Open APIs for Open Minds

FIWARE: an open standard-based framework for data integration based on digital twins

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Digital Twins: an approach for integration at multiple levels

Architecting Smart Solutions



Integrating systems and sharing data within organizations (system of systems)



Integrating services and sharing data across organizations (Data Spaces)





What are we referring to as Digital Twin?

- **Digital Twin** = Digital representation of a real-world asset
 - Characterized by attributes
 - Properties
 - Relationships
 - Values of attributes may change over time (or not)
 - Typically have a location (but it is not a must requirement)
- (digital representation of) Context = Digital Twins Collection
- Cornerstone for the development of interoperable and replicable (portable) Smart Solutions:
 - Standard API for getting access to Digital Twin data (context)
 - Common Data Models associated to Digital Twin classes
- **FIWARE** has driven standardization+adoption:
 - NGSI: NGSIv2
 ETSI NGSI-LD API
 - Smart Data Models initiative (500+ data models)

































- NGSI-LD is a simple yet powerful REST API
- Simple: simple operations are rather simple, what you would expect in a RESTful API
 - Entity types, entities, attributes have a path
 - You perform standard GET, POST, PUT, PATCH, DELETE operations
- Yet powerful: powerful operations supported
 - Geo-queries
 - Subscription / Notification
 - Pull/Push styles for gathering data
 - Multiple data "renderings" (key value, normalized, GeoJSON)
 - Temporal operations
 - Federation mechanisms



FIWARE driving key standards: Smart Data Models

- Goal: provide a useful global "resource library" for developers
- For each model:
 - documentation in 6 languages
 - mapping (with validation schemas and examples) to DTDL and 4 serialization formats: JSON, JSON-LD, CSV, GeoJSON feat.
- Principles:
 - Agile process (6 weeks)
 - Implementation-driven
 - Cross-sector
- Defined data models rely on relevantly <u>adopted</u> standards (e.g., schema.org, SAREF, IEC CIM in Energy or UNE 178503 for Tourism) and contributions from real projects by the Community





Endorsement at global level: Relevant standard and industry bodies



ETSI created Jan 2017 an Industry Specification Group (<u>ISG CIM</u>) for defining a Context Information Management API

FIWARE NGSIv2 provided the basis for the <u>NGSI-LD specs</u> published by ETSI

FIWARE provides several open source implementations of ETSI NGSI-LD



NGSI-LD plays the core role for the integration of components and the development of applications in the defined Reference Architecture tmforum

TM Forum supports FIWARE NGSI for real-time access to context information in cities

TM Forum and FIWARE collaborate in development of data marketplace platform components

TM Forum and FIWARE also collaborate in definition of common data models (<u>smart</u> <u>data models initiative</u>)



Endorsement at global level: Recommendations in cities



OASC MIMs (Minimum Interoperability Mechanisms) are being adopted by cities and the living-in.EU initiative

ETSI NGSI-LD specs maps to MIM-1

OASC has joined the smart data models initiative as base for developing MIM-2

MIM-3 leverages TM Forum recommendations



IUDX, which provides the trusted data exchange framework recommended to cities by the government of India, has adopted NGSI-LD as API for data exchange

IUDX will join the <u>smart</u> <u>data models initiative</u> and play a leading role in definition of data models for cities



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Smart Vertical solution: Reference Architecture (Smart Cities)



- Four major layers:
 - Data acquisition
 - Data management
 - Data processing/analysis & visualization
 - Application layer
- Data acquisition layer
 - Interface to IoT devices
 - Interface to cameras
 - Interface to robots
- Processing/analysis and visualization
 - Integration with most popular Apache processing engines (Spark, Flink, ...)
 - Advanced web mashup and if-then-else tools
- You may use FIWARE components ... or pick those you are interested and combine with 3rd components to create hybrid platforms



A KPIs Apache Superset monitoring Kurento 000000 000000 MySQL / PostgreSQL IDAS / IoT platform **Big Data** Algorithms IoT Agent 1 subscribe (MQTT) HDFS AR) **IoT Agent m** ۵ AI (OMA LWM2M) FIWARE -Algorithms notify **Context Broker O**[©] (Orion) Fast DDS / FIROS2 뜨 Flink **Complex Event** Processing **IDAS** framework QuantumLeap CrateDB / ... ≣:8 System Adapter 1 Operation STH-Comet MongoDB Dashboards System Adapter n Å Wirecloud FIWARE ----------Advanced NGSI **Data Maps**



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Smart Organizations: Reference Architecture following a System of Systems approach (Smart Manufacturing)



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Smart Organizations: Reference Architecture following a System of Systems approach (Smart Cities)



Smart Organizations: Reference Architecture following a System of Systems approach (Smart Agrifood)



Smart Organizations: Reference Architecture following a System of Systems approach (Smart Energy)



FIWARE vision for Data Spaces

- Fundamental principle in Data Spaces for a Data Economy:
 - Data providers publish data resources knowing that consumers, which are unknown "a priori", will know how to consume them
 - Data consumers know how to consume data resources published by data providers they can discover
- This requires all participants to speak the same "language":
 - Data exchange API (the sentences you construct)
 - Standard data models (what you speak about dictionary)
 - Common mechanisms for Identity and Access Management (IAM) (who speaks under what rules)
- Data Spaces powered by FIWARE involve smart applications exchanging context / digital twin data:
 - Standard Digital Twin API: ETSI NGSI-LD
 - Common data models: Smart Data Models initiative
 - IAM based on standards: OpenID Connect \rightarrow VC/VP, XACML PEP/PDP/PMP architecture implementing ABAC/RBAC
- Besides:
 - Trust Anchor Services leveraging eIDAS
 - Publication and Marketplace services: DCAT-AP, TM Forum APIs
 - Management of provenance, traceability: integration with DLTs







Effective and trusted data sharing



FIWARE: what is going on

- Digital Twin standardization
 - Consolidate NGSI-LD as reference standard
 - Standardization of advanced Digital Twin features
- Continue the definition of standard Data Models
 - <u>Smart Data Models</u> initiative JOIN US !
 - Cross-domain perspective
- Integration with blockchain / DLTs:
 - Transparency in processes quality certification
 - Audits and forensics
- Integration with AI/ML technologies:
 - Standard architecture enabling "AI/ML as a service"
 - plug&play extensibility of systems with AI/ML services
- Integration with Robotic systems:
 - Standardization of interfaces to robotics systems
 - Context-aware, smart, collaborative robots

- Data Spaces / Marketplaces Data Economy
 - Creation of multi-side markets
 - Monetization of data to incentivize sharing
 - Decentralized Identity and Access Management (IAM)
 - Data Usage Control





Success Stories (some of the Impact Stories on fiware.org)

- Smart Cities:
 - Japan municipalities collaborating for disaster resiliency and sustainable growth
 - <u>A platform to support the decision-making of public administrations on environmental matters</u>
 - <u>A Powered-by-FIWARE solution to provide a personalized view of urban data to citizens in the City of Malaga</u>
- Smart Industry:
 - Elliot Cloud is helping São Paulo to manage its water resources network
 - <u>Container and Shipment tracking System in India</u>
 - SARA IoT platform: designed to operate with maximum efficiency
 - Discover trends and predict anomalies in the shopfloor
- Smart Agrifood:
 - IoT, AI and Blockchain based platform improving livestock Farming
 - AGRICOLUS: the cloud data platform to support and optimise Farmers' work
- Smart Energy:
 - FIWARE Context Broker: The engine for future energy systems
- Health:
 - How biosurveillance and Open Source technologies are jointly contributing to fight COVID-19



Conclusions

- FIWARE brings response to existing challenges regarding interoperability and replicability of smart solutions in multiple sectors:
 - Relying on Digital Twin vision
 - Supporting System of Systems Data Spaces integration
- An approach paving the way for the connection of systems across domains
- An approach that is future proof comprehensive roadmap in place
- And don't forget ...



FIWARE is open, for all, for ever !!



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Sounds nice? - Contact us!

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