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Modelling with NGSI-LD

The **VALLPASS** project case study

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Presentation Overview

What is the VALLPASS project?

Linked data and semantic web technology

The NGSI-LD framework

The NGSI-LD data model at VALLPASS

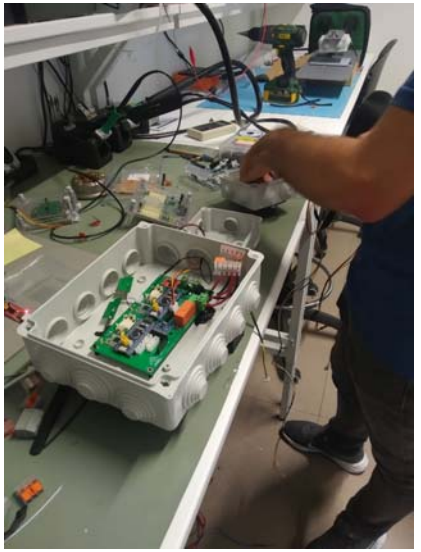
Results and discussion

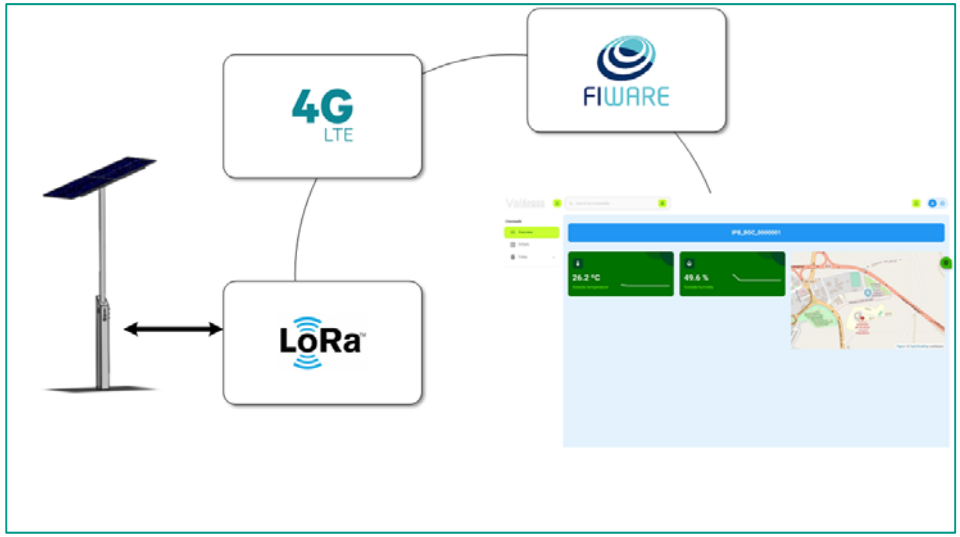
Conclusions

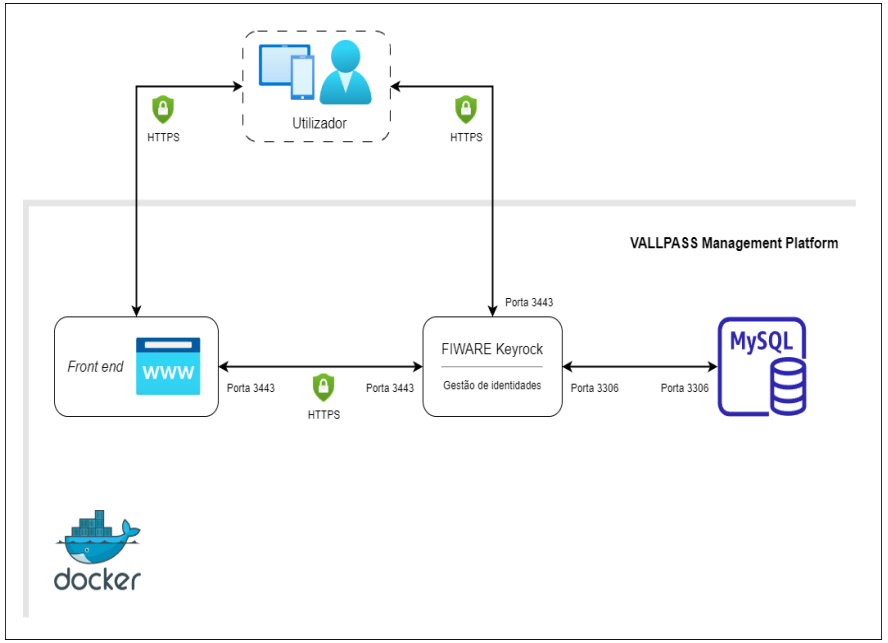
The VALLPASS project

- Funds from NORTE2020
- Three stakeholders
- Development of a smart crosswalk
- Remote access and monitoring
- Pedestrian and vehicle detection
- Energy self sustained
- Self-commissioning
- LoRa based communication
- Remote management platform "Powered by FIWARE"


VALPASS
PASSAGEM SEGURA

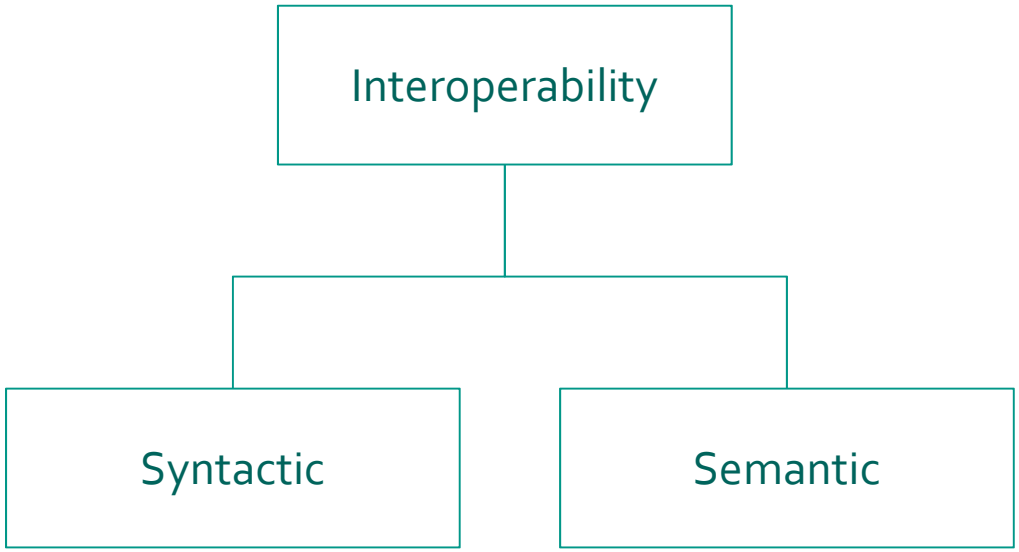






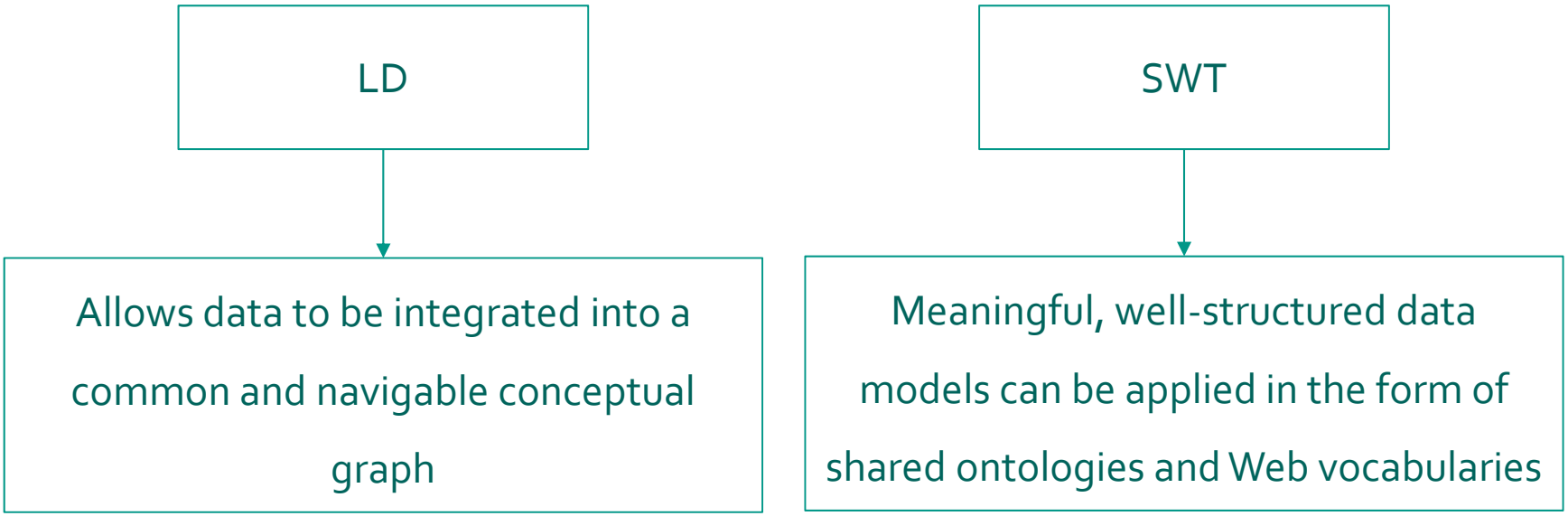
- Uplink and downlink using LoRa
- Backhaul from 4G/LTE or WiFi
- Data forward to an MQTT broker and consumed by IoT agents
- IoT agents represents logical bridges
- Data is delivered using JSON-LD format
- A context broker (FIWARE's ORION-LD) takes care of data management
- Orion-LD provides REST based APIs for data sharing

- The crosswalks from the VALLPASS project must be able to operate within a smart cities environment.
- Heterogeneous environment.
- Necessary to integrate data from different domains and sources:
  - Interoperability
  - Security
- Heterogeneity doesn't just apply to the data domain.
  - hardware,
  - protocols,
  - Platforms and policies
- **Syntactic interoperability is the first challenge!**



- Achieving interoperability => two types of integration must be achieved:
  - syntactic, related to content type
  - semantic, associated with the contextual meaning
- **Linked Data and Semantic Web Tecs to the rescue…**

- Powerful combination that leverages interoperability



- allows data to be integrated into a common and navigable conceptual graph
- **leaving data distributed and managed in different systems (loosely integrated).**

- They can solve the interoperability problem (at the data level)
- Developing them can be very tricky
  - **Practical** novelty of SWT
  - Mismatches between well-known ontologies and the actual scenario to be modeled.
  - Attributes definition and properties only if absolutely necessary
- **Resist the urge to reinvent the wheel!!!**

Our contribution

- Methodology for creating semantic data models within the IoT framework
- Demonstrated practically by creating an NGSI-LD semantic data model for the VALLPASS project (traffic domain)
- Focus on representing and describing data related to digital twins.

NGSI-LD

- Open framework for context information processing.
- Developed by the ETSI Industry Specification Group for cross-cutting Context Information Management (ISG CIM)
- The term LD represents the strong influence of Linked Data concepts
- It consists of a semantic information model and a RESTful API

NGSI-LD information model

- Facilitates the modelling of real-world entities, relationships and properties.
- Can link and federate other information models through the use of JSON-LD.
- Data takes the form of a graph of correspondence links between informational units
- **Correspond to real-world entities!**
- The semantic referencing used by NGSI-LD is based on standard RDF/RDS/OWL typing and public ontologies.

NGSI-LD meta-model

- The main constructs defined in the NGSI-LD meta-model are:
  - Entity - informational representative of something that is supposed to exist in the real world, physically or conceptually
  - Property - description instance that associates a main characteristic - Value - with an Entity, Relationship or other Property
  - Value - JSON value, JSON-LD typed value, or JSON-LD structured value
  - Relationship - represents a direct link between a subject which can be an Entity, Property or other Relationship and an object, which must be an Entity

FIWARE

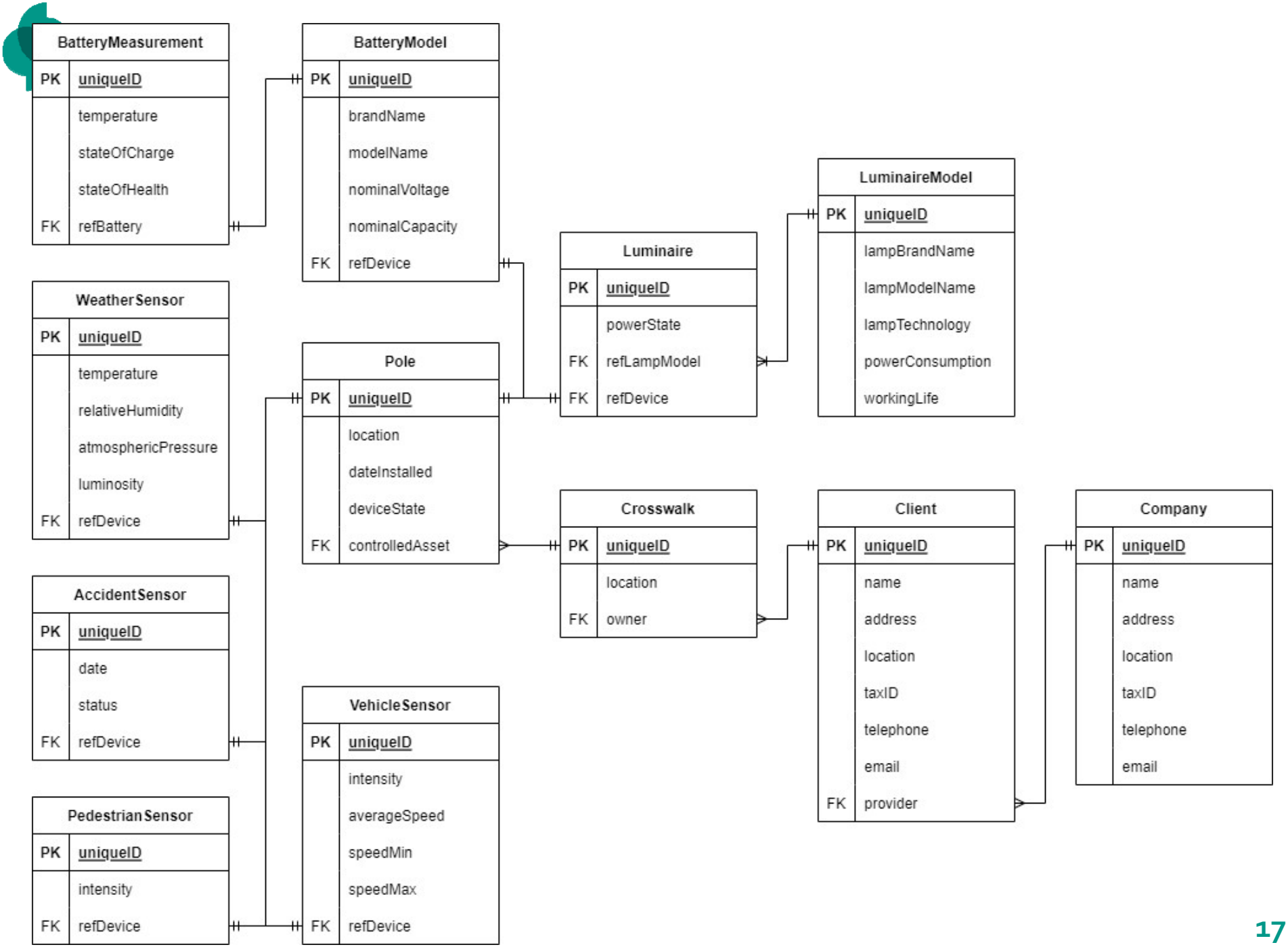
- Open-source initiative that aims to define and implement a set of standards for developing smart solutions for different IoT domains
- Framework of components – (GEs)
  - The main GE is FIWARE Context Broker
  - Interface with devices, data processing, context information
- Interoperability using a standardized data model and Application Programming Interface
- There are already more than **250 cities** using FIWARE technology

Smart Data Models Initiative

- Stems from a collaboration between the FIWARE Foundation, TM Forum, IUDX and the OASC
- Support the adoption of a common compatible reference architecture and data models that aims to interoperable and replicable smart solutions
- A Smart Data Model consists of three elements: schema, specification, and the examples.
- The data models are grouped into subjects, assigned to a GIT repository
- Can be associated with one or several domains, representing industry sectors

Development of the NGSI-LD data model

- The systematic process used to create the NGSI-LD semantic data model
- The proposed methodology for creating data models in the IoT domain.
- The semantic data model defined according to the OpenAPI specification (Version 3.1)
- Schema objects.


BatteryMeasurement
PK uniqueID
temperature
stateOfCharge
stateOfHealth
FK refBattery
BatteryModel
PK uniqueID
brandName
modelName
nominalVoltage
nominalCapacity
FK refDevice
LuminaireModel
PK uniqueID
lampBrandName
lampModelName
lampTechnology
powerConsumption
workingLife
Luminaire
PK uniqueID
powerState
FK refLampModel
FK refDevice
WeatherSensor
PK uniqueID
temperature
relativeHumidity
atmosphericPressure
luminosity
FK refDevice
Pole
PK uniqueID
location
dateInstalled
deviceState
FK controlledAsset
Crosswalk
PK uniqueID
location
FK owner
Client
PK uniqueID
name
address
location
taxID
telephone
email
FK provider
Company
PK uniqueID
name
address
location
taxID
telephone
email
AccidentSensor
PK uniqueID
date
status
FK refDevice
VehicleSensor
PK uniqueID
intensity
averageSpeed
speedMin
speedMax
FK refDevice
PedestrianSensor
PK uniqueID
intensity
FK refDevice

Amendment of the Entity-Relationship (ER) diagram

- Virtual sensor providing multiple measurements should be modelled as a system of sensors where each one is attached to a concentrator
- Following this recommendation, the WeatherSensor will be divided into two sensors:
  - TemperatureHumidityPressureSensor
  - BrightnessSensor

Baseline data models

- When creating a semantic data model, it is not necessary, and even advisable, to start from scratch
- The goal is to use **common**, shared ontologies
- The data models from the Smart Data Models Initiative will be used as baseline data models.
- For each of the VALLPASS entities, a search was made to look for the most appropriate Smart Data Model
- May be necessary to change some definition of the entities
  - Adding new schemas
  - Adding new properties

NGSI-LD @context file

- Last step to use the developed semantic data model:
  - Generate the NGSI-LD @context file that will be used to "expand" the terms, from shorthand strings, into concepts, specified by the URIs, and vice versa
- **Interoperability achieved**

Conclusions

- Achieving interoperability is one of the biggest, and most important, challenges in the IoT world today
- When it comes to interoperability at the data level, LD and SWT are powerful enablers
- Described the systematic process used in the development of the NGSI-LD semantic data model for the VALLPASS project.
- The data model is, at the moment, living inside FIWARE's Orion context broker where entities are populated with real-time data that comes from smart crosswalk prototypes.