Newsletter - Final Issue

Safe4RAIL - Safe architecture for Robust distributed Application Integration in roLling stock

Message from the Coordinator

After 27 months, our Safe4RAIL project is now in completion and the follow-up project Safe4RAIL-2 has just started. In this final newsletter, we look back on the last six months of Safe4RAIL and its progress toward the achievement of its goals in this timeframe. We have worked on the proof-of-concept implementation which is highlighted in this newsletter. Furthermore, the past six months were characterized by several concluding dissemination activities. These include, among other things, the hand-over workshop together with the successor projects Safe4RAIL-2 and CONNECTA-2, as well as our final conference, which was organized and conducted as a joint activity between our Call-for-Members project CONNECTA (730539). We will talk about those activities within this newsletter as well.

In this Issue

Activities & results of the past half year

First and foremost, what happened in the progress of Safe4RAIL in the past six months? Primarily, we concentrated on the convergence and consolidation of the exploratory activities, which we developed in the first year of Safe4RAIL.

- **Drive-by-Data**: this included among others the development of requirements regarding clock synchronisation, flow control, redundancy and inauguration as well as the development of system integration requirements and the system integration concept for Drive-by-Data and Functional Distribution Framework. Overall, the concepts and constraints were consolidated to achieve a detailed clear picture on the aspects contributing to the robustness, safety, security, reliability and availability of the communication system. Furthermore, the Train Network Simulation Concept was released, including prototypical implementation of the simulation testbed.
- **Functional Distribution Framework**: in terms of the Functional Distribution Framework, we were able to complete the architectural specifications. In detail, we finalized the reference architecture and worked on three different instantiations based on *INTEGRITY*, *PikeOS* and *AUTOSAR* respectively. Based on them, we created three proof-of-concept implementations and provided a set of conclusions resulting from all the activities during the project.
- **Simulation Framework**: a further achievement of the last months of Safe4RAIL was the completion and evaluation of the proof-of-concept implementations related to the Distributed Simulation Framework and the Train2Ground Test Environment, which are mainly based on the designs defined in the first year. The evaluations were performed under example test cases using real hardware and real mobile communication gateway implementations developed by the complementary action CONNECTA.
- **Brake-by-Wire**: finally, we were also able to finalize the requirements in terms of the emergency braking system and its system design, followed by first architectural step for the electronic control design.

Key Data:

Start Date:	1st October, 2016	*Consortium:*	11 partners (6 countries)
End Date:	30th September, 2018	*Project Coordinator:*	Arjan Geven
Duration:	24 months		arjan.geven@tttech.com
Project Reference:	730830	*Contact Person at Technikon:*	Mario Münzer
Project Costs:	€ 6,681,211.25	(Administrative Support)	technikon@safe4rail.eu
Project Funding:	€ 6,681,211.25	*Project Website:*	www.safe4rail.eu
Complementary Project:	CONNECTA (Ref: 730539)		

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Submitted Deliverables

In the remaining period, from M19 to M27, four public deliverables (three technical and one management report) have been submitted to the European Commission. Resulting, the final milestone with regards to the finalization of the proof-of-concept implementation was achieved.

D1.9: Final Drive-by-Data Concept Design (M24)

Describes the concept of design and methodology for next generation TCMS including all relevant technologies and open issues/gap analysis.

D2.5: Report on requirements of next generation TCMS framework (M24)

Elucidates the set of requirements for next generation TCMS frameworks, considering safety and security aspects.

D3.7: Evaluation results, conclusions and further recommendations, including derived requirement recom-mendations for drive-by-data and embedded platform (M24)

Contains the evaluation results and conclusions which are established using test-cases in the simulation and validation environment including TCMS and the train-to-ground interfaces.

D5.3: Final report and updates on dissemination, exploitation and standardisation activities (M24)

Includes a record of activities related to dissemination and exploitation that have been undertaken and some going beyond the project lifetime as well as a report of completed commnunication acitivities.

Find all public deliverables on https://safe4rail.eu/results/deliverables.

Throwback to Joint Final Conference

On September 26, Safe4RAIL and CONNECTA organized a Joint Final Conference, which took place in Paris, France. According to the motto “more functionality and interoperability, lower system complexity and cost”, the conference focused on final results for next-generation TCMS. Throughout the day, several graphical as well as physical demonstrators accompanied the conference. In total, CONNECTA and Safe4RAIL welcomed an audience of around 120 participants to this very successful and factful event.

Insights including images and a video were summarized at: https://safe4rail.eu/final-conference.

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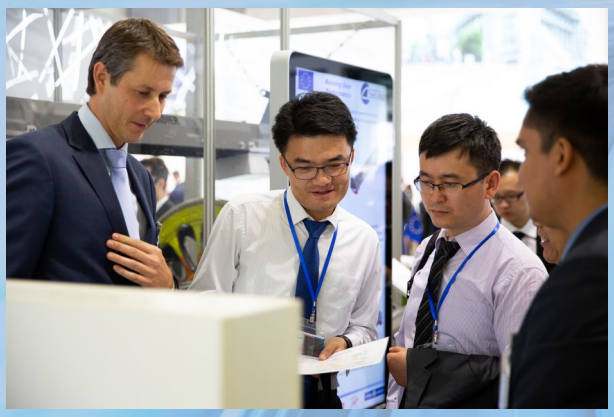
Revisiting InnoTrans 2018: Converged Communication & Computation

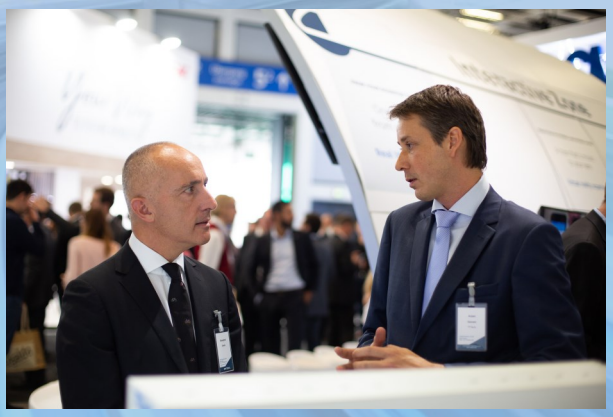
The core objective of Safe4RAIL is to provide a platform able to integrate safety-critical and non-critical train functions into one common converged platform for communication and computation. In the project, a proof-of-concept for this common Integrated Modular Platform has been developed resulting in a demonstrator. In detail, this demonstrator focuses on the following aspects:

- **Communication**: A tight control of network end-to-end latency regardless of network load and a new network topology, which results in less expensive components and a safe communication with fewer (but redundant) components.
- **Computation platform**: A framework that facilitates modular integration of applications and enables interoperability in order to open a new way of linkage different platforms, devices and (operating) systems.

One week before our final conference in Paris, the demonstrator was presented for the first time to the public at the InnoTrans 2018 fair in Berlin, Germany. Coming directly from Berlin to Paris, the demonstrator was showcased to our audience at the final conference as well.

Insights including images and a video were summarized at: https://safe4rail.eu/news/recent-news.





Shift2Rail Executive Director Carlo Borghini, EU Commissioner for Transport Ms. Bulc, German Minister for Transport Mr. Scheuer (from right to left)

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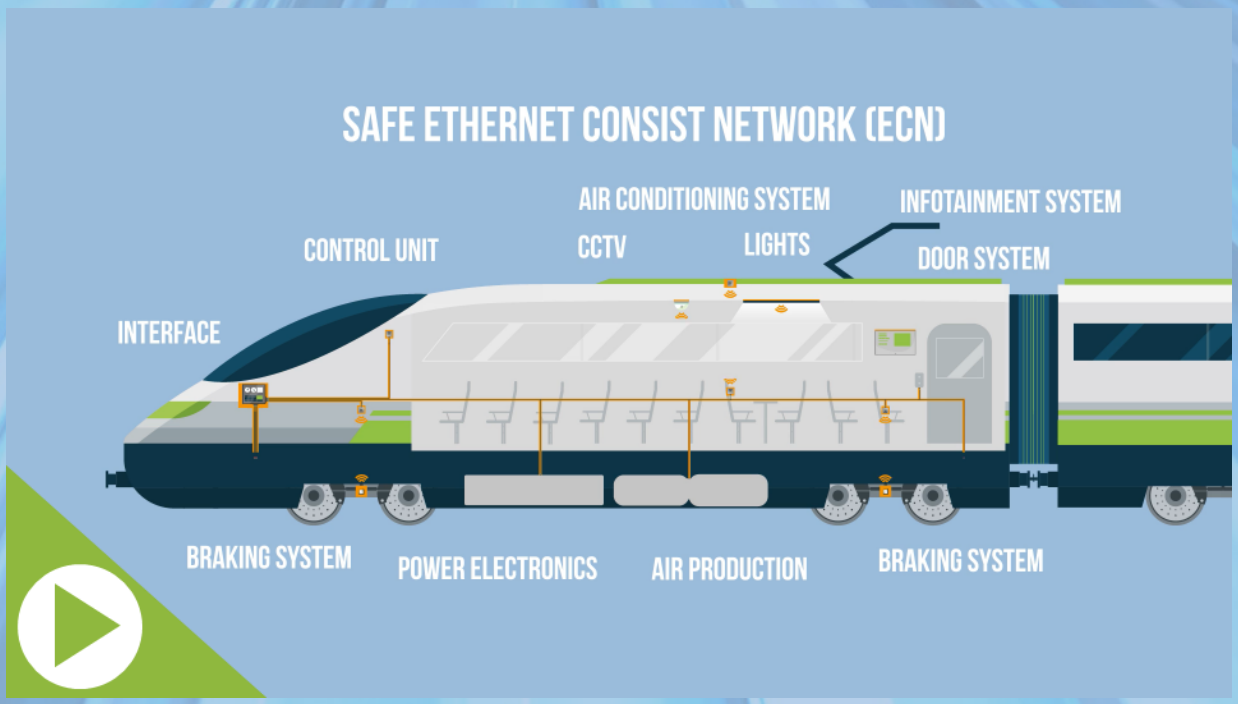
Four projects beneath the same roof

On December 3, the two Call-for-Members projects within the Innovation Programme 1 CONNECTA (730539) and CONNECTA-2 (826098) as well as its complementary projects Safe4RAIL and Safe4RAIL-2 met for a two-day workshop. This workshop focused on the proper handover of the defined requirements and gathered results within Safe4RAIL and CONNECTA for its successor projects. Open questions on the next-gen TCMS were answered based on the expertise of the past 2 years of the Safe4RAIL and CONNECTA consortium.

Read more at: https://safe4rail.eu/news/recent-news.

Animation explaining the Safe4RAIL concept

In order to bring the complex technology of the project nearer to the public and to promote the Safe4RAIL project, our project partner TECHNIKON created an animated video. The video was broadcasted through several social media channels. Among others, the video is accessible via our project website www.safe4rail.eu as well as via TECHNIKON's Vimeo channel https://vimeo.com/technikon.



Safe4RAIL's subject matter discussed

Recently, Peter Balint and Alexandra Stanek from Technikon visited the offices of TTTech in Vienna to interview Arjan Geven about the wrap-up of the Safe4RAIL project. In this podcast, Arjan describes some of the challenges and outcomes of this effort and looks at the future of railway transportation.

Interested to listen to the podcast? Check it out on Technikon's Vimeo channel: https://vimeo.com/310762004

Scientific publications submitted/released during 2nd project period

- Mirko Jakovljevic, Arjan Geven, Natasa Simanic-John, Derya Mete Saatci, *Next-Gen Train Control / Management (TCMS) Architectures: 'Drive-By-Data' System Integration Approach*, ERTS 2018, Toulouse, France, February 2018. https://www.tttech.com/fileadmin/content/general/files/pdf/company/academic/publications/2018-ERTS2017-Next-Gen-Train-Control.pdf

- Maryam Pahlevan and Roman Obermaisser, *Next-Gen Train Control / Management (TCMS) Architectures: 'Drive-By-Data' System Integration Approach*, ERTS 2018, Cambridge, UK, March 2018. https://ieeexplore.ieee.org/document/8374471/

- Tobias Pieper and Roman Obermaisser, *Distributed co-simulation for software-in-the-loop testing of networked railway systems*, 7th Mediterranean Conference on Embedded Computing, Budva, Montenegro, June 2018. https://networked-embedded.de/es/index.php/staff-details/pieper.html

- Maryam Pahlevan, Nadra Tabassam and Roman Obermaisser, *Heuristic List Scheduler for Time Triggered Traffic in Time Sensitive Networks*, 16th International Workshop on Real-Time Networks, Barcelona, Spain, July 2018. https://networked-embedded.de/es/index.php/staff-details/pahlevan.html

- Hongjie Fang and Roman Obermaisser, *Virtual Switch Supporting Time-Space Partitioning and Dynamic Configuration for Integrated Train Control and Management Systems*, 21st Euromicro Conference on Digital System Design, 2018, Prague, Czech Republic, August 2018. https://networked-embedded.de/es/index.php/staff-details/fang.html

- Maryam Pahlevan and Roman Obermaisser, *Genetic Algorithm for Scheduling Time-Triggered Traffic in Time-Sensitive Networks*, 23rd International Conference on Emerging Technologies and Factory Automation, Torino, Italy, September 2018. https://networked-embedded.de/es/index.php/staff-details/pahlevan.html

- Tobias Pieper and Roman Obermaisser, *Network-Centric Co-Simulation Framework for Software-In-the-Loop Testing of Geographically Distributed Simulation Components*, 21st IEEE International Conference on Computational Science and Engineering, Bucharest, Romania, October 2018. https://networked-embedded.de/es/index.php/staff-details/pieper.html

- Maryam Pahlevan and Roman Obermaisser, *Redundancy Management for Safety-Critical Applications with Time Sensitive Networking*, 28th International Telecommunication Networks And Applications Conference, Sydney Australia, November 2018. https://networked-embedded.de/es/index.php/staff-details/pahlevan.html

- Iñigo Odriozola, Lorea Belategi, Ekain Azketa, Jorge Parra, Rosa Iglesias, Hongjie Fang, *Functional Distribution Framework for railway systems*, IEEE Transactions on Intelligent Transportation Systems OR IEEE Transactions on Industry Applications, 2018.

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Outlook & follow-Up

On October 1 this year, the Safe4RAIL-2 (826073) project was kicked-off, which represents the direct successor of Safe4RAIL. Just like Safe4RAIL, Safe4RAIL-2 is carried out under the Shift2Rail Joint Undertaking Innovation Programme (IP1) and the Horizon 2020 framework. Safe4RAIL-2 focuses on technical solutions for the next-generation TCMS using the results of Safe4RAIL as a baseline. With a robust industry-oriented consortium composed of eight partners, the project will take these results to a higher Technology Readiness Levels (TRL) in the next two and a half years. This result will allow integration and validation in the planned laboratory demonstrators. Some cornerstones of Safe4RAIL-2 will be the interoperability in deterministic train communication, a wireless TCMS solution, the integration of subsystems in Functional Distribution Framework and a remote validation of the TCMS subsystems.

More information will be released soon on our project website: www.safe4rail.eu

Concluding words

At the on-set of this project, we knew that we wanted to bring innovations from various domains such as aerospace, automotive and industrial automation to the train. We knew that we would only have roughly two years time to accomplish it. So we took a leap and deep-dived into the different domains. With great team spirit learned from each other, applied, defined, refined, reworked new concepts together. Finally, we were ready to create proof-of-concept implementations and demonstrate them at the various events such as the InnoTrans 2018 in Berlin and the Final Conference in Paris. In two years, we have come a long way. Steadily, we will continue to progress the maturity of the technology to bring the next-generation TCMS to reality. With full speed, we are ready to steam on to Safe4RAIL-2.

Arjan Geven, Safe4RAIL Coordinator, TTTech Computertechnik AG