Snap4Industry

*Tools for
rapid implementation of
- Sustainable Smart Solutions
- Decision Support Systems
as a no-coding, low-coding*

info@disit.org
https://www.Snap4city.org,
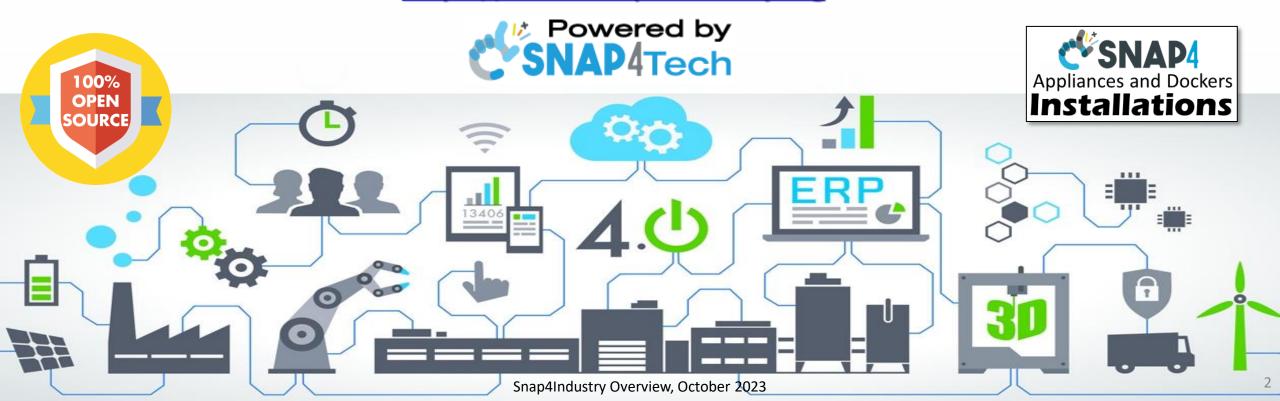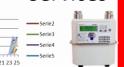*https://www.Snap4Industry.org*

SNAP4CITY

KM 4 CITY

Powered by SNAP4Tech

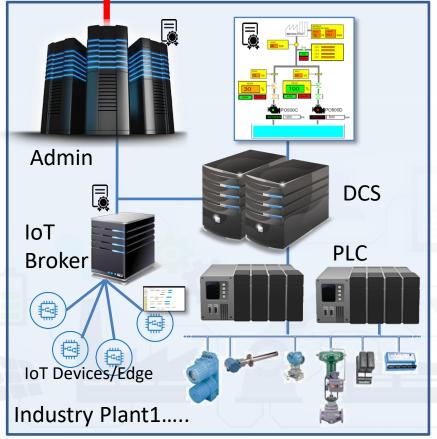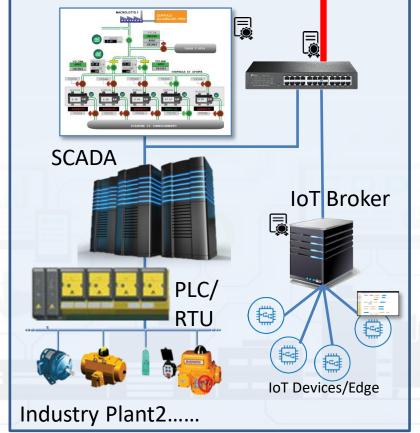https://www.snap4industry.org

https://www.snap4city.org/369

SNAP4INDUSTRY

External Services

Fleet management

IoT Devices/Edge

IoT Broker

Internet

SECURE

Admin

IoT Broker

DCS

PLC

IoT Devices/Edge

Industry Plant1…..

SCADA

PLC/RTU

IoT Broker

IoT Devices/Edge

Industry Plant2……

IOT Applications

Dashboards and Apps

Big Data Analytics, Artificial Intelligence
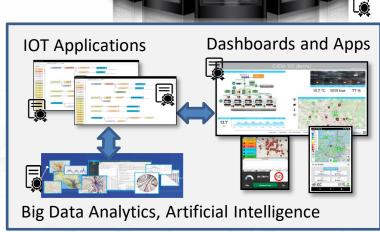
Control and Supervision on Multiple Supply Chains

Industry 4.0 as a Service

3

- **Aims**
  - **Increase**:
    - control, telecontrol and hyper-automation
    - Product Quality, Control, process understanding
  - **Reduce**:
    - Downtime, Costs (reducing waste), and Reaction Time to unpredicted events
- **By Means**
  - **Data aggregation, modelling, integrating and exploiting data of**
    - Digital Twin, IoT Brokers/Edge, SCADA, MES, ERP, DCS, Admin Data, BIM, Ticketing, etc.
    - Ontology and semantic reasoner for the industry plant
  - **Data Analytics:**
    - **descriptive, predictive and prescriptive**
    - **Beyond: Decision Support Systems, DSS**
      - Simulation, Visual Analytics, Data Analytics, Synoptics
      - XAI on predictions, anomaly detection (early warning), classifications
  - **Large Scale Integration**
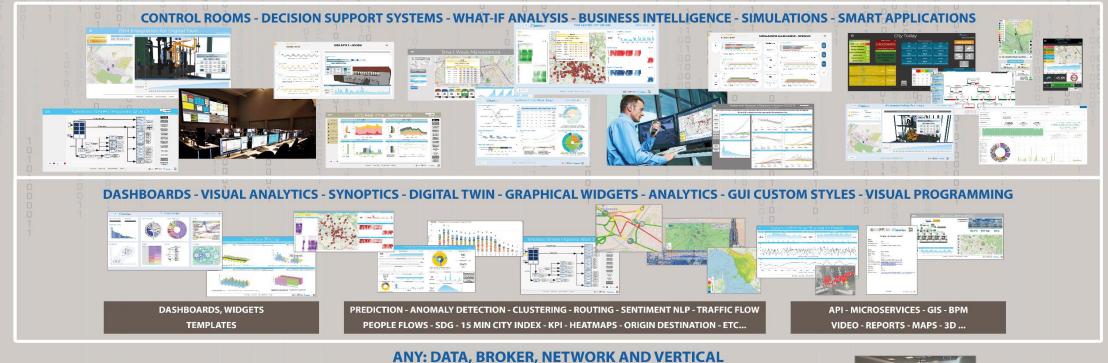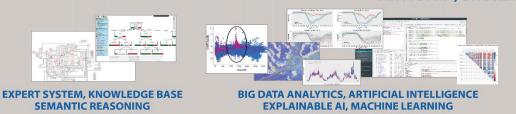 - **Security, privacy, ethics, GDPR, etc**.
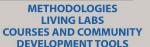
Smart Solutions and Decision Support Systems

UNIVERSITÀ DEGLI STUDI FIRENZE — DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE — DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB — SNAP4INDUSTRY — KM4CITY

100% OPEN SOURCE

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.

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

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

DASHBOARDS, WIDGETS TEMPLATES

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

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

ANY: DATA, BROKER, NETWORK AND VERTICAL

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

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

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

METHODOLOGIES
LIVING LABS
COURSES AND COMMUNITY
DEVELOPMENT TOOLS

CONTROL ROOM — ADMIN — MAINTENANCE — SERVER — PLC — DCS/SCADA — MES — LOGISTICS — WASTE — DRONES — ENERGY — ENVIRONMENT — CO_2

Tech Arch

SNAP4INDUSTRY

Entity Directory:
Smart Data Models
IoT Data Models
Digital Twins

FIWARE

Brokers
Brokers
Brokers

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

Node-RED

IoT App ProcLog.

On Edge
On Cloud

IoT App

API Manager

Federation Smart City API

OpenSearch

storage

KB, graph

virtuoso

GeoServer   **EntityInspector**

BIMserver.center   **Data Managers**

python
R Studio

Data Analytics:
ML, AI, XAI

Event Driven

Web and Mobile Apps

Smart Applications

Waste	Park	Light
Energy	Environment
Maintenance	......
Apps	Mobile App

Visual Analytics tools

Business Intelligence CSBL

Dashboard Bld & Mng

Service Map

HLT Manager

Synoptics

3D Digital Twin

Market/Sharing Place

Third parties solutions

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

09/23

8

Tech Arch

Big Data Analytics + Artificial Intelligence

- **Decision support**
  - **Early warning, City Indexes, etc.**
  - **What-IF analysis** (simulation + AI + data)
- **Predictions**
  - **Short and Long terms predictive models on:**
    - traffic, parking, people flow, maintenance, land sliding, NO2
  - **3D Flow prediction:** Pollutant (NOX, NO2, …)
- **Suggestions and recommendations**
- **Modeling, simulation, routing**
  - **Traffic Flow reconstruction**
  - **Constrained Routing**

AI & XAI:
- RF, XGBoost, BRNN, RNN, SVR, DNN, LSTM, CNN-LSTM, Autoencoders, neuro-symbolic..
- Clustering: K-means, K-Medoid, …
- Semantic Reasoning, ..
- XAI: Shap, variations, Lime, gradients, …

Representations, animated
- Heatmaps, Traffic, Flows, ..
- Trajectories, OD matrices,
- 3D Rendering
- Typical Time Trends, etc.

https://www.snap4city.org/download/video/course/da/

What we do

- **Data modelling and management**
  - Data discovery and data surrogates/replacements
  - Big data management and provider
  - GIS data management
  - satellite Copernicus data processing for smart city and industry
  - IoT interoperability, edge, fog and cloud
  - Data interoperability, data aggregation and semantic processing
- **AI, Data Analytic, Visual Analytic**
  - AI for: **predictions**, **anomaly detection**, **clustering**, suggestions, simulation, fluid dynamics, classification, recognition, ..
  - **XAI, Explained AI, Trustworthy AI**
  - cognitive reasoning: ontology development, semantic computing
  - modelling and computing KPI
  - What-if analysis by mixing simulation, AI, statistics, semantics
- **Different contexts:**
  - industry, smart city, human behaviour, mobility, environment, terrain sliding
  - E.g. predictions pollutants/aerosol, CO2, NO2, GHG; traffic, parking, etc.

to cope with
- any data, format
- any channel, protocol
- any AI/ML
- any place
- online development
- multi-tenant
- Secure, PENTest
- GDPR, privacy
- → *low costs*
- → *easy to evolve*

High Level Types
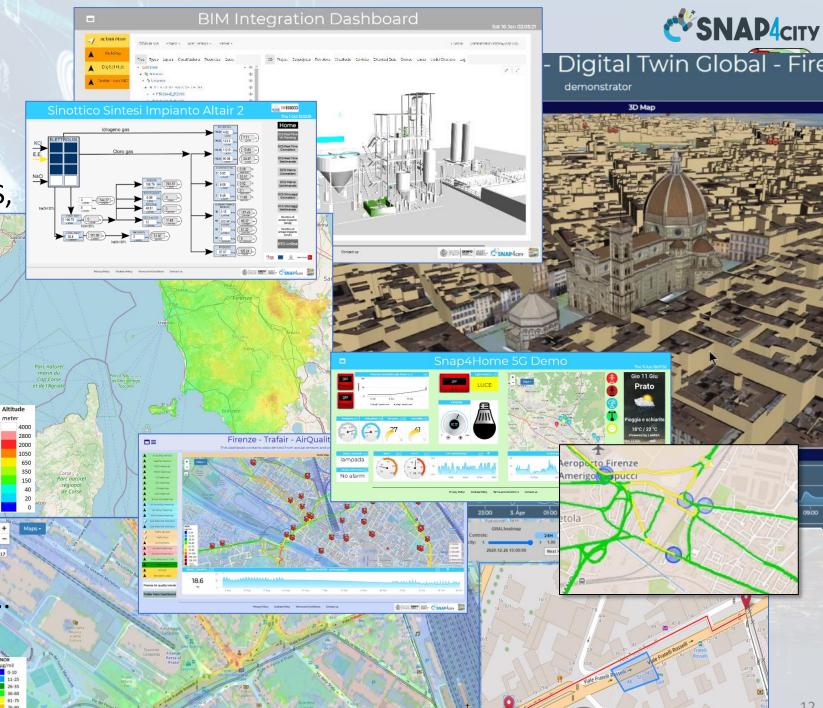
- POI, IOT Devices, shapes,..
  - FIWARE Smart Data Models,
  - IoT Device Models

- GIS, maps, orthomaps, WFS/WMS, GeoTiff, calibrated heatmaps, ..

- Satellite data, ..

- traffic flow, typical trends, ..

- trajectories, events, Workflow, ..

- 3D Models, BIM, Digital Twins, ..

- OD Matrices of several kinds, ..

- Dynamic icons/pins, ..

- Synoptics, animations, ..

- KPI, personal KPI,..

- social media data, TV Stream,

- routing, multimodal, constraints, ..

- decision scenarios, ….

- etc.

10/22

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 1.5

Km4City 1.4

2015

(2016-21)
H2020 REPLICATE
- Smart Energy
- Sustainable Mobility
- Control Room
- Dashboard

Km4City 1.6.2

(2016-21)
SII-MOBILITY SCN
- Infomobility
- Mobile App
- Routing
- Multimodality

2016 FIWARE

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

ckan resolute H2020 (2015-18)

Km4City 1.6.4

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

E015 digital ecosystem
Powered by EXPO MILANO 2015

(2016-19)
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

MOSAiC
MObility 4.0 for SmArt (i) City
(2018-20)

Sii-Mobility

2018

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

IOT/IOE

Km4City 1.6.6

Node-RED

SNAP4CITY
SELECT for Cities H2020
(2017-19)

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

life weee (2017-20)

- Smart Waste

- Mobility Demand / Offer Analytics and Strategy

5G (2018-21) 5G tech Energy Industry 4.0 Synoptics

SNAP4CITY

TRAFAIR
CEF (2018-21)
- Traffic and Mobility Impact on Pollution
- NOX predictions

2019

EUROPEAN OPEN SCIENCE CLOUD

SIRIUS

LAID Smart Bed
- Smart Health

GREEN FIELD PEAS Soda4.0
Optimization and Automated Decision System 4.0
- Industry 4.0

bee smart city

Winner of Select4Cities PCP

SELECT for Cities
CERTIFICATE OF ACHIEVEMENT
1° place award to
SNAP4CITY
UNIVERSITY OF FLORENCE DEPARTMENT OF INFORMATION ENGINEERING

- Smart Lonato

Reverberi Enetec
Gruppo MPES

SNAP4CITY roadmap

SODA

2020

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

- Smart Mobility
- PISA, PUMS
- Living lab

smartGARDAlake

Km4City 1.6.7

Smart Ambulance (2021-22)

Enterprise (2021-22) Industry 4.0

Sii-Mobility

enel x
Contract

JRC
EUROPEAN COMMISSION

2021

PC4City (2020-21) Monitoring Terrain

Winner of Open Data Challenge of
enel x

CAPELON

- Smart Light
- Sweden

ASYMMETRICA
URBAN TECHNOLOGY

Asymmetrica
Smart City, 2022-23

Almafluida Industry 4.0 (2021-22)

AMPERE (2021-22) Industry 4.0

SYN-RG-AI SmartCity

GRUPPO PRETTO
Industry 4.0

uni.systems
SmartCity, 2021-23

AXIS COMMUNICATIONS

AXIS collab SmartCity

2022

ITALFERR
GRUPPO FERROVIE DELLO STATO ITALIANE

Italferr, Smart City

JRC
EUROPEAN COMMISSION
Contract, 2022-23

2023

ART-ER
ATTRATTIVITÀ RICERCA TERRITORIO
Contract, 2022-23

Filippi
2022-2023

enel x
Contract

IMPETUS
Security and Risk

Smartea

CN MOST, 2022-26

EI THE, 2022-26

G. Agile, 2021-23

TUSCANY X.0   EDIH
2023-26

Merano, smart light

OceanRace, Genova, AWS

Cuneo, smart city

AMMIRARE

Interreg
MARITTIMO-IT FR-MARITIME

14

https://www.Snap4City.org

- 11 running installations in Europe
  - Snap4.city.org, Greece, Merano, …
  - Toscana, Pisa, Sweden, ISPRA, Snap4.eu,
  - Altair, Italmatic, Sweden, Romania, ….

- 16 projects, 12 pilots on 10 Countries
  - >40 cities/area

- **Widest MULTI-tenant deploy has**
  - 19 Organizations / tenant
  - > 8000 users on
  - > 1600 Dashboards
  - > 16 mobile Apps
  - **> 2.2 Million of structured data per day**
  - > 520 IoT Applications/node-RED
  - > 700 web pages with training
  - > 70 videos, training videos

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

- **+ Israel, Colombia, Brasile, Australia, India, China, etc.**
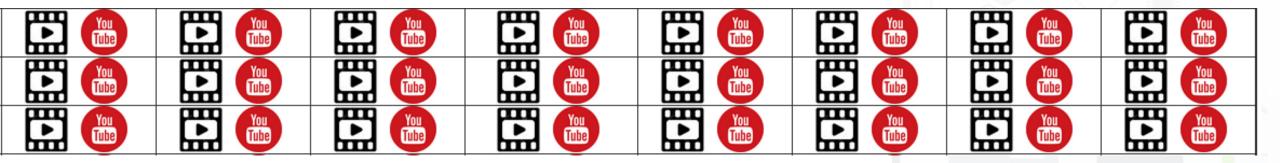
https://www.snap4city.org/944

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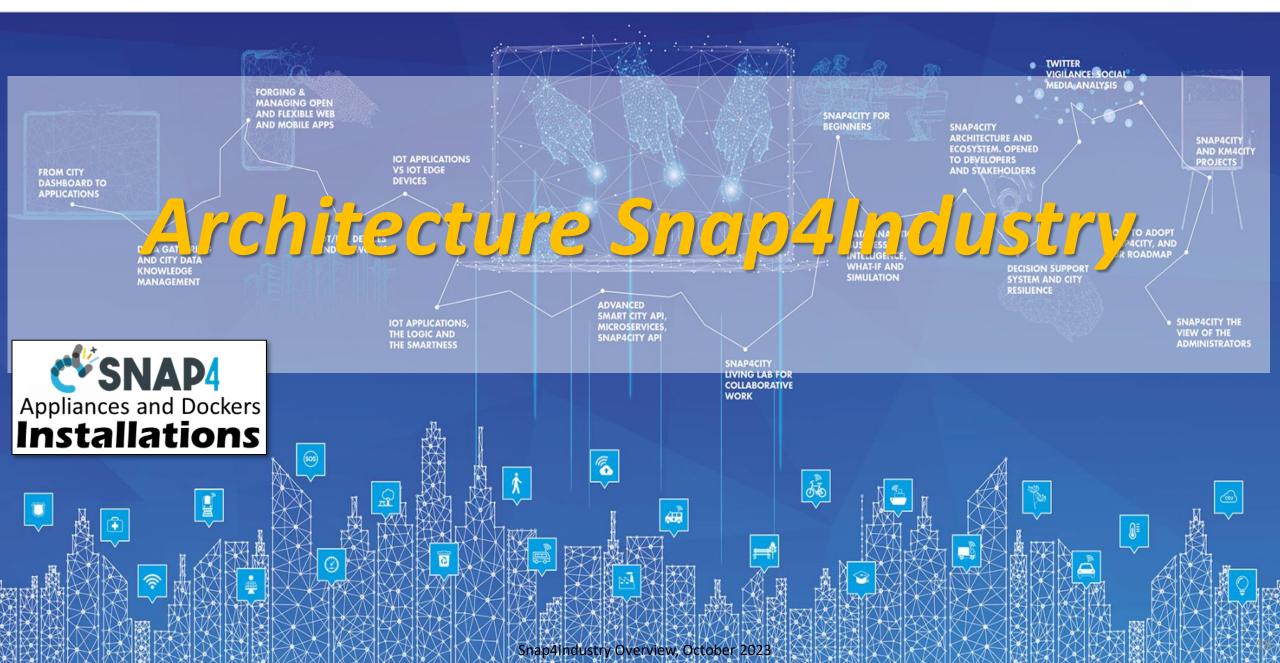
1st part	2nd part	3rd part	4th part	5th part	6th part	7th part	8th
Overview	Dashboards	IOT App, IOT Network	Data Analytics	Data Ingestion processes	System and Deploy Install	Smart City API: Web & Mob. App	Design and Develop Smart Solutions

Architecture Snap4Industry

SNAP4
Appliances and Dockers
Installations

FROM CITY
DASHBOARD TO
APPLICATIONS

FORGING &
MANAGING OPEN
AND FLEXIBLE WEB
AND MOBILE APPS

IOT APPLICATIONS
VS IOT EDGE
DEVICES

DATA GATHERING
AND CITY DATA
KNOWLEDGE
MANAGEMENT

IOT APPLICATIONS,
THE LOGIC AND
THE SMARTNESS

ADVANCED
SMART CITY API,
MICROSERVICES,
SNAP4CITY API

SNAP4CITY
LIVING LAB FOR
COLLABORATIVE
WORK

SNAP4CITY FOR
BEGINNERS

SNAP4CITY
ARCHITECTURE AND
ECOSYSTEM. OPENED
TO DEVELOPERS
AND STAKEHOLDERS

DATA ANALYTIC
BUSINESS
INTELLIGENCE,
WHAT-IF AND
SIMULATION

TWITTER
VIGILANCE: SOCIAL
MEDIA ANALYSIS

DECISION SUPPORT
SYSTEM AND CITY
RESILIENCE

TO ADOPT
4CITY, AND
R ROADMAP

SNAP4CITY
AND KM4CITY
PROJECTS

SNAP4CITY THE
VIEW OF THE
ADMINISTRATORS

Standards and Interoperability (6/2023)

Compliant with:

- **IoT:** NGSI V2/LD, LoRa, LoRaWan, MQTT, AMQP, COAP, OneM2M, TheThingsNetwork, SigFOX, Libelium, IBIMET/IBE, Enocean, Zigbee, DALI, ISEMC, Alexa, Sonoff, HUE Philips, Tplink, BACnet, TALQ, Protocol Buffer, KNX, OBD2, Proximus, ..
- **IoT model:** FIWARE Smart Data Model, Snap4City IoT Device Models
- **General**: HTTP, HTTPS, TLS, Rest Call, SMTP, TCP, UDP, SOAP, WSDL, FTP, FTPS, WebSocket, WebSocket Secure, GML, WFS, WMS, RTSP, ONVIF, AXIS TVCam, CISCO Meraki, OSM, Copernicus, The Weather Channel, Open Weather, OLAP, VMS, ...
- **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

Knowledge Engineering

Linked Open Data

Linked Open Graph

LOG: https://log.disit.org

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

https://www.snap4city.org/19

License Free 1.6.7

Altair
Chemical (I)

Snap4Altair Decision Support supervision and control, Industry 4.0

- **Multiple Domain Data**
  - Distributed Control System: energy, flows, storage, chemical data, settings, ..
  - Cost of energy, Orders,
  - Production Parameters
  - Maintenance data

- **Multiple Levels & Decision Makers**
  - Optimized planning on chemical model
  - Business Intelligence on Maintenance data

- **Historical and Real Time data**
  - Billions of Data

- **Services Exploited on:**
  - Multiple Levels, Mobile Apps, API

- **Since 2020**

Industry Plant Supervision and Maintenance

Aims
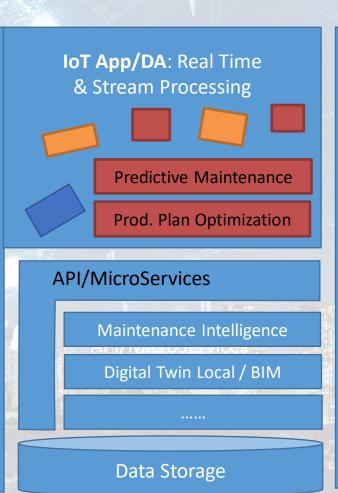
- **Control Room**: Higher level supervision and monitoring (since 2020)
    - Management of Production Plan *Optimization*
    - Control of Perimeter with drone and sensors
- **Maintenance ticketing** (since 2017)
    - *predictive* (in development)
    - 3D Digital Twin (in development)
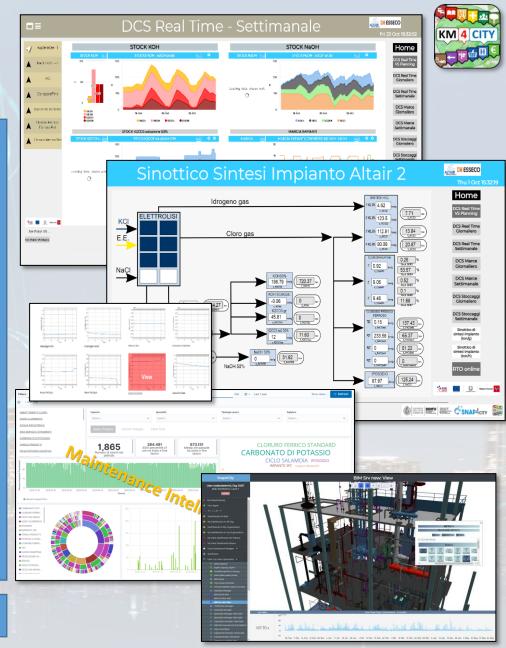
MicroService Architecture

Production vs Planning

Real Time Production Synoptic

Production Plan

Plant Status

Data Ingestion

Data Storage

Decision Support

Orders

Other Costs

AS400

Energy Service

Transportation

Production Plant Management

Optimized Production Planner

Possible Plan

Possible Plans

Production Parameters

Plant Management
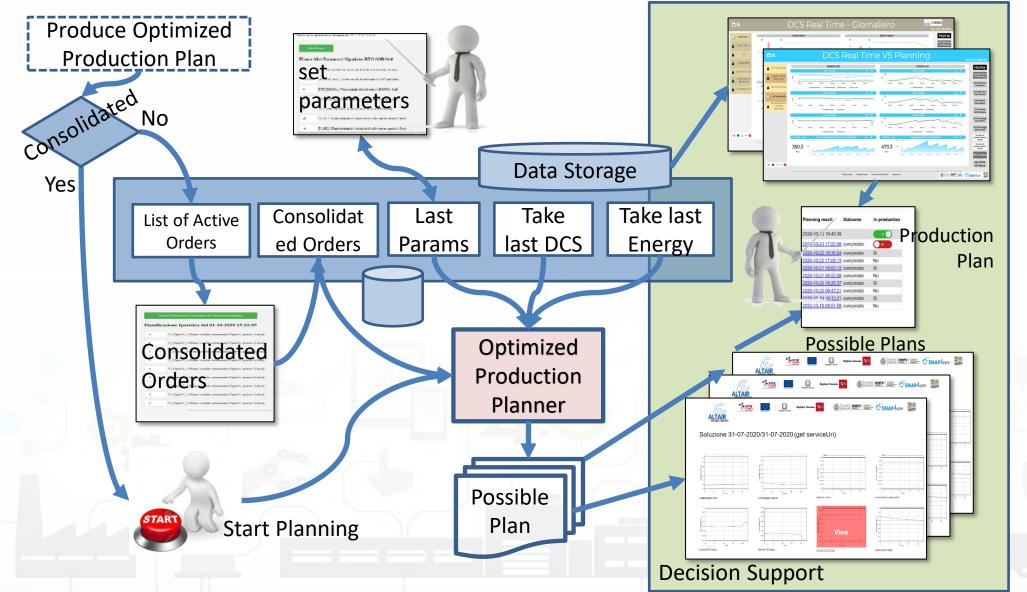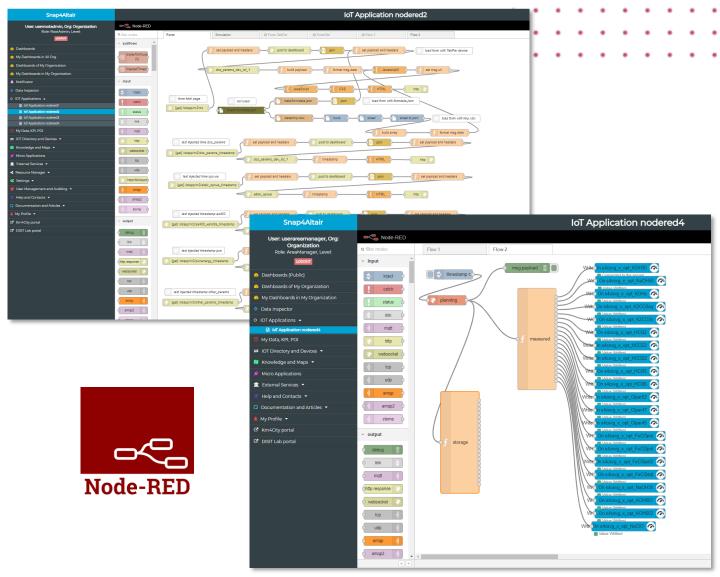
Business Logic

Snap4Industry Overview, October 2023

Snap4City/Industry IoT Apps

- Integration
  - Connection with Brokers, GWs, External services
- Data Driven Processing
- Data Analytics Manag.
- Smart City API
  - Search, discovering
  - Routing, Picking
- Dashboard Business logic
- Workflow, Digital Twin
- Management
- Scheduling
- ...etc...
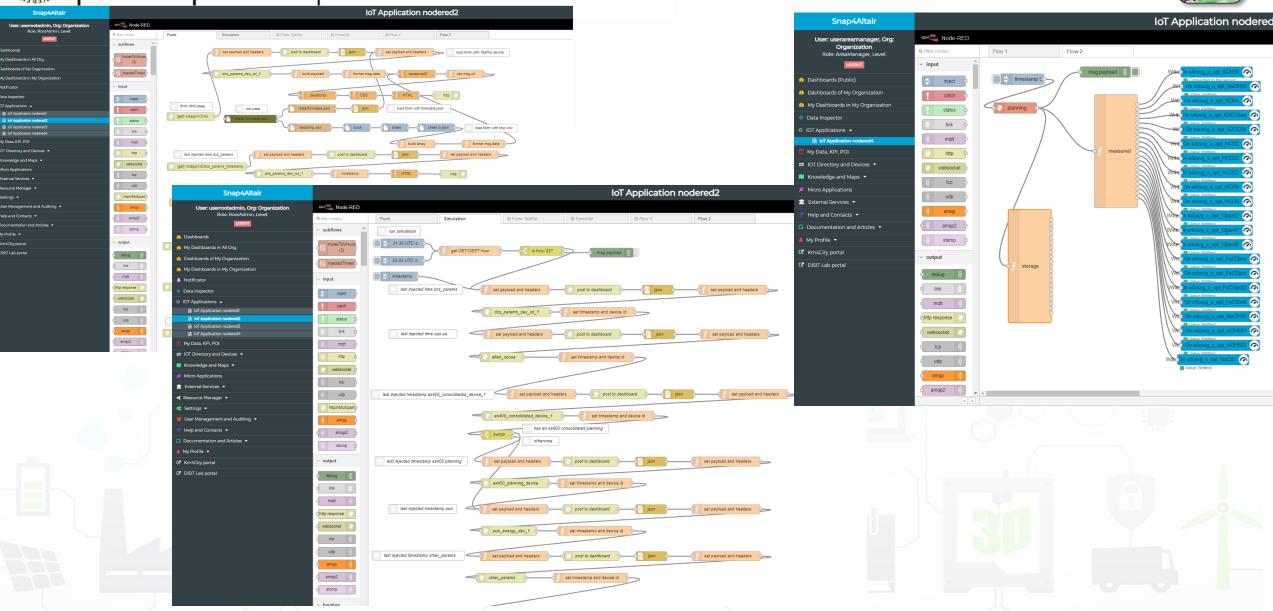
Some Flows

Green Impact Capacity (GIC)
Altair Control room

Green Impact Capacity (GIC)

- Improve productivity of chemical plant

- Keep GREEN the environmental impact

- Exploiting innovative technologies

- Diversify the production

- Monitoring environmental conditions
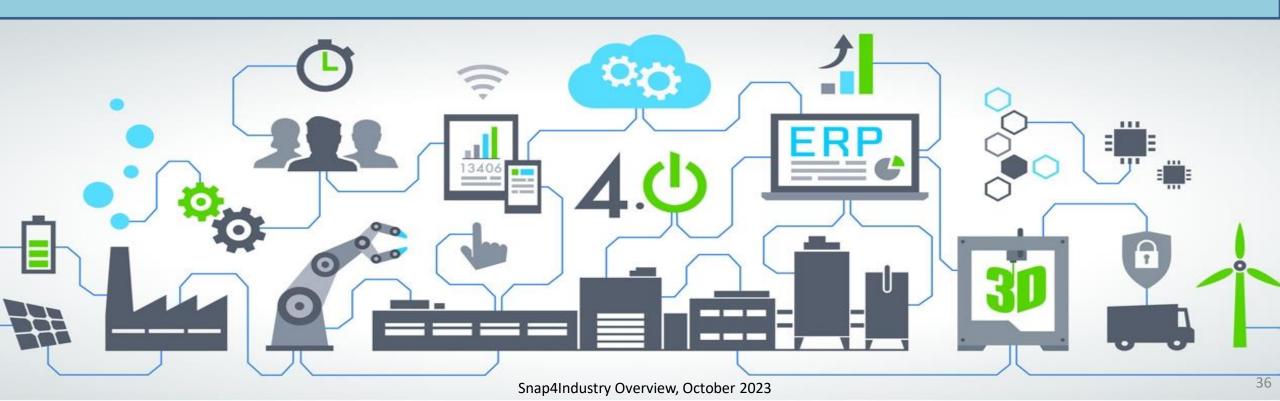
Digital Twin vs BIM

Digital Twin Local
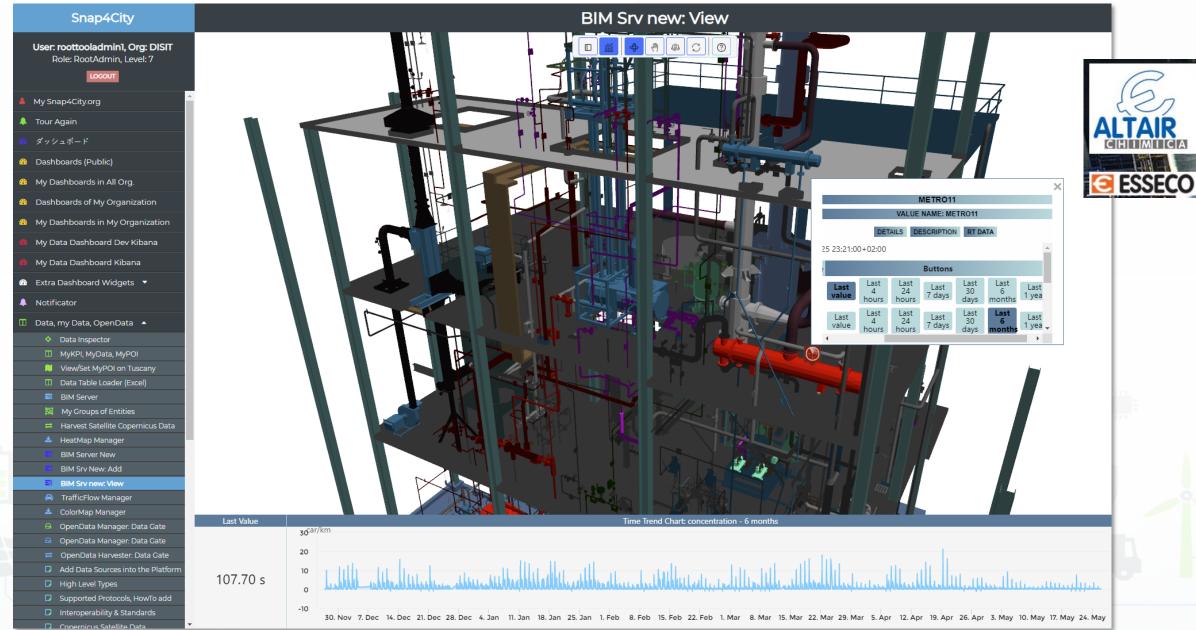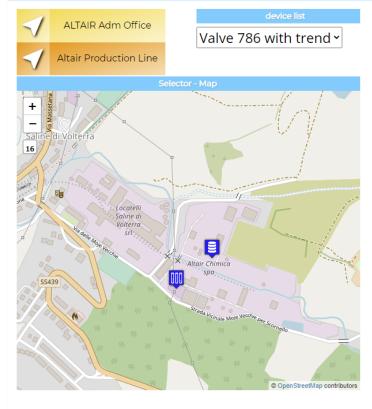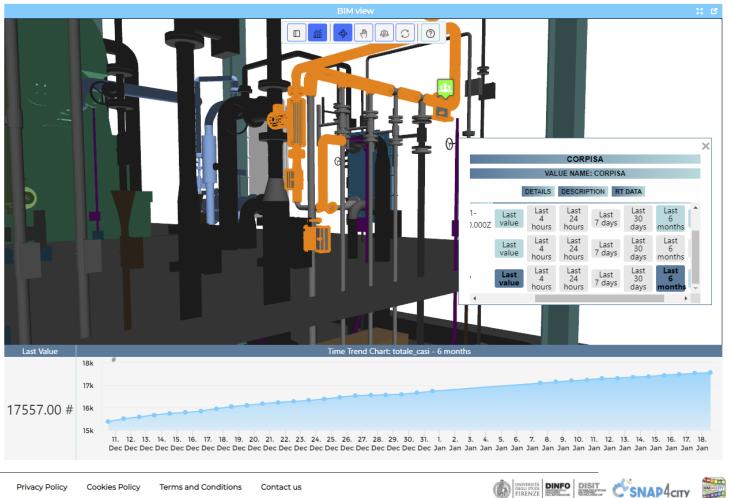
Digital Twin Local, 3D vs Real Time Data

BIM view of the Altair Chemical Plant
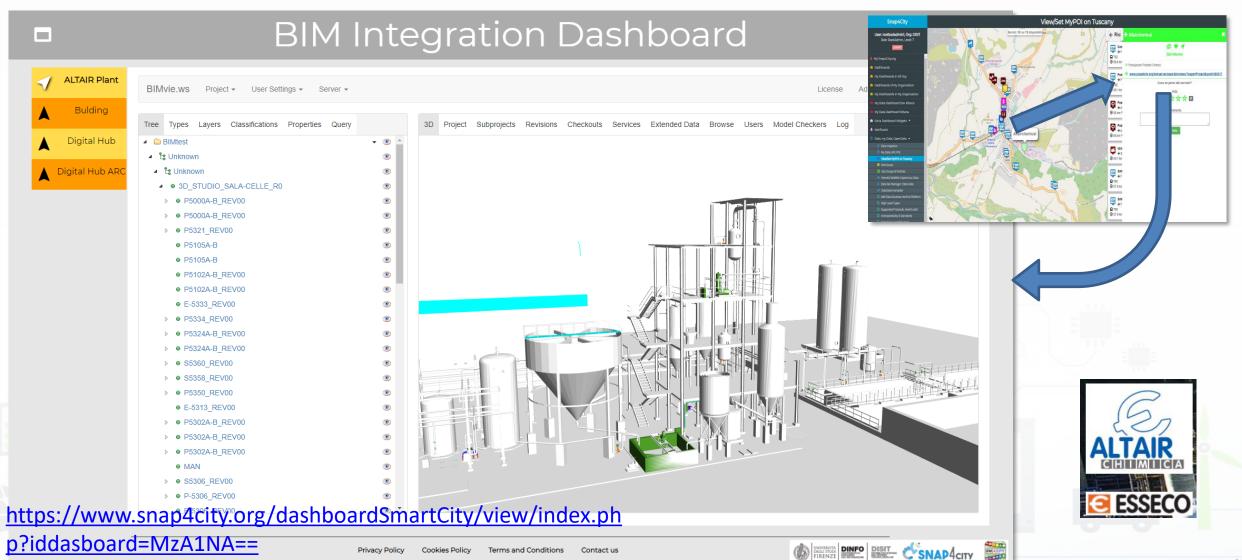
https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA1NA==
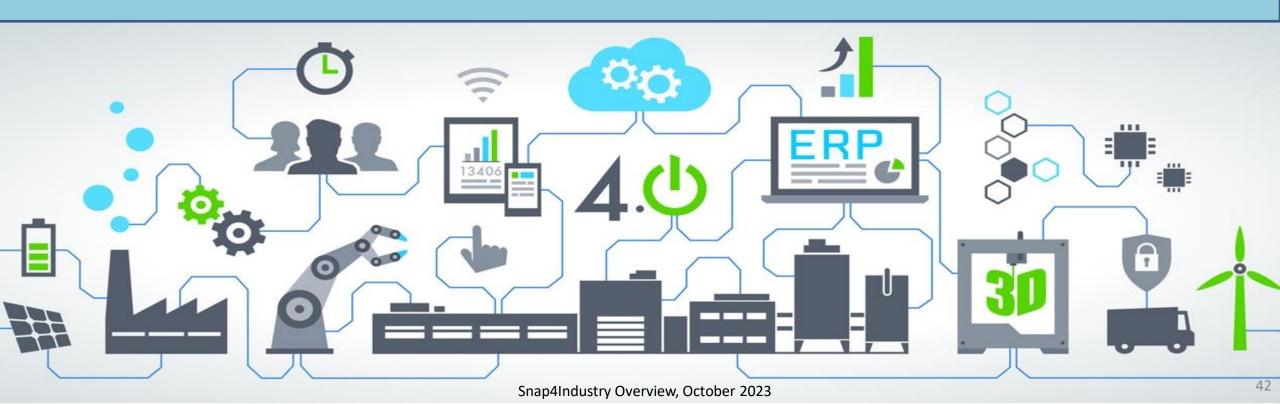
Integration with Ticketing Systems Workflows
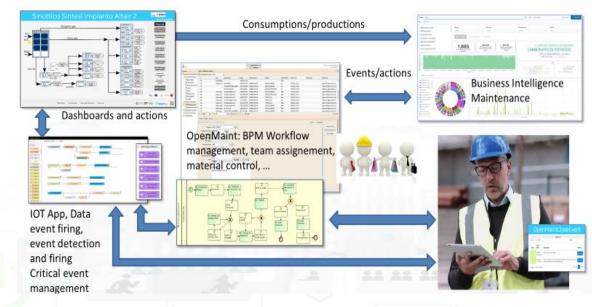
Snap4City Maintenance Solution

- **OpenMaint** open source solution for property & facility management which is a BPM;
  - Inventory of industry assets (movable, logistics, equipment, etc.)
  - Tickets management for corrective maintenance
  - User management with different levels of access
  - BIM Server integrated with OpenMaint
- **Snap4City OpenMaint Extension**
  - **Extended API** developed by Snap4City
    - Create new tickets
    - Manage steps, workflow
    - Collecting feedbacks and results from teams
    - Manage all phases of the workflow on the fields via IOT Apps and logics
    - The integration if via API and MicroServices into IOT App.
  - **MicroServices** integrated with Snap4City via IOT Applications
- **Business Intelligence** which is the **Snap4City tool based on** Elastic Search: which work on top of the database of tickets collected on OpenMaint
- **BIMServer** integration with Snap4City Dashboards;
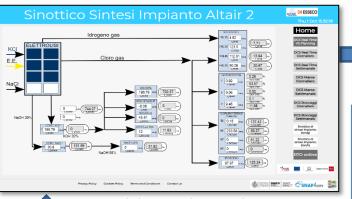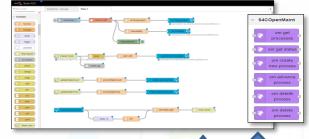
Example of Integrated workflow

Consumptions/productions

Events/actions

Business Intelligence Maintenance

Dashboards and actions

OpenMaint: BPM Workflow management, team assignement, material control, …
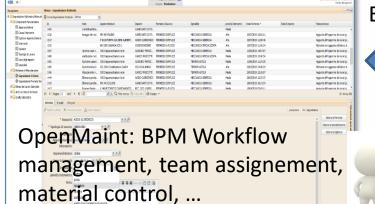
IOT App, Data event firing, event detection and firing Critical event management
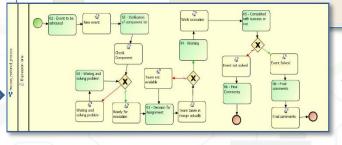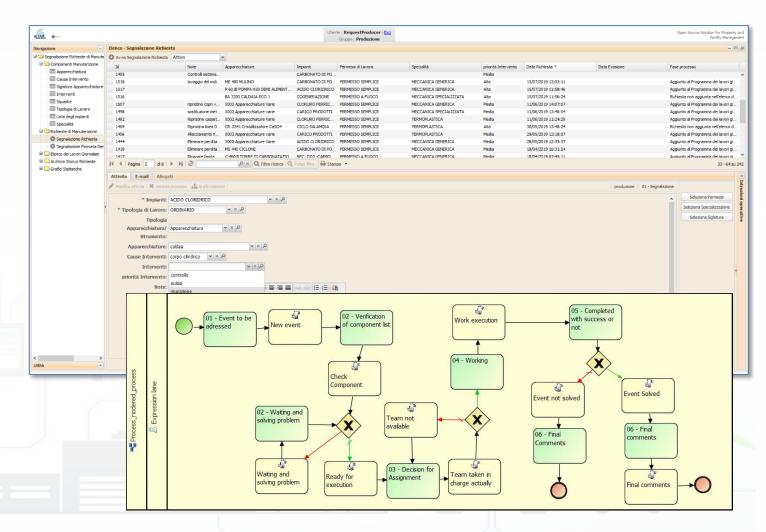
Integration with Ticketing Systems Workflow

- **Snap4City is integrated with OpenMaint Ticketing system. An Open Source solution for ticketing and workflow management, incident management.**

- Any ticketing systems can be integrated with Snap4City, by means of IOT Applications and Dashboards

- https://www.snap4city.org/597

Solution for Asset Management and Maintenance

- Inventory of industry assets (movable, logistics, equipments, etc.)

- Tickets management for corrective maintenance

- Reports and Dashboards

- Predictive maintenance and Early Warning support via analytics

- Business Intelligence support

- User management with different levels of access
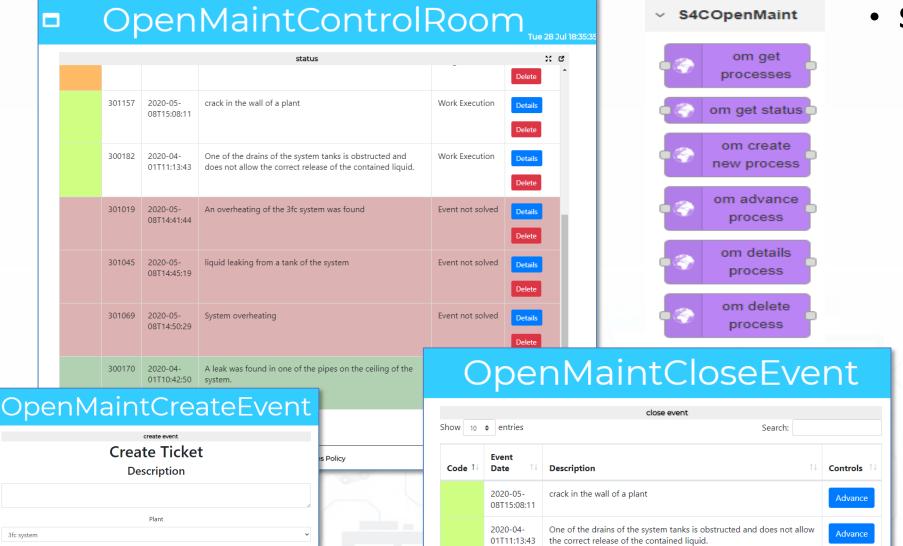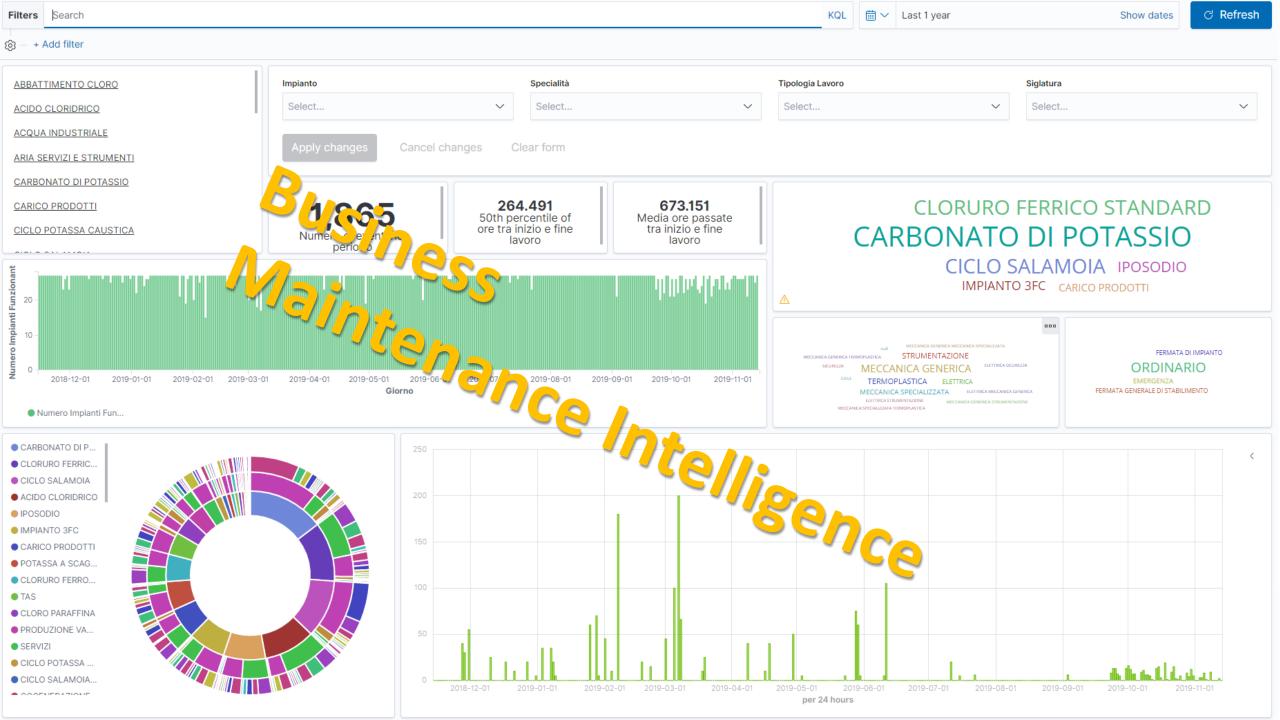
Dashboards

- **Snap4City can**
  - Create new tickets
  - Manage steps, workflow
  - Collecting feedbacks and results from teams
  - Manage all phases of the workflow on the fields via IOT Apps and logics
  - The integration if via API and MicroServices into IOT App.

+ Add filter

ABBATTIMENTO CLORO

ACIDO CLORIDRICO

ACQUA INDUSTRIALE

ARIA SERVIZI E STRUMENTI

CARBONATO DI POTASSIO

CARICO PRODOTTI

CICLO POTASSA CAUSTICA

Impianto
Select...

Specialità
Select...

Tipologia Lavoro
Select...

Siglatura
Select...

Apply changes | Cancel changes | Clear form

264.491
50th percentile of ore tra inizio e fine lavoro

673.151
Media ore passate tra inizio e fine lavoro

1.865
Numero ... in periodo

CLORURO FERRICO STANDARD
CARBONATO DI POTASSIO
CICLO SALAMOIA   IPOSODIO
IMPIANTO 3FC   CARICO PRODOTTI

MECCANICA GENERICA MECCANICA SPECIALIZZATA
MECCANICA GENERICA TERMOPLASTICA   STRUMENTAZIONE
SICUREZZA   ELETTRICA SICUREZZA
null
EDILE   MECCANICA GENERICA   ELETTRICA
TERMOPLASTICA
MECCANICA SPECIALIZZATA   ELETTRICA MECCANICA GENERICA
ELETTRICA STRUMENTAZIONE   MECCANICA GENERICA STRUMENTAZIONE
MECCANICA SPECIALIZZATA TERMOPLASTICA

FERMATA DI IMPIANTO
ORDINARIO
EMERGENZA
FERMATA GENERALE DI STABILIMENTO

Numero Impianti Funzionanti (y-axis)

Giorno: 2018-12-01, 2019-01-01, 2019-02-01, 2019-03-01, 2019-04-01, 2019-05-01, 2019-06-01, 2019-07-01, 2019-08-01, 2019-09-01, 2019-10-01, 2019-11-01

Numero Impianti Fun...

CARBONATO DI P...
CLORURO FERRIC...
CICLO SALAMOIA
ACIDO CLORIDRICO
IPOSODIO
IMPIANTO 3FC
CARICO PRODOTTI
POTASSA A SCAG...
CLORURO FERRO...
TAS
CLORO PARAFFINA
PRODUZIONE VA...
SERVIZI
CICLO POTASSA ...
CICLO SALAMOIA...

per 24 hours

2018-12-01, 2019-01-01, 2019-02-01, 2019-03-01, 2019-04-01, 2019-05-01, 2019-06-01, 2019-07-01, 2019-08-01, 2019-09-01, 2019-10-01, 2019-11-01

Business Maintenance Intelligence

Predictive Maintenance

Complex cause-effect relationships

- **Elements:**
  - Machines: A…C
  - Storage: silos…
  - Flows:…
- **Dependencies**
  - Cascade effects
- **Early warning**
  - Reduction of costs
  - Recovering from failure is more expensive than correcting in advance
  - Possible advanced replan and reschedule: secondary solutions
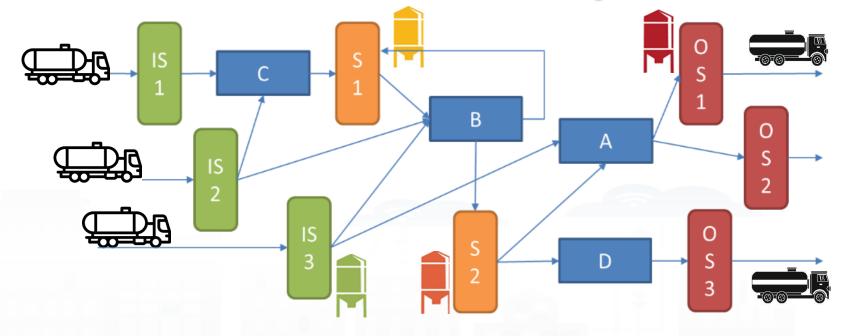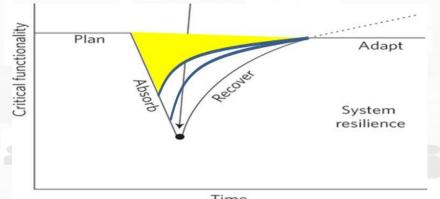
Workflow

Data acquisition Production - Maintenance

Feature selection, Feature engineering

CNN-LSTM Training

Validation AI Model

CNN-LSTM Engine

F/NF

Classification Model

Explainable/XAI (Shap)

Business Intelligence for Maintenance

{features (t)}

integration of workflow management system for maintenance with general control systems and data flow

Structure of the plant

Decision making on more cases

KPI

CNN: Convolutionary NN
LSTM: Long Short-Term Memory
(deep learning model)

Solution

Overview Features

Feature	Plant	Description	Unit of measure
TempreactoreR4001 - TempreactoreR4002 - TempreactorR4003	chlorine paraffins (CPS)	reactor temperature indication	°C
S904A - S904B - S904C	Potable Ferric std	Storage level indication	%
S4304	chlorine paraffins (CPS)	Storage level indication	%
standardFerric Chloride	Potable Ferric std	flow rate measurement and totalization	m3
potFerricChloride	Potable Ferric Chloride	flow rate measurement and totalization	m3
S904E - S904D	Potable Ferric Chloride	Storage level indication	%
QuantNaOHperBatchNaClO - QuantNaOHBatchNaClO_2	NaOH KOH	flow rate measure and totalization	lt – m3
ConversionNaOH - ConversionKOHlinea1	NaOH KOH	electrolysis load adjustment (production)	kA
KOH_1_charge - KOH_2_charge	NaOH KOH	flow rate measure and totalization	m3
S487 - S484 - S5104	NaOH KOH	Storage level indication	%
hypo sodium	sodium hypochlorite	quantity of material produced	m3
S851 - S852 - S854 - S856 - S857	sodium hypochlorite	Storage level indication	%
S871	HCl	Storage level indication	%
RedoxFeCl3Pot	Ferric Chloride std	potential measure redox Ferric Chloride	mV
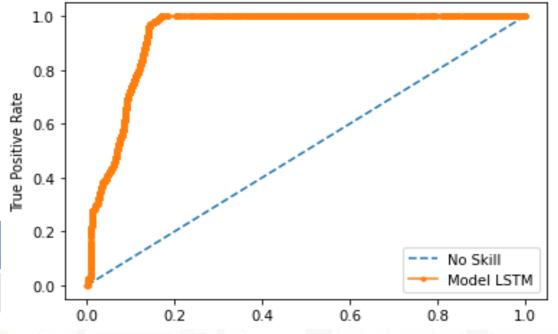
Preditive capabilities

- Deep Learning: LSTM, CNN-LSTM approached

- Explainable AI: Identification of possible causes of fault

	Precision %	Recall %	F_1 score %
weighted avg	0.90	0.92	0.90
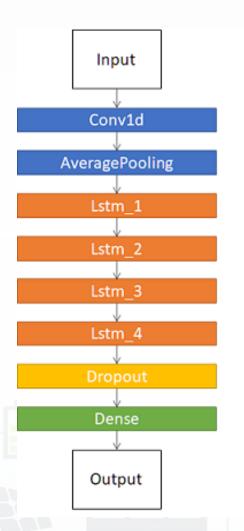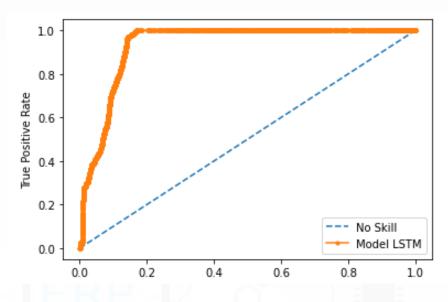
Classification model CNN-LSTM

Layer (type)	Output Shape	Param #
conv1d (Conv1D)	(None, 20, 64)	8320
average_pooling1d (AveragePo	(None, 10, 64)	0
lstm (LSTM)	(None, 10, 200)	212000
lstm_1 (LSTM)	(None, 10, 200)	320800
lstm_2 (LSTM)	(None, 10, 200)	320800
lstm_3 (LSTM)	(None, 10, 200)	320800
lstm_4 (LSTM)	(None, 100)	120400
dropout (Dropout)	(None, 100)	0
dense (Dense)	(None, 1)	101

Total params: 1,303,221
Trainable params: 1,303,221
Non-trainable params: 0

Predicted Class / Actual Class	Normality	Fault
Normality	45811	903
Fault	3306	1376

	Precision %	Recall %	F_1 score %
weighted avg	0.90	0.92	0.90
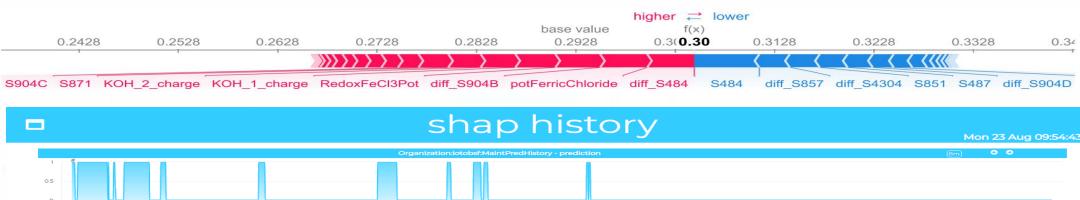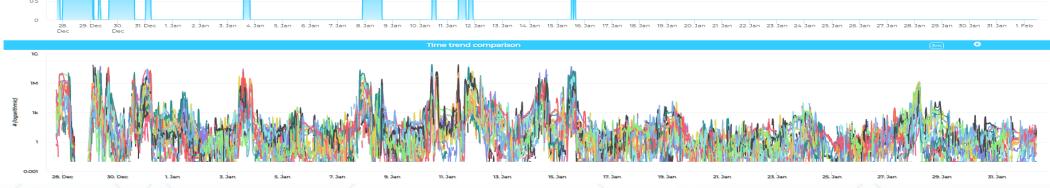
Explainable/XAI - CNN-LSTM (SHAP)

Explanation of prediction generated by model for fault

Explanation of prediction generated by model for normality
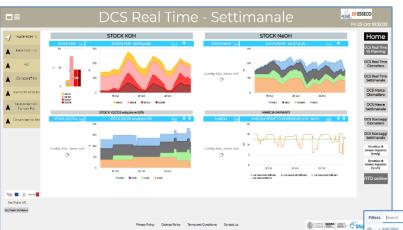
Closing the loop
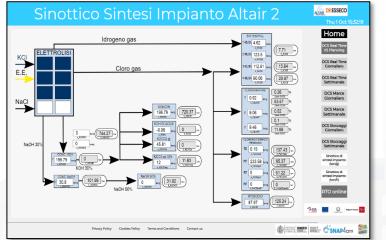
Map and 3D BIM modelling to:
-- represent the details
-- associate physical elements with data
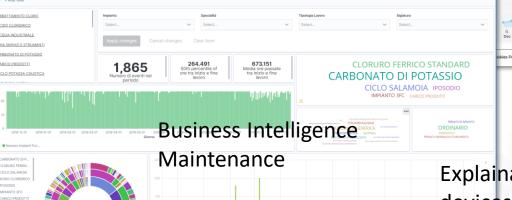
Historical and Real Time Data

Synoptics for real time monitoring

Business Intelligence Maintenance
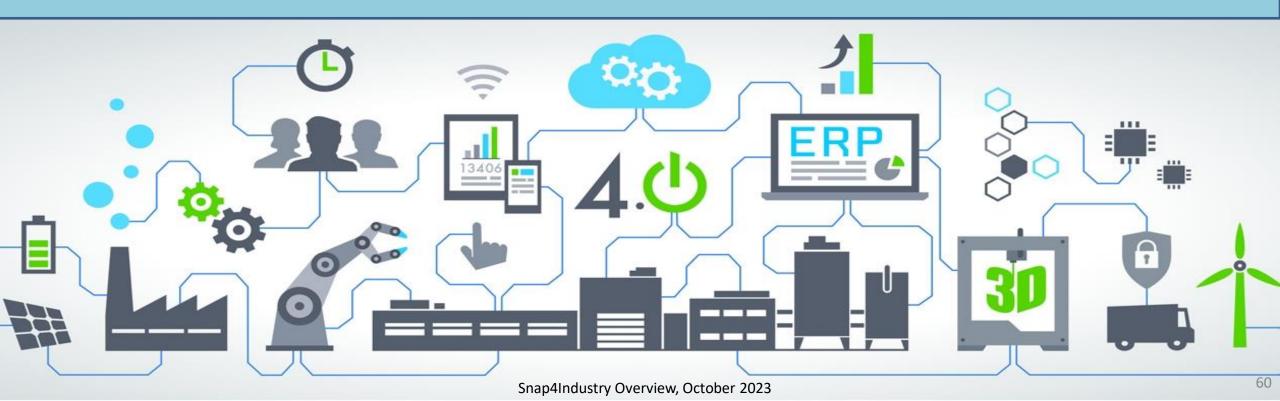
Explainable AI to map critical values of devices and detection to physical elements in the plant

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA1NA==

WHAT-IF Analysis

What-If Analysis

Available data and techniques	What happened	What is going on now	What is going to happen	What-If: what is going to happen if a scenario occurs in the future	Which is the best solution
Historical Data, HD	Yes	No ✗	No ✗	No ✗	No ✗
Real Time Data, RTD	No ✗	Yes	No ✗	No ✗	No ✗
HD + RTD + Short term Predictions, STP(.)	Yes	Yes	Yes	No ✗	No ✗
HD + RTD + Analytical Model, AM(.) + Scenario Model, SM(.)	Yes	Yes	Yes	(Yes)	No ✗
HD + RTD + Short and Very Long Term Predictions, SVLTP(.) + AM(.) + SM(.) + Simulation, S(.)	Yes	Yes	Yes	Yes	No ✗
HD + RTD + SVLTP(.) + AM(.) + SM(.) + S(.) + KPI(.) based Decision	Yes	Yes	Yes	Yes	Yes
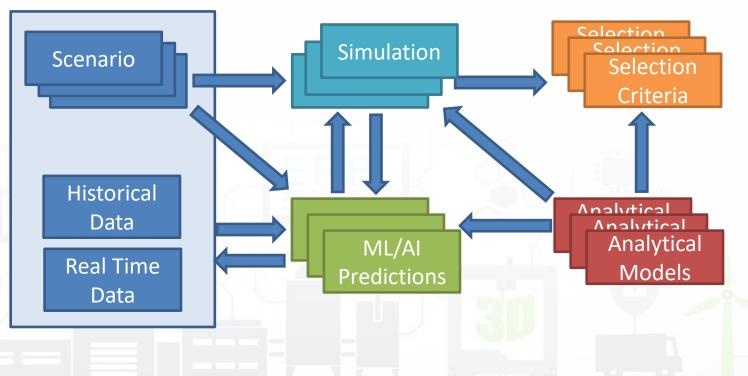
What-if: what is going to happen if …. this and that

- **What is going to happen at:**
  - People, Economy, Society, ..
  - Traffic, Pollutant, Parking, structures
  - Equipment, .. …

- **if certain unexpected events would occur**
  - Scenario definition
  - Guessing future data…

- **Taking into account**
  - Historical Data
  - Real Time Data
  - Contextual data
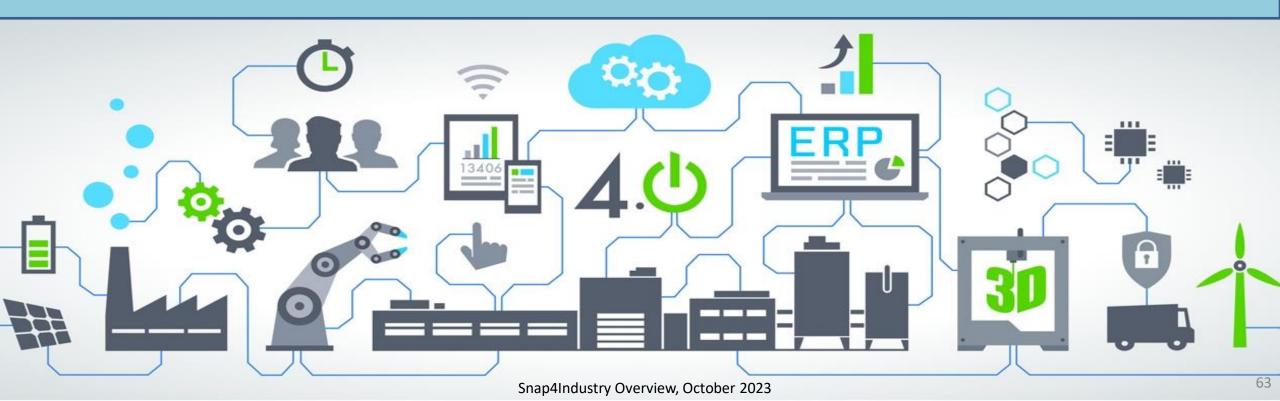
Decision Support System
KPI, Optimization
Visual Analytic: animations

Business Intelligence
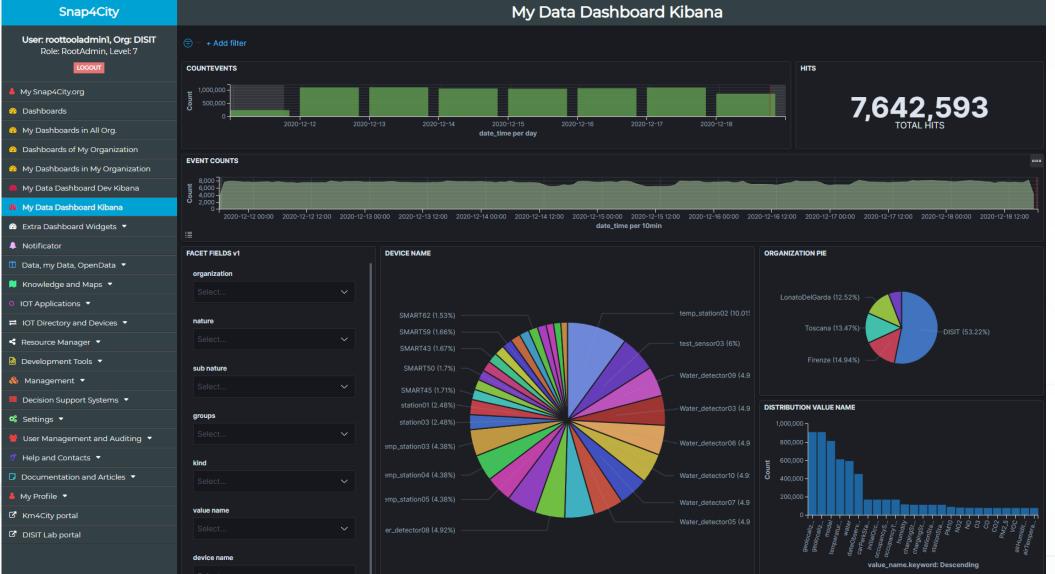
DevDash: My Data Dashboard Kibana

Business Analysis Dashboards For all kind of users: DevDash

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

- Multi faceted Search by
  - Devices
  - Organization
  - Drill on Time
  - Drill on Map
  - Value Types
  - Data Type
  - Value name
  - Data table
  - Etc.
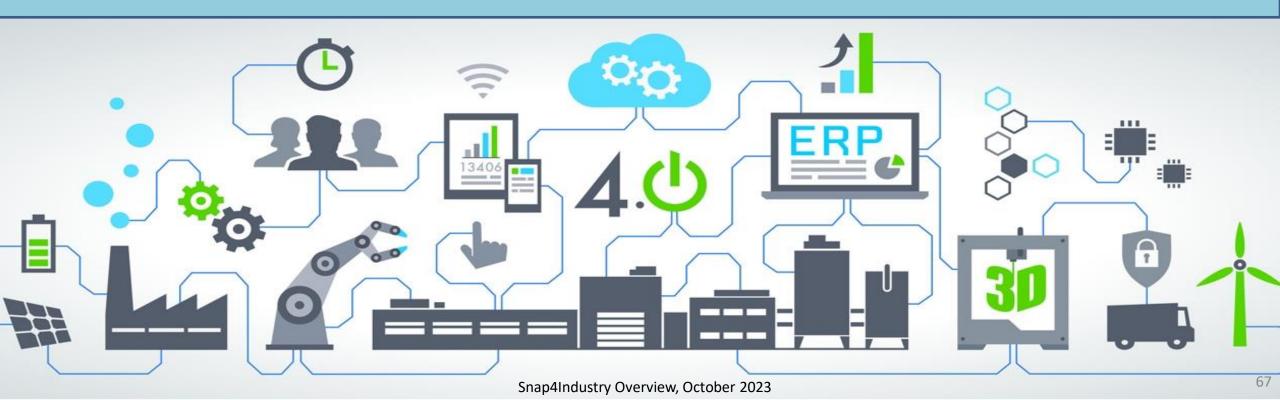
- Respect Privacy and GDPR
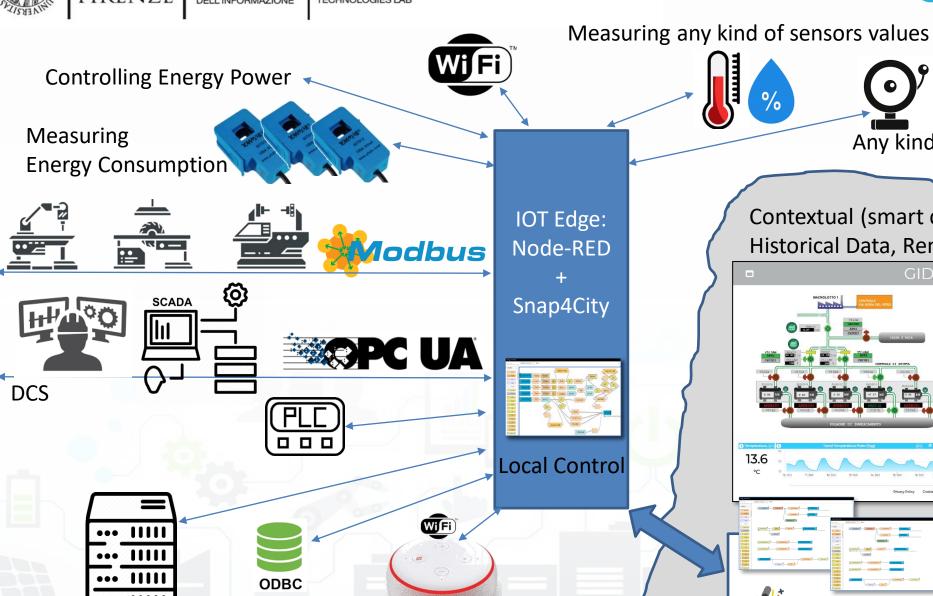
IoT Edge: IOT App Smart Industry 4.0
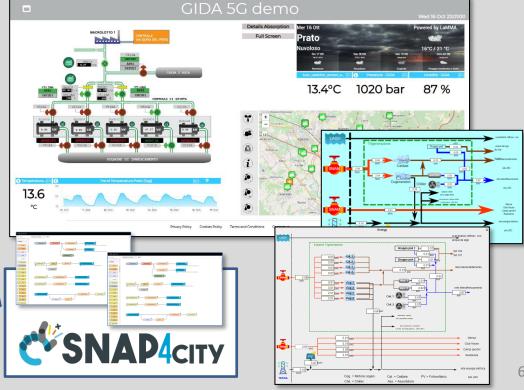
Devices

Temp, Humidity

+ Input DC
  5.0V-30V
- RS485A+
  RS458B-

Energy
Metering

8 Relais,
actuators

Modbus

USB -- ModBus

ModBus to Snap4City
Gateway Edge

IOT Applications

Dashboards and Apps

IOT Data
Shadow
Snap4City

Big Data Analytics, Artificial Intelligence
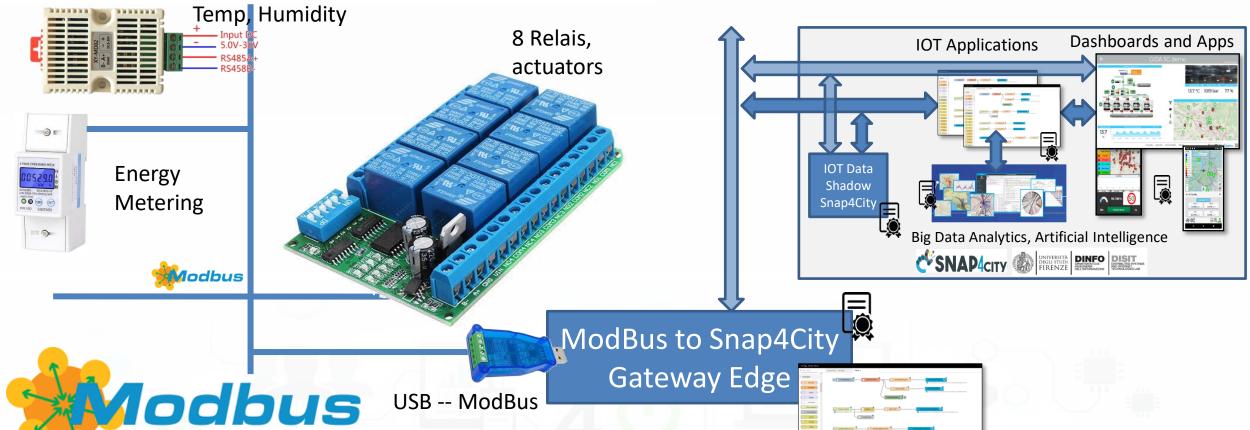
• A large range of devices:
  sensors and actuators

• Over serial as RS485 and/or IP
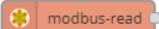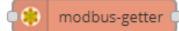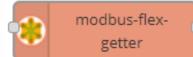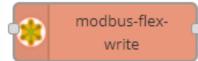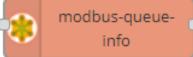
Snap4Industry Overview, October 2023

70

UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO
DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE
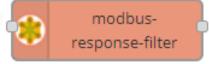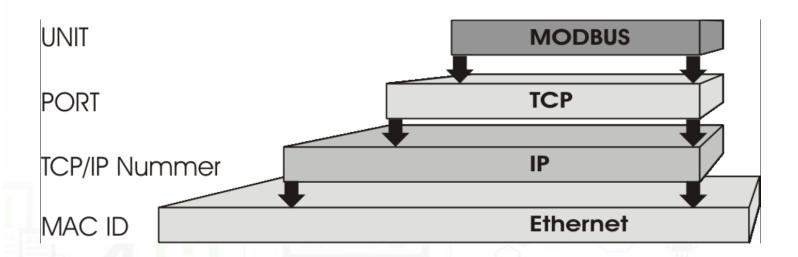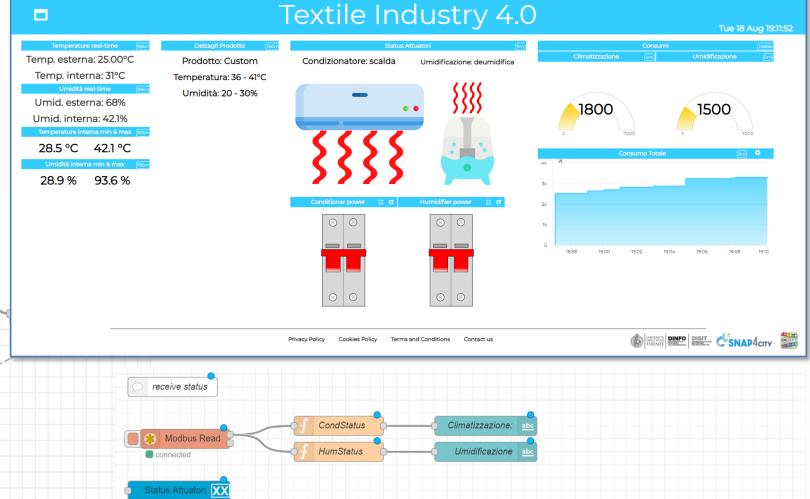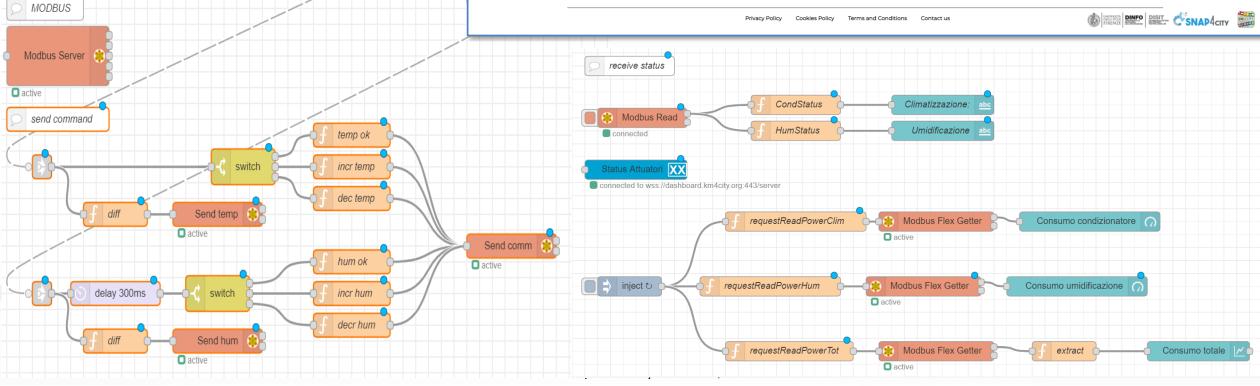
DISIT
DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

Modbus

Textile Industry 4.0

Tue 18 Aug 19:11:52

Temperature real-time
Temp. esterna: 25.00°C
Temp. interna: 31°C

Umidità real-time
Umid. esterna: 68%
Umid. interna: 42.1%

Temperatura interna min & max
28.5 °C   42.1 °C

Umidità interna min & max
28.9 %   93.6 %

Dettagli Prodotto
Prodotto: Custom
Temperatura: 36 - 41°C
Umidità: 20 - 30%

Status Attuatori
Condizionatore: scalda   Umidificazione: deumidifica

Conditioner power   Humidifier power

Consumi
Climatizzazione   Umidificazione

1800   1500

Consumo Totale

Privacy Policy   Cookies Policy   Terms and Conditions   Contact us

SNAP4CITY

MODBUS

Modbus Server
active

send command

switch
temp ok
incr temp
dec temp

diff   Send temp
active

delay 300ms   switch
hum ok
incr hum
decr hum

diff   Send hum
active

Send comm
active

receive status

Modbus Read
connected
CondStatus   Climatizzazione:
HumStatus   Umidificazione

Status Attuatori
connected to wss://dashboard.km4city.org:443/server

requestReadPowerClim   Modbus Flex Getter   Consumo condizionatore
active

inject   requestReadPowerHum   Modbus Flex Getter   Consumo umidificazione
active

requestReadPowerTot   Modbus Flex Getter   extract   Consumo totale
active

IoT edge

Hue Hub

Motion Control / Alarm

TP Link plugs: meter

Alexa: Voice Control
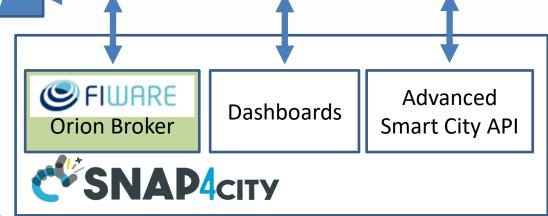
SNAP4CITY

IOT Edge:

**Raspberry pi:
Node-RED
+
Snap4City MicroService Library**

5G gateway

Environmental Contextual data from the city. Historical Data, Remote Control, Mobile App

FIWARE Orion Broker

Dashboards

Advanced Smart City API

SNAP4CITY

Snap4Home 5G Demo

IoT Edge

Sonoff: Controlling Energy Power

Philips Hue: Controlling Lights

Hue Hub

Hue: Motion Control / Alarm

Measuring Energy Consumption

TP Link: Controlling / Measuring Energy Plugs

Alexa: Voice Control

Measuring Temperature and Humidity

Garage Door

Window Roller Shutters

IOT Edge:

Raspberry pi: Node-RED + Snap4City

Controlling Motors

Alarm sound and light

Controlling Irrigators

My house

Environmental Contextual data from the city
Historical Data, Remote Control, Mobile App

Local Control
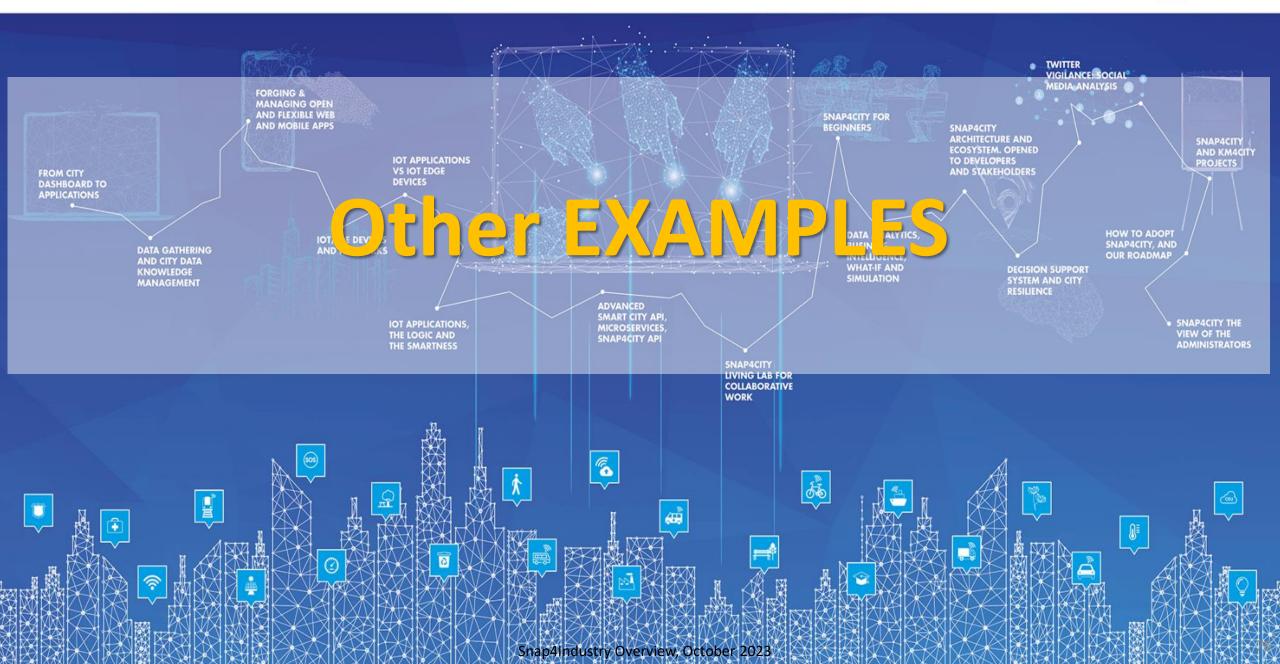
https://www.snap4city.org/620

Snap4Industry Overview, October 2023

Other EXAMPLES

PaD

Open Italy 2021

PaD

Open Italy 2021

PaD

Open Italy 2021

IoT Health Scenarios

1) Smart Ambulance:
Collecting and managing local data from tools and sensors inside the ambulance, IoT Devices, Tablets, Drones etc.

2) Personal Health devices:
e.g.: glucometers, etc.

3) Smart Bed:
Collecting and managing data from smart bed sensors, monitoring parameters in real-time

Smart Ambulance
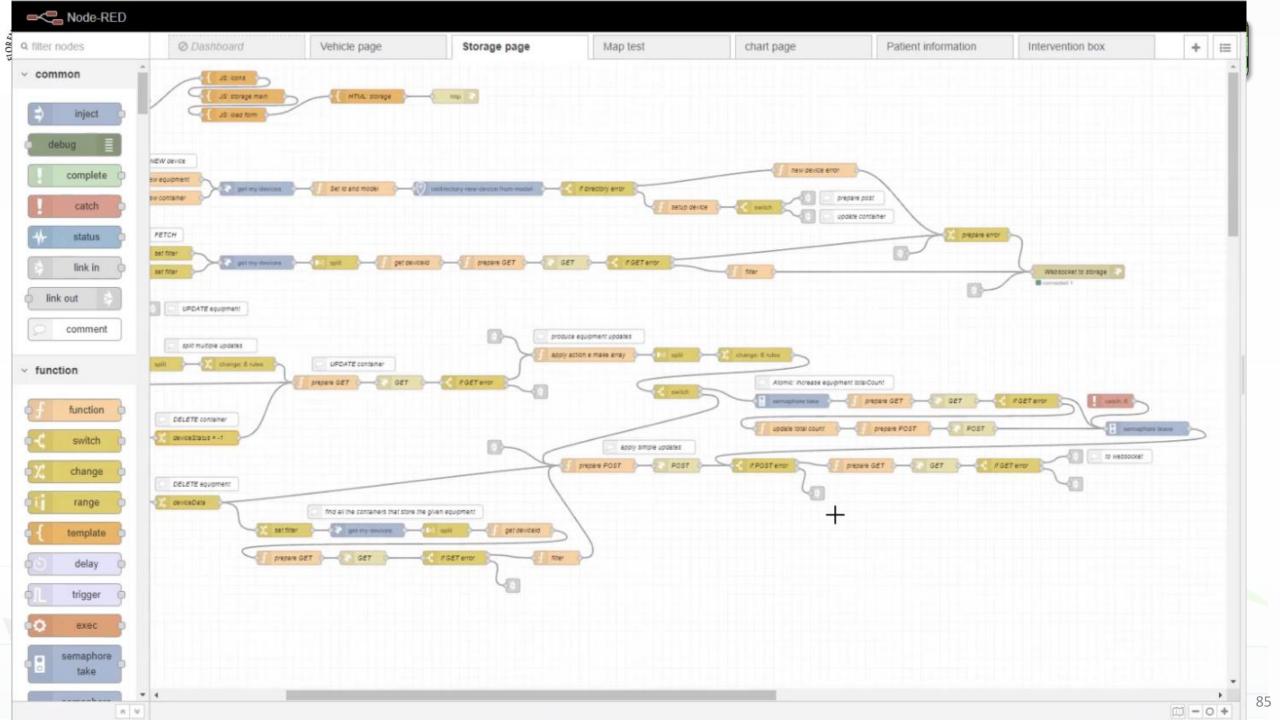
Smart Ambulance

- **HUD control**
- Monitoring Patient
- Intervention data

- Device/equipment Status:
  - Fridge, tanks (anestetic, oxigen, etc.)
- Stock
  - Load/get any drug/item per box/container
- Car Maintenance
  - Programmed, and accidents

36.82   Km a destinazione.

Jewel Alarms
AMPERE

Click on Jewel

NFC

BLE

Filters

Link to "Ampere User Management"

Ampere user list

Name	Surname	Ethnicity	Language	Age	Status	DateObserved
Daniele	Bologna	European	Italiano	33	not_active	2022-04-06T14:19:41.050Z

Email: dbologna120@gmail.com
Phone: 3381122333
Controls: See

Hdhdbdb	didjdj		Italiano		not_active	2022-04-10T09:43:45.016Z
Francesco	Vill		Italiano		not_active	2022-04-14T13:47:56.708Z
Mini Long	Mini Long		English	28	not_active	2022-04-14T18:56:49.203Z

Ampere User Management

👤 Anagraphic data:
- **Name:** Mini Long Mini Long
- **phone number:** 1250666585
- **Day of birth:** 1994-11-11
- **Address:** Fi
- **City:** Fi
- **locality:** Fi
- **Gender:** male
- **Language:** English
- **Ethnicity:**
- **Height:**
- **Weight:**

🏥 Healthcare data:
- **Medication:**
- **Vision Impaired:** false
- **Wheel Chair User:** false
- **Allergies:** No

📞 Emergency number:
- **Call 112:** false
- **Call 115:** true
- **Call 118:** true

📞 Contacts:
- **Contact name 1:** Longo Longo
- **Phone number:** 4588665556

User Metadata

List of user event's

Data Observed	DeviceId	Status	Description	Try
2022-04-11T13:56:29.952Z	Operator	Called: S Sev		
2022-04-11T14:37:52.656Z	APP	alert		Pin Action
2022-04-11T14:38:24.112Z	Operator	Called: 118		
2022-04-12T08:16:46.076Z	APP	alert		Pin Action
2022-04-13T12:07:27.586Z	Operator	Called: 118		
2022-04-13T15:16:45.987Z	Operator	Called: Daniele Bologna	test_description	
2022-04-14T13:00:15.680Z	Operator	Called: 115	new action	
2022-04-14T13:19:18.118Z	Operator	Called: 115	test new action	
2022-4-11T15:18:47.000Z	Operator	Called: M Bol		
2022-4-11T15:21:6.000Z	Operator	Called: 112		

Operator Actions

Call User:
○ Daniele Bologna (3381122333)

Call Contacts:
○ M Bol (057123693966)
○ S Sev (255249146)

ER Numbers:
○ Call 115
○ Call 112
○ Call 118

Description:

Cancel Confirm

Energy monitoring and business intelligence

Energy monitoring and business intelligence

- Environmental data
- Power meter Data
- Smart Light data are coming (in collaboration with a multinational company)

Smart Waste – Map view

Search bins on map by filtering per:
- **Kind** (All, generic, plastic, paper, glass, metal, organic)
- **Status** (Active, Not Active)
- **Fullness** (Full, Half-full, Empty)
- **Address**
- **Group of bins** (by GroupID)

- Refine a search by using the filters on the left side
- Click on a waste bin pin on the map:
- A popup with real time data is shown
- The fullness status of the selected group of bins is shown in the synoptic below the map
- Specific fullness weekly trends are shown below the map
- Chick on the «Table view» button to access the other dashboard

Smart Waste – Table view
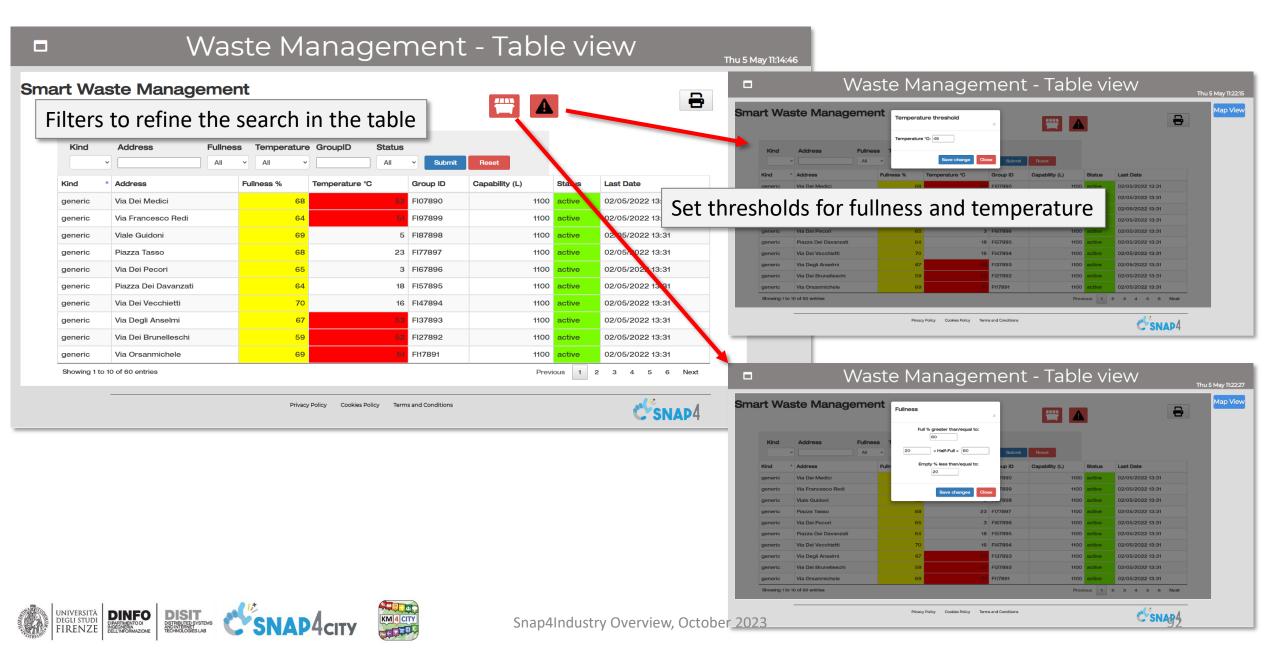
Filters to refine the search in the table

Set thresholds for fullness and temperature

Snap4Industry Overview, October 2023

Sinottico Impianto

http://dashboard/dashboardSmartCity/view/index.php?iddasboard=MTk=
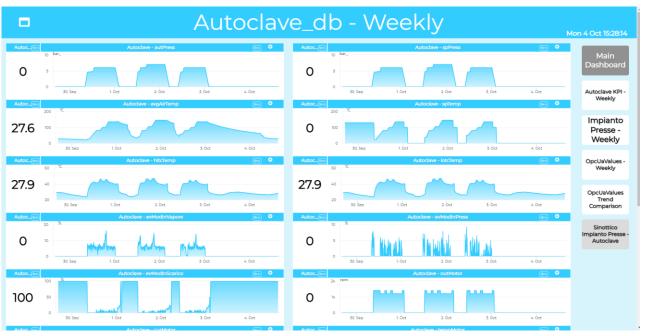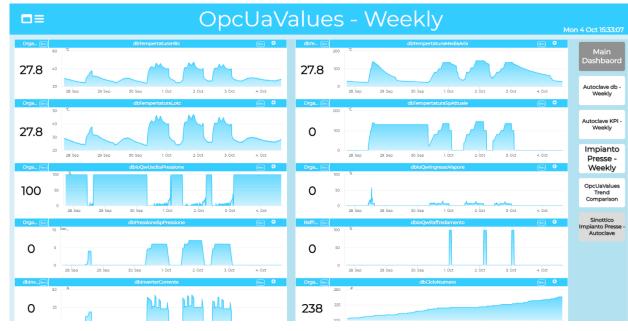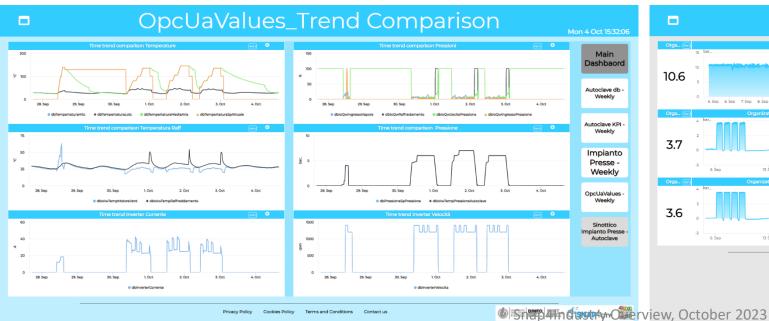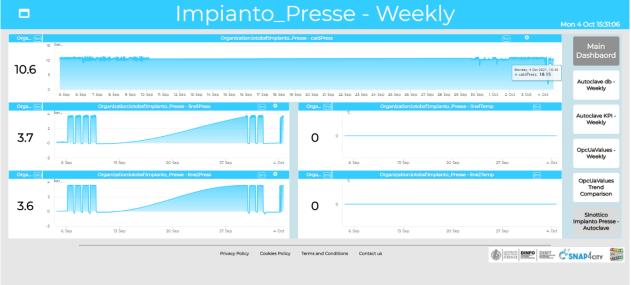
EN.TE.R.PR.I.S.E.

(**EN**hanced **TE**chnological **R**&D of new **PR**oducts and Processes for **I**nnovation, **S**mart factory and green **E**conomy)
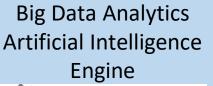
Administrative Data from AS400

Real Time Data, Historical, Events from DCS

Unique National Energy Costs (PUN)

Big Data Analytics Artificial Intelligence Engine

SNAP4INDUSTRY

Analytical Data from the product quality Lab (LIMS/SAM)

SNAP4

GeNotiLab

GeNotiLab Architecture for ALTAIR

Analytical Data from the product quality Lab(LIMS/SAM)

AS400

IOT App

Users

Analysis

Notifications

IOT App Analytics

Dashboards
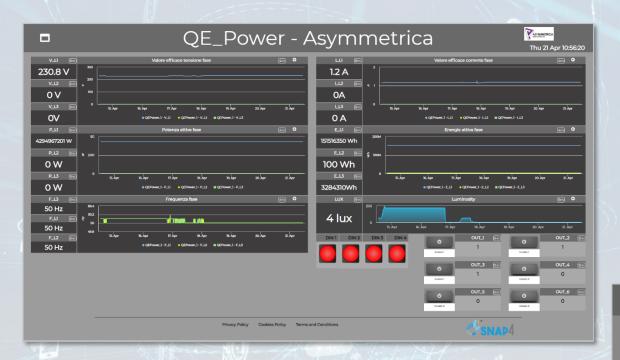
IOT App Management

IOT App Vs Telegram

Telegram Bot

Tools:
-- List of Chemical Analyses
-- List of Notifications
-- Define notifications
-- Program, send notifications
-- see notification status

- Environmental data
- Power meter Data
- Smart Light data are coming (in collaboration with a multinational company)
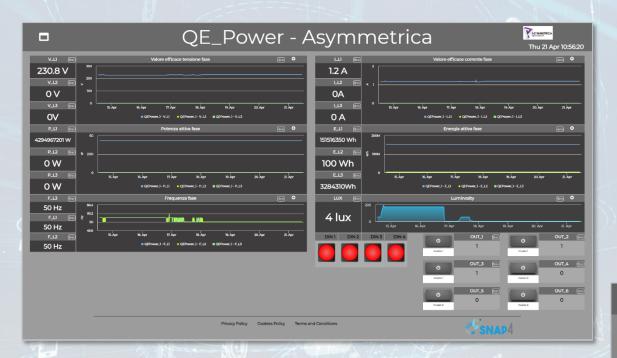
TheLab.City LivingLab by ICEBERG, Romania

- Airquality
- Urban planning
- Parking
- Waste
- Etc.

https://thelab.city/

- Environmental data
- Power meter Data
- Smart Light data are coming (in collaboration with a multinational company)

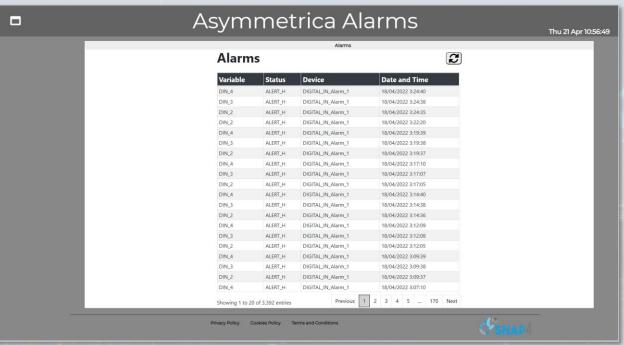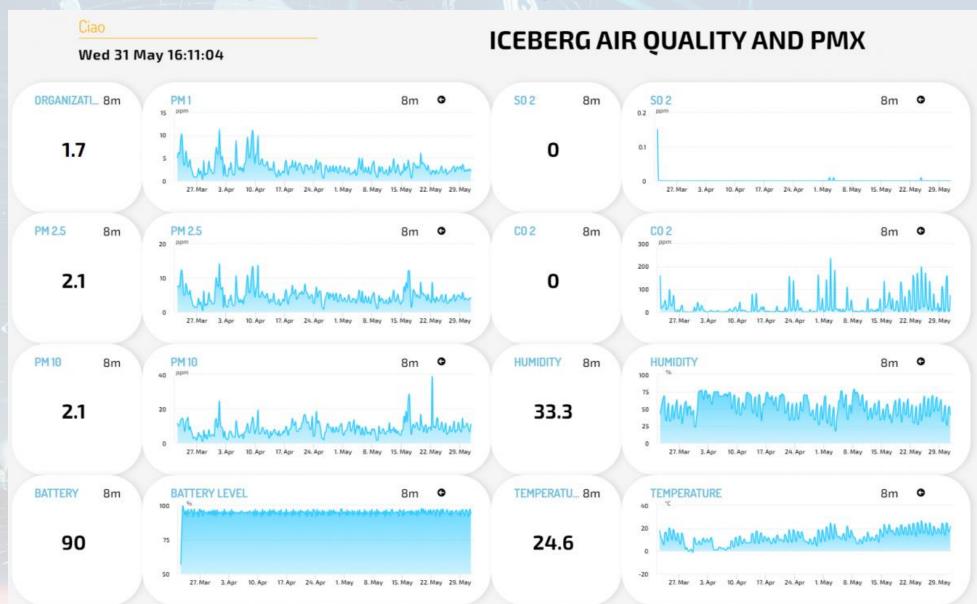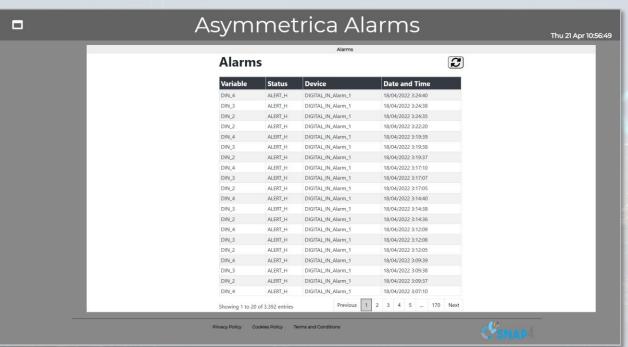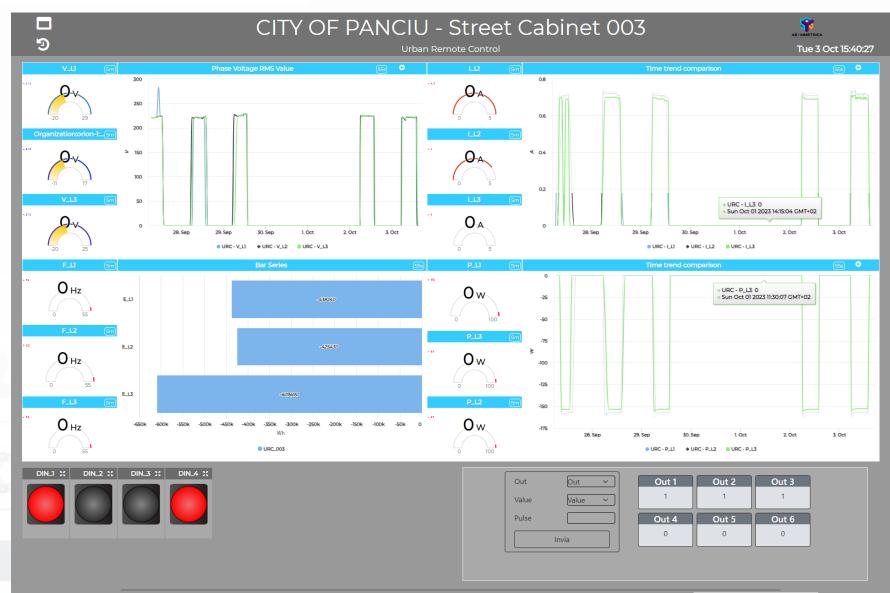City of Panciu in Romania

By Asymmetrica and Snap4

- **Field-tested energy community: the self-consumer condominium**
- The Self User project creates in the pilot condominium, through the collection and analysis of data, a model for calculating and enhancing the impact of an energy community on a community of people, with a view to actions to combat energy poverty

https://www.selfuser.it

Monitoring and Tracking via Thermal Cameras

Tracking People
AXIS Camera with Snap4City
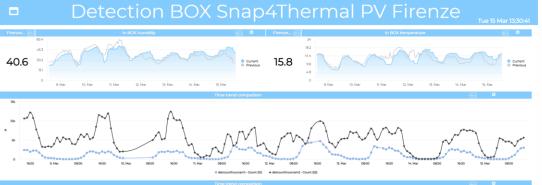
A view and data from the Thermal Camera

Detection BOX Snap4Thermal PV Firenze

Tue 15 Mar 13:30:41

109

2023
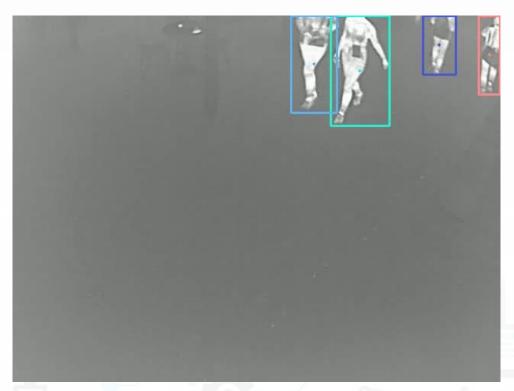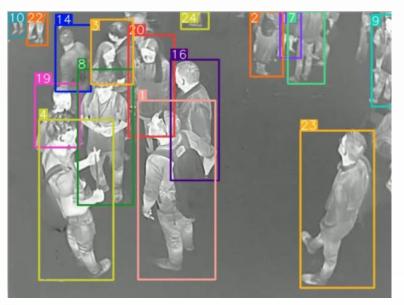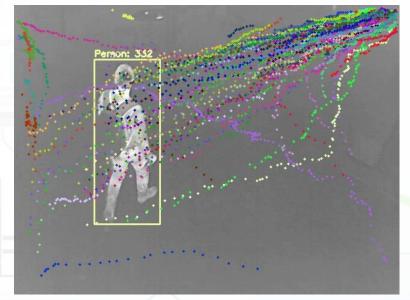
People Counting and Tracking

Retail Recommendations Feedback Pilot

Smart Retail
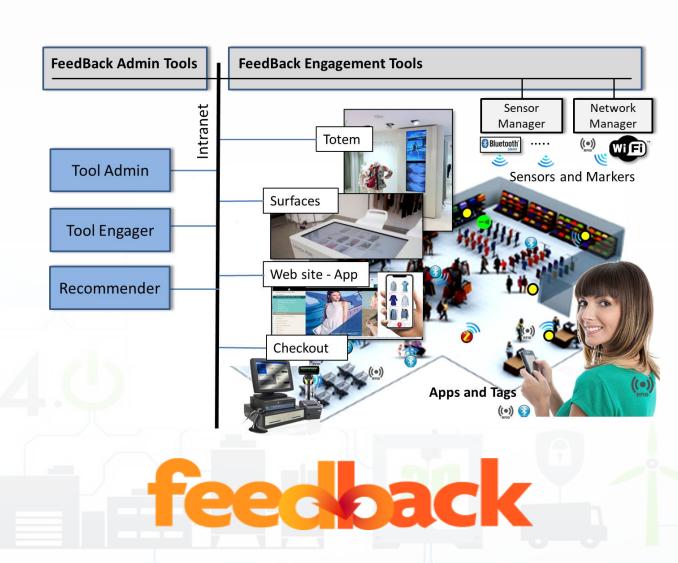
- **Feedback,** Flexible Advanced Engagement Exploiting User Profiles and Product/Production Knowledge
  - VAR, PatriziaPepe (Tessilform), DISIT, Effective Knowledge, SICE
  - Keywords: retail, GDO, …
- **Goals and drivers:**
  - adaptive user engagement, customer experience
  - Advanced user profiling, user behavior analysis
  - Predictive models for engagement
  - IOT and instrumentation
  - Integrated in city customer experience
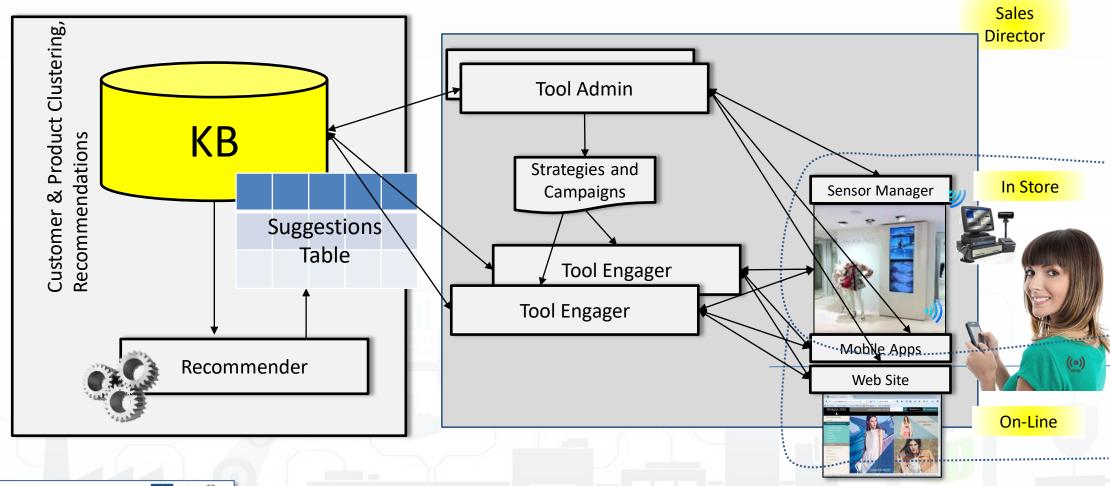
Reference Architecture
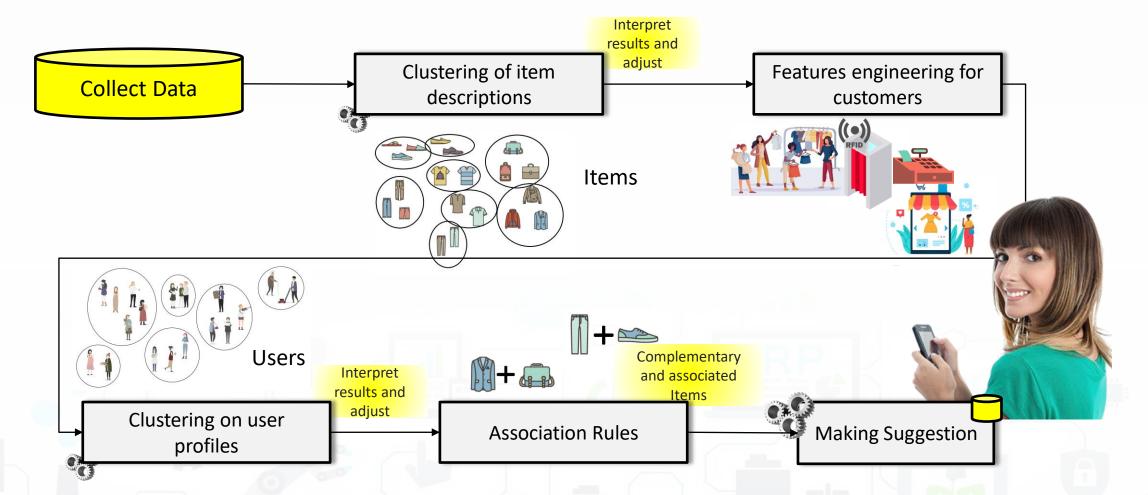
Workflow

- Using the stimulus of the recommendation system, we have increased the customers' attention of the 3.48%

- The solution is also functional in presence of a low number of customers and items

- The solution solved the cold start problems

- GDPR compliant

Water Depuration Plant

Prato
Smart City vs Industry 4.0

GIDA set up

Demo UC5 GIDA

How to Develop

https://www.snap4city.org/download/video/course/dev/

https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf
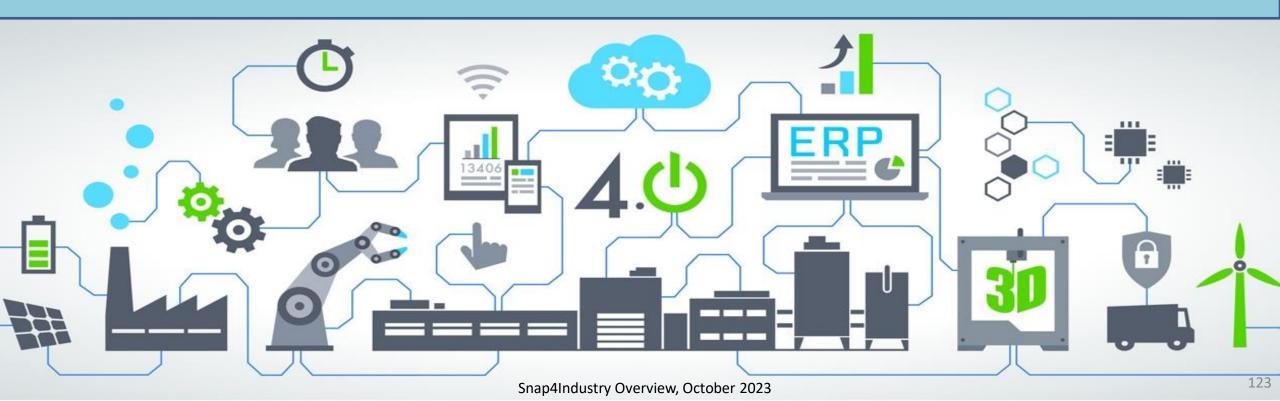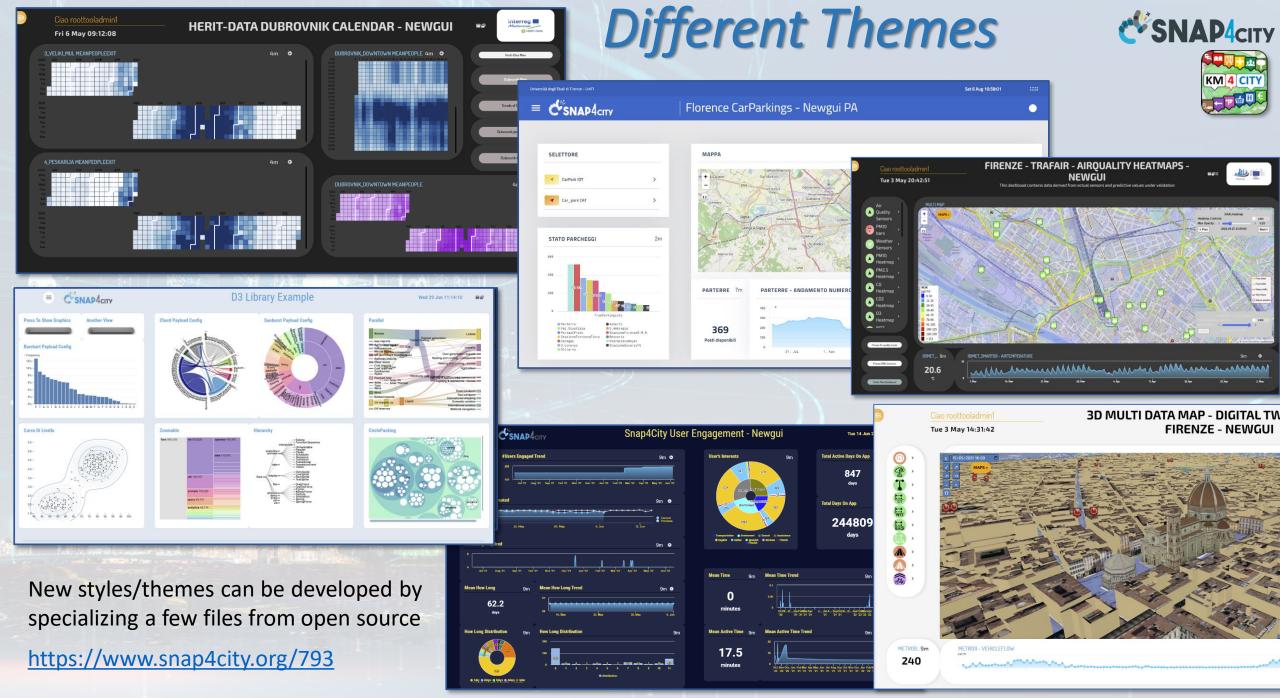
Creation of Dashboards and Applications

Different Themes

New styles/themes can be developed by specializing a few files from open source

https://www.snap4city.org/793

D3 Graph library capability
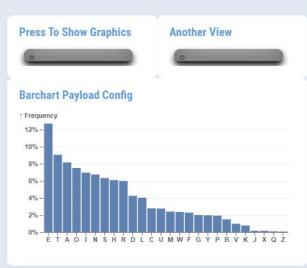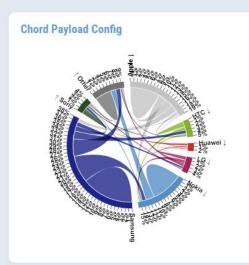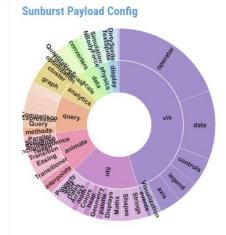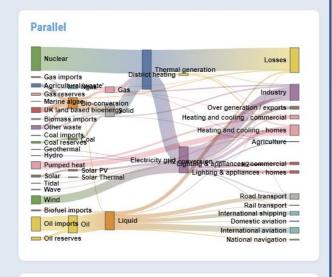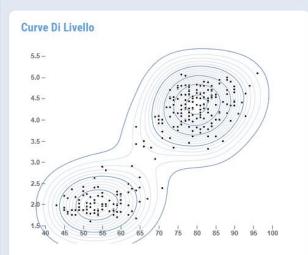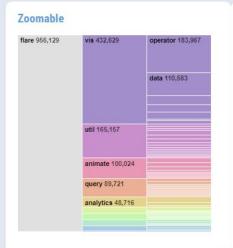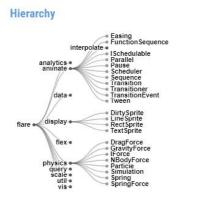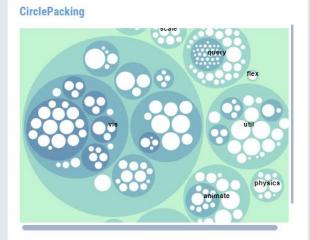
https://www.snap4city.org/dashboardSmartCity/view/Gea.php?iddasboard=MzQ4OQ==
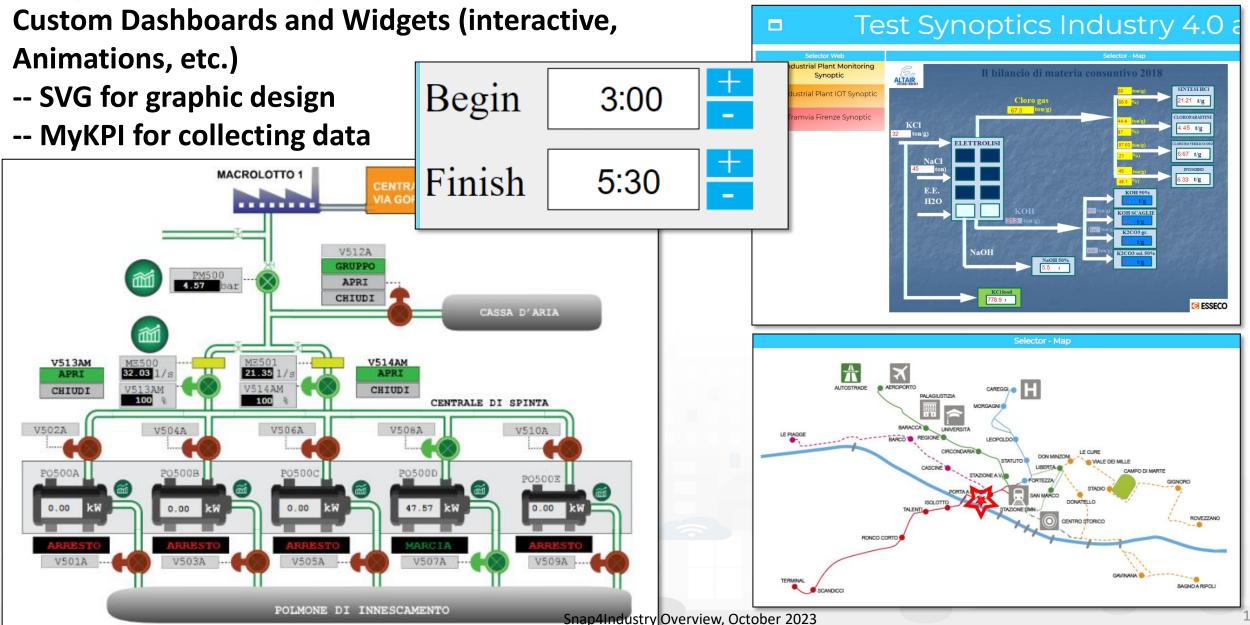
Custom Widgets

Custom Dashboards and Widgets (interactive, Animations, etc.)

-- SVG for graphic design

-- MyKPI for collecting data

MyKPI: Tracking of Devices and Mobiles

- Real Time Trajectories for
    - Mobile Phone
    - Moving IOT Devices
    - OBU, Vehicular Kits
    - Multiple tracks
    - Day by day

- Micro Application

Apps

Mobile
PAX Counter

OBU

OBD2

Special Custom Widgets

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

Dashboard Development

IOT Applications

Knowledge Base, Km4City

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

Widget Collection

Micro Applications

External Services

Custom Widgets/ Synoptics

Dashboard Wizard

Dashboard Editor

Public Dashboard Collection

Create, save, load, delegate, grant access

My Own Dash/App

Dashboard List and Editor

Wizard

Dashboard features	Data and widgets	Check and summary

Map

Single data widgets

Multi data widgets

Data sources

	All selected (10) ▾	All selected (55) ▾	All selected (776) ▾	All selected (315) ▾		All selected (47) ▾			All selected (2) ▾
	High-Level Type	**Nature**	**Subnature**	**Value Type**	**Value Name**	**Data Type**	**Last Date**	**Last Check**	**Ownership**
	Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather		2018-07-08 16:00:18	public
	Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather	Vergemoli	2018-07-08 16:00:18	public
	Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather		2018-07-08 16:00:18	public
	Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather	aiano	2018-07-08 16:00:18	public
	Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather	Vaglia	2018-07-08 16:00:18	public
	Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather	Vagli sotto	2018-07-08 16:00:18	public
	Special Widget	**Environment**	**Weather Forecast**		**Previ_Meteo**	**special weather**	**Vagli di sotto**	**2018-07-08 16:00:18**	**public**
	Special Widget	Environment	Weather Forecast		Previ_Meteo	special weather	Uzzano	2018-07-08 16:00:18	public

| Hide columns | ⚙▴ | | Res | | Selected rows: 0 | Previous 1 2 3 4 5 ... 1081 Next | | Search |

Choosen data sources

High-Level Type	Nature	Subnature	Value Type	Value Name	Data Type	Last Date	Last Value	Healthiness	Last Check	Ownership	Remove

Previous Next Search

- 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

Close

Custom Widget / Synoptic Development

Inkscape editor on your computer

SVG Symbols Collection

Create, save a Custom Widget in SVG

IOT Applications

Knowledge Base, Km4City
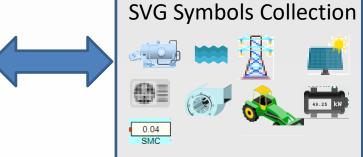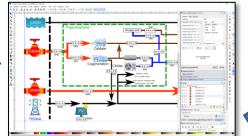
Knowledge and Storage Data from the Field and City

Create, save, load, delegate, grant access

Public Dashboard Collection

My Own Dash/App

Dashboard Editor

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

From-To Custom Widgets / Synoptics to Storage in WS

MyKPI

Sensors

MyKPI

Sensor

[   ]

New Shared Variables

Constant Values

Web Socket Secure
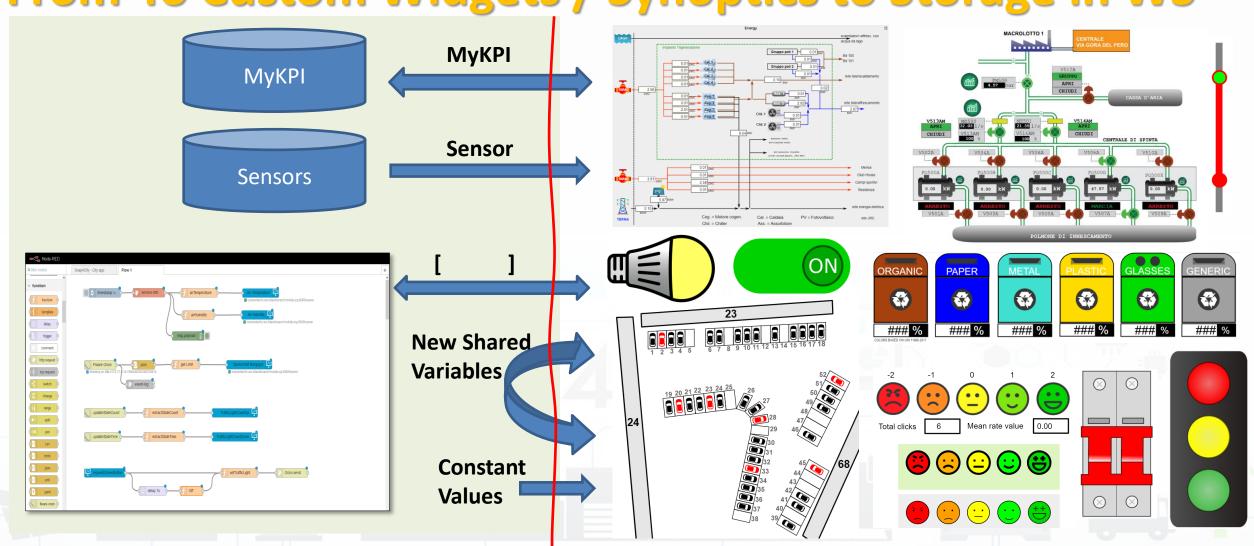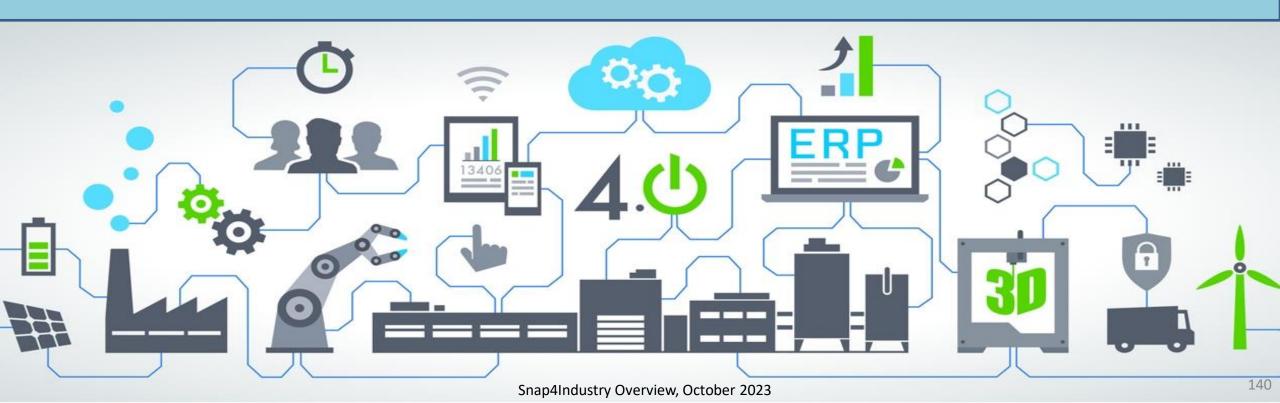
Dashboards' Intelligence on Web and Mobile Devices

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 ▾
- 🧩 Development Tools ▾
- 👥 Management ▾
- ⚙ Settings ▾
- 👤 User Management and Auditing ▾
- 🧗 Help and Contacts ▾
- 📄 Documentation and Articles ▾
- 🔑 My Profile ▾
- ⧉ Snap4City portal
- ⧉ Km4City portal
- ⧉ DISIT Lab portal

Prev **1** 2 3 … 9 Next

Filter 🔍 ✕

Create new

● 2018-09-14T04:44
IOT Edge App
owner: badii
Management

● 2018-09-21T03:19
IOT Edge App
owner: panesi
Management

● 2018-10-19T16:07
IOT Edge App
owner: pb3
Management

● 2018-10-19T17:17
IOT Edge App
owner: pb3
Management

● 2018-10-22T11:57
IOT Edge App
owner: semolarudy
Management

● application
IOT Application
owner: tester5
Management

● Bib APP
IOT Application
owner: semolarudy
Management

● ChargingStations
IOT Application
owner: comunedashres
Management

● Deprecated - SiiMobilityControlRoom
IOT Application
owner: badii
Management

● SamsungGalaxyS4BarCode
IOT Edge App
owner: badii
Management

● esercitazione
IOT Application
owner: tester2
Management

● Iot-App
IOT Application
owner: tester14
Management

IOT Applications Development

MicroServices collections

My IOT Applications

IOT App. Editor

Generating IOT App
With Dashboard

IOT Discovering

ServiceMap Discovery

Knowledge Base, Km4City
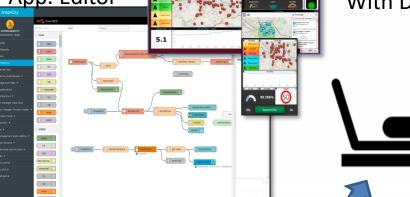
Dashboard Collection,
Editor and Wizard
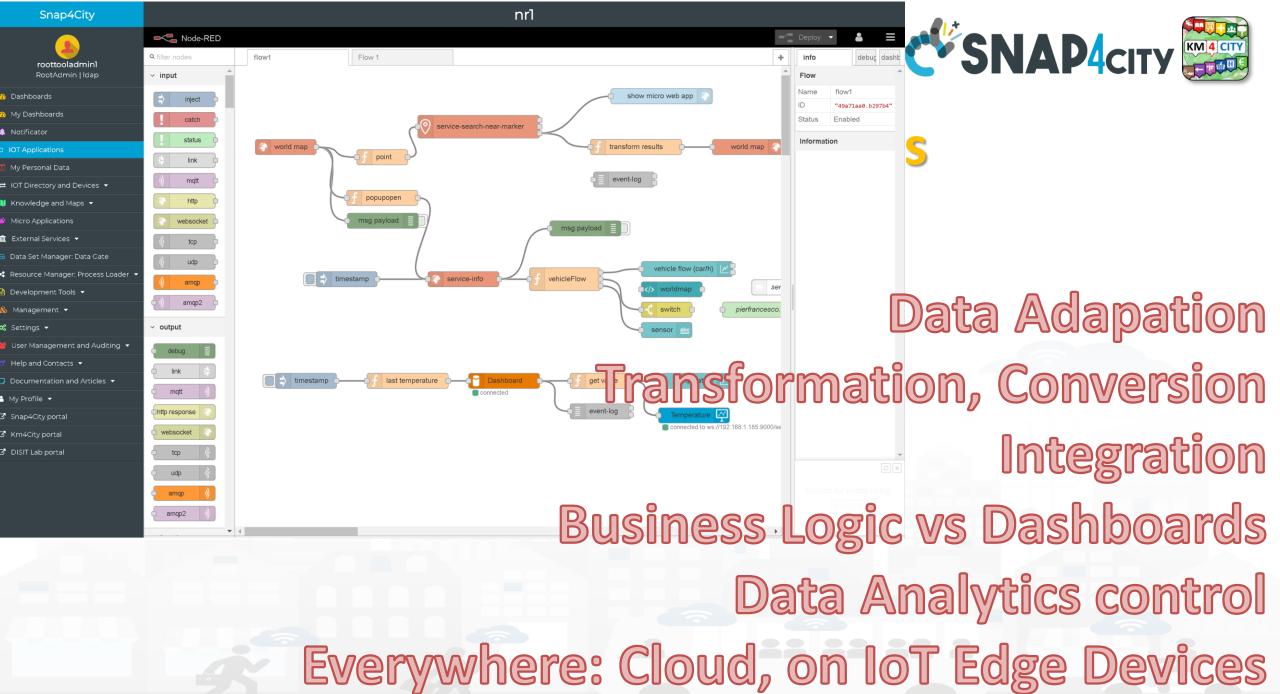
Sharing/saving
reusing IOT App

Resource Manager

Data Adapation
Transformation, Conversion
Integration
Business Logic vs Dashboards
Data Analytics control
Everywhere: Cloud, on IoT Edge Devices

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.

Ingestion, aggreg. → *exploitation*
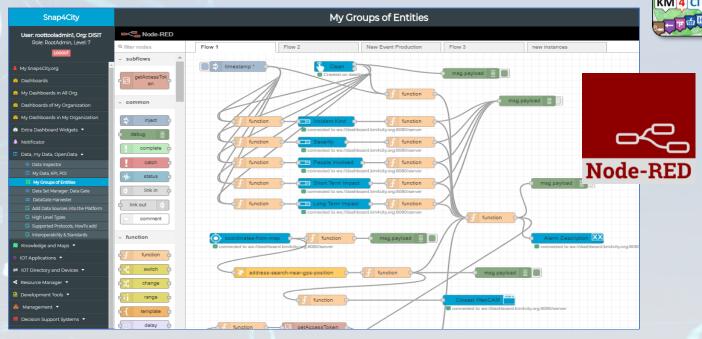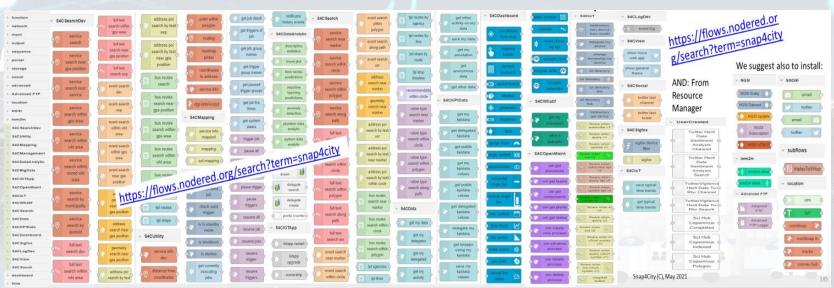
- **IoT App Visual Programming, no coding**
  - **Data transformation**
  - **Integration, Interoperab.**
  - **Scripting Data Analytics**
  - **Data ingestion**
  - **Business logic**

- **Edge and Cloud**

- **MicroServices** data driven develop via visual language Node-RED

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

We suggest also to install:

Snap4City (C), May 2021

145

From-To Custom Widgets / Synoptics to Storage in WS

MyKPI

Sensors

MyKPI

Sensor

[   ]

New Shared Variables

Constant Values

Web Socket Secure

Standards and Interoperability (6/2023)

Compliant with:

- **IoT:** NGSI V2/LD, LoRa, LoRaWan, MQTT, AMQP, COAP, OneM2M, TheThingsNetwork, SigFOX, Libelium, IBIMET/IBE, Enocean, Zigbee, DALI, ISEMC, Alexa, Sonoff, HUE Philips, Tplink, BACnet, TALQ, Protocol Buffer, KNX, OBD2, Proximus, ..
- **IoT model:** FIWARE Smart Data Model, Snap4City IoT Device Models
- **General**: HTTP, HTTPS, TLS, Rest Call, SMTP, TCP, UDP, SOAP, WSDL, FTP, FTPS, WebSocket, WebSocket Secure, GML, WFS, WMS, RTSP, ONVIF, AXIS TVCam, CISCO Meraki, OSM, Copernicus, The Weather Channel, Open Weather, OLAP, VMS, ….
- **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

Snap4Industry vs Formats

- Snap4City is capable to ingest and work with any format:
  - Data **exchange**: JSON, GeoJSON, XML, HTML, HTML5, DATEX, GTFS, binary, etc.
  - **Table**: CSV, XLSX, XLS, database, ...
  - Any **archive** file format: zip, rar, 7z, tgz, ...
  - Any **image** format: png, gif, tiff, ico, jpg, ...
  - Any **video** format: mp4, avi, mov, ...
- Search the format you need to cope on the search box of Snap4City portal!
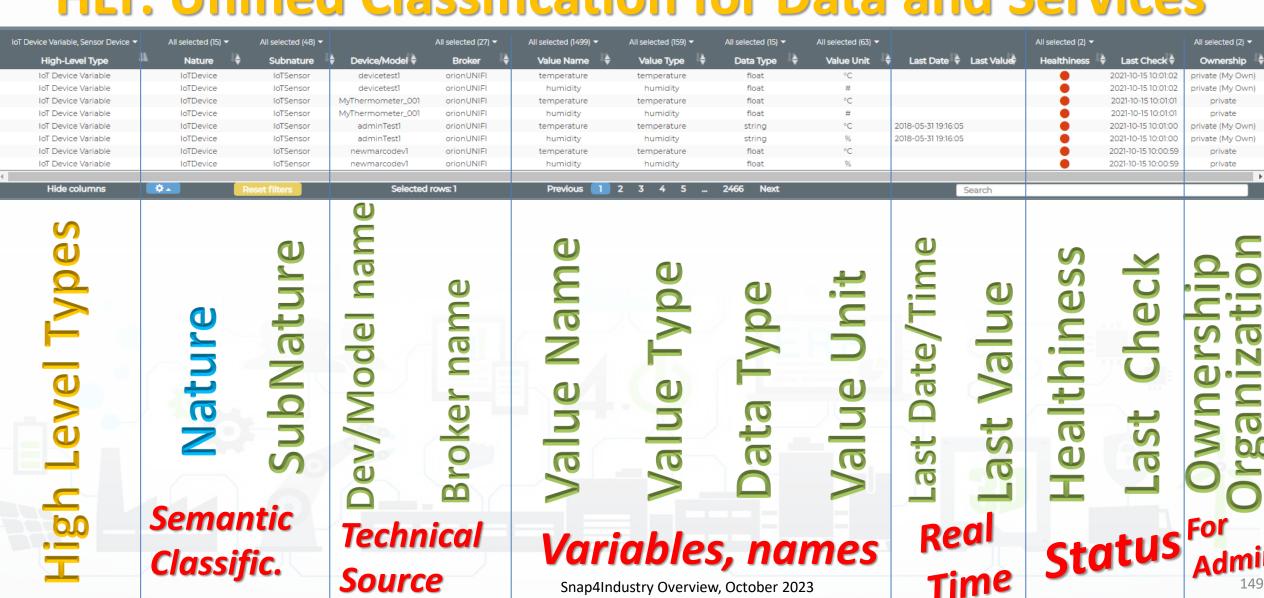
HLT: Unified Classification for Data and Services

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*

How the Dashboards exchange data (2022)

Snap4Industry Overview, October 2023

150

Dynamic (4/22)

Widgets ICONS		Widget Name, Description		IOT App	Dashboard-IOT App	KPI (metric)	MyPersonalData	MyData	My KPI	Sensor
XX		Single Content	single content XX	X (cs)	X (DD)	X	X	X	X	X
	50	Speed Limit (see custom widget for more)				X				X
(speedometer)		Speedometer	speedometer	X (cs)	X (DD)	X	X	X	X	X
(gauge)		Gauge	gauge chart	X (cs)	X (DD)	X	X	X	X	X
		Single Bar, V/H	horizontal single bar / vertical single bar	X	X (DD)	X				
		Single and Multiple Bars, stacked or not, ordered	Bar series	X (cs)	X (DD)	X	X	X	X	X
		MultiSeries, shaded, staked and non staked, TTT	curved line series	X (cs)	X (DD)	X	X	X	X	X
		Time Trend (single)	time trend	X	X (DD)	X	X	X	X	X
		Time Trend Compare				X			X	X
		SpiderNet, radar, Kiviat	radar series	X (cs)	X (DD)	X	X	X	X	X
		Pie, Donut, 2 layers Donut	pie chart	X (cs)	X (DD)	X	X	X	X	X
		Table	table content	X (cs)	X (DD)	X	X		X	X
		Calendar	calendar ABC	X (cs)	X (DD)				X	X
		Speak Synthesis	Speek Synthesis	X (cs)	X (DD)				string	string
		Maps	dashboard - map / Selector - Map	X (cs)	X (DD)	Many High Level Types			X	X

DD: Data Driven

- **IOT APP column in previous table:**

  - **X**: means that from the IOT App you can send a new value or array to the widget directly, without the need to have is stored into Sensor or MYKPI variable, etc.

  - **CS, widget supports Change Source**, in the sense that: from the IOT App is possible to send a command to the Widget to change the data source. E.g., selecting sources among: Sensors (service URI), MyKPI (ID), any value produced on the IOT App directly. (cs) recent additions

- **Dashboard IOT App column in previous table**:

  - **X:** there is a MicroService / node on IOT App to act on those widgets on dashboard. The data are visualized.

  - **DD, widget is Data Driven**, in the sense that new data in push can be sent and the widget is updated in real time on web page without web page realoading

TC4.9: New Support Widgets for Bars, Barseries, Trend, and Series, on Dashboards and IOT Applications (partially obsolete)
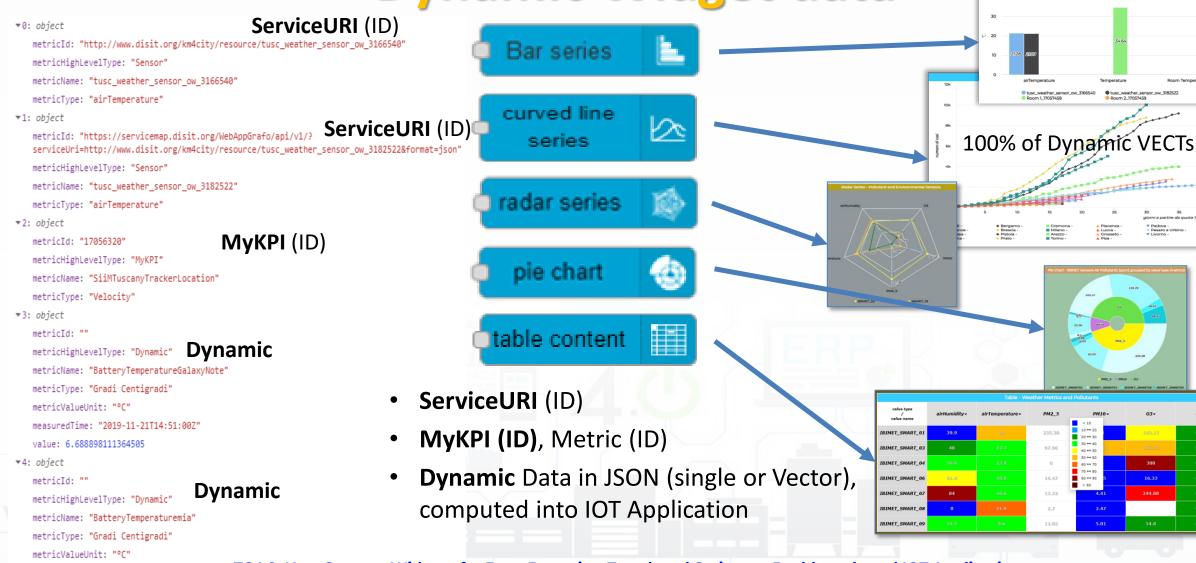
Dynamic Widget data

ServiceURI (ID)

```
▼0: object
    metricId: "http://www.disit.org/km4city/resource/tusc_weather_sensor_ow_3166540"
    metricHighLevelType: "Sensor"
    metricName: "tusc_weather_sensor_ow_3166540"
    metricType: "airTemperature"
▼1: object
    metricId: "https://servicemap.disit.org/WebAppGrafo/api/v1/?
    serviceUri=http://www.disit.org/km4city/resource/tusc_weather_sensor_ow_3182522&format=json"
    metricHighLevelType: "Sensor"
    metricName: "tusc_weather_sensor_ow_3182522"
    metricType: "airTemperature"
▼2: object
    metricId: "17056320"
    metricHighLevelType: "MyKPI"
    metricName: "SiiMTuscanyTrackerLocation"
    metricType: "Velocity"
▼3: object
    metricId: ""
    metricHighLevelType: "Dynamic"
    metricName: "BatteryTemperatureGalaxyNote"
    metricType: "Gradi Centigradi"
    metricValueUnit: "°C"
    measuredTime: "2019-11-21T14:51:00Z"
    value: 6.688898111364505
▼4: object
    metricId: ""
    metricHighLevelType: "Dynamic"
    metricName: "BatteryTemperaturemia"
    metricType: "Gradi Centigradi"
    metricValueUnit: "°C"
    measuredTime: "2019-11-21T14:51:00Z"
    value: 62.8502788741156
```

ServiceURI (ID)

MyKPI (ID)

Dynamic

Dynamic

100% of Dynamic VECTs

- **ServiceURI** (ID)
- **MyKPI (ID)**, Metric (ID)
- **Dynamic** Data in JSON (single or Vector), computed into IOT Application

TC4.9: New Support Widgets for Bars, Barseries, Trend, and Series, on Dashboards and IOT Applications

IOT Data Driven

Real Time

Real Time + Historical

IOT Applications

Snap4city Platform storage for «Data Shadow» and much more

Sensors

Actuator

Sensor Actuator
From Dashboard to IOT Device

From IOT Device to KB

Snap4City
IOT Brokers

Managing Public and Private IOT/IOE Devices

Sensors

Sensors

Dashboards also provide rendering for sensor values

Lavagnini   Statuto
45   45

Towards any IOT Device and/or Dashboard

Sensors

OFF
Green

Dashboard-IOT App

Nature

From Dashboard to IOT App

IOT Application

MapClick
MyKPI variable onchange
Synoptics

From Dashboard to IOT Devices/App

Acting on your systems
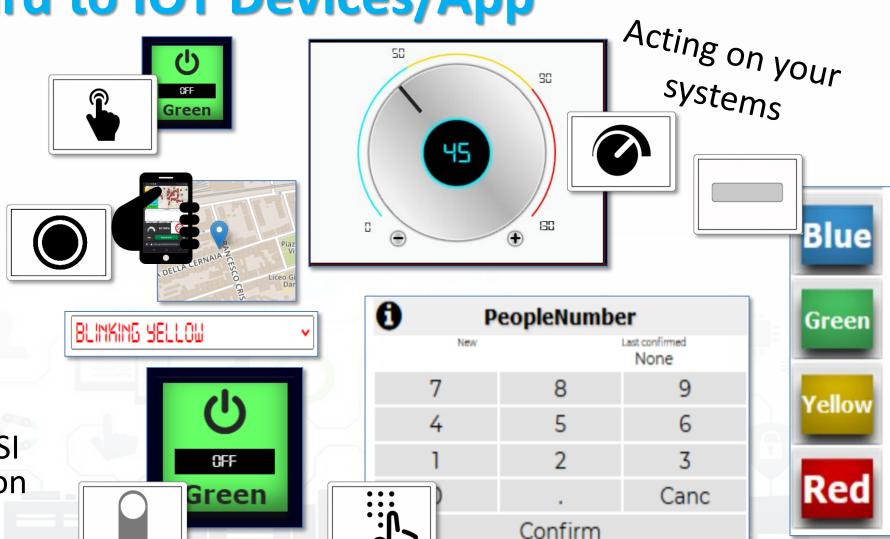
- **Widgets:**
  - Impulse Button
  - Button
  - Switch
  - Dimer/Knowb
  - KeyPad
  - Geolocator
  - Selection
  - Map Picking
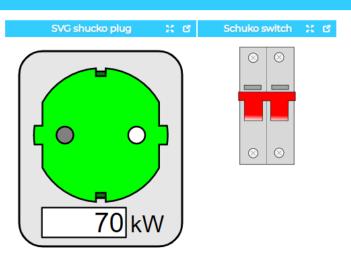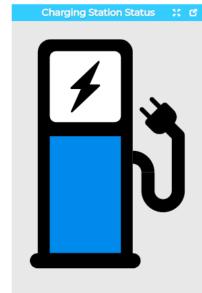- **Registered** on some IOT brokers with NGSI mutual authentication

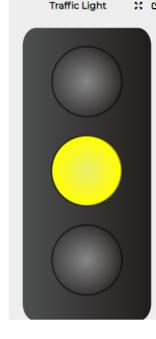# SVG Custom Widgets Examples 2

Tue 17 Nov 18:46:47

SVG shucko plug

70 kW

Schuko switch

Charging Station Status

Legenda

Charging Station Status

Set on the keypad one of the following values

0 = ERROR (RED)

1 = AVAIBLE (GREEN)

2 = BOOKED (YELLOW)

3 = CHARGING

9999 = white icon

Charging Station status		
New	Last confirmed	
	None	
7	8	9
4	5	6
1	2	3
0	.	Canc
Confirm		

Underpass **Set tunnel st...**

ON

Traffic Light status set

YELLOW LIGHT

Traffic Light

Speed Limit Set

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

Dynamic Speed Limit Sign

24

Speed Limit Explaination

Speed Limit Custom Widget example

Write the speed limit by using the keypad and click CONFIRM.

9999 = white sign.

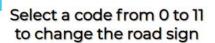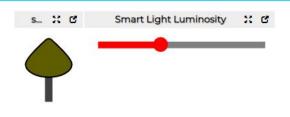https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mjk4Ng==
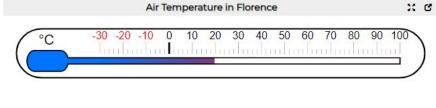
SVG Custom Widgets Examples

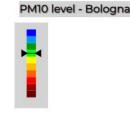https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=Mjk0NQ==
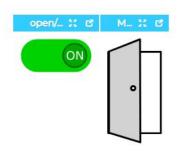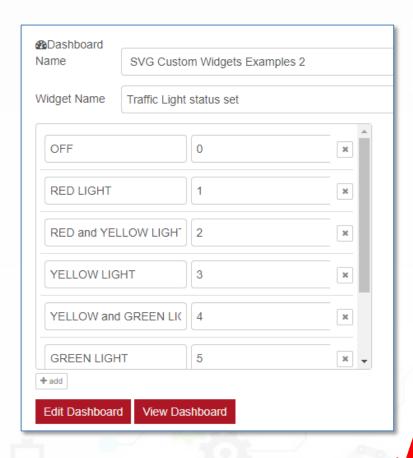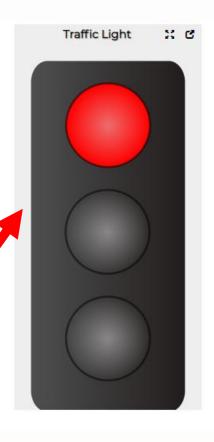
Selector

- Selecting MSG to be sent on the Business Logic IOT Application

```
msg.payload = {value:JSON.parse(msg.payload).selected};
return msg;
```

Dashboard-IOT App

Nature
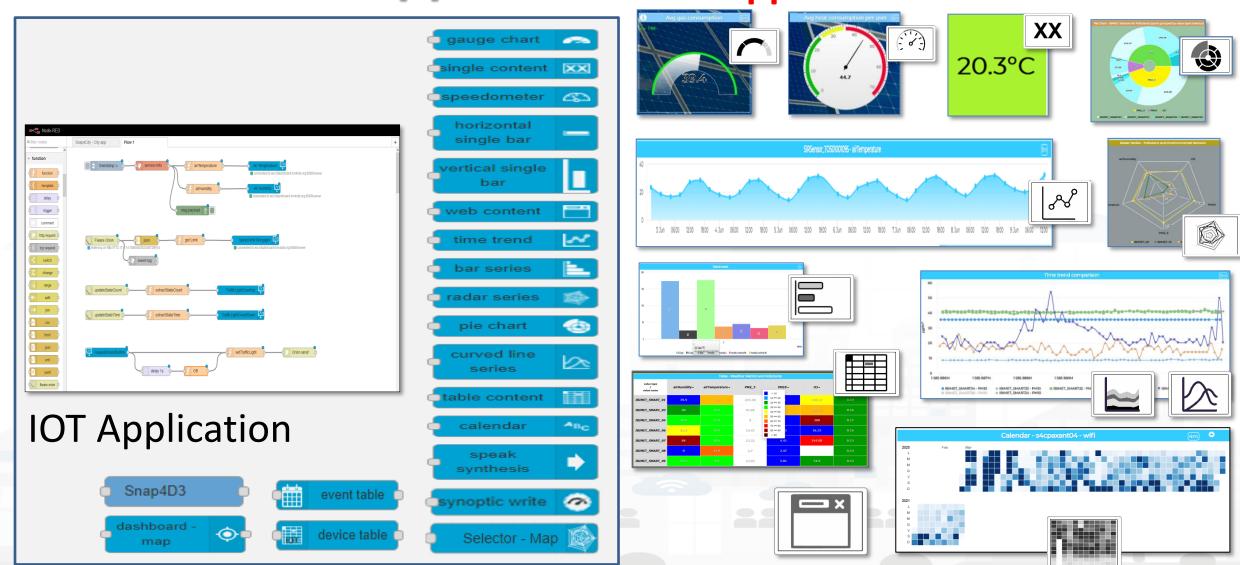
From IOT App to Dashboard

IOT Application
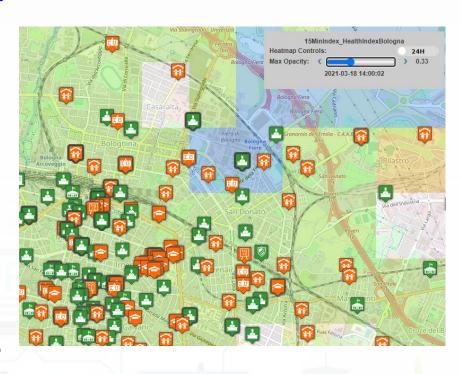
Selector Map Controlling Maps from IOT Apps

- User manual: https://www.snap4city.org/774
- To control Multi Data Map from IOT App
  - Add/remove a Category/SubCategory of Entities, via *more option query*
  - Add/remove a single Device/PIN, MyPOI, MyKPI, Dynamic Pins, moving devices, etc.....
  - Add/remove cycling paths
  - Add/remove OD Matrix
  - Add/remove an Heatmap, a Traffic Flows, …
  - Add/remove multiple entities with multiple More Option Queries
  - Add/remove Special Tools: scenarios, whatif, etc.
  - Add/remove a set/single temporary GeoInfoPin

Trajectories
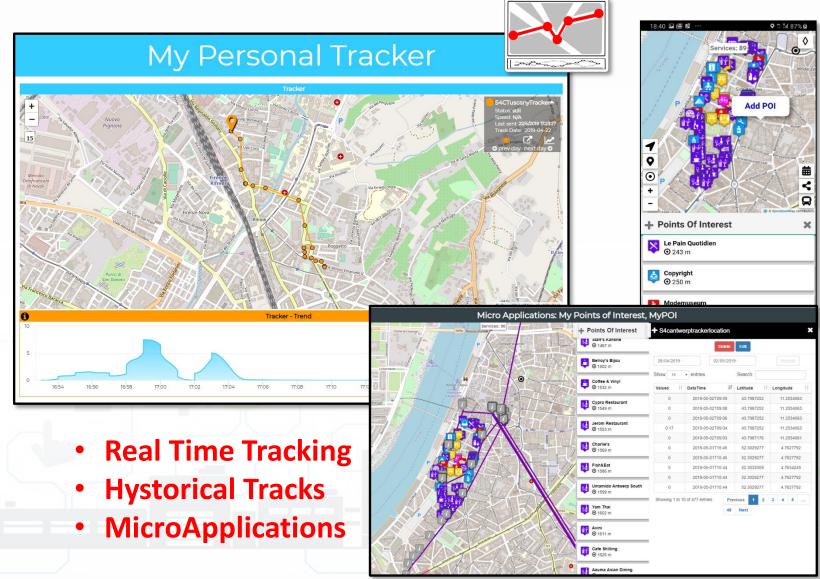
High Level Types
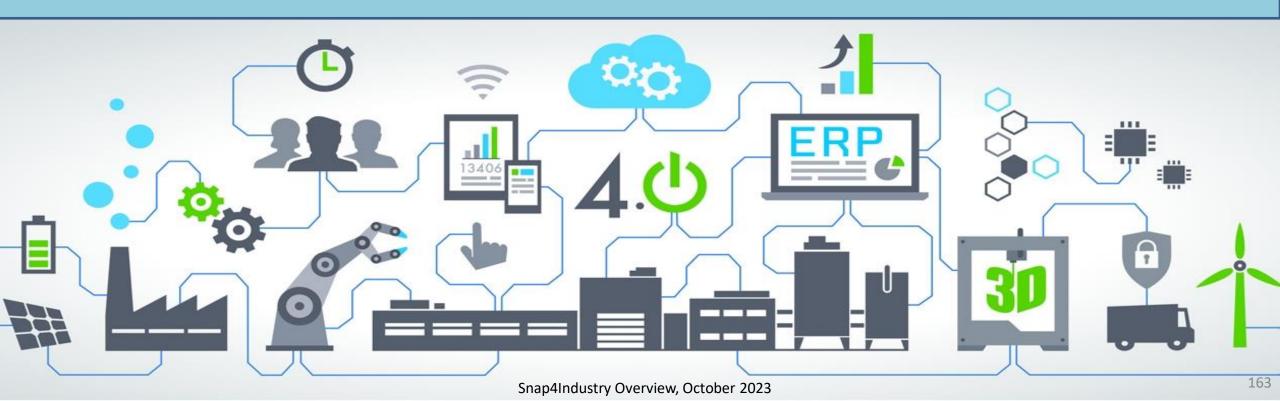
- **Variables,** Sensor/sensor-actuator, :
  - **Mobile Device Variable, Data Table Variable, Dashboard-IOT App:** messages from GUI to Business Logic on IoT App
- **MyKPI:** dynamic GPS, info, single variable, Time Series, (Classification)

- **Real Time Tracking**
- **Hystorical Tracks**
- **MicroApplications**
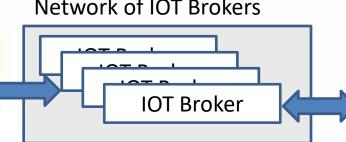
IoT Devices and IoT Apps
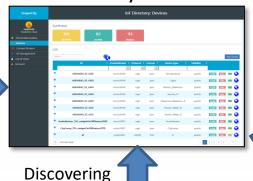
IOT Network Manager vs Final User

Network of IOT Brokers

IOT Directory

My IOT Device

IOT Broker

IOT Network Manager

Register

Registering

Discovering

Knowledge Base, Km4City

IOT Application

Final user Manager

Browsing

ServiceMap Knowledge Base

Discovering

Knowledge and Storage Data from the Field and From the City if needed

Dashboard Wizard

IOT Devices

Sensors/Actuators

IOT Edge Devices

LoraWAN + Arduino + I2C, NGSI
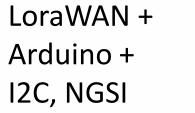
Arduino, Wi-Fi, NGSI

Snap4All IOT Button ESP, NGSI, Wi-FI, BT
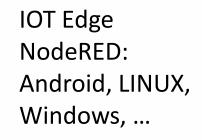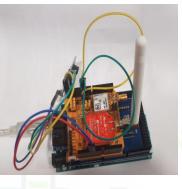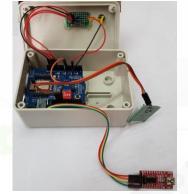
Snap4All PAX Counter LoraWAN WIFI, NGSI, GPS
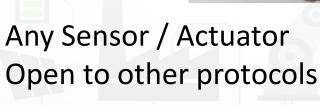
IOT Edge NodeRED: Raspberry Pi, NGSI, WiFi, RJ45,..

IOT Edge NodeRED: Android, LINUX, Windows, ...

LoraWan Gateway: IOT Edge, NGSI, WIFI, RJ45, GPS

Any Sensor / Actuator
Open to other protocols
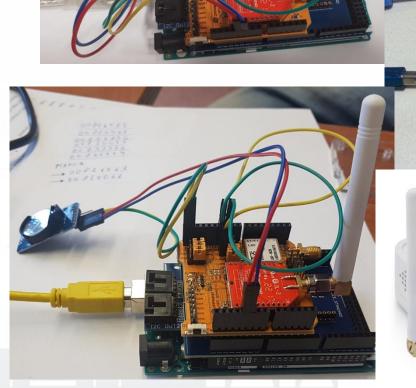
Lora IOT Device, Arduino

- Arduino Uno, Mega

- LoraWan Connection

- Any sensor, + I2C

- Fully Customizable

- Open Source

- NGSI or any other protocols

- Gateway: Dragino

https://www.snap4city.org/drupal/node/216

IOT Edge Snap4All App for Android

- **Android**, any version, App from: https://www.snap4city.org/download/video/Snap4All.apk
- **Mutual Authentication** with certificates
- *Secure encrypted connection*, NGSI
- **IOT Application inside**
- **Any sensor** + Local device sensors
- **Any protocol** from IOT devices
- **NGSI** or any other protocol
- **Fully Customizable**
- Local and Cloud Dashboard
- **Special MicroServices**

Moving IOT Devices / Sensors, Tracking Devices
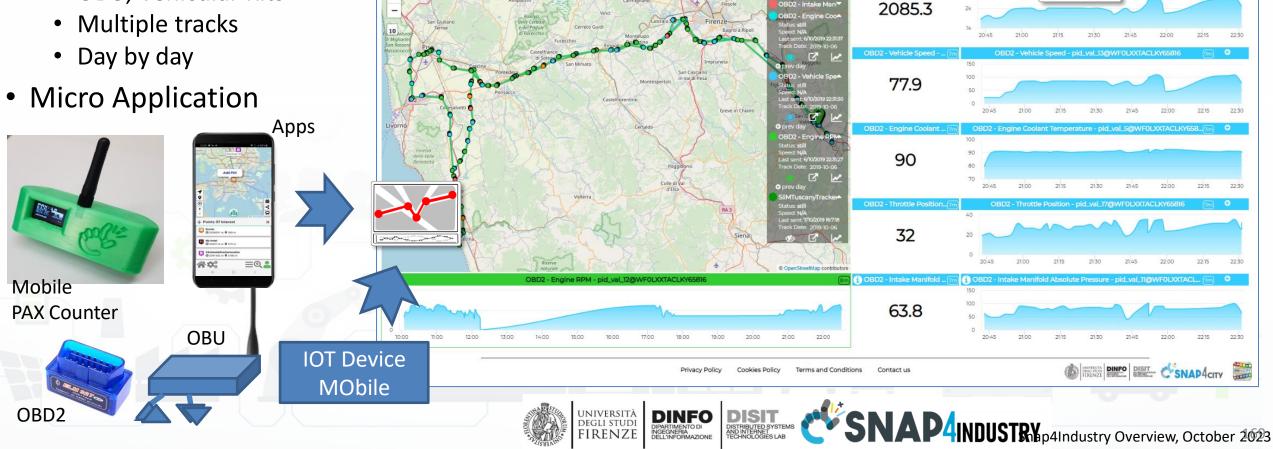
MyKPI: Tracking of Devices and Mobiles

- Real Time Trajectories for
  - Mobile Phone
  - Moving IOT Devices
  - OBU, Vehicular Kits
  - Multiple tracks
  - Day by day

- Micro Application

Apps

Mobile
PAX Counter

OBU

OBD2

IOT Device
MObile

Real time device tracking

Start

moving device

Selector

start

DISIT:orionUNIFI:MyMobileDeviceTest

movit it

⏻

movit it

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA1Ng==

Moving and changing Dynamic PIN
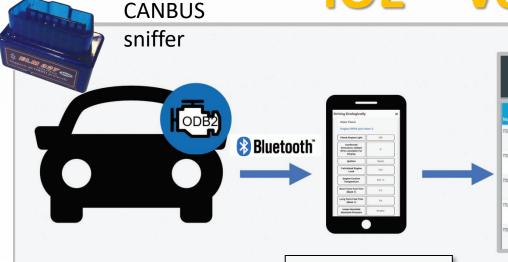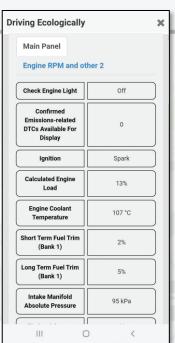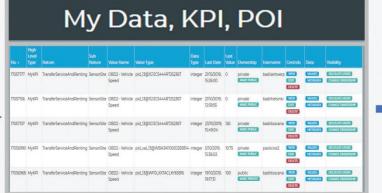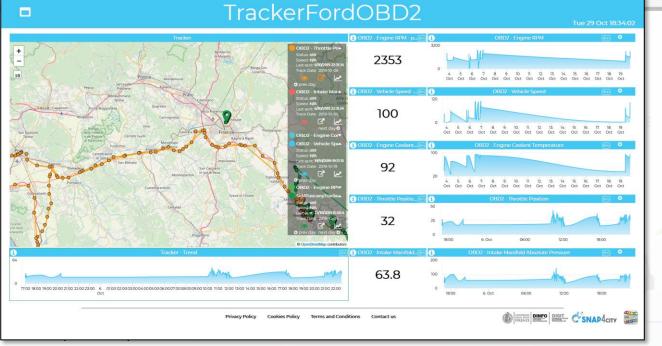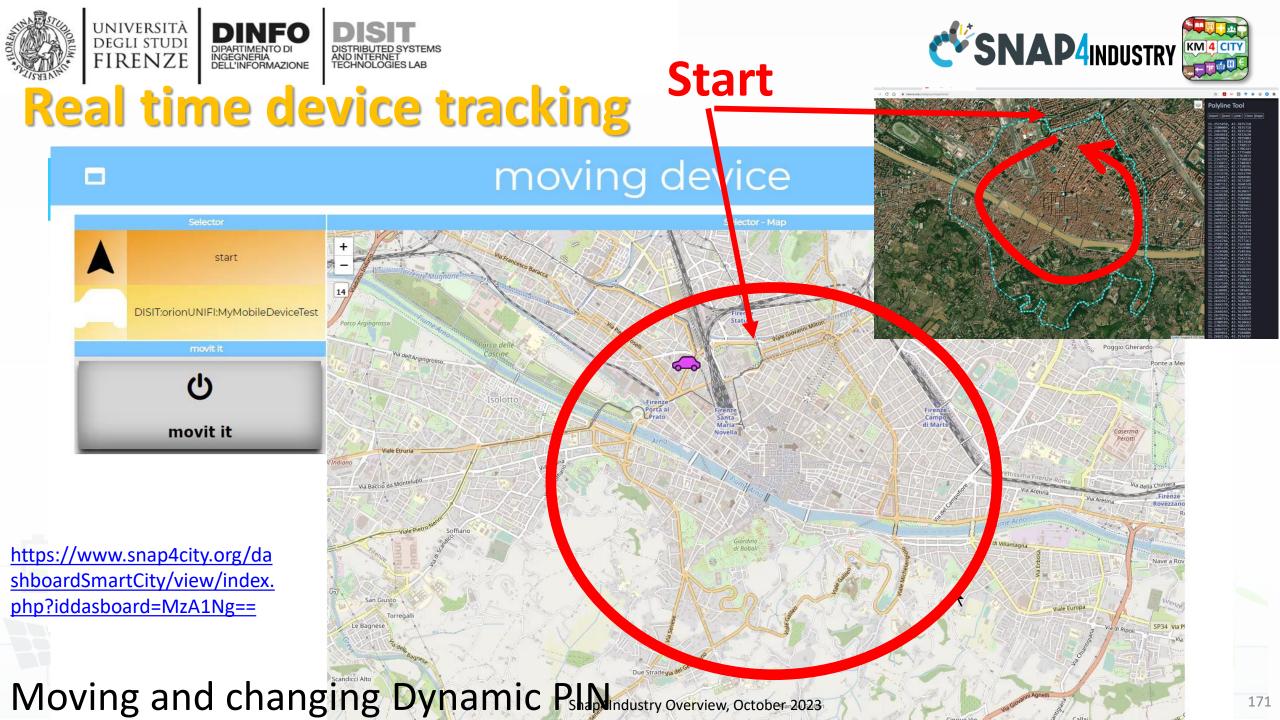
Managing IOT Applications

IOT Application Listing, they can be

- Basic (white)
- Advanced (red)
- IOT Edge
  - Raspberry Pi
  - Android
  - Win/Linux
- Data Analytic (Plumber)
- Web Scraper (Portia)
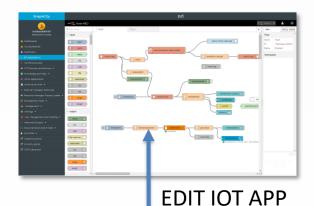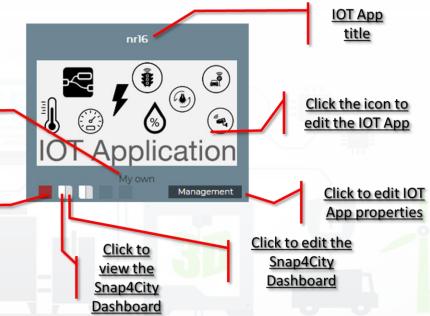
IOT Applications Listing

- Basic / Advanced
- On IOT Edge Raspberry Pi
- On IOT Edge Android
- On IOT Edge Win/Linux

EDIT IOT APP

VIEW

EDIT

IOT App title

Click the icon to edit the IOT App

Ownership of the IOT App

Click to open the Node-RED IOT App dashboard

Click to edit IOT App properties

Click to view the Snap4City Dashboard

Click to edit the Snap4City Dashboard

IOT Edge Device

Other Local Connections

IOT Brokers

WiFi™

Modbus

OPC UA

IOT Edge:
Node-RED + Snap4City

edge-tunnel-to-cloud

IOT Devices

HTTPS

HTTPS

WSs

Firewall
Gateway
Towards internet

HTTPS

IOT Brokers

Search and Query, Smart City API
Facet, semantic search

Knowledge base
Semantic reasoners

Indexing and aggregating
Elastic search

SNAP4CITY

Snap4Home 5G Demo

Remote Access/Control/program to your IOT Applications via secure connection

Access to IoT Edge Maintenance

HOW To install IOT Edge Remote Control feature

- **The installation is very simple**

1. install Snap4City basic library

2. Drag and drop block from S4CUtility

   edge-tunnel-to-cloud
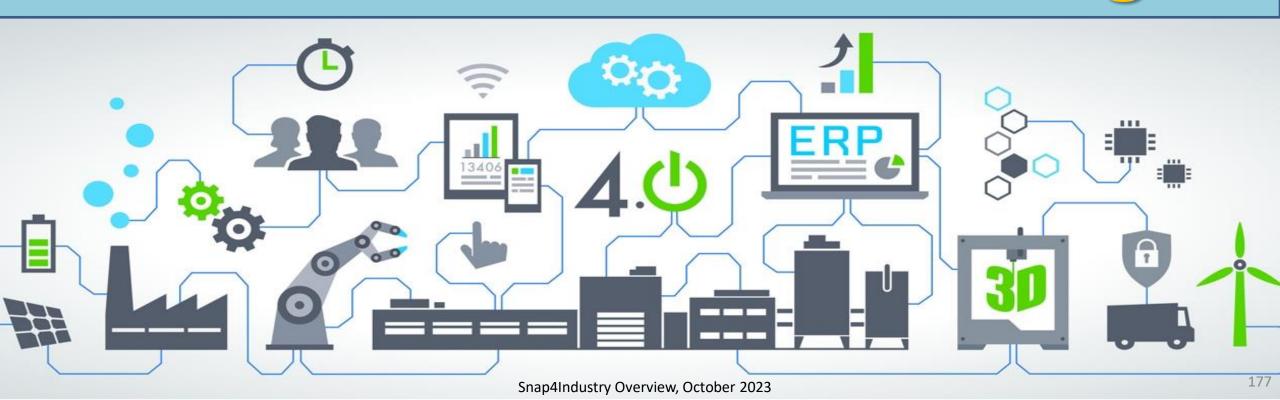
3. Configure the block with your credentials

4. Deploy of the IOT App

5. Go in the list of Your IOT Applications on Snap4City.org or other cloud or on premise installations

6. Identify the IOT Edge IOT App and click on it to open the view on the IOT Applications flows

Secure IOT Devices, IOT Edge Sensor and Dev Networking

The secure stack

Sensors, actuators

Data Shadow

User Interface

IoT Devices

HTTPS

HTTPS

IoT Edge

HTTPS

IoT Firewall IoT Context Broker

HTTPS

HTTPS

IoT App

WSs

Dashboard Builder

WSs

HTTPS

storage

Aggregator and distributor:
On premise computing

Via MicroServices:
Cloud computing
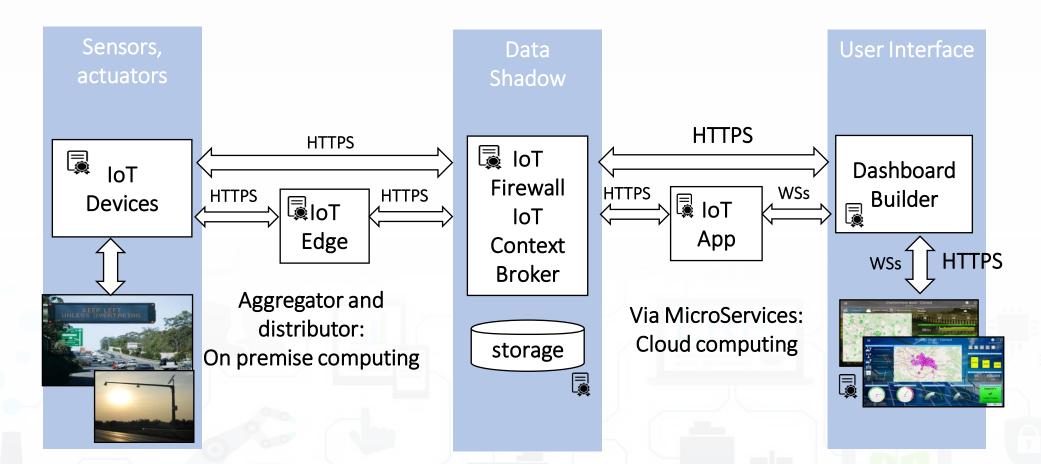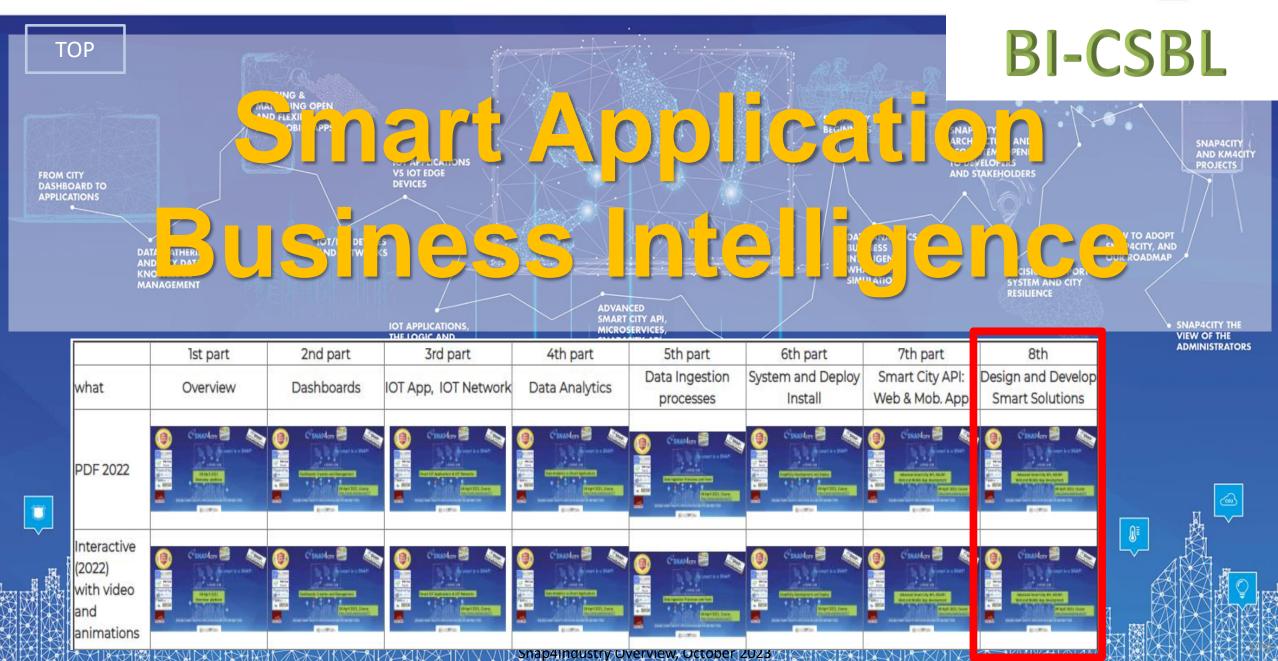
SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES

TOP

BI-CSBL

Smart Application Business Intelligence

	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								

How the Dashboards exchange data

BI-CSBL

SNAP4INDUSTRY

Dashboards

API, External Services, MicroApp

Traffic Flow, MAPS, Heatmaps
GIS, HTTPs URLs

Brokers

API
ServiceMap

Req. ServiceURI, KPI

Storage
and KB

Node-RED

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

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
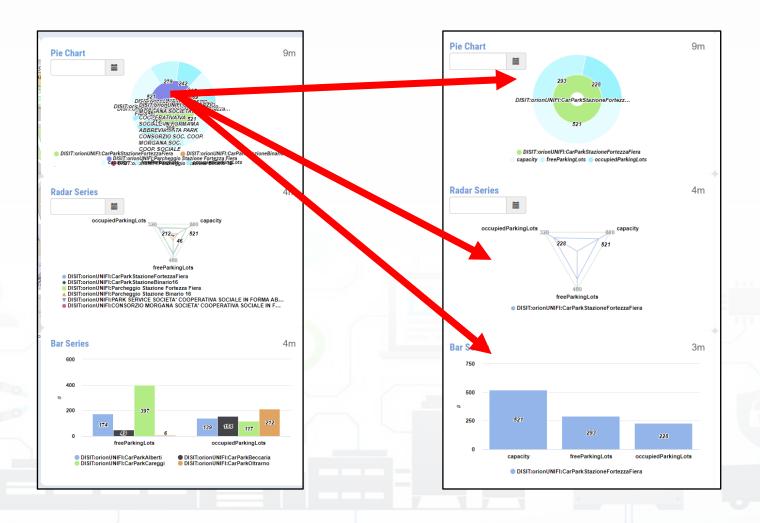
Example: From Data Graphs to Graphs (drill down)

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

BI-CSBL

Client Side Business Logic

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

TOP

100% OPEN SOURCE

Appliances and Dockers
Installations

Installing Snap4City

Installations

docker

https://www.snap4city.org/471

To get an updated version read it!
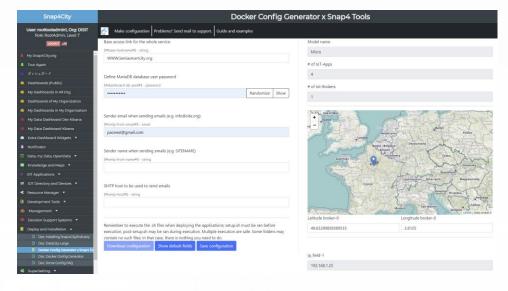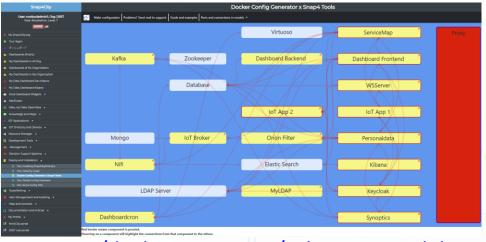
Installations, different models a TOOL to get them

- **Micro X:**
  - 1 VM of dockers
- **Normal X,Y:**
  - 2 VM of dockers
- **Small X,Y:** scalable
  - 4 VM of dockers
- **DataCitySmall X,Y,Z:** scalable
  - 6 VM of dockers
- **DataCityMid X,Y,Z,T:** scalable
  - # VM + X/70 VM + Y/3 VM + Z VM + T VM of dockers
- **DataCityLarge:** scalable
  - depending on your needs

https://www.snap4city.org/docker-generator/selecting_model

Micro 6 model

Micro 6 (technical)

| Web Interface | proxy |

Main

Synoptics (WS)	Dashboard Frontend	WSServer (node-red)	Resource Mng
PersonalData	DataBase	Kafka	MyLDAP, LDAP
Dashboard Cron	Dashboard BackEnd	ZooKeeper	KeyCloak
Smart Data Models	OD Manager	ExtBroker harvester	FIWARE IoT

Storage

| NIFI | Open Search | Open Search Dashboard |
| ServiceMap (SCAPI) | | Virtuoso |

Broker

| ORION | OrionFilter | Mongo |

IOT Apps

| IOT App 01 |
| IOT App 02 |
| IOT App 6 |

1Hour installation and ready to use

DATA ANALYTICS,
Big Data Science

Big Data Analytics + Artificial Intelligence

- **Decision support**
  - **Early warning, City Indexes, etc.**
  - **What-IF analysis** (simulation + AI + data)
- **Predictions**
  - **Short and Long terms predictive models on:**
    - traffic, parking, people flow, maintenance, land sliding, NO2
  - **3D Flow prediction:** Pollutant (NOX, NO2, …)
- **Suggestions and recommendations**
- **Modeling, simulation, routing**
  - **Traffic Flow reconstruction**
  - **Constrained Routing**

AI & XAI:
- RF, XGBoost, BRNN, RNN, SVR, DNN, LSTM, CNN-LSTM, Autoencoders, neuro-symbolic..
- Clustering: K-means, K-Medoid, …
- Semantic Reasoning, ..
- XAI: Shap, variations, Lime, gradients, …

Representations, animated
- Heatmaps, Traffic, Flows, ..
- Trajectories, OD matrices,
- 3D Rendering
- Typical Time Trends, etc.

https://www.snap4city.org/download/video/course/da/

Snap4City Analytics

- Decision support systems
- Improvement of life quality
- Sustainable Solutions
- Reduction of costs
- Risk Assessment
- Resilience

Prepare
Absorb
Recover
Adapt

damage

Data Analytics

System Modeling and Simulation
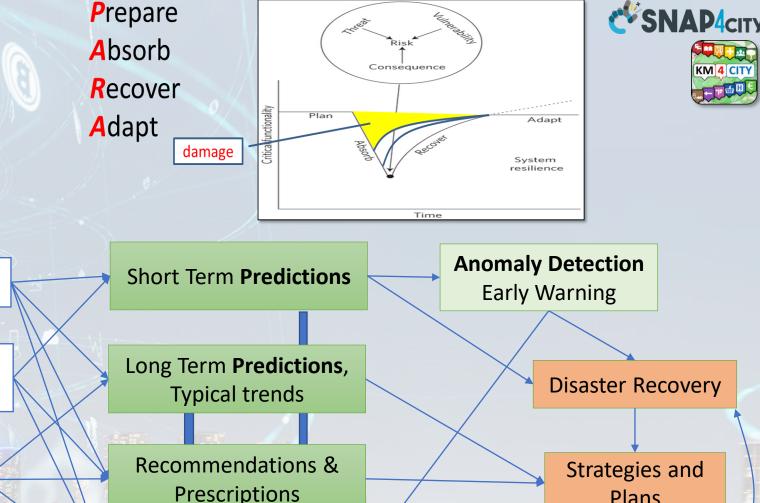
Knowledge Models

Scenarious

Short Term **Predictions**

Long Term **Predictions**, Typical trends

Recommendations & Prescriptions

What-if Analysis

Anomaly Detection
Early Warning

Disaster Recovery

Strategies and Plans

Partial graph
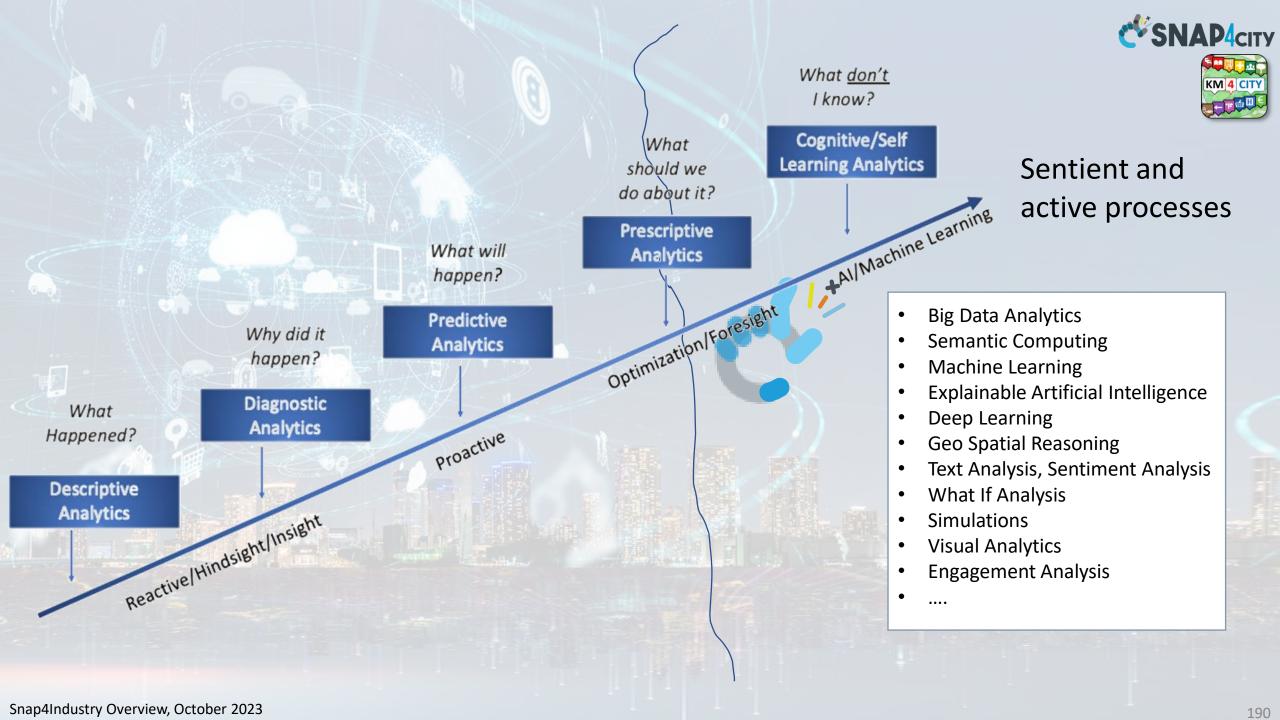
Decision Support System
targeting Indicators: Quality of Life, PUMS, SUMI, KPI, SDG, 15MinIndex,…

SNAP4CITY   KM4CITY

Sentient and active processes

What don't I know?

Cognitive/Self Learning Analytics

What should we do about it?

Prescriptive Analytics

What will happen?

Predictive Analytics

Why did it happen?

Diagnostic Analytics

What Happened?

Descriptive Analytics

Reactive/Hindsight/Insight

Proactive

Optimization/Foresight

+AI/Machine Learning

- Big Data Analytics
- Semantic Computing
- Machine Learning
- Explainable Artificial Intelligence
- Deep Learning
- Geo Spatial Reasoning
- Text Analysis, Sentiment Analysis
- What If Analysis
- Simulations
- Visual Analytics
- Engagement Analysis
- ….

Data Analytics on Snap4City platform

Swagger
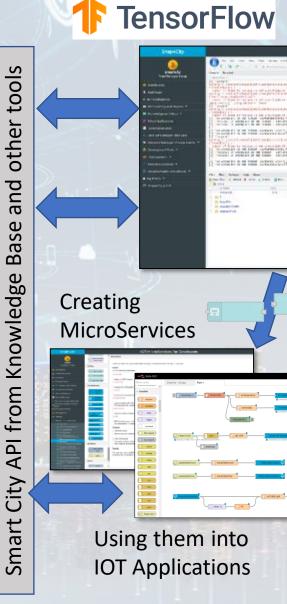
Ontology Schema

LOG.disit.org

Knowledge Base, Km4City

Big Data Store Facility

Smart City API from Knowledge Base and other tools

Creating MicroServices

Node-RED

Using them into IOT Applications

Saving / Sharing reusing

Resource Manager

- **15 Minute City Index:**
  - 13 subindexes: energy, slow mobility, fast mobility, housing, economy education, culture and cults, health, entertainment, gov, food, security…

7 AFFORDABLE AND CLEAN ENERGY
- Monitoring and Prediction of energy consumption
- Stimulating: Bike sharing, e-bikes, car charge, etc.
- Community of Energy, planning energy plant

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE
- Industry 4.0 integrated solutions
- Decisions Support Systems
- Process optimization, control
- Predictive maintenance

11 SUSTAINABLE CITIES AND COMMUNITIES
- Smart City infrastructure: monitoring and resilience, long terms predictions
- Effective and Low cost smart solutions
- What-if analysis, Simulations
- Origin Destination matrices computation

12 RESPONSIBLE CONSUMPTION AND PRODUCTION
- business intelligence tools for decision makers
- Reduction production costs
- Monitoring resource consumption
- Optimization of Waste Collection

13 CLIMATE ACTION **15 LIFE ON LAND**
- Monitoring and Predicting: NO2, NOX, CO2, Traffic flow, pollutant, landslide, waste, etc.
- Traffic flow reconstruction
- Demand vs Offer of Mobility analysis

16 PEACE, JUSTICE AND STRONG INSTITUTIONS
- Shortening justice time
- Anonymization and indexing legal docs.
- Prediction of mediation proneness
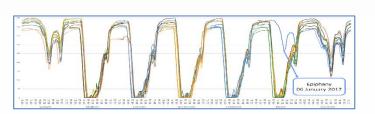- Ethical Explainable Artificial Intelligence

Parking predictions
I would arrive to surely Park in 45 Minutes??

Category	Features	Description of features variable
Baseline features of free slot data	Free parking slots	Real number of available slots recorded every 15 minutes
	Time	Hours and minutes
	Month	Month of the year (1-12)
	Day	Day of the month (1-31)
	Day week	Day of the week (0-6)
	Weekend	0 for working days, 1 else
	Previous observation's difference (POD)	Difference between the number of free spaces at time i and number of free spaces at time ($i - 15$ minutes) recorded in the previous week
	Subsequent observation's difference (SOD)	Difference between the number of free spaces at time i, and the number of free spaces at time ($i + 15$ minutes) recorded in the previous week
Weather features	Temperature	City temperature measured one hour earlier than Time (°C)
	Humidity	City humidity measured one hour earlier than Time (%)
	Rainfall	City rainfall measured one hour earlier than Time (mm)
Traffic Sensors features	Average Vehicle Speed	Average speed of vehicles on the road being closest to the parking, over one-hour period (km/h)
	Vehicle Flow	Number of vehicles passing by closest to the parking, over one-hour period
	Average Vehicle Time	Average of distance between vehicles, over one-hour period
	Vehicle Concentration	Number of vehicles per kilometer, over one-hour period

Artificial Intelligence Predictions
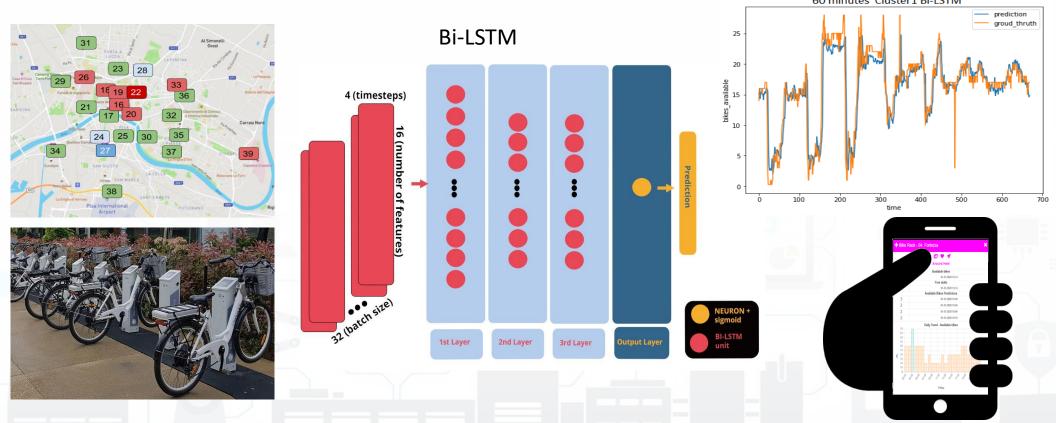
97% of precision

Deep Learning for Short-Term Prediction of Available Bikes on Bike-Sharing Stations

E. Collini, P. Nesi and G. Pantaleo, "Deep Learning for Short-Term Prediction of Available Bikes on Bike-Sharing Stations," in *IEEE Access*, vol. 9, pp. 124337-124347, 2021, doi: 10.1109/ACCESS.2021.3110794.
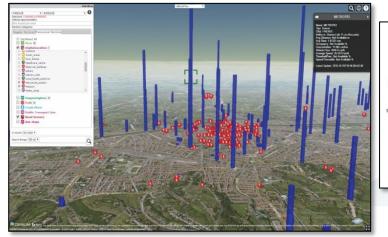https://ieeexplore.ieee.org/abstract/document/9530580
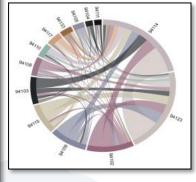
Predicting users movements

- **Issue:**
  - **How they move: vehicles, pedestrian, bike, ferry, metro,**
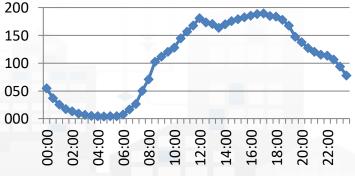 - **Where they go….**

- **Impact:**
  - **Tuning the services: cleaning, police, control, security**

- **Several metrics related to**
  - **Knowledge of the Context**
  - **Monitoring traffic and people flow**
  - **…….**

- Daily trends
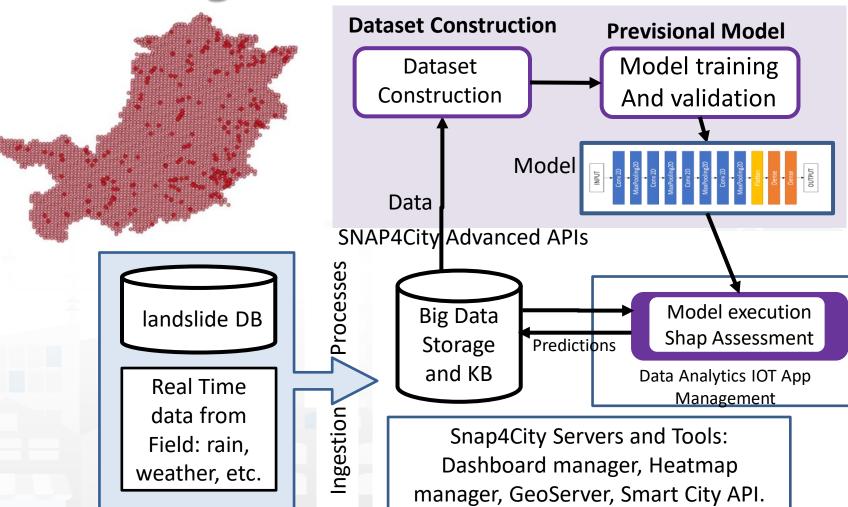- OD matrices
- Trajectories
- Prediction models

Predicting Land slides

Dataset Construction

Previsional Model

Dataset Construction → Model training And validation

Model

Data

SNAP4City Advanced APIs

landslide DB

Real Time data from Field: rain, weather, etc.

Processes

Ingestion

Big Data Storage and KB

Predictions

Model execution Shap Assessment

Data Analytics IOT App Management

predictions

Snap4City Servers and Tools: Dashboard manager, Heatmap manager, GeoServer, Smart City API.

Dashboards and Mobile Apps
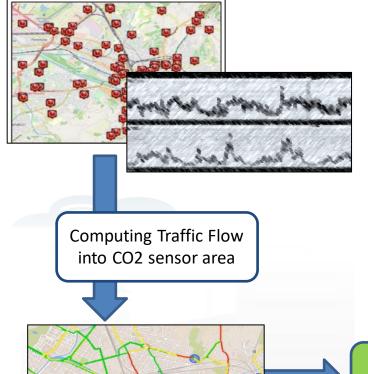
base value
0.4311

higher ⇄ lower

1.00

(a)

MaxTemperature Humidity   Day3 MaxTempSIR VelMaxSIR   Temperature Day15 MinTempSIR

base value
0.4311

higher ⇄ lower

1.00

(b)

WindSpeed Humidity   LevelSIRIdr   Day15   Day3   Temperature Day1 MaxTemperatu

f(x)
0.00

base value
0.4311

(c)

Day3 MaxTempSIR MaxTemperature Temperature LevelSIRIdr Day15

Day3
MaxTemperature
Humidity
LevelSIRFre
LevelSIRIdr
PrecipSIR
MaxTempSIR

21-12-2019

SHAP Values

2500   2510   2520   2530   2540   2550   day

Estimating City Local CO2 from Traffic Flow Data

- Traffic Flow is one the main source of CO2
- **Dense estimation of CO2 into the city** is very useful to know to target EC's KPIs

Computing Traffic Flow into CO2 sensor area
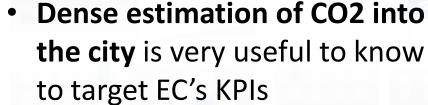
Computing CO2 on the basis of traffic flow data

Traffic Flow data

CO2 estimation

11 SUSTAINABLE CITIES AND COMMUNITIES

13 CLIMATE ACTION

S. Bilotta, P. Nesi, "Estimating CO2 Emissions from IoT Traffic Flow Sensors and Reconstruction", Sensors, MDPI, 2022. https://www.mdpi.com/1424-8220/22/9/3382/
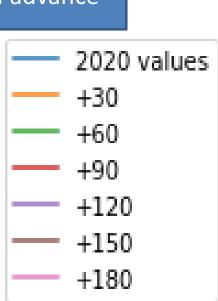
Predicting EC's KPI on NO2 months in advance
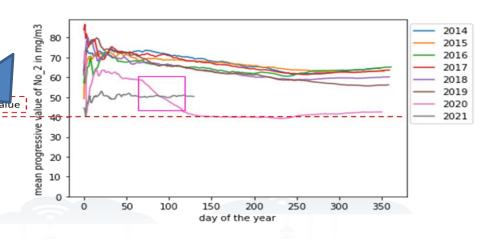
Deep Learning Long Terms Predictions of NO2 mean values, From 30 to 180 days in advance

- The features used as input for the predictive models are:
- **Month**
- **dayOfTheYear**
- **NO2**
- **Tmean**
- **Humidity**
- **windMean**
- **NoxDomestic**
- **numberOfVehicles**
- **NO2cumulated**
- **NO2progresseveMean**
- **numberOfVehiclesCumulated**

	2020 values
	+30
	+60
	+90
	+120
	+150
	+180

		Air Quality Directive			WHO guidelines	
Pollutant	**Averaging period**	**Objective and legal nature and concentration**	**Comments**		**Concentration**	**Comments**
$PM_{2.5}$	One day				25 µg/m³ (*)	99th percentile (3 days/year)
$PM_{2.5}$	Calendar year	Target value, 25 µg/m³	The target value has become a limit value since 1 January 2015		10 µg/m³	
PM_{10}	One day	Limit value, 50 µg/m³	Not to be exceeded on more than 35 days per year.		50 µg/m³ (*)	99th percentile (3 days/year)
PM_{10}	Calendar year	Limit value, 40 µg/m³ (*)			20 µg/m³	
O_3	Maximum daily 8-hour mean	Target value, 120 µg/m³	Not to be exceeded on more than 25 days per year, averaged over three years		100 µg/m³	
NO_2	One hour	Limit value, 200 µg/m³ (*)	Not to be exceeded more than 18 times a calendar year		200 µg/m³ (*)	
NO_2	Calendar year	Limit value, 40 µg/m³			40 µg/m³	

Smart Retail

- **Recommendations**
  - adaptive user engagement, customer experience
  - Advanced user profiling, user behaviour analysis
  - IOT and instrumentation
  - Predictive models for engagement
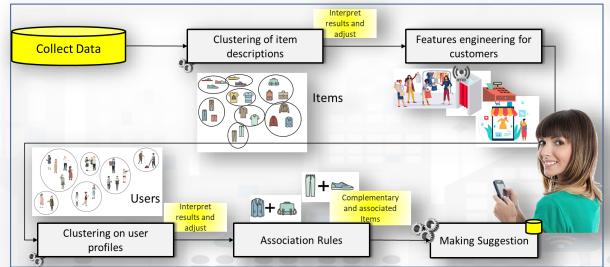 - Integrated in city customer experience

Techniques
- Multiple clustering
- Prediction models

- **Feedback:**
  - Flexible Advanced Engagement Exploiting User Profiles and Product/Production Knowledge
  - Keywords: retail, GDO, …

User Behaviour Analysis

- **Monitoring movements by traffic flow sensors**
  - Spires and virtual spires

- **Monitoring movements from Mobile Cells**
  - Unsuitable for precise tracking and OD production

- **Monitoring movements from Wi-Fi**

- **Monitoring movements** and much more from mobile Apps
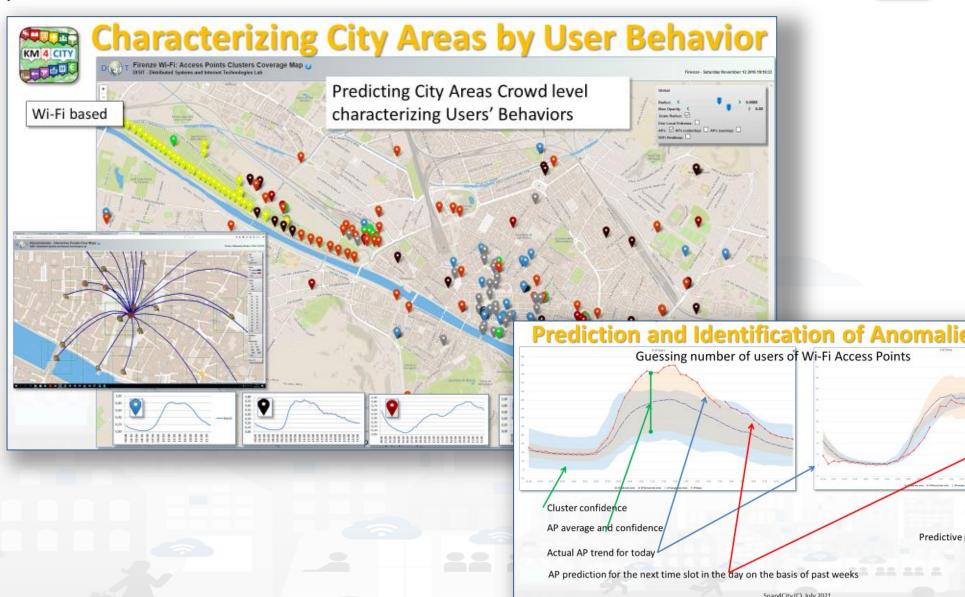
- **Prediction of people flows** on the basis of Wi-Fi data

- **Anomaly** detection

- **Resolute** H2020

- Classification of city areas
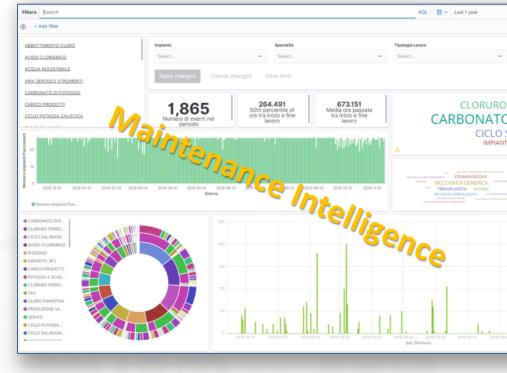
Predictive Maintenance

- **Predictive** Maintenance
  - LSTM
  - CNN-LSTM
- **Maintenance** Intelligence
- Explainable AI: SHAP, …
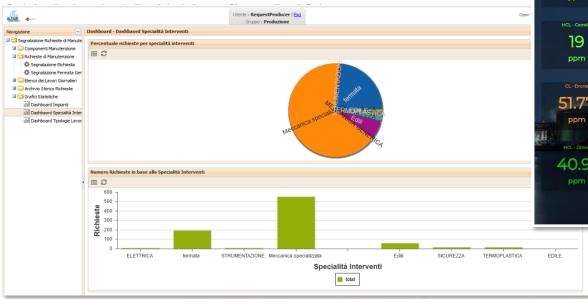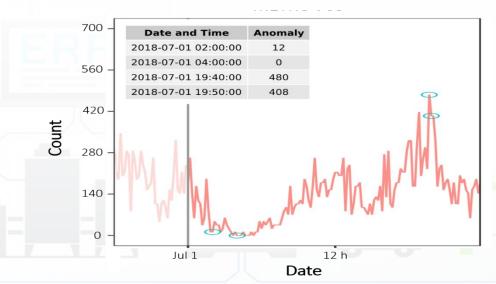
Reports and Dashboards
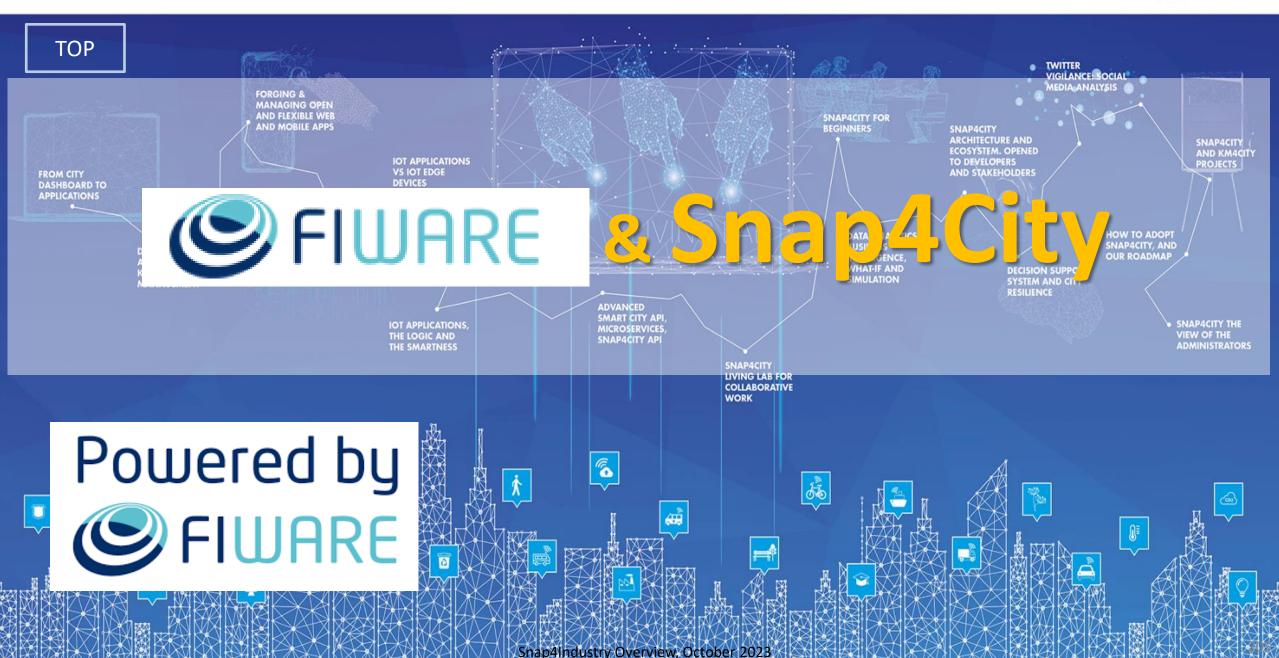
Anomaly detection
Early Warning

TOP

& Snap4City

FIWARE

Powered by FIWARE

- Snap4City - Powered by FIWARE Solution & Platform:
  - https://marketplace.fiware.org/pages/solutions/b8905e91973b420189cce972
  - https://marketplace.fiware.org/pages/solutions/d68534ec827500f1bde8720f
    - NGSI V1, V2 The IOT Orion Broker
    - IOT Orion Broker can connect JSON, MQTT, Lightweight M2M, LoraWAN, OPC, SigFOX, etc. see FiWare Https://www.fiware.org
- Snap4City - FIWARE Training Services:
  - https://marketplace.fiware.org/pages/solutions/03bccd83a0e1b0398ba7a0bf
- Snap4City - FIWARE Consultancy Services:
  - https://marketplace.fiware.org/pages/solutions/907f5ecc63927f643dd8421b
- **Snap4City is compatible** with all the above protocols
  - via IOT Orion Broker,
  - via IOT Applications.
  - via direct connection on ETL processes on their corresponding IOT brokers, and/or
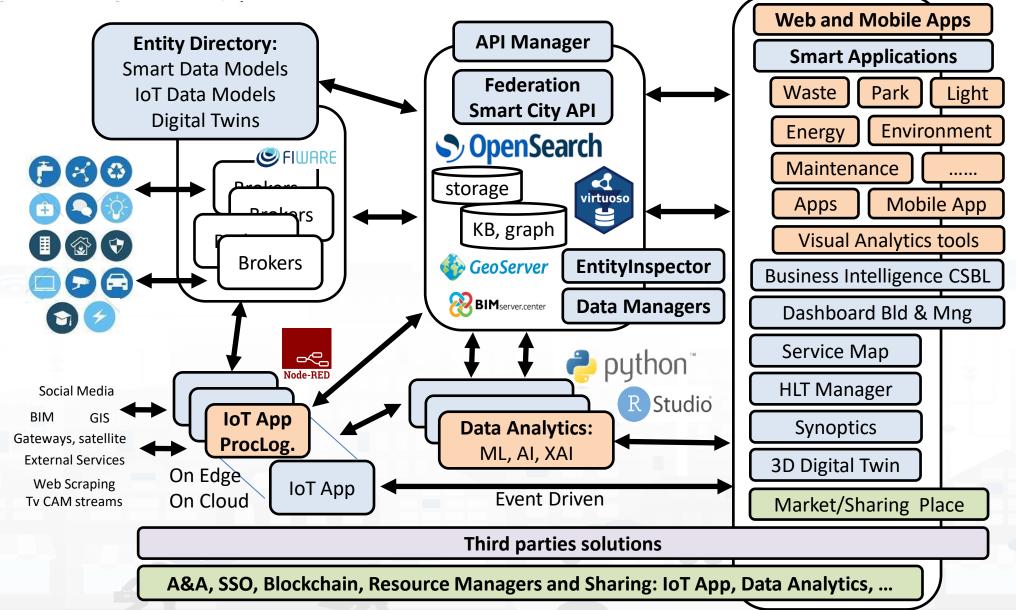- **Snap4City is also compatible** with many other protocols, see the table reported in page: https://www.snap4city.org/65

Tech Arch

Functional: FIWARE ref arc wrt Snap4City solutions

	FIWARE ref arc smart city	Snap4City
Multiple Protocols: IoT, Databases, etc..	10 on IOT, Limited on databases, etc.	More than 200, very very wide
Large set of high level types: maps, trends, heatmaps, traffic, trajectories, scenarios,…	No	Yes:
Integration with workflows, BPM	Not Supported	Yes: bidirectional
Integration and Modeling Digital Twin BIM	Not Supported	Yes: bidirectional
Integration with GIS: WFS, WMS	Not fully supported	Yes: bidirectional
Integration with Heatmaps and Satellite	Partially, not caòibrated	Yes: fully; calibarate and multiple versions, animations
Integration with Satellite	not supported	Yes: fully
Smart City API	no	Yes
Open Data Management	Partial with CKAN	Yes, Fully automated with CKAN
Federation of platforms	Partial on brokers	Full on Brokers and Knowledge base and API
Semantic model and queries	No, probably with NGSI-LD in the future	Yes since 2013
Multiple kinds of IoT Brokers	No, only agents	Yes: NGSI, COAP, AMQP, MQTT, SigFOX, etc.

Interoperability Openess

Functional: FIWARE ref.arc. wrt Snap4City solutions

|	FIWARE ref arc smart city	Snap4City
Data Transformation	Coding	Yes: IOT App, Node.JS, Visual Programming, scalable
Data Analytics	No	Yes
on line development	No, limited	Yes: Rstudio, Python, Tensor Flow, MapReduce, etc.
Dashboard on data	Grafana no LDAP	Yes: Dashboard Builder, OpenSeachDash with GDPR, LDAP (Open Search)
Dashboard Widgets	Limited, no custom, coding needed	Yes: A wide range including custom widgets, secure compliant, animations, configuration, also open to new development
Real Time end-to-end from Dashboards to any other channel, event driven	No, very limited	Yes, fully supported
Multi Data Map	Limited with non OS	Very extensive, with multiple widgets and sync
MicroApplications	No	Yes
Auditing, Assessment, accounting	No, no, no	Yes, Yes, Yes
Multitenacy on data management	No only on broker	Yes: on Broker, on data management, on dashboards, etc..
Living Lab for creating/managing communities/groups	Not supported	Yes: provided in the open source
Report generation/management	No	Yes
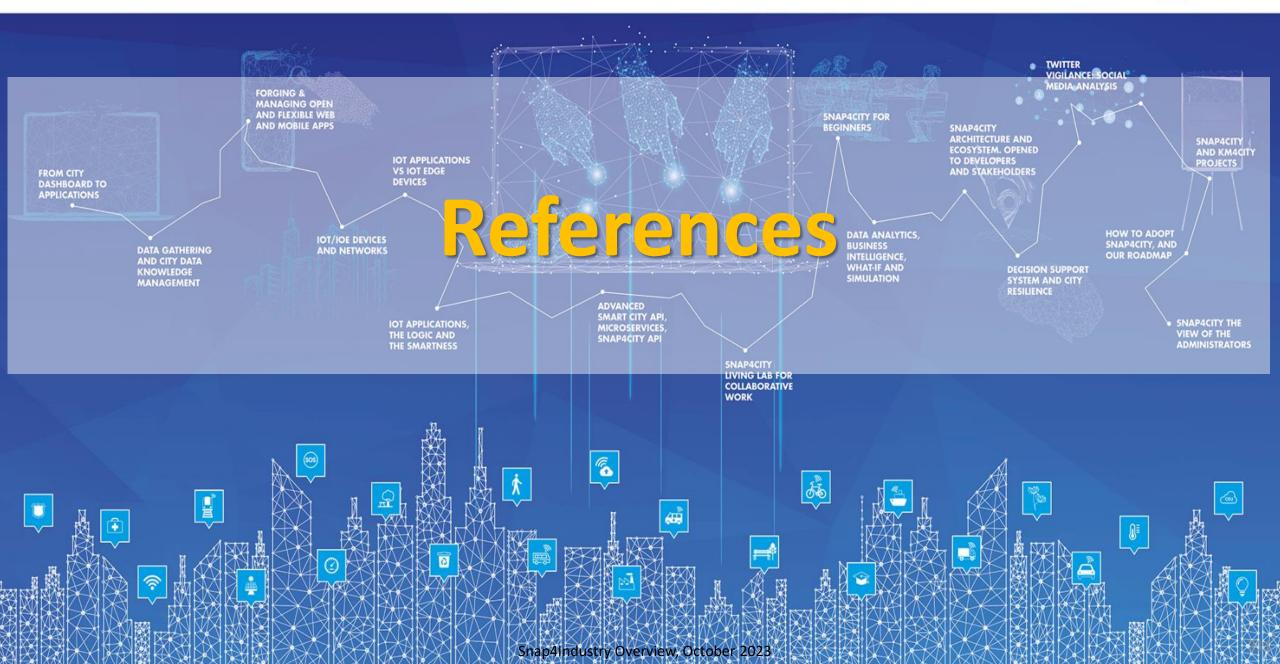
Exploiting FIWARE Smart Data Models

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

References

2023 booklets

- Smart City
- Industry
- Artificial Intelligence

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

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

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

Overview

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

Development ![SNAP4CITY logo]

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

CSBL
Client Side Business Logic

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

Client-Side Business Logic
Widget Manual

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

Be smart in a SNAP!

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