SNAP4CITY

www.snap4city.org
www.snap4solutions.org

KM4CITY

www.km4city.org



# Developing Smart Applications & Business Intelligence Solutions

## October 2025, Course, Part 8

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

0 1 0 0 1 0 0 1 1 0 1 1
0 1 1 1 0 1 0 1 0 0 1 0

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

BY NC ND
SOME RIGHTS RESERVED

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

SNAP4CITY

KM4CITY

SNAP4 Appliances and Dockers Installations

100% OPEN SOURCE

EU GDPR COMPLIANT

PEN Test Passed

Powered by FIWARE

SNAP4CITY on EUROPEAN OPEN SCIENCE CLOUD MARKETPLACE

Node-RED



*Be smart in a SNAP!*

SMARTCITY EXPO WORLD CONGRESS

# Developing Smart Applications & Business Intelligence Solutions

October 2025, Course, Part 8
https://www.snap4city.org/944
https://www.snap4city.org/577

**SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES**

UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO | DISIT

CC BY NC ND
SOME RIGHTS RESERVED

100% OPEN SOURCE

# THE POWER OF ARTIFICIAL INTELLIGENCE AT THE SERVICE OF YOUR OPERATION AND PLAN

SNAP4CITY · KM4CITY

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

www.snap4city.org

Powered by FIWARE

FREE TRIAL

PEN Test Passed

EU GDPR COMPLIANT

SNAP4 Appliances and Dockers Installations

EUROPEAN OPEN SCIENCE CLOUD

Node-RED

JS Foundation

E015 digital ecosystem

NVIDIA

## OPERATION AND PLAN - CONTROL ROOMS - DECISION SUPPORT SYSTEMS - WHAT-IF ANALYSIS - OPTIMIZATION - APPLICATIONS

### HORIZONTAL AI PLATFORM



### MOBILITY AND TRANSPORT



### SMART ENERGY AND SMART BUILDING



### ENVIRONMENT AND WASTE MANAGEMENT



### CITY USER'S SERVICES AND TOURISM MANAGEMENT



### SNAPADVISOR



## BUSINESS INTELLIGENCE - SIMULATIONS - VISUAL ANALYTICS - SYNOPTICS - GRAPHICAL WIDGETS - ANALYTICS



DASHBOARDS, WIDGETS
TEMPLATES



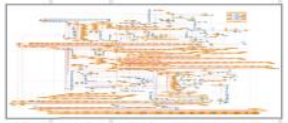
PREDICTION - ANOMALY DETECTION - CLUSTERING - ROUTING - SENTIMENT NLP - TRAFFIC FLOW - PEOPLE FLOWS - SDG
15 MIN CITY INDEX - KPI - HEATMAPS - ORIGIN DESTINATION - MAPS - VECTOR FIELD - ETC...



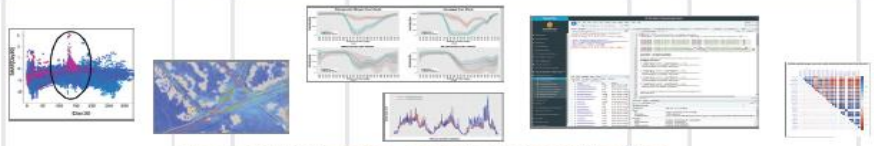
API - MICROSERVICES - GIS - BPM
VIDEO - REPORTS - MAPS - 3D ...

- DEVELOMENT ENVIRONMENT AND METHODOLOGY
- VISUAL PROGRAMMING, ML, AI, HPC
- TRAINING COURSES



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



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



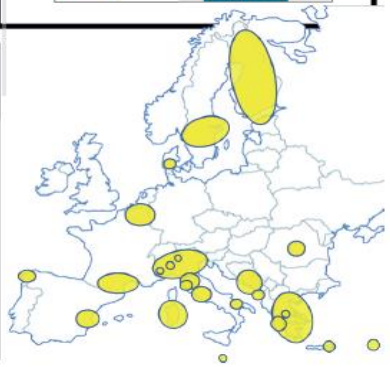
VISUAL PROGRAMMING, ADAPTERS
DATA FLOWS, WORKFLOWS
PARALLEL DISTRIBUTED PROCESSING
DATA DRIVEN

## FULL INTEROPERABILITY, ANY: DATA, BROKERS, NETWORKS AND VERTICALS

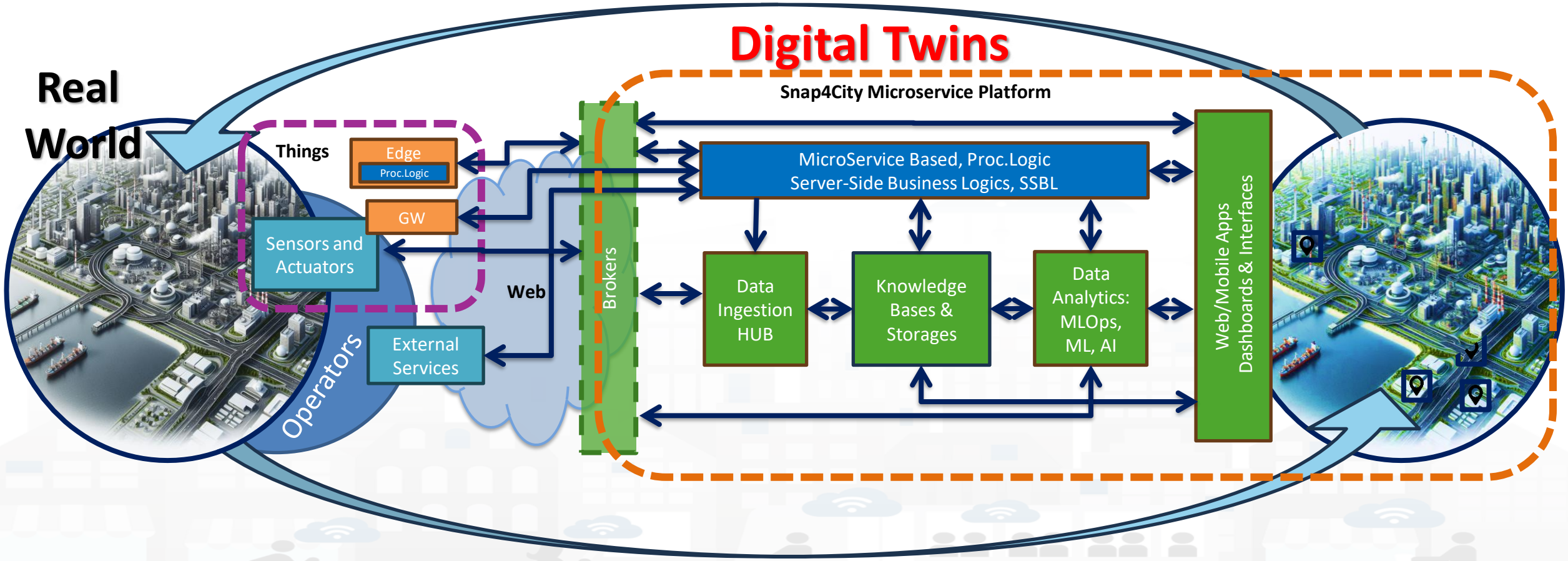



NATIVE AND EXTERNAL APPLICATIONS

- Smart Parking
- Smart Light
- Smart Waste
- Smart Energy
- Smart Building
- Smart Tourism
- ...



# Digital Twin Development Platform



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 |



# Part 1: Overview for researchers and developers

Part 1: Overview for researchers / developers

SLIDES



- Objectives and Tasks, architecture and Digital Twin
- Monitoring and Control: Mobility, Humans, Engagement, ..
- Decision Support Systems, planning, what-if and optimization
  - Data Analytics, Artificial Intelligence, XAI, ML
  - Traffic Light Plan Optimisation
  - Traffic Infrastructure Optimization
- Industry Domain: predictive maintenance
  - Autoclave Cycle: Energy Optimisation
- Developing on Snap4City platforms
- Training Suggestion and publications / further reading
- Development Costs Advantages
- Accelerating on Smart City Deploy with Snap4City
- Platform Administration

# Part 1: Overview for adopters, city, etc.

Part 1: Overview for adopters city/industry

SLIDES

Interactive Slides




- Needs of the Operators vs platform
- Platform Overview: from data to interactive tools
- Data Analytics, Artificial Intelligence
- Some Cases by Domains: solutions vs analytics
- Other Cases and scenarios
- Overview of the next parts of the Course
- References to other training material

# Part 2: Dashboard production and management

Part 2: Dashboards production and management

SLIDES

Interactive Slides



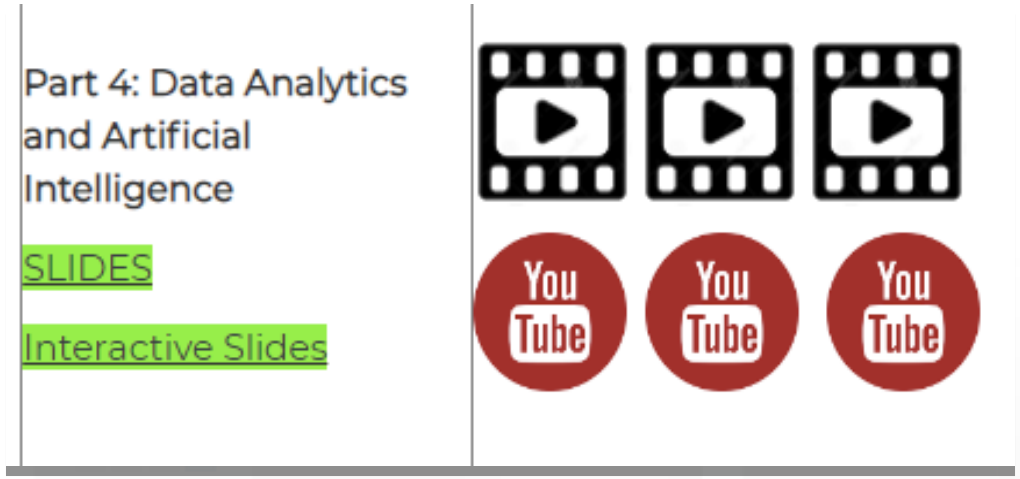

- Recall on Snap4City Architecture
- Dashboards Purposes and Uses
- Main Data Kinds: data vs representations
- Dashboards Main Concepts and simple Widgets
- Creating a Snap4City Dashboard, wizard
- Multi Data Map Widget
- High Level Types, video, external services, synoptics
- Selector for the Multi Data Map Widget
- Data Inspector vs Data Processes Details
- Dashboard Management

# Part 3: IoT App, process logic, server side BL



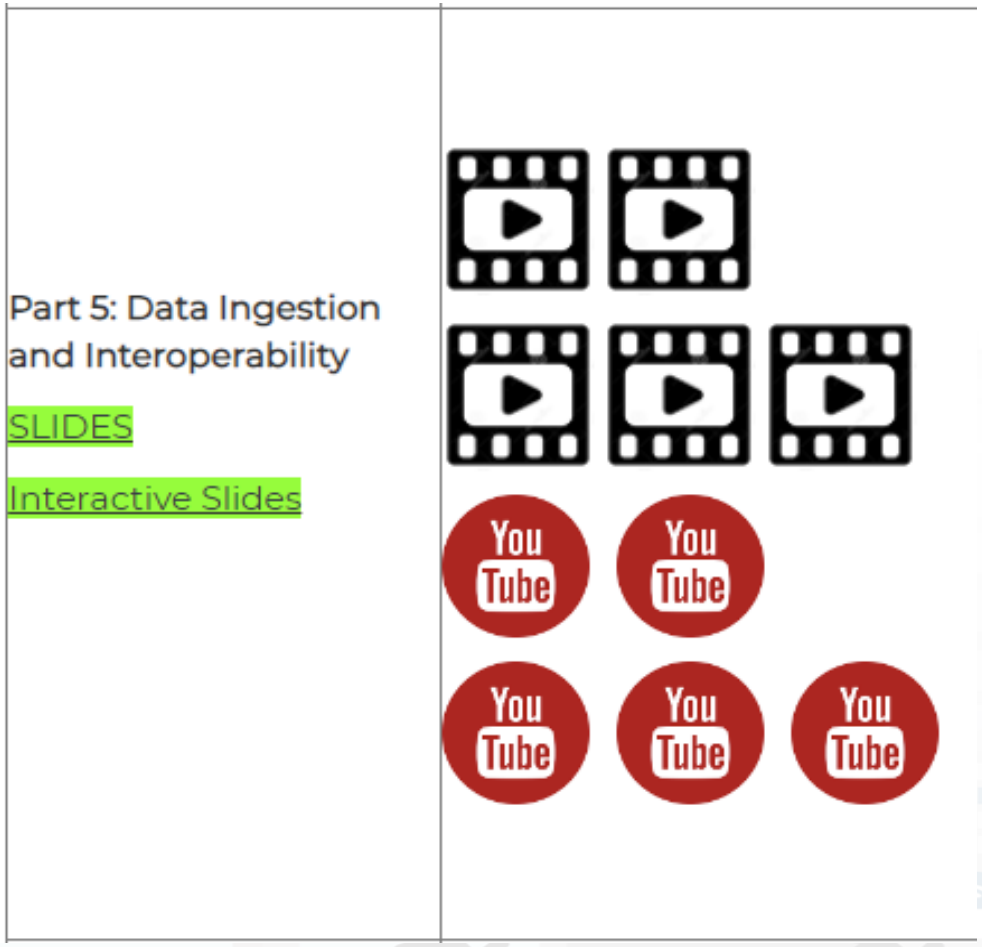

- Recall on Snap4City Architecture
- Node-RED
- IOT App = Node-RED + Snap4City
  - IoT App === Proc.Logic
- Examples of IOT App for Smartening Solutions
- Exploiting/Generating data by using: IoT App/Proc.Logic
- External Service <-> IoT App/Proc.Logic
- Dashboards <-> IoT App/Proc.Logic
  - Server Side Business Logic
- training material

# Part 4: Data Analytics




- Why and Where use DA, AI and XAI -> General Life Cycle, scenario editor, monitoring and control
- Data Processing: KPI, traffic, emissions, public transport quality, ..
- From Data Analytics, DA to Artificial Intelligence, AI
- List of the most relevant available DA and AI Solutions
- Predictions and Anomaly detections: parking, biking, NOx, landslide, people
- Computing: Higher Level Types Data and their representations: traffic, heatmaps, 3D
- Human Behavior, Engagement, Typical Time trends, WIFI sniffing
- Using AI in main domains: Mobility and transport, traffic optimization, Smart Energy, Smart Building,
- How AI/XAI, and Life Cycle, AI/ML requirements, XAI,
- Using DA, AI/XAI in Snap4City infrastructures
  - Data Analytics <-> IoT App / Proc.Logic
  - MLOps, ClearML, exploiting clusters of GPU/CPU
- Decision Support Systems and What-If Analysis, transport offer, DORAM tool
- Routing, Multimodal Routing, Dynamic Routing
- Predictive Maintenance
- Training Material

# Part 5: Data Ingestion and Interoperability




- 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

# Part 6: Platform Architecture, interop and Deploy

Part 6: Snap4City Platform Architecture, Interoperability, Management and Deploy

SLIDES

Interactive Slides



- Snap4City Architecture
- Interoperability of Snap4City Platform
- Interoperability with respect to Hardware staff
- Adding Features and Modules to Snap4City
- FIWARE and Snap4City
- Snap4City vs State of the Art Solutions
- Smart City planning with Snap4City Team Support
- The Role of the Living Lab Support
- Snap4City Platform: Administration Overview
- Snap4Tech: Smart Solutions as a Service
- Deploy Snap4Tech solutions: Docker Based

# Parts 7 & 8: API, Mobil, Business Intelligence

| | |
|---|---|
| Part 7: Exploiting Snap4City API, and Web/Mobile Applications SDK<br>SLIDES<br>Interactive Slides |  |
| Part 8: Developing Smart Applications & Business Intelligence Solutions<br>SLIDES<br>Interactive Slides |  |

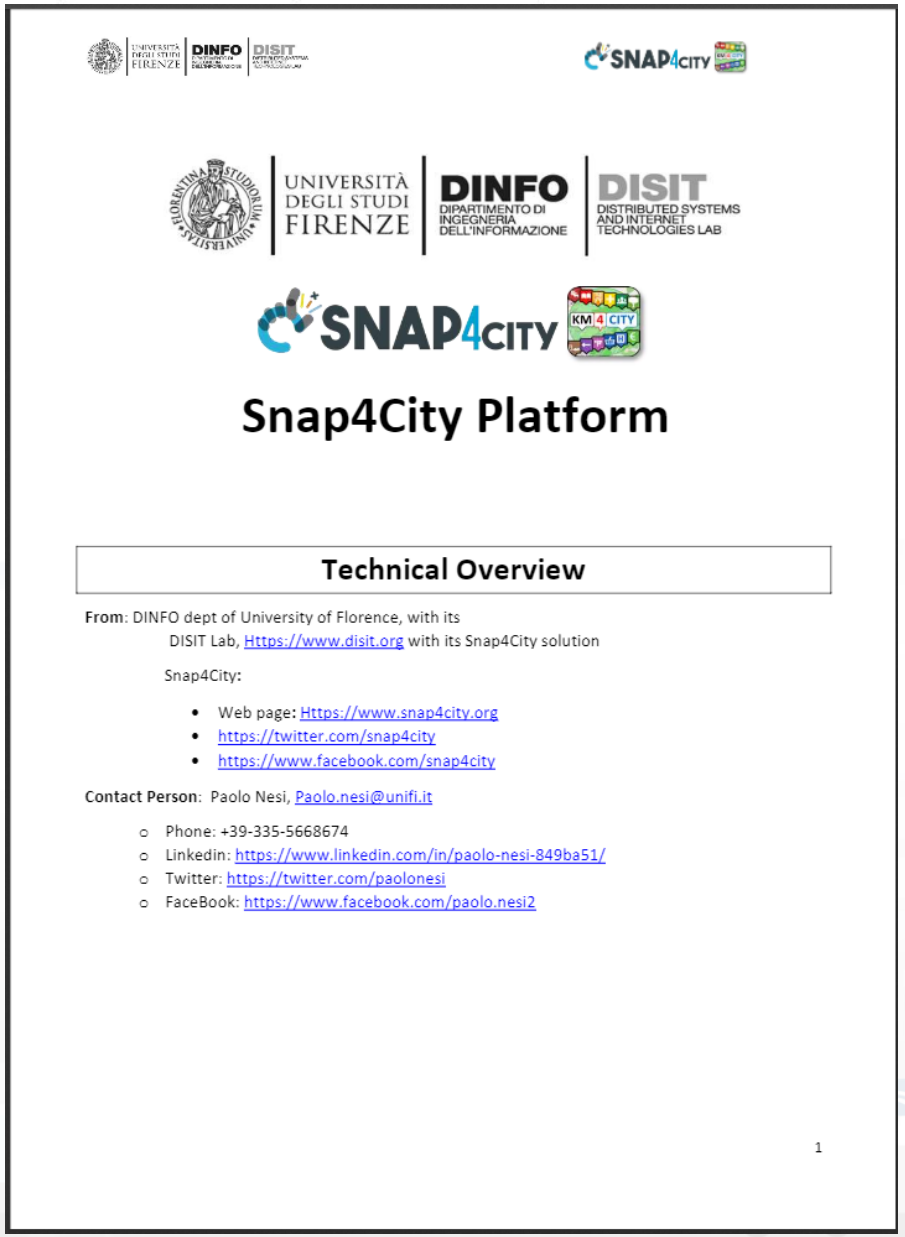
- Smart City API: Internal and External
- Concepts and tools for using Knowledge Base, ServiceMap, API
- Federated Knowledge Bases and Smart City APIs
- Advanced Smart City API
- Access to Protected data
- Forging and managing: Mobile and Web Apps, MicroApplications
- Web and Mobile App Development Kit
- ----------
- Developing in the smart city IoT/WoT context
- Smart Solutions Development Life Cycle
- Analysis for Innovation (Co-Creation and Co-Working)
- Design: Data, Data Models, Data Relationships
- Design & Develop: Data Processes Proc.Logic / IoT App
- Design & Develop of Data Analytics
- Design & Develop: user interfaces, visual tools
- Visual Analytic vs Data Analytics: Client Side Business Logic Intelligence
- Design and Control of Smart Applications
- What is missing here and you can get from former course

# Snap4City Training vs Targets

- **Estimate Indicators: P1, P2, P3, P4, P5**
  - IoT App/Proc.Logic JavaScript, Data Analytics, Dashboards to see data and results
- **Load additional data: P1, P2, P3, P5**
  - IoT App/Proc.Logic JavaScript, IoT Directory, ServiceMap, advanced interoperability, Dashboards to see them
- **Performing AI/XAI on accessible data: P1, P2, P3, P4, P5 (P8)**
  - IoT App/Proc.Logic JavaScript, ServiceMap, ASCAPI, Python, Dashboards to see data/results
- **Developing Business intelligence: P1, P2, P3, P7, P8**
  - IoT App/Proc.Logic JavaScript, Dashboards to see them, ASCAPI, CSBL for making them intelligent, JavaScript
- **Developing Web and Mobile Apps: P1, P2, P3, P7, P8**
  - ServiceMap, ASCAPI, Dashboards
- **Deploy, install, test and management: P1, P2, P3, P6**
  - IoT App/Proc.Logic JavaScript, ServiceMap, Dashboards to see them

# 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



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

SNAP4CITY

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

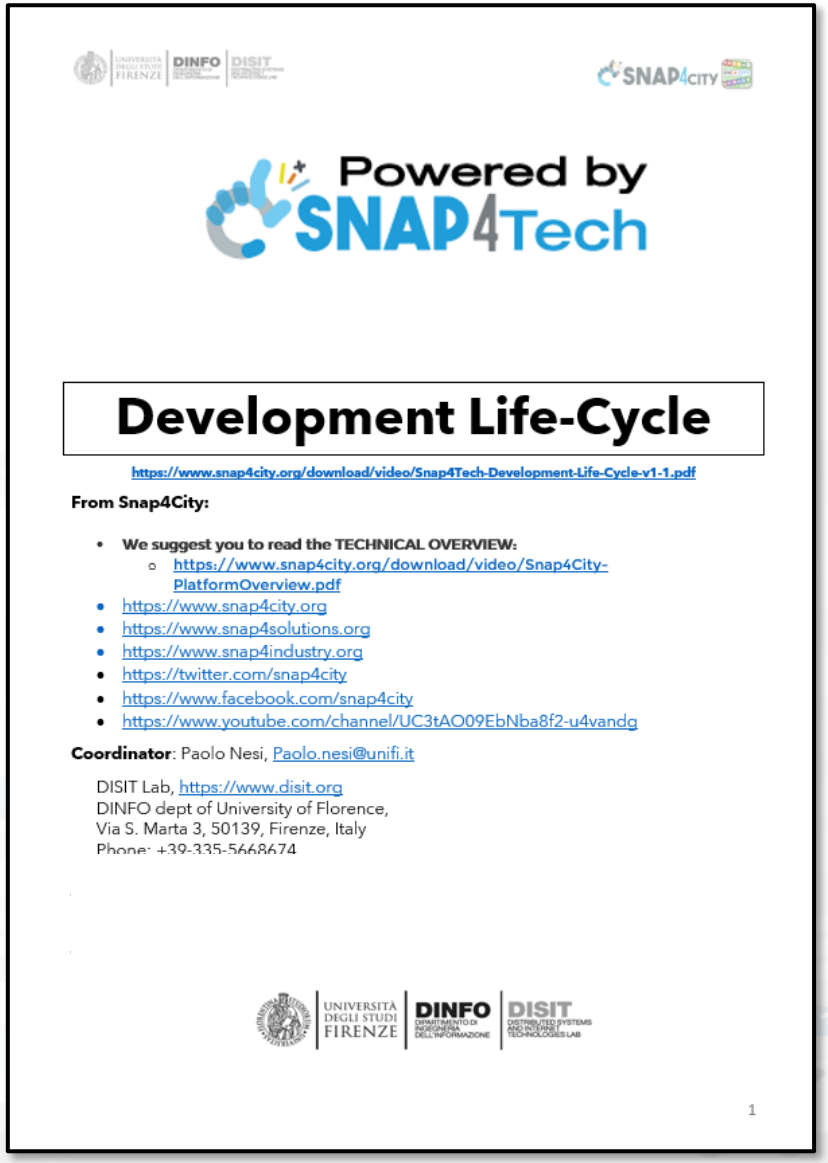
- Phone: +39-335-5668674
- Linkedin: https://www.linkedin.com/in/paolo-nesi-849ba51/
- Twitter: https://twitter.com/paolonesi
- FaceBook: https://www.facebook.com/paolo.nesi2

1

# Tech Overview

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

# Development



Powered by SNAP4Tech

## 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

UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO | DISIT

1

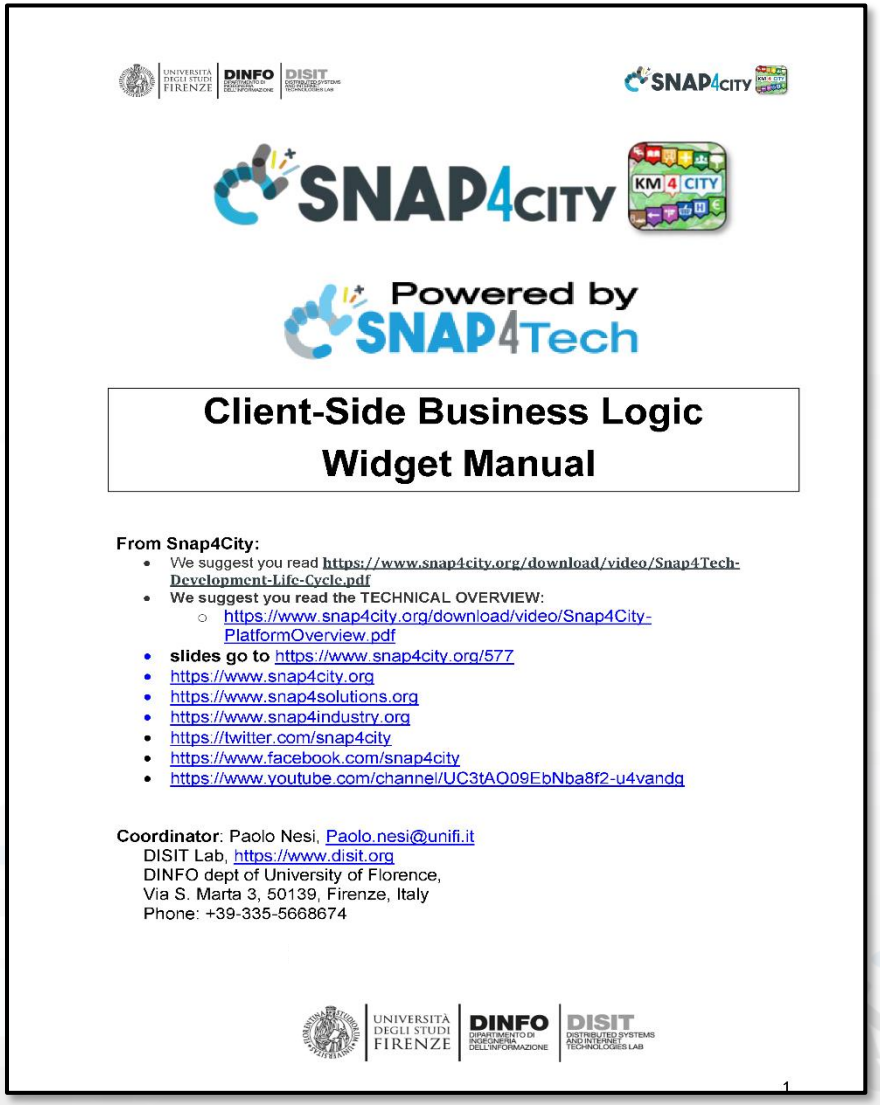
**https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf**

# Development Life Cycle vs Micro X

- Please be careful that not all features listed in the training are available on the Micro X installations.
- The list of modules and features is reported in the Micro X installation page.
- In the Development Life Cycle, the features and modules which are typically not accessible on the first Micro X installation are listed as Optional. In any case, it depends on your specific installation, since you may have requested features out of the standard ones.

# CSBL

# Client Side Business Logic



Powered by SNAP4Tech

**Client-Side Business Logic Widget Manual**

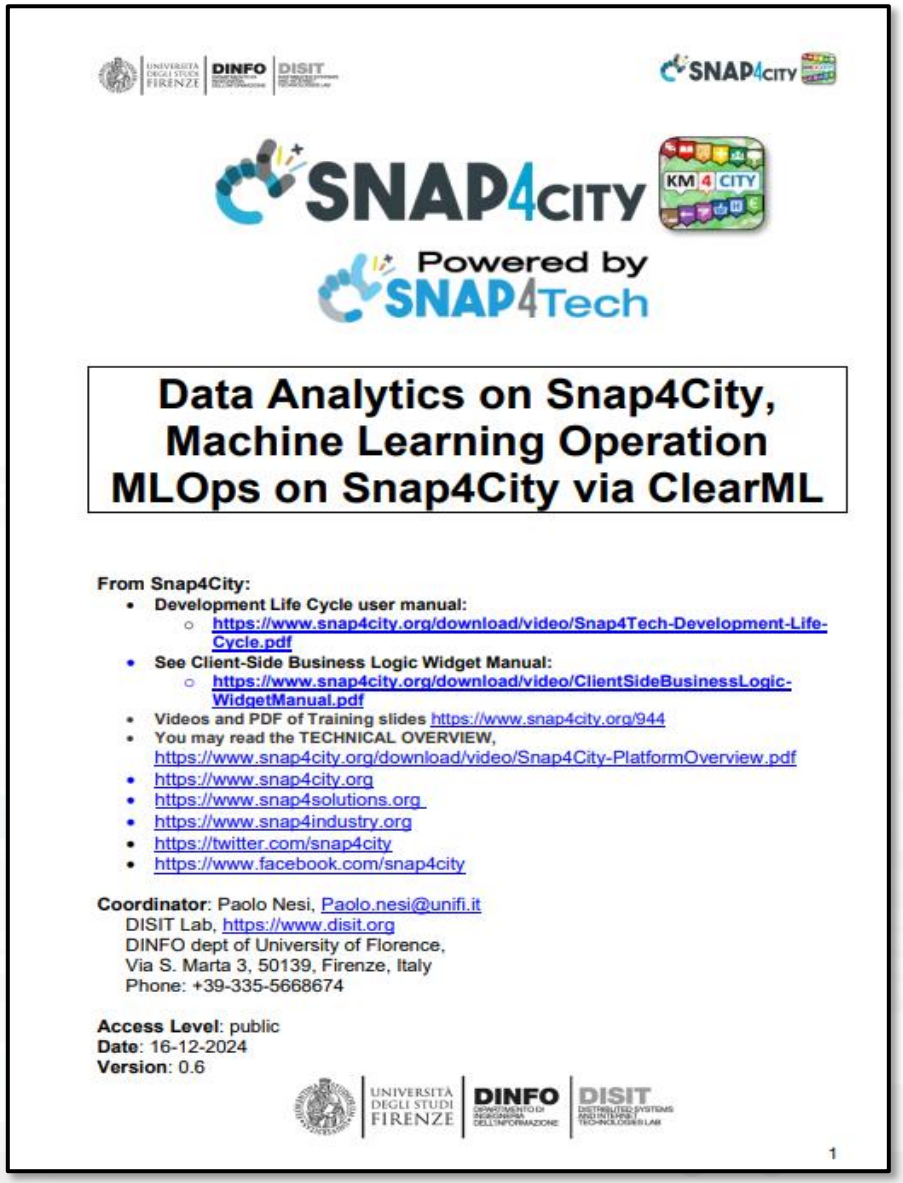
**From Snap4City:**

- 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/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

1

https://www.snap4city.org/download/video/ClientSideBusinessLogic-WidgetManual.pdf



SNAP4CITY

Powered by SNAP4Tech

**Data Analytics on Snap4City, Machine Learning Operation MLOps on Snap4City via ClearML**

**From Snap4City:**

- **Development Life Cycle user manual:**
  - https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf
- **See Client-Side Business Logic Widget Manual:**
  - https://www.snap4city.org/download/video/ClientSideBusinessLogic-WidgetManual.pdf
- Videos and PDF of Training slides https://www.snap4city.org/944
- You may 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

**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

**Access Level**: public
**Date**: 16-12-2024
**Version**: 0.6

UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO | DISIT

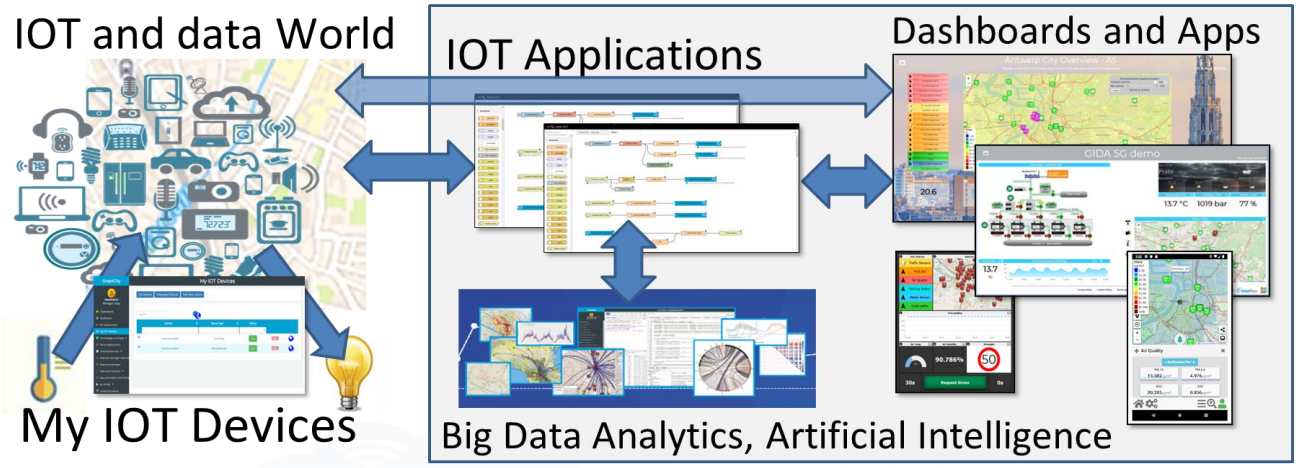
1

# MLOperations

https://www.snap4city.org/download/video/Snap4City-MLOps-Manual.pdf

# Free Trial

- Register on [WWW.snap4city.org](http://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.

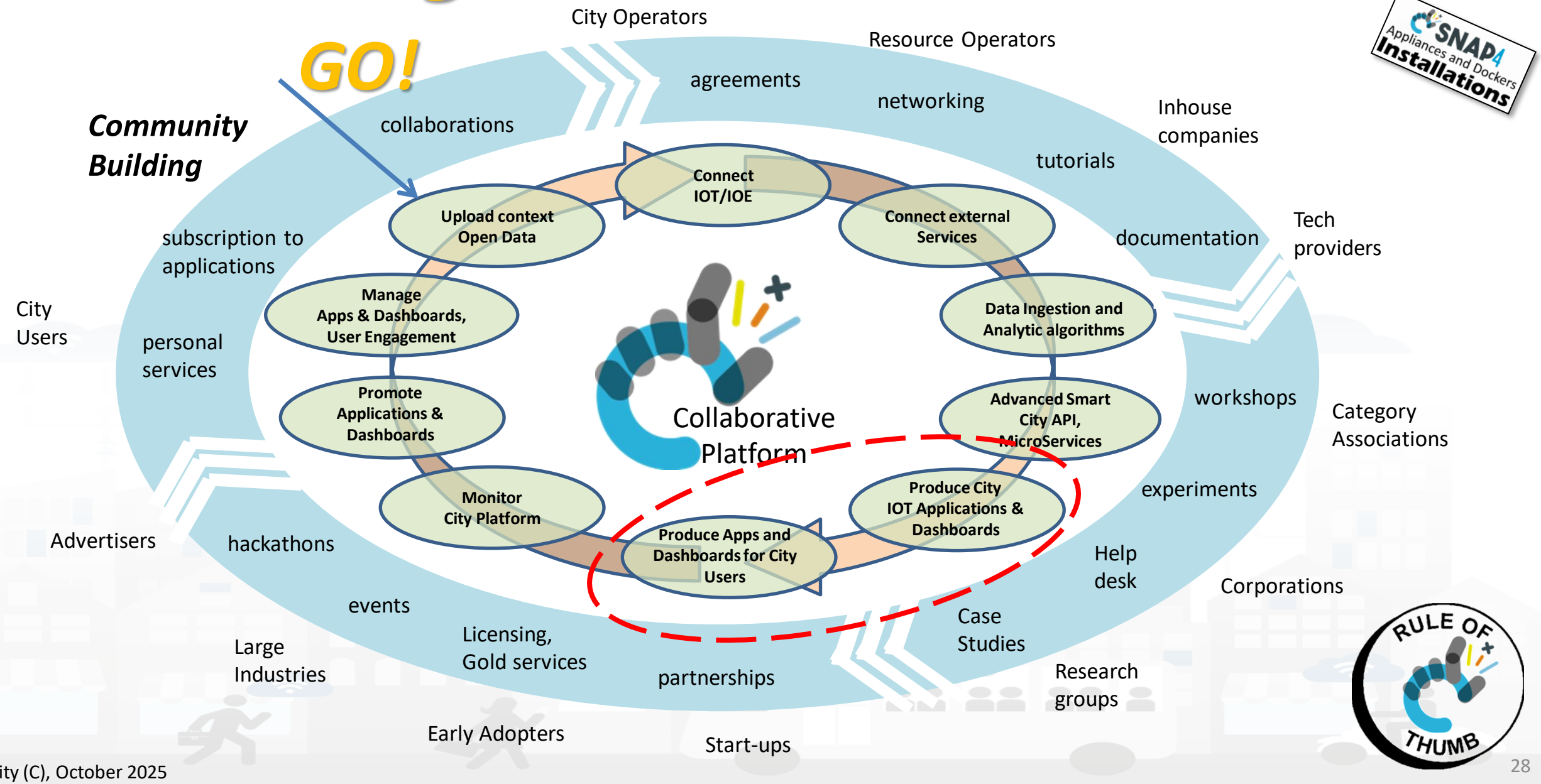
# Agenda of Part 8

- **Developing** in the smart city IoT/WoT context
- Smart Solutions **Development Life Cycle**
- **Analysis** for Innovation (Co-Creation and Co-Working)
- **Design**: Data, Data Models, Data Relationships
- **Design** & **Develop**: Data Processes Proc.Logic / IoT App
- **Design** & **Develop** of Data Analytics
- **Design** & **Develop**: user interfaces, visual tools
- **Visual Analytic vs Data Analytics**: Client Side Business Logic Intelligence
- **Design and Control** of Smart Applications
- What is missing here and you can get from former course

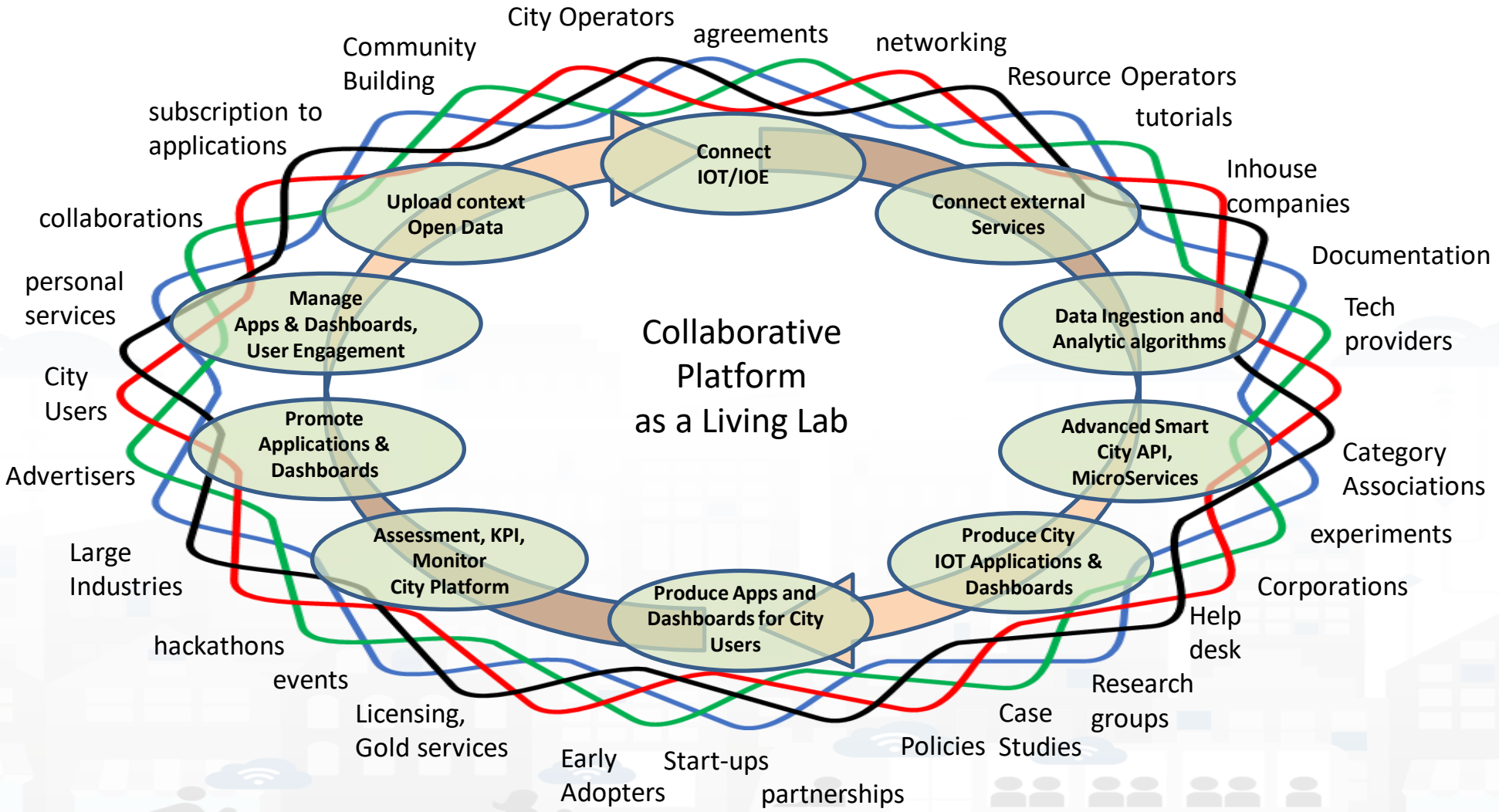



# Developing in the smart city IoT/WoT contexts

# Accelerating GO!



# Quadruple Helix process



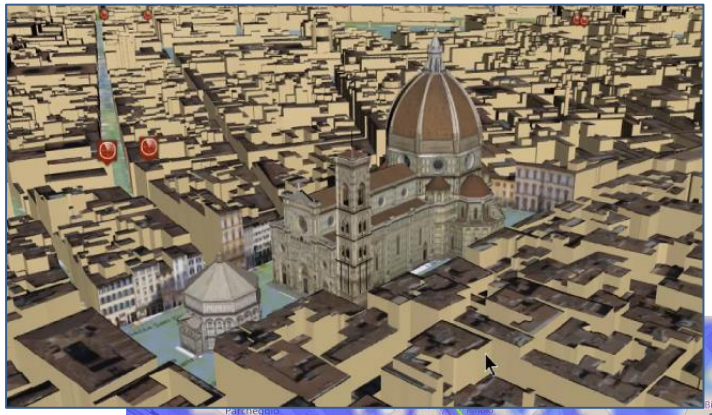
# Phases' Coverage

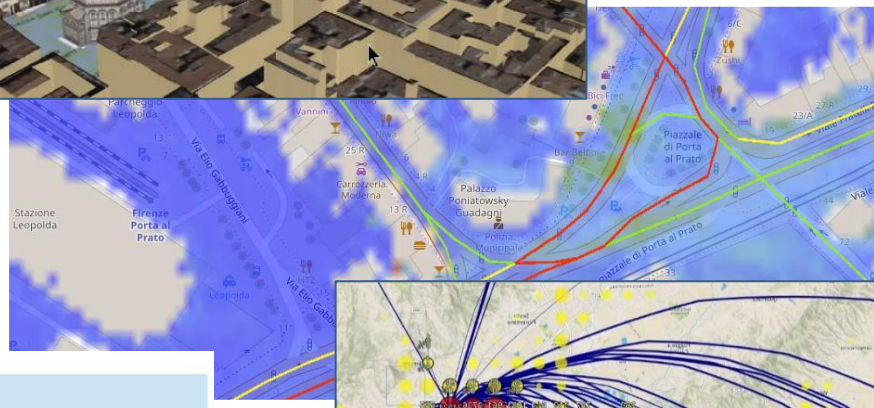
Data Identification → Data Gathering → Data Aggreg. Process. → Data Storage, semantic → Data search Retrieval → Data Analysis → Data Visualization → Visual Analytics

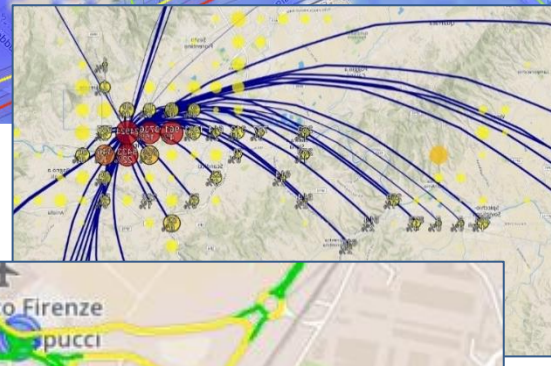
| what | Identification | Gathering | Complex data types | Aggregation | Storage (semantic) | Efficient Retrieval | Semantic Modeling, query | Data Analytics (micro, marco) | Scenarios context | Artificial Intelligence | Data rendering | Real Time Dashboard | Event Driven data rendering |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| GeoServer | | | | | (x) | | | | | | (x) | (x) | |
| GIS | | | (x) | | | | | (micro) | | | x | | |
| PowerBI | | | | | | x | | (x) | | | x | x | |
| Tableau | | | | | x | x | | (x) | | | x | x | |
| …. | | | | | | | | | | | | | |
| | | | | | | | | | | | | | |
| Snap4City | x | x | x | x | x | x | x | x | x | x | x | x | x |

# Main Tasks

- **Controlling Status: management, and operational**
  - Monitoring via KPI
  - Computing predictions data from the field and KPI
  - Anomaly detection
  - Early warning on critical conditions
- **Making plan: tactic and strategic, medium and long range**
  - Optimisation: Prescriptions, suggestions
  - Risk assessment
  - What-if analysis on scenarios
    - Simulation and predictions
  - Resilience
- **Be ready for Unexpected Unknows**





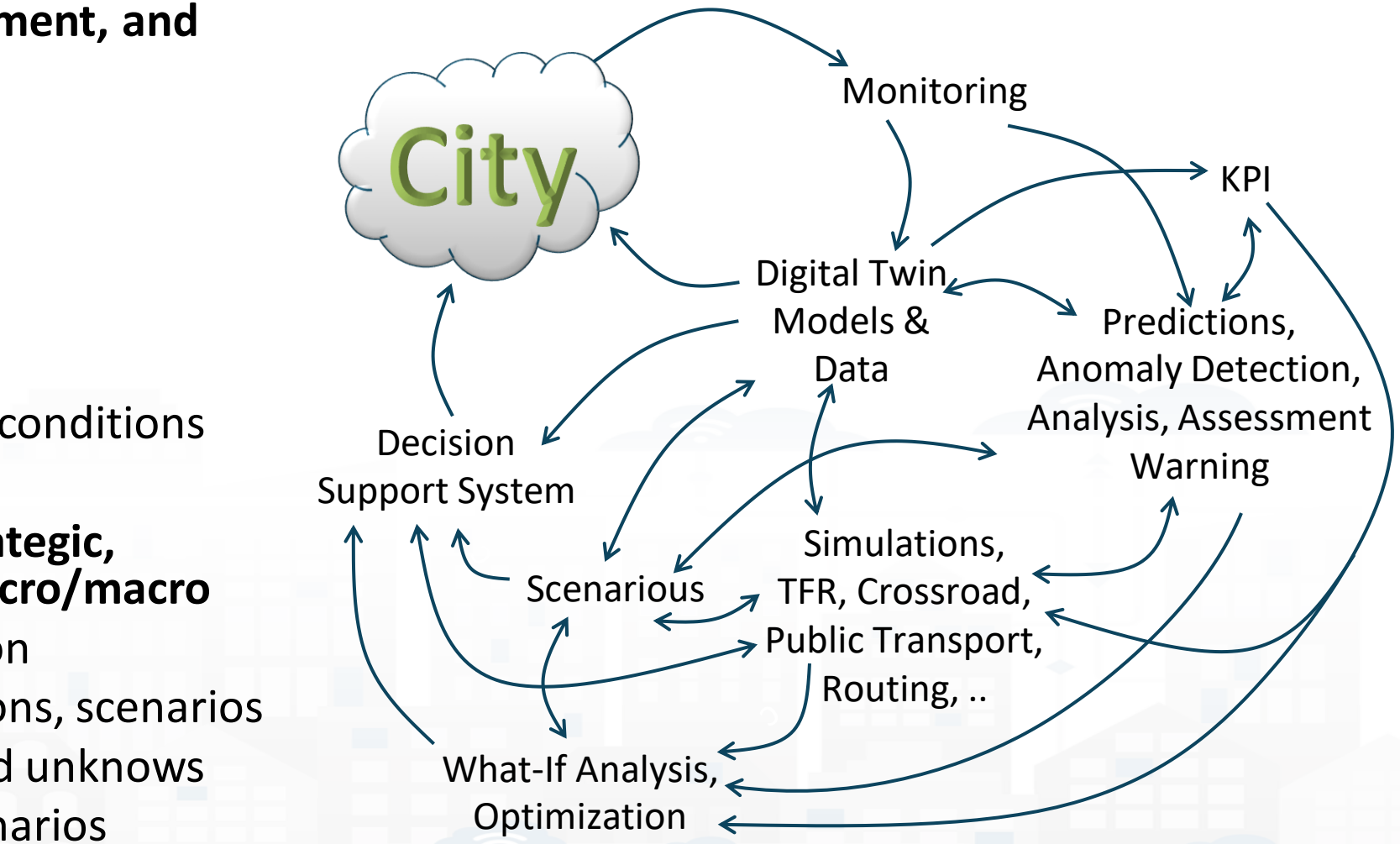






# Main tasks

- **Controlling Status: management, and operational**
  - Monitoring via KPI
  - Predictions vs KPI
  - Anomaly detection
  - Neuro-Symbolic analysis
  - Risk assessment
  - Early warning on critical conditions
  - Fast What-if analysis
- **Making plan: tactic and strategic, medium and long range, micro/macro**
  - Simulation & optimization
  - Generative AI Prescriptions, scenarios
  - Resilience to Unexpected unknows
  - What-if analysis wrt scenarios
  - Collaboration with stakeholders






City

Monitoring

KPI

Digital Twin
Models &
Data

Predictions,
Anomaly Detection,
Analysis, Assessment
Warning

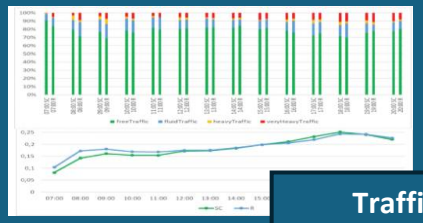
Decision
Support System

Scenarious

Simulations,
TFR, Crossroad,
Public Transport,
Routing, ..

What-If Analysis,
Optimization

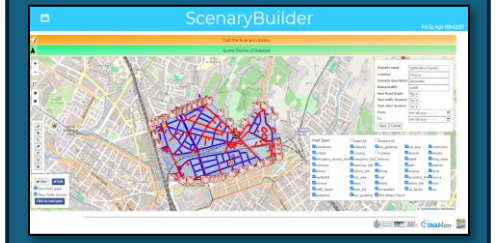
**KPI, Predictions, .....**



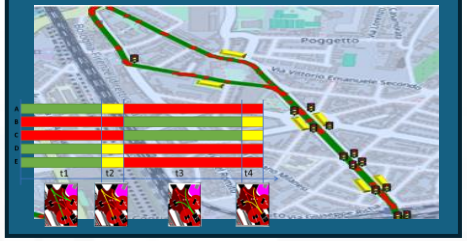
**Traffic Reconstruction**



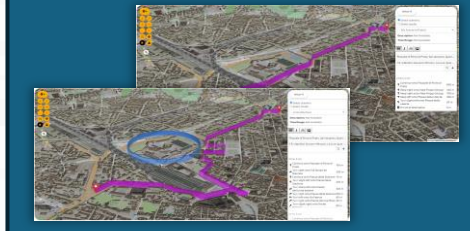
**Scenario Editor**



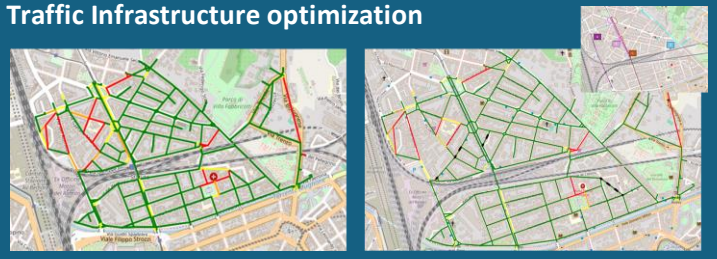

**Traffic Light Plan optimization**



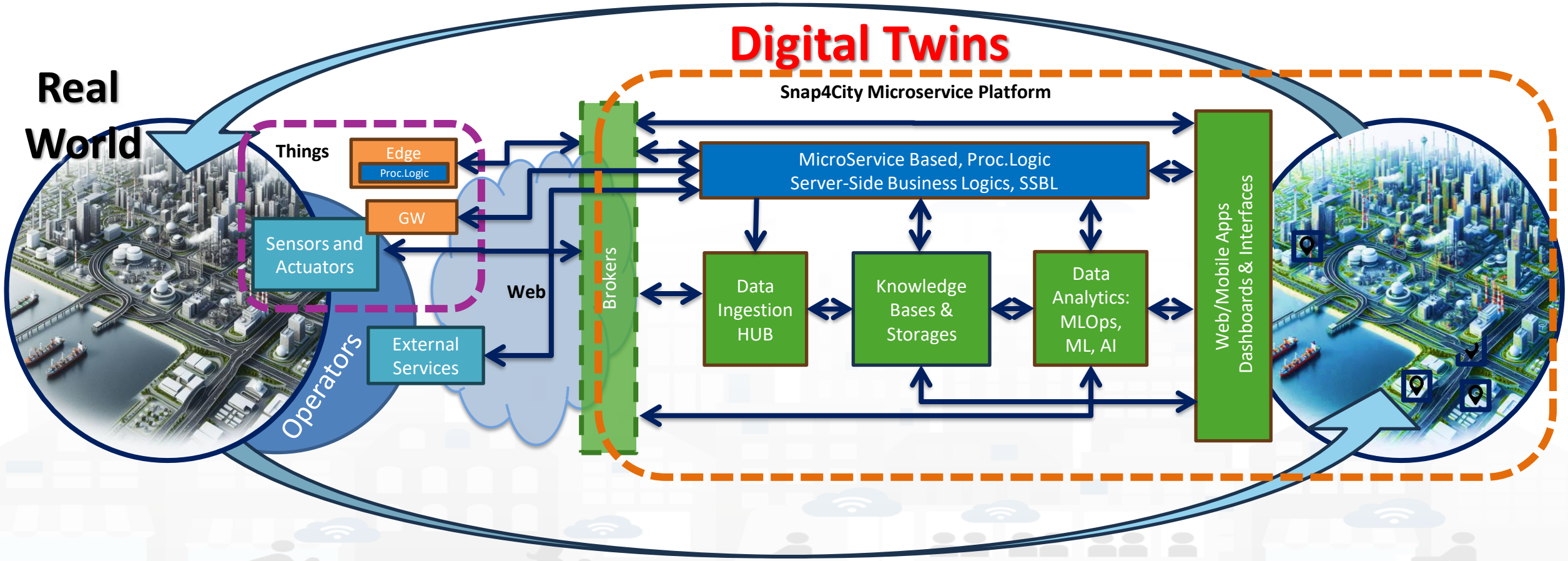
**Routing / Dynamic Routing**



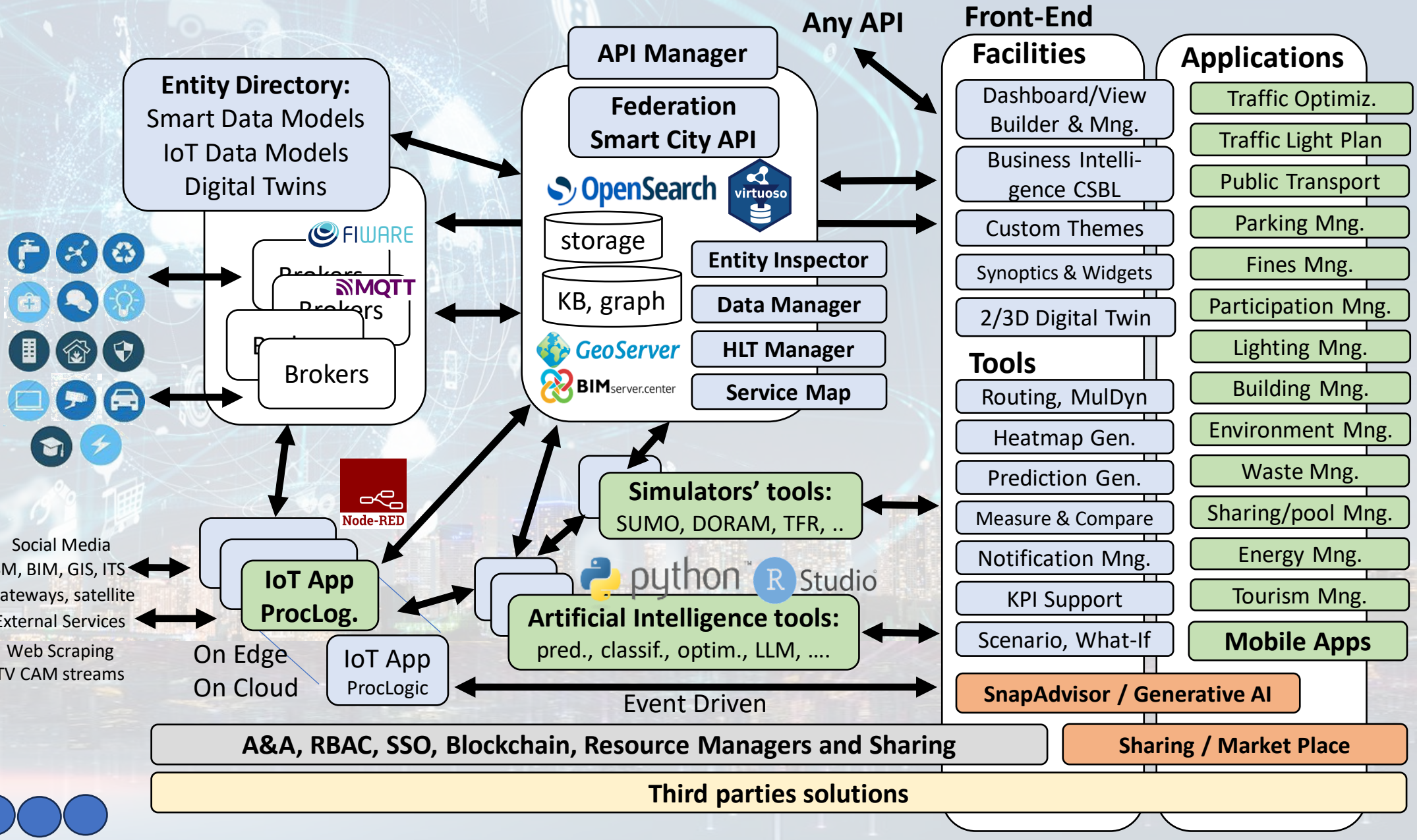
**Traffic Infrastructure optimization**



# Digital Twin Development Platform

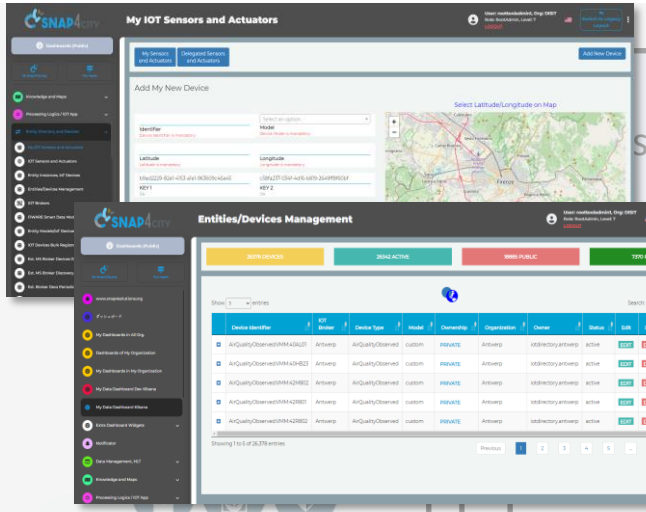


# Technical Architecture



# Tech Arch






Brokers

API Manager

Federation Smart City API

OpenSearch

storage

KB, graph

virtuoso

GeoServer

BIMserver.center

EntityInspector

Data Managers

Front-End Facilities

Scenario Editor

Business Intellig. CSBL

Dashboard Bld & Manager

CustomThemes

Synoptics

KPI Support

MobAppSupport

Service Map

HLT Manager

3D Digital Twin

Applications

Traffic Optimiz.

TrafficLightPlan

PublicTransport

Parking Mng.

Lighting Mng.

Building Mng.

Environment

Waste Mng.

Sharing/pool

Energy Mng.

Tourism Mng.

Mobile Apps

Node-RED

python

R Studio

Social Media

BIM GIS

Gateways, satellite

External Services

Web Scraping
Tv CAM streams

IoT App ProcLog.

On Edge
On Cloud

IoT App

Artificial Intelligence:
ML, AI, XAI, DA

Event Driven

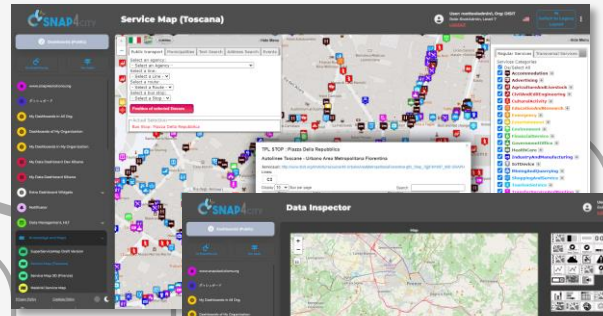
Market/Sharing Place

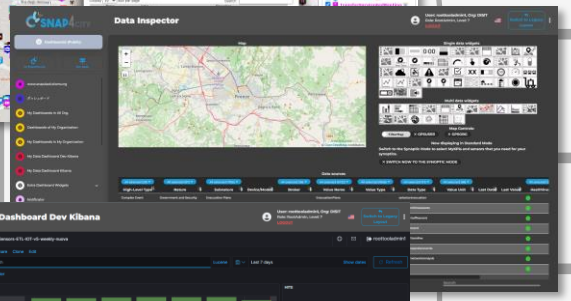
Third parties solutions

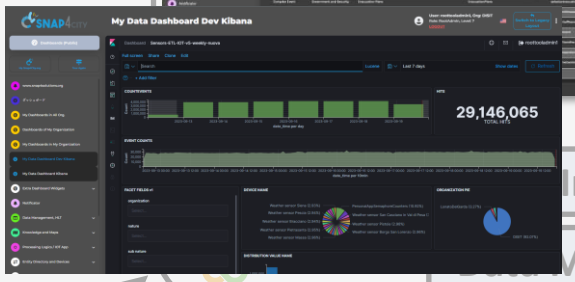
A&A, SSO, Blockchain, Resource Managers and Sharing: IoT App, Data Analytics, ...

# Tech Arch






**Entity Directory:**
Smart Data Models
IoT Data Models
Digital Twins

FIWARE Brokers

Brokers

Inspector

Managers

Node-RED

Social Media
BIM GIS
Gateways, satellite
External Services
Web Scraping
Tv CAM streams

**IoT App ProcLog.**

On Edge
On Cloud

IoT App

**Artificial Intelligence:**
ML, AI, XAI, DA

python

R Studio

Event Driven

**Front-End Facilities**

- Scenario Editor
- Business Intellig. CSBL
- Dashboard Bld & Manager
- CustomThemes
- Synoptics
- KPI Support
- MobAppSupport
- Service Map
- HLT Manager
- 3D Digital Twin

**Applications**

- Traffic Optimiz.
- TrafficLightPlan
- PublicTransport
- Parking Mng.
- Lighting Mng.
- Building Mng.
- Environment
- Waste Mng.
- Sharing/pool
- Energy Mng.
- Tourism Mng.
- **Mobile Apps**

Market/Sharing Place

**Third parties solutions**

**A&A, SSO, Blockchain, Resource Managers and Sharing: IoT App, Data Analytics, …**

# Tech Arch






Entity Directory:
Smart Data Models
IoT Data Models
Digital Twins

FIWARE Brokers

Brokers

API Manager

Federation
Smart City API

OpenSearch

storage

KB, graph

virtuoso

GeoServer

BIMserver.center

EntityInspector

Data Managers

Node-RED

python

R Studio

Artificial Intelligence:
ML, AI, XAI, DA

Event Driven

Front-End Facilities

- Scenario Editor
- Business Intellig. CSBL
- Dashboard Bld & Manager
- CustomThemes
- Synoptics
- KPI Support
- MobAppSupport
- Service Map
- HLT Manager
- 3D Digital Twin

Applications

- Traffic Optimiz.
- TrafficLightPlan
- PublicTransport
- Parking Mng.
- Lighting Mng.
- Building Mng.
- Environment
- Waste Mng.
- Sharing/pool
- Energy Mng.
- Tourism Mng.
- **Mobile Apps**

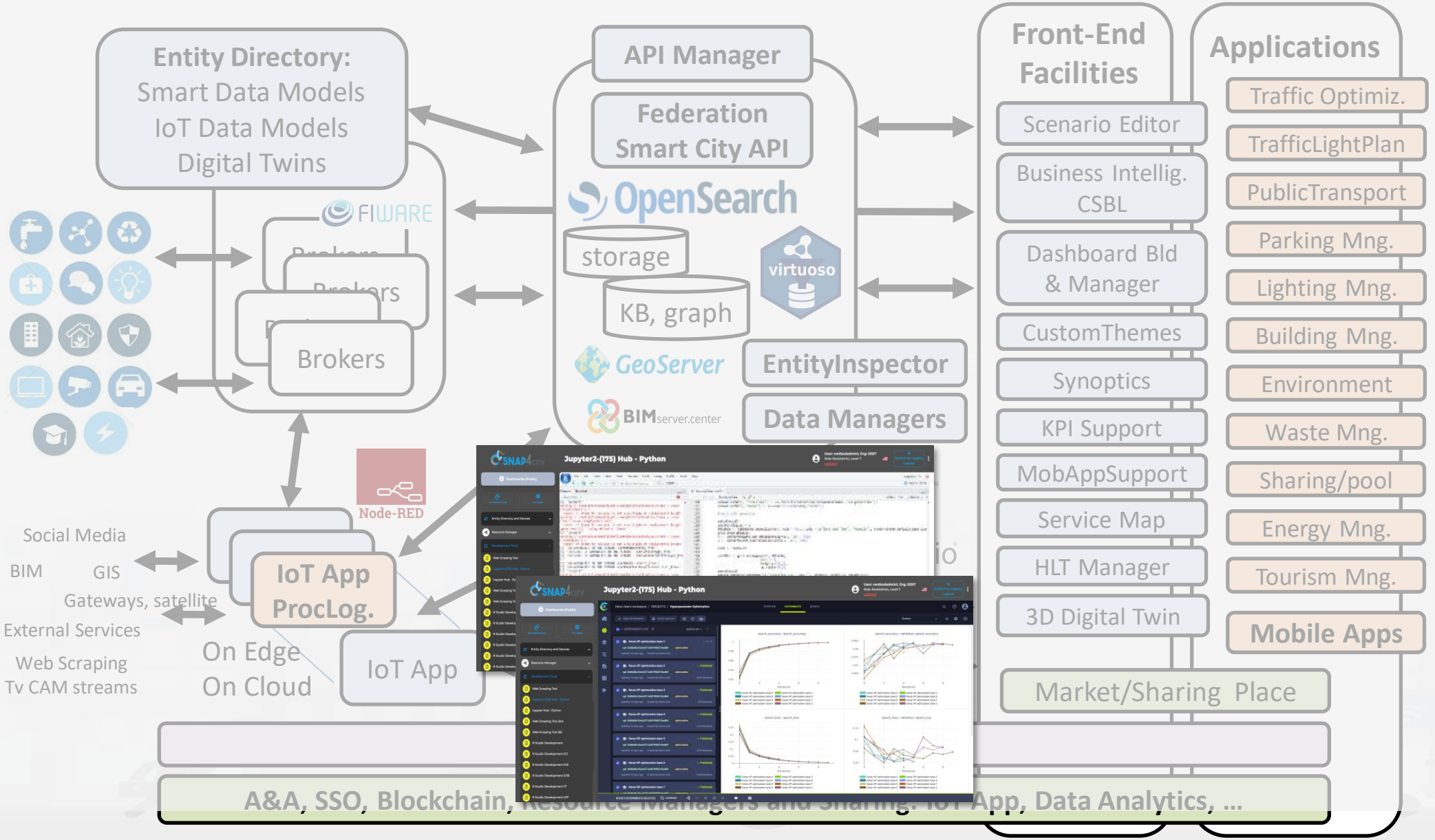
Market/Sharing Place

Third parties solutions

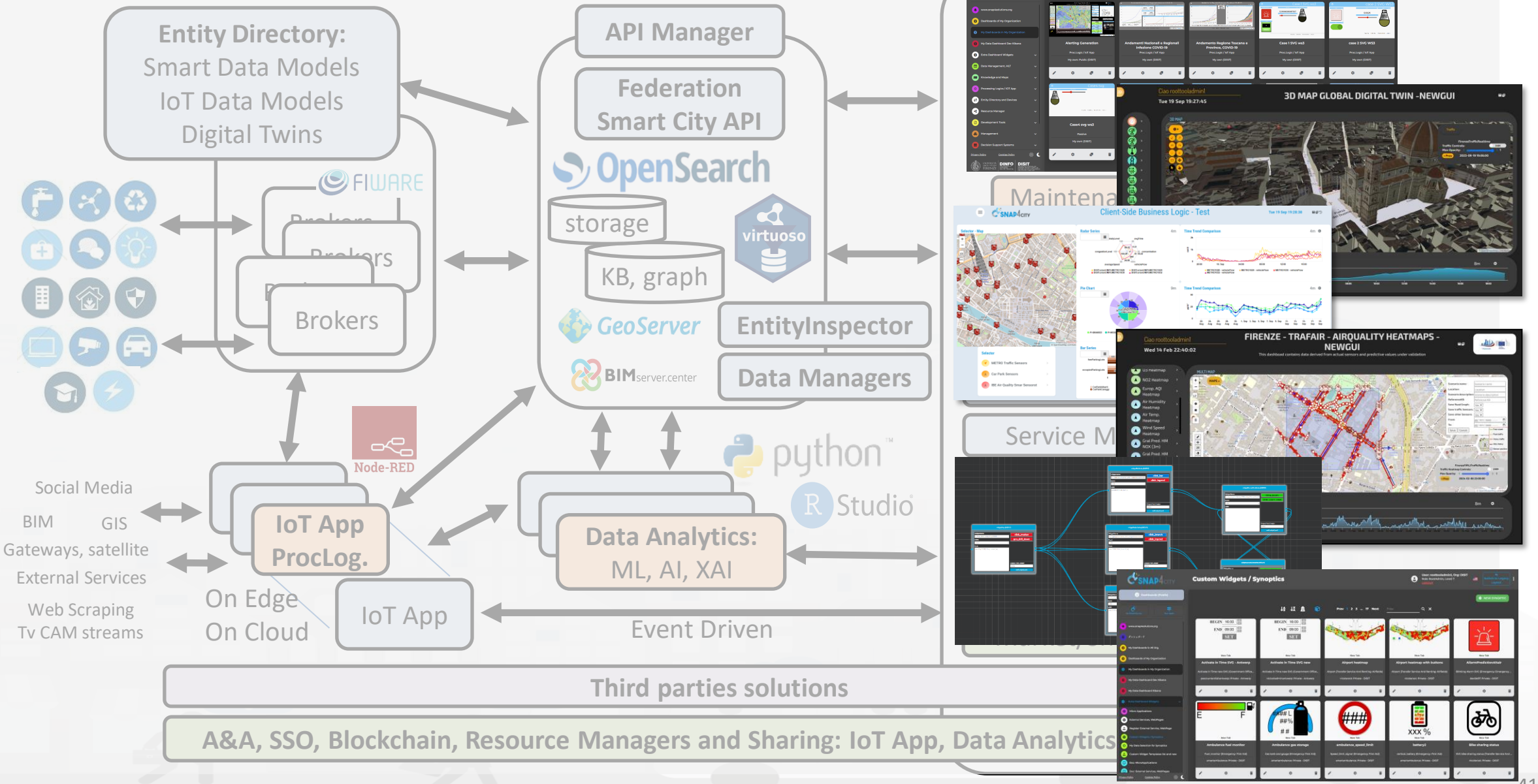
A&A, SSO, Blockchain, Resource Managers and Sharing: IoT App, Data Analytics, …

# Tech Arch

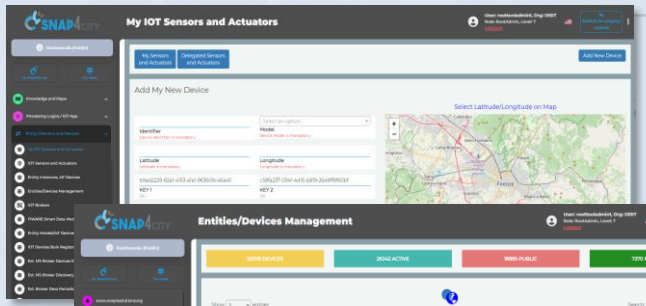


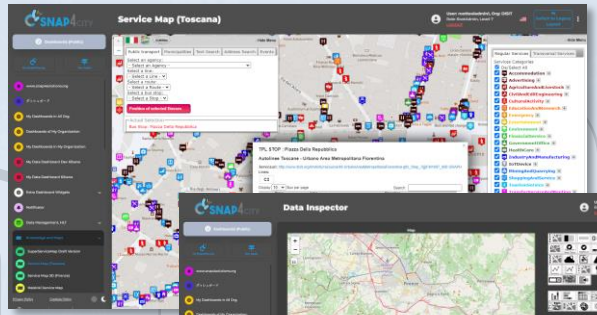

Entity Directory:
Smart Data Models
IoT Data Models
Digital Twins
FIWARE
Brokers
Brokers
Brokers
API Manager
Federation
Smart City API
OpenSearch
storage
KB, graph
virtuoso
GeoServer
BIMserver.center
EntityInspector
Data Managers
Front-End
Facilities
Scenario Editor
Business Intellig.
CSBL
Dashboard Bld
& Manager
CustomThemes
Synoptics
KPI Support
MobAppSupport
Service Map
HLT Manager
3D Digital Twin
Applications
Traffic Optimiz.
TrafficLightPlan
PublicTransport
Parking Mng.
Lighting Mng.
Building Mng.
Environment
Waste Mng.
Sharing/pool
Energy Mng.
Tourism Mng.
Mobile Apps
Market/Sharing Place
Node-RED
Social Media
BIM
GIS
Gateways, satellite
External Services
Web Scraping
Tv CAM streams
IoT App
ProcLog.
On Edge
On Cloud
IoT App
Jupyter2-(175) Hub - Python
Jupyter2-(175) Hub - Python
A&A, SSO, Blockchain, Resource Managers and Sharing, IoT App, Data Analytics, …

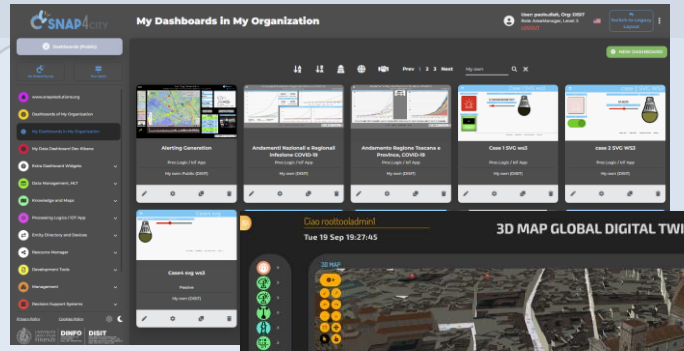
# Tech Arch

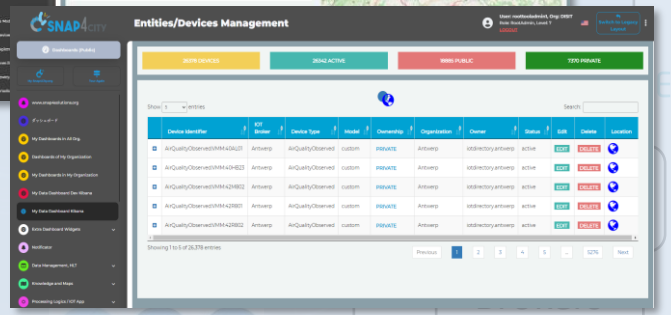

Entity Directory:
Smart Data Models
IoT Data Models
Digital Twins
FIWARE
Brokers
Brokers
Brokers
API Manager
Federation
Smart City API
OpenSearch
storage
KB, graph
virtuoso
GeoServer
EntityInspector
BIMserver.center
Data Managers
Node-RED
python
RStudio
Social Media
BIM
GIS
Gateways, satellite
External Services
Web Scraping
Tv CAM streams
IoT App
ProcLog.
On Edge
On Cloud
IoT App
Data Analytics:
ML, AI, XAI
Event Driven
Third parties solutions
A&A, SSO, Blockchain, Resource Managers and Sharing: IoT App, Data Analytics
My Dashboards in My Organization
3D MAP GLOBAL DIGITAL TWIN -NEWGUI
Client-Side Business Logic - Test
FIRENZE - TRAFAIR - AIRQUALITY HEATMAPS - NEWGUI
Custom Widgets / Synoptics

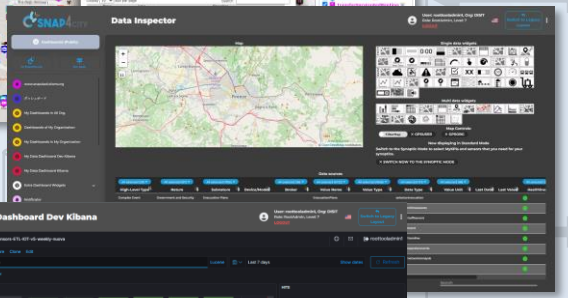
# Visual Development Tools



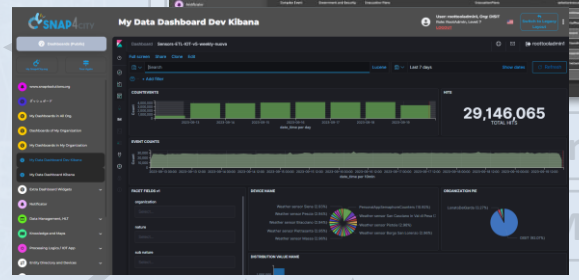



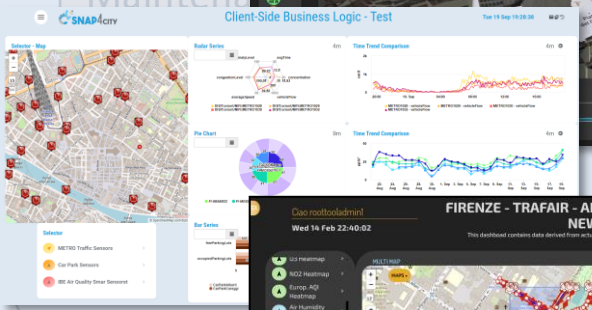



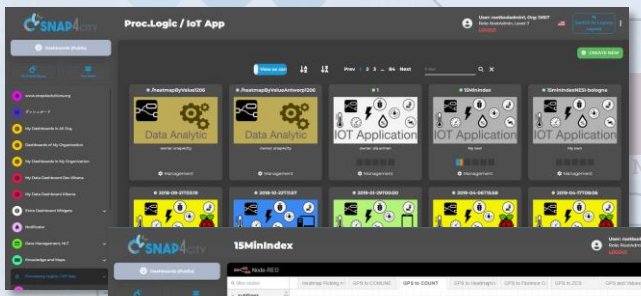



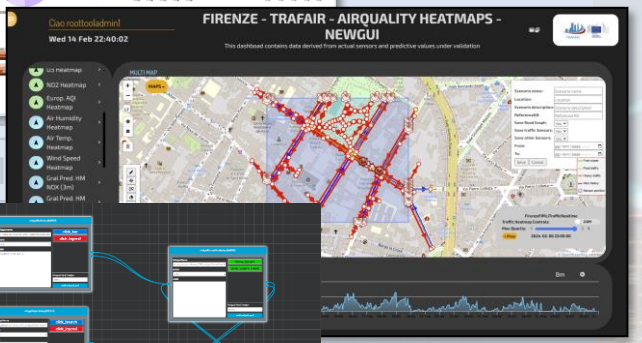


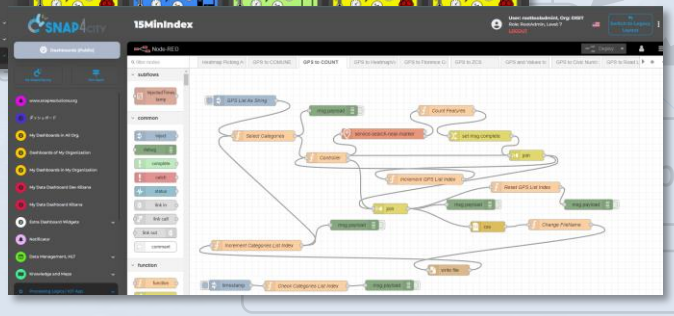


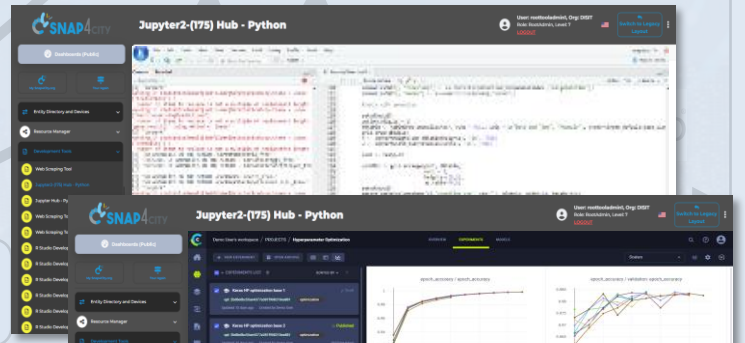


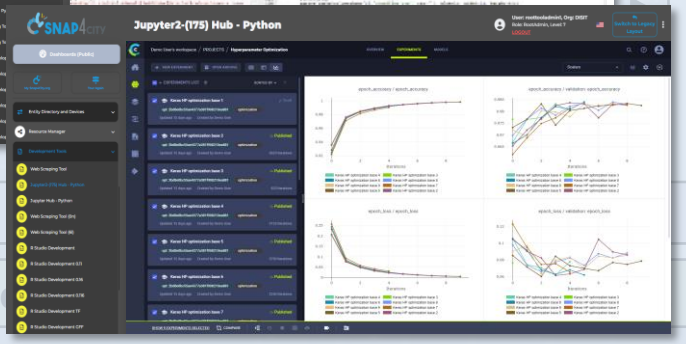



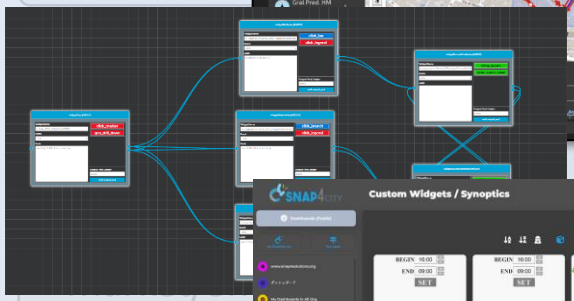





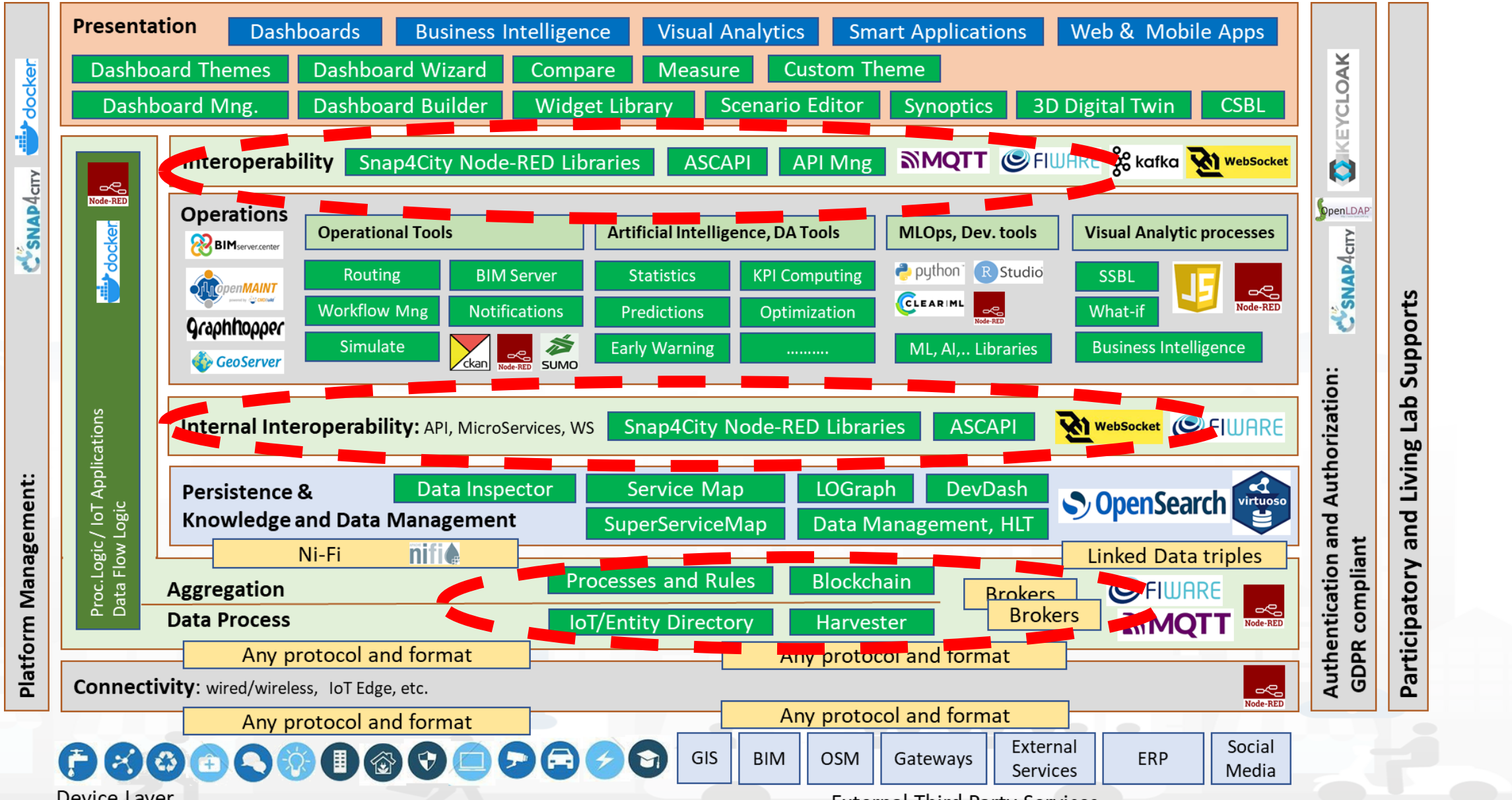
# Principles

- **Smart Applications can be easily developed exploiting the cloud infrastructure by producing only:**
  - **Processing Logic / IoT App** with almost no coding activities
  - **Data Analytics** in Python or Rstudio
  - **Dashboards** with almost no coding activities.
- **→ Orange parts of the previous figure slide are those usually developed,**
  - all the rest, is part of the provided microservices and infrastructure.

- **Third party applications can dialog with the solutions via**
  - **Smart City API**, Swagger: https://www.km4city.org/swagger/external/ and internal for some…
  - **Brokers/IoT Brokers**, for example for NGSI Orion Broker: https://www.km4city.org/swagger/external/?urls.primaryName=Orion%20Broker%20K1-K2%20Authentication%20API
  - **Processing Logic / IoT App** any protocols: https://www.snap4city.org/65 They can also expose some specific API, custom made

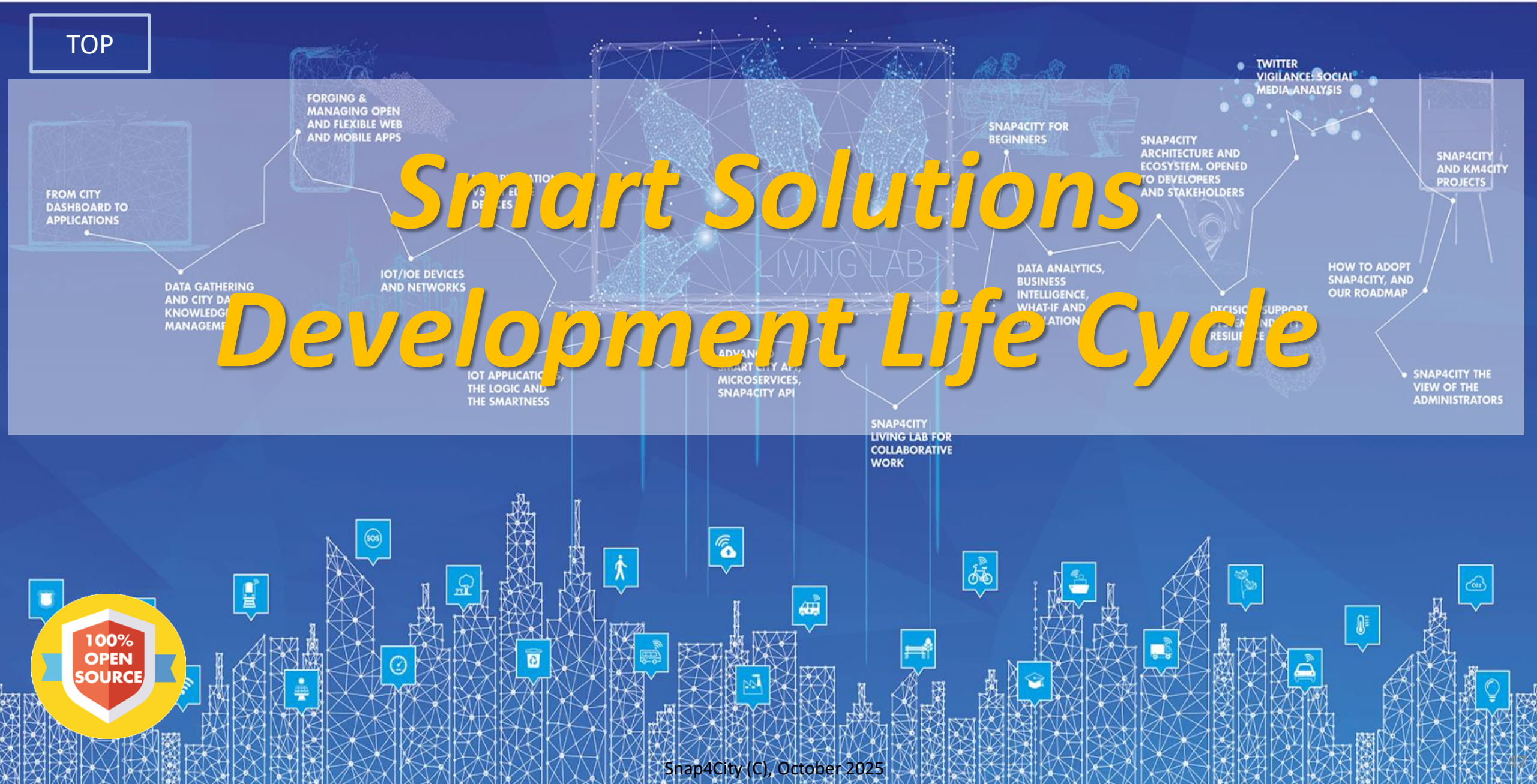
# Your Applications and IPR in Snap4City

- **Data Models**: Entity Models / IoT Device Models, Smart Data Models, etc.
- **Proc.Logic / IoT App**: data ingestion, adapter, transformation, wrappers, business logic, transcoding, integration, interoperability, algorithms, etc.
- **Data Analytics:** algorithm and processing in RStudio or Python, ML, AI, XAI, etc.
- **User Interface Design**: Dashboards, client-side business logic, Synoptics, widgets, templates, styles, etc.
- **Client-Side Business Logics (if any)** realized in JavaScript on Dashboard widgets.
- **Server-Side Business Logics (if any)** realized in Processing Logic as Node-RED and JavaScript.
- and the **data instances** for the High-Level Types.

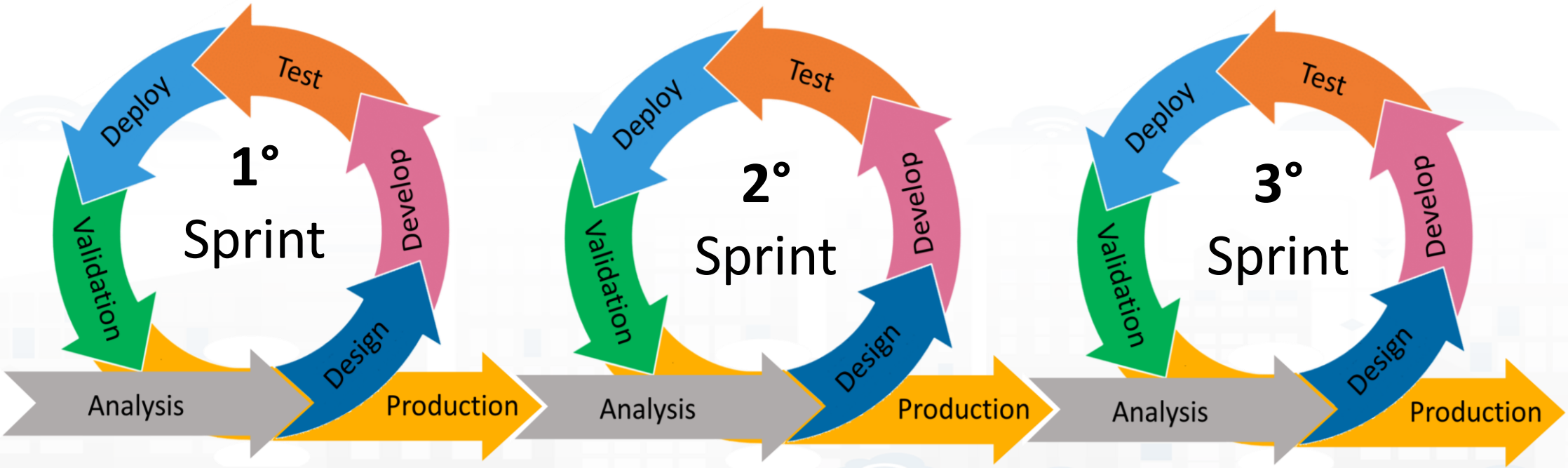

Presentation
Dashboards
Business Intelligence
Visual Analytics
Smart Applications
Web & Mobile Apps
Dashboard Themes
Dashboard Wizard
Compare
Measure
Custom Theme
Dashboard Mng.
Dashboard Builder
Widget Library
Scenario Editor
Synoptics
3D Digital Twin
CSBL
Interoperability
Snap4City Node-RED Libraries
ASCAPI
API Mng
MQTT
FIWARE
kafka
WebSocket
Operations
Operational Tools
Artificial Intelligence, DA Tools
MLOps, Dev. tools
Visual Analytic processes
Routing
BIM Server
Statistics
KPI Computing
Workflow Mng
Notifications
Predictions
Optimization
Simulate
Early Warning
.....
ML, AI,.. Libraries
SSBL
What-if
Business Intelligence
Internal Interoperability: API, MicroServices, WS
Snap4City Node-RED Libraries
ASCAPI
WebSocket
FIWARE
Persistence & Knowledge and Data Management
Data Inspector
Service Map
LOGraph
DevDash
SuperServiceMap
Data Management, HLT
OpenSearch
virtuoso
Ni-Fi
Linked Data triples
Aggregation
Data Process
Processes and Rules
Blockchain
IoT/Entity Directory
Harvester
Brokers
Brokers
FIWARE
MQTT
Any protocol and format
Any protocol and format
Connectivity: wired/wireless, IoT Edge, etc.
Any protocol and format
Any protocol and format
Proc.Logic / IoT Applications Data Flow Logic
Platform Management:
Authentication and Authorization: GDPR compliant
Participatory and Living Lab Supports
KEYCLOAK
OpenLDAP
GIS
BIM
OSM
Gateways
External Services
ERP
Social Media
Device Layer
External Third Party Services

TOP

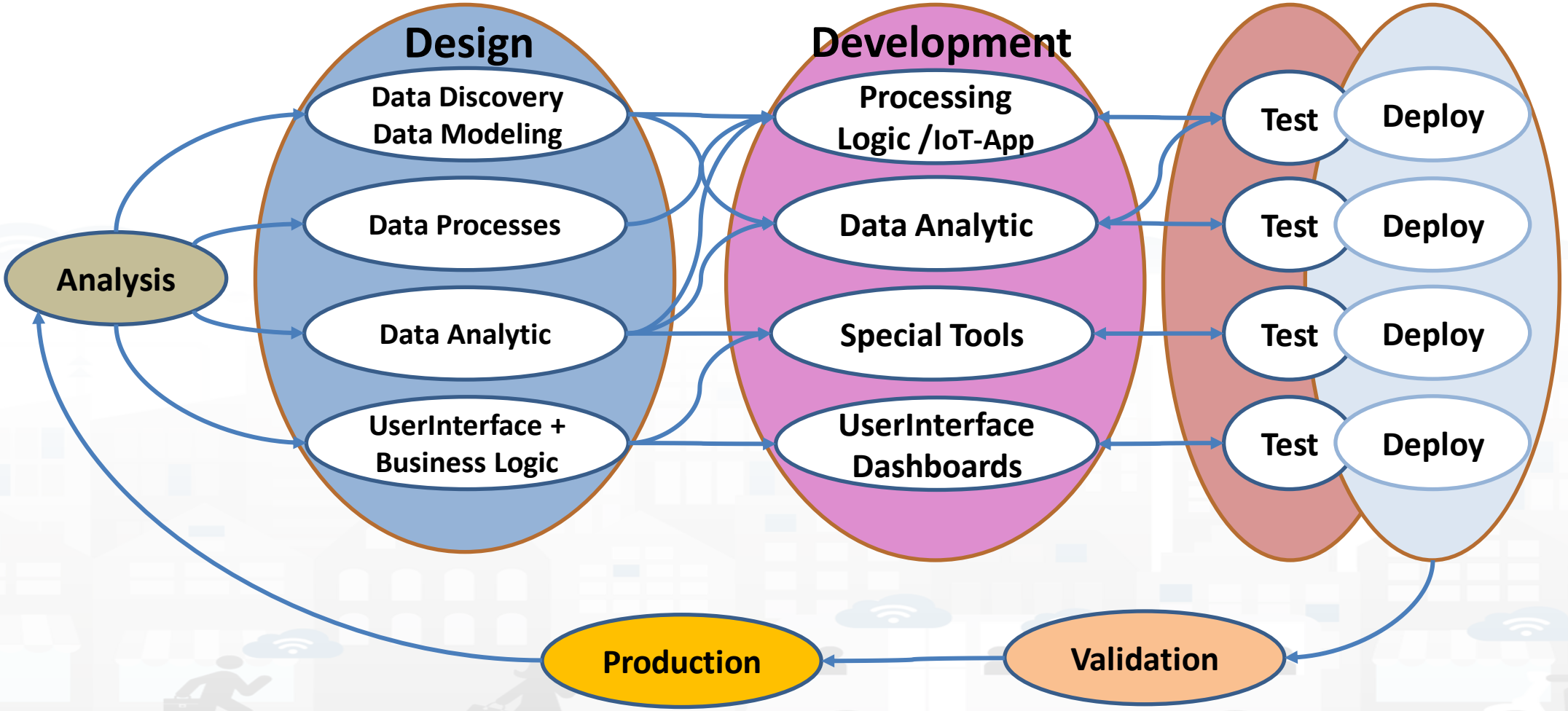
# Smart Solutions Development Life Cycle



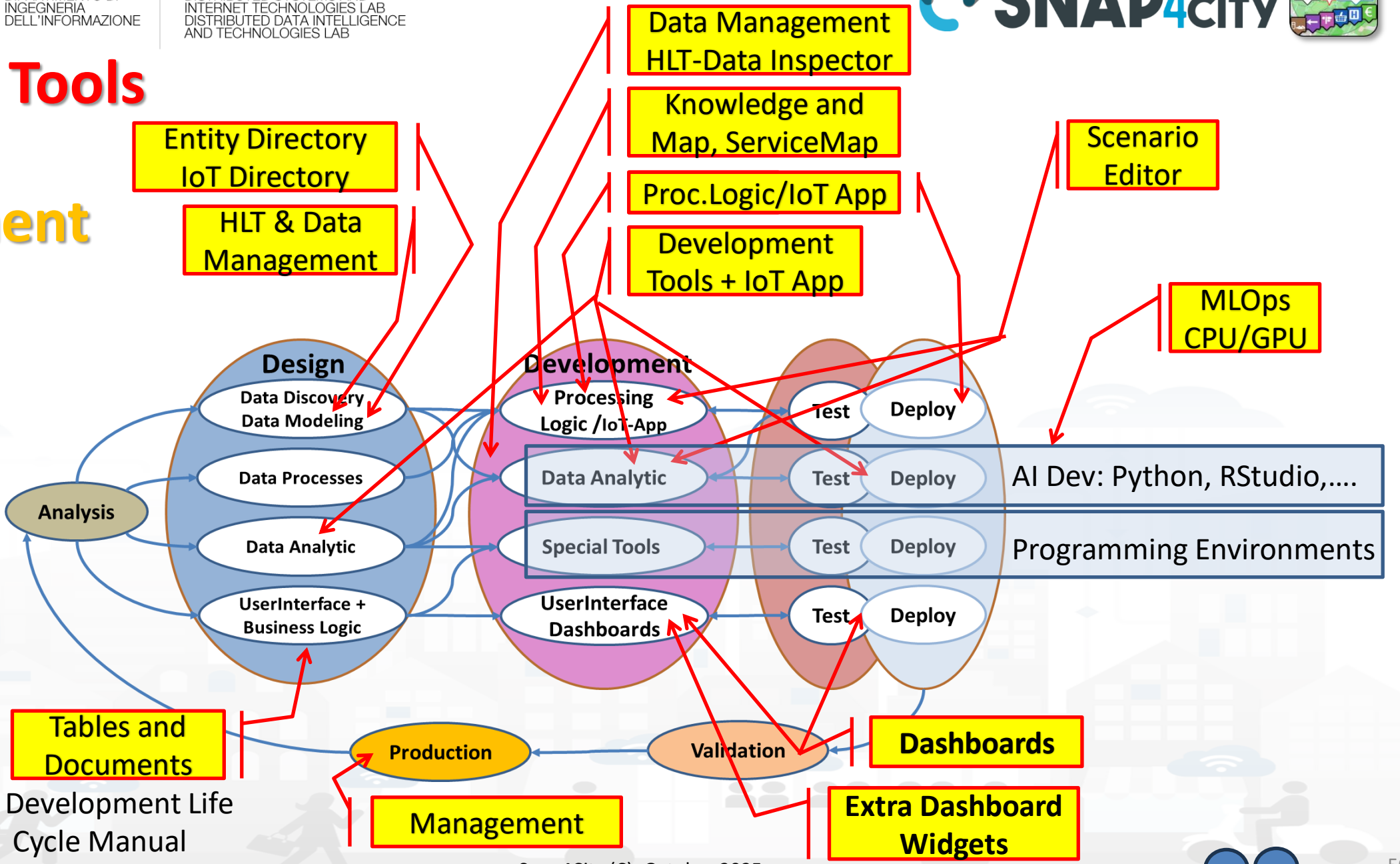
# Development Life Cycle
# Smart Solutions
# Agile: CD-CI, Continuos Dev – Continuos Improvement



# Development Life Cycle Smart Solutions



# Snap4City Tools vs Development Life Cycle



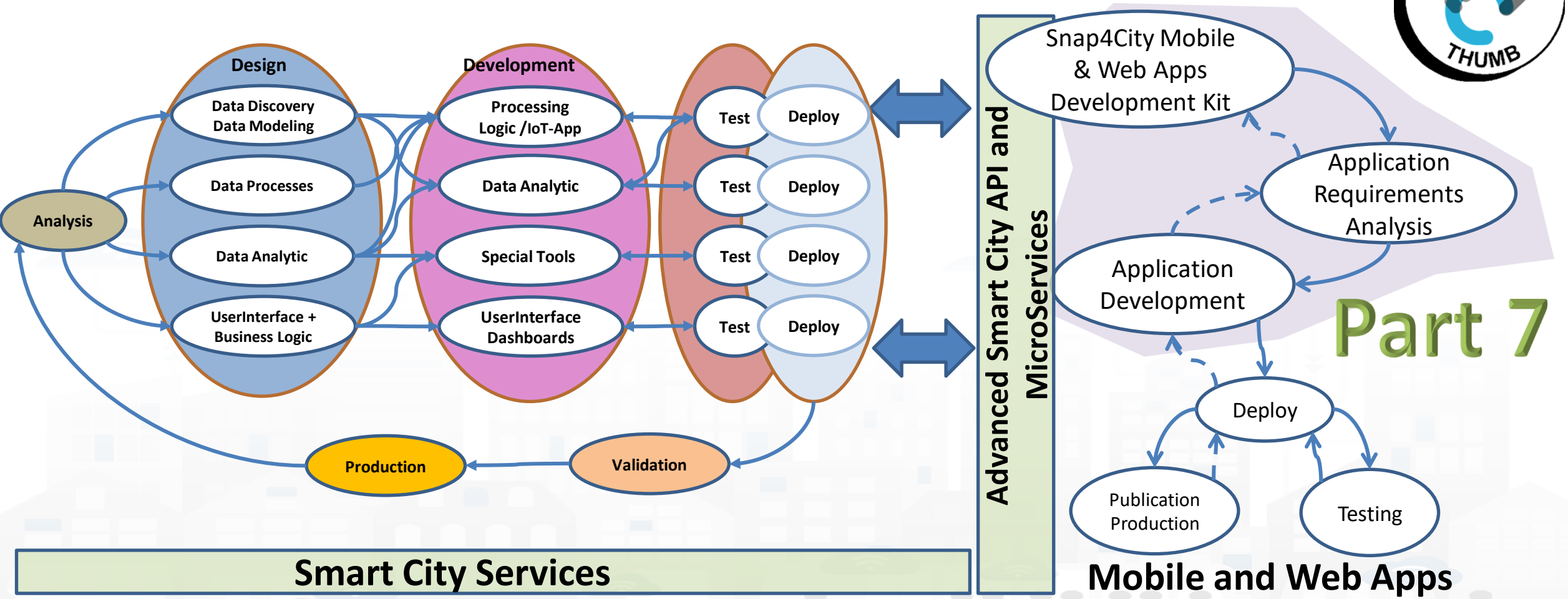
# Test & Deploy

- The activities of Test and Deploy are performed into the corresponding tools
  - **Processing Logic / IoT App Editor Node-RED** provides a button for Deploy and a Debug console for testing
  - **Data Analytics** are
    - tested on development user interface on RStudio and Python
    - Tested on Deploy when they are executed as container from IoT Apps
  - **Dashboards** are tested directly into the Dashboard editor and preview

# Validation and Production

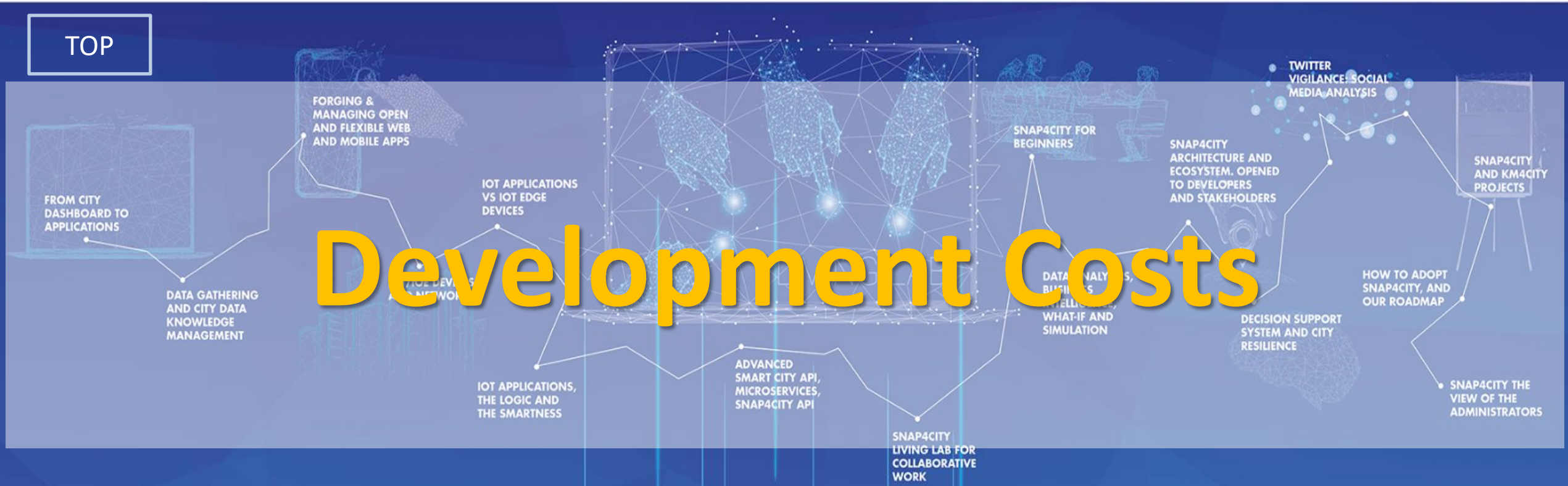
- Is the phase in which all components can be integrated and tested in their integration on the platform ready to be used in production.
- The **validation** should be performed verifying:
  - Functional Requirements
  - Non functional Requirements
- The **production** process is very easy in Snap4City since implies to provide access to the tools and services to final users you planned.
  - The grant can be performed on Dashboard Management and on IoT Directory, and on Data Management for the data.
- Once put in production the **Solution can be monitored** in deep on Dashboard usage, on data status, on IoT App, etc. See Part 6 of the training course.

# Develop Mobile & Web Applications Exploiting Snap4City Smart City Services



TOP

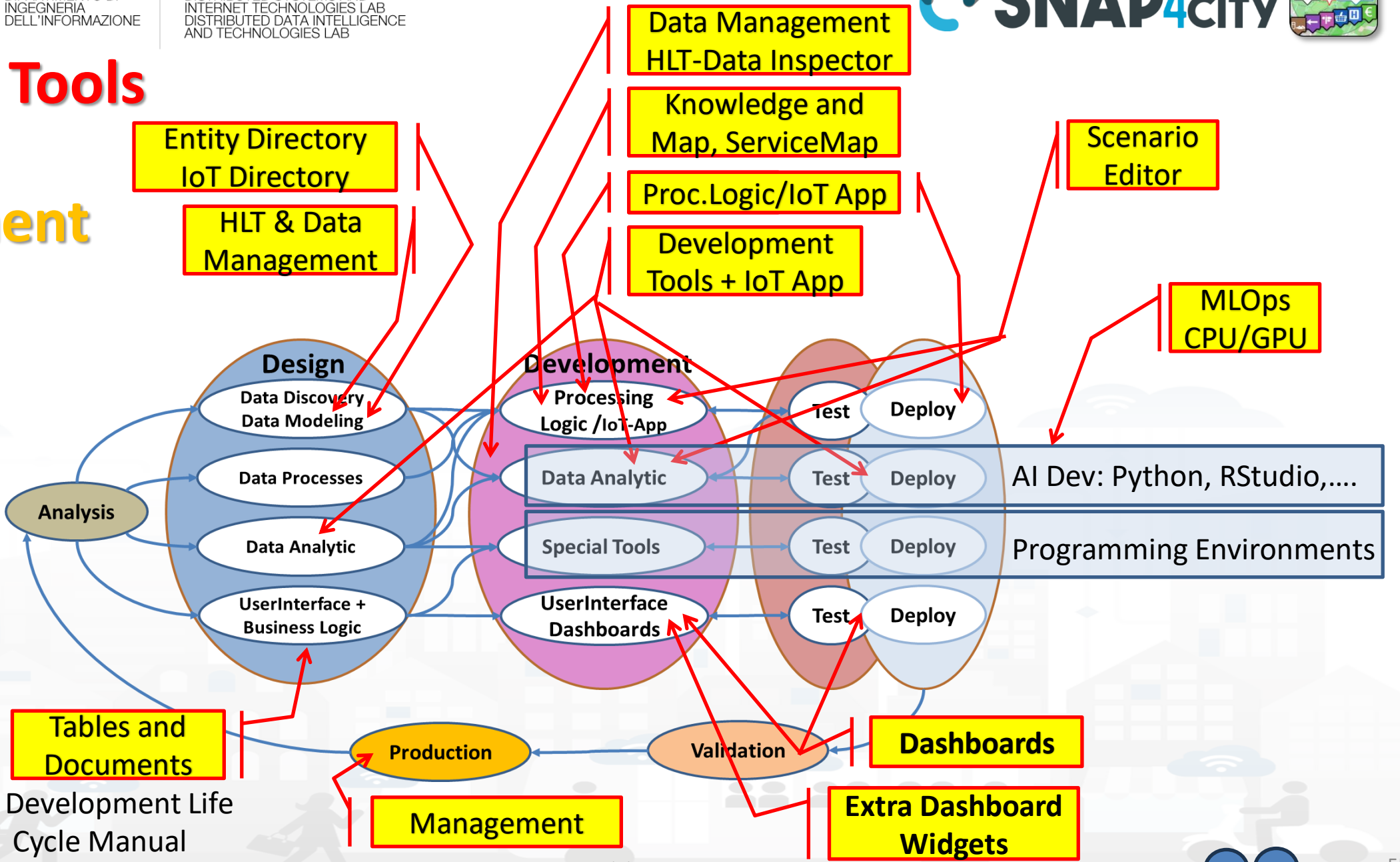
# Development Costs




100% OPEN SOURCE

SNAP4 Appliances and Dockers **Installations**

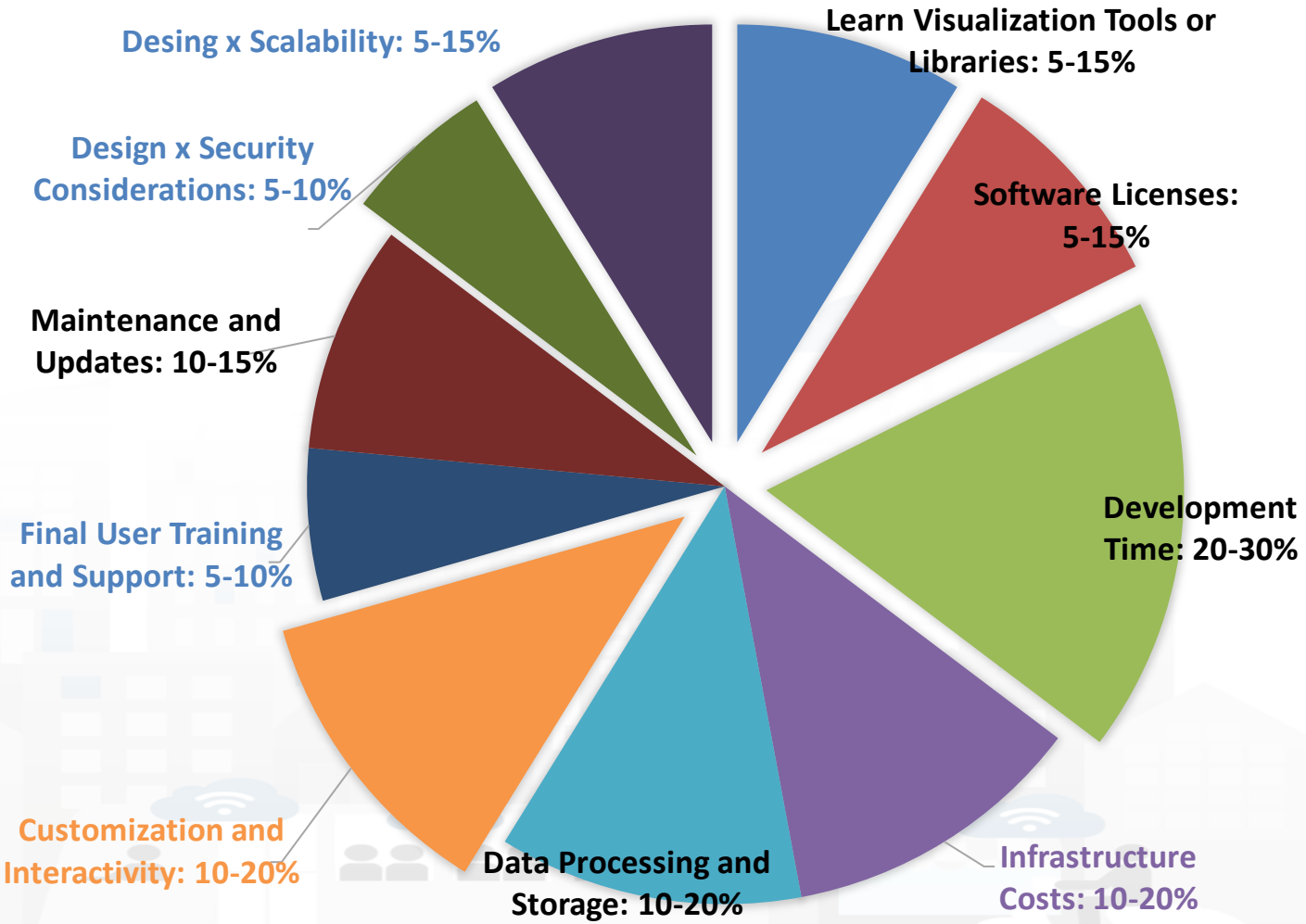
# Snap4City Tools vs Development Life Cycle



# Typical costs to setup operative conditions

- Learn Visualization Tools or Libraries: 5-15%
- Software Licenses: 5-15%
- Development Time: 20-30%
- Infrastructure Costs: 10-20%
- Data Processing and Storage: 10-20%
- Customization and Interactivity: 10-20%
- Final Users Training and Support: 5-10%
- Maintenance and Updates: 10-15%
- Design for Security/privacy: 5-10%
- Design for Scalability: 5-15%

- *In yellow, what is **not impacted***



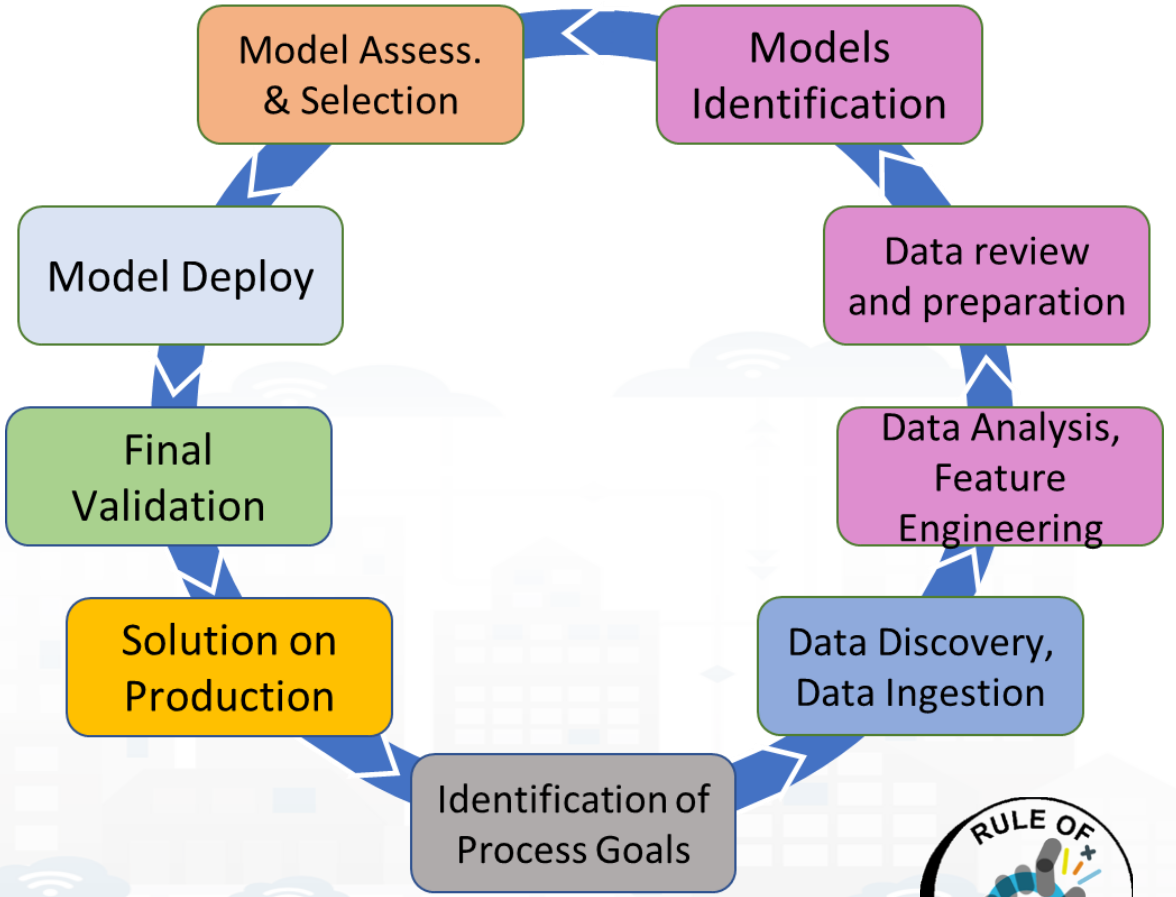
# Snap4City strongly reduces the effort/costs for

- **Learn Visualization Tools or Libraries**: 5-15% → **10%**
  - Visual tools, visual programming, training course, dev. Manuals, etc.
- **Software Licenses**: 5-15% → **0%**
  - Development environment fully open source
- **Development Time**: 20-30% → **5%**
  - Dashboard builder, synoptics, widget exchange, dashboard exchange, clone, delegations, etc.
  - Reused cloned and shared solutions, artefacts
- **Customization and Interactivity**: 10-20% → **10%**
  - Dashboards with Business Logic: CSBL, Node-red SSBL
  - Direct development of Business Intelligence without coding all details
- **Design for Security/privacy**: 5-10% → **only respect the guidelines**
  - Snap4City is end-to-end secure and GDPR compliant, all is already in place
- **Design for Scalability**: 5-15% → **only respect the guidelines**
  - Snap4City is scalable from Back-End to Front-End, all is already in place

- ***Reduction of: 45% for development effort of smart city solutions***

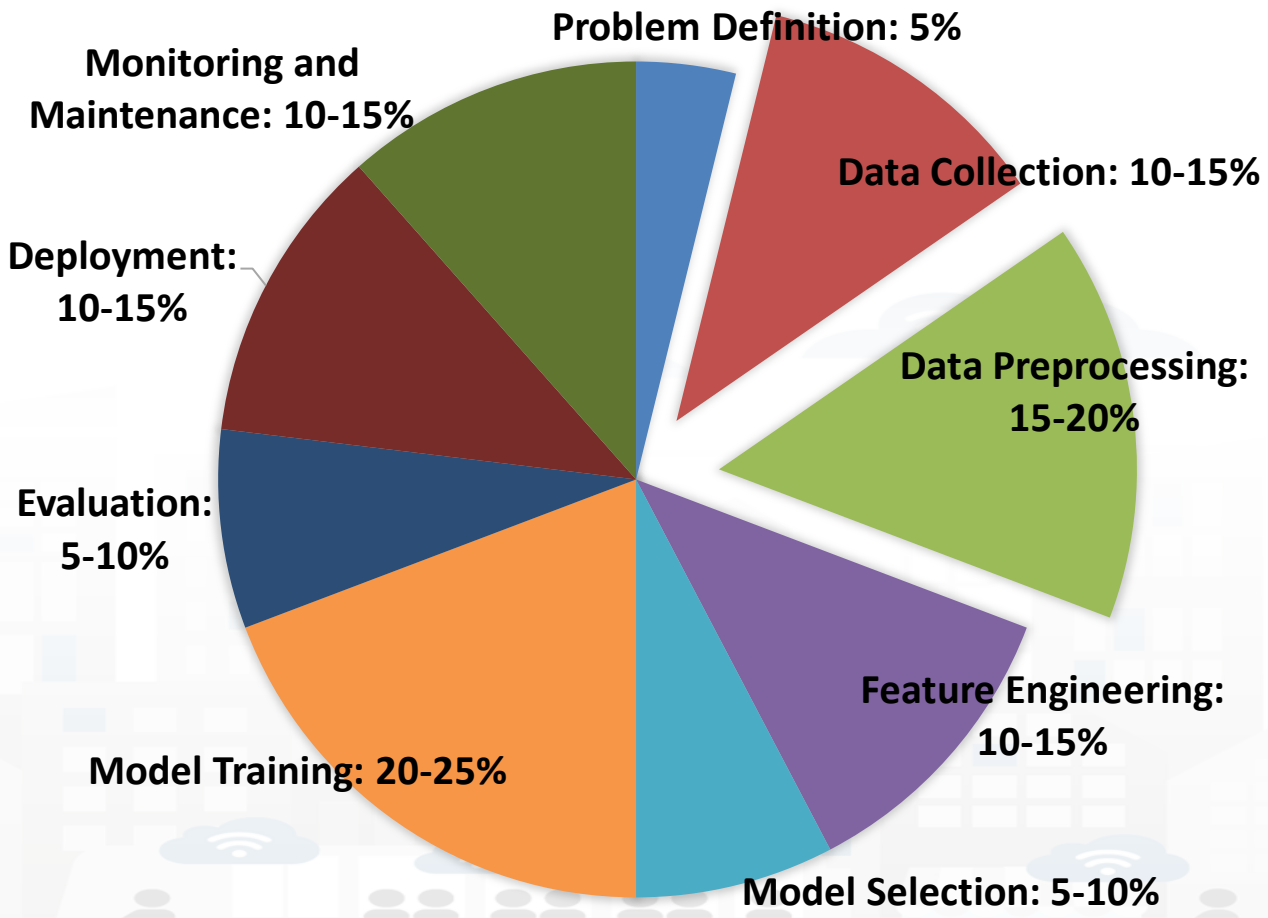
# Model/Technique Development/testing

- **Identification of Process goals and Planning (problem definition)**
  - Which goals
  - How to compute, which language
  - Which environment, which libraries
- **Data Discovery and Ingestion (from the general life cycle)**
  - Data Collection, Data Preprocessing if needed
- **Data Analysis: feature engineering, feature selection**
  - Data ethics assessment
- **Data review and preparation for the model, splitting, encoding**
- **Model Identification and building: ML, AI, etc….**
  - Model Training
  - Tuning hyperparameters when possible
- **Model Assessment and Selection (Evaluation)**
  - Validation in testing
  - Assessment on a set of metrics depending on the goals: global relevant and feature assessment
  - Assessing computational costs
  - Impact Assessment, Ethic Assessment and incidental findings
  - Global and Local Explanation via Explainable AI techniques
- **Model Deploy and Final Validation**
  - Optimisation of computation cost for features, if needed reiterate
  - Solution on Production (security, scalability, etc.)
- **Monitoring and Maintenance on production**
- **Documentation, incremental documentation**



# Typical Effort of Phases without Snap4City

- Please note the ***effort for Data Preprocessing and Data Collection***
  - 25-35%
- Please note that the **pie has not taken into account the effort** for creating
  - an actual **applications** or
  - simple **web results rendering** on dashboard

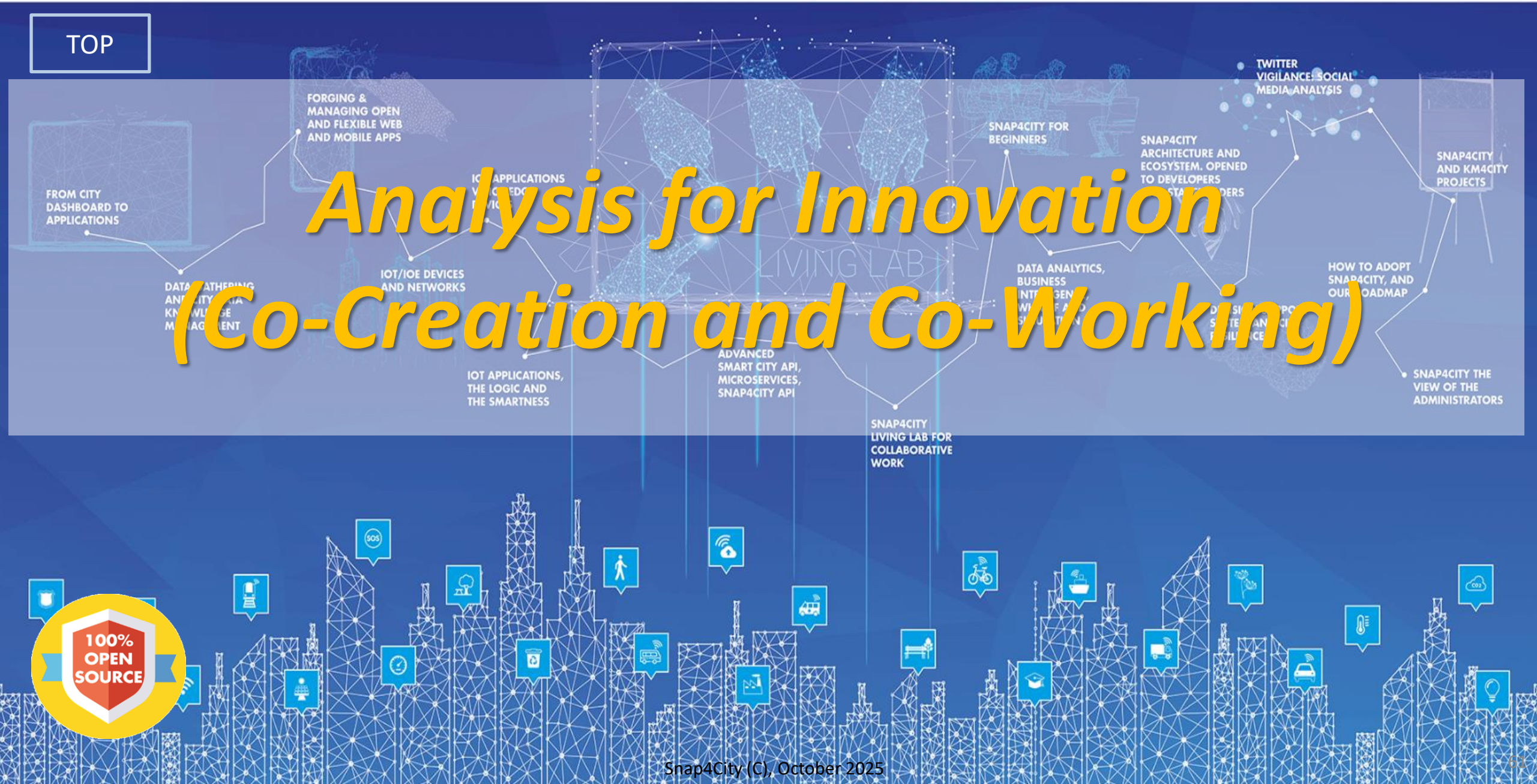


# Snap4City on *Data Collection and PreProcess*

- **Effort reduction from 25-35% to 10-15%, >55% reduction of effort for**
  - **Data Collection** via
    - Direct collection access with Brokers, harvesting of external brokers and data models
    - Usage of library of data models, more than 1700 models: saving analysis
      - Custom data models, massive automated construction of entities
    - Automated enrichment of Km4City Ontology and knowledge base: saving time analysis
    - IoT App / Node-red development of data collection processes: fast development
  - **Data PreProcess** via
    - Node-red visual programming (node.js) for preprocessing, transcoding, thousands of microservices and libraries, reuse of blocks and data flows, etc.
    - Semantic recovering of data relationships via semantic graph DB with Km4City models
    - Eventually usage of Python or R-studio or others when needed
  - *Reuse and share of Node-RED solutions, large number of cases*

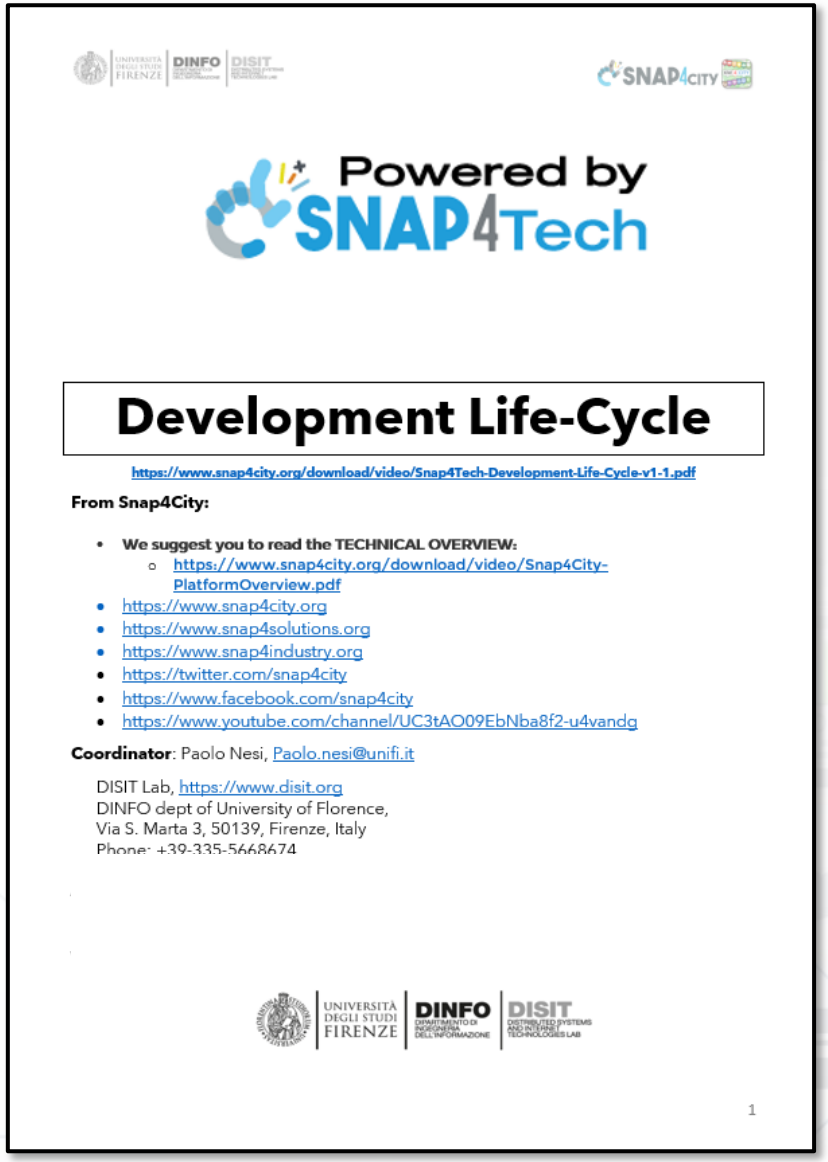
TOP

# Analysis for Innovation (Co-Creation and Co-Working)



# Development

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



Powered by SNAP4Tech

## 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

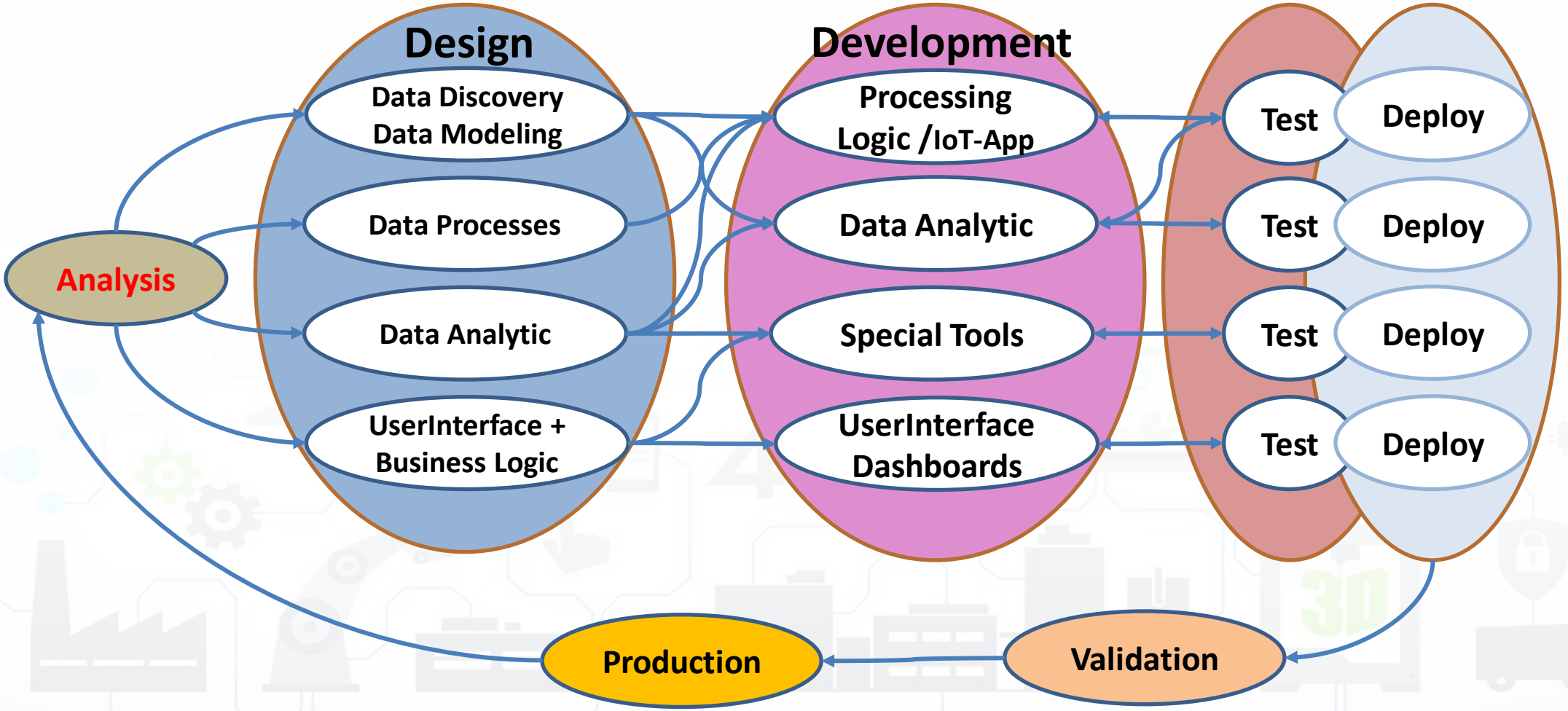
**Coordinator**: Paolo Nesi, Paolo.nesi@unifi.it

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

UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO | DISIT

1

# Development Life Cycle Smart Solutions



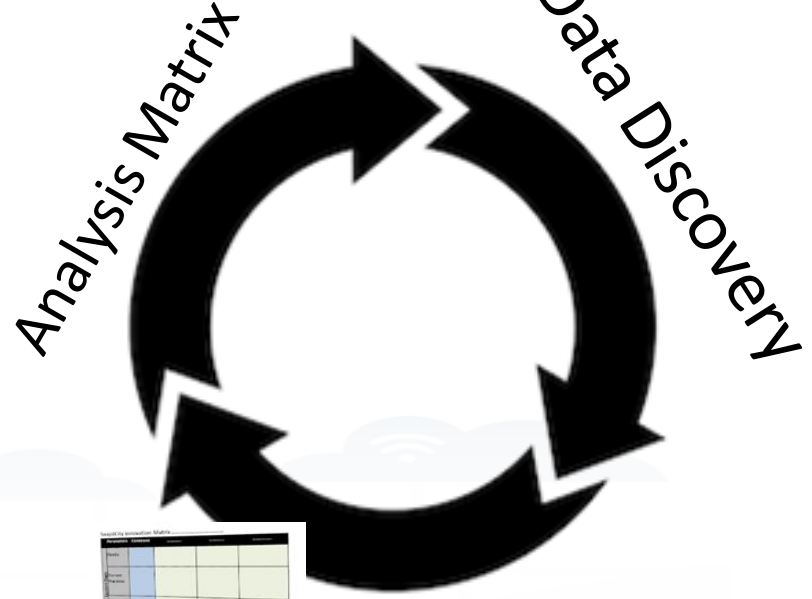
# Analysis 1/2

- **Performing workshops:** Innovation Matrix by domain
- **Entity Identification**: which is the **Dictionary**
  - **Actors and their profiles (as Entity Models, IoT Device Model):** User, Operator, final user, ict expert, decision maker, doctors, driver, etc.
  - **entities and their digital counterpart (as Entity Models, IoT Device Model)** for: Vehicle, Analysis, Server, Client, Mobile App, parking area, etc.
  - **Entity Instances / IoT Devices which are instances of the models** as: City user XX, Control Room Operator, Doctor Rossi, Cop 3726, Car FI796HG, IoT Device XY, Trip 34, Patient Health Record for Robert, etc.
  - **Modules or Tools** of Third party or legacy tools: they are applications, servers, IoT Edge subsystems, well known services for data providing, gateway, brokers, etc., which should interact some how with your solutions. They can be on cloud or on some premise, they can provide you some External API, of some kind: WebServer, Rest Call, FTP, Web Socket, MQTT, etc.
    - **External API:** to interoperate with any other application and service / servers.
    - **External Services / Web Pages:** to host into the user interface and Dashboards elements coming from third party applications.
    - **Tools:** which can be actual software or hardware tools, and also data analytics, algorithms, procedures.

# Snap4City Innovation Matrix and Process

## Part 6



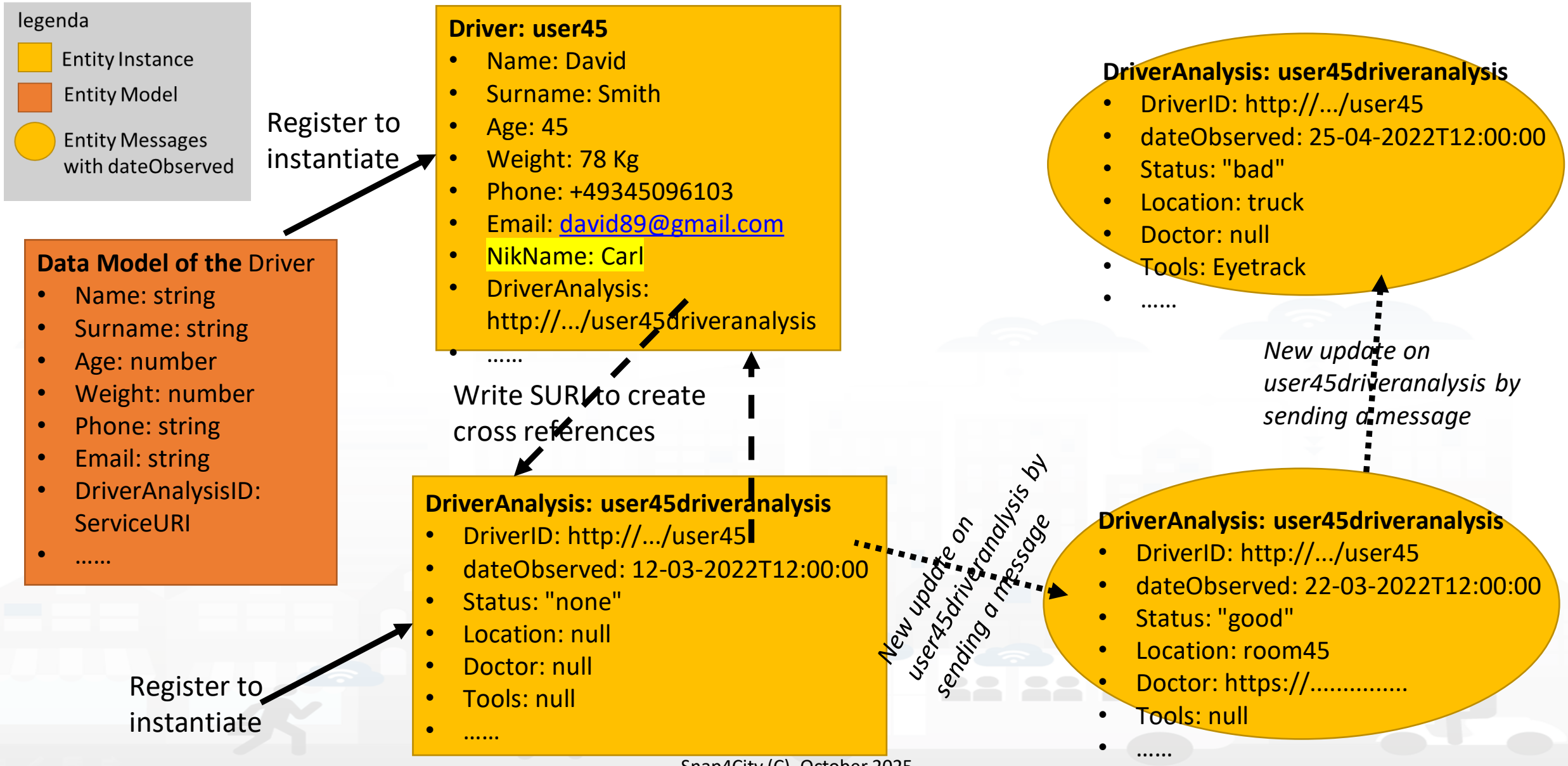


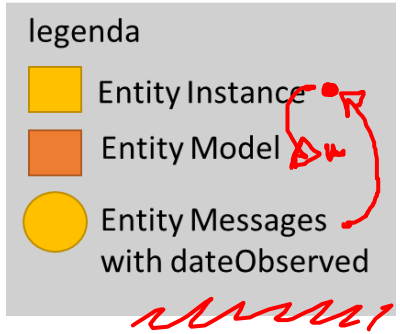

# The Dictionary of Entities

| Dictionary of Entities | | | | | |
|---|---|---|---|---|---|
| **Term** | DataModel or Module | Kind | Responsible | Status | Spec where |
| | | | | | |
| **Driver Healthiness** | DriverHealthiness | Entity Model | Dr. Rick Ross | To be done | To be defined |
| | | | | | |
| **User profile A** | DriverA | Entity Model | | | |
| | | | | | |
| **Vehicle Event** | VehicleEvent | Entity Model | | | |
| **Remote Consolle** | MyOperation | Application | J.T. Kirk | To be done | lost |
| | | IoT App | | | |
| | | Dashboards | | | |

Columns in green are expected to be filled in the design phase

- **For example:** *Let us now to suppose that we have to develop a solution for monitoring Vehicles and Drivers. Each Vehicle has a profile description and can be driven by a number of Drivers over time.* ***Each Vehicle*** *can experience some maintenance and performs trips in the city area. A trip has an official start/end and over time is described by its velocity, acceleration, brakes, charging level, or thank level, etc.* ***Each Drive****r has a profile and can use a number of Vehicles to perform trips. During the trip also the Driver is monitored for its healthiness, attention, etc., and before, during and after the driving, periodically or sporadically may experience some Analysis to certify its capability to drive in that moment and for the next days. The Driver may experience some warning cases for healthiness, some tickets from policeman, some warning for high-speed velocity or generically bad driving, some problems from the vehicle's status, etc.*


legenda
Entity Instance
Entity Model
Entity Messages with dateObserved
Register to instantiate
Data Model of the Driver
• Name: string
• Surname: string
• Age: number
• Weight: number
• Phone: string
• Email: string
• DriverAnalysisID: ServiceURI
• ……
Driver: user45
• Name: David
• Surname: Smith
• Age: 45
• Weight: 78 Kg
• Phone: +49345096103
• Email: david89@gmail.com
• NikName: Carl
• DriverAnalysis: http://.../user45driveranalysis
• ……
Write SURI to create cross references
DriverAnalysis: user45driveranalysis
• DriverID: http://.../user45
• dateObserved: 12-03-2022T12:00:00
• Status: "none"
• Location: null
• Doctor: null
• Tools: null
• ……
Register to instantiate
New update on user45driveranalysis by sending a message
DriverAnalysis: user45driveranalysis
• DriverID: http://.../user45
• dateObserved: 22-03-2022T12:00:00
• Status: "good"
• Location: room45
• Doctor: https://.....
• Tools: null
• ……
New update on user45driveranalysis by sending a message
DriverAnalysis: user45driveranalysis
• DriverID: http://.../user45
• dateObserved: 25-04-2022T12:00:00
• Status: "bad"
• Location: truck
• Doctor: null
• Tools: Eyetrack
• ……




Register to instantiate

**Data Model of the** Driver
- Name: string
- Surname: string
- Age: number
- Weight: number
- Phone: string
- Email: string
- DriverAnalysisID: ServiceURI
- ……

**Driver: user45**
- Name: David
- Surname: Smith
- Age: 45
- Weight: 78 Kg
- Phone: +49345096103
- Email: david89@gmail.com
- NikName: Carl
- DriverAnalysis: http://.../user45driveranalysis
- ……

Write SURI to create cross references

**DriverAnalysis: user45driveranalysis**
- DriverID: http://.../user45
- dateObserved: 12-03-2022T12:00:00
- Status: "none"
- Location: null
- Doctor: null
- Tools: null
- ……

Register to instantiate

*New update on user45driveranalysis by sending a message*

**DriverAnalysis: user45driveranalysis**
- DriverID: http://.../user45
- dateObserved: 25-04-2022T12:00:00
- Status: "bad"
- Location: truck
- Doctor: null
- Tools: Eyetrack
- ……

*New update on user45driveranalysis by sending a message*

**DriverAnalysis: user45driveranalysis**
- DriverID: http://.../user45
- dateObserved: 22-03-2022T12:00:00
- Status: "good"
- Location: room45
- Doctor: https://……
- Tools: null
- ……

# API, External Services

| External API | | | | | | |
|---|---|---|---|---|---|---|
| **API name** | API url and shape | Kind | parameter | Credentials approach | status | Description, Swagger link, Postman, … |
| | GIS… | | | | | |
| | CKAN… | | | | | |
| | | | | | | |

Columns in green are expected to be filled in the design phase

| External Services | | | | |
|---|---|---|---|---|
| **URL Web pages** | parameter | Description | Nature | Subnature |
| | | | | |
| | | | | |
| | | | | |

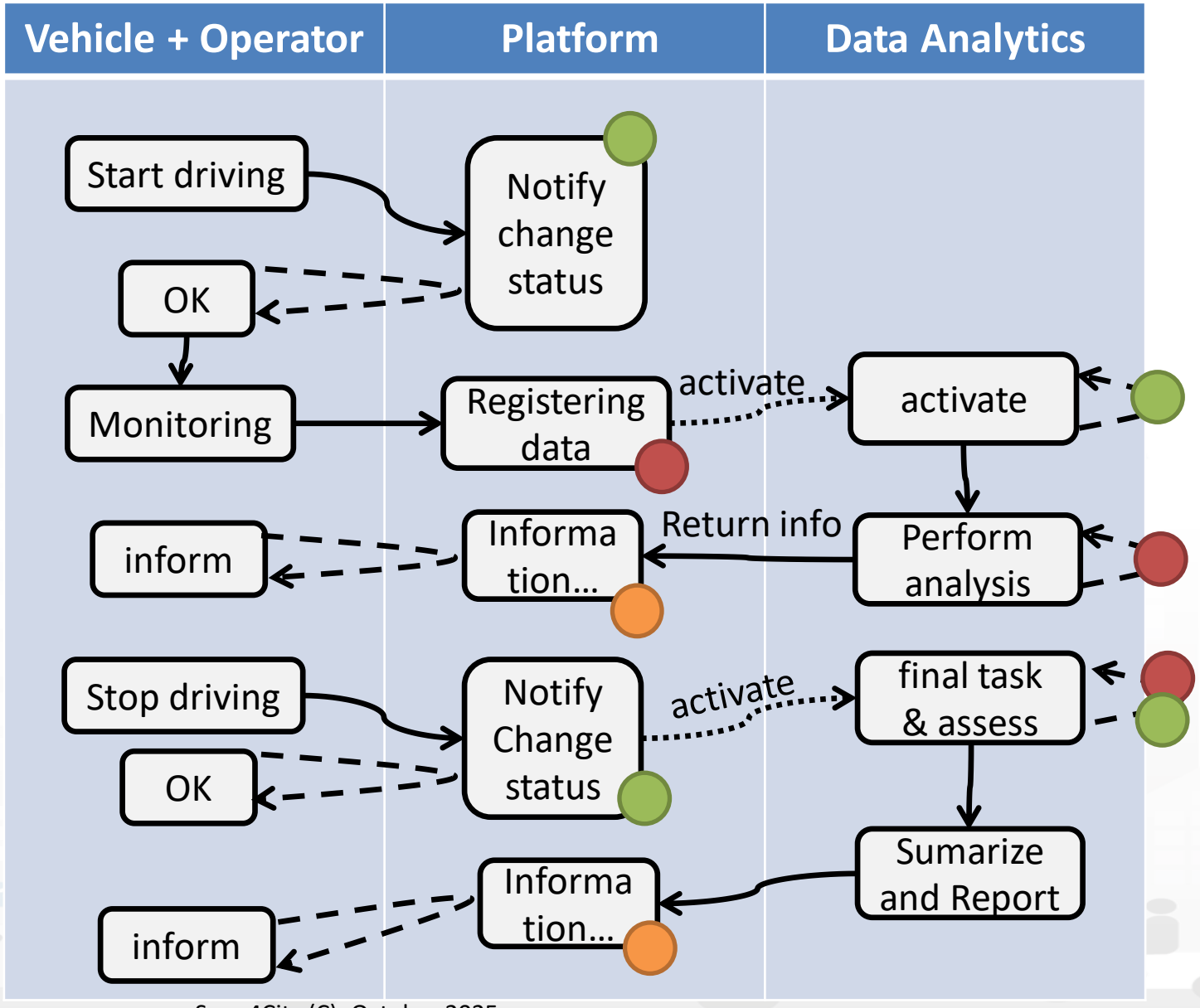
These info can be loaded on Snap4City platform to show them on dashboards easily

# Analysis 2/2

- **Scenarios** describing the application/task, textual definition, with some standard table as UML. The scenarios have to refer to identified entities.
  - https://www.uml-diagrams.org/activity-diagrams-examples.html
- **Use Cases** describing the different cases into the single applications, by using UML formalization, there are specific Use Cases for each Scenario. Please focus on the most relevant, those that are adding value to your solutions. The others can be given for granted in a first phase.
- **Requirements** by using standard tables, using identified **Dictionary** of **Entities**, prioritizing them, setting mandatory/preferred/optional, functional and non-functional, first/second/third release, etc.
- **Sequence Diagrams:** for some of the critical aspects- For example for describing the user interaction, and/or the interaction among major entities, putting in evidence which is the Entity starting the dialogue with respect to the other **Entities** involved (e.g., a client requesting data to the server, a device sending data to the broker). UML sequence diagrams are a suitable formalization for the purpose.
  - https://en.wikipedia.org/wiki/Sequence_diagram

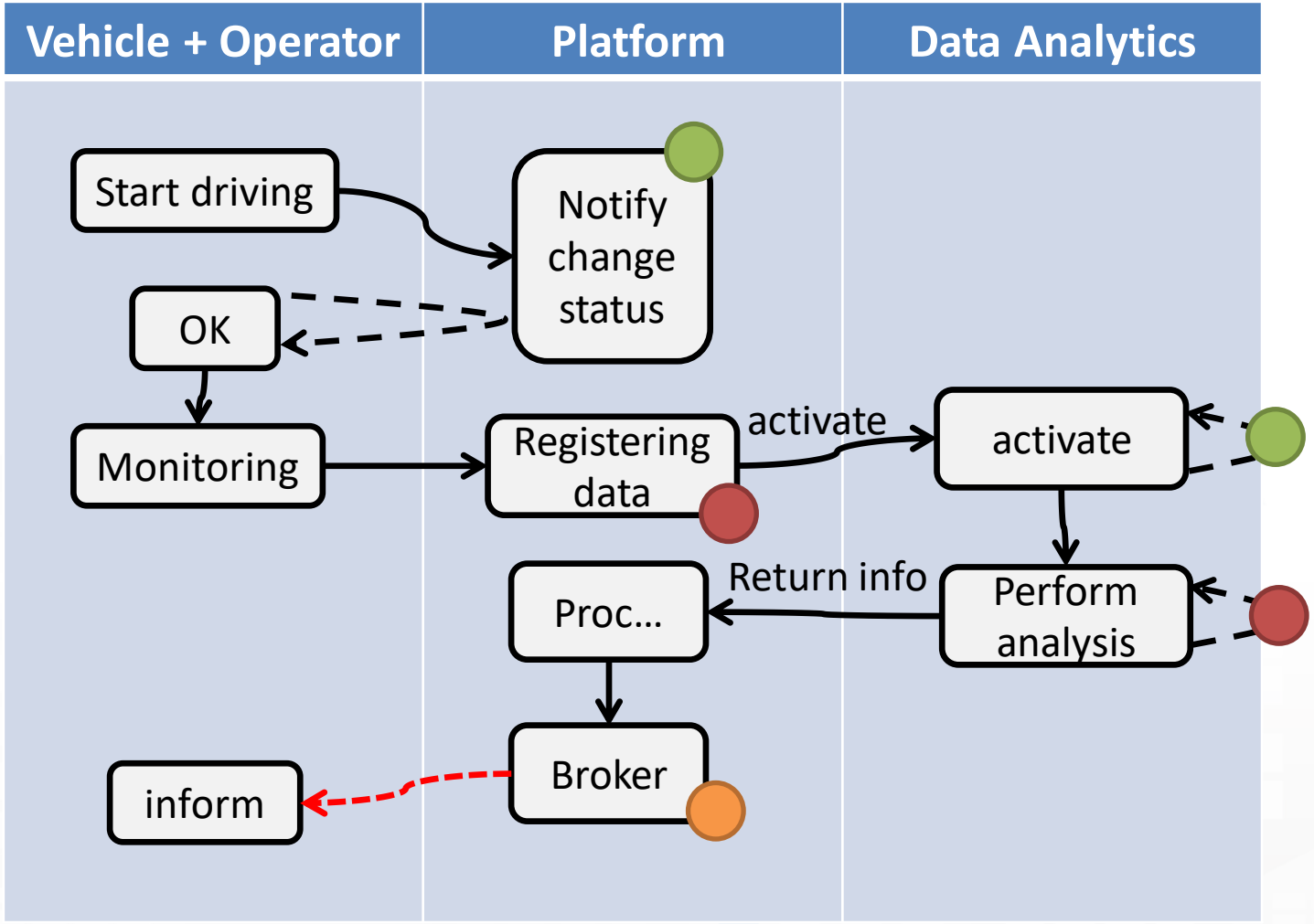
# Example: Activity Diagram

- **Continuous Lines** can denote event driven, sync communications… for example by sending data on IoT Broker
- **Dashed lines** can denote Pull data collected. Via Async. Communication from Platform to Mobile Devices, via SCAPI
- **Dotted line** can be even driven internal mechanism, internal call of API or other event drv.
- **Coloured Dots** are the different devices data storage



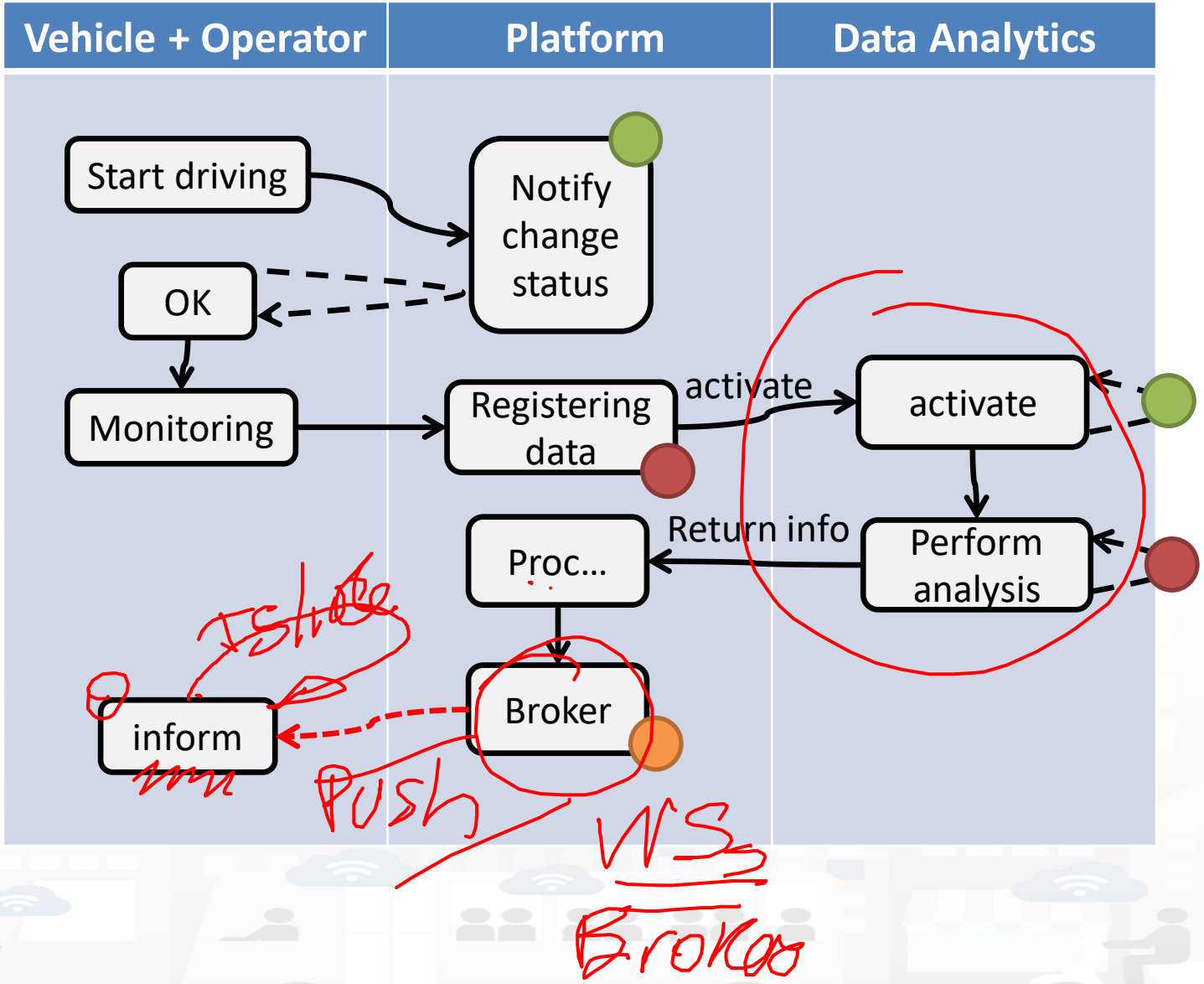
# A variant

- Every time a data is entered into the Storage an event occurs into the broker
- The server «Inform» can be subscribed from an IoT App to receive in push these changes **(red dashed line)**



# A variant

- Every time a data is entered into the Storage an event occurs into the broker
- The server «Inform» can be subscribed from an IoT App to receive in push these changes **(red dashed line)**



# The above figure

- The driver on its Mobile App, he/she marks the start of the driving section, and the App notifies the change of status to the platform via some broker, once performed all the needed verifications (taking some minutes, may be).
- The effective change and authorization to start is made accessible by the platform to the mobile app which is requesting the status in pull (dashed line).
- Then the mobile app starts to monitor the drive status continuously, and send new data (e.g., the level of attention, the road taken, etc.) to the platform via some broker every minute.
- The arrival of new data may activate some data analytics to perform some analysis of the collected data (red dots) and producing results on the platform data. In the case in which the process detected critical conditions for the driver, the assessment procedure on platform may decide to send an event/message (dashed red, in push from platform to clients) to the operator and driver via a Broker to warning the driving of the lack of attention or for some wrong path.
- The event in push from platform to client could be a viable approach on some platforms and may have some limitation on Mobile App in which the interaction paradigm can be changed in a periodic REST call from the Mobile to the Platform.

# Legenda on REST Call 1/2

- the **black continuous line** (push) will be used to send some data on the platform broker with a REST call which has to be Authenticated and Authorized according to the OpenId Connect as explained later, and would be in the form of:
  - https://<platformdomain>:8443/orionbrokerfilter/v1/updateContext
  - Or in the form for non TSL protected interaction:
    - *http://iot-app.snap4city.org:80/orion-broker/v1/updateContext?elementid=**ELEMENTID**&k1=**K1**&k2=**K2***
- the **black dashed line** (pull) will be used to request some data from the platform by using a REST call to smart city API (Authenticated and Authorized according to the OpenId Connect as explained later), in the forms:
  - via regular Smart city API by category, etc.
    - http://svealand.snap4city.org/ServiceMap/api/v1/?selection=59.581458578537955;16.71183586120606;59.62875017053684;16.875171661376957&categories=Street_light&maxResults=100&format=json
  - Via Super
    - https://www.disit.org/superservicemap/api/v1/?.....
  - Via Super by values
    - https://www.snap4city.org/superservicemap/api/v1/iot-search/?selection=43.77;11.2&maxDists=700.2&model=CarPark
  - https://www.snap4city.org/superservicemap/api/v1/iot-search/?selection=42.014990;10.217347;43.7768;11.2515&model=metrotrafficsensor&valueFilters=vehicleFlow>0.5;vehicleFlow<300

# Legenda on REST Call 2/2

- the **red dashed line** (push) will be used to send some data from the platform (from an Orion broker) to some stable IP client or other machine for machine-to-machine communication
  - As a first step the client has to subscribe to some entity on the Orion Broker passing its IP where the broker will have to send the data in push
    - The POST will be in the form of /v1/subscribeContext passing as parameters: elementid (the device ID, and K1, K2) or TSL approach
    - curl -X POST "https://broker1.snap4city.org:8080/v1/subscribeContext?elementid=mypersonaldatatester-device&k1=4e0924a8-fdd6-49cf-8d4a-f49cb5710d8b&k2=240567da-64a4-43b3-8ac9-1265178f3cbe" -H "accept: application/json" -H "Content-Type: application/json" -d "{\"entities\":[{\"type\":\"Ambiental\",\"isPattern\":false,\"id\":\"mypersonaldatatester-device\"}],\"attributes\":[\"temperature\"],\"reference\":\"http://prova/\",\"duration\":\"P1M\",\"notifyConditions\":[{\"type\":\"ONCHANGE\",\"condValues\":\"temperature\"}],\"throttling\":\"PT10S\"}"
  - Then the broker will send the messages to the subscribed client
  - it could be possible to have this kind of push also by using Kafka and/or WebSocket, but this is possible with simple and direct exposed API to all Snap4City platforms.
- **The external APIs of Snap4City are documented in Swagger**
  - **https://www.km4city.org/swagger/external/index.html**

# Fun Requirements

| Requirements | | | | | | |
|---|---|---|---|---|---|---|
| **ID** | Main Entity / Area | Description | Relevance / Priority | Main Tool-Module / Entity involved | Status | Source Code |
| **D1** | Operator | The Operator has to be authorized to register Drivers | mandatory | OperatorTool | Not developed | JavaScript by xxxx on GitLab …. |
| **D2** | Driver | The Drive can verify its registration by putting Password to access to its data on the solution | optional | Web and/or Mobile App accessible for the Drivers | accessible as open source | Yes In Java with AGPL licence |
| | | | | | | |
| | OperatorTool | Has to provide the list of pending assessment to be done | | | | |
| | | | | | | |

Columns in green are expected to be filled in the design phase

# Non Functional Requirements

Somehow related each other

- Protection, privacy, PENTest, GDPR compliance, …
- Scalability, performance, efficiency, cloud/edge/container compliance
- Resilience, robustness
- Modularity, flexibility, reusability, maintainability, ..
- Portability, Openness, opensource
- Interoperability, standards compliance
- Responsive, usability, ..
- Etc.

*All largely covered by Snap4City platform*

# Be carefull

- **Despite** the Snap4City platform provides a full range of Non-Functional Requirements
  - You can with your analysis and design produce poor solutions
- **For example, it is not a good approach to:**
  - Collect user profiles and putting them public
  - Collect data every 10 second of phenomena which change only once a day
  - Couple your web/mobile applications with server-side processes by using synchronous communication in a context which is not synchronous and neither real time

- ***As a general remark:***

***Do not worry*** *if at the first sprint of the above steps you forgotten to fill some details. It is quite sure that, you have also provided some details that would have to be revised/changed at the next iteration.*

*The suggestion is* ***start developing from the core parts****, which are the production of Entity Instances from the Entity Models, the ingestion of Entity Messages for the Entity Instances, etc., and detailing the most relevant and innovative Use Cases with respect to the state of the art.*

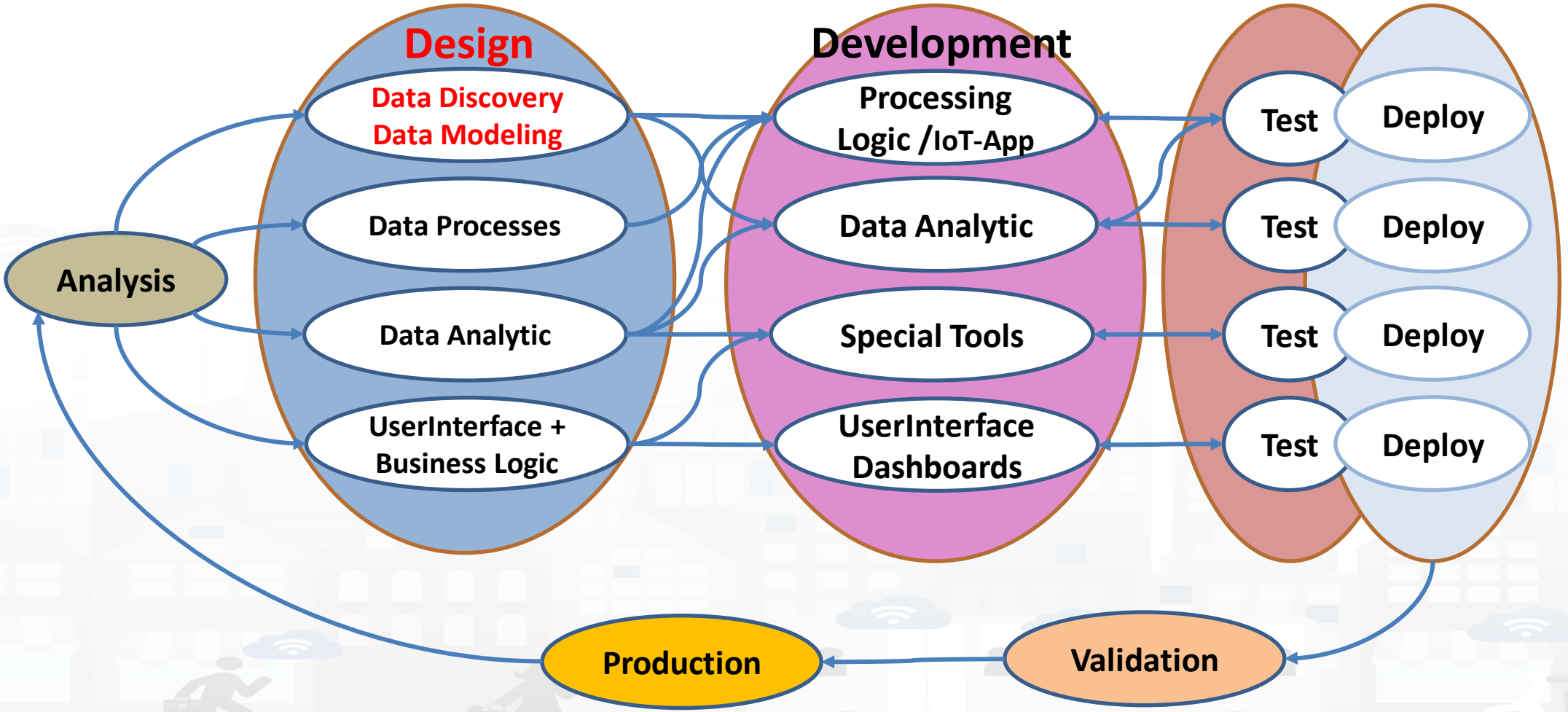
*They would leverage the smart solutions to a new level, at each sprint.*

TOP

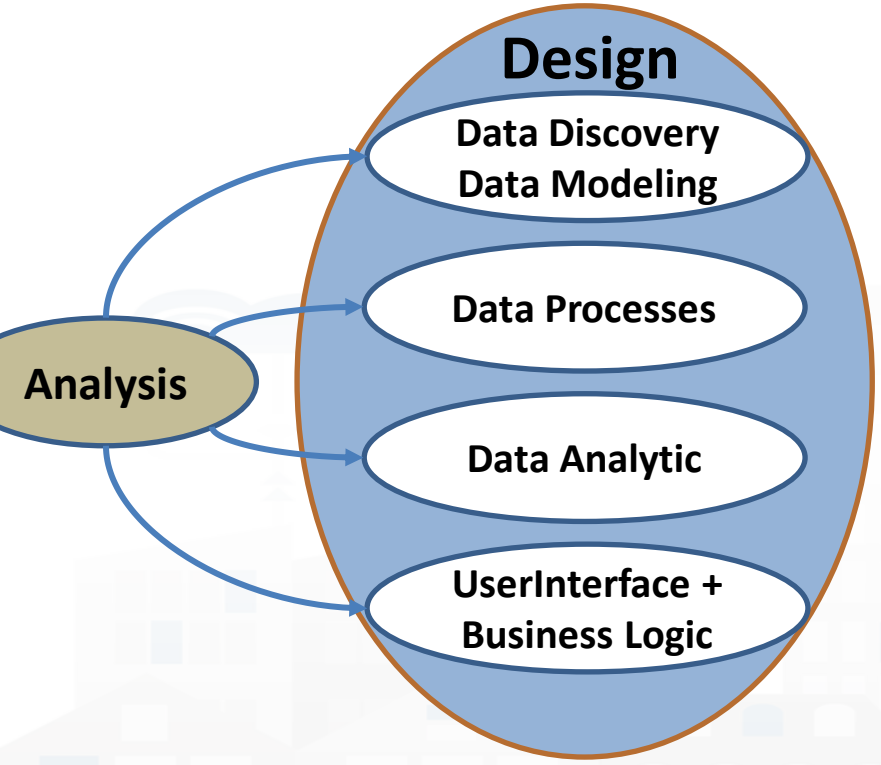
# Design: Data, Data Models, Data Relationships



# Development Life Cycle Smart Solutions

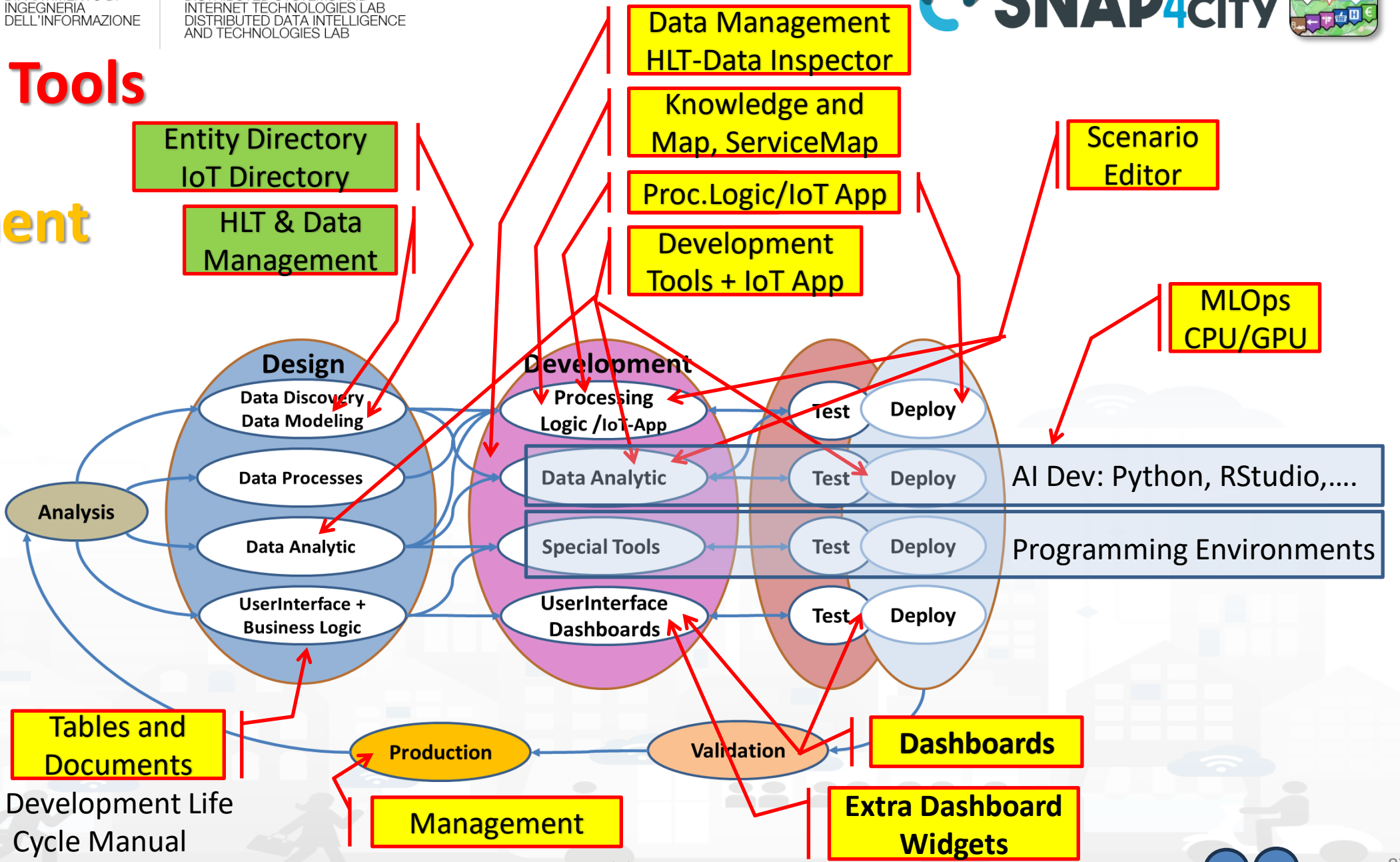


# Main Activities of Design




- **Data Discovery**: Ingestion, gathering, interoperability, discovery, modeling, aggregation, mapping → digital twin modeling
- **Data Processing**: transformation, interoperability; computing Indexes, KPIs and benchmarks, …
- **Data Analytic**: statistic, predictions, classification, anomaly detection, simulations, optimization, routing, ML, AI, XAI, HPC, …
- **User Interface:** dashboards, web pages, business intelligence, visual analytics, what-if analysis, business logic, mobile applications.

# Snap4City Tools vs Development Life Cycle



# Design: Data Discovery



# Data Discovery

- Performed by analyzing data from:
  I. identified scenarios from the **Snap4City Innovation Matrix**
  II. main organizations, third parties (via interviews)
  III. other stakeholders (via interview and web pages)
  IV. regional, national and international sources:
    I. open data portals, CKAN network, weather sources,
    II. IOT networks, etc. via web pages and sites
  V. Mobile Applications (via Snap4City API)
  VI. Snap4City portal Https://www.snap4city.org
  VII. Data market……
  VIII. etc.

- Exploiting Snap4City experience, data and tools
- By following the Snap4City guidelines on Data Search on web and world reported in the training course and on Snap4City.org portal.

# Data Collection per Domain/Scenario

| Description | domain | S/CO/RT | I/O | Type | Status | Referent | Provider | endpoint | Authentication | HL protocol | protocol | HLT | Format | Size | Volume | Rate | GPSed | foto | License / Condition of use |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Graph road | Energy | Static | In | Struct | Understood | Name Surname | Stakeholder ID | url | Simple | Push | Datex | Sensor | XML | 2 variables | 10Byte | Every 10 minutes | Yes | URL, | Public as CC… |
| Parking | Graph | Real Time | Out | Non struct | Acquired | Email | Staff or not staff | Broker | Certificate | Pull | WS | Sens-Actuator | JSON | 15 fields | 1245 Kbyte | Sporadic, max 1000 times per day | No | IMG | Link to file |
| Consumption of energy | Mobility | Combined | In/out | | Scheduled | Phone | Internal.. | | Etc. | | REST | KPI | GeoJSON | | | Periodic | Kind | | Private … |
| | Transport | RT stream | | | Tested | Etc.. | | | | | Custom | Personal Data | KMZ | | | 2 per day | Inside msg | | Restricted to … |
| | …. | RT Messages | | | Operative | | | | | | ODBC | Ext Srv | WFS | | | | Static … | | Sensible data |
| | | | | | Failed | | | | | | JDBC | IOT | WMS | | | | | | GDPR aspects |
| | | | | | Not needed | | | | | | | Virtual Sensor | GTFS | | | | | | |
| | | | | | | | | | | | | GIS | db | | | | | | |
| | | | | | | | | | | | | Heatmap | | | | | | | |
| | | | | | | | | | | | | Path, trajectory | | | | | | | |
| | | | | | | | | | | | | Trend | | | | | | | |
| | | | | | | | | | | | | …. | | | | | | | |

**Examples are provided per colum**.

The resulted raws may have not sense.

The status refers to the ingestion process.

# Design: Data Modeling

Part 4

Part 5

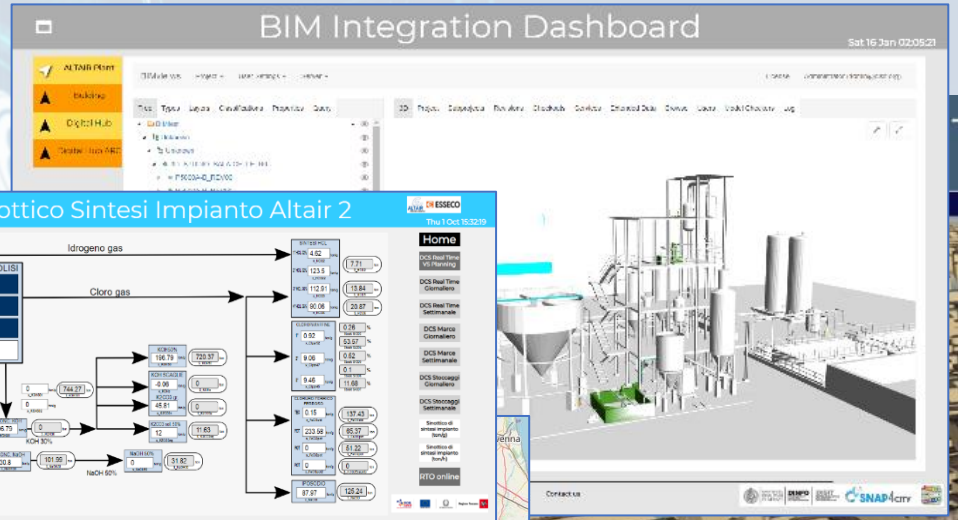


# High Level Types

Snap4City (C), October 2025

- POI, IOT Devices, shapes,..
  - FIWARE Smart Data Models,
  - IoT Device Models
- GIS, maps, orthomaps, WFS/WMS, GeoTiff, calibrated heatmaps, ..
- Satellite data, any kind..
- traffic flow, typical trends, ..
- Vector fields + heatmaps, ..
- 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, ..
- scenarios, ….
- etc.





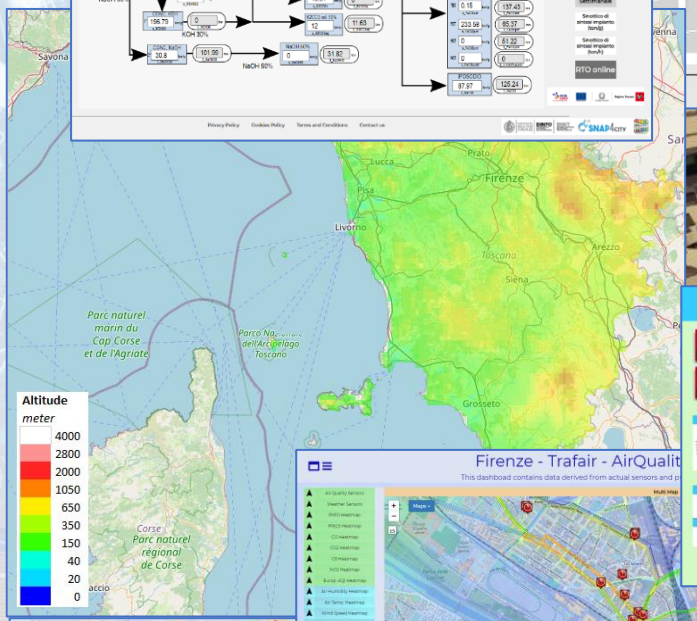












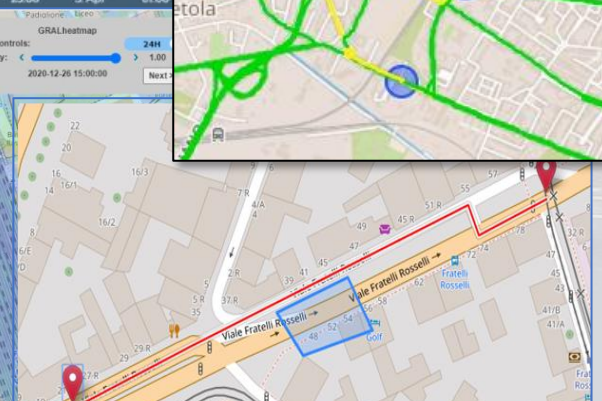












# Standards and Interoperability

**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, WCS, RTSP, ONVIF, AXIS TVCam, CISCO Meraki, OSM, Copernicus, The Weather Channel, Open Weather, OLAP, VMS Milestone, TIM, HERE, OGC, ….
- **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

# Parts 3, 5



## What About Entity Instances / IoT Devices, Time Series

Entity / IOT Device



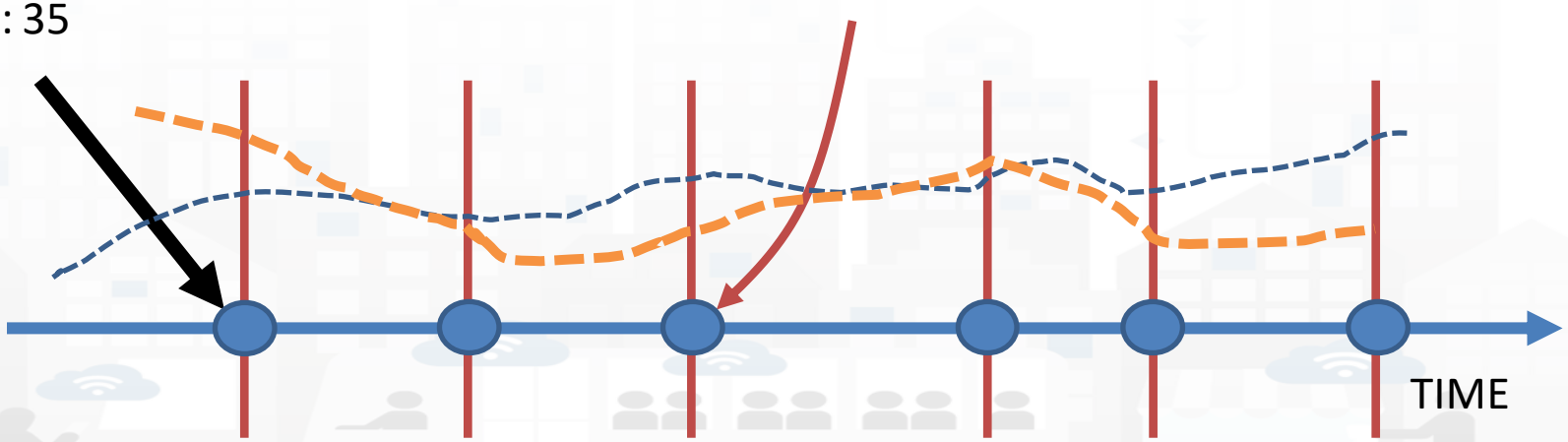
Entity: IOT Device

Sends a message

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

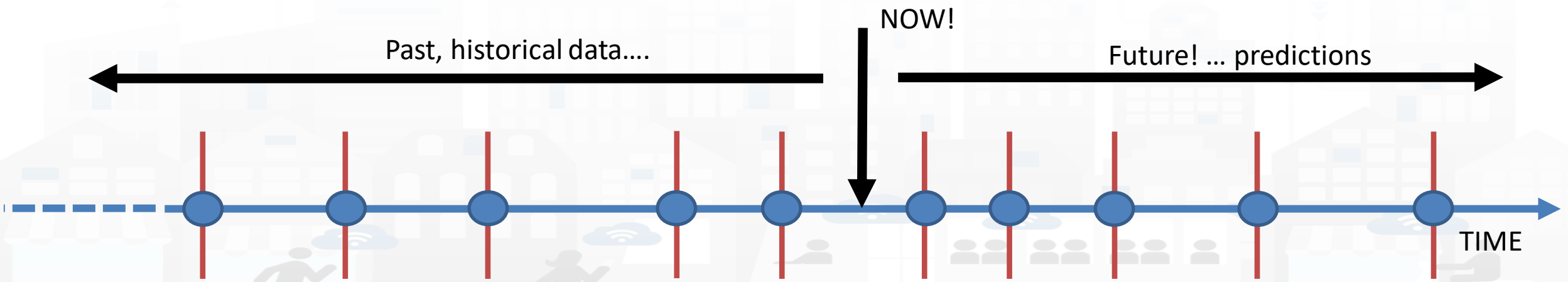
| dateObserved | Temp | Humidity |
|---|---|---|
| 02-04-2020 10:30 | 34.5 | 23 |
| 02-04-2020 10:40 | 36.5 | 24 |
| 02-04-2020 10:50 | 36.0 | 22.5 |
| | | |

- A set of data coming from an Entity Instance / 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 registered an Entity Instance / IoT Device
  - 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.
    - Loaded in PULL with some  File or Data Table Loader



# 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

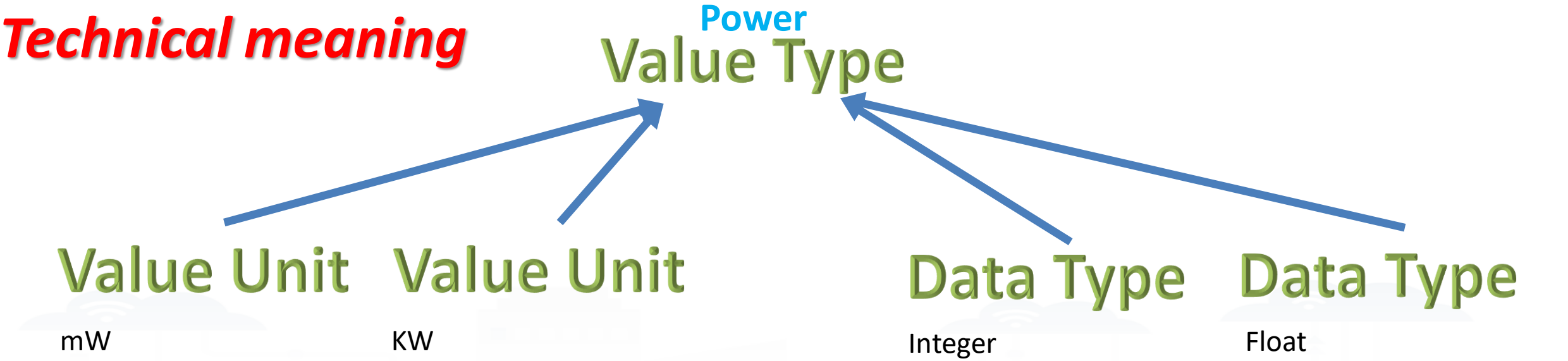
Ownership

Organization

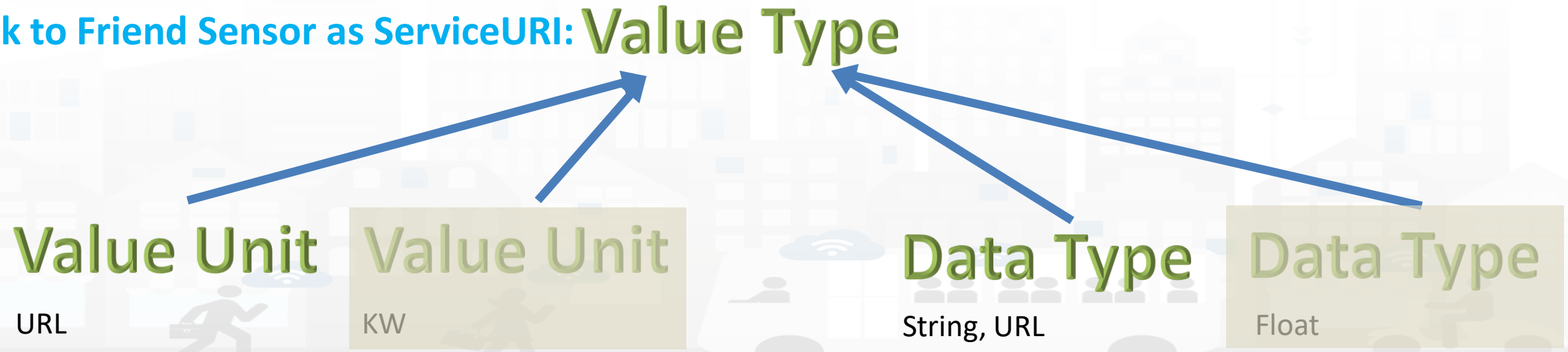
For Admin

# For example

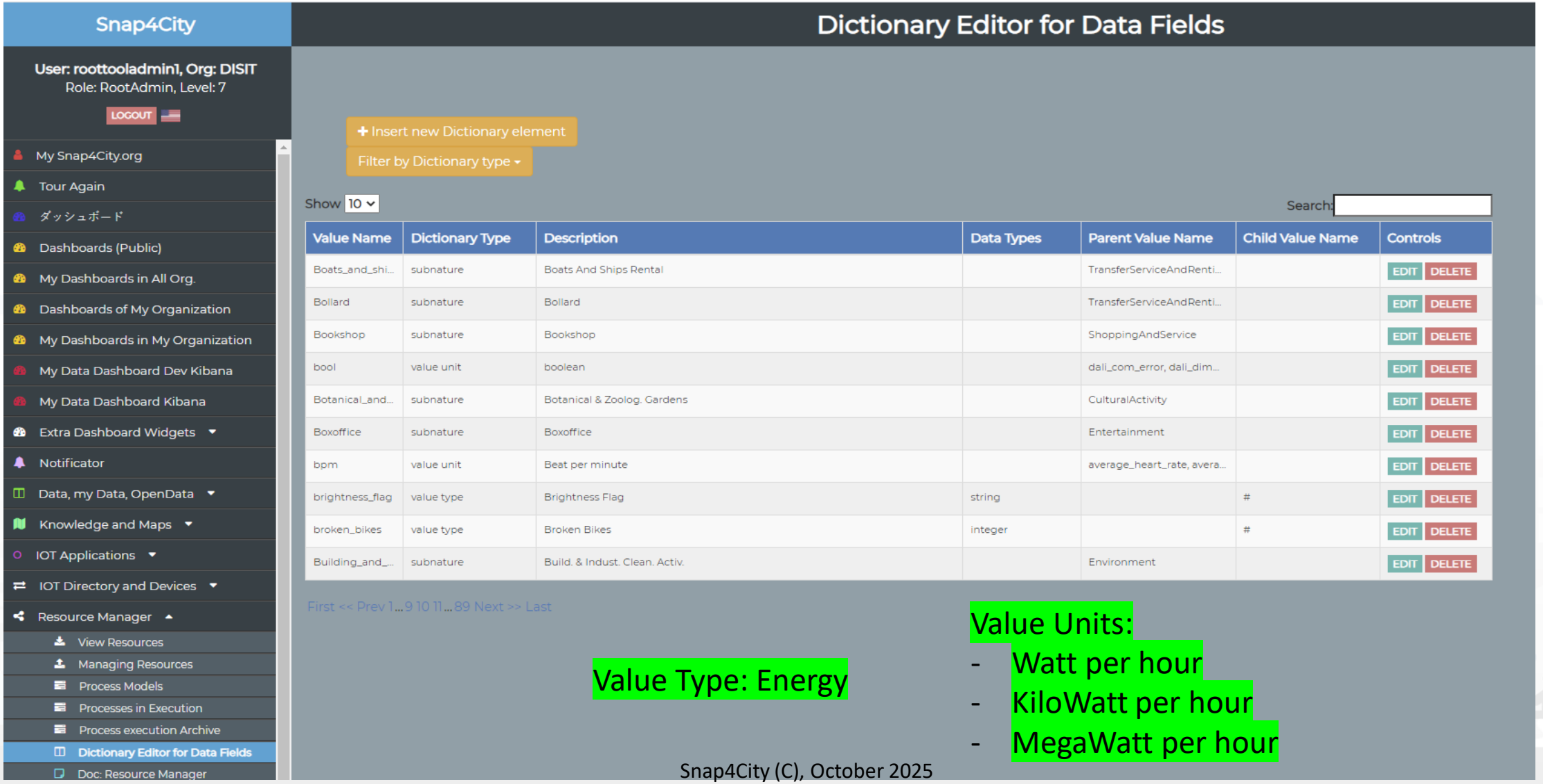
***Technical meaning***




**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), on/off as 1/0, etc.
  - **String**: url, links, names, id, descriptions, status code, SURI, etc.
  - **Json** Objects: structured data, vector, matrices, etc.
  - …..

# 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**

# 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 |

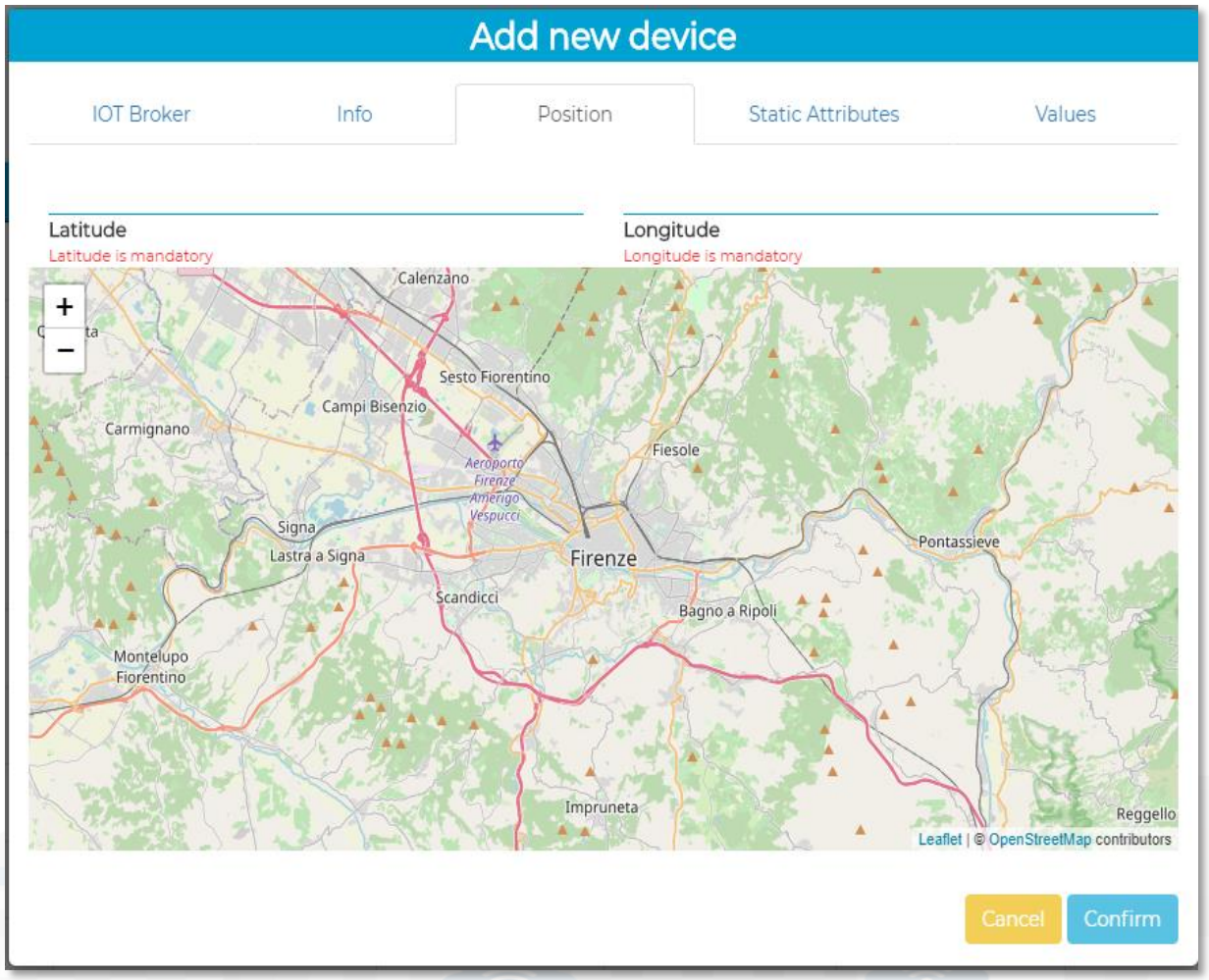
# Model meaning

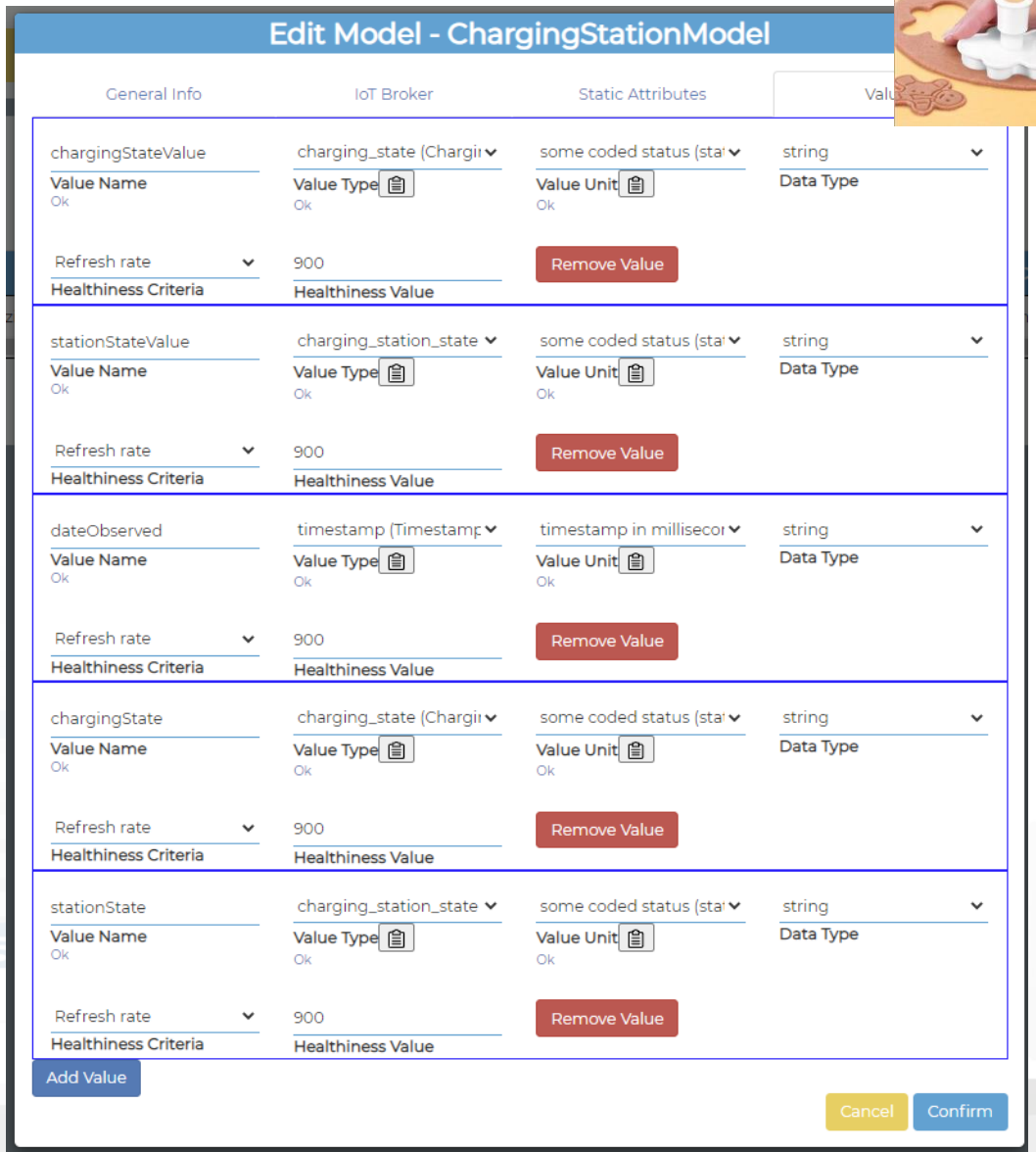


Parts 3 and 5

- **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 (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" |

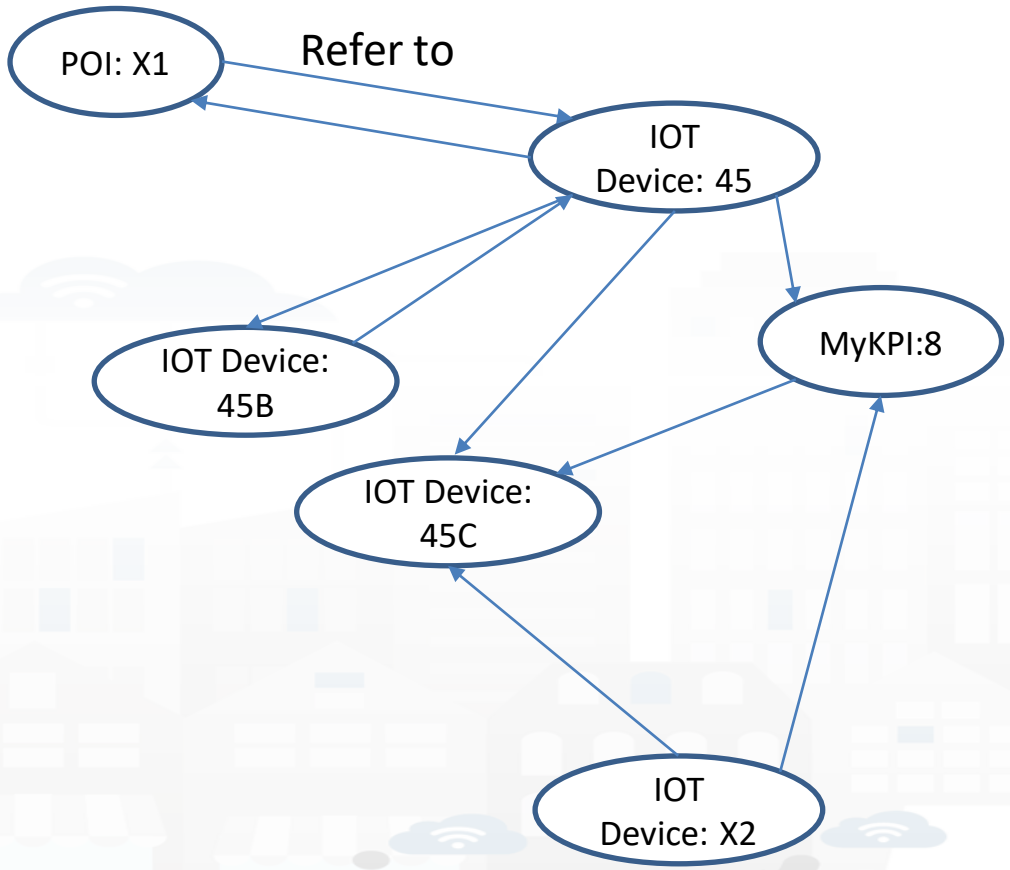
www.disit.org/km4city/resource/iot/traffic

- They are triples
- Subject-predicate-Object
  - Subject=SURI
  - Predicate=p
  - Object = o

# 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*

# Data Modeling example1



# Example 1

**IoT Device Model: Driver**
**Nature:…….**
**Subnature: ……**
**Lat,lon:** Default (they do not need to be specified in the variables, they are provided by default, but values have to be imposed at the instantiation of the device from model), they are float
**Device in Mobility:** No (the variable do not need to be specified, while the value has to be set to state if the Lat,Lon are going to change, moving the device or not)

| Value_name | Value Type | Value Unit | Data Type |
|---|---|---|---|
| **dateObserved** | **Timestamp** | **Timestamp in ms** | **String** |
| identifier | ID | text | String |
| name | entity | text | String |
| surname | entity | text | String |
| age | age | number | Integer |
| sex | status | some coded status | String |
| language | entity | text | String |
| email | entity | text | String |
| phone | entity | text | String |
| address | entity | text | String |
| locality | entity | text | String |
| city | entity | text | String |
| nationality | entity | text | String |
| civicNmber | entity | text | String |
| dateofBorn | DateTime | Timestamp in ms | String |
| gender | status | some coded status | String |
| driverHelthiness | Identifier | ServiceURI | String |
| driverEvent | Identifier | ServiceURI | String |
| driverAnalysis | Identifier | ServiceURI | String |
| Vechicle | Identifier | ServiceURI | String |

# Example 2

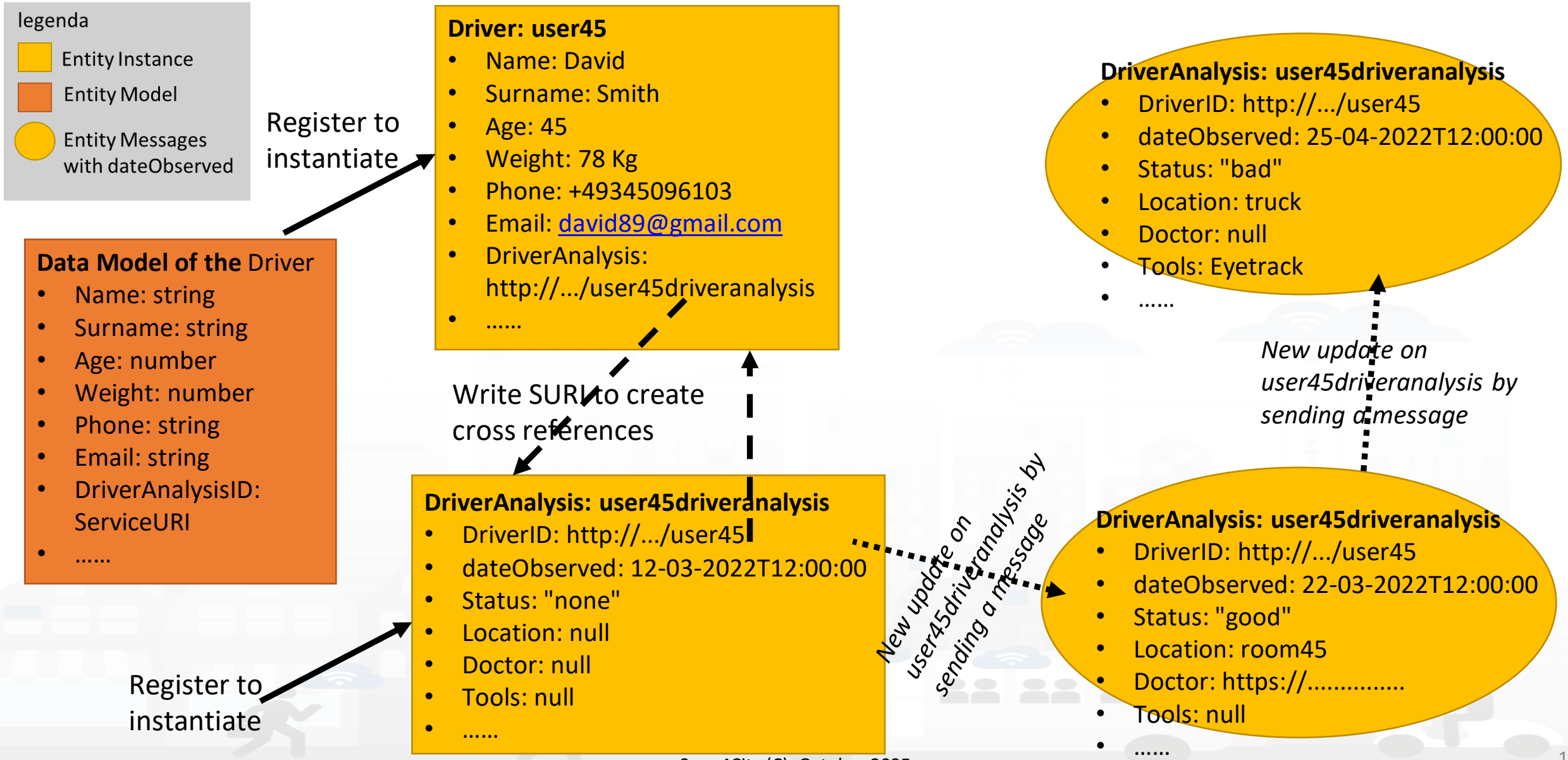
| IoT Device Model: driverHelthiness<br>Nature:……<br>Subnature: ……<br>Lat,lon: ……<br>Device in Mobility: …… | | | |
|---|---|---|---|
| Value_name | Value Type | Value Unit | Data Type |
| dateObserved | Timestamp | Timestamp in ms | String |
| kind | | | |
| levelAttentionFactor1 | | | |
| levelAttentionFactor2 | | | |
| | | | |
| | | | |
| driver | Identifier | ServiceURI | String |

# Example 3

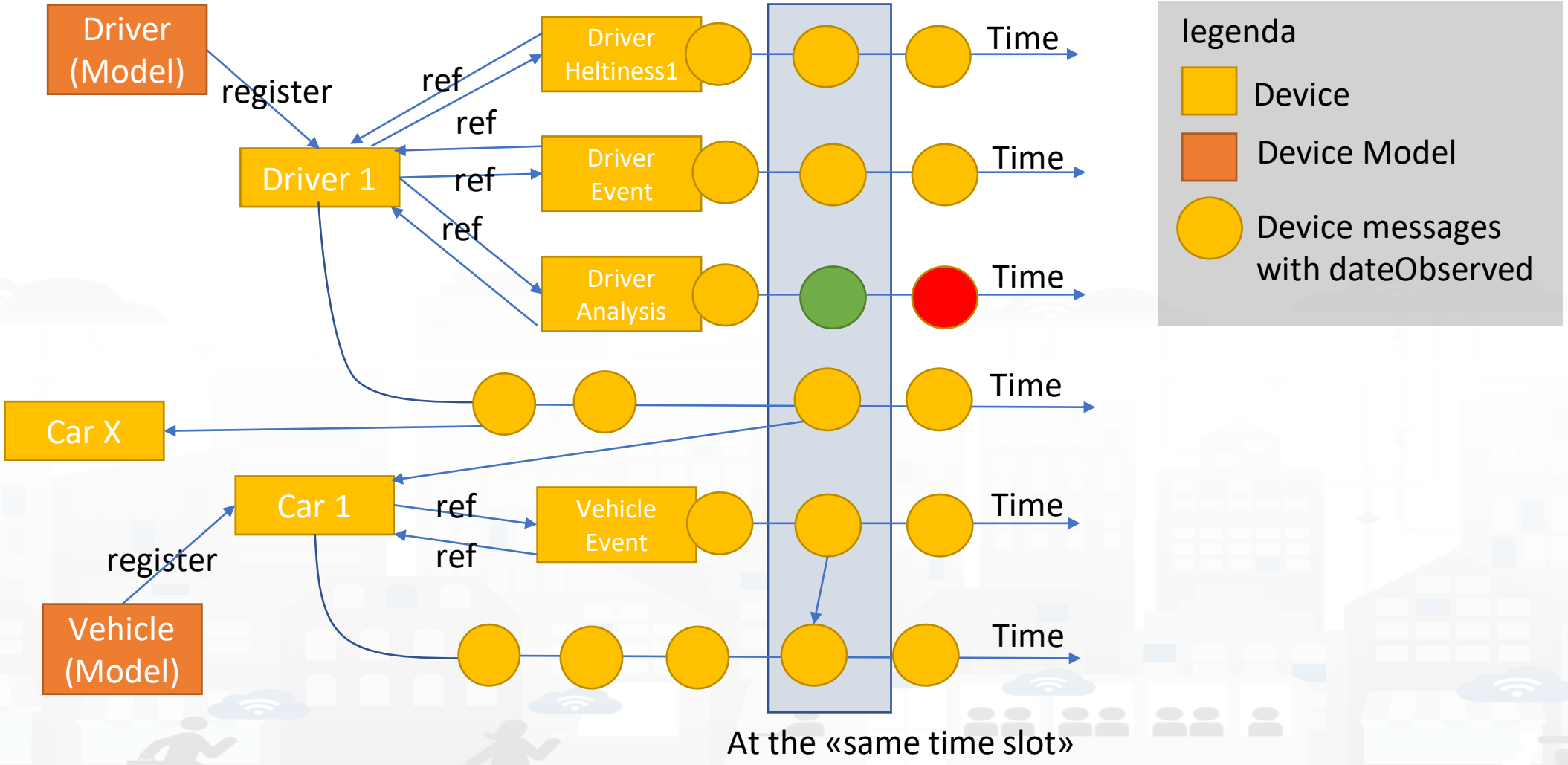
| **IoT Device Model: Vehicle**<br>**Nature:……**<br>**Subnature: ……**<br>**Lat,lon: ……**<br>**Device in Mobility: ……** | | | |
|---|---|---|---|
| Value_name | Value Type | Value Unit | Data Type |
| dateObserved | Timestamp | Timestamp in ms | String |
| producer | entity | text | String |
| model | entity | text | String |
| plate | entity | text | String |
| companyID | entity | text | String |
| velocity | velocity | km/h | float |
| acceleration | acceleration | m/s2 | float |
| Status | status | some coded status | String |
| energyLevel | energy level | percentage | Float |
| kmTotal | distance | km | Float |
| thankLevel | energy level | percentage | Float |
| vehicleEvent | Identifier | ServiceURI | String |

# Example 4

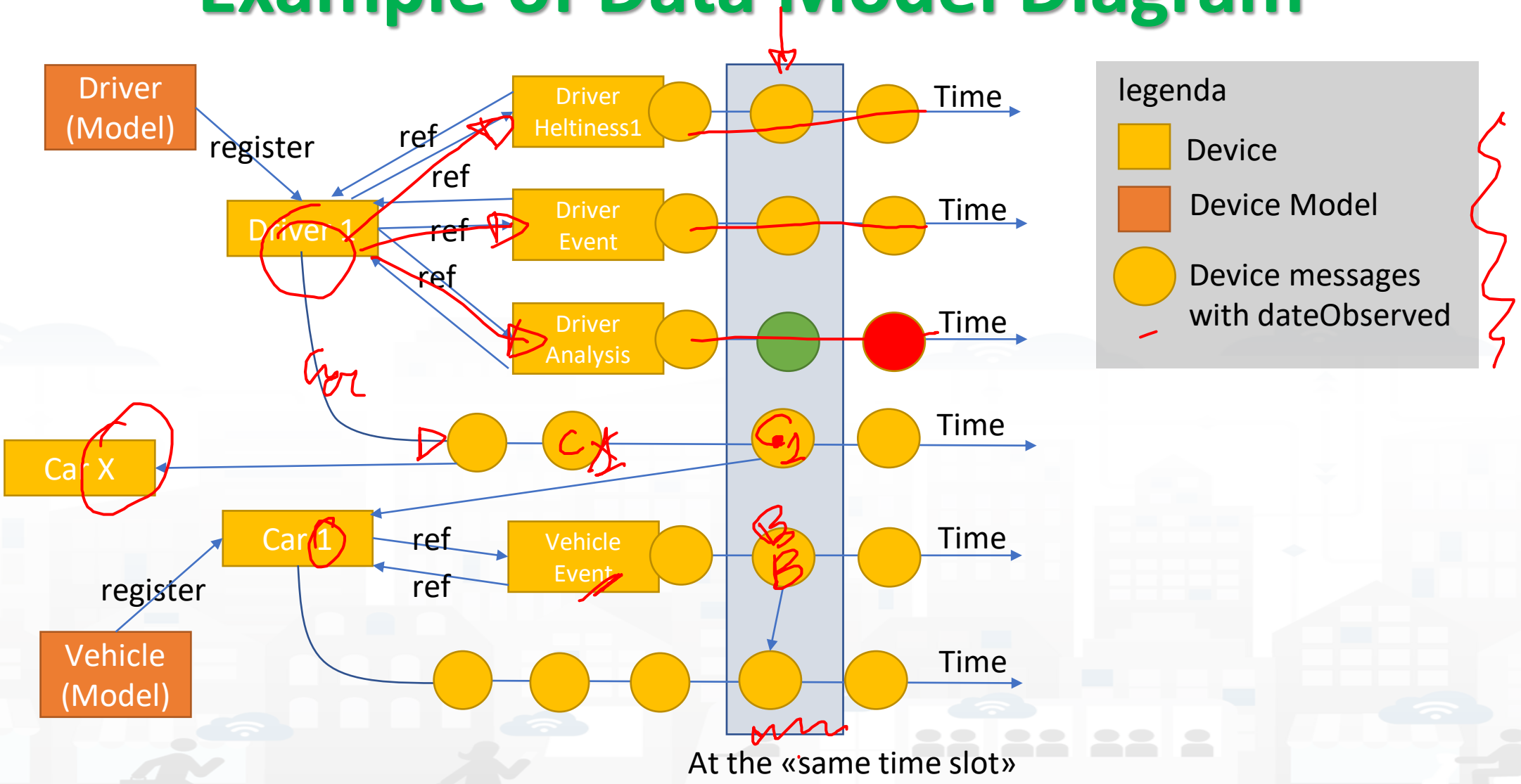
| IoT Device Model: VehicleEvent<br>Nature:……<br>Subnature: ……<br>Lat,lon: ……<br>Device in Mobility: …… | | | |
|---|---|---|---|
| Value_name | Value Type | Value Unit | Data Type |
| dateObserved | Timestamp | Timestamp in ms | String |
| eventID | ID | text | String |
| eventKind | status | some coded status | String |
| status | status | some coded status | String |
| vehicle | Identifier | ServiceURI | String |

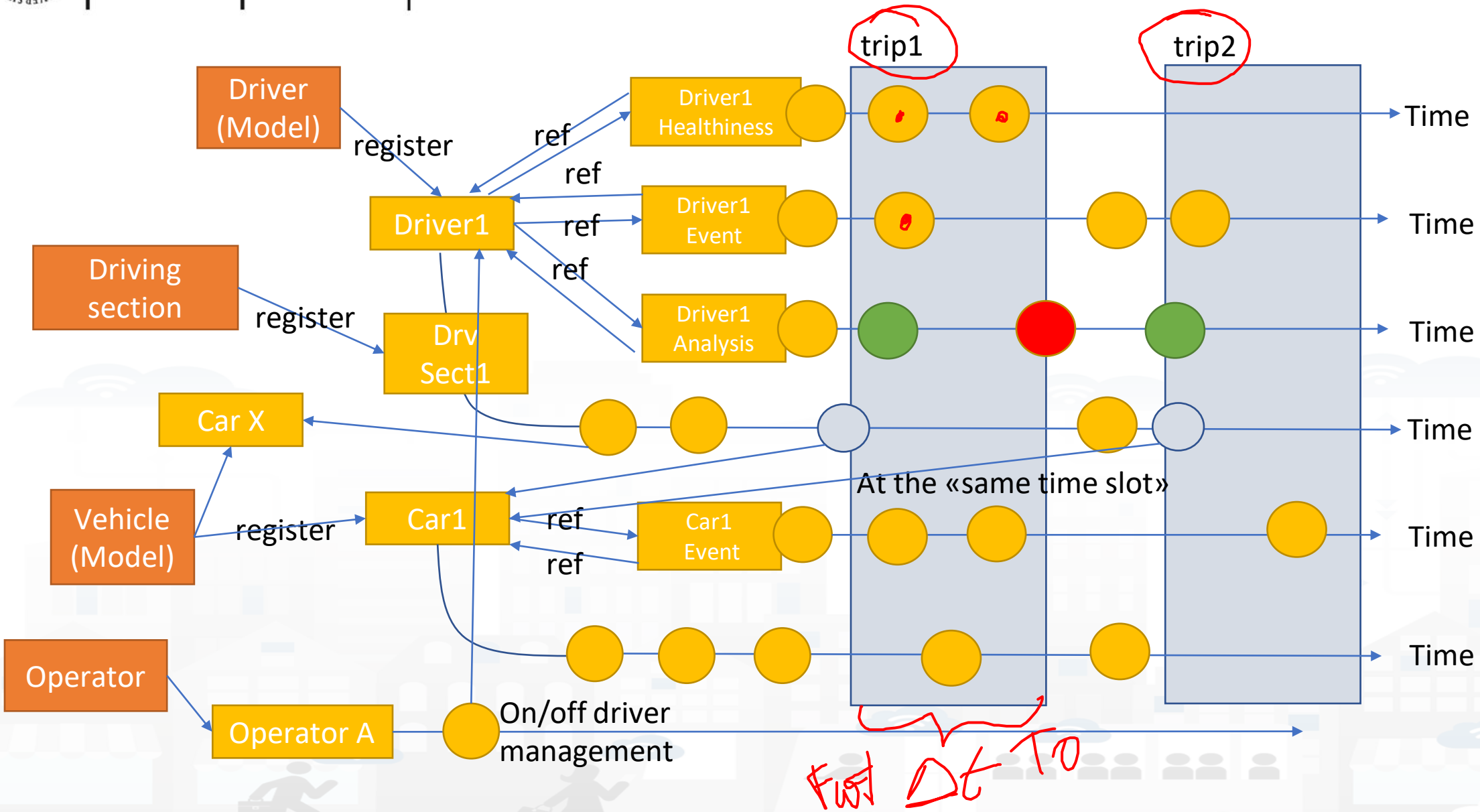

legenda
Entity Instance
Entity Model
Entity Messages with dateObserved
Register to instantiate
Data Model of the Driver
Name: string
Surname: string
Age: number
Weight: number
Phone: string
Email: string
DriverAnalysisID: ServiceURI
……
Driver: user45
Name: David
Surname: Smith
Age: 45
Weight: 78 Kg
Phone: +49345096103
Email: david89@gmail.com
DriverAnalysis: http://.../user45driveranalysis
……
Write SURI to create cross references
DriverAnalysis: user45driveranalysis
DriverID: http://.../user45
dateObserved: 12-03-2022T12:00:00
Status: "none"
Location: null
Doctor: null
Tools: null
……
Register to instantiate
New update on user45driveranalysis by sending a message
DriverAnalysis: user45driveranalysis
DriverID: http://.../user45
dateObserved: 22-03-2022T12:00:00
Status: "good"
Location: room45
Doctor: https://.....
Tools: null
……
New update on user45driveranalysis by sending a message
DriverAnalysis: user45driveranalysis
DriverID: http://.../user45
dateObserved: 25-04-2022T12:00:00
Status: "bad"
Location: truck
Doctor: null
Tools: Eyetrack
……

# Example of Data Model Diagram



# Example of Data Model Diagram




trip1
trip2
Driver (Model)
register
ref
Driver1 Healthiness
ref
Driver1
ref
Driver1 Event
ref
Driver1 Analysis
Driving section
register
Drv Sect1
Car X
Vehicle (Model)
register
Car1
ref
ref
Car1 Event
Operator
Operator A
On/off driver management
Time
Time
Time
Time
Time
Time
At the «same time slot»
Fwd Dt To

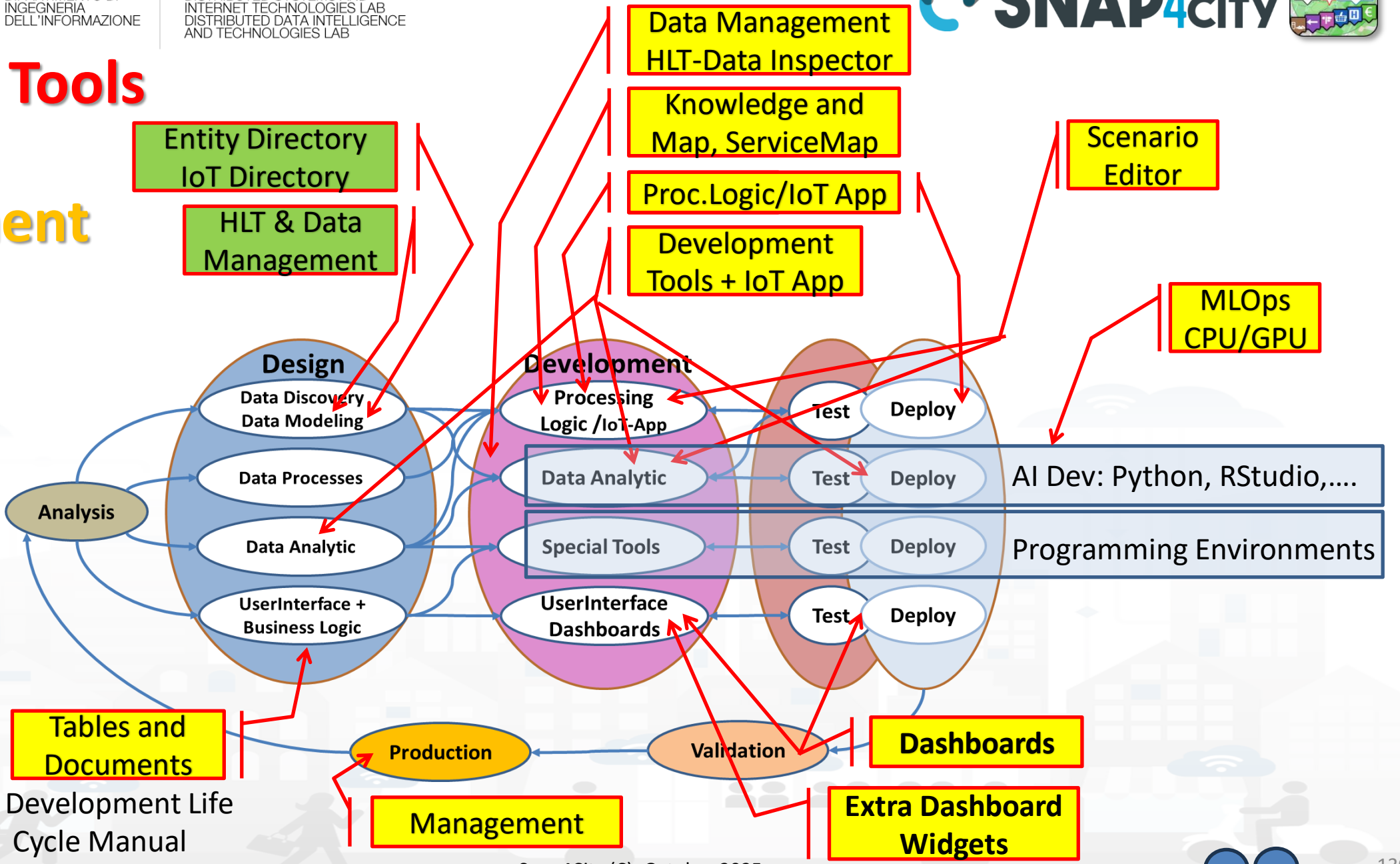
# TOOLS for Data Design and HLT Exploitation

Part 2

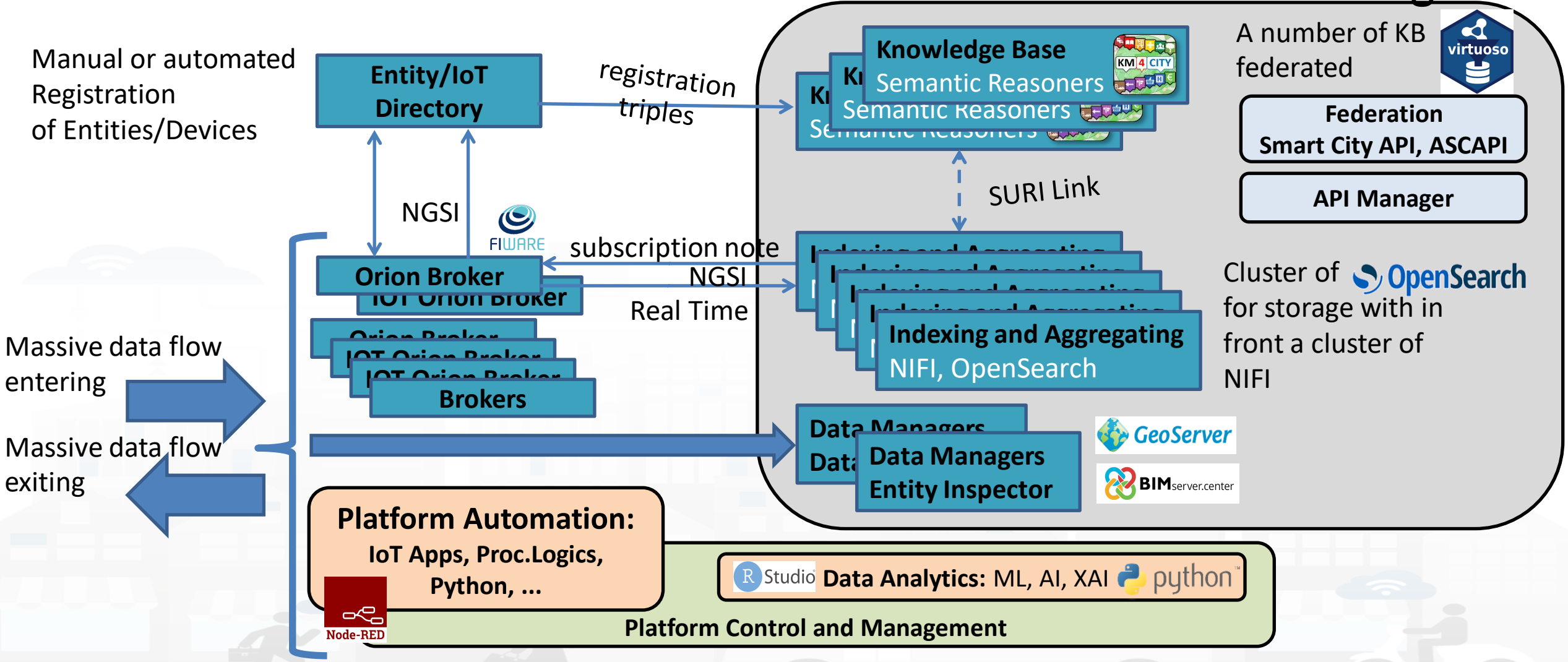
Part 5



# Snap4City Tools vs Development Life Cycle



# Snap4city Data Ingestion Diagram

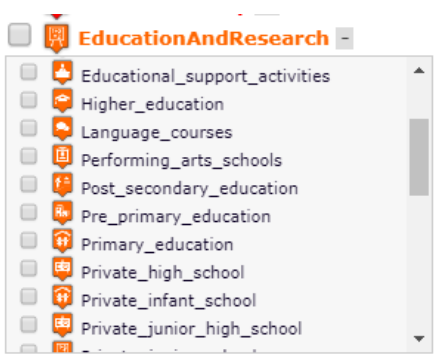


# Any Entity has a Semantic *Classification*

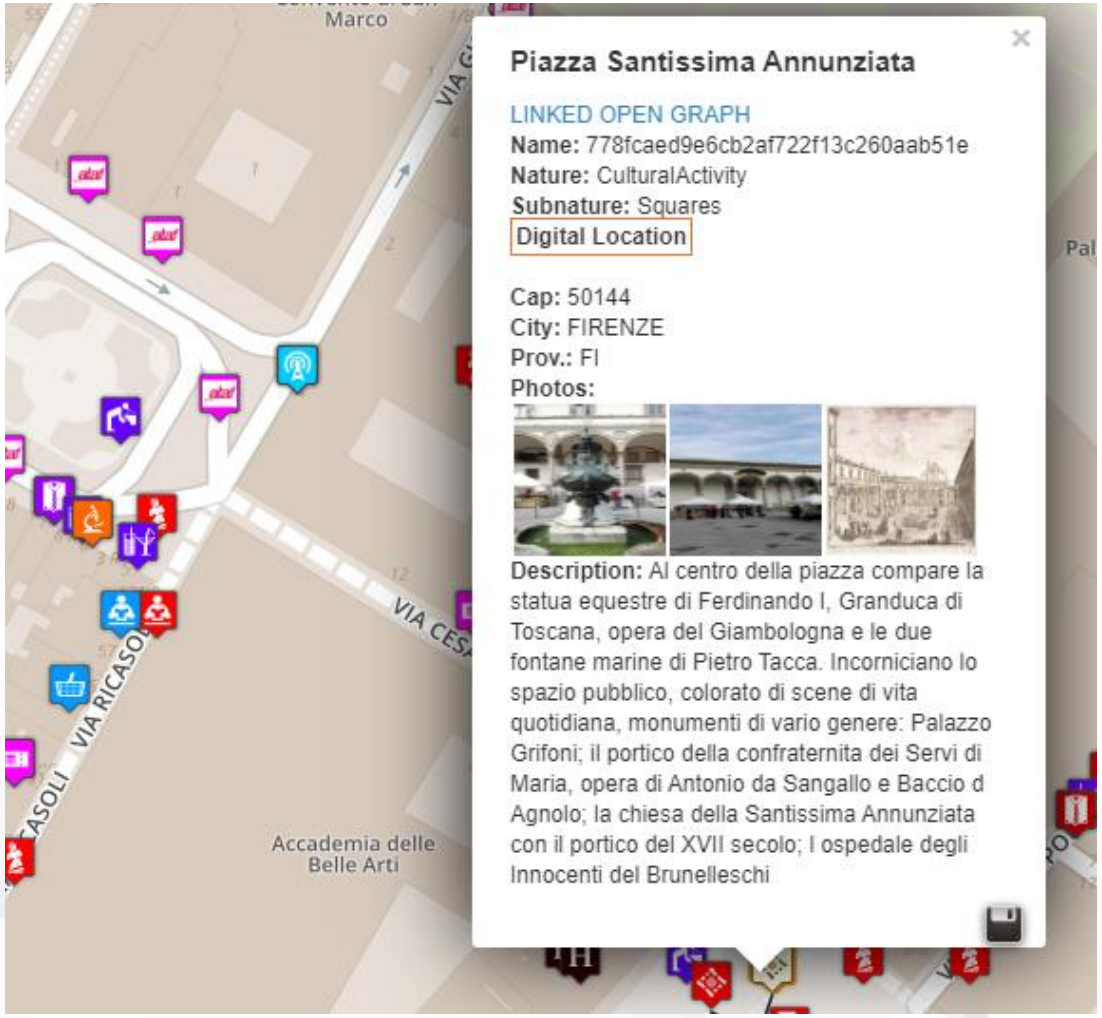
## Nature

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

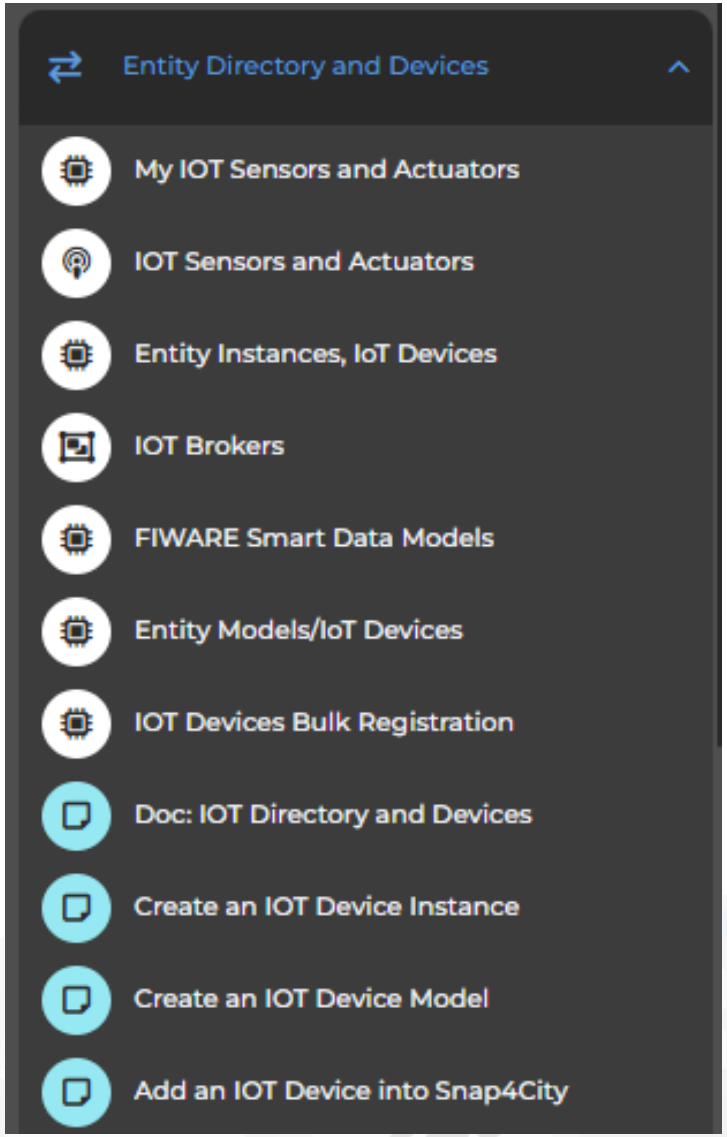
## SubNature

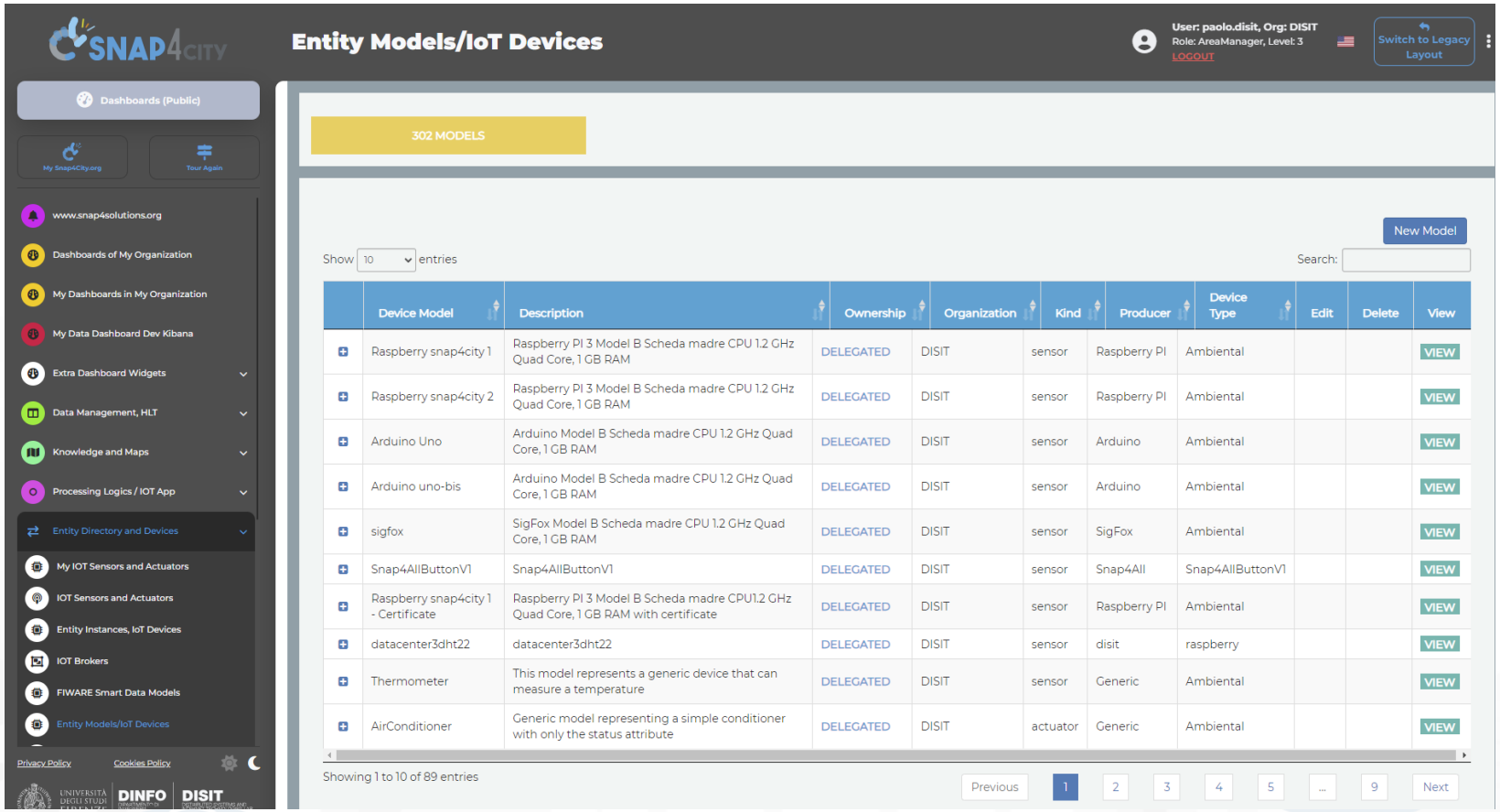



SKOS



# Entity / Iot Directory: User Role



# Entity Directory for Beginners

- Browse and see models and entities/devices of other users, that publiched them
- Create your Entity / Device Models
  - User the dictionary approach: value type, data type, value unit
  - Manage delegation of the models and ownership
- Create your Entities / Devices from scratch and/or from models
  - Several models are ready to be used…..
- Send a Message to a Device, thus to the broker
- Read a Message from the Broker, see the message forma expected to be sent at the Broker in NGSI format

# 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

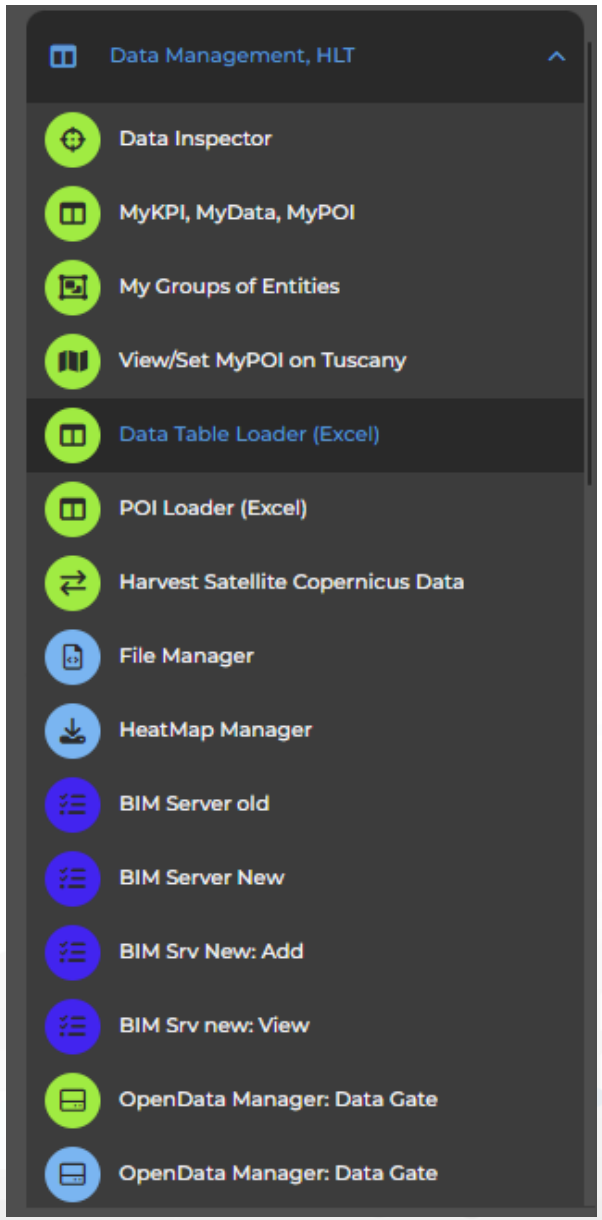
Any update and addtion to the dictionary of snap4city.org has to be requested to snap4city@disit.org

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 |




# Data management, HLT

- Data Inspector
- MyKPI…..
- My Groups of Entities
- HeatMap Manager
- BIM Server…….
- Open Data…
- For user kind of users, other Managers:
  - ODM, File, TV CAM, Traffic Flow, …..

TOP

# Design & Develop: Data Processes

# Proc.Logic / IoT App

Part 3

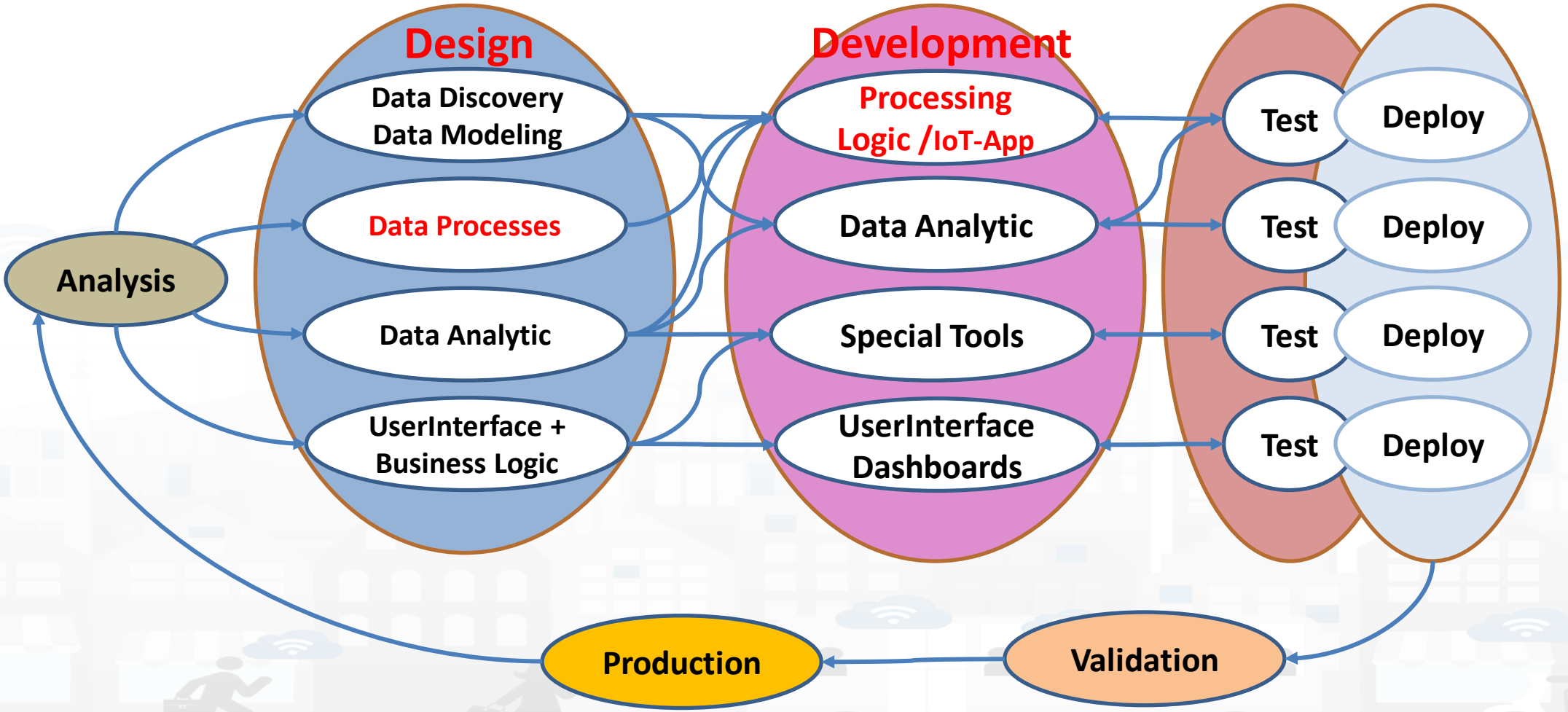
Part 5



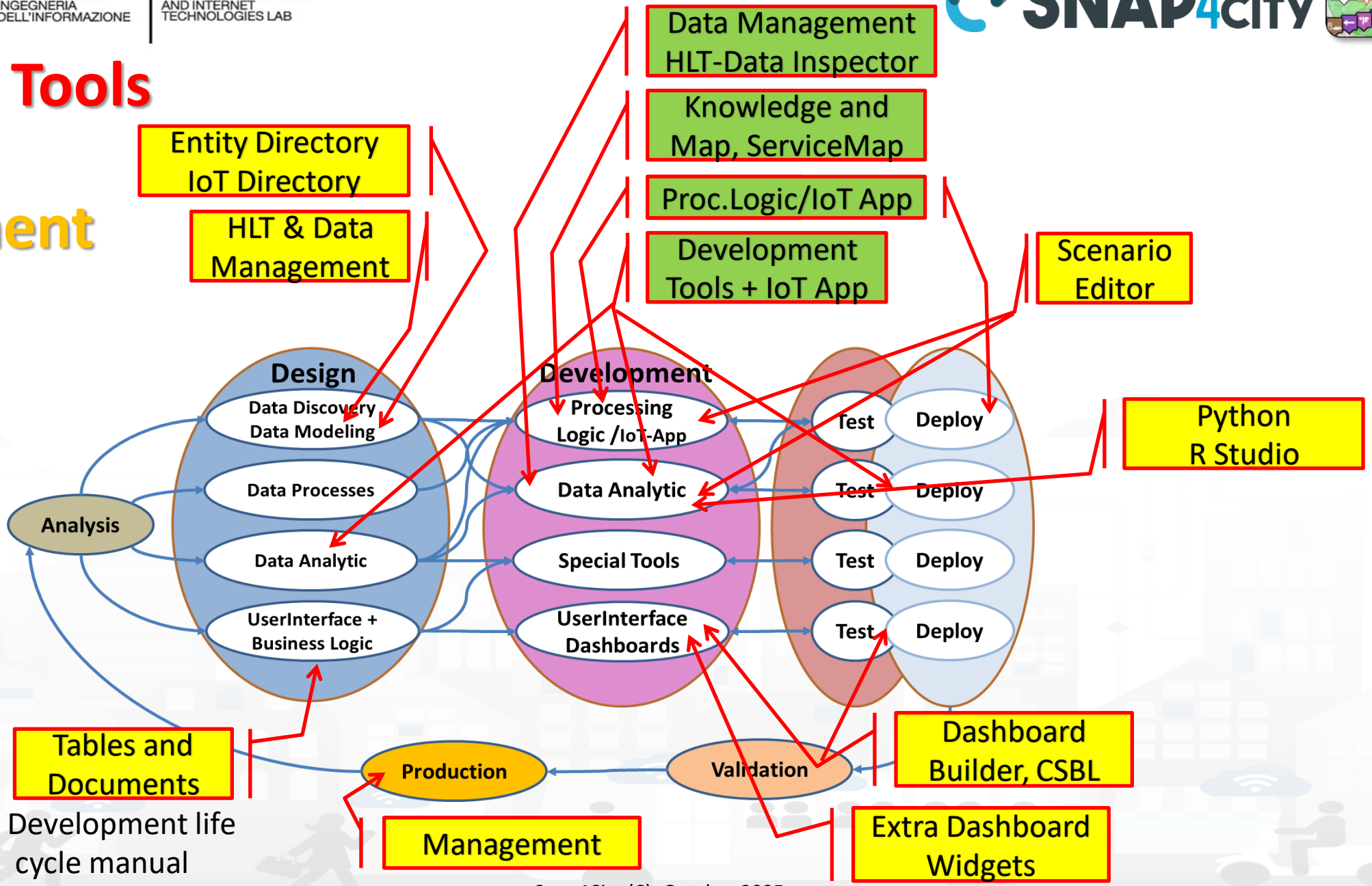
# Activities for IoT App data processes

- **Data Ingestion, gathering, harvesting, grabbing**
- **Data Transformation, transcoding, decoding, converting, reformatting, ..**
- **Data load to storage, retrieve from storage**
  - the load is typically performed loading data on some Internal Orion Broker V2/LD, or on some MyKPI storage
  - the retrieval is typically performed using one of the several query / search nodes.
  - Many other kinds of storage connections are accessible in Snap4City Proc.Logic / IoT Apps
- **Data Production, generation, reformatting, etc.**
- **Data Publication, post in other channels of any kind, etc.**
- **Server Side Business  Logic as described in the following**

# Development Life Cycle Smart Solutions



# Snap4City Tools vs Development Life Cycle




Development life cycle manual

# Design: Data Processes

Part 3

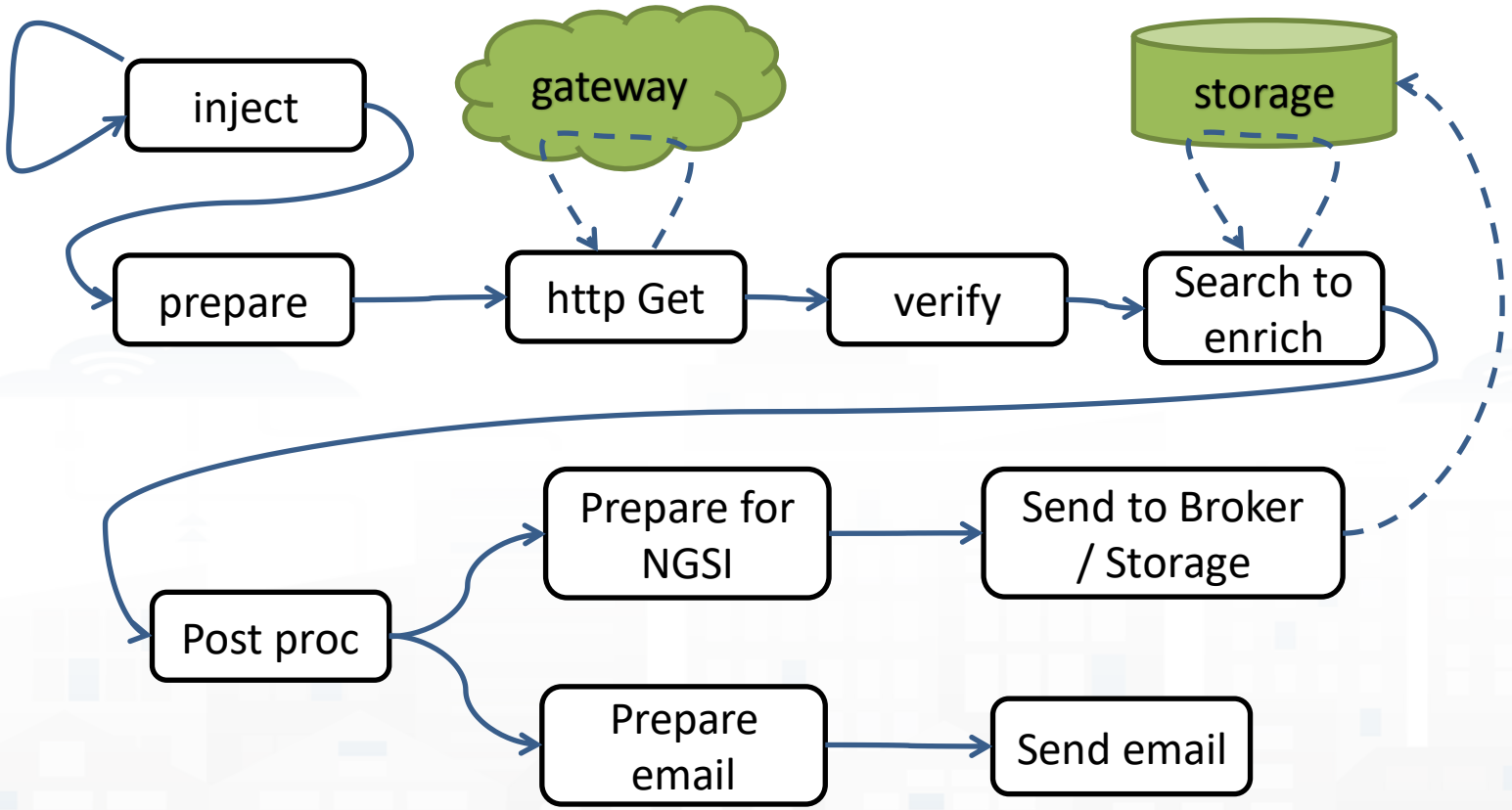
Part 5



# How to Design

1. **Business Logic** is going to be implemented in Proc.Logic (IoT App), with a set of flows.
2. **Decompose your problem** and sequence diagram in single Data/event Flows, from client side and server side.
3. **Identify the single Data/Event** Flow, as those that start from a certain event (periodic or provoked from other messages), and that finish with: sending of data in the storage, change status, send an event, provide a message into a dashboard, send an email, etc.
4. **Design the single Data/Event Flows** with a mixt of possible **activities**.
    1. The design can be performed using data flow diagrams.
    2. It can have sequences, switch, serialization, packing, joining, distribution, communication, transformation, search, etc.
5. When the design of Data/Event Flow mechanism is clear the designers can pass to directly sketch the flow in Node-RED which is a visual programming.
6. **Incrementally improve the Proc.Logic** (IoT App) Node-RED flows by adding nodes needed
7. **Once obtained the Proc.Logic** (IoT App) Node-RED flows in the correct data model you can send data to the ingestion broker, but also perform many other actions on several services.

# IoT App / Proc.Logic Design, for each Data/Event Flow




a. Periodically activate the flow
b. Call a gateway to get data
c. Verify the correctness of data
d. Enrich the data with other information coming from Cloud data into the storage
e. Transform the data in the correct forma
f. Send the data into the IoT Broker, and thus send the data in the storage on a specific IoT Device
g. Send also a notification via email

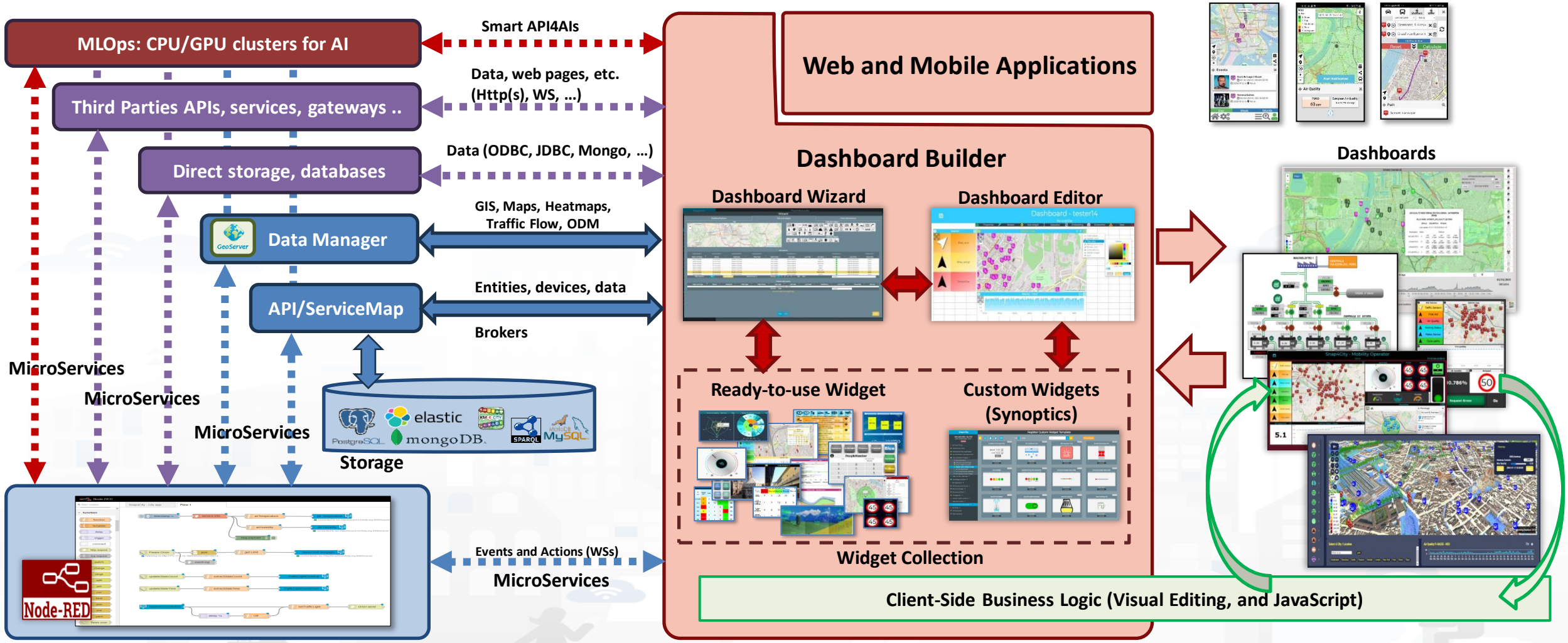
# Develop: Data Processes

Part 3

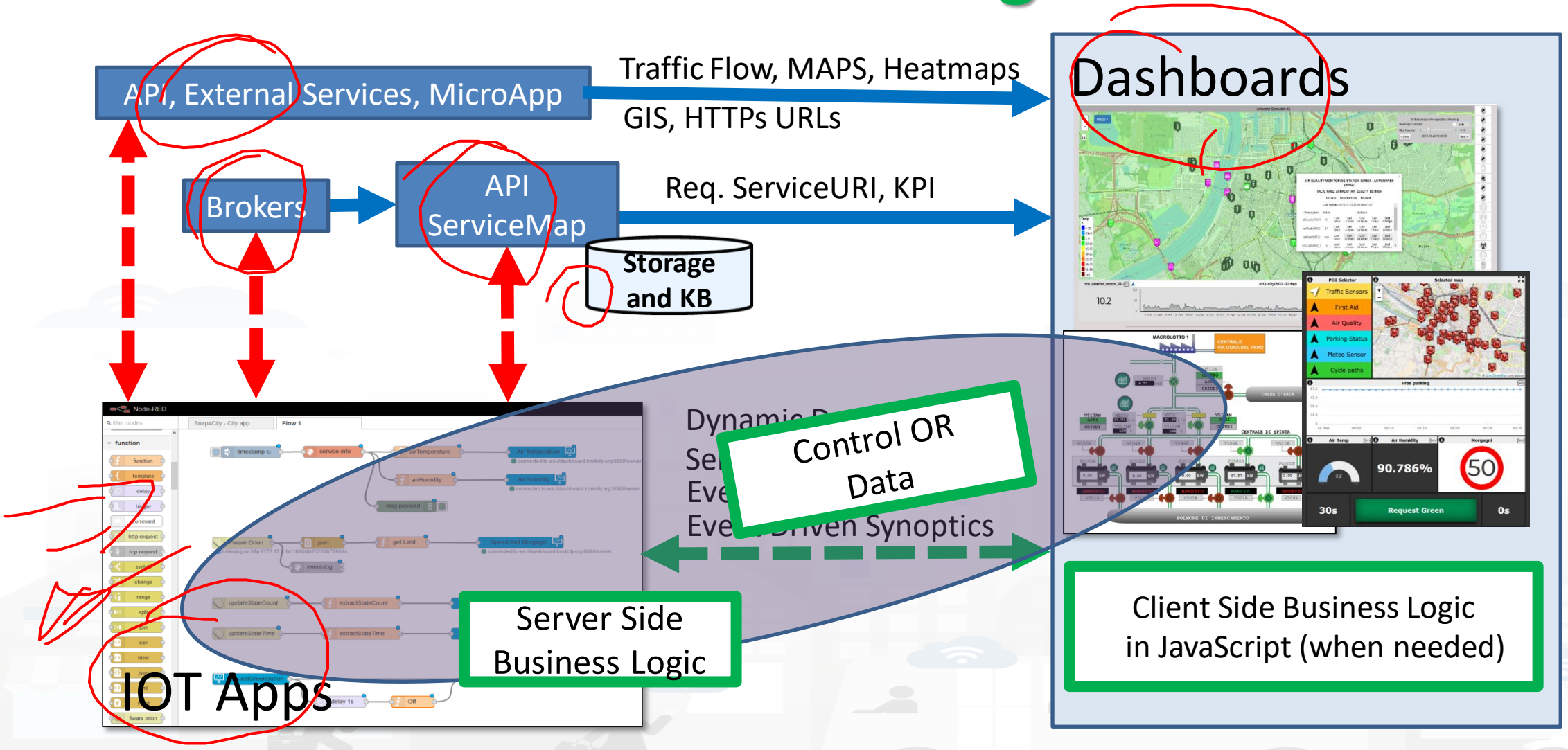
Part 5

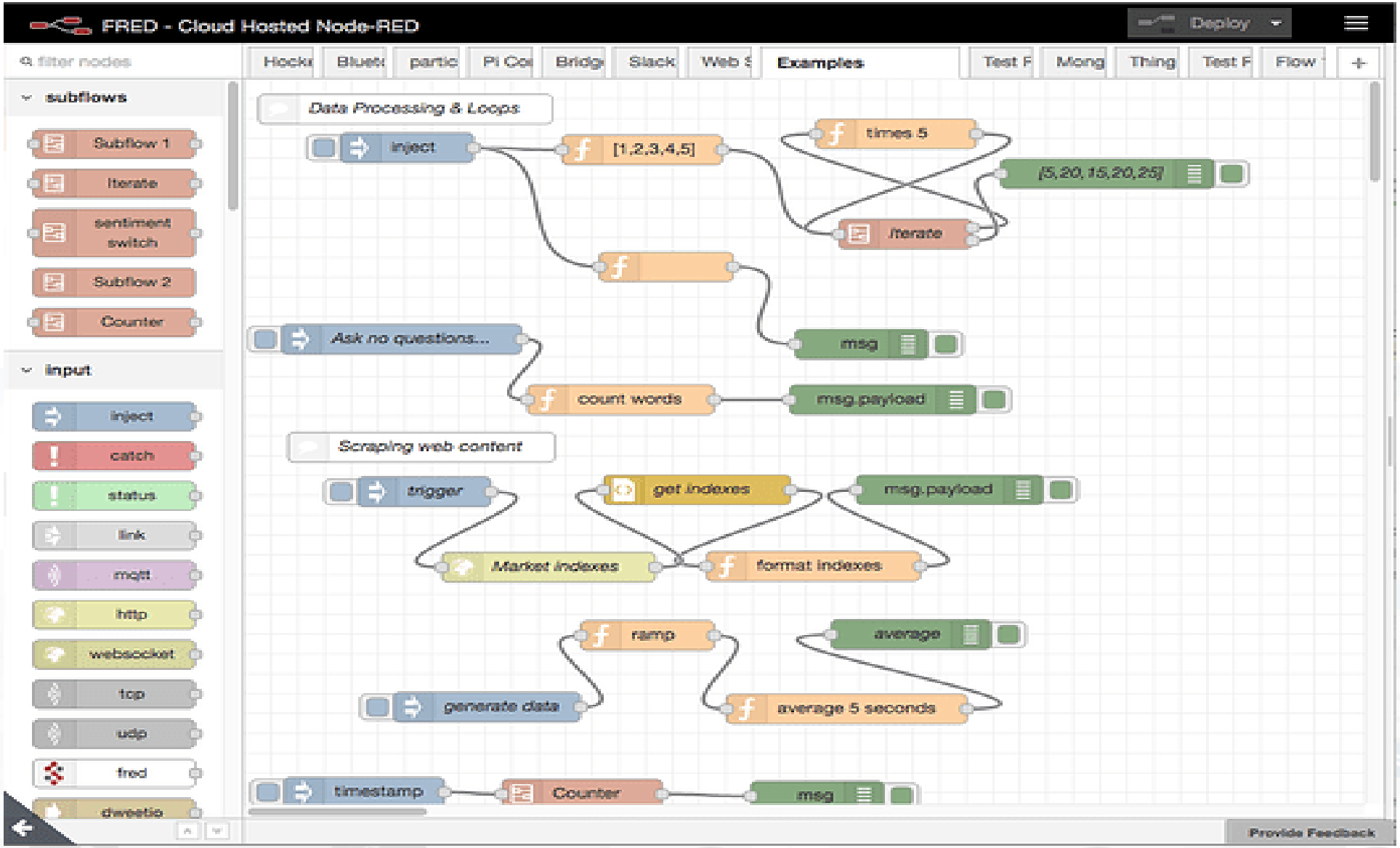


# How the Dashboards / Apps Exchange data (2024/8)

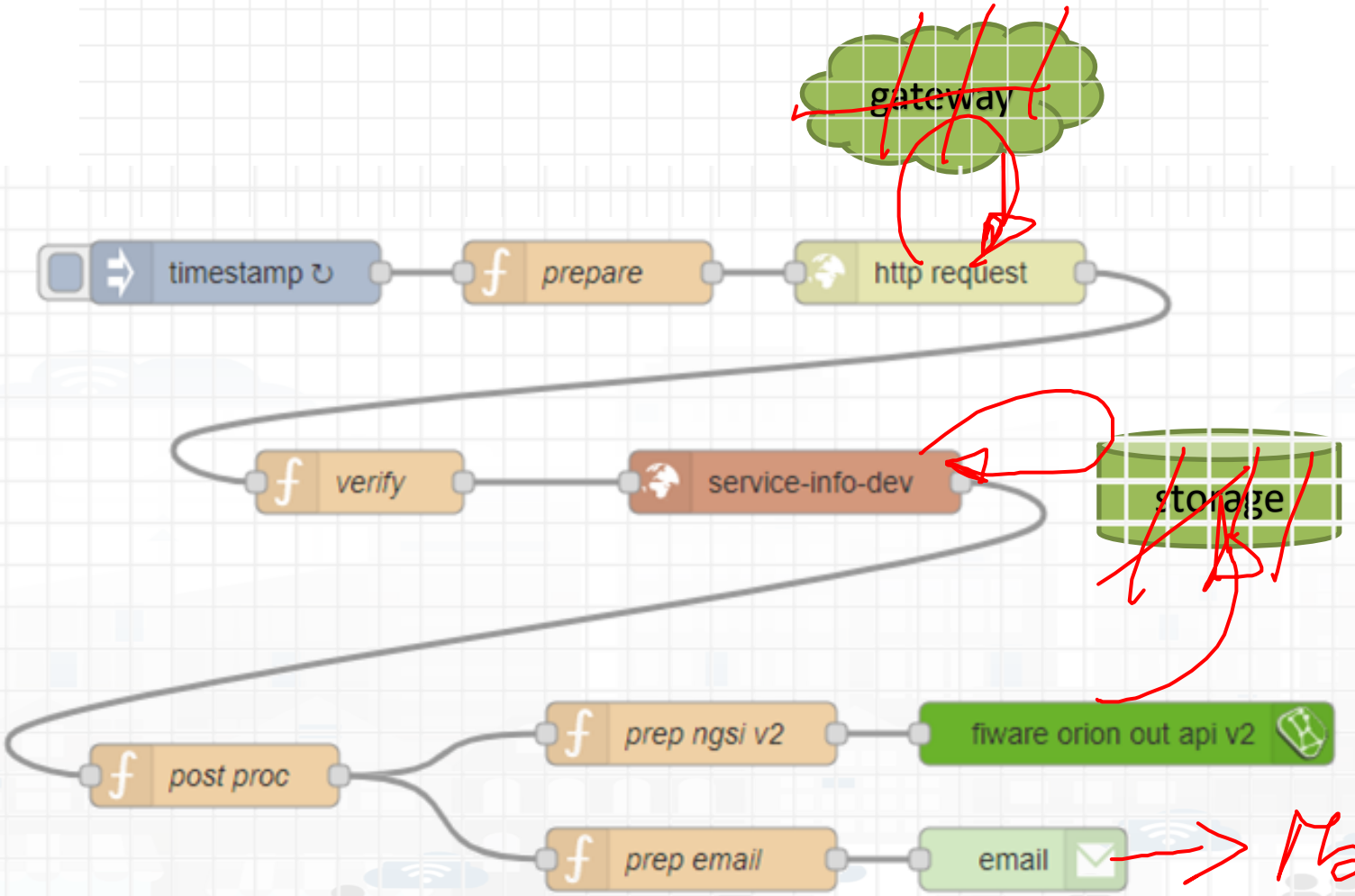


# How the Dashboards exchange data




FRED - Cloud Hosted Node-RED
Deploy
filter nodes
Examples
subflows
Subflow 1
Iterate
sentiment switch
Subflow 2
Counter
input
inject
catch
status
link
mqtt
http
websocket
tcp
udp
fred
dweetio
Data Processing & Loops
inject
[1,2,3,4,5]
times 5
[5,20,15,20,25]
iterate
msg
Ask no questions...
count words
msg.payload
Scraping web content
trigger
get indexes
msg.payload
Market indexes
format indexes
ramp
average
generate data
average 5 seconds
timestamp
Counter
msg
Provide Feedback

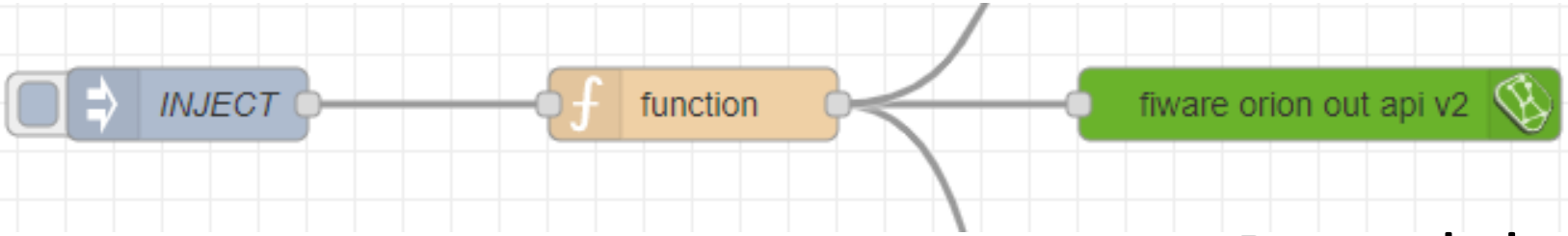
# Proc.Logic (IoT App) Design, for each Data/Event Flow




a. Periodically activate the flow
b. Call a gateway to get data
c. Verify the correctness of data
d. Enrich the data with other information coming from Cloud data into the storage
e. Transform the data in the correct forma
f. Send the data into the Broker, and thus send the data in the storage on a specific Entity Instance
g. Send also a notification via email

***Implicit services are not drawn***

# A sample of Data Ingestion

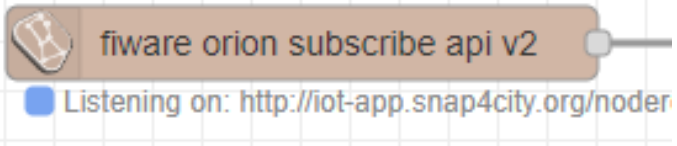



Function, example of NGSI V2 payload:

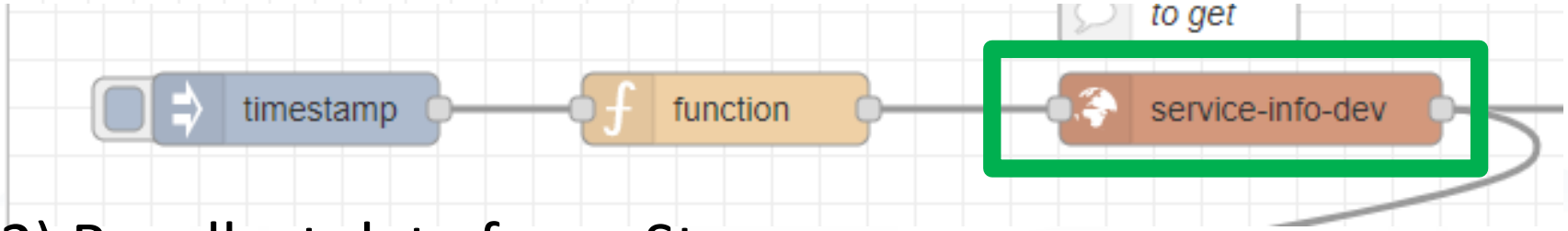
```
var time_now = new Date().toISOString();
var arandvalue = Math.random()
msg.payload =
        {"id":"mydev",
        "type":"mydevSensor",
        "anID":{"type": "integer", "value": "http://www.disit.org/km4city/resource/iot/...../anuser"},
        "VDDValue":{"type":"float","value":arandvalue},
        "dateObserved":{"type":"string","value":time_now},   // it is a time serie
        "latitude":{"type":"float","value":"28.61810"},      // it may move over time
        "longitude":{"type":"float","value":"11.34300"},     // it may move over time
        "status":{"type":"integer","value":34}
        }
return msg;
```

Posted data on IoT Brokers green nodes are automatically saved into the data Storage

# Read and share Data and Context Data




1) Event driven from Broker, read last context data. It is not sure that this change is on Storage



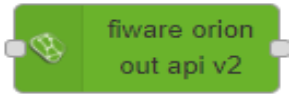
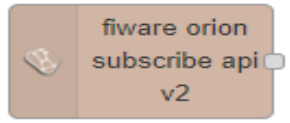
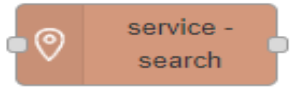
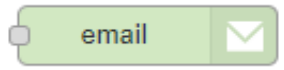
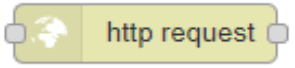

2) Recollect data from Storage
   - This node uses the Smart City API
- Any External Application can get the same data in authenticated authorized manner via Smart City API
- Smart City API is a better approach instead of producing a file outside or providing data via some local API service created from IoT Application (feasible but not protected)

- Please note that the most important blocks nodes to interact with the platforms are reported in this table to familiarize with the main concepts. ***They are actually families of blocks/nodes*** since many others are present that allow you to perform a very large number of other features.

- YOU DO NOT HAVE TO ACCESS AT THE API all is provided in terms of NODEs/BLOCKS into IoT APP. Everything can be parametrized via JSON passed in input to the nodes.

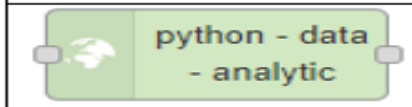
- Most of the nodes can be also configured once from their user settings but the JSON is primary mode for setting parameters.

# examples

| Node shape | Description | Snap4City or standard |
|---|---|---|
|  | To generate injection messages into a flow, scheduled or on manual demand by click it on left. | standard |
|  | A java script function, from a JSON input to one or more JSON outputs, which can be produced by setting it. | standard |
|  | To send an Entity Message of an Entity Instance into the storage. The Entity Instance has to be registered on Entity Directory (IoT Directory) and you have to be the owner or to be delegated in READ-WRITE to send messages to it. The node represents the broker, so that the same node can be used to send any Entity Message you need. | Snap4city |
|  | To subscribe the Processing Logic (IoT App) to receive event-driven notifications related to Entity Instances changes. The node is substantially a listener connected to an Orion Broker. You can subscribe to many Entities and then to get all of them from the output of the listener. The new version will go to provide an input port to send at this listener multiple subscriptions. | Snap4city |
|  | 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 and recover vectors of ServiceURIs. | Snap4city |
|  | To perform queries on the storage to obtain a list of ServiceURI. The nodes of this family can allow you to perform searching queries by filtering for distance, area, subnature/category, values of attributes, time period, etc. | Snap4city |
|  | Send email. With other nodes you can send Telegram, SMS, etc. | standard |
|  | To send a REST CALL (get, post, etc.). Please USE THIS NODE ONLY for the access at external API and not to access at the Snap4City API for which a lot of MicroServices are accessible as NODEs/Blocks in the Processing Logic and they are simpler to be used and ready to use. | standard |

# examples



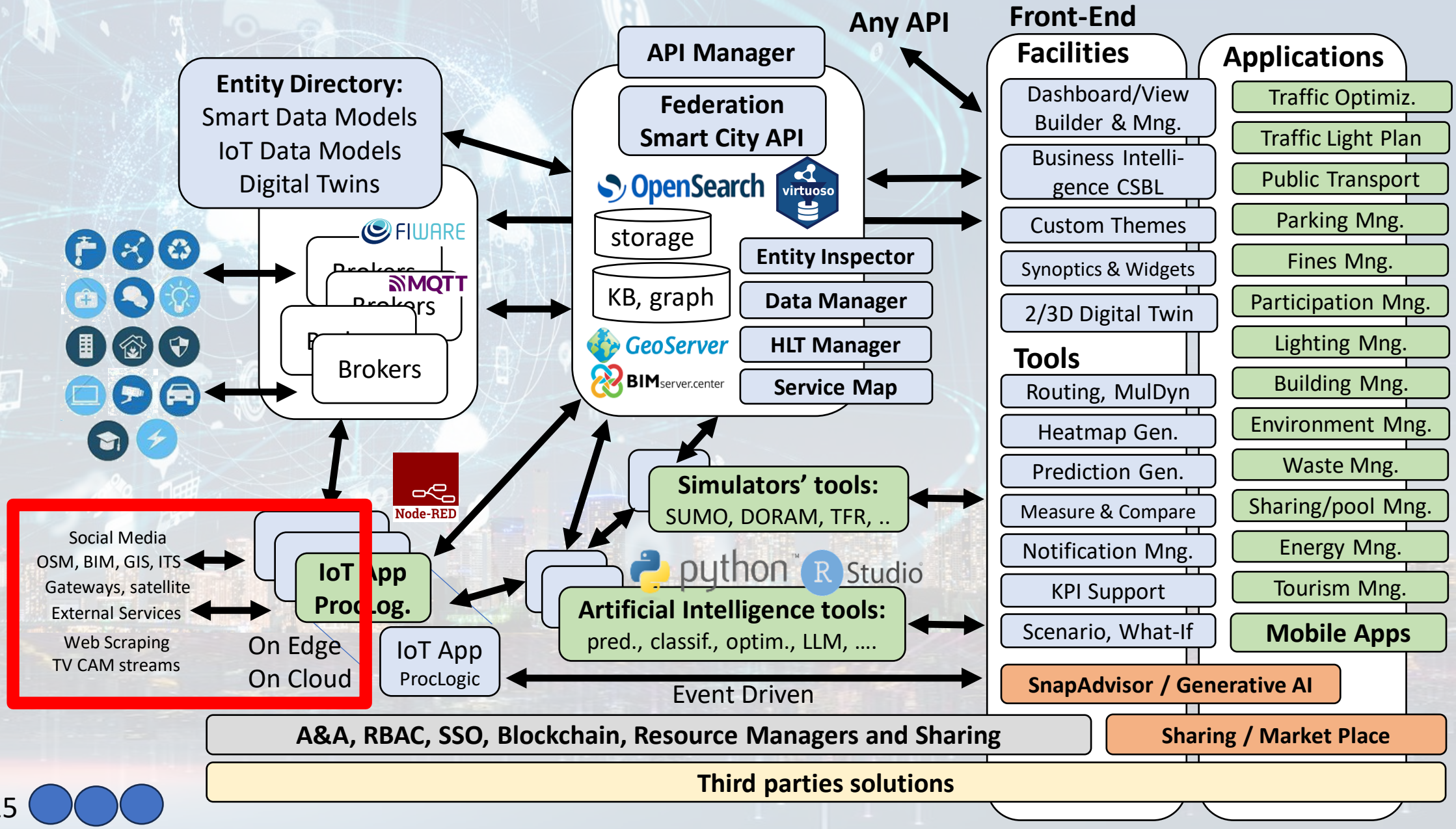
| | | |
|---|---|---|
|  | A block which is printing on **debug** view the data JSON passed in its input. Please note that the node can be tuned to provide only msg.payload or the full JSON message, change configuration of the node. | standard |
|  | To **create an Entity Instance** (device instance) from a model prepared on Entity Directory (IoT Directory). | Snap4city |
|  | To **change the ownership** of an Entity Instance (IoT Device). | Snap4city |
|  | To **delegate a certain Entity Instance** (IoT Device) to some other user for which you have to know the Nickname. Delegations can be: Read access, Read write, Modify (to modify the Entity Instance structure). | Snap4city |
|  | To **show something on Snap4City dashboard** with a single content widget (one of the simplest widgets). A large set of dashboard nodes/widgets to send and retrieve data to/from dashboards are provided. This specific Nodes allows to send on dashboard HTML formatted messages with some limitations. Full HTTP widget is also accessible.<br>See in the following section for the Full list of Nodes for Snap4City Dashboard Widgets. | Snap4city |
|  | **MQTT broker listener**, to receive messages from the Broker. Another similar node can be used to send MQTT messages to the MQTT broker. This node allows to perform a subscription to a topic of the MQTT broker. | standard |
|  | **DATA ANALYTICS**<br>Request performed on a Container including a Python data analytics, which is loaded into the node and the container is created at the first Deploy of the Processing Logic. Similar Approach is performed for RStudio Data Analytics. | Snap4city |
|  | **SPLIT:** This block takes in input a buffer, or an array, or an object and split it on a set of messages in output, for each line in the buffer, each element of the array, each element in the object, respectively. | standard |
|  | **JOIN:** This block takes in input a set of messages and join/merge them into a single message (string, buffer, array or object, etc.), on the basis of specific criteria. | standard |

# The Proc.Logic (IoT App) microservices

Actually, there are more than 180 nodes/blocks in the Snap4City libraries on Processing Logic (IoT App) which can really facilitate your life and save you time in producing Smart Applications for composition of the following microservices and using those that you can install from internet, thousands of functionalities:

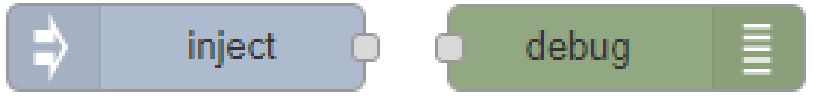
- **Data ingestion**: more than 100 protocols IOT and Industry 4.0, web Scraping, external services, any protocol database, etc.
- **Data access**: save/retrieve data, query search on expert system, georeverse solution, search on expert system Km4City ontology, call to Smart City API, etc.
- **Data Transformation/transcoding:** binary, hexadecimal, XML, JSON, String, any format
- **Integration**: CKAN, Web Scraping, FTP, Copernicus satellite, Twitter Vigilance, Workflow OpenMaint, Digital Twin BIM Server, any external service REST Call, etc.
- **Manipulation of complex data**: heatmaps, scenarios, typical time trend, multi series, calendar, maps, etc.
- **Access to Smart City Entities and exploitation of Smart City Services**: transport, parking, POI, KPI, personal data, scenarios, etc.
- **Data Analytic**: managing Python native, calling and scheduling Python/Rstudio containers as snap4city microservices (predictions, anomaly detection, statistics, etc.)
- **User interaction on Dashboard**: get data and message from the user interface, providing messages to the user (form, buttons, switches, animations, selector, maps, etc. ), send data to special graphical widgets: D3, Highcharts, etc.
- **Custom Widgets**: SVG, synoptics, animations, dynamic pins on maps, etc
- **Event management**: Telegram, Twitter, Facebook, SMS, WhatsApp, CAP, etc.
- **Special tools as**: routing, georeverse, Twitter Vigilance and sentiment analysis, etc.
- **Hardware Specific Devices**: Raspberry Pi, Android, Philips, video wall management, etc.
- **Etc**. etc.

# Technical Architecture



# Some patterns

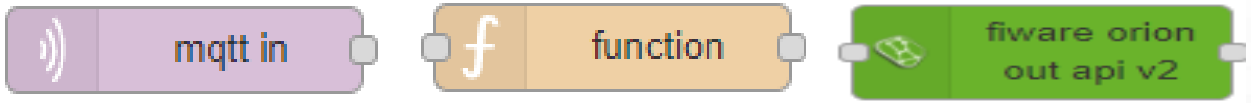
1) Hello world of node-red, the inject may provide a string to the debug.



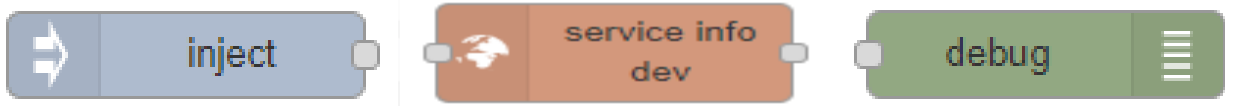

2) Hello world of node-red at two steps, the inject provides a push while a JSON is created into the function as *msg.payload = {……}* and sent/shown to/by the debug.



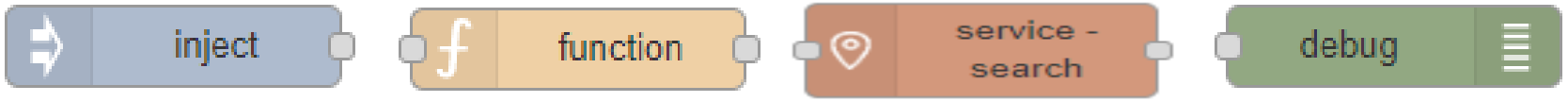

3) Event data reception from an MQTT broker, transformation and send it to the storage pushing data into the Orion Broker V2.



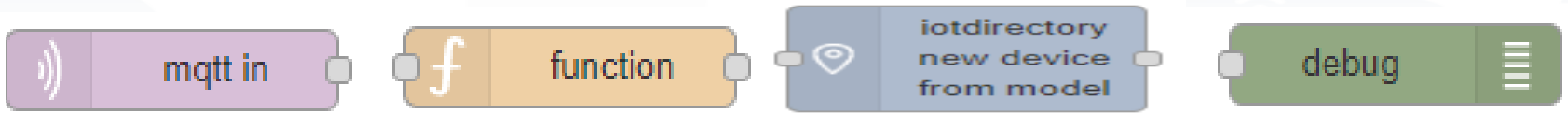

4) request on inject of a SURI to the storage to see data on debug.



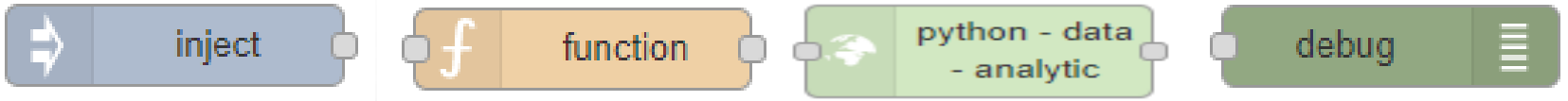
1) Preparation of data request on function, query to the storage and see data result on debug.




2) Event data reception from an MQTT broker, transformation to create an Entity Instance from a known Entity Model, debug to see eventual errors, for example if the device is already present (to avoid production of error, one may verify if the Entity Instance is already present by posing a query on the system):

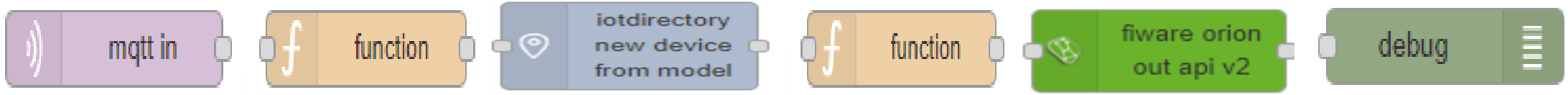



3) Preparation of data parameters on function, request computing Data Analytic, see data result on debug.



**Typical strange patterns that may be not efficient in most cases:**

A. data reception from an MQTT broker, their transformation to create an Entity Instance from a known Entity Model, contextually to create and send an Entity Message into newly created Entity Instance, the debug to see eventual errors. This approach is typically strange since at each new message the Entity Directory is queried to see if the Entity is already be created and if not to create it and then pass the data to register the message. In most cases, it is much better to decouple the activity of creating with respect to that of sending message. In fact, this approach would largely reduce the ingestion rate and probably when the Entities are already created would create un-useful workload on Entity Directory (IoT Directory).

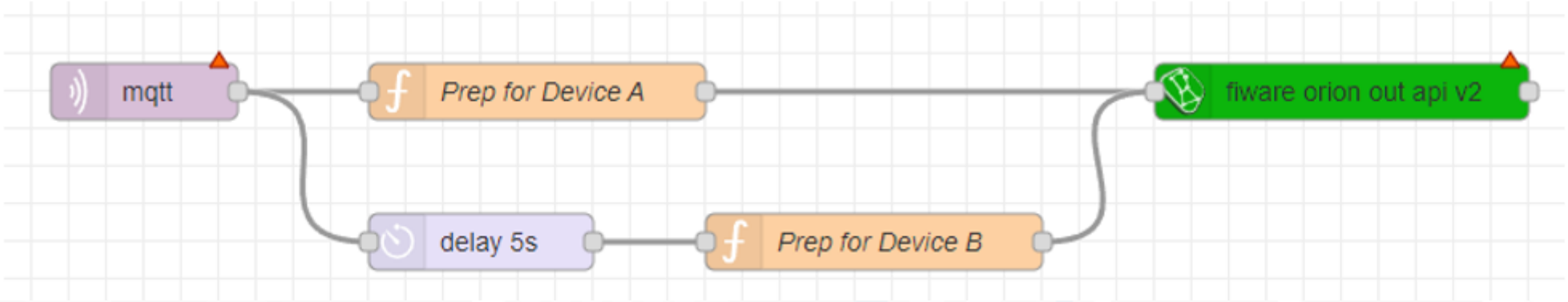



In most cases, it should be done the opposite: try to send the Entity Message, if it fails than create a new Entity Instance by known model, and if successful send again the Entity Message, or just wait for the new message to save it the first.



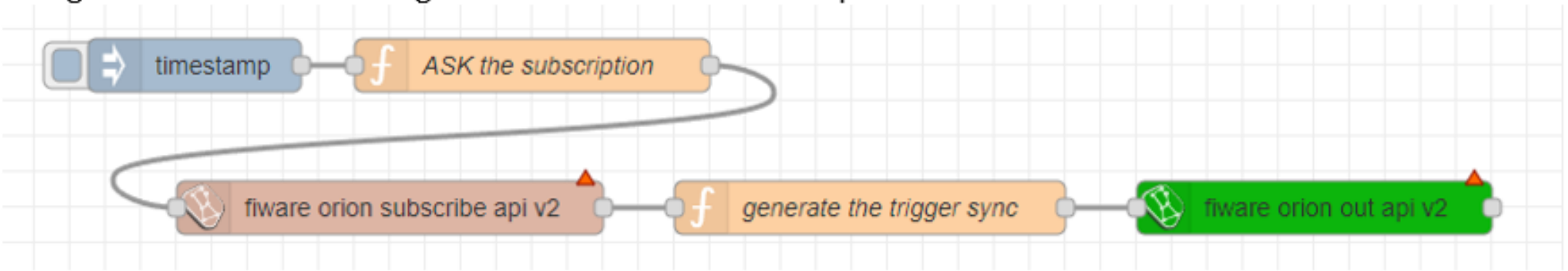
# Sync data changes on Entities from an Event

**If I would like to synchronize a device data A with another B by trigger event, I can do it in several manners.** The first case would be the simplest. A triggering message arrives from MQTT event or from some NGSI ORION, or from some MyKPI, from dashboard event button, or email or anything, it does not matter. I can use two functions to prepare the message for A device and B device as follow:

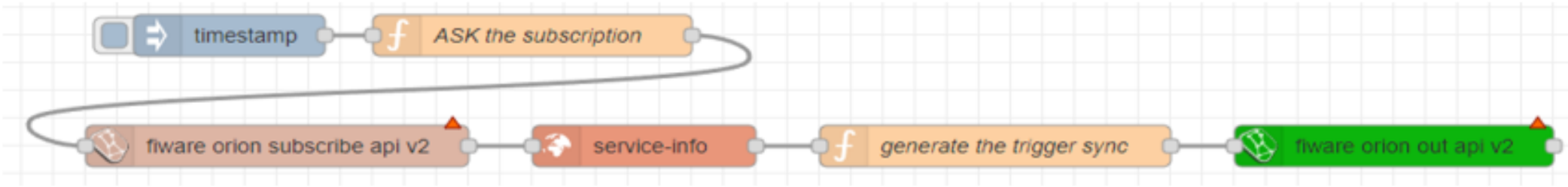


# Subscribe on event from Broker, be carefull....

**If the event for triggering is from another device/entity** changed by some action performed posting a data on Orion Broker V2, you can subscribe with the event on the Orion broker by using a specific Node (do it once otherwise you risk receiving many events). Every time the device / entity receives a message you can take it and generated a new message for a different device and post it on Orion API V2.




If you need to verify if the new data has been changed, you can read the last value of recipient Device/entity to compare and decide to update or not:



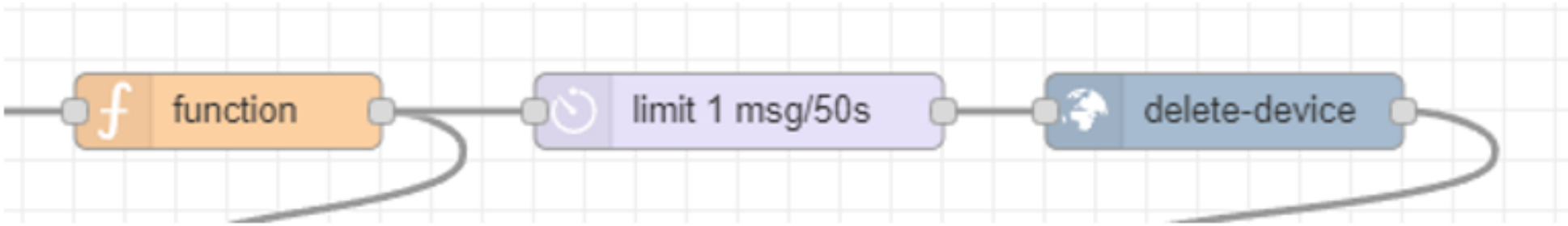
# Delete Devices

## *IV.C.1.e- Delete Devices*

Recently a node to delete devices has been added. It has to be used veery carefully since to delete data is always a terrible activity in a big data storage.

The delete of a device is allowed only for the Owner of the device and the root administrator of the platform. The device delete can be also performed from the Entity Directory and now with the Delete-Device node can be performed also from Proc. Logic / IoT App.

The classic pattern is as follows, including preparation, a RATE Limitation avoiding to provide more than one delete message every 50 seconds:



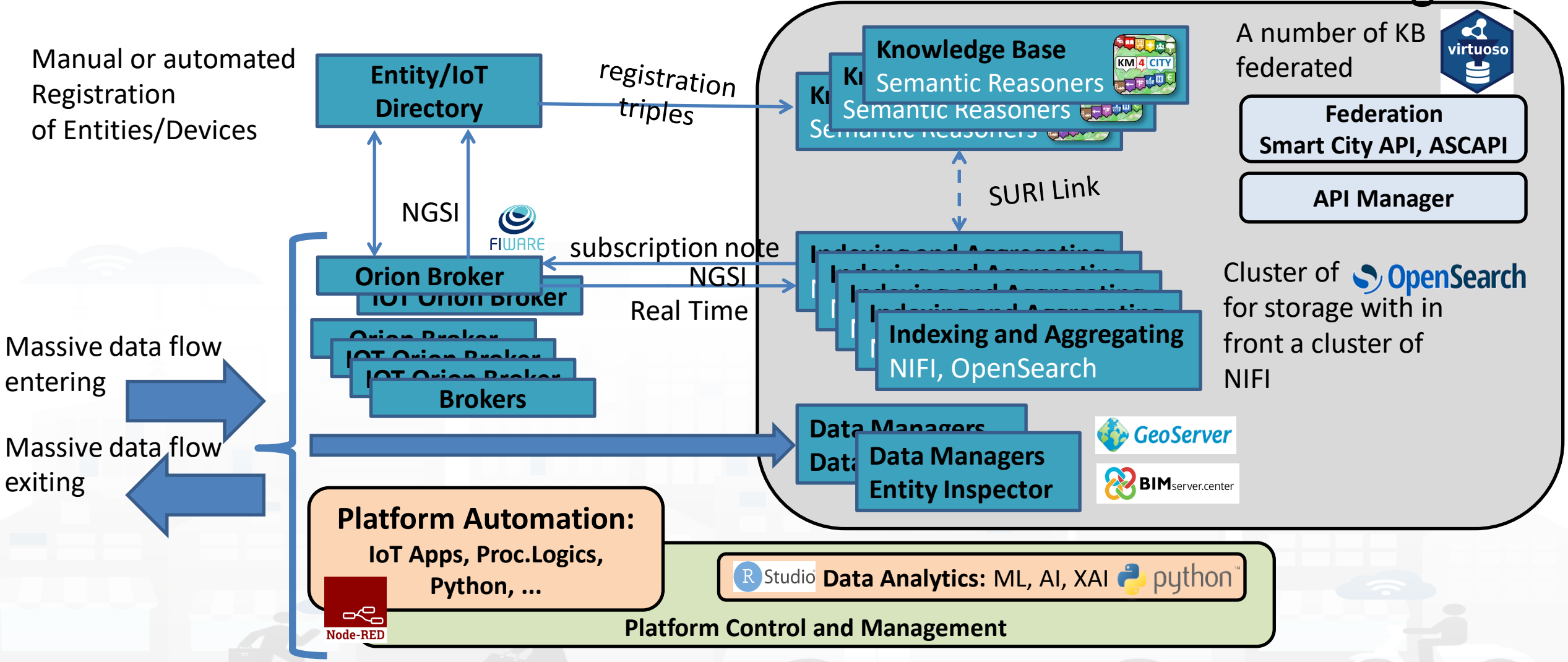

The delete device node needs in input Device ID and Broker ID. All data that you can recover from the Entity Directory.

# Proc.Logic / IoT App Development

Part 3
Part 5



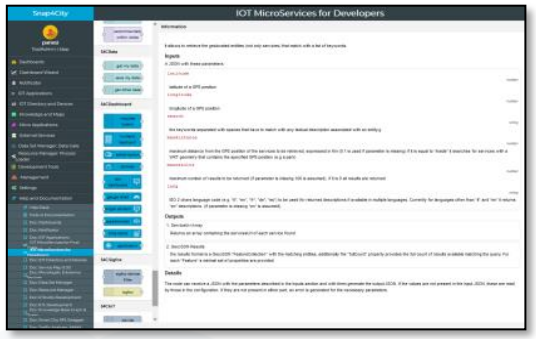
# Snap4city Data Ingestion Diagram



# Proc.Logic / IoT App Development

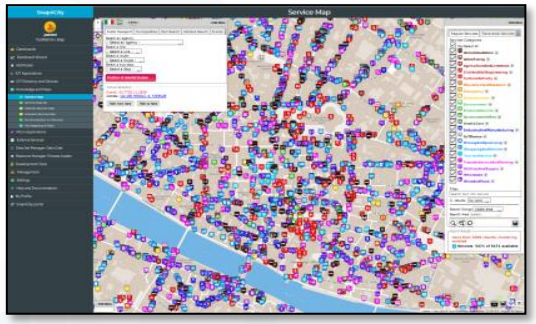
IOT Discovering

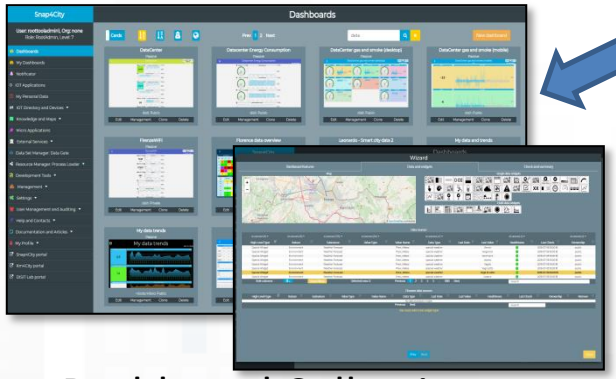
MicroServices collections




My IoT Applications




ServiceMap Discovery




Dashboard Collection, Editor and Wizard

IoT App. Editor




Generating IoT App With Dashboard



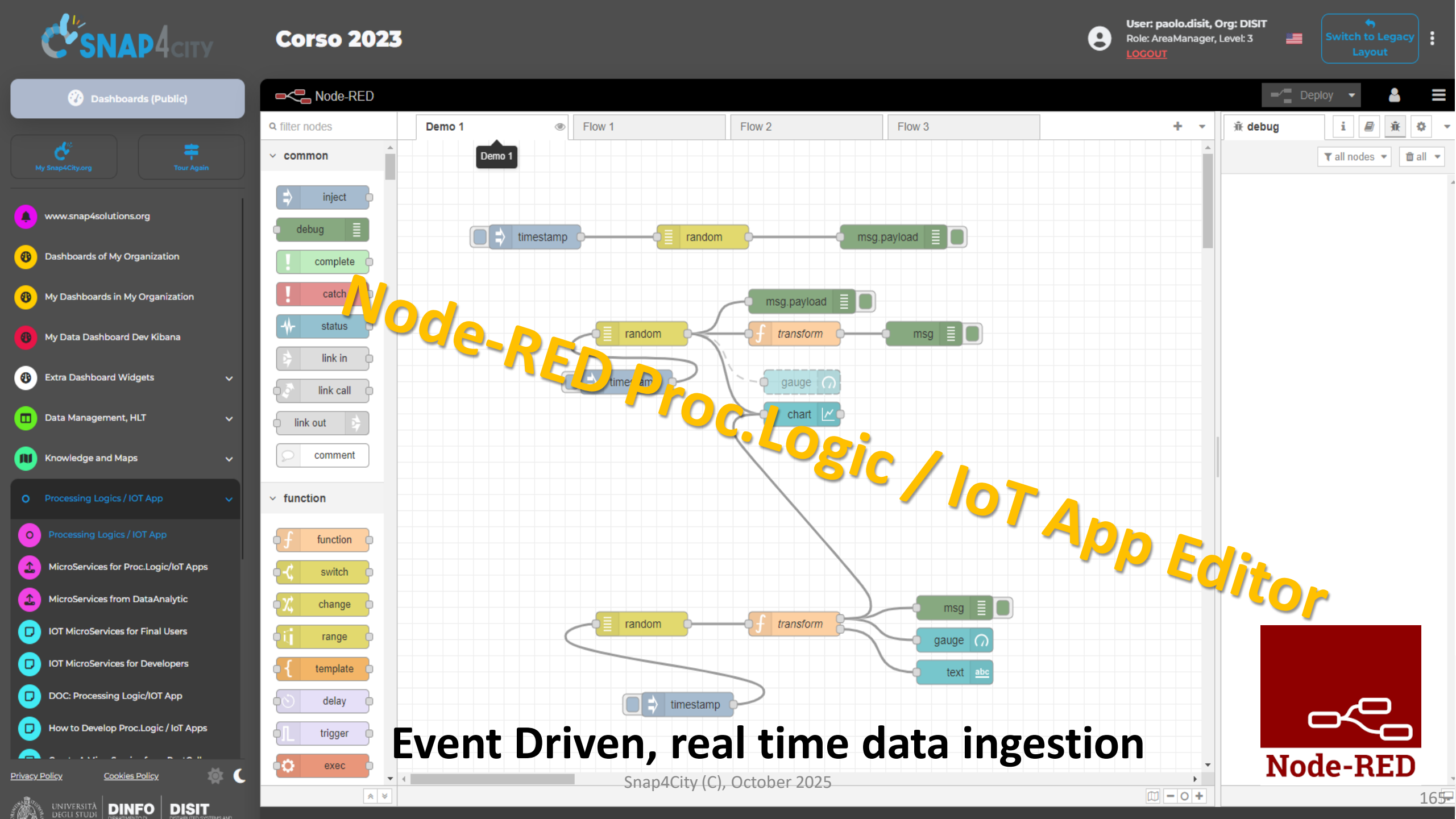
Sharing/saving reusing IoT App






Resource Manager

GitHub


SNAP4CITY
Corso 2023
User: paolo.disit, Org: DISIT
Role: AreaManager, Level: 3
LOGOUT
Switch to Legacy Layout
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
Processing Logics / IOT App
MicroServices for Proc.Logic/IoT Apps
MicroServices from DataAnalytic
IOT MicroServices for Final Users
IOT MicroServices for Developers
DOC: Processing Logic/IOT App
How to Develop Proc.Logic / IoT Apps
Privacy Policy
Cookies Policy
UNIVERSITÀ DEGLI STUDI
DINFO
DISIT
Node-RED
Deploy
filter nodes
Demo 1
Flow 1
Flow 2
Flow 3
common
inject
debug
complete
catch
status
link in
link call
link out
comment
function
function
switch
change
range
template
delay
trigger
exec
timestamp
random
msg.payload
transform
msg
gauge
chart
text
debug
all nodes
all
Node-RED Proc.Logic / IoT App Editor
Event Driven, real time data ingestion
Snap4City (C), October 2025
165

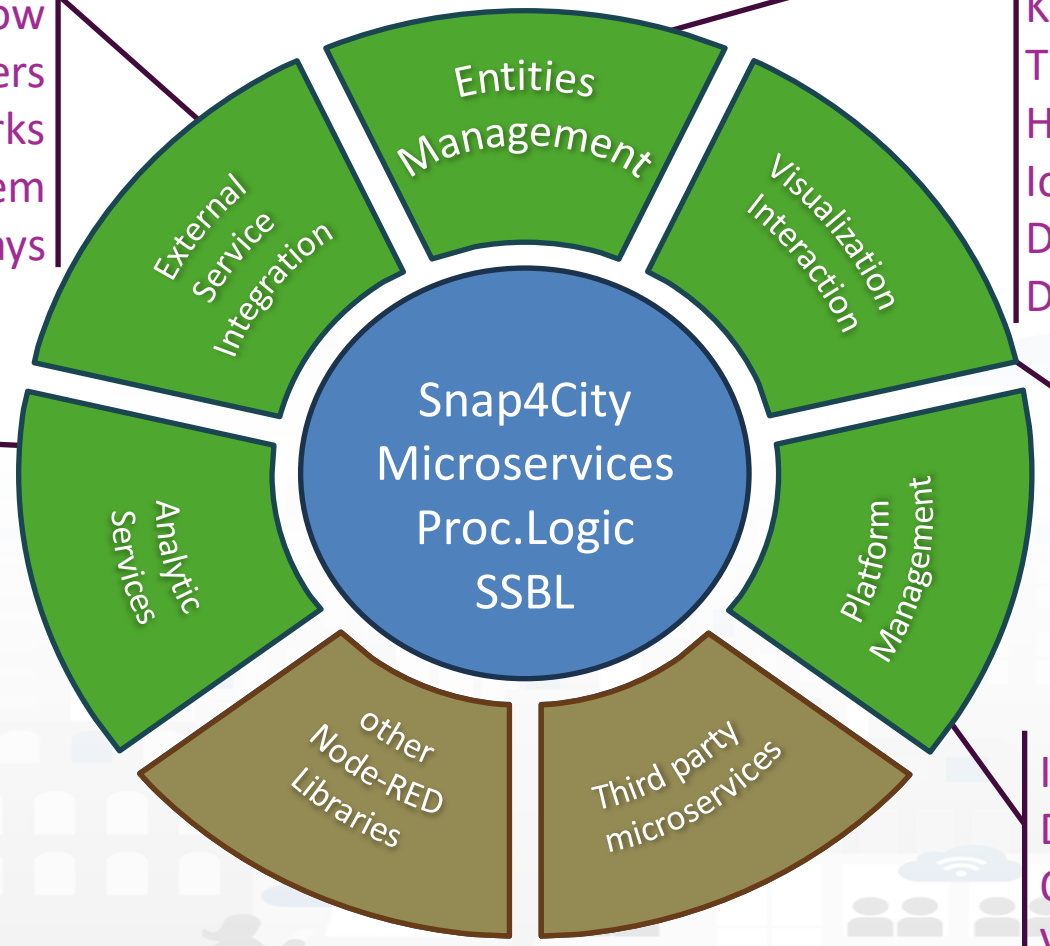
# MicroServices Areas



**> 60.000 downloads**

Open Data CKAN
Ticket Management, workflow
BIM Servers
Social Networks
Video Management system
Gateways

Data Analytics
Statistic, Optimization
Simulation
Artificial Intelligence
What-if Analysis Support
Geo Utilities Support
Routing & Traffic Flow
MLOps support
Python support
R Studio Support




Data Load / Search / Retrieval
KPI, POI, GIS Data, Scenarios
Time Series, Public transport
High Level Types: heatmaps, ODM,…
IoT / Entity Discovery
Delegation Management
Data Mapping

Dashboards
Widgets: Graphic Libraries
Interactive Widgets
Maps, 3D representations
Synoptics, External Content
Micro Web App

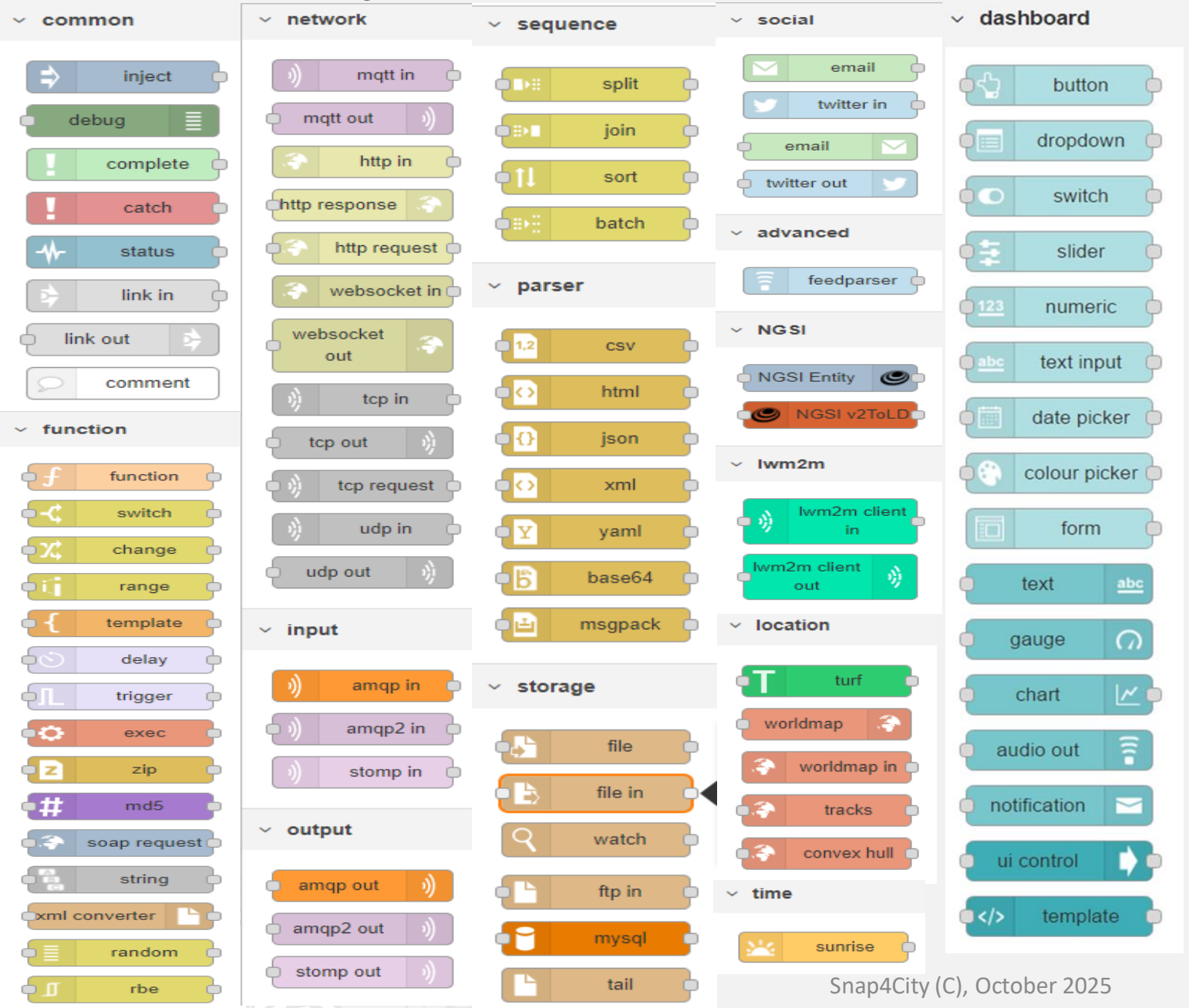
IoTApp Management
Data Logs, A&A, Security
Ownership Management
VPN remote access

Node-RED

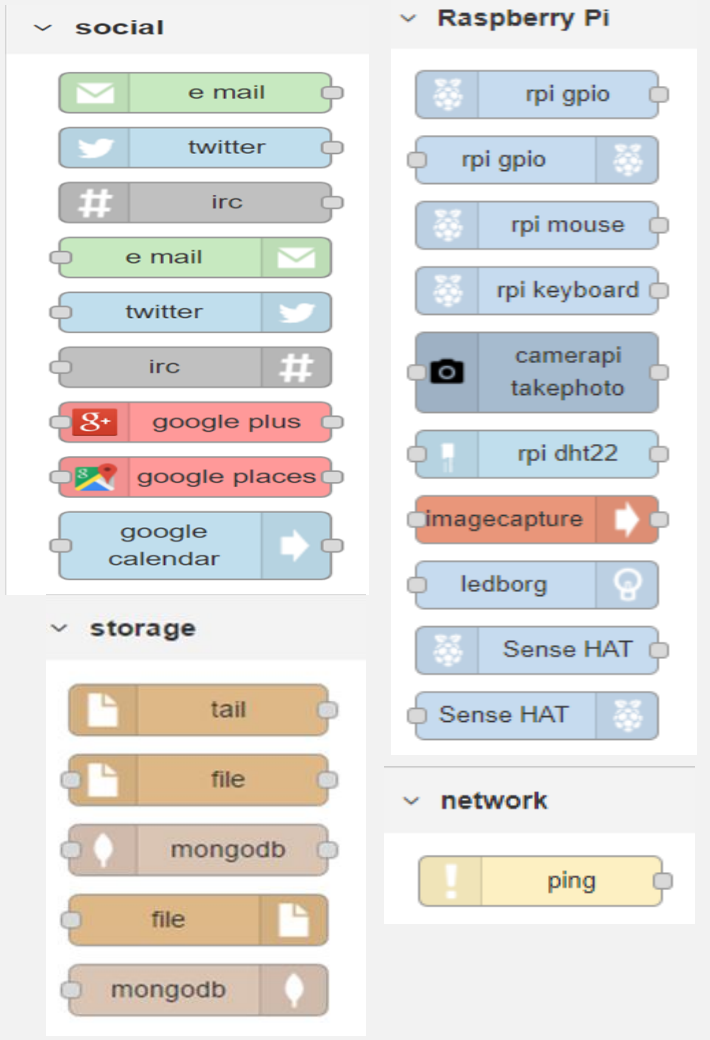
# Basic Node.js Blocks on NodeRed on our Advanced IOT Apps

DISIT Lab, Distributed Data Intelligence and
http://www.di




## + on IOT Edge Raspberry

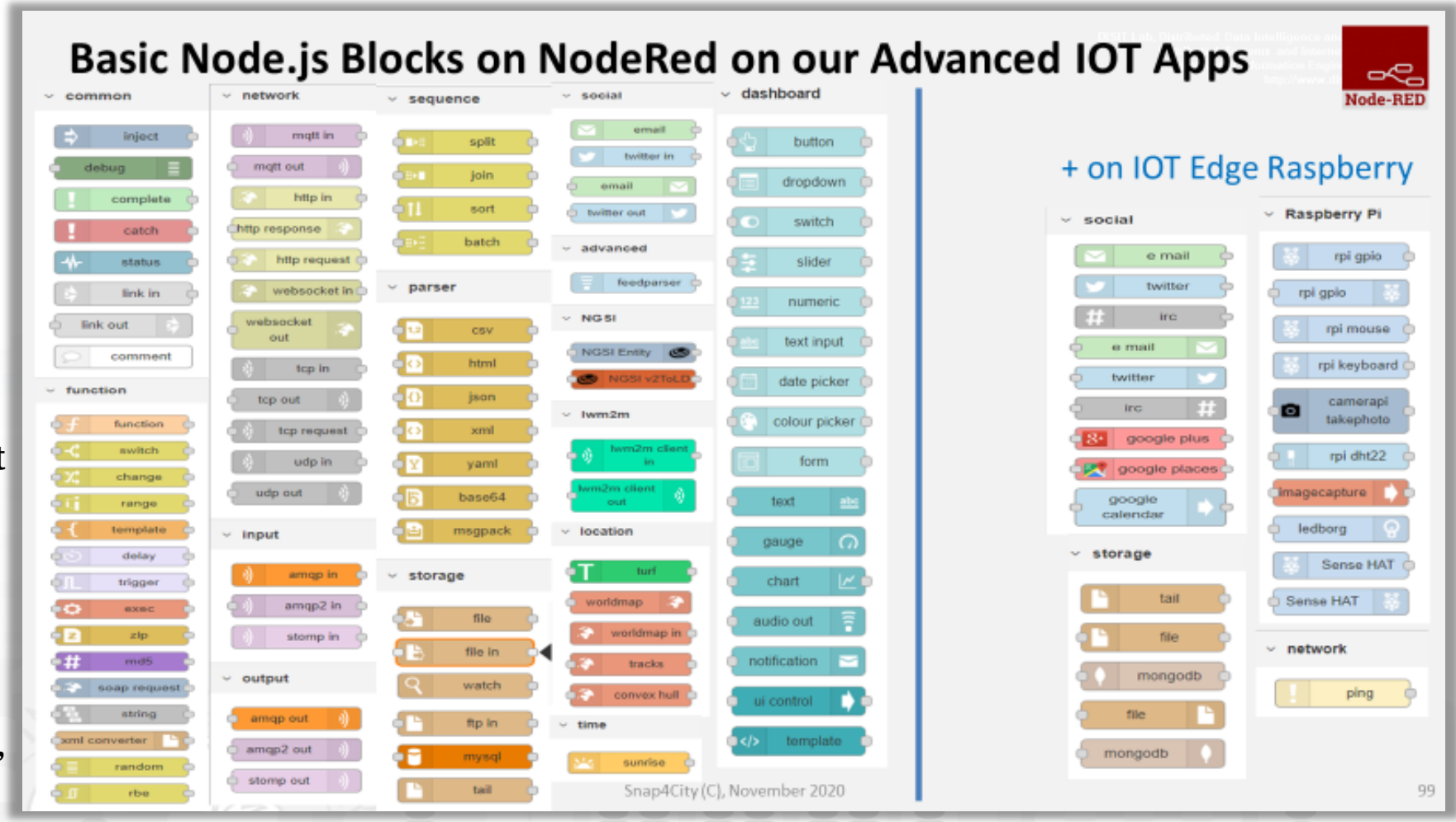


# Node-RED Basic Blocks

It is provided with **a minimum set** of functionalities (the building blocks/nodes) while other blocks can be easily added loading them from a **large library** made available by the **JS Foundation**.

Despite to its diffusion, for the usage in the context of Smart City it was **not powerful** to cope with the **basic requirements** of the domain.

The classical nodes provided in the standard version can be classified as: input, output, function, social, storage, analysis, advanced, and dashboard.



# IoT Applications

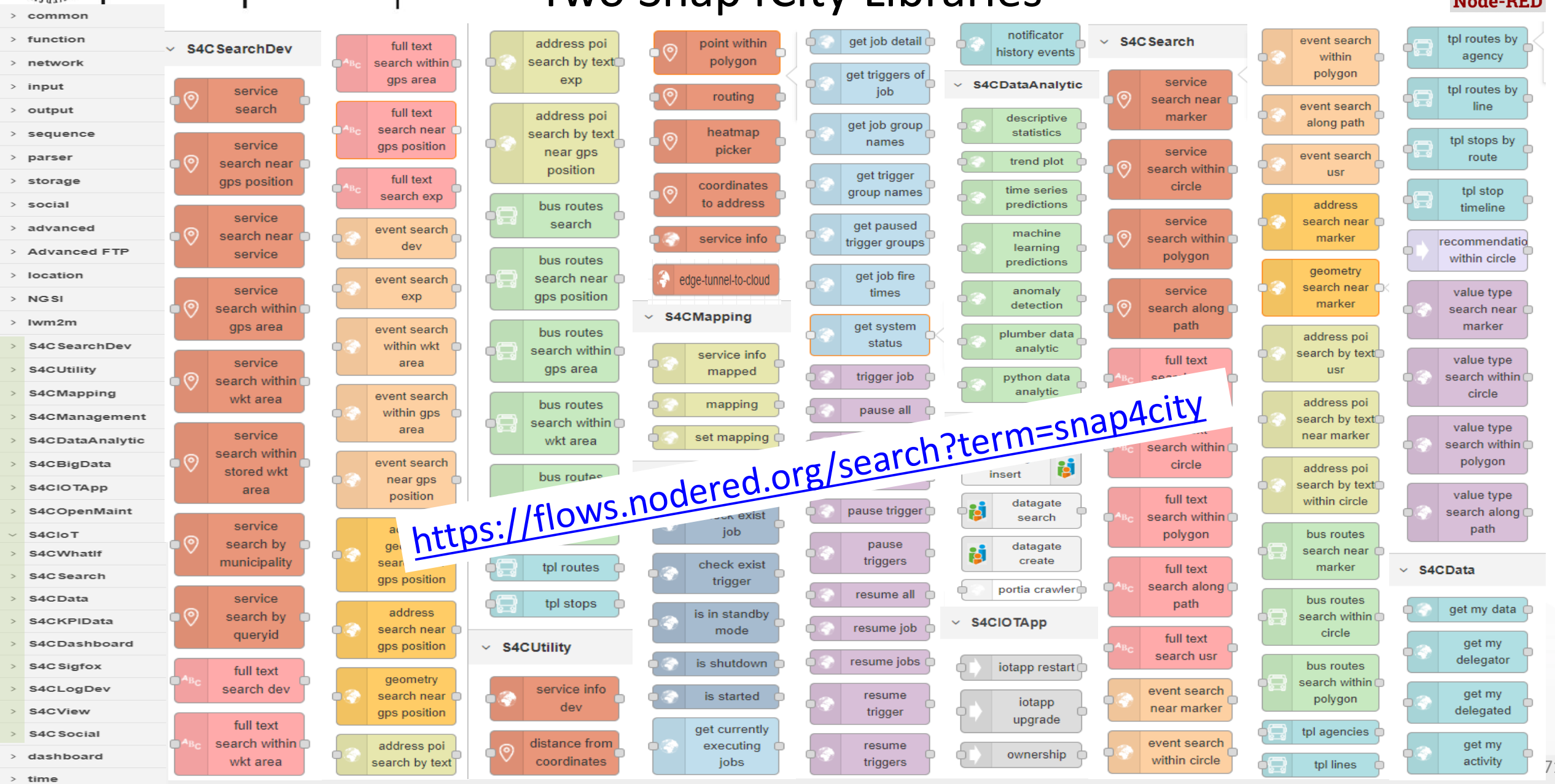
- **Data ingestion**: more than 70 protocols IOT and Industry 4.0, web Scraping, external services, any protocol database, etc.
- **Data access**: save/retrieve data, query search on expert system, georeverse solution, search on expert system Km4City ontology, etc.
- **Data Transformation/transcoding:** binary, hexadecimal, XML, JSON, String, any format
- **Integration**: CKAN, Web Scraping, FTP, Copernicus satellite, Twitter Vigilance, Workflow OpenMaint, Digital Twin BIMServer, any external service REST Call, etc.
- **Manipulation of complex data**: heatmaps, scenarios, typical time trend, multi series, calendar, maps, etc.
- **Access to Smart City Entities and exploitation of Smart City Services**: transport, parking, POI, KPI, personal data, scenarios, etc.
- **Data Analytic**: managing Python native, calling and scheduling Python/Rstudio containers as snap4city microservices (predictions, anomaly detection, statistics, etc.)
- **User interaction on Dashboard**: get data and message from the user interface, providing messages to the user (form, buttons, switches, animations, selector, maps, etc. )
- **Custom Widgets**: SVG, synoptics, animations, dynamic pins on maps, etc
- **Event management**: Telegram, Twitter, Facebook, SMS, WhatsApp, CAP, etc.
- **Hardware Specific Devices**: Raspberry Pi, Android, Philips, video wall management, etc.

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

# 2025 collection
# Two Snap4City Libraries

SNAP4CITY | Node-RED

https://flows.nodered.org/search?term=snap4city



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

# 2025 collection

## Two Snap4City Libraries

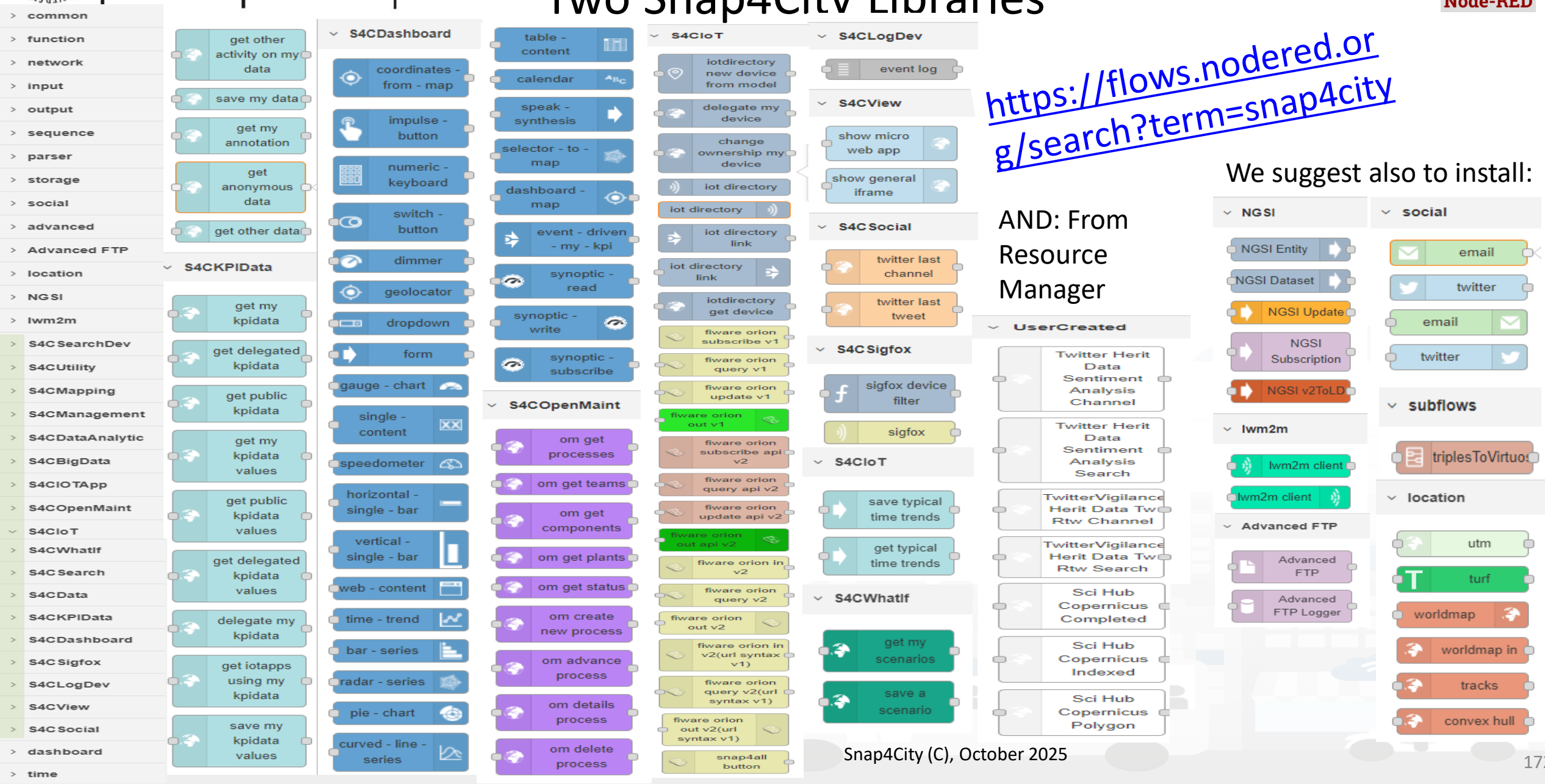
SNAP4CITY

Node-RED

https://flows.nodered.org/search?term=snap4city

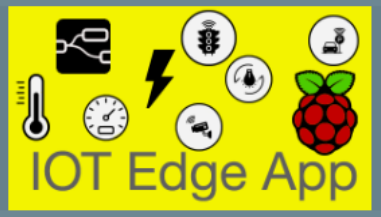
We suggest also to install:

AND: From Resource Manager

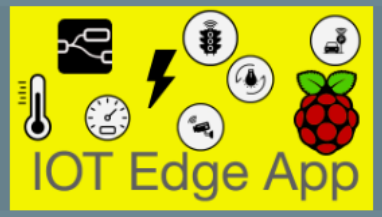


# IOT Applications

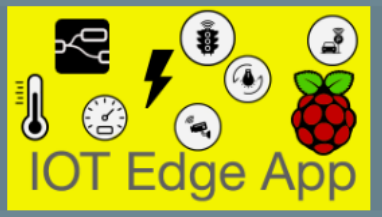


2018-09-14T04:44


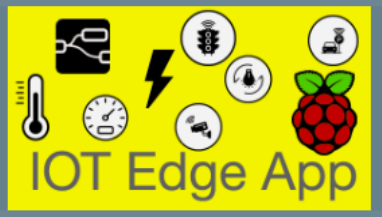
owner: badii
Management

2018-09-21T03:19


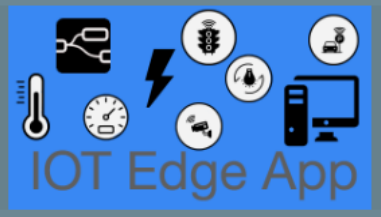
owner: panesi
Management

2018-10-19T16:07


owner: pb3
Management

2018-10-19T17:17


owner: pb3
Management

2018-10-22T11:57


owner: semolarudy
Management

application

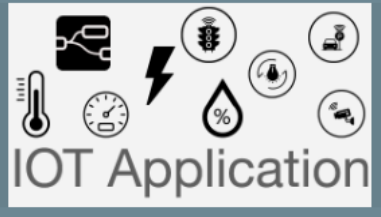

owner: tester5
Management

Bib APP


owner: semolarudy
Management

ChargingStations

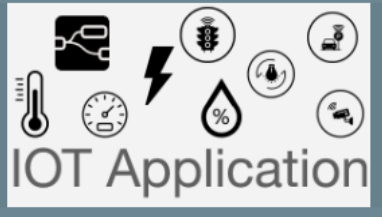

owner: comunedashres
Management

Deprecated - SiiMobilityControlRoom


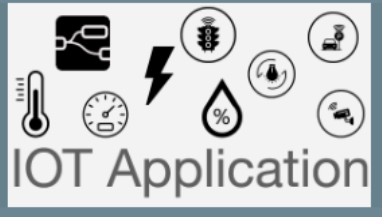
owner: badii
Management

SamsungGalaxyS4BarCode


owner: badii
Management

esercitazione


owner: tester2
Management

Iot-App


owner: tester14
Management

# Resource Manager: public and sharing

Snap4City

User: roottooladmin1, Org: DISIT
Role: RootAdmin, Level: 7

- Dashboards
- My Dashboards
- Notificator
- IOT Applications
- My Personal Data
- IOT Directory and Devices
- Knowledge and Maps
- Micro Applications
- External Services
- Data Set Manager: Data Gate
- Resource Manager: Process Loader
  - View Resources
  - Managing Resources
  - MicroServices for IOT Applications
  - Process Models
  - Processes in Execution
  - Process execution Archive
- Development Tools
- Management
- Settings
- User Management and Auditing
- Help and Contacts
- Documentation and Articles
- My Profile
- Snap4City portal

## View Resources

Pages: Prev 1 2 3 ... 12 Next

dev

Reset | Username | Nature | Sub_nature | License | Resource_type | Format

Resource_type:
- IoTApp (118)
- ETL (53)
- MicroService (8)
- AMMA (4)
- R (3)
- DevDash (2)
- IoTBlocks (2)

**Florence_Pharmacies_CSV.zip**
developer1: Public
Username: developer1
Resource type: ETL
Nature: geolocated
Description: Florence Pharmacies o...
View Edit Unpublish Owner

developer1: Public
Username: developer1
Resource type: ETL
Nature: sensors
Description: Smart bench
View Edit Unpublish Owner

**DeveloperDash-V3-1523555417880**
Dev Dashboard
snap4city: Private
Username: snap4city
Resource type: DevDash
Nature: data category (ie: geolocat...
Description: Snap4city Developer D...
View Edit Publish Owner

**node-red-contrib-snap4city-developer.rar**
snap4city: Private
Username: snap4city
Resource type: IoTBlocks
Nature: data category (ie: geolocat...
Description: Snap4city NodeRed Li...
View Edit Publish Owner

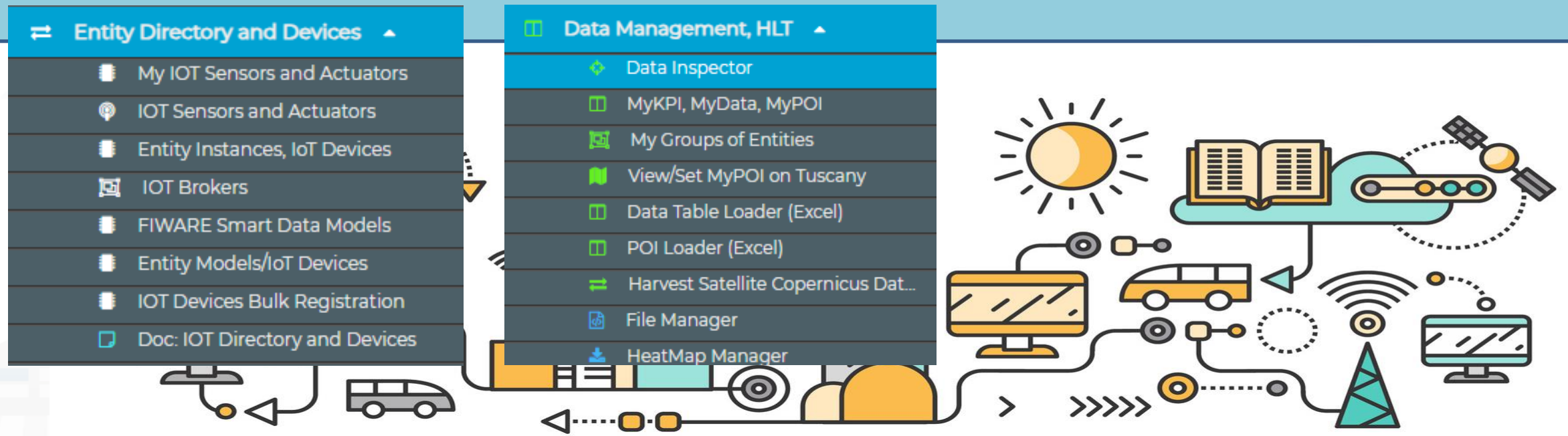
**PaoloApplication.json**
IOT Application
developer1: Private
Username: developer1
Resource type: IoTApp
Nature: data category (ie: geolocat...
Description: NodeRed Flow Shared ...
View Edit Publish Owner

**AMMADashSnap4City-30minview-v2-152...**
AMMA Tool
developer1: Private
Username: developer1
Resource type: AMMA
Nature: ToBeDefined
Description: AMMA snap4city dash...
View Edit Publish Owner

**Developer Dashboard New-1526308876256**
Dev Dashboard
developer1: Private
Username: developer1
Resource type: DevDash
Nature: ToBeDefined
Description: Developer Dashboard ...
View Edit Publish Owner

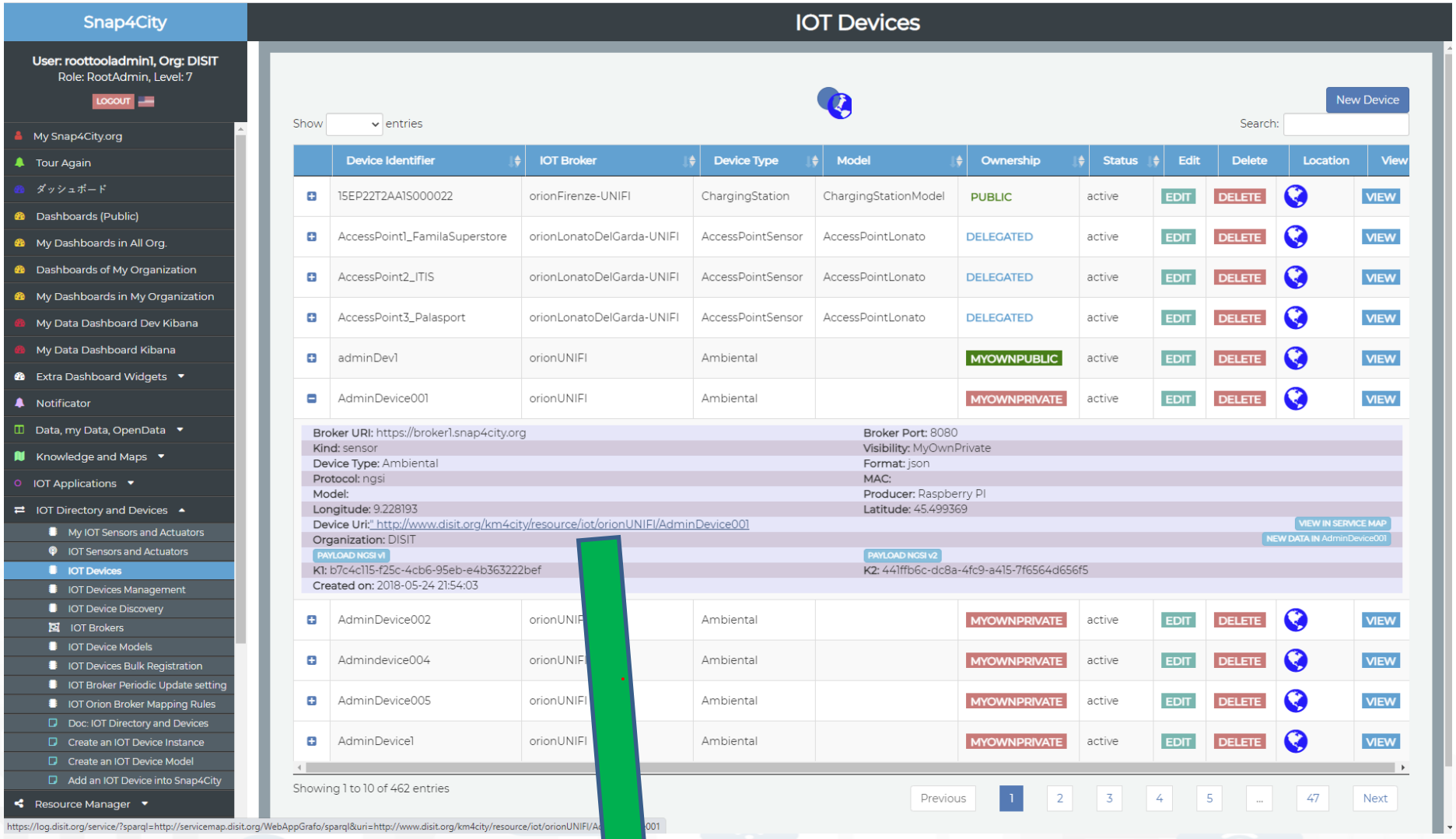
**ResDash Docker-1526308998809**
Res Dashboard
developer1: Private
Username: developer1
Resource type: ResDash
Nature: ToBeDefined
Description: Resource Dashboard: ...
View Edit Publish Owner

# search vs services, the ServiceURI

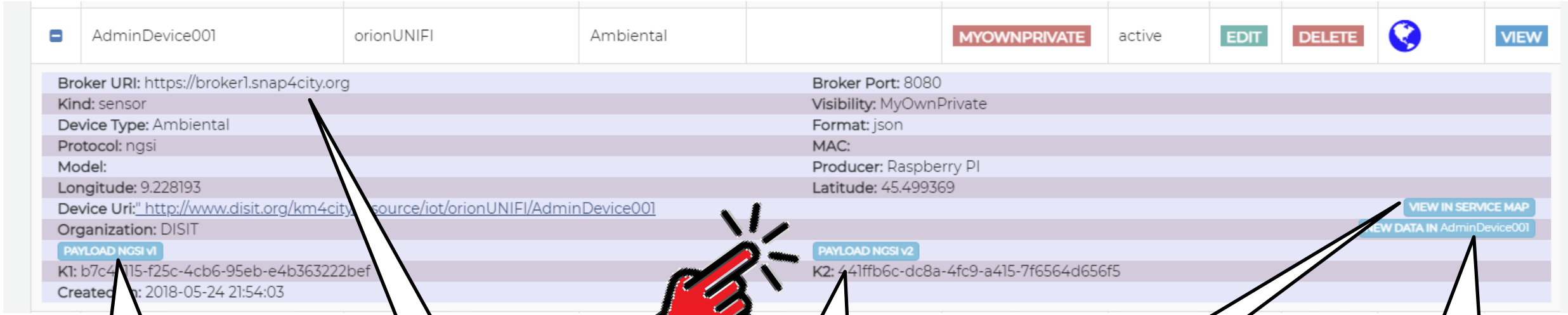


# IoT Directory

- **For:**
  IOT Devices, Sensors, Sensor mobile, Actuators, Virtual Sensors, etc.
- Accessible as
  - ServiceURI
  - **Device URI**



# Understanding / Testing an Entity/ IoT Device




See Payload NGSI V1 in JSON directly from the Broker, Last message of the broker

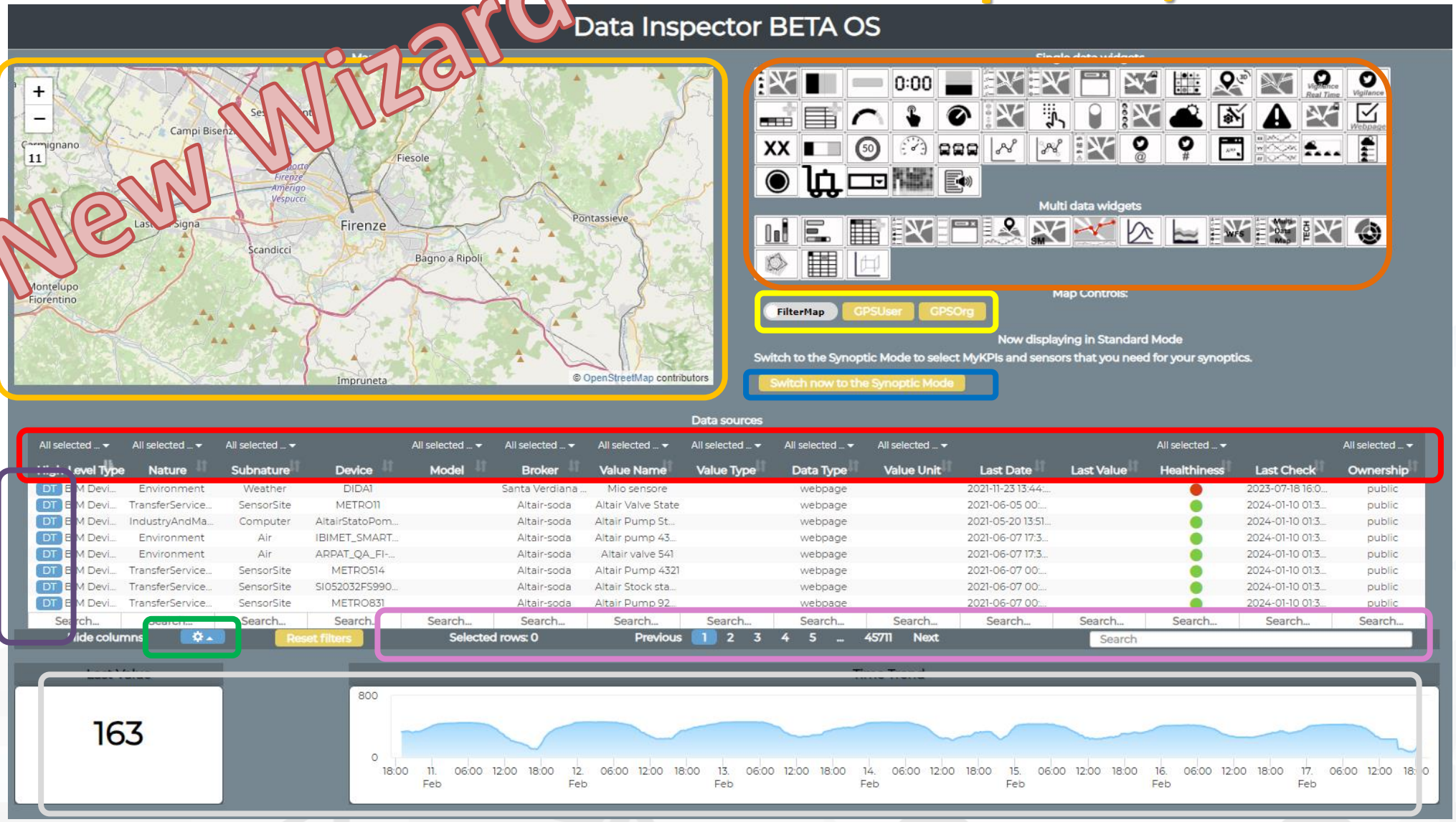
The Broker

See Payload NGSI V2 in JSON directly from the Broker, Last message of the broker

See IoT Device on ServiceMap

Create a Message to be sent at the IoT broker regarding this device.

# New Data Inspector/Wizard




Filtering/Searching for individual fields (even for some fields not displayed as geographic coordinates)

Geographic Filtering

**Text Search on all fields**

Menu for choosing the fields to display in the table

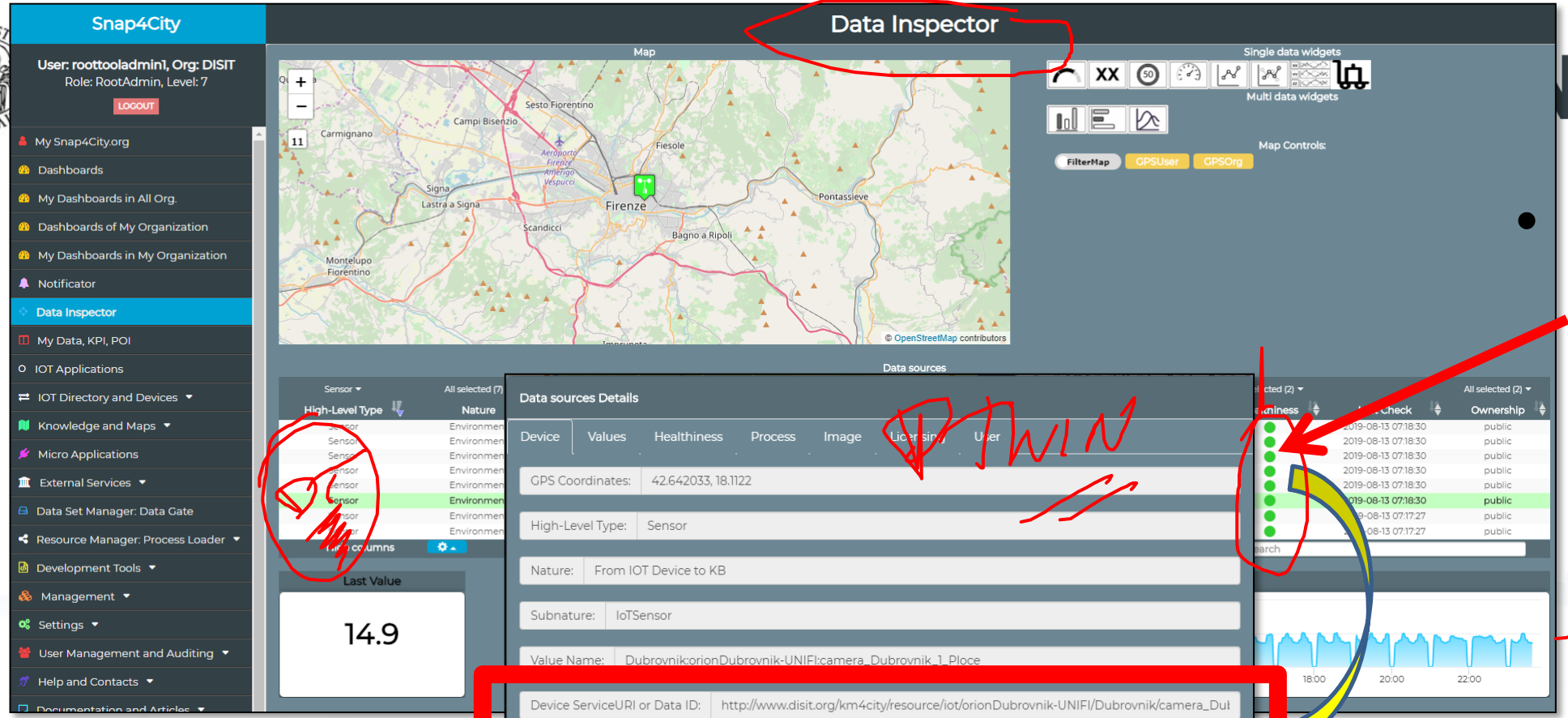
View on Map(via PREVIEW)

Data and Trend visualization

Opening Digital Twin

Pass to Synoptic mode

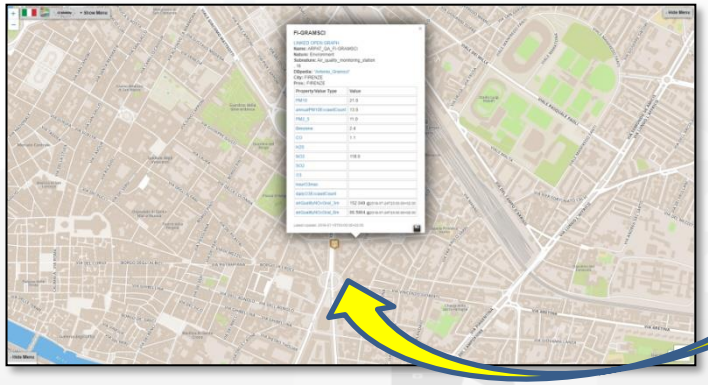
Select the graph representation

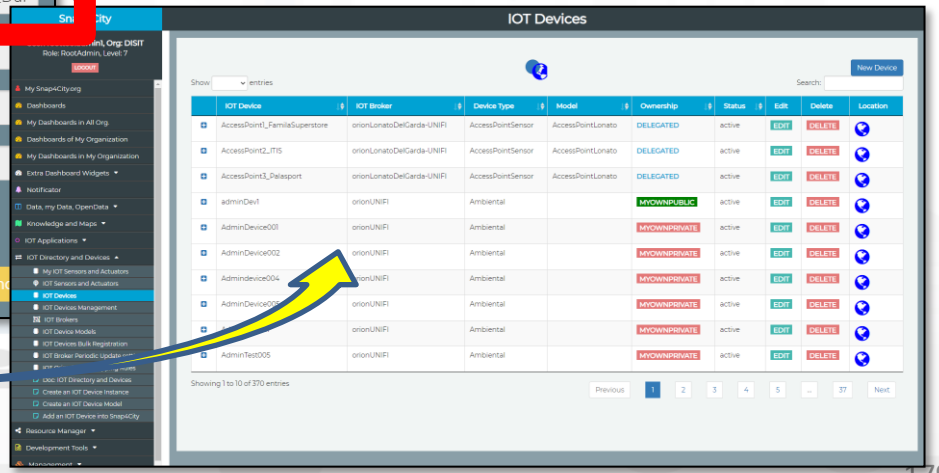



Knowledge Base view

- Click with the mouse on it

**Data Inspector Wizard**






*Some functionalities are limited to certain roles*

# Notation Terminology

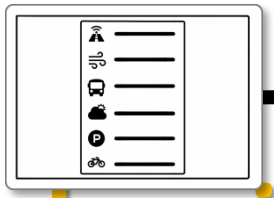
| WHERE | Are synonymous at level of service which can be IoT device or entity with data and references to | Are synonymous at level of the single attribute of the entity, device, service, etc. |
|---|---|---|
| IoT Directory, Entity Directory | IoT Device, Entity Instance, Device URI | Sensor, Actuator, Attributes, Values (value name) |
| Knowledge Base, ServiceMap, SmartCity API, ASCAPI | Service, ServiceURI, SURI | Attribute, Metric |
| DataInspector, Wizard, Dashboard | Value Name | 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**

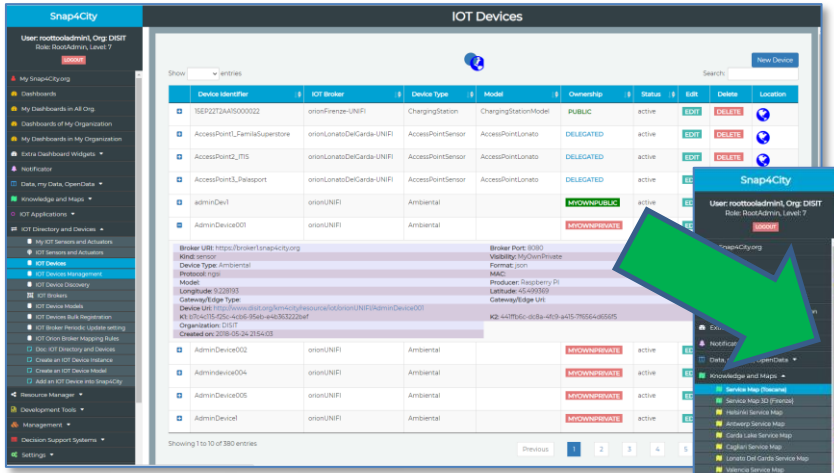



# Dashboard Usage and recipe: Event map target

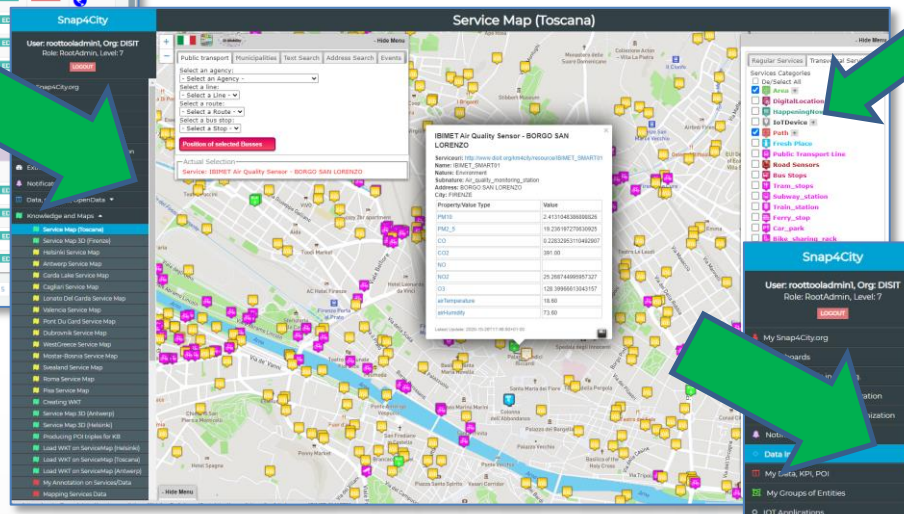
Parts 2, 3 and 7

- **Selector to Show on Map a**
  - **category of Map positioned elements**
    - https://servicemap.disit.org/WebAppGrafo/api/v1/?selection=43.08694333811321;8.791809082031252;43.93758500391093;14.065246582031252&categories=Traffic_sensor&maxResults=0&maxDists=0.1&text=&model=&value_type=&format=json
    - https://servicemap.disit.org/WebAppGrafo/api/v1/?queryId=e5f39066cd68ffe259ed8877bcee222b&format=json
  - **Entity by Model**
    - https://www.disit.org/superservicemap/api/v1?selection=59.36535064975547;13.457822799682619;59.39031474260852;13.56999435424806&model=SmartLightCapelon&format=json
  - **Single Entity**
    - https://servicemap.disit.org/WebAppGrafo/api/v1/?serviceUri=http://www.disit.org/km4city/resource/iot/orionFirenze2/Firenze/SH20ab_new&format=json&fromTime=3-day
  - **Heatmap among many**
    - https://wmsserver.snap4city.org/geoserver/Snap4City/wms?service=WMS&layers=Florence_PM10
  - **Traffic flow**
    - https://wmsserver.snap4city.org/geoserver/Snap4City/wms?service=WMS&layers=FirenzeFIPILITrafficRealtime&trafficflowmanager=true
    - https://firenzetraffic.km4city.org/trafficRTDetails/roads/read.php
  - **Origin Destination Map**
    - https://odmm.snap4city.org/api/get?precision=communes&from_date=&organization=Toscana&inflow=True&longitude=11.255751&latitude=43.769710&od_id=mobile_Toscana_1000&perc=True
- **Events which are also PIN on map**
- **Il Service URI as the unique identifier of the Entity**
  - **http://www.disit.org/km4city/resource/iot/orionUNIFI/DISIT/METRO632**

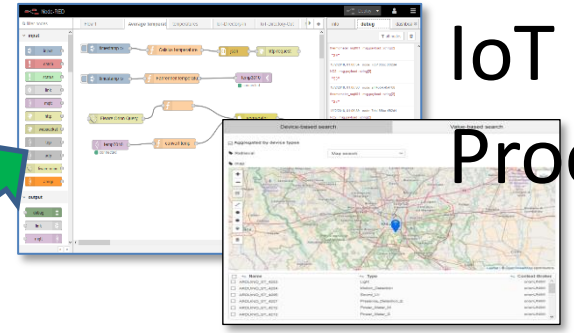
# Data Registration Flow at a Glance



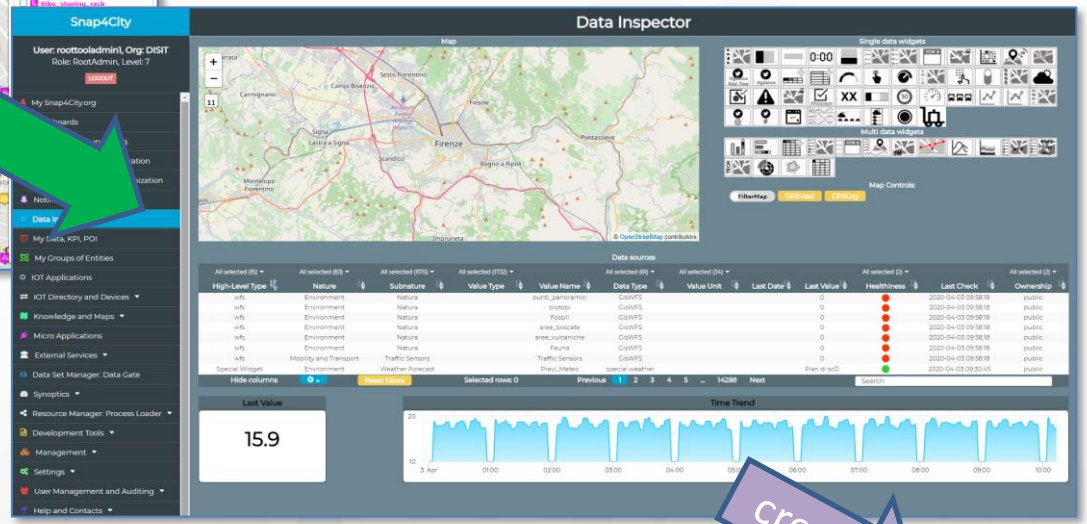

IOT Directory:
Devices…
Sensors..
Actuators…




Knowledge Base,
ServiceMap,
SuperServiceMap
SmartCity API,
ASCAPI



IoT Apps
Proc.Logic




DataInspector
Dashboard Wizard

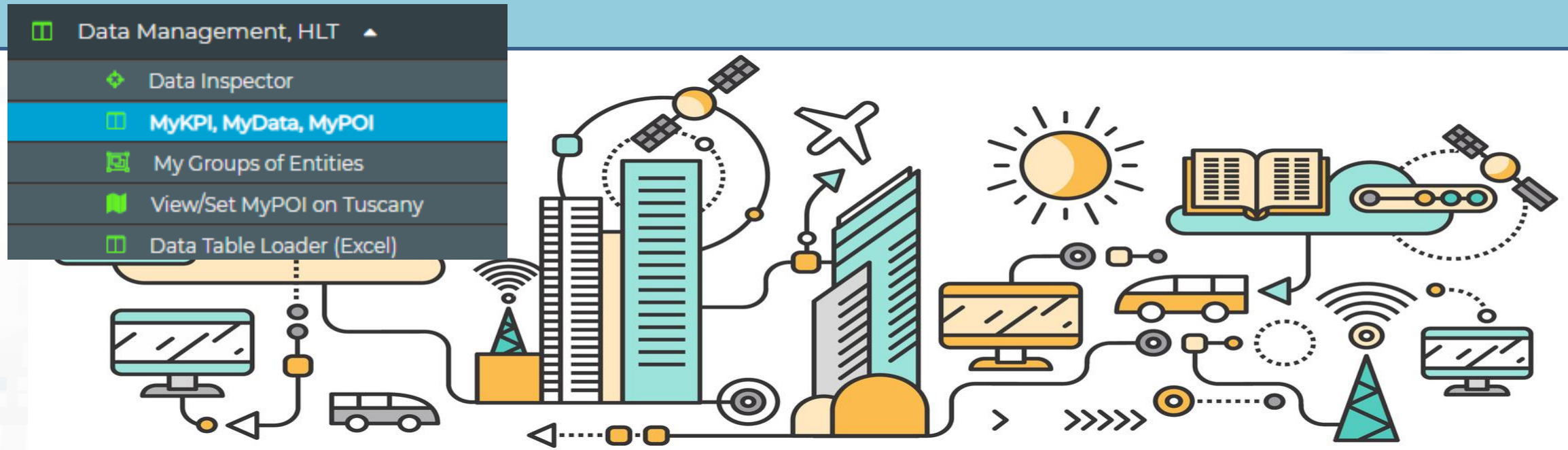
create

Dashboards

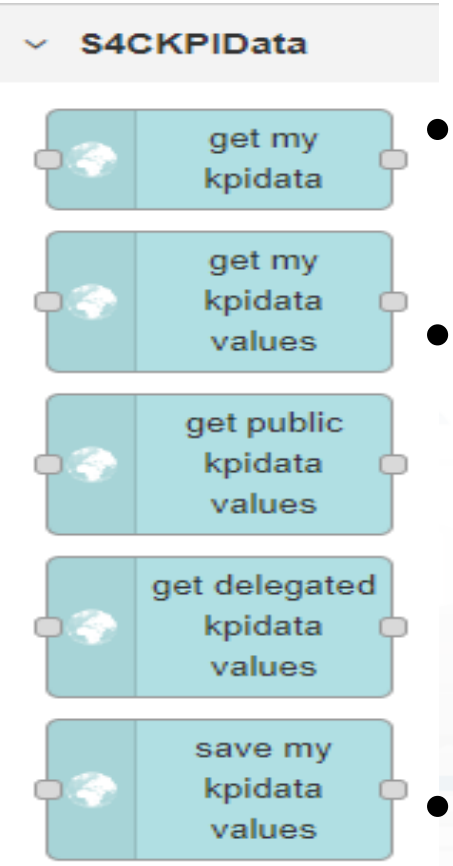
# MyKPI Nodes

Part 3

Part 5



# S4C KPI Data




- Save and retrieve MyKPI into the safe personal data storage
- Access to MyKPI and to those that other user have delegated to Me
- **MyKPI are:**
  - Time series of data with GPS coordinates that can chage over time
  - Suitable for: moving sensors, trajectories, data from OBU, data from mobile, sensor data (if needed), etc. etc.
- **MyPOI are:**
  - POI with full metadata description and static coordinates

# TOOLS for Data Ingestion Verifications

Part 3

Part 5

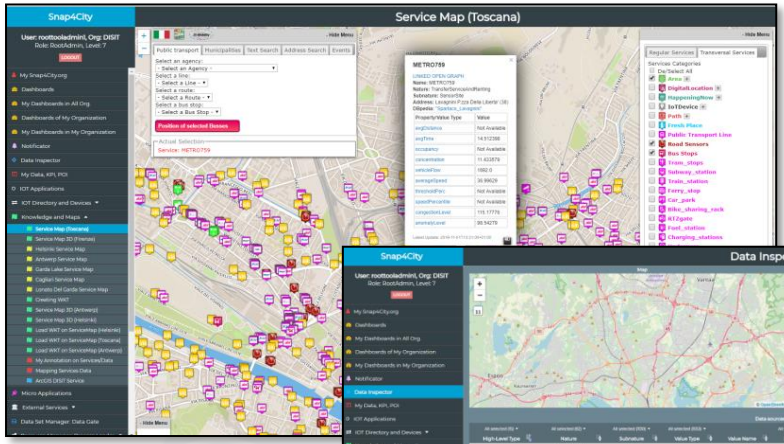


# Checking data/Entity ingestion results

**Knowledge base**
Semantic reasoners

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

- **ServiceMap**, SCAPI, **SuperSM**
  - LOG / LOD viewer
  - Super Service Map
  - SCAPI: Swagger
  - Last data
- **Data Inspector (last data)**
- IoT/Entity Directory
  - IoT Brokers



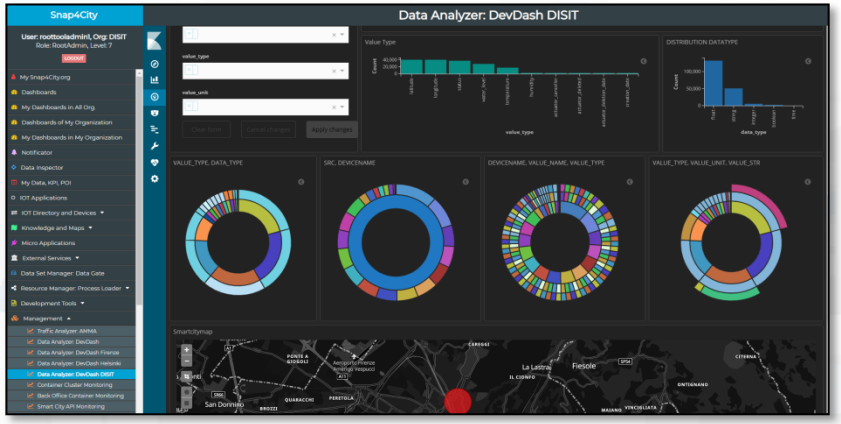

ServiceMap or
Super ServiceMap

Data Inspector
Digital Twin view

**Indexing and aggregating**
NIFI, OpenSearch

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

- **ServiceMap**, SCAPI (last data), **SuperSM**
- **My Data Dashboard,** OpenSearchDash
- **Data Inspector (last data)**

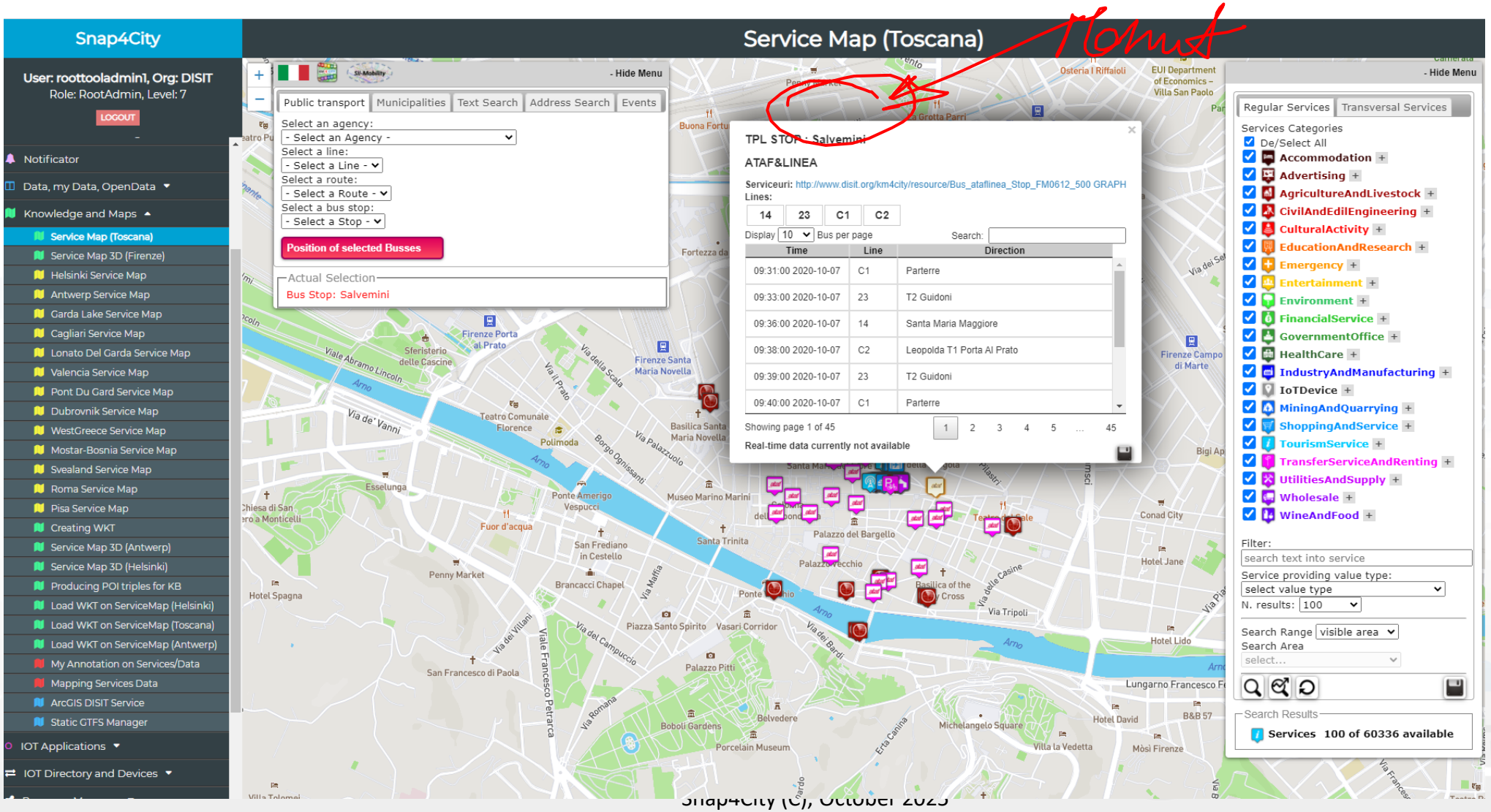



My Data Dashboard

DevDash

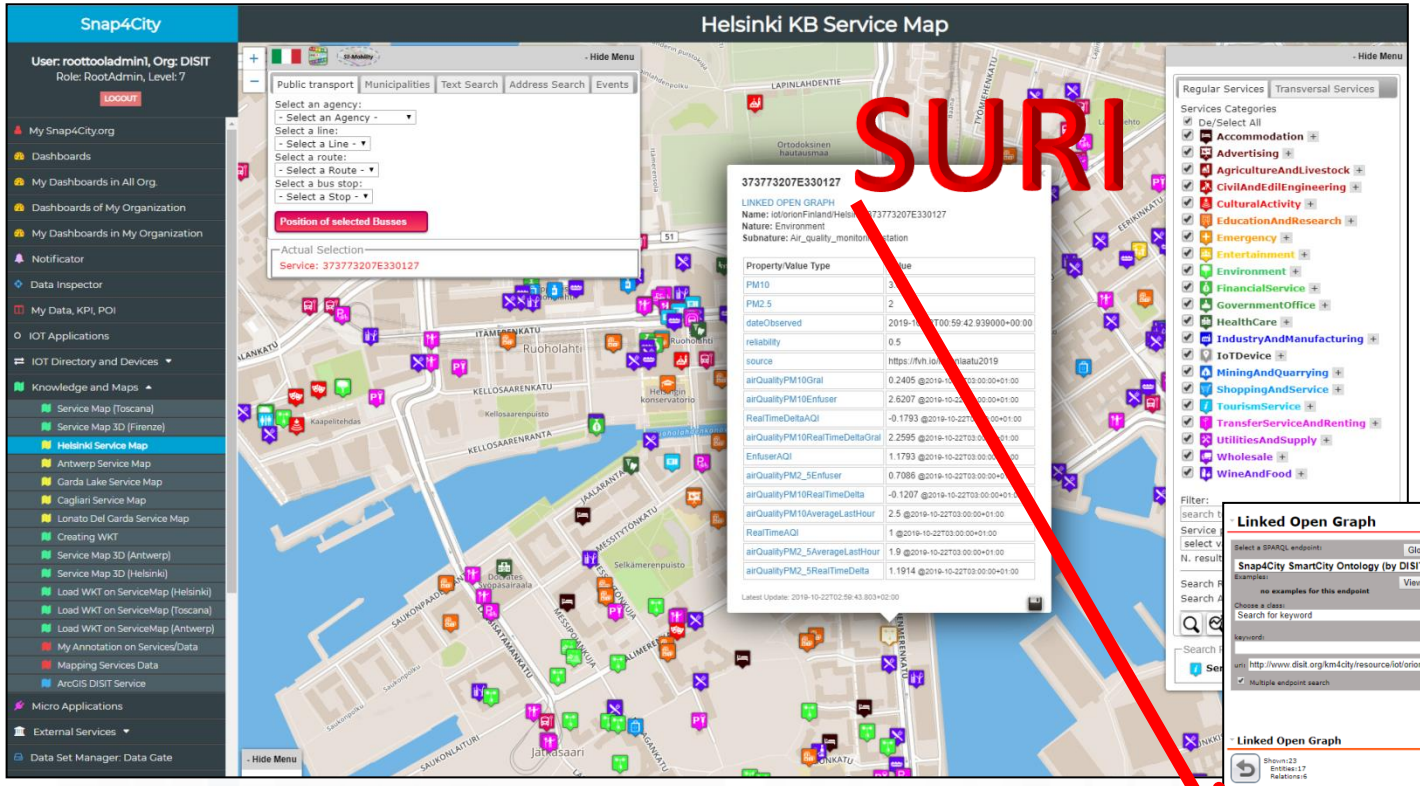
*Some functionalities are limited to certain roles*

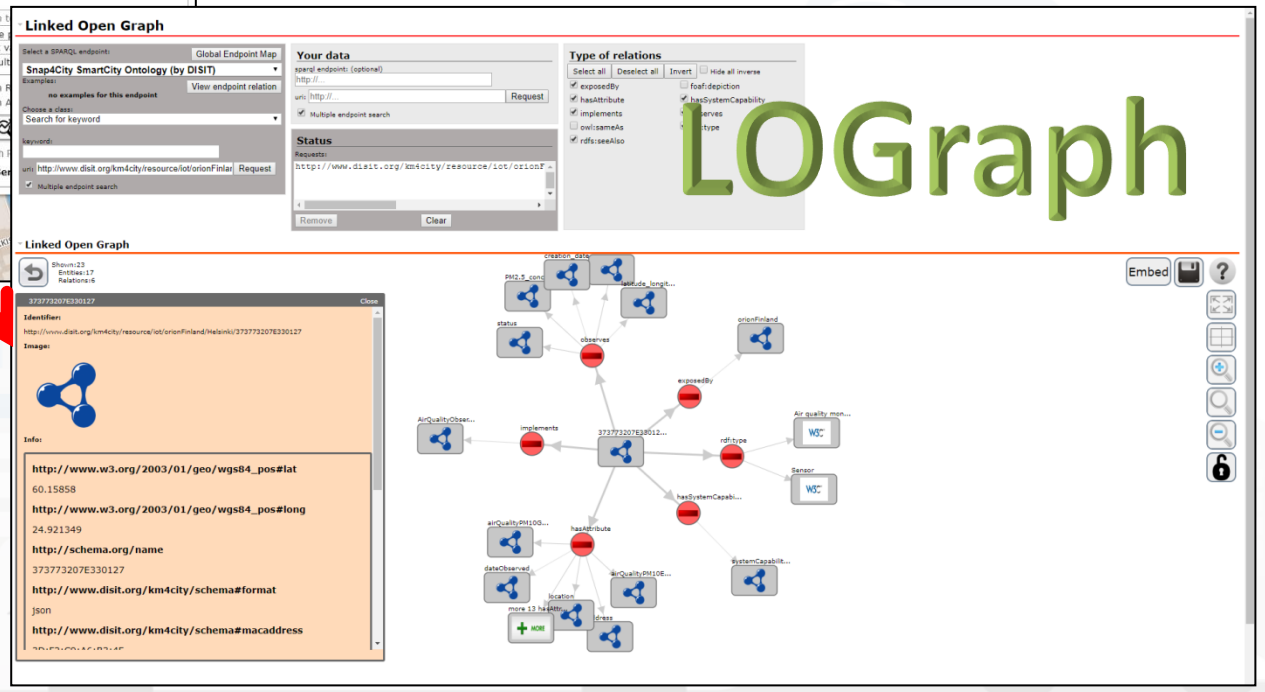
# ServiceMaps/Super ServiceMap



# Views of the Knowledge Base

**Knowledge Base**
Semantic Reasoners



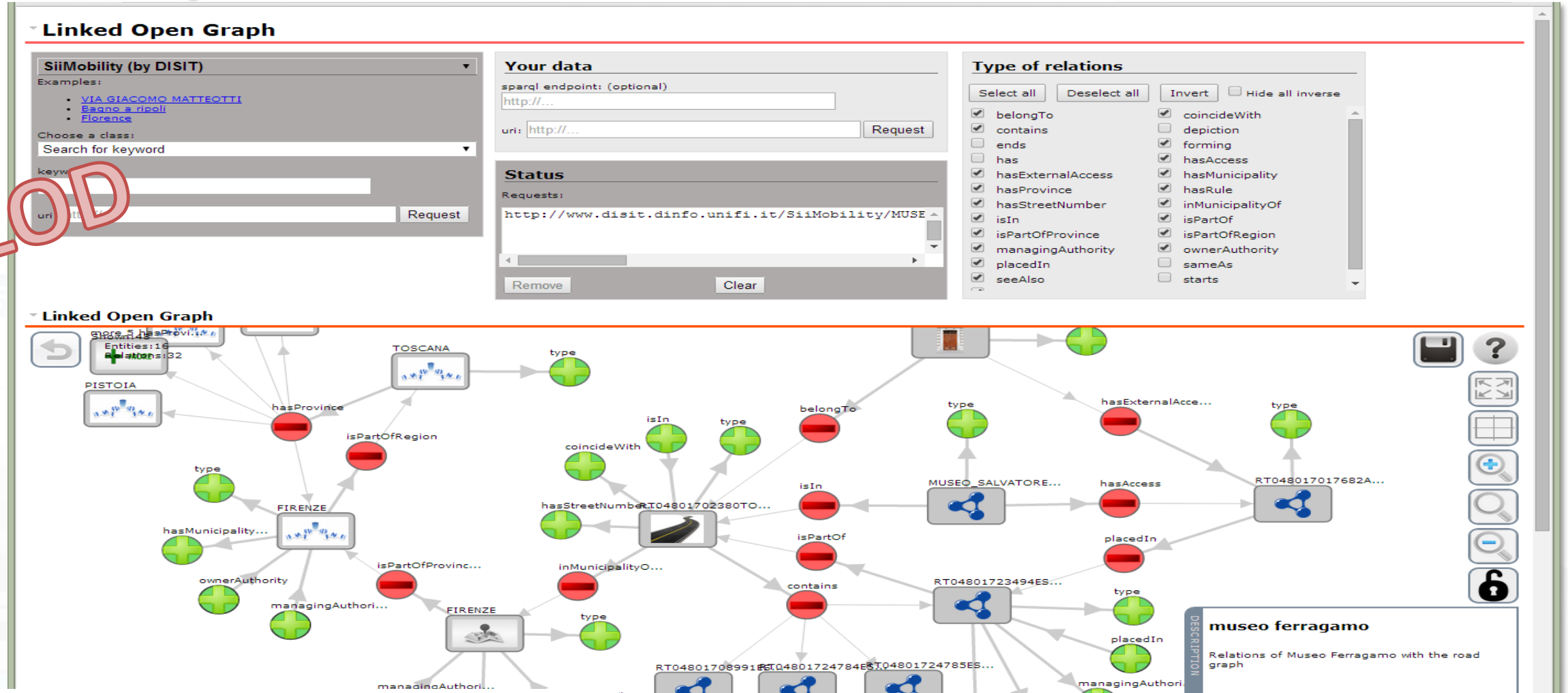




- How pass from ServiceMap to Linked Open Graph, Linked Data view tool

# LOGraph

## Linked Open Data

LOG: https://log.disit.org

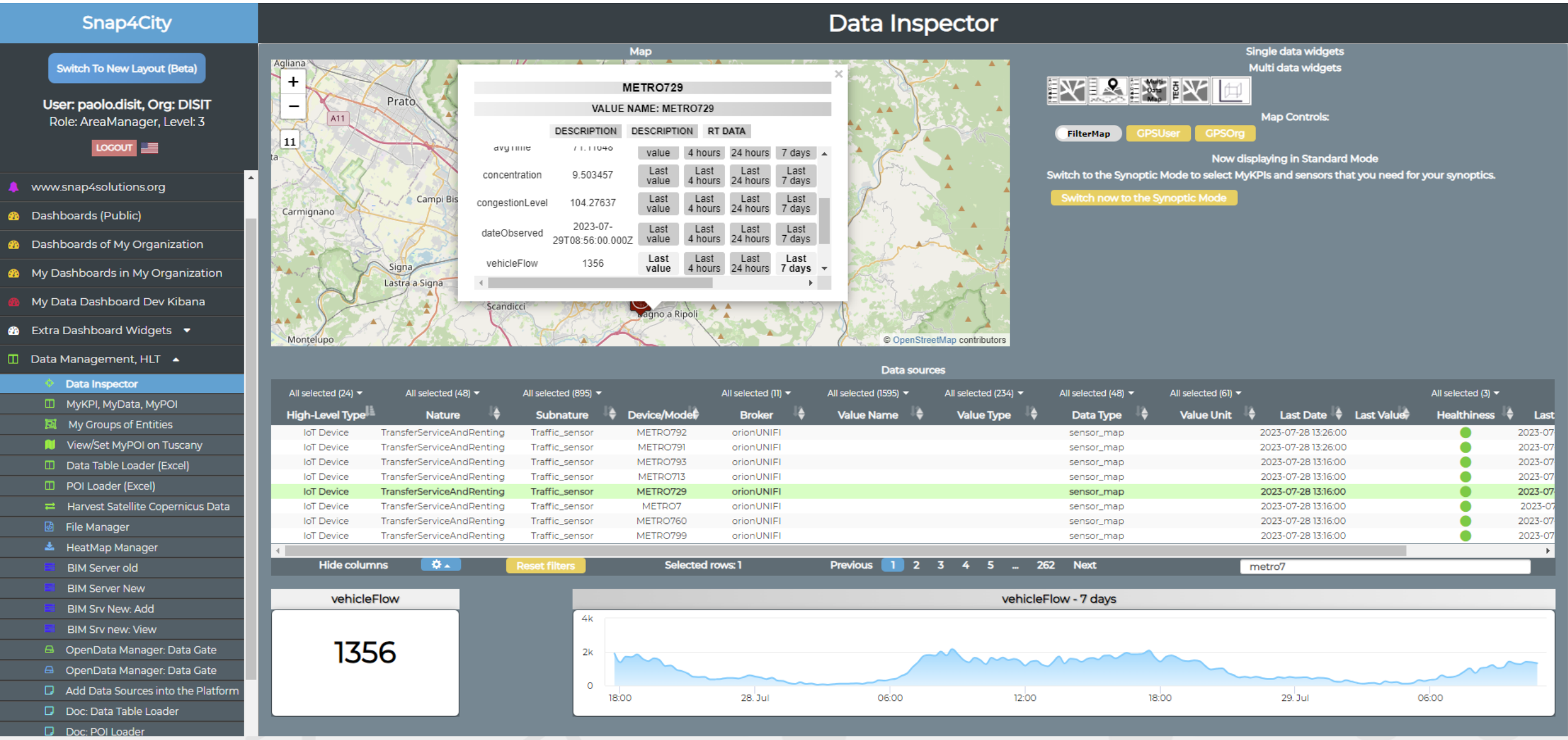



LOD

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

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

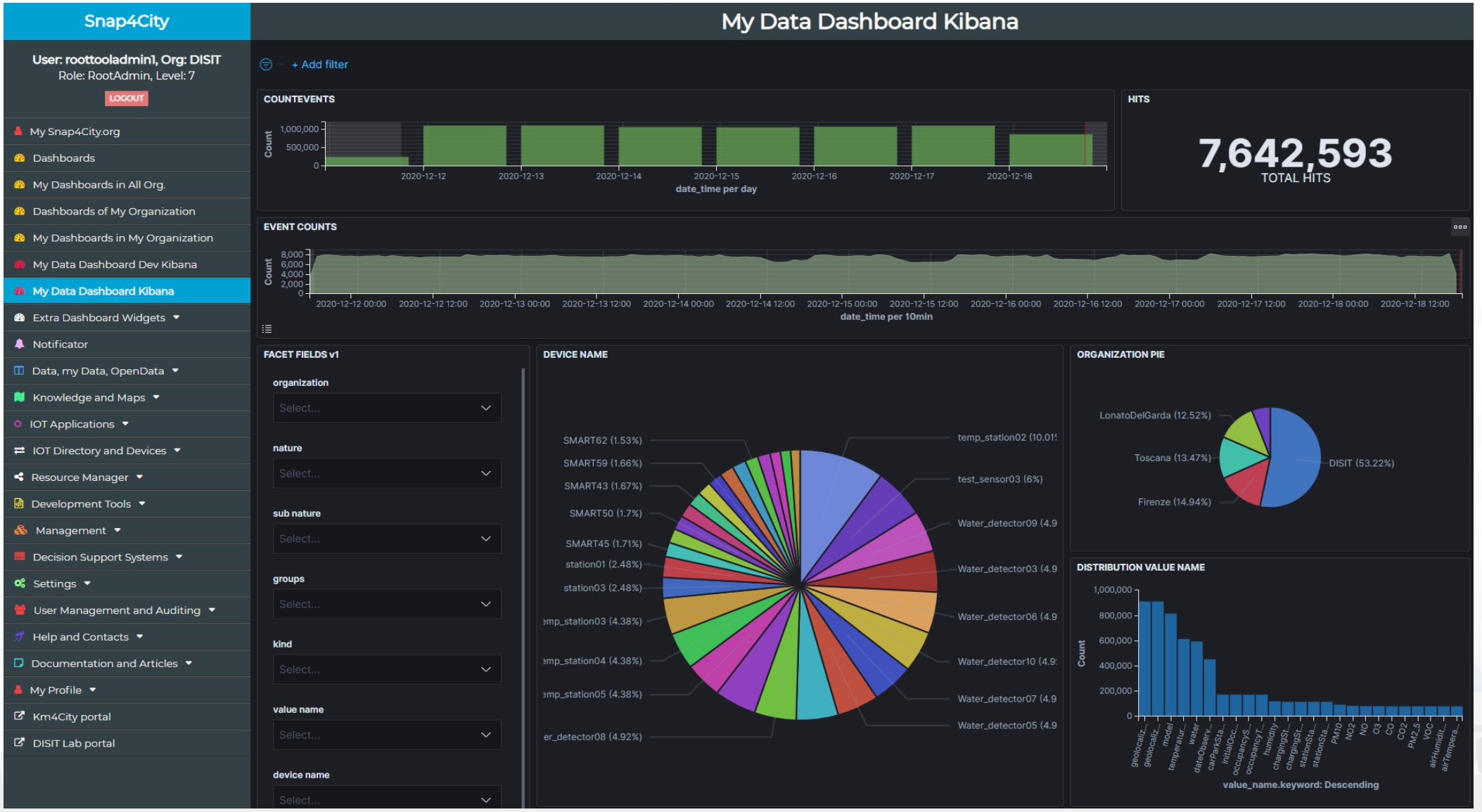
# Data Inspector



# Data Inspector for Beginner

- Browse and see models data via HLT, nature and Subnature
  - All the other faceted views, search and filter, filter by map, etc.
- Identify, click them to see
  - Remaining icons representing dashboard widgets which can be used in the Dashboard Wizard
  - ICON: Click on the icon on map and on value to preview data time serie if any
- See detailed Digital Twin data on the microbutton of the healthiness
- Wider data preview is coming

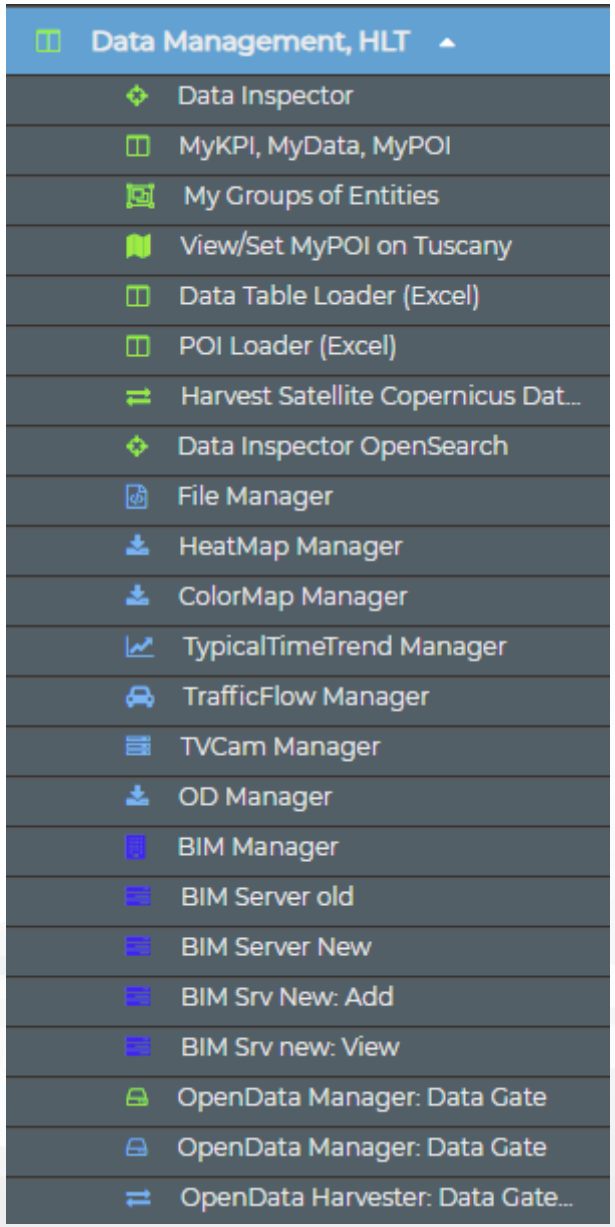
# DevDash: My Data Dashboard



# Data Managers



# Data Managers




- Data Inspector
- MyKPI….
- File Manager
- HeatMap Manager
- Typical Time Trend Manager
- TV Cam Manager
- OD, Origin Destination Matrix Manager
- Bim Manager
- Open Data Manager

# HeatMap Manager

Snap4City

Switch To New Layout (Beta)

User: roottooladmin1, Org: DISIT
Role: RootAdmin, Level: 7

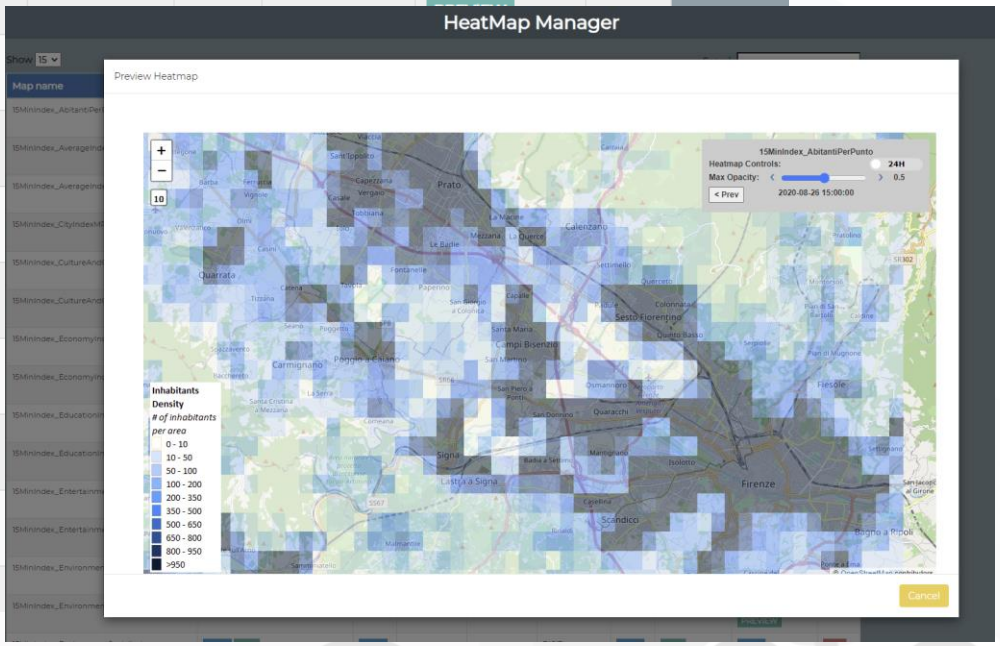
LOGOUT

- My Snap4City.org
- Tour Again
- www.snap4solutions.org
- 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 Management, HLT
  - Data Inspector
  - MyKPI, MyData, MyPOI
  - My Groups of Entities
  - View/Set MyPOI on Tuscany
  - Data Table Loader (Excel)
  - POI Loader (Excel)

## HeatMap Manager

Show 15 Search:

| Map name | Color Map | Owner | Nature | Subnature | Organization | Details | Management | View Data | Delete |
|---|---|---|---|---|---|---|---|---|---|
| 15MinIndex_AbitantiPerPunto | VIEW EDIT 15minsubindex | VIEW | CulturalActivity | Cultural_centre | DISIT | VIEW | EDIT | VIEW PREVIEW | DEL |
| 15MinIndex_AverageIndex | VIEW EDIT 15minsubindex | VIEW | | | DISIT | VIEW | EDIT | VIEW PREVIEW | DEL |
| 15MinIndex_AverageIndexBologna | VIEW EDIT 15minsubindex | VIEW | | | DISIT | VIEW | EDIT | VIEW PREVIEW | DEL |
| 15MinIndex_CityIndexMP1 | VIEW EDIT 15minsubindex | VIEW | | | DISIT | VIEW | EDIT | VIEW | DEL |
| 15MinIndex_CultureAndCultsIndex | VIEW EDIT 15minsubindex | VIEW | | | | | | | |
| 15MinIndex_CultureAndCultsIndexBologna | VIEW EDIT 15minsubindex | VIEW | | | | | | | |
| 15MinIndex_EconomyIndex | VIEW EDIT 15minsubindex | VIEW | | | | | | | |
| 15MinIndex_EconomyIndexBologna | VIEW EDIT 15minsubindex | VIEW | | | | | | | |
| 15MinIndex_EducationIndex | VIEW EDIT 15minsubindex | VIEW | | | | | | | |
| 15MinIndex_EducationIndexBologna | VIEW EDIT 15minsubindex | VIEW | | | | | | | |
| 15MinIndex_EntertainmentSocialIndex | VIEW EDIT 15minsubindex | VIEW | | | | | | | |
| 15MinIndex_EntertainmentSocialIndexBologna | VIEW EDIT 15minsubindex | VIEW | | | | | | | |



# TrafficFlow Manager

Snap4City

Switch To New Layout (Beta)

User: roottooladmin1, Org: DISIT
Role: RootAdmin, Level: 7

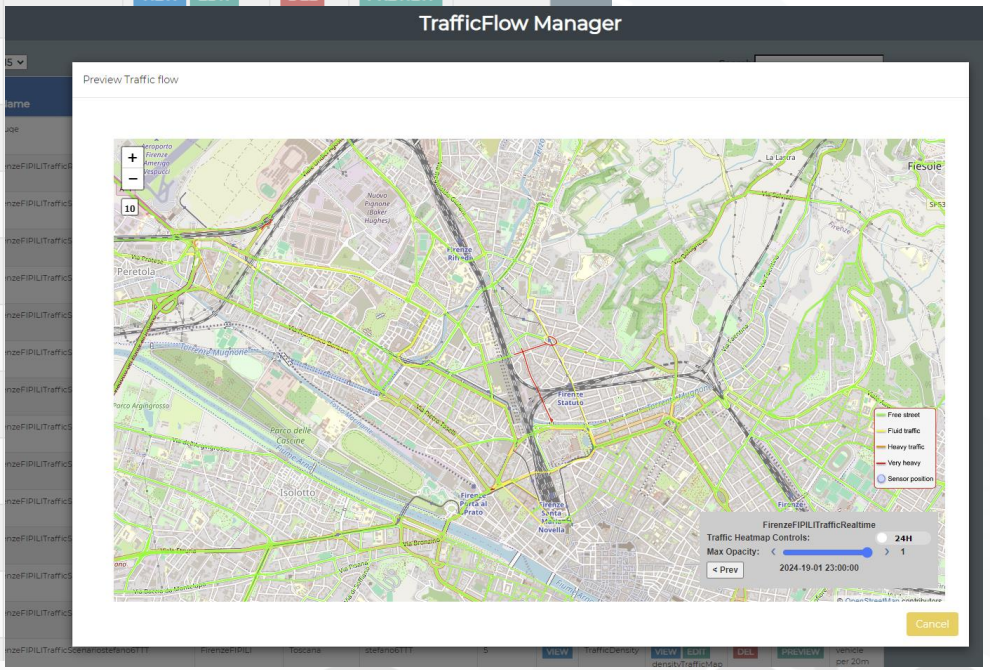
LOGOUT

- Data Management, HLT
  - 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
  - Data Inspector OpenSearch
  - File Manager
  - HeatMap Manager
  - ColorMap Manager
  - TypicalTimeTrend Manager
  - TrafficFlow Manager
  - TVCam Manager
  - OD Manager
  - BIM Manager
  - BIM Server old
  - BIM Server New
  - BIM Srv New: Add
  - BIM Srv new: View
  - OpenData Manager: Data Gate
  - OpenData Manager: Data Gate
  - OpenData Harvester: Data Gate
  - Add Data Sources into the Platform
  - Doc: Data Table Loader

## TrafficFlow Manager

Show 15 Search:

| Flux Name | Locality | Organization | Scenario | Instances | View Data | Metric | ColorMap | Delete | Preview | Unit of Measure |
|---|---|---|---|---|---|---|---|---|---|---|
| cinuqe | nomedelloscenario | Toscana | cinuqe | 3 | VIEW | TrafficDensity | VIEW EDIT densityTrafficMap | DEL | PREVIEW | vehicle per 20m |
| FirenzeFIPILITrafficRealtime | FirenzeFIPILI | Toscana | TrafficRealtime | 114241 | VIEW | TrafficDensity | VIEW EDIT densityTrafficMap | DEL | PREVIEW | vehicle per 20m |
| FirenzeFIPILITrafficScenarioScenario1before | FirenzeFIPILI | Toscana | Scenario1before | 1 | VIEW | TrafficDensity | VIEW EDIT densityTrafficMap | DEL | PREVIEW | vehicle per 20m |
| FirenzeFIPILITrafficScenarioScenarioAFeb2020 | FirenzeFIPILI | Toscana | ScenarioAFeb2020 | 14 | VIEW | TrafficDensity | VIEW EDIT | DEL | PREVIEW | vehicle |
| FirenzeFIPILITrafficScenarioScenarioAFeb2020TTT | FirenzeFIPILI | Toscana | ScenarioAFeb2020TTT | 14 | VIEW | | | | | |
| FirenzeFIPILITrafficScenarioScenarioANov2019 | FirenzeFIPILI | Toscana | ScenarioANov2019 | 14 | VIEW | | | | | |
| FirenzeFIPILITrafficScenarioScenarioANov2019TTT | FirenzeFIPILI | Toscana | ScenarioANov2019TTT | 14 | VIEW | | | | | |
| FirenzeFIPILITrafficScenariostefano2 | FirenzeFIPILI | Toscana | stefano2 | 4 | VIEW | | | | | |
| FirenzeFIPILITrafficScenariostefano2TTT | FirenzeFIPILI | Toscana | stefano2TTT | 4 | VIEW | | | | | |
| FirenzeFIPILITrafficScenariostefano3 | FirenzeFIPILI | Toscana | stefano3 | 7 | VIEW | | | | | |
| FirenzeFIPILITrafficScenariostefano3TTT | FirenzeFIPILI | Toscana | stefano3TTT | 7 | VIEW | | | | | |
| FirenzeFIPILITrafficScenariostefano5 | FirenzeFIPILI | Toscana | stefano5 | 8 | VIEW | | | | | |
| FirenzeFIPILITrafficScenariostefano5TTT | FirenzeFIPILI | Toscana | stefano5TTT | 8 | VIEW | | | | | |
| FirenzeFIPILITrafficScenariostefano6 | FirenzeFIPILI | Toscana | stefano6 | 5 | VIEW | | | | | |



TOP

# Design & Develop of Data Analytics (here only overview of Tools)

Part 4




100% OPEN SOURCE

TOP

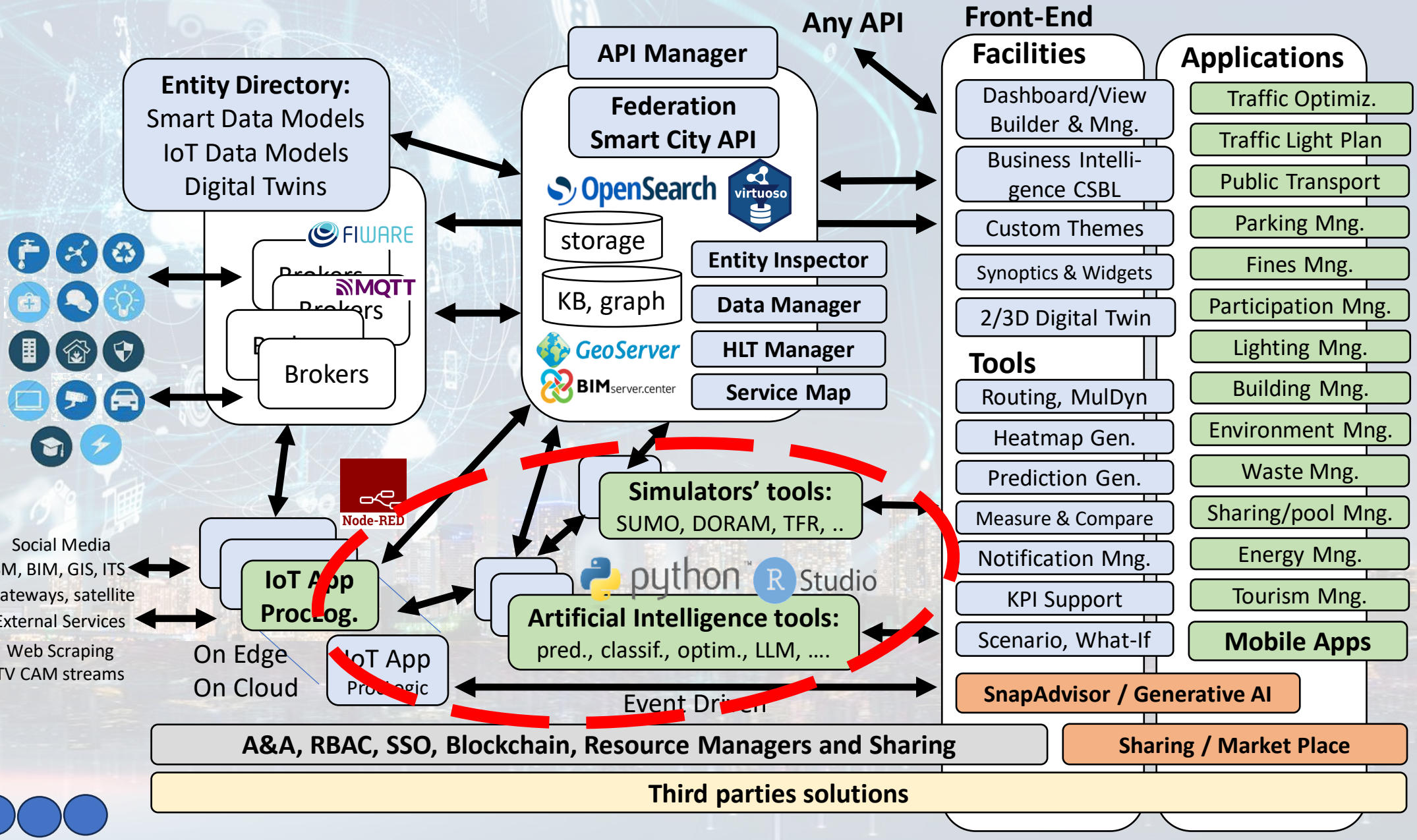



**For more details on Developing**

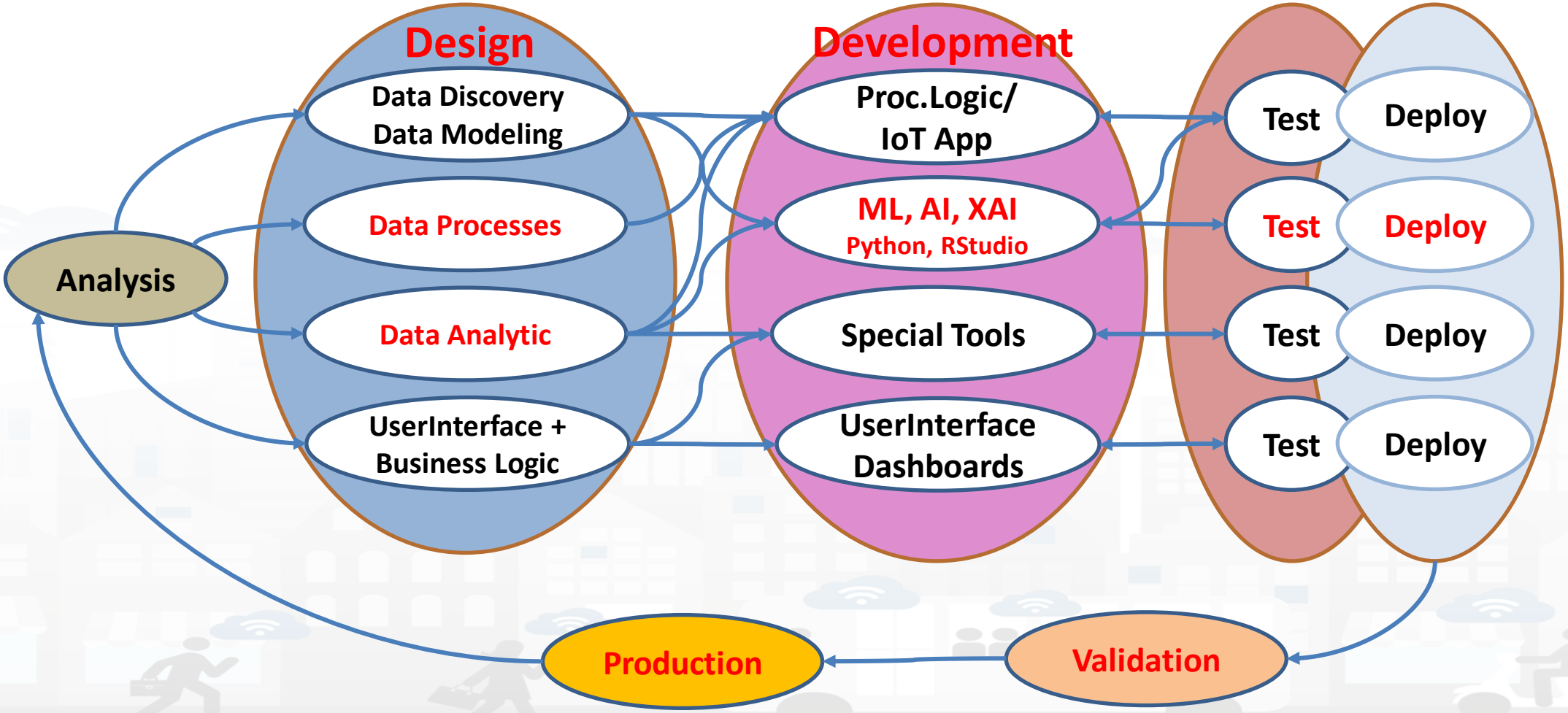
**Data Analytics, ML, AI, XAI simulation, etc.**

**see Part 4 of this training course**

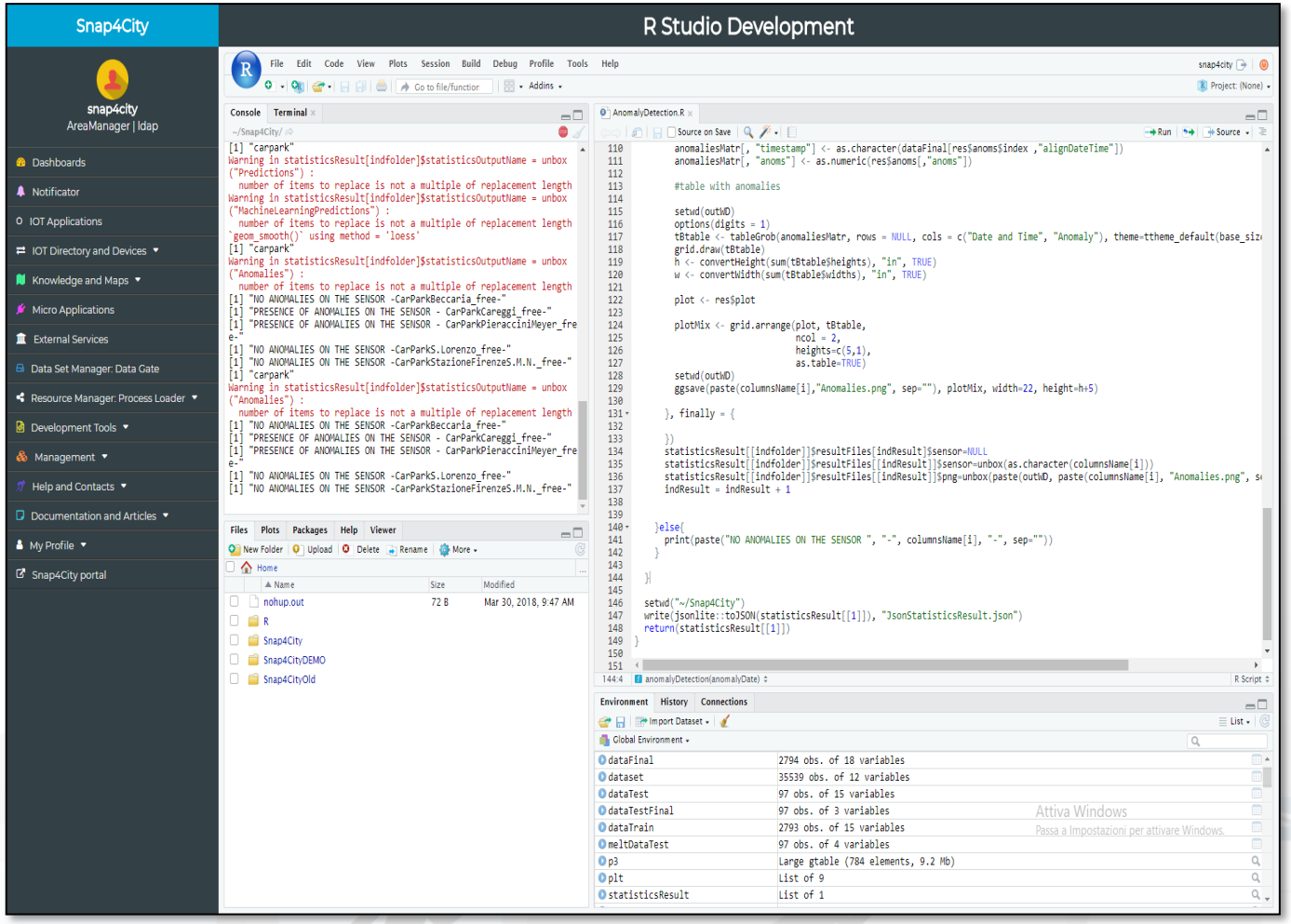
# Technical Architecture



# Development Life Cycle Smart Solutions

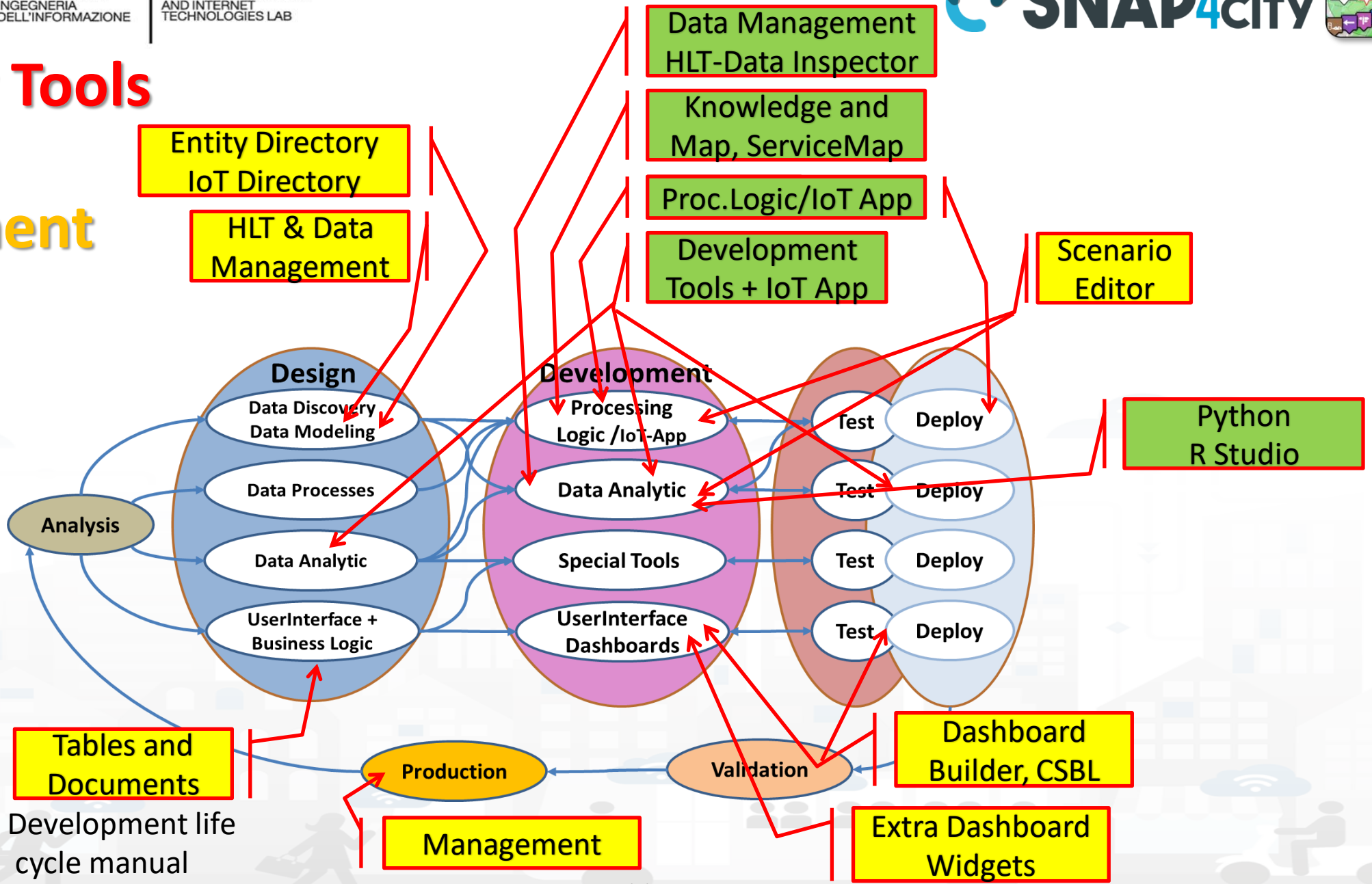


# 1 Developer in R Studio + Tensor Flow



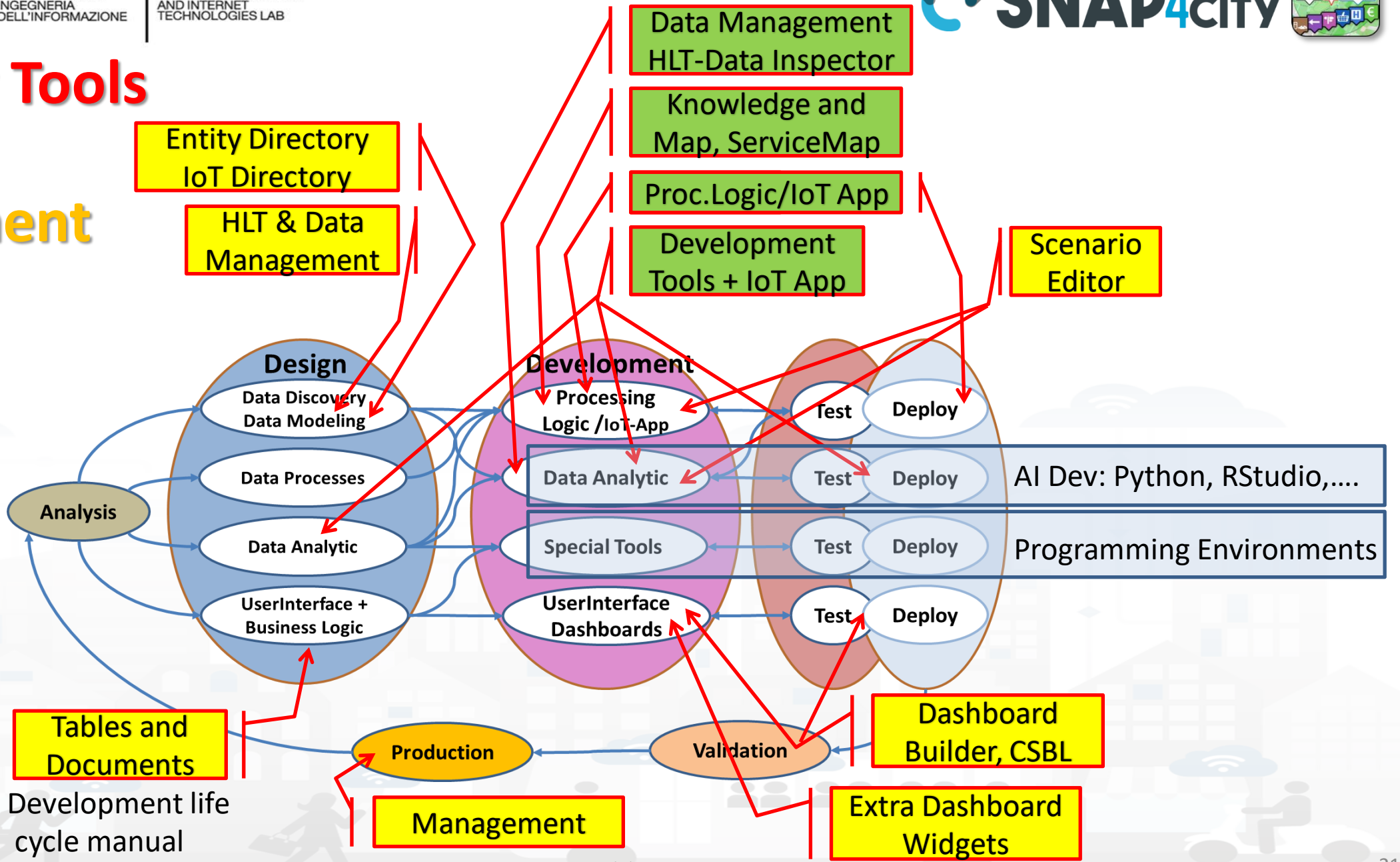



# Snap4City Tools vs Development Life Cycle




Development life cycle manual

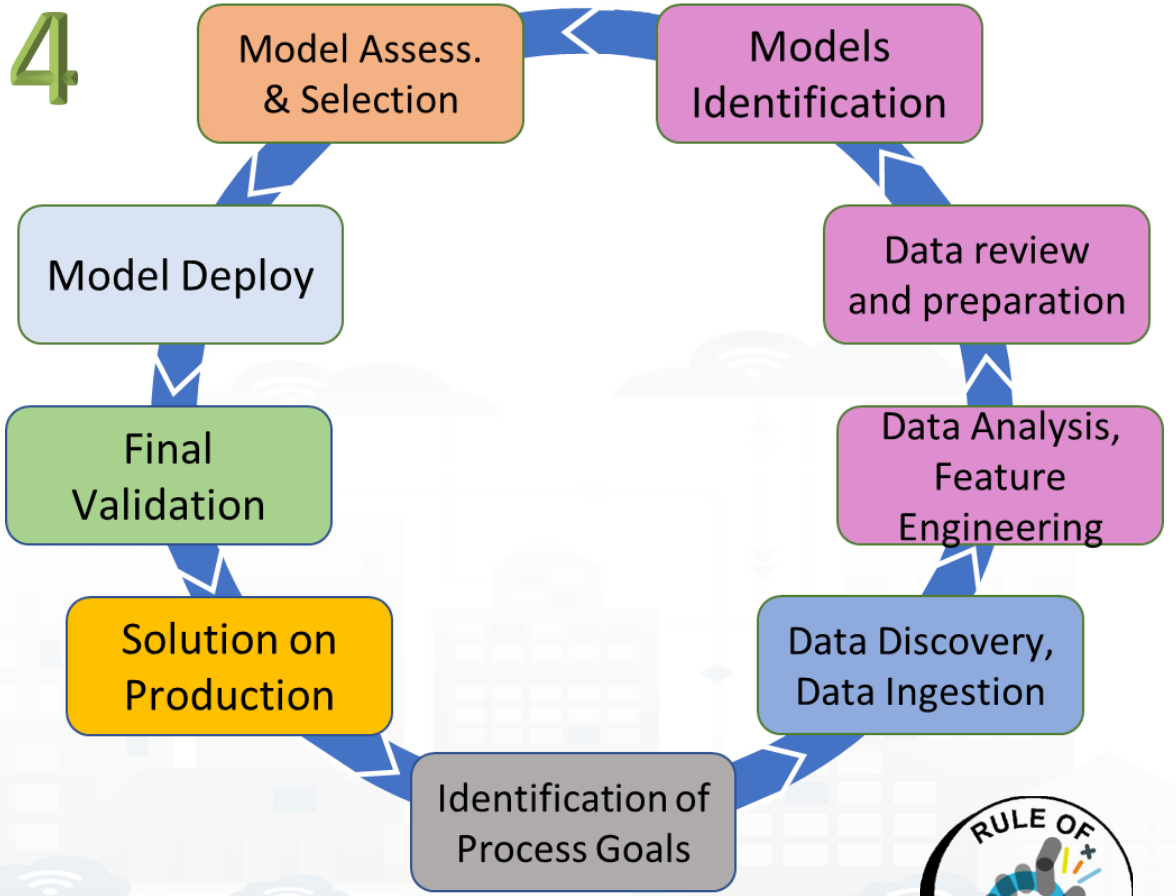
# Snap4City Tools vs Development Life Cycle



# Model/Technique Development/testing

## Part 4

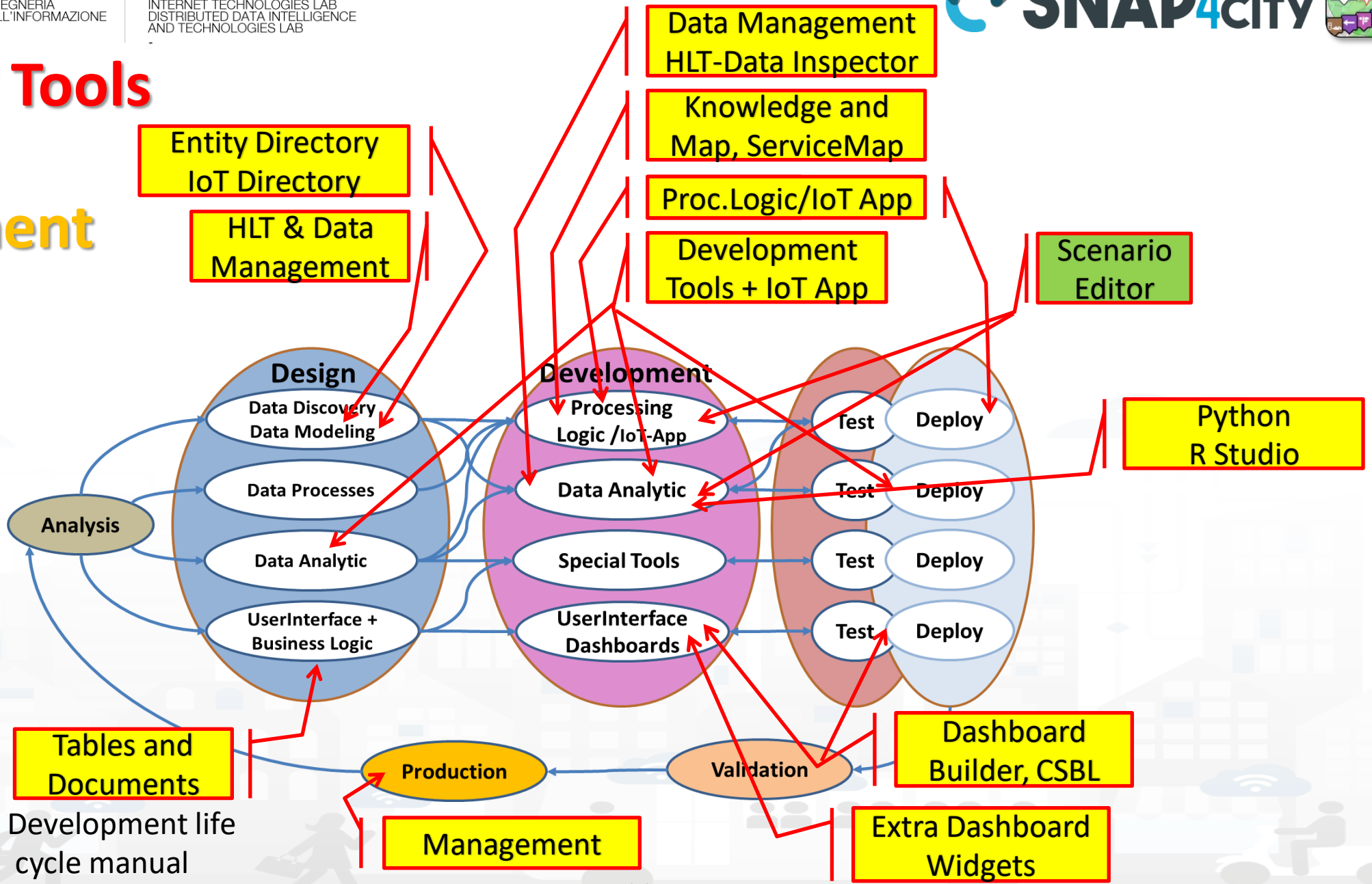
- **Identification of Process goals and Planning**
  - Which goals
  - How to compute, which language
  - Which environment, which libraries
- **Data Discovery and Ingestion (from the general life cycle)**
- **Data Analysis: feature engineering, feature selection**
- **Data review and preparation for the model**
- **Model Identification and building: ML, AI, etc….**
  - **Training**
  - **Tuning hyperparameters when possible**
- **Model Assessment and Selection**
  - **Validation in testing**
  - **Assessment** on a set of **metrics** depending on the goals: global relevant and feature assessment
  - **Assessing computational costs**
  - **Impact Assessment, Ethic Assessment** and incidental findings
  - **Global and Local Explanation via Explainable AI techniques**
- **Model Deploy and Final Validation**
  - **Optimisation** of computation cost for features, if needed reiterate
- **Solution on Production (security, scalability, etc.)**



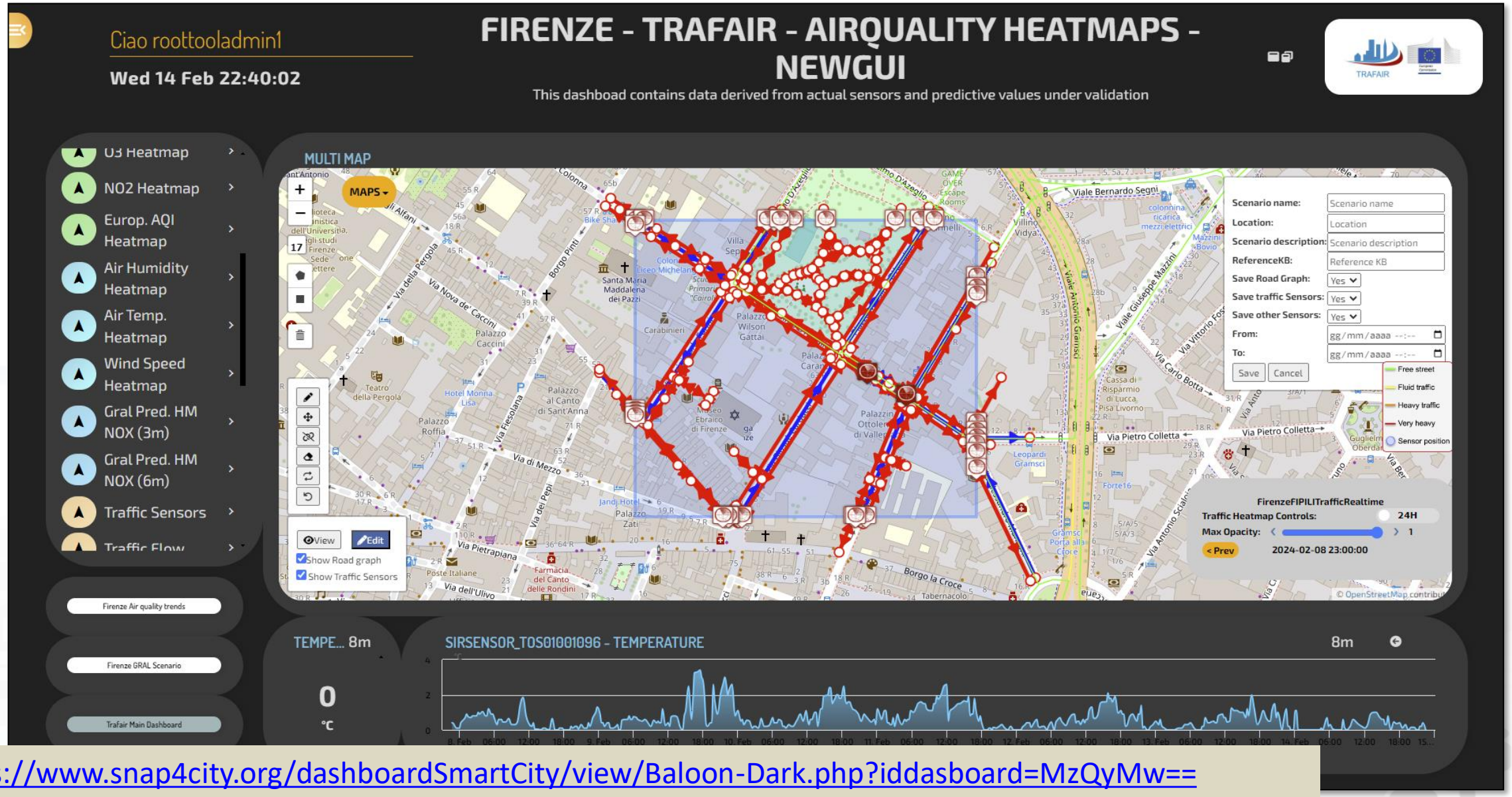
# Scenario Editor:
# Snap4City Infrastructures



# Snap4City Tools vs Development Life Cycle



# Trial:




https://www.snap4city.org/dashboardSmartCity/view/Baloon-Dark.php?iddasboard=MzQyMw==

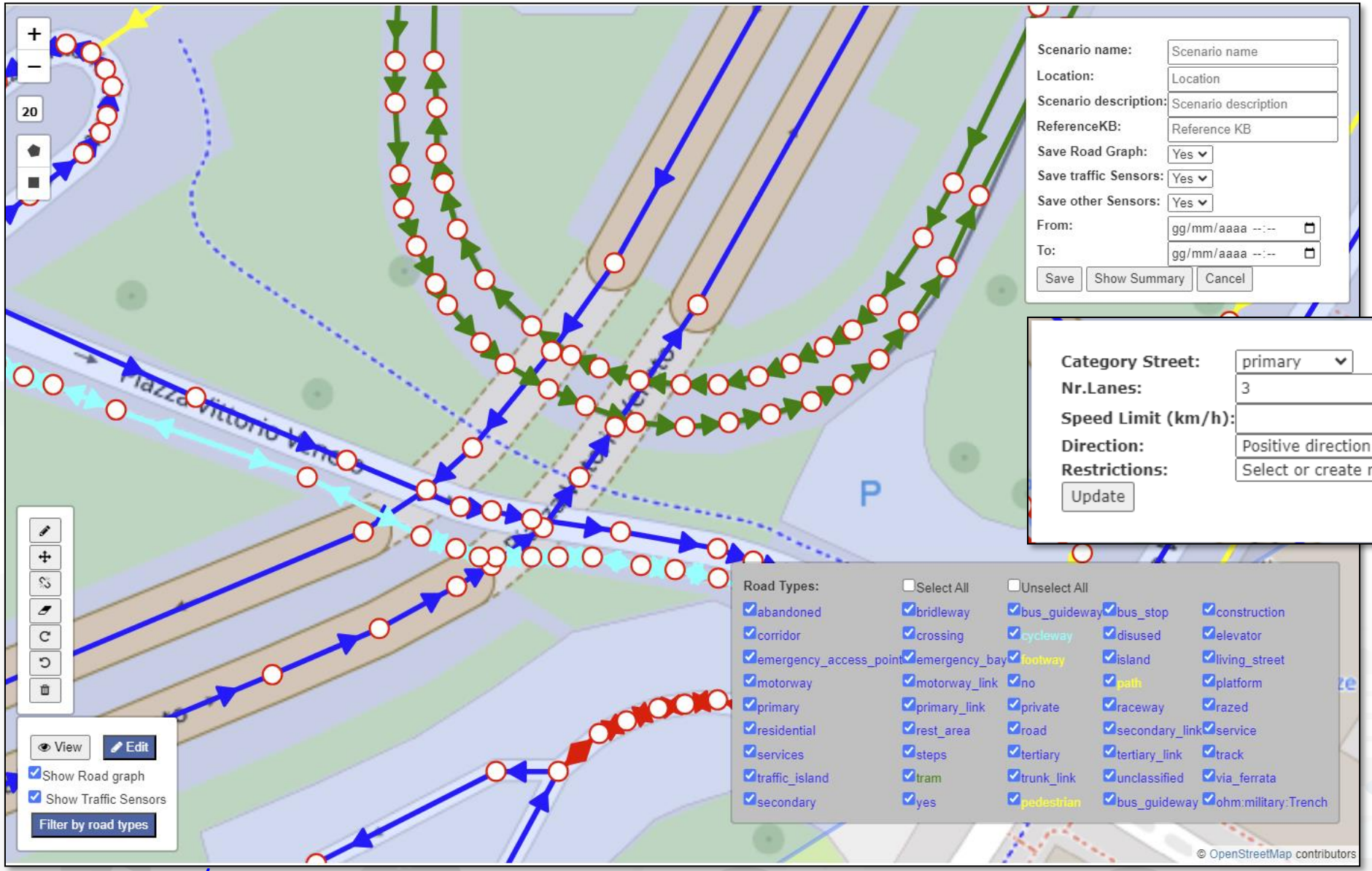
# Scenario Editor

Select map

Zoom

New Scenario

Editing
Drag & drop
Split & Join
Delete
Do and Undo



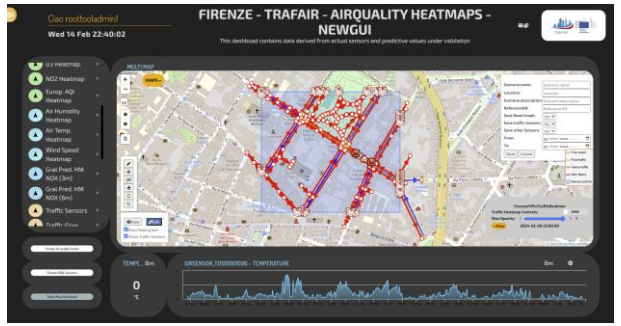

Edit Road Segment

- identifier
- composition
- elemLocation
- elementClass
- elementType
- length
- operatingStatus
- speedLimit
- trafficDir
- width
- highwayType
- route

Properties of Road Elements

https://www.snap4city.org/976

# The actual Scenario Exploitation





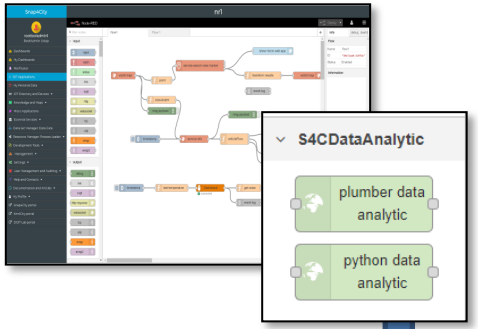

Defining Context via Editing Scenario:

- Select area and data
- Editing roads, POI, IoT entities, ..
- Save/load, share
- Change status




A Scenario includes:

- Metadata
- Status and versions, date time
- Period of validity
- Road graphs, cycling, pedestrian seg.
- List of data, sensors
- Etc.

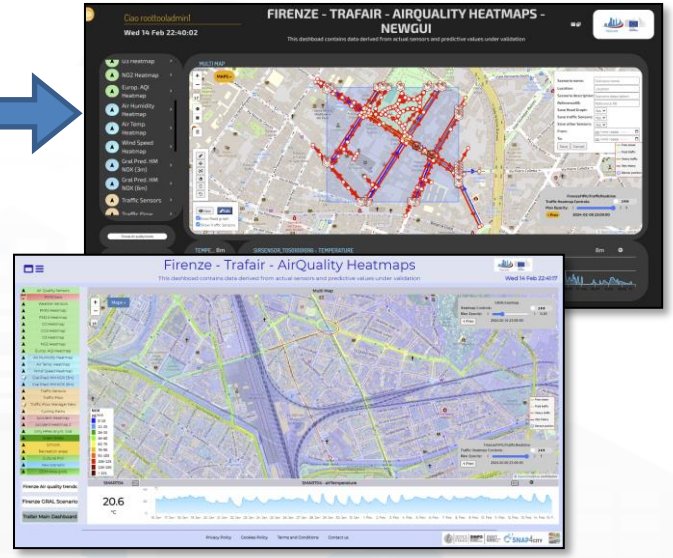



Computing in the Scenario Context as:

- KPI, Metrics, SUMI, SUMP, 15MinCity Index
- Heatmaps
- OD Matrices
- Traffic Flow reconstructions
- Predictions
- Routing, constrained routing
- Early Warnings
- Etc.

ReLoading Scenario in JavaScript

- Evolve Scenarios
- Use Scenario to context the Data Analytics: R Studio, Python for computing



# Trial:

## Firenze - Trafair - AirQuality Heatmaps

This dashboad contains data derived from actual sensors and predictive values under validation

Wed 14 Feb 22:41:17

- Air Quality Sensors
- PM10 bars
- Weather Sensors
- PM10 Heatmap
- PM2.5 Heatmap
- CO Heatmap
- CO2 Heatmap
- O3 Heatmap
- NO2 Heatmap
- Europ. AQI Heatmap
- Air Humidity Heatmap
- Air Temp. Heatmap
- Wind Speed Heatmap
- Gral Pred. HM NOX (3m)
- Gral Pred. HM NOX (6m)
- Traffic Sensors
- Traffic Flow
- Traffic Flow Manager New
- Cycling Paths
- Accident Heatmap
- Accident Heatmap 2
- Only HRes Anym. Gral
- Green Areas
- Schools
- Recreation areas
- Cultural POI
- new scenario
- ODM Area-grids

Firenze Air quality trends

Firenze GRAL Scenario

Trafair Main Dashboard

Multi Map

Maps

NOX µg/m3: 0-10, 11-25, 26-35, 36-60, 61-75, 76-90, 91-105, 106-125, 126-150, >151

GRALheatmap — Heatmap Controls: 24H — Max Opacity: 0.25 — < Prev — 2024-02-14 23:00:00

FirenzeFIPILITrafficRealtime — Traffic Heatmap Controls: 24H — Max Opacity: 1 — < Prev — 2024-02-08 23:00:00

Free street, Fluid traffic, Heavy traffic, Very heavy, Sensor position

© OpenStreetMap contributors

SMART04 — 20.6 °C

SMART04 - airTemperature

Privacy Policy | Cookies Policy | Terms and Conditions | Contact us

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

# Data Analytics on Cloud:
# Snap4City Infrastructures



# Data Analytics on Snap4City platform

Swagger







Ontology Schema



LOG.disit.org




**Big Data Store Facility**

Smart City API from Knowledge Base and other tools

TensorFlow

NVIDIA CUDA

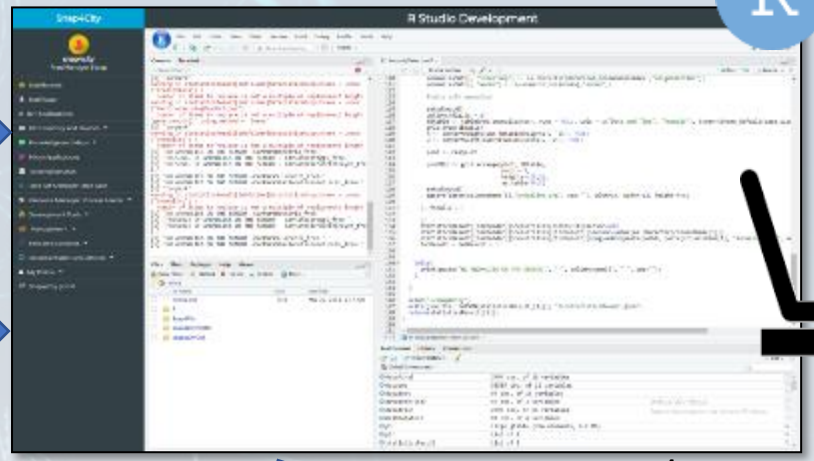
python

jupyter

R Studio

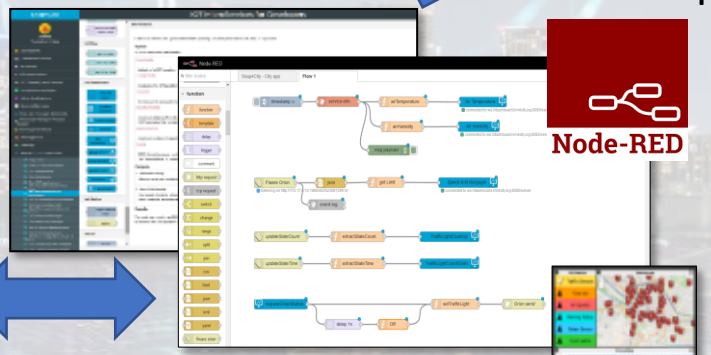
SNAP4CITY

KM4CITY





Creating MicroServices




Using them into IOT Applications

Saving / Sharing reusing

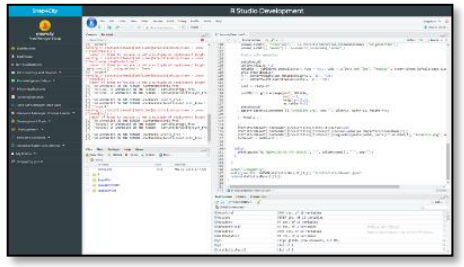


Resource Manager



# Development



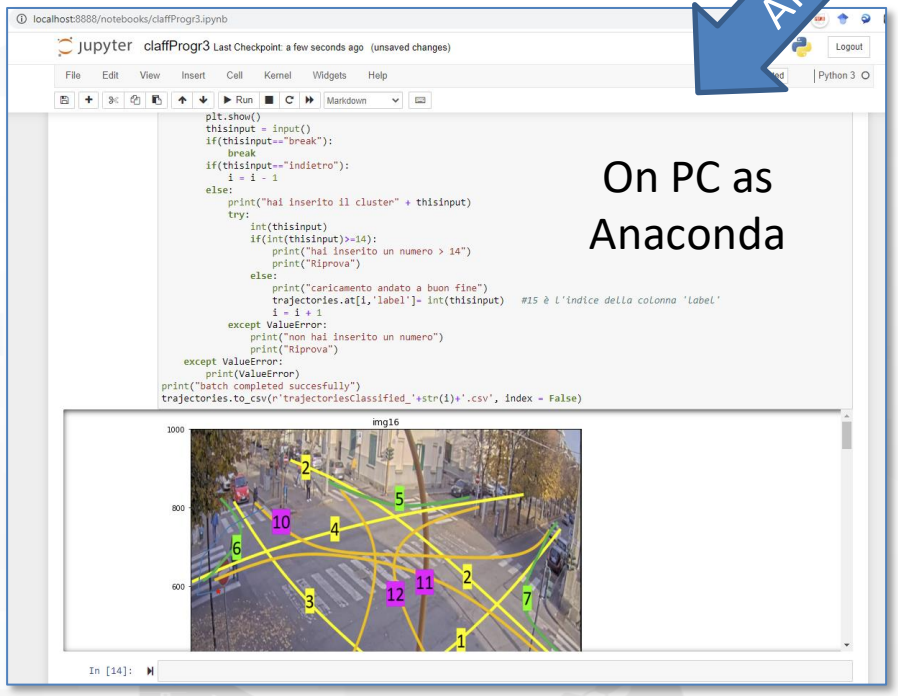


API

Big Data Store Facility

API

On Server
Or
On PC




On PC as Anaconda

Once finalized

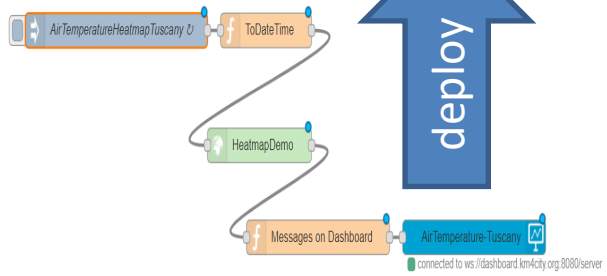
File.py
AI Model
Mapping
Data..

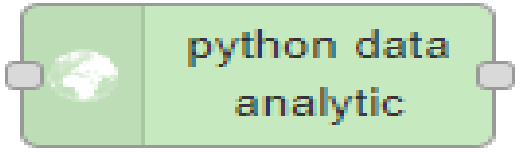
ZIP

Load
File.py
or .zip




deploy




To make the .PY usable as MicroService you need to adapt it to get and send data in/out with Node-RED from a Container.
**If you provide a .zip file the main .py inside has to be called doScript.py**

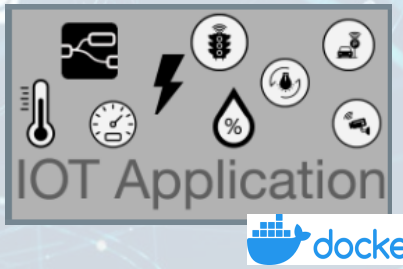
# Data Analytic Container

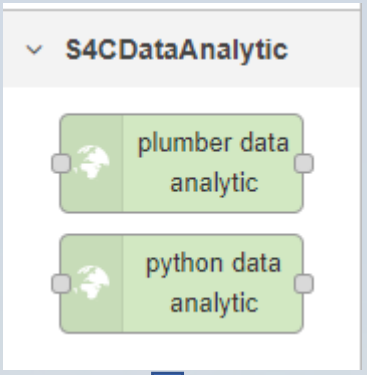



**1**

Develop .py **or** .r program on (i) Snap4City platform online, or (ii) your Development Machine.
The code has to respect the guidelines provided. For example see:
https://www.snap4city.org/641
https://www.snap4city.org/645

**2** Open an Advanced IoT App / Node-RED

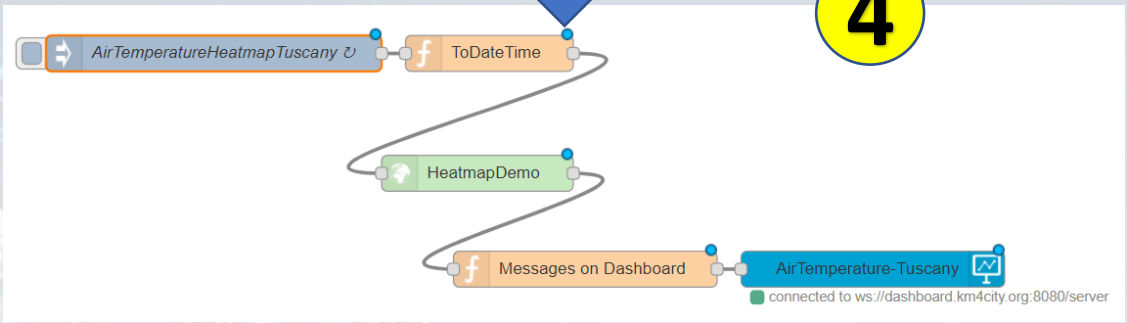


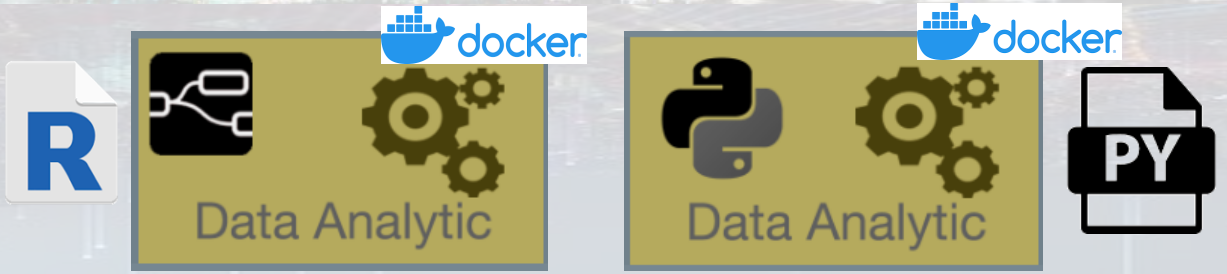

**3**

Use Snap4City Data Analytic Node, and load in the code you developed

**4**

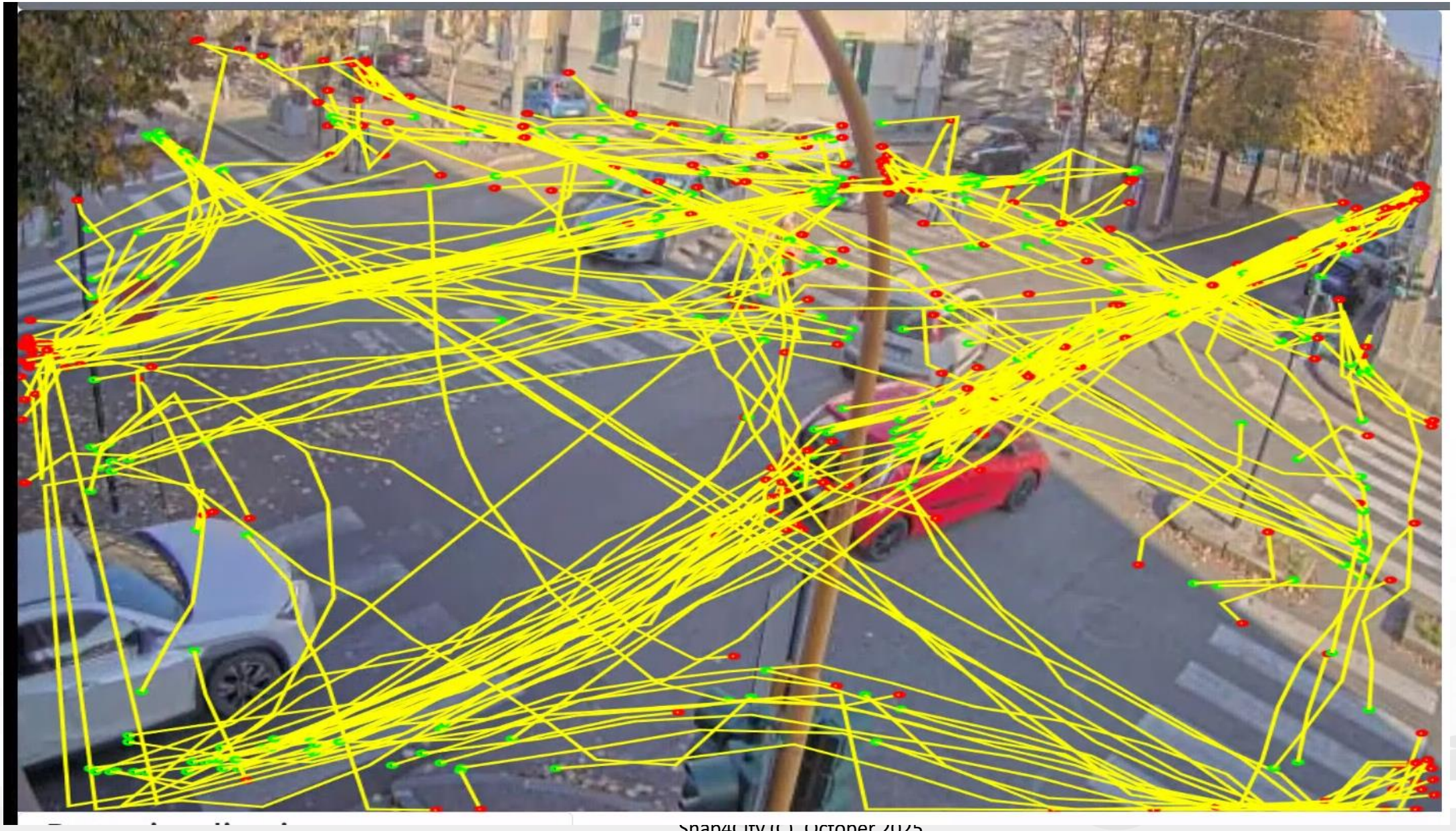


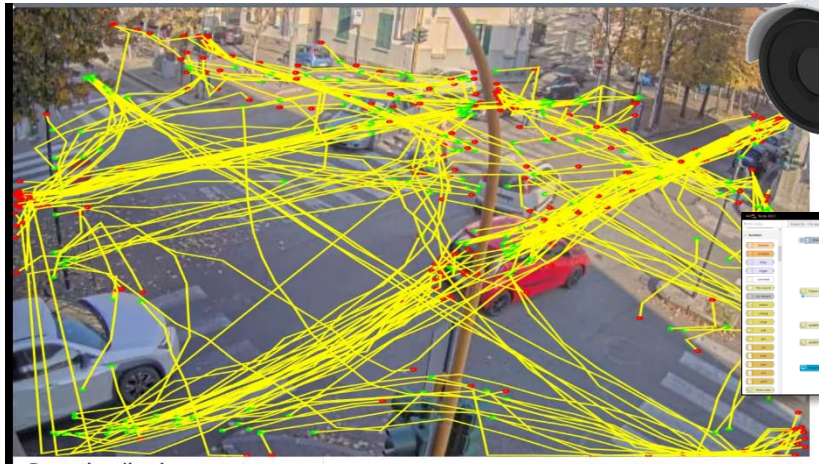

**5** Deploy the IoT App → Snap4City Container Manager based on Marathon/Mesos is creating a Container for your Data Analytic code



# analytics example







IoT edge on
TV Camera

1

Send data to Broker

Send Trajectories

2

IOT Broker

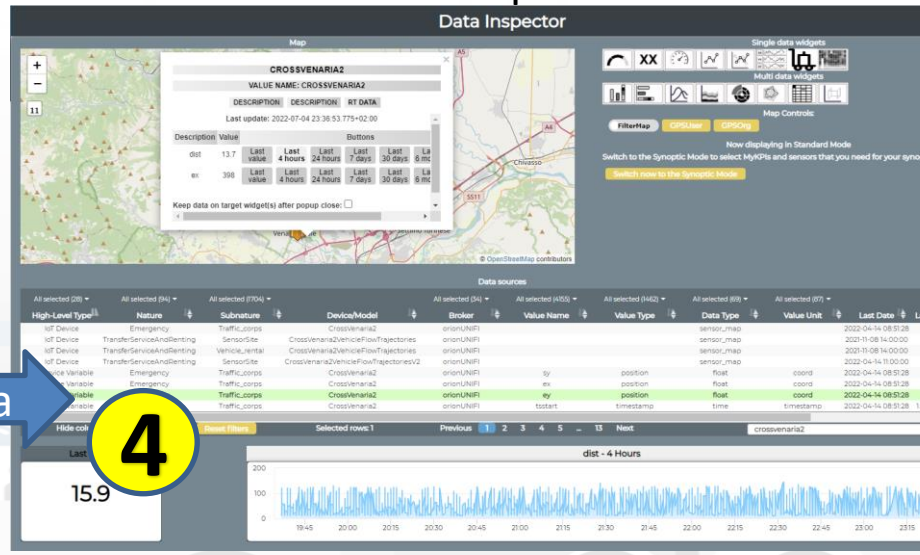
Device: CrossVenaria2
with trajectories

Save data

3

Big Data
Store
Facility

Data Inspector




show data

4



IoT edge on
TV Camera

Send Trajectories

Send data to Broker

IOT Broker

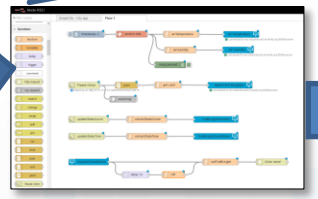
**Devices**:
- CrossVenaria2VehicleFlowTrajectoriesV2
- VenariaConteggio

Save data

**f** Save Counting per Cluster

**e** Send data to Broker

Periodically



**b** Activate

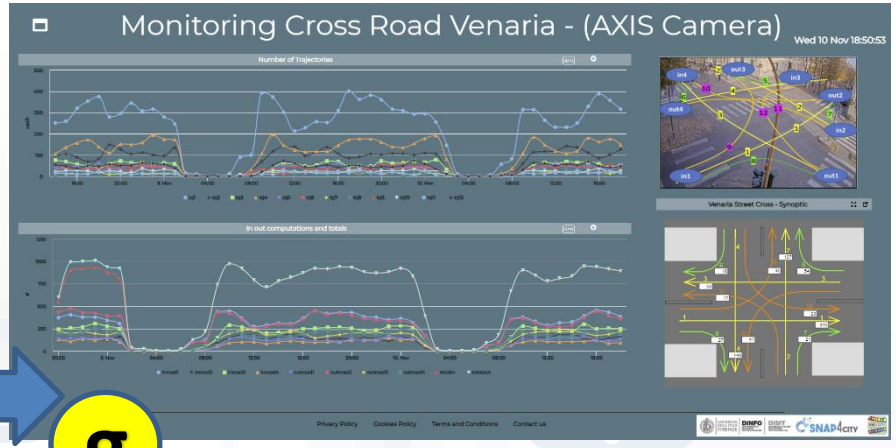



**d**

Get data

**c**

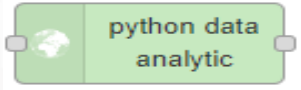
Big Data
Store
Facility




show data

**g** Create and use a Dashboard

**a**



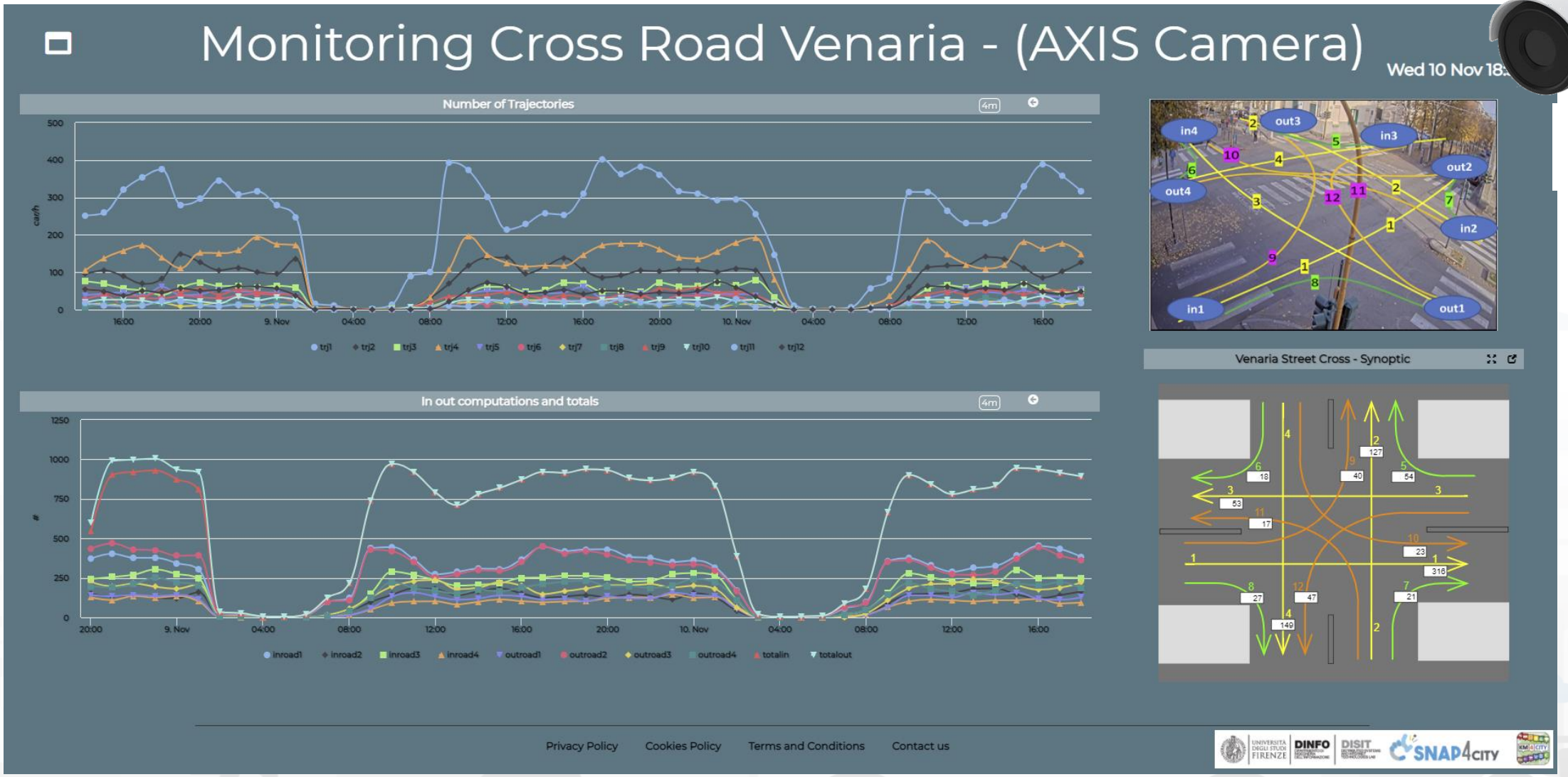

From Trajectories to clusters. Counting in/out and flows

**Device**: CrossVenaria2 with trajectories

# An example

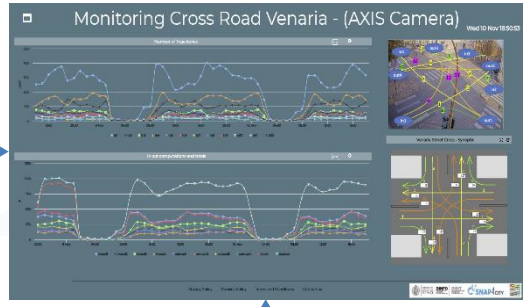
Traffic Flow Analysis via TV Camera and Clustering on cloud





# Managing TV Cam






SNAP4CITY

IOT Directory

triples

Knowledge Base
Semantic Reasoners

IOT Devices
Registration

SURI Link

push

FIWARE

subscription note

IOT Orion Broker

Real Time

Indexing and Aggregating
NIFI, OpenSearch

Processing if needed

IOT
App

Real Time data in Pull, Push
Any gateway, server

Data Analytics

Data Analytic

MQTT

# Data Analytics on Dedicated Computer or HPC



# Data Analytics on Snap4City platform

Swagger







Ontology Schema



LOG.disit.org

Knowledge Base, Km4City

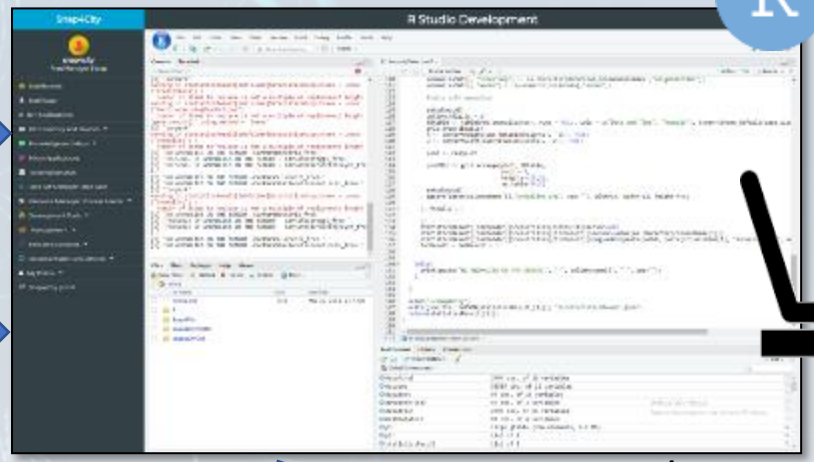


**Big Data Store Facility**

Smart City API from Knowledge Base and other tools

TensorFlow

NVIDIA CUDA



R Studio



Saving / Sharing reusing

TensorFlow

NVIDIA CUDA

- Python *file.py* ……..
- Rscript *file.r* …….



Resource Manager



python jupyter

SNAP4CITY

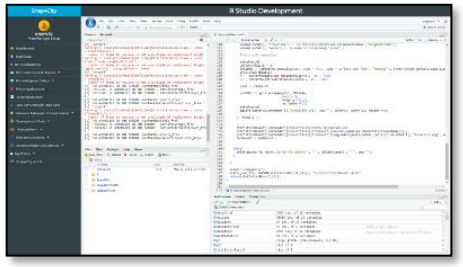
KM4CITY

# Development

python jupyter

R Studio





API

SNAP4CITY

Big Data Store Facility

Save data

Get data

EXECUTION

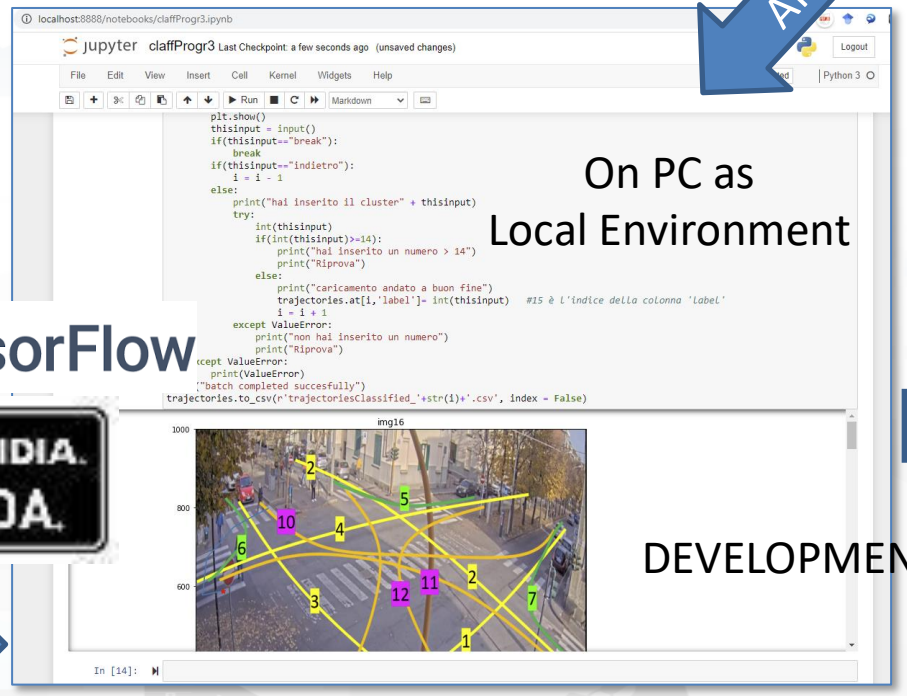
TensorFlow

NVIDIA CUDA

- Python file.py……..
- Rscript file.r…….

API

On Server
Or
On PC




On PC as
Local Environment

TensorFlow

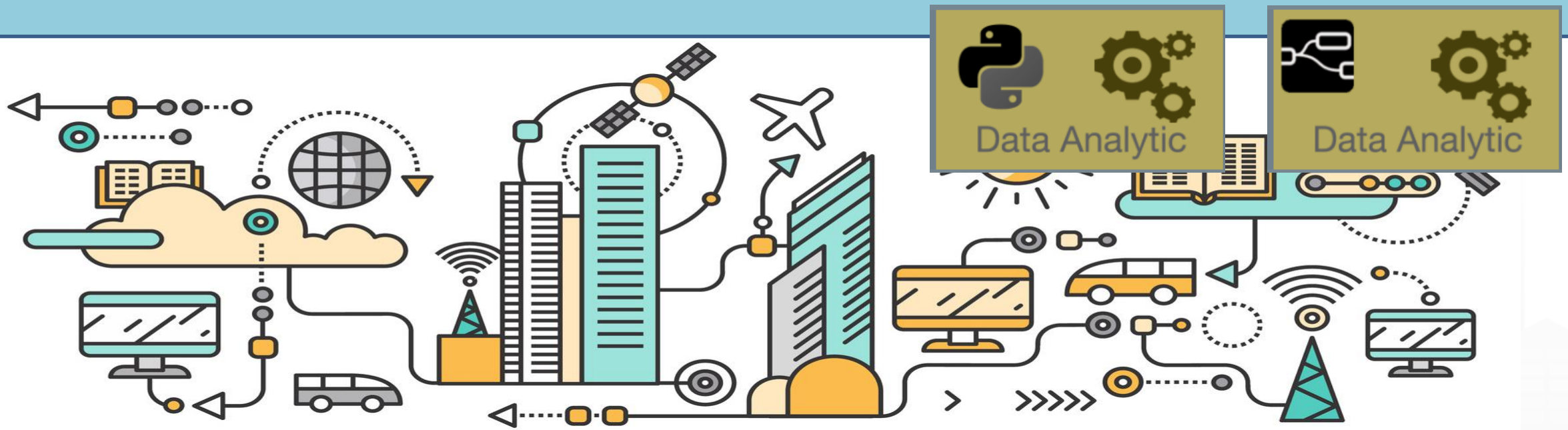
NVIDIA CUDA

DEVELOPMENT

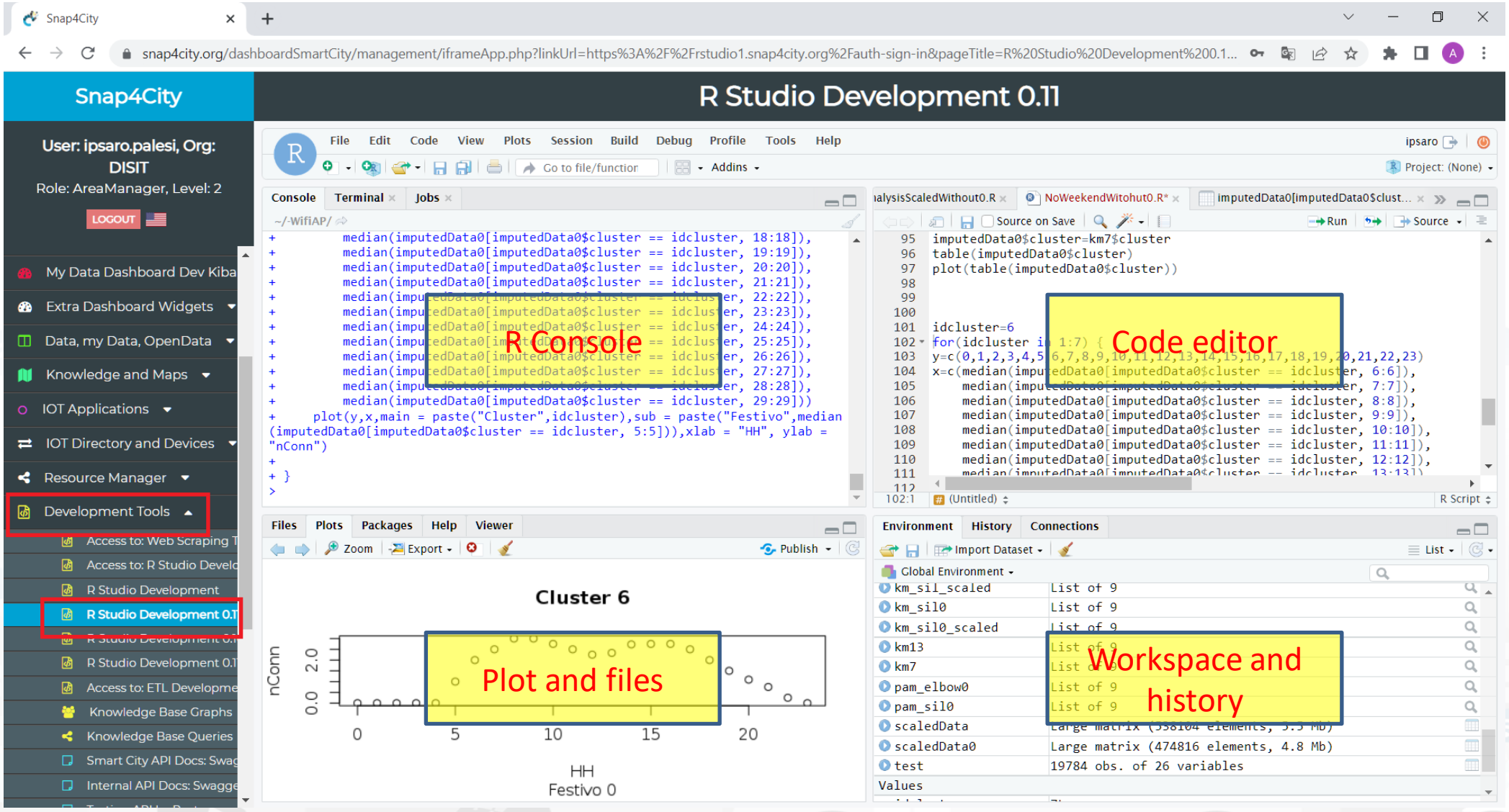
Once finalized

Process: file .R or .Py (+ the AI/ML model, data) can be put in execution with local scheduler or Cron

# DP, for DA, AI, XAI on Container RStudio



# Rstudio


Snap4City
R Studio Development 0.11
User: ipsaro.palesi, Org: DISIT
Role: AreaManager, Level: 2
LOGOUT
My Data Dashboard Dev Kiba
Extra Dashboard Widgets
Data, my Data, OpenData
Knowledge and Maps
IOT Applications
IOT Directory and Devices
Resource Manager
Development Tools
Access to: Web Scraping T
Access to: R Studio Develo
R Studio Development
R Studio Development 0.1
R Studio Development 0.1
Access to: ETL Developme
Knowledge Base Graphs
Knowledge Base Queries
Smart City API Docs: Swag
Internal API Docs: Swagge
File Edit Code View Plots Session Build Debug Profile Tools Help
ipsaro
Console Terminal Jobs
R Console
Code editor
Files Plots Packages Help Viewer
Cluster 6
nConn
HH
Festivo 0
Plot and files
Environment History Connections
Import Dataset
Global Environment
km_sil_scaled List of 9
km_sil0 List of 9
km_sil0_scaled List of 9
km13 List of 9
km7 List of 9
pam_elbow0 List of 9
pam_sil0 List of 9
scaledData Large matrix (358104 elements, 3.3 Mb)
scaledData0 Large matrix (474816 elements, 4.8 Mb)
test 19784 obs. of 26 variables
Values
Workspace and history

# R code

- Installing and loading R packages

*install.packages("cluster")*

From GitHub

*install.packages("devtools")*

*devtools::install_github("kassambara/factoextra")*

- Getting help with functions in R

*?kmeans*

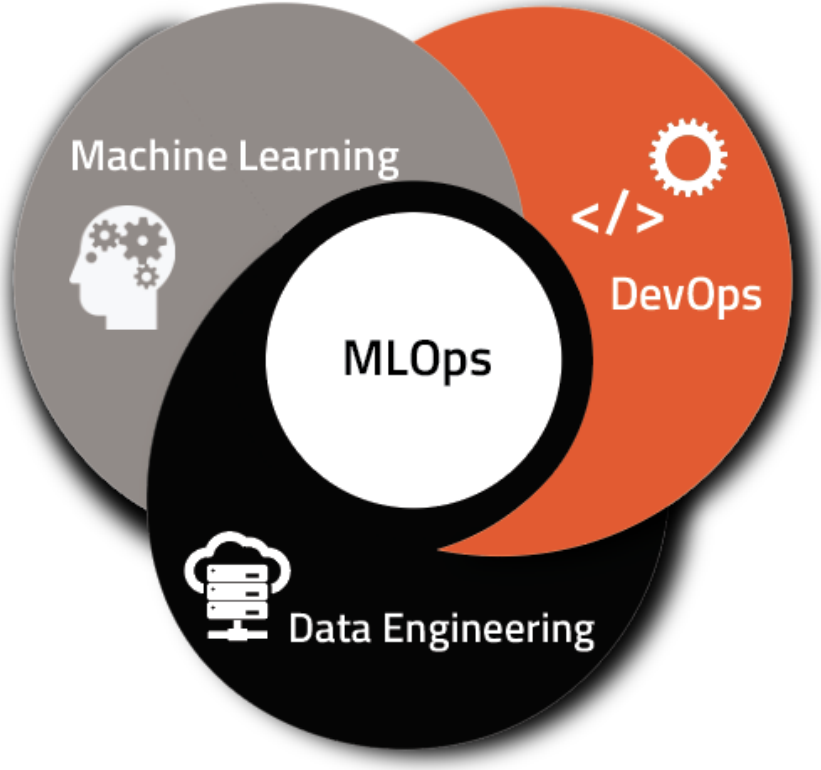
- Importing your data into R

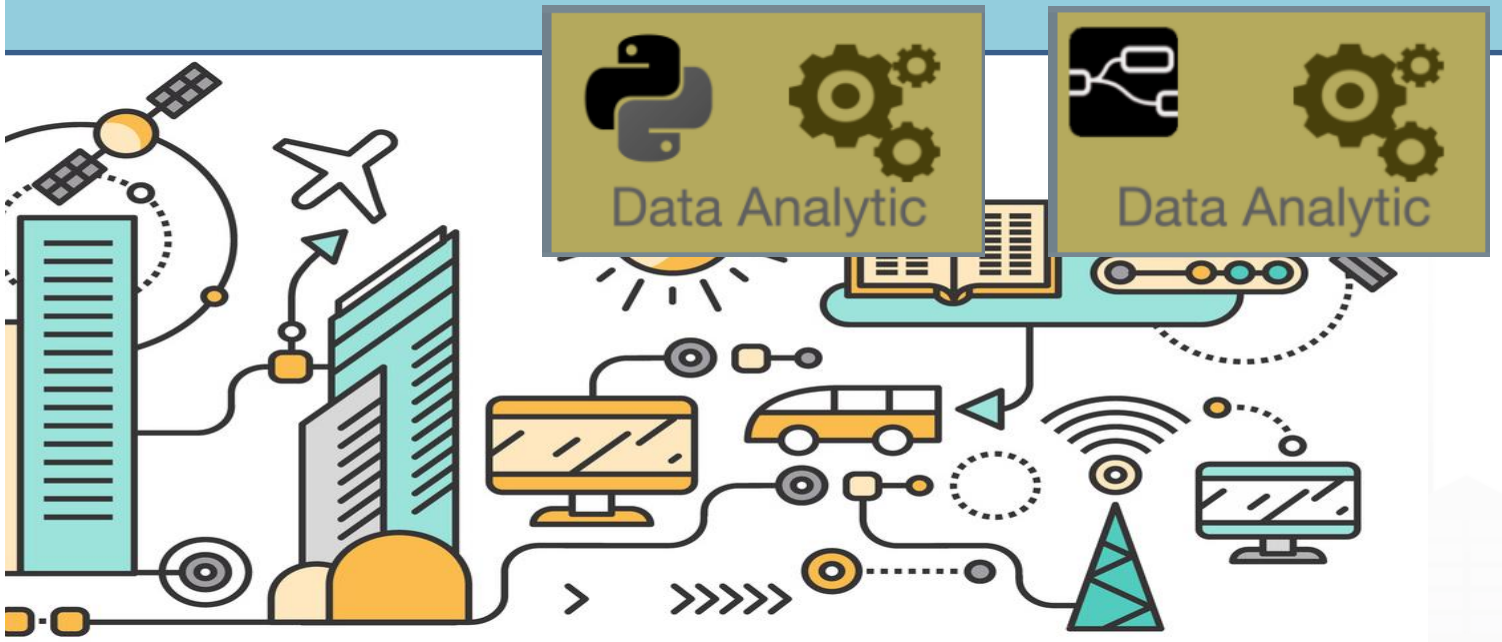
*# .csv file: Read comma (",") separated values*

*my_data <- read.csv(file.choose())*

# AI/ML Operation and Development

## MLOps



# Managing AI/ML operation/development: MLOps

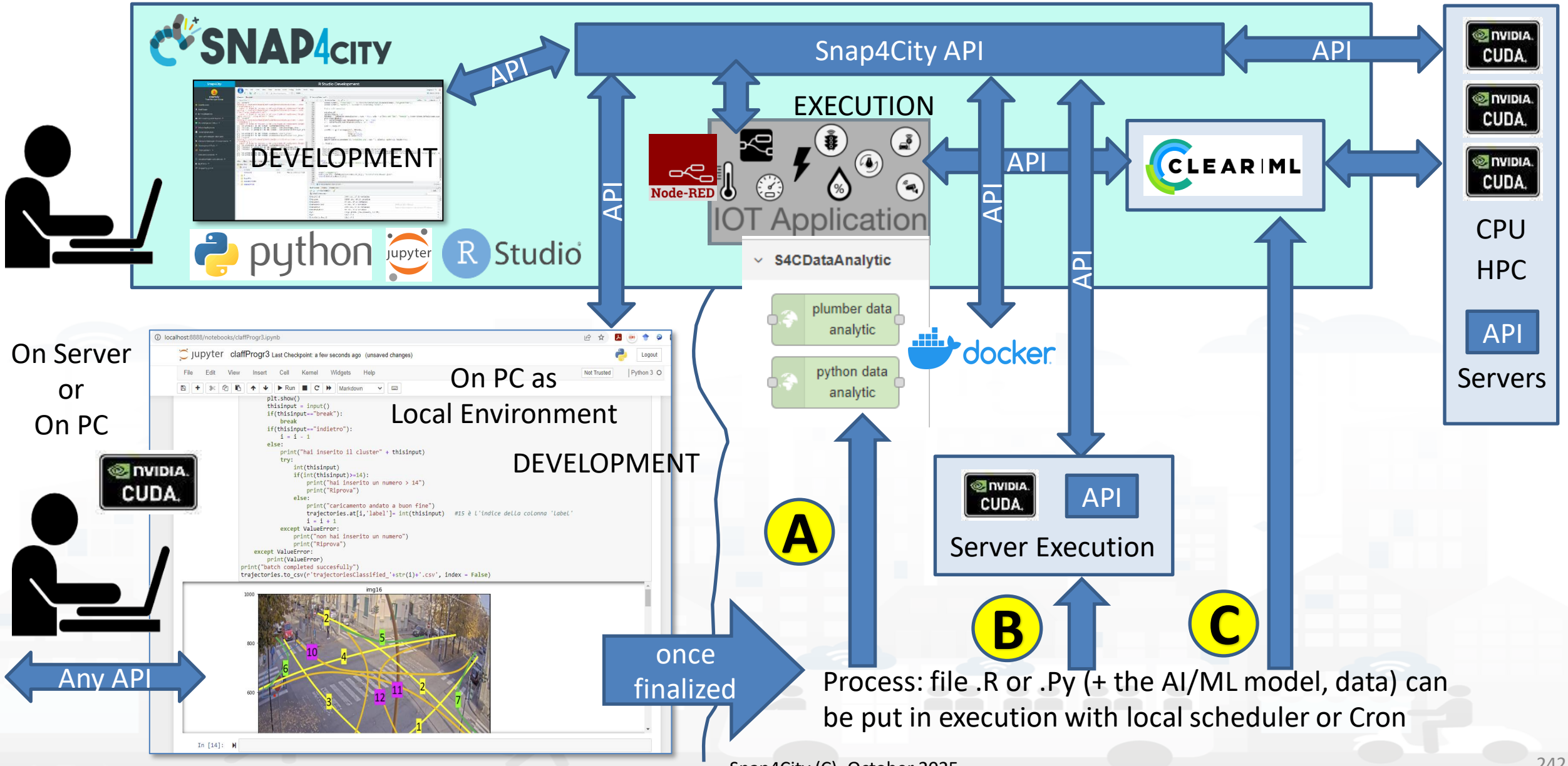
- **Management of AI/ML processes**: training and execution
- **Development, Training needs**: several processes
  - with different parameters and models to be trained, validated and test in batch to find the best results wrt metrics
  - High computational costs, time consuming if the processes have to be sent on GPU/CPU manually
- **Execution needs**, single executions in most cases singularly cheaper, but expensive for large volume of executions:
  - periodically as predictions (saving time if the model is loaded permanent)
  - on demand as optimisation, clustering, etc. (loading model, burning time)

# AI Training on Snap4City Infrastructure

- The training processes can be performed:
  - **On Jupyter HUB provided** by Snap4City in Python using ASCAPI, in this case the Jupyter HUB can be on CPU or CPU/GPU server
    - **By using ClearML** for the Training and/or Execution, on Cluster of GPU/CPU
      - Only Jupiter HUB of Snap4City can access to ClearML and Cluster of GPU/CPU
      - The access at ClearML facility has to be authorized by Snap4City Administrator
  - **On Jupyter HUB provided** by Snap4City in Python using ASCAPI, in this case the Jupyter HUB can be on CPU or CPU/GPU server
  - **On Jupyter HUB** in Python using ASCAPI, in this case the Jupyter HUB can be on CPU or CPU/GPU server, not provided by Snap4City, not accessing to CPU/GPU of Snap4City
  - **On your computer in Python** using ASCAPI, not accessing to on cloud CPU/GPU of Snap4City.

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

# AI/ML Infrastruct.




Process: file .R or .Py (+ the AI/ML model, data) can be put in execution with local scheduler or Cron

# MLOps Possibilities on Snap4City infrastructure

The developers can create their AI models using Snap4City data and infrastructure (Jupiter Hub):

- 1) **to put them in execution** (they could develop the solution on their Computer as well)
  - A) on stable container on CPUs via Node-RED, Docker
  - B) on some server with GPU/CPUs
- 2) **using ClearML and to put them in execution** on a process managed by ClearML on some cluster of GPU/CPU
  - 2a) **OnDemand:** as stable process on ClearML managed Docker, via API (usable from Rest Calls as well as from Node-RED Snap4City MicroServices, from the platform)
  - 2b) **Enqueue:** as sporadic process ClearML managed, via API (usable from Rest Calls as well as from Node-RED Snap4City MicroServices, from the platform)

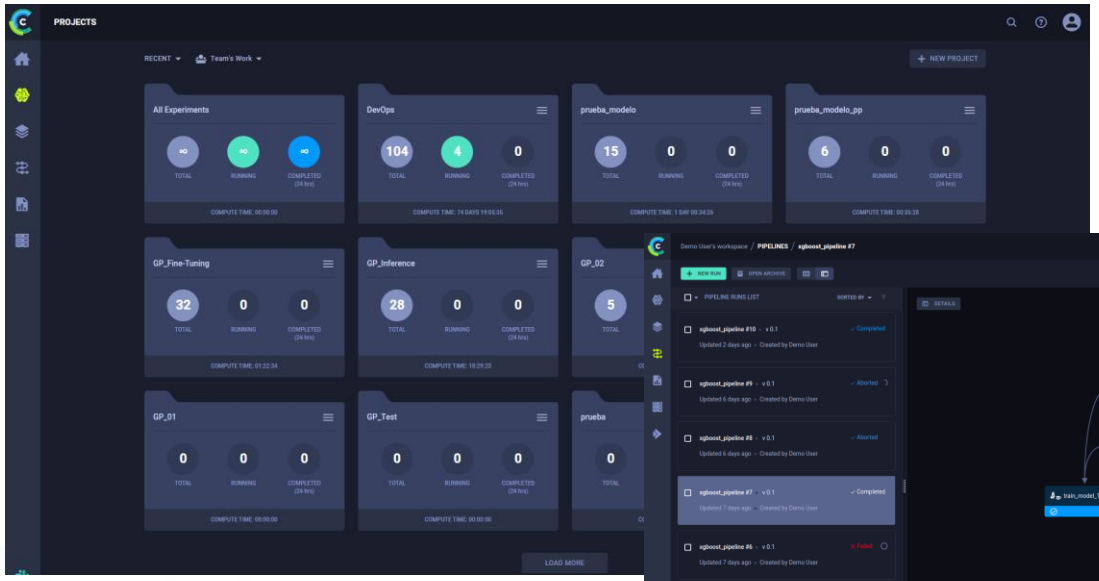
UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB
DISTRIBUTED DATA INTELLIGENCE AND TECHNOLOGIES LAB

# ClearML on S4C

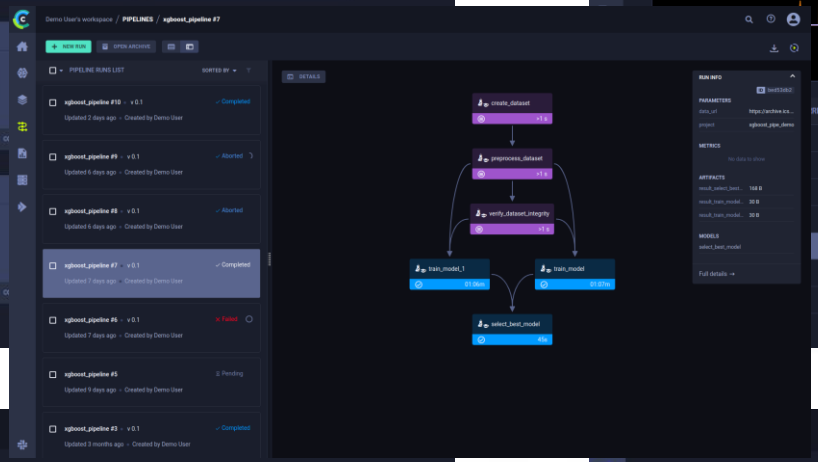
SNAP4CITY KM4CITY

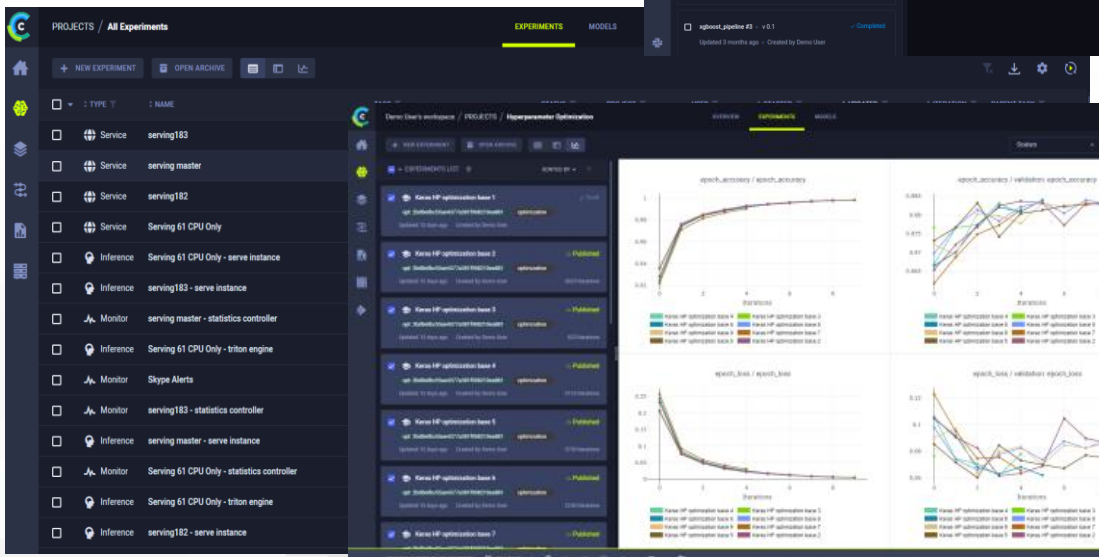




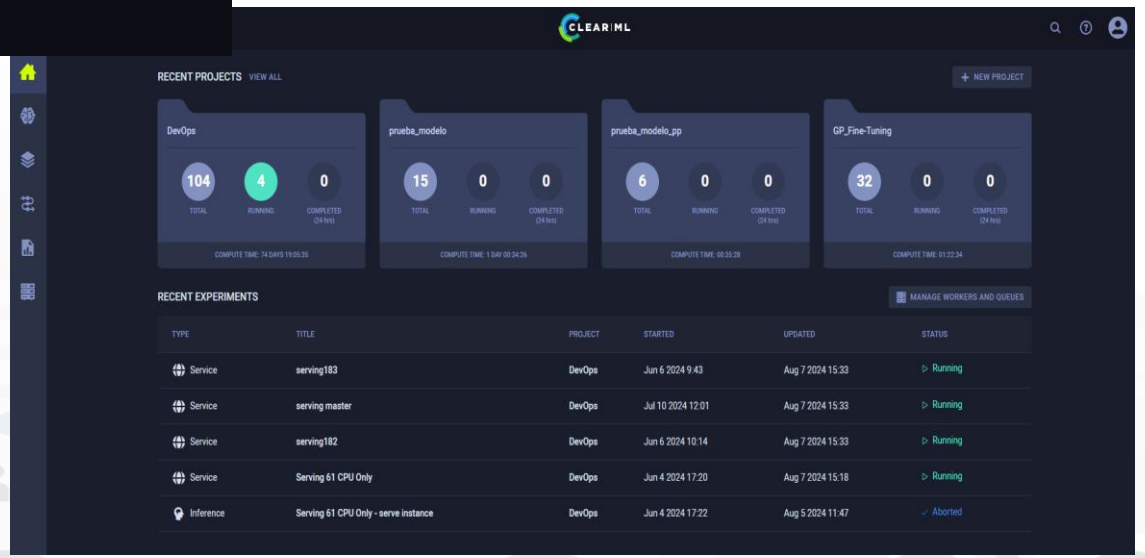


CLEAR|ML





# ClearML Features

- **Experiment Tracking:** Provides advanced features for experiment tracking, including automatic logging of metrics, output, source code, and the execution environment. This ensures that each experiment is reproducible, and its results are easily shareable and comparable.
- **Data and Model Management:** Provides tools for efficient management of datasets and models, allowing for easy versioning, archiving, and sharing. Users can track model versions and easily associate them with corresponding experiments.
- **Integration and Compatibility**: ClearML is designed to integrate with existing development environments and tools, such as **Jupyter Notebooks, TensorFlow, PyTorch, and many others**, thus supporting a wide variety of workflows and technology stacks.
- **User Interface and Dashboard:** offers an intuitive dashboard that allows users to monitor the status of experiments in real time, view metrics and outputs, and manage resources and execution queues, all from a single interface.
- **Automation and Orchestration:** It allows the remote execution of experiments on any machine and distributes the tasks to be executed according to a system of queues and priorities. Also automating Hyper-parametrization via **Optuna**

# Enqueue Services

```
{
   "task_id": "hash_task_id",
   "queue_name": "queue",
   "input": {
         "param1": "value_1",
         "param2": "value_2"
         }
}
```




```
{
         "status": "ok"
}
```



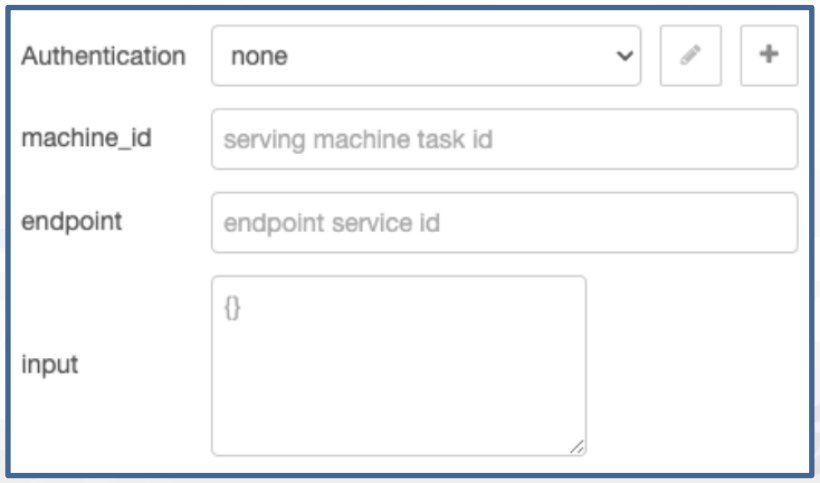

Robust Authentication implemented using authentication_token requested by the block and provided by Snap4City

# OnDemand services

```
{
   "machine_id": "serving_hash",
   "endpoint": "endpoint_name",
   "input": {
         "param1": "value_1",
         "param2": "value_2"
         }
}
```




```
{
         "status": "ok"
}
```

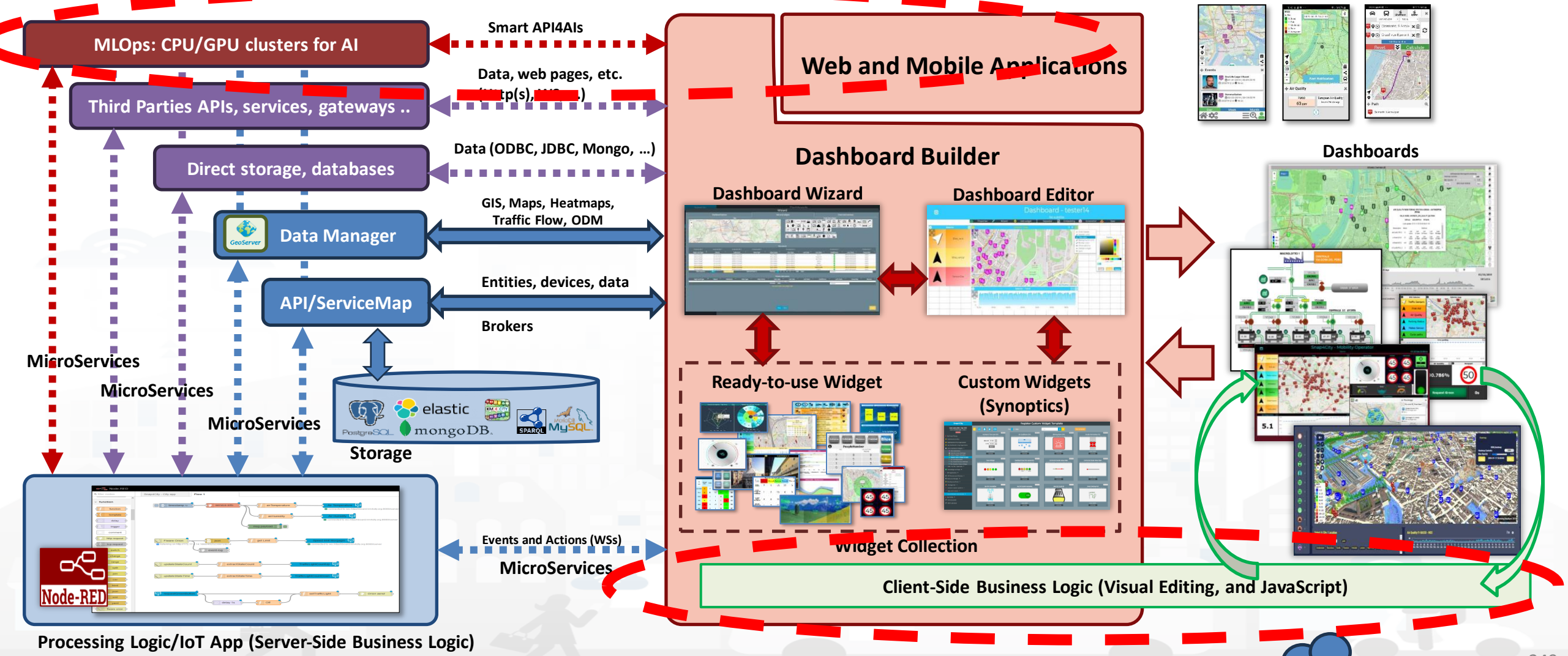



Robust Authentication implemented using authentication_token requested by the block and provided by Snap4City

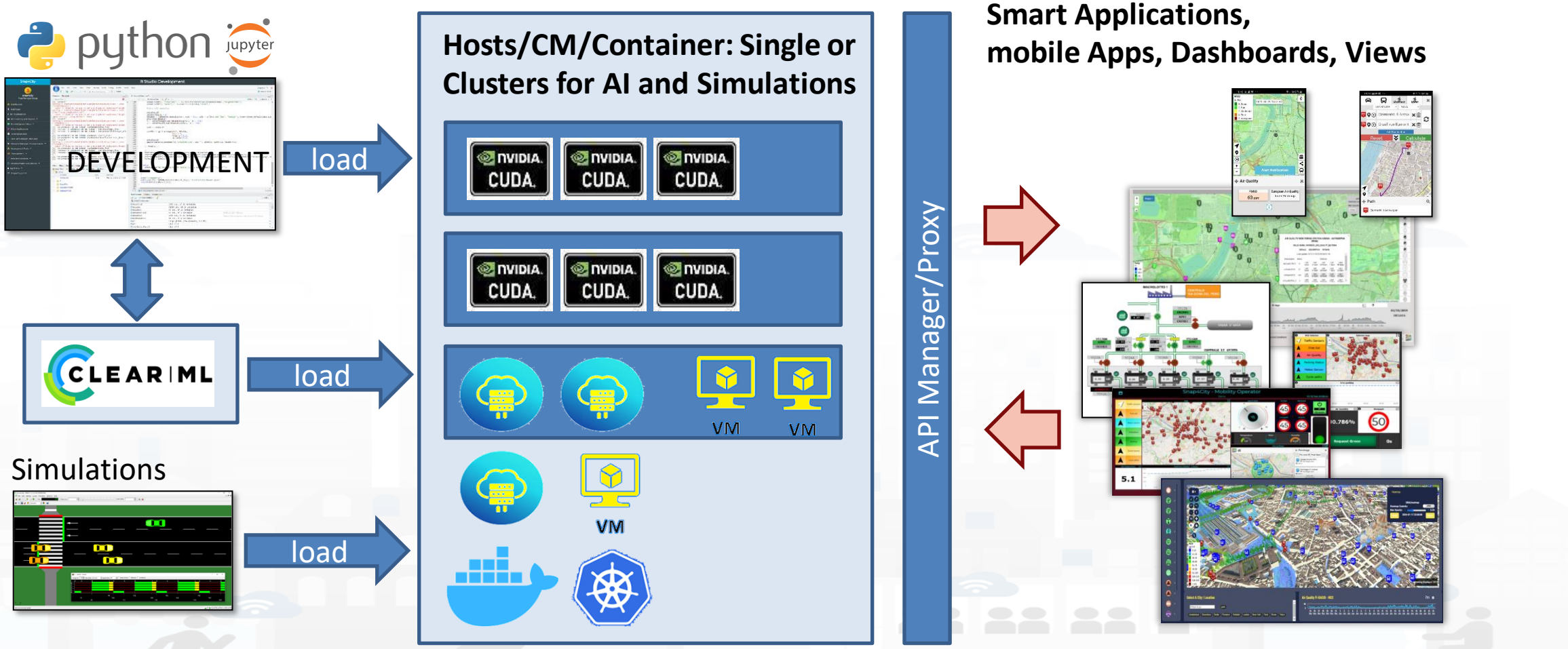
# Exploit AI/ML Tools from Mobile App and/or Smart Applications



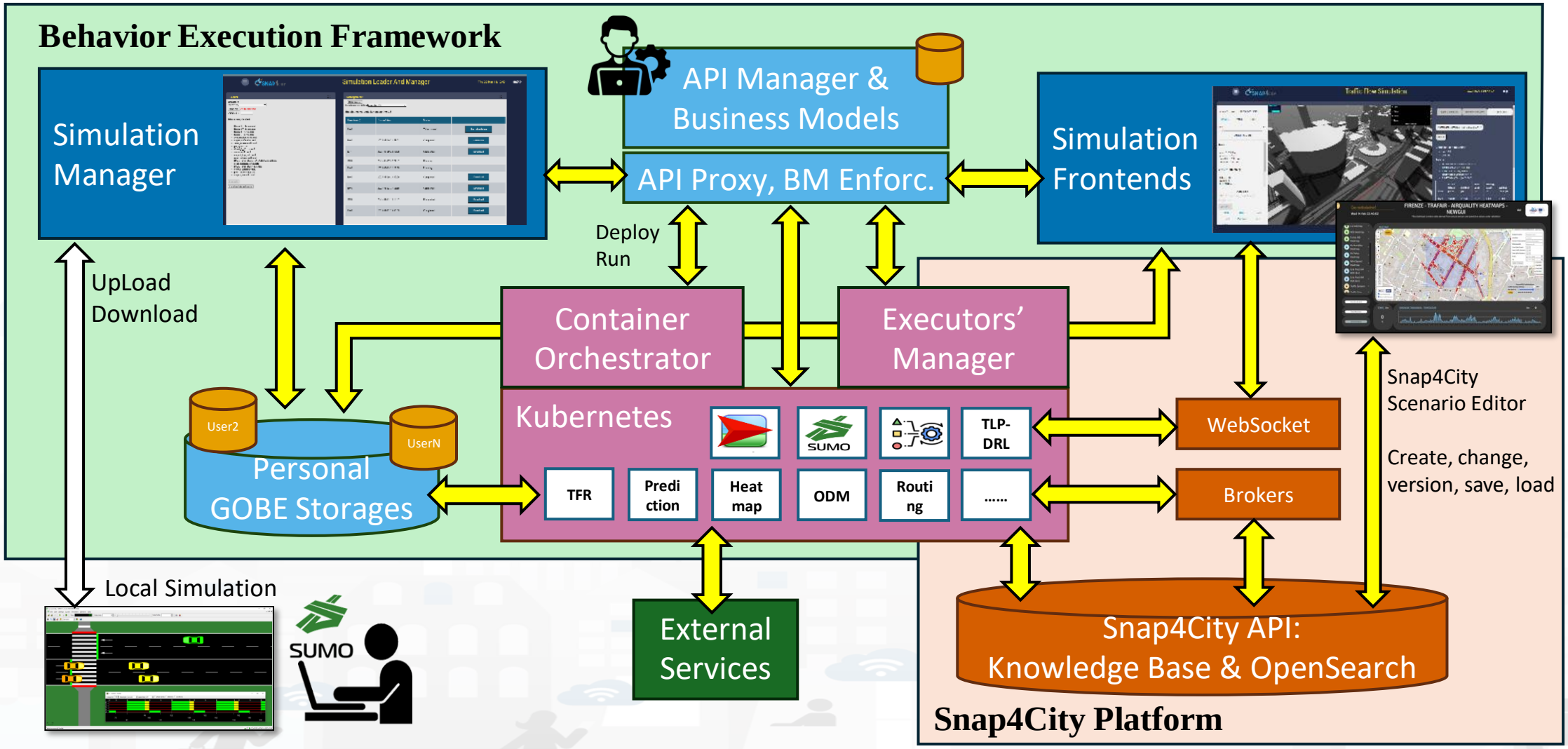
# How the Dashboards / Apps Exchange data (2024/8)

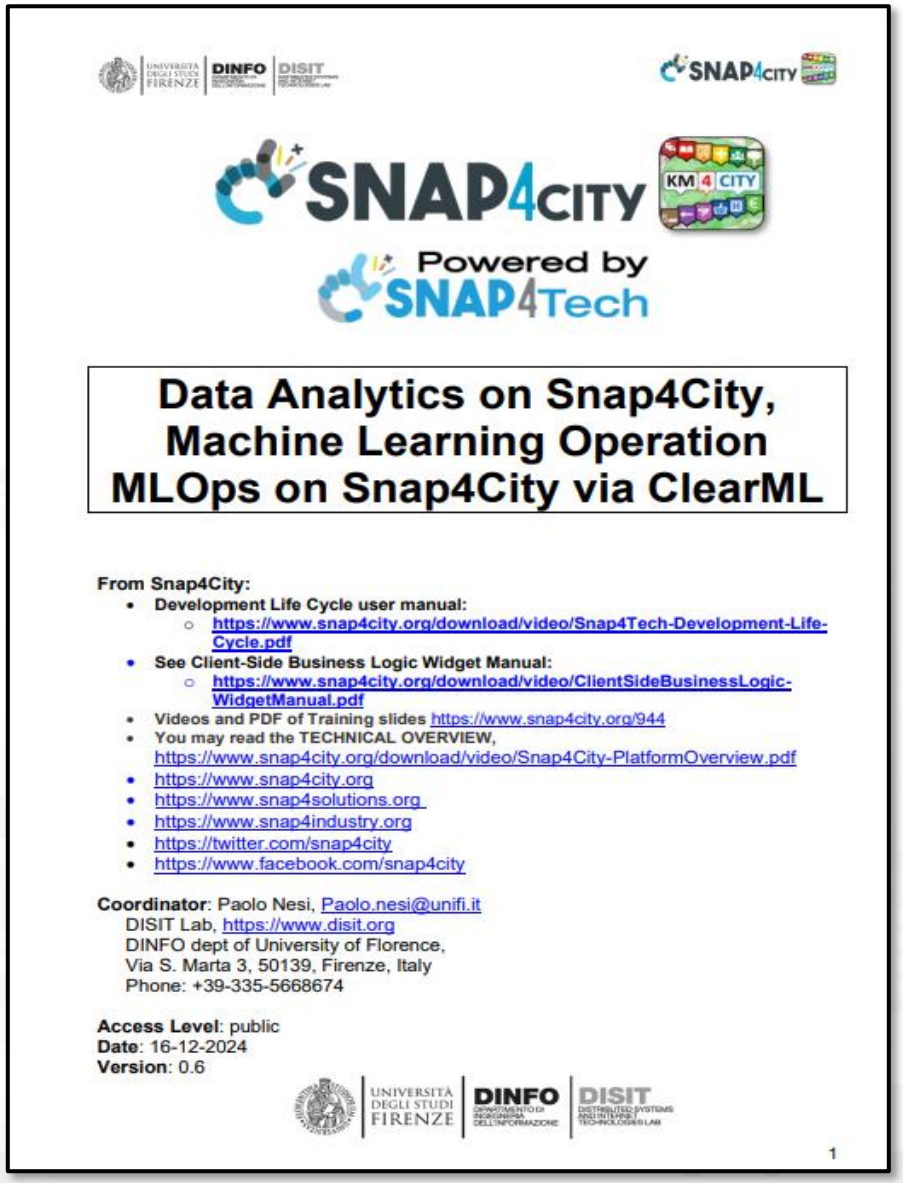


# Exploiting Intelligence from Applications



# BEFDIT Architecture





SNAP4CITY

Powered by SNAP4Tech

**Data Analytics on Snap4City, Machine Learning Operation MLOps on Snap4City via ClearML**

**From Snap4City:**

- **Development Life Cycle user manual:**
  - https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf
- **See Client-Side Business Logic Widget Manual:**
  - https://www.snap4city.org/download/video/ClientSideBusinessLogic-WidgetManual.pdf
- Videos and PDF of Training slides https://www.snap4city.org/944
- You may 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

**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

**Access Level**: public
**Date**: 16-12-2024
**Version**: 0.6

1

# MLOperation

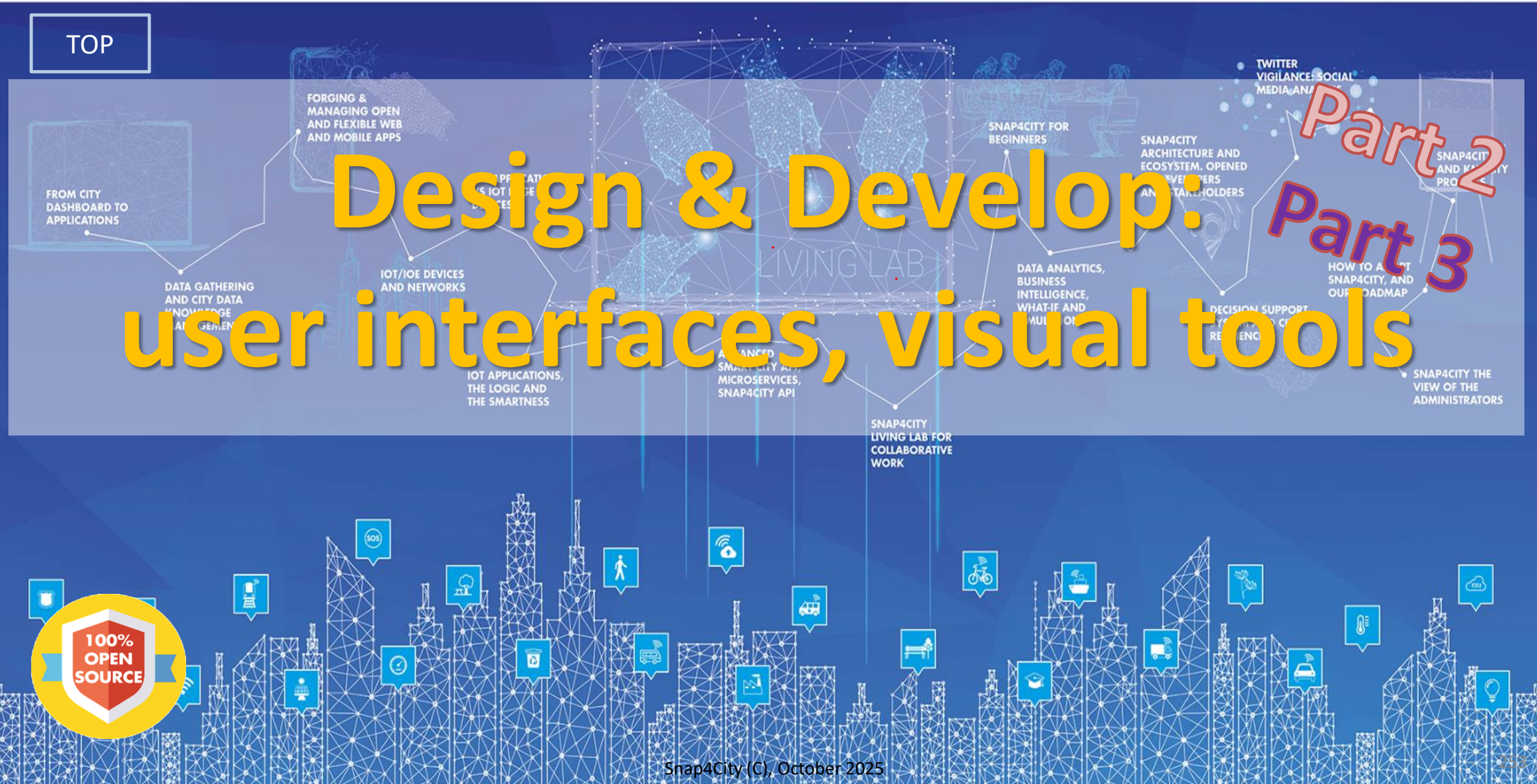
https://www.snap4city.org/download/video/Snap4City-MLOps-Manual.pdf

TOP

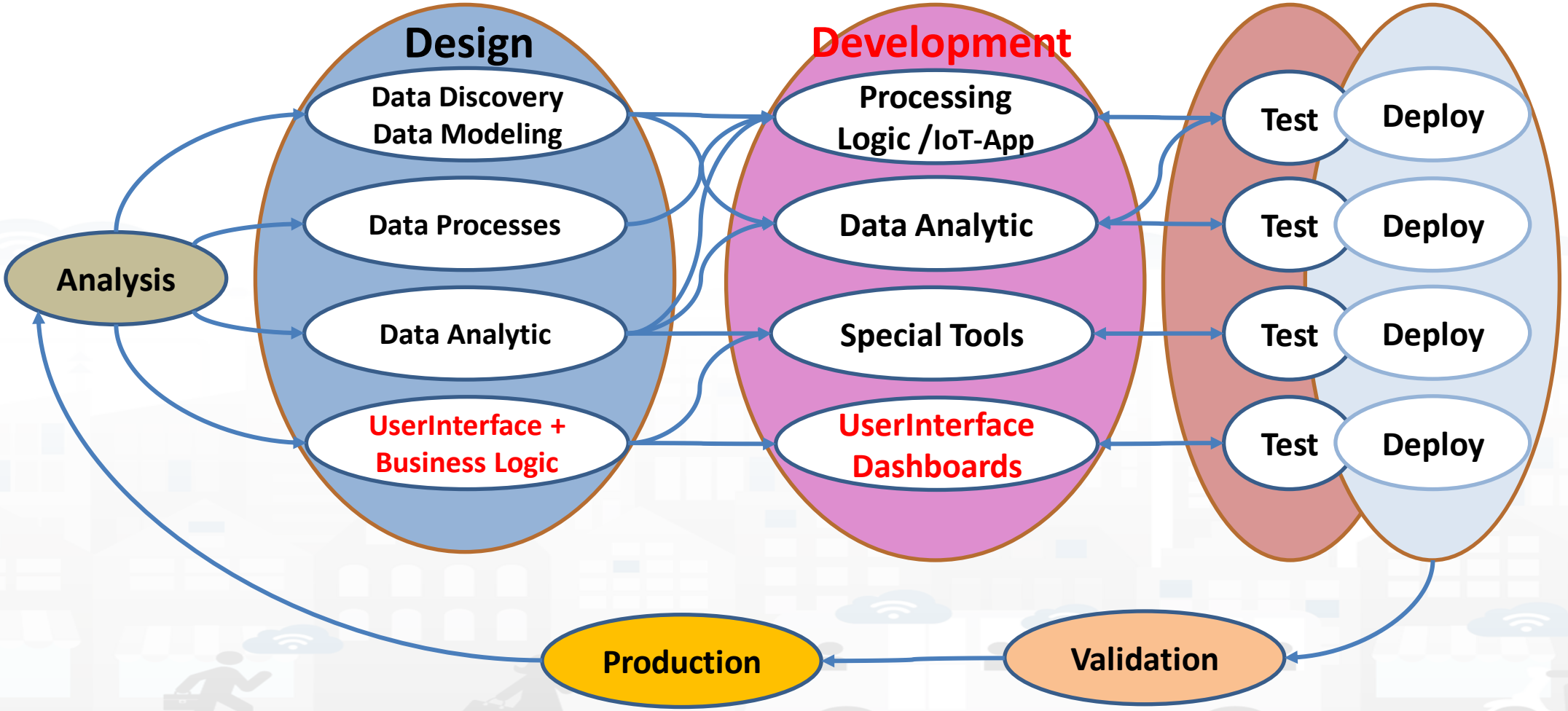
# Design & Develop: user interfaces, visual tools

Part 2

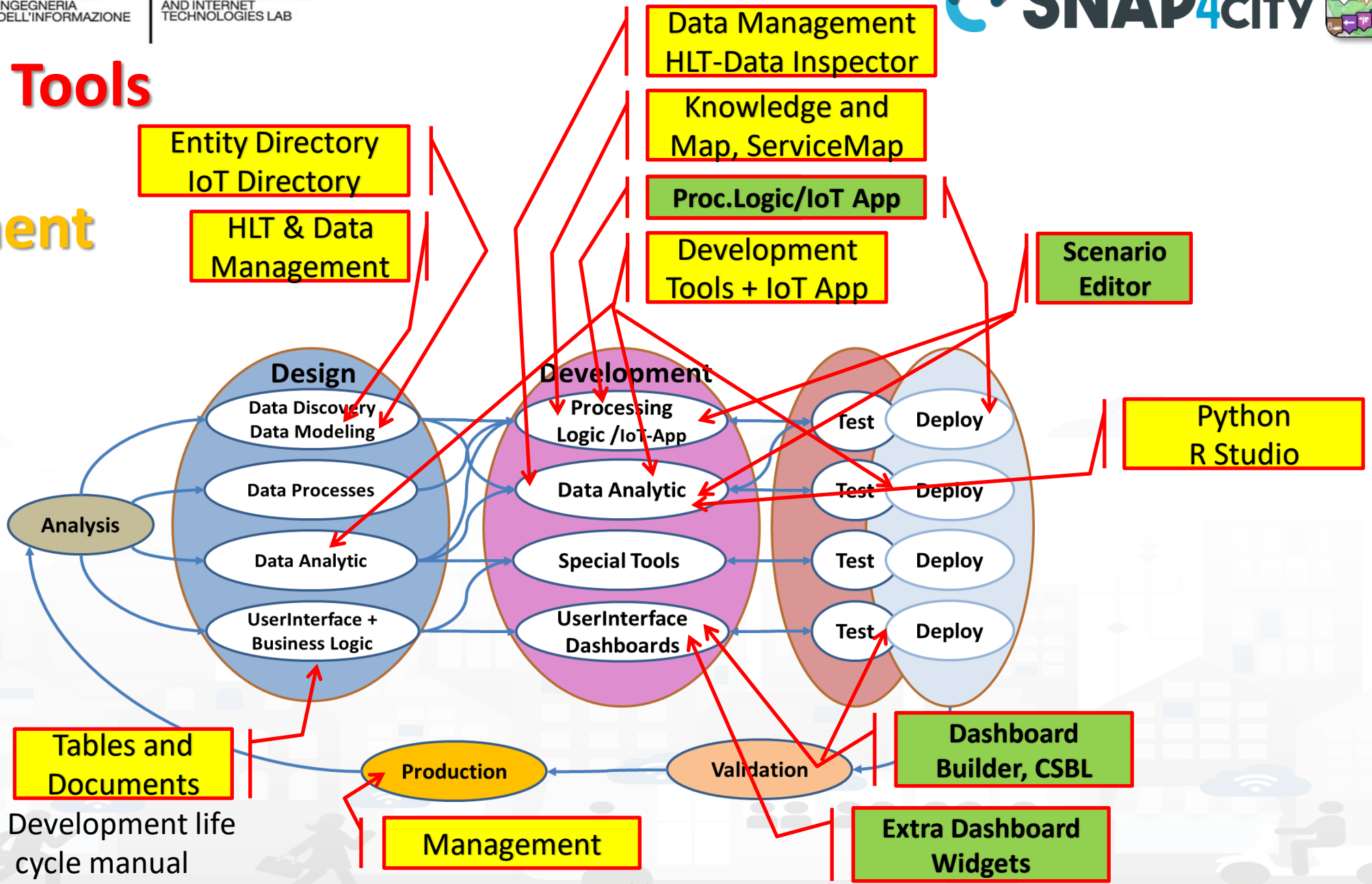
Part 3



# Development Life Cycle Smart Solutions

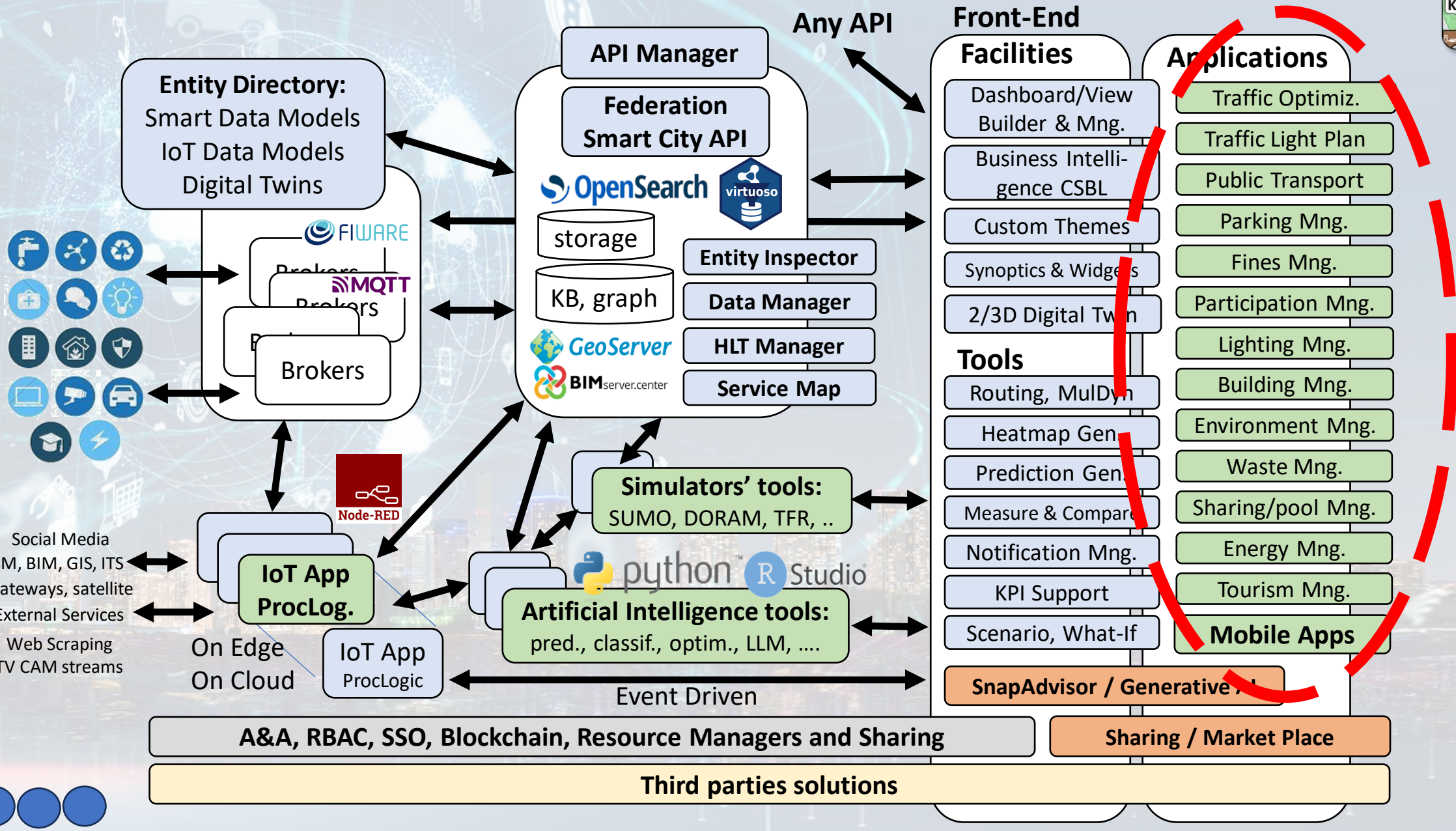


# Snap4City Tools vs Development Life Cycle




Development life cycle manual

# Technical Architecture



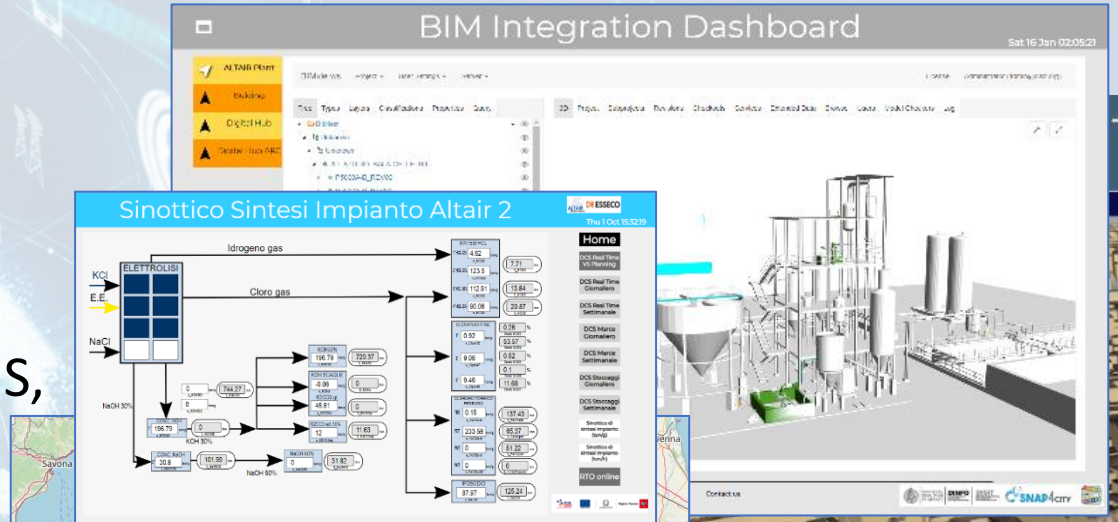
# Snap4City Dashboard Builder (2023) vs Kibana/Grafana

| Features | Snap4City Dashboard Builder | Kibana, Grafana |
|---|---|---|
| Large Collection of Widgets, also from D3 library | YES | Nothing |
| Custom Widgets SVG of any kind, full defined process for customization | YES | Nothing |
| Real time event driven widgets and data | YES | Nothing |
| Server/Client Side Business Logic for data transformation with visual programming: Node-RED | YES: visual/coding | coding |
| Maps with custom PIN, bubbles, animated and moving, etc. | YES | Nothing |
| Maps with paths, shapes, traffic flow, scenarios, routing, heatmaps, what-if, Origin Destination Matrix, … | YES | Nothing |
| Maps with Orthomaps from WFS, WMS, GIS connection, etc. | YES | Nothing |
| TV camera integration and selection | YES | Nothing |
| Widgets for business logic integration on real time: buttons, selector, switch, etc. | YES | Nothing |
| Kiviat, Spider net, Calendar (also any other D3 Widgets) | YES | Nothing |
| Typical Time Trends: day hours, month week, month days, ….. | YES | Nothing |
| Time Trend Compare: day, week, month, year | YES | Nothing |
| Selectors/Menus: text, icons, etc., also in connection with IOT APP, Node-RED | YES | Nothing |
| Full control of graphic layout, font, colours, refresh per widget, etc. | YES | Nothing |
| Iframe integration of third party widgets and web pages, nesting dashboards, embedding Kibana | YES | Nothing |
| Connection among multiple Dashboards and Widgets | YES | Nothing |
| Synchronization with Video Wall, and Operators Views | YES | Nothing |
| Multiseries, bar lines, charts, pie, donut, simple selectors, trends, etc., also from business logic | YES | Limited |
| Single content, string, html, any data, etc. | YES | Limited |
| Special widgets: Weather forecast, civil protection, road plates, Twitter, SVG, etc… | YES | Nothing |
| Digital Twin Local (BIM) and Global (3D city representation) with 3D traffic, Heatmaps, Devices, … | YES | Nothing |
| Faceted search | YES: selectors, forms, buttons | YES |

# High Level Types

Snap4City (C), October 2025

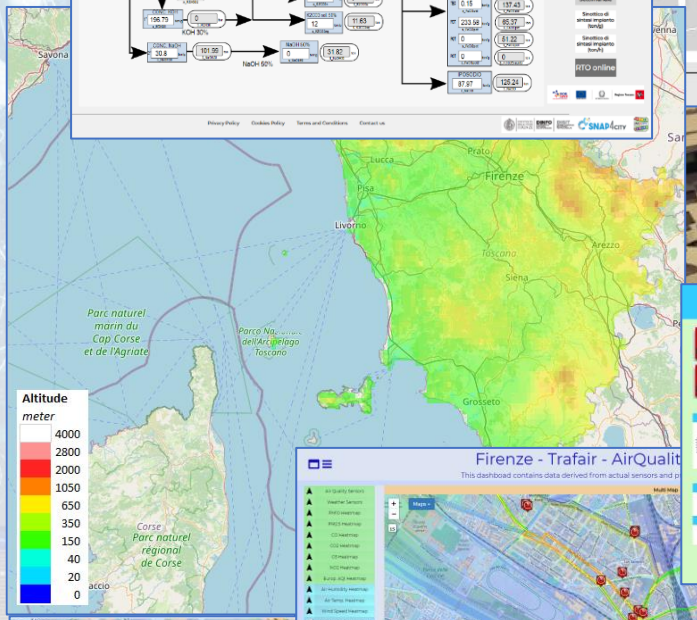
- POI, IOT Devices, shapes,..
  - FIWARE Smart Data Models,
  - IoT Device Models
- GIS, maps, orthomaps, WFS/WMS, GeoTiff, calibrated heatmaps, ..
- Satellite data, ..
- traffic flow, typical trends, ..
- trajectories, events, Workflow, ..
- 3D Models, BIM, Digital Twins, ..
- OD Matrices of several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















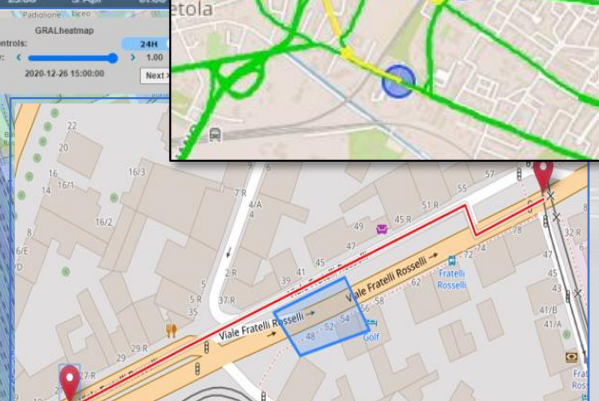


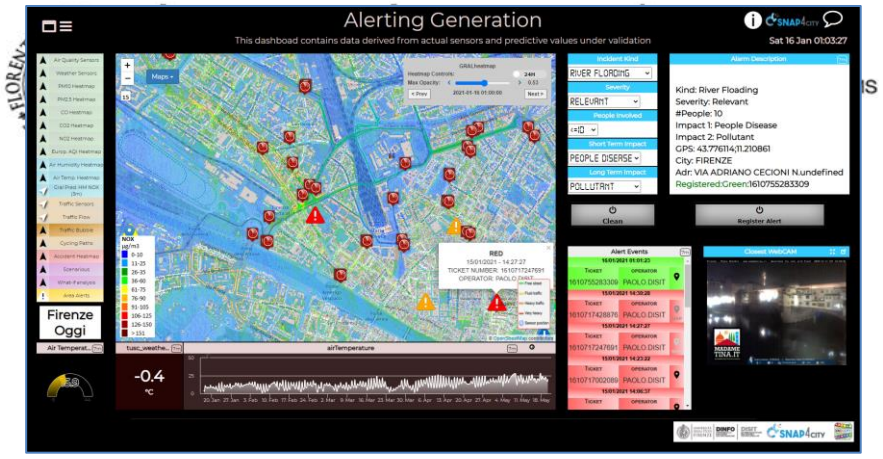


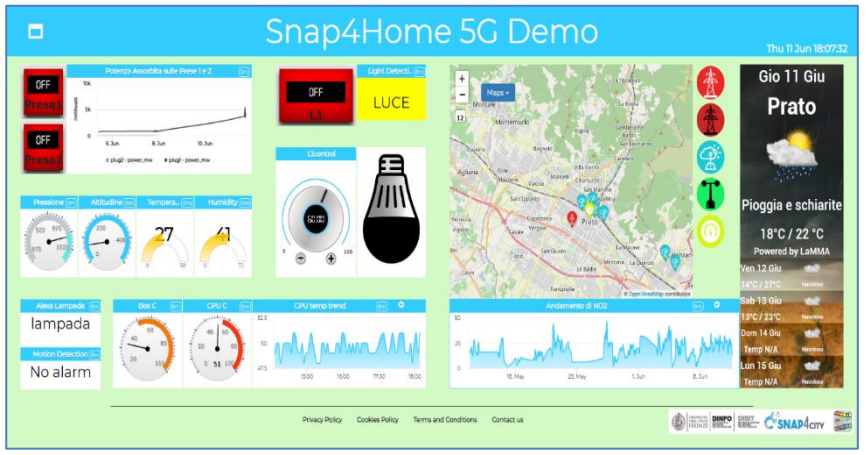


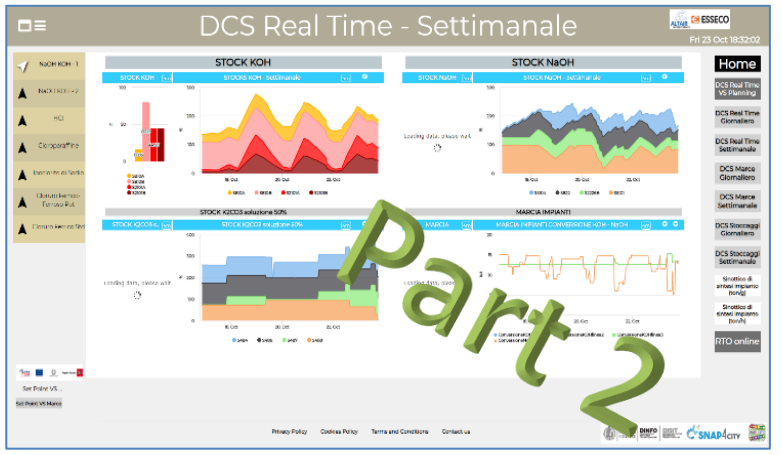


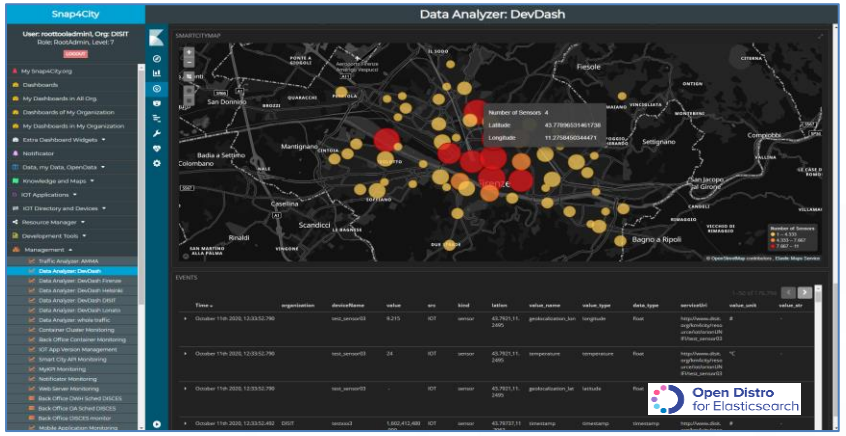


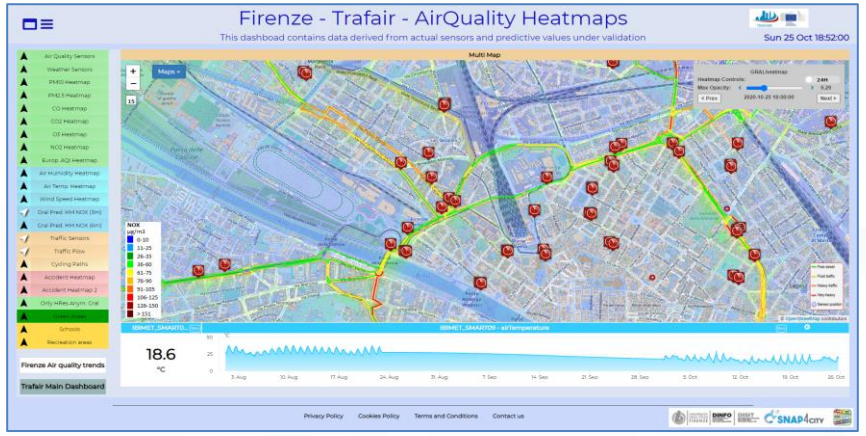



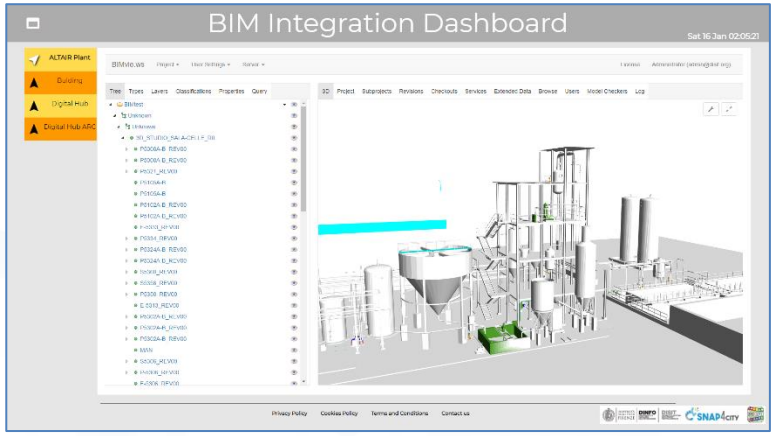

Alerting Generation
This dashboad contains data derived from actual sensors and predictive values under validation
Sat 16 Jan 01:03:27
Firenze Oggi
-0.4

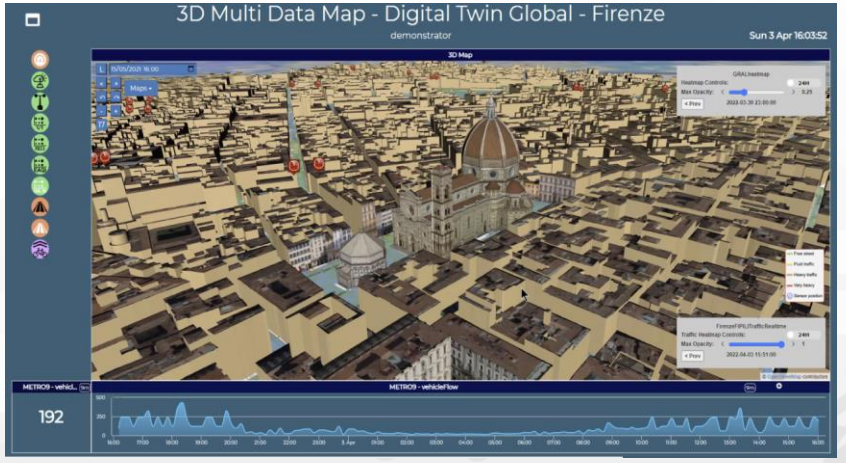

Snap4Home 5G Demo
Thu 11 Jun 18:07:32
LUCE
Gio 11 Giu
Prato
Pioggia e schiarite
18°C / 22 °C
Powered by LaMMA
lampada
No alarm

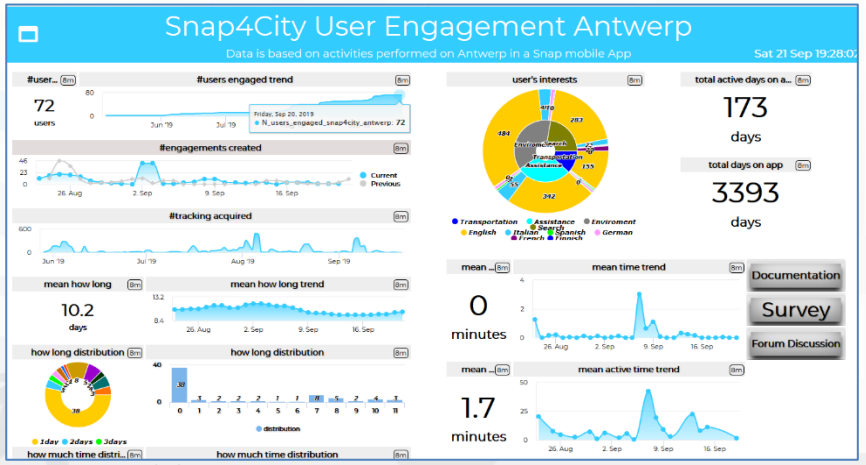

DCS Real Time - Settimanale
Fri 23 Oct 18:32:02
STOCK KOH
STOCK NaOH
Home
Part 2

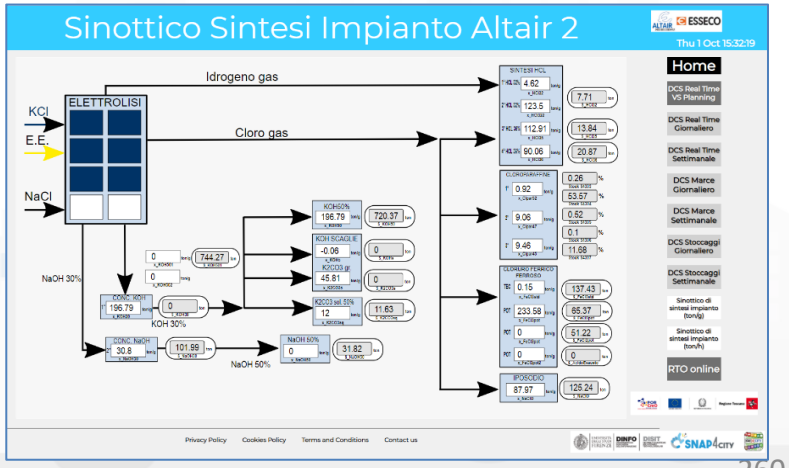

Data Analyzer: DevDash
Open Distro for Elasticsearch


Firenze - Trafair - AirQuality Heatmaps
This dashboad contains data derived from actual sensors and predictive values under validation
Sun 25 Oct 18:52:00
18.6

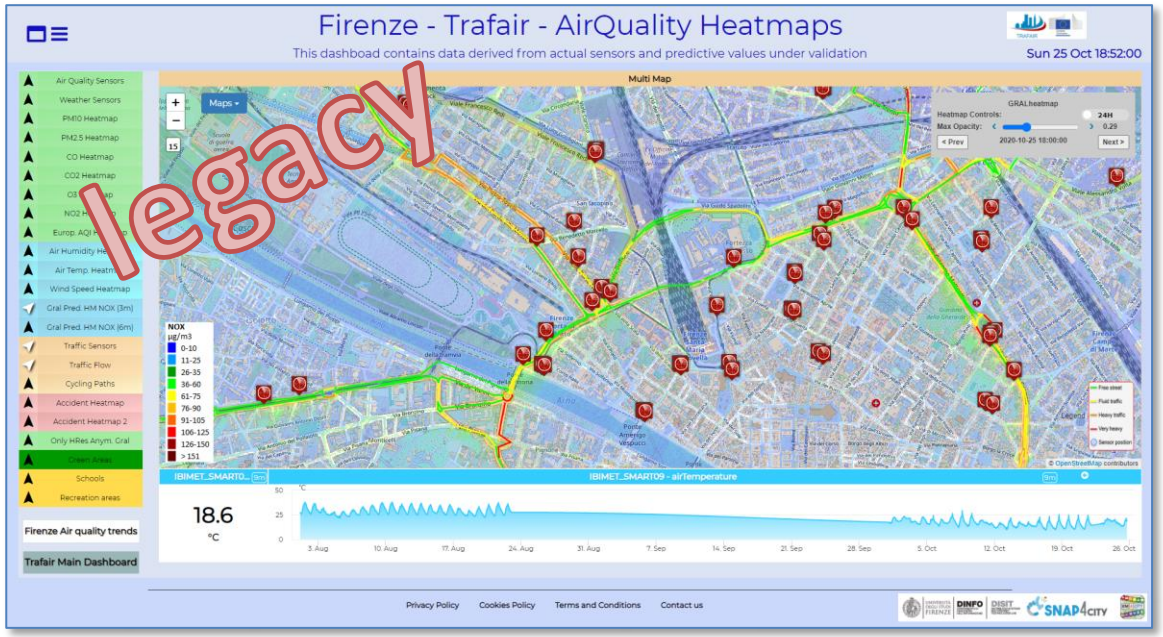

BIM Integration Dashboard
Sat 16 Jan 02:05:21

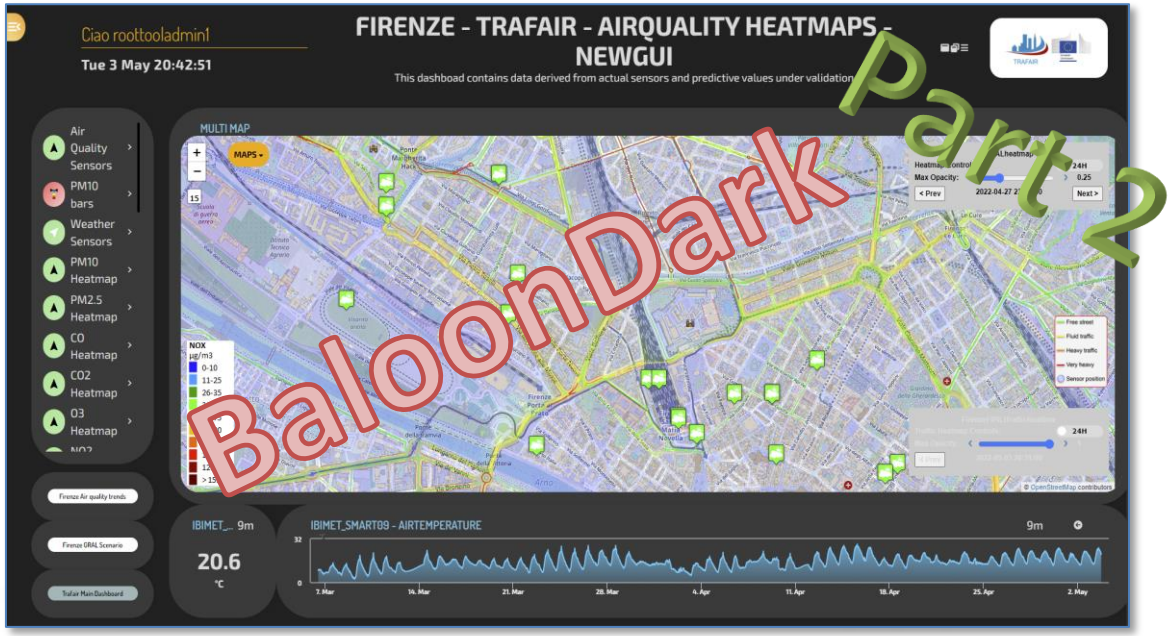

3D Multi Data Map - Digital Twin Global - Firenze
demonstrator
Sun 3 Apr 16:03:52
192

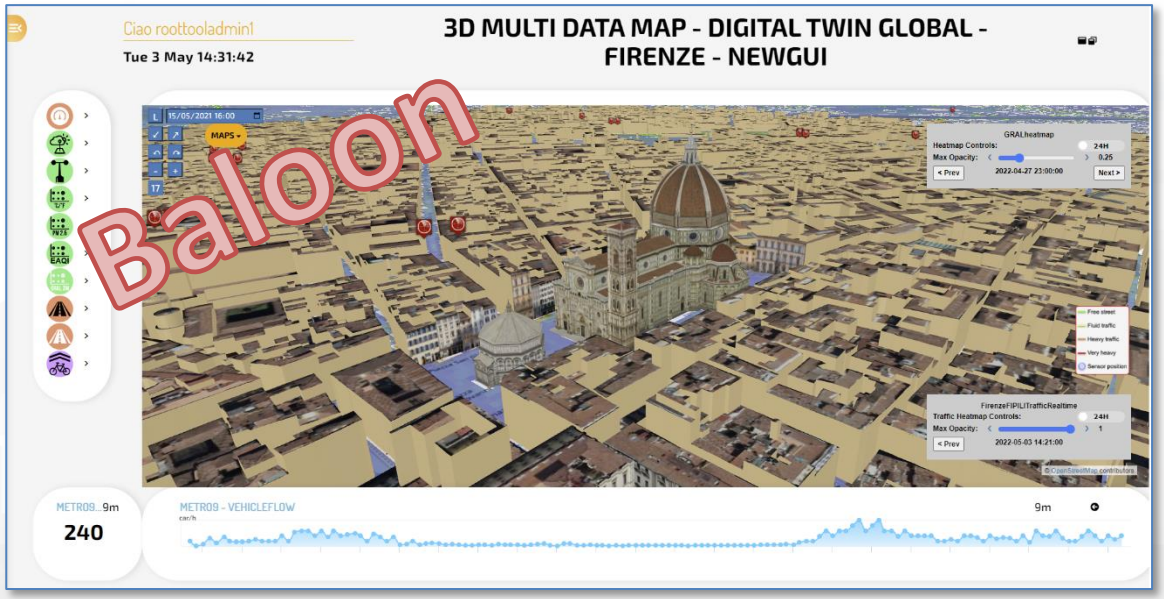

Snap4City User Engagement Antwerp
Data is based on activities performed on Antwerp in a Snap mobile App
Sat 21 Sep 19:28:07
72
users
173
days
3393
days
0
minutes
1.7
minutes
10.2
days
Documentation
Survey
Forum Discussion

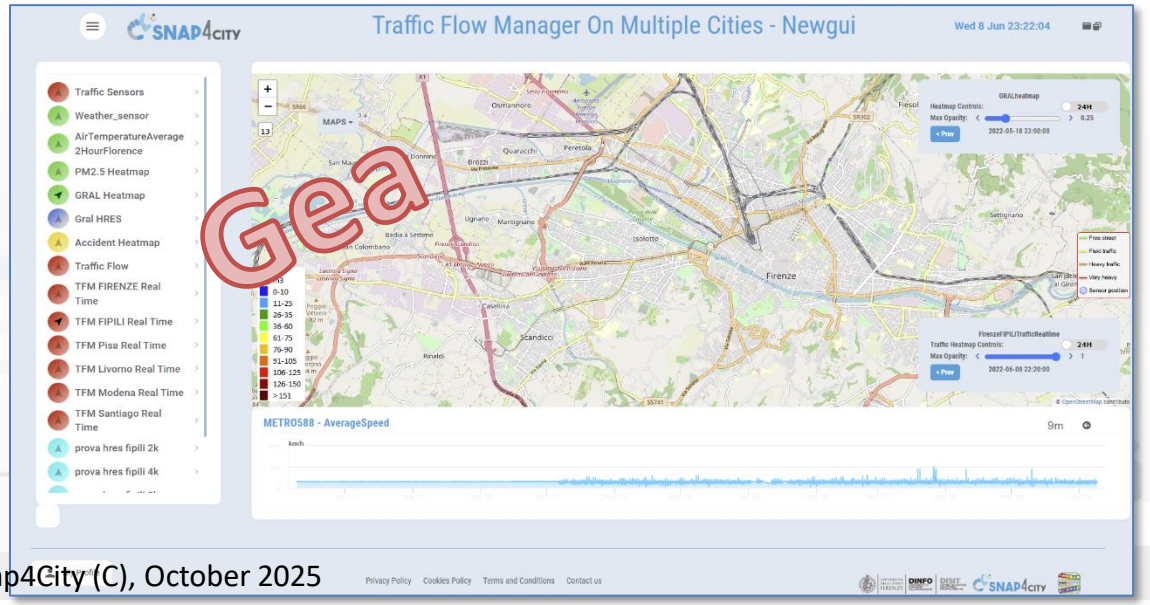

Sinottico Sintesi Impianto Altair 2
Thu 1 Oct 15:32:19
Home
Idrogeno gas
Cloro gas
ELETTROLISI
KCl
E.E.
NaCl
NaOH 30%
KOH 30%
NaOH 50%

# Different Themes



# Dashboards (Public by (ORG))

LOGIN

Switch to Legacy Layout

Part 2

Dashboards (Public)

- www.snap4solutions.org
- 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
- Km4City portal

Privacy Policy  Cookies Policy

Prev 1 ... 34 35 36 37 38 Next

Filter by dashboarc




**Traffic Flow Manager test**

Passive

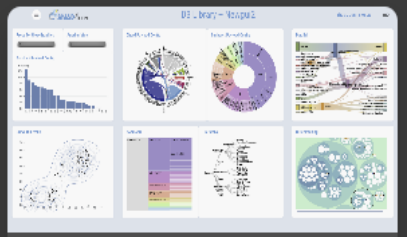
Public (DISIT)




**Traffic Flow Monitoring - Firenze - Cloned2**

Passive

Public (Firenze)



**D3 library -- newgui2**

Proc.Logic / IoT App

Public (DISIT)




**Traffic Flow Reconstruction - Sii-Mobility**

Passive

Public (Other)




**Traffic Flow Reconstruction for the cities**

Passive

Public (Other)




**3D Map Global Digital Twin -newgui2**

Passive

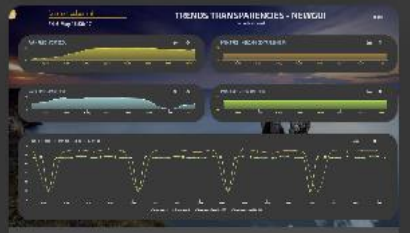
Public (DISIT)




**3D Multi Data Map - Digital Twin Global - Firenze**

Passive

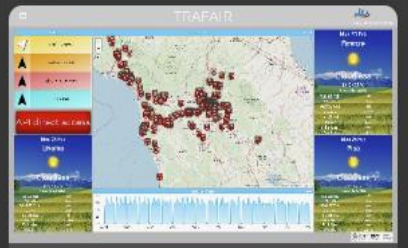
Public (DISIT)




**Trends transparencies - newgui**

Passive

Public (DISIT)




**Tuscany TRAFAIR Data Dashboard**

Passive

Public (DISIT)



**Tuscany weather dashboard 1**

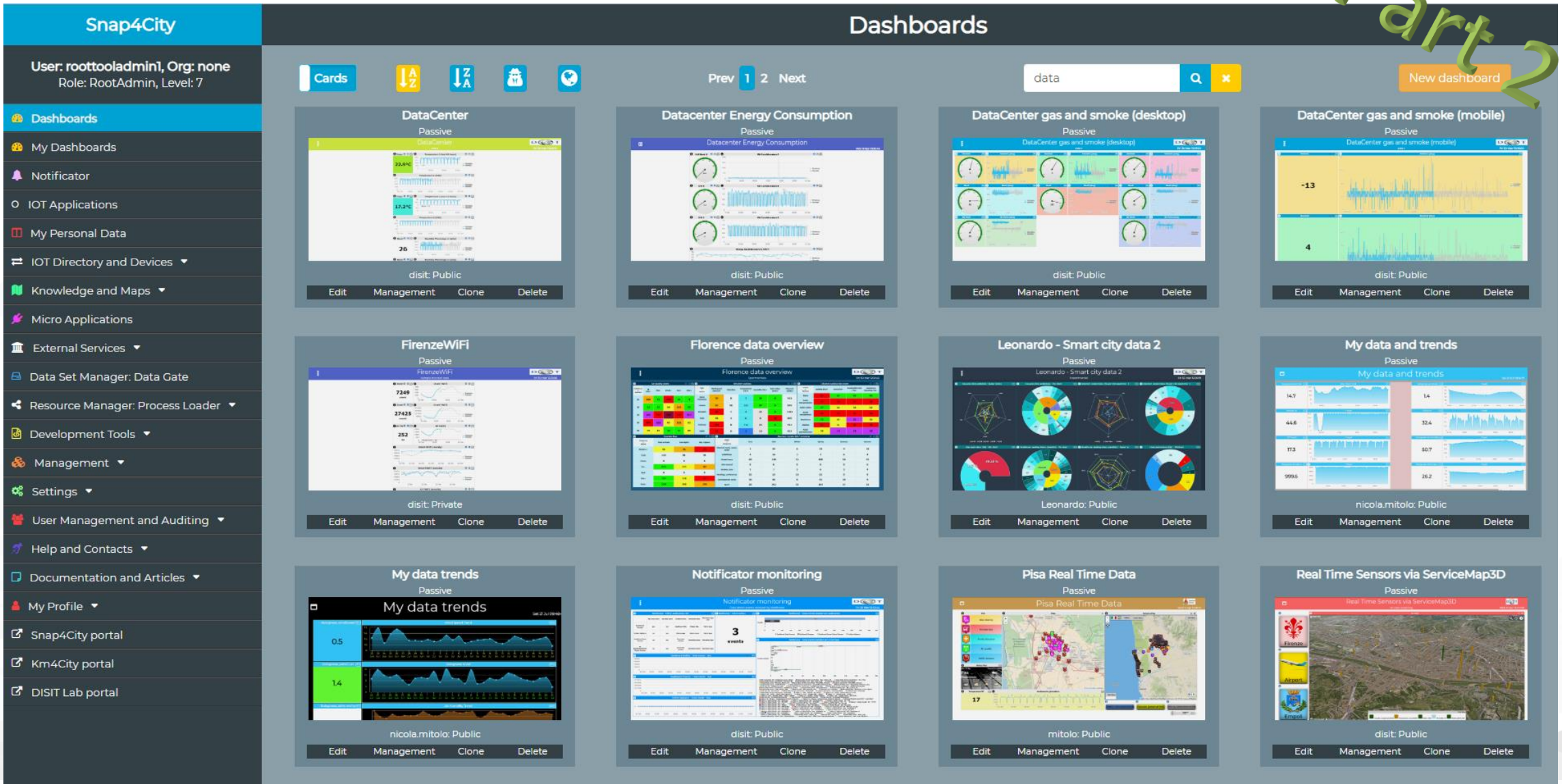
Passive

Public (DISIT)

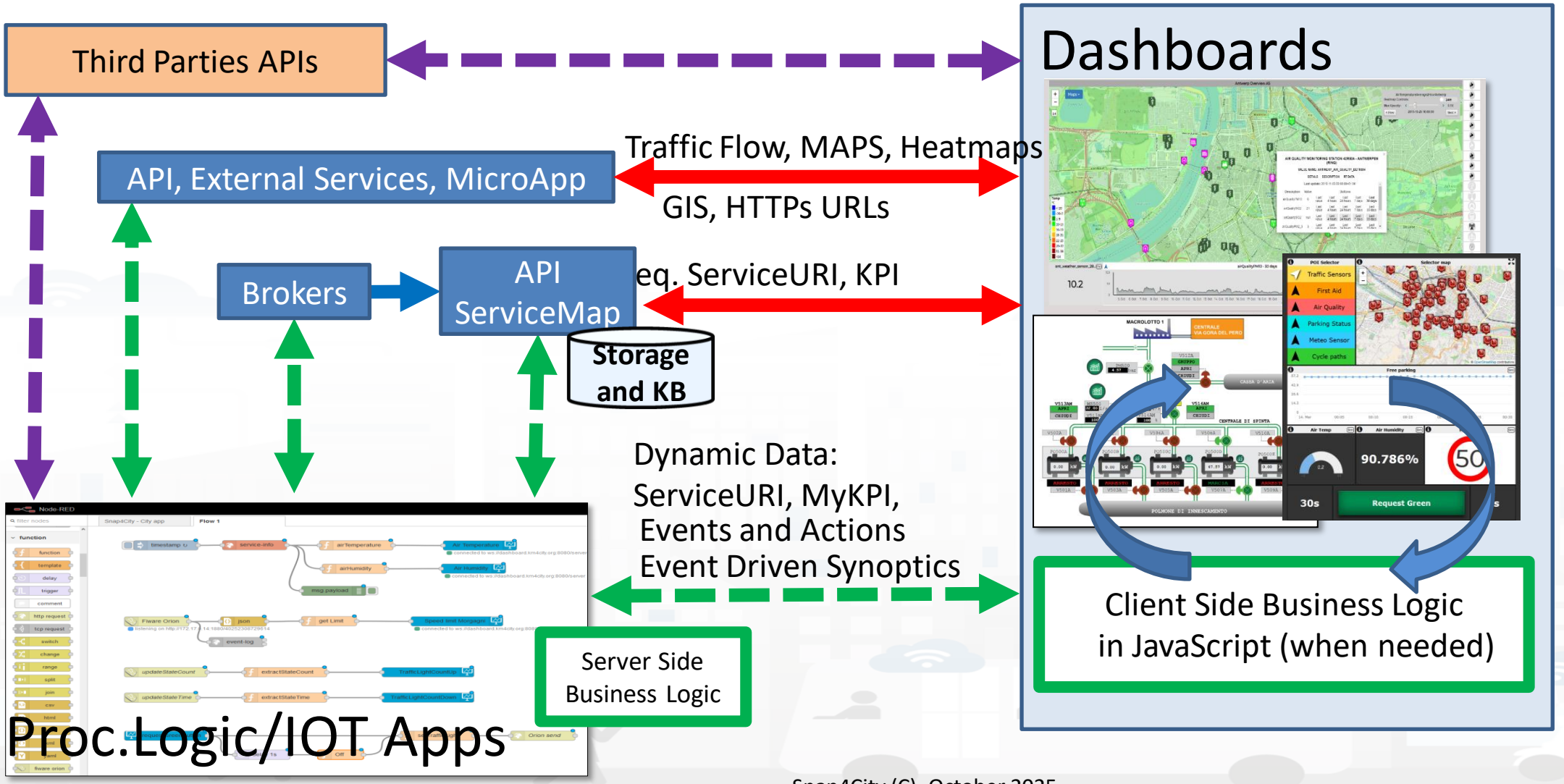
UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO | DISIT

# Dashboard List and Editor

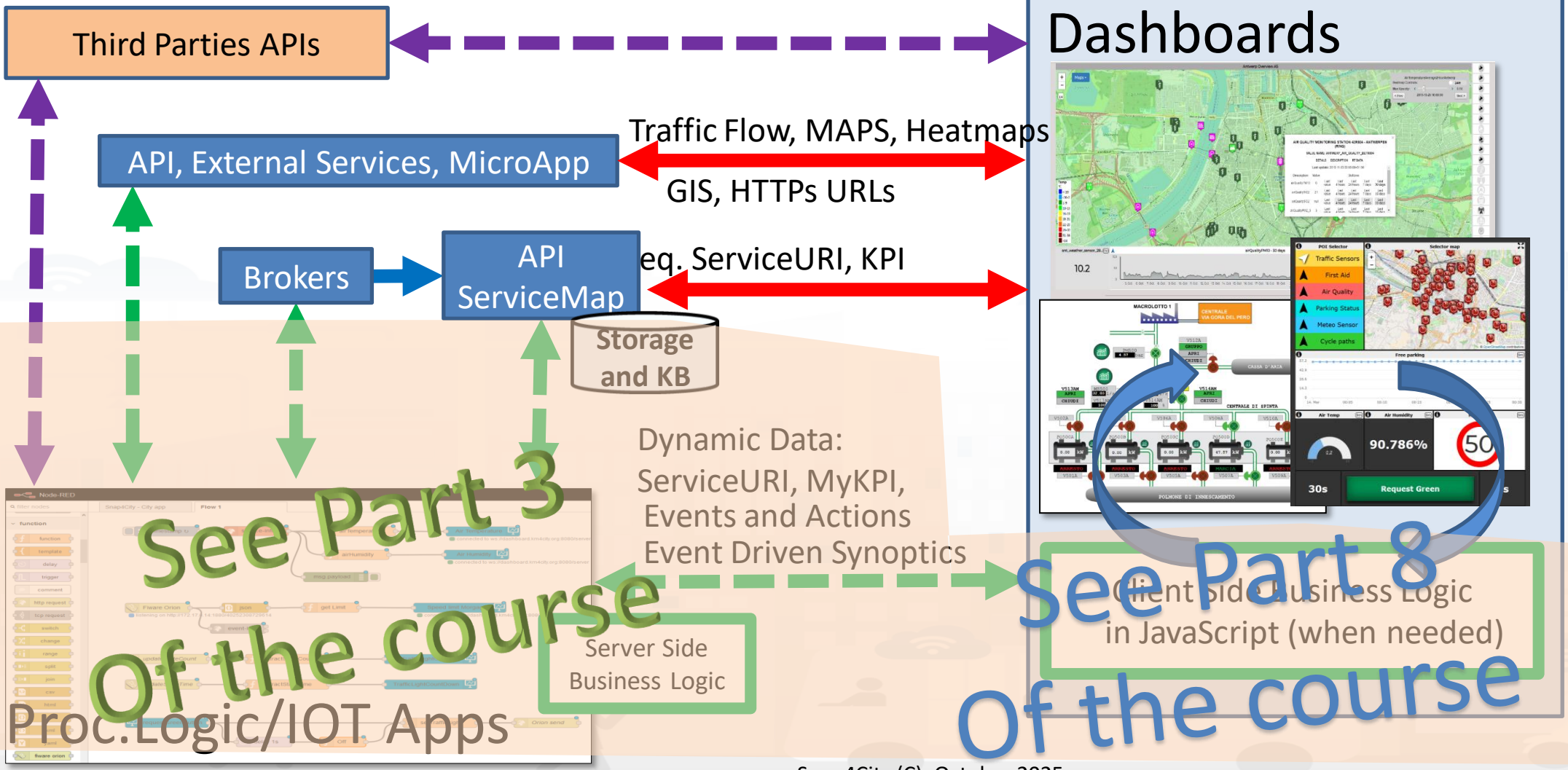
Part 2



# How the Dashboards exchange data



# How the Dashboards exchange data



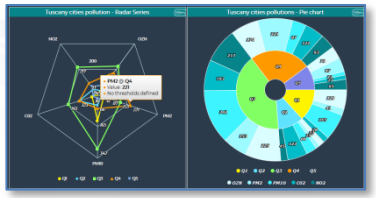
# Dashboard List and Editor



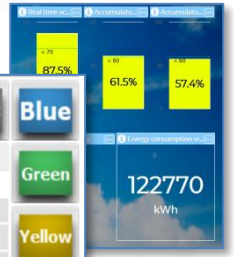






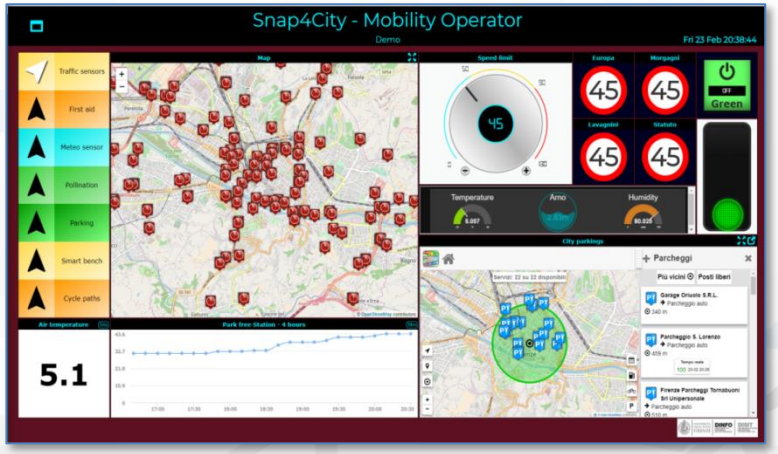


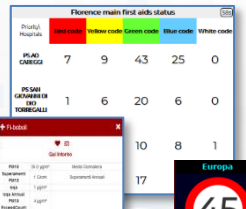


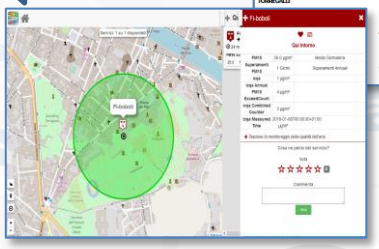




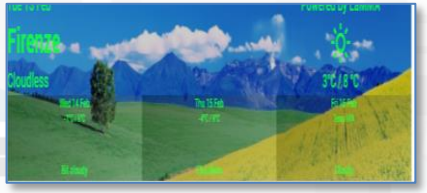


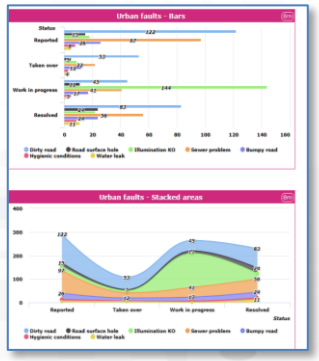






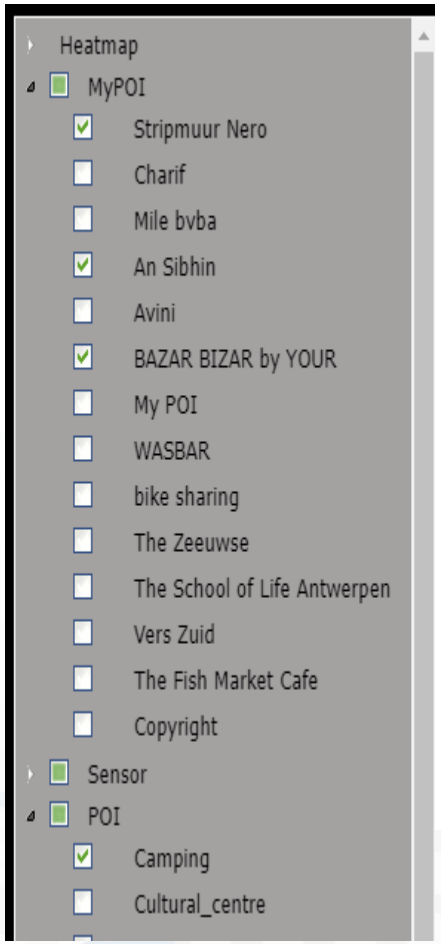


# The Selector for Multi Data Maps





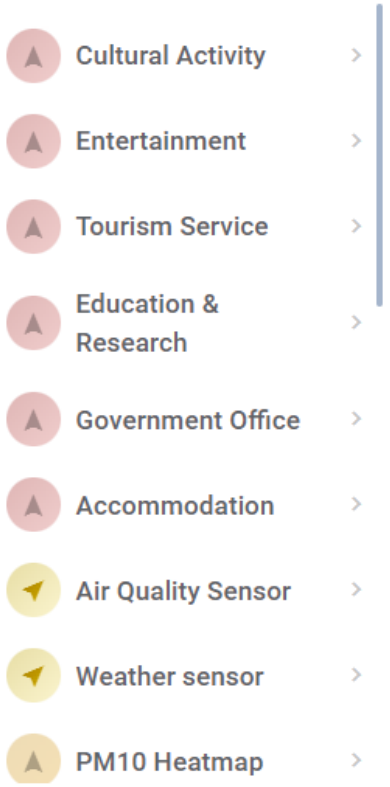










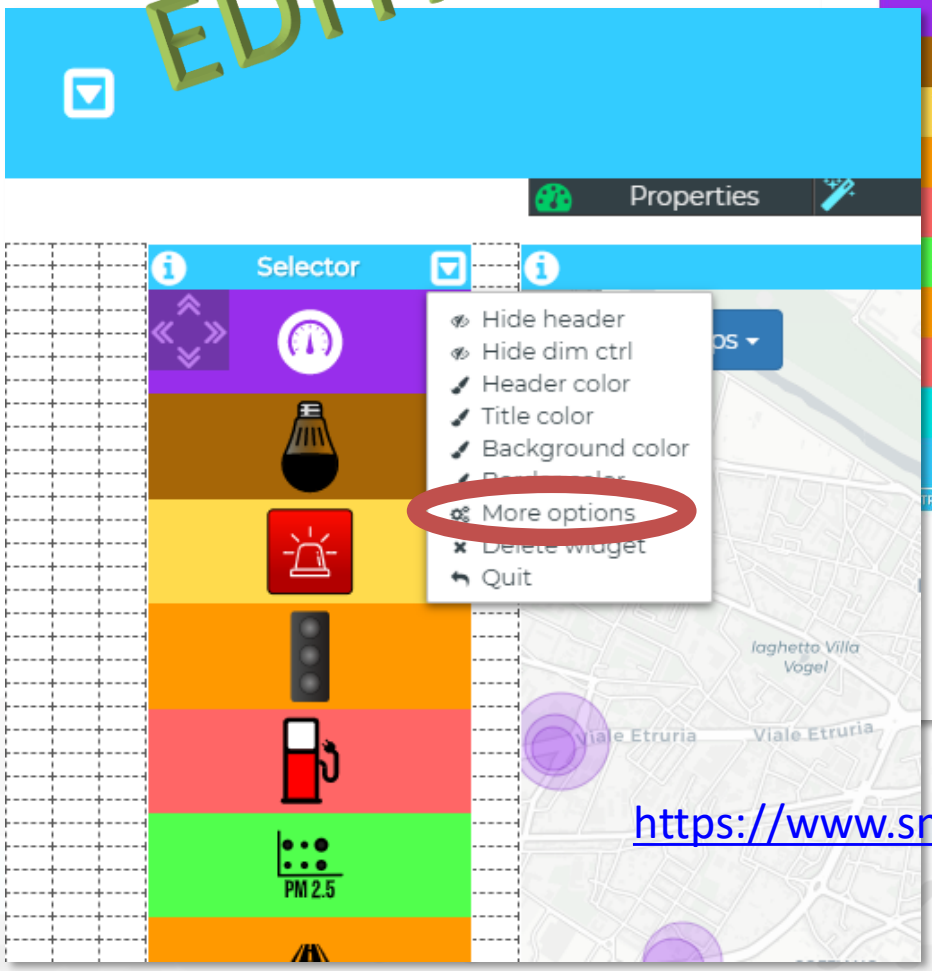



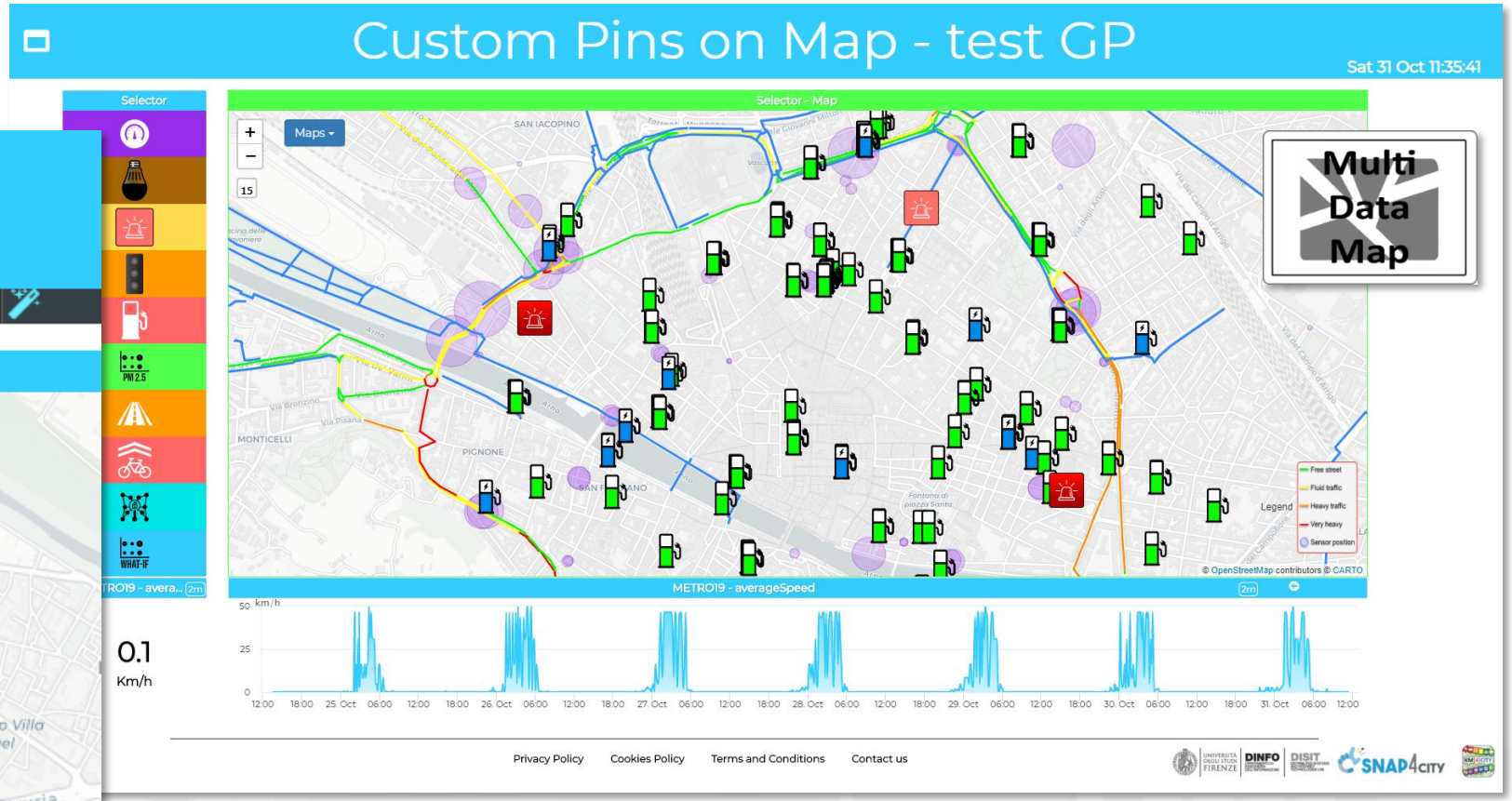

- **Different styles**
  - Icon and Text menu
  - Custom Menu Icon
  - Icon Menu buttons
  - Etc.
- **Features**
  - Removable header
  - Colours custom
  - Transparencies
  - Mixed modalities
- **Note:**
  - Manus can be realized also with a set of Buttons

*The Selector is the Map Controller*

# Custom Dynamic Pins

EDITING

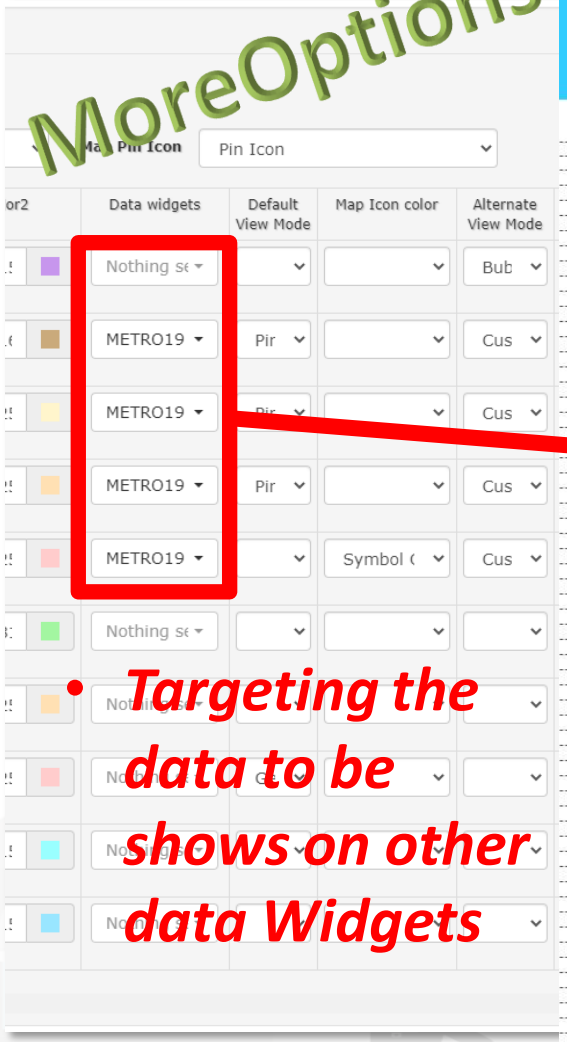


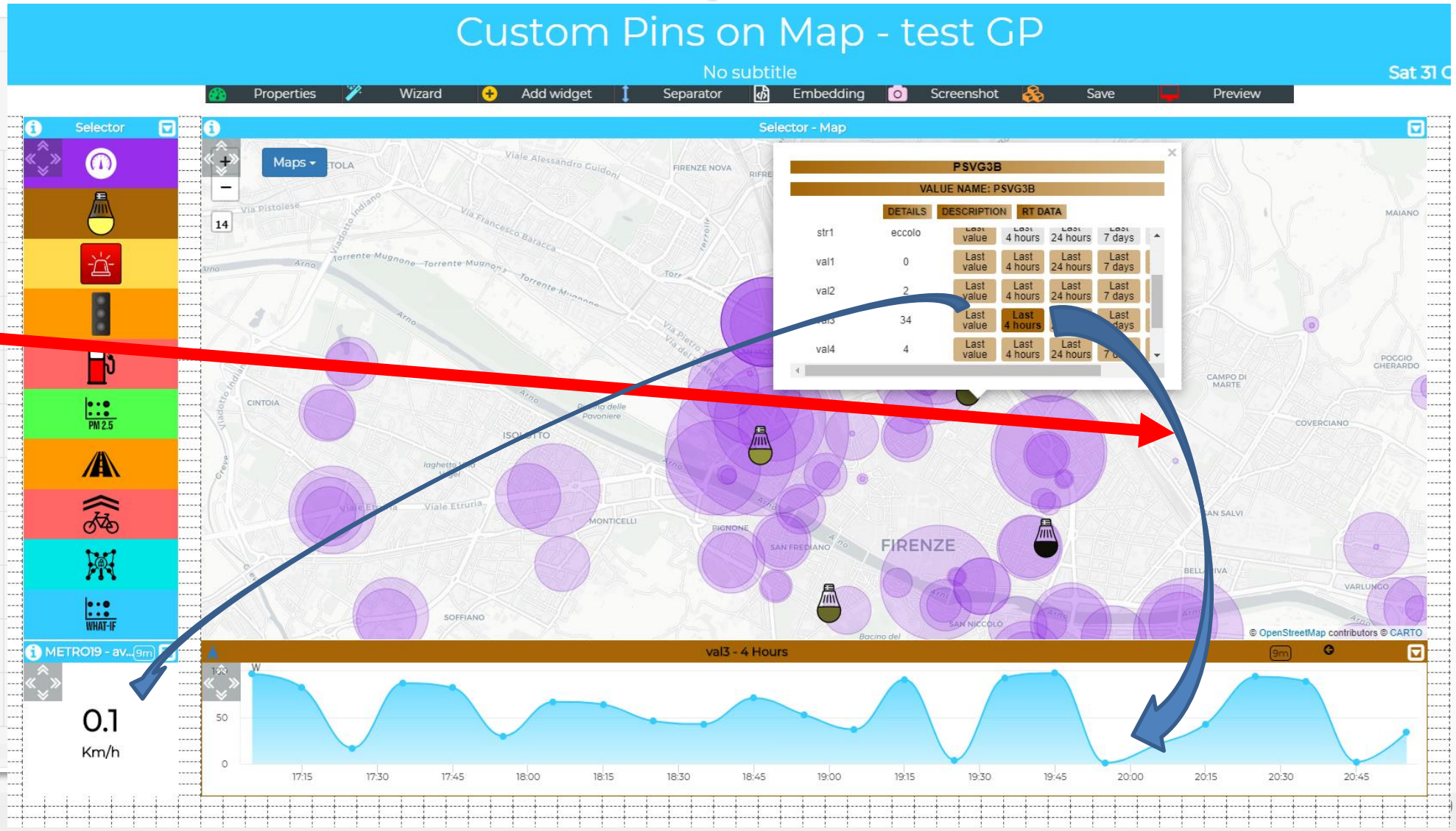

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mjk5MA==

# The Selector is the Map Controller

MoreOptions




- *Targeting the data to be shows on other data Widgets*



# Develop Dashboard
# Main Concepts

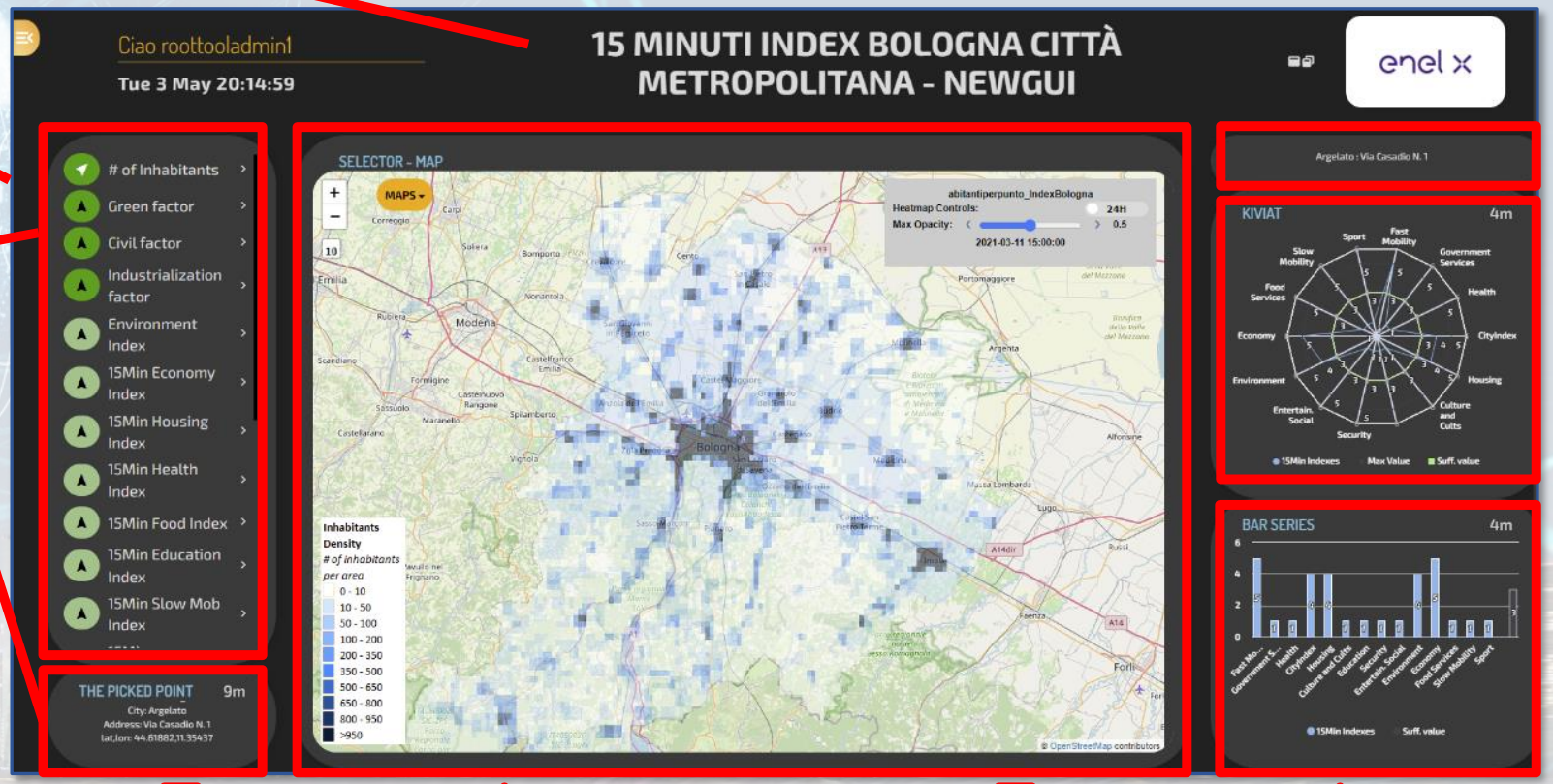


# Snap4City Dashboards main concepts

**Header**

**Dashboard**

**Interactive Widgets**




**Server Communication**

- **Real Time data requests/send**
- **Event Driven**
- **Server Side Business Logic**
  - **See Part 3 of the course**

**Inter Widget Communication:**

**Client Side Business Logic**

**See part 8 of the Course**

# A Dashboard Design Schema is provided

In the following section, the schema that should be adopted to design each single Dashboard/view of the solution.

### IV.B.7. Example of Dashboard Schema

**For each Dashboard or View we suggest to specify:**

| | |
|---|---|
| **Name** | Vehicle dashboard |
| |  |
| **Aim** | Display vehicle information and measured values |
| **Purpose** | Monitoring |
| **Status** | Draft |
| **Missing** | None |
| **Preferred size** | PC |
| **Style** | PA |
| **Chat enabled** | No |
| **Kind** | Active |
| **Data vs Widget** | **Map Widget**<br>• Description: map showing the vehicle position over time<br>• Kind: monitoring only<br>• Preferred Data representation: map<br>• Data: Vehicle.latitude, Vehicle.longitude<br><br>**DataTable Widget**<br>• Description: table reporting the vehicle events<br>• Kind: monitoring only<br>• Preferred Data representation: table<br>• Data: VehicleEvent.eventID, VechicleEvent.dateObserved, VehicleEvent.status, VehicleEvent.kind<br><br>**SingleContent Widget**<br>• Description: single content showing the total km travelled by the vehicle<br>• Kind: IoT App<br>• Preferred Data representation: single number<br>• Data: Vehicle.kmTotal<br><br>**Synoptic Widget**<br>• Description: battery shaped synoptic to represent the available energy percentage<br>• Kind: monitoring only |



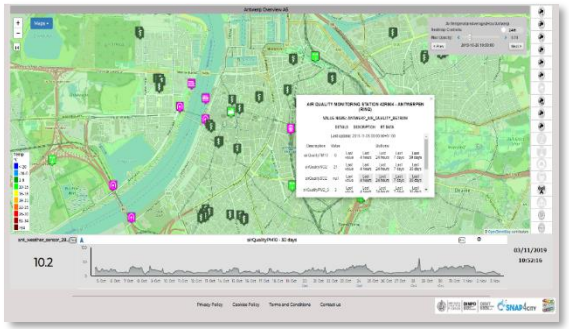
| | |
|---|---|
| | • Preferred Data representation: animated synoptic<br>• Data: Vehicle.energyLevel<br><br>**Time series Widget**<br>• Description: to plot the evolution of the velocity and acceleration values over time<br>• Kind: SC Business Logic<br>• Preferred Data representation: time series plot<br>• Data: Vehicle.velocity, Vehicle.acceleration |
| **Client Side Business Logic** | • **To be developed in JavaScript into the Dashboard Widget**<br>• Event driven: ..... |
| **Server Side Business Logic** | • **To be developed in IoT App with S4C Dashboard Nodes**<br>• IoT Application →<br>  ○ Event driven: .....<br>• IoT Application →<br>  ○ Event driven: ..... |

As can be seen in the example dashboard schema above, several information must be specified:

- Name: name or ID of the dashboard
- Mockup: a graphical example showing the overall appearance of the dashboard. This can be realized using some graphic painting tool (a screenshot of an empty dashboard can be used as background element)
- Aim: a description of the dashboard
- Purpose: it can be monitoring, simulation, what-if, data entry, etc. Multiple values are possible.
- Status: it can be draft, developed, finalized, accepted
- Missing: in this field list all missing element that should be included in future
- Preferred Size: specify the preferred viewing size of the dashboard, such as PC, HD, mobile, or an explicit resolution size (row x column)
- Style: the base style to be used for the dashboard. Available styles include Gea, Ballon, PA, Ballon Dark, etc.
- Chat enabled: yes or no
- Kind: passive or active. A passive dashboard show data taken from storage only, without sending actions toward an IoT App; however, passive dashboards may have selectors, maps, etc., and a lot of interactive visualization that do not requires neither changes in the status on server, nor sending commands to the server side. Differently, active dashboards, are those that send or receive commands to/from the server side, via some client-side Business Logic, server side Business Logic on IoT Apps, or both
- Data vs Widget: for each widget required in the dashboard, some information must be specified according to the following schema:
  - Name: the name of the widget to be used
  - Description: a brief description of the widget and its use
  - Kind: monitoring, IoT App, or Client-Side business logic (note that, the last two entries characterize an active dashboard)
  - Data: the data the be used in the widget, typically retrieved from some IoT device. Multiple entries can be accepted.
- Client Side business logic: to be specified if present
  - Description of the effects: a description of the implemented client-side business logic effects
- Server Side business logic: to be specified if present
  - IoT App: description of the involved IoT App
  - Event driven: indicate to which events the IoT App responds

# Dashboard Kind

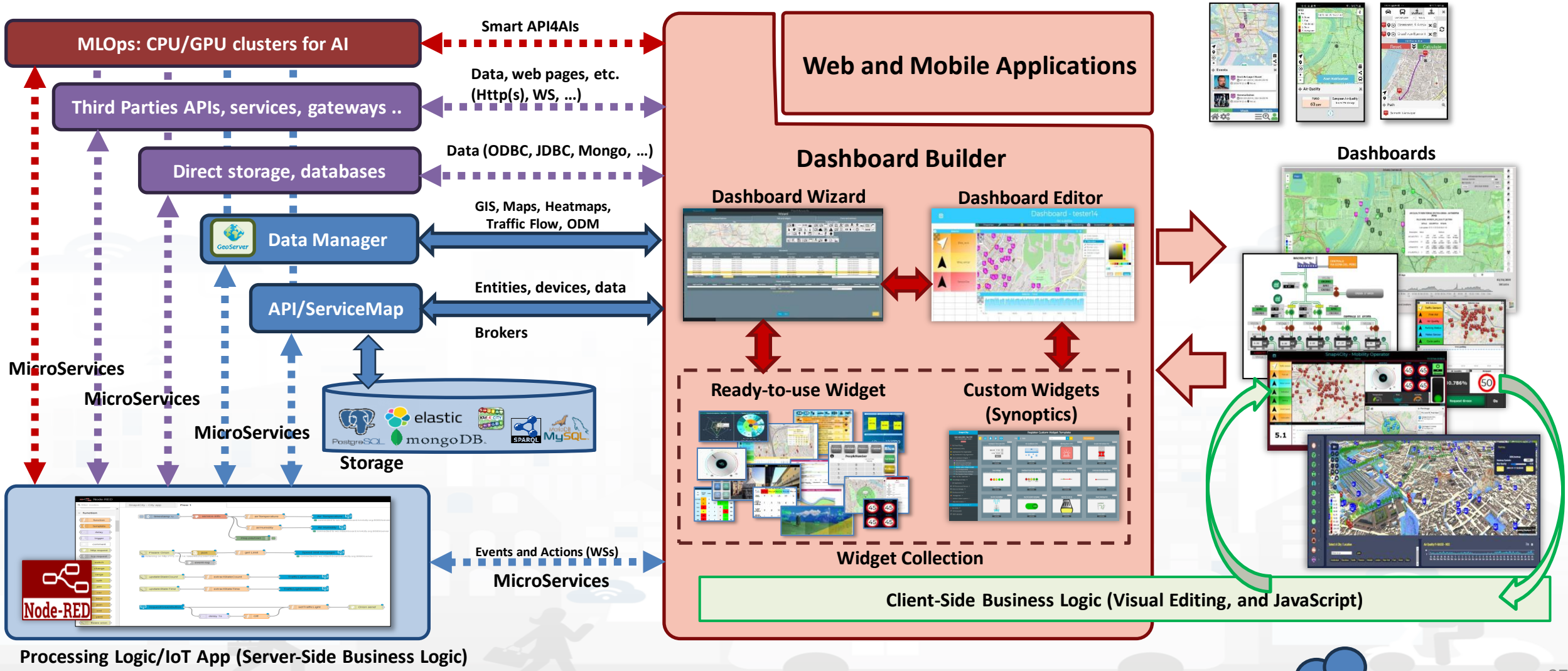
- **Passive Dashboards**: showing data taken from Storage only, no actions toward IoT App
  - Passive dashboards may have Selectors, maps, etc., and a lot of visualization without changing the status on Server, no sending commands to the Server Side.



- **Custom Business Logic**
- **Active Dashboards, which can be those sending or receiving commands to/from the logic coded somehow and in particular for**
  - **Server Side Business Logic** → logic on IoT Apps with Snap4City Dashboard Nodes, which is easier to be programmed begin based on Node-RED visual programming.
  - **Client Side Business Logic** → logic on JavaScript on specific Dashboard Widgets only for skilled developers of Snap4City Platform. We suggest first prototype by using Server Side Business Logic, then pass to Client Side Business Logic in JavaScript.
  - Both kind of Business Logics may be active on the same Active Dashboard.



# How the Dashboards / Apps Exchange data (2024/8)



# Dashboard Widgets' Capabilities for Business Logics

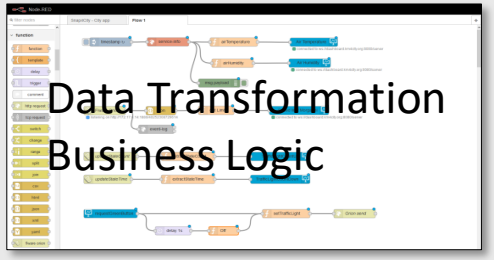
| Widget name / description | Event Driven | Some Local Interaction | Server-Side Business Logic Node-RED | Client-Side Business Logic (IN = JavaScript) |
|---|---|---|---|---|
| Single Content | Yes | -- | OUT | OUT |
| Speedometer | Yes | -- | OUT | OUT |
| Gauge | Yes | -- | OUT | OUT |
| MultiSeries, Time Series, Curved Line, time compare | Yes | Yes | OUT | IN/OUT |
| Time Trend, Time Series | Yes | Yes | OUT | IN/OUT |
| Spidernet, Radar | Yes | Yes | OUT | IN/OUT |
| BarSeries | Yes | Yes | OUT | IN/OUT |
| Donut, Pie | Yes | Yes | OUT | IN/OUT |
| Device Table | Yes | Yes | IN/OUT | IN/OUT |
| Multi Data Map (dashboard Map) | Yes | Yes | IN/OUT | IN/OUT |
| Selector | Yes | Yes | -- | -- |
| Button, Impulse button | Yes | Yes | IN | IN |
| Switch, on/off but. | Yes | Yes | IN/OUT | IN/OUT |
| Knob, Dimer | Yes | Yes | IN/OUT | IN/OUT |
| Keypad, Num Pad | Yes | Yes | IN | IN |
| External Content | Yes | Yes | IN/OUT | IN/OUT |
| Event Driven MyKPI | Yes | -- | IN | -- |
| Synoptics (see External Content) (read, write, subscribe) | Yes | Yes | IN/OUT | -- |
| Dashboard Form | Yes | Yes | IN/OUT | Possible on Ext.Content |
| Speak Synthesis | Yes | -- | OUT | Possible on Ext.Content |
| D3 charts | Yes | Yes | OUT | -- |

See for this column CSBL PDF

# Develop: via Dashboard Wizard



# Dashboard Builder: Development




IOT Applications



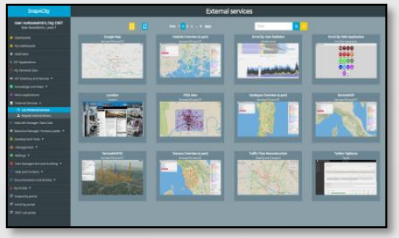

Knowledge and Storage
Data from the Field and
City + MyKPI ++

Widget Collection





Micro
Applicat
ions

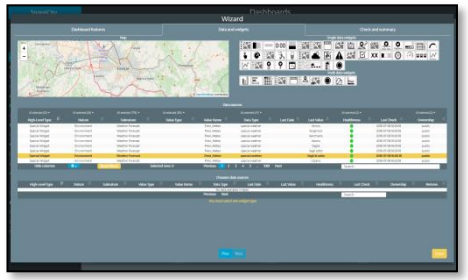


External
Services



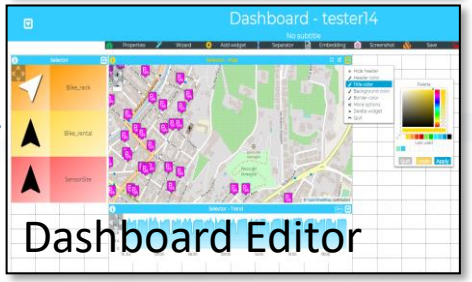
Custom
Widgets/
Synoptics

Dashboard Wizard



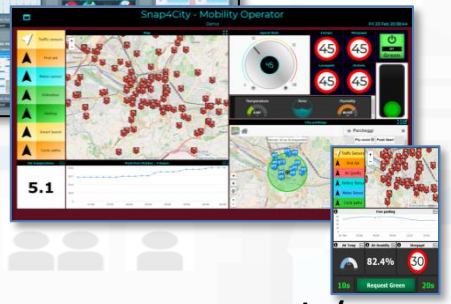
Create, save, load,
delegate, grant access,
change ownerhip






Dashboard Editor





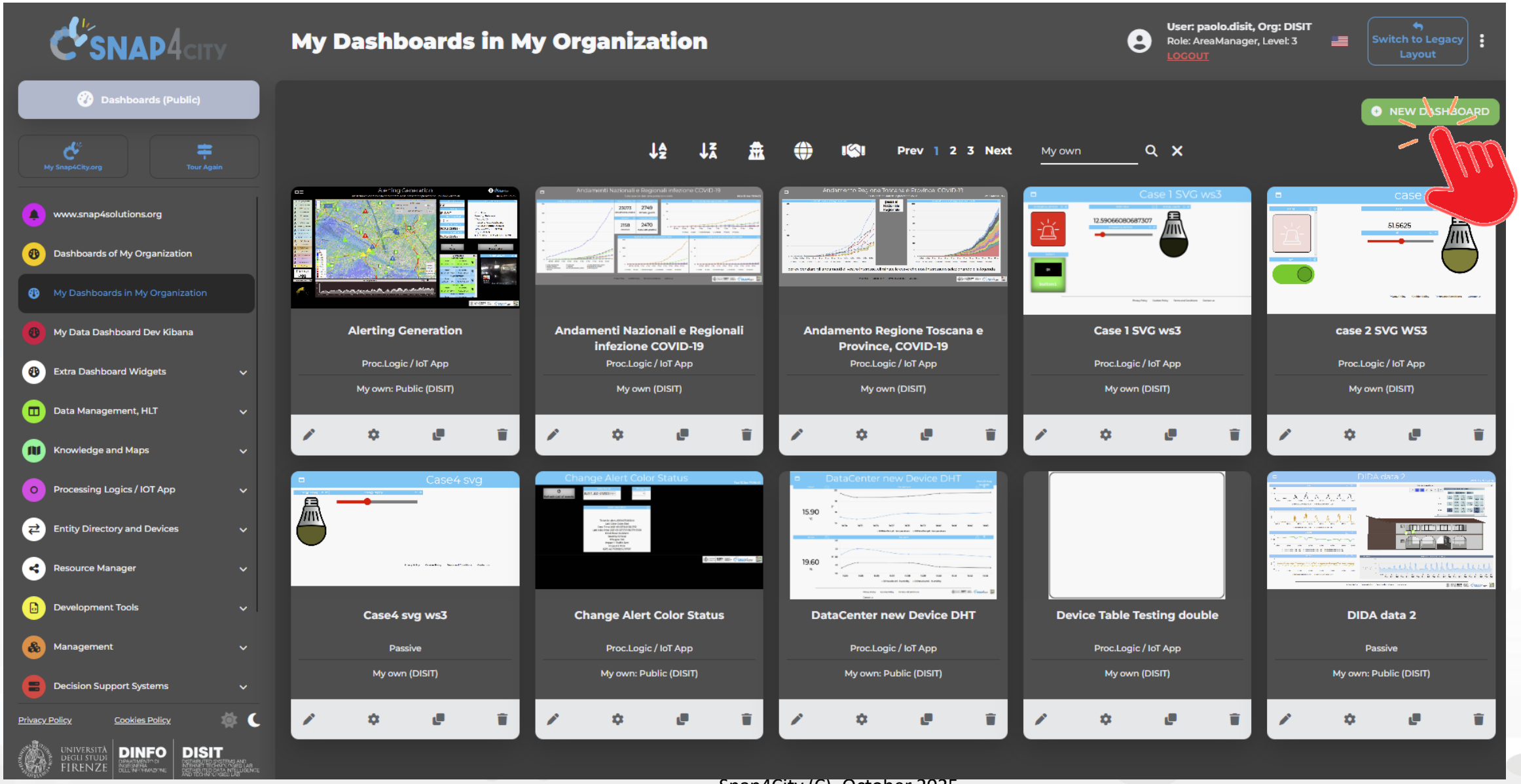

Public
Dashboard
Collection

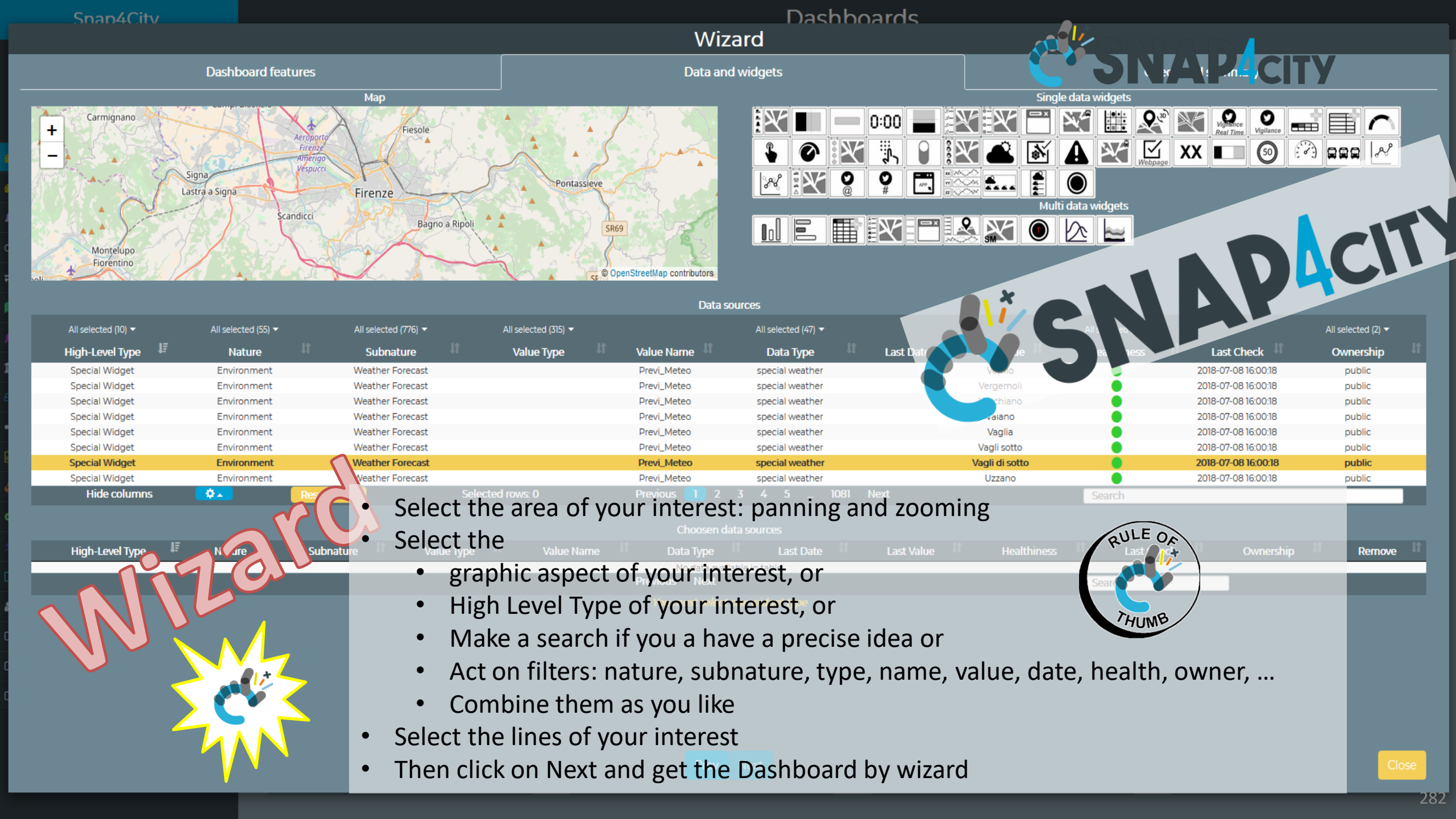
My Own Dash/App



# New Dash ?

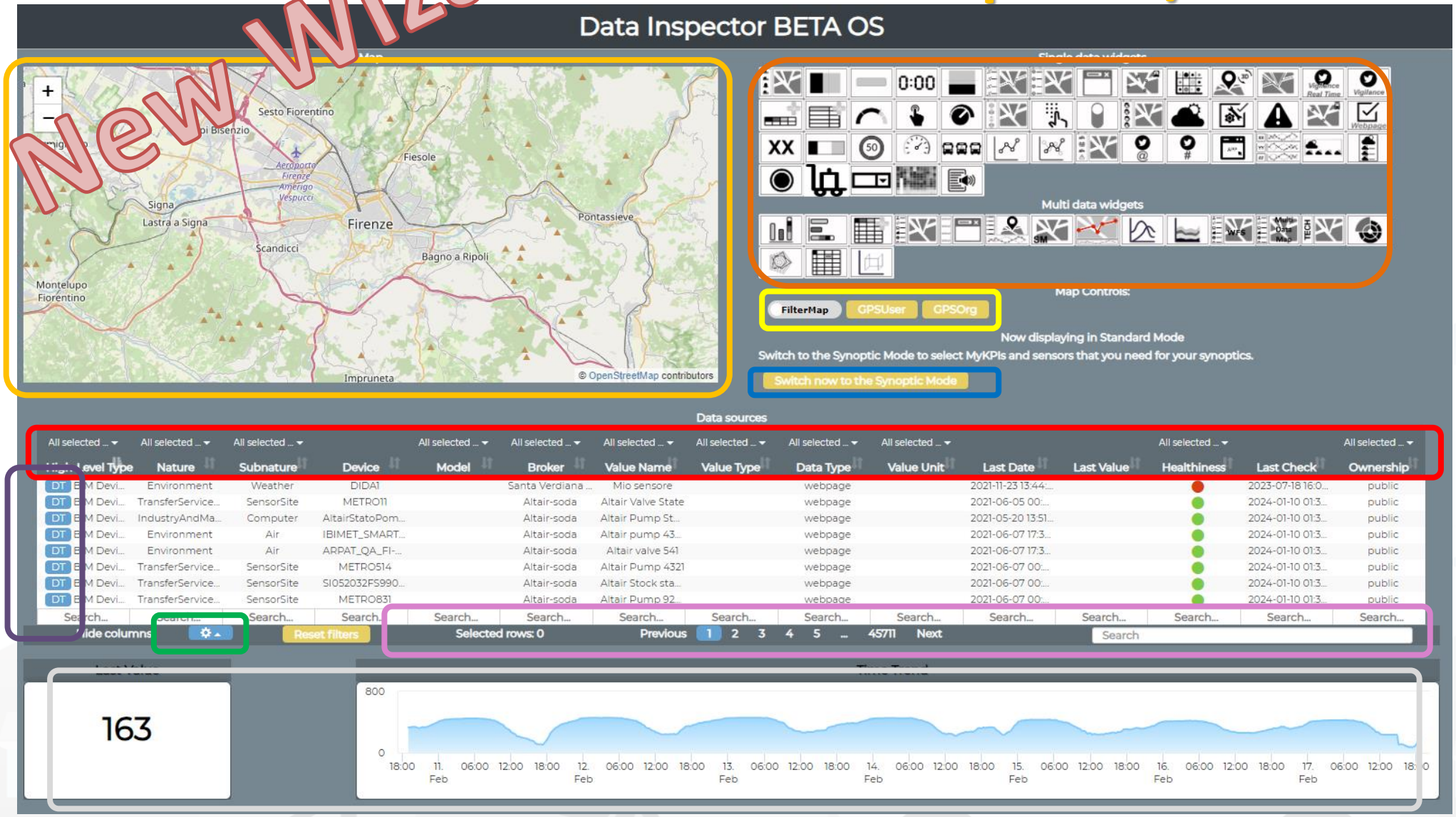



SNAP4CITY
My Dashboards in My Organization
User: paolo.disit, Org: DISIT
Role: AreaManager, Level: 3
LOGOUT
Switch to Legacy Layout
NEW DASHBOARD
Dashboards (Public)
My Snap4City.org
Tour Again
www.snap4solutions.org
Dashboards of My Organization
My Dashboards in My Organization
My Data Dashboard Dev 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
Privacy Policy
Cookies Policy
Prev 1 2 3 Next
My own
Alerting Generation
Proc.Logic / IoT App
My own: Public (DISIT)
Andamenti Nazionali e Regionali infezione COVID-19
Proc.Logic / IoT App
My own (DISIT)
Andamento Regione Toscana e Province, COVID-19
Proc.Logic / IoT App
My own (DISIT)
Case 1 SVG ws3
Proc.Logic / IoT App
My own (DISIT)
case 2 SVG WS3
Proc.Logic / IoT App
My own (DISIT)
Case4 svg ws3
Passive
My own (DISIT)
Change Alert Color Status
Proc.Logic / IoT App
My own: Public (DISIT)
DataCenter new Device DHT
Proc.Logic / IoT App
My own: Public (DISIT)
Device Table Testing double
Proc.Logic / IoT App
My own (DISIT)
DIDA data 2
Passive
My own: Public (DISIT)




- Select the area of your interest: panning and zooming
- Select the
  - graphic aspect of your interest, or
  - High Level Type of your interest, or
  - Make a search if you a have a precise idea or
  - Act on filters: nature, subnature, type, name, value, date, health, owner, …
  - Combine them as you like
- Select the lines of your interest
- Then click on Next and get the Dashboard by wizard

# New Data Inspector/Wizard




Filtering/Searching for individual fields (even for some fields not displayed as geographic coordinates)

Geographic Filtering

**Text Search on all fields**

Menu for choosing the fields to display in the table

View on Map(via PREVIEW)

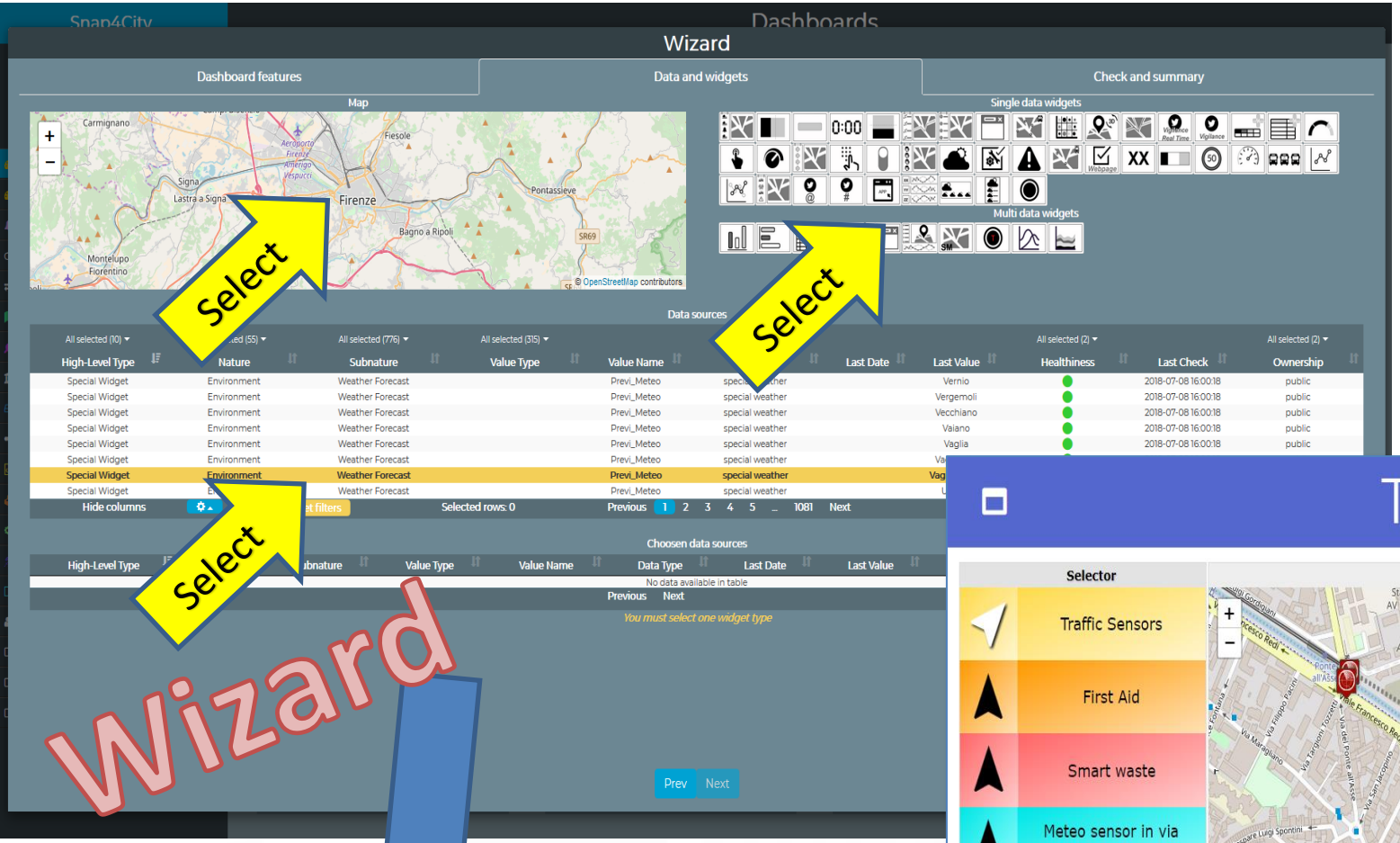
Data and Trend visualization

Opening Digital Twin

Pass to Synoptic mode

Select the graph representation

# Dashboard Wizard







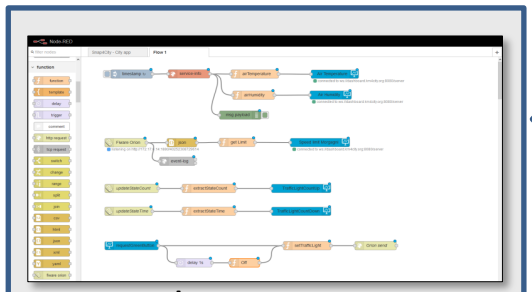
The Wizard help you in selecting only possible combination of data vs graphic representation

# Develop:
# Dashboard Synoptics

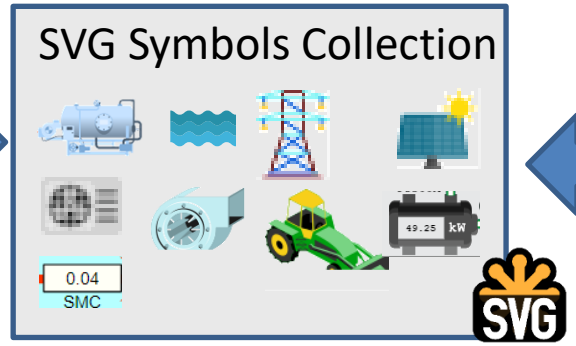


# Part 3

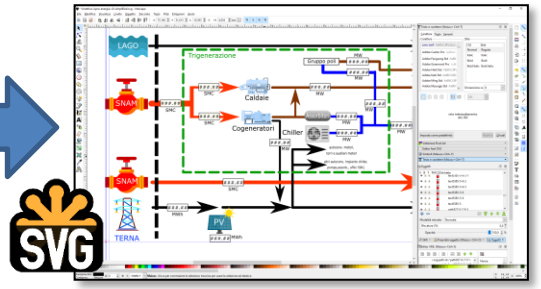
# Custom Widget / Synoptic / PIN Development



IOT Applications



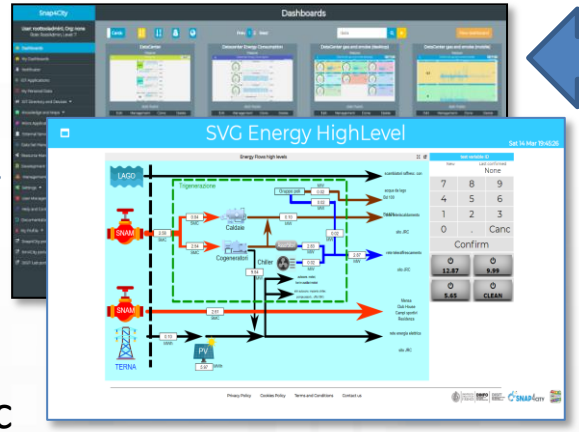

Inkscape editor on your computer




Create, save a Custom Widget in SVG



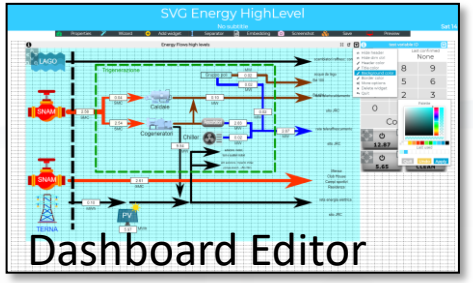

Knowledge and Storage Data from the Field and City




Public Dashboard Collection

My Own Dash/App





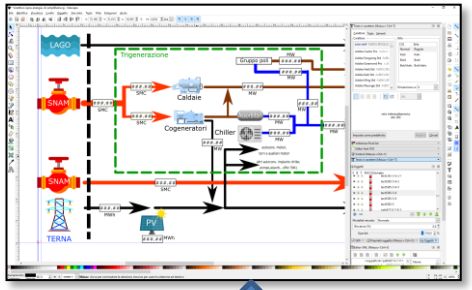



Create, save, load, delegate, grant access

1. Create and Load a Custom SVG
2. Select/Reuse an SVG
3. Make and Instance of Synoptic by Associate Variables with MyKPI
4. Create on Dashboard a Widget based on Synoptic HLT such as Ext. Srv.:
   - https://www.snap4city.org/synoptic/v2/synoptic.html?id=xxxx

**CW with a single READ Variable are automatically usable as PINS**

**Create**, save a Custom Widget in SVG

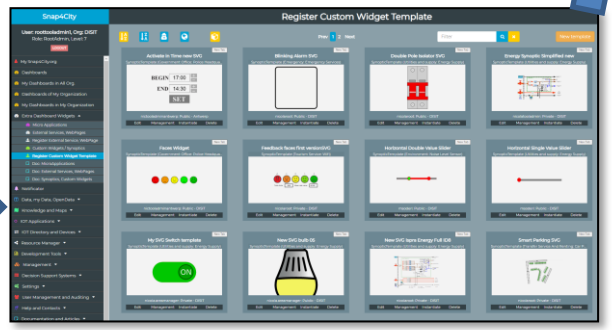


SVG Symbols Collection

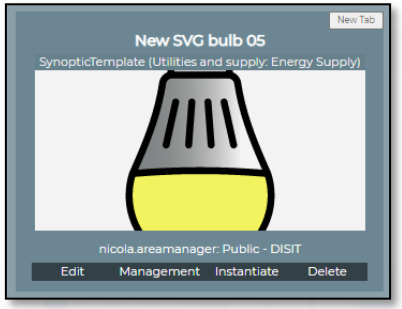


From any open library

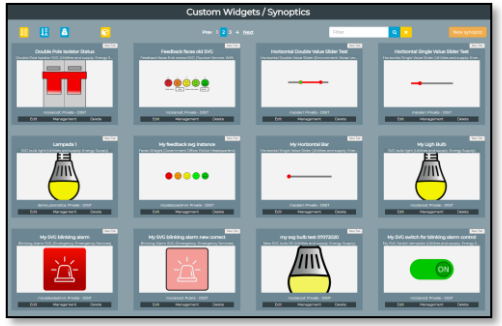
**Upload** as Custom Widget Template



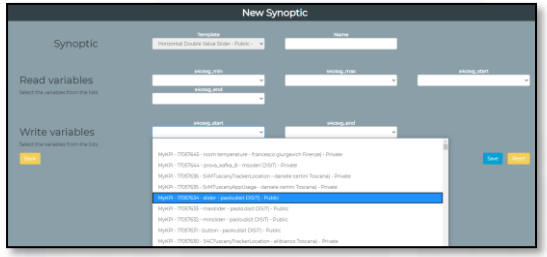

select



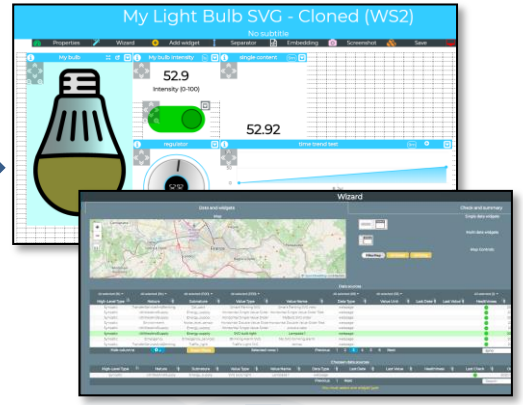

List of Custom Widgets / Synoptics

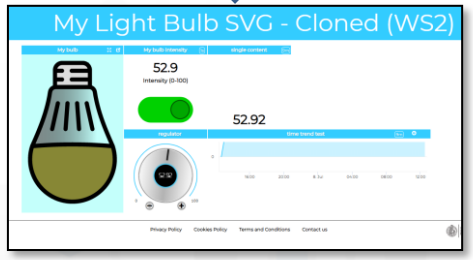



**Instantiate** as Custom Widgets / Synoptics Connect with WebSockets



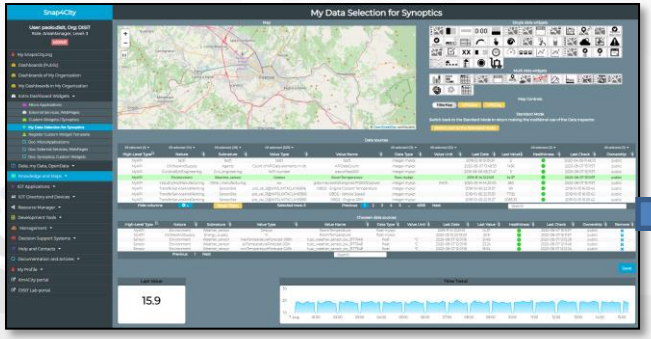

**Dashboard Editing/wizard**




Final Dashboard

Select MyKPI and Sensor Data for Synoptics cases

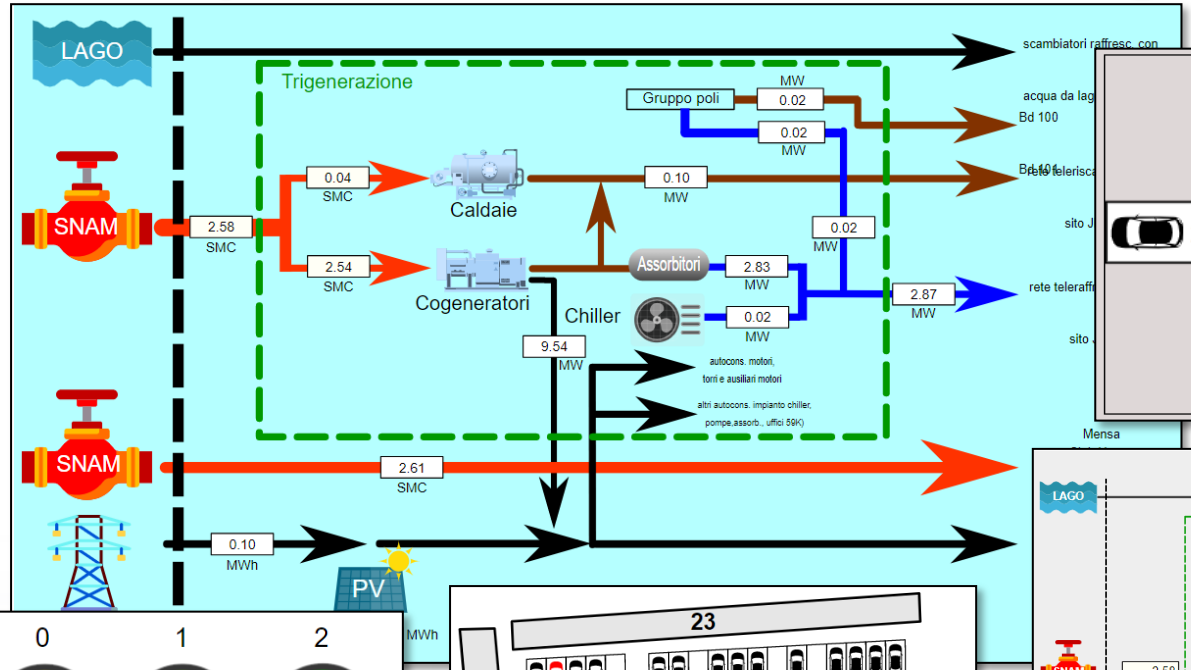


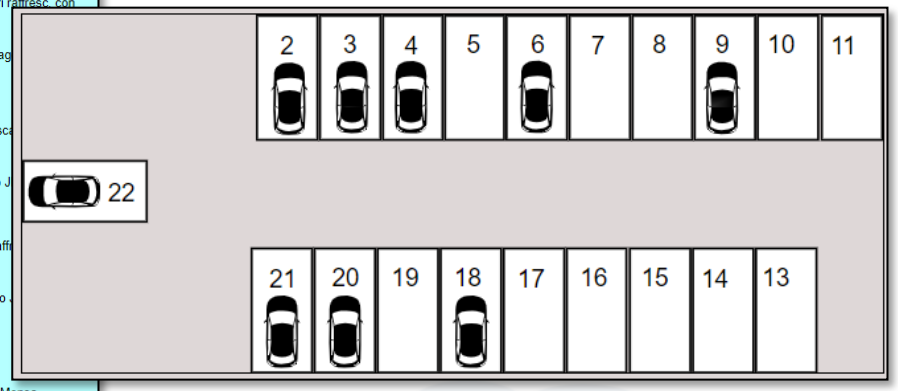

# Part 3

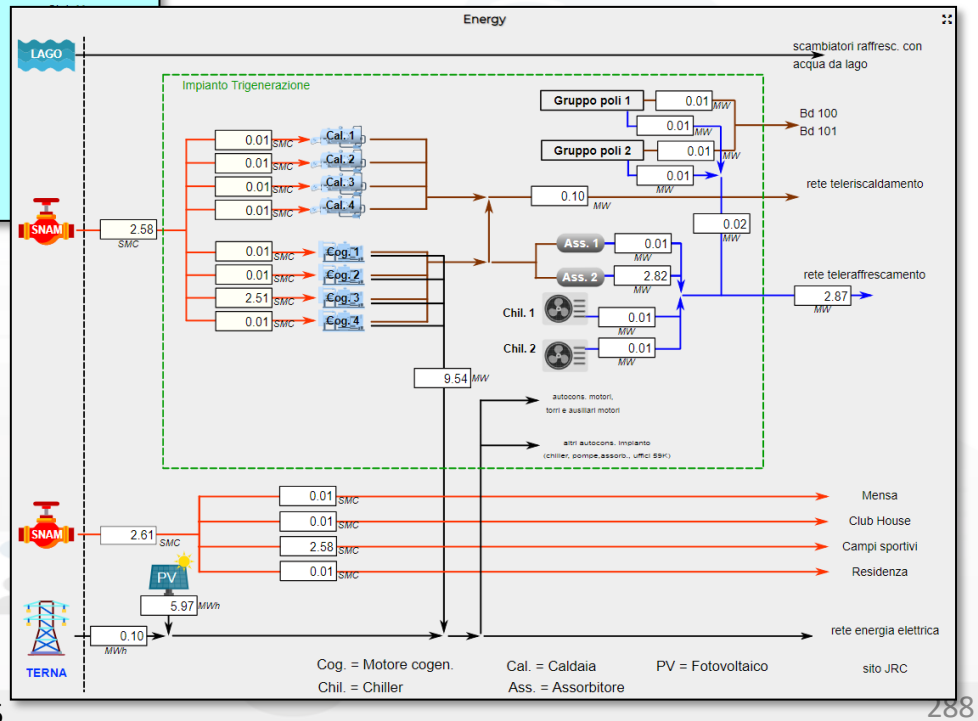
# Part 3
# Special Custom Widgets

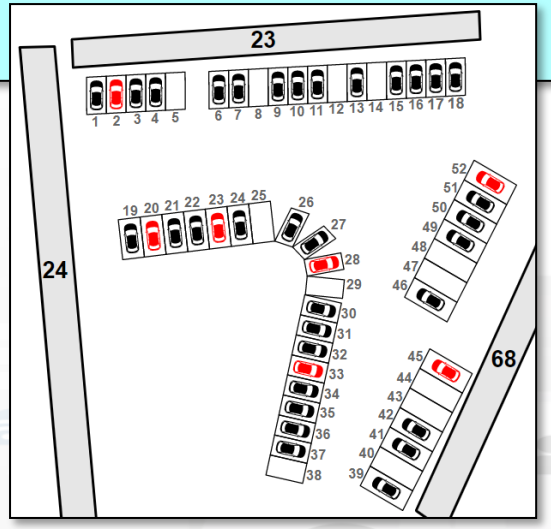


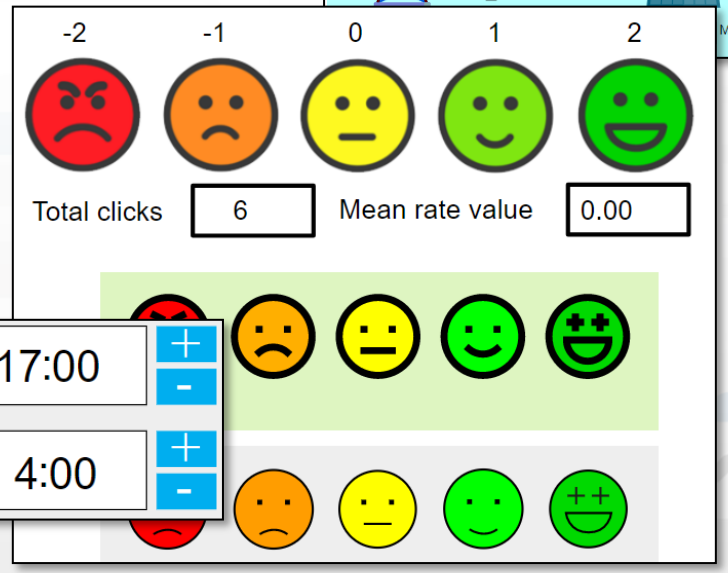
- Smart parking
- Smart Energy
- Smart Light
- Smart ….
- Energy View
- Custom Controls



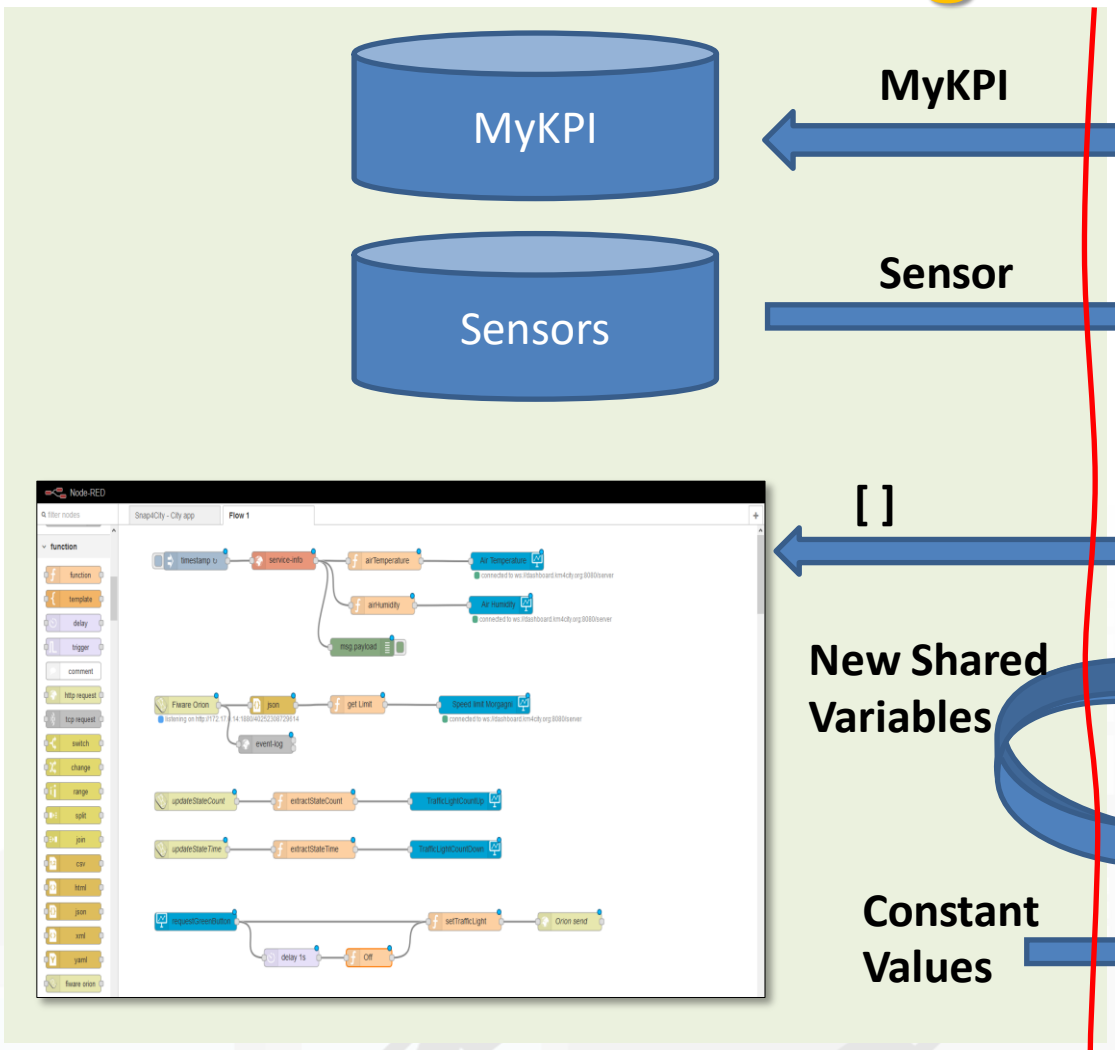



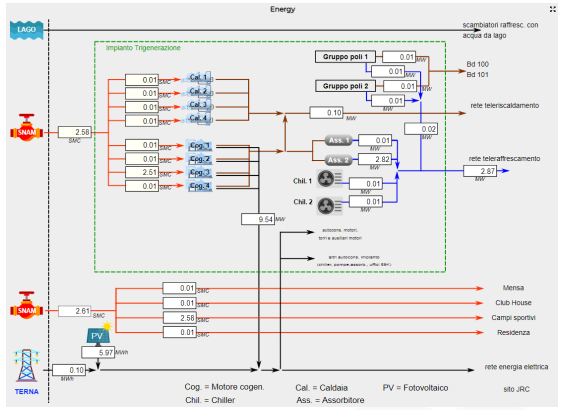



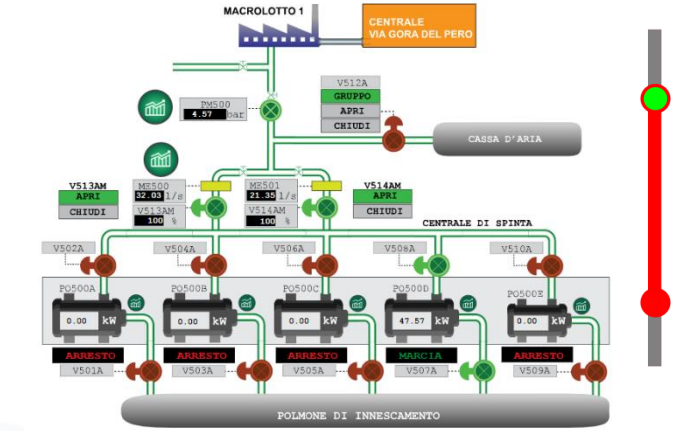



# Part 3

# From-To Custom Widgets / Synoptics to Storage in WS

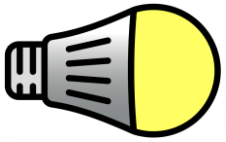


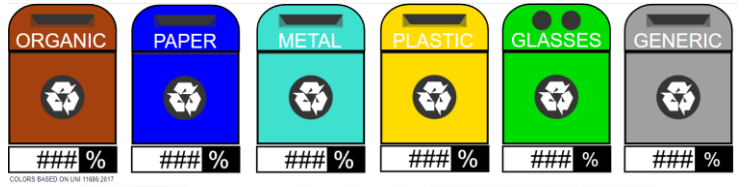



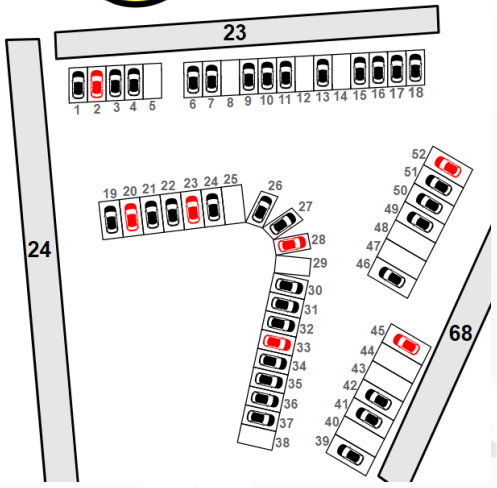






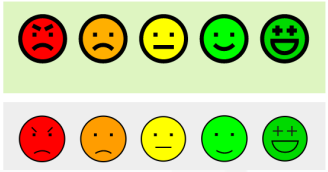


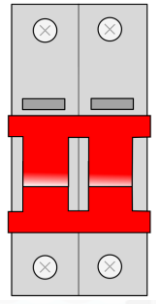



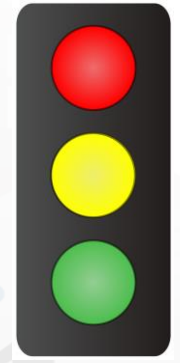









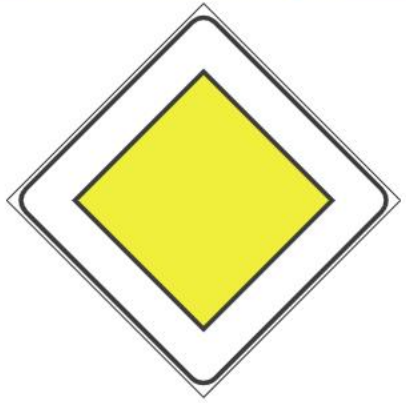




# SVG Custom Widgets Examples

Sat 16 Jan 01:07:39

**Precedence Italians Road signals**



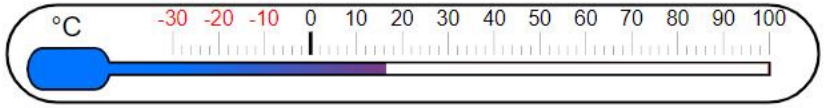
Select a code from 0 to 11 to change the road sign

| New | | Last confirmed: None |
|---|---|---|
| 7 | 8 | 9 |
| 4 | 5 | 6 |
| 1 | 2 | 3 |
| 0 | . | Canc |
| Confirm | | |

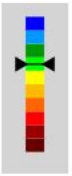
**s... | Smart Light Luminosity**



**Air Temperature in Florence**




**PM10 level - Bologna**



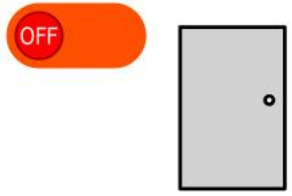
**fan | Fan velocity**






Symbols Legenda

**open/... | M...**




**Dynamic Prohibition...**

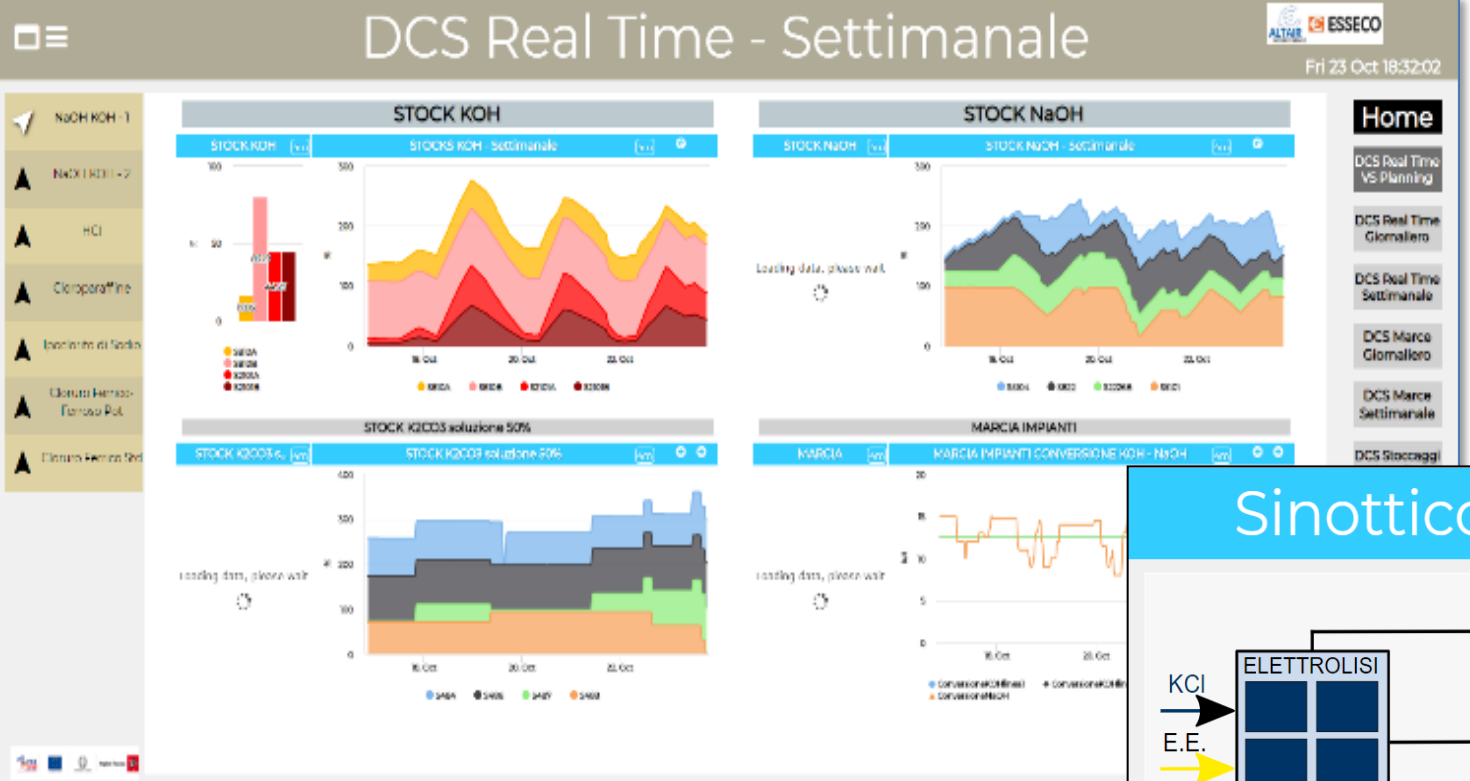


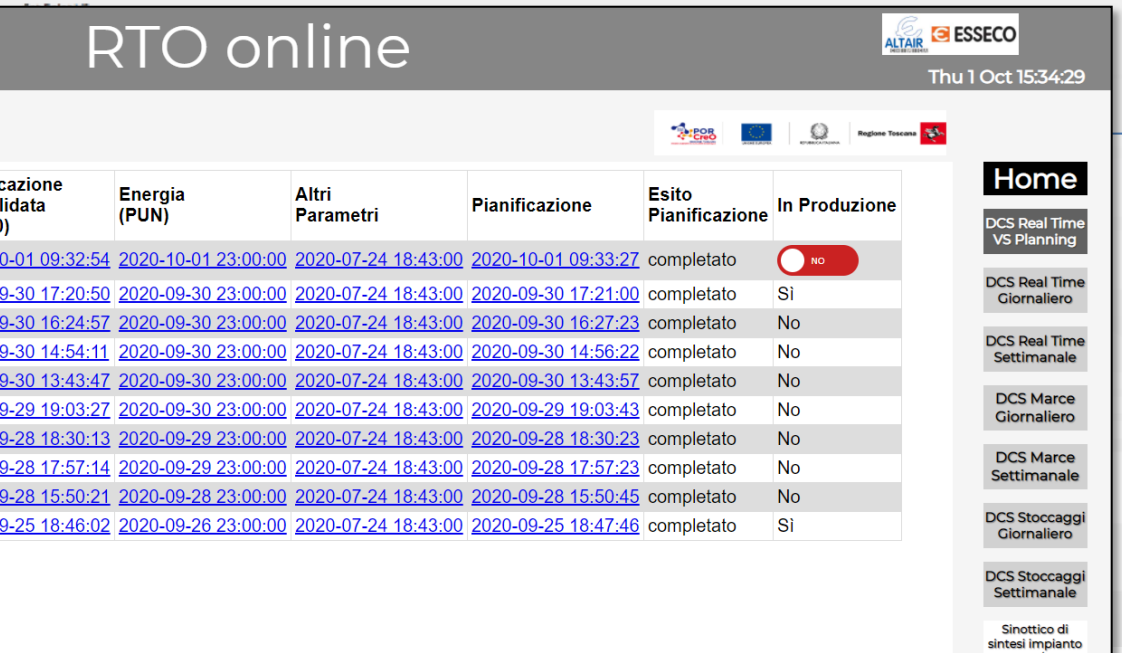
**Prohibition Traffic Signs Co...**

| New | | Last confirmed: None |
|---|---|---|
| 7 | 8 | 9 |
| 4 | 5 | 6 |
| 1 | 2 | 3 |
| 0 | . | Canc |
| Confirm | | |

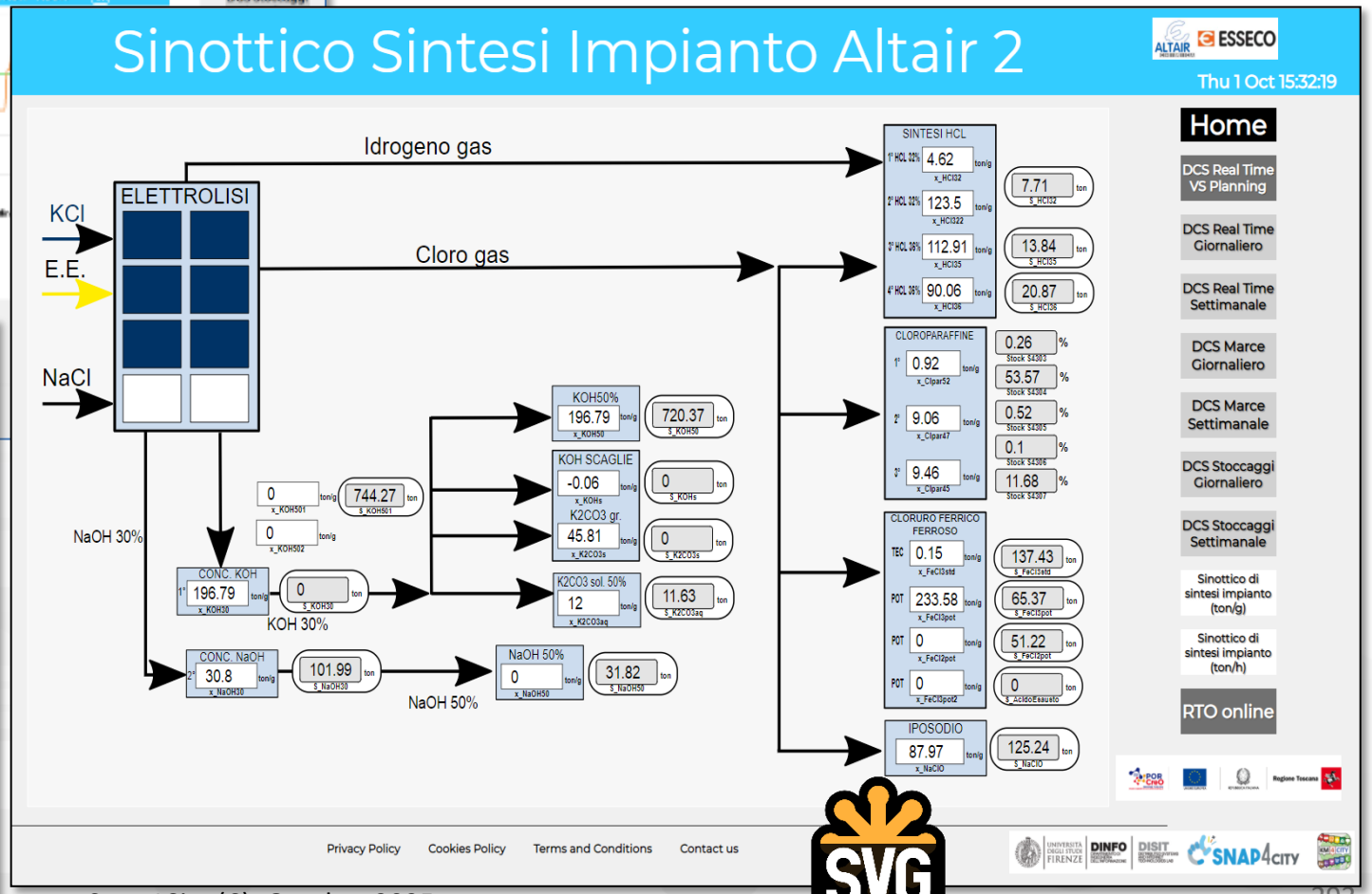



Prohibition Traffic Signs Legenda




| cazione lidata ) | Energia (PUN) | Altri Parametri | Pianificazione | Esito Pianificazione | In Produzione |
|---|---|---|---|---|---|
| 0-01 09:32:54 | 2020-10-01 23:00:00 | 2020-07-24 18:43:00 | 2020-10-01 09:33:27 | completato | NO |
| 9-30 17:20:50 | 2020-09-30 23:00:00 | 2020-07-24 18:43:00 | 2020-09-30 17:21:00 | completato | Sì |
| 9-30 16:24:57 | 2020-09-30 23:00:00 | 2020-07-24 18:43:00 | 2020-09-30 16:27:23 | completato | No |
| 9-30 14:54:11 | 2020-09-30 23:00:00 | 2020-07-24 18:43:00 | 2020-09-30 14:56:22 | completato | No |
| 9-30 13:43:47 | 2020-09-30 23:00:00 | 2020-07-24 18:43:00 | 2020-09-30 13:43:57 | completato | No |
| 9-29 19:03:27 | 2020-09-30 23:00:00 | 2020-07-24 18:43:00 | 2020-09-29 19:03:43 | completato | No |
| 9-28 18:30:13 | 2020-09-29 23:00:00 | 2020-07-24 18:43:00 | 2020-09-28 18:30:23 | completato | No |
| 9-28 17:57:14 | 2020-09-29 23:00:00 | 2020-07-24 18:43:00 | 2020-09-28 17:57:23 | completato | No |
| 9-28 15:50:21 | 2020-09-28 23:00:00 | 2020-07-24 18:43:00 | 2020-09-28 15:50:45 | completato | No |
| 9-25 18:46:02 | 2020-09-26 23:00:00 | 2020-07-24 18:43:00 | 2020-09-25 18:47:46 | completato | Sì |



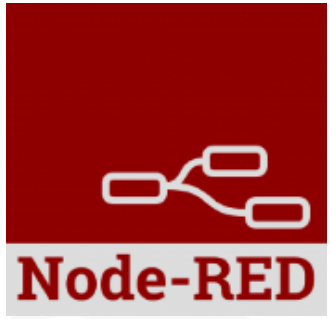
# Develop: Dashboards with Server-Side Business Logic, Part 3



# IoT App / Proc.Logic

- Storage → IoT App / Proc.Logic
- External Service ←→ IoT App / Proc.Logic
- Dashboards ←→ IoT App / Proc.Logic

Part 3




- Data Analytics ←→ IoT App / Proc.Logic
- Broker → Storage
- IoT App / Proc.Logic → Broker
- Broker → IoT App / Proc.Logic
- IoT App / Proc.Logic → Storage

Part 4

Part 5

# Principles of Server Side Business Logic

- It is possible to have one Processing Logic (IoT App) referring to multiple Dashboards, and one Dashboard referring multiple Processing Logic (IoT Apps)
- Let see a 1:1 relationship from Proc.Logic and Dashboard
  - Any Action performed on Dashboard is provided to the Proc.Logic, which may produce reactions on Dashboard.
  - The context of Proc.Logic ←→Dashboard is a singleton, thus any user connected to the Dashboard will observe the evolutions performed. So that all the users will see the same story and view
  - This is good for control rooms, and single/few users prototypes

# How the Dashboards exchange data

API, External Services, MicroApp

Traffic Flow, MAPS, Heatmaps

GIS, HTTPs URLs

Brokers

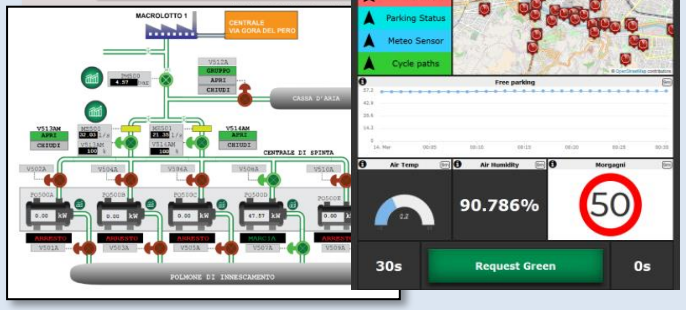
API ServiceMap

Req. ServiceURI, KPI

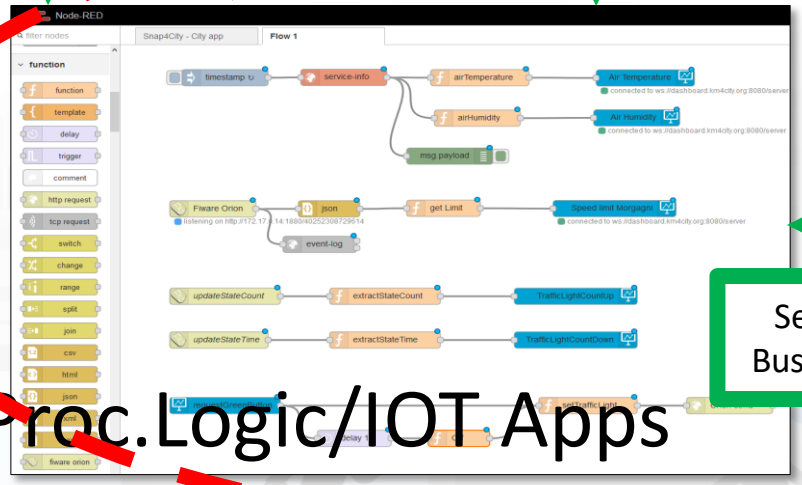
Storage and KB

Dashboards





Dynamic Data:
ServiceURI, MyKPI,
Events and Actions
Event Driven Synoptics



Server Side Business Logic

Client Side Business Logic in JavaScript (when needed)

Proc.Logic/IOT Apps

# Maps Server Side Business Logic vs IOT Apps

Any Snap4City data and sources: IoT Devices, Variables, Heatmaps, traffic, tools, KPI, etc.

data

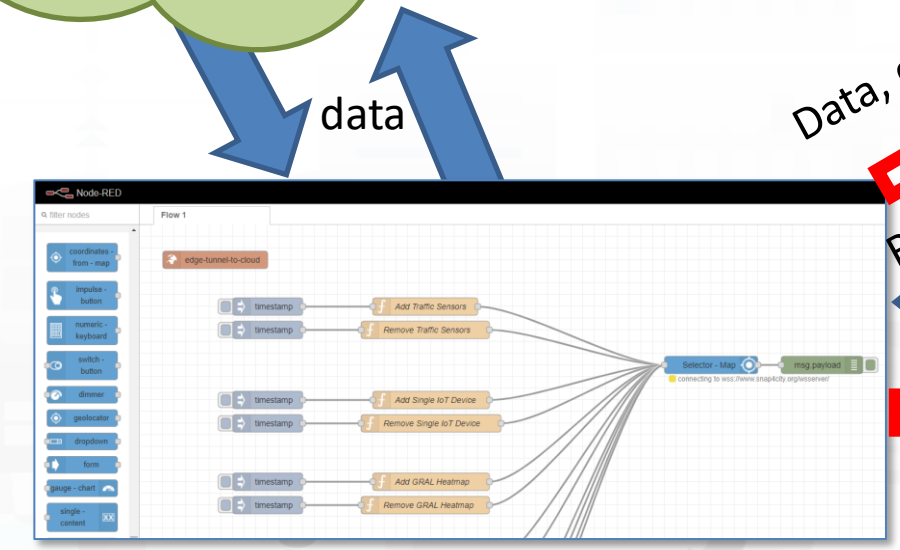
data

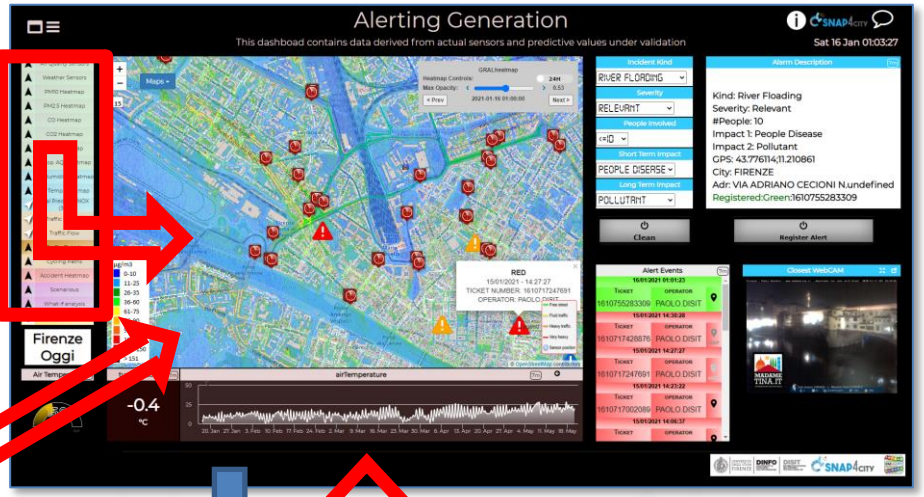
Selector

Data, changed data

References, commands, directives, selections

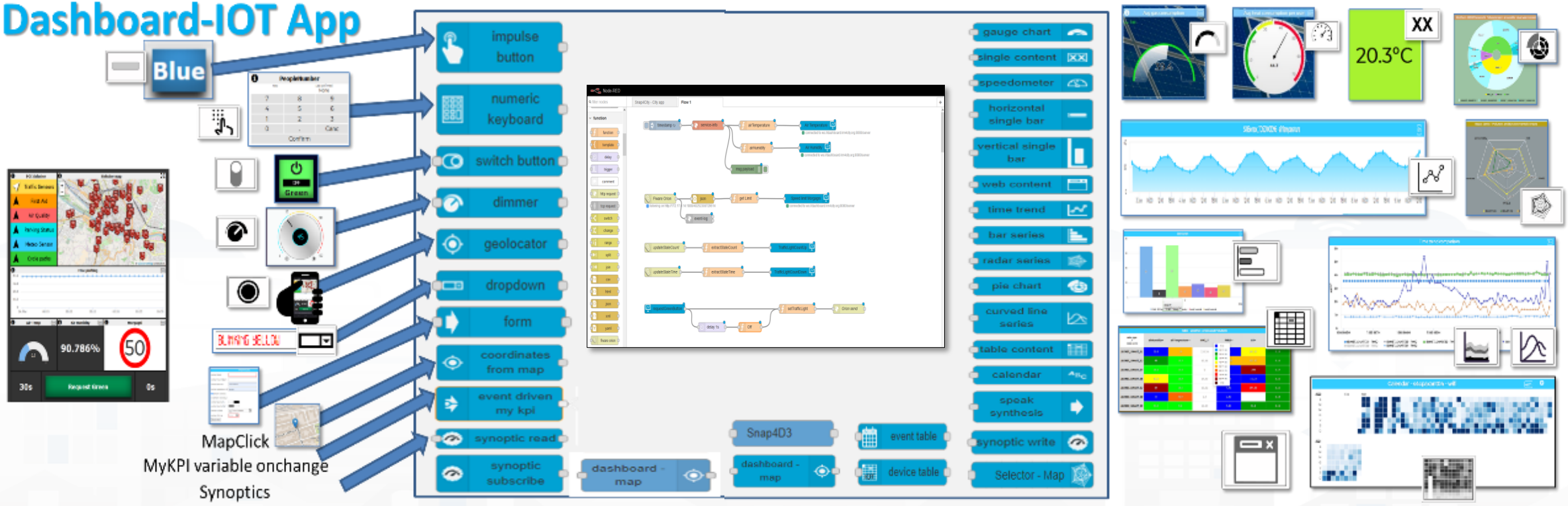
selections, positions, ServiceURI





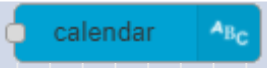
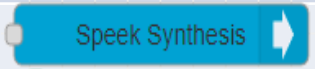

# Dashboard-IOT App



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

# Dynamic (6/23)

SNAP4CITY | Node-RED

| Widgets ICONS | Widget Name, Description | IOT App | Dashboard-IOT App | KPI (metric) | MyPersonalData | MyData | My KPI | Sensor |
|---|---|---|---|---|---|---|---|---|
| XX | Single Content   | X (cs) | X (ED) | X | X | X | X | X |
| 50 | Custom widgets in SVG are data driven | X (cs) | X (ED) | | | | X | X |
| | Speedometer, Gauge   | X (cs) | X (ED) | X | X | X | X | X |
| | Device Table   | X (cs) | X (ED) | | | | X | X |
| | Single Bar, V/H   | X | X (ED) | X | | | | |
| | Single and Multiple Bars, stacked or not, ordered   | X (cs) | X (ED) | X | X | X | X | X |
| | MultiSeries, shaded, staked and non staked, TTT   | X (cs) | X (ED) | X | X | X | X | X |
| | Time Trend (single)   | X | X (ED) | X | X | X | X | X |
| XX YY ZZ | Time Trend Compare | | | X | | | X | X |
| | SpiderNet, radar, Kiviat   | X (cs) | X (ED) | X | X | X | X | X |
| | Pie, Donut, 2 layers Donut   | X (cs) | X (ED) | X | X | X | X | X |
| | Table   | X (cs) | X (ED) | X | X | X | X | X |
| | Calendar   | X (cs) | X (ED) | | | | X | X |
| | Speak Synthesis   | X (cs) | X (ED) | | | | string | string |
| | Maps   | X (cs) | X (ED) | Many High Level Types | | | X | X |

DD: Event Driven

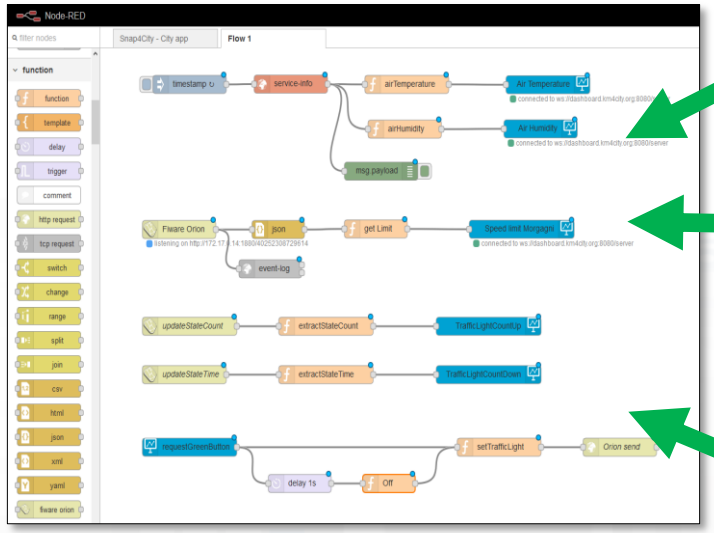
# Widgets and their counterpart Nodes

- **Send** information and commands to the Dashboard Widget, for example for an action produced by the users. (**in widget/node**)
- **Receive** information and commands from the Dashboard Widget, for example presenting a dashboard change to the users. (**out widget/node**).
- **Send/receive** information and commands to/from the Dashboard Widget, for example for collecting users' actions and presenting a change to the users on the same widget (**in/out widget/node**).

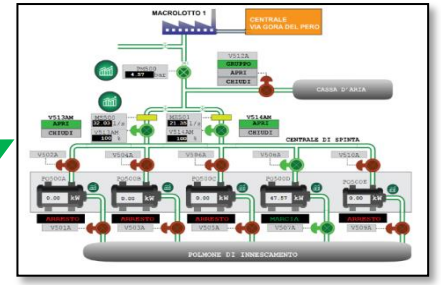
On Server-Side (into Proc.Logic) the developer can even create some HTML pages and provide them into a Dashboard Widget. And a mixt of Widgets in, out, in/out

# Advanced IOT Applications

- **Synoptics can ……**
  - **do all ☺**
- **Widgets can**
  - send/receive dynamic data,
  - change data sources, etc.
  - Provide interactive maps
- **HTML pages** can
  - be dynamically generated
  - provide forms to produce data for IOT Applications
  - Collect files on web and system
  - produce files on web ad system
  - have CSS and AJAX control



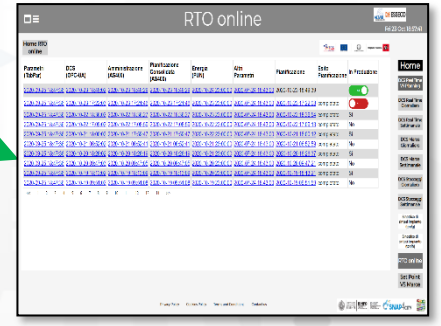

Synoptics
Custom
Widgets




Widgets
Maps
Buttons
Keypads
Controls
..




HTML pages
HTML Forms
Tables
..

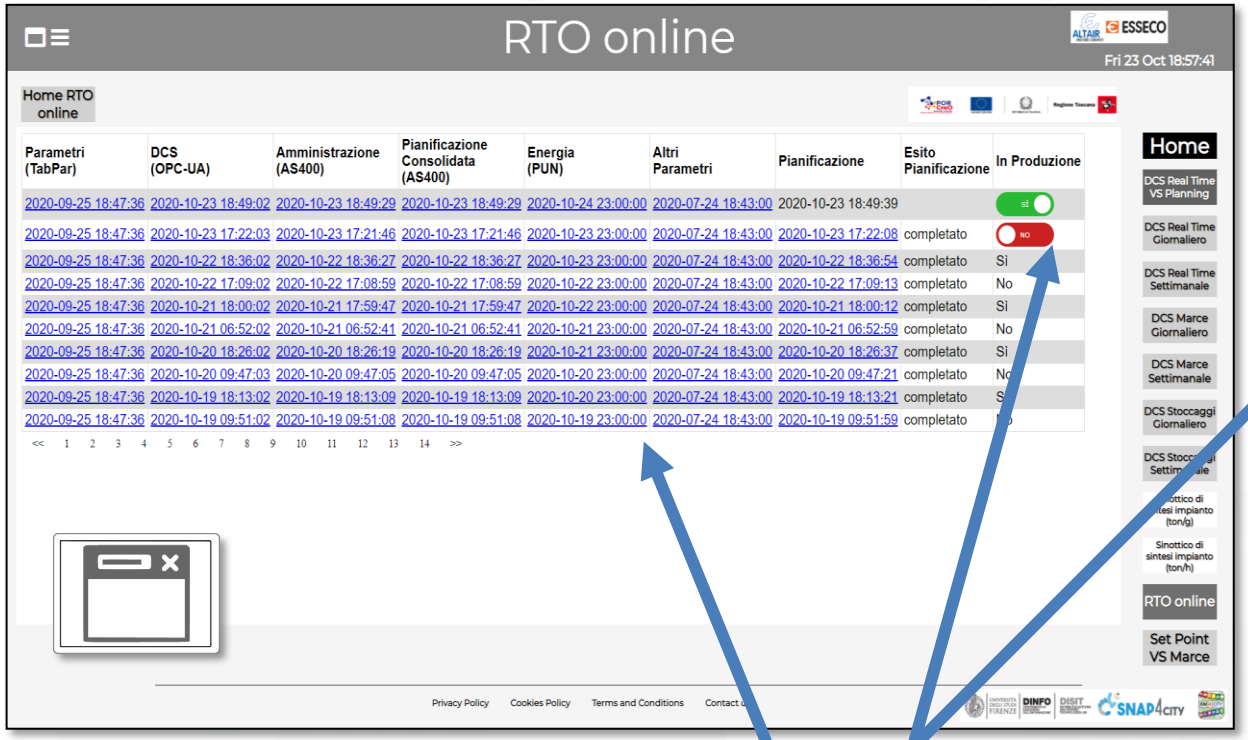


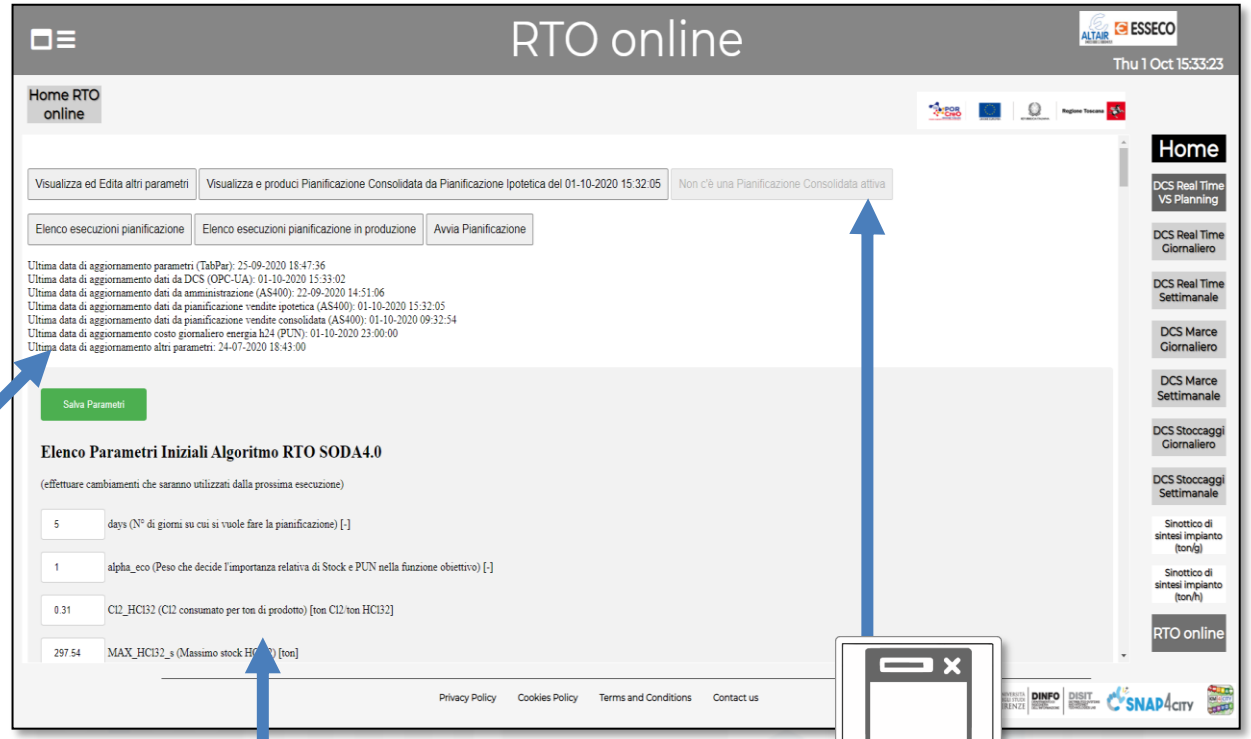

HTML

https://www.snap4city.org/394

https://www.snap4city.org/596

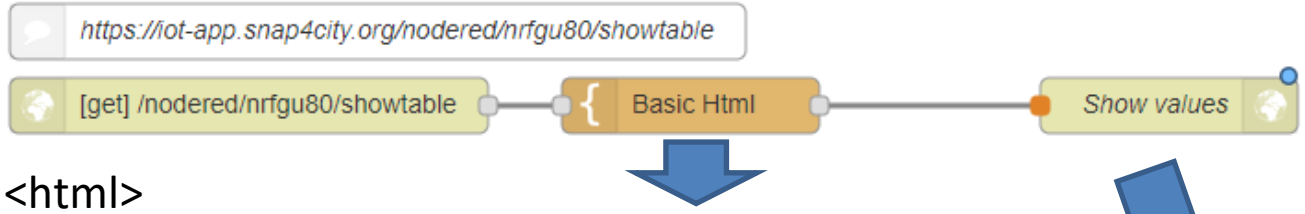
# Proc.Logic (IOT App) with Dynamic Web Pages



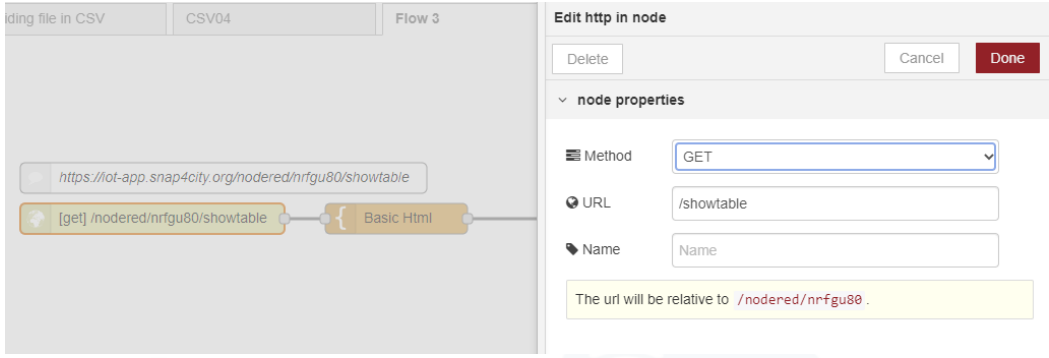




- **HTML pages** can
  - be dynamically generated from the Proc.Logic / IoT App
  - provide forms to produce data to the Proc.Logic / IoT App, also including interactive elements
  - collect file from users, and produce files to web and to the system
  - have CSS and AJAX controls

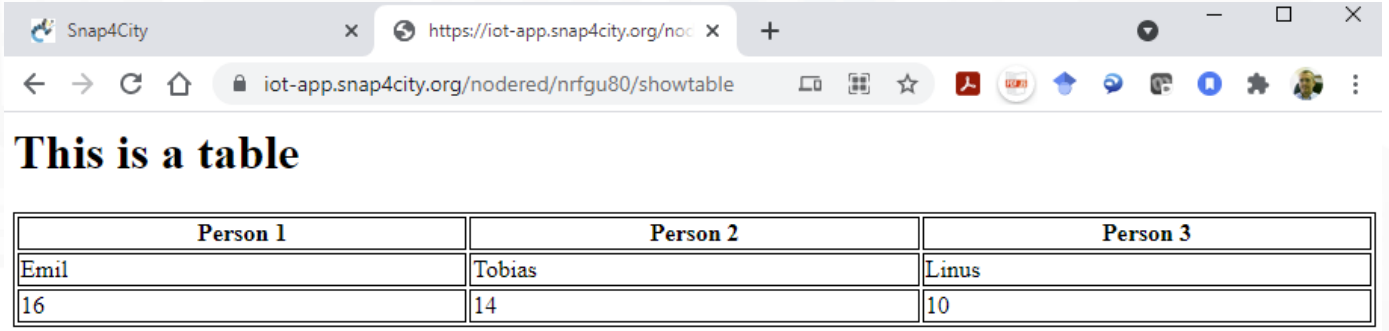
# From IoT App to generate HTML pages, forms




```
<html>
<style>table, th, td {  border:1px solid black;}</style>
<head></head>
<body>
<h1>This is a table</h1><table style="width:100%">
      <tr>
        <th>Person 1</th>   <th>Person 2</th>   <th>Person 3</th>
      </tr>
      <tr>
        <td>Emil</td>   <td>Tobias</td>   <td>Linus</td>
      </tr>
      <tr>
        <td>16</td>   <td>14</td>   <td>10</td>
      </tr>
</table>
</body> </html>
```



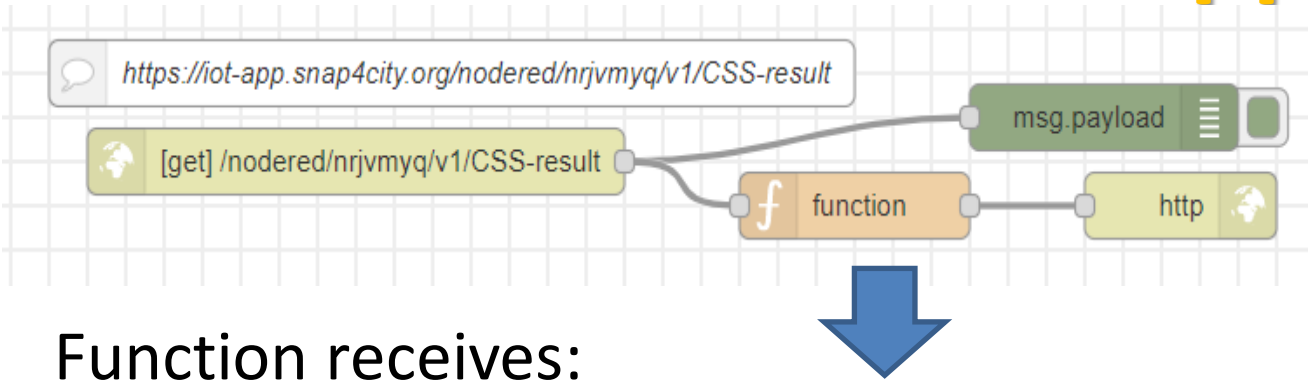

Edit “HTTP IN NODE” as above, also to get the ID of your IoT APP.
The ID is used in the URL of the generated page



# HTML & Tables on Dashboards

- HTML page can expose forms to collect data for the IoT App.
- The table can be
  - constructed with the style you prefer according to HTML, CSS, etc.
  - dynamically generated on the basis of the values you collect/generate, receive, recover from storage in the flow
  - updated by send a message on the node
  - show on Dashboard by using the link (URL) into an External Content Widget
- In alternative there is to the Widget Table with less flexibility

# From IoT App to API Get




Function receives:

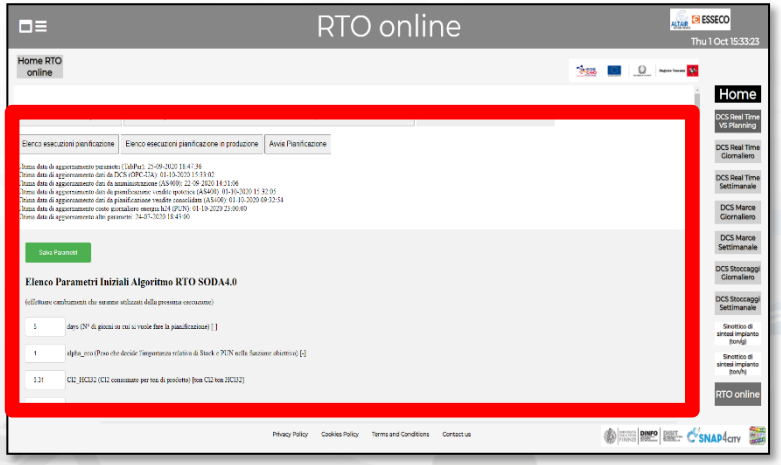
{"prova":"1","test":"mio"}

It can interpretes the REST call to provide at the next Node the result

**Call on Browser:**

https://iot-app.snap4city.org/nodered/nrjvmyq/v1/CSS-result/?prova=1&test=mio

The HTML page can be emebedded into External Content widget of a dashboard



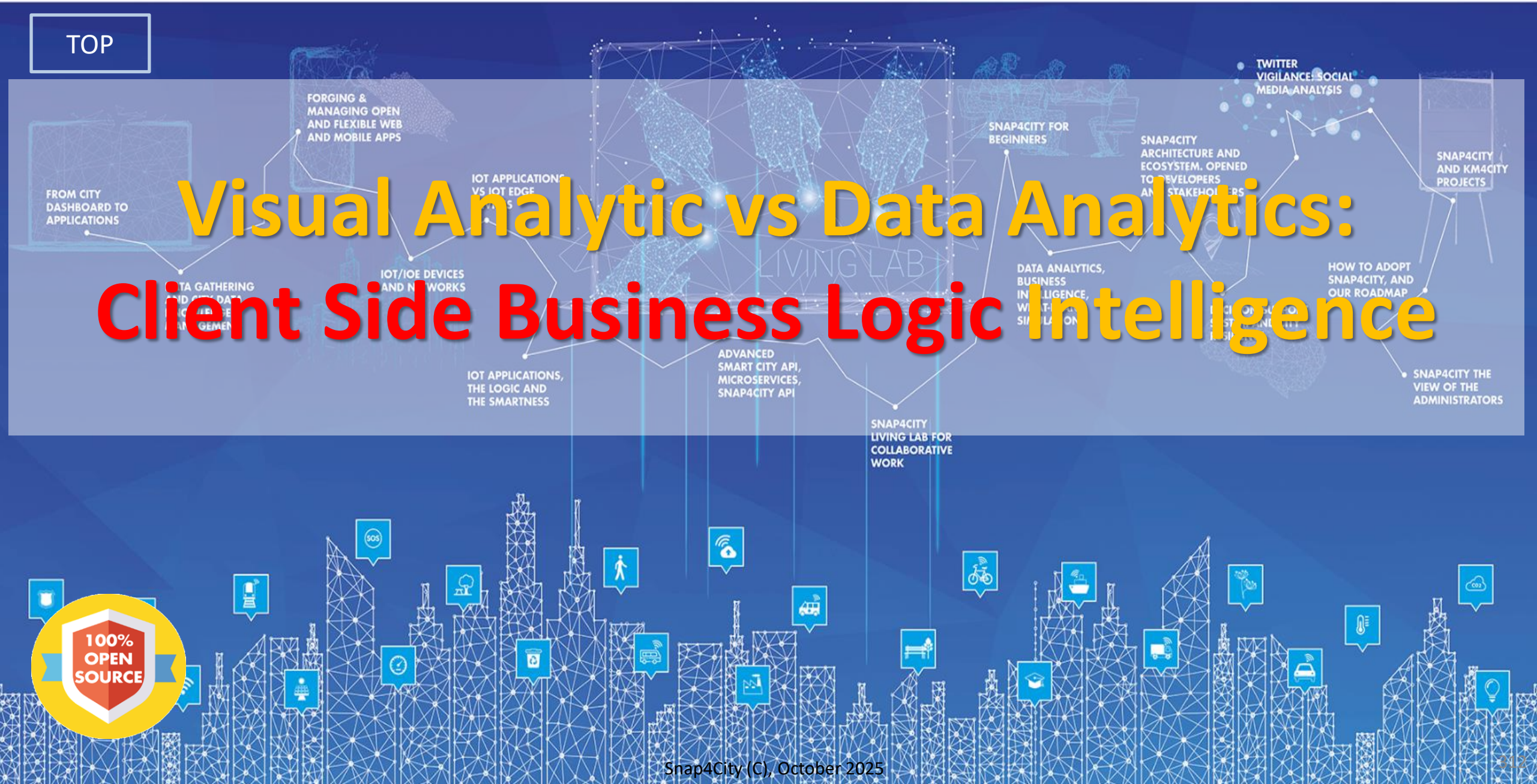

*Domain Prefix*

*IoT App ID*

*Your custom*

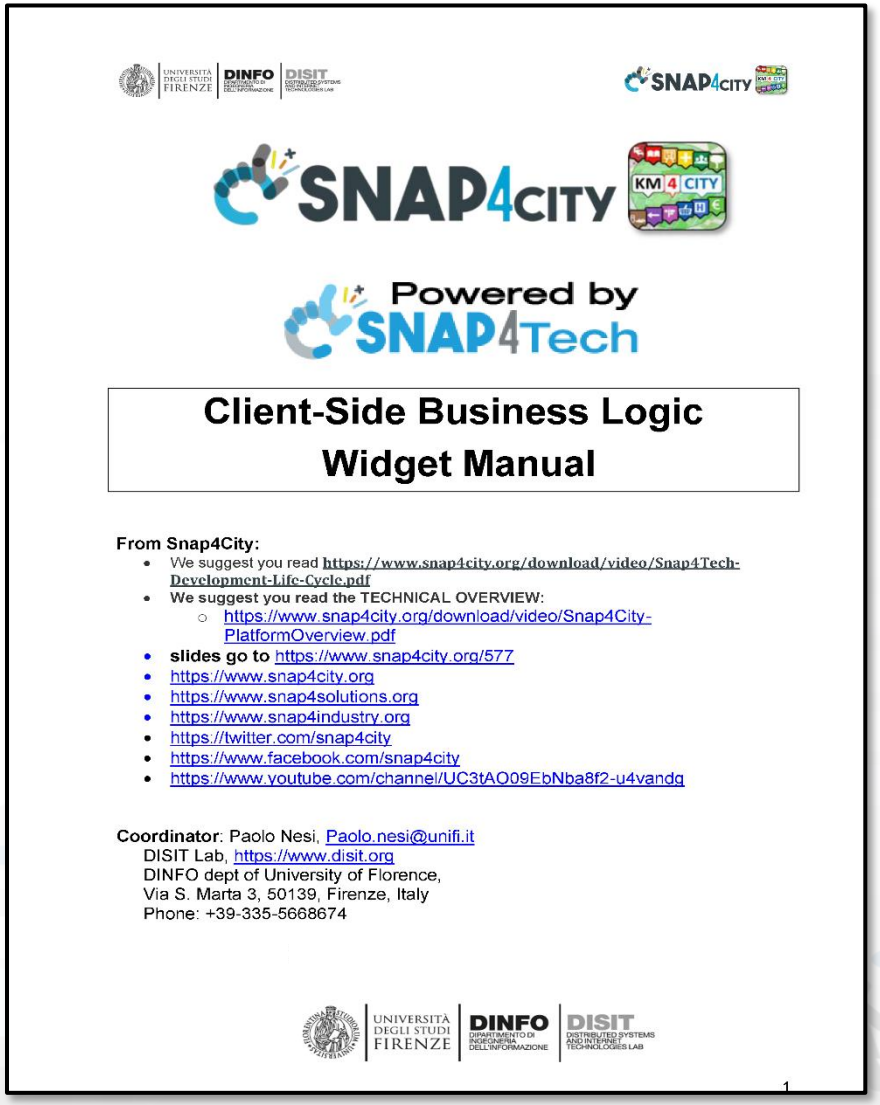
TOP

# Visual Analytic vs Data Analytics: Client Side Business Logic Intelligence



# CSBL

# Client Side Business Logic



Powered by SNAP4Tech

**Client-Side Business Logic Widget Manual**

**From Snap4City:**

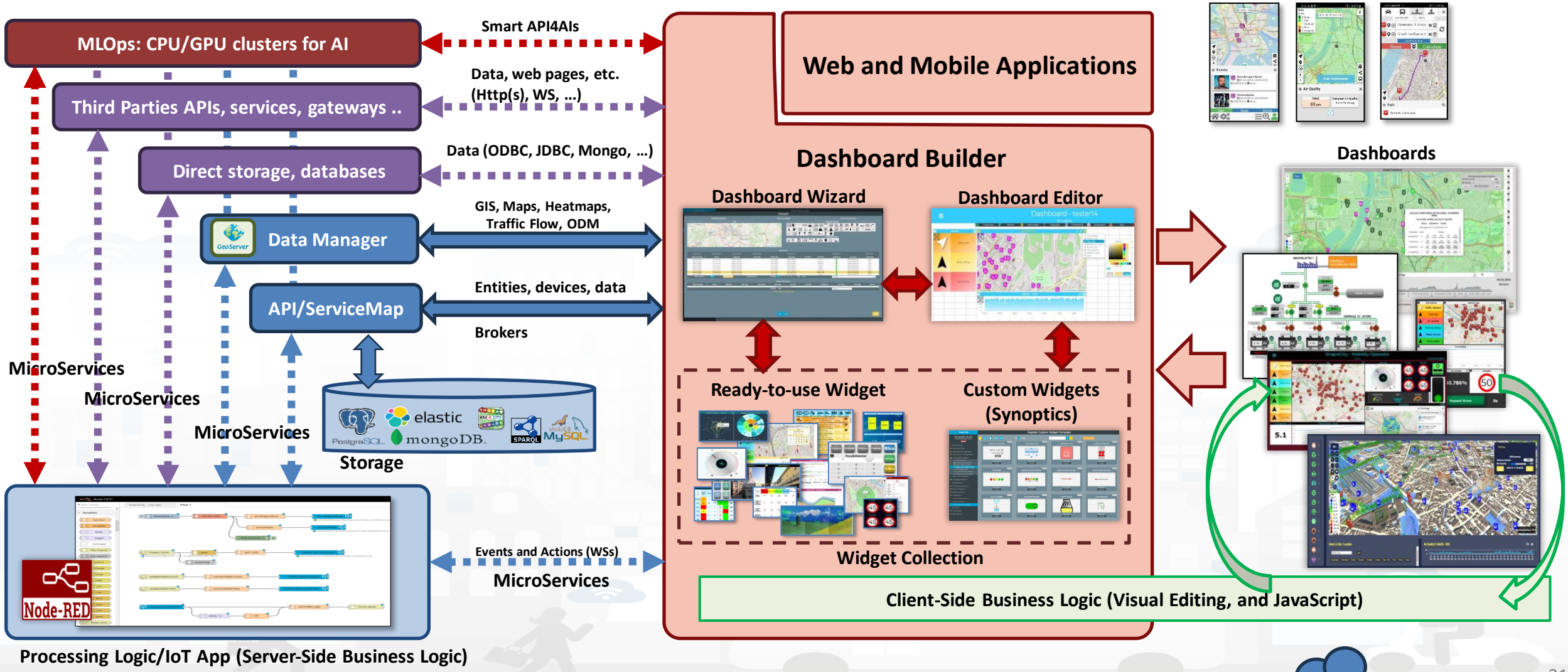
- We suggest you read **https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf**
- **We suggest you read the TECHNICAL OVERVIEW:**
  - https://www.snap4city.org/download/video/Snap4City-PlatformOverview.pdf
- **slides go to** https://www.snap4city.org/577
- https://www.snap4city.org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

1

https://www.snap4city.org/download/video/ClientSideBusinessLogic-WidgetManual.pdf

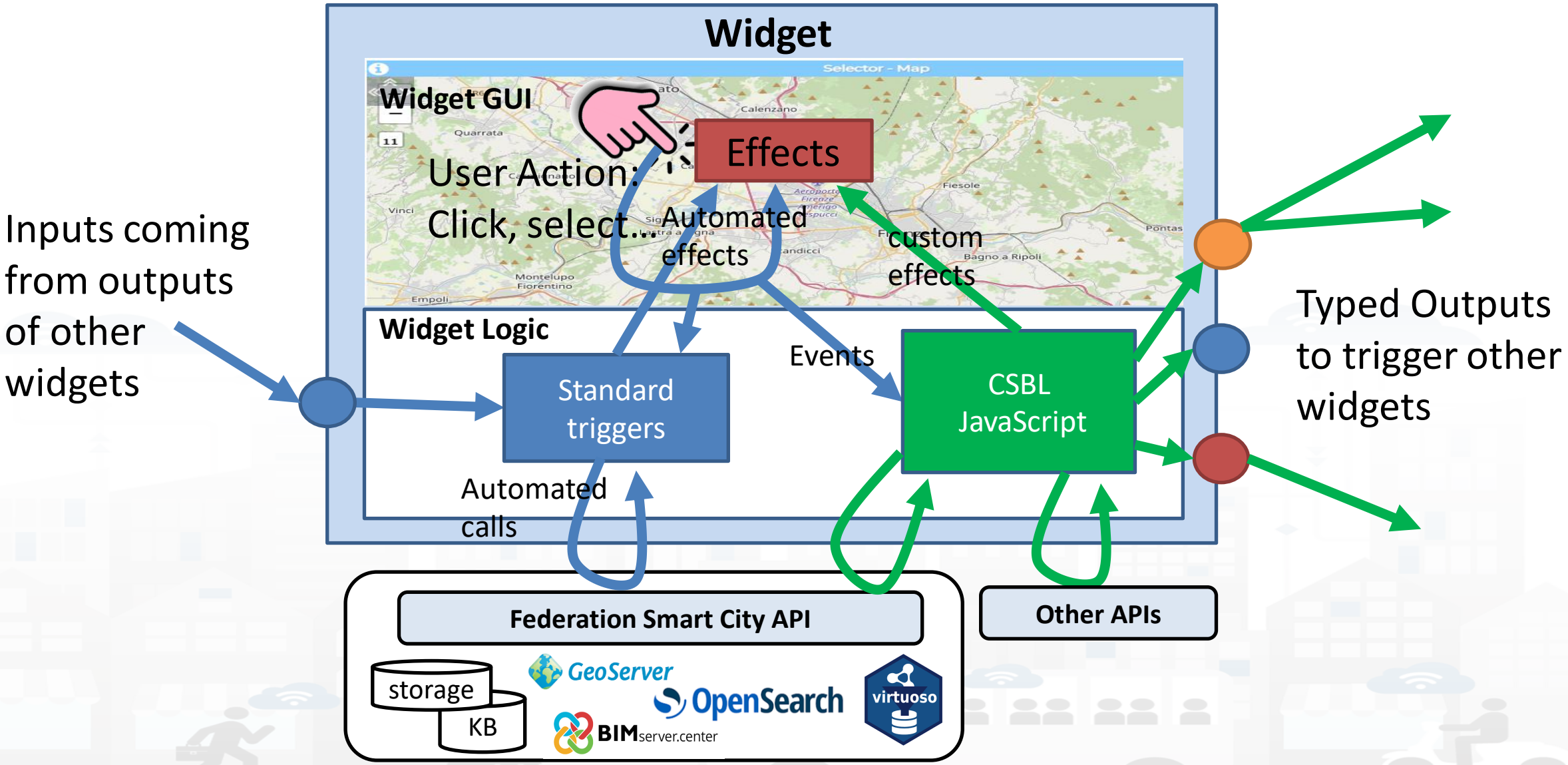
# How the Dashboards / Apps Exchange data (2024/8)



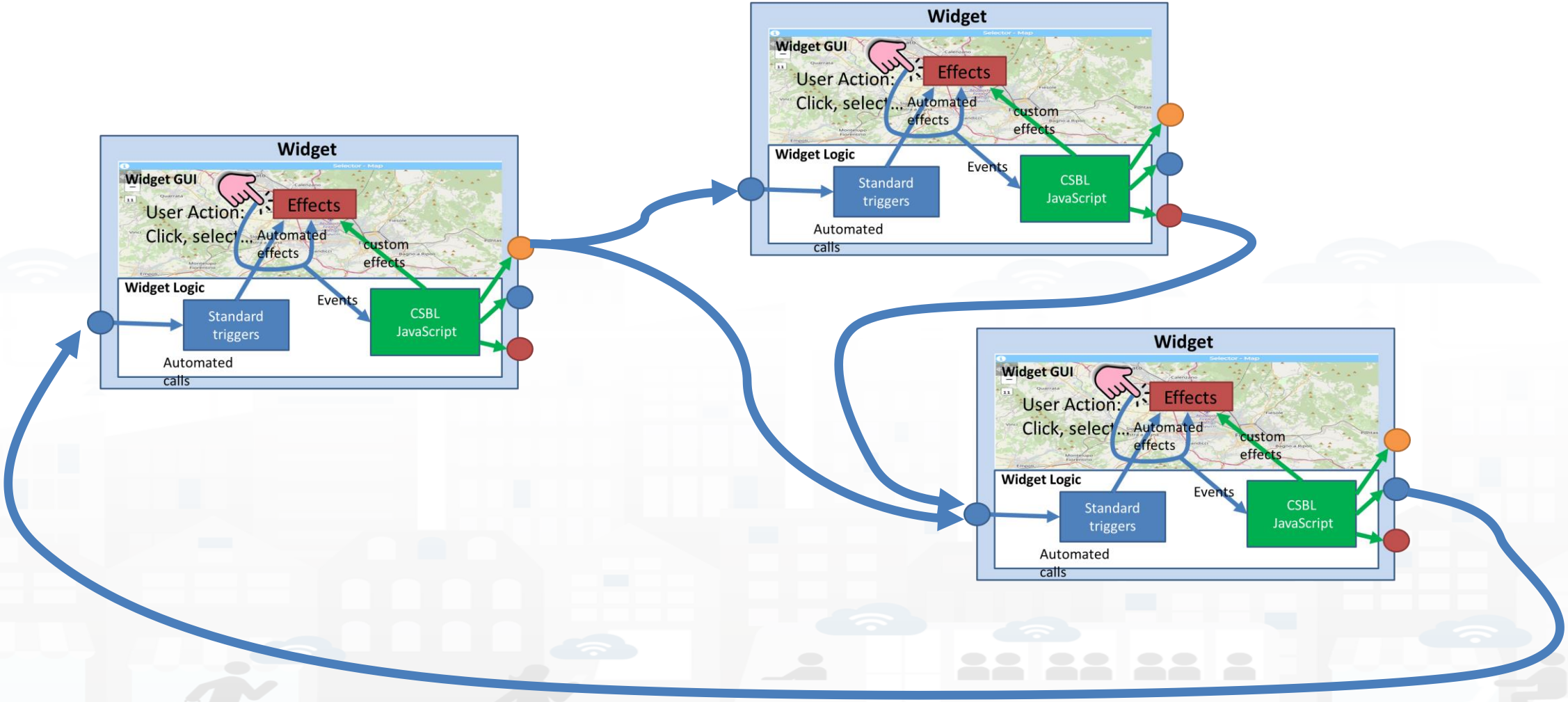
# Client Side Business Logic, CSBL

- solution to close the loop from user actions and effects on widgets directly on the client side, on the browser
- **Client-Side Business Logic, CSBL**, and **Server-Side Business Logics, SSBL**, may be present at the same time behind a Dashboard and thus behind a Business Intelligence / Smart Application
- CSBL the logic code is formalized in JavaScript only, while in SSBL the logic is formalized in Proc.Logic which is Node-RED plus some JavaScript.
- Developers that would like to develop CSBL have to be authorized, please ask to snap4city@disit.org
- When working in SSBL, widgets can be created
  - and edited from Node-Red Processing Logic.
  - also through the Dashboard Wizard

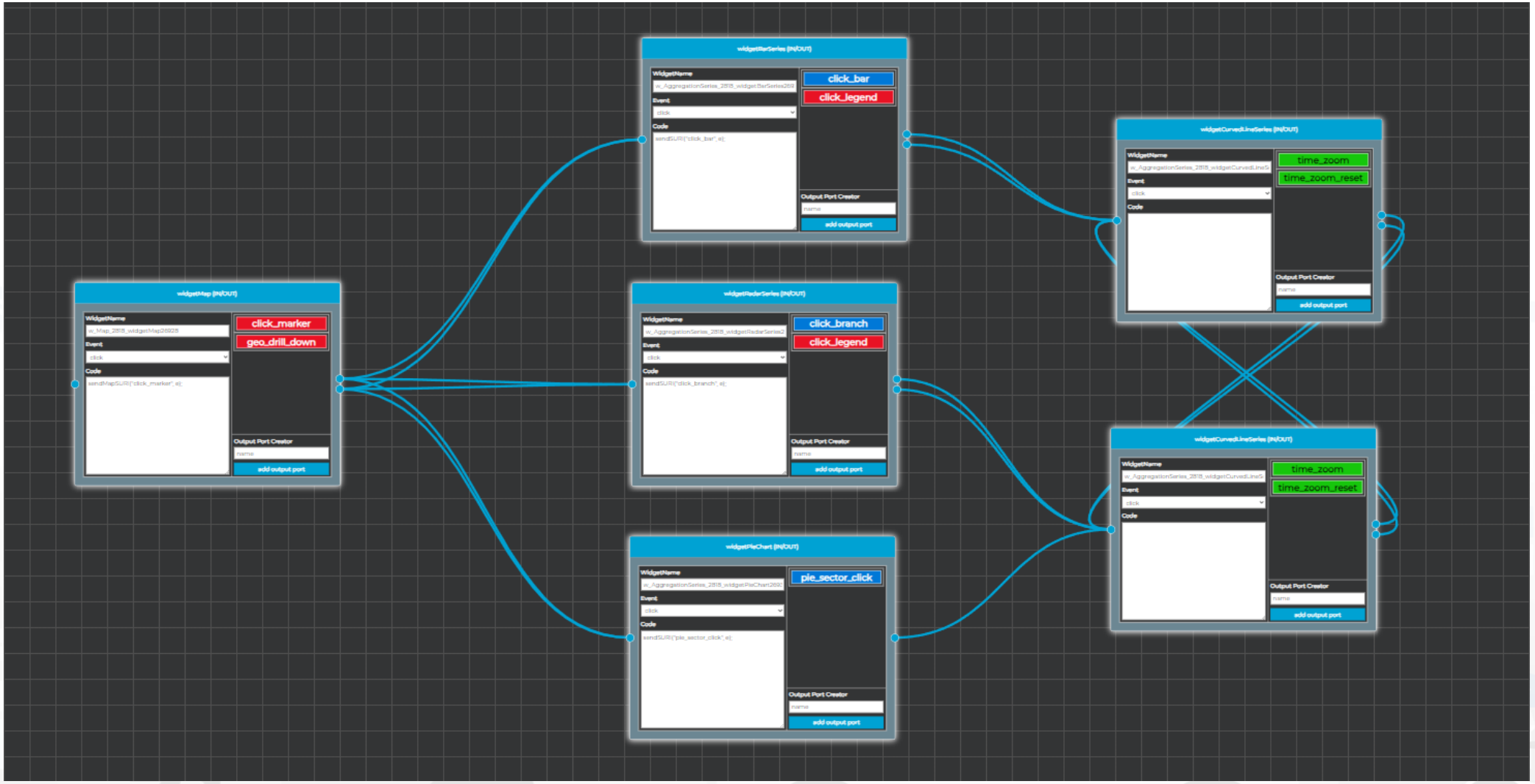
# Concepts of CSBL



# Composition

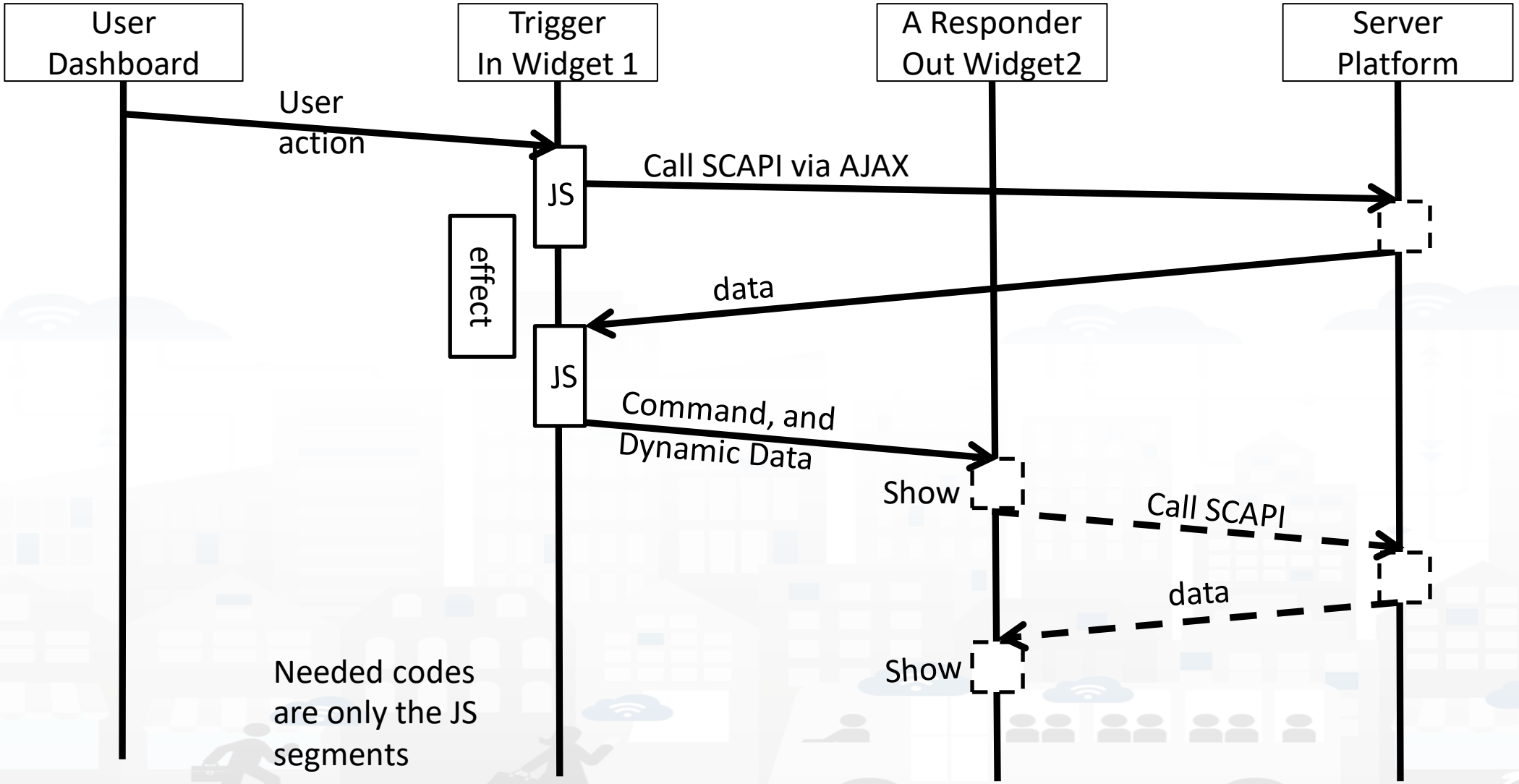


# Visual programming for CSBL is coming soon

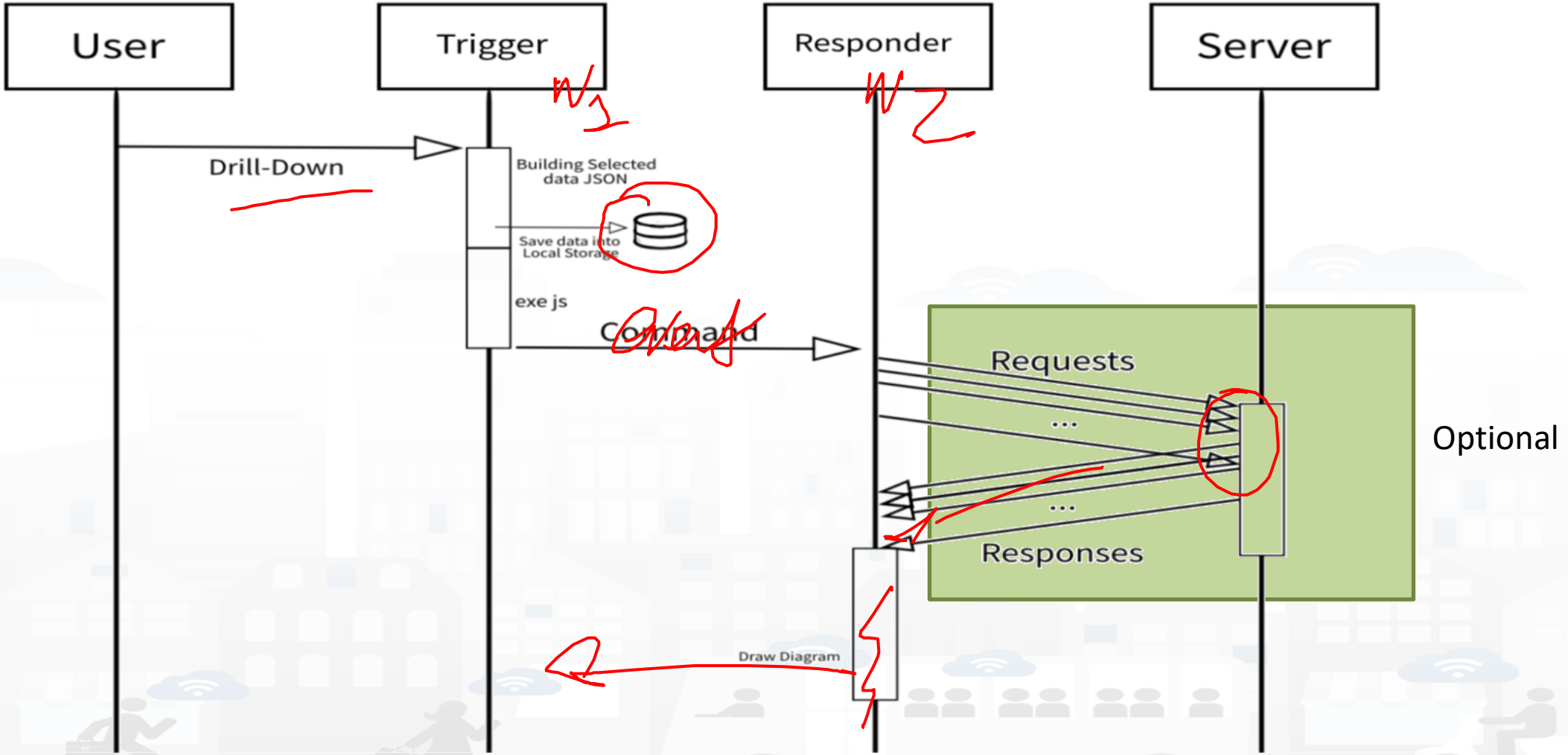


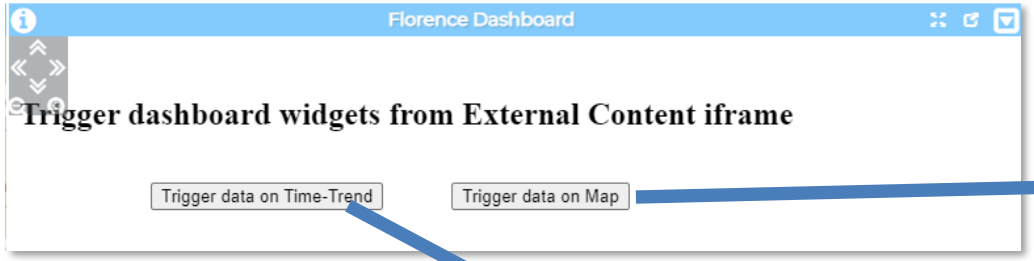

Save & Exit
Legenda
widgetMap (IN/OUT)
WidgetName
w_Map_2818_widgetMap26928
Event
click
Code
sendMapSURI("click_marker", e);
click_marker
geo_drill_down
Output Port Creator
name
add output port
widgetBarSeries (IN/OUT)
WidgetName
w_AggregationSeries_2818_widgetBarSeries269
Event
click
Code
sendSURI("click_bar", e);
click_bar
click_legend
Output Port Creator
name
add output port
widgetCurvedLineSeries (IN/OUT)
WidgetName
Event
time_zoom
Code
sendTimeRange("time_zoom", e);
time_zoom
time_zoom_reset
Output Port Creator
name
add output port

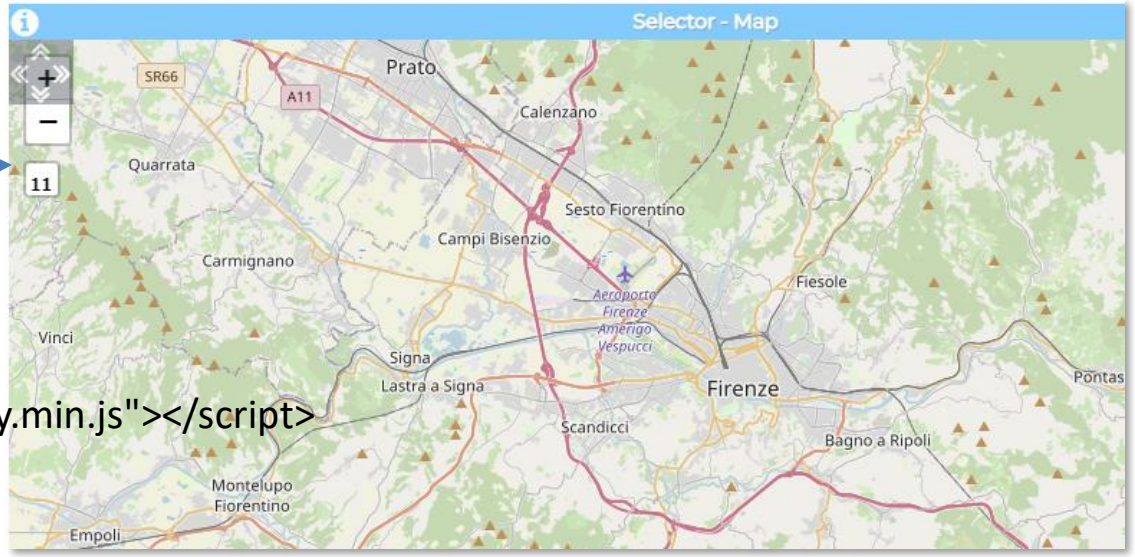
# User Actions, Triggers on Risponder



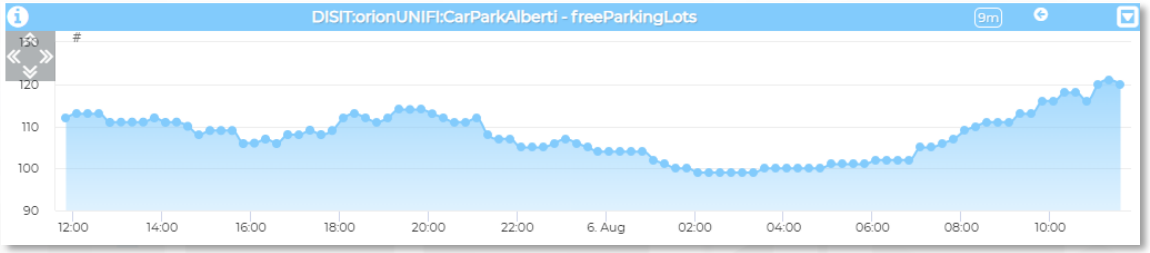
# User Actions, Triggers on Risponder





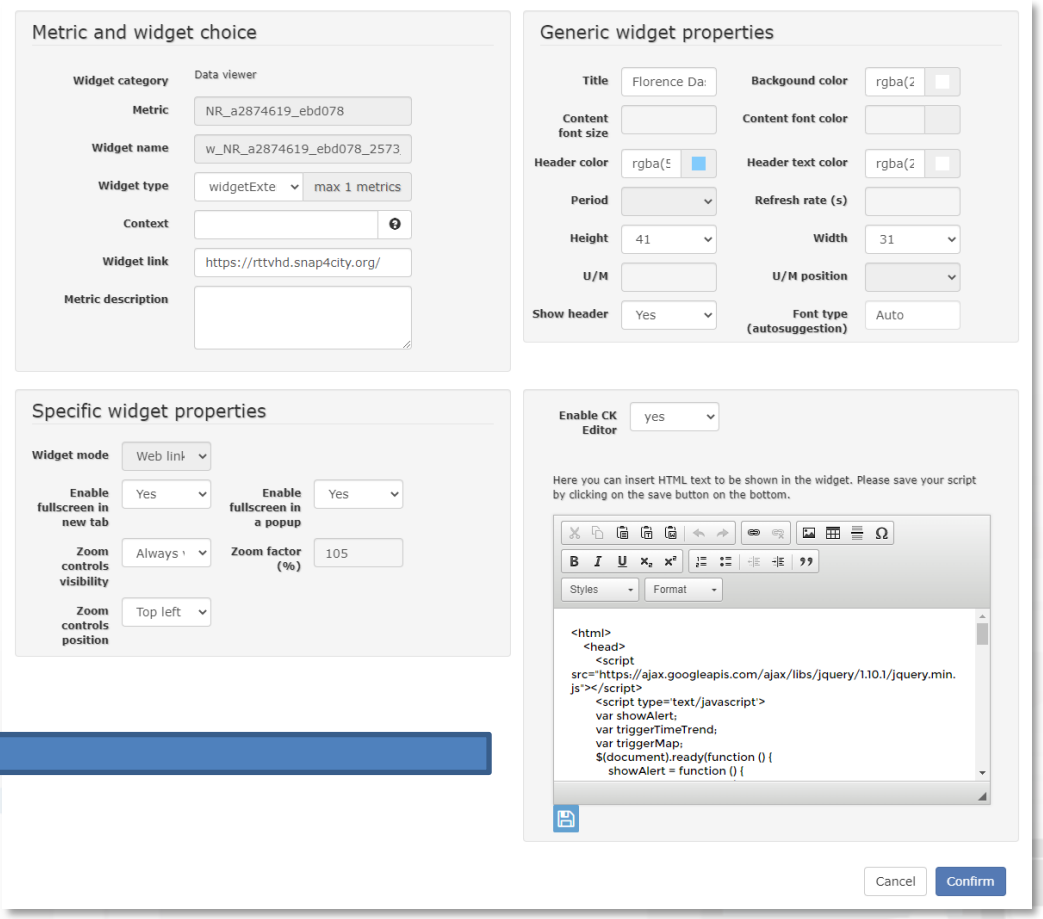

```
<html>
  <head>
    <script src="https://ajax.googleapis.com/ajax/libs/jquery/1.10.1/jquery.min.js"></script>
    <script type='text/javascript'>
            .....
    </script>
  </head>
  <body>
    <h2>Trigger dashboard widgets from External Content iframe</h2>
    <div>
      <!-- <button onclick="showAlert()">Alert Button GP</button>   -->
      <button id="triggerTTrend">Trigger data on Time-Trend</button>
      <button id="triggerMap">Trigger data on Map</button>
    </div>
  </body>
</html>
```



# Trigger based

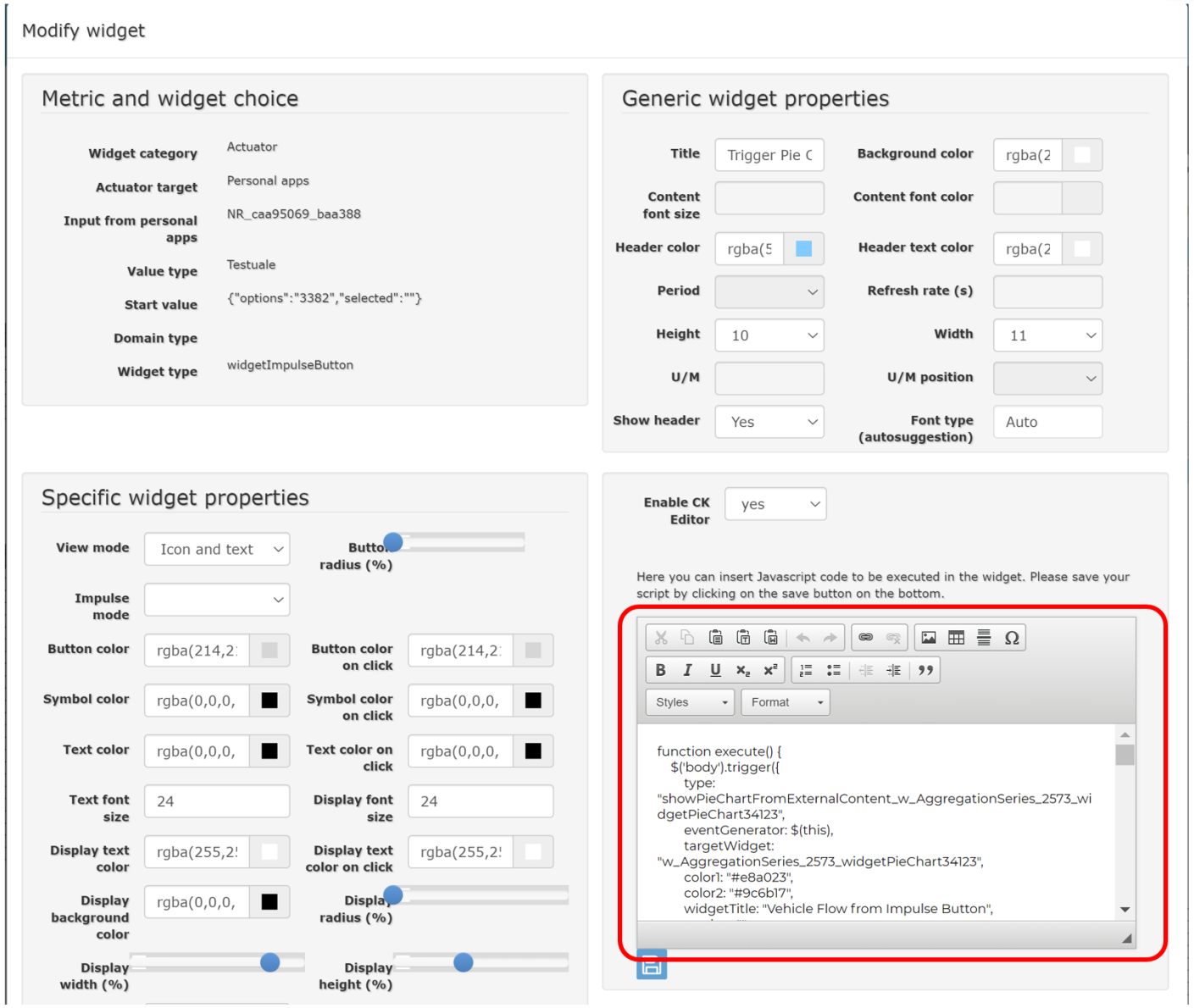
```
<script type='text/javascript'>
var showAlert;
var triggerTimeTrend;
var triggerMap;
$(document).ready(function () {
    showAlert = function () {
        var myText = "Test alert";
        alert (myText);
    }
    $('#triggerTTrend').click(function (event) {
        .................
        parent.$('body').trigger({      .................          });
    });
    $('#triggerMap').click(function (event) {
        .................
        parent.$('body').trigger({      .................          });
    });
});
</script>
```

## *Enforcing HTML and JavaScript on MoreOptions of the External Content Widget*



# Formalization of SSBL on In Widget More Options

- CK EDITOR



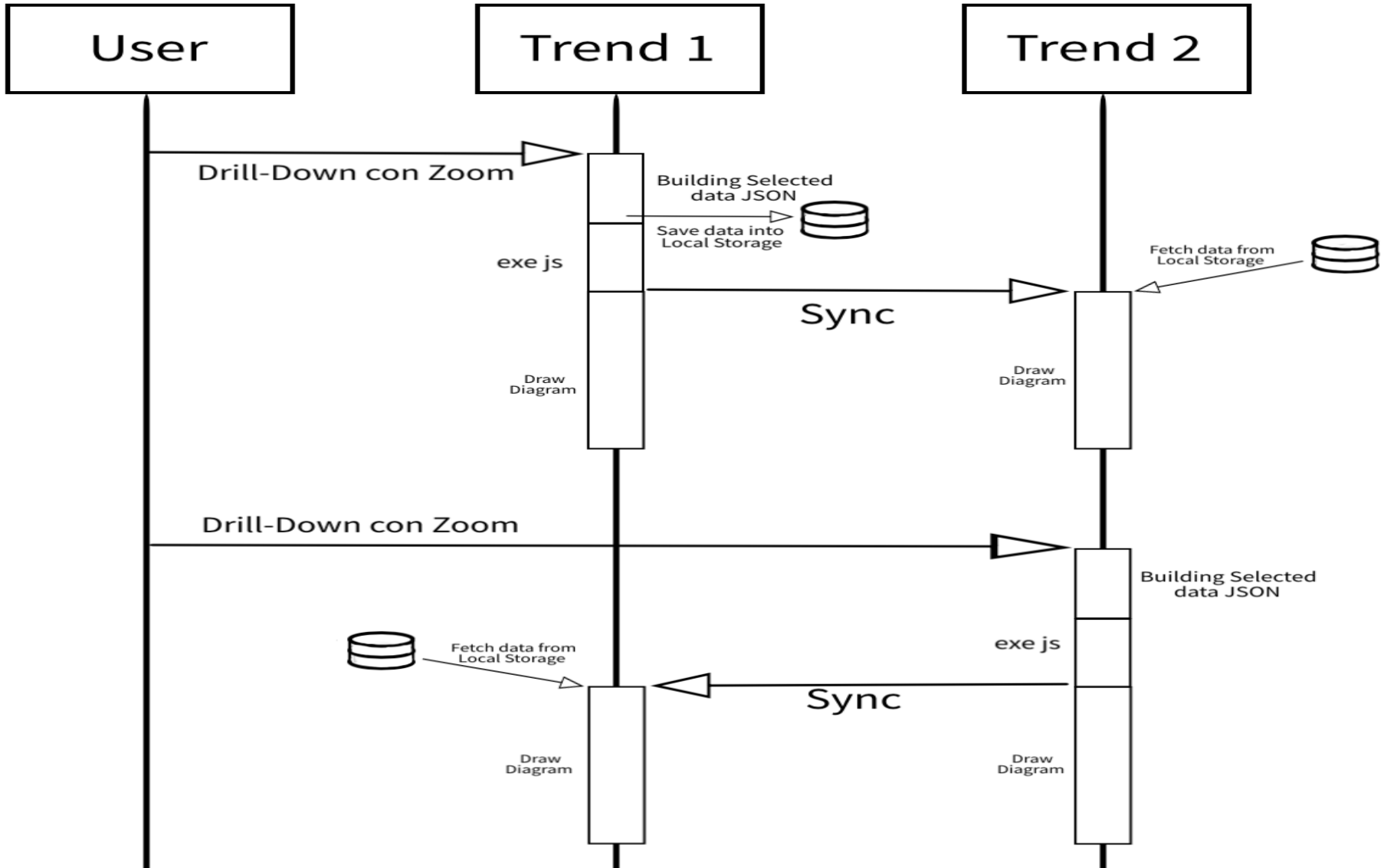
# Trigger map

```
$('#triggerMap').click(function (event) {
        let coordsAndType = {};
        coordsAndType.eventGenerator = $(this);
        coordsAndType.desc = "CarPark";
        coordsAndType.query =
"https://servicemap.disit.org/WebAppGrafo/api/v1/?selection=43.64471;11.005751;43.89471;11.505751&categories=Car_park&maxResults=200&format=j
son&model=CarPark";
        coordsAndType.color1 = "#ebb113";
        coordsAndType.color2 = "#eb8a13";
        coordsAndType.targets = "w_DISIT_orionUNIFI_CarParkAlberti_2573_widgetTimeTrend33703";    // the Time Trend Widget ID once pop up open
        coordsAndType.display = "pins";
        coordsAndType.queryType = "Default";
        coordsAndType.iconTextMode = "text";
        coordsAndType.pinattr = "square";
        coordsAndType.pincolor = "#959595";
        coordsAndType.symbolcolor = "undefined";
        // coordsAndType.altViewMode = altViewMode;
        coordsAndType.bubbleSelectedMetric = "";
        parent.$('body').trigger({
           type: "addSelectorPin",
           target: "w_Map_2573_widgetMap33705", // the Time Trend Widget ID of the event performed on clik
           passedData: coordsAndType
        });
    });
```

# Trigger Time trend

```
$('#triggerTTrend').click(function (event) {
    parent.$('body').trigger({
        type:
"showTimeTrendFromExternalContentGis_w_DISIT_orionUNIFI_CarParkAlberti_2573_widgetTimeTrend33703",
        eventGenerator: $(this),
        targetWidget: "w_DISIT_orionUNIFI_CarParkAlberti_2573_widgetTimeTrend33703",
        range: "7/DAY",
        color1: "#34eb6e",
        color2: "#114a23",
        widgetTitle: "Free Parking Lots data from External Content",
        field: "freeParkingLots",
        serviceUri: "http://www.disit.org/km4city/resource/iot/orionUNIFI/DISIT/CarParkPal.Giustizia",
        marker: "",
        mapRef: "",
        fake: false
    });
});
```

# Synchronization Multiple Time Trends



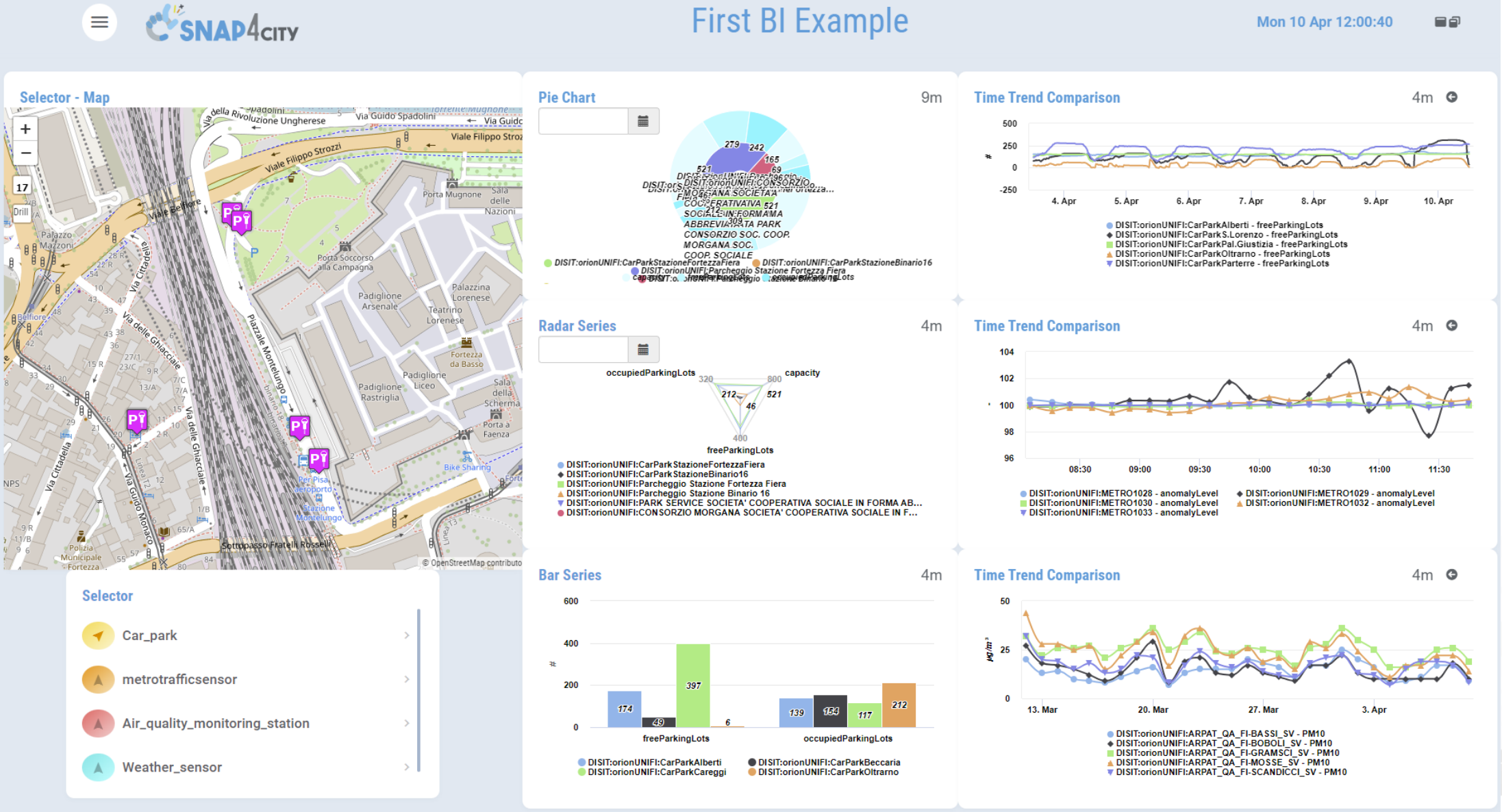
# Client Side Business Logic, CSBL

- **IN Widgets** are those that are prepared to receive some actions/commands from the Users. For example, a click on a button, a click on the map, etc. These IN Widgets can be regarded as Virtual Sensors.
- **OUT Widgets** are those that are prepared to provide some changes to be shown into the Users' interface. For example, a view of a barseries on some other data, a rendering of a time series, a rendering of a set of Entities on the map, etc. These OUT Widgets can be regarded as Virtual Actuators.
- **IN/OUT Widgets** are those that provide capabilities of both IN and OUT Widgets. For example, a map can receive an IN command about a selected PIN, and can receive an OUT command to show a selection of services, devices, etc. These IN/OUT Widgets can be regarded as Virtual Sensors/Actuators.

# Client Side Business Logic Example



# example

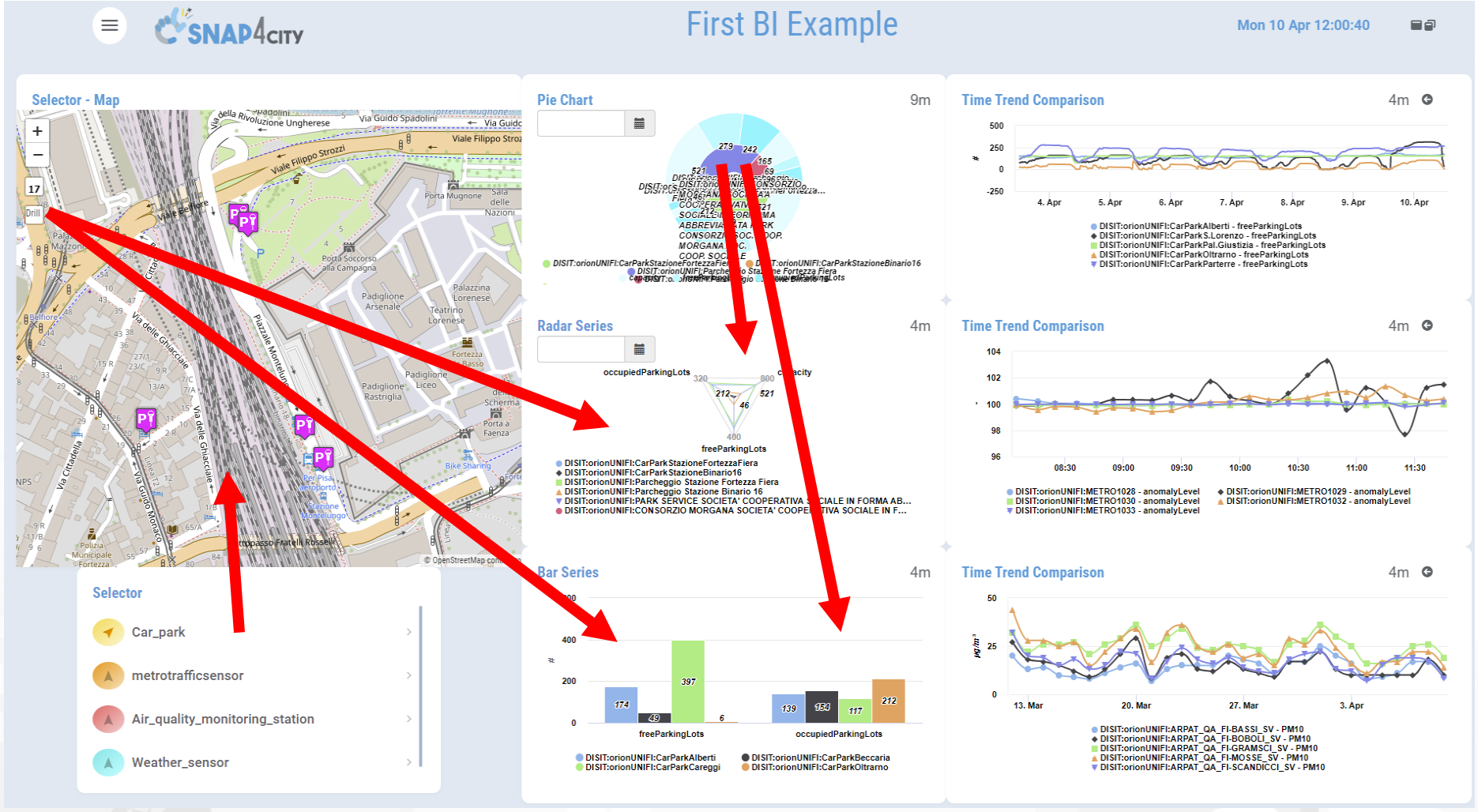



https://www.snap4city.org/dashboardSmartCity/view/Gea.php?iddasboard=MzcyNA==

# Example: From Map to Graphs (spatial drill down)

1) Select the area of interest on map
2) Select the sensors kind of interest
3) Drill down on map

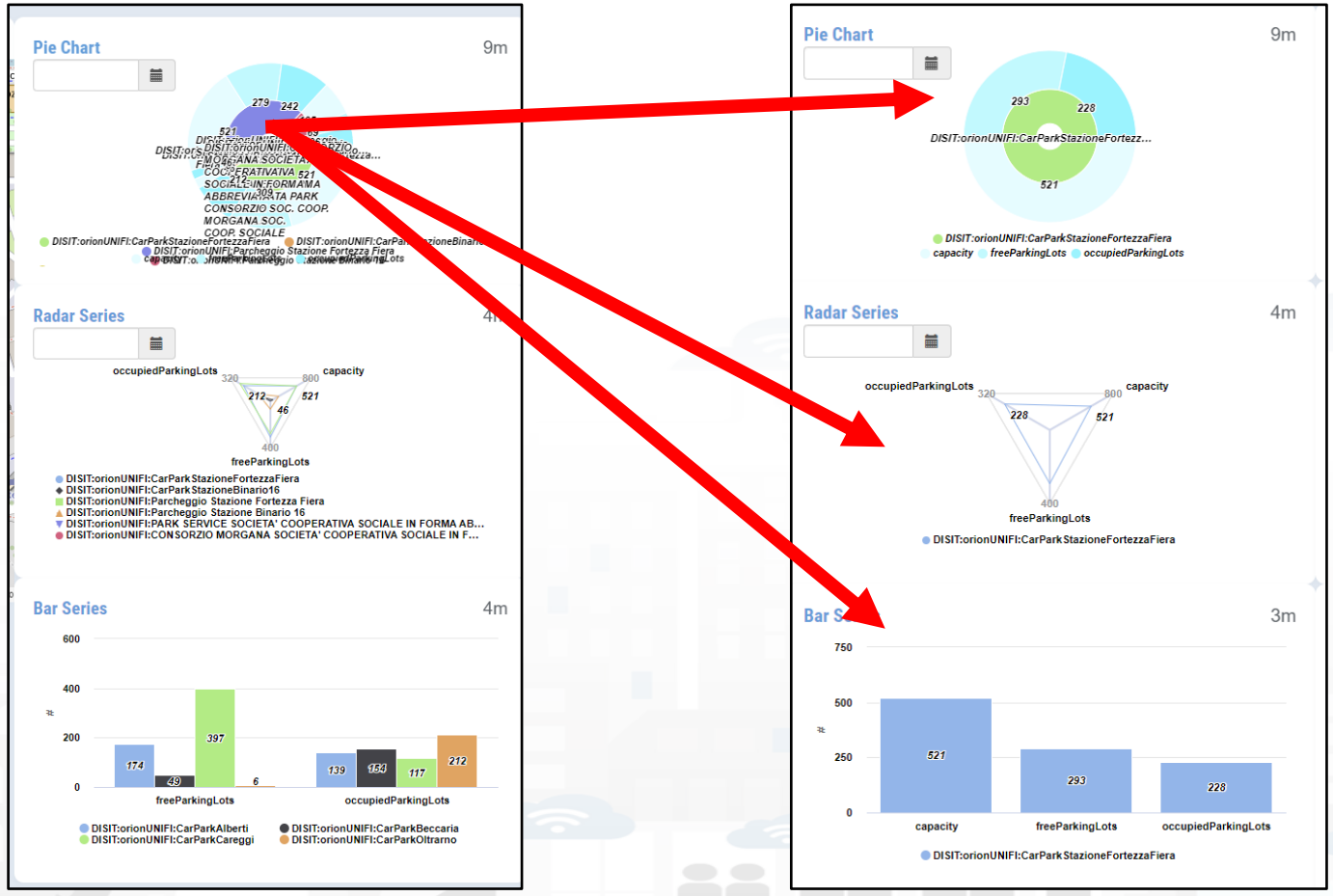
4) The JavaScript CSBL on Map will send data to the programmed Widgets. In this case, arrowed in RED



# Example: From Data Graphs to Graphs (drill down)

1) Click on the Donut element

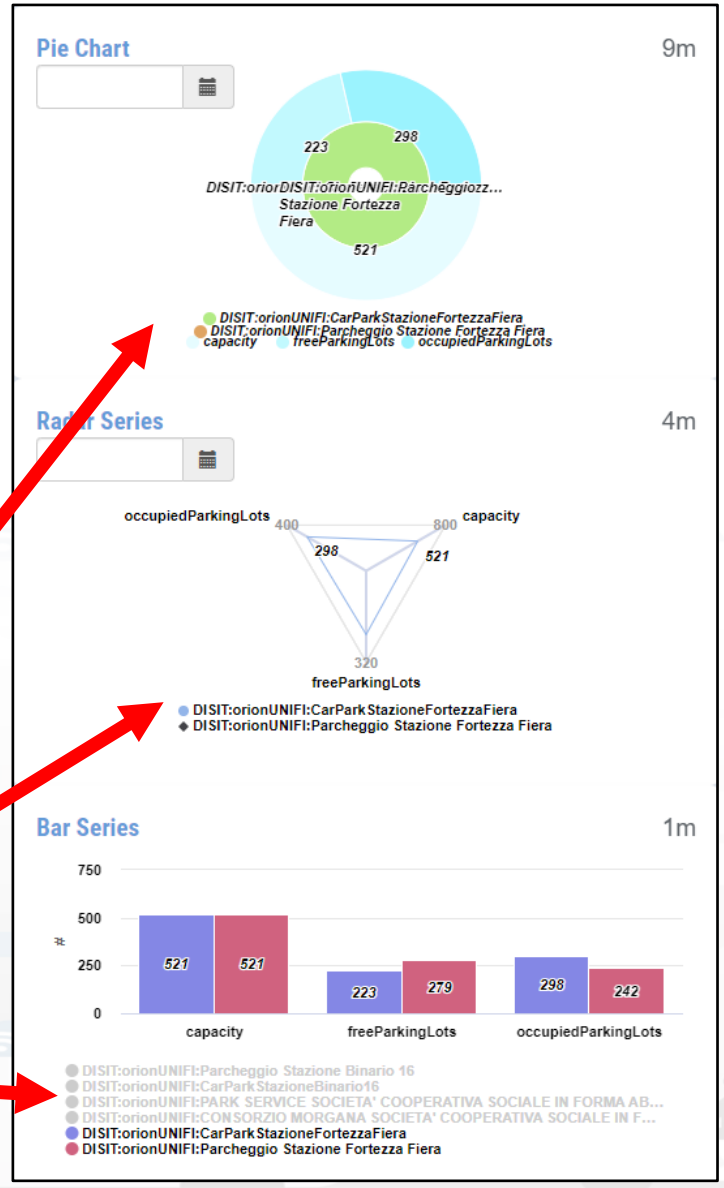
2) The JavaScript CSBL on the Donut Widget will send commands to the programmed Widgets to focus on selection, as highlighted by the red arrows



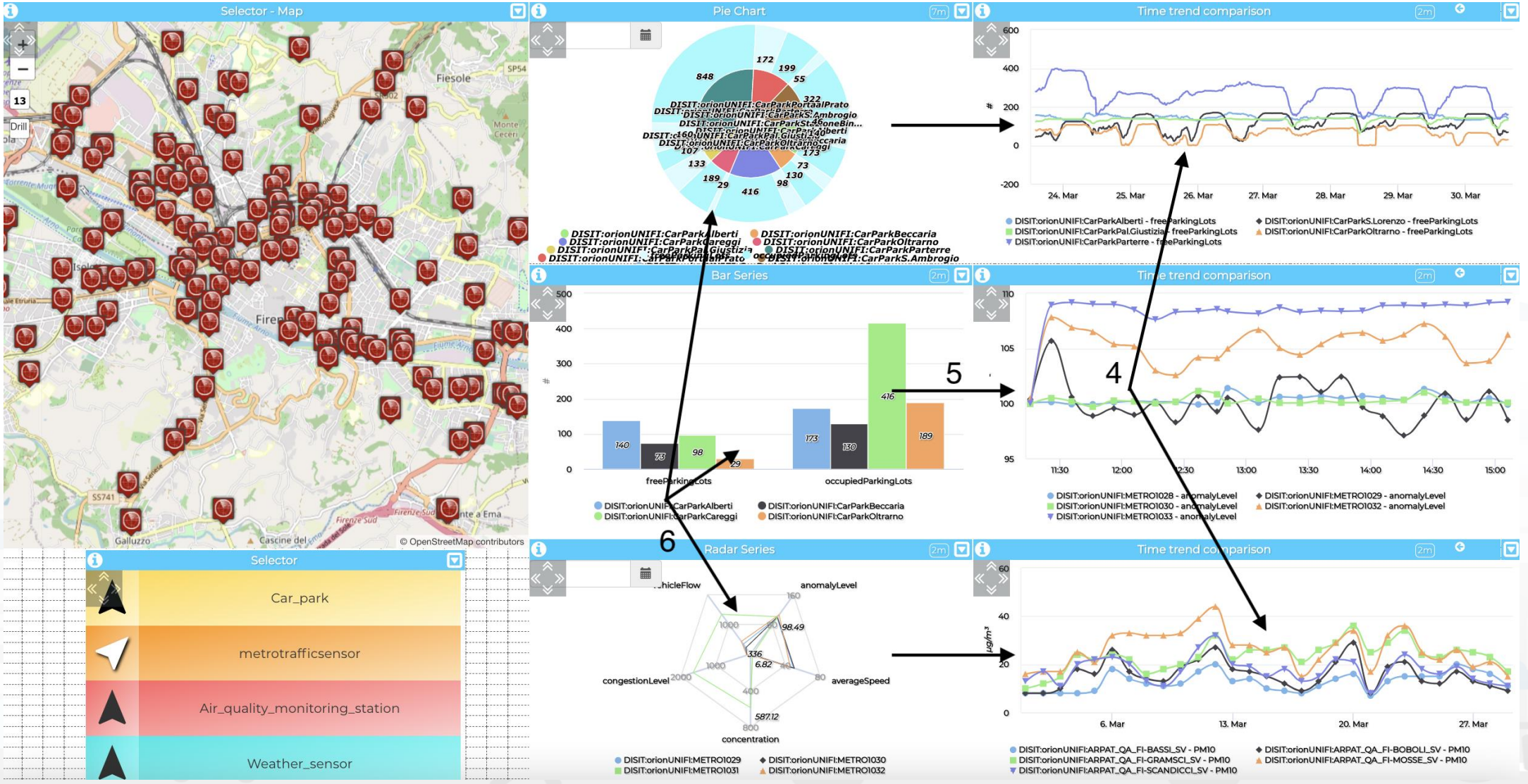
1) Click on the Legenda of Bar Series

2) The JavaScript CSBL on the Bar Series will send commands to the programmed Widgets to remove the unselected devices, as highlighted by the red arrows



# Other Actions



# Example Triggers



| IN and IN/OUT Widgets | Users' Action Description and effects |
|---|---|
| widgetTimeTrend | Drill-Down on time interval selection (zoom), providing, SURI, value name, start and end time stamp |
| | Send Reset Drill-Down |
| | Click on a single time instant, providing time stamp, SURI and value name |
| widgetMap (multidatamap) | Click on a generic point on the map, providing coordinates (under development, currently it only works for SSBL) |
| | Click on a PIN, providing coordinates and ServiceURI of the clicked PIN |
| | Select the bounding box area shown on the map, and the zoom level in order to perform geographical Drill-Down on the entities (devices identified by SURIs, Points of Interest etc.) which are currently shown on map |
| widgetPieChart | Click on a sector that identifies the name of a metric, providing: value, timestamp, entity name (from which the SURI can be reconstructed) value name, value type and value unit |
| | click on a sector that identifies a device ID or MyKPI ID, providing: value, timestamp, entity name (from which the SURI can be reconstructed) value name, value type and value unit |
| | Click on legend, providing the status (e.g.: "checked" or "unchecked") of the metric/SURI which has been clicked (under development) |
| widgetBarSeries | Click on a bar, providing: value, timestamp, entity name (from which the SURI can be reconstructed) value name, value type and value unit |
| | Click on legend, providing the visibility status of each metric/SURI |
| widgetRadarSeries | Click on a radar axis related to a specific metric of a specific device, providing: value, timestamp, entity name (from which the SURI can be reconstructed) value name, value type and value unit |
| | Click on legend, providing the visibility status of each metric/SURI |
| widgetCurvedLineSeries (multi series) | Drill-Down on time interval selection (zoom), providing: start and end time stamp, and list of SURI. It is also possible to program the synchronization of multiple widgetCurvedLineSeries widgets. |
| | Click on a single time instant, providing: time stamp and list of objects including SURIs and related entity names and value names |
| | Click on legend, providing the visibility status of each metric/SURI |
| | Send Reset Drill-Down |
| widgetDeviceTable | Click on the action buttons, providing the action type, the corresponding SURI and a list of attributes with their corresponding values |
| widgetImpulseButton | Click on button as a trigger (no parameters are provided) |
| widgetOnOffButton | Click on button, providing the new status |
| widgetKnob | Drag on knob, providing the value selected on the knob |
| | Click on minus and plus action |
| widgetNumericKeyboard | Click on the confirm button, providing the numeric value typed on the keyboard |
| widgetEventTable | Click on the action buttons, providing the action type, the corresponding event SURI and the ordering criteria |
| widgetExternalContent | It can support HTML pages and SVG Synoptics, in addition to JavaScript, so that it can perform a wide range of actions that can be defined in the HTML/SVG/JS code by the users. |

# Typical Triggered Events

- SURI, List of SURI
  - Variable: Value Name (or metric)
- DateTime: date and time instant
- DateTime Interval: fromdatetime, todatetime
- ResetCommand
- GPS Coordinates, Bounding Box: a couple of coordinates
- Action (status | value)
- Etc.

# Examp. Responders

| OUT and IN/OUT Widgets | Commands which are ready to be executed from Widgets according to JavaScript in some IN Widget |
|---|---|
| widgetPieChart | Receive a JSON containing a list of SURI, metric names and/or values, and show their corresponding values on a Pie Chart graph. |
| widgetRadarSeries | Receive a JSON containing a list of SURI, metric names and/or values, and show their corresponding values on a Radar/Kiviat graph. |
| widgetBarSeries | Receive a JSON object containing a list of SURI, metric names and/or values, and show their corresponding values on a Bar graph. |
| widgetSingleContent | • Receive a SURI and a metric name, or a value, or a text string, and show the corresponding value.<br>• Receive and show a HTML/JS page |
| widgetSpeedometer | Receive a SURI and a metric name, or a value, and show the corresponding value on a speedometer graph. |
| widgetGaugeChart | Receive a SURI and a metric name, or a value, and show the corresponding value on a gauge graph. |
| widgetTimeTrend | Receive a SURI and a metric name, or a value, and show the corresponding time-series on a line, spline, area or stacked area graph. |
| | Receive reset zoom |
| widgetTable | Receive a JSON containing a list SURI, metric names and/or values, and show the corresponding time-series on a HTML static table. |
| | Receive start datetime, end datetime without change sources IDs |
| widgetCurvedLineSeries | Receive a JSON containing a list of SURI, metric names and/or values, and show the corresponding time-series on a line, spline, area or stacked area graph. |
| | Receive start datetime, end datetime without change sources IDs |
| | Receive reset zoom |
| widgetDeviceTable | Receive a JSON containing a list of SURI representing IoT devices, and show their related attributes and values on an interactive table which provides action buttons. |
| widgetEvent | Receive a JSON containing a list of SURI representing events as virtual devices, and show their related attributes (e.g., start and end date) and values on an interactive table which provides action buttons. |
| widgetMap | Receive a JSON containing a list of SURI or entities (such as heatmaps, categories of Points of Interest etc.) and show them on an interactive map as clickable markers, dynamic SVG pins, traffic flows, heatmaps etc. |
| widgetOnOffButton | Receive and show a value representing the status |
| widgetKnob | Receive and show a value |
| widgetNumericKeyboard | Receive and show a value |

# Typical commands received

- SURI, List of SURI
  - Variable: Value Name (or metric)
- DateTime: date and time instant
- DateTime Interval: fromdatetime, todatetime
- ResetCommand
- MyKPI, List of MyKPI
- GPS Coordinates, Bounding Box: a couple of coordinates
- Action (status | value)
- Etc.

# CSBL: Useful Functions

**functions on Actions JavaScript segments:**

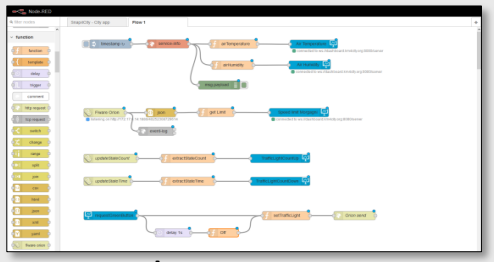
- Open a New Dashboard: **openNewDashboard()**
- Get parameters: **getParams()**

As a result, it is possible to activate in a new dashboard some actions on specific elements.

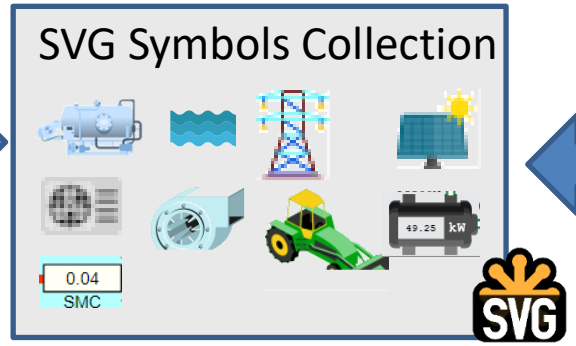
# Develop: Client Side Business Logic Dashboards with Synoptics



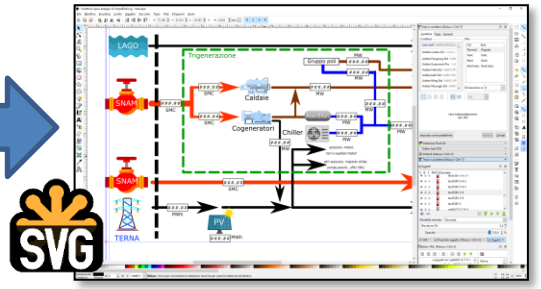
# Custom Widget / Synoptic / PIN Development



IOT Applications



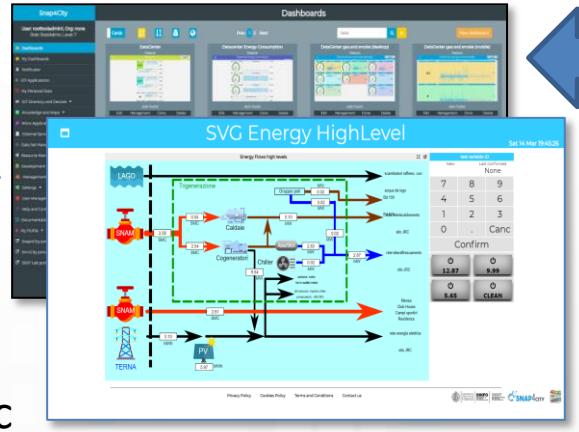

Inkscape editor on your computer




Create, save a Custom Widget in SVG

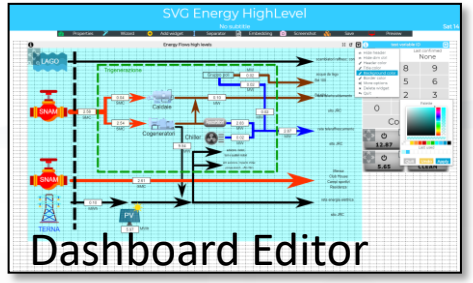



Knowledge and Storage Data from the Field and City




Public Dashboard Collection

My Own Dash/App

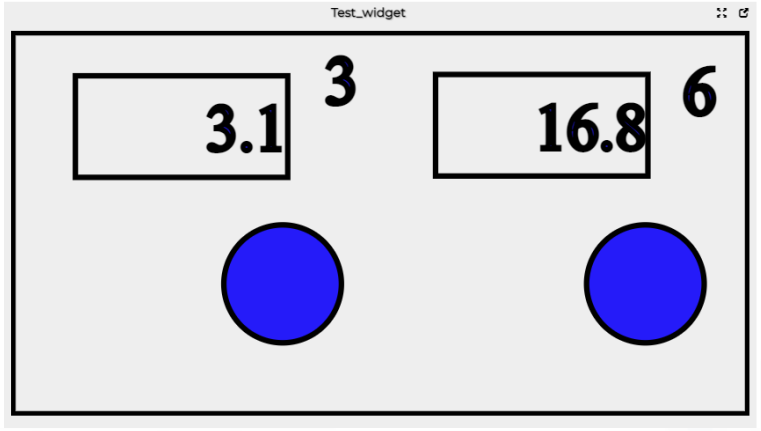





Create, save, load, delegate, grant access

1. Create and Load a Custom SVG
2. Select/Reuse an SVG
3. Make and Instance of Synoptic by Associate Variables with MyKPI or sensors
4. Create on Dashboard a Widget based on Synoptic HLT such as Ext. Srv.:
   - https://www.snap4city.org/synoptic/v2/synoptic.html?id=xxxx

# Synoptic for Client Side Business Logic




**In the SVG puts some code:**

-- at the button for example OnClick(), triggering an event

-- at the text box to write the value in the box, for example:

TextBoxWrite3(……)

TextBoxWrite6(…..)

**In the JavaScript of the External Content Widget hosting the SVG html code**

**The programmer can:**

**-- exploit the functions**

TextBoxWrite3(……)

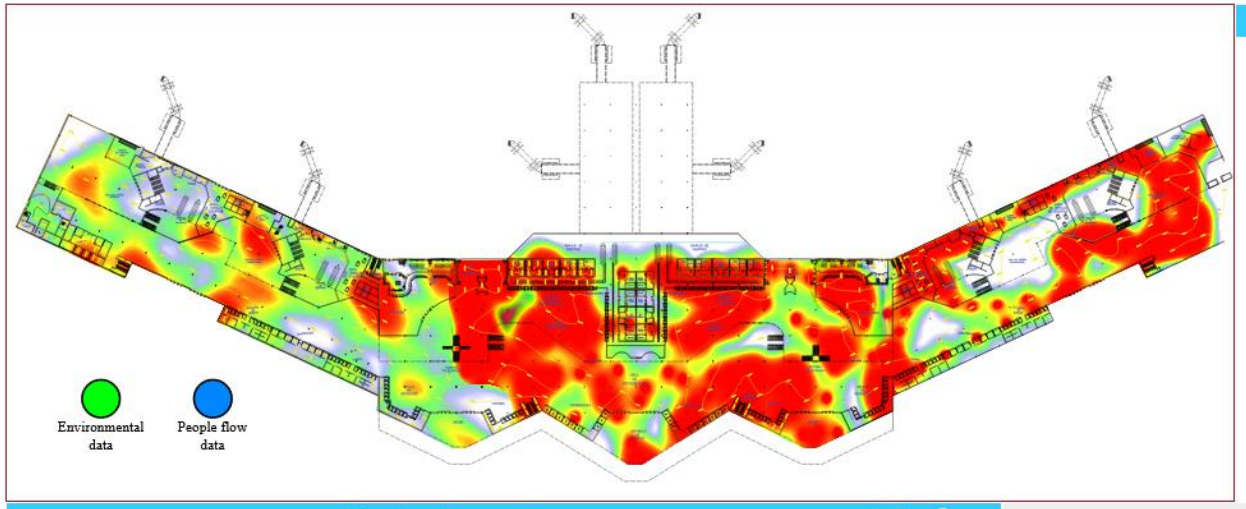
TextBoxWrite4(……)

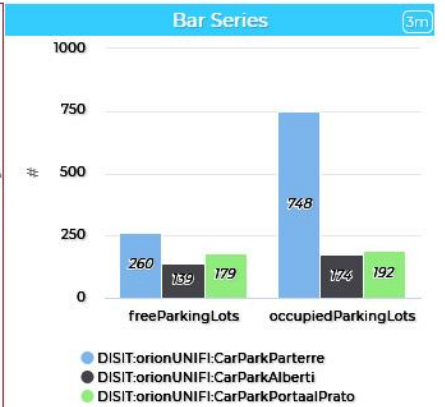
**-- receive the Triggered event and**

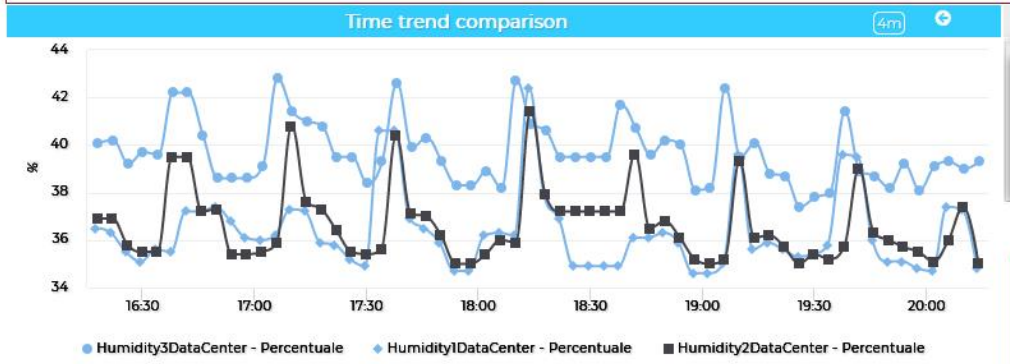
write a JavaScript with a corresponding action

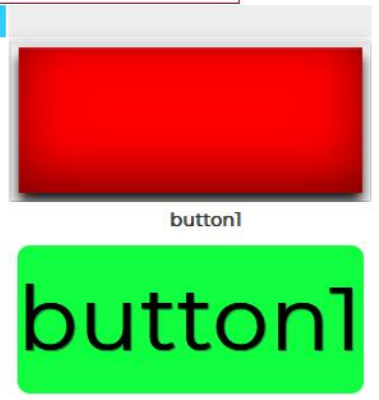
***The same SVG may have some elements working with respect to Server, IoT App, etc., and also with Client Side Business Logic***

# svg_embed1




Privacy Policy Cookies Policy Terms and Conditions Contact us

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mzg0OA==

TOP

# Design and Control of Smart Applications

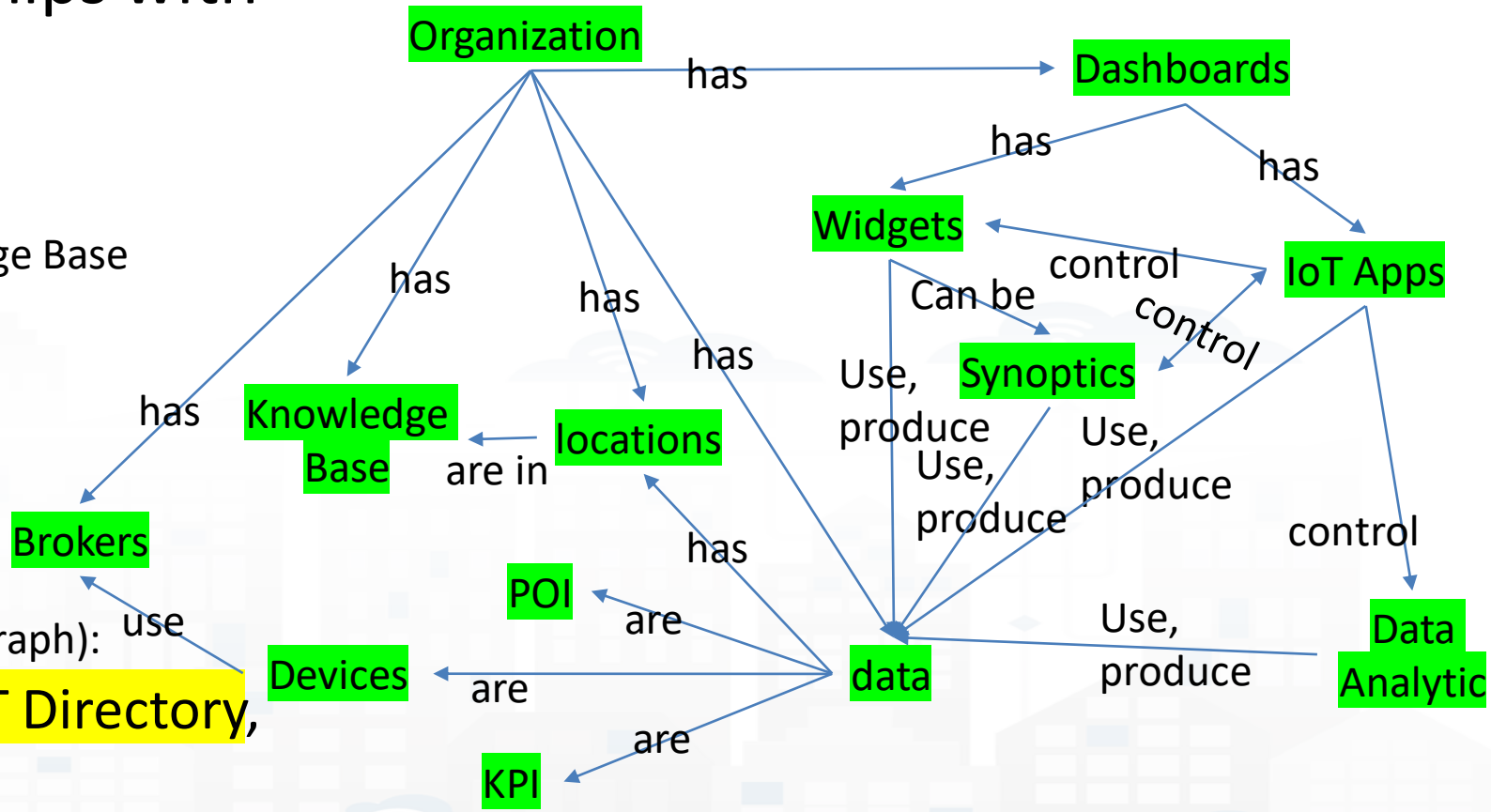
**only for user with RootAdmin role**

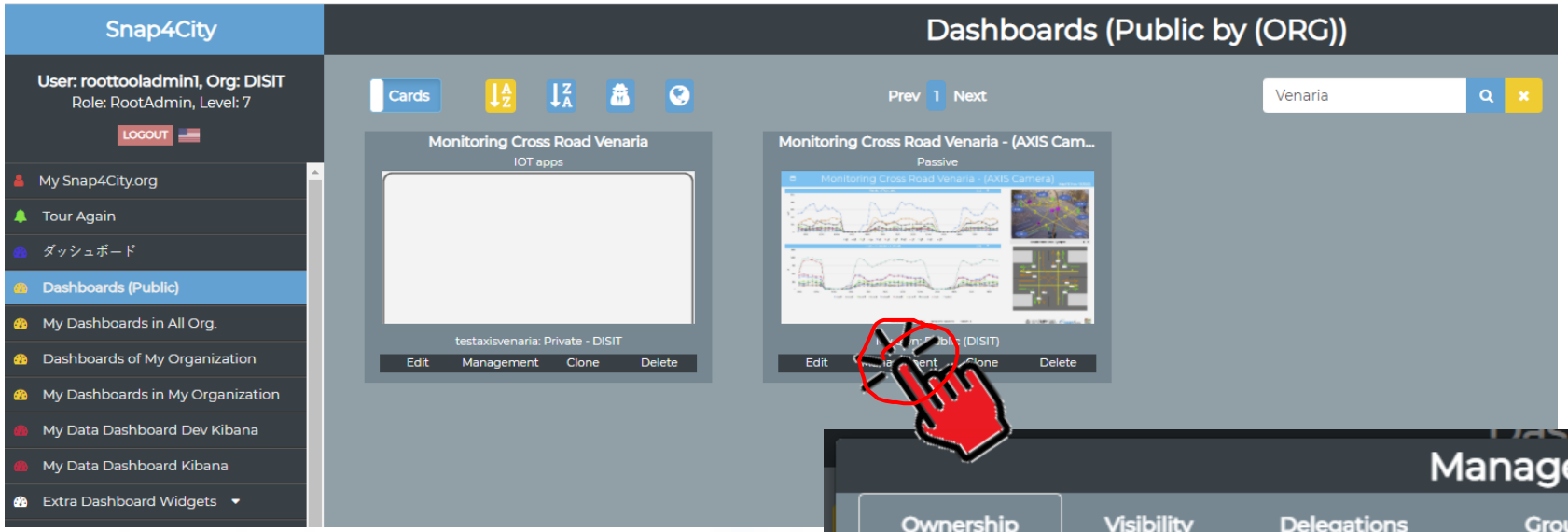
**partially accessible also for all Dashboard owners**

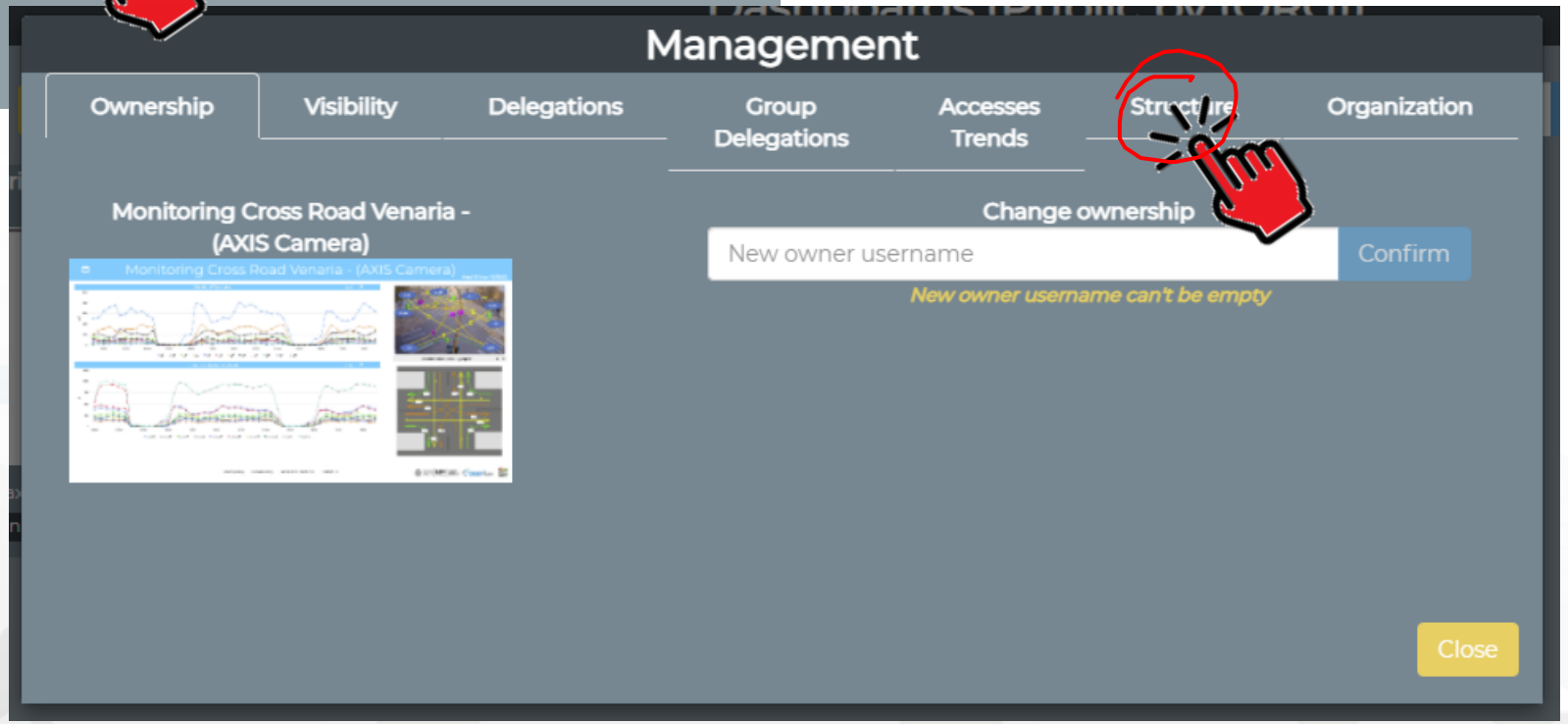


# Semantic Reasoning on Smart Applications

- Dashboards have relationships with
  - Org. at which they belong
  - Widgets with
    - data they use, and each of which
      - is connected with the Knowledge Base
      - May be: device, kpi, etc.
  - IoT Apps with
    - Data they use
    - Data Analytic
    - Widget they control
- Processes are (not in the simplified graph):
  - Data, Broker, Data Analytic, IoT Directory, Device, IoT App, UserInterface
  - owned, and delegated in some manner from the owner to other users



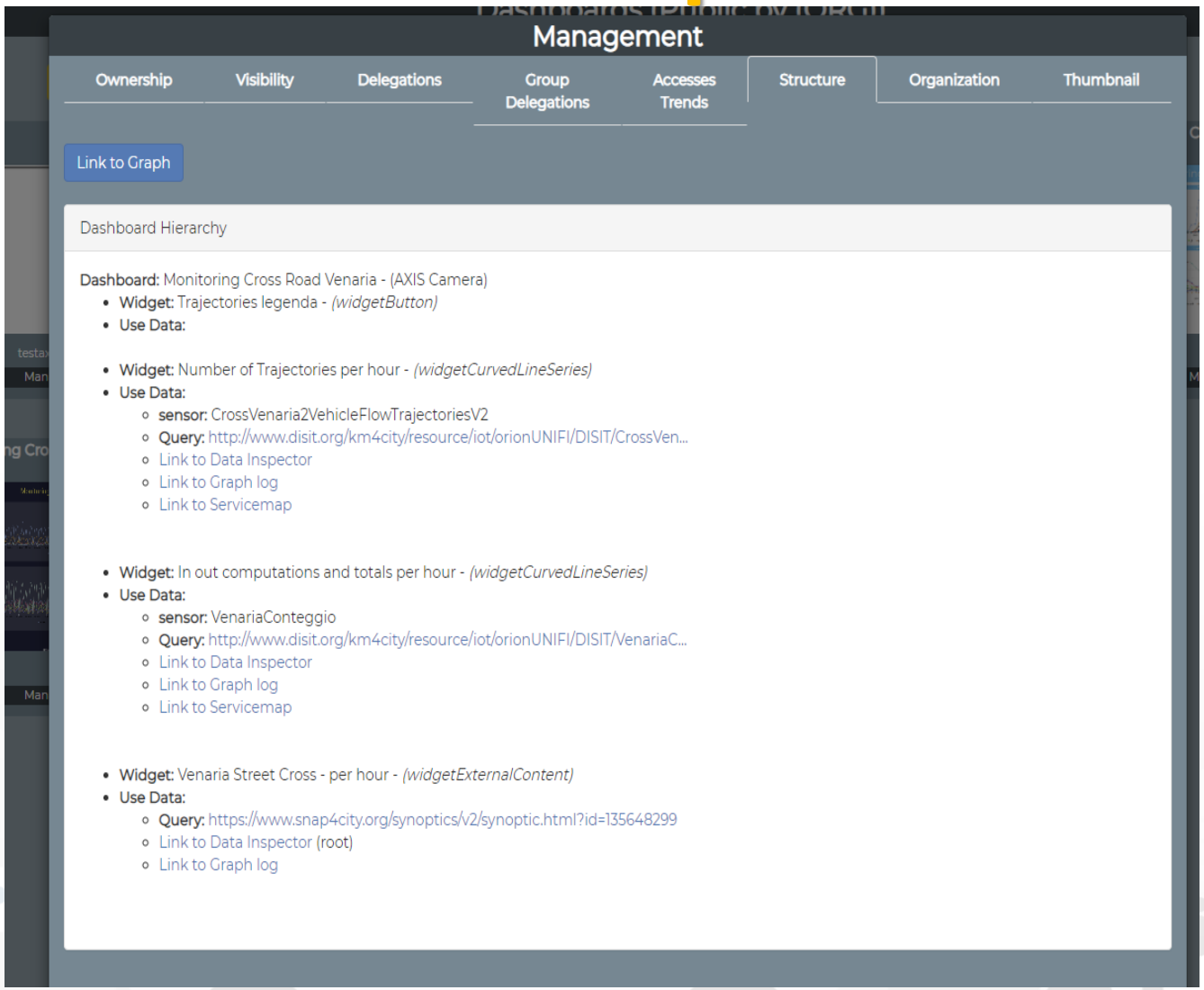

Snap4City
User: roottooladmin1, Org: DISIT
Role: RootAdmin, Level: 7
LOGOUT
My Snap4City.org
Tour Again
ダッシュボード
Dashboards (Public)
My Dashboards in All Org.
Dashboards of My Organization
My Dashboards in My Organization
My Data Dashboard Dev Kibana
My Data Dashboard Kibana
Extra Dashboard Widgets
Dashboards (Public by (ORG))
Cards
Prev 1 Next
Venaria
Monitoring Cross Road Venaria
IOT apps
testaxisvenaria: Private - DISIT
Edit Management Clone Delete
Monitoring Cross Road Venaria - (AXIS Cam...
Passive
Edit Clone Delete


Management
Ownership
Visibility
Delegations
Group Delegations
Accesses Trends
Organization
Monitoring Cross Road Venaria - (AXIS Camera)
Change ownership
New owner username
Confirm
New owner username can't be empty
Close

# Dashboard Structure and Components

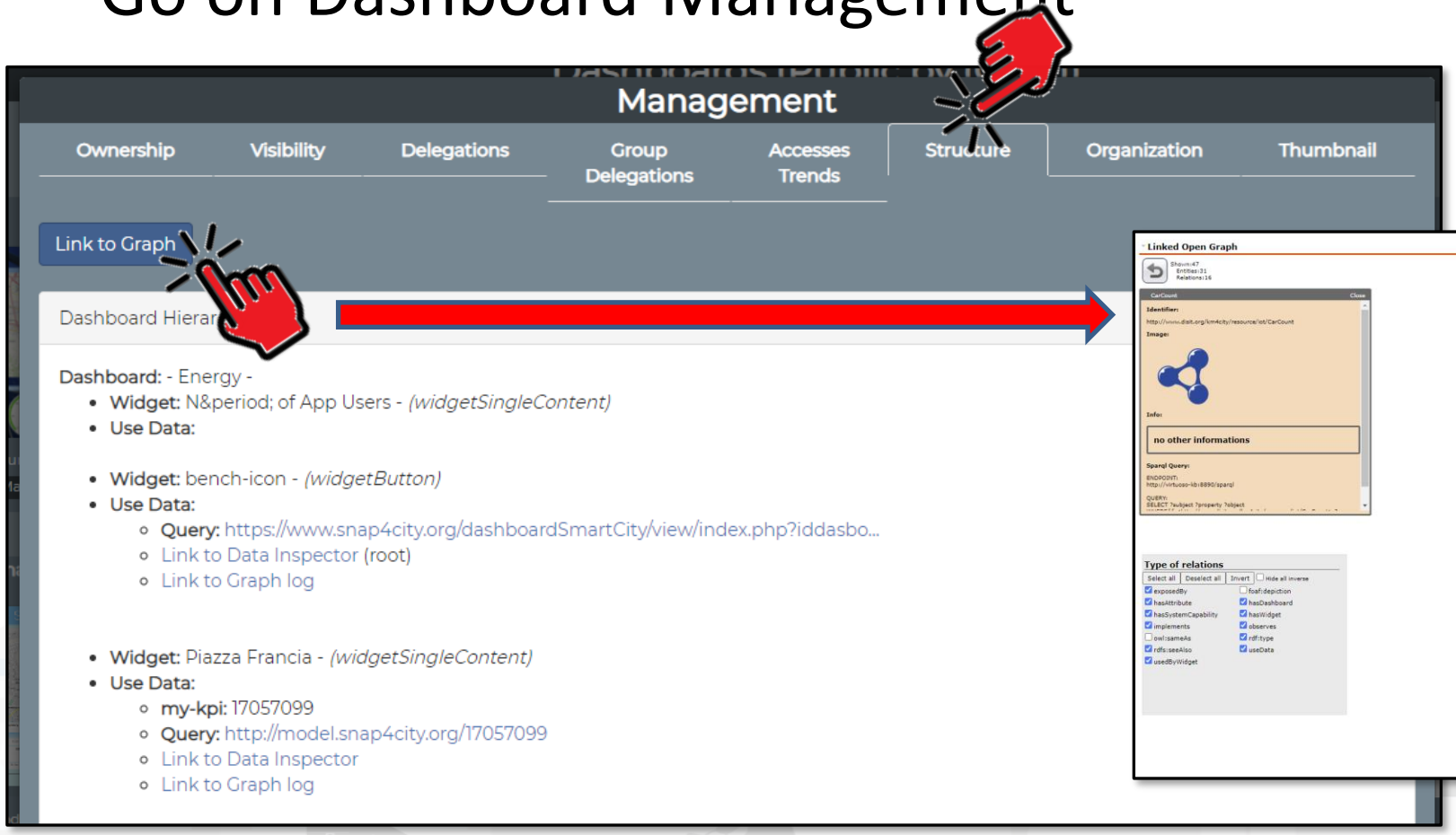
4 Widgets

- Button
  - It is the image
- Curved LineSeries
  - …. Set of data….
- Curved LineSeries
  - ….set of data…
- External Content
  - With synoptic

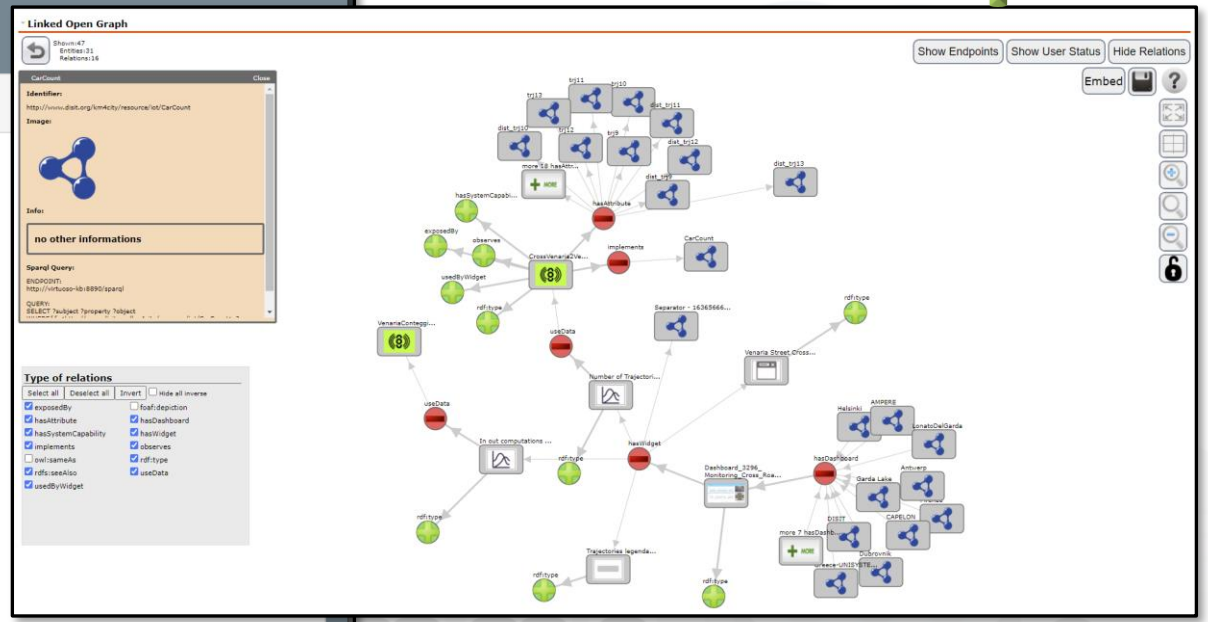


# For All Dashboard owners: Graph and Structure

- Go on Dashboard Management



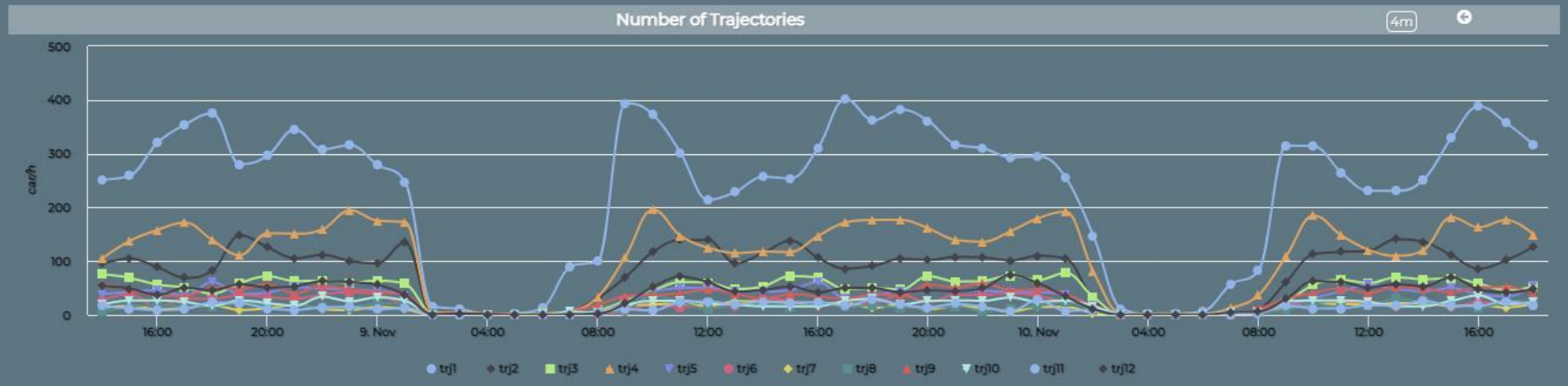

LOGraph

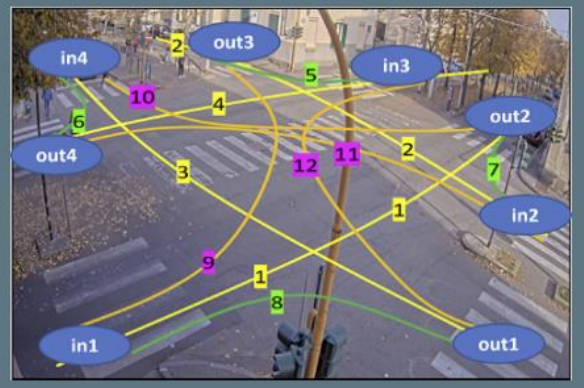


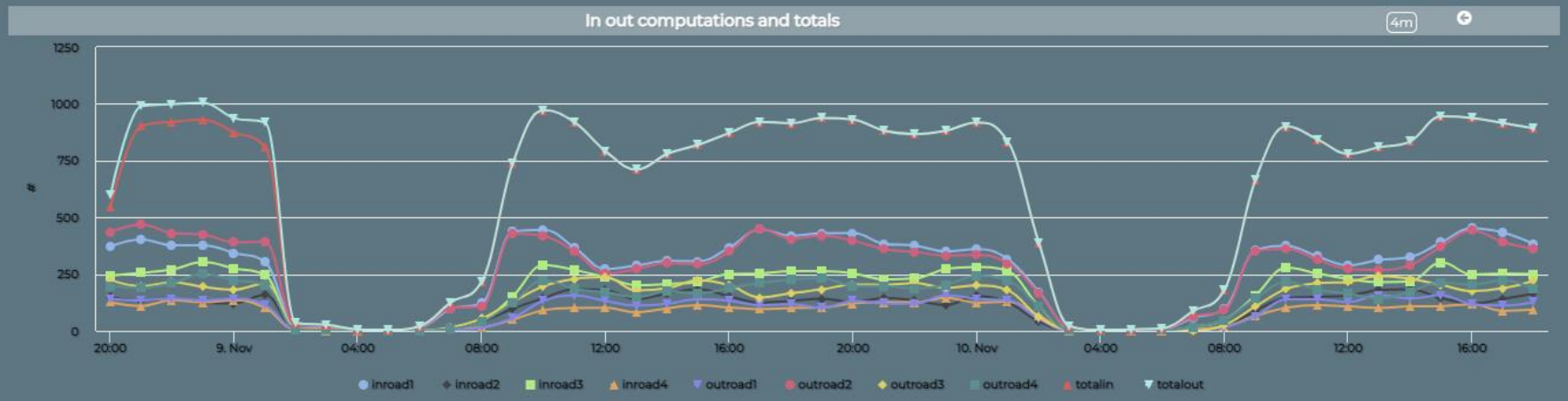
# Venaria Reale

## Monitoring Cross Road Venaria - (AXIS Camera)

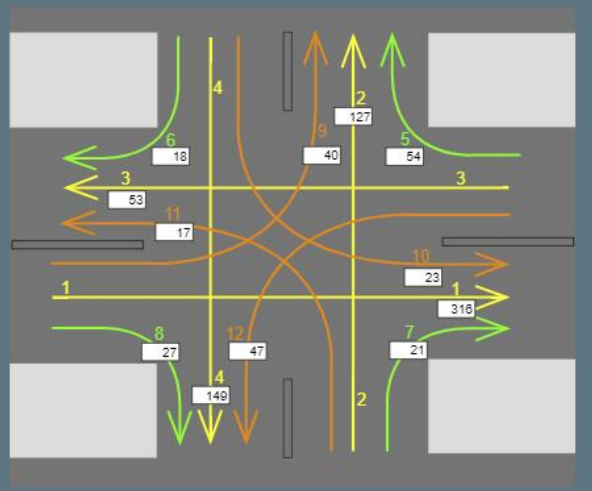
Wed 10 Nov 18:50:53




Venaria Street Cross - Synoptic




https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzI5Ng==

## Linked Open Graph

Shown:47
Entities:31
Relations:16

**CarCount** Close

**Identifier:**
http://www.disit.org/km4city/resource/iot/CarCount

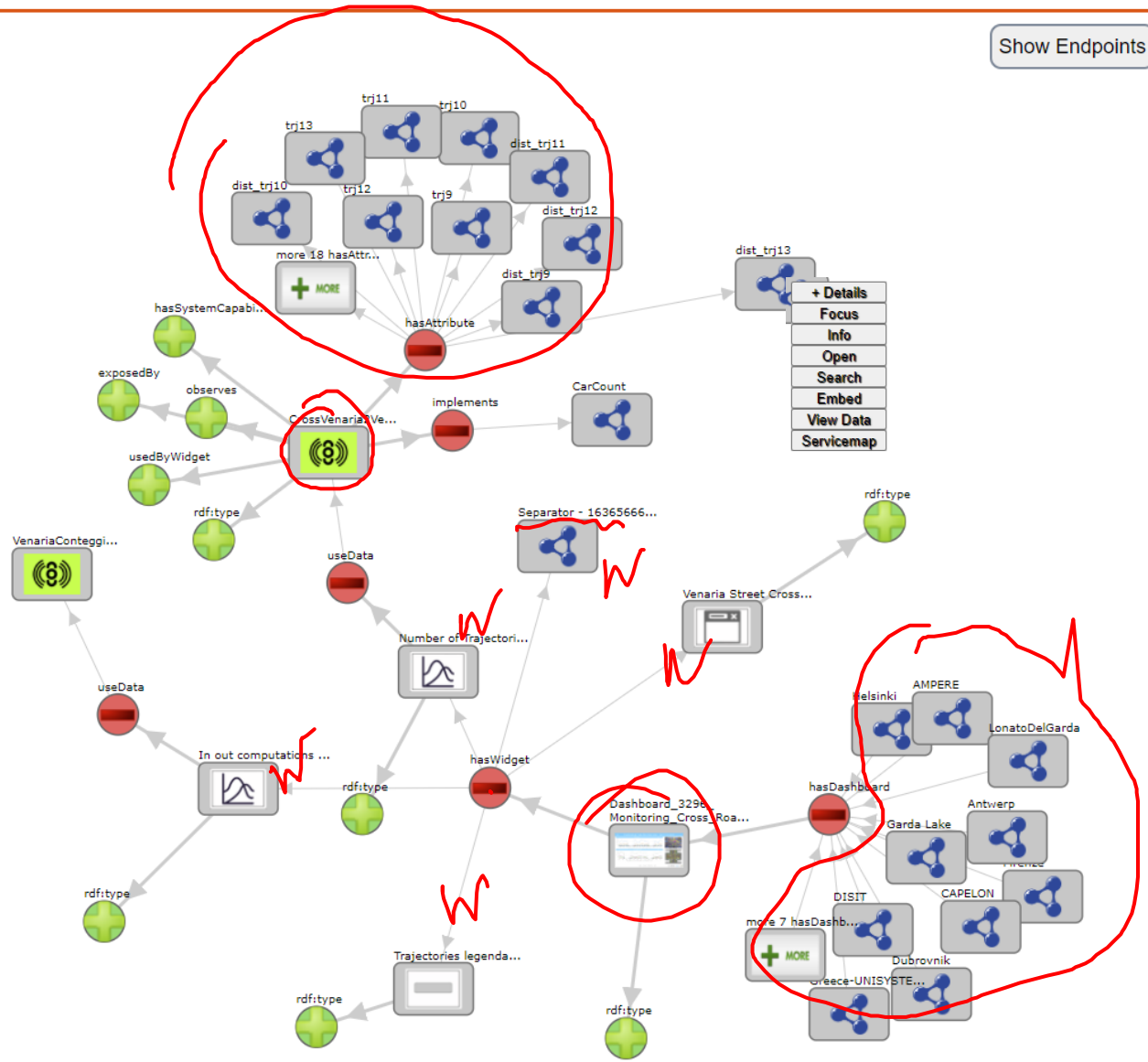
**Image:**

**Info:**
no other informations

**Sparql Query:**
ENDPOINT:
http://virtuoso-kb:8890/sparql

QUERY:
SELECT ?subject ?property ?object

Show Endpoints | Show User Status | Hide Relations | Embed

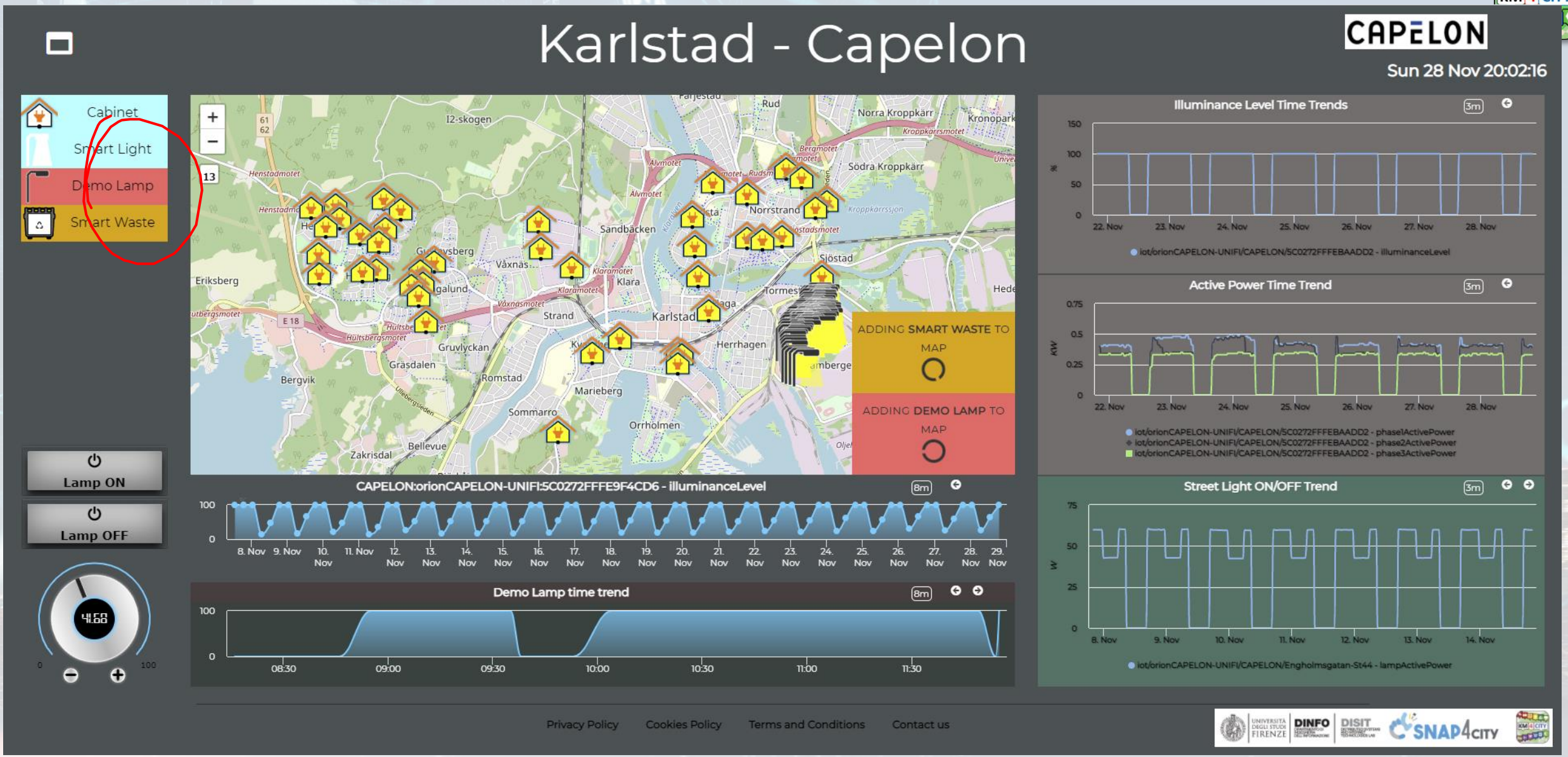



### Type of relations

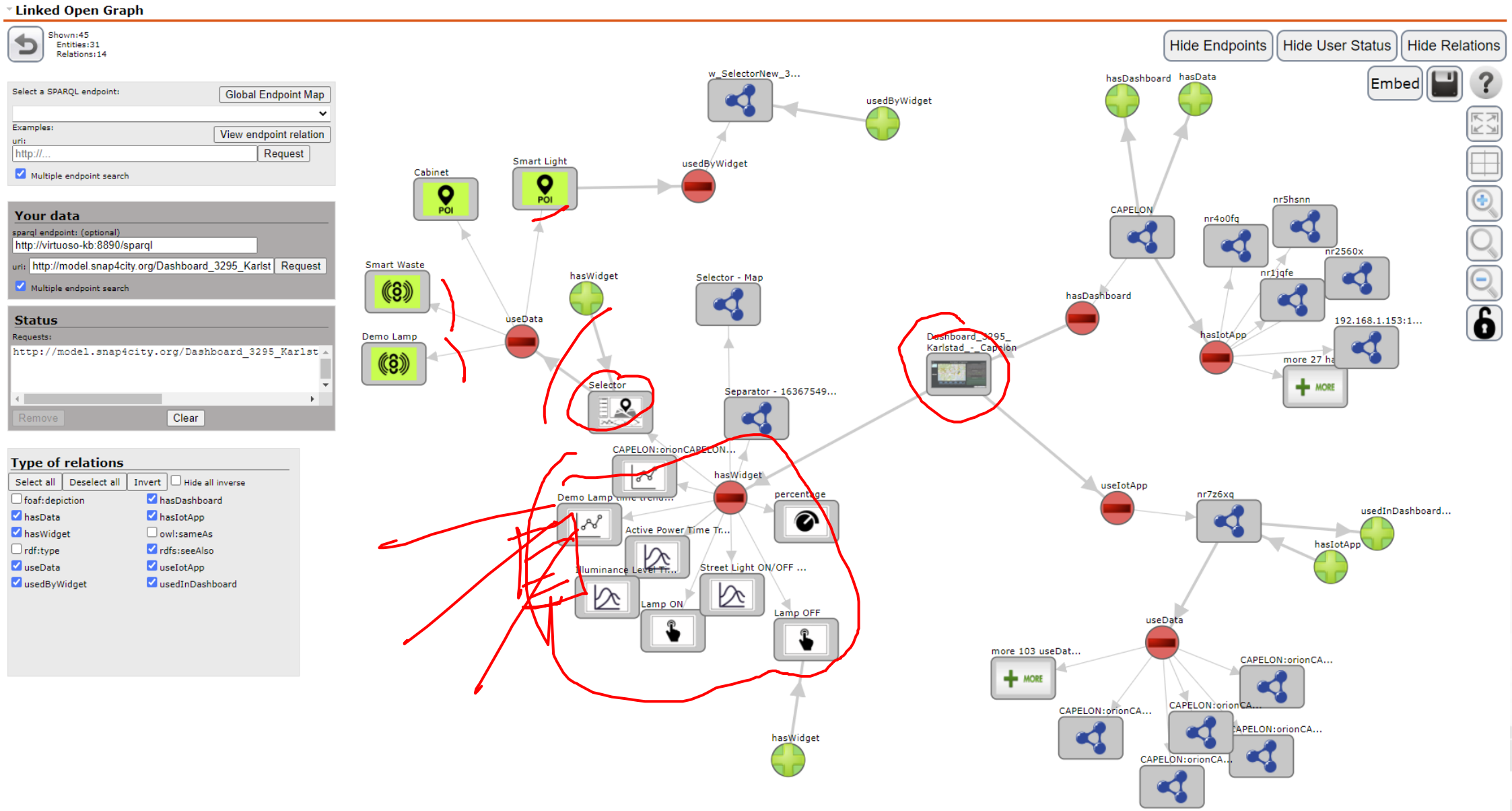
Select all | Deselect all | Invert | Hide all inverse

| | |
|---|---|
| exposedBy | foaf:depiction |
| hasAttribute | hasDashboard |
| hasSystemCapability | hasWidget |
| implements | observes |
| owl:sameAs | rdf:type |
| rdfs:seeAlso | useData |
| usedByWidget | |

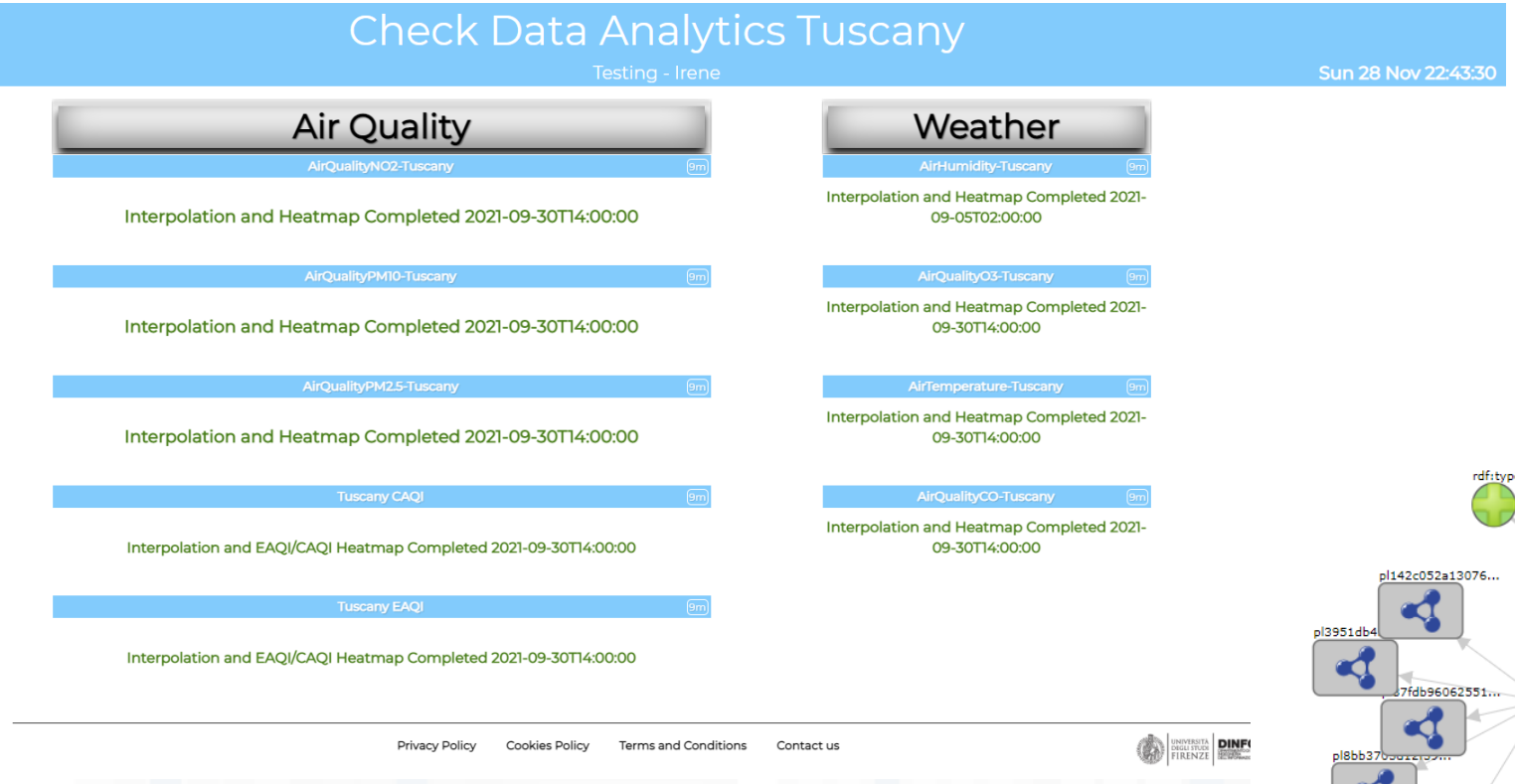
# Karlstad Street Lights

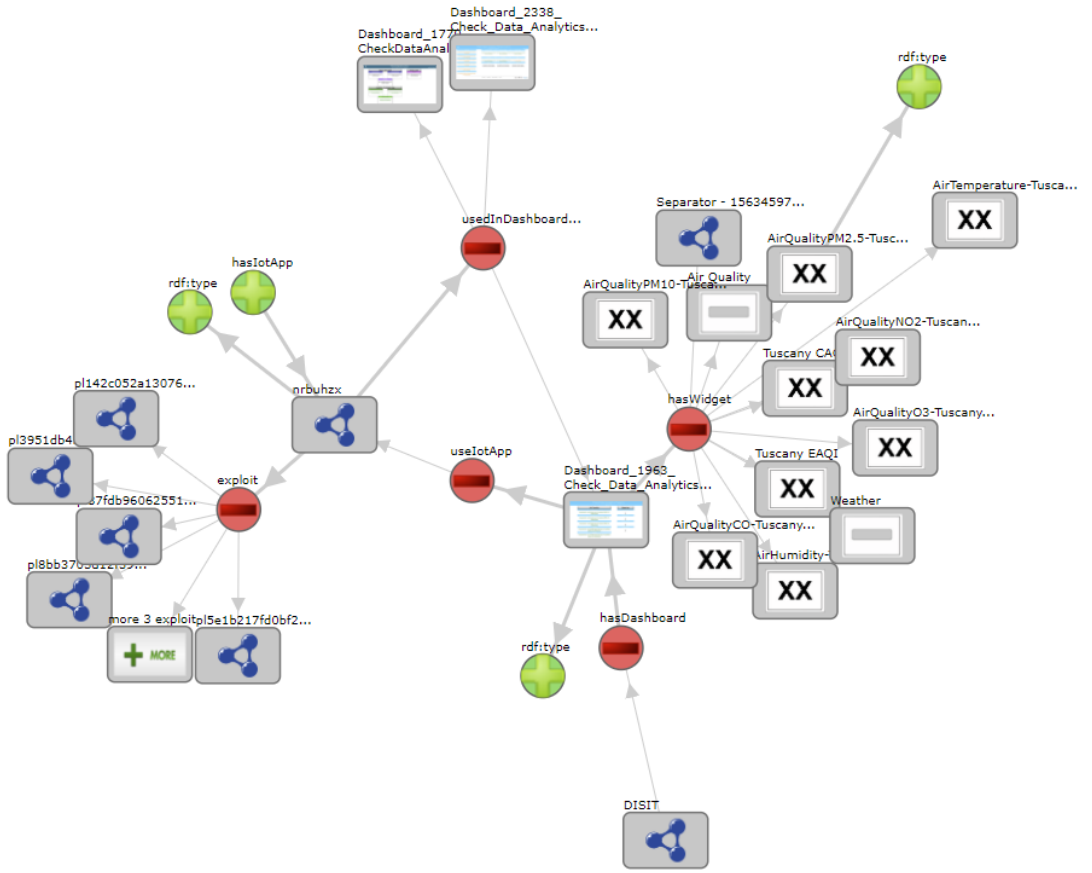



https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzI5NQ==


Linked Open Graph
Shown:45
Entities:31
Relations:14
Select a SPARQL endpoint:
Global Endpoint Map
Examples:
uri:
View endpoint relation
http://...
Request
Multiple endpoint search
Your data
sparql endpoint: (optional)
http://virtuoso-kb:8890/sparql
uri:
http://model.snap4city.org/Dashboard_3295_Karlst
Request
Multiple endpoint search
Status
Requests:
http://model.snap4city.org/Dashboard_3295_Karlst
Remove
Clear
Type of relations
Select all
Deselect all
Invert
Hide all inverse
foaf:depiction
hasData
hasWidget
rdf:type
useData
usedByWidget
hasDashboard
hasIotApp
owl:sameAs
rdfs:seeAlso
useIotApp
usedInDashboard
Hide Endpoints
Hide User Status
Hide Relations
Embed
w_SelectorNew_3...
usedByWidget
Cabinet
POI
Smart Light
POI
usedByWidget
Smart Waste
hasWidget
Selector - Map
Demo Lamp
useData
Selector
Separator - 16367549...
CAPELON:orionCAPELON...
hasWidget
Demo Lamp time trend...
percentage
Active Power Time Tr...
Illuminance Level Tr...
Street Light ON/OFF ...
Lamp ON
Lamp OFF
hasWidget
hasDashboard
hasData
CAPELON
nr4o0fq
nr5hsnn
nr2560x
nr1jqfe
hasDashboard
hasIotApp
192.168.1.153:1...
more 27 ha...
MORE
Dashboard_3295_
Karlstad_-_Capelon
useIotApp
nr7z6xq
usedInDashboard...
hasIotApp
useData
more 103 useDat...
MORE
CAPELON:orionCA...
CAPELON:orionCA...
CAPELON:orionCA...
CAPELON:orionCA...
CAPELON:orionCA...

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTk2Mw==






# What is missing here and you can get from former course

# What is missing here and you can find in the former course

https://www.snap4city.org/577

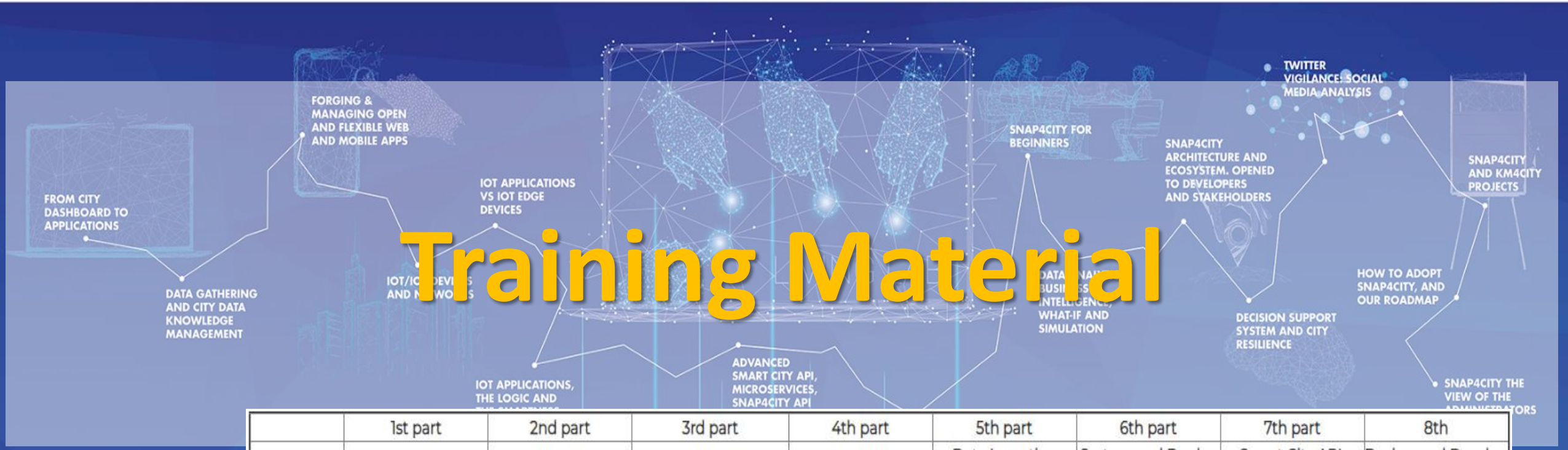
- Data Streams from partecipatori, Mobile App
- Data streams from Mobile vehicles and smart phones Devices
- Data Ingestion via Web Scraping
- Data stream from TV Cameras, TV Cam Manager
- From external API to Node-RED node/block automatically
- Social Media interoperability

- **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
- VM based installation of Snap4City
- ETL: Penthao Kettle interoperability

# 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 |
|  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |




# 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** !

Share / Save ...

Add to your favorites





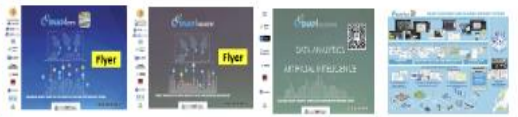

















































- TECHNICAL OVERVIEW: https://www.snap4city.org/download/video/Snap4City-PlatformOverview.pdf
- Development Life Cycle: https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf
- Client-Side Business Logic Widget Manual: https://www.snap4city.org/download/video/ClientSideBusinessLogic-WidgetManual.pdf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






## 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

Privacy Policy | Cookies Policy






# Snap4City: Smart aNalytic APp builder for sentient Cities and IOT

You can't delete this newsletter because it has not been sent to all its subscribers.

















































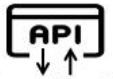
































- TECHNICAL OVERVIEW: https://www.snap4city.org/download/video/Snap4City-PlatformOverview.pdf
- Development Life Cycle: https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf
- Client-Side Business Logic Widget Manual: https://www.snap4city.org/download/video/ClientSideBusinessLogic-WidgetManual.pdf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

Username: paolo.disit

## Search

Search
-Any-

Training on Tools and Platform

Powered by www.km4city.org

FIWARE | Node-RED

Sii-Mobility

## Organization Groups

DISIT
- Developer
- Operativo

## Updates on

# booklets

- Smart City




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

- Industry




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

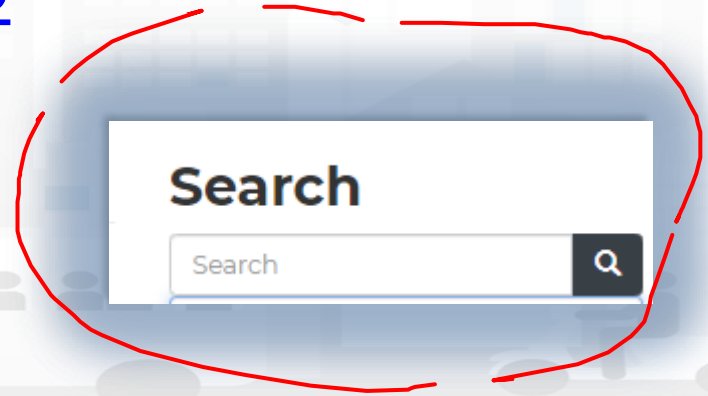
- Artificial Intelligence

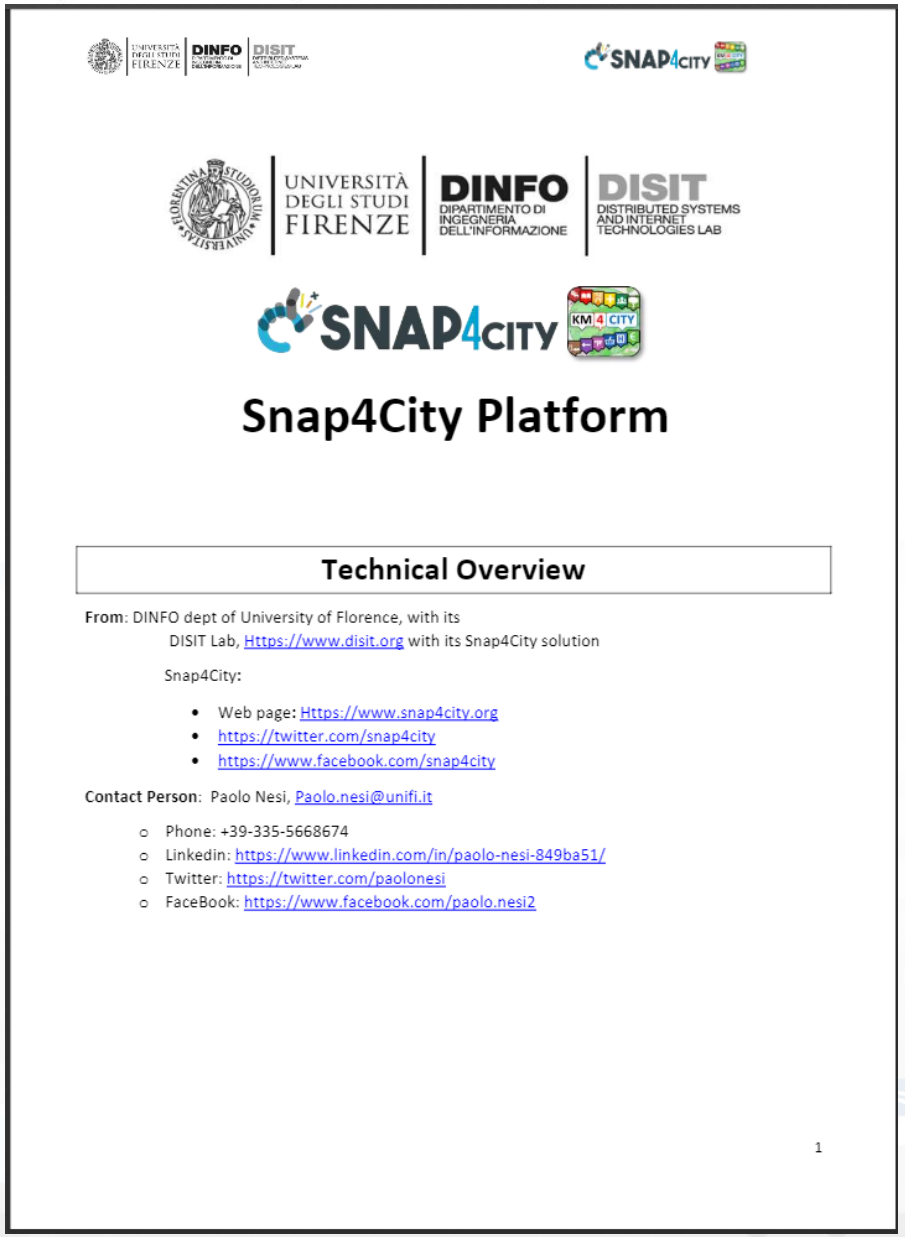



https://www.snap4city.org/download/video/DPL_SNAP4SOLU.pdf

# 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

- 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

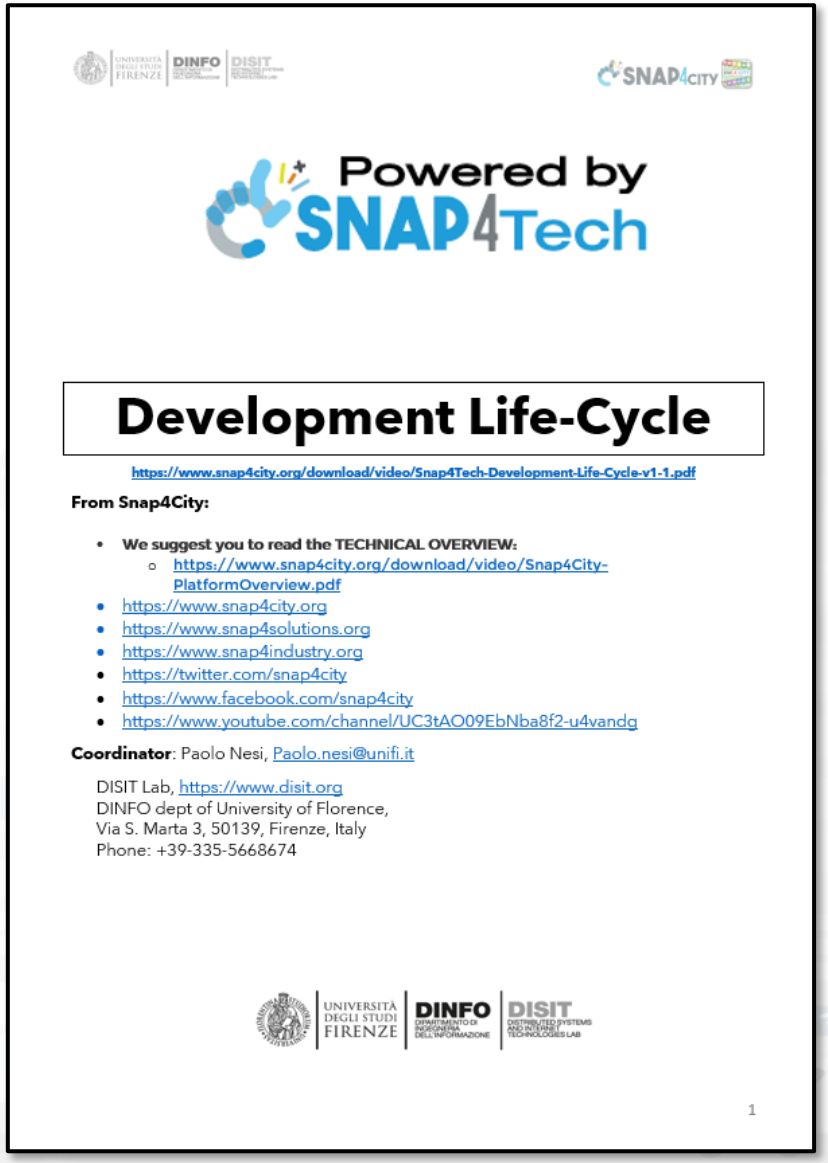
1

# Tech. Overview

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

# Development

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



Powered by SNAP4Tech

## Development Life-Cycle

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

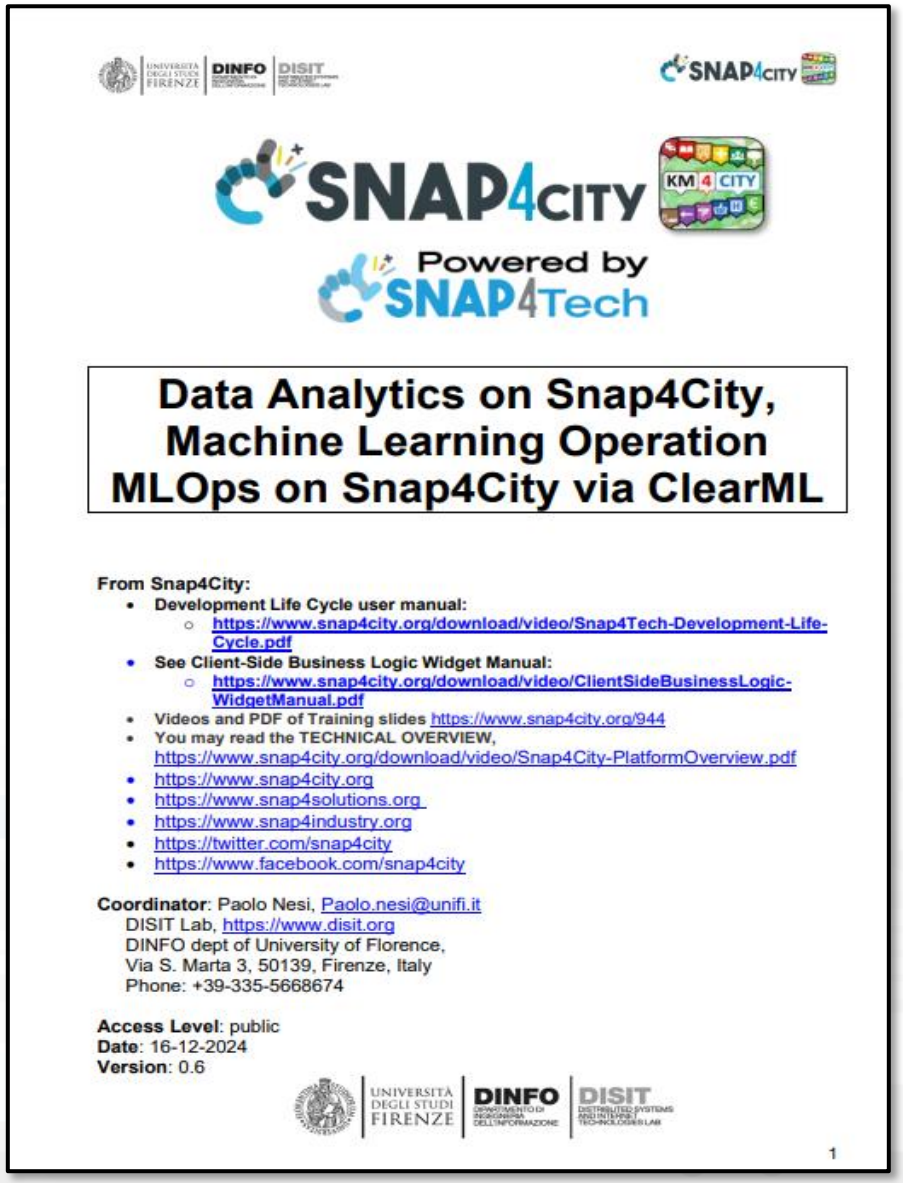
**From Snap4City:**

- **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

1



SNAP4CITY

Powered by SNAP4Tech

**Data Analytics on Snap4City, Machine Learning Operation MLOps on Snap4City via ClearML**

**From Snap4City:**

- **Development Life Cycle user manual:**
  - https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf
- **See Client-Side Business Logic Widget Manual:**
  - https://www.snap4city.org/download/video/ClientSideBusinessLogic-WidgetManual.pdf
- Videos and PDF of Training slides https://www.snap4city.org/944
- You may 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

**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

**Access Level**: public
**Date**: 16-12-2024
**Version**: 0.6

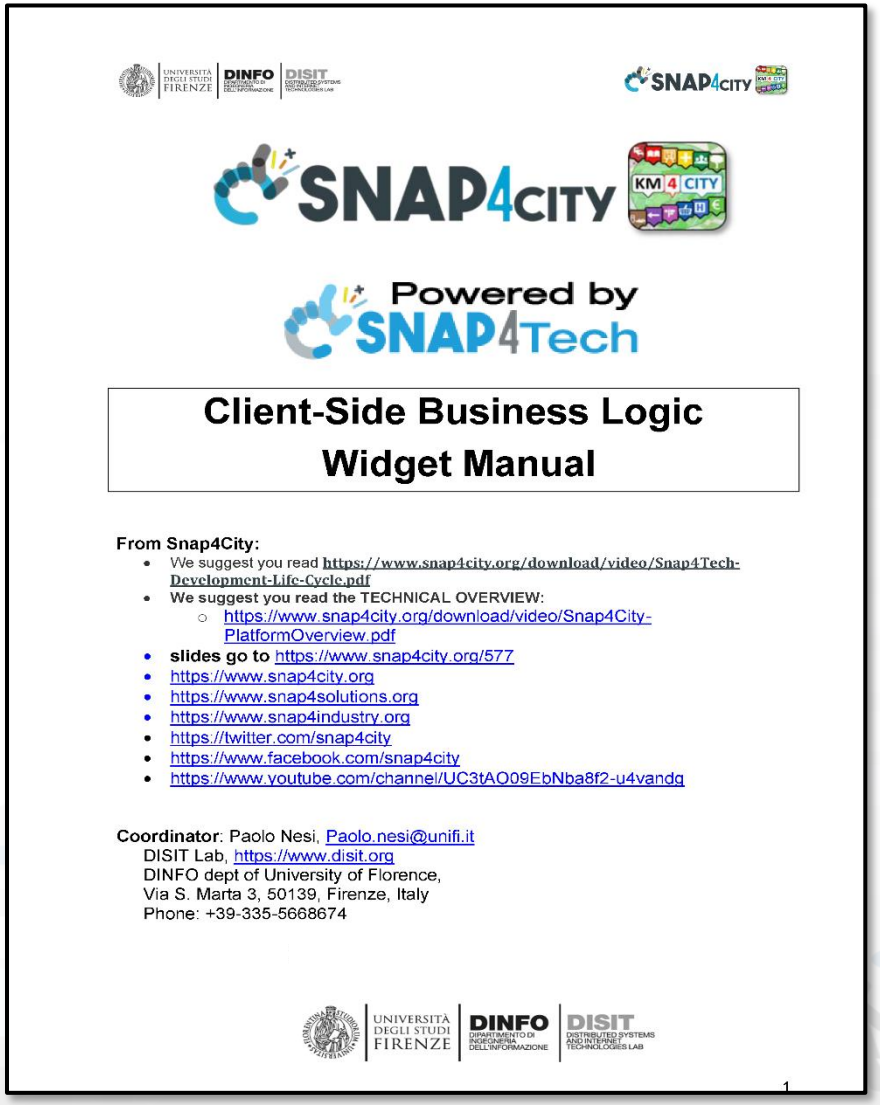
1

# MLOperation

https://www.snap4city.org/download/video/Snap4City-MLOps-Manual.pdf

# CSBL

# Client Side Business Logic



Powered by SNAP4Tech

**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/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

1

https://www.snap4city.org/download/video/ClientSideBusinessLogic-WidgetManual.pdf




# 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)

(2016-21) H2020 REPLICATE

- Smart Energy
- Sustainable Mobility
- Control Room
- Dashboard

Km4City 1.6.2

Sii-Mobility (2016-21) MIUR

SII-MOBILITY SCN

- Infomobility
- Mobile App
- Routing
- Multimodality

## 2016
FIWARE

Km4City 1.6.4

Sii-Mobility

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

E015 digital ecosystem (Powered by EXPO MILANO 2015)

(2016-19) MIUR GHOST SIR

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

life weee (2017-20)

- Smart Waste

MOSAiC Mobility 4.0 for SmArt (i) City (POR CreO, Regione Toscana)

(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)

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

SIRIUS

LAID Smart Bed (POR CreO, Regione Toscana)

- Smart Health

GREEN FIELD PEAS Soda4.0 Optimization and Automated Decision System 4.0 (POR CreO, Regione Toscana)

- Industry 4.0

bee smart city

- Smart Lonato

Reverberi Enetec Gruppo MPES

SODA

Winner of Select4Cities PCP

SELECT for Cities — CERTIFICATE OF ACHIEVEMENT — 1° place award to — UNIVERSITY OF FLORENCE - DEPARTMENT OF INFORMATION ENGINEERING — SNAP4CITY — DIGIPOLIS FORUM VIRIUM HELSINKI CITY OF COPENHAGEN Buyers Group

SNAP4CITY KM4CITY

# SNAP4CITY roadmap

Smart Ambulance (2021-22)

Enterprise (2021-22) Industry 4.0

Almafluida Industry 4.0 (2021-22)

Contract, 2022-23

CN MOST, 2022-26

ELLIE IA 2025-2027

UrbanDT4TF

## 2020

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

Contract

- Smart Mobility
- PISA, PUMS
- Living lab

## 2021

Sii-Mobility

Contract

Contract

PC4City (2020-21) Monitoring Terrain

Winner of Open Data Challenge of

- Smart Light
- Sweden

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

Italferr, Smart City

## 2023

Contract, 2022-23

2022-2023

Contract, 15min

Security and Risk

EI THE, 2022-26

G. Agile, 2021-23

2023-26

Merano, smart light

OceanRace, Genova, AWS

Cuneo, smart city

## 2024

Km4City 1.6.8

TOURISMO

Contract, 2024-25

CAI4DSA

Future Artificial Intelligence Research

OPTIFaaS

SASUAM

Rhodes, smart city

eShare UNIFI TUSS

AMMIRARE

Km4City 1.6.7

# Currently 2025

- **UrbanDT4TF**, CN HPC: Digital Twin mobility, https://www.snap4city.org/drupal/node/1057
- **DI-DTPlatform**, CN HPC: Digital Twin, mobility, environment, https://www.snap4city.org/drupal/node/1097
- **Sasuam**, CN MOST, PNRR: AI, mobility, https://www.snap4city.org/drupal/node/999
- **OPTIFaaS**, CN MOST, PNRR: AI, mobility, DSS, https://www.snap4city.org/drupal/node/1008
- **LeverageOPTIFaaS**, CN MOST: PNRR, mobility, https://www.snap4city.org/drupal/node/1064
- **TOURISMO**, Interreg, EC: Tourism, NLP, DSS, https://www.snap4city.org/drupal/node/1001
- **ELLIE**, Horizon Europe, EC: AI, VR, https://www.snap4city.org/drupal/node/1056
- **CN MOST**, PNRR: sustainable mobility, platform, https://www.snap4city.org/drupal/node/1050
- **ISPRA JRC contract**, EC: DSS, SOC, control room, energy, https://www.snap4city.org/drupal/node/970
- **AMMIRARE**, Interreg, EC: AI, environment, Big Data, https://www.snap4city.org/drupal/node/1002
- **CAI4DSA**, FAIR PE1, PNRR: AI, Neuro-Symbolic, PINN, NG-DSS, https://www.snap4city.org/drupal/node/1016
- **SADI-MIAC**, RT, partner: AI, Tourism, Retail, Computer Vision, https://www.snap4city.org/drupal/node/1055
- **SMART3R,** PRIN UNICagliari: mobility, DSS, https://www.snap4city.org/drupal/node/1087
- **Tuscany X.0, EDIH,** TestBeforeInvest, Training on AI, Big Data, Security, HPC: https://www.tuscanyx.eu/
- **The IE**, PNRR: AI, NLP, LLM, Legal Aspects
- **BullVIT** , RT, conv**:** NLP, LLM
- **Energia**, RT, conv: AI, PINN, DSS
- **RFI contract**: mobility, AI, DSS
- **Salerno Port**: container ID recognition and tracking
- **Talent Hub**, ECRF, conv: NLP, match demand vs offer

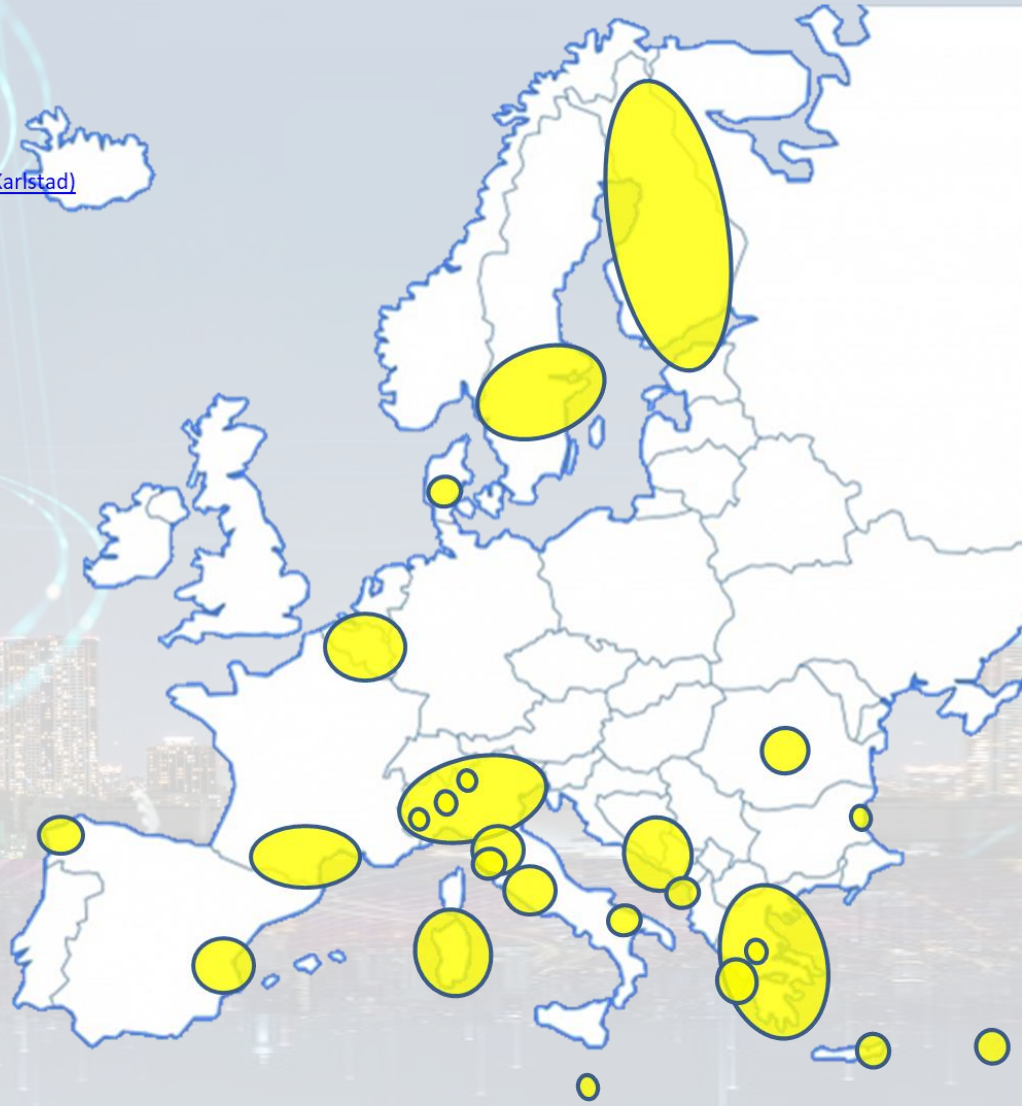
+ currently: Merano, Salerno, Cuneo, Rhodes, Reverberi, Florence, IDTS, ALTAIR, etc.

# https://www.Snap4City.org

- 11 running installations in Europe
  - Snap4city.org, Greece, Merano, Cuneo, …
  - Toscana, Pisa, Sweden, ISPRA, Snap4.eu,
  - Altair, Italmatic, M4F, Romania, ….
- 20 projects, 12 pilots on 10 Countries
  - >40 cities/area
- **Widest MULTI-tenant deploy has**
  - 26 Organizations / tenant
  - > 8850 users on
  - > 1800 Dashboards
  - > 17 mobile Apps
  - **> 2.2 Million of structured data per day**
  - > 580 IoT Applications/node-RED
  - > 850 web pages with training
  - > 85 videos, training videos

**Main Organizations/areas**

- Antwerp area (Be)
- Bari (I)
- Bisevo, Croatia
- Bologna (I)
- Brasov (Ro), by ICEBERG
- Capelon (Sweden: Västerås, Eskilstuna, Karlstad)
- Cuneo (I)
- DISIT demo (multiple)
- Dubrovnik, Croatia
- Firenze area (I)
- Garda Lake area (I)
- Greece (Gr)
- Helsinki area (Fin)
- Limassol (Cy)
- Livorno area (I)
- Lonato del Garda (I)
- Malta (Malta)
- Merano (I)
- Modena (I)
- Mostar, Bosnia-Herzegovina
- Oslo & Padova (Impetus)
- Pisa area (I)
- Pistoia (I)
- Pont du Gard, Occitanie (Fr)
- Prato (I)
- Rhodes (Gr)
- Roma (I)
- Santiago de Compostela (S)
- Sardegna Region (I)
- Siena (I)
- SmartBed (multiple)
- Toscana Region (I), SM
- Valencia (S)
- Varna (Bulgaria)
- Venezia area (I)
- WestGreece area (Gr)



- **+ Israel, Colombia, Brasile, Australia, India, China, etc.**

# SNAP4CITY

KM4CITY

CITY

INDUSTRY

ARTIFICIAL INTELLIGENCE

MOST Centro Nazionale per la Mobilità Sostenibile

SASUAM

LUTECH

Università degli Studi di Napoli Federico II

Funded by the European Union NextGenerationEU

PTIFaaS

Università degli Studi Firenze

DINFO Dipartimento di Ingegneria dell'Informazione

DISIT

Politecnico di Bari

FAIR Future Artificial Intelligence Research

MUR

CAI4DSA

UNIVERSITÀ DEGLI STUDI DI CAGLIARI

MUR

Interreg Maritime-IT FR-Maritime

AMMIRARE

TOURISMO

Interreg Euro-MED

Co-funded by the European Union

SADI-MIAC

Coesione Italia Toscana

Cofinanziato dall'Unione europea

Regione Toscana

ELLIE

Funded by the European Union

Comune di Firenze

ASM Meran Stadtwerke Meran

Città di Cuneo

Rodhes

Development Agency of Iemesos LTD

Santa María la Real fundación

Fundación Valenciaport

READ S.A. Development Agency of South Aegean Region

Varna Economic Development Agency

rerasd

MRDD Foundation

SNAP4 CAPELON

uni.systems

European Commission Joint Research Centre

italmatic Autoclaves Ovens & Rollers

cyta

100% Open Source

FREE TRIAL

PEN Test Passed

EU GDPR COMPLIANT

SNAP4 Appliances and Dockers Installations

EUROPEAN OPEN SCIENCE CLOUD

Node-RED

NVIDIA

Powered by FIWARE

FIWARE SERVICES Training & Coaching

FIWARE SERVICES Consultancy & Integration

gaia-x

JS Foundation

E015 digital ecosystem

TOP

SNAP4CITY

KM4CITY

*Be smart in a SNAP!*

100% OPEN SOURCE

SMARTCITY EXPO WORLD CONGRESS

SNAP4 Appliances and Dockers **Installations**

## CONTACT


DISIT Lab, DINFO: Department of Information Engineering
Università degli Studi di Firenze - School of Engineering

Via S. Marta, 3 - 50139 Firenze, ITALY
https://www.disit.org

www.snap4city.org

Email: snap4city@disit.org

Office: +39-055-2758-515 / 517
Cell: +39-335-566-86-74
Fax.: +39-055-2758570


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