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Safe4RAIL2

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Message from Coordinator

I am delighted to announce the second issue of the SafeRAIL-2 project newsletter, which marks the completion of the first year of the project. During this year, project activities have been focused on requirement definition and state-of-the-art review of technologies, based on a strong interaction with CONNECTA-2 project. As a result, all requirement deliverables have been completed (they are available on our project website), and several conference papers have been published. Design activities have also started in this period, and they will be completed in the next few months.

In this issue of the newsletter, one of the main technological pillars of Safe4RAIL-2 project is described, which is the Wireless TCMS. This is a major cornerstone for obtaining more flexible and cost-effective communications along and inside the train, and for setting a new path for more advanced railway applications.

In the next period of the project, the designs of the different devices will be completed, and advances on implementation and integration on demonstrators will be done. We expect to provide you further updates very soon on this new and exciting period in the project.

Fewer wires, more flexible communication: the challenge and benefit of a wireless TCMS

One major innovation targeted for Next Gerenration Train Control and Monitoring System (NG-TCMS) is to replace parts of the railway vehicles wire by wireless technologies, creating a Wireless TCMS. The objectives of Wireless TCMS are to reduce cost, enhance maintenance and diagnosis, as well as enable innovative applications such as wireless drive-by-wire or virtual coupling and train platoons. Many challenges lie ahead, such as uncontrolled interferences, unreliable wireless links, unstable capacity and delay, not mentioning cyber-security. Wireless technologies will need to be carefully selected and adapted to the peculiar rail environment. The Wireless TCMS will operate at both backbone and consist levels, thus creating WireLess Train Backbone (WLTB) and WireLess Consist Network (WLCN) solutions.

Wireless Train Backbone

The Wireless Train Backbone (WLTB) is an evolution of the IEC 61375-2-5 to provide a wireless alternative to the Ethernet Train Backbone (ETB). In particular, the major innovation in WLTB is to provide wireless communication between consists in order to avoid time losses due to manual coupling and improve the infrastructure capacity. The architecture of the Wireless Train Backbone (WLTB) is composed of one WLTB Node (WLTBN) for each Ethernet Consist Network (ECN) plane, whose role is to provide single-hop and multi-hop wireless communication between WLTBN of multiple consists of the same train. WLTB may also be used to provide wireless communication between trains. Accordingly, WLTB must be capable of industrial wireless communications over short and long distance, and over single and multi-hop.

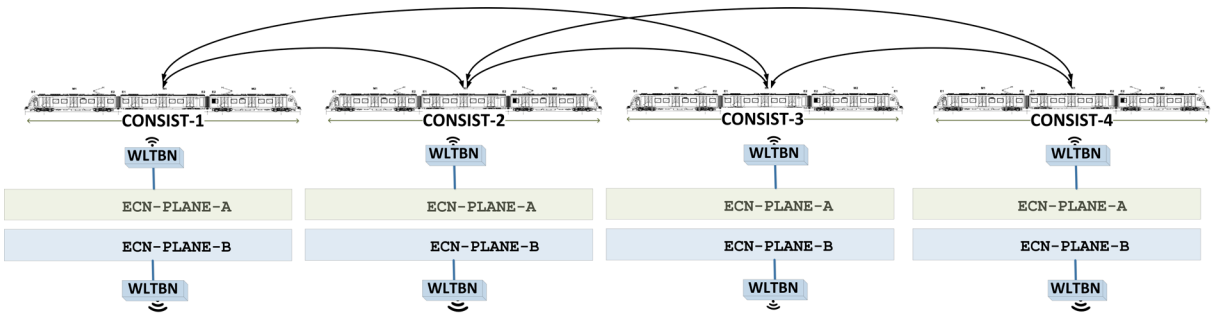


Figure: Single and multi-hop approach for WLTB

Wireless Consist Network

The Wireless Consist Network (WLCN) covers the communications inside each consist and towards the train backbone. The main difference with the WLTB lies in the fact that the WLCN requires a higher number of nodes and has to operate in a more complex propagation environment (e.g. reflections on metallic structures and cabinets, influence of passengers, etc.). The WLCN architecture is made of two redundant wireless networks, each of them having one Wireless Access Point (WAP) per vehicle. Wireless End Devices (WEDs) will be connected to a WAP, except the Safe Wireless End Devices (WED-S), which will be connected to two WAPs (which is a safety related design approach), each one from a different wireless network, and therefore will require two wireless interfaces. On the other hand, all WAPs will be connected to Consist Switches (CS), which will be interconnected via a wired Ethernet Consist Network (ECN). This is a suitable solution, because it eases the integration of different wireless technologies. In the future, architectures with a complete wireless CN could be achieved (MESH technology); this would require deterministic and reliable communication for non-safe, safe, and time-critical devices.

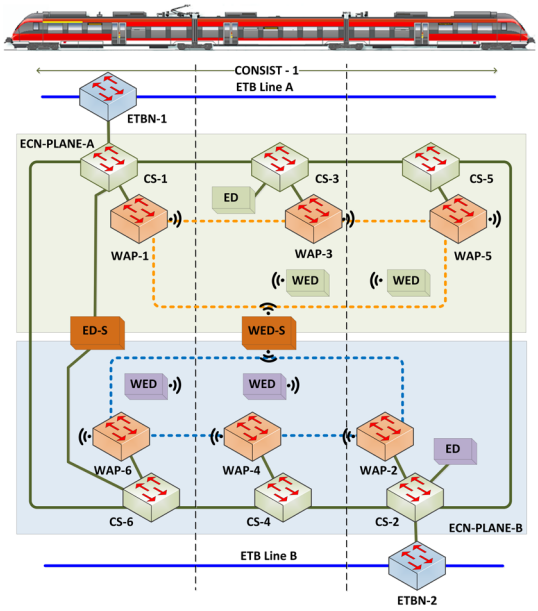


Figure: WLCN network architecture

5G as Enabler for next-generation TCMS

As mentioned, a key challenge in Wireless TCMS is the capacity and reliability of the wireless link. The ITU defines 5G features in three aspects: Ultra-Reliable and Low Latency Communications (URLLC), enhanced Mobile Broadband (eMBB), and massive Machine Type Communications (mMTC). Each of them is expected to be beneficial to Wireless TCMS: URLL supporting mission critical control, mMTC integrating massive amount of railway vehicles sensors, and eMBB providing future multimedia services to passengers. The future NR V2X (LTE rel.16) has been designed to support these features in a highly mobile vehicular environment and accordingly is expected to be a key enabler for Wireless TCMS, in particular the WLTB. For the WLCN, deterministic WiFi solutions also represent a promising solution, in addition to NR V2X.

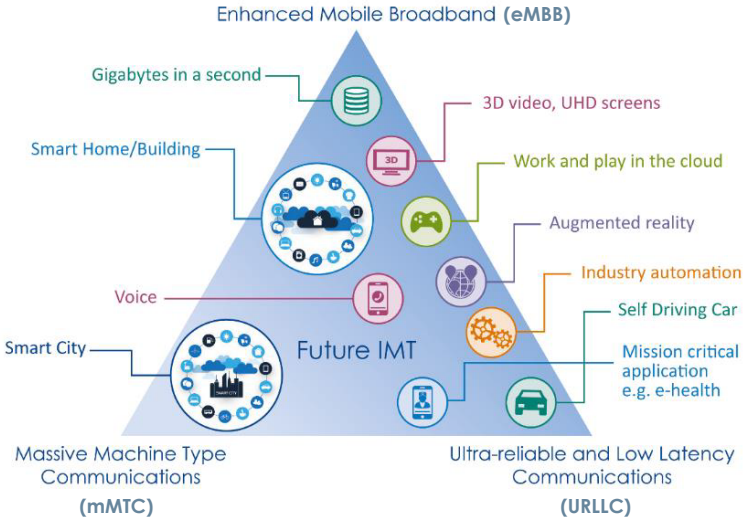


Figure: Key features and applications of 5G networks

Ongoing Activities

WP1 TSN-based Drive-by-Data

Within WP1, the following activities with respect to architecture design and development have been carried out:

- Ethernet Switches for NG-TCN: WP1 is finalizing the architecture design for the backbone and local switches to support the new features with the collaboration of CONNECTA-2 project partners. The focus has been on the new inauguration concepts and to safely recognize and handle coupling and uncoupling of trains, as well as the redundant topology concept over multiple train consists.

- End-Devices for NG-TCN: The current focus is on the development and adaptation of the End-devices to realize the required safety-level of the devices and their integration into the software layers of the functional distribution framework activities of CONNECTA-2.

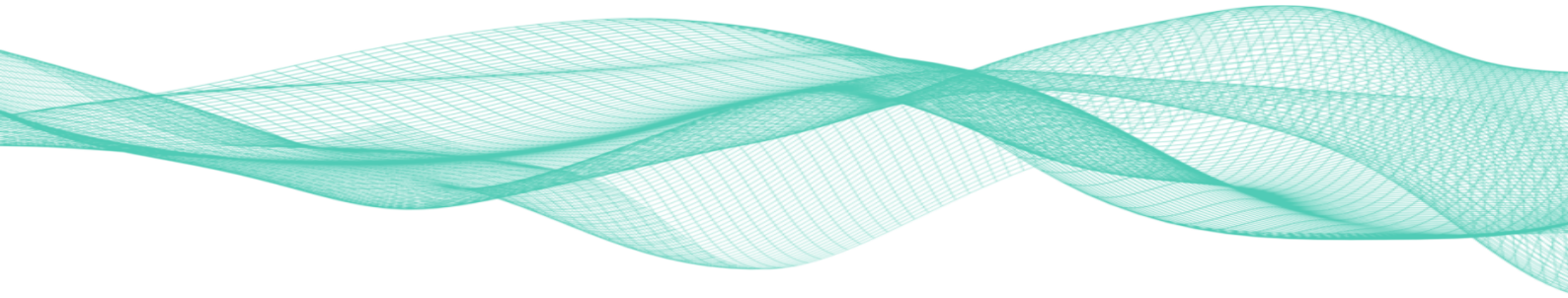
- Bridging across ECN and ETB: WP1 has started on the concepts and architecture design for the gateway to support the new features. Besides that, WP1 has started the primary development for the gateway.

WP2 Future Wireless TCMS

The requirements for WLTB and WLCN devices have been completed based on CONNECTA-2 inputs. A state-of-art of the wireless technologies for both WLTB and WLCN has been conducted, leading to technology choices meeting the identified requirements. The result has been presented to the IEEE 5G WorldForum as joint work with CONNECTA-2. An early WLTB LTE V2X prototype based on the software-defined-radio platform OAI has been presented.

WP3 Functional Distribution Framework (FDF) and Simulation Framework (SF)

After finishing the requirements phase successfully, WP3 is heavily involved in the support for the development of the regional and urban demonstrators. The current focus is on the development and adaptation of the HVAC system to enable its integration into the different implementations of the functional distribution framework and simulation framework solutions. Besides, WP3 is contributing to the definition of a common base for the Software-In-the-Loop (SIL) solution, which is going to be adopted in the simulation framework of the regional demonstrator. Moreover, regular integration meetings with CONNECTA-2 have been held in order to support this ongoing work. WP3 has organised two successful inter-consortia technical meetings to clarify doubts and identify needs and collaboration points.



Public Deliverables Submitted

From M07 to M12, three public deliverables have been finalized and released on our project website:

Deliverable D1.1 “Drive-by-Data Requirements Specifications” deals with the refinement of performance, availability and safety requirements of ETBN, consist switches and end-nodes.

Deliverable D2.1 “Requirements of LTE Equipment and ETBNs for wireless TCMS” addresses the requirements of LTE equipment for integration in train backbone and ETBNs in order to deal with wireless train inauguration.

Deliverable D3.1 “Report on requirements for integration of HVAC into the Functional Distribution Framework and Simulation Framework” includes the requirements to address the integration of TCMS functions into FDF and SF. Particularly, considering the HVAC Application Profile defined by CFM members, which will be applied to the HVAC system.

SAVE THE DATE!

JANUARY 21ST 2020, BRUSSELS

Mid-Term Conference

We are pleased to invite you to attend the Mid-Term Conference in Brussels on January 21st 2020, which is executed as a joined collaboration between Safe4RAIL-2 and CONNECTA-2. The conference aims to provide you an overview on the next-generation TCMS that has been developed in the 1st year of the Safe4RAIL-2 and CONNECTA-2 projects. Presentations and talks centralized around Drive-by-Data, Functional Distribution Framework and Simulation Framework as well as wireless TCMS will be given. The conference welcomes participants from railway technology suppliers and manufacturers, safety experts, and authorities as well as academic participants in the domain of train control and communication systems.

Past Meetings

Functional Distribution Framework API Workshop
Munich, Germany
2nd-3rd of May 2019,
12th-13th of June 2019,
22nd-23rd of July 2019

AUTOSAR Adaptive Platform Training
Stuttgart, Germany
14th-15th of May 2019,
3rd-4th of June 2019,
17th-18th of July 2019

TSN Plugfest
Beasain, Spain
28th of May 2019

1st Executive Board Meeting
18th of June 2019

Wireless Activities Meeting
Mannheim, Germany
24th of July 2019

Advisory Board Meeting
Hernani, Spain
1st of October 2019

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