

Enabling IoT-enhanced Transportation Systems using the NGSI Protocol





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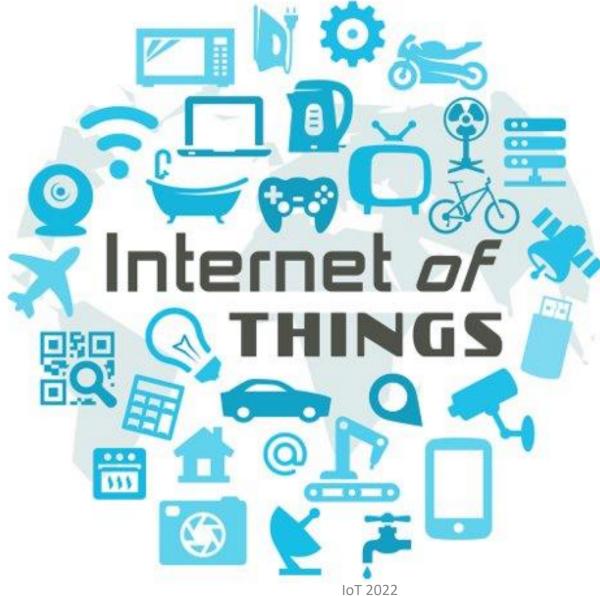
Panagiotis Zervakis Dimitris Plexousakis Kostas Magoutis IOT 2022 The 12th International Conference on the Internet of Things

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The advent of Internet of Things





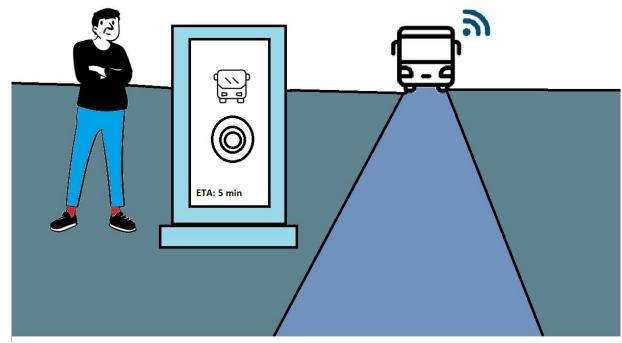


- ☐ Health Monitoring
- ☐ Home Automation
- ☐ Smart Agriculture
- **☐** Smart Transportation

Smart Transportation





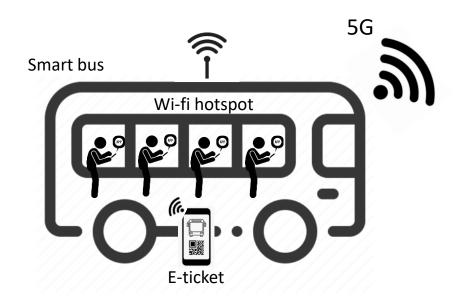


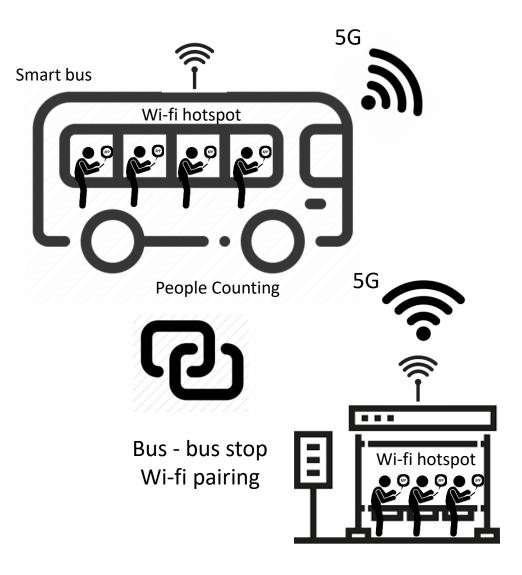
Smart Transportation: Smart Buses









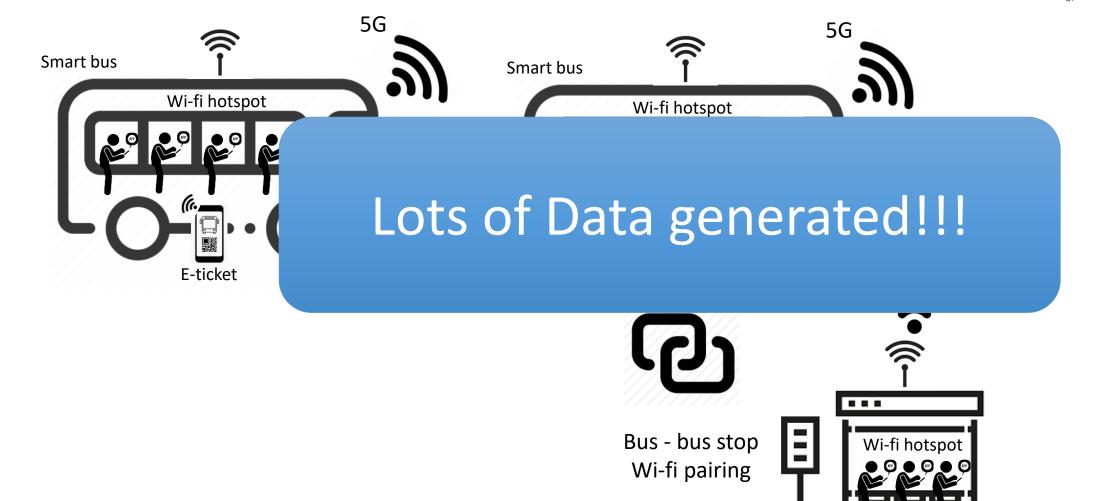


Smart Transportation: Smart Buses









Prevalent smart transportation data models





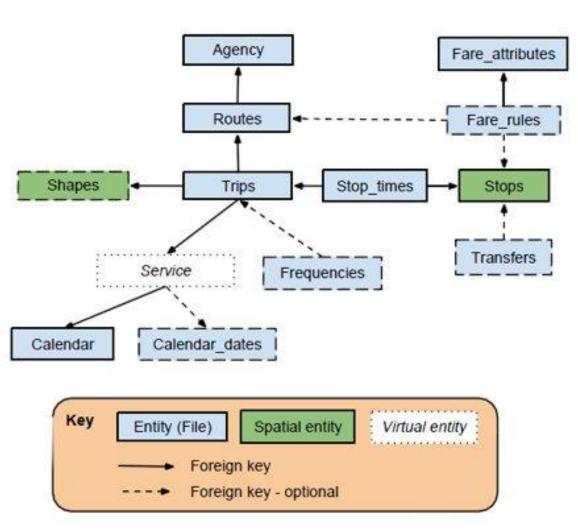




Using these models as is.







Limitations of prevalent standards

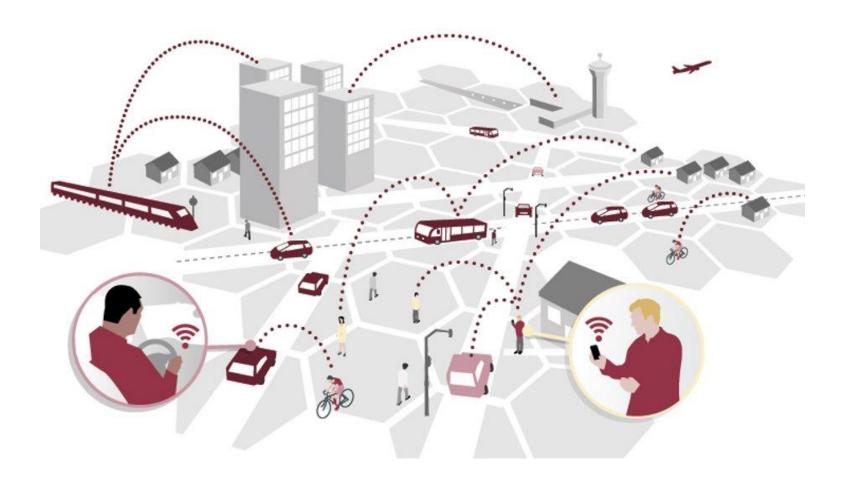




Compatibility with IoT is limited as current standards just offer ways to model transportation networks

Using existing IoT Platforms for smart transportation





Limited contextual expressiveness of existing data models and diminished resemblance with the current rich IoT ecosystem.

Using existing IoT Platforms for smart transportation





- Limited contextual expressiveness of existing data models and diminished resemblance with the current rich IoT ecosystem.
- Vendor Lock-in

Using existing IoT Platforms for smart transportation





- Limited contextual expressiveness of existing data models and diminished resemblance with the current rich IoT ecosystem.
- Vendor Lock-in
- Focus on using specific devices

How can we develop applications that can be portable to multiple transportation systems?

NGSI-LD in a nutshell

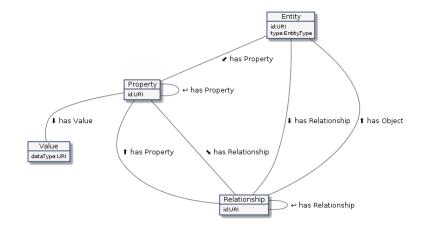


Next Generation Service Interfaces-Linked Data <u>Data Model + API</u>

- ➤ Standardised by ETSI, and the evolution of NGSI-v2
- ➤ It is based on JSON-LD (connected to the world of linked data)
- NGSI-LD's design was focused on supporting the property graph paradigm.
 (Entity, Property, Relationship, Value), with its meta model on the basis of RDF.
 Trying to achieve the best of both worlds.







Existing NGSI-LD models

















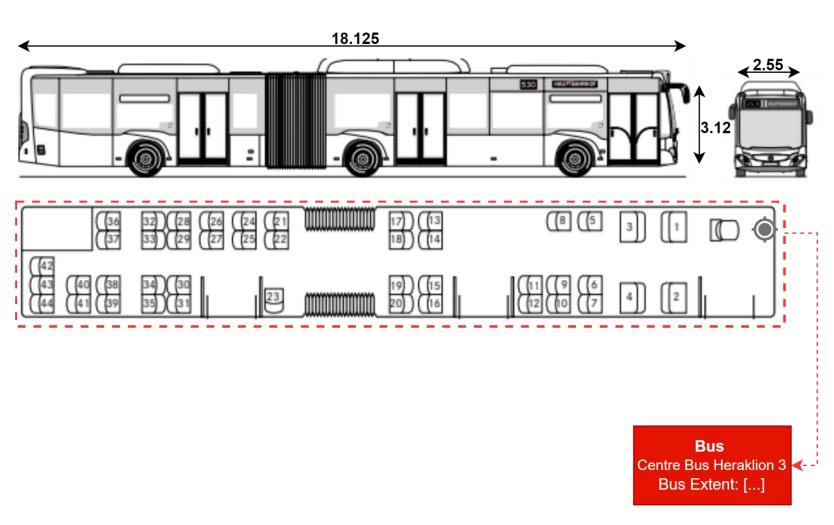


Available models

- ☐ Transportation
- ☐ Urban Mobility

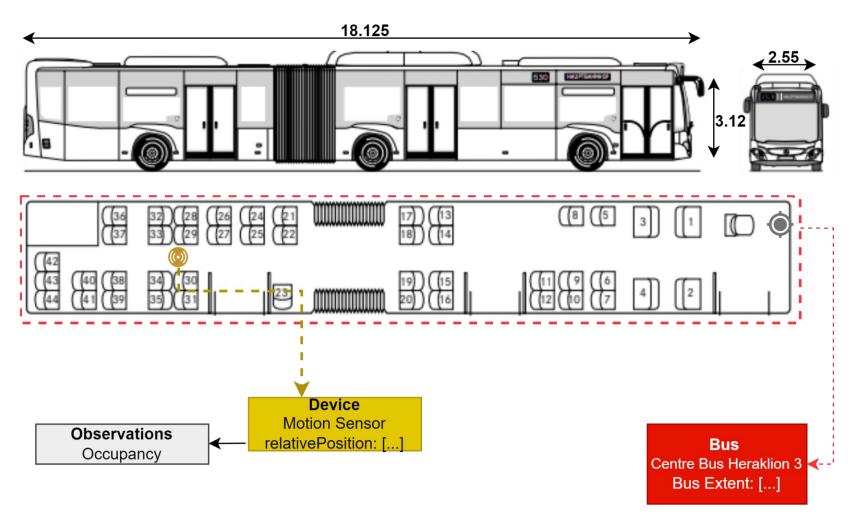
Modeling of Smart Buses





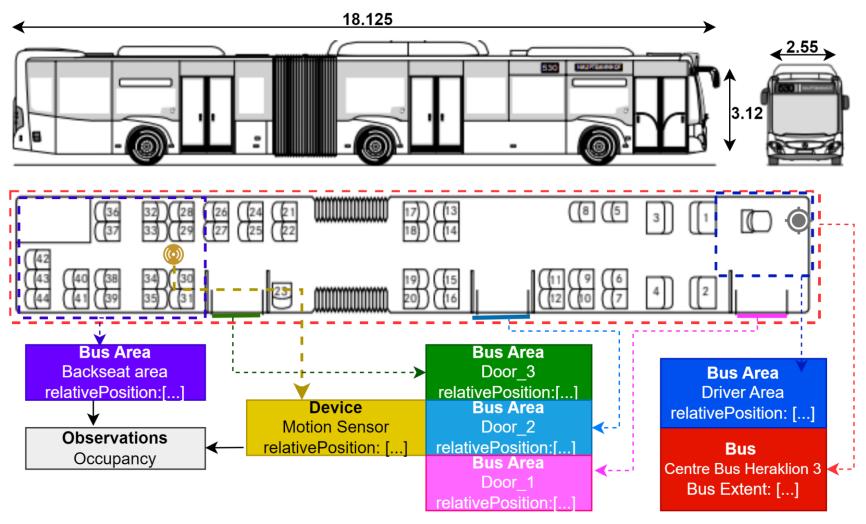
Modeling of Smart Buses





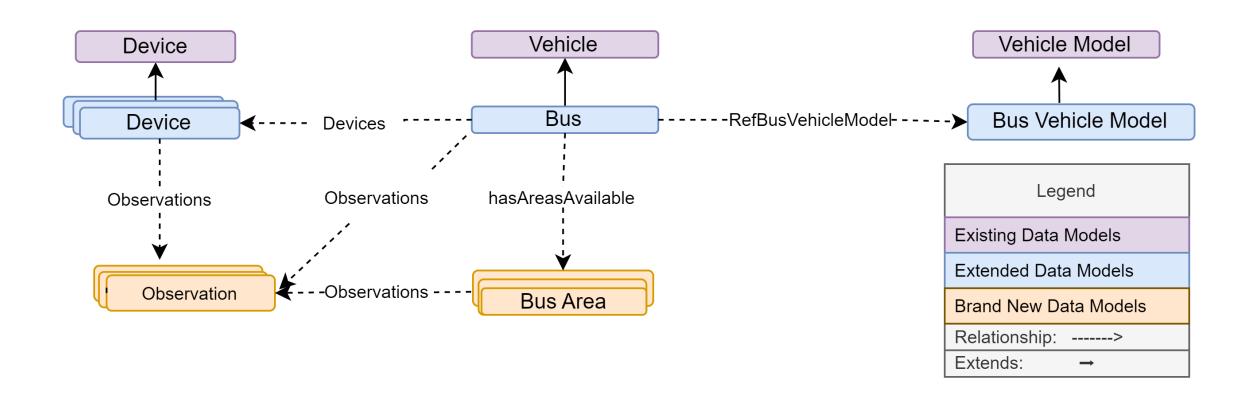
Modeling of Smart Buses





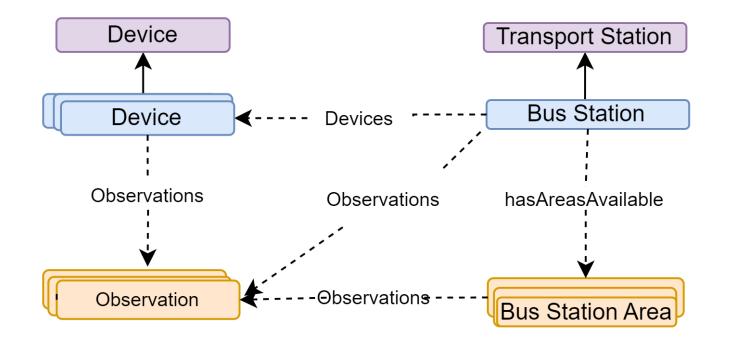
Enhancing existing models





Enhancing Existing Models





Legend

Existing Data Models

Extended Data Models

Brand New Data Models

Relationship: ----->
Extends: →

GTFS-RT to NGSI-LD MAPPING

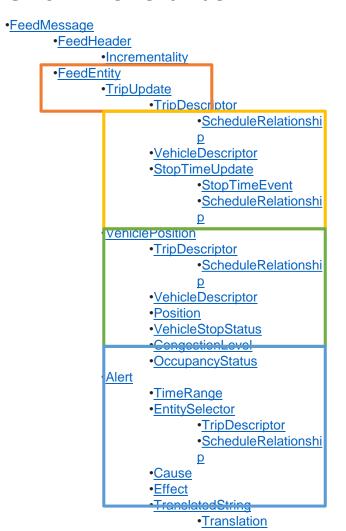


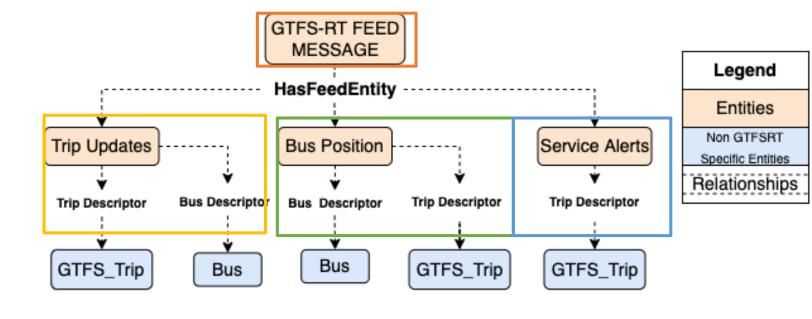


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GTFS-RT Element Index

Our GTFS-RT NGSI-LD data model.

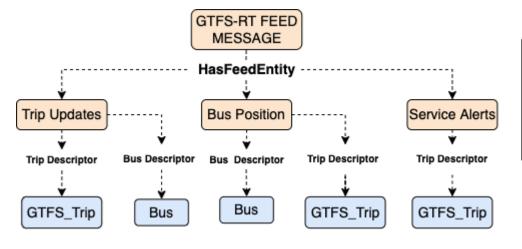




GTFS-RT to NGSI-LD MAPPING









message FeedHeader

Metadata about a feed, included in feed messages

```
//FeedMessage
1: "1.0"
                //gtfs_realtime_version
2: 0
                //incrementality
3: 1644784163 //timestamp
```

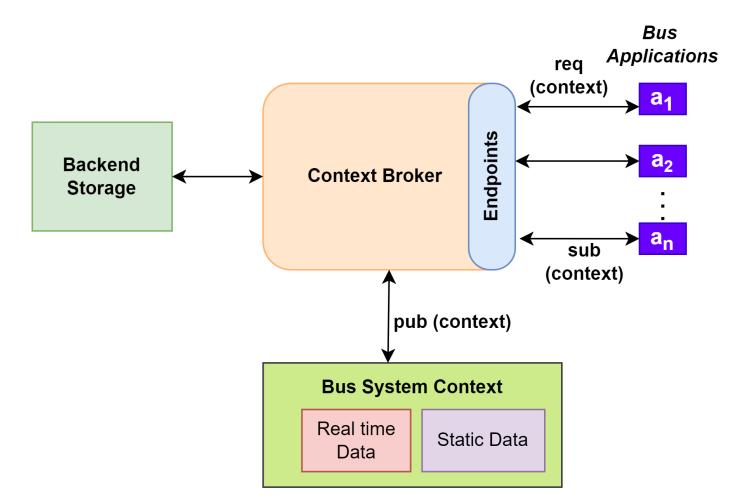
The corresponding NGSI-LD enitity

```
"@context": "https://locationofourcontext.jsonld",
 "id": "urn:ngsi-ld:FeedMessage:8314",
 "type": "FeedMessage",
 "FeedHeader":{
   "type": "Property",
   "value":{
       "gtfs_realtime_version": "1.0",
       "incrementality": 0,
       "timestamp": 1644784163,
"hasFeedEntity":{
   "type": "Relationship",
   "object":["urn:ngsi-ld:TripUpdates:1"]
```

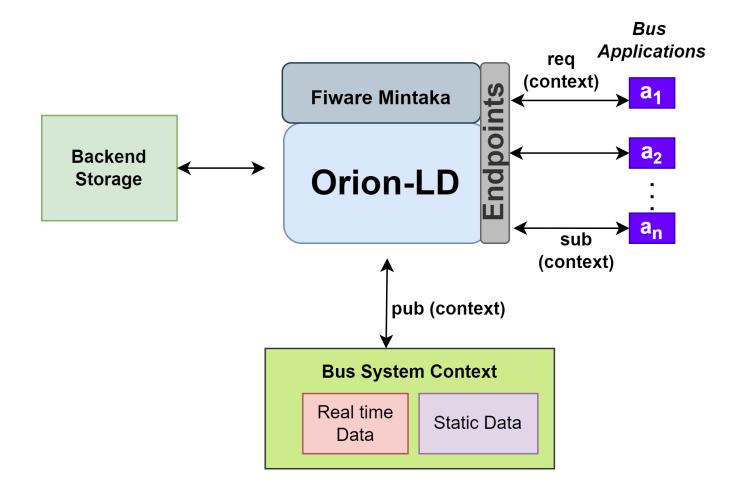
Proposed IoT-based platform architecture



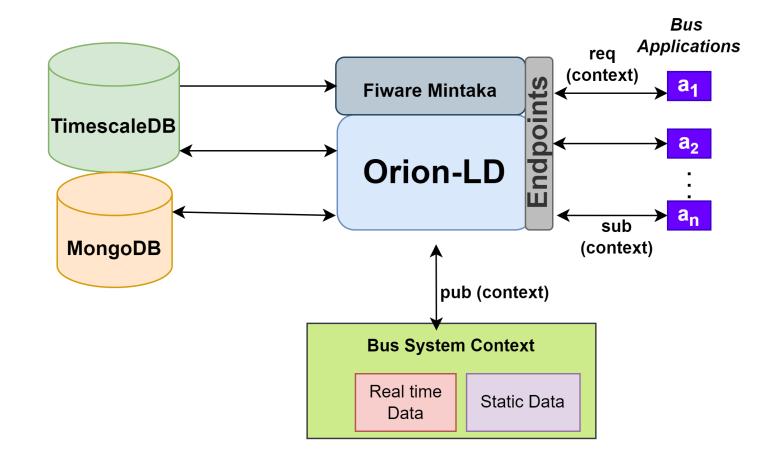




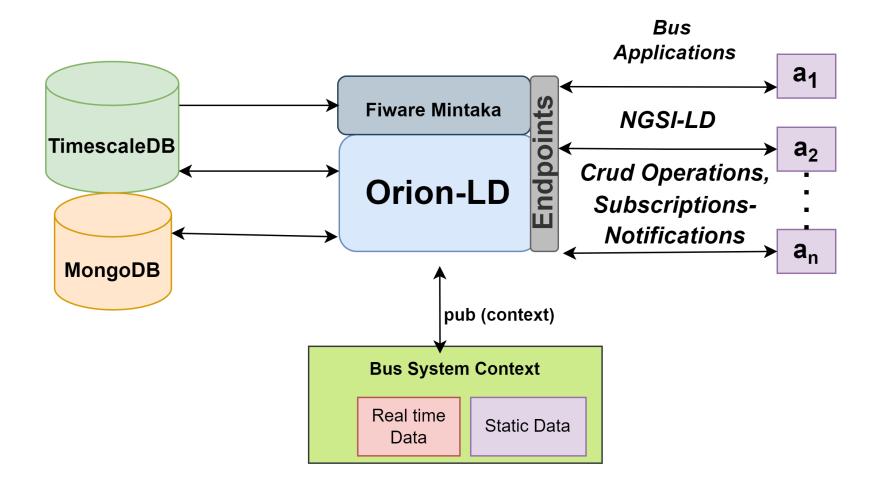




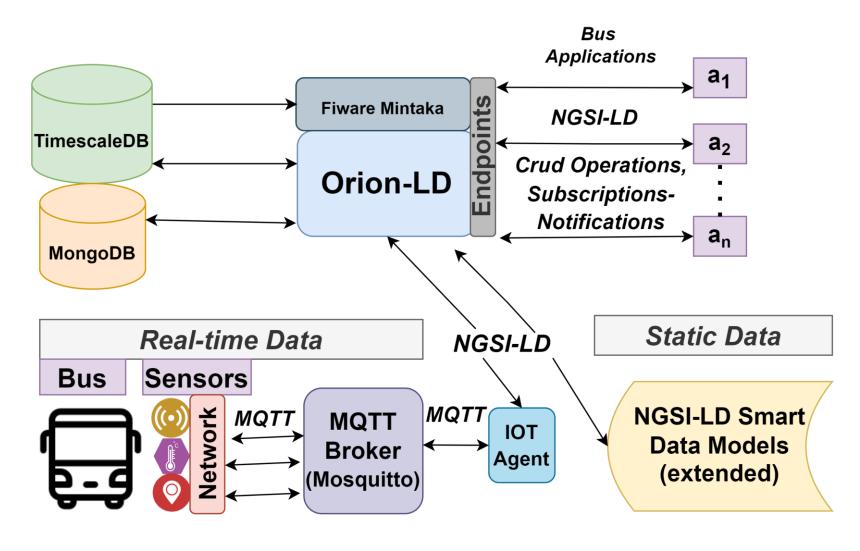












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Prototype Implementation Data

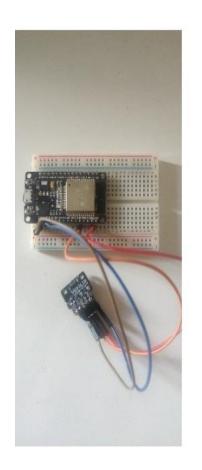






TOF Sensor









Enabling IoT-enhanced Transportation Systems using the NGSI Protocol



- A generic approach that can be following from application developers to represent in a standard way the interior of transportation systems and enhance it with IoT capabilities.
- An extension of the public transportation NGSI-LD model is proposed by adding entities that represent static and dynamic properties of the bus interior space as well as the space of bus stations.
- A tool for mapping GTFS-RT to NGSI-LD data models for public transportation systems is presented.
- A prototype platform that collects real data in GTFS-RT from the Rome bus system and stores them using the extended NGSI-LD entities





https://smartcitybusproject.github.io/

The future





- Validate our GTFS-RT mapped data model
- Examine potential passenger privacy violation concerns
- Deploy a prototype on a real bus.

