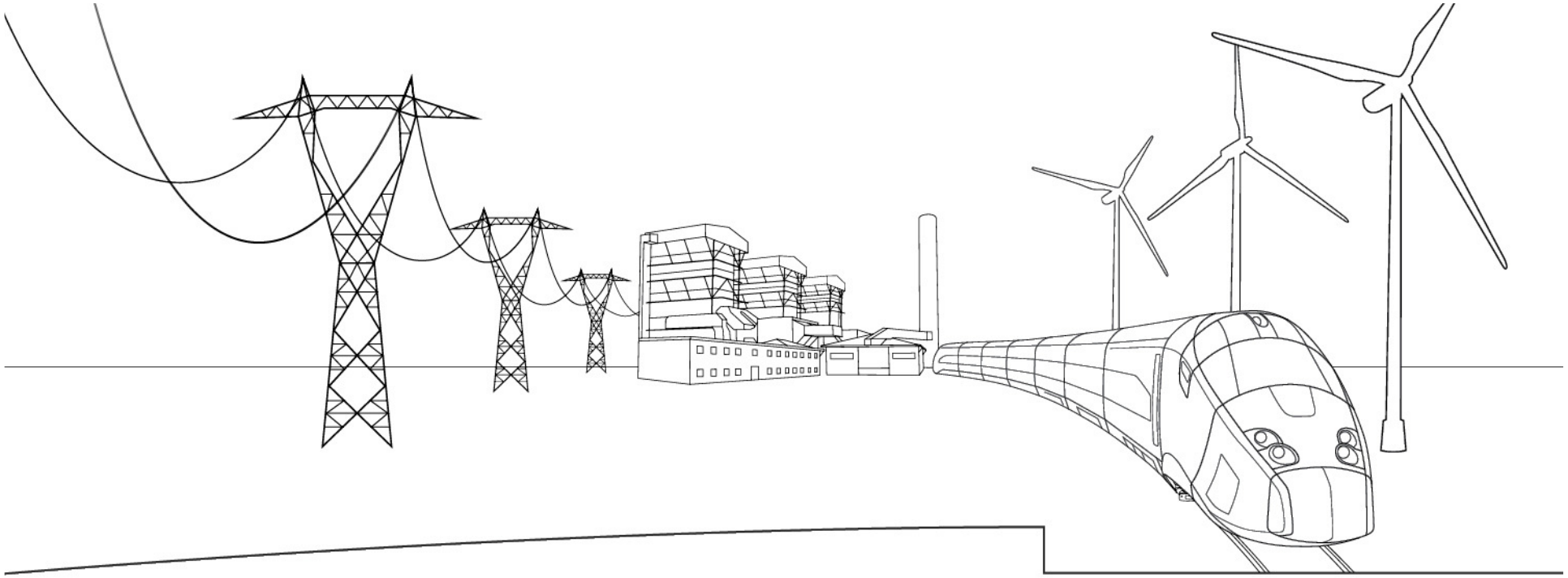

Open-ETCS Functional model

S. Besure

TIS Charleroi

22/10/2013

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Shaping the future

Agenda

- **Overview**
- Model presentation
- Equivalent SysML diagrams (proposal)
- Example: display text messages

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Overview

TRB sub-system model

- Model developed by Alstom
- Based on structured analysis (Teamwork SA/RT)
  - Data Flow Diagram (DFD)
  - Process Specification (P-spec)
  - Data dictionary
- Updated for baseline 3
- Extract limited to ETCS functions

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Overview

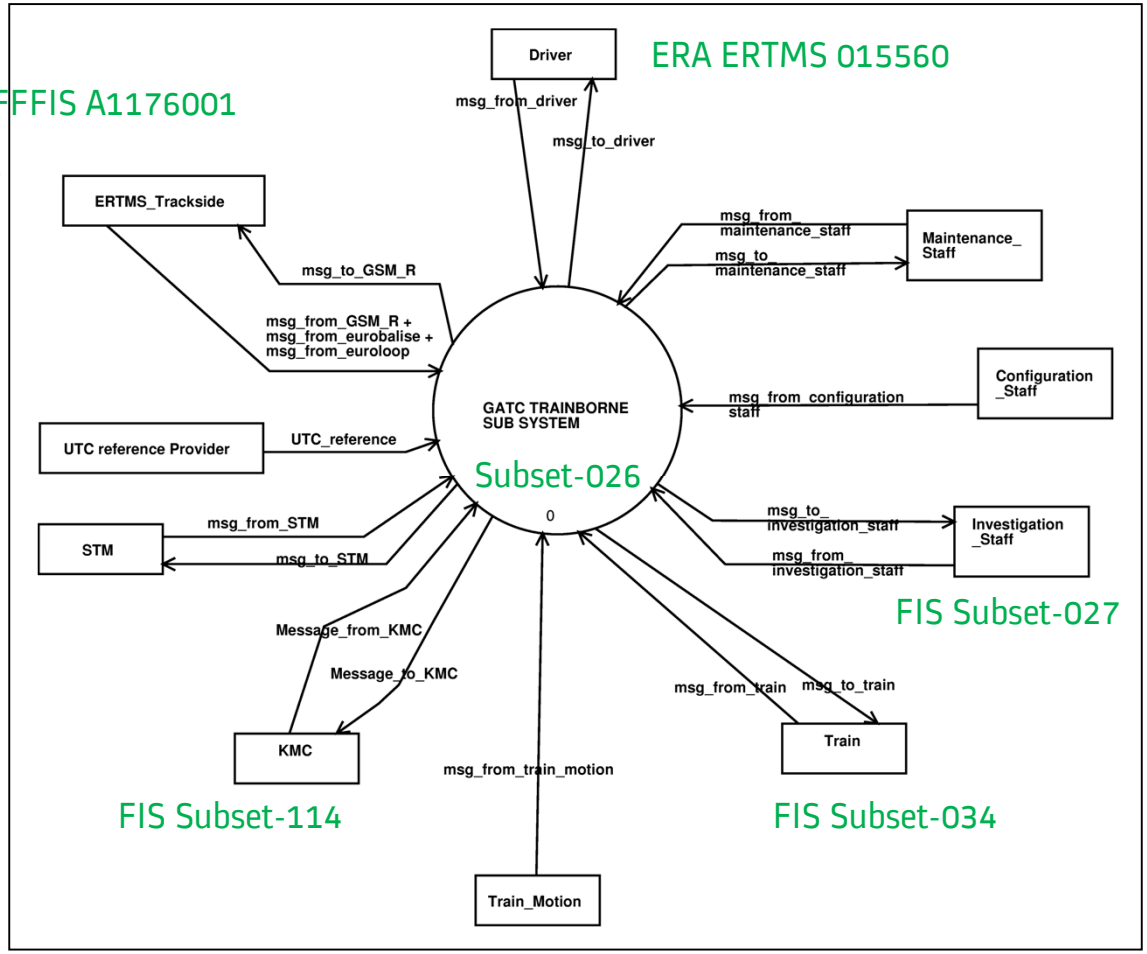
Context diagram – links with TSI

Euroradio FIS Subset-037 + FFFIS A1176001

Eurobalise FFFIS Subset-036

Euroloop FFFIS Subset-044

FFFIS Subset-035, 056,0 57, 058



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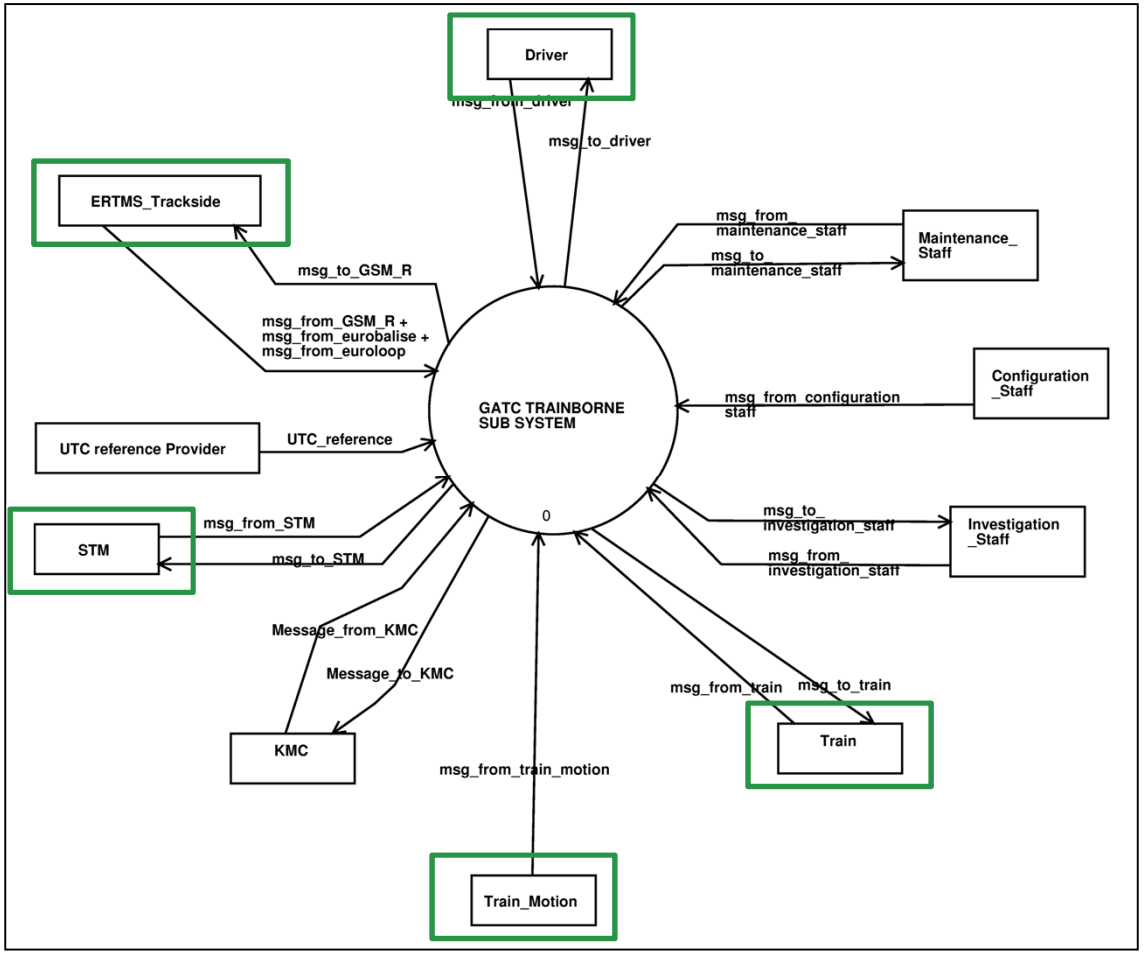
Overview

Operation context – ETCS trackside levels

- Level 0
- Level 1
- Level 2
- Level 3
- Level SN



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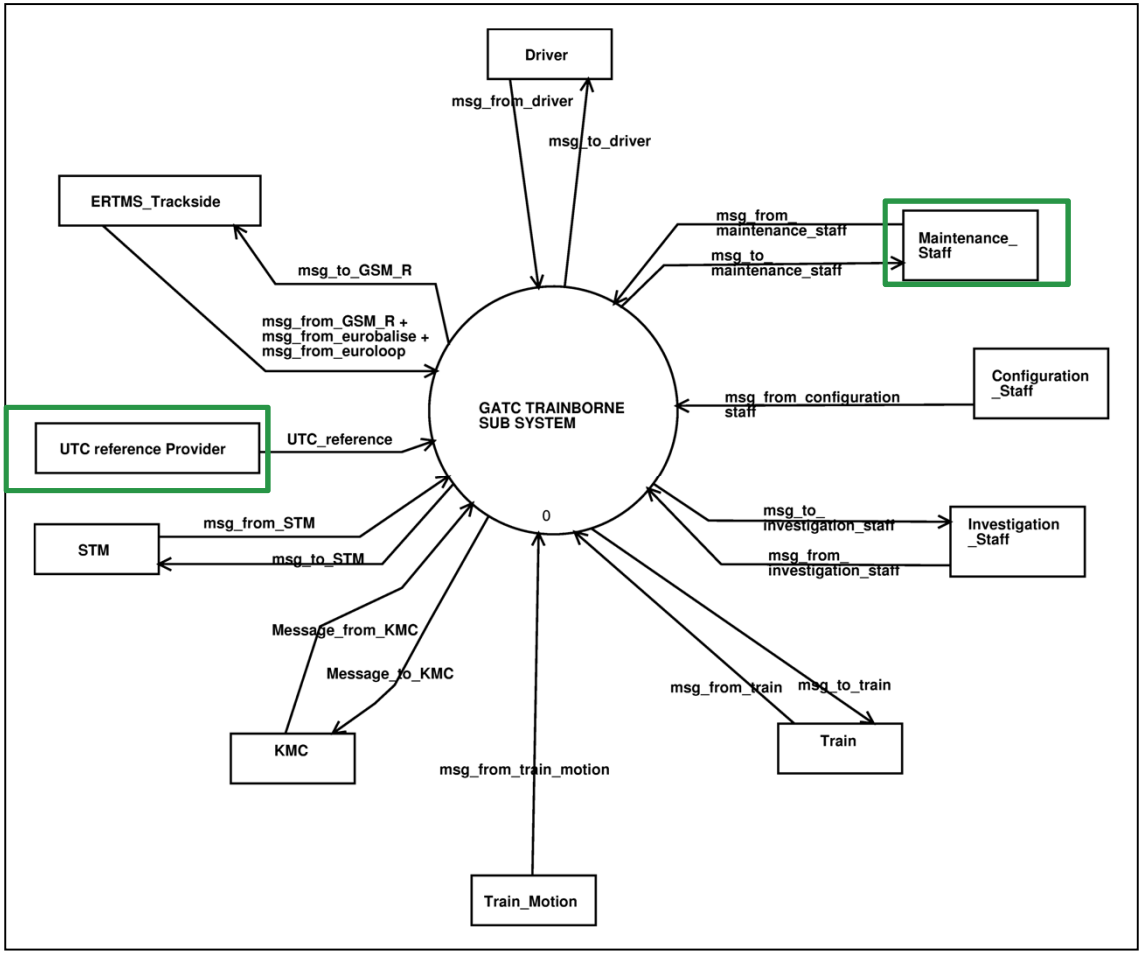
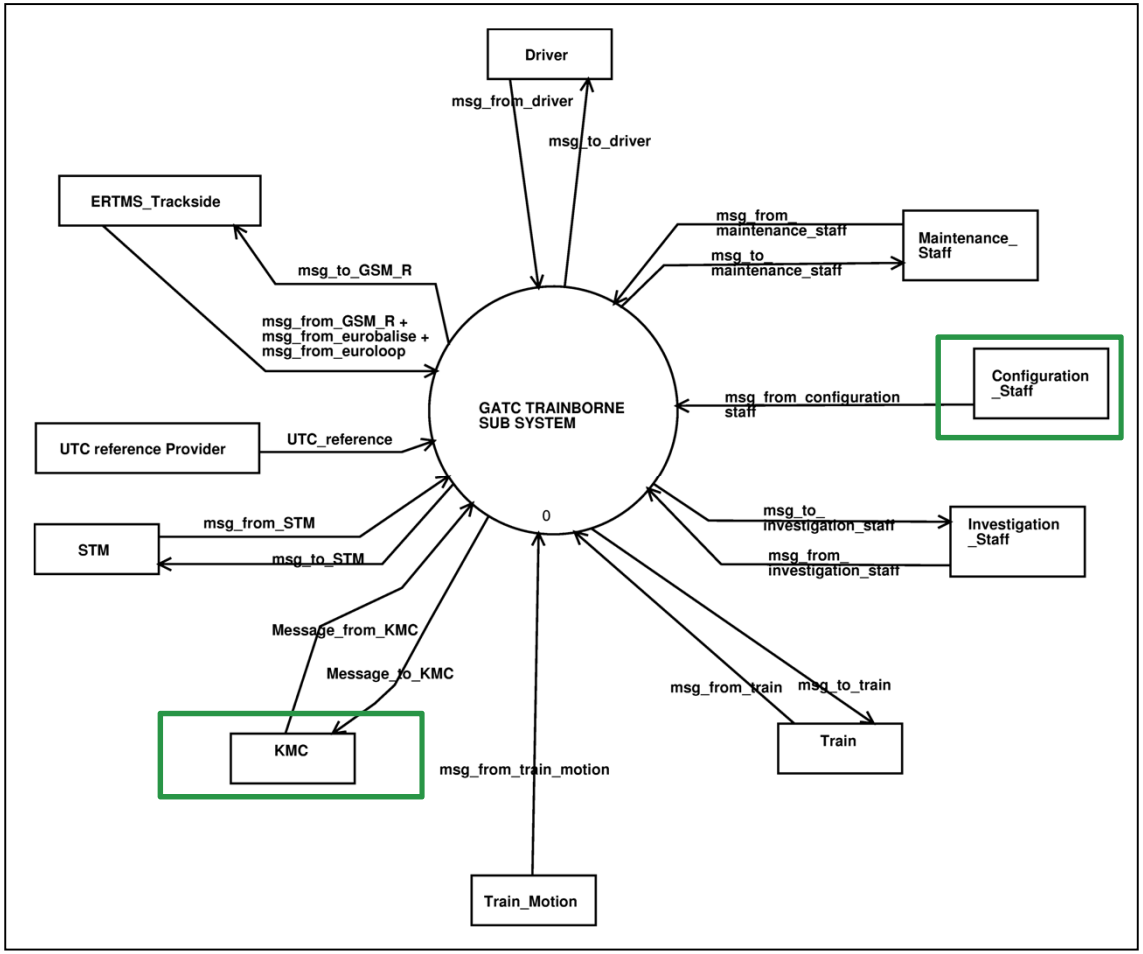
Overview

Maintenance context



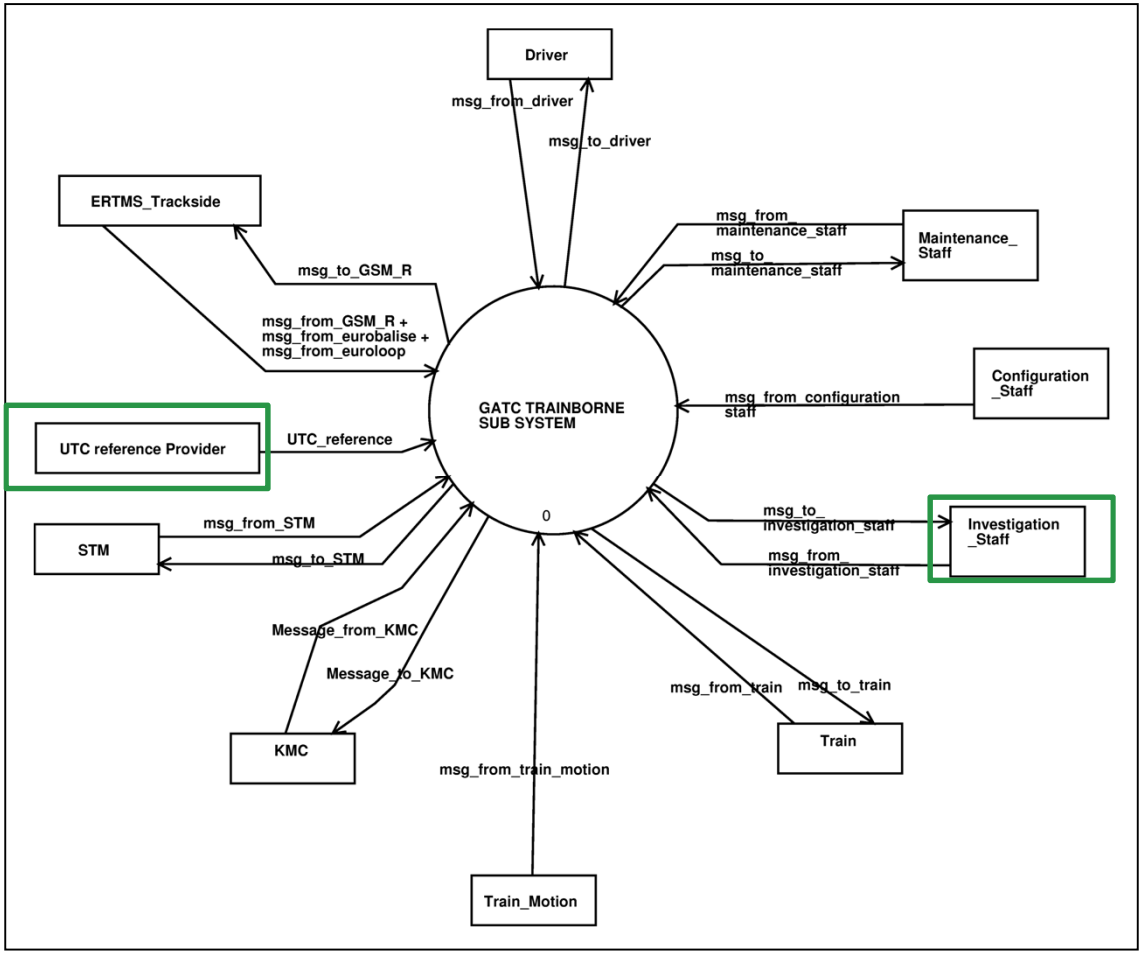
Overview

Configuration context



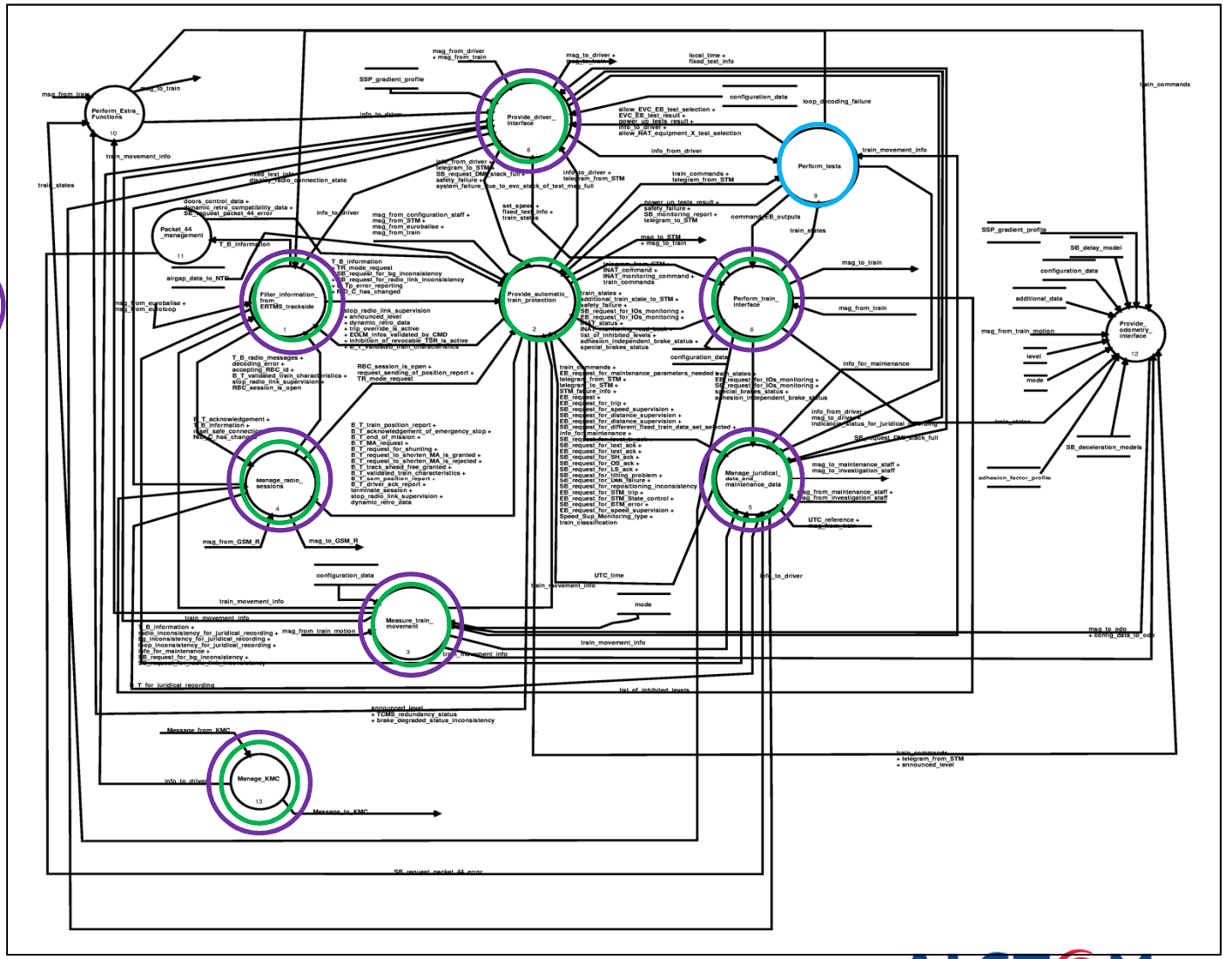
Overview

Investigation context



Data flow diagram – first level

- ETCS
- Interface
- Other
- proprietary



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DFD 0 – Trainborne Sub-system

Main trainborne functions:

- DFD 1 Filter information from ERTMS trackside
- DFD 2 Perform automatic train protection
- PS 3 Measure train movement
- DFD 4 Manage radio sessions
- DFD 5 Manage juridical data and maintenance data
- DFD 6 Perform train interface
- PS 8 Provide driver interface
- DFD 9 Perform tests
- DFD 13 Manage KMC

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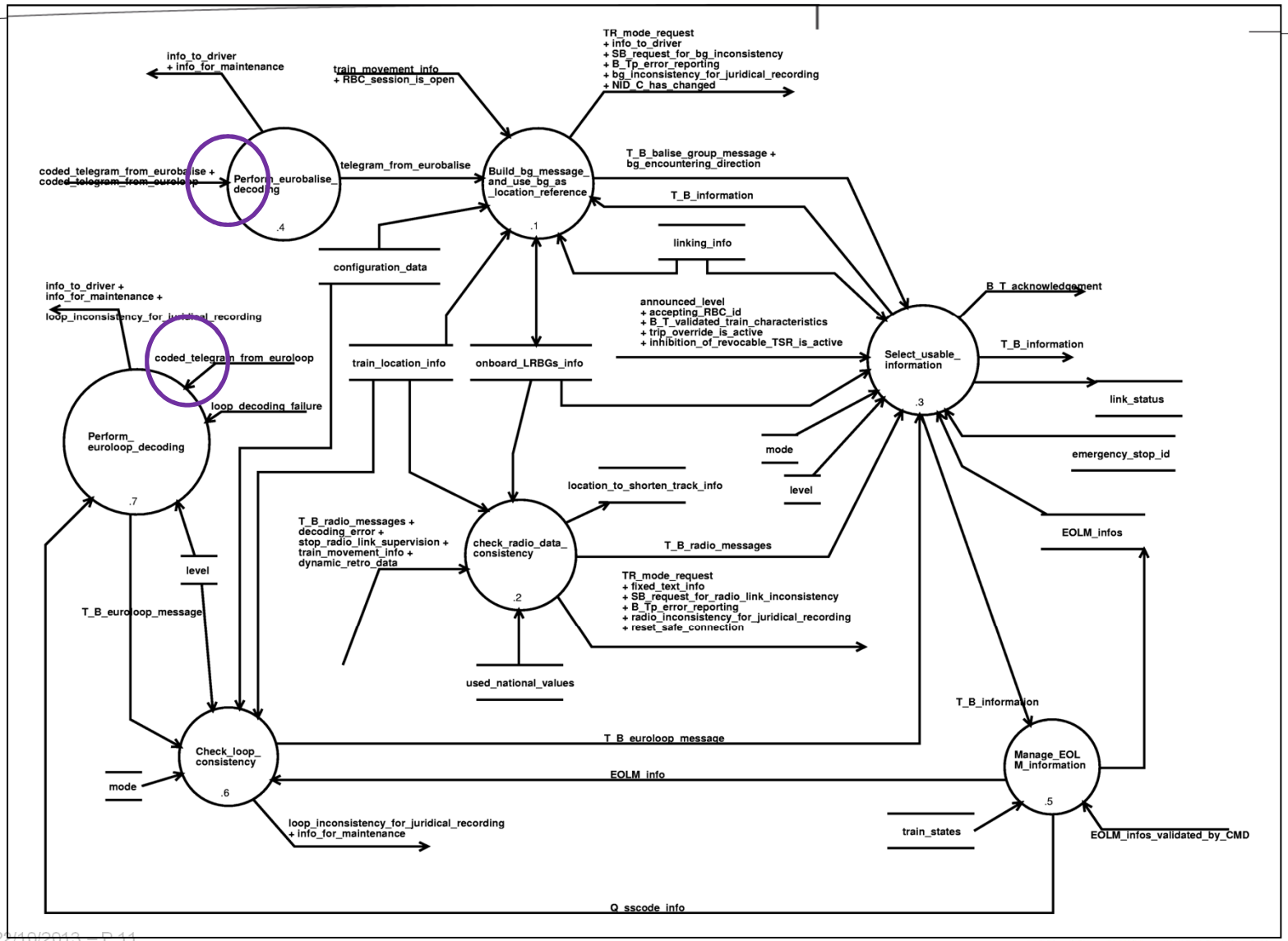
DFD 1 Filter information from ERTMS trackside



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DFD 1 Filter information from ERTMS trackside

Perform Eurobalise decoding

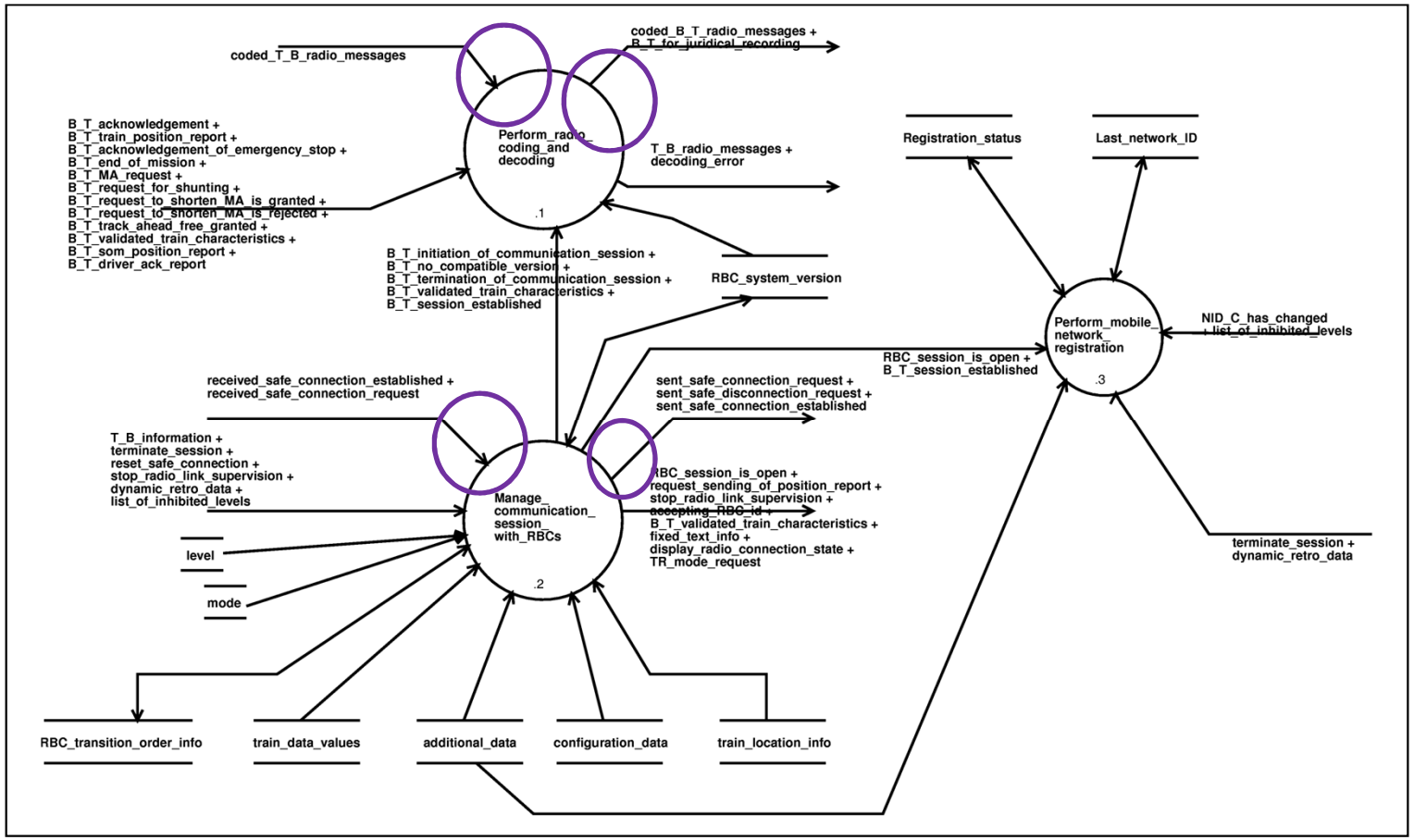
- P-spec interfacing with API

107. coded_telegram_from_eurobalise (data flow, pel) =
**.

---
rate : N/A
range : N/A
resolution : N/A
units : N/A
value names : N/A
description : telegram which is coded respect to eurobalise coding strategy.

745. telegram_from_eurobalise (data flow) =
T_B_balise_telegram_header +
0{T_Bp_national_values}1 +
0{T_Bp_national_values_for_braking_curves}1 +
0{T_Bp_linking}1 +
0{T_Bp_level_1_movement_authority}1 +
...
---
rate : N/A
range : N/A
resolution : N/A
units : N/A
value names : N/A
description :
"Telegram from eurobalise" is defined in SRS.

DFD 4 Manage radio sessions



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DFD 4 Manage radio sessions

Perform radio coding and decoding

- P-spec interfacing with API

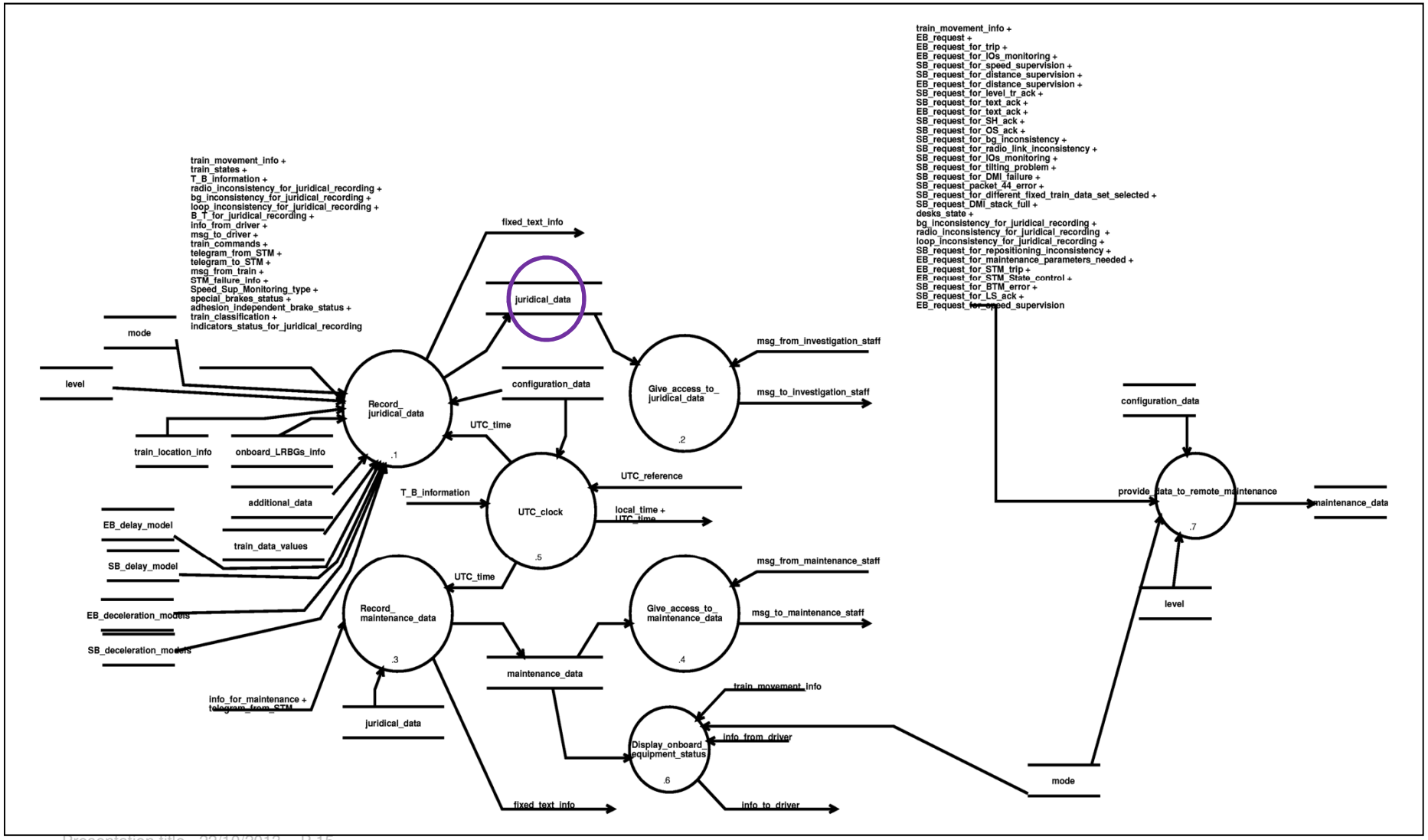
431. msg_from_GSM_R (data flow) =
coded_T_B_radio_messages +
received_safe_connection_request +
received_safe_connection_established.

---
rate : N/A
range : N/A
resolution : N/A
units : N/A
value names : N/A
description : message received from EURORADIO via GSM-R

670. T_B_movement_authority (data flow) =
T_B_radio_message_header
+T_Bp_level_2_3_movement_authority
+T_Bp_gradient_profile
+T_Bp_international_SSP
+T_Bp_MA_optional_packets.

---
rate : N/A
range : N/A
resolution : N/A
units : N/A
value names : N/A
description : Movement Authority from trackside,see SRS message ID 3
constituent of data/control flow: T_B_radio_messages

DFD 5 Manage juridical data and maintenance data



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DFD 5 Manage juridical data and maintenance data

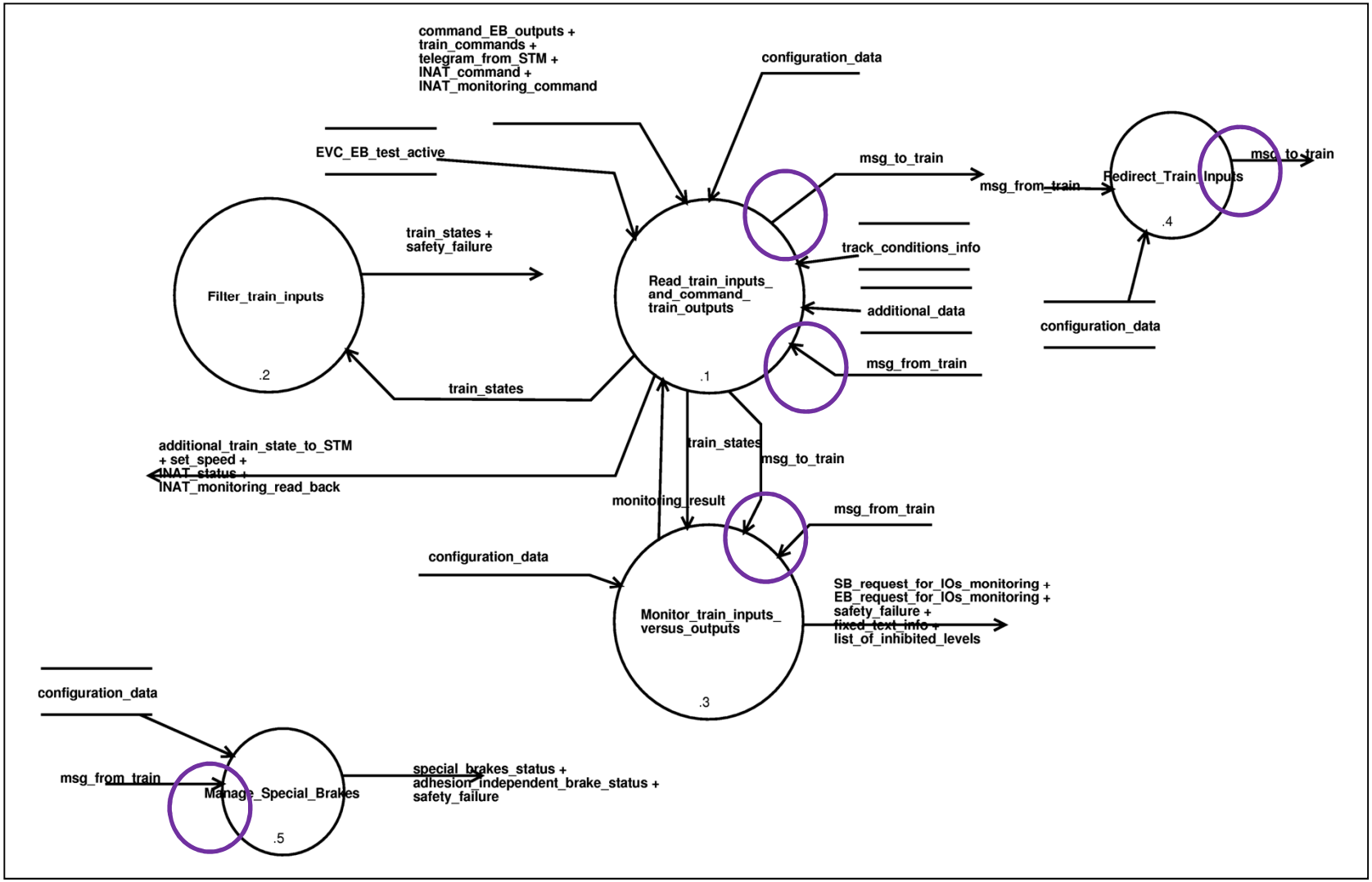
Record juridical data

- P-spec interfacing with API
- Subset-027

373. juridical_data (store, pel) =
**.

---
full name :
description : data recorder for juridical purpose.

DFD 6 Perform train interface



DFD 6 Perform train interface

Read train inputs and command train outputs

- P-spec interfacing with API
- Subset-034

435. msg_from_train (data flow) =
input_contacts
+ input_MVB
+ input_serial_link.

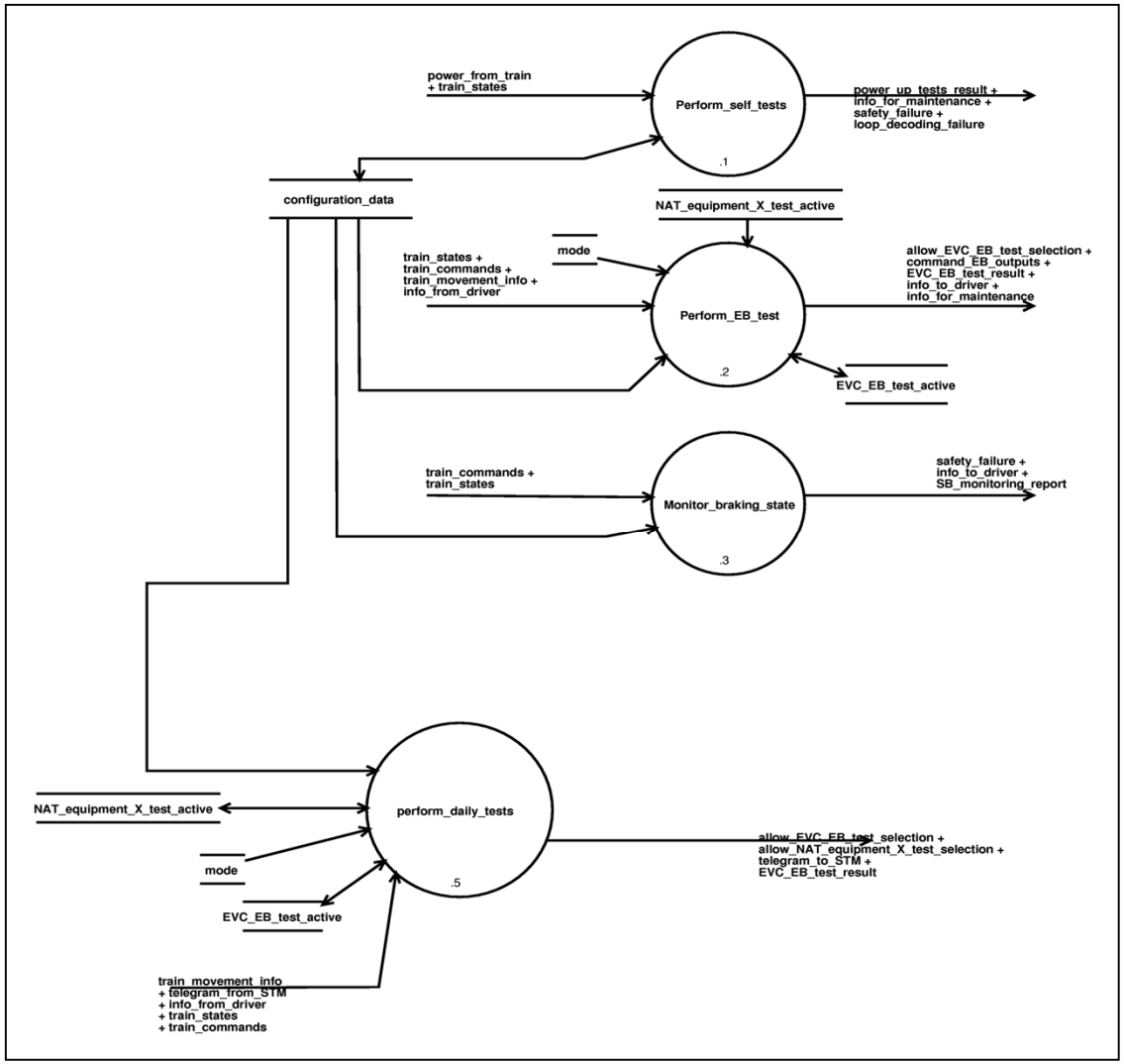
443. msg_to_train (data flow) =
output_contacts +
output_contact_EB1 +
output_contact_EB2 +
output_MVB +
output_serial_link.

786. train_states (store) =
power_from_train +
isolation_state +
desks_state +
sleeping_state +
direction_controller_state +
...
---
description : states of train equipments

766. train_commands (data flow) =
command_pantograph
+ command_circuit_breaker
+ command_air_tigthness
+ command_traction_cut_off
+ ...

description : commands sent to the train interface

DFD 9 Perform tests



DFD 9 Perform tests

Perform Emergency Brake test

- Essential function in StandBy mode
- Not described in Subset-026
- Driver interface (operational text messages): « 13.1.1.4 Results of the self-test and of the test of the external devices as mentioned in doc [3] §4.4.7.1.2 shall result in text messages only when some tests failed. These text messages are product dependent texts and are therefore not part of Table 50. »

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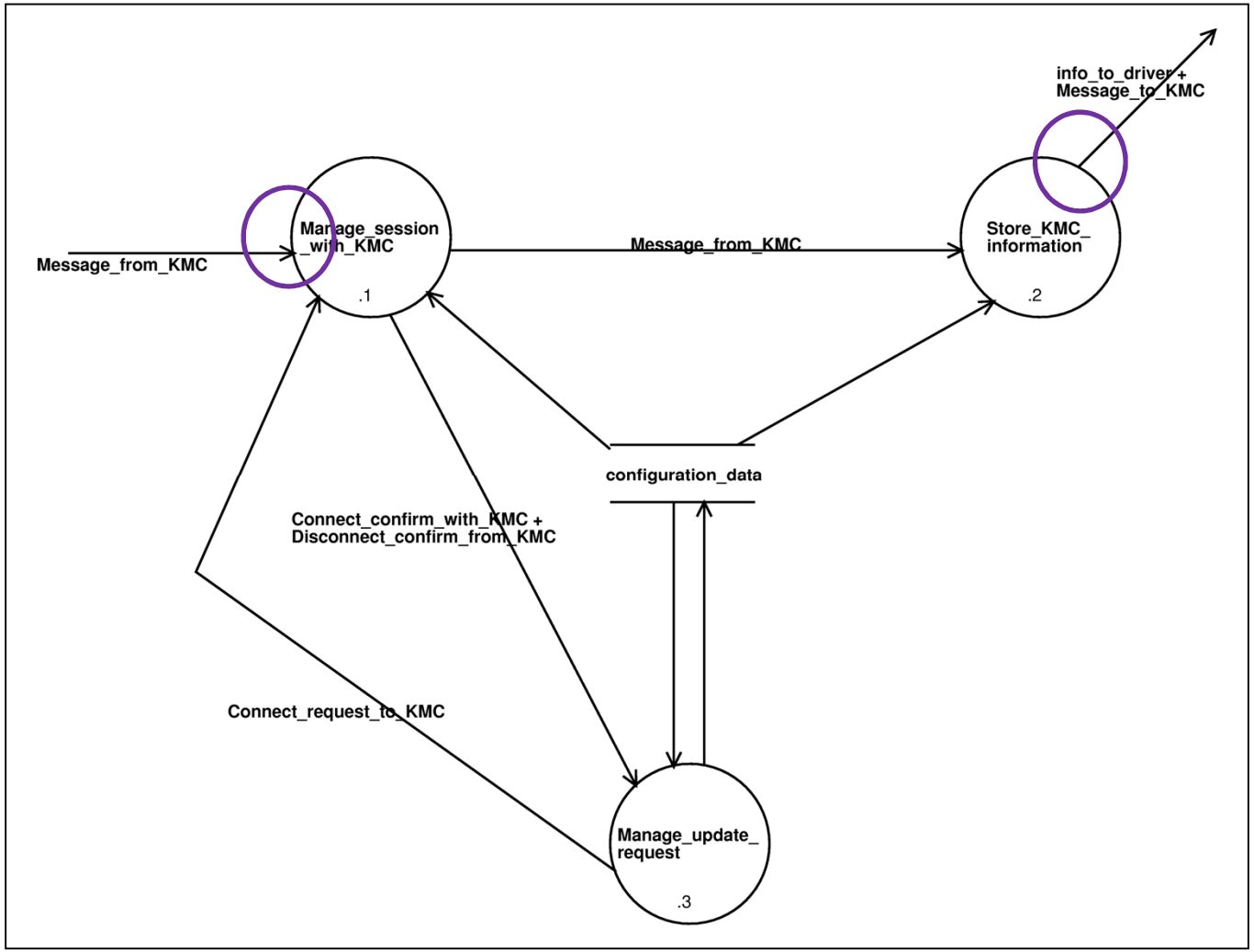
DFD 13 Manage KMC



DFD 13 Manage KMC

Manage session with KMC

- Subset-114
- Not part of application SW
- No interface with API

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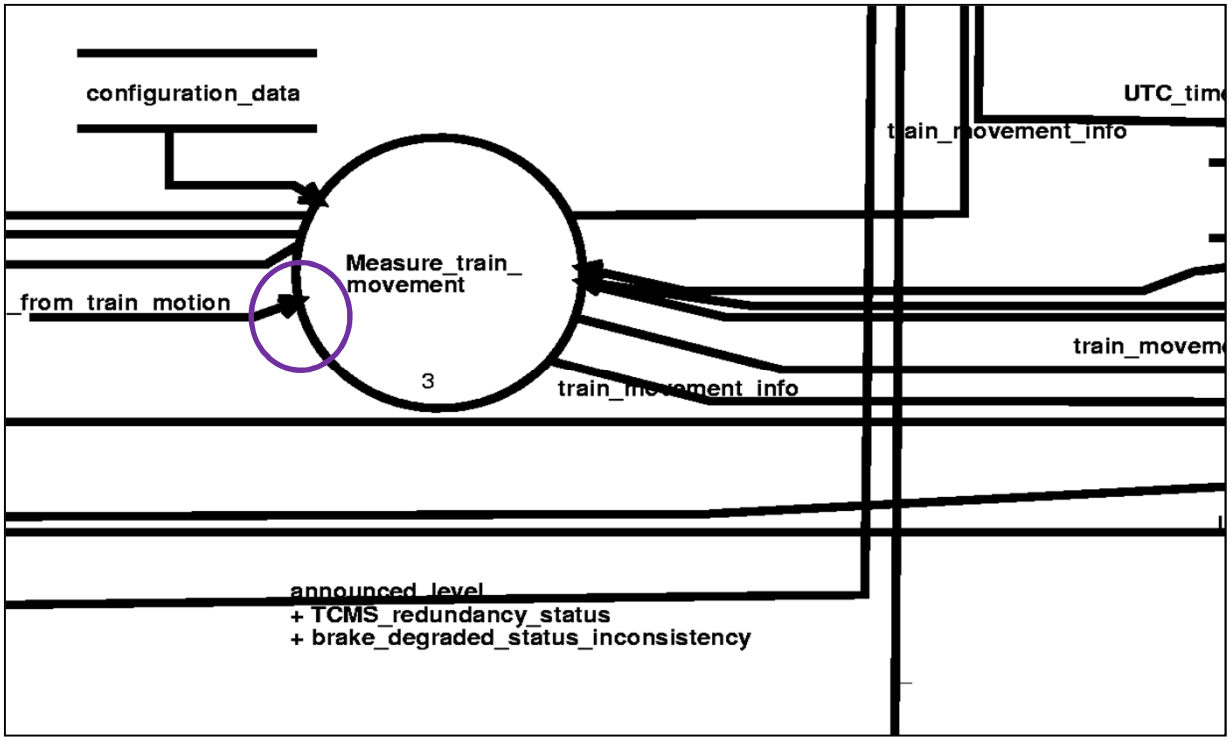
P-Spec 3 Measure train movement



P-Spec 3 Measure train movement

Measure train movement

- P-spec interfacing with API

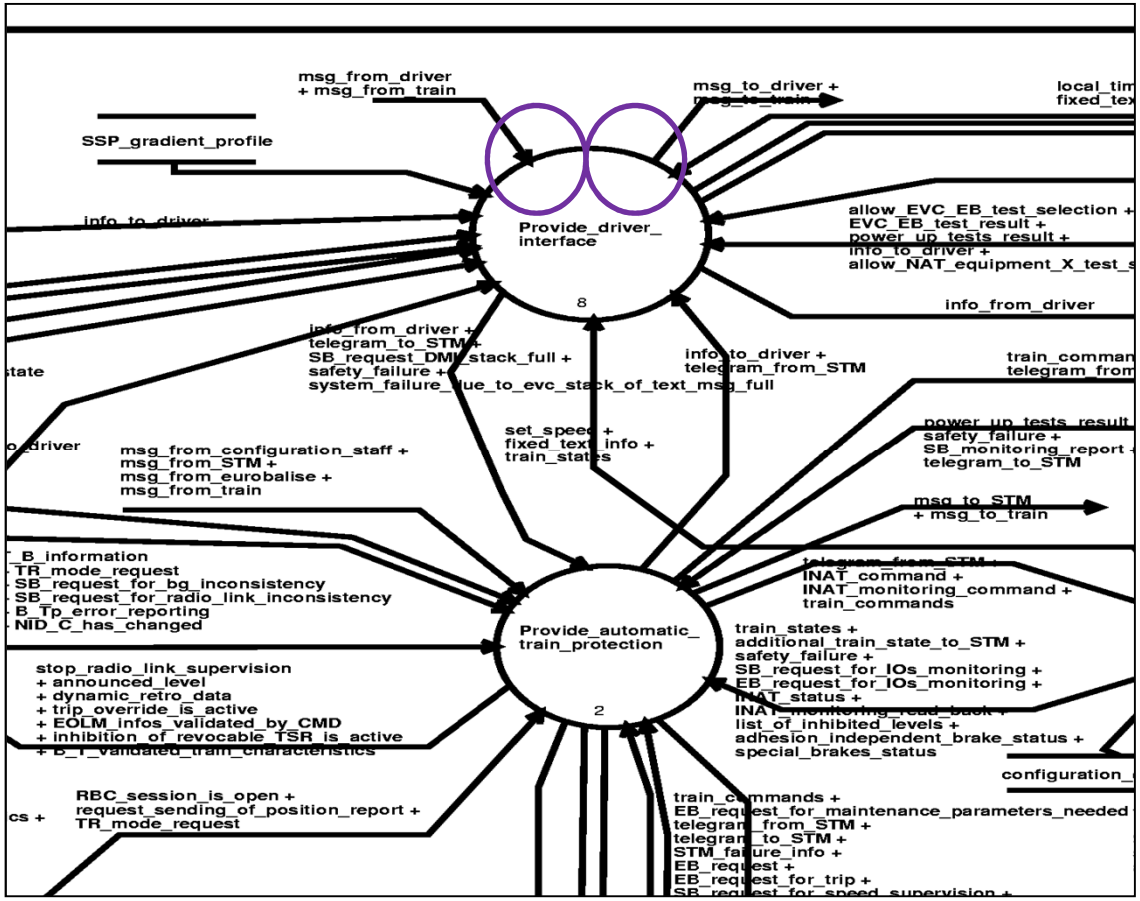
436. msg_from_train_motion (data flow, pel) =
**.

---
rate : N/A
range : N/A
resolution : N/A
units : N/A
value names : N/A
description : This msg is representative of the train motion, which is seen as an input for motion sensors (such as wheel sensors or doppler radar).

780. train_movement_info (data flow) =
absolute_distance_counter
+ train_speed
+ train_acceleration
+ motion_direction
+ motion_state
+ train_adhesion.

---
rate : Continously available since the power-on of the equipment.
range : N/A
resolution : N/A
units : N/A
value names : N/A
description : train movement information provided by the function handling the MMU equipment.

P-spec 8 Provide driver interface



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P-spec 8 Provide driver interface

Provide driver interface

- P-spec interfacing with API
- ERA ERTMS 015560

363. info_to_driver (data flow) =

announced_level
+ display_route_suitability_data
+ display_ack_request
+ display_track_conditions
+ ...

---

rate : N/A
range : N/A
resolution : N/A
units : N/A
value names : N/A
description : This is the raw message to the driver, it shall include all the output to the driver.

359. info_from_driver (data flow) =

driver_enters_SR_data
+ driver_select_EVC_EB_test
+ driver_select_change_level
+ driver_shunting_request
+ driver_select_exit_shunting
+ driver_non_leading_request
+ driver_select_exit_non_leading
+ ...

---

rate : N/A
range : N/A
resolution : N/A
units : N/A
value names : N/A
description : This is the raw message from the driver, it shall include all the input from the driver regardless of the mean of communication.

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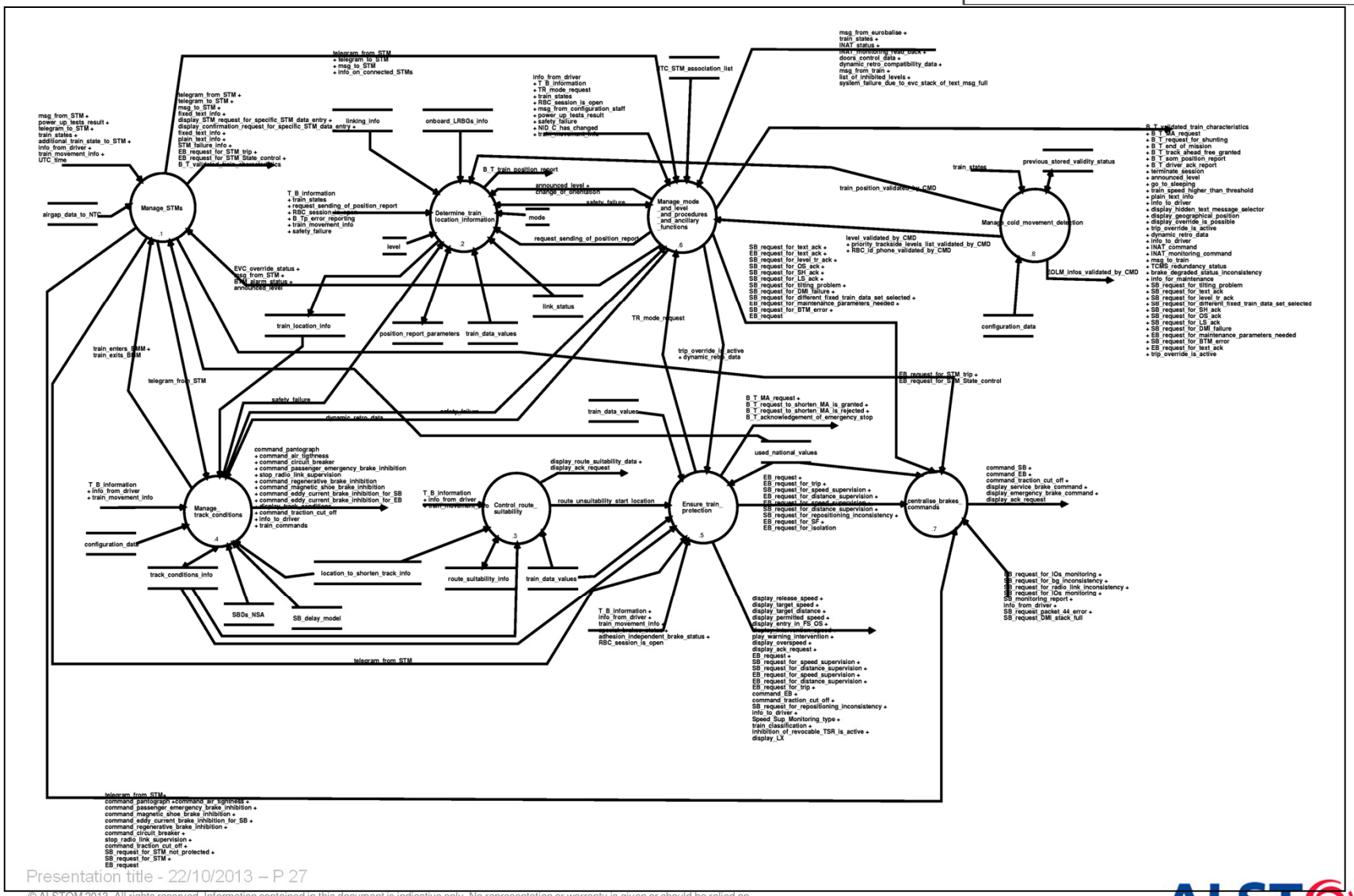
DFD 2 Provide automatic train protection



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DFD 2 Provide automatic train protection

Core function composed of:

- DFD 2.1 Manage STMs
- PS 2.2 Determine train location information
- PS 2.3 Control route suitability
- PS 2.4 Manage track conditions
- DFD 2.5 Ensure train protection
- DFD 2.6 Manage mode and level and procedure and ancillary functions
- PS 2.7 Centralize brake commands
- PS 8 Manage cold movement detection

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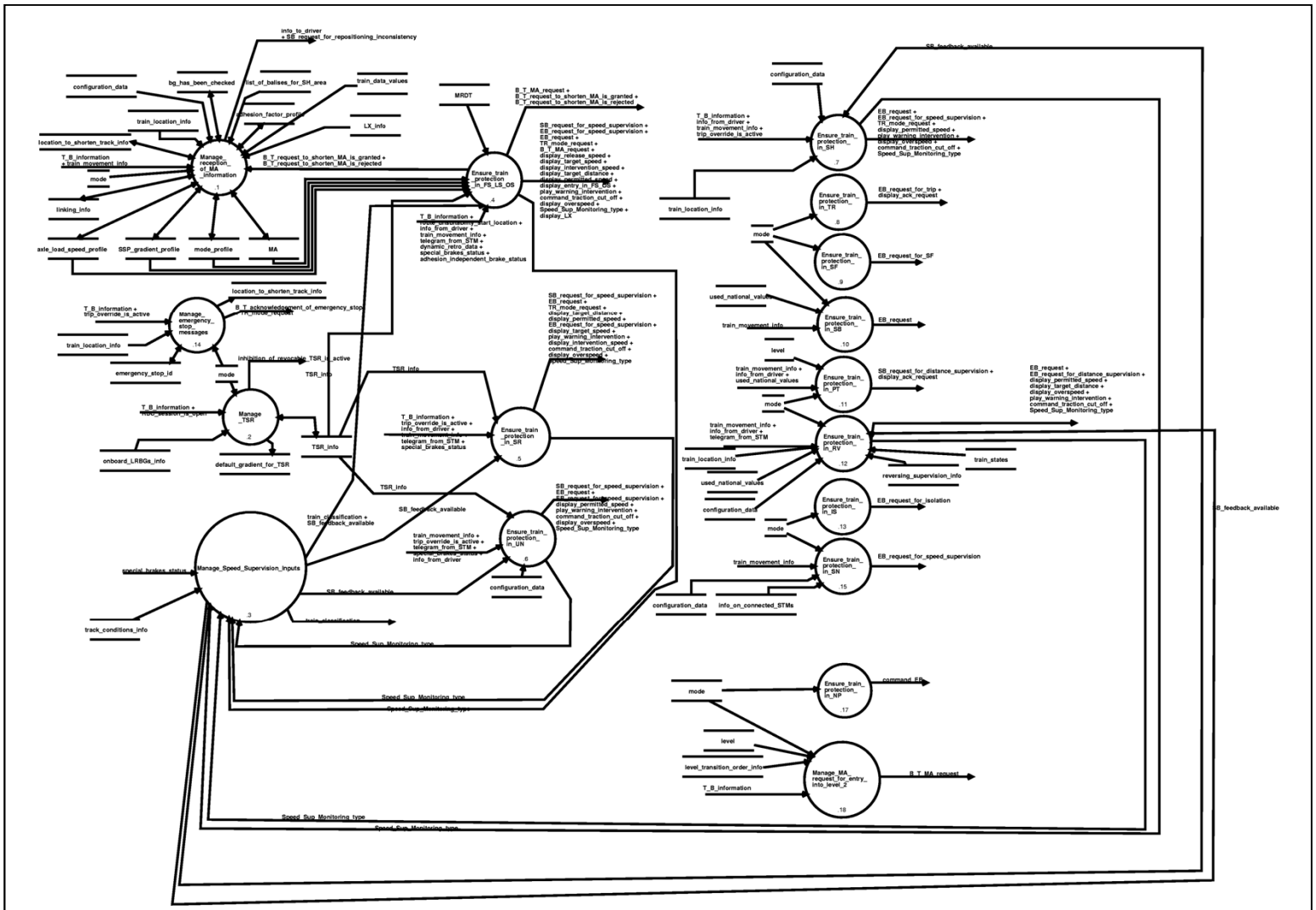
DFD 2.5 Ensure train protection



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DFD 2.5 Ensure train protection

Composed of:

- PS 2.5.1 Manage_reception_of_MA_information
- PS 2.5.2 Manage_TSR
- DFD 2.5.3 Manage speed supervision inputs
- DFD 2.5.4 Ensure_train_protection_in_FS_LS_OS
- DFD 2.5.5 Ensure_train_protection_in_SR
- DFD 2.5.6 Ensure_train_protection_in_UN
- DFD 2.5.7 Ensure_train_protection_in_SH
- PS 2.5.8/9/10/11/12/13/15/17 Ensure_train_protection_in_XX
- PS 2.5.14 Manage_emergency_stop_messages
- PS 2.5.18 Manage_MA_request_for_entry_into_level_2

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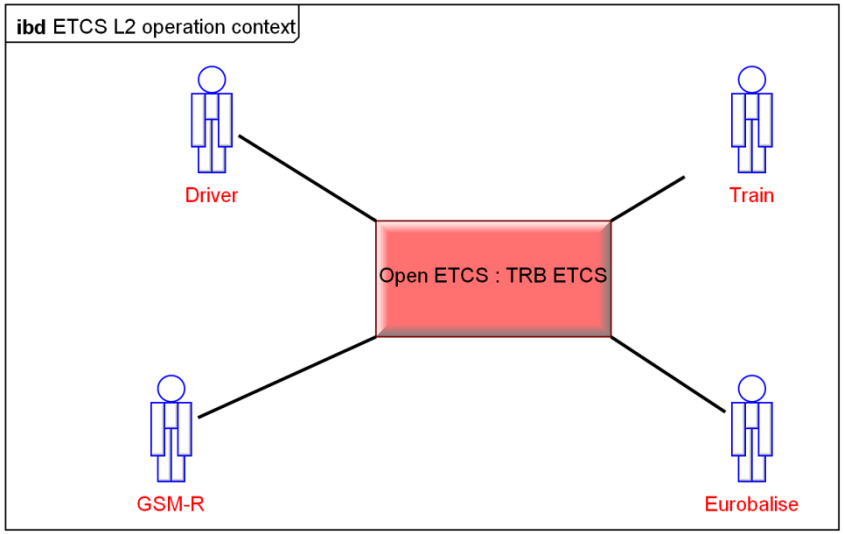
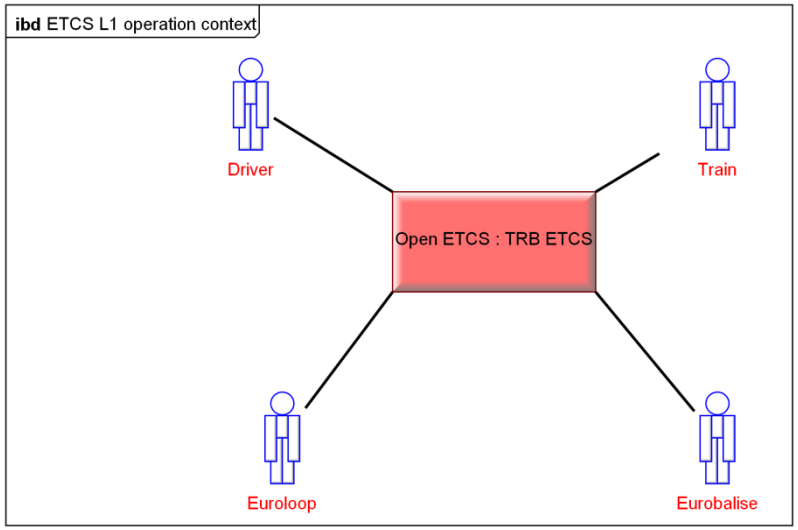
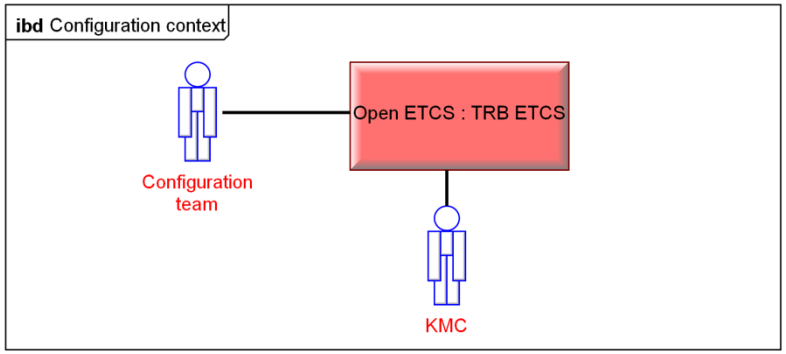
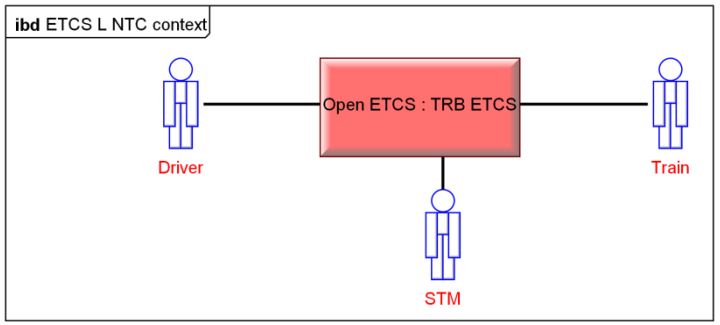
Evolution to SysML

SysML equivalent for ETCS contexts (proposal)









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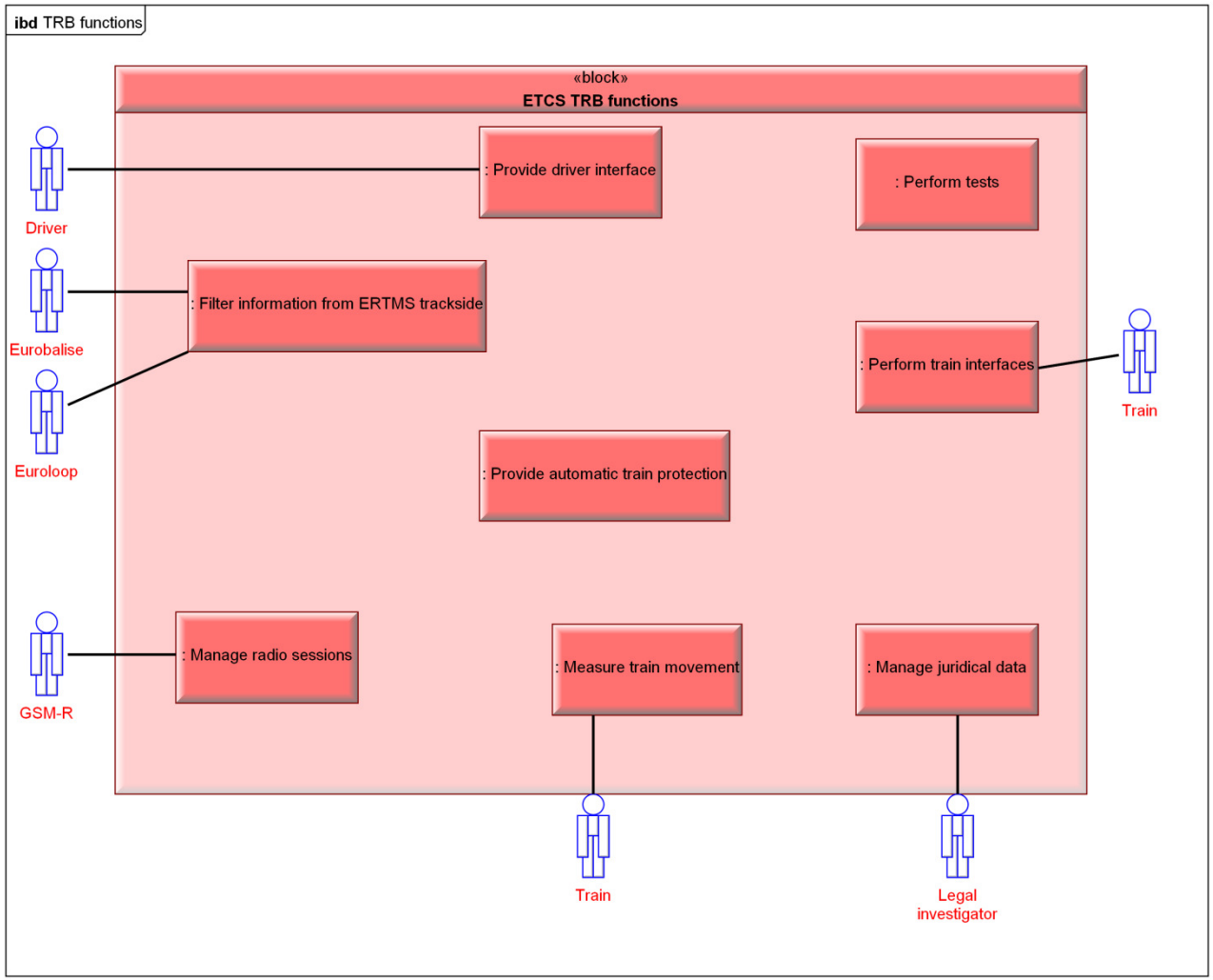
Evolution to SysML

SysML equivalent for DFD0 (proposal)



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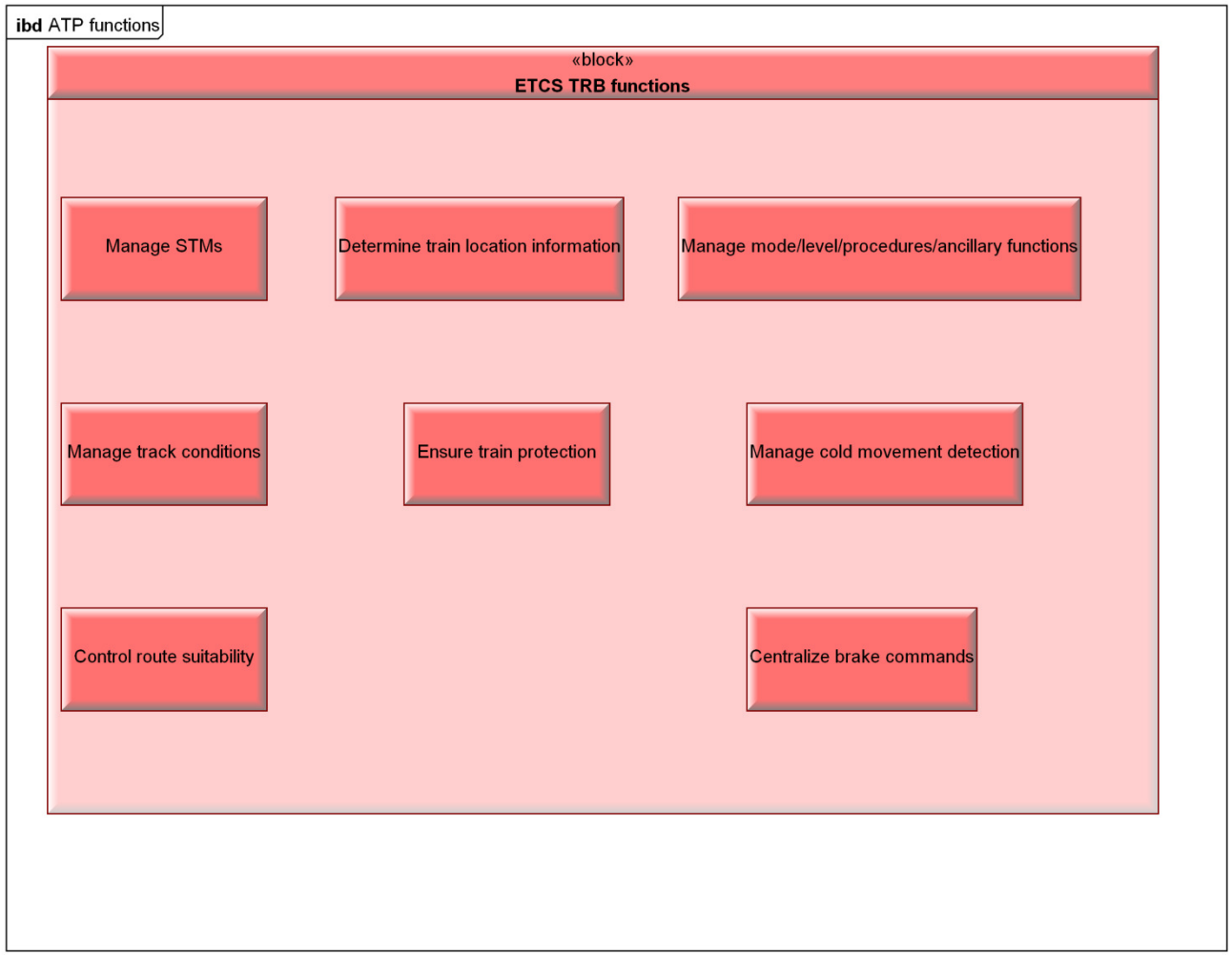
Evolution to SysML

SysML equivalent for DFD 2 (proposal)



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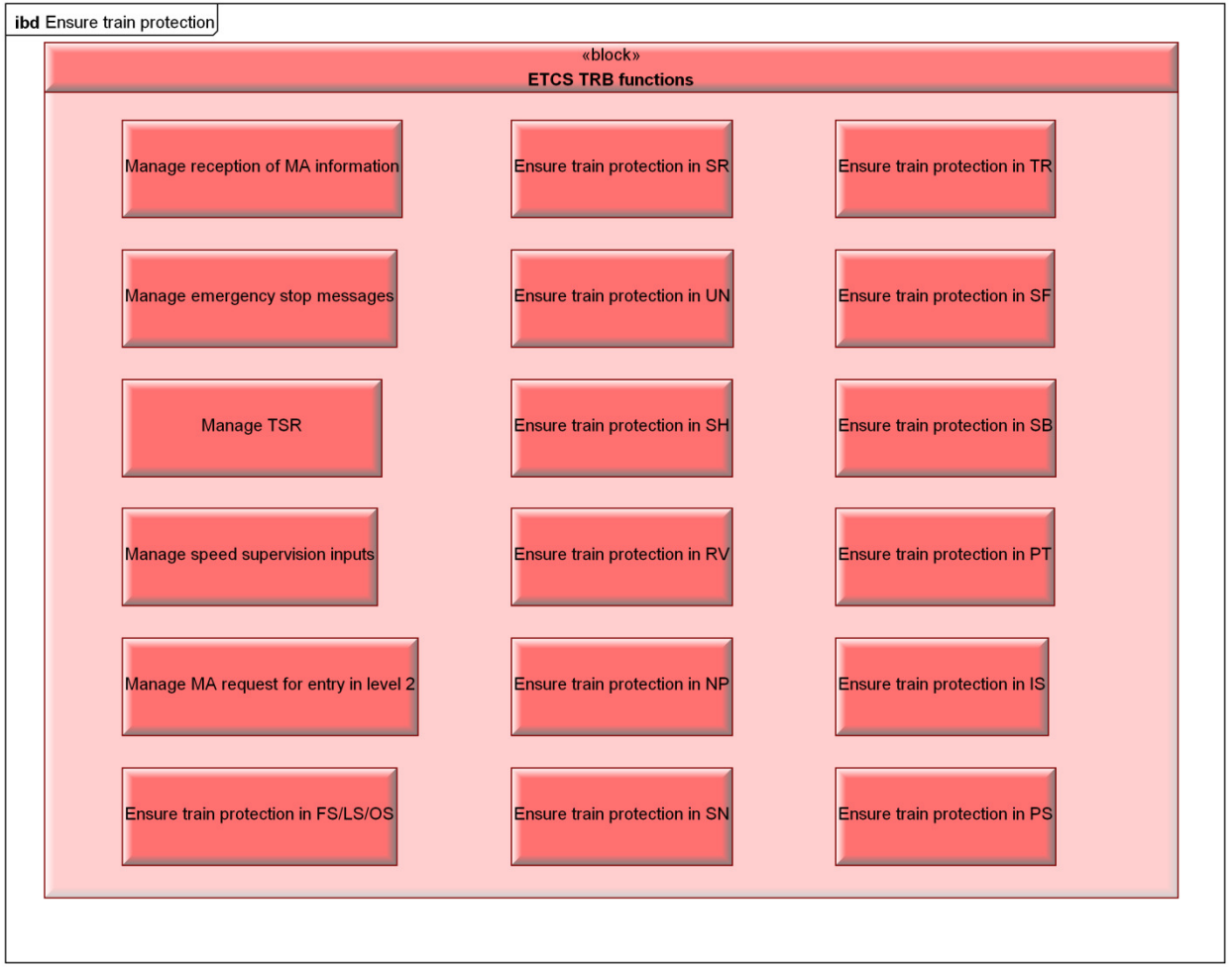
Evolution to SysML

SysML equivalent for DFD 2.5 (proposal)



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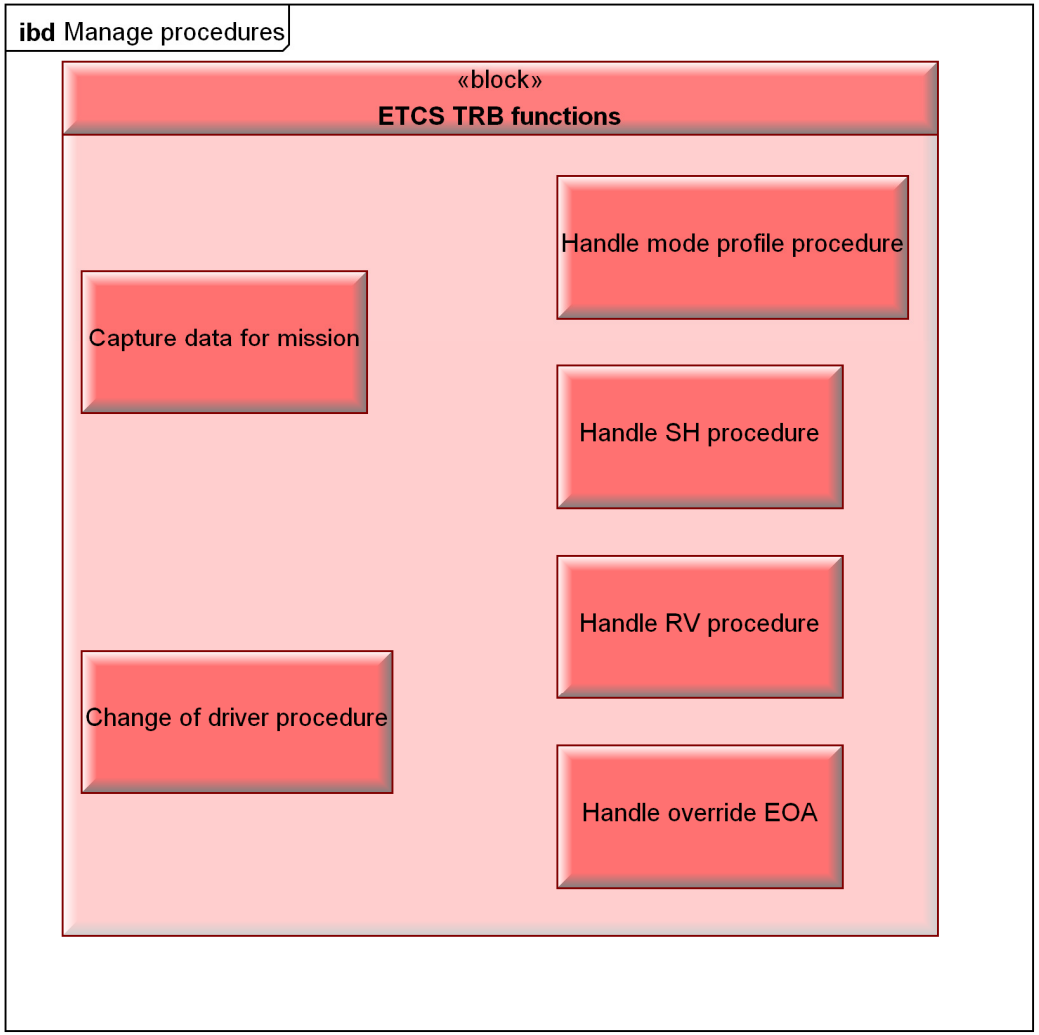
Evolution to SysML

SysML equivalent for DFD 2.6.3 (proposal)



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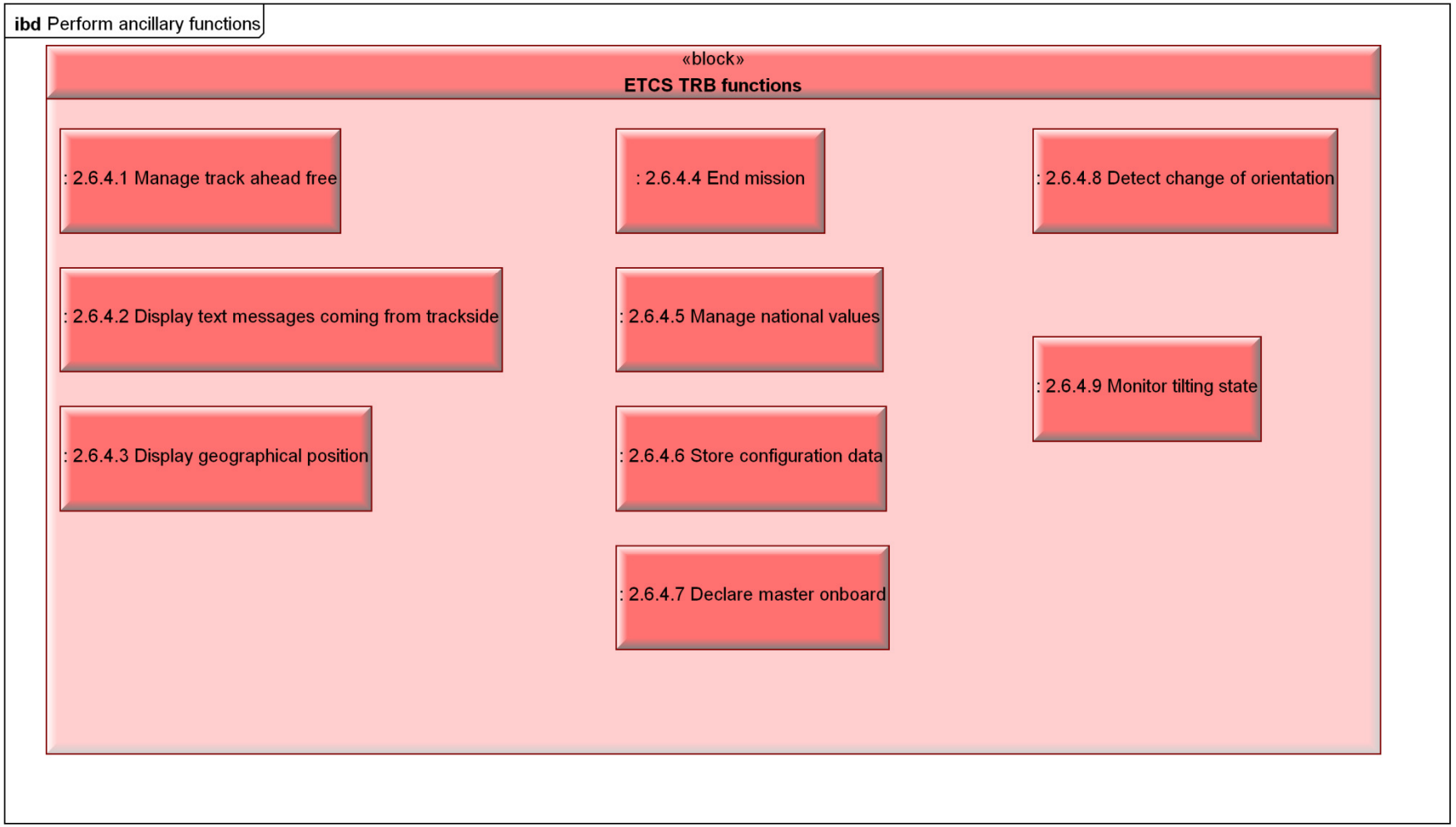
Evolution to SysML

SysML equivalent for DFD 2.6.4 (proposal)

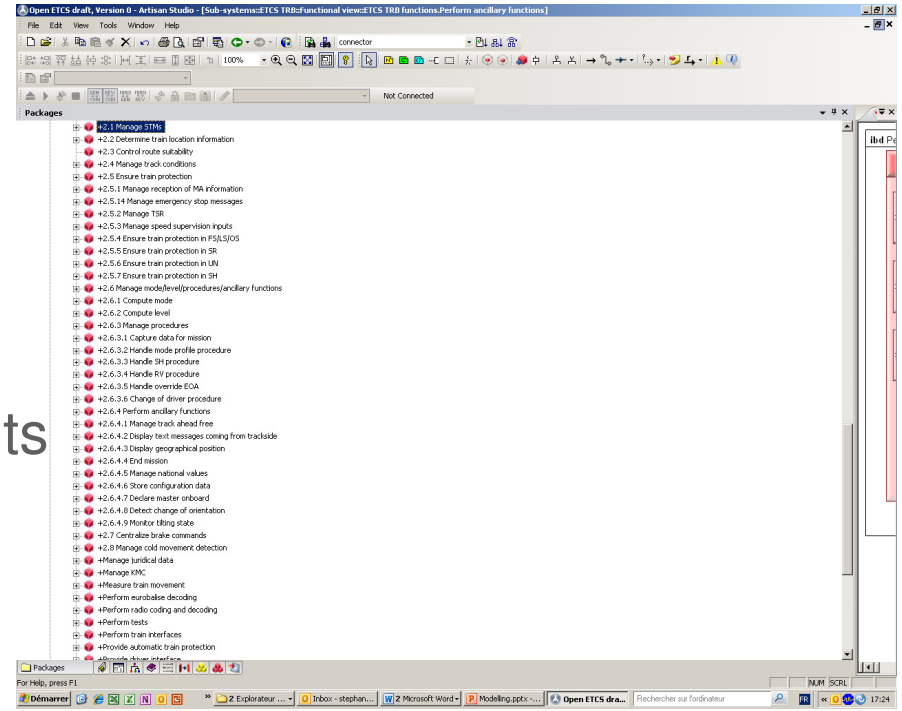


Evolution to SysML

Modelling task (proposal)

- 48 building blocks for the solution
- Defined interfaces (data flows)
- Subset-026 is covered
- SysML modelling with IBD:
  - 1 IBD / function (context)
  - Static behavior based on I/O
- SysML modelling distributed
  - Allocation between participants

Feuille Microsoft Excel 97-2003



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Example: Display text messages coming from trackside

Inputs:

- Subset-026 chapter 3 - Text transmission
  - 3.12.3.1 General rules
  - 3.12.3.2 Text message classes
  - 3.12.3.3 Fixed text messages
  - 3.12.3.4 Conditions for start/end of indication
  - 3.12.3.5 Report of driver acknowledgement to RBC
- Subset-026 chapter 4
  - 4.7.2 DMI vs mode
  - 4.8.3 Accepted information depending on the level and transmission media
- Subset-026 chapter 7 & 8
  - Packets 72 & 76
  - Messages 24 & 158

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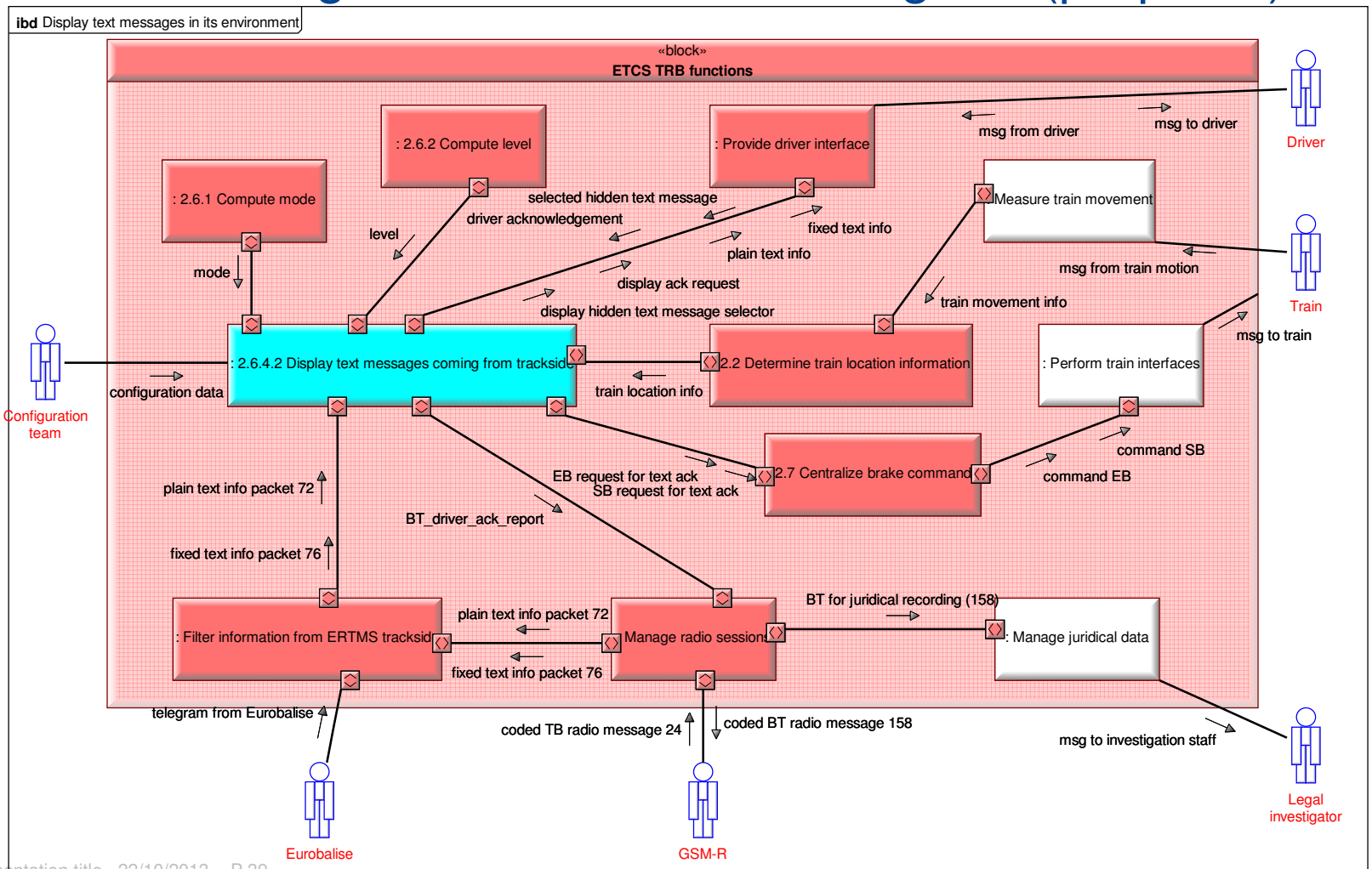
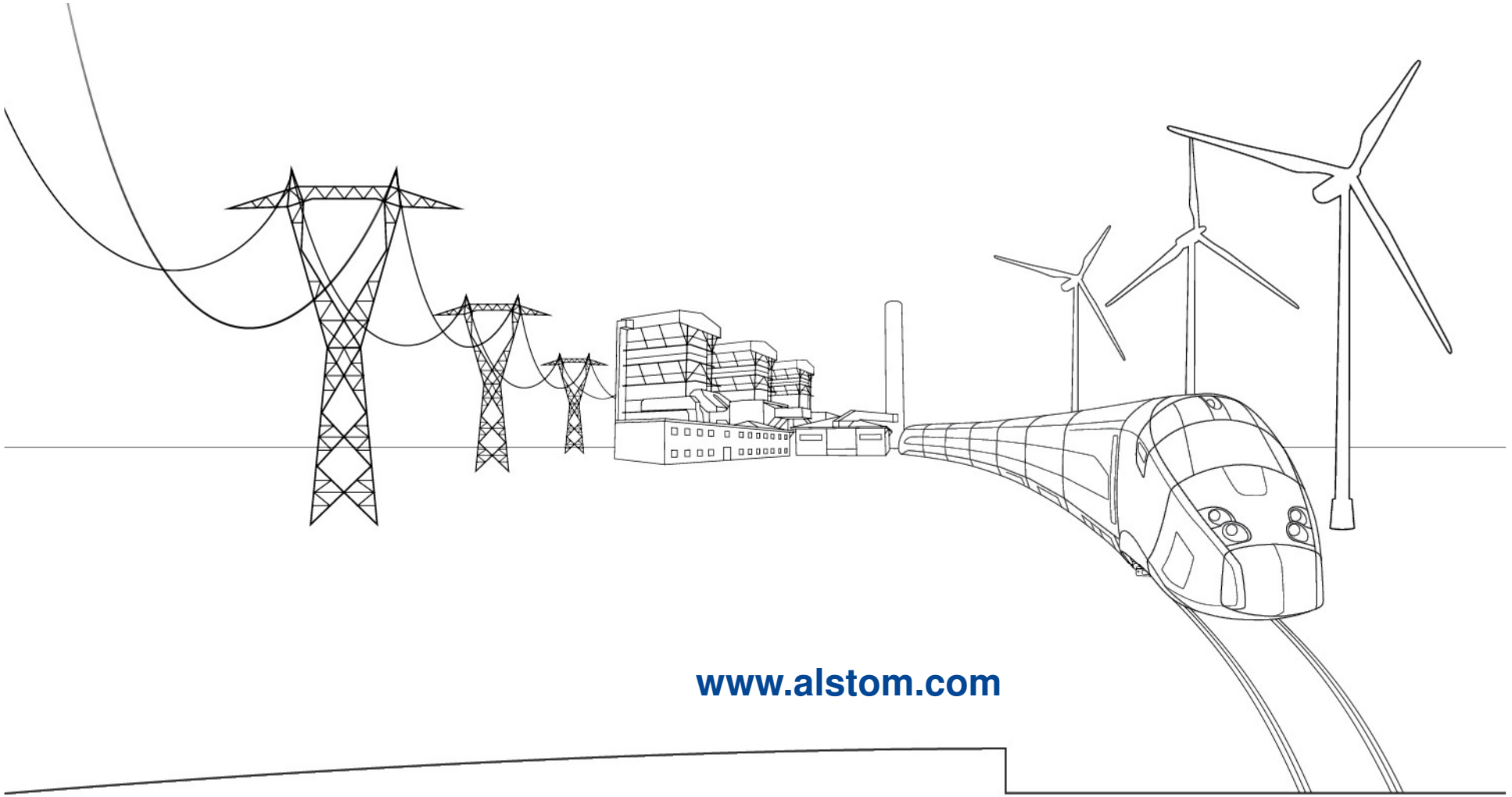
Example: Display text messages coming from trackside

Modelling with Internal Block Diagram (proposal)





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Is printing this presentation really necessary?

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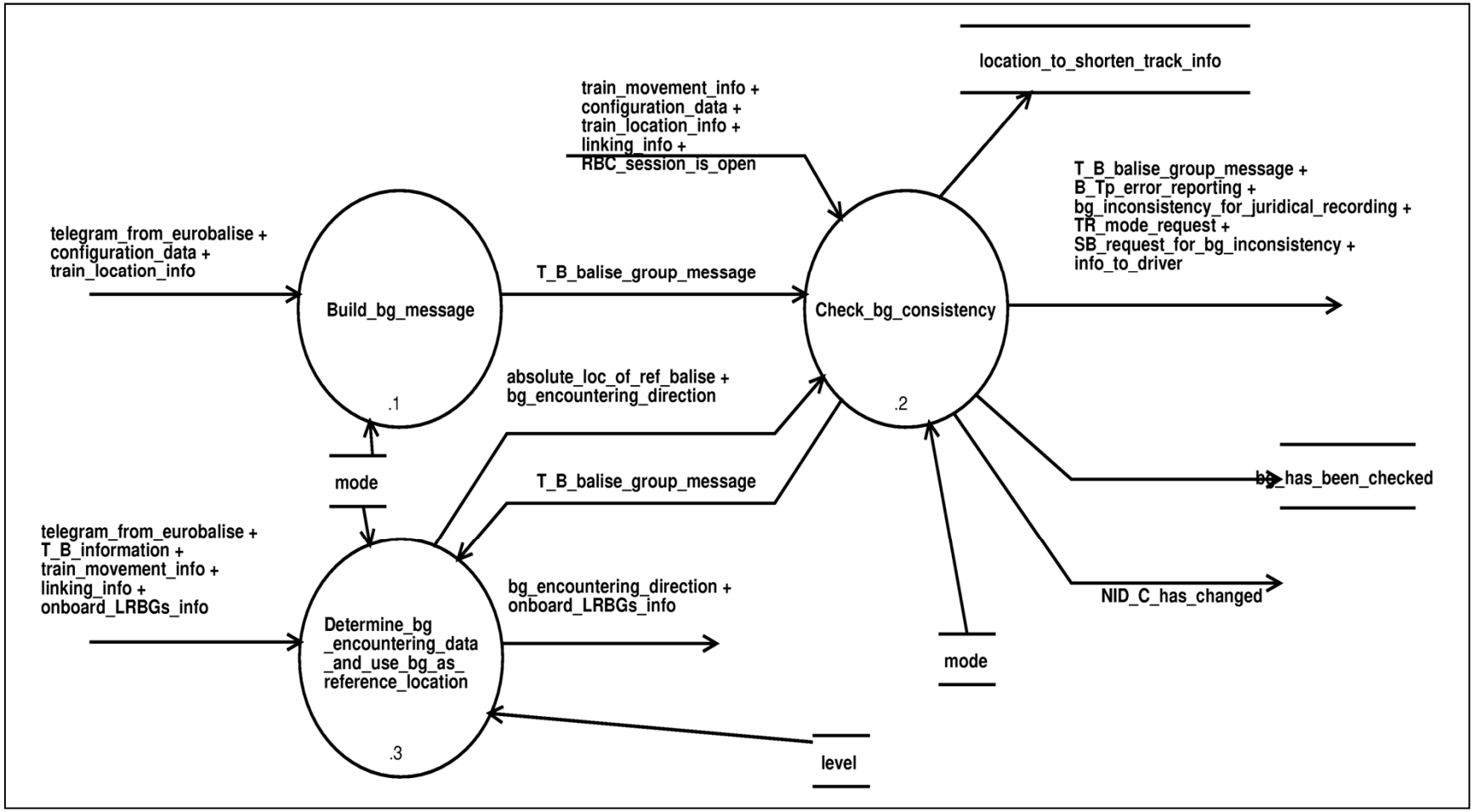
Shaping the future

Build_bg_message_and_use_bg_as_location_reference



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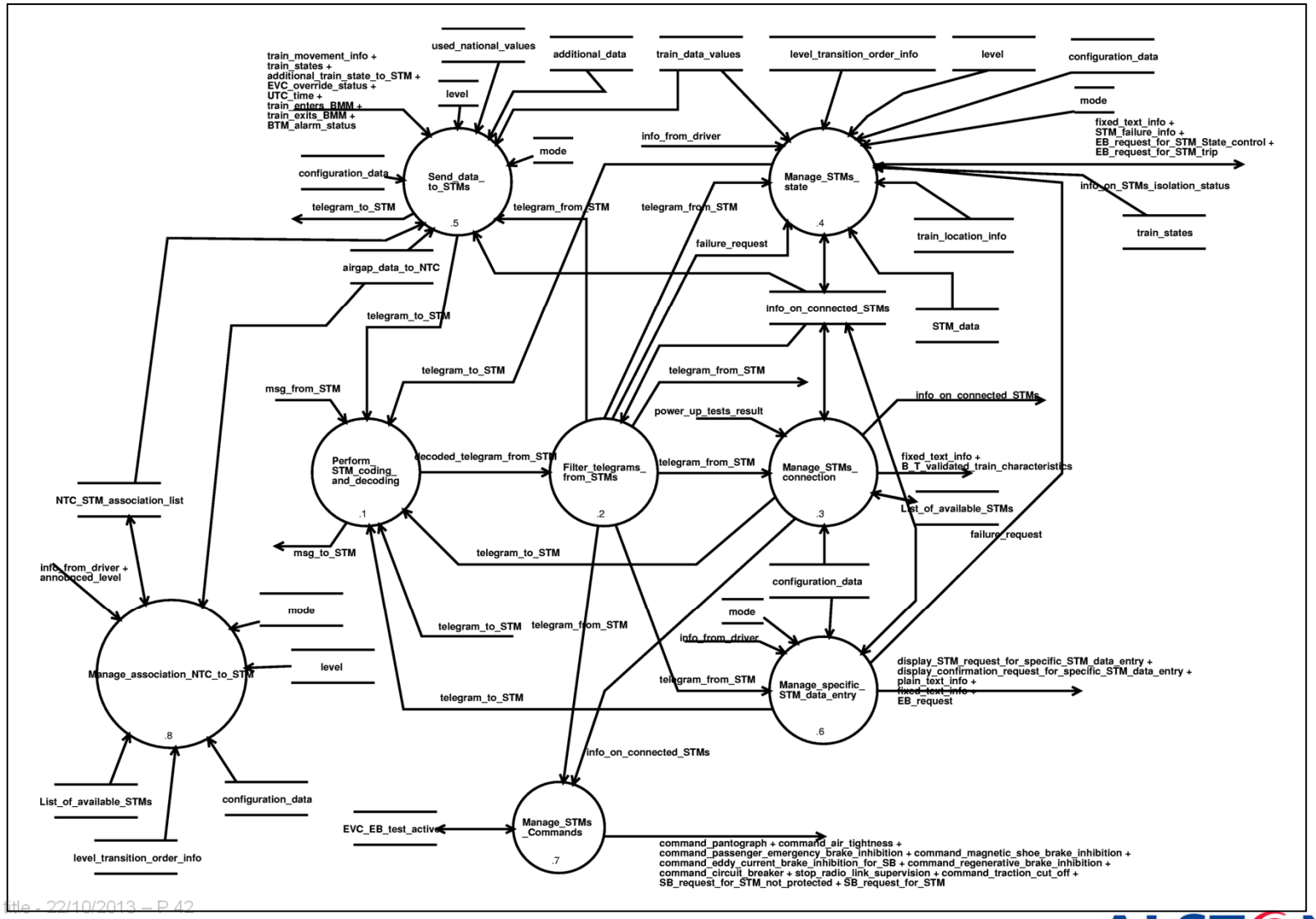
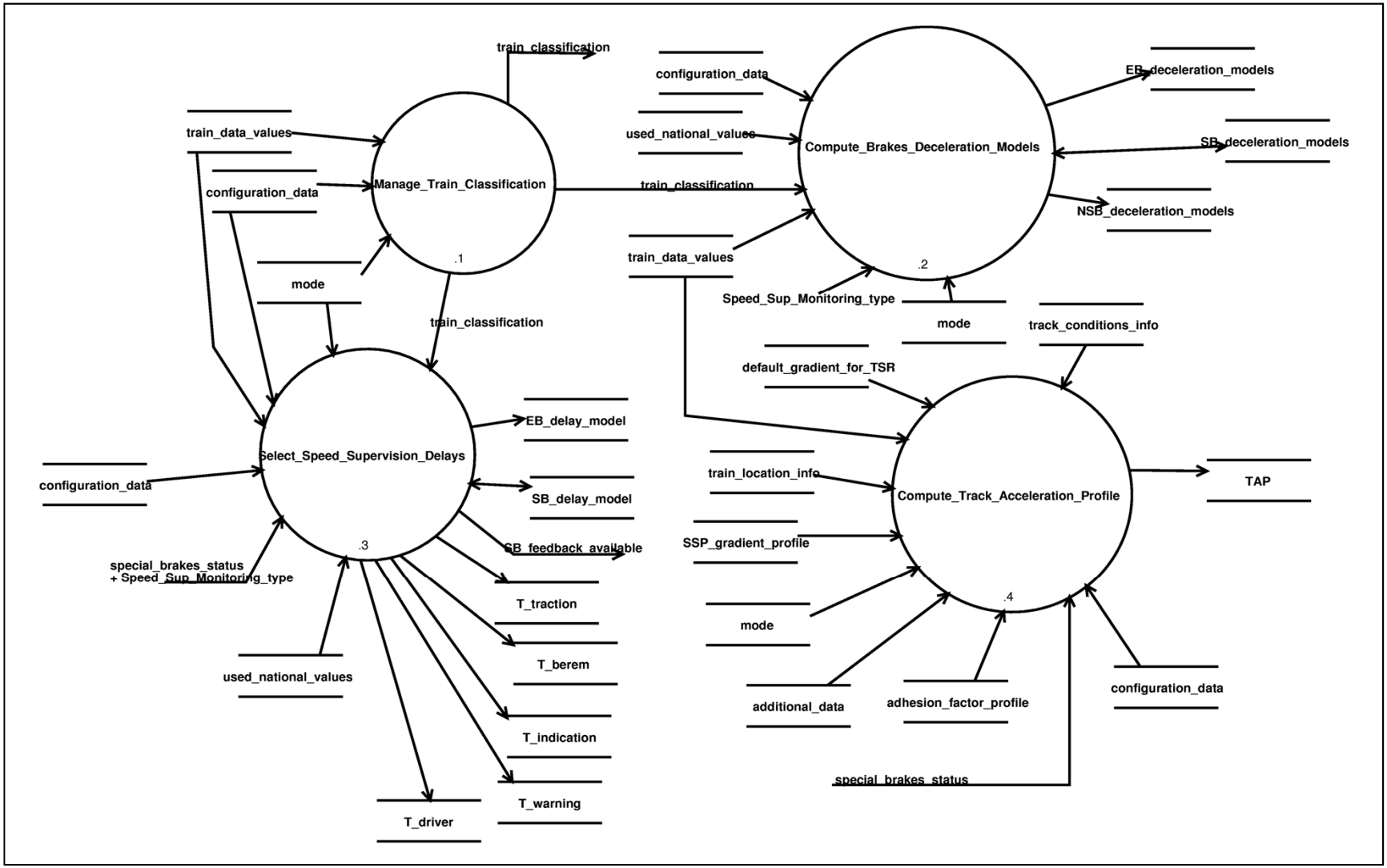
Manage_STMs



Manage_Speed_Supervision_Inputs



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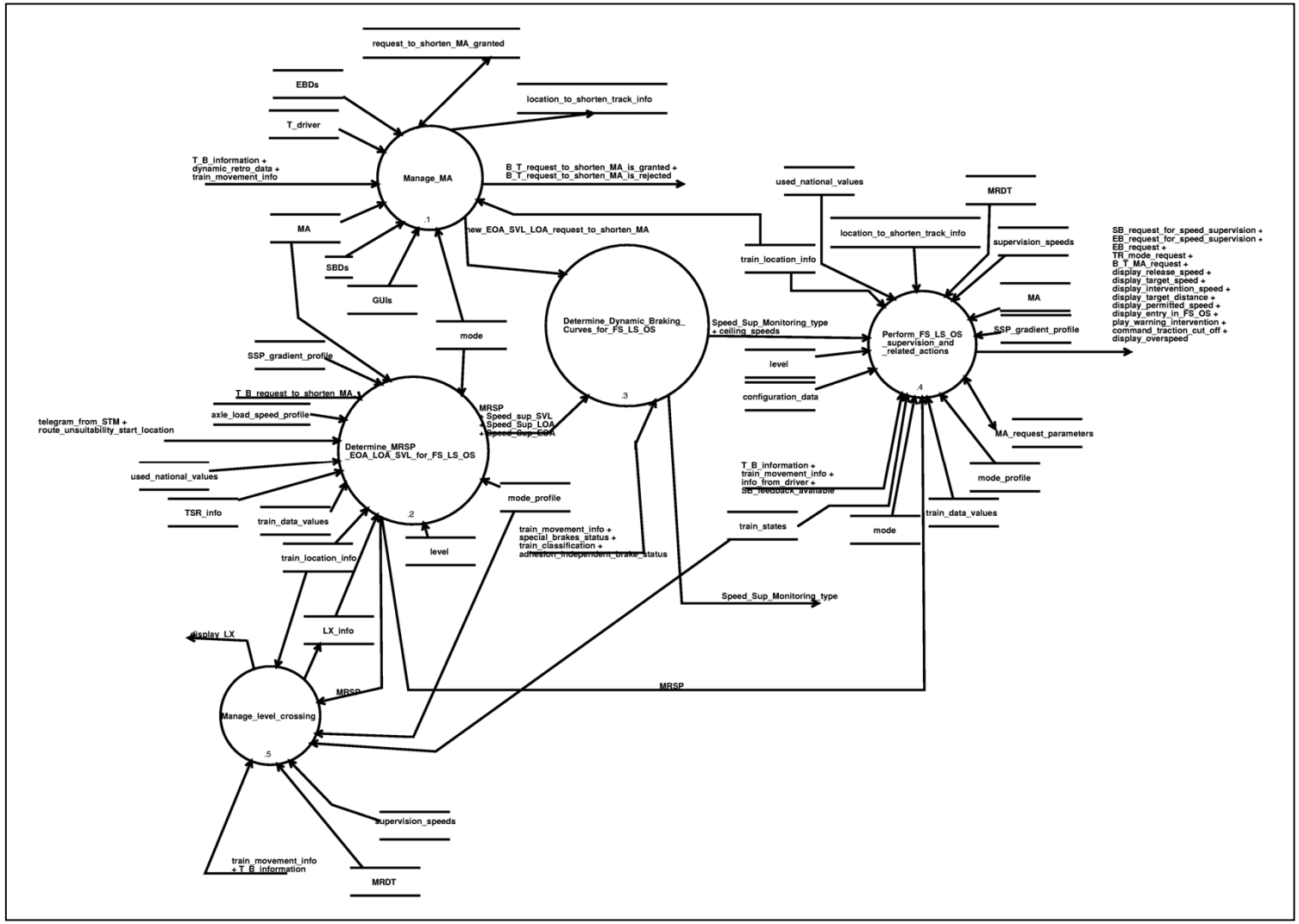
Ensure_train_protection_in_FS_LS_OS



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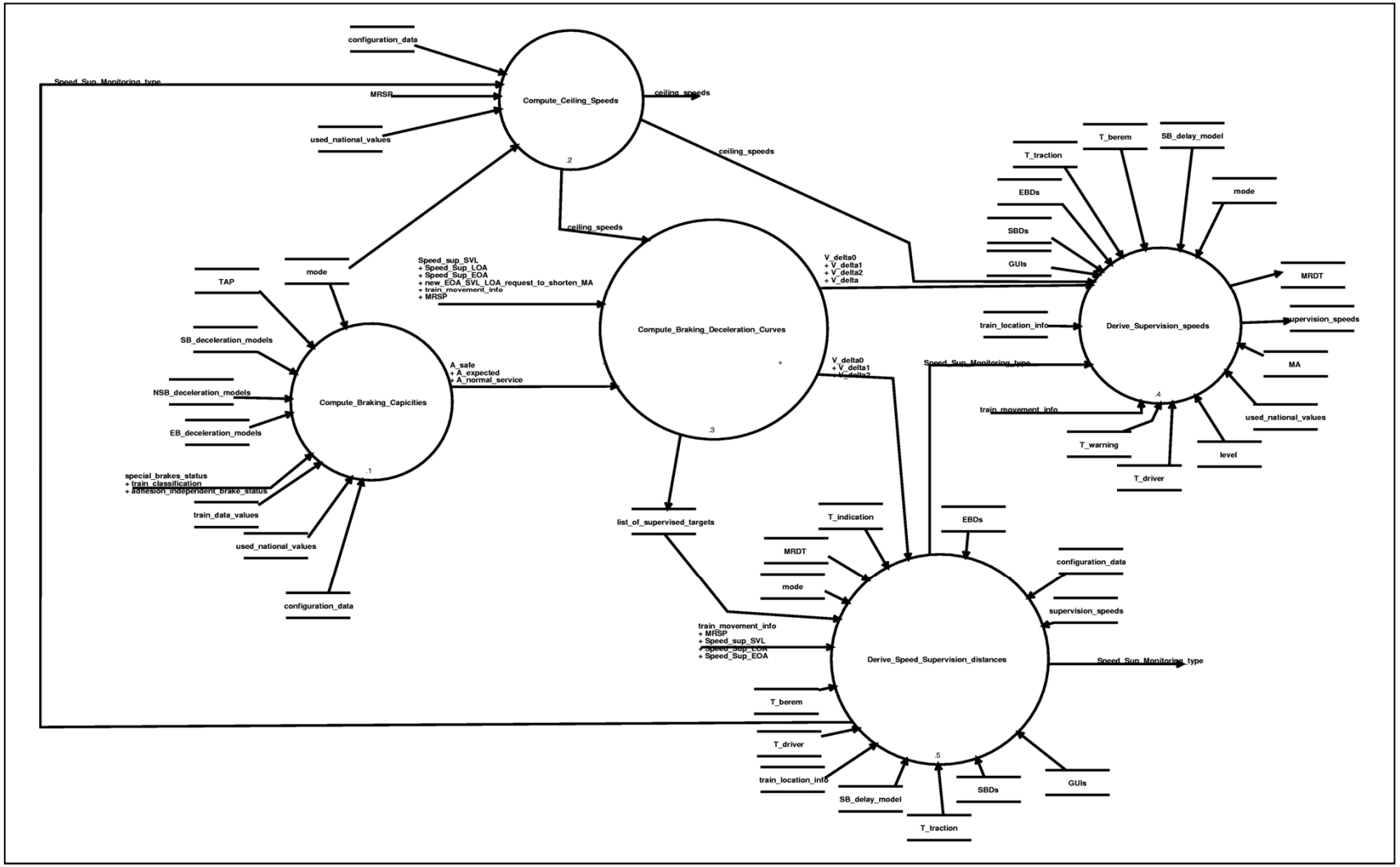
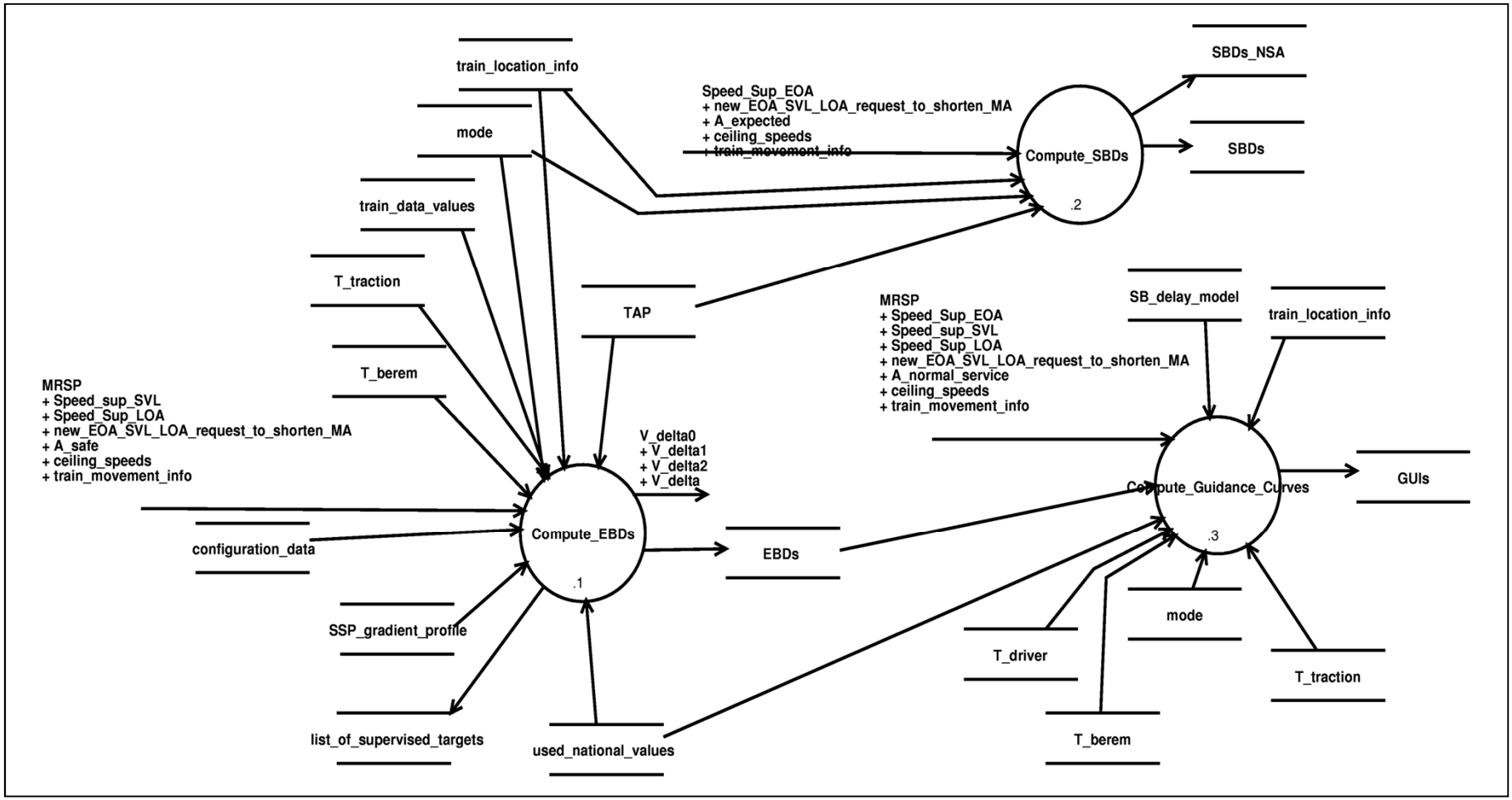
Determine_Dynamic_Braking_Curves_for_FS_LS_OS



Compute_Braking_Deceleration_Curves



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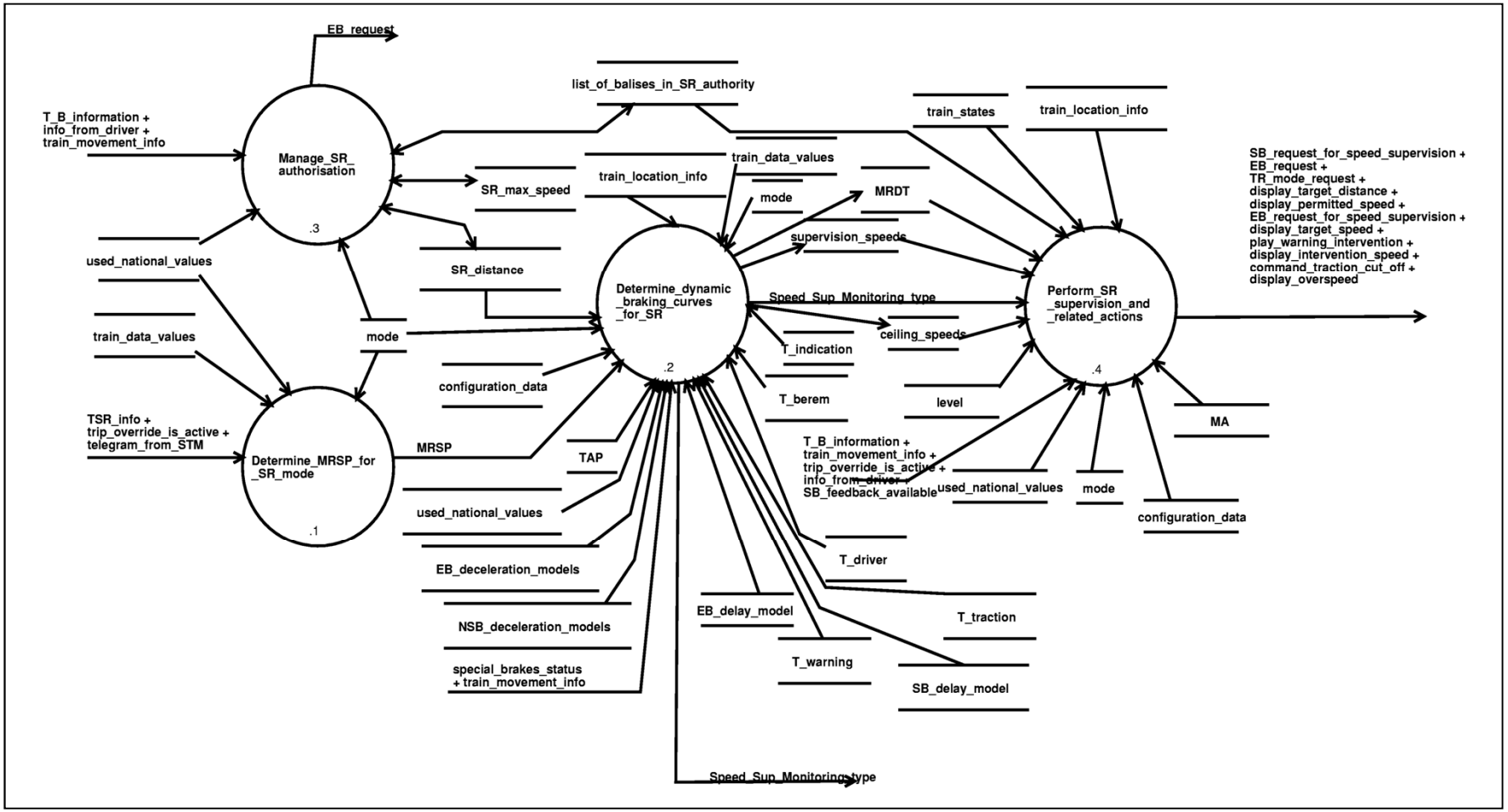
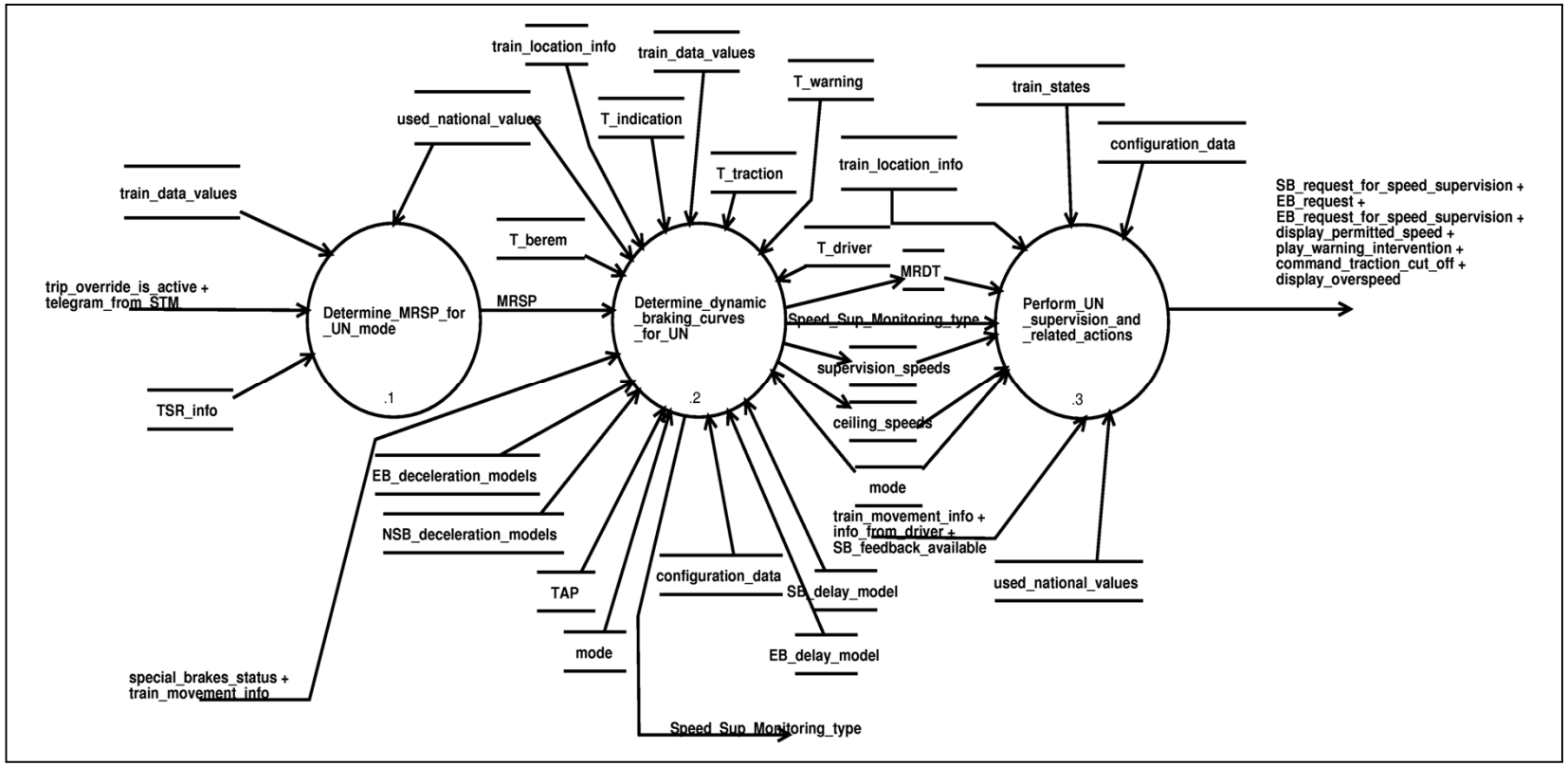
Ensure_train_protection_in_SR



Ensure_train_protection_in_UN



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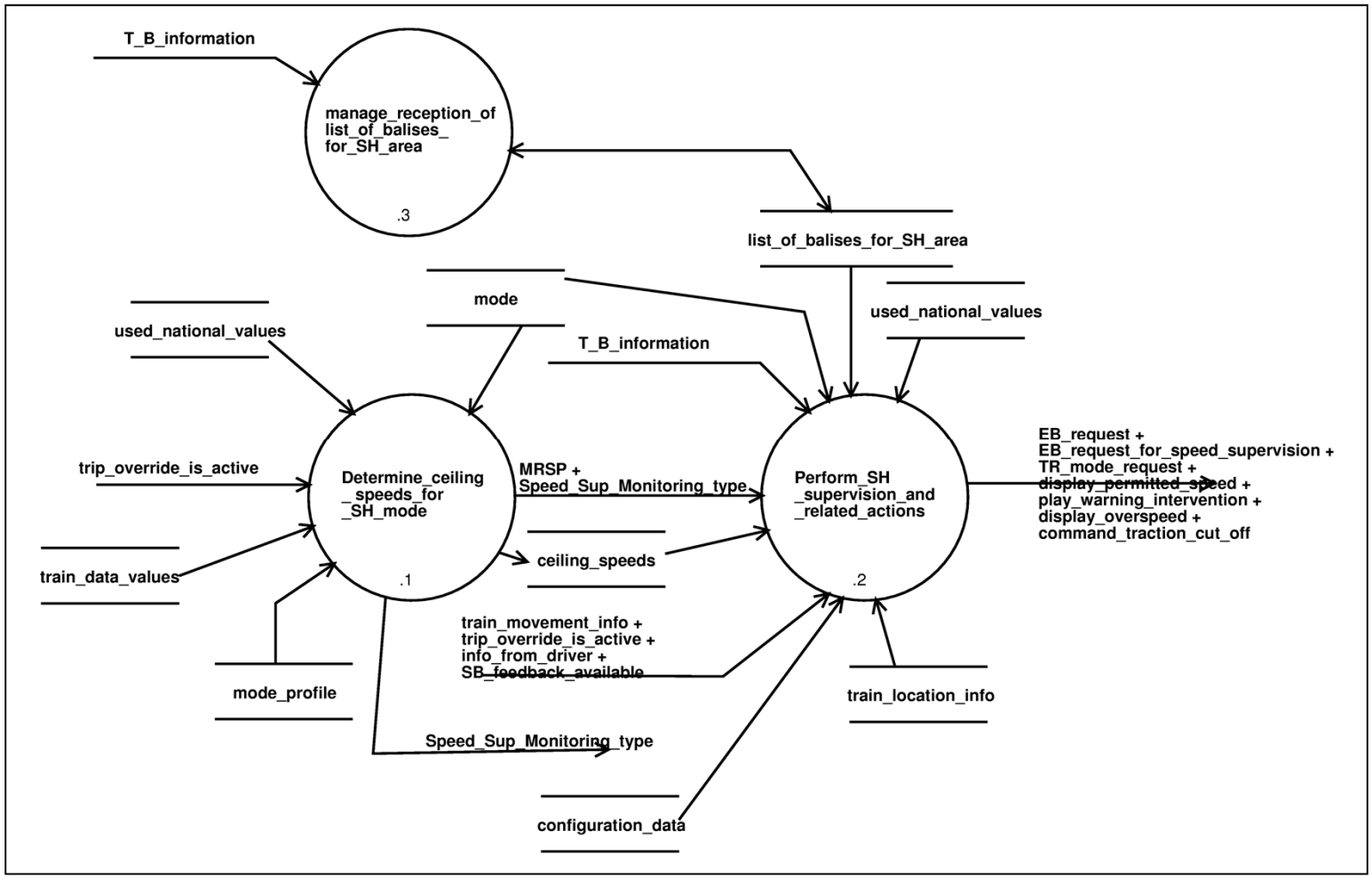
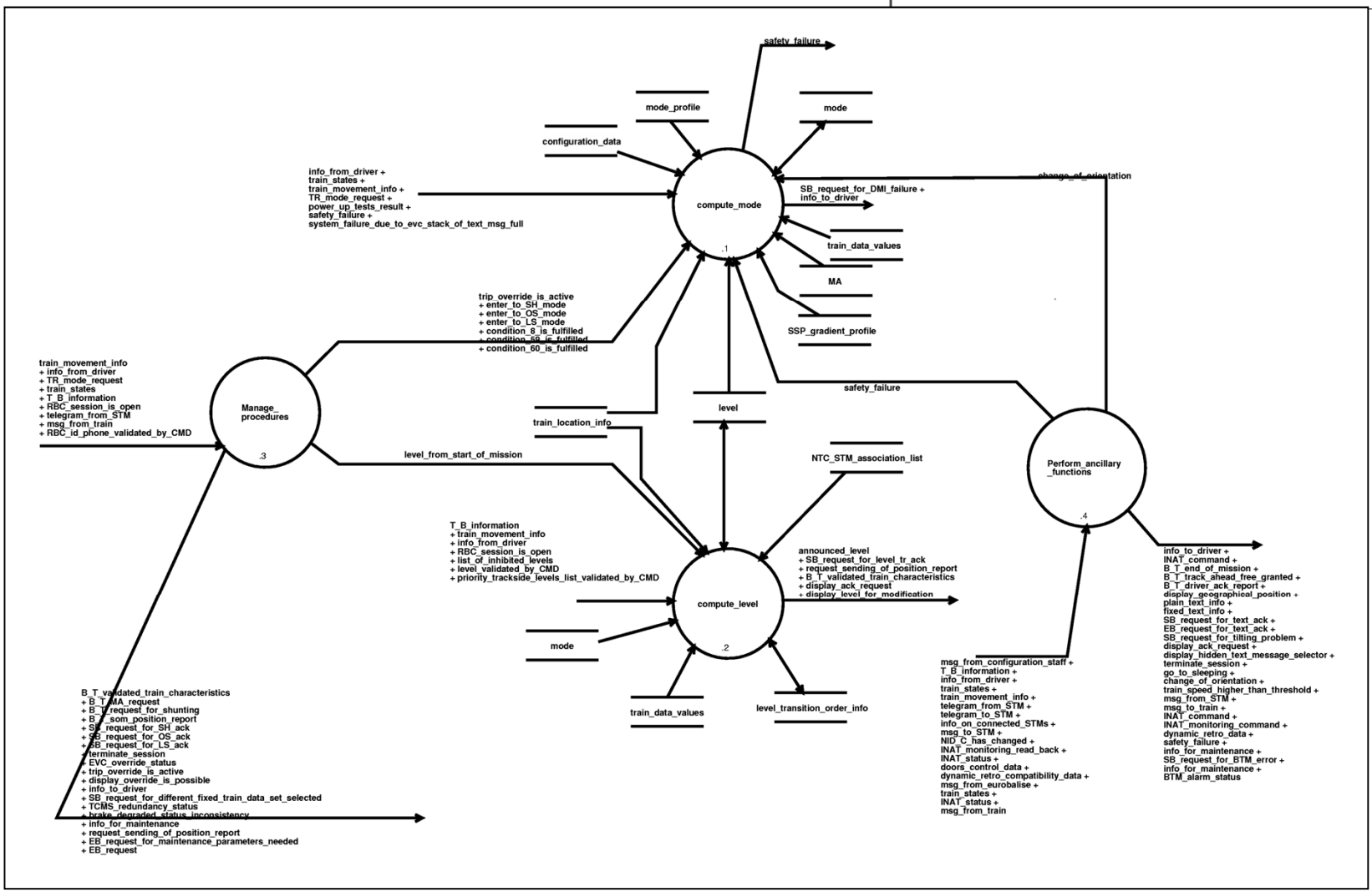
Ensure_train_protection_in_SH



Manage_mode_and_level_and_procedures_and_ancillary_functions



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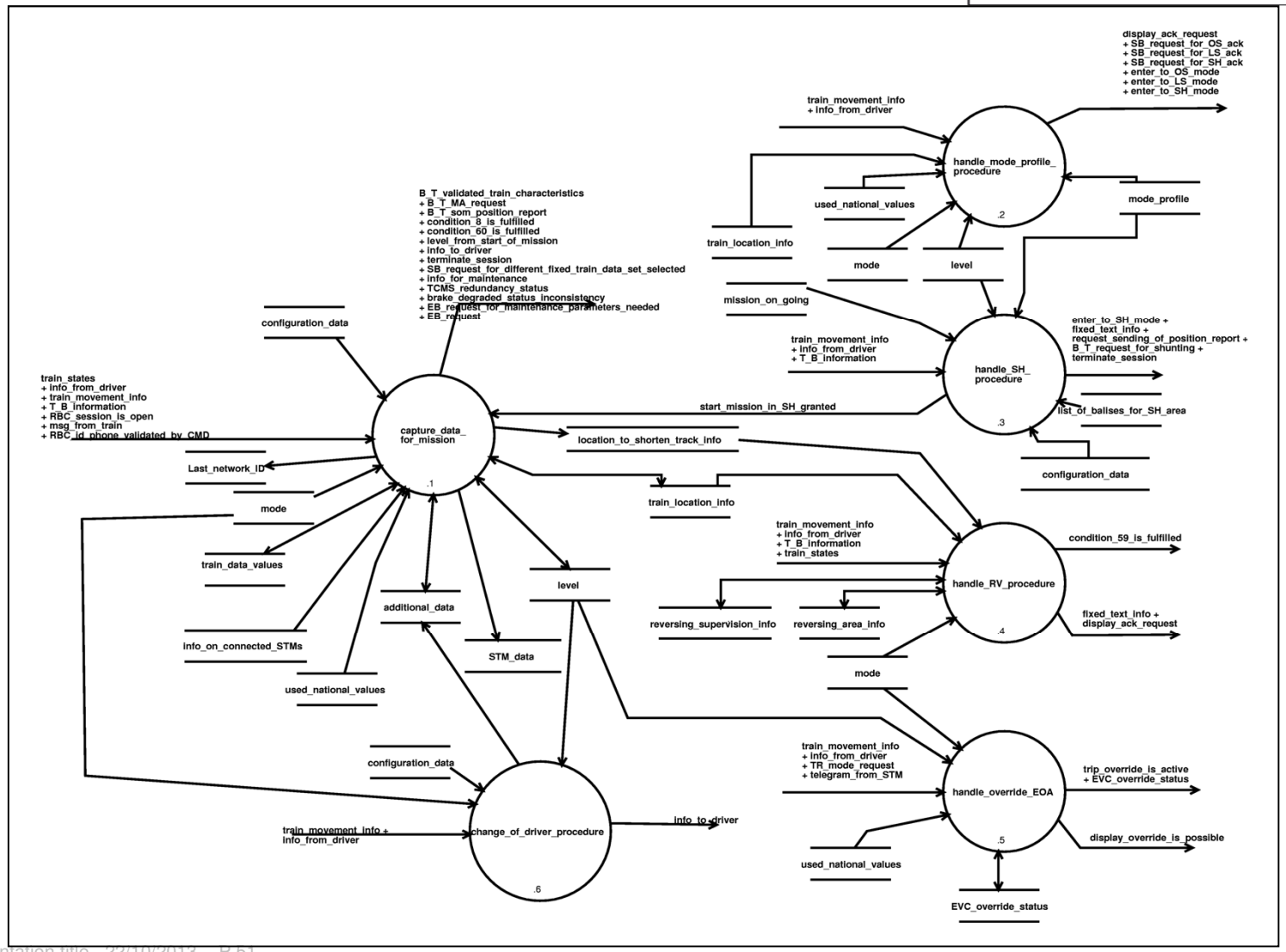
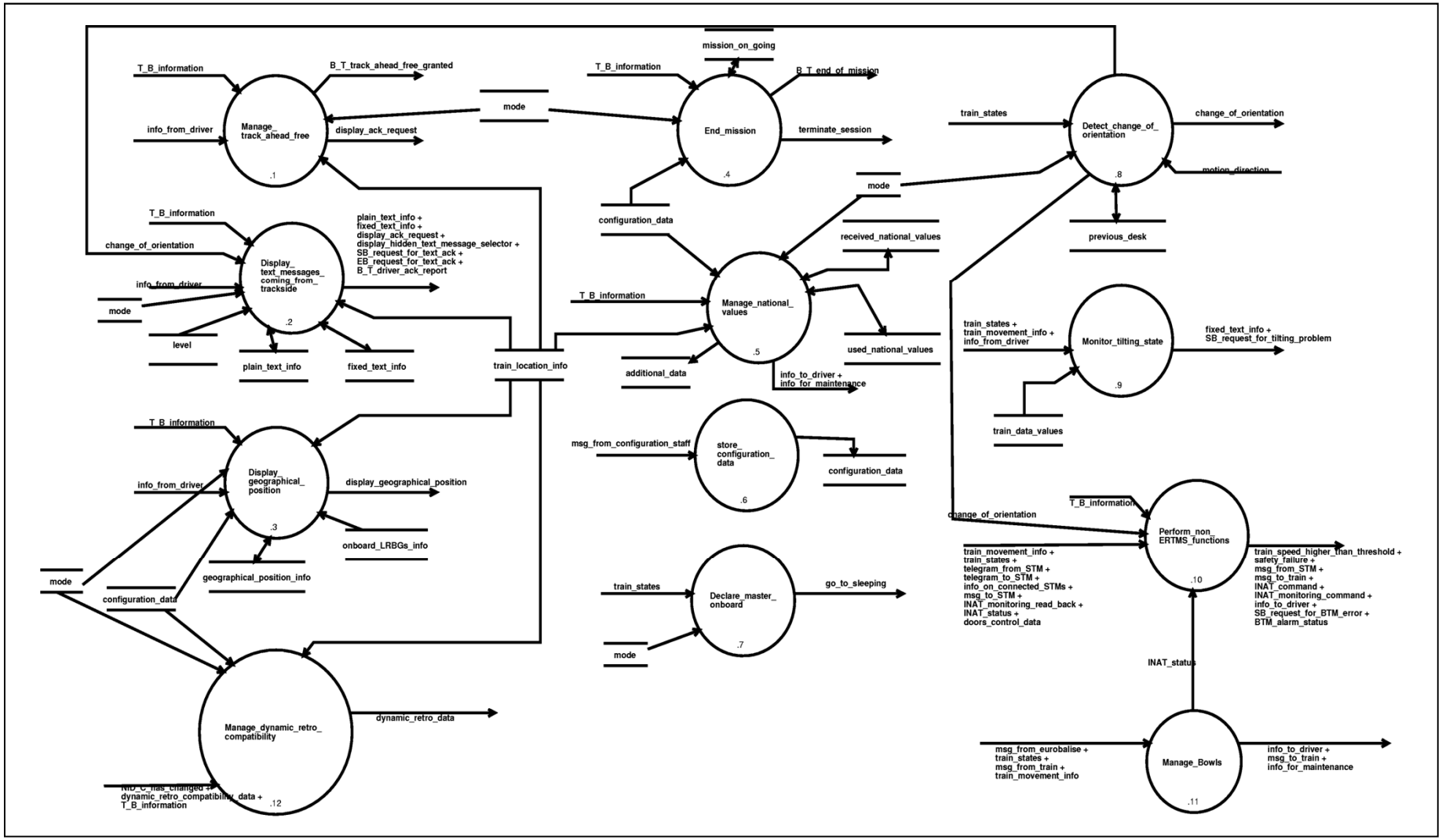


ALSTOM

Perform_ancillary_functions



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