Integrated Digital Twin and Explainable AI for Metro Passenger Flow Management

Pietro De Vito

p.devito@stamtech.com

05/09/2024

stamtech.com

+70
PEOPLE

34
YEAR AVERAGE AGE

+25
YEARS SINCE ESTBLISHMENT

6,5
M€ TURNOVER

5
PATENTED TECHNOLOGIES

#1 SME
EU INNOVATION PROJECTS

STAM
MASTERING EXCELLENCE

STAM is an **engineering and technology consulting** company that provides support to clients facing new business and innovation challenges.

Our Key Strengths:

- Multidisciplinary and Cross-sectoral Expertise
- In house laboratories to develop High-Tech Solutions
- Partnerships with +1000 Major Industries, Start-ups and Research Organizations
- Management certifications (SCRUM, PMP)
- Technical Certifications (K8S, KNX, Angular)
- *(Membership and affiliations (AIAD, IAI, EOS)*

OUR OFFICES

- Genova
- Cagliari
- Roma
- Bari


ROBOTICS & AUTOMATION
DIGITAL SOLUTIONS
ENERGY & SUSTAINABILITY
RESEARCH & INNOVATION SERVICES
ENGINEERING SOLUTIONS

Business challenge

In the modern, rapidly urbanizing world, the efficiency of metro stations is crucial for smooth and safe passenger transportation. With growing population density, congestion within metro stations has become a significant challenge. Our research addresses these issues through the "**Integrated Digital Twin and Explainable AI for Metro Passenger Flow Management**" project. By leveraging advanced simulation techniques and real-time data integration, our goal is to optimize metro station operations, enhance passenger experience, and ensure safety.

Architecture

Cameras on board train

Train weighing sensors

Metro station cameras

Data integration layer

Real-time simulator
(Digital Twin)

Predictive simulator

Digital Twin

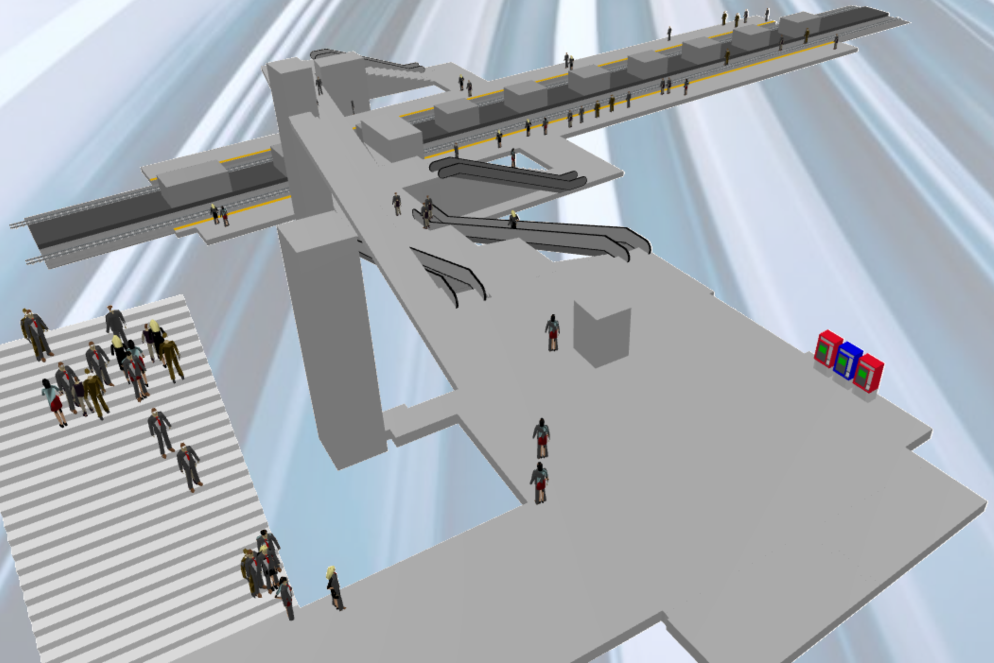
Comprehensive Visualization

The digital twin generates intuitive 2D and 3D visualizations that display crowd density, congestion hotspots, and other key metrics within the station. These visual representations enable stakeholders to quickly comprehend complex data and make informed decisions.

Real-Time Data Integration

The digital twin integrates **live data** feeds from sensors and cameras deployed within the metro station. This continuous data stream ensures that the virtual environment accurately represents the current state of the station, enabling stakeholders to **monitor real-time crowd dynamics** and **operational performance**.

Real-time simulator (Digital Twin)



Predictive Engine

Predictive Simulation

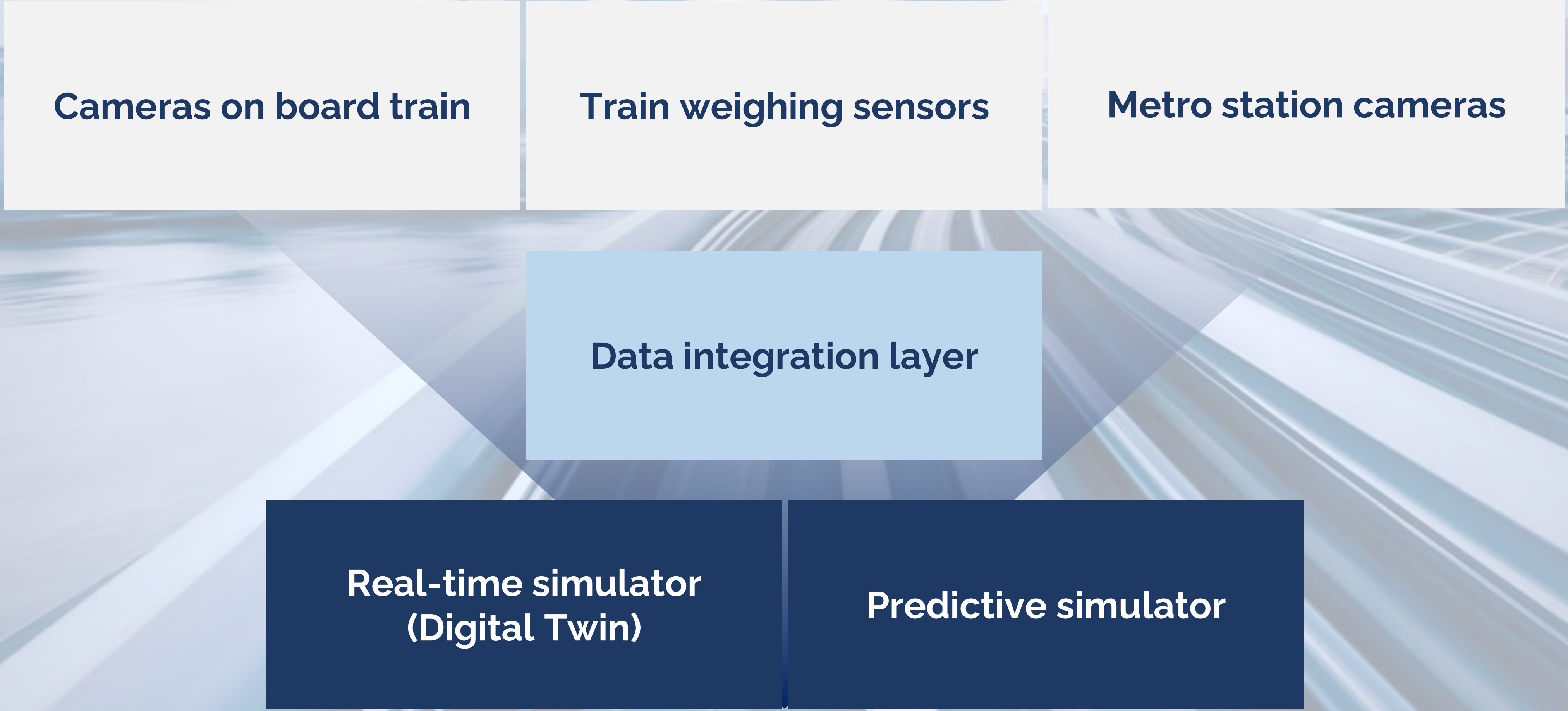
Leveraging historical data and **eXplainable AI** techniques, the digital twin enables predictive simulations. Users can generate optimistic and pessimistic scenarios to assess potential crowd levels and congestion under different conditions, facilitating proactive planning and risk mitigation.

What-If Scenario Analysis

The digital twin allows users to create and simulate customized what-if scenarios based on specific parameters. By adjusting factors like passenger flows and infrastructure utilization, stakeholders can explore **different hypothetical situations** and **evaluate their impact** on station performance.

Predictive simulator

Architecture



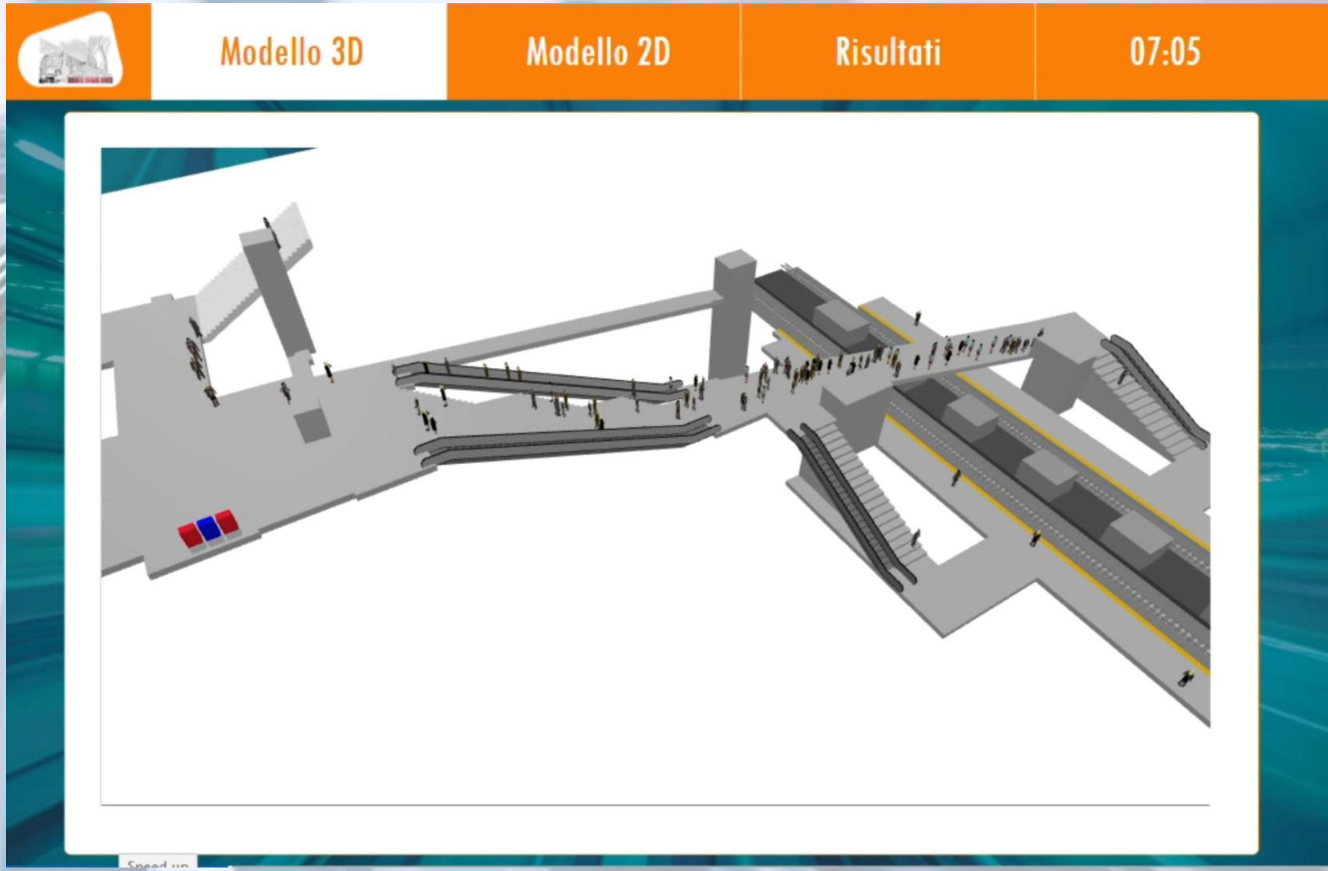
Data integration layer

The Data Integration Layer is pivotal in our architecture. It continuously collects and integrates **data from various sensors** and **cameras** within the station. The communication between these sensors and AnyLogic was facilitated through the development of a **WebSocket** and the use of **AnyLogic Cloud APIs**. This real-time data feed allows the system to reflect current operating conditions accurately. By leveraging this data, we can ensure our simulations and predictions are based on up-to-date information, enhancing their reliability and relevance.

Achievements

Our solution has demonstrated significant potential benefits:

- **Tangible Benefits:** Improved operational efficiency, including potential reductions in passenger wait times and optimized train schedules and platform assignments. This could lead to smoother passenger flow and enhanced service reliability.
- **Intangible Benefits:** Enhanced passenger experience through improved safety and comfort. Real-time and predictive insights facilitate better crowd management, potentially reducing stress and increasing overall satisfaction.



Future improvements

- CROWD MANAGEMENT AND SAFETY OPTIMIZATION
- INFRASTRUCTURE DESIGN AND CAPACITY PLANNING
- EMERGENCY RESPONSE AND EVACUATION PLANNING
- PASSENGER EXPERIENCE ENHANCEMENT
- SUSTAINABLE TRANSPORTATION INITIATIVES
- SMART CITY INTEGRATION
- TRAINING AND EDUCATION
- TRANSFERABILITY TO OTHER CRITICAL INFRASTRUCTURES

THANK YOU FOR THE ATTENTION

STAM
MASTERING EXCELLENCE

Pietro De Vito

p.devito@stamtech.com

CONTACTS

stamtech.com

STAM S.r.l

Stam_Tech

stam_tech

stamtech.com