



# Wireless Communication Emulator device and methodology for the ETCS BTM subsystem

Gonzalo Solas

CEIT and Tecnun (University of Navarra)

NETS4TRAINS 2016

Donostia – San Sebastián

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# Outline

1. Introduction
2. State of the Art
3. Functional requirements
4. System implementation
5. Results and validation
6. Conclusions



## ▶ ERTMS

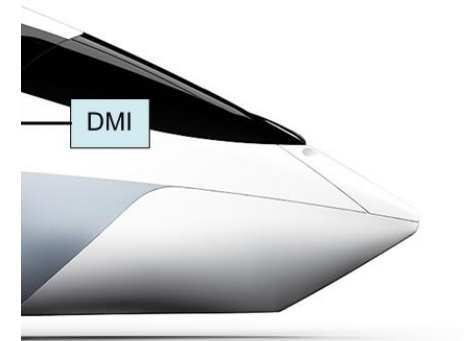
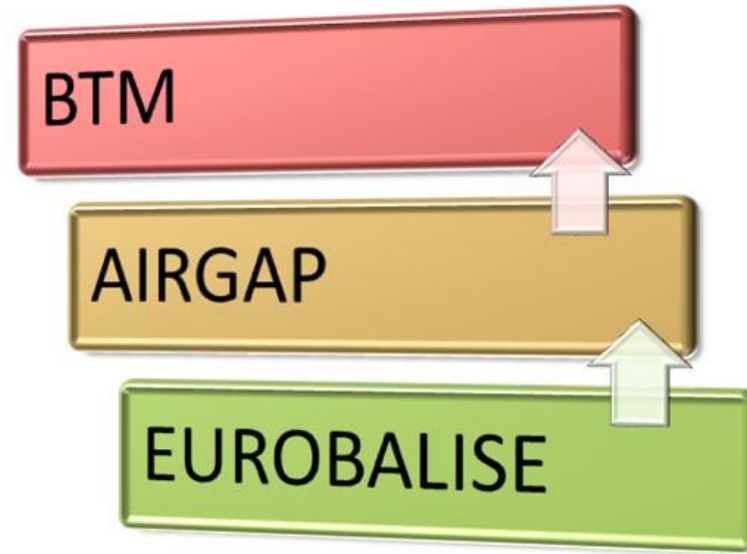
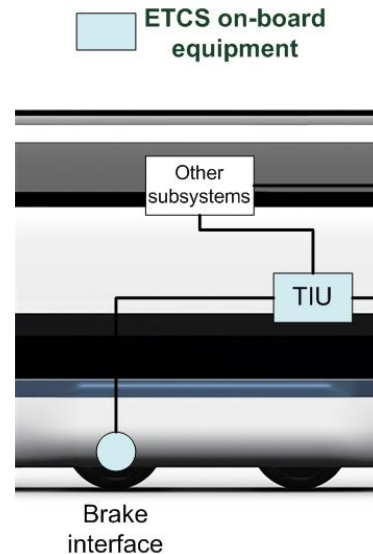
- Improve the interoperability of railway signaling within the European Union
- ETCS (onboard + trackside) + GSM-R

## ▶ Eurobalise/BTM subsystem

- Provide the data transmission capabilities between the trackside and on-board

## ▶ Current problems

- Laboratory certification procedures do not completely address all the needs



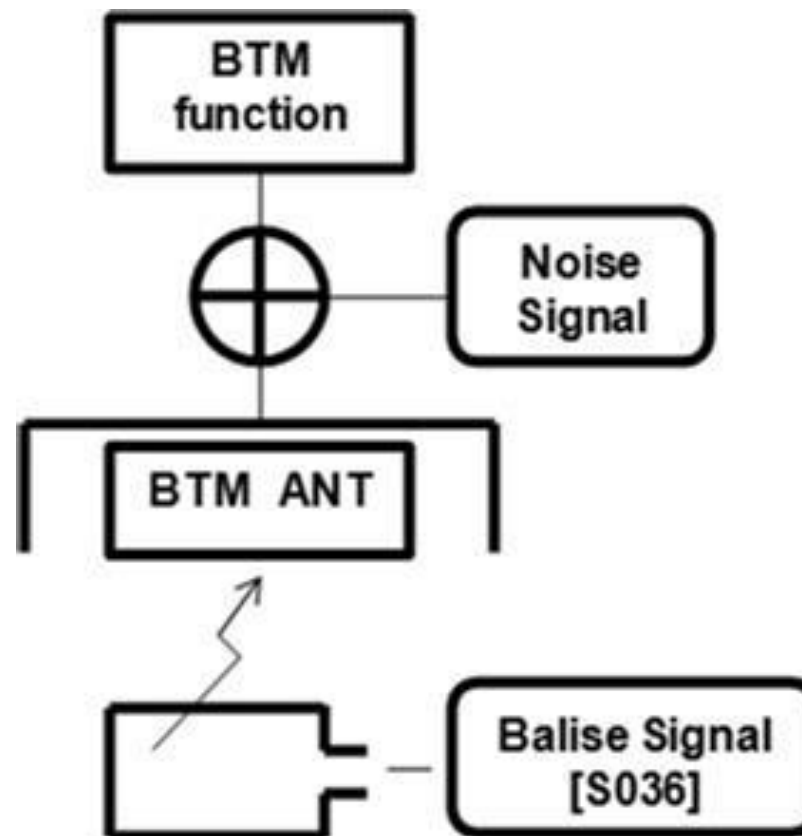
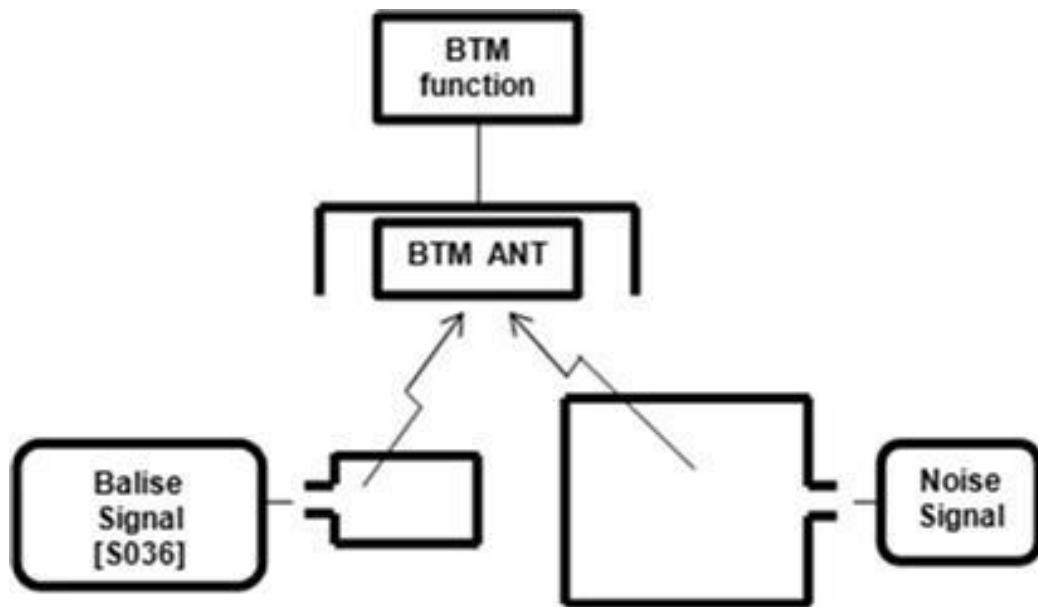
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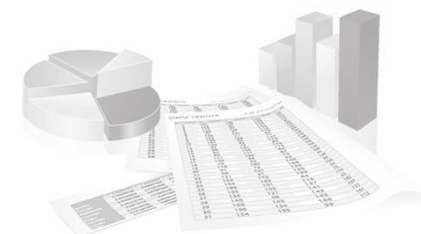
► Subset 116

► TREND Project



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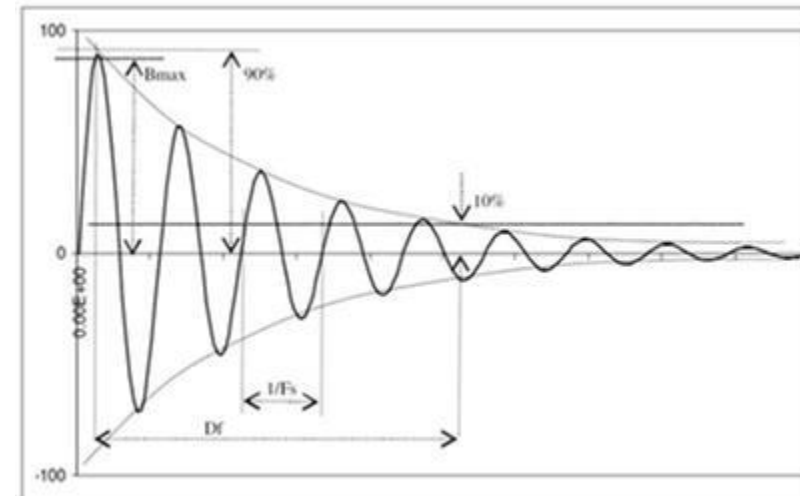


- ▶ Subset 036: main source of requirement specification
- ▶ Susceptibility tests
  - BTM shall be able to operate when being exposed to:

## Pure sinusoidal constant wave

ID	Frequency [MHz]	Field Strength, RMS [dB $\mu$ A/m]
CW_01	1.0	100
CW_02	2.5	83
CW_03	3.9	49
CW_04	4.5	49
CW_05	6.0	74

## Damped sinusoidal transient wave



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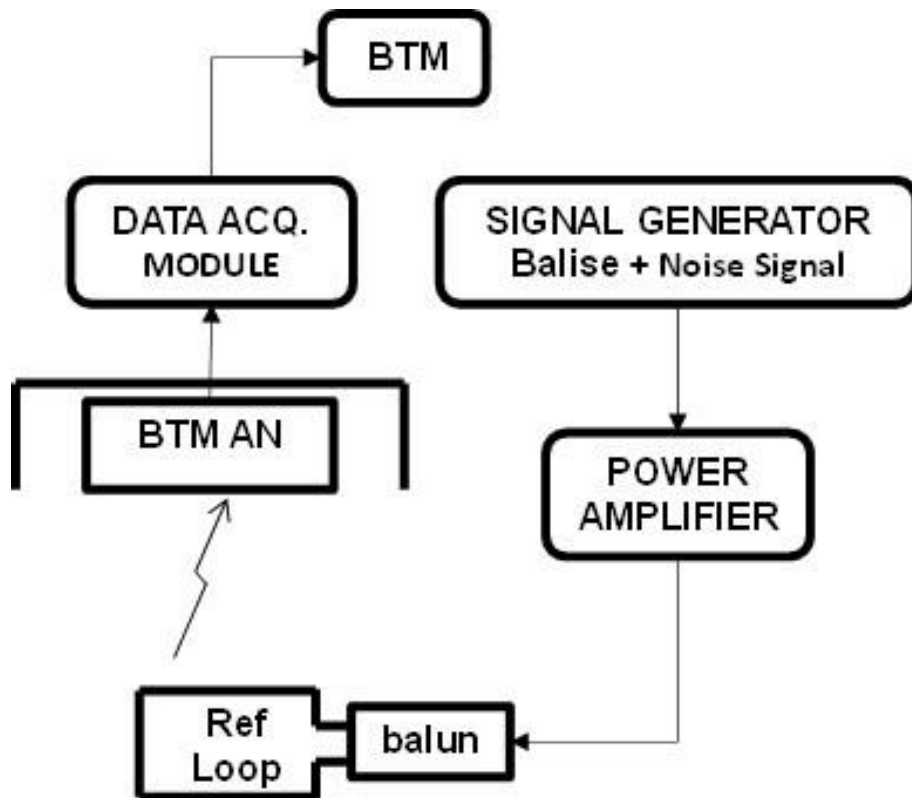
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# System implementation

## System architecture



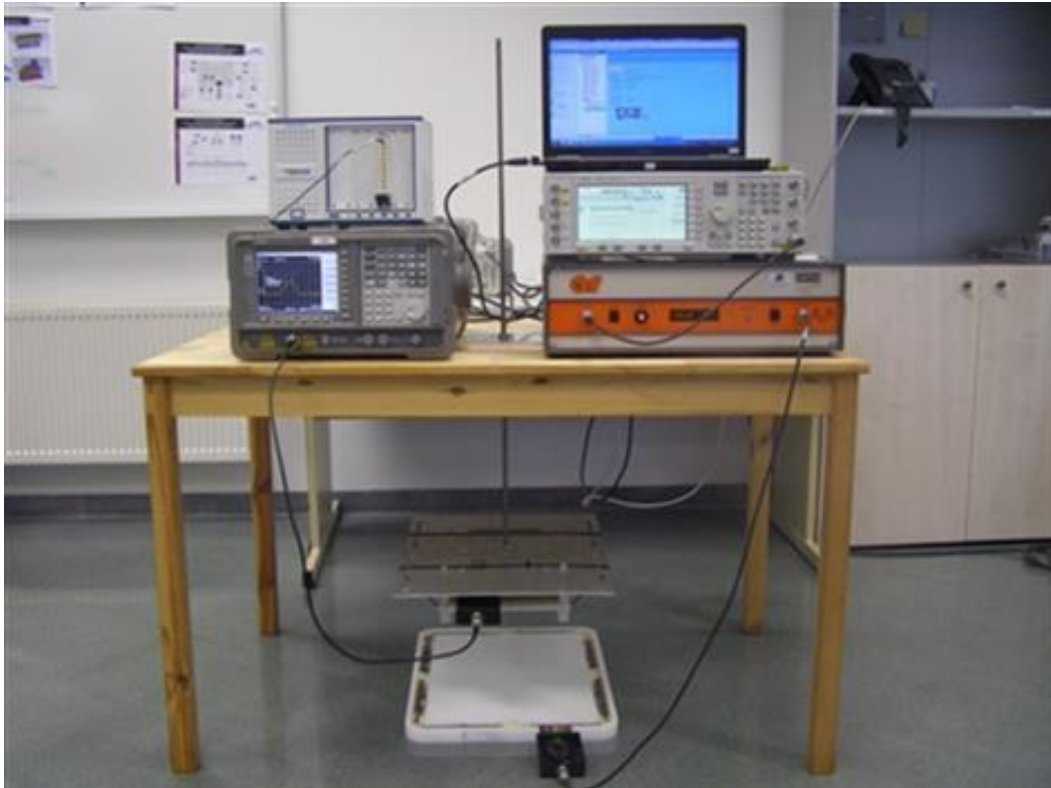
► The addition of the signals is done before the generation

► Operation

- 1) Balise and noise signals are generated computationally
- 2) Signals are amplified
- 3) The added signals are injected to a reference loop
- 4) Physical signal is acquired by a data acquisition module
- 5) BTM function model processes it

# System implementation

## Implementation and calibration



### ► Calibration

- Objective: to obtain the values defined in Subset 036 for the currents in the reference loop

Current	$P_{sa}$	$P_{in}$	G	WS
$I_{u1} = 37 \text{ mA}$	-15,62 dBm	12,67 dBm	15%	18%
<b>75 mA</b>	-9,48 dBm	18,71 dBm	15%	32%
$I_{u3} = 116 \text{ mA}$	-5,7 dBm	23 dBm	15%	49%

# Outline

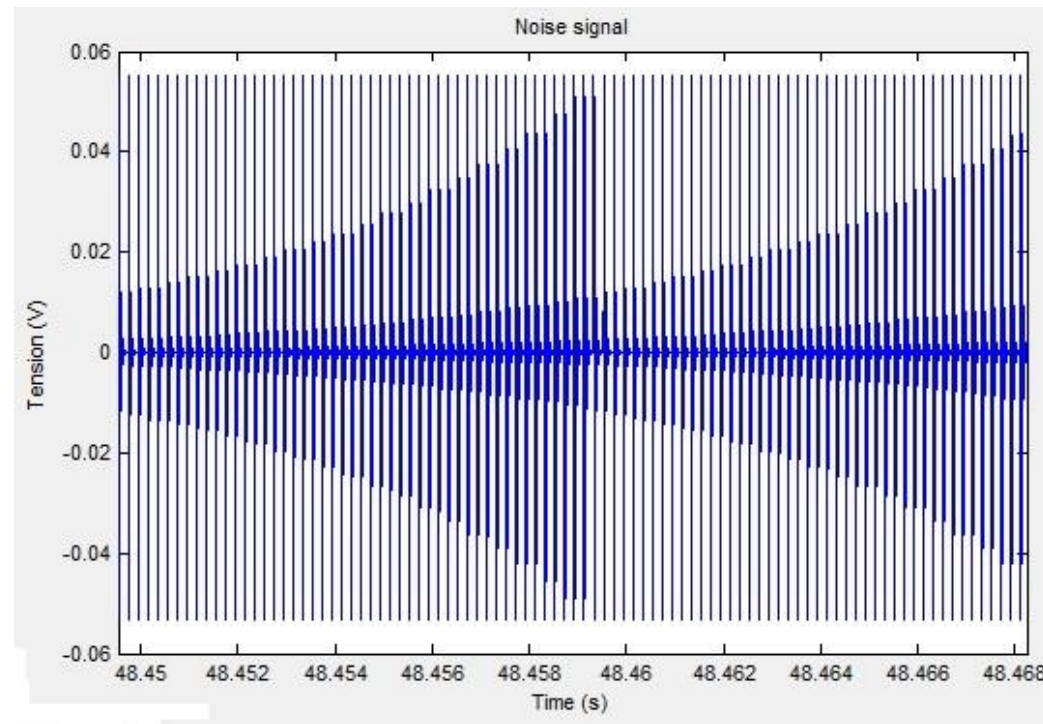
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# Results and validation

## Testing methodology

- ▶ Main objective: validation of the fulfilment of the functional requirements
- ▶ Thus, one test per each interferer identified in the requirements
- ▶ Employed balise telegram: one containing the renewal of a Movement Authority



# Results and validation

## Results example

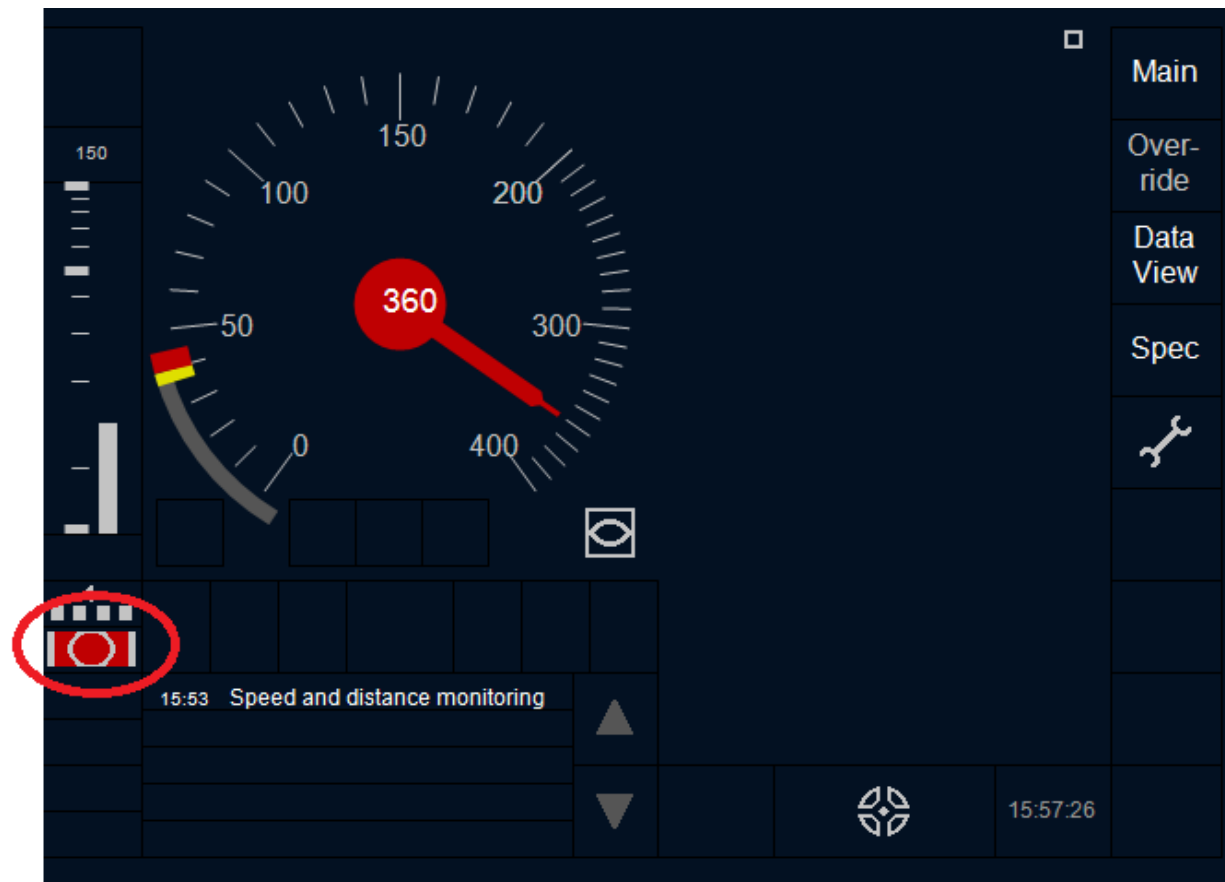
### ► Log of an ETCS JRU

```

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<StoredJruEvent xsi:type="JruGeneralEvent">
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    <L_MESSAGE>0</L_MESSAGE>
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    <TIME>
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    <MODE>Messages.M_MODE.Trip</MODE>
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<StoredJruEvent xsi:type="JruGeneralEvent">
<StoredJruEvent xsi:type="JruGeneralEvent">
<StoredJruEvent xsi:type="JruGeneralEvent">

```

### ► Appearance of a DMI



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- ▶ Objective “Zero On-Site Testing”
  - Laboratory procedures and tools need to be improved
  
- ▶ One such improvement: capability of reproducing in the laboratory the worst case scenarios
  
- ▶ Main contribution: design and implementation of a Wireless Communication Emulator (WCE) for the BTM subsystem
  
- ▶ This tool offers
  - Improved flexibility to test different on-board configurations and environment conditions
  - Evaluation of the robustness of the Eurobalise/BTM subsystem to noise found in the air-gap





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