



The logo for Safe4RAIL, featuring the text "Safe4RAIL" in a green and blue font, with a blue and white checkered pattern below it, all set against a background of blue light rays.

Wireless Train Backbone (WLTB)

Igor Lopez, CAF



CONNECTA has received funding from the European Union's Horizon 2020 research and innovation programme under agreement No: 730539. Safe4RAIL has received funding from the Shift2Rail Joint Undertaking under grant agreement No: 730830. This Joint Undertaking receives support from the European Union's Horizon 2020 research and innovation programme.

Safe4RAIL – SAFE architecture for Robust distributed Application Integration in rolling stock (730830)

CONNECTA – CONTRIBUTING TO SHIFT2RAIL'S NEXT GENERATION OF HIGH CAPABLE AND SAFE TCMS AND BRAKES (730539)

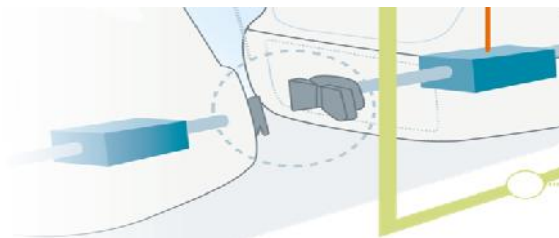


What is WLTB?

- The Wireless Train Backbone (WLTB) is a new train-level network proposed for TCMS.
- WLTB removes the inherent cost of cabling and connectors of traditional wired Train Control networks.
- A reliable and performant wireless TCMS allows the introduction of new functions with relative low cost:
 - Train Integrity function which will help to reduce trackside.
 - Virtual Coupling which supposes a new paradigm in railway operations.

Why WLTB?

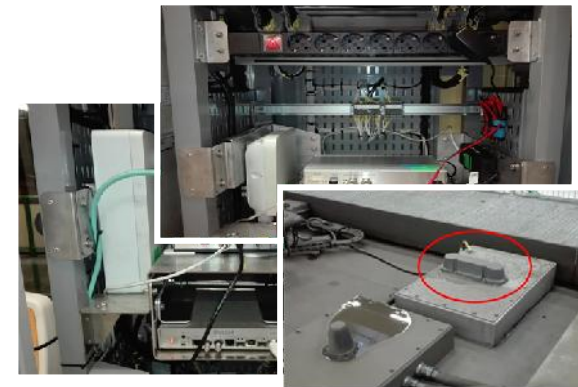
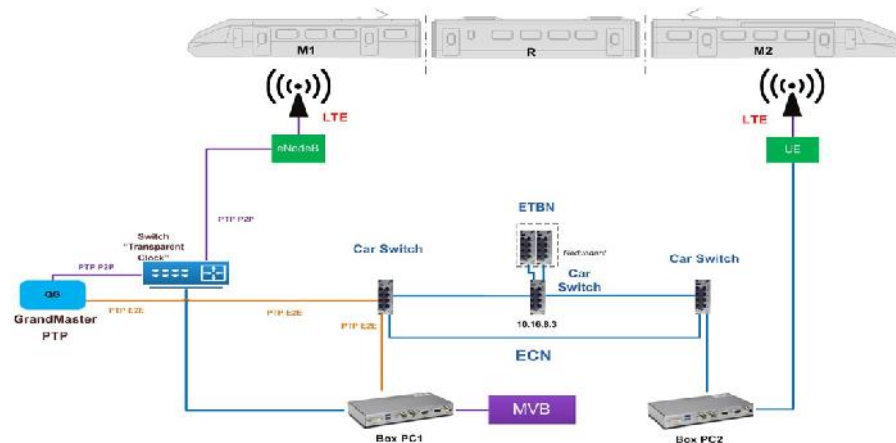
Today	With WLTB
Multiple wired network in a single train, increasing cost and weight.	Removes wires decreasing drastically the associated cost and weight.
Difficult to install new wired networks in existing train units.	Possible to install simply in modernization projects.
Coupling has to be done when consists are stopped and the process takes couple of minutes, reducing the capacity of the infrastructure.	The units are automatically associated to the WLTB and the wireless link is transparent for onboard devices. WLTB allows faster coupling.



Safe4RAIL – SAFE architecture for Robust distributed Application Integration in rOlling stock (730830)

WLTB tests in detail

- No couple units in Bilbao's underground -> Tests from the front to the rear of the same consist.
- To validate the maximum throughput, additional traffic will be injected on the Test Setup network (ECN)



Safe4RAIL – SAFE architecture for Robust distributed Application Integration in rolling stock (730830)

CONNECTA – CONTRIBUTING to Shift2Rail's NEXt generation of high Capable and safe TCMS and brAkes (730539)



Field Tests Results of WLTB

WLTB Dissemination video

Safe4RAIL – SAFE architecture for Robust distributed Application Integration in roLling stock (730830)

CONNECTA – CONtributing to Shift2Rail's NExt generation of high Capable and safe TCMS and brAkes (730539)

202

Conclusions (I)

- Depot tests:
 - Theoretical performance: 50Mbps Downlink and 25Mbps Uplink.
 - Tests at 3.2 Mbps have been supported with low FER and latency; not at 256 Mbps.

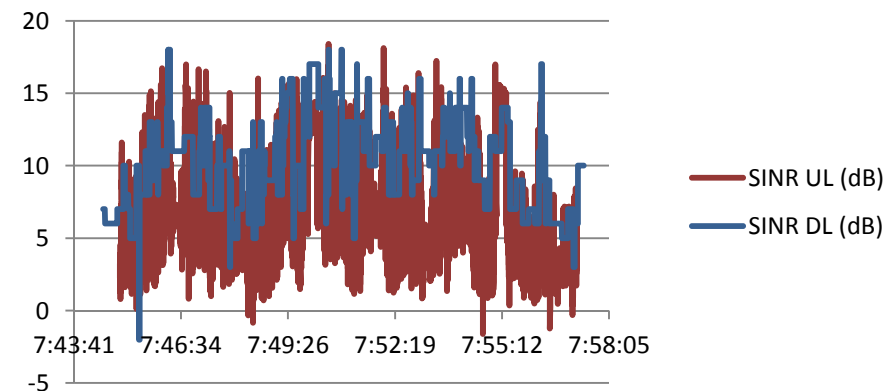
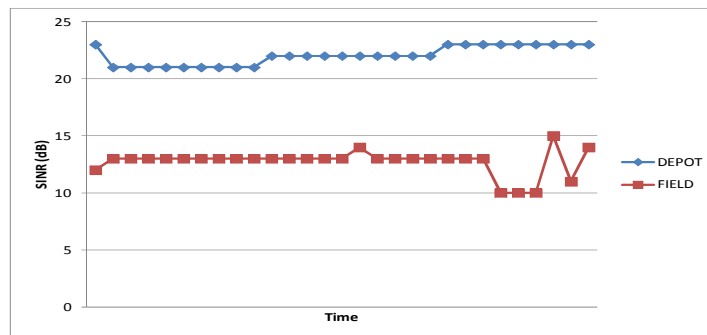
Uplink-downlink configuration	Downlink-to-Uplink Switch-point periodicity	Subframe number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U	U	U	D	S	U	U	U
1	5 ms	D	S	U	U	D	D	S	U	U	D
2	5 ms	D	S	U	D	D	D	S	U	D	D
3	10 ms	D	S	U	U	U	D	D	D	D	D
4	10 ms	D	S	U	U	D	D	D	D	D	D
5	10 ms	D	S	U	D	D	D	D	D	D	D
6	5 ms	D	S	U	U	U	D	S	U	U	D



freq.	UE	Losses (dB)
5.8 GHz	Cable LTE 1	7,5
5.8 GHz	Cable LTE 2	7,3
freq.	eNodeB	Losses (dB)
5.8 GHz	Cable LTE 1	8,6
5.8 GHz	Cable LTE 2	8,5

Conclusions (II)

- *Field Tests:*
 - Much better performance in the DL than in the UL:
 - UL uses a single-carrier modulation, which is less robust against multipath and Doppler effects.
 - UL is also based on 1x2 MIMO, while DL is based on 2x2 MIMO and multicarrier modulation.



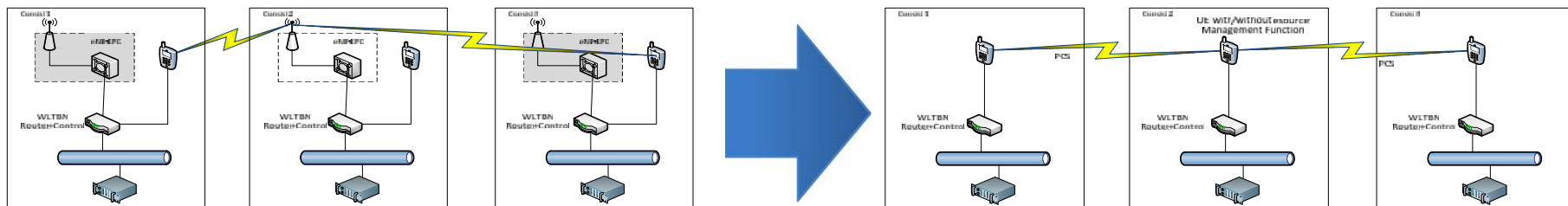
Safe4RAIL – SAFE architecture for Robust distributed Application Integration in rolling stock (730830)

Conclusions (III)

- General conclusions:
 - Current architecture is complex and expensive: 1 eNB+EPC per consist.
 - Up to 100 Mbps throughput can only be achieved with broader bandwidth: difficulties to obtain such big frequency reservation.
 - High effect of environment, need for more directive communications, pay special attention in the installation phase (RF cabling, antenna positions, etc).

Next station is

- Evolve to PC5-based communications: 1UE per consist instead of eNB+EPC+EU.
- Evaluate the division of C2C communications in 2 networks:
 - TCMS->Cellular-based communications. High reliability, low latency, low throughput needs.
 - OMTS->802.11-based communications. Best effort traffic, high throughput needs.
- Evaluation of a Safe Wireless Inauguration.
- Apply MIMO and higher transmission power (below the legal limits) to improve the SNR.
- Adapt the SDTv4 (Safety Layer) for wireless channel (e.g. apply EN50159)
- Standardization activities:
 - Propose WLTB Use Case in ETSI/3GPP to be adopted by upcoming releases
 - IEC 61375-2-7



Safe4RAIL – SAFE architecture for Robust distributed Application Integration in rolling stock (730830)