ITEA 4

Project Results

TiDiT

Collaborative, timeline-driven digital twins

To increase the accessibility and efficiency of digital twins across Europe, the ITEA project TiDiT (Timeline-Driven Digital Twin) developed a platform in which seamless data exchange and semantic interoperability boost the collective intelligence of digital twins.

Semantic interoperability is a crucial element of digital twins, often requiring customisation. However, existing frameworks struggle with such customisation; options are especially limited for organisations with fewer resources or expertise. Further complexities include real-time data processing, system integration, and data source management, as well as the integration of artificial intelligence (AI) and machine learning (ML) tools with real-time data. Overcoming these challenges would allow more businesses to take up digital twin technology, thereby preventing unexpected breakdowns, reducing maintenance costs, and enhancing cost-effectiveness.

Technology applied

To achieve this, TiDiT created new architectures to combine 'digital twin as a service' (DTaaS) with timeline-driven and cooperative digital twin structures, resulting in a platform that brings together solutions for different markets. This TiDiT Platform approach enables users to analyse data and calculate both forward (prediction) and backward/forward (what-if analysis) while enabling interoperability between different digital twins. This is based around a timeline data repository in which the platform stores data collected from different users. When a new user accesses the platform and cannot provide enough of their own data, they can feed their digital twin from this repository. To further increase accessibility, the platform is web-based and compatible with traditional screens. Together, these elements enable both new and experienced users of digital twins to predict future events, replay historical data, monitor the present, and test different scenarios.

During the project, this was demonstrated within two use cases: elderly care and smart manufacturing. The former worked to streamline documentation processes for nurses in healthcare through the development of a digital twin system that integrates patient data and provides automated documentation assistance. This includes analysing the allocation and utilisation of resources, particularly nursing staff, and identifying potential risk factors for adverse events – in short, the integration of patient needs, staff experience, caregiver availability, and required service level. In the latter, TiDiT focused on a simulation-driven, multi-physics model for 3D residual stress prediction. As residual stress critically impacts the strength, accuracy and lifespan of machined parts, accurate and efficient detection is crucial to reducing the costs of rework and scrap in fields like aerospace, automotive and medical manufacturing.
To increase future uptake, the project's results are widely applicable in domains beyond these examples: TiDiT's unified data repository supports seamless data exchange and therefore integration with existing systems, data sources, simulation tools, and AI models. Its ontology model also allows easy customisation in new domains, which sets it apart from other digital twin frameworks. Finally, an edge/fog module designed for low-latency decision-making helps to ensure reliability, data privacy and cost-effectiveness, particularly for industrial applications.

Making the difference

The practical benefits of such a platform have already been demonstrated in two diverse domains, each yielding major successes. In the elderly care use case, staff utilisation efficiency was initially estimated at 60% due to inefficiencies in manual scheduling; the project was able to raise this to 90% through preliminary implementation of digital twin simulations. At the same time, average response time to patient requests was reduced from 15 minutes to 10 minutes, which translates into better patient safety, satisfaction and overall care quality. Similar results were seen in the smart manufacturing use case, where simulation model residual stress error was reduced from 15% to 9% and material waste was reduced from 8-10% of material volume scrapped to 5%. Most

TiDiT offers a timeline-driven DT-as-a-Service solution that enables better business decision-making.

notably, TiDiT was able to use soft actor-critic (SAC) agent-based optimisation to reduce process set-up time from an average of 40 hours for conventional parameter tuning to just 1-10 minutes.

For elderly care, the project additionally established partnerships with healthcare institutions for data access and collaboration, then conducted interviews and surveys with nurses to gather requirements. In a corresponding pilot study in a nursing home in Slovenia, users reported a 25% reduction in routine documentation and 15% quicker average staff response time, as well as a perceived 20% increase in workflow efficiency. This is a springboard for Caretronic to expand evaluation to three additional facilities, which will pave the way for market introduction to both care organisations and telecom companies via their network of distributors in more than 40 countries worldwide.

Future outlook

Regarding further exploitation, the TiDiT Platform will target a combination of open-source access, modular commercialisation, and subscription-based service models. BİTES, for instance, will incorporate TiDiT's modular DTaaS architecture into its existing digital transformation portfolio while also developing commercial-grade digital twin solutions that leverage TiDiT's open-source base. Likewise, INNOVA will exploit TiDiT within its Health Integrated Campus (HICAMP) middleware and smart manufacturing portfolio – introducing digital twin-based services for predictive maintenance, energy efficiency, and process optimisation – while extending its consultancy offerings into telecommunication, energy, and healthcare through domain-specific analytics packages.

This hybrid exploitation approach across the consortium enables flexibility in adoption, supports scalability across industries, and promotes the creation of an open European ecosystem for interoperable digital twin solutions, all of which strategically position TiDiT for long-term sustainability and success.

Major project outcomes

Dissemination

- Scientific and technical publications related to timeline-based digital twins, AI-driven prediction and collaborative DT architectures.
- Presentations and demonstrations at international conferences, industrial events and ITEA-related dissemination activities.

Exploitation (so far)

New products

- TiDiT Platform: A timeline-driven digital twin platform delivered as-a-service, enabling predictive, prescriptive and retrospective decision support across multiple industries.

New services

- Timeline-Driven Digital Twin Services: Digital twin-based decision support services offering predictive analytics, what-if simulations and operational optimisation.

New systems

- Domain-Specific Digital Twin Systems: Customised digital twin implementations for healthcare, manufacturing, production planning, textile and elderly care use cases, built on the TiDiT core platform.

Standardisation

- Contributions to open, ontology-based knowledge models and alignment with existing Industry 4.0 / RAMI 4.0 principles to support interoperability and vendor-neutral digital twin ecosystems.
- Input to open-source-friendly architectures and APIs enabling future standardisation and ecosystem growth.

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TiDiT

21023

Partners

Slovenia

- Caretronic

Türkiye

- Bewell Teknolojli
- BITES
- Innova
- Necdet Alpata Pazarlama Lojistik ve Turizm Sanayi ve Ticaret

Project start

October 2022

Project end

September 2025

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