

Tuesday, 4th November 2025

WP34/35 Testing, Validation and Certification

Emilie CHENEAU-GREHALLE
SNCF VOYAGEURS

- ❖ While some activities among competitors are both legal and beneficial to the industry, group activities of competitors are inherently suspect under the antitrust/competition laws of the countries in which our companies do business. Agreements between or among competitors need not be formal to raise questions under EU or international antitrust laws. They may include any kind of understanding, formal or informal, secretive or public, under which each of the participants can reasonably expect that another will follow a particular course of action or conduct. Each of the participants in this project is responsible for seeing that topics which may give an appearance of an agreement that would violate the antitrust laws are not discussed. It is the responsibility of each participant in the first instance to avoid raising improper subjects for discussion, notably such as those identified below.
- ❖ It is the sole purpose of any meeting of this project to provide a forum for expression of various points of view which must be strictly limited on topics
 - i. that are strictly related to the purpose or the execution of the project,<
 - ii. that need to be discussed among the participants of the project,<
 - iii. that are duly mentioned in the agenda of this meeting (unless a deviating decision is duly taken, and formalized in a protocol, by the respective Consortium Body) and,
 - iv. that are extensively described in the minutes of the meeting.
- ❖ Under no circumstances shall this meeting be used as a means for competing companies to reach any understanding, expressed or implied, which restricts or tends to restrict competition, or in any way impairs or tends to impair the ability of members to exercise independent business judgment regarding matters affecting competition.
- ❖ As a general rule, participants may not exchange any information about any business secret of their respective companies. In particular, participants must avoid any agreement or exchange of information on topics on the following non-exhaustive list:
 - a) Prices, including calculation methodologies, surcharges, fees, rebates, conditions, freight rates, marketing terms, and pricing policies in general
 - b) any kind of market allocation, such as the allocation of territories, routes, product markets, customers, suppliers, and tenders
 - c) production planning; marketing or investment plans; capacities; levels of production or sales; customer base; customer relationships; margins; costs in general; product development; specific R&D projects
 - d) standards setting (when its purpose is to limit the availability and selection of products, limit competition, restrict entry into an industry, inhibit innovation or inhibit the ability of competitors to compete)
 - e) codes of ethics administered in a way that could inhibit or restrict competition
 - f) group boycotts
 - g) validity of patents
 - h) ongoing litigations

Participants to the meeting

DOETSCH Bettina
GALLAIS Cedric
Monique de Wit
Miguel Fernández Elorriaga
Jonathan Schoener
Antoine Legros
Vincent Tarif
Thibault LAROUMAGNE
Andrea LOYER POLLASTRI
Etienne KUNTZEL
Jean-Baptiste SIMONNET
Emilie CHENEAU
Thomas Jousselin
François Foussard
Diarra DIOP

Introduction and CIM presentation (09:30-10:00)



01

ETCS certification and interoperability tests (10:00-11:00)

02

R2DATO WP34/35 presentation (11:00-12:00)



03

Network of laboratories and demonstration R2DATO SNCF test bench with Stella (13:00-13:45)

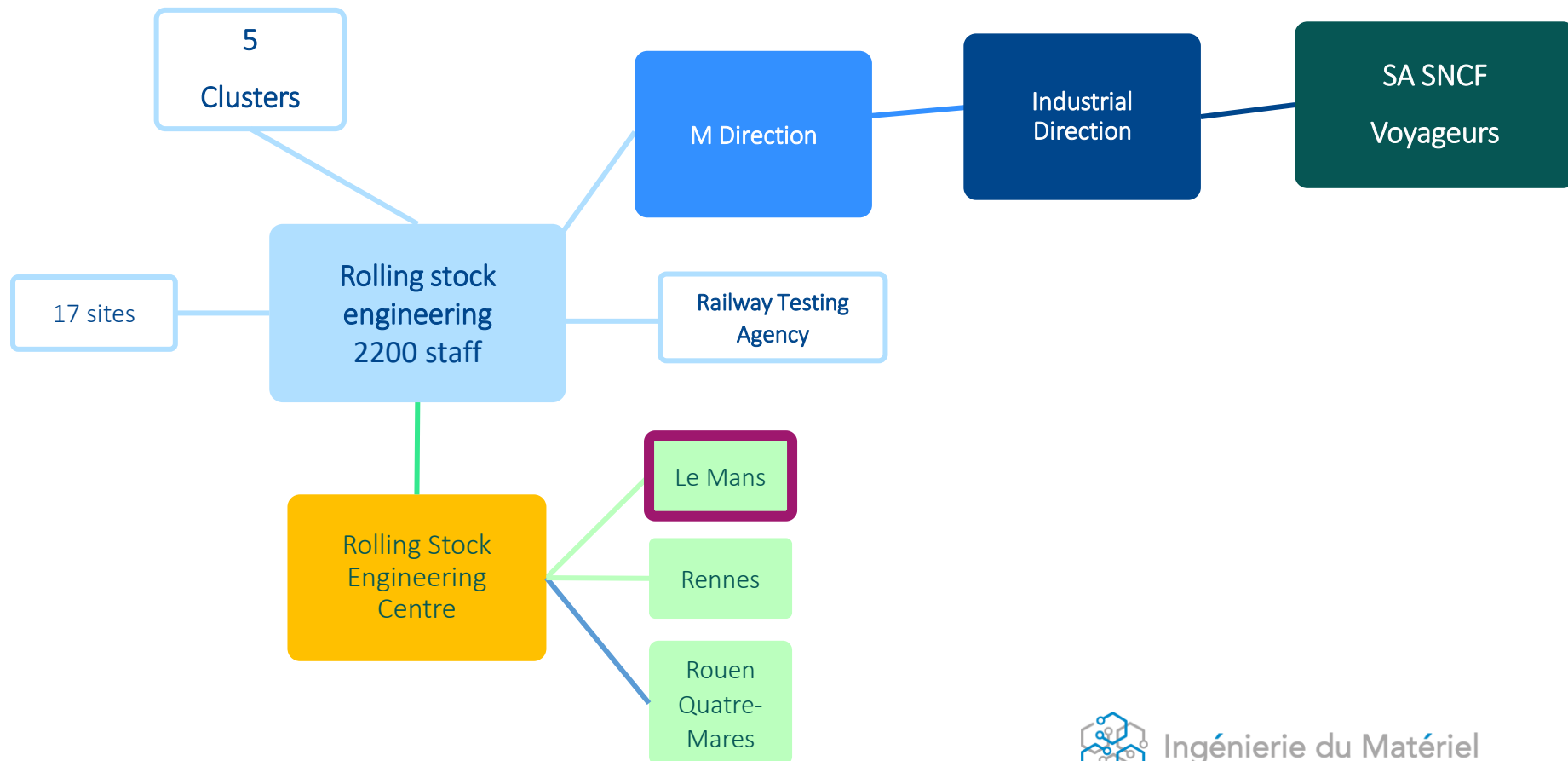
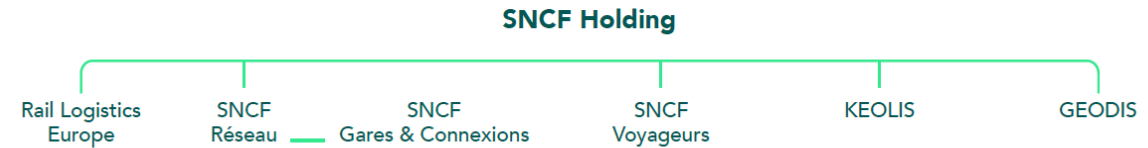
04

R2DATO Phase 2 ambition for SNCF-CEDEX-DLR (13:45-15-30)

05

Open discussion and conclusion

M Engineering : A unique entity



The main tasks



Acquisition : specifying and supporting the design of new rolling stock



Ensure the maintainability and performance of the Brake and Thermal subsystems



Participate in standardization and regulatory bodies



Lead R&D projects and invent the mobilities of tomorrow



Provide high-level expertise tailored to the needs



Certification and labelling tests of embedded signaling systems and IT infrastructures



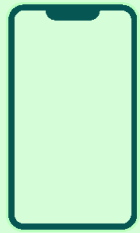
Renovations/ Transformations: propose innovative solutions and support the clusters on targeted expertise (admission...)



Carry out projects for greening rolling stock (biofuel, H2...)

Our resources

the Rolling Stock Engineering Centre



45

Numerical
simulation tools

16



Safety Equipment test
benches

5 3D scans

1



Creativity room

1

Virtual reality
room



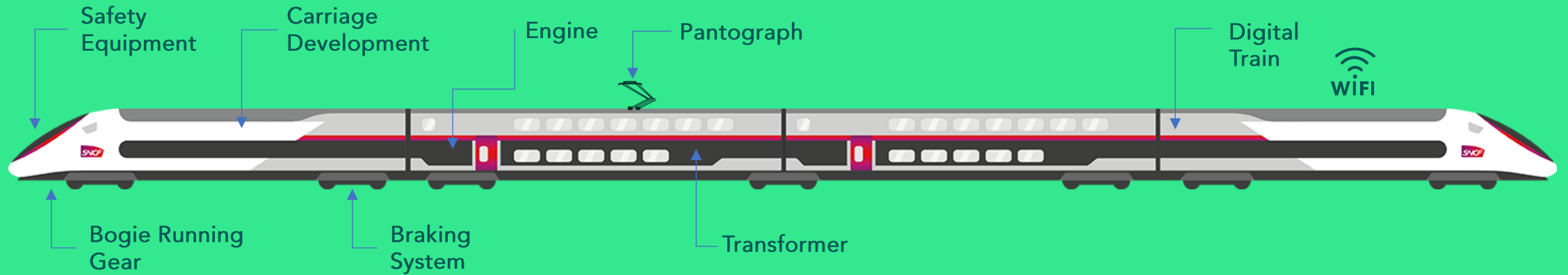
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Employees (mainly
engineers)



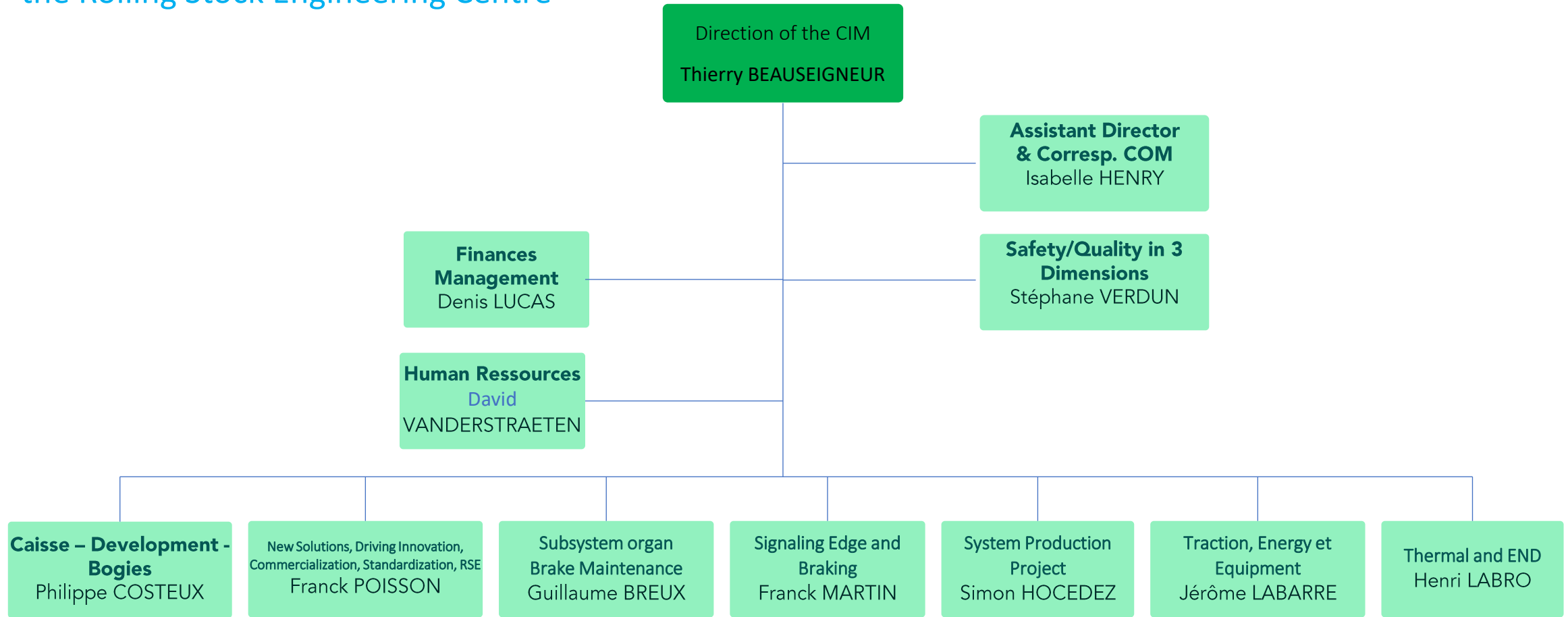
Our skills

The CIM covers all rolling stock techniques



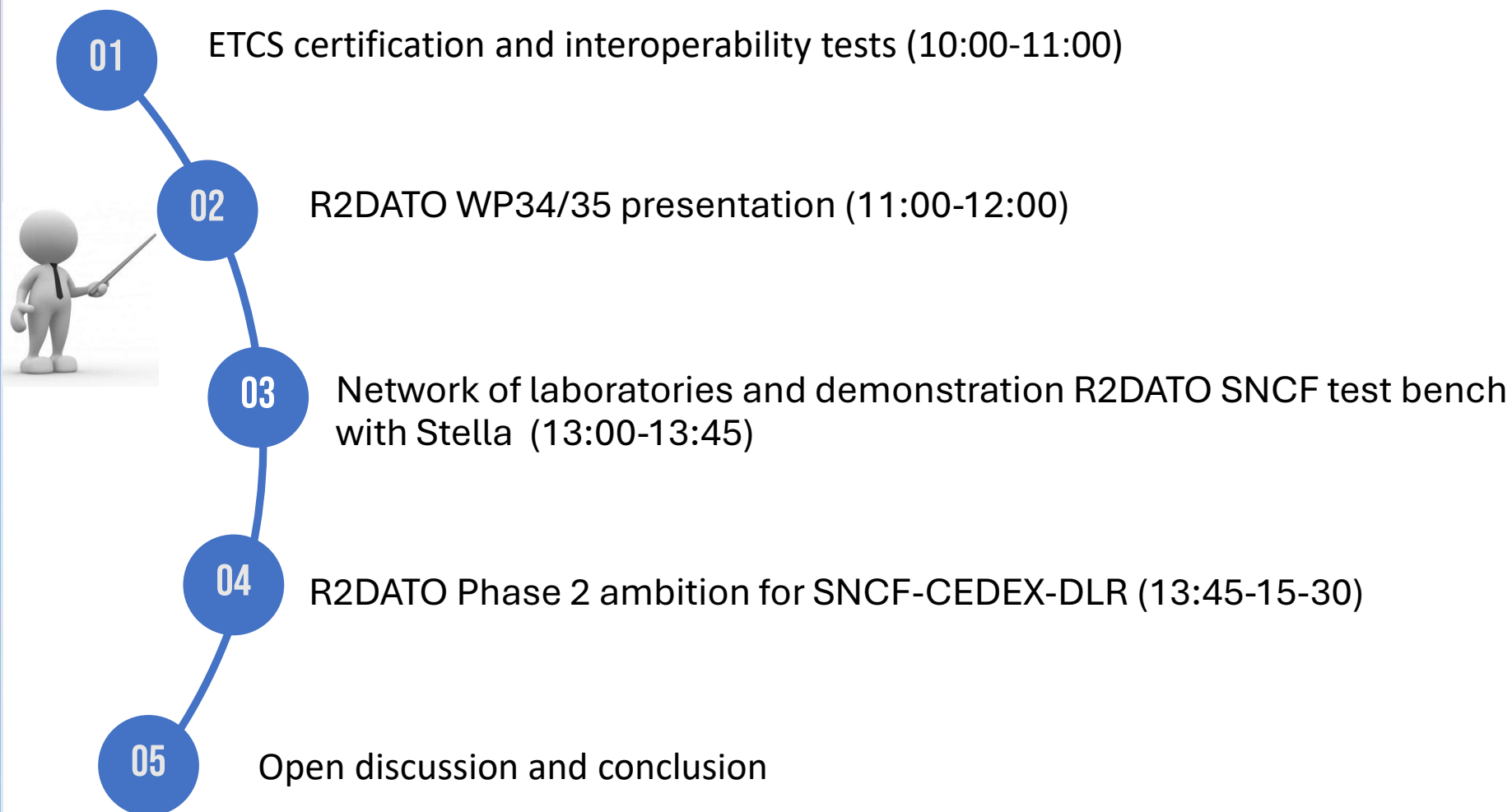
Our organisation

the Rolling Stock Engineering Centre



ETCS certification and interoperability tests (10:00-11:00)

- Presentation of ETCS certification, ESC/interoperability tests and laboratories ([Andrea - François](#))
- Visit and lab demonstrations :
 - ESC ([François](#))
 - ERTMS France Laboratory (LEF) ([Andrea](#))



R2DATO WP34/35 presentation (11:00-12:00)

- WP34/35 overall presentation

WP 34 closed :

- Deliverable [D34.1](#) – General testing Strategy for a common virtual certification process
- Deliverable [D34.2](#) – Requirements for certification methodology
- Deliverable [D34.3](#) – Tests facilities specifications
- Deliverable [D34.4](#) – Design of Test platform
- Deliverable [D34.5](#) – Requirements and specifications for digital Twin model of subsystems and Functionalities

WP 35 is the continuation of WP34.

Focus on Task 1 to 4

WP34/35 Planning

	2022	2023												2024												2025												2026																										
	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May																						
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42																						
Define Strategy and Process for Virtual Certification (Leader: ADIF; Participants: SNCF, DB, DLR, CAF, NS, GTSD, HITACHI, SMO, MERMEC, FSI, ATSA, TRV) (Duration: M1 to M24)																																																																
Define requirements for certification methodology (Leader: DLR; Participants: SNCF, ADIF, DB, FSI, HITACHI, SMO) (Duration: M13 to M24)																																																																
Task 34.3: Tests facilities specifications (Leader: SNCF; Participants: ADIF, DB, DLR, FSI, HITACHI, SMO, MERMEC, TRV) (Duration: M1 to M21)																																																																
Task 34.4: Define a Test platform for virtual certification (Leader: SNCF; Participants: ADIF, DB, DLR, TRV, SMO) (Duration: M4 to M24)																																																																
Task 34.5: Virtual integration and certification of subsystems and functionalities apart from CCS+~ Subsystem analysis, requirements (Leader CAF; participants: ADIF, SNCF, DLR, TRV, KB, DB, NS, SMO, ATSA) (Duration: M1 to M21)																																																																
Task 35.1: Define Strategy and Process for Virtual Certification (Leader: ADIF; Participants: SNCF, DB, DLR, CAF, NS, GTSD, HITACHI, SMO, MERMEC, FSI, ATSA, TRV) (Duration: M13 to M36)																																																																
Task 35.2: Define certification methodology (Leader: DLR; Participants: SNCF, ADIF, DB, FSI, HITACHI, SMO, TRV) (Duration: M25 to M36)																																																																
Task 35.3: Define analysis tools for test bench (Leader: SNCF; Participants: ADIF, DB, DLR, FSI, HITACHI, SMO, MERMEC, TRV) (Duration: M13 to M33)																																																																
Task 35.4: Realise virtual certification test platform (Leader: SNCF; Participants: ADIF, DB, DLR, TRV, SMO, KB) (Duration: M13 to M42)																																																																
Task 35.5: Virtual integration and certification of subsystems and functionalities apart from CCS+: model validations and certification process (Leader CAF; participants: ADIF, SNCF, DLR, TRV, DB, NS, SMO, MERMEC, ATSA, KB) (Duration: M19 to M42)																																																																



- Focus on task1 to 4

COMMON STARTING POINT AND INPUTS

- › Clarify and secure dependencies with others (inputs, outputs, when)
- › Common understanding of past work: OCORA, EULYNX, S2R ZOST, VITE, S2R Gate4Rail, S2R PIVOT 2, S2R In2TRACK

COMMON METHODOLOGY

- › Define standard models for building simulation and define common modular test bench architecture
- › Studying new technologies/ ways to validate future new modules like ASTP, ATO, OB network, DR ...
 - › Testing Strategy
 - › Certification methodology

NETWORK OF LABORATORIES

- › Network of labs (on-board/ trackside):
 - Many configurations possible to optimize know-how
 - Specific technologies defined for each laboratory
 - Define lab compatibilities (subset 111 and others)
 - Lab interconnectivity solution



TECHNOLOGIES

- › Evaluated on the test bench :
 - › CEIT demonstrator
 - › ASTP modeling from SNCF

Test platforms

- › SNCF test bench with Stella M3System for GNSS simulation
- › CEDEX test bench with Skydel SAFRAN for GNSS simulation

- T34.1-T35.1

Task 35.1 (CEDEX): Define Strategy and Process for Virtual Certification

Participants: SNCF, DLR, CAF, NS, GTSD, HITACHI, SMO, MERMEC, FSI, ATSA)

Deliverable 35.1

- | | | | | | |
|--|--|---|---|---|---|
| <p>1.</p> <p>Introduction.</p> | <p>2.</p> <p>System design: operational needs</p> <p>2.1 Initial constraints</p> <p>2.2 Operational Users</p> <p>2.3 Operational Use Cases</p> | <p>3.</p> <p>High level integration and testing requirements</p> <p>3.1 Scope and Capabilities of the Integration and Testing</p> <p>3.2 Actors, Process and Methods</p> <p>3.3 Tools and Environment</p> | <p>4.</p> <p>General integration and testing strategy guidelines for CCS+ on-board</p> <p>4.1 CCS Integration Verification Validation (IVV) activities</p> <p>4.2 CCS Integration and Testing activities sequencing</p> | <p>5.</p> <p>CCS+ On-board Level specific activities</p> | <p>6.</p> <p>CCS+ On-board Building Blocks specific activities</p> <p>6.1 Automatic Train Protection On-Board (ATP-OB)</p> <p>6.2 Automatic Train Operation On-Board (ATO-OB)</p> <p>6.3 Digital Register On-Board (DR-OB)</p> <p>6.4 Localisation On-Board (LOC-OB) / Advanced Safe Train Positioning (ASTP)</p> <p>6.5 CCS Communication Network (CCN) / One common bus</p> |
| <p>7.</p> <p>General integration and testing strategy guidelines for CCS+ trackside</p> <p>7.1 CCS Integration Verification Validation (IVV) activities</p> <p>7.2 CCS Integration and Testing activities sequencing</p> | <p>8.</p> <p>CCS+ Trackside Level specific activities</p> | <p>9.</p> <p>CCS+ Trackside Building Blocks specific activities</p> <p>9.1 Radio Block Center (RBC)</p> <p>9.2 Digital Register Trackside (DR-TS)</p> | <p>10.</p> <p>Evolution Management for CCS</p> | <p>11.</p> <p>Architecture of a cooperative network of test laboratories</p> <p>11.1 State of the art</p> <p>11.2 Distributed testing concepts, methods and tools</p> | <p>12.</p> <p>Integrating formal modelling into model-driven analysis of the impact of cyberattacks on safety</p> |
| | | | | | <p>13.</p> <p>Conclusions</p> |

R2DATO WP34/35 presentation (11:00-12:00)

- T34.1-T35.1 (Miguel)

Task 35.1 (CEDEX): Define Strategy and Process for Virtual Certification
Participants: SNCF, DLR, CAF, NS, GTSD, HITACHI, SMO, MERMEC, FSI, ATSA)

Annex I: Testing Strategy for ASTPs

1.

Introduction.

2.

Description of ASTP generic architecture

- 2.1 Generic ASTP architecture
- 2.2 Components

3.

ASTP Basic Observables and Estimations.

- 3.1 GNSS Basic Observables and Estimations

4.

Definition of Performance Metrics/KPIs for ASTPs

- 4.1 General
- 4.2 Outputs of the ASTP
- 4.3 Inputs to the performance characterization process
- 4.4 Performance features
- 4.5 Performance metrics

5.

Features and Test Cases

- 5.1 Definition
- 5.2 Features for testing the GNSS receiver
- 5.3 Features for testing the IMU
- 5.4 Features for testing the ODO sensors

6.

Test Scenarios

- 6.1 Definition
- 6.2 Set-up conditions
- 6.3 Simulated ASTP parameters
- 6.4 Trajectory
- 6.5 Environmental conditions



High risk of planning shift

Needs attention to stay on track

On track



Key Achievements

- DDP Agreed
- Second version of the Annex I (dedicated to ASTP testing strategy) is being completed
- Addition of CCN section (Ch. 6.5) - SNCF
- Update ASTP-OB section (Ch. 6.4) - CEDEX
- Increase Ch 11 (new Ch. 11.2:Distributed testing concepts, methods and tools) - SNCF



Risks and tricky points

- Not sure to be able to use WP3 outputs for architecture



Next Activities

- Contributors to finish their update work on the Chapters 2 to 10 (for 17.11.2025), plus the second version of Annex I
- Review of the documents until 01.12.2025.
- Peer review meeting on the 01.12.2025



Status



Deliverable

- **Deliverable D35.1**
– Updated Testing Strategy
- **Completion** :50%
- **M42**



Actions & decisions needed

None

- T34.2-T35.2 (Jonathan)

Task 35.2 (DLR): Define certification methodology
Participants: SNCF, ADIF, FSI, HITACHI, SMO

1.

Introduction

2.

ASTP certification methodology

- ❖ Boundaries of an ASTP as System under Test
- ❖ Certification as an Interoperability Constituent
- ❖ Integration of ASTP Certification into the CCS TSI
- ❖ Laboratory tests accompanying Certification
- ❖ Certification of a Degraded Mode of ASTP

3.

ATO Certification Methodology

- ❖ Integration of ASTP Certification into ATO Certification
- ❖ Short- and Medium-Term Solution of ATO Certification
- ❖ Long Term ATO Certification approach

4.

Conclusion



Key Achievements

- DDP finalized (Revision 1 on CT5 online)
- Work on Sub Chapter 1, 2 and 3 is going great
- Ideas/Visions of Chapters start to be clear



Risks and tricky points

- Content of most chapters will not be final until draft v2



Next Activities

- Review text of other partners (CDEX, RFI)
- Draft v2 will be due on 17th of November
- Review Phase



Actions & decisions needed



Status



Deliverable

- **Deliverable D35.2**
– Certification methodology approach for the CCS+ domain
- **Completion** : 30%
- **M42**

T34.3-T35.3 (Antoine)

Task 35.3 (SNCF) : Define analysis tools for test bench

Participants: ADIF, DLR, FSI, HITACHI, SMO, MERMEC

1.

Executive Summary

2.

Introduction

3.

Generic concept of Test Evaluation

- ❖ Verification/Validation and Performance tests
- ❖ Steps classification (Interface Nature and Category)
- ❖ Test Evaluation categories (steps and overall test)
- ❖ Evaluation rules

4.

Generic types of checks

- ❖ Event-based checks (possibly with time/distance validation ranges)
- ❖ Continuous checks
- ❖ Checks on time/distance windows

5.

Examples for some interfaces

- ❖ Advanced Safe Train Positioning
- ❖ ATO up to GoA2
- ❖ Digital Register
- ❖ Onboard Communication Network

6.

Test report

- ❖ Content
- ❖ Template (Annex document)

7.

Requirements for analysis tools

- ❖ Tools running during the test (quality and functional requirements)
- ❖ Tools running in post treatment (quality and functional requirements)

8.

Conclusions



High risk of planning shift

Needs attention to stay on track

On track



Key Achievements

- Contributors have completed their part of the deliverable in September 2025.
- WP review has been organized in October 2025.



Next Activities

- TMT review
- Steering Committee review



Status



Deliverable

- Deliverable D35.3:** Analysis Tools specification
- Completion** : 95 %
- M42**



Risks and tricky points

None.



Actions & decisions needed

None.

T34.4-T35.4 (Thibault)

Task 35.4 (SNCF): Realise virtual certification test platform
Participants: ADIF, DLR, SMO

2. Certification platform's goals

Reminder of WP34.4

Objectives of an ASTP's certification

3. Certification platform's architecture

Interfaces of a certification platform

Specificities of both platforms

4. Certification of SNCF's prototype ASTP by SNCF

ASTP developed by SNCF

Test Catalog for this certification

Certification campaign

Comparison of results

T34.4-T35.4 (Thibault)

Task 35.4 (SNCF): Realise virtual certification test platform
Participants: ADIF, DLR, SMO

5. Certification of CEIT's ASTP

Specificities of CEIT's ASTP

Certification by CEDEX

Remote certification by SNCF

6. Network of laboratories

System-level tests

Externalisation of the GNSS
Simulation

Addition of a CCN simulator



High risk of planning shift

Needs attention to stay on track

On track



Key Achievements

- DDP agreed
- First and second version of the deliverable available and reviewed
- GNSS available on both platforms.
- Third version of the deliverable to be completed: certification of SNCF's ASTP



Risks and tricky points

- IMU simulation with Real time constraints



Next Activities

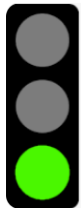
- Next meeting planned the 27th November to review draft 3.
- Complete IMU simulation (CEDEX)
- Certify SNCF's ASTP (CEDEX and SNCF)



Actions & decisions needed



Status



Deliverable

- **Deliverable** D35.4 – System and Interoperability test bench demonstrator report
- **Completion** : 40%
- **M42**

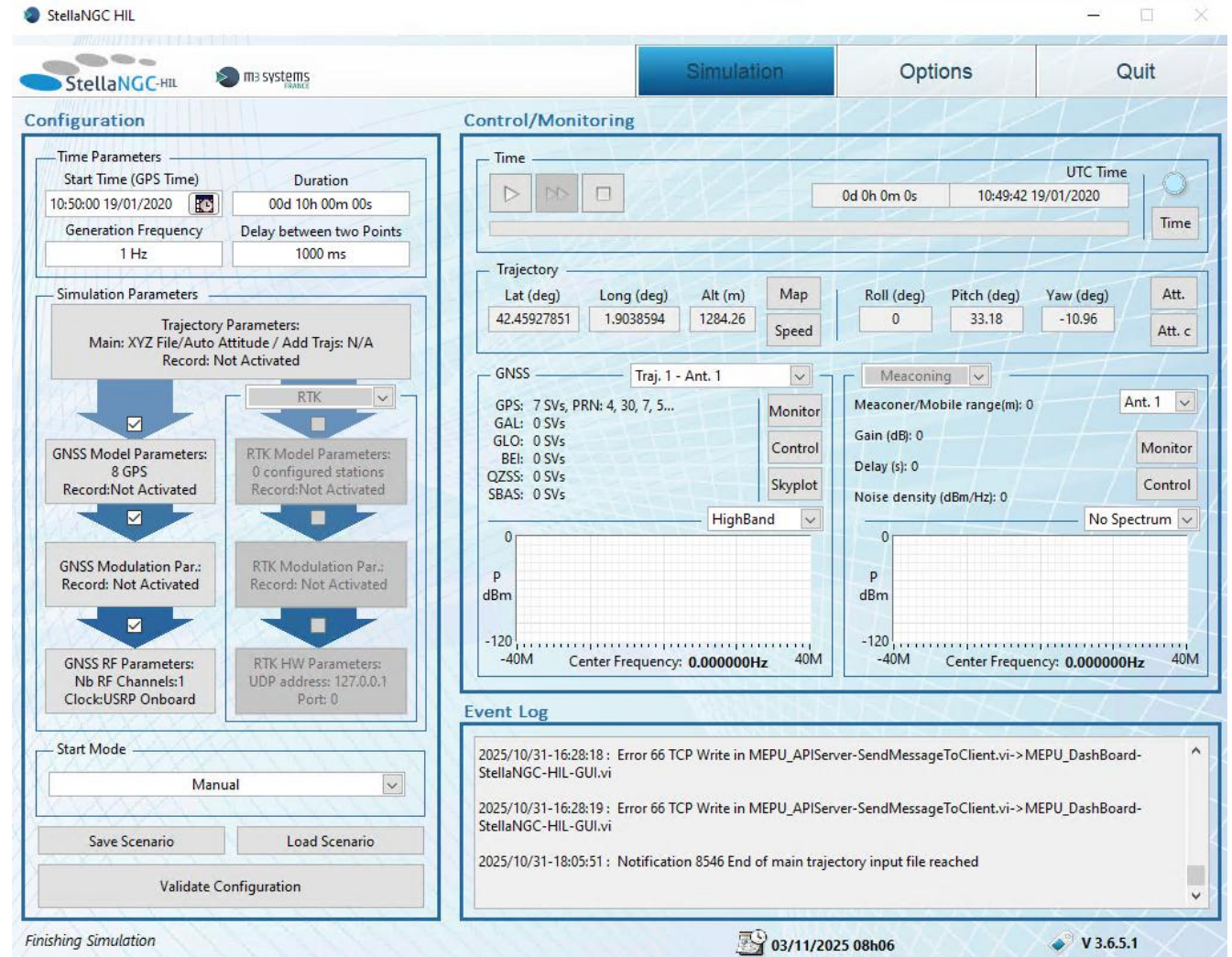
SNCF Platform:

- Test strategy: playback of registered data
- Simulation capabilities:
 - IMU through IP communication
 - Odometry through IP or signal simulation
 - LRBG through IP or signal simulation

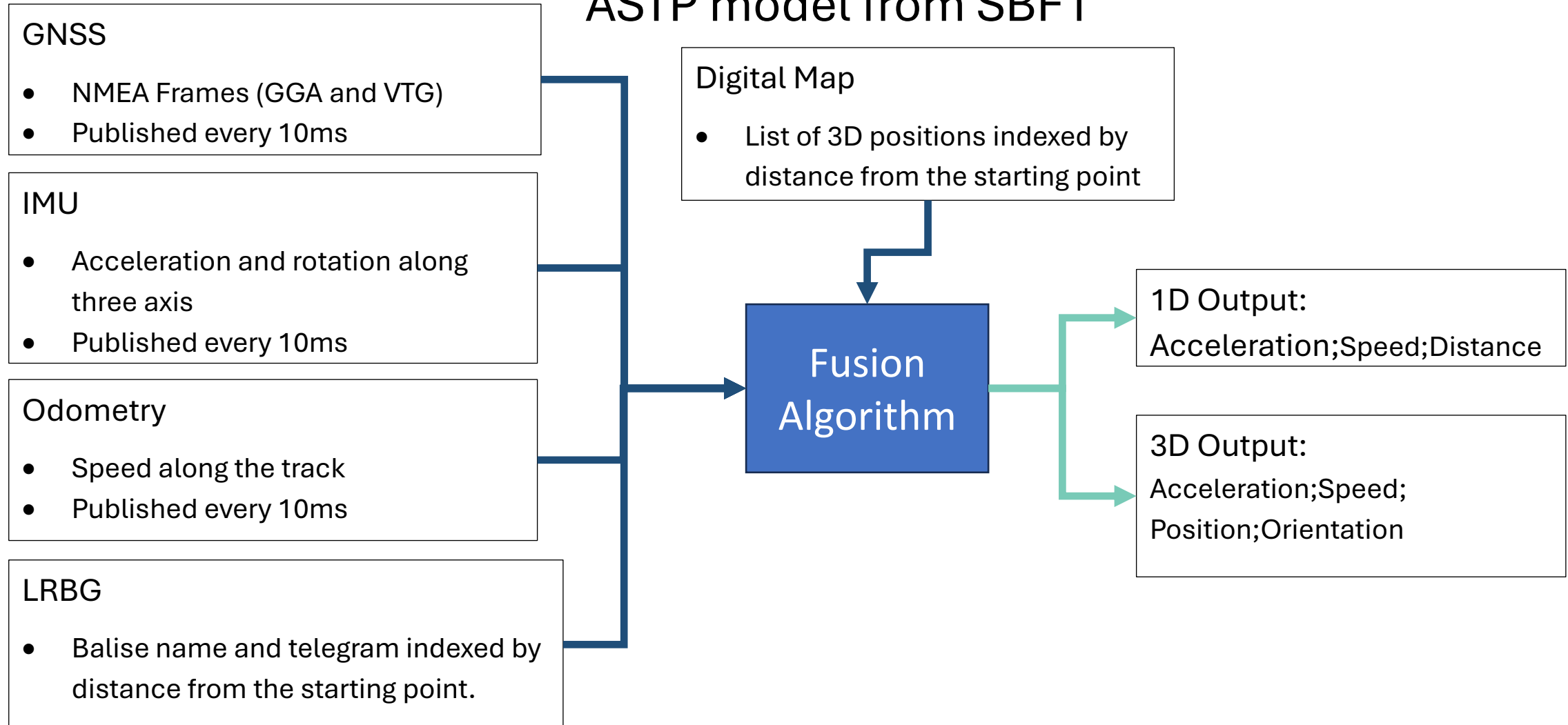


SNCF Platform:

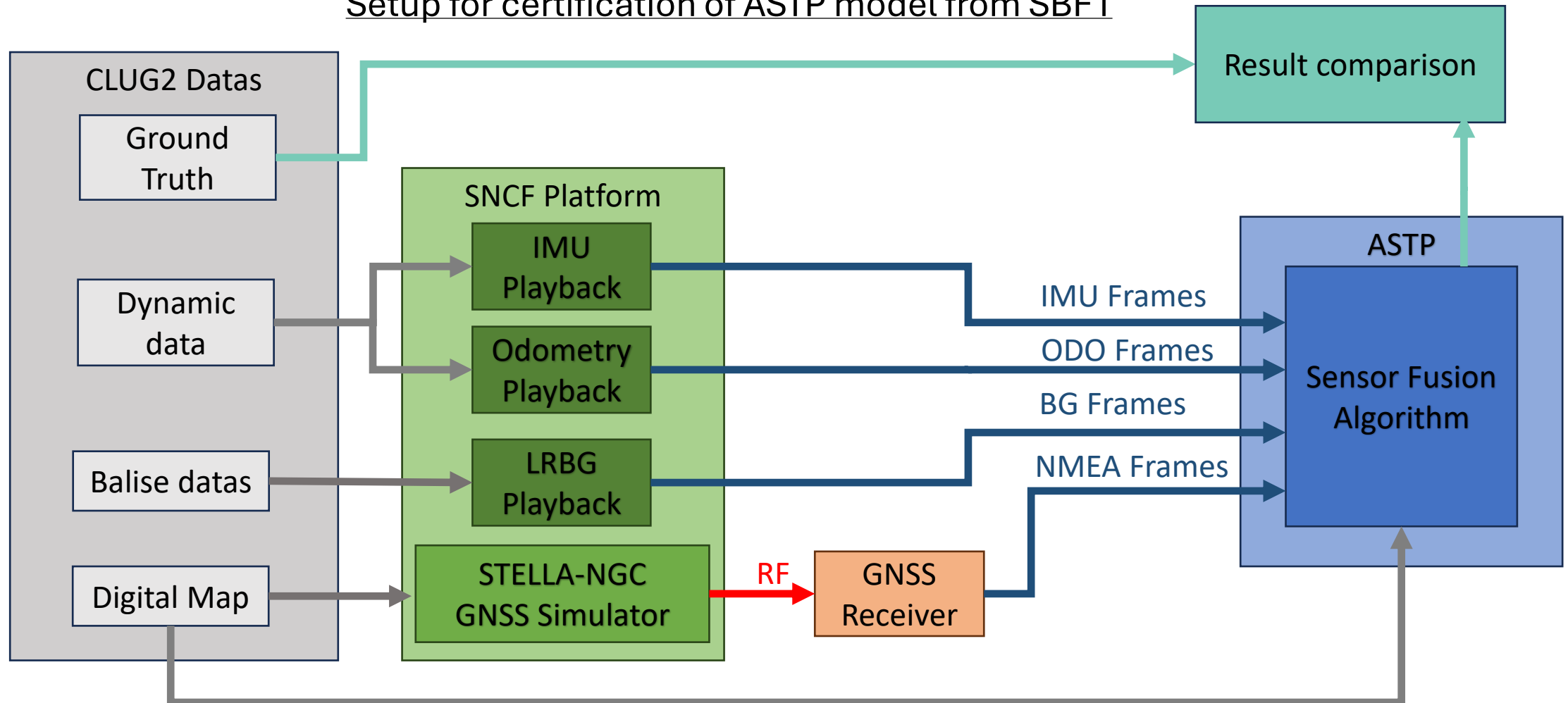
- GNSS Simulation with Stella NGC:
 - Multiple constellation simulation
 - The output format depends on the receiver used
 - Some error simulation already exists
- The platform can playback NMEA or SBF file instead of using the simulator



ASTP model from SBF1



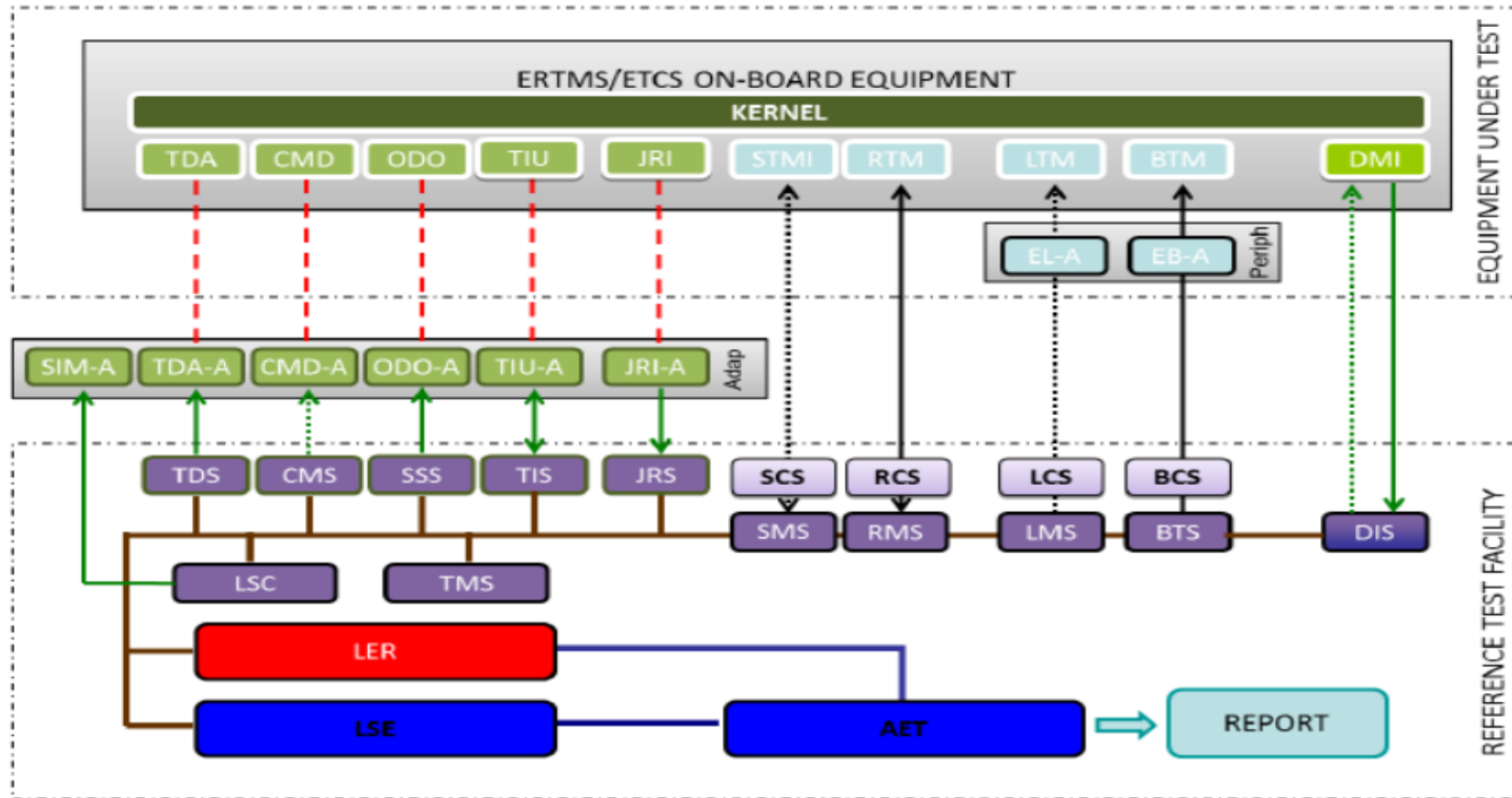
Setup for certification of ASTP model from SBF1



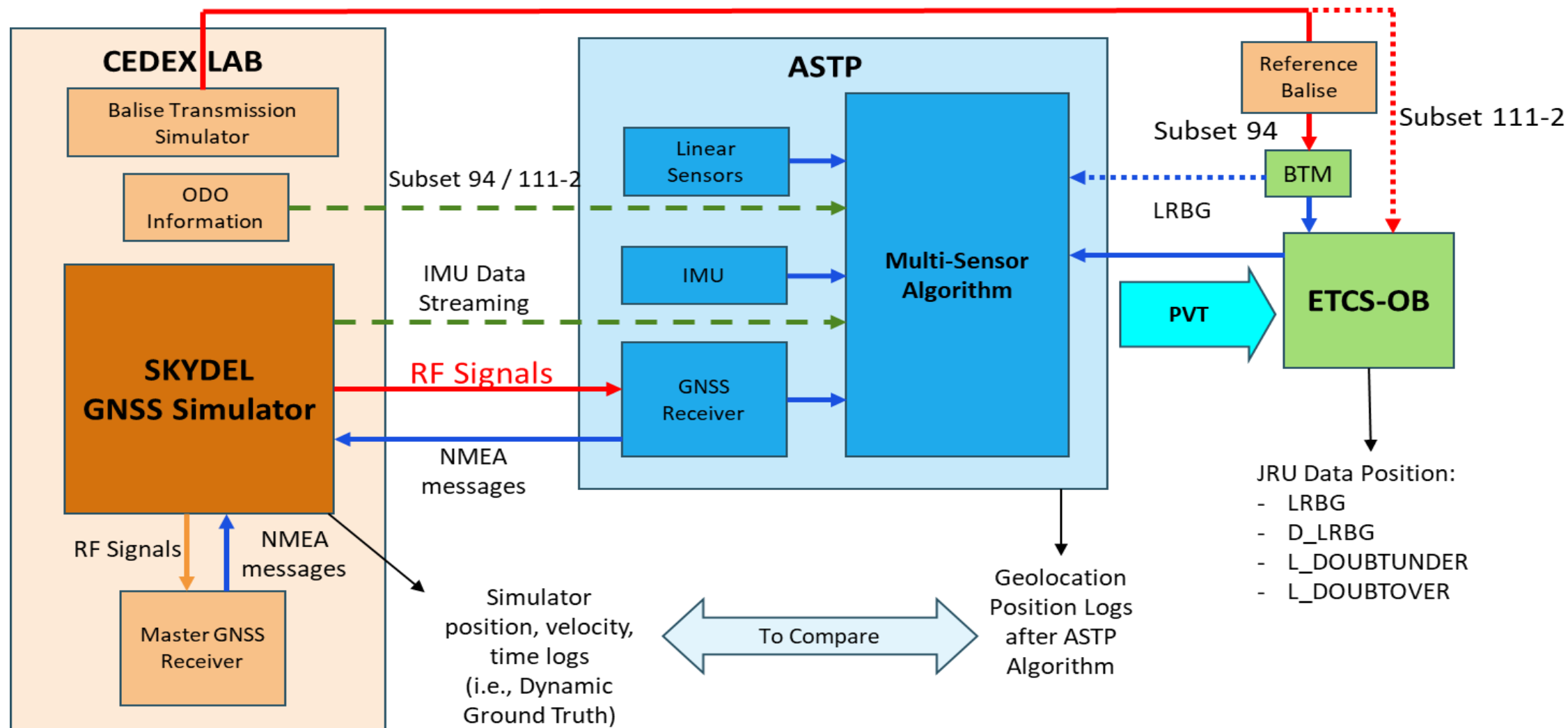
R2DATO WP34/35 presentation (11:00-12:00)

T34.4-T35.4 (Miguel): CEDEX lab and test bench + CEIT demonstrator

ETCS-OB Test Bench at CEDEX (SS-94)

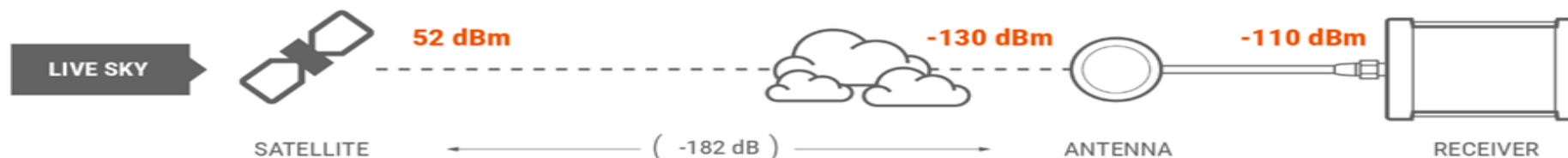


Test Set-up for ASTP testing (one option)



GNSS simulation with SKYDEL

- Simulate the trajectory of a vehicle:
 - In FP2-WP34: CLUG data and RAILGAP (Málaga-Spain line) data
 - Under different GNSS configurations (elevation masks, Ionospheric/ Tropospheric errors, Multipath, etc.)
 - At a specific time (day/hour)
- Create the Radio Frequency Signals identical to the “Live Sky”.
- Inject the Radio Frequency Signals generated to the GNSS Receiver replacing the antenna by:
 - Attenuators: To avoid damaging the GNSS receiver
 - DC-Block: To avoid return signals from the Receiver (normally used to power the antenna)



Propagation of the real GNSS signal from the satellite to the GNSS receiver



Propagation of the simulated GNSS signal from Skydel to the GNSS receiver

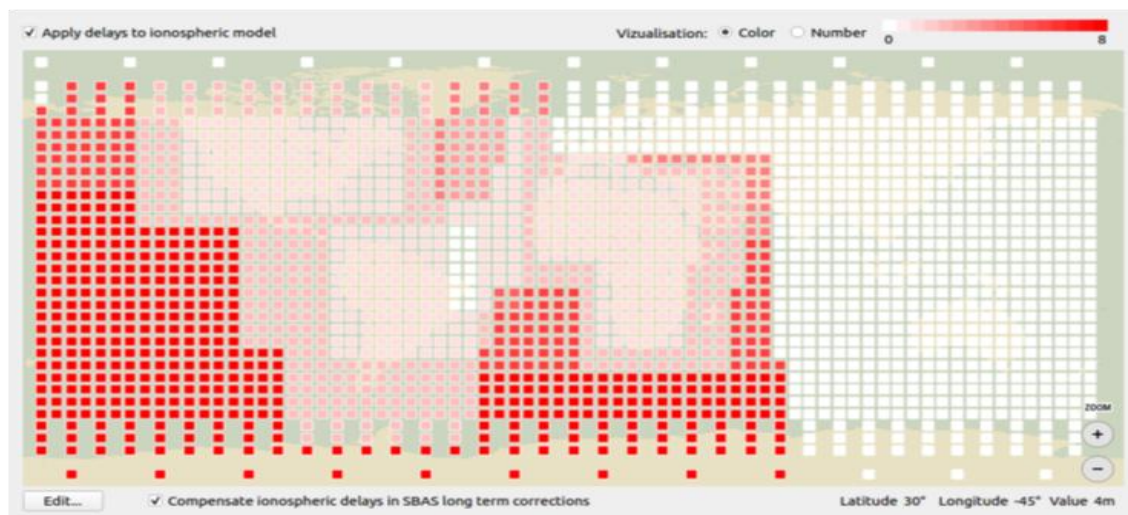
SKYDEL Configuration example

Example: Change Ionospheric and Tropospheric Models.

- **Ionospheric models:** None, Klobuchar, Spacecraft, NeQuick.
- **Tropospheric models:** None, Saastamoinen, Stanag, DO-229.

Add possible errors to the models:

- Positive offsets to the current Ionospheric model.
- Apply delays to Ionospheric model. Compensate ionospheric delays in SBAS long term corrections.



Tropospheric Model: Stanag

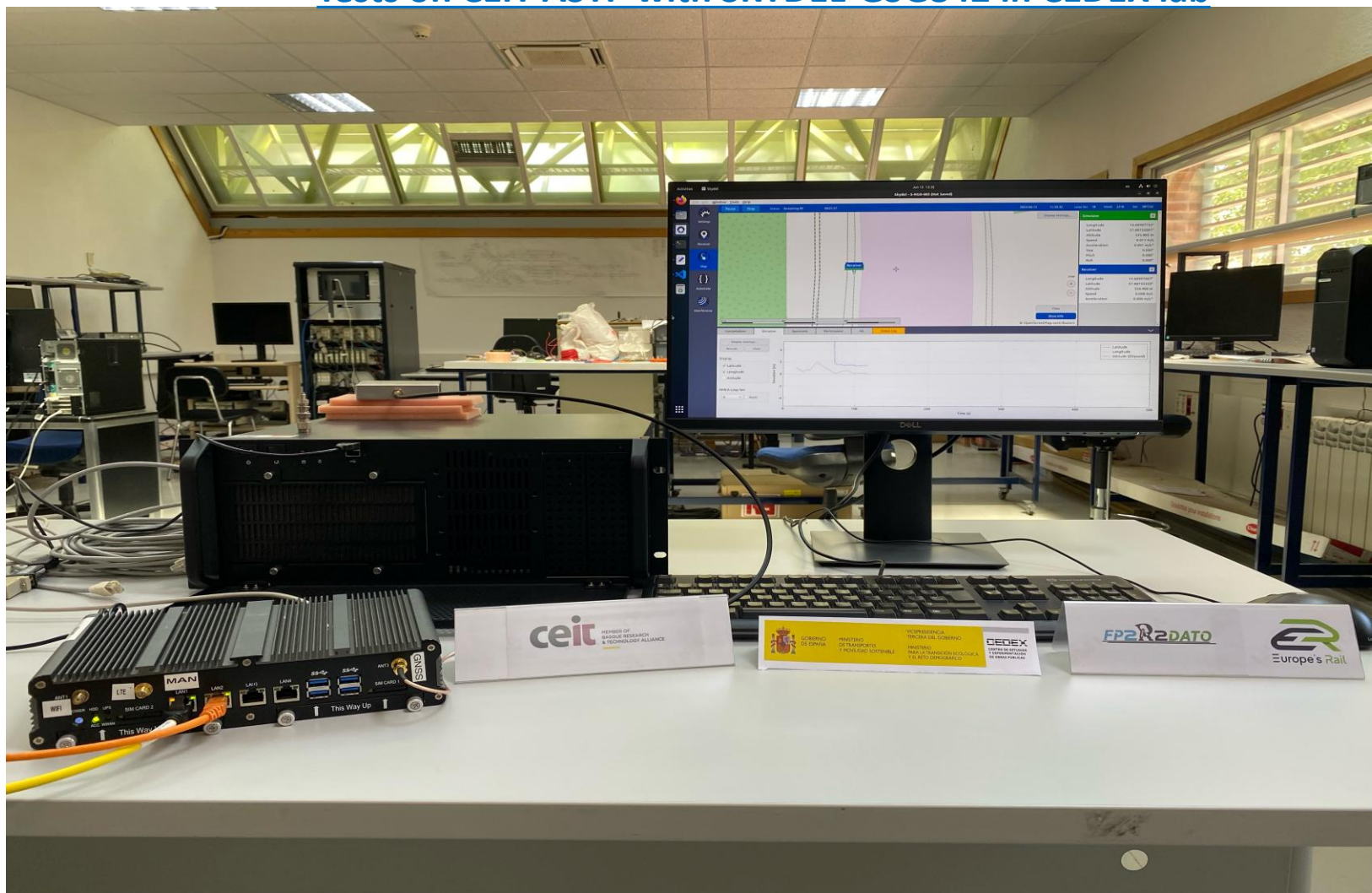
Ionospheric Model: Nequick

Klobuchar BDGIM NeQuick

	Alpha	Beta	
0	4.6570000e-09	81920	s
1	1.4900000e-08	81920	s/semicircle
2	-5.9600000e-08	-65540	s/semicircle ²
3	-1.1920000e-07	-524300	s/semicircle ³

RINEX File Import Iono Parameters...

Tests on CEIT ASTP with SKYDEL-GSG842 in CEDEX lab



CEIT's ASTP results against Skydel simulator

OUTPUTS AND KPIs/metrics

Three files were generated containing the Data Outputs and the KPIs for each scenario (input data: CLUG and RAILGAP projects):

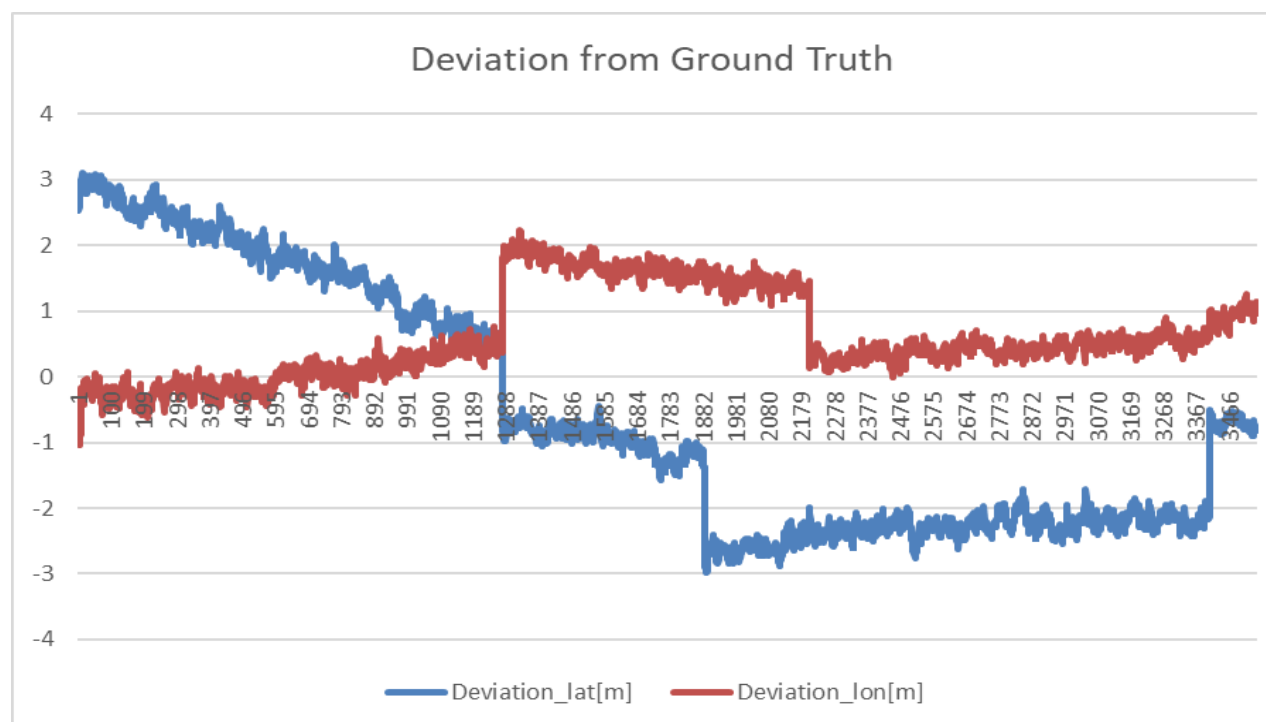
- **S-XXX-NNN_CEIT_ASTP_date-time_ASTP_analysis_ID_xxx.csv:**
 1. Data from the ASTP: time, lat, lon, alt, PL
 2. Data from the simulator (i.e., the dynamic ground truth): time_aso, lat_aso, lon_aso, alt_aso
 3. Automatic comparison data (non-exhaustive list):
 - HPL (a copy of the original PL[m] from the ASTP)
 - deviation_lat[m]
 - deviation_lon[m]
 - deviation_alt[m]
 - h_pos_err (horizontal position error)
 - v_pos_err (vertical position error)
 - h_err_greater_PL (horizontal position errors that are greater than their PLs)
 - pos_PL_lower_half_MAPCI
 - h_pos_err_greater_accu_with_cons
- **S-XXX-NNN_CEIT_ASTP_date-time_ASTP_analysis_ID_xxx_KPIs.csv:**
 1. H_Position_Integrity_Rate: (Integrity Rate) Ratio of the number of position errors (with respect to the Ground Truth) that are greater than their corresponding PLs divided by the total number of samples.
 2. Avail_Safe_Pos_Rate: (Safe Solution Availability) percentage of time that HPL < half MAPCI (= half of Max Accepted Position Confidence Interval)
 3. Acc_H_Pos_Rate (Unsafe Solution Accuracy) percentage of time with position errors less than the target precision value, which is 2.5m both horizontally and vertically for 3D position
- **S-XXX-NNN_CEIT_ASTP_date-time_ASTP_stdID_xxx.csv:** statistics: mean, median, variance, etc. of the following parameters: h_pos_err, v_pos_err and HPL

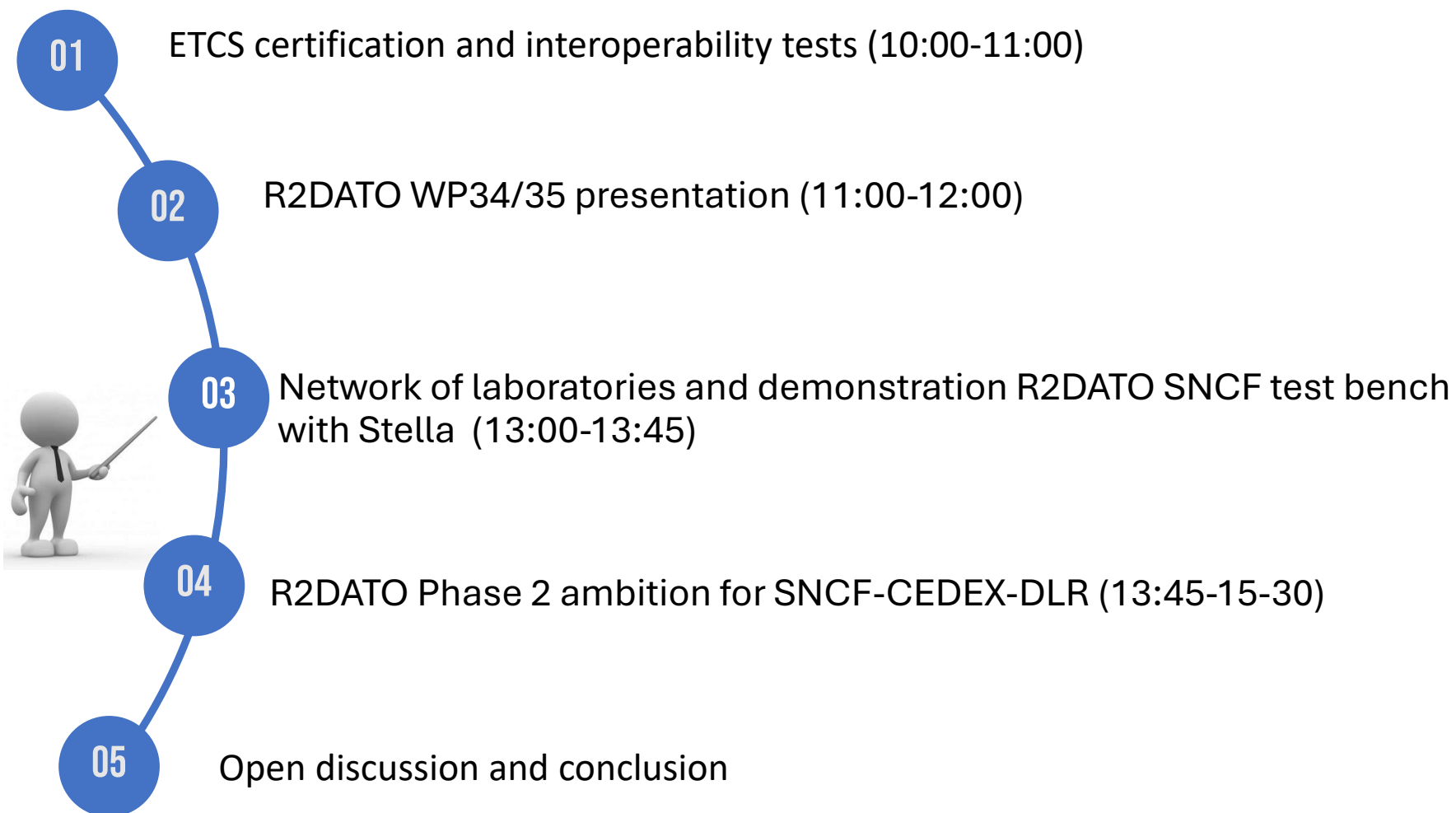
R2DATO WP34/35 presentation (11:00-12:00)

CEIT's ASTP results against Skydel simulator (in WP34, ended in 11.2024)

Example from CLUG project: S-POR-002 with Test_exec_ID=83 (Brief description: CLUG project, Potsdam-Oranienburg, for 04_ATL. GPS+GALILEO+SBAS. Active signals = L1CA, E1. Elevation Mask = 10. Importing the (mixed) Rinex navigation file for GPS, Galileo and SBAS in the "Data sets" tab (Skydel) of the respective constellation; and importing the same Rinex file for setting Ionospheric model to Klobuchar.

The values of h_pos_err are all less than 3,1m. For h_pos_err: Mean=1.9m; median=2.1m; std_dev=0.6m; variance=0.37m. The values of the PLs are between 3.9m and 5.9m.





Network of laboratories (13:00-13:20)

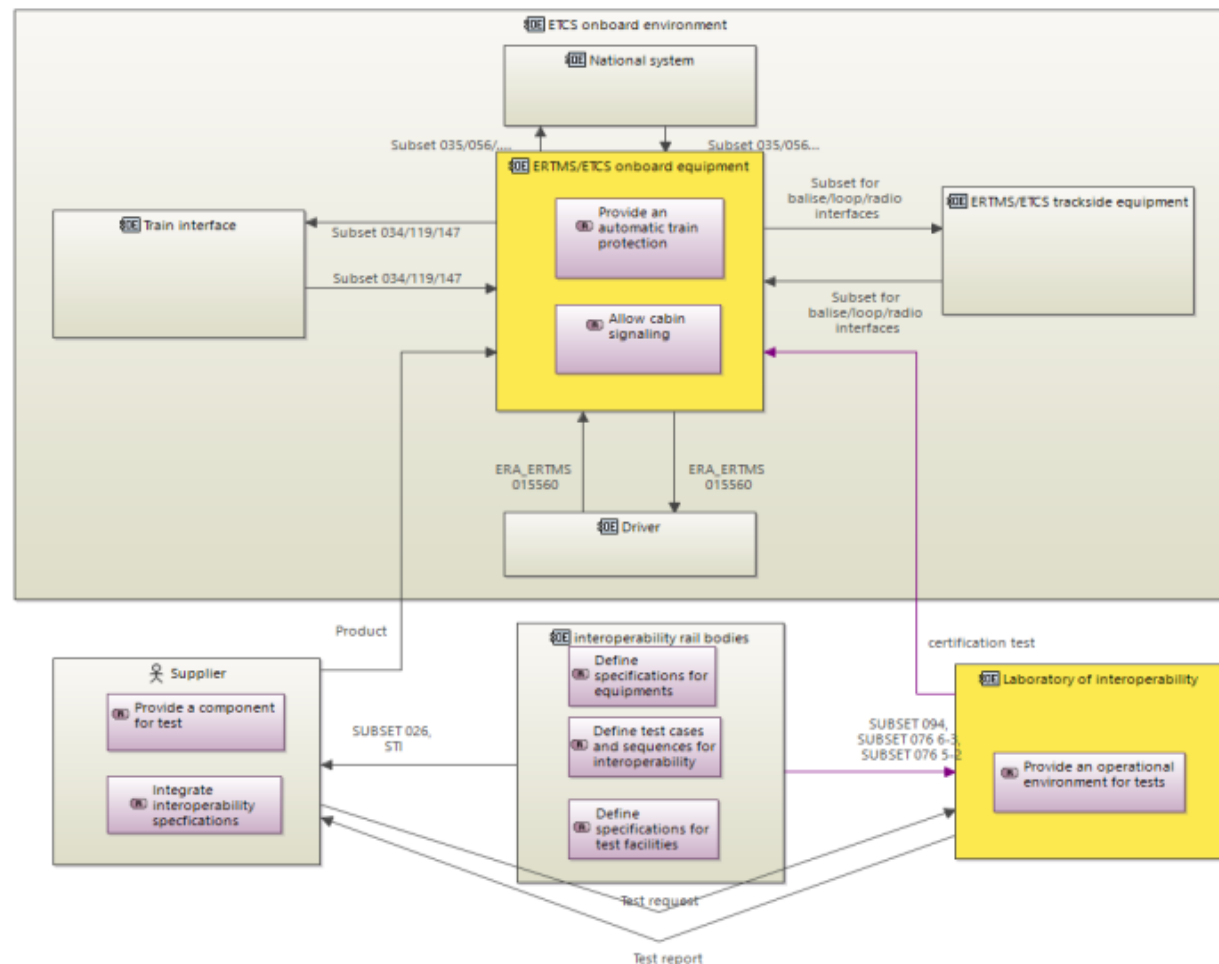
Context

- Interoperability : a legal and operational requirement in Europe(TSI)
- Certification testing is mandatory to:
 - Verify CCS conformity
 - Validate interoperability between multi-supplier components



SS-110/111/112: interoperability testing
 SS-094: EVC certification
 SS-041: performance requirement for interoperability....

Implication for labs



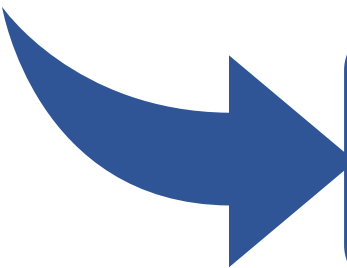
Why independent laboratories matter within a modular ERTMS system ?

- **ERTMS modularity => specialization**
→ ERTMS is intentionally divided into subsystems: OBU, RBC, RIU, ATO, etc..
- **Specialization laboratories emerged accordingly**
→ each lab focuses on specific subsystems and interfaces.
- **Compliance with UNISIG standards**
→ laboratories guarantee objective verification between multiple suppliers and national implementations.
- **Infrastructure investment**
→ test benches, simulators, and hardware interfaces require heavy technical setups.
- **Cross-border role**
→ labs act as bridges ensuring European-level interoperability, beyond national frameworks.
- **Collaboration becomes necessary**
→ diversity of expertise calls for cooperation and shared methods.



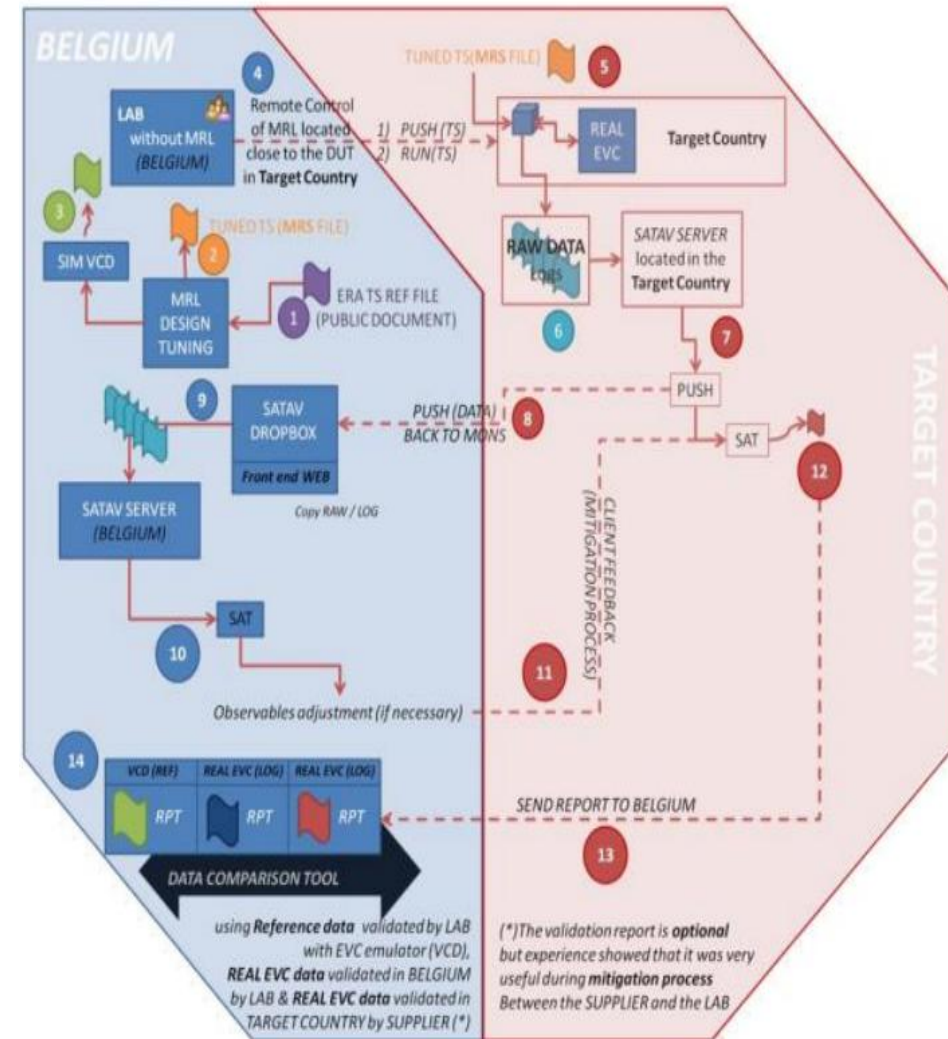
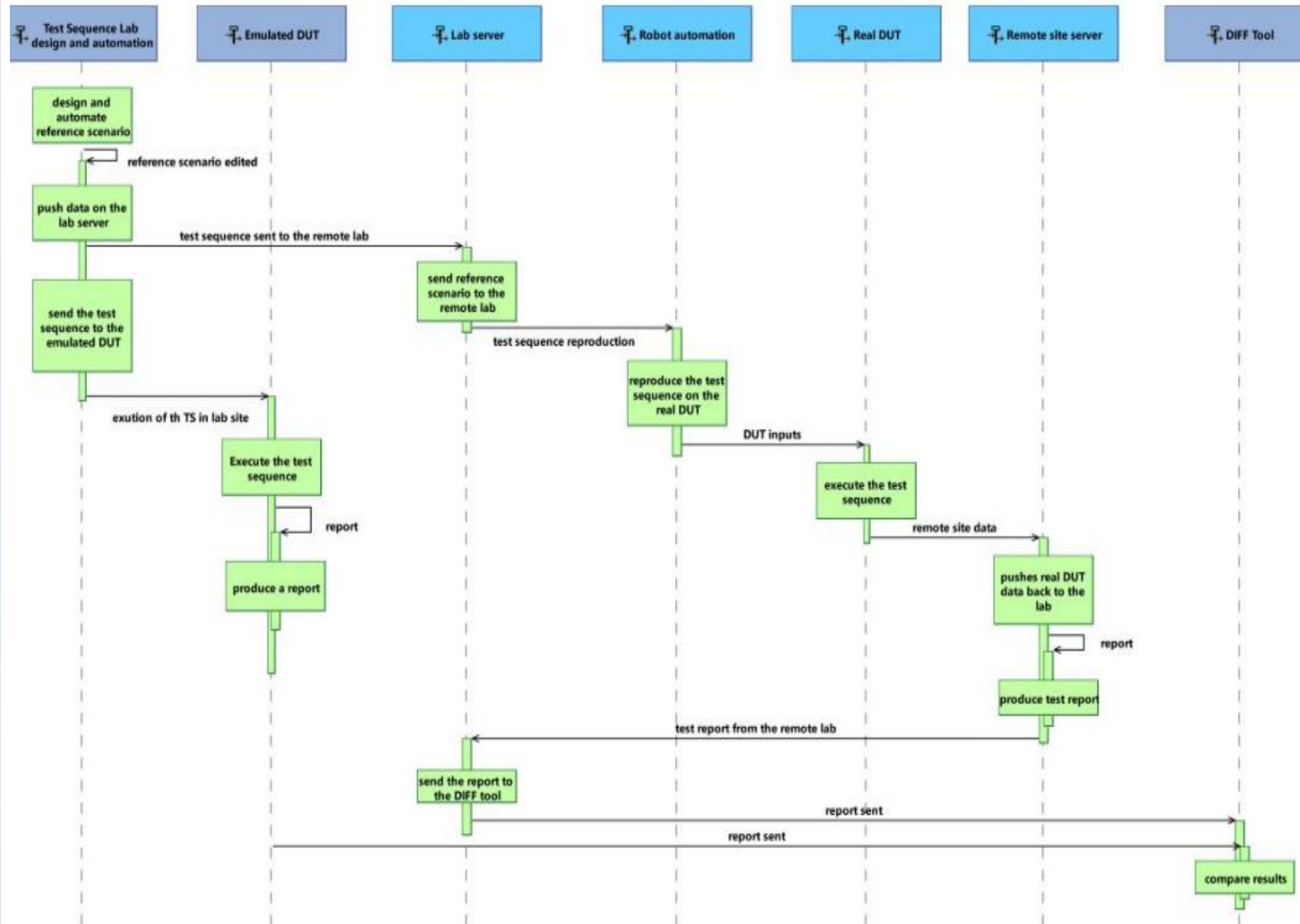
Challenges in testing the ERTMS system

- **System modularity and interdependence**
→ Testing requires validating both individual components and their end-to-end integration.
- **Geographical distribution of expertise and infrastructures**
→ Each subsystem requires specific test benches and environments often located in different laboratories or countries.
- **Complexity of real operational conditions**
→ Ensuring realism across distributed configurations is a challenge.
- **Testing logistics and delays**
Moving equipment or setting up cross-lab test campaigns can be costly and time-consuming (up to several months).
→ The process needs to become more flexible and collaborative.



Instead of bringing all subsystems together physically in one place, can we make them work together virtually across laboratories while preserving the same level of reliability and performance ?

Concept of distributed testing



Cedex and DLR use case: cross-border distributed testing experiment

Objective

→ Validate the interoperability between on-board and trackside simulators

Deployment of ERTMS: demonstrate the feasibility of IOP testing between geographically distant laboratories

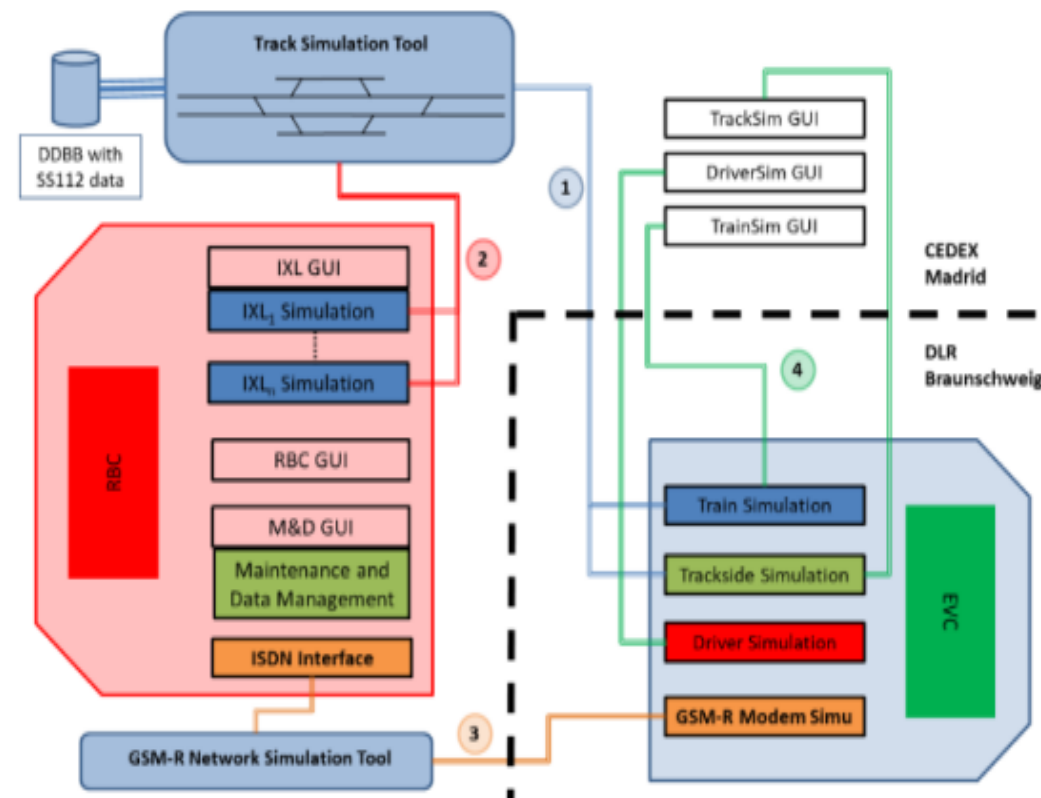
Configuration

- Real On-board equipment connected to the simulation chain
- The RBC environment hosted the Radio Block Centre simulation and managed route setting, signal aspects, and IXL logic
- A VPN over the Internet using CORBA/IOP over TCP/IP ensured secure inter-laboratory communication

Results

- Successful remote execution and interoperability validation
- Highlighted latency sensitivity, synchronization complexity
- lack of a unified orchestrator layer to control, monitor and synchronize all distributed entities in real-time

Test environment



Cedex-DLR remote test environment

Lessons learned from existing use cases

What works today:	What remains challenging:	What is needed next:
- Feasibility is proven through experiences. - Laboratories strong expertise. - Commun understanding of functional interfaces via IOP subsets.	- Lack of harmonized architecture: each setup is still custom-built. - Differences in communication technologies and synchronization methods. - Lack of shared tools for monitoring, control, and performance measurement. - Limited traceability and comparability of results between sites.	- A common reference architecture defining standard communication layers, synchronization methods, and monitoring tools. - A step toward formal European standardization for collaborative testing.

Key takeaways

- Strengthens cooperation between accredited laboratories
- Accelerate innovation and market access for suppliers
- Support european technical sovereignty in railway interoperability



- Real-time interoperability without physical relocation of equipment
- Flexibility to integrate new subsystems(ATO, ASTP) into existing setups
- Improved test efficiency with faster processes and reusability of infrastructures

- Mutualization of resources between laboratories
- Reduced campaign duration and cost by avoiding transport, re-setup, recalibration
- Scalability: easy replication of configuration across partner sites

Conclusion : Toward a collaborative European Testing Network



Demonstration R2DATO SNCF test bench with Stella (13:20-13:45)

- Scenario SC01
 - Toulouses to Foix
 - Beginning time : 2021/04/03 - 16h 53mn 06.923s
 - Duration : 1h 58mn
- Challenges in the region: tunnels, mountains, cities
- Scenario extracted from SNCF's data

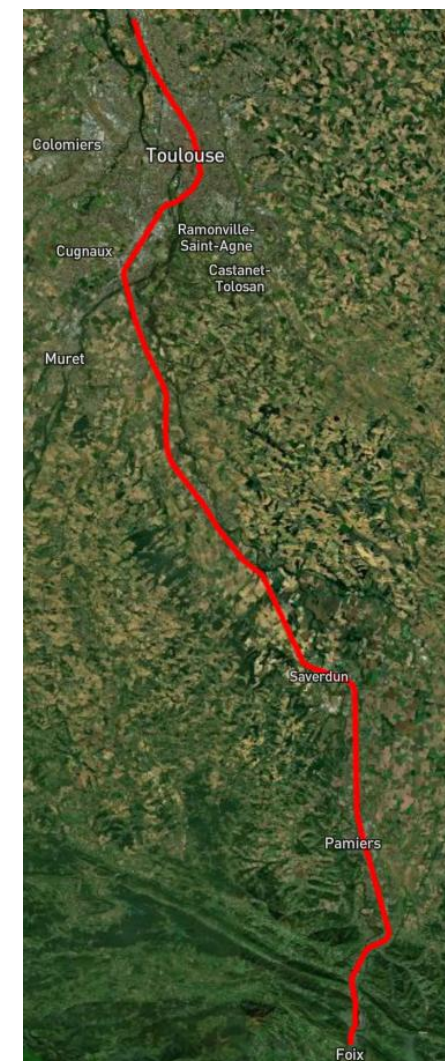
 01-Scenario_01_Digital_Map.csv

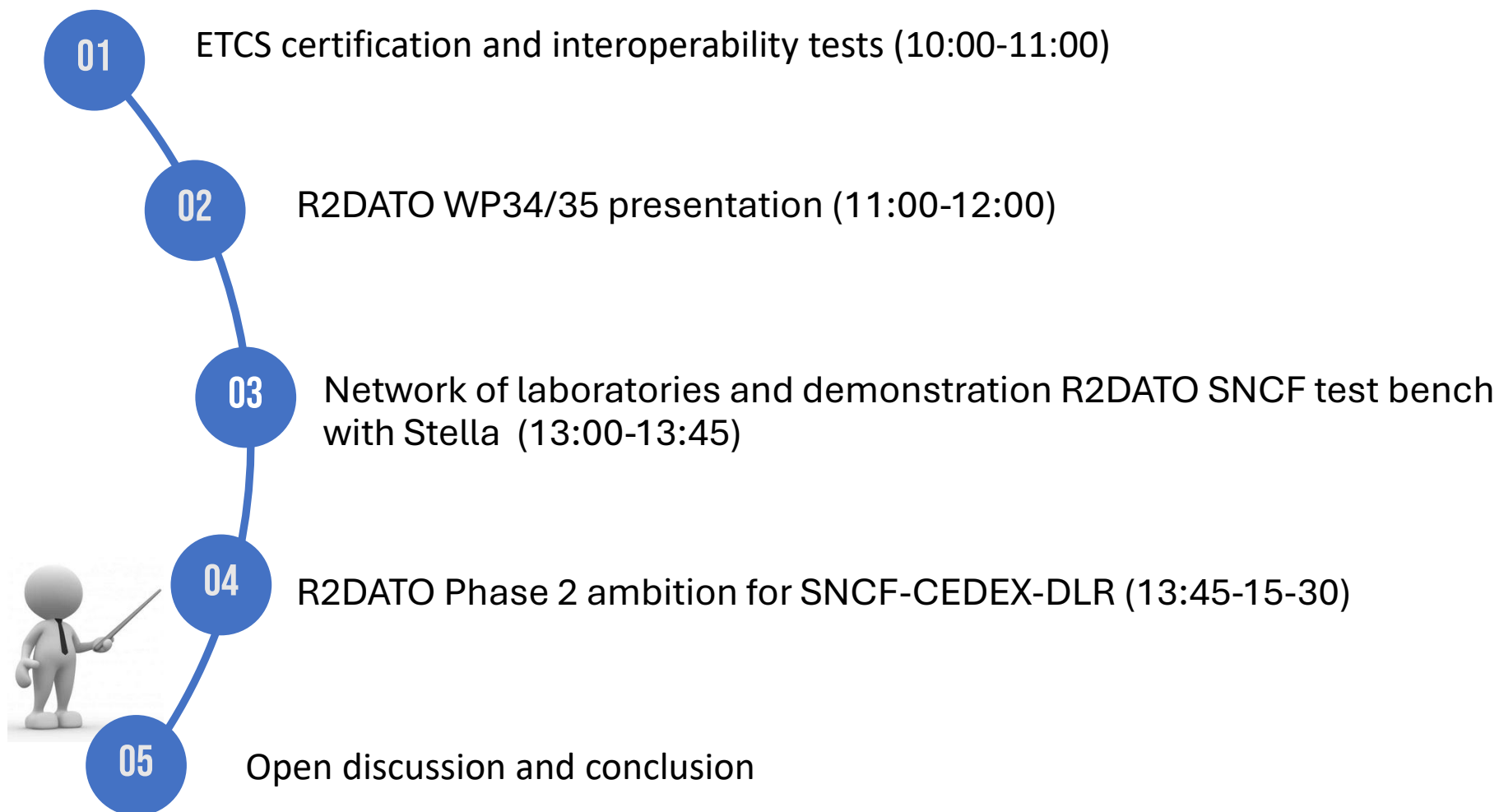
 01-Scenario_01_MCTP_data.csv

 01-Scenario_01_Orientation.csv

 01-Scenario_01_PK_BG.csv

 01-Scenario_01_Stella_data.dat





Système FerroviairesSCOPE in R2Dato Wave 2 & 3

WP3 - System Design

WPx - NG Brakes

WP - Others ...

Jean-Baptiste SIMONNET

~20% of foreseen budget

Solutions for High performance railway system

Hélène ARFAOUI

~15% of foreseen budget

TE 4 - New ATO Technology

Support industrialization of ATO Solutions

Autonomous Train Team Scope

Valentin BARREAU

~15% of foreseen budget

TE 2 - Absolute Safe Train Positioning

Alternative solutions to localization with odometry and balises

ASTP Team Scope

TE 5 - FRMCS

Task OBRAD

TE 21 - New upgrade of ETCS

Task GVA

Task MDS

Etienne KUNTZEL

~50% of foreseen budget

Modular solutions and modular testing / certification

TE 14 - Testing, validation & (virtual) certification

Testing

Overview of overall topics

Modular Solutions and Testing (TE05, TE 14 and TE 21)

TE 05 :

- ☐ FRMCS test benches: OBRAD interface testing on CCN

TE 21 :

- ☐ Development of an interface solution for existing vehicles with onboard CCS (GVA)
- ☐ Demonstrator for sharing MDS driver screens between multiple onboard systems

TE 14 :

- ☐ Test benches for CCS component certification (ASTP/CCN/MDS/Train Interface)
- ☐ Lead SNCF Testing and Certification
- ☐ Initiate collaboration with other laboratories (CEDEX, etc.)

Alternative solutions to localization with odometry and balises

TE 2 :

- ☐ Support manufacturers in **defining specifications and interface choices** for future Localization systems (ASTP)
- ☐ Monitor the testing of these systems on an online demonstrator and ensure that manufacturers' solutions meet the set objectives
- ☐ Conduct **platform tests** (cf. Modularity) based on GNSS or other technologies (according to ERJU guidelines)

Support industrialization of ATO Solutions

TE 4 : Support :

- ☐ Specifications, safety analysis, architecture, and ATO use cases up to GoA4 aligned with SNCF's DAS and ATO strategy
- ☐ Contribution to testing with one or several ATO GoA4 demonstrators within a cost-reduction approach for LCC
- ☐ Evaluation of socio-economic KPIs for ATO and DAS (tools and their support: outside FA2, within FA1)

Solutions for High performance railway system

- ☐ Develop consistency and interoperability between different systems, and explore new approaches to system integration
- ☐ Assess the performance of the ERTMS+ system based on design choices
- ☐ Support FVY and KB in developing advanced functions for adhesion management
- ☐ Coordinate SNCF Group's participation in FA2 projects (wave 2, wave 3, and FP10 technology roadmap)

7 novembre 2025

GVA – Generic Vehicle Adaptator – Interface with existing Trains

STIP_71: Train Interfaces Enhancement (2027)

Problem statement :

No issue on new Build RS Project 😊 ➔ SS-119 interface as per TSI 2023

Issue for Retrofit projects 😞 : Specific development is needed for each kind of RS and each kind of CCS.

For SNCF : > 1000 trains in retrofit between 2030 and 2040.

Proposition :

Demonstrate the feasibility of a **GVA common to various kinds of RS** :

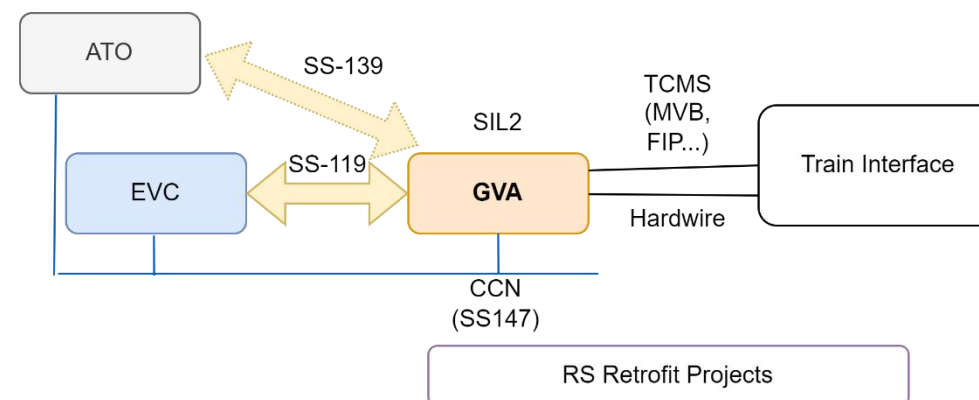
- using configurable GVA in terms of HW boards and parametrization.
- Implementation of interface SS-119 for several types of CCS.

Apply Standard communication protocol SS-147

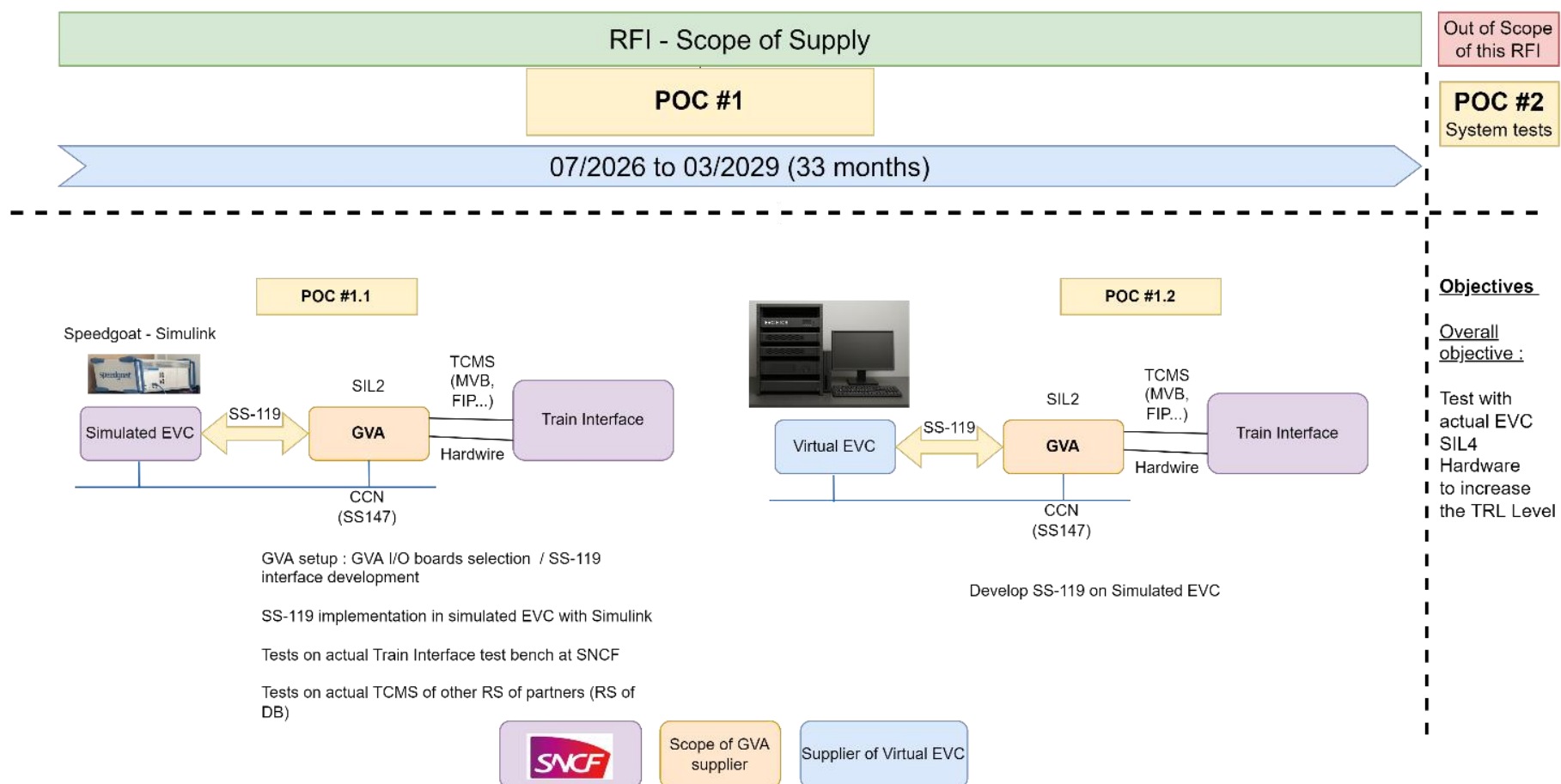
Benefits :

Fewer developments : Use of CCS common to retrofit and new build RS.

Smaller testing effort : Reduce the need of certifications by using the similar CCS configuration across different types of trains.



GVA – Generic Vehicle Adaptator – Interface with existing Trains



MDS – Multiple Display System

STIP_69: TDS FFFIS Update (2030) and STIP_70: Multi-Display On-Board (2030)

Problem statement :

1 Display per application. Up to 6 different Displays for all required applications such as ETCS, TCMS, CVR, NTC, RearView, ...etc.

Issue of **cabin space** 😞

Varied technologies involved **with very short life cycles** – obsolescence management issue 😞

Proposition :

Mutualize Displays between applications (as done in aircraft industry)

Specification work is **on-going in the System Pillar** activities : guidelines and concept.

Demonstration and validation of the concepts are needed **to prove the feasibility**.

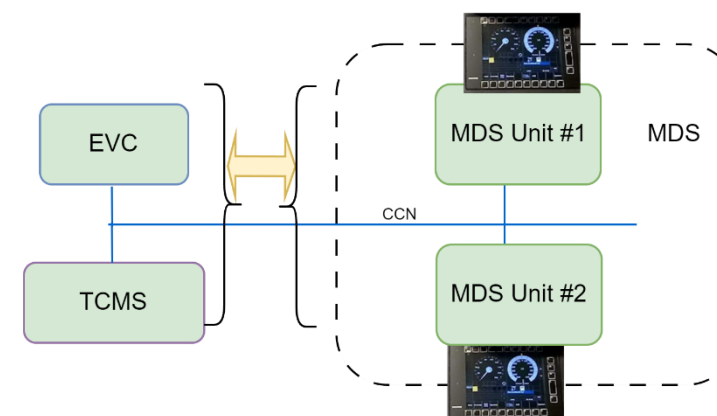
Apply Standard communication protocol SS-147

Consider Computing environment to allow : 1/ installation of software of different suppliers on the same hardware and 2/ Ease obsolescence management

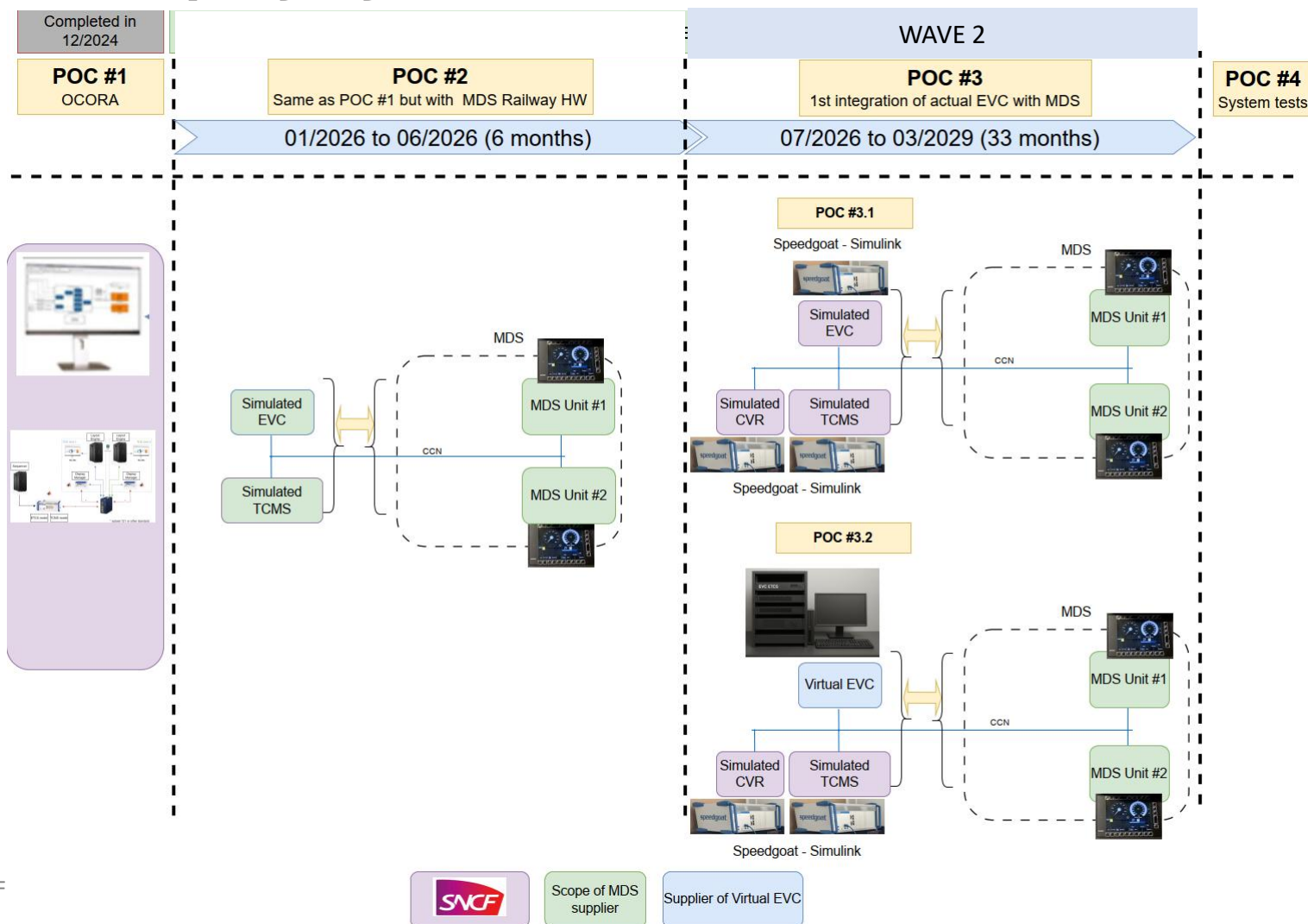
Benefits :

Ease of **integration** in the RS

Ease **obsolescence** management of hardware



MDS – Multiple Display System



OBRAD Interface

Problem statement :

Radio communication is highly **obsolescent**.

Radio cables need to be as short as possible

Little room for installation in RS

Proposition :

Make Radio Function independent from Gateway Function.

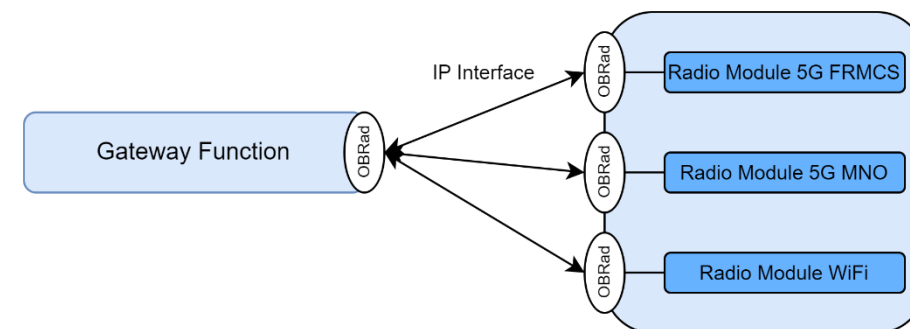
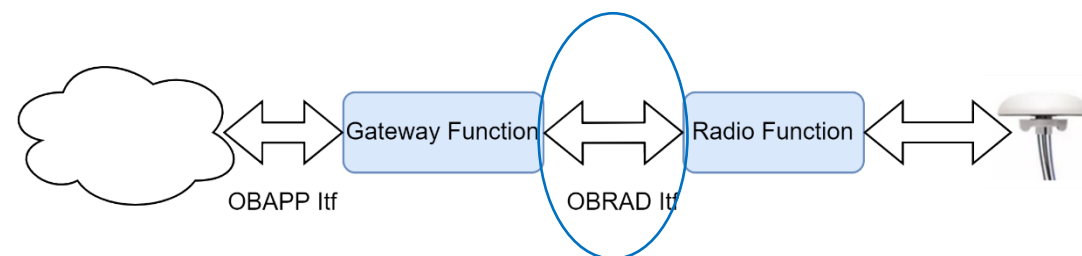
UIC TS and TR specifications for OBRAD Interface available at end of 2025.

Outside of Morane 2 project. Target result S1/2027

Benefits :

Be able to **change / add / remove only Radio Function easily** : obsolescence of 5G (6G) / vendor diversity / Be able to add new communication means (Satellite, WiFi, 5G MNO)

Ease the installation of the Radio Function as close as possible to the on-board 5G antenna for shorter radio cables and better data communication..



TE 14 Description for FA2 Wave2

TE 14 Testing, validation and certification

Continue development of Testing means for ASTP (GNSS Signals, IMU...) and other systems/components/functionalities

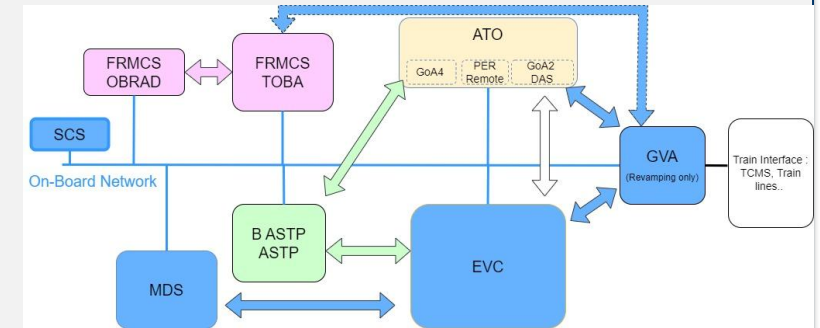
Develop interface test specification and demonstrate their feasibility for the following topics:

- ASTP interface
- GVA Interface – SS119
- MDS Interface
- Develop test specifications for CCN according to SS-147
- Virtual Coupling



Develop test platform, test scenarios and perform test for certifying :

- ATO and perception
- FRMCS / IRIS²



Collaborative activities – need for information exchange and synergies

Certification activities to be defined with different laboratories and NoBo/DeBo if possible

Interoperability (ESC/RSC) tests based on conformity tests (subset076) between OB and IM laboratories

Inputs from System Pillar on interfaces and architecture definition

Inputs from TE21 (ETCS Onboard Upgrade)

Inputs from TE2 (Advanced safe train positioning, highly accurate and safe, incorporating new sensors)

Inputs from TE4 (New ATO technologies solutions)

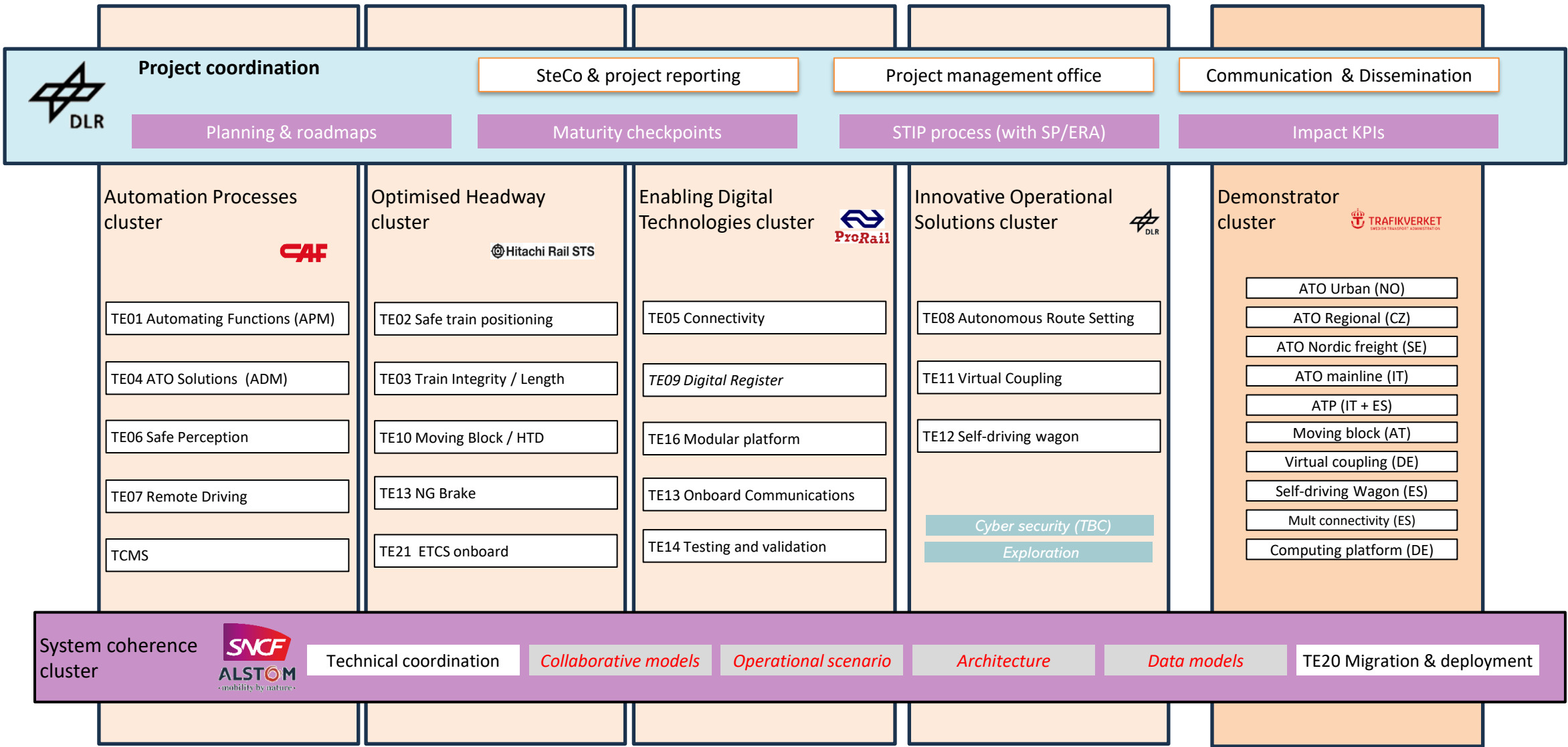
Inputs from TE9 (Digital Register)

Inputs from TE05-2 (Sat-Com)

Inputs from TE11 (Virtual Coupling)

FA2 wave 2 organisational structure

Challenge: Building an integrated system project



System coherence cluster

Technical coordination

- Challenge : boost reconciliation, develop coherence within FA2 and with SP, support STIP & MCP process
- Status : TMT/TCT Concept defined, involving System expert (still to be nominated)

Operational analysis

- Challenge : support exploitable result at the end of FA2 (support from EUG?)

Architecture

- Challenge: define applicable baseline, identify variants and open points

Data model

- Challenge : converging ontology and data models as prerequisite for compatibility and evolution

Tools / collaborative modelling

- Challenge : promote MBSE based on common method, develop and integrate models for R2DATO TEs

TE 20 deployment and migration

- Challenge : qualify DATO implementation benefit, consolidate impact KPIs
- Status : on track (basic collaborative activities defined)

Workshop in Rome on 19/11
morning

→ Align on system coherence
needs & collaborative activities

→ Define leaders for grey zones

→ Share roles

- Be able to certify and validate ASTP solutions and interfaces in the framework of ETCS modular system
- Be able to test candidate interfaces for TSI and new features involving the following modules : ASTP, FRMCS, ATO GOA2 up to GOA4
 - Define a network of laboratories to perform interoperability tests (SNCF/CEDEX/DLR)

TE 14 Testing, validation and certification

- Continue development of Testing means for ASTP (GNSS Signals, IMU...) and other systems/components/functionalities
- Develop interface test specification and demonstrate their feasibility for the following topics:
 - ASTP interface
 - Develop test specifications for CCN according to SS-147 (reviewer)
 - Virtual Coupling (reviewer)
- Develop test platform, test scenarios and perform test for certifying :
 - ATO and perception
 - FRMCS

Need From Others

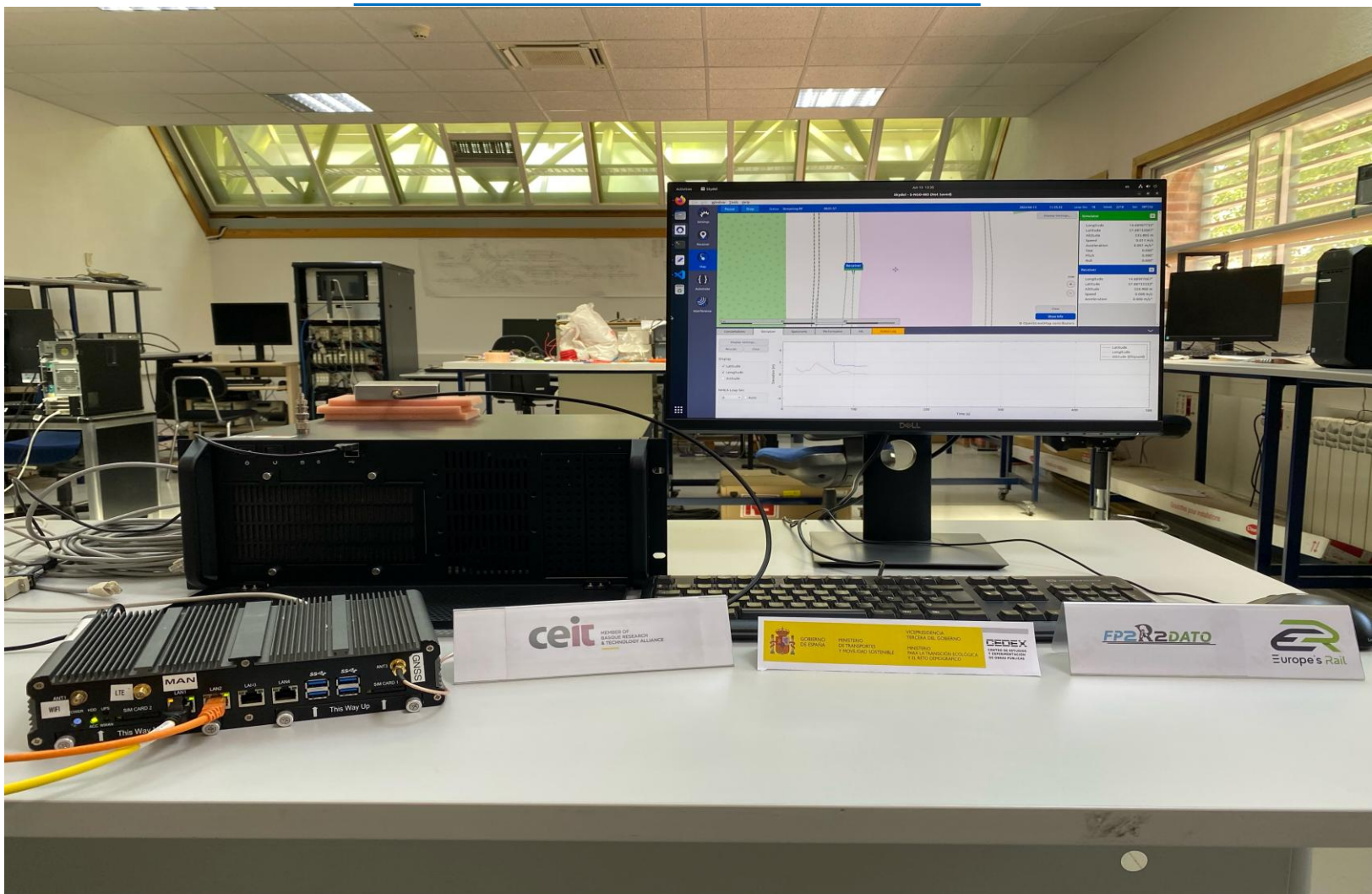
- Need support from ESA for setup and definition of GNSS testing means and strategy of ASTP solutions.
- System or components from other TEs/Demonstrators : ASTP, ATO, FRMCS
- System Pillar: FFFIS for ASTP

TE 14 Testing, validation and certification: ASTP

To be able to certify and validate ASTP solutions and interface in the framework of ETCS modular system (in collaboration with ESA), the following topics are envisaged:

- Test requirements for certification
- Test Specification with tests cases and tests sequences:
 - System-level functional testing:
 - Performance testing
 - Interoperability testing: different CCS on-board subsystems with ASTPs are interoperable with CCS trackside subsystem (including GNSS augmentation).
- Test methodology for certification with NoBo
- Test environment specification and development: The reference test facility is defined in SUBSET-094 (to be updated for ASTP), construction of a reference testing environment, based on the 'near zero-on-site' testing approach to support the validation and certification process:
 - Models
 - Data
 - Tools
 - Test bench
- IMU
- EGNOS
- Perform tests and report : Provide a preliminary verification of compliance test platform with the applicable Regulatory Standards and by Notified Bodies (NoBo) and Assessment Bodies (AsBo) for certification.

CEDEX relies on CEIT ASTP for Wave 2



TE 14 Testing, validation and certification: ATO

To be able to certify and validate the modules of ATO up to GOA4 (included ADM, APM, PER), the following topics are envisaged:

- Specify Test requirements for certification of each block and the whole system
- Consolidate test specifications (with tests cases and tests sequences) from R2DATO Wave 1 deliverables: WP5 Use Cases, WP11 perception system validation strategy and certification with NoBo
- Integration of the simulated environment (R2DATO Phase 1 WP7 data factory + ADM +APM+PER) in the laboratory test bench
- Perform test and report on APM, ADM and the whole system
- Evaluation of the perception and certification strategy of PER subsystem on the test bench (data from R2DATO Phase 1 WP7). Define a methodology to evaluate AI algorithms

CEDEX relies on Wave 2 Spanish Transversal Demonstrator 11

SPANISH TRANSVERSAL DEMO (on regional line)

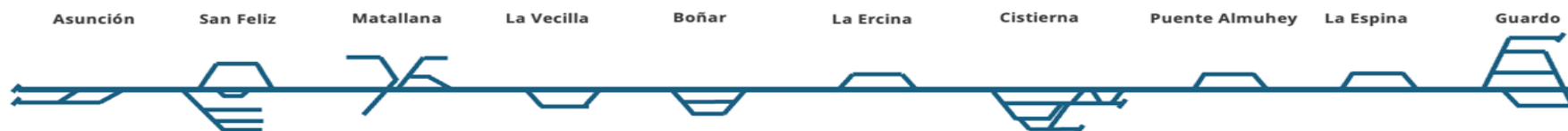
FA1-FA2-FA6 Demo in SPAIN

Integrated Demo to test new improvements on TMS, ASTP, ATO-TS, Perception, HL3

- **Partners:** INDRA, ADIF, RENFE, INECO and CEDEX.
- **Related TEs:** TE 02 ASTP, TE 03 TIMS, TE 04 ATO, TE 06 Perception, TE 10.2 HTD
- An integrated demonstrator composed of the **following systems**, developed in the following FAs:
 - TMS (FA1): which will improve RTTP (including conflict management) through the SR, MA
 - IL (FA1): Integration Layer for integration with ATO-TS following standardized protocols.
 - ATO-TS (FA2, FA6): integrated with TMS, which, together with AI algorithms, guarantees optimization for driving (through policies for energy savings, maximum punctuality, etc.)
 - ASTP (FA2,FA6): for safe train positioning (Satellite+IMU)
 - TIMS (FA2, FA6): for monitoring the train and its effective length
 - ATO-OB (FA2, FA6): for generating movement and control directions
 - Perception (FA2): Use of AI for computer vision
 - ETCS HL3 (FA2,FA6): for generating MAs

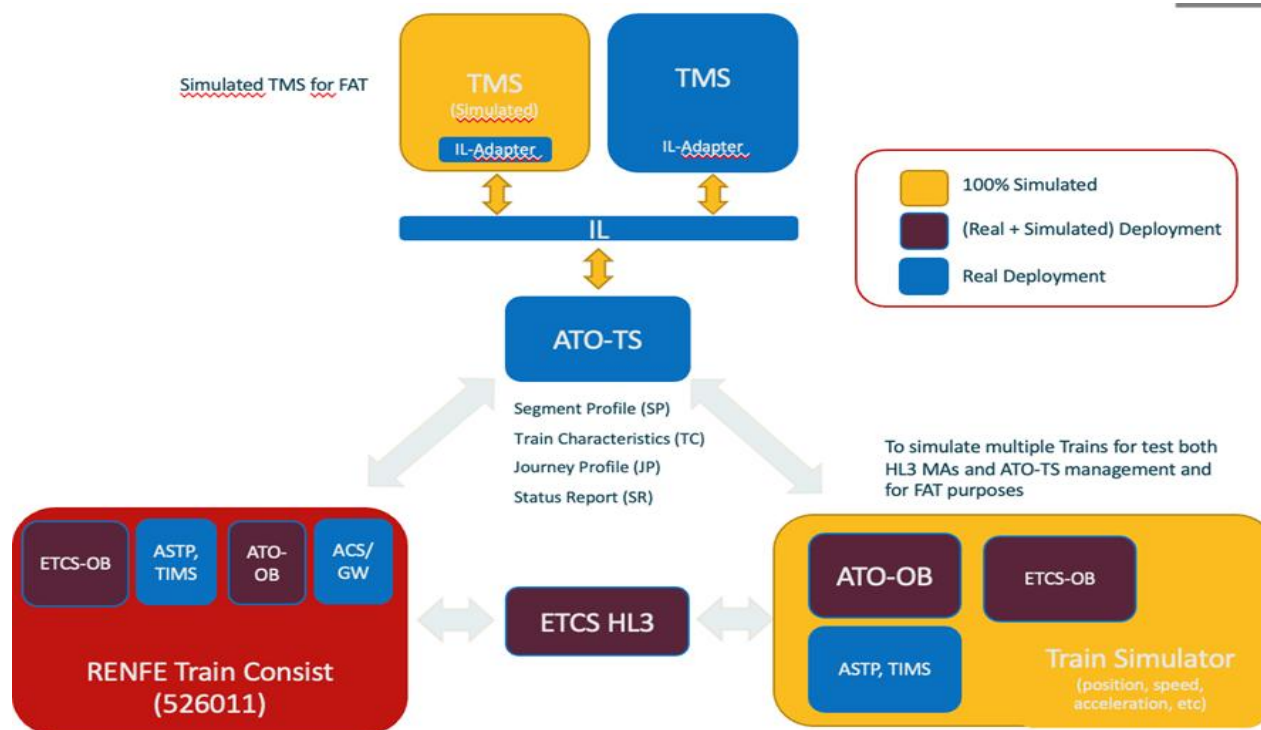
CEDEX relies on Wave 2 Spanish Transversal Demonstrator 11

Asunción-Guardo Railway Regional Line (ADIF, SPAIN)



Test Support
(CEDEX)

High Level Architecture (INDRA)



Rolling Stock (RENFE)



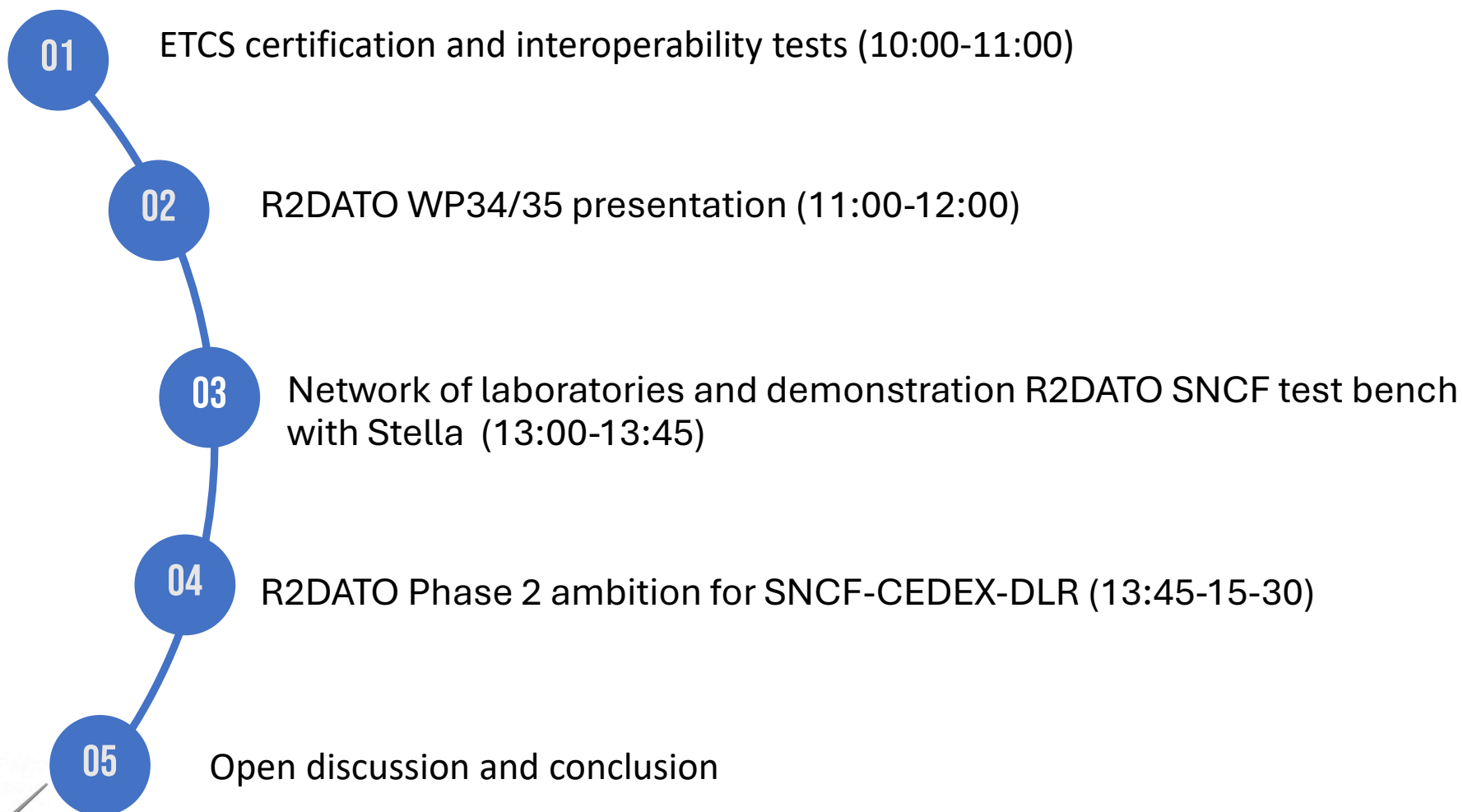
UTDH-2600 Series

- Fleet:** 12 units
- Distribution:** 3 Leon, 8 Asturias, 1 Cartagena.
- Unit type:** Hydraulic diesel unit with M-M configuration and two motor-transmission groups.
- Maximum speed:** 80 km/h.
- Seated capacity:** 99 passengers.
- Total capacity:** 244 passengers.
- Services offered:** Cercanías (Commuter) for Asturias and León.

R2DATO Phase 2 ambition for DLR

R2DATO Phase 2 Strategy of DLR (TE14)

- Virtual Coupling Train Set (VCTS)
- Test methodology for certification as well for VCTS to show integration of future innovations (Task 2)
- Demonstration of VCTS in the RailSite incl. 3D simulation
- IRIS²: specification of the IRIS² interface (Task 4)
- Extend the network of laboratories to perform interoperability tests (SNCF, CEDEX, DLR)
- Build upon the results of D35.2 if needed/useful (ASTP Certification)
- Validation of LIDAR sensors for train odometry to use in multisensor ASTP Systems



Open discussion and conclusion

AOB

Thank you for your attention!



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