CO-CREATING THE SMART CITIES OF TOMORROW

ORCHESTRA CITIES

PRODUCT SHEET

Features	Security Management Device Management Data Management Dashboard Management Data Integration Management
IoT Standards	COAP, MQTT, AMQP, LORAWAN
Security standards	OAUTH 2.0, OIDC, SAML, KERBEROS, LDAP, X.509
Supported Clouds	AWS, GCE, AZURE, OpenStack, VWMARE vCloud

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“Technology is nothing. What's important is that you have a faith in people, that they're basically good and smart, and if you give them tools, they'll do wonderful things with them.„

Steve Jobs

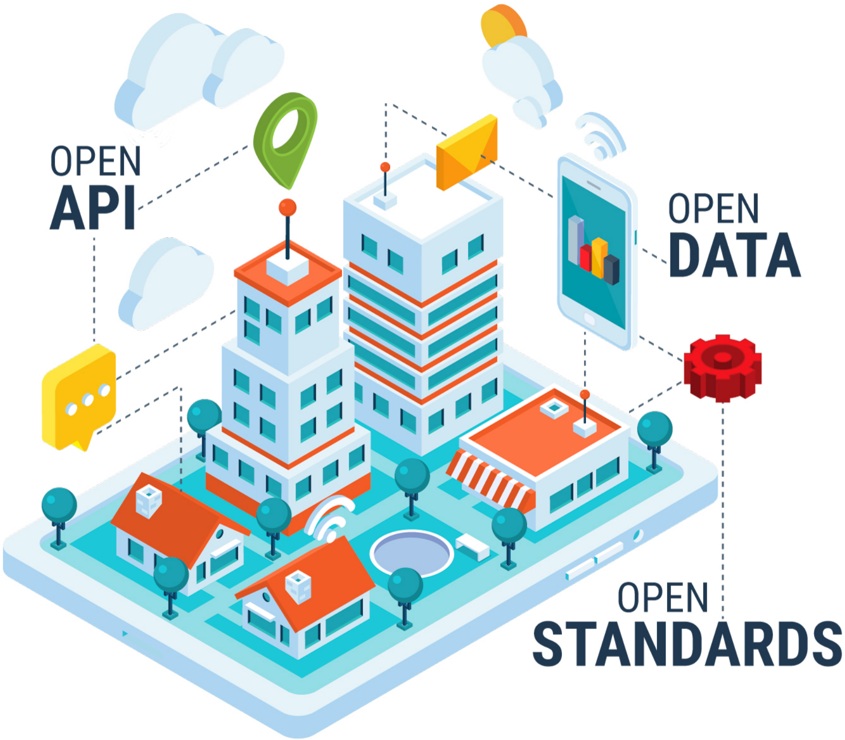
1. Concept

Why Orchestra Cities?

The Smart City solutions market is mostly driven by large players that rely on proprietary technologies. Only recently have a small niche of solutions been adopting an Open approach. The forerunner technology in this niche is FIWARE, the most mature Open Source framework available today dealing with requirements for Smart Cities. The Orchestra Cities concept takes on FIWARE principles and strives to push them further.

FIWARE is designed around the concept of Openness. Concretely this means:

- Open Standards
- Open Data Models
- Open APIS



Orchestra Cities embraces the above principles and aims to extend them to enable City-to-City collaboration and Citizens-to-City collaboration.

Specifically, what does it mean? Orchestra Cities aims at building a collaborative space for shaping a sustainable and participatory future for our cities, where:

- Citizens can share data from their devices with other citizens or with the city
- Businesses can easily build services on top of APIs that are shared across different cities
- Cities can benefit from data published by other cities to create analysis, comparisons and forecast

Orchestra Cities differs from other platforms in that it believes the most efficient and effective way to achieve its goals is to support multiple cities in a single platform. This approach brings several advantages in terms of: costs, scalability and modularity.

Key Benefits

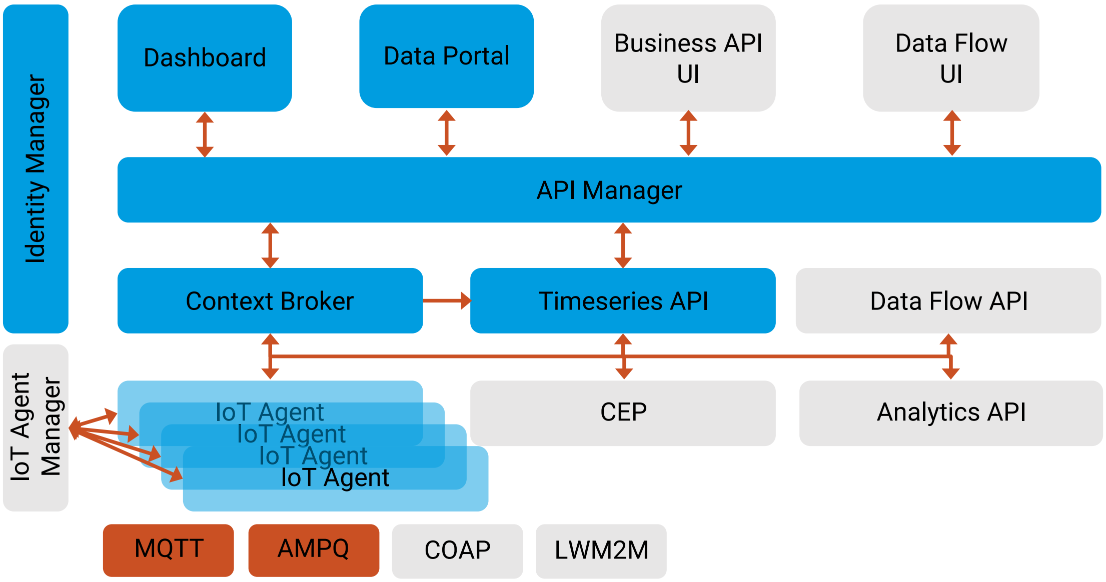
- Support the migration from vertical data silos[1] to a unified data space for a single integrated view over the city
- A collaborative space where different cities can share data and services, while retaining control on their own data
- Modular and flexible approach where each city can acquire just the needed services and quotas
- Reduced ownerships costs thanks to the possibility of sharing the platform among different cities
- Leverage Open Standards and Open Source code, thus building on the work of a large European and global community
- Allow citizens and businesses to take part on the city services co-creation process

[1] The concept of *vertical data silos* refers to data stored in different not interoperable platforms (e.g. waste management, parking management).

"As an artificial world, so the city should be in the best sense: made by art, shaped for human purposes.„

Kevin Lynch

2. Platform Overview



The platform, as depicted in the picture above, is composed of different microservices that are orchestrated using state-of-the-art solutions such as Docker[2] and Kubernetes[3].

Orchestra Cities functionalities available as of today include:

- Security Management.
- Device Management
- Data Management
- Dashboard Management
- Data Integration Management

Security

The core of the security management is based on OIDC and OAUTH 2.0 standards. The solution supports Identity, Access and Organisation Management.

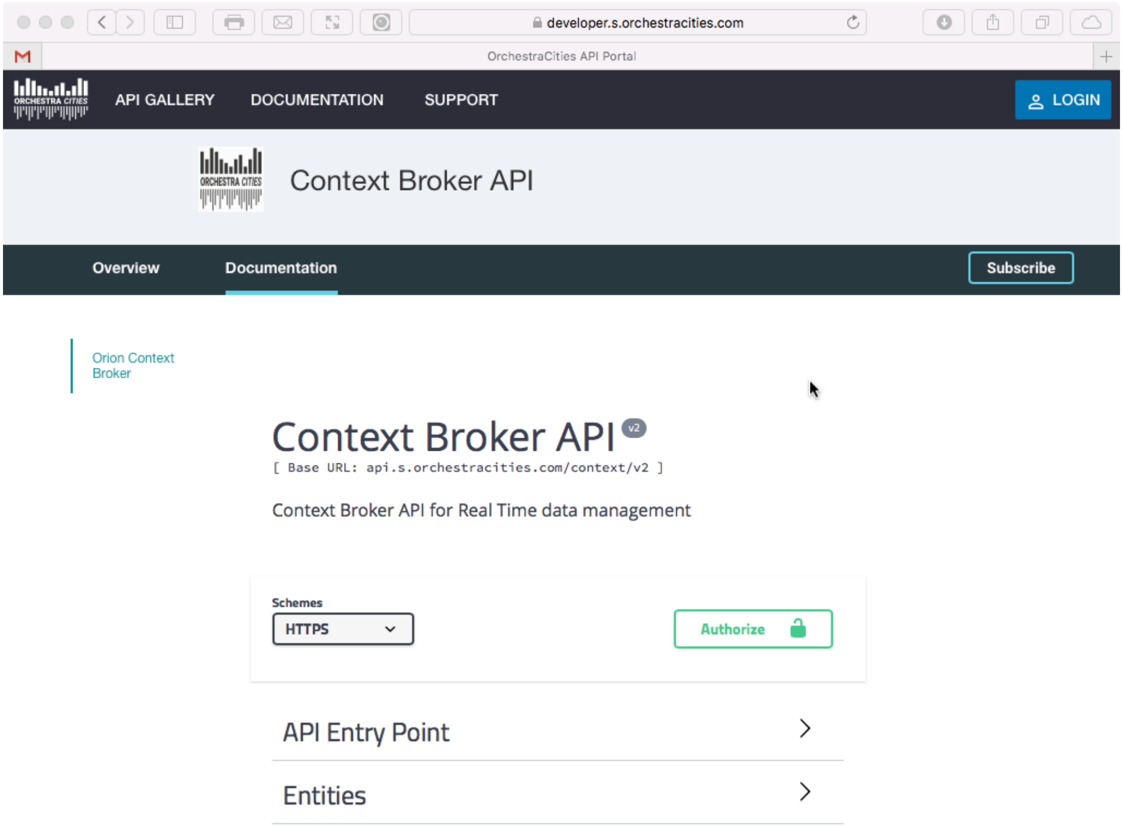
[2] https://www.docker.com
[3] https://kubernetes.io

- The Identity Management support enables it to manage single users (covering authentication aspects).
- The Access Management supports the control of access of users to specific applications or platform services (e.g. dashboard) with a given role (e.g. editor), thus covering authorization and audit aspects.
- The Organization Management support maps users to organizations (i.e. cities) so to host a multi-tenants within a single platform instance (i.e. different cities, same users) approach.

This solution, in combination with the support in the data management layer of data partitioning by tenant, enables the secure and controlled access by each tenant (e.g. a city) to its specific data. Moreover, it empowers different users to have access to different city data spaces with the same account.

The open source solution adopted for the Identity and Access Management is Keycloak[4], the market-leading open source identity and access management solution developed by RedHat.

The adopted open source solution for API Management is gravitee.io[5]. To apply access control to APIs, Gravitee offers a flexible plugin mechanism to implement access control policies.



Context Broker API

Context Broker API

[Base URL: api.s.orchestracities.com/context/v2]

Context Broker API for Real Time data management

API Entry Point

Entities

The process works as follow:

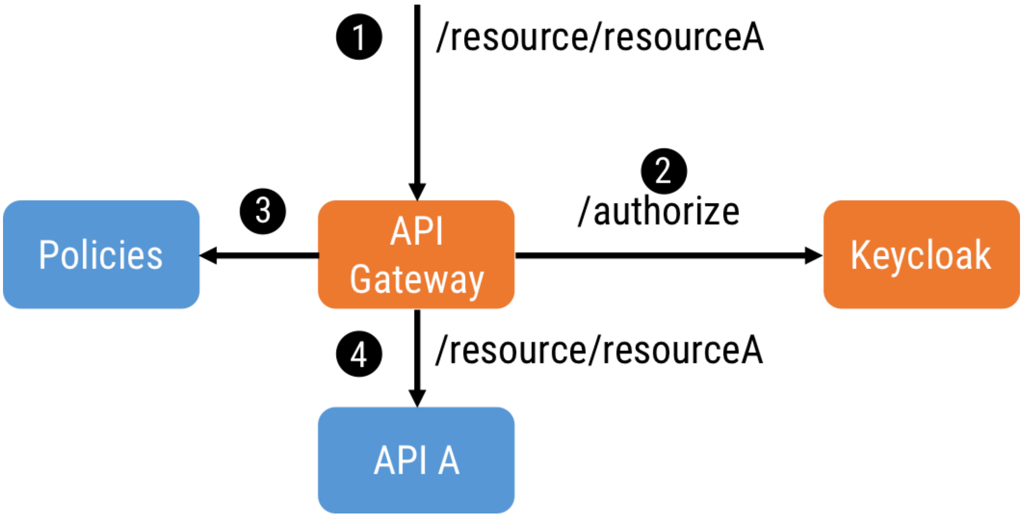
1. When an API request is generated by a client

[4] https://www.keycloak.org

[5] https://gravitee.io

2. The token for the specific Application/Client is checked at Keycloak OAuth 2.0 API
3. If the token is valid (i.e. authenticated and authorized for a given OAuth client), the policy extracts from the token the list of tenants and verifies that the requested tenant space is included in the ones accessible.

In case of success, the call will be forwarded to the API in the backend (if not, the user will be returned a 401 “Not Authorized” response).



Data Management

The core of the data management is a “data bus” collecting data from the different sources and forwarding them to the different backend APIs based on the specific scenarios. This “data bus” is provided by Orion Context Broker[6], the reference implementation for a NGSIv2 broker. All data used in the platform transits through it: IoT Devices data, External services data, Platform generated data.

Orion Context Broker supports different interaction modes. Services can provide data to the Orion Context Broker with the following modality:

- Data Push: services send data to it.
- Data Pull: services expose data via a standard API, that the Orion Context Broker queries to retrieve data.
- Services can obtain data with the following modality:
    - Data Subscription: services subscribe to a given data and get notified when the data is updated.
    - Data Query: services query the Orion Context Broker to retrieve data.

These interaction modes provide a very flexible way to integrate data provider (e.g. sensors) and data processing services (e.g. analytics). In the case of IoT Agent, as discussed in the following section, the recommended solution is the

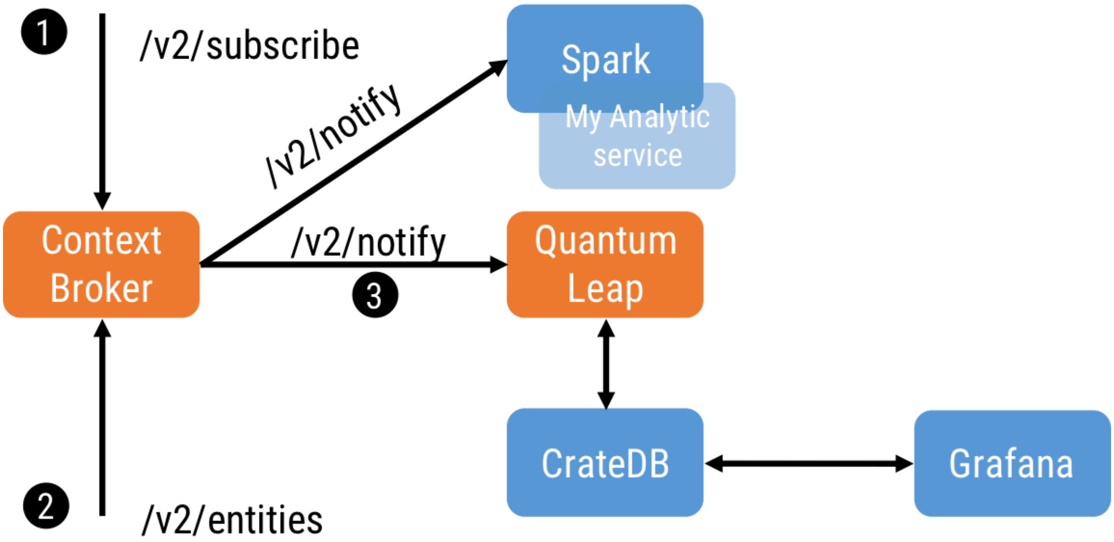
[6] https://fiware-orion.readthedocs.io/en/master/

Data Push model (however the Data Pull model is also supported), since this allows constantly up-to-date data in the Orion Context Broker that can be used to generate Data Subscriptions.

The other core component of the Data Management layer is the Timeseries API. The role of this component is to store all the historical data of a given entity (Orion Context Broker stores only the current value in time of a data). The Timeseries API will be provided by Quantum Leap[7], an NGSIv2 compliant time series API. Quantum Leap supports as backend CrateDB, which is also supported by Grafana (see next section) to generate dashboards. QuantumLeap supports a variety of queries (including geographical-based), facilitating the access to historical data by services in need of working on batch data sets.

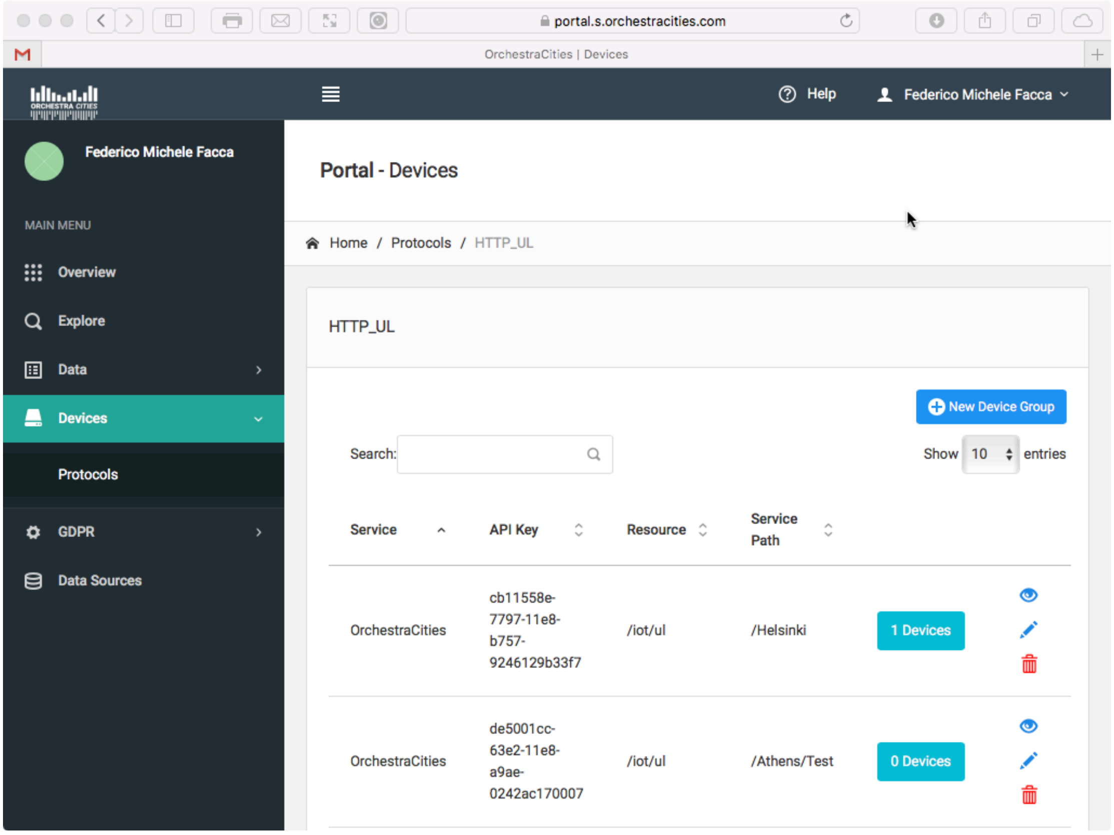
In short, the process will work as follows:

1. A subscription is created for each data model (e.g. Weather), to get notifications forwarded to the Timeseries API service (e.g. Quantum Leap)
2. Data of entities matching the created subscription gets updated in the Context Broker
3. Notifications are sent to the subscribed services (e.g. Quantum Leap). Each notification includes the whole data model (or a fragment, depending on the subscription created).
4. The subscribed service processes it using its logic (in the case of Quantum Leap, it stores the received data in CrateDB).



[7] https://quantumleap.readthedocs.io

Device Management



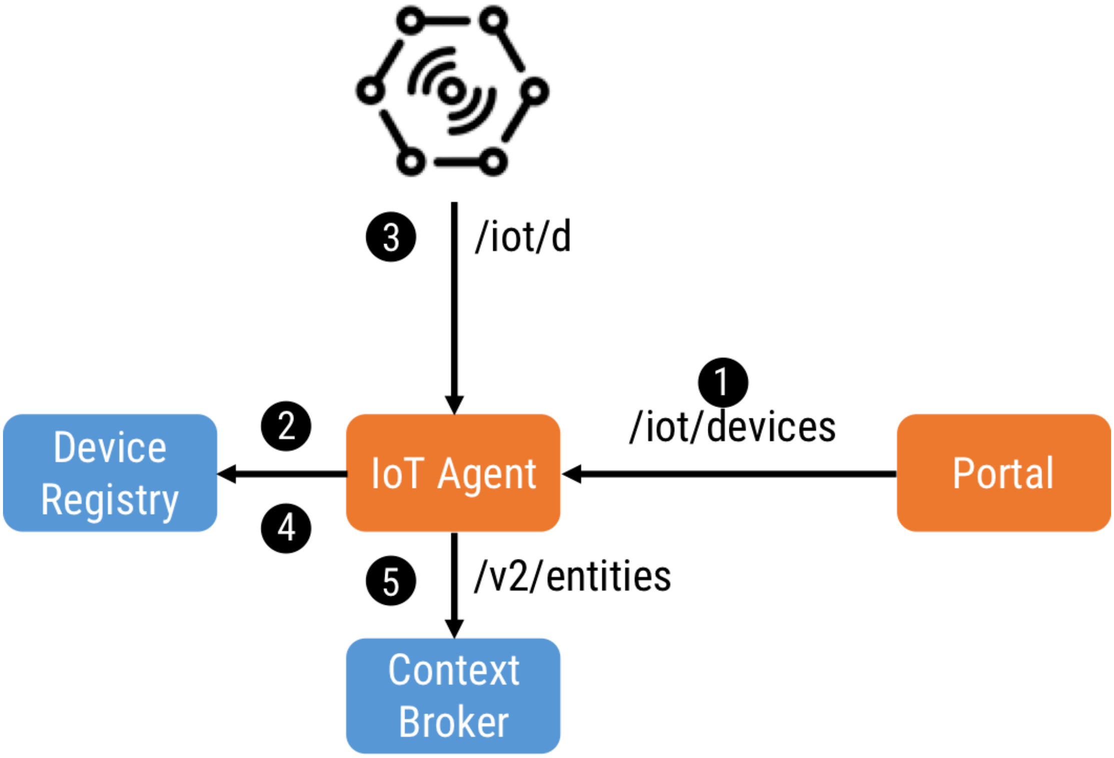
Service	API Key	Resource	Service Path		
OrchestraCities	cb11558e-7797-11e8-b757-9246129b33f7	/iot/ul	/Helsinki	1 Devices	
OrchestraCities	de5001cc-63e2-11e8-a9ae-0242ac170007	/iot/ul	/Athens/Test	0 Devices	

To manage the IoT devices, Orchestra Cities leverages FIWARE stack and hence the NGSIv2 API and data format. FIWARE offers a wide range of so-called IoT Agents. Each IoT Agent enables different transport and message protocols to be used to connect IoT Devices. Orchestra Cities covers all protocols supported by FIWARE (UL, JSON, LOWARAN), being the recommended one UL, a very lightweight message protocol (e.g. attribute1|value1|attribute2|value2 becomes t|10|s|true|l|78.8) that supports MQTT, AMQP or HTTP transports. The IoT Agent role is to map low level messages generated by the device to higher level information used at the so-called application layer and to forward the structured and aggregated information to the data management layer of the platform. FIWARE IoT Agents support the concept of “device groups”, i.e. a set of devices sharing the same information model. This facilitates the registration of a large set of devices that provides the same information, which would otherwise have required the user to configure one-by-one with device-specific information (if required at all).

To facilitate the registration of IoT Devices within IoT Agents, we provide an UI, thus simplifying the overall operation. The process will work as follow:

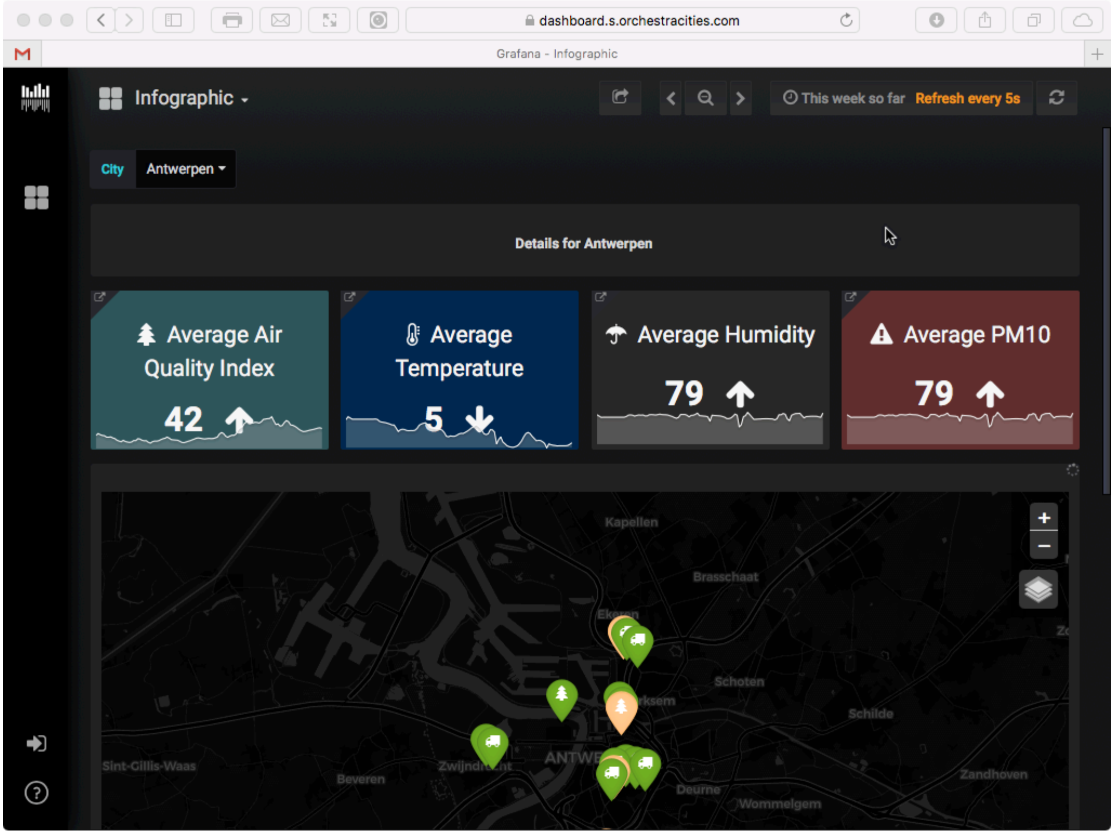
1. Through the portal (or the API) a user can register a device
2. The device configuration (which includes for example the transport, besides the attribute mapping discussed above) is stored in the device registry for later use

3. Once configured, the device can send messages to the agent (in the picture, the HTTP transport is assumed)
4. When receiving a payload, the Agent checks the configuration of the device to transform the incoming “simple” message into the NGSIv2 payload
5. Finally, the Agent sends the NGSIv2 payload to the Context Broker



Dashboard Management

To allow the creation of custom dashboards, we use an open-source dashboard engine called Grafana, an open platform for beautiful analytics and monitoring. This technology integrates a set of “panels” that provides support for rendering objects such as lines, points, bars and heat graphs, basic maps with info pointers, picture panels and more useful panels to display any kind of data. It also includes a collection of data-source plugins, that allows it to integrate Grafana with different databases and backends such as Crate (the back-end of Quantum Leap), JSON, and Google calendar. Grafana aims to provide an easy and intuitive way for public officers to monitor different KPIs of their city. This dashboard can run on multiple end-user devices without installation and provides good responsiveness for the dimensions of desktop screens, mobile phones and tablets. Also, it can show online historical data while filtering and sorting data dynamically. The data can be zoomed in to have fine-grained views of values or the same data can be seen in a Tabular format, allowing users to sort data by different column values. The ability to present maps with information points allows cities to visualize in real-time all the data that is being collected by the sensors. Besides that, cities are able to define actions based on the information and events of the dashboards and create alerts based on data thresholds; for example set an alert when a waste bin is on fire. Dashboards can be easily shared, customized and embedded in other tools.



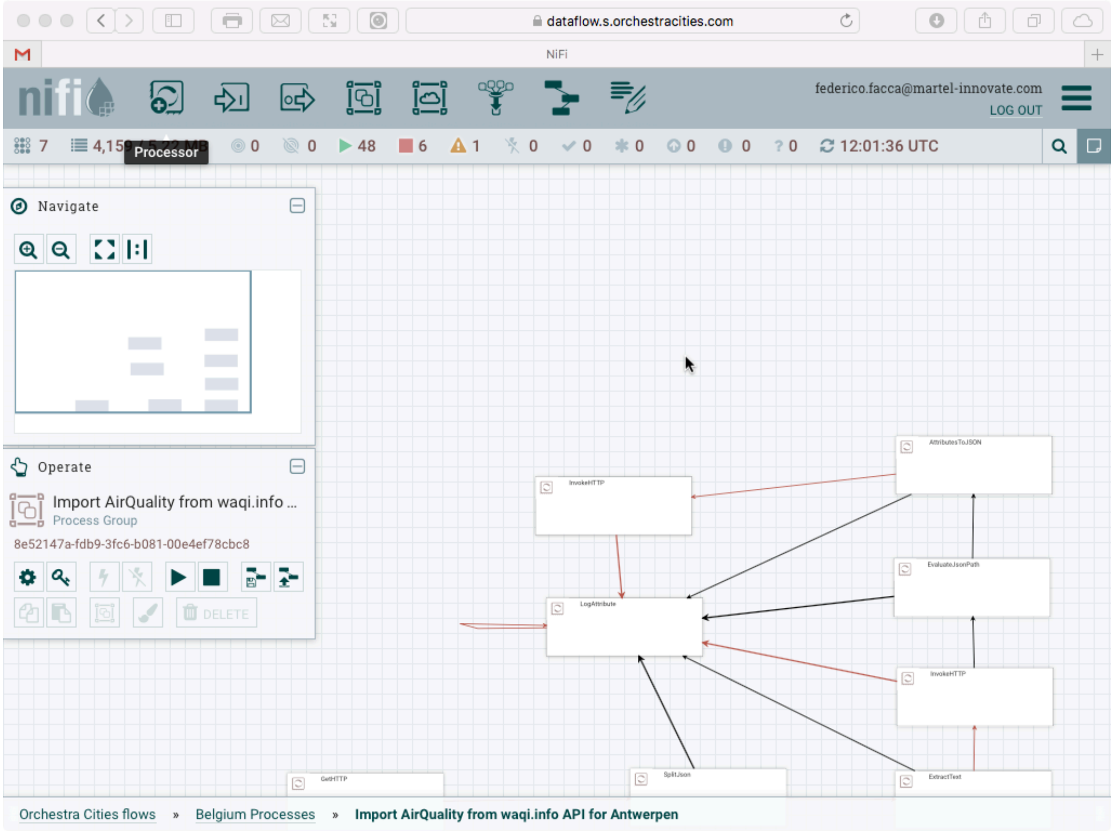
Analytics

While the dashboard can provide simple real-time analytics, for more complex tasks we integrated an Apache Spark[8] cluster in the platform. The cluster, integrated to the Data Management layer, enables the analysis of a data set (e.g. Weather forecast) whether they are real-time and/or historical data.

Data Integration

To integrate external services and data sources, Orchestra Cities currently leverages on Apache NIFI. This tool allows the creation of visual workflows for data injection into the platform. Workflows support web services, files and other sources and can be saved to replicable templates so that different cities can instantiate and customise their own data import flow for a given service.

[8] https://spark.apache.org



Open Standards

Orchestra Cities relies on different Open Standards that facilitates the integration with existing solutions.

Security	OAUTH 2.0, OIDC, SAML, KERBEROS, LDAP, X.509
IoT	Protocols: UL, JSON, LWM2M Transport: HTTP, COAP, MQTT, AMQP, LORAWAN
Data Exchange	Protocols: JSON/REST, XML/SOAP, FTP/HTTP, WEBSOCKETS Data format: NGSI, JSON, GEOJSON, CSV, EXCEL, TEXT
Cloud	Docker, Kubernetes

“If everyone is moving forward together, then success takes care of itself.„

Michael Jordan

3. Roadmap

Orchestra Cities is under active development, these are some of the features we plan to work on in 2019.

New release of the Orchestra Cities portal, with integrated management for: devices, entities, historical data, users.

Live City: a City-Centric App to display pre-cooked scenarios to help the management of cities. E.g. status of waste bins, parking, …

Deep Learning API: an early stage demonstrator to show how Machine Learning can be applied to create models and data forecasts in Orchestra Cities.

Simplified Data Flow design leveraging StreamSets

Improved integration with CKAN

> *“Some people want it to happen,*
> *some wish it would happen,*
> *others make it happen. „*
>
> *Henry Ford*

4. Our Partners

To develop our solutions and to test them we have worked and continue to work with a number of selected partners.

Atos
FIWARE
redhat
Telefónica
Gravitee Source
ubiwhere
hop ubiquitous

Solutions have been tested in POC with

Wolfsburg
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