SNAP4CITY

www.snap4city.org
www.snap4solutions.org

www.km4city.org

Data Ingestion and Interoperability

Nov. 2023, Course, Part 5

https://www.snap4city.org/944
https://www.snap4city.org/577

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DIGITAL TWIN SOLUTIONS TO SETUP SUSTAINABLE DECISON SUPPORT SYSTEMS AND BUSINESS INTELLIGENCE

UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

Paolo Nesi, paolo.nesi@unifi.it
https://www.Km4City.org
https://www.disit.org

SNAP4CITY

KM4CITY

SNAP4 Appliances and Dockers Installations

Be smart in a SNAP!

SMARTCITY EXPO WORLD CONGRESS
7-9 November 2023, Barcelona, Spain
Visit Snap4City in Hall 1

Data Ingestion and Interoperability

Data Analytic

Nov. 2023, Course, Part 5

https://www.snap4city.org/944
https://www.snap4city.org/577

100% OPEN SOURCE

EU GDPR COMPLIANT

PEN Test Passed

Powered by FIWARE

SNAP4CITY on EUROPEAN OPEN SCIENCE CLOUD MARKETPLACE

Node-RED

SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES

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Smart Solutions and Decision Support Systems

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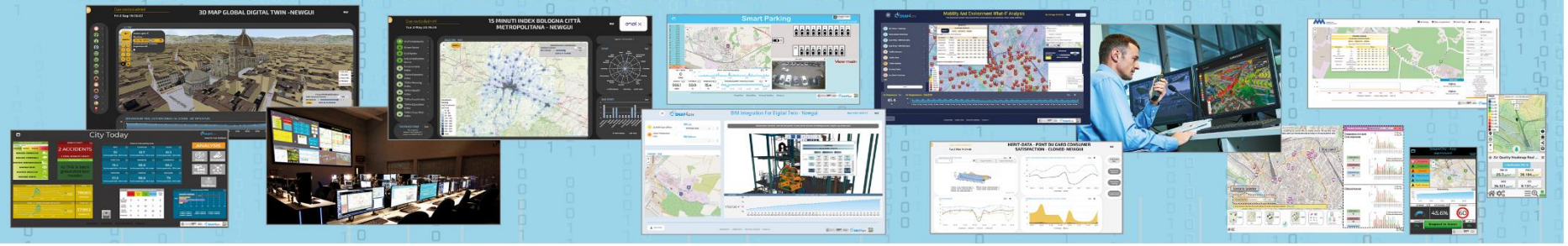
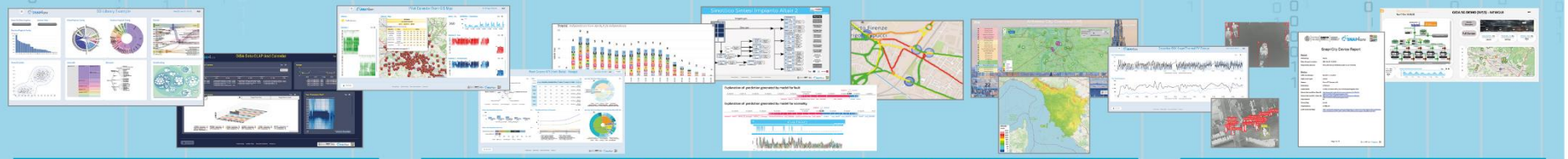
CONTROL ROOMS - DECISION SUPPORT SYSTEMS - WHAT-IF ANALYSIS - BUSINESS INTELLIGENCE - SIMULATIONS - SMART APPLICATIONS



DASHBOARDS - VISUAL ANALYTICS - SYNOPTICS - DIGITAL TWIN - GRAPHICAL WIDGETS - ANALYTICS - GUI CUSTOM STYLES - VISUAL PROGRAMMING

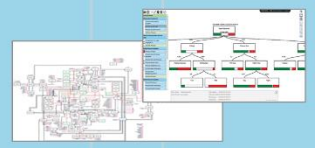


DASHBOARDS, WIDGETS
TEMPLATES

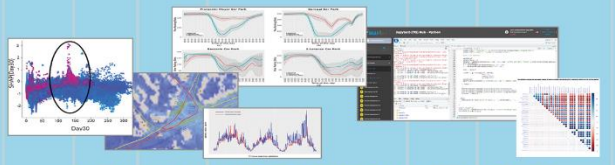
PREDICTION - ANOMALY DETECTION - CLUSTERING - ROUTING - SENTIMENT NLP - TRAFFIC FLOW
PEOPLE FLOWS - SDG - 15 MIN CITY INDEX - KPI - HEATMAPS - ORIGIN DESTINATION - ETC...

API - MICROSERVICES - GIS - BPM
VIDEO - REPORTS - MAPS - 3D ...

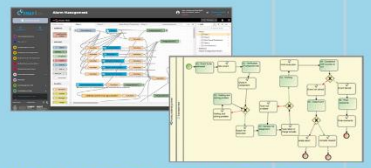
ANY: DATA, BROKER, NETWORK AND VERTICAL



EXPERT SYSTEM, KNOWLEDGE BASE
SEMANTIC REASONING
SMART DATA MODEL
IOT DEVICE MODELS, STORAGE



BIG DATA ANALYTICS, ARTIFICIAL INTELLIGENCE
EXPLAINABLE AI, MACHINE LEARNING
OPERATIVE RESEARCH, STATISTICS

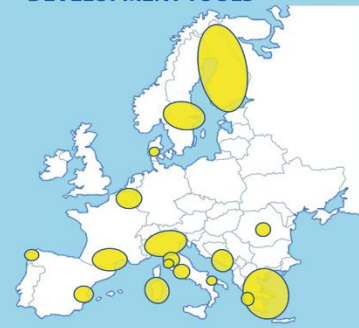


VISUAL PROGRAMMING, ADAPTERS
DATA FLOWS, WORKFLOWS
PARALLEL DISTRIBUTED PROCESSING
EVENT DRIVEN

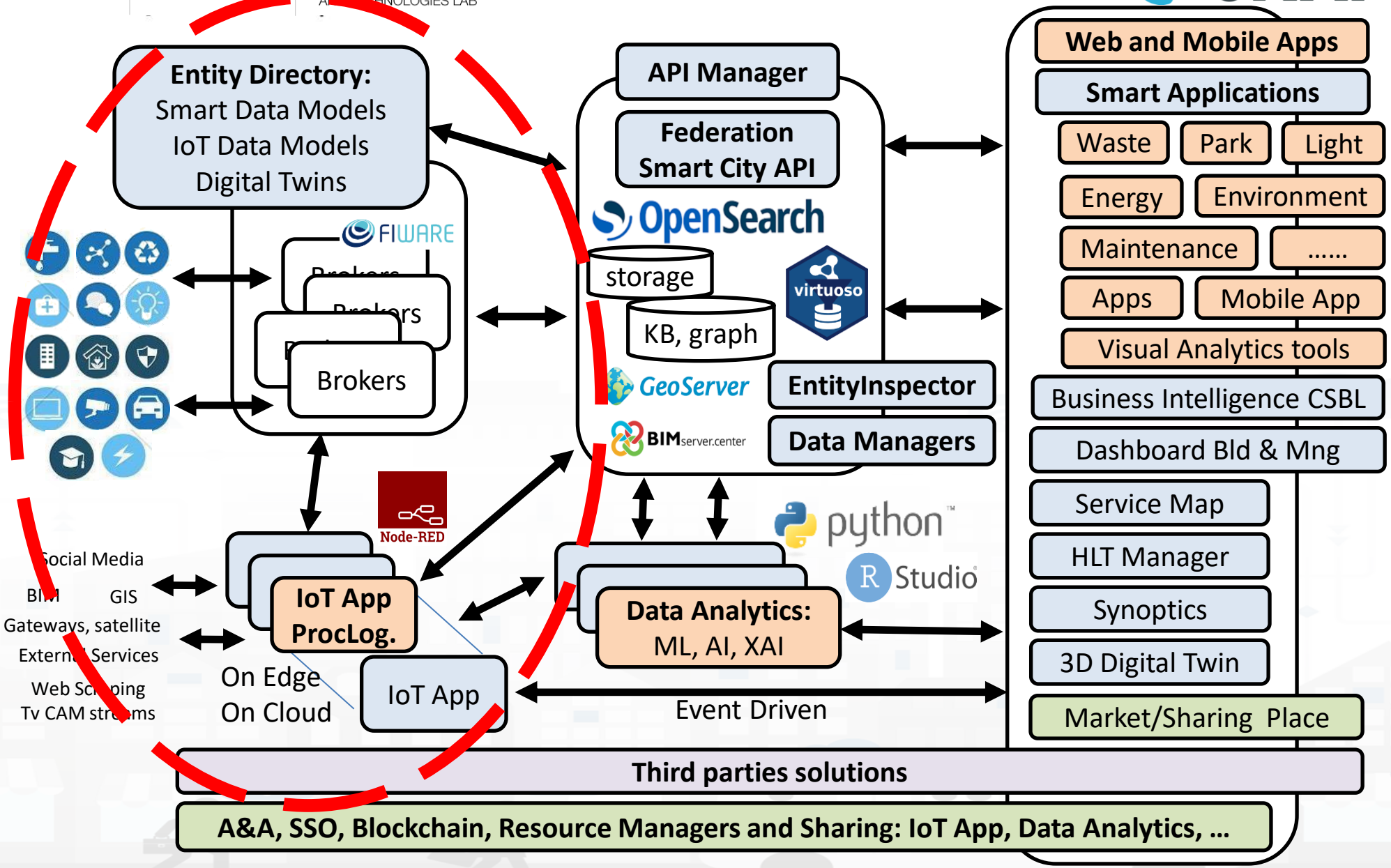
Native and External Smart Applications

- Mobility & Transport
- Light & Energy
- Waste
- Environment
- Building
- Tourism
- Asset Management
- Security and Safety
- Social Media
- ...

METHODOLOGIES
LIVING LABS
COURSES AND COMMUNITY
DEVELOPMENT TOOLS



Tech Arch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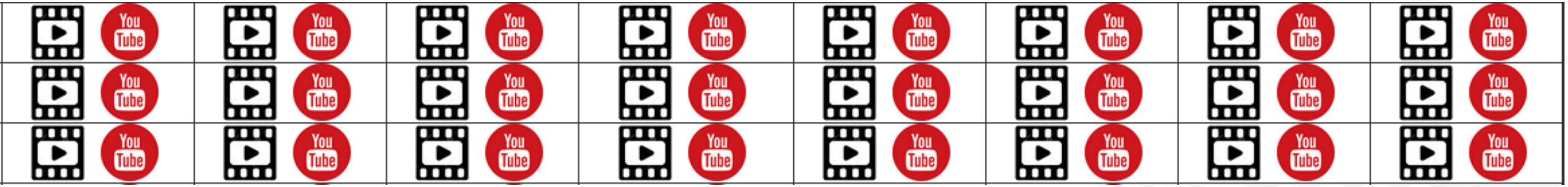
Synoptics
3D Digital Twin
Market/Sharing Place
Third parties solutions
A&A, SSO, Blockchain, Resource Managers and Sharing: IoT App, Data Analytics, …

https://www.snap4city.org/944

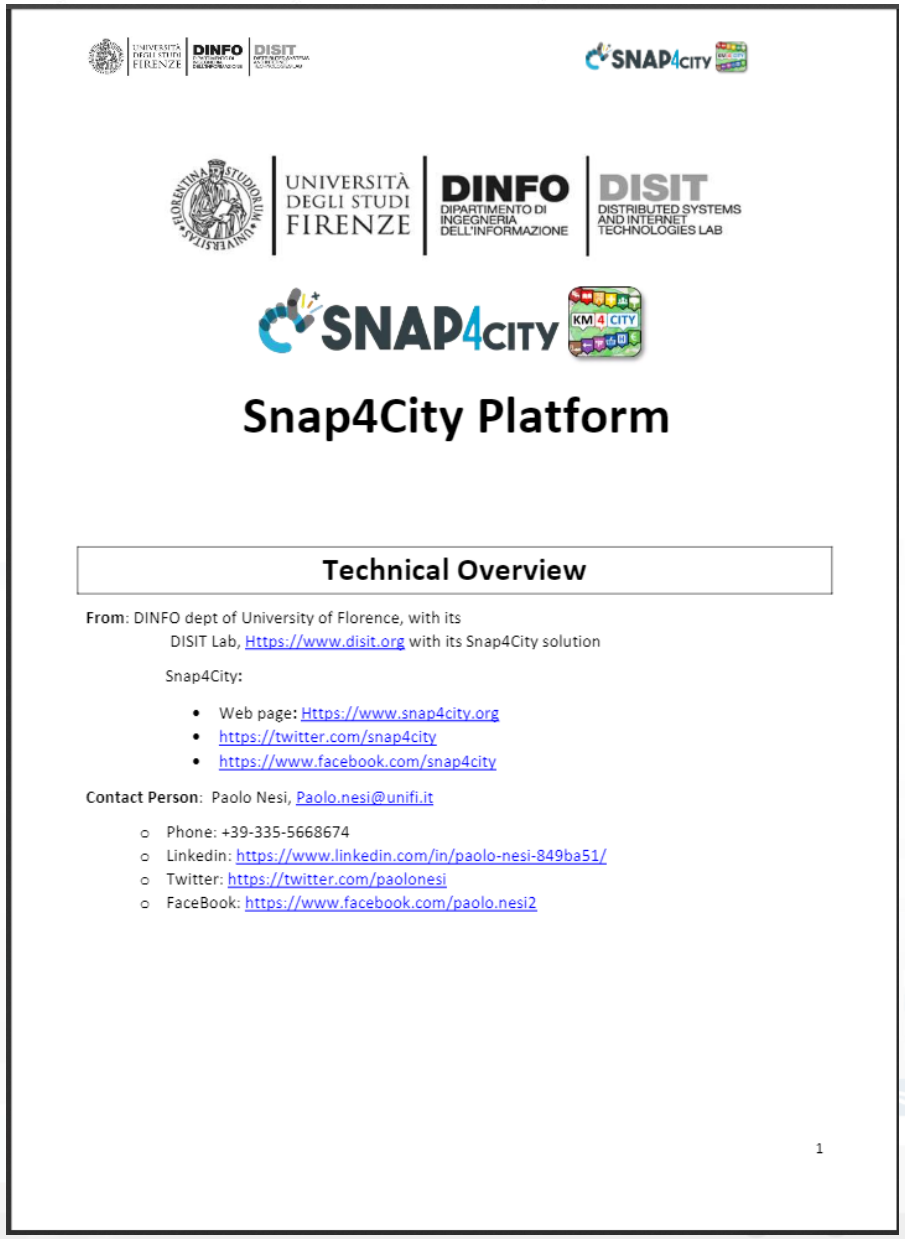
On Line Training Material (free of charge)

1st part	2nd part	3rd part	4th part	5th part	6th part	7th part	8th
Overview	Dashboards	IOT App, IOT Network	Data Analytics	Data Ingestion processes	System and Deploy Install	Smart City API: Web & Mob. App	Design and Develop Smart Solutions
							
							



Note on Training Material

- **Course 2023**: https://www.snap4city.org/944
  - Introductionary course to Snap4City technology
- **Course** https://www.snap4city.org/577
  - Full training course with much more details on mechanisms and a wider set of cases/solutions of the Snap4City Technology
- **Documentation** includes a deeper round of details
  - Snap4City Platform Overview:
    - https://www.snap4city.org/drupal/sites/default/files/files/Snap4City-PlatformOverview.pdf
  - Development Life Cycle:
    - https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf
  - Client Side Business Logic:
    - https://www.snap4city.org/download/video/ClientSideBusinessLogic-WidgetManual.pdf
- **On line cases and documentation**:
  - https://www.snap4city.org/108
  - https://www.snap4city.org/78
  - https://www.snap4city.org/426



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Snap4City Platform

Technical Overview

From: DINFO dept of University of Florence, with its
DISIT Lab, Https://www.disit.org with its Snap4City solution

Snap4City:

- Web page: Https://www.snap4city.org
- https://twitter.com/snap4city
- https://www.facebook.com/snap4city

Contact Person: Paolo Nesi, Paolo.nesi@unifi.it

- Phone: +39-335-5668674
- Linkedin: https://www.linkedin.com/in/paolo-nesi-849ba51/
- Twitter: https://twitter.com/paolonesi
- FaceBook: https://www.facebook.com/paolo.nesi2

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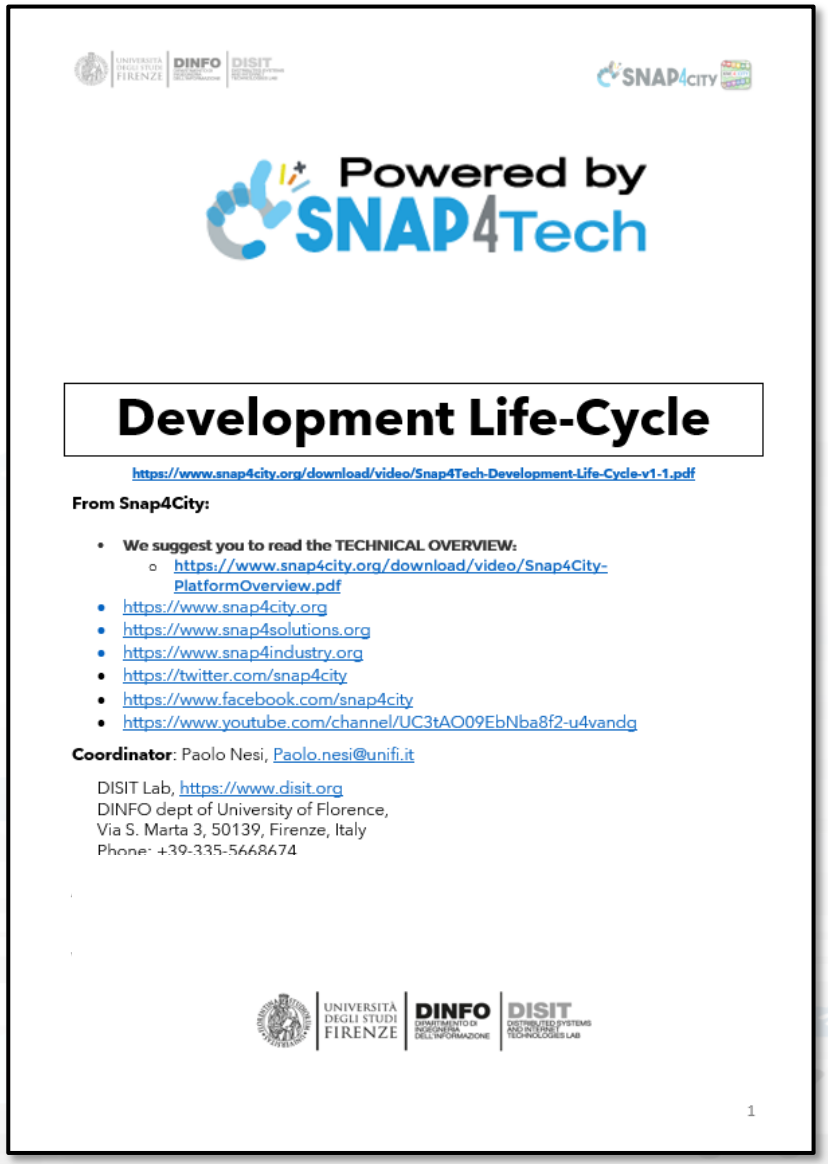
Tech Overview

- https://www.snap4city.org/drupal/sites/default/files/files/Snap4City-PlatformOverview.pdf

Development



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Development Life-Cycle

https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle-v1-1.pdf

From Snap4City:

- **We suggest you to read the TECHNICAL OVERVIEW:**
  - https://www.snap4city.org/download/video/Snap4City-PlatformOverview.pdf
- https://www.snap4city.org
- https://www.snap4solutions.org
- https://www.snap4industry.org
- https://twitter.com/snap4city
- https://www.facebook.com/snap4city
- https://www.youtube.com/channel/UC3tAO09EbNba8f2-u4vandg

Coordinator: Paolo Nesi, Paolo.nesi@unifi.it

DISIT Lab, https://www.disit.org
DINFO dept of University of Florence,
Via S. Marta 3, 50139, Firenze, Italy
Phone: +39-335-5668674

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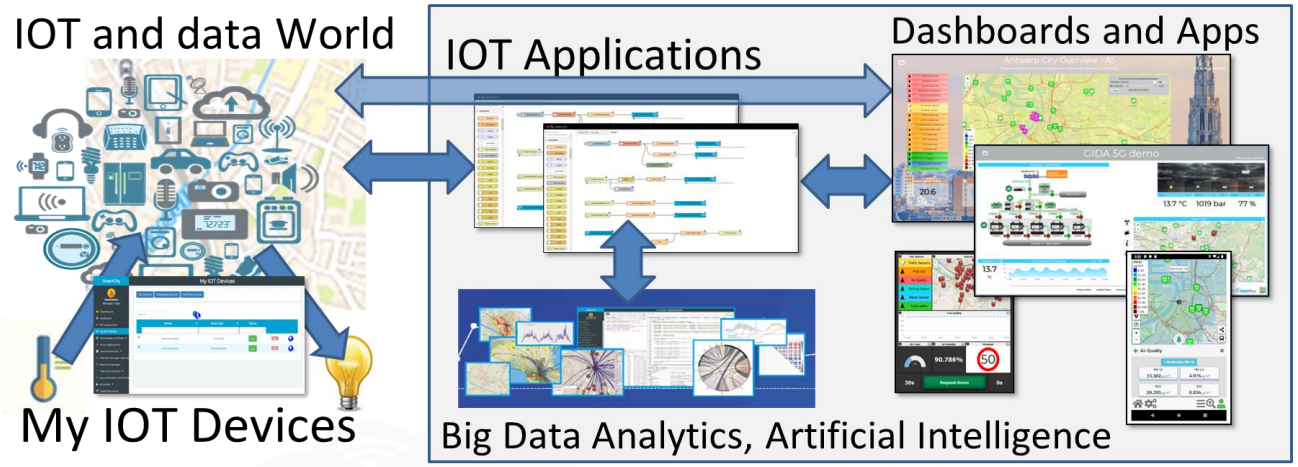
https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf

Free Trial

- Register on WWW.snap4city.org
  - Subscribe on **DISIT Organization**
- **You can:**
  - Access on basic Tools
  - Access to a large volume of Data
  - Create Dashboards
  - Create IOT Applications
  - Connect your IOT Devices
  - Exploit Tutorials and Demonstrations



IF you need to go more in deep you can ask us to pass at the next Role becoming full AreaManager with full rights of development, also for Data Analytics, machine learning, etc.

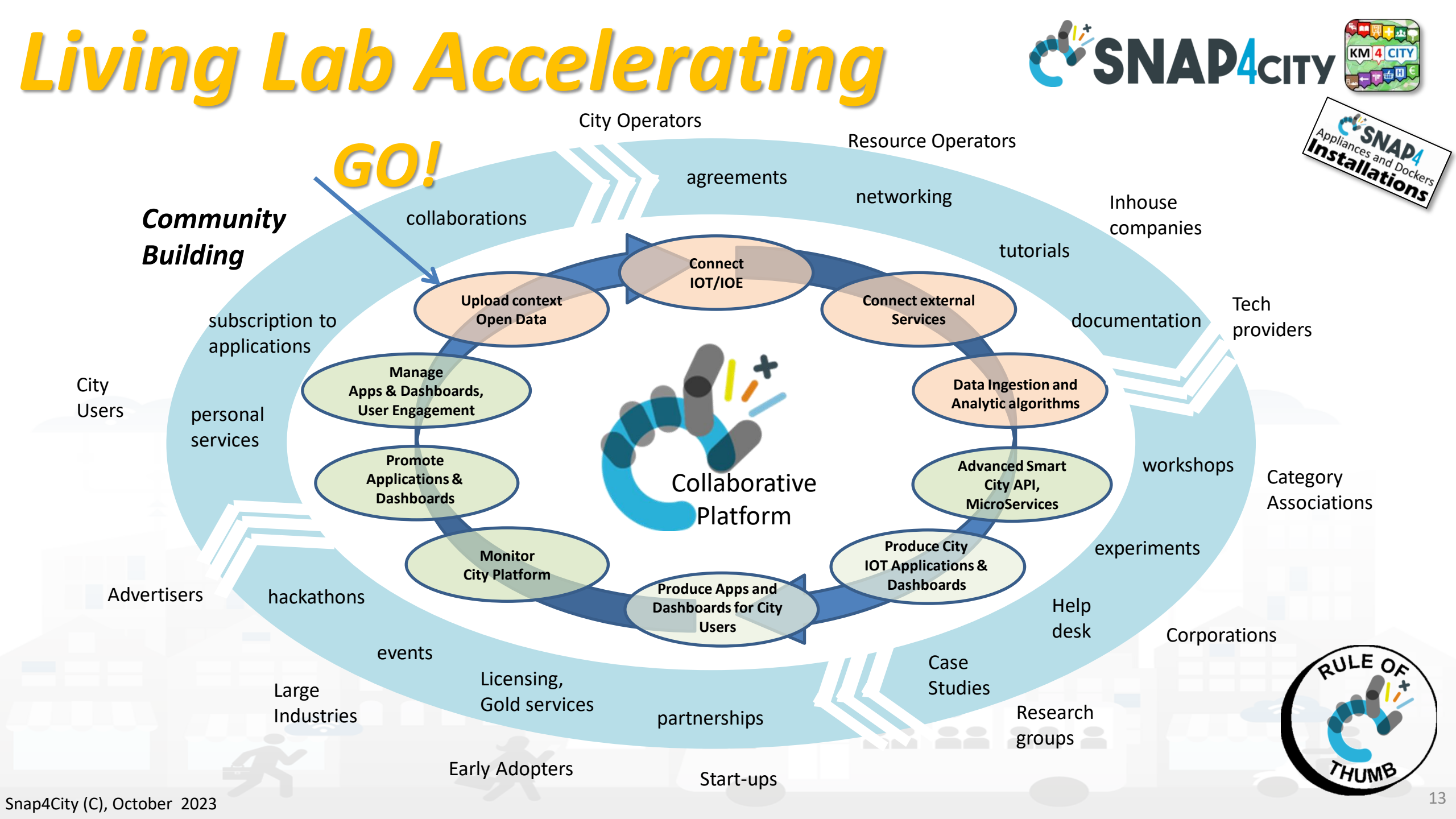
Agenda of Part 5

- When Solutions and tools for Data Ingestion and Interoperability are needed
- Overview of Snap4City Data Storage and Stack
- Knowledge Base: Modelling and Setting Up
- High Level Types vs Ingestion Process
- Data Ingestion Strategy and Orientation
- Ingestion of Points of Interest with POI Loader
- Models vs Devices/Entities and Registration
- Verification of Data Ingestion
  - Digital Twin Data Inspector vs Data Processes Details
  - My Data Dashboard Dev to assess data on Open Search Storage
- An Integrated Example for Time Series
- Entities Ingestion with Data Table Loader
- High Performance Ingestion via Python
- FIWARE Smart Data Models on Snap4City
- Ingestion of MyKPI with Proc.Logic / IoT App
- Training Material

TOP

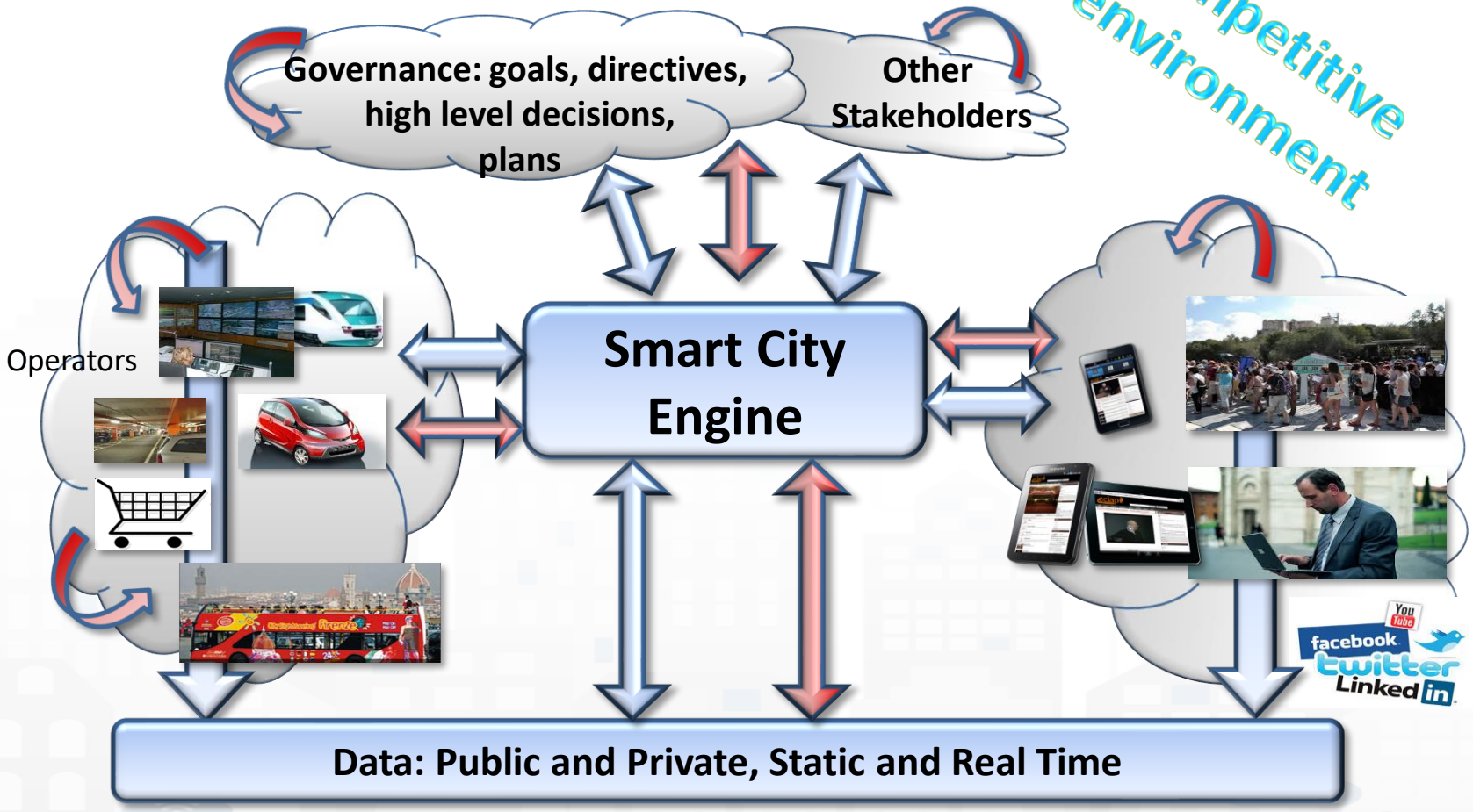
When Solutions and tools for Data Ingestion and Interoperability are needed

Living Lab Accelerating

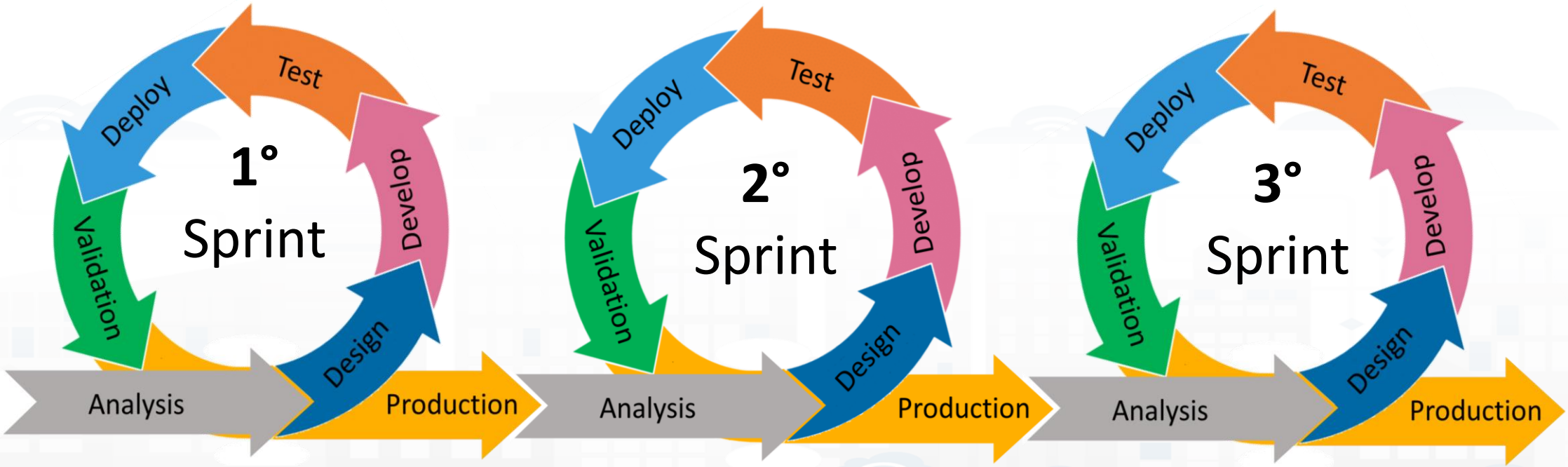


From Strategies to (re-)Actions

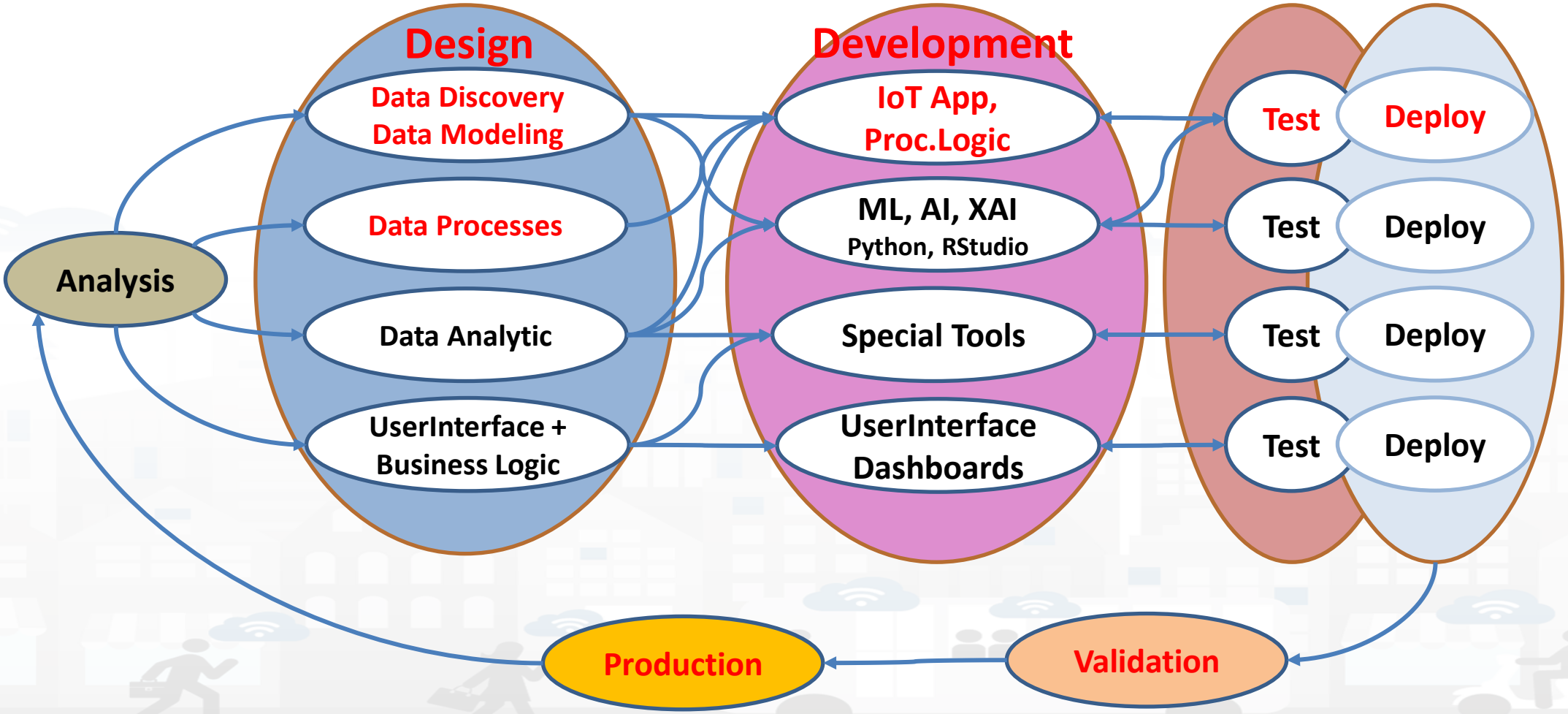
- Analyze
- Alerting, Early Warning
- Support Decision makers
- Plans
- Prescriptions
- Inform
- Suggest
- Engage
- Research



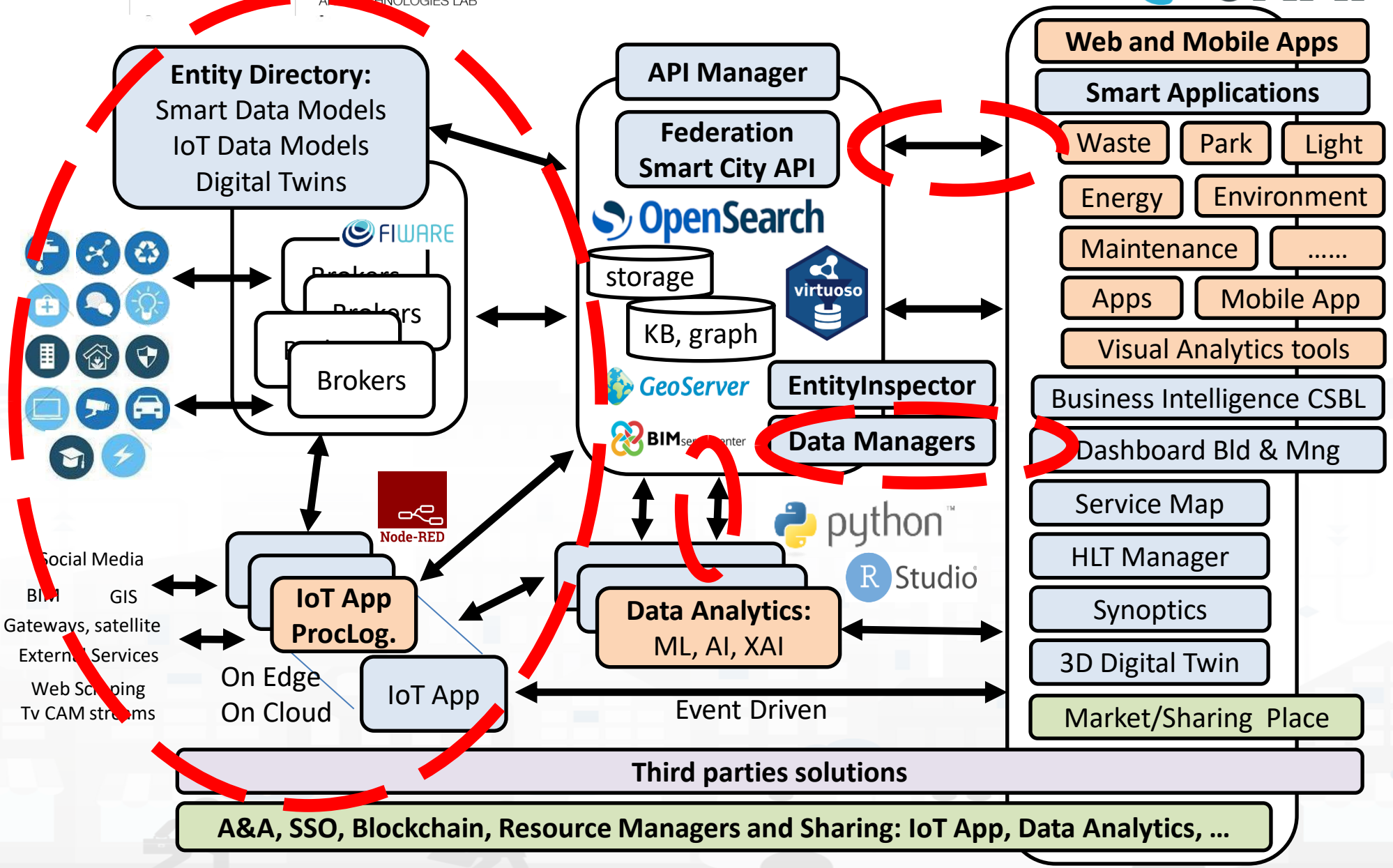
Agile Development Life Cycle by sprint Smart Solutions



Development Life Cycle Smart Solutions



Tech Arch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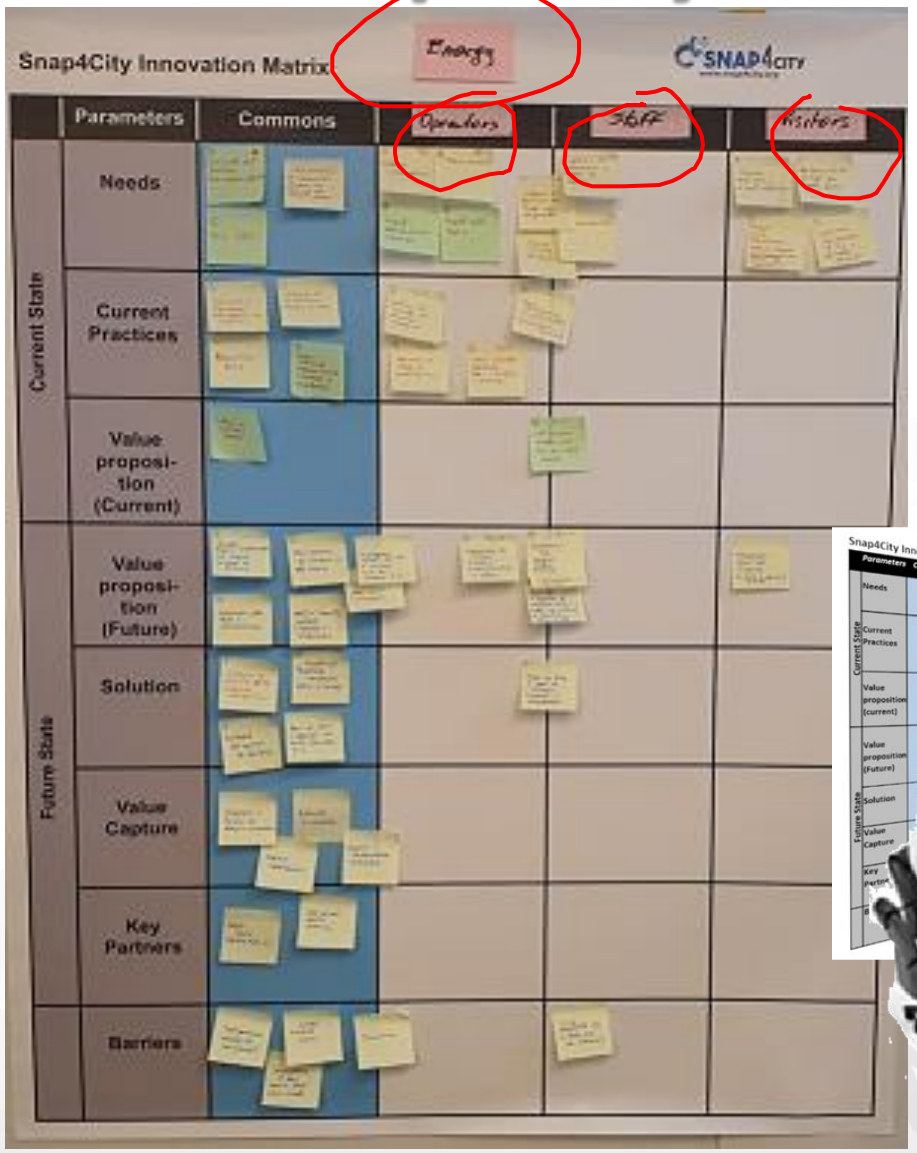
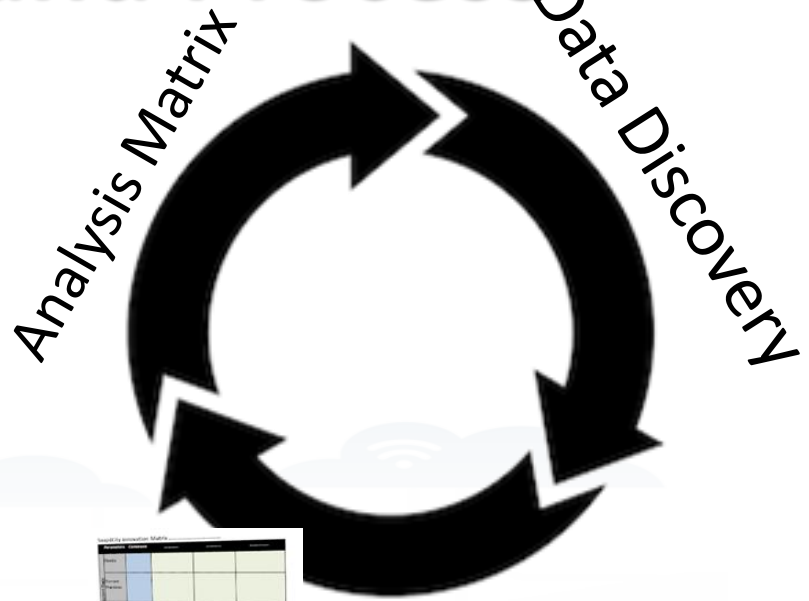
Business Intelligence CSBL
Dashboard Bld & Mng
Service Map
HLT Manager
Synoptics
3D Digital Twin
Market/Sharing Place
Third parties solutions
A&A, SSO, Blockchain, Resource Managers and Sharing: IoT App, Data Analytics, ...

Snap4City Innovation Matrix and Process





see Course Part 6

Data vs Smart Services enabling on Snap4City

- **Public Transportation and mobility activated services in some where with Snap4City**
  - **Smart parking** (parking locations, real time parking data, traffic, meteo) → predictions
  - **Smart Fuel pricing** (fuel station locations and real time prices)
  - **Routing** (detailed GIS information, text indexing of streets, POI, etc.)
    - **Quite routing, perfect shopping, etc. etc**. (more data in needed….)
  - **multimodal routing** (detailed GIS information, Public transport time schedule)
  - **Info traffic** (traffic flow sensors, real time Traffic events, their localization, etc.)
  - **Dense info traffic** (traffic flow sensors and traffic flow reconstruction algorithm)
  - **Car/Bike/Scooter Sharing** (position and availability of Cars/Bikes, Scooters) … predictions
  - **Smart Biking** (cycling paths, environmental data) → predictions
  - **E-vehicles** (position, status of recharging stations,. …) … predictions vs booking
  - **Smart river crossing** (position and status of Underpass, Ferry) … prediction
  - **Quality of Public Transport** (actual time of arrival at the bus stops, wrt planned time schedule**)**
  - **Early Warning vs Resilience** (combination of several data including mobility, events, Social to perform early warning…)

Data vs Smart Services enabling on Snap4City

- **Social and Users Behaviour**
  - **Smart First Aid** (Location of First AID, real time status of triage)
  - **search for POI and public transport services** (POI geolocalized, spatial queries, along paths)
  - **Social Media Monitoring and acting** (Identification of dysfunction, quality of service perceived)
  - **Information to Tourists** (Entertainment Events)
  - **Early Warning, prediction of audience** (Twitter data, social media)
  - **Improvement of services for Tourists** (people flow, usage of services)

    (Origin Destination Matrices, trajectories, heatmaps)
    (People Monitoring, via App, Wifi, PAX Counter)
    (Twitter Data, social mea,….)

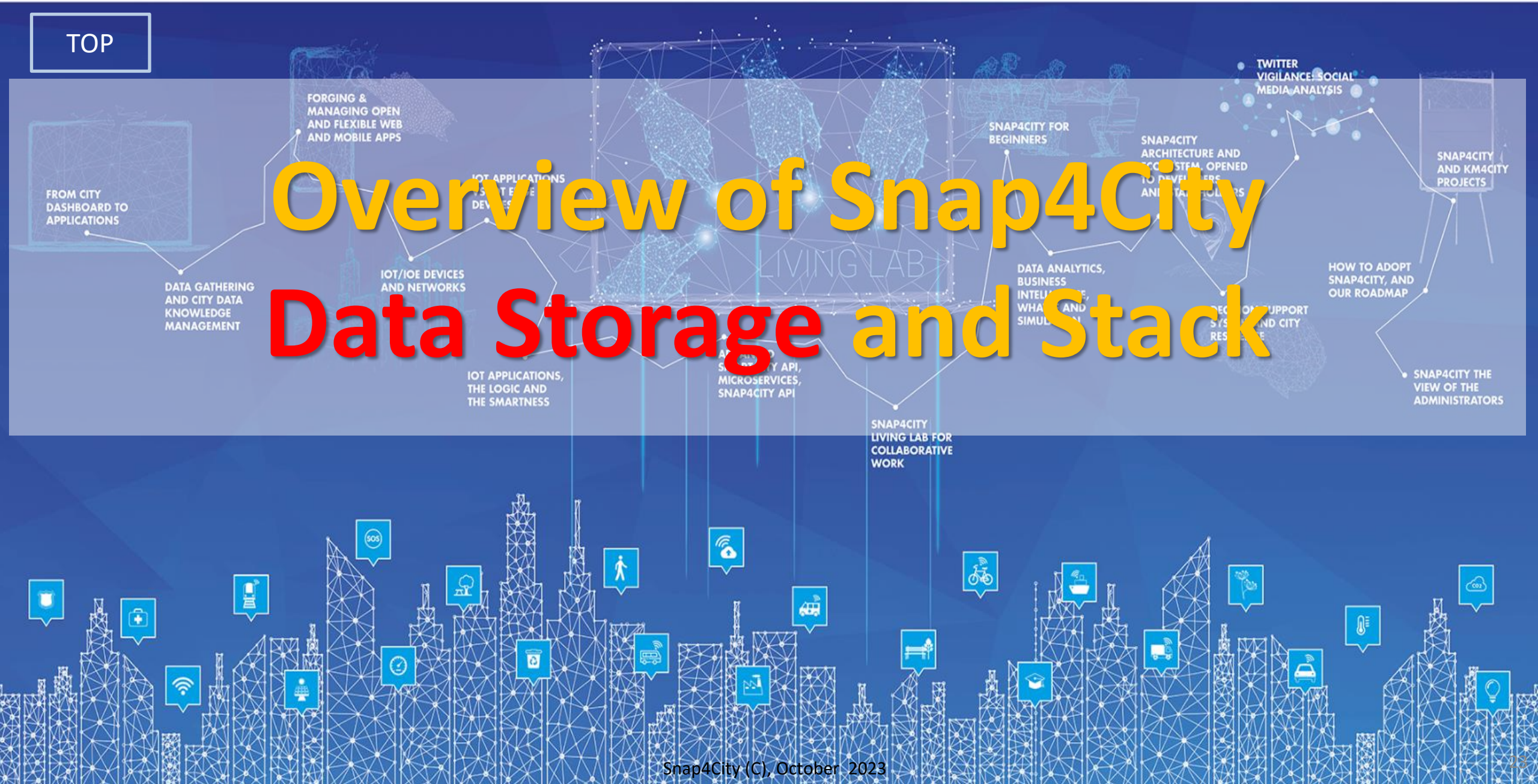
- **Weather and environment, quality of life**
  - **Weather forecast/condition** (Weather forecast)
  - **Air quality Pollution** (pollution sensors, PM10, PM2.5, NOX, etc.)
  - **Pollination** (Pollination sensors)
  - **Alerting on Air quality for multiple parameters** (Prediction of parameters time slots, notification)
  - **Information Heatmaps for weather and air quality** (air quality sensors, heatmaps, prediction)
  - **Air quality indexes, and forecast** (…….

Kind of Data Sources/channels

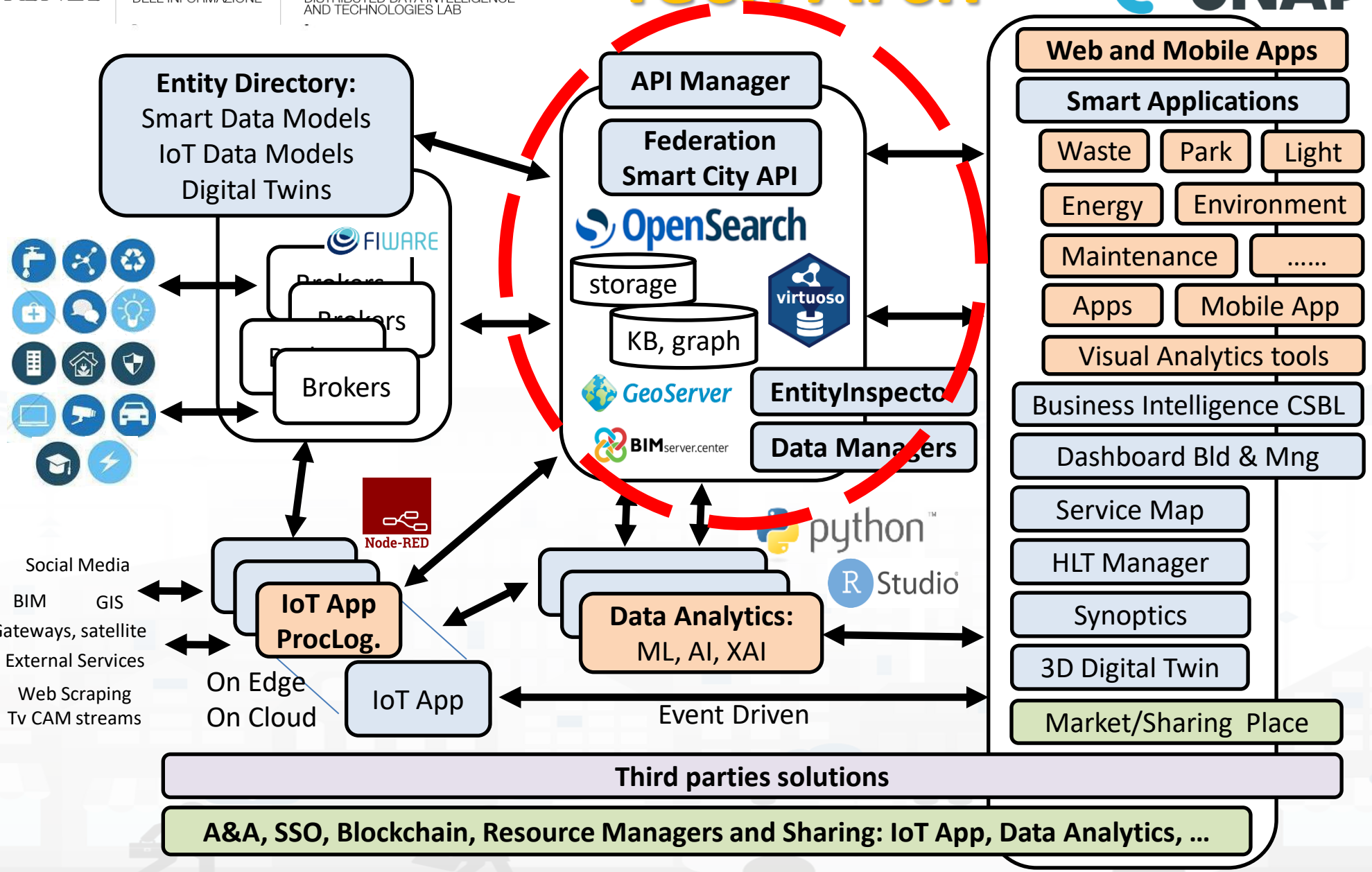
- **IoT Networks and/or devices** which
  - provide data in PUSH: Brokers, devices, etc.
  - receive data in PUSH to act on devices, via brokers, gateways, etc.
- **Gateways and Services** which provide data access from some API or other protocols in PULL
  - GIS, governmental servers, legacy servers, admin servers, …
  - Satellite, open data CKAN networks, …
  - third party services: Here, Vodafone, ...
  - some devices may be ready to provide data in PULL
- **Mobile Apps** which
  - get data in PULL from the smart city servers and
  - provide data in PUSH to the smart city servers
- **ETC…..**

TOP

Overview of Snap4City Data Storage and Stack



Tech Arch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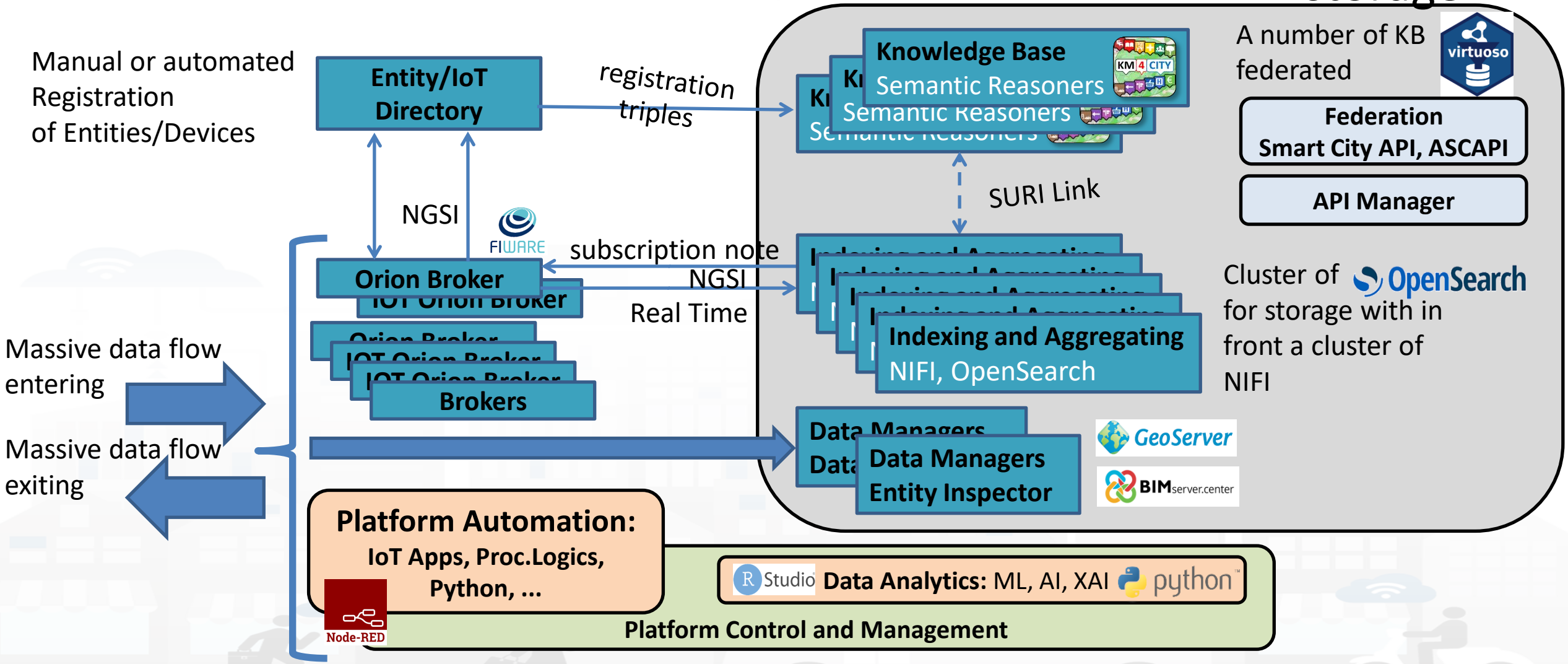
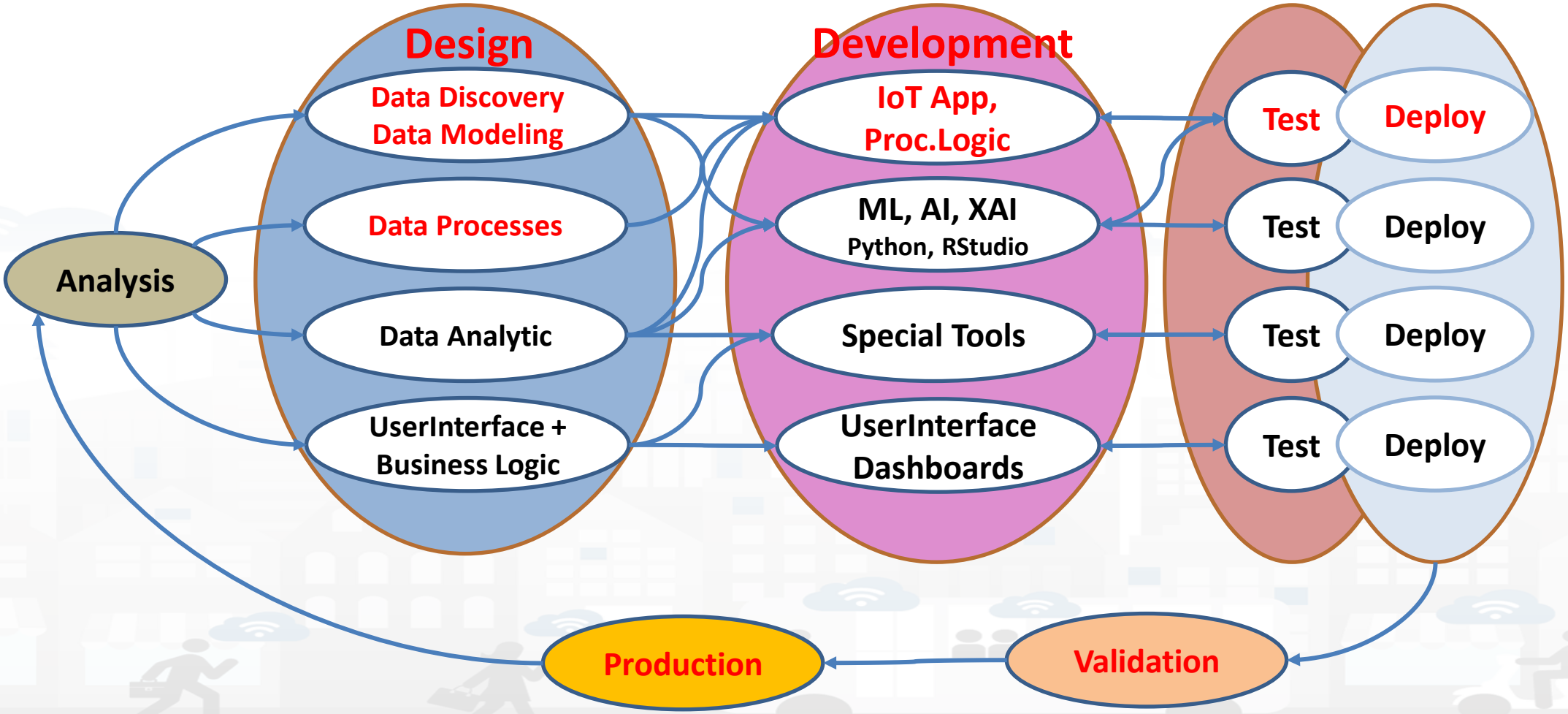
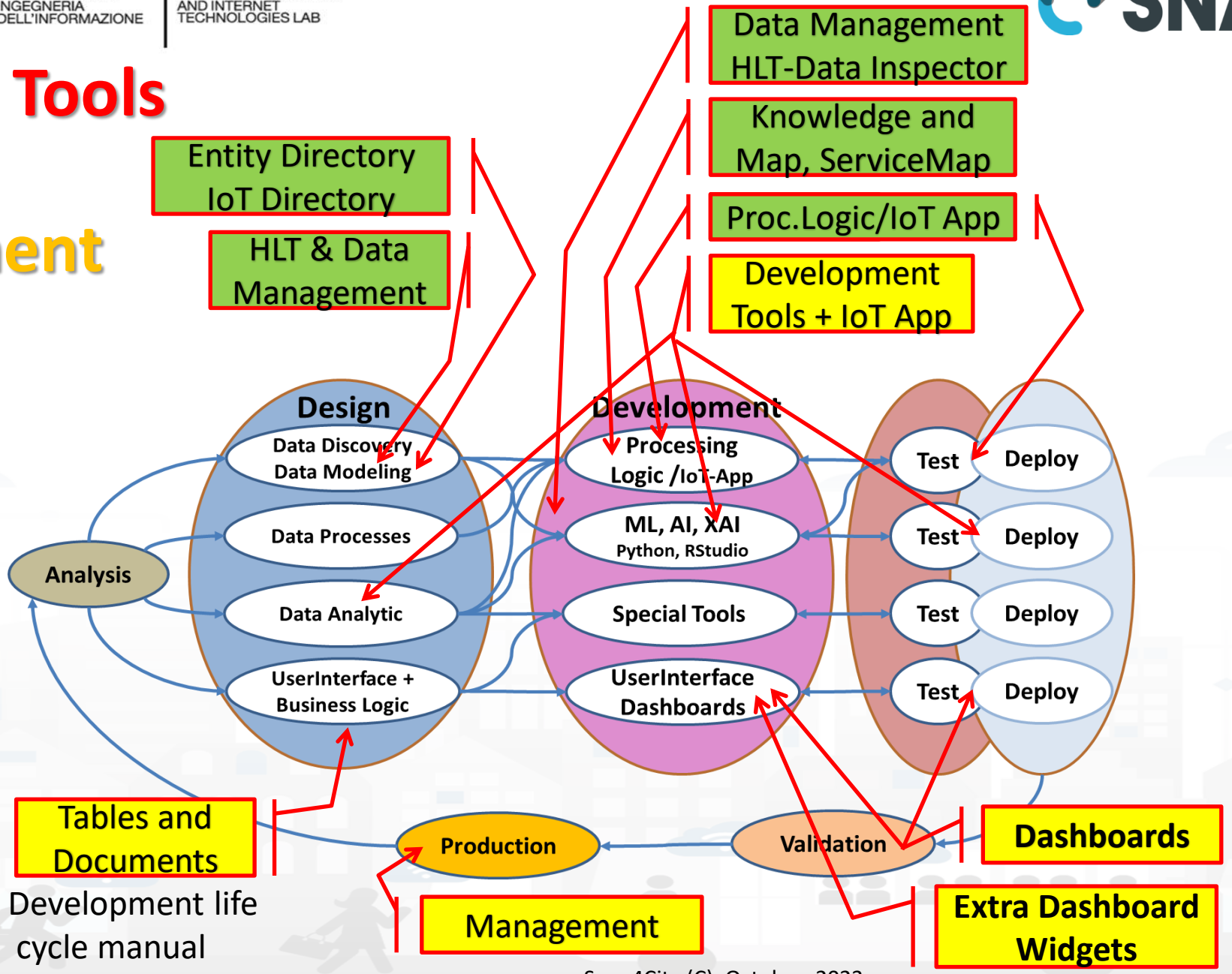
Snap4city Data Ingestion Diagram



Development Life Cycle Smart Solutions



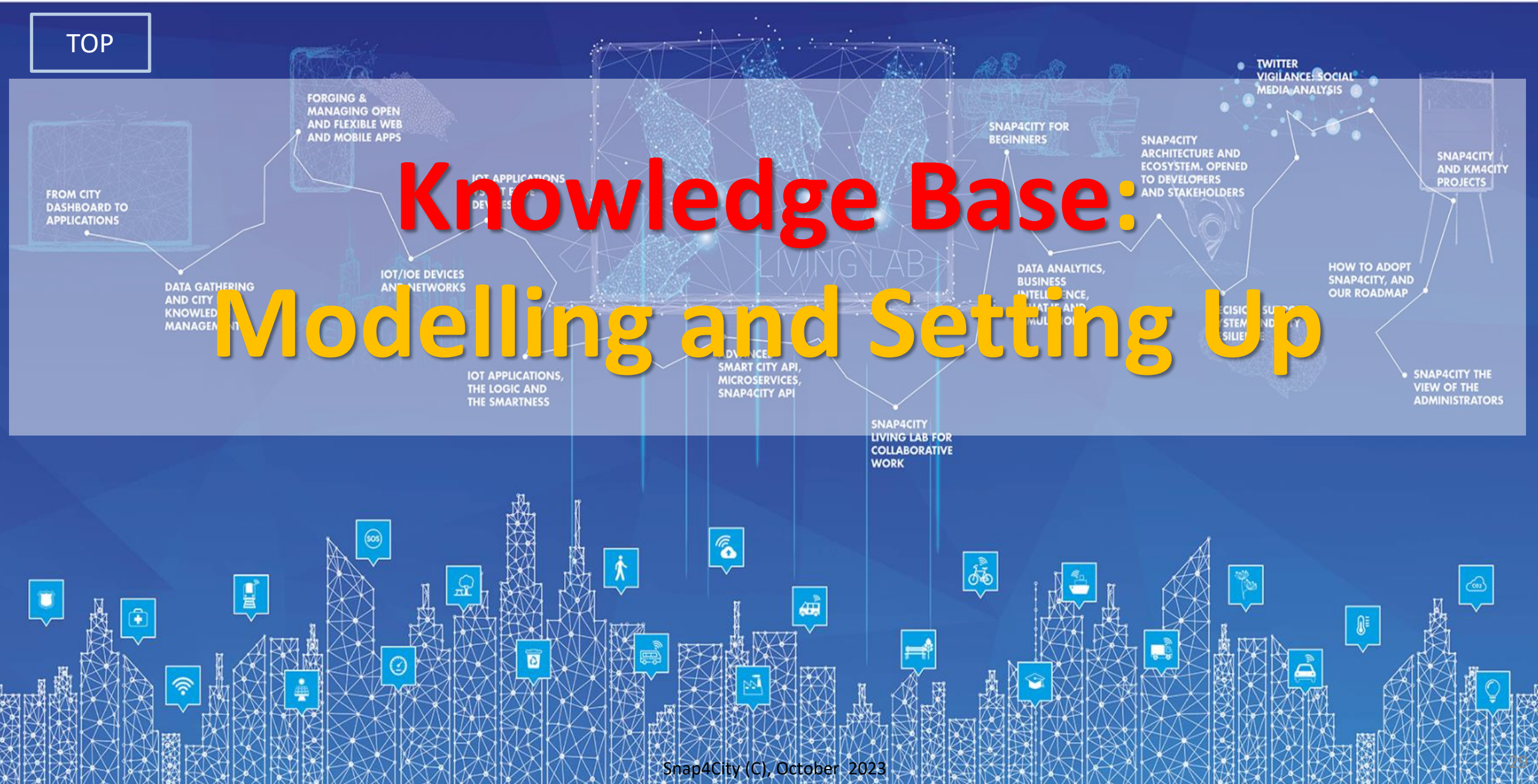
Snap4City Tools vs Development Life Cycle



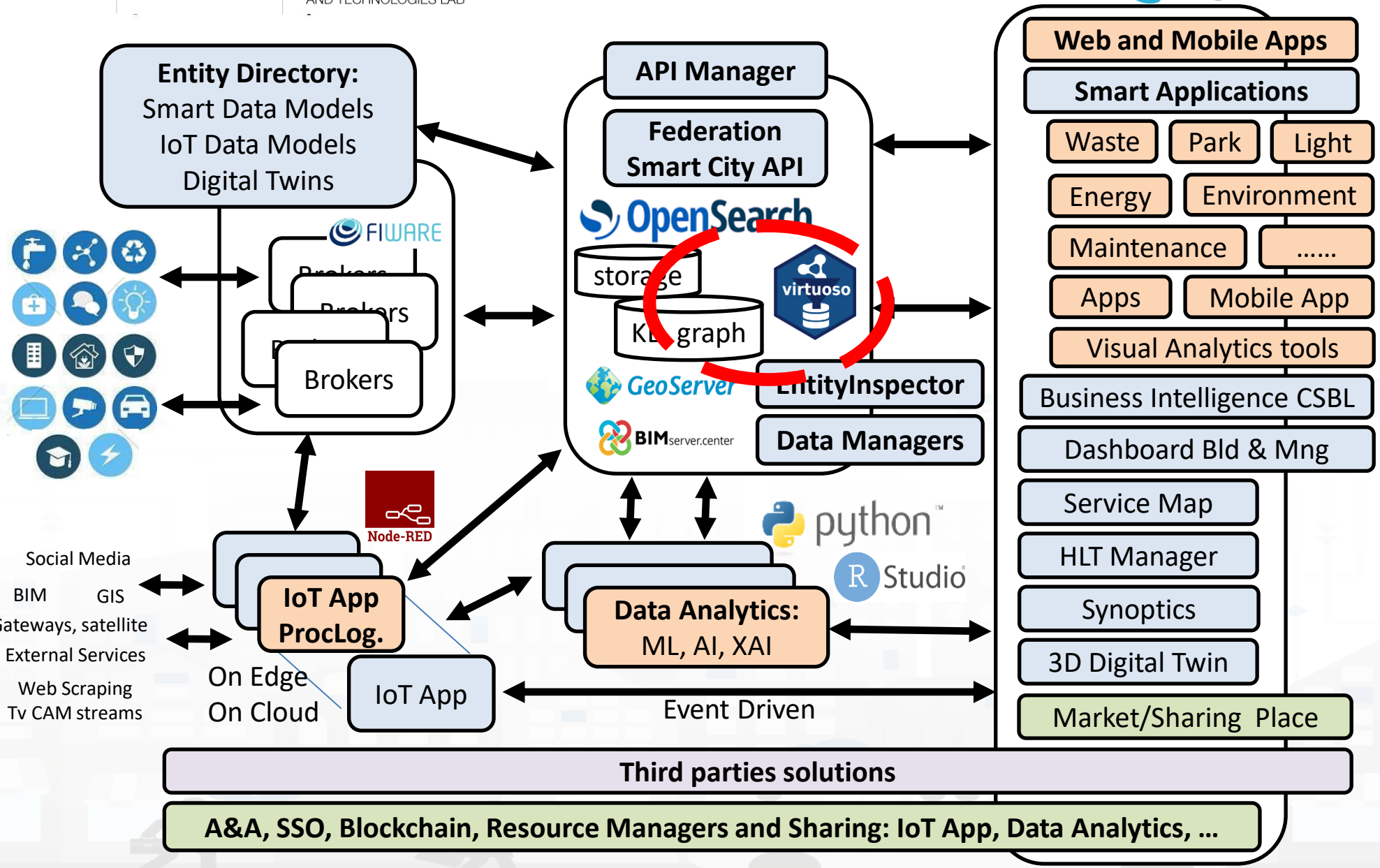
Development life cycle manual

TOP

Knowledge Base: Modelling and Setting Up



Tech Arch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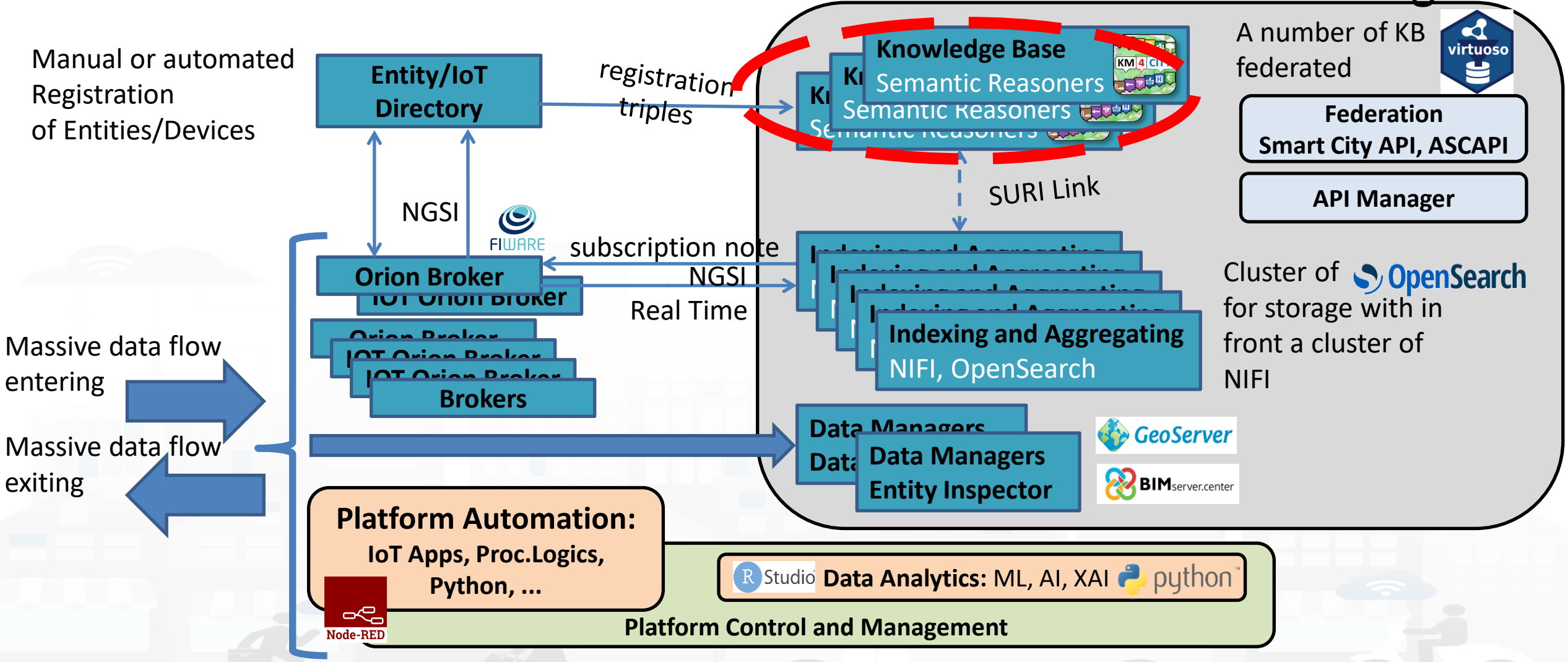
HLT Manager
Synoptics
3D Digital Twin
Market/Sharing Place
Third parties solutions
A&A, SSO, Blockchain, Resource Managers and Sharing: IoT App, Data Analytics, …

Knowledge Base city structure

- Needs of the KB city Structure:
  - For many trivial applications of Smart City the KB does not need to be initialized with some road graph, for example taken from OSM
  - For example, if you need only to position devices on map to some GPS coordinates you do now need to set up the KB
- The KB Set up is needed only when is needed to have:
  - Geoserver functionality
  - Routing based on KB
  - Some spatial reasoning queries
  - Etc.

Usage of the ServiceMap and Knowledge Base Browsing

Snap4city Data Ingestion Diagram



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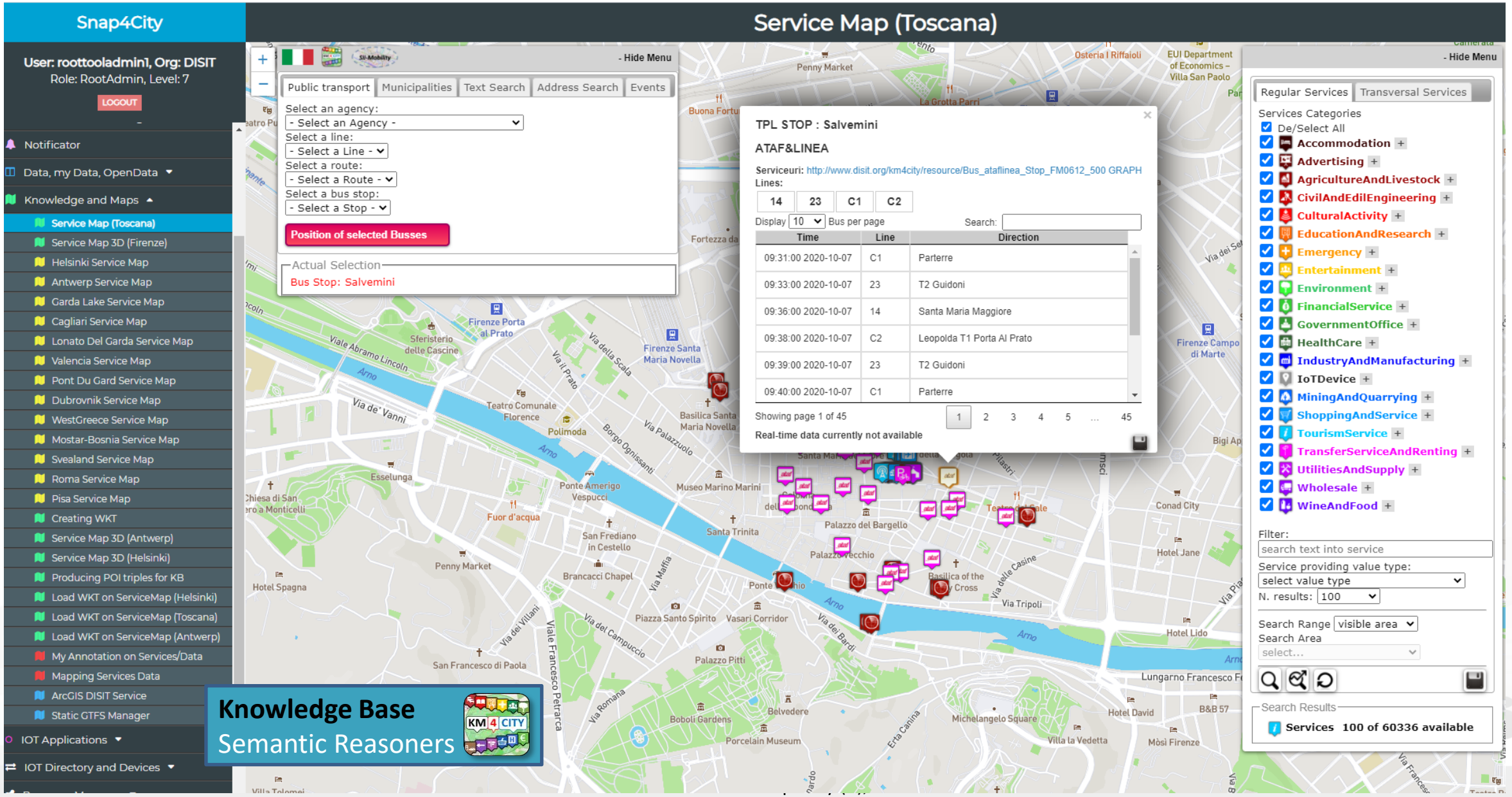
ServiceMaps

SNAP4CITY | KM4CITY

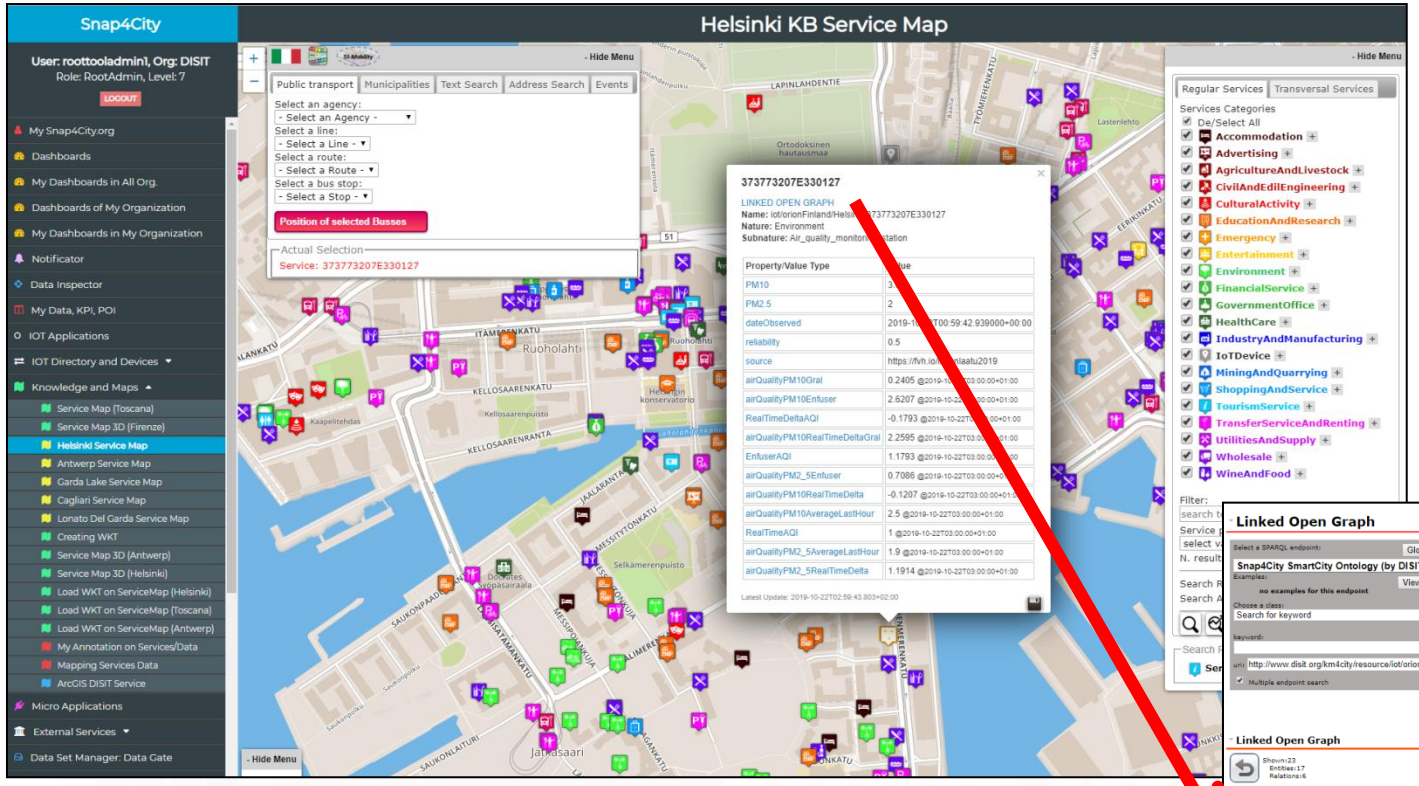


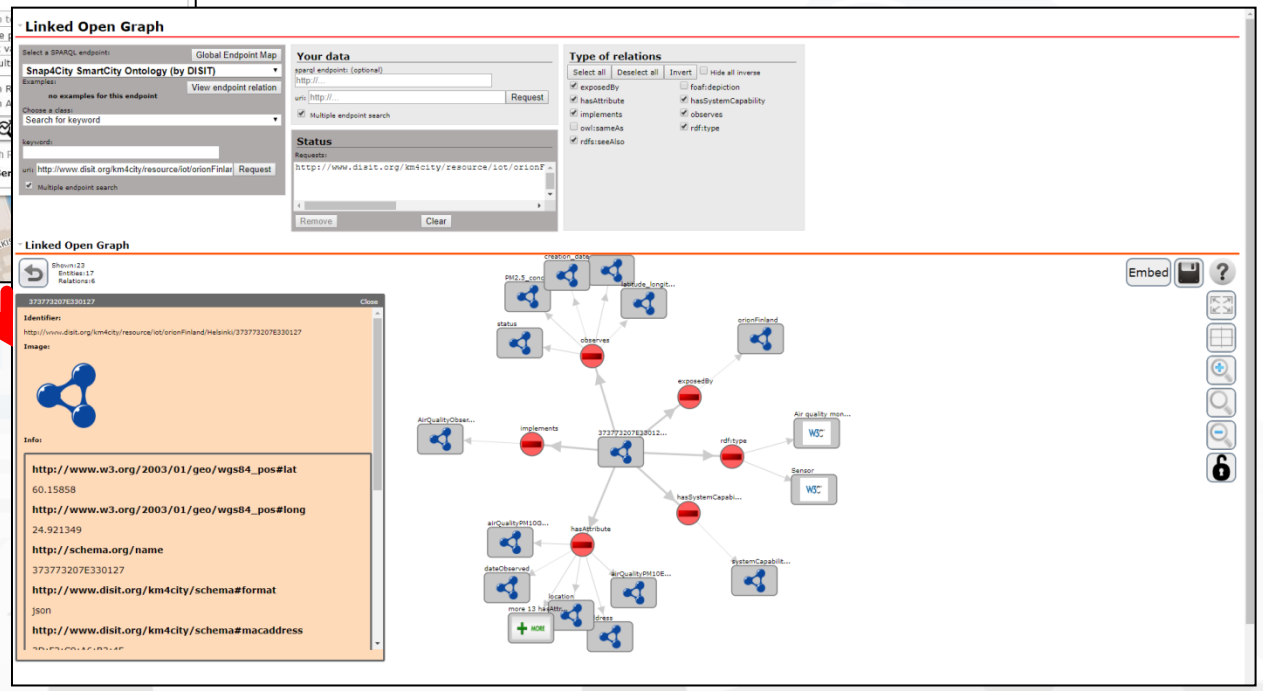
Semantic modeling

- **KB is based on the Km4City ontology,** It allows to:
  - keep connected city entities each other:
    - Semantic Index, reticular
    - Perform spatial, geo graphic, and temporal reasoning
  - Discover city entities and their relationships via Proc.Logic / IoT App and Smart City API:
    - Entities / devices, sensors, city elements, roads, services, Brokers, etc. etc.
  - Provide access via Advanced Smart City API
  - Federate other Smart Cities / Knowledge Bases, the approach allows to scale geographically and create redundancies, improving performances

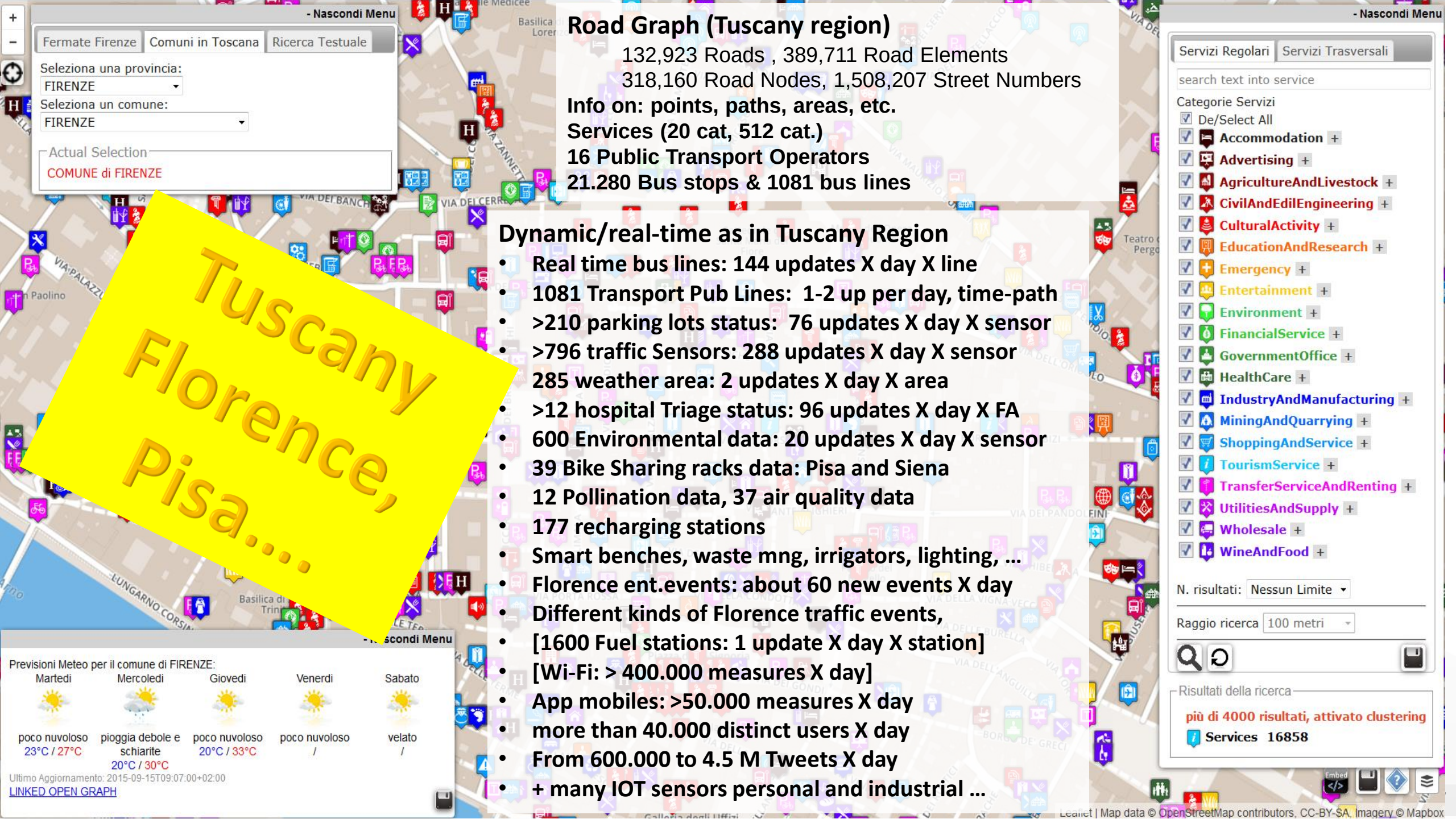
Views of the Knowledge Base

Knowledge Base
Semantic Reasoners





- How pass from ServiceMap to Linked Open Graph, Linked Data view tool


- Nascondi Menu
Fermate Firenze
Comuni in Toscana
Ricerca Testuale
Seleziona una provincia:
FIRENZE
Seleziona un comune:
FIRENZE
Actual Selection
COMUNE di FIRENZE
Tuscany Florence, Pisa....
Road Graph (Tuscany region)
132,923 Roads , 389,711 Road Elements
318,160 Road Nodes, 1,508,207 Street Numbers
Info on: points, paths, areas, etc.
Services (20 cat, 512 cat.)
16 Public Transport Operators
21.280 Bus stops & 1081 bus lines
Dynamic/real-time as in Tuscany Region
• Real time bus lines: 144 updates X day X line
• 1081 Transport Pub Lines: 1-2 up per day, time-path
• >210 parking lots status: 76 updates X day X sensor
• >796 traffic Sensors: 288 updates X day X sensor
285 weather area: 2 updates X day X area
• >12 hospital Triage status: 96 updates X day X FA
• 600 Environmental data: 20 updates X day X sensor
• 39 Bike Sharing racks data: Pisa and Siena
• 12 Pollination data, 37 air quality data
• 177 recharging stations
• Smart benches, waste mng, irrigators, lighting, …
• Florence ent.events: about 60 new events X day
• Different kinds of Florence traffic events,
• [1600 Fuel stations: 1 update X day X station]
• [Wi-Fi: > 400.000 measures X day]
• App mobiles: >50.000 measures X day
• more than 40.000 distinct users X day
• From 600.000 to 4.5 M Tweets X day
• + many IOT sensors personal and industrial …
- Nascondi Menu
Previsioni Meteo per il comune di FIRENZE:
Martedi
poco nuvoloso
23°C / 27°C
Mercoledi
pioggia debole e schiarite
20°C / 30°C
Giovedi
poco nuvoloso
20°C / 33°C
Venerdi
poco nuvoloso
/
Sabato
velato
/
Ultimo Aggiornamento: 2015-09-15T09:07:00+02:00
LINKED OPEN GRAPH
- Nascondi Menu
Servizi Regolari
Servizi Trasversali
search text into service
Categorie Servizi
De/Select All
Accommodation
Advertising
AgricultureAndLivestock
CivilAndEdilEngineering
CulturalActivity
EducationAndResearch
Emergency
Entertainment
Environment
FinancialService
GovernmentOffice
HealthCare
IndustryAndManufacturing
MiningAndQuarrying
ShoppingAndService
TourismService
TransferServiceAndRenting
UtilitiesAndSupply
Wholesale
WineAndFood
N. risultati: Nessun Limite
Raggio ricerca 100 metri
Risultati della ricerca
più di 4000 risultati, attivato clustering
Services 16858
Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox

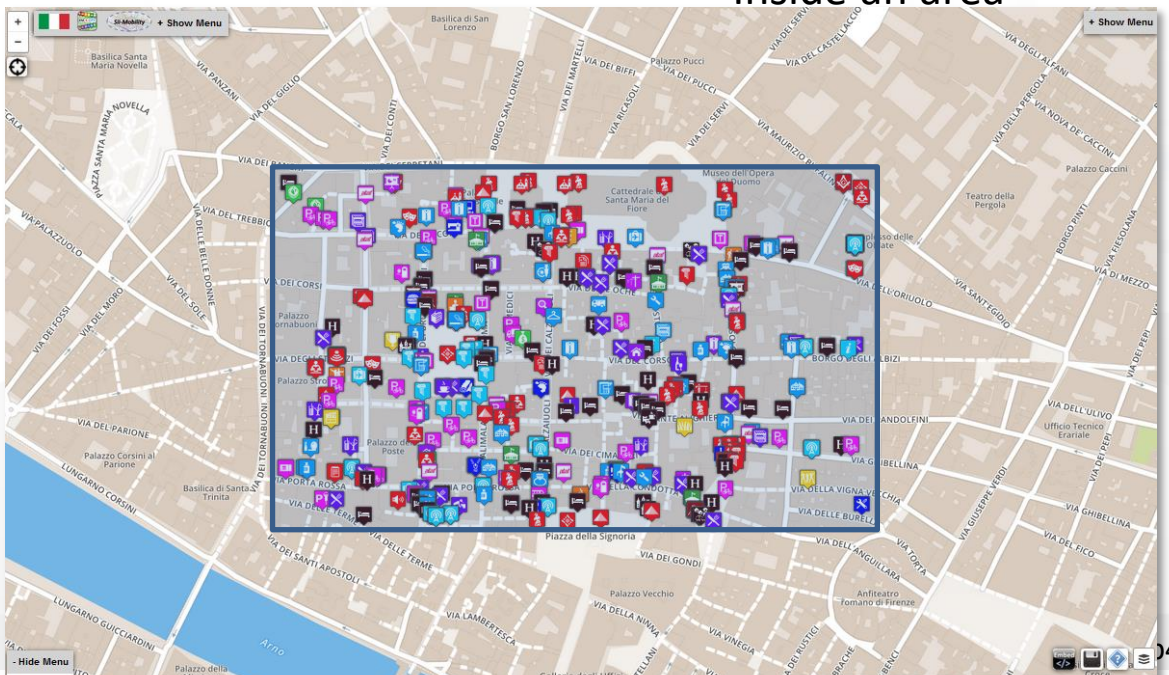
Discovery

Search by Shape and Distance

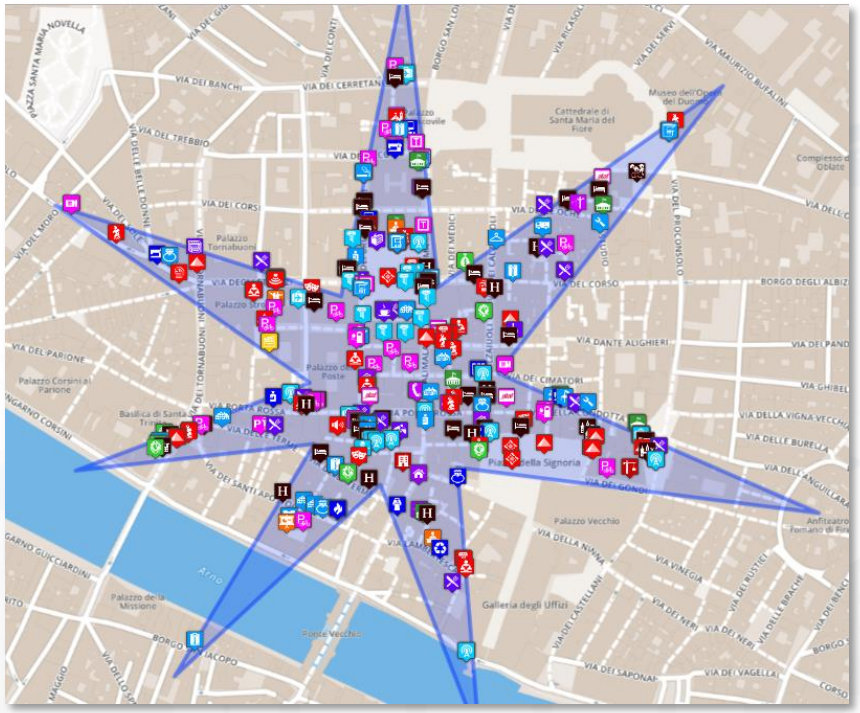
Around a point or POI

Each request or search in the Km4City model can be referred to a point and a ray, to an area, to a polyline

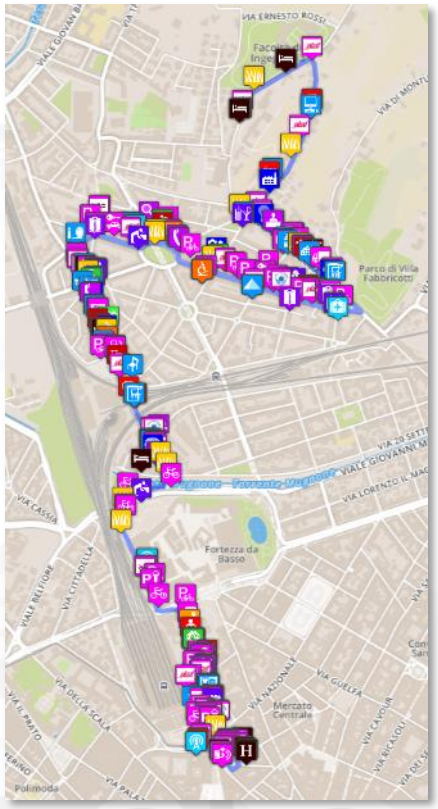
Inside an area



Inside a closed polyline

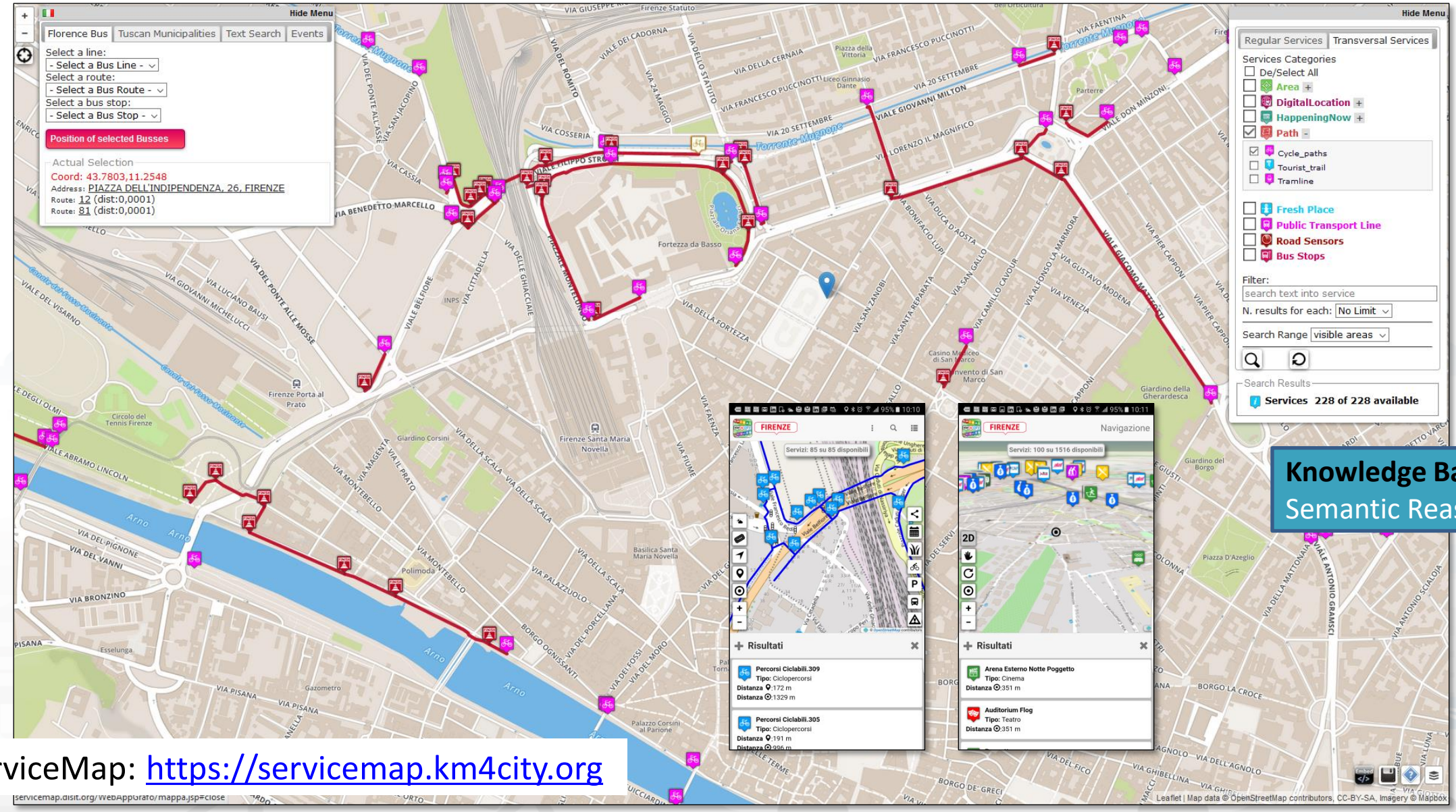


Along a polyline



Knowledge Base
Semantic Reasoners

Cycling Paths

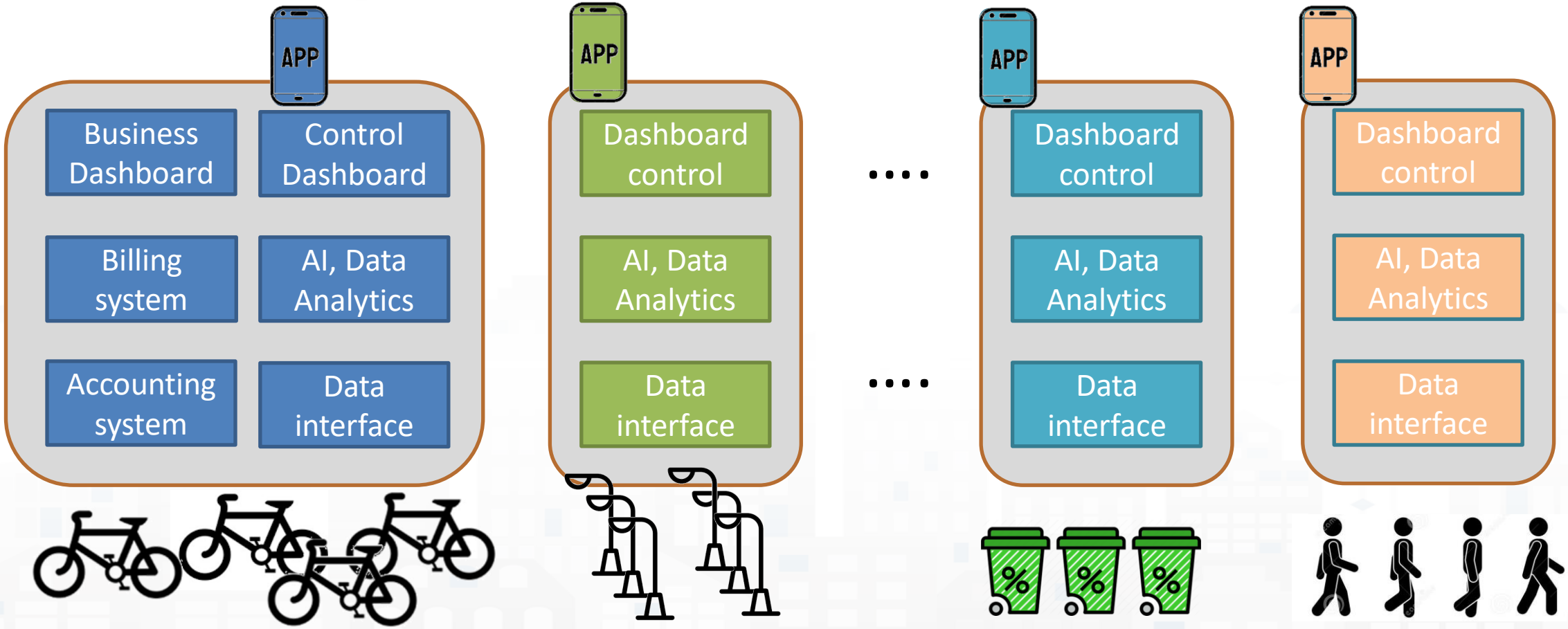


Knowledge Base
Semantic Reasoners

ServiceMap: https://servicemap.km4city.org

Set up of the Knowledge Base performed with an open source tool

Avoiding to have a collection of verticals

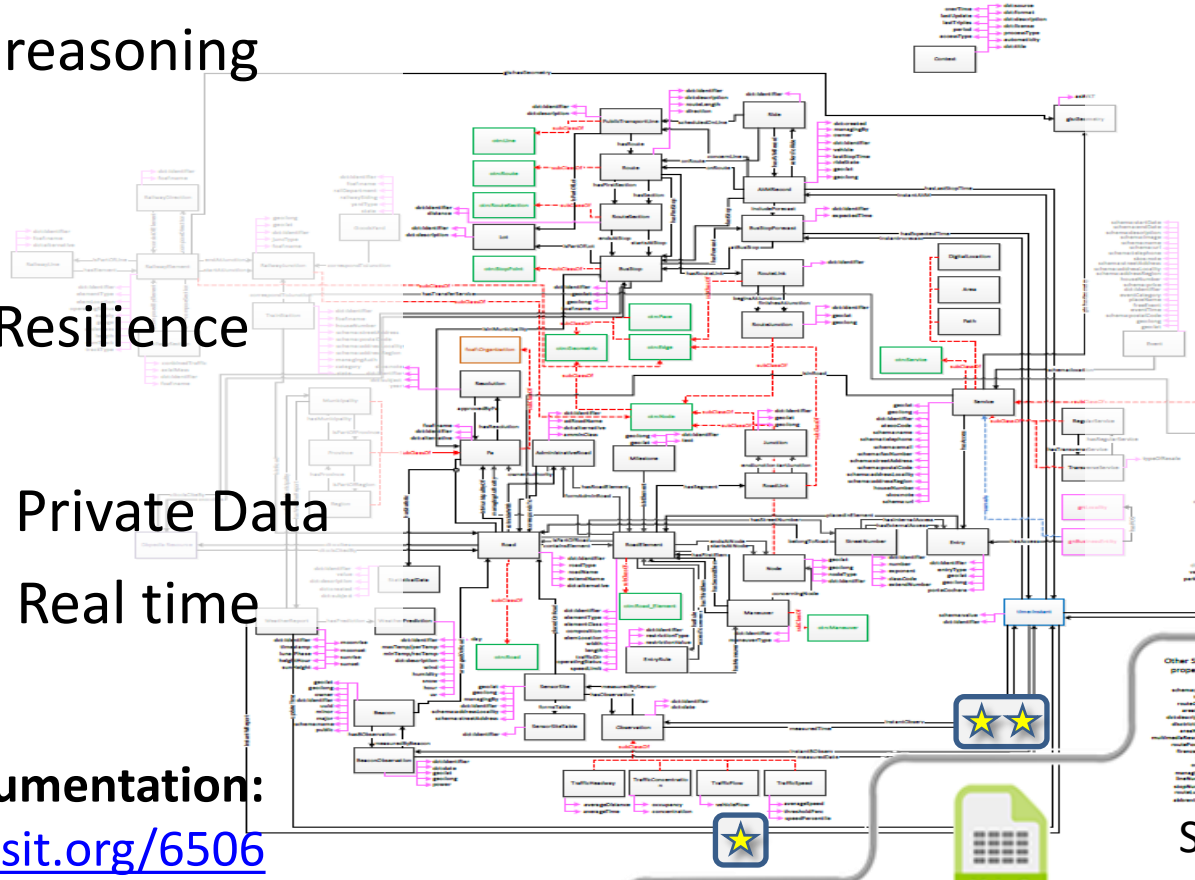


Simplifying the development and integration of verticals

Km4City: Knowledge Base

- **Multiple DOMAINS**
- Geospatial reasoning
- Temporal reasoning
- Metadata
- Statistics
- Risk and Resilience
- Licensing
- Open and Private Data
- Static and Real time
- IOT/IOE

- Street-Guide
- Mobility and transport
- Points of interest
- Sensors, IOT, …
- Energy
- Administration
- Citations from strings
- ..



Big Data Tools

LOD and reasoners

Ontology Documentation:

http://www.disit.org/6506
http://www.disit.org/6507
http://www.disit.org/5606
http://www.disit.org/6461

Schema: http://www.disit.org/km4city/schema
RDF version: http://www.disit.org/km4city.rdf

Semantic modeling

- **Km4City is the reference ontology for Snap4City,** It allows to:
  - keep connected city entities each other:
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    - Perform spatial, geo graphic, and temporal reasoning
  - Provide access via Advanced Smart City API
  - Discover city entities and their relationships via Proc.Logic / IoT App and Smart City API:
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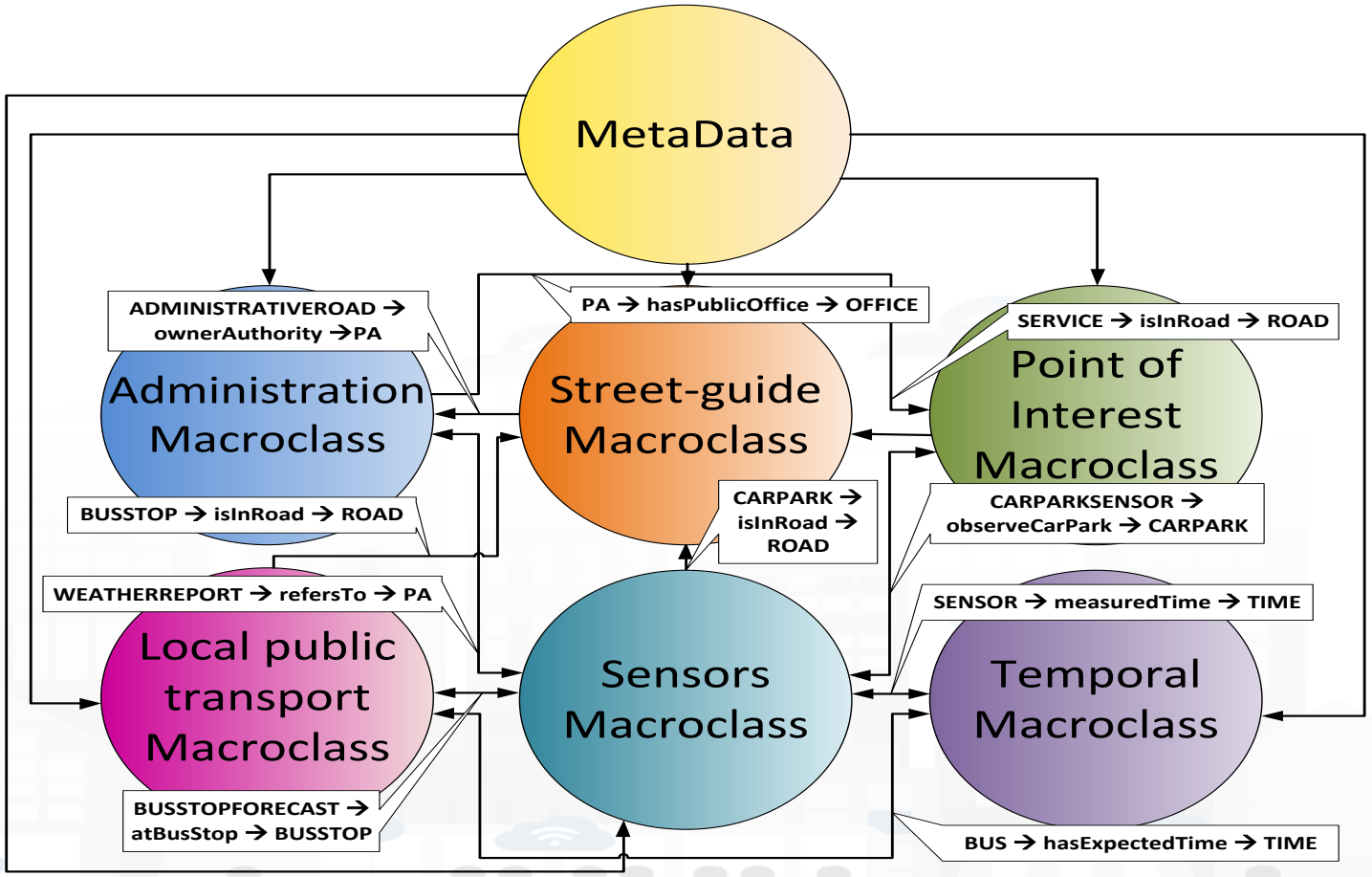
  - Federate other Km4City Knowledge Bases, the approach allows to scale geographically and create redundancies, improving performances
- Documentation
  - **TC5.15 - Snap4City Smart City API Collection and overview, real time**
  - **ServiceMap and ServiceMap3D, Knowledge Model, Km4City Ontology**
  - **Knowledge Base Graphs and Queries: browsing and queries into the KB**

Smart-city Ontology: 1.6

- covers different aspects:
  - Administration
  - Street-guide
  - Points of interest
  - Local public transport
  - Sensors
  - Temporal aspects
  - Metadata on the data
  - Industry 4.0 structures



Km4City Ontology elements 1.6.7

- **Km4C**: Km4City 1.6.7
- Using
  - **DCTERMS**: for metadata Dublin Core Metadata Initiative
  - **FOAF**: friends of a friends
  - **Good Relation**: entities relationships
  - **iot-lite**: IOT Vocabuary
  - **OTN**: Ontology of Transportation Networks
  - **OWL-Time**: time reasoning
  - **SAREF** Smart Appliances REFerence extension for building devices available at https://saref.etsi.org/saref4bldg/
  - **Schema.org** for people and organizations
  - **SSN**: Semantic Sensor Network Ontology (see https://www.w3.org/TR/vocab-ssn/
  - **WGS84** Datum of Geo-Objects
  - **GTFS**, General Transit Feed Specification, and **Transmodel**, for public transport infrastructures: lines/rides time schedules, real-time records, paths, etc.;

UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

Knowledge Base
Semantic Reasoners

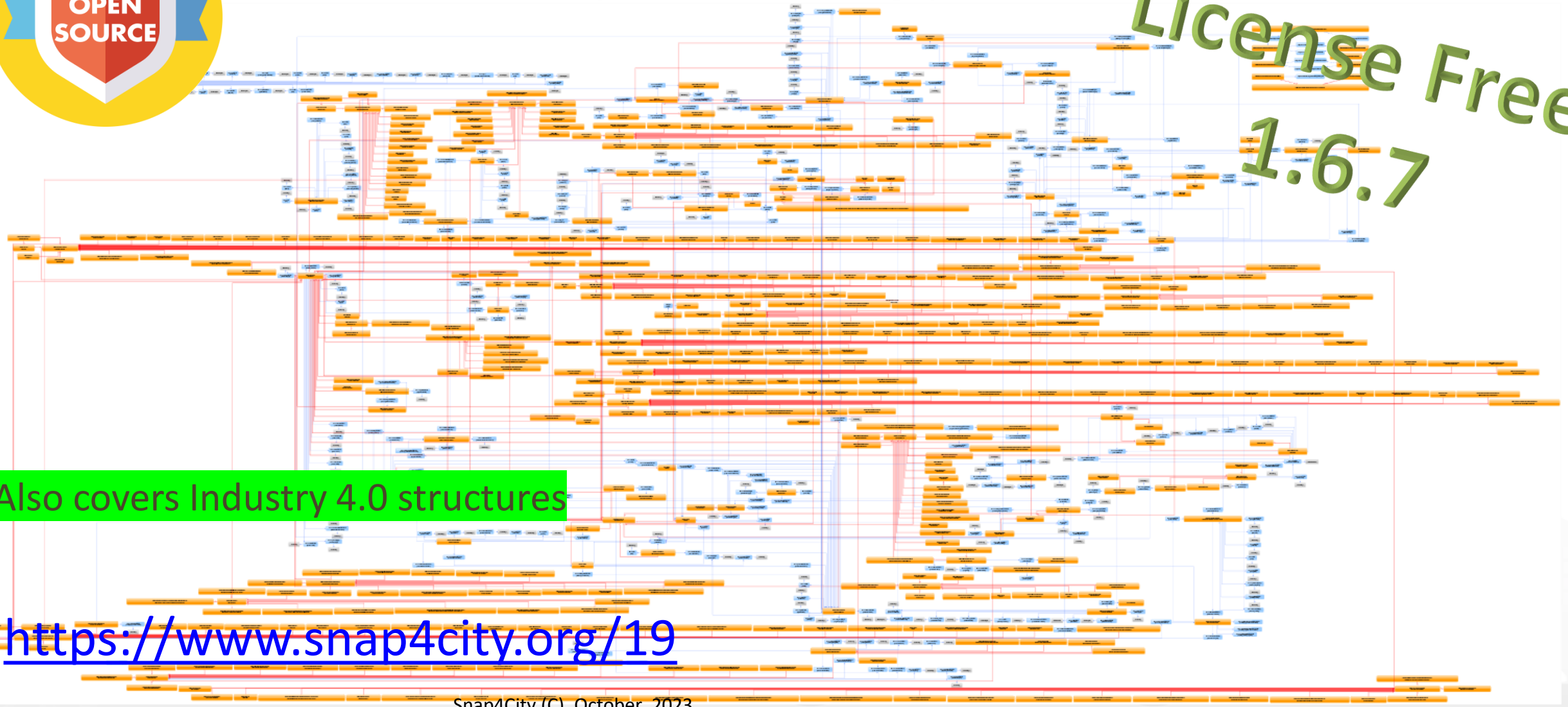
SNAP4CITY

Smart-city Ontology km4city

100% OPEN SOURCE

License Free

1.6.7



Also covers Industry 4.0 structures

https://www.snap4city.org/19

Set up of the Knowledge Base, KB

- The **KB starts with the ontology and empty in terms of instances**, it should to be **initialized** with the Road Graph(s) of interest, but may be not needed in some cases.
- **Road Graphs** can be obtained from:
  - GIS of the municipalities, regional govern, etc.
  - Open Street Map, OSM
  - Etc.
  - See this note on KM vs OSM: https://www.snap4city.org/397
- Snap4City provides a tool for **feeding the KB with OSM**
  - TC5.10- Open Street Map ingestion process
  - From the Open Street Map to the Km4City street graph
    - https://www.snap4city.org/download/video/From%20the%20Open%20Street%20Map%20to%20the%20Km4City%20street%20graph.pdf
  - **OSM2KM4C** tool is included into KBSM, VM and Docker https://www.snap4city.org/471
  - Tool: https://github.com/disit/osm2km4c
- The load of a city of 1 Million of inhabitants can be done in few hours.

From FAQ

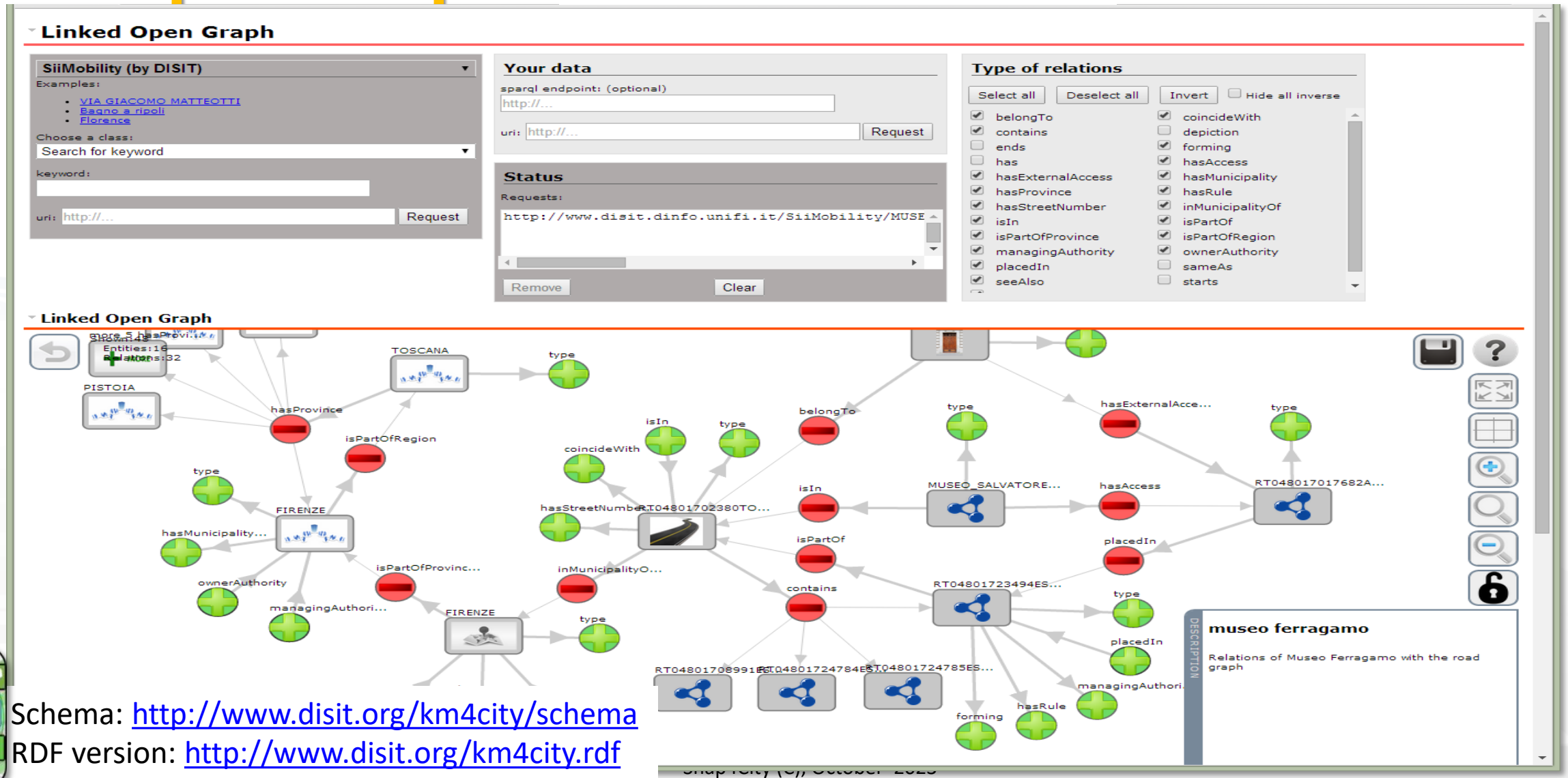
Which are the mechanisms to send data into the Knowledge Base?

The KB is feed with new concepts and entities, and they are produced by the solution and feed into the KB:

- (i) automatically by the Entity/Device Directory about all the new registered Entities / Devices which are registered on some IoT broker which have been already registered on Directory
- (ii) automatically from an Proc.Logic / IoT App it is possible to generate triples in somehow and poste them in N3 formats into the specific KB you targeted, according to the ORG you have
- (iii) automatically from POI Loader tool that takes Excel file in input and generate triples for a specific your organization
- (iii) manually producing triples and send them to RootAdming for feeding KB, or using an IOT App for feeding KB
- (iv) converting OSM in triples about road graph details by using a tool called
  - From the Open Street Map to the Km4City street graph, OSM2SM, OSMOSIS
  - https://www.snap4city.org/download/video/From%20the%20Open%20Street%20Map%20to%20the%20Km4City%20street%20graph.pdf

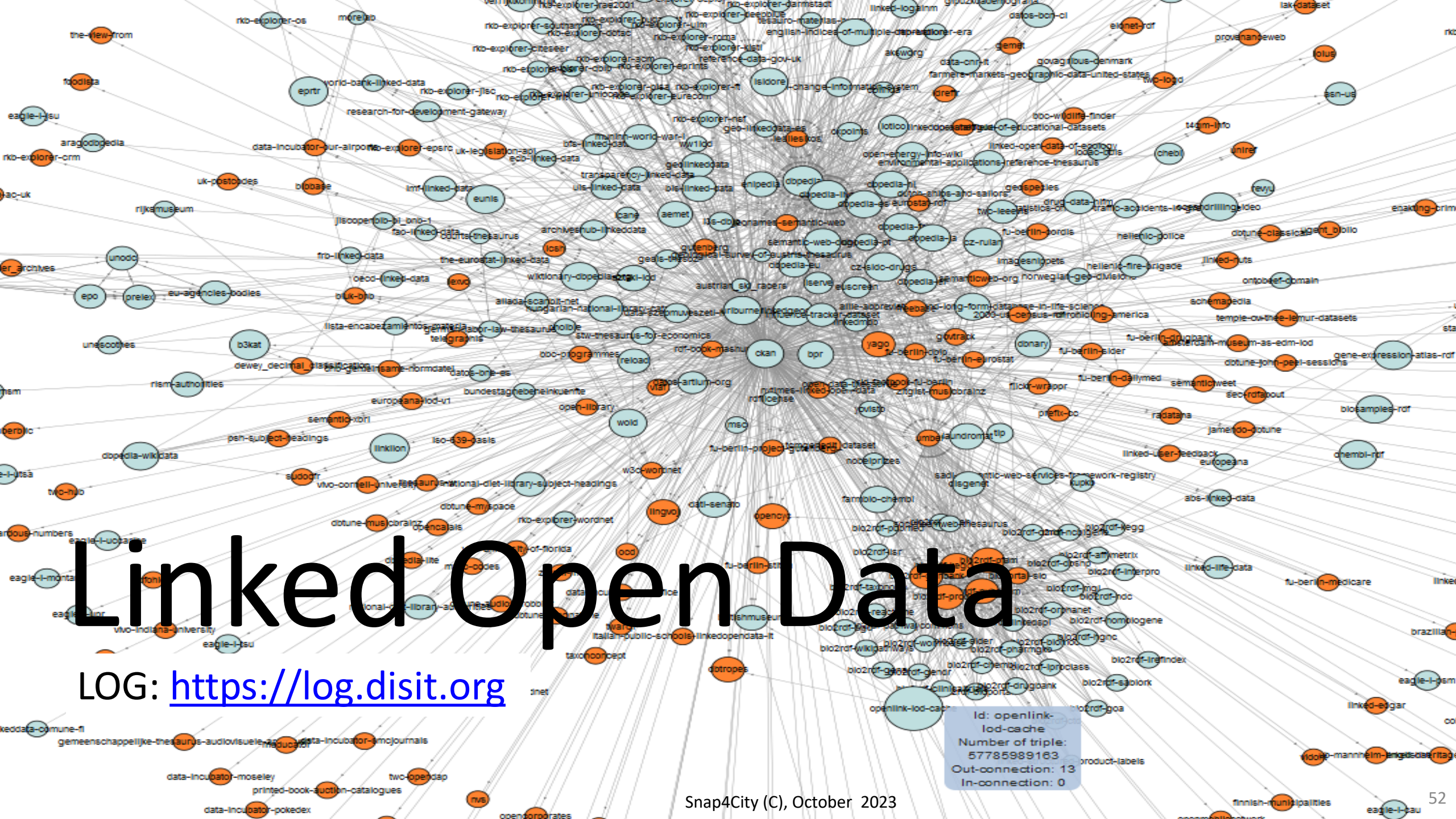
Linked Open Graph

LOG: https://log.disit.org



Schema: http://www.disit.org/km4city/schema

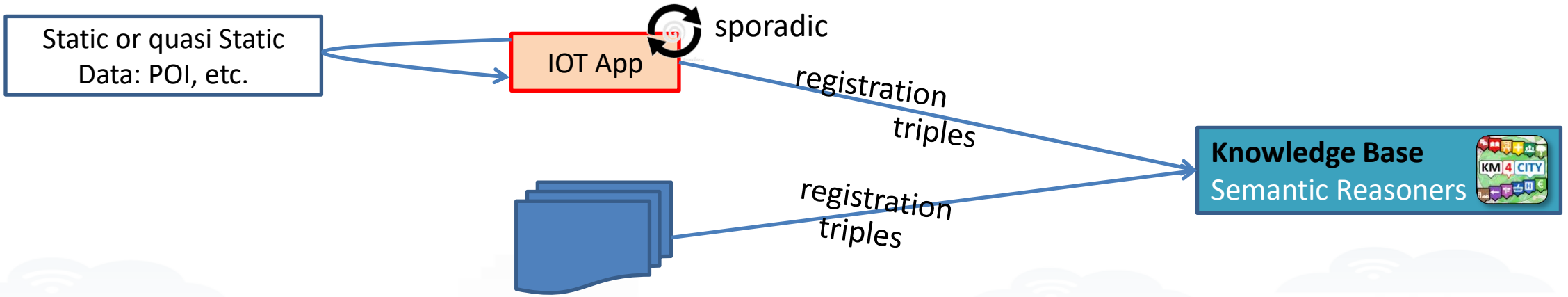
RDF version: http://www.disit.org/km4city.rdf


Linked Open Data
LOG: https://log.disit.org
Id: openlink-lod-cache
Number of triple: 57785989163
Out-connection: 13
In-connection: 0

How to load triples into the KB

(Admin and on-premise)

Loading Static Data into KB



- The loading is performed via
  - Proc.Logic / IoT App, with a specific flow exploiting a **MicroService/API of ServiceMap**, KB
  - **files of triples** on a shared folder of the ServiceMap, KB, for massing loading of Triples. For batch loading of triples

Load Triples in KB

Pre-requirements:

- Available only for your Proc.Logic / App on premise and for administrators

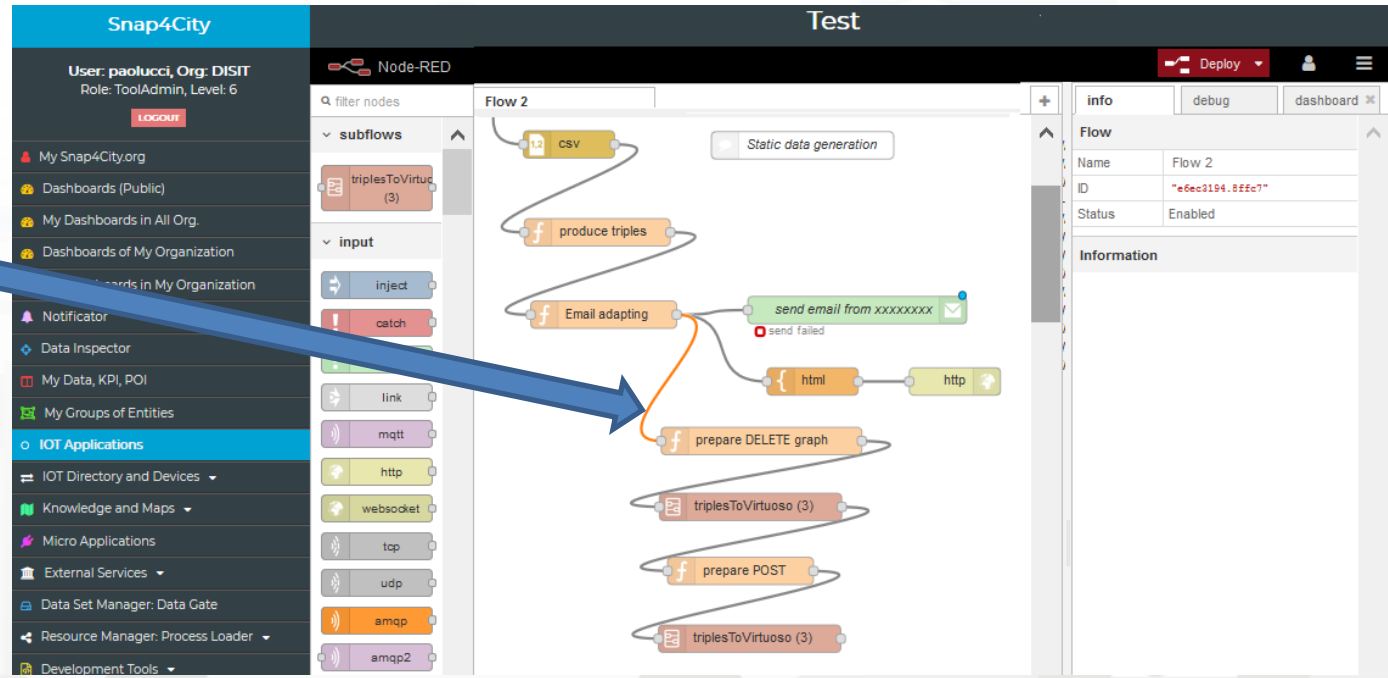
Load Static Data on Snap4City KB:

- Register Static Data on Snap4City KB (point 1 and 2 on the right)
- Connect the additional blocks present in the IOT App and save ('Deploy' button)
- Upload your csv

https://www.snap4city.org/596

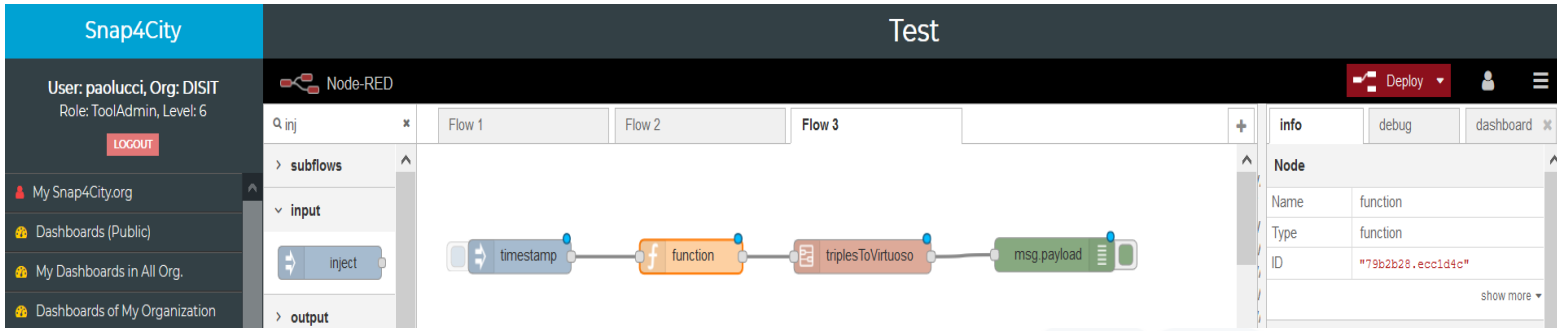
Register Static Data on Snap4City KB:

1. 'Regularize' your data (csv)
2. Create your IoTApp
3. Upload your csv



Load Triples in KB

- Additional Option Only for ONPREMISE Snap4City versions and for administrators
- In case you need to upload ONLY on the Knowledge Base a set of data containing static data and dynamic data all together:
  - Example: Cultural Events or weather predictions
- Use a predefined IoT App available here https://www.snap4city.org/594 (with the copy and past method, you can create your Mobile App)
- Add:
  - Inject block
  - Function block
  - Debug block
- The function block must contain …
- Now you can see the triples to be updated in the Knowledge Base in the Debug Tab



The input message to be provided to *triplesToVirtuoso* has to have the following properties:

msg.user="dba" // the user of virtuoso to be used to access to virtuoso
msg.passw="dba" //the password
msg.method="POST" //the http method: GET, POST, DELETE, PUT
msg.url="http://virtuoso-kb:8890/sparql-graph-crud-auth?graph-uri=urn:graph:POIs"
msg.triples= "..."

The role of Knowledge base and ServiceMaps

Accessing to Snap4City Services

storage

Other federated Smart City

Knowledge Base
Semantic Reasoners

SURI Link

Indexing and Aggregating
NIFI, OpenSearch

Data Managers
Entity Inspector

A number of KB federated

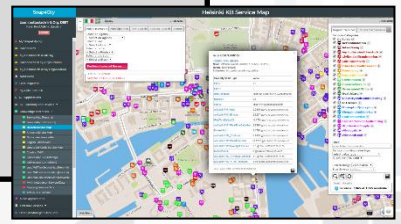
Federation Smart City API, ASCAPI

SCAPI

Super SCAPI

API Manager (Optional)

Cluster of OpenSearch for storage with in front a cluster of NIFI



ServiceMap

Multi/Super ServiceMap

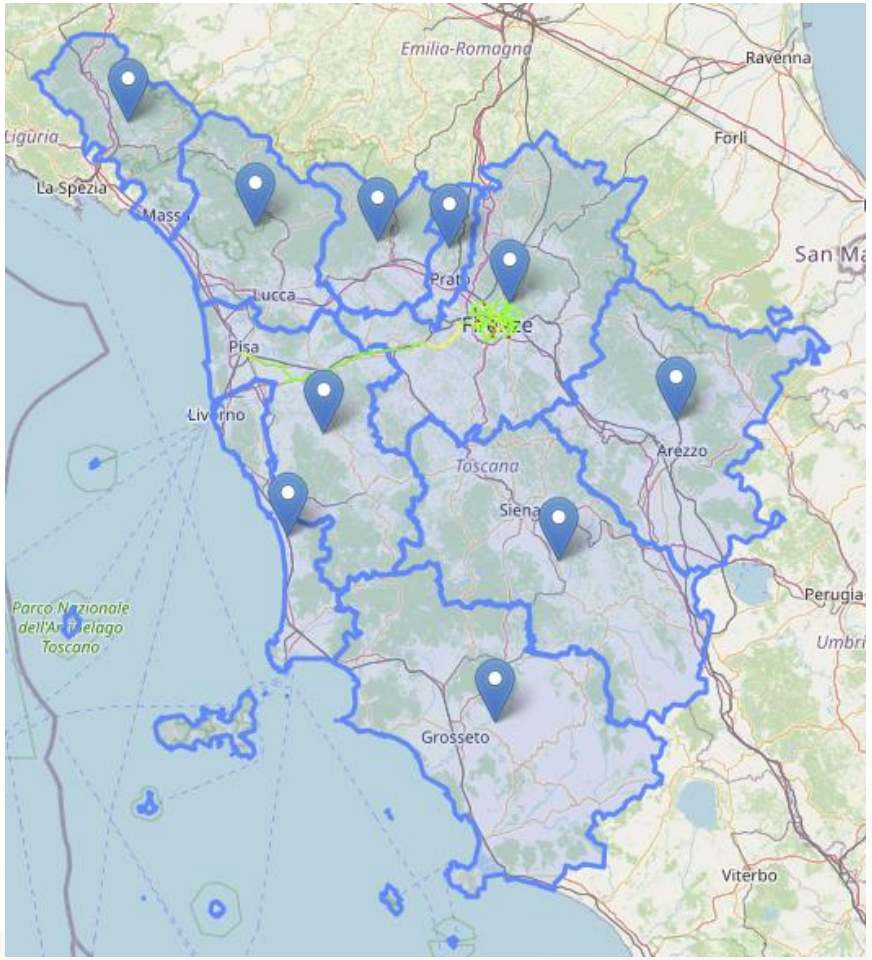
ServiceMaps

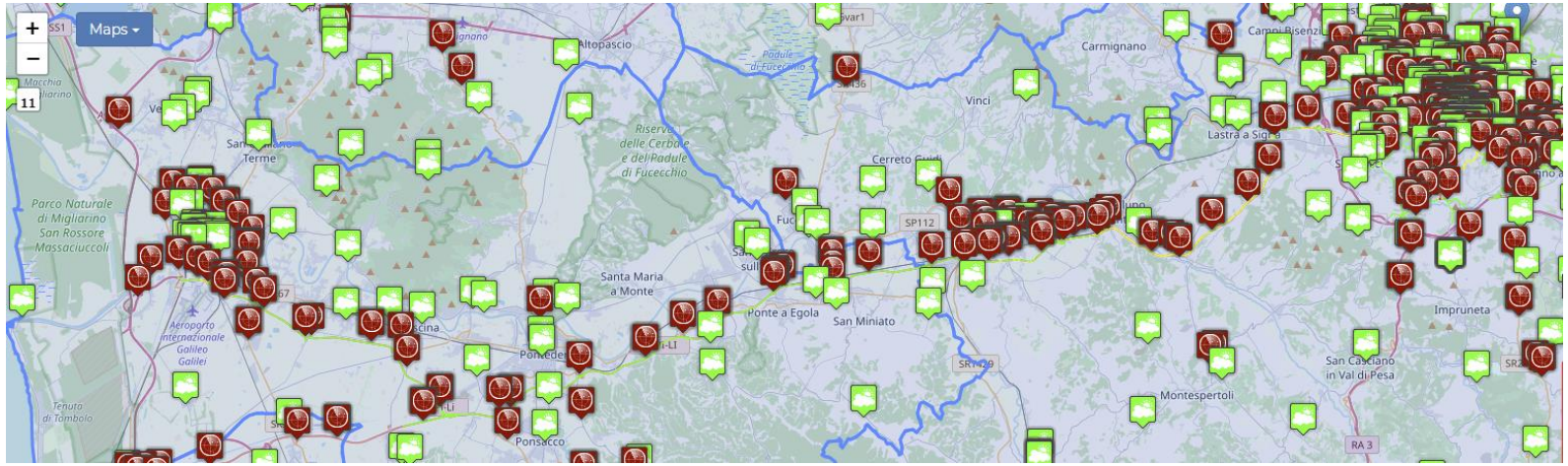
Knowledge Base
Semantic Reasoners

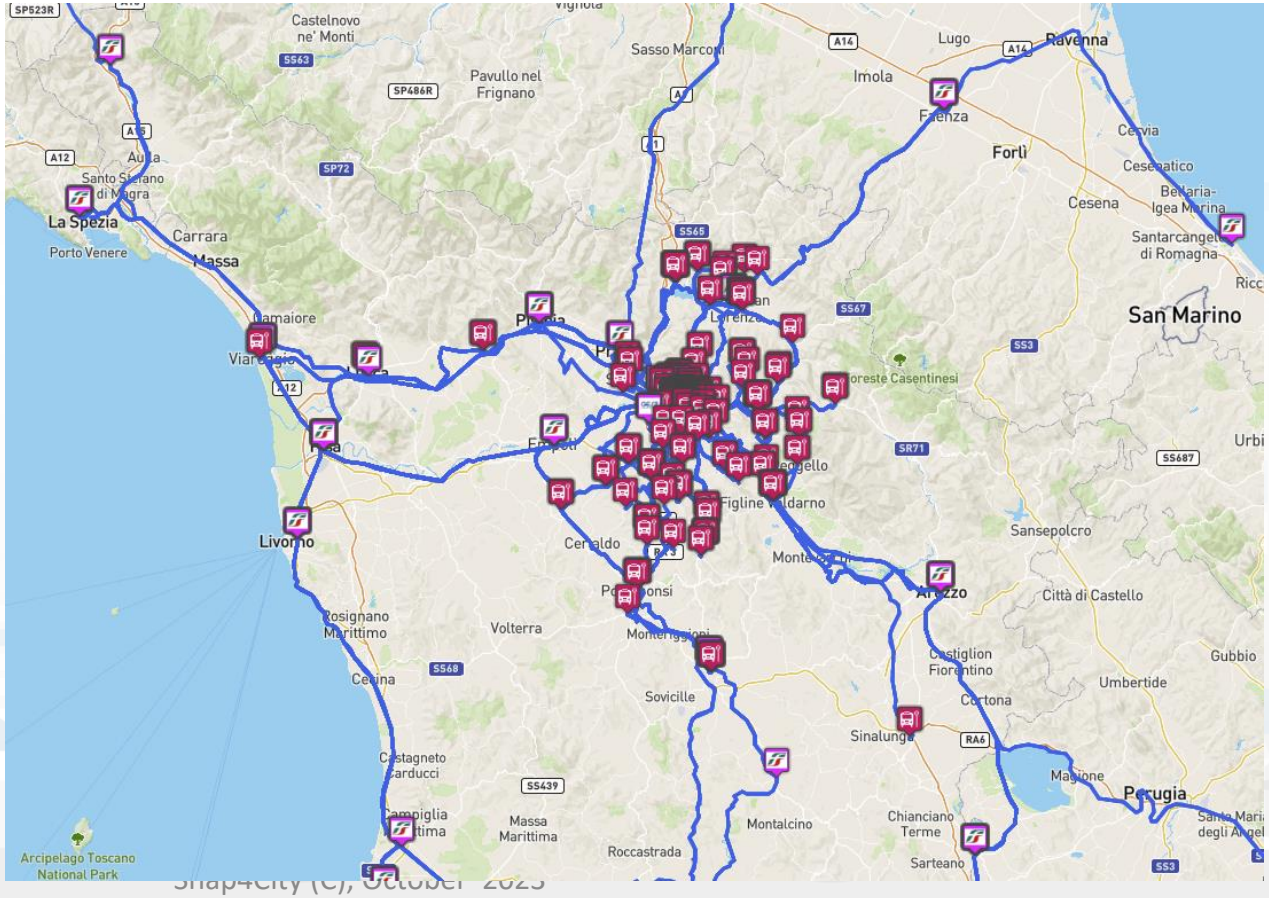
- ServiceMap is the **main Tool** to:
  - monitor the status of the Knowledge Base
  - test queries and produce query and SmartCity API testing calls for developers
    - Any kind of search (semantic, full text, etc.), routing,
  - Access at the specific Graph Data base via LOG.disit.org
- **ServiceMap is showing**:
  - only **public data**. Private data are not shown via ServiceMap but can be accessed via DataInspector
  - data regarding **a single Knowledge Base** of the federated network of KBs. Each KB may contain multiple Organizations.
  - technical views for developers
- **Super ServiceMap** shows to you your private data and data which have been delegated in Access to you.
- In most cases we refer as ServiceMap to intend both Super and basic
- In the installations on Cloud, the Super is the Default used by Dashboards, on premise the basic ASCAPI are the default

Federation of: Service Maps, Knowledge Bases, Smart City APIs

- Knowledge and Maps
  - Service Map (Toscana)
  - Service Map 3D (Firenze)
  - Helsinki Service Map
  - Antwerp Service Map
  - Garda Lake Service Map
  - Cagliari Service Map
  - Lonato Del Garda Service Map
  - Greece Service Map
  - Valencia Service Map
  - Pont Du Gard Service Map
  - Dubrovnik Service Map
  - WestGreece Service Map
  - Mostar-Bosnia Service Map
  - Svealand Service Map
  - Bologna Service Map
  - Roma Service Map
  - Pisa Service Map

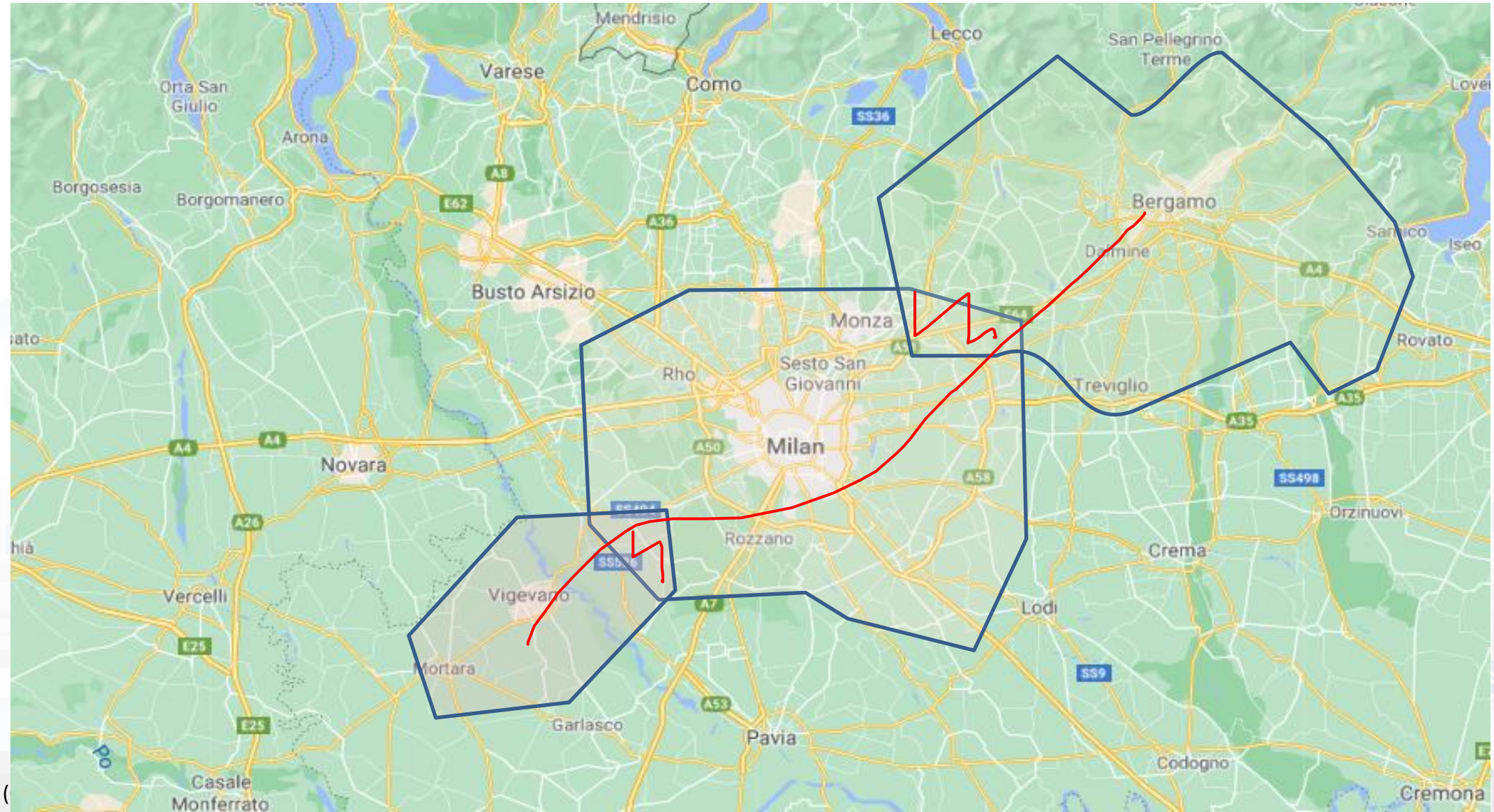


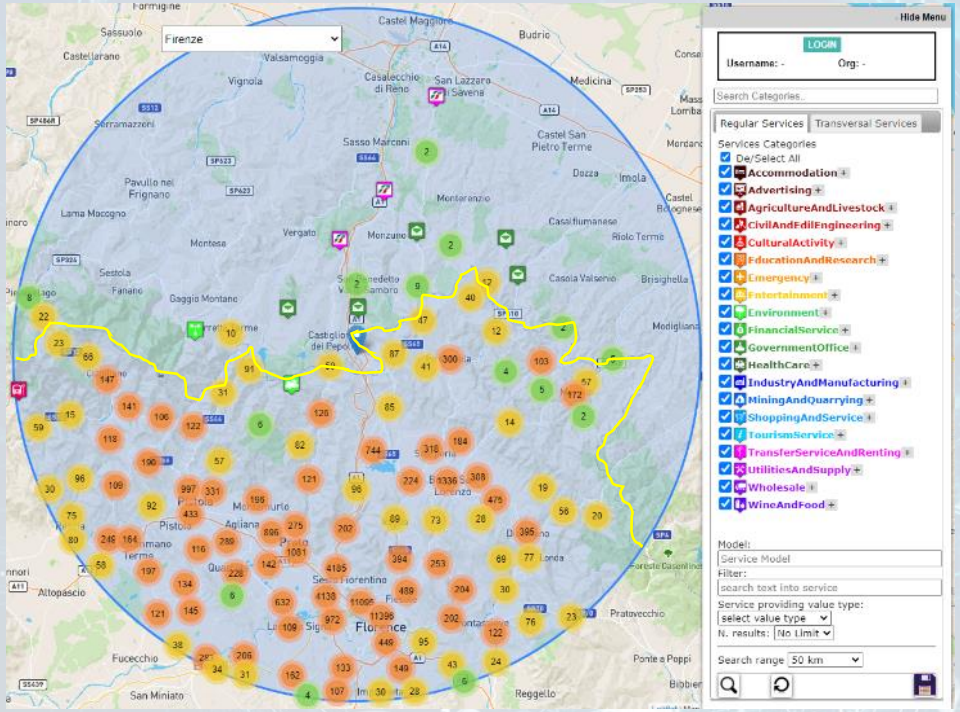


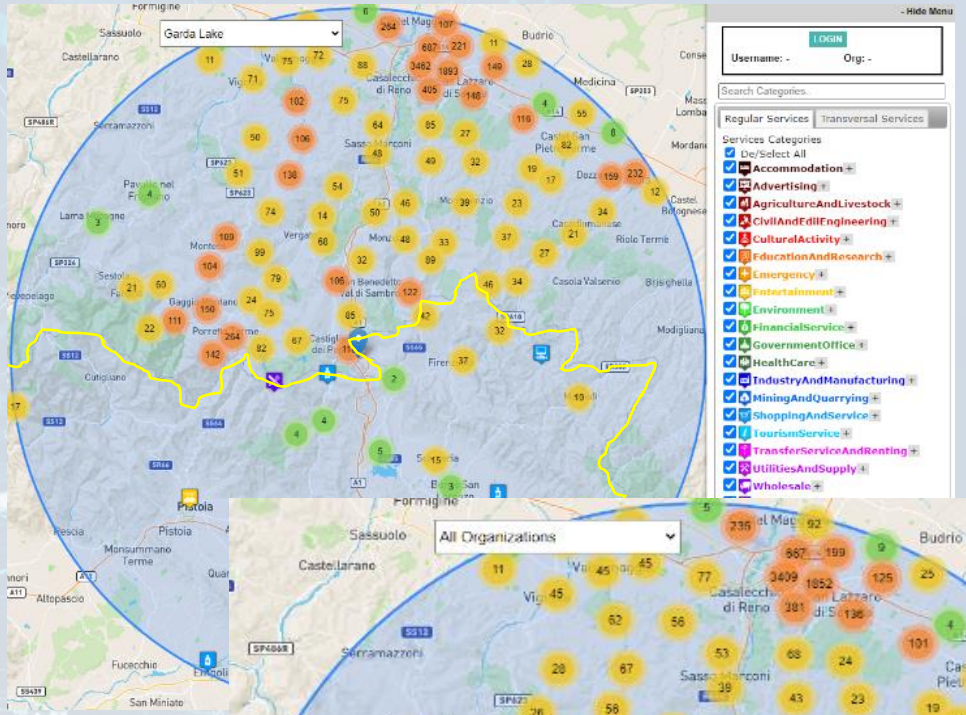


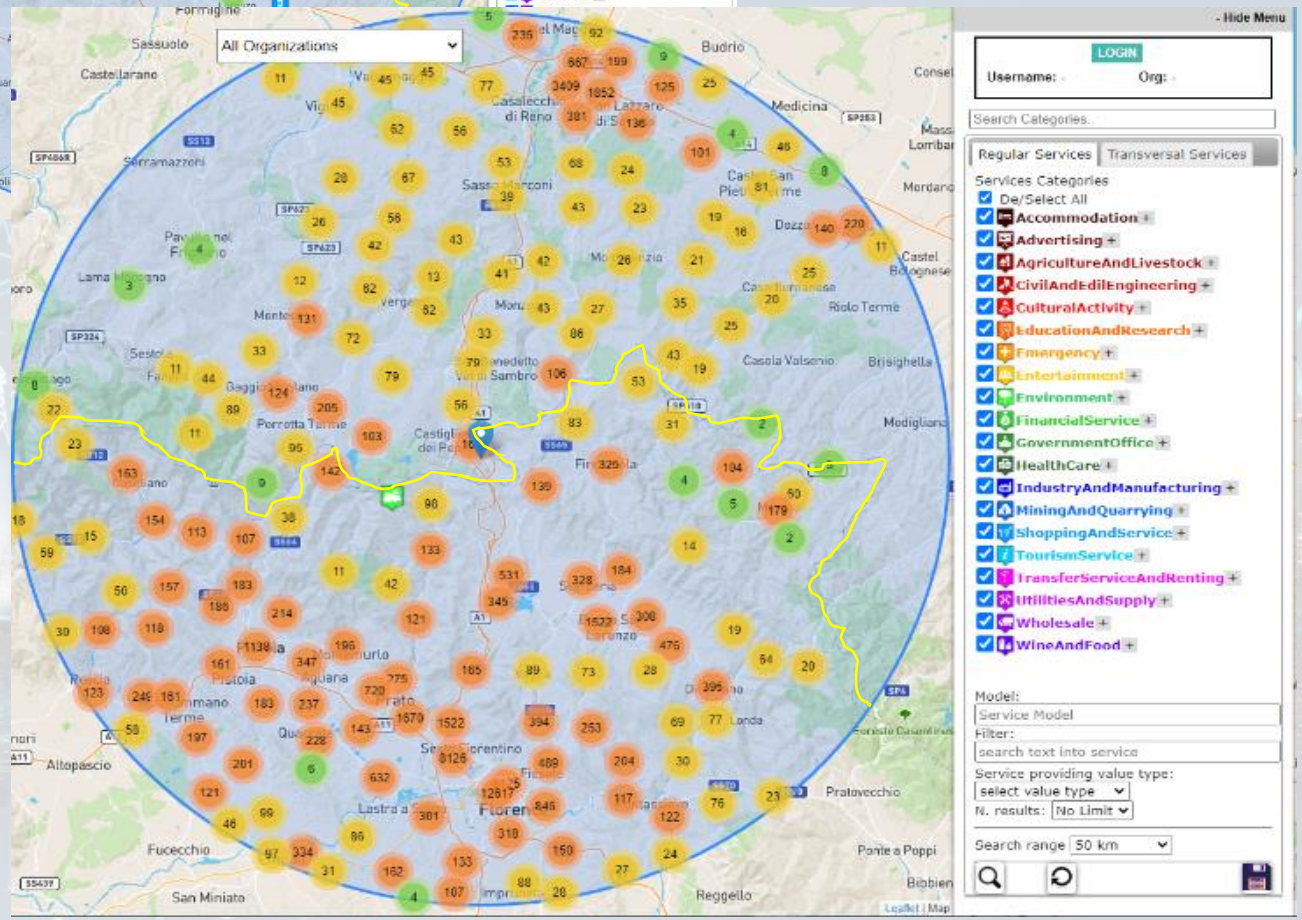
Admin Models & limitations

One Snap4City Platform may serve Multiple Cities

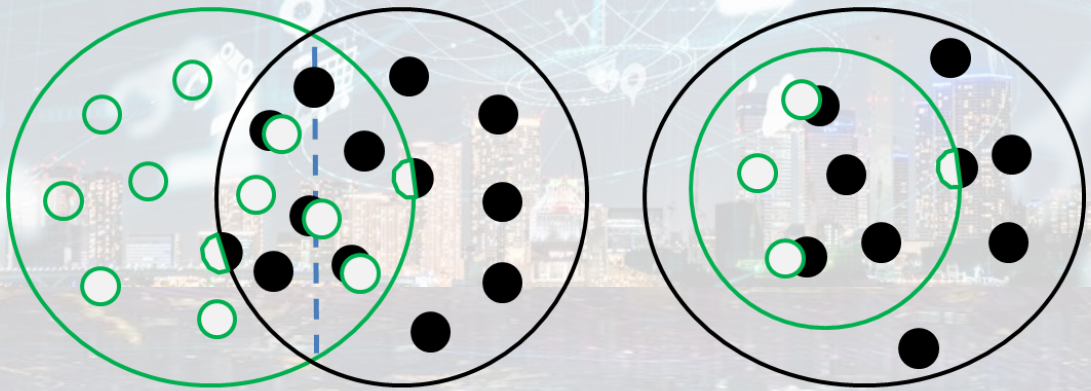








Knowledge Base
Semantic Reasoners



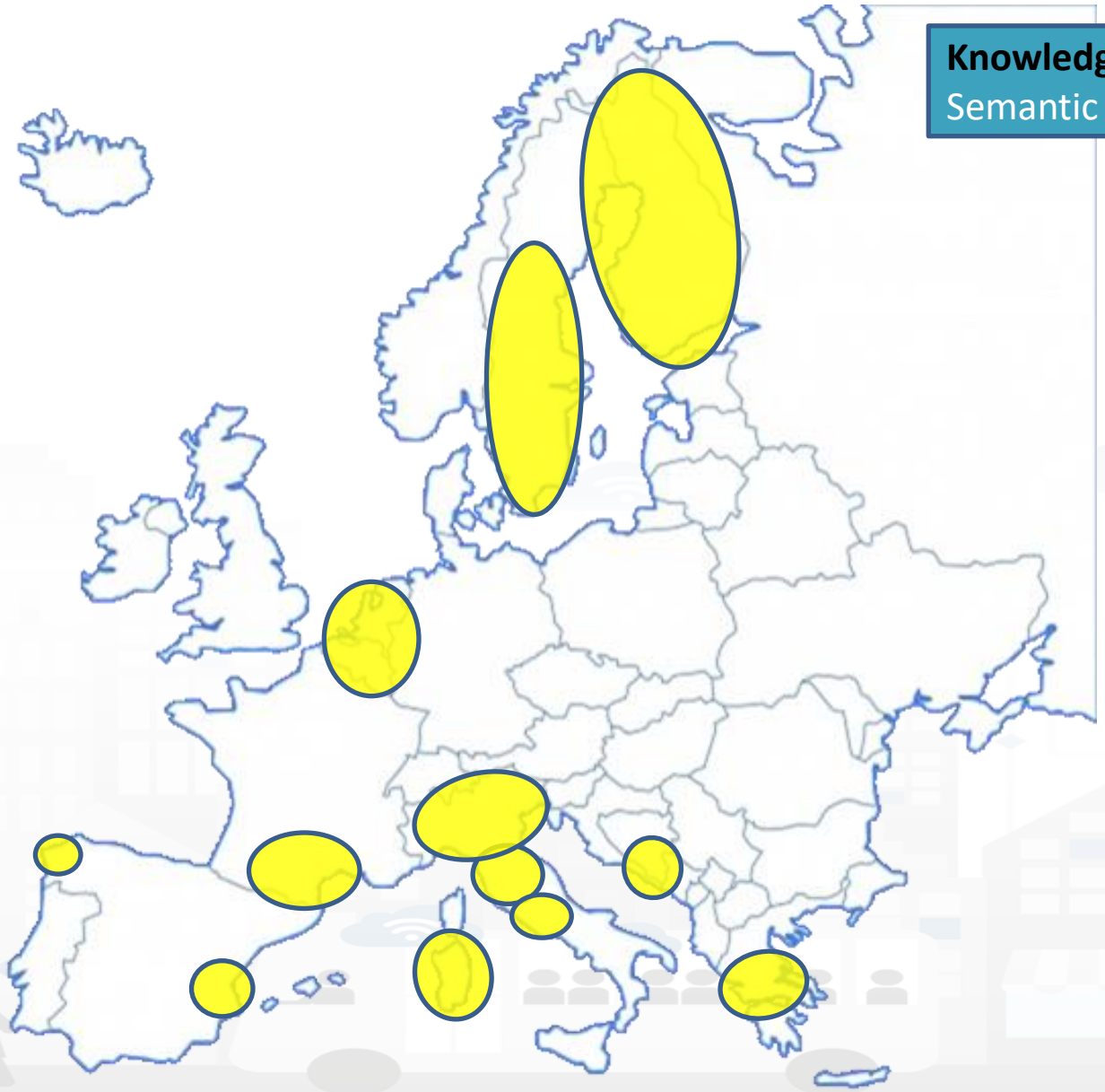
a) Overlap

b) Inclusion

Coverage 2022

Main Organizations/areas

- Antwerp area (Be)
- Capelon (Sweden)
- DISIT demo (multiple)
- Dubrovnik, Croatia
- Firenze area (I)
- Garda Lake area (I)
- Helsinki area (Fin)
- Livorno area (I)
- Lonato del Garda (I)
- Modena (I)
- Mostar, Bosnia-Herzegovina
- Pisa area (I)
- Pont du Gard, Occitanie (Fr)
- Roma (I)
- Santiago de Compostela (S)
- Sardegna Region (I)
- SmartBed (multiple)
- Toscana Region (I), SM
- Valencia (S)
- Venezia area (I)
- WestGreece area (Gr)



Federated ServiceMap and Smart City API

To improve scalability, fault tolerance and federation among cities:

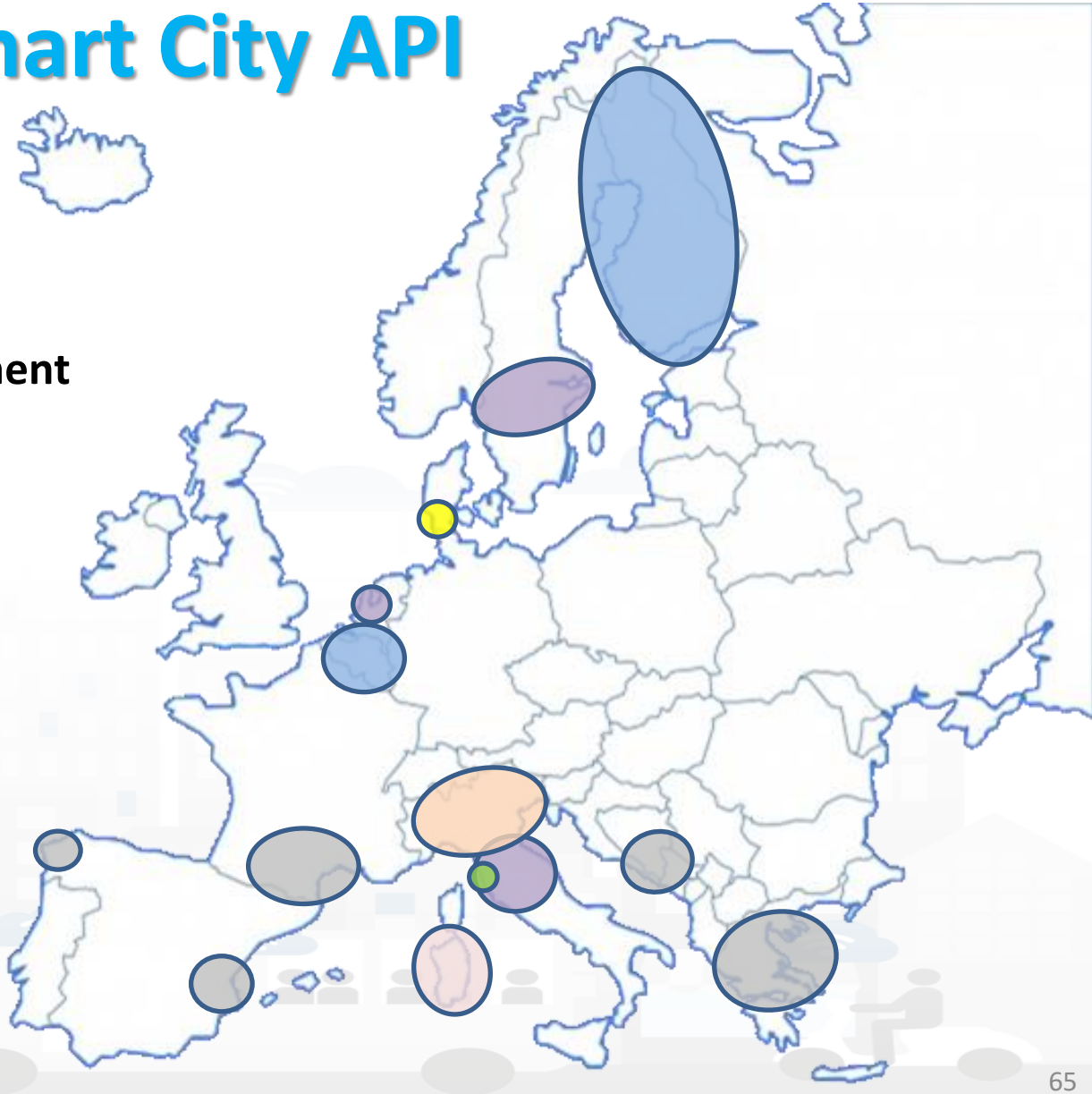
- **One entry point Smart City API for all zones**
- **Multiple Knowledge base See performance assessment**

At different levels:

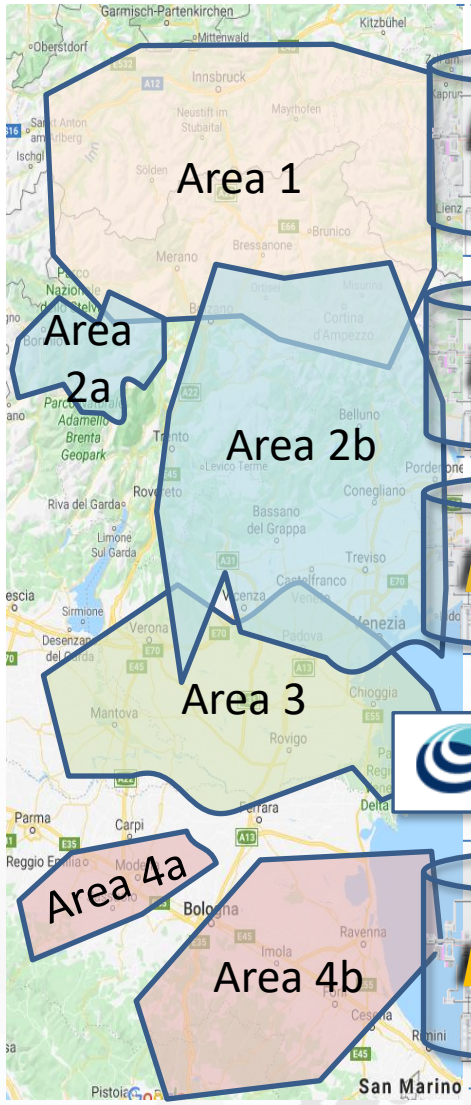
- Among cities/regions
- Among data providers, Operators

By Means of:

- Smart City API → Apps
- Smart City Ontology
- Dashboards/data analytics
- Organization independent



MultiServiceMap



Node a

Km4City

Smart City API

SUPER: Smart City API

Multi ServiceMap

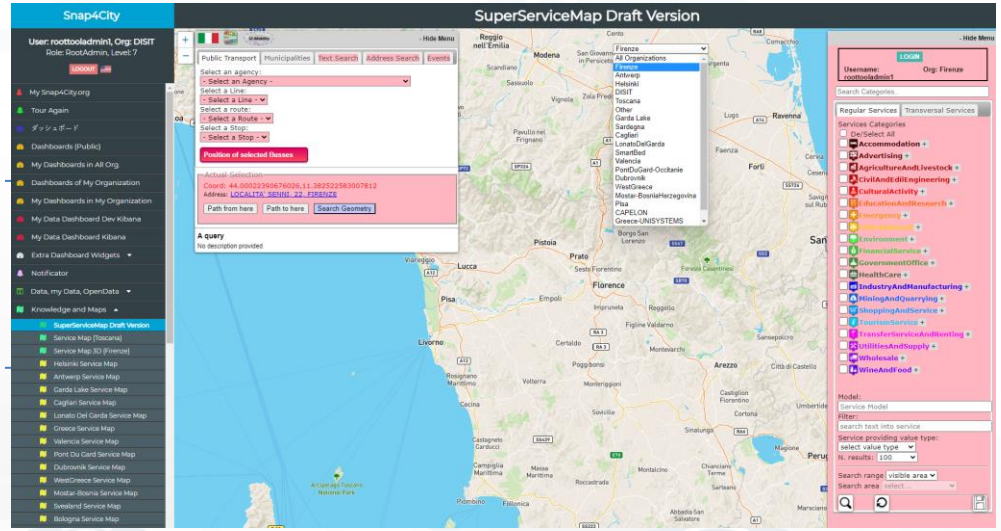
SUPER

FIWARE

SSM2ORION

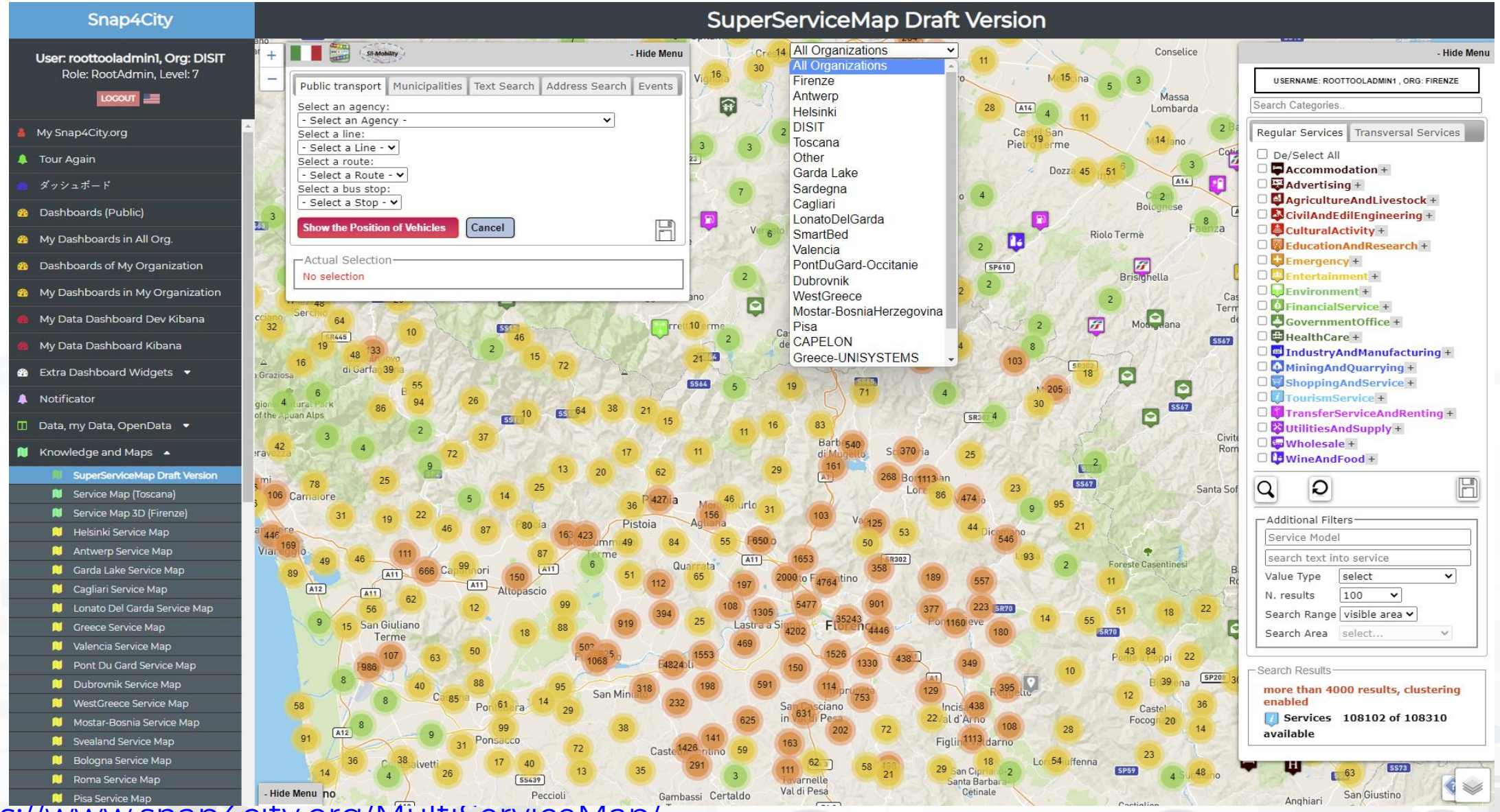
SUPER

Independent service



https://www.snap4city.org/MultiServiceMap/

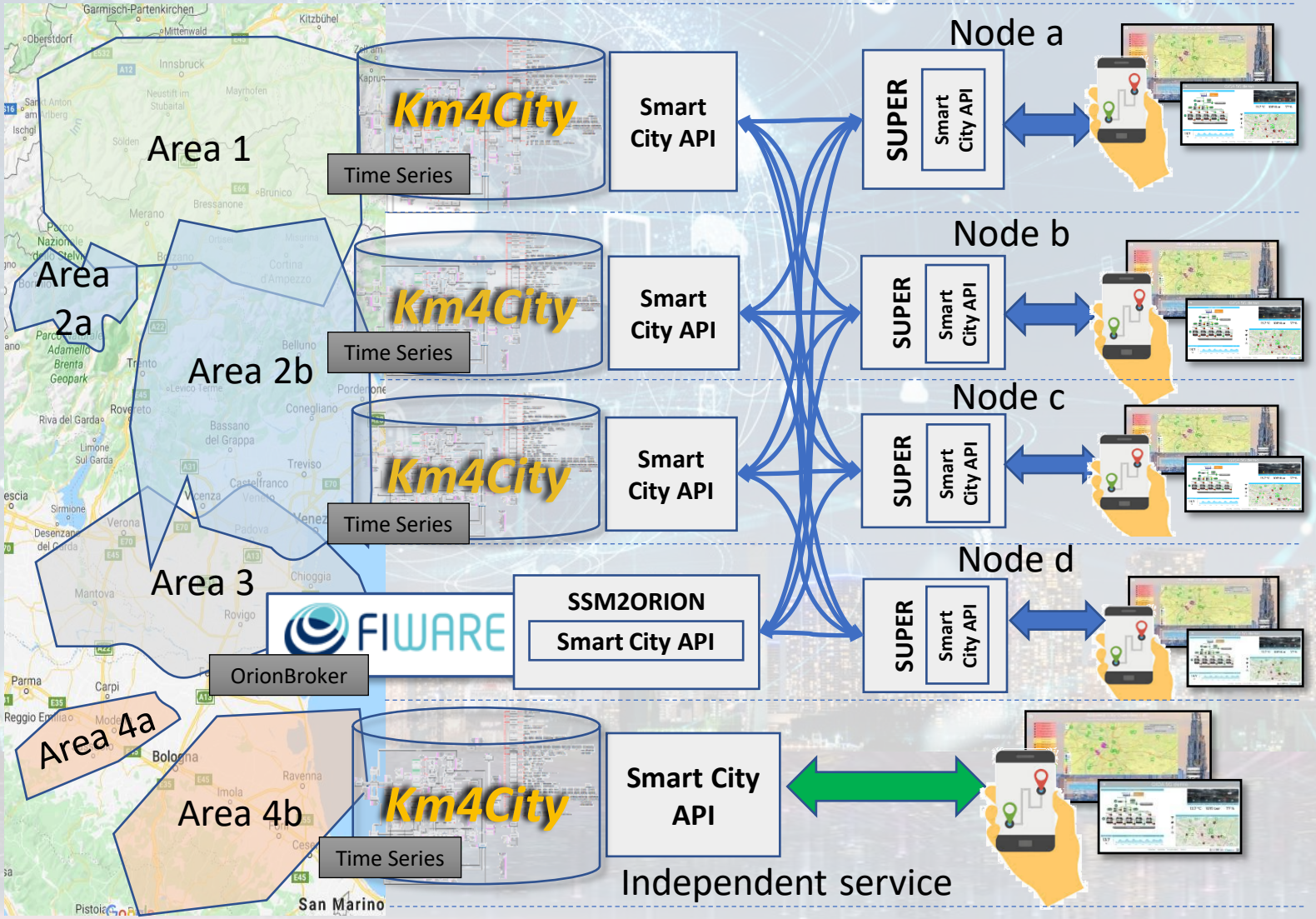
MultiServiceMap



https://www.snap4city.org/MultiServiceMap/

Federation of Smart City Services

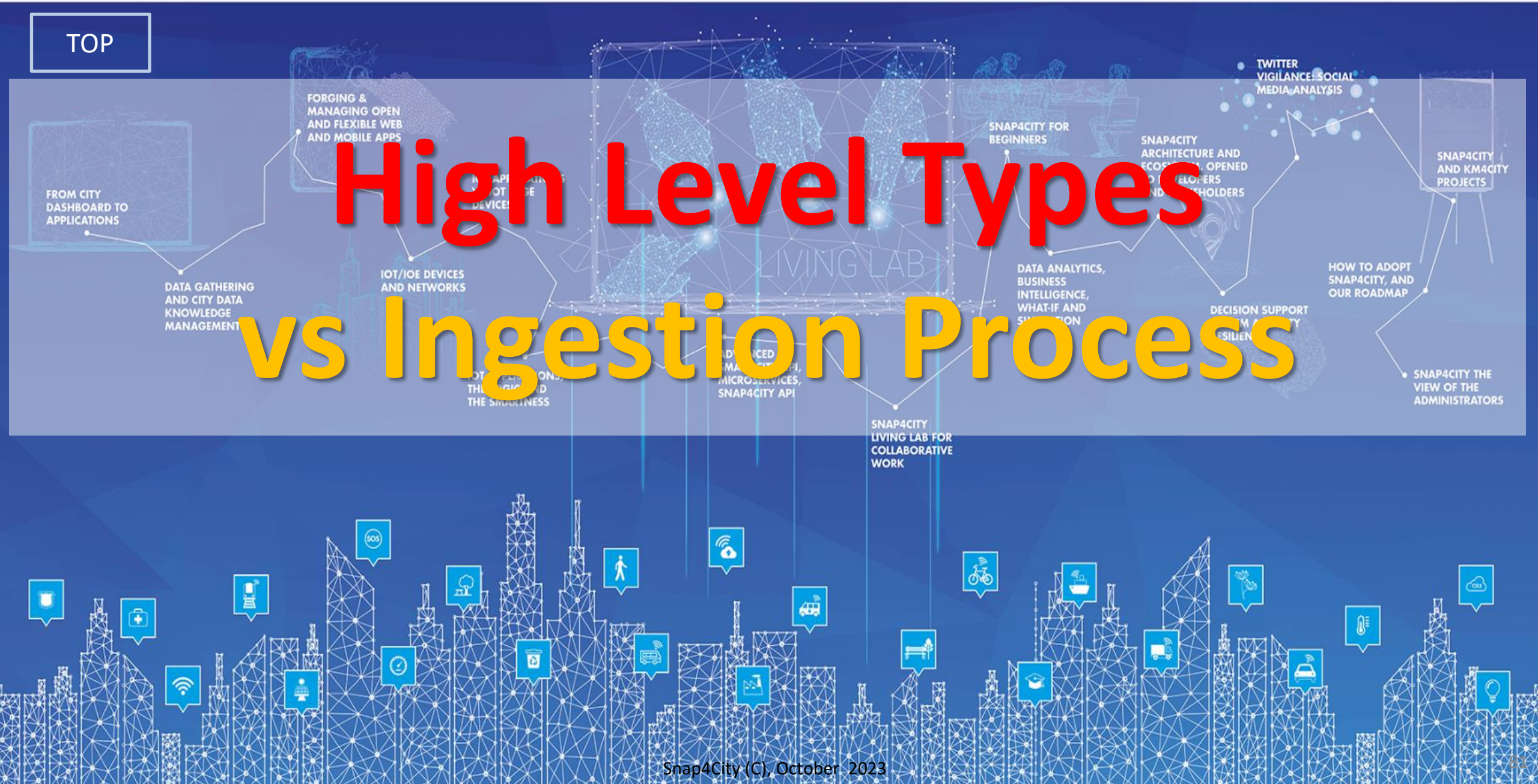
Knowledge Base
Semantic Reasoners



- Km4City **Semantic Reasoner**
- **ServiceMap** interoperability
- **Seamless for multiple Mobile Apps**
- **Smart City API**
- **Super**:
  - distributed access and sharing services
  - Each city control its own data
  - Final user can pass from one city / area to another in seamless manner: without changing the mobile Apps

Super

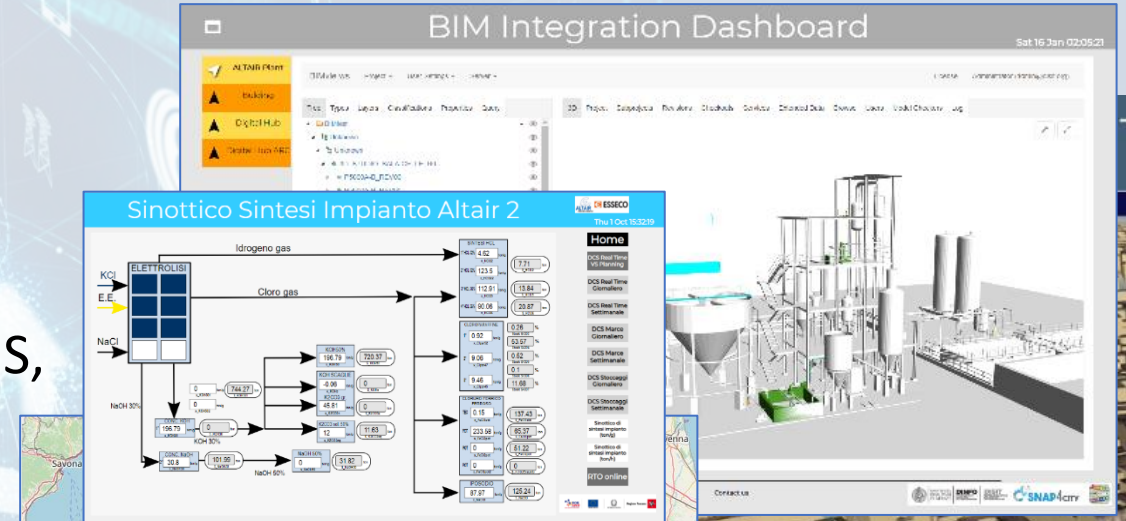
- Super, Nodes and SSM2ORION presents the same Smart City APIs.
- The **network of Super** can be reconfigured dynamically
  - Multiple networks of Super can be realized as well
  - Distributed Searches via the Federation of Super are performed with o(1) complexity
  - Results from an API rest calls are provided in real time also when the size of the network is large
  - Dashboard widgets and Mobile Apps are enabled to use the Super
  - Clients can pass from one Super to another transparently: moving devices
- Nodes
  - do not need to permanently share data
  - data can be of any size, the data shared is typically public since users of different KB are different and not refer to the same LDAP/KeyCloak authentication/authorization service.
  - may have different number of services
  - Services can be based on KB as well as on Brokers
  - Services managed as HLT of: Sensors, Sensor-Actuators, POI.
    - Data of other HLTs are managed independently from the other SmartCity API such as: MyKPI, External Services, WFS GIS, Heatmaps, special tools, etc. etc.
- The solution support disjoined nodes, federation and independent services

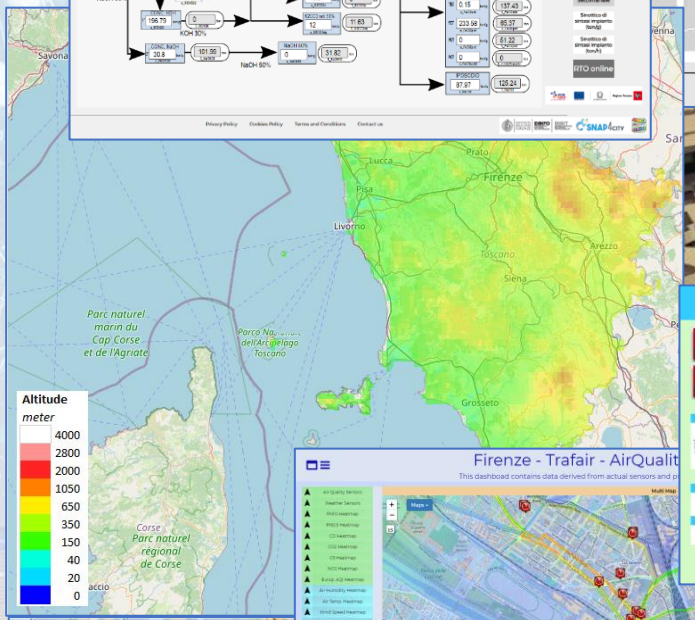


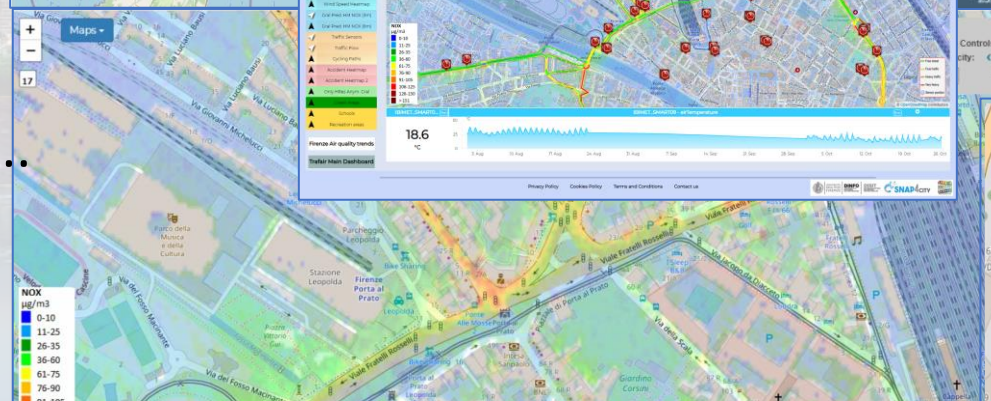
High Level Types vs Ingestion Process

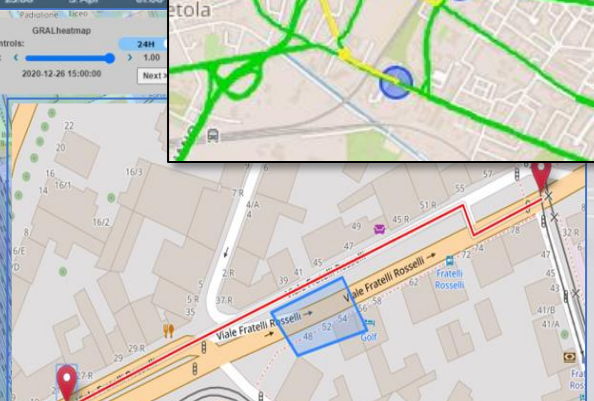
High Level Types

- POI, IOT Devices, shapes,..
  - FIWARE Smart Data Models,
  - IoT Device Models
- GIS, maps, orthomaps, WFS/WMS, GeoTiff, calibrated heatmaps, ..
- Satellite data, ..
- traffic flow, typical trends, ..
- trajectories, events, Workflow, ..
- 3D Models, BIM, Digital Twins, ..
- OD Matrices of several kinds, ..
- Dynamic icons/pins, ..
- Synoptics, animations, ..
- KPI, personal KPI,..
- social media data, TV Stream,
- routing, multimodal, constraints, ..
- decision scenarios, ….
- etc.









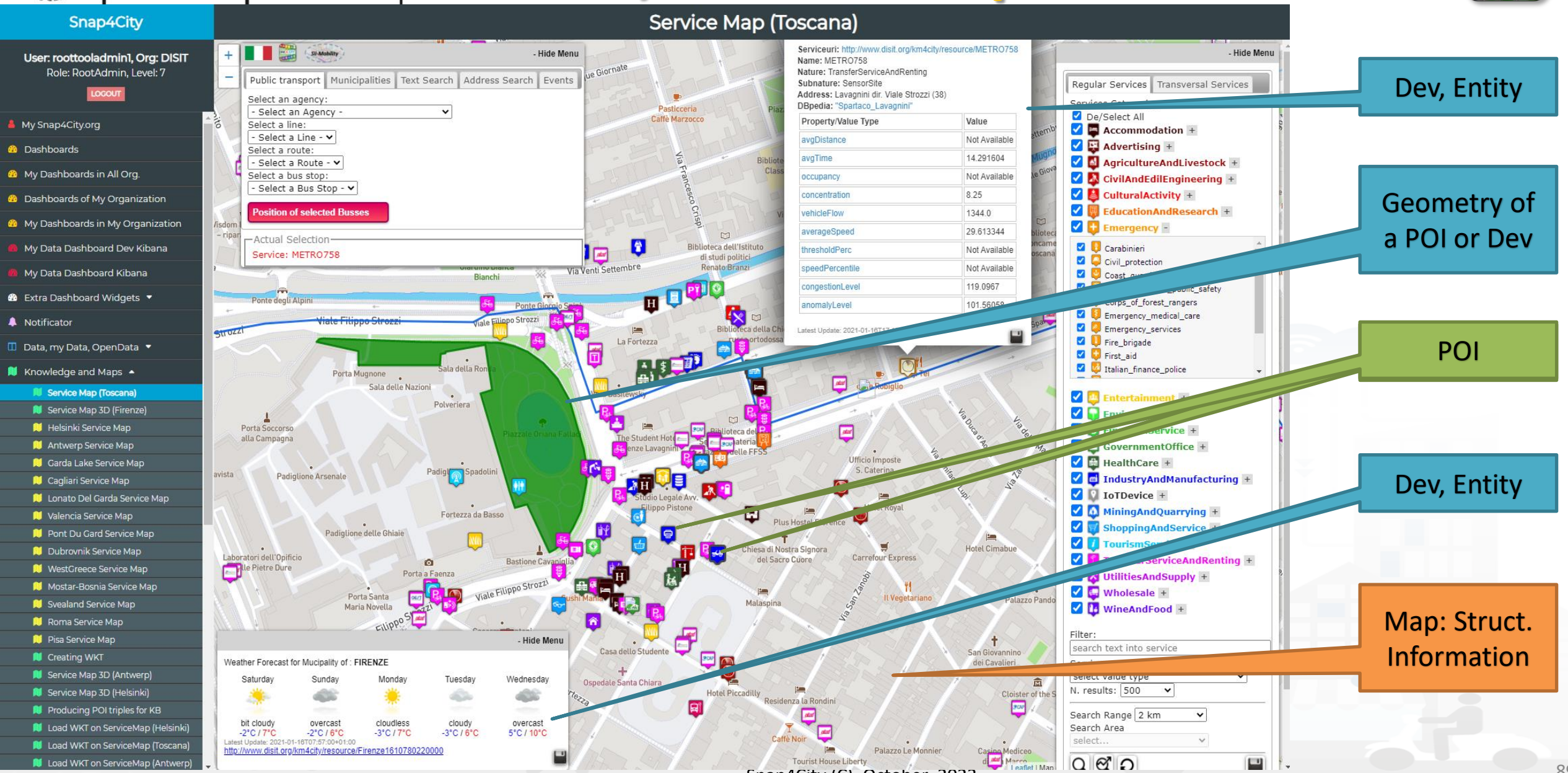
Standards and Interoperability (6/2023)

Compliant with:

- **IoT:** NGSI V2/LD, LoRa, LoRaWan, MQTT, AMQP, COAP, OneM2M, TheThingsNetwork, SigFOX, Libelium, IBIMET/IBE, Enocean, Zigbee, DALI, ISEMC, Alexa, Sonoff, HUE Philips, Tplink, BACnet, TALQ, Protocol Buffer, KNX, OBD2, Proximus, ..
- **IoT model:** FIWARE Smart Data Model, Snap4City IoT Device Models
- **General**: HTTP, HTTPS, TLS, Rest Call, SNMP, TCP, UDP, SOAP, WSDL, FTP, FTPS, WebSocket, WebSocket Secure, GML, WFS, WMS, RTSP, ONVIF, AXIS TVCam, CISCO Meraki, OSM, Copernicus, The Weather Channel, Open Weather, OLAP, VMS Milestone, ….
- **Formats**: JSON, GeoJSON, XML, CSV, GeoTIFF, OWL, WKT, KML, SHP, db, XLS, XLSX, TXT, HTML, CSS, SVG, IFC, XPDL, OSM, Enfuser FMI, Lidar, glTF, GLB, DTM, GDAL, Satellite, D3 JSON, …
- **Database**: Open Search, MySQL, Mongo, HBASE, SOLR, SPARQL, ODBC, JDBC, Elastic Search, Phoenix, PostGres, MS Azure, ..
- **Industry**: OPC/OPC-UA, OLAP, ModBUS, RS485, RS232,..
- **Mobility**: DATEX, GTFS, Transmodel, ETSI, NeTEx, ..
- **Social**:Twitter, FaceBook, Telegram, ..
- **Events**: SMS, EMAIL, CAP, RSS Feed, ..
- **OS**: Linux, Windows, Android, Raspberry Pi, Local File System, AXIS, ESP32, etc.

https://www.snap4city.org/65

KB, ServiceMap



Dev, Entity

Geometry of a POI or Dev

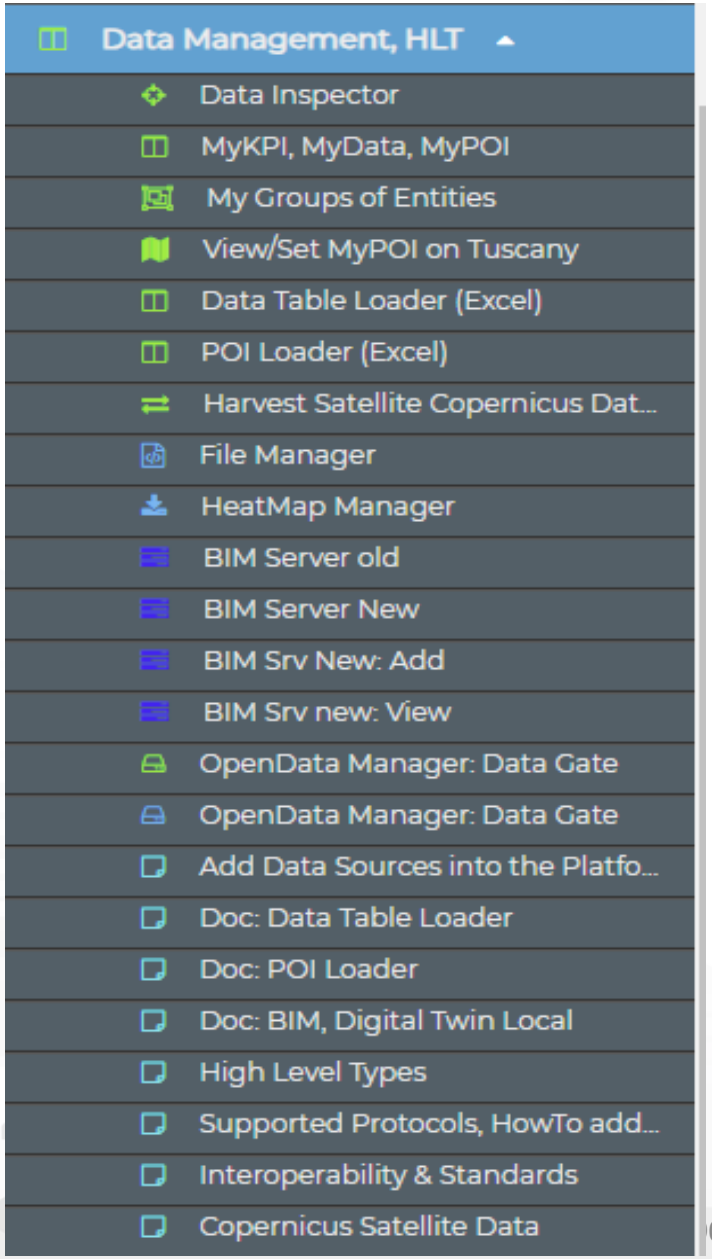
POI

Dev, Entity

Map: Struct. Information

Snap4City vs Formats

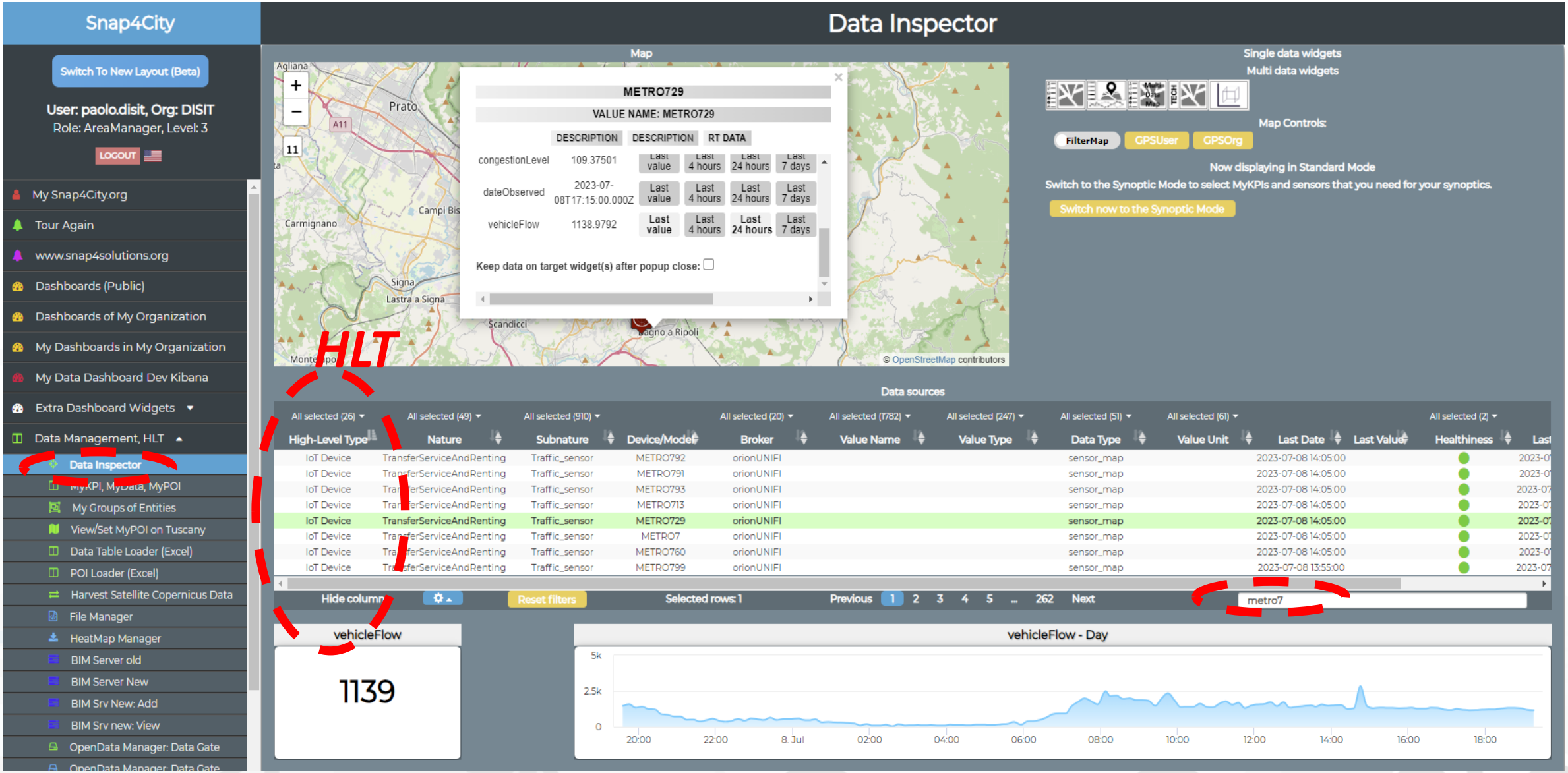
- ***Snap4City is capable to ingest*** and work with ***any format***:
  - Data **exchange**: JSON, GeoJSON, XML, HTML, HTML5, DATEX, GTFS, binary, etc.
  - **GIS formats:** WMF, WFS, heatmaps, ….
  - **Table**: CSV, XLSX, XLS, database, …
  - **Road graphs:** OSM, triples, geoJSON, etc.
  - **graphics:** IFC, Shape, WKT, SVG, …
  - **archive** file formats: zip, rar, 7z, tgz, pdf, …
  - **image** formats: png, gif, tiff, geoTiff, ico, jpg, …
  - **ODM**: JSON and other formats
  - **Traffic Flow**: JSON and other formats
  - **Heatmaps**: GeoTIFF, JSON, etc.
  - **video** formats: mp4, avi, mov, RTSP, …
  - **3D elements**: GLB, DWG, IFC, etc.
- Search the format you need to cope on the search box of Snap4City portal!: **Snap4City Supported Protocols, adding new protocols**



How to ingest with most relevant HLT

main High Level Types	1st option	2nd option
POI, Point of Interest	**IOT App/Proc.Logic or POI Loader (from EXCEL files)**	Create an **Entity Model, Entity Registration**, ingest via IoT App
IoT Devices, KPI multivariable, WoT, Entities Instances	Create an **Entity Model, Entity Registration**, ingest via broker (e.g., Time Series) or IoT App/proc.Logic	**Data Table Loader (from EXCEL files)**
GIS data	Use GIS API from IoT App/Proc.Logic, Create an **Entity Model, Entity Registration**, ingest via IoT App/Proc.Logic	Load them on GeoServer
Satellite Data	Use Snap4City tool to download satellite data and push them into the **Heatmap Manager/GeoServer**, via API	***(seen in Course Part 3)***
Traffic Flow	Compute the traffic flow and/or load them into the **TrafficFlow Manager**, via API	***(seen in Course Part 3)***
Heatmaps	Compute them and/or push them into the **Heatmap Manager/GeoServer, via** API	***(seen in Course Part 3)***
OD Matrices	Compute the ODM and/or push them into the **OD Manager**, via API	***(seen in Course Part 3)***
BIM Models	Produce them on some BIM editor, convert into IFC and load them on **BIM Manager** and server	***(seen in Course Part 3)***
MyKPI (single var)	Create them on **MyKPI Manager**, save/load by using IoT App / Proc.Logic and/or API	***(seen in Course Part 2)***

Data Inspector



HLT wrt to Time Series, GPS and Geometry

High Level Types	Evolution over time ?	May have GPS/Geom
POI, Point of Interest	**Sporadically, for versioning**	*Yes/Yes*
IoT Devices, KPI multivariable, WoT Entities	A set of values for each time instant of observation (dateObserved)	*Yes/Yes*
GIS data	**Sporadically, for versioning**	*Yes/Yes*
Satellite Data	An image for each time instant of observation (dateObserved)	*Yes/Yes*
Traffic Flow	A Traffic Flow network for each time instant of observation (dateObserved)	*Yes/Yes*
Heatmaps	An Heatmap for each time instant of observation (dateObserved)	*Yes/Yes*
OD Matrices	An ODM for each time instant of observation (dateObserved)	*Yes/Yes*
BIM Models	**Sporadically, for versioning**	*Yes/Yes*
MyKPI (single variable)	A value for each time instant of observation (dateObserved)	*Yes/no*
3D model data	**Sporadically, for versioning or for model kind for example**	*Yes/Yes*
Messages exchanged with Dashboards	*A set of values for each time instant of observation (dateObserved)*	*No/No*
Messages exchanged with Synoptics	*A set of values for each time instant of observation (dateObserved)*	*No/No*

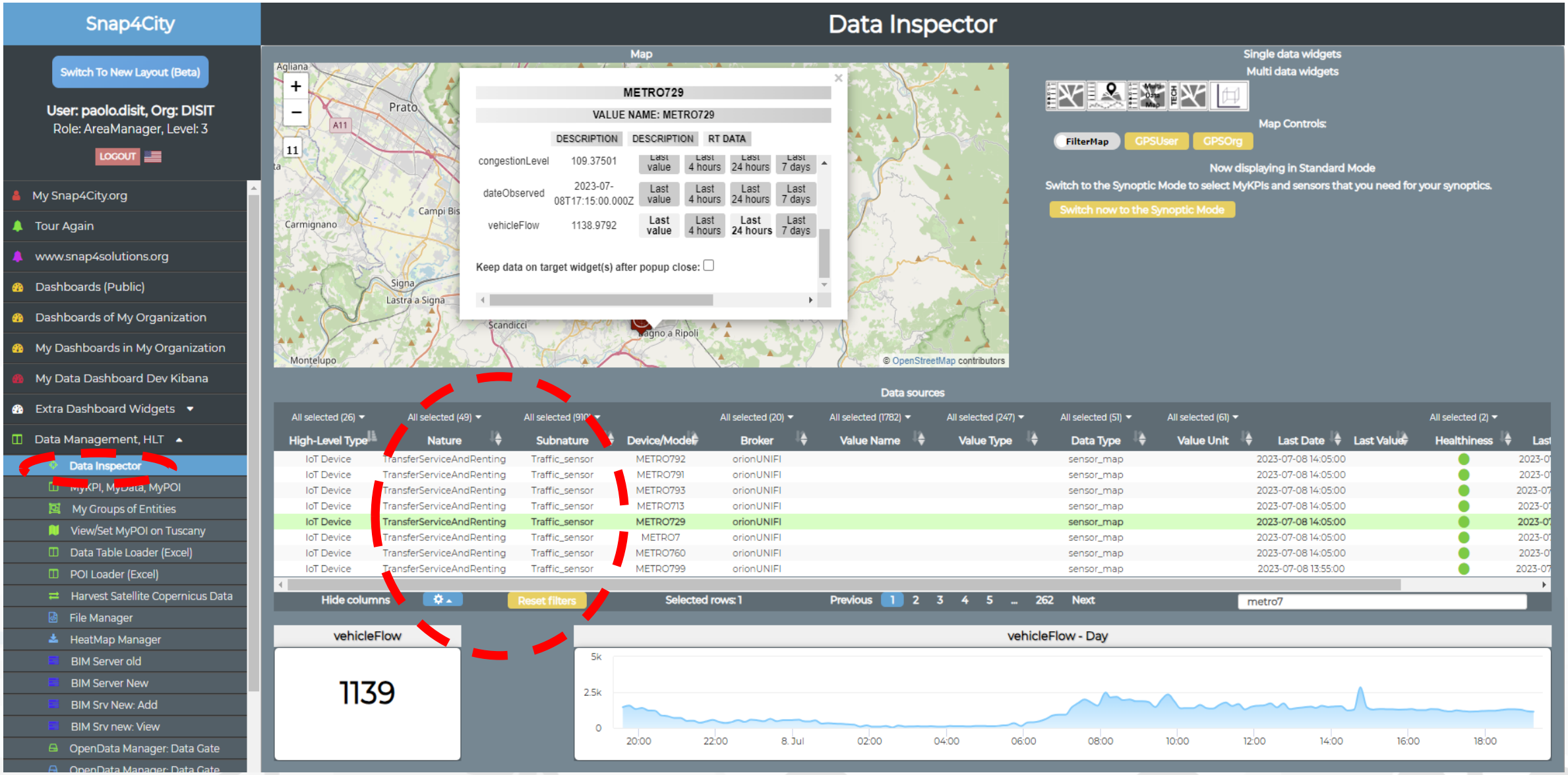
SubStantially

- **Entities** are used to model Digital Twins and thus:
  - POI, MyPOI, KPI, MyKPI, IoT Devices, etc.
  - **including: metadata info, time series, GPS position, geometries, hyper Links, and Actions which are links to tools/functions/processes to Act on them**
- **Complex Data** such as used to model spec. aspects as Traffic Flow, Heatmaps, ODM, BIM, TV cameras, 3D elements, .. :
  - Are placed on map as an Entity plus **additional information** into a dedicated <data> Manager
  - **Entity includes**: **metadata info, time series, GPS posizione, geometries, iper Links, and Actions which are links to tools/functions/processes to Act on them**

Classification by Nature/SubNature

Semantic Classification

Data Inspector



Any Entity has a Semantic *Classification*

Nature

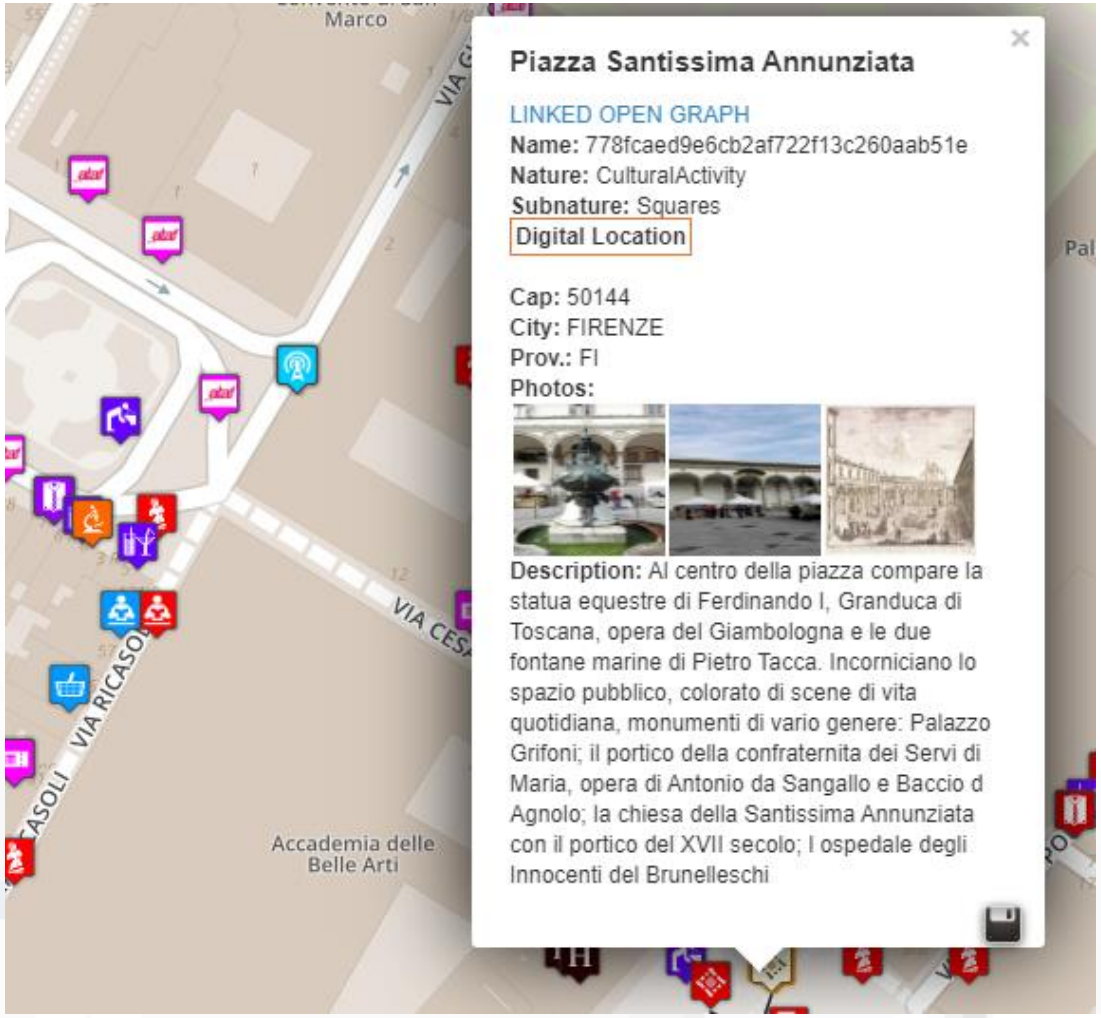
- Accommodation +
- Advertising +
- AgricultureAndLivestock +
- CivilAndEdilEngineering +
- CulturalActivity +
- EducationAndResearch +
- Emergency +
- Entertainment +
- Environment +
- FinancialService +
- GovernmentOffice +
- HealthCare +
- IndustryAndManufacturing +
- IoTDevice +
- MiningAndQuarrying +
- ShoppingAndService +
- TourismService +
- TransferServiceAndRenting +
- UtilitiesAndSupply +
- Wholesale +
- WineAndFood +

SubNature

EducationAndResearch -

- Educational_support_activities
- Higher_education
- Language_courses
- Performing_arts_schools
- Post_secondary_education
- Pre_primary_education
- Primary_education
- Private_high_school
- Private_infant_school
- Private_junior_high_school

SKOS

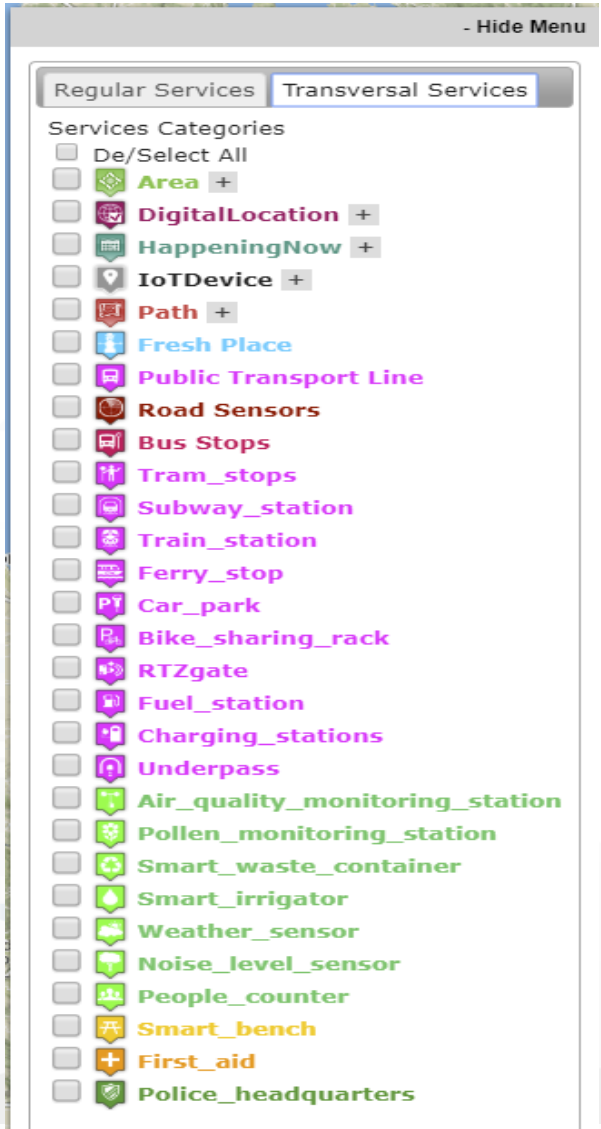


Point of Interests, POI

mainly static data

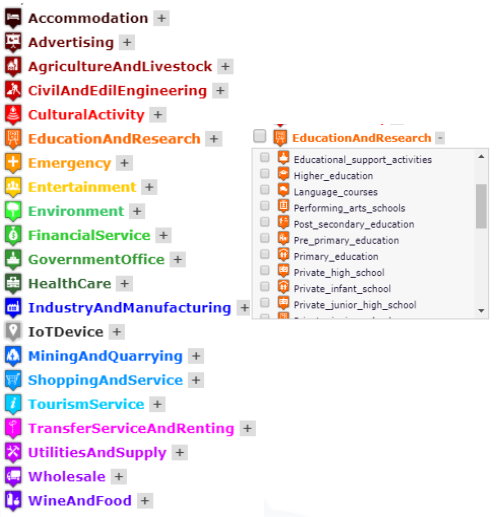
Access to Point of Interest information, POI

- **POI**: point of interest
- **type**: macro (nature) and subcategories (subnature)
- **Position**: GPS, address, telephone, fax, email, URL, …
- **Description**: textual, multilingual, with images, …
- **Link** to dbPedia, Linked Open Data
- **Links to other services**
  - **Not Real time data if any, please use Entities / devices connected:** sensors data, timeline, events, prices, opening time, rules of access, status of services, status of queue, etc..
- *See transversal services on ServiceMap*
  - *Regular and in test platform*



POI, Point of Interest

- They are
  - classified in terms of nature/subnature
  - relevant services with codified metadata to simplify the massive management of huge amount of POIs
  - mapped on Knowledge Base on **specific GPS location**
  - Do not move over time
  - represented as PIN
- Do not have Time Series for variable over time
- May sporadically change over time



Time Series can be:
IoT Devices, MyKPI, Entities, etc.

What About a Time Series

IOT Device

Entity: IOT Device

Sends a message

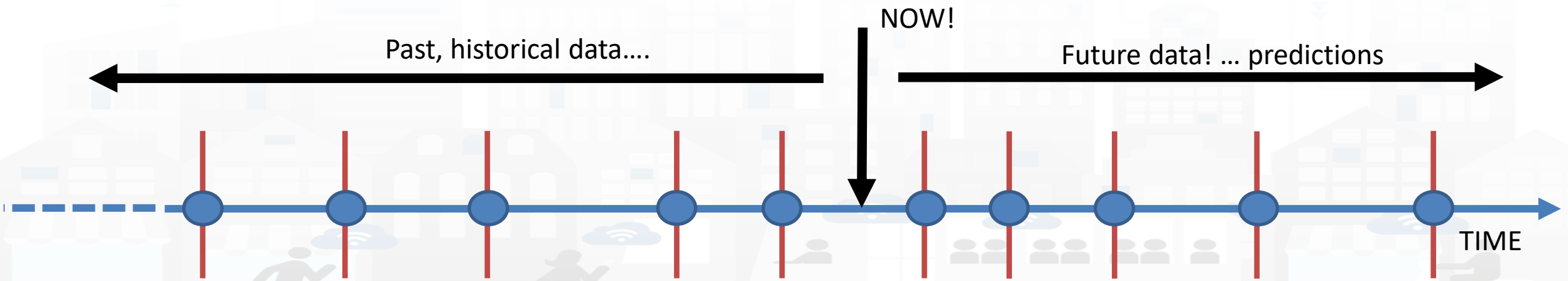
Message (
timestamp: 02-04-2020 at 10:30,
Temperature: 29.34,
Humidity: 35
)

dateObserved	Temp	Humidity
02-04-2020 10:30	34.5	23
02-04-2020 10:40	36.5	24
02-04-2020 10:50	36.0	22.5

- A set of data coming from an IoT Device with multiple sensor become a time series of values for devices.
  - For example: taking a new measure every 10 minutes (Red Lines)
  - Non regular rates can be valid data as well.
- Each new measure in Snap4City is conventionally time located in «dateObserved», which has to be **Unique.**
  - **Only one message per dateObserved is allowed**

Time Series: they are data streams

- As soon as you have a variable changing over time → time series
  - You are ready to get Future data, may be arriving in PUSH
  - Recall and store historical data as well, but they have to be
    - recalled in PULL with some IoT App/Proc.Logic
    - Loaded in PULL with some File or Data Table Loader



A time series

The messages posted on Entity Instances / IoT Devices can produce different effects on time series.

Omitting the message would allow the broker to reuse the last data to fill it, as for V5, which appear

- valid in all messages on graphs
- With holes in tables

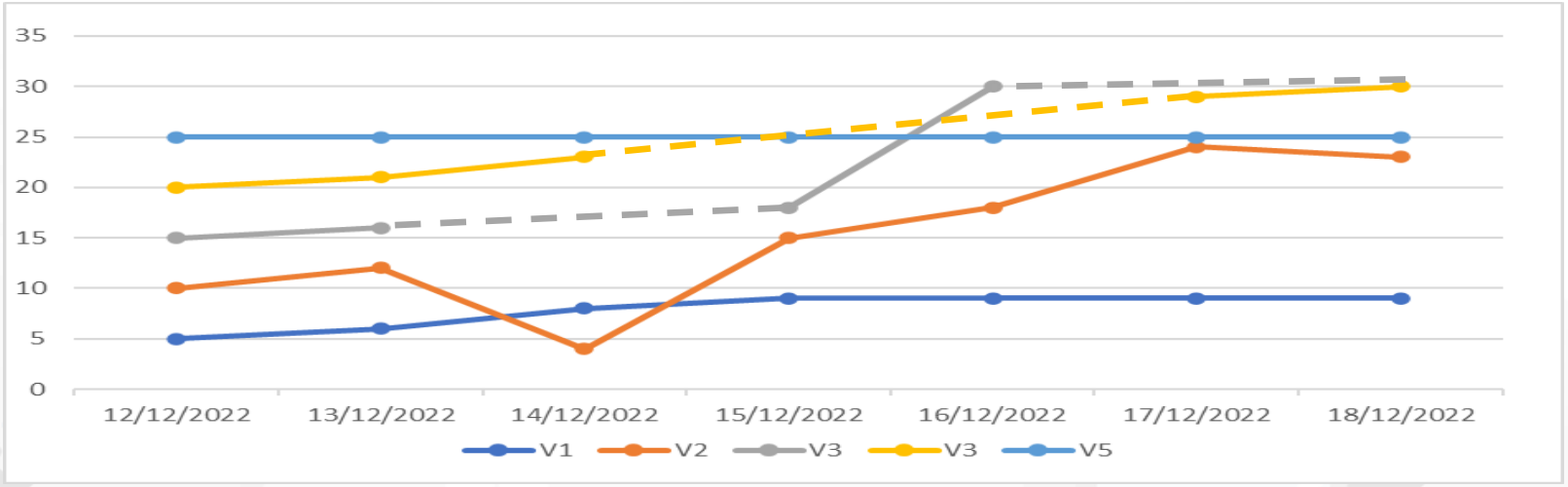
Putting null values (as in V3) would produce a missing data and thus would lead to create:

- interpolate line on graphs: dashed are actually continuous lines in Dashboards
- Empty values in the tables

device42 Entity Messages over time

Color for missed

12-12-2022	13-12-22	14-12-22	15-12-22	16-12-22	17-12-22	18-12-22
V1: 5	5	6	8	9	9	9
V2: 10	10	12	4	15	18	24
V3: 16	15	16	null	18	30	null
V4: 20	20	21	23	null	null	29
V5: 25	25	25	25	25	25	25



IoT Devices, Entities Instances, WoT

IoT Device Models

IoT Device

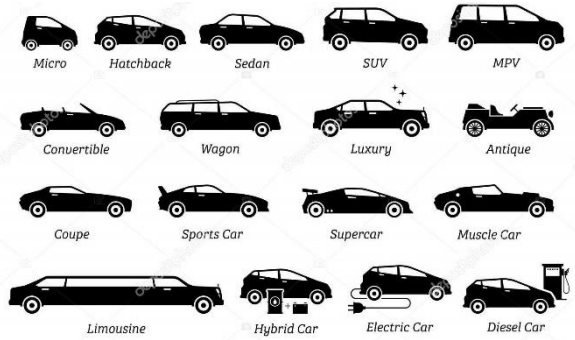
- Name: CM23
- Model: Lavazza
- Position: …….

IoT Device Variables

- dateObserved: ……..
- ID: CM23
- Status: ready
- Temperature: 70°
- WaterLevel: 35%
- UsedCapsBox: 30%
- Power: OK
- …..

- Conceptually are Devices with sensors/actuators, IN/IN-OUT
- They are classified in terms of nature/subnature
- For Searching and showing on maps and dashboards
  HLT of Devices/Entities can be:
  - **(IoT Device) Entity Models**, for example: «personal coffee machine»
  - **Entity** name, for example: «mycoffemachine1», «CM23»
  - **Entity Variable**, for example: «Temperature»

Mobile Devices/Entities



Mobile Device Models

Mobile Device

- Name: BMWJD7356HD
- Model: BMW 318
- Spec:…

Mobile Entity/device Variables

- ID: BMWJD7356HD
- **dateObserved: ……..**
- Status: ready
- Temperature: 70%
- Gasoline: 35%
- Velocity: 231,3 Km/h
- **Position: 44.3223, 11.3432**
- …..

- They are a special case of devices/entities
  - they are managed as Devices/Entities in the system
- They are classified in terms of nature/subnature
- For Searching and showing on maps and dashboards, they are different
  HLT of Mobile Devices/entities can be:
  - **Mobile Entity Model**, for example: «sedan»
  - **Mobile Entity Instance** name, for example: «BMW JD7356HD», «Ford KO786KK»
  - **Mobile Entity Variable**, for example: «velocity»

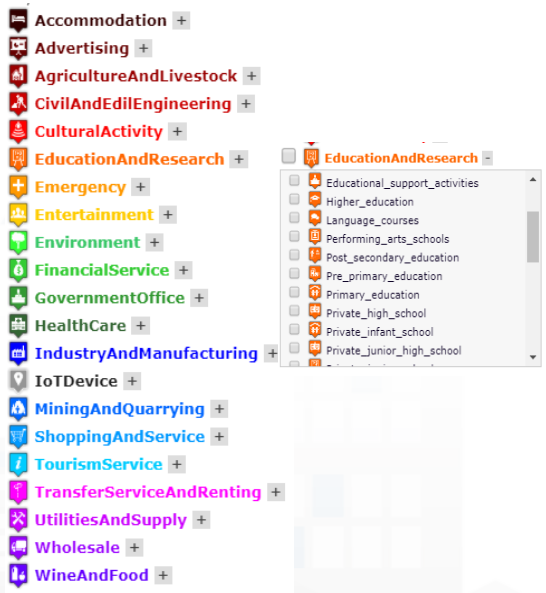
Sensor/Sensor-Actuator

IoT Device

- Name: CM23
- Model: Lavazza
- Position: …….

Sensors

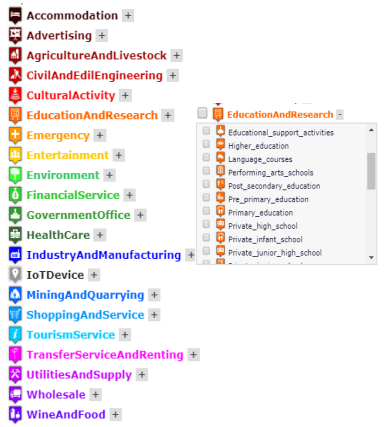
- **dateObserved: ……..**
- ID: CM23
- Status: ready
- Temperature: 60°
- WaterLevel: 35%
- UsedCapsBox: 30%
- Power: OK
- …..



- They are classified in terms of nature/subnature
- For Searching and showing on maps and dashboards **HLT of Sensors/Sensor-Actuator** can be:
  - **Sensor Device** name, for example: «mycoffemachine1», «CM23»
  - **Sensor/sensor-actuator** is a variable of a Sensor Device, for example: «Temperature»
- They do not have a model, while, in KB, have a reference process from which their real time data are collected from the field, from gateways, etc..

KPIs, Key Performance Indicators

- They are classified in terms of nature/subnature
- **Typically associated with**
  - **City or infrastructure, so that the GPS can be city center**
  - Some date: 2019, march 2019, etc.
- **For example:**
  - Number of Arrivals from France in March 2019
  - Average price for **** hotels in 2019, downtown
  - Net income of the region
  - CO2 saved in the April 2020
  - Total number of vehicles sold in 2020
  - Stock option value of Airport
- **Note that in most cases:**
  - They are time series, change over time, by year
  - they can be managed as ***Virtual IoT Devices***



Data from INSETE

Basic Sizes of Incoming Tourism

Basic Sizes of Incoming Tourism of the Region of Western Greece 2019

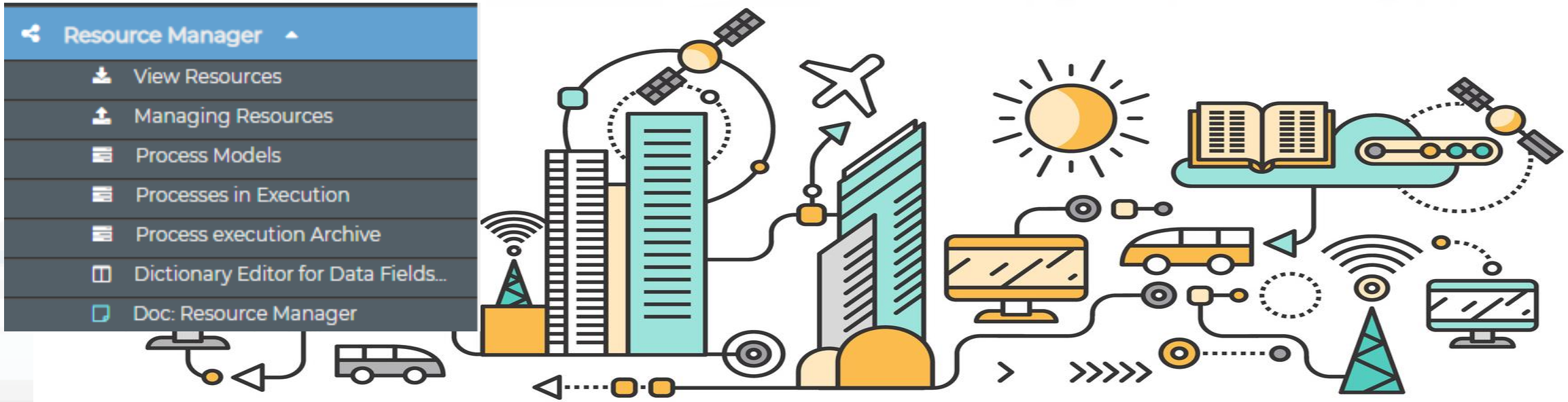
Regions	Countries Origin	Visits (in thousands)	Receipts (in € million)	Nights (in thousands)	Expenditure / Visit (in €)	Cost / Night (in €)	Average Length of Stay
West Hellas	Albania	132.9	26.5	225.8	199.7	117.5	1.7
	United Kingdom	47.7	17.9	345.8	375.2	51.8	7.2
	Germany	70.3	36.4	672.4	517.9	54.1	9.6
	France	55.4	16.5	321.6	298.1	51.4	5.8
	Other	510.7	160.0	2,964.9	313.3	54.0	5.8
	Total	**817.0**	**257.4**	**4,530.4**	**315.0**	**56.8**	**5.5**
	% of the total	**2.2%**	**1.5%**	**1.9%**			

Source: BoG Border Research, INSETE Intelligence Editing

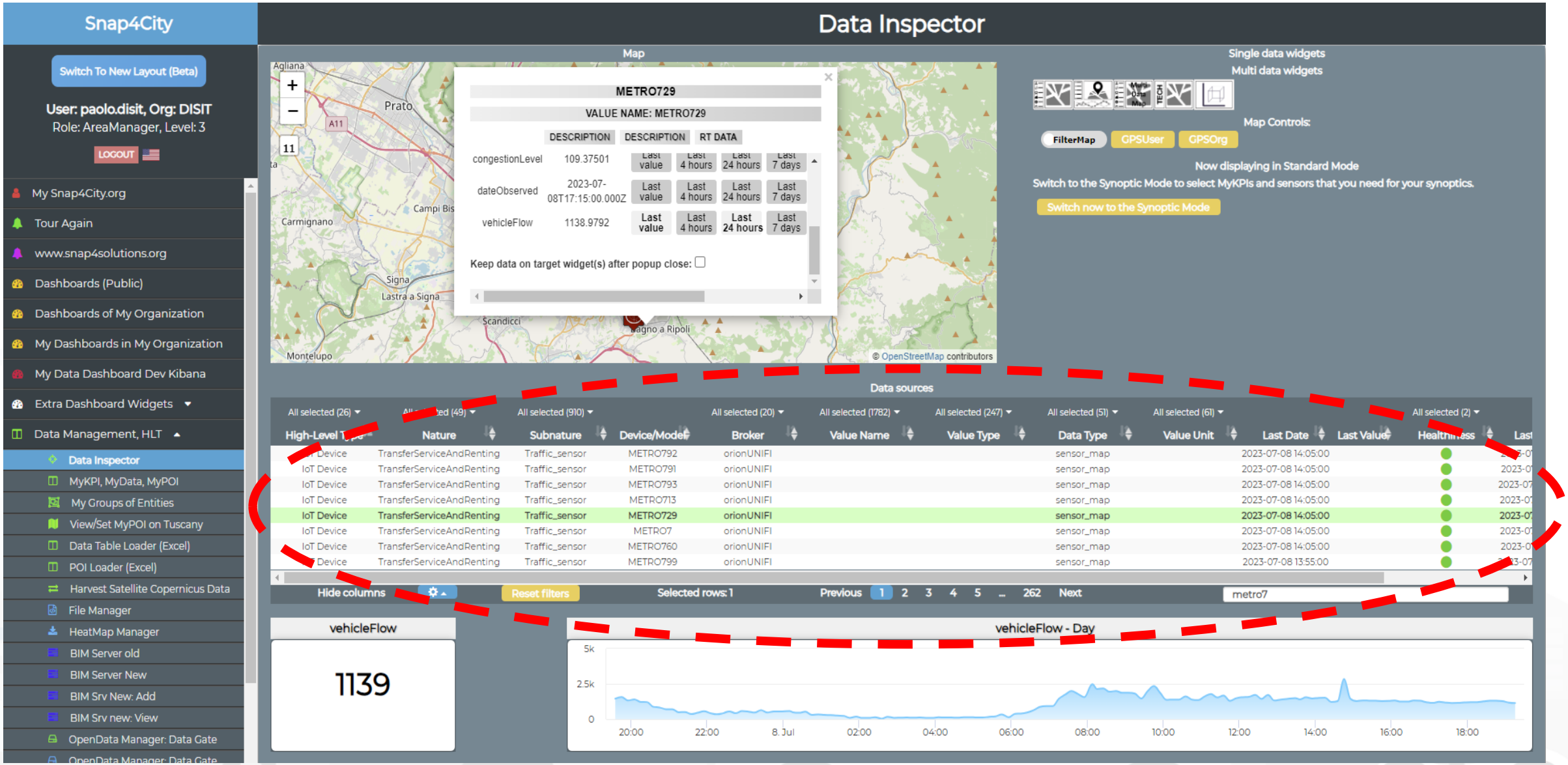
Basic Sizes of Incoming Tourism of the Region of Western Greece 2018

Regions	Countries of Origin	Visits (in thousands)	Receipts (in € million)	Nights (in thousands)	Expenditure / Visit (in €)	Cost / Night (in €)	Average Length of Stay
West Greece	Albania	138.7	29.0	222.9	209.2	130.1	1.6
	United Kingdom	42.6	13.5	180.6	317.6	74.9	4.2
	Germany	71.3	26.0	466.5	365.1	55.8	6.5
	France	44.2	13.5	262.9	304.7	51.2	6.0
	Other	402.5	129.8	2,050.7	322.4	63.3	5.1
	Total	**699.2**	**211.8**	**3,183.5**	**302.9**	**66.5**	**4.6**
	% of the total	**2.0%**	**1.4%**	**1.4%**			

Classification of Variables of Devices, Entities, Sensors, etc. Data Dictionary



Data Inspector



HLT: Unified Classification for Data and Services

IoT Device Variable, Sensor Device	All selected (15)	All selected (48)	All selected (27)		All selected (1499)	All selected (159)	All selected (15)	All selected (63)		All selected (2)		All selected (2)
High-Level Type	Nature	Subnature	Device/Model	Broker	Value Name	Value Type	Data Type	Value Unit	Last Date Last Value	Healthiness	Last Check	Ownership
IoT Device Variable	IoTDevice	IoTSensor	devicetest1	orionUNIFI	temperature	temperature	float	°C			2021-10-15 10:01:02	private (My Own)
IoT Device Variable	IoTDevice	IoTSensor	devicetest1	orionUNIFI	humidity	humidity	float	#			2021-10-15 10:01:02	private (My Own)
IoT Device Variable	IoTDevice	IoTSensor	MyThermometer_001	orionUNIFI	temperature	temperature	float	°C			2021-10-15 10:01:01	private
IoT Device Variable	IoTDevice	IoTSensor	MyThermometer_001	orionUNIFI	humidity	humidity	float	#			2021-10-15 10:01:01	private
IoT Device Variable	IoTDevice	IoTSensor	adminTest1	orionUNIFI	temperature	temperature	string	°C	2018-05-31 19:16:05		2021-10-15 10:01:00	private (My Own)
IoT Device Variable	IoTDevice	IoTSensor	adminTest1	orionUNIFI	humidity	humidity	string	%	2018-05-31 19:16:05		2021-10-15 10:01:00	private (My Own)
IoT Device Variable	IoTDevice	IoTSensor	newmarcodev1	orionUNIFI	temperature	temperature	float	°C			2021-10-15 10:00:59	private
IoT Device Variable	IoTDevice	IoTSensor	newmarcodev1	orionUNIFI	humidity	humidity	float	%			2021-10-15 10:00:59	private

Hide columns | Reset filters | Selected rows: 1 | Previous 1 2 3 4 5 ... 2466 Next | Search

High Level Types

Nature

SubNature

Semantic Classific.

Dev/Model name

Broker name

Technical Source

Value Name

Value Type

Data Type

Value Unit

Variables, names

Last Date/Time

Last Value

Real Time

Healthiness

Last Check

Status

Ownership

Organization

For Admin

Main HLT diff.

- **HLT: MyKPI**
- **Nature: Industry and manufacturing**
- **Subnature: Chemical**
- **Value Name**: CloroParaffine
- **Value Type: Density percentage**
- **Value Unit: %**
- **Data Type**: float mykpi
- **Last Date**: 2019-02-25 *«DateTime»*
- **Last Value**: 87.0
- **Healthiness**:
- **Last Check**: 2020-04-03 10:28:12
- **Ownership**: private for xyz…
- **Organization**: Firenze

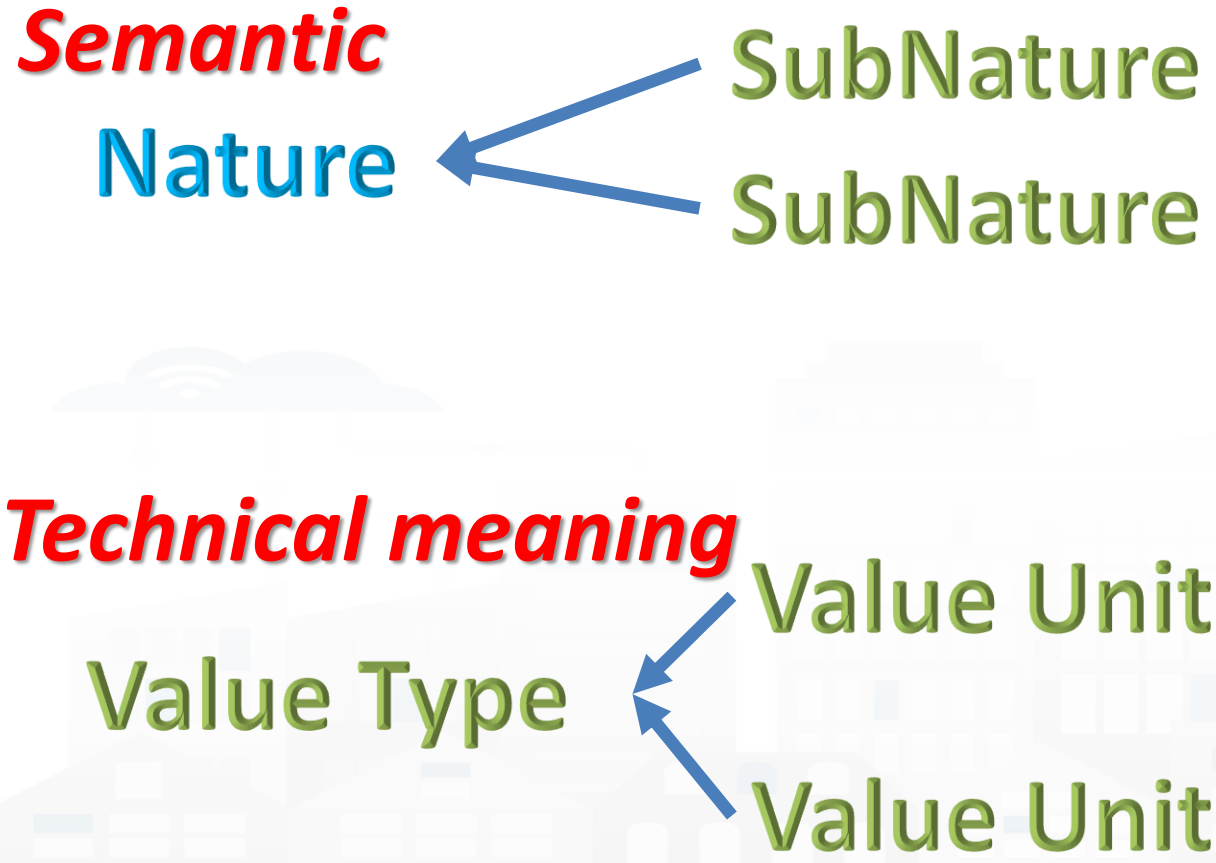
Single Variable for MyKPI

- **HLT: IoT Device, Sensor Device, Data Tab Devic**
- **Nature: Industry and manufacturing**
- **Subnature: Chemical**
- **Value Name**: Irrigator fioriera Gag
- **Value Type: Battery Level**
- **Value Unit: V**
- **Data Type**: float
- **Last Date**: 2020-04-01 12:59:00 *«dateObserved»*
- **Last Value**: 5.18
- **Healthiness**:
- **Last Check**: 2020-04-03 03:28:12
- **Ownership**: public/private
- **Organization**: Firenze

This Section is repeated for each variable

an IoT Device may have multiple Sensors/variables

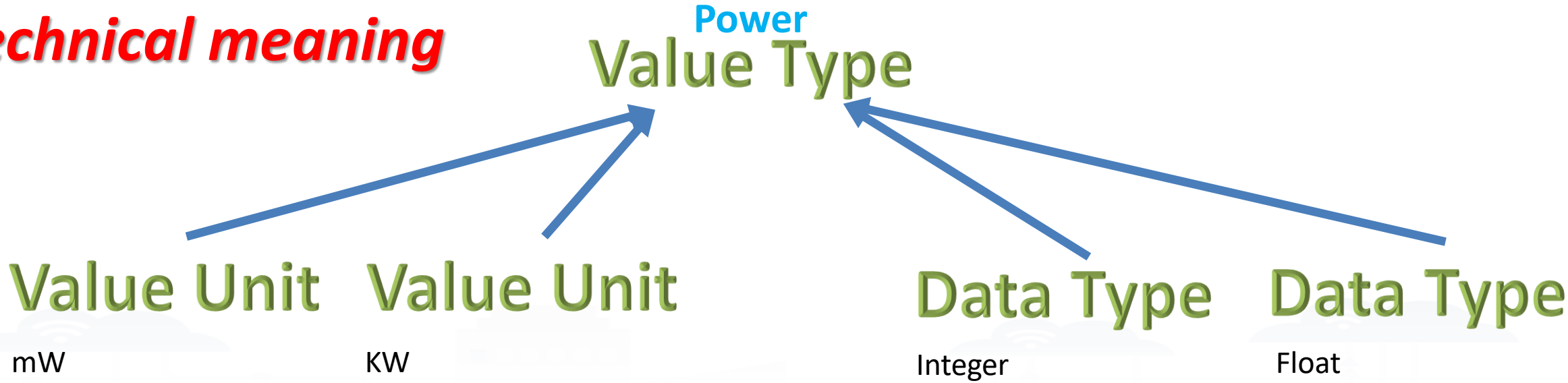
Unified Data and Services Model/Classification



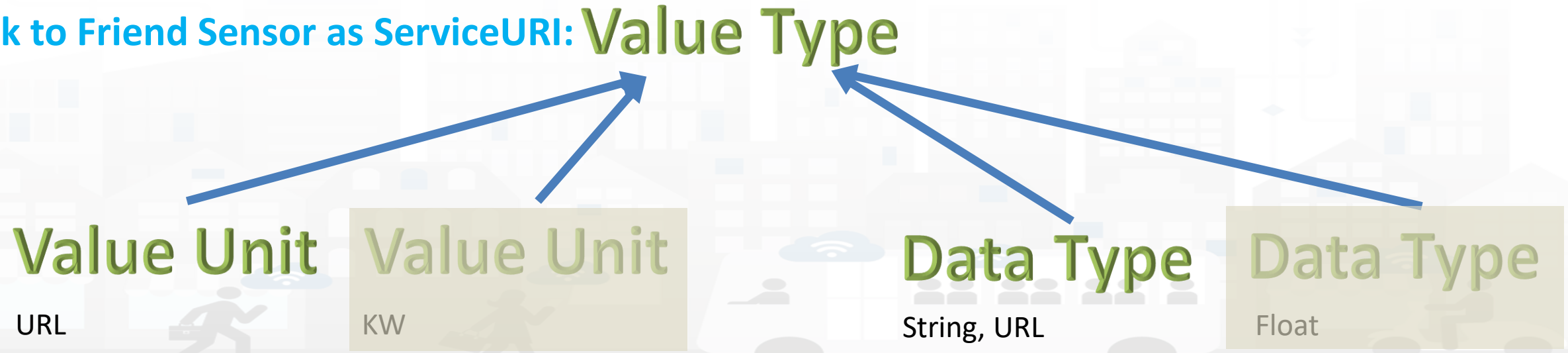
- Exists a Dictionary for the 4 categories
- They are related each other and not all values are possible
- **Right setting** leads to right rendering on graphs / dash
- **automated** combinations and processing
- The Dictionary is used by many tools

For example

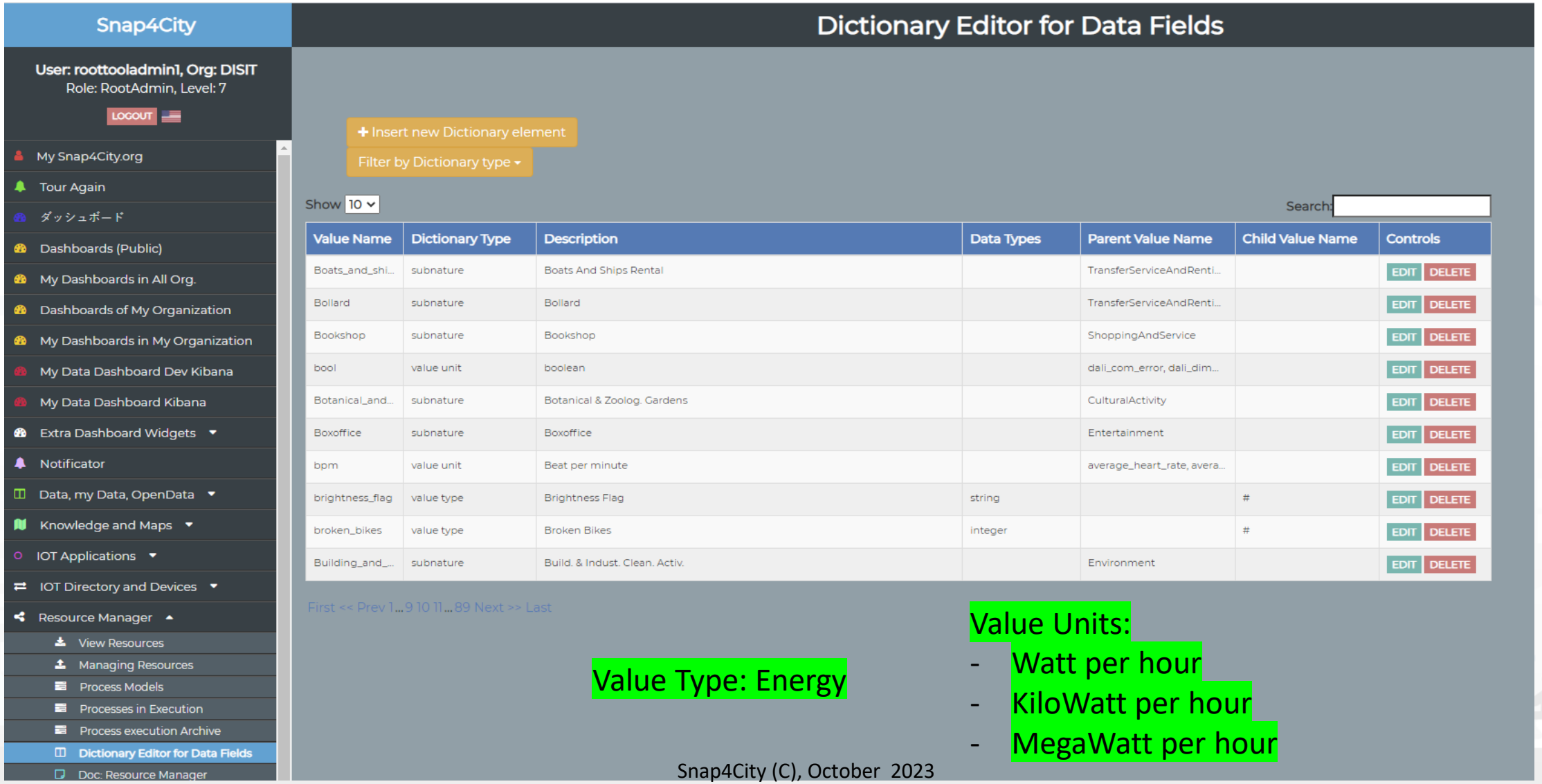
Technical meaning



Link to Friend Sensor as ServiceURI:



Example of Energy and its Value Units



Value Type: Energy

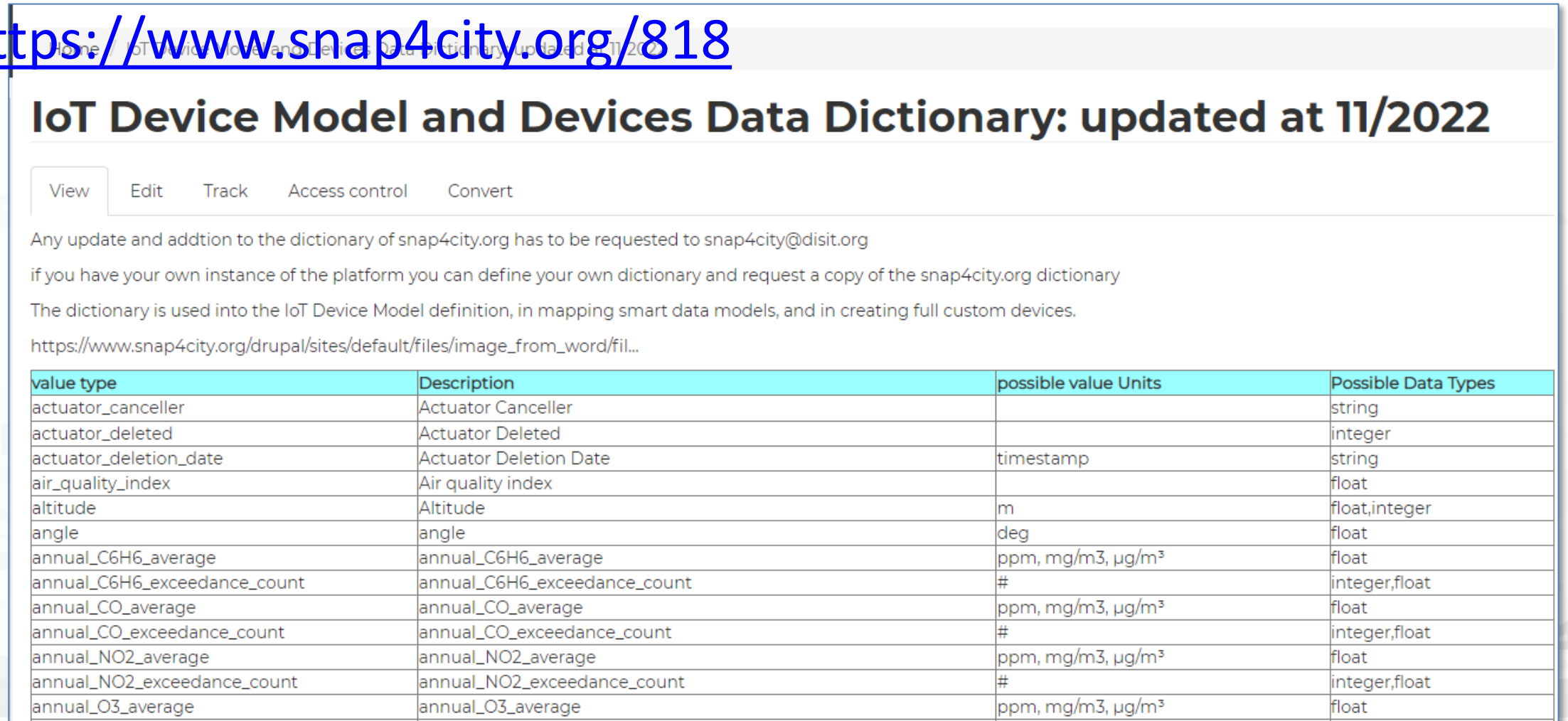
Value Units:
- Watt per hour
- KiloWatt per hour
- MegaWatt per hour

Please note on: Data Type

- Value Types have only a few number of **Data Types** because they represent how the data area treated into the system
- Therefore: main Data Types are:
  - **Float**: numbers with decimals large as you like, etc.
  - **Integer**: numbers, booleans (0/1), etc.
  - **String**: url, links, names, id, descriptions, status code, etc.
  - **Json**: structured data, vector, matrices, etc.
  - …..

IoT Device Model and Devices Data Dictionary: updated at 11/2022

https://www.snap4city.org/818



IoT Device Model and Devices Data Dictionary: updated at 11/2022

View | Edit | Track | Access control | Convert

Any update and addtion to the dictionary of snap4city.org has to be requested to snap4city@disit.org

if you have your own instance of the platform you can define your own dictionary and request a copy of the snap4city.org dictionary

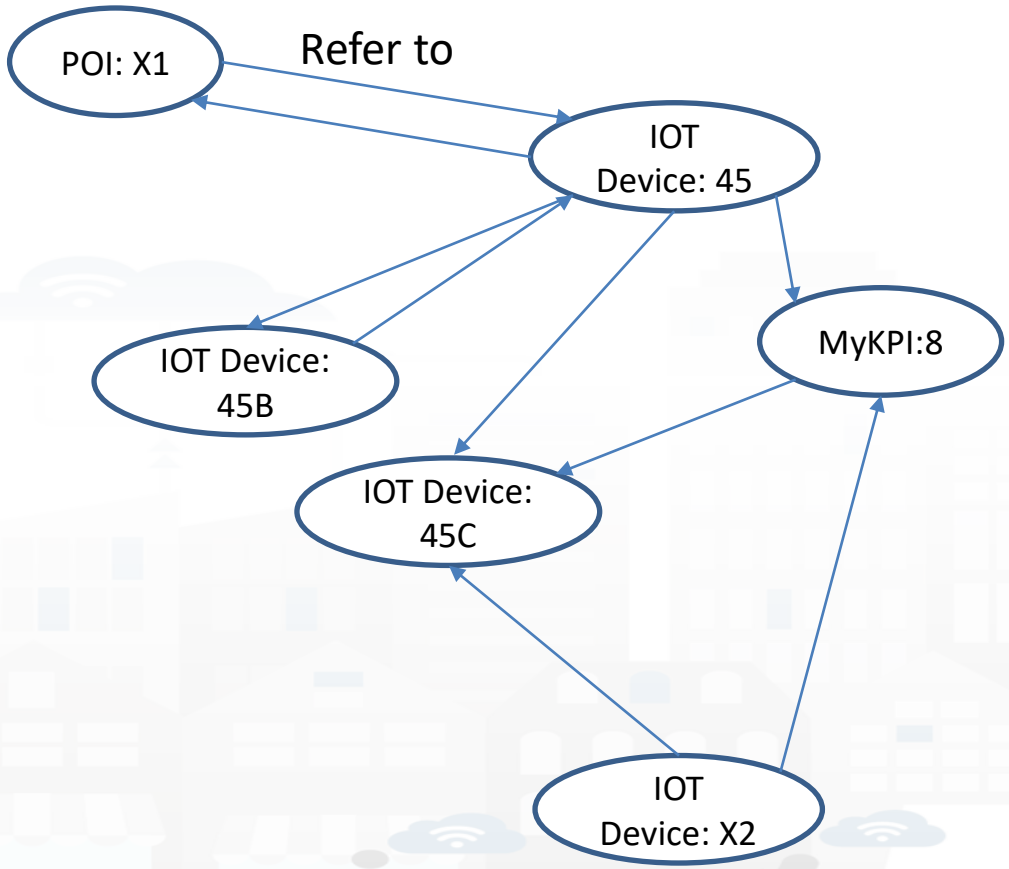
The dictionary is used into the IoT Device Model definition, in mapping smart data models, and in creating full custom devices.

https://www.snap4city.org/drupal/sites/default/files/image_from_word/fil...

value type	Description	possible value Units	Possible Data Types
actuator_canceller	Actuator Canceller		string
actuator_deleted	Actuator Deleted		integer
actuator_deletion_date	Actuator Deletion Date	timestamp	string
air_quality_index	Air quality index		float
altitude	Altitude	m	float,integer
angle	angle	deg	float
annual_C6H6_average	annual_C6H6_average	ppm, mg/m3, µg/m³	float
annual_C6H6_exceedance_count	annual_C6H6_exceedance_count	#	integer,float
annual_CO_average	annual_CO_average	ppm, mg/m3, µg/m³	float
annual_CO_exceedance_count	annual_CO_exceedance_count	#	integer,float
annual_NO2_average	annual_NO2_average	ppm, mg/m3, µg/m³	float
annual_NO2_exceedance_count	annual_NO2_exceedance_count	#	integer,float
annual_O3_average	annual_O3_average	ppm, mg/m3, µg/m³	float

References/Links to Entities Instances / IoT Devices

Relationships among Devices/Entities, POI and MyKPI



- **Devices and POI** may refer to:
  - IoT Devices/Entities, POI, MyKPI, Heatmaps, etc.
  - The Links may change over time
- **MultiDataMap** can be used for navigation:
  - Among: IoT Devices, POI, MyKPI
  - Automated focus
  - Accessing Time Trends

IoT device with References to other and MyKPI


```
{
"id":"ThermalBOX1",
"type":"thermalbox",
"dateObserved":{"type":"string","value":"2022-02-24T17:15:34.609Z"},
"latitude":{"type":"float","value":"43.76965"},
"longitude":{"type":"float","value":"11.25570"},
"SHTdevice":{"type":"string",
      "value":"http:\/\/www.disit.org\/km4city\/resource\/iot\/orionFirenze2\/Firenze\/SHT20lab_new"},
"cam51count":{"type":"string","value":"datamanager\/api\/v1\/poidata\/17058000"},
"cam52count":{"type":"string","value":"datamanager\/api\/v1\/poidata\/17058001"},
…
}
```


Value Type: Identifier

Value Unit: ServiceURI *//any query: such as those of the Selector*

Data Type: String

TOP

Data Ingestion Strategy and Orientation

The main High Level Types

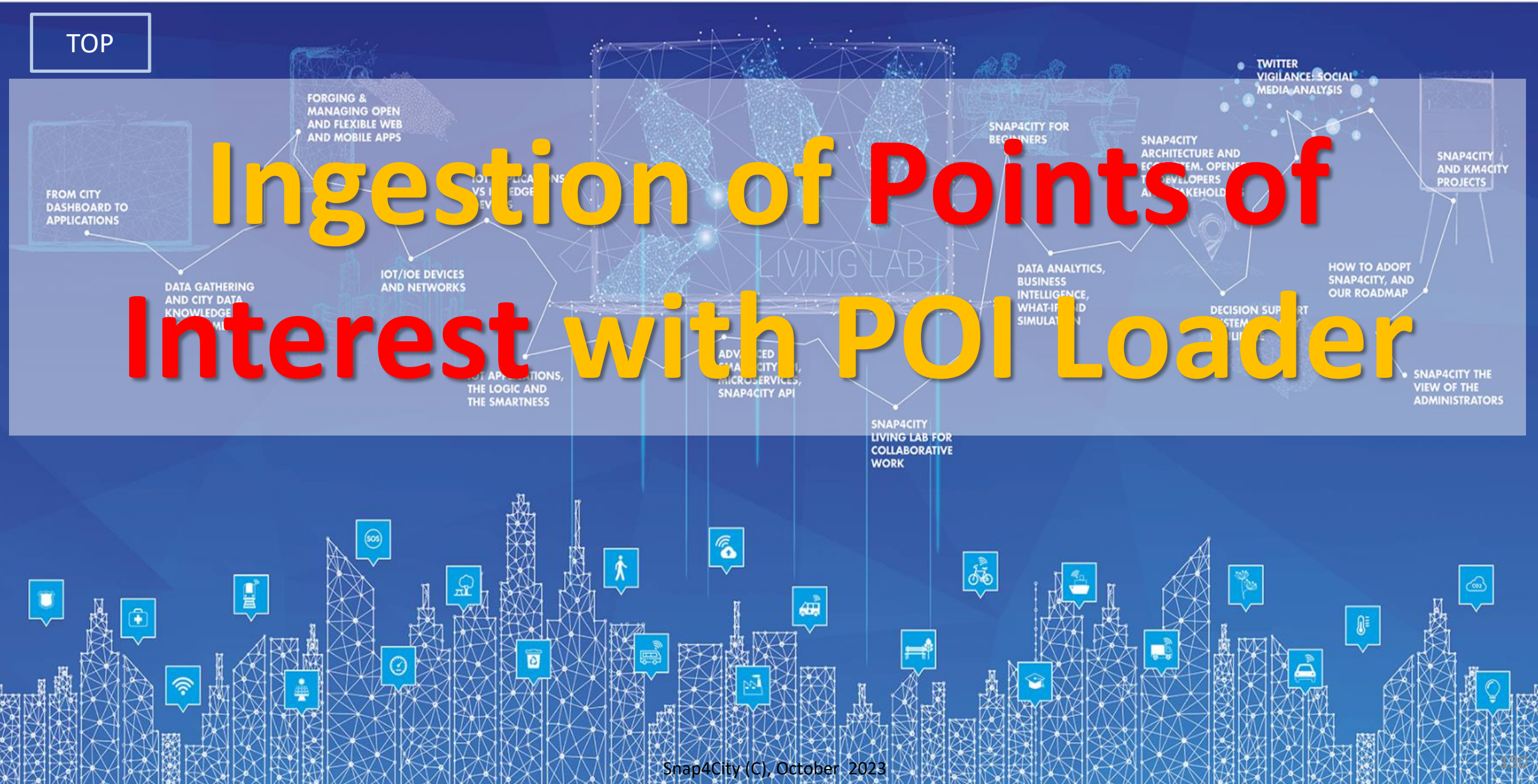
- **POI**: codified metadata, static GPS, + info, no time series
- **Entity Instance / IoT Device**: static GPS, Info, variable data, Time Series
  - Sensors and actuators
  - **Entity Mobile / IoT Device Mobile**: if dynamic GPS
- **MyKPI**: dynamic GPS, - info, single variable, Time Series
- ***Heatmaps**: matrices on some area, Time Series*
- ***Traffic Flow**: road segments with flow density, Time Series*
- ***OD matrix:** different parameters, Time Series*
- …

Part 4

How to ingest with most relevant HLT

main High Level Types	1st option	2nd option
POI, Point of Interest	**IOT App/Proc.Logic or POI Loader (from EXCEL files)**	Create an **Entity Model, Entity Registration**, ingest via IoT App
IoT Devices, KPI multivariable, WoT, Entities Instances	Create an **Entity Model, Entity Registration**, ingest via broker (e.g., Time Series) or IoT App/proc.Logic	**Data Table Loader (from EXCEL files)**
GIS data	Use GIS API from IoT App/Proc.Logic, Create an **Entity Model, Entity Registration**, ingest via IoT App/Proc.Logic	Load them on GeoServer
Satellite Data	Use Snap4City tool to download satellite data and push them into the **Heatmap Manager/GeoServer**, via API	***(seen in Course Part 3)***
Traffic Flow	Compute the traffic flow and/or load them into the **TrafficFlow Manager**, via API	***(seen in Course Part 3)***
Heatmaps	Compute them and/or push them into the **Heatmap Manager/GeoServer, via** API	***(seen in Course Part 3)***
OD Matrices	Compute the ODM and/or push them into the **OD Manager**, via API	***(seen in Course Part 3)***
BIM Models	Produce them on some BIM editor, convert into IFC and load them on **BIM Manager** and server	***(seen in Course Part 3)***
MyKPI (single var)	Create them on **MyKPI Manager**, save/load by using IoT App / Proc.Logic and/or API	***(seen in Course Part 2)***

TOP



Ingestion of Points of Interest with POI Loader

How to ingest POI

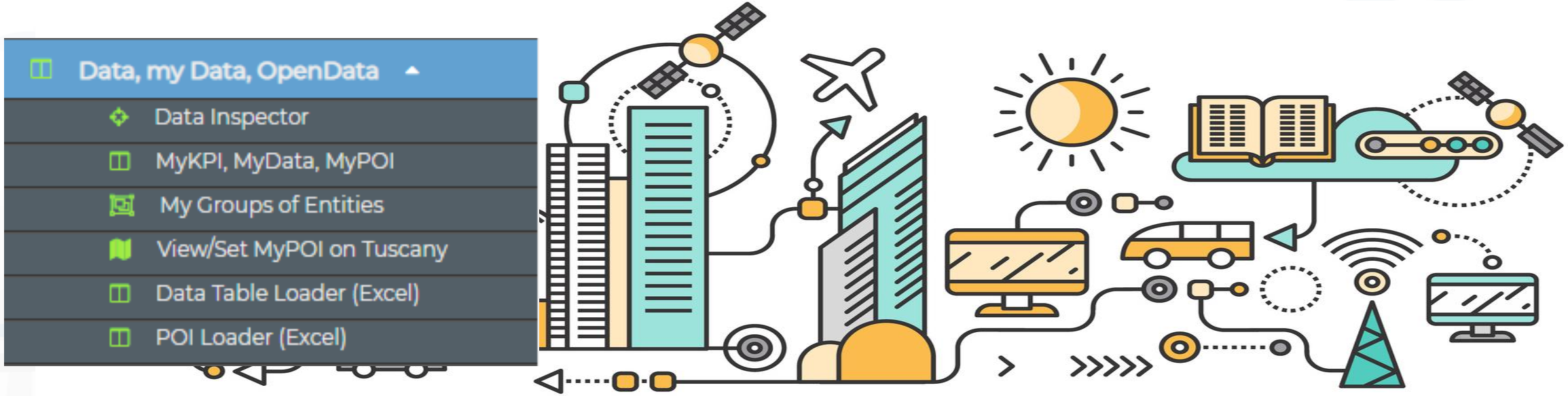
main High Level Types	1st option	2nd option
POI, Point of Interest	**IoT App or POI Loader (from EXCEL files)**	Create an **Entity Model, Entity Registration**, ingest via IoT App
IoT Devices, KPI multivariable, WoT, Entities Instances	Create an **Entity Model, Entity Registration**, ingest via broker (e.g., Time Series) or IoT App	**Data Table Loader**
GIS data	Pose query from IoT App, Create an **Entity Model, Entity Registration**, ingest via IoT App	Load them on GeoServer

Ingestion of POI

- Their structure has been described previously
  - They do not change over time → they do not have dateObserved
- **Open Data** referring to services on the territory can be regarded as POI
- **POI Loader** to perform the automated loading of new POI
- There is also a **MicroApplication** which allows to load MyPOI one by one, and a procedure to pass from MyPOI to POI can be activated by the RootAdmin
- **POI may be modelled as Entity Instances / IoT Devices**

POI Loader, from Excel Files

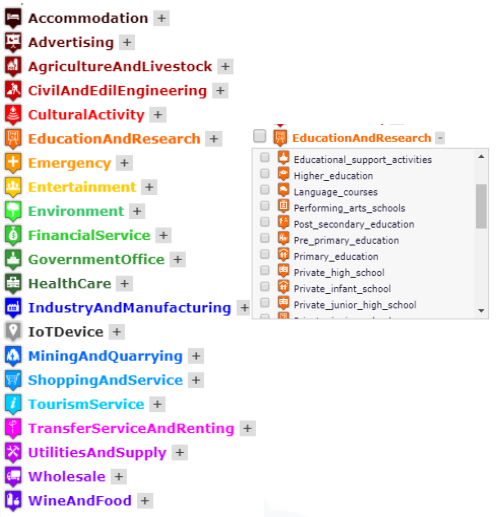
(for authorized AreaManagers)



https://www.snap4city.org/731

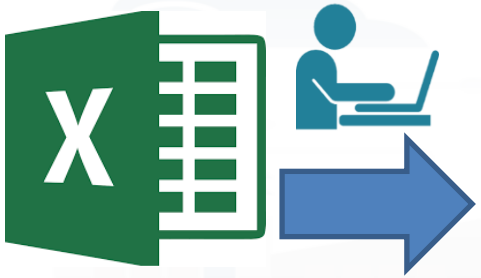
POI, Point of Interest

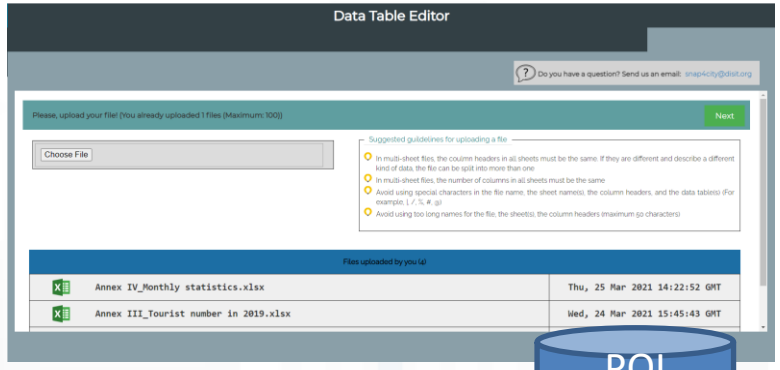
- They are
  - classified in terms of nature/subnature
  - relevant services with codified metadata to simplify the massive management of huge amount of POIs
  - mapped on Knowledge Base on **specific GPS location**
  - Do not move over time
  - represented as PIN
- Do not have Time Series for variable over time
- May sporadically change over time



POI Loader

- To help you to **upload POI data in short/zero time** https://www.snap4city.org/731
  - **Start from Excel Files, they should be formatted some how or well formatted according to our guidelines (model provided)**
    - **https://www.snap4city.org/drupal/system/files/private/POI_loader_template.zip**
  - Custom upload for each Organization is possible on the provided IOT App/Proc.Logic
- To **enable you** to
  - create dashboards from them according to different views and nature



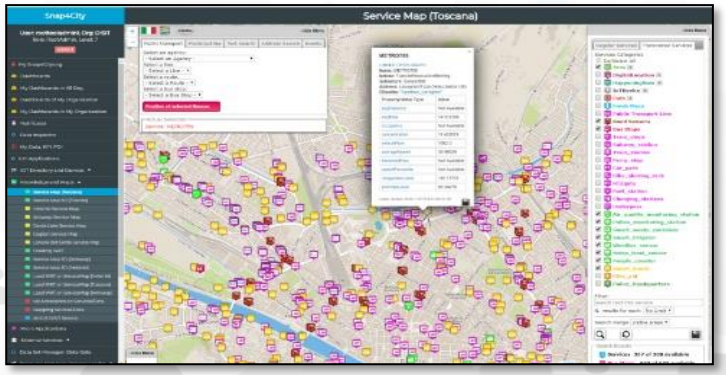


POI Table

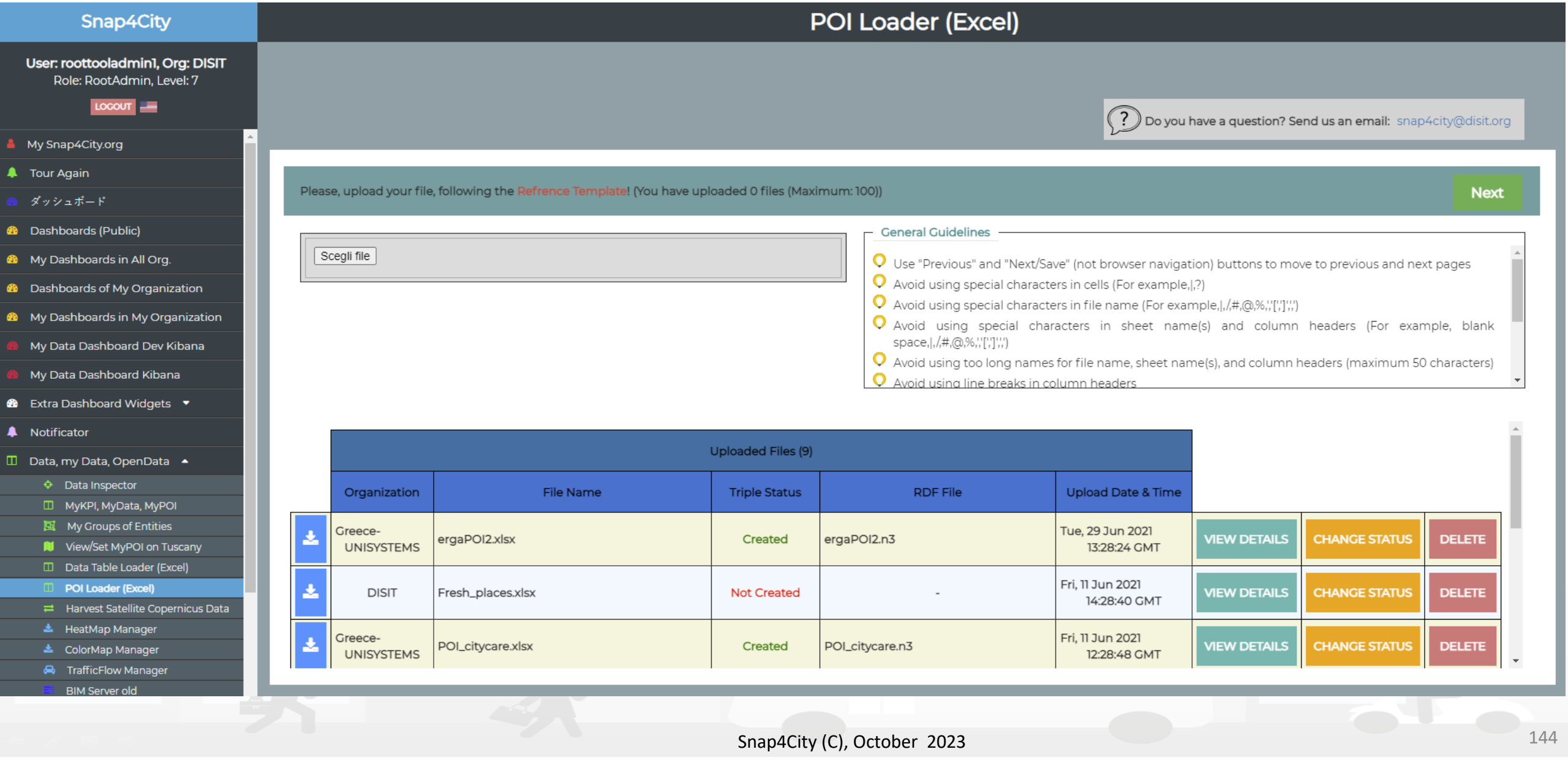
IOT App/Proc:logic

File with Triples

The Administrator can load on KB



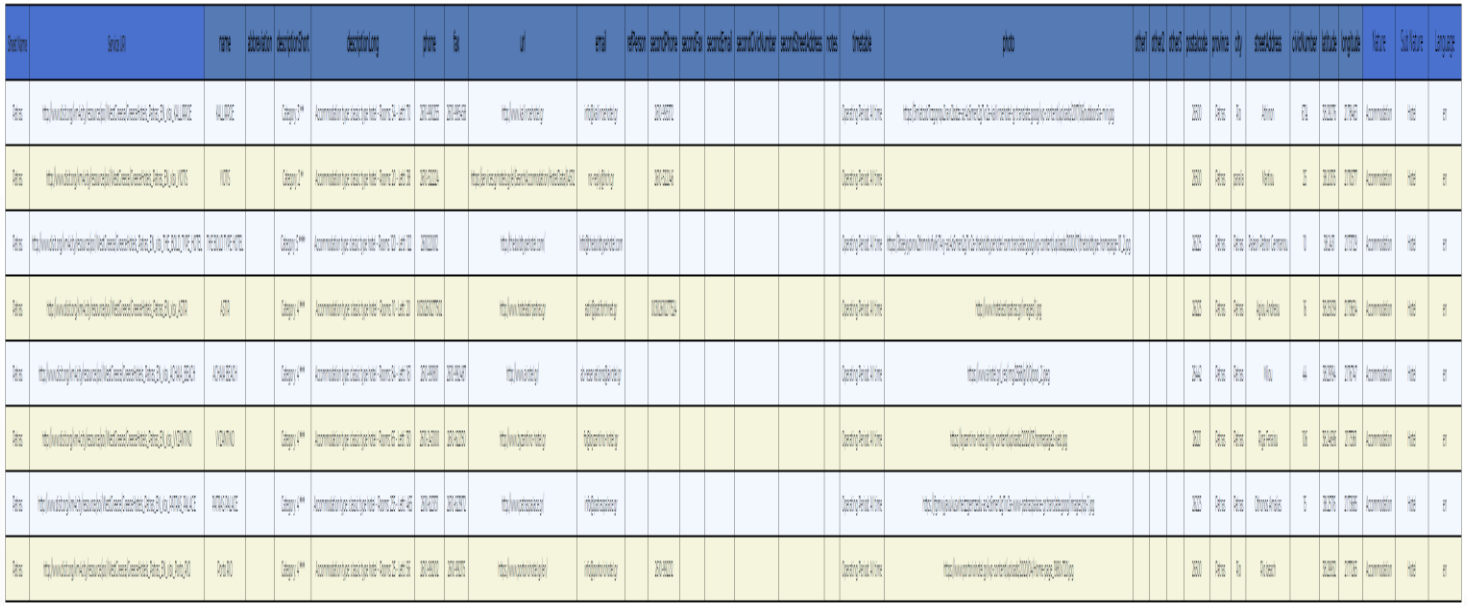
POI Loader


Snap4City
User: roottooladmin1, Org: DISIT
Role: RootAdmin, Level: 7
LOGOUT
My Snap4City.org
Tour Again
ダッシュボード
Dashboards (Public)
My Dashboards in All Org.
Dashboards of My Organization
My Dashboards in My Organization
My Data Dashboard Dev Kibana
My Data Dashboard Kibana
Extra Dashboard Widgets
Notificator
Data, my Data, OpenData
Data Inspector
MyKPI, MyData, MyPOI
My Groups of Entities
View/Set MyPOI on Tuscany
Data Table Loader (Excel)
POI Loader (Excel)
Harvest Satellite Copernicus Data
HeatMap Manager
ColorMap Manager
TrafficFlow Manager
BIM Server old
POI Loader (Excel)
Do you have a question? Send us an email: snap4city@disit.org
Please, upload your file, following the Refrence Template! (You have uploaded 0 files (Maximum: 100))
Next
Scegli file
General Guidelines
Use "Previous" and "Next/Save" (not browser navigation) buttons to move to previous and next pages
Avoid using special characters in cells (For example,|,?)
Avoid using special characters in file name (For example,|,/,#,@,%,'',[',],',')
Avoid using special characters in sheet name(s) and column headers (For example, blank space,|,/,#,@,%,'',[',],',')
Avoid using too long names for file name, sheet name(s), and column headers (maximum 50 characters)
Avoid using line breaks in column headers
Uploaded Files (9)
Organization
File Name
Triple Status
RDF File
Upload Date & Time
Greece-UNISYSTEMS
ergaPOI2.xlsx
Created
ergaPOI2.n3
Tue, 29 Jun 2021 13:28:24 GMT
VIEW DETAILS
CHANGE STATUS
DELETE
DISIT
Fresh_places.xlsx
Not Created
-
Fri, 11 Jun 2021 14:28:40 GMT
VIEW DETAILS
CHANGE STATUS
DELETE
Greece-UNISYSTEMS
POI_citycare.xlsx
Created
POI_citycare.n3
Fri, 11 Jun 2021 12:28:48 GMT
VIEW DETAILS
CHANGE STATUS
DELETE

POI Structure, EXCEL

- nameENG, abbreviationENG, descriptionShortENG, descriptionLongENG
- Phone, Fax,
- url (web page), email
- refPerson
- secondPhone, secondFax, secondEmail, secondCivicNumber, secondStreetAddress
- notes
- timetable
- photo
- Other1, other2, other3
- Postalcode, Province, city
- streetAddress, civicNumber
- Latitude, longitude

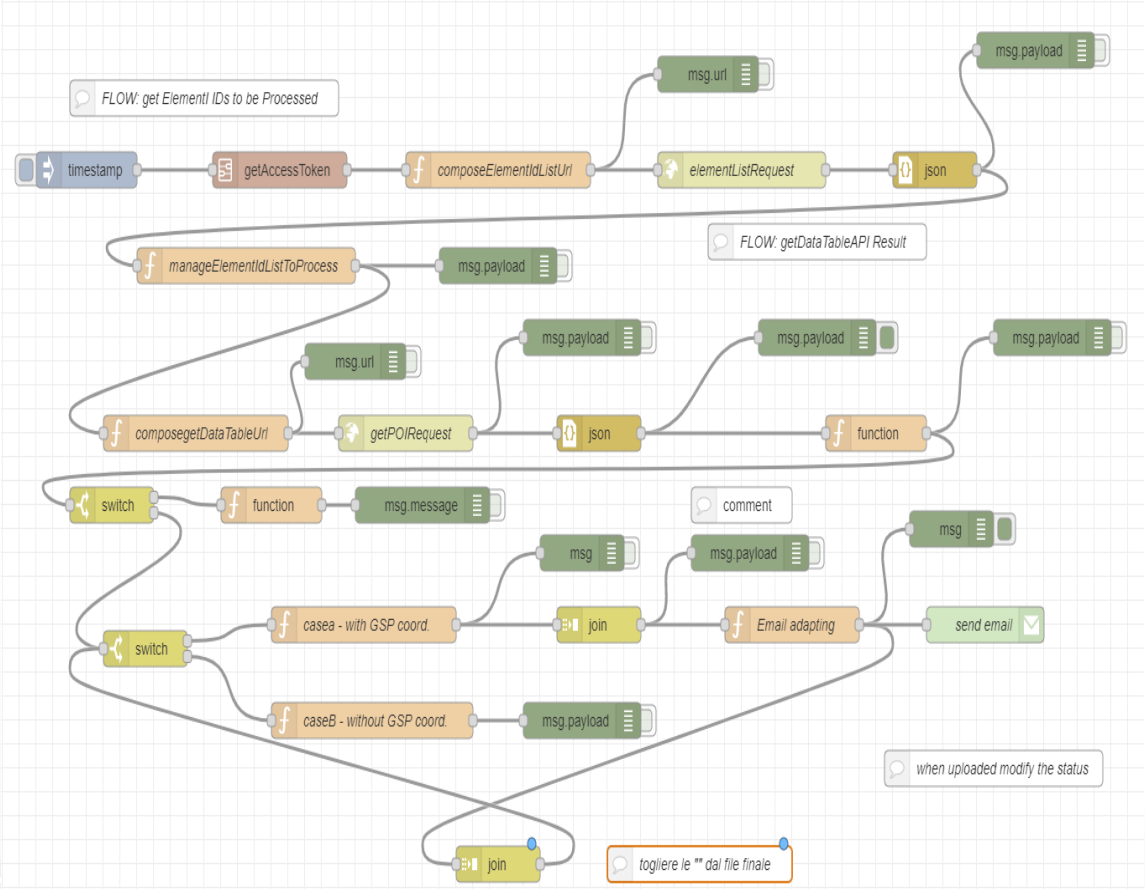
https://www.snap4city.org/731 Manual



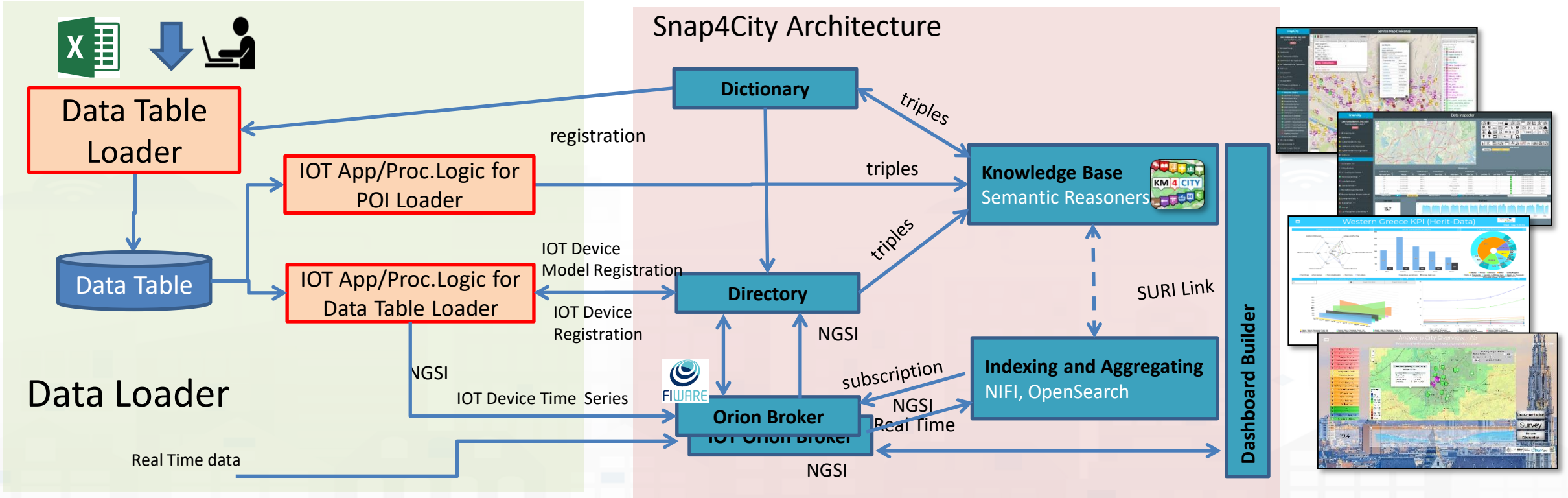
https://www.snap4city.org/drupal/system/files/private/POI_loader_template.zip

Note on POI Loader

- The structure of Excel File is fixed
- UTF8 characters can be used into the values and not in the device name neither on field names
- Follow the guidelines in the first page and the instruction during the upload
- POI Loading is performed via an IoT App which produces triples
  - They are verified and loaded by some administrator
- Any AreaManager can upload POI data sets but only specific dedicated responsible for data upload can actually load being owners and responsible of the IOT App process, which can be customized also.

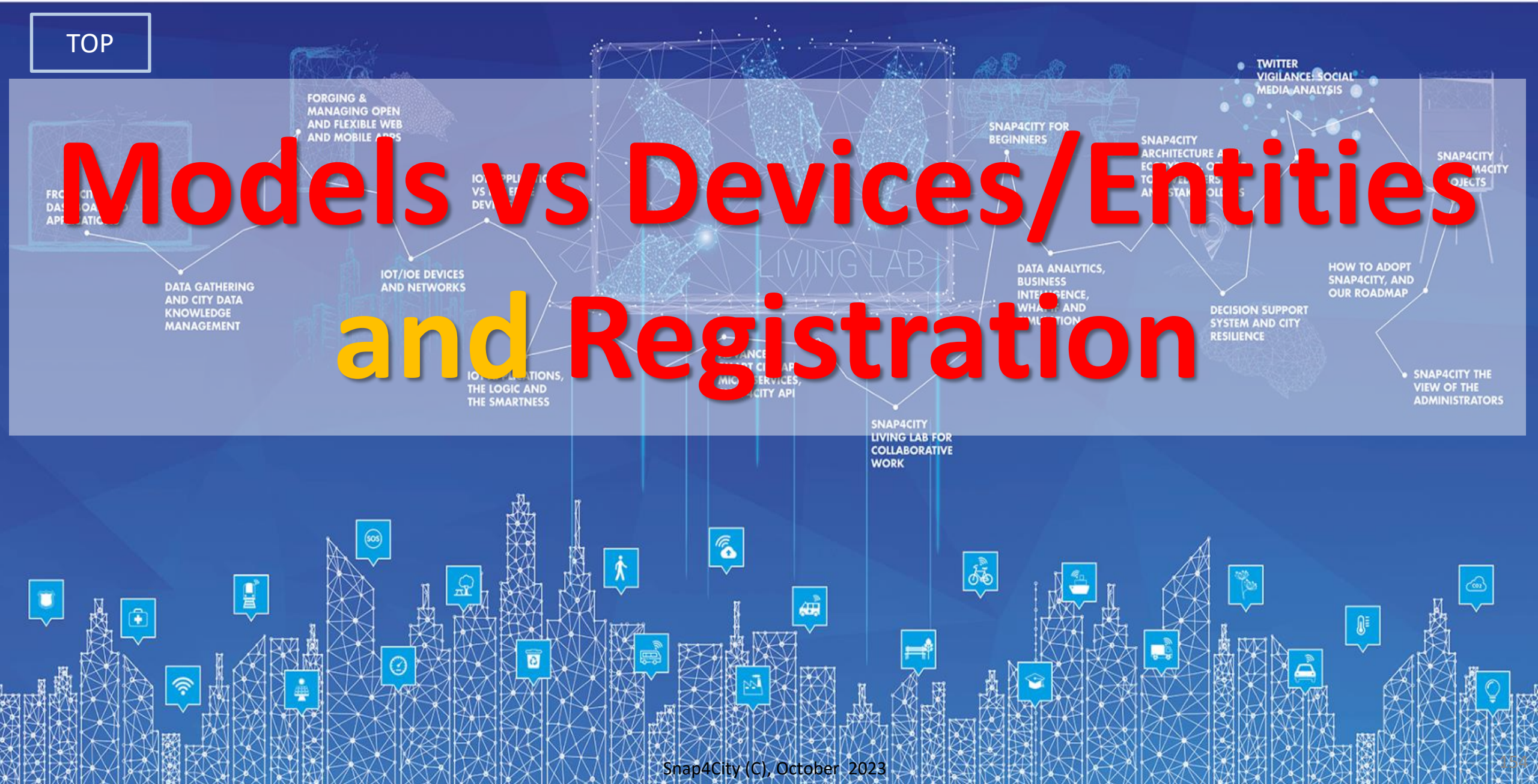


Short cut Data Ingestion from Excel file

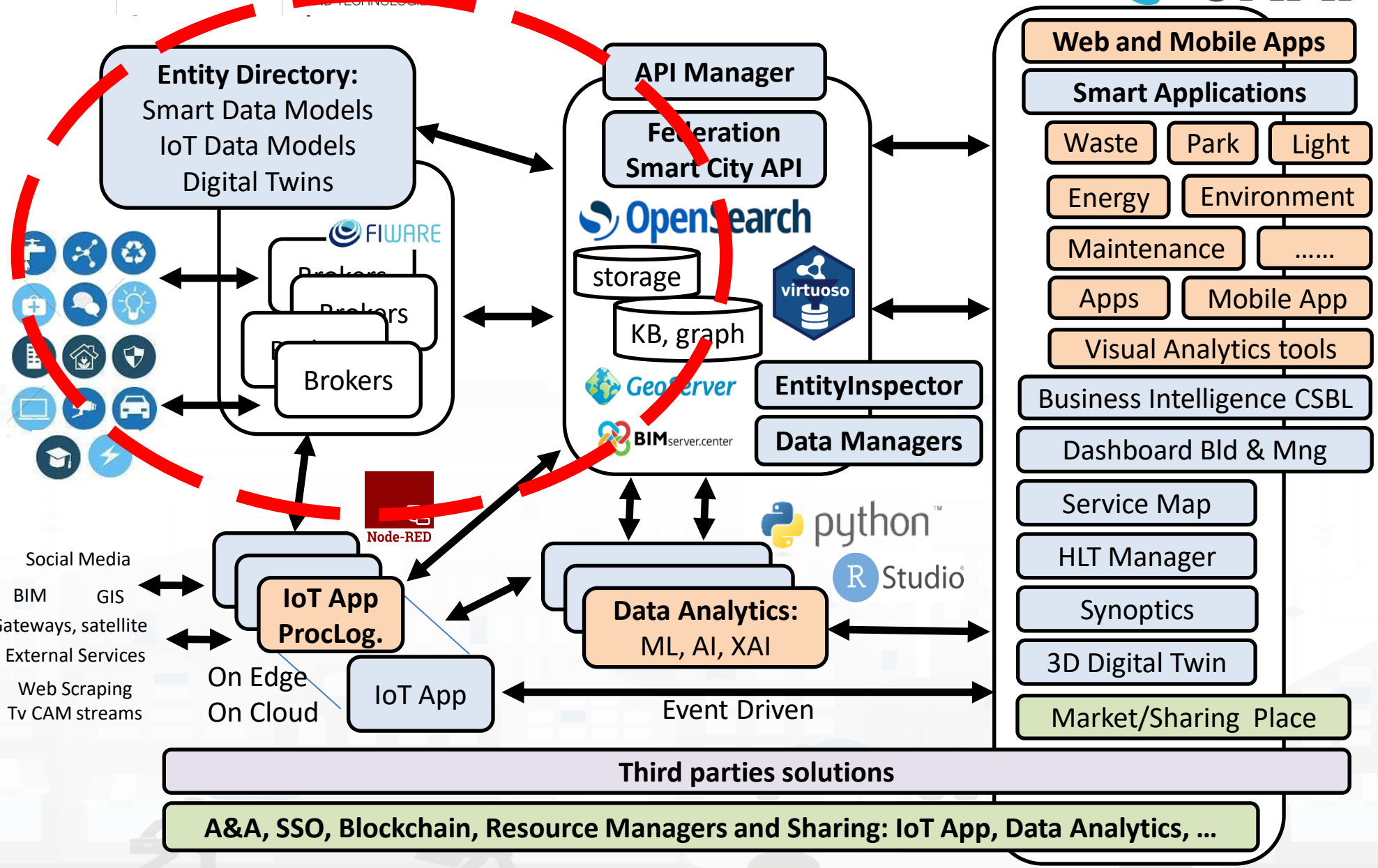


TOP

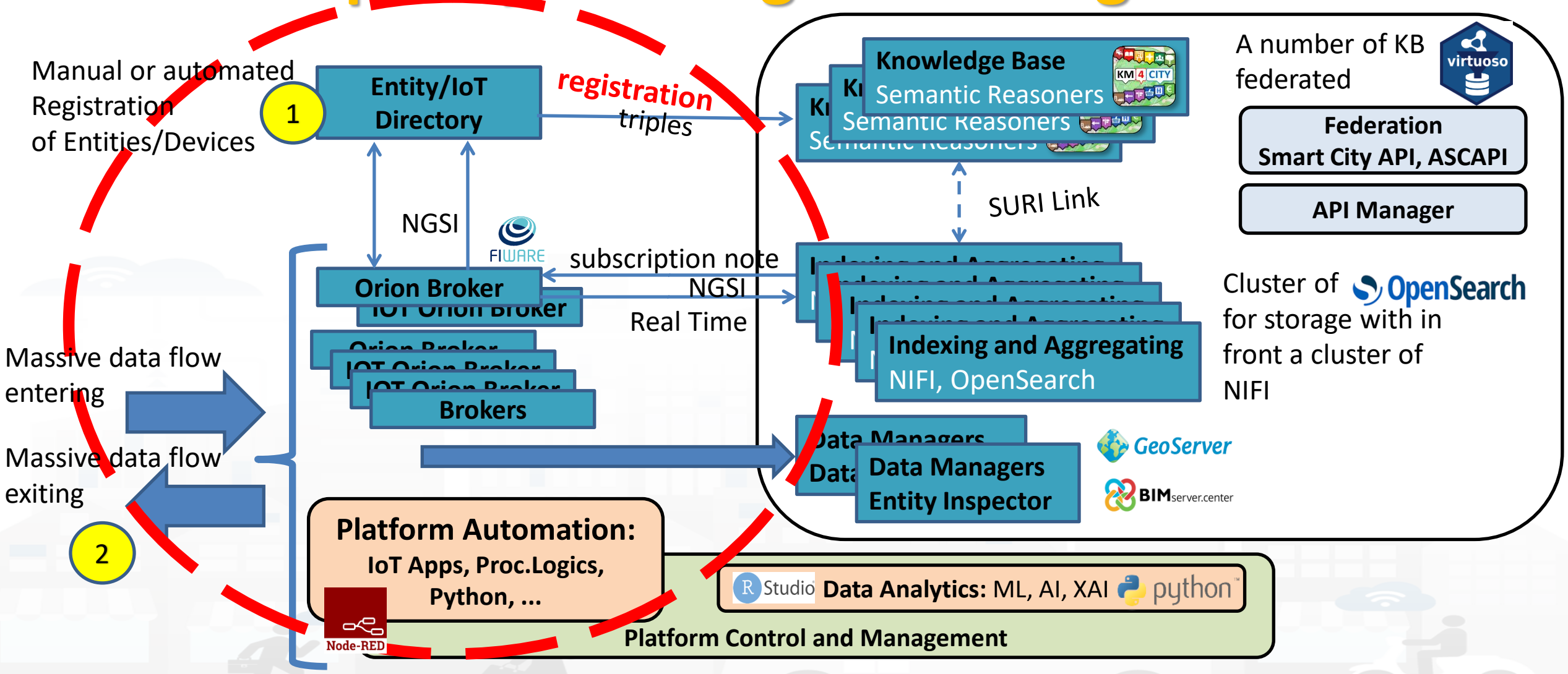
Models vs Devices/Entities and Registration



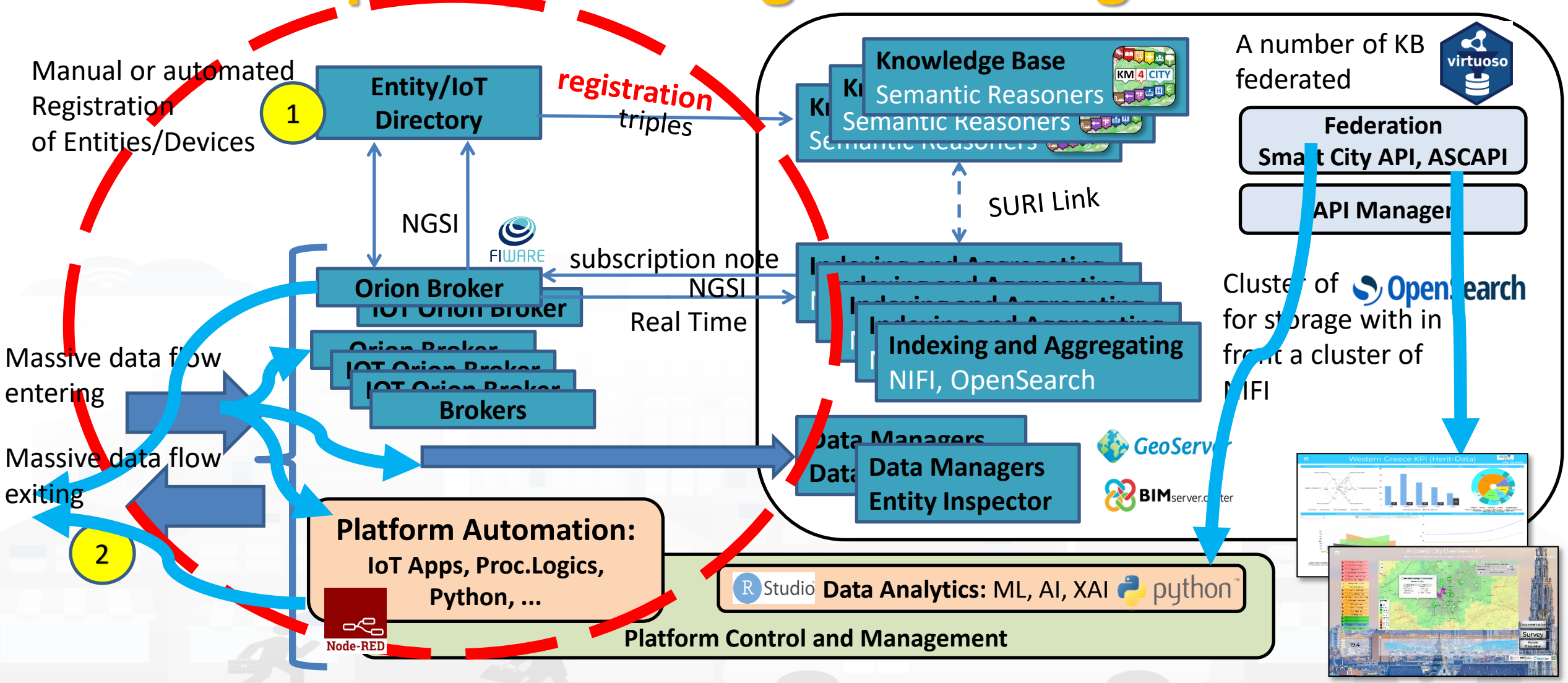
Tech Arch


Entity Directory:
Smart Data Models
IoT Data Models
Digital Twins
FIWARE
Brokers
Brokers
Brokers
API Manager
Federation
Smart City API
OpenSearch
storage
KB, graph
virtuoso
GeoServer
BIMserver.center
EntityInspector
Data Managers
Node-RED
python
RStudio
Social Media
BIM
GIS
Gateways, satellite
External Services
Web Scraping
Tv CAM streams
IoT App
ProcLog.
On Edge
On Cloud
IoT App
Data Analytics:
ML, AI, XAI
Event Driven
Web and Mobile Apps
Smart Applications
Waste
Park
Light
Energy
Environment
Maintenance
……
Apps
Mobile App
Visual Analytics tools
Business Intelligence CSBL
Dashboard Bld & Mng
Service Map
HLT Manager
Synoptics
3D Digital Twin
Market/Sharing Place
Third parties solutions
A&A, SSO, Blockchain, Resource Managers and Sharing: IoT App, Data Analytics, …

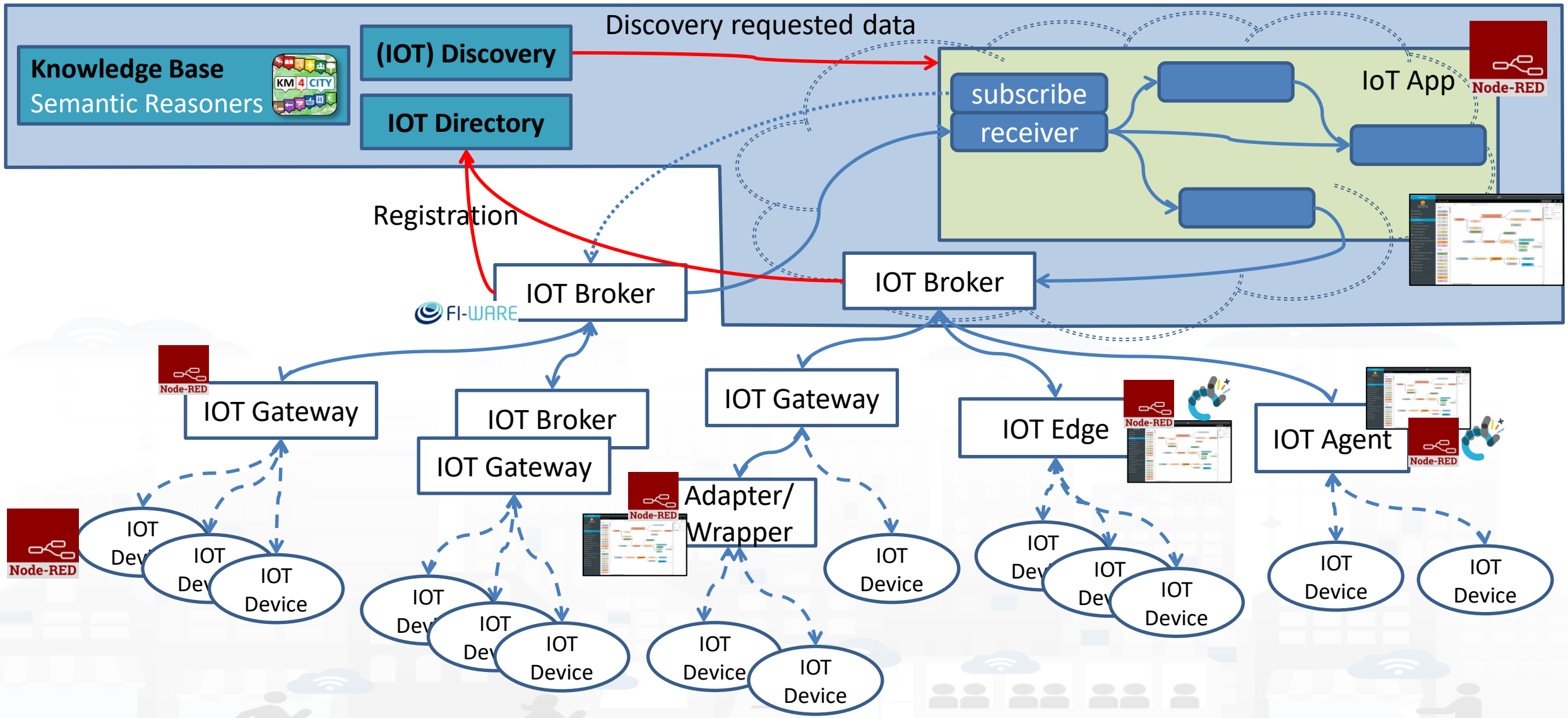
Snap4city Data Ingestion Diagram



Snap4city Data Ingestion Diagram



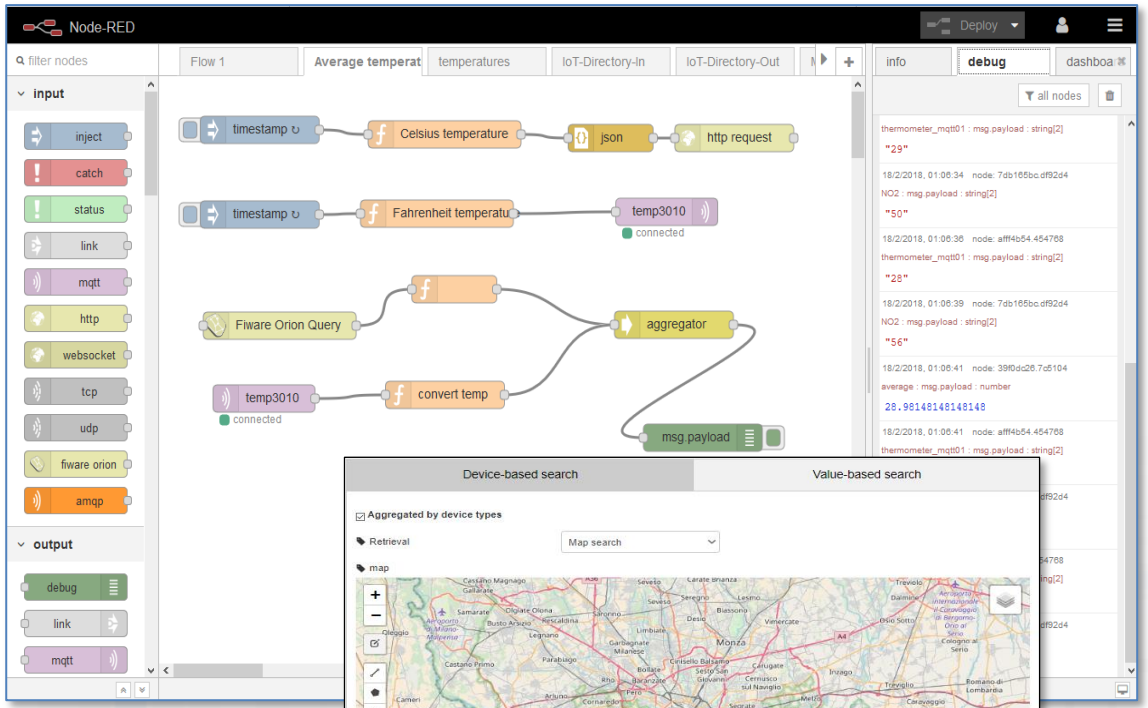
IoT Network

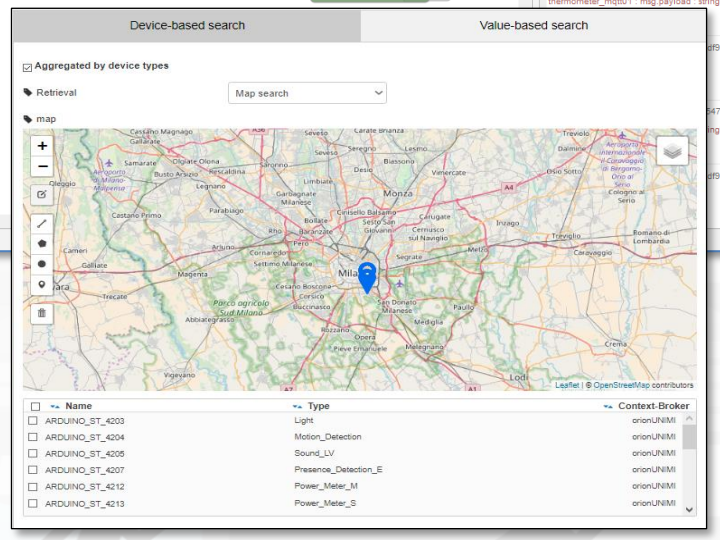

Knowledge Base
Semantic Reasoners
(IOT) Discovery
IOT Directory
Discovery requested data
subscribe
receiver
IoT App
Node-RED
Registration
IOT Broker
FI-WARE
IOT Broker
IOT Gateway
IOT Broker
IOT Gateway
IOT Gateway
Adapter/
Wrapper
IOT Edge
IOT Agent
IOT Device

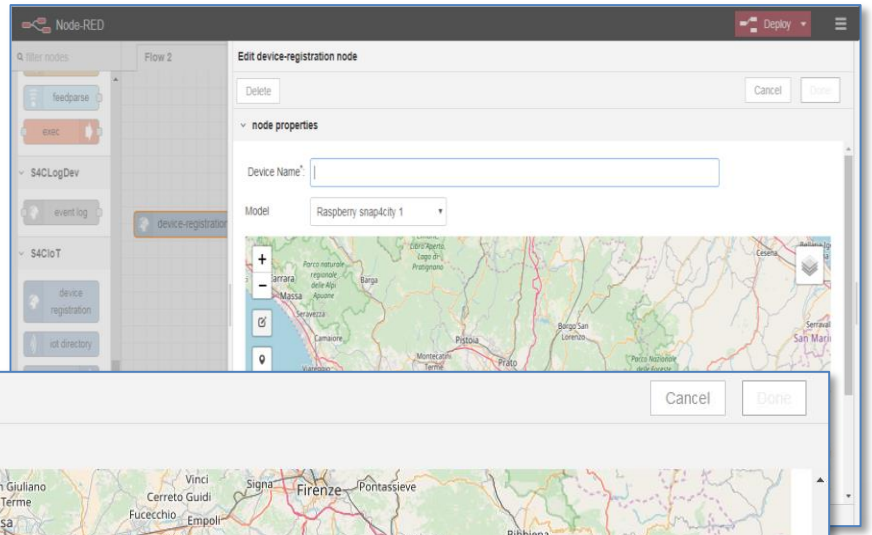
Directory Features vs Users Roles (07/23)

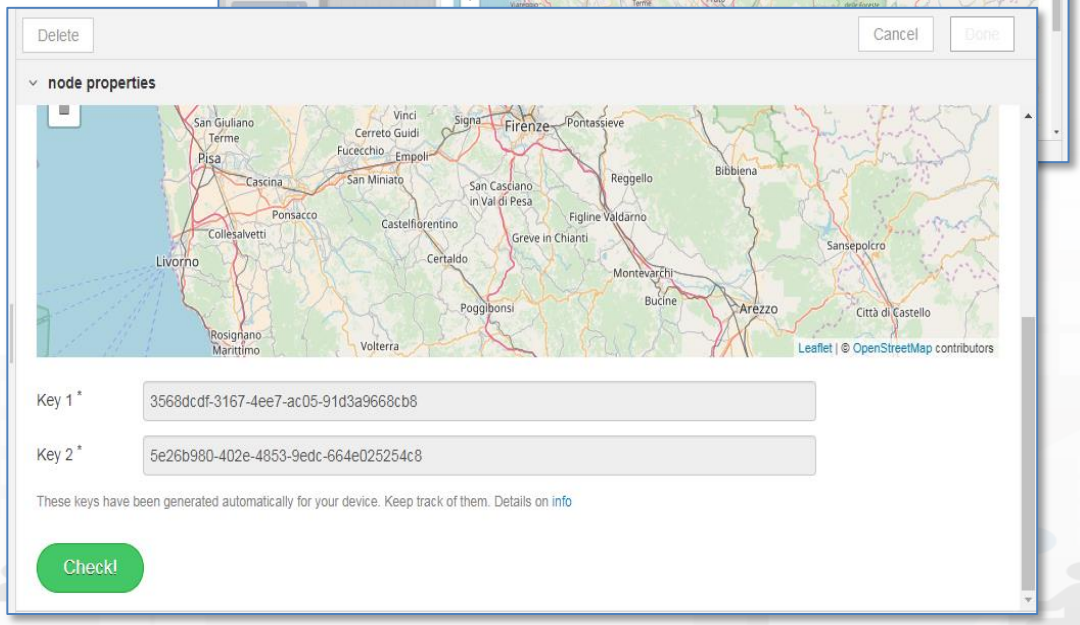
Entities	what	By using IOT Directory and:	Manager	AreaManager	ToolAdmin/ RootAdmin	Proc.Logic/IOT App microservices
Sensor/Actuator	Browse, use	Several Tools	X	X	X	Yes
	Delegate	API, ..	X	X	X	
	Discovery	KB, API, ..	X	X	X	Yes
Devices/Entities	Browse, use	Several Tools	X	X	X	Yes (use)
	Create, change, delete	API, ..	X	X	X	Yes
	Register in Bulk	API, ..		X	X	Yes
	Delegate, Change Owner	API, ..	X	X	X	Yes
	Discovery	KB, API, ..	X	X	X	Yes
Models (S4C, Fiware)	Browse, Use		X	X	X	(Yes)
	Create, change, delete		X	X	X	(Yes)
	delegate, change ownership		X	X	X	
Brokers	Browse, use		use	Browse, use	X	Yes (use)
	Register/change/Delete				X	
	Deploy Orion Broker				ToolAdmin	
	Delegate				X	
	Periodic Update				X	

Discovery on Proc.Logic/IoT App Node-RED





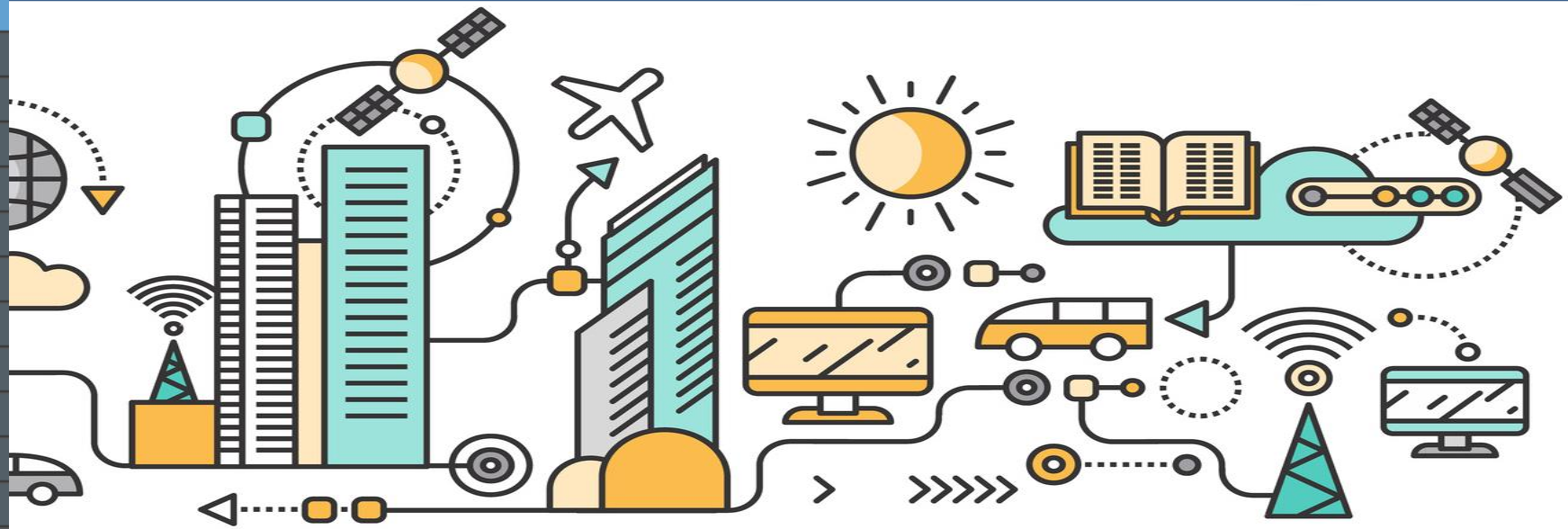




Entity/Device Registration

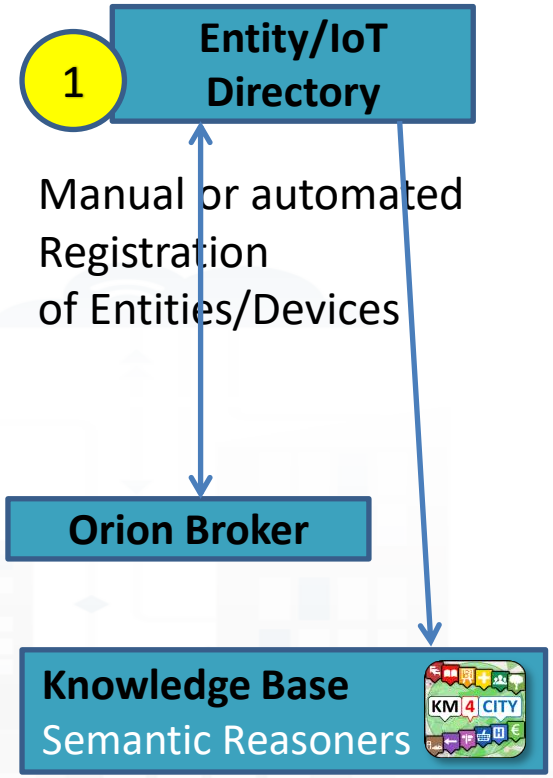
many possibilities

- IOT Directory and Devices
  - My IOT Sensors and Actuators
  - IOT Sensors and Actuators
  - IOT Devices
  - IOT Devices Management
  - IOT Device Discovery
  - IOT Brokers
  - IOT Device Models
  - IOT Devices Bulk Registration
  - IOT Broker Periodic Update setti...
  - IOT Orion Broker Mapping Rules...
  - Doc: IOT Directory and Devices
  - Create an IOT Device Instance
  - Create an IOT Device Model
  - Add an IOT Device into Snap4Cit...



Benefits of Registration on Directory

- **The registration implies the automated production of the Digital Twin Device into the Knowledge Base**
  - Registration of the Entity on Brokers and KB
  - Activation of the Storage “DataShadow” for historical data access
  - Activation of all the relationships
  - Activation of Discovery mechanisms via Entity Directory, KB and SCAPI, etc.
  - Activation of Dashboard Wizard (after a few minutes), and Data Inspector



Activities for Registration on Directory

- **Manual Registration**
  - From scratch Single Device / Entity Registration → **Entity Directory / IoT Directory**
  - From a template (the templates are called Models)
- **Automated Registration for bulk/massive registration: N** Entities / Devices
  - From IoT App/Proc.Logic on the basis of some **Models** from IoT App
  - From IoT App/Proc.Logic **loading a CSV** (with or without a reference IoT/Entity Model)
  - Programming from scratch or from a **Model**
  - On the basis of some EXCEL file with data by using the **Data Table Loader, which create model, devices and data**
  - Etc.

Manual or automated Registration of Entities/Devices

Entity Instances, IoT Devices

Snap4City

Switch To New Layout (Beta)

User: paolo.disit, Org: DISIT
Role: AreaManager, Level: 3

LOGOUT

- My Snap4City.org
- Tour Again
- www.snap4solutions.org
- Dashboards (Public)
- Dashboards of My Organization
- My Dashboards in My Organization
- My Data Dashboard Dev Kibana
- Extra Dashboard Widgets
- Data Management, HLT
- Knowledge and Maps
- Processing Logics / IOT App
- Entity Directory and Devices
  - My IOT Sensors and Actuators
  - IOT Sensors and Actuators
  - Entity Instances, IoT Devices
  - IOT Brokers
  - FIWARE Smart Data Models
  - Entity Models/IoT Devices
  - IOT Devices Bulk Registration
  - Doc: IOT Directory and Devices
  - Create an IOT Device Instance
  - Create an IOT Device Model

Show delegated dev. | Show public dev. | Show my dev. | Show all dev

Add new device

Show entries

Search:

	Device Identifier	IOT Broker	Device Type	Model	Ownership	Status	Edit	Delete	Location	View
+	1dd79caa95f6771afad4fd38e699c8542022-12-05T18:54:13.000Z	orionUNIFI	File	fileModel	MYOWNPUBLIC	active	EDIT	DELETE		VIEW
+	alert_1610543238306	orionUNIFI	event	AlertGeneric	MYOWNPRIVATE	active	EDIT	DELETE		VIEW
+	alert_1610548534047	orionUNIFI	event	AlertGeneric	MYOWNPRIVATE	active	EDIT	DELETE		VIEW
+	alert_1610613189703	orionUNIFI	event	AlertGeneric	MYOWNPRIVATE	active	EDIT	DELETE		VIEW
+	alert_1610629197473	orionUNIFI	event	AlertGeneric	MYOWNPRIVATE	active	EDIT	DELETE		VIEW
		orionUNIFI	event	AlertGeneric	MYOWNPRIVATE	active	EDIT	DELETE		VIEW
		orionUNIFI	event	AlertGeneric	MYOWNPRIVATE	active	EDIT	DELETE		VIEW
		orionUNIFI	event	AlertGeneric	MYOWNPRIVATE	active	EDIT	DELETE		VIEW
		orionUNIFI	event	AlertGeneric	MYOWNPRIVATE	active	EDIT	DELETE		VIEW
		orionUNIFI	event	AlertGeneric	MYOWNPRIVATE	active	EDIT	DELETE		VIEW

Previous 1 2 3 4 5 ... 12 Next

What you can do ?

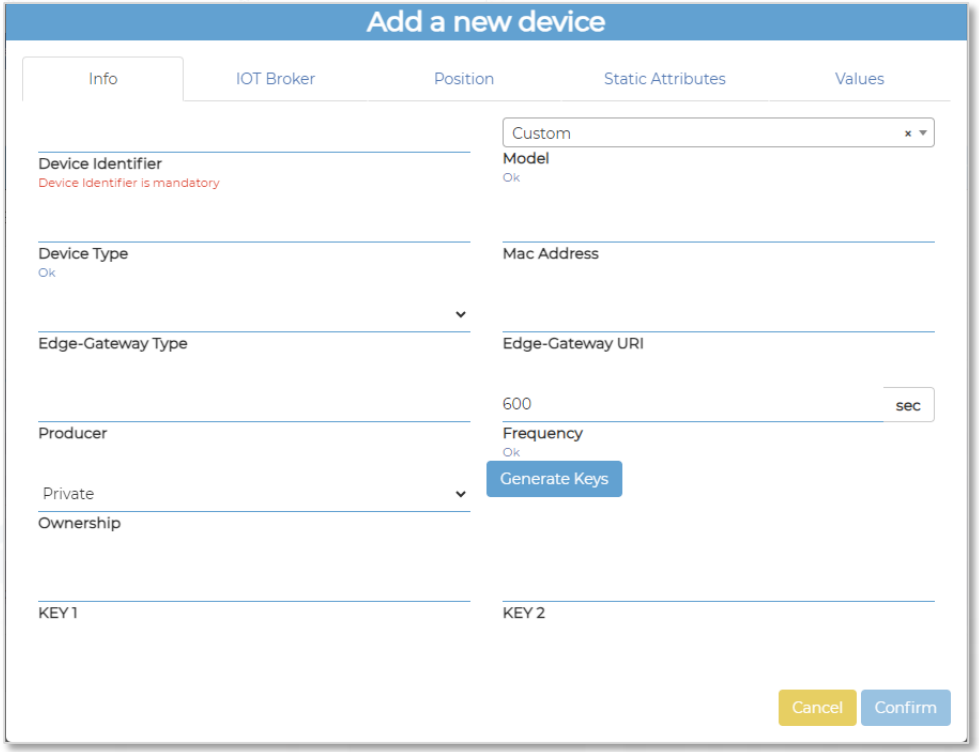
- List and browse your devices and those received in delegation
- Change ownership, control the delegation
- Edit, Change, delete all paramerters
- View on map and view all data
- See details

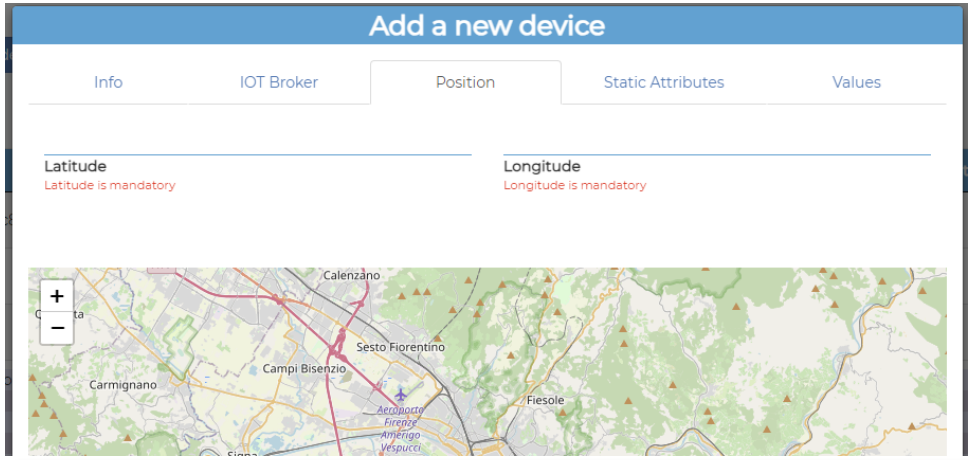
Entity/IoT Directory

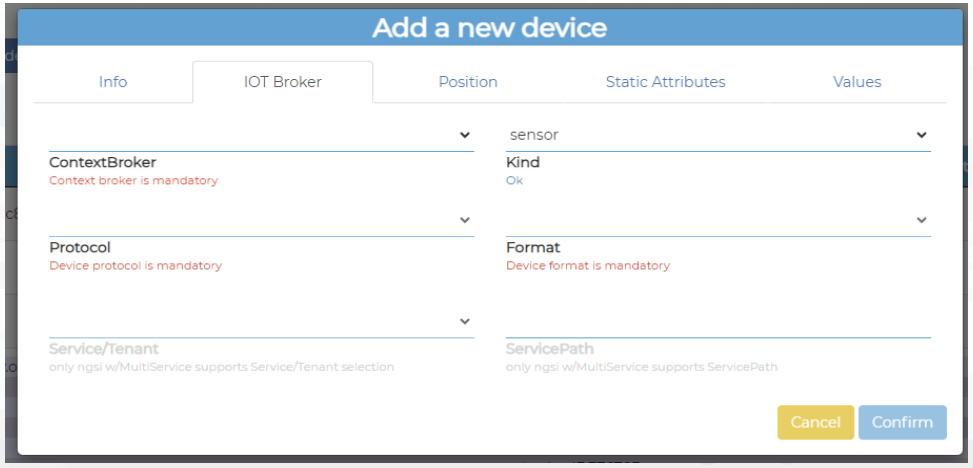
⊟	alert_1610548534047	orionUNIFI	event	AlertGeneric	MYOWNPRIVATE	active	EDIT	DELETE	🌐	VIEW

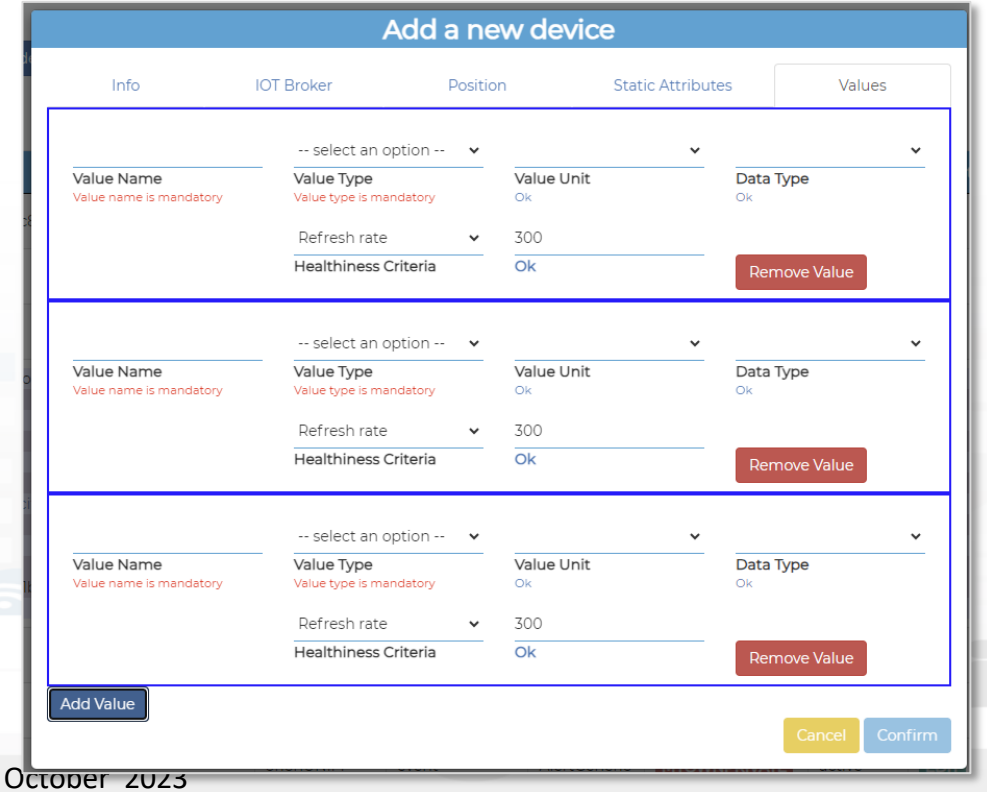
Broker URI: https://broker1.snap4city.org
Broker Port: 8080
Kind: sensor
Visibility: MyOwnPrivate
Device Type: event
Format: json
Protocol: ngsi
MAC:
Model: AlertGeneric
Producer: disit
Longitude: 11.241117
Latitude: 43.776703
Device Uri: http://www.disit.org/km4city/resource/iot/orionUNIFI/DISIT/alert_1610548534047
VIEW IN SERVICE MAP
Organization: DISIT
NEW DATA IN alert_1610548534047
Owner: undefined
PAYLOAD NGSI v1
PAYLOAD NGSI v2
K1: 44eca781-af56-490f-a6c6-36d88b1bcd9c
K2: 6a620551-e4e5-4c0d-8777-d0721175cfb0
Created on: 2021-01-13 15:35:41

Add New Device





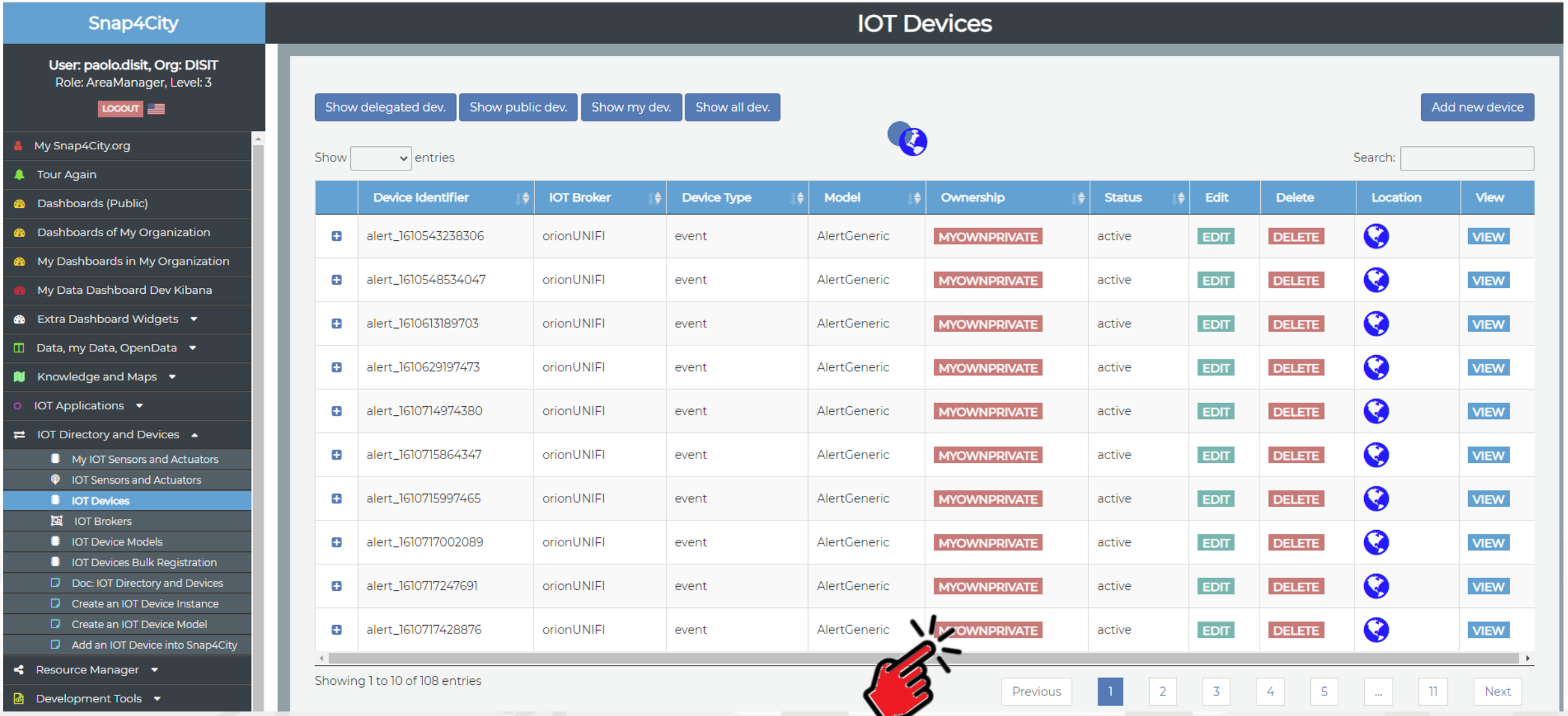




Entity / Device: Attributes

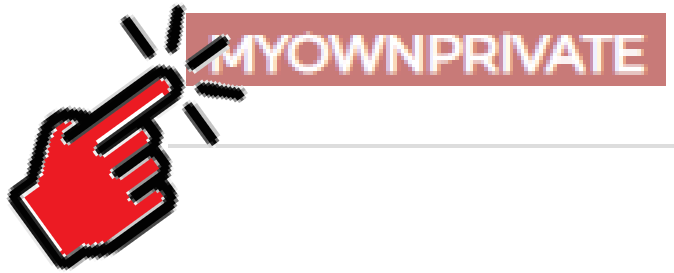
Where	IOT Device	AT 23-12-2019T20:13:12…	AT 23-12-2019T22:13:12…
IOT Broker	**Broker: OrionUNIFI**	--	
IOT Broker	**Protocol: NGSI**	--	
Info	ID: "park45"	**park45**	**park45**
Position	GSP Position: 43.12, 11.34	GSP Position: 44.12, 11.12	GSP Position: 44.14, 11.13
Static attribute	Description: "parking massaia"	--	
Static attribute	Location: "Via Massaia"	--	
Static attribute	Civic Number: 3	--	
Static attribute	MaxCapacity: 456	--	
Values	**dateObserved: Timestamp**	23-12-2019T20:13:12…	23-12-2019T22:13:12…
Values	**FreeSlots: Integer, #**	345	356
Values	**Humidity: float, %**	25,5	25,5
Values	**Temperature: float, celsius**	34	

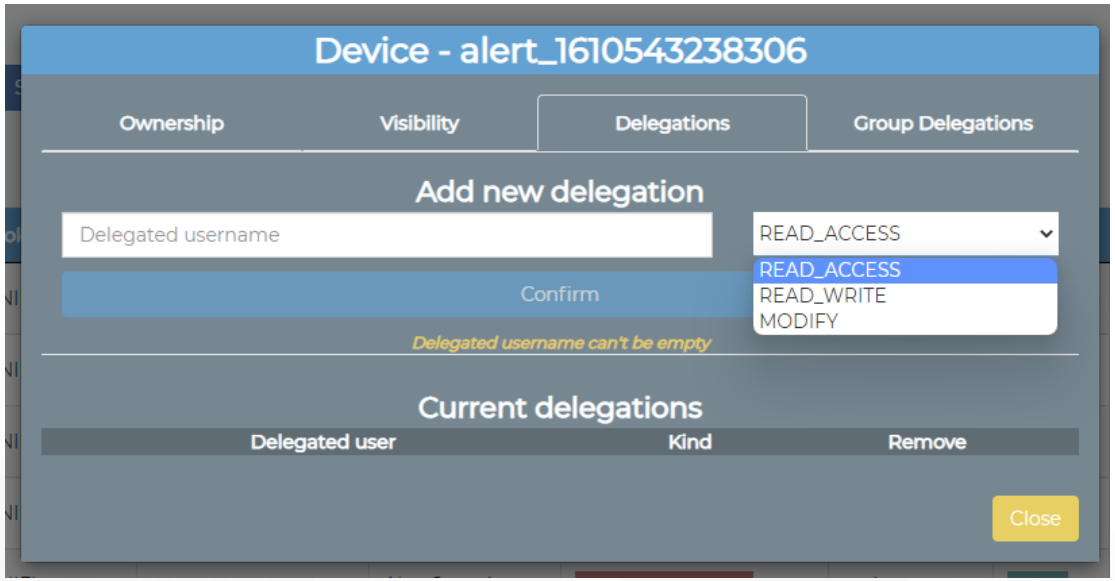
IoT Device Management for All, Developers



Developers can

- Manage their own Devices
  - Edit/Modify, Delete, view, send messages, etc.
  - Pass the ownership of a Device to another user
  - Delegate in
    - READ_ACCESS the IoT Device to other users
    - READ_WRITE the IoT Device to other users
    - MODIFY the IoT Device to other users
  - See and change the Delegations
- See Delegated IoT Devices, …
- See Public IoT Devices, …





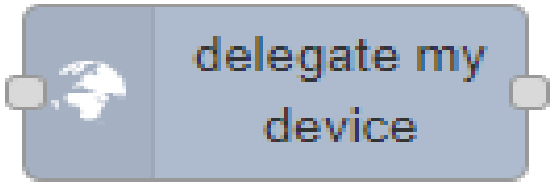
What they mean ?

Supposing that User User45 has the Device D34 !

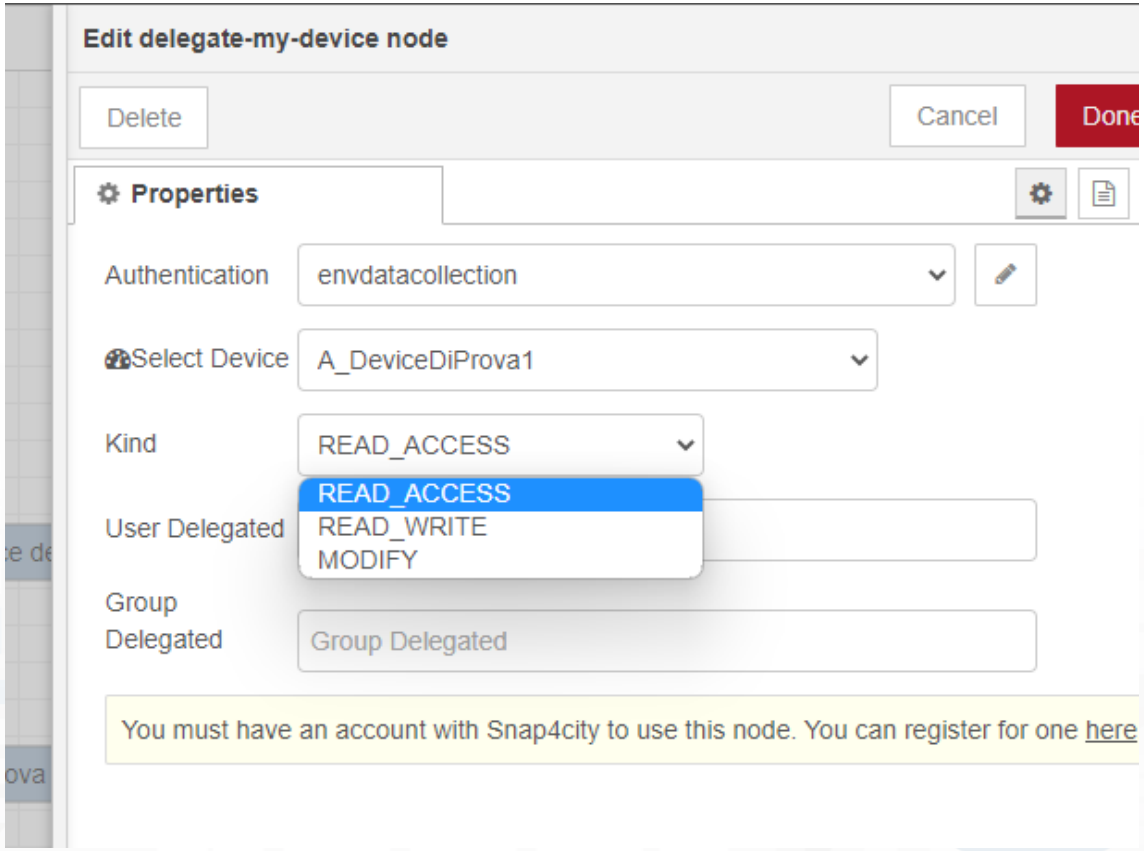
THUS: User45 can delegate Device D34 at User DD12 for

- **READ_ACCESS**. This means that User DD12 can read the values/data of Device D34, real time and historical
- **READ_WRITE**. This means that User DD12 can
  - read the values/data of Device D34, real time and historical
  - Send messages to the broker to add them for device DD12
- **MODIFY**. This means that User DD12 can Modify structure of Device D34, for example: changing the name of variables, etc.

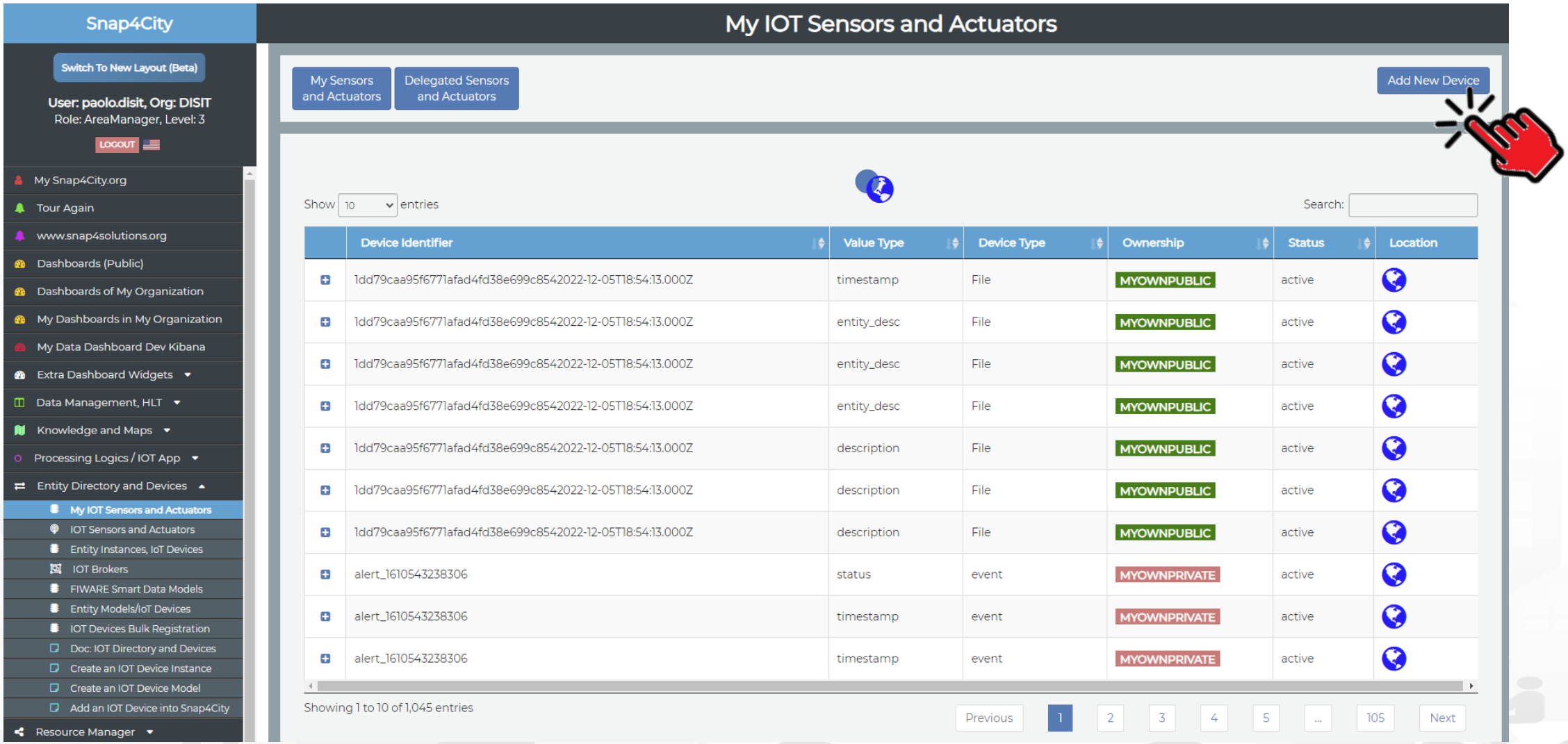
Delegate Management from IoT App



To delegate a certain device to some other user



Simplified Device Management



Simplified Add Device: only from Model

Snap4City

My IOT Sensors and Actuators

Switch To New Layout (Beta)

User: paolo.disit, Org: DISIT
Role: AreaManager, Level: 3

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  - IOT Brokers
  - FIWARE Smart Data Models
  - Entity Models/IoT Devices
  - IOT Devices Bulk Registration
  - Doc: IOT Directory and Devices

My Sensors and Actuators | Delegated Sensors and Actuators | Add New Device

Add My New Device

Identifier
Device Identifier is mandatory

Model: Select an option
Device Model is mandatory

Latitude
Latitude is mandatory

Longitude
Longitude is mandatory

KEY 1: 3c4bab66-c273-4599-a1ed-1db1a35d15fe
Ok

KEY 2: 1743d0d5-01d6-42a4-a443-1c09c3834ae7
Ok

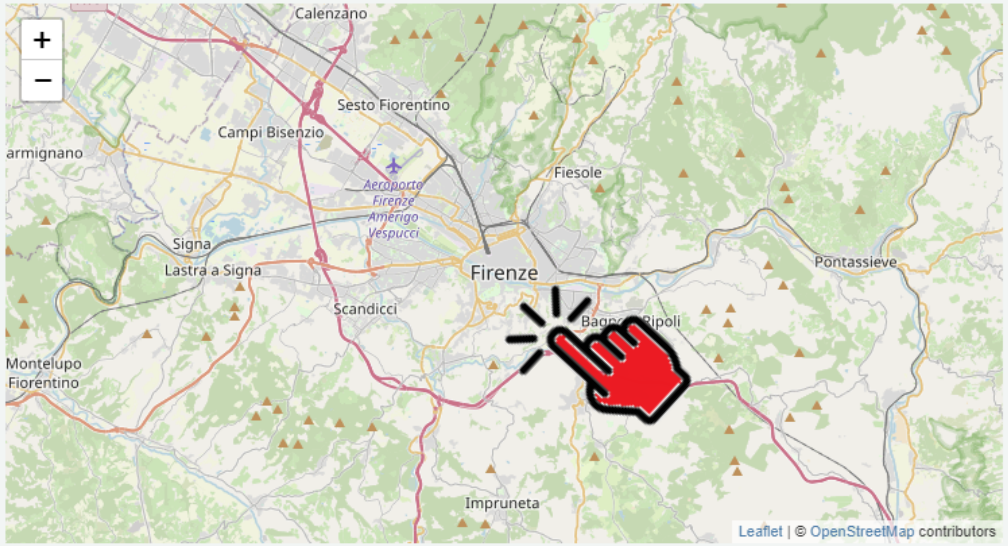
ContextBroker

Protocol

Format

Submit Device

Select Latitude/Longitude on Map



Design: from Data Modelling to Data Ingestion

IoT/Entity Network Manager vs Final User

Network of Brokers

IOT Broker

External

Internal

Entity/IOT Directory

My Entity Mode /
IoT Device Model

My Entity Instances
My IoT Device

Register

Network
Manager

Registering

Discovering

Knowledge Base,
Km4City

Knowledge and Storage
Data from the Field and
City

Browsing

ServiceMap
Knowledge Base

Discovering

Processing Logic
IoT Application

Final user
Manager

Dashboard Wizard

Using the Entity/Device Model notes!!!

- Once performed the Entity/Device Model, a number of Entities/Devices can be produce **using the model as a Template**

  - **NOTE:** the produced Entities/Devices are not going to change if the Entity/Device Model is modified.
  - *Your biscuit is not changing if the template is modified after the printout*

The Data Models can be simply instantiated from

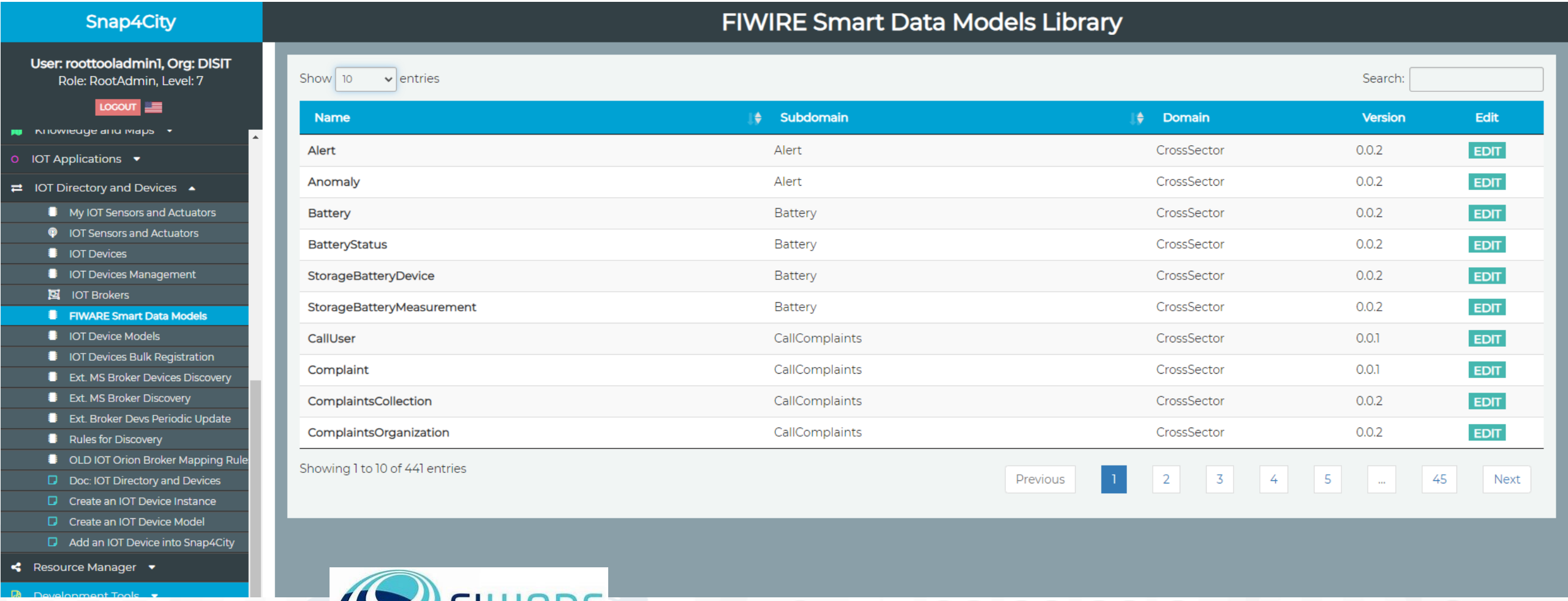
a) **FIWARE Smart Data Models**, versioning, and harvesting the standard repository

b) **Entity Model / IoT Device Model** which are accessible into the Snap4City environment

c) **Excel files by using Data Table tool**, which extracts the model from the excel table and automatically creates **Entity Model /** IoT Device Model, Entity Instances / IoT Devices and data attached to them

d) Creating a **custom Entity Model / IoT Device Model** in standard Snap4City format via **Entity Directory** / **IoT Directory**

FIWARE Smart Data Models -- Library



Connections among Entities

Where	Entity Model (IOT Device Model)	Entity Instance (IOT Device)	Entity Message at 23-12-2019T20:15:00	Entity Message at 23-12-2019T20:30:12
Broker	**Broker: OrionUNIFI**			
Broker	**Protocol: NGSI**			
Info	**ID: string**	ID: "park45"	**park45**	**park45**
Position	**GPS: lat, long**	GSP: 43.12, 11.34	GSP: 44.1256, 11.1234	GSP: 44.1259, 11.1233
Static attribute	**Description: string**	Description: "parking massaia"		
Static attribute	**MyAddInfoSURI: string**	**MyAddInfoSURI**: "http://...../InfoPersonal"		
Values	**dateObserved: Timestamp**		23-12-2019T20:15:00	23-12-2019T20:30:12
Values	**FreeSlots: Integer, #**		**FreeSlots:** 345	**FreeSlots:** 234
Values	**TodayCarSURI: string**		**TodayCarSURI:** "http://...../CarNF126GD"	**TodayCarSURI:** "http://...../CarGF789KK"
Values	**Temperature: float, celsius**		34	34

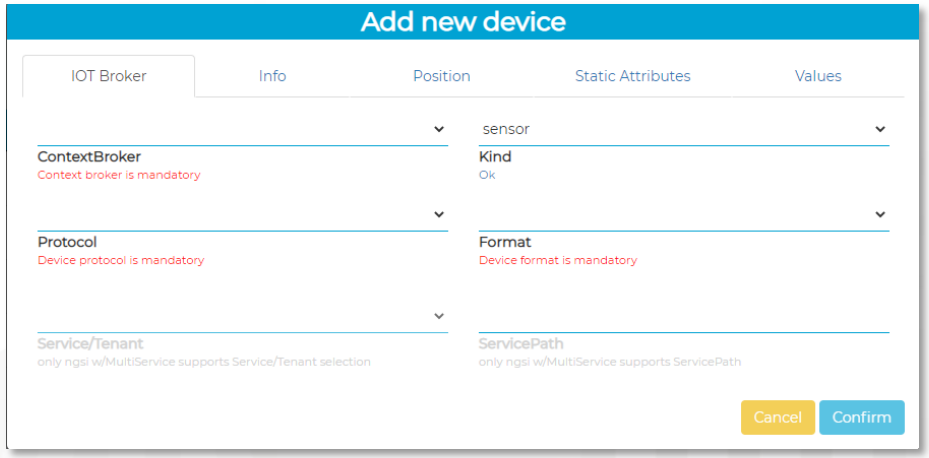
Model meaning

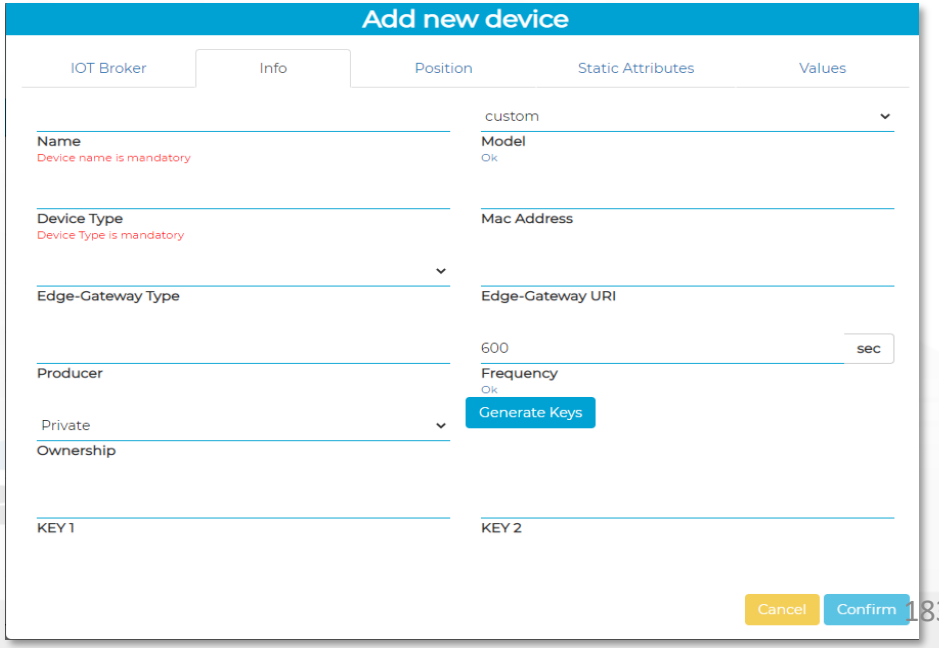
- **ID:** is the unique identifier for reconnecting Temporal Instances with registered Entity / Devices
- **Static Attributes:**
  - Are typically associated with instances of the IOT Device.
    E.g.:, You have a set of parking areas, each of them is located in a specific street, and has its one name, etc.
  - Different kinds of attributes can be set for each SubNature. Their definition has to be prepared into the Knowledge Base ☺ for automated indexing.
- **Values**: they are time varying variables (temporal values/instances)
  - They change over time, the timestamp of the time series is conventionally «dateObserved» in Snap4City
  - In new *SensorMobile* HLT, also GPS can be changing over time as in the MyKPI
- **NOTE for:**
  - **names/IDs**: Spaces or strange characters are not allowed in the. Please use simple alfphanumeric strings, it is a limitation of many solutions including Orion Broker and increase interoperability of your data.
  - **Values of attributes and variables**: can be UTF8, but similarly, they do not accept: () <> “ ‘ ; = into values
  - https://fiware-orion.readthedocs.io/en/master/user/forbidden_characters/index.html

Entity / Device Model (1)

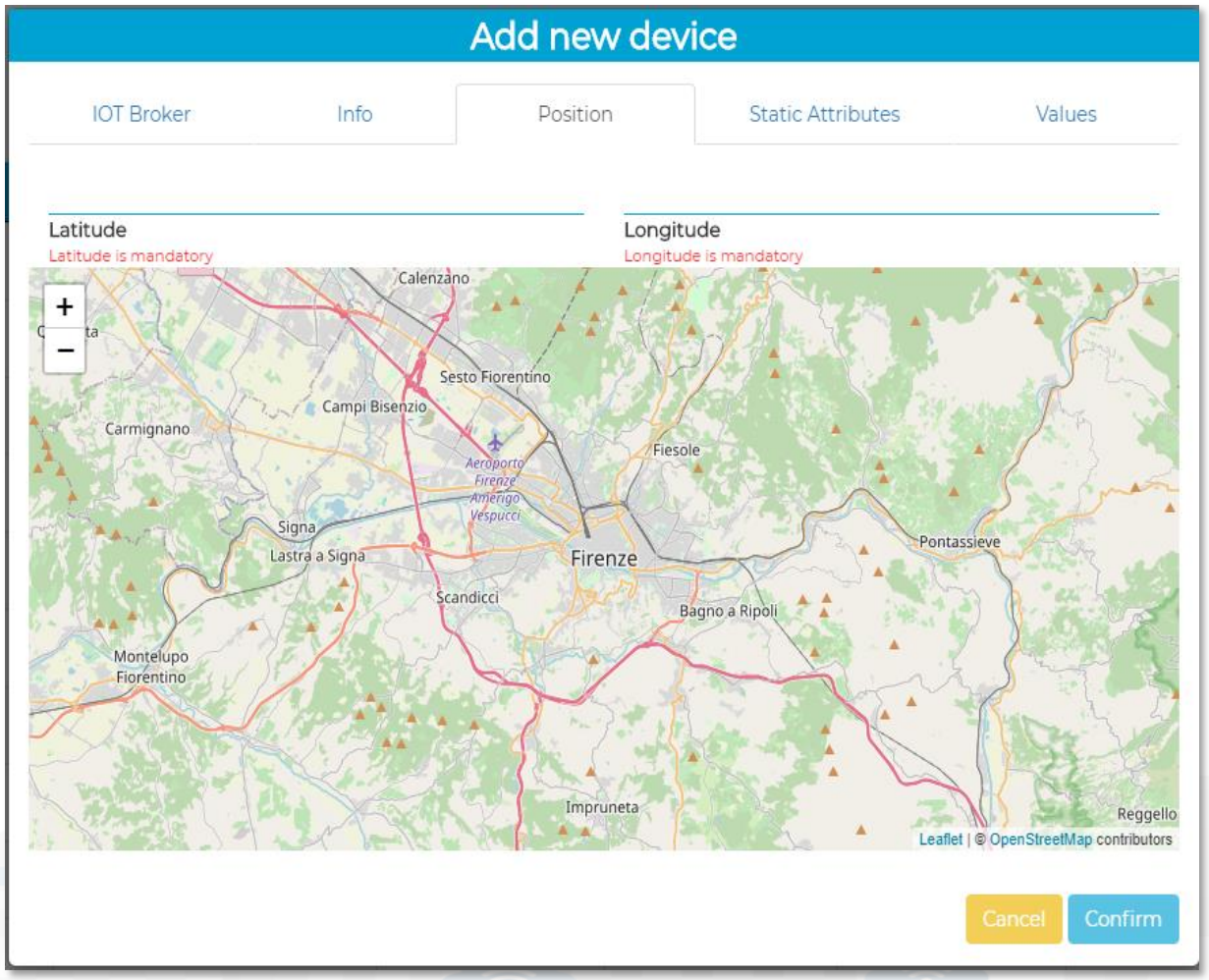
- IOT Broker
  - Name of the Brokers: among those registered
  - Protocol: NGSI, AMQP, MQTT, etc..
  - Format: CSV, JSON, XML.
  - Service/Tenant:…….
  - ServicePath:……

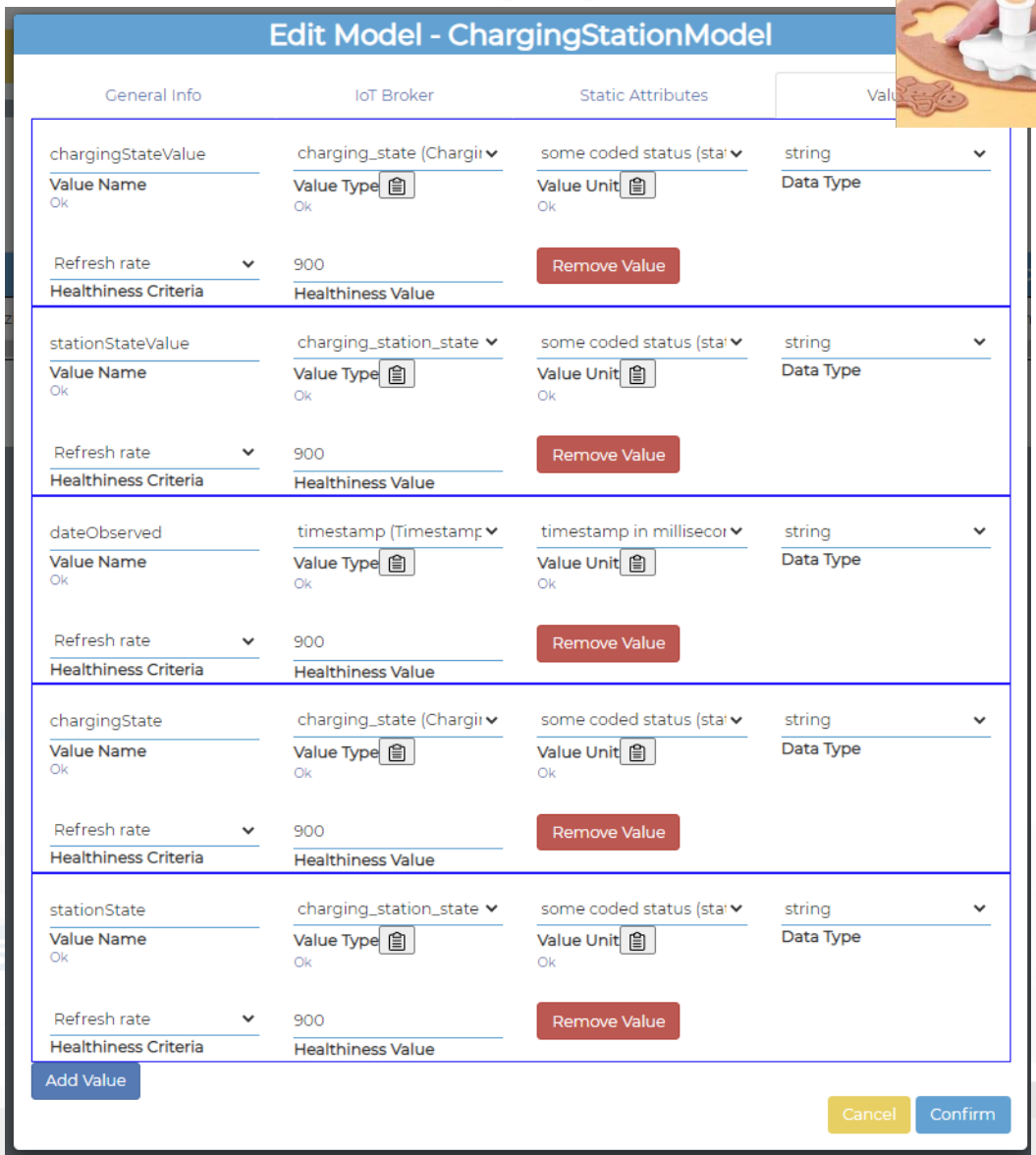
- Info
  - Name (Identifier)
  - Model: Custom or Model ID
  - DeviceType: ..a string..
  - MAC address: …optional…
  - Edge-GW: Raspberry, Android, …
  - Edge-GW: URI
  - Producer
  - Owner
  - Freq: ….. Sec
  - Keys: K1, K2





Entity / Device Data Model (2)





SURI Connections

From a

- *Static* Attribute of an Entity Instance to another Entity Instance, as highlighted in green in previous table.
- *Dynamic* Value/Variable of an Entity Message of an Entity Instance to another Entity Instance, as highlighted in green in previous table.

- *the example reports a*
  - *static connection and*
  - *dynamic connection to change the car at a given timestamp, note also change of position and other parameters, if needed*

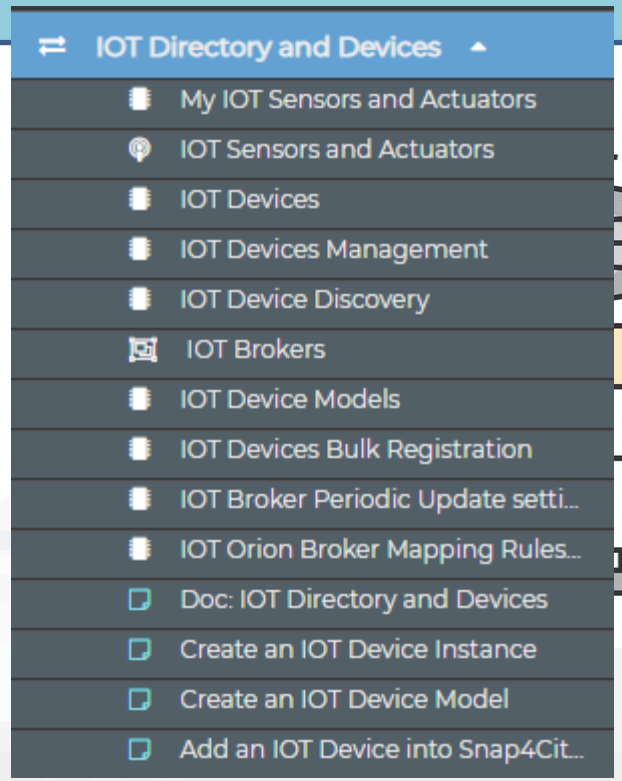
Non sicuro | disit.org/km4city/resource/iot/orionUNIFI/DISIT/METRO759

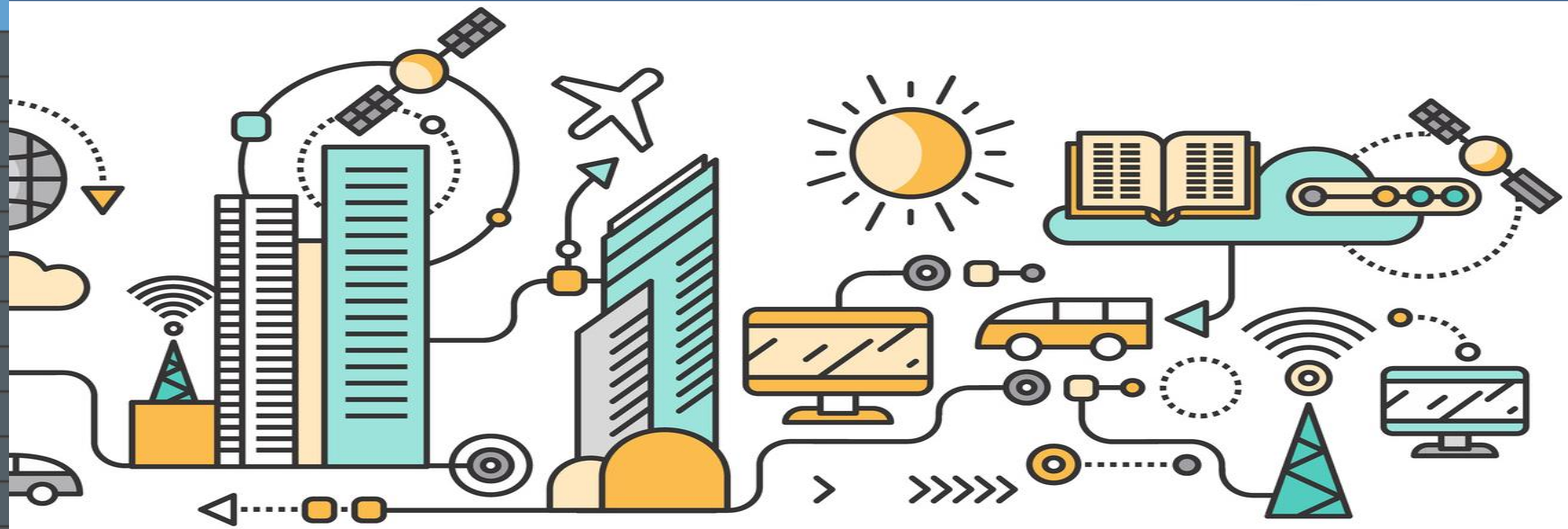
App Maps Google Gmail Snap4City Snap4 Calendar Translate Google Scholar Cita... DISIT DISIT old Facebook DataCe

p	o
http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/ns/sosa/Sensor
http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.disit.org/km4city/schema#Traffic_sensor
http://www.w3.org/ns/ssn/implements	http://www.disit.org/km4city/resource/iot/traffic
http://www.disit.org/km4city/schema#hasAttribute	http://www.disit.org/km4city/resource/iot/orionUNIFI/DISIT/METRO759/avgDistance
http://www.disit.org/km4city/schema#hasAttribute	http://www.disit.org/km4city/resource/iot/orionUNIFI/DISIT/METRO759/occupancy
http://www.disit.org/km4city/schema#hasAttribute	http://www.disit.org/km4city/resource/iot/orionUNIFI/DISIT/METRO759/thresholdPerc
http://www.disit.org/km4city/schema#hasAttribute	http://www.disit.org/km4city/resource/iot/orionUNIFI/DISIT/METRO759/speedPercentile
http://www.disit.org/km4city/schema#hasAttribute	http://www.disit.org/km4city/resource/iot/orionUNIFI/DISIT/METRO759/dateObserved
http://www.disit.org/km4city/schema#hasAttribute	http://www.disit.org/km4city/resource/iot/orionUNIFI/DISIT/METRO759/avgTime
http://www.disit.org/km4city/schema#hasAttribute	http://www.disit.org/km4city/resource/iot/orionUNIFI/DISIT/METRO759/concentration
http://www.disit.org/km4city/schema#hasAttribute	http://www.disit.org/km4city/resource/iot/orionUNIFI/DISIT/METRO759/vehicleFlow
http://www.disit.org/km4city/schema#hasAttribute	http://www.disit.org/km4city/resource/iot/orionUNIFI/DISIT/METRO759/averageSpeed
http://www.disit.org/km4city/schema#hasAttribute	http://www.disit.org/km4city/resource/iot/orionUNIFI/DISIT/METRO759/congestionLevel
http://www.disit.org/km4city/schema#hasAttribute	http://www.disit.org/km4city/resource/iot/orionUNIFI/DISIT/METRO759/anomalyLevel
http://www.w3.org/ns/sosa/observes	http://www.disit.org/km4city/resource/value_type/average_vehicle_distance
http://www.w3.org/ns/sosa/observes	http://www.disit.org/km4city/resource/value_type/average_vehicle_speed
http://www.w3.org/ns/sosa/observes	http://www.disit.org/km4city/resource/value_type/average_vehicle_time
http://www.w3.org/ns/sosa/observes	http://www.disit.org/km4city/resource/value_type/vehicle_concentration
http://www.w3.org/ns/sosa/observes	http://www.disit.org/km4city/resource/value_type/vehicle_speed_percentile
http://www.w3.org/ns/sosa/observes	http://www.disit.org/km4city/resource/value_type/vehicle_threshold_perc
http://www.w3.org/ns/sosa/observes	http://www.disit.org/km4city/resource/value_type/vehicle_flow
http://www.w3.org/ns/sosa/observes	http://www.disit.org/km4city/resource/value_type/timestamp
http://www.w3.org/ns/sosa/observes	http://www.disit.org/km4city/resource/value_type/anomaly_level
http://www.w3.org/ns/sosa/observes	http://www.disit.org/km4city/resource/value_type/traffic_congestion
http://www.w3.org/ns/ssn/hasSystemCapability	http://www.disit.org/km4city/resource/iot/orionUNIFI/DISIT/METRO759/systemCapability
http://purl.oclc.org/NET/UNIS/fiware/iot-lite#exposedBy	http://www.disit.org/km4city/resource/iot/orionUNIFI
http://www.disit.org/km4city/schema#protocol	"ngsi"
http://www.disit.org/km4city/schema#format	"json"
http://www.w3.org/2003/01/geo/wgs84_pos#long	11.25673
http://schema.org/addressLocality	"FIRENZE"
http://schema.org/name	"METRO759"
http://schema.org/streetAddress	"Lavagnini P.zza Della Liberta' (38)"
http://www.w3.org/2003/01/geo/wgs84_pos#lat	43.78278
http://www.disit.org/km4city/schema#isInRoad	http://www.disit.org/km4city/resource/RT04801703772TO
http://www.w3.org/2003/01/geo/wgs84_pos#geometry	"POINT(11.256730079651 43.782779693604)"^^<http://www.openlinksw.com/schemas/virtrdf#Geometry>
http://www.disit.org/km4city/schema#model	"metrotrafficsensor"
http://www.disit.org/km4city/schema#producer	"metro"
ma#organization	"DISIT"

www.disit.org/km4city/resource/iot/traffic

Entity / Device Registration from Model

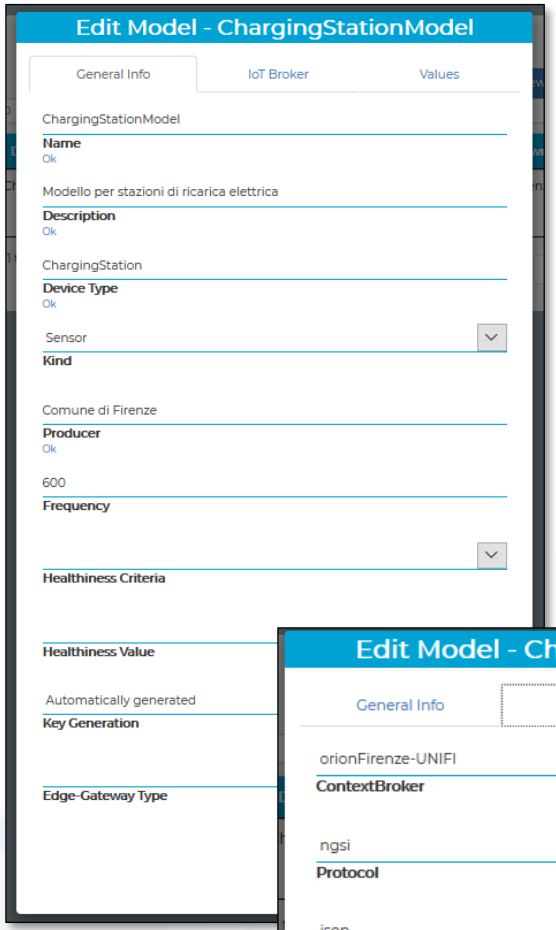


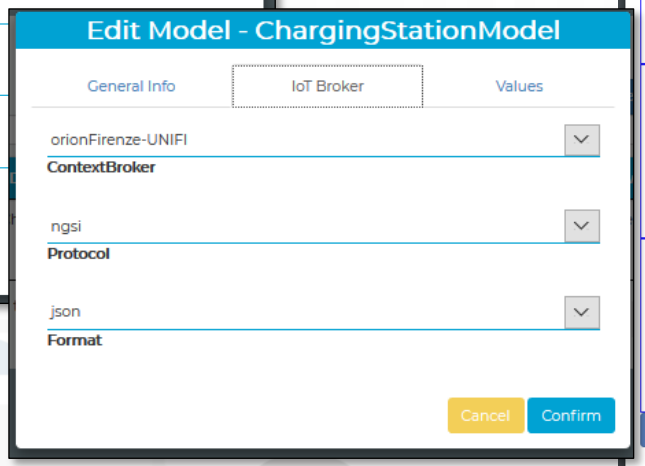


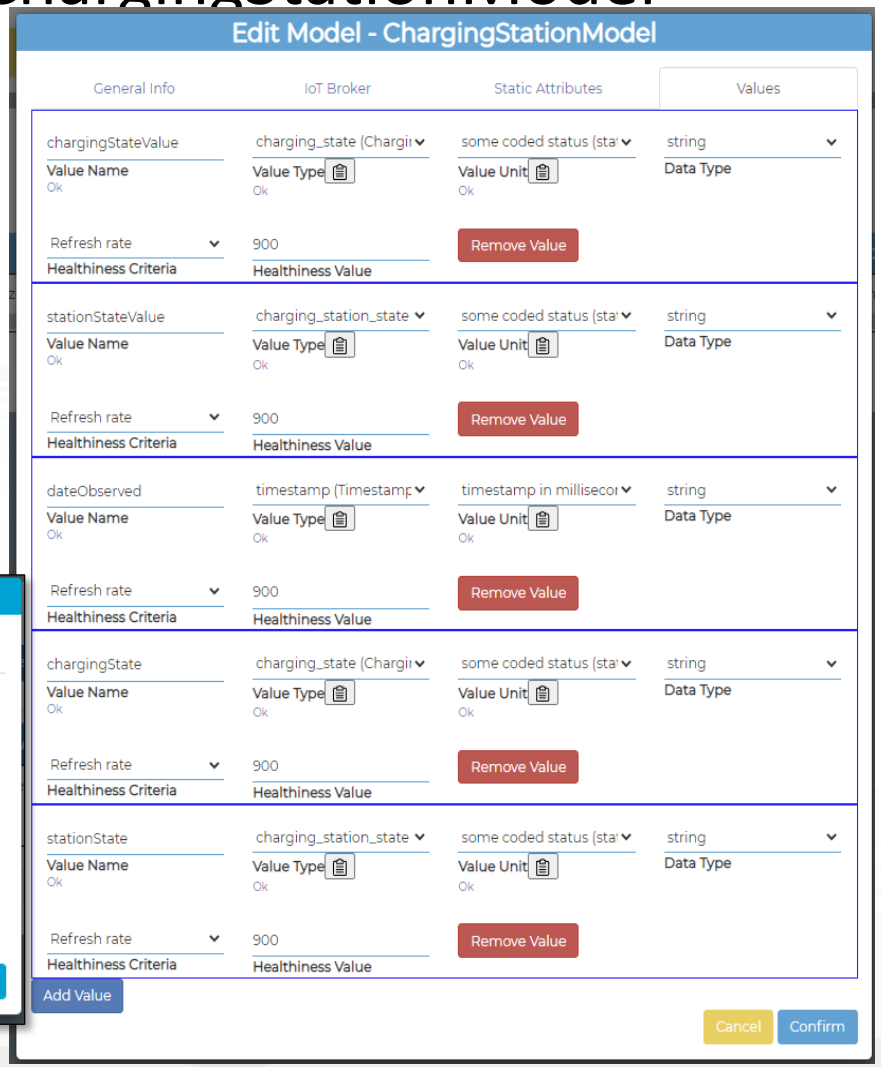
Many IoT Devices? IOT Device Model!!!

- **Prerequirements**: only for AreaManager users
- If you have a set of sensors with the same features,
  - you can create a model and then a set of instances (IoT Devices) in compliance with the model (not time consuming and avoiding errors)
- IoT Directory and Devices > IoT Device Models > ‘New Model’ button

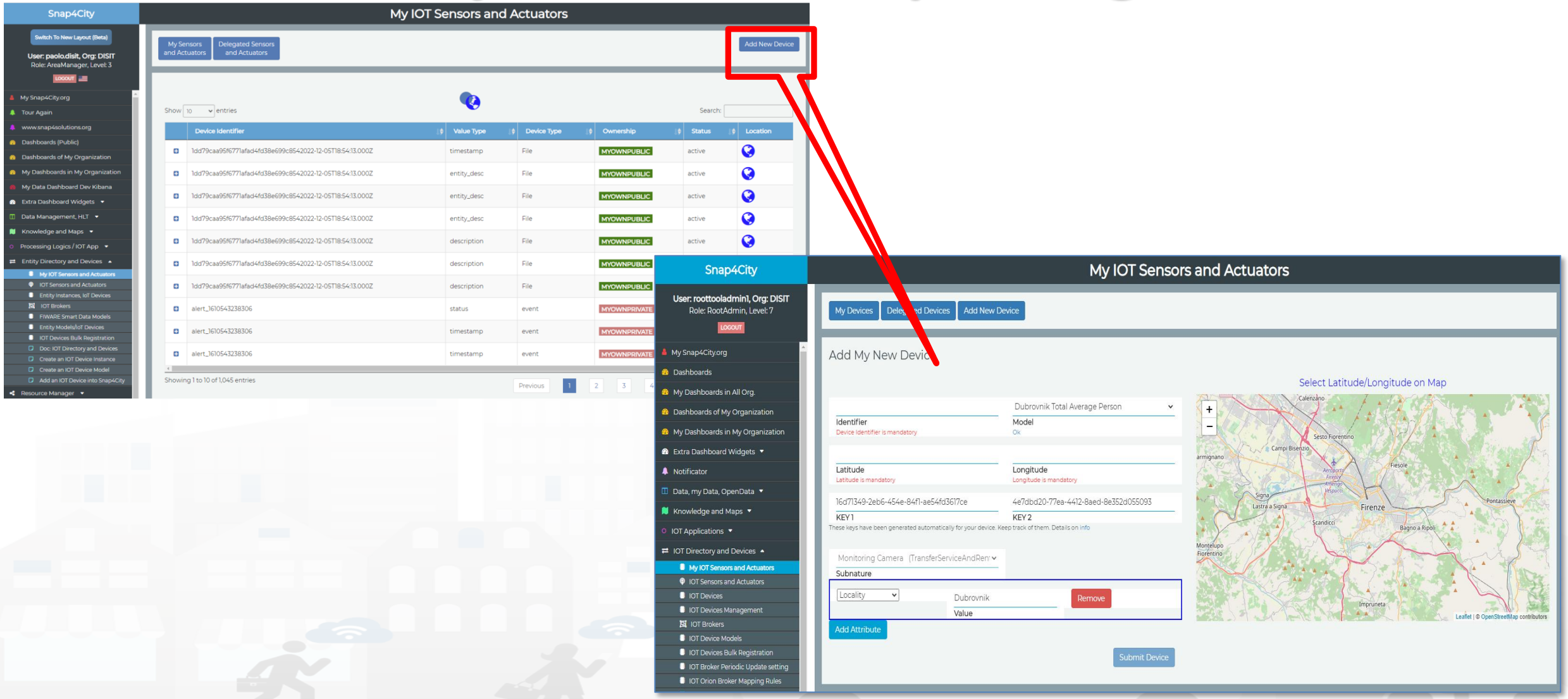
Example: ChargingStationModel







Add Entity / Devices, exploiting a Model



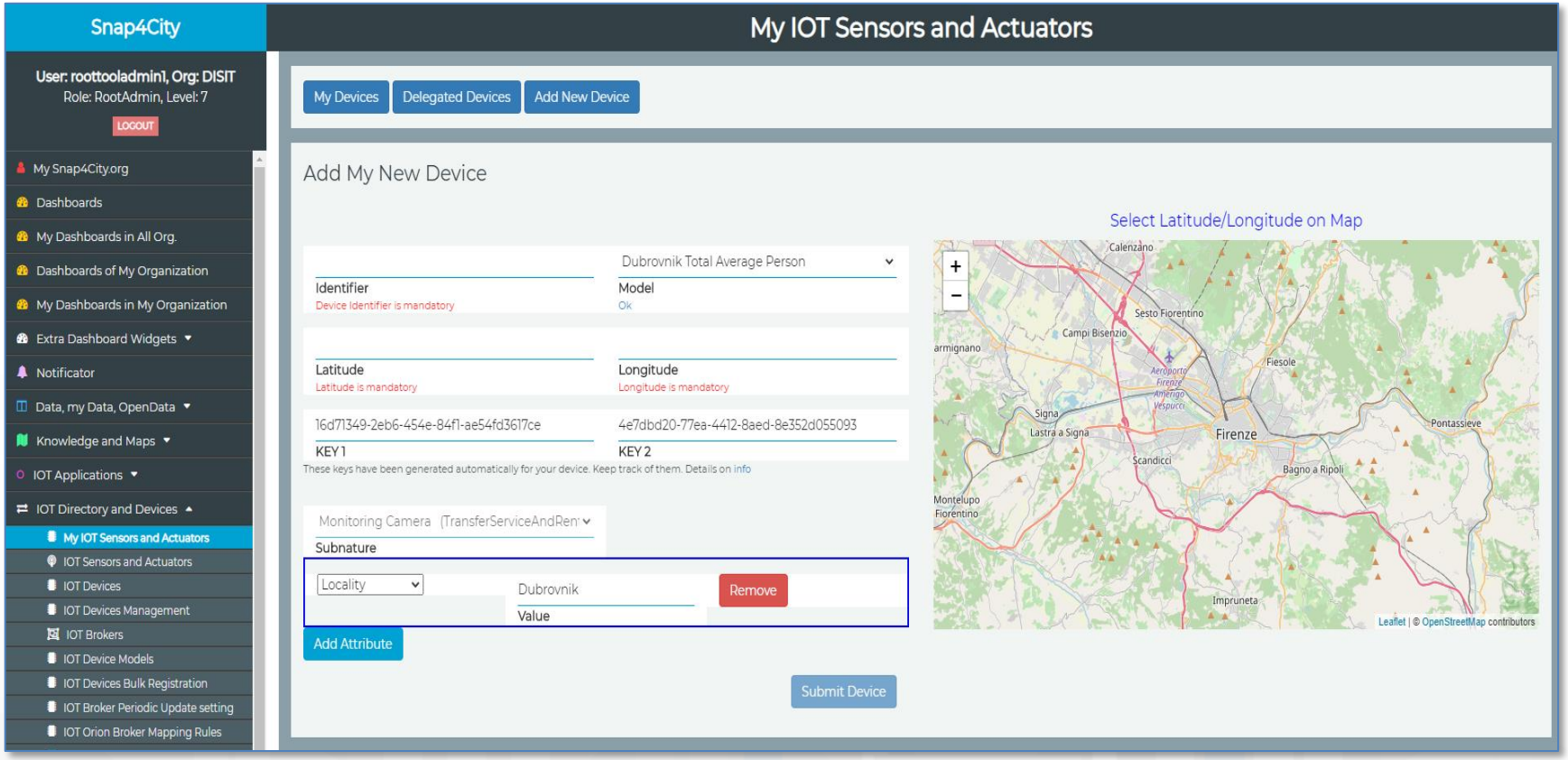
Add Entity / Devices, exploiting a Model

Just Buy an IOT Device and register: SigFOX, MQTT, NGSI (FiWare), …

- Attach them by
  - Models
- A range of protocols, formats, approaches

Create your own devices:

- Arduino,
- Raspberry,
- Android,
- LoraWAN + Arduino,
- etc.

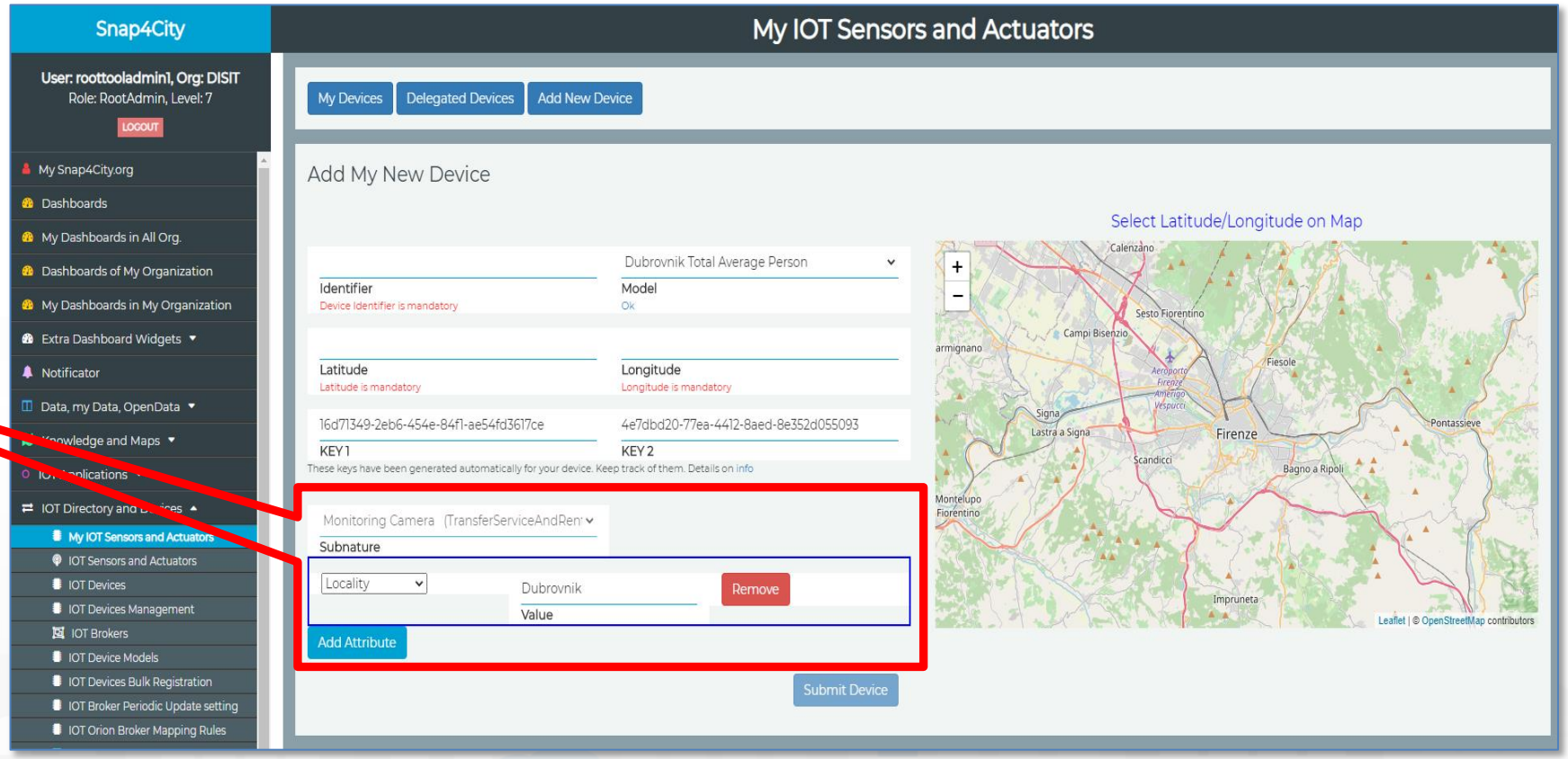


Secure Communication: HTTPS, TLS (K1, K2), Certificates

Add Entity / Devices, exploiting a Model

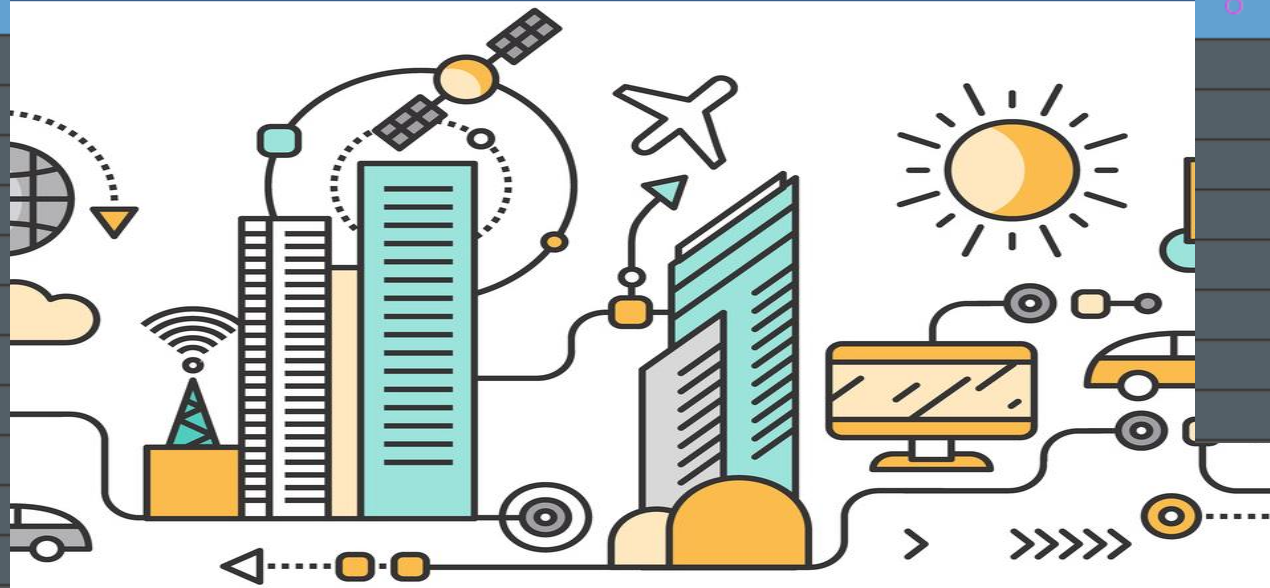
Addition of Static Attributes of the Entity Instance / IoT Device

Only if you enabled from model



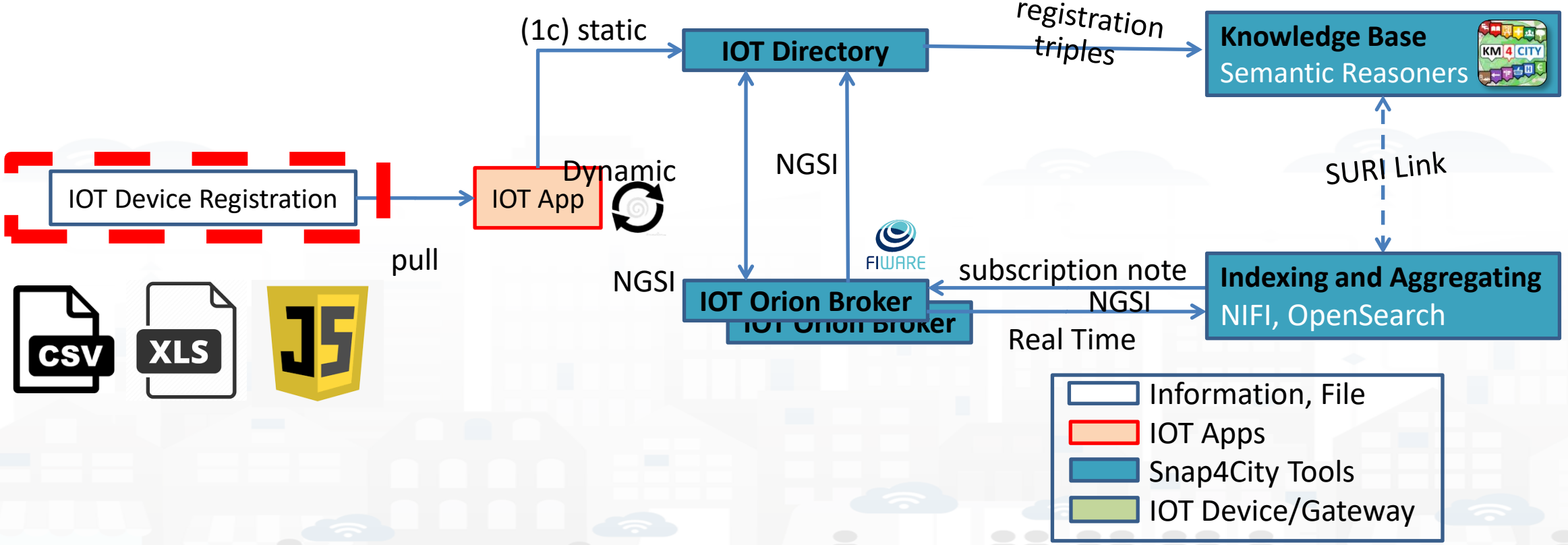
Entity / Device Registration from IOT App/Proc.Logic (automation)

- IOT Directory and Devices
  - My IOT Sensors and Actuators
  - IOT Sensors and Actuators
  - IOT Devices
  - IOT Devices Management
  - IOT Device Discovery
  - IOT Brokers
  - IOT Device Models
  - IOT Devices Bulk Registration
  - IOT Broker Periodic Update setti...
  - IOT Orion Broker Mapping Rules...
  - Doc: IOT Directory and Devices
  - Create an IOT Device Instance
  - Create an IOT Device Model
  - Add an IOT Device into Snap4Cit...



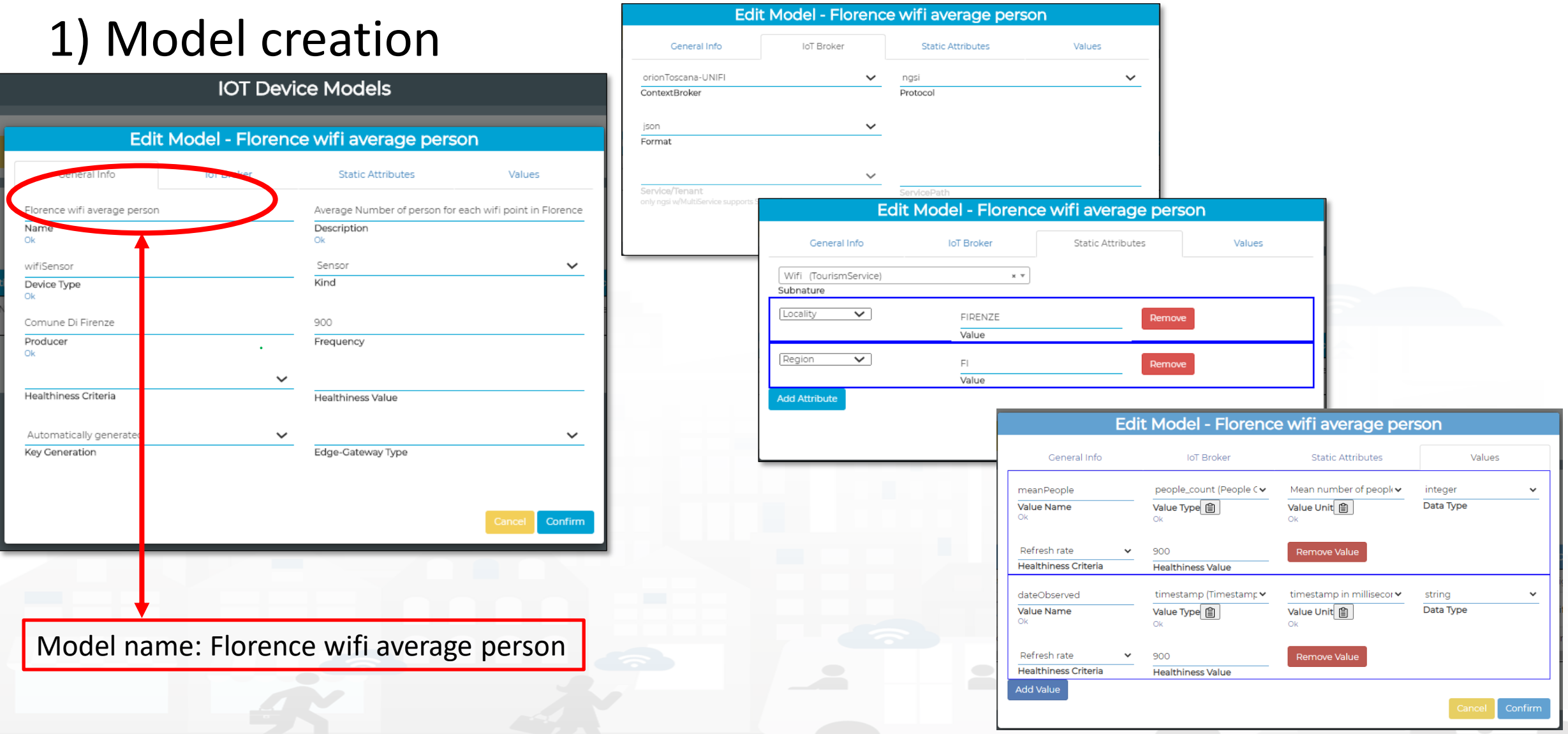
- IOT Applications
  - IOT Applications
  - MicroServices for IOT Applicatio...
  - MicroServices from DataAnalyti...
  - IOT MicroServices for Final Users...
  - IOT MicroServices for Developers...
  - Doc: IOT Applications
  - How to Develop IOT Application...
  - Create A MicroService from Rest...

Snap4city Data Ingestion Flow Diagram



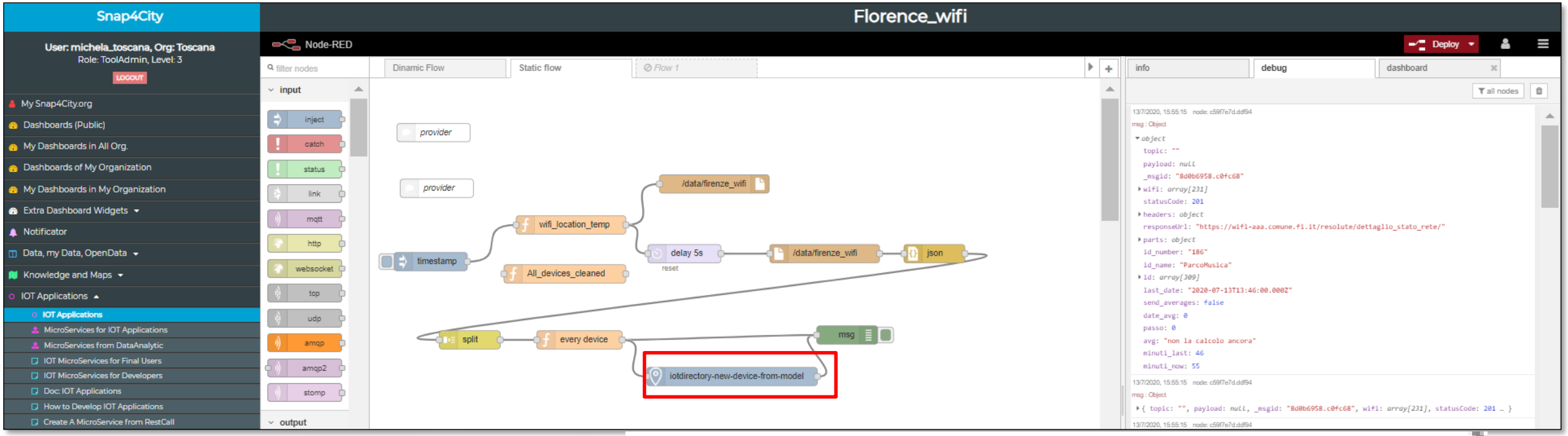
Dataset Creation

1) Model creation



Model name: Florence wifi average person

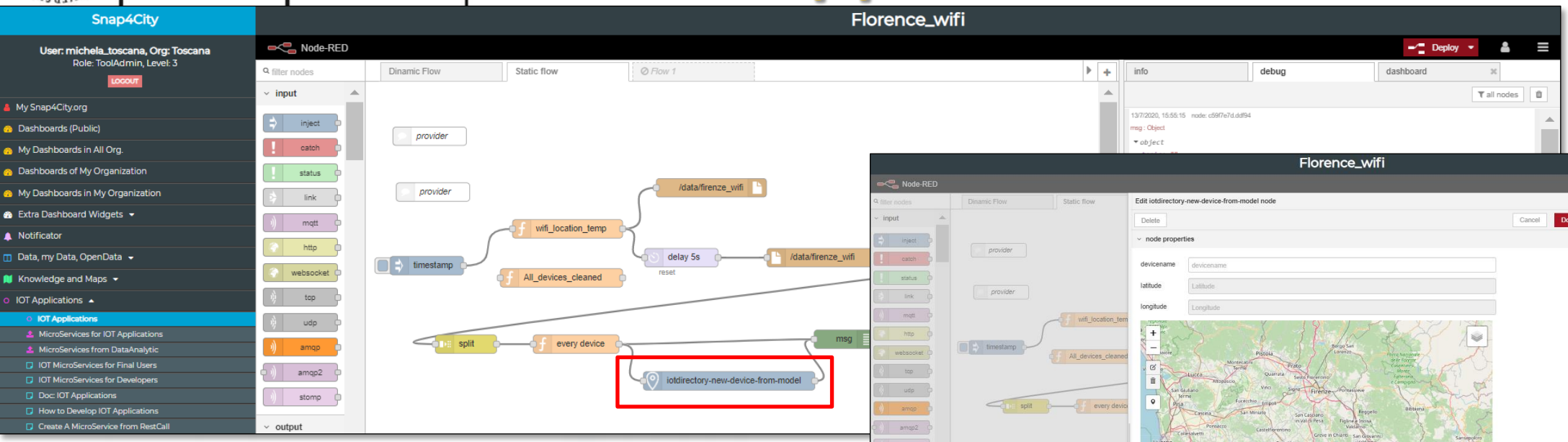
IoTApp static flow



2) IoT Devices Creation from IOT APP

BLOCK: 'IoTDirectory-new-device-from-model'
Model name: Florence wifi average person

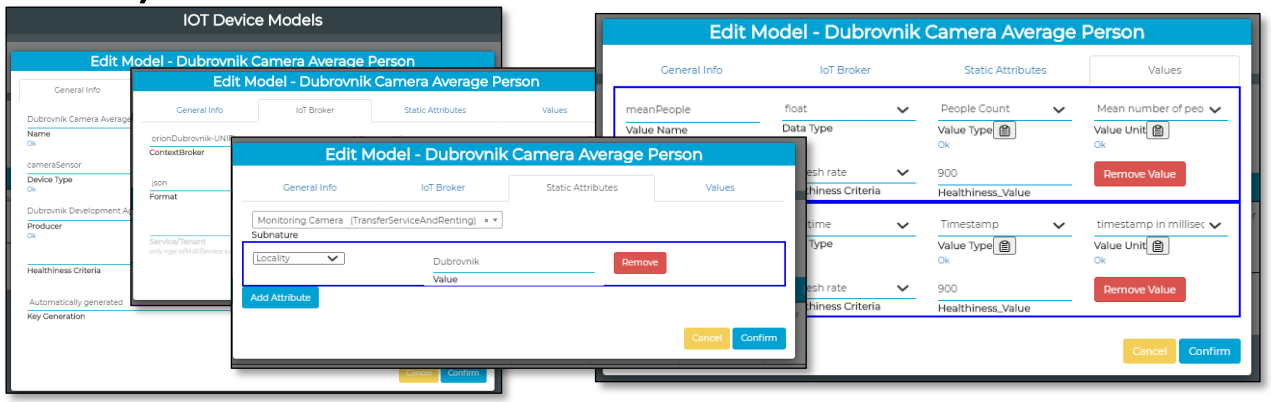
IoTApp static flow



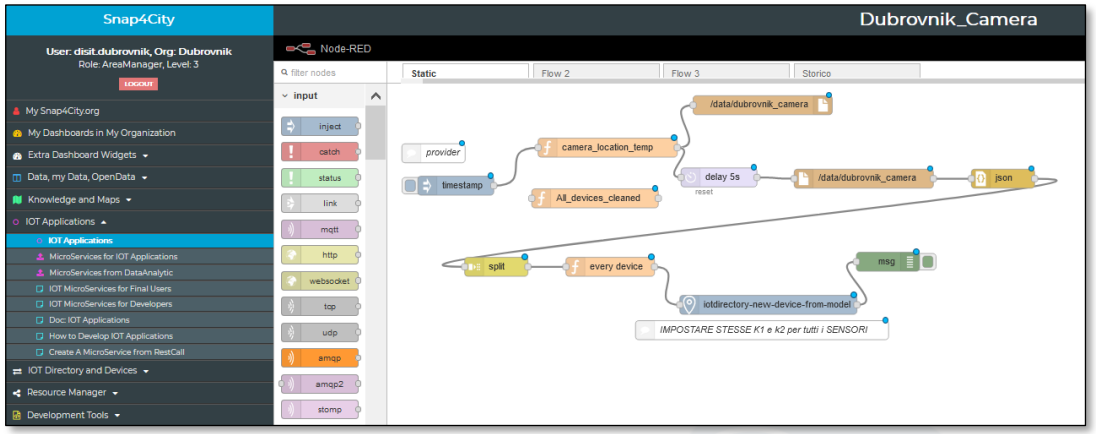
3) Group Creation (more than 200 devices) -> put all the devices in the group and put them as ‘public’ (or they remain private)

How to....

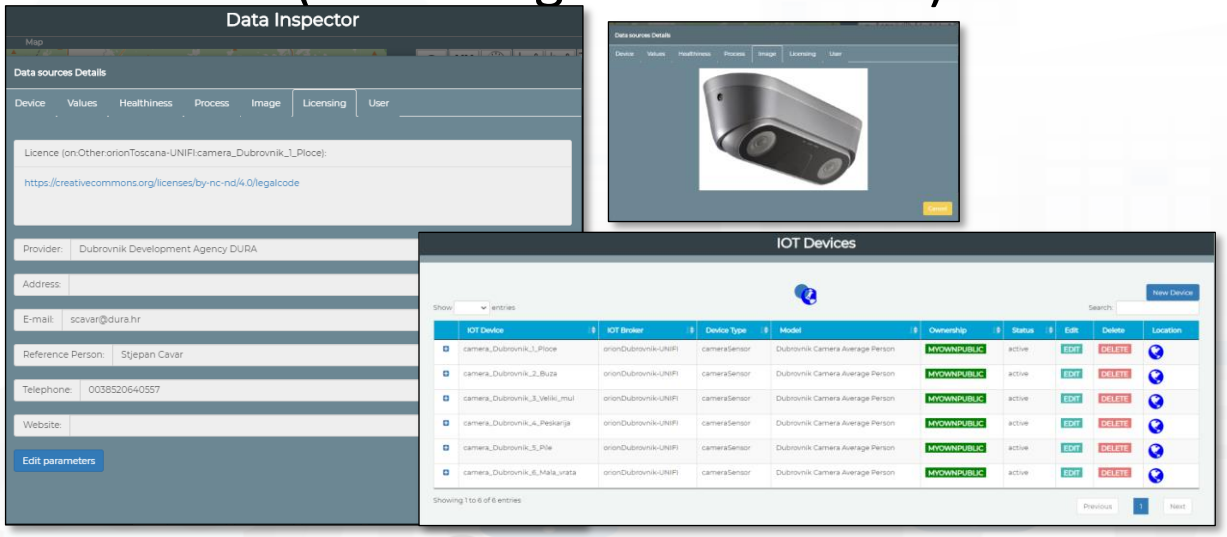
1) IoTModel



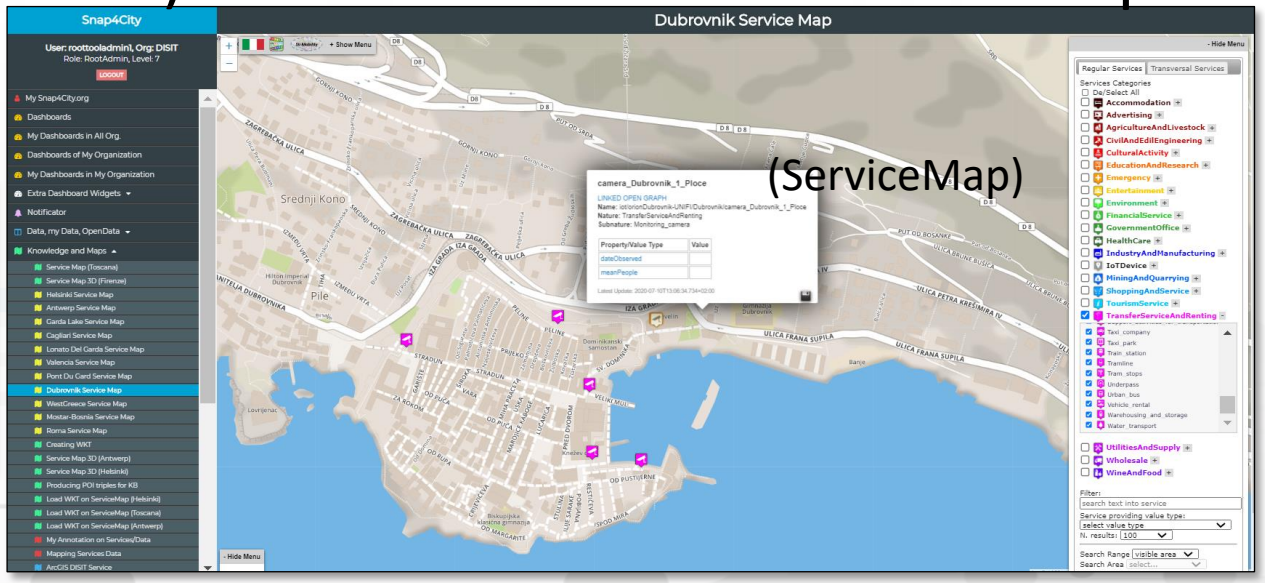
2) Static Flow to create IoTDevices



3) Add the license and Make Public the IoTDevices (according to the license)

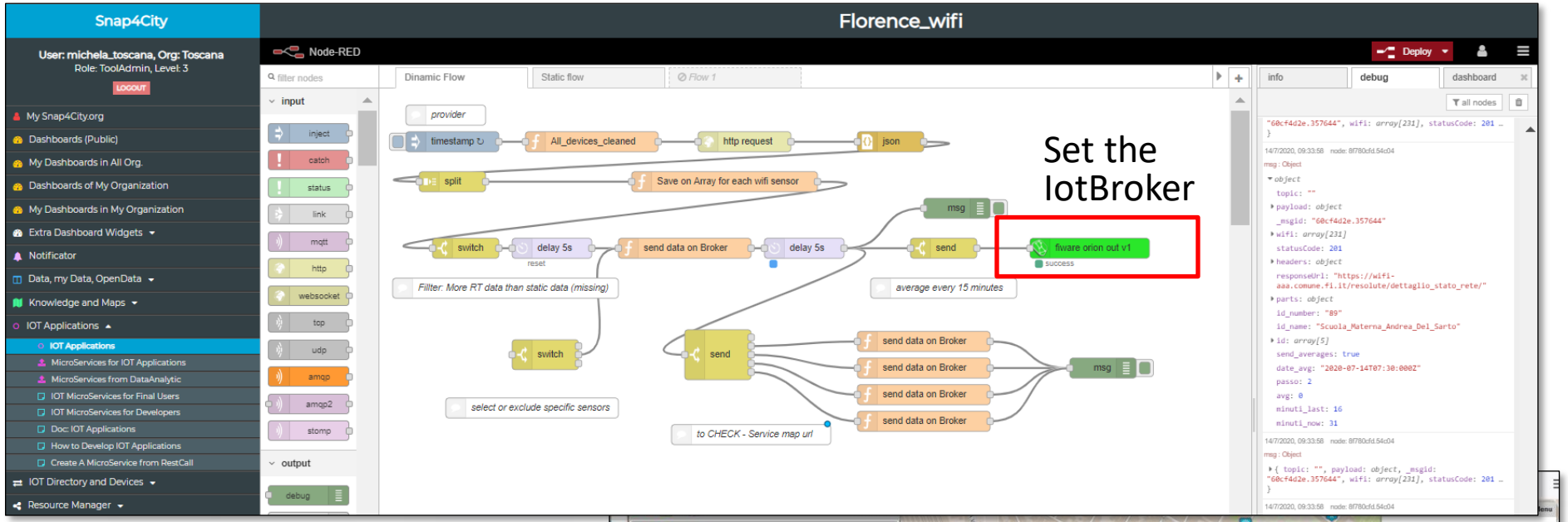


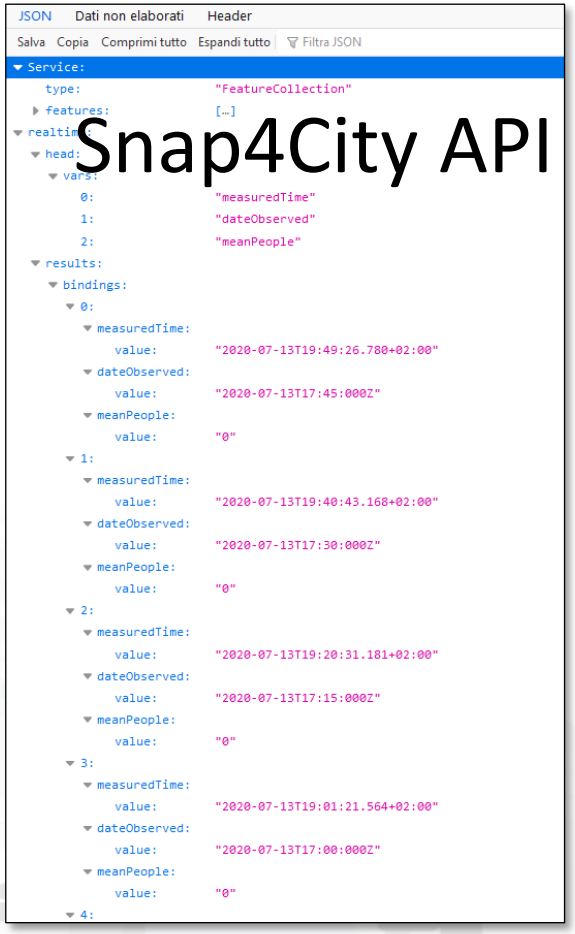
4) Search for the Cameras on Map



5) **Working on** Dynamic Flow to save Average #people every 15 minutes for each IoTDevice

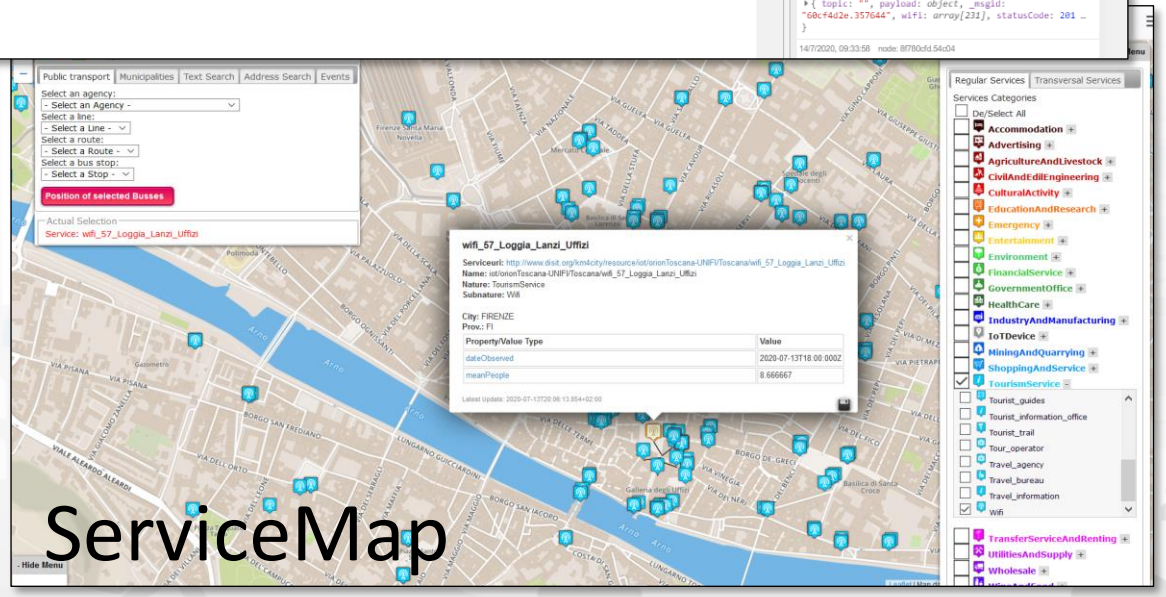
IoTApp Dynamic Flow





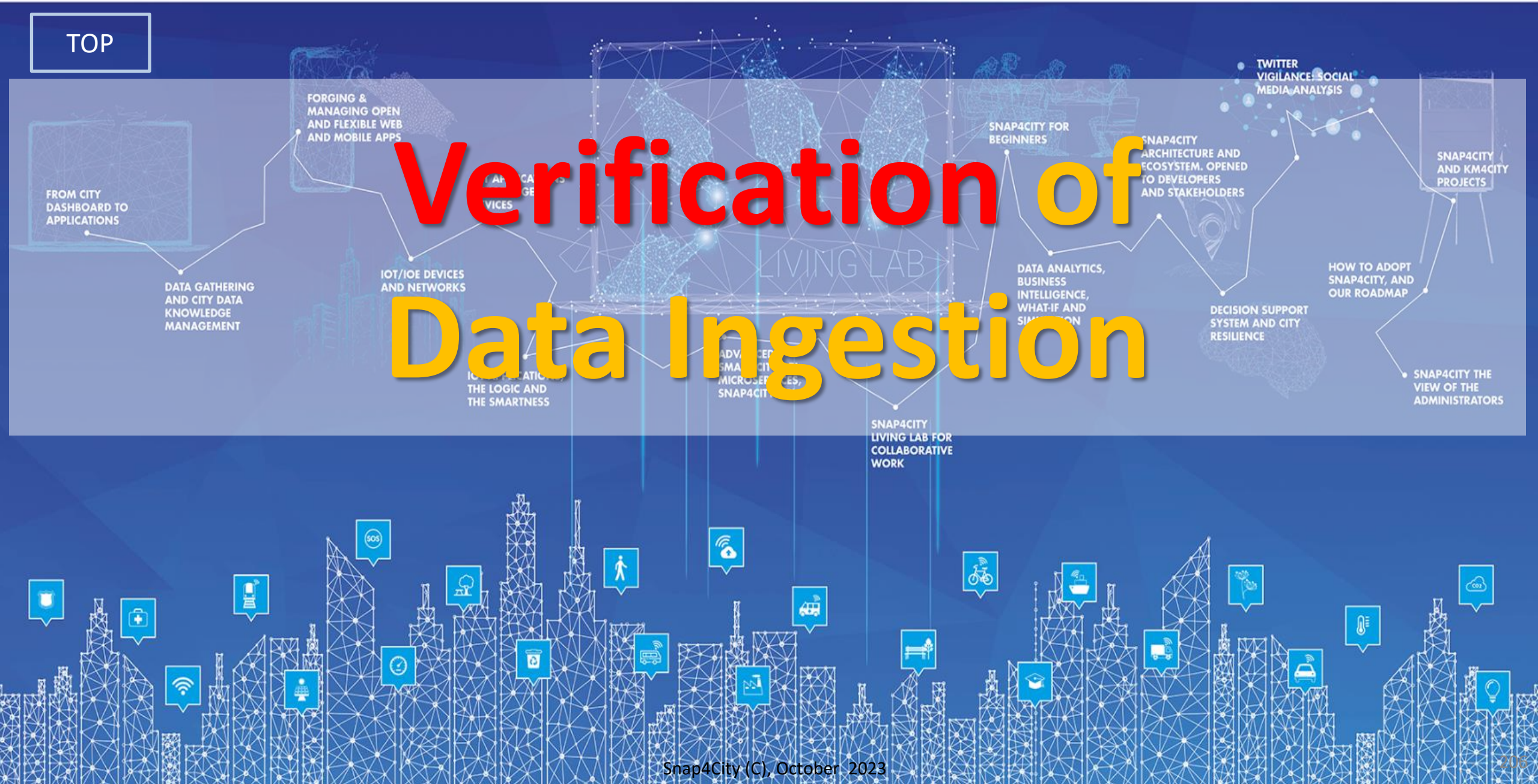
5) Send RT data to the IoTDevices

6) Verify RT Data via Snap4City API or via ServiceMap

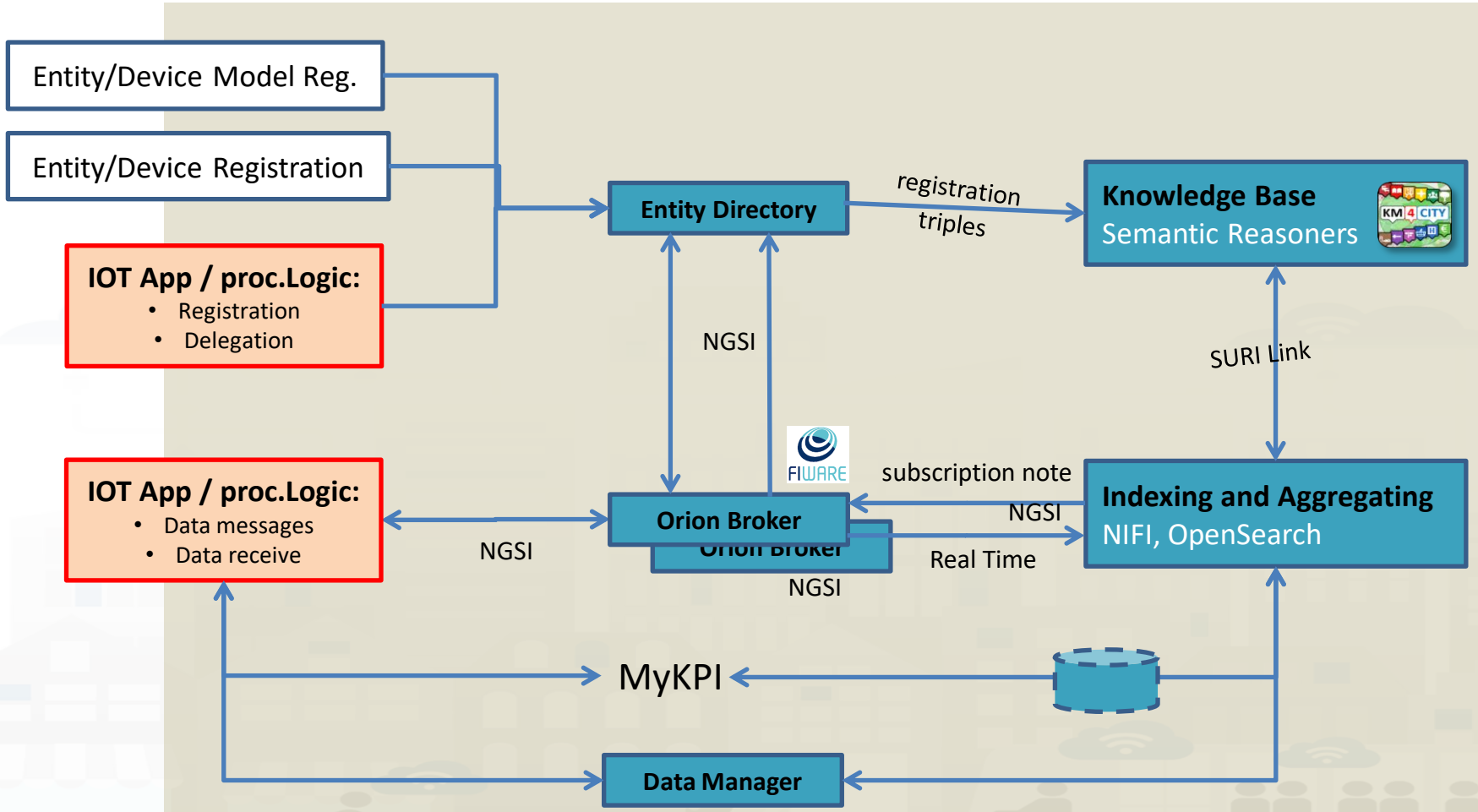


TOP

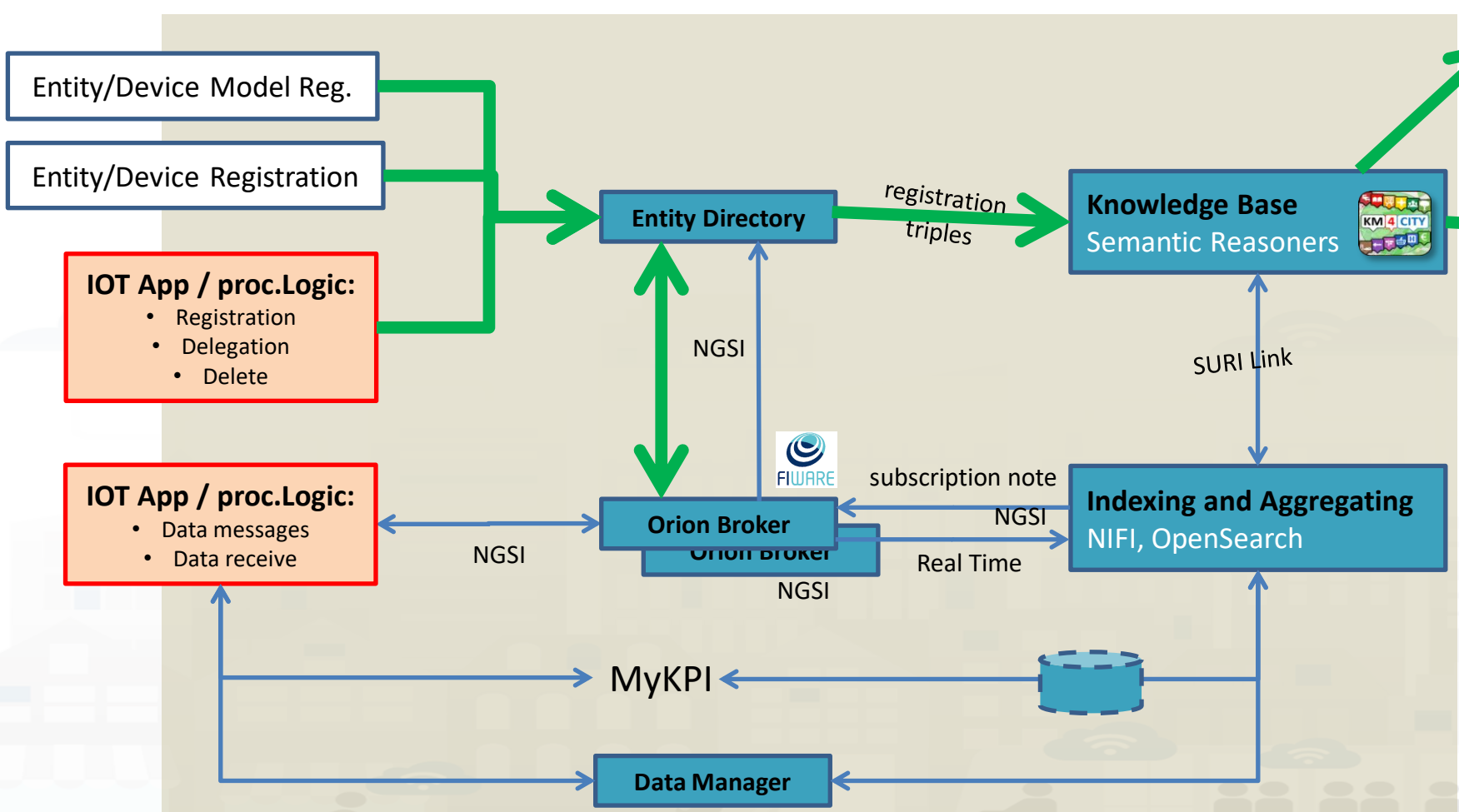
Verification of Data Ingestion



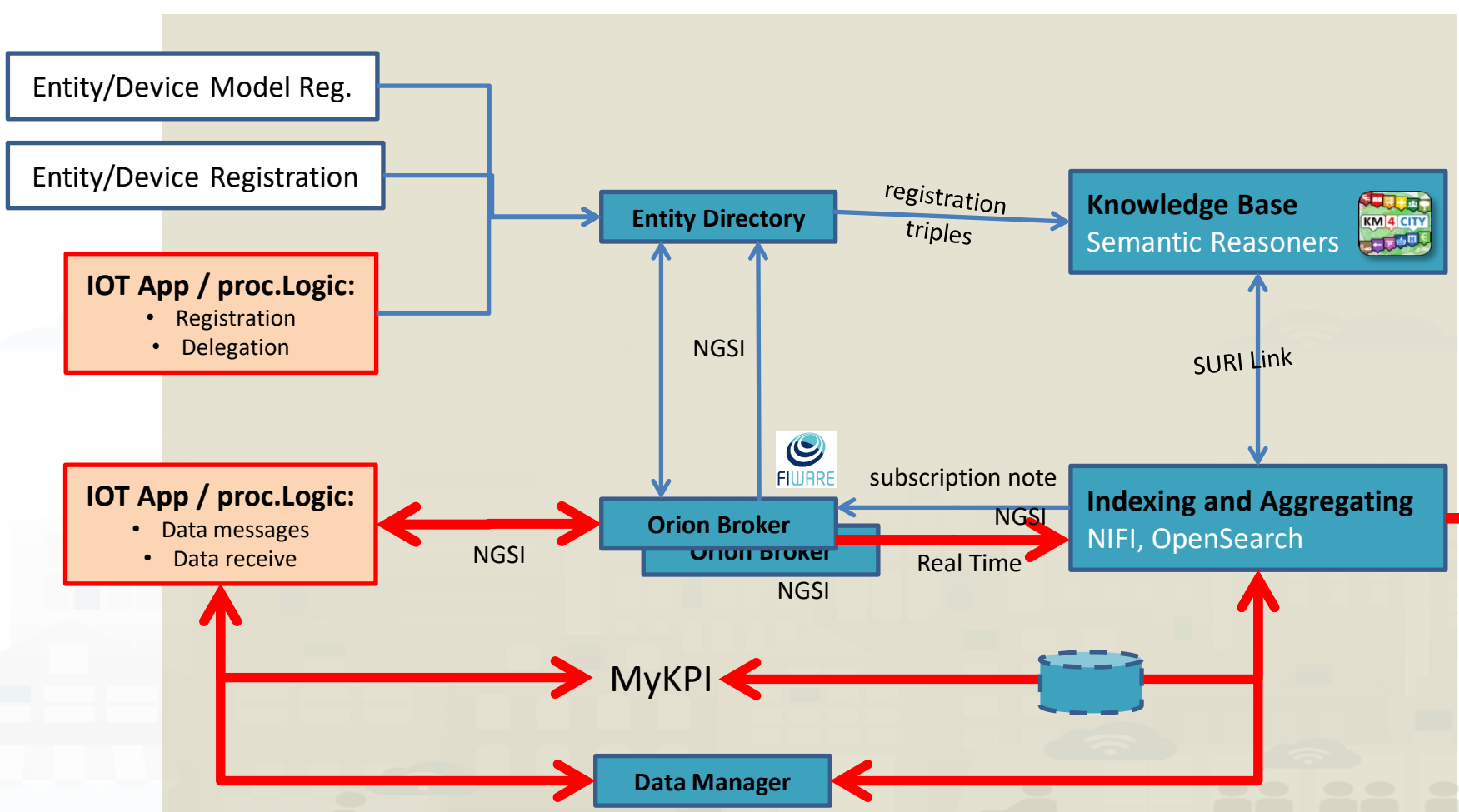
Main Data In/Out flows



Main Data In/Out flows



Main Data In/Out flows

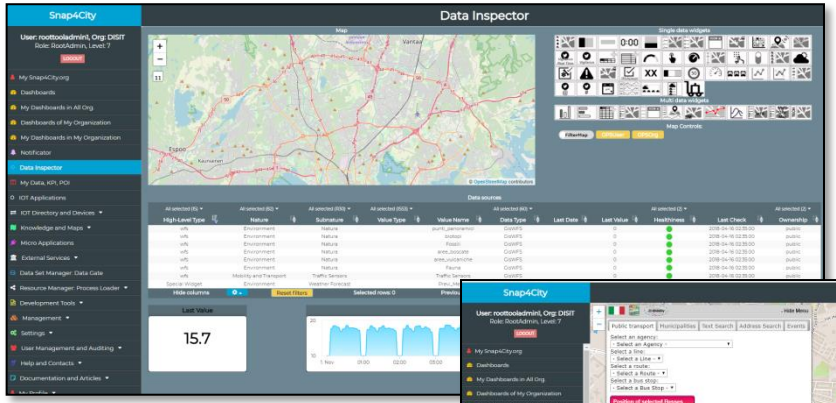


Checking data/Entity ingestion results

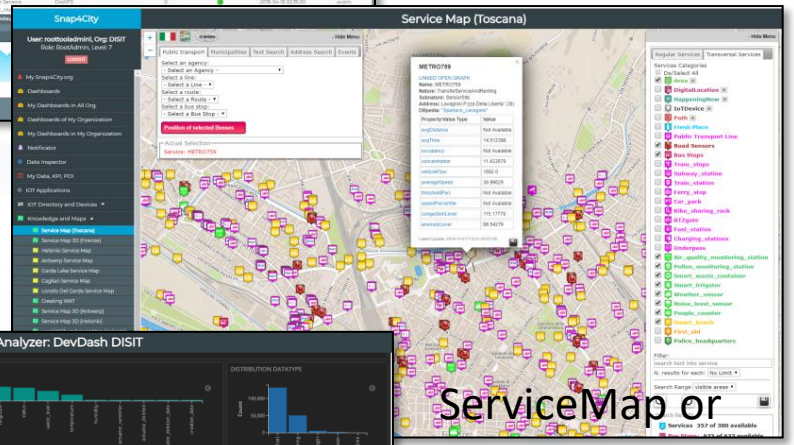
Knowledge base
Semantic reasoners

- All searches
- Metata
- Structure
- Last values of IoT Dev
- GTFS
- Only public IoT Dev

- **Data Inspector**
- **ServiceMap**, SCAPI
  - LOG / LOD viewer
  - Super Service Map
- IoT/Entity Directory
- SCAPI: Swagger
- IoT Brokers



Data Inspector
Digital Twin view

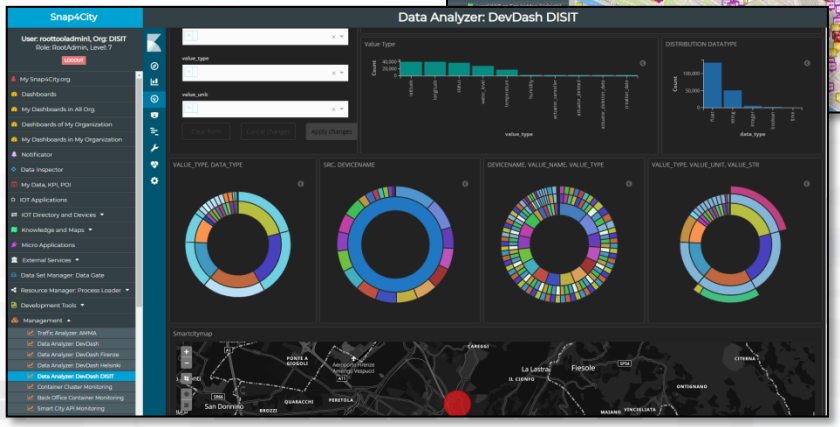


ServiceMap or
Super ServiceMap

Indexing and aggregating
NIFI, OpenSearch

- Faceted search
- Geo search
- Time Series
- Private and Public

- **Data Inspector**
- **ServiceMap**, SCAPI
- **My Data Dashboard,** OpenSearchDash
- OpenSearch

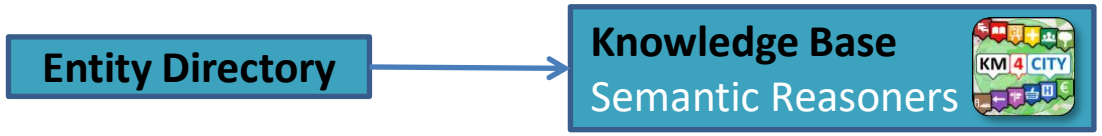


My Data Dashboard
DevDash

Some functionalities are limited to certain roles

Verification of Data Ingestion Process

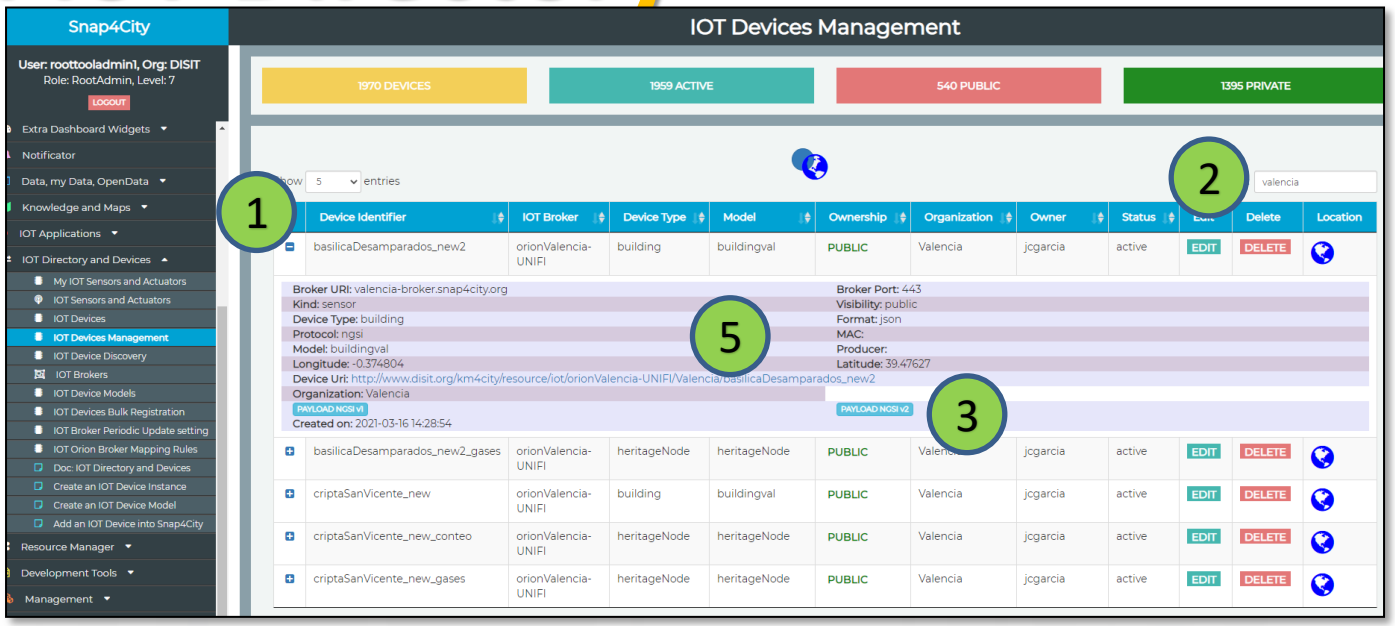
- **Verify that**
  - **Entity/Device Creation** see it on
    - Entity/IoT Directory, Entities/Devices list
    - Service Map if the device is Public
    - Data Inspector if the device is public and/or private
      - You can see the trend to see the time series and last value from the pin on map of the Data Inspector
    - Dashboards…… you can create a specific one using the Dashboard Wizard
  - **Entities/Device Data (time series)** see them on
    - Broker, via …… A dedicated services is coming….
    - Service Map if the device is Public
    - Data Inspector, this means that the data are on Storage
      - You can see the trend to see the time series and last value from the pin on map of the Data Inspector
    - Dashboards…… you can create a specific one using the Dashboard Wizard



Verify on IoT Directory

1. Verify the presence of the IoT Device you created
2. Verify the structure of the device by edit tool
3. See the **NGSI V2 JSON** format to be used on sending data msgs

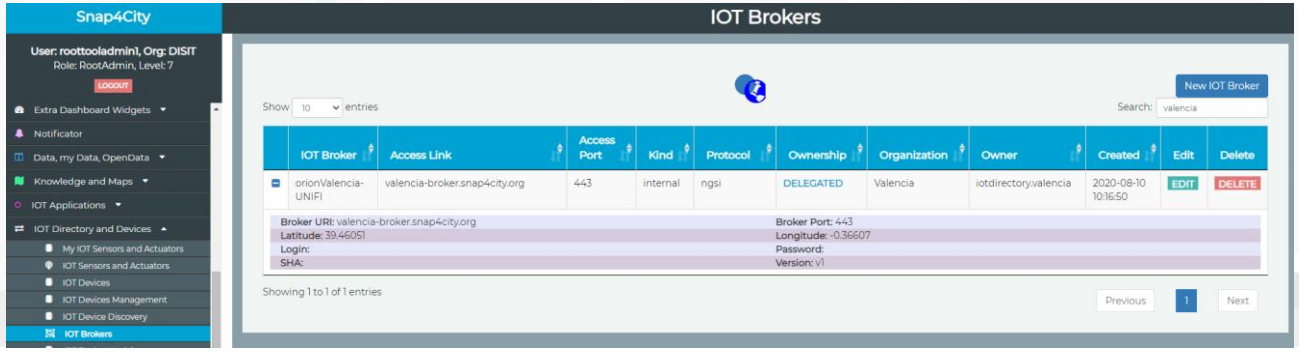
4. Call the IoT Broker to see the last data on it (some user name and Pwd can be needed)
   - Get the Broker Name from the device profile
5. See next slide



Broker service URL such as

-- https://www.snap4city.org/brokername/v2/entities

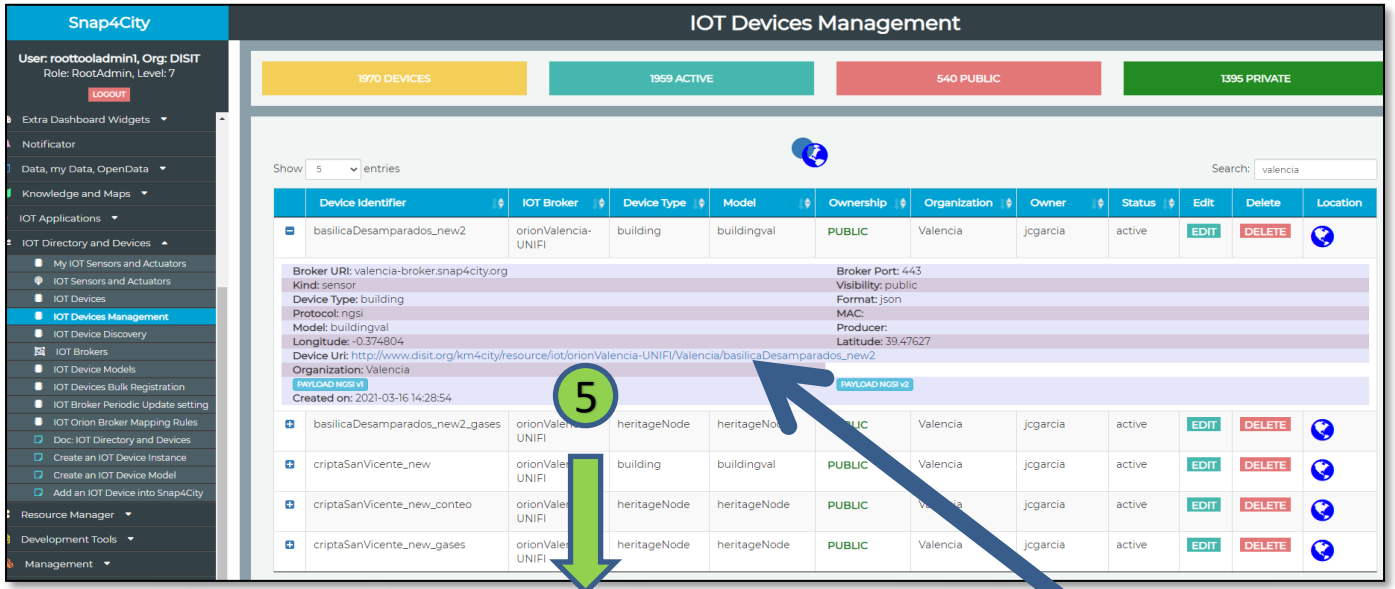
-- http:// brokername.snap4city.org/v2/entities/

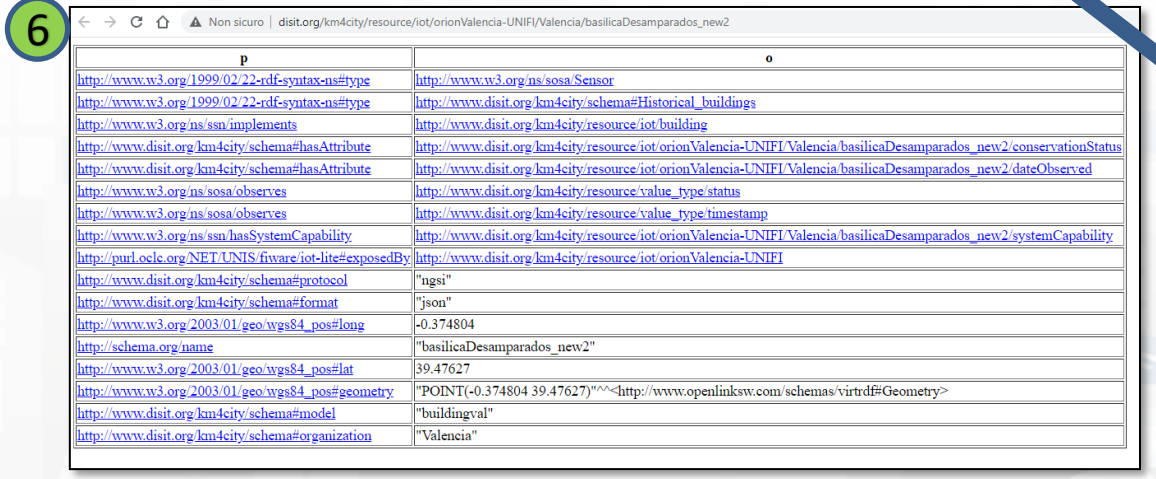


Verify on Knowledge Base

5. Click on ServiceURI (device URI) to Open in a new TAB the data sent on the KB

6. If your device is Public and you have sent data → the list of the last data from OpenSearch querying from KB will appear as:



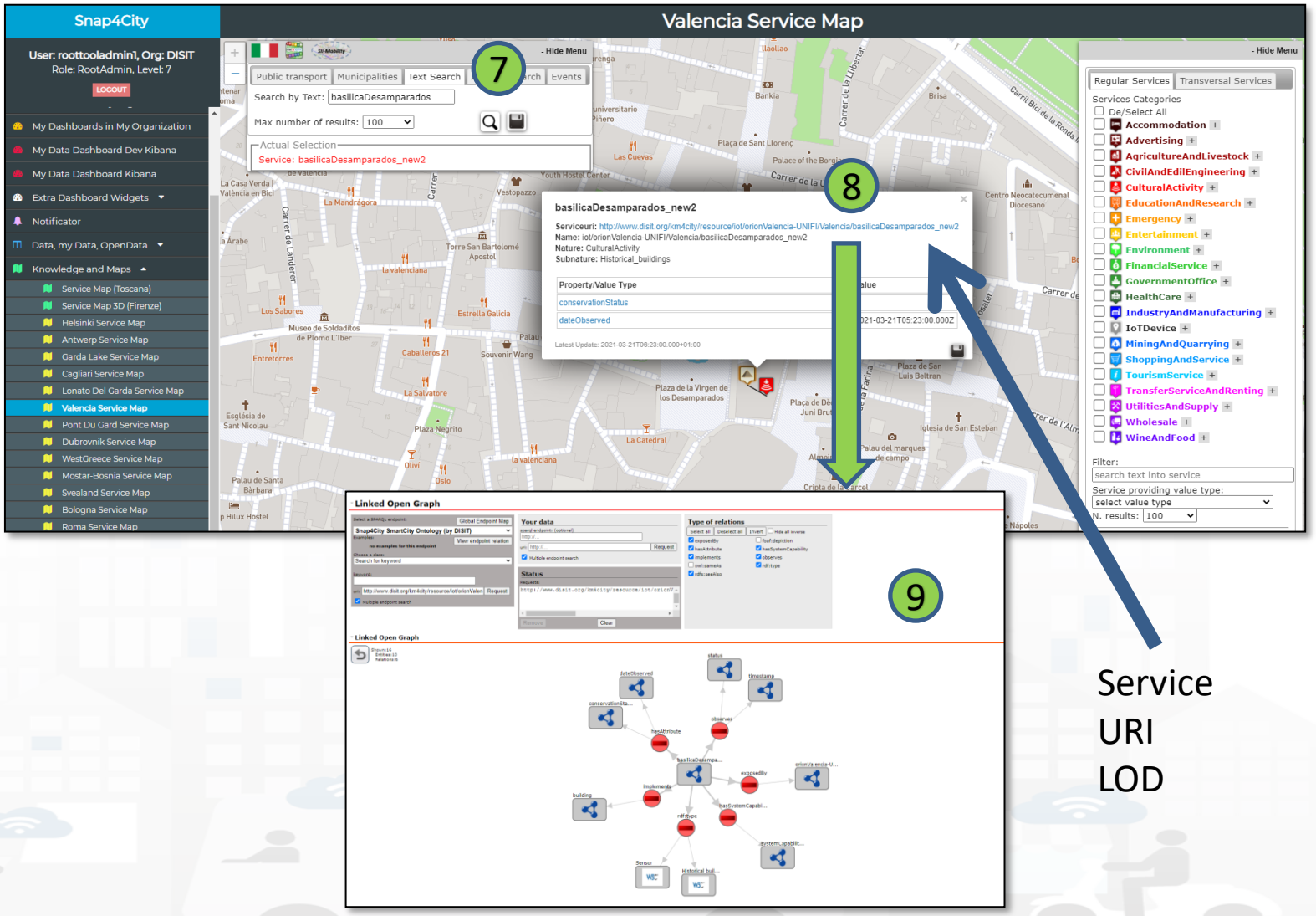


p	o
http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.w3.org/ns/sosa/Sensor
http://www.w3.org/1999/02/22-rdf-syntax-ns#type	http://www.disit.org/km4city/schema#Historical_buildings
http://www.w3.org/ns/ssn/implements	http://www.disit.org/km4city/resource/iot/building
http://www.disit.org/km4city/schema#hasAttribute	http://www.disit.org/km4city/resource/iot/orionValencia-UNIFI/Valencia/basilicaDesamparados_new2/conservationStatus
http://www.disit.org/km4city/schema#hasAttribute	http://www.disit.org/km4city/resource/iot/orionValencia-UNIFI/Valencia/basilicaDesamparados_new2/dateObserved
http://www.w3.org/ns/sosa/observes	http://www.disit.org/km4city/resource/value_type/status
http://www.w3.org/ns/sosa/observes	http://www.disit.org/km4city/resource/value_type/timestamp
http://www.w3.org/ns/ssn/hasSystemCapability	http://www.disit.org/km4city/resource/iot/orionValencia-UNIFI/Valencia/basilicaDesamparados_new2/systemCapability
http://purl.oclc.org/NET/UNIS/fiware/iot-lite#exposedBy	http://www.disit.org/km4city/resource/iot/orionValencia-UNIFI
http://www.disit.org/km4city/schema#protocol	"ngsi"
http://www.disit.org/km4city/schema#format	"json"
http://www.w3.org/2003/01/geo/wgs84_pos#long	-0.374804
http://schema.org/name	"basilicaDesamparados_new2"
http://www.w3.org/2003/01/geo/wgs84_pos#lat	39.47627
http://www.w3.org/2003/01/geo/wgs84_pos#geometry	"POINT(-0.374804 39.47627)"^^<http://www.openlinksw.com/schemas/virtrdf#Geometry>
http://www.disit.org/km4city/schema#model	"buildingval"
http://www.disit.org/km4city/schema#organization	"Valencia"

Service URI LOD

Verify data ingestion on KB via ServiceMap

- 7) Verify on ServiceMa by Search on data location or by text name of the device
- 8) click on ServiceURI to jump on 9 LOG.DISIT.ORG to see semantic structure in terms of Linked Open Data, LOD



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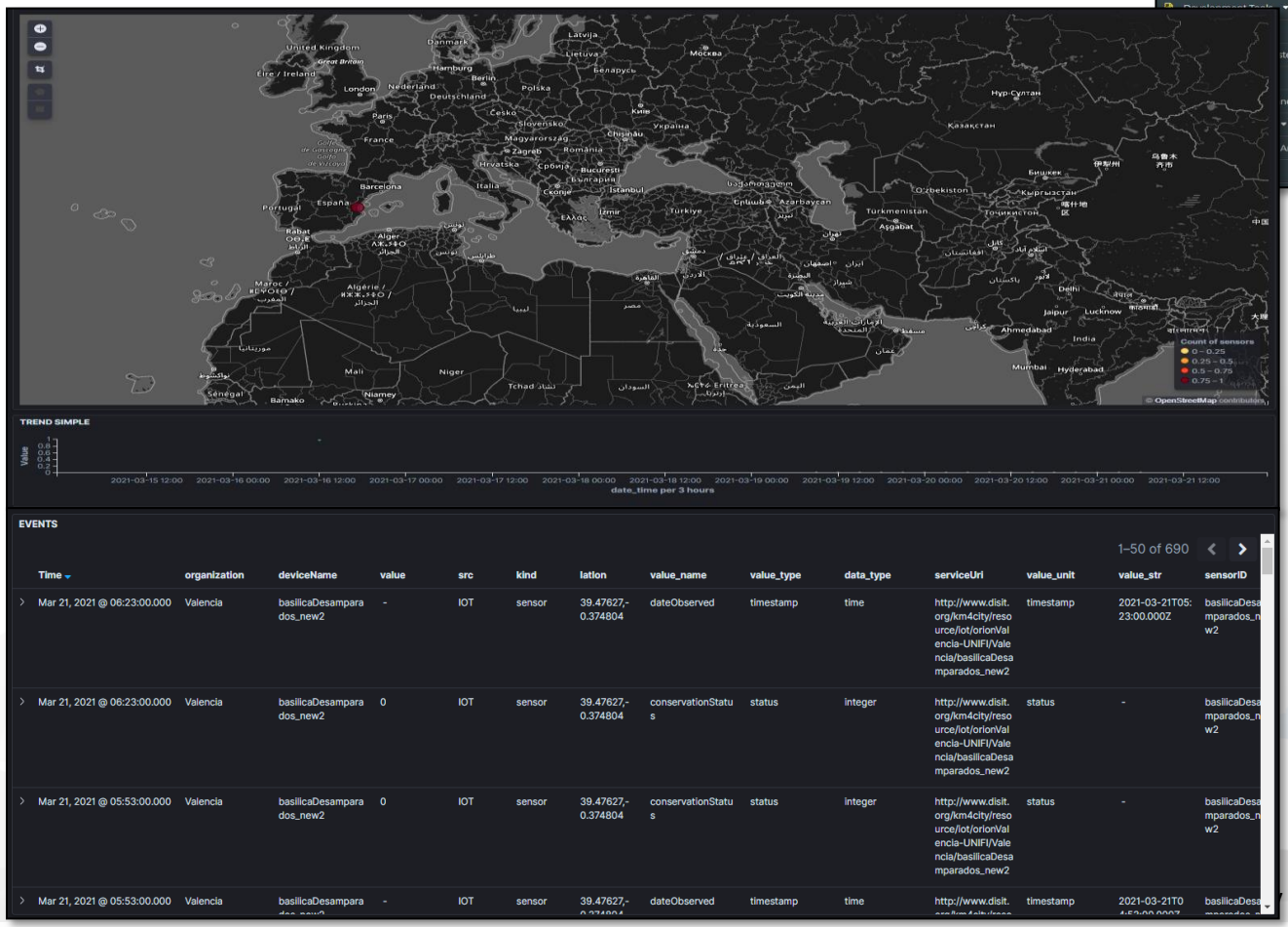
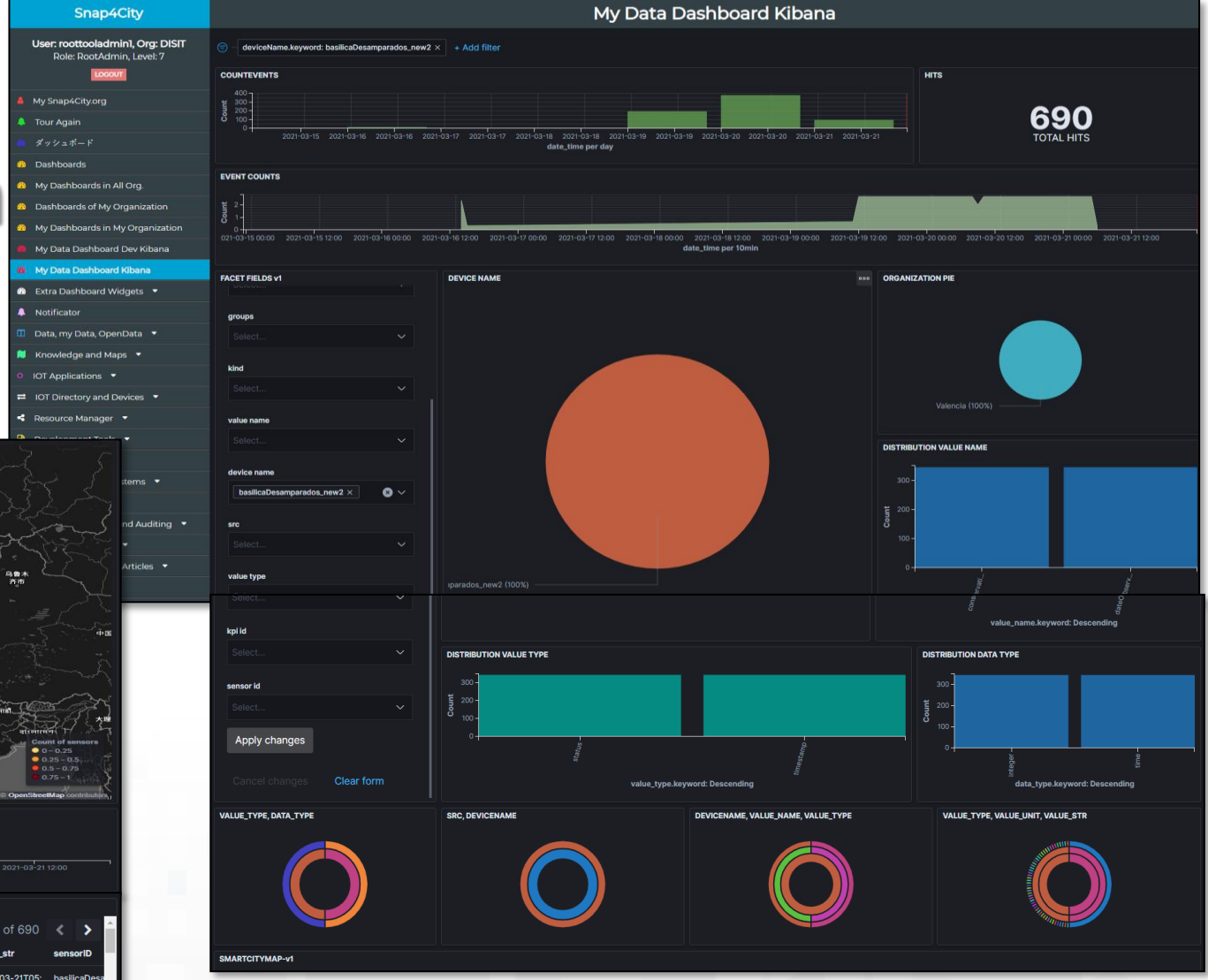
Every data on OpenSearch

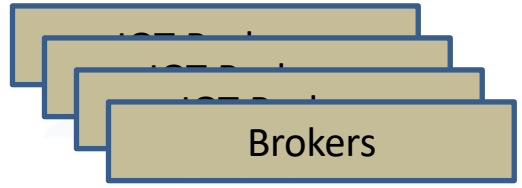
- Verify on OpenSearch Dash which monitor Open Search: My data Dash



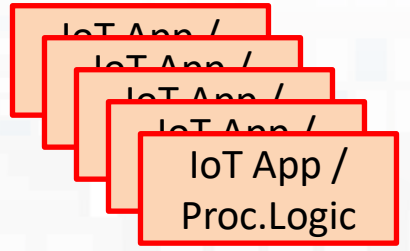


Additional Notes

- The **Orion Brokers** can be feed by means of
  - **IoT App/Proc.Logic** of Snap4City (to implement Agents and/or Adapters)
  - **IoT Agents** and/or **NGSI Adapters** by FiWare for different protocols
  - **Brokers** of any kind, different protocols and producers, also as Gateways, and they can be located on premise and/or on any cloud



- **Proc.Logic/IoT App, IoT Agents, Adapters** can
  - be on IoT Edge
  - be implemented as IoT App/Proc.Logic of Snap4City
  - be on other clouds and services
  - work on a large range of different protocols and kinds
  - have or not Snap4City libraries installed



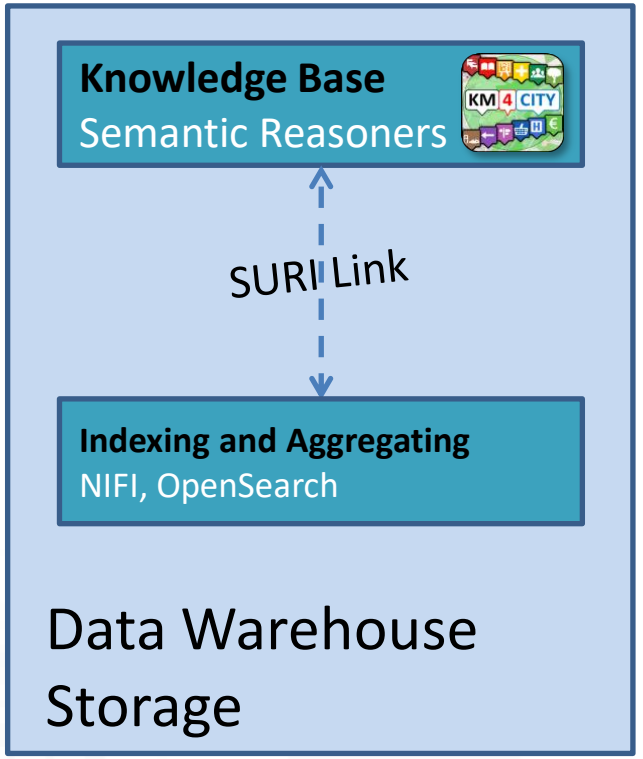
Additional Notes

- The **Internal Orion Brokers** at Snap4City Orion Broker are used as a gate for data ingestion and actuations. Since they are
  - connected with the Directory and discovery of the Knowledge Base to make easy the production of Dashboards by wizard, Data Inspector;
  - Synchronized automatically with NIFI/OpenSearch for the Automated Data Shadow and Indexing
  - Ready to be used by Proc.Logic/IoT App to subscribe for creating even driven Proc.Logic/IoT Apps, on Edge and Cloud, etc...
  - Compatible and harmonized with FiWare networks

Direct Ingestion

- **Direct Data Ingestion is also possible:**
  - **From data sources to Data Warehouse Storage of Snap4City, Snap4Industry**

- **Data Warehouse Storage includes:** KB, and I&A, reported on right side can be acted via API REST Call
  - for direct feeding data into store and retrieval,
  - which can be exploited by:
    - IOT App/Proc.Logic
    - applications in Python, R Studio, Java



Notation Terminology

WHERE	Are synonymous at level of service which can be IoT device or entity with data and references to	Are synonymous at level of the single attribute of the entity, device, service, etc.
IoT Directory, Entity Directory	IoT Device, Entity Instance, Device URI	Sensor, Actuator, Attributes, Values (value name)
Knowledge Base, ServiceMap, SmartCity API, ASCAPI	Service, ServiceURI, SURI	Attribute, Metric, SURI with metric
DataInspector, Wizard, Dashboard	Value Name(Model name, Category)	Sensor, Sensor Actuator, ValueType
IoT App., Proc.Logic, Node-RED	ServiceURI, SURI	SURI and its real time results of the objects into the data structure

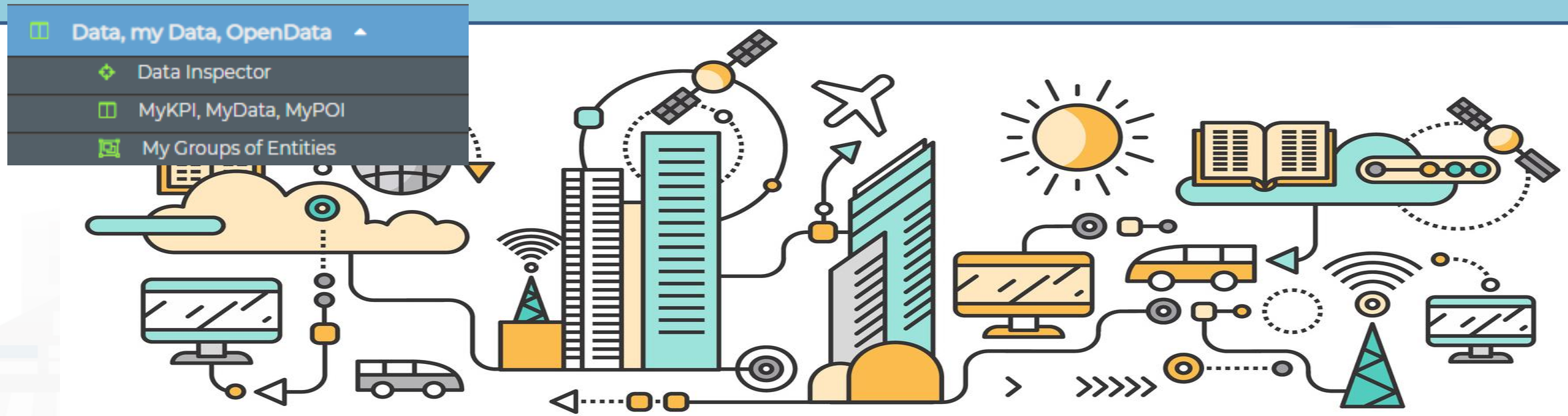
ServiceURI, SURI of a sensor device:

- http://www.disit.org/km4city/resource/METRO759
- http://www.disit.org/km4city/resource/iot/orionCAPELON-UNIFI/CAPELON/Streetlight%3A90FD9FFFFEBD5A7F

ServiceURI, SURI extended with attribute/variable/value:

- http://www.disit.org/km4city/resource/METRO759&metric=vehicleFlow
- http%3A%2F%2Fwww.disit.org%2Fkm4city%2Fresource%2FMETRO759&metric=vehicleFlow
- In some cases
  - **http://www.disit.org/km4city/resource/METRO759/vehicleFlow**

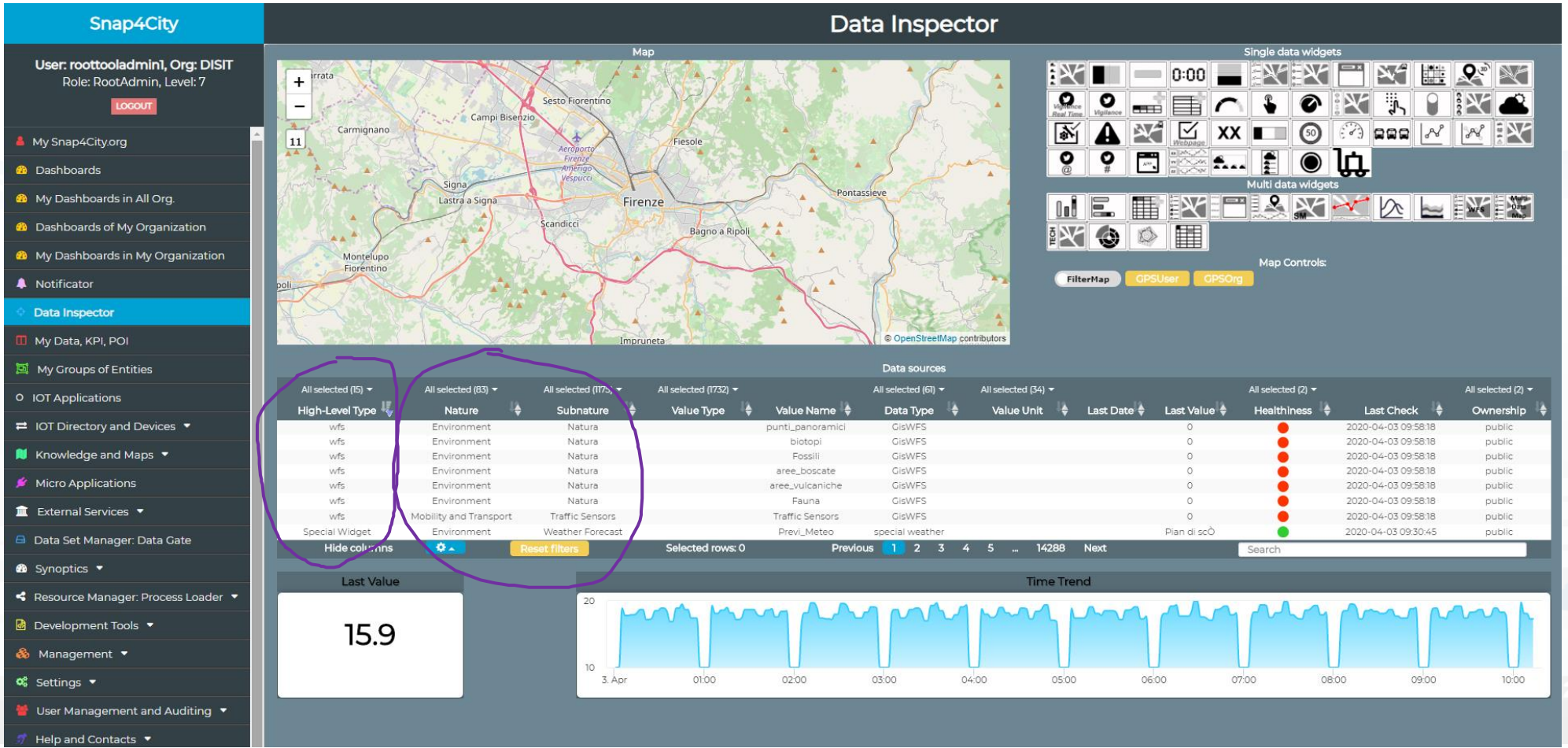
Digital Twin Data Inspector vs Data Processes Details



Some functionalities are limited to certain roles

Data Inspector

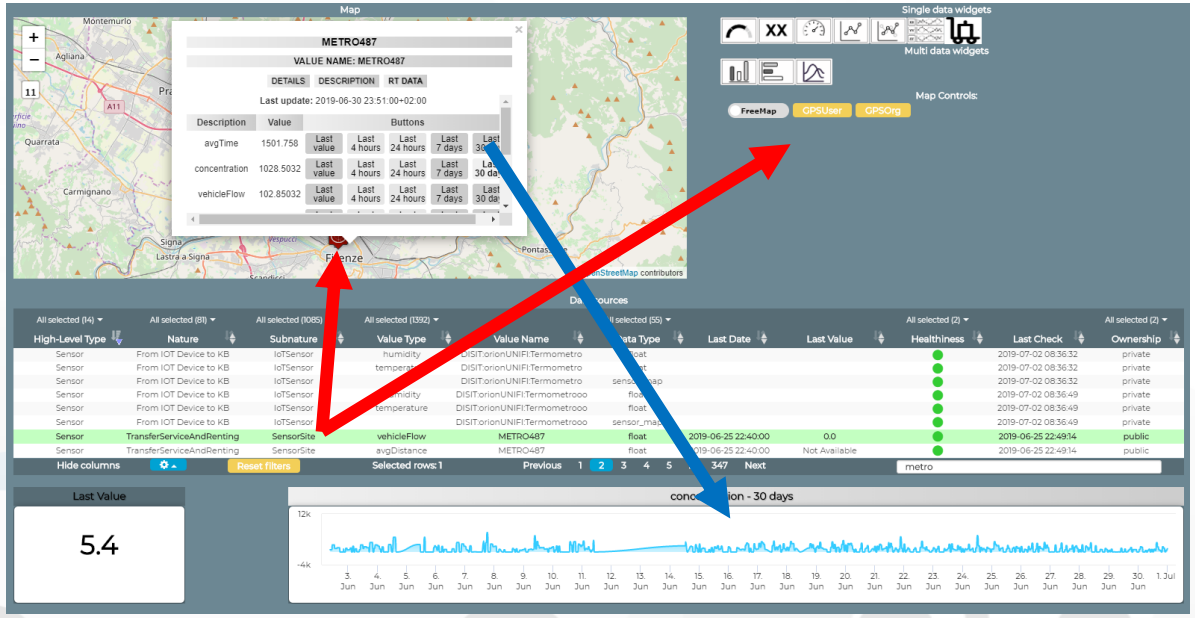
- It is showing data:
  - Listed by High Level Types, and classified as in the **Dashboard WIZARD: see Tutorial Part 2 for details**.
  - of your Organization only, that are public of the organization, your private or those that have been delegated to you some how.

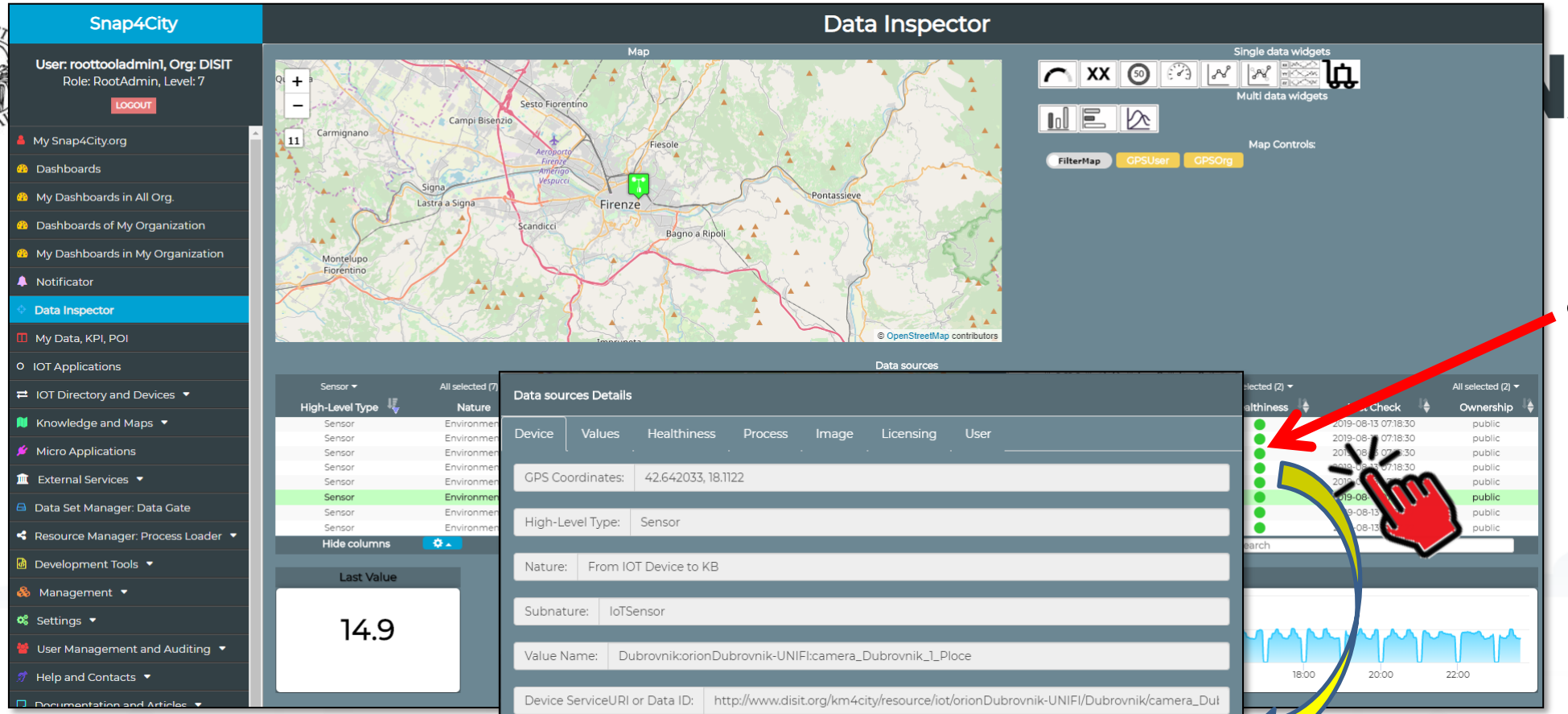


Data Inspector (open on your left side menu)

- **Cross Filtering on the basis of**:
  - **MAP**: pan and zoom → lock , center on GPS coordinates of the user
  - **Data Source Classification**:
    - faceted filtering
    - full text search
  - **Click on data source** to see it on map, and see the graphics representation, just to learn how widgeting it.
  - **Full Text Search** if you remember some desc…

- **Selecting a Data Source on Map**:
  on its Pin you can see:
  - Real time data
  - Time trend: 4 hours, 12 hours, 1 day, 1 week, 30 days.
  - Full status and description (only for Administrators)

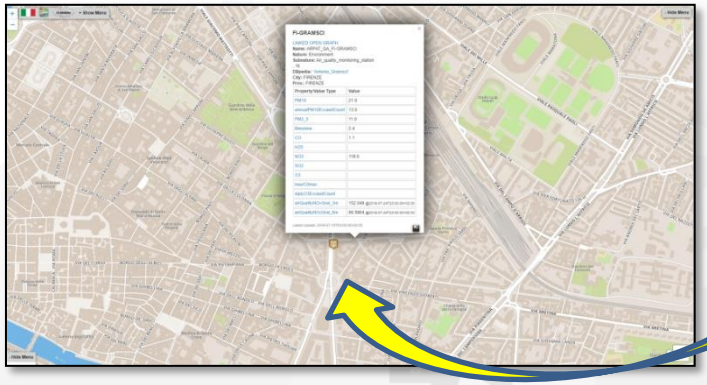


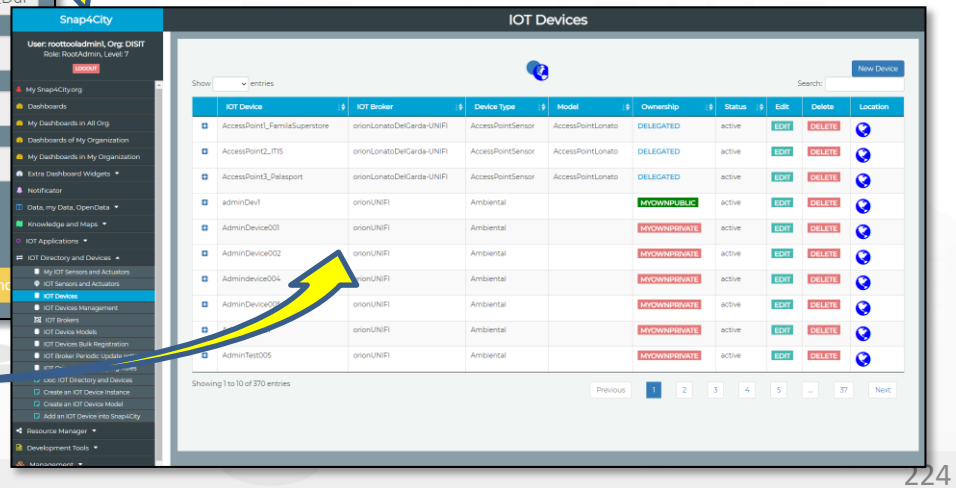


Knowledge Base view

- Click with the mouse on it

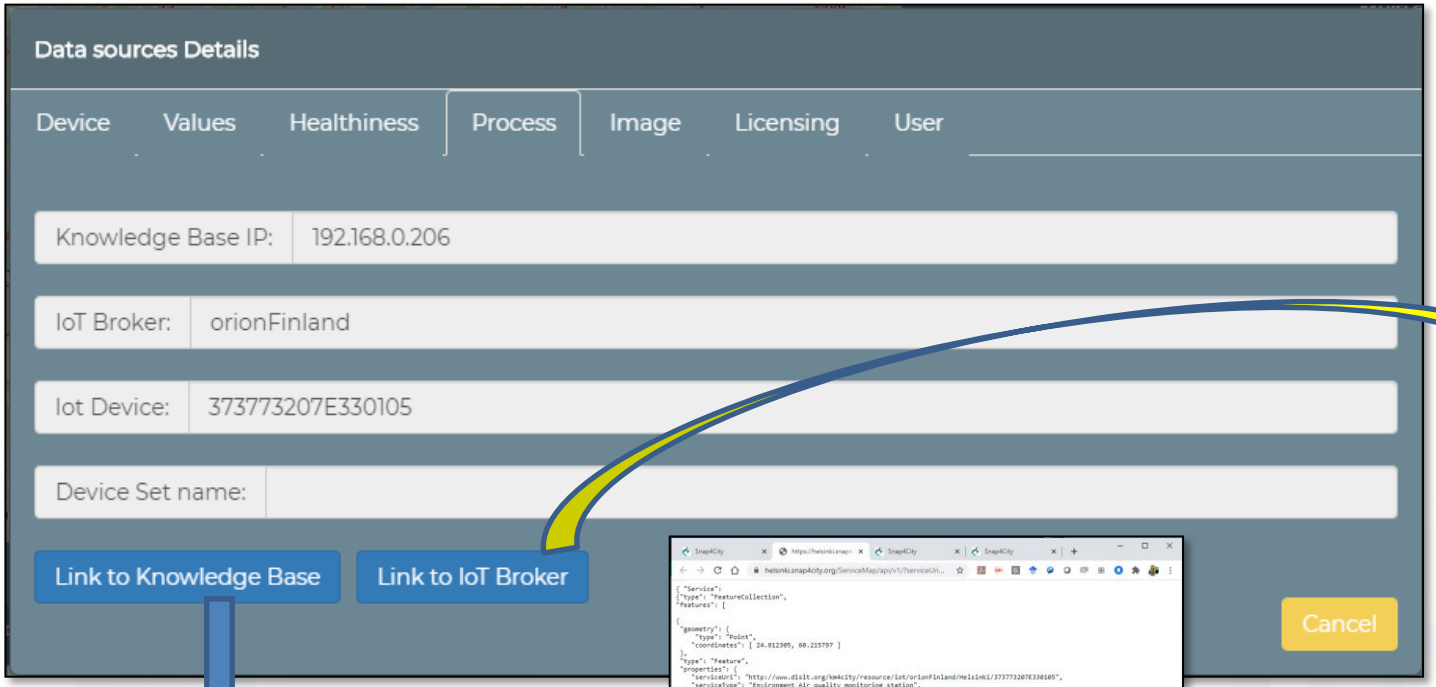
HLT: Sensor

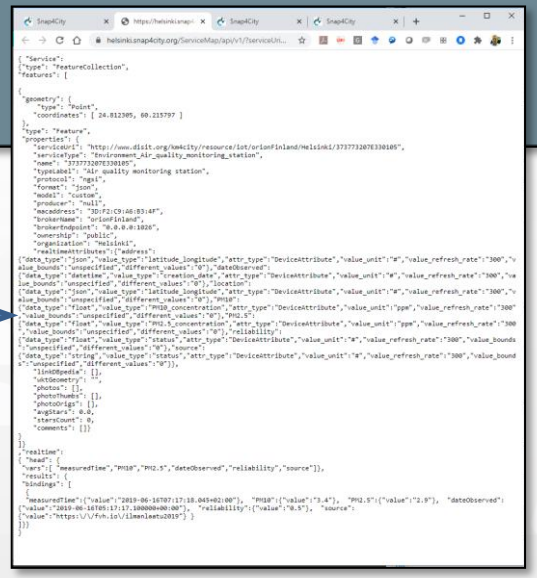


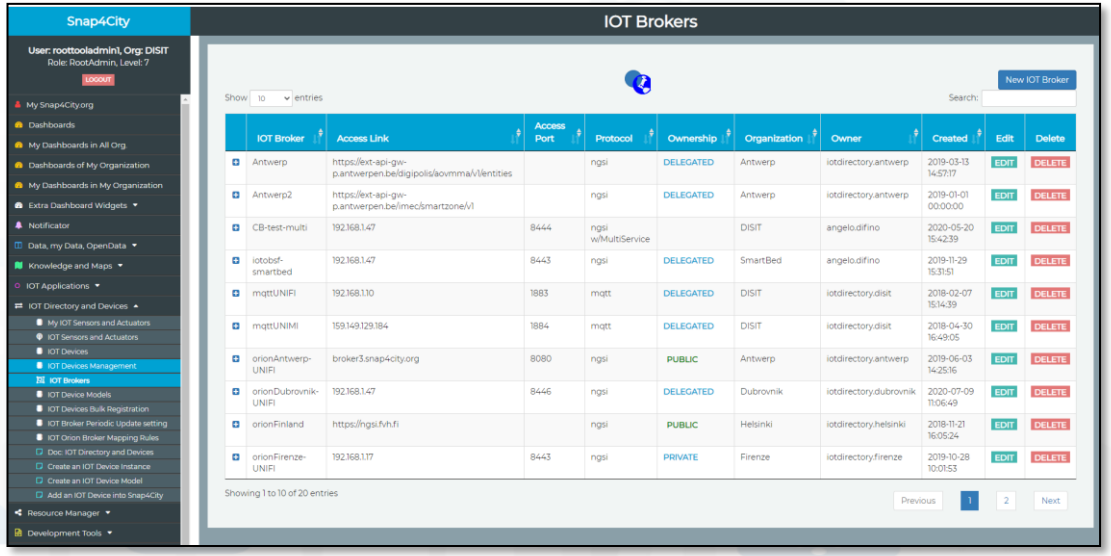


Some functionalities are limited to certain roles

Details regarding the IOT Ingestion process







- For IOT Device data
- IOT Broker details

Some functionalities are limited to certain roles

HLT: Sensor

- Specific values of selected
- Information of the values of the other sensors on the same device
- View Trends, marking problems, healthiness by point according to a Fuzzy model
- Marking problems for future machine learning processes (separate tool)

Data sources Details

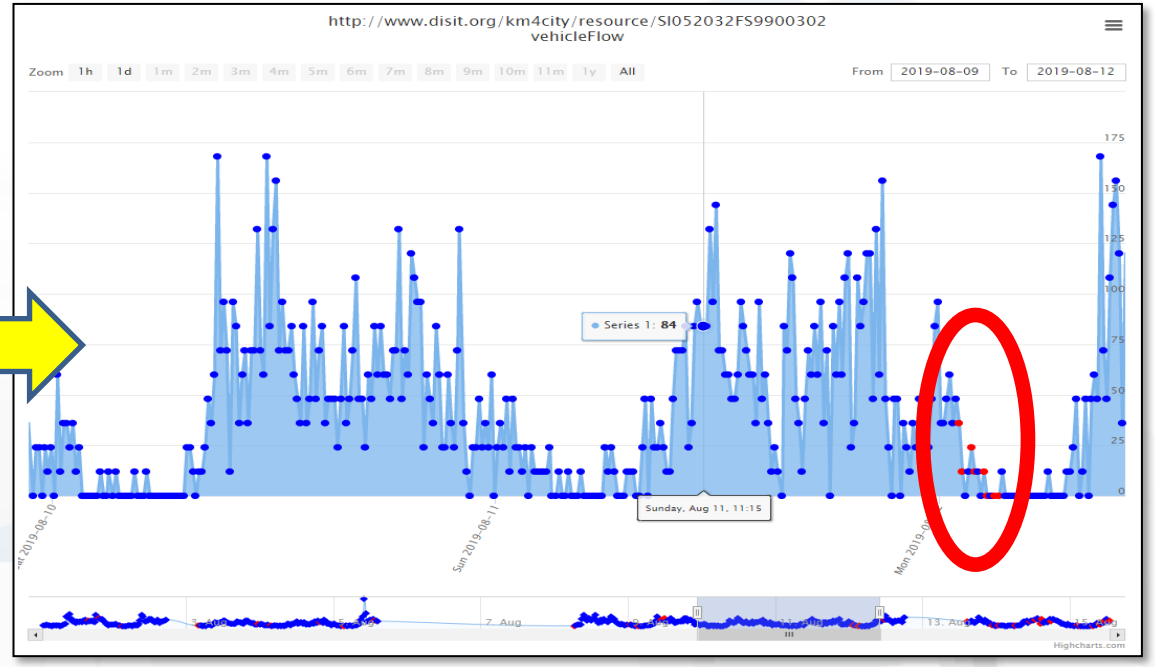
Device | Values | Healthiness | Process | Image | Licensing | User

Last Date: 2020-07-21 19:00:00

Last Value:

Value Type	Healthy	Delay (s)	Reason	Healthiness Criteria	Refresh Rate (s)	Data type	Unit	Value	Time Trend
dateObserved	●	61890	undefined	undefined	300	time	timestamp	2020-07-21T17:00:00.000Z	VIEW
deceduti	●	61890	undefined	undefined	300	integer	#	16797	VIEW
dimessi_guariti	●	61890	undefined	undefined	300	integer	#	71775	VIEW
isolamento_domiciliare	●	61890	undefined	undefined	300	integer	#	6838	VIEW
nuovi_attualmente_positivi	●	61890	undefined	undefined	300	integer	#	-131	VIEW
ricoverati_con_sintomi	●	61890	undefined	undefined	300	integer	#	151	VIEW
stato	●	61890	undefined	undefined	300	string	#	ITA	VIEW
tamponi	●	61890	undefined	undefined	300	integer	#	1212468	VIEW
terapia_intensiva	●	61890	undefined	undefined	300	integer	#	21	VIEW
totale_attualmente_positivi	●	61890	undefined	undefined	300	integer	#	7010	VIEW
totale_casi	●	61890	undefined	undefined	300	integer	#	95582	VIEW
totale_ospedalizzati	●	61890	undefined	undefined	300	integer	#	172	VIEW
codice_regione	●	61890	missing value	undefined	300	integer	status		VIEW
denominazione_regione	●	61890	missing value	undefined	300	string	status		VIEW

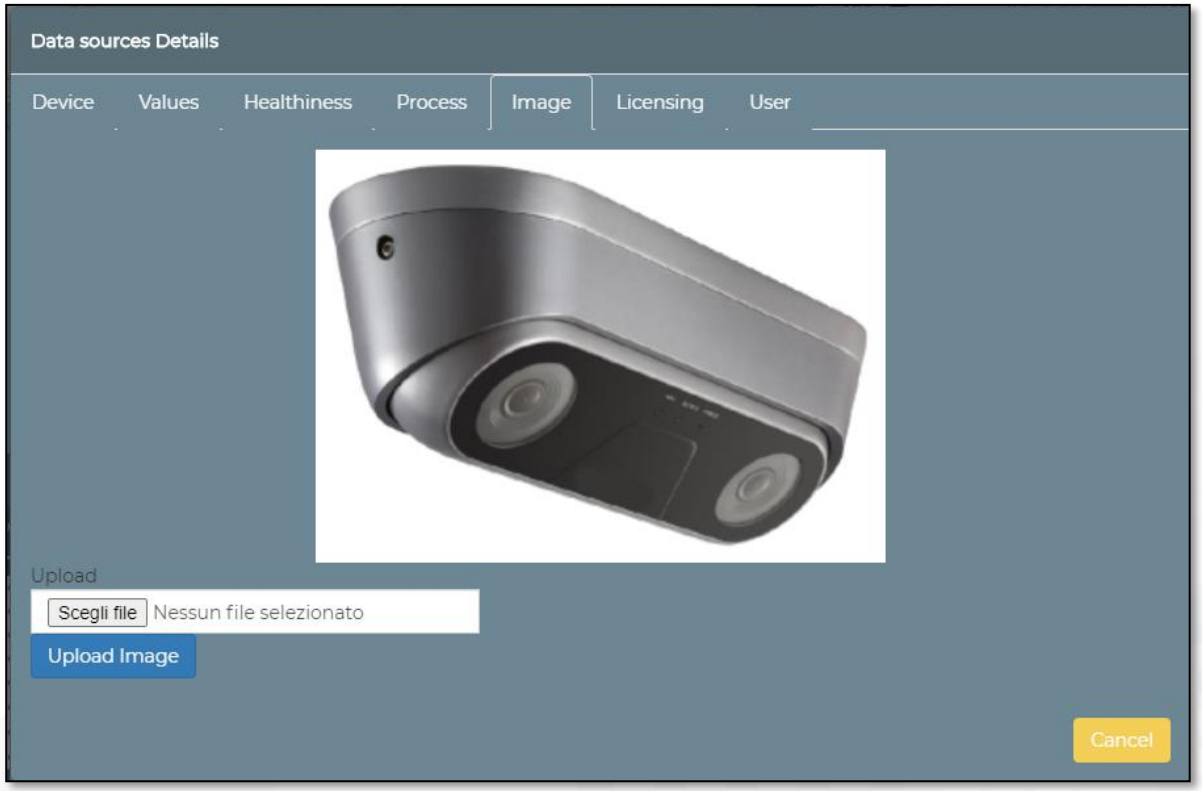
Cancel

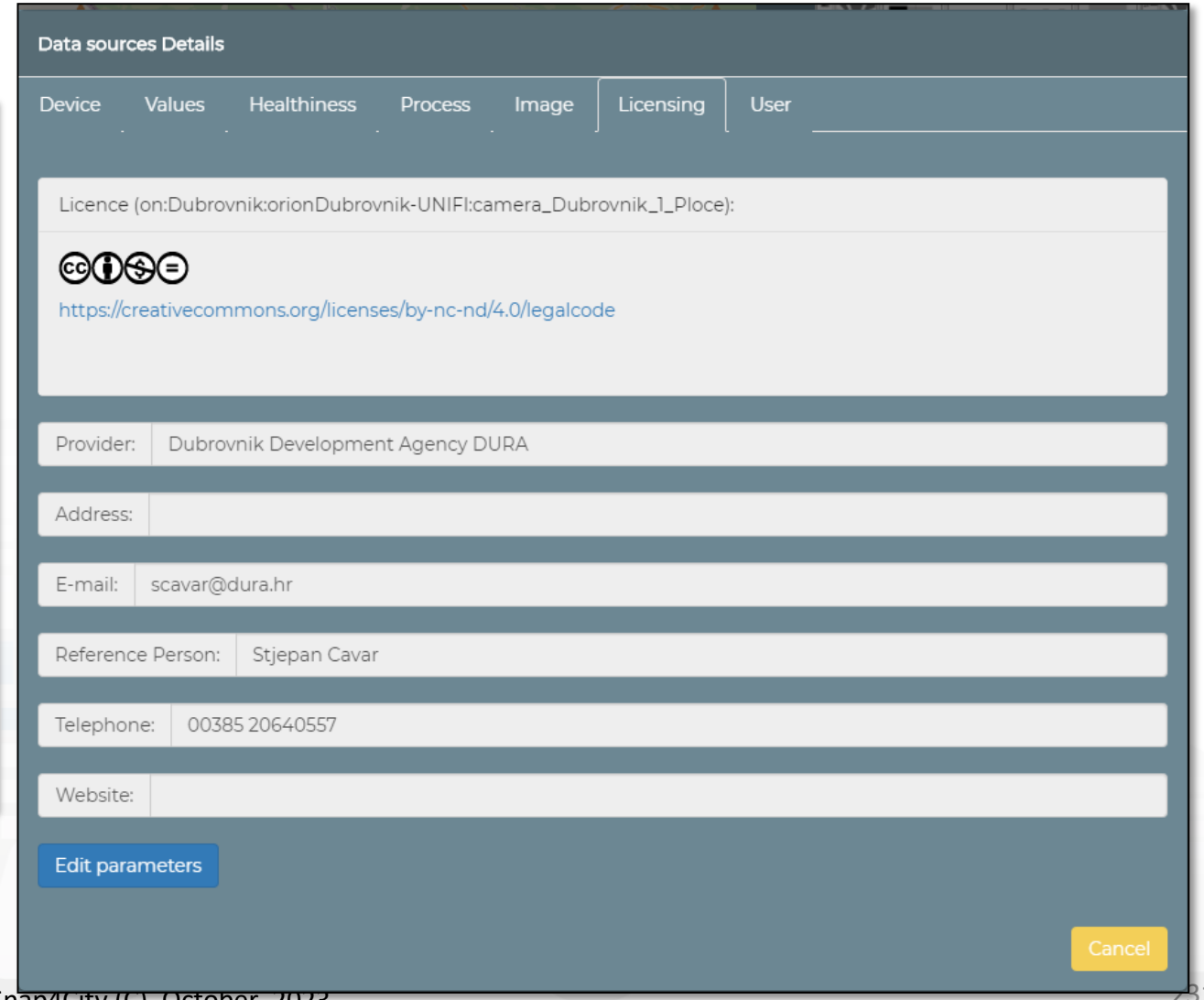


Some functionalities are limited to certain roles

HLT: Sensor

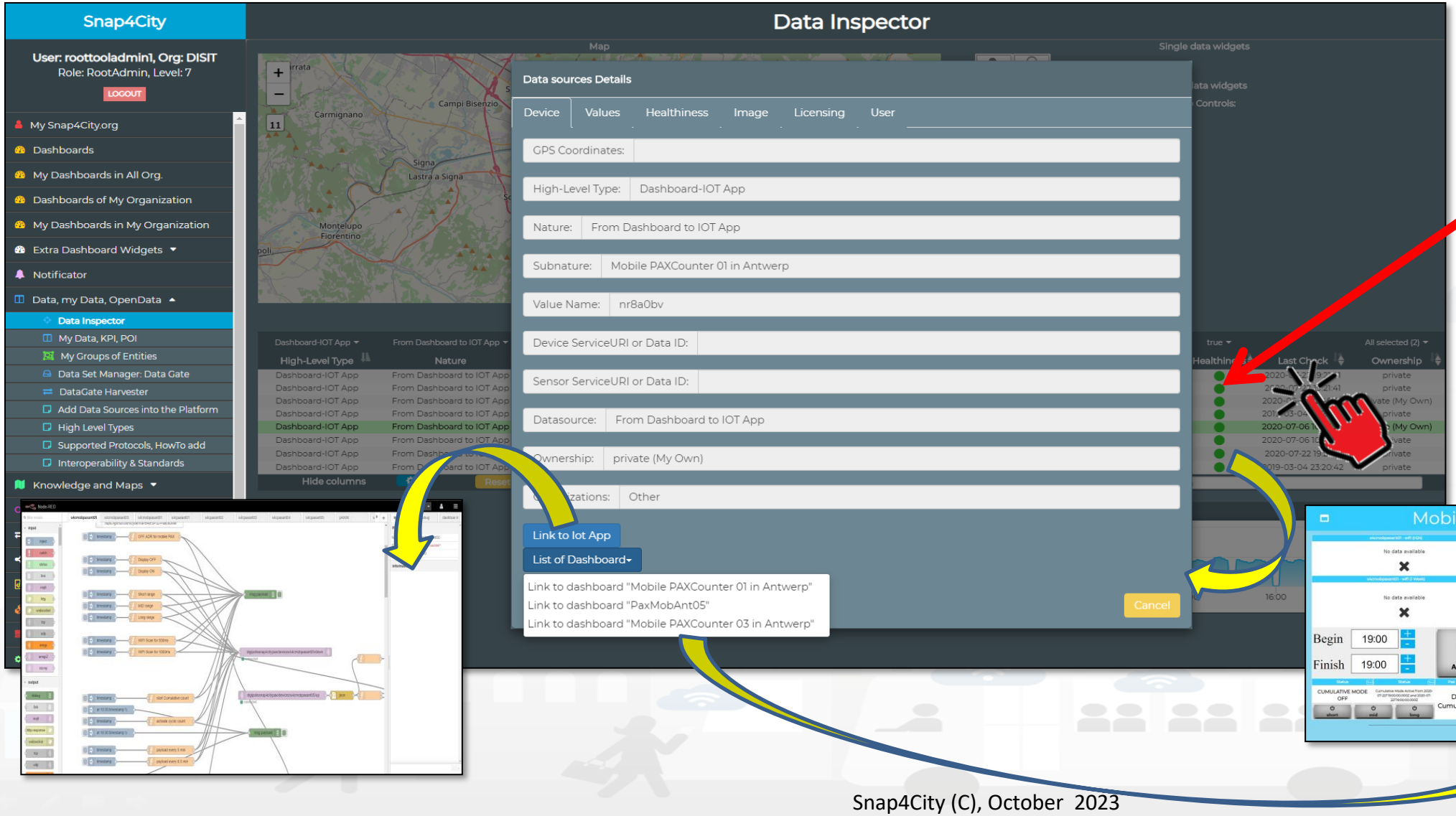
Image of the Devices and Licensing





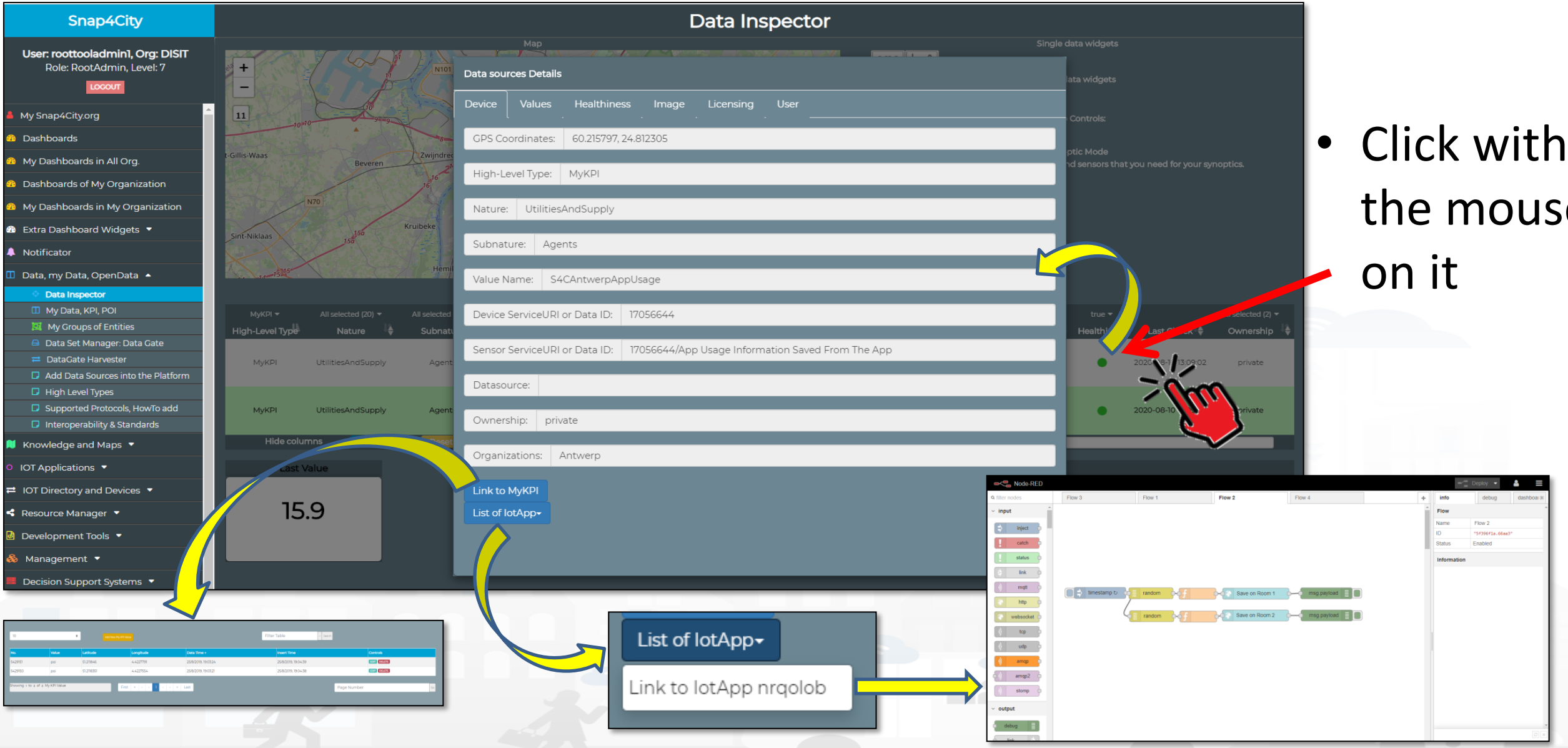
Some functionalities are limited to certain roles

HLT: From Dashboard to IOT APP



- Click with the mouse on it

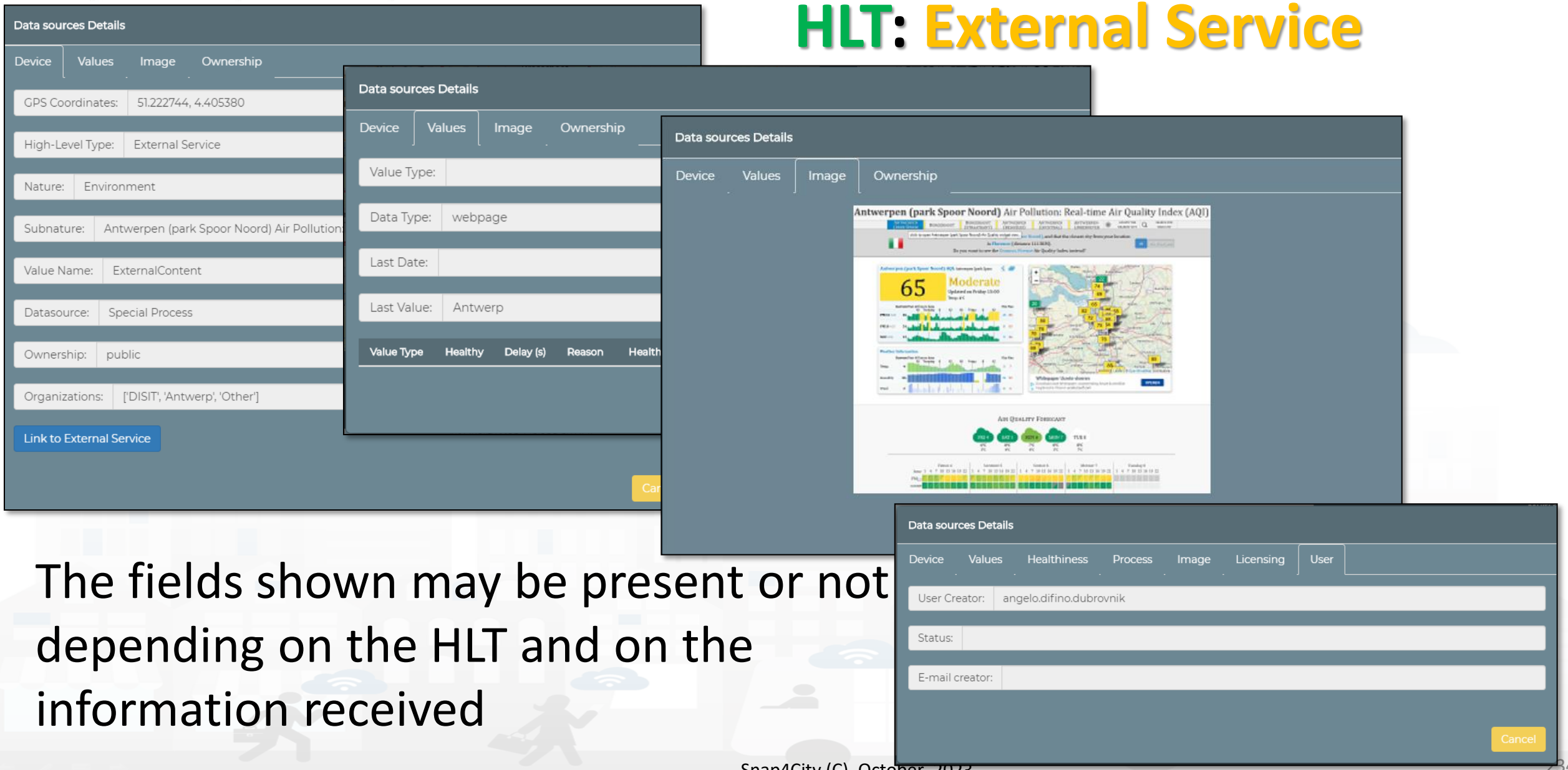
HLT: MyKPI



- Click with the mouse on it

Some functionalities are limited to certain roles

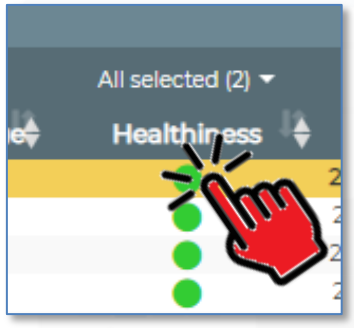
HLT: External Service



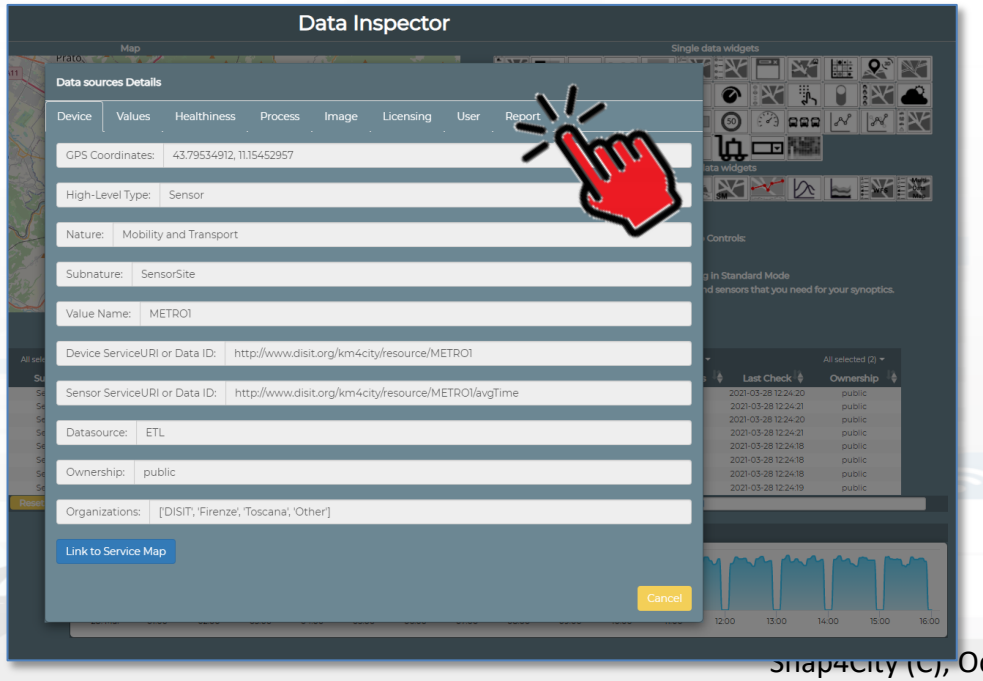
The fields shown may be present or not depending on the HLT and on the information received

Report Generation and Access

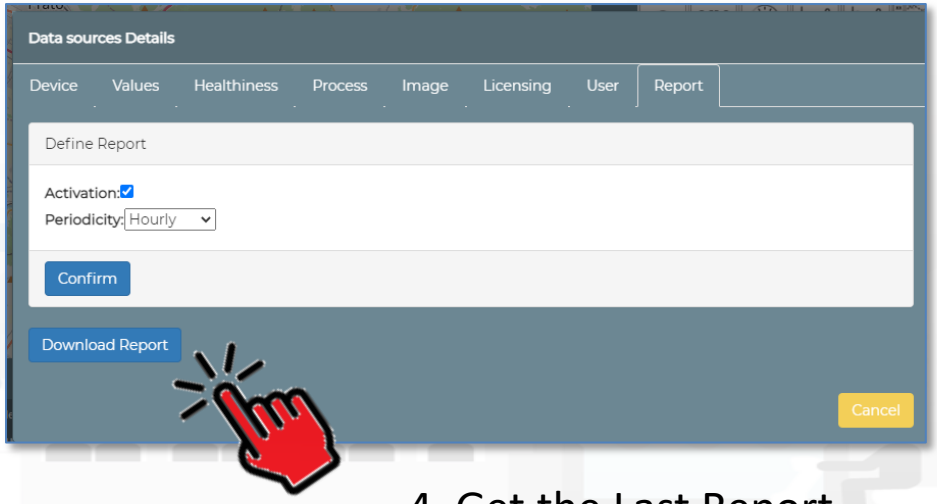
- **Device/data** owner may have their reports: **monthly or 3-monthly**
  - Ready to use reports are available for:
    - Single Device: ETL and IOT
  - Ask to your RootAdmin to activate the production of reports (and also **hourly** report **for testing only**).



1. Open data Inspector
2. Click on Device or sensor



3. Click on report

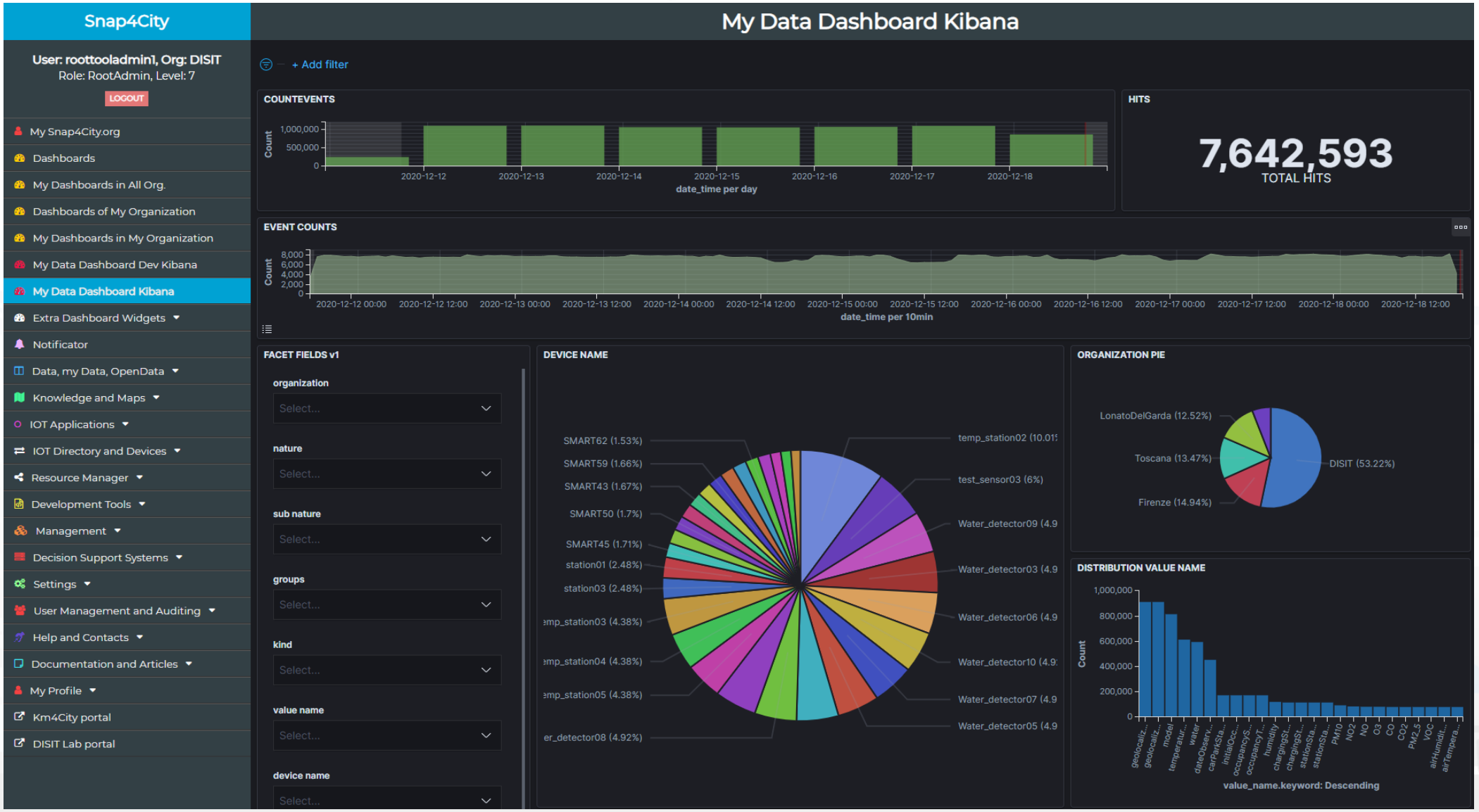


4. Get the Last Report

My Data Dashboard Dev to assess data on Open Search Storage

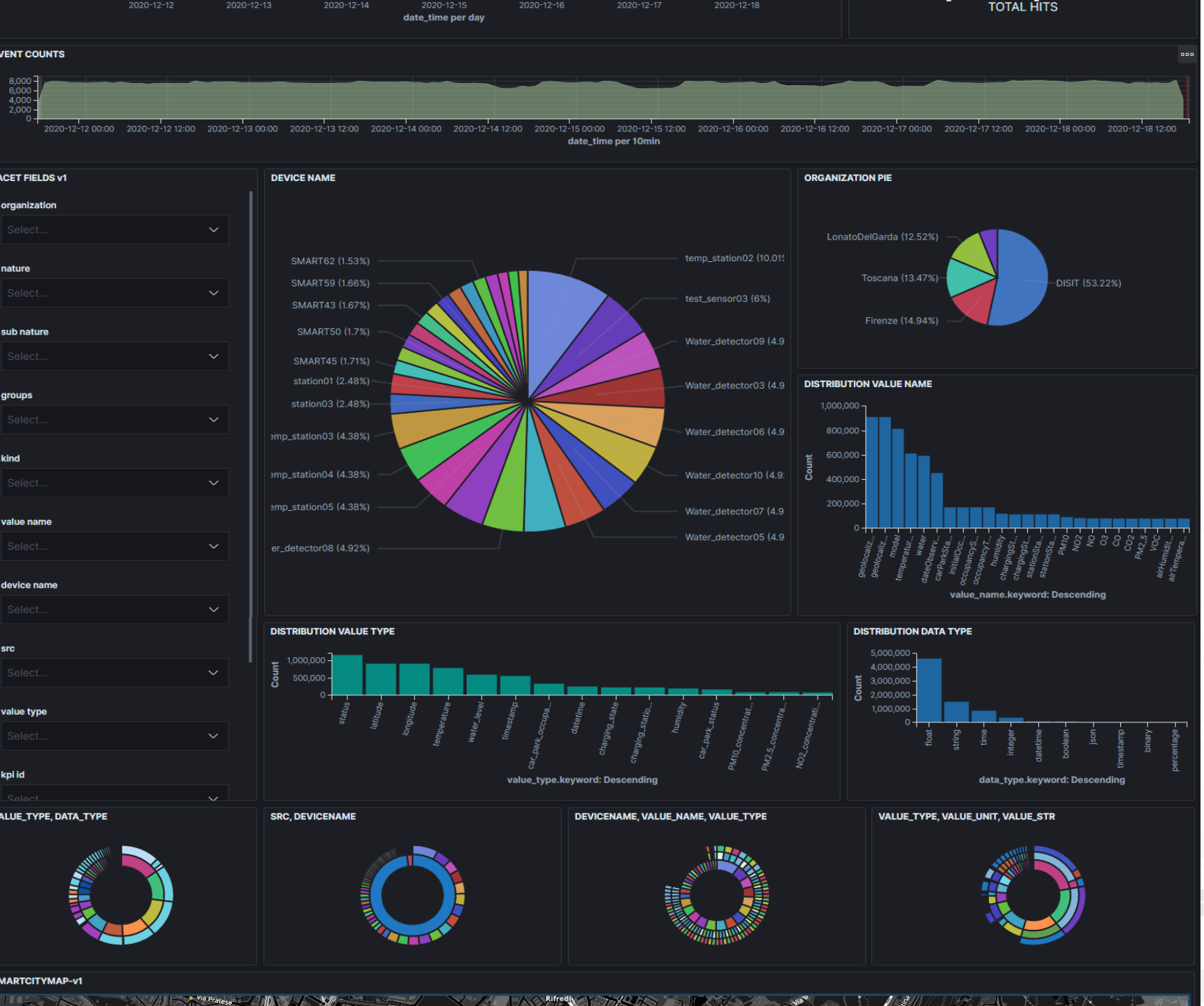
Some functionalities are limited to certain roles

DevDash: My Data Dashboard



Business Analysis Dashboards For all kind of users: DevDash

- Dynamic Filtering, Adaptable, …
- Full data details, drill down,…
- Synergic with **Data Inspector** which addresses data relationships, processing and information
- **Only Your Data for**
  - Manager and Area Managers
- **All Accessible Data for**
  - ToolAdmin and RootAdmin



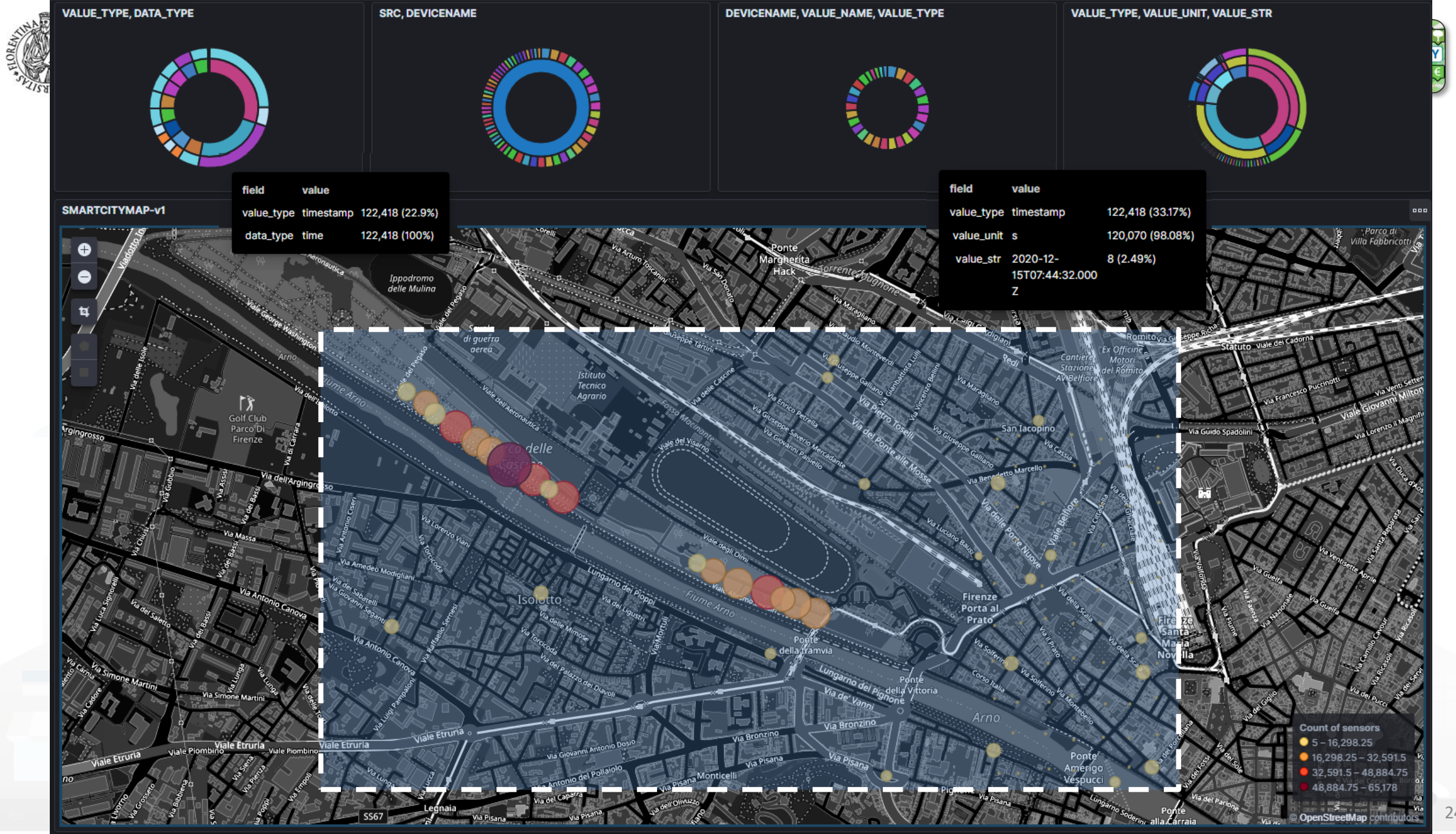
SNAP4CITY

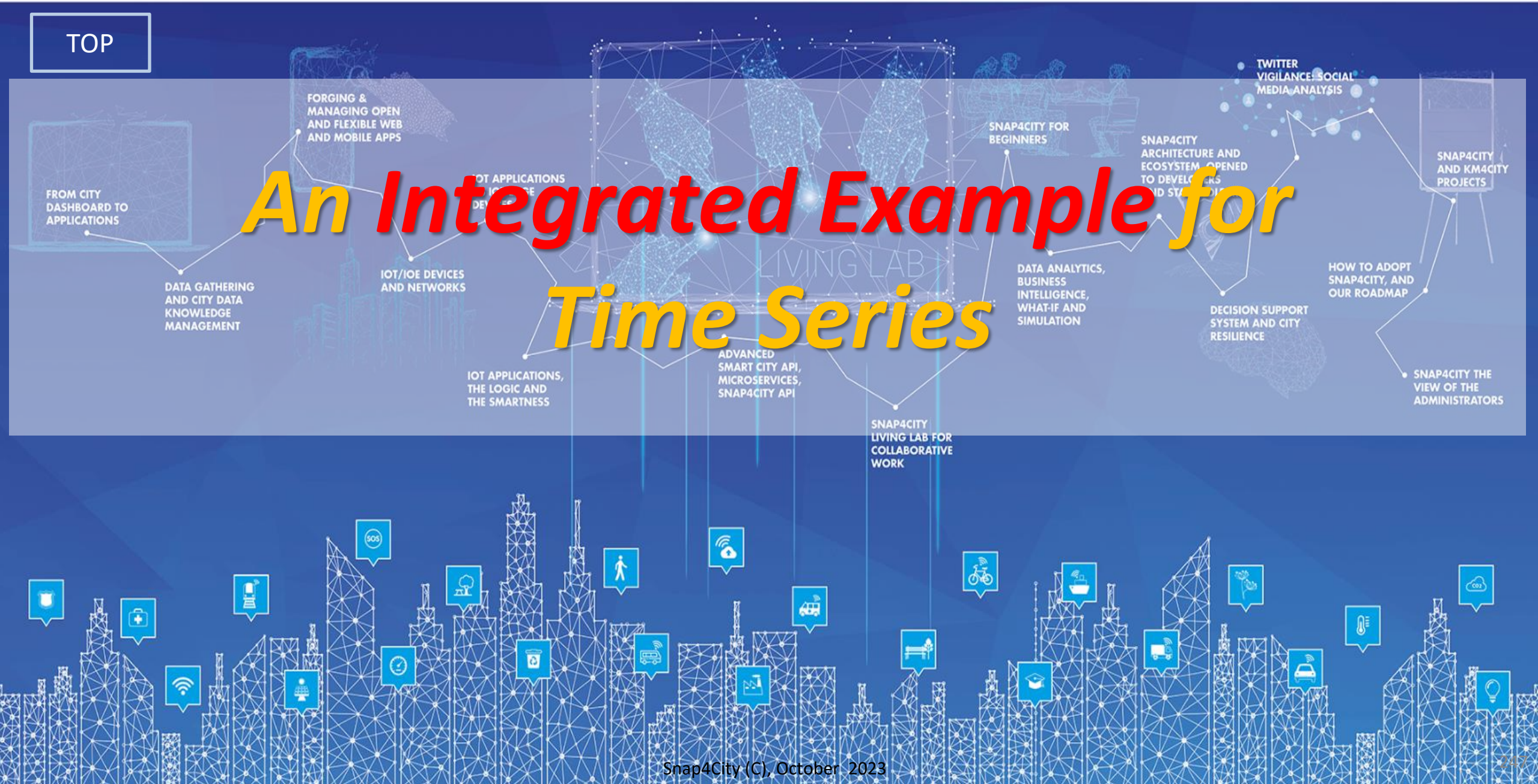
KM4CITY

- Multi faceted Search by
  - Devices
  - Organization
  - Drill on Time
  - Drill on Map
  - Value Types
  - Data Type
  - Value name
  - Data table
  - Etc.

OpenSearch

- Respect Privacy and GDPR


VALUE_TYPE, DATA_TYPE
SRC, DEVICENAME
DEVICENAME, VALUE_NAME, VALUE_TYPE
VALUE_TYPE, VALUE_UNIT, VALUE_STR
field value
value_type timestamp 122,418 (22.9%)
data_type time 122,418 (100%)
field value
value_type timestamp 122,418 (33.17%)
value_unit s 120,070 (98.08%)
value_str 2020-12-15T07:44:32.000Z 8 (2.49%)
SMARTCITYMAP-v1
Count of sensors
5 – 16,298.25
16,298.25 – 32,591.5
32,591.5 – 48,884.75
48,884.75 – 65,178
© OpenStreetMap contributors



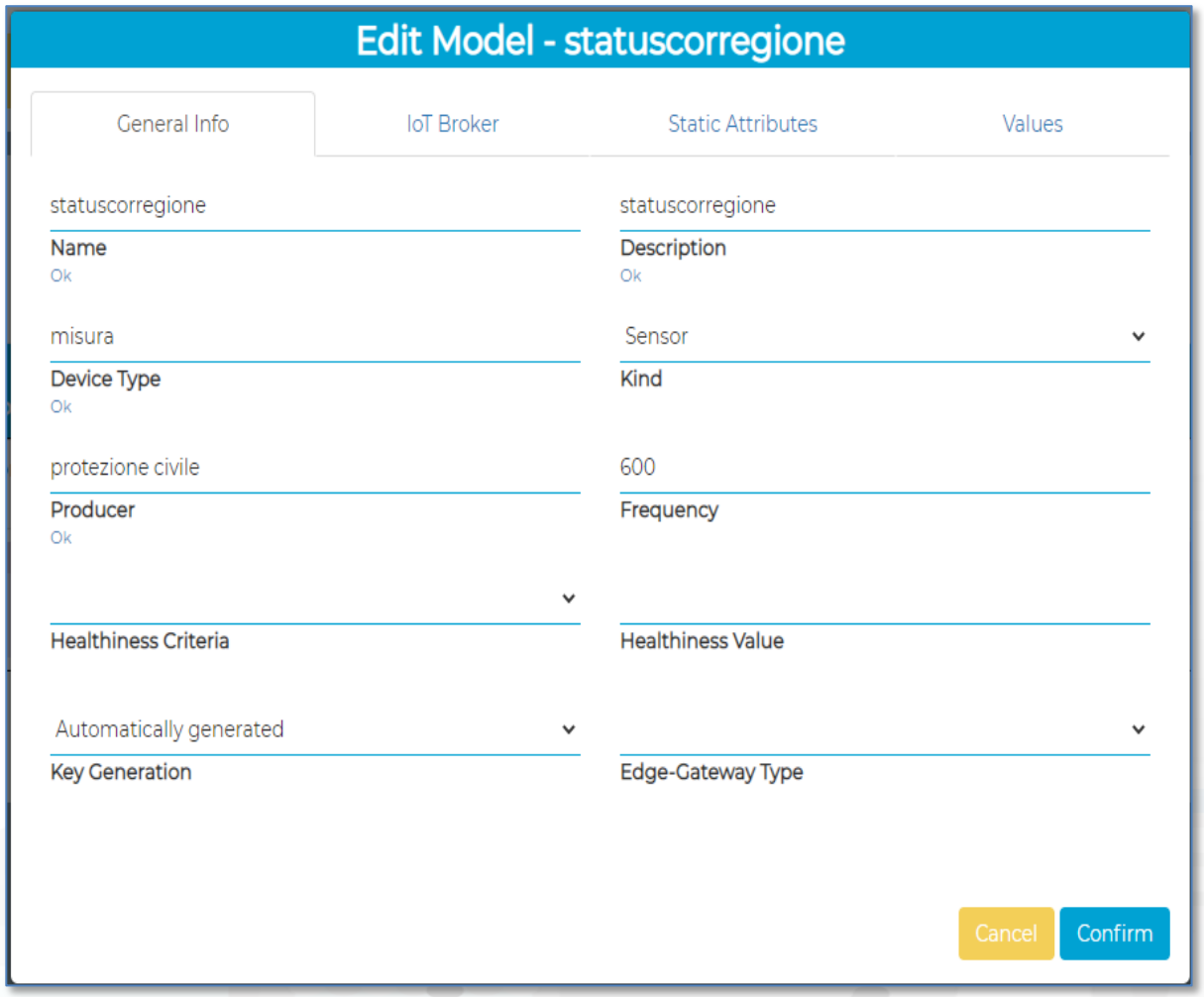
An Integrated Example for Time Series

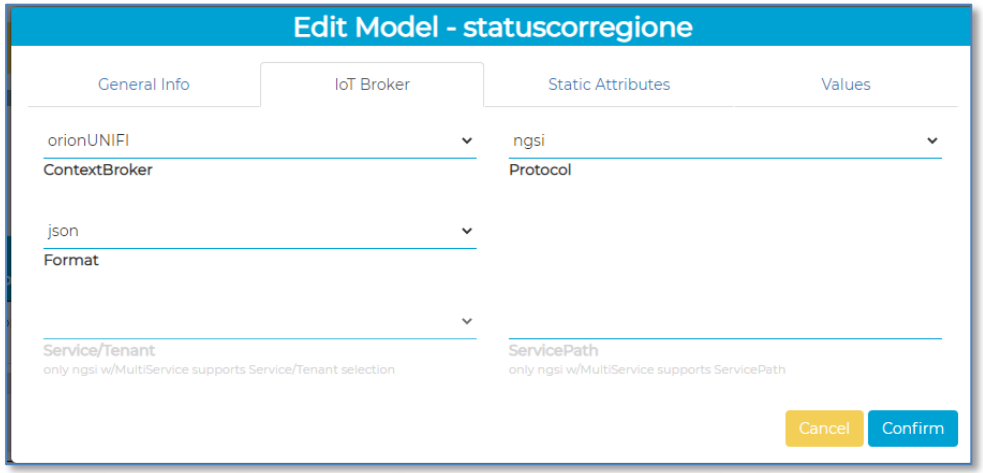
Activities for Registration on Directory

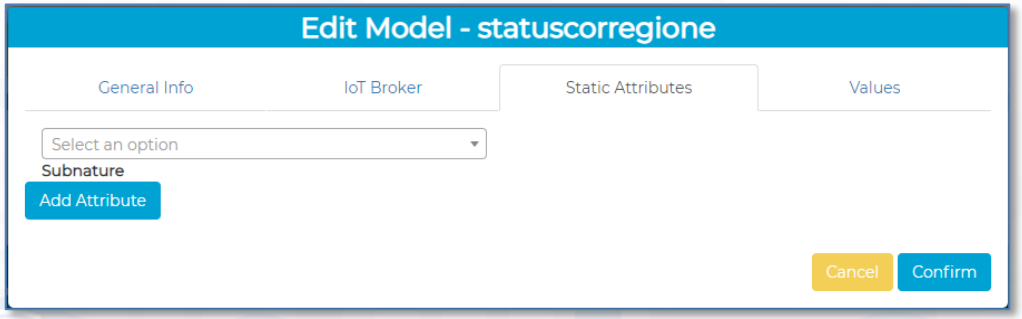
- **Manual Registration**
  - From scratch Single Device / Entity Registration → **Entity Directory / IoT Directory**
  - From a template (the templates are called Models)
- **Automated Registration for bulk/massive registration: N** Entities / Devices
  - From IoT App on the basis of some **Models** from IoT App
  - From IoT App **loading a CSV** (with or without a reference IOT Model)
  - Programming from scratch or from a **Model**
  - On the basis of some EXCEL file with data by using the **Data Table Loader, which create model, devices and data**
  - Etc.

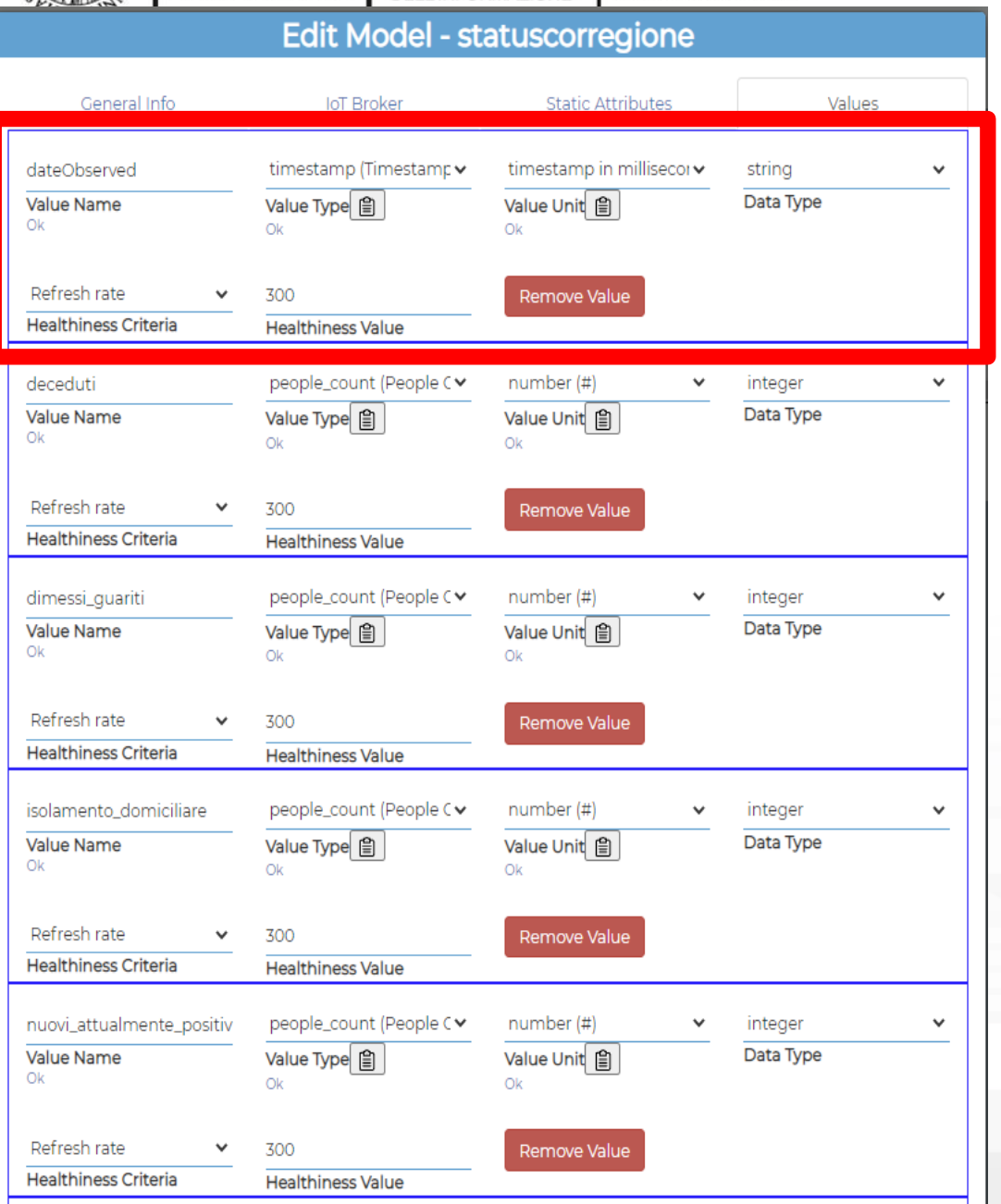
Manual or automated Registration of Entities/Devices

created a Model as:



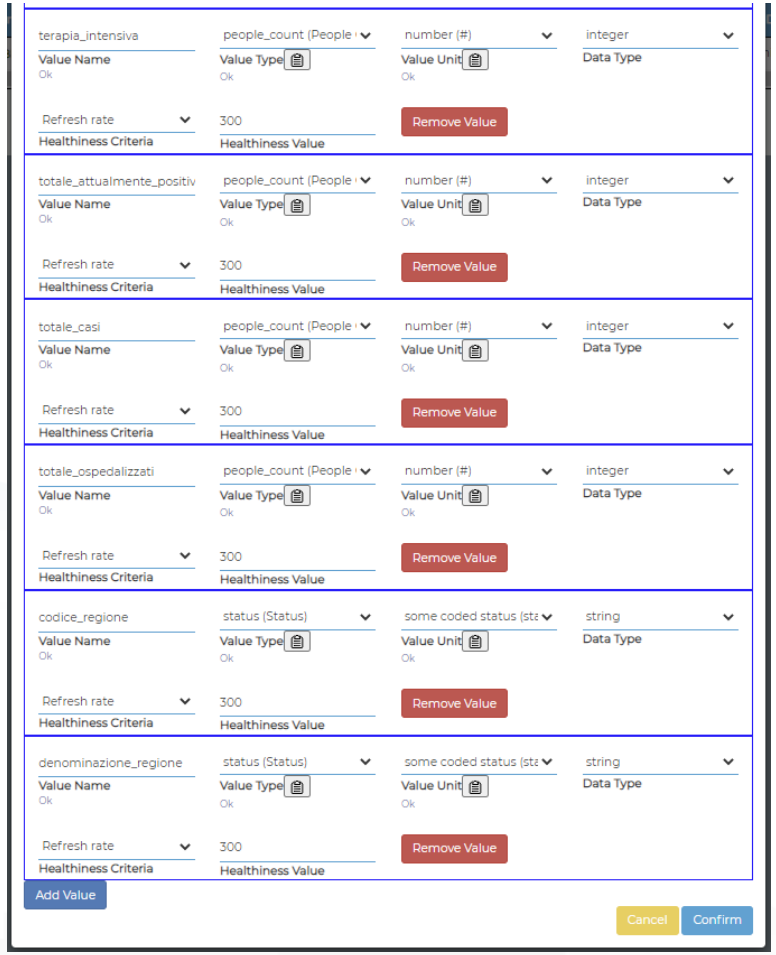






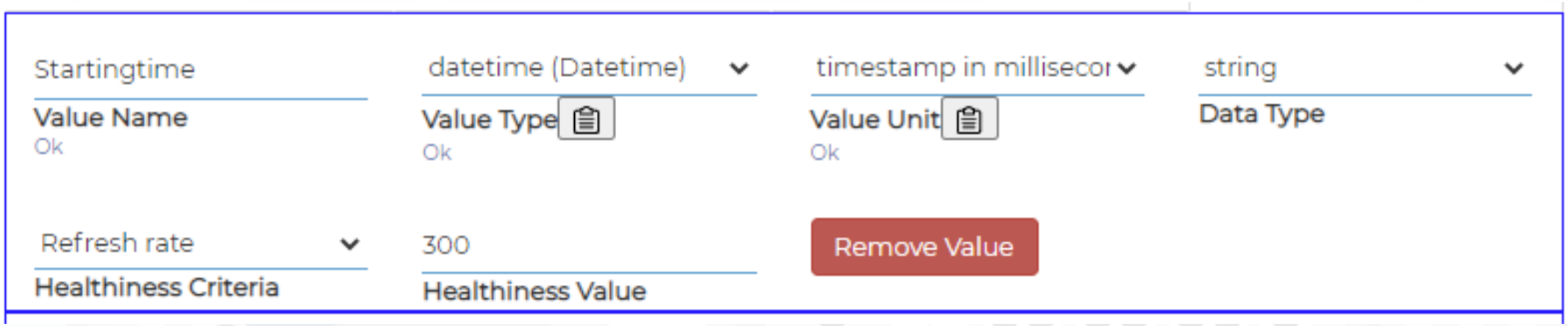
For Time Series

- ValueName: dateObserved
- ValueType: timestamp
- ValueUnit: timestamp in millisecond
- DataType: string
  - E.g.: ISO string of the date-time

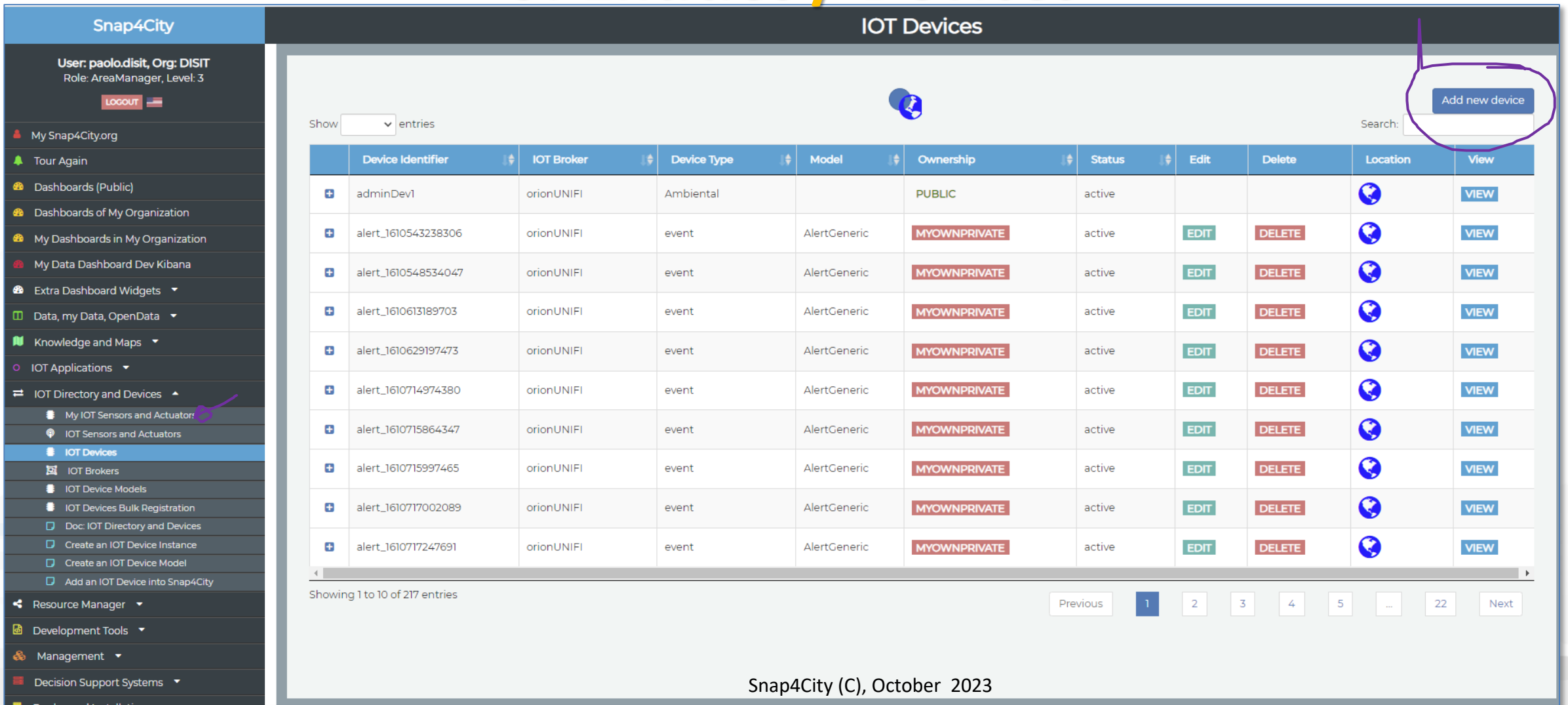


Please note for Time Series of IoT Devices

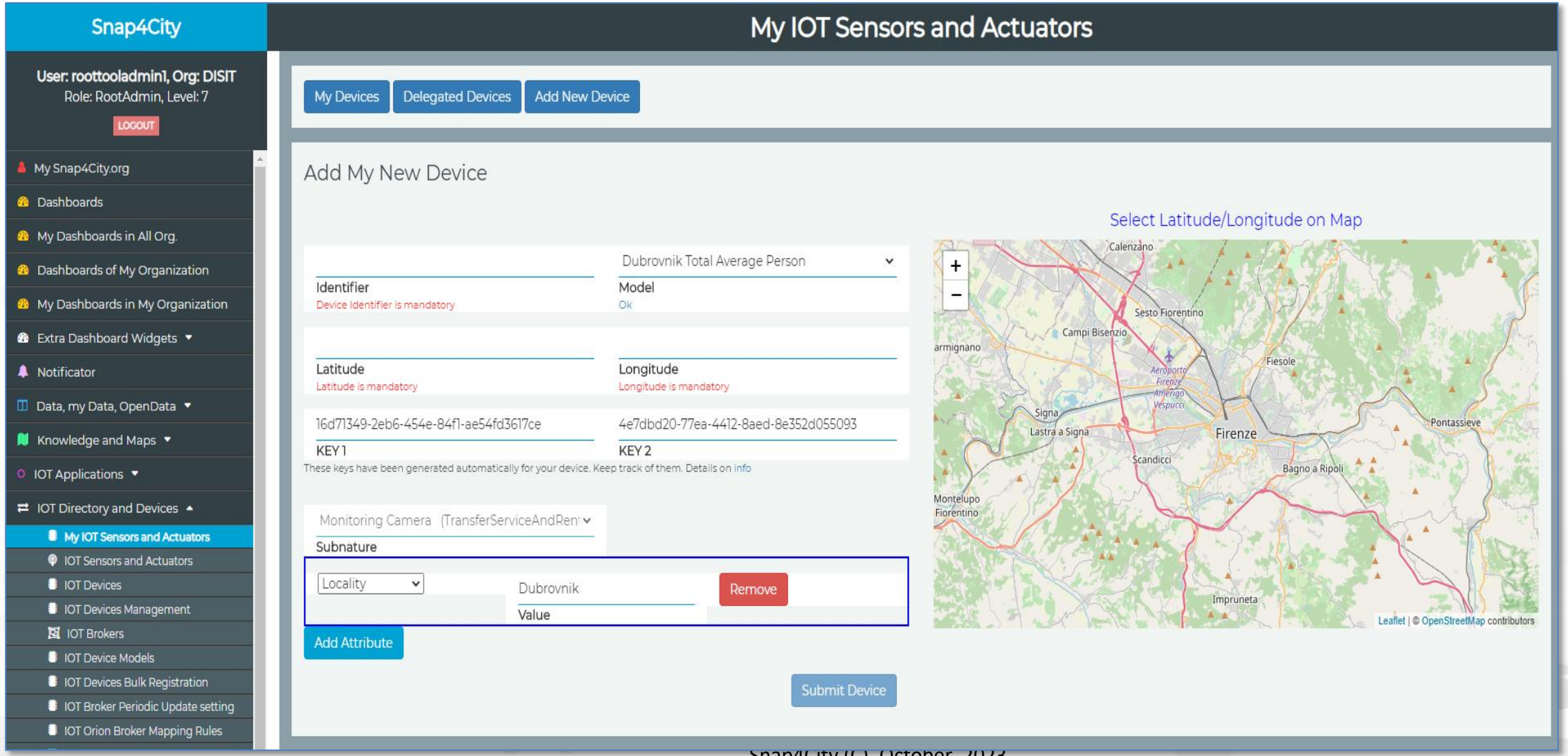
- Snap4City engine recognizes as time basis for the TimeSerie only 1 Varible with
  - ValueType as TimeStamp (in milliseconds)
- **If you need more than one timestamp** in milliseconds use:
  - ValueType as ***DateTime*** (in milliseconds)



From Model, you can create instances of Entities / Devices



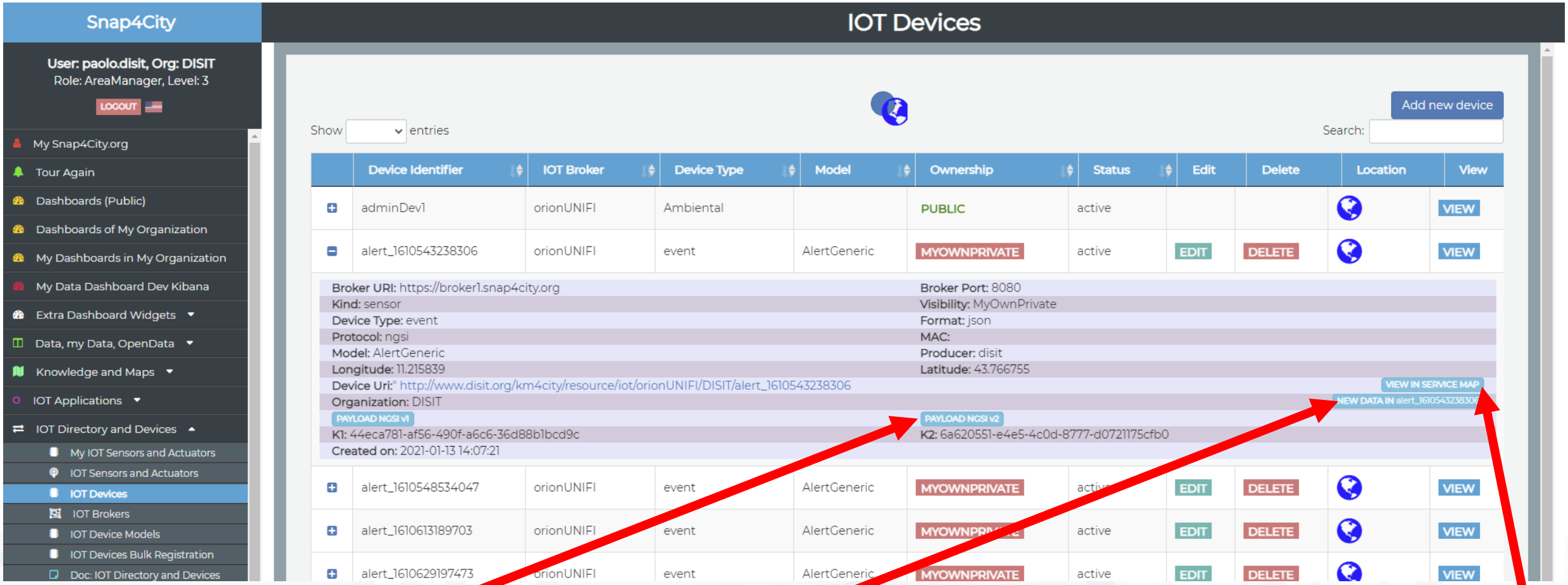
They have been created by «Add new Device»



Device from Model by Providing:

- **NAME (it has to be unique)**
- Select the IoT/Entity Model: «**statuscorregione**»
  - Thus the K1, K2 appears since the model is associated to an Orion Broker that needs to have them, the tool generate them for you but you can impose if you like
  - See in previous slide the ID name of the IOT Broker used
- **Lat** and **Lon**, GPS coordinates you can:
  - pick on the map
  - Write the coordinates manually and see the pin on map

Once Created, I may send a new data to it

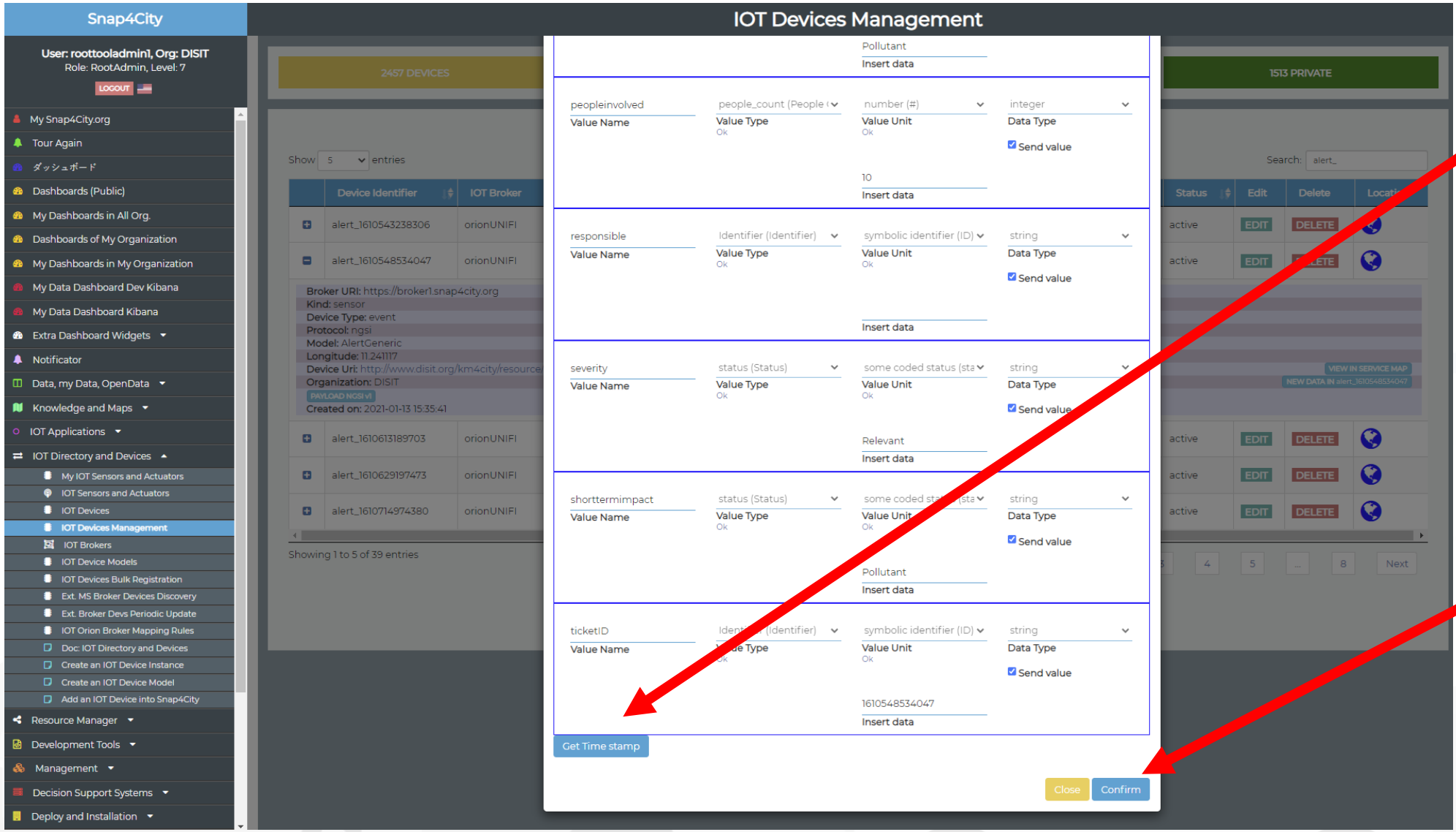


Get/See last message from Broker

Generate a New Message towards the Device, Storage

View IoT Device on map and its last value

Edit Message



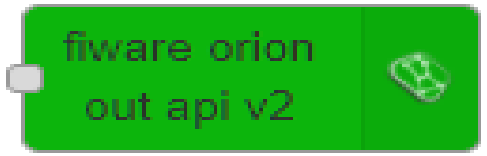
Impose current date time on dateObserved

Send the Message to the Device, Storage

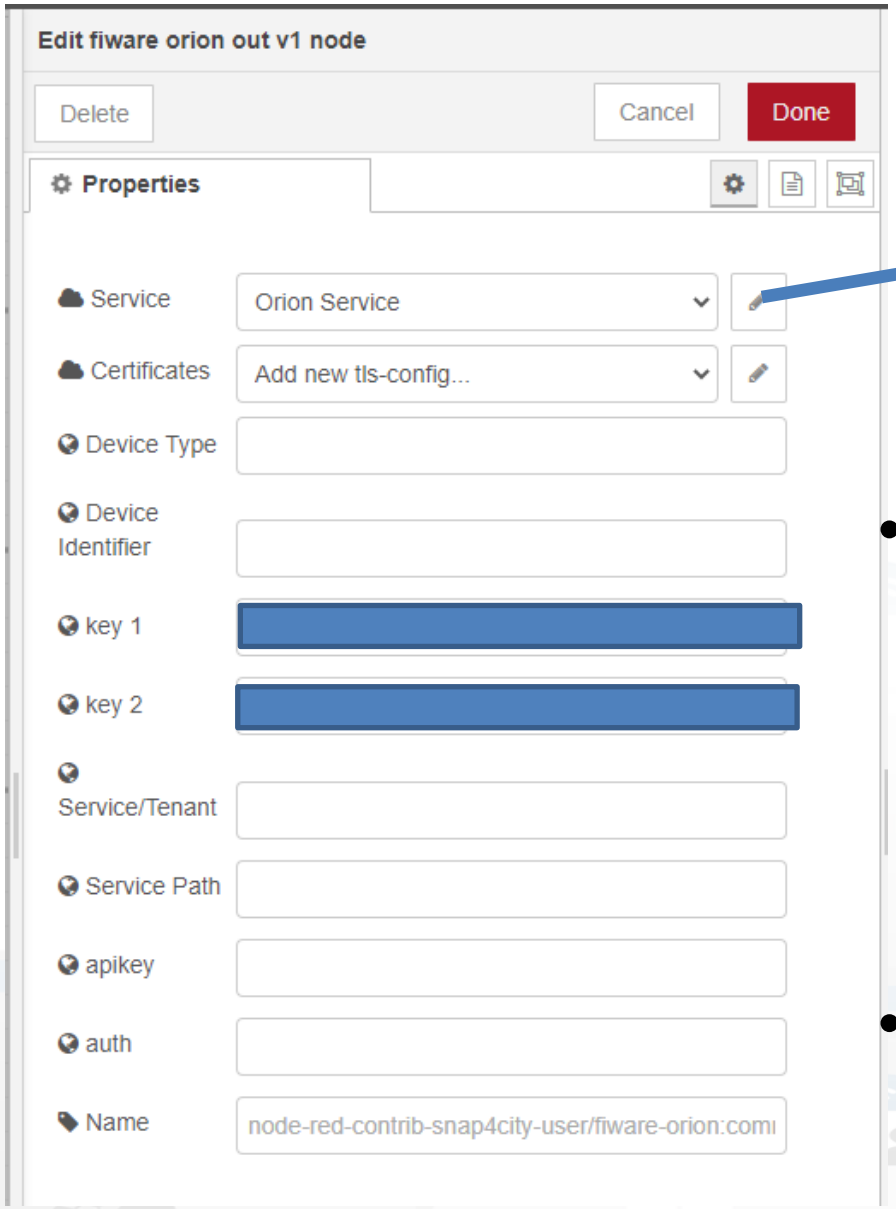
Once created the Device you may send data on it

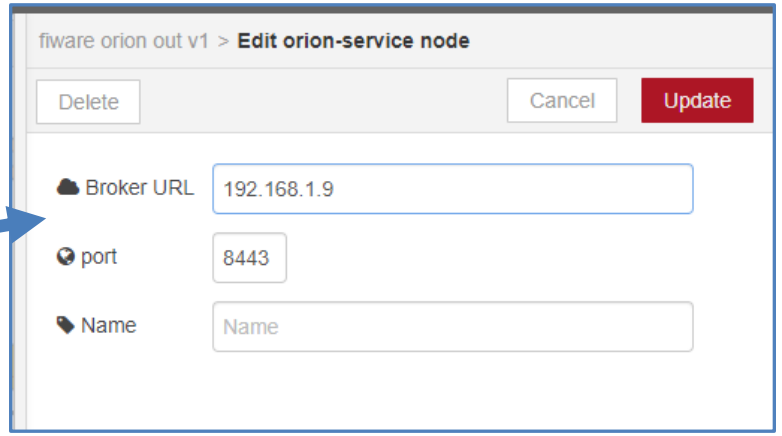
- You may create a Proc.Logic / IOT App, where:
  - Function: is preparing the JSON package
  - Block «FIWARE Orion OUT V2» is sending the data to the Orion Broker. Namely: «OrionUNIFI»
  - Please note that several version of ORION Brokers and protocols exists:
    - So that you have to know which protocols you need to use for your broker

Settings ?



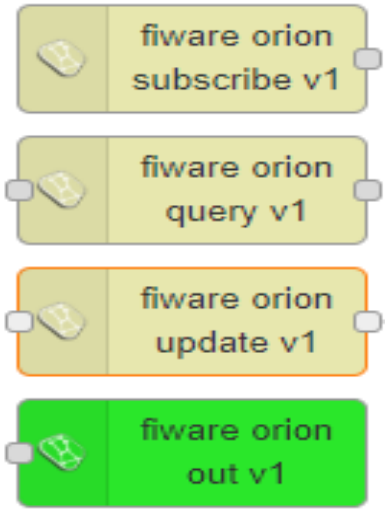
- Certificates are automatically loaded at the first authentication
- Done!!



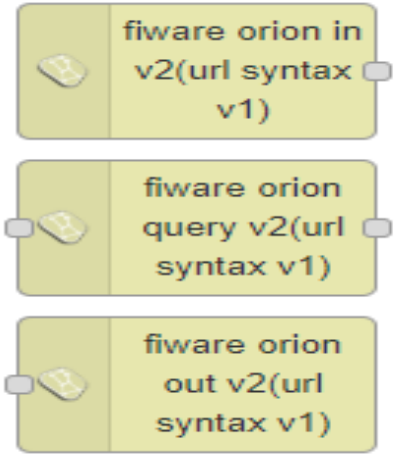


- IP if the Broker is in cloud (internal)
  - List of brokers is automatically provides
  - The K1, K2 is automatically provided if you are authenticated
- Symbolic address of Broker can be taken from Directory

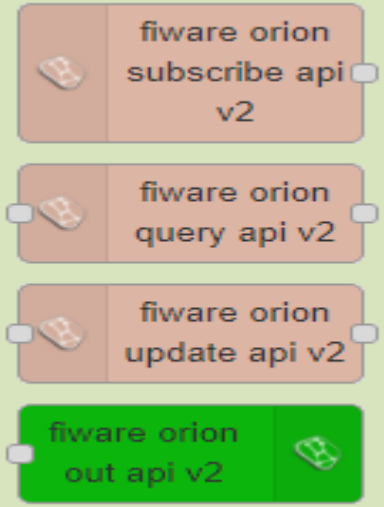
NGSI versions



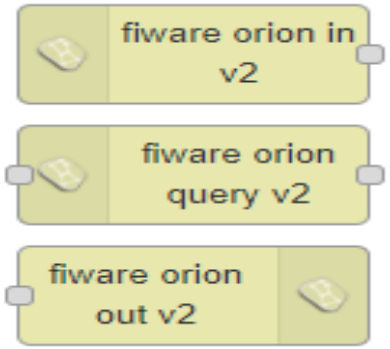
- Orion Broker of V1 with **NGSI syntax of V1** + Secure Filter of Snap4city (deprecated)



- Orion Broker of V2 with NGSI syntax of V1 (deprecated)

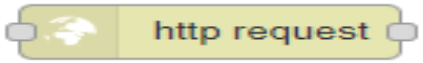
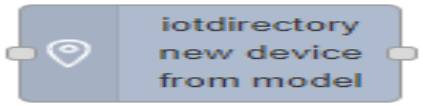


- Orion Broker of V2 with **NGSI syntax of V2** + Secure Filter of Snap4city



- Orion Broker of V2 with NGSI syntax of V2 (deprecated)

examples

	To generate injection messages into a flow, scheduled or on demand by click
	A java script function, from a JSON input to one or more JSON outputs
	To send a message of and Entity Instance into the storage. The Device has to be registered and you have to be the owner or to be delegated in READ-WRITE to send messages to it.
	To subscribe an IoT App to receive event-driven notification about messages and changes on specific devices. You can subscribe to many and then to get all of them from it.
	Query call to Smart City API to get any information about a SURI, ServiceURI. There are many other Nodes which can be used to pose Smart City API queries in very simple manner
	Send email, you can even send Telegram, SMS, etc.
	To send a REST CALL (get, post, etc.). Please USE THIS ONLY for the external API not for the Snap4City API for which a lot of MicroService accessible as NODEs/Blocks in the IoT App are simpler and ready to use.
	A block which is printing on debug view the data JSON passed in input.
	To create a device instance from a model prepared on IoT Directory
	To change the ownership of a device.
	To delegate a certain device to some other user
	To show something on Snap4City dashboard with a simple widget.

- A Json from the IOT App
  - NGSI V1
- **ID**: The Name of the IOT Device: «corveneto»
- **Type** as that defince in the IOT Device when you created
- The **Time stamp**: “dateObserved” to have a time series data
  - “str” is a string with the date and time in standard ISO, such as ,
  - “2020-08-04T04:00:00+02:00”,
  - “2020-08-03T00:00:00.000Z”
- And the **vector** of “**attributes**”

```
msg = { payload : {
  "id": "corveneto",
  "type": "misura",
  "attributes":[
 { "name": "dateObserved", "value": str, "type": "timestamp" },
 { "name": "stato",  "value": “active”,  "type": "string" },
 { "name": "ricoverati_con_sintomi",  "value": 12,  "type": "integer" },
 { "name": "terapia_intensiva",  "value": 34,  "type": "integer" },
 { "name": "totale_ospedalizzati", "value": 34,  "type": "integer" },
 { "name": "isolamento_domiciliare",  "value": 334,  "type": "integer" },
 { "name": "totale_attualmente_positivi",  "value": 12,  "type": "integer" },
 { "name": "nuovi_attualmente_positivi", "value": 33,  "type": "integer" },
 { "name": "dimessi_guariti",  "value": 22222,  "type": "integer" },
 { "name": "deceduti",  "value": 2,  "type": "integer" },
 { "name": "totale_casi",  "value": 2222,  "type": "integer" },
 { "name": "tamponi",  "value": 222222344,  "type": "integer" }
 ]
}
}
return msg;
```

NGSI V2

{"id":"corveneto",
"type":"misura",
"codice_regione":{"type":"integer","value":""},
"dateObserved":{"type":"time","value":"2021-01-18T17:00:00.000Z"},
"deceduti":{"type":"integer","value":"8025"},
"denominazione_regione":{"type":"string","value":""},
"dimessi_guariti":{"type":"integer","value":"222062"},
"isolamento_domiciliare":{"type":"integer","value":"66514"},
"latitude":{"type":"float","value":"45.43490"},
"longitude":{"type":"float","value":"12.33845"},
"nuovi_attualmente_positivi":{"type":"integer","value":"-1557"},
"ricoverati_con_sintomi":{"type":"integer","value":"2233"},
"stato":{"type":"string","value":"ITA"},
"tamponi":{"type":"integer","value":"3663538"},
"terapia_intensiva":{"type":"integer","value":"336"},
"totale_attualmente_positivi":{"type":"integer","value":"69083"},
"totale_casi":{"type":"integer","value":"299170"},
"totale_ospedalizzati":{"type":"integer","value":"2569"}
}

NGSI V2

The differences are mainly on how the variable are provided:

{
"id":"MyMobileDeviceTest",
"type":"misura",
"dateObserved":{"type":"timestamp","value":"2021-06-11T16:17:23.425Z"},
"status":{"type":"float","value":25}
"mydescription":{"type":"string","value":"**see below the note for the forbidden characters**"}
}

- **NOTE for:**
  - **names/IDs**: Spaces or strange characters are not allowed in the. Please use simple alfphanumeric strings, it is a limitation of many solutions including Orion Broker and increase interoperability of your data.
  - **Values of attributes and variables**: can be UTF8, but similarly, they do not accept: () <> “ ‘ ; = into values
  - https://fiware-orion.readthedocs.io/en/master/user/forbidden_characters/index.html

DateObserved

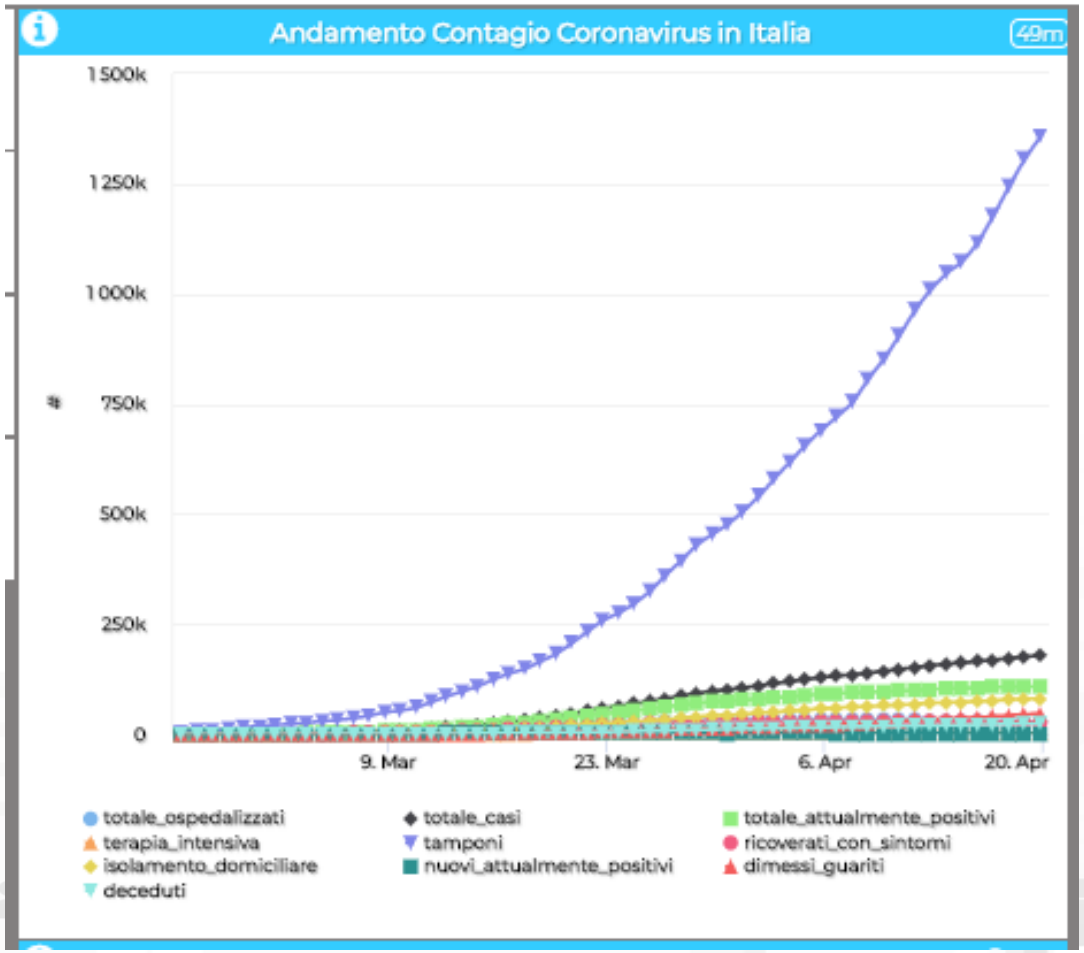
- The **Timestamp**: “dateObserved” to have a time series data
  - “str” is a string with the date and time in standard ISO, such as ,
  - “2020-08-04T04:00:00+02:00”,
  - “2020-08-03T00:00:00.000Z”
- In JavaScript you can obtain by using:
  - Var str = new Date().toISOString();
  - **Str** has to be the ISO date string of today-now (at the current time).

From date to ISOString with fuse aligned time

```
var todaynow = new Date();
dateCET2Z(todaynow).toISOString();
---
function dateCET2Z(date) {
    d = new Date(date).toLocaleString('nl-BE', {timeZone: 'Europe/Brussels'});
    offset = new Date(d).getTime() - new Date(date).getTime();
    return new Date(new Date(date).getTime() - offset);
}
```

Multi Series Widget coming from the same IOT Device

- Over on the serie label to highlight
- Click on the serie label to on/ok
- Over on the graph to see the values

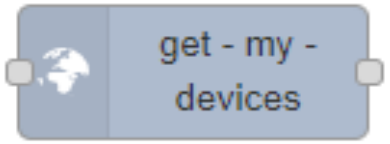


https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjU2OQ==

JSON for Authentication as well

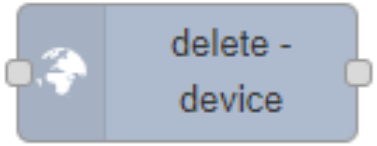
```
 msg.auth= {
"k1": "1ef0e5e8-yyyy-xxxx-9462-0aa4cfcf5e19",
"k2": "b2b34425-yyyy-xxxx-818d-2d6cac2314a6",
"apikey":"apikey",
"basicAuth": "basicAuthKey"
};
```

You may use other functions from Directory

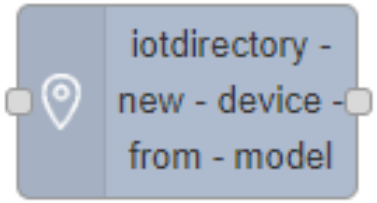


- Discovery in an area
- Query on Directory

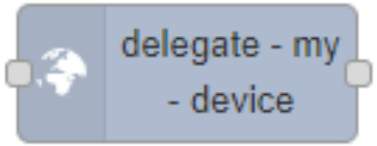
- Get Device Info



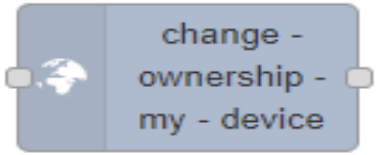
- Delete a Device (max rate 1 per minute)



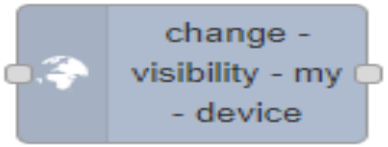
- Registering an Device from model



- Delegate an Device

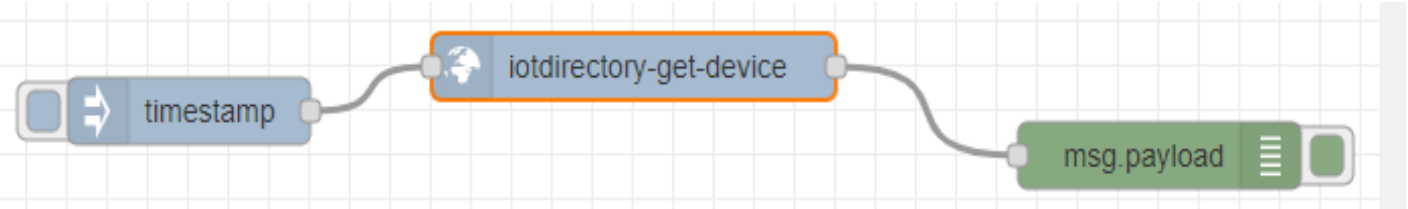


- Change Ownerhip of an Device



- Change Visibili, Publish

Get IOT Device Info



- You can create smart Proc.Logic / IoT App that on the basis of the list of Devices would request all what you need to load data into **YOUR OWN** Devices including:
  - **Service URI**
  - **K1, K2**
  - Authentication

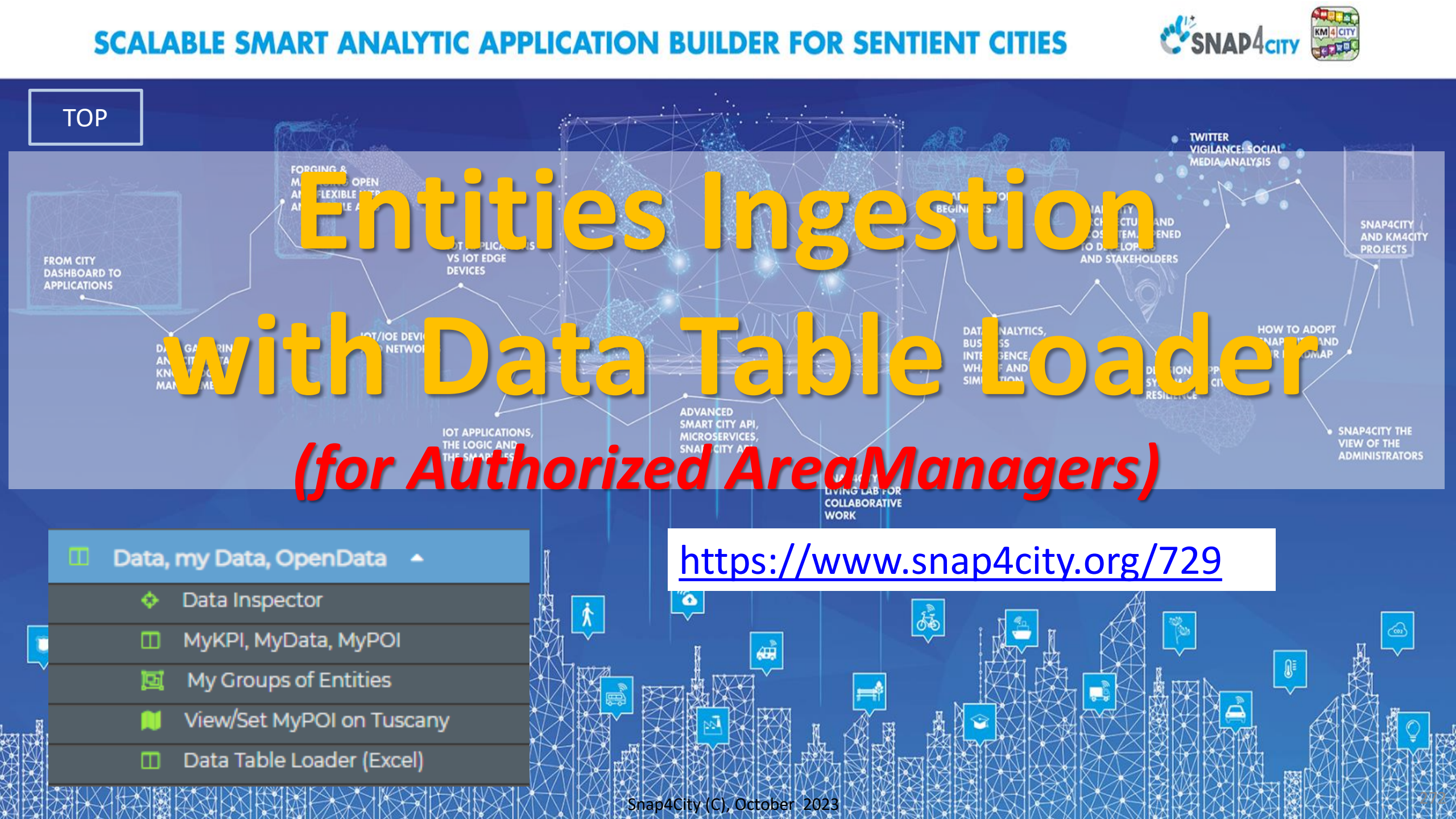
msg.payload : Object

```
object
  status: "ok"
  content: object
    uri: "http://www.disit.org/km4city/resource/iot/orionUNIFI/DISIT/corarezzo"
    devicetype: "misura"
    kind: "sensor"
    status1: "active"
    macaddress: ""
    model: "statuscorregione"
    producer: "protezione civile"
    longitude: "11.88228"
    latitude: "43.46642"
    protocol: "ngsi"
    format: "json"
    visibility: "public"
    frequency: "600"
    created: "2020-03-21 18:34:32"
    privatekey: ""
    certificate: ""
    organization: "DISIT"
    accesslink: "https://broker1.snap4city.org"
    accessport: "8080"
    sha: "C61E32DBFAE7F14C0810177F2D2300843C41C550"
    subnature: null
    static_attributes: null
    k1: "bf739214-f6b4-45fe-85f7-97cd09fe8e57"
    k2: "c19e0b6f-8f98-4130-b135-e7a1dfae9273"
  error_msg: ""
```

TOP

Entities Ingestion with Data Table Loader

(for Authorized AreaManagers)



https://www.snap4city.org/729

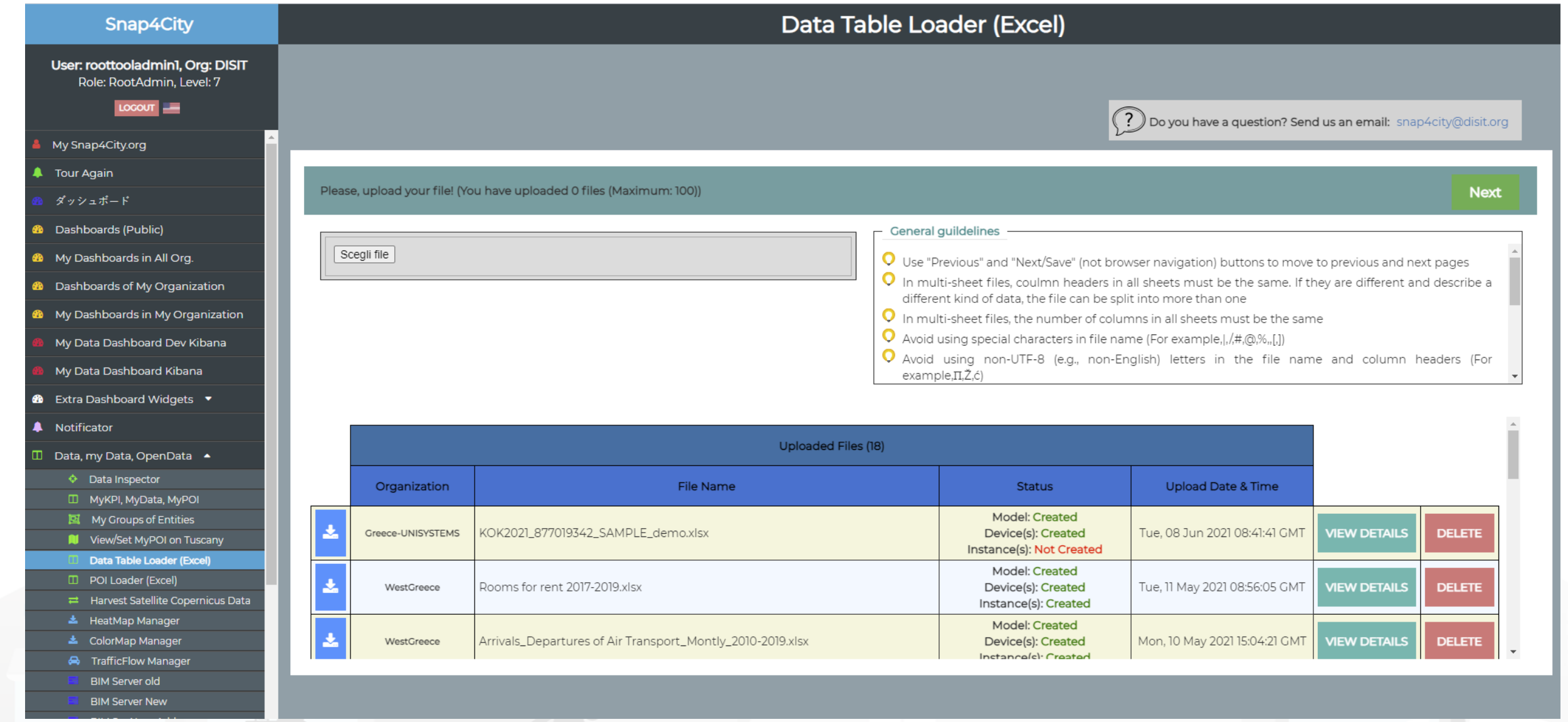
How to ingest Devices/Entities in automatic

main High Level Types	1st option	2nd option
POI, Point of Interest	IoT App or POI Loader (from EXCEL files)	Create an **Entity Model, Entity Registration**, ingest via IoT App
IoT Devices, KPI multivariable, WoT, Entities Instances	Create an **Entity Model, Entity Registration**, ingest via broker (e.g., Time Series) or IoT App	**Data Table Loader**
GIS data	Pose query from IoT App, Create an **Entity Model, Entity Registration**, ingest via IoT App	Load them on GeoServer

Ingestion of Entities

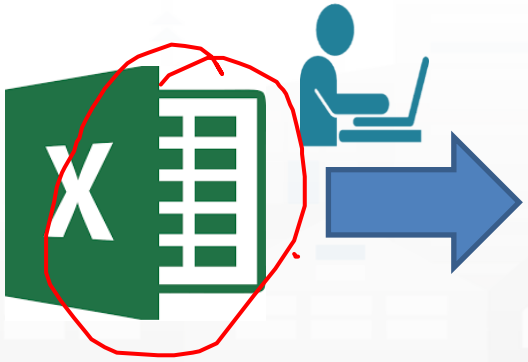
- .....

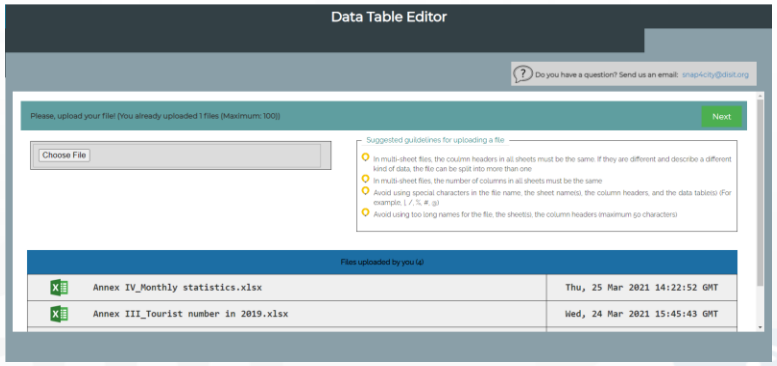
Data Table Loader

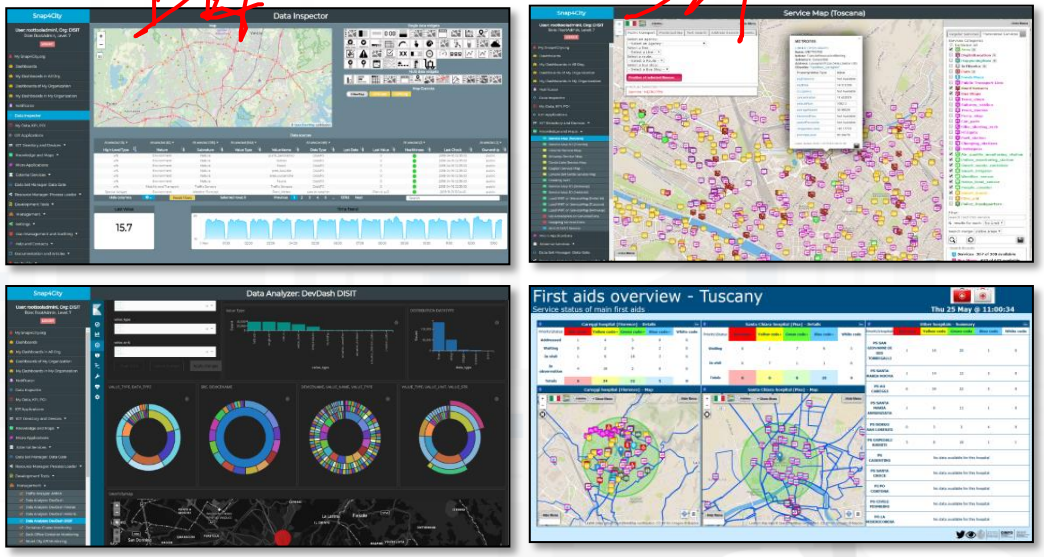


Data Table Loader

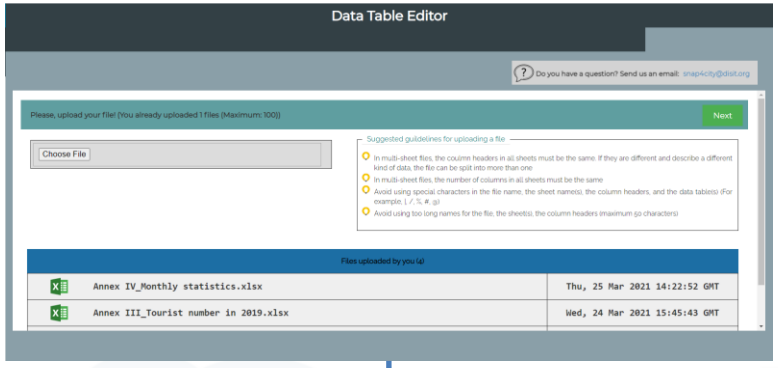
- For: IoT Devices, KPI as devices, OD as devices, time Series …
- To help you to **upload data in short/zero time**
  - **Start from Excel Files, they should be formatted some how or well formatted according to our guidelines (models are provided)**
  - Custom upload for each Organization is possible
- To **enable you** to
  - create dashboards from them according to different views and nature



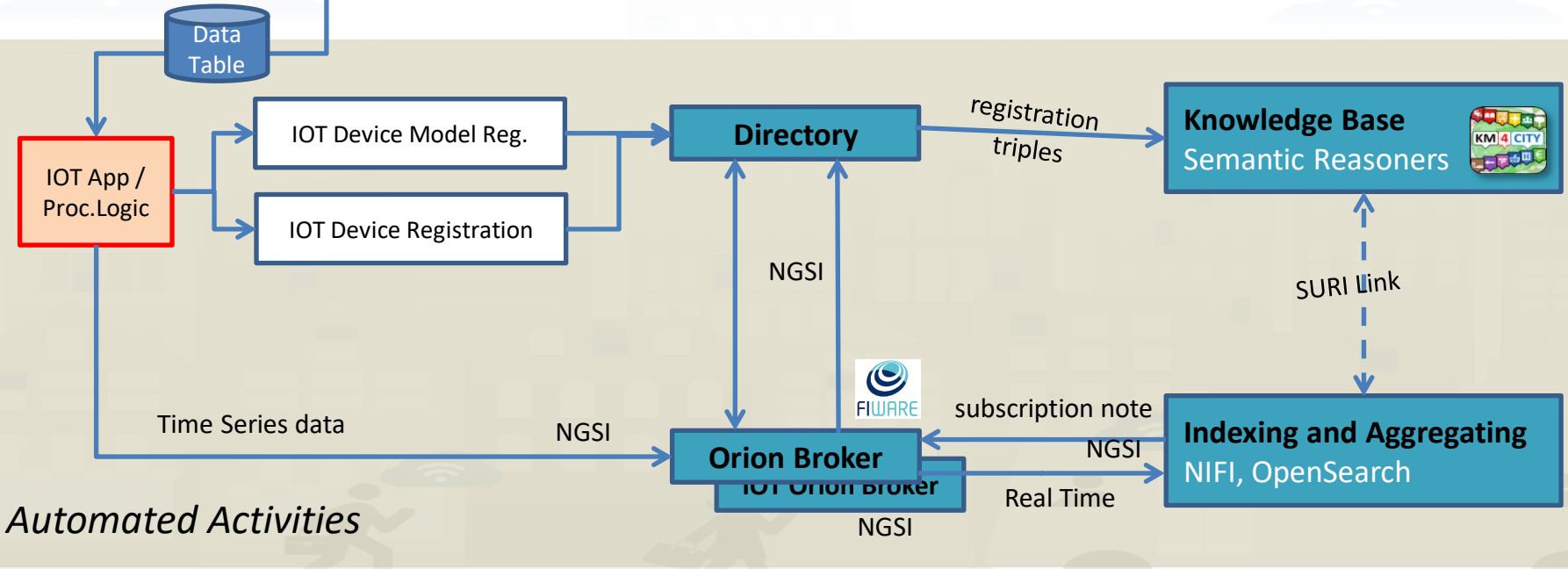




Short cut Data Ingestion from Excel file

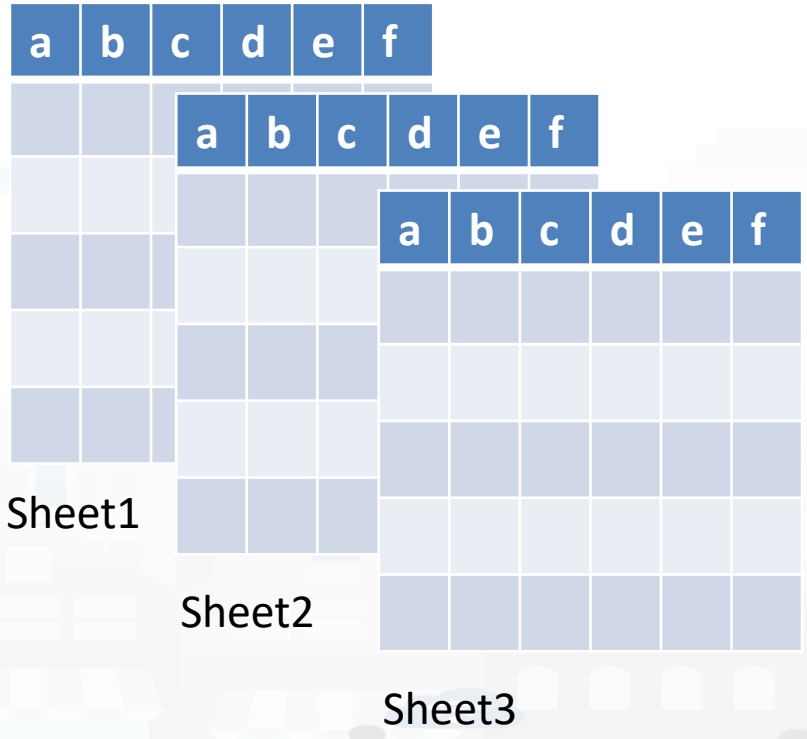


1) Upload the file on **Data Table Loader**
2) Follows the instructions and guidelines
   -- the dirty work will be done in a Snap
   -- wait! –
3) See data on your Data Inspector ☺
4) Use Data Into Dashboards ☺



Row Case

Assuming an Excel file with 1 or more Sheets all of them with the same structure



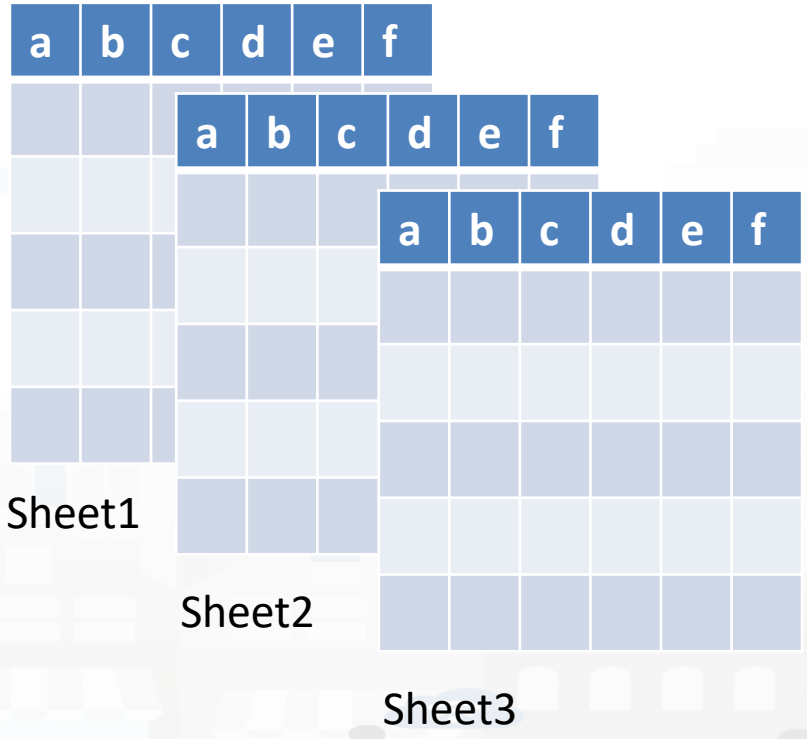
If this is not the case!

- Columns in the sheets are different AND *it is not possible to regularize them (by editing: adding empty columns, change names, etc.)*

→ split the excel file in multiple files

Row Case

Assuming an Excel file with 1 or more Sheets all of them with the same structure

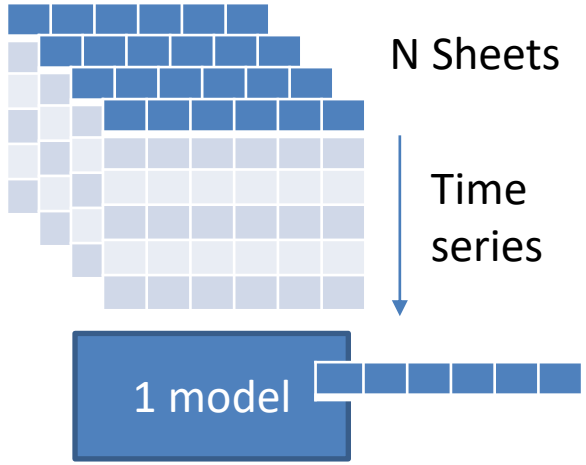


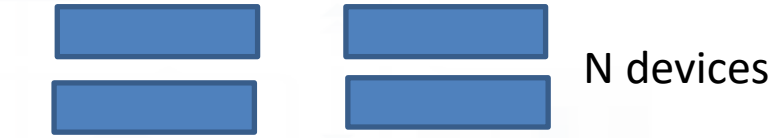
If this is the case!

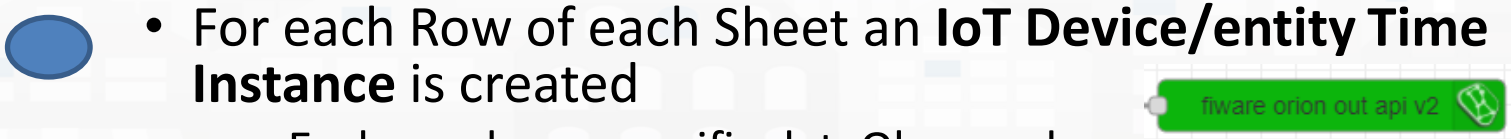
1) The Schema of the sheet**s** is becoming an IoT Device Model
2) Each single Sheet is becoming a single IoT Device
3) The row in the single Sheet are becoming instances of the corresponding IoT Device

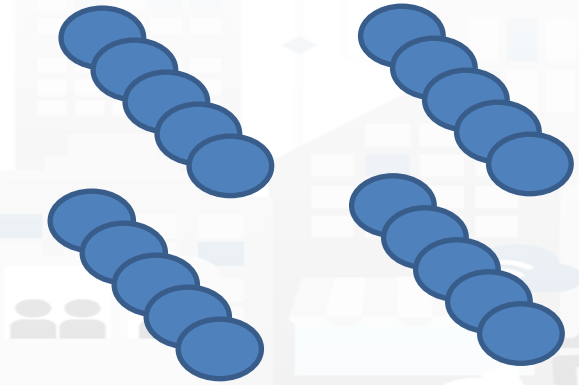
Row Case

- One **dateObserved for each Row of each Sheet**, multiple sheets with the same structure
  - An **IoT Device/Entity Model** is created for the structure of the sheet
    - a number of **variables are produced**
    - Including dateObserved variable which is a column
  - For each Sheet an **IoT Device/Entity** is produced from the model
    - The device name is the combination: sheet+…… as defined by the user
      - Sheet name is part of the IOT Device Name and may also become a variable
      - Sheets may have a different number of rows
    - For each Row of each Sheet an **IoT Device/entity Time Instance** is created
      - Each row has a specific dateObserved
      - Each row has … other attributes as well









Example

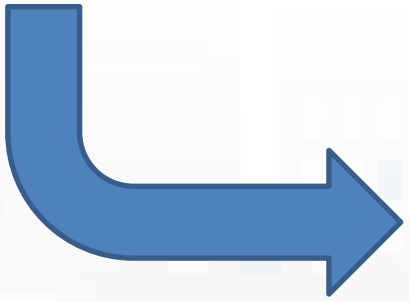
Data from INSETE

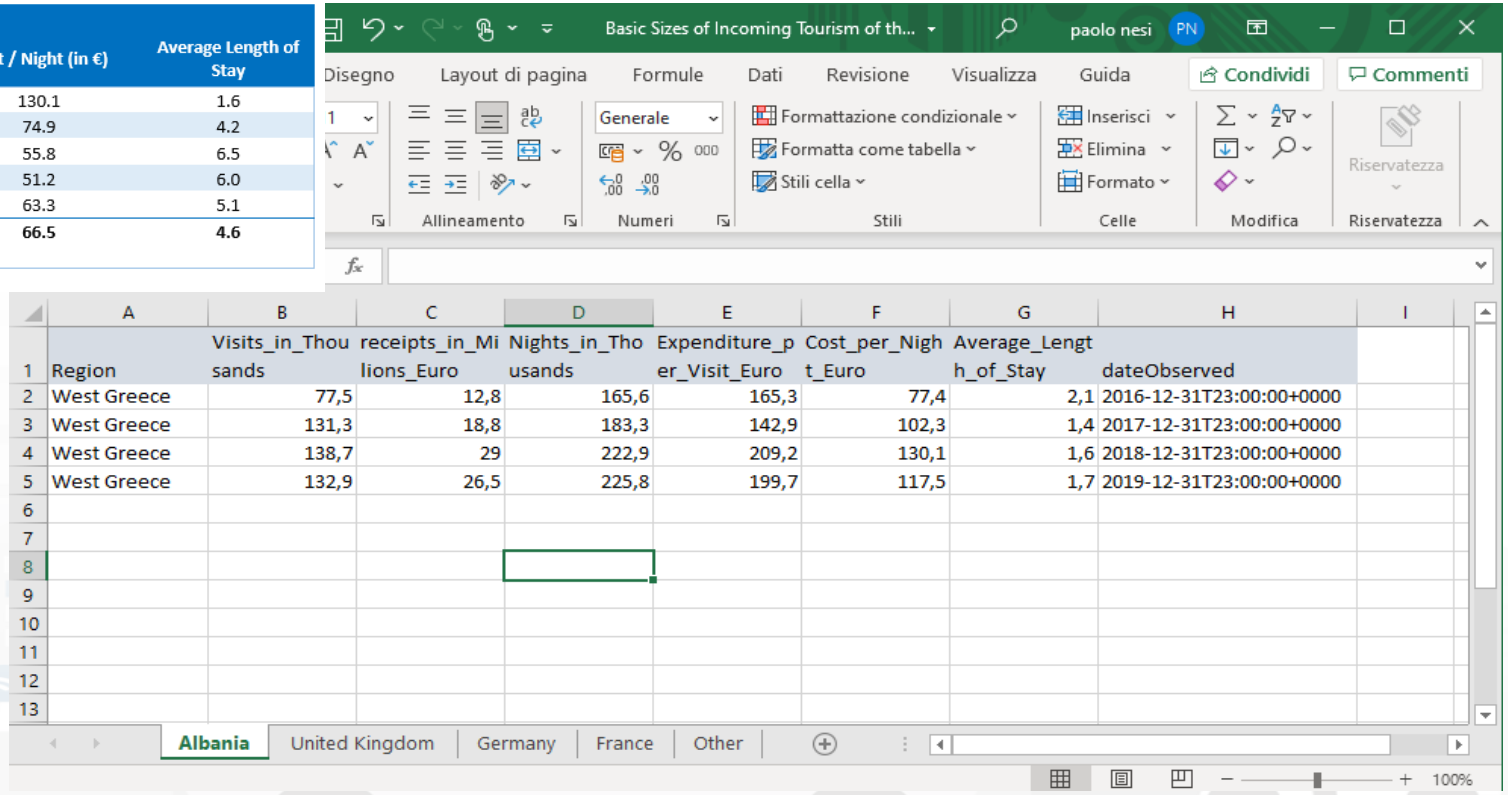
Basic Sizes of Incoming Tourism

Basic Sizes of Incoming Tourism of the Region of Western Greece 2019							
Regions	Countries Origin	Visits (in thousands)	Receipts (in € million)	Nights (in thousands)	Expenditure / Visit (in €)	Cost / Night (in €)	Average Length of Stay
West Hellas	Albania	132.9	26.5	225.8	199.7	117.5	1.7
	United Kingdom	47.7	17.9	345.8	375.2	51.8	7.2
	Germany	70.3	36.4	672.4	517.9	54.1	9.6
	France	55.4	16.5	321.6	298.1	51.4	5.8
	Other	510.7	160.0	2,964.9	313.3	54.0	5.8
	Total	**817.0**	**257.4**	**4,530.4**	**315.0**	**56.8**	**5.5**
	% of the total	**2.2%**	**1.5%**	**1.9%**			

Source: BoG Border Research, INSETE Intelligence Editing

Basic Sizes of Incoming Tourism of the Region of Western Greece 2018							
Regions	Countries of Origin	Visits (in thousands)	Receipts (in € million)	Nights (in thousands)	Expenditure / Visit (in €)	Cost / Night (in €)	Average Length of Stay
West Greece	Albania	138.7	29.0	222.9	209.2	130.1	1.6
	United Kingdom	42.6	13.5	180.6	317.6	74.9	4.2
	Germany	71.3	26.0	466.5	365.1	55.8	6.5
	France	44.2	13.5	262.9	304.7	51.2	6.0
	Other	402.5	129.8	2,050.7	322.4	63.3	5.1
	Total	**699.2**	**211.8**	**3,183.5**	**302.9**	**66.5**	**4.6**
	% of the total	**2.0%**	**1.4%**	**1.4%**			





	A	B	C	D	E	F	G	H	I
1	Region	Visits_in_Thousands	receipts_in_Millions_Euro	Nights_in_Thousands	Expenditure_per_Visit_Euro	Cost_per_Night_Euro	Average_Length_of_Stay	dateObserved	
2	West Greece	77,5	12,8	165,6	165,3	77,4	2,1	2016-12-31T23:00:00+0000	
3	West Greece	131,3	18,8	183,3	142,9	102,3	1,4	2017-12-31T23:00:00+0000	
4	West Greece	138,7	29	222,9	209,2	130,1	1,6	2018-12-31T23:00:00+0000	
5	West Greece	132,9	26,5	225,8	199,7	117,5	1,7	2019-12-31T23:00:00+0000	
6									
7									
8									
9									
10									
11									
12									
13									

Albania | United Kingdom | Germany | France | Other

Resulted Data Table Loaded by Row Model

		Value Type												
		geolocation	Count	price	Count	price	price	duration	timestamp					
		Value Unit												
		text	K#	Meuro	K#	euro	euro	day	timestamp					
		Data Type												
		string	float	float	float	float	float	float	time					
Device Name	Sheet Name	Region	Visits_in_Thousands	receipts_in_Milions_Euro	Nights_in_Thousands	Expenditure_per_Visit_Euro	Cost_per_Night_Euro	Average_Length_of_Stay	dateObserved	Latitude	Longitude	Nature	Sub-Nature	Context Broker
BasicSizesofIncomingTourismoftheRegionofWesternGreece.xlsx__Albania	Albania	West Greece	77.5	12.8	165.6	165.3	77.4	2.1	2016-12-31T12:00:00.000+02:00	38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
BasicSizesofIncomingTourismoftheRegionofWesternGreece.xlsx__Albania	Albania	West Greece	131.3	18.8	183.3	142.9	102.3	1.4	2017-12-31T12:00:00.000+02:00	38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
BasicSizesofIncomingTourismoftheRegionofWesternGreece.xlsx__Albania	Albania	West Greece	138.7	29	222.9	209.2	130.1	1.6	2018-12-31T12:00:00.000+02:00	38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
BasicSizesofIncomingTourismoftheRegionofWesternGreece.xlsx__Albania	Albania	West Greece	132.9	26.5	225.8	199.7	117.5	1.7	2019-12-31T12:00:00.000+02:00	38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
BasicSizesofIncomingTourismoftheRegionofWesternGreece.xlsx__UnitedKingdom	United Kingdom	West Greece	48.1	17.4	373.1	362.6	46.8	7.8	2016-12-31T12:00:00.000+02:00	38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
BasicSizesofIncomingTourismoftheRegionofWesternGreece.xlsx__UnitedKingdom	United Kingdom	West Greece	49.7	20	290.5	402.5	68.8	5.8	2017-12-31T12:00:00.000+02:00	38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
BasicSizesofIncomingTourismoftheRegionofWesternGreece.xlsx__UnitedKingdom	United Kingdom	West Greece	42.6	13.5	180.6	317.6	74.9	4.2	2018-12-31T12:00:00.000+02:00	38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
BasicSizesofIncomingTourismoftheRegionofWesternGreece.xlsx__UnitedKingdom	United Kingdom	West Greece	47.7	17.9	345.8	375.2	51.8	7.2	2019-12-31T12:00:00.000+02:00	38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
BasicSizesofIncomingTourismoftheRegionofWesternGreece.xlsx__Germany	Germany	West Greece	42.5	13.6	237.9	319.2	57	5.6	2016-12-31T12:00:00.000+02:00	38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
BasicSizesofIncomingTourismoftheRegionofWesternGreece.xlsx__Germany	Germany	West Greece	46.5	15	320.3	323.6	47	6.9	2017-12-31T12:00:00.000+02:00	38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
BasicSizesofIncomingTourismoftheRegionofWesternGreece.xlsx__Germany	Germany	West Greece	71.3	26	466.5	365.1	55.8	6.5	2018-12-31T12:00:00.000+02:00	38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
BasicSizesofIncomingTourismoftheRegionofWesternGreece.xlsx__Germany	Germany	West Greece	70.3	36.4	672.4	517.9	54.1	9.6	2019-12-31T12:00:00.000+02:00	38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
BasicSizesofIncomingTourismoftheRegionofWesternGreece.xlsx__France	France	West Greece	36.3	12.1	173.3	334.7	70.1	4.8	2016-12-31T12:00:00.000+02:00	38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
BasicSizesofIncomingTourismoftheRegionofWesternGreece.xlsx__France	France	West Greece	34.7	14.7	213.7	424.8	69	6.2	2017-12-31T12:00:00.000+02:00	38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
BasicSizesofIncomingTourismoftheRegionofWesternGreece.xlsx__France	France	West Greece	44.2	13.5	262.9	304.7	51.2	6	2018-12-31T12:00:00.000+02:00	38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
BasicSizesofIncomingTourismoftheRegionofWesternGreece.xlsx__France	France	West Greece	55.4	16.5	321.6	298.1	51.4	5.8	2019-12-31T12:00:00.000+02:00	38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
BasicSizesofIncomingTourismoftheRegionofWesternGreece.xlsx__Other	Other	West Greece	308.9	89.5	1791.9	289.8	50	5.8	2016-12-31T12:00:00.000+02:00	38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
BasicSizesofIncomingTourismoftheRegionofWesternGreece.xlsx__Other	Other	West Greece	301.3	90.3	1810.8	299.7	49.9	6	2017-12-31T12:00:00.000+02:00	38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
BasicSizesofIncomingTourismoftheRegionofWesternGreece.xlsx__Other	Other	West Greece	402.5	129.8	2050.7	322.4	63.3	5.1	2018-12-31T12:00:00.000+02:00	38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI

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Requested information if not provided

GeoLocation to assign at the city or area

- Latitude
- Longitude

Classification to simplify the search

- Nature
- Subnature

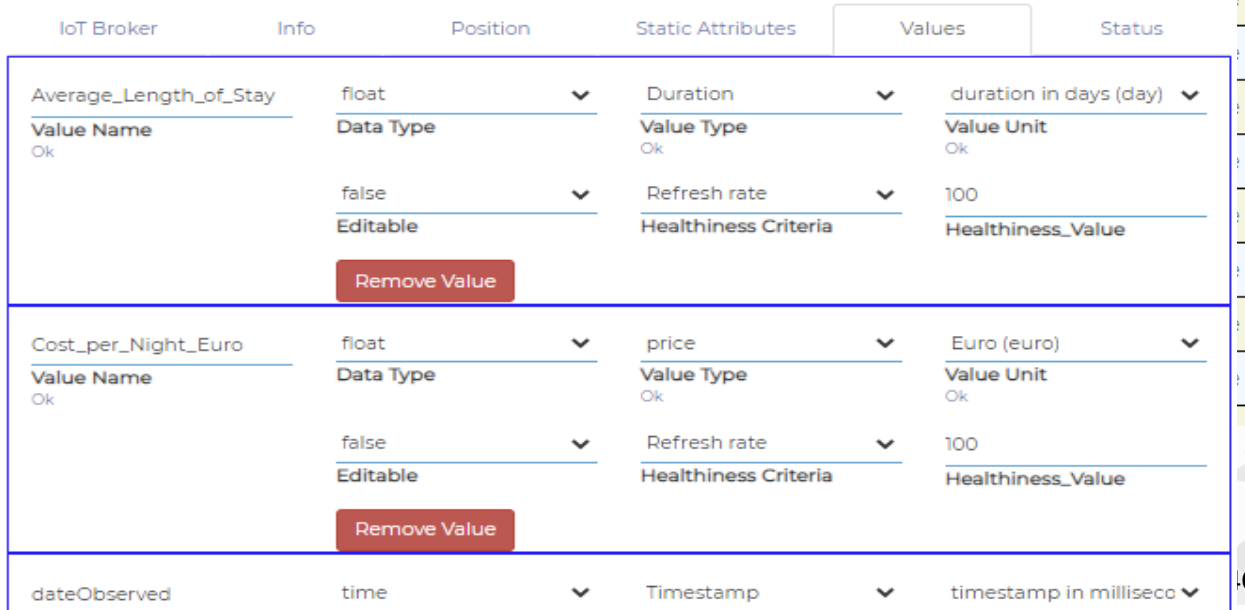
Broker is assigned automatically on the basis of Organization / tenant

Latitude	Longitude	Nature	Sub-Nature	Context Broker
38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI
38.2384	21.7385	TourismService	Travel_information	orionWestGreece-UNIFI

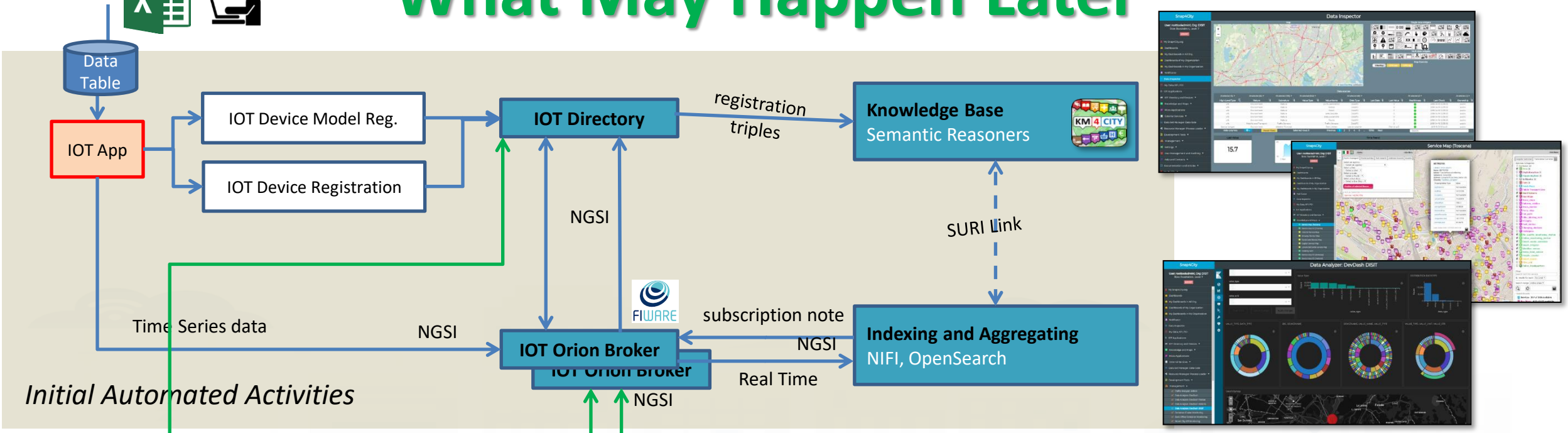
Variables of the Device

- dateObserved for Time Series, UNIQUE!
- Variables have to be assigned to:
  - Value Type, Value Unit, Data Type
- For example for Device BasicSizesofIncomingTourismoftheRegionofWesternGreece.xlsx__UnitedKingdomb

Value Type							
geolocation	Count	price	Count	price	price	duration	timestamp
Value Unit							
text	K#	Meuro	K#	euro	euro	day	timestamp
Data Type							
string	float	float	float	float	float	float	time
Region	Visits_in_Thousands	receipts_in_Milions_Euro	Nights_in_Thousands	Expenditure_per_Visit_Euro	Cost_per_Night_Euro	Average_Length_of_Stay	dateObserved
West Greece	77.5	12.8	165.6	165.3	77.4	2.1	2016-12-31T12:00:00.000+02:00
	131.3	18.8	183.3	142.9	102.3	1.4	2017-12-31T12:00:00.000+02:00
	138.7	29	222.9	209.2	130.1	1.6	2018-12-31T12:00:00.000+02:00
	132.9	26.5	225.8	199.7	117.5	1.7	2019-12-31T12:00:00.000+02:00
	48.1	17.4	373.1	362.6	46.8	7.8	2016-12-31T12:00:00.000+02:00
	49.7	20	290.5	402.5	68.8	5.8	2017-12-31T12:00:00.000+02:00
	42.6	13.5	180.6	317.6	74.9	4.2	2018-12-31T12:00:00.000+02:00
	47.7	17.9	345.8	375.2	51.8	7.2	2019-12-31T12:00:00.000+02:00
	42.5	13.6	237.9	319.2	57	5.6	2016-12-31T12:00:00.000+02:00



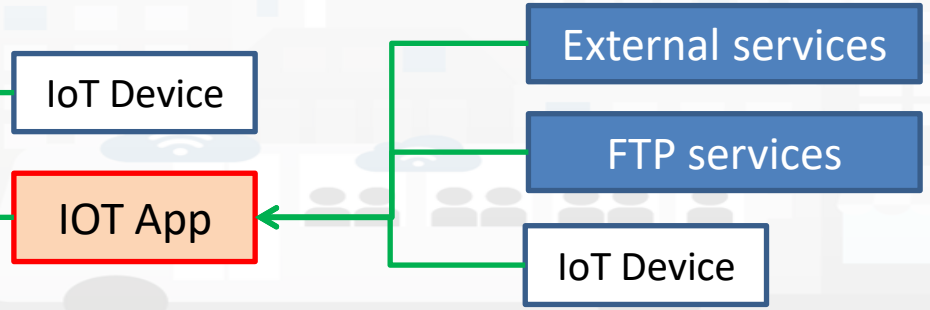
What May Happen Later



A) User may Add data on IoT Directory Tool (time series)

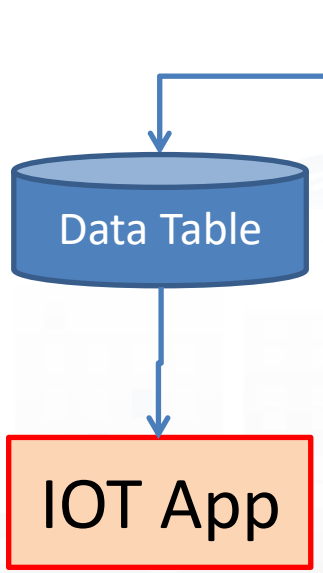
B) IoT Device may send additional data (time Series) on Broker

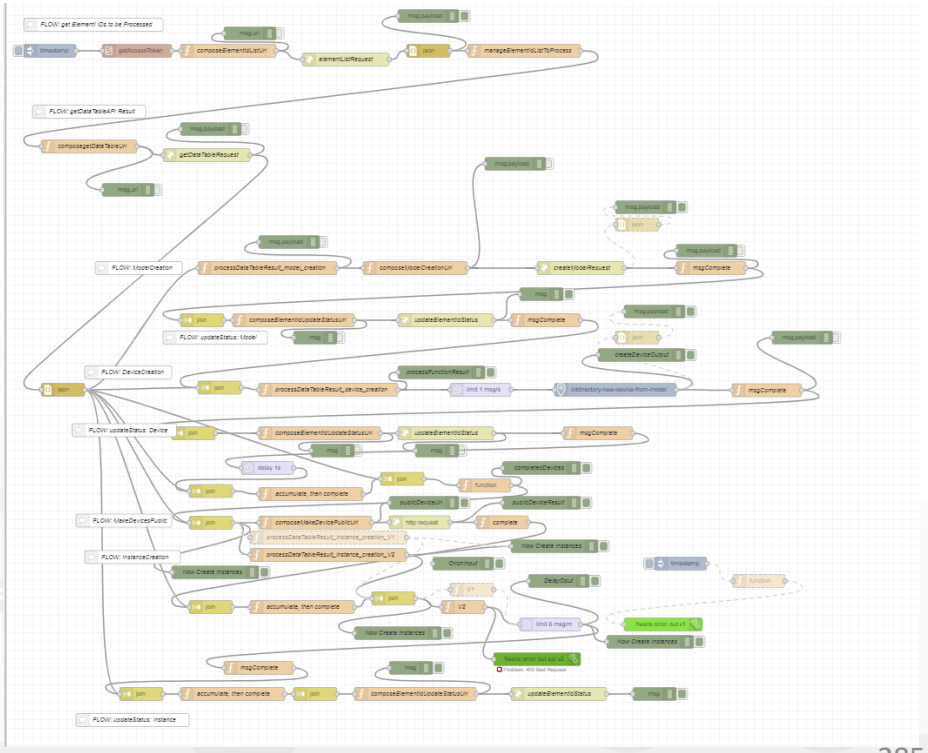
C) Other IoT Apps may get / produce and load additional Data (time Series)



Notes on the implementation

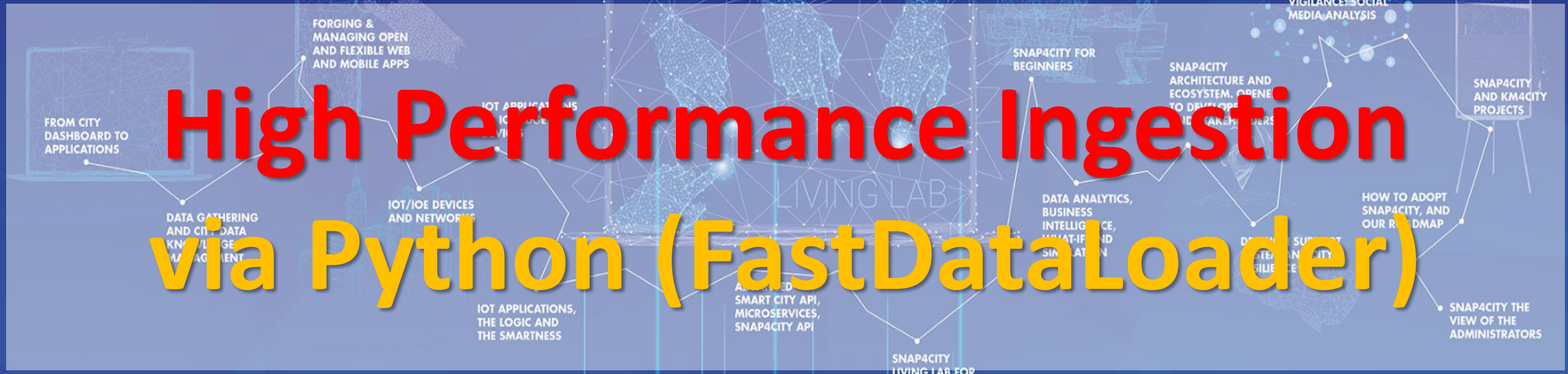
- The Data Table Loader has been developed in PHP to interact with the user to regularize data in ingestion, request missing information, etc., and finally to save this information on a **DataTable** in MySQL
  - A Status for data ingestion is defined, managed, evolved
- **The IoT App** gets the data and when possible and needed: creates the IoT Device Modes, IoT Devices, and IoT Device Instances (time series)
- Any AreaManager can upload DataTable sets but only specific dedicated responsible users for data upload can actually load. We suggest one.
  - Each of them is becoming the owner and responsible of the IOT App process, which can be customized also, and of the IoT Device Model, IoT Device.





TOP

High Performance Ingestion via Python (FastDataLoader)



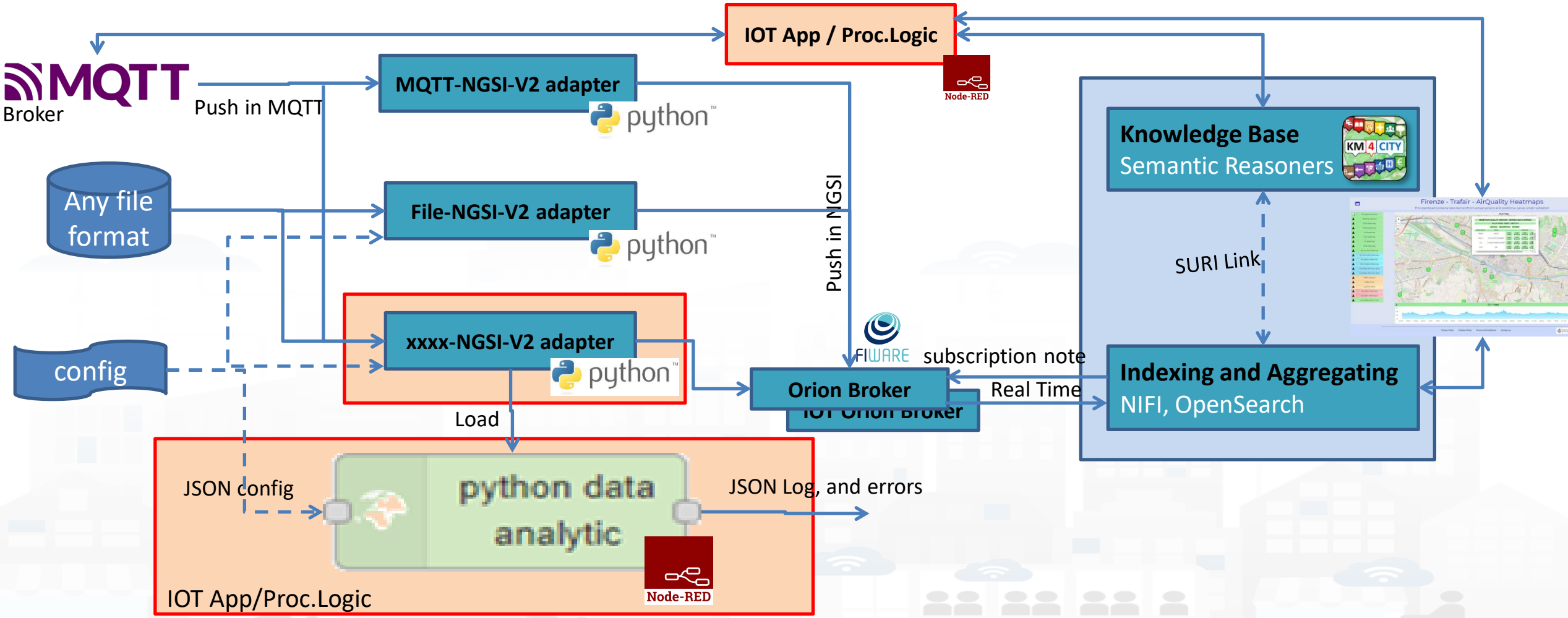
https://www.snap4city.org/831

Fast and Massive Data Ingestion

- The ingestion processes passes data to some Orion Broker when the device is registered on Directory.
  - The ingestion in this case consists in posting each single message on the broker and the broker posts them on NIFI which performs regularization exploiting KB and passes them on Open Search
  - The process can be performed by IoT App, thus in Node-RED with high flexibility (95% of cases is ok) but with some limitation on throughput
- **Faster approaches** can be to **write a Python process** to get data and:
  - **Case A)** post each single message on one of the Orion Brokers
  - Case B) post each single message directly on Ni-Fi cluster (not suggested but viable)
  - For Both: *you have to register the IoT devices/Entities on Directory*

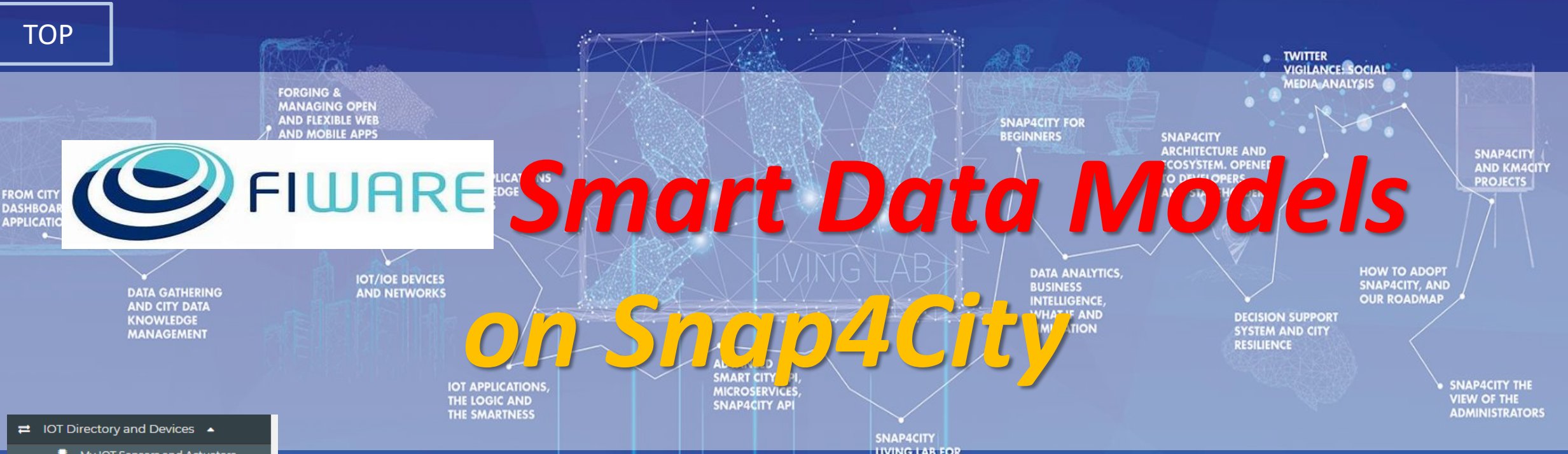
Case A)

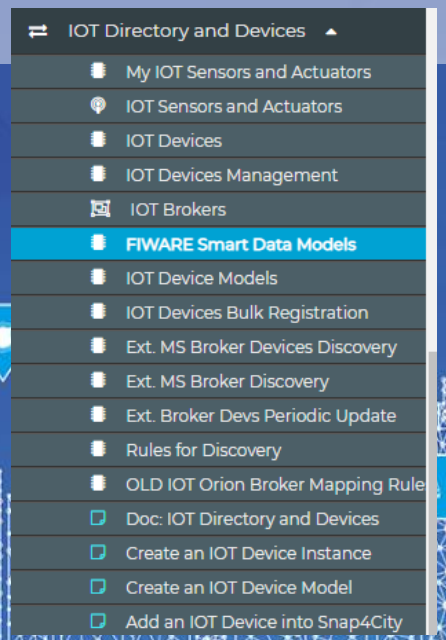
High Performance Solutions on Snap4City Framework



TOP

Smart Data Models on Snap4City





https://www.snap4city.org/800

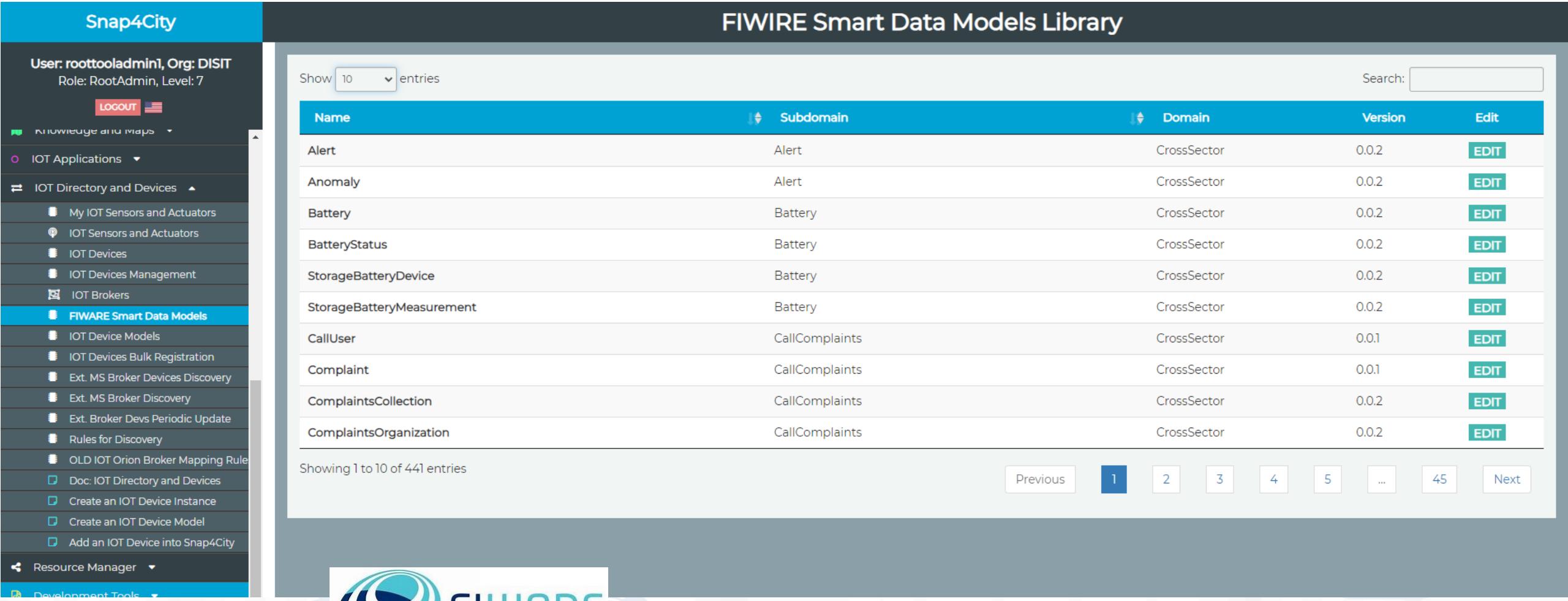
FIWARE Smart Data Model

- Include
  - JSON Schema (for verification and validation) and Specs
  - Examples in: NGSI V2, NGSI LD
- Domains

SMART CITIES	SMART AGRIFOOD	SMART WATER	SMART ENERGY
SMART ENVIRONMENT	SMART SENSORING	SMART AERONAUTICS	SMART DESTINATION
CROSS SECTOR	SMART ROBOTICS	SMART HEALTH	SMART MANUFACTURING

https://www.fiware.org/smart-data-models/

FIWARE Smart Data Models -- Library



Exploiting FIWARE Smart Data Models

- **Smart Data Models** can be used into Snap4City:
  - as initial IoT Data Model without precise Variable Definitions
  - Attach automated rules to each specific Smart Data Model of a Broker for directly registration and management of IoT Device Messages
- **Exploitation** to simplify IoT Device Registration from Orion Brokers, for
  - **External Brokers**: automating Device Registration while Device Discovery
  - **Internal Brokers**: exploiting the Smart Data Model as a Template for Device Registration

Get a New Orion Broker

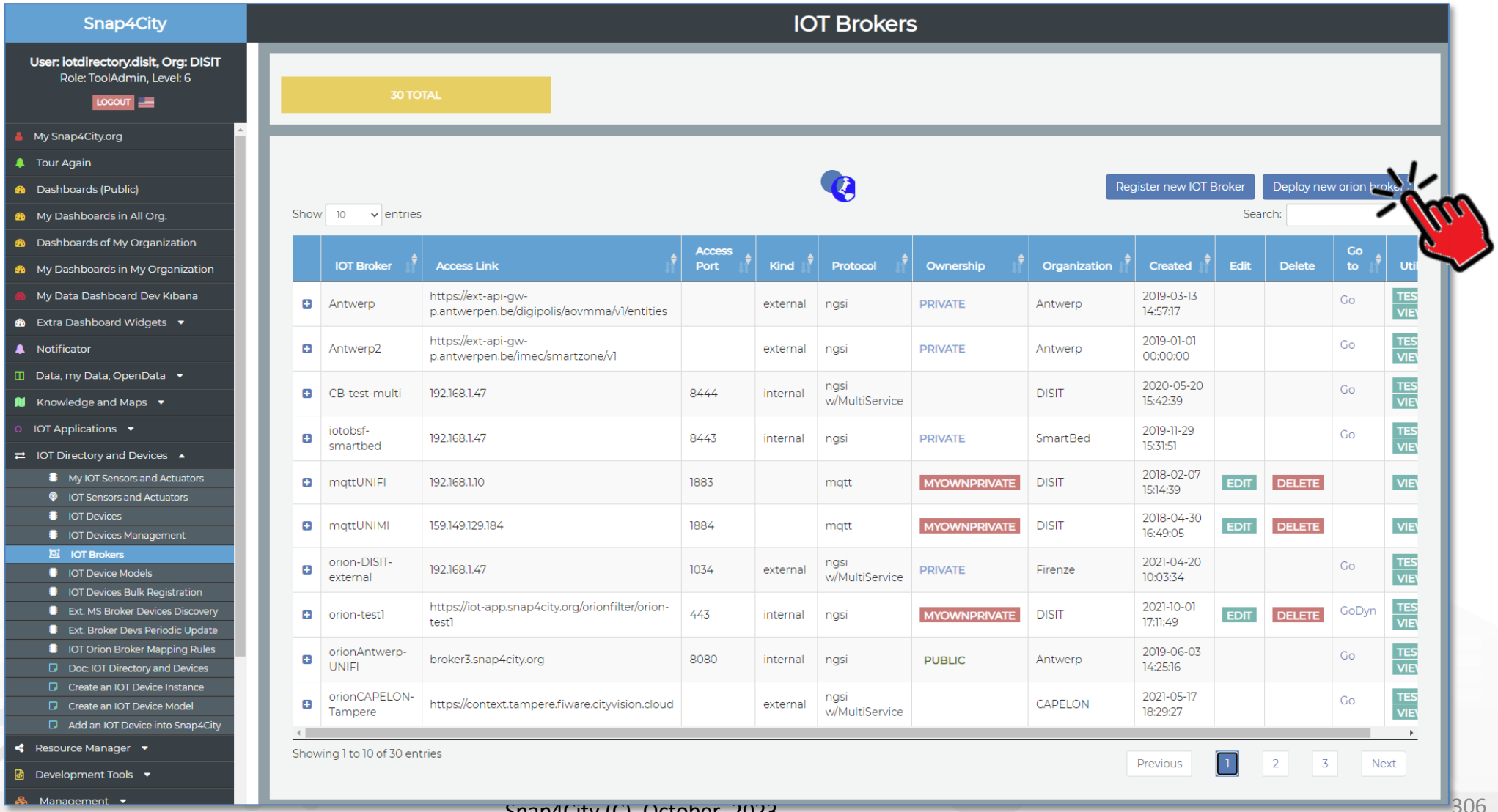
automated deploy of Orion Brokers

- IOT Directory and Devices
  - My IOT Sensors and Actuators
  - IOT Sensors and Actuators
  - IOT Devices
  - IOT Devices Management
  - IOT Device Discovery
  - IOT Brokers
  - IOT Device Models
  - IOT Devices Bulk Registration
  - IOT Broker Periodic Update setti...
  - IOT Orion Broker Mapping Rules...
  - Doc: IOT Directory and Devices
  - Create an IOT Device Instance
  - Create an IOT Device Model
  - Add an IOT Device into Snap4Cit...

Automated Deploy of Orion Brokers

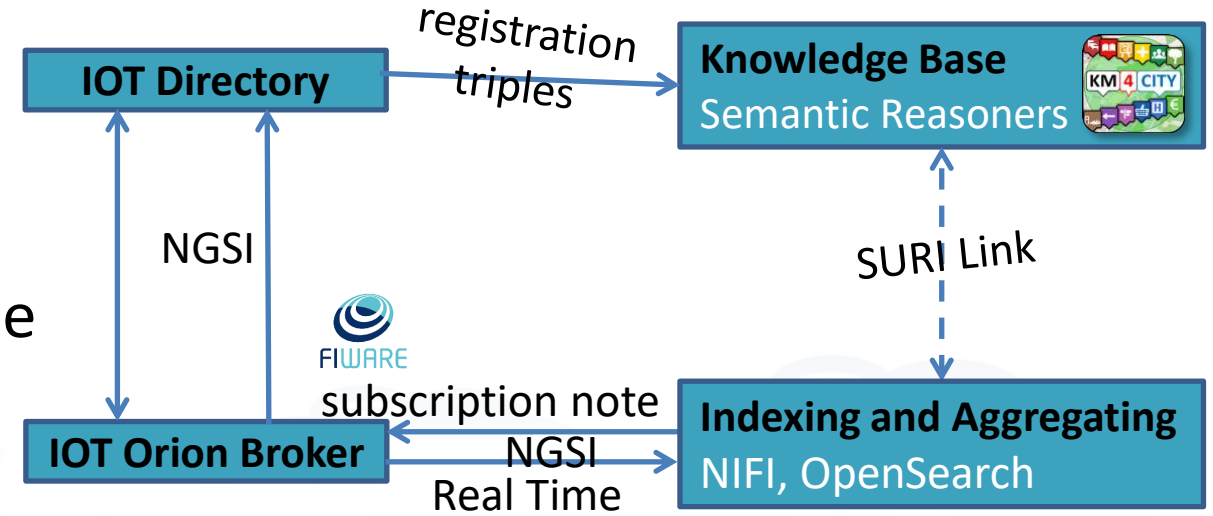
ToolAdmin user access to the button for the automated Deploy of Orion Brokers.

This feature can be provided to large Organizations and on demand to medium and small

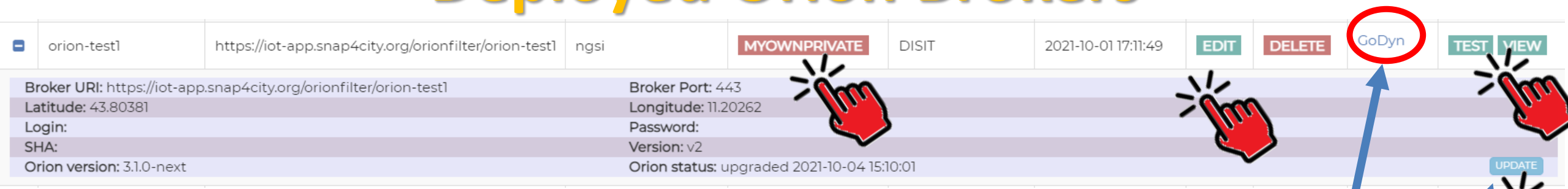


Automated Deploy of Orion Brokers

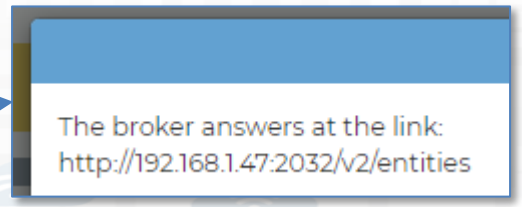
- **You can define**
  - Name/nickname
  - GPS position
  - Accessible from inside and/or outside
- **→ Automatically….**
  - an Orion Broker is deployed in
  - Container for your organization
  - Proxy are set up
  - Registration on data shadow is established (OpenDistro ES)
  - New IoT Device Model and IoT Devices can be registered, etc. (NIFI)



Deployed Orion Brokers



- You can:
  - Delete: undeploy the broker from the cloud
  - Change ownership, delegate access
  - See/View/Edit of config parameters
  - Access: public / private
  - External access test
  - Test on internal registration
  - Update to upgrade the Broker at the last Docker version from FIWARE

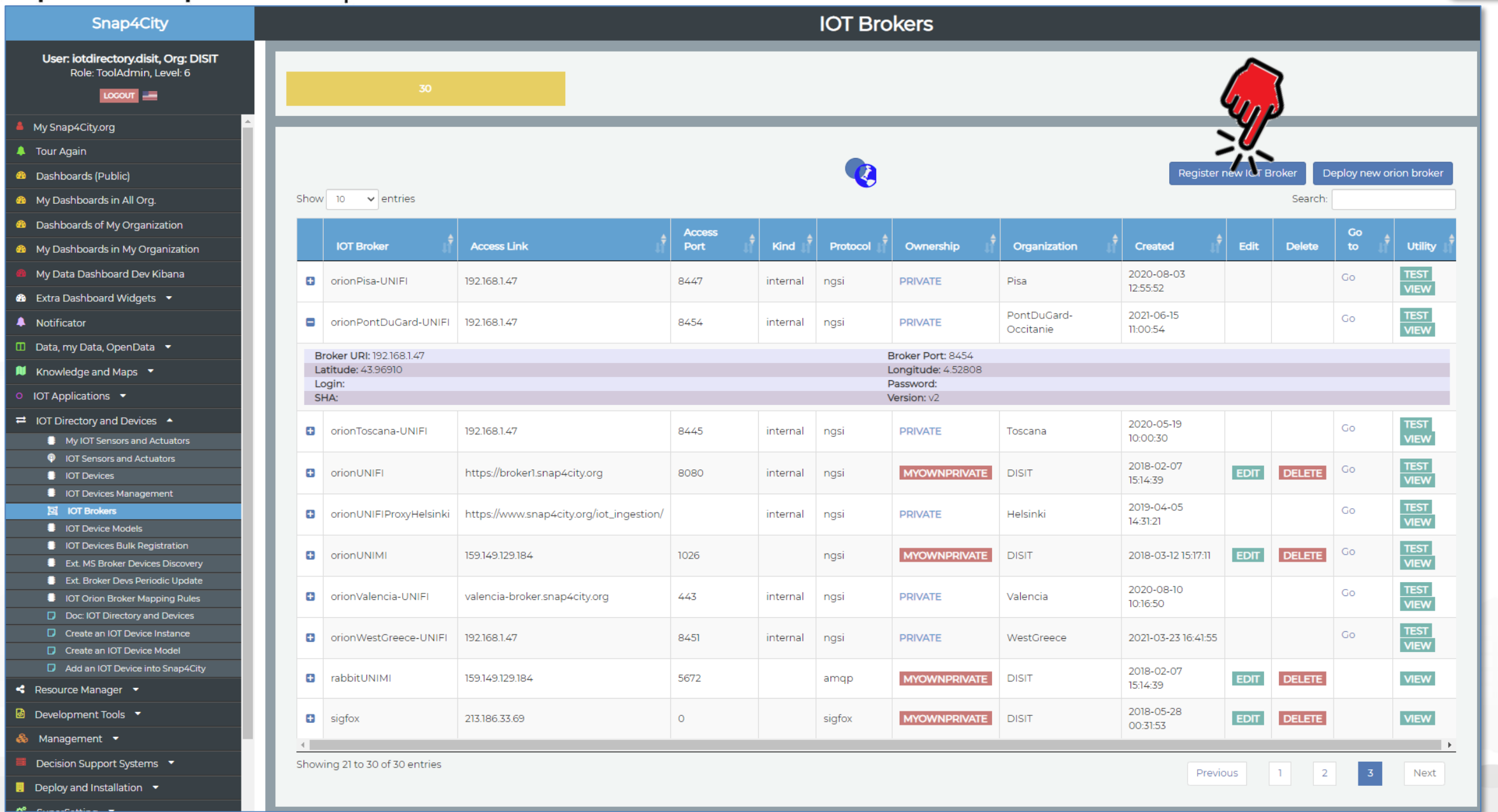


IOT Broker Registration

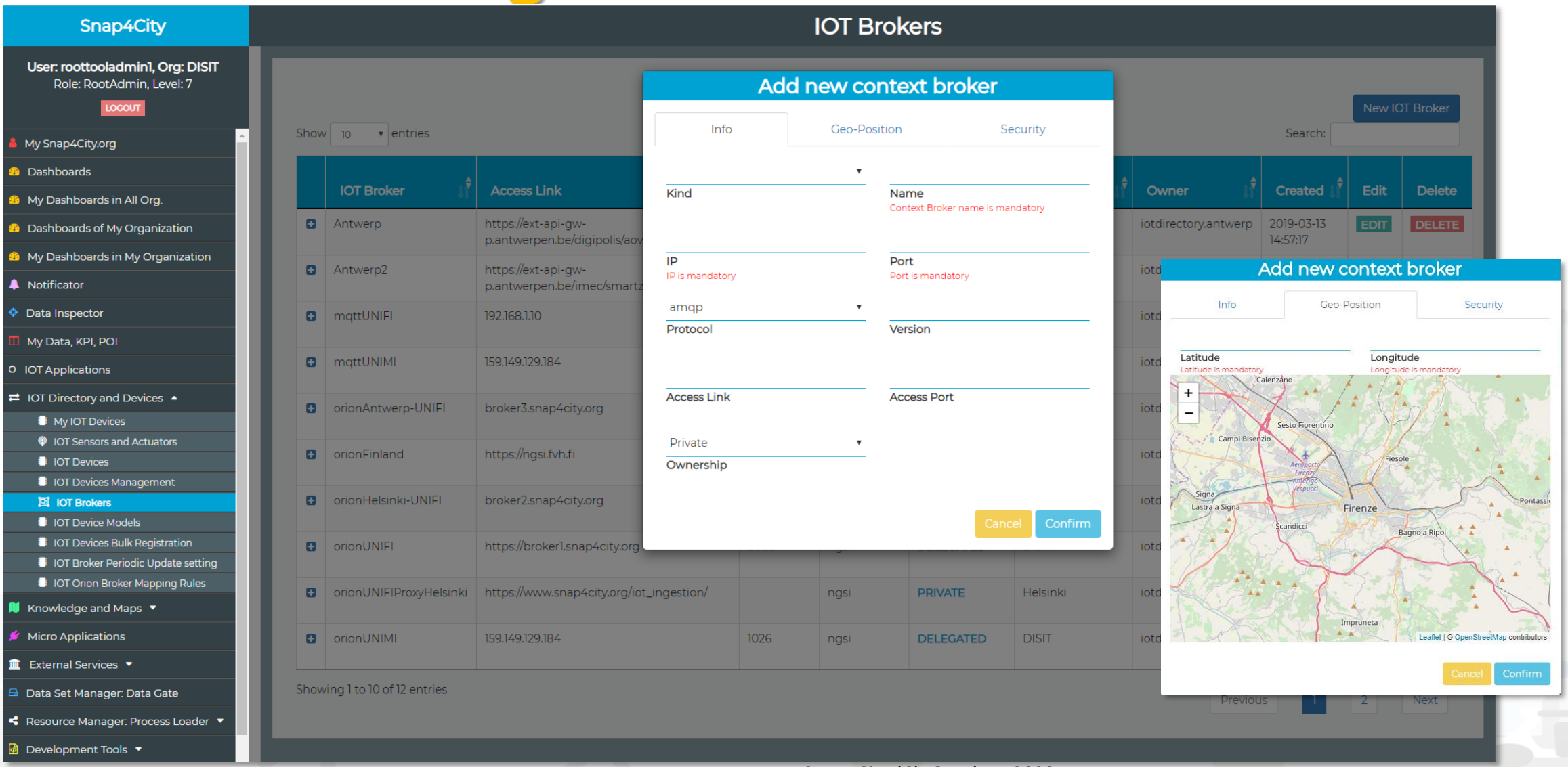
(for External/Internal Orion Brokers or other Brokers)

- IOT Directory and Devices
  - My IOT Sensors and Actuators
  - IOT Sensors and Actuators
  - IOT Devices
  - IOT Devices Management
  - IOT Device Discovery
  - IOT Brokers
  - IOT Device Models
  - IOT Devices Bulk Registration
  - IOT Broker Periodic Update setti...
  - IOT Orion Broker Mapping Rules...
  - Doc: IOT Directory and Devices
  - Create an IOT Device Instance
  - Create an IOT Device Model
  - Add an IOT Device into Snap4Cit...

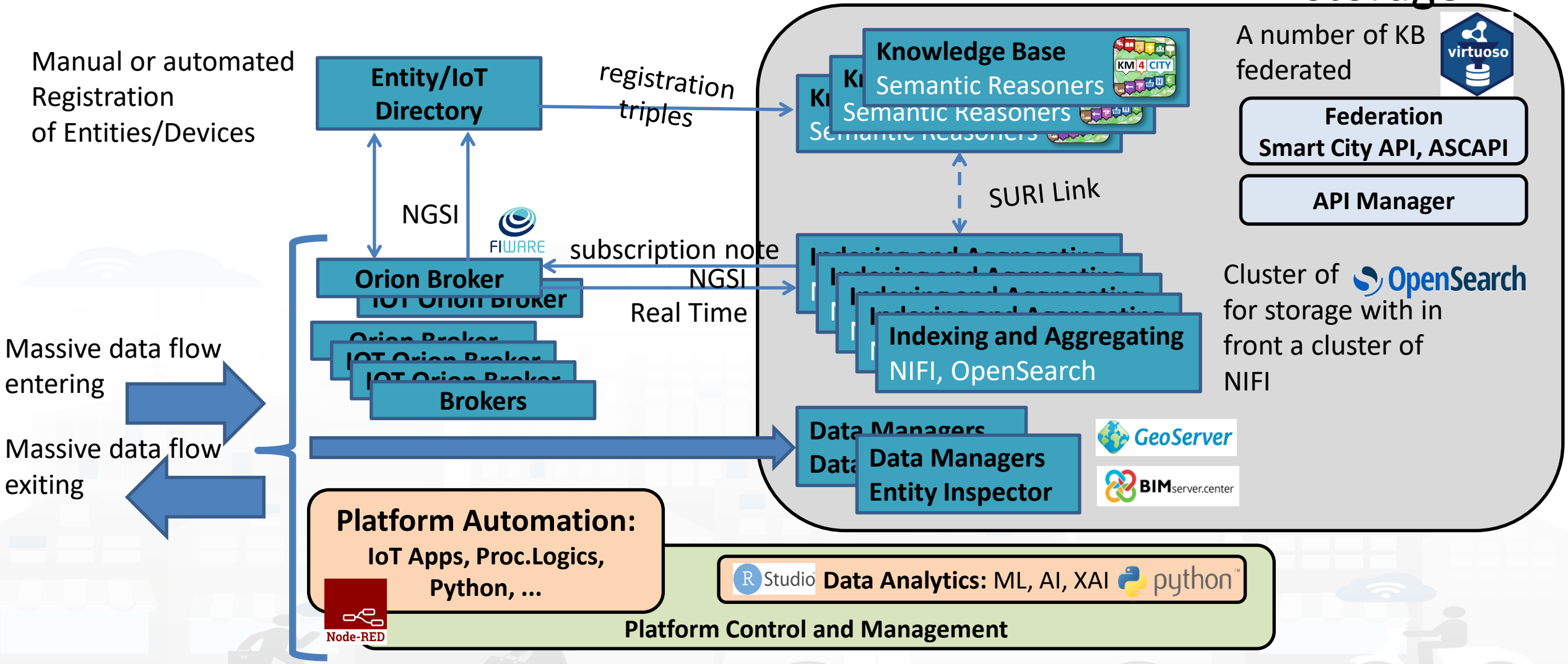
IOT Brokers


Snap4City
User: iotdirectory.disit, Org: DISIT
Role: ToolAdmin, Level: 6
LOGOUT
My Snap4City.org
Tour Again
Dashboards (Public)
My Dashboards in All Org.
Dashboards of My Organization
My Dashboards in My Organization
My Data Dashboard Dev Kibana
Extra Dashboard Widgets
Notificator
Data, my Data, OpenData
Knowledge and Maps
IOT Applications
IOT Directory and Devices
My IOT Sensors and Actuators
IOT Sensors and Actuators
IOT Devices
IOT Devices Management
IOT Brokers
IOT Device Models
IOT Devices Bulk Registration
Ext. MS Broker Devices Discovery
Ext. Broker Devs Periodic Update
IOT Orion Broker Mapping Rules
Doc: IOT Directory and Devices
Create an IOT Device Instance
Create an IOT Device Model
Add an IOT Device into Snap4City
Resource Manager
Development Tools
Management
Decision Support Systems
Deploy and Installation
IOT Brokers
30
Register new IOT Broker
Deploy new orion broker
Show 10 entries
Search:
IOT Broker
Access Link
Access Port
Kind
Protocol
Ownership
Organization
Created
Edit
Delete
Go to
Utility
orionPisa-UNIFI 192.168.1.47 8447 internal ngsi PRIVATE Pisa 2020-08-03 12:55:52 Go TEST VIEW
orionPontDuGard-UNIFI 192.168.1.47 8454 internal ngsi PRIVATE PontDuGard-Occitanie 2021-06-15 11:00:54 Go TEST VIEW
Broker URI: 192.168.1.47
Broker Port: 8454
Latitude: 43.96910
Longitude: 4.52808
Login:
Password:
SHA:
Version: v2
orionToscana-UNIFI 192.168.1.47 8445 internal ngsi PRIVATE Toscana 2020-05-19 10:00:30 Go TEST VIEW
orionUNIFI https://broker1.snap4city.org 8080 internal ngsi MYOWNPRIVATE DISIT 2018-02-07 15:14:39 EDIT DELETE Go TEST VIEW
orionUNIFIProxyHelsinki https://www.snap4city.org/iot_ingestion/ internal ngsi PRIVATE Helsinki 2019-04-05 14:31:21 Go TEST VIEW
orionUNIMI 159.149.129.184 1026 ngsi MYOWNPRIVATE DISIT 2018-03-12 15:17:11 EDIT DELETE Go TEST VIEW
orionValencia-UNIFI valencia-broker.snap4city.org 443 internal ngsi PRIVATE Valencia 2020-08-10 10:16:50 Go TEST VIEW
orionWestGreece-UNIFI 192.168.1.47 8451 internal ngsi PRIVATE WestGreece 2021-03-23 16:41:55 Go TEST VIEW
rabbitUNIMI 159.149.129.184 5672 amqp MYOWNPRIVATE DISIT 2018-02-07 15:14:39 EDIT DELETE VIEW
sigfox 213.186.33.69 0 sigfox MYOWNPRIVATE DISIT 2018-05-28 00:31:53 EDIT DELETE VIEW
Showing 21 to 30 of 30 entries
Previous 1 2 3 Next

Register a New IOT Broker



Snap4city Data Ingestion Diagram



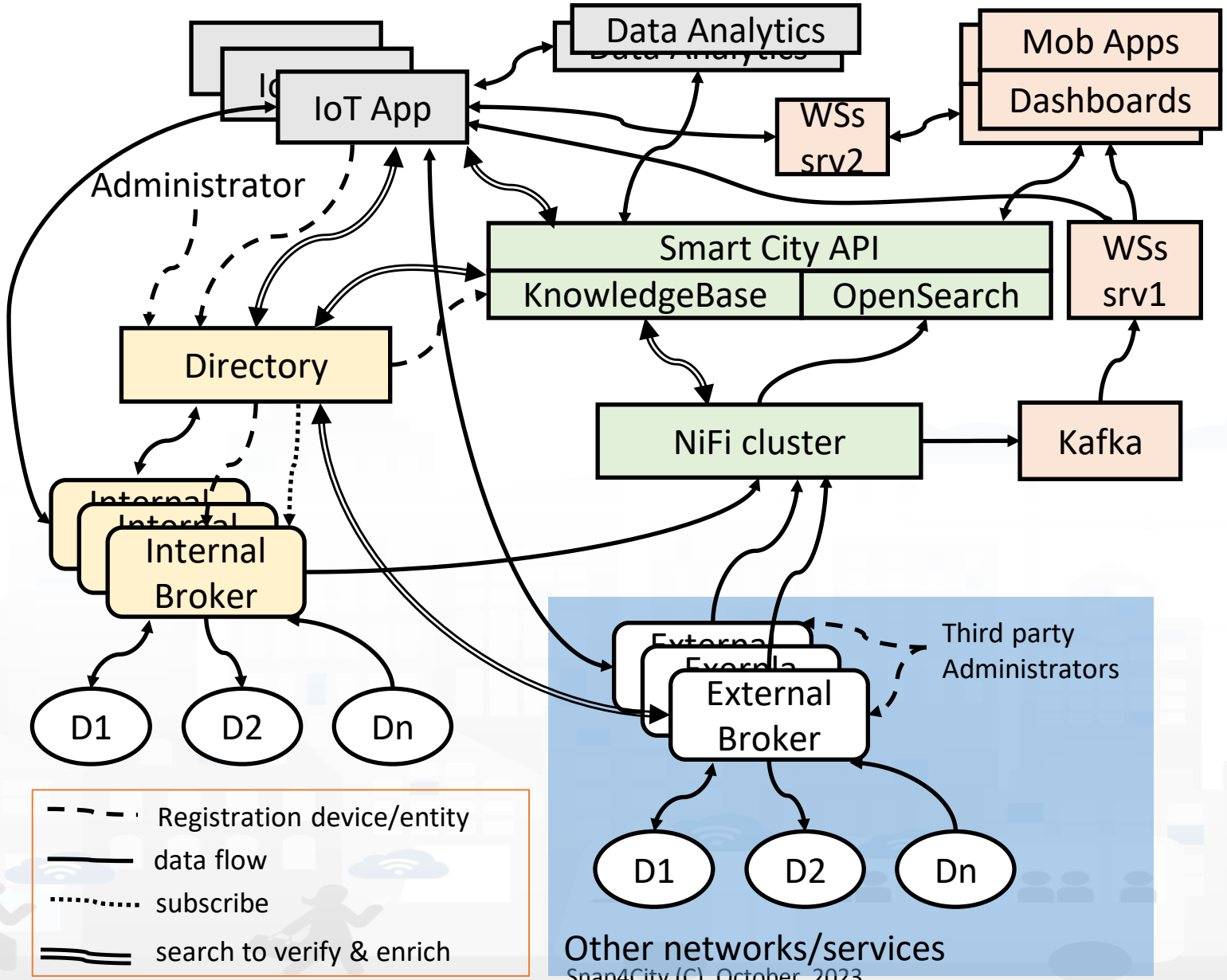
Snap4 technology is broker Agnostic. Most of the features are only accessible for FIWARE Orion Brokers

- **IOT Brokers**
  - You can test, view, and register, and also automatically deploy Orion Brokers
  - are associated with an Organization
    - Each **Organization** has a **Knowledge Base** of reference (KB, ServiceMap)
    - Each **KB** may host multiple **Organizations** and addresses multiple **Geographic areas**
  - can be compliant with
    - **NGSI version**: V1, V2-1, V2, etc…
      - with Snap4City Security or regular NGSI FiWare
    - other protocols as well such as: MQTT, COAP, AMQP, etc.
  - can
    - expose different **authentication methods**: K1/K2, Certificate, etc.
    - be accessible from IOT Devices and IOT App **in Cloud only**
    - be accessible **from Internet to post data from outside, etc.**

IOT Orion Broker Network: NGSI V1 and V2

- **IOT Broker can be Internal (on Snap4City Cloud)**
  - Registration of IOT Devices can be performed by the IOT Directory
  - Authentication is automatic, K1 and K2 are not needed since the security is performed via Access Token, M2M secure communication, on the basis of IOT App ownership
  - The **NIFI Cluster** automatically subscribes to all the entities on the Broker, to post data into the Data Shadow enriched with data of the KB
- **IOT Broker can be External (managed by third party)**
  - Registration of IOT Devices is managed by third parties
  - The registered IOT Devices can be collected and queried from the IOT Directory as well
  - The NIFI Cluster **may** automatically subscribes to all the entities on the Broker, to post data into the Data Shadow enriched with data of the KB
- **IOT Brokers can be networked**
  - Services, Service paths: for managing the IOT Broker network
  - Multi-tenant: more than one user/org on the same IOT Broker

Req.	Snap4 City	Azure IoT	Aws IOT	IBM Watson	Mind sphere
R1	Y	N	(y)	(y)	(y)
R2	Y	N	(y)	N	(y)
R3	Y	N	N	(y)	N
R4	Y	Y	Y	Y	Y
R5	Y	Y	Y	Y	N
R6	Y	N	(y)	N	(y)
R7	Y	N	N	N	N
R8	Y	Y	(y)	N	N
R9	Y	N	N	N	N
R10	Y	(y)	(y)	(y)	(y)
R11	Y	(y)	Y	Y	Y

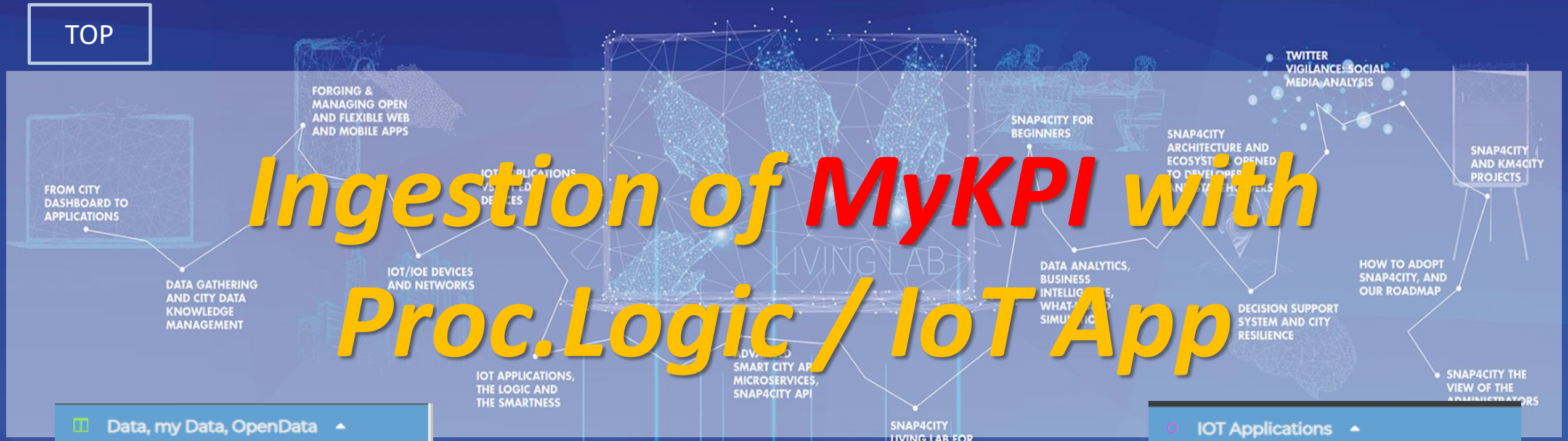

Data Analytics
IoT App
Mob Apps
Dashboards
WSs srv2
Administrator
Smart City API
KnowledgeBase
OpenSearch
WSs srv1
Directory
NiFi cluster
Kafka
Internal Broker
D1
D2
Dn
Third party Administrators
External Broker
D1
D2
Dn
Other networks/services
Registration device/entity
data flow
subscribe
search to verify & enrich

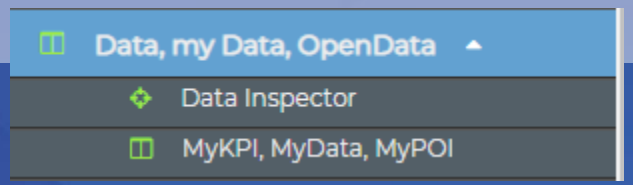
Conclusions

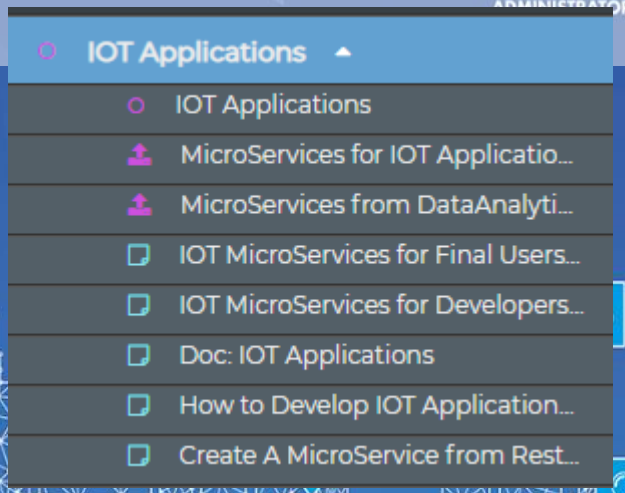
- (i) Internal and External brokers,
- (ii) automated registration of devices/entities managed into External Brokers' single- or multi-tenant services,
- (iii) automated registration by harvesting and reasoning of data models/entities compliant with standard models such as FIWARE SDM, and any custom Data Model in Snap4City IoT Device Model providing a formal semantic definition of device attributes,
- (iv) fast data ingestion for ingesting / migrating historical data from legacy platforms and services to a new established uplevel platform,
- (v) sustained data usage from query demand and for data driven show changes in real time.

TOP

Ingestion of MyKPI with Proc.Logic / IoT App

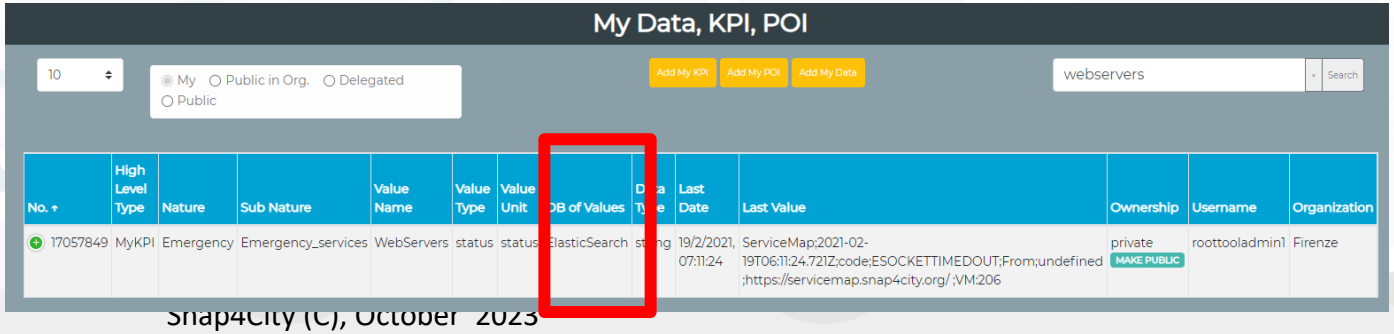






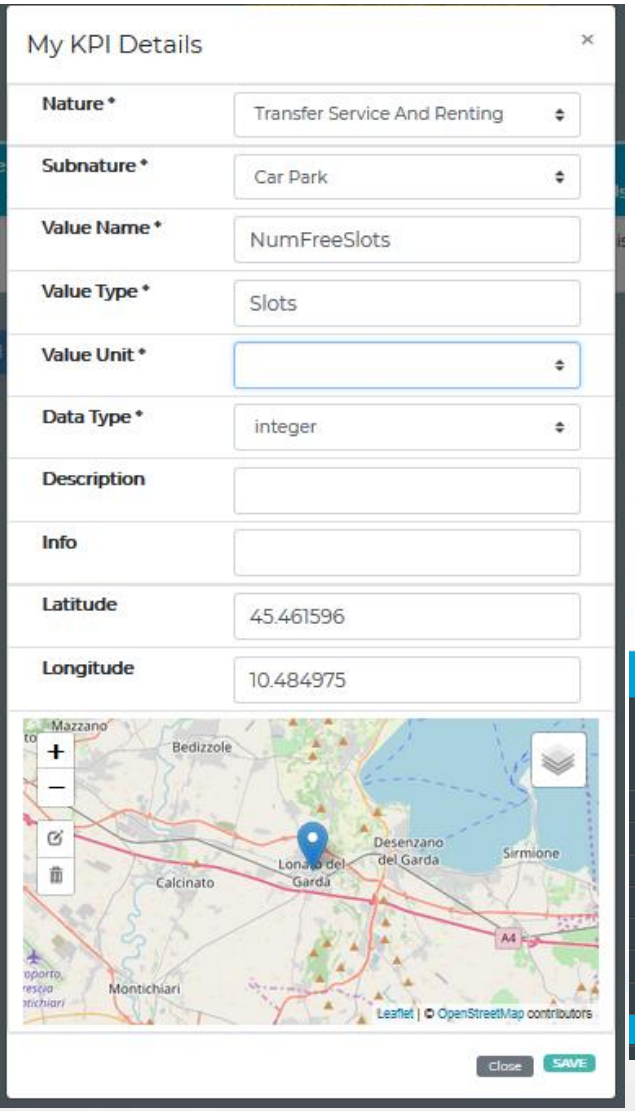
MyKPI can

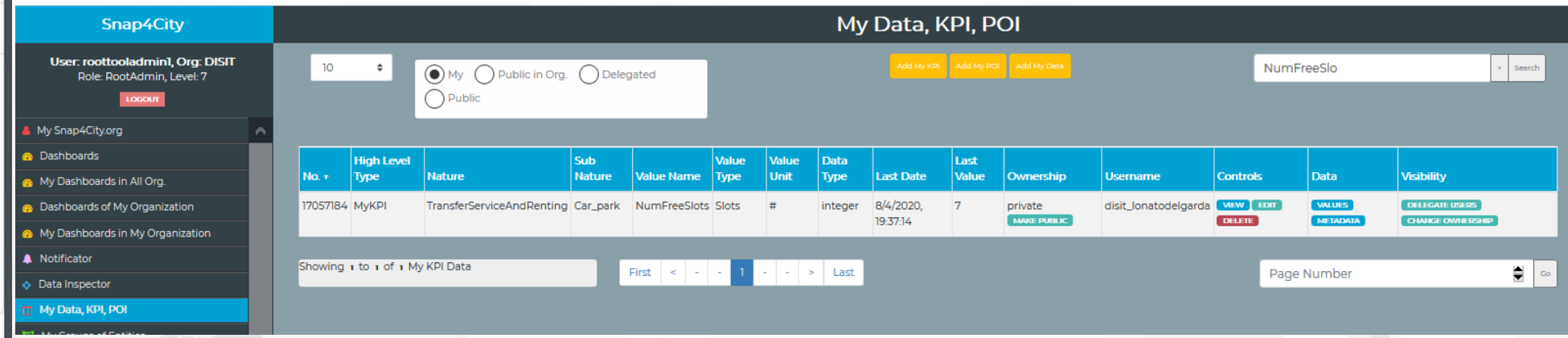
- be time series + metadata
- be POI with full metadata decryption, MyPOI
- be passed in ownership to other users,
- be delegated in access to other users
- model daily trajectories from: Mobile Phone Apps, CANBUS data and GPS location from mobiles, PAX Counter Mobile, mobile IOT Devices, etc.
- be saved and retrieved from IOT Apps
- create events at their changes towards IOT Apps
- be saved into: MySQL and/or OpenSearch (default saving modality can be different for solutions on cloud and on premise)
  - The access from smart city API is in any way transparent, while only when they are saved into the OpenSearch they are accessible from the so called
    - "My Data Dashboard"



Create your MyKPIs

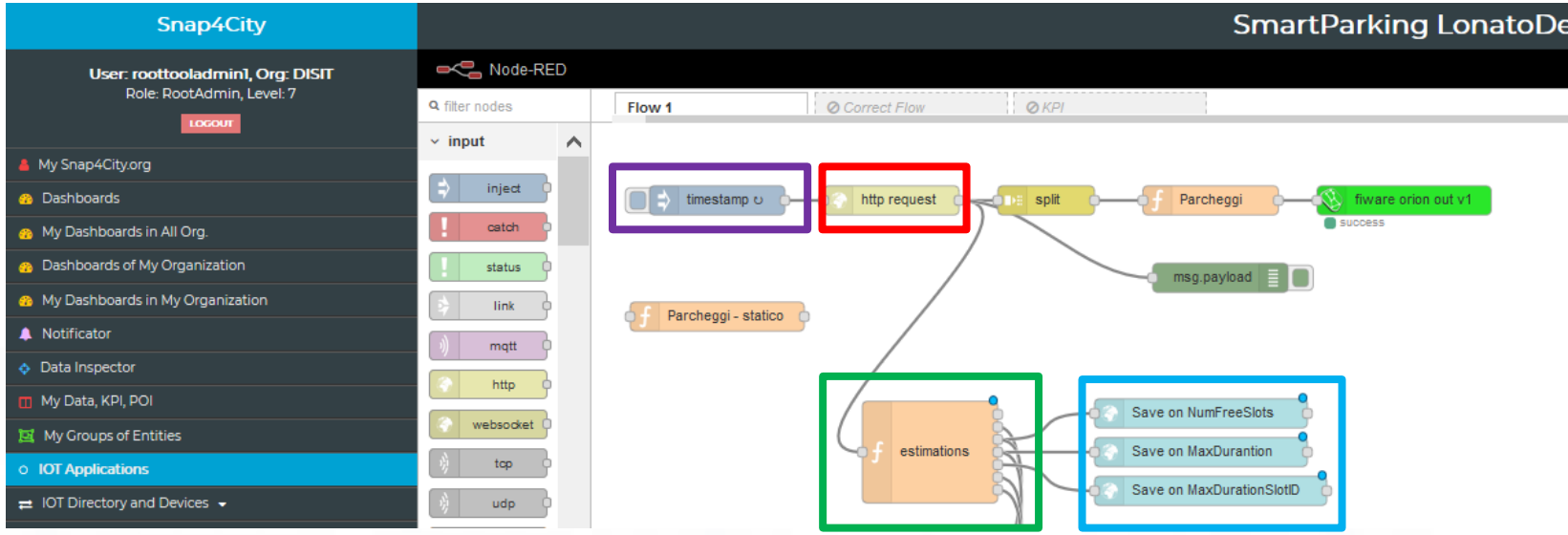
- My Data, KPI, POI > ‘Add My KPI’ button
- Verify the KPI existence in My Data, KPI, POI
- Create your IoT App/Proc.Logic sending data to your KPIs
- Example: Lonato Car Park:
  - NumFreeSlots
  - MaxDuration
  - MaxDurationSlotId

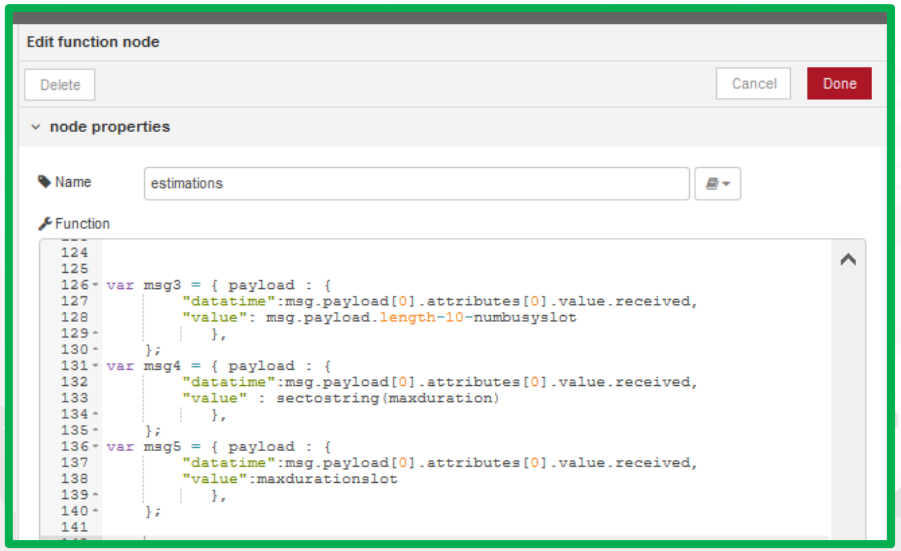


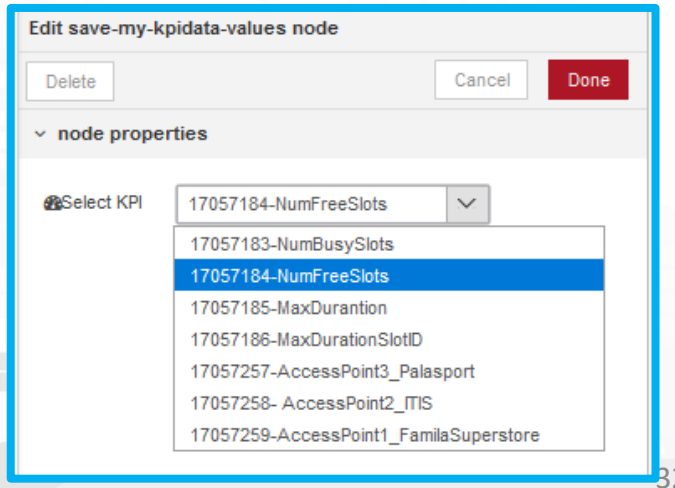


IoT App sending data to your KPIs

- Create your IoT App (ex: ‘SmartParking LonatoDelGarda’)
  1. Use an **inject** block to choose the frequency of update
  2. Use **http** block to download data (e.g.)
  3. Use a **function** of blocks to convert data in a specific json sending data to each KPI
  4. Use a **save-my-kpidata-values** block







What is missing here and you can get from former course

What is missing here and you can find in the former course or other parts of this

- **GIS Interoperability**
- **Ingestion of Public Transportation data:**
  - **GTFS, Transmodel, GTFS RT, NeTEx, etc.**
- **CKAN interoperability**
- **Satellite data Ingestion**
- **IOT Devices integration**
  - **AIRQINO, Libelium, SIGFOX,**
  - **LORA, MQTT, OBD2, AXIS Cameras**
- **Snap4City vs FIWARE**

Part 6

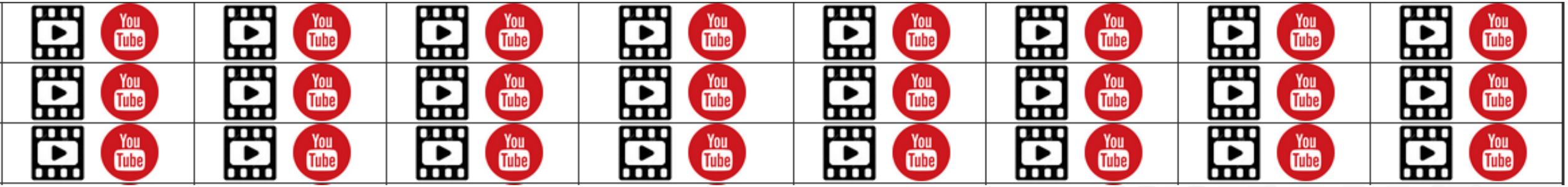
- Data Streams from participatory, Mobile App
- Data streams from Mobile vehicles and smart phones Devices
- Data Ingestion via Web Scraping
- Data stream from TV Cameras, TV Cam Manager
- Social Media interoperability
- Open Maintenance Ticketing Interoperability
- Telegram Interoperability
- **Another Complete Example**
- **BlockChain models and devices in Snap4City (new feature)**
- **Orion Broker:**
  - **Services/SrvPath and Multitenant**
- **External and Internal Brokers,**
  - **External Broker harvesting**
- Managing Node-RED on edge from cloud
- More on Security of Snap4City Stack from device to dashboards
- …

https://www.snap4city.org/577

https://www.snap4city.org/944

On Line Training Material (free of charge)

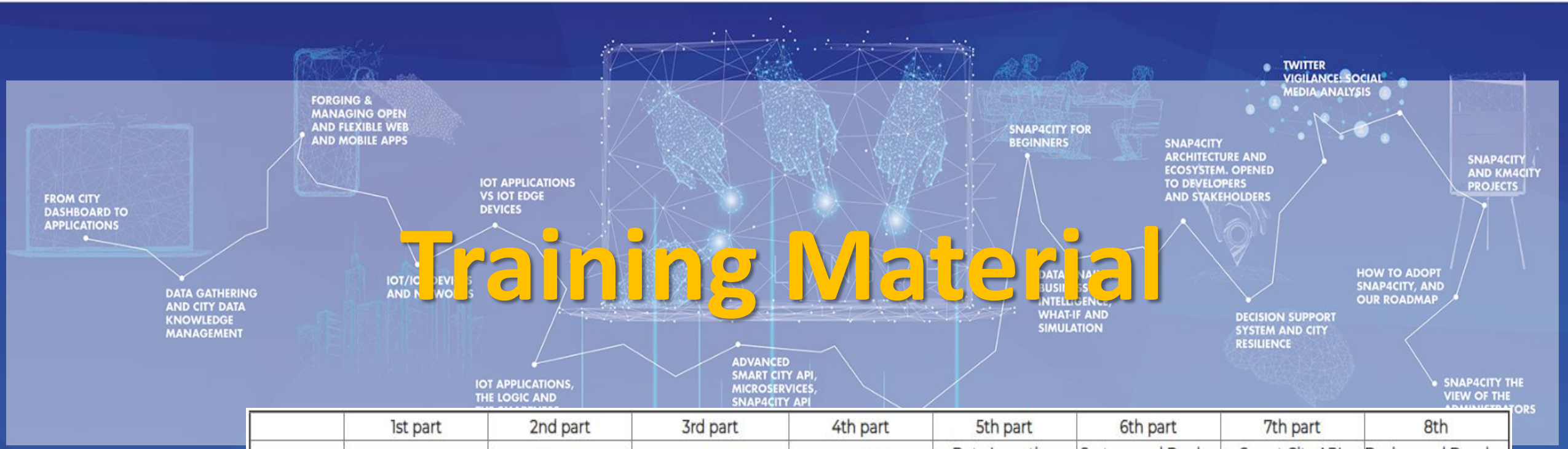
1st part	2nd part	3rd part	4th part	5th part	6th part	7th part	8th
Overview	Dashboards	IOT App, IOT Network	Data Analytics	Data Ingestion processes	System and Deploy Install	Smart City API: Web & Mob. App	Design and Develop Smart Solutions
							
							



SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT

SNAP4INDUSTRY

KM4CITY



Training Material

	1st part	2nd part	3rd part	4th part	5th part	6th part	7th part	8th
what	Overview	Dashboards	IOT App, IOT Network	Data Analytics	Data Ingestion processes	System and Deploy Install	Smart City API: Web & Mob. App	Design and Develop Smart Solutions
PDF 2022								
Interactive (2022) with video and animations								

Note on Training Material

- **Course 2023**: https://www.snap4city.org/944
  - Introductionary course to Snap4City technology
- **Course** https://www.snap4city.org/577
  - Full training course with much more details on mechanisms and a wider set of cases/solutions of the Snap4City Technology
- **Documentation** includes a deeper round of details
  - Snap4City Platform Overview:
    - https://www.snap4city.org/drupal/sites/default/files/files/Snap4City-PlatformOverview.pdf
  - Development Life Cycle:
    - https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf
  - Client Side Business Logic:
    - https://www.snap4city.org/download/video/ClientSideBusinessLogic-WidgetManual.pdf
- **On line cases and documentation**:
  - https://www.snap4city.org/108
  - https://www.snap4city.org/78
  - https://www.snap4city.org/426

Welcome: how to start using Snap4City for beginners

We suggest you:

Congratulations! You have really contributed to Snap4City and successfully passed all first levels!

You have reached a level in which you can contribute with competence to the city improvement and smartness. We hope you interested in helping other users in conquering higher levels on the city smartness ranking, and provising of smart services to all city users!
So that we could be interested in engaging and elevating your role in the Snap4City community as coordinator of thematic groups, for example on **Mobile APP development**, **Dashboard** on Mobility, **IOT Application** Development, etc., according to your preferences.

Please contact **paonesi@gmail.com** !


- TECHNICAL OVERVIEW: https://www.snap4city.org/download/video/Snap4City-PlatformOverview.pdf
- Development Life Cycle: https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf
- Client-Side Business Logic Widget Manual: https://www.snap4city.org/download/video/ClientSideBusinessLogic-WidgetManual.pdf
- Booklet Data Analytics, Snap4Solutions: https://www.snap4city.org/download/video/DPL_SNAP4SOLU.pdf

Please start a fully guided training cases:

- HOW TO: create a Dashboard in Snap4City
- HOW TO: add a device to the Snap4City Platform
- HOW TO: add data sources to the Snap4City Platform

Powered by www.km4city.org

FIWARE Node-RED

Sii-Mobility

Organization Groups

DISIT

- Developer
- Operativo

Updates on Tools

Training Course Snap4City - 2023 Edition new
drupaladmin

Snap4City Newsletter of April 2023 new
roottooladmin1

Dashboards (Public)

My Snap4City.org | Tour Again

www.snap4solutions.org
Dashboards of My Organization
My Dashboards in My Organization
My Data Dashboard Dev Kibana
Extra Dashboard Widgets
Data Management, HLT
Knowledge and Maps
Processing Logics / IOT App
Entity Directory and Devices
Resource Manager
Development Tools
Management
Decision Support Systems
Deploy and Installation
Help and Contacts
Documentation and Articles

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Snap4City: Smart aNalytic APp builder for sentient Cities and IOT

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- TECHNICAL OVERVIEW: https://www.snap4city.org/download/video/Snap4City-PlatformOverview.pdf
- Development Life Cycle: https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf
- Client-Side Business Logic Widget Manual: https://www.snap4city.org/download/video/ClientSideBusinessLogic-WidgetManual.pdf
- Booklet Data Analytics Snap4Solutions: https://www.snap4city.org/download/video/DRL_SNAP4SOLU.pdf

Username: paolo.disit

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Training on Tools and Platform

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Updates on

2023 booklets

- Smart City

https://www.snap4city.org/download/video/DPL_SNAP4CITY.pdf

- Industry

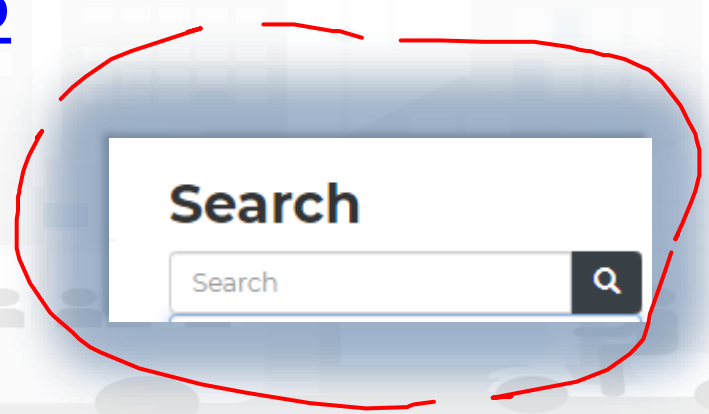
https://www.snap4city.org/download/video/DPL_SNAP4INDUSTRY.pdf

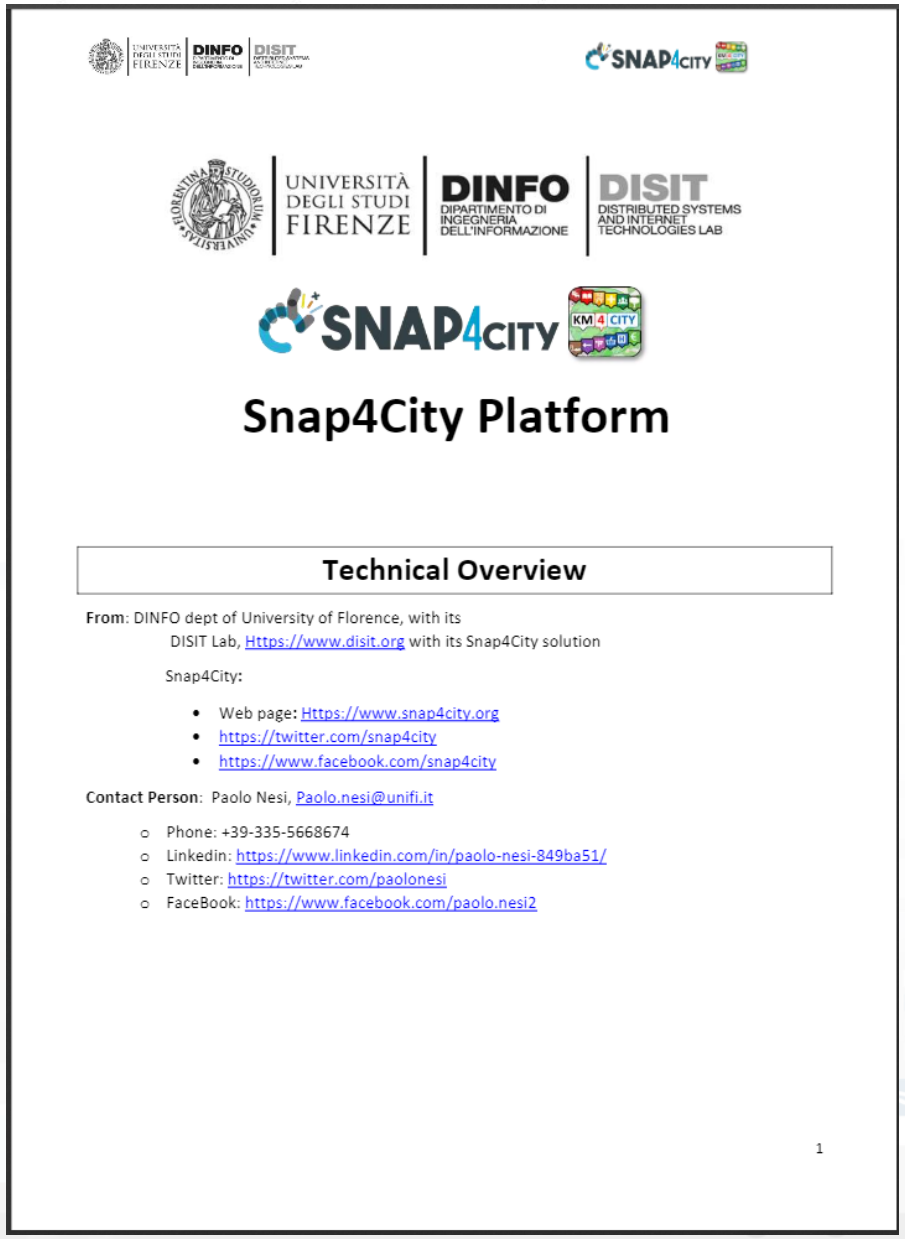
- Artificial Intelligence

https://www.snap4city.org/download/video/DPL_SNAP4SOLU.pdf

The Platform

- **Free Registration on Snap4City.org**
  - Please select DISIT ORG to be sure to access at the examples
  - Most of the cities / tenant are private and they do not left much visible
- **What you get** is probably the 10% of what is on the platform ☺
- **Training**: https://www.snap4city.org/577
- **Scenarious**: https://www.snap4city.org/4
- **Publications**: https://www.snap4city.org/426
- **WEB pages**: https://www.snap4city.org/78
- ***SEARCH on the right side***





Snap4City Platform

Technical Overview

From: DINFO dept of University of Florence, with its
DISIT Lab, Https://www.disit.org with its Snap4City solution

Snap4City:

- Web page: Https://www.snap4city.org
- https://twitter.com/snap4city
- https://www.facebook.com/snap4city

Contact Person: Paolo Nesi, Paolo.nesi@unifi.it

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- Twitter: https://twitter.com/paolonesi
- FaceBook: https://www.facebook.com/paolo.nesi2

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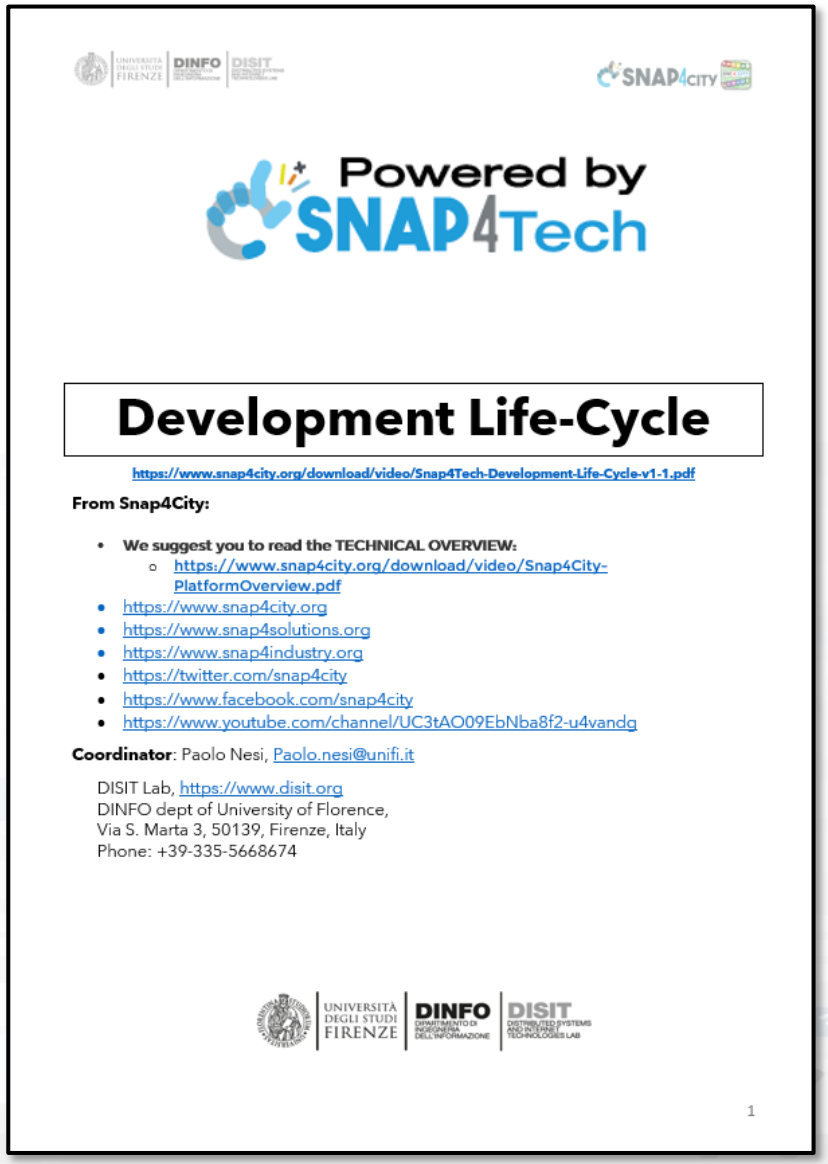
Tech. Overview

- https://www.snap4city.org/drupal/sites/default/files/files/Snap4City-PlatformOverview.pdf

Development



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Development Life-Cycle

https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle-v1-1.pdf

From Snap4City:

- **We suggest you to read the TECHNICAL OVERVIEW:**
  - https://www.snap4city.org/download/video/Snap4City-PlatformOverview.pdf
- https://www.snap4city.org
- https://www.snap4solutions.org
- https://www.snap4industry.org
- https://twitter.com/snap4city
- https://www.facebook.com/snap4city
- https://www.youtube.com/channel/UC3tAO09EbNba8f2-u4vandg

Coordinator: Paolo Nesi, Paolo.nesi@unifi.it

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Via S. Marta 3, 50139, Firenze, Italy
Phone: +39-335-5668674

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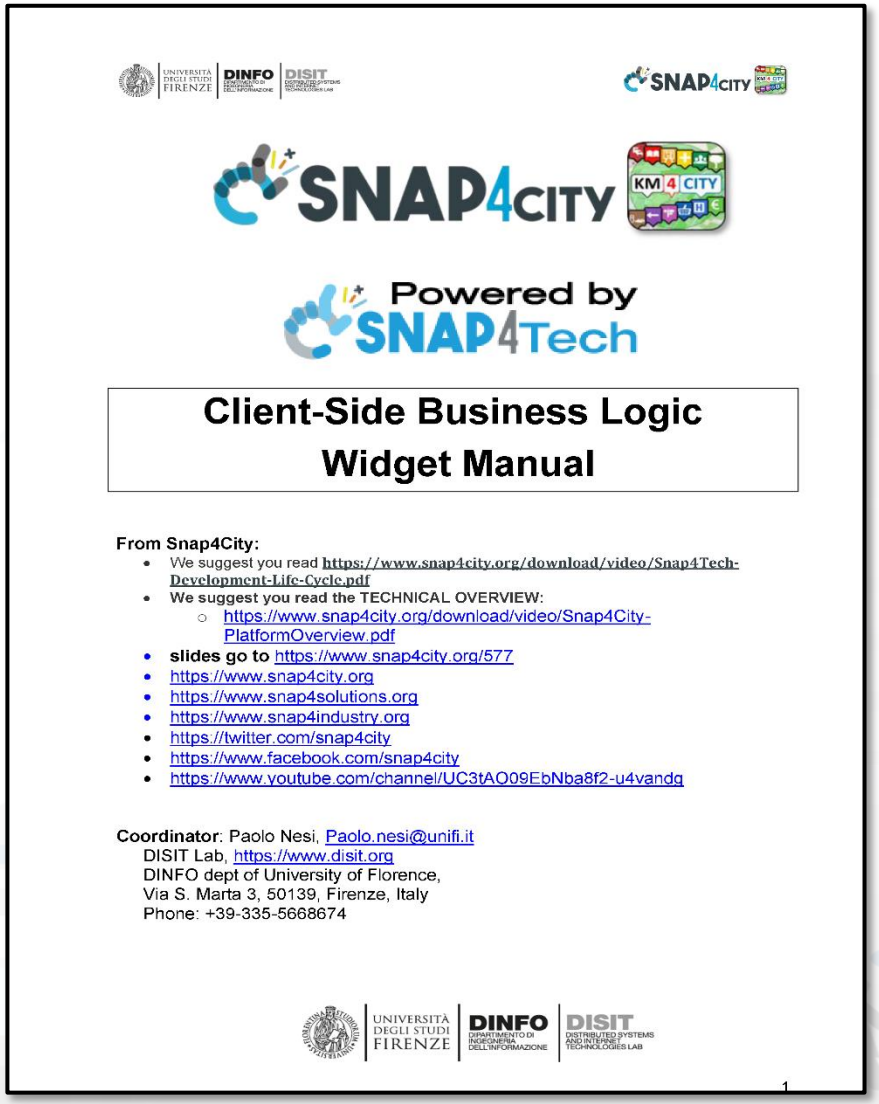
https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf

CSBL

Client Side Business Logic



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Client-Side Business Logic Widget Manual

From Snap4City:

- We suggest you read https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf
- We suggest you read the TECHNICAL OVERVIEW:
  - https://www.snap4city.org/download/video/Snap4City-PlatformOverview.pdf
- **slides go to** https://www.snap4city.org/577
- https://www.snap4city.org
- https://www.snap4solutions.org
- https://www.snap4industry.org
- https://twitter.com/snap4city
- https://www.facebook.com/snap4city
- https://www.youtube.com/channel/UC3tAQ09EbNba8f2-u4vandg

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Phone: +39-335-5668674

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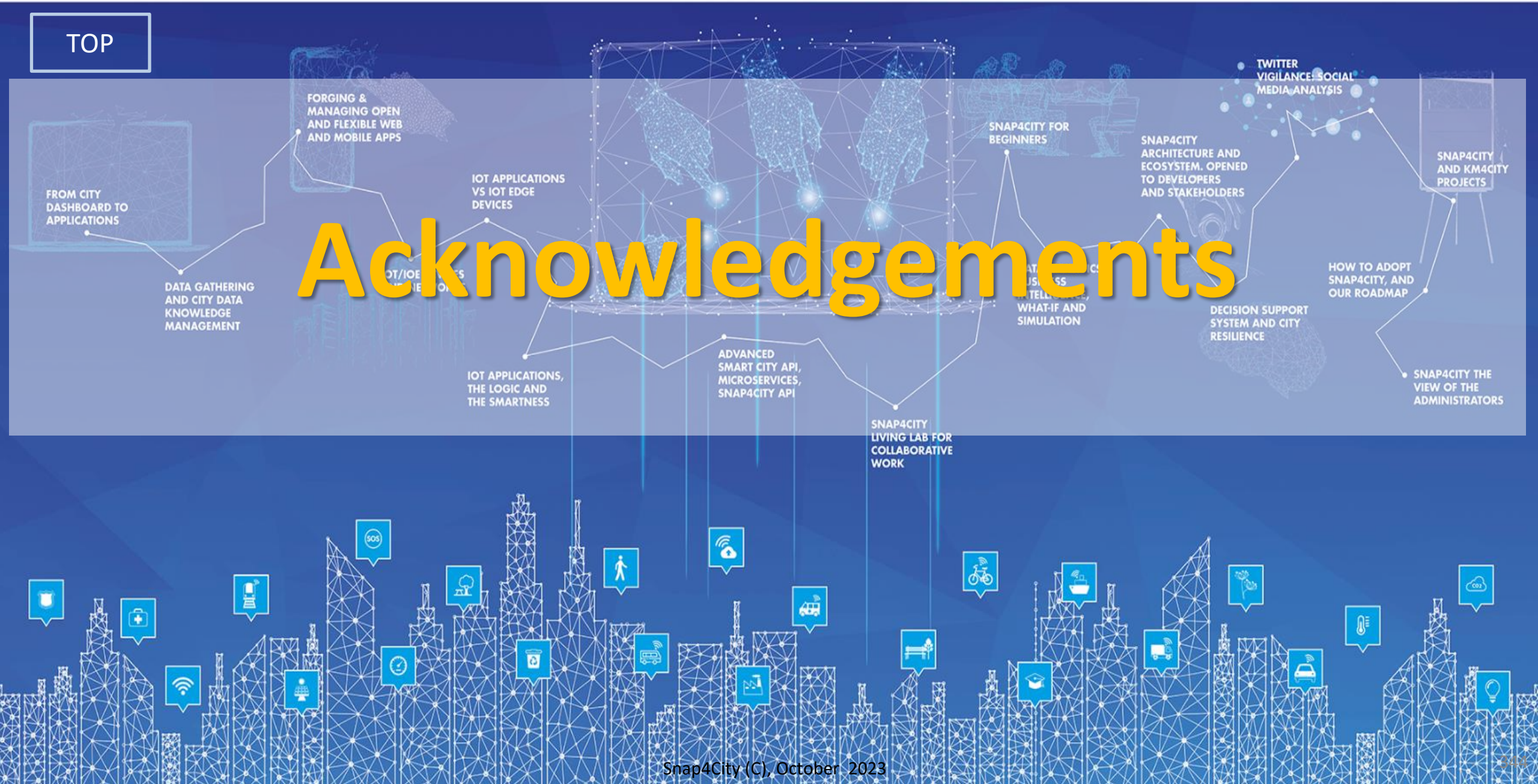
https://www.snap4city.org/download/video/ClientSideBusinessLogic-W

df

Commercial Overview

- https://fiware-foundation.medium.com/snap4city-fiware-powered-smart-app-builder-for-sentient-cities-acfe24df49d5
- https://www.snap4city.org/drupal/sites/default/files/files/FF_ImpactStories_Snap4City.pdf

TOP



Acknowledgements

DISIT lab roadmap vs model and tools' usage

2013
Km4City Ontology 1.1

- Tuscany, Road Graph
- Mobility
- culture, tourism
- Events
- Parking
- Services
- Linked open graph

2014
- Weather Forecast
- Real Time Wi-Fi
- Entertainment
- LOD

- Twitter Vigilance
- Social Media Analytics, Sentiment Analysis

Km4City 1.4

2015
Km4City 1.5

- Resilience Decision Support
- Smart First Aid
- User Behaviour Analysis, predictions
- Risk Analysis

ckan, resolute

H2020 (2015-18)

2016
(2016-21) H2020 REPLICATE

Km4City 1.6.4

- Smart Energy
- Sustainable Mobility
- Control Room
- Dashboard

Km4City 1.6.2

Sii-Mobility (2016-21)

SII-MOBILITY SCN

- Infomobility
- Mobile App
- Routing
- Multimodality

FIWARE

- Sardinia Region Smart City Strategies and plan

GREEN IMPACT C.A.P.A.C.I.T.Y.

GREEN IMPACT
POR FESR 2014-2020

- Industry 4.0
- Critical Plant
- Monitoring

2017
Sii-Mobility

- Origin-Destination and trajectories
- Traffic Reconstruction
- Offer Analysis
- OBU, smart devices

E015 digital ecosystem

(2016-19) GHOST SIR

- IOT/IOE, IOT App
- Living Lab
- Maker Support
- IOT Edge
- Smart City IOT
- GDPR,
- Privacy & Security

life weee (2017-20)

- Smart Waste

MOSAiC (2018-20)

- Mobility Demand / Offer Analytics and Strategy

2018
Sii-Mobility

- User engagement
- Bike Sharing
- Data Analytics ++
- Social Predictions
- OBD2

IOT/IOE

Km4City 1.6.6

Node-RED

SNAP4CITY SELECT for Cities H2020 (2017-19)

SIRIUS

5G (2018-21)

5G tech
Energy
Industry 4.0
Synoptics

TRAFAIR CEF (2018-21)

- Traffic and Mobility Impact on Pollution
- NOX predictions

2019
EUROPEAN OPEN SCIENCE CLOUD

LAID Smart Bed

- Smart Health

GREEN FIELD PEAS Soda4.0

- Industry 4.0

bee smart city

- Smart Lonato

Reverberi Enetec Gruppo MPES

Winner of Select4Cities PCP

SELECT for Cities — 1° place award to SNAP4CITY

SNAP4CITY roadmap

SODA

2020

- Smart Tourism
- 6 Pilots
- Data Analytics
- Extended platform

- Smart Mobility
- PISA, PUMS
- Living lab

smartGARDAlake

Km4City 1.6.7

Smart Ambulance (2021-22)

Enterprise (2021-22) Industry 4.0

Contract

PC4City (2020-21) Monitoring Terrain

Winner of Open Data Challenge of

- Smart Light
- Sweden

2021

Almafluida Industry 4.0 (2021-22)

AMPERE (2021-22) Industry 4.0

SYN-RG-AI SmartCity

Industry 4.0

SmartCity, 2021-23

AXIS collab SmartCity

2022

Asymmetrica Smart City, 2022-23

Contract, 2022-23

2023

Contract, 2022-23

2022-2023

Contract

Security and Risk

Italferr, Smart City

Contract, 2022-23

CN MOST, 2022-26

EI THE, 2022-26

G. Agile, 2021-23

2023-26

Merano, smart light

OceanRace, Genova, AWS

Cuneo, smart city

AMMIRARE

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CONTACT

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Università degli Studi di Firenze - School of Engineering

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