Authors	**e-mail address of corresponding author**
Dr. Niels Brandenburger Friedrich Maximilian Strauß Igor Bier	niels.brandenburger@dlr.de
Title of presentation **Implementation of a Remote Control Workplace to Realize Remote Train Control over 5G-Network in Real-World Testing**	**Institution** German Aerospace Center (DLR e.V.)

Please highlight workshop topic(s) your paper is relevant for

- ☐ Ergonomics and Usability of advisory and assistance systems
- ☐ **Automation, Train control systems**
- ☐ Fatigue, monotony, mental workload
- ☐ Risk, Human error and Human reliability
- ☐ Situation awareness
- ☐ Incident investigation
- ☐ Safety culture
- ☐ Human Factors Integration (e.g., in organizational processes)
- ☐ Rules and Standards
- ☐ others

Abstract

Remote diagnosis, control and recovery of malfunctioning automated and unmanned trains is seen as a key enabler for automatic train operation along the Grades of Automation taxonomy. Therefore, a major aim of the 5G-Reallabor project, which is set out to bring technology under research into field-testing setups, is the technical demonstration of remote train control over physical distance via a 5G mobile network connection. This technical demonstration requires the development and implementation of a remote control workplace, equipped with all necessary functionalities to attain remote control of a connected train in real-world employing 5G mobile network technology. Significant available knowledge from the prior development and setup of a remote control simulator, called the Train Operator Workplace, served as a starting point for the current topic under investigation. The key step in the process of implementing the remote control workplace for real-world purposes was the derivation of functional user requirements in terms of information needs and control functionality. In the domain of information needs the presentation of in-train train protection system information (European Train Control System), video footage, vehicle status data and traction/braking data was identified, documented in several functional user requirements and implemented accordingly. In the domain of the required control functionality user control over traction, several braking systems, vehicle functions such as horn, light or door release, video cameras and direction of travel were identified and technically realized. Additional safety-related functional requirements mainly related to network quality, connection or package loss were also identified and implemented. The process of scenario-based user requirement derivation and subsequent implementation into a real-world demonstration case ready to satisfy safety-requirements for physically operating a train on railway infrastructure is presented. Lessons-learned in the field of automatic train operation are discussed to derive insights and best-practice for further testing in this promising new field of research.