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

SNAP4CITY

Powered by KM4CITY

Architetture e Soluzioni IOT, fino a Snap4City

https://www.snap4City.org https://www.Km4City.org

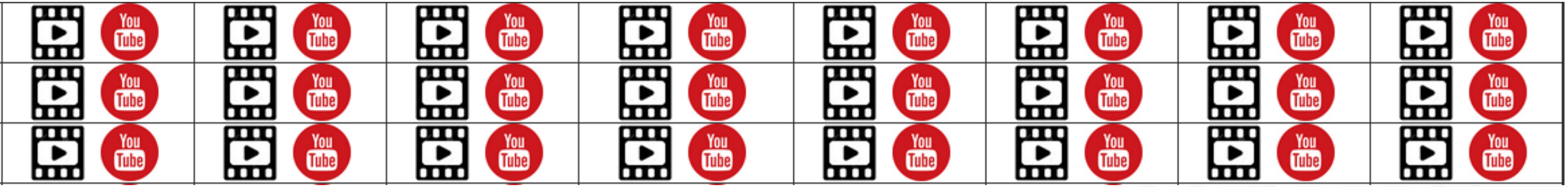
https://www.disit.org/

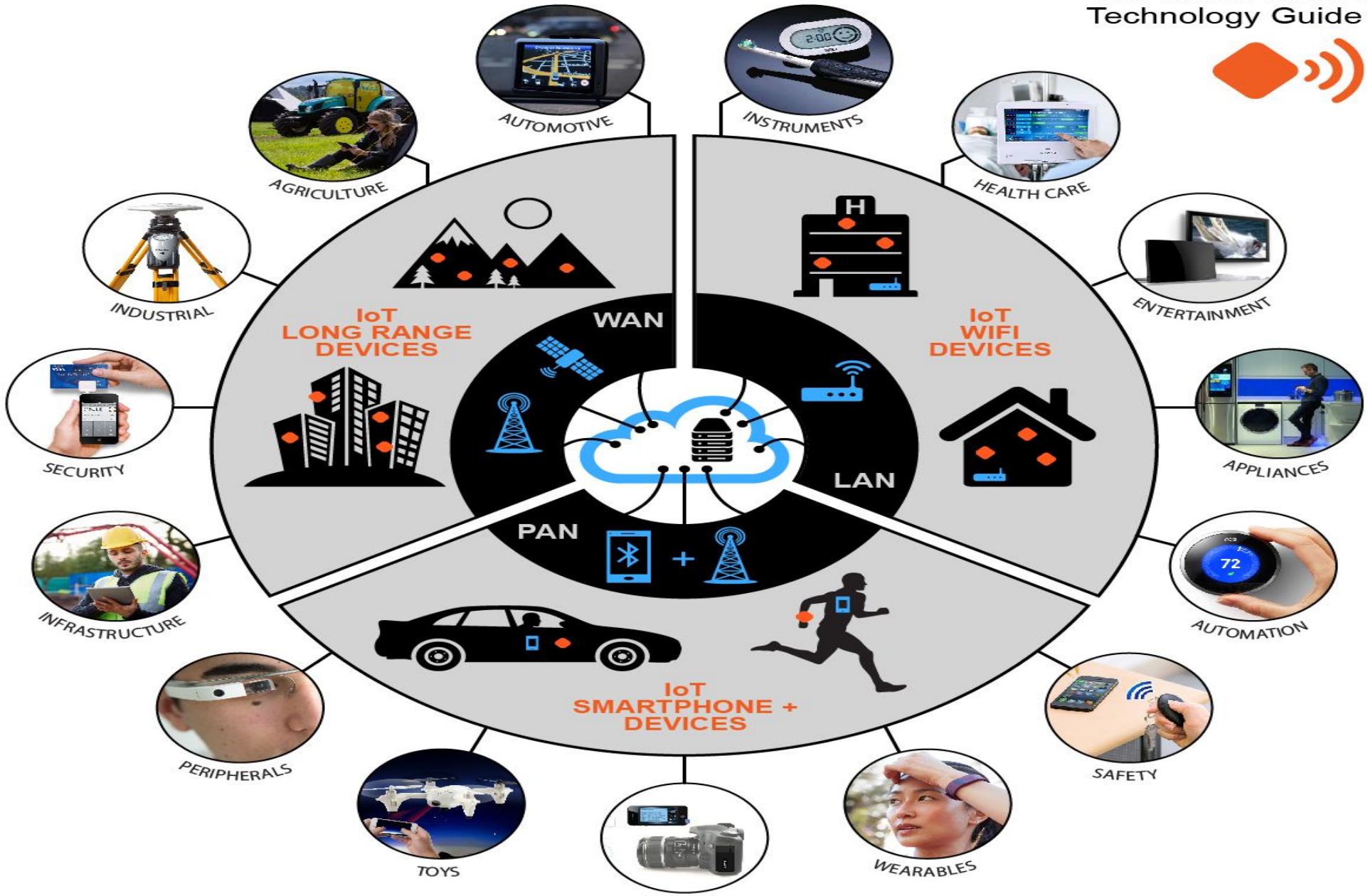
Paolo Nesi, paolo.nesi@unifi.it

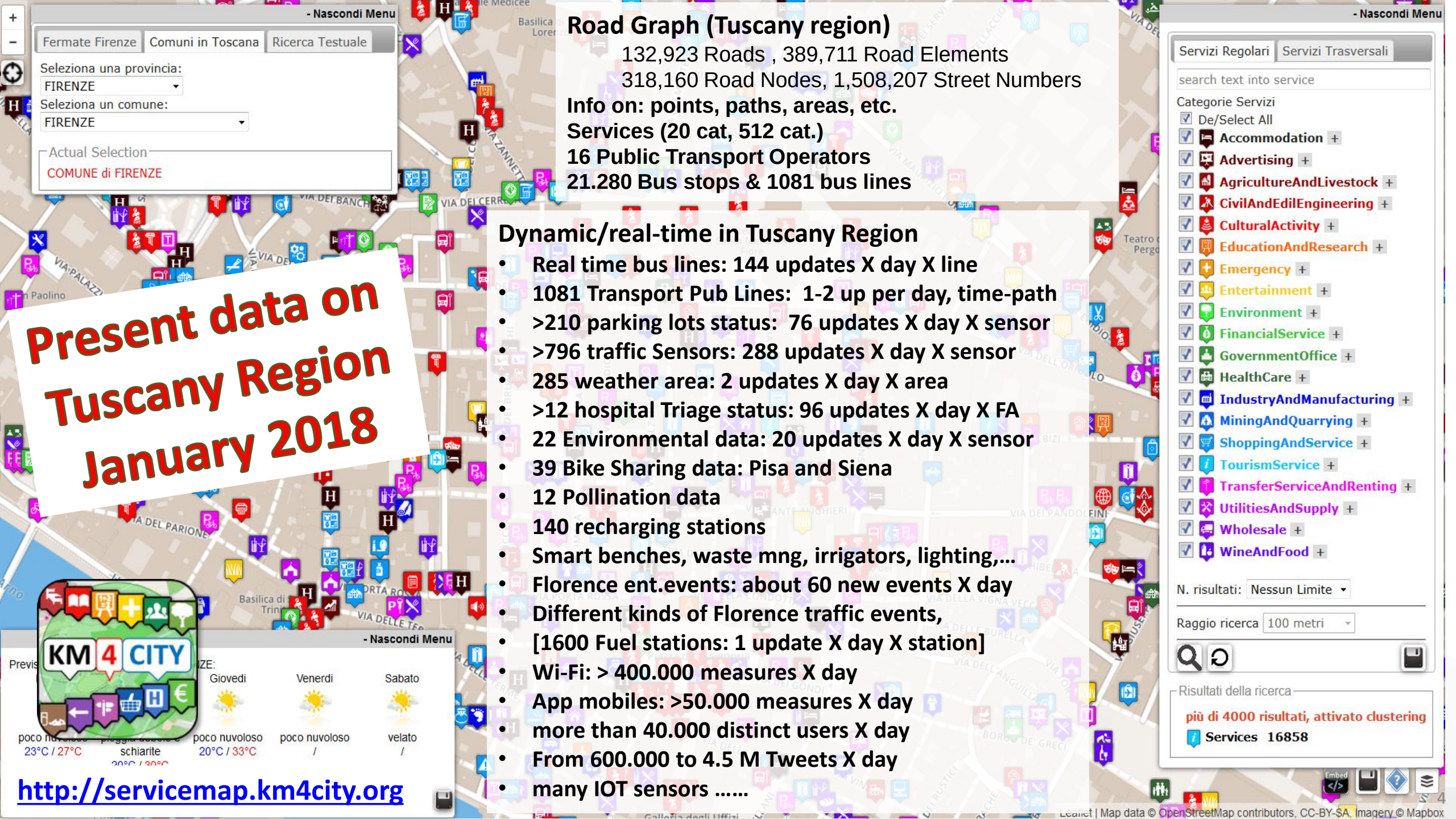
https://www.snap4city.org/944

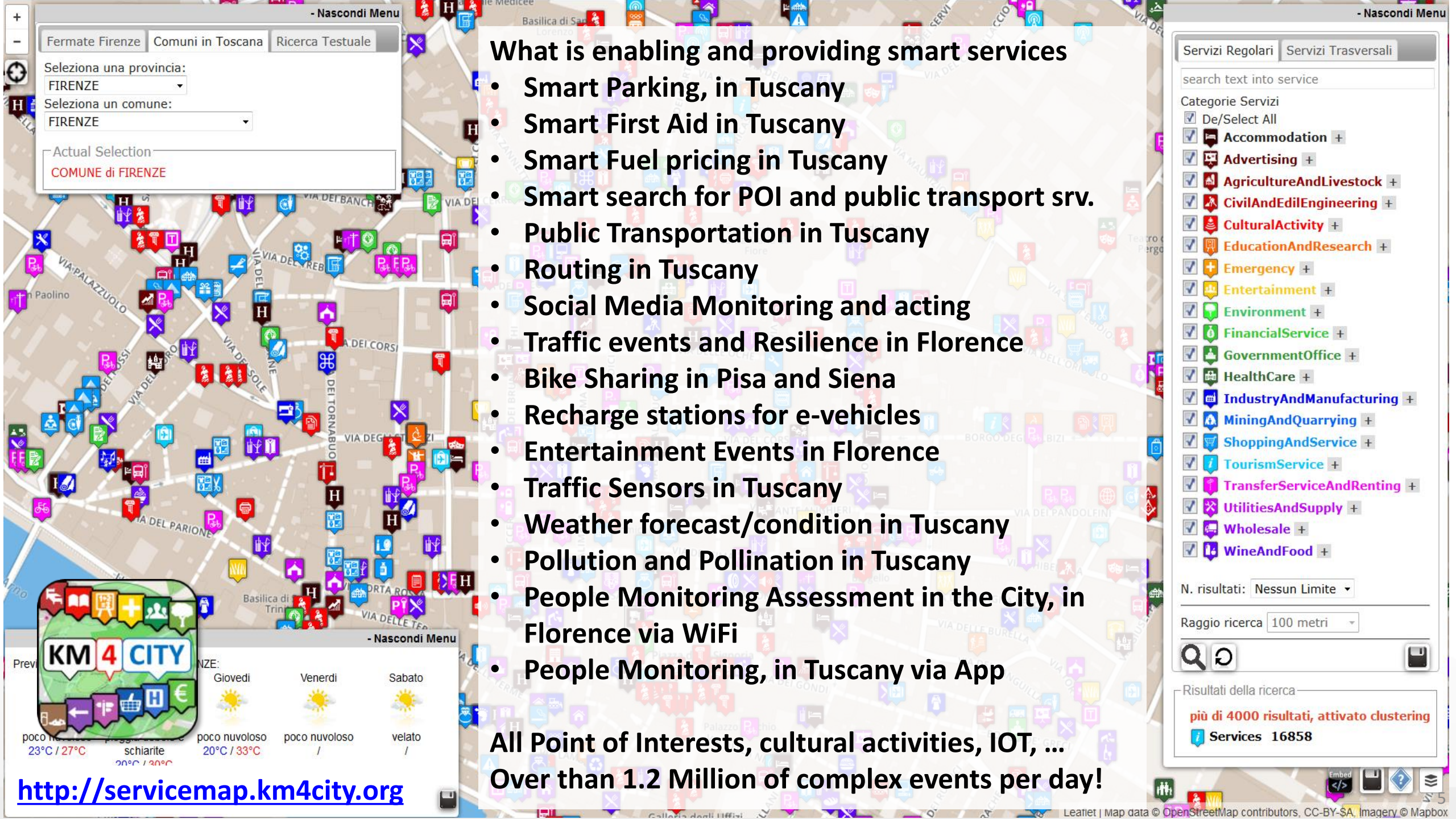
On Line Training Material (free of charge)

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
							
							




IoT HARDWARE
Technology Guide
AUTOMOTIVE
INSTRUMENTS
AGRICULTURE
HEALTH CARE
INDUSTRIAL
ENTERTAINMENT
IoT
LONG RANGE
DEVICES
WAN
IoT
WIFI
DEVICES
LAN
SECURITY
APPLIANCES
PAN
INFRASTRUCTURE
AUTOMATION
IoT
SMARTPHONE +
DEVICES
PERIPHERALS
SAFETY
TOYS
WEARABLES
REMOTES


- Nascondi Menu
Fermate Firenze
Comuni in Toscana
Ricerca Testuale
Seleziona una provincia:
FIRENZE
Seleziona un comune:
FIRENZE
Actual Selection
COMUNE di FIRENZE
Road Graph (Tuscany region)
132,923 Roads , 389,711 Road Elements
318,160 Road Nodes, 1,508,207 Street Numbers
Info on: points, paths, areas, etc.
Services (20 cat, 512 cat.)
16 Public Transport Operators
21.280 Bus stops & 1081 bus lines
Present data on Tuscany Region January 2018
Dynamic/real-time in Tuscany Region
• Real time bus lines: 144 updates X day X line
• 1081 Transport Pub Lines: 1-2 up per day, time-path
• >210 parking lots status: 76 updates X day X sensor
• >796 traffic Sensors: 288 updates X day X sensor
• 285 weather area: 2 updates X day X area
• >12 hospital Triage status: 96 updates X day X FA
• 22 Environmental data: 20 updates X day X sensor
• 39 Bike Sharing data: Pisa and Siena
• 12 Pollination data
• 140 recharging stations
• Smart benches, waste mng, irrigators, lighting,…
• Florence ent.events: about 60 new events X day
• Different kinds of Florence traffic events,
• [1600 Fuel stations: 1 update X day X station]
• Wi-Fi: > 400.000 measures X day
• App mobiles: >50.000 measures X day
• more than 40.000 distinct users X day
• From 600.000 to 4.5 M Tweets X day
• many IOT sensors ……
- Nascondi Menu
Servizi Regolari
Servizi Trasversali
search text into service
Categorie Servizi
De/Select All
Accommodation
Advertising
AgricultureAndLivestock
CivilAndEdilEngineering
CulturalActivity
EducationAndResearch
Emergency
Entertainment
Environment
FinancialService
GovernmentOffice
HealthCare
IndustryAndManufacturing
MiningAndQuarrying
ShoppingAndService
TourismService
TransferServiceAndRenting
UtilitiesAndSupply
Wholesale
WineAndFood
N. risultati: Nessun Limite
Raggio ricerca 100 metri
Risultati della ricerca
più di 4000 risultati, attivato clustering
Services 16858
KM 4 CITY
- Nascondi Menu
Giovedì
Venerdì
Sabato
poco nuvoloso
20°C / 33°C
poco nuvoloso
/
velato
/
23°C / 27°C
schiarite
http://servicemap.km4city.org
Leaflet | Map data © OpenStreetMap contributors, CC-BY-SA, Imagery © Mapbox



What is enabling and providing smart services

- Smart Parking, in Tuscany
- Smart First Aid in Tuscany
- Smart Fuel pricing in Tuscany
- Smart search for POI and public transport srv.
- Public Transportation in Tuscany
- Routing in Tuscany
- Social Media Monitoring and acting
- Traffic events and Resilience in Florence
- Bike Sharing in Pisa and Siena
- Recharge stations for e-vehicles
- Entertainment Events in Florence
- Traffic Sensors in Tuscany
- Weather forecast/condition in Tuscany
- Pollution and Pollination in Tuscany
- People Monitoring Assessment in the City, in Florence via WiFi
- People Monitoring, in Tuscany via App

All Point of Interests, cultural activities, IOT, …

Over than 1.2 Million of complex events per day!

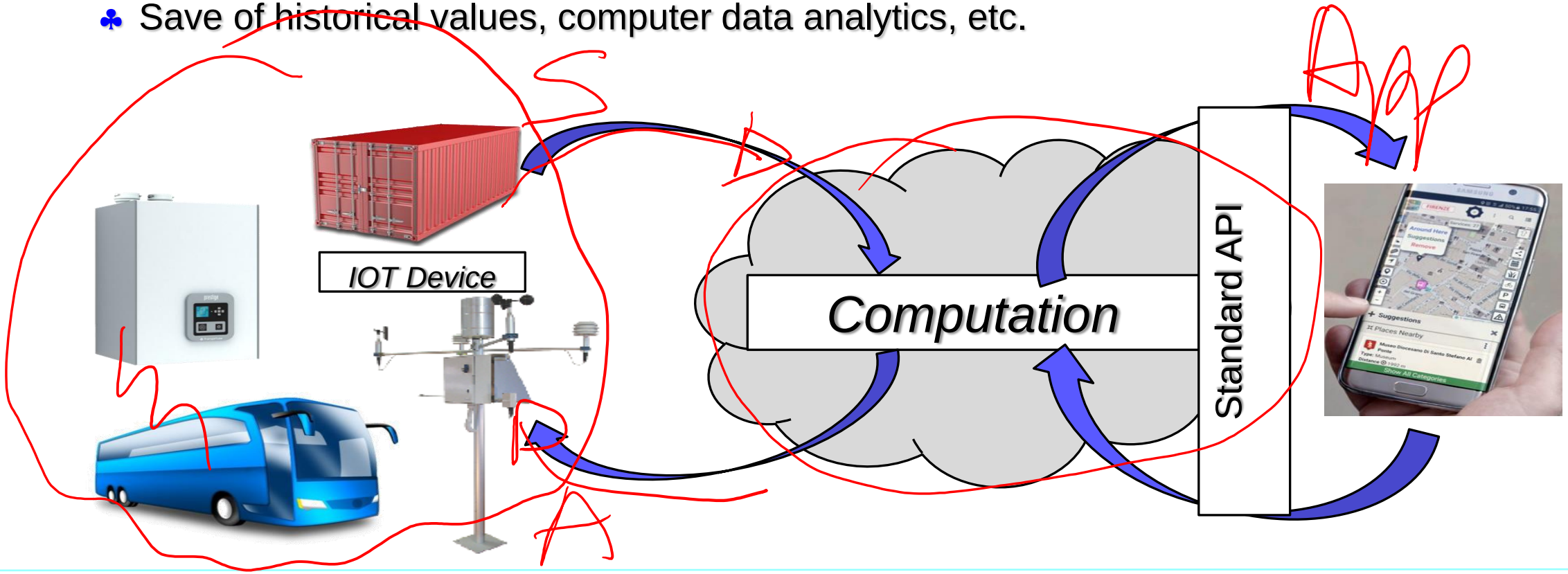
http://servicemap.km4city.org

IOT Solutions

IOT Main Concept

The implementation of smart services may implies the:

- acquisition of data from the field
- computation and imposition of actions/values
- Save of historical values, computer data analytics, etc.



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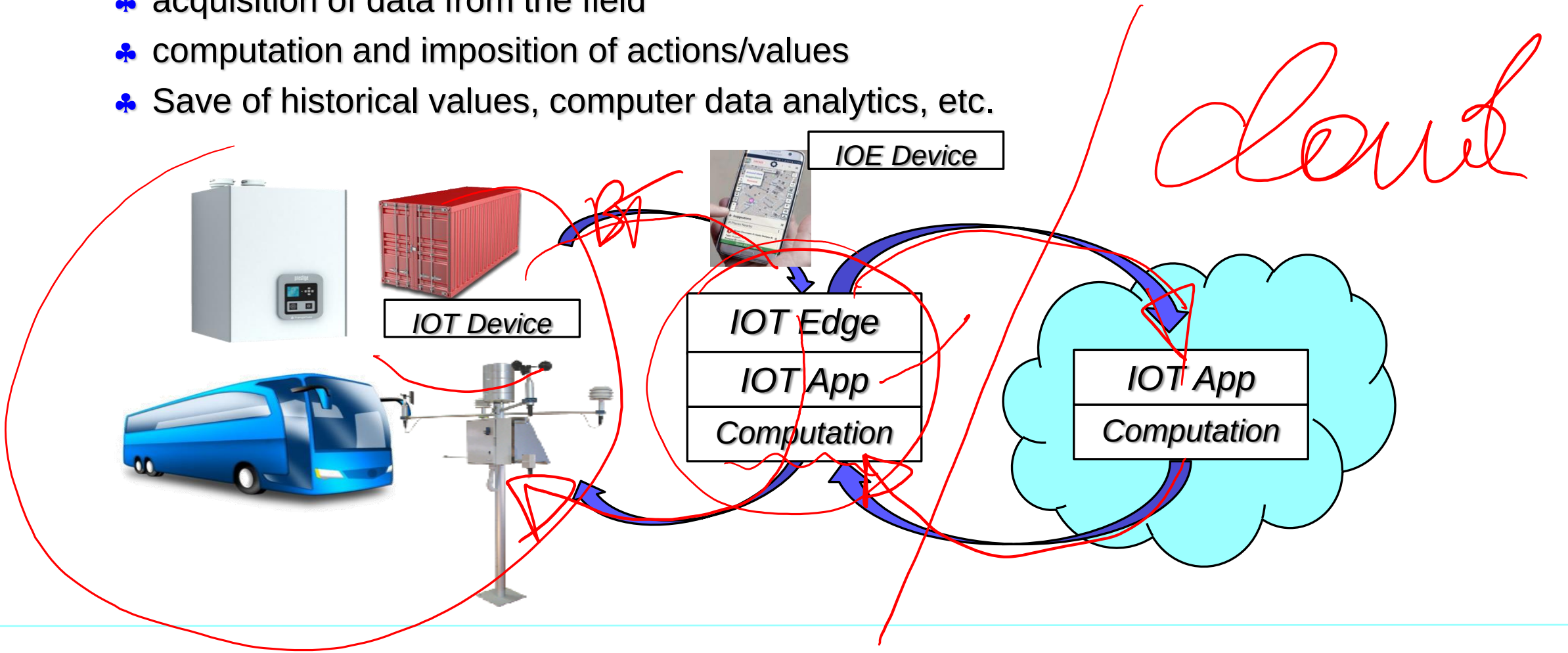
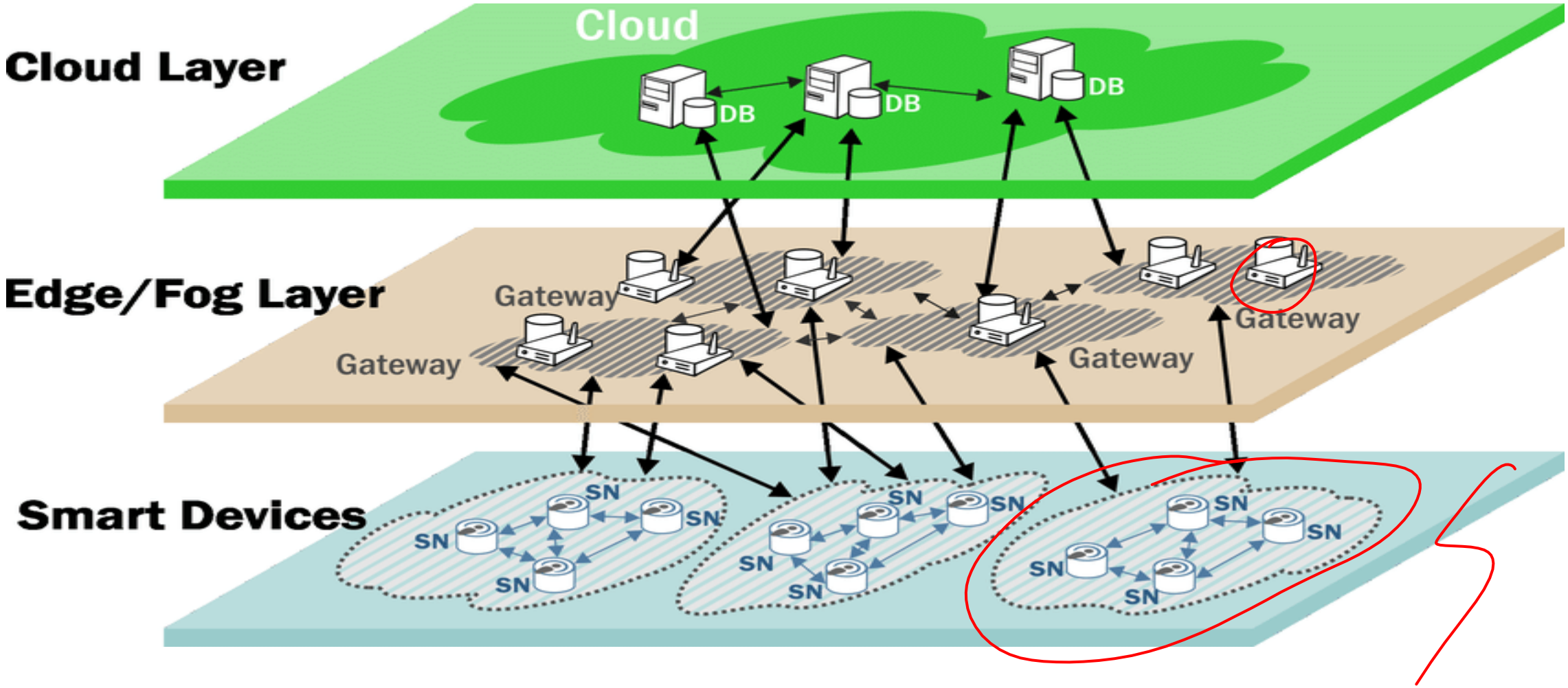
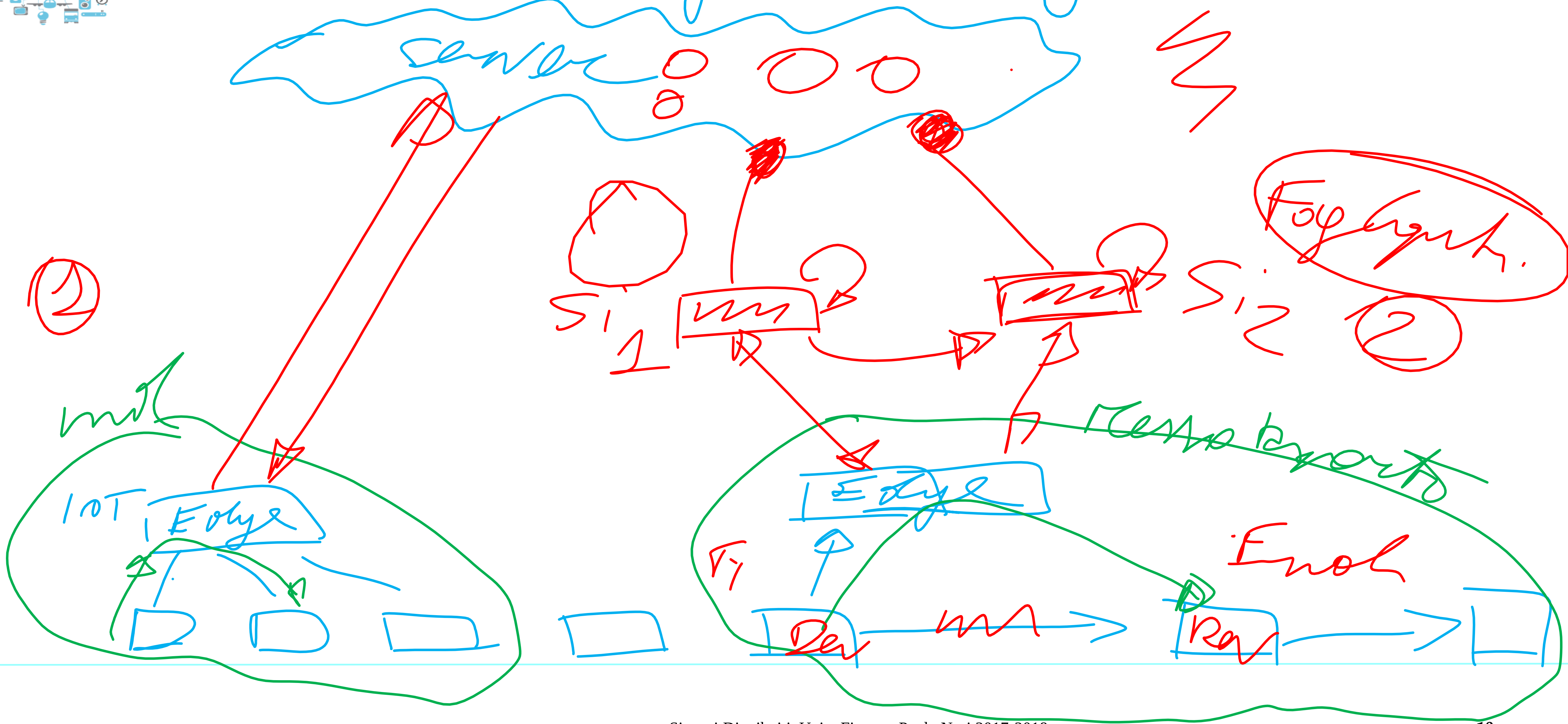


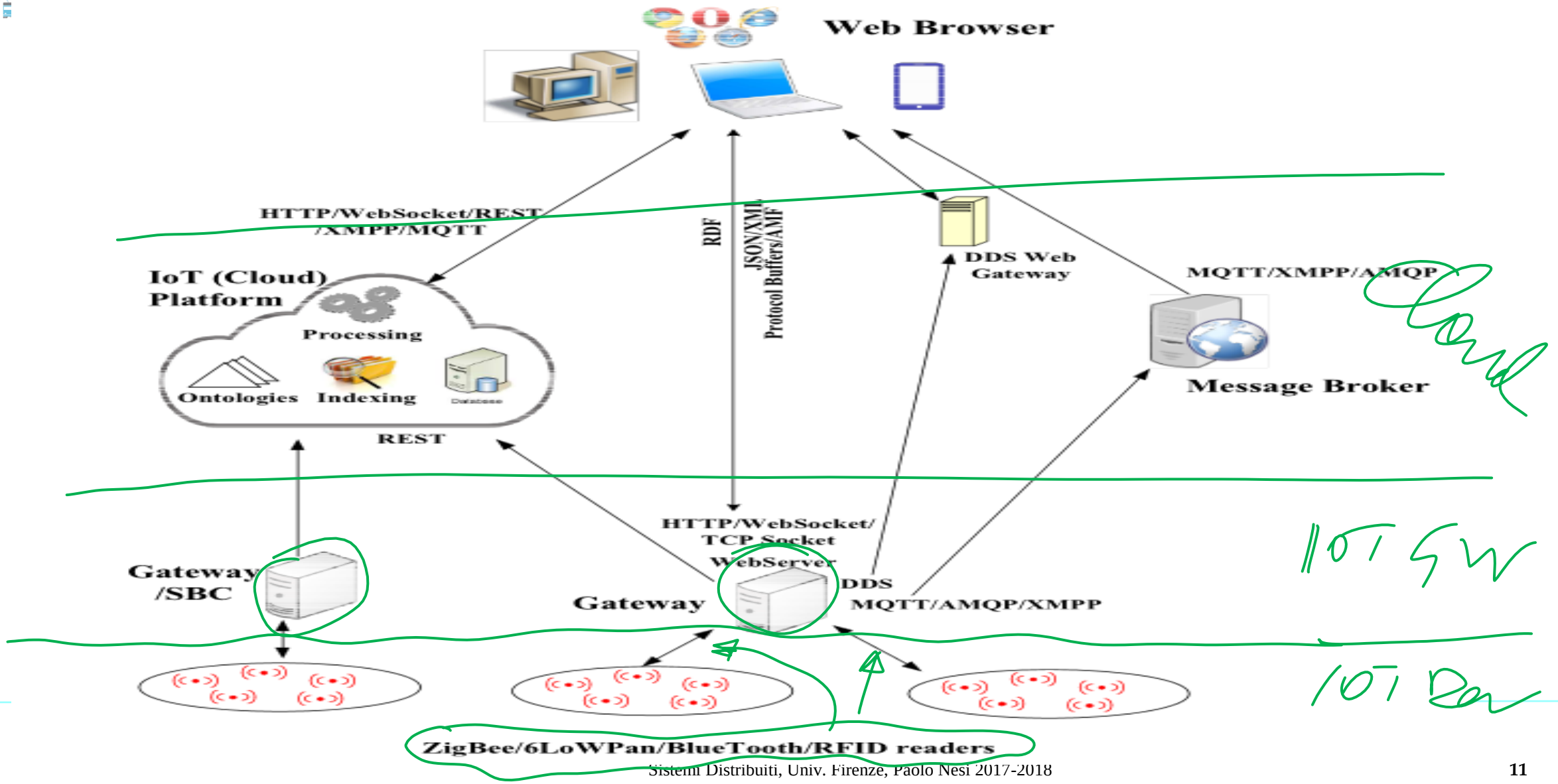
Cloud vs Fog/Edge Computing

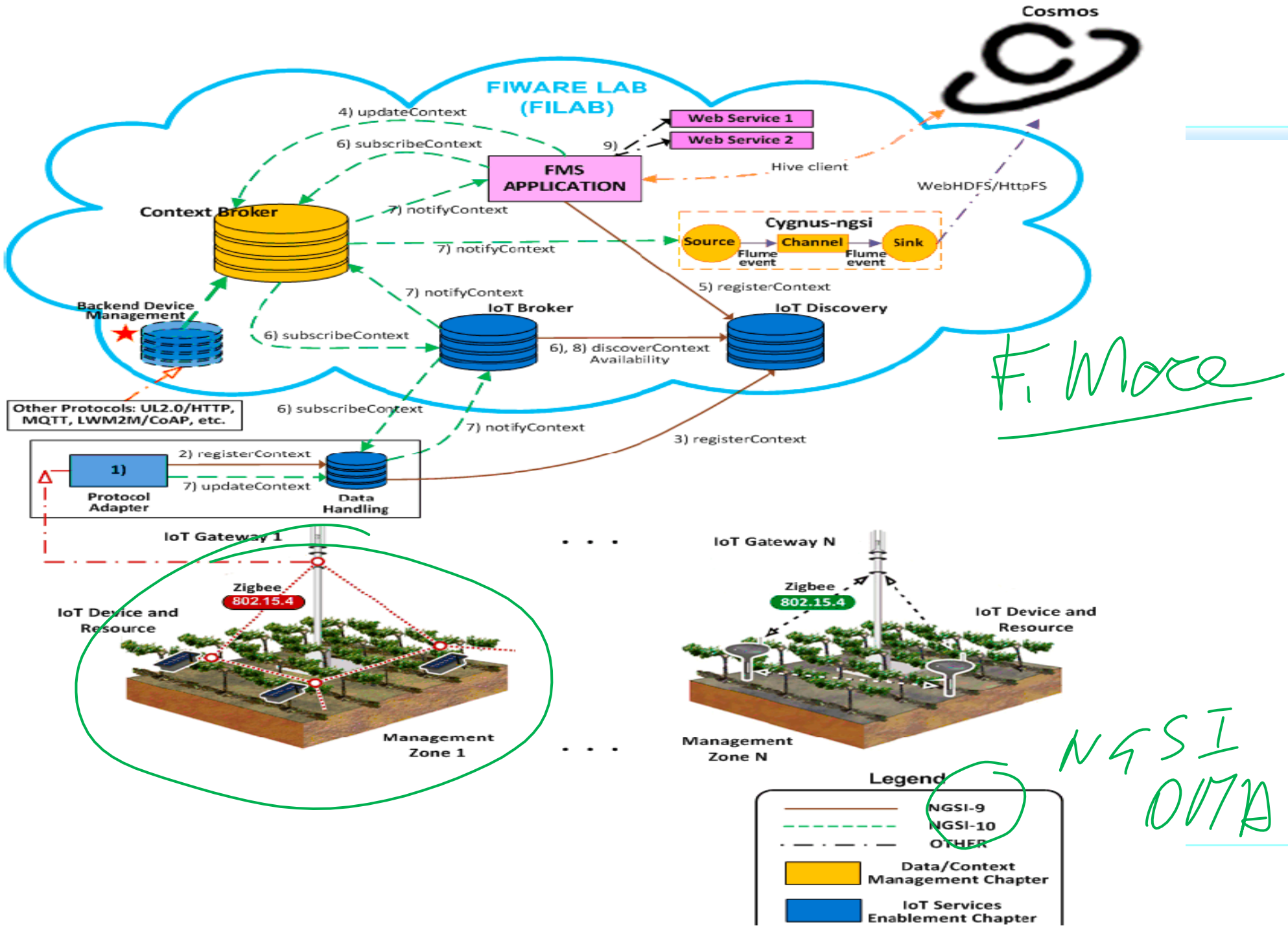


IOT edge vs Fog



Edge Computing, Fog Computing





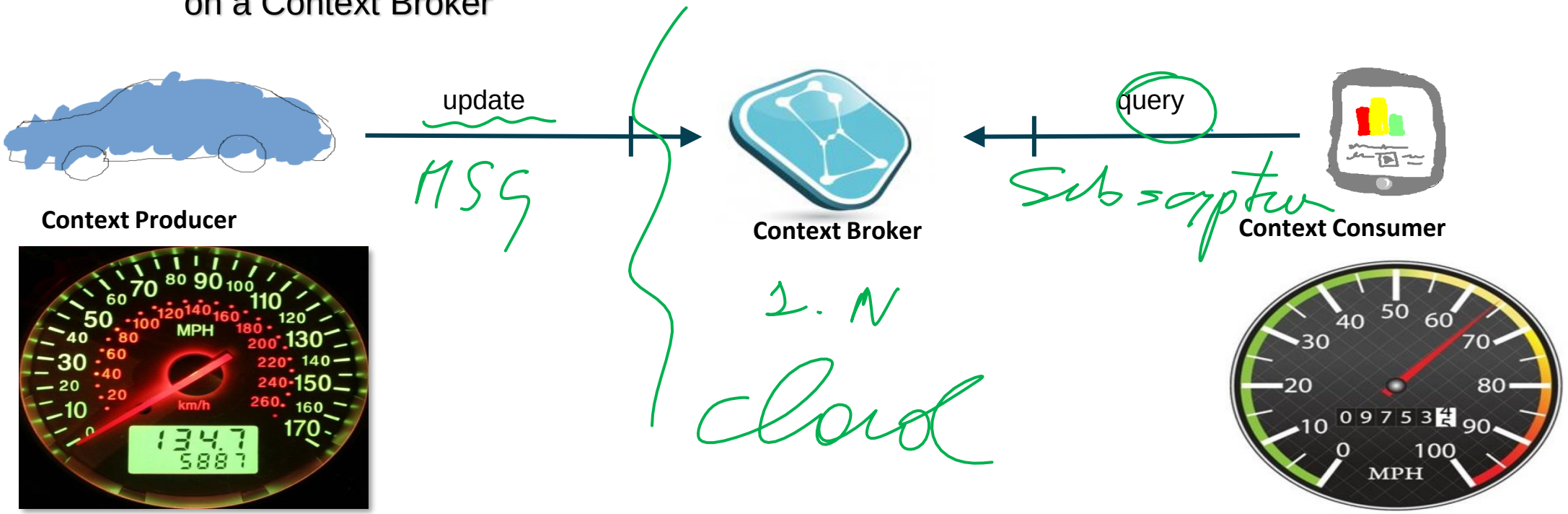
F. Mazzo

NGSI OMA

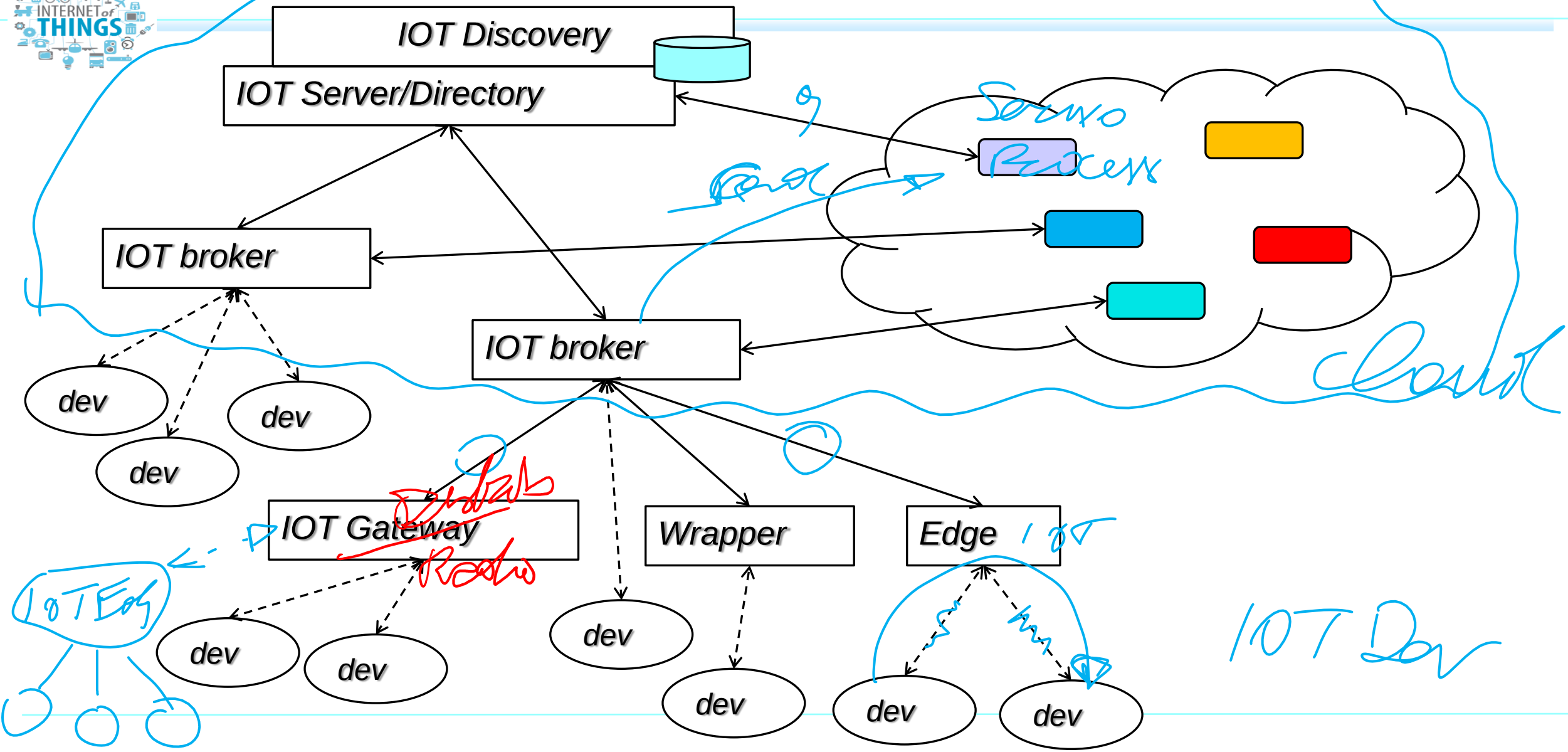
IOT Context Broker

Context Broker operations: create & pull data

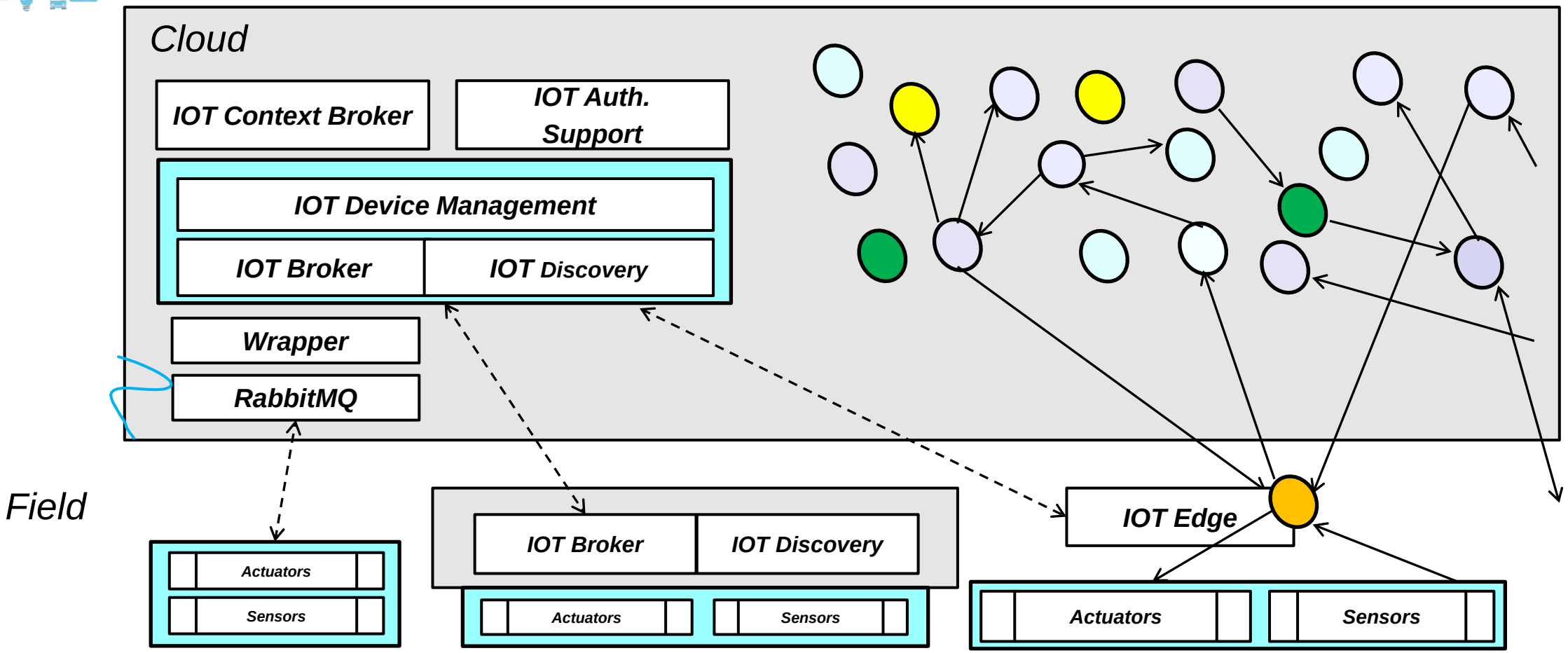
- **Context Producers** publish data/context elements by invoking the **update** operations on a Context Broker.
- **Context Consumers** can retrieve data/context elements by invoking the **query** operations on a Context Broker



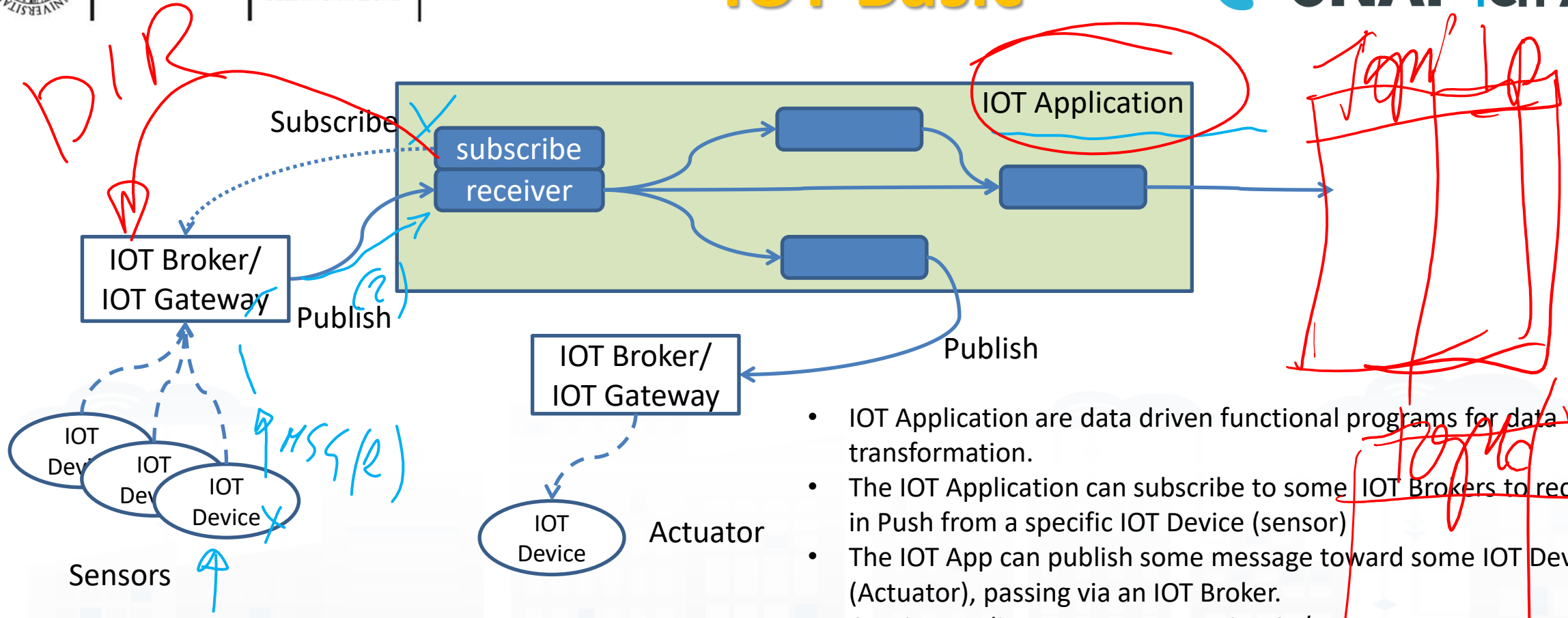
architettura



Conceptual architecture



IOT Basic

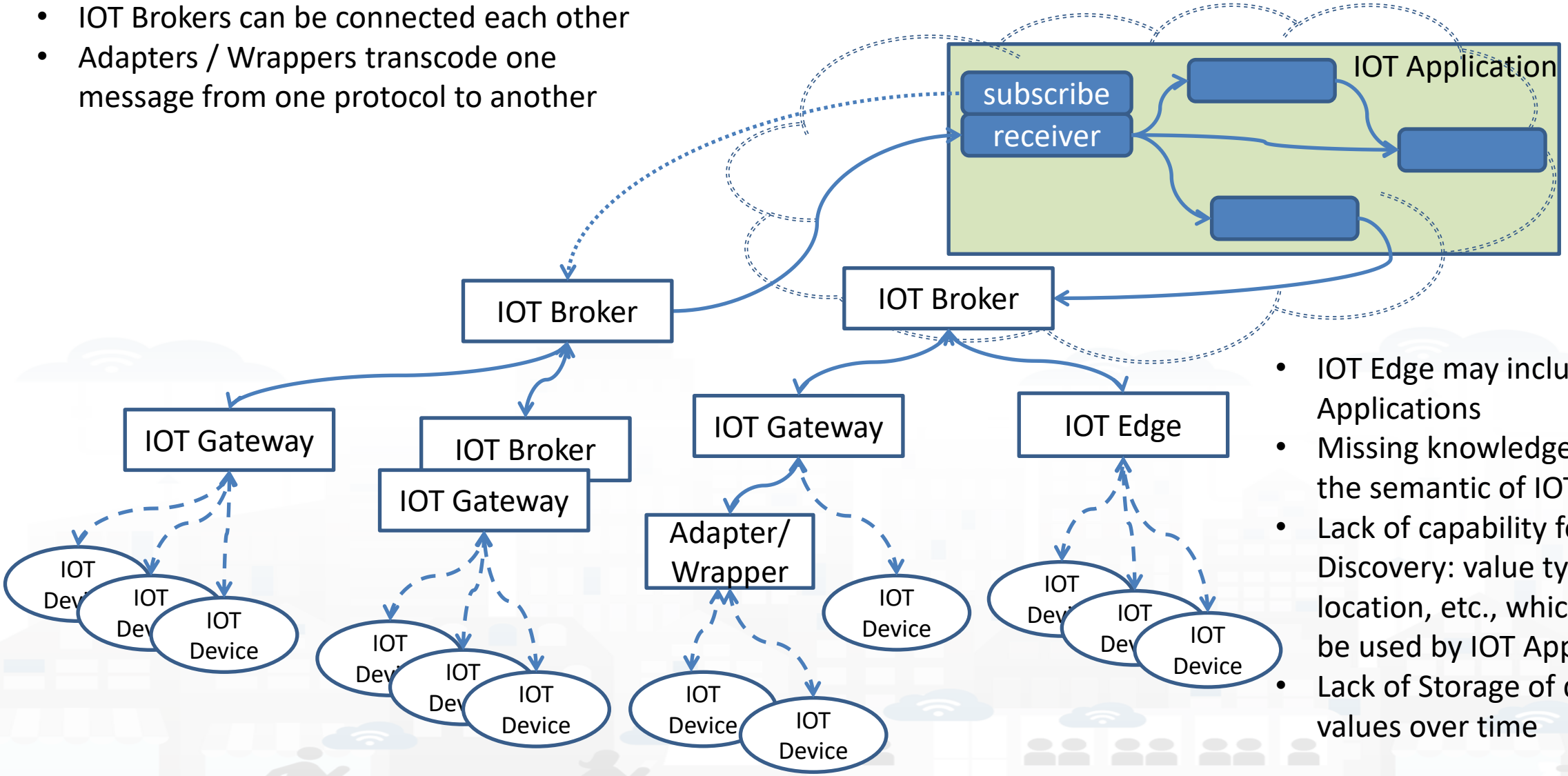


- Sensors are programmed to send data (i) periodically, or (ii) when a relevant change occurs in the sensor value, or (iii) when events occur (for example a change of status of something), etc.
- Actuator perform some action on the field: change of status, reset, turn on something, change setting value, etc.

- IOT Application are data driven functional programs for data transformation.
- The IOT Application can subscribe to some IOT Brokers to receive data in Push from a specific IOT Device (sensor)
- The IOT App can publish some message toward some IOT Device (Actuator), passing via an IOT Broker.
- Continuous lines are messages via TCP/IP
- Dashed lines are message via some radio channel (Lora, BT, Wi-Fi, …)
- IOT Brokers and IOT Gateway can be distinct servers
- IOT Brokers can be on cloud
- IOT Gateway performs the SW update, the business management, access in Push and Pull

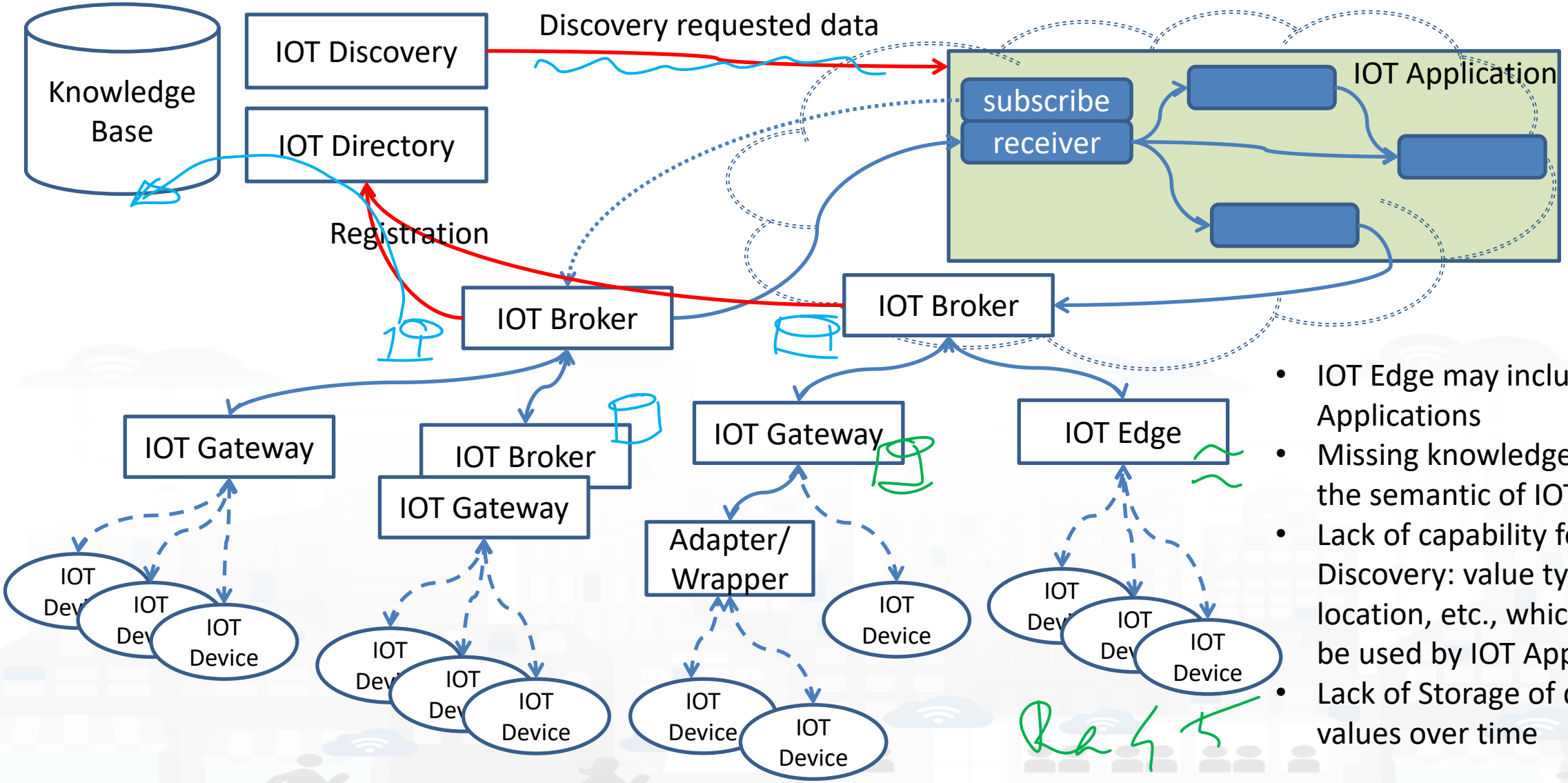
Definitions

- IOT Brokers can be connected each other
- Adapters / Wrappers transcode one message from one protocol to another



- IOT Edge may include IOT Applications
- Missing knowledge about the semantic of IOT devices
- Lack of capability for IOT Discovery: value type, location, etc., which could be used by IOT App
- Lack of Storage of data values over time

Definitions



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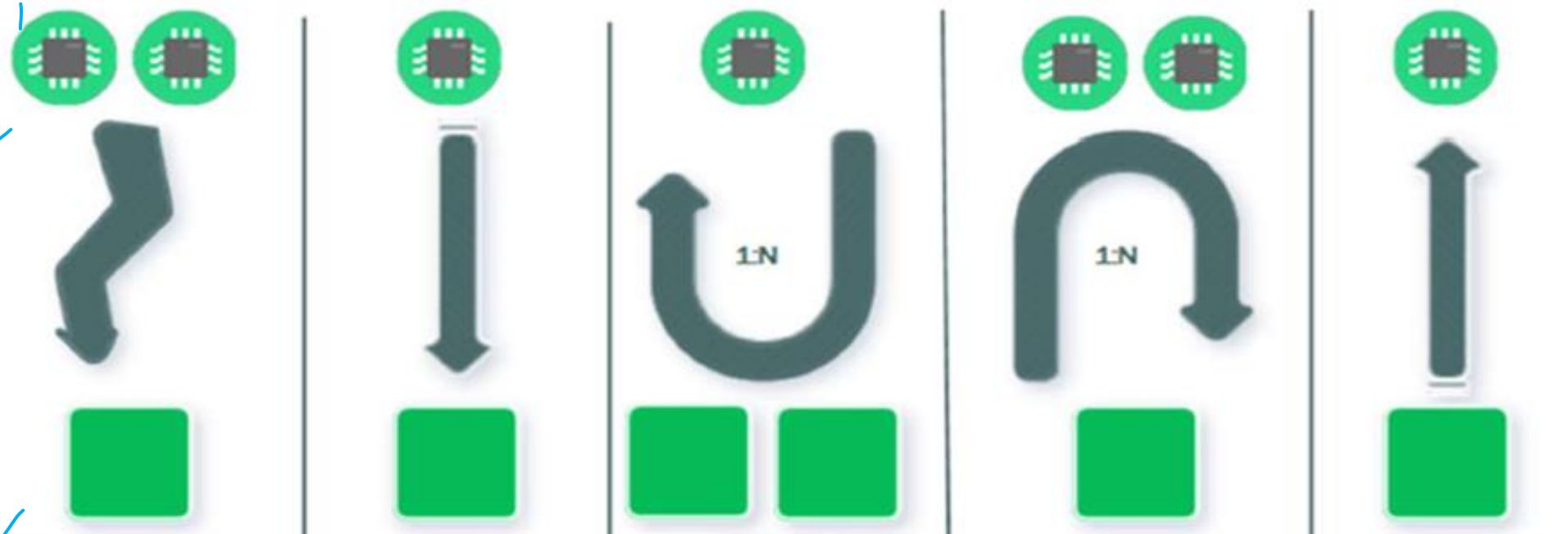
IOT/IOE Protocols

Communication Patterns



Discovery
Discover, register and "thrust" new devices on the network

Telemetry
Information Flows From device to another system for conveying status changes in the device

Inquiries
Requests from devices looking to gather required information or asking to initiate activities

Commands
Commands from other systems to a device or a group of devices to perform specific activities

Notifications
Information flows from other systems to a device or a group for conveying status changes in the world

- MQTT
- HTTP(s)
- AMQP
- COAP
- NGSI
- OneM2M
- WebSocket s
- ……..
- Etc.

Registration

Push

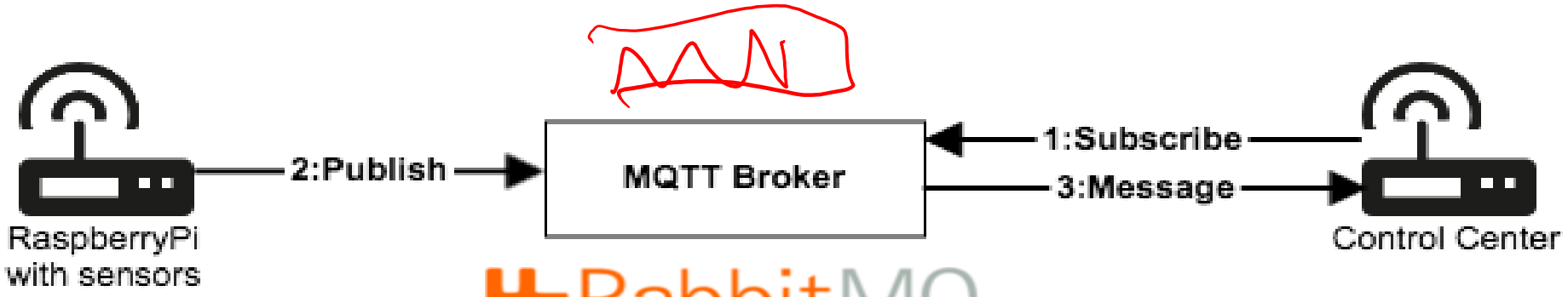
Bulk action

Note on Communication patterns

- Not all Communication Patterns are supported by all Protocols
- Protocols implement Patterns, + formats, + sequences, etc.
- They are referred at level of communications
  - IOT Device ← → IOT Gateway ←→IOT Broker
- IOT Protocols mostly used at level of IP are:
  - NGSI V1/2, MQTT, COAP, AMQP, OneM2M, WS, ModBUS,
- Radio protocols are: Lora, ZigBee, 3G, Wi-Fi, etc.
- Formats: JSON, Geo-JSON, Linked Data, XML, CSV,

IOT Brokers

	AMQP	STOMP	JMS	COAP	NGSI	MQTT OASIS
RabbitMQ	X	X	X	X		X
Mosquitto						X
ActiveMQ	X	X	X			X
StormMQ	X					
HIVEMQ			X			X
ORION BROKER				X	X	X



IOT stack protocols

			Security	Management
Session		MQTT, SMQTT, CoRE, DDS, AMQP , XMPP, CoAP, …	TCG, Oath 2.0, SMACK, SASL, ISASecure, ace, DTLS, Dice, …	IEEE 1905, IEEE 1451, …
Network	Encapsulation	6LowPAN, 6TiSCH, 6Lo, Thread, …		
	Routing	RPL, CORPL, CARP, …		
Datalink		WiFi, Bluetooth Low Energy, Z-Wave, ZigBee Smart, DECT/ULE, 3G/LTE, NFC, Weightless, HomePlug GP, 802.11ah, 802.15.4e, G.9959, WirelessHART, DASH7, ANT+, LTE-A, LoRaWAN, …		

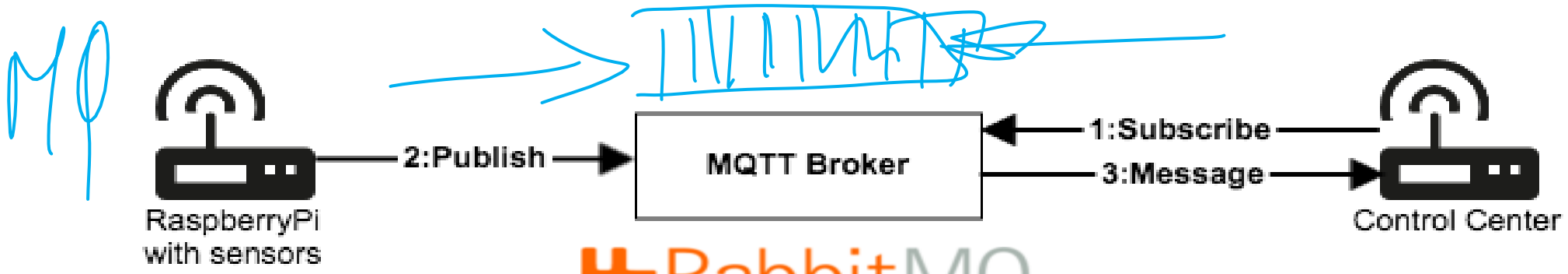
https://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/

http GET vs POST

	GET	POST
BACK button/Reload	Harmless	Data will be re-submitted (the browser should alert the user that the data are about to be re-submitted)
Bookmarked	Can be bookmarked	Cannot be bookmarked
Cached	Can be cached	Not cached
Encoding type	application/x-www-form-urlencoded	application/x-www-form-urlencoded or multipart/form-data. Use multipart encoding for binary data
History	Parameters remain in browser history	Parameters are not saved in browser history
Restrictions on data length	Yes, when sending data, the GET method adds the data to the URL; and the length of a URL is limited (maximum URL length is 2048 characters)	No restrictions
Restrictions on data type	Only ASCII characters allowed	No restrictions. Binary data is also allowed
Security	GET is less secure compared to POST because data sent is part of the URL Never use GET when sending passwords or other sensitive information!	POST is a little safer than GET because the parameters are not stored in browser history or in web server logs
Visibility	Data is visible to everyone in the URL	Data is not displayed in the URL

IOT Brokers

	AMQP	STOMP	JMS	COAP	NGSI	MQTT OASIS
RabbitMQ	X	X	X	X		X
Mosquitto						X
ActiveMQ	X	X	X			X
StormMQ	X					
HIVEMQ			X			X
ORION BROKER				X	X	X



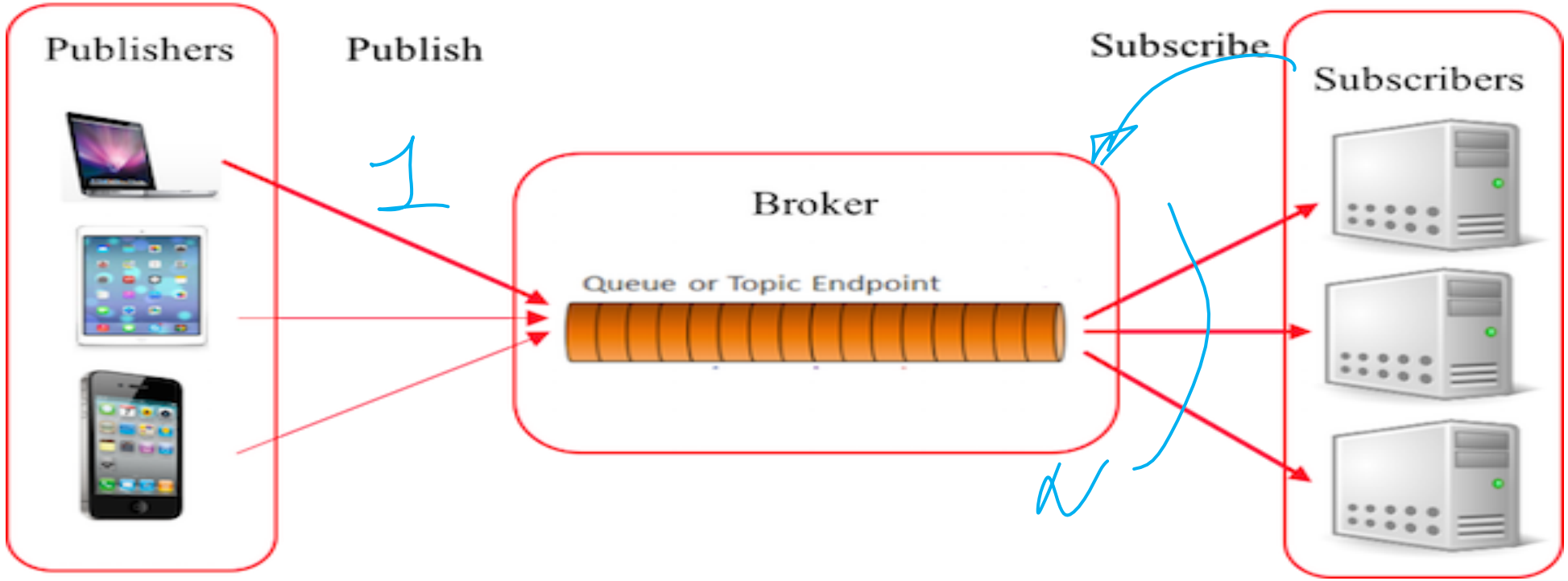
RabbitMQ
Open Source Enterprise Messaging

Comparison high level IOT protocols

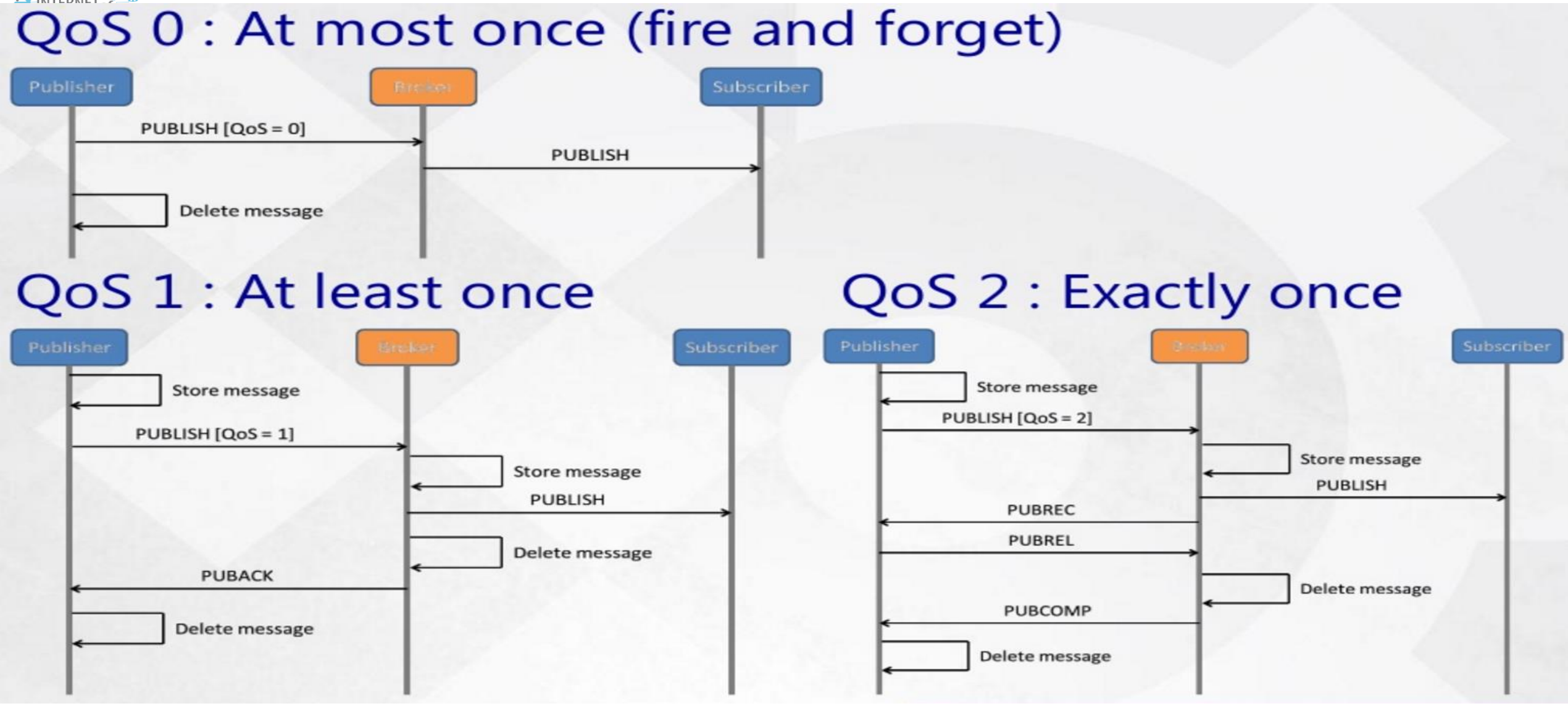
Protocols	UDP/TCP	Architecture	Security and QoS	Header Size (bytes)	Max Length(bytes)
MQTT	TCP	Pub/Sub	Both	2	5
AMQP	TCP	Pub/Sub	Both	8	-
CoAP	UDP	Req/Res	Both	4	20 (typical)
XMPP	TCP	Both	Security	-	-
DDS	TCP/UDP	Pub/Sub	QoS	-	-
NGSI	TCP/IP				

MQTT: Message Queue Telemetry Transport

- security obtained with SSL/TLS since it is over TCP
- ISO/IEC PRF 20922
- Over TCP/IP, Async, pub/subscribe,
- payload agnostic (can be encrypted)

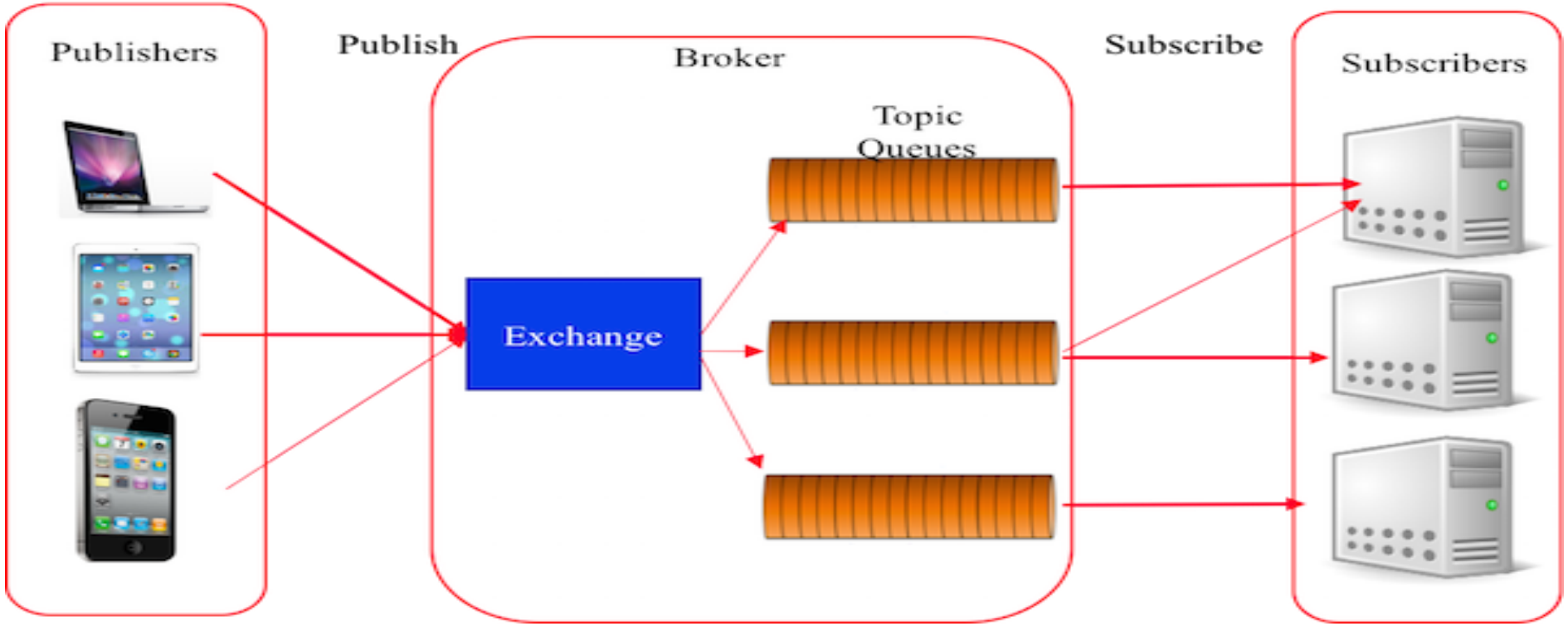


MQTT QoS


QoS 0 : At most once (fire and forget)
Publisher
Broker
Subscriber
PUBLISH [QoS = 0]
PUBLISH
Delete message
QoS 1 : At least once
Publisher
Broker
Subscriber
Store message
PUBLISH [QoS = 1]
Store message
PUBLISH
Delete message
PUBACK
Delete message
QoS 2 : Exactly once
Publisher
Broker
Subscriber
Store message
PUBLISH [QoS = 2]
Store message
PUBLISH
PUBREC
PUBREL
Delete message
PUBCOMP
Delete message

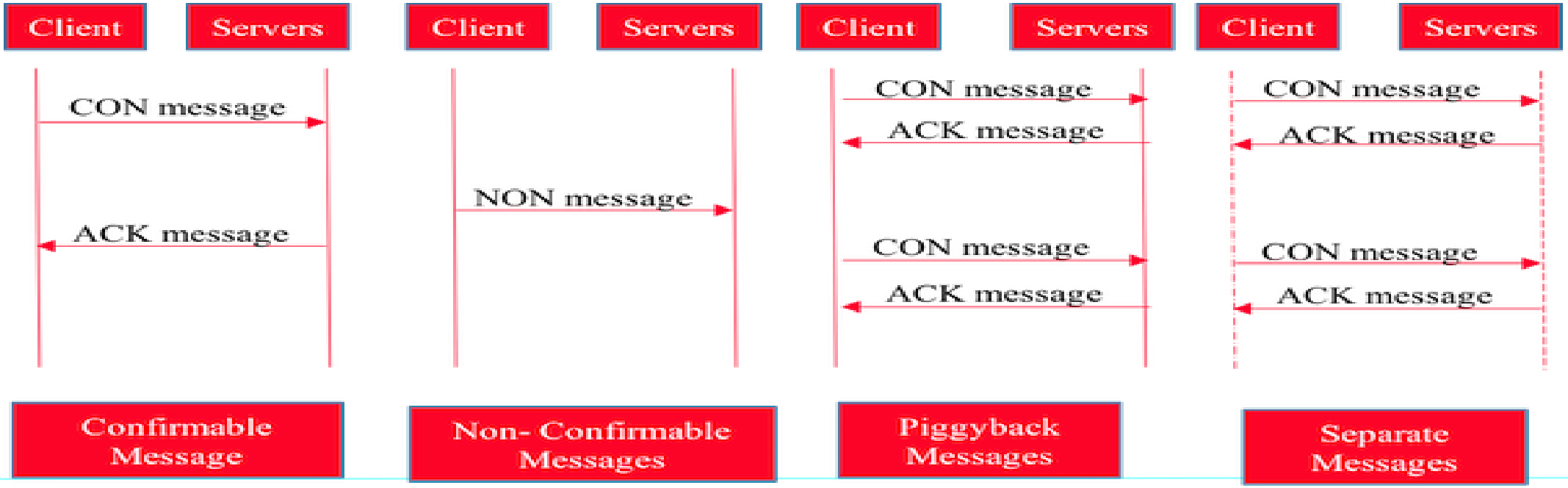
AMQP Advanced Message Queuing Protocol

- Over TCP, binary wire protocol
- Exchange decoupling



CoAP: Constrained Application Protocol

- OMA LWM2M over IETF CoAP (Internet Engineering Task Force)
- security obtained with DTLS, Datagram TLS
- HTTP like over UDP with fixed header, no TCP



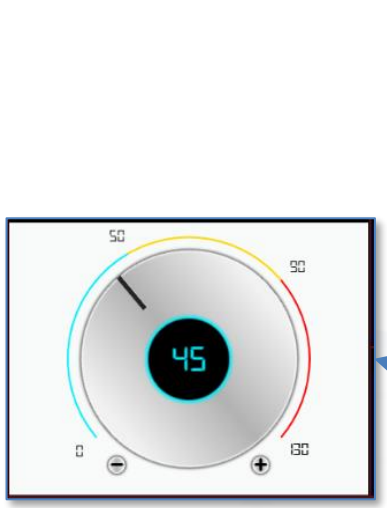
Other protocols

- **STOMP**: Streaming Text Oriented Messaging Protocol
  - Similar to HTTP
- **XMPP**: Extensible Messaging and Presence Protocol
  - Based on XML, proposed by IETF
  - Over TCP, can use HTTP
- **WAMP**: Web Application Messaging Protocol
  - WebSocket protocol by IANA
  - Over level 6
- **SNMP** by IETF, level 7
  - Over UDP, or IP
  - Monitoring status of servers
- **SigFOX**
- **OneM2M** AIOTI
  - a strategic enabler for IoT applications and companies developing IoT solutions

Comparison of lowlevel IOT prot.

Protocolli IoT	Standard	Frequenza	Range	Data Rates
Bluetooth	Bluetooth 4.2	2.4GHz (ISM)	50-150m (Smart/BLE)	1Mbps (Smart/BLE)
ZigBee	ZigBee 3.0 based on IEEE802.15.4	2.4GHz	10-100m	250kbps
6LoWPAN	RFC6282	(adapted and used over a variety of other networking media including Bluetooth Smart (2.4GHz) or ZigBee or low-power RF (sub-1GHz)	Vedi protocollo di supporto	Vedi protocollo di supporto
WiFi	Based on 802.11n (most common usage in homes today)	2.4GHz and 5GHz bands	Approximately 50m	600 Mbps maximum, but 150-200Mbps is more typical, depending on channel frequency used and number of antennas (latest 802.11-ac standard should offer 500Mbps to 1Gbps)
Cellular	GSM/GPRS/EDGE (2G), UMTS/HSPA (3G), LTE (4G)	900/1800/1900/2100MHz	35km max for GSM; 200km max for HSPA	(typical download): 35-170kps (GPRS), 120-384kbps (EDGE), 384Kbps-2Mbps (UMTS), 600kbps-10Mbps (HSPA), 3-10Mbps (LTE)
NFC	ISO/IEC 18000-3	13.56MHz (ISM)	10cm	100–420kbps
LoRaWAN	LoRaWAN	Various (europe, 868Mhz)	2-5km (urban environment), 15km (suburban environment)	0.3-50 kbps

IOT Data Driven



Actuator

Sensor Actuator

From Dashboard to IOT Device

From IOT Device to KB

Sensors

Snap4city Platform
Data Shadow

Real Time
+ Historical

Sensors

Snap4City
IOT Brokers

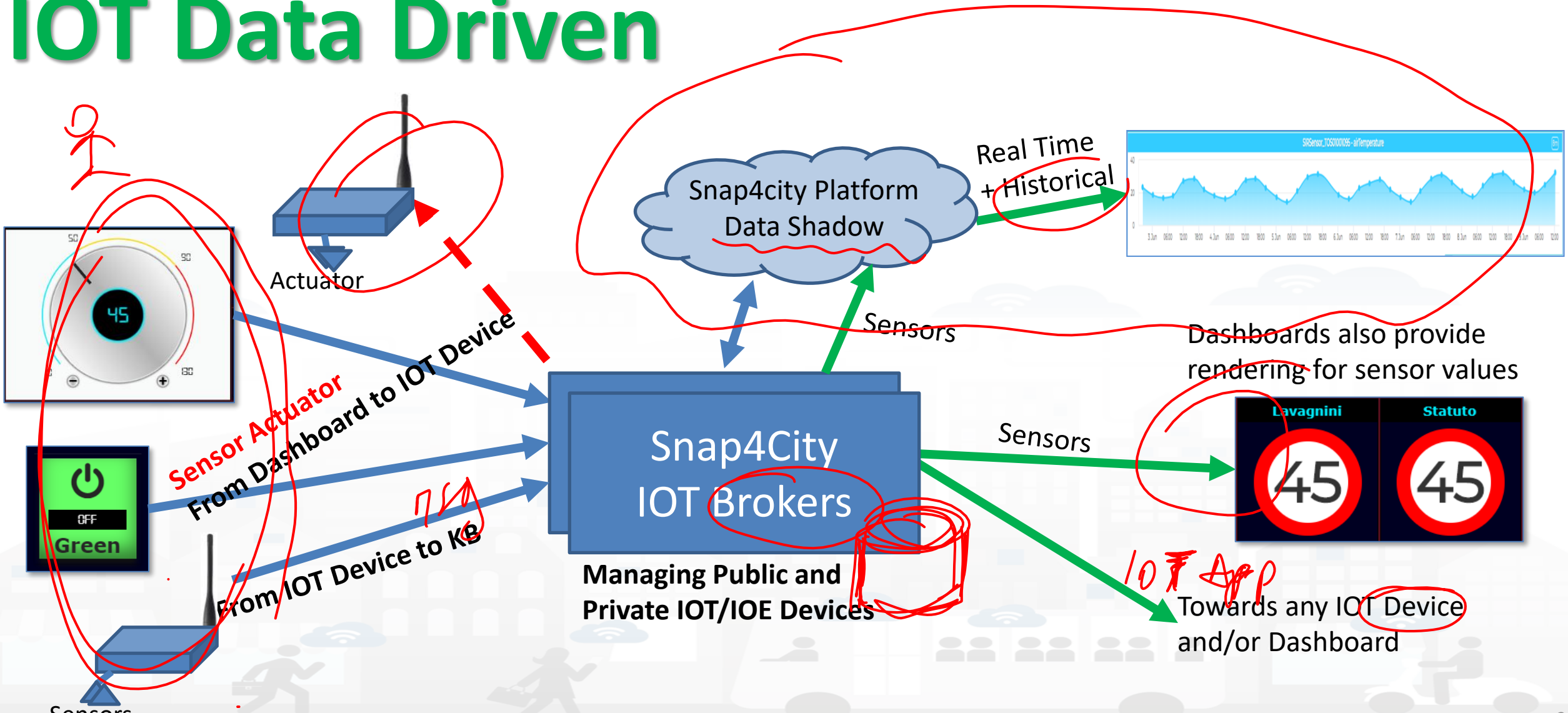
Managing Public and Private IOT/IOE Devices

Sensors

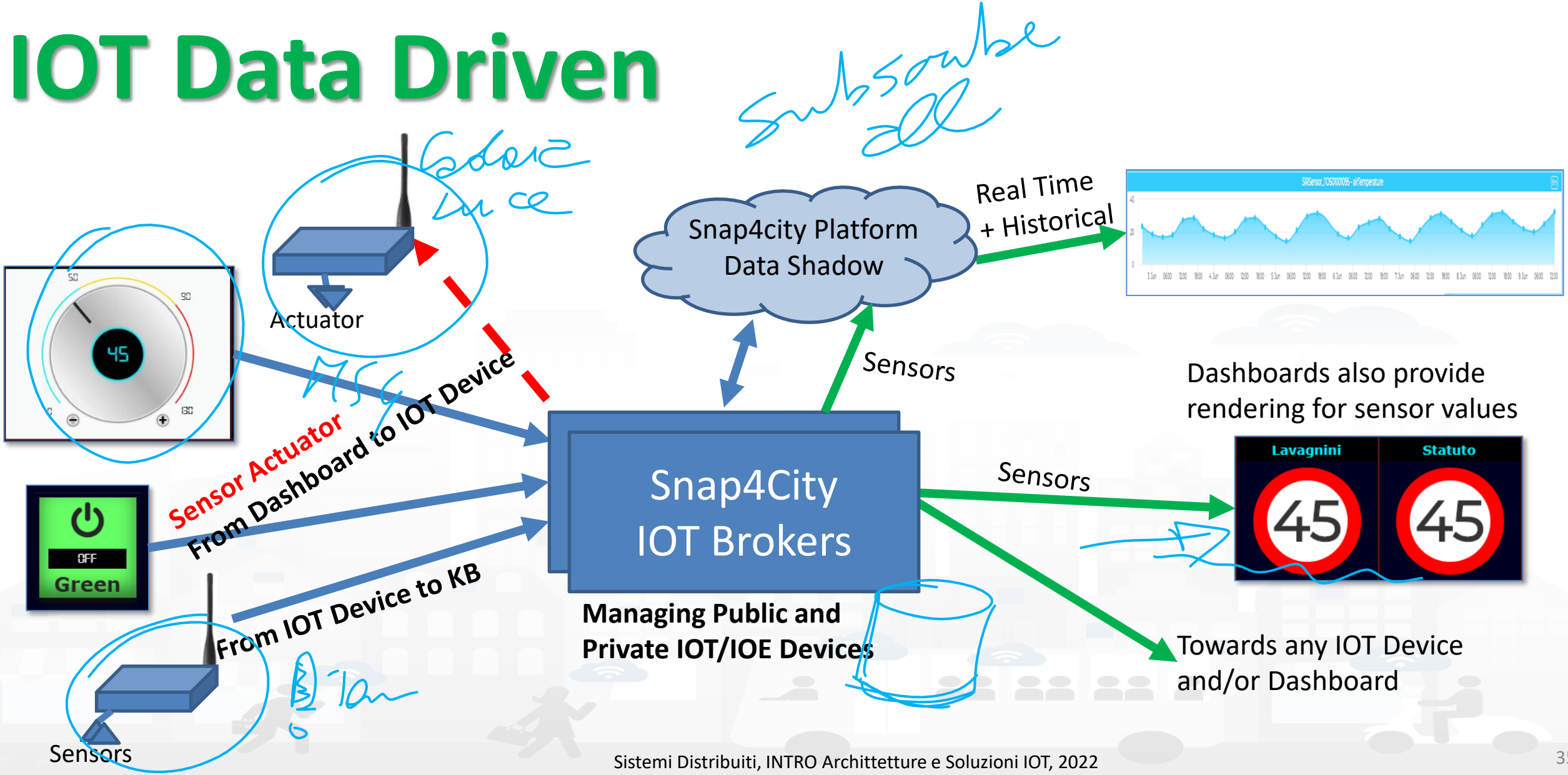
Towards any IOT Device and/or Dashboard

Dashboards also provide rendering for sensor values

IOT Data Driven



IOT Data Driven



IOT Architectures Comparison

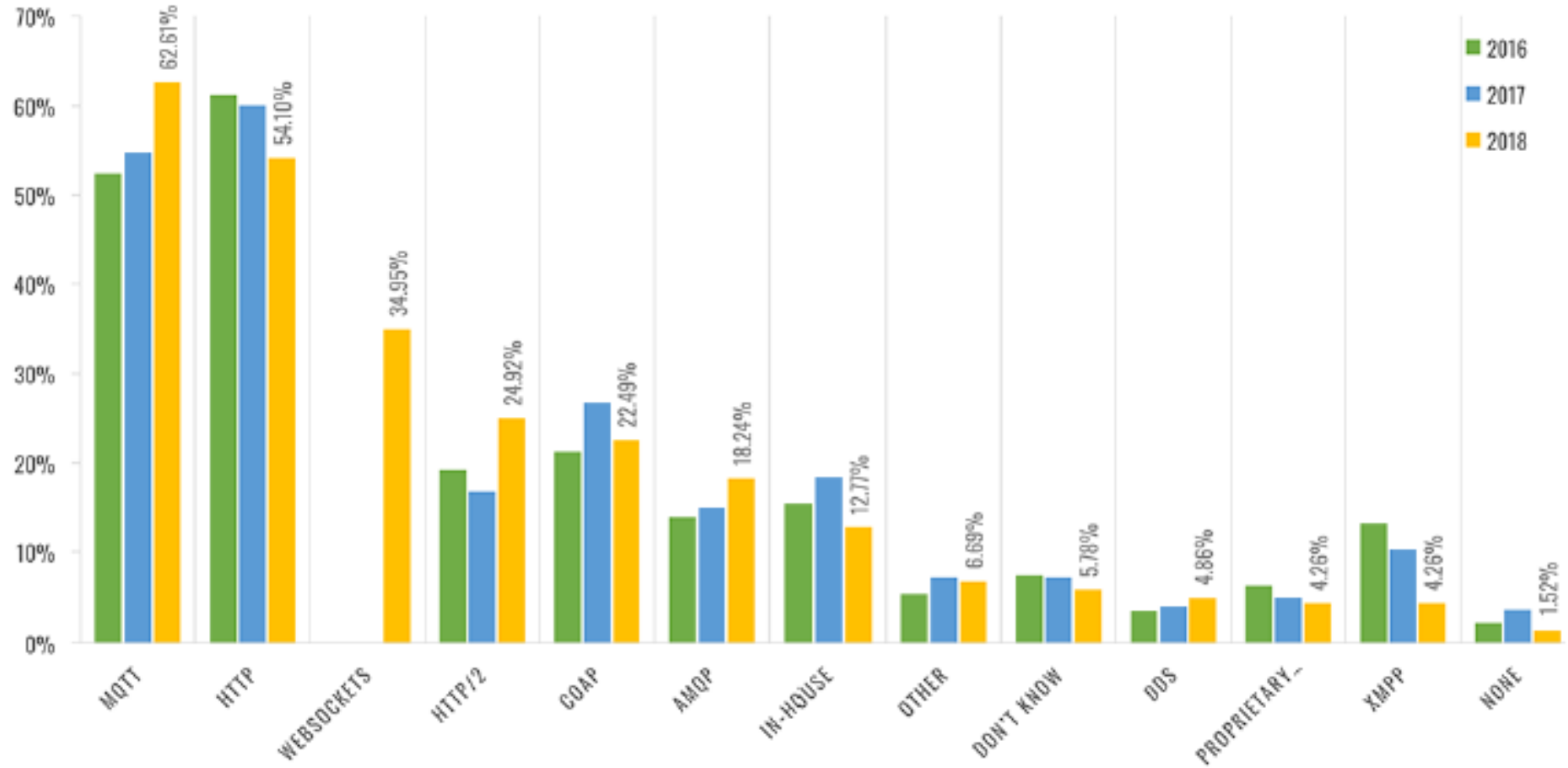
Market Solutions

	IOT Discovery Abstraction	Authentication, Authorization	Security end-2-end, secure on IOT and Dashboards	Open HW and Open SW	Integrated Community management	Data Types: IOT Devices, IOT App, Dashboard, Data	Data Type: Publish/share, Delegation, Consent and change	Data Type: Download and Delete	Auditing on Data Type Access	Open Source end-to-end	Scalability IOT	Visual Programming end-to-end applications	Advanced Smart City API, MicroServices	Multi Domain Semantic Platform	Standard based Modules and IOT, Open Devices	Resource Sharing	Data Analytics integrated	Dashboard H24/7, protected connection	Multi-protocol on IOT
		G				G	G	G	G										
Snap4City	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KAA [53]	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	N	(Y)	N	N	Y	Y
Thingsboard [55]	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	Y	MQTT,coap, http
IOT eclipse.org [56]	N	N	N	(Y)	N	Y	N	N	N	Y	Y	N	N	N	Y	N	N	N	Y
IOT IGNITE [57]	N	Y	N	Y	N	Y	N	Y	Y	Y	Y	Y	N	N	N	N	N	Y	MQTT
FIWARE [47]	N	Y	N	Y	N	N	N	Y	N	Y	(Y)	(N)	Y	N	Y	N	N	Y	Y
ARM mbed IoT [48]	Y	Y	Y	Y	Y	N	(N)	N	Y	Y	Y	N	N	N	Y	N	N	Y	Limited
Airvantage [51]	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	Y	MQTT, HTTP
AWS [43]	Y	Y	Y	Y	N	Y	(N)	Y	Y	N	Y	N	N	N	Y	Y	(Y)	Y	Limited
Azure IOT [44]	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	N	N	Y	Y	(Y)	Y	Limited
PTC ThingWorkx [59]	N	Y	Y	Y	Y	Y	N	N	Y	N	Y	Y	N	N	Y	N	N	Y	Y
Bosch IoT Suite [58]	Y	Y	Y	Y	Y	(Y)	(N)	Y	Y	N	Y	Y	Y	N	Y	N	Y	Y	Y
CISCO Jasper [55]	Y	Y	Y	Y	N	(Y)	(N)	N	Y	N	Y	N	N	N	N	--	(Y)	Y	N
Siemens MindSphere [60]	Y	Y	Y	(Y)	N	Y	(N)	Y	Y	N	Y	Y	N	N	Y	N	Y	Y	Y
Carriots [54]	Y	Y	Y	(Y)	N	Y	N	N	Y	N	Y	N	N	N	--	N	N	Y	MQTT
Google IOT [45]	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	N	N	N	N	N	(Y)	(Y)	MQTT, HTTP
Homekit Apple [50]	Y	Y	Y	Y	N	Y	N	N	Y	N	(Y)	N	N	N	N	Y	N	Y	Limited
Smarthing Samsung [52]	Y	Y	Y	Y	Y	Y	(Y)	Y	Y	N	(Y)	N	N	N	N	N	N	Y	Limited

Market Solutions

	IOT Discovery Abstraction	Authentication, Authorization	Security end-2-end, secure on IOT and Dashboards	Open HW and Open SW	Integrated Community management	Data Types: IOT Devices, IOT App, Dashboard, Data	Data Type: Publish/share, Delegation, Consent and change	Data Type: Download and Delete	Auditing on Data Type Access	Open Source end-to-end	Scalability IOT	Visual Programming end-to-end applications	Advanced Smart City API, MicroServices	Multi Domain Semantic Platform	Standard based Modules and IOT, Open Devices	Resource Sharing	Data Analytics integrated	Dashboard H24/7, protected connection	Multi-protocol on IOT
		G				G	G	G	G										
Snap4City	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KAA [53]	Y	Y	Y	Y	Y	Y	N	Y	Y	Y	Y	N	Y	N	(Y)	N	N	Y	Y
Thingsboard [55]	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	Y	MQTT,coap, http
IOT eclipse.org [56]	N	N	N	(Y)	N	Y	N	N	N	Y	Y	N	N	N	Y	N	N	N	Y
IOT IGNITE [57]	N	Y	N	Y	N	Y	N	Y	Y	Y	Y	Y	N	N	N	N	N	Y	MQTT
FIWARE [47]	N	Y	N	Y	N	N	N	Y	N	Y	(Y)	(N)	Y	N	Y	N	N	Y	Y
ARM mbed IoT [48]	Y	Y	Y	Y	Y	N	(N)	N	Y	Y	Y	N	N	N	Y	N	N	Y	Limited
Airvantage [51]	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	Y	MQTT, HTTP
AWS [43]	Y	Y	Y	Y	N	Y	(N)	Y	Y	N	Y	N	N	N	Y	Y	(Y)	Y	Limited
Azure IOT [44]	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	N	N	Y	Y	(Y)	Y	Limited
PTC ThingWorkx [59]	N	Y	Y	Y	Y	Y	N	N	Y	N	Y	Y	N	N	Y	N	N	Y	Y
Bosch IoT Suite [58]	Y	Y	Y	Y	Y	(Y)	(N)	Y	Y	N	Y	Y	Y	N	Y	N	Y	Y	Y
CISCO Jasper [55]	Y	Y	Y	Y	N	(Y)	(N)	N	Y	N	Y	N	N	N	N	--	(Y)	Y	N
Siemens MindSphere [60]	Y	Y	Y	(Y)	N	Y	(N)	Y	Y	N	Y	Y	N	N	Y	N	Y	Y	Y
Carriots [54]	Y	Y	Y	(Y)	N	Y	N	N	Y	N	Y	N	N	N	--	N	N	Y	MQTT
Google IOT [45]	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	N	N	N	N	N	(Y)	(Y)	MQTT, HTTP
Homekit Apple [50]	Y	Y	Y	Y	N	Y	N	N	Y	N	(Y)	N	N	N	N	Y	N	Y	Limited
Smarthing Samsung [52]	Y	Y	Y	Y	Y	Y	(Y)	Y	Y	N	(Y)	N	N	N	N	N	N	Y	Limited

	Azure IoT	AWS	Google IoT
Data di rilascio (Out of beta)	Febbraio 2016	Dicembre 2015	Febbraio 2018
Quota di mercato	31.21%	51.82%	18.79%



	Azure IoT	AWS	Google IoT
Data di Rilascio (Out of Beta)	Febbraio 2016	Dicembre 2015	Febbraio 2018
Documentazione	Ottima	Molto Buona	Sufficiente
Certificazione	Ottenibile inviando l'applicazione sviluppata	Ottenibile sostenendo esami relativi a specifici ambiti	Ottenibile sostenendo esami relativi a specifici ambiti
Tipologia Certificazione	Non definita	Per specializzazione (Big Data, Security ecc) oppure per ruolo (Architect, Developer ecc)	Cloud Architect, Data Engineer, Suite Administrator
Vantaggi	Logo, crediti, sottoscrizioni, consulenze, accesso alla community ed eventi	Accesso alla community, logo, merchandise, accesso ad eventi	Non previsti

	Azure IoT	AWS	Google IoT
Architettura	Hub che comunica con tutti gli altri servizi.	I dati vengono raccolti dal Rules Engine e dal Device Shadows. A partire da questi si attivano i vari servizi.	Core che comunica con Funzioni, Pub/Sub e Dataflow. Questo si interfaccia agli altri servizi
API	REST	REST	REST
Protocolli	MQTT, AMQP, MQTT on WebSocket, AMQP on WebSocket, HTTPS, (1)	MQTT, MQTT on WebSocket, HTTPS	MQTT, HTTP
Sicurezza	TLS	TLS (mutual)	TLS
Autenticazione	SAS Token, IAM, x.509	x.509, IAM, Amazon Cognito, Federated, (2)	JSON Token, IAM, x.509
SDK	.NET, Java, Node.js, C, Python, (3)	C, Javascript, Java, Python, IOS, Android, Arduino Yun	Go, Java, .NET, Javascript, IOS, Android, PHP, Ruby, Python
Starter Kit	Intel. Raspberry Pi, Freescale, Texas Instruments, Seeed, resin.io, MinnowBoard, BeagleBoard	Broadcome, Marvell, Renesas, Texas Instruments, Intel, Microchip, Seeed, Mediatek, Qualcomm, BeagleBoard	Microchip, Adafruit, Marvell, TechNexion, Grove, Realtek, Allwinner, MangOH.

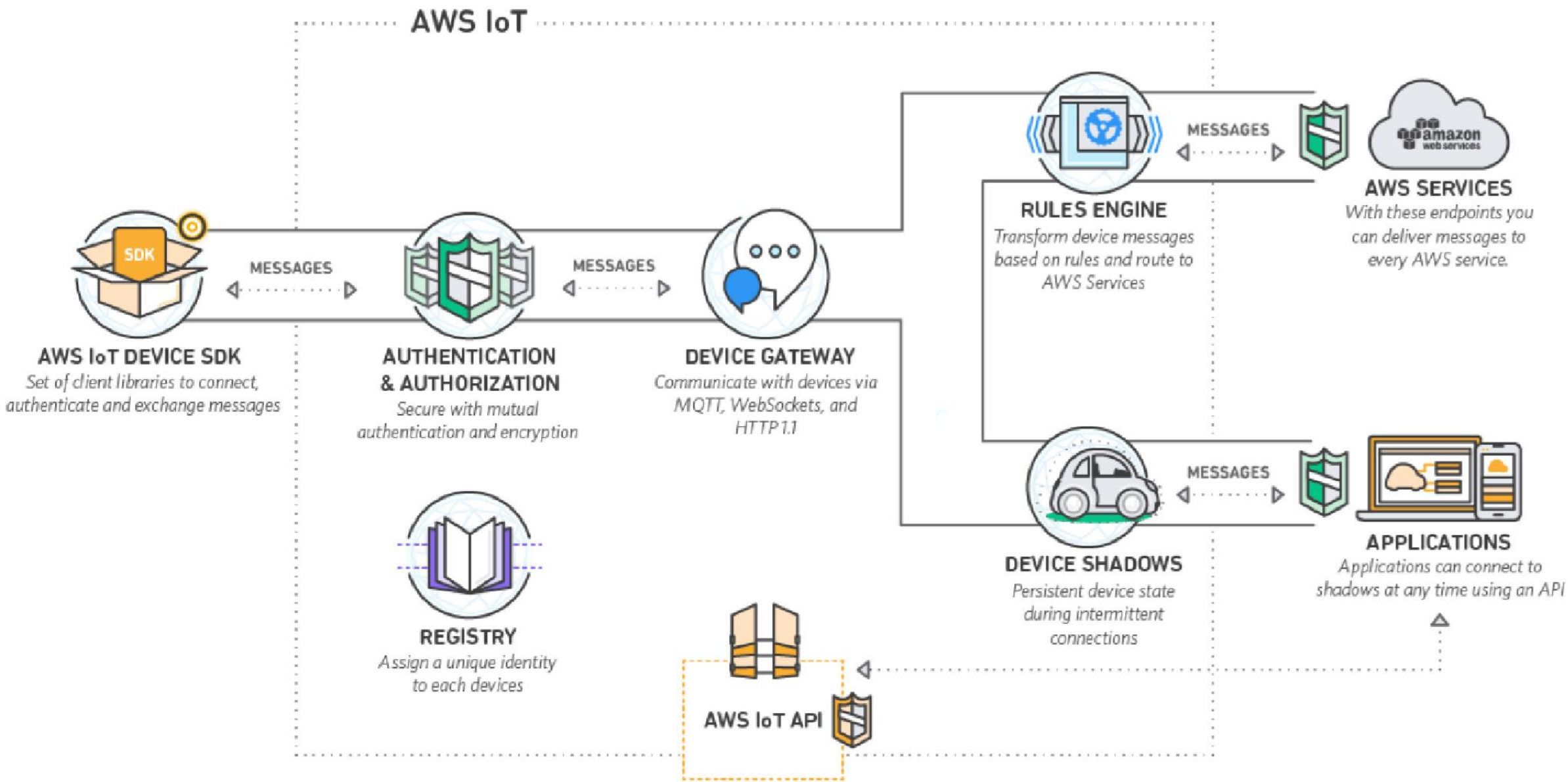
	Azure IoT	AWS	Google IoT
Edge			
Storage	Blob, CosmosDB, SQL		
Big Data			
Data Visualization	Power Bi		
Artificial Intelligence			
Intelligence API	Language, Speech, Vision, Knowledge		

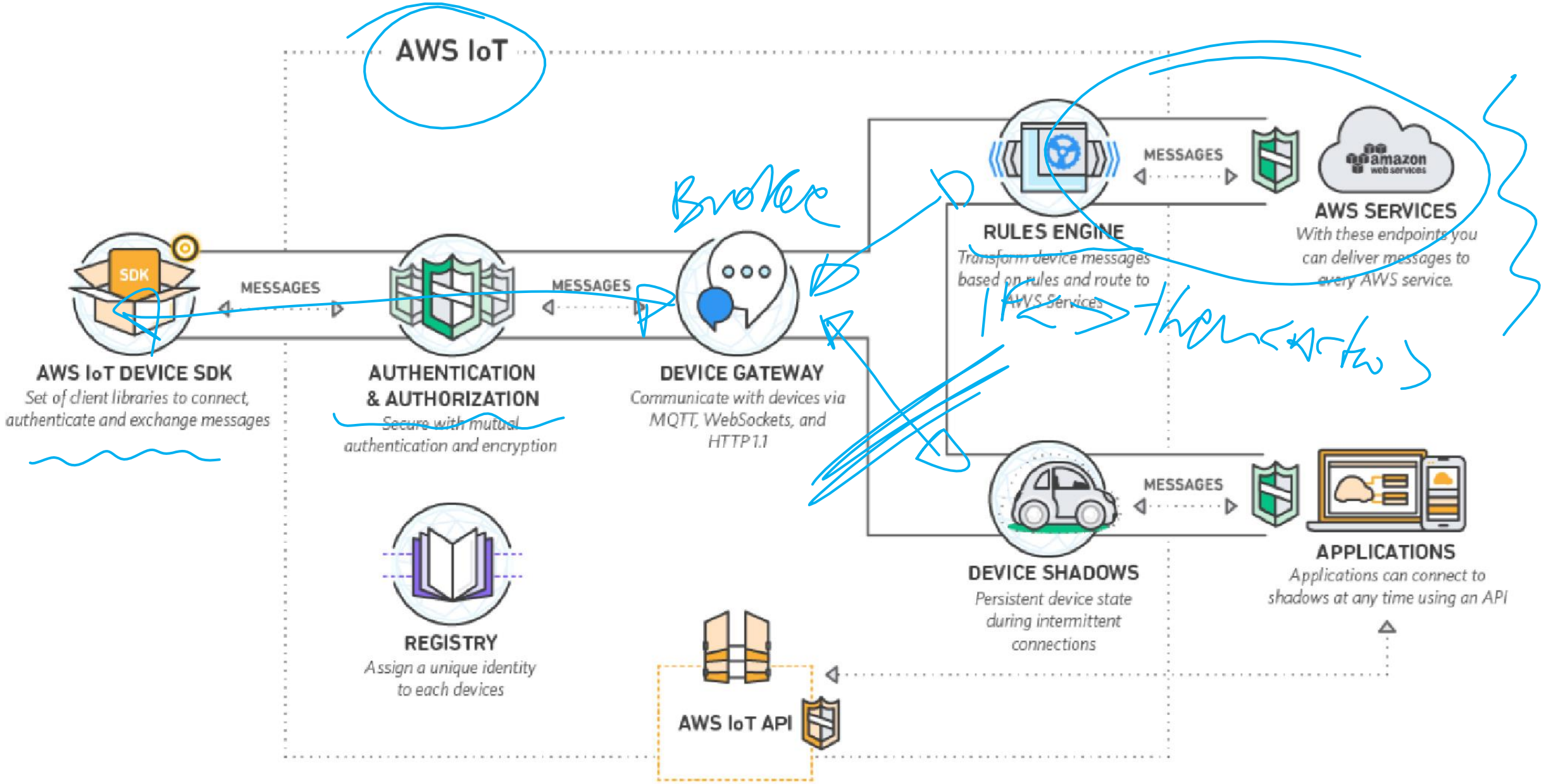
	Azure IoT	AWS	Google IoT
Protocolli	MQTT, AMQP, MQTT on WebSocket, HTTPS, AMQP on WebSocket	MQTT, MQTT on WebSocket, HTTPS	MQTT, HTTP
Communication Patterns	Telemetry, Query, Notification, Command	Telemetry, Query, Notification, Command	Telemetry, Query, Notification, Command

	Azure IoT	AWS	Google IoT
Prezzo	Diverse fasce di prezzo in base al numero di messaggi scambiati	Costo unitario per messaggio e per tempo di connessione del dispositivo	Costo basato sul volume di dati scambiati

	Azure IoT	AWS	Google IoT
Scalability	Scaling da configurare mediante funzione	Servizio di scaling automatico	Servizio di scaling automatico
Rimborsi	10% di rimborso fino al 99%, al di sotto viene rimborsato il 25%	10% di rimborso fino al 99%, al di sotto viene rimborsato il 30%	10% di rimborso fino al 99%, nella fascia fino al 95% viene restituito il 25% e al di sotto di questa il 50%

	Azure IoT	AWS	Google IoT
Sicurezza	TLS	TLS (mutual)	TLS
Autenticazione	SAS Token, IAM, x.509	x.509, IAM, Amazon Cognito, Federated Identities	JSON Token, IAM, x.509


AWS IoT
SDK
MESSAGES
MESSAGES
MESSAGES
MESSAGES
amazon web services
AWS IoT DEVICE SDK
Set of client libraries to connect, authenticate and exchange messages
AUTHENTICATION & AUTHORIZATION
Secure with mutual authentication and encryption
DEVICE GATEWAY
Communicate with devices via MQTT, WebSockets, and HTTP 1.1
RULES ENGINE
Transform device messages based on rules and route to AWS Services
AWS SERVICES
With these endpoints you can deliver messages to every AWS service.
REGISTRY
Assign a unique identity to each devices
AWS IoT API
DEVICE SHADOWS
Persistent device state during intermittent connections
APPLICATIONS
Applications can connect to shadows at any time using an API


AWS IoT
SDK
MESSAGES
MESSAGES
MESSAGES
MESSAGES
amazon web services
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Set of client libraries to connect, authenticate and exchange messages
AUTHENTICATION & AUTHORIZATION
Secure with mutual authentication and encryption
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Transform device messages based on rules and route to AWS Services
AWS SERVICES
With these endpoints you can deliver messages to every AWS service.
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Assign a unique identity to each devices
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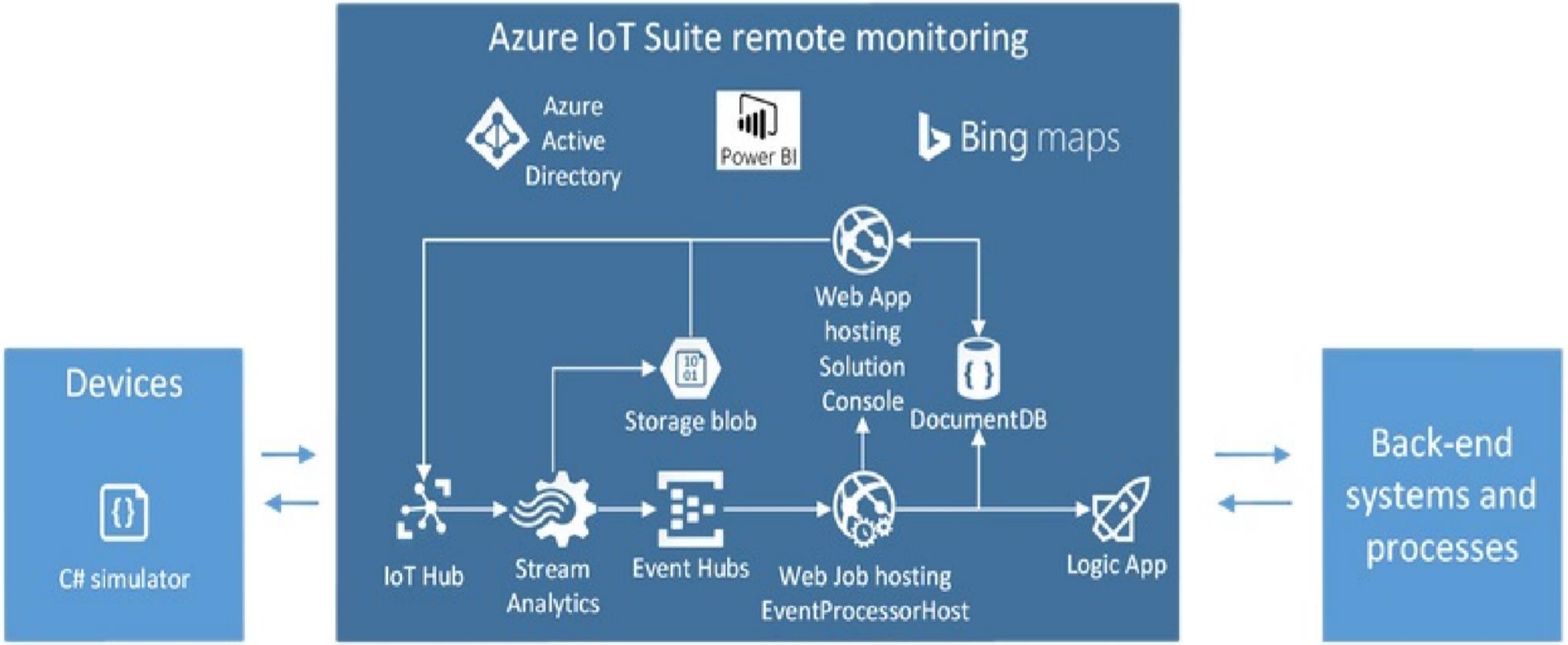
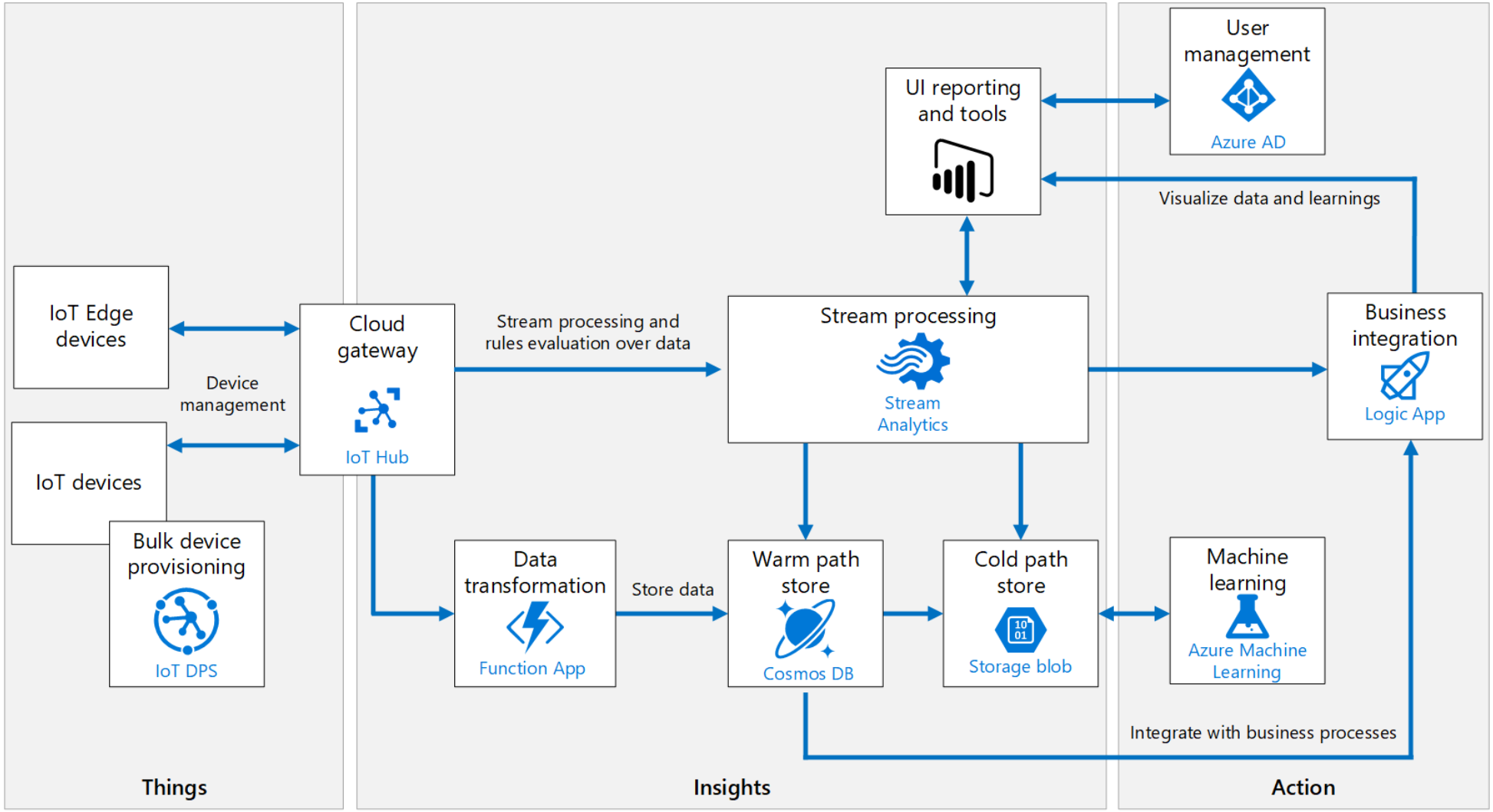
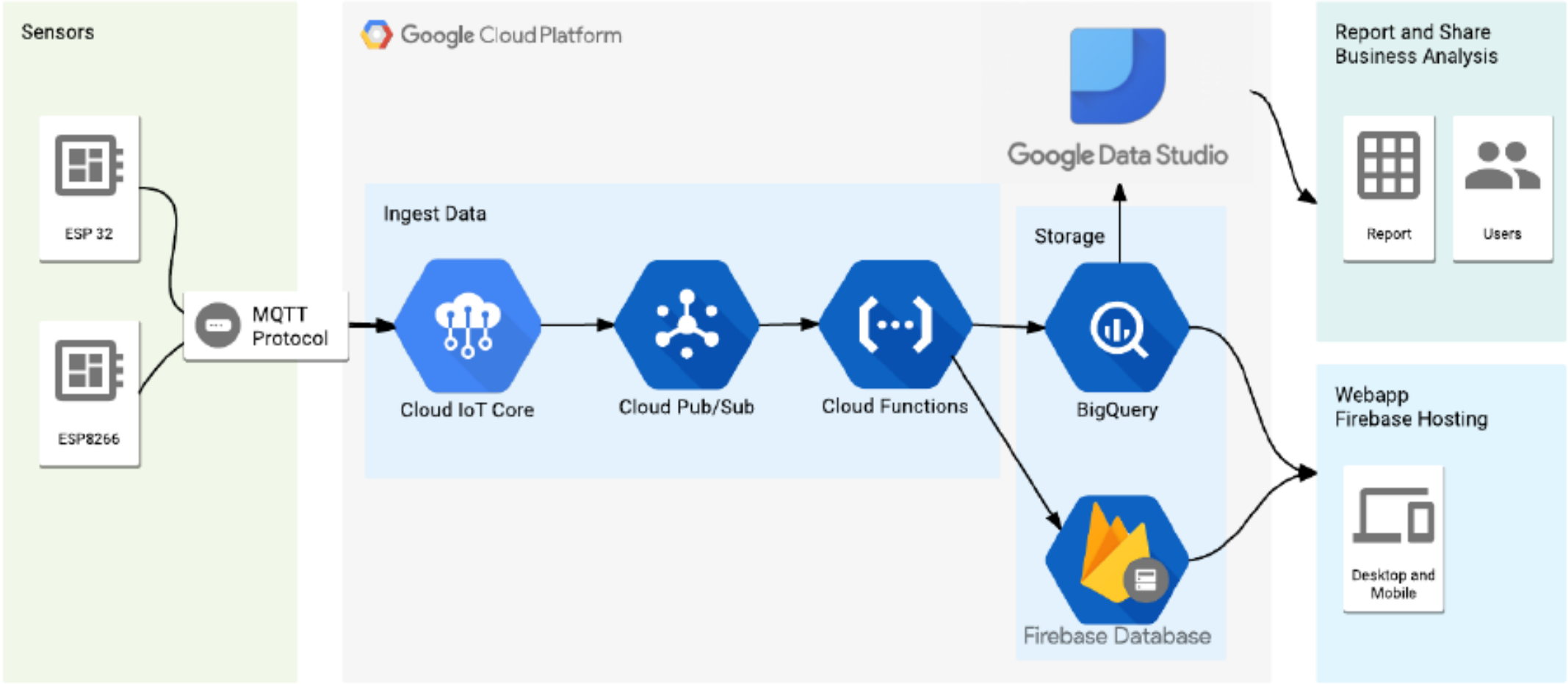
DEVICE SHADOWS
Persistent device state during intermittent connections
APPLICATIONS
Applications can connect to shadows at any time using an API

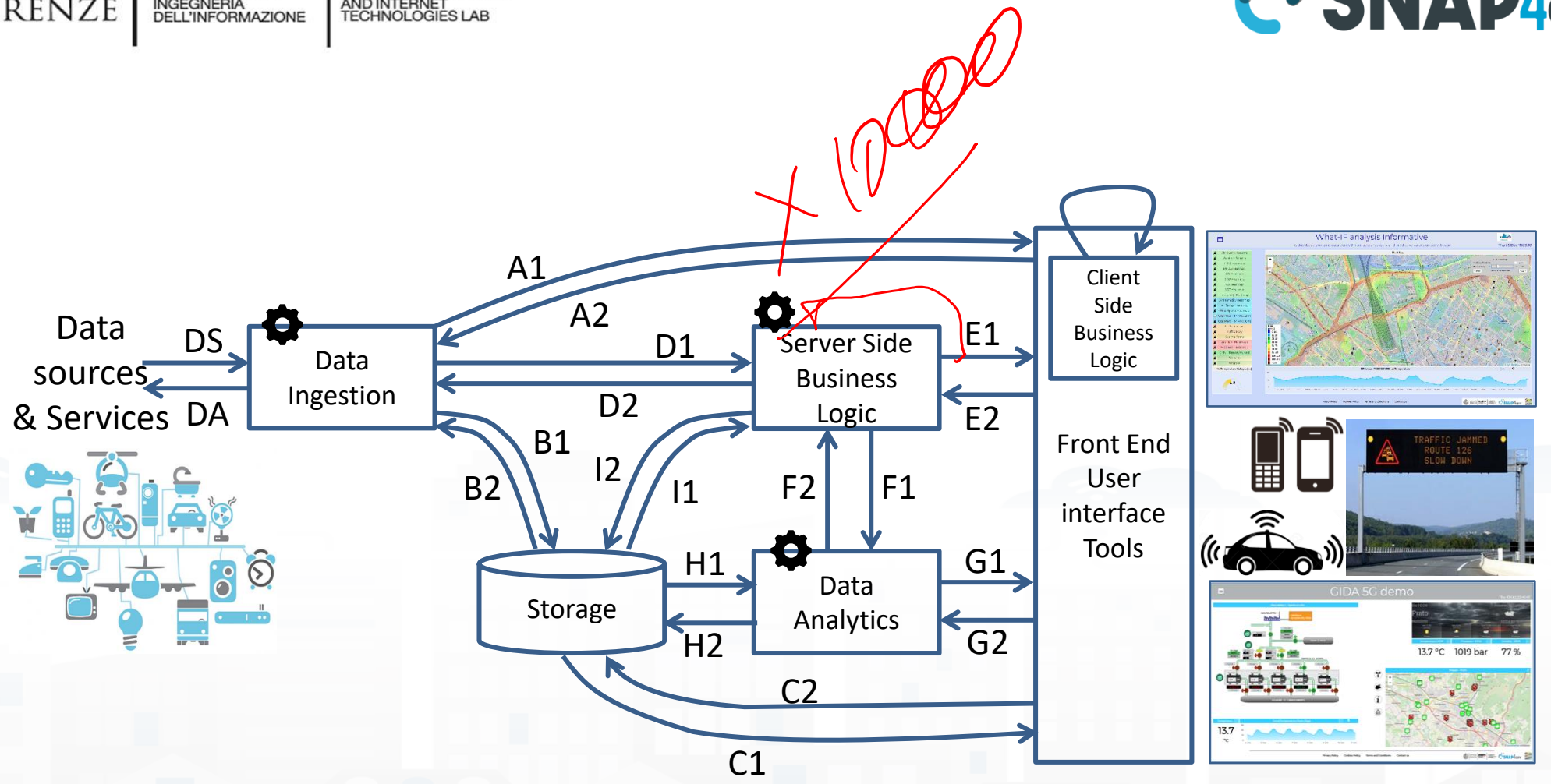

Azure IoT Suite remote monitoring
Azure Active Directory
Power BI
Bing maps
Web App hosting Solution Console
Storage blob
DocumentDB
Devices
C# simulator
IoT Hub
Stream Analytics
Event Hubs
Web Job hosting EventProcessorHost
Logic App
Back-end systems and processes

Azure Microsoft IoT (1)



Google IoT (1)


Sensors
ESP 32
ESP8266
MQTT Protocol
Google Cloud Platform
Ingest Data
Cloud IoT Core
Cloud Pub/Sub
Cloud Functions
Storage
BigQuery
Firebase Database
Google Data Studio
Report and Share Business Analysis
Report
Users
Webapp Firebase Hosting
Desktop and Mobile


Data sources & Services
DS
DA
Data Ingestion
A1
A2
D1
D2
B1
B2
I2
I1
Server Side Business Logic
E1
E2
F2
F1
Client Side Business Logic
Front End User interface Tools
Storage
H1
H2
Data Analytics
G1
G2
C2
C1
What-IF analysis Informative
TRAFFIC JAMMED
ROUTE 126
SLOW DOWN
GIDA 5G demo
13.7 °C
1019 bar
77 %

100% OPEN SOURCE

EU GDPR COMPLIANT

PEN Test Passed

Powered by FIWARE

SNAP4CITY on EUROPEAN OPEN SCIENCE CLOUD MARKETPLACE

Node-RED

SNAP4CITY

KM4CITY

SNAP4 Appliances and Dockers Installations

Be smart in a SNAP!

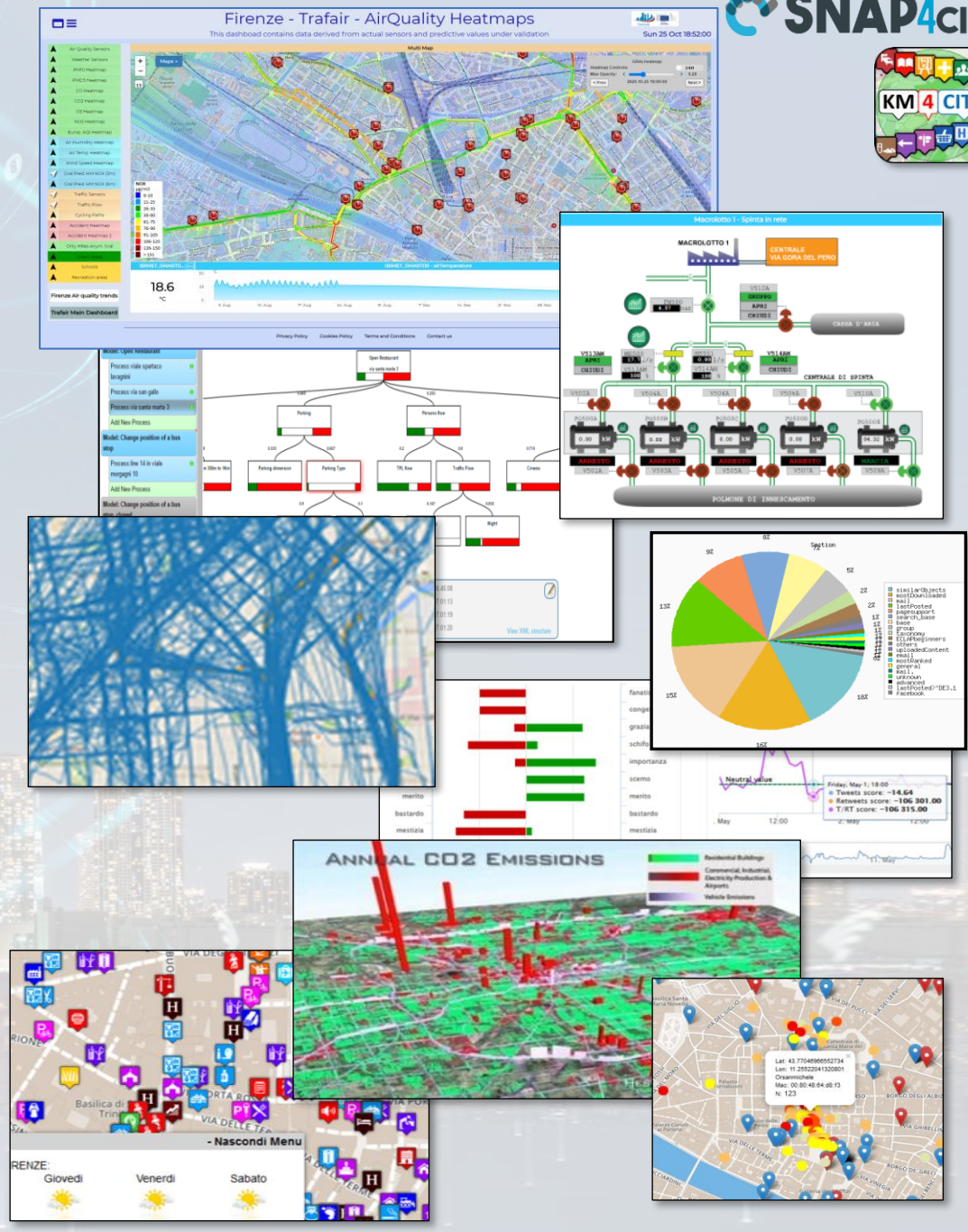
A Framework for rapid implementation of
- Sustainable Smart Solutions
- Decision Support Systems
as a no-coding, low-coding

SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES

UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO | DISIT

Data Driven Decision Support

- Decision Support system
- Assessment / Strategies
- Data Rendering, visual analytics
- Data Processing
- Data aggregation, Storage, indexing
- Data Ingestion



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

Smart Solutions and Decision Support Systems

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

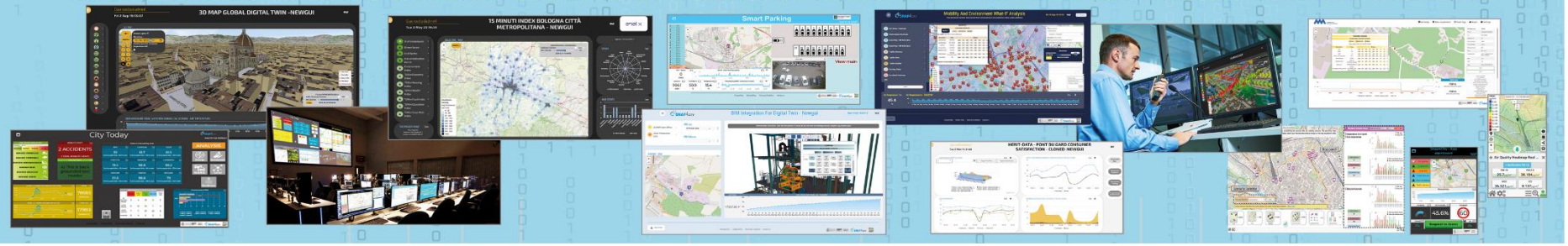
JS Foundation

EØ15 digital ecosystem

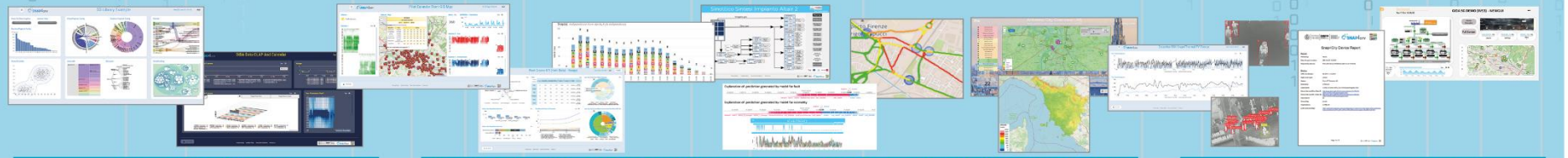
NVIDIA

UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE | DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB | SNAP4CITY | KM4CITY

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



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

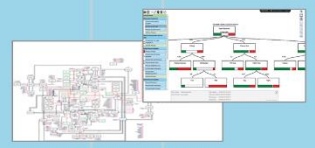


DASHBOARDS, WIDGETS
TEMPLATES

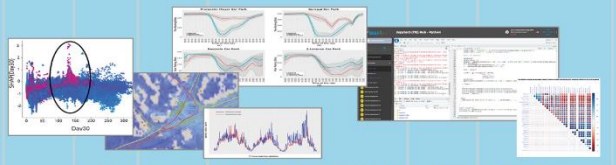
PREDICTION - ANOMALY DETECTION - CLUSTERING - ROUTING - SENTIMENT NLP - TRAFFIC FLOW
PEOPLE FLOWS - SDG - 15 MIN CITY INDEX - KPI - HEATMAPS - ORIGIN DESTINATION - ETC...

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

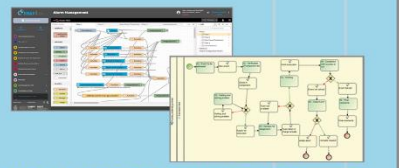
ANY: DATA, BROKER, NETWORK AND VERTICAL



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



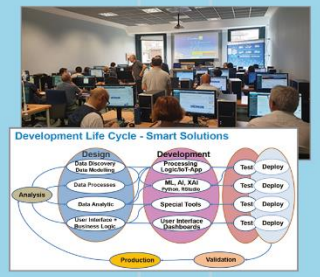
BIG DATA ANALYTICS, ARTIFICIAL INTELLIGENCE
EXPLAINABLE AI, MACHINE LEARNING
OPERATIVE RESEARCH, STATISTICS



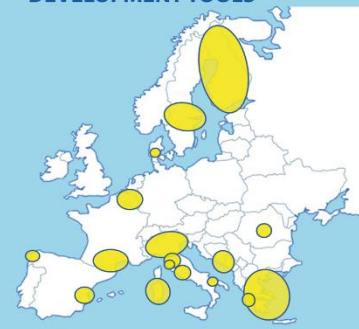
VISUAL PROGRAMMING, ADAPTERS
DATA FLOWS, WORKFLOWS
PARALLEL DISTRIBUTED PROCESSING
EVENT DRIVEN

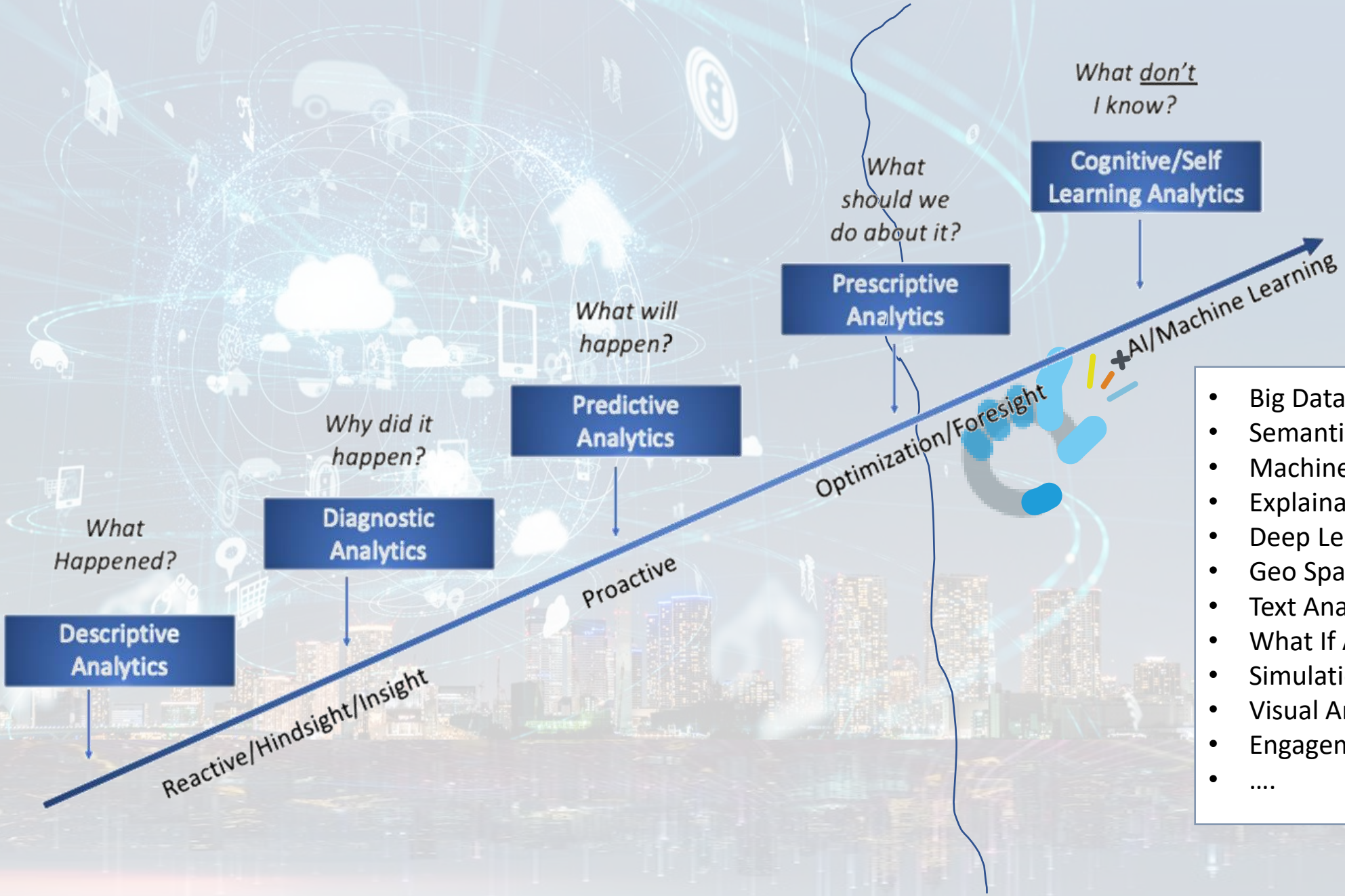
Native and External Smart Applications

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



METHODOLOGIES
LIVING LABS
COURSES AND COMMUNITY
DEVELOPMENT TOOLS



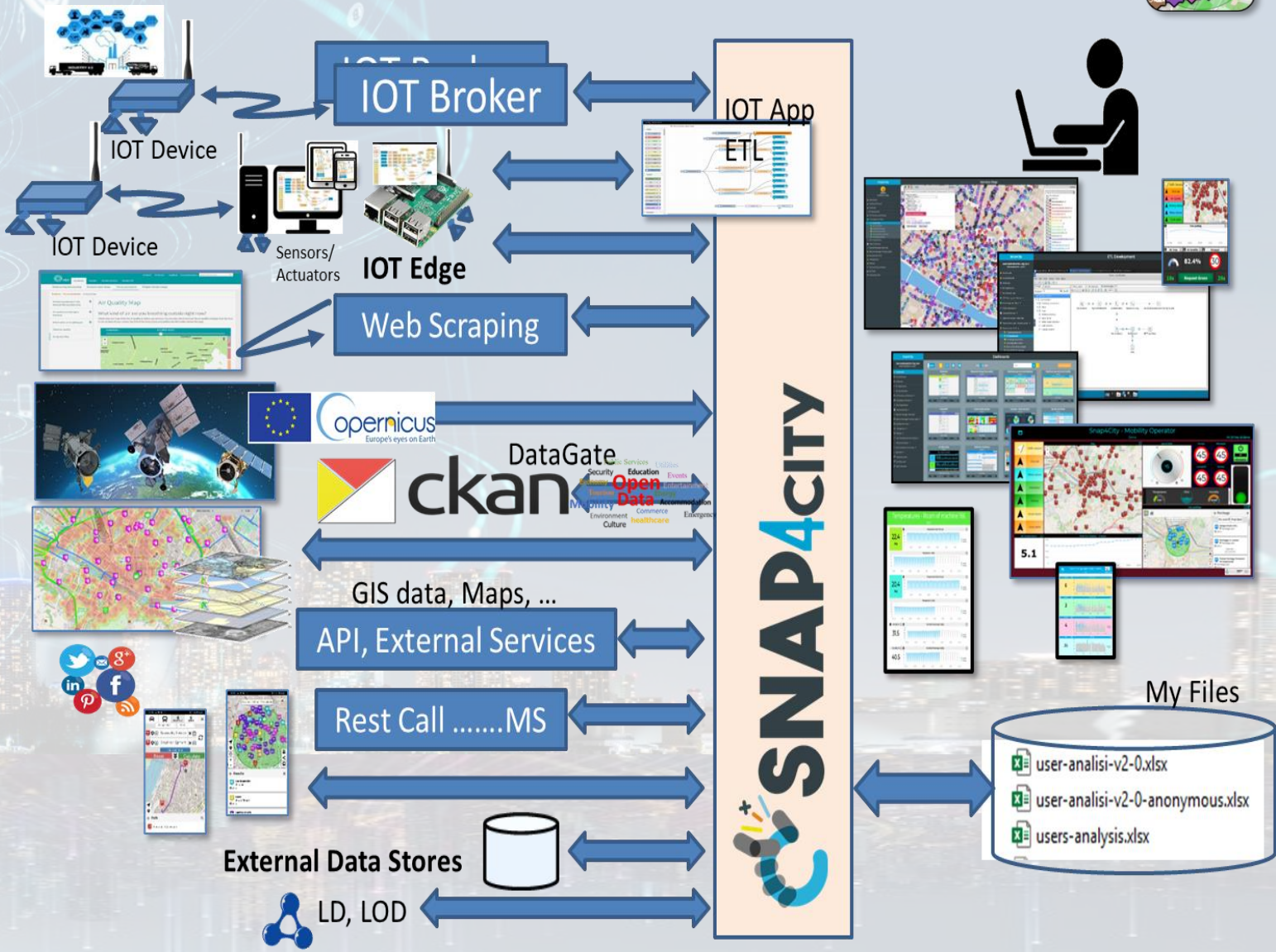


Sentient and active processes

- 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
- ….

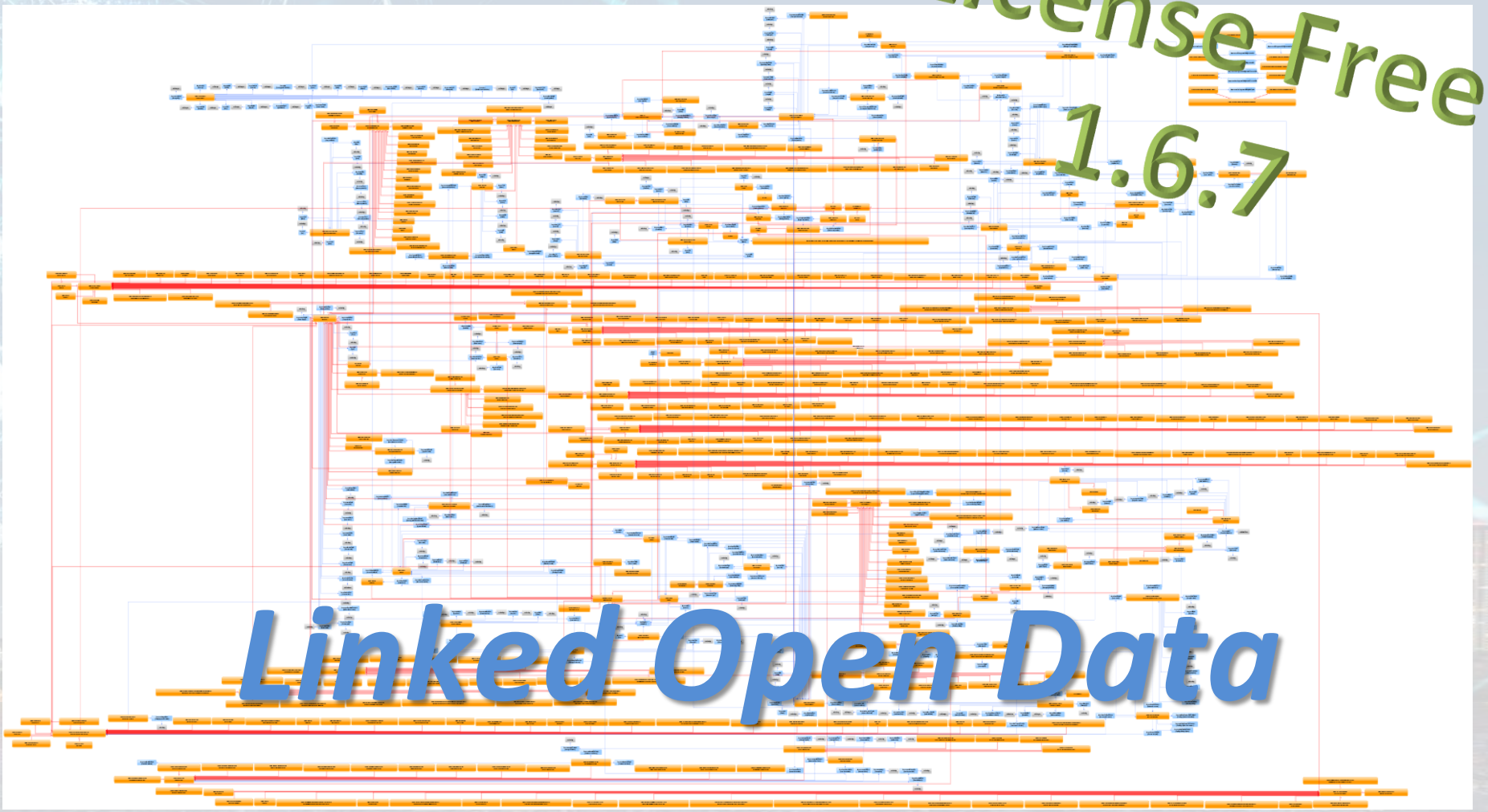
Ingestion, agg. → exploitation

- **Snap4City efficient tools for**
  - Bidirectional data channels
  - Any format, any channel, any data, any broker, any protocol, …
  - **Km4City** Knowledge base Ontology reasoning on geo, space, time, relationships



Expert System semantic queries

- **via**:
- **Smart City API** for Apps and third party
- **MicroServices** data driven develop via visual language Node-RED

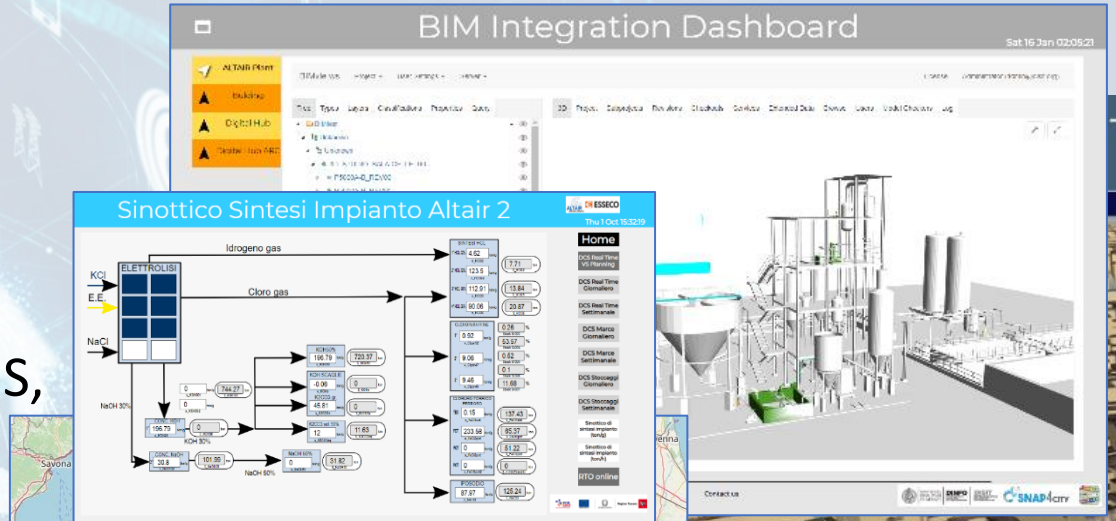


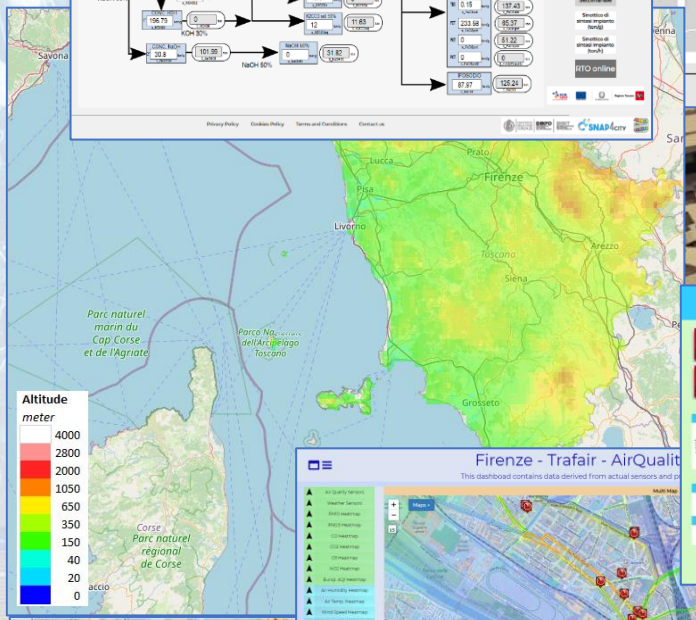
https://www.snap4city.org/19

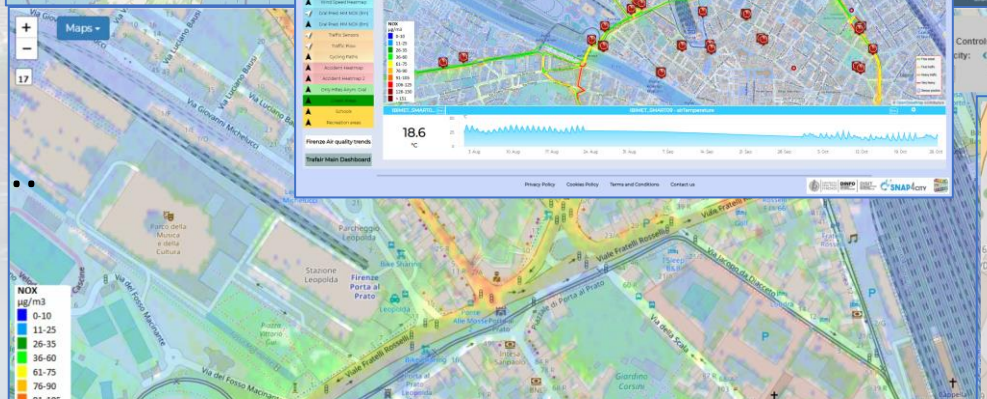
High Level Types

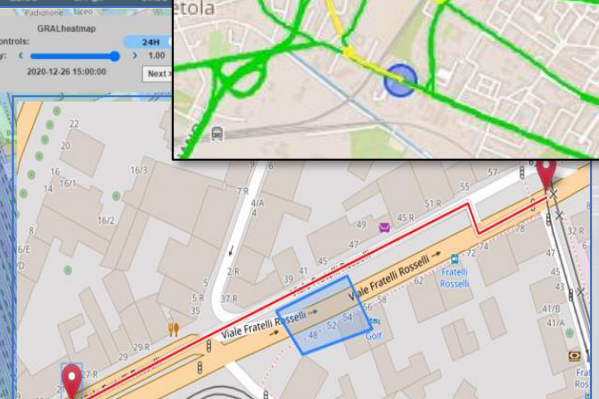
Snap4City (C), October 2023

- 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.



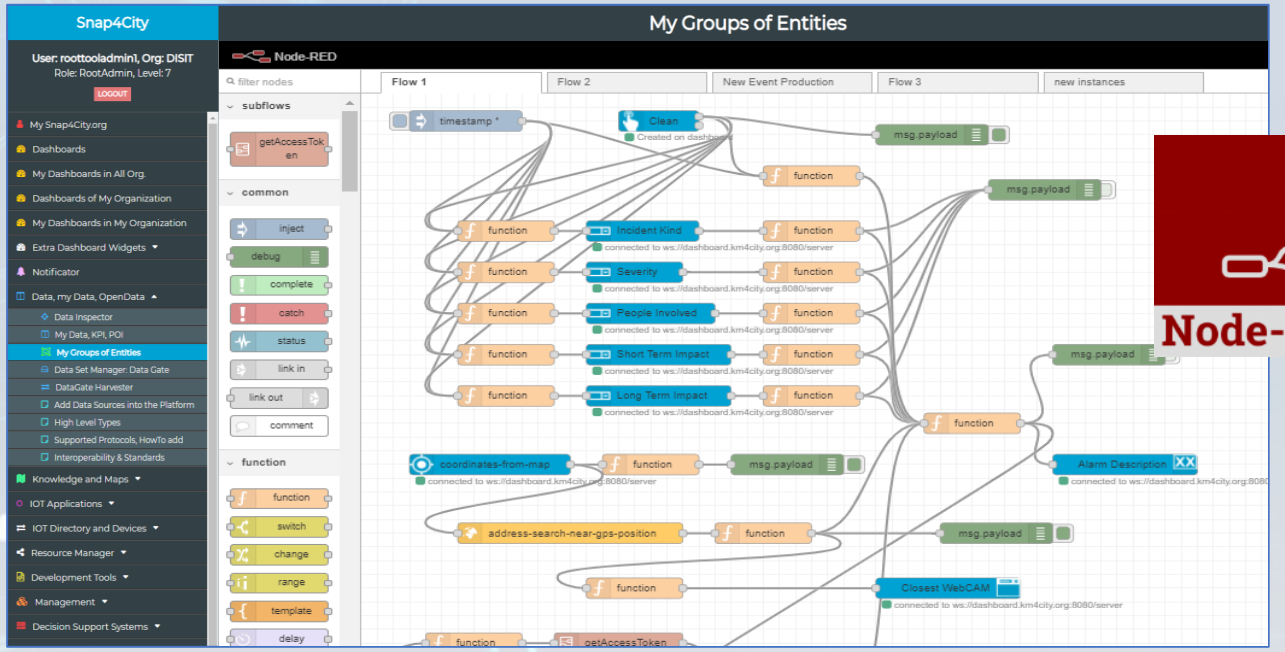


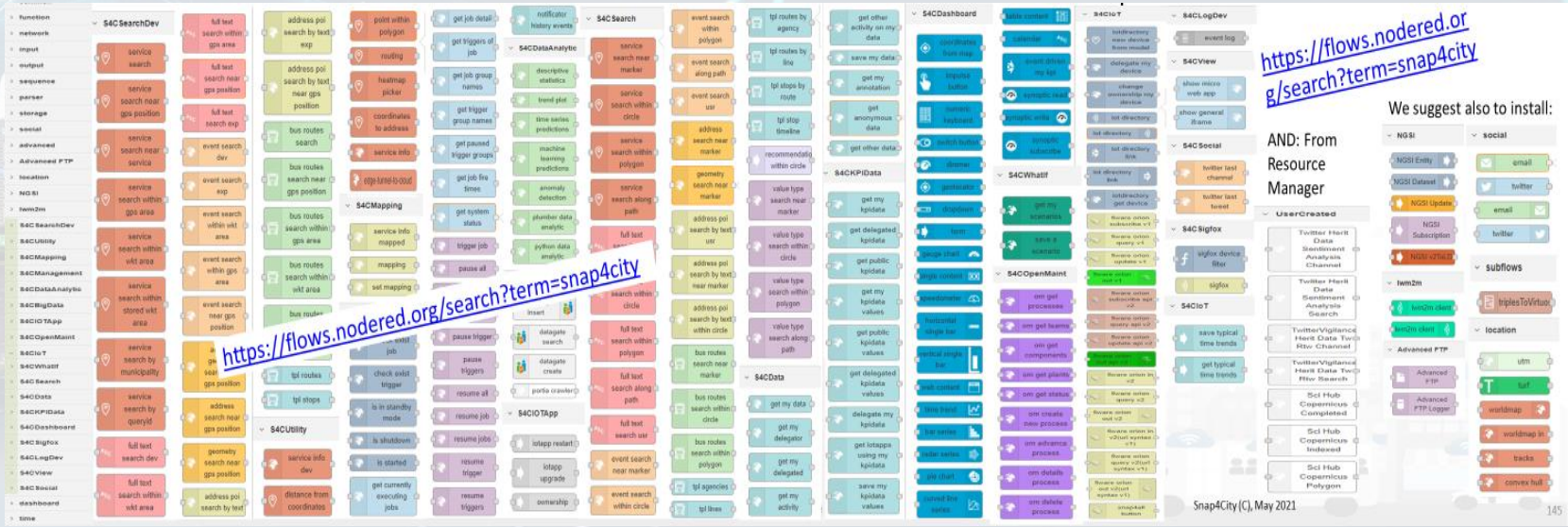




Ingestion, aggreg. → exploitation

- **IoT App Visual Programming, no coding**
  - **Data transformation**
  - **Integration**
  - **Scripting Data Analytics**
  - **Data ingestion**
  - **Business logic**
- **MicroServices** data driven develop via visual language Node-RED

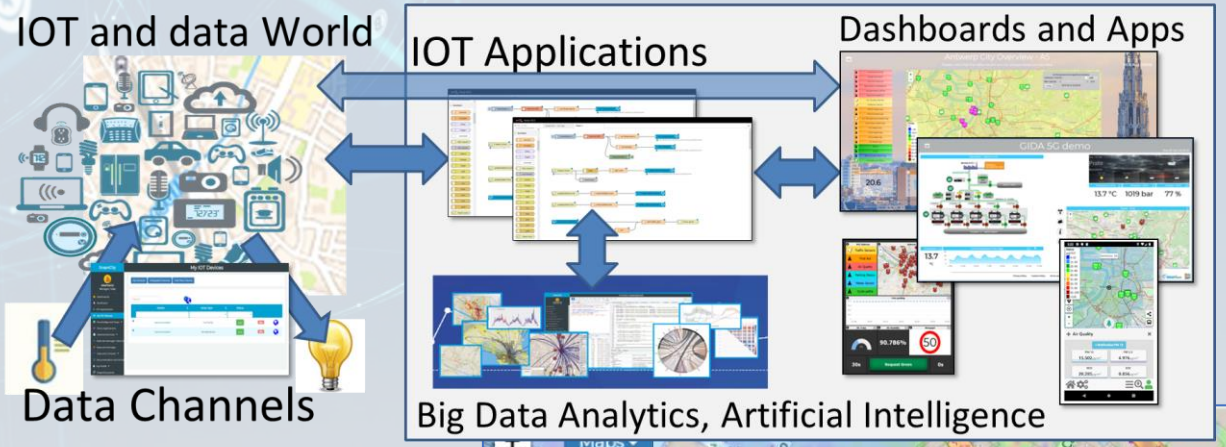


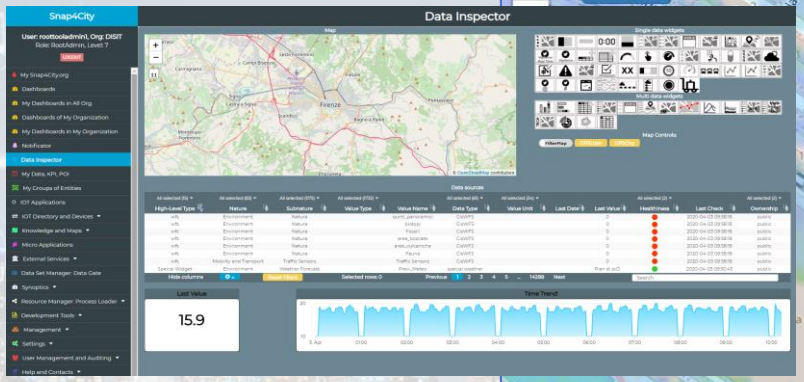


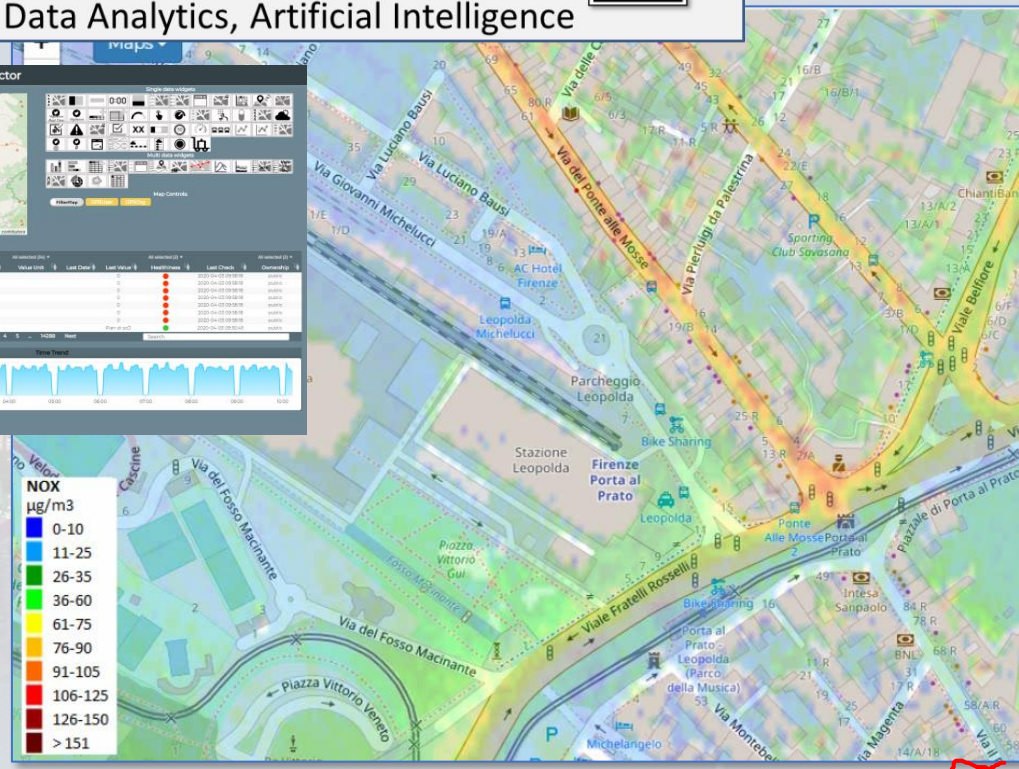
Solutions: reliable, secure and fast to realize

- **Via Snap4City tools**
  - **Dashboard Wizard**
  - **Dashboard Builder**
  - **Data/Visual Analytic**

- **Smart Solutions results to be**
  - **Real time data drive**
  - **Secure end-to-end**
  - **GDPR compliant**
  - **Reliable, interoperable**
  - **Auditable, marketable**







Data Analytics on Snap4City platform

Swagger

Ontology Schema

LOG.disit.org

Knowledge Base, Km4City

Big Data Store Facility

Smart City API from Knowledge Base and other tools

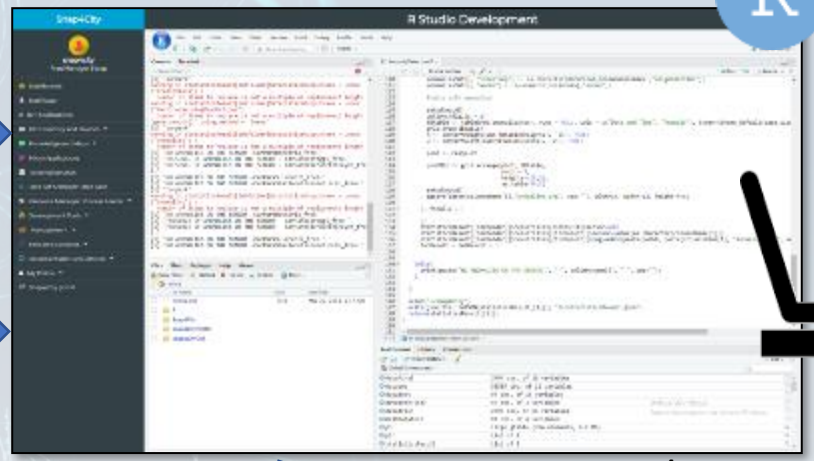
TensorFlow

NVIDIA CUDA

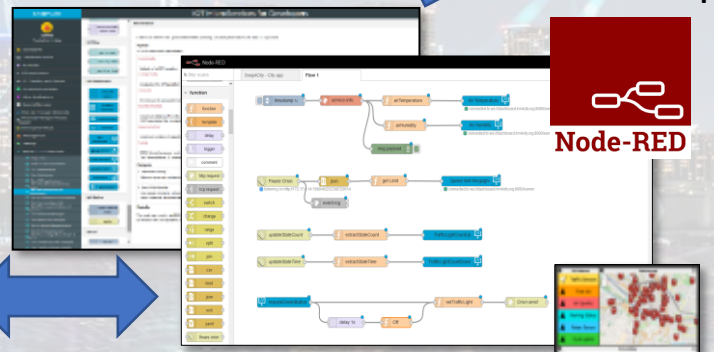
python

jupyter

R Studio



Creating MicroServices

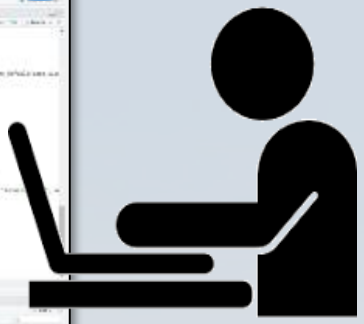


Node-RED

Using them into IOT Applications

Saving / Sharing reusing

Resource Manager



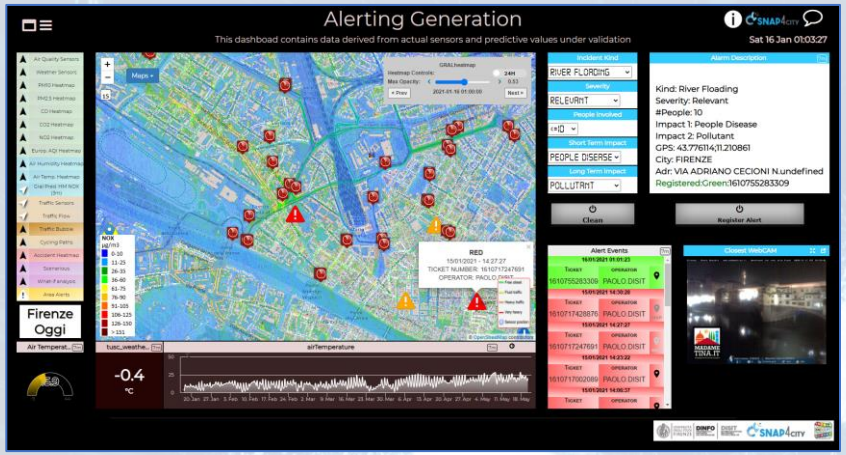
Big Data Analytics + Artificial Intelligence

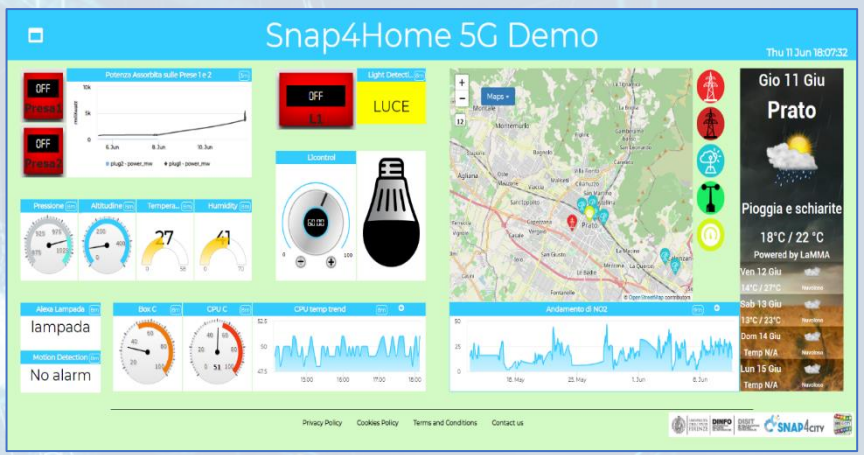
- **Short and Long terms predictive models on:**
  - traffic, parking, people flow, maintenance, land sliding, NO2
- **3D Flow prediction:** Pollutant (NOX, NO2, …)
- **Early warning, City Indexes, etc.**
- **AI & XAI:**
  - RF, XGBoost, BRNN, RNN, SVR, DNN, LSTM, CNN-LSTM, Autoencoders, …
  - Clustering: K-means, K-Medoid, …
  - XAI: Shap, variations, ..
- **Modeling, simulation, routing**
  - **Traffic Flow reconstruction**
  - **Constrained Routing**
- **What-IF analysis** (simulation + AI + data)
- **Based on several computational models**:
  - trajectories, OD matrices, Typical Time Trends, etc.

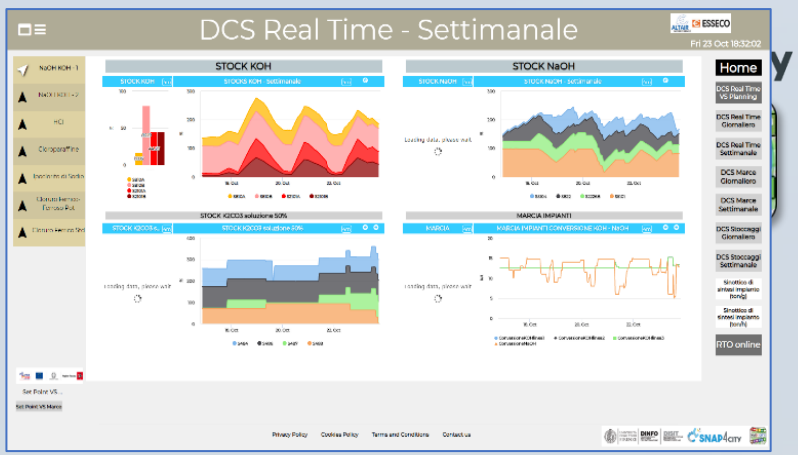
to cope with

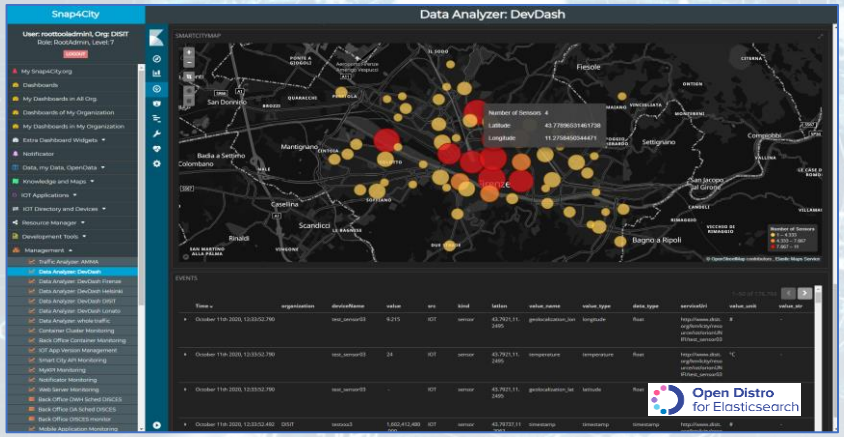
- *any data, format*
- *any channel, protocol*
- *any AI/ML*
- *any place*
- *online development*
- *multi-tenant*
- *Secure, PENTest*
- *GDPR, privacy*
- ***→ low costs***
- ***→ easy to evolve***

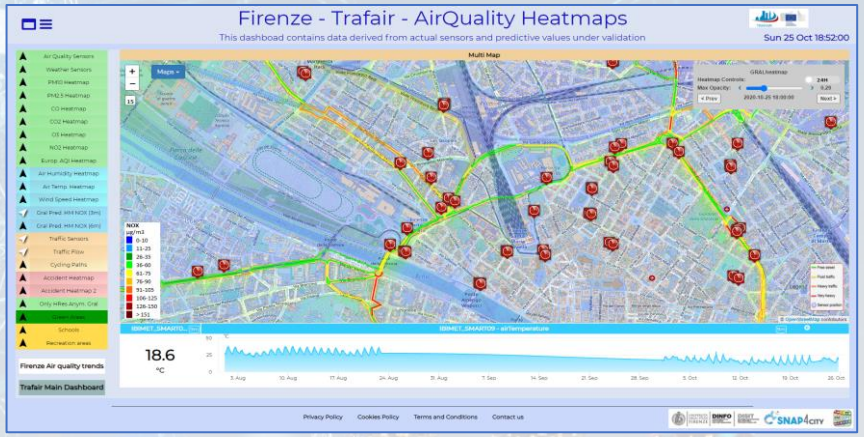
https://www.snap4city.org/download/video/course2020/da/Snap4City-4th-slot-Data-Analytic-v4-6.pdf

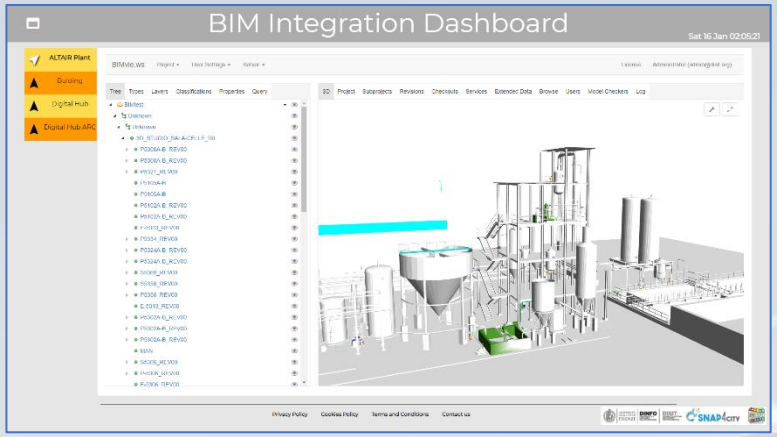

Alerting Generation
This dashboad contains data derived from actual sensors and predictive values under validation
Sat 16 Jan 01:03:27
Firenze Oggi
-0.4


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

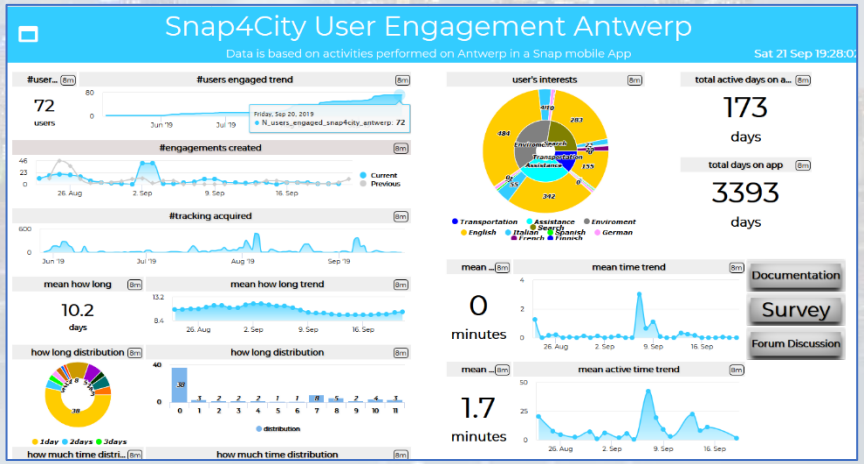

DCS Real Time - Settimanale
Fri 23 Oct 18:32:02
STOCK KOH
STOCK NaOH
Home

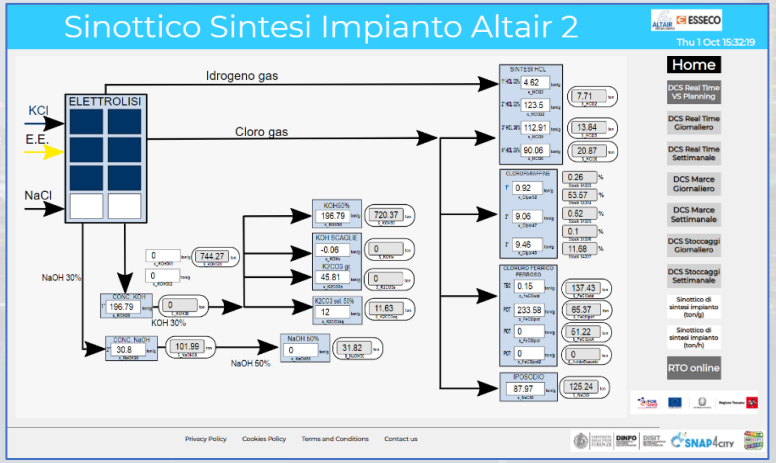

Data Analyzer: DevDash
Open Distro for Elasticsearch


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

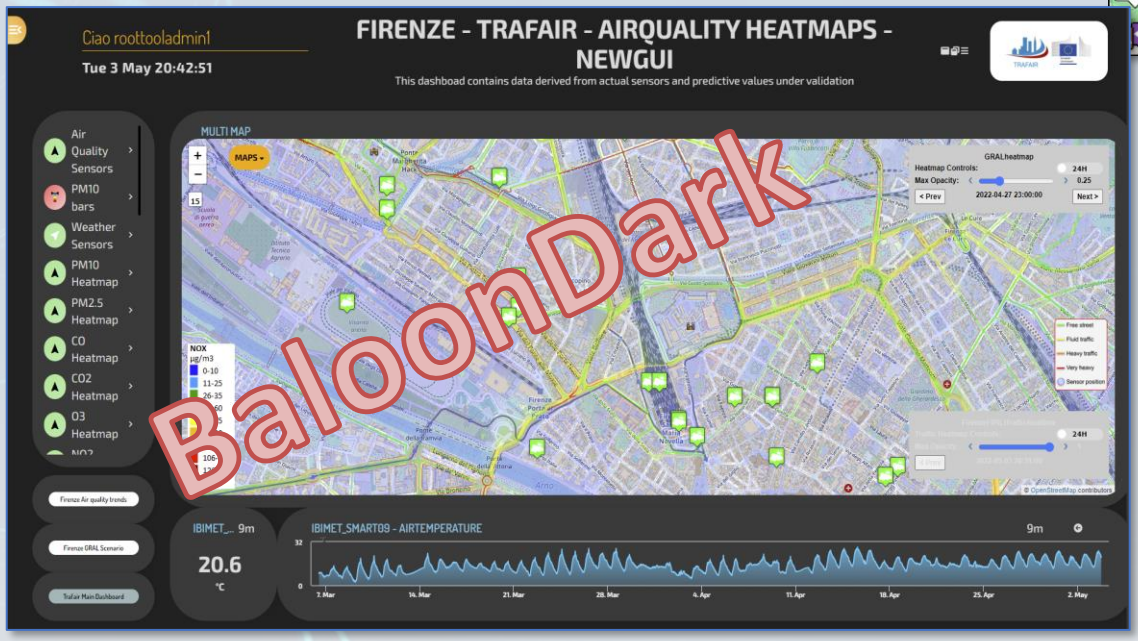

BIM Integration Dashboard
Sat 16 Jan 02:05:21

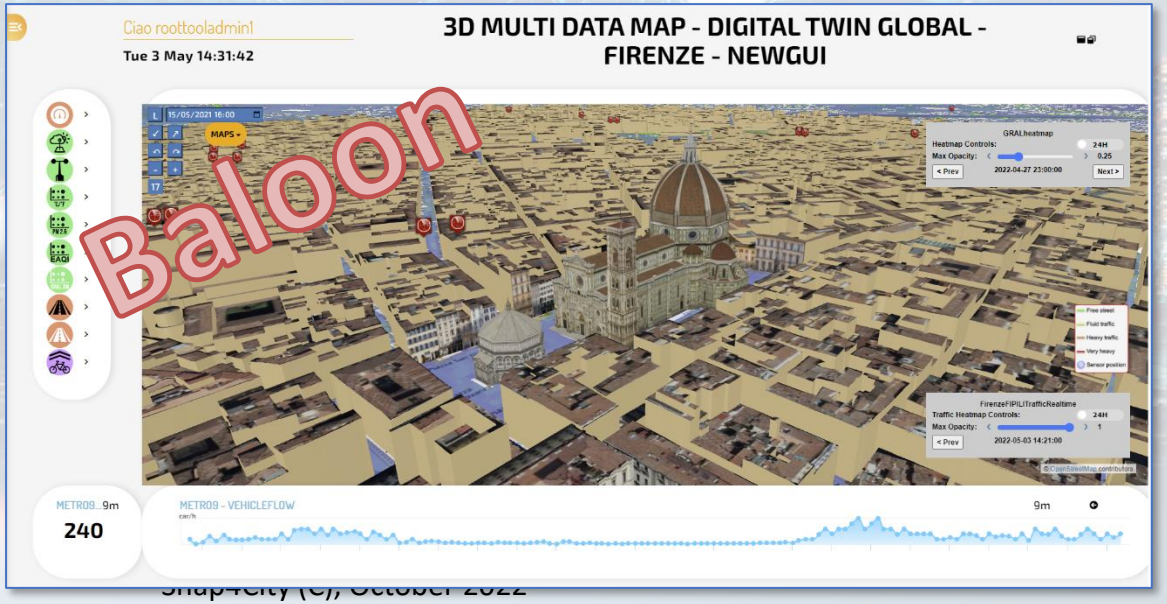

3D Multi Data Map - Digital Twin Global - Firenze
demonstrator
Sun 3 Apr 16:03:52
192

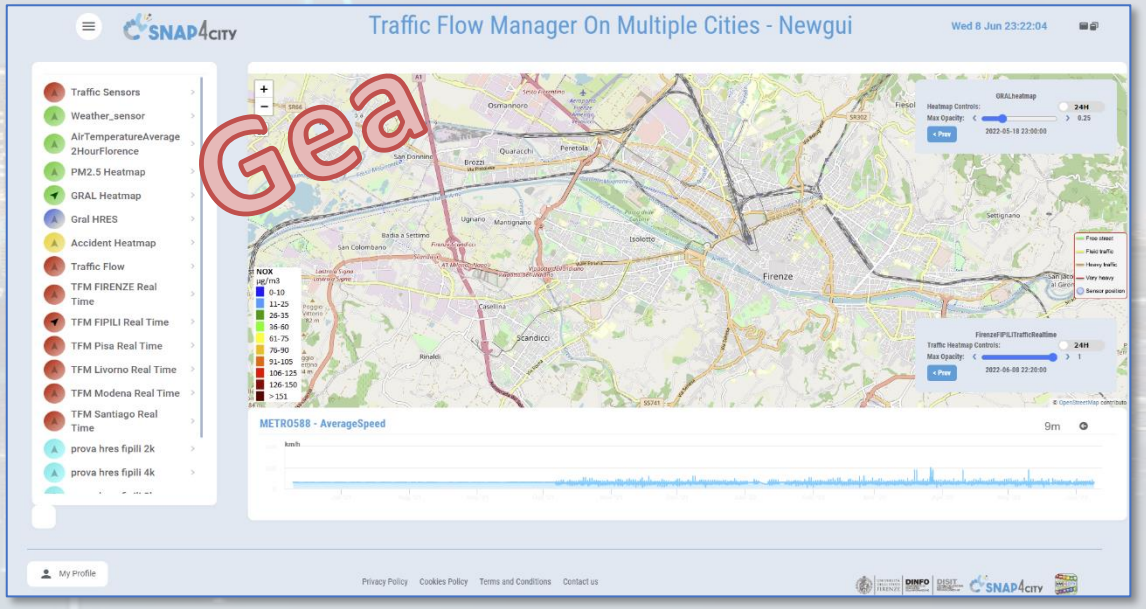

Snap4City User Engagement Antwerp
Data is based on activities performed on Antwerp in a Snap mobile App
Sat 21 Sep 19:28:0
72
users
173
days
3393
days
10.2
days
0
minutes
1.7
minutes
Documentation
Survey
Forum Discussion


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

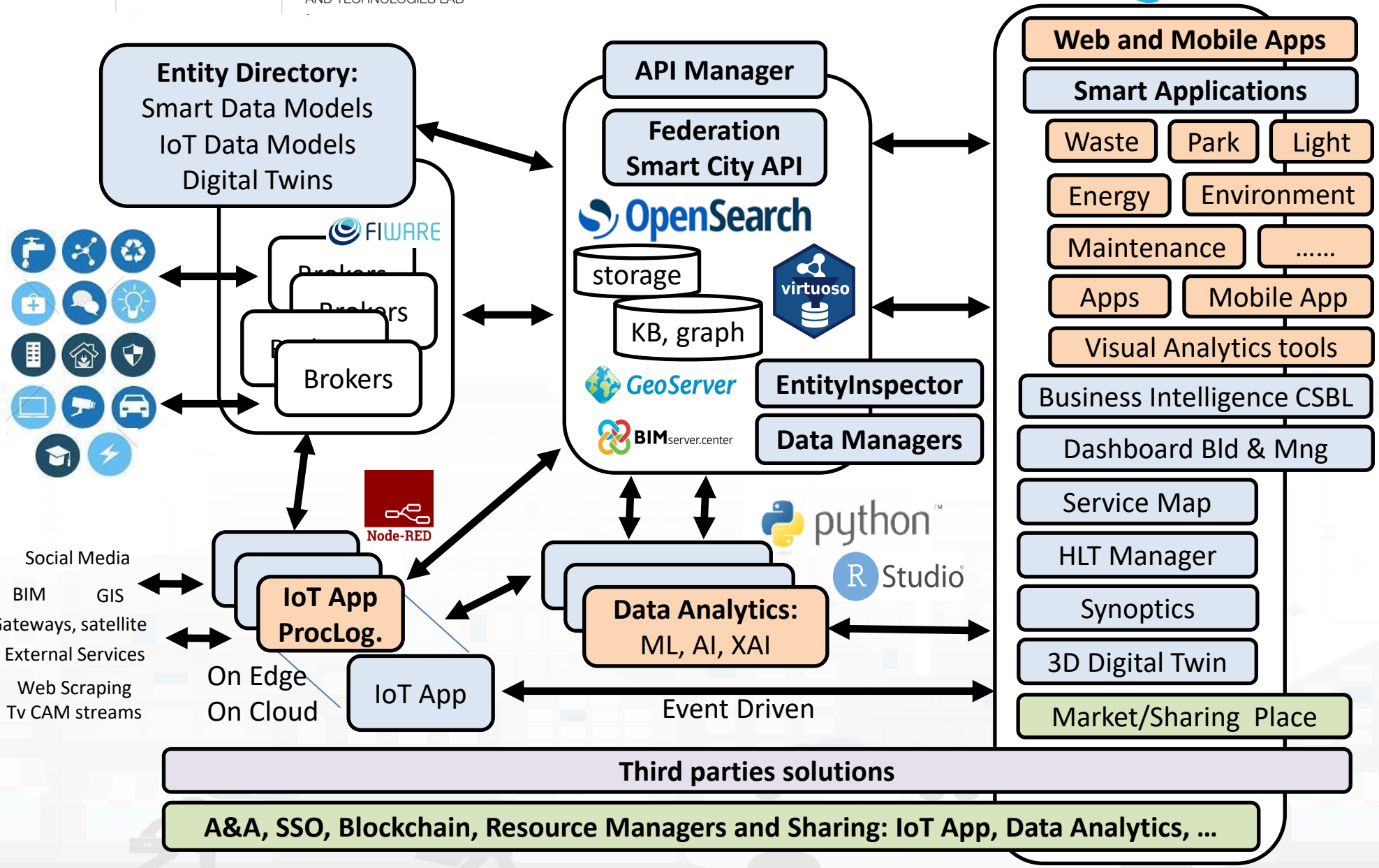
Different Themes







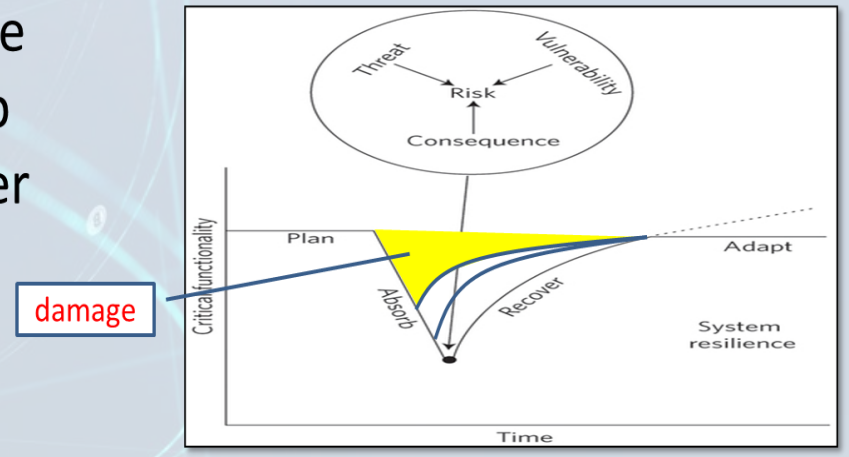
Tech Arch


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

Snap4City Analytics

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

Prepare
Absorb
Recover
Adapt



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,…

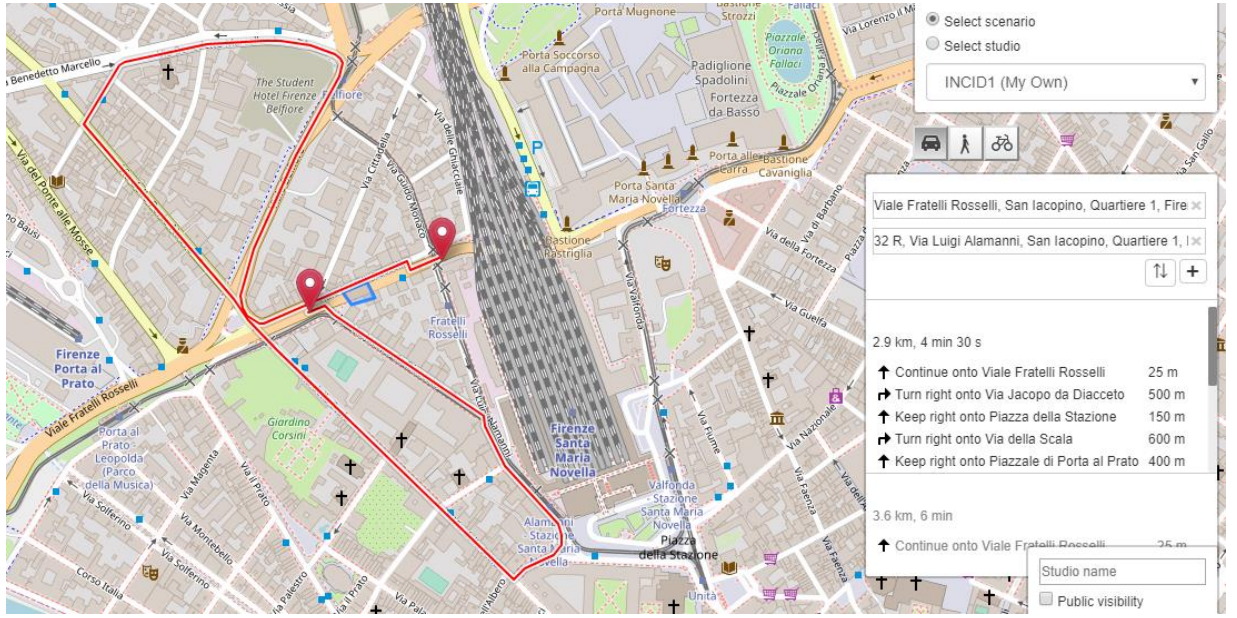
What-If Analysis

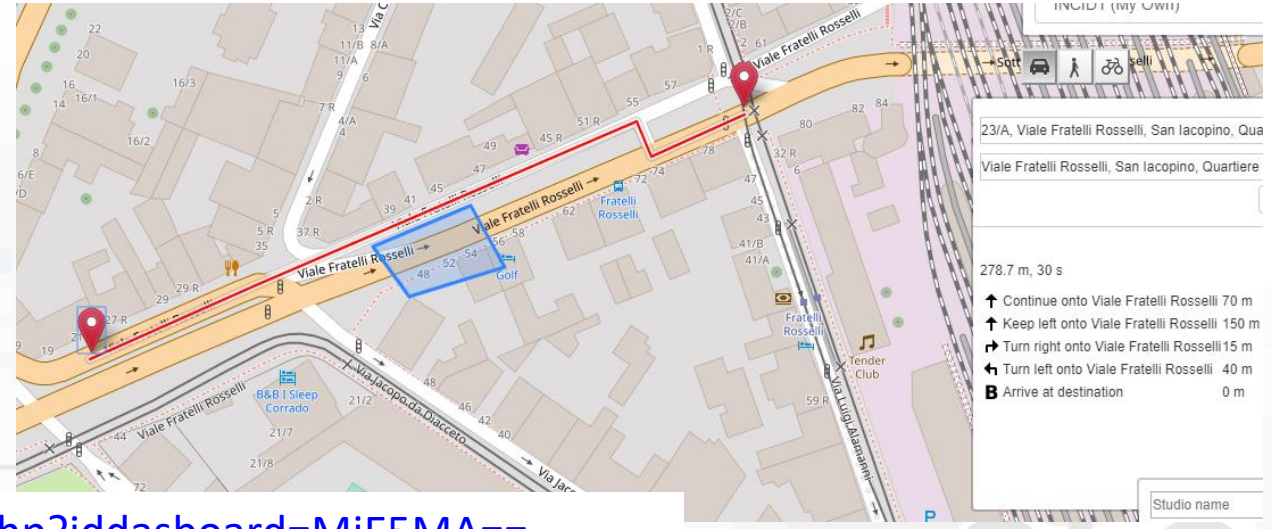
Accidents and elements blocking Points and Shapes taken into account for:

- Routing
- Traffic Flow reconstruction
- Evacuation paths
- Rescue team paths

Assessment on the basis of changes:

- Mobility demand assessment
- Mobility Offer assessment

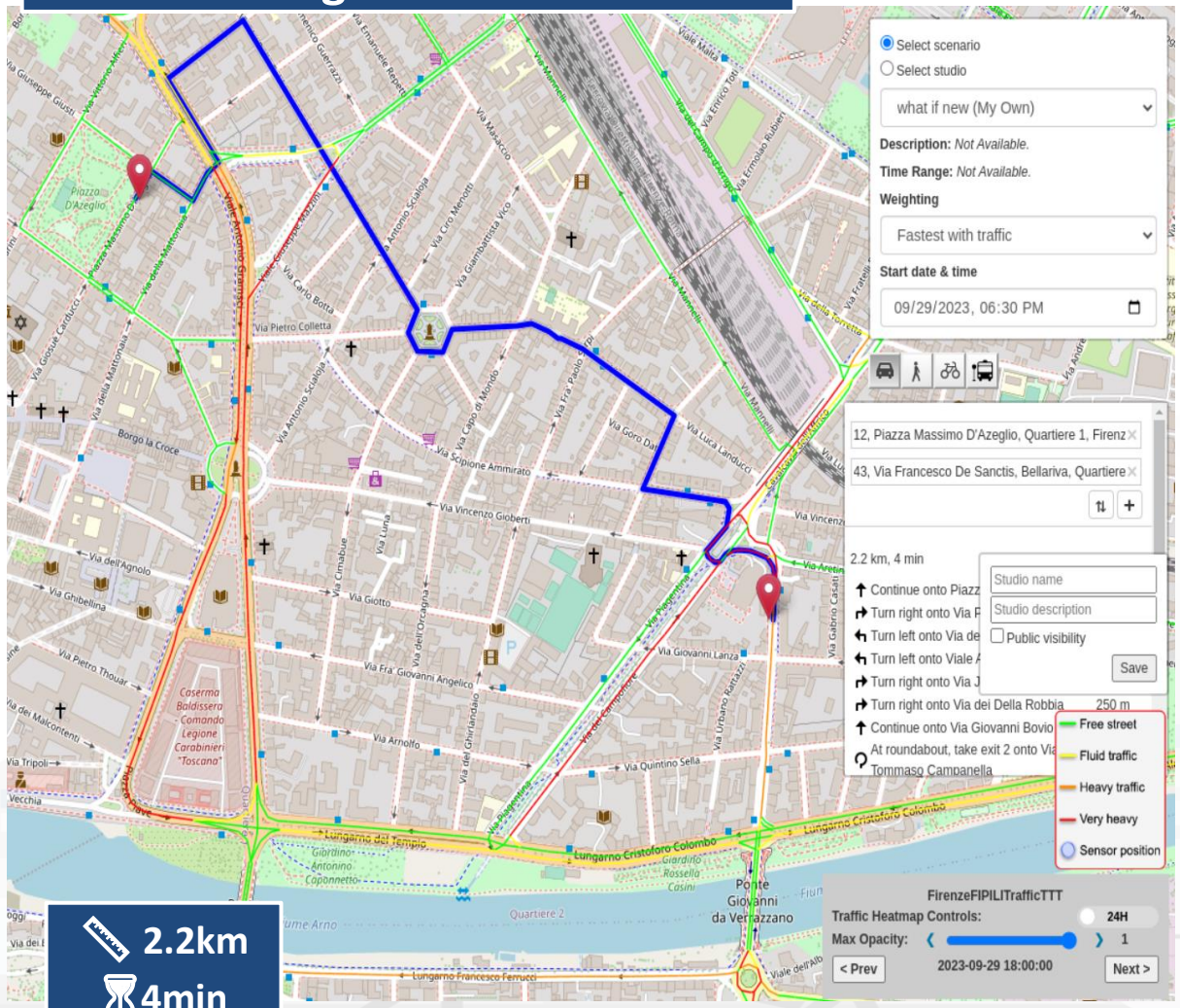




https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjE5MA==

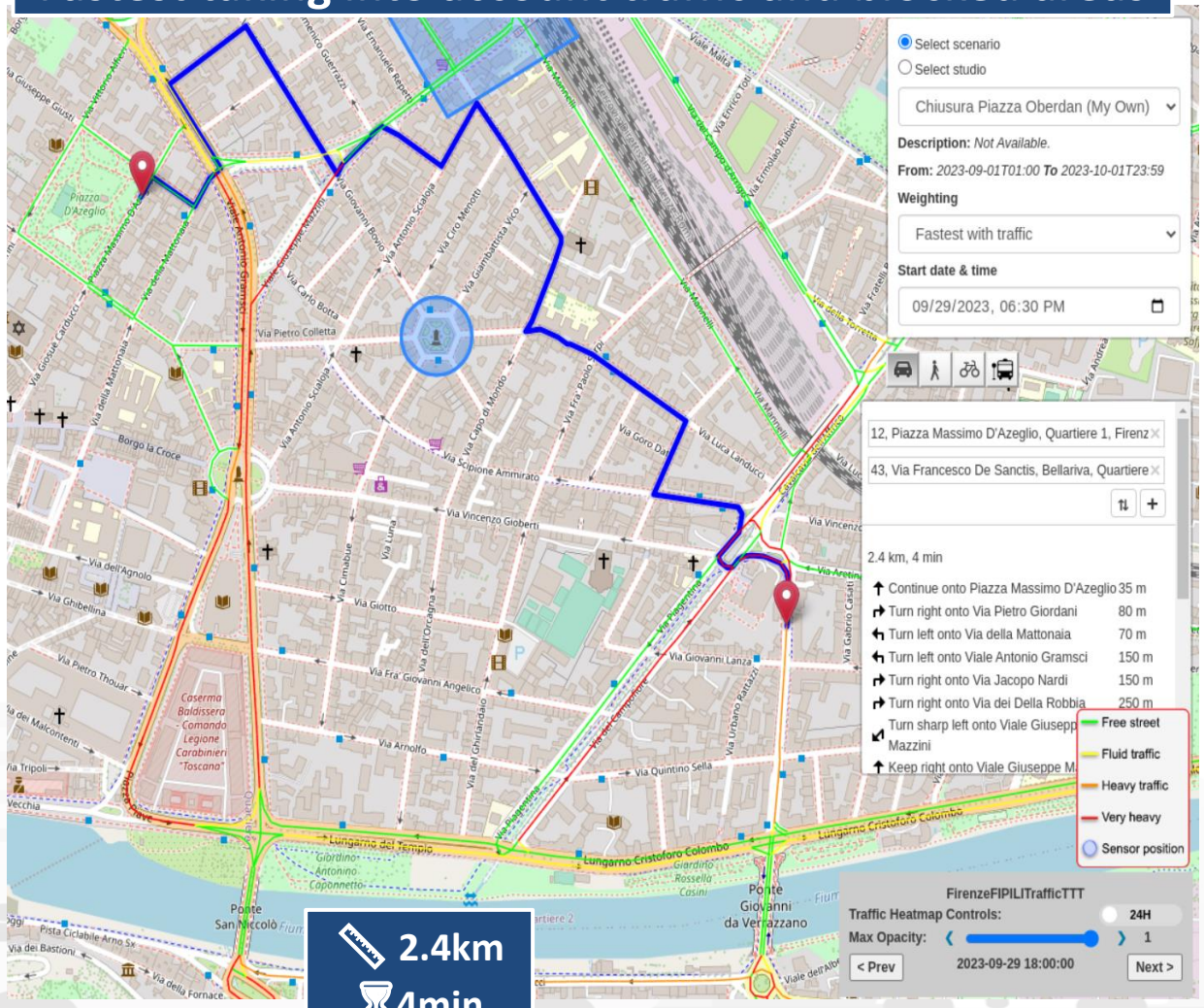
Constrained Dynamic Routing: Traffic Flow

Fastest taking into account traffic



2.2km
4min

Fastest taking into account traffic and blocked areas



2.4km
4min

Florence

Smart City Control Room
Florence Metropolitan City

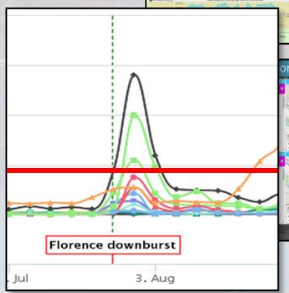
COMUNE DI FIRENZE

reference

SNAP4CITY

KM 4 CITY

- **Multiple Domain Data**
  - Thousands of Open/Private data, POI, IOT, etc.
  - ***mobility and transport***: accidents, public transport, parking, traffic flow, Traffic Reconstruction, KPI, …
  - ***AND***: environment, civil protection, gov KPI, covid-19, social & social media, people flow, tourism, energy, culture, …
- **Multiple dash/tool Levels & Decision Makers**
  - Real Time monitoring, Alerting, quality assess.
  - Predictions, KPI, DSS, what-if analysis
- **Historical and Real Time data**
  - Billions of Data
- **Services Exploited on:**
  - Multiple Levels, Mobile Apps, API
- **Since 2017**

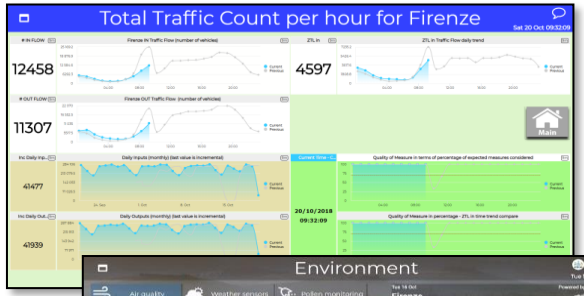


https://www.snap4city.org/747


Snap4City
Dashboard Management Syst
Dashboard Management Syst
Nuova scheda
snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTQzOA==
Ospite
Firenze Oggi
Mon 16 May 12:59:27
20991
COLONNINE
SITUAZIONE VIABILI
0 INCIDENTI
0 CHIUSURE AL TRAFFICO (TOT)
0 CHIUSURE PER CANTIERI
0 PROGR.
0 NON PROG.
0 LIMITAZIONI AL TRAFFICO (TOT)
0 LIMITAZIONI PER CANTIERI
0 NON PROG.
0 PROGR.
0 TOT. EVENTI SULLA RETE
SMN
42.2
BINA...
54.5
FORT...
23.2
LEOP...
37.3
CALZA...
48
S.AM...
58.6
PART...
55
CARE...
13.8
BECC...
77.6
ANALYSIS
Energy
Environment
Mobility
Social
Resilience
FLUSSI INGRESSO CIT
TOTA...
92207
FLUSSI INGRESSO ZTL
TOTA...
15964
Nati italiani
175
Nati s...
48
Dece...
499
Matri...
72
Unio...
2
Manutenzioni Strad...
19
Verd...
18
Decoro Urba...
3
Reiti...
5
Indicatore Rt per la provincia di
Rt
0.94
Linea...
Linea...
Linea...
Linea...
Linea...
Linea...
The European House
Ambrosetti

Florence Case

- **Smart City Control Room**
- **Dashboards and Services**
- **Mobile App:** Firenze Where What

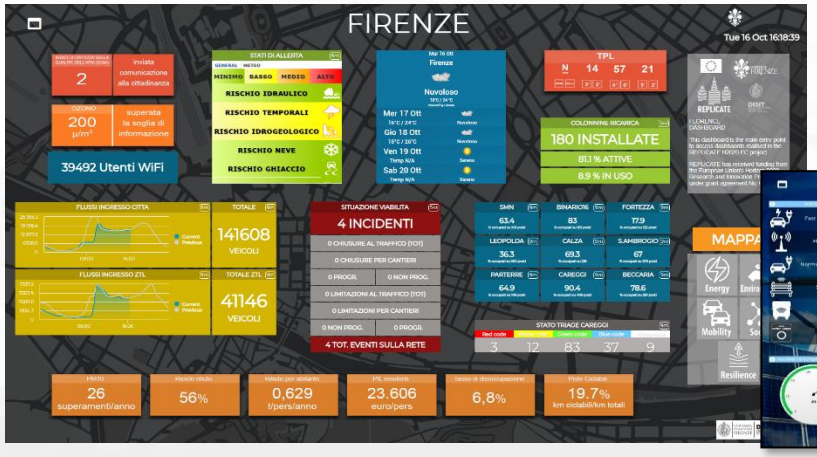


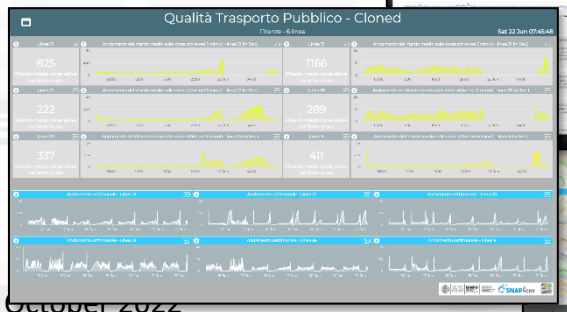
- **Mobility**:
  - quality of public transportation service (mean delay on bus-stops)
  - public transport operators schedule and paths, routing, multimodal routing
  - traffic flow reconstruction
  - Smart parking: predictions
  - Accidents and events, Log, heatmaps
- **Environment**:
  - smart irrigators
  - smart waste
  - Sensors: PM10. PM2.5,…..
  - Heatmaps: PM10, PM2.5, ….
  - NOX predictions
- **Energy**:
  - recharging stations (fast and reg.)
  - consumption meters (smart info)
  - smart light, street lights
- **Weather**
  - Forecast and actual

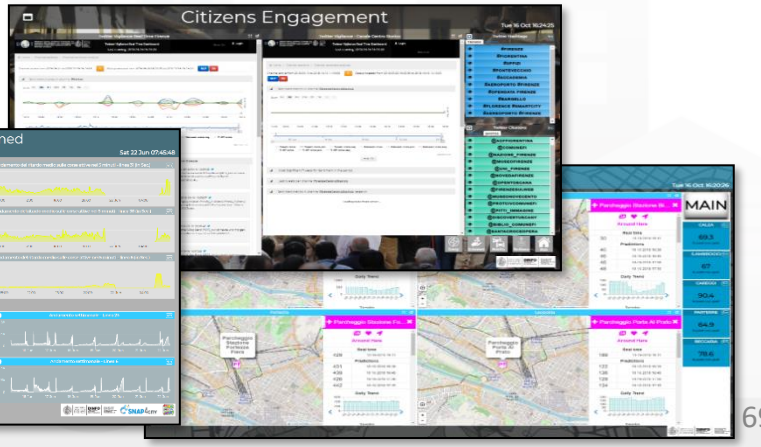
- **Social**:
  - smart benches
  - Twitter monitoring, Sentiment analysis, NLP text
  - TV camera streams
- **People Flows**:
  - Wi-Fi, people flow
  - Origin destination matrices
- **Governmental and Communications**:
  - KPI of the City
  - Digital Signage
  - Civil protection, Resilience (Resolute)
- **Tourism and Culture:**
  - POI, etc.

Analysis:

- **what-if routing, scenarios,**
- **traffic flow, environmental predictions**

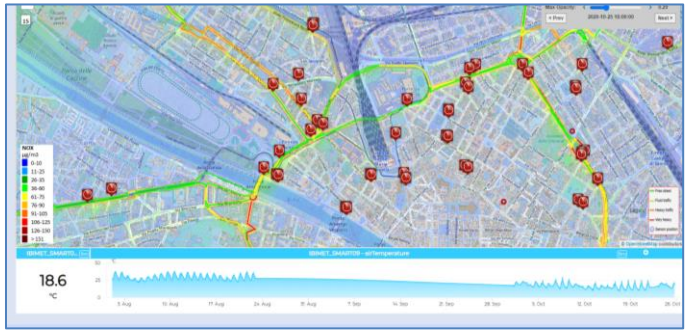


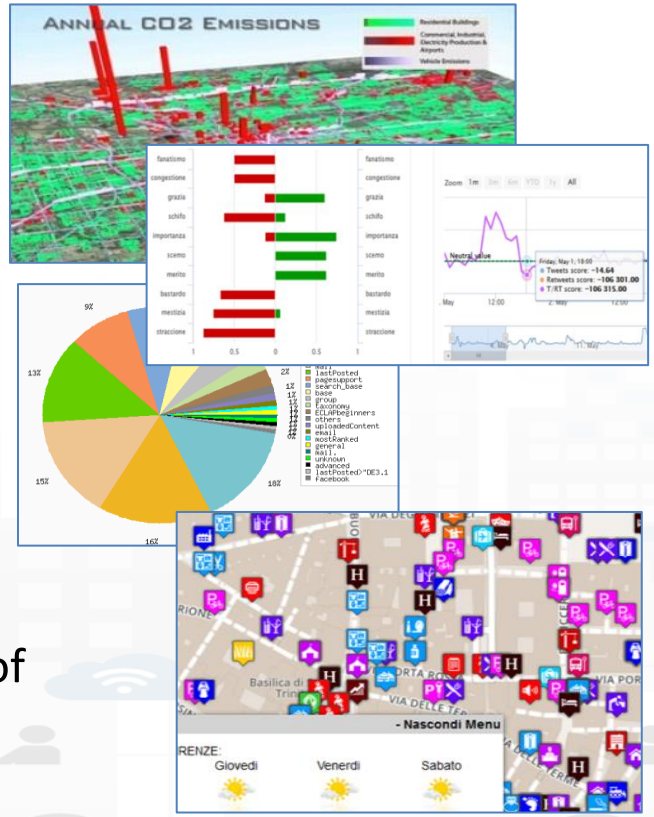


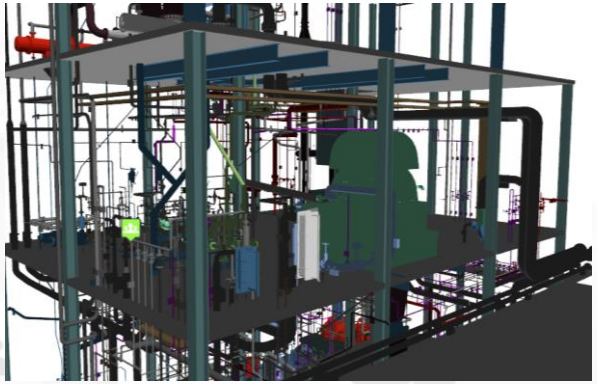


Digital Twin

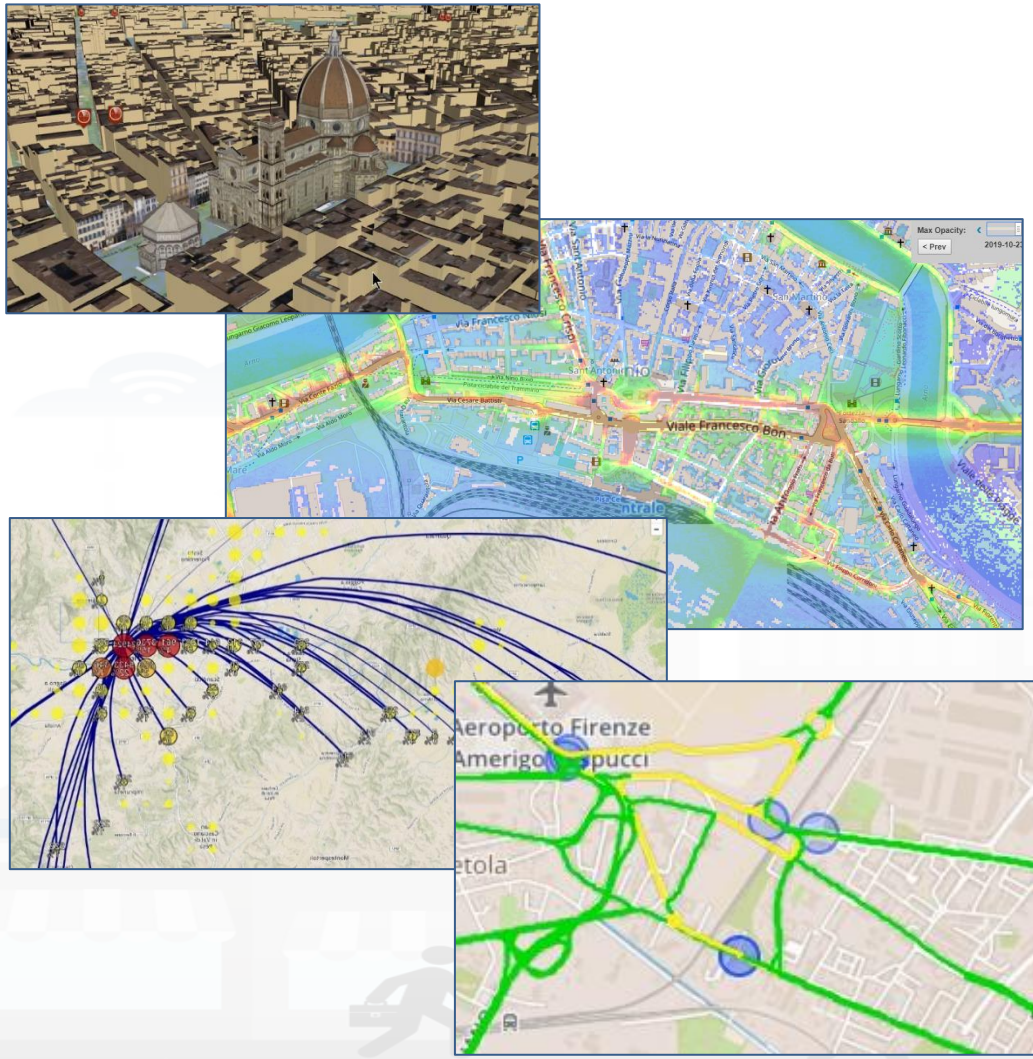
- **Digital Twin**
  - **Connected** with real systems
  - **Modelling** aspects: structural, visual, informative, real time data sensors (context), POI, functional, resources, etc.
  - **Analytics:** AI/XAI techniques, simulations, users' needs, etc.
- **Easier to understand the context, review from multiple points of view**
- **Useful to perform**
  - Discussion with city users
  - Support decision makers
  - By Case Experiments for analysing
    - New solutions, impact of disaster (natural and provoked)
    - Reduction of costs in the analysis, in reduction of mistakes







Global Digital Twin



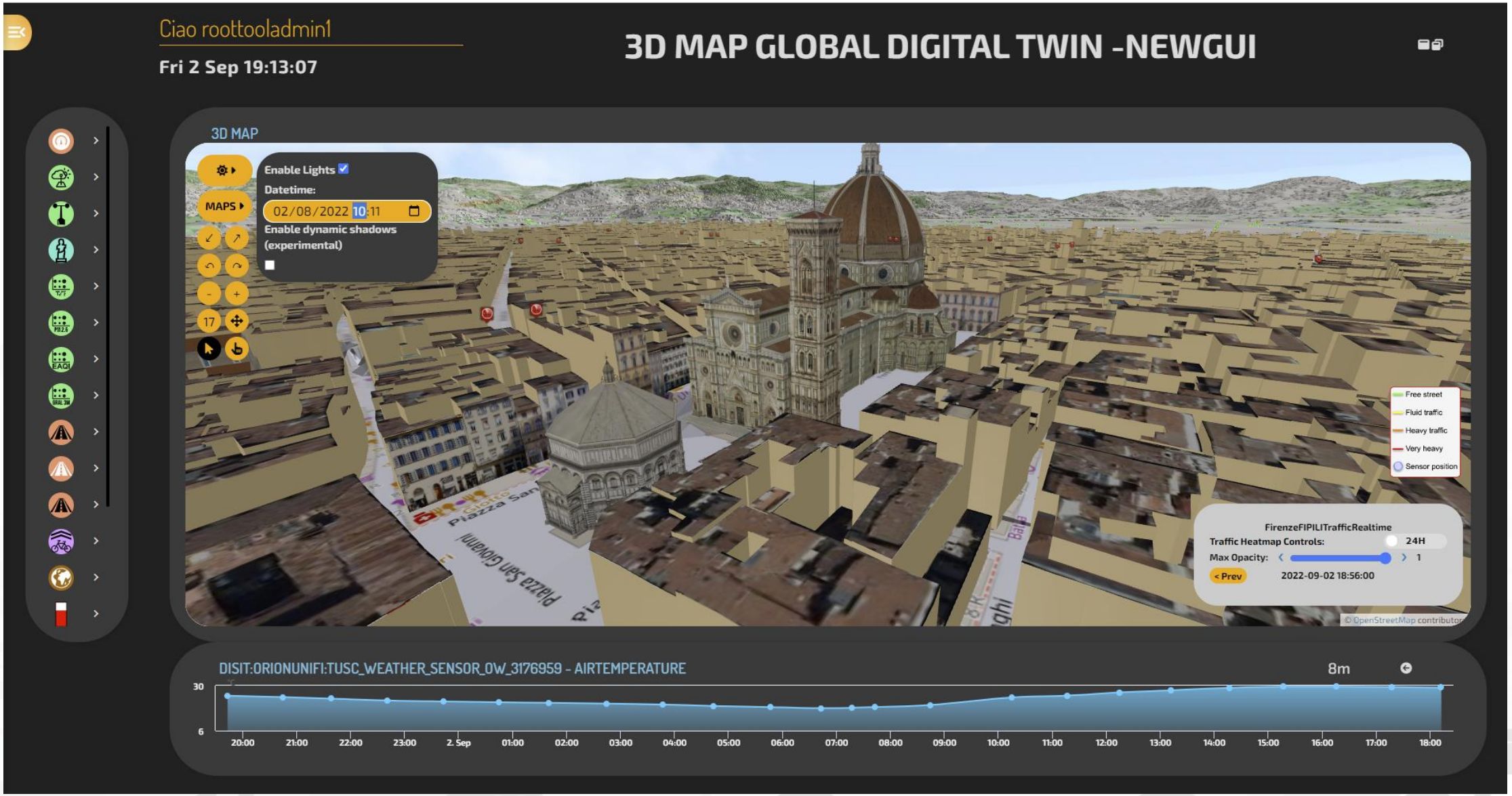
Digital representation of the city with…

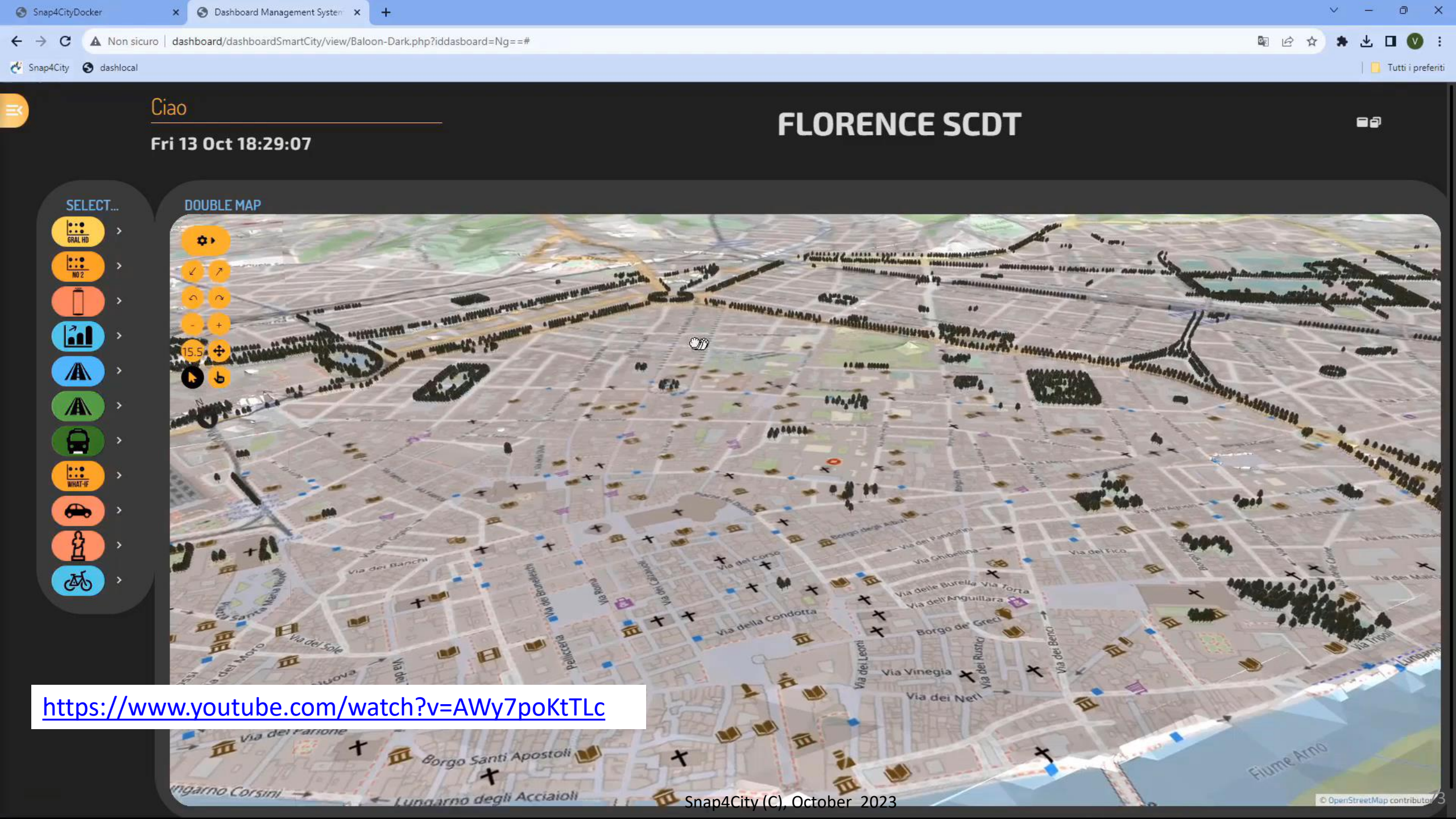
- 3D representation with data behind
- geomorphological, hydrogeological aspects,
- private and public transport networks,
- waste recovery systems,
- weather conditions, climate and microclimate,
- events, emergencies, ..., parking, sharing, ...
- tourist and city user flows, origin destination matrices,
- commercial activities, urban decorum, public lighting,
- green areas, cleanliness, safety on the road and in pedestrian areas,
- places for entertainment events, cultural activities, attraction and aggregation points of the city,

Complex and heterogeneous information, structured and unstructured, historical series and in real time data, public/private and sensitive data for security aspects. → **Reuse of legacy systems**

- GIS (Geographical Information System),
- ITS (Intelligent Transportation System),
- AVM (Automatic vehicle monitoring),
- from IoT (Internet of Thing) systems and networks.
- BIM data from many sources….

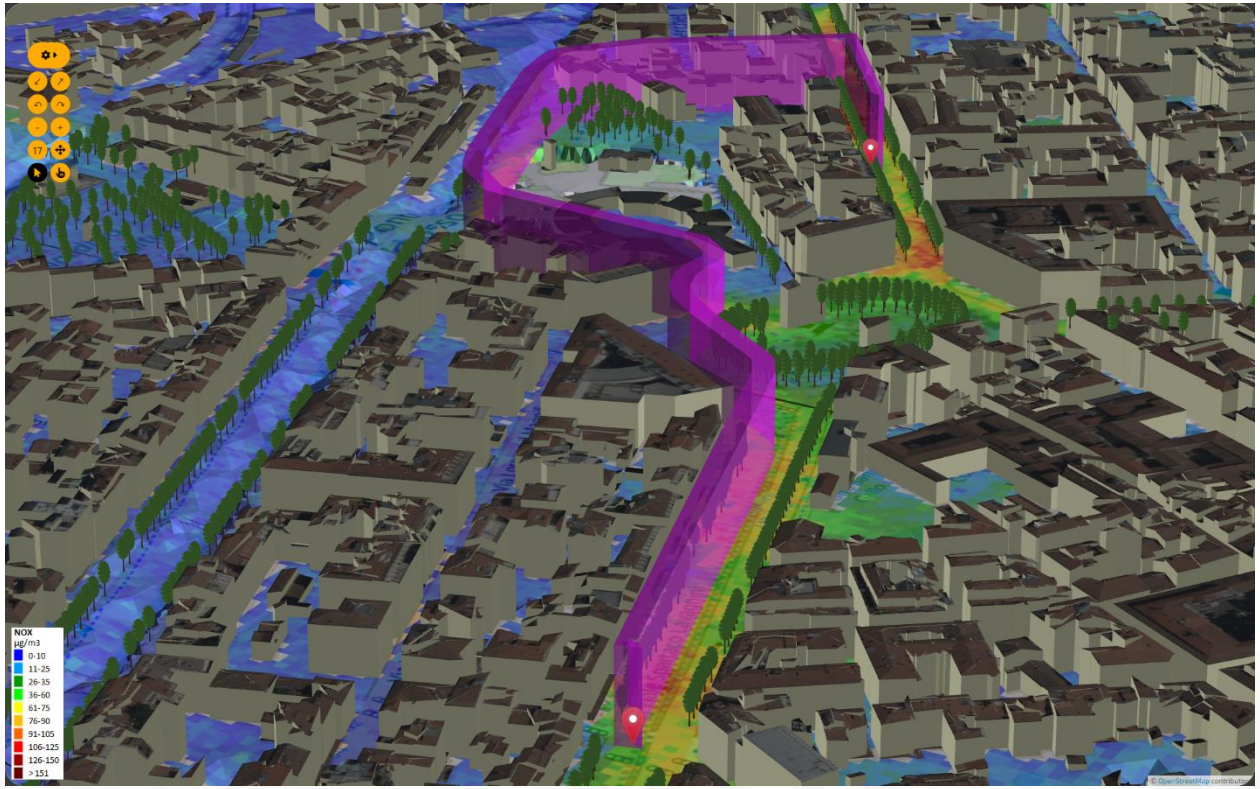
3D Digital Twin

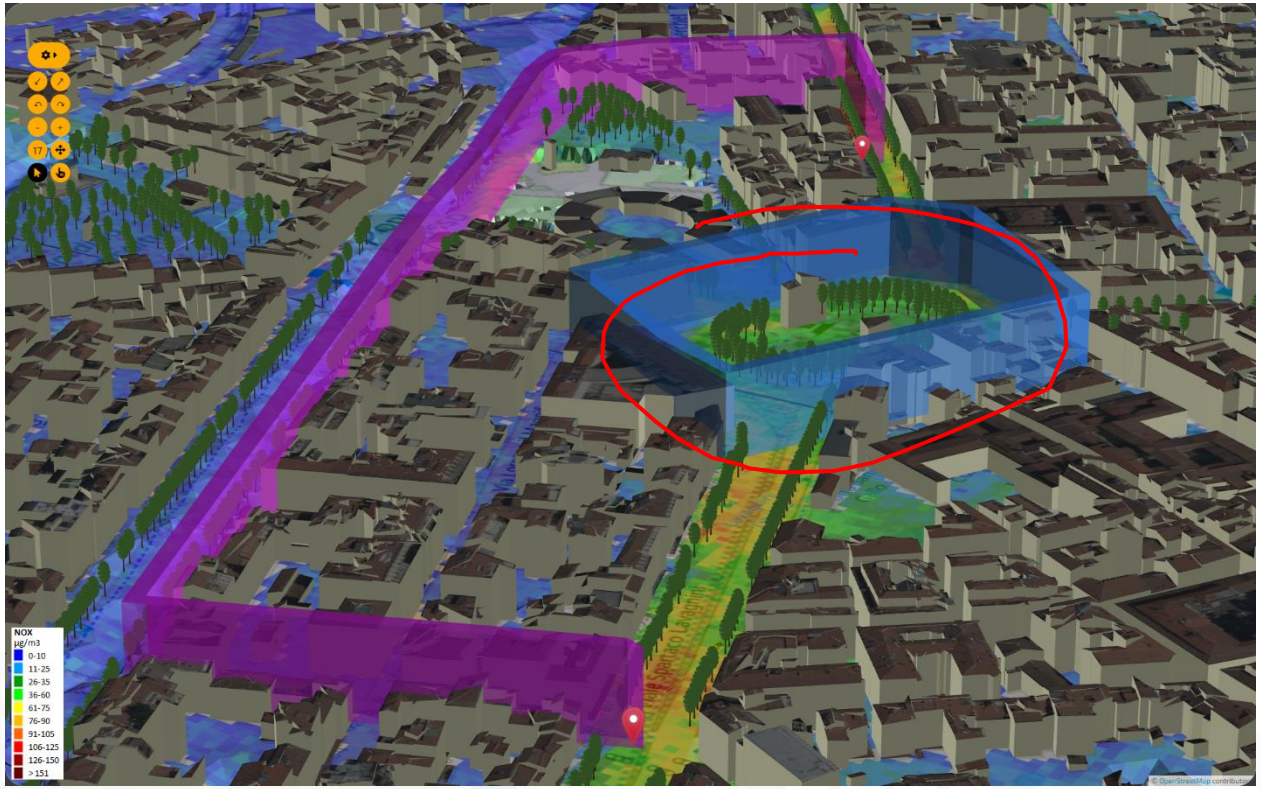




https://www.youtube.com/watch?v=AWy7poKtTLc

Dyamic Routing in 3D space

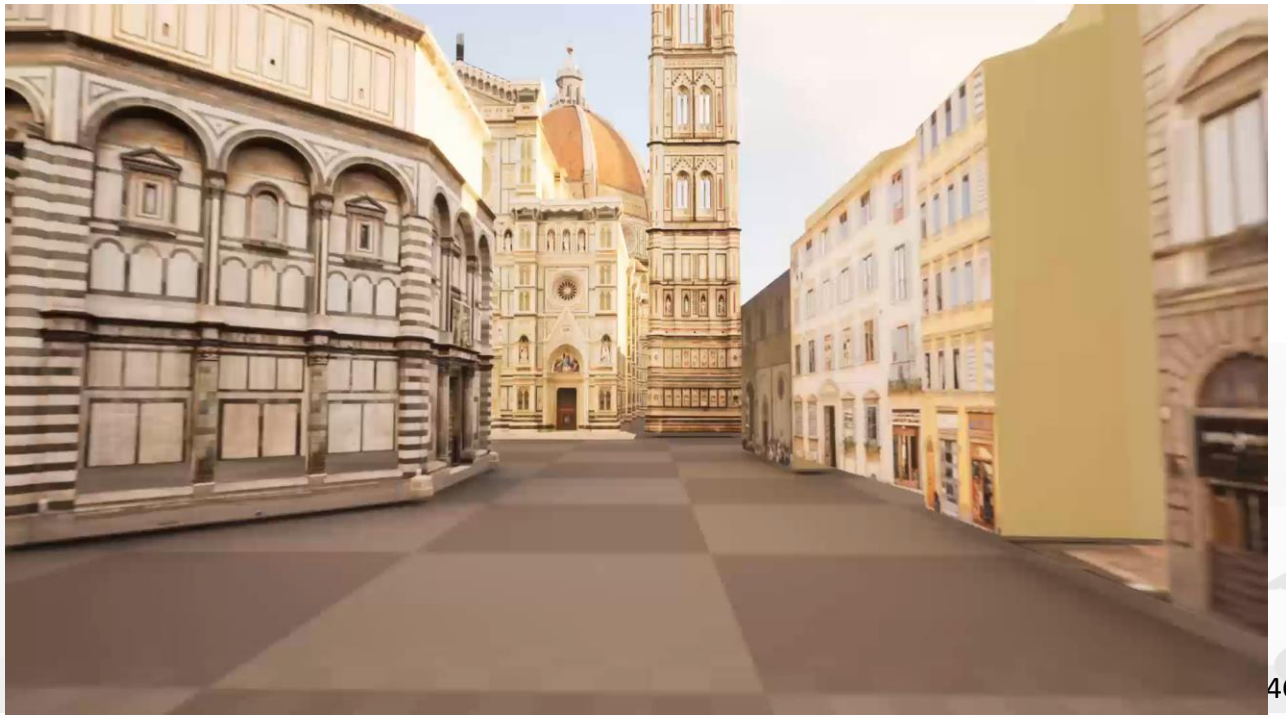




OCULUS

https://digitaltwin.snap4city.org

https://www.youtube.com/watch?v=Rcf_B2_GOio

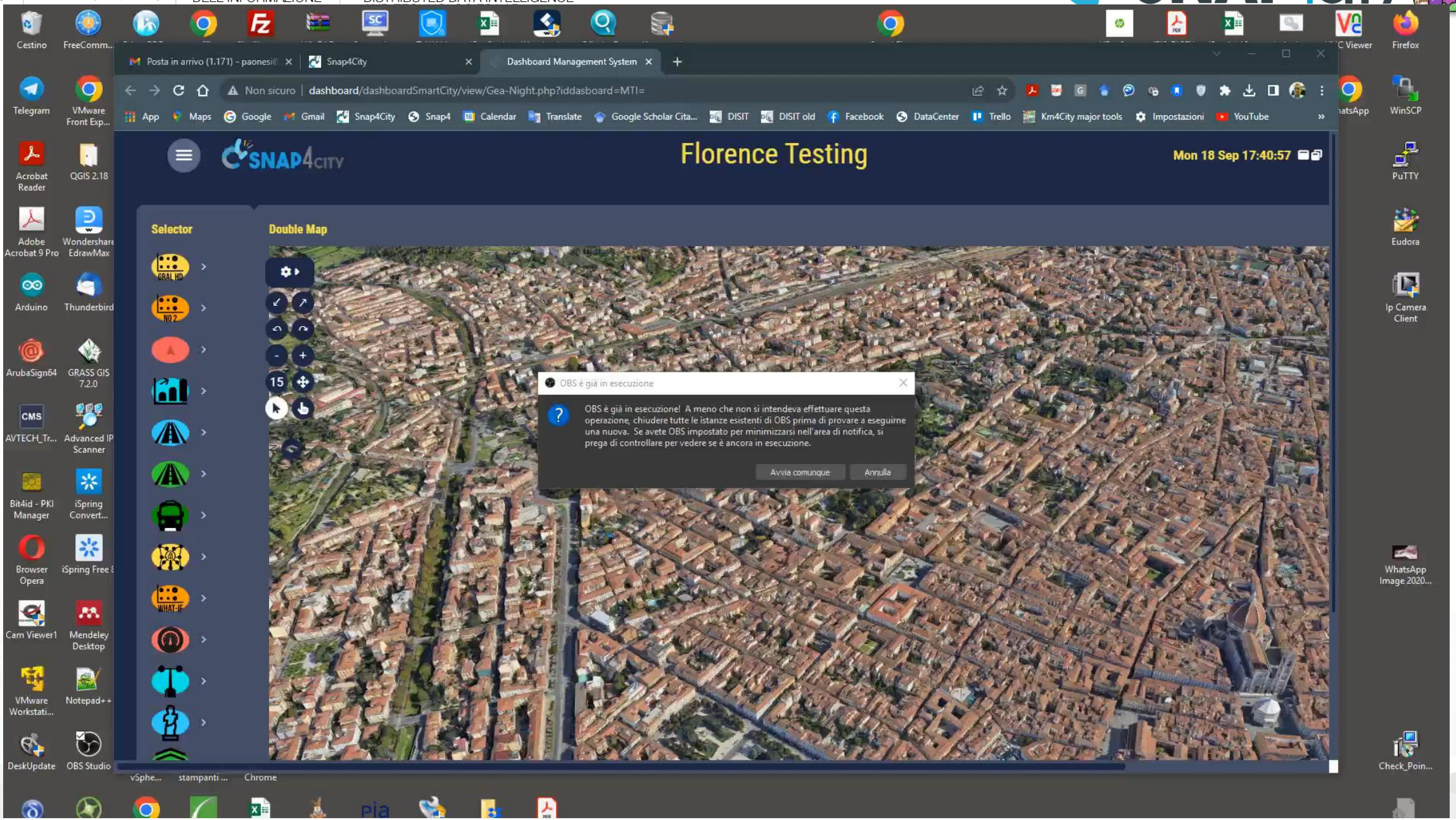


Exploiting Google API with Snap4City engine

- Select any city/locality and see if 3D Representation of your city is Available
- Snap4City redendering and distribution engine allows to
  - Optimize distribution of data
  - Integrate any kind of data on Digital Twin with 3D tileds of Google
    - PIN, IoT Data
    - Traffic Flows
    - Cycling paths
    - 3D shapes superimposed
    - Etc.

Snap4City Digital Twin Engine and data + 3D Google Data

Firenze


Florence Testing
Mon 18 Sep 17:40:57
Selector
Double Map
OBS è già in esecuzione
OBS è già in esecuzione! A meno che non si intendeva effettuare questa operazione, chiudere tutte le istanze esistenti di OBS prima di provare a eseguirne una nuova. Se avete OBS impostato per minimizzarsi nell'area di notifica, si prega di controllare per vedere se è ancora in esecuzione.
Avvia comunque
Annulla

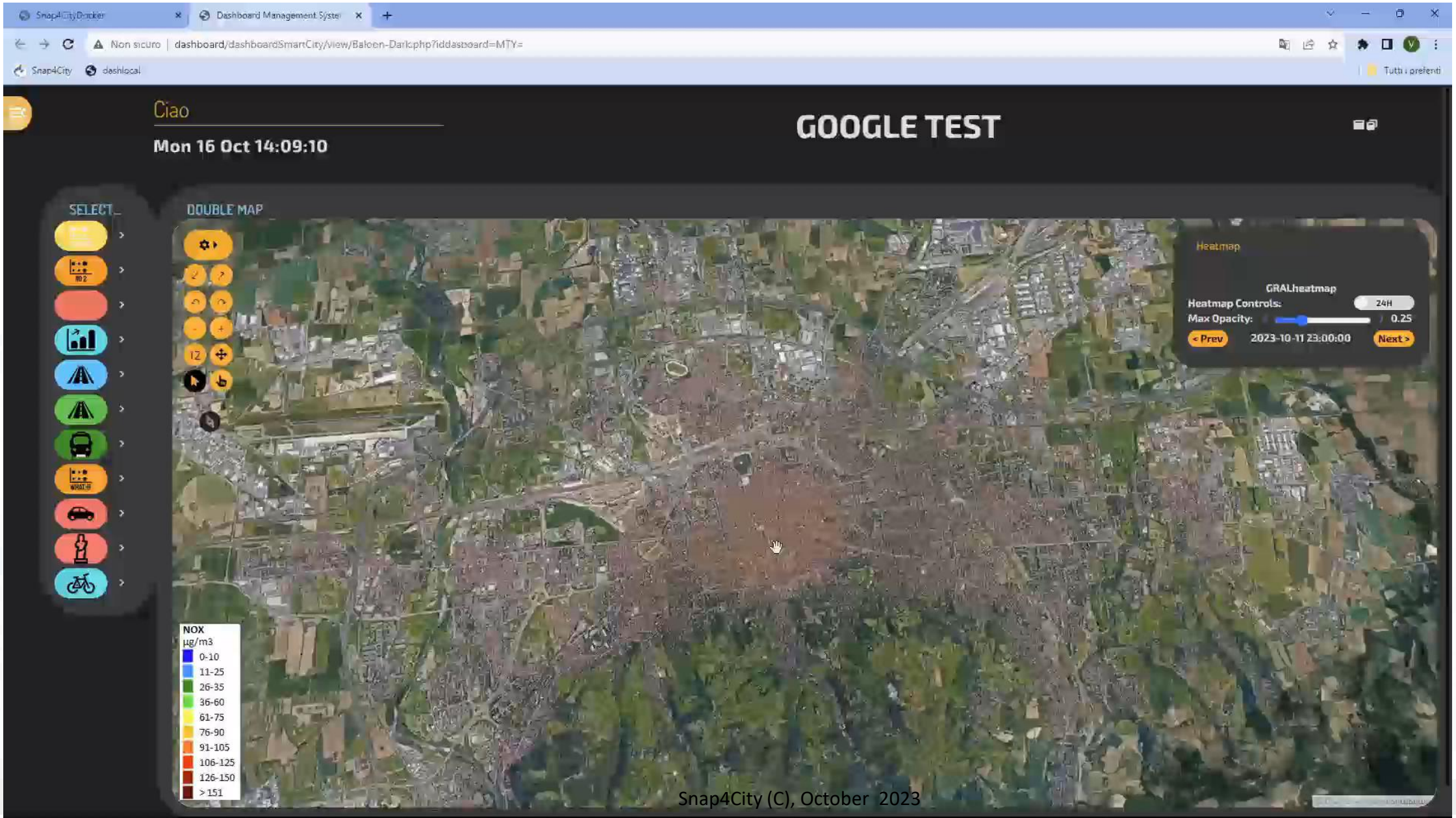
UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

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

Bologna

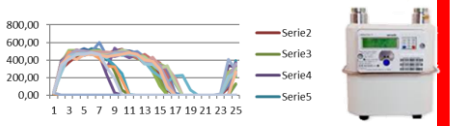
SNAP4CITY KM4CITY



IOT App Smart Industry 4.0
Snap4Industry

https://www.snap4city.org/369

External Services



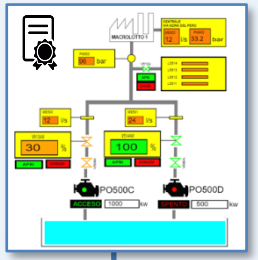
Fleet management

IoT Devices/Edge

IoT Broker

Internet

SECURE



Admin

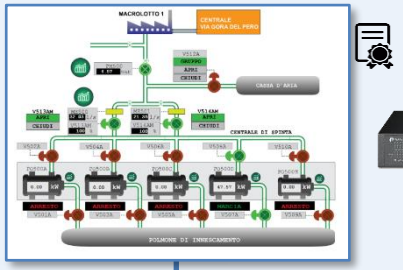
DCS

IoT Broker

PLC

IoT Devices/Edge

Industry Plant1.....



SCADA

IoT Broker

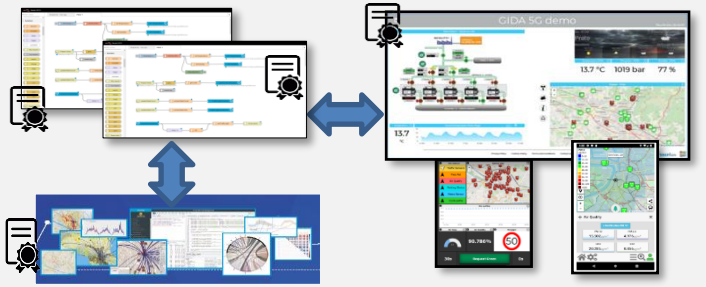
PLC/ RTU

IoT Devices/Edge

Industry Plant2.....

IOT Applications

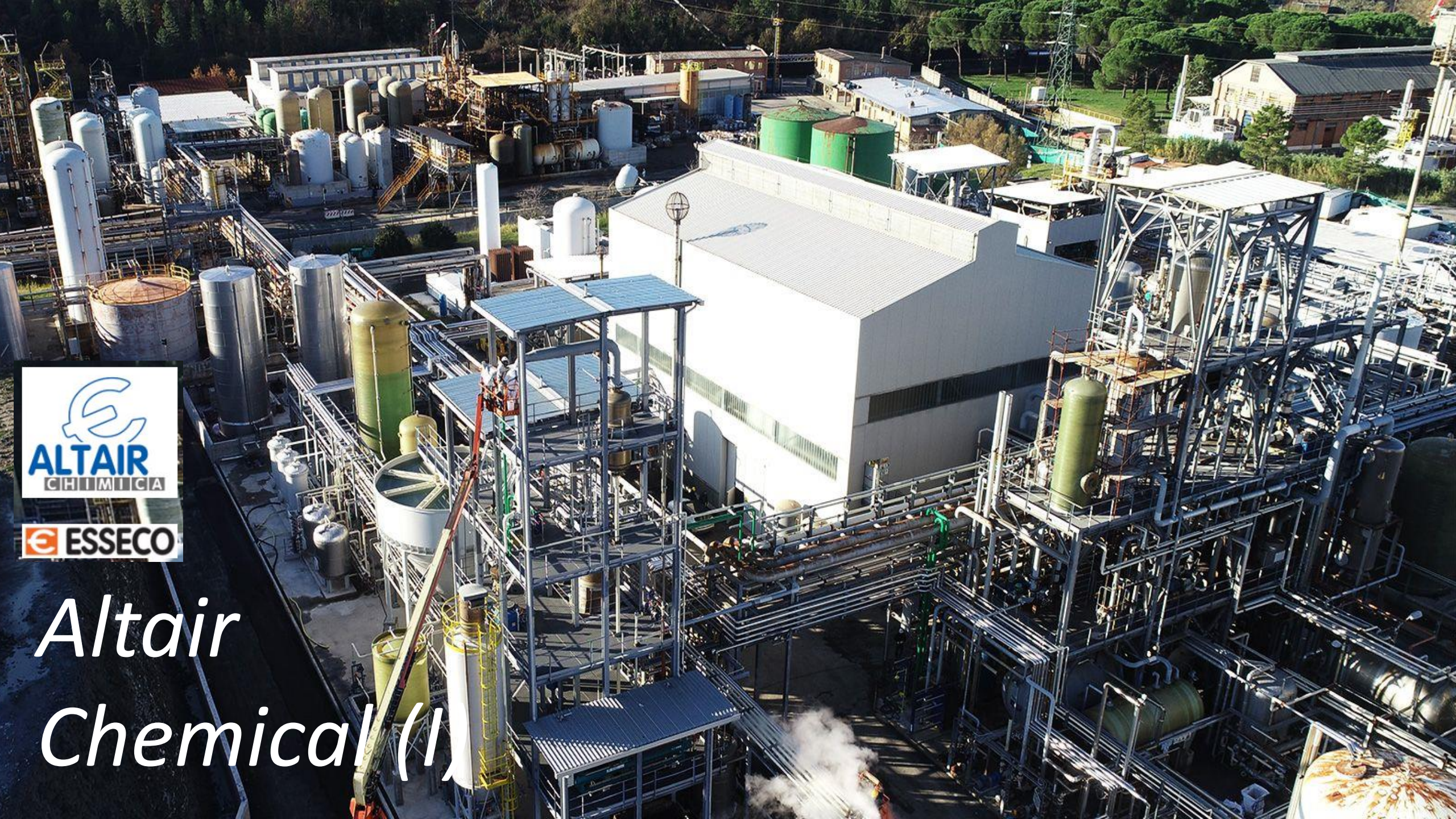
Dashboards and Apps



Big Data Analytics, Artificial Intelligence

Control and Supervision on Multiple Supply Chains

Industry 4.0 as a Service

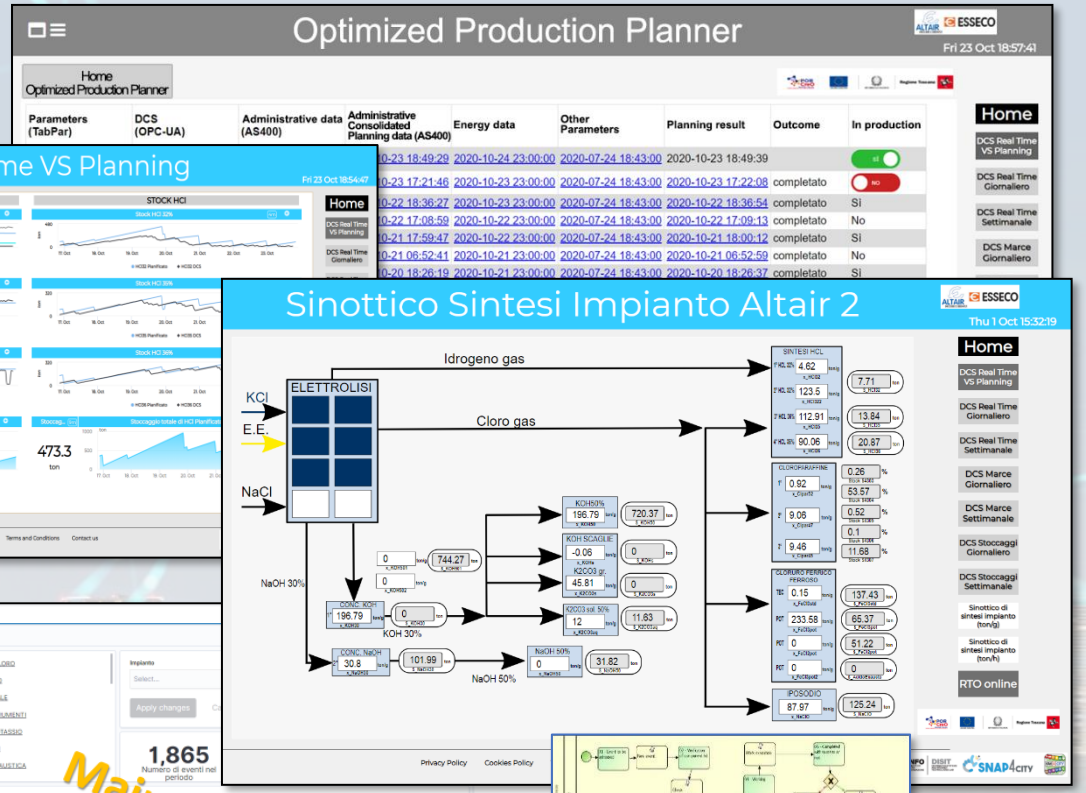


Altair Chemical (I)

Snap4Altair Decision Support supervision and control, Industry 4.0

reference

- **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

Energy Service

Data Connections and Transformation

IoT App/DA: Real Time & Stream Processing

Predictive Maintenance

Prod. Plan Optimization

API/MicroServices

Maintenance Intelligence

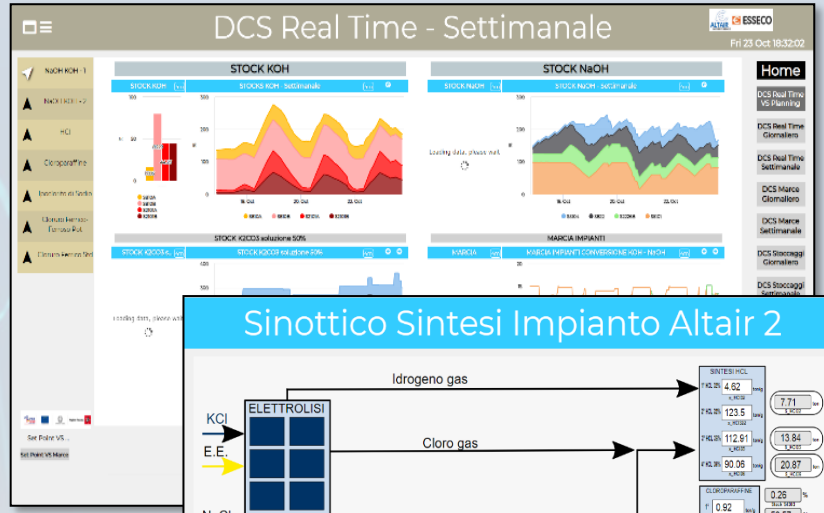
Digital Twin Local / BIM

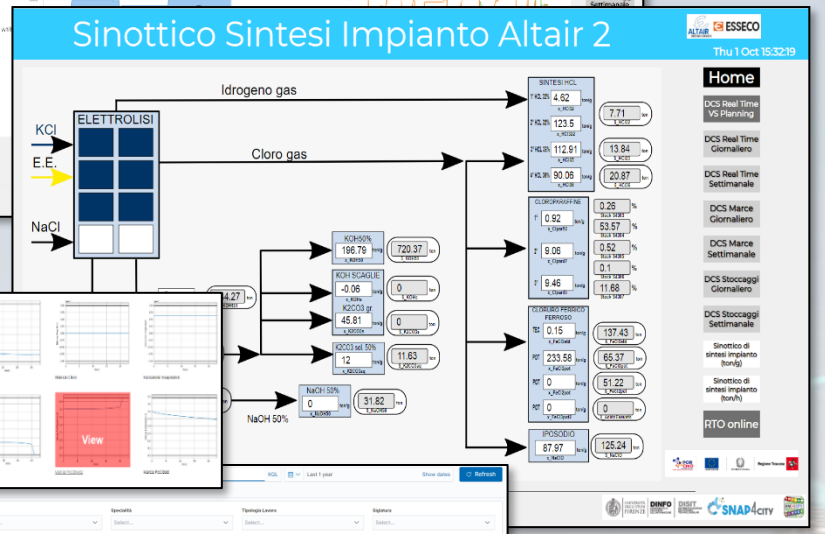
.....

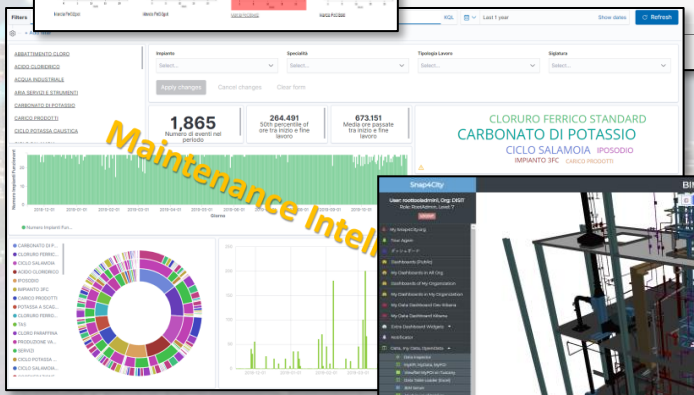
Data Storage

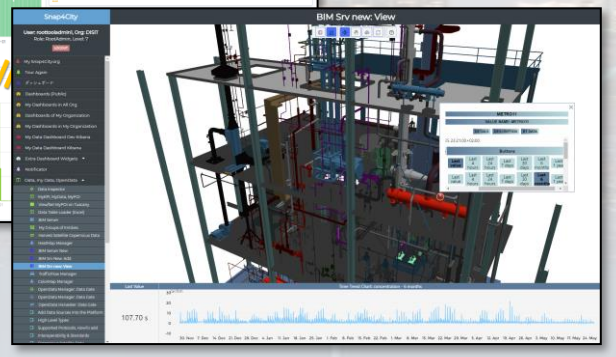
Management, Auth./Autoriz.

Snap4City Dashboard Builder

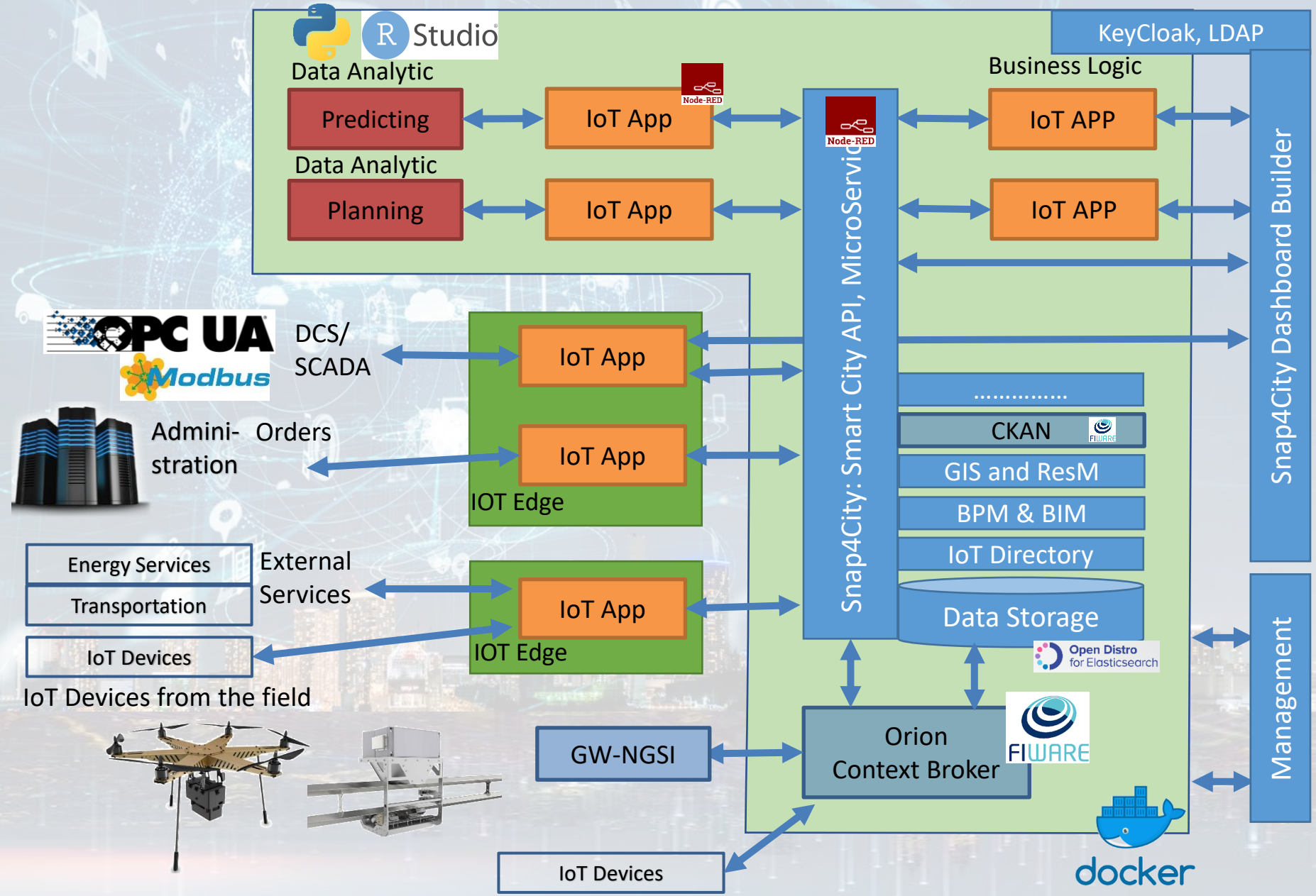






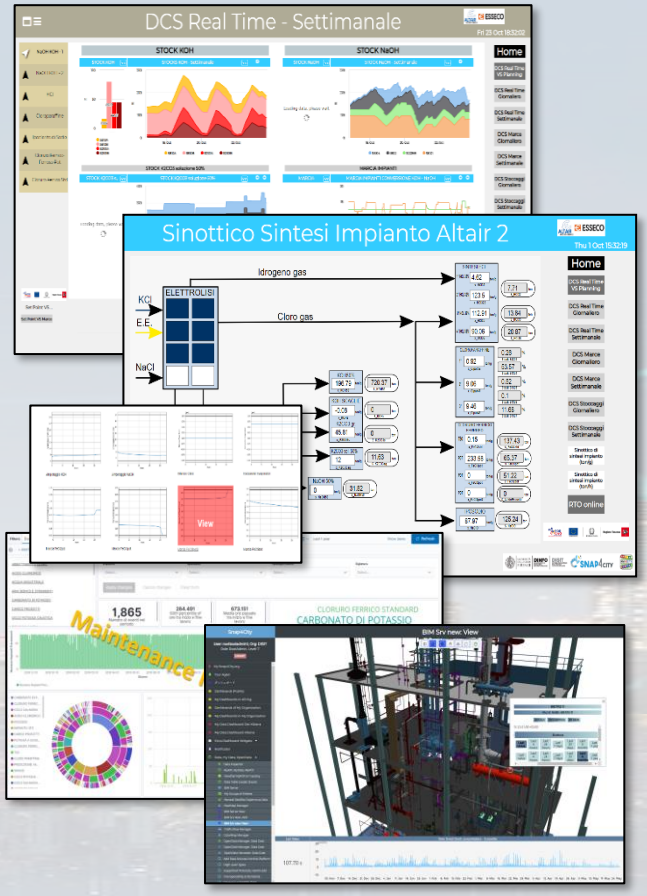


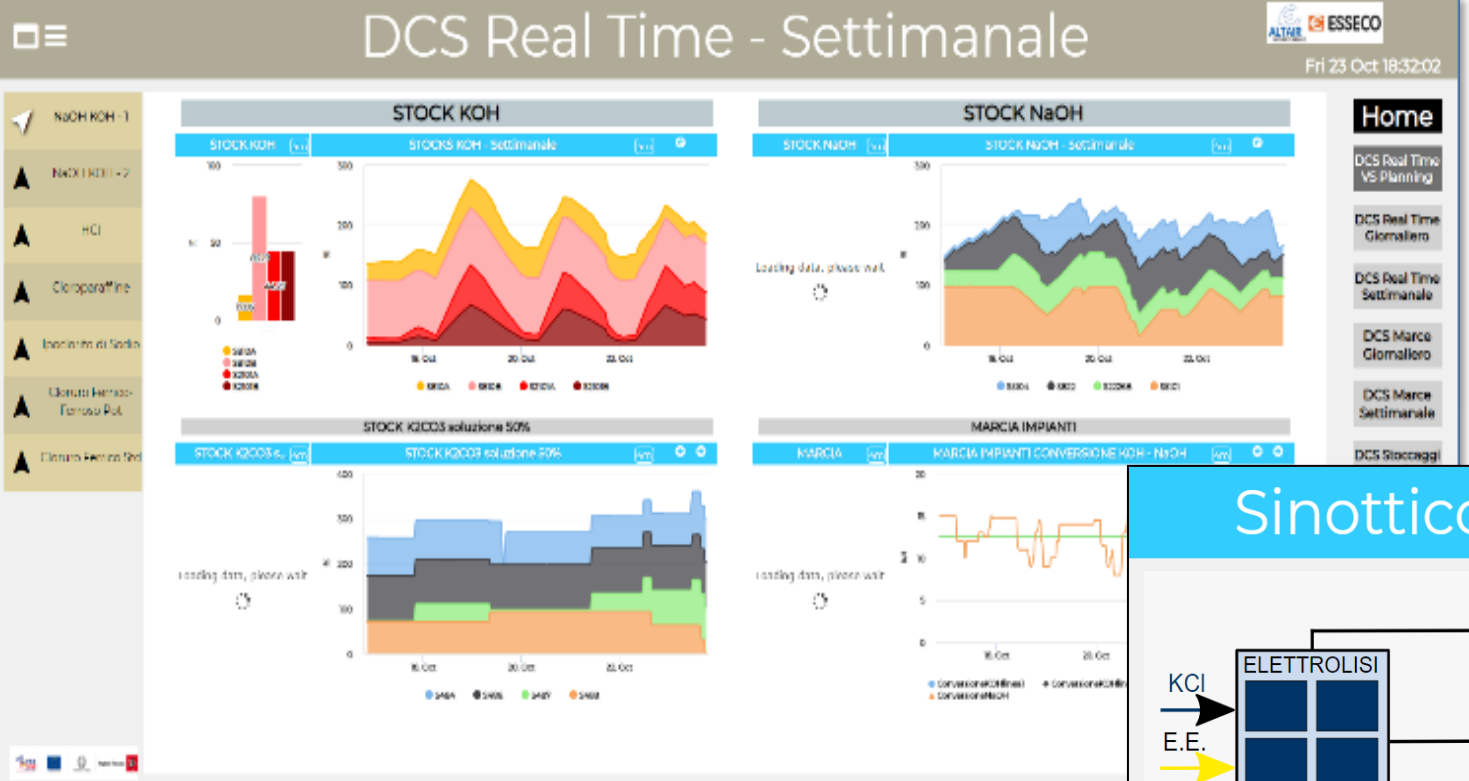
Snap4City/Industry Detailed Architecture

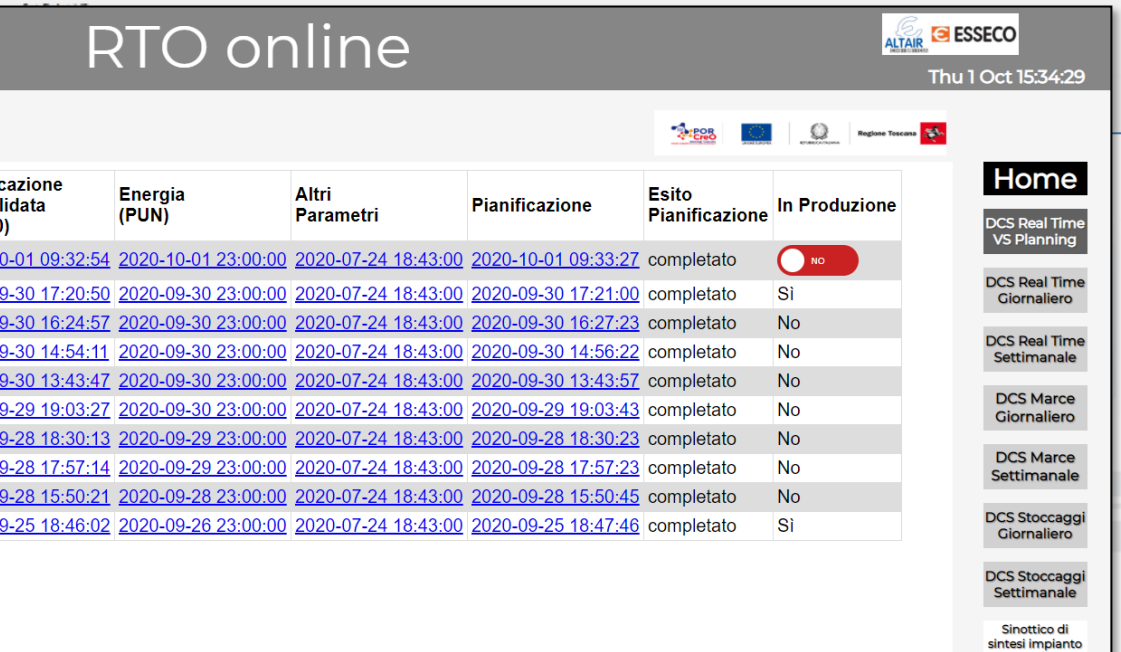


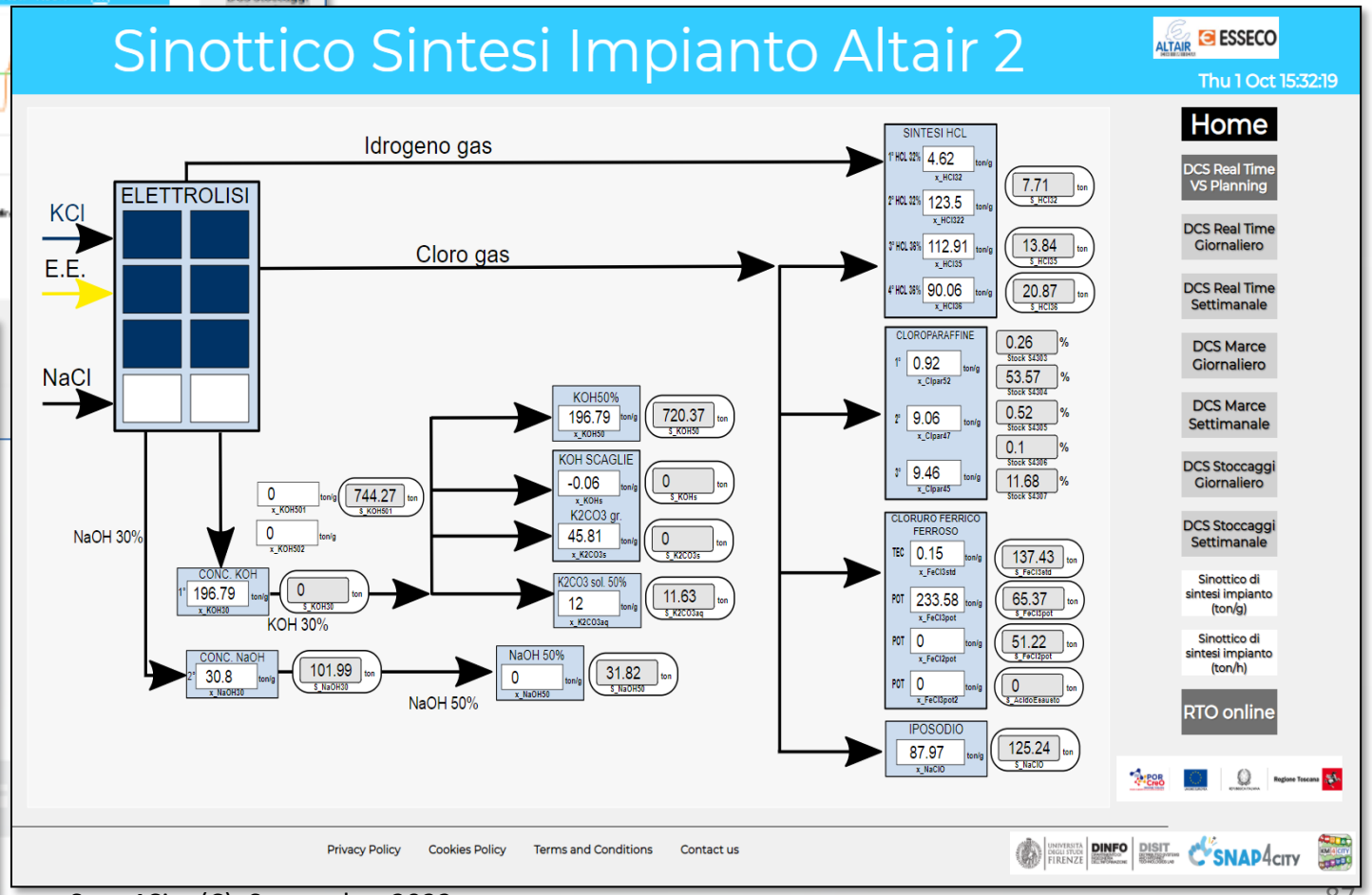
Production Parameters

Dashboards, Visual Analytics, Synoptics, 3D, Maps




DCS Real Time - Settimanale
ESSECO
Fri 23 Oct 18:32:02
STOCK KOH
STOCK NaOH
STOCK K2CO3 soluzione 50%
MARCIA IMPIANTI
Home
DCS Real Time VS Planning
DCS Real Time Giornaliero
DCS Real Time Settimanale
DCS Marce Giornaliero
DCS Marce Settimanale
DCS Stoccaggi


RTO online
ESSECO
Thu 1 Oct 15:34:29
Energia (PUN)
Altri Parametri
Pianificazione
Esito Pianificazione
In Produzione
2020-10-01 09:32:54 2020-10-01 23:00:00 2020-07-24 18:43:00 2020-10-01 09:33:27 completato NO
2020-09-30 17:20:50 2020-09-30 23:00:00 2020-07-24 18:43:00 2020-09-30 17:21:00 completato Sì
2020-09-30 16:24:57 2020-09-30 23:00:00 2020-07-24 18:43:00 2020-09-30 16:27:23 completato No
2020-09-30 14:54:11 2020-09-30 23:00:00 2020-07-24 18:43:00 2020-09-30 14:56:22 completato No
2020-09-30 13:43:47 2020-09-30 23:00:00 2020-07-24 18:43:00 2020-09-30 13:43:57 completato No
2020-09-29 19:03:27 2020-09-30 23:00:00 2020-07-24 18:43:00 2020-09-29 19:03:43 completato No
2020-09-28 18:30:13 2020-09-29 23:00:00 2020-07-24 18:43:00 2020-09-28 18:30:23 completato No
2020-09-28 17:57:14 2020-09-29 23:00:00 2020-07-24 18:43:00 2020-09-28 17:57:23 completato No
2020-09-28 15:50:21 2020-09-28 23:00:00 2020-07-24 18:43:00 2020-09-28 15:50:45 completato No
2020-09-25 18:46:02 2020-09-26 23:00:00 2020-07-24 18:43:00 2020-09-25 18:47:46 completato Sì
Home
DCS Real Time VS Planning
DCS Real Time Giornaliero
DCS Real Time Settimanale
DCS Marce Giornaliero
DCS Marce Settimanale
DCS Stoccaggi Giornaliero
DCS Stoccaggi Settimanale


Sinottico Sintesi Impianto Altair 2
ESSECO
Thu 1 Oct 15:32:19
Idrogeno gas
KCl
E.E.
NaCl
ELETTROLISI
Cloro gas
NaOH 30%
KOH 30%
NaOH 50%
SINTESI HCL
CLOROPARAFFINE
CLORURO FERRICO FERROSO
IPOSODIO
Home
DCS Real Time VS Planning
DCS Real Time Giornaliero
DCS Real Time Settimanale
DCS Marce Giornaliero
DCS Marce Settimanale
DCS Stoccaggi Giornaliero
DCS Stoccaggi Settimanale
Sinottico di sintesi impianto (ton/g)
Sinottico di sintesi impianto (ton/h)
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Optimized Production Planner

ALTAIR ESSECO

Fri 23 Oct 18:57:41

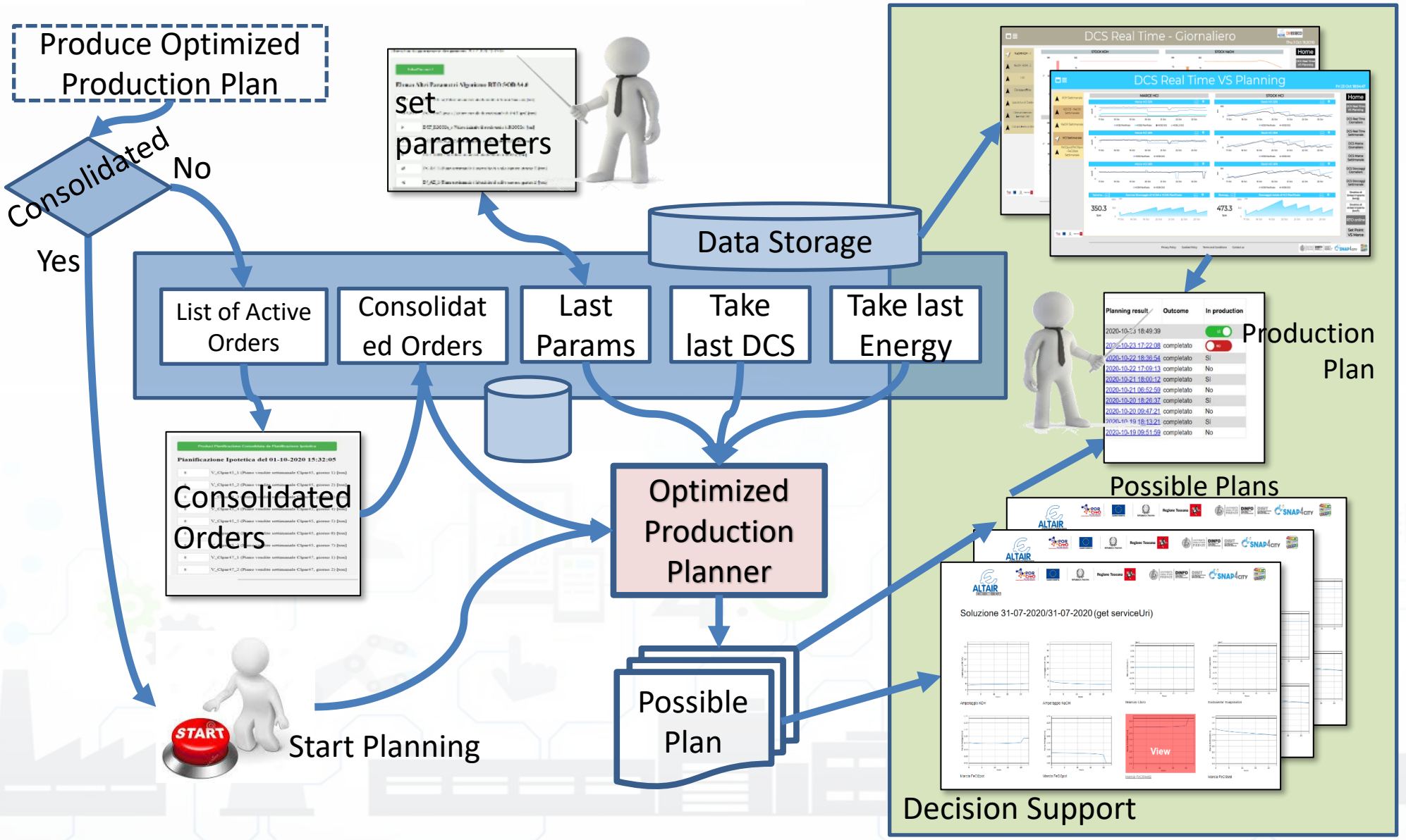
Home
Optimized Production Planner

Parameters (TabPar)	DCS (OPC-UA)	Administrative data (AS400)	Administrative Consolidated Planning data (AS400)	Energy data	Other Parameters	Planning result	Outcome	In production
2020-09-25 18:47:36	2020-10-23 18:49:02	2020-10-23 18:49:29	2020-10-23 18:49:29	2020-10-24 23:00:00	2020-07-24 18:43:00	2020-10-23 18:49:39		SI
2020-09-25 18:47:36	2020-10-23 17:22:03	2020-10-23 17:21:46	2020-10-23 17:21:46	2020-10-23 23:00:00	2020-07-24 18:43:00	2020-10-23 17:22:08	completato	NO
2020-09-25 18:47:36	2020-10-22 18:36:02	2020-10-22 18:36:27	2020-10-22 18:36:27	2020-10-23 23:00:00	2020-07-24 18:43:00	2020-10-22 18:36:54	completato	Si
2020-09-25 18:47:36	2020-10-22 17:09:02	2020-10-22 17:08:59	2020-10-22 17:08:59	2020-10-22 23:00:00	2020-07-24 18:43:00	2020-10-22 17:09:13	completato	No
2020-09-25 18:47:36	2020-10-21 18:00:02	2020-10-21 17:59:47	2020-10-21 17:59:47	2020-10-22 23:00:00	2020-07-24 18:43:00	2020-10-21 18:00:12	completato	Si
2020-09-25 18:47:36	2020-10-21 06:52:02	2020-10-21 06:52:41	2020-10-21 06:52:41	2020-10-21 23:00:00	2020-07-24 18:43:00	2020-10-21 06:52:59	completato	No
2020-09-25 18:47:36	2020-10-20 18:26:02	2020-10-20 18:26:19	2020-10-20 18:26:19	2020-10-21 23:00:00	2020-07-24 18:43:00	2020-10-20 18:26:37	completato	Si
2020-09-25 18:47:36	2020-10-20 09:47:03	2020-10-20 09:47:05	2020-10-20 09:47:05	2020-10-20 23:00:00	2020-07-24 18:43:00	2020-10-20 09:47:21	completato	No
2020-09-25 18:47:36	2020-10-19 18:13:02	2020-10-19 18:13:09	2020-10-19 18:13:09	2020-10-20 23:00:00	2020-07-24 18:43:00	2020-10-19 18:13:21	completato	Si
2020-09-25 18:47:36	2020-10-19 09:51:02	2020-10-19 09:51:08	2020-10-19 09:51:08	2020-10-19 23:00:00	2020-07-24 18:43:00	2020-10-19 09:51:59	completato	No

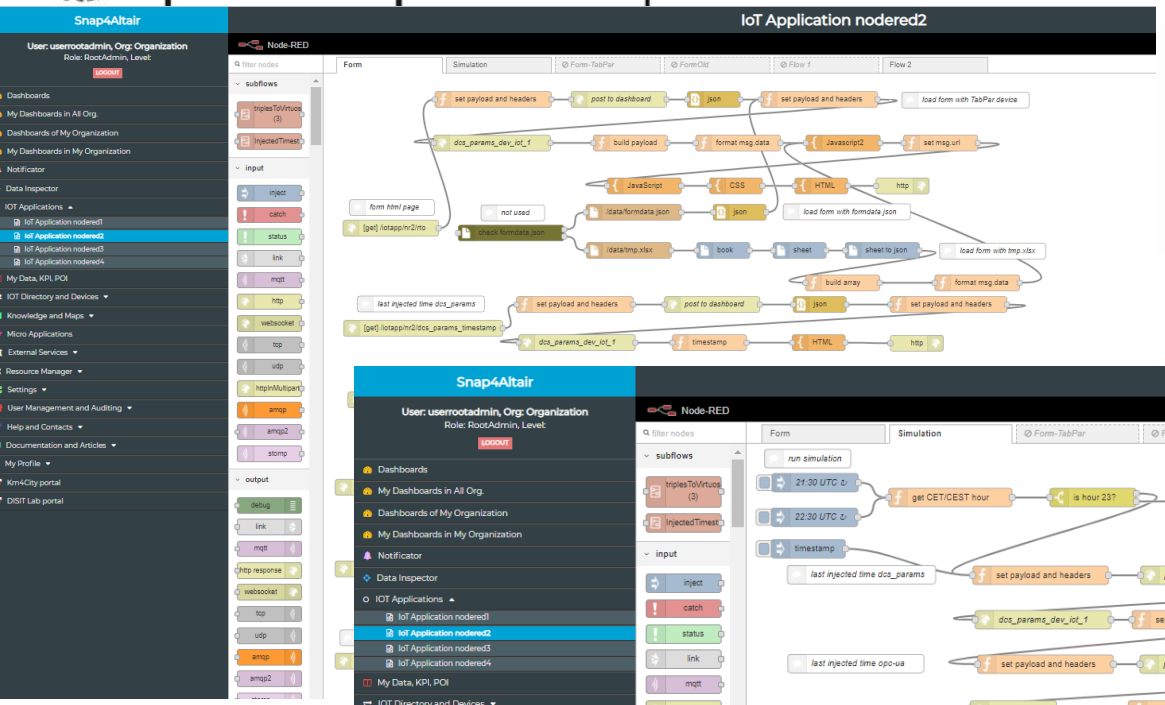
<< 1 2 3 4 5 6 7 8 9 10 11 12 13 14 >>

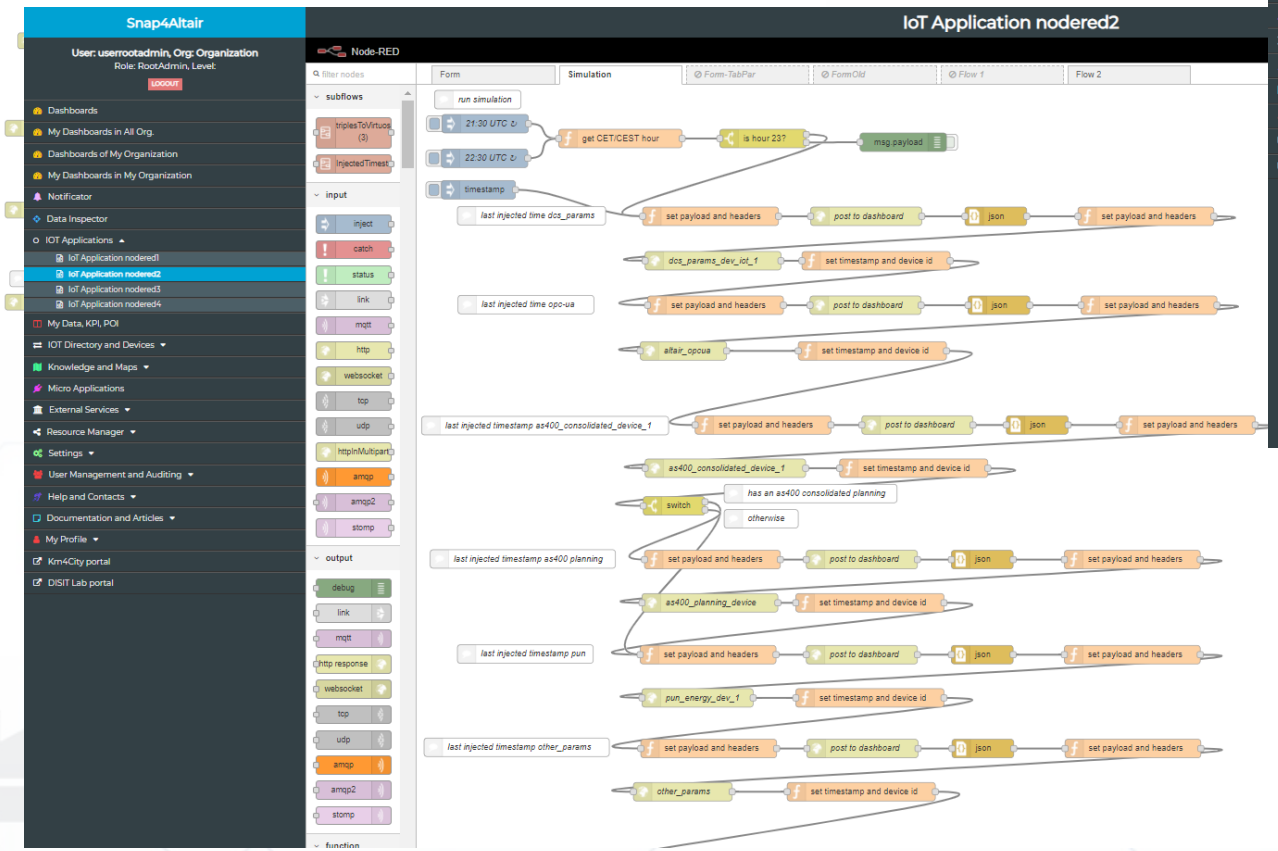
Home
DCS Real Time VS Planning
DCS Real Time Giornaliero
DCS Real Time Settimanale
DCS Marce Giornaliero
DCS Marce Settimanale
DCS Stoccaggi Giornaliero
DCS Stoccaggi Settimanale

Business Logic



Some Flows


Snap4Altair
IoT Application nodered2
Node-RED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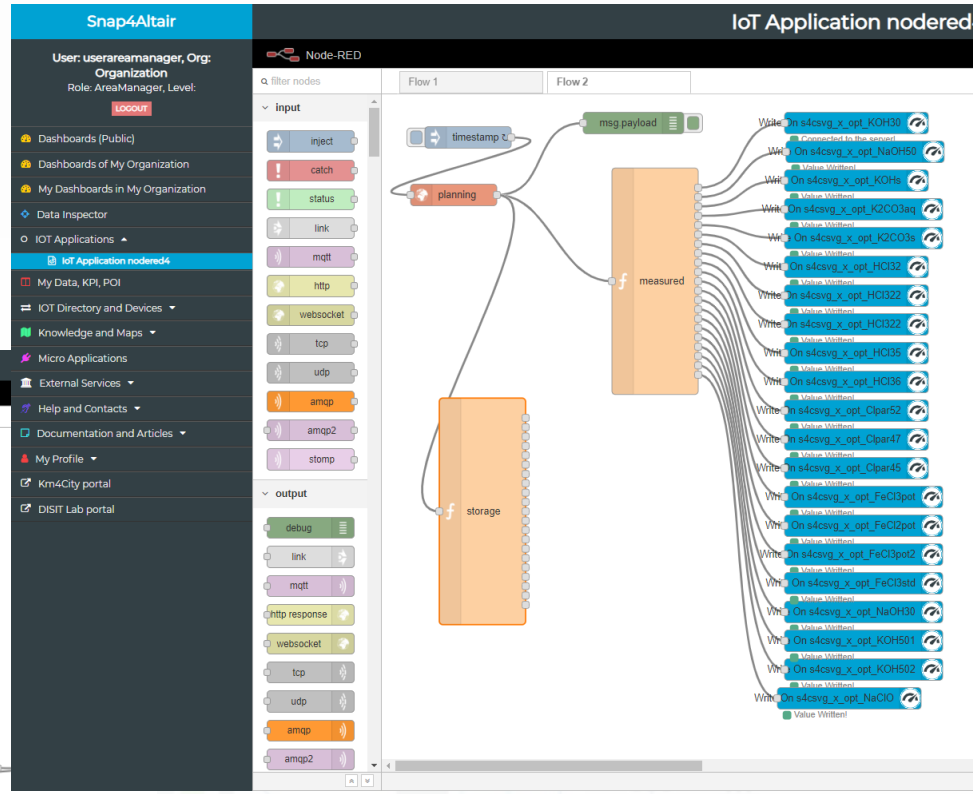
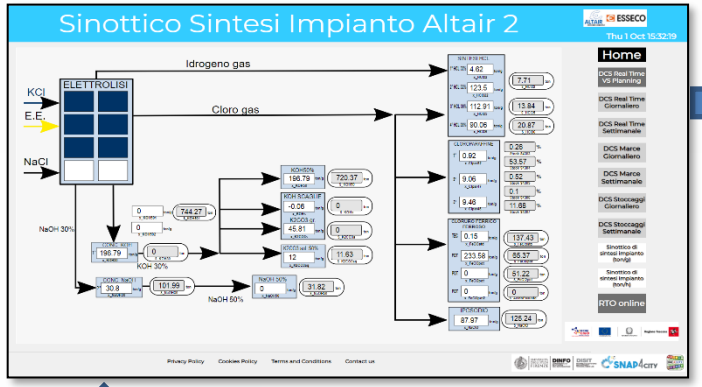
IoT Application nodered2
Node-RED

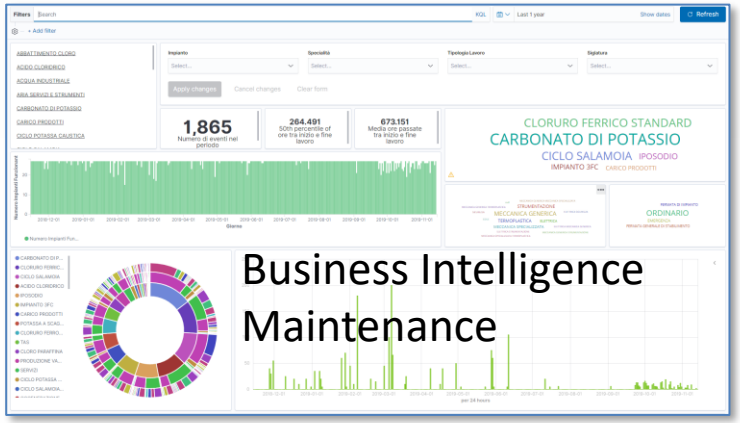

Snap4Altair
IoT Application nodered
Node-RED

Workflow for Ticket management



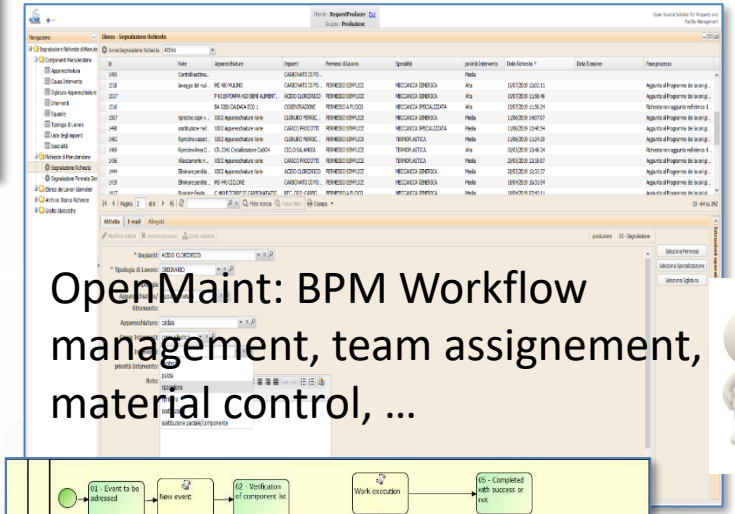
Dashboards and actions

Consumptions/productions

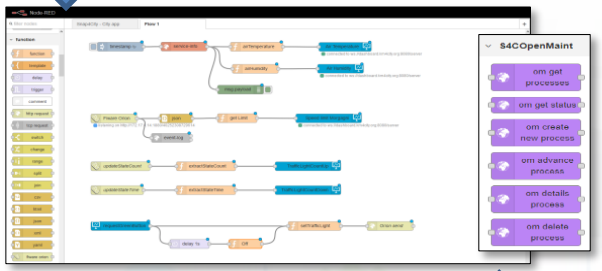


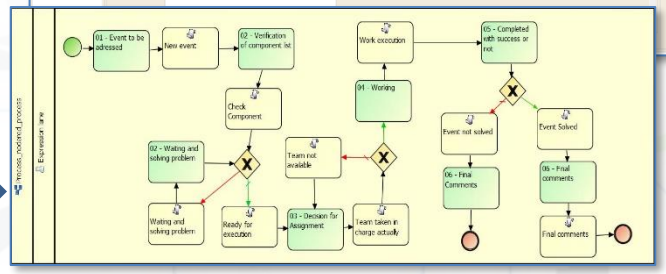
Events/actions

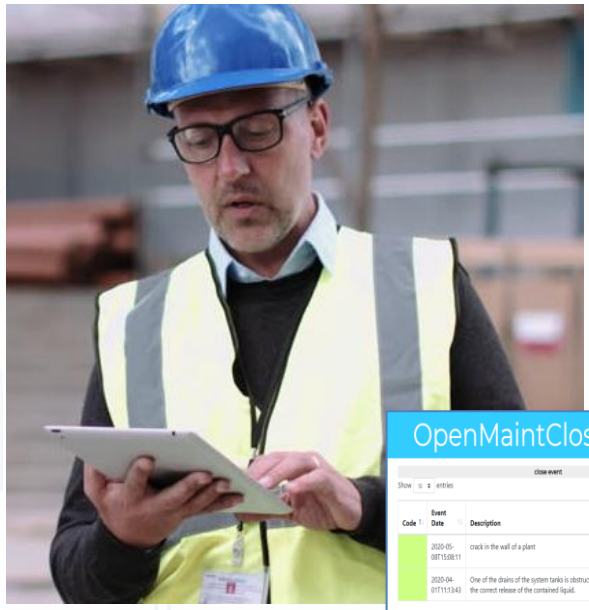
Business Intelligence
Maintenance

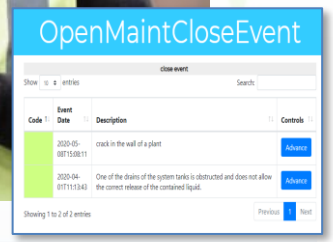


OpenMaint: BPM Workflow management, team assignement, material control, …









IOT App, Data event firing, event detection and firing Critical event management

Filters | Search | KQL | Last 1 year | Show dates | Refresh

+ 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

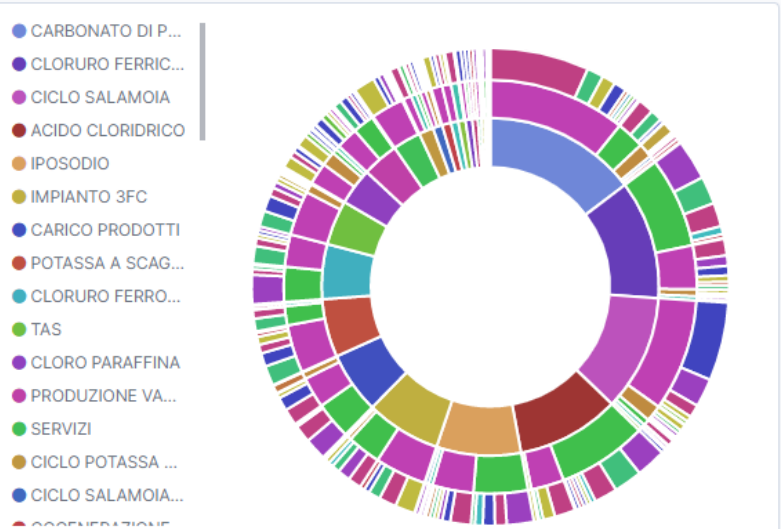
1,865
Numero di eventi nel periodo

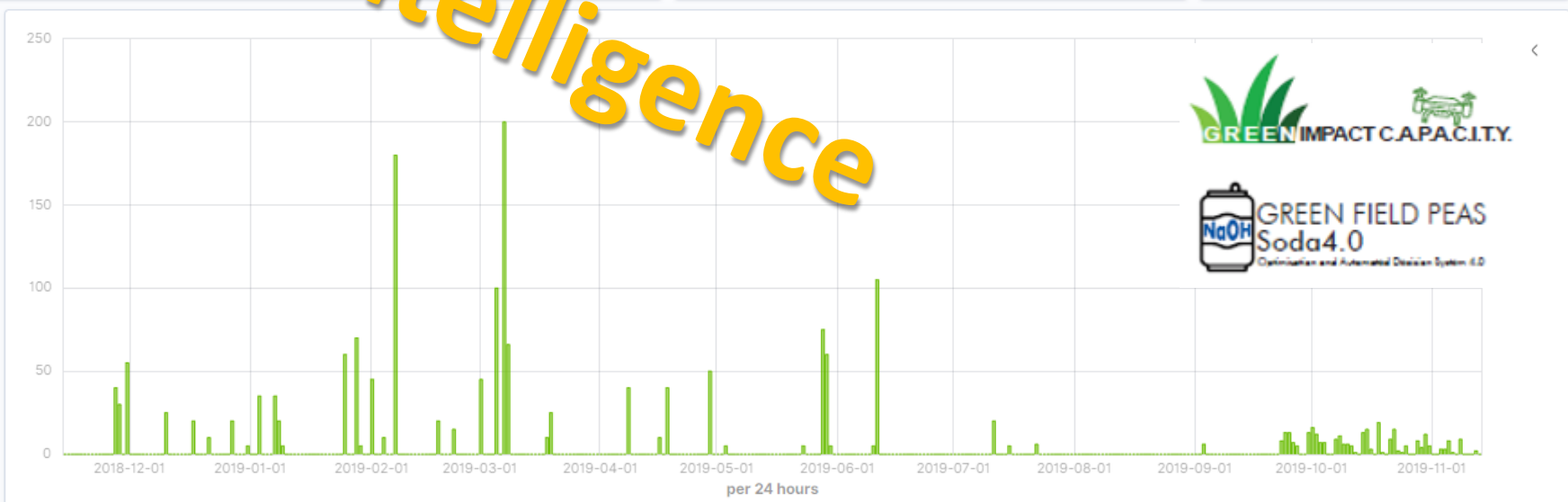
264.491
50th percentile of ore tra inizio e fine lavoro

673.151
Media ore passate tra inizio e fine lavoro

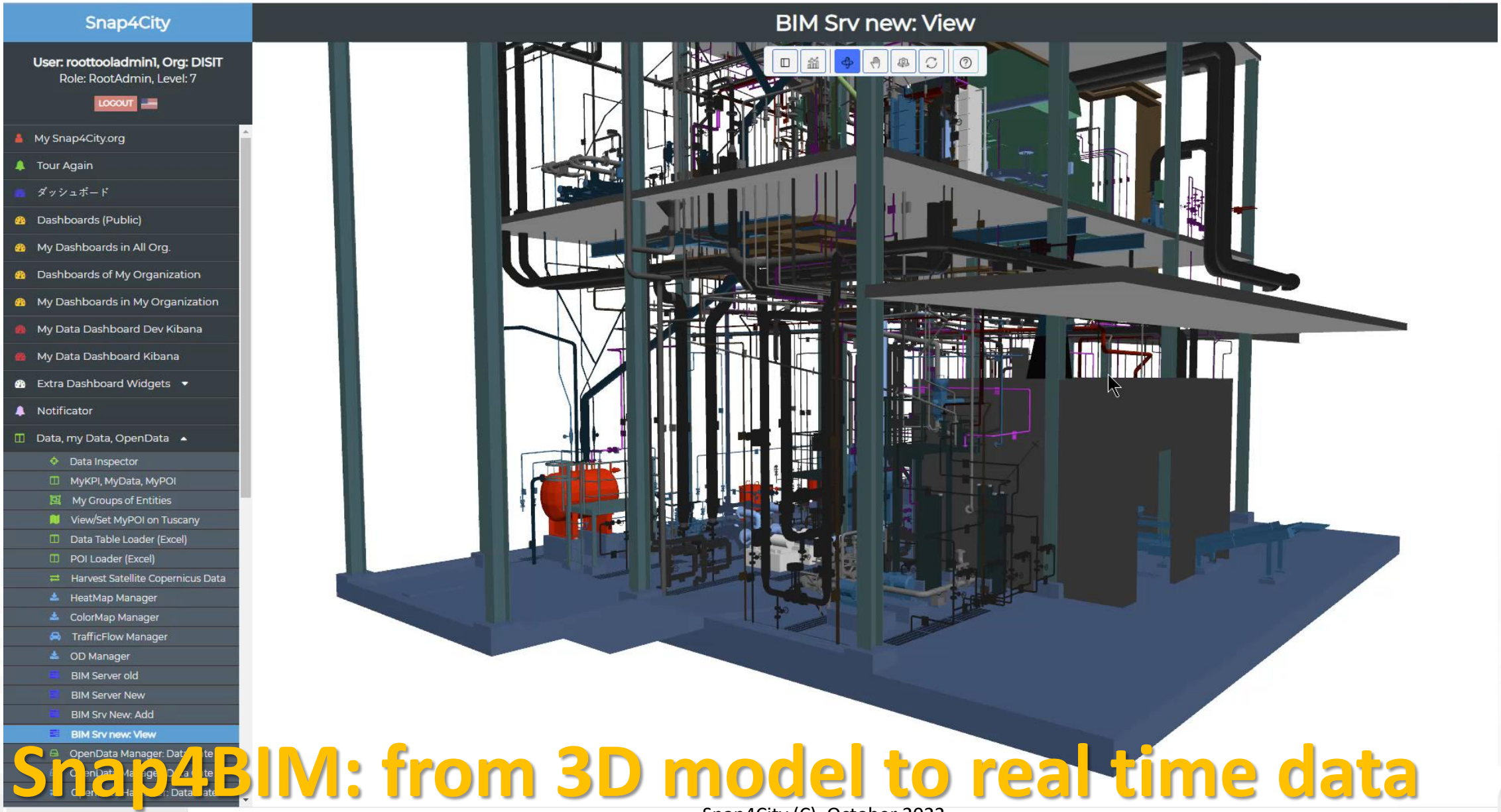
CLORURO FERRICO STANDARD
CARBONATO DI POTASSIO
CICLO SALAMOIA IPOSODIO
IMPIANTO 3FC CARICO PRODOTTI

Maintenance Intelligence



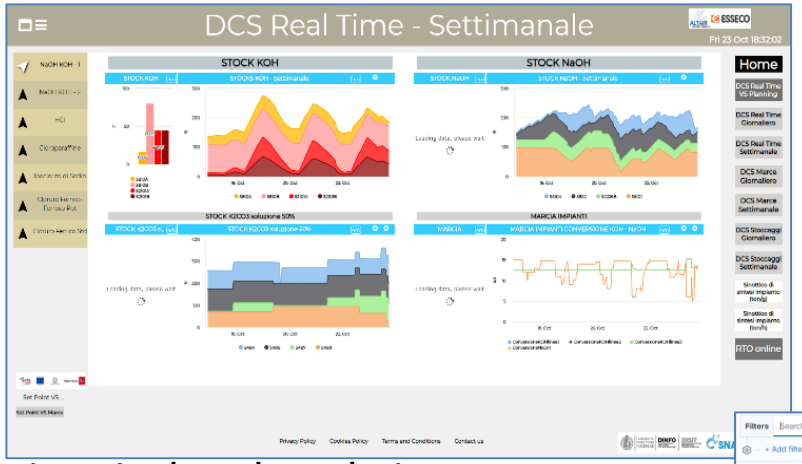


Digital Twin Local

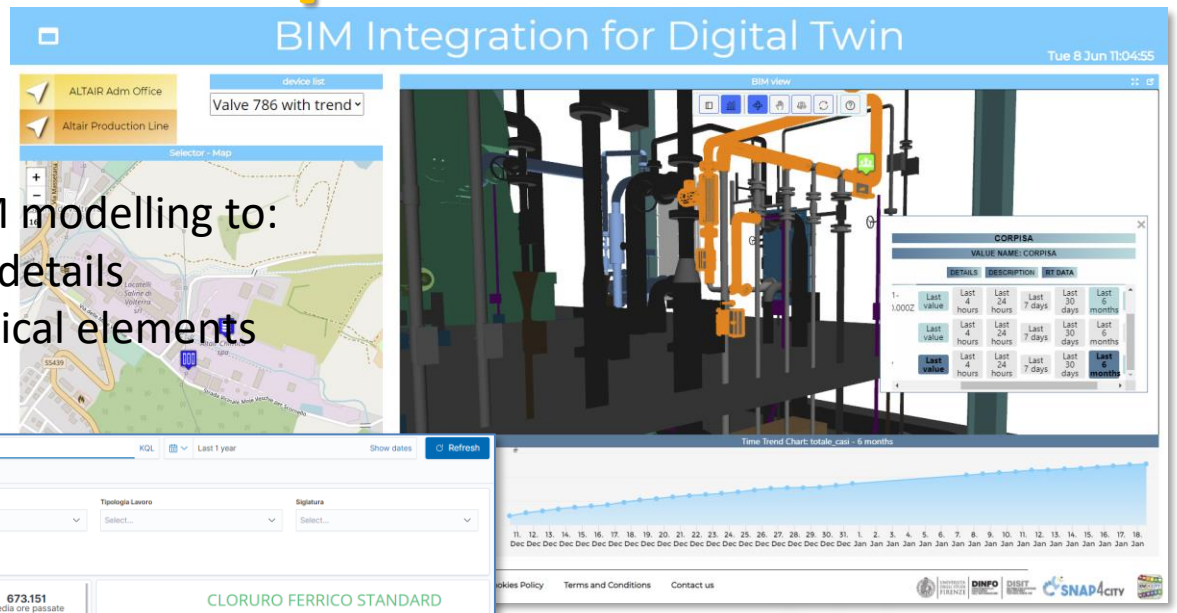


Snap4BIM: from 3D model to real time data

Closing the loop

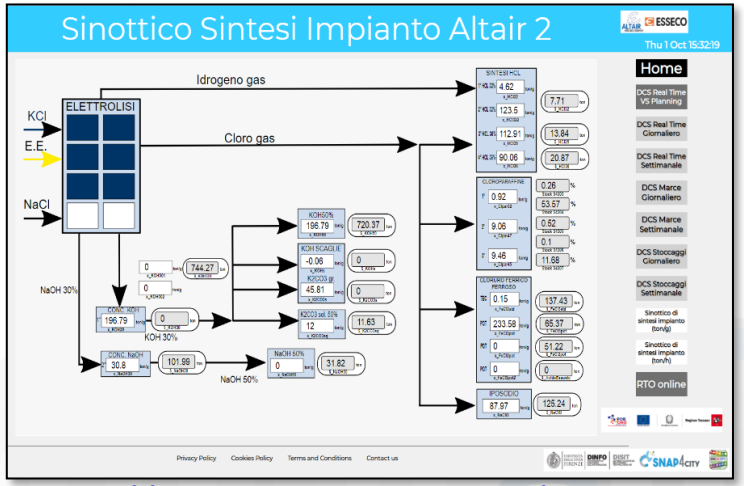


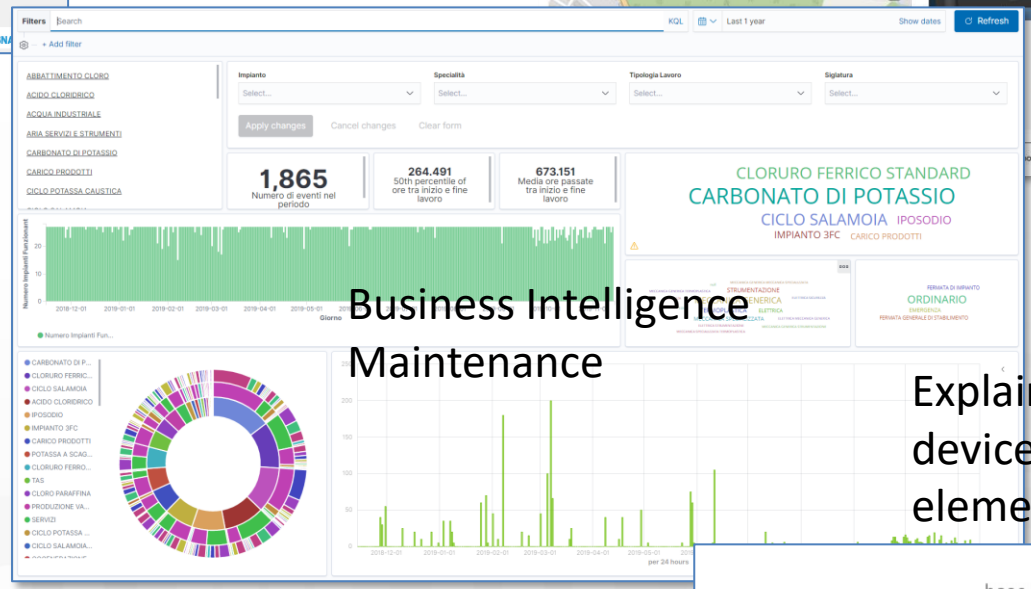
Historical and Real Time Data



Map and 3D BIM modelling to:
-- represent the details
-- associate physical elements with data

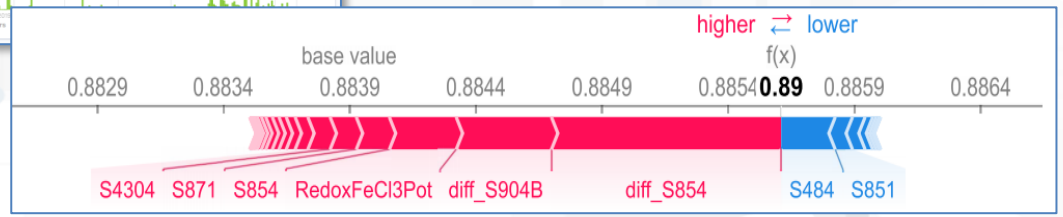
Synoptics for real time monitoring





Business Intelligence Maintenance

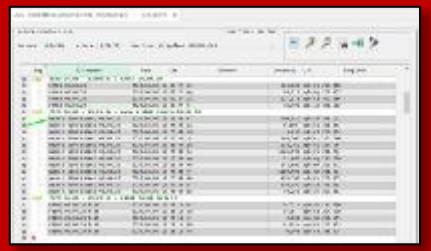
Explainable AI to map critical values of devices and detection to physical elements in the plant



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

GeNotiLab Architecture for ALTAIR

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



AS400

IOT App

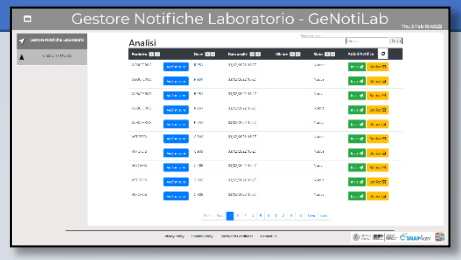
Users

Analysis

Notifications

IOT App Analytics

Dashboards



IOT App Management

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

IOT App Vs Telegram

Telegram Bot

Sinottico Impianto

Sinottico Impianto Presse - Autoclave

Mon 4 Oct 15:34:59

Stato Presse

OFF 1, OFF 2, OFF 3, OFF 4, OFF 5, ON 6
OFF 7, OFF 8, OFF 9, OFF 10, ON 11, OFF 12
OFF 13, ON 14, OFF 15, OFF 16, OFF 17, OFF 18
OFF 19, OFF 20, OFF 21, OFF 22, OFF 23

Select Pressa

PRESSA 6

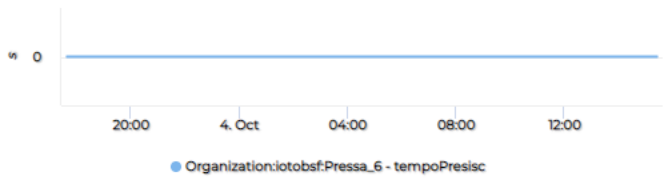
Press to update the list

Status

NO STATUS

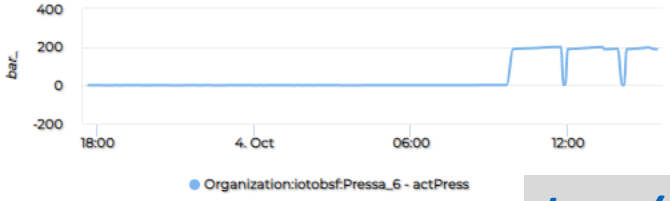
Tempo Vulcanizzione Pressa

Tempo Preriscaldo Pressa



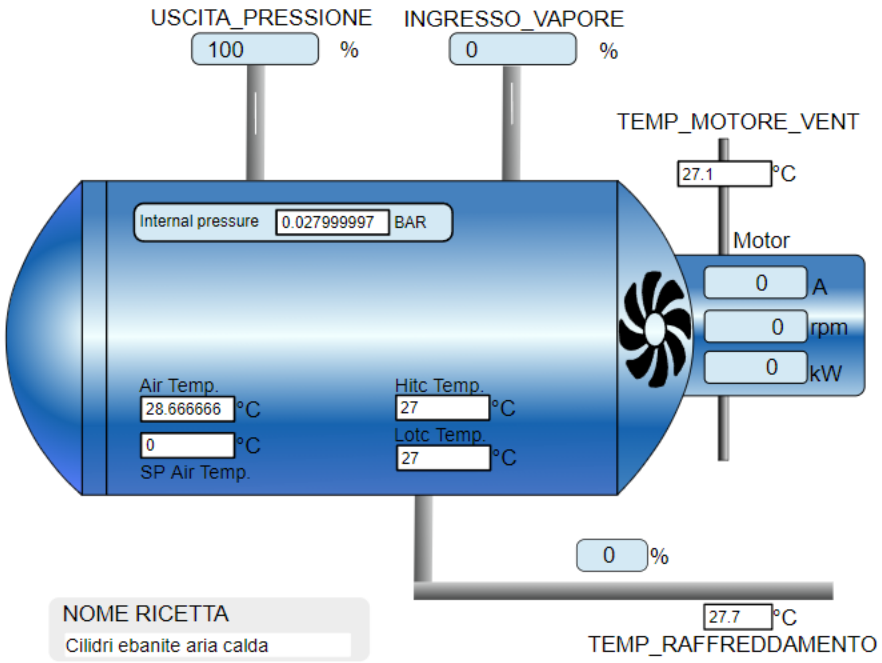
Temperatura Settore Pressa

Pressione Pressa



Temperatura Piani Pressa

Stato autoclave



NOME RICETTA
Cilidri ebanite aria calda

- Main Dashbaord
- Autoclave db - Weekly
- Autoclave KPI - Weekly
- Impianto Presse - Weekly
- OpcUaValues - Weekly
- OpcUaValues Trend Comparison

http://dashboard/dashboardSmartCity/view/index.php?iddasboard=MTk=

Energy monitoring and business intelligence

Green and Data Driven District @ MIND

Aggregated KPI | JuicePark | SmartPole | CityAnalytics

enel x

Energy produced to date		CityAnalytics insight		Videoanalysis – KPI to date	
JuicePark	0 kWh	Average daily people	9845.3	People counted	0
SmartPole	27.341 kWh	Average Milan resident over tourist ratio	1.57	Vehicle counted	520
				People aggregation	0
WiFi sessions daily peak		**SOS events to date**		**Vehicle charging sessions to date**	
Max connected devices	0	SmartPole requests	0	EV car	0
		JuicePark requests	0		
		AED requests	0		

Juice Park
Detailed KPIs

Smart Pole
Detailed KPIs

Privacy Policy Cookies Policy Terms and Conditions

enel-x juice park

enel x
Thu 21 Apr 10:48:31

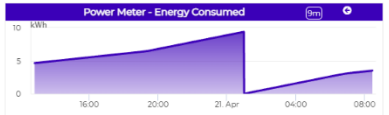
main
smart pole

Charging Station

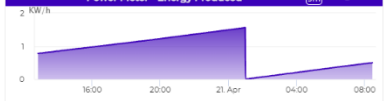
Number of Daily Ses...	Daily Energy Consumpti...
0 #	0 kWh
Number of Total Ses...	Total Energy Consumed
10 #	15 kWh

SOS - Number of Pushes	SOS - Last button us...
7 #	29/03/2022 11:48
SOS - Daily Number of Button Pus...	
0 #	

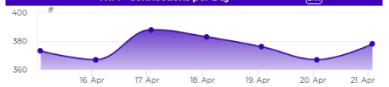
Power Meter - Energy Consumed



Power Meter - Energy Produced

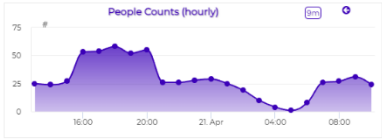


WiFi - Connections per Day

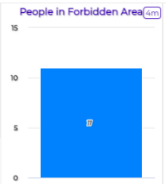


Video Analysis

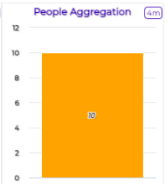
People Counts (hourly)



People in Forbidden Area



People Aggregation



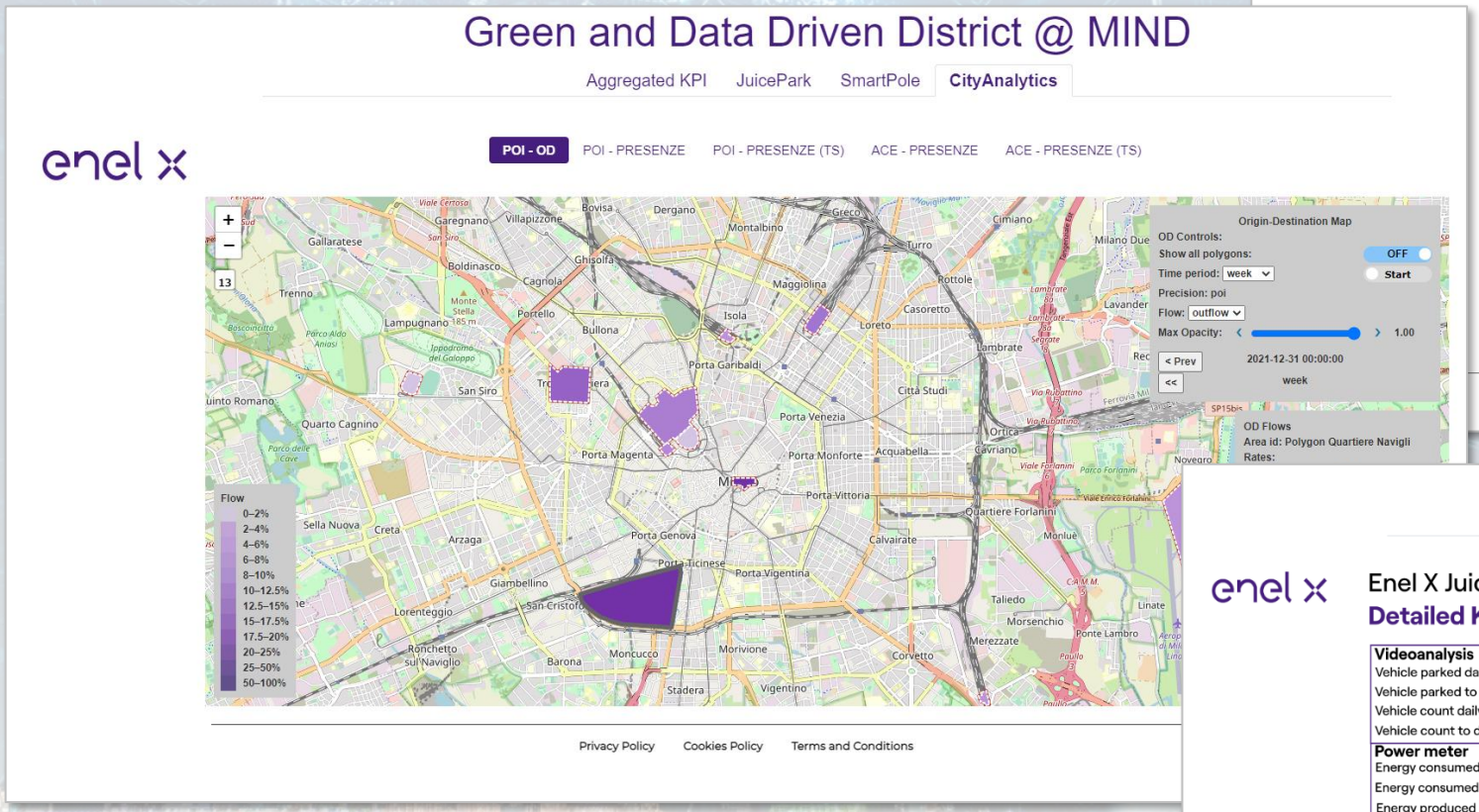
Last Event	Last Event
21/04/2022 10:48	21/04/2022 10:47

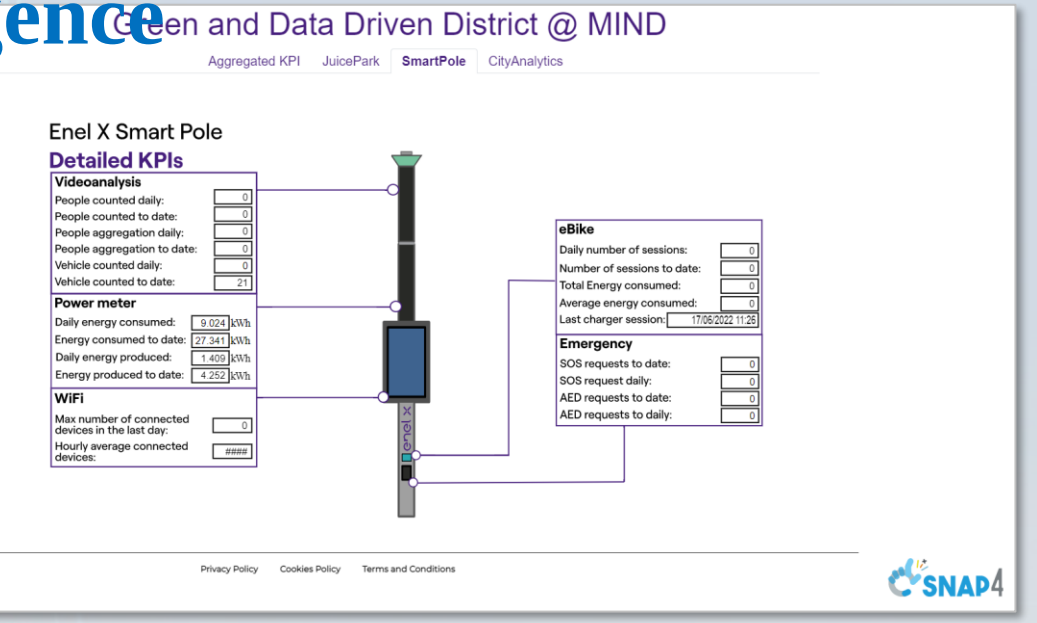
Privacy Policy Cookies Policy Terms and Conditions

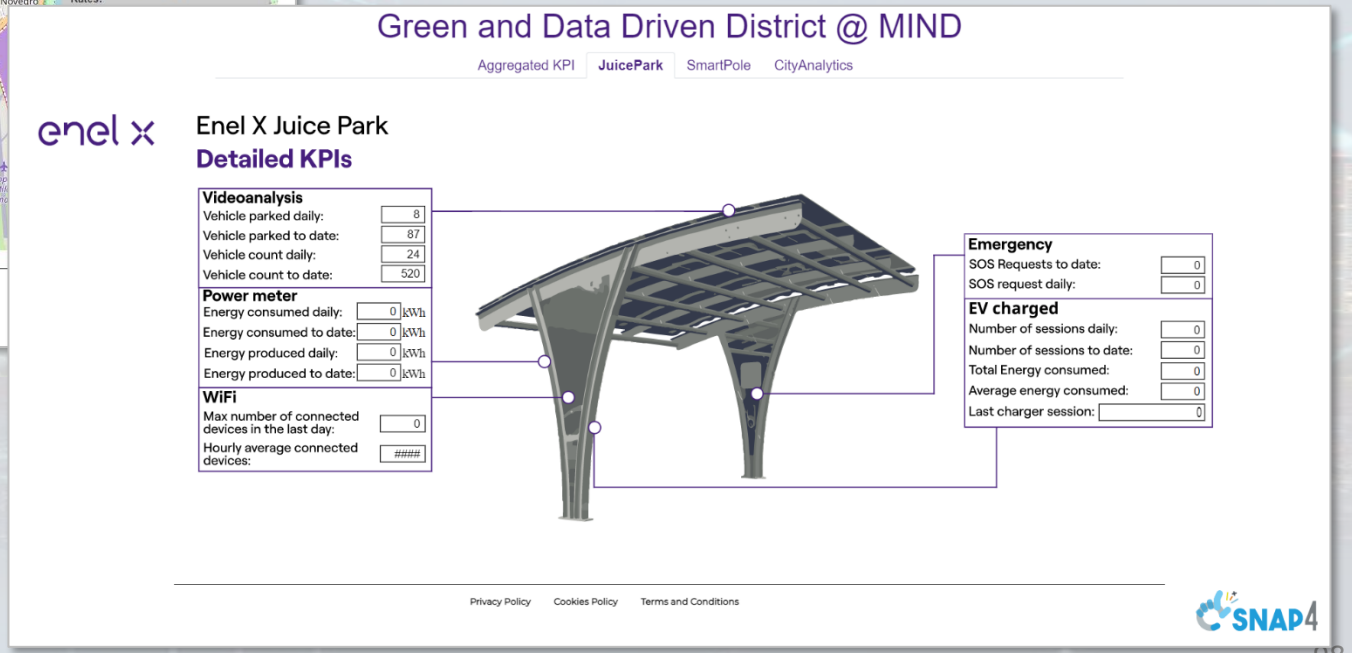
SNAP4

enel x

Energy monitoring and business intelligence







Herit-Data Twitter Vigilance

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

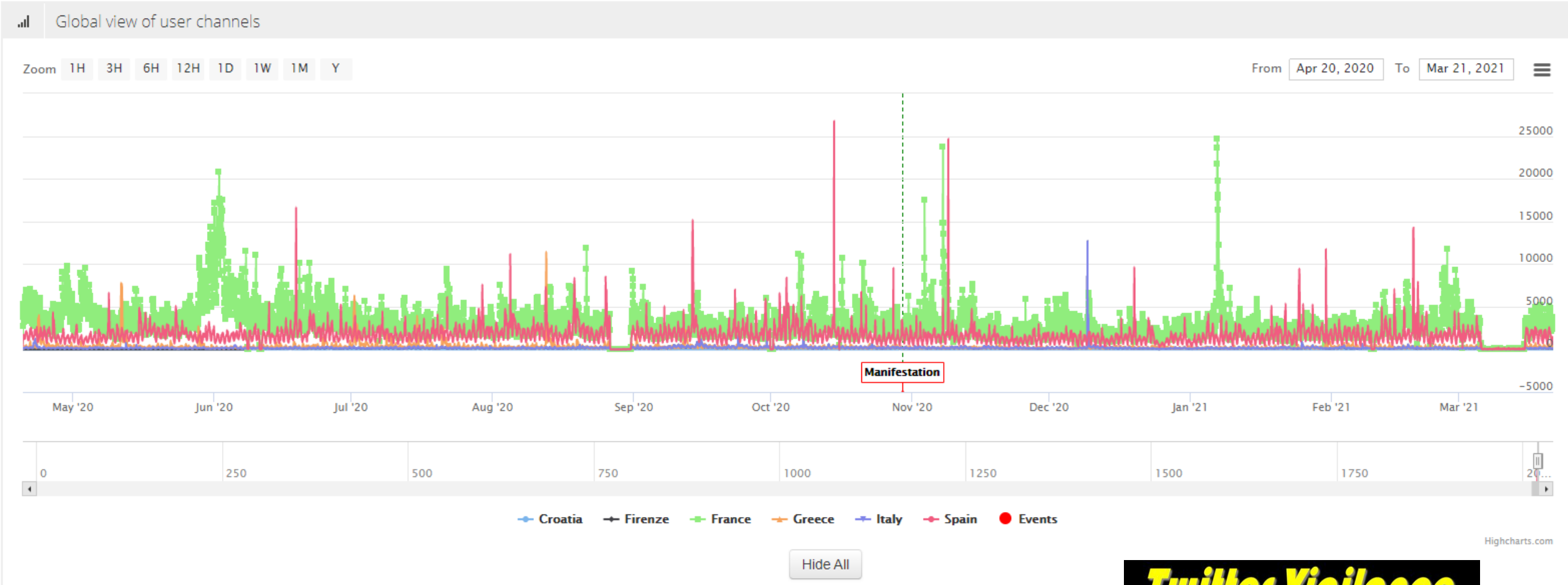
Twitter Vigilance Herit-Data: *Some Numbers*

Channel Name	Total Number of Collected TW+RTW	Number of Collected Tweets	Number of Collected Retweets	Twitter Volume Processing Time Range	NLP & Sentiment Analysis Processing Time Range	NLP & Sentiment Analysis Languages
Spain	113.7 Millions	40.99 Millions	72.49 Millions	From 30-01-2020 to current datetime	From 01-02-2020 to current datetime	English, Spanish
France	50,1 Millions	16.0 Millions	34.1 Millions	From 30-01-2020 to current datetime	From 01-02-2020 to current datetime	Italian, English, French
Greece	12.3 Millions	4.2 Millions	8.1 Millions	From 30-01-2020 to current datetime	From 01-02-2020 to current datetime	English
Italy	2.97 Millions	1.0 Million	1.9 Millions	From 30-01-2020 to current datetime	From 01-02-2020 to current datetime	Italian, English
Croatia	35.8 Thousands	15.5 Thousands	19,8 Thousands	From 30-01-2020 to current datetime	From 01-02-2020 to current datetime	English

Updated: Dec. 2021

Twitter Vigilance

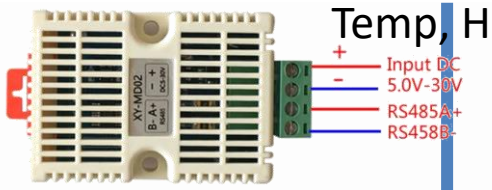
Overview on the last 12 months



Twitter Vigilance

IOT App Smart Industry 4.0
ModBus Integration

Devices

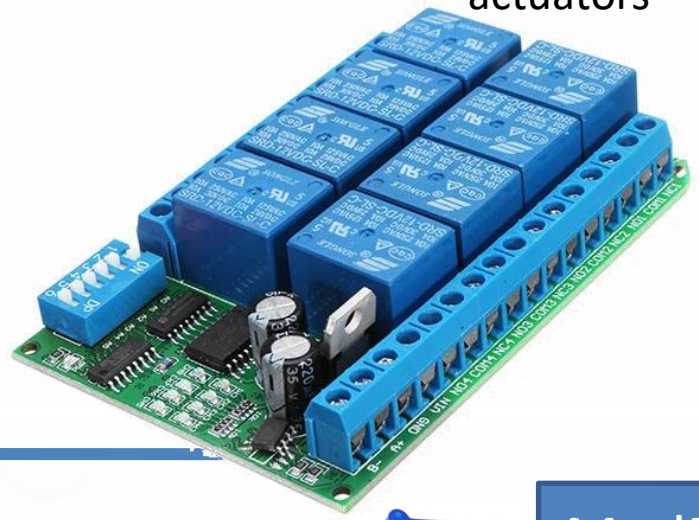


Temp, Humidity

Energy Metering

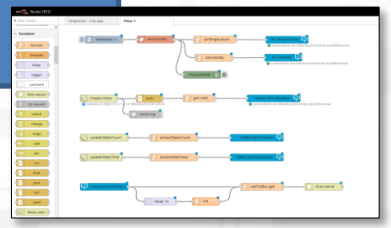
Modbus

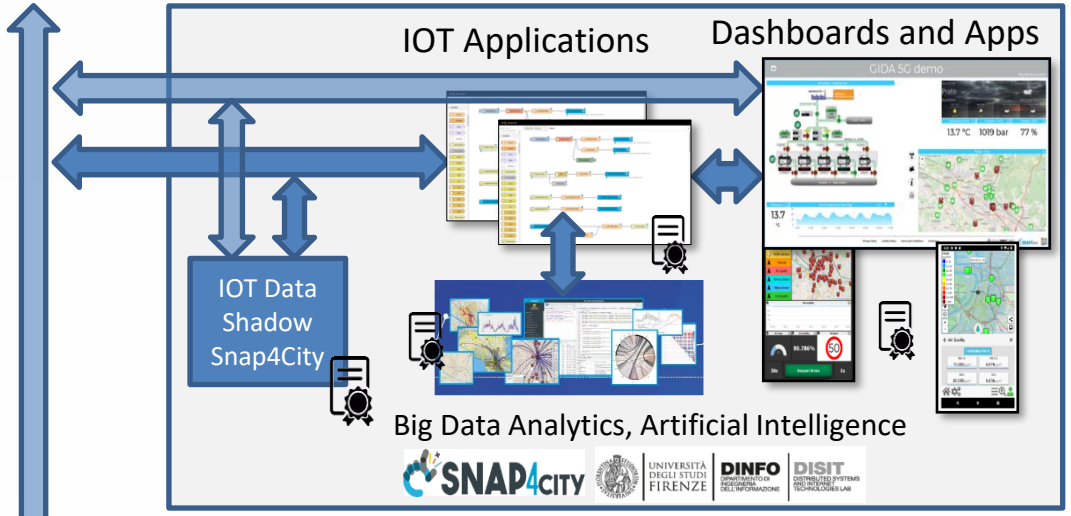
8 Relais, actuators



USB -- ModBus

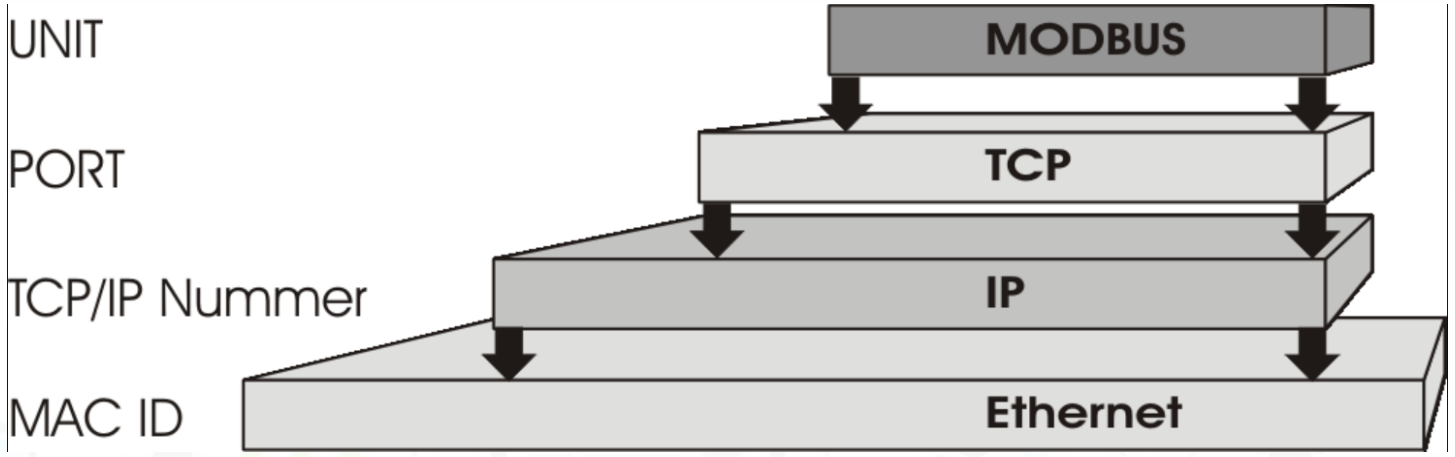
ModBus to Snap4City Gateway Edge





- A large range of devices: sensors and actuators
- Over serial as RS485 and/or IP

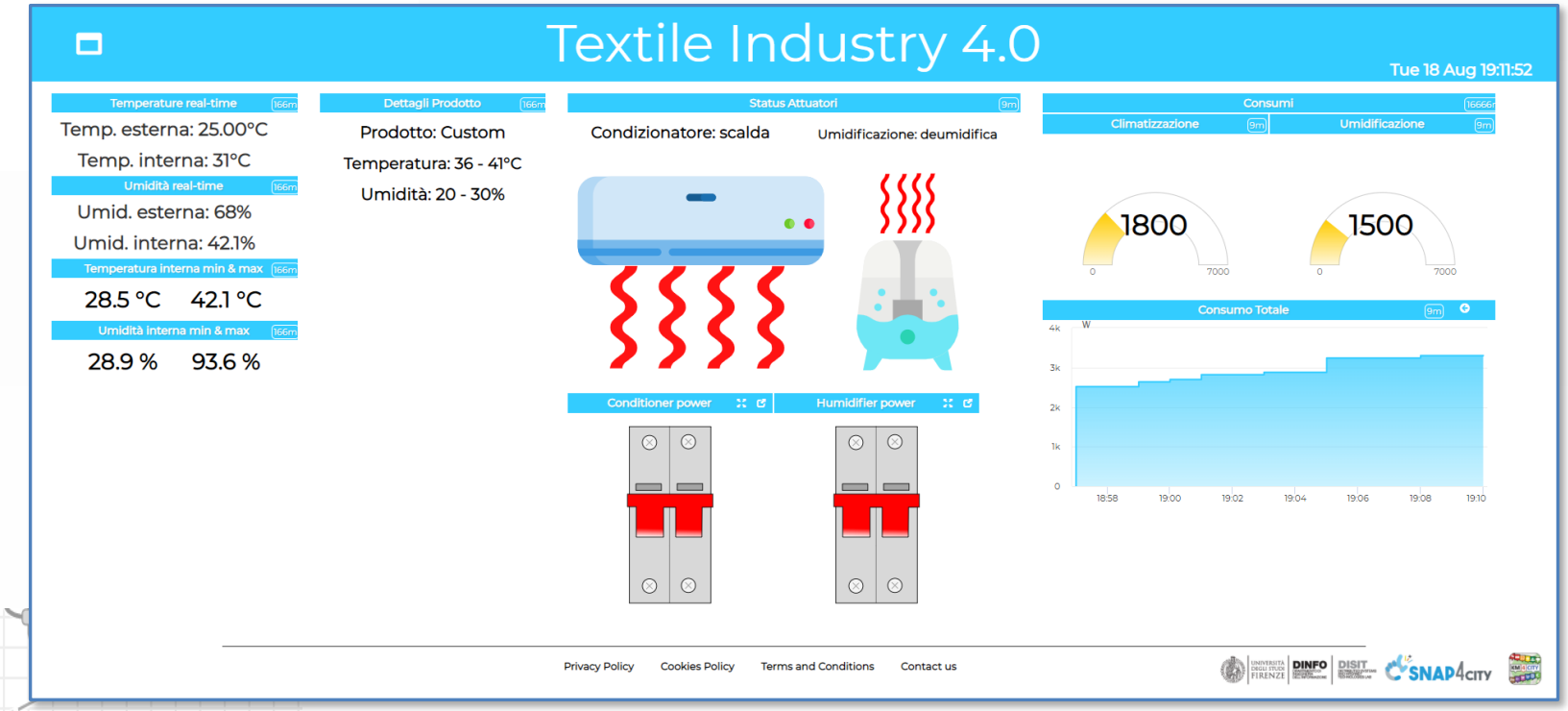
- modbus-response
- modbus-read
- modbus-getter
- modbus-flex-getter
- modbus-write
- modbus-flex-write
- modbus-server
- modbus-flex-server
- modbus-queue-info
- modbus-flex-connector
- modbus-io-config
- modbus-response-filter

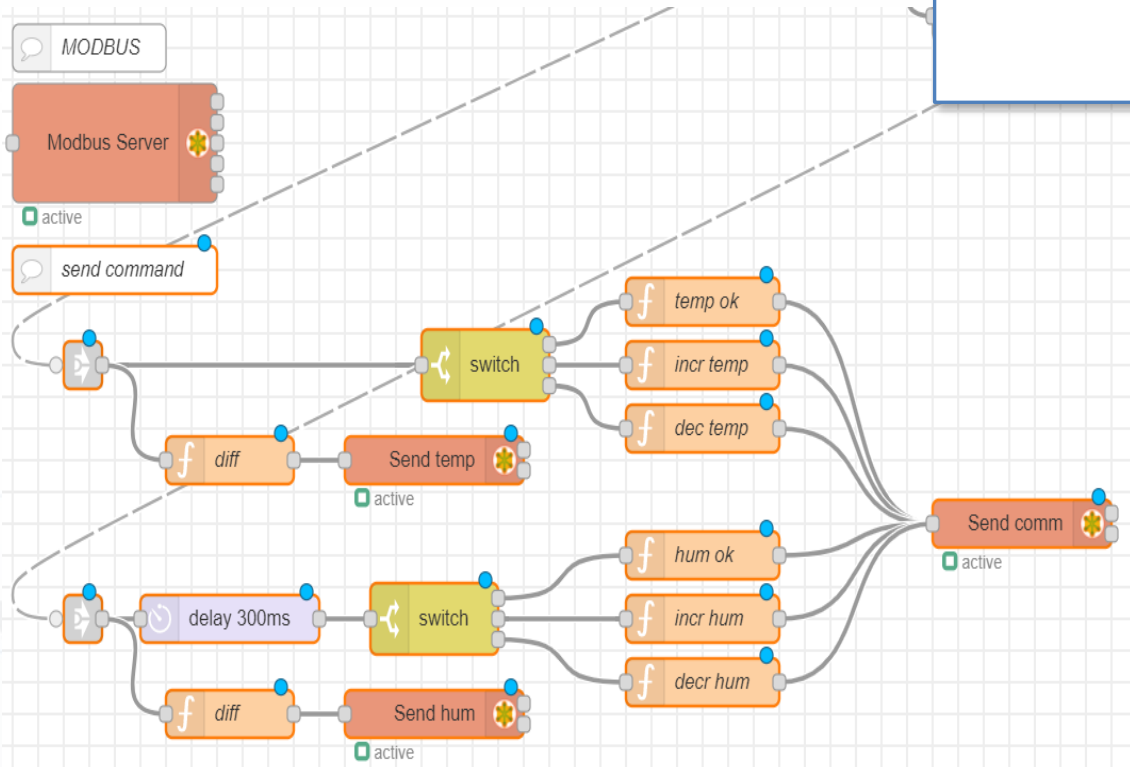


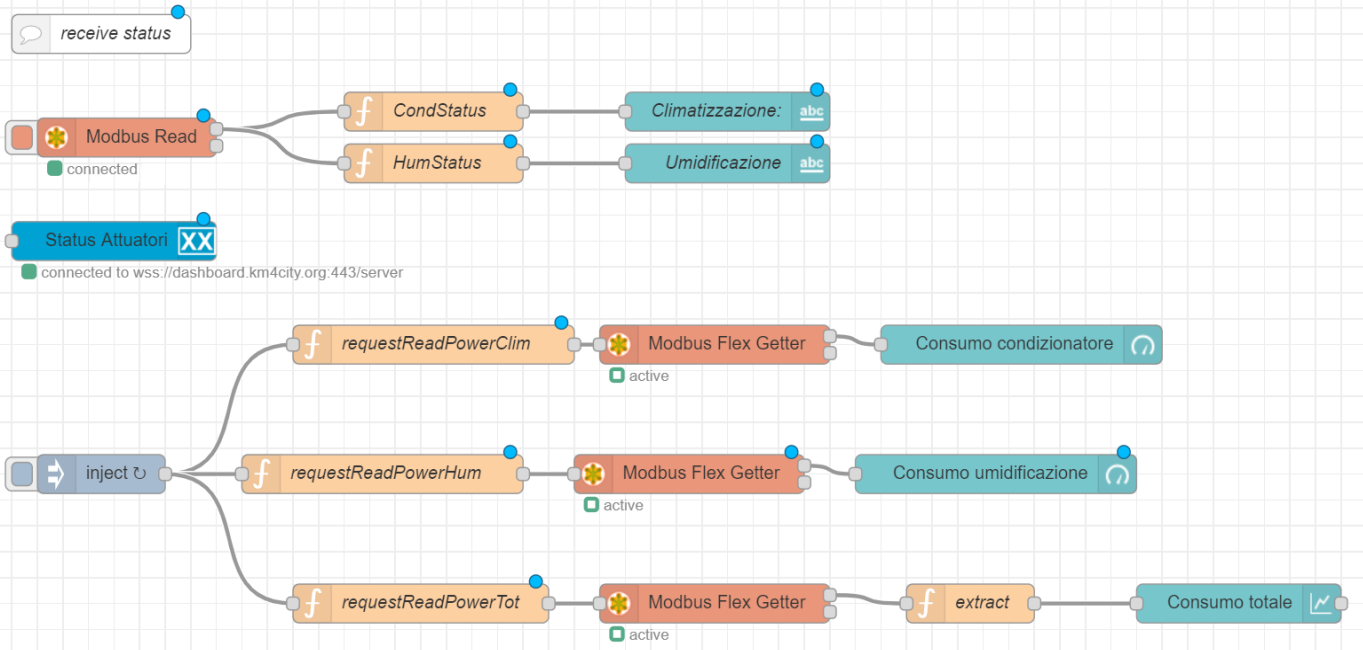
- ..

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

Modbus







IOT App vs Smart Home
Snap4Home

Snap4Home

Sonoff: Controlling Energy Power

Philips Hue: Controlling Lights

Hue: Motion Control / Alarm

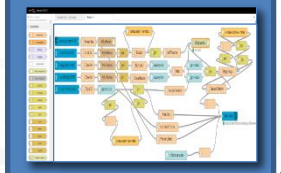
Measuring
Energy Consumption

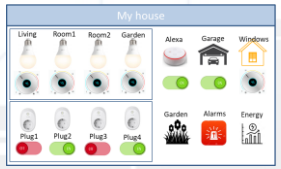
TP Link: Controlling / Measuring Energy Plugs

Alexa: Voice Control

IOT Edge:

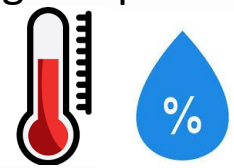
Raspberry pi: Node-RED + Snap4City





Local Control

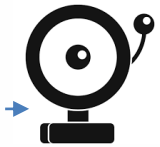
Measuring Temperature and Humidity



Garage Door

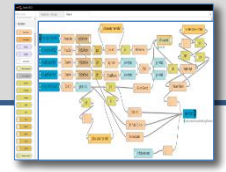
Window
Roller Shutters

Controlling Motors

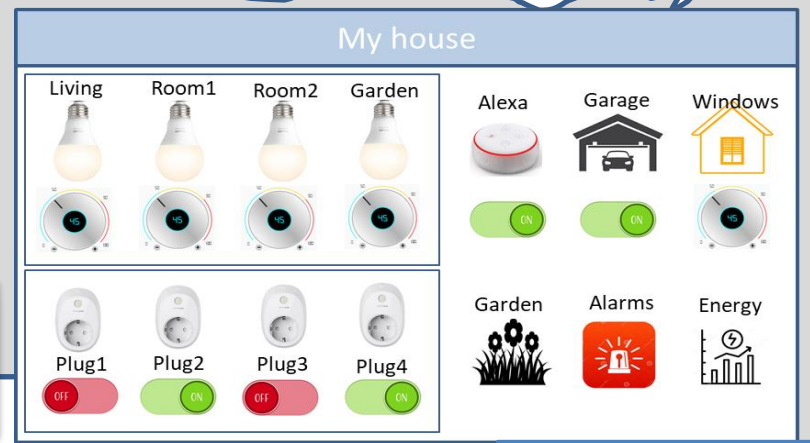


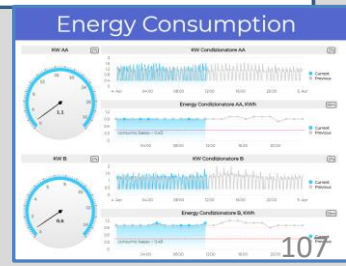
Alarm sound
and light

Controlling
Irrigators



SNAP4CITY

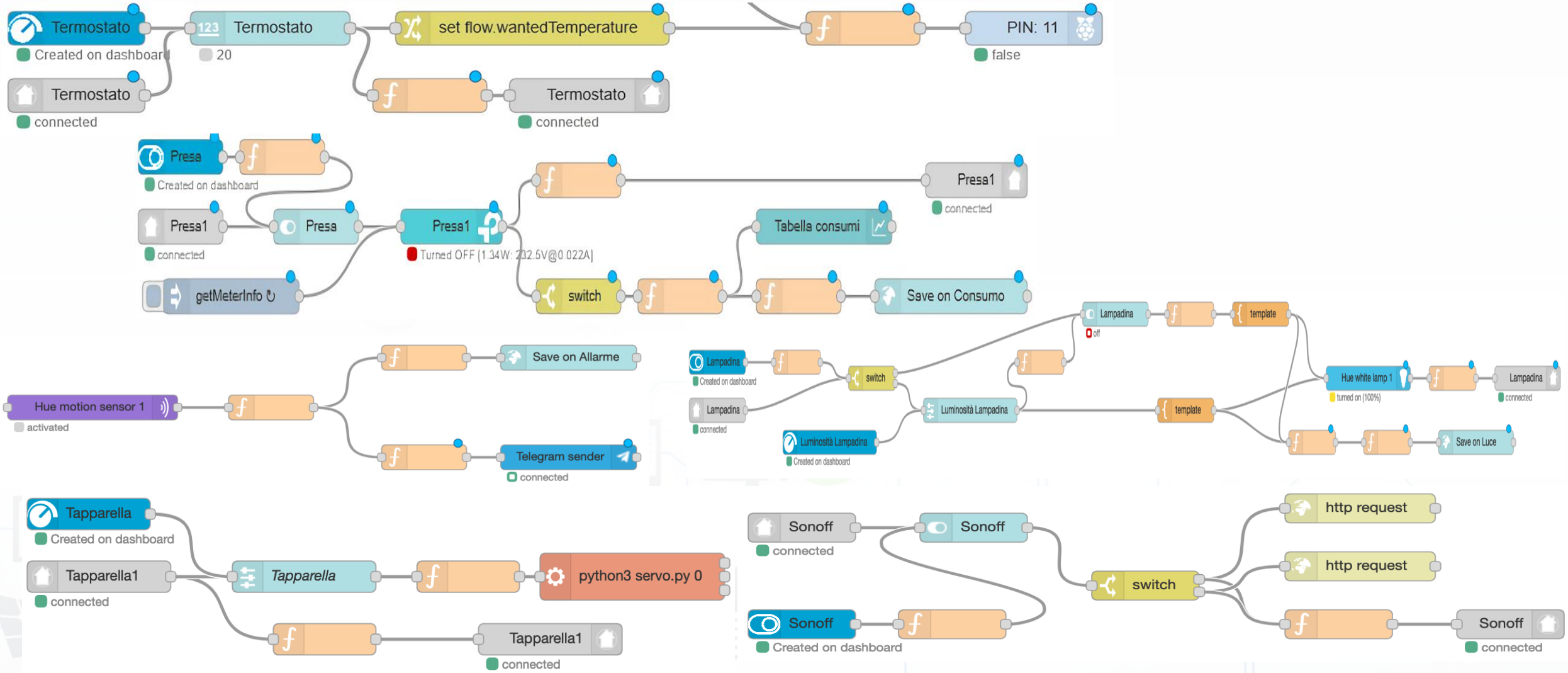




Environmental Contextual data from the city
Historical Data, Remote Control, Mobile App

https://www.snap4city.org/620

Example: IOT App on Snap4Home



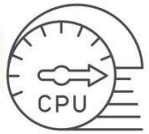
Snap4Home

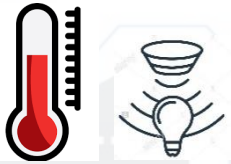
Hue Hub

Motion Control / Alarm

TP Link plugs: meter

Alexa: Voice Control





IOT Edge:

Raspberry pi: Node-RED + Snap4City MicroService Library

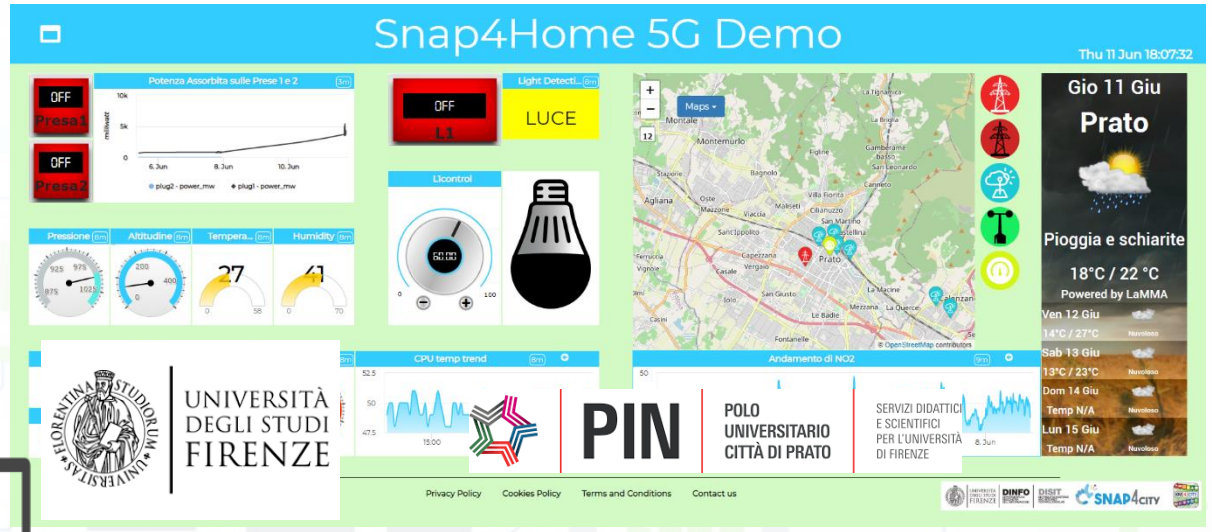
5G gateway

FIWARE Orion Broker

Dashboards

Advanced Smart City API

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



https://www.snap4city.org/369

Snap4Home

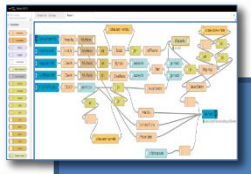
Philips Hue: Controlling Lights

Hue Hub

Hue: Motion Control / Alarm

TP Link: Controlling / Measuring Energy Plugs

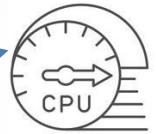
Alexa: Voice Control



IOT Edge:

Raspberry pi: Node-RED + Snap4City

Measuring: Temperature, Humidity, light in the room

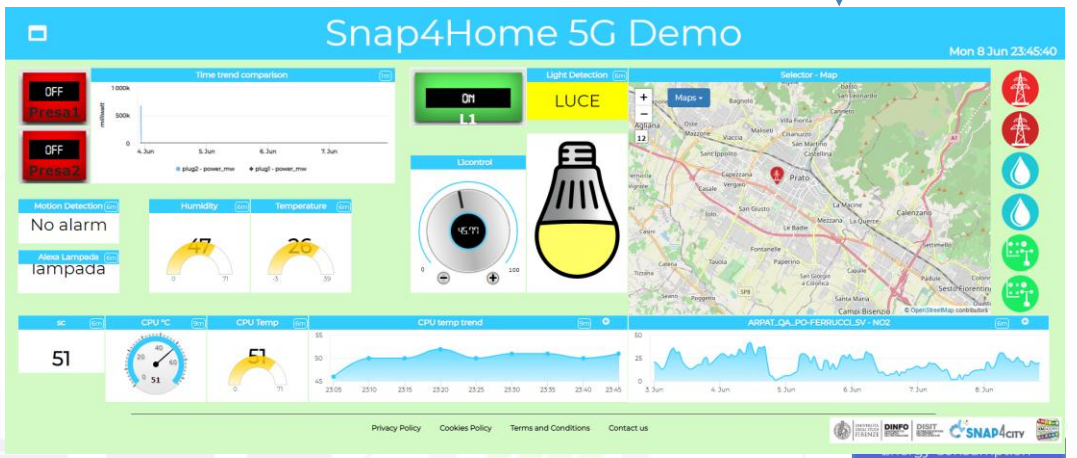


Monitoring: CPU clock, status

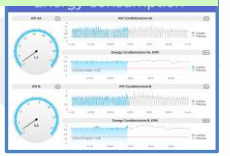
5G gateway

Internet

SNAP4CITY

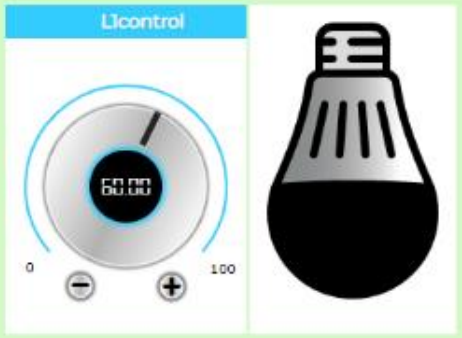


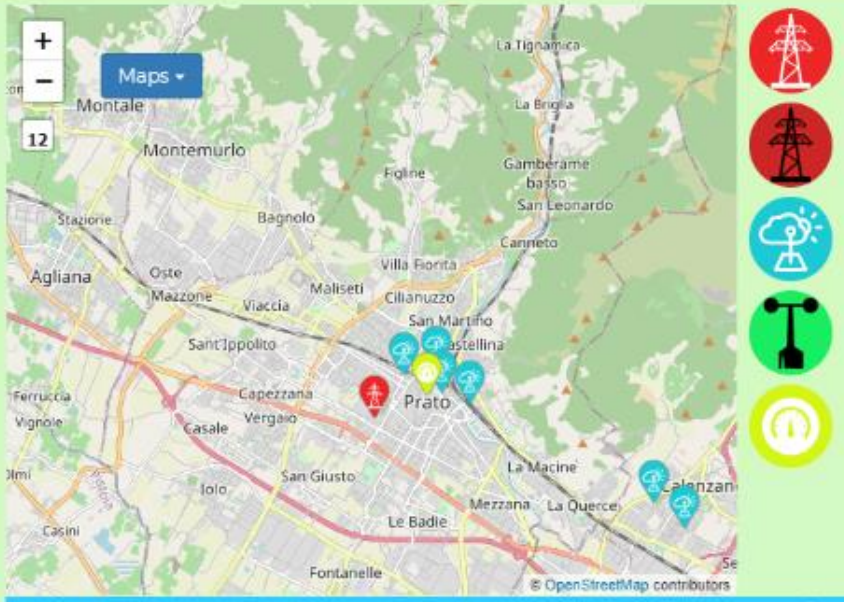
Environmental Contextual data from the city.
Historical Data, Remote Control, Mobile App

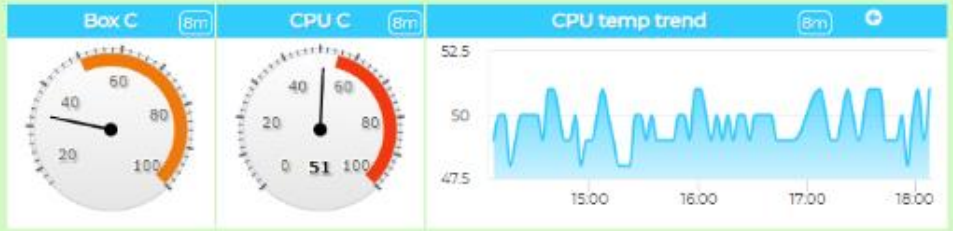


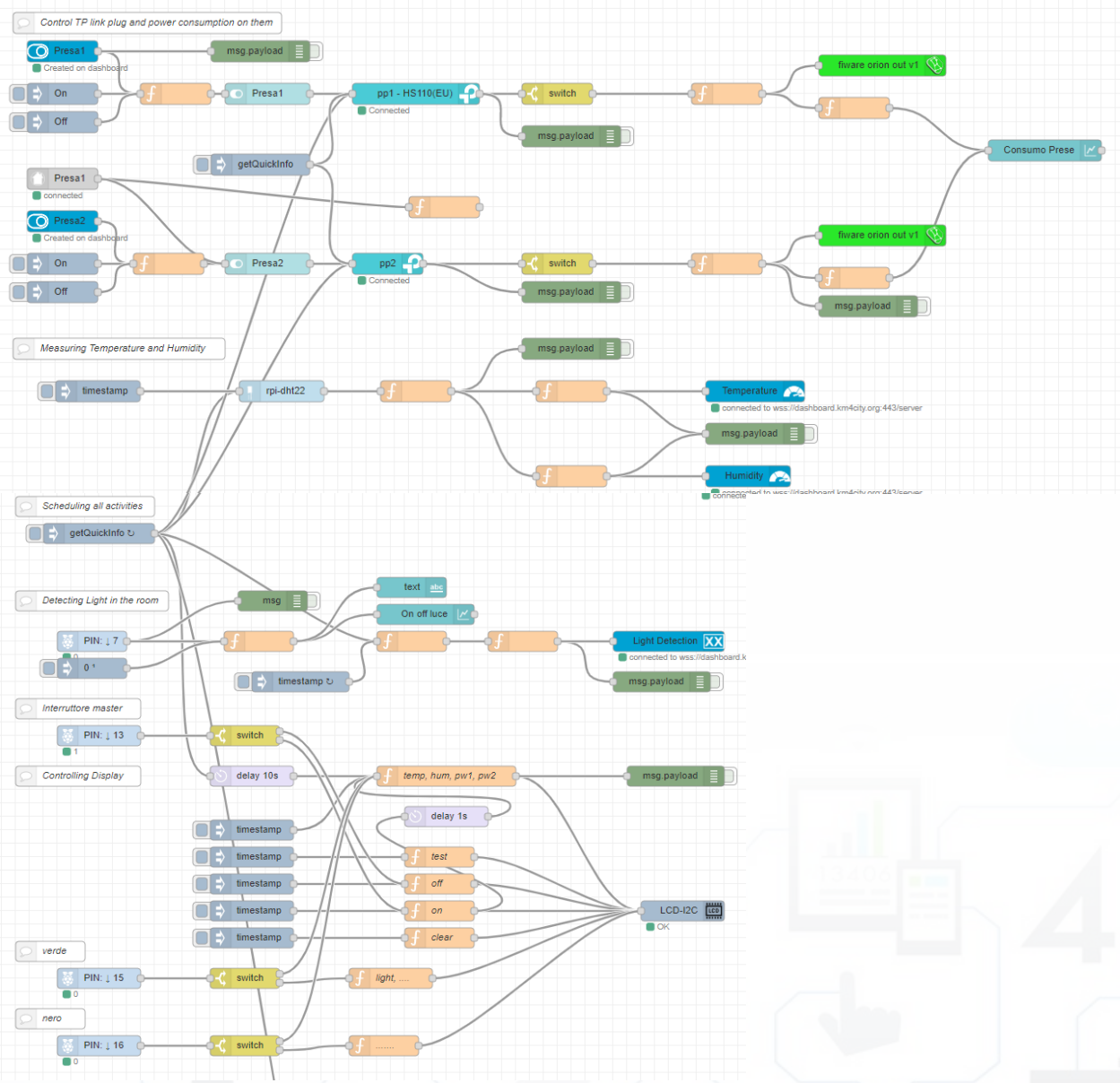
Snap4Home 5G Demo

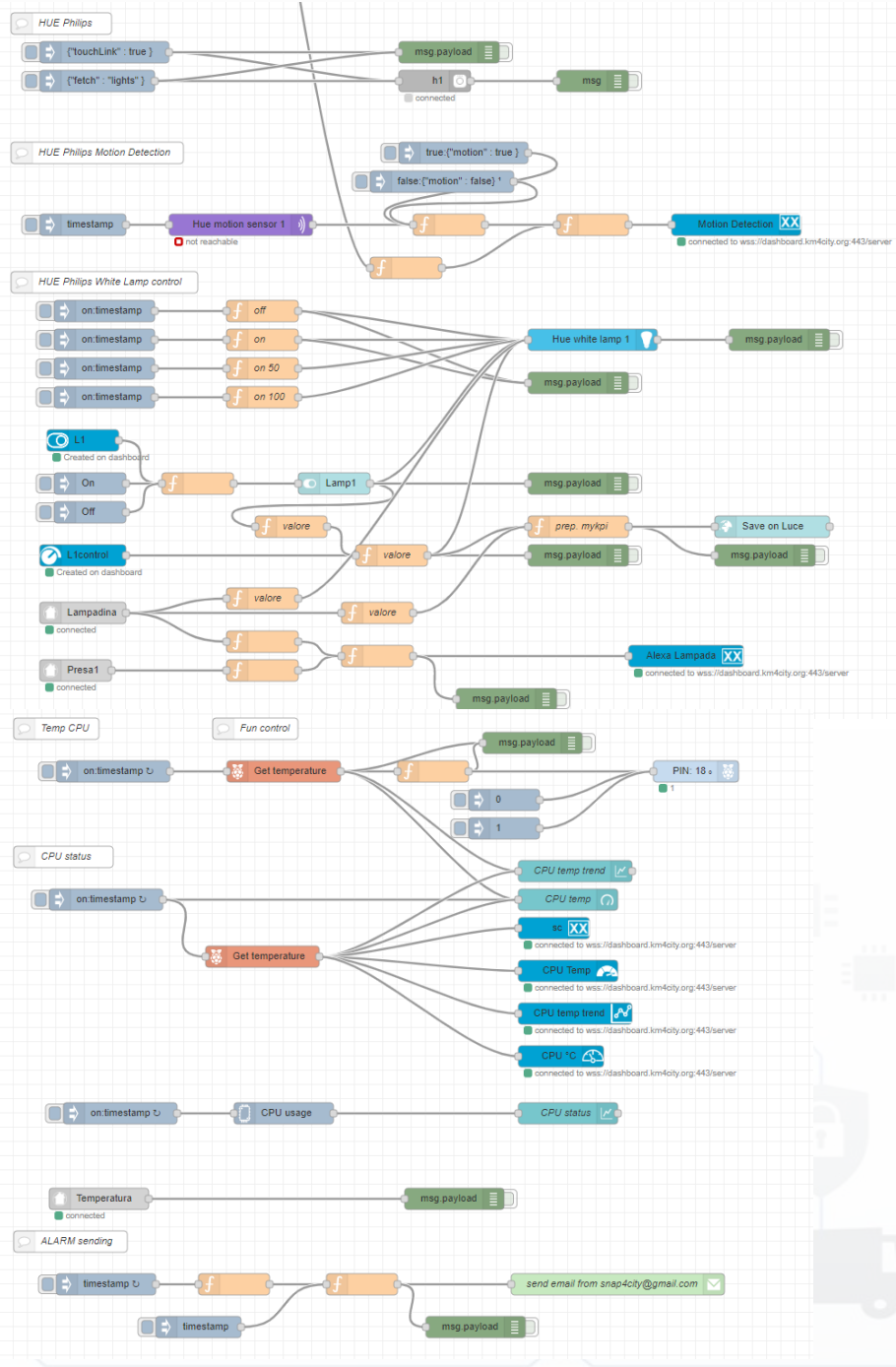
Thu 11 Jun 18:07:32



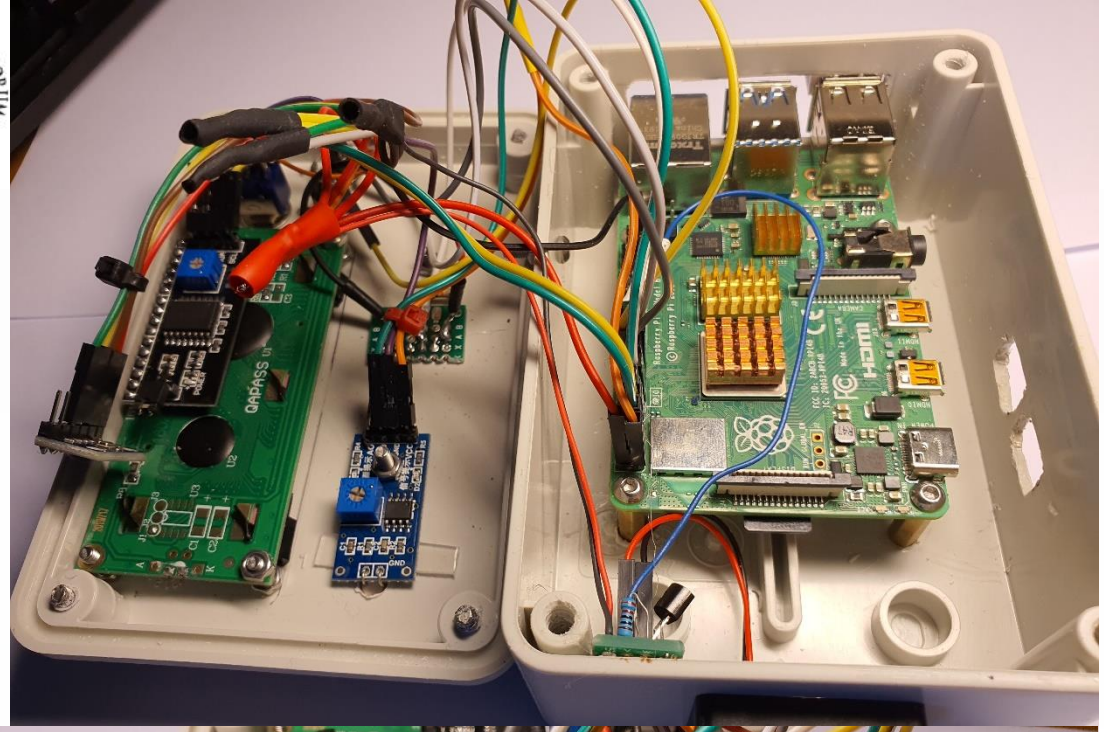


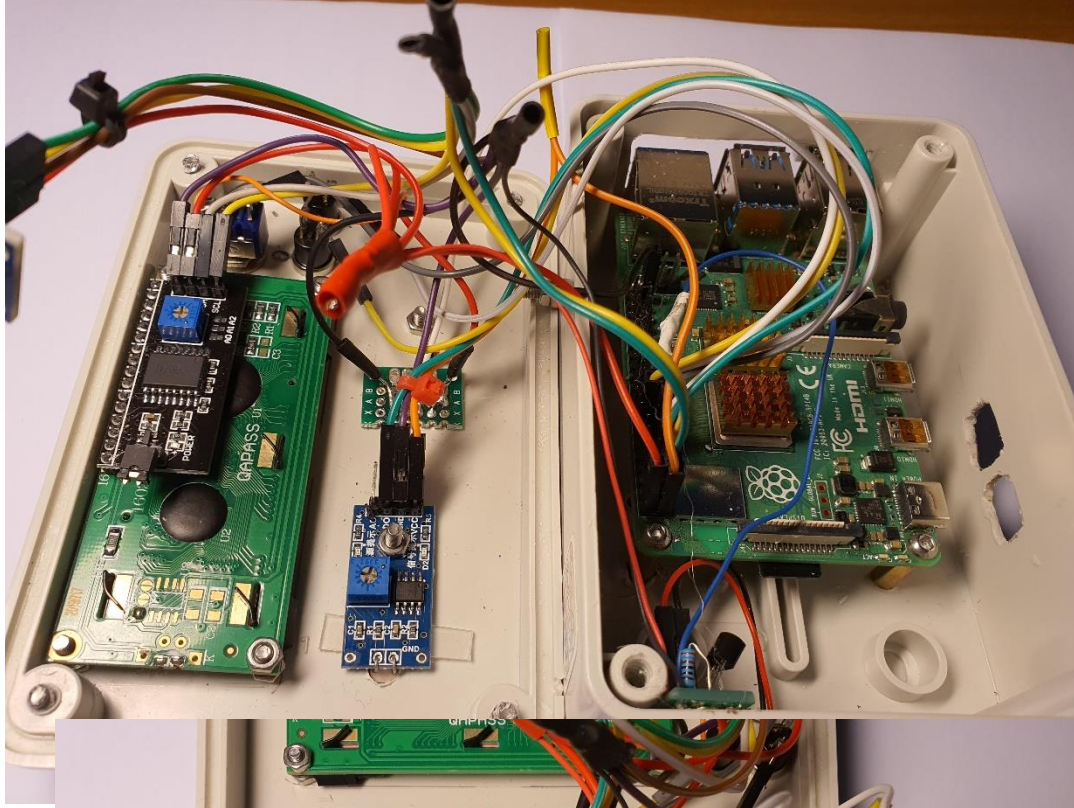


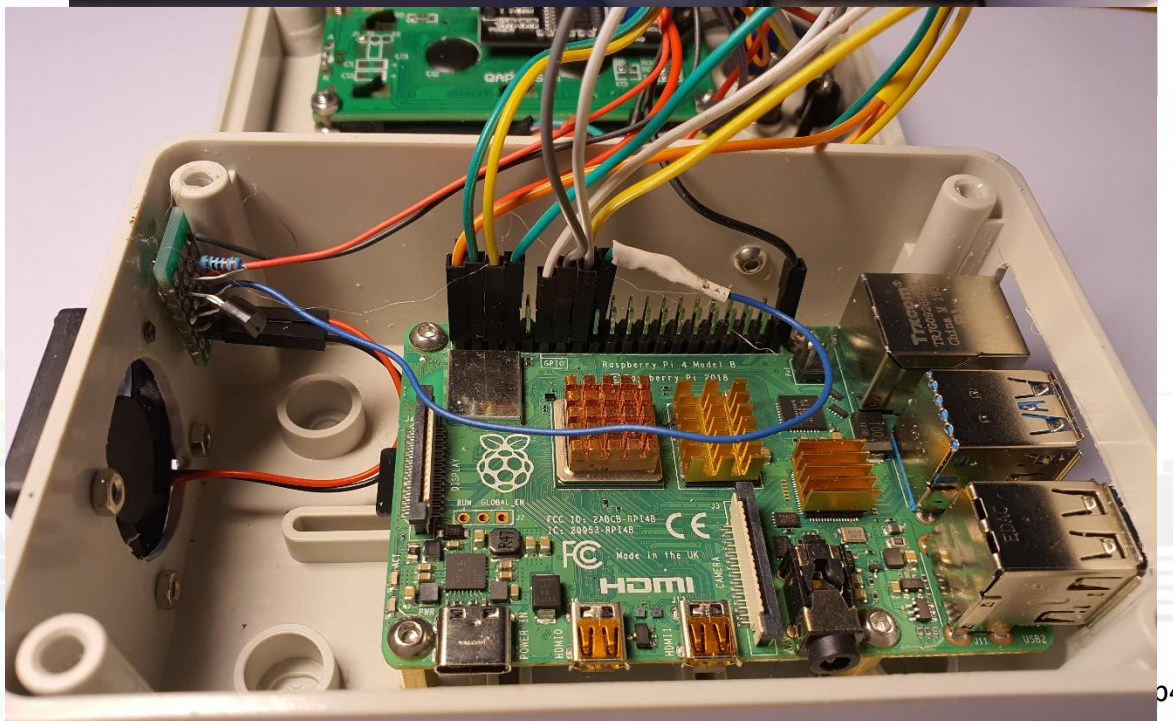

Control TP link plug and power consumption on them
Presa1
Created on dashboard
msg.payload
On
Off
Presa1
pp1 - HS110(EU)
Connected
switch
fiware orion out v1
msg.payload
Consumo Prese
getQuickInfo
Presa1
connected
Presa2
Created on dashboard
On
Off
Presa2
pp2
Connected
switch
fiware orion out v1
msg.payload
Measuring Temperature and Humidity
msg.payload
timestamp
rpi-dht22
Temperature
connected to wss://dashboard.km4city.org:443/server
msg.payload
Humidity
Scheduling all activities
getQuickInfo
Detecting Light in the room
msg
text
On off luce
PIN: 7
0
Light Detection
connected to wss://dashboard.k
msg.payload
timestamp
Interruttore master
PIN: 13
1
switch
Controlling Display
delay 10s
temp, hum, pw1, pw2
msg.payload
delay 1s
timestamp
timestamp
timestamp
timestamp
timestamp
test
off
on
clear
LCD-I2C
OK
verde
PIN: 15
0
switch
light, ...
nero
PIN: 16
0
switch
.....

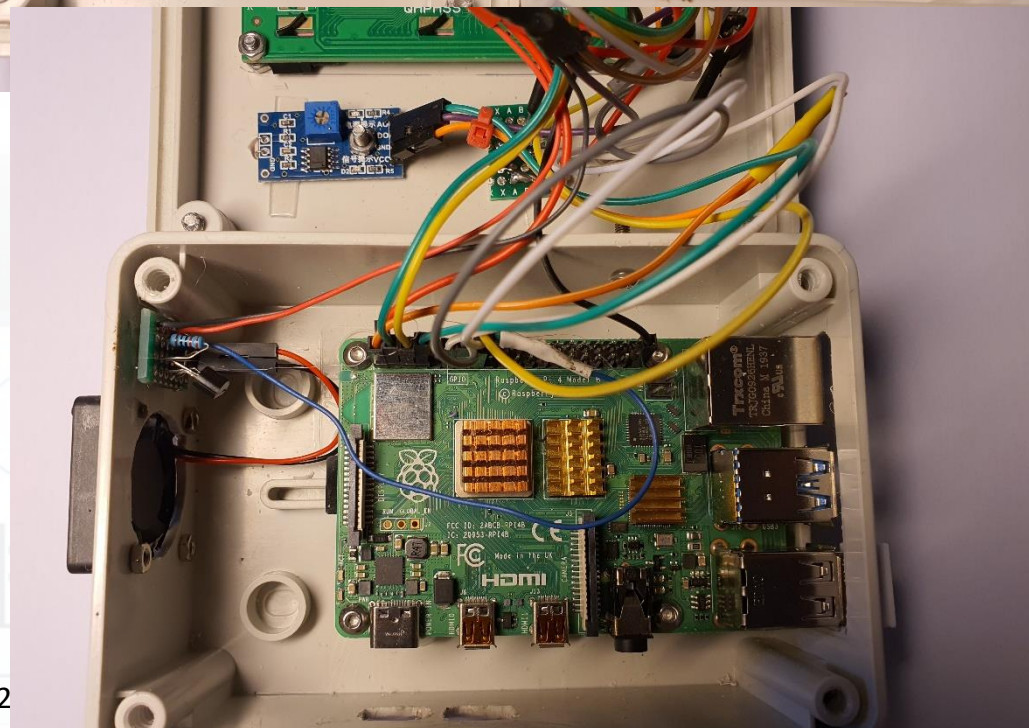

HUE Philips
{"touchLink" : true }
{"fetch" : "lights" }
msg.payload
h1
connected
msg
HUE Philips Motion Detection
true:{"motion" : true }
false:{"motion" : false} *
timestamp
Hue motion sensor 1
not reachable
Motion Detection
connected to wss://dashboard.km4city.org:443/server
HUE Philips White Lamp control
on:timestamp
on:timestamp
on:timestamp
on:timestamp
off
on
on 50
on 100
Hue white lamp 1
msg.payload
msg.payload
L1
Created on dashboard
On
Off
Lamp1
msg.payload
valore
prep. mykpi
Save on Luce
msg.payload
L1control
Created on dashboard
valore
valore
msg.payload
Lampadina
connected
valore
valore
Presa1
connected
Alexa Lampada
connected to wss://dashboard.km4city.org:443/server
msg.payload
Temp CPU
Fun control
on:timestamp
Get temperature
msg.payload
PIN: 18
1
0
1
CPU status
CPU temp trend
on:timestamp
CPU temp
sc
connected to wss://dashboard.km4city.org:443/server
Get temperature
CPU Temp
connected to wss://dashboard.km4city.org:443/server
CPU temp trend
connected to wss://dashboard.km4city.org:443/server
CPU °C
connected to wss://dashboard.km4city.org:443/server
on:timestamp
CPU usage
CPU status
Temperatura
connected
msg.payload
ALARM sending
timestamp
send email from snap4city@gmail.com
timestamp
msg.payload


T:27'C; Hum:43%
P1:NaNW;P2:NaNW
SNAP4CITY
PHILIPS
tp-link





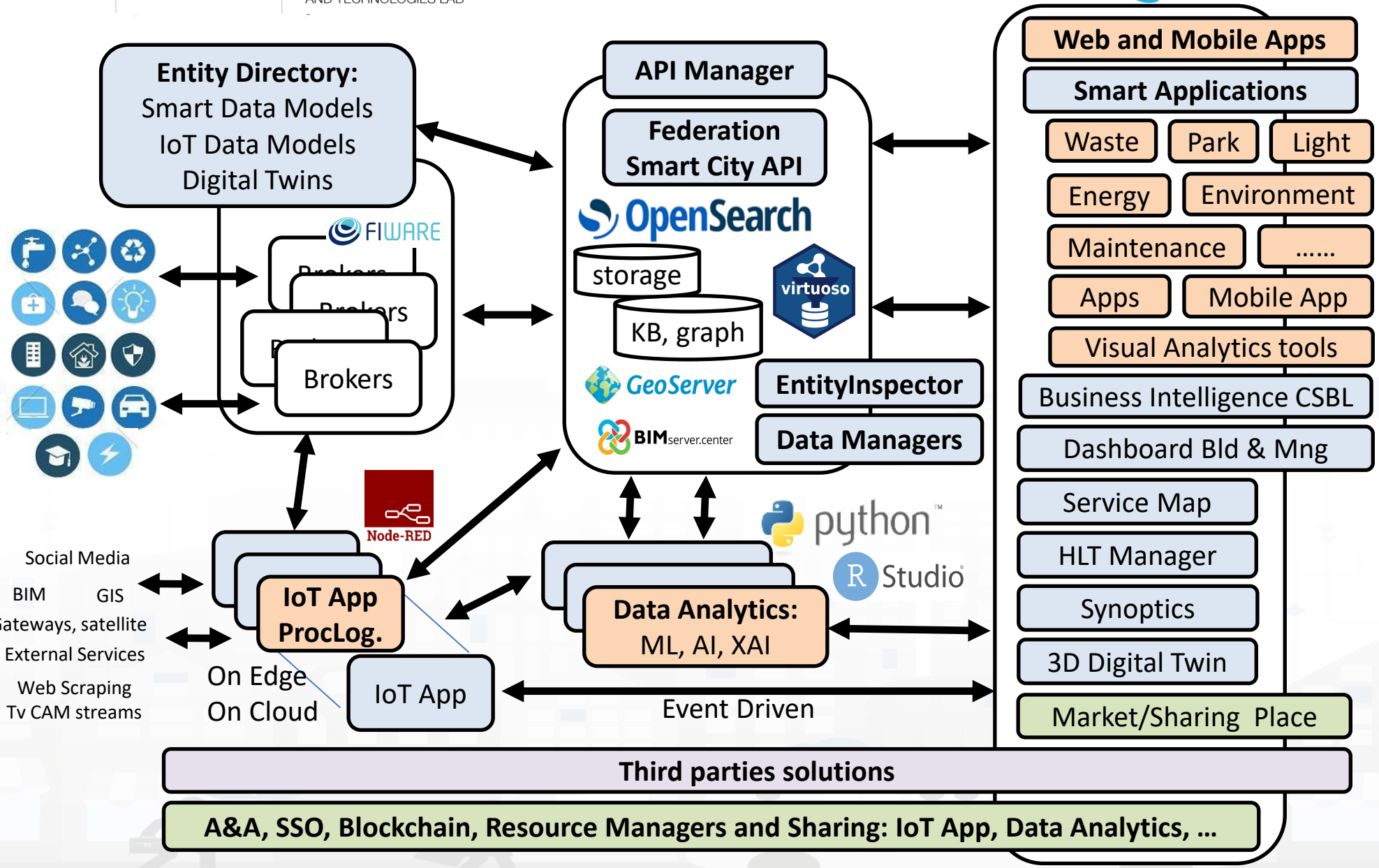




TOP

IOT App for Smartening Solutions

Tech Arch


Entity Directory:
Smart Data Models
IoT Data Models
Digital Twins
FIWARE
Brokers
Brokers
Brokers
API Manager
Federation
Smart City API
OpenSearch
storage
KB, graph
virtuoso
GeoServer
EntityInspector
BIMserver.center
Data Managers
Node-RED
python
RStudio
Social Media
BIM
GIS
Gateways, satellite
External Services
Web Scraping
Tv CAM streams
IoT App
ProcLog.
On Edge
On Cloud
IoT App
Data Analytics:
ML, AI, XAI
Event Driven
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, …

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

IoT Devices

IoT Device Models

IoT Device
- Name:…..
- Model:…..
- Position: …….

IoT Device Variables
- **dateObserved: …….**
- ID:
- Status: ready
- Temperature: 70%
- WaterLevel: 35%
- UsedCapsBox: 30%
- Power: OK
- …..

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

What About IoT Devices, Time Series

IOT Device

IOT Device

Sends a message

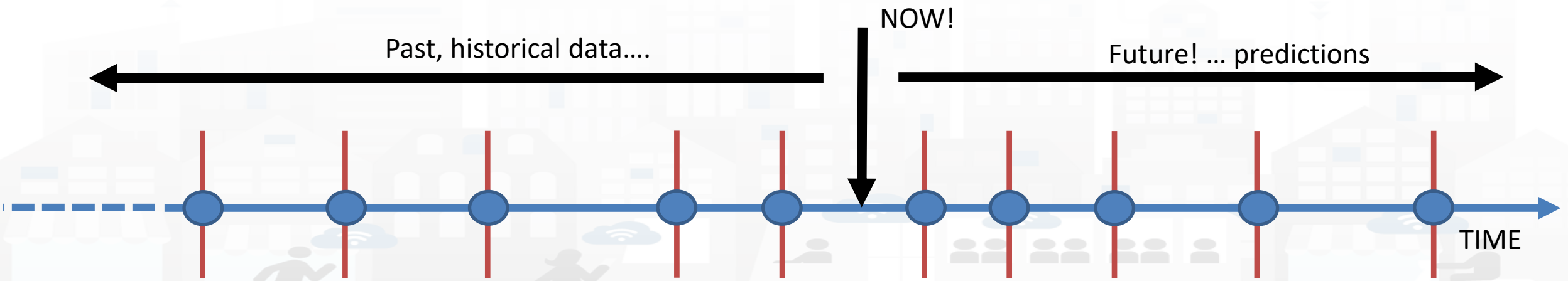
Message (
timestamp: 02-04-2020 at 10:30,
Temperature: 29.34,
Humidity: 35
)

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

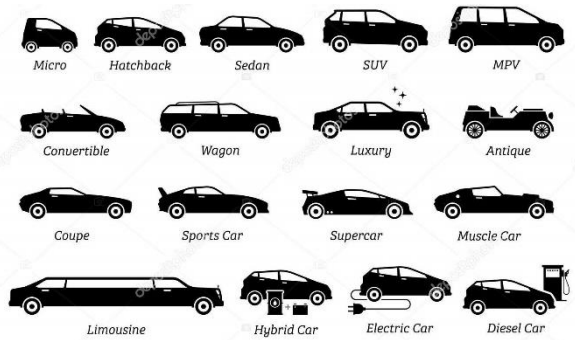
- A set of data coming from an IoT Device with multiple sensor become a time series of values for devices.
  - For example: taking a new measure every 10 minutes (Red Lines)
  - Non regular rates can be valid data as well.
- Each new measure in Snap4City is conventionally time located in «dateObserved»,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

Time Series: they are data streams

- As soon as you have registered an IoT Device
  - You are ready to get Future data, may be arriving in PUSH
  - Recall and store historical data as well, but they have to be
    - recalled in PULL with some IoT App.
    - Loaded in PULL with some File or Data Table Loader



Mobile Devices



Mobile Device Models

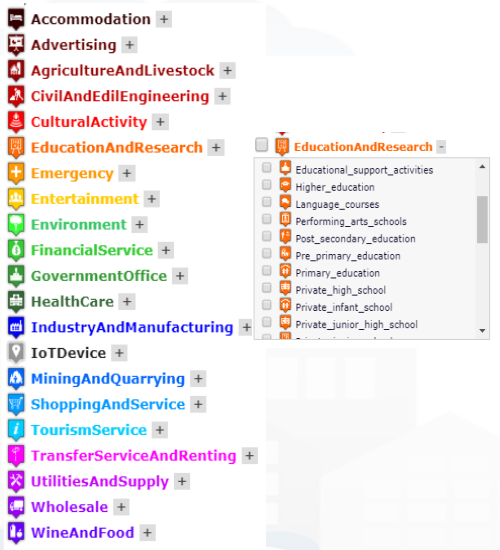
Mobile Device
- Name:…..
- Model:…..
- Spec:…

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

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

Data Tables

- When you have many **IoT Devices or Virtual Devices**, you may have them listed with their information in some data table
  - Then you can load them in short time via **Data Table Loader** tool, to produce:
    - Data Table Model, Data Table Device, Data Table Variable
    - with the same corresponding meanings of **IoT Devices and Mobile Devices**.
- **Data Tables** are a just **a special case of IoT Devices**, which have not been created manually or via some broker but at the end are
  - managed as IoT Devices, Mobile Devices in the system
  - Once created from the Data Table Loader,
  - they can be received from some IoT Orion Broker
- They are classified in terms of nature/subnature
- For Searching and showing on maps and dashboards, they are identical to **IoT/Mobile Devices** can be:
  - **Data Table Model**, for example: «sedan», «personal coffeemachine»
  - **Data Table Device** name, for example: «BMW JD7356HD», «Ford KO786KK»
  - **Data table Variable**, for example: «velocity», «temperature»



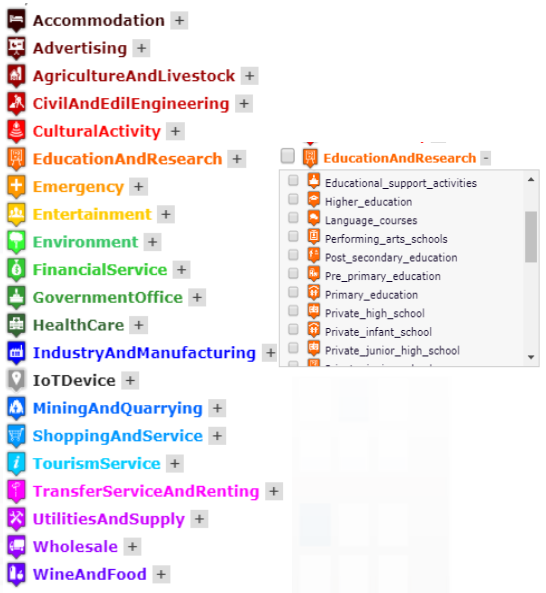
Sensor/Sensor-Actuator

Sensor Device

- Name:…..
- Model:…..
- Position: …….

Sensors

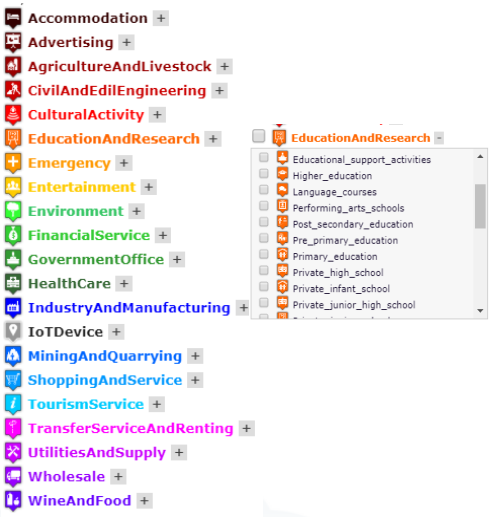
- **dateObserved: …….**
- ID:
- Status: ready
- Temperature: 70%
- WaterLevel: 35%
- UsedCapsBox: 30%
- Power: OK
- …..



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

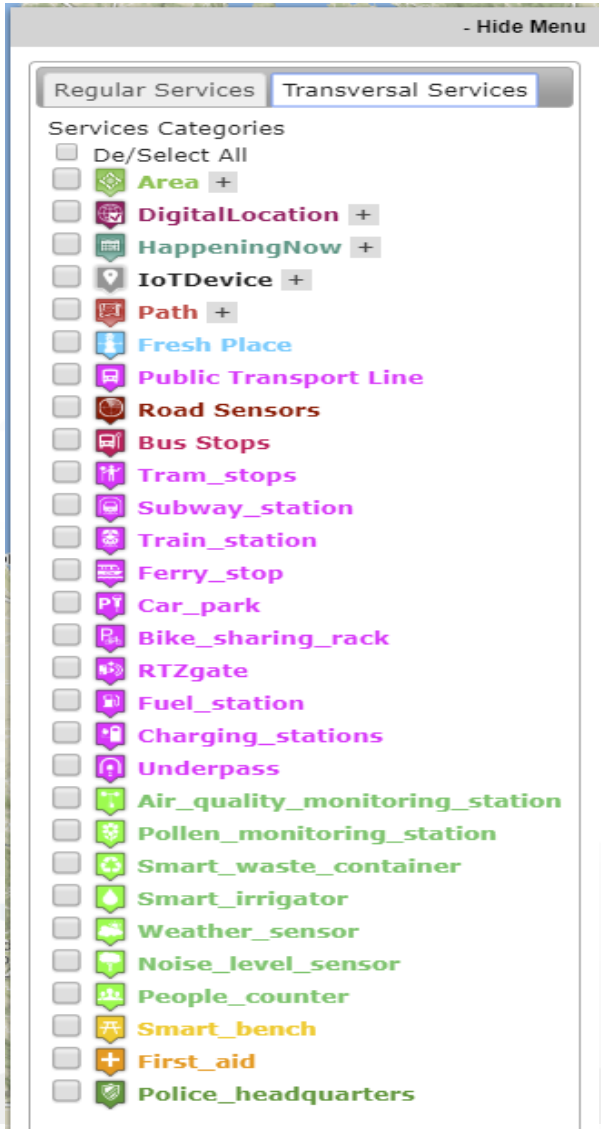
POI, Point of Interest

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



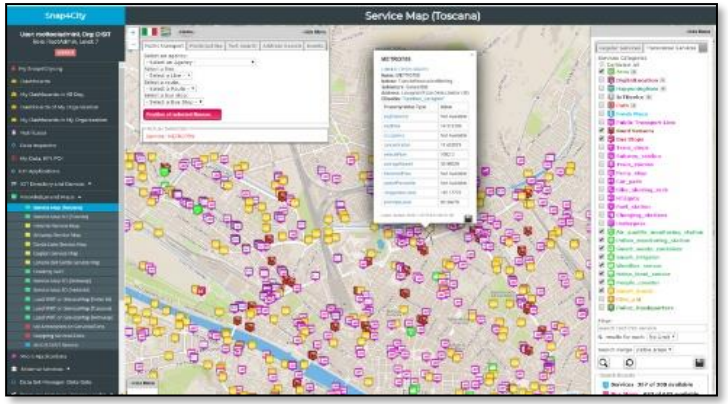
Access to Point of Interest information, POI

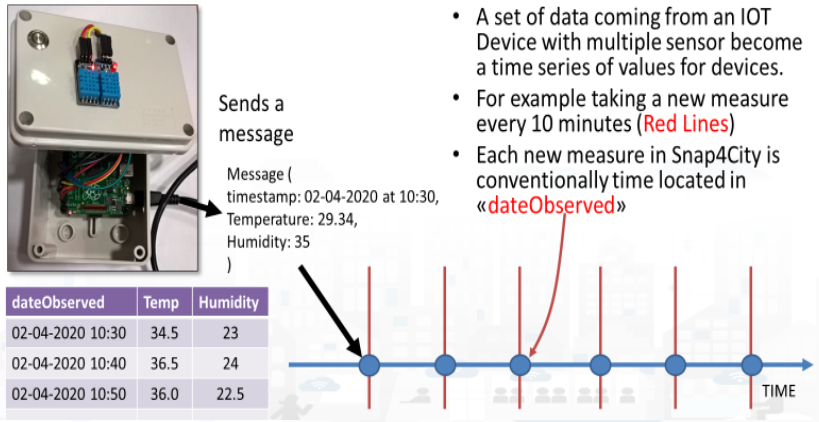
- **POI**: point of interest
- **type**: macro (nature) and subcategories (subnature)
- **Position**: GPS, address, telephone, fax, email, URL, …
- **Description**: textual, multilingual, with images, …
- **Link** to dbPedia, Linked Open Data
- **Links to other services**
- **Real time data if any:** sensors data, timeline, events, prices, opening time, rules of access, status of services, status of queue, etc..
- *See transversal services on ServiceMap*
  - *Regular and in test platform*



Data Ingestion Stragey

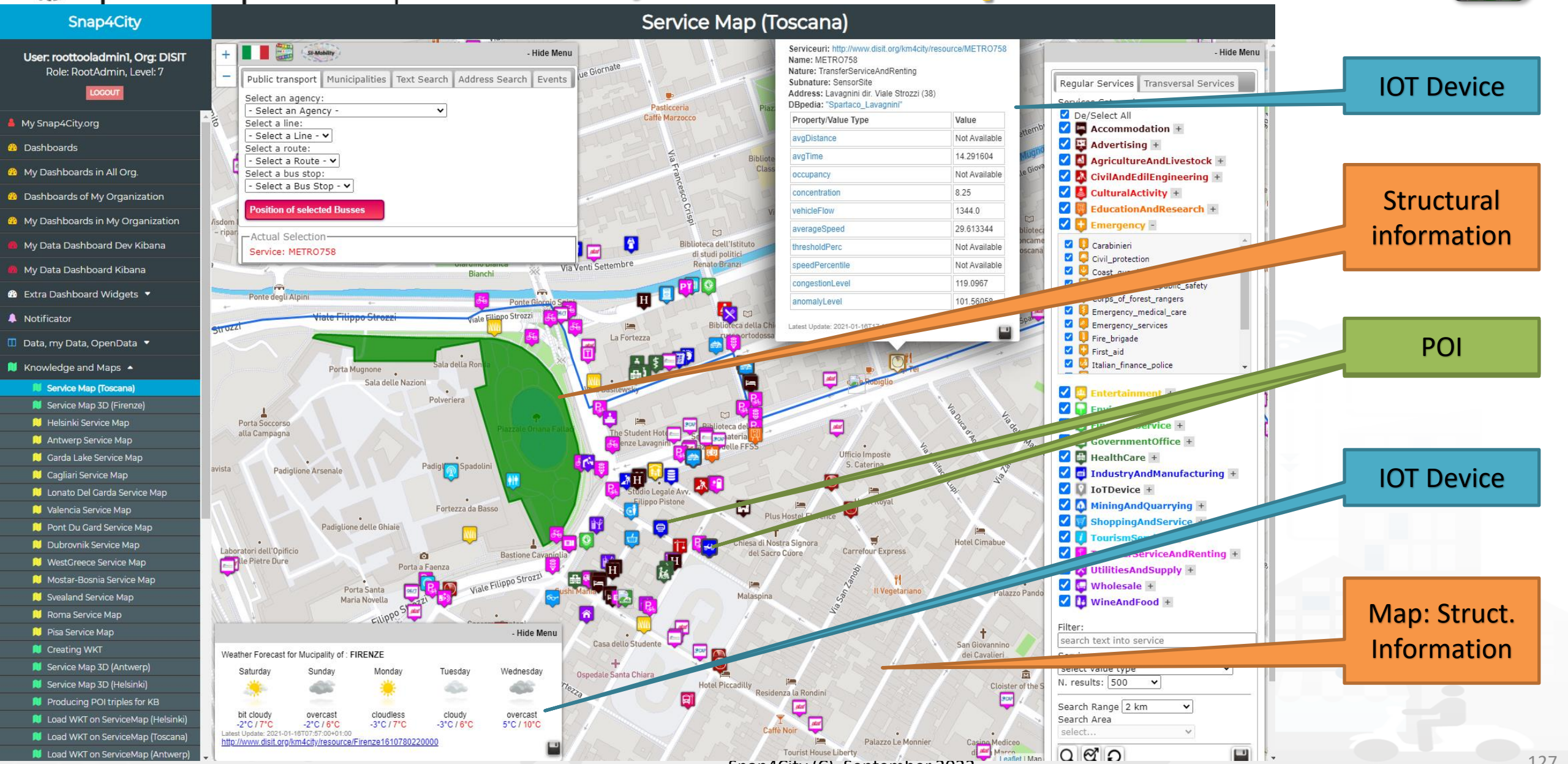
- **Structural Data**: Maps, orthomaps, geolocations, roads, etc.
  - Typically arrive as database, GIS data, etc.
  - **Suggested approaches**: **IoT App, OSM → SM, ETL**
- **POI (point of interest):** info point with geolocation as services, museums, restaurants, banks, email, urls, etc.
  - Typically arrive as: excel files, GIS data, etc.
  - **Suggested approaches**: **POI Loader, IoT App, ETL**
- **IoT Devices, Data Tables,… (Devices and Virtual Devices/KPI), including**
  - Description, including geolocations, etc.
  - Time Series: measures that change over time,
  - They can also move → **IoT Device Mobile, Data Tables**
  - Typically arrive as:
    - description and real time values or additional values
    - Excel files with description and data all together
  - **Suggested approach**: **Data Table Loader, IoT App, Brokers, ETL**
    - IoT Brokers also send data in real time





ETL: deprecated approach in V2

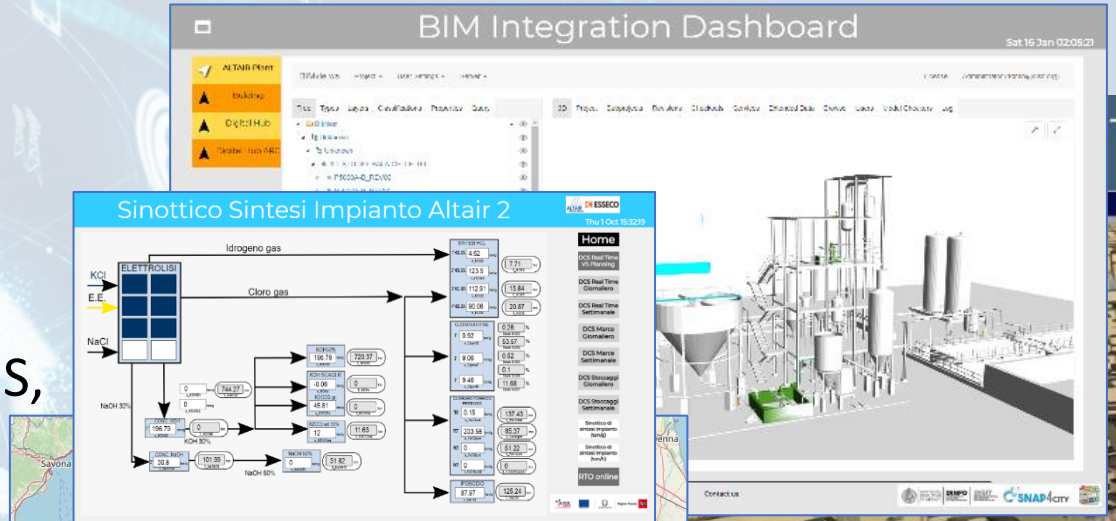
KB, ServiceMap

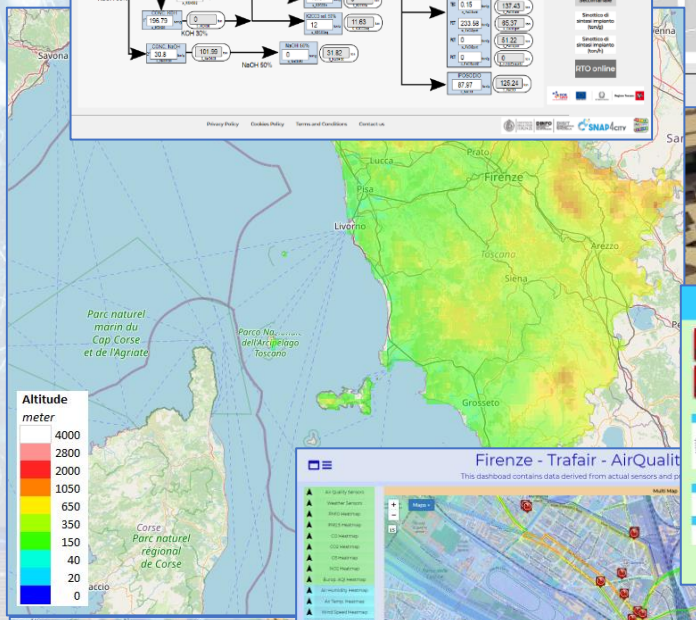


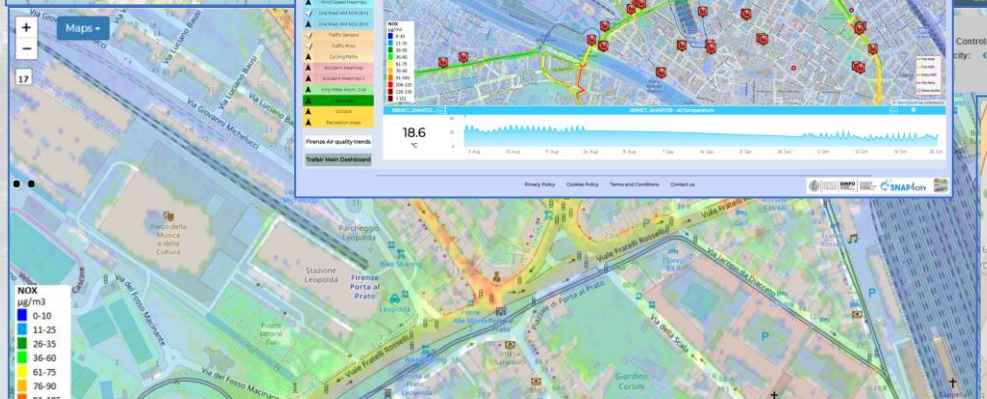
High Level Types

Snap4City (C), October 2023

- 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.



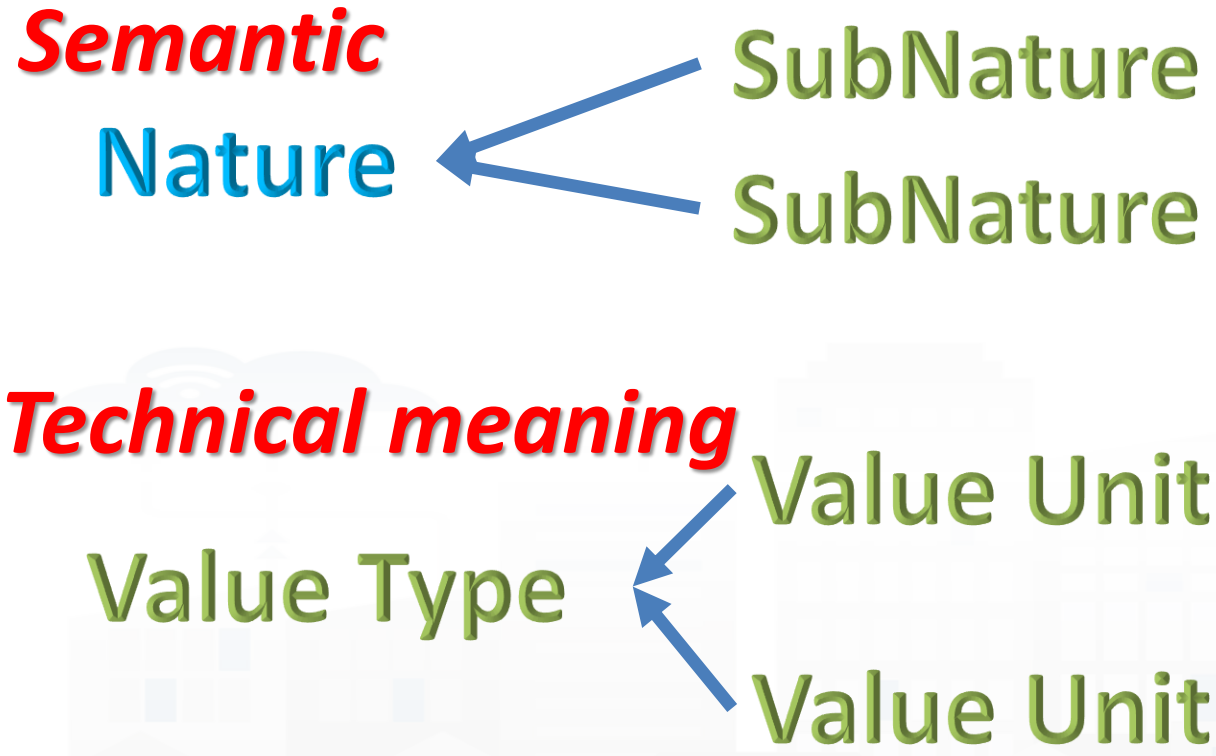




Dictionary for Data Fields

Semantics and Technical Meaning

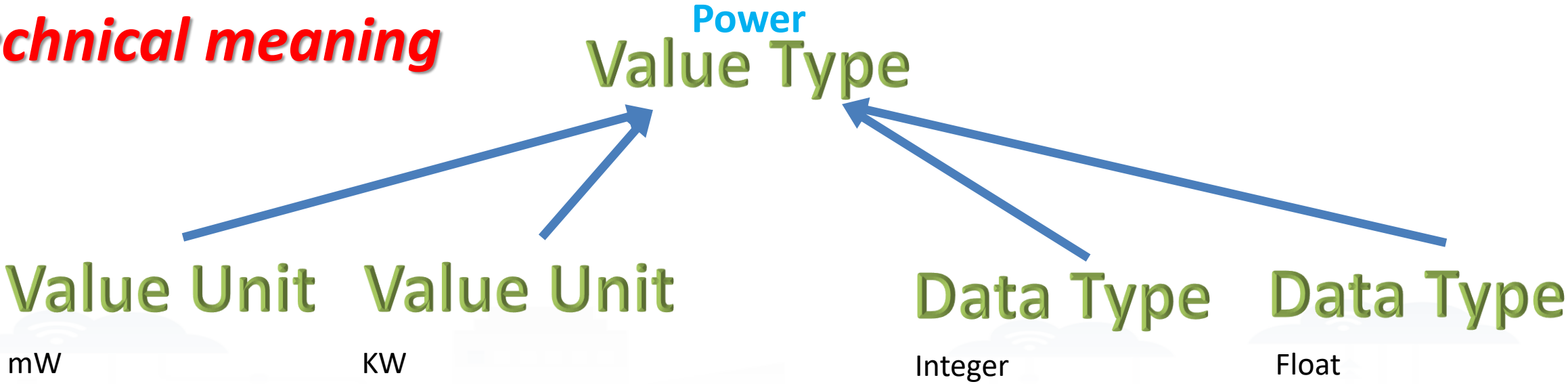
Unified Data and Services Model/Classification



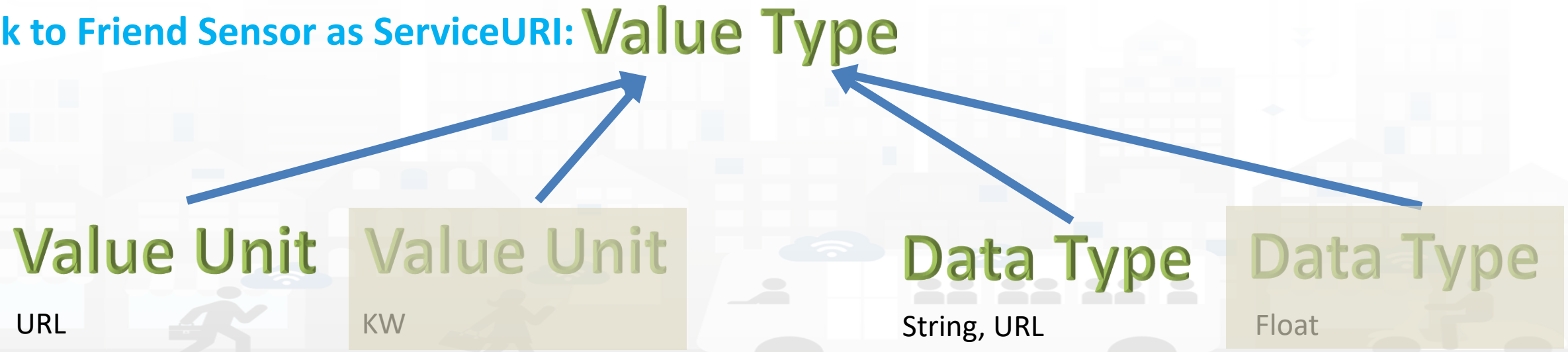
- Exists a Dictionary for the 4 categories
- They are related each other and not all values are possible
- Right setting lead to right rendering on graphs and automated combinations and processing
- The Disctionary is used by many tools

For example

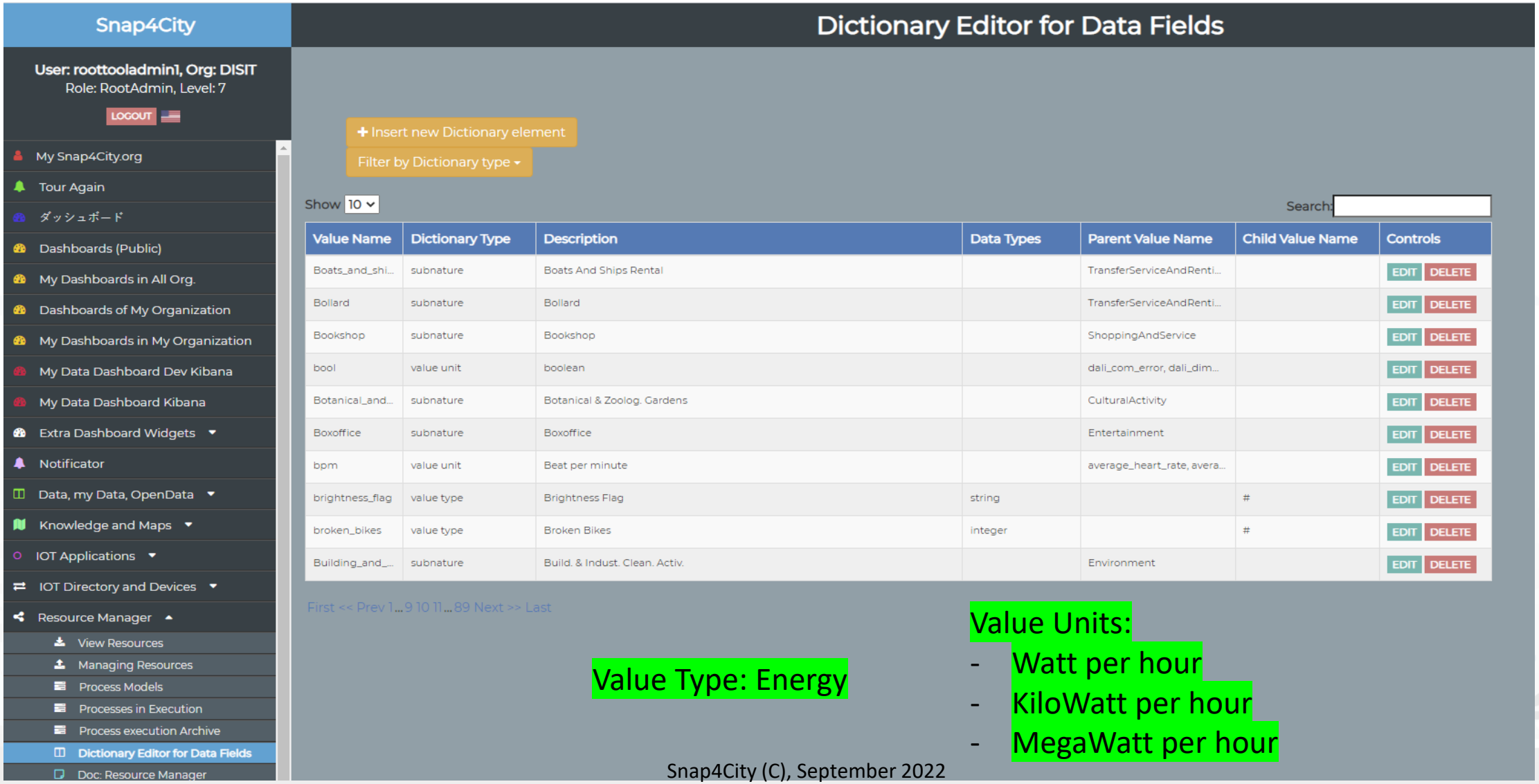
Technical meaning



Link to Friend Sensor as ServiceURI:



Example of Energy and its Value Units



Value Type: Energy

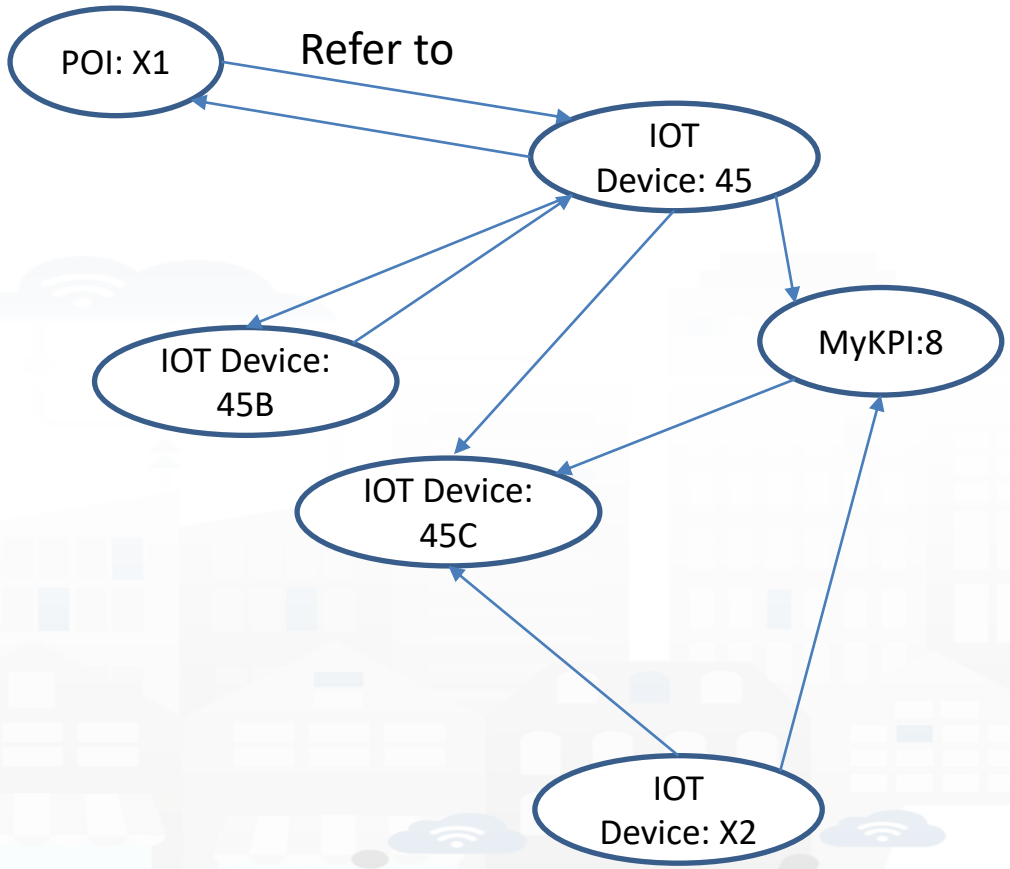
Value Units:
- Watt per hour
- KiloWatt per hour
- MegaWatt per hour

Please note on: Data Type

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

IOT Device References

Relationships among IoT Devices, POI and MyKPI



- **IoT Devices and POI** may refer to:
  - IoT Devices, POI, MyKPI, Heatmaps, etc.
- **MultiDataMap** can be used for navigation:
  - Among: IoT Devices, POI, MyKPI
  - Automated focus
  - Accessing Time Trends

IoT device with References to other and MyKPI


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


Value Type: Identifier

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

Data Type: String

IOT Directory

IOT Network Manager vs Final User

Network of IOT Brokers

IOT Broker

External

Internal

IOT Directory

Registering

Discovering

Knowledge Base, Km4City

Knowledge and Storage Data from the Field and City

Browsing

ServiceMap Knowledge Base

IOT Network Manager

Discovering

My IOT Device

Register

IOT Application

Final user Manager

Dashboard Wizard

Prepare

Deep Manage

Exploit

Main Features of the Snap4City IOT Directory:

- **IOT Directory is a technology of Snap4City ONLY**
- **Register IOT Brokers**
  - Different kind of Brokers, different kinds of authentications and protocols
  - Registered IOT Orion Brokers can be queried for collecting their managed devices (typically for External IOT Brokers), so that those IOT Devices are registered
  - IOT Brokers/Gateways are registered on NIFI to send messages into the Data Shadow, automatically
- **Register IOT Devices**: singularly or at groups (in Bulk)
  - Registration can be custom or based on IOT Device Model
  - IOT Edge are registered as IOT Devices as well
  - Registered IOT Devices are saved into local DataBase and into the Knowledge Base
- **Provide support for security aspects**:
  - Generation of Certificates, Keys, etc., according to the model
  - Collection of keys when IOT devices are on some IOT Gateway or Second Level IOT Broker.
- **Manage Ownership and Delegation** for
  - IOT Brokers, IOT Devices, IOT Device Values also called Sensors/actuators, IOT Device Models

IOT Directory Features vs Users Roles (10/21)

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

SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES

TOP

FORGING & MANAGING OPEN AND FLEXIBLE WEB AND MOBILE APPS

FROM CITY DASHBOARD TO APPLICATIONS

IOT APPLICATIONS VS IOT EDGE DEVICES

SNAP4CITY FOR BEGINNERS

TWITTER VIGILANCE: SOCIAL MEDIA ANALYSIS

SNAP4CITY ARCHITECTURE AND ECOSYSTEM. OPENED TO DEVELOPERS AND STAKEHOLDERS

SNAP4CITY AND KM4CITY PROJECTS

TA GATHERING AND CITY DATA KNOWLEDGE MANAGEMENT

IOT APPLICATIONS, THE LOGIC AND THE SMARTNESS

ADVANCED SMART CITY API, MICROSERVICES, SNAP4CITY API

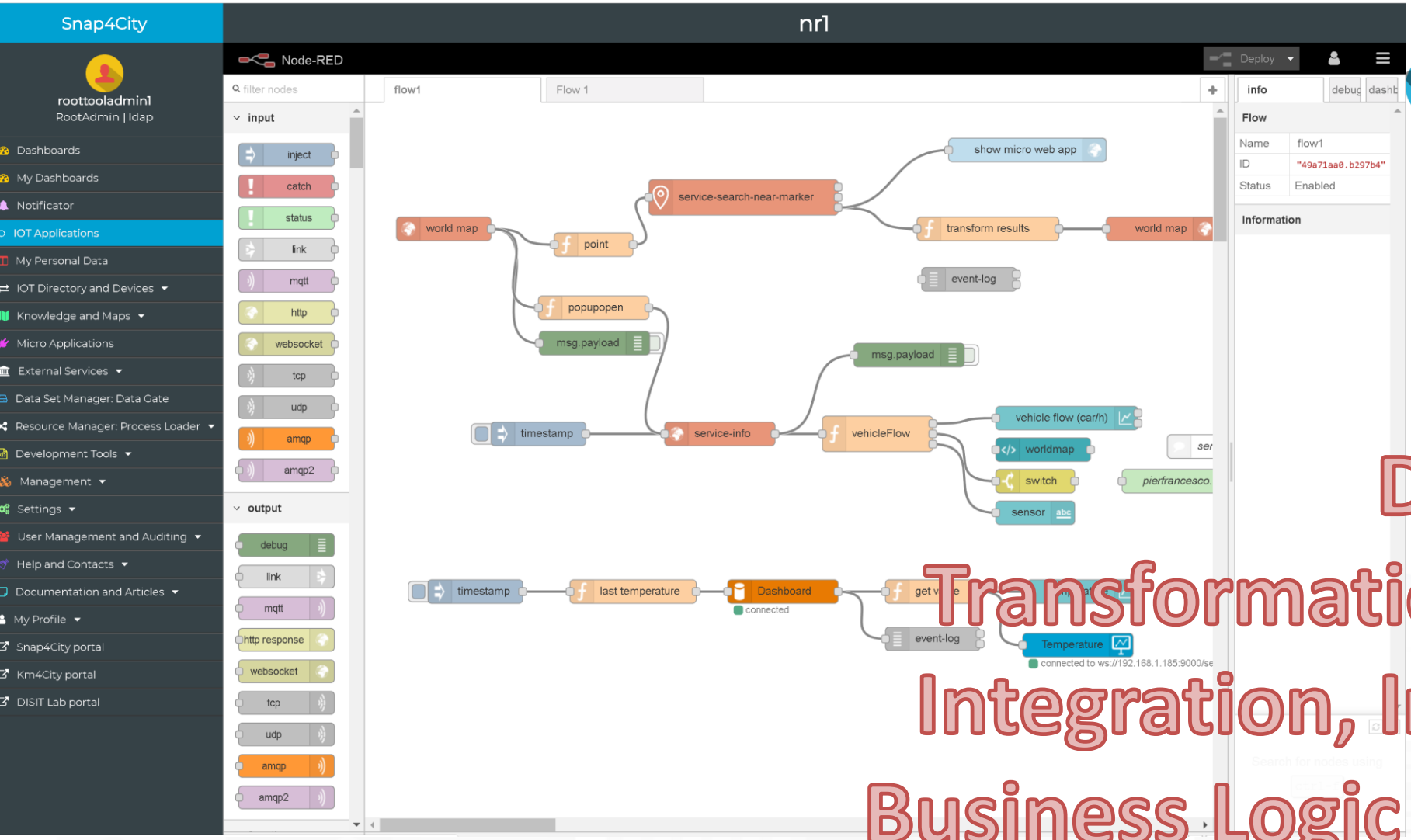
SNAP4CITY LIVING LAB FOR COLLABORATIVE WORK

DATA ANALYTICS BUSINESS INTELLIGENCE, WHAT-IF AND SIMULATION

ECISION SUPPORT SYSTEM AND CITY RESILIENCE

Node-RED

IOT App= Node-RED +Snap4City



Editing IOT Applications

Data Adapation

Transformation, Conversion

Integration, Interoperability

Business Logic vs Dashboards

Data Analytics control

Everywhere: Cloud, on IoT Edge Devices

IOT Application Editor: NODE-RED

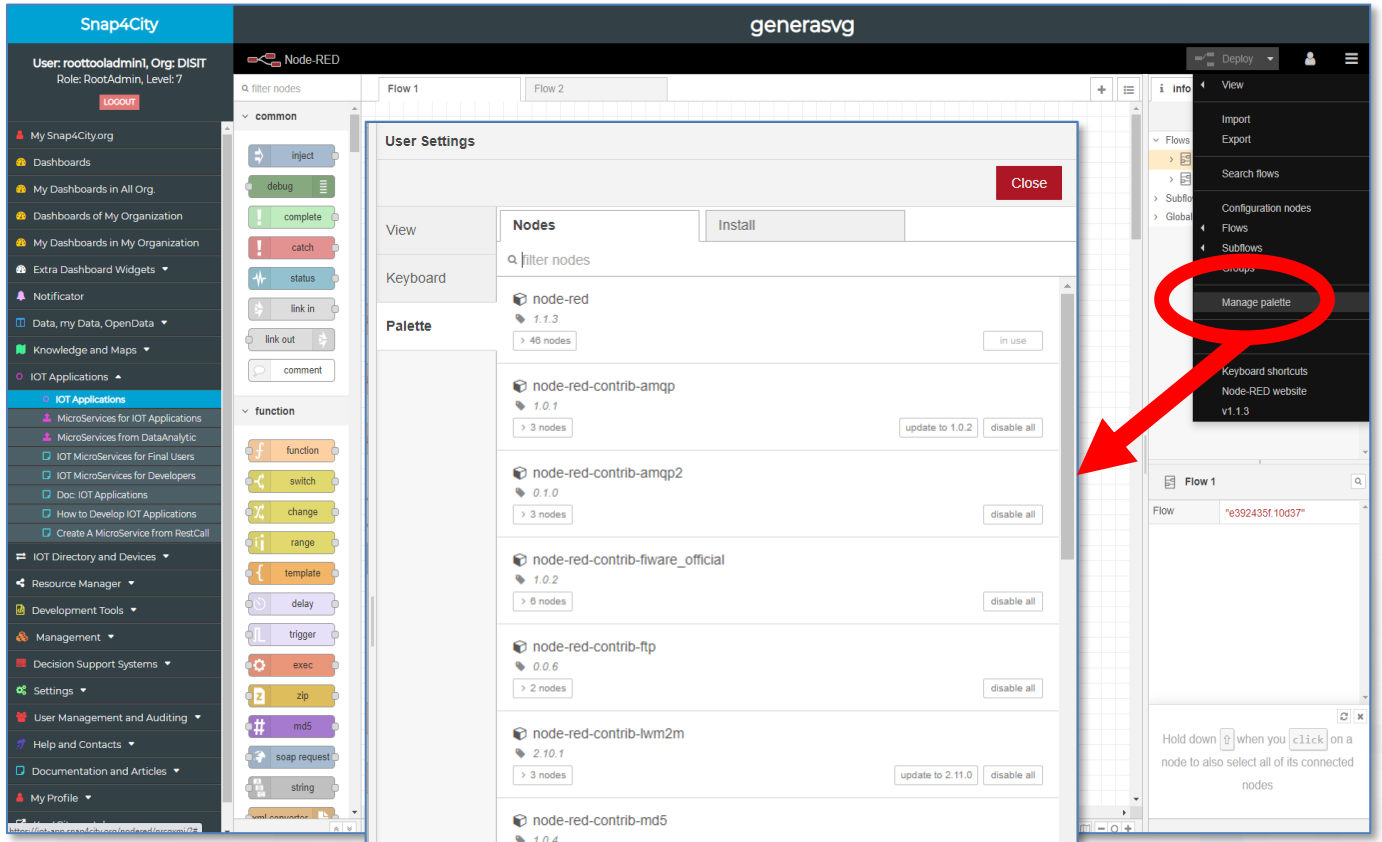
- In the **IOT Application of Snap4City**, it is possible to:
  - Execute flows that process data as: Event Driven, Batch (periodic or not)
  - Create multiple concurrent Flows for each IOT Application
  - Create subflows as macros to be reused
  - Create Groups of nodes as macro
  - **Save/load**, **share**, of nodes, flows and applications with other users via
    - the Snap4City Resource Manager or
    - with JS Foundation or
    - via email, skype, file sharing in general
  - ..

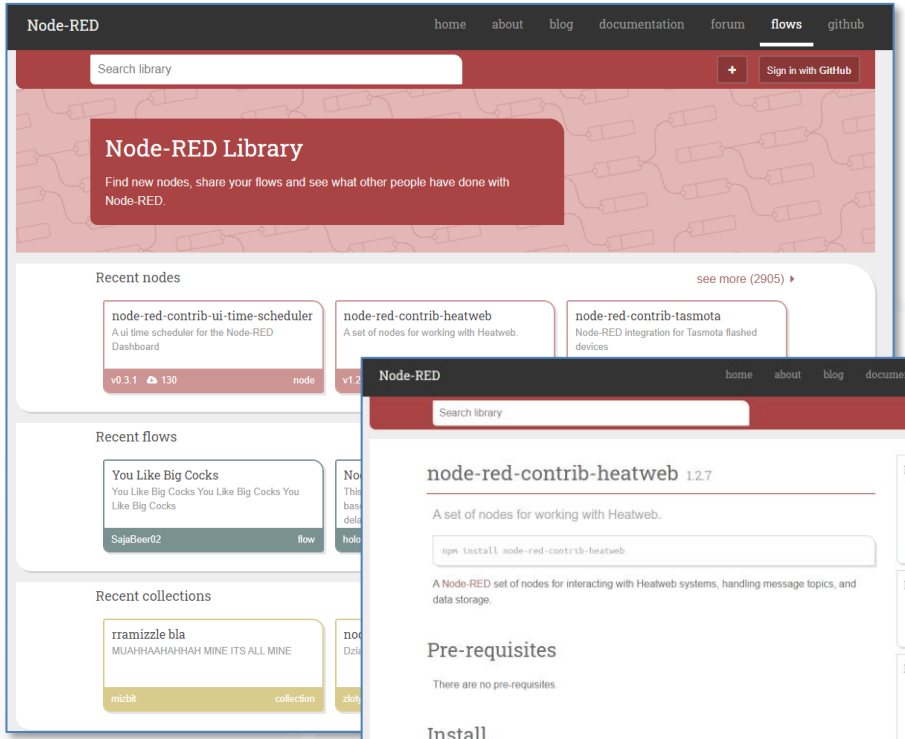
IOT Application Editor: NODE-RED

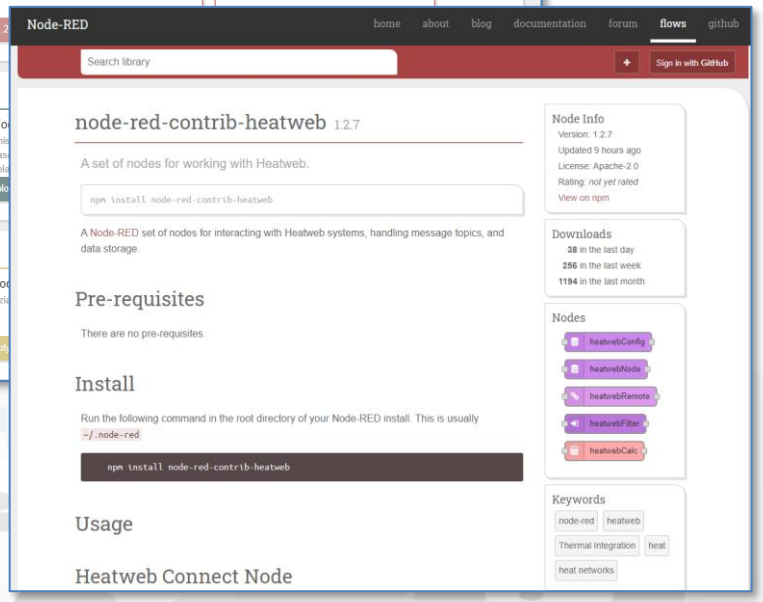
- In the **IOT Apps of Snap4City**, it is possible to Extend the Capabilities:
  - Load other Nodes, segments of flow and entire flows from several sources: email, libraries, S4C repository, etc.
  - Load other libraries of MicroServices/Nodes/Blocks from **Manage Palette**
    - A large set of Libraries of Node is available.
    - The loading may have some limitations for security reasons
  - **Get more IOT Apps** above the Limit that may depend on the organization and/or on personal authorizations, ask to Admin
  - ..

Load Library from Palette

https://flows.nodered.org/

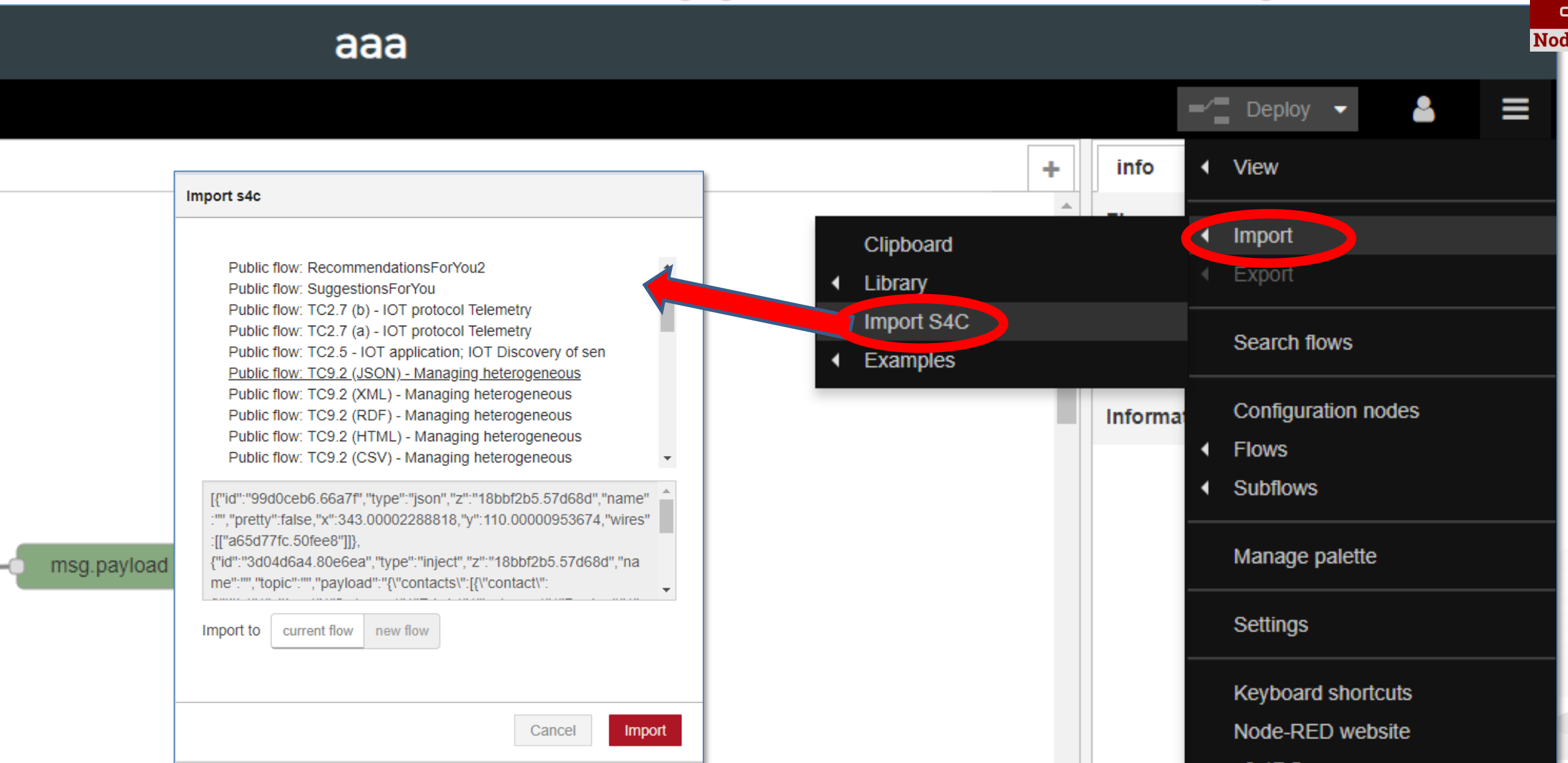






Two views of the same libraries

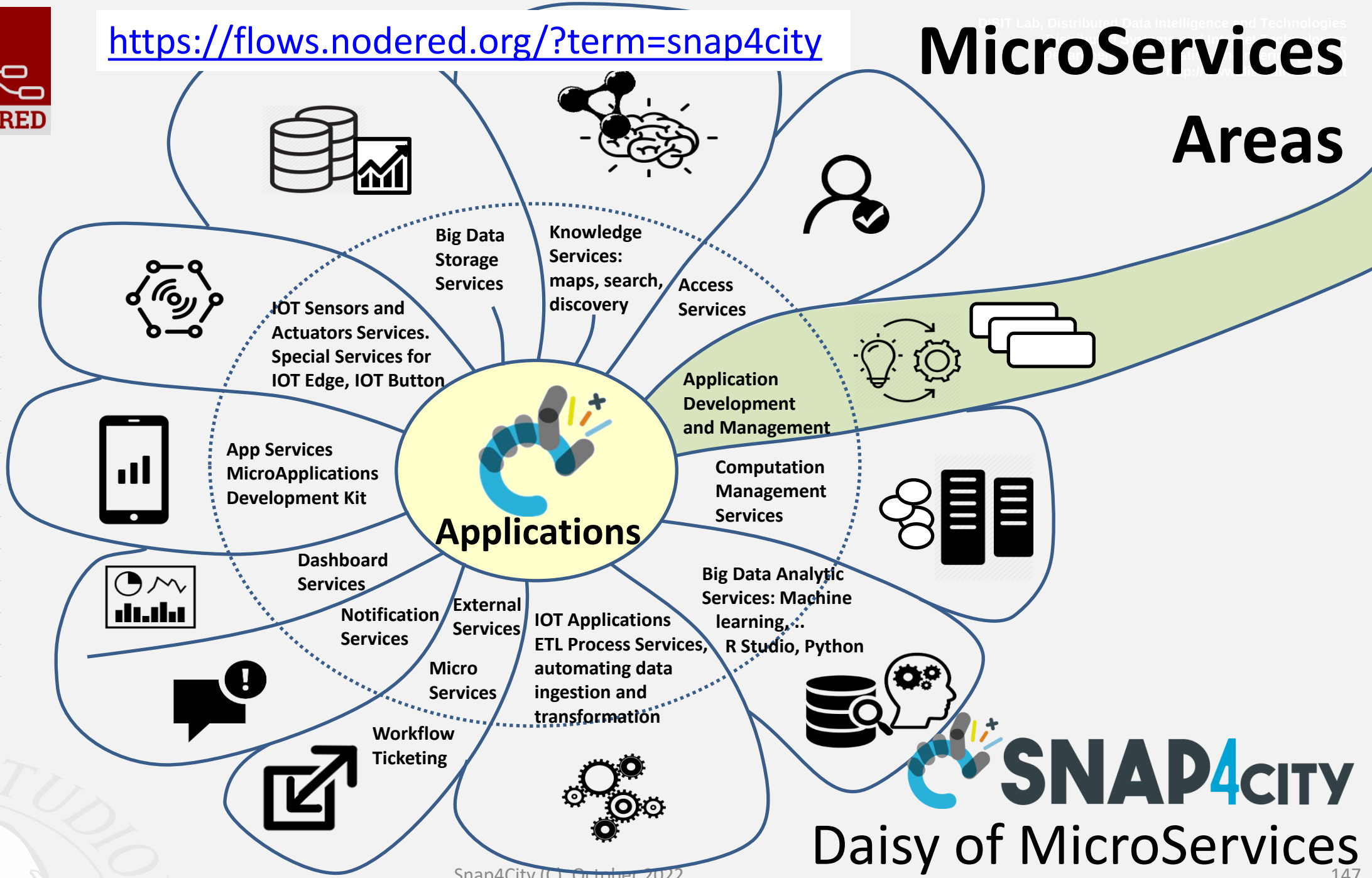
Load an IOT application of example



MicroServices Areas

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

- input
- output
- function
- social
- storage
- analysis
- advanced
- NGSI
- lwm2m
- S4CSearchDev
- S4CUtility
- S4CMapping
- S4CManagement
- S4CDataAnalytic
- S4CBigData
- S4CIOTApp
- S4CSearch
- S4CData
- S4CKPIData
- S4CDashboard
- S4CSigfox
- S4CIoT
- S4CLogDev
- S4CView
- S4CSocial
- location
- dashboard



SNAP4CITY

Daisy of MicroServices

Smart City and IOT main needs

Smart City Entities Search: search and access to city entities and their relationships in the city.

Historical Data: search and access to data collected over time into the smart city data aggregator.

Save and Get Personal Data: for many smart city applications, the possibility of saving and retrieval of personal data enables a large variety of smart scenarios for the final users and operators.

Advanced Dashboards: This means to have the possibility of developing a real user interface of the IOT App (to render and produce data for the IOT network).

Data Analytic: The real need in the context of smart City is to have the possibility for a data-analysts of creating some data analytic processes and use it into the flow as MicroService without the intervention of a programmer nor administrator.

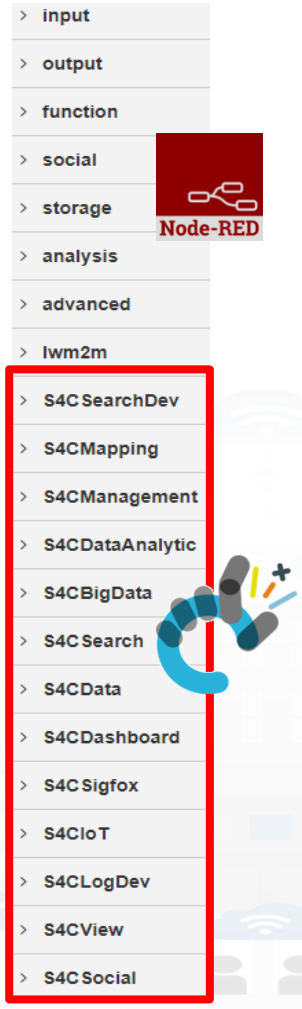
IOT Device Connection: This means that the developers expect to have the possibility of using nodes for connecting to a large set of IOT devices using different protocols, and thus connecting to different kind of IOT brokers.

IOT Directory: It should be a single point service for searching, managing and discovering all the IOT Devices which can be connected to the infrastructure by means of a large set of heterogenous IOT Brokers.

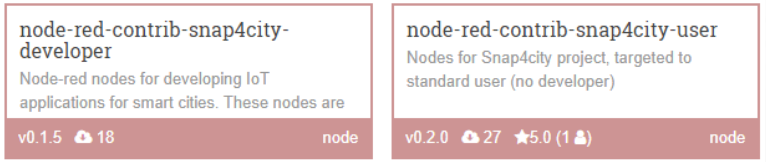
IOT Applications

IOT Applications = Node-RED + Snap4City Platform

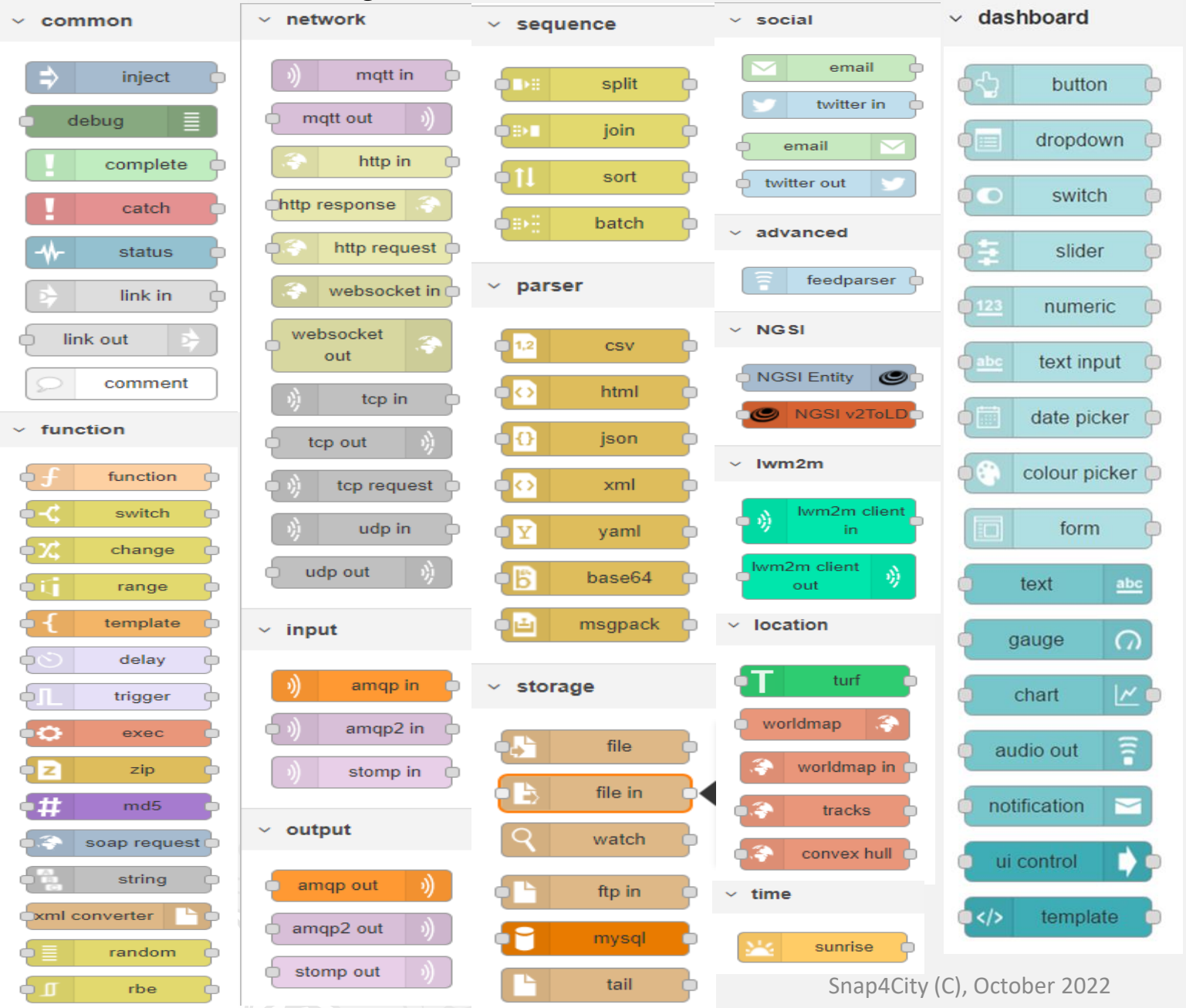
- A collection of more than **150 MicroServices** have been developed covering the above-mentioned requirements and much more.
- The issue was not only to formalize the MicroServices, but also to create the infrastructure that enable their usage. In many cases, the simple MicroServices hide very **complex** and **sophisticate tools and algorithms (Snap4city Platform)**.
- They are formally distributed as two official libraries of Node-RED nodes (**Snap4City Basic and Advanced**) by the JS Foundation portal.
- They can be **directly installed** in any Node-RED tool of any operating system.



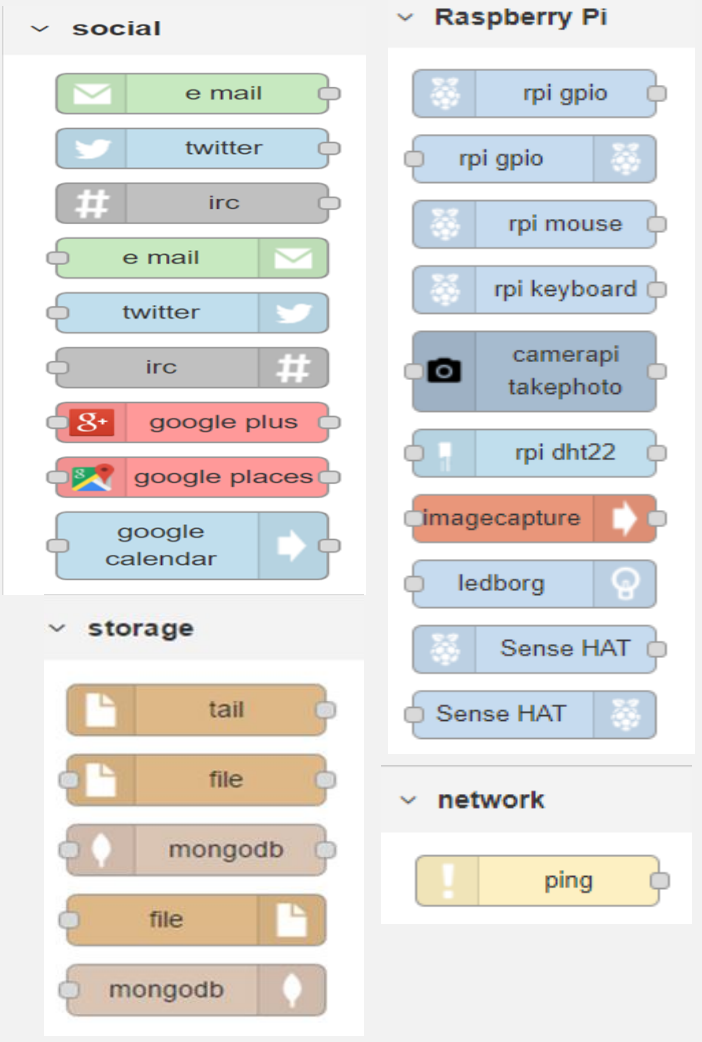
https://flows.nodered.org/?term=snap4city



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



+ on IOT Edge Raspberry

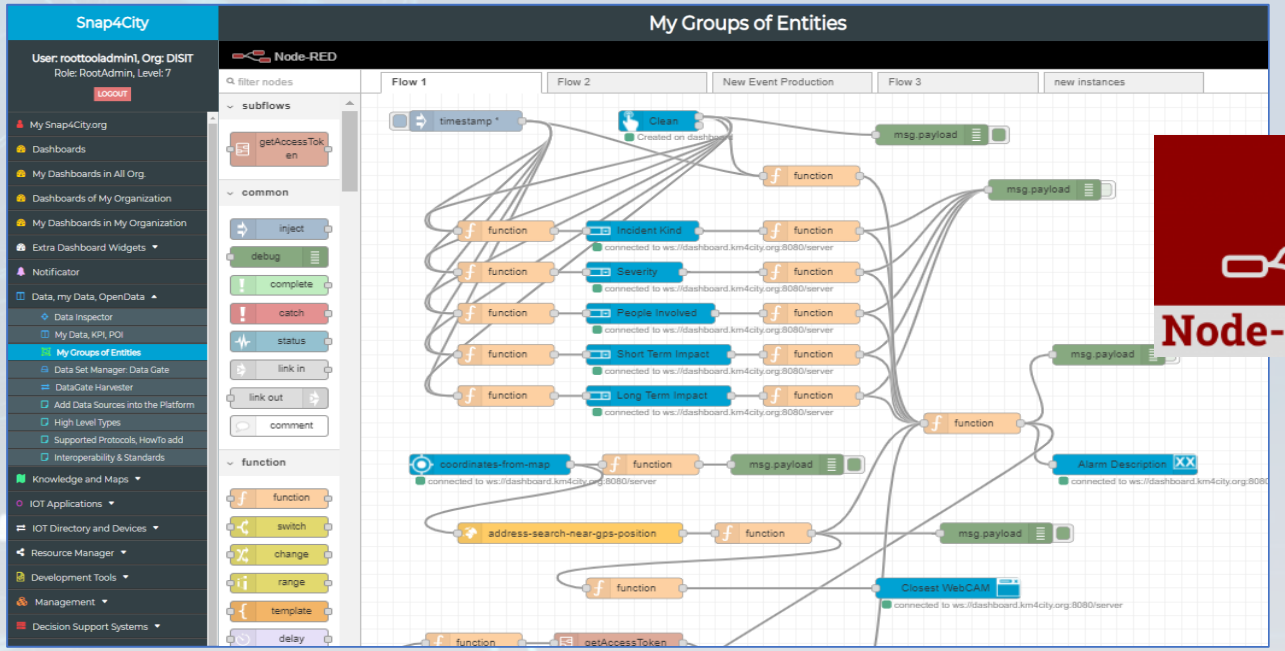


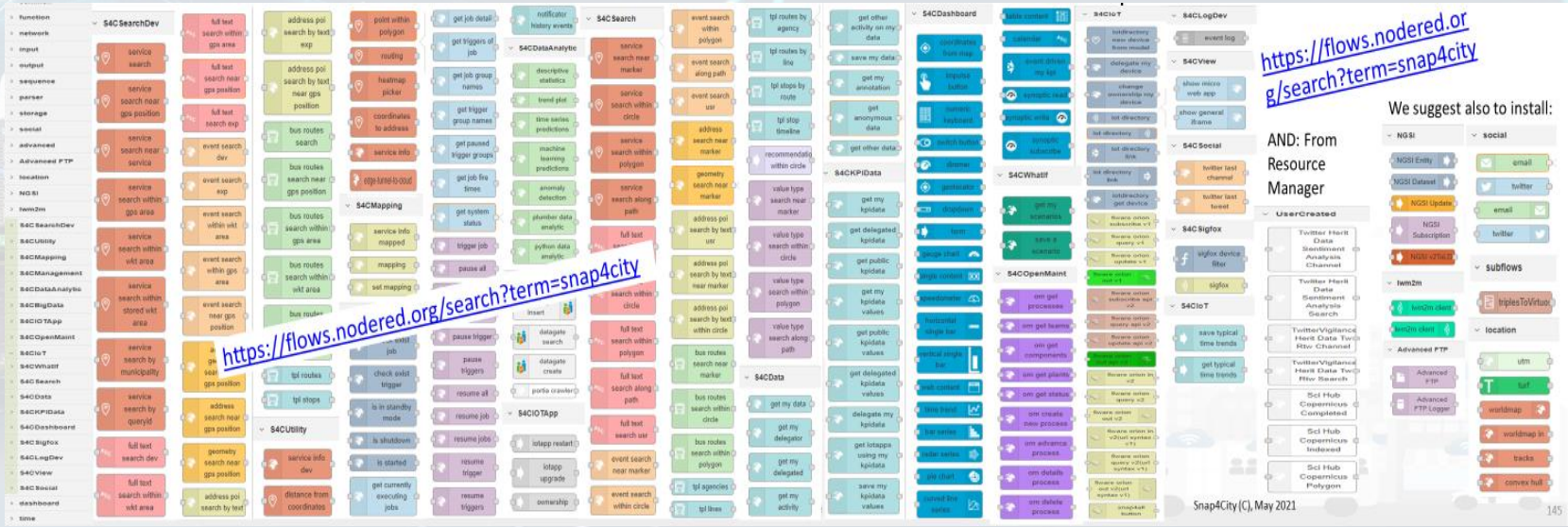
IoT Applications

- **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





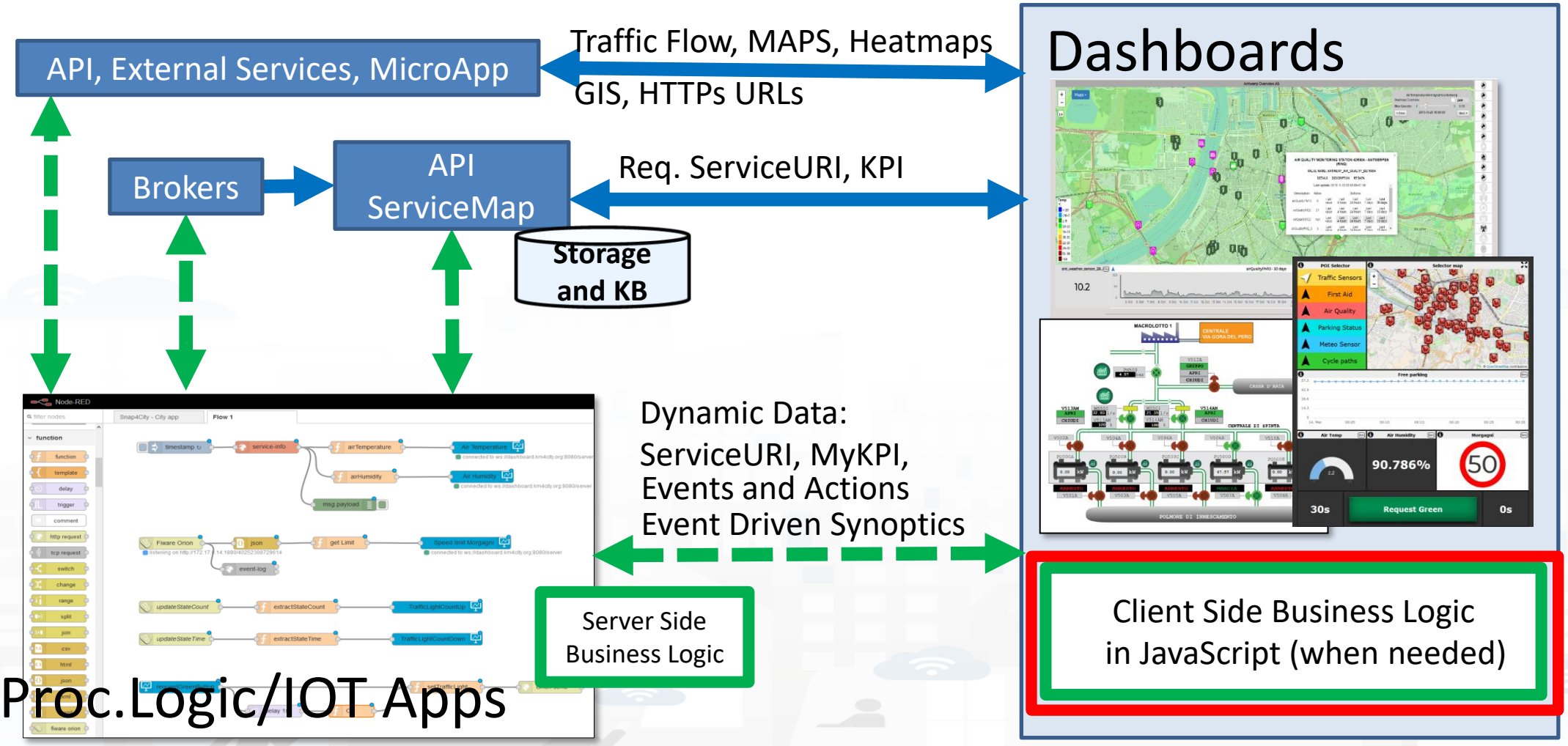
TOP

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

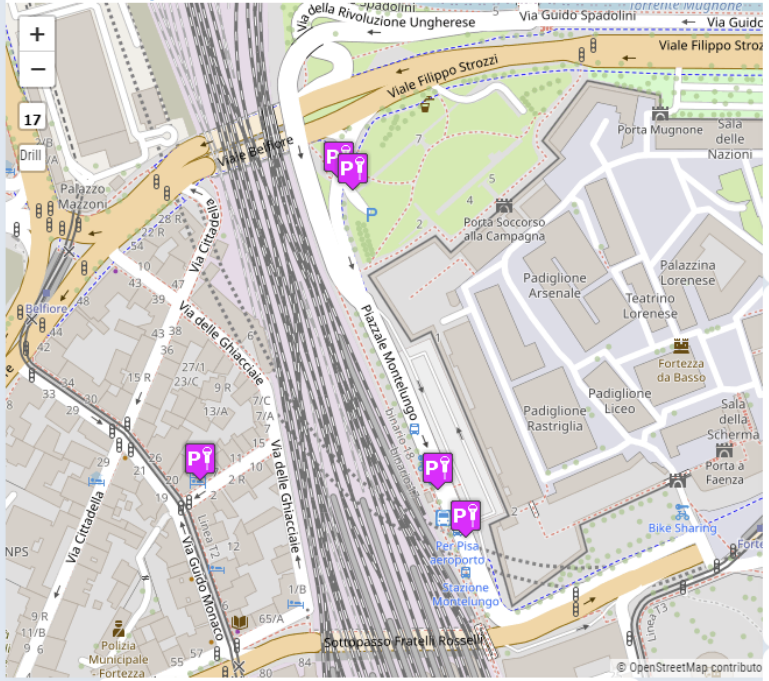


example

First BI Example

Mon 10 Apr 12:00:40

Selector - Map

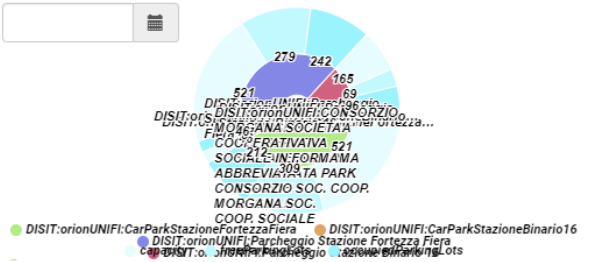


Selector

- Car_park
- metrotrafficsensor
- Air_quality_monitoring_station
- Weather_sensor

Pie Chart

9m

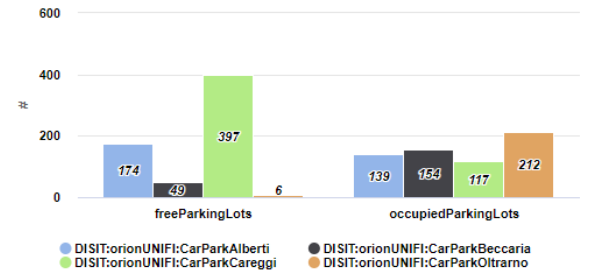


Radar Series

4m

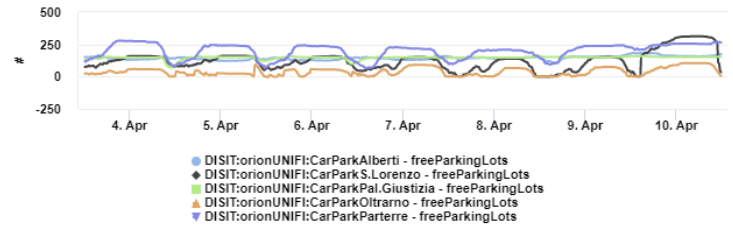
Bar Series

4m



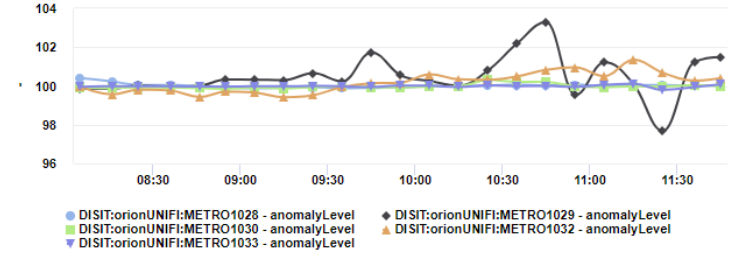
Time Trend Comparison

4m



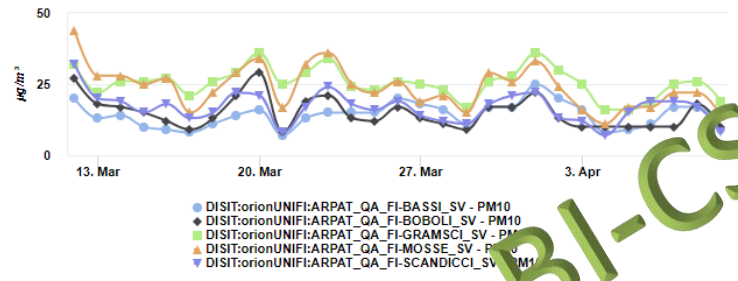
Time Trend Comparison

4m



Time Trend Comparison

4m



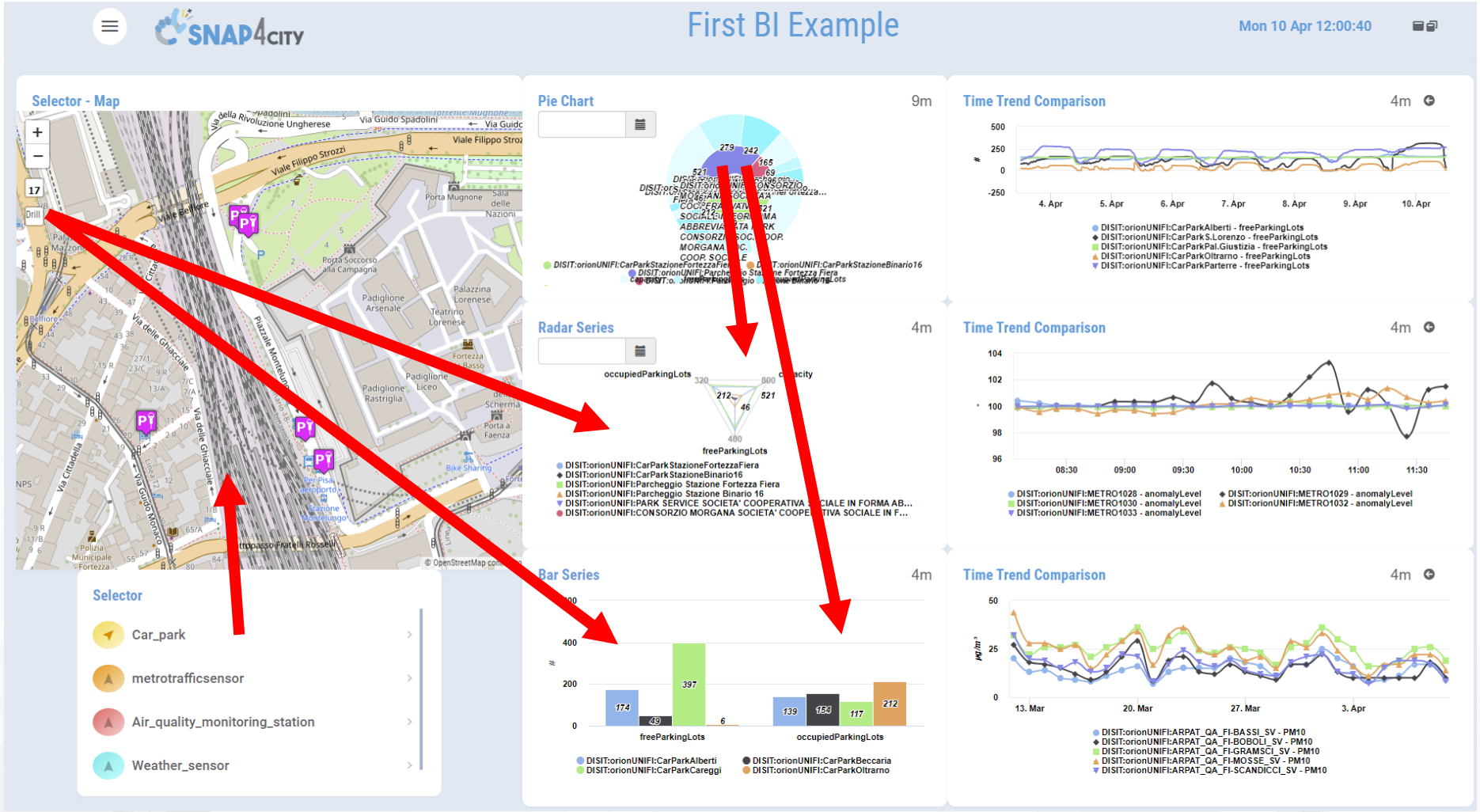
BI-CSBL

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

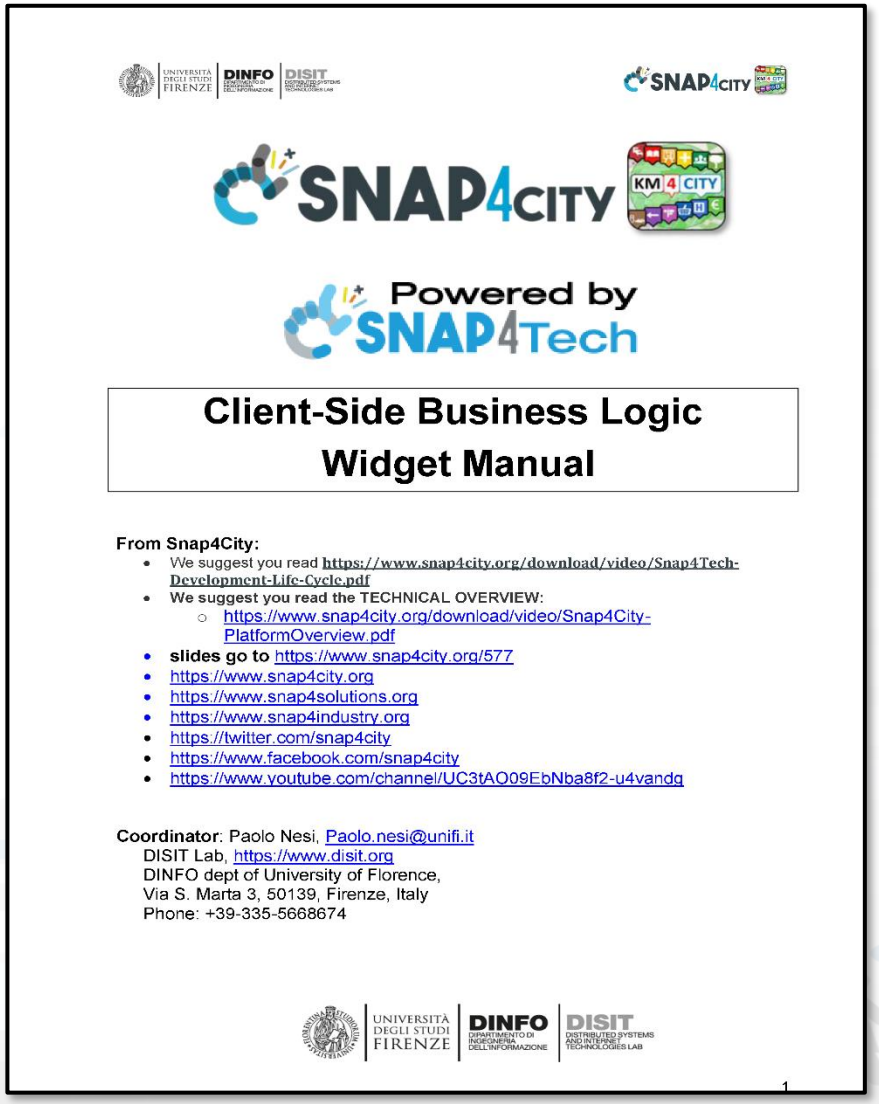
Example: From Map to Graphs (spatial drill down)

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

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



Client Side Business Logic



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Client-Side Business Logic Widget Manual

From Snap4City:

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

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

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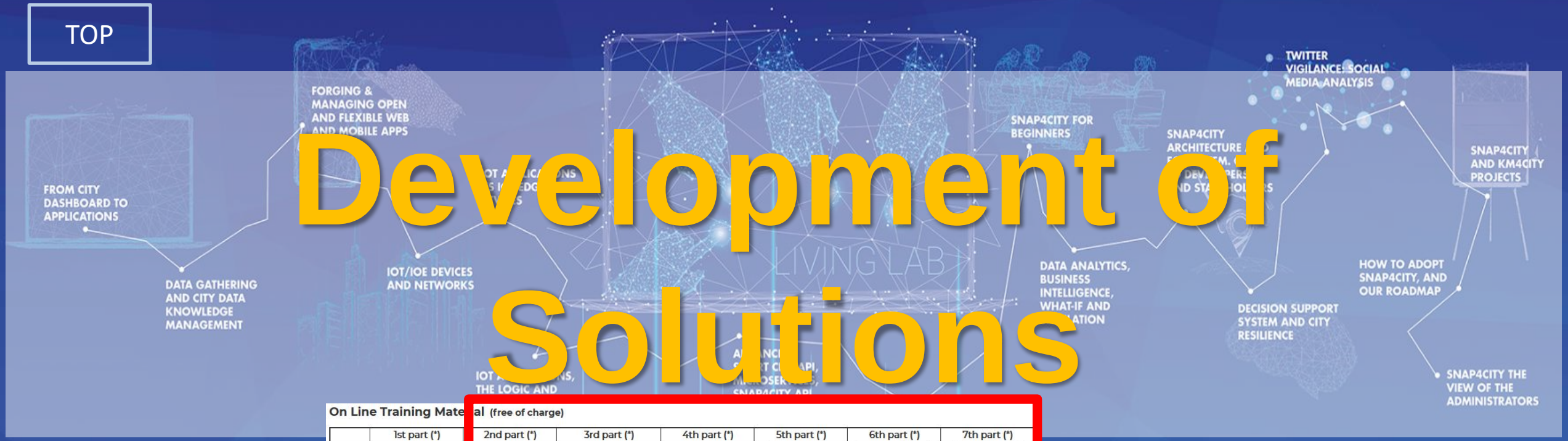
https://www.snap4city.org/download/video/ClientSideBusinessLogic-W[QR]df

TOP

Development of Solutions



On Line Training Mate al (free of charge)

	1st part (*)	2nd part (*)	3rd part (*)	4th part (*)	5th part (*)	6th part (*)	7th part (*)
what	General	Dashboards	IOT App, IOT Network	Data Analytics	Data Ingestion processes	System and Deploy Install	Smart City API: Web & Mob. App
PDF							
Inter active							
Video1							
Video2							
Video3							
Video4				none		none	none
duration	2:55	3:16	3:41	2:00	2:48	2:35	1:47

100% OPEN SOURCE

SNAP4 Appliances and Dockers **Installations**

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

- My Snap4City.org
- Tour Again
- Dashboards (Public)
- Dashboards of My Organization
- My Dashboards in My Organization
- My Data Dashboard Dev Kibana
- Extra Dashboard Widgets
- Data, my Data, OpenData
- Knowledge and Maps
- IOT Applications
- IOT Directory and Devices
- Resource Manager
- Development Tools
- Management
- Decision Support Systems
- Deploy and Installation
- Help and Contacts
- Documentation and Articles
- My Profile
- Km4City portal
- DISIT Lab portal

Home / Tutorials and Videos / Welcome: how to start using Snap4City for beginners

Welcome: how to start using Snap4City for beginners

We suggest you:

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

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

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

Please start a fully guided training cases:

- HOW TO: create a Dashboard in Snap4City
- HOW TO: add a device to the Snap4City Platform
- HOW TO: add data sources to the Snap4City Platform
- HOW TO: define privacy rules for personal data, produced by the end-users own device
- HOW TO: Develop Smart Applications, Snap4City development Life Cycle
- HOW TO: HLT vs Ingestion, and HLT vs Widgets
- HOW TO: Develop an IOT Application for Data Ingestion

Username: paolo.disit

Search

Search
-Any-

Snap4City Training on Tools and Platform

Powered by www.km4city.org

FIWARE Node-RED

Organization Groups

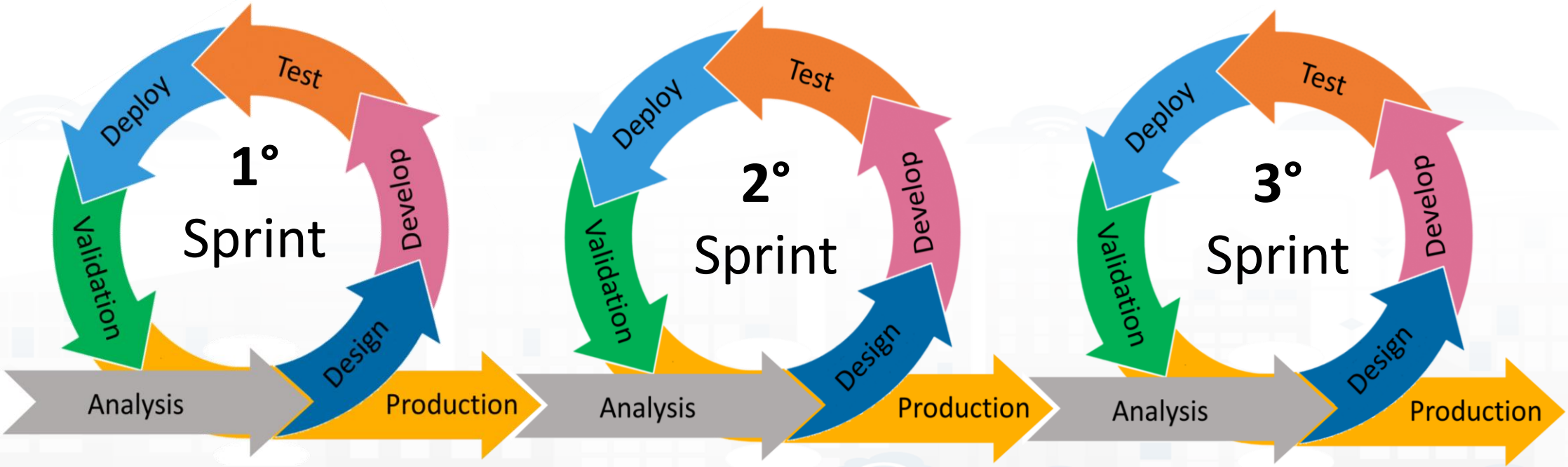
DISIT
- Developer
- Operativo

Updates on Tools

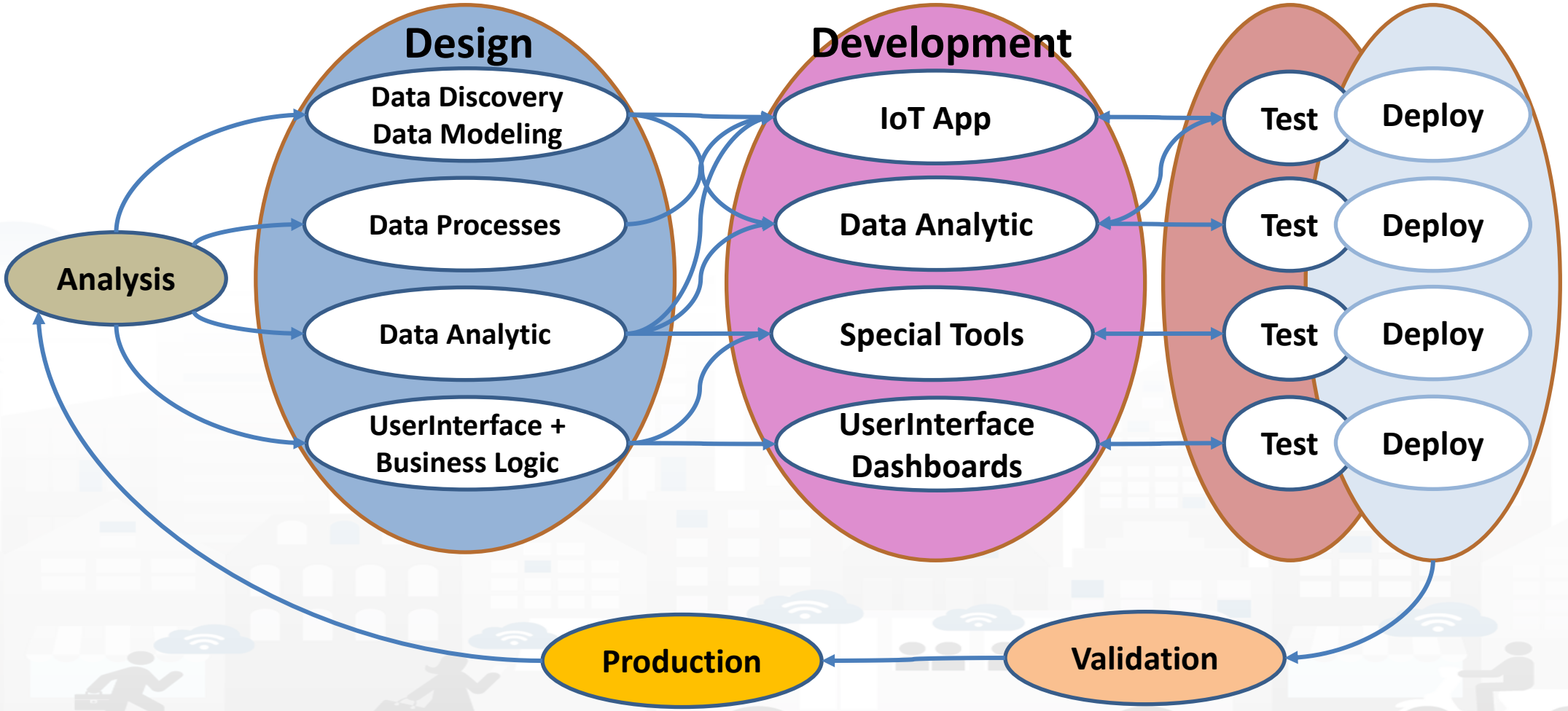
News from Snap4City & slides, Where to Meet Snap4City experts
updated
roottooladmin1

HOWTO: FIWARE Orion

Development Life Cycle Smart Solutions

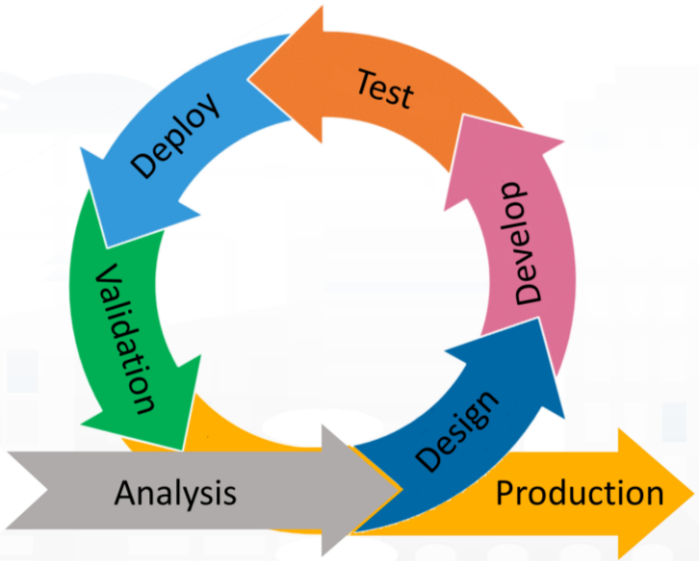


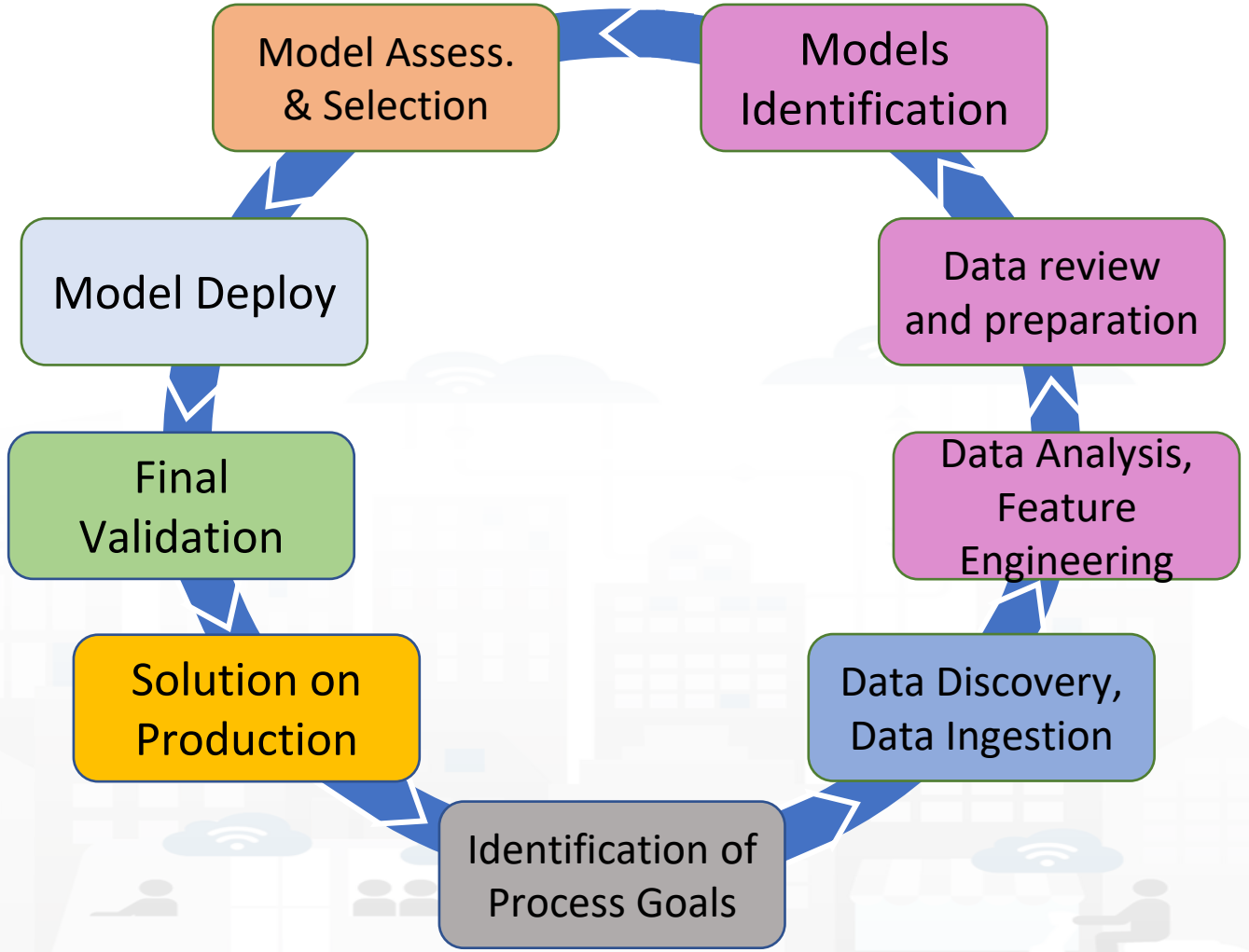
Development Life Cycle Smart Solutions



Data Analytics Development Life Cycle

- Detailed development process

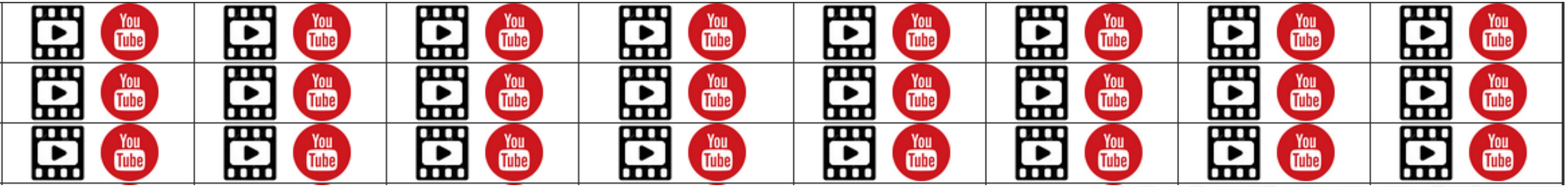




https://www.snap4city.org/944

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
							
							



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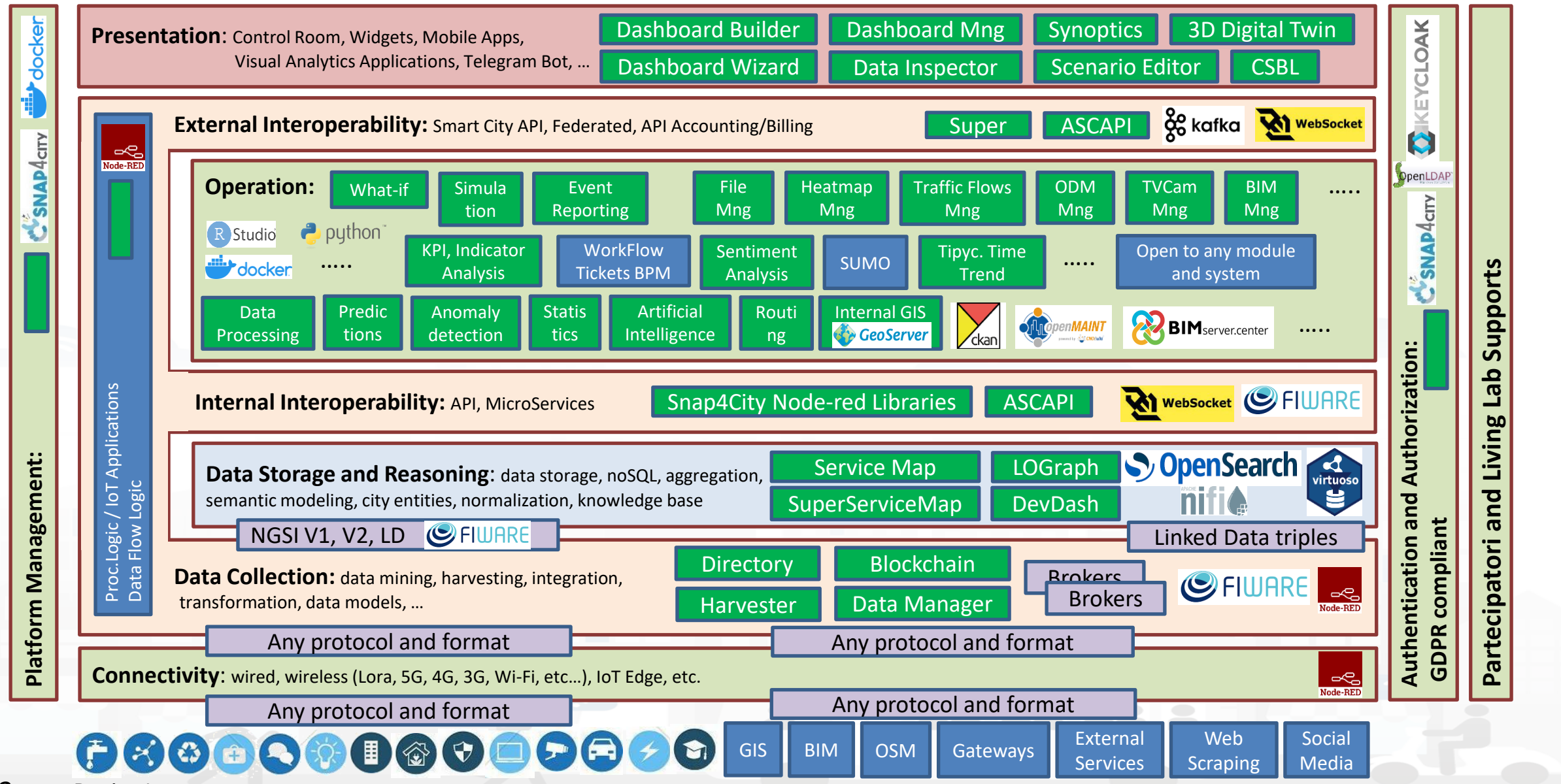
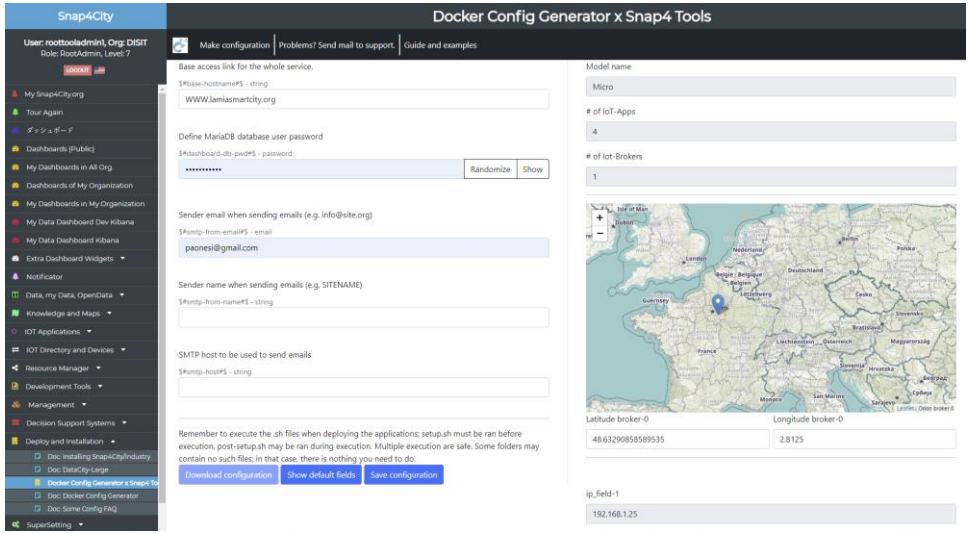
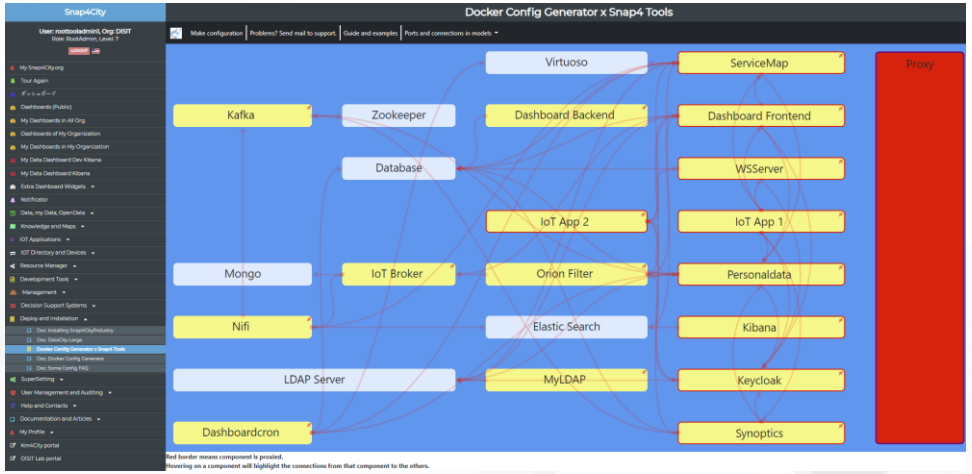
SNAP4CITY | KM 4 CITY



Installations, different models a TOOL to get them

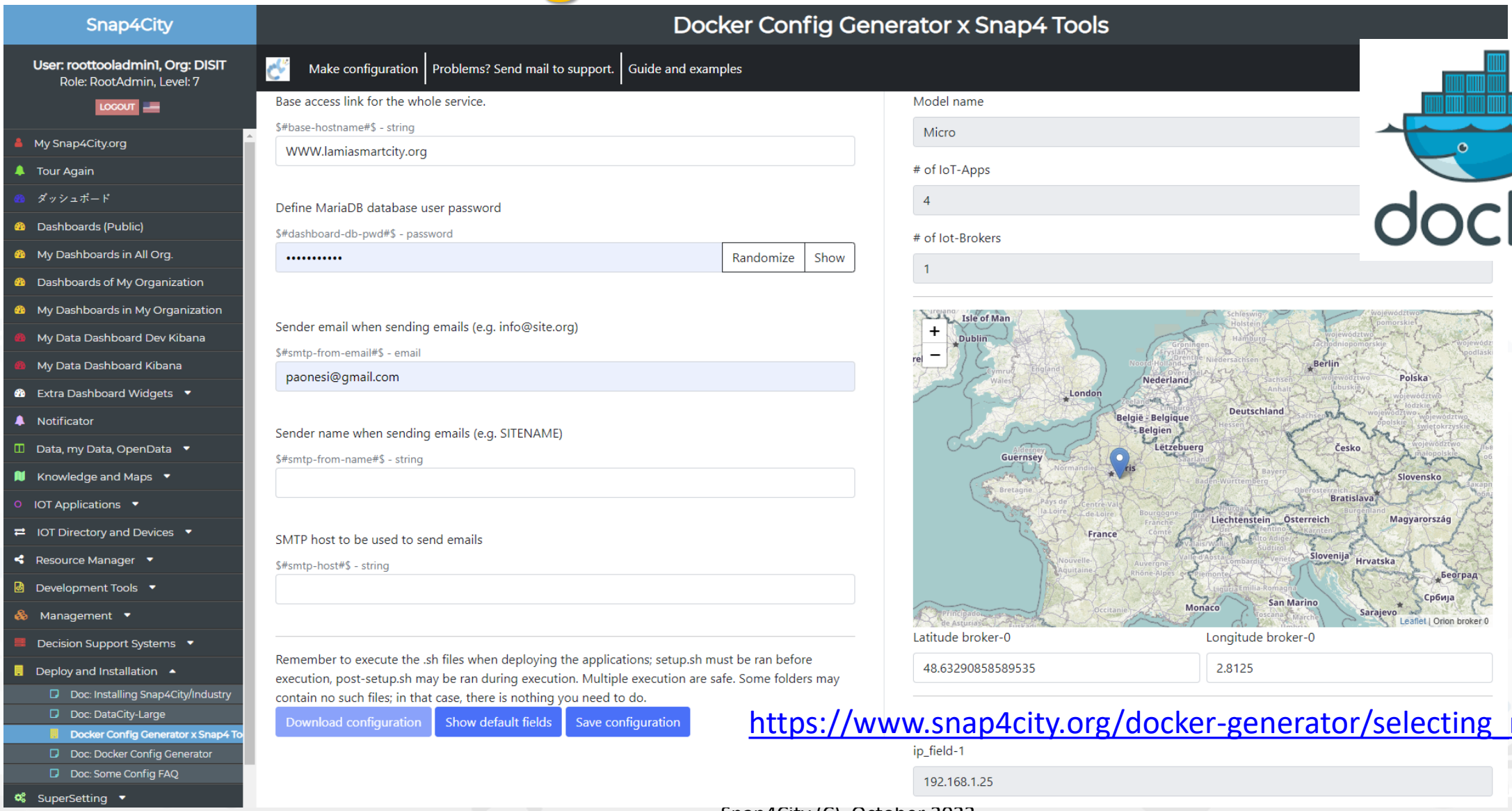
- Micro X:
  - 1 VM of dockers
- Normal X,Y:
  - 2 VM of dockers
- Small X,Y: scalable
  - 4 VM of dockers
- DataCitySmall X,Y,Z: scalable
  - 6 VM of dockers
- DataCityMid X,Y,Z,T: scalable
  - # VM + X/70 VM + Y/3 VM + Z VM + T VM of dockers
- DataCityLarge: scalable
  - depending on your needs





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

Config Generator Tools



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

2023 booklets

- Smart City

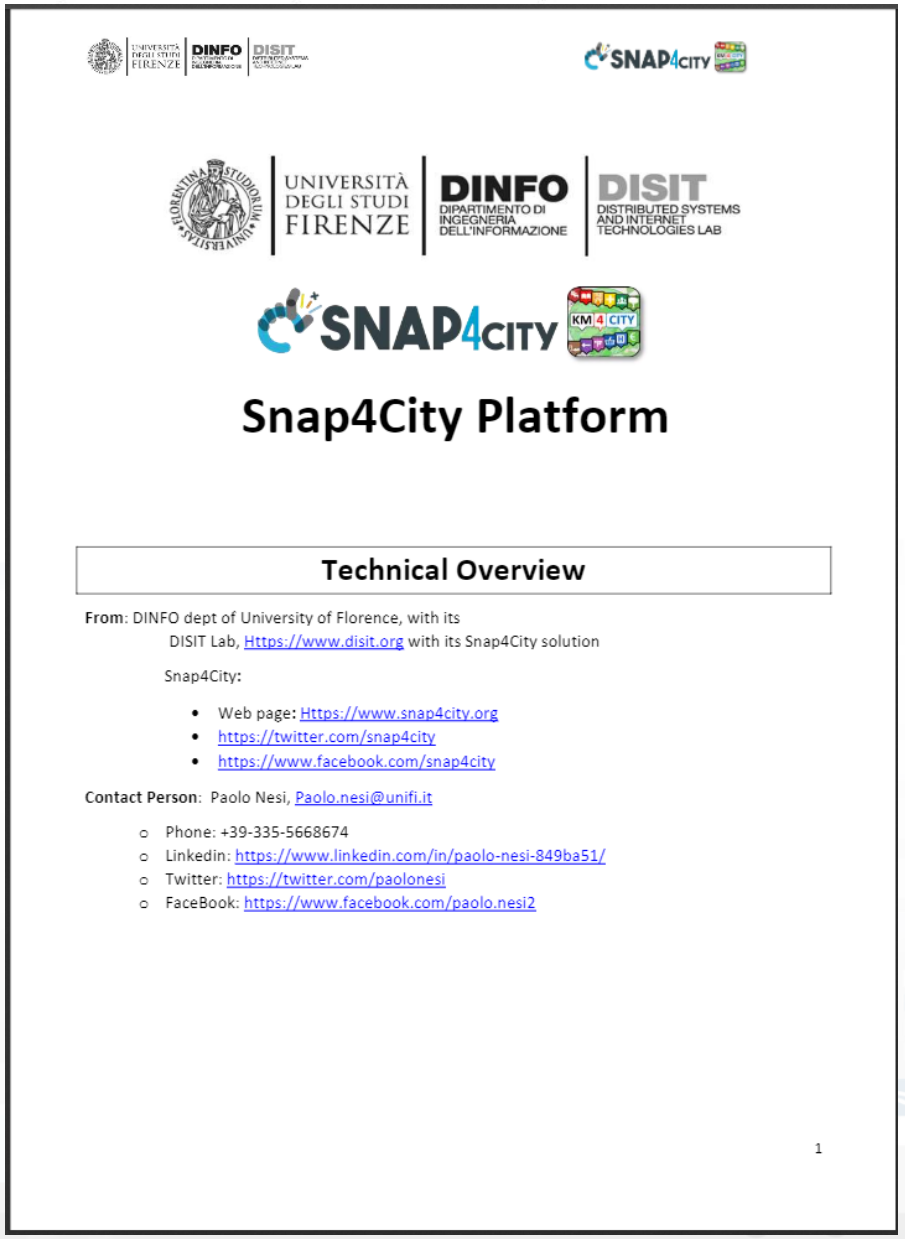
https://www.snap4city.org/download/video/DPL_SNAP4CITY.pdf

- Industry

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

- Artificial Intelligence

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



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SNAP4CITY

Snap4City Platform

Technical Overview

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

Snap4City:

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

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

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

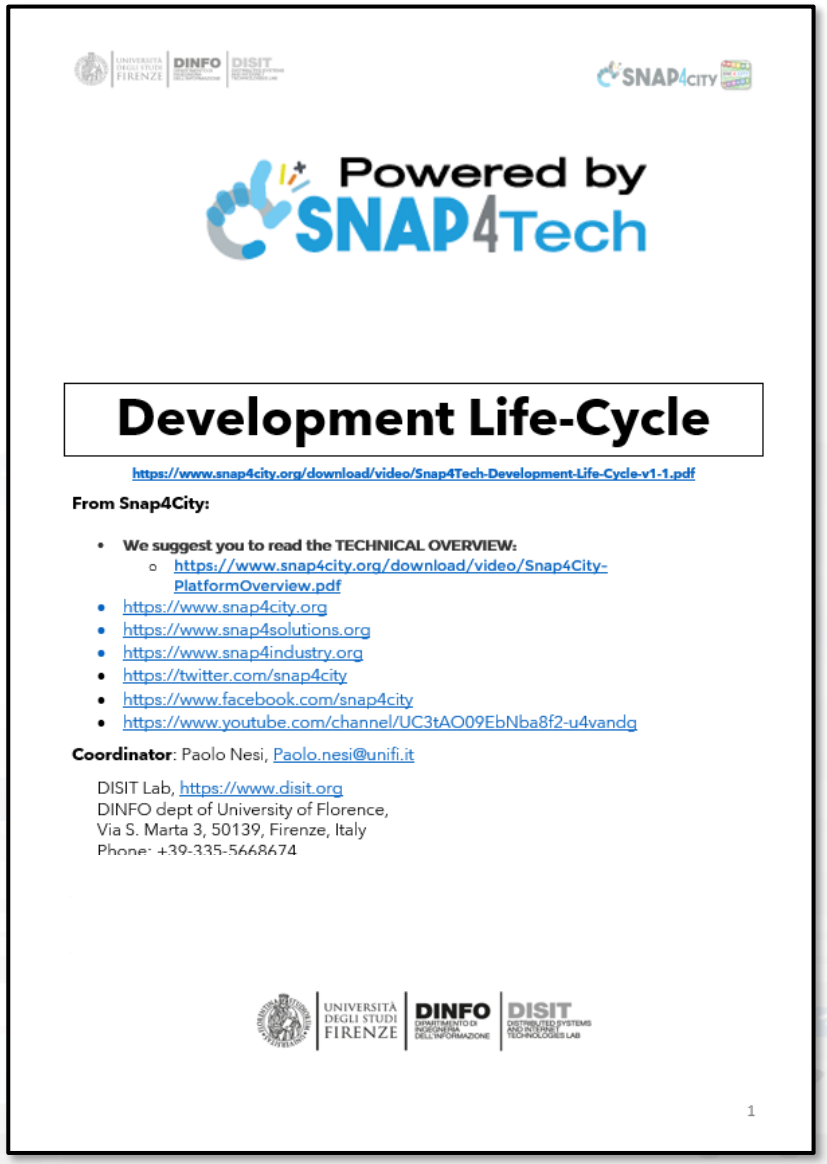
1

Tech Overview

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

Development

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



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Development Life-Cycle

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

From Snap4City:

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

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

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

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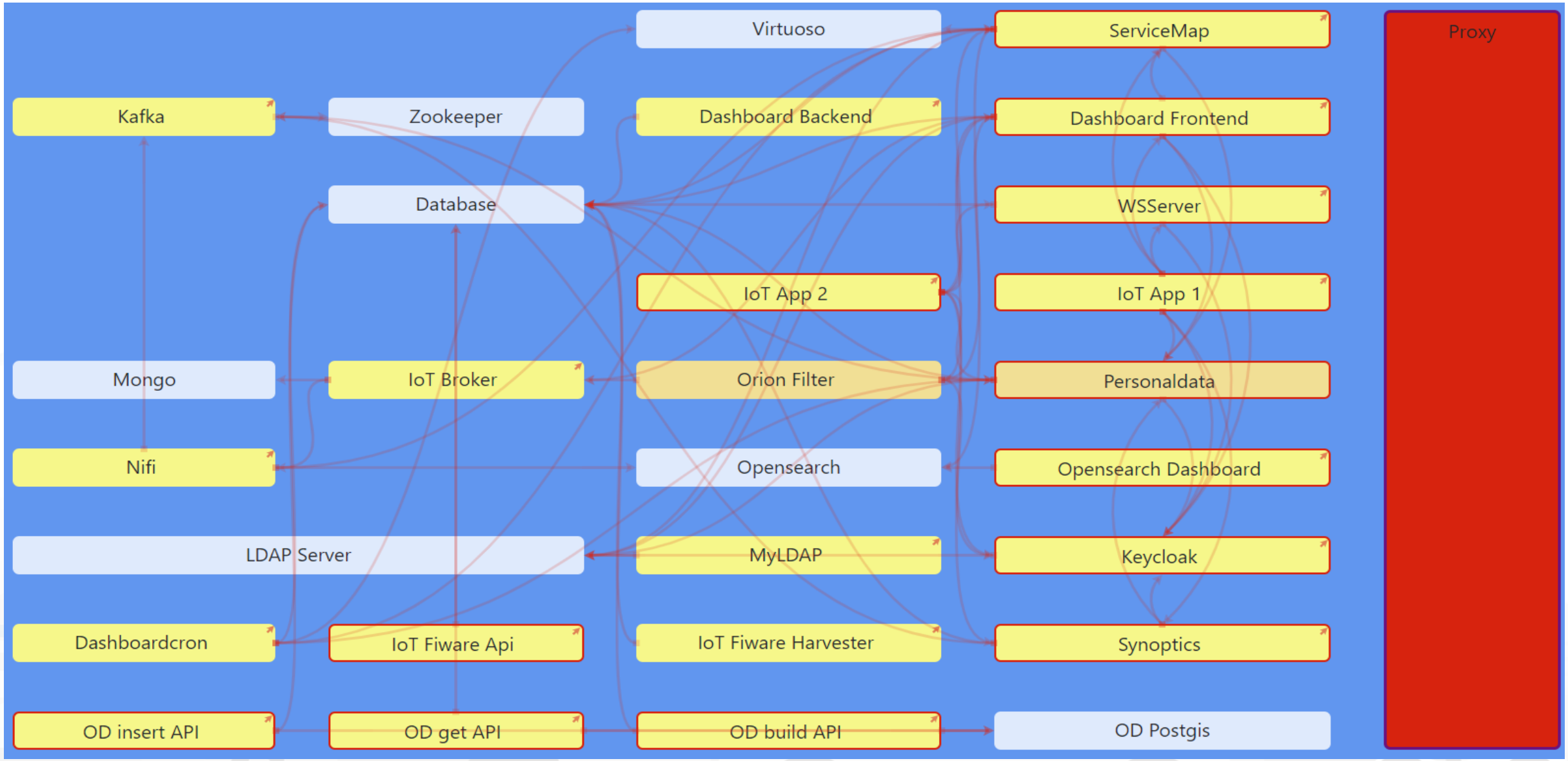
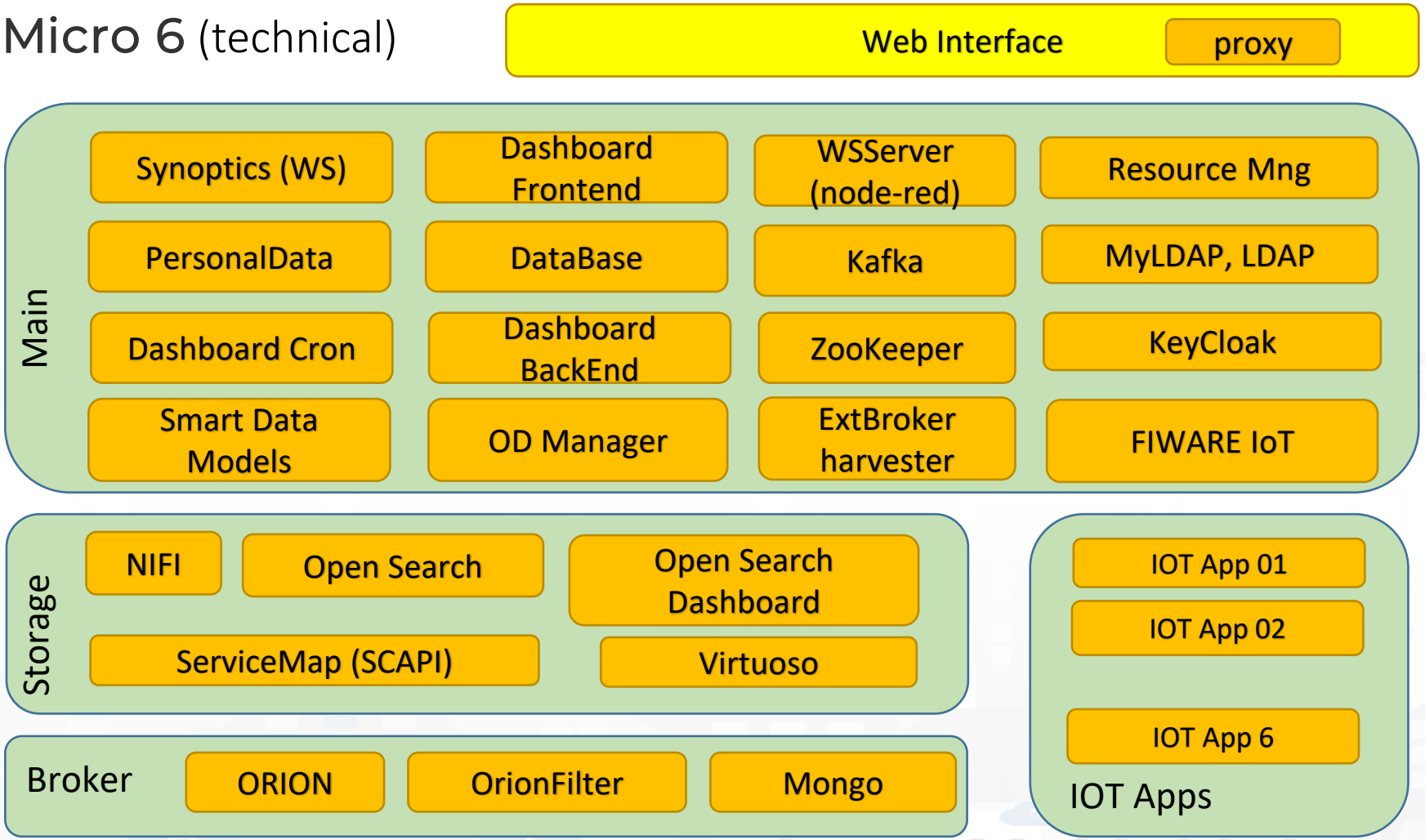

Virtuoso
ServiceMap
Proxy
Kafka
Zookeeper
Dashboard Backend
Dashboard Frontend
Database
WSServer
IoT App 2
IoT App 1
Mongo
IoT Broker
Orion Filter
Personaldata
Nifi
Opensearch
Opensearch Dashboard
LDAP Server
MyLDAP
Keycloak
Dashboardcron
IoT Fiware Api
IoT Fiware Harvester
Synoptics
OD insert API
OD get API
OD build API
OD Postgis

Micro 6 model

Micro 6 (technical)



DataCitySmall X-2-2