ETSI TR 103 827 V1.1.1 (2023-09)

SmartM2M;
SAREF: Digital Twins opportunities for the Ontology Context

Reference
DTR/SmartM2M-103827

Keywords
artificial intelligence, digital twins, interoperability, IoT, IoT platforms, oneM2M, ontology, SAREF, semantic, Smart Cities

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Sous-Préfecture de Grasse (06) N° w061004871

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Smart Machine-to-Machine communications (SmartM2M).

Modal verbs terminology

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Introduction

In an increasingly interconnected and technology-driven world, the concept of Digital Twins (DTs) has emerged as a powerful tool in various domains. Among these domains, the urban landscape stands out as a fascinating and complex environment where DTs have immense potential. A Digital Twin (DT) refers to a virtual representation of a physical entity, such as a building, infrastructure, or even an entire city, that is synchronized and connected in real-time with its physical counterpart. In the urban domain, DTs offer a transformative approach to urban planning, development, and management. By leveraging advanced technologies like the Internet of Things (IoT), Artificial Intelligence (AI), big data analytics, and cloud computing, DTs enable a comprehensive understanding of urban systems and facilitate data-driven decision-making.

DTs for the urban domain go beyond traditional 2D maps and static models by incorporating real-time data streams from sensors, cameras, and other devices embedded throughout the city. These data streams provide a continuous flow of information on various aspects of urban life, including traffic patterns, energy consumption, air quality, infrastructure health, and social dynamics. By capturing and analysing this wealth of data, DTs create dynamic, virtual replicas that mirror the behaviour and characteristics of the physical urban environment. One of the key benefits of DTs in the urban domain is their ability to simulate and predict outcomes. Urban planners, architects, and policymakers can use DTs to model different scenarios and assess the potential impact of changes in the urban landscape before implementing them. This predictive capability helps optimize resource allocation, enhance sustainability, improve infrastructure design, and ultimately create more liveable and efficient cities.

Furthermore, DTs enable enhanced situational awareness and real-time monitoring. City officials and emergency responders can use DTs to monitor critical infrastructure, detect anomalies, and respond swiftly to incidents or emergencies. By integrating data from various sources, such as surveillance cameras, weather sensors, and social media feeds, DTs provide a holistic view of the urban environment, fostering proactive and informed decision-making. However, the adoption of DTs in the urban domain comes with challenges. Ensuring data privacy and security, managing the complexity of integrating diverse data sources, addressing interoperability issues, and gaining public trust are some of the hurdles that need to be overcome. Additionally, the scalability and sustainability of DT ecosystems require careful consideration to ensure their long-term viability. Despite these challenges, DTs have the potential to revolutionize urban planning and management. By harnessing the power of technology, these virtual replicas provide invaluable insights, empower decision-makers, and enable the creation of more sustainable, resilient, and inclusive cities. As urban populations continue to grow and cities face unprecedented challenges, DTs offer a promising pathway towards a smarter and better-connected urban future.

The present document provides an analysis of the utilization of DTs in the urban field, with a specific emphasis on interoperability. The adoption of existing standards and the utilization of semantic-based solutions have been surveyed to determine their implementation. Furthermore, a comprehensive examination of the SAREF suite in relation to various use cases is discussed together with the identification of the priority gaps that need to be addressed in the near future.

1 Scope

The present document provides an overview of the DT landscape for the urban domain. It is also discussed how the DT domain has been addressed from the standard perspectives by presenting the existing ones by also including a deeper overview about how ontologies have been employed to manage interoperability aspects. The present document also lists a set of use cases is presented in order to depict concrete implementation of DTs to use as starting point for an interoperability analysis. Finally, the present document provides preliminary insights about how the SAREF Core ontology, and its extensions can be exploited to support interoperability aspects within the DTs domain.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

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3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

Digital Twin (DT): set of virtual information constructs that fully describes a potential or actual physical manufactured product from the micro atomic level to the macro geometrical level

ontology: formal specification of a conceptualization, used to explicit capture the semantics of a certain reality

real time: timespan sufficient for the entity to accomplish the task for which the entity has been built

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AI	Artificial Intelligence
API	Application Programming Interface
BIM	Building Information Modelling
DT	Digital Twin
IoT	Internet of Things
JSON	JavaScript Object Notation
OWL	Web Ontology Language
RDF	Resource Description Framework
SAREF	Smart Applications REFerence ontology
TR	Technical Report
TS	Technical Specification
XML	Extensible Markup Language