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# ERTMS/ETCS – Class 1

# RADIO IN-FILL FFFS

REF    :    SUBSET-046
ISSUE :    2.0.0
DATE  :    30-03-00

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| Company | Technical Approval | Management approval |
|---|---|---|
| ADTRANZ | | |
| ALCATEL | | |
| ALSTOM | | |
| ANSALDO SIGNAL | | |
| INVENSYS RAIL | | |
| SIEMENS | | |

# 1. MODIFICATION HISTORY

| Issue Number Date | Section Number | Modification / Description | Author |
|---|---|---|---|
| 0.0.1 15-Sep-99 | All | Creation | M. Ferrettino |
| 1.0.0 13-Oct-99 | All | Final issue | M. Ferrettino |
| 1.1.0 21-Jan-00 | All | Updating to SRS 2.0.0 | M. Ferrettino |
| 1.1.1 8-Mar-00 | All | Update according to ECSAG comments. Issue for discussion | A. Chiappini M. Ferrettino |
| 1.1.2 13-Mar-00 | 4, 7 and 8 | Update according to received comments | A. Chiappini M. Ferrettino |
| 1.1.3 15-Mar-00 | 7 and 8 | Update according to received comments | A. Chiappini M. Ferrettino |
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| 2.0.0 30-03-00 | References § 3.2 | Final Issue to ECSAG | D. Degavre (Ed) |

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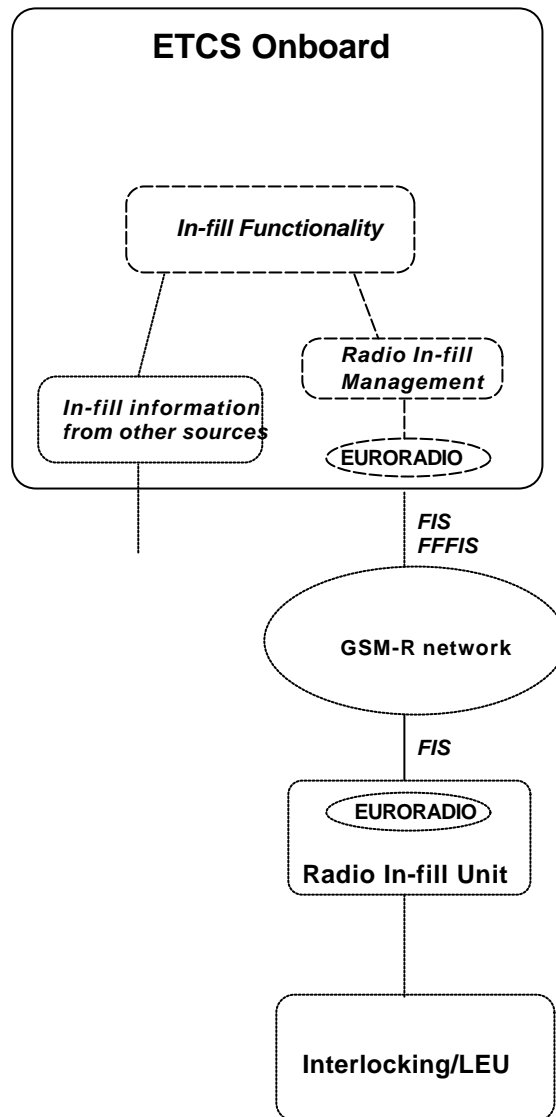
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# 3. GENERAL ASPECTS

## 3.1 Scope

3.1.1.1    This document contains the Form Fit Functional Specification of Radio In-fill Subsystem.

3.1.1.2    The purpose of this documents is to define the set of functional and interface requirements necessary to allow the Radio In-fill Subsystem to perform the functions required by the ERTMS system.

## 3.2 References

[1]    ERTMS/ETCS Class 1 "SRS Chapter 2 Basic System Description" – issue 2.0.0 – 22.12.1999

[2]    ERTMS/ETCS Class 1 "SRS Chapter 3 Principles" – issue 2.0.0 – 22.12.1999

[3]    ERTMS/ETCS Class 1 "SRS Chapter 7 ERTMS/ETCS language" – issue 2.0.0 – 22.12.1999

[4]    ERTMS/ETCS Class 1 "SRS Chapter 8 Messages" – issue 2.0.0 – 22.12.1999

[5]    ERTMS/ETCS Class 1 "Trackside-Trainborne FIS for Radio In-fill" – issue 2.0.0 – 30.03.00

[6]    ERTMS/ETCS Class 1 " Trainborne FFFIS for Radio In-fill" – issue 2.0.0 – 30.03.00

# 4. INTRODUCTION

4.1.1.1    This section is only a general description of the main principles of Radio In-fill. The requirements are contained in chapter "Functions".

4.1.1.2    The Radio In-fill Subsystem operates on Level 1 lines and provides signalling information in advance with respect to the next main signal in the train running direction.

4.1.1.3    The Radio In-fill Subsystem is composed of on-board functionality and by one or more trackside parts (named Radio In-fill Unit, RIU).

4.1.1.4    Each RIU is related to a set of balise groups at a main signal (the set can include one or more balise groups).

4.1.1.5    Each RIU is able to manage the communication for Radio In-fill with more than one train at a time.

4.1.1.6    Note: in any case, if more than one train is in the same block section, only the first one will be able to receive in-fill information (in fact the following ones will not be in Full Supervision and will ignore the order to contact the Radio In-fill Unit).

4.1.1.7    Since the communication protocol and network used is the same as for Level 2/3 operations (EURORADIO, connection oriented), no broadcast communication is performed by a RIU. A RIU is able to manage different point-to-point communication with different trains.

4.1.1.8    The Radio In-fill Subsystem uses the same Key Management as used for Level 2/3 operations (EURORADIO).

4.1.1.9    No communication between different RIUs is required.

4.1.1.10    The establishment of a communication session for Radio In-fill does not change the operational level of the on-board equipment, i.e., the information in the  balises are always taken into account as usual in Level 1.

4.1.1.11    The Radio In-fill Unit will never call a train. The train always initiates the establishment of the communication session.

4.1.1.12    Figure 1 shows the functional architecture of a Radio In-fill Subsystem with the related interfaces.

4.1.1.13    From the point of view of communication, no additional requirements are foreseen, since Radio In-fill Subsystem use the same interface protocols and communication network specified for EURORADIO.

4.1.1.14    Only a functional interface with LEU/Interlocking is necessary, in order to acquire the signalling information associated with the next main signal.

## ETCS Onboard

In-fill Functionality

Radio In-fill Management

In-fill information from other sources

EURORADIO

*FIS*
*FFFIS*

GSM-R network

*FIS*

EURORADIO

**Radio In-fill Unit**

**Interlocking/LEU**

# 5. FUNCTIONS

## 5.1 Sending Radio In-fill area information from trackside to train

5.1.1.1    A special order to establish/terminate a communication session with a Radio In-fill Unit (RIU) shall be sent to a train entering in a Radio In-fill area.

5.1.1.2    The orders shall be sent via balises.

5.1.1.3    The order to establish/terminate a communication session shall contain:

    a)    RIU identifier (NID_RIU)

    b)    phone number of the RIU

    c)    action to be performed (establish/terminate communication session)

    d)    location where the action is to be performed (referred to the balise containing the order)

    e)    next main balise group identifier (this piece of information shall be ignored by the on-board equipment, if the action is "terminate")

5.1.1.4    According to [3], packet type 133 "Radio In-fill area information" shall be used.

5.1.1.5    The order to establish a communication session shall be ignored by the onboard equipment:

    a)    if it is not in Full Supervision (FS)       or

    b)    if it is not equipped with radio

## 5.2 Communication session establishment from train to RIU

5.2.1.1    The communication session shall be established using the same protocols and interfaces as for Level 2/3 operations.

5.2.1.2    If the order to establish a communication session with a RIU is received by an on-board equipment connected with another RIU, the existing session shall be terminated and the new one shall be established (one Mobile Terminal only is required for In-fill).

5.2.1.3    If the communication session with the indicated RIU already exists, it shall be maintained (no action).

5.2.1.4    In case of accidental disconnection of the communication link with the RIU, the train shall try to re-connect.

## 5.3 In-fill request transmission from train to RIU

5.3.1.1 After the radio communication session has been established the onboard equipment shall transmit a request for in-fill information to the RIU.

5.3.1.2 The information sent to the RIU by the on-board equipment shall include:
- a) train identity
- b) identifier of the next main signal balise group
- c) time stamp
- d) train position report

5.3.1.3 According to [4], message 153 "Radio In-fill request" shall be used.

5.3.1.4 The onboard equipment shall send cyclically the in-fill request until the first in-fill MA is received from the RIU (regardless of the content).

5.3.1.5 The cycle time shall be configurable. A typical value can be 10 seconds.

5.3.1.6 The same message 153 "Radio In-fill request" shall be used to inform the RIU:
- a) when the next main balise group indicated in the order is read (therefore the train is exiting the Radio In-fill area for current balise group)
- b) when the on-board equipment detects that the next main balise group has been missed

5.3.1.7 In case of accidental disconnection of the communication link with the RIU, the train shall try to re-connect and send a new request for in-fill information Attempts of re-connecting shall be stopped when
- a) the next main balise group is read or its location is passed    or
- b) an order to terminate the communication session with the Radio In-fill Unit is received (i.e., found in a balise)    or
- c) an order to contact another Radio In-fill Unit is received

## 5.4 In-fill MA from RIU to train

5.4.1.1 As soon as the RIU is informed that a train has entered an in-fill area, it shall terminate any previous transmission of in-fill information to that train.

5.4.1.2 Justification. This is useful in case the message informing that the train has exited a previous in-fill area was lost.

5.4.1.3 The RIU shall transmit cyclically to the train the in-fill MA corresponding to the MA currently sent by the next main balise group indicated in the information from the on-board equipment.

5.4.1.4 The cycle time shall be configurable. A typical value can be 5 seconds

5.4.1.5 The MA shall be acquired from the LEU/Interlocking through the related interface.

5.4.1.6    In addition to the in-fill information the message from the RIU shall include:

a) the identifier of LRBG

b) time stamp (expressed in train time). In fact the in-fill MA could also contain time limited MA section. For this reason a time stamp, indicating the initial validity of the information, is needed. The RIU knows the train time stamp from the previous in-fill request.

5.4.1.7    According to [4], message 37 "In-fill MA" shall be used.

5.4.1.8    The RIU shall terminate the sending of in-fill information as soon as information is received that the on-board equipment has read the next main balise group indicated in the order or that it has detected that it was missed.

5.4.1.9    Moreover the RIU shall terminate the sending of in-fill information in case of disconnection (initiated by the train or accidental).
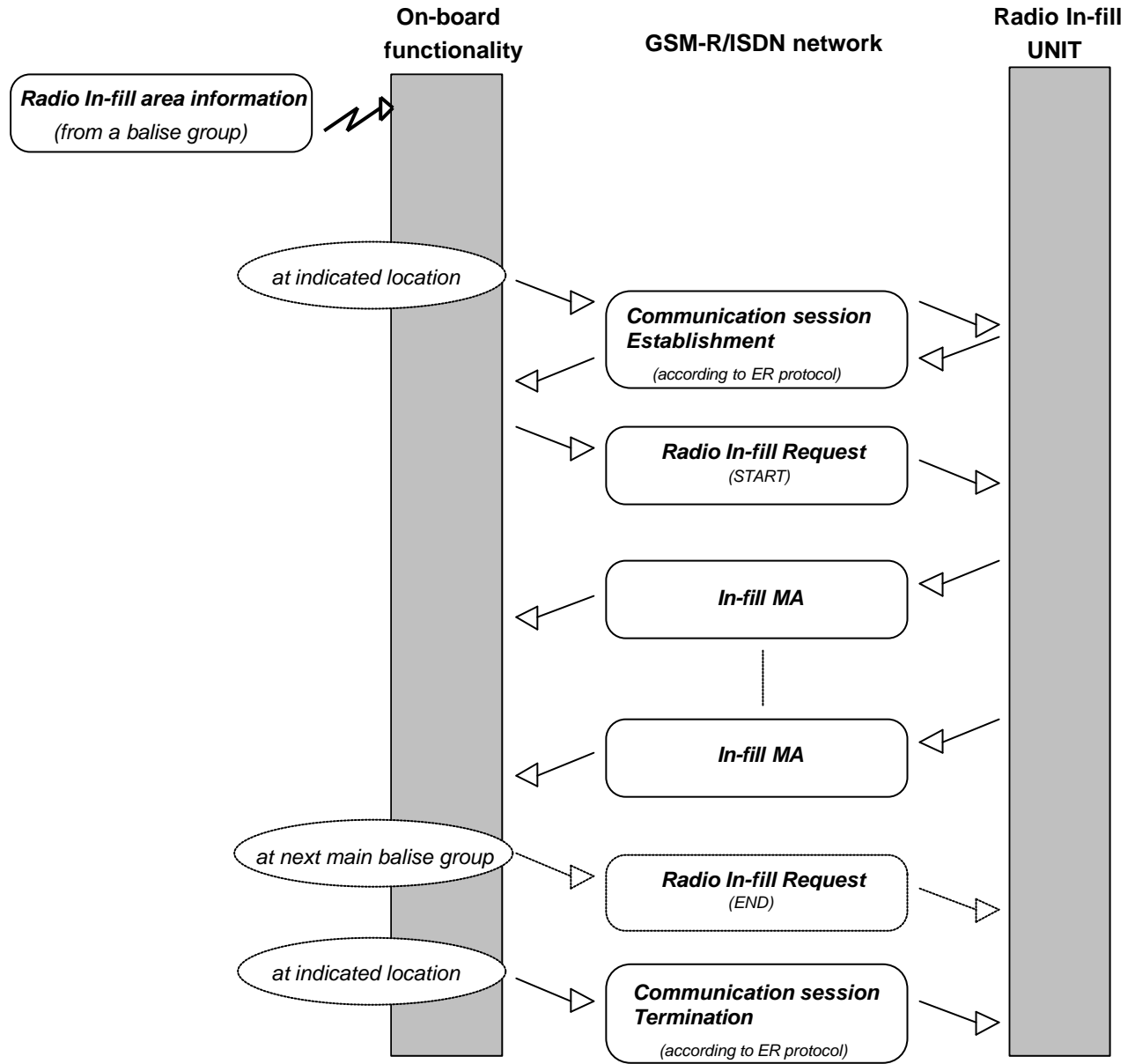
## 5.5  Evaluation of In-fill MA by the on-board equipment

5.5.1.1    The on-board equipment shall use the received In-fill MA according to [2].

5.5.1.2    When the on-board equipment reads the next main group balise (i.e. the train is exiting from the in-fill area) or when it detects that the next main balise group was missed, new in-fill information possibly received shall be ignored.

## 5.6  Communication session termination from train to RIU

5.6.1.1    The on-board equipment shall terminate the communication session according to the orders received from the trackside (balise group).

5.6.1.2    It shall use the same protocols and interfaces as for Level 2/3 operations (EURORADIO).
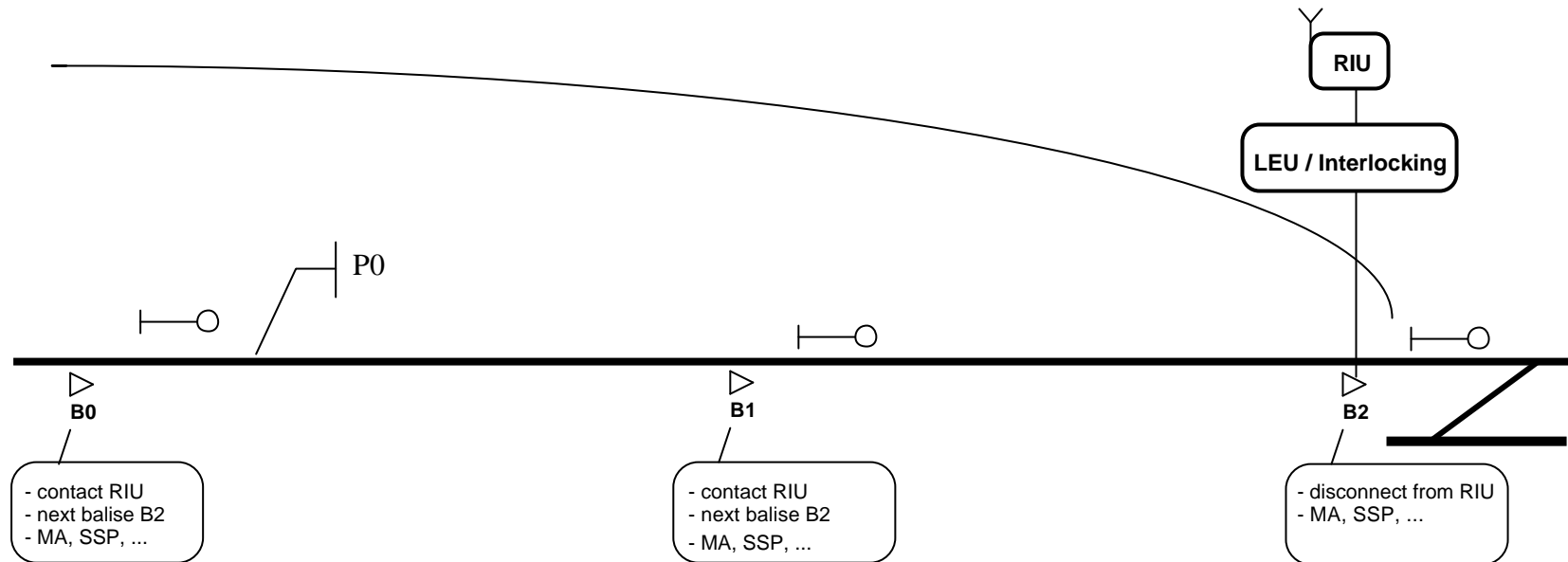
# 6. EVENT DIAGRAMS (TYPICAL)

| On-board functionality | GSM-R/ISDN network | Radio In-fill UNIT |
|---|---|---|

**Radio In-fill area information**
*(from a balise group)*

*at indicated location*

**Communication session Establishment**
*(according to ER protocol)*

**Radio In-fill Request**
*(START)*

**In-fill MA**

**In-fill MA**

*at next main balise group*

**Radio In-fill Request**
*(END)*

*at indicated location*

**Communication session Termination**
*(according to ER protocol)*

# 7. APPLICATION EXAMPLES

## 7.1 Example 1

### 7.1.1 General

7.1.1.1 This example shows the use of radio in-fill to increase safety in case of a signal installed very close to the danger point (no possibility of defining a safe release speed).

7.1.1.2 In this example the length of a block section is shorter than the braking distance of a train at line speed.

7.1.1.3 Also the end of communication with the RIU with an order to terminate the communication session immediately is described.

## 7.1.2  Procedure



RIU

LEU / Interlocking

P0

B0

B1

B2

- contact RIU
- next balise B2
- MA, SSP, ...

- contact RIU
- next balise B2
- MA, SSP, ...

- disconnect from RIU
- MA, SSP, ...

7.1.2.1      It is assumed that the signal at B2 is red.

7.1.2.2      When passing on B0, the on-board equipment receives a MA with EOA and DP at the B2 signal (i.e., release speed = 0) and the order to establish immediately a communication session with the RIU ( i.e., the distance indicated is 0).

7.1.2.3      At the location P0 the communication session is established.

7.1.2.4      As soon as the communication session is established, the on-board equipment sends a "radio in-fill request" message

7.1.2.5      As soon as the request is received, the RIU starts sending in-fill information

7.1.2.6      Assuming that the signal at B2 remains red, when passing on B1 the on-board equipment receives a MA with EOA and DP at the B2 signal and the order to establish immediately a communication session with the RIU. Being the communication session already

established, it is maintained. The on-board sends therefore immediately a "radio in-fill request" message to the RIU.

7.1.2.7     The RIU continues to send in-fill information

7.1.2.8     As soon as the in-fill information extends the MA, the train can proceed

7.1.2.9     When passing on B2, the on-board equipment receives the order to terminate immediately the communication session with the RIU. The on-board equipment terminates immediately.

7.1.2.10    As soon as the communication session is terminated, the RIU stops sending in-fill information

## 7.2  Example 2

### 7.2.1  General

7.2.1.1     This example shows the use of radio in-fill to increase the performance of a line.

7.2.1.2     The line considered is a "medium" traffic line, with "long" block sections (e.g., their length can be equal to the braking distance and, therefore, a train spacing of about two times the braking distance).

7.2.1.3     This kind of implementation is cost effective (few signals and balise groups) but has the disadvantage that, if  a train is a little late in exiting from a block section, it is necessary that the following one initiates a braking and passes the next signal (possibly at the release speed), to receive a new more permissive MA. In-fill can improve performances.

### 7.2.2  Procedure
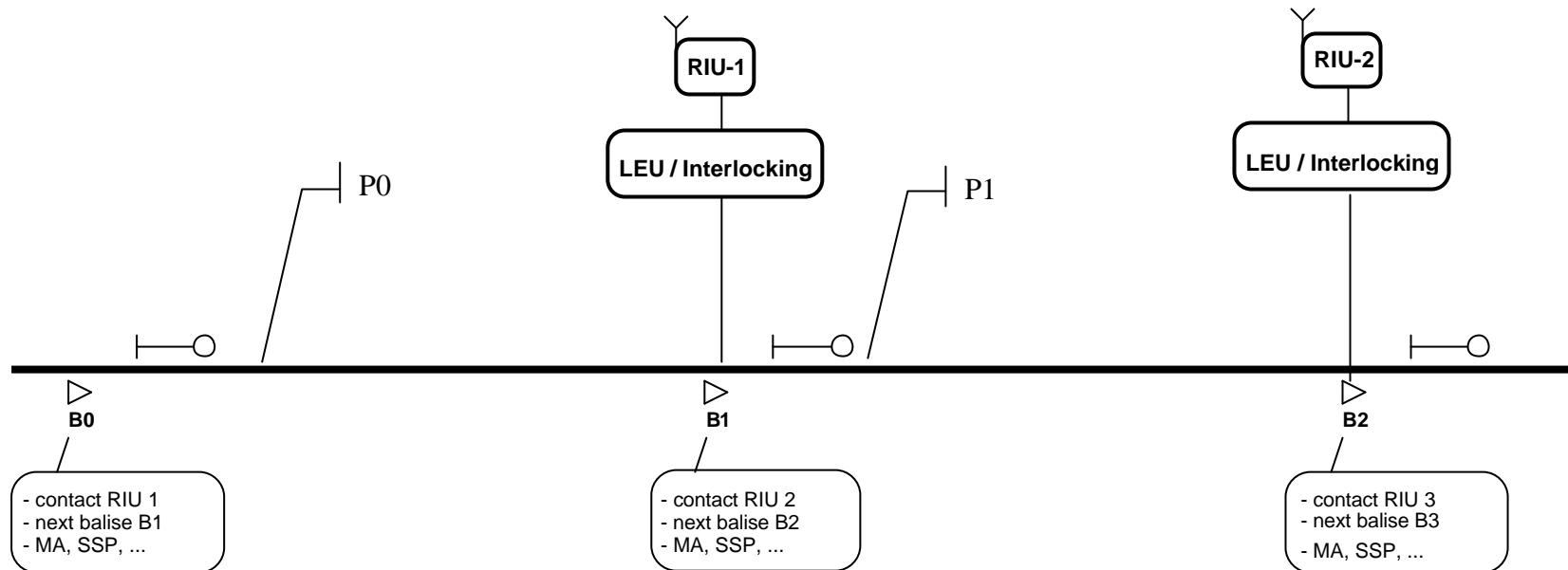


7.2.2.1    Main signal balise groups are used to send in-fill area information.

7.2.2.2    When passing on B0, the on-board equipment receives the order to establish immediately a communication session with the RIU-1. It is also informed that the ID of the next main balise group is B1.

7.2.2.3    *A*t the location P0 the on-board can send the "radio in-fill request".

7.2.2.4    The RIU-1 sends then cyclically in-fill information related to B1

7.2.2.5    When passing on B1, the on-board equipment receives the order to establish a communication session with the RIU-2. It is also informed that the ID of the next main balise group is B2. The on-board terminates immediately the communication session with RIU-1 and initiates the establishment of the communication session with the RIU-2.

7.2.2.6    When the communication session is terminated, the RIU-1 stops sending in-fill information

7.2.2.7    The on-board is able to send a "radio in-fill request" at the location P1.

7.2.2.8    The RIU-2 sends then cyclically in-fill information related to B2

## 7.3  Example 3

### 7.3.1  General

7.3.1.1    This example shows a possible improvement of performances, with respect to the previous case, if two (or more) consecutive main signal balise groups are connected to the same LEU and RIU.

7.3.1.2    Also the end of communication with the RIU with an order to be executed at a distance from the balise group is shown.

### 7.3.2  Procedure
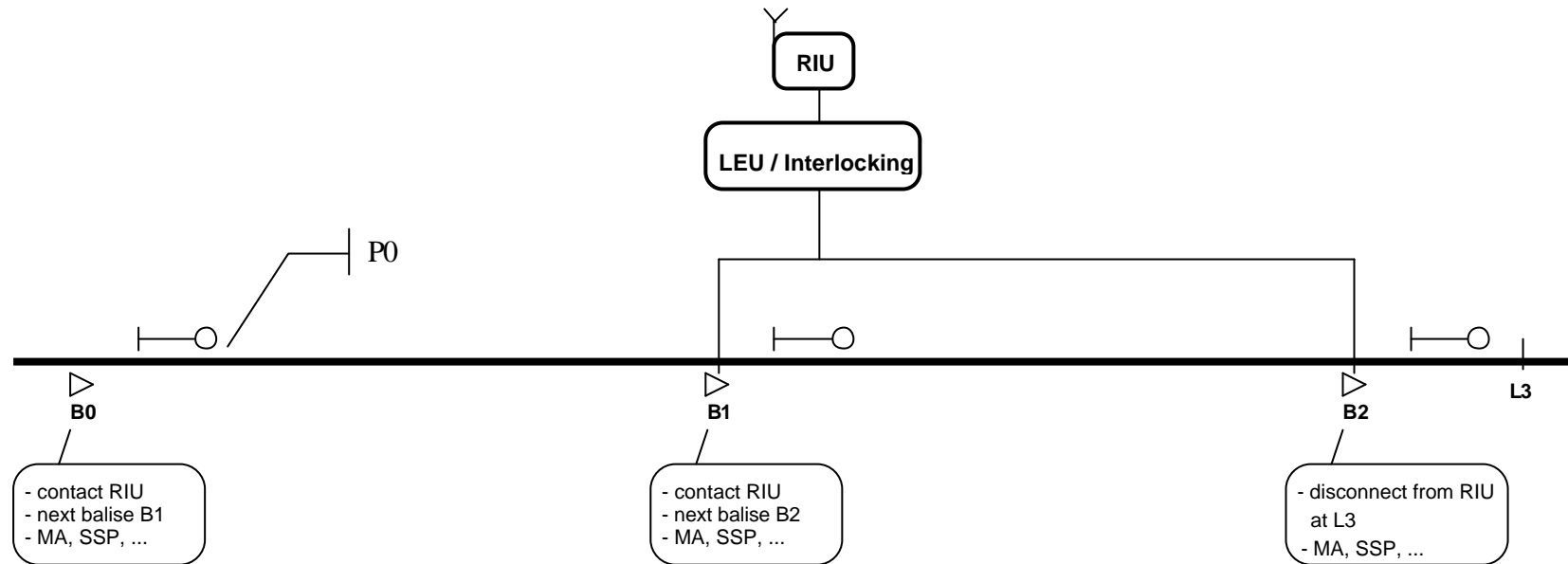


7.3.2.1　When passing on B0, the on-board equipment receives the order to establish immediately a communication session with the RIU. It is also informed that the ID of the next main balise group is B1.

7.3.2.2　At the location P0 the on-board can send the "radio in-fill request"

7.3.2.3　The RIU sends then cyclically in-fill information related to B1

7.3.2.4　When passing on B1, the on-board equipment receives the order to establish immediately a communication session with the RIU. It is also informed that the ID of the next main balise group is B2 (it is assumed that B1 or previous balise groups met have sent to the on-board linking information about B2). Being the communication session already established, it is maintained. The on-board also stops accepting in-fill information related to B1 and sends a "radio in-fill end" (related to B1) message and a "radio in-fill request"

(related to B2) message to the RIU.

7.3.2.5    When the "radio in-fill end" message is received, the RIU stops sending in-fill information related to B1

7.3.2.6    When the "radio in-fill request" message is received, the RIU start sending in-fill information related to B2.

7.3.2.7    If the "radio in-fill end" and "radio in-fill request" messages reach the RIU in the wrong order, there is no problem: the reception of a new "radio in-fill request" terminates in fact the sending of previous in-fill information.

7.3.2.8    The RIU sends then cyclically in-fill information related to B2

7.3.2.9    When passing on B2, the on-board equipment receives an order to terminate the communication session when location L3 is reached. The on-board also stops accepting in-fill information related to B2 and sends a "radio in-fill end" message to the RIU.

7.3.2.10    As soon as the "radio in-fill end" message is received, the RIU stops sending in-fill information

7.3.2.11    When location L3 is reached, the on-board equipment terminates the communication session with the RIU