OETCS/WP5/M5.1

openETCS

ITEA2 Project
Call 6 11025
2012 – 2015

openETCS@ITEA Work-Package 5: “Demonstrator”

EVC simulator architecture

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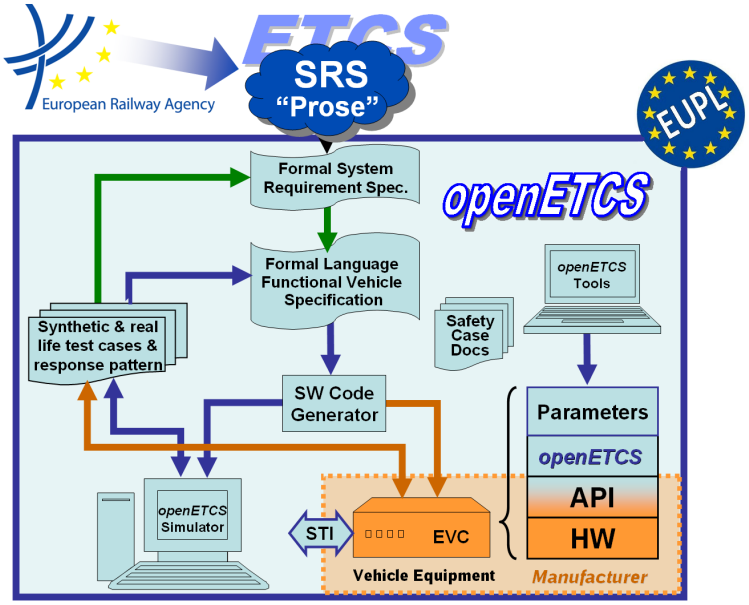
June 2014



Funded by:

Federal Ministry of Education and Research

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openETCS@ITEA Work-Package 5: "Demonstrator" **OETCS/WP5/M5.1**
June 2014

EVC simulator architecture

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Final Report

Prepared for openETCS@ITEA2 Project

Abstract: The purpose of this document is to describe the architecture of the EVC simulator: its breakdown into modules, the exchanged data, and the interfaces with external devices. The EVC simulator behaves according to the SRS Class 1 version 3.3.0. The first part of this document describes the context of the EVC simulator, its interfaces and its breakdown into modules. The following parts describe for each modules of the ERSA EVC simulator the exchanged data, the allocated functions.

Modification History

Version	Section	Modification / Description	Author
0.1	All parts	Creation	Eric Schellenberg
1.0	All parts	Official version	Eric Schellenberg
1.1	All parts	Update	Eric Schellenberg
2.0	All parts	Update for OpenETCS review	Alexis Julin

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1 Introduction

1.1 Overview of European Vital Computer (EVC)

The European Vital Computer (EVC) is the brain or kernel of the ERTMS/ETCS system which is installed in trains. It allows the safe movement of trains on lines equipped with ERTMS/ETCS. It uses a certain number of interfaces with other equipments. Some of them are defined as mandatory at FFFIS or FIS level, and some others are not standard.

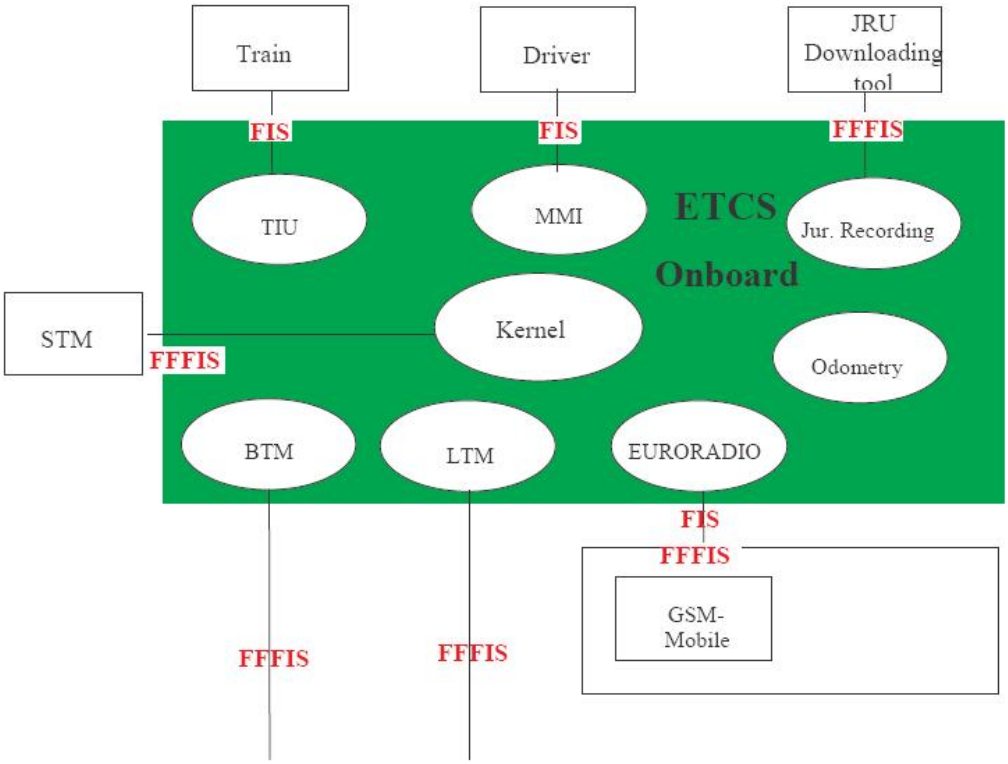

Figure 1. Overview of ETCS Onboard

- MMI : this interface is in fact the DMI product, which has a non standardized interface to the EVC;
- TIU : this interface defined at FIS level allows the communication with the train;
- BTM : this interface defined at FFFIS level reads the balise telegrams;
- LTM : this interface defined at FFFIS level reads the loop telegrams;
- Euroradio (RIM) : this interface defined at FFFIS level allows the communication by radio;
- Odometry : this module calculates the travelled distance, train speed and accelerations;
- JRU : this module records all events occurring in the train; the extraction of data is defined at FFFIS level;

- STM : this module exists in theory in two versions: national or European; it converts as far as possible national information into ETCS information, including braking the train, when appropriate. It is optional in openETCS' scope.

1.2 Limitations

The mode STM European is not supported.

2 System overview

2.1 Context diagram

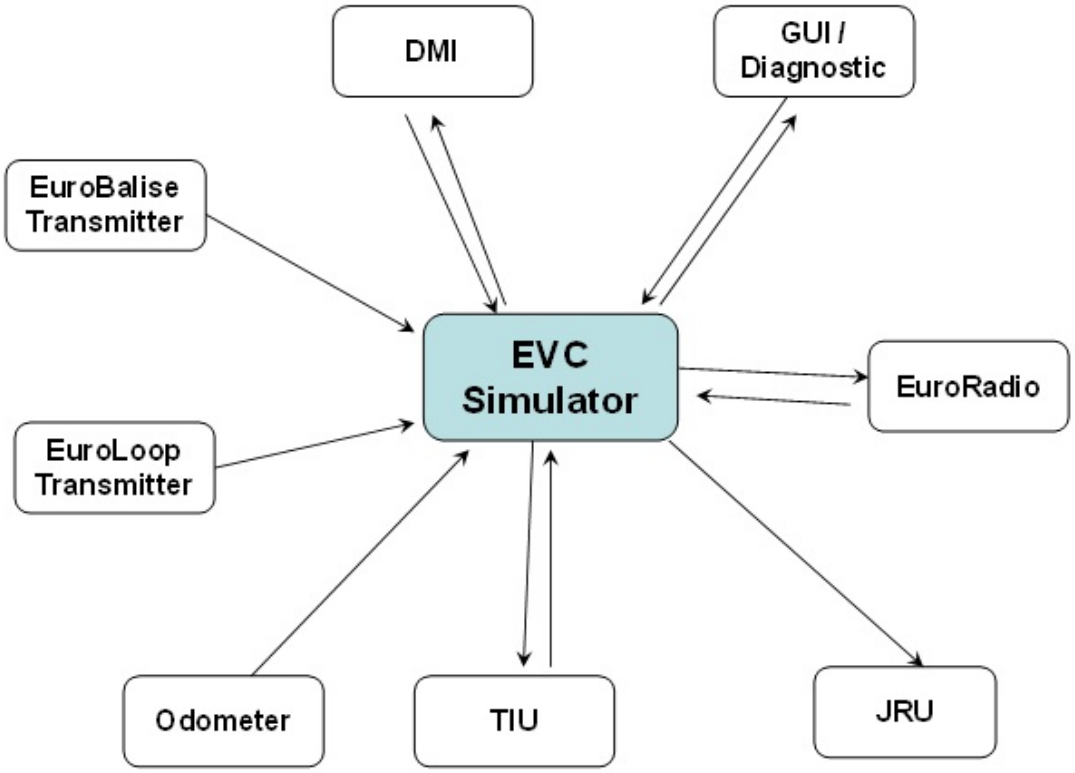

Figure 2. Context diagram

2.1.1 EVC simulator

The EVC simulator is, fundamentally, the centre of all the control process and protection of the train movement. It performs the following main tasks:

- it checks the state of the system and performs all mode and level transitions;
- it validates the data entered by the driver;
- it calculates the train supervision curves;
- it reads the balise, loop and radio telegrams and processes the data;
- it validates the RBC messages and processes the data;
- it transmits the train location and other information to the RBC;
- it manages the movement authorities from the RBC, balises or loops;
- it calculates the most restrictive speed limits for the current train location;

- it supervises the train movements (including the protection against undesirable movement) and triggers warnings and interventions;
- it records all events occurring in the system.

2.1.2 EuroBalise transmitter

The EuroBalise transmitter manages the reception of the balise messages and transmits them to the EVC simulator. The useful data are binary balise messages according to SRS Class 1 v3.3.0, Chapter 7&8. It is a simplified BTM.

2.1.3 EuroLoop transmitter

The EuroLoop transmitter manages the reception of the loop messages and transmits them to the EVC simulator. The useful data are binary loop messages according to SRS Class 1 v3.3.0, Chapter 7&8. It is a simplified LTM.

2.1.4 EuroRadio

The EuroRadio manages the interface with the radio network. It manages the connection and the exchanged of data between the EVC simulator and the RBC / RIU. The exchanged data are composed of radio primitives and radio messages. The format of the exchanged messages is described in Appendix D (page 53)

2.1.5 Odometer

The Odometer transmits to the EVC simulator the train location data (position, speed, acceleration). The odometric data are described in Appendix B (page 49)

2.1.6 TIU

The TIU manages the interface between the EVC simulator and the train equipment. It receives some commands from the EVC simulator (service brake application, emergency brake application,...) and transmits some status (main power switch, cabin open, service brake applied,...). The TIU data are described in Appendix C (page 50)

2.1.7 DMI

The DMI manages the interface with the driver. It receives from the EVC simulator the information to displayed to the driver (train speed, permitted speed, track description,...) and it transmits the driver action (train data entry, shunting request,...). The data are exchanged according to specification for EVC-DMI communication (see /6/). The DMI interface is according to /6/.

2.1.8 GUI/Diagnostic

The GUI / diagnostic interface is specific to the EVC simulator. It displays the status of internal data of the EVC simulator and the operator can send some commands.

2.1.9 JRU

The JRU receives the juridical data to record. The format of the binary frame is according to /1/.

2.2 Architecture diagram

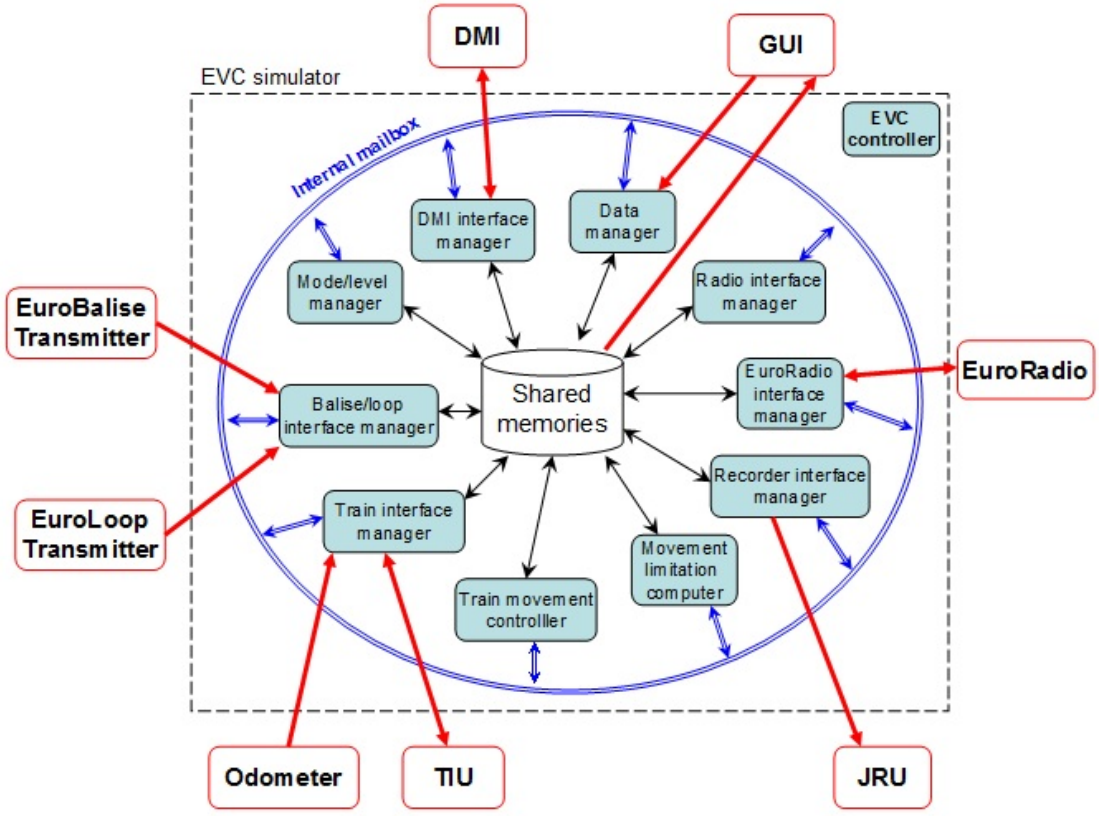

Figure 3. Architecture diagrams

The EVC simulator has been divided into 10 separate modules (a module is implemented by a periodic thread). The communication between the modules is performed via an internal mailbox and shared memories.

- Train interface manager: it performs the following tasks:
  - It receives and processes the odometric data to update the internal location data.
  - It updates the EVC commands on the TIU.
  - It gets the train statuses from the TIU.
- Balise/loop interface manager: it performs the following tasks:
  - It receives and decodes the balise and loop message.
  - It manages the balise groups.
  - It manages the balise linking.
  - It manages the track condition about big metal masses.
- DMI interface manager: it performs the following tasks:
  - It manages the communication with the DMI.
  - It sends relevant data for display.
  - It manages the train data entry.
  - It gets the driver request.

- Radio interface manager: it performs the following tasks:
  - It manages the radio session with RBC/RIU.
  - It receives and decodes the radio messages.
  - It builds and sends radio messages.
  - It manages the supervision of the radio link.
  - It manages the RBC transition.
- EuroRadio interface manager: it performs the following tasks:
  - It manages the communication with the EuroRadio.
  - It manages the safe radio connection.
  - It transmits the radio messages.
- Recorder interface manager: it performs the following tasks:
  - It manages the recording of juridical data.
- Data manager: it performs the following tasks:
  - It manages the received data from trackside: apply filter according to the ETCS mode/level and current level transition, dispatch data to the other modules.
  - It manages the track condition.
  - It manages the national data.
  - It manages the route suitability data.
  - It manages the emergency stop.
  - It manages the operator action on the GUI.
- Movement limitation computer: it performs the following tasks:
  - It computes and provides supervision data according to ETCS mode/level.
  - It manages the track description: static speed profile, gradient profile, temporary speed restriction, axle load speed profile.
  - It manages reduction of movement authority according to conditional emergency stop, route unsuitability, mode profile.
- Train movement controller: it performs the following tasks:
  - It manages the supervision of the train movement according to the ETCS mode and the available supervision data.
  - It manages the service brakes and emergency brakes requests.
  - It supervises an area according to a list of balise group (in shunting or staff responsible mode).
- Mode/level manager: it performs the following tasks:
  - It manages the EVC status, ETCS mode and level.
  - It manages the level transition.
  - It manages the reversing area.
  - It manages the Override EOA.
  - It manages the mode profile.

There is one additional module: the EVC simulator controller. It performs the following main tasks:

- It creates the shared memories.
- It gets the configuration data to initialise the shared memories and to configure the EVC simulation.
- It creates the internal mailbox of the EVC simulator.
- It manages the start and stop of the other modules.
- It manages the GUI.

3 Train interface manager

3.1 Overview

The Train interface manager performs the following tasks:

- It receives and processes the odometric data to update the internal location data.
- It updates the EVC commands on the TIU.
- It gets the train statuses from the TIU.

3.2 Exchanged data

This part provides a list of the main exchanged data.

3.2.1 Input data

Table 1. Train interface manager : Input data

Source	Data
Odometer	• Estimated train position • Position accuracy • Estimated speed • Speed accuracy • Estimated acceleration • Reference time • Train movement direction •

TIU	• Main power switch status • Train integrity status • Active cabin • Sleeping signal status • Non leading permission • Passive shunting permission • Direction controller position • Regenerative brake status • Magnetic shoe brake status • Eddy current brake status • Electro Pneumatic brake status • Additional brake status • Train data information • Type of train data entry • Traction status • National system isolation status • Brake pressure
Shared memories	• Odometry error model • TIU data (outputs)

3.2.2 Output data

Table 2. Train interface manager : Output data

Destination	Data

TIU	• Service Brake command • Emergency Brake command • Traction Cut-Off command • Regenerative Brake inhibition • Magnetic Shoe Brake inhibition • Eddy Current Brake for SB inhibition • Eddy Current Brake for EB inhibition • Change of traction system • Pantograph command • Air Tightness command • Main Power Switch command (sometimes named main circuit breaker) • Isolation status • Station location • Allowed current consumption
Shared memories	• TIU data (inputs) • Train location data

3.3 Functions

The following functions are performed by the Train interface manager:

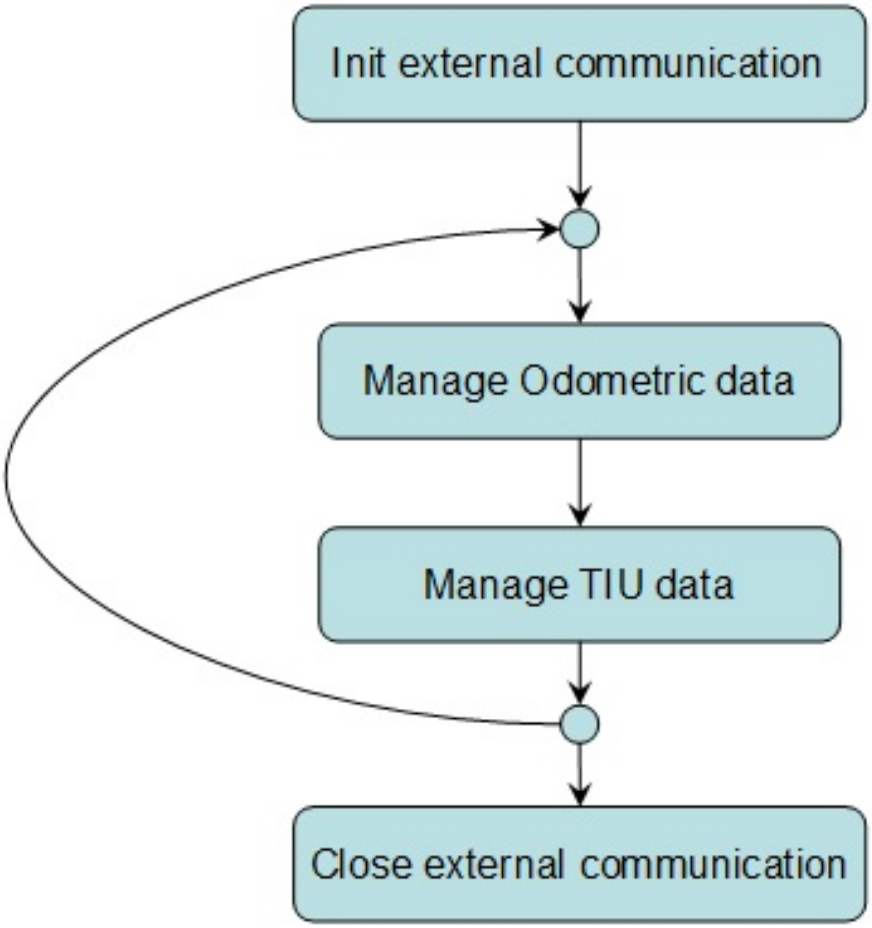

Figure 4. Train interface manager, sequence diagram

3.3.1 Initialize the external communication

It initialises the communication with the Odometer. It initialises the communication with the TIU.

3.3.2 Manage odometric data

It gets the odometric data (position, speed, acceleration) of the train. It calculates the internal train location data (train front location, train rear location,...) :

- It converts the location data in train coordinate according to the active cabin: the distance increment direction is the train orientation defined by the active cabin.
- It calculates the location error according to the error model.

It updates the train location data stored in shared memory.

3.3.3 Manage TIU data

It updates the EVC commands on TIU from data in the shared memories. It gets the train statuses from TIU and stores them in the shared memories.

3.3.4 Close the external communication

It closes the communication with the Odometer. It closes the communication with the TIU.

4 Balise/loop interface manager

4.1 Overview

The Balise/loop interface manager performs the following tasks:

- It receives and decodes the balise and loop message.
- It manages the balise groups.
- It manages the balise linking.
- It manages the track condition about big metal masses

4.2 Exchanged data

4.2.1 Input data

Table 3. Balise/loop interface manager : Input data

Source	Data
EuroBalise transmitter	• Balise message
EuroLoop transmitter	• Loop message
Data manager	• Linking data • Track condition about big metal masses • Loop information
Shared memories	• Train location data • Onboard status data • LRBG data • Train equipment

4.2.2 Output data

Table 4. Balise/loop interface manager : Output data

Destination	Data
Data manager	• Balise group message • Loop message
Train movement controller	• Service brake application request • Service brake release request
Movement limitation computer	• MA reduction request

Mode/level manager	• Train trip request
DMI interface manager	• Track condition data about big metal masses
Shared memories	• Current linking data • LRBG data • Indication of big metal masses (TIU data)

4.3 Functions

The following functions are performed by the Balise/loop interface manager:

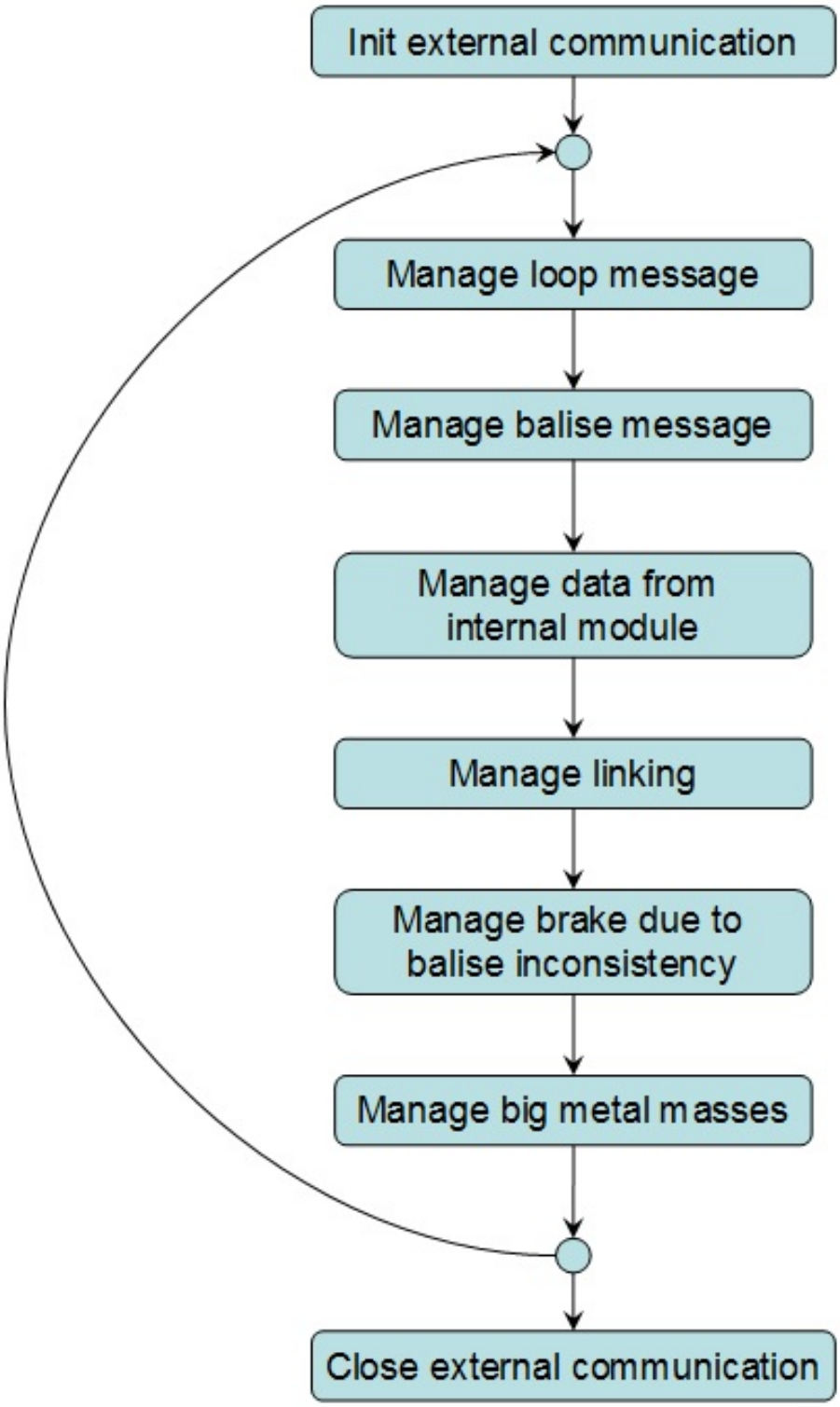

Figure 5. Balise/loop interface manager, sequence diagram

4.3.1 Initialize the external communication

It initialises the communication with the EuroLoop transmitter. It initialises the communication with the EuroBalise transmitter.

4.3.2 Manage loop message

It receives and decodes the loop messages. It selects the data valid for the train direction according to the available information about the loop. It transmits the decoded loop message to the data manager.

4.3.3 Manage balise message

It receives and decodes the balise messages. It manages the balise group and checks its consistency (place of balise in group, number of balise in group). It selects the data valid for the train direction according to the balise group orientation. It checks the balise group linking and applies the required reaction if an inconsistency is detected. It transmits the valid balise group message to the data manager.

4.3.4 Manage data from internal module

It receives and processes the following data from the others modules:

- new linking data: it is taken into account to update the current linking data used to check the balise group linking.
- Loop information: it is stored and will be used for the management of loop message reception.
- Track condition about big metal masses: it is taken into account to update the current list of track condition.

4.3.5 Manage linking

It checks if a balise group has not been missed according to the current linking data and performs the required reaction.

4.3.6 Manage brake due to balise inconsistency

If a service brakes application has been requested due to balise inconsistency, it manages the request for the release of the service brakes when the train reaches standstill and it request the reduction of the movement authority to the current train location.

4.3.7 Manage big metal masses

It manages the current list of track condition about big metal masses and it ignores the balise reception alarm when the balise antenna is in an area with big metal masses.

4.3.8 Close the external communication

It closes the communication with the EuroLoop transmitter. It closes the communication with the EuroBalise transmitter.

5 DMI interface manager

5.1 Overview

The DMI interface manager performs the following tasks:

- It manages the communication with the DMI.
- It sends relevant data for display.
- It manages the train data entry.
- It gets the driver request

5.2 Exchanged data

5.2.1 Input data

Table 5. DMI interface manager : Input data

Source	Data
Data manager	• Track condition • Text message from trackside
Balise/loop interface manager	• Track condition data about big metal masses
All modules	• Text messages
Movement limitation computer	• Track description (gradient profile, static speed profile, TSR)
Shared memories	• On-board status data • Train location data • Route unsuitability indication • Train data • RBC data • SR data • TIU data • Emergency stop • Supervision data • Radio communication status • Reversing area indication • Adhesion data

5.2.2 Output data

Table 6. DMI interface manager : Output data

Destination	Data
All modules	• Text message acknowledgement result
Train movement controller	• Service brake application request • Service brake release request
Mode/level manager	• Driver request (Start, shunting, non leading, override,...) • Data entry (driver id, level, train data, ...)
Data manager	• Override route unsuitability • Adhesion factor from driver
Movement limitation computer	• MA reduction request • Request for new calculation of supervision data
Shared memories	• RBC data • Train data • SR data

5.3 Functions

The following functions are performed by the DMI interface manager:

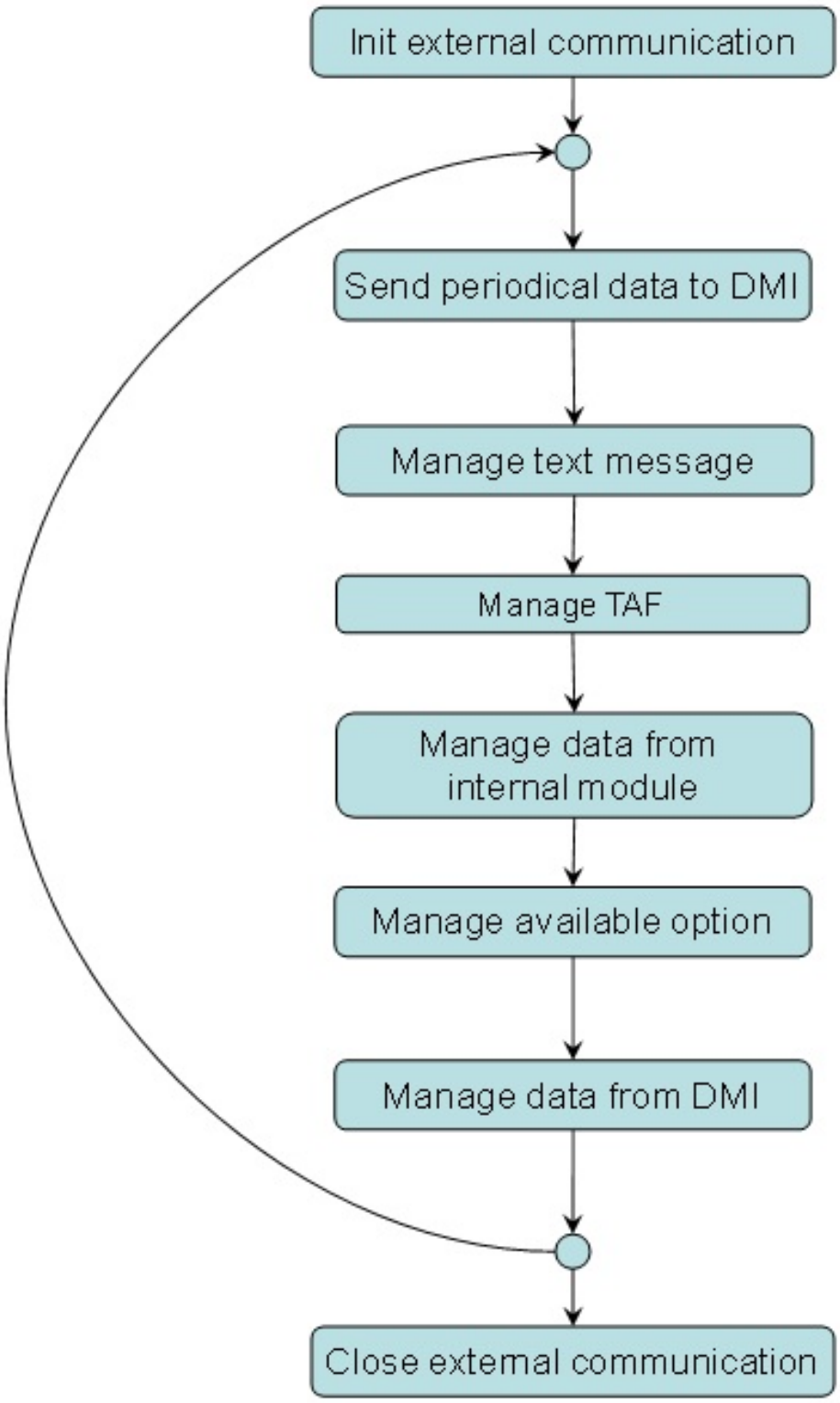

Figure 6. DMI interface manager, sequence diagram

5.3.1 Initialize the external communication

It initialises the communication with the DMI.

5.3.2 Send periodical data to DMI

It builds and sends a message containing some data to be updated periodically on DMI: train location, train speed, supervised speed, status of brakes, ETCS mode & level,...

5.3.3 Manage text message

It manages the conditions to display or remove a text message on the DMI from a list of text message.

5.3.4 Manage TAF

It manages the display, the remove of the track ahead free request. It processes the acknowledgment.

5.3.5 Manage data from internal modules

It receives and processes the following data from the others modules:

- New text message to display: it adds the text message in the current list of text message to manage.
- New track description: it builds and sends a message containing the track description (static speed profile, gradient profile, track condition,...) to the DMI.
- Operator request via GUI: it manages the operation request performed on the GUI as it was a driver action performed on the DMI.

5.3.6 Manage available option

According to the On-board status, it builds and sends a message to the DMI containing the available option (entry of level, selection of shunting request,...).

5.3.7 Manage data from DMI

It receives, decodes and processes the messages from the DMI:

- It manages the data entry (driver id, ETCS level, train data,...) and informs the other modules.
- It gets the driver request (Shunting request, Start of Mission request,...) and transmits them to the suitable module.
- It manages the text message acknowledgements.

5.3.8 Close the external communication

It closes the communication with the DMI.

6 Radio interface manager

6.1 Overview

The Radio interface manager performs the following tasks:

- It manages the radio session with RBC/RIU.
- It receives and decodes the radio messages.
- It builds and sends radio messages.
- It manages the supervision of the radio link.
- It manages the RBC transition.

6.2 Exchanged data

6.2.1 Input data

Table 7. Radio interface manager : Input data

Source	Data
Data manager	• Request to send a radio message • RBC transition data • Radio session data • RBC connection /.disconnection request
Mode /level manager	• Request to send a radio message • RBC connection /.disconnection request
EuroRadio interface manager	• Connection / disconnection information • Radio message received
Movement limitation computer	• Request to send a radio message
Shared memories	• RBC data • National values • Train location data • LRBG data • Train data

6.2.2 Output data

Table 8. Radio interface manager : Output data

Destination	Data
EuroRadio interface manager	• Connection /.disconnection request • Request to send a radio message
Mode /level manager	• Radio communication session open/closed • Train trip request
Train movement controller Movement limitation computer	• Service brake application request • Service brake release request • MA reduction request
Data manager	• Received radio message
Shared memories	• Radio communication status • RBC data

6.3 Functions

The following functions are performed by the Radio interface manager:

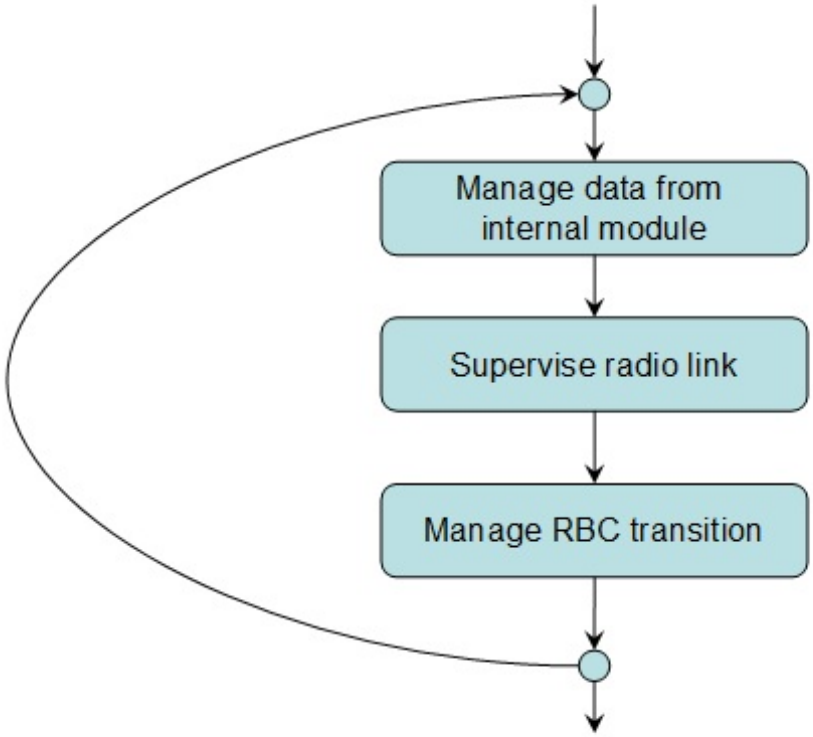

Figure 7. Radio interface manager, sequence diagram

6.3.1 Manage data from internal module

It receives and processes the following data from the others modules:

- Connection / disconnection request: it manages the radio communication session establishment / termination.
- Send message request: it builds and sends the requested message.
- New RBC transition data: it is stored for the management of the RBC transition.
- Connection / disconnection indication: it is taken into account for the management of the radio communication session.
- Reception of radio message: it is decoded, the timestamp consistency is checked, it checks the used LRBG, it selects the data valid for the train direction, it manages the acknowledgement, it manages the radio communication session and it transmits the message to the Data manager.

6.3.2 Supervise radio link

According to the national values, it checks the maximum time since the last received radio message when a radio communication session is established and it applies the required reaction. It manages the radio holes.

6.3.3 Manage RBC transition

It manages the RBC transition according to the available radio equipment (one or two equipment available).

7 EuroRadio interface manager

7.1 Overview

The EuroRadio interface manager performs the following tasks:

- It manages the communication with the EuroRadio.
- It manages the safe radio connection.
- It transmits the radio messages.

7.2 Exchanged data

7.2.1 Input data

Table 9. EuroRadio interface manager : Input data

Source	Data
EuroRadio	• Connection / disconnection indication • Reception of radio message
Radio interface manager	• Connection /.disconnection request • Request to send a radio message

7.2.2 Output data

Table 10. EuroRadio interface manager : Output data

Destination	Data
Radio interface manager	• Connection / disconnection information • Radio message received
EuroRadio	• Connection / disconnection request • Transmission of radio message request
Shared memories	• Radio connection status

7.3 Functions

The following functions are performed by the EuroRadio interface manager:

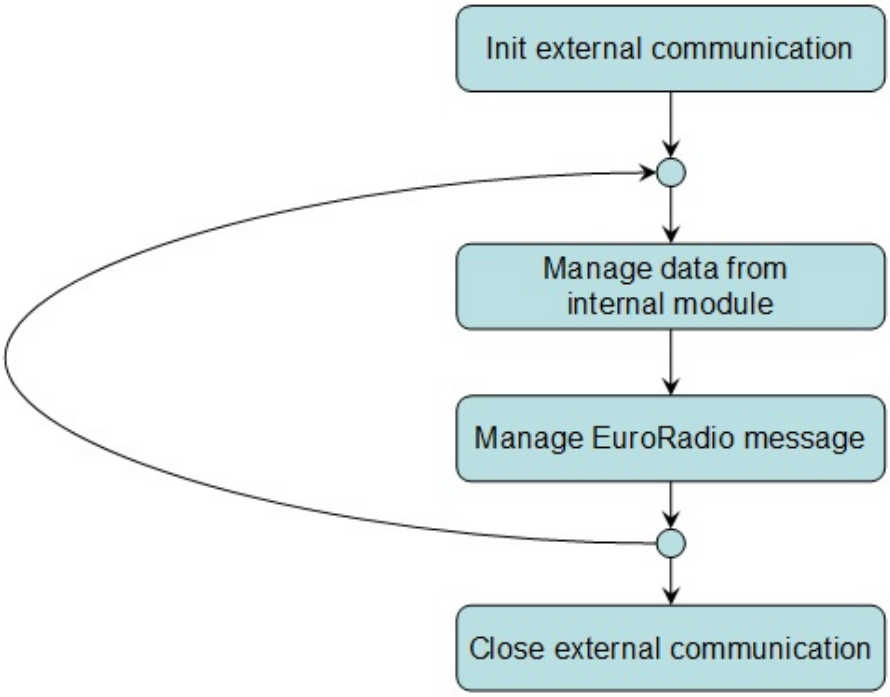

Figure 8. EuroRadio interface manager, sequence diagram

7.3.1 Initialize the external communication

It initialises the communication with the EuroRadio.

7.3.2 Manage data from internal module

It receives and processes the following data from the others modules:

- Connection / disconnection request: it builds and sends the message for the connection / disconnection request to the EuroRadio.
- Data send request: it builds and sends the message for the data send request to the EuroRadio.

7.3.3 Manage EuroRadio message

It receives and decodes the messages from the EuroRadio, it manages the radio connection and it informs the Radio interface manager of the connection / disconnection and reception of radio message.

7.3.4 Close the external communication

It closes the communication with the EuroRadio.

8 Recorder interface manager

8.1 Overview

The Recorder interface manager performs the following tasks:

- It manages the recording of juridical data.

8.2 Exchanged data

8.2.1 Input data

Table 11. Recorder interface manager : Input data

Source	Data
All modules	• Juridical event to record
Shared memories	• ETCS mode & level (on-board status) • Train location data

8.2.2 Output data

Table 12. Recorder interface manager : Output data

Destination	Data
JRU	• Juridical data to record

8.3 Functions

The following functions are performed by the Recorder interface manager:

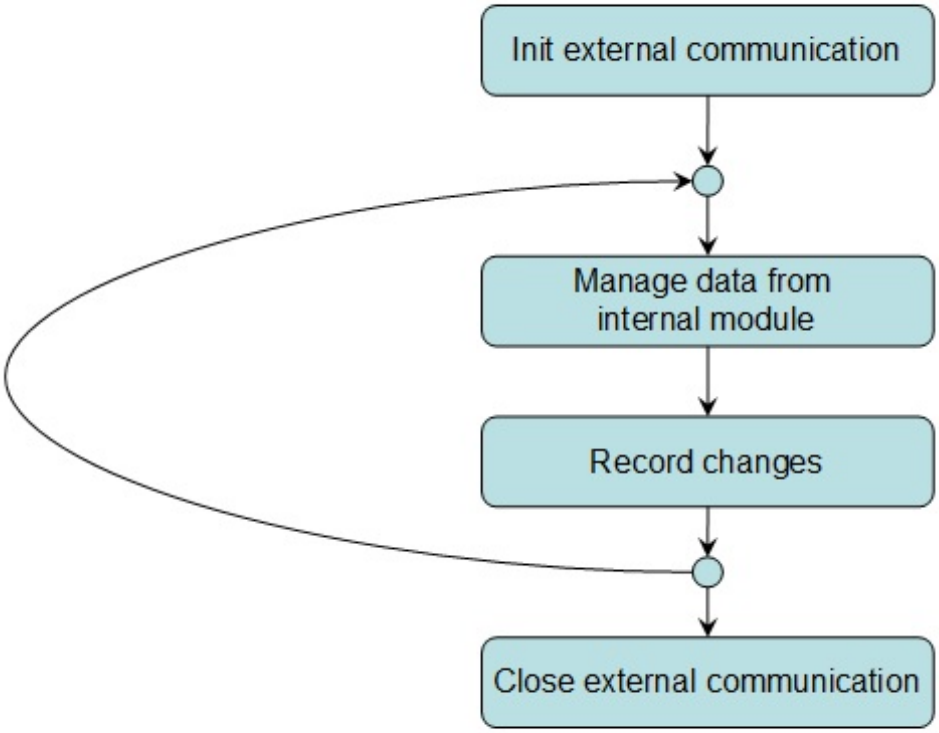

Figure 9. Recorder interface manager, sequence diagram

8.3.1 Initialize the external communication

It initialises the communication with the JRU.

8.3.2 Manage data from internal module

It receives the juridical event to record: it builds and sends the corresponding message to the JRU.

8.3.3 Record changes

It builds and sends message to the JRU for the record of periodical data (train location , speed,...) or when a juridical data changes (ETCS mode, level,...)

8.3.4 Close the external communication

It closes the communication with the JRU.

9 Data manager

9.1 Overview

The Data manager performs the following tasks:

- It manages the received data from trackside: apply filter according to the ETCS mode/level and current level transition, dispatch data to the other modules.
- It manages the track condition.
- It manages the national data.
- It manages the route suitability data.
- It manages the emergency stop.

9.2 Exchanged data

9.2.1 Input data

Table 13. Data manager : Input data

Source	Data
Balise/loop interface manager	• Balise group message • Loop message
DMI interface manager	• Override route unsuitability • Adhesion factor from driver
Mode/level manager	• MA request
Radio interface manager	• Received radio message
Movement limitation computer	• MA request
Shared memories	• On-board status data • Level transition data • Train location data • Train data • LRBG data • Current linking data • RBC data

9.2.2 Output data

Table 14. Data manager : Output data

Destination	Data
Movement limitation computer	• Route unsuitability data • Indication of new national data • Repositioning information • Track description (gradient, speed profile, âĂę) • Mode profile • Reversing supervision data • Temporary speed restriction • MA revocation request • MA • Emergency stop
DMI interface manager	• Track condition • Text message from trackside
Radio interface manager	• Request to send radio message • RBC transition data • Radio session data • Connection / disconnection request
Mode/level manager	• Level transition data • RBC answer (ack of train data, Shunting accepted/rejected,...) • Mode profile • Train trip request • Reversing area data
Train movement controller	• Shunting area data • Staff responsible area data • Service brakes application request • Service brakes release request • Emergency brakes application request • Emergency brakes release request • New balise group indication

Balise/loop interface manager	• Linking data • Loop information • Track condition about big metal masses
Shared memories	• Track condition data • Main circuit breaker open request (TIU data) • Pantograph low request (TIU data) • Inhibition of passenger emergency brakes request (TIU data) • Airtight request (TIU data) • Switch off regenerative brakes request (TIU data) • Switch off eddy current brakes request (TIU data) • Switch off magnetic shoe brakes request (TIU data) • National data • Adhesion data • Radio communication session status

9.3 Functions

The following functions are performed by the Data manager:

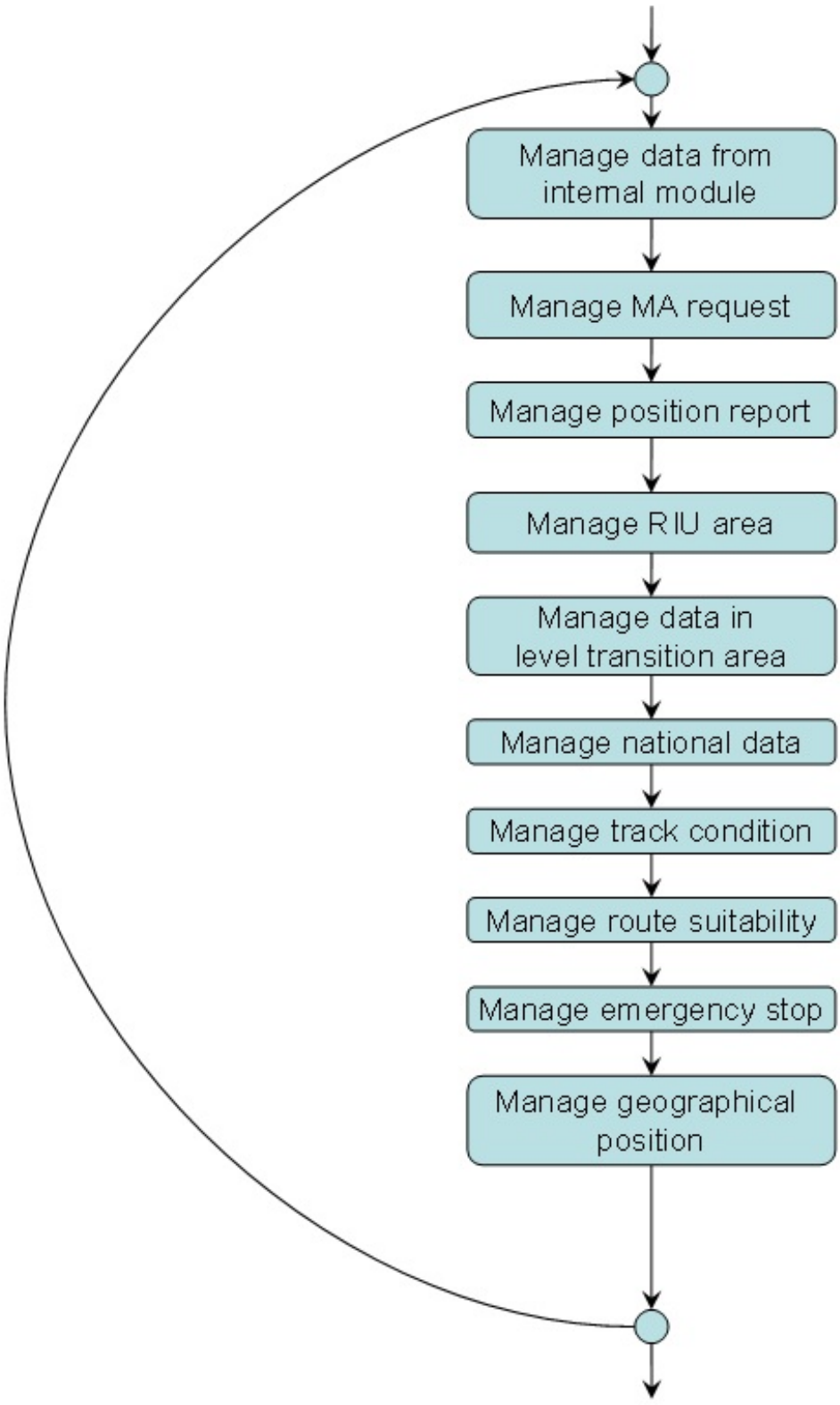

Figure 10. Data manager, sequence diagram

9.3.1 Manage data from internal modules

It receives the balise group message, loop message and radio message. It filters the data according to the current ETCS mode and level. It dispatches the valid data to the other modules. It receives and manages the request for override of route unsuitability.

9.3.2 Manage MA request

It manages the sending request of the "‘MA request"’ radio message to the RBC according to the MA request parameters.

9.3.3 Manage position report

It manages the sending request of the "‘position report"’ radio message to the RBC according to the position report parameters.

9.3.4 Manage RIU area

It manages the entry / exit in the radio infill area. It manages the sending request of "‘infill MA request"’ radio message.

9.3.5 Manage data in level transition area

It manages the data stored in buffer during the level transition when the train enters in the new level.

9.3.6 Manage national data

It manages the national data, it checks when the new national data becomes valid, it checks the validity of the current national data, it sets the default national data.

9.3.7 Manage track conditions

It manages the list of the track condition and checks when the train enters /exits in a track condition area. It sets the TIU output required by the active track condition (switch off eddy current brakes,...).

9.3.8 Manage route suitability

It manages the list of route suitability, it detects if there is an unsuitability according to the train data, it requests the reduction of the MA to the next unsuitability, it manages the override of the unsuitability.

9.3.9 Manage emergency stop

It manages the list of the active emergency stop. It manages the train trip request due to unconditional emergency stop, it manages the MA reduction due to conditional emergency stop. It manages the acknowledgement of the emergency stop and the revocation of the emergency stop.

9.3.10 Manage geographical position

It manages the received geographical data in order to calculate the corresponding KP to the train location.

10 Movement limitation computer

10.1 Overview

The Movement limitation computer performs the following tasks:

- It computes and provides supervision data according to ETCS mode/level.
- It manages the track description: static speed profile, gradient profile, temporary speed restriction, axle load speed profile.
- It manages reduction of movement authority according to conditional emergency stop, route unsuitability, mode profile.

10.2 Exchanged data

10.2.1 Input data

Table 15. Movement limitation computer : Input data

Source	Data
Balise/loop interface manager	• MA reduction request
DMI interface manager	• MA reduction request • Request for new calculation of supervision data
Radio interface manager	• MA reduction request
Data manager	• Route unsuitability data • Indication of new national data • Repositioning information • Track description (gradient, speed profile,...) • Mode profile • Reversing supervision data • Temporary speed restriction • MA revocation request • MA • Emergency stop
Mode/level manager	• Request to calculate supervision data

Shared memories	• Train data • National data • On-board status data • Train location data • Adhesion data • SR data

10.2.2 Output data

Table 16. Movement limitation computer : Output data

Destination	**Data**
DMI interface manager	• Track description (gradient profile, static speed profile, TSR)
Radio interface manager	• Request to send a radio message
Data manager	• MA request
Mode/Level manager	• Indication of MA valid
Shared memories	• Supervision data

10.3 Functions

The following functions are performed by the Movement limitation computer:

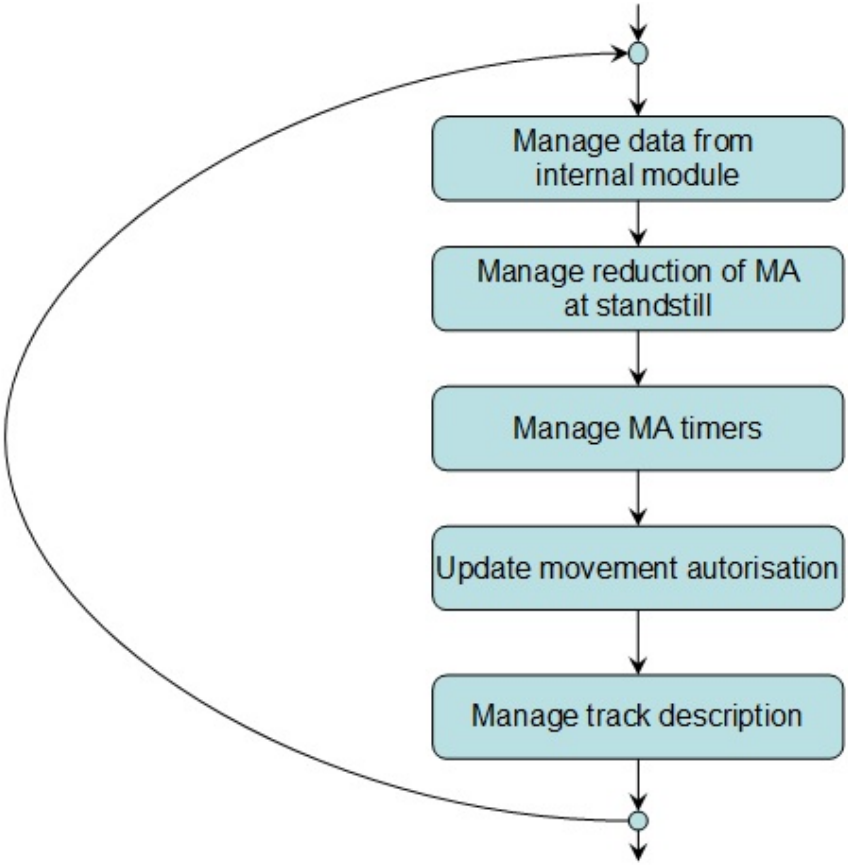

Figure 11. Movement limitation computer, sequence diagram

10.3.1 Manage data from internal module

It manages the reception of data from other modules:

- Track description data (static speed profile, gradient profile, temporary speed restriction, axle load speed profile,...). It is stored and used for the calculation of the supervision data.
- MA data, SR data, reversing supervision data: it is stored and used for the calculation of the supervision data.
- Reduction due to route unsuitability: it stored and used to reduce the current MA to the location of the route unsuitability.
- Mode profile: it is stored and used for the calculation of the supervision data.
- Request to reduce MA to standstill location: it is stored.
- Cooperative MA revocation request: it is processed in order to check if the train can be stopped before the new EOA.
- Emergency stop data: it manages the stop location due to a conditional emergency stop. It is taken into account for the calculation of the supervision data.

10.3.2 Manage reduction of MA at standstill

When a request to reduce the current MA to the standstill location has been received, it checks if the train has reached standstill and it requests the calculation of supervision curves for the new reduced MA.

10.3.3 Manage MA timers

It manages the timers associated to the current MA. It manages the start and the stop of the timers. If there is a timer expiration, it requests the calculation of supervision curves for the modified MA data.

10.3.4 Update movement authorization

It requests the calculation of the suitable supervision data according to the current ETCS mode. The new calculation can be due to a mode change, the use of new national data or the modification of the input data (staff responsible speed / distance, reversing supervision data, MA, track description,...).

10.3.5 Manage track description

It manages the deletion of a part or the whole track description data according to the change of the stop location and the ETCS mode.

11 Train movement controller

11.1 Overview

The Train movement controller performs the following tasks:

- It manages the supervision of the train movement according to the ETCS mode and the available supervision data.
- It manages the service brakes and emergency brakes application requests.
- It supervises an area according to a list of balise group (in shunting or staff responsible mode).

11.2 Exchanged data

11.2.1 Input data

Table 17. Train movement controller : Input data

Source	Data
Data manager	• Shunting area data • Staff responsible area data • Service brakes application request • Service brakes release request • Emergency brakes application request • Emergency brakes release request • New balise group indication
Radio interface manager	• Service brake application request • Service brake release request
DMI interface manager	• Service brake application request • Service brake release request
Mode/Level manager	• Service brake application request • Service brake release request
Balise/loop interface manager	• Service brake application request • Service brake release request

Shared memories	• Train location data • On-board status data • Supervision data • Direction controller position (TIU data) • Emergency brakes status (TIU data) • Service brakes status (TIU data)

11.2.2 Output data

Table 18. Train movement controller : Output data

Destination	Data
Mode/level manager	• Train trip request
Radio interface manager	• Request to send a radio message
Shared memories	• Current supervision speeds • Target data • Traction cut off request (TIU data) • Service brakes application request (TIU data) • Emergency brakes application request (TIU data)

11.3 Functions

The following functions are performed by the Train movement controller:

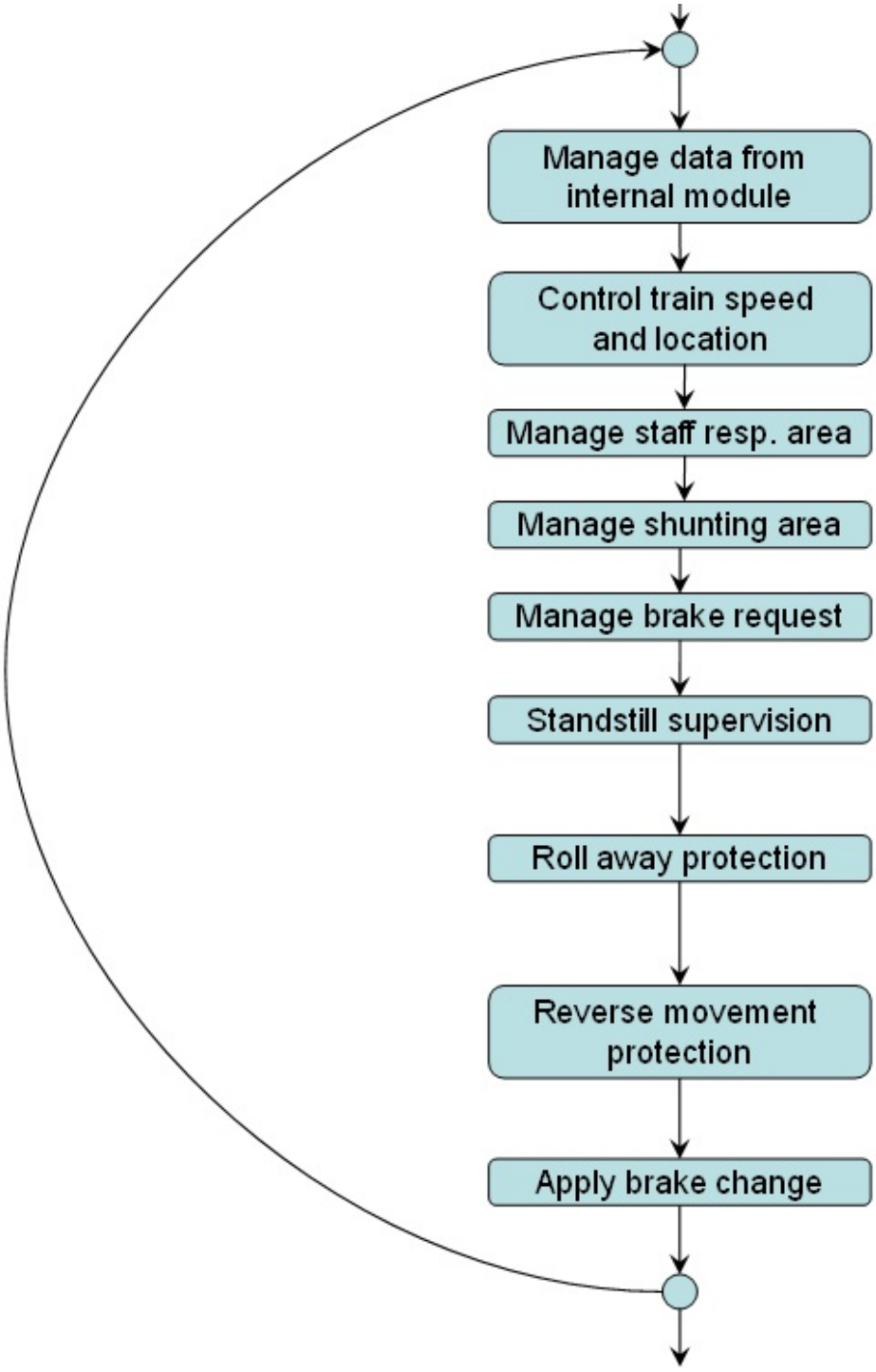

Figure 12. Train movement controller, sequence diagram

11.3.1 Manage data from internal module

It manages the reception of data from other modules:

- Service brakes / emergency brakes application /release request from another module: it stores the request.
- Shunting area data: it stores the list of balise group composing the area.
- Staff responsible area data: it stores the list of balise group composing the area.
- Indication of a new balise group: if the current ETCS mode is shunting or staff responsible, it checks if the passed balise group belong to the authorised area.
- Driver acknowledgement: it processed the acknowledgement for release of brakes application (roll away protection, standstill supervision, reverse movement protection).

11.3.2 Control train speed and location

According to the supervision data, it supervises the train speed and location. It requests the brakes application / release for the control of the train speed. It can send a train trip request to the mode manager when the train is not at an authorised location. It updates the supervision speeds and the target data in the shared memory.

11.3.3 Manage brake request

It manages the requests to apply / release the brakes received from the other modules.

11.3.4 Standstill supervision

According to the ETCS mode, it manages the standstill supervision. It applies the brakes when a movement is detected. It releases the brakes when the intervention is acknowledged by the driver and the train is at standstill.

11.3.5 Roll away protection

According to the ETCS mode, it manages the roll away protection. It applies the brakes when a roll away movement is detected according to the direction controller position. It releases the brakes when the intervention is acknowledged by the driver and the train is at standstill.

11.3.6 Reverse movement protection

According to the ETCS mode, it manages the reverse movement protection. It applies the brakes when a reverse movement is detected. It releases the brakes when the intervention is acknowledged by the driver and the train is at standstill.

11.3.7 Apply brake change

According to the brake requests, it updates the brakes commands of the TIU outputs in the shared memory. It takes into account the previous brakes commands when some brakes application should be released only at standstill. It requests the emergency brakes application when the service brakes application fails.

12 Mode/level manager

12.1 Overview

The Mode/level manager performs the following tasks:

- It manages the EVC status, ETCS mode and level.
- It manages the level transition.
- It manages the reversing area.
- It manages the Override EOA.
- It manages the mode profile.

12.2 Exchanged data

12.2.1 Input data

Table 19. Mode/level manager: Input data

Source	Data
Movement limitation computer	• Indication of MA valid
Data manager	• Level transition data • RBC answer (ack of train data, Shunting accepted/rejected,...) • Mode profile • Train trip request • Reversing area data
DMI interface manager	• Driver request (shunting, start of mission, entry of level,...) • Data entry (driver id, level, train data,...)
Balise/loop interface manager	• Train trip request
Radio interface manager	• Radio communication session open/closed • Train trip request
Train movement controller	• Train trip request

Shared memories	• Main power switch status (TIU data) • Active cabin (TIU data) • Isolation status (TIU data) • Sleeping signal status (TIU data) • Train location data • National data • Train equipment data • Radio communication status

12.2.2 Output data

Table 20. Mode/level manager : Output data

Destination	Data
Radio message	• Request to send a radio message • RBC connection /.disconnection request
Data manager	• MA request
Movement limitation computer	• Request to calculate supervision data
Train movement controller	• Service brake application request • Service brake release request
Shared memories	• On-board status data • Train data status • Reversing area indication • Deadman isolation request (TIU data)

12.3 Functions

The following functions are performed by the Mode/level manager:

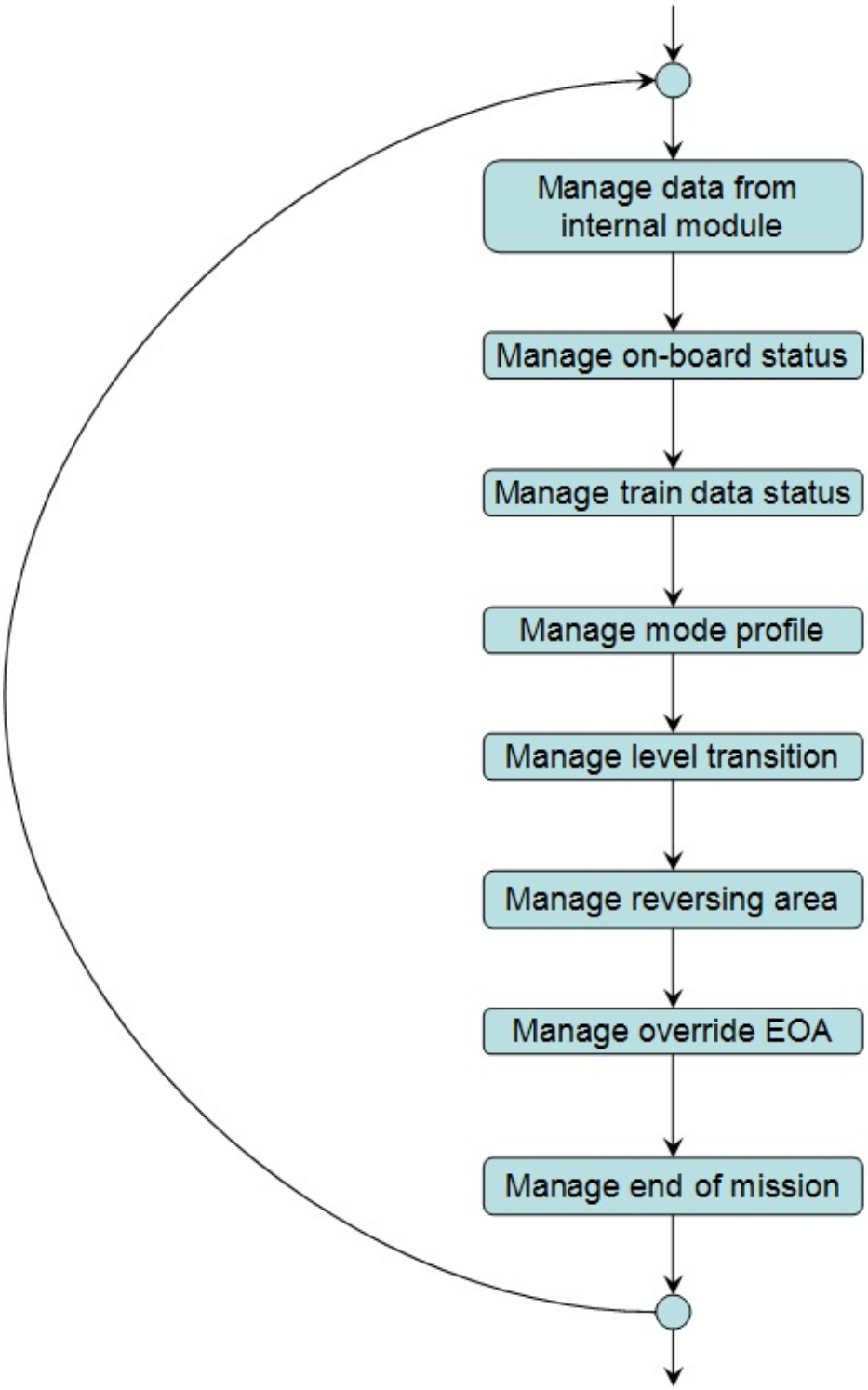

Figure 13. Mode/level manager, sequence diagram

12.3.1 Manage data from internal module

It manages the reception of data from other modules:

- Mode profile data: it is stored for the management of the mode profile.
- Level transition data: it is stored for the management of the level transition.
- Reversing area data: it is stored for the management of the reversing area.
- Driver acknowledgement, action: it is used in the management of the on-board status.
- Internal event (RBC answer, train trip request,...): it is used in the management of the on-board status.

12.3.2 Manage on-board status

It manages the status of the on-board according to the current ETCS level, the received event (driver action, RBC answer,...), the TIU data (power on/off, cabin status,...). It sets the ETCS mode. It manages the required actions in the current status.

12.3.3 Manage train data status

It manages the status of the train data according to the mode changes and the driver data entry.

12.3.4 Manage mode profile

It manages the entry / exit in shunting or on sight according to the stored mode profile. It manages the acknowledgment request to the driver.

12.3.5 Manage level transition

According to the stored level transition data and the available train equipments, it selects the suitable level transition. It performs the level transition at the required location and sets the new level. It manages the acknowledgment request to the driver for the level transition. It manages the mode change due to the level transition if required.

12.3.6 Manage reversing area

According to the stored reversing area data, it manages the indication to the driver of the area where the selection of reversing is possible.

12.3.7 Manage override EOA

It manages the override EOA request from the driver, the inhibition of the transition to trip. It manages the end of the override EOA according to the National values, train trip request or former EOA.

12.3.8 Manage end of mission

It manages the end of mission procedure according to the mode change. In level 2/3, it requests the sending of âĂIJend of missionâĂİ radio message. It manages the repetition of the sending of the radio message if required. It requests the disconnection if no disconnection order has been received from the RBC.

Appendix A: Glossary

Table A1. Glossary

Term	Abb.	Description
European Vital Computer	EVC	
Train Interface Unit	TIU	
Driver Machine Interface	DMI	
Juridical Recording Unit	JRU	
Graphical User Interface	GUI	
Kilometer Point	KP	
Radio Block Centre	RBC	
Radio Infill Unit	RIU	
Radio Interface Module	RIM	
Movement authority	MA	

Appendix B: Odometric data

The following data are received from the odometer:

Table B1. Odometric data

Name	Unit	Description
Position	m	Absolute train location
Speed	m/s	Train speed. If it has a positive value, the train is moving forward, otherwise it is moving backward.
Acceleration	m/s^2	Train acceleration. If it has a positive value, the train accelerates (the absolute value of the train speed increases), otherwise the train decelerates (the absolute value of the train speed decreases).

Appendix C: TIU data

The following data are received from the TIU:

Table C1. TIU received data

Name	Range
Main power switch status	• 0: power off • 1: power on
Train integrity status	• 0: train integrity lost • 1: train integrity
Sleeping permission	• 0: no sleeping signal • 1: sleeping signal is set
Non leading permission	• 0: no leading signal • 1: leading signal is set
Passive shunting permission	• 0: no passive shunting signal • 1: passive shunting signal is set
Active cabin status	• 0: all cabins are closed • 1: cabin A is open • 2: cabin B is open • 3: cabin A & B are open
Direction controller position	• 0: forward direction • 1: backward direction • 2: neutral position
Regenartive brake status	• 0: regenerative brakes are not applied • 1: regenartive brakes are applied
Magnetic shoe brake status	• 0: magnetic shoe brakes are not applied • 1: magnetic shoe brakes are applied
Eddy current brake status	• 0: eddy current brakes are not applied • 1: eddy current brakes are applied
Regenartive brake status	• 0: electro pneumatic brakes are not applied • 1: electro pneumatic brakes are applied
Additional brake status	• 0: additional brakes are not applied • 1: additional brakes are applied
Traction status	• 0: no traction • 1: traction is set

National system isolation status	• 0: no national system isolation • 1: national system isolation is set
Brake pressure	• 0.0 bar to 5.0 bar
Train data information	
Type of train data entry	

The following data are sent to the TIU:

Table C2. TIU sent data

Name	**Range**
Traction cut off request	• 0: no request for traction cut off • 1: request for traction cut off
Service brakes application request	• 0: no request for service brakes application • 1: request for service brakes application
Emergency brakes application request	• 0: no request for emergency brakes application • 1: request for emergency brakes application
Inhibition of regenerative brakes request	• 0: no request to inhibit the regenerative brakes • 1: request to inhibit the regenerative brakes
Inhibition of magnetic shoe brakes request	• 0: no request to inhibit the magnetic shoe brakes • 1: request to inhibit the magnetic shoe brakes
Inhibition of eddy current brakes for SB request	• 0: no request to inhibit the eddy current brakes for SB • 1: request to inhibit the eddy current brakes for SB
Inhibition of eddy current brakes for EB request	• 0: no request to inhibit the eddy current brakes for EB • 1: request to inhibit the eddy current brakes for EB
Main circuit breaker open request	• 0: no request to open main circuit breaker • 1: request to open main circuit breaker
Pantograph request	• 0: request for pantograph low • 1: request for pantograph down
Airtight request	• 0: no request for airtight • 1: request for airtight
Isolation status	• 0: no isolation • 1: isolation is set

Change of traction system	• 600V DC to 25 kV AC
Status location	
Allowed current consumption	• 0 A to 10000 A

Appendix D: EuroRadio data

The communication between the EVC and the EuroRadio is based on the exchanged of radio primitives. The following primitives are available:

Table D1. Connection on EVC initiative

Primitive	Description	Dir.
Connection request	This primitive is used to request a connection establishment.	⇒
Connection confirm	This primitive is used to confirm a connection establishment after a request.	⇐

Table D2. Connection on RBC initiative

Primitive	Description	Dir.
Connection indication	This primitive is used to indicate a connection establishment.	⇒
Connection response	This primitive is used to respond to a connection establishment indication.	⇐

Table D3. Transmission of data

Primitive	Description	Dir.
Data request	This primitive is used to request the transmission of a radio message.	⇒
Data indication	This primitive is used to indicate the reception of a radio message.	⇐
High priority data request	This primitive is used to request the transmission of an emergency radio message.	⇒
High priority data indication	This primitive is used to indicate the reception of an emergency radio message.	⇐

Table D4. Disconnection

Primitive	Description	Dir.
Disconnection request	This primitive is used to request a disconnection.	⇒
Disconnection indication	This primitive is used to indicate a disconnection (after a request or due to other reason).	⇐

D.1 Format of the exchanged primitives

The primitives are exchanged between the EVC simulator and the EuroRadio according to the following format:

Table D5. Format of the exchanged primitives

Size	Description	Range
2 bytes	Length of the radio primitive (in bytes)	
1 byte	Identity of the radio primitive.	
n bytes	Content of the message according to the radio primitive identity.	

D.1.1 Connection request

This primitive is used to request a connection (EVC → EuroRadio).

Table D6. Connection request

Size	Description	Range
1 byte	Identity of the radio primitive "'Connection request"'	0x01 (fixed)
1 byte	Address type	0x01 (fixed)
1 byte	Size of called number (in bytes)	0 to 16
1 byte	Reserved	0x00 (fixed)
16 bytes	Called number (the unused bytes are coded as 0x00)	
1 byte	Called ETCS Id type	• 0x01: RBC/RIU • 0x02: train
3 bytes	Called ETCS Id (NID_ENGINE or NID_RBC)	
1 byte	Calling ETCS Id type	• 0x01: RBC/RIU • 0x02: train
3 bytes	Calling ETCS Id (NID_ENGINE or NID_RBC)	
1 byte	Application type (fixed)	0x10 (fixed)
2 bytes	Quality of service	

Length : 31 bytes

D.1.2 Connection indication

This primitive is used to indicate that a safe connection is established (EuroRadio → EVC).

Table D7. Connection indication

Size	Description	Range
1 byte	Identity of the radio primitive "'Connection indication"'	0x03 (fixed)
4 bytes	Connection identifier (SaCEPID)	
1 byte	Called ETCS Id type	• 0x01: RBC/RIU • 0x02: train
3 bytes	Called ETCS Id (NID_ENGINE or NID_RBC)	

1 byte	Calling ETCS Id type	• 0x01: RBC/RIU • 0x02: train
3 bytes	Calling ETCS Id (NID_ENGINE or NID_RBC)	
1 byte	Application type	0x10 (fixed)
2 bytes	Quality of service	

Length : 16 bytes

D.1.3 Connection response

This primitive is used to respond on reception of "‘connection indication"’ (EVC → EuroRadio).

Table D8. Connection response

Size	Description	Range
1 byte	Identity of the radio primitive "‘Connection response"’	0x02 (fixed)
4 bytes	Connection identifier (SaCEPID)	
1 byte	Responding ETCS Id type	• 0x01: RBC/RIU • 0x02: train
3 bytes	Responding ETCS Id (NID_ENGINE or NID_RBC)	

Length : 9 bytes

D.1.4 Connection confirmation

This primitive is used to confirm the establishment of a connection on reception of "‘connection request"’ (EuroRadio → EVC).

Table D9. Connection confirmation

Size	Description	Range
1 byte	Identity of the radio primitive "‘Connection confirmation"’	0x04 (fixed)
4 bytes	Connection identifier (SaCEPID)	
1 bytes	Responding ETCS Id type	• 0x01: RBC/RIU • 0x02: train
3 bytes	Responding ETCS Id (NID_ENGINE or NID_RBC)	

Length : 9 bytes

D.1.5 Data request

This primitive is used to request the transmission of a radio message (EVC → EuroRadio).

Table D10. Data request

Size	Description	Range
1 byte	Identity of the radio primitive "'Data request"'	0x05 (fixed)
4 bytes	Connection identifier (SaCEPID)	
2 bytes	Length of the radio message in bytes: n	0 to 255
n bytes	Radio message according to SRS Class 1 v3.3.0 (see [/1/])	

Length : up to 262 bytes

D.1.6 Data indication

This primitive is used to indicate the reception of a radio message (EuroRadio → EVC).

Table D11. Data indication

Size	Description	Range
1 byte	Identity of the radio primitive "'Data indication"'	0x06 (fixed)
4 bytes	Connection identifier (SaCEPID)	
2 bytes	Length of the radio message in bytes: n	0 to 255
n bytes	Radio message according to SRS Class 1 v3.3.0 (see [/1/])	

Length : up to 262 bytes

D.1.7 Hight priority data request

This primitive is used to request the transmission of an emergency radio message (EVC → EuroRadio).

Table D12. Hight priority data request

Size	Description	Range
1 byte	Identity of the radio primitive "'High priority data request"'	0x0B (fixed)
4 bytes	Connection identifier (SaCEPID)	
2 bytes	Length of the radio message in bytes: n	0 to 255
n bytes	Radio message according to SRS Class 1 v3.3.0 (see [/1/])	

Length : up to 262 bytes

D.1.8 Hight priority data indication

This primitive is used to indicate the reception of an emergency radio message (EuroRadio → EVC).

Table D13. Hight priority data indication

Size	Description	Range
1 byte	Identity of the radio primitive "‘Hight priority data indication"’	0x0C (fixed)
4 bytes	Connection identifier (SaCEPID)	
2 bytes	Length of the radio message in bytes: n	0 to 255
n bytes	Radio message according to SRS Class 1 v3.3.0 (see [/1/])	

Length : up to 262 bytes

D.1.9 Disconnection request

This primitive is used to request a disconnection (EVC → EuroRadio).

Table D14. Disconnection request

Size	Description	Range
1 byte	Identity of the radio primitive "‘Disconnection request"’	0x07 (fixed)
4 bytes	Connection identifier (SaCEPID)	

Length : 5 bytes

D.1.10 Disconnection indication

This primitive is used to indicate a disconnection (EuroRadio → EVC).

Table D15. Disconnection indication

Size	Description	Range
1 byte	Identity of the radio primitive "‘Disconnection indication"’	0x08 (fixed)
4 bytes	Connection identifier (SaCEPID)	
1 bytes	Reason	
1 bytes	Sub-reason	

Length : 7 bytes