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### ERTMS USERS GROUP - ENGINEERING GUIDELINE

# 67. LEVEL TRANSITION FROM LEVEL NTC TO LEVEL 1 (SYSTEM VERSION 2.Y)

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|---|---|
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## Modification history

| Version | Date | Modification / Description | Editor |
|---------|------|---------------------------|--------|
| 0.1 | 27/10/14 | Guideline transposed to LNTC to L1 system for system version 2.Y<br><br>Based on ERA Guideline "LSTM to L1 transition" | A. Bossy |
| 0.2 | 15/04/15 | Take into consideration of SMc and AJM comments | A. Bossy |
| 0.3 | 01/07/15 | Take into consideration of SMc and AJM comments | A. Bossy |
| 1.0 | 25/01/16 | Final version after quality check | E. Kleine |

# Table of Contents

# 1. Introduction

## 1.1 Introduction

1.1.1.1 The procedure for level transitions is defined technically in chapter 5 of the SRS (see [SS026-B3]) and operationally the harmonised ETCS rules apply (see [OPE]) in addition to national rules. The procedures possible for transitions from level NTC to level 1 are very flexible and currently there are many different ERTMS implementations dealing with this issue.

1.1.1.2 The aim of this document is to define a set of recommended trackside solutions for the engineering of transitions from level NTC to an area only equipped for level 1 with system version 2.Y for the benefit of future ERTMS projects. The objective is to support an efficient and safe implementation of ERTMS, both from a technical and operational point, simplifying and harmonising future system implementations taking advantage of the experience obtained from projects already in operation.

## 1.2 Scope and Field of Application

1.2.1.1 This document is based on ERTMS/ETCS Baseline 3 and applicable for transitions from an area only equipped with ETCS level NTC (where the onboard is using system version 2.Y) to an area only equipped with ETCS Level 1 where system version is 2.Y. See chapter 1.3.

1.2.1.2 Some ERTMS functions, controls or information are considered out of scope of this document because they are not directly related to the transition procedure:

- The route suitability check in rear of a level 1 area depends on many local issues such as national procedures, national rules, type of unsuitability, geographical location of the unsuitability and places to stop trains if not suitable. Thus, the route suitability function is considered out of scope for this document.

- Track conditions information is considered as general information to be sent to the train independent of the transition and thus out of scope for this document.

1.2.1.3 Preventing trains that are not fitted with ERTMS/ETCS onboard equipment from entering the ETCS Level 1 area is out of the scope for this document.

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

## 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 | [ERA-LSTM-L1] | This guideline |
| 2.Y | [EUG_72] | This guideline |

*Table 1: System version management*

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

1.3.1.3    However; 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 when approaching the level transition

– Onboard system supporting version 1.Y and 2.Y, with active system version 2.Y when approaching the level transition

## 1.4    Definitions

1.4.1.1    ETCS approach area: The area in rear of the ETCS border where balise groups are located to facilitate the transition to ETCS Level 1

1.4.1.2    ETCS area: The area in between ETCS borders with infrastructure for trains running in ETCS levels 1, 2 or 3

1.4.1.3    ETCS border: The location where the ETCS level is changed

1.4.1.4    On-sight route: A locked route which is not unambiguously detected free

## 1.5    Document structure

1.5.1.1    Chapter 1 introduces the document and defines the scope.

1.5.1.2    Chapter 2 provides references, terms and abbreviations used in this document.

1.5.1.3    Chapter 3 provides the general functional steps for transition to level 1.

1.5.1.4    Chapter 4 provides the criteria assessed for the recommendations.

1.5.1.5    Chapter 5 provides the recommendations for each functional step.

## 2. References and Abbreviations

### 2.1 Abbreviations

| Abbreviation | Description |
|---|---|
| ATP | Automatic Train Protection (national systems) |
| BG | Balise Group |
| DMI | Driver Machine Interface |
| EoA | End of Authority |
| FS | Full Supervision (ETCS mode) |
| LRBG | Last Relevant Balise Group |
| L1 | ERTMS/ETCS Level 1 |
| LNTC | ERTMS/ETCS Level NTC |
| LTA | Balise group for Level Transition Announcement |
| LTC | Balise group for Level Transition Cancellation |
| LTO | Balise group for Level Transition Order |
| MA | Movement Authority |
| OS | On-sight (ETCS mode) |
| P | Packet, e.g. P41 is ETCS packet 41 |
| SoM | Start-of-Mission; procedure for start-up of an ERTMS/ETCS train |
| NTC | Specific Transmission Module (for national ATP systems) |
| SvL | Supervised Location |
| TSR | Temporary Speed Restriction |

## 2.2 References

2.2.1.1 The following documents and versions apply:

| Ref. N° | Document Reference | Title | Version |
|---|---|---|---|
| [OPE] | TSI OPE Annex A | Annex A, TSI OPE, 2012/464/EC, ERTMS Rules and Principles | 3 |
| [SS041] | SUBSET-041 | Performance Requirements for Interoperability | 3.1.0 |
| [SS026-B3] | SUBSET-026 | ERTMS/ETCS Class 1 System Requirements Specification | 3.4.0 |
| [SS026-B2] | SUBSET-026 | ERTMS/ETCS Class 1 System Requirements Specification | 2.3.0 |
| [SS108] | SUBSET-108 | Interoperability-related consolidation on TSI annex A documents | 1.2.0 |
| [ERA-LSTM-L1] | ERA_040058 | LEVEL TRANSITION FROM LEVEL STM TO LEVEL 1 | 1.0 |
| [EUG_72] | EUG_72 | LEVEL TRANSITION FROM LEVEL STM TO LEVEL 1 | Last official version |

# 3. Transition from Level NTC to Level 1

## 3.1 Introduction

3.1.1.1 This chapter intends to give a general overview of how to perform a transition from level NTC to level 1 and can be used as a reference for the issues discussed in chapter 4. The track layout and sequence diagram presented here are further detailed in chapter 5. with alternative solutions as applicable for each functional step

## 3.2 Functional Steps

3.2.1.1 In order to facilitate the recommendations detailed in chapter 5 4.2.19, the transition to ETCS Level 1 is divided into the following functional steps:

    1)        Level 1 announcement

    2)        Level 1 transition

## 3.3 General Track Layout

3.3.1.1 The following drawing shows the general and relevant track design and balise groups needed to perform the functional steps of the transition from level NTC to level 1 listed in paragraph 3.2.1.1.
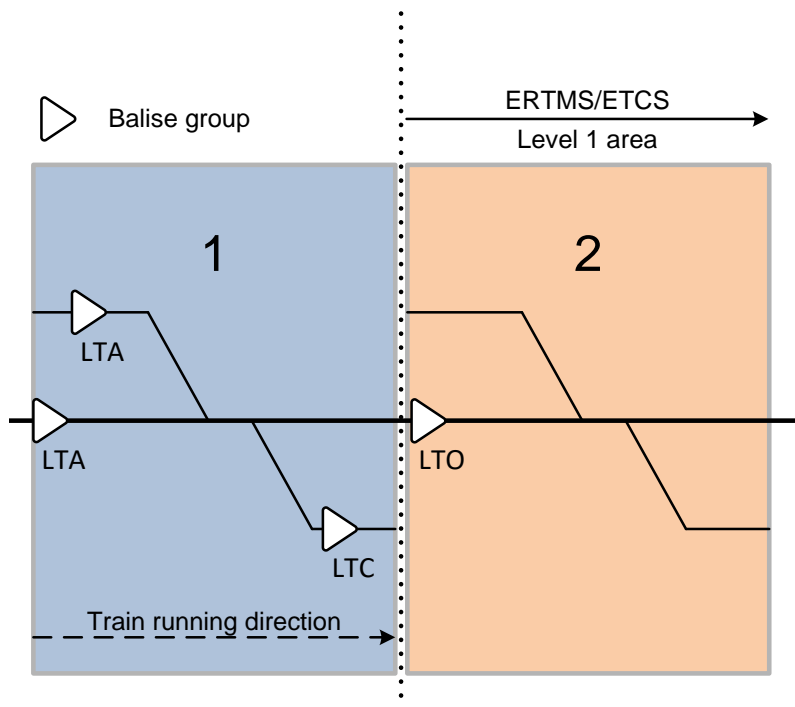


**Figure 1: Generic track layout for transition from LNTC to L1**

3.3.1.2 There are intentionally no optical signals or marker boards shown in the figures as they are not relevant for the transition procedure as such from a technical point of view. Optical signals and marker boards are useful for degraded situations related to level transition, as described in [OPE].

3.3.1.3 The train approaching the ETCS border needs to get a Movement Authority and track description before or at the border; otherwise it will be tripped when making the transition to level 1. This information can be given either together with the announcement or at the ETCS border or in a balise group in between. These options are detailed in sections 5.1 and 5.2.

3.3.1.4 The table below represents the balise groups and information (in ETCS packets) recommended for each functional step to succeed with a transition from level NTC to level 1. Optional and alternative balise groups and packets will be suggested in chapter 5.

| BG | BG DESCRIPTION | BG INFORMATION (ETCS PACKETS) |
|---|---|---|
| LTA | Level Transition Announcement | Packet 41: Level Transition Order announcing the coming transition to level 1 at the ETCS border |
| LTC | Level Transition Cancellation | Packet 41: Level Transition Order with immediate transition to the level applicable in that area; this cancels the announced transition to level 1 |
| LTO | Level Transition Order | Packet 41: Level Transition Order (with immediate transition to level 1) Packet 12: Level 1 Movement Authority (together with applicable packets) |

**Table 2: Balise groups for transition from LNTC to L1**

3.3.1.5 The information in the balise groups in the figures is only valid in the indicated train running direction, unless defined otherwise.

3.3.1.6 Balise group LTA announces the transition to level 1. Announcing the transition to level 1 is not required by the ERTMS/ETCS SRS [SS026-B3] and using this is a project decision. However, there are advantages in informing the driver in advance and in specifying an acknowledgement window; as it allows for more time than 5 seconds to acknowledge the level transition, see [SS026-B3] 5.10.4.

3.3.1.7 Balise group LTC is needed for cancelling a level transition order in case there are diverging tracks between the LTA and the ETCS border. Alternatively, the LTC can be left out if the LTA has a switchable balise with the transition announcement depending on route locking; this is elaborated in 5.1.2.7 and 5.1.2.8. In that case, the LTA may also send Level 1 Movement Authority to the train.

3.3.1.8 Balise group LTO is located at the ETCS border; it orders the immediate transition to ETCS Level 1 and provides a Level 1 MA with linking (optional) and track description.

## 3.4 General Sequence Diagram

The following sequence diagram shows the relevant information that is exchanged between the main actors when performing the transition to ETCS Level 1 according to the functional steps listed in 3.2.1.1 above.
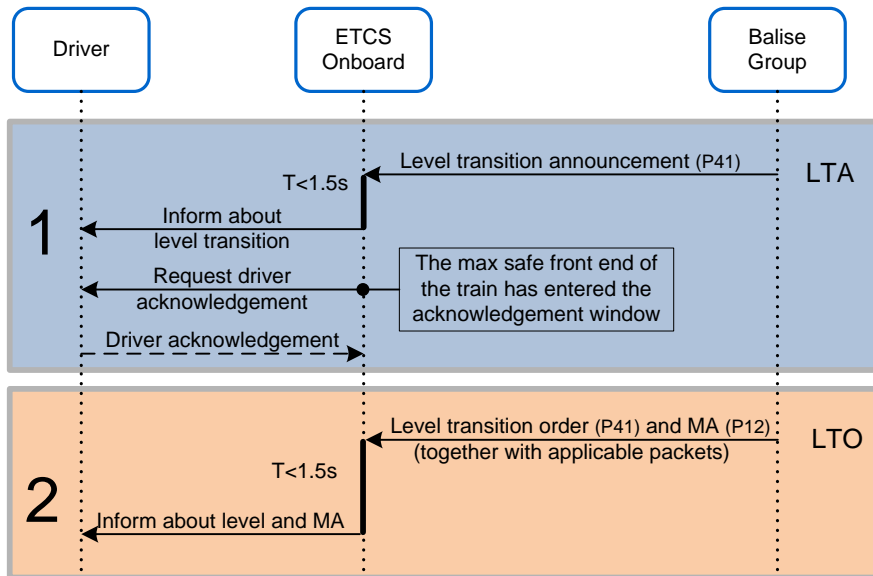
**Figure 2: General sequence diagram for transition from LNTC to L1**

3.4.1.1 T is the time needed by the ERTMS/ETCS onboard equipment to process the information received from a balise group before presenting it on the DMI according to [SS041] 5.2.1.3.

3.4.1.2 The arrow for driver acknowledgement is 'dashed' as it is not absolutely needed because the level transition will take place also without it. The driver can acknowledge before the level transition is executed (from the location specified in the transition announcement) or at latest 5 seconds after the transition (see [SS026-B3] 5.10.4.2); i.e. in step 1 or 2.

# 4. Issues to be addressed

## 4.1 Introduction

4.1.1.1 This chapter lists issues that need to be considered for the transition from level NTC to level 1 and some of them are further detailed in the recommendations given in chapter 5. The issues that are not part of the recommendations are mentioned here because projects could still need to consider them.

## 4.2 Issues

### 4.2.1 Entry location determination

4.2.1.1 For a successful announcement of the transition to ETCS Level 1, it is essential that the trackside system is able to determine at which ETCS border location an approaching train will enter. It is also necessary to determine the entry location if providing the L1 Movement Authority already in rear the border. This issue depends on the track layout in the area in rear of the ETCS border and is considered in section 5.1.

### 4.2.2 First entering train determination

4.2.2.1 For a safe transition to ETCS Level 1, it is essential that there is no other train entering at that border location. This must cover multiple track occupations by vehicles on the approach to the ETCS border; e.g. when driving on-sight or splitting trains before the border.

4.2.2.2    This issue is in principle solved by the fact that a train should not receive an authorisation from a balise group unless this is safe. This is an issue for the interlocking system and not further considered in chapter 5.

4.2.2.3    Note that in case the replacement of the authorisation depends on track detection being located far from the balise group, then measures have to be taken to avoid that a following train may receive the same authorisation as a preceding train.

### 4.2.3    Loss of route protection in the route from the ETCS border

4.2.3.1    There must be a safe reaction in case one or more conditions supervised to protect the route in advance of the ETCS border fail; e.g. due to unexpected track occupations.

4.2.3.2    The system that detects the loss of route protection is responsible to take action trying to resolve the hazardous situation for an affected train, e.g. by changing the authorisation from balise groups as controlled by the interlocking. As this has an impact on the Movement Authority, this issue is considered in section 5.2.

### 4.2.4    Manual cancellation of the route from the ETCS border

4.2.4.1    In case the route from the ETCS border is cancelled manually for operational purposes (e.g. for preferred vehicle movements, change of departure sequence, etc.), an already given authorisation must be revoked.

4.2.4.2    To cover for the case of a lost balise message in the balise group at the border, a Movement Authority given to a train outside the ETCS area with EoA inside the ETCS area can be limited in time by specifying a section timeout for the MA. If the timeout expires the train will shorten the MA to the location of the border. The section timeout must be defined considering the operational needs.

4.2.4.3    This issue has no direct impact on the transition procedure and is not further considered in chapter 5.

### 4.2.5    Avoid contradiction between line side and cab signalling

4.2.5.1    Unclear or overlapping responsibilities of two signalling systems can give different and contradicting signalling information to the driver. This could be caused by different delays, different signalling principles (e.g. speed signalling / distance to go), different track information, different odometers, etc.

4.2.5.2    This issue is avoided by synchronisation of the involved signalling systems or a clear split of responsibility at the ETCS border.

4.2.5.3    This issue has no impact on the transition procedure and is not further considered in chapter 5.

### 4.2.6    Authorisation across the ETCS border

4.2.6.1    The authorisation for the train to pass the ETCS border is the responsibility of the national system; this is a project issue and therefore not considered in chapter 5.

### 4.2.7 Allow level transition at line speed

4.2.7.1 Trains approaching the ETCS area should not face speed restrictions caused by the transition procedure to ETCS Level 1, e.g. limitations in length of movement authority.

4.2.7.2 When the conditions in the Level 1 area allows it, the underlying signalling system has to provide proceed information to the level 1 trackside system being long enough to avoid ETCS braking until reaching the next balise group with MA extension.

4.2.7.3 This is not further considered in chapter 5 as each project must decide for which situations the level transition should be possible at line speed and make the additional provisions for that.

4.2.7.4 Note that this is partly an engineering issue for the first blocks in the ETCS area as the speed monitoring in the ERTMS/ETCS onboard may be more restrictive than for the national system area. Thus, it might not be possible to approach the ETCS border at the line speed allowed in that area unless the first block section in the ETCS area is long enough to avoid an immediate brake intervention after making the transition to level 1.

### 4.2.8 Allow transition with On-sight route to and/or from the ETCS border

4.2.8.1 The possibility for a train to approach the ETCS border in an On-sight route on a track which is not detected clear may cause problems for determining if it is the correct train that enters the ETCS area.

4.2.8.2 Considerations for approaching the ETCS border in an On-sight route are further detailed in section 5.2.

4.2.8.3 For an On-sight route from the ETCS border, the driver could be requested to acknowledge both the OS mode and the level transition at the same time. This is avoided by announcing the level transition with a distance in rear of the border where the driver is requested to acknowledge the transition; i.e. by separating the requests in time as mentioned in 5.1.1.6.

4.2.8.4 For an On-sight route starting shortly in advance of the border, there is a risk that the train will be braked after the transition to level 1 due to the onboard supervising the start of the OS mode profile as EoA/SvL. As it may not be possible to move the start of the On-sight route/area further from the border, this can instead be solved by engineering the start of the OS profile at the ETCS border, but then the national system or national rules must consider this in the authorisation for passing the ETCS border. This issue is not further considered in chapter 5.

### 4.2.9 Avoid transition announcements for diverging trains

4.2.9.1 Vehicles moving in the ETCS approach area should not receive a level transition announcement (which has to be displayed to the driver) or be forced to make a level transition unless they are routed to the ETCS border. This issue is considered in section 5.1.

4.2.9.2 Note that the announcement is optional, but if the announcement is given in a fixed balise group then it must be cancelled for a diverging train before the level transition is performed onboard and preferably before the driver is requested to acknowledge the level transition.

4.2.9.3 This problem can be avoided if using a switchable balise to announce the level transition only if the train is routed towards the ETCS border.

### 4.2.10 Driver acknowledgement of level transition

4.2.10.1 The driver will be requested to acknowledge the transition to level 1, except if the onboard is in non-leading (NL) mode. This request to acknowledge can appear either at a certain distance in rear of the border (if specified in the level transition announcement) or when switching level at the border.

4.2.10.2 The distance in rear of the border can be seen as a certain time before making the transition considering the applicable line speed and the announcement must be transmitted in rear of the required acknowledgement distance/time, including the required processing time of the level transition announcement. If the driver is not required to acknowledge in rear of the border, the distance is set to zero.

4.2.10.3 When requested to acknowledge the driver should do so at latest 5 seconds after making the transition, as otherwise the train will be braked; see [SS026-B3] 5.10.4.2.

4.2.10.4 This issue is considered in section 5.1 together with the announcement, i.e. in step 1, even if the driver acknowledgement may be done in step 2.

### 4.2.11 Start of mission in rear of the ETCS border

4.2.11.1 ERTMS/ETCS trains always have the possibility to perform start-of-mission in the area before the ETCS border, but the selection of ETCS level(s) and national systems is limited by a table of priority of trackside supported levels if available onboard the train. This table is assumed to contain only the applicable level and hence the train is assumed to start in level NTC in rear of the ETCS border.

4.2.11.2 As the start-up location may have impact on receiving a transition announcement, this issue is further considered in section 5.1.

### 4.2.12 Avoid displaying "Entry in FS/OS" to the drivers

4.2.12.1 This issue depends on the fact that the ETCS onboard does not have track description for the full length of the train. It can be solved by giving the track description from a location in rear of the border considering the longest train expected to enter at this border location.

4.2.12.2 This issue is further considered in chapter 5.1. But, there is no general solution as it depends on the actual track layout. For the onboard to accept the track description, the transition to L1 must be announced before or together with the track description.

4.2.12.3 Note that the display of "Entry in FS/OS" is not limited to the level transition and in level 1 it will also appear after start-of-mission.

### 4.2.13 Minimise the use of switchable balises

4.2.13.1 The use of switchable balises should be minimised due to the extra costs, e.g. for cabling, compared with a fixed balise. But, for level 1 they cannot be completely avoided even if it is possible to engineer this level transition without switchable balises in rear of the ETCS border. Therefore, this is not further discussed in chapter 5.

### 4.2.14 Minimise the size of the ETCS approach area

4.2.14.1 For the transition to ETCS Level 1, the approach area is between the transition announcement and the level border.

4.2.14.2 There are only two relevant parameters for this issue; the time given for the driver to acknowledge the level transition at the applicable line speed and the maximum train length if requested to avoid displaying "Entry in FS/OS" to the driver. The optimal size of the approach area is project specific and therefore not further discussed in chapter 5.

### 4.2.15 Management of TSRs in the area in advance of the ETCS border

4.2.15.1 The systems on both sides of the ETCS border must be aware of speed restrictions having an impact on the train speeds. It is always possible to transmit TSRs to ETCS onboard from balise groups after announcing the level transition. Note that braking curves may differ between ETCS and the national ATP.

4.2.15.2 This has no impact on the transition procedure and is not further considered in chapter 5.

### 4.2.16 Management of National Values

4.2.16.1 The ERTMS/ETCS train that enters the ETCS area should have the correct National values stored onboard. This can be achieved by transmitting them from a balise group and is noted in section 5.3.2.

4.2.16.2 For system versions 1.1 and 2.0, national values concerning braking curves are used. The location of the transmission of national values shall also avoid potential brake application due to the change in the braking curves. This topic is project specific and is not considered in chapter 5.

### 4.2.17 Avoid transition to Trip mode at the ETCS border

4.2.17.1 When announcing a level transition, the train will make the transition to level 1 after travelling the indicated distance to the ETCS border; if it then has no Movement Authority it will change to Trip mode.

4.2.17.2 This can be avoided either by giving MA when announcing the level transition or by engineering the announced distance so that the train makes the transition when reading the border balise group which then also gives the relevant MA.

4.2.17.3 This issue is further considered in section 5.1.

4.2.17.4 Note that harmonised operational rules for degraded situations related to level transitions are available in [OPE].

### 4.2.18 Manual level selection in rear of the ETCS border

4.2.18.1 The train driver may manually select level when the train is at standstill. In case the L1 MA is given in rear of the border and level 1 is available for manual selection (in the table of trackside supported levels or with no table onboard), the driver could change to level 1 already in rear of the border and use the MA in the transition buffer to move in the level NTC area.

4.2.18.2 This is potentially unsafe and it is advised to start in level NTC close to the ETCS border for operational reasons because the train is in the national ATP area and should apply the operational rules for that area.

4.2.18.3 This issue is avoided either by not giving the L1 MA in rear of the border or by updating the table of trackside supported levels with a Packet 46 Conditional Level Transition Order not including level 1 in a balise group in rear of the LTA balise group (assuming that the LTA announces the transition and gives MA).

4.2.18.4 Note that Packet 46 should not be read from balises after a train has received an announcement by Packet 41, because this may cancel the announcement as the onboard behaviour is unclear on this in ERTMS/ETCS Baseline 2.

4.2.18.5 This issue is considered for the option when a L1 MA is provided together with the level transition announcement as described in 5.1.1.10.

### 4.2.19 Allow transition with Limited Supervision route from the ETCS border

4.2.19.1 If necessary, it should be possible to allow, , trains to transition to L1 Limited Supervision at the ETCS border.

4.2.19.2 The conditions to allow a transition to the Limited Supervision mode are project specific, this topic is therefore not managed in chapter 5.

### 4.2.20 Avoid overlapping acknowledgements

4.2.20.1 If the approaching train is to transition to L1 On Sight at the ETCS border, this this could result in two overlapping acknowledgements, one for the level transition and one for the entry in OS.

4.2.20.2 If the approaching train is to transition to L1 Limited Supervision at the ETCS border; this could result in two overlapping acknowledgements, one for the level transition and one for the entry in LS.

4.2.20.3 Two overlapping acknowledgements could lead to the application of service brake due to the second acknowledgement request not fulfilled.

4.2.20.4 Two overlapping acknowledgements could lead to a "subconscious" acknowledgement by the driver, and therefore the operational rules of the entered mode and/or level may not be applied.

4.2.20.5  This topic is managed in 5.1.1.6

### 4.2.21 Shunting and Passive Shunting

4.2.21.1  Level transition orders received in Shunting and Passive Shunting are stored and applied after switching to another mode. (see [SS026-B3] § 4.4.8.1.5). This means an EVC equipped in M_VERSION 2.Y system crossing the border in SH or PS will apply the transition.

4.2.21.2  However, the shunting movement could be operated with an active NTC system without SH nor PS mode. The EVC would then ignore eventual "Danger for Shunting" information. The L1 area shall be equipped with the appropriate NTC shunting protection devices.

4.2.21.3  If no appropriate NTC shunting protection device can be implemented, and if the transition shall not be operated in SH of PS, "Danger for Shunting" information shall be transmitted together with immediate level transition order. (See [13] in 4.8.3 of [SS026-B3])

4.2.21.4  The subject is NTC specific and therefore not managed in chapter 5.

### 4.2.22 Protect movement of trains equipped with system version 1.Y only

4.2.22.1  A train using an EVC only supporting version 1.Y of ETCS and running in L0 or LSTM upstream LTA and LTO will ignore level transition information transmitted by these BG. In this situation, the train could run in the L1 without any protection.

4.2.22.2  If trains equipped with system version 1.Y of ETCS and NTC system shall also be allowed to run on the L1 line, the L1 area shall also be equipped with any necessary NTC equipment required to ensure safety. This topic is NTC specific and is therefore not developed in chapter 5.

4.2.22.3  If trains equipped with system version 1.Y of ETCS and NTC system shall not be allowed to run on the L1 line, any necessary protection (e.g. transition to L1 Trip using baseline 2.Y balise group or NTC Trip device) shall be implemented. This topic is project specific and is therefore not developed in chapter 5.

### 4.2.23 Ensure all trains supporting system version 2.Y can enter the L1 area

4.2.23.1  All trains managing system version 2.Y shall be allowed in the L1 area at full speed, including train approaching the ETCS border with active system version 1.Y.

4.2.23.2  According to 3.17.2.3 of [SS026-B3], when reading a BG with system version 2.Y, and the active version is 1.Y, the onboard shall switch to version 2.Y.  Applying recommendations of chapter **Error! Reference source not found.** covers this issue.

# 5. Recommended solutions

## 5.1 Level 1 Announcement

### 5.1.1 Basic considerations

5.1.1.1 Functional step 1 is about the process to announce the transition to level 1 before passing the ETCS border. It is recommended to announce this level transition even if it is not required in the ERTMS/ETCS SRS; see [SS026-B3] 5.10.1.1.

5.1.1.2 The following issues from chapter 4 must be considered in this functional step:

- Entry location determination
- Allow transition with On-sight route to and/or from the ETCS border
- Avoid transition announcements for diverging trains
- Driver acknowledgement of level transition
- Start of mission in rear of the ETCS border
- Avoid displaying "Entry in FS/OS" to the driver
- Avoid transition to TRIP mode at the ETCS border
- Manual level selection in rear of the ETCS border

5.1.1.3 The recommendation is to have a balise group LTA announcing the transition to ETCS Level 1. This has the following benefits:

- The driver is alerted about the upcoming level transition
- Possibility to configure the driver acknowledgement of the level transition to be requested in rear of the ETCS border
- Redundancy for the level transition order at the ETCS border

5.1.1.4 Note that when performing start-of-mission in rear of the border, receiving an announcement depends on the location where the train starts.

5.1.1.4.1 Note that if a balise group LTA is used, it is recommended, when possible, to locate the ETCS approach area so that there are no points between LTA and LTO. This minimizes the use LTC balises groups if needed, and reduces the need for switchable BG.

5.1.1.5 When announcing the level transition, an additional benefit is that the onboard will accept MA, linking and track description in rear of the border. This gives the possibility to avoid displaying "Entry in FS/OS" to the driver by providing track description, if the distance to the ETCS border is enough for the longest train.

5.1.1.6 The announcement should specify the driver acknowledgement of the level transition to be requested in rear of the border. This has the added benefit that there will be no concurrent requests for driver acknowledgement in case of an On-sight route or LS starting at the border.

5.1.1.7 When using fixed balises for LTA, depending on the track layout, it may require additional LTC balises for cancellation of the transition order for trains diverging from the ETCS border. Depending on the track layout, it may also be possible to give track description to avoid displaying "Entry in FS/OS" to the driver.

5.1.1.8 In case the LTA balise group can have a switchable balise, then there are the following independent options:

- The announcement can differ between routes towards the border, thus providing the entry location, avoiding announcements to diverging trains and minimising the need for cancellation balise groups.
- The announcement can depend on having a route locked from the border.
- To avoid transition to Trip mode at the ETCS border, the LTA balise group can also provide a Movement Authority to pass this border.
- To avoid displaying "Entry in FS/OS" to the driver, the LTA balise group can provide route-dependent linking and track description, with or without MA.

5.1.1.9   If providing MA already in rear of the ETCS border, it is recommended to use section timers to limit the possibility to use this MA in case changes to the routes make it invalid, e.g. if new route setting leads the train to divert from the ETCS border. This MA may also need to consider restrictions in the route in rear of the border and the general recommendation on using linking in 5.3.1.3.

5.1.1.10  In case the LTA provides a L1 MA it could be necessary to have a balise group in rear of the LTA with a packet 46, Conditional Level Transition Order, to update the table of trackside supported level not listing level 1. This is to prevent the driver from selecting level 1 in rear of the border, but that can also be mitigated by giving the MA with a restrictive speed up to the border; the speed profile should then be given without train length delay to avoid unnecessary braking.

5.1.1.11  The choice of system version for LTA shall depend on the system version used inside the L1 area.

5.1.1.12  Note: the use of system version 2.Y (M_VERSION = 2.Y) for LTA and LTO will not prevent trains only fitted with system version 1.Y to enter the L1 area, this topic is addressed in chapter 4.2.22. According to [SS026-B2], §3.17.3.12 a train only fitted with system version 1.Y reading a BG with system version = 2.Y shall not be tripped when in level 0 or level STM.

### 5.1.2   Track layout

5.1.2.1   The need for balises in this functional step depends on the track layout. The level transition can be announced independent of the presence of diverging routes, but then the transition must be cancelled for trains routed away from the border.

5.1.2.2   In case of diverging tracks near the ETCS border, it is recommended to avoid announcing a level transition to trains that will not pass the ETCS border as this may be confusing to the train driver when seen on the DMI. This is achieved by placing the LTA after the last diverging points; thus there is no need for any cancellations.

| TRACK LAYOUT | BG | DESCRIPTION | BG INFORMATION |
|---|---|---|---|
| Solution with fixed LTA balises<br><br>Option with switchable balises | LTA | Level Transition Announcement | Packet 41: Level Transition Order announcing transition to level 1 at the location of the ETCS border<br><br>Packet 12: Level 1 MA (optional) (together with applicable packets) |
| | LTC | Level Transition Cancellation (if needed) | Packet 41: Level Transition Order with immediate transition to the applicable level; this cancels the transition to level 1 |
| | LTO | Level Transition Order | See section 5.2 for details about the content of LTO balise group |

**Table 3: Balise groups used for functional step 1**

5.1.2.3 Note that in the track layout above, the solutions consider the case when the LTA balise group cannot be placed after the last diverging points as this would be too close to the border for the required time for driver acknowledgement.

5.1.2.4 Balise group LTA announces the transition to ETCS Level 1. The announcement gives the distance to the level border and the distance in rear of the border where the driver is requested to acknowledge the transition. In case the transition should be performed when reading the LTO balise group, then the level transition order in the LTA should announce the transition for a location in advance of the border at the LTO. This is because the ERTMS/ETCS onboard equipment will otherwise make the transition according to the travelled distance of the estimated front end of the train and this depends on the actual accumulated odometer inaccuracy. In that case the announced location must consider the possible accumulated odometer inaccuracy near the border. Optionally, the LTA is switchable and gives a Movement Authority with linking information and track description; see 5.1.1.8.

5.1.2.5 The parameter for placing the LTA balise group announcing the level transition is the time given for the driver to acknowledge the level transition before the ETCS border. The minimum distance D1 should be calculated using this time together with the time T from section 5.1.2.8 below and the applicable line speed. In case there are multiple tracks leading

to the ETCS border then the distance D1 may need to be calculated for each track based on its own specific speed profile. In case there is need to avoid displaying "Entry in FS/OS" to the driver, then the distance D1 must also consider the longest train operating on this line.

5.1.2.6    Note that if start-of-mission is common in rear of the ETCS border, then this may need to be considered for the location of the LTA as otherwise the train will not receive the level transition announcement; alternatively, a redundant LTA can be placed closer to the border at a location fulfilling a distance D1 for a lower speed.

5.1.2.7    Balise group LTC cancels the transition to ETCS Level 1. If needed, the LTC is put in tracks diverging from the route leading to the ETCS border and must be located so that the transition is cancelled before being executed after travelling the announced distance, preferably even before the driver is requested to acknowledge the level transition. Note that this location must also consider the accumulated odometer inaccuracy onboard the train.

5.1.2.8    Balise group LTC is needed when a route to the border can be cancelled after the transition announcement. This applies also if the LTA giving the announcement is switchable.
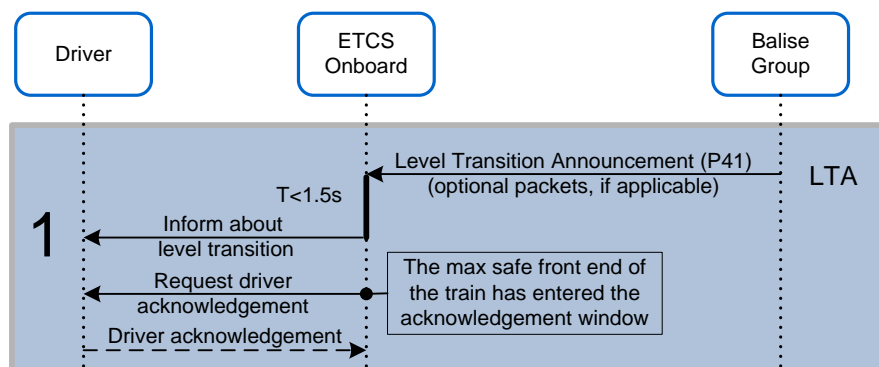
### 5.1.3    Sequence diagram



**Figure 3: Sequence diagram for step 1**

5.1.3.1    T is the time needed by the ERTMS/ETCS onboard equipment to process the information received from the LTA balise group before presenting it on the driver DMI according to [SS041] 5.2.1.3.

5.1.3.2    The arrow for driver acknowledgement is 'dashed' as it is not absolutely needed because the level transition will take place also without it. The driver can acknowledge before the level transition is executed (as specified in the transition announcement) or within 5 seconds after the transition (see [SS026-B3] 5.10.4.2); i.e. in step 1 or 2.

### 5.1.4    Alternative solution

5.1.4.1    The alternative solution is not having any announcement as it is anyway not required by the ERTMS/ETCS SRS [SS026-B3]. The benefit from this is that:

- there is no announcement for trains diverging from the ETCS border;
- the behaviour is the same after performing start-of-mission at different locations in rear of the border (otherwise announcements in some places);
- depending on track layout, costs for one or more balise groups can be saved.

5.1.4.2 The disadvantages of not having the announcement are that:

- drivers only have 5 seconds for acknowledgement after the level transition;
- drivers will always see the "Entry in FS/OS" on the DMI;
- there is no redundancy for the level transition order;
- with an On-sight route from the border, the driver will be requested to acknowledge both the level transition and the OS mode at the same time.

### 5.1.5 Degraded situations

5.1.5.1 This functional step has the following degraded situations:

1. Failure to read the LTA balise group
2. Failure to read the LTC balise group

5.1.5.2 The consequence of degraded situation 1 is that the train driver will not be informed about the upcoming level transition. This can be mitigated by repeating the information in other balises, but as there is no requirement in the ERTMS/ETCS SRS [SS026-B3] to announce transitions to level 1, the need for this mitigation has to be decided by the actual project.

5.1.5.3 The consequence of degraded situation 2 is that the train will make the level transition after travelling the announced distance and trip if it has no MA. This can be mitigated by repeating the LTC information in other balises or by having the announcement in a switchable balise.

## 5.2 Level 1 Transition

### 5.2.1 Basic considerations

5.2.1.1 The following recommendations are related to functional step 2; i.e. the transition to ETCS Level 1.

5.2.1.2 The following issues from chapter 4 must be considered in this functional step:

- Loss of route protection in the route from the ETCS border
- Allow transition with On-sight route to and/or from the ETCS border

5.2.1.3 It is recommended to use a switchable balise group providing the MA with linking (optional) and track description together with the immediate level transition order to level 1. This has the following advantages:

- The MA can be updated (reduced or extended) depending on changes in route statuses, thus solving the issues of loss of route protection.
- It is possible to approach the ETCS border in On-sight routes and still get a FS MA from the LTO depending on information of the replacement track.
- Trains can start-up at any location in rear of the ETCS border as the MA is given in the LTO balise group.

5.2.1.4 In case the Movement Authority is not available at the ETCS border, then it must be given from a balise group in rear of the border. The alternatives are to give this in the LTA balise group announcing the level transition or in another balise group in between the announcement and the border.

5.2.1.5 The choice of system version for LTO shall depend on the system version used inside the L1 area.

5.2.1.6 Note : the use of system version 2.Y (M_VERSION = 2.Y) for LTA and LTO will not prevent trains only fitted with system version 1.Y to enter the L1 area, this topic is addressed in chapter 4.2.22. According to [SS026-B2], §3.17.3.12 a train only fitted with system version 1.Y reading a BG with system version = 2.Y shall not be tripped when in level 0 or level STM.

## 5.2.2 Track layout

| TRACK LAYOUT | BG | DESCRIPTION | BG INFORMATION |
|---|---|---|---|
|  ERTMS/ETCS Level 1 area  2  LTO | LTO | Level Transition Order | Packet 41: Level Transition Order (immediate transition to Level 1)  Packet 12: Level 1 MA (together with applicable packets) |

**Table 4: Balise group used for functional step 2**

5.2.2.1 Balise group LTO is switchable and located at the ETCS border; it orders immediate transition to ETCS Level 1 and provides a Level 1 MA with track description and optionally linking and mode profile depending on the actual route status.
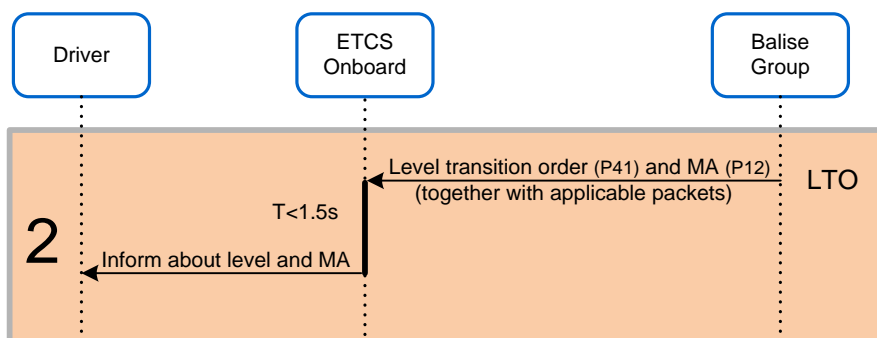
## 5.2.3 Sequence diagram



**Figure 4: Sequence diagram for step 2**

5.2.3.1 T is the time needed by the ERTMS/ETCS onboard equipment to process the information received from the LTO before presenting it on the driver DMI according to [SS041] 5.2.1.3.

5.2.3.2 Note that after the transition to ETCS Level 1, the NTC may still have access to the brake system for some time until it is in state Cold Standby and may therefore need access to

information from the national system. As the NTC is not in the scope of this guideline, this is not further considered here.

### 5.2.4 Alternative solution

5.2.4.1 The alternative is to have the LTO as a fixed balise group with only a Level Transition Order. The benefit of this is that the border location can be more flexible as it does not need to be located at a signal.

5.2.4.2 The alternative solution has the following disadvantages:

- the LTA balise group or an additional balise group between the LTA and the LTO must be switchable (to be able to give the MA; see also 5.1.1.9);
- there is no possibility to give or update (reduce or extend) the MA in the LTO, thus it is not recommended to stop or perform start-of-mission between balise groups LTA and LTO as this may lead to using override to be able to enter the level 1 area;
- there is need for additional measures to determine the first entering train and to handle On-sight routes to the ETCS border as otherwise the train may need to continue in OS mode in the first route.

### 5.2.5 Degraded situations

5.2.5.1 This functional step has the following degraded situation:

1. Failure to read the LTO balise group

5.2.5.2 This may result in that a train can continue in LNTC for some (infinite) distance. An ERTMS/ETCS train shall be in level 1 in a level 1 area, so it is recommended to mitigate this failure by announcing the level transition in the LTA balise group or by repeating the transition order in another balise group in advance of the border, thus having a redundant solution. It could be partly mitigated by having the balises in the LTO duplicated.

5.2.5.3 Note that this degraded situation may also have impact on the Movement Authority. This is especially important if an MA has been given together with the transition announcement and there is a need to revoke it in the LTO; in this case the LTO should be linked with a restrictive linking reaction which will be applied after the train has executed the level transition. But this is a general engineering issue for balises in a level 1 area and it is not further detailed here.

## 5.3 General Recommendations for Transition to Level 1

### 5.3.1 Balises

5.3.1.1 The balise groups in the ETCS approach area must consist of at least two balises for the information in them to be valid in a defined direction.

5.3.1.2 In case there is problem with big metal masses near the ETCS border, this could have an impact on placing of the LTA balise group.

5.3.1.3 If providing MA in the LTA balise group, it is recommended to have the LTO balise group and any balise group located between LTA and LTO marked as linked and included in linking

information given together with the MA. This is to have the relocation of information taken from the transition buffer based on accurate reference locations.

### 5.3.2    National Values

5.3.2.1    The ERTMS/ETCS train entering the ETCS area should have the correct National Values stored onboard. The National Values for the level 1 area must be given at the latest at the ETCS border. It may also be necessary to provide another set of National Values in rear of the border, e.g. the time and distance for the validity of using override to pass the ETCS border.

5.3.2.2    Note that if giving National Values for the ETCS area in a balise group in rear of the ETCS border, then the National Values may need to be changed if the train moves away from the ETCS area.