NetWare 2023 Congress
The Ninth International Conference on Fundamentals and Advances in Software Systems Integration
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Leveraging Digital Twins for Condition Monitoring in Railway Infrastructure

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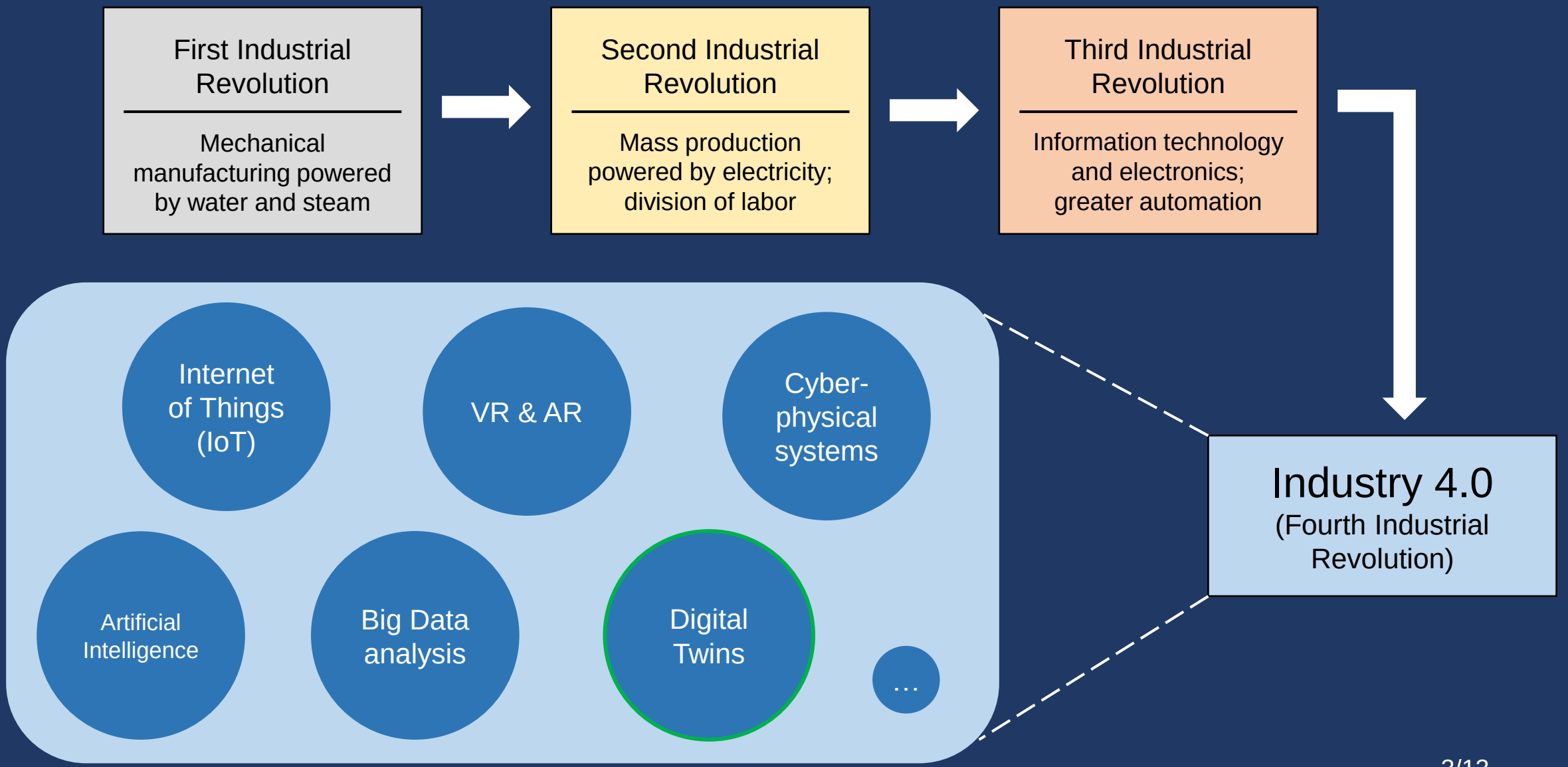
IARIA

Lucas Rocha

- Received a Master’s Degree in Multimedia from the University of Porto in 2022.
- Currently a student in the Doctoral Program in Informatics Engineering at the Faculty of Engineering of the University of Porto (FEUP).
- Researcher at the Digital and Intelligent Industry Lab (DIGI2), at the Faculty of Engineering of the University of Porto.
- Areas of research include digital twins, computer graphics, augmented reality and mixed reality.

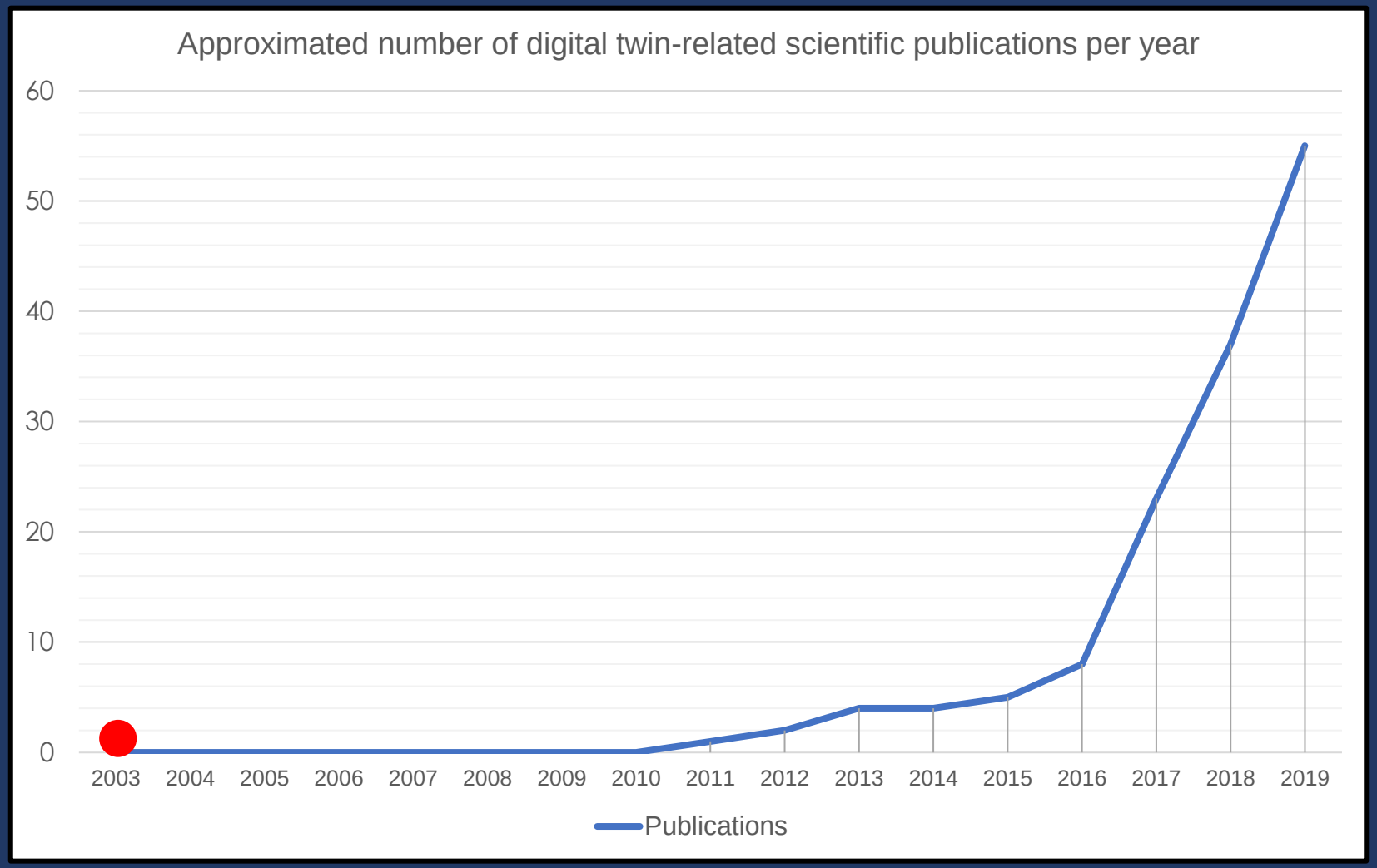
Contextualization



Motivations

- Optimization of service and maintenance
- Increase sustainability
- Increase rail transport competitivity

Related Work

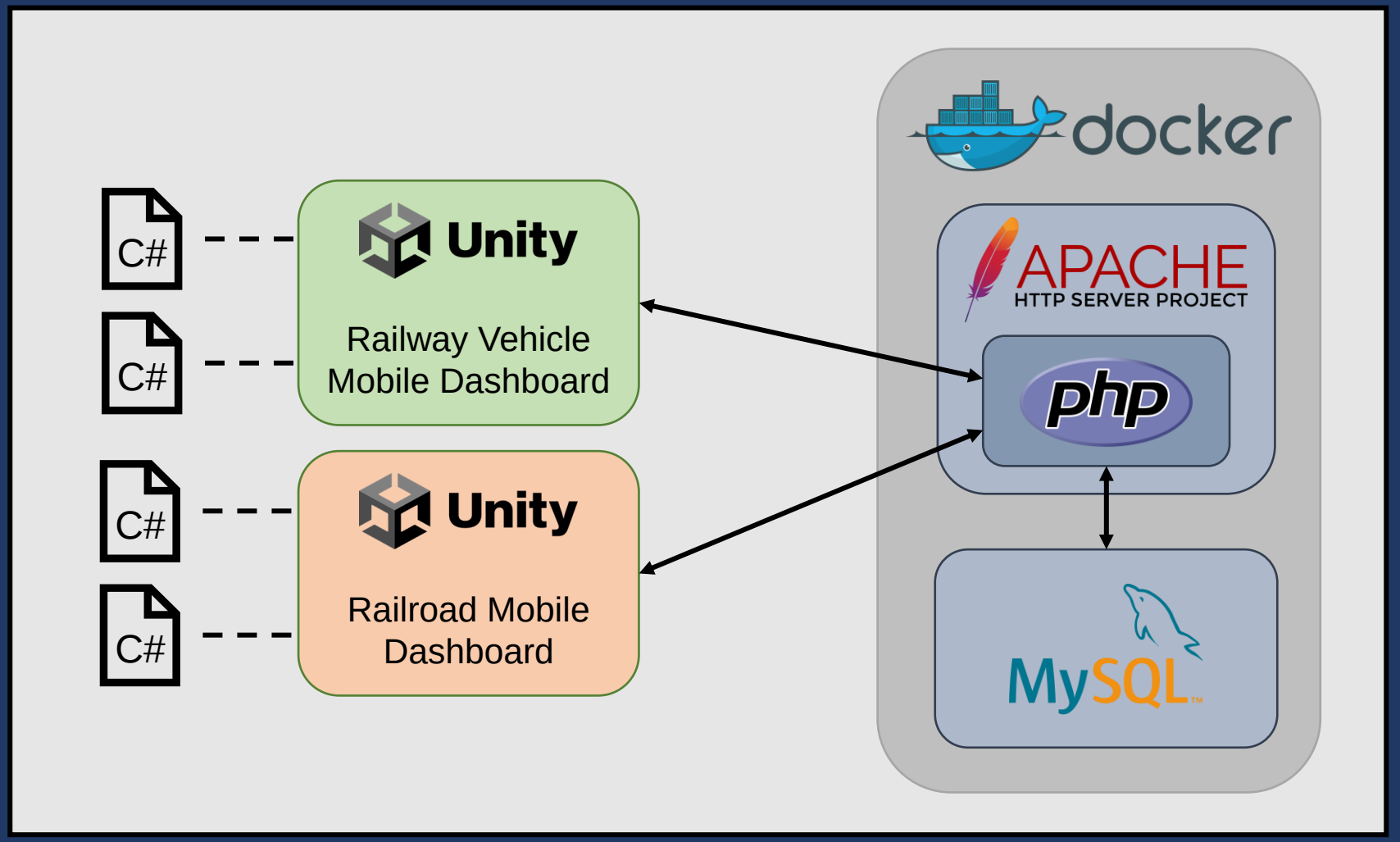


Adapted from Tao et al., (2019) and Lim et al. (2020)

Related Work

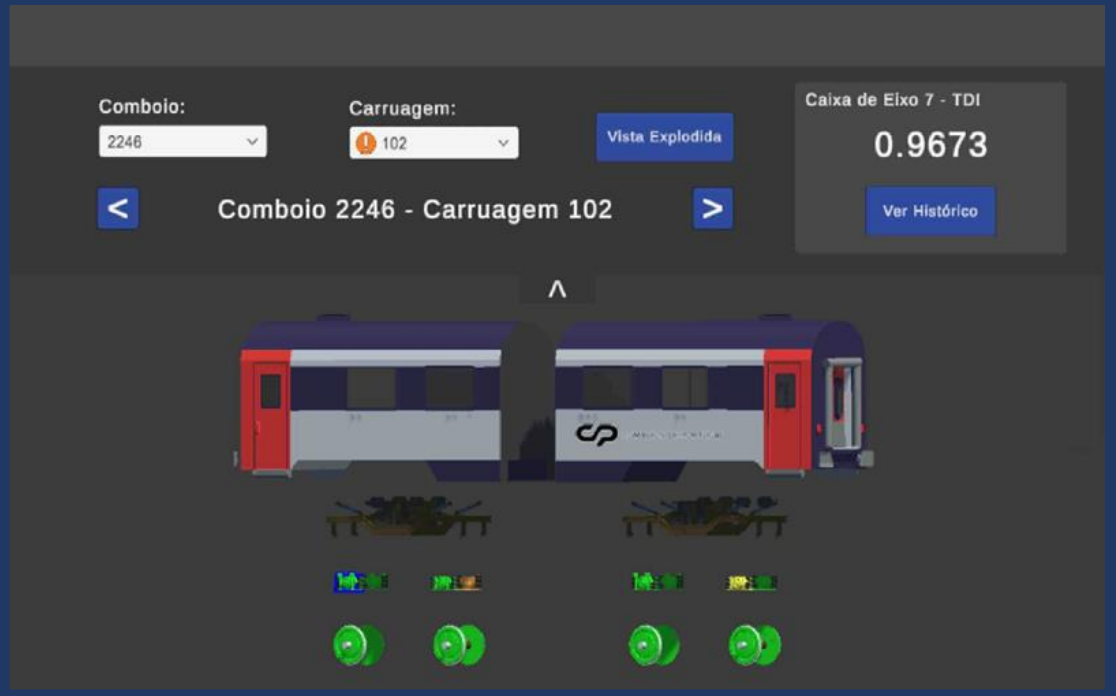
- Digital Twin: Manufacturing Excellence through Virtual Factory Replication (Grieves, 2015)
- Reengineering Aircraft Structural Life Prediction Using a Digital Twin (Tuegel et al., 2011)
- The digital twin of an industrial production line within the industry 4.0 concept (Vachalek et al., 2017)
- Digital Twin Shop-Floor: A New Shop-Floor Paradigm Towards Smart Manufacturing (Tao & Zhang, 2017)
- Development of a Generic Implementation Strategy of Digital Twins in Logistics Systems under Consideration of the German Rail Transport (Jeschke & Grassmann, 2021)
- Alstom Develops a Rail Network Digital Twin for Railway Yard Design and Predictive Fleet Maintenance (The AnyLogic Company)

Materials and Methods

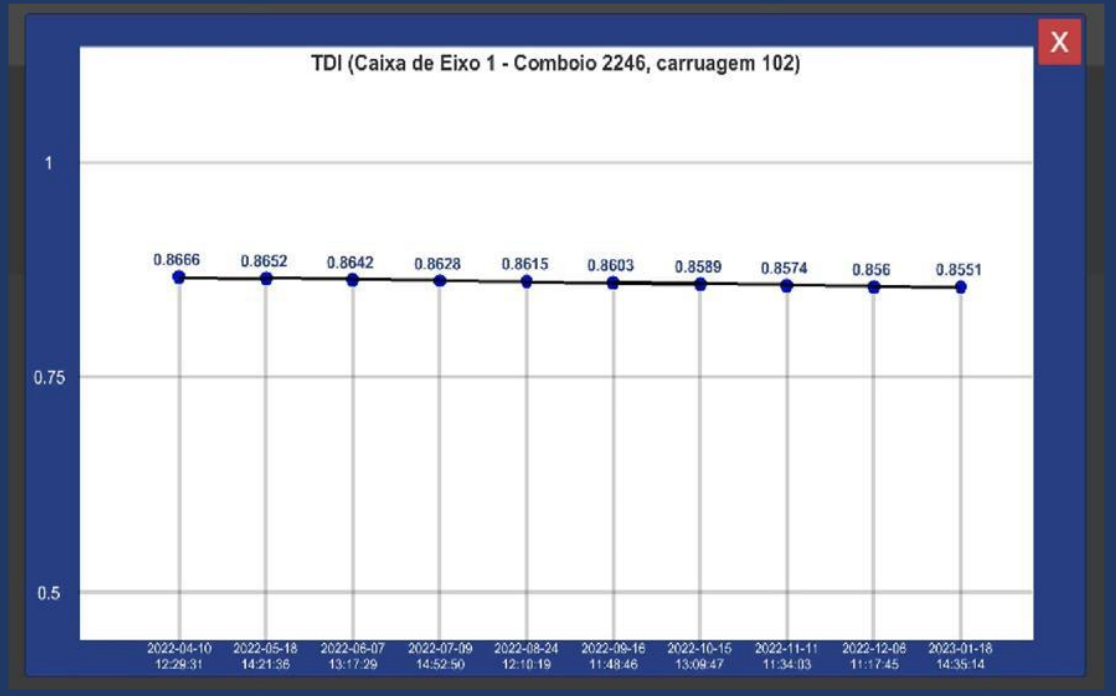


Structure of the Digital Twin System Environment

Implementation – Railway Vehicle Digital Twin

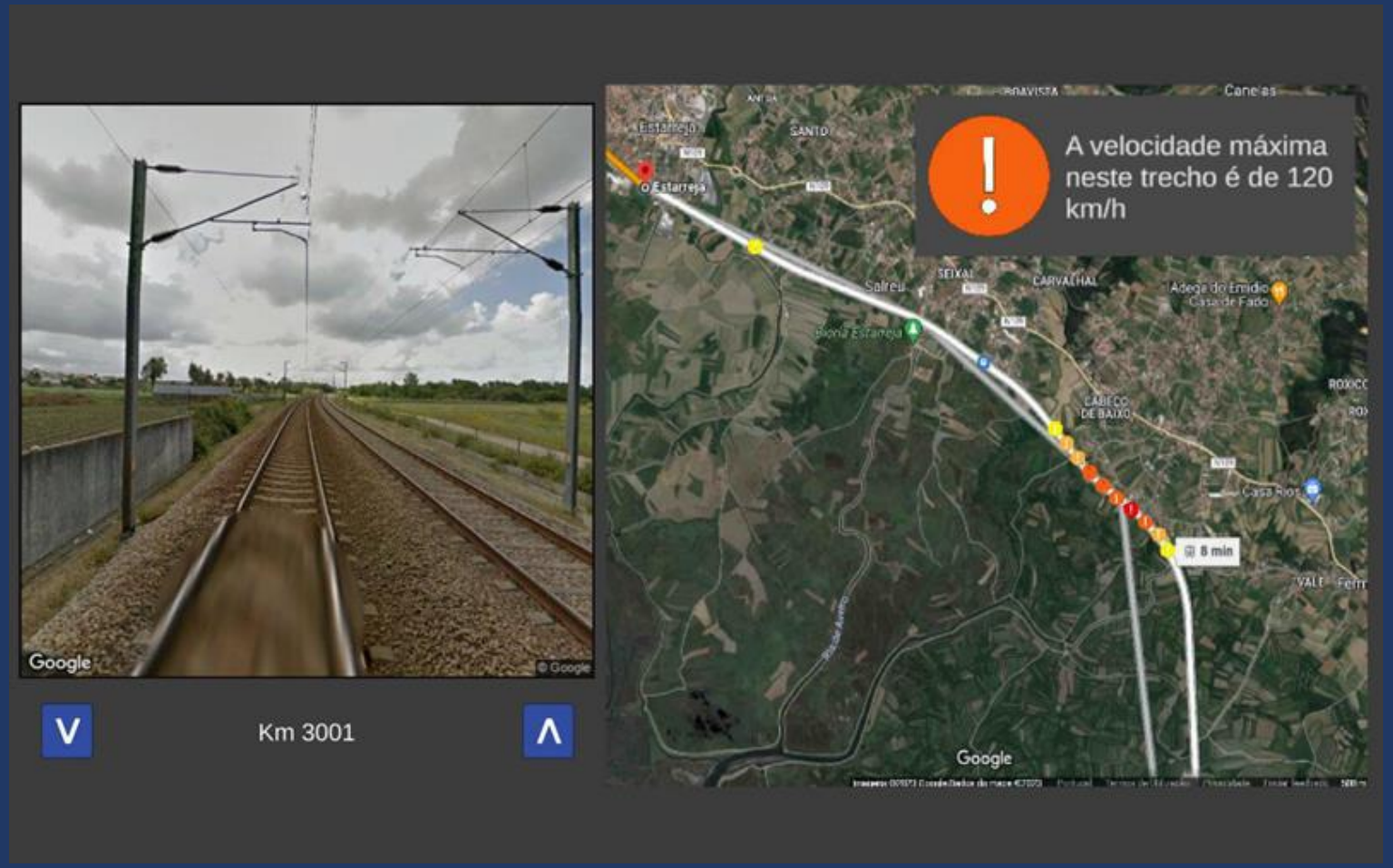


Mobile Dashboard – Main View



Mobile Dashboard – History Graph View

Implementation – Railroad Infrastructure Digital Twin



Mobile Dashboard – Main View

Evaluation Method

- Online survey based on five-value Likert scale method
- Five Likert statements + text field for feedback
- Survey sent to project partners

#	Statement
S1	The user interface of the prototype is, in general, intuitive and easy to interact with.
S2	The data on the damage indicators is presented in a clear and understandable way.
S3	The data shown by the history graph of the damage indicators is presented in a clear and comprehensible manner.
S4	If employed in a real-world context, the proposed prototype would be useful for supporting the monitoring of the conditions of rail transport vehicles.
S5	If employed in a real-world context, the proposed prototype would be useful for supporting preventive maintenance.

Results

#	Respondent 1	Respondent 2	Respondent 3
S1	5	4	5
S2	5	4	4
S3	5	4	4
S4	4	5	5
S5	4	4	5

Main issues raised by feedback:

- Confusing placeholder text on launch
- Touch selection not clear enough
- Navigation along the history graph not clear enough
- Use of continuous lines instead of broken lines in the history graph

Conclusion and Future Work

- Greater understanding of the potential of digital twins for rail transport operations
- Improvement: User-generated alert notices
- Improvement: Real-time display of data on vehicle location
- Future Work: Explore the potential of other Industry 4.0 technologies for rail transport operations

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