onboard for the particular country or region identifier, the default national values are used as fall-back. The NID_C value is also used as part of the ETCS identity of an RBC, balise group, loop or RIU.

4.1.1.2 Depending of the implementation, national values are transmitted to the train by balise and/or by RBC. In some RBC implementations, only a single set of national values can be held which are always sent if applicable (for additional details see [EUG74]). This could lead to overwriting other national values which were sent by balises after passing a national value boundary.

4.1.1.3 If the location of a border is different depending on direction, there is a risk that a train performing a turnback move in the vicinity of the border may have received the national values applicable to a new area in one direction and will retain these when returning in the opposite direction into the previous area following the turnback move.

4.1.1.4 If using p3 for sending national values with D_VALIDNV > 0 and NID_C different from NID_C of the header, OBU could apply default national values when at location D_VALIDNV due to a mismatch between the country or region identifier read from a balise group and the corresponding identifier(s) of the applicable set with which the National Value was received and stored. To avoid this mismatch the distance between the balise antenna and the front end of the train has to be considered as well.

4.1.2 Changes That May Impact Train Operations at Borders

4.1.2.1 Where national values are changed at border crossings there is a risk that differences in certain national values might have an undesired operational impact. National values which might introduce this undesired impact include:

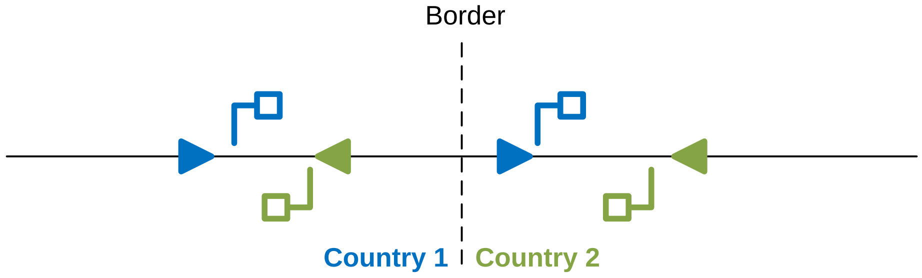
- When the national values for mode related speed restrictions (V_NVUNFIT, V_NVREL, V_NVSTFF, V_NVSHUNT) are changed to lower values this could lead to unexpected brake interventions when actual train speed is above the new applicable speed value.
- Braking curves are based on the national values for braking curves; in SV 2 by packet 3 and in SV 1.1 by packet 203. Using different values on each side of a boundary will result in different braking curves. Changing the national values for braking curves at a border crossing could lead to a more restrictive braking curve being supervised which could lead to unexpected brake intervention. If B2 trains, with no regulated braking model, have to be considered, braking characteristics have to be taken into account to optimize the engineering of the border crossing (e.g. use of the permitted braking distance function).
- Using different values for M_NVCONTACT and/or T_NVCONTACT on each side of a boundary could lead to an unexpected reaction if the communication session is

disturbed. E.g. if T_NVCONTACT value is lowered or M_NVCONTACT is set to a more restrictive reaction.

- Using different values for T_NVOVTRP and/or D_NVOVTRP on each side of a boundary could lead to an unexpected reaction while performing the Override procedure. E.g. if T_NVOVTRP and/or D_NVOVTRP values are lowered.

4.1.3 Mixing NV in separate BG (filtered by linking)

4.1.3.1 At national borders, there may be an overlap in the provision of national signalling equipment, for example to facilitate transitions, and it could be difficult to define where the change in NID_C, and the application of the associated national values, should be. Balise groups associated to country 1 signals will contain a country 1 NID_C. Balise groups associated to country 2 signals will contain a country 2 NID_C. This means that a train running from country 1 to country 2 will read NID_C1 – NID_C2 – NID_C1 – NID_C2.



4.1.3.2 In the above situation it is possible when driving from country 1 to country 2 that announced national values for country 2 will be applicable before a balise group with NID_C1 is evaluated. This will lead to default national values becoming applicable as a mismatch will be detected between NID_C associated with the national values and the NID_C in the balise group.

4.2 Train Data

4.2.1 V_MAXTRAIN

4.2.1.1 According to [SS026 – v.2.3.0d] 3.18.3.2 d, the maximum train speed entered by the driver is defined as “Maximum train speed, taking into account the maximum speed of every vehicle contained in the train”. However, [SS026] 3.11.8.1 states “It shall be possible to define the maximum train speed related to the actual performance and configuration of the train.” This could be interpreted to allow the entry of a V_MAXTRAIN value that fits the performance requirements of the train on a certain line.

4.2.1.2 There might be various reasons why a certain V_MAXTRAIN value has been chosen for a train on a certain line:

- Brake performance.
- Train length.
- Train configuration.
- Axle load (which might or might not be covered by M_AXLELOAD).

- Train category (which might or might not be covered by NC_TRAIN or NC_CDTRAIN).

4.2.1.3 If the V_MAXTRAIN value does not fit the requirements of all lines on which the train runs on its mission, V_MAXTRAIN has to be changed at the border(s) to avoid a safety or performance impact.

4.2.1.4 The OPE harmonisation workgroup have agreed [OPE HARM] that "The maximum train speed, as it reflects the maximum speed of the slowest vehicle in the train, must be the same value from the start of the journey until the final destination.

4.2.2 Axle load

4.2.2.1 [SS026 - v.2.3.0d] defines M_AXLELOAD as a value between 0 t and 40 t in 0.5 t steps and a special value for > 40t, for both train and line categorisation. However, it is not clear, whether the axle load entered by the driver as part of data entry is the weight of the heaviest axle of the train (with or without locomotive?) or the mean axle weight, nor is the correlation to the axle load of the infrastructure clear.

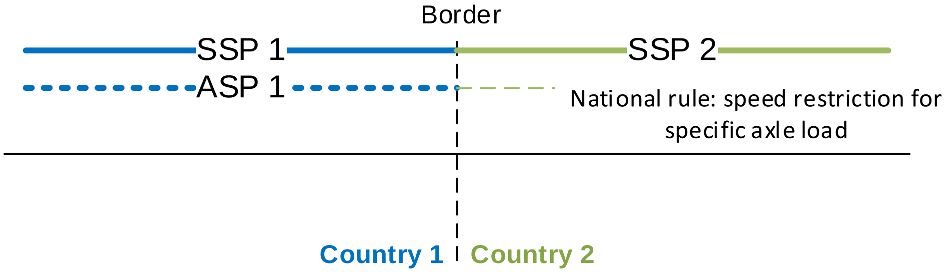
4.2.2.2 If the axle load definition on different sides of a border crossing is not harmonized the driver may need to change the axle load value at the border(s) to avoid the incorrect speed profile being used by the train, which leads to a performance or safety impact.

4.2.2.3 For system version X=2 trains operating on system version X=1 infrastructure the conversion of axle load parameter (M_AXLELOAD to M_AXLELOADCAT) could lead to unexpected speed profile changes due to the limited number of translation options. Section 6.6.3.2 of [SS026 – v.3.x.0] includes a lookup table for conversion from M_AXLELOAD to M_AXLELOADCAT – only 6 conversion options are available but M_AXLELOADCAT can define 13 axle loads. As the ERTMS/ETCS on-board equipment considers the most restrictive speed restriction that is associated with any axle load category lower than, or equal to that of the train, there may be instances a lower axle load speed profile becomes applicable when the system version changes.

4.2.3 Non-harmonised axle load speed restrictions

4.2.3.1 The axle load speed restriction of a line could be such that non-harmonised axle load categories are applicable. In this case the axle load speed profile cannot be used. If at least one non-harmonised axle load category is applicable on this line it is not possible to restrict the speed by a generic speed restriction. The driver is in this situation responsible to supervise the non-harmonised axle load speed restriction and this obligation can be part of the national rules.

4.2.3.2 If the axle load speed restriction on at least one side of a border crossing is non-harmonised this could lead to driver confusion and introduces a risk of overspeeding when



passing this border. For instance, the driver relies on the supervision of axle load speed restrictions (ASP 1) by the onboard at one side (Country 1) and could continue relying on the speed supervision by the onboard at the other side (Country 2), where only a higher generic speed restriction (SSP 2) is in force. But by national rule the driver should use the non-harmonised speed restriction for its specific axle load.

4.2.3.3 Informing the driver by signs that the operational rules change could be an issue at higher speeds especially in level 2/3 where the driver is not used to get information from lineside signs and signals. Also, the driver should be informed early enough to already adapt to the allowed speed at the other side of the border. Using text messages to inform driver could partly overcome this problem, but there is no harmonised way to inform the driver for this kind of situation.

4.2.3.4 Harmonising the speed constraints on both sides of the border could introduce the same issue at another location outside this border area.

4.2.3.5 A solution is project specific and is not considered in chapter 5.

4.2.4 Brake Percentage Calculation

4.2.4.1 According to [SS026 – v.3.x.0], the conversion model for Lambda trains “has been designed assuming that all the provisions laid down in the UIC leaflet 544-1, with the exception of sections 9.1.2 and 9.2.2, apply for the acquired brake percentage”. However, the use of UIC544-1 is not mandated for use in calculating the brake percentage value entered as part of the train data, and it is possible that in different countries, brake percentages may be calculated in different ways, and that a brake percentage for a particular train consist that would be considered unacceptable in one country may be acceptable in another. Where the brake percentage values are not harmonized (e.g. eddy current brake contribution) a train crossing the border will be required to stop to allow the driver to re-enter the applicable brake percentage value.

4.2.5 Train Categories

4.2.5.1 The definition of the train categories is not harmonized across Europe (different values of CANT deficiency are considered for national train categories’ speeds)

4.3 Level Transition

Guidance on B2 level transitions is provided by the guidelines as follows (see table of references):

To \ From	Level STM	Level 1	Level 2
Level STM	NA	[EUG_70] ***	[EUG_71] ***
Level 1	[LSTM-1] * [EUG_72] ****	NA	[ERA_L2-1]**
Level 2	[LSTM-2] *	[ERA_L1-2] **	[EUG_74] ***

(*) approved by ERA

(**) without final ERA approval

(***) EUG internal

(****) follow-up of ERA Guideline [LSTM-1]

4.3.1.1 Guidance on B3 level transitions is provided, at the date of the present document, only for LNTC to L1 transition (see [EUG67] in the table of references).

4.3.1.2 Consider if Class B system is available as a fall back in one or both sides of the border, even if the train will cross in ETCS, to design level priority tables.

4.3.1.3 Section 4.4.1 includes details of using level transitions to manage differences in system version at a border.

4.3.1.4 The transition from Level 2 to Level 2 is to be intended as the RBC-RBC handover (see also § 4.8).

4.3.1.5 When leaving a Level 3 area the location of the disconnect order after leaving this area should be considered carefully to take care of sending a position report with integrity confirmed to the Level 3 RBC after the train has left the area completely otherwise the last section in the Level 3 area will be kept occupied if no integer train reports this section is free.

4.4 Change of system version

4.4.1 Transitions Between System Versions

4.4.1.1 With the introduction of system version X=2 ETCS, a new type of transition has appeared: transitions between system versions.

4.4.1.2 The problem implied by this new system version is the incompatibility of system version X=1 OBUs with system version X=2 trackside: a train running with an OBU only supporting system version X=1 trips when reading system version X=2 balise groups.

4.4.1.3 Guidance on transition from system version 1.Y to system version 2.Y for L1/2/3 with NTC fall-back system is provided by [EUG66].

4.4.2 Baseline 2/3 Parameter Differences

4.4.2.1 Between system version X=1 and X=2 some parameter definitions are changed which could affect the train behaviour. In Baseline 3[1] OBUs, information received from an X=1 trackside is sometimes translated (see section 6 of [SRS-3]). At system version boundaries, this could lead to unexpected behaviour.

4.4.2.2 An example of this unexpected behaviour is:

- conversion of axle load parameter (M_AXLELOAD to M_AXLELOADCAT) could lead to unexpected speed profile changes due to the limited number of translation options - see section 4.2.
- changes to the brake model behaviour due to different factors contained in the national values (available factors differ between versions) could lead to unexpected changes in braking information displayed to the driver.
- Chapter 6 of [SS026 – v3.x.0] defines a translation between packet 39 in baseline 2 and packet 39 in baseline 3. If also defines a translation between M_TRACTION (baseline 2) and NID_CTRACTION (baseline 3). Some M_TRACTION values are not translated in NID_CTRACTION. Without the transmission of P239 together with P39, the change of traction will be ignored if the onboard cannot translate the M_TRACTION in NID_CTRACTION.

4.5 Implementation of Non-Mandatory Change Requests

4.5.1.1 There could be some change requests (not mandatory for M_VERSION 1, see [BCA B3 MR1], [BCA B3 R2] and [OPINION ERA 2017-2]) implemented in the system version X=1 RBC to facilitate the baseline 3 OBUs. Differences in the implementation of these non-mandatory change requests on either side of a border crossing could adversely impact train behavior.

4.5.1.2 This issue can also occur with baseline 2 foreign trains on a system version X=1 infrastructure if the implemented non-mandatory change requests are not the same between the two countries.

4.6 SoM with position not known for the RBC in a border zone

4.6.1.1 Due to multiple RBCs, it is possible that during Start of Mission a train reports a valid position relevant to a BG that is not known to the RBC. This train could be rejected or only disconnected by the RBC. This scenario could happen for instance in these 2 cases:

- Driver selects the wrong RBC at SoM while onboard has valid position
- After cold movement the onboard is connected with the wrong RBC (last connected); when after SoM the train is accepted (based on invalid position) a BG not known for the RBC could be passed.

4.6.1.2 If the train is rejected, the train position is set to unknown, but when a further attempt to connect is made, the train with an unknown position is accepted. The issue with this is

[1] An ETCS OBU is either baseline 2 (compatible with track side system version X=1) or baseline 3 (compatible with track side system versions X=1 and X=2)

that if a train is connecting to the incorrect RBC, the RBC could issue SR authorization to a train that is outside its area.

4.6.1.3 If the train is only disconnected, the position remains invalid and the train will never be allowed to connect i.e., at every subsequent attempt at connection, the train will be disconnected again.

4.7 SoM with incorrect data in a border zone

4.7.1.1 National values and changes to this information are managed by the OBU based on packets received from the trackside.

4.7.1.2 Transitions to No Power (NP) mode do not affect National Values.

4.7.1.3 Where trains are hauled in NP mode over a border and re-awakened in a different location, the National Values stored by the OBU may not be suitable for the awakening location. Using unsuitable National Values could lead to operational hindrance and/or safety risks.

4.8 RBC-RBC Handover

4.8.1.1 Refer to the Guideline [EUG74] for all the issues and the possible recommendations concerning RBC-RBC handover.

4.8.1.2 Refer to [A.5] for an example of a possible implementation of an RBC-RBC border providing interoperability when interface versions (SUBSET-039) of the RBCs are not compatible.

4.9 Communication issues

4.9.1 GSM-R/GPRS Network Coverage Overlap

4.9.1.1 At the boundary between ‘current’ and ‘new’ GSM-R networks the onboard modems need to register with the new network and may need to setup a call with a new RBC (normally by RBC transition) using the new network. As these processes take time for a seamless passage it is necessary to have coverage of the adjacent network while still in the ‘current’ network area.

4.9.1.2 If this coverage in the additional area is not provided, trains with the capability of establishing more than one communication session will experience the same potential performance penalties at GSM-R network borders as trains with the capability of establishing only one communication session (See [SS026] clause 3.15.1.1.3.)

4.9.1.3 <u>Note:</u> The required network quality for network registration and for setting up a call are different.

4.9.1.4 <u>Note:</u> The issue also affects GPRS connections (only available for B2 and B3 R2).

4.9.2 GSM-R Network Registration and Turn back Moves

4.9.2.1 When a train registered with a ‘current’ radio network and approaching a GSM-R boundary receives an order to register to a ‘new’ GSM-R network all inactive modems will register to the new network. If the active modem becomes inactive, e.g. by closing the cab, this modem will also register to the new network when the cab is reopened ([SS26] clause 3.5.6.5 and 3.5.6.6). If the train is still in rear of the GSM-R boundary when this happens all modems will be registered to the new network while the train is still in the current network area.

4.9.2.2 If the train is to subsequently continue in the reverse direction or continue in the same direction but is rerouted and avoids the GSM-R boundary the wrong network is used. This could lead to several issues when performing Start of Mission and departing such as:

- loss of connection at some point after departure due to a loss of 'new' GSM-R network coverage
- unable to connect due to insufficient GSM-R signal level. The required signal level for GSM-R network registration is less than that required for connection setup.

4.9.3 Radio Network Identity and RBC Contact Details

4.9.3.1 Refer to the Guideline [EUG74] for the issues and the possible recommendations concerning radio network Identity and RBC Contact Details.

4.9.4 Keys

4.9.4.1 No operational intervention is normally necessary to allow a duly authorised OBU to traverse into several separately controlled ERTMS areas, provided that the relevant preparatory actions have been carried out in advance of arrival at each area. Among these actions, specific key management (KM) functions are required to establish interoperable services. Without the correct keys in both the RBC and OBU, communications between the two will not be possible, leading to performance issues at a border crossing.

4.9.4.2 Symmetric (KMAC) keys are used to sign ETCS messages exchanged between ETCS entities, ensuring secure ETCS operation.

4.9.4.3 KMAC keys are distributed/installed in OBUs, KMCs, RBCs and RIUs manually (off-line KM: [SS038], [SS114]) or without staff action ([SS137]).

4.9.4.4 With off-line KM, all notification/installation of keys needs to be done manually in related ETCS/KMS entities.

4.9.4.5 With on-line KM all assignment/installation/updating of keys can be done automatically in related ETCS/KMS entities, both in the home or in a foreign domain, via the entities' Home-KMC.

4.10 Informing driver about border crossings

4.10.1.1 Drivers should be informed about border crossings, e.g. GSM-R network border, state border. This is especially needed in situations where ETCS does not provide information. This could be in degraded situations or when ETCS has no function to inform the driver.

4.10.1.2 The driver can get information from several sources:

- On DMI with specific ETCS function
- On DMI with text message
- Route book
- Harmonised lineside signs, i.e. ETCS marker boards and GSM-R marker boards
- Non-harmonised lineside signs

4.10.1.3 The use of specific ETCS functions and ETCS/GSM-R marker boards will help the driver to receive harmonised information and this will lead to an interoperable border crossing.

4.10.1.4 The use of national text messages and non-harmonised line side signals could lead to misunderstanding and requires drivers to be educated well. The use should be agreed bilateral.

4.10.1.5 Also the sources of information should be agreed and preferably the same sources should be used per type of border crossings, i.e. GSM-R network border always by GSM-R marker board.

5 Recommended solution

5.1 National Values

5.1.1 Location Change of National Values

5.1.1.1 When changing national values at a boundary there shall be an implementation check for undesired consequences due to the required national values being overwritten by an undesirable set, or the default national values becoming applicable.

5.1.1.2 It should be taken into account that not yet applicable national values will be deleted in specific situations like cab closing, see hazard ETCS-H0005 [SS113] reported here after:

In certain degraded situations defined in SUBSET-026, section §3.18.2.5 for v2.3.0, v3.4.0 and v3.6.0, ERTMS/ETCS On-Board shall use Default Values instead of National Values. If these Default Values are less restrictive than the National Values, an unsafe supervision might result.

Furthermore, note that the safe ceiling speed in Unfitted will be according to the National Values. Therefore, if passing a border in an unfitted area without border balises, the “old” National Values will still apply.

If the national values have to be changed it is recommended that at least once per direction/route a NV packet is sent at or just after the NID_C change location in which the distance to start of validity of NV (D_VALIDNV) is zero (B2) or now (B3).

5.1.1.3 If the border for both directions is not at the same place, the implementation should consider the implications of any possible turnback moves in the vicinity of the border on the availability of the necessary national values and ensure that the correct national values can be provided to the train.

5.1.1.4 A possible solution to the overlap in signalling provision issue is to define a common NID_C, and/or common national values, for the border area agreed by all involved parties. Where the two RBCs permit, it is possible to send a common set of national values which are valid in both NID_C areas. This allows the changes in national value to be managed within each RBC area through appropriate speed profiles, etc. It is also possible to define a common NID_C, but use different sets of national values depending on the direction of the train movement.

5.1.1.5 However, creating a common NID_C and common national values for a border area in effect creates two new borders between the common set at both country sets which could also create new (operational) problems.

5.1.1.6 Alternatively, the validity of the national values before the overlap could be extended to both country identifiers, i.e. NID_C1 and NID_C2, and then after the overlap reduce the validity of the national values to the respective country identifier. The set of national values shall be chosen with respect to the national signalling equipment and is therefore dependent of the direction of the train movement. This alternative is a solution for a simple topology in a short overlap area, but in extended overlap areas turnback moves shall be considered and secured for additional detail see also § 5.1.3.

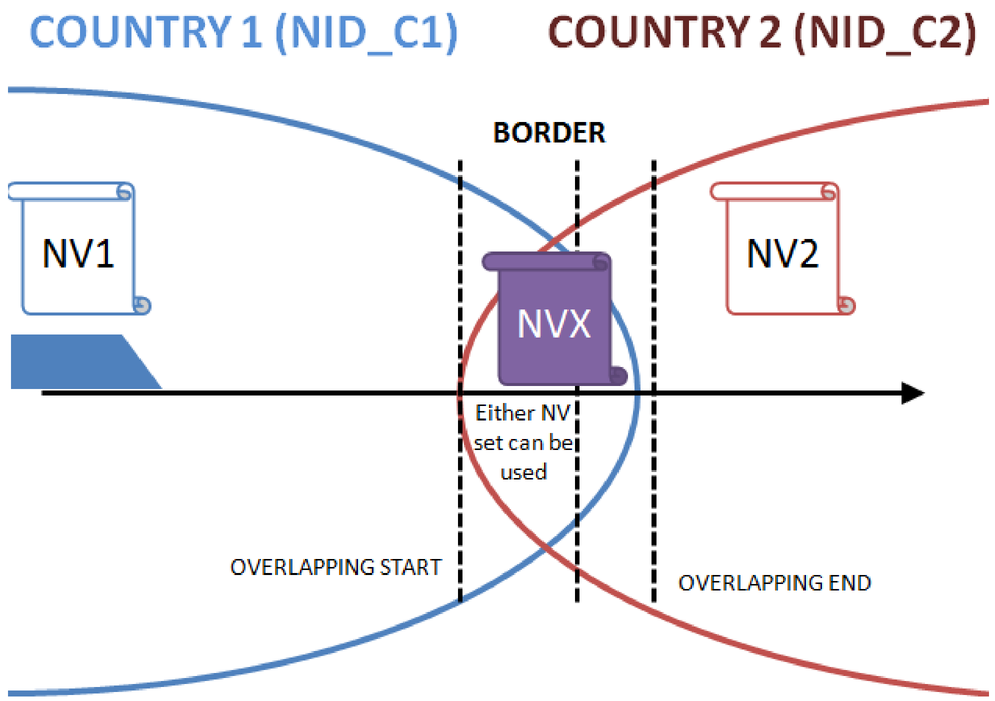


Figure 1 – Overlapping national values

5.1.1.7 Another possible solution to the overlap in signalling provision is to define the NID_C change related to the geographical border i.e. independent of the signalling provision. At the geographical border there is a clear change of ownership of NID_C values.

5.1.1.8 For the possible application of default national values when using D_VALIDNV > 0 and NID_C different from NID_C of the header, a Call for Clarification [CFC12] has been raised.

5.1.2 Changes That May Impact Train Operations at Borders

5.1.2.1 Consideration of the potential impact of changes in national values at a border shall form part of the border crossing design – this will require the independent analysis of each difference in the national values. It may become necessary for some of the changes in national values (e.g. V_NVSTFF) to be managed by operational rules rather than technical solutions.

5.1.2.2 Analyse braking curves, under the different NVs, to find a location where the sudden change of braking parameters does not cause unwanted braking interventions.

5.1.2.3 For Baseline 3 OBU Braking curve management on Baseline 2 track, P203 (SV 1.1) has to be used from track to train.

5.1.3 Mixing NV in separate BG (filtered by linking)

5.1.3.1 In [SS026 – v.3.x.0], it is clear that no consistency check shall be performed between national values available onboard and linked balise groups which are not included in the linking (more generally, if a balise group message is rejected or ignored, it shall not be used for such checks). This allows to use linking to make a seamless national values transition, if the change of NID_C border is asymmetrical, which means balise groups with different NID_C have to be interlaced at the transition. The following figure represents an example of such a trackside configuration. On this figure, all the balise groups are linked (in the telegram header, Q_LINK = linked).

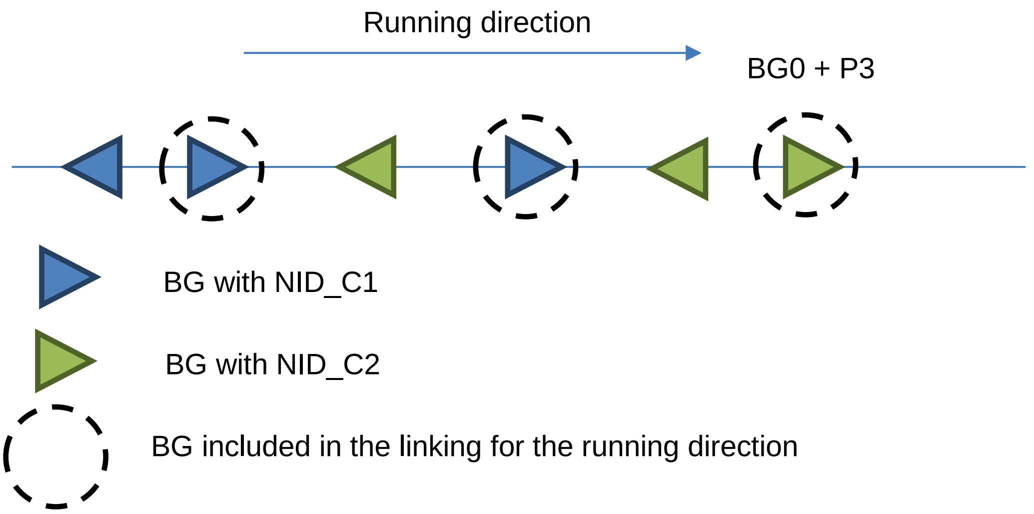


Figure 2 – Possible trackside configuration for an asymmetrical border

5.1.3.2 On the previous figure, it is possible to make a national value change only at BG0, by transmitting them in BG0, with D_VALIDNV = 0 or “Now”. The other BG with NID_C2 will not interfere in the change of national values.

5.1.3.3 Note: the previous solution is only applicable for SV 2.Y lines, as there is an ambiguity in the [SS026 – v.2.3.0d] on how the onboard should perform checks on the national values if the onboard encounters a linked BG not included the linking with a NID_C for which it does not have national values. See CR 1183 fixed in B3 MR1.

5.1.3.4 For SV 1.Y lines, including the one where a B2 trains are authorized to operate, it is recommended not to implement such a solution. The following figure describes the track layout to handle a change of national values for such lines.

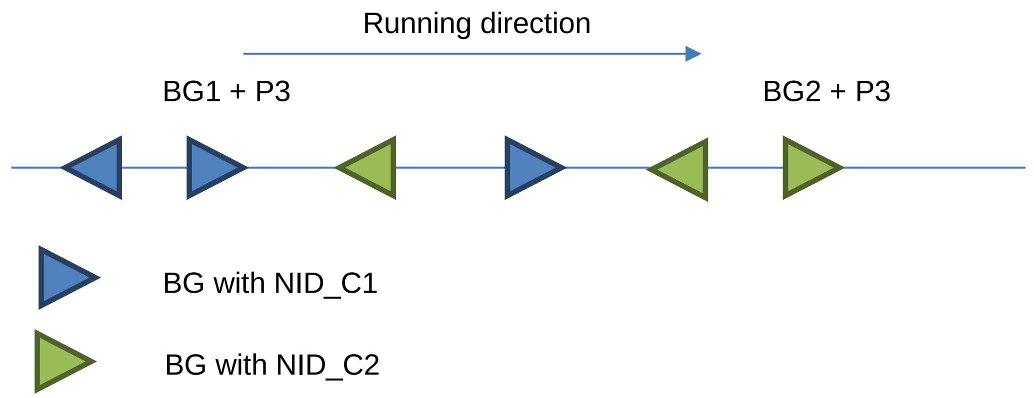


Figure 3 – Possible trackside configuration for an asymmetrical border with SV 1.Y

5.1.3.5 For SV 1.Y lines, independently from linking strategy, it is recommended to transmit national values in BG1 with D_VALIDNV = 0. These national values have to be applicable both for NID_C1 and NID_C2, to ensure a B2 train will not fall-back to default values when passing on a linked balise group (Q_LINK = linked) with NID_C2, even if it is not in the linking. The set of national values can be different from the one for NID_C1 or NID_C2 areas. Finally, national values only valid for NID_C2 shall be transmitted by BG2 with D_VALIDNV = 0.

5.2 Train Data

5.2.1 V_MAXTRAIN (from Guideline 31)

5.2.1.1 V_MAXTRAIN (and, ultimately, all other train data) should not depend on the line/country at all. I.e. the SSP and/or the axle load speed profile should be enough for safe supervision, and the maximum train speed should reflect the maximum speed of the slowest vehicle in the train.

5.2.1.2 Where the operator requires that the maximum train speed fits the performance requirements of the train on a certain line, then for a dynamic border transition the maximum train speed entered by the driver should take into account the requirements of both lines (i.e. the lowest value should be entered). This means that driver does not need to change train data at the border, and dynamic border transitions are possible.

5.2.1.3 In case V_MAXTRAIN for line A would be higher than for line B, this solution will cause a performance loss on line A for the sake of a dynamic border transition between lines A and B.

5.2.1.4 The implementation must consider that the trackside design might rely on V_MAXTRAIN supervision, i.e. on some lines V_MAXTRAIN might need to be lower than (at least parts of) the SSP based on train category or axle load.

5.2.2 Axle load

5.2.2.1 For operations by system version X=1 trains on system version X=1 infrastructure, the axle load entered by the driver should ideally be the maximum axle load of any vehicle in the train consist including the locomotive (for the locomotive, this may be an “operationally relevant axle load rather than the physical axle load, for example in Switzerland, the operationally relevant axle load of locos is 20 t (corresponding to a C2/3/4 axle load category) although almost all are physically heavier). Axle load speed profiles should take this definition into account.

5.2.2.2 Alternatively, at border crossings where a different interpretation of axle load definition exists, the axle load entered by the driver of a train crossing the border should take into account the axle load definition of both lines (i.e. the highest value should be entered).

5.2.2.3 Note - For system version X=2 trains operating on system version X=2 infrastructure, and applying the categorization processes and categories specified in EN15528, the axle load definition is harmonized. According to section 7 of EN15528, when considering a train, the ruling case for the train shall be the vehicle with the most onerous categorisation with the maximum speed of the train limited to the most restrictive speed requirement. Dynamic border crossings to system version X=2 areas are not therefore an issue.

5.2.2.4 For system version X=2 trains operating on system version X=1 infrastructure, the continued operation over border crossings between the two system versions without requiring a change of axle load value at the border will be supported as long as the line categorisation in the system version X=1 area is compatible with the lookup table in section 6.

5.2.2.5 Regarding the axle load conversion table issue, consideration must be given to the axle load speed profiles on either side of a system version change and the impact of the conversion table once the system version changes on the MRSP supervised by the train.

5.2.3 Brake Percentage Calculation

5.2.3.1 At border crossings where a different interpretation of brake percentage exists, the impact of these differences must be assessed as part of the border crossing design. It may be necessary for the brake percentage entered by the driver of a train crossing the border to take into account the brake percentage definitions of both lines and use a value that is acceptable to all affected areas.

5.2.4 Train Categories

5.2.4.1 Both parties have to share the way they intend to allocate the speed values to the ERTMS train categories to check the possible impact on performance and safety.

5.3 Level Transition

5.3.1.1 See section 4.3.

5.4 Change of system version

5.4.1 Transitions Between System Versions

5.4.1.1 The transition from system version X=2 to system version X=1 can be done under ETCS supervision as OBUs supporting system version X=2 are also compatible with system version X=1. The design of the transition between the system versions shall take into consideration the results of [BCA B3 MR1] and [BCA B3 R2]**.**

5.4.1.2 The system version order packet (packet 2) could be used to command the transition from system version X=2 to system version X=1 by balise group only. The use of system version order packet (packet 2) is not recommended. This recommendation is especially for Level 2/3 tracksides, because the RBC determines the OBU operating system version while establishing the communication session and will overrule the system version order. When using the system version order hazard ETCS-H0093 [SS113] should be considered if stop-if-in-SR or National Values are used in the same balise group.

5.4.1.3 To support some system version X=2 functionality (like brake curve calculation) on system version X=2 OBUs on a system version X=1 trackside, it is possible to use system version 1.1 in the track side, (e.g. p203).

5.4.1.4 The transition from system version X=1 to system version X=2 can be done under ETCS supervision only if all of the trains running on the lines are equipped with system version

X=2 OBUs. The design of the transition between the system versions shall take into consideration the results of [BCA B3 MR1] and [BCA B3 R2].

5.4.1.5 The transition from system version X=1 to system version X=2 cannot be done under ETCS supervision if some trains running on the lines are equipped with system version X=1 OBUs.

5.4.1.6 One solution is to not allow system version X=1 trains to cross the border into the system version X=2 area and to design the trackside implementation to prevent this from happening.

5.4.1.7 However, if it is required that the system version X=1 train continue over the border then one possible solution is for the train to transition to class B operation at the border, or remain in class B operation, for example:

- System version X=1 train in ETCS operation approaching a system version X=2 ETCS border transitions to Class B operation; to avoid that also system version X=2 train in ETCS operation could switch to Class B operation, the VBC function can be used.
- System version X=1 train in class B operation approaching a system version X=2 ETCS border remains in class B operation.

5.4.1.8 This solution can only be applicable at border crossings where:

- The area beyond the border supports class B operation, and
- The train has a compatible and available onboard class B system, and
- The train driver is competent to operate under Class B operation.

5.4.1.9 To limit the impact on performance, the trackside application should support this level transition, or lack thereof, to be managed automatically without the train having to stop. An example of how this might be achieved is as follows:

- Border between system version X=1 Level 2 area and system version X=2 Level 2/Class B area:
  - o RBC transition where HOV RBC is system version X=1 and ACC RBC is X=2.
  - o System version X=2 OBU performs RBC Handover and continues in Level 2.
  - o System version X=1 OBU is not accepted by ACC RBC and continues without radio (solved by T_NVCONTACT or Radio hole)
  - o System version X=1 OBU performs a transition to Class B in next signalling block based on transition order in balises which are masked (by linking information) for system version X=2 train.

5.4.1.10 An alternative solution where the automatic control of a level transition is not available could require the driver to stop and manually change level before proceeding over the border.

5.4.1.11 Note: In Level NTC/0, OBUs ignore the content of balise groups using incompatible version, and do not provoke a trip of the train. OBUs supporting system version X=2 will accept the level transition to ETCS system version X=2.

5.4.1.12 Note: If the trackside class B system uses Eurobalise and packet 44 to transmit information to the OBU, tests should be executed to ensure that the packet 44 is accepted by version X=1 OBUs in level NTC/STM/0.

5.4.2 Baseline 2/3 Parameter Differences

5.4.2.1 The implementation design shall identify and address any undesirable consequences for train behaviour resulting from a change in system version and the associated differences in parameter definitions.

5.5 Implementation of Non-Mandatory Change Requests

5.5.1.1 Adopt system version 1.1 within the RBC and send the extra packets as defined in [SS026] Chapter 6 of Baseline 3.

5.5.1.2 Ensure a harmonized implementation within a country's borders and check for compatibility between implemented change requests with neighbouring countries as part of the implementation.

5.6 SoM with position not known to the RBC in a border zone

5.6.1.1 The trackside and operational design must consider the impact of train rejection or disconnection during Start of Mission.

5.6.1.2 The UK solution includes the provision of a text message sent by the RBC prior to rejection of a train reporting an invalid or unknown position which guides the driver on what to do.

5.7 SoM with incorrect data in a border zone

5.7.1.1 For tracks using radio communication (Level 2 or 3) the RBC should send the correct National Values before authorizing the train to drive. For Level 1 and in Level 2/3 for degraded situations without radio communication the National Values should be repeated at appropriate locations, e.g. where nominal Start of Mission takes place.

5.8 Communication issues

5.8.1 GSM-R/GPRS Network Coverage Overlap

5.8.1.1 To avoid trains with the capability of establishing more than one communication session potentially experiencing performance penalties, an overlap in GSM-R network coverage is required. The required distance of the overlap in rear of the boundary should be based on the time to register to the 'new' network (40s – see [SS093], 6.3.7.3) and (where necessary) the time to set up the communication session with the new RBC (~40s - see [SS037], 7.3.2.3.1) and complete any RBC handover related activities necessary before crossing the border using the maximum track speed.

5.8.2 GSM-R Network Registration and Turn back Moves

5.8.2.1 Note: CR 1227 has been raised to propose a solution to this issue. The CR has not been incorporated into the relevant specifications as part of release 2 for baseline 3 and as of the date of issue of this document there is no agreed solution.

5.8.2.2 For baseline 3 and baseline 2 implementations, the implications of this issue need to be considered by the technical and operational design. Local instructions could require that drivers physically change the required radio network at start of mission in identified situations, but this will require the driver to power down the OBU (Entry to NP mode) to invalidate the position and level information and is not recommended – also this will only be effective if cold movement detection is not available. Additional registration balise groups could be installed, or registration packets included in existing balises, to force registration to the correct network by trains that will not cross the border, or the RBC could be configured to command connection to the correct network based on the route set.

5.8.2.3 This problem could also be avoided with seamless handover between the different networks i.e. if the network handover is handled for the active modem in a similar way as a cell handover (inter-PLMN handover) and using Packet 45 at the border for idle modems only (connected modems will not switch). This would require that this sort of handover is possible and provided for within the GSM-R system. The active modem will not realise that a network change has occurred, and at subsequent startup the idle modem will connect to correct network (active modem will connect when disconnected).

5.8.3 Keys

5.8.3.1 The OBU needs the key for the RBC it is attempting to connect to, the KM domain and radio network are irrelevant.

5.8.3.2 When borders are crossed and an OBU enters a foreign KM domain the following conditions should be met:

- the OBU holds a KMAC for the foreign domain RBC
- this KMAC shall not be expired or revoked.

5.8.3.3 In order to have seamless border transitions bi-lateral agreements across borders must be met to enable the exchange of foreign OBU KMACs into each related KM domain.

5.8.3.4 When on-line KM is in use, an OBU must be able to contact its home KMC from anywhere it may operate. This requires connections between the GPRS networks (cross border) to allow the necessary requests and transfers to be made, including updating “home key” or acquiring key for a third domain while being outside of home domain.

6 Appendix

6.1 [A.1] List of National Values with functional and operational impact

National Value [SS026 – v3.6.0] Paragraph 7.4.2.1.1	**Functional impact**	**Operational impact (driver)**	**Impact on**
V_NVSHUNT		X	Change of allowed speed
V_NVSTFF		X	Change of allowed speed
V_NVONSIGHT		X	Change of allowed speed
V_NVLIMSUPERV		X	Change of allowed speed
V_NVUNFIT		X	Change of allowed speed
V_NVREL		X	Change of allowed speed
D_NVROLL		X	Change of allowed distance to move
Q_NVSBTSMPERM	X		Braking distance
Q_NVEMRRLS		X	Change of allowance driver action
Q_NVGUIPERM		X	Change of information braking
Q_NVSBFBPERM	X		Braking distance
Q_NVINHSMICPERM	X		Braking distance
V_NVALLOWOVTRP		X	Change of allowed speed
V_NVSUPOVTRP		X	Change of allowed speed
D_NVOVTRP		X	Change of allowed distance to move
T_NVOVTRP		X	Change of allowed time to move
D_NVPOTRP		X	Change of allowed distance to move
M_NVCONTACT	X		Failure reaction
T_NVCONTACT	X		Time to detect failure
M_NVDERUN		X	Change of allowance driver action
D_NVSTFF		X	Change of allowed distance to move
Q_NVDRIVER_ADHES		X	Change of allowance driver action
A_NVMAXREDADH1[2]	X	X	Braking distance or change of information DMI
A_NVMAXREDADH2[2]	X	X	Braking distance or change of information DMI
A_NVMAXREDADH3[2]	X	X	Braking distance or change of information DMI
Q_NVLOCACC	X		Distance to detect failure
M_NVAVADH	X		Braking distance
M_NVEBCL	X		Braking distance
Q_NVKINT	X		Braking distance
Q_NVKVINTSET	X		Braking distance
V_NVKVINT	X		Braking distance
M_NVKVINT	X		Braking distance
N_ITER	X		Braking distance

National Value [SS026 – v3.6.0] Paragraph 7.4.2.1.1	**Functional impact**	**Operational impact (driver)**	**Impact on**
V_NVKVINT(n)	X		Braking distance
M_NVKVINT(n)	X		Braking distance
N_ITER	X		Braking distance
Q_NVKVINTSET(k)	X		Braking distance
A_NVP12(k)	X		Braking distance
A_NVP23(k)	X		Braking distance
V_NVKVINT(k)	X		Braking distance
M_NVKVINT(k)	X		Braking distance
M_NVKVINT(k)	X		Braking distance
N_ITER(k)	X		Braking distance
V_NVKVINT(k,m)	X		Braking distance
M_NVKVINT(k,m)	X		Braking distance
M_NVKVINT(k,m)	X		Braking distance
L_NVKRINT	X		Braking distance
M_NVKRINT	X		Braking distance
N_ITER	X		Braking distance
M_NVKTINT	X		Braking distance

[2] Impact depends on the use of special values for displaying

6.2 [A.2] List of operational Scenarios

In general, all operational scenarios that are used on both sides of the border are applicable. Scenarios not used in the border area are not to be considered applicable.

The following is an example of list of common operational scenarios.

Normal operation

1. Normal operation (Both directions, Possible asymmetrical, border BG)
   a. Normal passing in FS mode
   b. Normal passing in OS mode
   c. Normal passing in SR mode
   d. Normal passing in SH mode (Shunting movements)
      i. Shunting is not allowed in B2 near border, but is allowed in B3
   e. Normal passing with level transition
      i. Maybe only for trained drivers (specific STM), untrained drivers keep in LNTC
      ii. overlay
   f. Normal passing with mode change
      i. FS->OS
      ii. OS->FS
      iii. FS/OS->SH
      iv. …
   g. Normal passing with SV change
   h. Normal passing with NV change
      i. Slippery track allowance
      ii. Braking curves
      iii. .. all national values with operational impact
   i. National area
      i. Change of unit of speed (km/h vs mph)
   j. Change of RBC
   k. Change of GSM-R radio network
   l. Change of Track conditions
      i. Change of traction system
      ii. Passing a phase lock
      iii. Tunnel
      iv. …..
   m. Change of GSM-R voice radio
   n. Multiple trains
2. Departure (SoM)
   a. Entering Train data
      i. Train categories handling
      ii. Axle load
      iii. Train running number changes
   b. Start of Mission procedure
      i. Known position (time to announce border)
      ii. Known position (no time to announce border)
      iii. Unknown position
      iv. Wrong system connected (GSM-R/RBC)
      v. RBC not able to provide (FS) MA
      vi. Not able to start Handover

        vii. Stop/driver closing desk in handover area
3. Turn back movement combined with SoM
    a. After passing border
    b. Before passing border
    c. Needed for nominal operation (local traffic)
    d. Needed for degraded operation (out of service of an area, failures)
    e. Connection with the right GSM-R network and right RBC
    f. Asymmetrical borders
    g. RBC not able to provide MA
    h. Not able to start HO
4. Performing EoM in border zone
5. Splitting and combining
6. Shortening of MA's in border zone
    a. Cooperative MA revocation
    b. Emergency stops (CES,UES) including revocation
    c. Shorten MA
7. Use of functions outside the ERTMS spec (i.e. by p44)
    a. Door control
    b. …
8. Passing Level crossings
    a. Different operational procedures
    b. Possible connected to systems from other area
9. Hot axle detectors (hot box)
    a. Different operational procedures
    b. Possible connected to systems from other area

Degraded situations

1. Temporary Speed restriction (TSR)
    a. Application
    b. Revocation
2. Handling emergencies e.g. Signal passed at danger
3. Passing procedurally not cleared signal
4. Degraded systems behaviour
    a. Infrastructure
        i. Lost connection between RBCs
        ii. Failure connection between IXLs (influencing RBC-RBC interface)
        iii. Communication failures
        iv. Defective balises
    b. Train borne
        i. Single modem HO
        ii. Loss of connection
5. Stopping a not allowed train

Maintenance

1. Maintenance activities
    a. Out of service periods (planned)
    b. Mode/level for work trains
    c. Entering/exiting work area
2. Possession of line (e.g. by failed train)
3. Key management
    a. Invalid key for specific area

6.3 [A.3] List of implemented/planned Border Crossings

Hereafter follows a list of currently implemented border crossings, or border crossings being designed, that have contributed to the content of this document:

Line				Supported Operating Levels		System Versions			
Line Name	**From (Country)**	**To (Country)**	**Border location**	**From (Operating level/s)**	**To (Operating level/s)**	**From (System Version)**	**To (System Version)**	**Implementation status**	**Notes**
HSL	The Netherlands	Belgium	Meer	Level 2 or Level 1	Level 2 or Level 1	SV 1.0 "230c", compatible with 230d onboards	SV 1.0	2009	Level 2 and Level 1 not operated simultaneously in the Netherlands. In Belgium simultaneously operation is possible. Possibilities: L2->L2; L2->L1; L1->L2; L1->L1
Weert-Neerpelt	The Netherlands	Belgium	Budel	Level NTC ATB (NID_NTC=1)	Level NTC TBL 1+ (NID_NTC=28), Level NTC TBL2/3 (NID_NTC=7), Level NTC TBL1 (NID_NTC=5), Level NTC Memor (NID_NTC=18), Level NTC KVB ((NID_NTC=8)	SV 1.0	SV 1.0	2010	
Roosendaal - Essen	The Netherlands	Belgium	Essen	Level NTC ATB (NID_NTC=1)	Level NTC TBL 1+ (NID_NTC=28), Level NTC TBL2/3 (NID_NTC=7),	SV 1.0	SV 1.0	2009	Planned Level 2+ Level NTC in Belgium

Line				Supported Operating Levels		System Versions			
Line Name	**From (Country)**	**To (Country)**	**Border location**	**From (Operating level/s)**	**To (Operating level/s)**	**From (System Version)**	**To (System Version)**	**Implementation status**	**Notes**
					Level NTC TBL1 (NID_NTC=5), Level NTC Memor (NID_NTC=18), Level NTC KVB ((NID_NTC=8)				
Maastricht-Visé	The Netherlands	Belgium	Eijsden	Level NTC ATB (NID_NTC=1)	Level NTC TBL 1+ (NID_NTC=28), Level NTC TBL2/3 (NID_NTC=7), Level NTC TBL1 (NID_NTC=5), Level NTC Memor (NID_NTC=18), Level NTC KVB ((NID_NTC=8)	SV 1.0	SV 1.0	2009	
Zevenaar-Emmerich	The Netherlands	Germany	Zevenaar -Oost	Level 2	Level NTC LZB (NID_NTC = 9),Level NTC Indusi (NID_NTC =6), Level 0	SV 1.0	SV 1.0	2014	part of RFC1
Oldenzaal - Bad Bentheim	The Netherlands	Germany	Bad Bentheim	Level NTC ATB (NID_NTC=1)	Level NTC LZB (NID_NTC = 9),Level NTC Indusi (NID_NTC =6), Level 0	SV 1.0	SV 1.0	2010	
Coevorden – Laarveld	The Netherlands	Germany	Coevorden	Level NTC ATB (NID_NTC=1)	Level NTC LZB (NID_NTC = 9),Level NTC Indusi (NID_NTC =6), Level 0	SV 1.0	SV 1.0	2010	
Venlo - Kaldenkirchen	The Netherlands	Germany	Venlo	Level NTC ATB (NID_NTC=1)	Level NTC LZB (NID_NTC = 9),Level NTC Indusi (NID_NTC =6), Level 0	SV 1.0	SV 1.0	2010	

Line				Supported Operating Levels		System Versions			
Line Name	**From (Country)**	**To (Country)**	**Border location**	**From (Operating level/s)**	**To (Operating level/s)**	**From (System Version)**	**To (System Version)**	**Implementation status**	**Notes**
Landgraaf–Herzogenrath	The Netherlands	Germany	Herzogenrath	Level NTC ATB (NID_NTC=1)	Level NTC LZB (NID_NTC = 9),Level NTC Indusi (NID_NTC =6), Level 0	SV 1.0	SV 1.0	2010	
Nieuweschans– Ihrhove	The Netherlands	Germany		Level NTC ATB (NID_NTC=1)	Level NTC LZB (NID_NTC = 9),Level NTC Indusi (NID_NTC =6), Level 0	SV 1.0	SV 1.0	2011	
Oresund Link	Denmark	Sweden	Peberholm	Level 2	Level 2	SV 2.0	SV 2.0 *)	planned	*) Swedish SV not yet finally decided. First step may be L2 DK & LNTC SE.
Padborg border	Denmark	Germany	Padborg	Level 2	TBD	SV 2.0	TBD *)	planned	*) German equipment of the border line not yet decided. 1st step maybe PZB overlaid on Level 2 at Padborg. 2nd step L1 LS on German side.
Tønder Border	Denmark	Germany (neg)	Tønder	Level 2	TBD	SV 2.0	TBD *)	planned	*) German equipment of the border line not yet decided. Probably PZB on German side.
Femern Tunnel link	Denmark	Germany	Puttgarden	Level 2	Level 2 *)	SV 2.0	SV 2.0 *)	planned	*) German level on the line not yet confirmed. L1 LS was also a possibility on the German side.
East/West border	Denmark	Denmark	Lillebælt bridge	Level 2	Level 2	SV 2.0	SV 2.0	planned	First step LNTC/L2 (E/W), then L2/L2.
Private lines	Denmark	Denmark	Various	Level 2	Level 0	SV 2.0	N/A	planned	
Temporary transition	Denmark	Denmark	Various	Level 2	Level NTC ZUB 123 (NID_NTC=30)	SV 2.0	N/A	2018	

Line				Supported Operating Levels		System Versions			
Line Name	**From (Country)**	**To (Country)**	**Border location**	**From (Operating level/s)**	**To (Operating level/s)**	**From (System Version)**	**To (System Version)**	**Implementation status**	**Notes**
Ligne 180 000 Uckange - Zoufftgen	France	Luxembourg	Zoufftgen Frontière (P 203,720)	Level 1, STM-KVB (Nid_NTC = 8), STM-RPS (Ni_NTC=32)	Level 1 FS/Level NTC	SV 1.0	SV 1.0	Apr-16	
Ligne 202000 Longuyon - Mont Saint Martin	France	Luxembourg	Mont Saint Martin (P 249,074)	Level 1, STM-KVB (Nid_NTC = 8), STM-RPS (Ni_NTC=32)	Level 1 FS/Level NTC	SV 1.0	SV 1.0	Dec-16	
Ligne 202000 Longuyon - Mont Saint Martin	France	Belgique	Mont Saint Martin (P 249,074)	Level 1, STM-KVB (Nid_NTC = 8), STM-RPS (Ni_NTC=32)	Level 1 NID_NTC 28 (TBL1+) NID_NTC 7 (TBL2) NID_NTC 5 (TBL1) NID_NTC 18 (croco) NID_NTC 8 (KVB) Level 0	SV 1.0	SV 1.0	Dec-16	
L37 Welkenraedt -Aachen	Belgium	Germany	Hergenrath	Level 1 NID_NTC 28 (TBL1+) NID_NTC 7 (TBL2) NID_NTC 5 (TBL1) NID_NTC 18 (croco) NID_NTC 8 (KVB) Level 0	NID_NTC 9 (LZB) NID_NTC 6 (PZB) NID_NTC 28 (TBL1+) NID_NTC 7 (TBL2) Level 0	SV 1.0	SV 1.0	2014	
L162 Arlon - Kleinbettingen	Belgium	Luxembourg	Kleinbettingen (P 207,742)	Level 1	Level 1 FS/ Level NTC	SV 1.0	SV 1.0	01/12/2016	
L167 Athus - Rodange	Belgium	Luxembourg	Athus (P 214,755)	NID_NTC 28 (TBL1+) NID_NTC 7 (TBL2) NID_NTC 5 (TBL1) NID_NTC 18 (croco) NID_NTC 8 (KVB) Level 0	Level 1 FS/ Level NTC	SV 1.0	SV 1.0	01/12/2016	

Line				Supported Operating Levels		System Versions			
Line Name	**From (Country)**	**To (Country)**	**Border location**	**From (Operating level/s)**	**To (Operating level/s)**	**From (System Version)**	**To (System Version)**	**Implementation status**	**Notes**
L165/1 Aubange - Rodange	Belgium	Luxembourg	Aubange (P 141,236)	Level 1	Level 1 FS/ Level NTC	SV 1.0	SV 1.0	01/12/2016	
L42 Gouvy - Troisvierges	Belgium	Luxembourg	Gouvy (P 80,123)	NID_NTC 28 (TBL1+) NID_NTC 7 (TBL2) NID_NTC 5 (TBL1) NID_NTC 18 (croco) NID_NTC 8 (KVB) Level 0	Level 1 FS/ Level NTC	SV 1.0	SV 1.0	01/12/2016	
Basel SBB-Basel Bad. Bhf	Switzerland	Germany	Basel	ETCS L1 LS	ETCS L1 LS / Level NTC PZB (NID_NTC = 9, 6)	SV 2.0	SV 2.0 / Class B	2017	RFC Rhine-Alpine
Hafenbahn-Basel Bad. Bhf	Switzerland	Germany	Basel	ETCS L1 LS	ETCS L1 LS / Level NTC PZB (NID_NTC = 9, 6)	SV 2.0	SV 2.0 / Class B	2017	
Schaffhausen-Erzingen	Switzerland	Germany	Various	ETCS L1 LS	ETCS L1 LS / Level NTC PZB (NID_NTC = 9, 6)	SV 2.0	SV 2.0 / Class B	2017	
Schaffhausen-Singen	Switzerland	Germany	Various	ETCS L1 LS	ETCS L1 LS / Level NTC PZB (NID_NTC = 9, 6)	SV 2.0	SV 2.0 / Class B	2017	
Kreuzlingen-Konstanz	Switzerland	Germany	Konstanz	ETCS L1 LS	ETCS L1 LS / Level NTC PZB (NID_NTC = 9, 6)	SV 2.0	SV 2.0 / Class B	2017	
St. Margrethen	Switzerland	Austria	St. Margrethen	ETCS L1 LS	Level NTC PZB (NID_NTC = 9, 6, 27, 36)	SV 2.0	Class B	2017	
Buchs SG	Switzerland	Austria	Buchs SG	ETCS L1 LS	Level NTC PZB (NID_NTC = 9, 6, 27, 36)	SV 2.0	Class B	2017	

Line				Supported Operating Levels		System Versions			
Line Name	**From (Country)**	**To (Country)**	**Border location**	**From (Operating level/s)**	**To (Operating level/s)**	**From (System Version)**	**To (System Version)**	**Implementation status**	**Notes**
Chiasso	Switzerland	Italy	Chiasso (Monteolimpino 1 e 2)	ETCS L1 LS	Level 2 /Level NTC SCMT	SV 2.0	SV 2.0	planned	RFC Rhine-Alpine
Mendrisio - Varese (FMV)	Switzerland	Italy	Various	ETCS L1 LS	Level NTC SCMT	SV 2.0	Class B SCMT *)	planned	*) according to the request of the TILO RU
Ranzo - Luino	Switzerland	Italy	Pino Tronzano	ETCS L1 LS	ETCS L1 LS	SV 2.0	SV 2.0	2018	RFC Rhine-Alpine
Iselle - Domodossola	Switzerland	Italy	Iselle	ETCS L1 LS	ETCS L1 LS	SV 2.0	SV 2.0	2017	RFC Rhine-Alpine
Genève - Anmasse	Switzerland	France	Anmasse	ETCS L1 LS	Level NTC KVB	SV 2.0	Class B	planned	
(Genève) - La Plaine - Bellegard	Switzerland	France	La Plaine	ETCS L1 LS	Level NTC KVB	SV 2.0	Class B	2017	
Vallorbe	Switzerland	France	Vallorbe	ETCS L1 LS	Level NTC KVB	SV 2.0	Class B	2017	
Les Verrières - Pontarlier	Switzerland	France	Pontarlier	ETCS L1 LS	Level NTC KVB	SV 2.0	Class B	2017	
Le Locle - Col-des-Roches	Switzerland	France	Col-des-Roches	ETCS L1 LS	Level NTC KVB	SV 2.0	Class B	2018	
Boncourt - Delle	Switzerland	France	Delle	ETCS L1 LS	Level NTC KVB	SV 2.0	Class B	2017	
Basel PB - Basel St. Louis	Switzerland	France	Basel-St. Johann	ETCS L1 LS	Level NTC KVB / ETCS L1 FS	SV 2.0	SV 1.1	2017 / planned	RFC North Sea Mediterranean
Brennero - Steinach in Tirol	Italy	Austria	Brennero	ETCS L2	ETCS L2	SV 2.0	SV 1.0	planned	RFC ScanMed
Sezana – Villa Opicina	Italy	Austria	In line	ETCS L1 + radio infill	ETCS L1	SV 2.0	SV 1.0	planned	RFC6 Mediterranean
Wasserbillig - Igel	Luxembourg	Germany	Wasserbillig (P19,163)	ETCS L1 FS	Level NTC PZB	SV 1.0	Class B	2017	

6.4 [A.4] SBB example of border crossing commissioning process

Phases approach

The system change of the automatic train control systems within and at the boundaries of the mixing zone is divided into three phases:

- Phase I: preparation of system change
- Phase II: system change
- Phase III: control of system change

The phases I (preparation of system change) and II (system change) are considered both in the direction of travel from Switzerland as well as from the foreign country in the direction of the mixed zone.

The phase III (control of system change) is only viewed in the direction of travel from the mixed zone towards Switzerland. In the direction of the foreign infrastructure operator, the phase III (control of system change) is not considered in this document. This check must be defined by the foreign infrastructure manager.

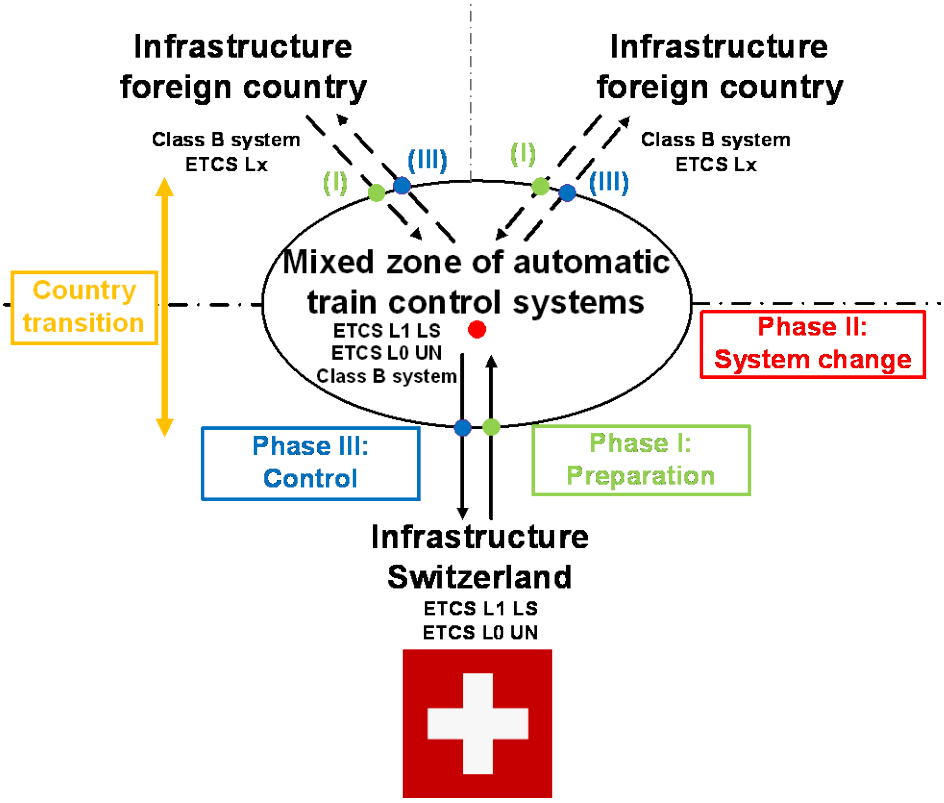


Figure 4 - Overview of phases for transitions near a mixed zone of automatic train control systems

Phase I: preparation of system change

Phase I includes:

- Update of the table of priority
- Provide correct national values
- Provide the correct GSM-R network ID

The table of priority must be prepared for a fast and safe static transition of the train control system. Only the levels permitted in the mixed zone may be transferred to the vehicle.

Phase II: system change:

Phase II includes:

- Static transition for B2 vehicles
- Static or dynamic transition for B3 vehicles

Whether a static or dynamic transition is carried out depends not only on the baseline, but also on the track and catenary configuration as well as on the operating concept.

Phase III: control system change:

Phase III includes:

- Make sure the vehicle runs in the correct ETCS level
- Forced transition to the correct level if the vehicle runs in a disallowed level
- Redundant transfer of the national values respectively ensure that the necessary National Values are available
- Reduction of the Table of Priority to safe levels for outside the mixed zone

It must always be checked that the phase II (system change) of the automatic train control system has been carried out successfully. If this is not the case, the level transition is enforced at this point at the latest.

Information to be transmitted in phase I (depending on the real situation):

- Packet 3 (National Values), according to baseline 2 and/or baseline 3
- Packet 45 (Radio Network registration)
- Packet 46 (Conditional Level Transition Order)
- Packet 145 (Inhibition of balise group message consistency reaction)
- Optionally Packet 203 (National Values for braking curves)

Information to be transmitted in phase II (depending on the real situation):

- Packet 3 (National Values), according to baseline 2 and/or baseline 3
- Packet 41 (Level Transition Order)
- Packet 45 (Radio Network registration)
- Optionally Packet 203 (National Values for braking curves)
- Other packets depending on the level and the mode (e.g. 12 (Level 1 Movement Authority), 21 (Gradient Profile), 27 (international Static Speed Profile), 80 (Mode profile) etc.)

Information to be transmitted in phase III (depending on the real situation):

- Packet 3 (National Values), according to baseline 2 and/or baseline 3
- Packet 41 (Level Transition Order)
- Packet 45 (Radio Network registration)
- Packet 46 (Conditional Level Transition Order)
- Packet 145 (Inhibition of balise group message consistency reaction)
- Optionally Packet 203 (National Values for braking curves)

Location of the balise groups of the phases I to III:

- The balise groups of phase I shall be as close as possible to the edge of the mixed zone of automatic train control systems. That means:
    - The installation should take place in rear of the first signal, which is equipped with more than one automatic train control system
    - All tracks into the mixed zone of automatic train control systems should be fitted with balise groups for phase I
    - The balise groups should not be installed in an area of a station but on a line
    - If a station is located between the balise groups for phase I and the mixed zone of automatic train control systems, the balise groups for phase I shall be installed on both sides of the station

    - The balise groups should not be installed in an area of a shunting yard

- The balise groups of phase II shall be installed within the mixed zone of automatic train control systems. That means:
    - The balise groups should not be installed in an area of a station or in an area with frequent turn back but on a line
    - The installation should take place between a distant and a main signal
    - The balise groups should not be installed in an area of a shunting yard

- The balise groups of phase III shall be as close as possible to the edge of the mixed zone of automatic train control systems. That means:
    - The installation should take place in advance of the last signal, which is equipped with more than one automatic train control system
    - All tracks out of the mixed zone of automatic train control systems should be fitted with balise groups for phase III
    - The balise groups should not be installed in an area of a station but on a line
    - The balise groups should not be installed in an area of a shunting yard

6.5 [A.5] RBC – RBC border when RBC interfaces are not compatible

6.5.1.1 Note: this issue comes from RFI experience on the connection between the two HS L2 lines Milano – Bologna e Bologna – Firenze.

6.5.1.2 It is possible that due to different versions of the RBC (and time constraints) the two RBCs are not compatible through SUBSET-039 interface.

6.5.1.3 As a possible way to realise a fully interoperable solution, the “train supervision transfer function” (referred to Hand Over procedure) can be realised as following (so called Change-over):

- no physical communication between the two RBCs (Handing Over and Accepting); neighbour RBCs don’t know the boundary location; OBUs know the boundary location through a balise group (P131 “RBC Transition order”).
- the two IXLs (Handing Over and Accepting) exchange information concerning an overlapping area (beyond the border)
- the Handing Over RBC sends an MA which covers also the overlapping area thanks to the safe information (to complement the MA) received from the Accepting IXL via the Handing-Over IXL
- specific Balise groups are located on the track for the management of Radio connection sessions (P41) as well as for the transition L2 → L2 at the Change-Over Border.

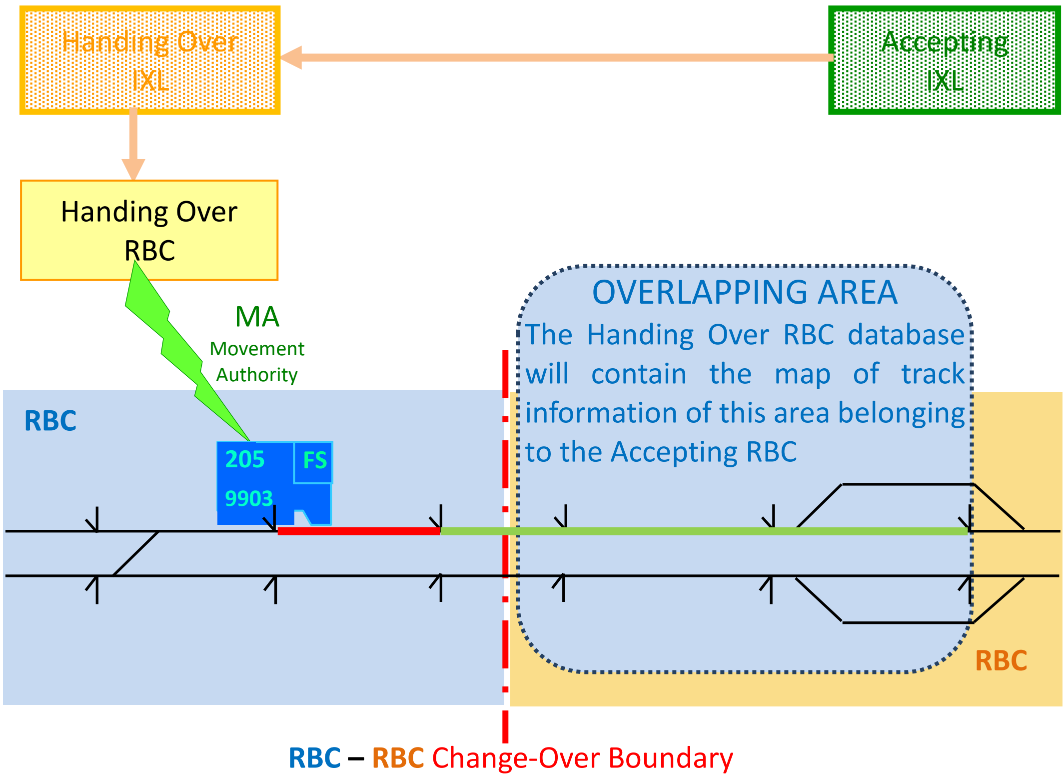


Figure 5 – RBC Handover through IXL interface (Change over)

6.6 [A.6] Methodology to identified the possible issues to be tackled when designing a border area

Here after a proposal of methodology to identify in a structured way the possible issues to be tackled when designing a border area and the relevant tests to be designed.

Step 1: Choose direction: A→B or B→A

Step 2: Fill in right order from top (A) to bottom (B) the first column of the table in Figure 6:

If applicable, for the selected direction, "changes" (borders) initiated by infrastructure ([A.2] can be used as possible check list helping to identify the possible "changes"):

- Mode (SH, FS, LS, OS …..)
- Specifications outside ERTMS (P44)
  - Door control
  - …..
- Level (NTC, L1, L2, L3)
- Track conditions
  - Traction system
  - TSR
  - …..
- RBC (RBC-RBC handover)
- International border
  - Unit of speed (km/h vs mph)
  - Safety regulations
  - Law
- NV
- GSM-R
- Level crossing
  - Operational procedures
  - Connection to systems from other area
- Key
- ….

Step 3: Fill in from left to right (additional columns of the table in Figure 6):

If applicable, for the selected direction, operational scenarios initiated by the train ([A.2] can be used as possible check list helping to identify the possible operational scenarios):

- Normal passing
- Turn back movement
- Start of Mission
- Work / maintenance train
- Traindata
  - Train running number
  - Train category
  - Axle load category

- ….

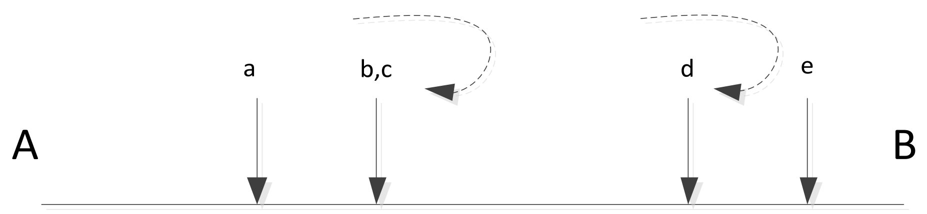
Step 4: Determine geographical position of possible turn back movement within border zone.

Step 5: Determine baseline of trains related to operational scenarios (B2 / B3)

Step 6: Determine possible issues for each cell of the table in Figure 6 that has to be analyzed / solved including degraded scenarios related to infrastructure and trainborne; for example:

- o Lost connection between RBC's
- o Failure connection between IXLs
- o Communication / modem failures
- o Defective balises
- o …..

Example: A →B (numbers refer to possible issues)



A→ B	**Train (operational scenario)**				
Infrastructure border zone	Normal passing (B2/B3)	Turn back movement (B2) (**)	SoM (B2/B3)	Work / maintenance (B2)	Traindata
a. GSM-R	2				
b. RBC handover	5	1,2,3,4	1,2,3,4		8
c. NV change					
d. Level crossing	7			7	
e. International border					
……					

Figure 6 - Table of possible issues to tackle at border crossing

(*) : specifications outside ERTMS are not applicable in above mentioned example.
(**) : turn back movement before a certain location between A and B takes places

Possible issues:

1. Not able to start handover
2. Connection with wrong GSM-R network
3. Connection with wrong RBC

Driver closing desk in HO/announcement area

4. RBC not able to provide MA
5. Invalid key for specific area
6. Different operational procedures
7. Train running number
8. Maybe only for trained drivers (specific STM), untrained drivers remain in LNTC
9. Issues related to overlay
10. Shunting not allowed in B2 near border, but is allowed in B3
11. Level transition / mode change allowed for work trains?
12. …

Individual cells in table refer to known issues in Guideline Border Crossings.

6.7 [A.7] Template of the 2012 Agreement between RFI and SBB on Crossing Border Train Control System between Italy – Switzerland

Memorandum of Understanding (MoU)

between

Rete Ferroviaria Italiana (RFI)

and

Schweizerische Bundesbahnen AG (SBB),

Division Infrastruktur

concerning

Crossing Border Train Control System between Italy – Switzerland

Date: 27th of July 2012, Status: **Final**

1. Preamble

1. In January 2003 the Memorandum of Understanding (MoU) was signed by the Ministers of the four corridor countries namely Italy, Germany, the Netherlands and Switzerland. With the MoU, the International Group for Improving the Quality of Rail Transport in the North-South-Corridor Rotterdam - Genoa (IQ-C) started its work dealing with the aim to further improve the quality and punctuality in international rail freight transport on the Corridor.

2. In March 2006, the Ministers signed – as a result of a mandate of the Ministers to the IQ-C Working Group – the “Letter of Intent ERTMS deployment on Rotterdam – Genoa corridor” (LoI) with the aim to complete the ERTMS/ETCS infrastructure on the corridor 1/A until 2015.

3. In May 2009, the Ministers signed a common declaration in Genoa on the ERTMS corridor 1/A and re-emphasised to implement ERTMS on the corridor by 2015.

4. Referring to the MoU “Accordo tra RFI e SBB Infrastruttura” of 3rd August 2012, with the aim to improve the corporation between RFI and SBB Infrastructure to guarantee the quality and capacity for expected cross border railway traffic.

5. On 16th of April2012, the European commission, the European Railway Agency and the European Rail sector Association (CER –UIC – UNIFE –EIM GSM-R Industry Group – ERFA) signed a MoU concerning the strengthening of cooperation for the management of ERTMS.

6. The present MoU focusses on the procedure for the implementation of trackside Train Control Systems between SBB and RFI on the Corridor1/A.

7. The regulations enacted by the National Security Agencies, Federal Office of Transport (FOT) and Agenzia Nazionale per la Sicurezza Ferroviaria (ANSF) remains unaffected by this MoU.

2. Objectives

1. The present MoU describes the working principles and arrangements for future implementation of Train Control Systems (e.g. ETCS, SCMT, EuroSIGNUM/EuroZUB) at the borders and on border lines between Switzerland and Italy.

2. The purpose of this MoU is to identify the roles and responsibilities of each party as they relate to the implementation of Train Control Systems at the Swiss-Italian border and border lines.

3. In particular, this MoU has the following specific objectives:

   a) to reach a mutual understanding of the detailed targets (topics, results, time line, project organization, scope of work),

   b) to foster collaboration of the project team (at technical and steering committee level),

   c) to support the implementation of Train Control Systems at the border lines Domodossola-Iselle and Luino-Ranzo based on European Train Control System (ETCS) and EuroSIGNUM/EuroZUB technology,

   d) to support the implementation of Train Control Systems (SCMT and ETCS) in Chiasso Station, and

   e) regarding the aims of the agreements of Corridor1/A (Zeebrugge - Antwerp- Rotterdam – Duisburg – Basel - Milano -Genoa), dynamic transition shall be reached,

   f) to support an open and transparent exchange of all project- and system-relevant information, especially where Train Control Systems are of importance, in order to assure the required capacity on the freight Corridors in due time.

4. The following projects, lines and operational points are affected by the implementation of Train Control System upgrade:

#, Projects, Lines, Operational Points	Territory
1. Project Corridor1/A interoperability and capacity	I, CH
2. Implementation of SCMTat Chiasso	CH
3. Line Ranzo-Luino	I
4. Line Iselle-Domodossola	I
5. Line Mendrisio– Varese[3]	I, CH
6. Operational Points Domodossola I and Domodossola II	I
7. Operational Point Luino	I
8. Operational Point Chiasso	CH
I = Italy; CH = Switzerland,	

[3]The line Mendrisio – Varese is not part of Corridor 1/A. This line will be implemented in a separate project group with a solution for a continuous (dynamic) border transition (SIGNUM/ZUB ⇔ SCMT). Anyhow, on this line there will be transitions between ETCS L1 LS and Level NTC SCMT in near future.

3. Working principles and arrangements

SBB and RFI agree on the following working principles and arrangements:

1. Implementation of a safe, available and interoperable Train Control System on their infrastructure respectively border transition by the end of 2015 (change of timetable), in order to fulfil the requests of the Corridor1/A agreement.

2. To provide the required railway transport capacity for freight and passenger transport (in particular Corridor1/A resp. Chiasso-Milano) in due time.

3. Guarantee the implementation of interoperable Train Control Systems (ETCS) on their network by enabling required technology, ensuring financing and providing adapted organisational structures.

4. Non interoperable systems (SCMT, EuroSIGNUM/EuroZUB) will be financed by the infrastructure ordering the respective Train Control Systems.

5. Providing all information needed to analyse and define the train control solutions needed at the border between Italy and Switzerland.

6. Ensure enough manpower to achieve the targets. Mandatory attendance at the project group meetings Corridor1/A for border transition (monthly).

7. Support and coordinate the national authorisation process of solutions and products by the National Safety Agencies (FOT, ANSF).

8. The infrastructure companies take the necessary steps to assure a dynamic transition between their countries. Beforehand the requirements of dynamic transition shall be analysed together.

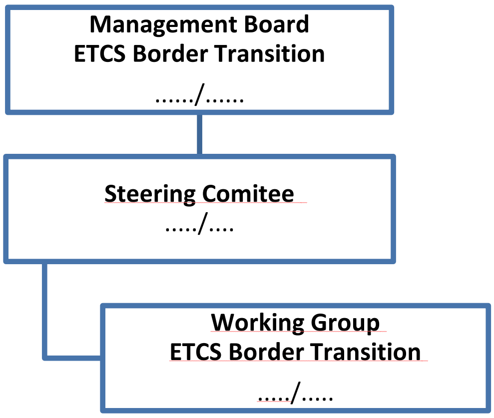
9. Open information by SBB and RFI, in case of changes related to critical parameters of the projects described (such as change of priority, financing, target dates and resources). Exchange of all project- and system-information especially where Train Control Systems are involved or impacted in a way that they could hamper the required capacity on the freight Corridor between Chiasso and Milano.

10. Realization of technical measures (for instance by implementing appropriate levels or modes e.g. ETCS L1 LS, ETCS L1 FS, ETCS L2), which are necessary to guarantee the capacities at cross-border traffic.

11. Support Railway Undertaker for approval of rolling stock.

4. Organization

1. The parties agree on the creation of the following organization of the ETCS Border Transition Group:



2. The Management Board. Superior controlling of overall progress.

3. The Working Group meets periodically. The working group is responsible for the implementation of Train Control Systems according the agreed program. Therefore will be established a Train Control System Project Group. The working group reports to the steering committee and to the management board.

4. The Train Control System Project Group: In order to organize a formal, non-formal and effective exchange of information.

5. Schedule and deliverables

1. In order to achieve the objectives for operational points and lines defined in Chapter 2, the parties mutually agree on the following timelines and deliverables:

#	Task, Description	Deliverables	Date
1	**Requirements and initialisation Phase** **Train Control Systems at borders**	Documents: • Initial Situation • Requirements • Project Plan / Roadmap	…
2	**Conceptual Design Phase,** **Train Control Systems at borders,** conceptual design for the implementation of train control systems based on ETCS atthe borders between Italy and Switzerland (Chiasso, Luino, Domodossola and at the lines Iselle-Domodossola and Ranzo-Luino). Defined ETCS Strategy on Corridor 1/A.	Documents: • Conceptual Design • Implementation Strategy of ETCS at borders.	…
3	**Conceptual Design Phase,** **SCMT in Chiasso** conceptual design for the implementation of SCMT in Chiasso station	Documents: • Conceptual Design • Implementation Strategy	…
4	**Review and Approval of Conceptual Design by the agencies (FOT, ANSF),** Participation of the NSAs in the approval process of the concepts.	Documents: • Conceptsapproved by the NSAs	…
5	**Final Design Phase** **Train Control Systems at borders,** final design for the implementation of train control systems based on ETCS at the borders between Italy and Switzerland (Chiasso, Luino, Domodossola and on the lines Iselle-Domodossola and Ranzo-Luino).	Documents: • Final design • Letter of Intent	…
6	**Final Design Phase** **SCMT in Chiasso,** final Design for the implementation of SCMT in Chiasso.	Documents: • Final design • Letter of Intent	…
7	**Implementation Phase** **Train Control Systems at borders,** Implementation of the ETCS technology, in order to fulfil the requests of the Corridor agreement.	Results: • Implemented and validated ETCS solutions at defined operational points and lines.	…
8	**Implementation Phase** **SCMT in Chiasso,** Implementation of SCMT in Chiasso	Results: • Implemented and validated SCMTsolutions at defined operational points and lines.	…
9	**Implementation of National Value (NV) Balises in Domodossola 2**	Results: • Implemented NV Balises in Domodossola.	…
10	**Analyse the need of the dynamic / continuous transition for the railway operation companies.**	Documents: • Requirements • Conceptual Design • Final Design • Letter of Intent	…

6. Non-binding clause

This MoU is a legally not binding declaration of intent. No rights and obligations shall arise out of this MoU.

Signed in Ascona on 3rd of August 2012.

Rete Ferroviaria Italiana	**SchweizerischeBundesbahnen**