

Smart Railway Infrastructures: Efficiency, Reliability and Safety

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SmaRIERS (Smart Railway Infrastructures: Efficiency, Reliability and Safety) is a technology transfer project financed by the Tuscany Region. The project partners include ECM s.p.a. (Progress Rail of the multinational Caterpillar Inc. group), a Pistoia-based company and leader in the railway sector that develops solutions and technologies for the safety and control of railway infrastructure, and the Formal Methods and Tools (FMT) and Software Engineering and Dependable Computing (SEDC) research labs of ISTI-CNR. The project is conducted in strong collaboration with the Department of Information Engineering of the University of Pisa.

A railway infrastructure is a highly complex system that includes several interconnected and co-operating devices, components, and subsystems. In SmaRIERS, we focus on the study of Uninterruptible Power Supply (UPS). UPS is a modular system that ensures the uninterrupted power supply of signalling systems. The main components of such signalling systems are control logic devices and so-called “yard devices” installed along the railway infrastructure (switches, train detection elements, light signals, etc.) that perform the signalling tasks – vital elements for the safety of people and property that therefore require an uninterrupted power supply. The project idea is to equip the UPS with a “SMART” diagnostic system capable of becoming proactive, i.e., capable of preventing critical situations or future problems, so as to allow the operator to plan appropriate actions in advance, through the analysis of plant diagnostic data. SmaRIERS also includes studies of measurements related to system availability by means of sto-

chastic modelling, as a support to the design of innovative station power systems.

The aforementioned UPS systems are equipped with a communication port and support a standardised protocol according to the ISO1 standard published by the Italian national railway infrastructure manager (RFI). In SmaRIERS, we design a new communication protocol that allows collection of the data of UPS sensors in a simple and efficient way. The idea is to exploit the advantages offered by the so-called MQTT protocol for transporting UPS data to the database. MQTT is an ISO standard publish-subscribe type protocol, which can manage message dispatching in a simple way. The data of UPS sensors are thus published and made available via the MQTT broker. Figure 1 depicts the system architecture, with the UPS data given as input on the left. The data published in the MQTT broker is read and decoded in the JSON format to be stored in the Time Series Database (TSDB). Such a TSDB is exploited by a Web application to monitor the sensor values via a dashboard that allows the data to be monitored interactively. The system will also allow generation of alerts, via email and Telegram messages, to inform the plant managers about anomalies and errors.

Furthermore, we study predictive maintenance algorithms for improving the system maintenance as well as algorithms to recommend actions for improving the system’s availability (prescriptive analytics), starting from the data collected as mentioned above. To allow a better training of the machine-learning systems, it is of particular importance to be able to use a set of field data. To this aim, we plan to use data from apparatuses already employed in current railway stations, available to ECM; even if they concern less innovative systems than those proposed in SmaRIERS, they still represent a reasonable knowledge base that can provide added value. At the same time, a preliminary analysis of the power supply system is carried out to identify the availability characteristics of the station power systems, also in relation to power consumption characteristics. We study measures representative of availability and energy consumption through stochastic modelling, to support innovative design of the station power systems. The planned

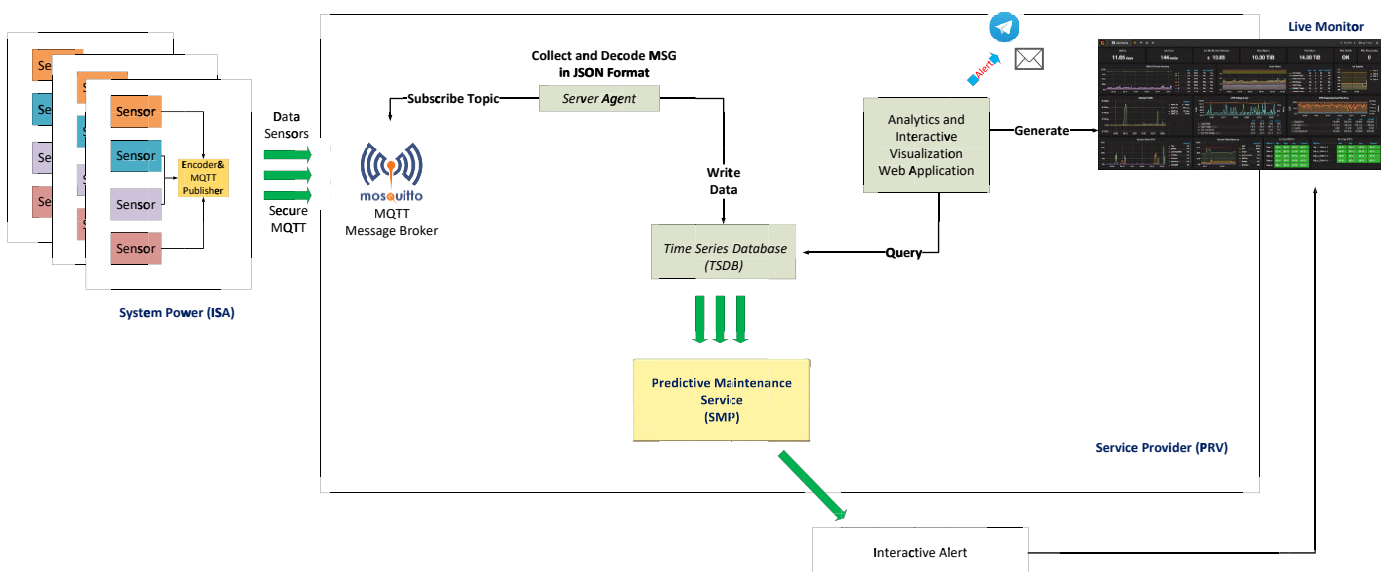


Figure 1: SmaRIERS system architecture.

case studies are useful for achieving, among others, the following goals:

- Identify critical elements of the existing configuration;
- Identify the degree of redundancy of particularly critical system elements;
- Identify the optimal charge level of the batteries, trading between costs and availability.

SmaRIERS lasts for two years and is coordinated by ECM.

Link: <https://smarriers.isti.cnr.it/>

References:

- [1] N. Davari, et al.: “A Survey on Data-Driven Predictive Maintenance for the Railway Industry”, *Sensors* 21(17), 2021. <https://doi.org/10.3390/s21175739>
- [2] A. Ferrari, M.H. ter Beek “Formal Methods in Railways: a Systematic Mapping Study”, *ACM Computing Surveys*, 2022. <https://doi.org/10.1145/3520480>

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Call for Participation

SAFECOMP 2022 and the DECSOs 2022 Workshop

Munich and online, 6-9 September 2022,

SAFECOM has contributed since 1979 to the progress of the state-of-the-art in dependable application of computers in safety-related and safety-critical systems. SafeComp is an annual event covering the state-of-the-art, experience and new trends in the areas of safety, security and reliability of critical computer applications. SAFECOMP 2022 will take place on 6-9 September 2022 at Fraunhofer AISEC and the Galileo Science Technology Park in Munich Garching.

DECOS Workshop

The 17th International Workshop on Dependable Smart Embedded Cyber-Physical Systems and Systems-of-System (DECOS) was created by the ERCIM Dependable Embedded Systems Working Group. Topics cover a large scope in context of dependable, trustworthy systems. It is collocated with SAFECOMP as one of the seven workshops on 6 September at the same venue. Online participation is possible (hybrid). For details see [L1]. It is also possible to attend only for the workshop at a reduced fee.

IDIMIT 2022

IDIMT 2022, the 30th Interdisciplinary Information Management Talks, is held in Prague as joint Central European event of the University of Economics, Prague, and the Johannes-Kepler University, Linz, Austria, from 7-9 September 2022. The session “Smart Technologies for a Sustainable Green World”, is organized by the chair of the ERCIM DES Working Group, who is also the keynote speaker. For details see [L2].

Link

[L1] <https://safecomp22.iks.fraunhofer.de/>
[L2] <https://idimt.org/>

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SCHLOSS DAGSTUHL
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Call for Proposals

Dagstuhl Seminars and Perspectives Workshops

Schloss Dagstuhl – Leibniz-Zentrum für Informatik is accepting proposals for scientific seminars/workshops in all areas of computer science, in particular also in connection with other fields.

If accepted, the event will be hosted in the seclusion of Dagstuhl’s well known, own, dedicated facilities in Wadern on the western fringe of Germany. Moreover, the Dagstuhl office will assume most of the organisational/ administrative work, and the Dagstuhl scientific staff will support the organizers in preparing, running, and documenting the event. Thanks to subsidies the costs are very low for participants.

Dagstuhl events are typically proposed by a group of three to four outstanding researchers of different affiliations. This organizer team should represent a range of research communities and reflect Dagstuhl’s international orientation. More information, in particular details about event form and setup, as well as the proposal form and the proposing process, can be found on

<https://www.dagstuhl.de/dsproposal>

Schloss Dagstuhl – Leibniz-Zentrum für Informatik is funded by the German federal and state government. It pursues a mission of furthering world class research in computer science by facilitating communication and interaction between researchers.

Important Dates

- *Next submission period:*
October 15 to November 1, 2022
Seminar dates: In 2023/2024.