



UNIVERSITÀ  
DEGLI STUDI  
FIRENZE

**DINFO**  
DIPARTIMENTO DI  
INGEGNERIA  
DELL'INFORMAZIONE

**DISIT**  
DISTRIBUTED SYSTEMS  
AND INTERNET  
TECHNOLOGIES LAB



# SNAP4CITY



Powered by

## *Sistemi Distribuiti, Architetture e Soluzioni IOT*

<https://www.snap4City.org>

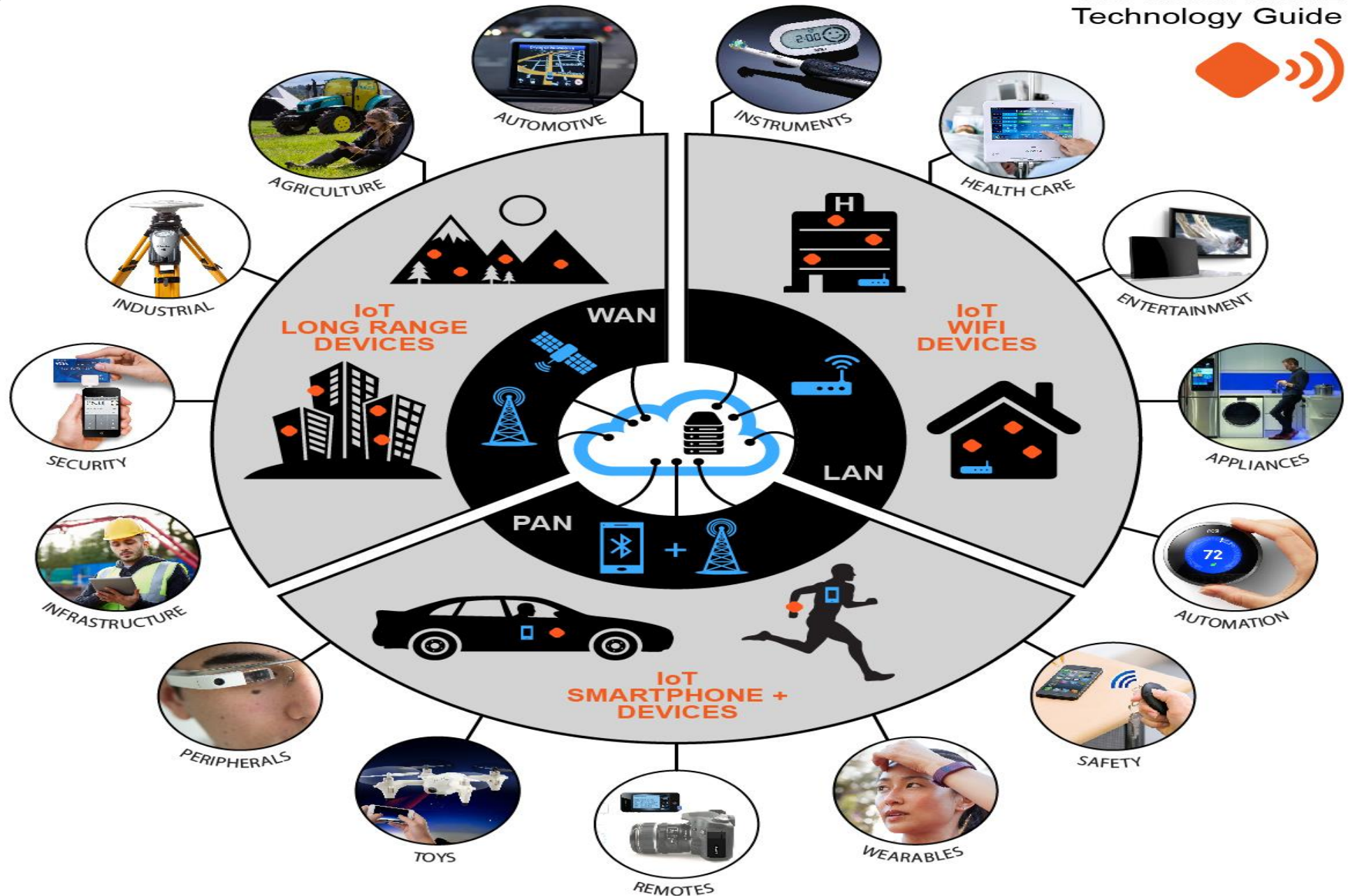
<https://www.Km4City.org>



<https://www.disit.org/>

Paolo Nesi, [paolo.nesi@unifi.it](mailto:paolo.nesi@unifi.it)





**Present data on  
Tuscany Region  
January 2018**

## Road Graph (Tuscany region)

132,923 Roads , 389,711 Road Elements

318,160 Road Nodes, 1,508,207 Street Numbers

Info on: points, paths, areas, etc.

Services (20 cat, 512 cat.)

16 Public Transport Operators

21.280 Bus stops & 1081 bus lines

## Dynamic/real-time 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 .....

Fermate Firenze Comuni in Toscana Ricerca Testuale

Seleziona una provincia:

FIRENZE

Seleziona un comune:

FIRENZE

Actual Selection

COMUNE di FIRENZE

KM4 CITY

Giovedì

Venerdì

Sabato

poco nuvoloso

poco nuvoloso

20°C / 33°C

/

velato

/

<http://servicemap.km4city.org>

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



Fermate Firenze Comuni in Toscana Ricerca Testuale

Seleziona una provincia:

FIRENZE

Seleziona un comune:

FIRENZE

Actual Selection

COMUNE di FIRENZE

## 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!

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** +

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Raggio ricerca 100 metri



Risultati della ricerca

più di 4000 risultati, attivato clustering

Services 16858



- Nascondi Menu

PREV: Giovedì Venerdì Sabato

poco nuvoloso 23°C / 27°C

schiarite 20°C / 33°C

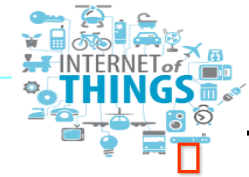
poco nuvoloso /

velato /

# *IOT Solutions*

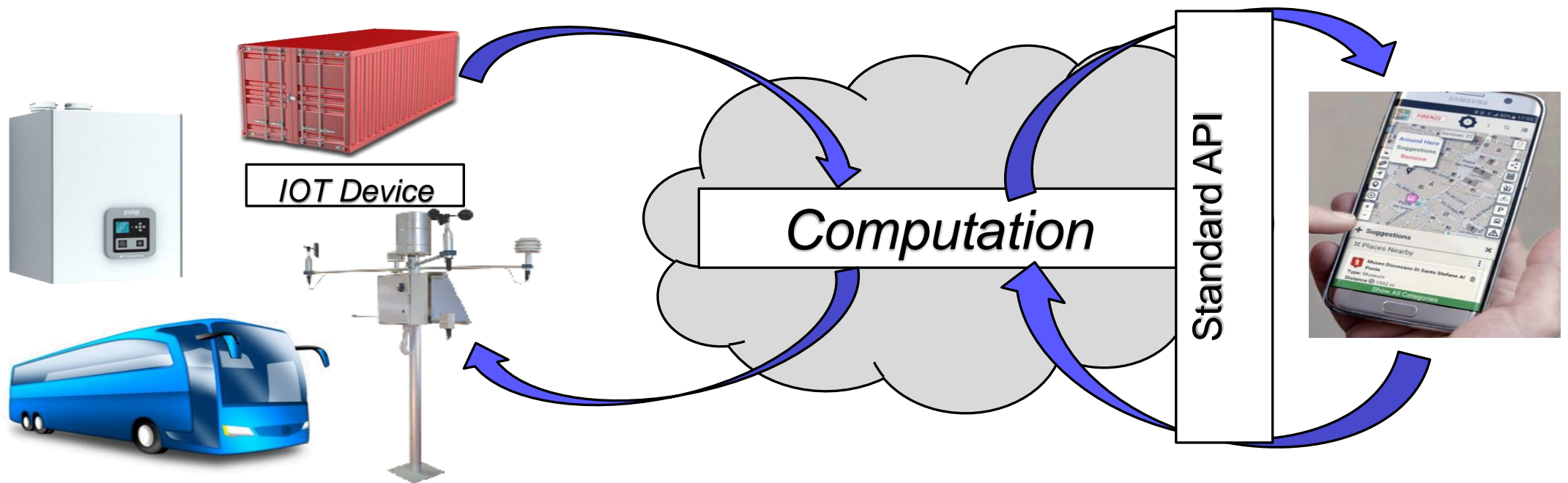


# IOT Main Concept



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.

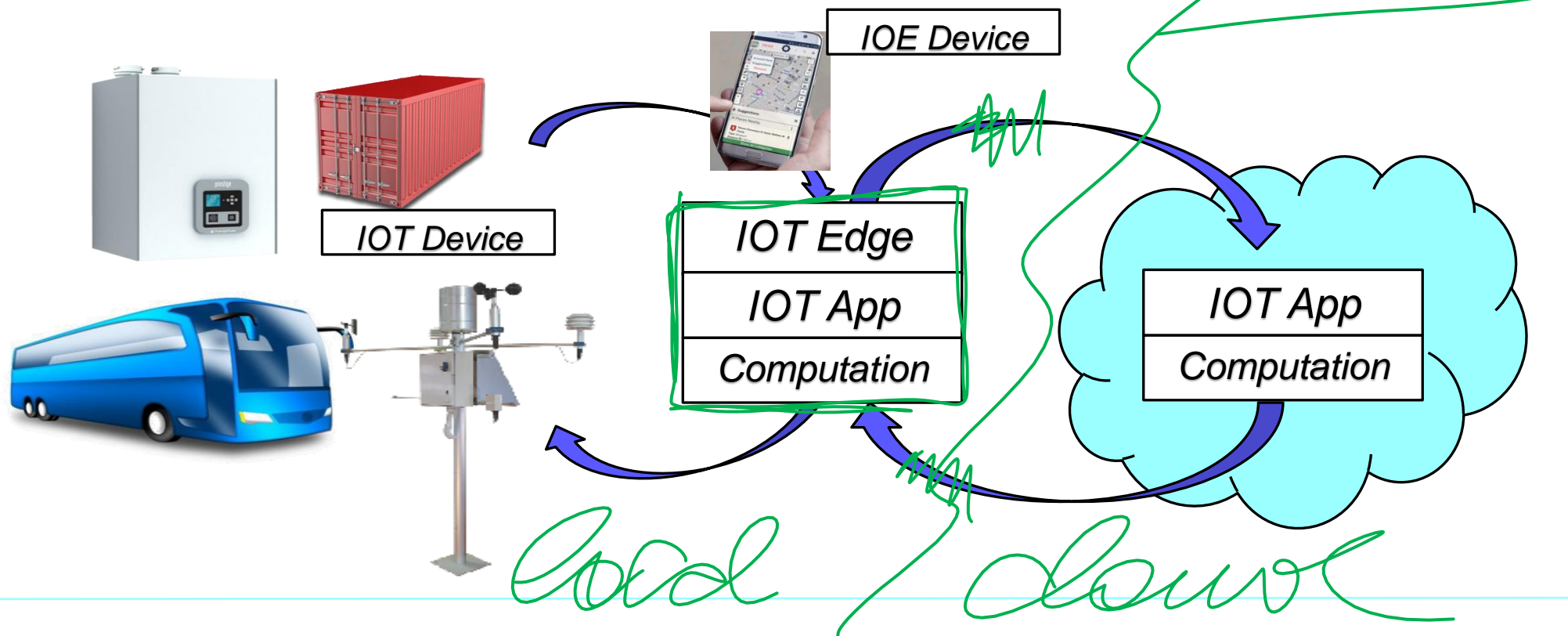


# IOT Main Concept



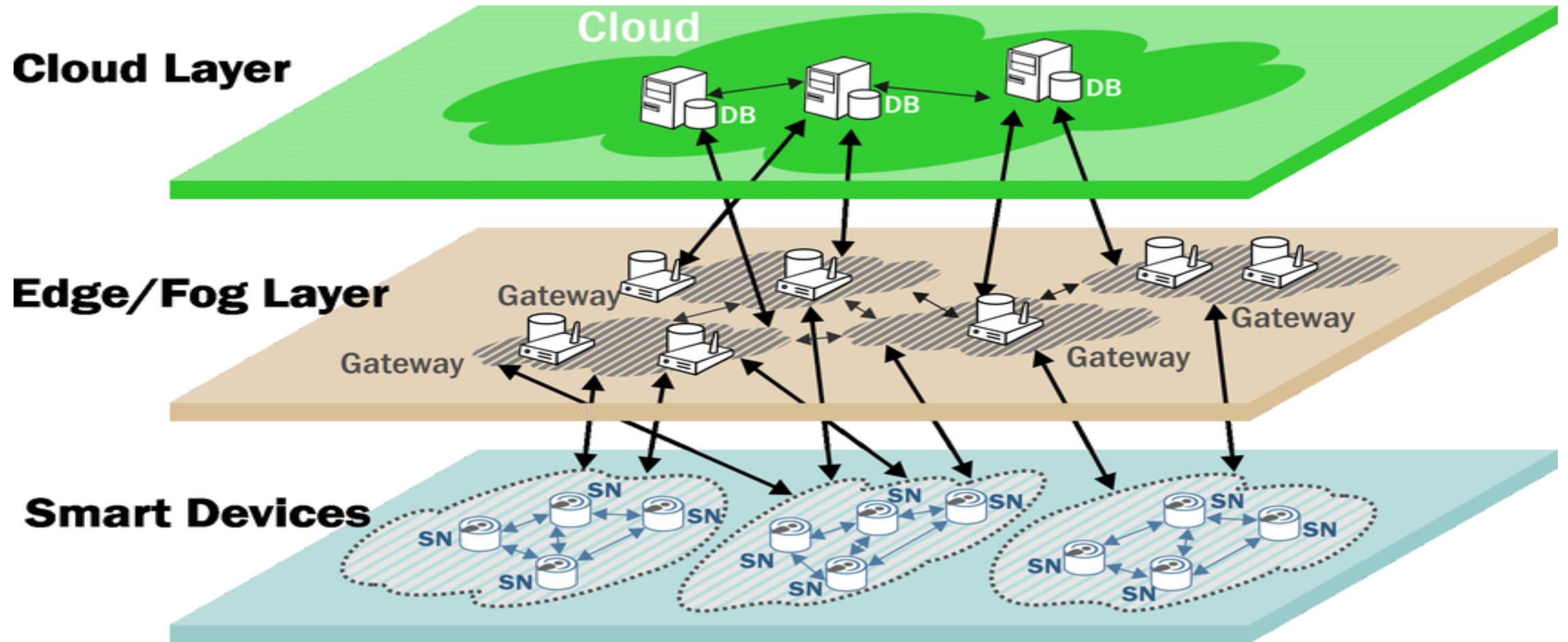
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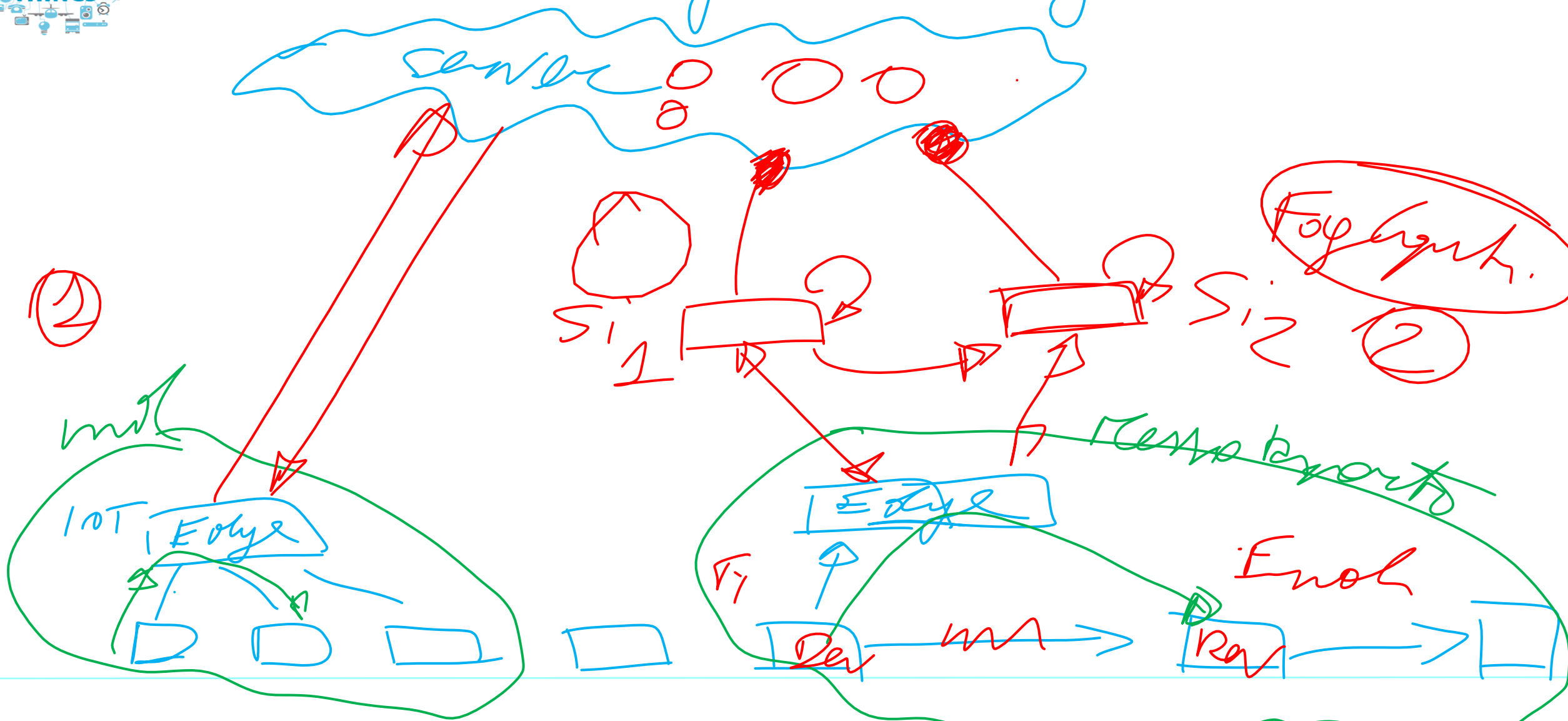
# Cloud vs Fog/Edge Computing



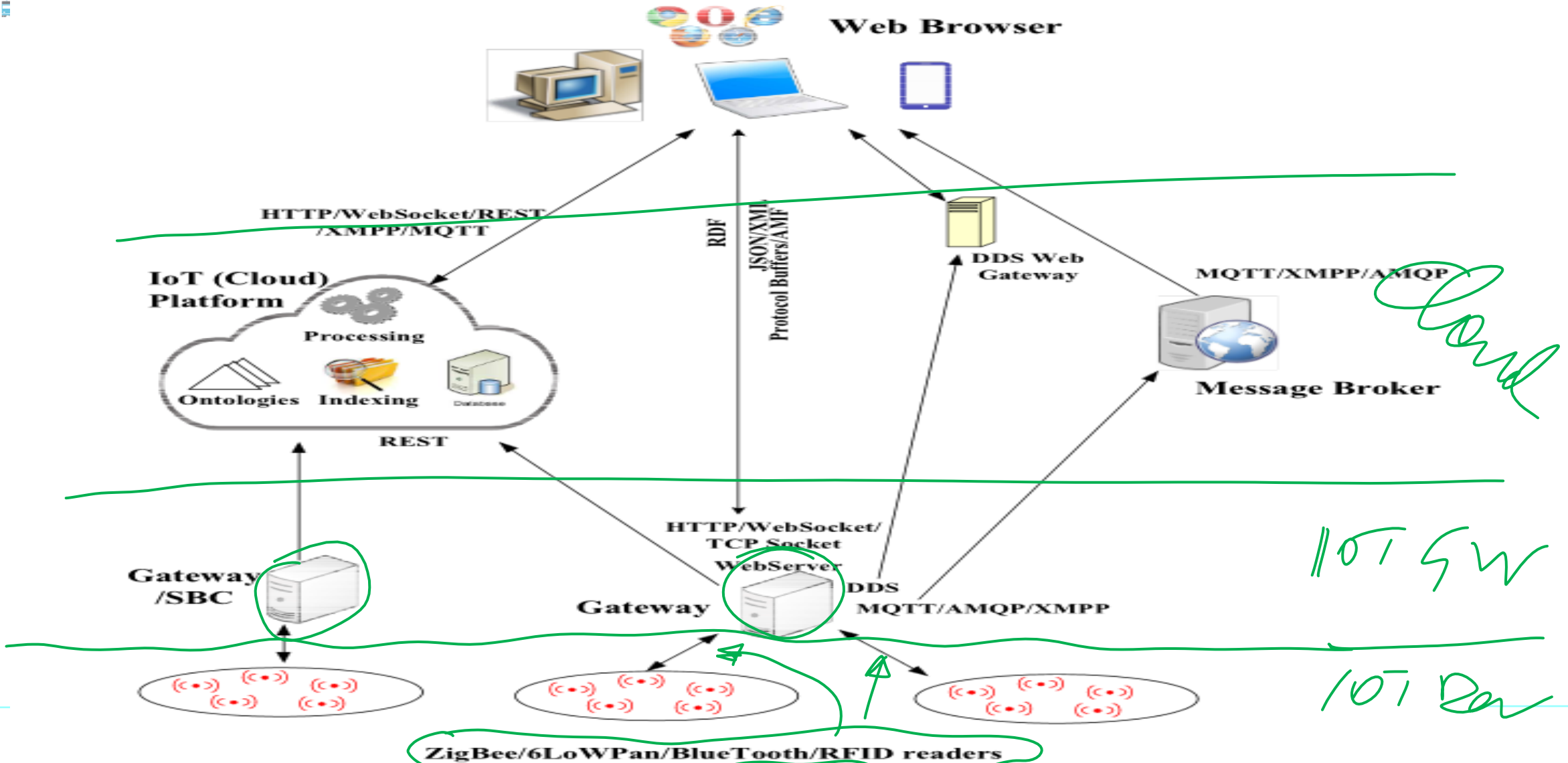


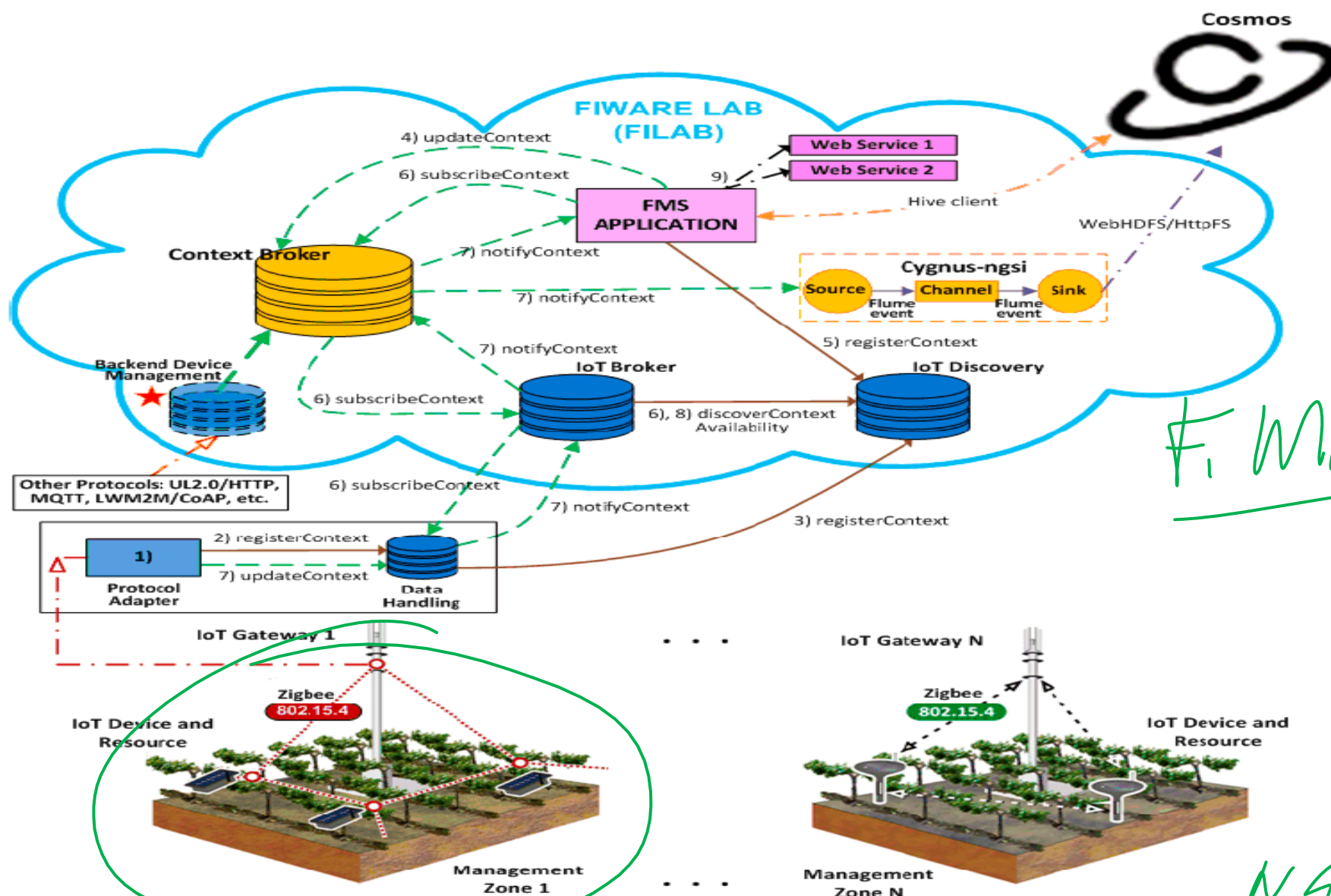


# IoT edge vs Fog



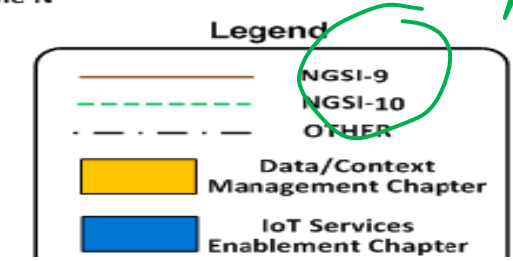
# Edge Computing, Fog Computing





*F. More*

*NGSI  
OUTA*

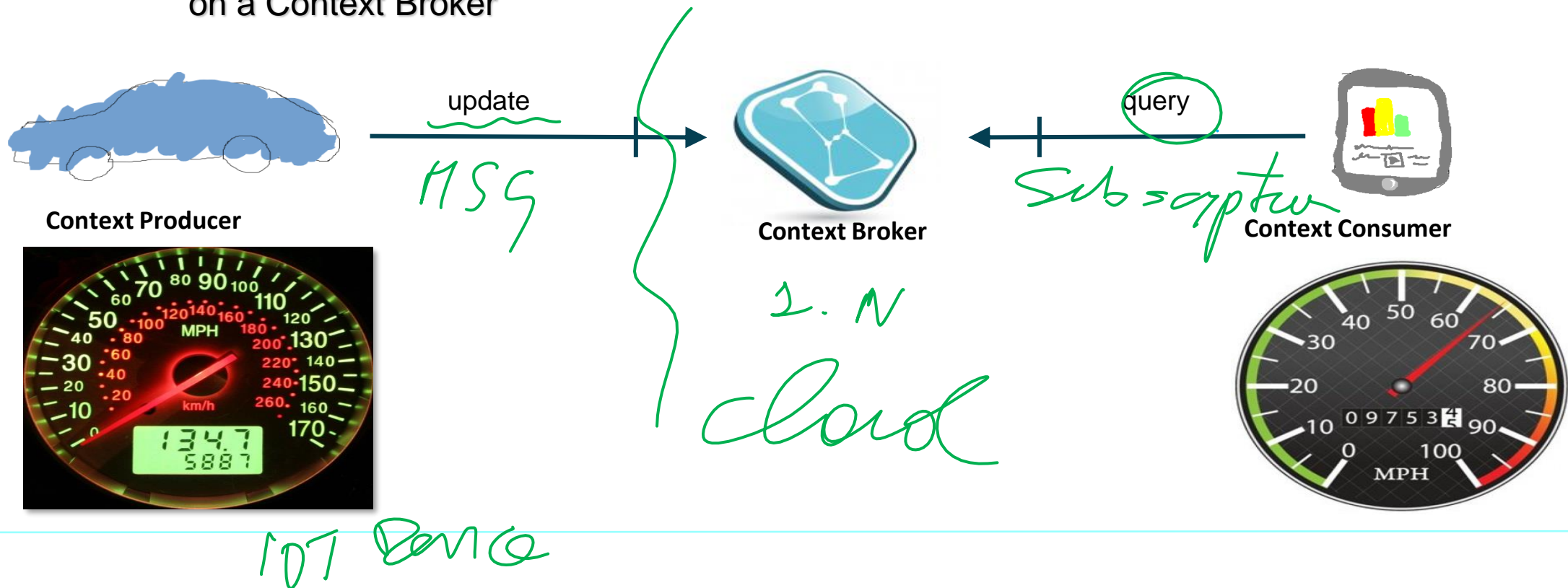


# IOT Context Broker



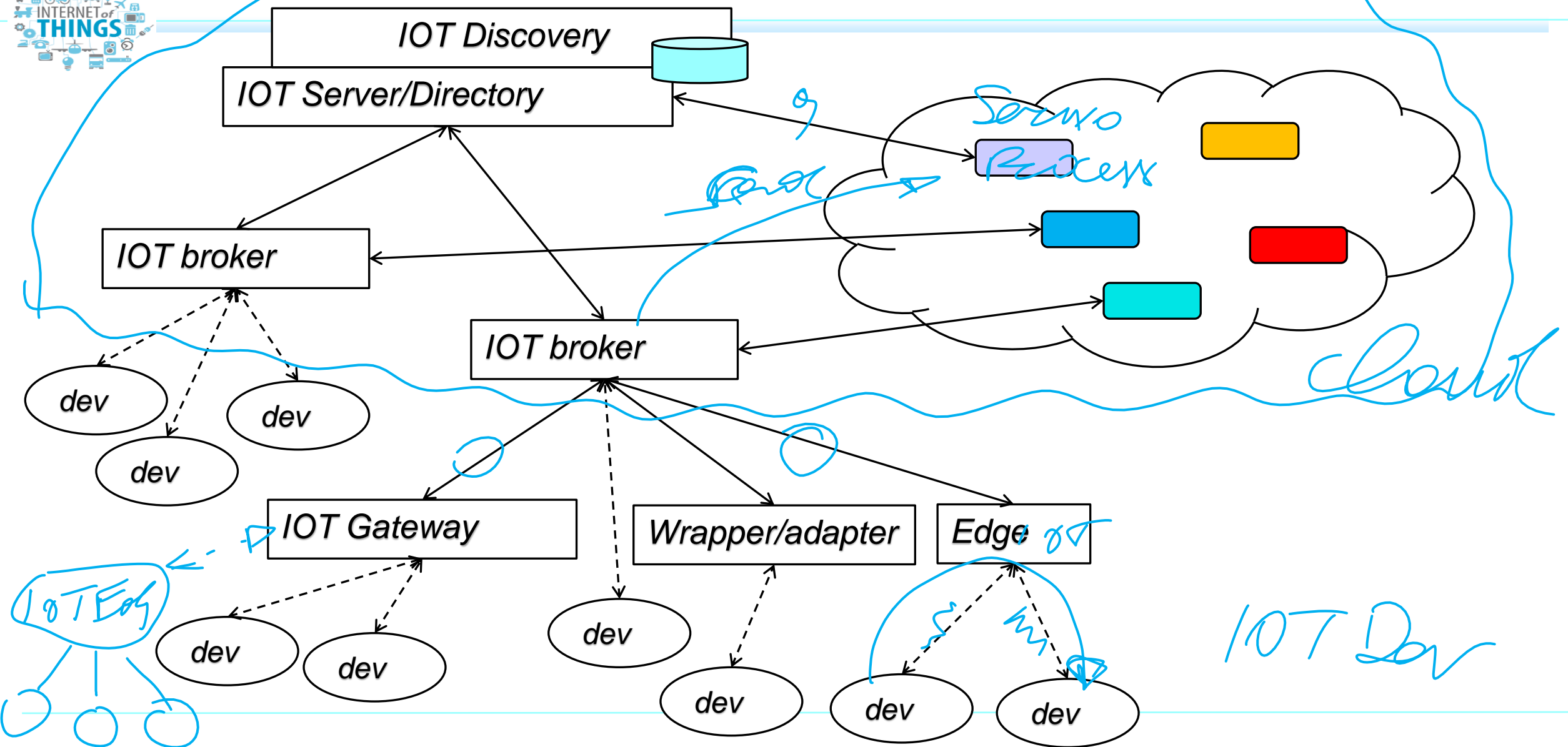
## Context Broker operations: **create** & **pull** data

- 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

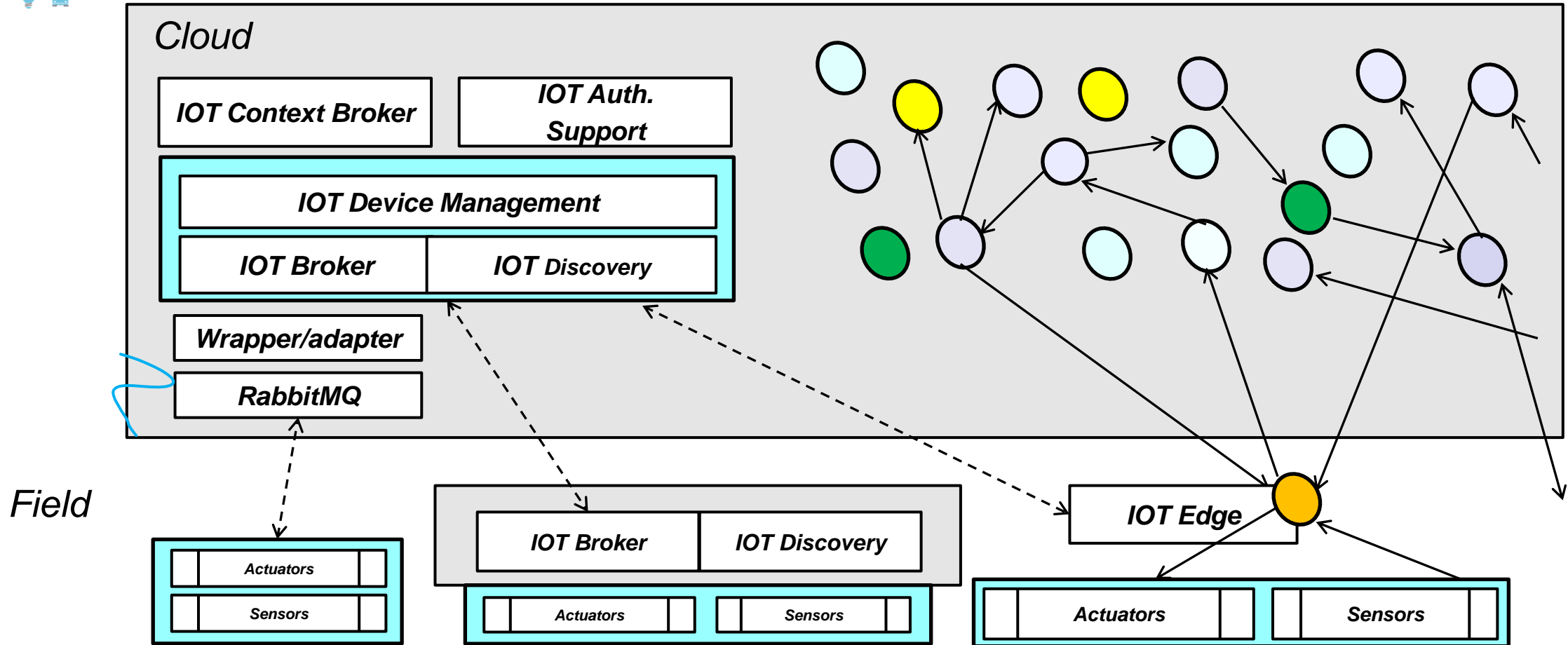


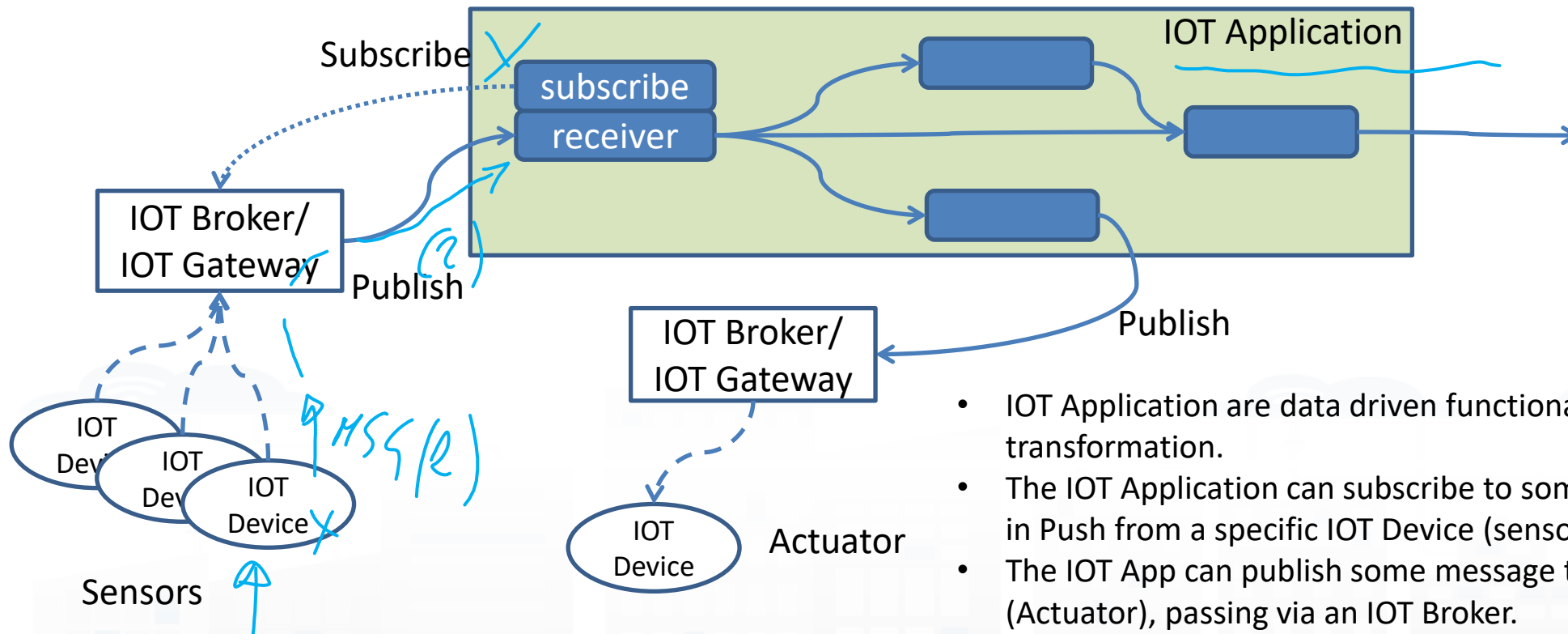
# architettura IOT

IOT



# Conceptual architecture



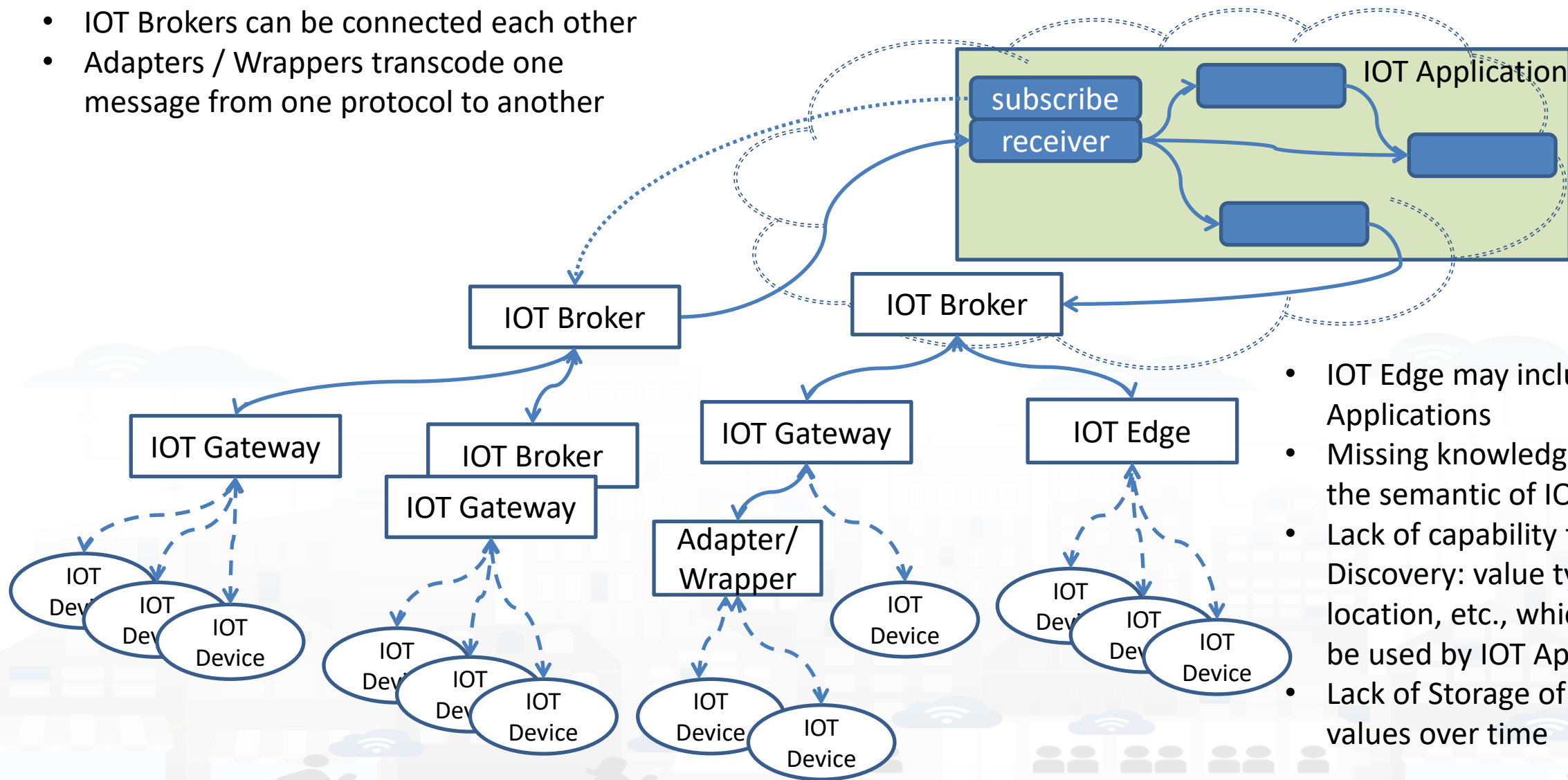


- Sensors are programmed to send data (i) periodically, or (ii) when a relevant change occurs in the sensor value, or (iii) when events occur (for example a change of status of something), etc.
- Actuator perform some action on the field: change of status, reset, turn on something, change setting value,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

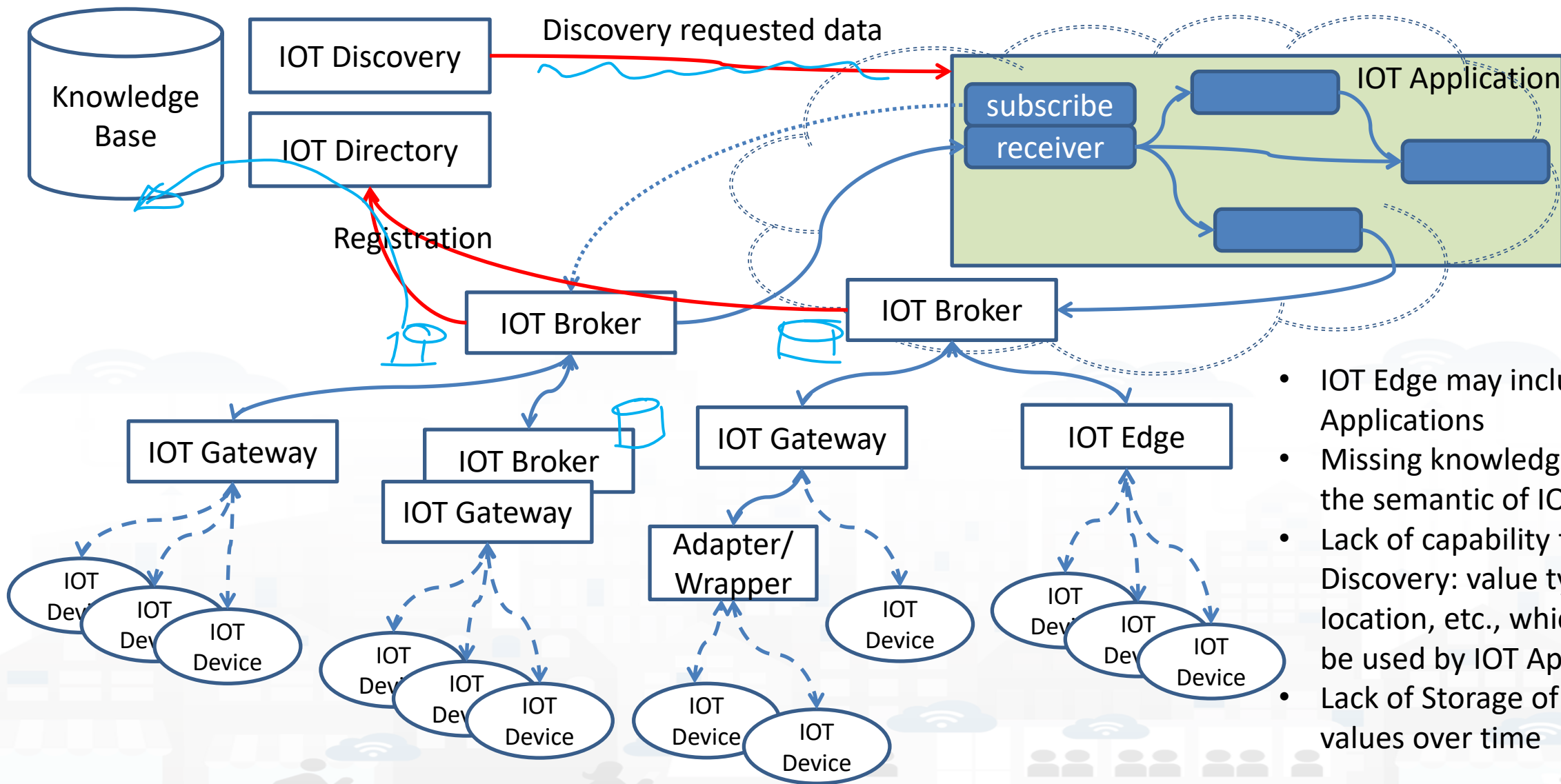
- IOT Brokers can be connected each other
- Adapters / Wrappers transcode one message from one protocol to another



- 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



- 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
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# IOT/IOE Protocols



## Communication Patterns

*IoT  
dev*

*SW*



### Discovery

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

Registration  
Search and registration



### Telemetry

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

Push



### 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

Bulk action



### 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.

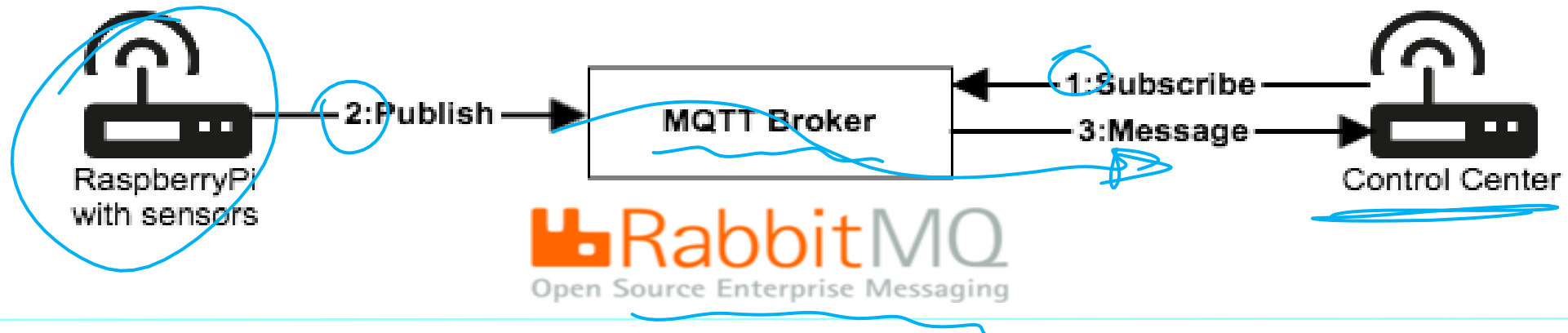
## Note on Communication patterns

- Not all Communication Patterns are supported by all Protocols
- Protocols implement Patterns, + formats, + sequences, etc.
- They are referred at level of communications
  - IOT Device  $\leftarrow \rightarrow$  IOT Gateway  $\leftrightarrow$  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, ...
- Coding and compression: ZIP, base64, etc..

# 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



<b>Session</b>		MQTT, SMQTT, CoRE, DDS, AMQP, XMPP, CoAP, ...	<b>Security</b> TCG, Oath 2.0, SMACK, SASL, ISASecure, ace, DTLS, Dice, ...	<b>Management</b> IEEE 1905, IEEE 1451, ...
<b>Network</b>	<b>Encapsulation</b>	6LowPAN, 6TiSCH, 6Lo, Thread, ...		
	<b>Routing</b>	RPL, CORPL, CARP, ...		
<b>Datalink</b>		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/](https://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/)



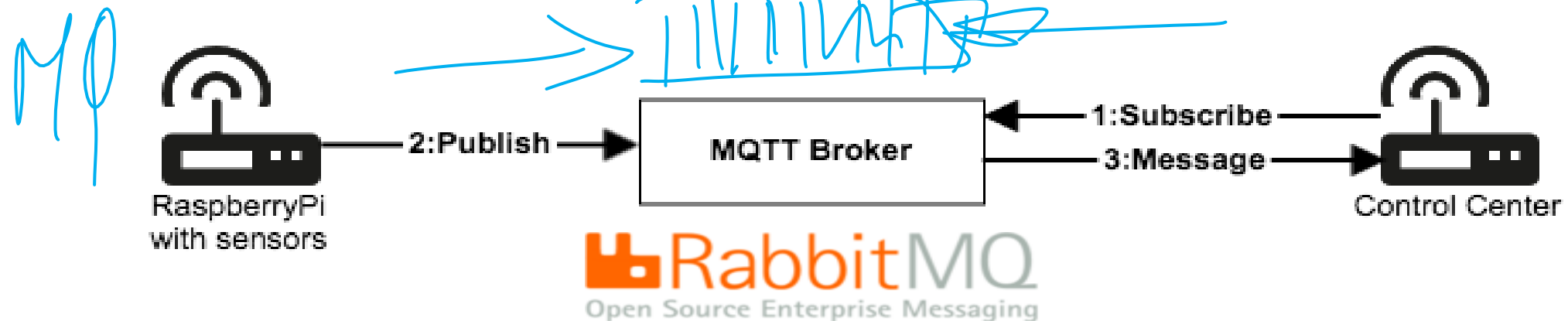
# http GET vs POST

	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
<b>RabbitMQ</b>	X	X	X	X		X
<b>Mosquitto</b>						X
<b>ActiveMQ</b>	X	X	X			X
<b>StormMQ</b>	X					
<b>HIVEMQ</b>			X			X
<b>ORION BROKER</b>				X	X	X





# Comparison high level IOT protocols

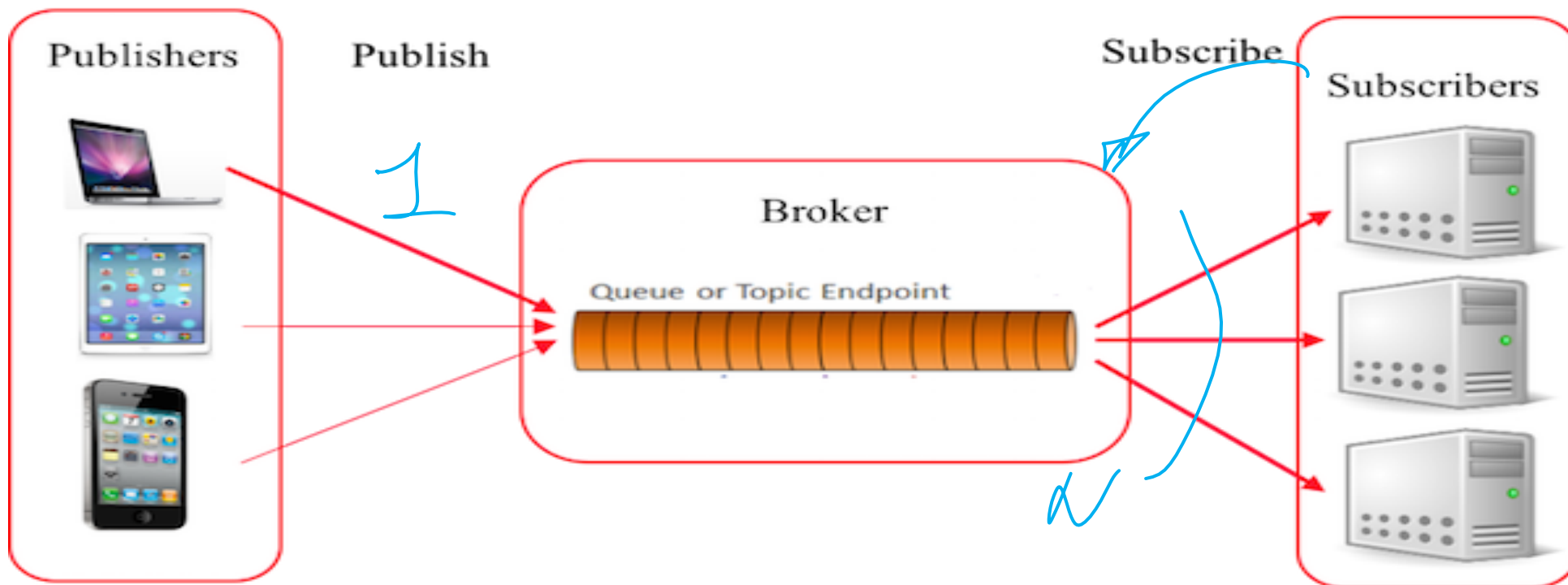
Protocols	UDP/TCP	Architecture	Security and QoS	Header Size (bytes)	Max Length(bytes)
MQTT	TCP	Pub/Sub	Both	2	5
AMQP	TCP	Pub/Sub	Both	8	-
CoAP	UDP	Req/Res	Both	4	20 (typical)
XMPP	TCP	Both	Security	-	-
DDS	TCP/UDP	Pub/Sub	QoS	-	-
<b>NGSI</b>	TCP/IP			7	—



# MQTT: Message Queue Telemetry Transport



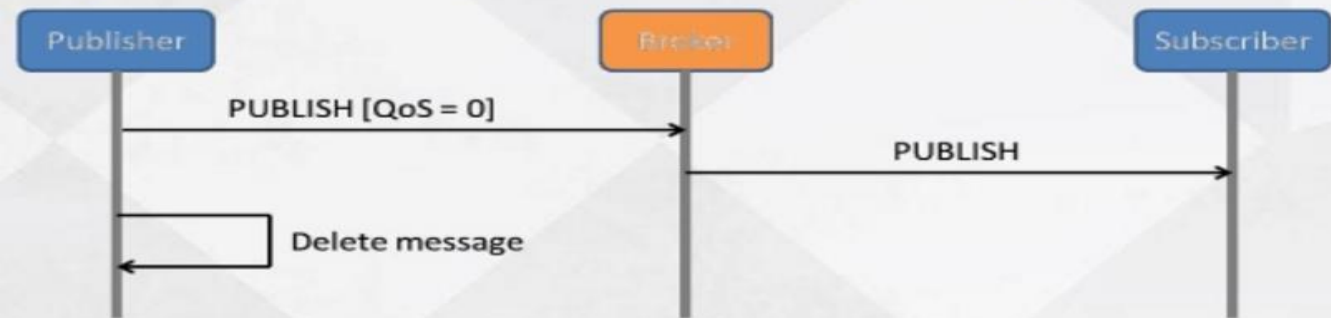
- ❑ security obtained with SSL/TLS since it is over TCP
- ❑ ISO/IEC PRF 20922
- ❑ Over TCP/IP, Async, pub/subscribe,
- ❑ payload agnostic (can be encrypted)



# MQTT QoS



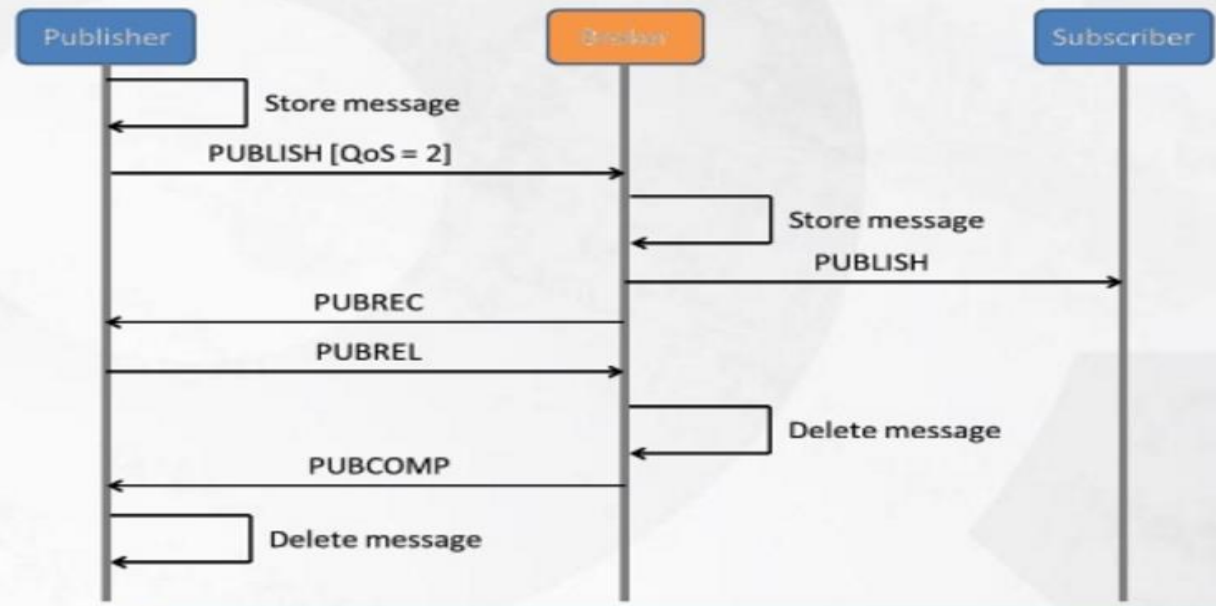
## QoS 0 : At most once (fire and forget)



## QoS 1 : At least once



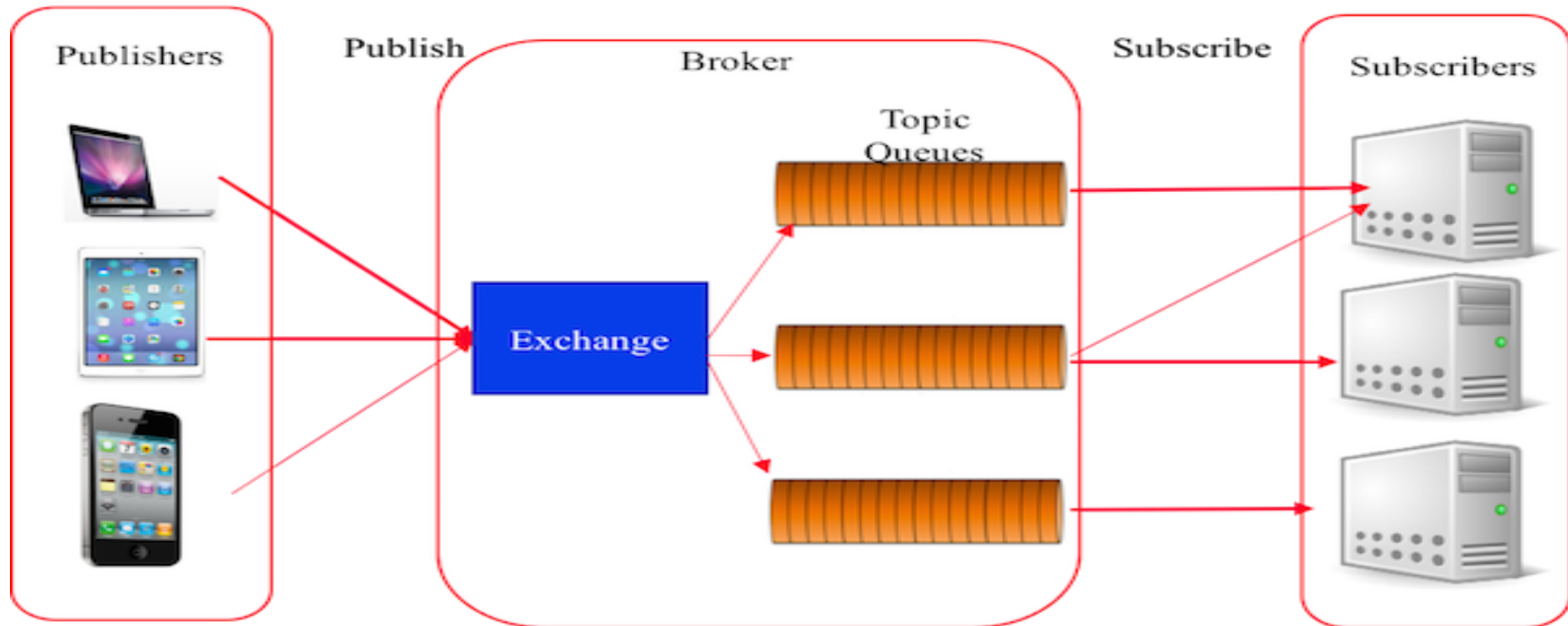
## QoS 2 : Exactly once





# AMQP Advanced Message Queuing Protocol

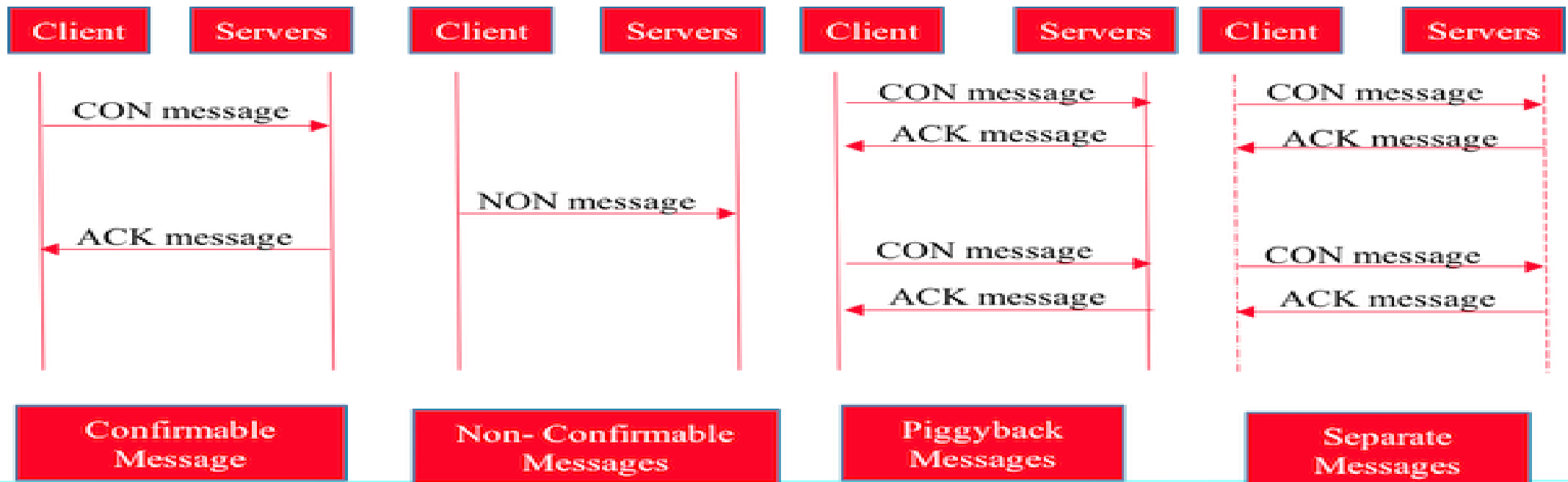
- ❑ Over TCP, binary wire protocol
- ❑ Exchange decoupling



# 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



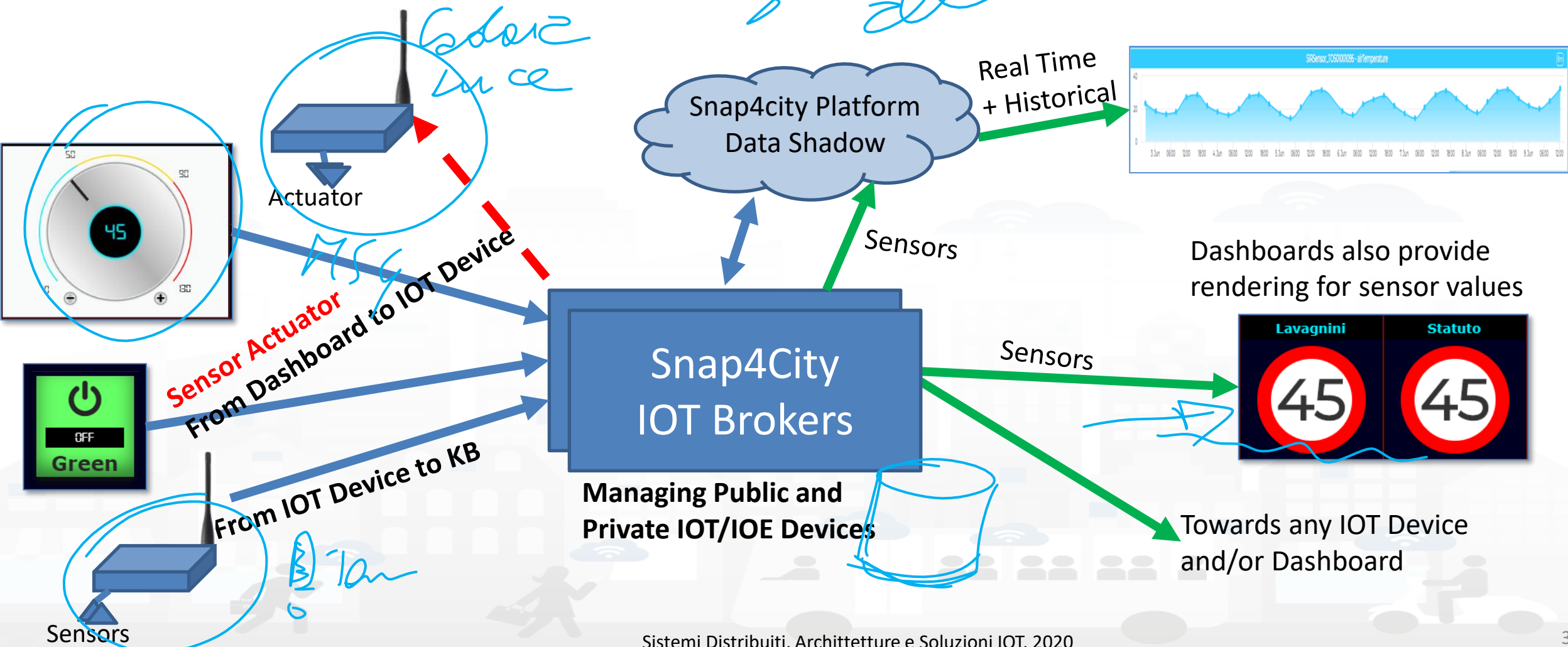
- **STOMP**: Streaming Text Oriented Messaging Protocol
  - ♣ Similar to HTTP
- **XMPP**: Extensible Messaging and Presence Protocol
  - ♣ Based on XML, proposed by IETF
  - ♣ Over TCP, can use HTTP
- **WAMP**: Web Application Messaging Protocol
  - ♣ WebSocket protocol by IANA
  - ♣ Over level 6
- **SNMP** 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
<b>Bluetooth</b>	Bluetooth 4.2	2.4GHz (ISM)	50-150m (Smart/BLE)	1Mbps (Smart/BLE)
<b>ZigBee</b>	ZigBee 3.0 based on IEEE802.15.4	2.4GHz	10-100m	250kbps
<b>6LoWPAN</b>	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
<b>WiFi</b>	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)
<b>Cellular</b>	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)
<b>NFC</b>	ISO/IEC 18000-3	13.56MHz (ISM)	10cm	100-420kbps
<b>LoRaWAN</b>	LoRaWAN	Various (europe, 868Mhz) <i>USA 450m</i>	2-5km (urban environment), 15km (suburban environment) <i>USA</i>	0.3-50 kbps <i>300m</i>

# IOT Data Driven

*Subscribe all*



# *IOT Architectures Comparison*





# Market Solutions



	OT Discovery Abstraction	Authentication, Authorization	Security end-2-end, secure on OT and Dashboards	Open HW and Open SW	Integrated Community management	Data Type: 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
KAAs [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
Smarthings Samsung [52]	Y	Y	Y	Y	Y	Y	(Y)	Y	Y	N	(Y)	N	N	N	N	N	N	Y	Limited

Handwritten notes in blue ink:

- Under "Authentication, Authorization": *Auth*
- Under "Security end-2-end, secure on OT and Dashboards": *Sec*
- Under "Data Type: Publish/share, Delegation, Consent and change": *Share*
- Under "Auditing on Data Type Access": *Access Data*
- Under "Visual Programming end-to-end applications": *IOT App*
- Under "Multi Domain Semantic Platform": *KB*
- Under "Resource Sharing": *OT type*

Azure IoT

AWS

Google IoT

Data di rilascio (Out of beta)

Febbraio 2016

Dicembre 2015

Febbraio 2018

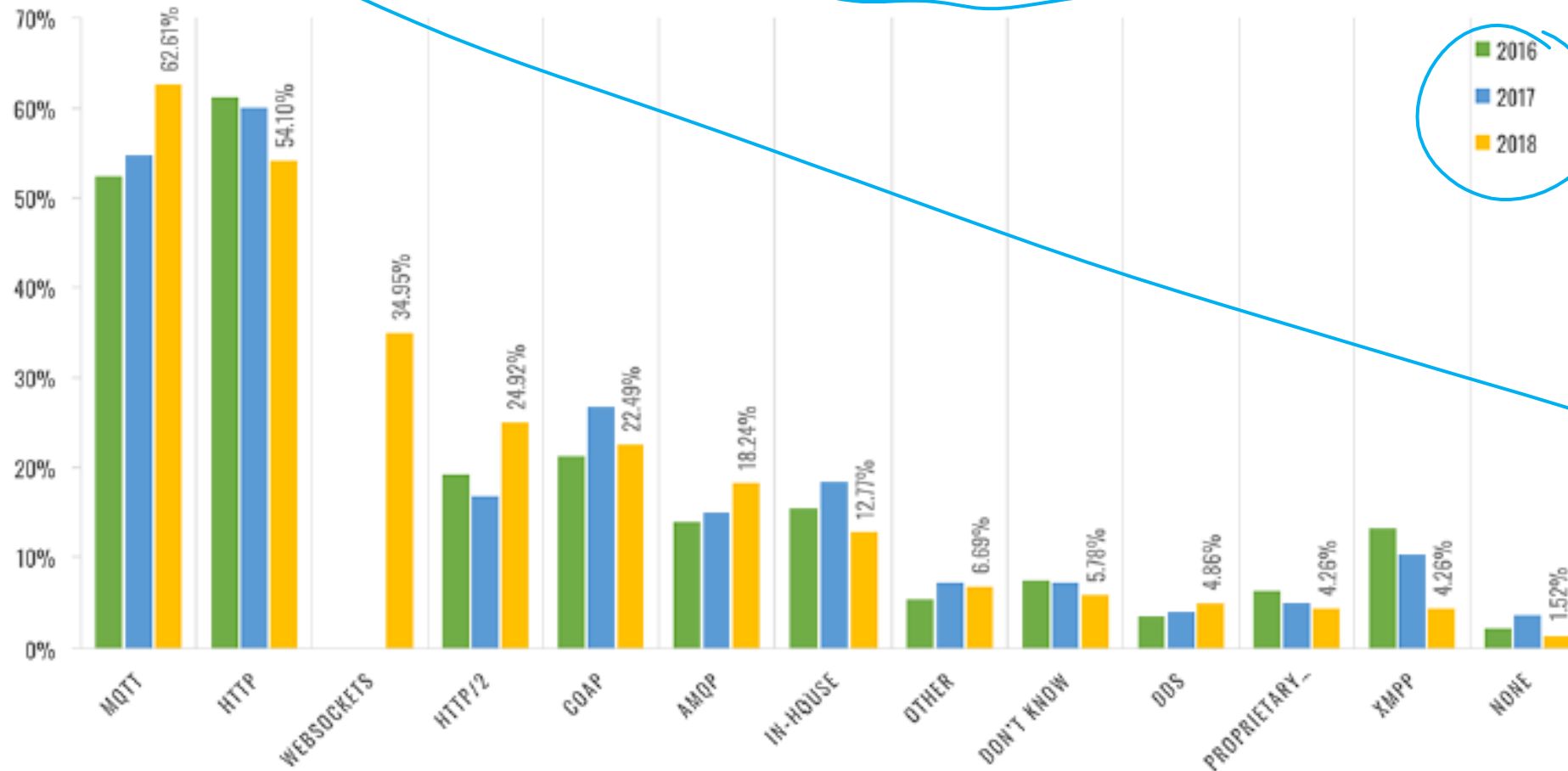
Quota di mercato

31.21%

51.82%

18.79%

2019



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

	Azure IoT	AWS	Google IoT
<b>Architettura</b>	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
<b>API</b>	REST	REST	REST
<b>Protocolli</b>	MQTT, AMQP, MQTT on WebSocket, AMQP on WebSocket, HTTPS, (1)	MQTT, MQTT on WebSocket, HTTPS	MQTT, HTTP
<b>Sicurezza</b>	TLS	TLS (mutual)	TLS
<b>Autenticazione</b>	SAS Token, IAM, x.509	x.509, IAM, Amazon Cognito, Federated, (2)	JSON Token, IAM, x.509
<b>SDK</b>	.NET, Java, Node.js, C, Python, (3)	C, Javascript, Java, Python, IOS, Android, Arduino Yun	Go, Java, .NET, Javascript, IOS, Android, PHP, Ruby, Python
<b>Starter Kit</b>	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	X	X	X
Intelligence API	Language, Speech, Vision, Knowledge	X	/

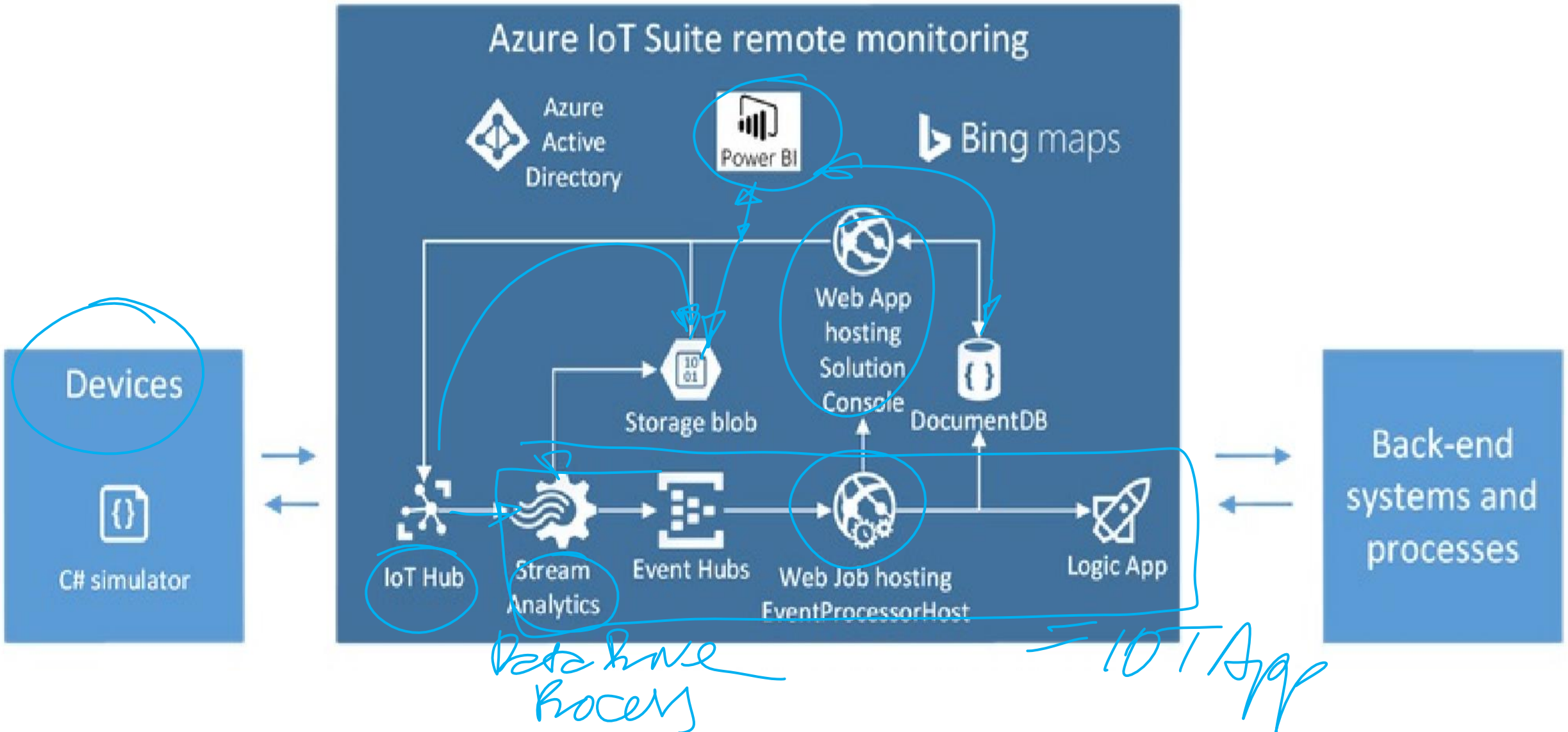
	Azure IoT	AWS	Google IoT
Prezzo	Diverse fasce di prezzo in base al numero di messaggi scambiati	Costo unitario per messaggio e per tempo di connessione del dispositivo	Costo basato sul volume di dati scambiati

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

	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
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%









SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES





# URBAN PLATFORM: SMART CITY IOT AS A SERVICE AND ON PREMISE



## APPLIANCES CONTAINERS

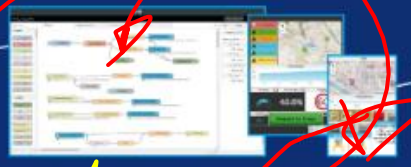
- LOCAL GOVERN
- STAKEHOLDERS
- CITY USERS
- IN-HOUSE
- ENERGY OPERATORS
- MOBILITY OPERATORS
- COMMERCIAL OPERATORS
- SECURITY OPERATORS
- INDUSTRIES
- RESEARCHERS
- START-UPS
- ASSOCIATIONS



- GDPR
- SECURITY
- PRIVACY
- ASSESSMENT
- AUDITING
- PENTESTED
- OPEN IOT DEVICES
- IOT EDGE
- IOT GATEWAY
- PAX COUNTERS
- IOT BUTTONS
- TEST CASES, SCENARIOS, VIDEOS, HACKATHONS
- OPEN SOURCES, COMMUNITY OF CITIES
- TRAINING TUTORIALS, COMMUNITY MANAGEMENT

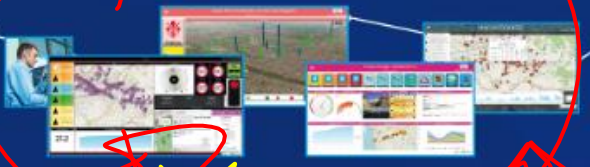
*Node Red*

### IOT APPLICATIONS - INSTANT APPS



DATA DRIVEN APPLICATIONS • REAL TIME PROCESSING • BATCH PROCESSING • ANY PROTOCOL • ANY FORMAT

### DASHBOARDS & APPLICATIONS



CONTROL ROOM • SITUATION ROOM • OPERATIONAL DASHBOARDS • BUSINESS INTELLIGENCE • WHAT-IF ANALYSIS • DECISION SUPPORT • SIMULATIONS • RISK ANALYSIS • RESILIENCE ANALYSIS

### MOBILE & WEB APPLICATIONS



DEVELOPMENT PANELS • SUGGESTIONS • MOBILE APPS • MONITORING PANELS • PLATFORM UTILITIES • REMOVE USE SMART APPLICATIONS

## MICROSERVICES & ADVANCED SMART CITY API

### LIVING LAB - DEV TOOLS - COWORKING



IOT DIRECTORY • SERVICE MAP • RESOURCE MANAGER • DATA GATE • STUDIO • ETC

### BIG DATA - DATA ANALYTICS



PREDICTIONS • ANOMALY DETECTION • WHAT-IF ANALYSIS • TRAFFIC FLOW RECONSTRUCTION • ORIGIN-DESTINATION MATRICES • SOCIAL MEDIA ANALYSIS • OFFER VS DEMAND ANALYSIS • ENVIRONMENTAL DATA ANALYSIS AND PREDICTIONS • REAL TIME HEATMAPS • ROUTING • ALERTING • ENERGY WARNING • PERSONAL AND VIRTUAL ASSISTANTS • SMART SOLUTIONS • SMART SHARING • PARTICIPATORY

### DATA ANALYTICS TOOLS - MICRO-APPLICATIONS



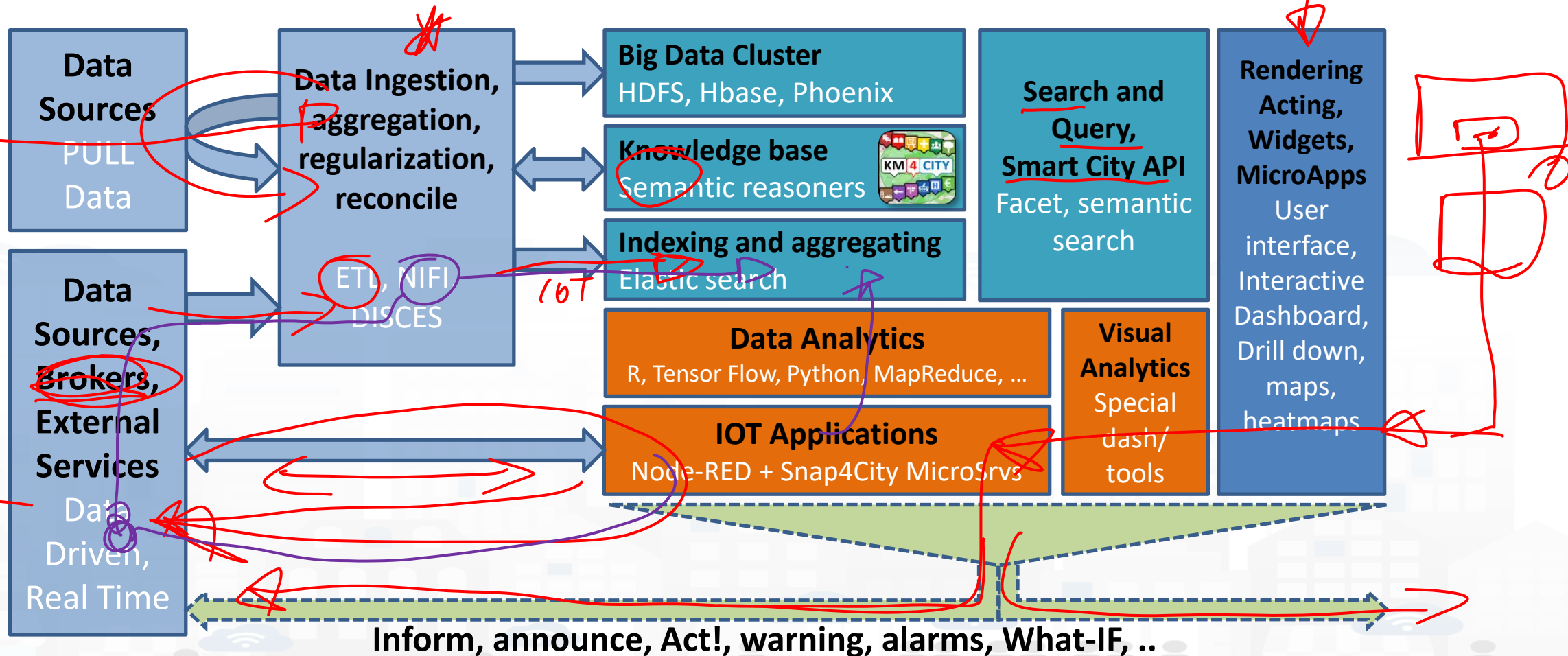
## KM4CITY DATA AGGREGAT KNOWLEDGE BASE - EXPERT SYSTEM OF THE CITY - BIG DATA STORE

## IOT MNG - DATA MNG - DATA INSPECTOR - PROCESS MNG - USER ENGAGEMENT - GDPR MNG ...

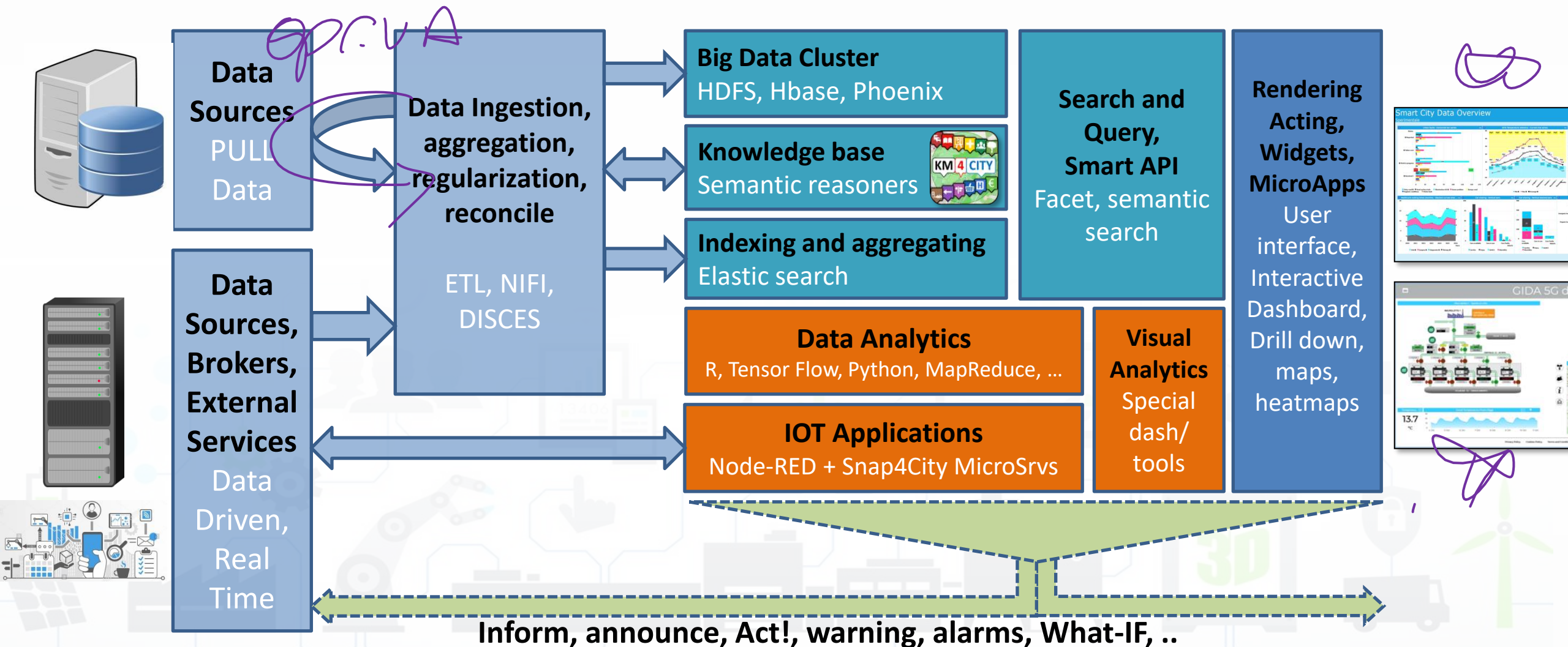
- BIS
- CITY UTILITIES
- OPEN DATA
- LEGACY & EXTERNAL SERVICES
- PERSONAL DATA
- IOT / IOE
- BROKERS
- IoT
- INDUSTRY 4.0
- SOCIAL MEDIA



# Snap4City as a Lambda Architecture



# Snap4Industry as a Lambda Architecture



# Smart City Functional Architecture

*FROTA*

Transport systems  
Mobility, parking



Public Services,  
Govern, events, ...



Sensors, IOT Cameras,  
Wi-Fi



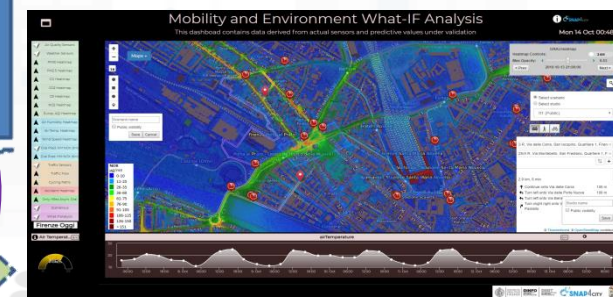
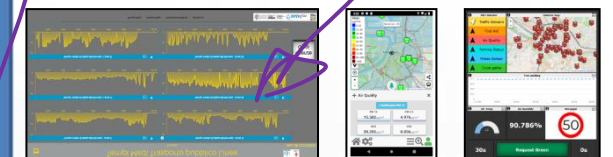
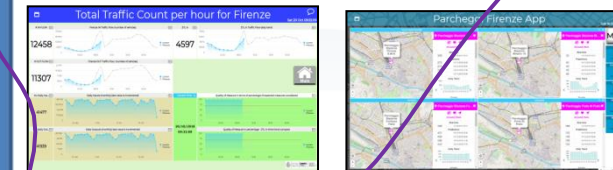
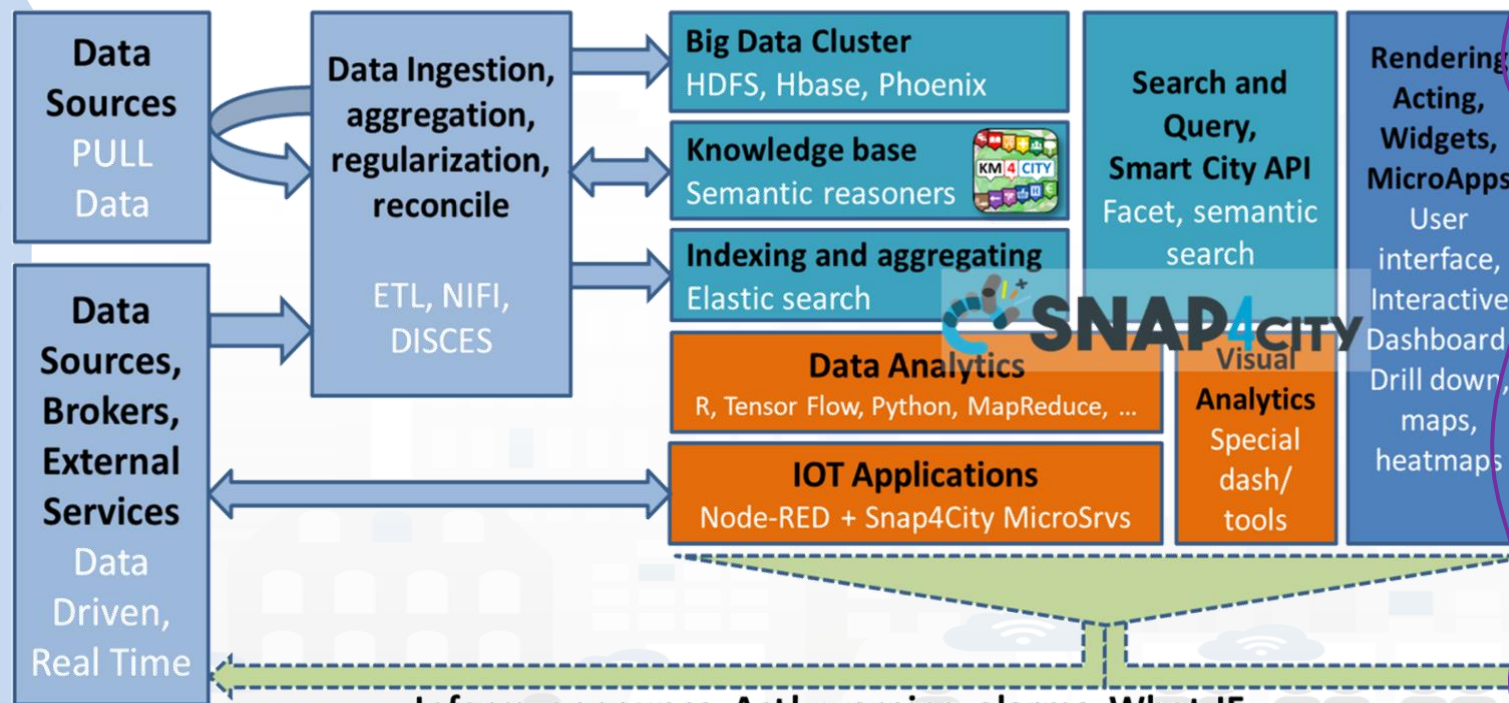
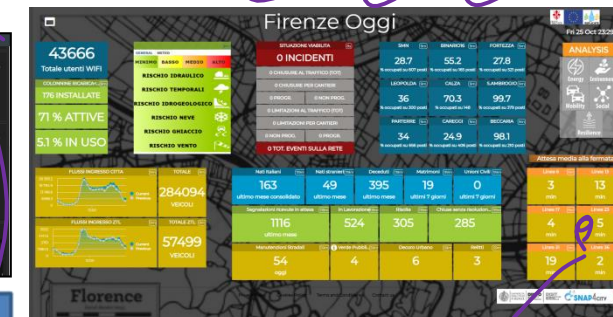
Environment, Water,  
energy



Shops, services,  
operators



Social Media



Inform, announce, Act!, warning, alarms, What-IF, ...

LOGIN

Dashboards (Public)

Knowledge and Maps

- Service Map (Toscana)
- Service Map 3D (Firenze)
- Helsinki Service Map
- Garda Lake Service Map
- Cagliari Service Map
- Service Map 3D (Helsinki)

Micro Applications

External Services

Data Set Manager: Data Gate

Resource Manager

Development Tools

Management

Help and Contacts

Documentation and Articles

Km4City portal

DISIT Lab portal



Home / Snap4City - scalable Smart aNalytic APplication builder for sentient Cities

# Snap4City - scalable Smart aNalytic APplication builder for sentient Cities



Tutorials



Scenarios



Innovations



Interoperability



Installations



What People say



Mobile Apps



IOT Devices



IOT Applications



Data Analytics



Dashboards



Living Lab



Smart City API



Smart City Ontology



Articles



Smart Cities need to set up a flexible Living Lab to cope with the city evolution in terms of services and city users' needs and sustainability. Snap4City solution (<https://www.snap4city.org>) provides a flexible method and solution to quickly create a large range of smart city applications exploiting heterogeneous data and enabling services for stakeholders by IOT/IOE, data analytics and big data technologies. Snap4City applications may exploit multiple paradigms as data driven, stream and batch processing, putting co-creation tools in the hands of: (i) Smart Living Lab users and developers a plethora of solutions to develop applications without vendor lock-in nor technology lock-in, (ii) final users customizable / flexible mobile Apps and tools, (iii) city operators and decision makers specialized / sophisticated city dashboards and IOT/IOE applications for city status monitoring, control and decision support. Snap4City satisfies all the expected requirements of Select4Cities challenge PCP and much more, and it is 100% open source, scalable, robust, respects user needs and privacy; provides MicroServices and easily replaceable tools; compliant with GDPR; provides a set of tools for knowledge and living lab management, and it is compliant with more than 60 protocols including and its end user oriented communication. Snap4City is an official platform of FIWARE, an official library of 3C Foundation, Node-RED, registered on

Login

## Registration

New Registration

Request a new password

## Search

Search

-Any-



# IOT Device Registration



# Standards and Interoperability

**Compliant with:** AMQP, COAP, MQTT, OneM2M, HTTP, HTTPS, TLS, Rest Call, SMTP, TCP, UDP, NGSI, LoRa, LoRaWan, TheThingsNetwork, SigFOX, DATEX II, SOAP, WSDL, Twitter, FaceBook, Telegram, SMS, OLAP, MySQL, Mongo, HBASE, SOLR, SPARQL, EMAIL, FTP, FTPS, WebSocket, WebSocket Secure, ModBUS, OPC, GML, RS485, WFS, WMS, ODBC, JDBC, Elastic Search, Phoenix, XML, JSON, CSV, db, GeoJSON, Enfuser FMI, Android, Raspberry Pi, Local File System, ESP32, Libelium, IBIMET, OBD2, SVG, XLS, XLSX, TXT, HTML, CSS, etc.



# Level 3 user: add personal devices and create Dash

- With Smart city data and information +
- Personal IOT/IOE, which can be registered and created IOT and City data World My Dashboard

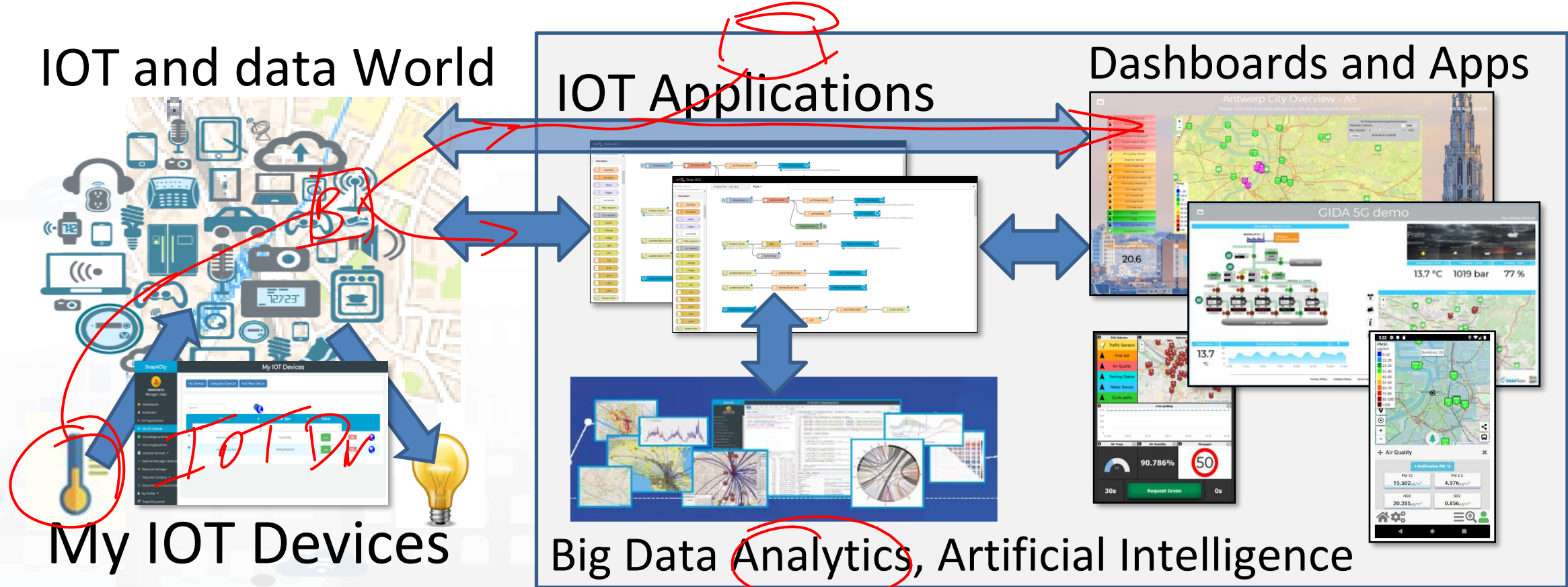


## Registration of My IOT Devices



# Sentient Solutions

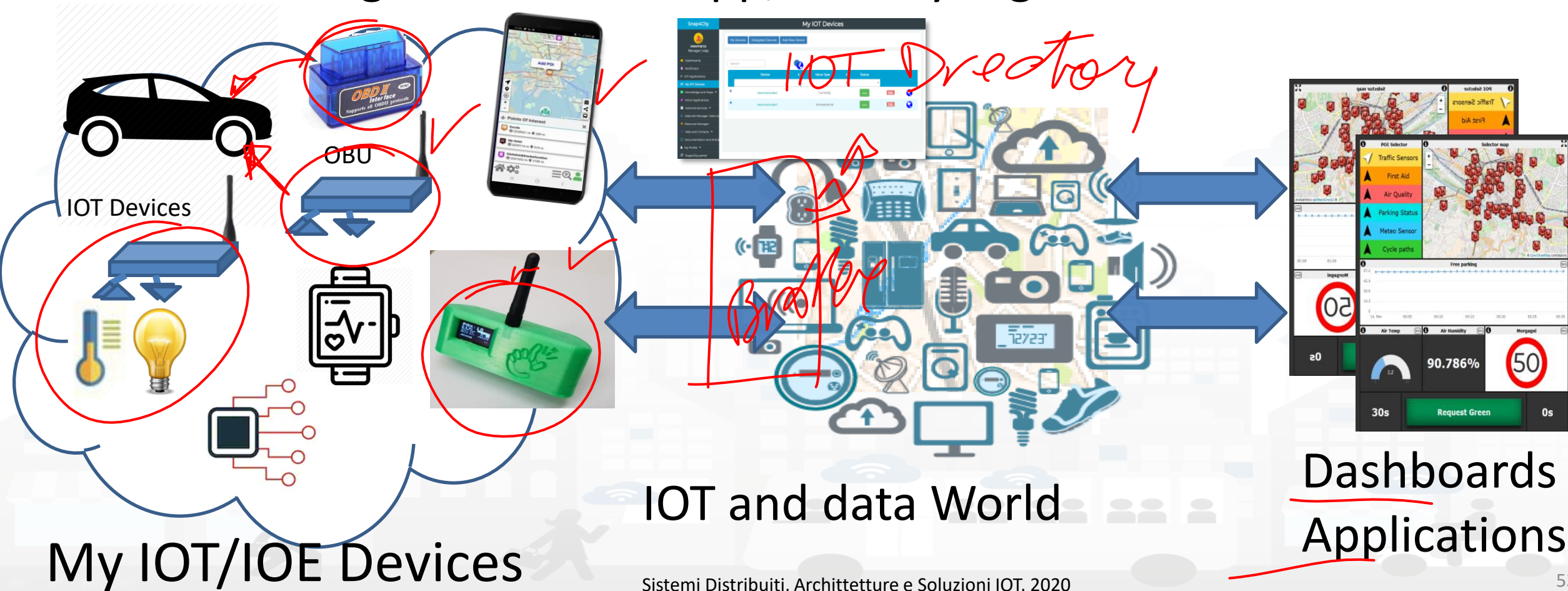
Dashboards with data driven IOT Applications enforcing intelligence



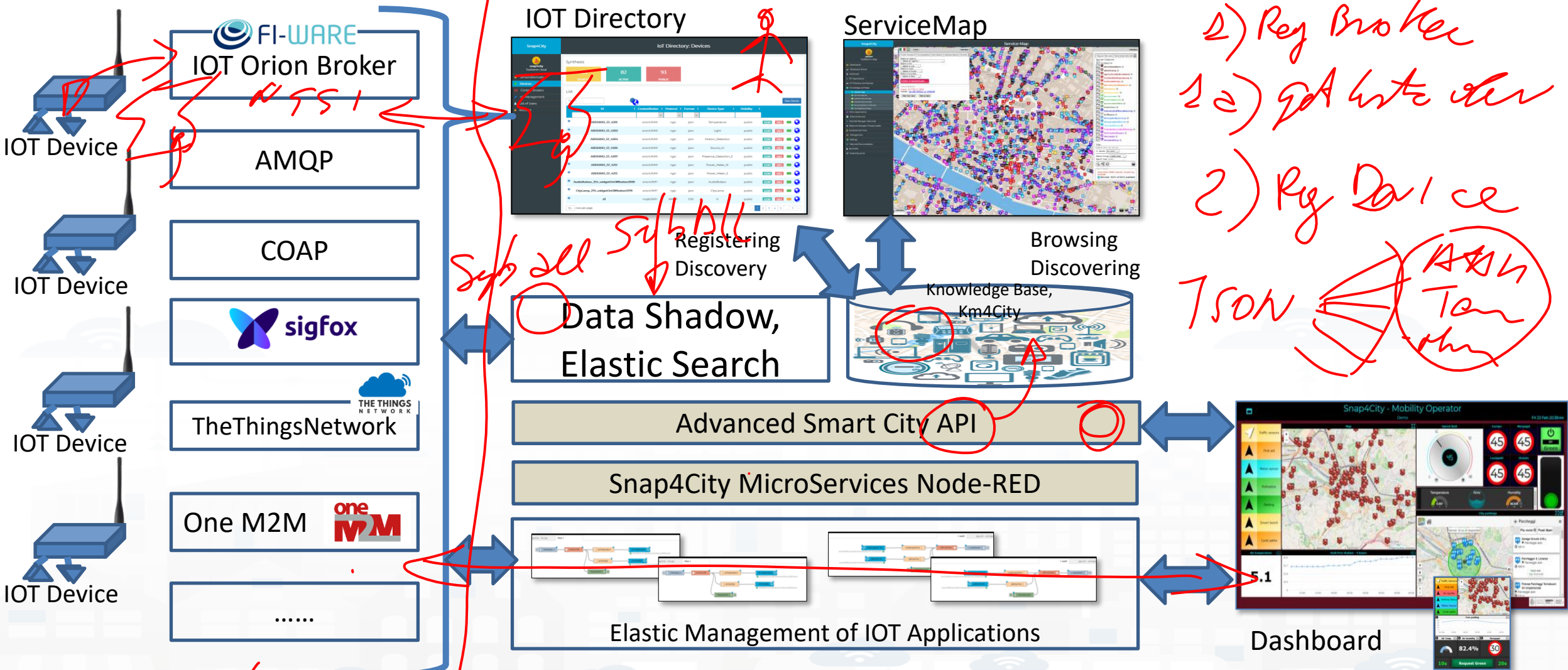


# To Start we are going to use Direct Dashboards

Dashboards accessing data available on Platform, including your own data coming from Mobile App, already registered!!!



# IOT Architecture



1) Reg Broker  
 1a) gA hntc vcr  
 2) Reg Device  
 TSON  
 (ASH)  
 Ten  
 vcr

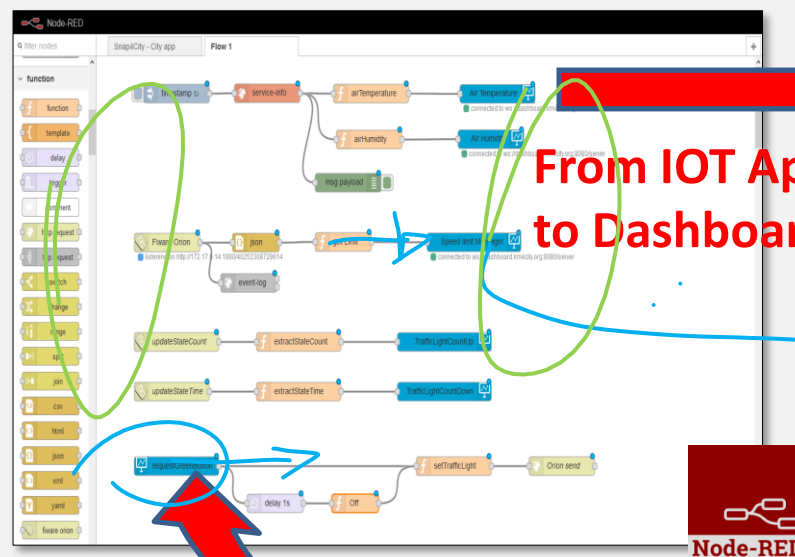
*ex f*  
*cloud*

# HLT: Sensors-Actuators

High Level Types

- Complex Event
- **Dashboard-IOT App**
- External Service
- Heatmap
- KPI (Key Performance Indicator)
- MicroApplication
- My Personal Data
- MyKPI
- MyPOI
- POI (Point of Interest) *POI*
- Sensor
- Sensor Actuator
- Special Widget *WMS*
- Wfs (GIS) *←*

## IOT Application



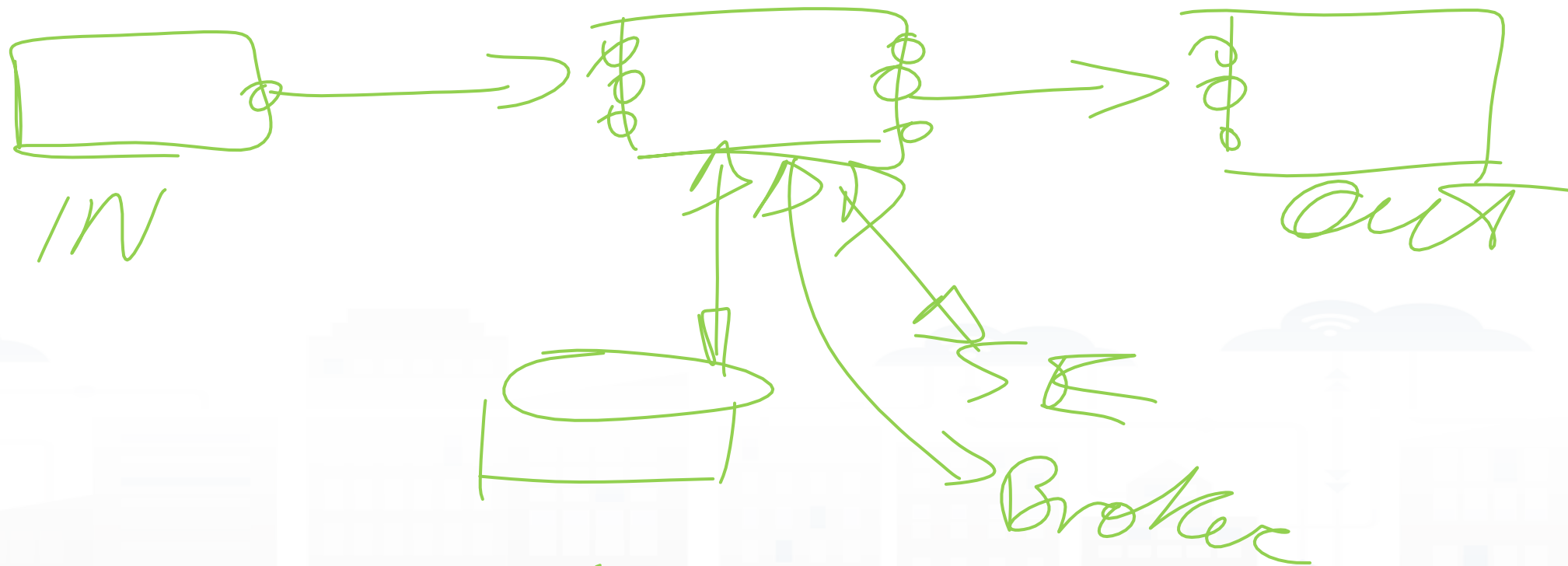
## Dashboards



From IOT App to Dashboard

From Dashboard to IOT App

# Nature



IOT App = Node Pool + Snap4City

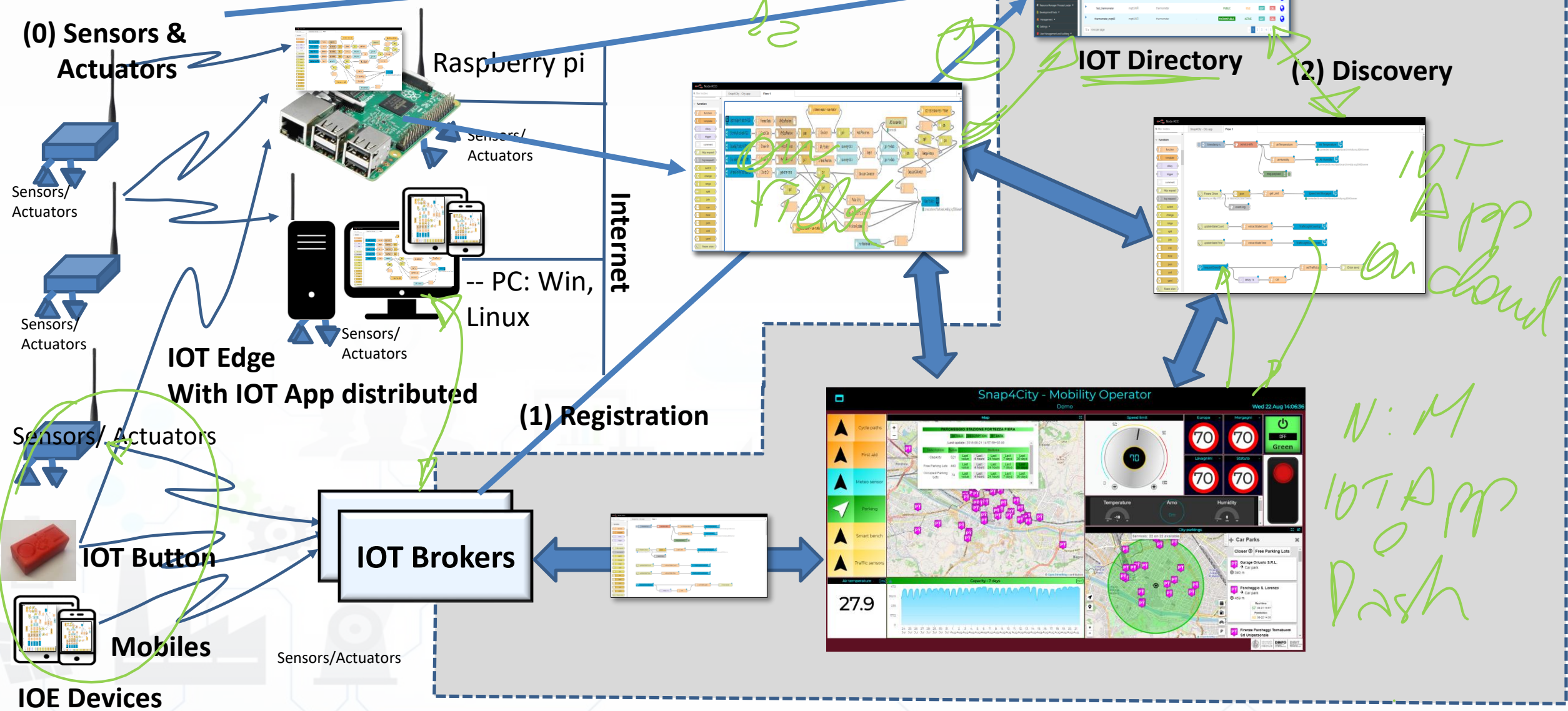
TOP

# *IOT Directory*



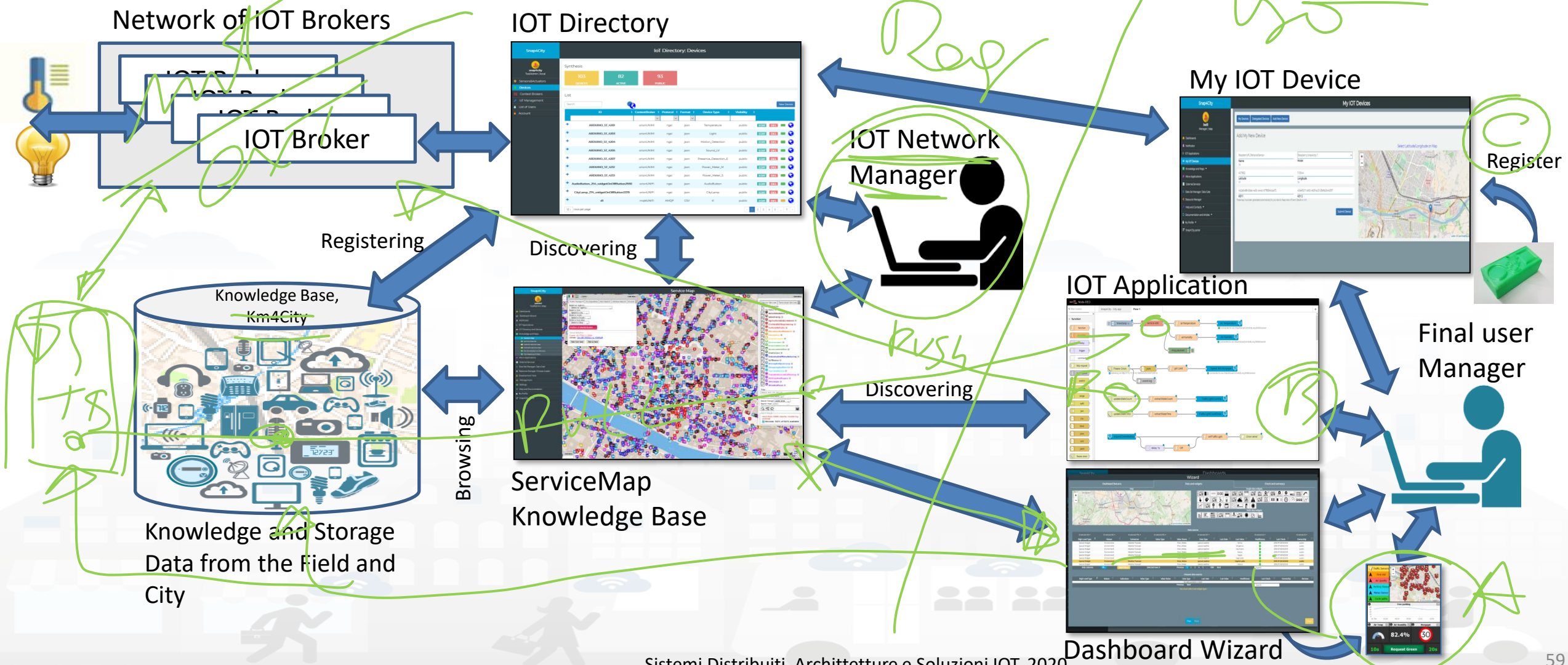
# IOT/IOE on the field

On Cloud





# IOT Network Manager vs Final User



# Main Features of the IOT Directory

- **Registers IOT Brokers**

- Different kind of Brokers, different kinds of authentications and protocols
- Registered IOT Orion Brokers can be queried for collecting their managed devices, so that those IOT Devices are registered

*INT/EXT → Par*

- **Registers IOT Devices:** singularly or at groups (in Bulk)

- Registration can be custom or based on IOT Device Model
- IOT Edge are registered as special IOT Devices
- Registered IOT Devices are saved into local Data base and Knowledge Base

*DSynch → BULK*

- **Provides support for security aspects:**

- Generation of Certificates, Keys, etc.
- Collection of keys when IOT devices are on some IOT Gateway or Second Level IOT Broker.

*allo IOT Directory*

- **Manages Ownership and Delegation for**

- IOT brokers, IOT devices, IOT Device Values

*IOT Device Model*

# IOT Directory Features vs Users Roles

Entities	what	By using	Manager	AreaManager	ToolAdmin/RootAdmin
IOT Sensor/Actuator	Browse, use	Several Tools	X	X	X
	Delegate	IOT Directory	X	X	X
	Discovery	KB, API, MicroServices	X	X	X
IOT Devices	Browse, use	Several Tools	X	X	X
	Add/change/Delete	IOT Directory, API, ..	X	X	X
	Add in Bulk	IOT Directory, API, ..			X
	Delegate	IOT Directory	X	X	X
	Discovery	KB, API, MicroServices (MS)	X	X	X
IOT Device Model	use	IOT Directory	X	X	X
	create	IOT Directory		X	X
IOT Broker	Browse, use	IOT Directory	use	Browse, use	X
	Add/change/Delete	IOT Directory	final use	Envelope	X
	Delegate	IOT Directory	use		X
	Periodic Update	IOT Directory	by Devices		X

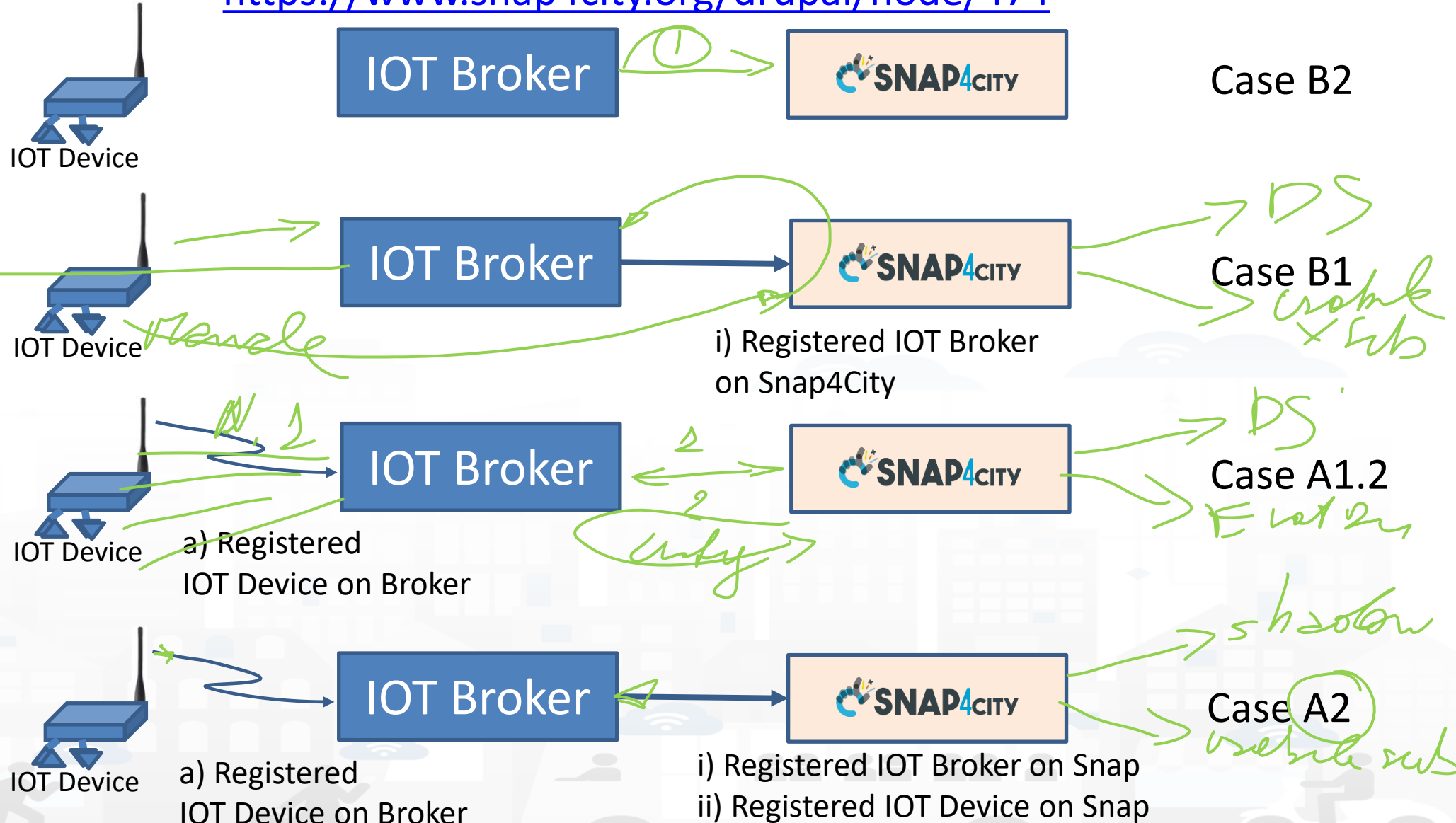
# Privacy vs IOT Directory features

- In IOT Directory of Snap4City:
  - Each Sensor Value, IOT Device, IOT broker can be private or public
  - Private Entities
    - Are accessible only for the Owner in edit/change/delete
    - can be delegated in access to: single user, group, or to organizations

*Accesso Privato*

# In which case you are?

<https://www.snap4city.org/drupal/node/474>



# How to setup and IOT Data Stream

## Managers/AreaManagers:

1. Register the IOT Broker you want to use.
  - If you do not have one, you can ask one to Snap4City
2. Register the IOT Device you want to use.
  - If it is only one Device to reg, you can do it manually,
  - if they are many, we suggest you to create an IOT Device Model, then register the device (only AreaManagers)
3. Use IT

## Administrators:

1. Register the IOT Broker you want to use, or use one already registered.
  - If the IOT Orion Broker has IOT Devices registered in you can use the procedure for automated registration (from your Broker to the IOT Directory and KB), with rule for transformation, etc.
  - If not see points 2 and/or 3
2. Register a single IOT Device manually
3. Register a group of IOT Devices
  - create a IOT Device Model
  - Create a CVS file for Registering devices in Bulk
4. Use IT

# Register IOT Broker

**Snap4City**

User: roottooladmin1, Org: DISIT  
Role: RootAdmin, Level: 7  
[LOGOUT](#)

- My Snap4City.org
- Dashboards
- My Dashboards in All Org.
- Dashboards of My Organization
- My Dashboards in My Organization
- Notificator
- Data Inspector
- My Data, KPI, POI
- IOT Applications
- IOT Directory and Devices
  - My IOT Devices
  - IOT Sensors and Actuators
  - IOT Devices
  - IOT Devices Management
  - IOT Brokers**
  - IOT Device Models
  - IOT Devices Bulk Registration
  - IOT Broker Periodic Update setting
  - IOT Orion Broker Mapping Rules
- Knowledge and Maps
- Micro Applications
- External Services
- Data Set Manager: Data Gate
- Resource Manager: Process Loader
- Development Tools

## IOT Brokers

Show 10 entries

IOT Broker	Access Link	Owner	Created	Edit	Delete
+ Antwerp	https://ext-api-gw-p.antwerpen.be/digipolis/aov	iotdirectory.antwerp	2019-03-13 14:57:17	EDIT	DELETE
+ Antwerp2	https://ext-api-gw-p.antwerpen.be/imec/smarta	iotdirectory.antwerp	2019-01-01	EDIT	DELETE
+ mqttUNIFI	192.168.1.10			DELETE	DELETE
+ mqttUNIMI	159.149.129.184			DELETE	DELETE
+ orionAntwerp-UNIFI	broker3.snap4city.org			DELETE	DELETE
+ orionFinland	https://ngsi.fvh.fi			DELETE	DELETE
+ orionHelsinki-UNIFI	broker2.snap4city.org			DELETE	DELETE
+ orionUNIFI	https://broker1.snap4city.org			DELETE	DELETE
+ orionUNIFIProxyHelsinki	https://www.snap4city.org/iot_ingestion/	ngsi		DELETE	DELETE
+ orionUNIMI	159.149.129.184	1026	ngsi	DELETE	DELETE

Showing 1 to 10 of 12 entries

### Add new context broker

Info | Geo-Position | **Security**

Kind:

IP:  IP is mandatory

Protocol:

Access Link:

Private:

Ownership:

Name:  Context Broker name is mandatory

Port:  Port is mandatory

Version:

Access Port:

Latitude:  Latitude is mandatory

Longitude:  Longitude is mandatory

Cancel Confirm

# Add IOT/IOE Devices

Just Buy an IOT Device and register: SigFOX, MQTT, FiWare, ...

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

Create your own devices:

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

The screenshot shows the 'My IOT Devices' interface in Snap4City. On the left is a navigation sidebar with 'My IOT Devices' selected. The main area has tabs for 'My Devices', 'Delegated Devices', and 'Add New Device'. The 'Add My New Device' form includes:
 

- Name:** RaspberryPi\_PersonalSensor
- Model:** Raspberry snap4city1
- Latitude:** 43.7652
- Longitude:** 11.3044
- KEY1:** 4b2a6486-65ea-4e3c-a44b-0778594bba72
- KEY2:** 40eef2c7-ce92-462f-ac21-29dfa2b4b337

 A 'Submit Device' button is at the bottom right. A map on the right is titled 'Select Latitude/Longitude on Map'. Handwritten green annotations include '1) by Model' pointing to the Model dropdown and '2) by details' pointing to the map area.

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





UNIVERSITÀ  
DEGLI STUDI  
FIRENZE

**DINFO**  
DIPARTIMENTO DI  
INGEGNERIA  
DELL'INFORMAZIONE

**DISIT**  
DISTRIBUTED SYSTEMS  
AND INTERNET  
TECHNOLOGIES LAB



# SNAP4city



## IOT Directory

**Snap4City**

AreaManager | Idap

- Dashboards
- Notifier
- IOT Applications
- IOT Directory and Devices
  - IOT Sensors and Actuator
  - IOT Devices**
  - IOT Brokers
- Knowledge and Maps
- Micro Applications
- External Services
- Data Set Manager: Data Gate
- Resource Manager: Process Load
- Development Tools
- Management

**IOT Devices**

Search

New Device

Name	IOT Broker	Protocol	Format	Device Type	Ownership	Status
ARDUINO_ST_4203	orionUNIMI	ngsi	json	Light	public	active
ARDUINO_ST_4204	orionUNIMI	ngsi	json	Motion_Detection	public	active
ARDUINO_ST_4205	orionUNIMI	ngsi	json	Sound_LV	public	active
ARDUINO_ST_4207	orionUNIMI	ngsi	json	Presence_Detection_E	public	active
ARDUINO_ST_4212	orionUNIMI	ngsi	json	Power_Meter_M	public	active
ARDUINO_ST_4213	orionUNIMI	ngsi	json	Power_Meter_S	public	active
AudioButton_254_widgetOnOffButton2930	orionUNIFI	ngsi	json	AudioButton	public	active
CityLamp_274_widgetOnOffButton3379	orionUNIFI	ngsi	json	CityLamp	public	active
fan02	mqttUNIFI	mqtt	csv	fancoil	public	active
Impulse					public	active

**Add new device**

Info | IOT Broker | Position | Values

Name:

Type:

Producer:

Public Visibility:

KEY1:

KEY2:

Model:

Mac Address:

Frequency:

Cancel Confirm

**Search Device Location on Map**

Cancel

**Snap4City**

AreaManager | Idap

- Dashboards
- Notifier
- IOT Applications
- IOT Directory and Devices
  - IOT Sensors and Actuator
  - IOT Devices
  - IOT Brokers
- Knowledge and Maps
- Micro Applications
- External Services
- Data Set Manager: Data Gate
- Resource Manager: Process Load
- Development Tools
- Management
- Help and Contacts
- Documentation and Articles
- My Profile
- Snap4City portal

**IOT Sensors and Actuators**

List

Search

New Value

IOT Broker	Device	Value Name	Value Type	Healthiness Criteria	Refresh Rate	Status
orionUNIMI	ARDUINO_ST_4203	latitude	latitude	refresh_rate	300	active
orionUNIMI	ARDUINO_ST_4203	light	light	refresh_rate	300	active
orionUNIMI	ARDUINO_ST_4203	longitude	longitude	refresh_rate	300	active
orionUNIMI	ARDUINO_ST_4203	measure_units	-	refresh_rate	300	active
orionUNIMI	ARDUINO_ST_4204	timestamp	timestamp	refresh_rate	300	active
orionUNIMI	ARDUINO_ST_4204	latitude	latitude	refresh_rate	300	active
orionUNIMI	ARDUINO_ST_4204	longitude	longitude	refresh_rate	300	active
orionUNIMI	ARDUINO_ST_4204	measure_units	actuator_canceller	refresh_rate	300	active
orionUNIMI	ARDUINO_ST_4204	motion_detection	motion_detection	refresh_rate	300	active
orionUNIMI	ARDUINO_ST_4204	timestamp	timestamp	refresh_rate	300	active



# IOT Discovery on IOT Application Development

Node-RED interface showing a flow for temperature data processing. The flow includes nodes for timestamp, Celsius temperature, Fahrenheit temperature, JSON, http request, temp3010, Fiware Orion Query, aggregator, and convert temp. A green box highlights the 'Fiware Orion Query' node.

Device-based search interface showing a map of Tuscany with a blue location pin near Florence. Below the map is a table of device types:

Name	Type	Context-Broker
ARDUINO_ST_4203	Light	orionUNIMI
ARDUINO_ST_4204	Motion_Detection	orionUNIMI
ARDUINO_ST_4205	Sound_LV	orionUNIMI
ARDUINO_ST_4207	Presence_Detection_E	orionUNIMI
ARDUINO_ST_4212	Power_Meter_M	orionUNIMI
ARDUINO_ST_4213	Power_Meter_S	orionUNIMI

Node-RED interface showing the 'Edit device-registration node' dialog. It includes a map of Tuscany and two key input fields:

Key 1 \* 3568dcdf-3167-4ee7-ac05-91d3a9668cb8

Key 2 \* 5e26b980-402e-4853-9edc-664e025254c8

These keys have been generated automatically for your device. Keep track of them. Details on info

Check!

here  
low  
Vmt  
Typed

2) sub  
3) sub  
4) sub

## Activities for IOT data ingestion

- **Registration of**
  - an IOT Device
  - a Set of IOT Devices with the same model: loading in Bulk
- The registration implies the **automated production of the model into the Knowledge Base**, which implies:
  - Activation of the DataShadow memory for historical data access
  - Activation of Discovery mechanisms
  - Activation of Dashboard Wizard

*Tramite l'uso di un IOT Broker*

## Further readings

- [HOW TO: add a device to the Snap4City Platform](#)
- [HOW TO: add data sources to the Snap4City Platform](#)
- [HOW TO: add IOT Device data source from external broker to the platform.](#)
- [TC9.13: How to upload a local file into your IOT Application](#)
- [TC9.2. Managing heterogeneous File Ingestion, protocols, formats via IOT applications, and open standards](#)
- [TC2.25. Registering external MicroService calling RestCall services, using it on IOT applications](#)

# IOT Devices Registration (self training)

- IOT device registration can be performed by all kind of users.
- Higher level users can register large sets of IOT devices, reg. in Bulk
- Suggested training:
  - [HOW TO: add a device to the Snap4City Platform](#)
  - [Snap4City IOT Devices Registration](#)
  - [TC2.15 - IOT device registration](#)
  - [TC2.11 - Search on IOT Directory for Devices and Sensors, IOT Device Registration](#)
  - [TC2.30 - Bulk Load for IoT Devices Registration](#)
  - [TC10.9 - IOT Directory and Multiple Brokers](#)

# Fi-Ware vs Snap4City



**SMART CITIES REFERENCE ARCHITECTURE**

- Is open to the Development of Applications leaving large space to developers
- Is centered on the Orion Broker that result central in the architecture: any Broker or data source is sending data to Orion
- Security level is not clear, partially demanded to developers
- Visual Flexible IOT processing is not clearly provided
- **Limited API** for IOT data access
- **Knowage BI** presents several limitations in showing Smart City Data
- Market place on Open Data
- Support of Developers via Fi-Ware
- Deployed as VM and Dockers
- open source, not the application parts

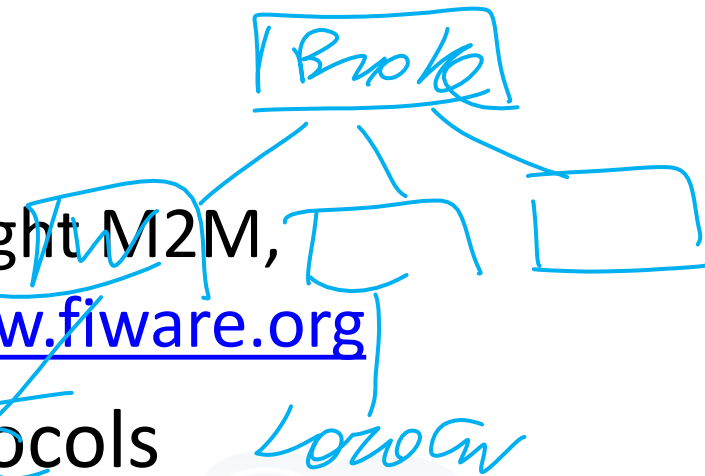
- NO Data Shadow  $\rightarrow$  Broker

**VS**

- Is open to the Development of Applications leaving large space and providing a **large set of ready to use applicative tools** and solutions to build their solutions on top or aside.
- Is fully distributed, **any kind of data source** can be ingested, automatically. *Data shadow*
- **Orion Broker is only one of the Brokers** that can be used. It can be also protected by Snap4City tech, with Mutual Authentication
- **Visual Flexible IOT processing is provided** as Node-RED and Snap4City MicroServices suites *IOT App*
- **Advanced Smart City API** are provided on top of Knowledge Base
- **Dashboard Builder** has been designed for Smart City Data and automated dashboards' production *Share*
- **Market Place** on Open Data, tools, processes, experiences
- Full Support for Living Lab of the city, coworking, tutorials
- Deployed as VM and Dockers
- 100% open Source *Multi-datasource* *107 App*

- **Snap4City is an official Fi-Ware Solution via**

- NGSI V1, V2 The IOT Orion Broker
- IOT Orion Broker can connect JSON, MQTT, Lightweight M2M, LoraWAN, OPC, SigFOX, etc. see Fi-Ware <https://www.fiware.org>



- **Snap4City is compatible** with all the above protocols

- via IOT Orion Broker,
- via direct connection on ETL processes on their corresponding IOT brokers, and/or
- via IOT Applications.

*Real-time VETAL*

- **Snap4City is also compatible** with many other protocols, see the table reported in page: <https://www.snap4city.org/65>



- In Snap4City you can chose to connect your devices at Snap4City Platform in different manners:

- (a) directly to Snap4City, *or App → Broker*
- (b) via an IOT Orion Broker (external IOT Broker or those provided by Snap4City), or *→ My KPI*
- (c) via any third party IOT Brokers in any protocol you have.

- **Snap4City has**

- **Improved IOT Orion Broker** with the so called Orion Broker Filter (Orion Broker Filter, NGSI Security Wrapper) which is a secure wrapper for NGSI V1 and V2 protocol for enforcing Mutual Authentication, Security, roles, etc.
- **Produced open hardware and open software NGSI Compliant:** as
  - **IOT Devices** with mutual authentication and security based for NGSI on: Android, Arduino and ESP32, IOT Button, etc.
  - **IOT Edge** devices with mutual authentication and security based for NGSI on: Raspberry PI, Windows, Linux.

TOP

# Proprietary IOT Devices as well as Open Hardware / Open Software

FORGING & MANAGING OPEN AND FLEXIBLE WEB AND MOBILE APPS

SNAP4CITY FOR BEGINNERS

SNAP4CITY ARCHITECTURE AND ECOSYSTEM. OPENED TO DEVELOPERS AND STAKEHOLDERS

TWITTER VIGILANCE: SOCIAL MEDIA ANALYSIS

SNAP4CITY AND KM4CITY PROJECT

DATA GATHERING AND CITY DATA KNOWLEDGE MANAGEMENT

IOT/IOE DEVICES AND NETWORKS

IOT APPLICATIONS, SMART PHONE DEVICES

DATA ANALYTICS, BUSINESS INTELLIGENCE, WHAT-IF AND PREDICTION

HOW TO ADOPT SNAP4CITY, AND OUR ROADMAP

IOT APPLICATIONS, THE LOGIC AND THE SMARTNESS

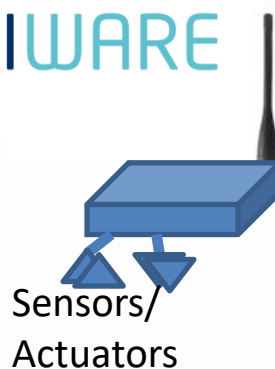
ADVANCE SMART CITY API, MICROSERVICES, SNAP4CITY API

TECHNICAL SUPPORT FOR SYSTEMS AND CITY SILENCE

SNAP4CITY THE VIEW OF THE ADMINISTRATORS

SNAP4CITY LIVING LAB FOR COLLABORATIVE WORK





Sensors/  
Actuators

# IOT Devices

# IOT Edge Devices

LoraWAN +  
Arduino +  
I2C, NGSI

Arduino,  
Wi-Fi, NGSI

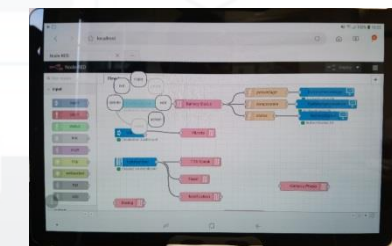
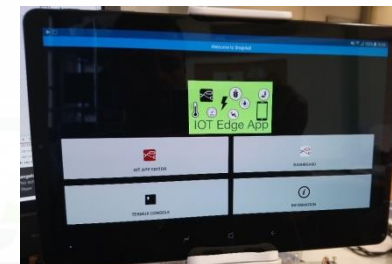
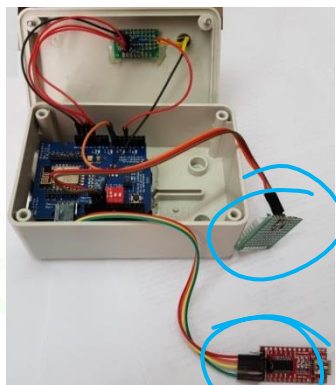
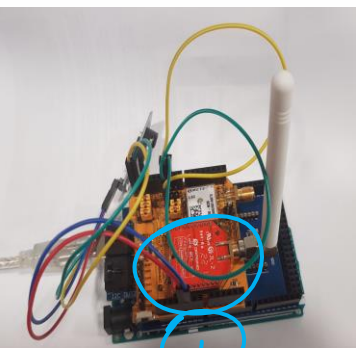
Snap4All  
IOT Button  
ESP, NGSI,  
Wi-Fi, BT

Snap4All PAX  
Counter  
LoraWAN  
WIFI, NGSI,  
GPS

IOT Edge  
NodeRED:  
Raspberry Pi,  
NGSI, WiFi,  
RJ45,..

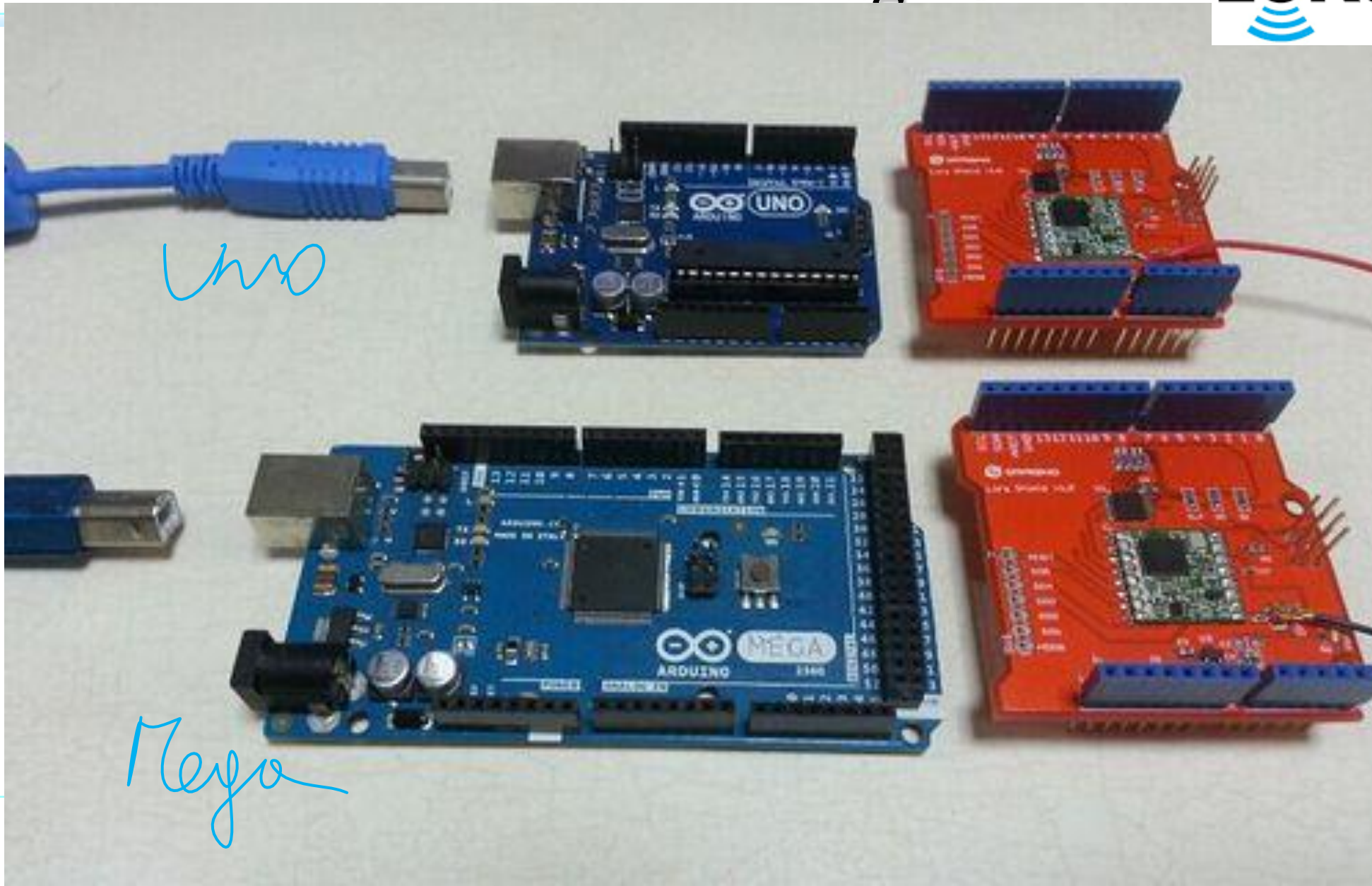
IOT Edge  
NodeRED:  
Android, LINUX,  
Windows, ...

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

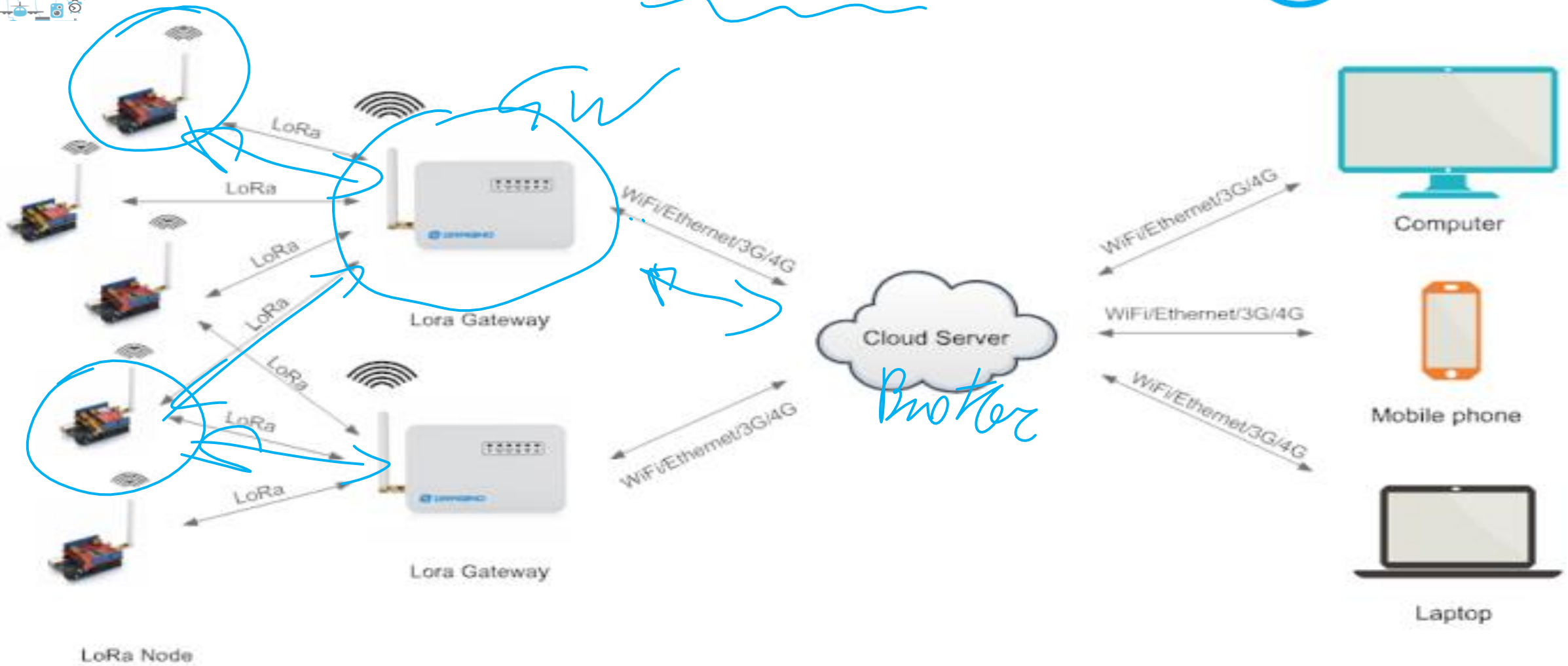


Any Sensor / Actuator  
Open to other protocols

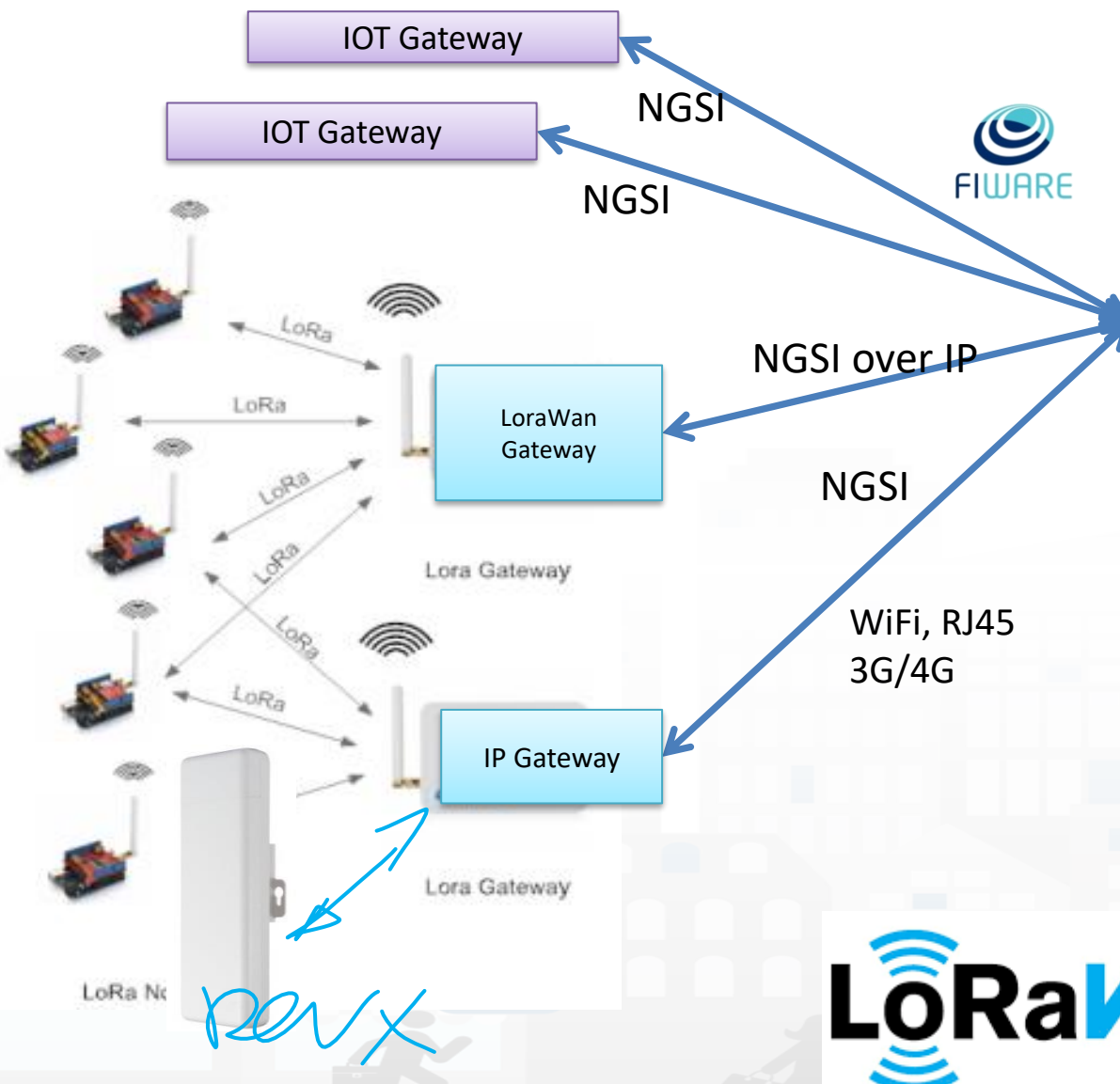
# LoraWAN Dragino



# LoraWAN Dragino (Arduino)



# IOT Management

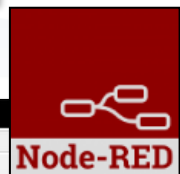
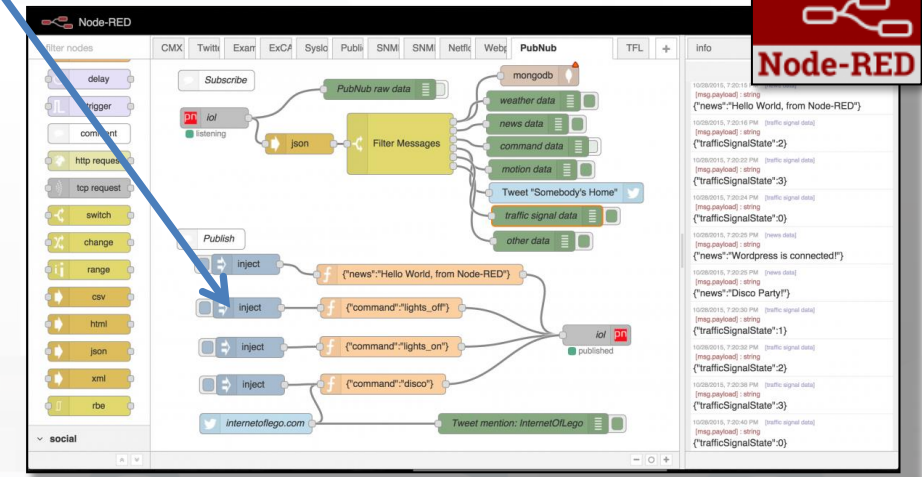


*IOT Orchestration*

*optimal*

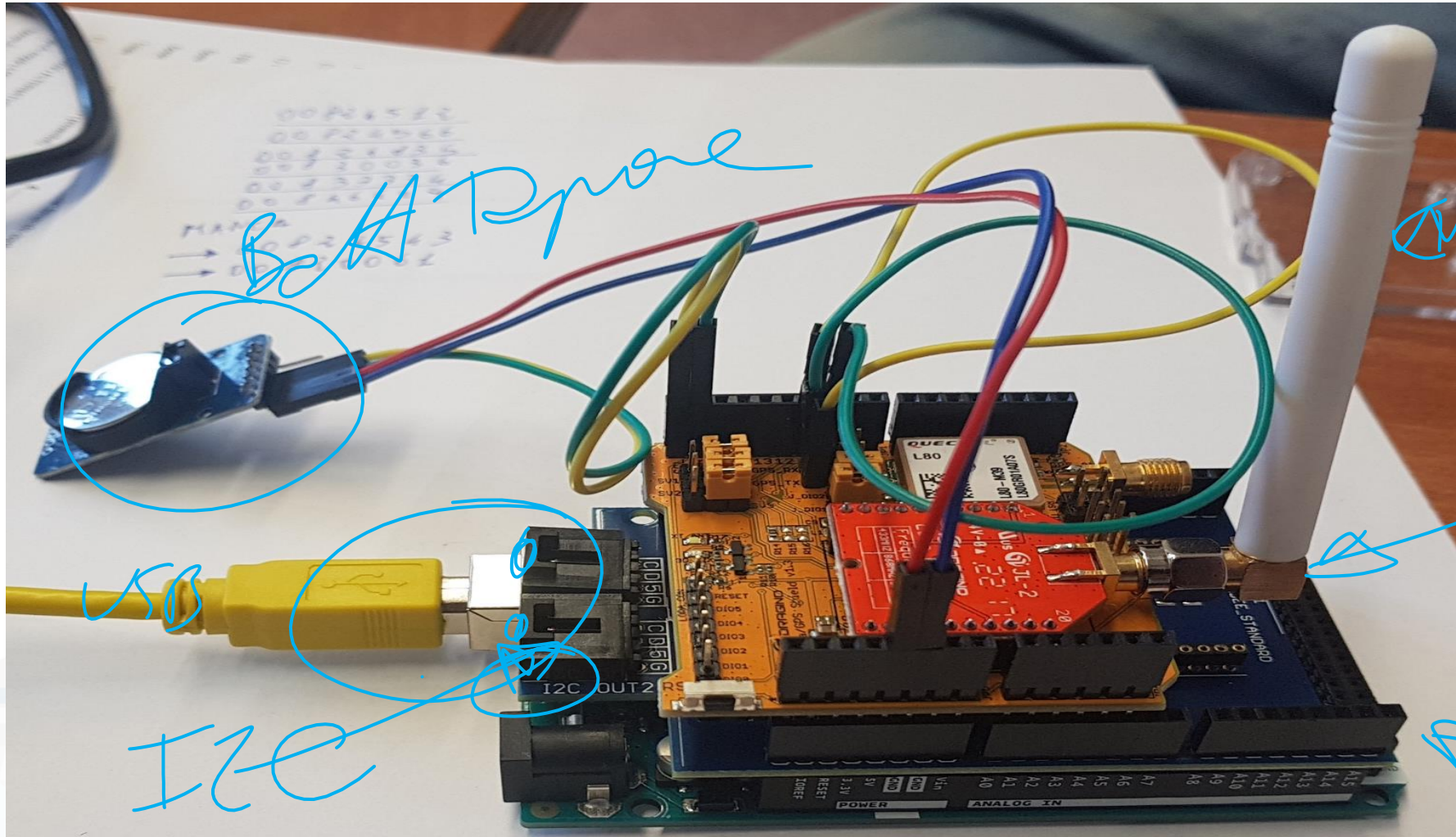


*Sub dev*





## Piattaforma di sviluppo per LoraWan



I2C

# SigFOX Server Side



- ❑ Proprietary Protocol
- ❑ Final users, consumers may buy SigFox devices and subscribe to network to register their devices
- ❑ Limited number of msg per day, per year

1) Copro. / Don  
2) Lo registrare  
3) Lo usare



DEVICE DEVICE TYPE USER GROUP BILLING

## Device - List

New New series Edit series Transfer series Replace series

Id

State

Average SNR (all)

Last seen from date

Count: 2 / 2

page 1

Communication status	Id	Last seen	Name	Token state	Protocol version	Product certificate	Device type
<input checked="" type="checkbox"/>	<input type="text"/>	2018-05-06 17:58:46	Nesi_bib_01	<input checked="" type="checkbox"/>	V1		BIB - Paolo Nesi
<input checked="" type="checkbox"/>	<input type="text"/>	2018-05-06 17:58:49	Nesi_bib_02	<input checked="" type="checkbox"/>	V1		BIB - Paolo Nesi

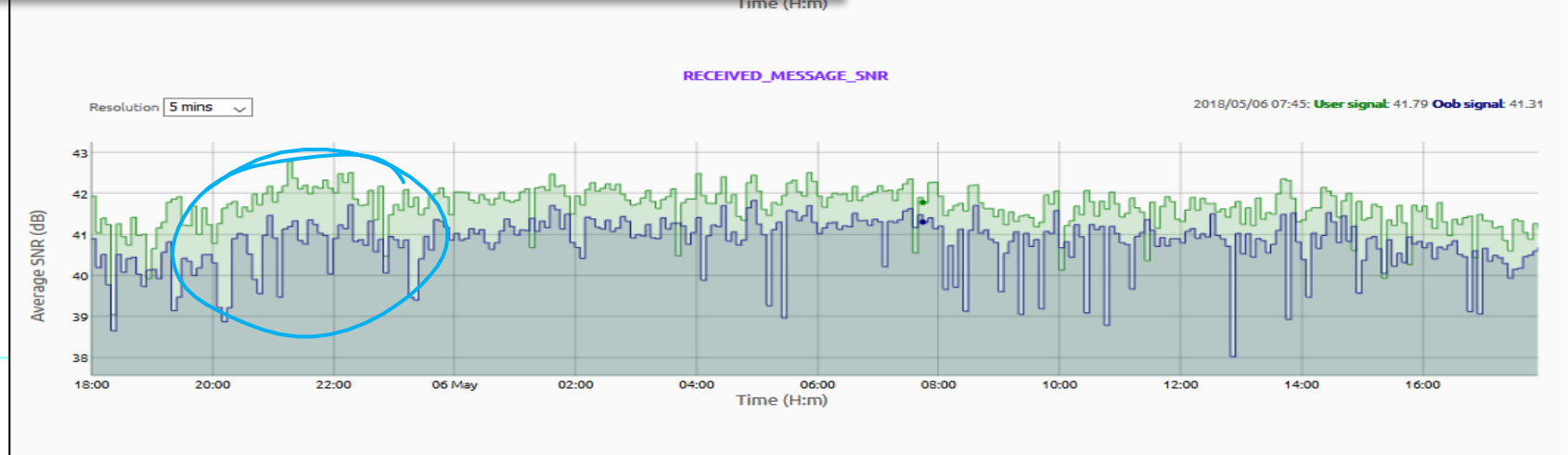
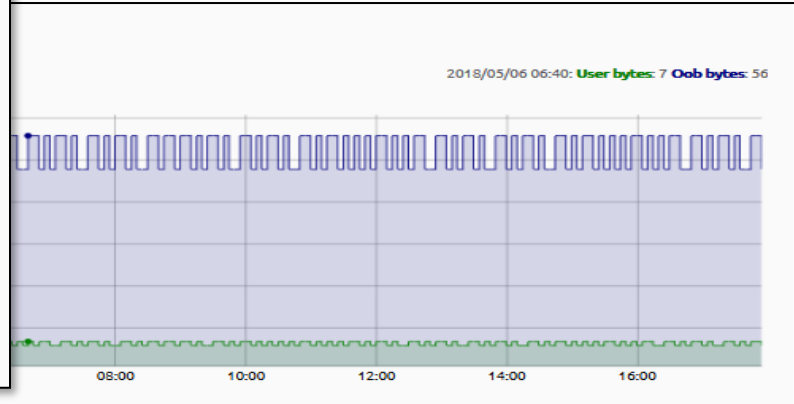
page 1



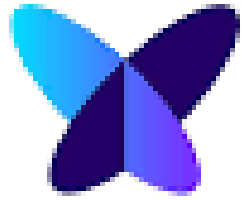
page 1 ➔ Frame reception time

Time	Delay (s)	Header	Data / Decoding	Location	Base station reception attributes					Callbacks	
					Base station	RSSI (dBm)	SNR (dB)	Freq (MHz)	Frames		
2018-05-06 18:03:27	< 1	0000 ack required	24	✚	28A8	-122.00		29.40	868.1491	3/3	⬆️⬇️
					2896	-136.00		15.60	868.1420	3/3	
					25F2	-119.00		32.03	868.1373	3/3	
2018-05-06 18:03:25	< 1	0010	09dd0b4f0b040103 Temp: 26.0 °C VDD idle: 3.037 V VDD bc: 2.895 V RSSI: -97.0	✚	25F2	-120.00		31.57	868.1187	1/3	⬆️
					28A8	-122.00		29.05	868.1185	1/3	
					2627	-141.00		10.48	868.1173	1/3	
2018-05-06 18:02:51	< 1	0000 ack required	24	✚	28A8	-122.00		29.39	868.1357	3/3	⬆️⬇️
					2896	-136.00		14.81	868.1347	3/3	
					2884	-134.00		17.36	868.1229	3/3	
2018-05-06 18:02:23	< 1	0010	09d30b4a0b0e0102 Temp: 27.0 °C VDD idle: 3.027 V VDD bc: 2.890 V RSSI: -98.0	✚	23DB	-110.00		41.00	868.1449	1/3	⬆️
					2896	-137.00		14.40	868.1442	1/3	
					2889	-137.00		13.67	868.1447	1/3	
2018-05-06 18:01:48	< 1	0000 ack required	24	✚	23DB	-109.00		41.66	868.1553	1/3	⬆️⬇️
					2889	-136.00		15.06	868.1550	3/3	
					28C8	-139.00		11.81	868.1546	1/3	

# SigFOX



# SigFOX piattaforma di sviluppo



**sigfox**

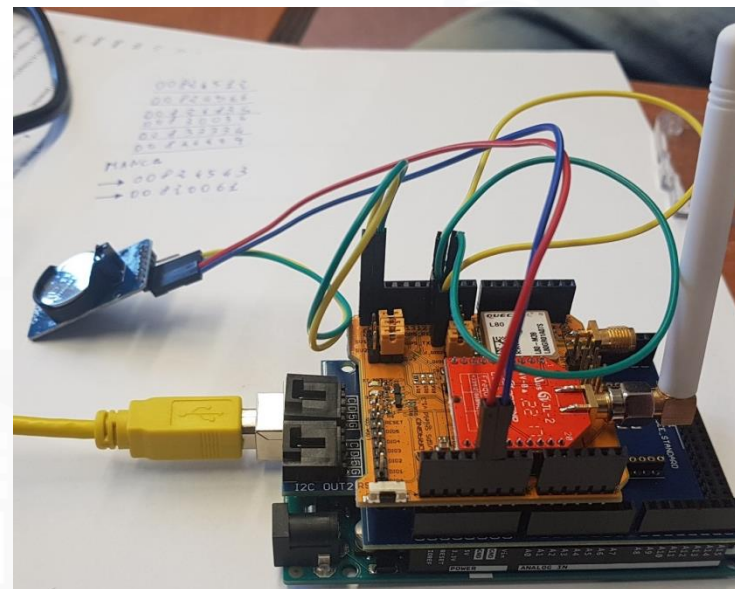
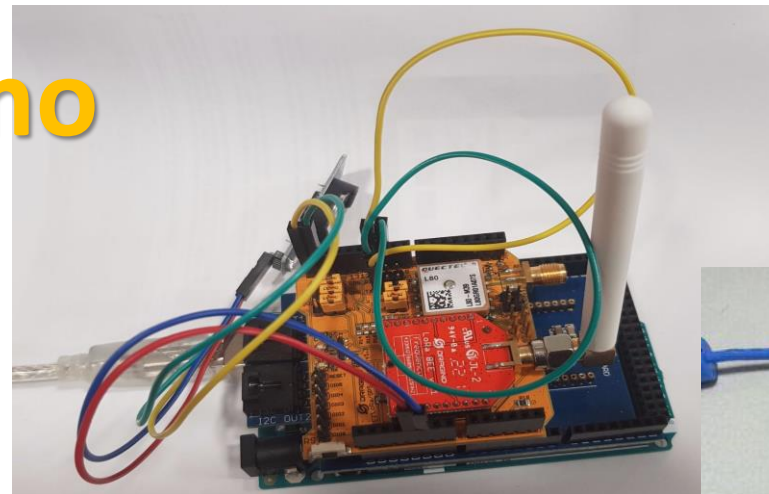


# IOT Dev Management: activities

- **IOT Devices can be open or proprietary**
- **IOT Devices:** a large range of protocols, formats and kind
  - IOT Devices (single or in bulk) are **registered** on IOT Directory and thus according to Knowledge base are registered to be used in IOT Applications, Dashboards, etc. with Shadow values, etc.
  - IOT Models are saved on IOT Directory for shortening the registration process
  - IOT Device healthiness is monitored automatically
- **IOT Devices can be public or private**
  - **Full support of Proprietary protocols and devices**
  - **Providing Open Hardware and Open Software** IOT Devices/IOT Edge: NGSI fully secure
- **IOT Edge** are devices with some computing capability, realized by using: Raspberry, Android, Linux, Windows, etc.
  - **Release as:** OS images on SD, APK for Android, Virtual Machine, Docker Container, etc.
- IOT Devices are connected via **Secure Encrypted Mutual Authenticated** channel of communication

# Lora IOT Device, Arduino

- Arduino Uno, Mega
- LoraWan Connection
- Any sensor, + I2C
- Fully Customizable
- Open Source
- NGSI or any other protocols
- Gateway: Dragino

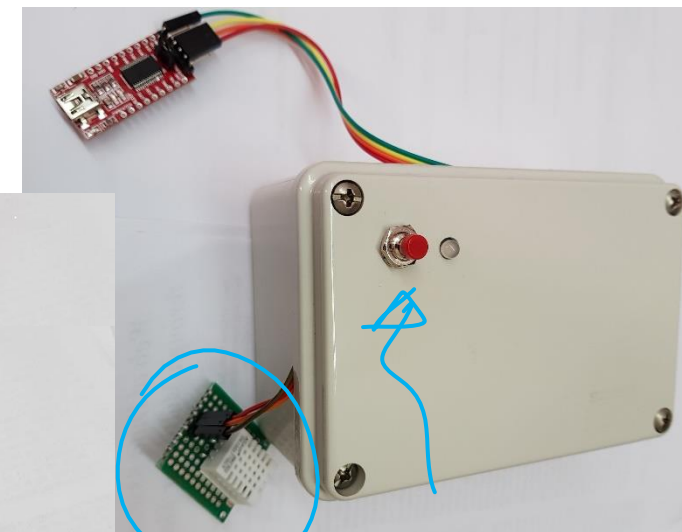
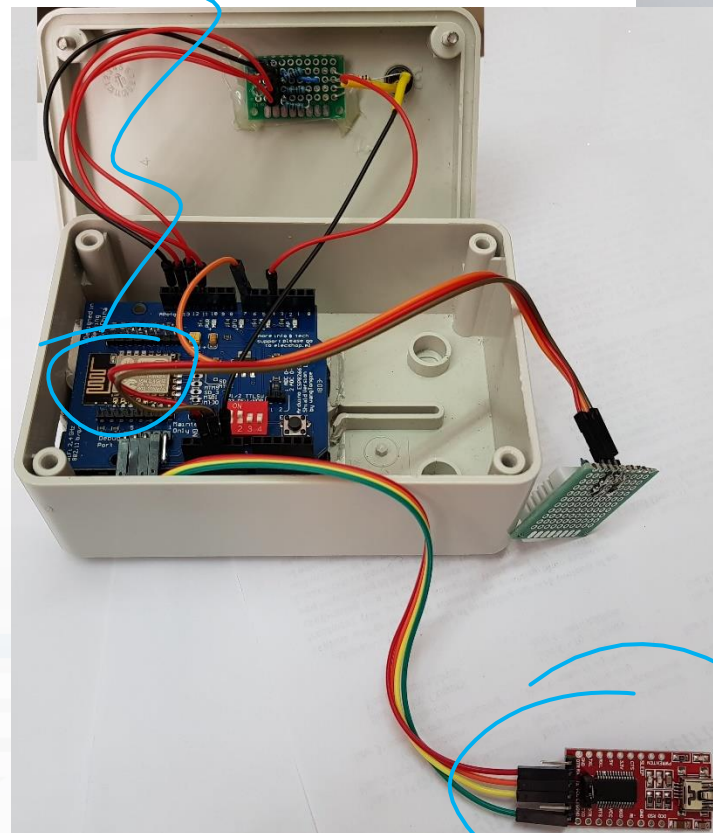


# IOT Device with Arduino

- Arduino Uno
- Wi-Fi shield, standard
- Mutual Authentication with certificates, or K1,K2,sha
- Secure encrypted connection, NGSI
- Open Source
- Fully Customizable
  - Any sensor
  - NGSI or any other protocol

Broker

WiFi



DHT22

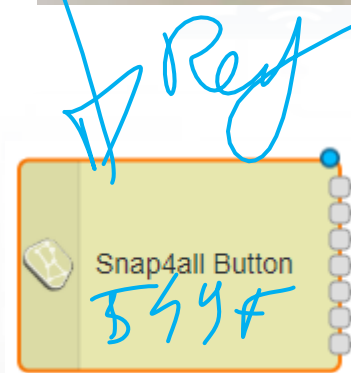
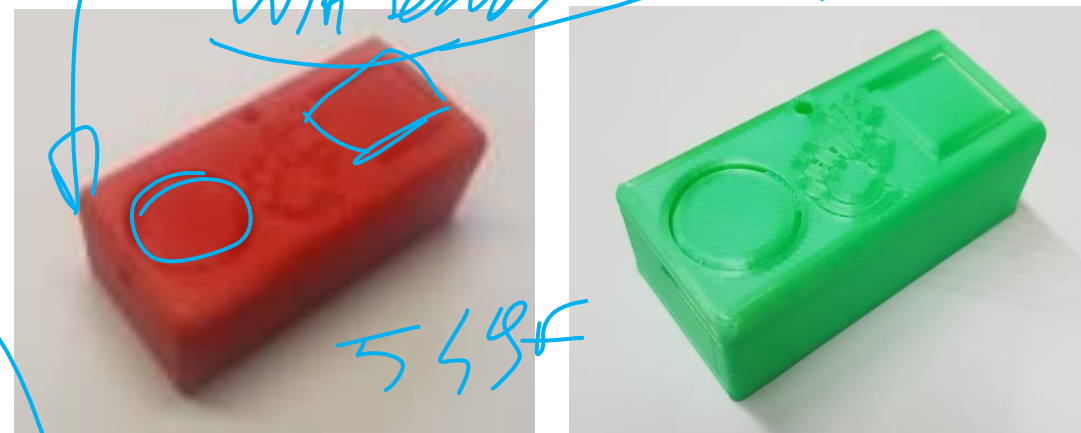
IPC



# Snap4All IOT Button

- Multi Wi-Fi
- Ready to use BLE
- ESP based, cheap & easy
  - low/no energy consumption/standby
- Mutual Authentication with certificates, or K1,K2,sha
- secure encrypted connection, NGSI
- Open Source, Fully Customizable
- HW extensible to sensors

*Carry*  
*Broker*  
*Modello*  
*Go Home*



- Squared Short
- Squared Double
- Squared Long
- Round Short
- Round Double
- Round Long

*HW SW open source*

<https://www.snap4city.org/drupal/node/276>

<https://www.snap4city.org/drupal/node/297> help config



Consiglio Nazionale  
delle Ricerche

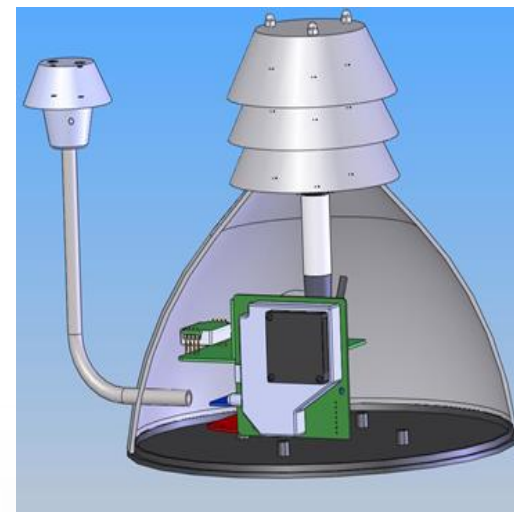
# CNR IBE AirQuino





Consiglio Nazionale  
delle Ricerche

- CNR developed a circuit board "AirQuino", [Arduino](#) Shield compatible, integrated with low cost and high resolution sensors, dedicated to the monitoring of environmental parameters and [air quality](#) pollutants
  - Noise, Humidity, Temperature,
  - CO, CO<sub>2</sub>, O<sub>3</sub>, NO<sub>2</sub>, CH<sub>4</sub>),
  - road pavement quality (accelerometer) and the indices of well-being (globethermometer to calculate the index of thermal comfort) in an urban environment.
- The board integrates a microprocessor unit that acquires all the sensors installed and analyses fast data from accelerometer and noise sensor.

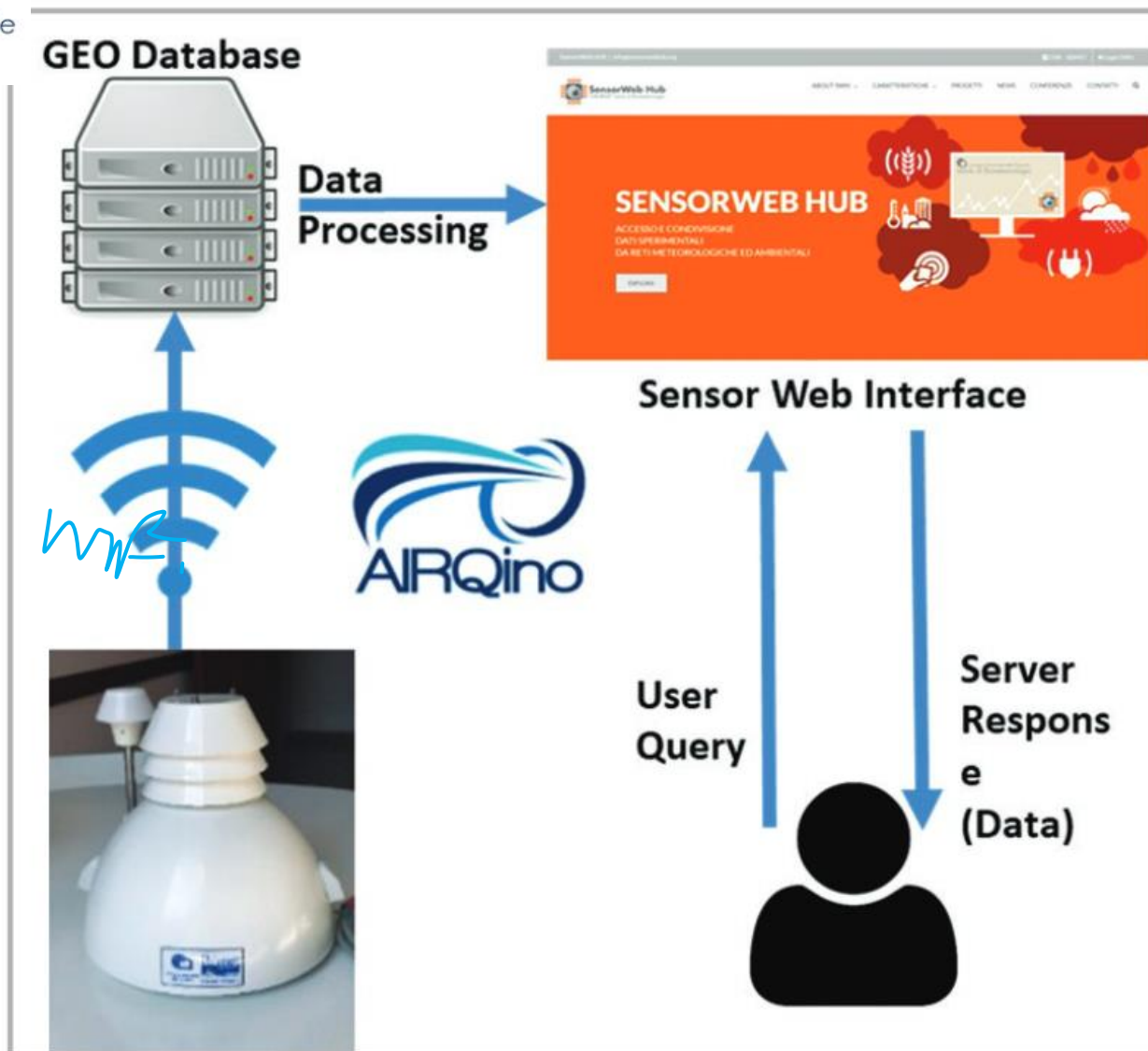


Parameter	Unit	Range
Temperature	°C	-40 – 80
Relative Umidity	%	0 – 100
CO <sub>2</sub>	ppm	0 – 2000
O <sub>3</sub>	ppb	0 – 400
NO <sub>2</sub>	ppm	0.05 – 5
CO	ppm	1 – 30
PM	µg/m <sup>3</sup>	0 – 999
VOC	ppm	1 – 100





Consiglio Nazionale  
delle Ricerche





# Libelium Sensors



# Libelium



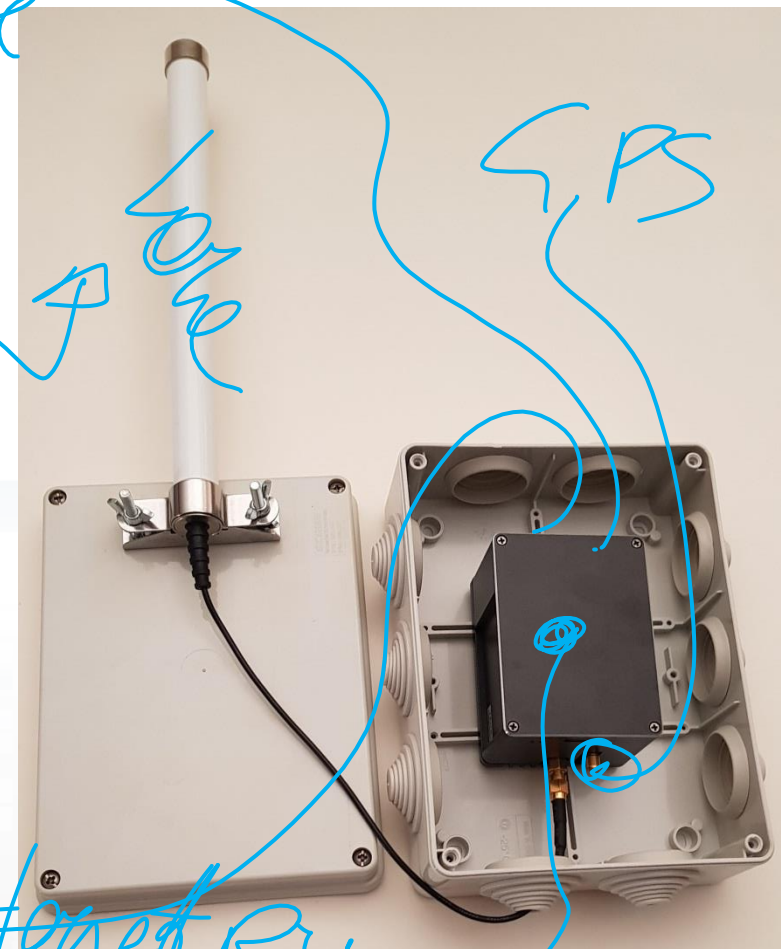
*Wind*

- PM10
- Temp
- Humidity
- Pm2.5
- NO
- NO2
- CO2
- Etc.



# LoraWan Gateway out of the Box

- Raspberry Pi Based LoraWan Gateway
- Physical UpLink as: Wi-Fi, RJ45
- Logical UpLink: LoraWAN TheThingsNetwork, NGSI V2 (mutual authenticated Snap4City)
- Powered 5V
- GeoLocated GPS Antenna
- IOT Edge Snap4City Included if needed



# IOT Edge *Dance*

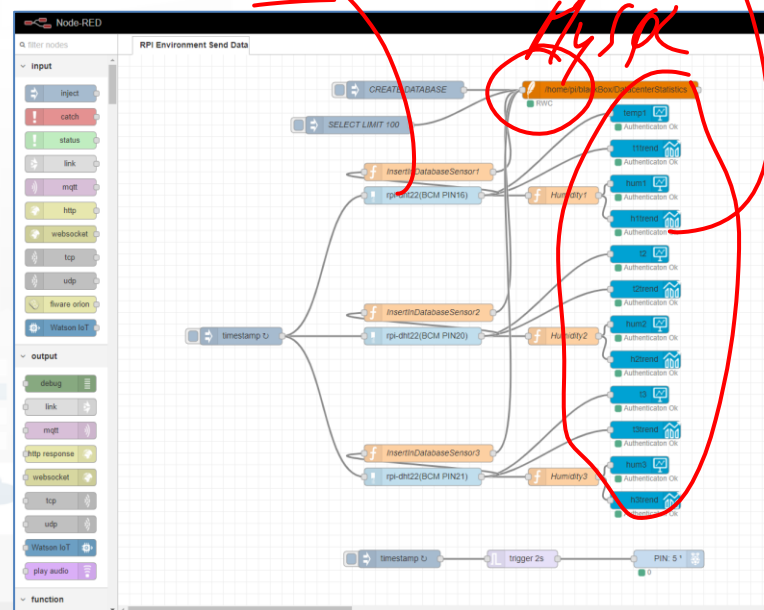
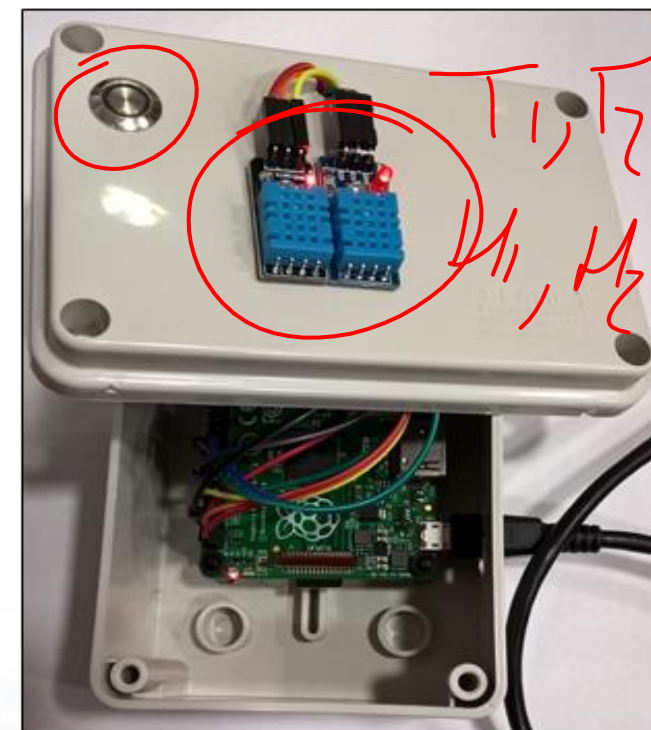
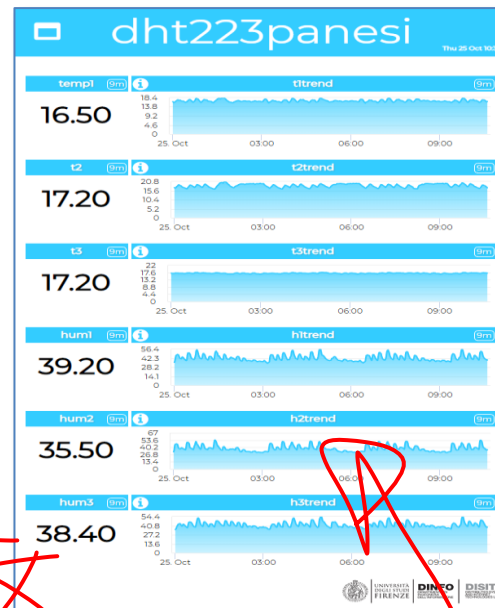


# IOT Edge on Raspberry Pi

- Raspberry Pi
- Mutual Authentication with certificates
- Secure encrypted connection
- IOT Application inside
- Any sensor
- Any protocol from IOT devices
- NGSI or any other protocol
- Fully Customizable
- Local and Cloud Dashboard
- **Special MicroServices**

*IOT Dashboard*

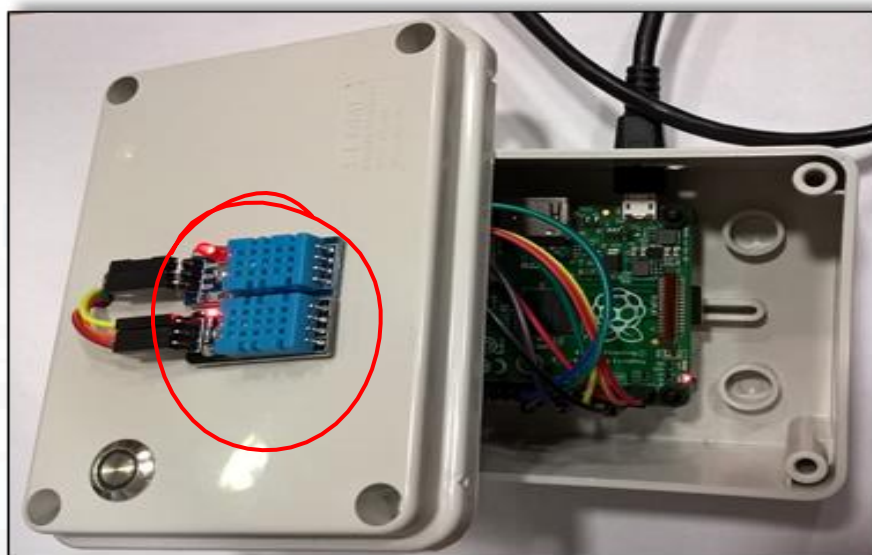
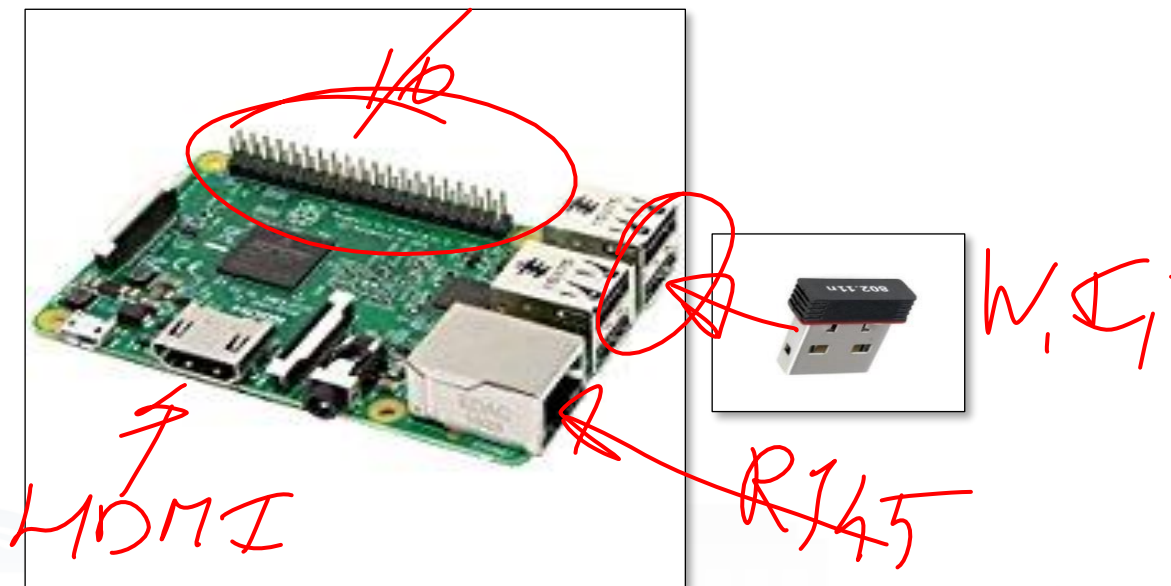
*DASHBOARD*



### MicroServices:

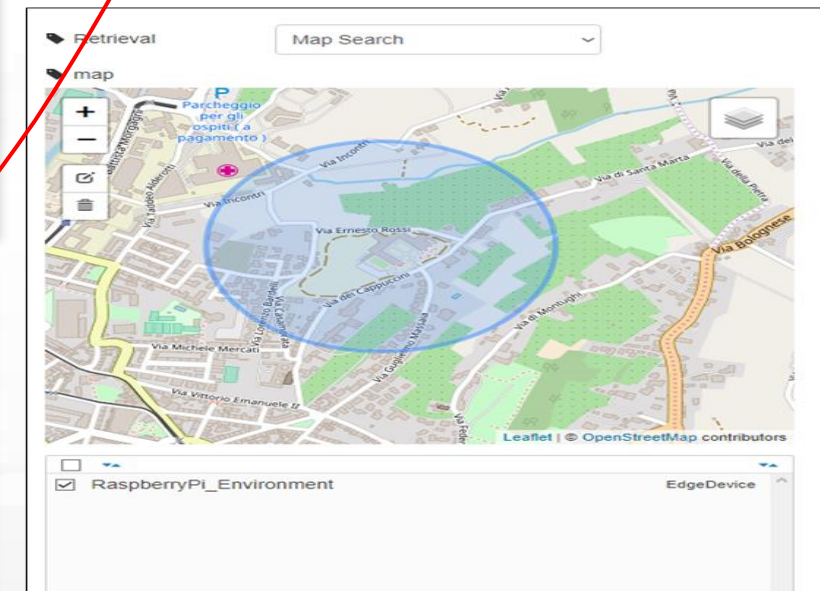
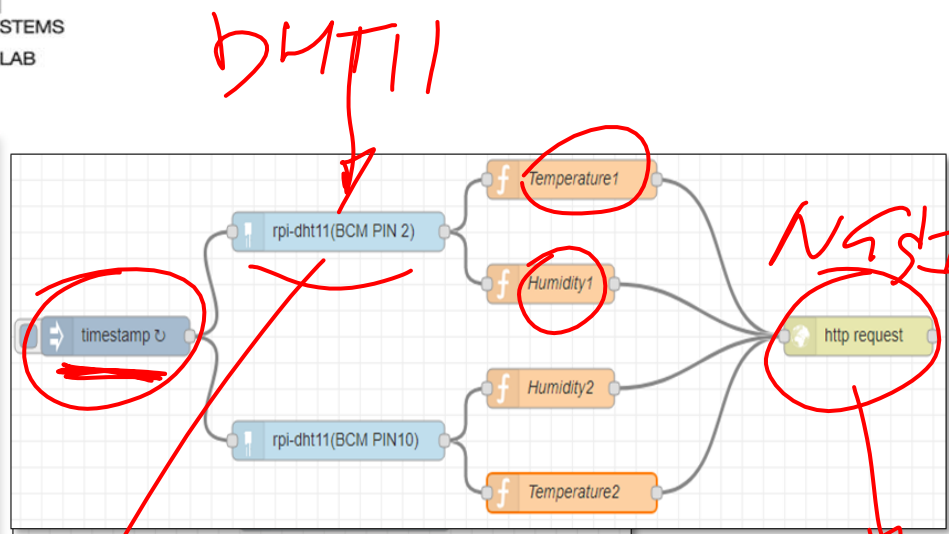
- DHT
- ModBus
- any shield
- etc....

# Raspberry for Edge





3.3V Power - 1	2 - 5V Power
SDA1 - GPIO02 - 3	4 - 5V Power
SCL1 - GPIO03 - 5	6 - Ground
GPIO04 - 7	8 - GPIO14 - TxD
Ground - 9	10 - GPIO15 - RxD
GPIO17 - 11	12 - GPIO18
GPIO27 - 13	14 - Ground
GPIO22 - 15	16 - GPIO23
3.3V Power - 17	18 - GPIO24
MOSI - GPIO10 - 19	20 - Ground
MISO - GPIO09 - 21	22 - GPIO25
SCLK - GPIO11 - 23	24 - GPIO8 - CE0
Ground - 25	26 - GPIO7 - CE1
SD - 27	28 - SC
GPIO05 - 29	30 - Ground
GPIO06 - 31	32 - GPIO12
GPIO13 - 33	34 - Ground
GPIO19 - 35	36 - GPIO16
GPIO26 - 37	38 - GPIO20
Ground - 39	40 - GPIO21



```

1 msg.payload={"temperature1":{"value":msg.payload , "type":"Float"}};
2 return msg;

```

Topic: rpi-dht11(BCM PIN 2)

Sensor model: **DHT11**

Pin numbering: BCM GPIO

Pin number: 2

Name: Name

▼ Raspberry Pi

- rpi gpio
- rpi gpio
- rpi mouse
- rpi keyboard
- camerapi takephoto
- rpi dht22
- imagecapture
- ledborg
- Sense HAT**
- Sense HAT**

▼ storage

- tail
- file
- sqlite**
- file

▼ network

- ping

▼ S4CDashboard

- dashboard websocket
- dashboard websocket

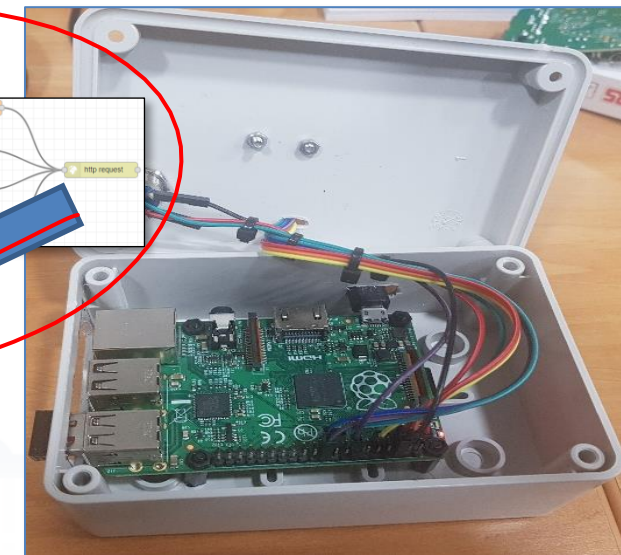
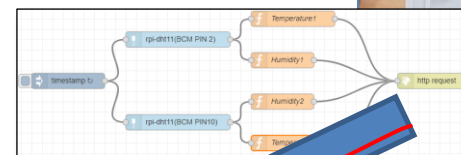
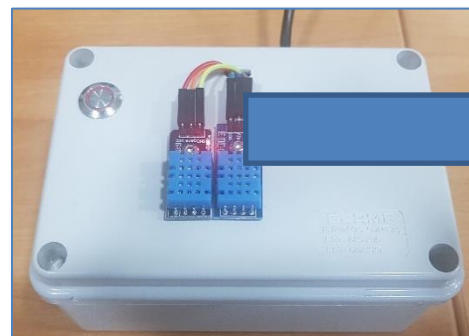
# Snap4City on Raspberry Pi, IOT edge

# IOT Edge Computing

## City user

Would like to:

- Monitor and exploit temperature and humidity
- Manage sensors
- Perform edge computing
- Using these data for multiple applications



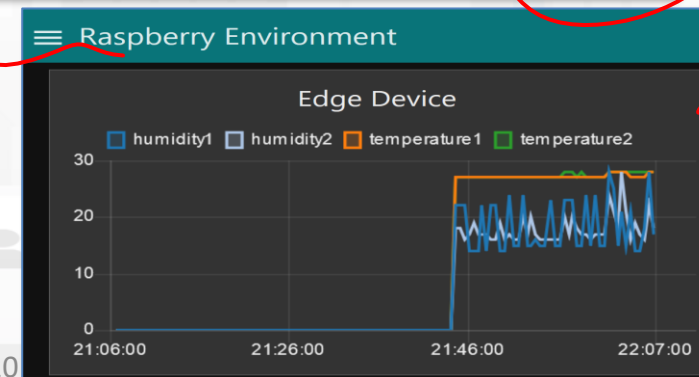
IOT Broker

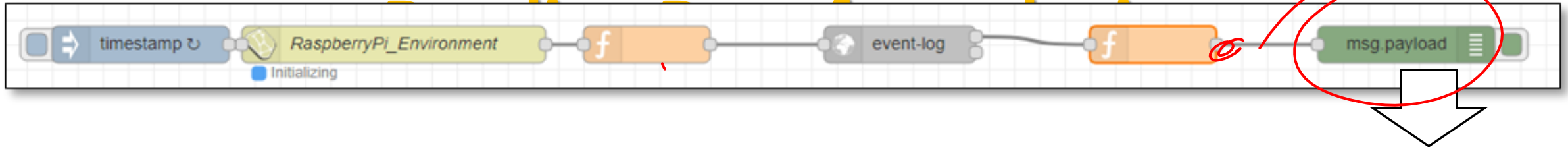
Click here



## Steps:

1. Registering the device and sensors
2. Create flow on edge device using NodeRed with Snap4City, sending data to Broker
3. Use data from Broker on Snap4City IOT App





```
19/3/2018, 22:20:48 node: 1fc37579.28dbfb
msg.payload : string[459]
[{"type": "EdgeDevice", "id": "RaspberryPi_Environment", "attributes": [{"name": "geolocalization_lat", "type": "Float", "value": "43.798778"}, {"name": "geolocalization_lon", "type": "Float", "value": "11.253522"}, {"name": "humidity1", "type": "Float", "value": "30.00"}, {"name": "humidity2", "type": "Float", "value": "33.00"}, {"name": "model", "type": "String", "value": ""}, {"name": "temperature1", "type": "Float", "value": "26.00"}, {"name": "temperature2", "type": "Float", "value": "26.00"}]}]

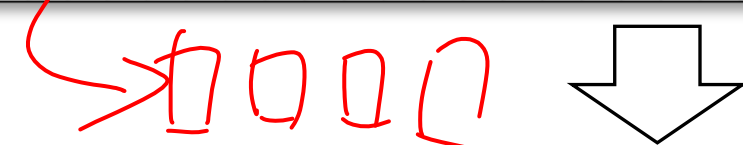
19/3/2018, 22:21:02 node: 1fc37579.28dbfb
msg.payload : string[459]
[{"type": "EdgeDevice", "id": "RaspberryPi_Environment", "attributes": [{"name": "geolocalization_lat", "type": "Float", "value": "43.798778"}, {"name": "geolocalization_lon", "type": "Float", "value": "11.253522"}, {"name": "humidity1", "type": "Float", "value": "30.00"}, {"name": "humidity2", "type": "Float", "value": "35.00"}, {"name": "model", "type": "String", "value": ""}, {"name": "temperature1", "type": "Float", "value": "26.00"}, {"name": "temperature2", "type": "Float", "value": "26.00"}]}]

19/3/2018, 22:21:08 node: 1fc37579.28dbfb
msg.payload : string[459]
[{"type": "EdgeDevice", "id": "RaspberryPi_Environment", "attributes": [{"name": "geolocalization_lat", "type": "Float", "value": "43.798778"}, {"name": "geolocalization_lon", "type": "Float", "value": "11.253522"}, {"name": "humidity1", "type": "Float", "value": "30.00"}, {"name": "humidity2", "type": "Float", "value": "35.00"}, {"name": "model", "type": "String", "value": ""}, {"name": "temperature1", "type": "Float", "value": "26.00"}, {"name": "temperature2", "type": "Float", "value": "26.00"}]}]

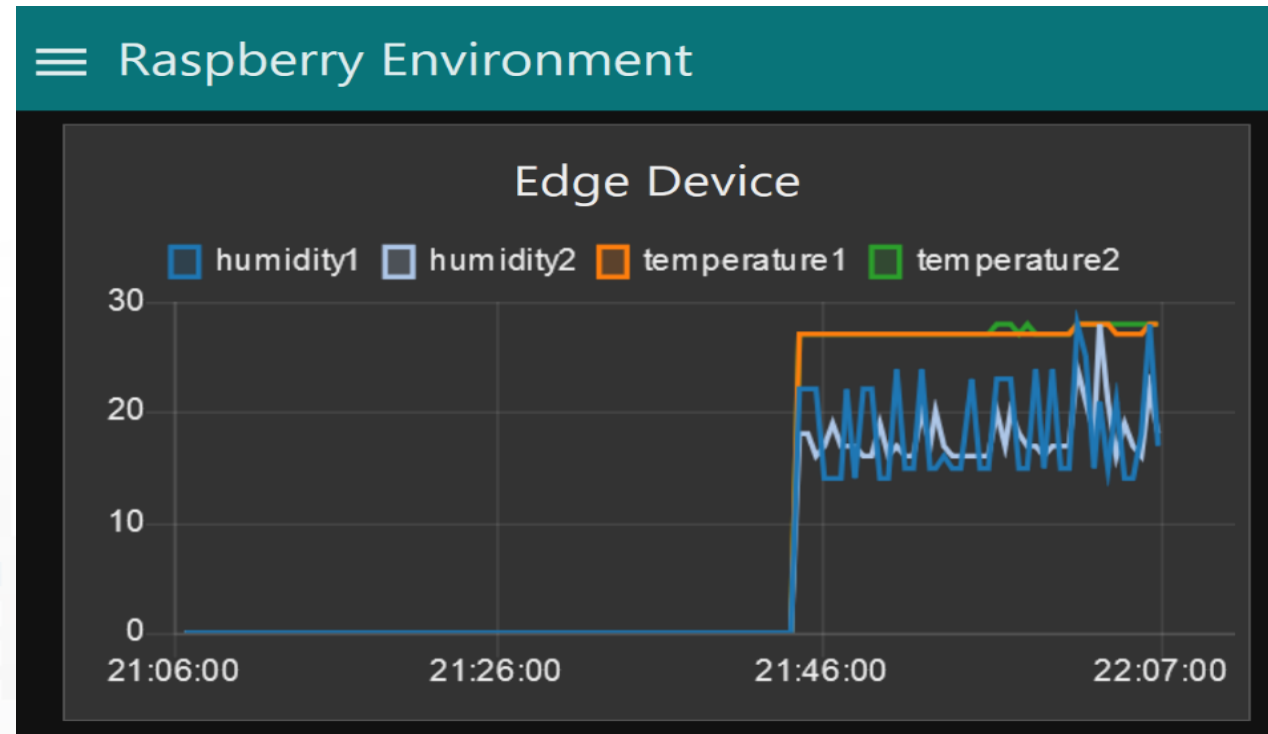
19/3/2018, 22:21:20 node: 1fc37579.28dbfb
msg.payload : string[459]
[{"type": "EdgeDevice", "id": "RaspberryPi_Environment", "attributes": [{"name": "geolocalization_lat", "type": "Float", "value": "43.798778"}, {"name": "geolocalization_lon", "type": "Float", "value": "11.253522"}, {"name": "humidity1", "type": "Float", "value": "30.00"}, {"name": "humidity2", "type": "Float", "value": "35.00"}, {"name": "model", "type": "String", "value": ""}, {"name": "temperature1", "type": "Float", "value": "26.00"}, {"name": "temperature2", "type": "Float", "value": "26.00"}]}]
```



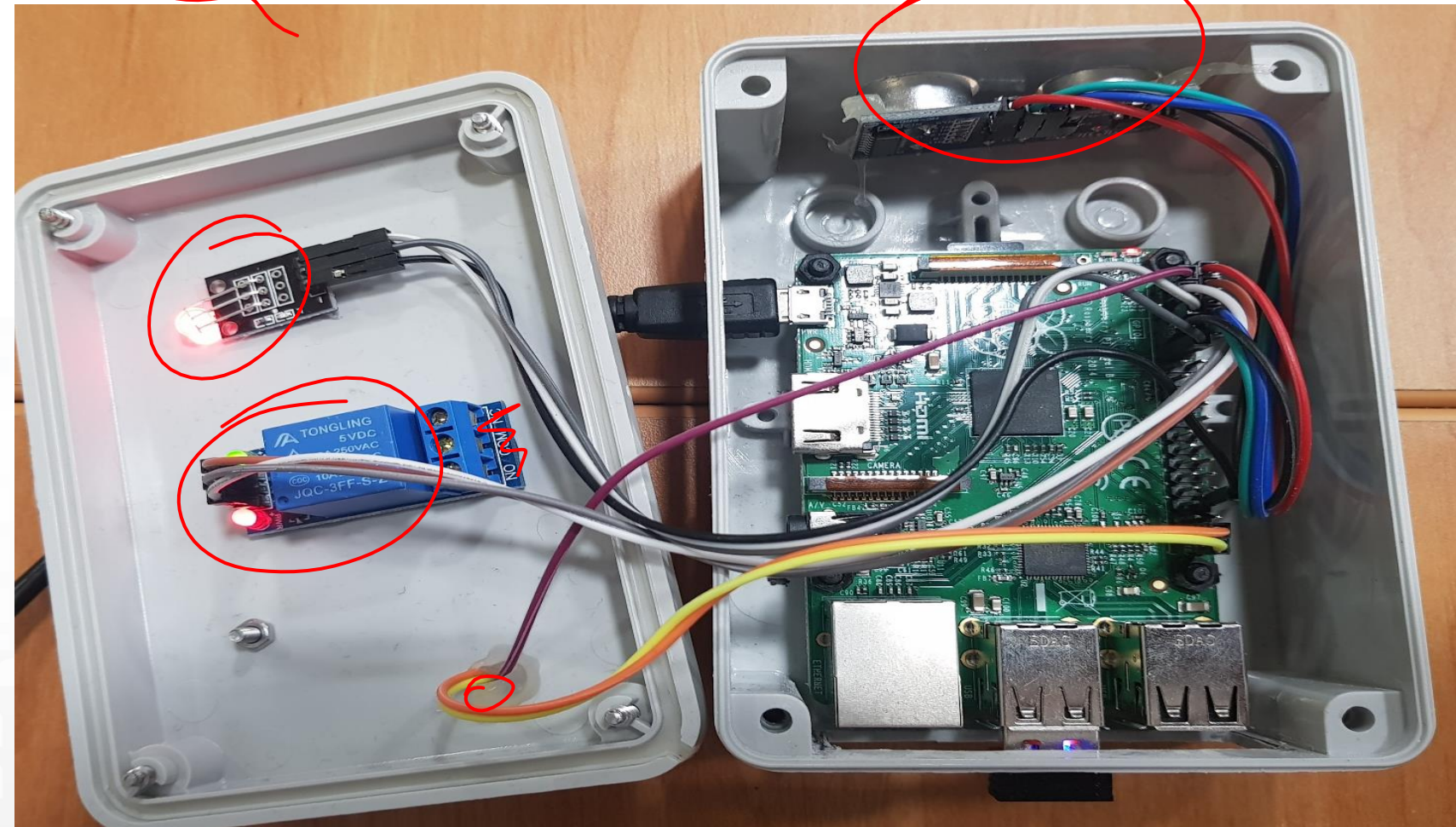
a



b



# Altro device: distanza, temperatura, attuazione



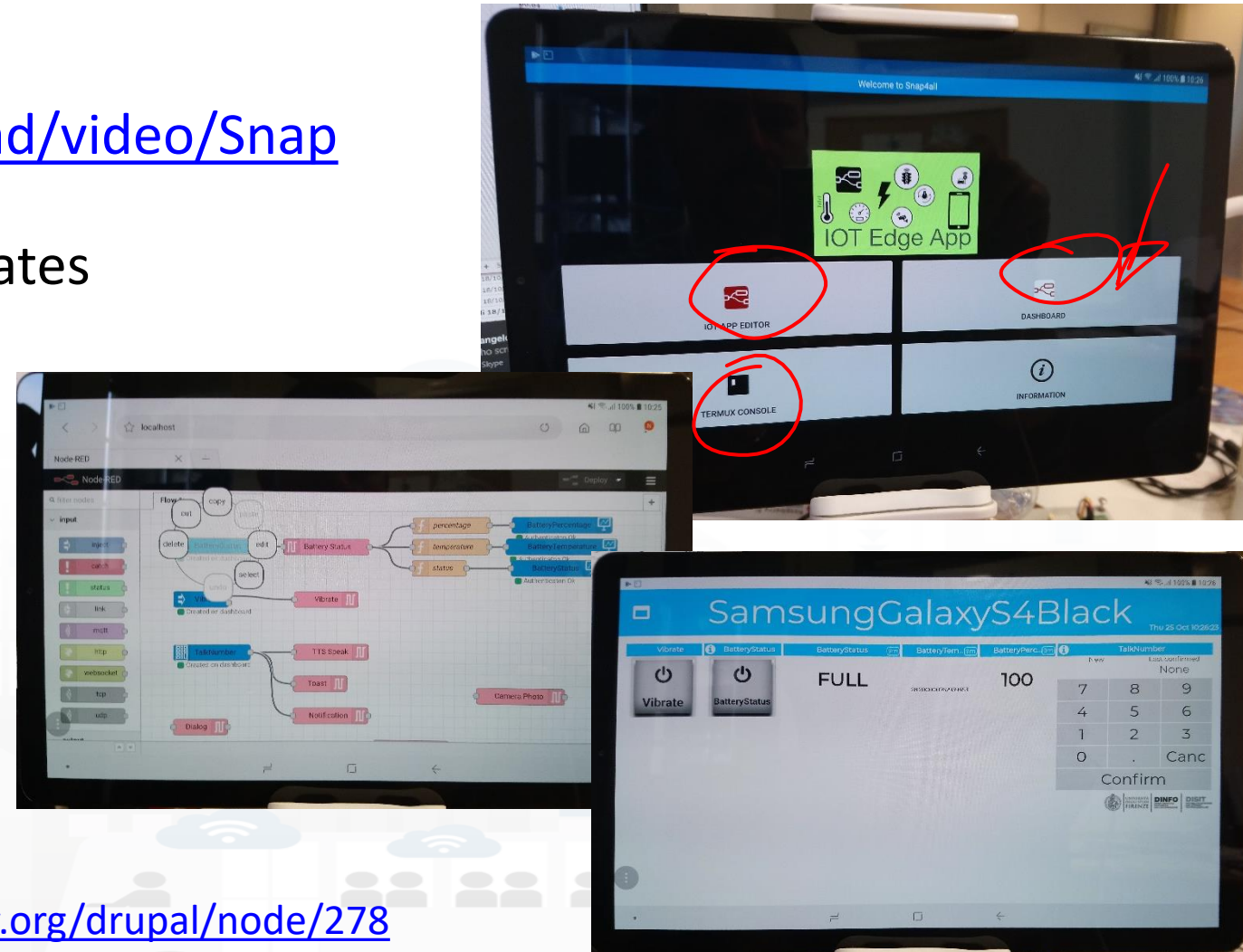
# IOT Edge on Mobiles



# IOT Edge Snap4All App for Android

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

<https://www.snap4city.org/drupal/node/278>



# IOT Edge Snap4All App for Android

termux-battery-status

termux-camera-info

termux-clipboard-get

termux-contact-list

termux-telephony-cellinfo

termux-telephony-deviceinfo

termux-tts-engines

termux-camera-photo

termux-clipboard-set

termux-dialog

termux-download

termux-location

termux-tts-speak

termux-vibrate

termux-sms-inbox

termux-toast

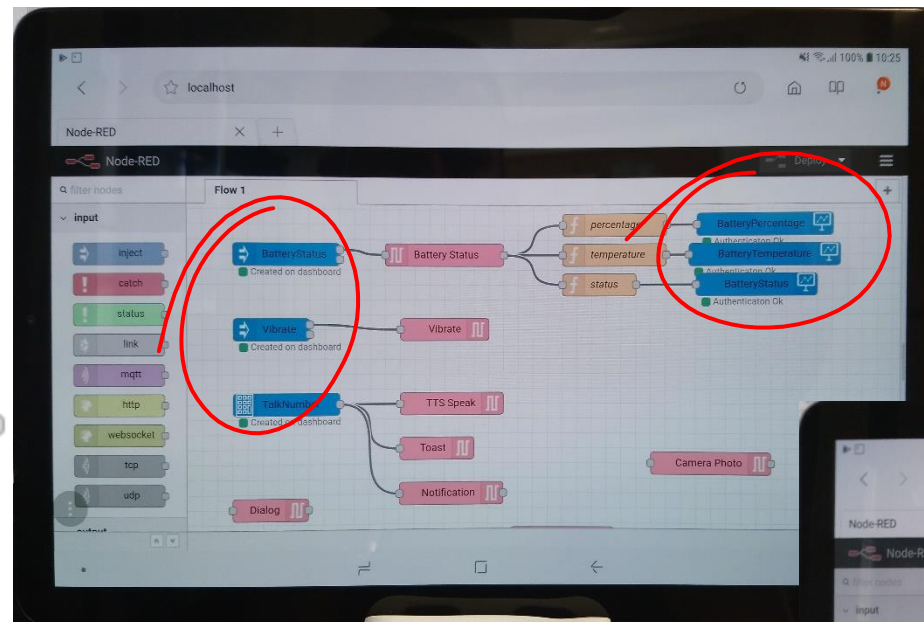
termux-sms-send

termux-share

termux-notification

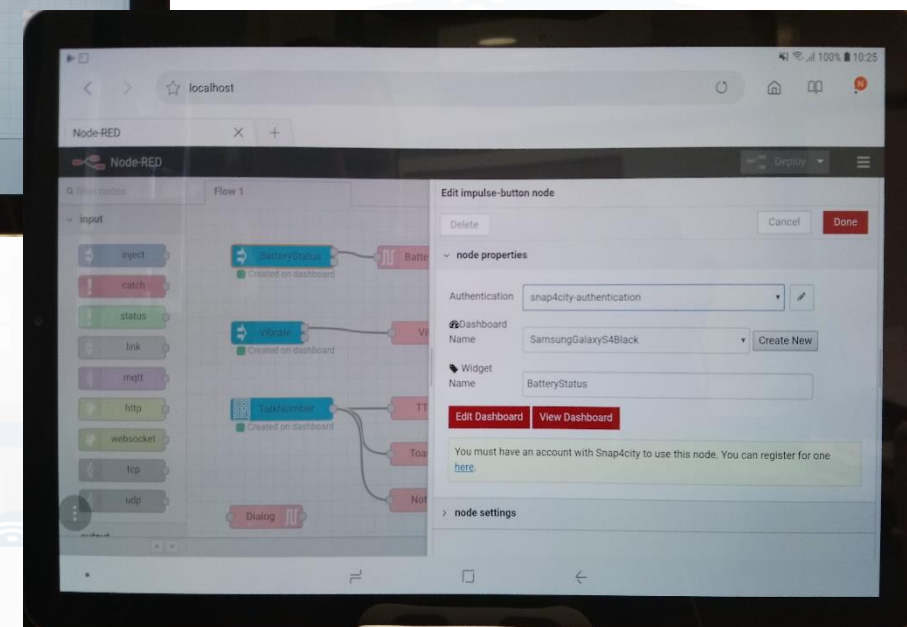
termux-wifi-connectioninfo

termux-wifi-scaninfo



## MicroServices:

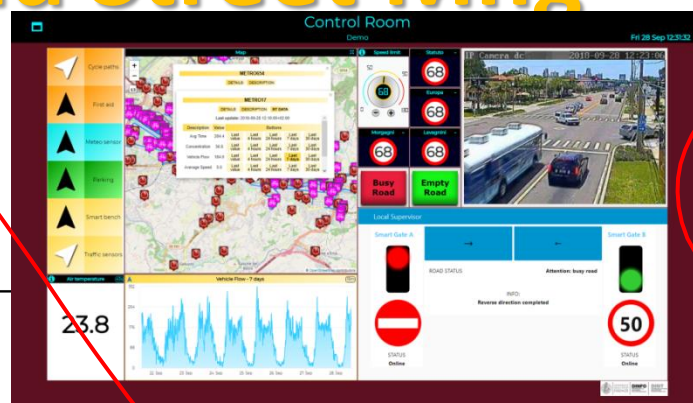
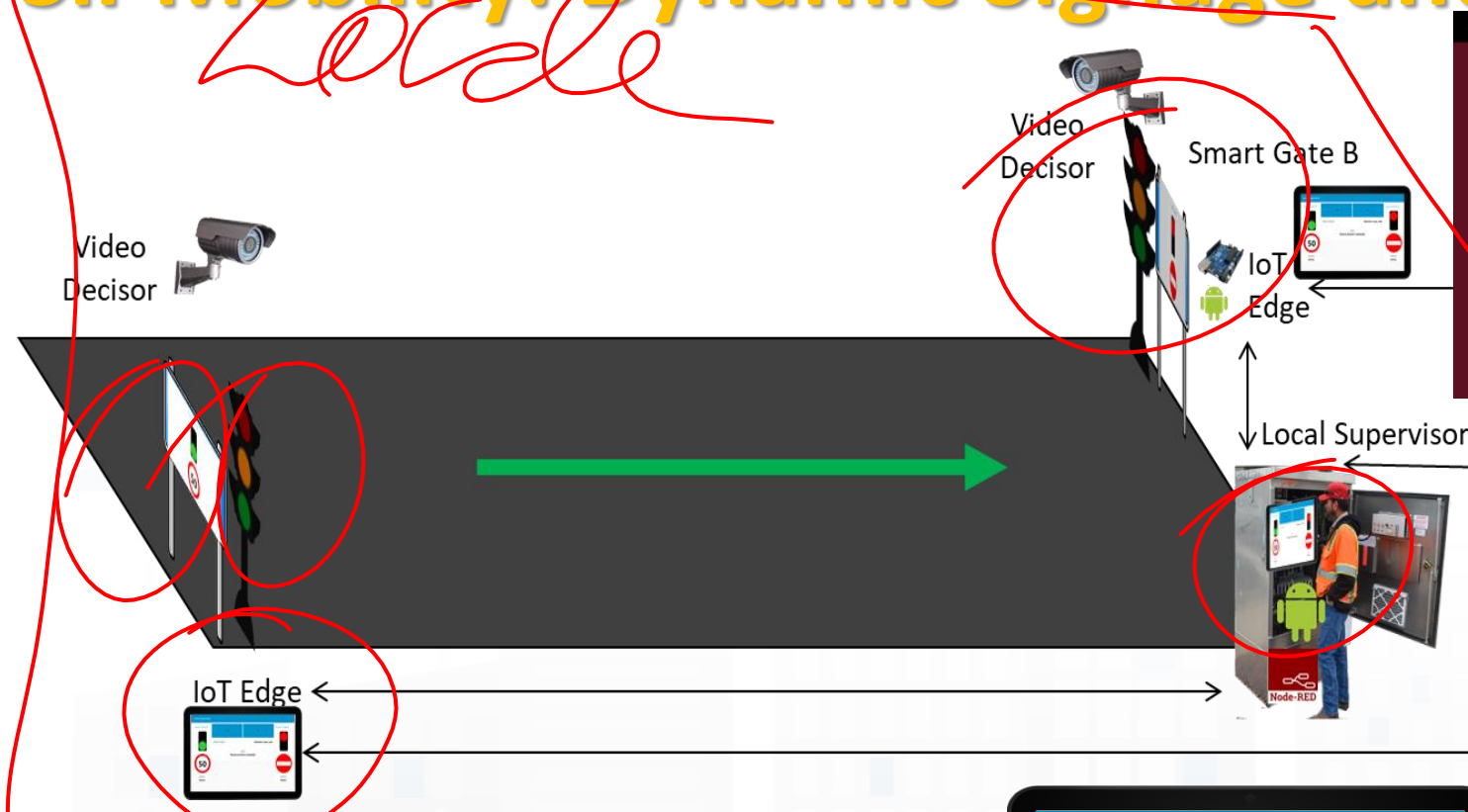
- Snap4City
- Termux Snap4City specific
- etc.



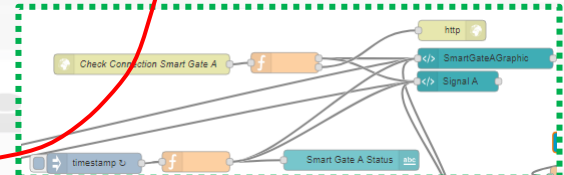
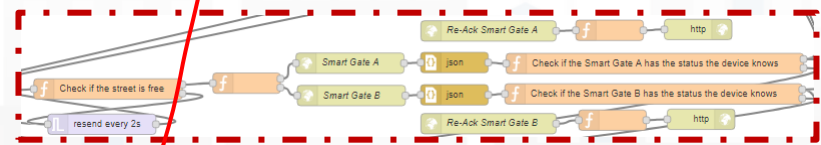
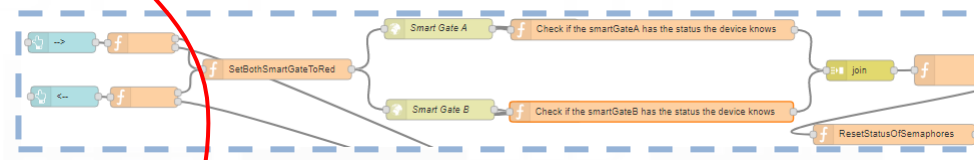


# Sii-Mobility: Dynamic Signage and Street Mng

*Locale*



Control Room



Local Control Dashboard



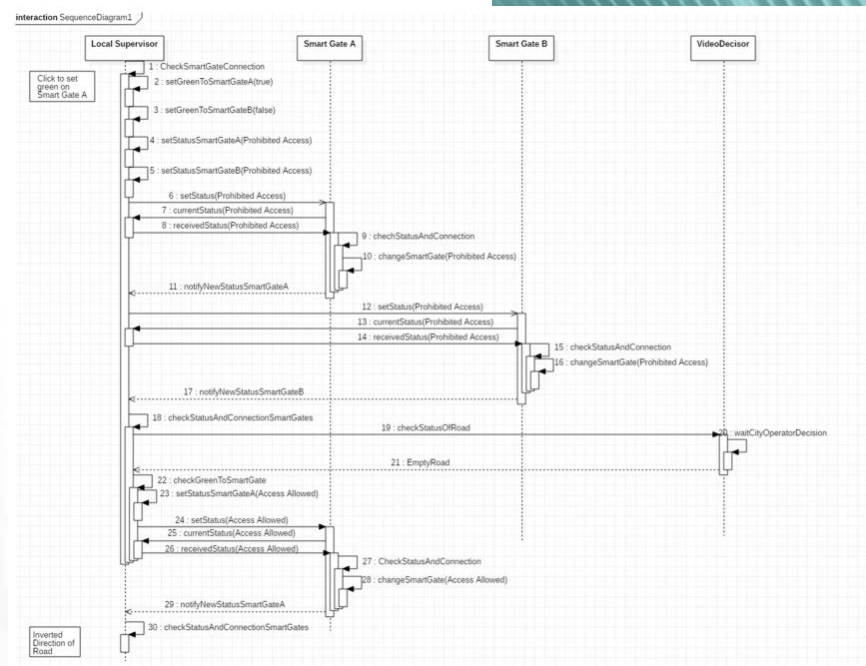
*Safe and resilient solution managing Degradated conditions*



# IOT for Mobility Infrastructure

- C. Badii, P. Bellini, A. Difino, P. Nesi, "*Sii-Mobility: an IOT/IOE architecture to enhance smart city services of mobility and transportation*", Sensors, MDPI, 2019

- <https://www.mdpi.com/1424-8220/19/1/1/pdf>





# PaxCounter devices



- Fixed PaxCounter LoraWan
  - Based on Wi-Fi- Bluetooth
- Mobile PaxCounter LoraWan
  - Based on Wi-Fi- Bluetooth
- Fixed PaxCounter(LoraWan+Wifi out)
  - Based on Wi-Fi- Bluetooth

<https://www.snap4city.org/drupal/node/456>

# Programmable PAX counting

Mobile PAXCounter 01 in Antwerp

Mon 23 Sep 18:39:46

s4cmobpaxant01 - wifi (H24) 9m

s4cmobpaxant01 - wifi (1 Week) 9m

Begin 3:00 + -

Finish 5:30 + -

Activate

Status 9m

CUMULATIVE MODE OFF

Status 9m

Cumulative Mode Active from 2019-09-23T03:00:00.000Z and 2019-09-23T05:30:00.000Z

Pax Counter Status 9m

Device in Cumulative Mode OFF

Tracker - Trend 9m

Privacy Policy Cookies Policy Terms and Conditions Contact us

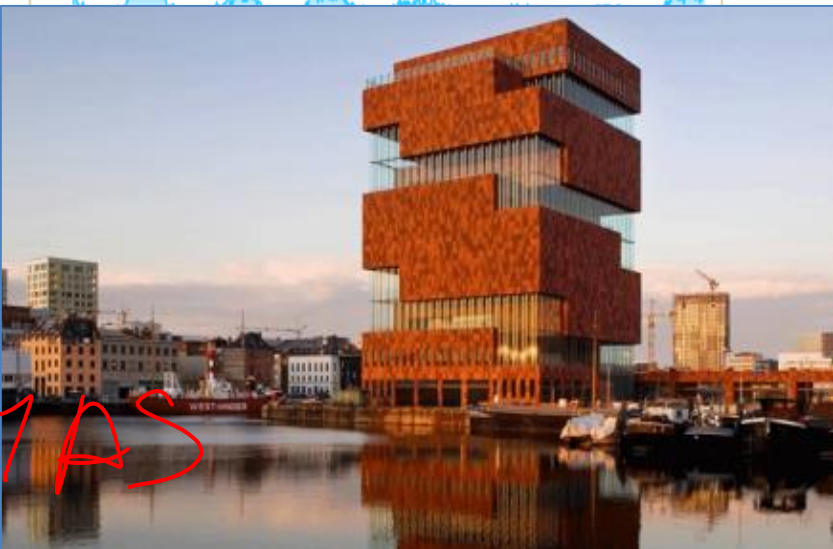
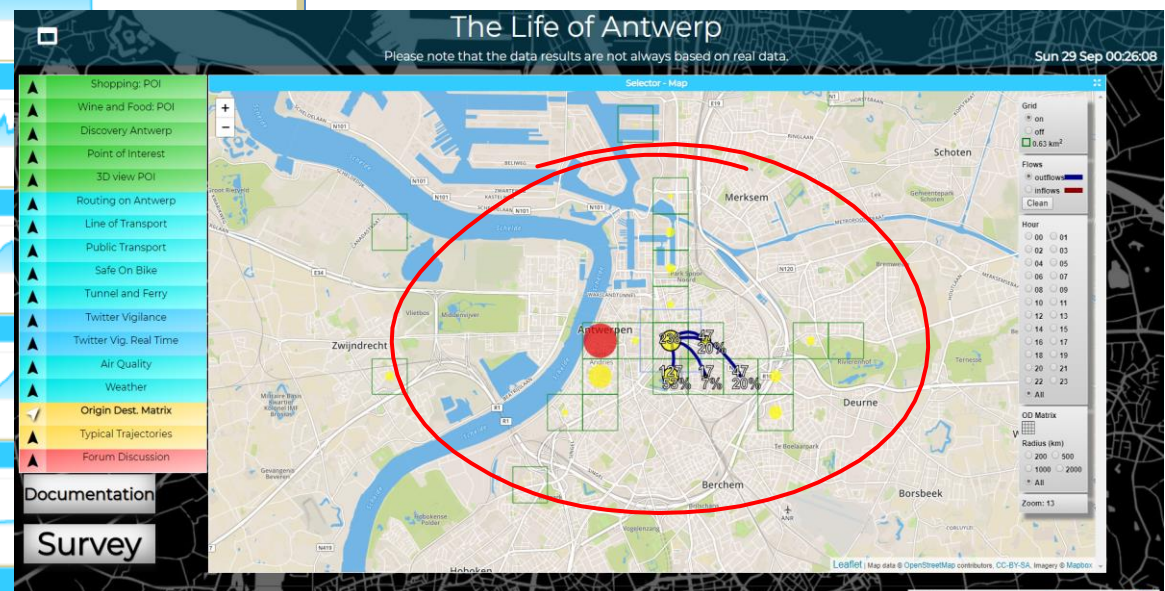
UNIVERSITÀ DEGLI STUDI FIRENZE DINFO DISIT SNAP4CITY KM4CITY

# lot app behind

The screenshot displays the Node-RED web interface for 'PAXCounter Antwerp Control'. On the left, the Snap4City user interface is visible, showing the user 'roottooladmin1' and various navigation menus. The main workspace contains a complex flow graph. The flow starts with a URL node pointing to 'https://github.com/cyberman54/ESP32-Paxcounter'. It branches into multiple parallel paths, each starting with a 'timestamp' node followed by a 'function' node. These functions perform tasks such as 'OFF ADR for mobile PAX', 'Display OFF', 'Display ON', 'Short range', 'MID range', 'Long range', 'WIFI Scan for 500ms', and 'WIFI Scan for 1000ms'. The outputs of these functions are sent to 'msg.payload' nodes. These payloads are then processed by 'mqtt' nodes, which are connected to various MQTT topics like 'digipolisnap4citypax/devices/s4cmobpaxant03/down' and 'digipolisnap4citypax/devices/s4cmobpaxant03/up'. A red circle highlights a specific 'function' node with the handwritten text 'SW'. The interface also shows a 'Tax Counter Status' widget connected to a specific URL.

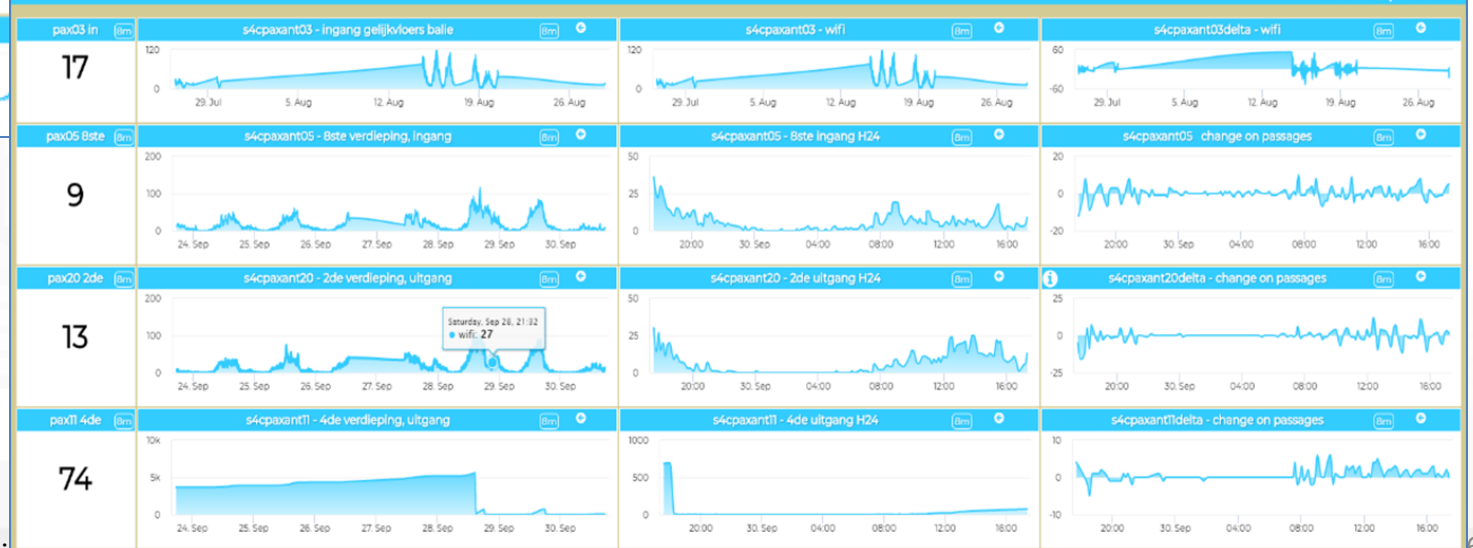
# PAXCounter real time and trend

Mon 30 Sep 17:18:48



# MAS Monitoring via PAXCounter

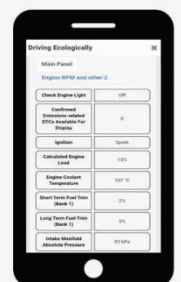
Mon 30 Sep 17:31:32



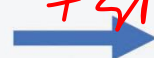
# IOE – Vehicle Monitoring



BT



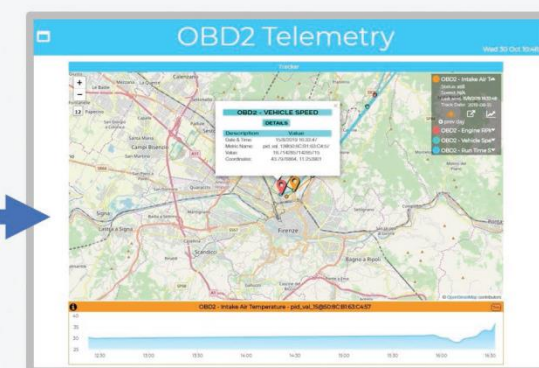
Auto + GPS



*SNAP4CITY*

### My Data, KPI, POI

No.	High Level Type	Nature	Sub Nature	Value Name	Value Type	Data Type	Last Date	Last Value	Ownership	Username	Controls	Data	Visibility
17057177	MyKPI	TransferServiceAndRouting	SensorSite	OBD2 - Vehicle Speed	pid_13(IG)C544407252367	integer	2/7/2019	152600	private	badiantberg	YES	VALUES	DELEGATED
17057176	MyKPI	TransferServiceAndRouting	SensorSite	OBD2 - Vehicle Speed	pid_13(IG)C544407252367	integer	2/7/2019	125955	private	badihelinski	YES	VALUES	DELEGATED
17057137	MyKPI	TransferServiceAndRouting	SensorSite	OBD2 - Vehicle Speed	pid_13(IG)C544407252367	integer	23/7/2019	126154904	private	badi toscana	YES	VALUES	DELEGATED
17056990	MyKPI	TransferServiceAndRouting	SensorSite	OBD2 - Vehicle Speed	pid_val_13(W)B4310000283814	integer	5/7/2019	1075153602	private	padlotoc2	YES	VALUES	DELEGATED
17056968	MyKPI	TransferServiceAndRouting	SensorSite	OBD2 - Vehicle Speed	pid_13(AF)Q10X2ACLXV65816	integer	19/7/2019	187731	public	badi toscana	YES	VALUES	DELEGATED



CAN BUS  
VEHICLE

DPP

*SNAP4CITY*

### Driving Ecologically

Main Panel

Engine RPM and other 2

Check Engine Light	Off
Confirmed Emissions-related DTCs Available For Display	0
Ignition	Spark
Calculated Engine Load	13%
Engine Coolant Temperature	107 °C
Short Term Fuel Trim (Bank 1)	2%
Long Term Fuel Trim (Bank 1)	5%
Intake Manifold Absolute Pressure	95 kPa

### TrackerFordOBD2

Tue 29 Oct 18:34:02

Tracker

2353

100

92

32

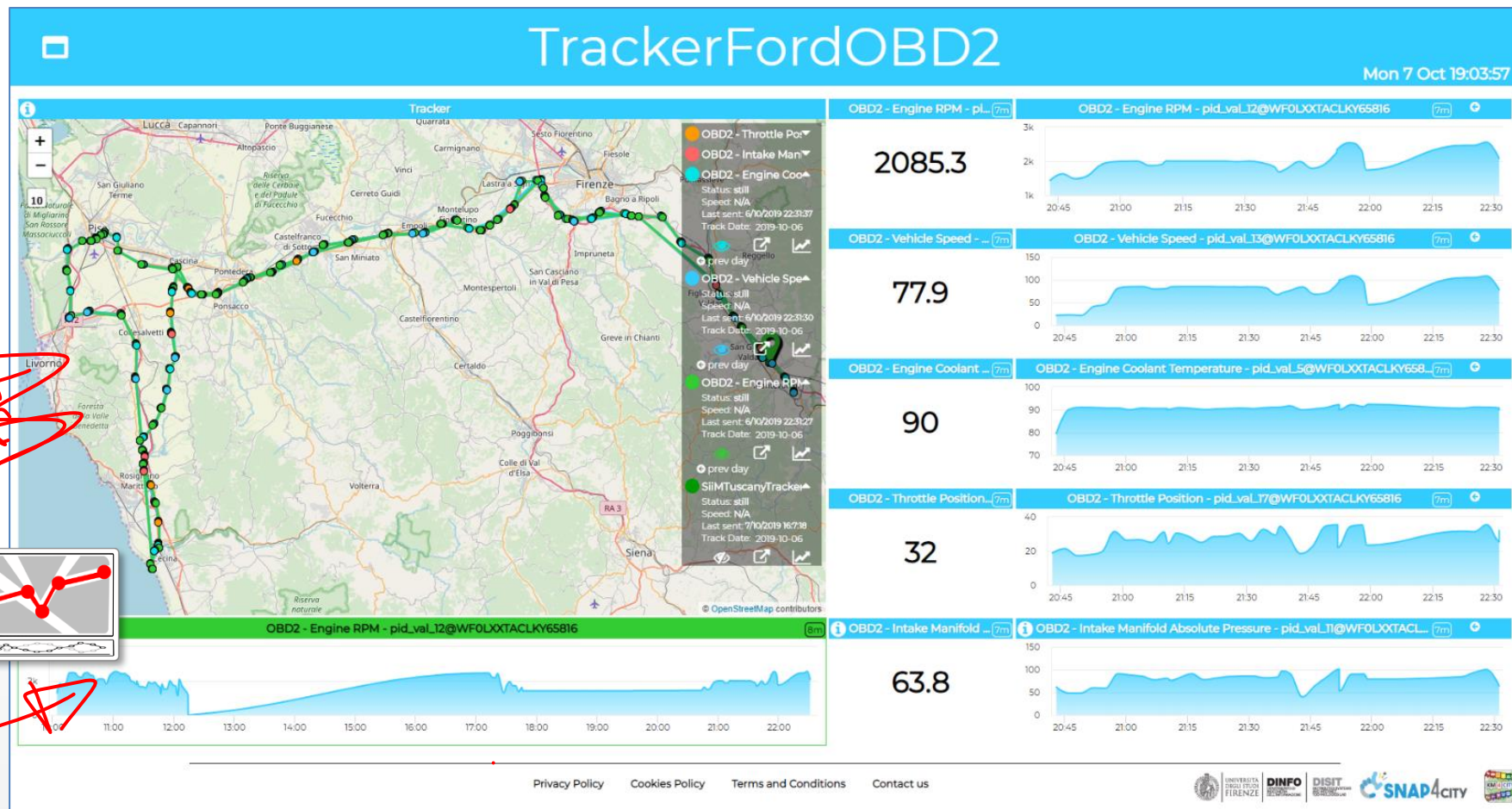
63.8

Graphs for: OBD2 - Engine RPM, OBD2 - Vehicle Speed, OBD2 - Engine Coolant Temperature, OBD2 - Throttle Position, OBD2 - Intake Manifold Absolute Pressure.



# MyKPI: Tracking of Devices and Mobiles

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



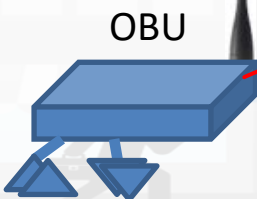
Mobile  
PAX Counter



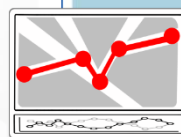
Apps



OBD2



OBU



# Capabilities

- **Creating IOT Applications for:**
  - **Controlling industrial/local processes** locally and globally
  - **Exploiting IOT Edge for local IOT Applications**
    - Local smartness, limited computational capabilities, limited dashboarding
    - Resilience wrt lack of power and connectivity: autonomous
  - **Sending data on Cloud** via secure connection and for:
    - business intelligence, data analytics, machine learning
    - Global scale and local scale analytics
    - Dashboarding at global scale
    - remote control and actions on industrial processes
    - Logging of the activities

# IOT Devices and IOT Edge (Self Training)

- **A large range of Devices** can be used on Snap4City:
  - Proprietary or Open HW/SW.
  - Devices of/for makers on which we provide Open source code
- **Documentation and instructions:**
  - [TC9.4 - IOT application exploiting Edge computing with Raspberry](#)
  - [TC9.7 - Connection from LoraWan Dragino/arduino to Orion broker](#)
  - [Snap4City: Arduino & ESP8266 IOT Device NGSI](#)
  - [Snap4City IOT Devices Registration](#)
  - [Snap4All IOT Button: based on ESP32, NGSI compliant secure connection](#)
  - [IDE Setup for Snap4All IOT Button, and source code](#)
  - [Registering IOT Edge: example of Raspberry Pi, total security](#)
  - [Creating: IOT Device, Raspberry Pi based, totally compliant with Snap4City](#)

TOP

# IOT APPLICATIONS, THE LOGIC AND THE SMARTNESS

FROM CITY DASHBOARD APPLICATIONS

FORGING & MANAGING OPEN AND FLEXIBLE WEB AND MOBILE APPS

DATA GATHERING AND CITY DATA KNOWLEDGE MANAGEMENT

IOT/IOE DEVICES AND NETWORKS

IOT APPLICATIONS, THE LOGIC AND THE SMARTNESS

SMART CITY API, MICROSERVICES, SNAP4CITY API

SNAP4CITY LIVING LAB FOR COLLABORATIVE WORK

SNAP4CITY FOR BEGINNERS

SNAP4CITY ARCHITECTURE AND ECOSYSTEM. OPEN TO DEVELOPERS AND TAKEHOLDERS

DATA ANALYTICS, BUSINESS INTELLIGENCE, WHAT AN SIMILAR

TWITTER VIGILANCE, SOCIAL MEDIA ANALYSIS

DECISION SUPPORT SYSTEM AND CITY RESILIENCE

HOW TO ADOPT SNAP4CITY, AND OUR ROADMAP

SNAP4CITY AND KM4CITY PROJECTS

SNAP4CITY THE VIEW OF THE ADMINISTRATORS

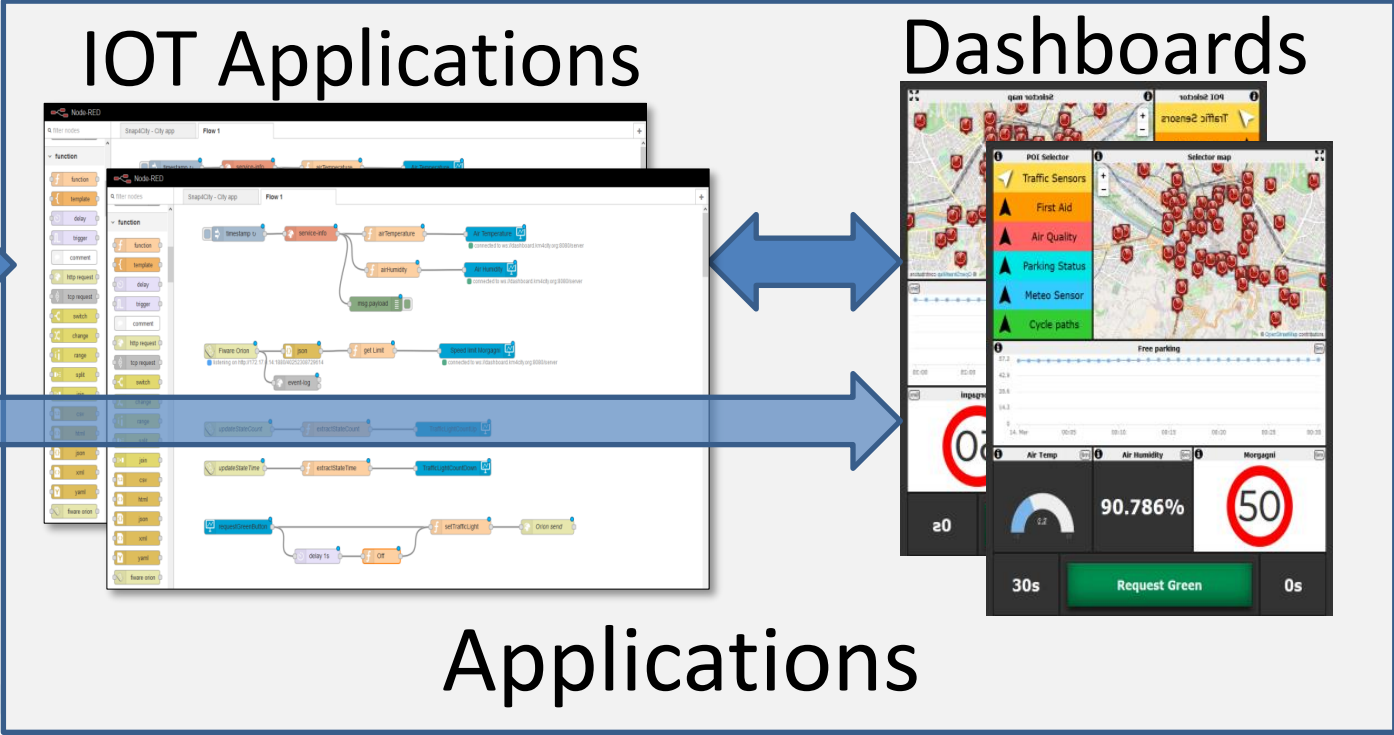
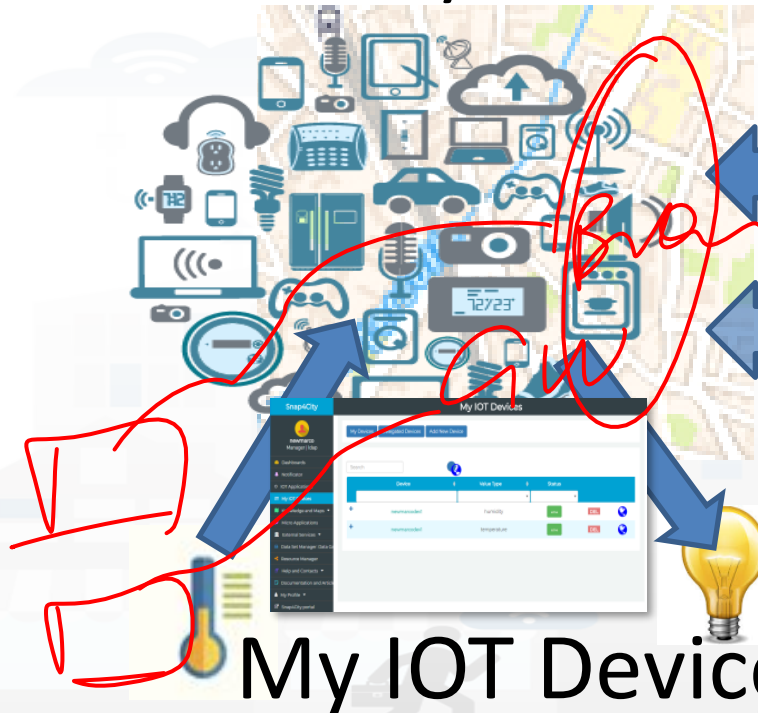


# Dashboard with intelligence App

Dashboards with IOT Applications for enforcing smart and intelligence into them

**Dashboard-IOT App**

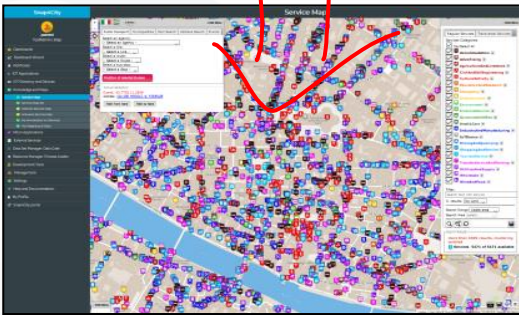
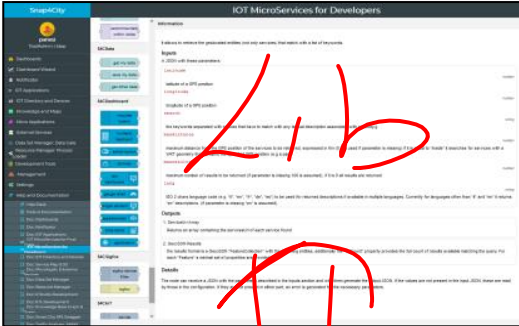
IOT and City data World



# IOT Applications Development

IOT Discovering

MicroServices collections



ServiceMap Discovery

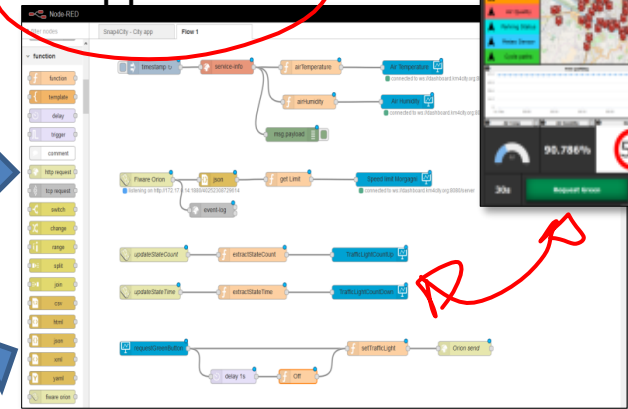
Knowledge Base, Km4City

My IOT Applications



Dashboard Collection,  
Editor and Wizard

IOT App. Editor



Sharing/saving  
IOT App



Resource Manager

Generating IOT App  
With Dashboard



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

- Dashboards
- My Dashboards
- Notificator
- IOT Applications**
- My Personal Data
- IOT Directory and Devices
- Knowledge and Maps
- Micro Applications
- External Services
- Data Set Manager: Data Gate
- Resource Manager: Process Loader
- Development Tools
- Management
- Settings
- User Management and Auditing
- Help and Contacts
- Documentation and Articles
- My Profile
- Snap4City portal
- Km4City portal
- DISIT Lab portal



Prev 1 2 3 ... 9 Next

Create new

2018-09-14T04:44

IOT Edge App

owner: badii

Management

*both*

2018-09-21T03:19

IOT Edge App

owner: panesi

Management

2018-10-19T16:07

IOT Edge App

owner: pb3

Management

2018-10-19T17:17

IOT Edge App

owner: pb3

Management

2018-10-22T11:57

IOT Edge App

owner: semolarudy

Management

application

IOT Application

owner: tester5

Management

Bib APP

IOT Application

owner: semolarudy

Management

ChargingStations

IOT Application

owner: comunedashres

Management

Deprecated - SiIMobilityControlRoom

IOT Application

owner: badii

Management

SamsungGalaxyS4Barcode

IOT Edge App

owner: badii

Management

esercitazione

IOT Application

owner: tester2

Management

lot-App

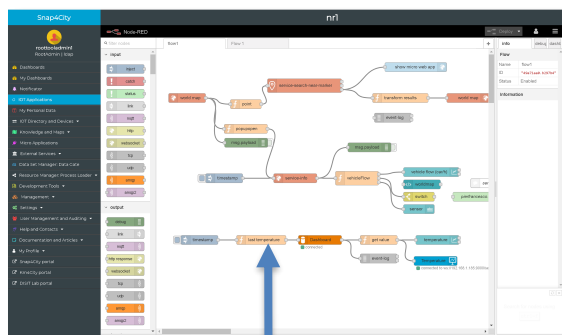
IOT Application

owner: tester14

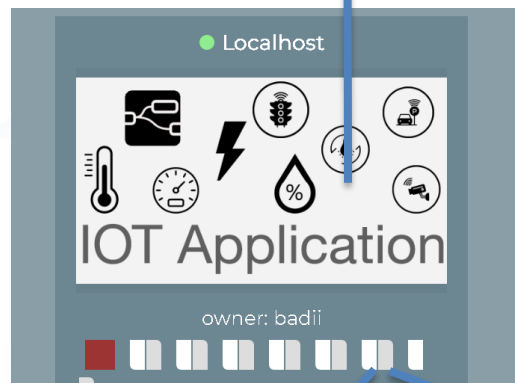
Management

# IOT Applications

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

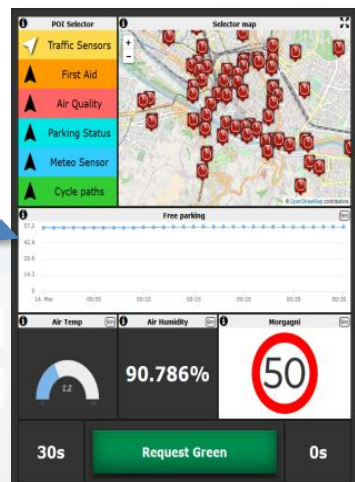


EDIT IOT APP



VIEW

EDIT



Ownership of the IOT App

Click to open the Node-RED IOT App dashboard

Click to view the Snap4City Dashboard

IOT App title

Click the icon to edit the IOT App

Click to edit IOT App properties

Click to edit the Snap4City Dashboard



# IOT Application Management

- **Properties**
  - Name, Type, Creation date
- **Control**
  - Restart
  - Delete
- **Change of ownership**
  - Toward another Snap4City User

**IoT Application Management**

Properties      Control      Ownership

Application name:

Application type:

Created:

**IoT Application Management**

Properties      Control      Ownership

**IoT Application Management**

Properties      Control      Ownership

Change ownership

*New owner username can't be empty*



rootooladmin1  
RootAdmin | ldap

- Dashboards
- My Dashboards
- Notificator
- IOT Applications
- My Personal Data
- IOT Directory and Devices
- Knowledge and Maps
- Micro Applications
- External Services
- Data Set Manager: Data Gate
- Resource Manager: Process Loader
- Development Tools
- Management
- Settings
- User Management and Auditing
- Help and Contacts
- Documentation and Articles
- My Profile
- Snap4City portal
- Km4City portal
- DISIT Lab portal

Node-RED

Deploy

filter nodes

flow1

Flow 1

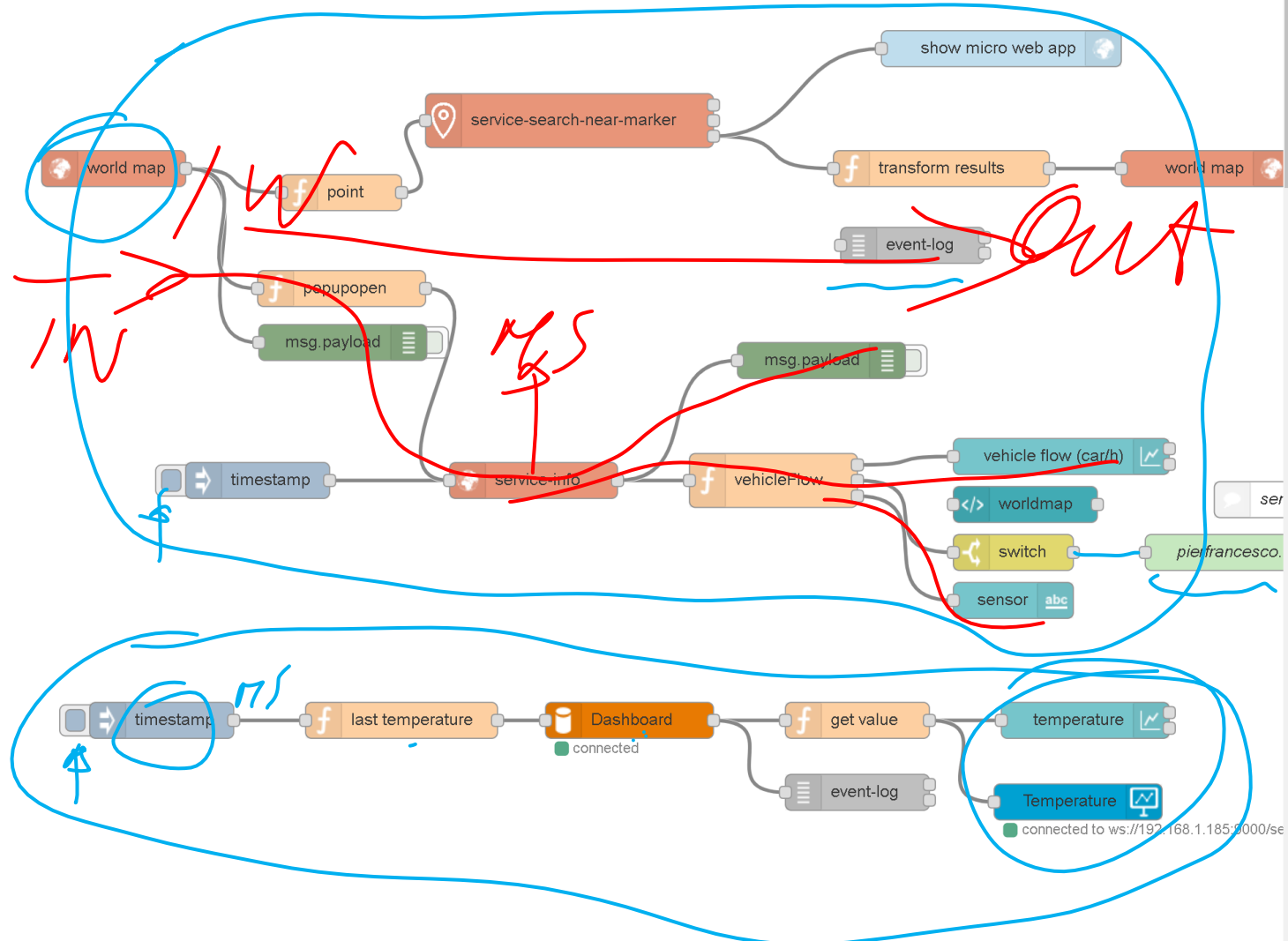
nrl

input

- inject
- catch
- status
- link
- mqtt
- http
- websocket
- tcp
- udp
- amqp
- amqp2

output

- debug
- link
- mqtt
- http response
- websocket
- tcp
- udp
- amqp
- amqp2



Flow

Name	flow1
ID	"49a71aa0.b297b4"
Status	Enabled

Information

Information section containing details about the flow and its components.

Search for nodes using





roottooladmin1  
RootAdmin | ldap

- Dashboards
- My Dashboards
- Notificator
- IOT Applications**
- My Personal Data
- IOT Directory and Devices
- Knowledge and Maps
- Micro Applications
- External Services
- Data Set Manager: Data Gate
- Resource Manager: Process Loader
- Development Tools
- Management
- Settings
- User Management and Auditing
- Help and Contacts
- Documentation and Articles
- My Profile
- Snap4City portal
- Km4City portal
- DISIT Lab portal

Node-RED

filter nodes

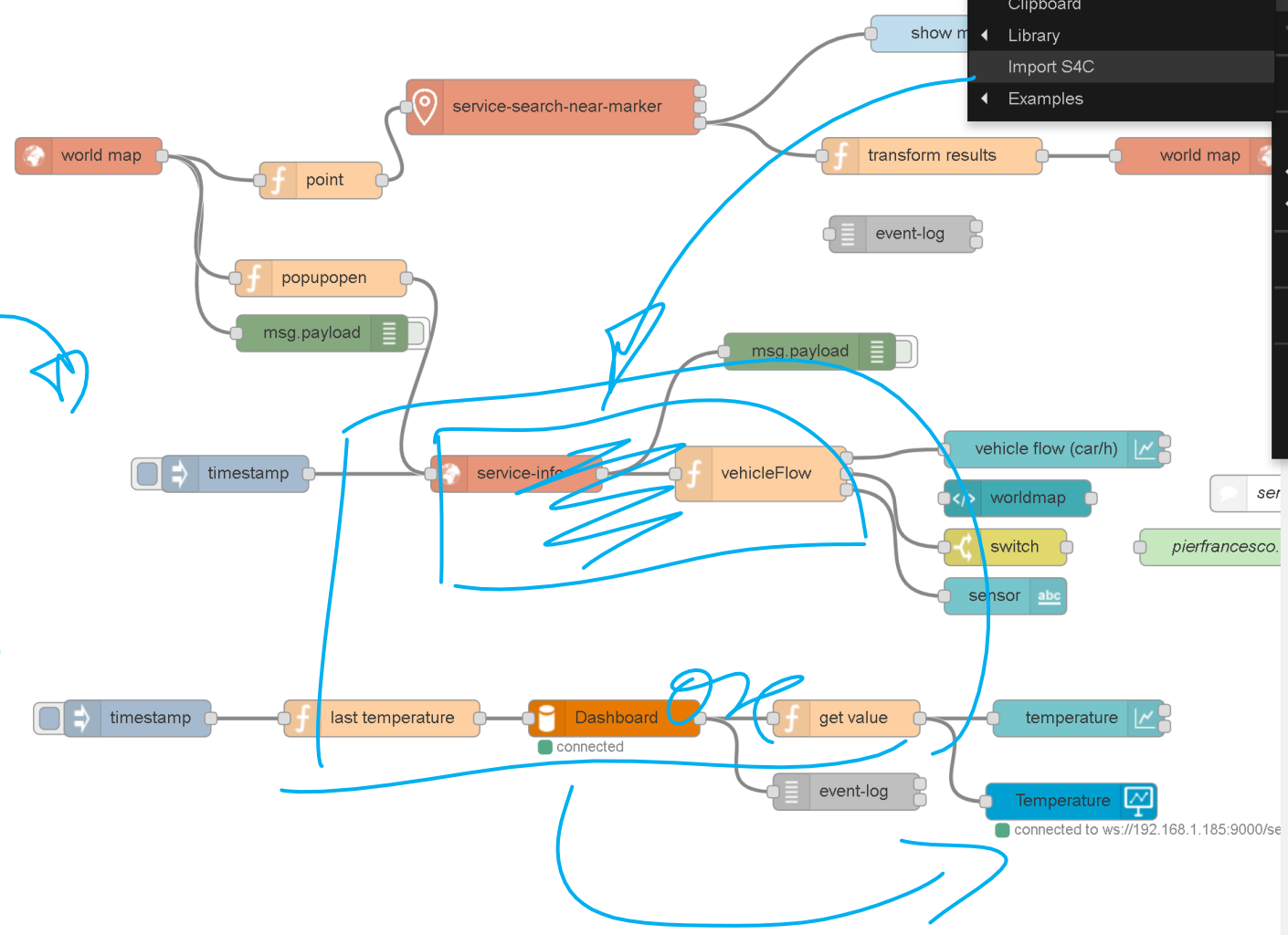
Flow 1

input

- inject
- catch
- status
- link
- mqtt
- http
- websocket
- tcp
- udp
- amqp
- amqp2

output

- debug
- link
- mqtt
- http response
- websocket
- tcp
- udp
- amqp
- amqp2



Deploy

- View
- Import
- Export
- Search flows
- Configuration nodes
- Flows
- Subflows
- Manage palette
- Settings
- Keyboard shortcuts
- Node-RED website
- v0.17.5

click and drag  
on a node port to  
move all of the  
attached wires or just

# IOT Application Editor: NODE-RED

- In the IOT Application of Snap4City, it is possible to:
  - Create multiple concurrent Flows for each IOT Application
  - Execute flow that process data as: Event Driven, Batch (periodic or not)
  - Load other libraries of MicroServices/Nodes/Blocks
    - The loading is allowed only for Administrators for security reasons
  - Save/load, share, Flows, and applications with other users via the Resource Manager or with JS Foundation
  - Ask a limited number of IOT Applications.
    - The Limit may depend on the organization or on personal authorization
  - ..

*News  
47 MS*

*JSON →  
enrol*



## Load an application

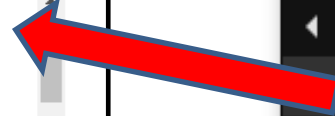
aaa

### Import s4c

Public flow: RecommendationsForYou2  
Public flow: SuggestionsForYou  
Public flow: TC2.7 (b) - IOT protocol Telemetry  
Public flow: TC2.7 (a) - IOT protocol Telemetry  
Public flow: TC2.5 - IOT application; IOT Discovery of sen  
Public flow: TC9.2 (JSON) - Managing heterogeneous  
Public flow: TC9.2 (XML) - Managing heterogeneous  
Public flow: TC9.2 (RDF) - Managing heterogeneous  
Public flow: TC9.2 (HTML) - Managing heterogeneous  
Public flow: TC9.2 (CSV) - Managing heterogeneous

```
[{"id":"99d0ceb6.66a7f","type":"json","z":"18bbf2b5.57d68d","name":"","pretty":false,"x":343.00002288818,"y":110.00000953674,"wires":["a65d77fc.50fee8"]}, {"id":"3d04d6a4.80e6ea","type":"inject","z":"18bbf2b5.57d68d","name":"","topic":"","payload":{"contacts":[{"contact":
```

Import to



*JSON*

- Clipboard
- Library
- Import S4C**
- Examples

- Deploy
- View
- Import**
- Export
- Search flows
- Configuration nodes
- Flows
- Subflows
- Manage palette
- Settings
- Keyboard shortcuts
- Node-RED website

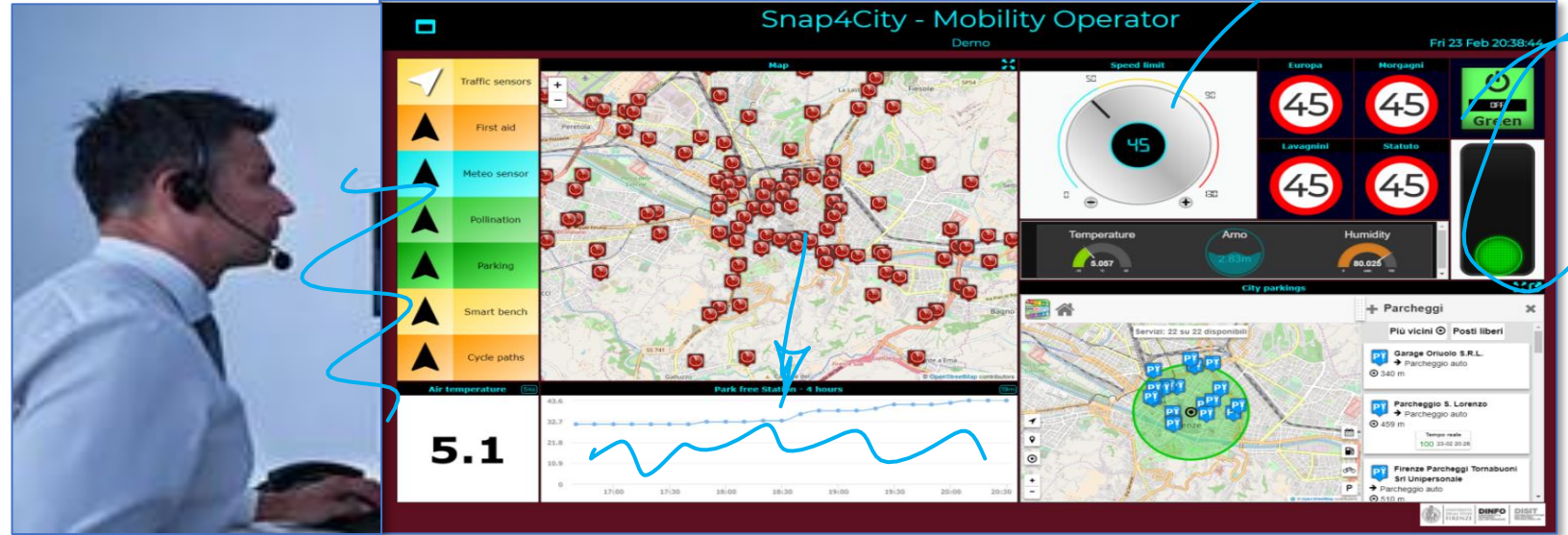
msg.payload

*Ref*

## Control Room Operator

Would like to:

- **Monitor** traffic flow, Environment, Car parking, Cycling, First aid, temp., ..
- **Act and** monitor Dynamic Plates
- **Act and** monitor red lights



## Driver, Policeman

Would like to:

- Monitor traffic, Parking, env., speed limit, ...
- **Act and** monitor red lights



# Dashboards with city data and your data/actuators

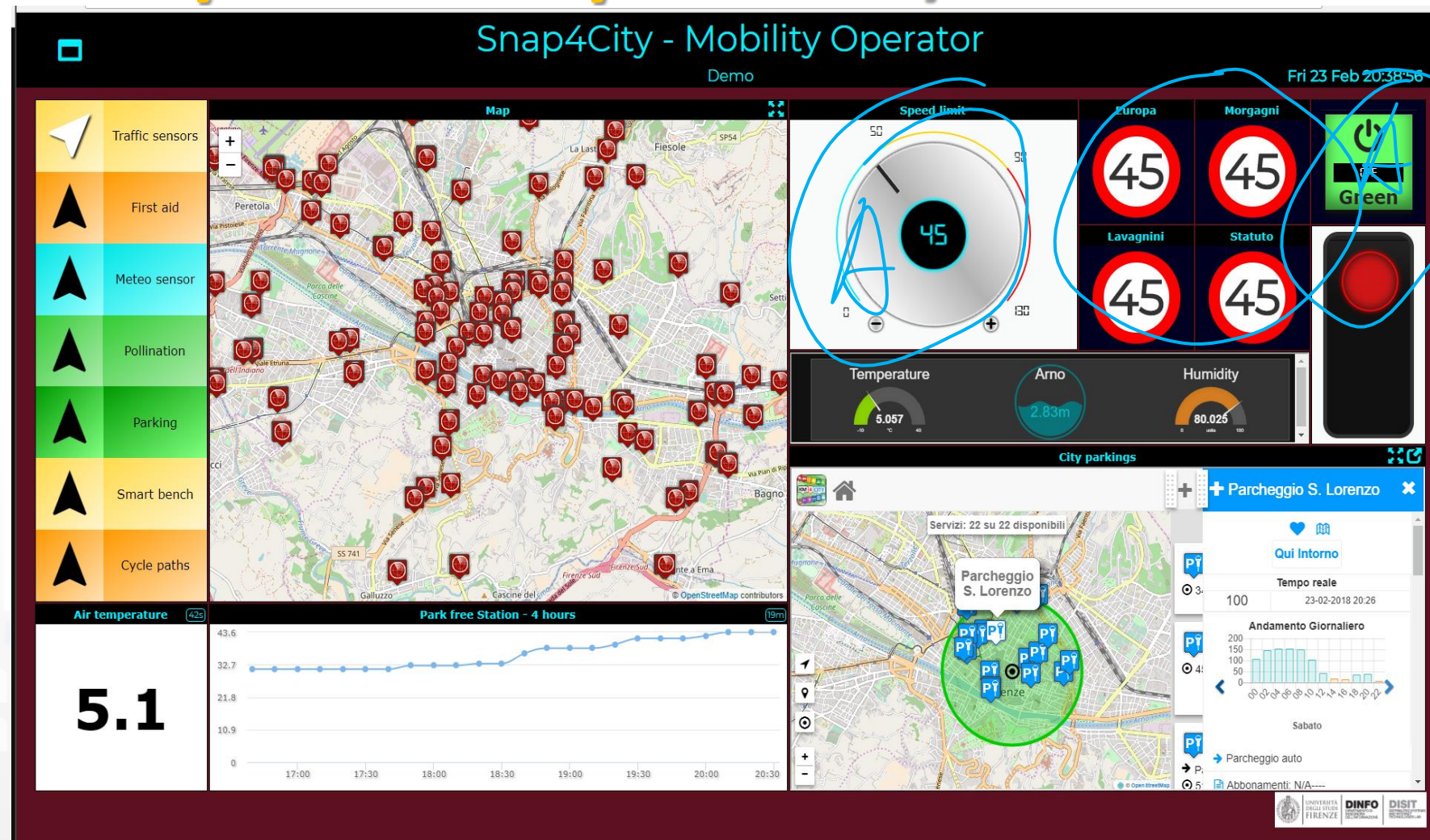
## Sensors:

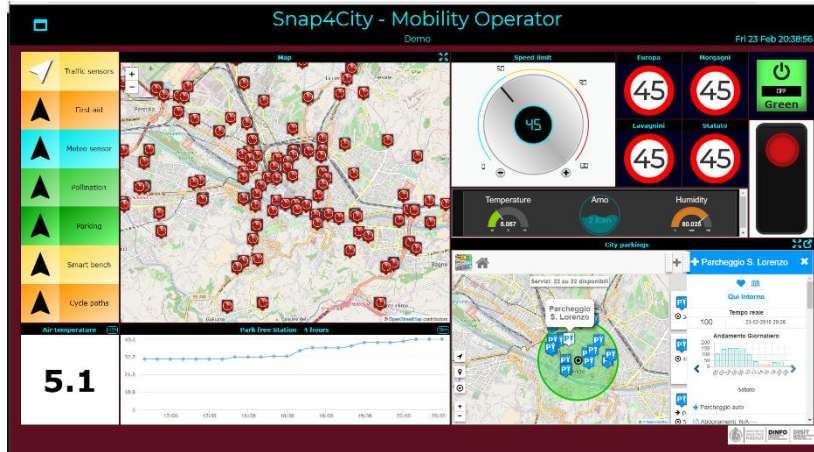
- Values
- Status

## Actuators:

- Buttons
- Dimers
- Etc.

## Virtual Sensors and Actuators



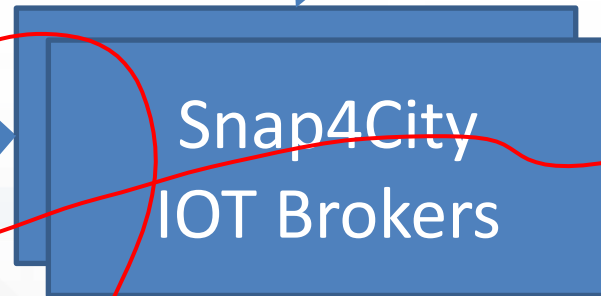


# Dashboard vs IOT Devices



Dashboards also provide rendering for actuator-sensor values

Actuator device on Dashboard are regarded as Virtual Sensors



From any IOT Device and/or Dashboard

Managing Public and Private IOT/IOE Devices

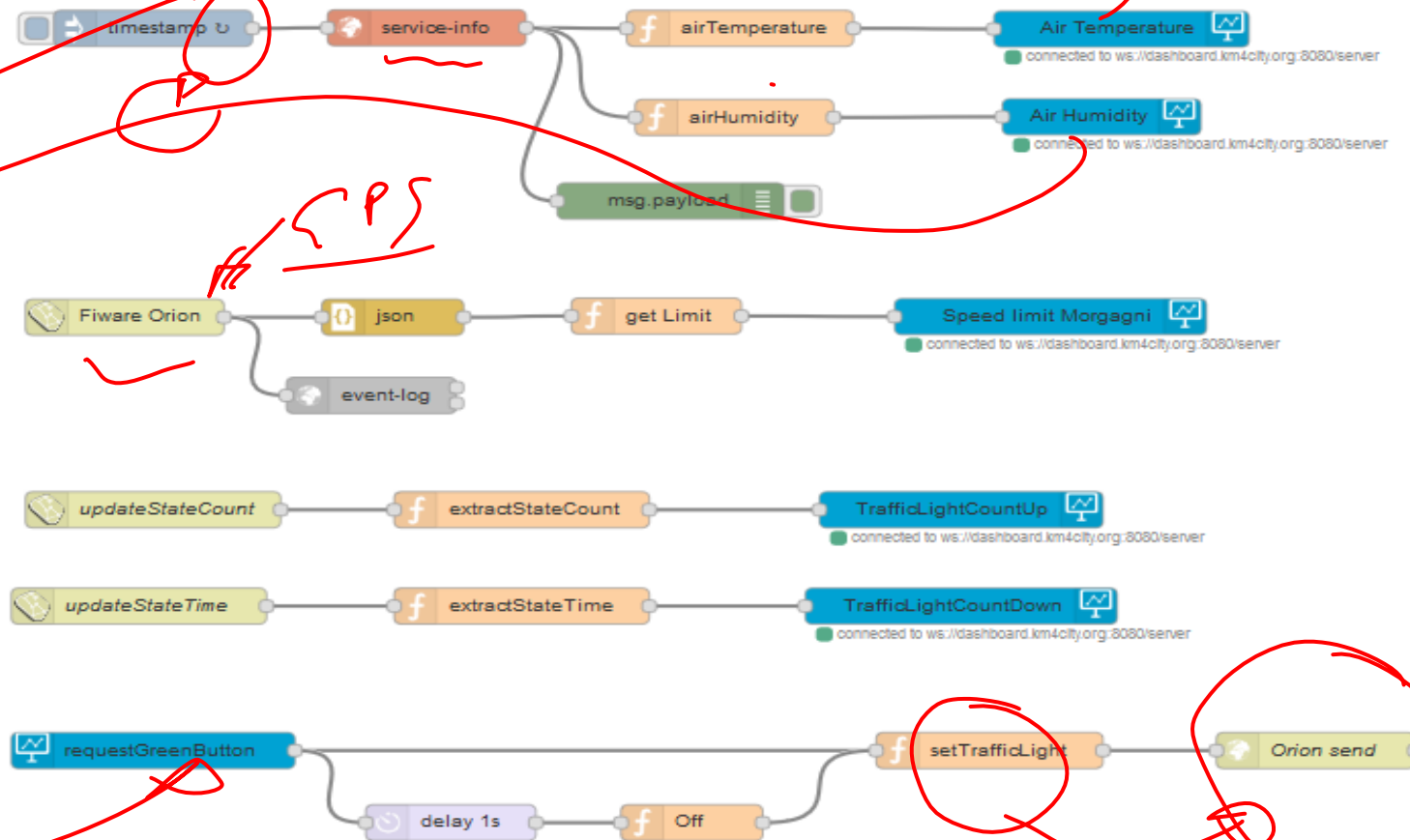
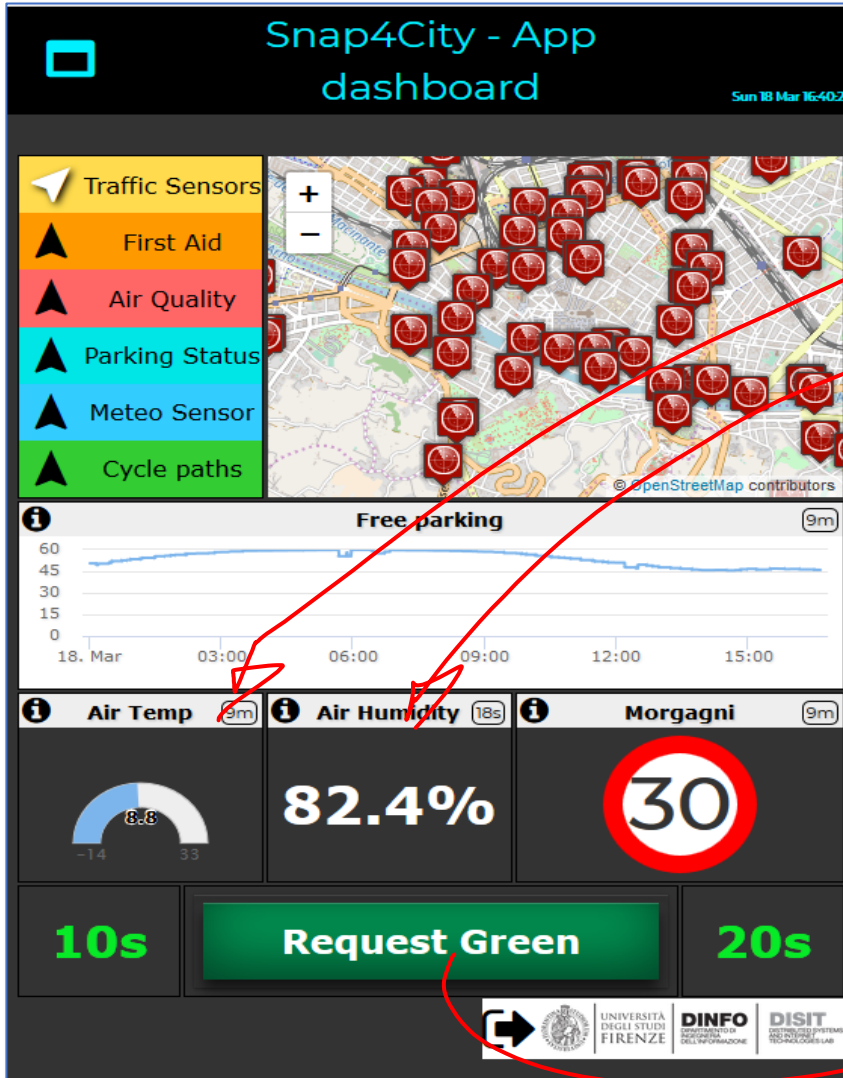
Towards any IOT Device and/or Dashboard

*Force Vels* (handwritten red text with a circled arrow pointing to the IOT Brokers box)

Sensors/  
Actuators



# IOT Application with City Dashboard simple development

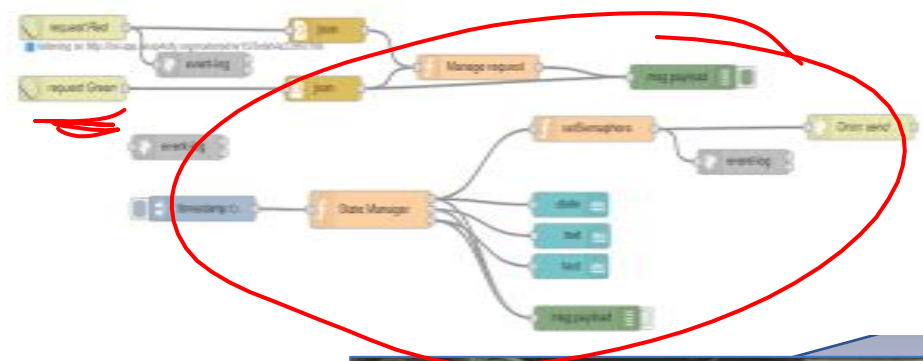


Traffic Sensors  
 First Aid  
 Air Quality  
 Parking Status  
 Meteo Sensor  
 Cycle paths

Free parking

Air Temp: 8.8°C  
 Air Humidity: 82.4%  
 Morgagni: 30

10s Request Green 20s



Snap4City - Mobility Operator

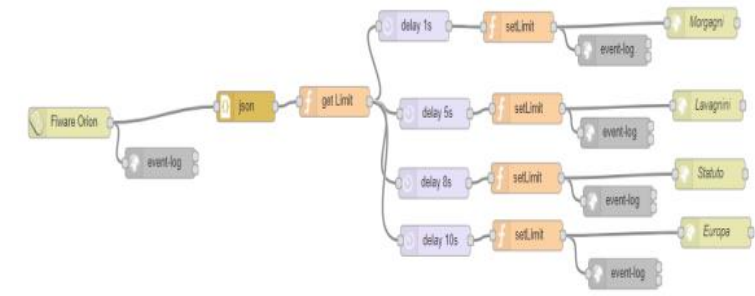
Speed limit: 45

Temperature: 5.057°C  
 Humidity: 80.02%

City parkings: 22 su 22 disponibili

Parcheggi: Più vicini Posti liberi

Air temperature: 5.1

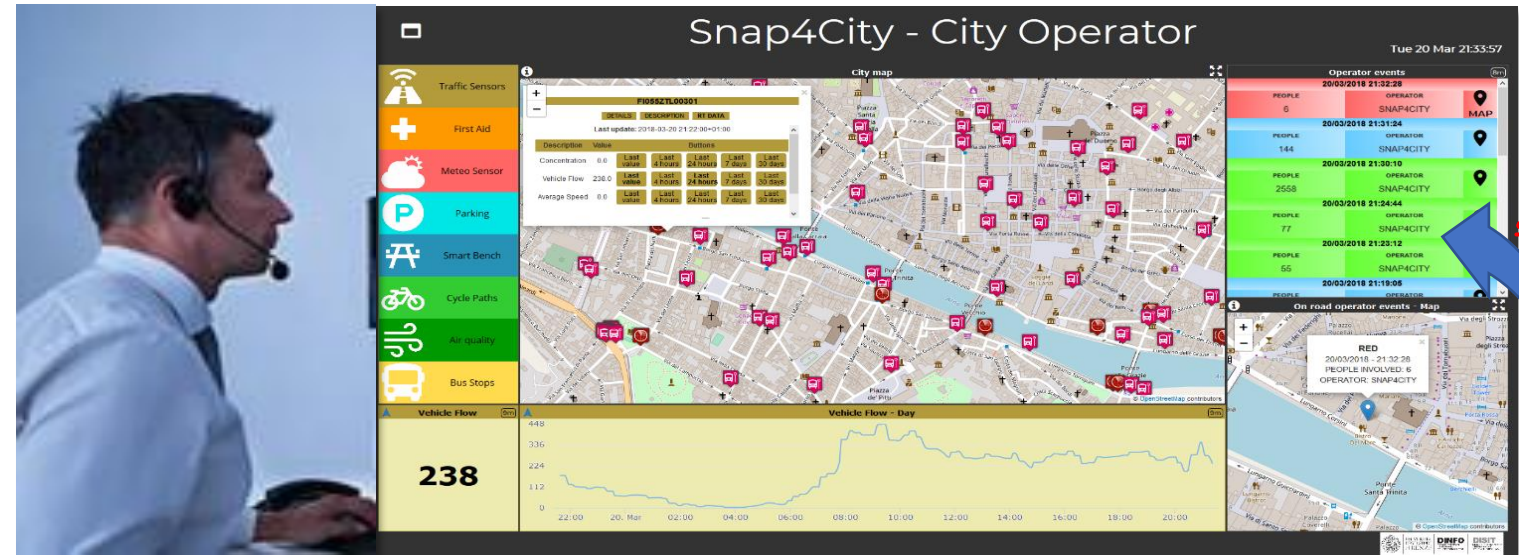


# Reporting Critical Events

## Control Room Operator

Would like to:

- **Monitor** events vs services in the city and receive critical event notifications from on the road operators.
- **Assess contextual condition**, services status



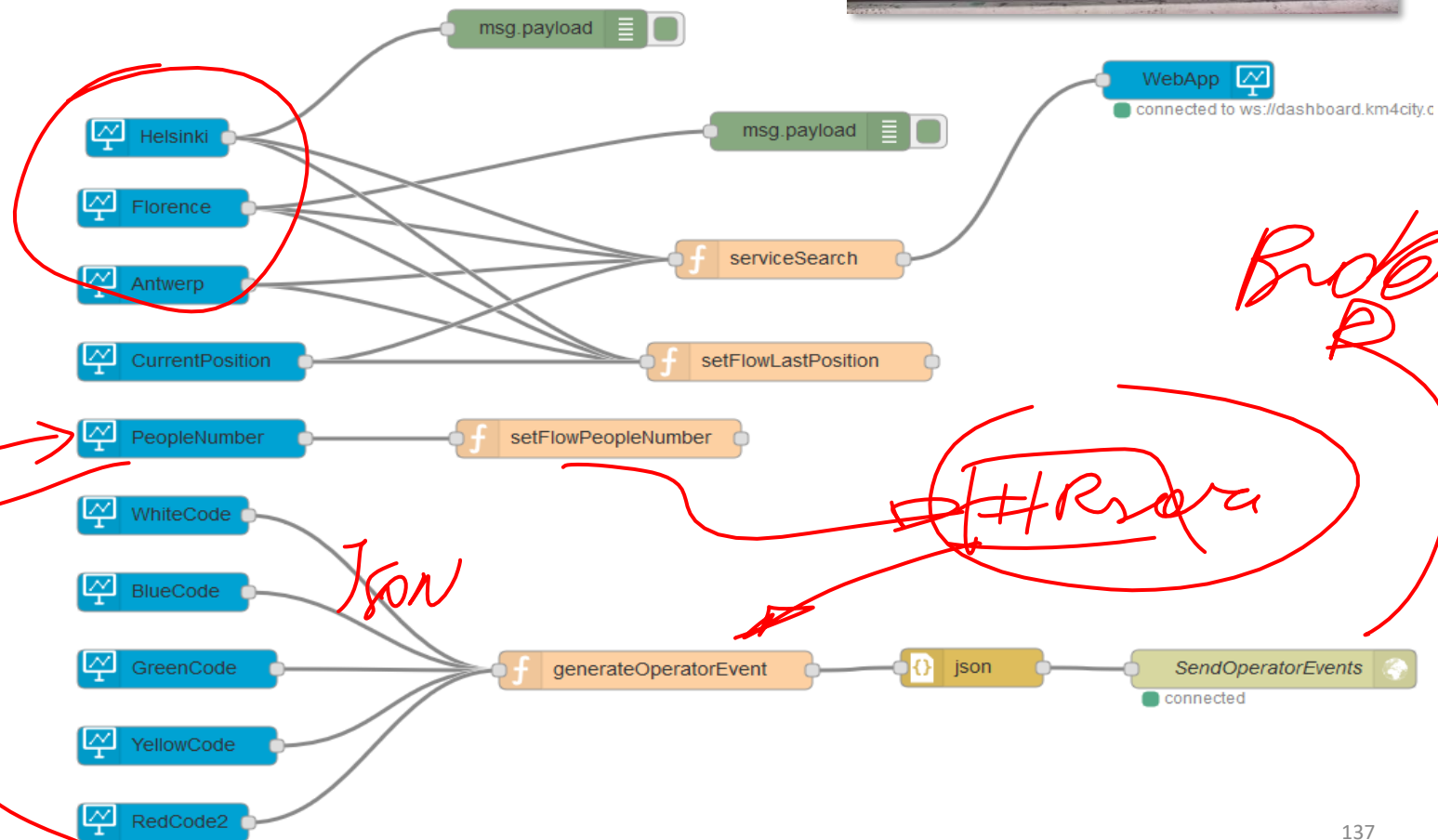
## On the road operator

Would like to:

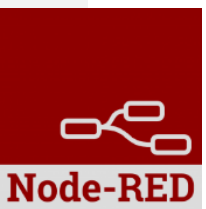
- Monitor traffic, Parking, env., speed limit, services,
- **Send critical event notifications via coded description**



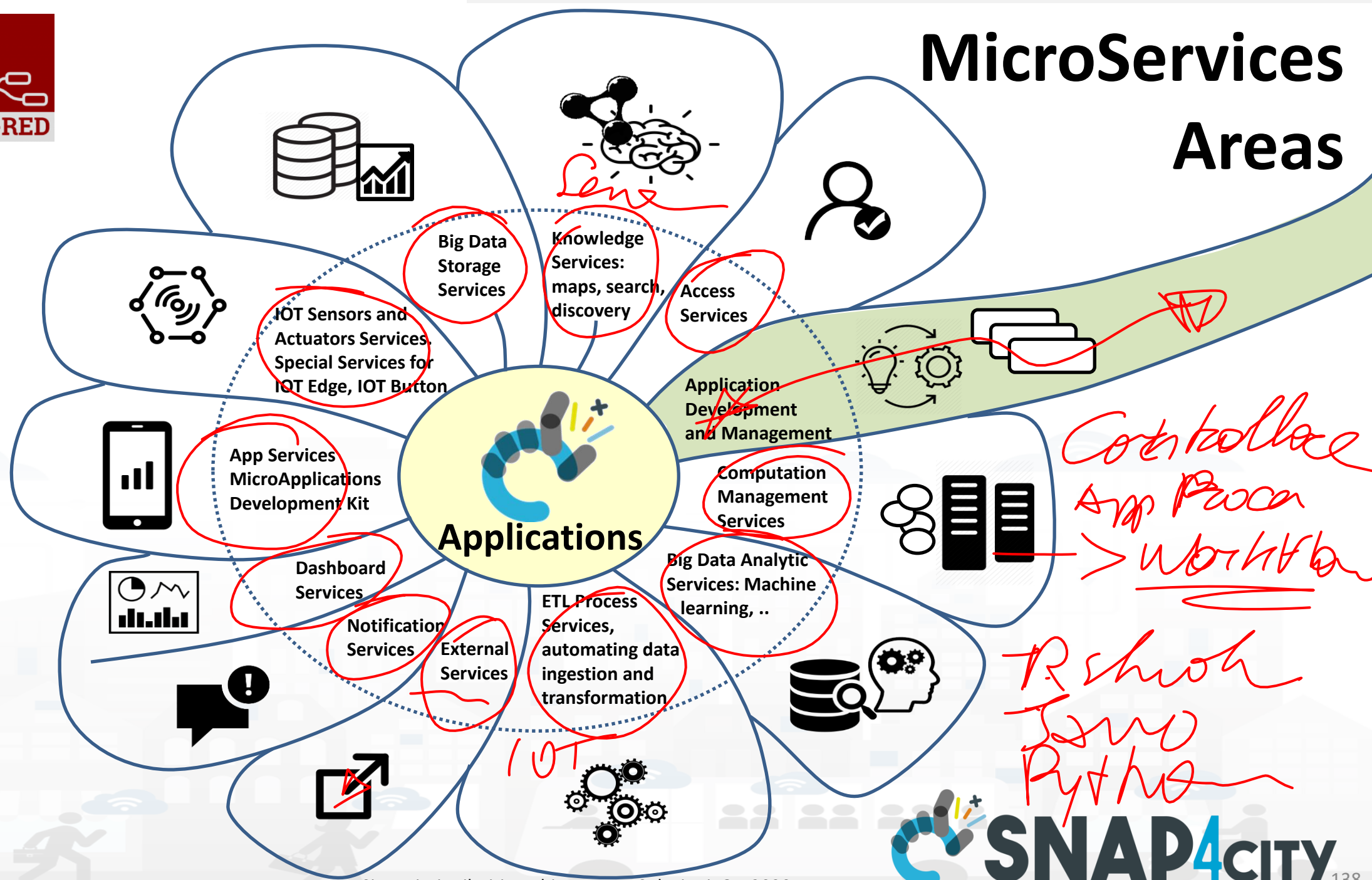
# IOT Application with City Dash simpler development



- > input
- > output
- > function
- > social
- > storage
- > analysis
- > advanced
- > Iwm2m
- > S4C SearchDev
- > S4C Mapping
- > S4C Management
- > S4C Data Analytic
- > S4C Big Data
- > S4C Search
- > S4C Data
- > S4C Dashboard
- > S4C Sigfox
- > S4C IoT
- > S4C LogDev
- > S4C View
- > S4C Social
- > location
- > dashboard



# MicroServices Areas



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



This screenshot shows the Node-RED block palette with several categories and handwritten annotations:

- input**: A red circle highlights the 'input' category header.
- output**: A red circle highlights the 'output' category header.
- function**: A red circle highlights the 'function' block, with 'JS' written in red next to it.
- social**: A red circle highlights the 'e mail' block.
- storage**: A red circle highlights the 'mysql' block.
- location**: A red circle highlights the 'location' category header.
- lwm2m**: A red circle highlights the 'lwm2m' category header.
- tracks**: A red circle highlights the 'tracks' block, with 'MAP' written in red below it.

## + on IOT Edge Raspberry

This screenshot shows the Node-RED block palette for Raspberry Pi, with the following categories and blocks:

- social**: e mail, twitter, irc, e mail, twitter, irc, google plus, google places, google calendar.
- storage**: tail, file, file, mongodb, file, mongodb.
- Raspberry Pi**: rpi gpio, rpi gpio, rpi mouse, rpi keyboard, camerapi takephoto, rpi dht22, imagecapture, ledborg, Sense HAT, Sense HAT.
- network**: ping.

# Node-RED Basic Blocks

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

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

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

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

**+ on IOT Edge Raspberry**

- input**: inject, catch, status, link, mqtt, http, websocket, tcp, udp, amqp, amqp2, stomp
- output**: debug, link, mqtt, http response, websocket, tcp, udp, amqp, amqp2, stomp
- function**: function, template, delay, trigger, comment, http request, tcp request, switch, change, range, split, join, csv, html, json, xml, yaml, soap request, base64, msgpack, random, rbe
- social**: e mail, twitter, e mail, twitter
- storage**: tail, file, ftp, mysql, file
- analysis**: sentiment
- advanced**: watch, feedparse, sunrise, exec
- dashboard**: button, dropdown, switch, slider, numeric, text input, date picker, colour picker, form, text, gauge, chart, audio out, notification, ui control, template

**+ on IOT Edge Raspberry**

- social**: e mail, twitter, irc, e mail, twitter, irc, google plus, google places, google calendar
- Raspberry Pi**: rpi gpio, rpi gpio, rpi mouse, rpi keyboard, camerapi takephoto, rpi dht22, imagecapture, ledborg, Sense HAT, Sense HAT
- storage**: tail, file, mongodb, file, mongodb
- network**: ping

# Hello World of Node-RED

- <http://developer.opto22.com/nodered/general/getting-started/node-red-hello-world/>

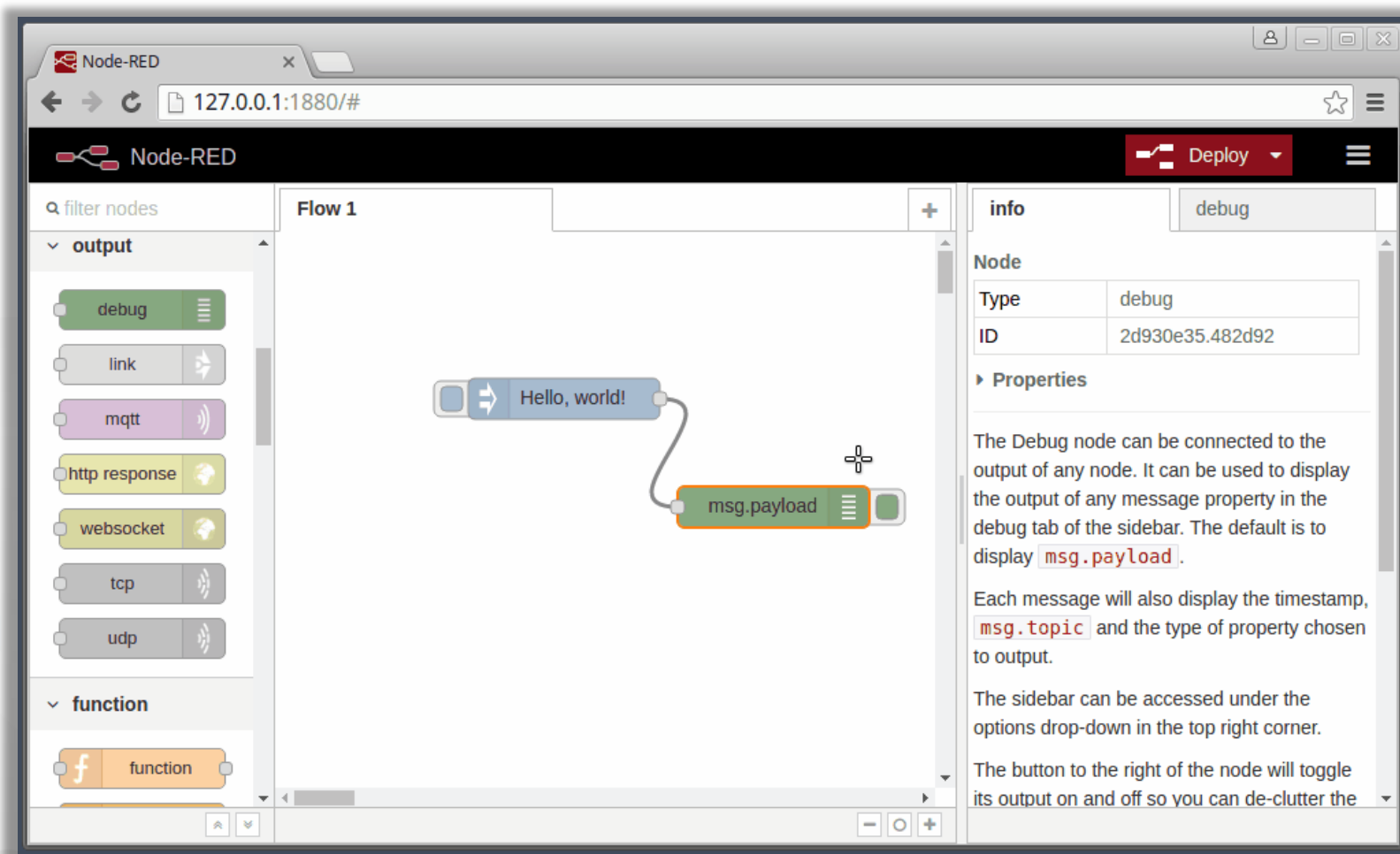
The screenshot shows the Node-RED web interface in a browser window. The address bar shows the URL `127.0.0.1:1880/#`. The interface includes a top navigation bar with a 'Deploy' button. On the left, there is a sidebar with a search bar and two main sections: 'output' and 'function'. The 'output' section contains several nodes, with the 'debug' node highlighted by a red line. The main workspace, titled 'Flow 1', contains a flow with two nodes: a 'Hello, world!' node and a 'msg.payload' node. The 'info' tab is selected in the top right of the sidebar, and the 'debug' node is highlighted in the left panel. The 'info' panel on the right shows the details of the selected node, including its type ('debug') and ID ('2d930e35.482d92'). Below the details, there is a 'Properties' section with a description of the debug node and its usage. A red signature is visible in the bottom right corner of the screenshot.





# Node-RED

- Node-RED is a **flow-based** development tool for visual programming proposed by **JS Foundation**
- The Node-RED approach is a mix of **visual composition** of **nodes/blocks** to compose the so-called **flows** that are concurrently executed by an engine **Node.js**.
- It is quite diffuse being also directly provided into **official releases** of IOT devices as **Raspberry Pi** family
- Based on **Node.js**
- 100% **open source**



function

- function
- template
- delay
- trigger
- comment
- http request
- tcp request
- switch
- change
- range
- split
- join
- csv
- html
- json
- xml
- yaml
- soap request
- base64
- msgpack
- random
- rbe

Divides the input message into multiple messages as indicated in the configuration. If you have an array at the input, you can configure it to send each element of the array individually at the output.

Treads the input message on possible different outputs based on a comparison made on the input message.

Operates in reverse order to the split. Joins the incoming messages in the mode indicated in the configuration.

Split `msg.payload` based on type:

**String / Buffer**

Split using `a-z \n`

Handle as a stream of messages

**Array**

Split using `Fixed length of 1`

**Object**

Send a message for each key/value pair

Copy key to `msg.topic`

Property `msg.payload`

`>=` `50` → 1

`<` `50` → 2

+ add

checking all rules

Mode `manual`

Combine each `msg.payload`

to create `an Array`

Send the message:

- After a number of message parts `count`
- After a timeout following the first message `3`
- After a message with the `msg.complete` property set

Name `Name`

# 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.

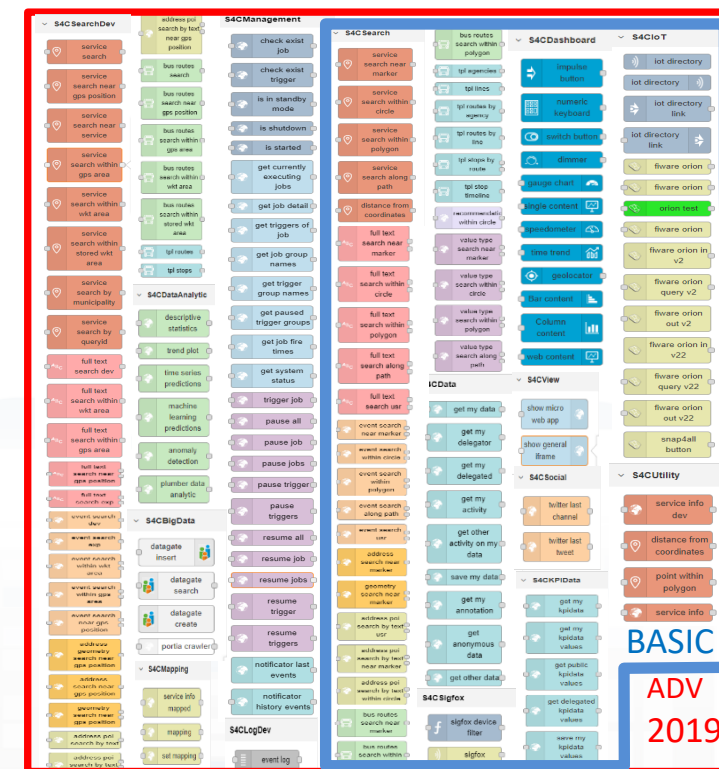
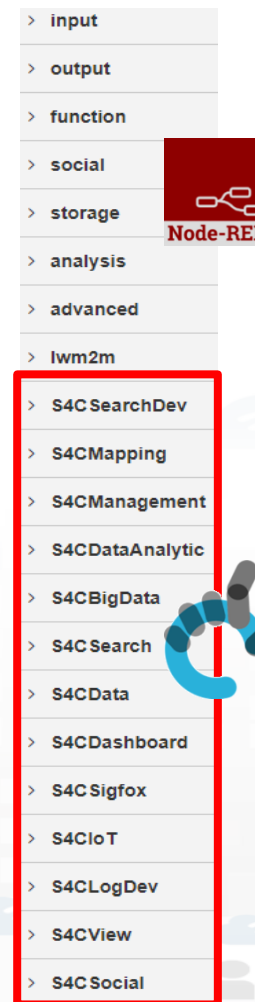


**IOT Directory:** It should be a single point service for searching, managing and discovering all the IOT Devices which can be connected to the infrastructure by means of a large set of heterogenous IOT Brokers.

# IOT Applications

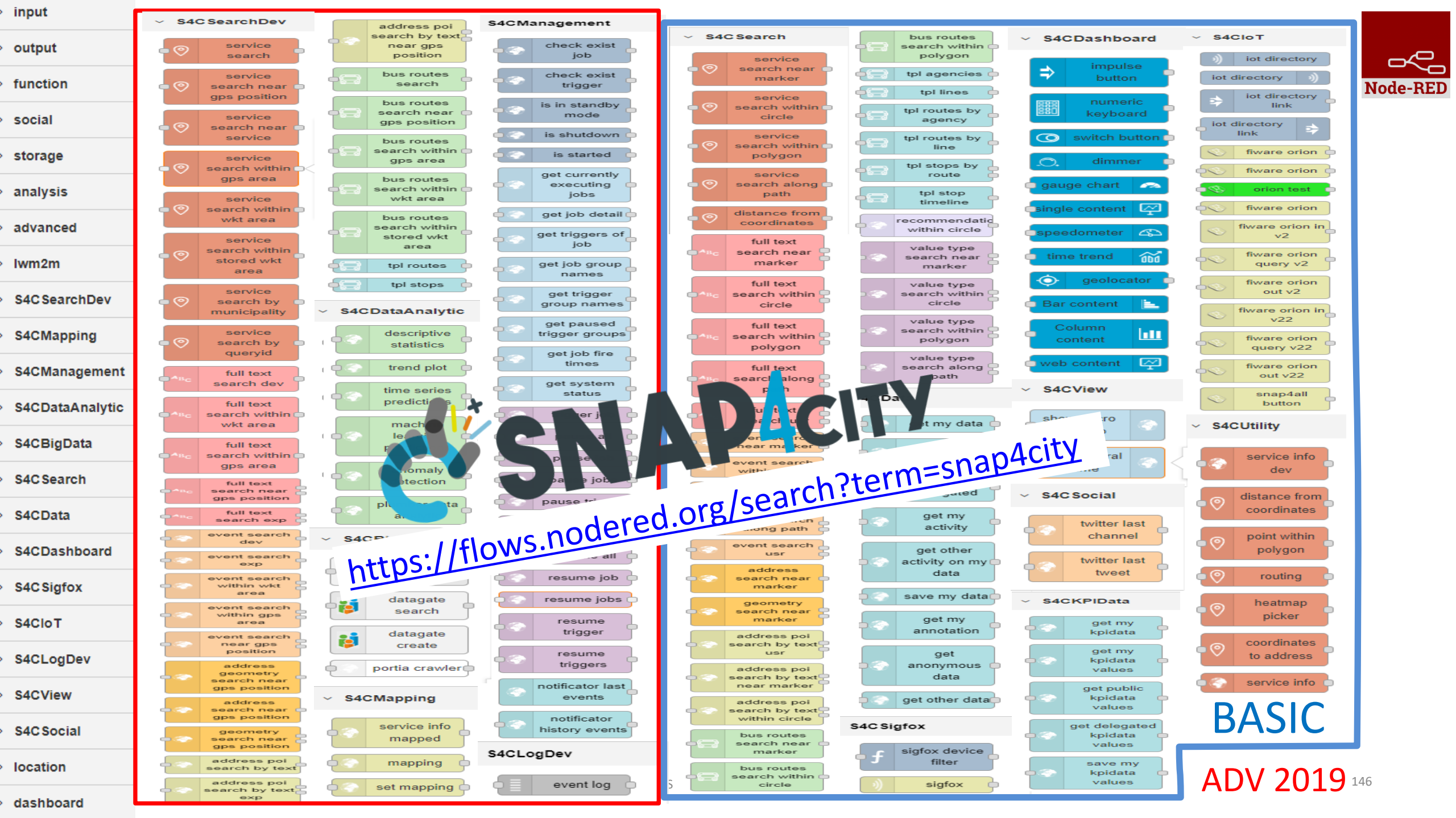
## IOT Applications = Node-RED + Snap4City Platform

- 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>

<p>node-red-contrib-snap4city-developer</p> <p>Node-red nodes for developing IoT applications for smart cities. These nodes are</p> <p>v0.1.5 18 node</p>	<p>node-red-contrib-snap4city-user</p> <p>Nodes for Snap4city project, targeted to standard user (no developer)</p> <p>v0.2.0 27 5.0 (1) node</p>
---	---



The image displays a comprehensive library of Node-RED function blocks, organized into several categories. The categories include: **Input**, **output**, **function**, **social**, **storage**, **analysis**, **advanced**, **lwm2m**, **S4C SearchDev**, **S4C Mapping**, **S4C Management**, **S4C Data Analytic**, **S4C Big Data**, **S4C Search**, **S4C Data**, **S4C Dashboard**, **S4C Sigfox**, **S4C IoT**, **S4C LogDev**, **S4C View**, **S4C Social**, **S4C KPIData**, **S4C Sigfox**, and **S4C Utility**. Each category contains multiple blocks with icons and labels, such as 'service search', 'bus routes search', 'check exist job', 'impulse button', 'numeric keyboard', 'switch button', 'dimmer', 'gauge chart', 'single content', 'speedometer', 'time trend', 'geolocator', 'Bar content', 'Column content', 'web content', 'show my data', 'get my data', 'twitter last channel', 'twitter last tweet', 'get my activity', 'get other activity on my data', 'save my data', 'get my annotation', 'get anonymous data', 'get other data', 'get my kpdata', 'get my kpdata values', 'get public kpdata values', 'get delegated kpdata values', 'save my kpdata values', 'service info dev', 'distance from coordinates', 'point within polygon', 'routing', 'heatmap picker', 'coordinates to address', and 'service info'. A large watermark 'SNAP4CITY' is overlaid on the center, along with a URL: <https://flows.nodered.org/search?term=snap4city>. The interface is styled with a blue border and a red border on the left side.

BASIC  
ADV 2019 146

▼ S4CUtility

- ANY kind of sensors
- To Get DATA of a Service / POI /sensor
  - Historical and real time
  - Real Time

- service info dev
- distance from coordinates
- point within polygon
- service info

- service info dev
- service info dev
- service info

Loggia San Paolo

LINKED OPEN GRAPH

Tipology: CulturalActivity - Monument\_location

Digital Location

Address: VIA DELLA SCALA, 3

Cap: 50123

City: FIRENZE

Prov.: FI

Photos:

Description: The rounded arches, the stone skeleton and the glazed terracotta medallions recall the model of the Loggiato degli Innocenti. The medallions in glazed terracotta by Andrea della Robbia and his sons Marco and Luca contain seven polychrome figures of Santi Francescani and two works of mercy Cristo conforta un Giovane and Cristo conforta un Anziano. Beneath the portico can be admired the expressive embrace between San Domenico Guzman and San Francesco d Assisi by Andrea della Robbia

TPL STOP : Piazza Stazione (Fr. Cc)

Vaubus

LINKED OPEN GRAPH

Lines:

FI-LU FI-VG

No available routes

Display 50 Bus per page

Search:

Time	Line	Direction
06:46:00 2017-03-20	FI-LU	Piazzale Verdi
08:16:00 2017-03-20	FI-LU	Piazzale Verdi
10:09:00 2017-03-20	FI-LU	Piazzale Verdi
11:09:00 2017-03-20	FI-LU	Piazzale Verdi
12:16:00 2017-03-20	FI-LU	Piazzale Verdi
13:16:00 2017-03-20	FI-LU	Piazzale Verdi

Showing page 1 of 1

Real-time data currently not available

AURORA

LINKED OPEN GRAPH

Tipology: Accommodation - Hotel

Email: info@hotelaurora.info

Website: www.hotelaurora.info

Phone: 055210283

Address: VIA L. ALAMANNI, 5

Cap: 50100

City: FIRENZE

Prov.: FI

Giardino di piazza dell'Indipendenza

LINKED OPEN GRAPH

Tipology: Entertainment - Green\_areas

Digital Location

Address: PIAZZA DELLA INDIPENDENZA, 15

Cap: 50129

City: FIRENZE

Prov.: FI

Note: areeverdi238

Remove from map

ZCS\_1\_D

LINKED OPEN GRAPH

Tipology: TransferServiceAndRenting - Controlled\_parking\_zone

Digital Location

Address: VIA GUSCIANA

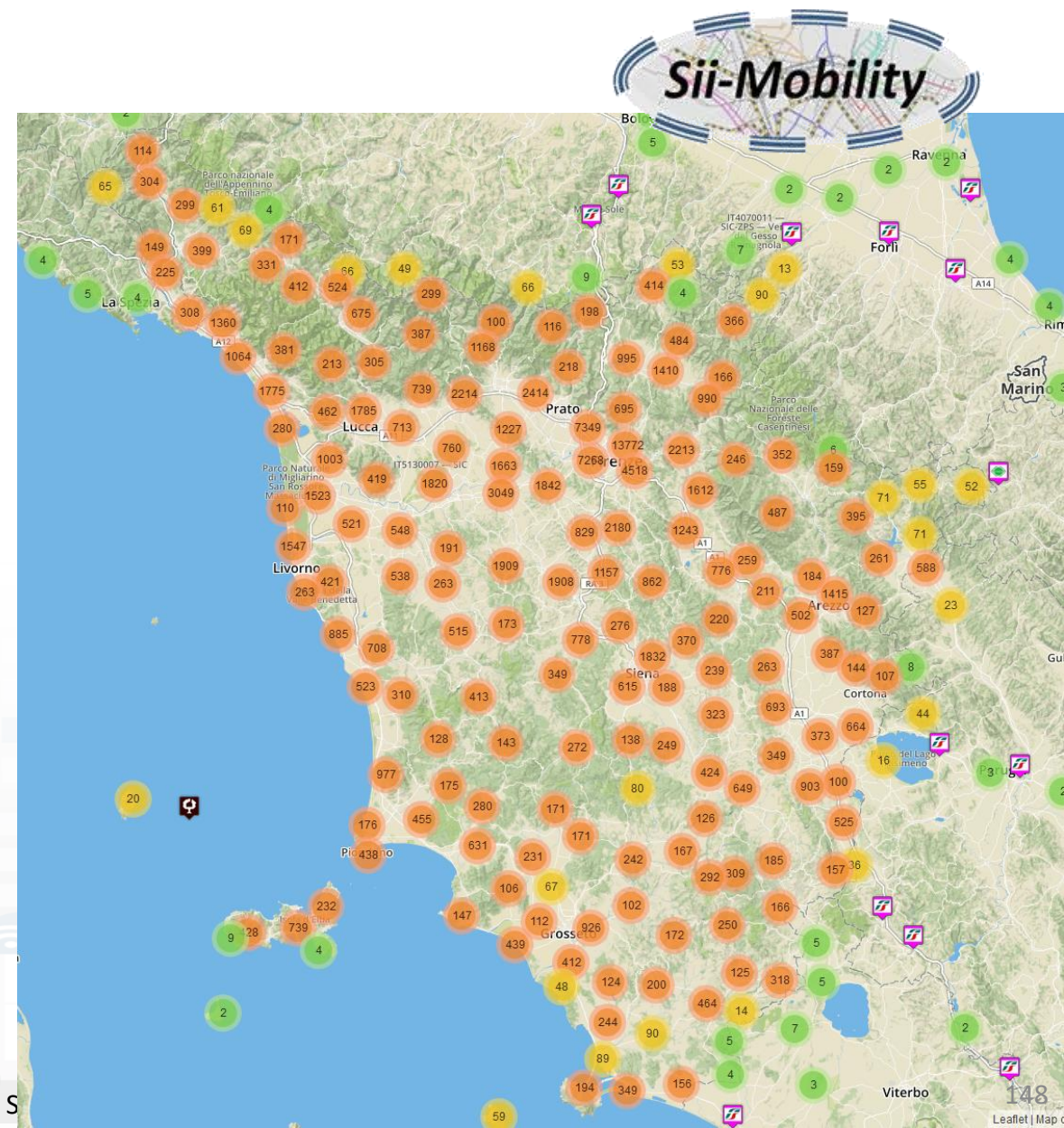
Cap: 50124

City: FIRENZE

Prov.: FI

Remove from map

- **Street and geoinformation of the territory and details for routing, navigation, ...**
- **GeoResolution, Environmental data**
- **Mobility and Transport:** public and private, public transport, parking status, fuel stations prices, traffic sensors, etc.
- **Culture and Tourism:** POI, churches, museum, schools, university, theatres, events in Florence
- **Environmental:** pollution real time, weather forecast, etc.
  - Environmental data geo resolution
- **Social Media:** twitter data
- **Health:** hospital, pharmacies, status of the first aid triage in major hospitals, ...
- **Alarms:** civil protection alerts, hot areas, ...



# Concepts of Services: Macro and subcategory

A SKOS area into the Km4City Ontology and Knowledge base for modeling POI and any element on map

Regular Services | Transversal Services

Services Categories

- De/Select All
- Accommodation** +
- Advertising** +
- AgricultureAndLivestock** +
- CivilAndEditEngineering** -

Architectural\_consulting

Building\_construction

Cartographers

Civil\_engineering

Engineering\_consulting

Other\_specialized\_construction

Specialized\_construction

Surveyor

Technical\_consultants

- CulturalActivity** +
- EducationAndResearch** +
- Emergency** +
- Entertainment** +
- Environment** +
- FinancialService** +
- GovernmentOffice** +
- HealthCare** +
- IndustryAndManufacturing** +
- MiningAndQuarrying** +
- ShoppingAndService** +
- TourismService** +
- TransferServiceAndRenting** +
- UtilitiesAndSupply** +
- Wholesale** +
- WineAndFood** +

20 Service Macro Classes

Service Class

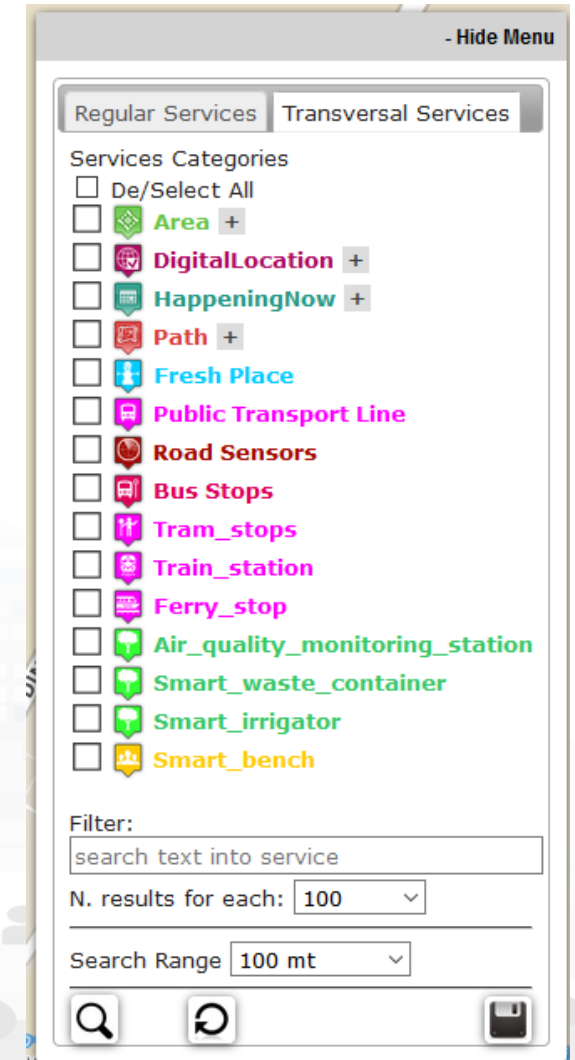
**Accommodation** -

- Agritourism
- Beach\_resort
- Bed\_and\_breakfast
- Boarding\_house
- Camping
- Day\_care\_centre
- Farm\_house
- Historic\_residence

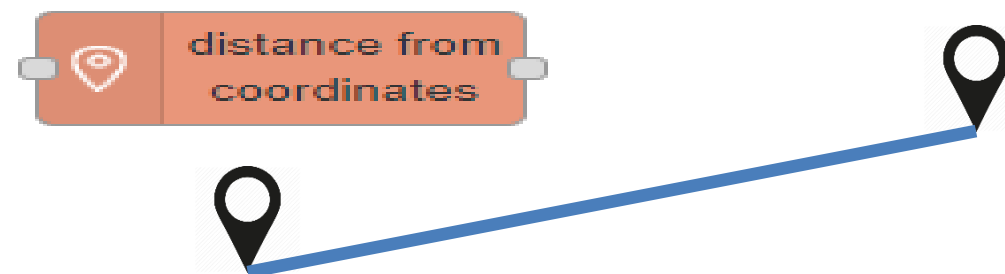


# Access to Point of Interest information, POI

- **POI:** point of interest
- **type:** macro and subcategories
- **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



- Distance from GPS point



- Point  is in Polygon ?



**S4CUtility**

- service info dev
- distance from coordinates
- point within polygon
- service info

## Smart City Entities Search

Simple and Fast

▼ S4C Search

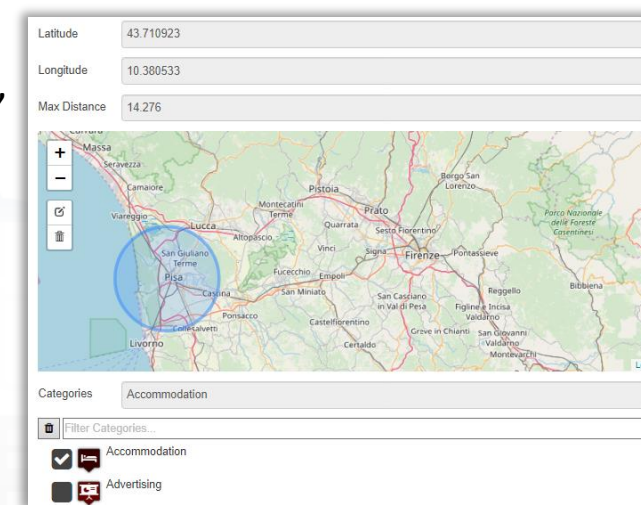
- service search near marker
- service search within circle
- service search within polygon
- service search along path
- service info
- full text search near marker
- full text search within circle
- full text search within polygon
- full text search along path
- full text search usr
- event search near marker
- event search within circle
- event search within polygon
- event search along path
- event search usr
- address search near marker
- geometry search near marker
- address poi search by text usr
- address poi search by text near marker
- address poi search by text within circle
- bus routes search near marker
- bus routes search within circle
- bus routes search within polygon
- tpl agencies
- tpl lines
- tpl routes by agency
- tpl routes by line
- tpl stops by route
- tpl stop timeline
- recommendation within circle
- value type search near marker
- value type search within circle
- value type search within polygon
- value type search along path

- **For example to search for:**

- POIs:
  - near a GPS position, from text, along a path, in an area, etc..
- Public Transport information / data
- Suggestions
- Public Transport Means Routes/Paths
- Events in the area
- Value Type (kind of data)
- Etc.

- **To Get DATA of a Service / POI /sensor**

- Real Time
- ANY kind of senso



~ S4C SearchDev

service search	event search near marker	bus routes search within polygon
service search near gps position	event search within circle	tpl agencies
service search near service	event search within polygon	tpl lines
service search within gps area	event search along path	tpl routes by agency
service search within wkt area	event search usr	tpl routes by line
service search within stored wkt area	address search near marker	tpl stops by route
service search by municipality	geometry search near marker	tpl stop timeline
service search by queryid	address poi search by text usr	recommendatic within circle
full text search near marker	address poi search by text near marker	value type search near marker
full text search within circle	address poi search by text within circle	value type search within circle
full text search within polygon	bus routes search near marker	value type search within polygon
full text search along path	bus routes search within circle	value type search along path
full text search usr		

## • For example to search for:

– POIs:

- near a GPS position, from text, along a path, in an area, etc..

– Public Transport information / data

– Suggestions

– Public Transport Means Routes/Paths

– Events in the area

– Value Type (kind of data)

– Etc.

## • To Get DATA of a Service / POI /sensor

– Real Time

– ANY kind of sensors

## • Distance from GPS point

## Smart City Entities Advanced Search

### Flexibility

- Similar to basic Search functions but with more flexibility of the function for programming the search
- Adding Dynamic behavior:
  - Getting in input JSON with parameters
- **To Get DATA of a Service / POI /sensor**
  - Historical and real time
  - ANY kind of sensors

Latitude	<input type="text" value="0"/>
Longitude	<input type="text" value="0"/>
Categories	<input type="text" value="Categories"/>
Max Distance (in km)	<input type="text" value="1"/>
Max Results (0 for all Results)	<input type="text" value="100"/>
Geometry	<input type="checkbox"/>
Language	<input type="text" value=""/>

▼ S4CSearchDev

service search	full text search dev	address geometry search near gps position
service search near gps position	full text search within wkt area	address search near gps position
service search near service	full text search within gps area	geometry search near gps position
service search within gps area	full text search near gps position	address poi search by text
service search within wkt area	full text search exp	address poi search by text near gps position
service search within stored wkt area	event search dev	bus routes search
service search by municipality	event search exp	bus routes search near gps position
service search by queryid	event search within wkt area	bus routes search within gps area
service info dev	event search within gps area	bus routes search within wkt area
	event search near gps position	bus routes search within stored wkt area
	tpl routes	
	tpl stops	

service info dev

- **Search** for IOT Devices in a given area, or for kind (temperature, model, location, producer, Broker, ...)
- **Subscribe** to one or more IOT Devices independently on their protocol, broker, owner, etc.
- **Send** data to IOT devices
- Establish with IOT Devices **Secure** certified Connections
- Please note that many other protocols can be also added, adding mode nodes, or registering IOT brokers to the Snap4City IOT Directory

▼ S4CIoT

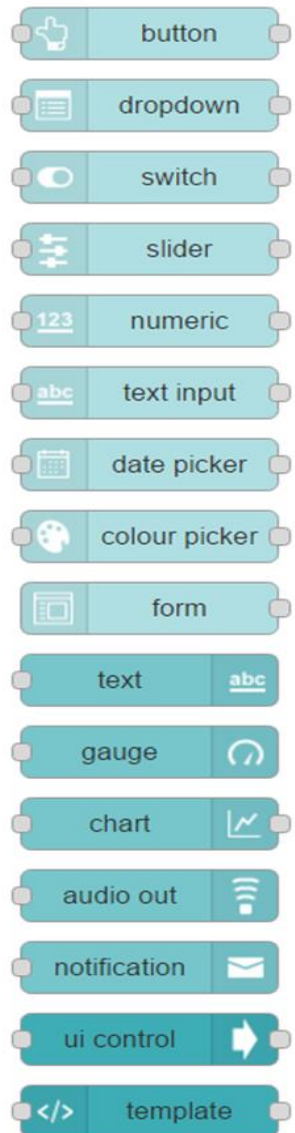
- iot directory
- iot directory
- iot directory link
- iot directory link
- fiware orion
- fiware orion
- orion test
- fiware orion
- fiware orion in v2
- fiware orion query v2
- fiware orion out v2
- fiware orion in v22
- fiware orion query v22
- fiware orion out v22
- snap4all button

Service: Add new orion-service...  
Certificates: Add new tls-config...  
Device type:   
Device NameID:   
key 1:   
key 2:   
apikey:

S4C Sigfox

- sigfox device filter
- sigfox

▼ dashboard



## Native Local

- **Input/output**
- **non secure**
- **Limited in graphics**
- **No authentication**
- **No HLT**
- **No integration**
- **Etc..**

- **Local on IOT Edge**

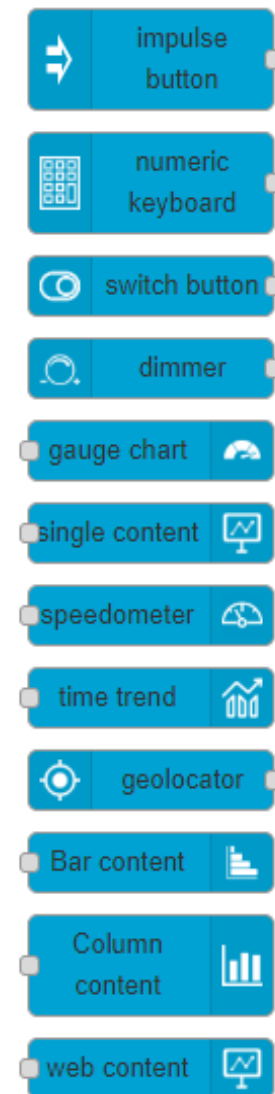
or

## Snap4City

- **Input/output**
- **Secure**
- **Advanced in graphics**
- **Single Sign On**
- **Several HLT**
- **Fully integrated**
- **Etc..**

- **Remote for IOT Edge via WebSocket Secure**

▼ S4CDashboard

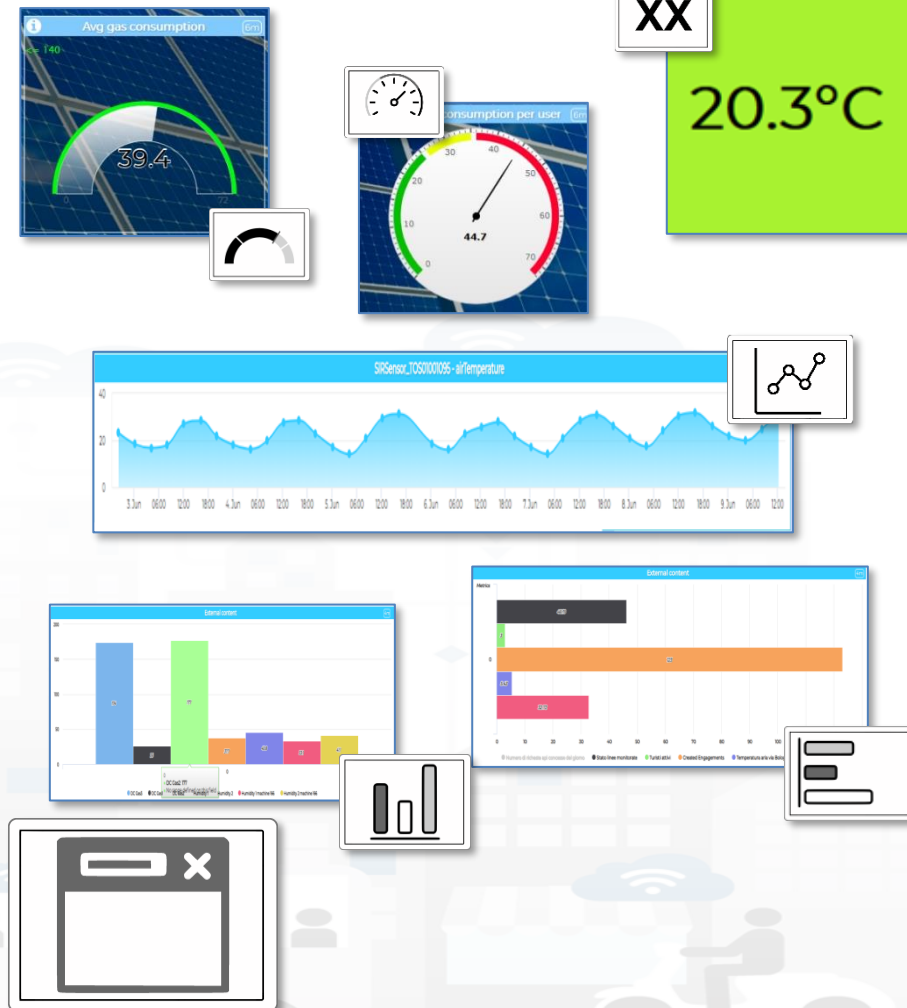
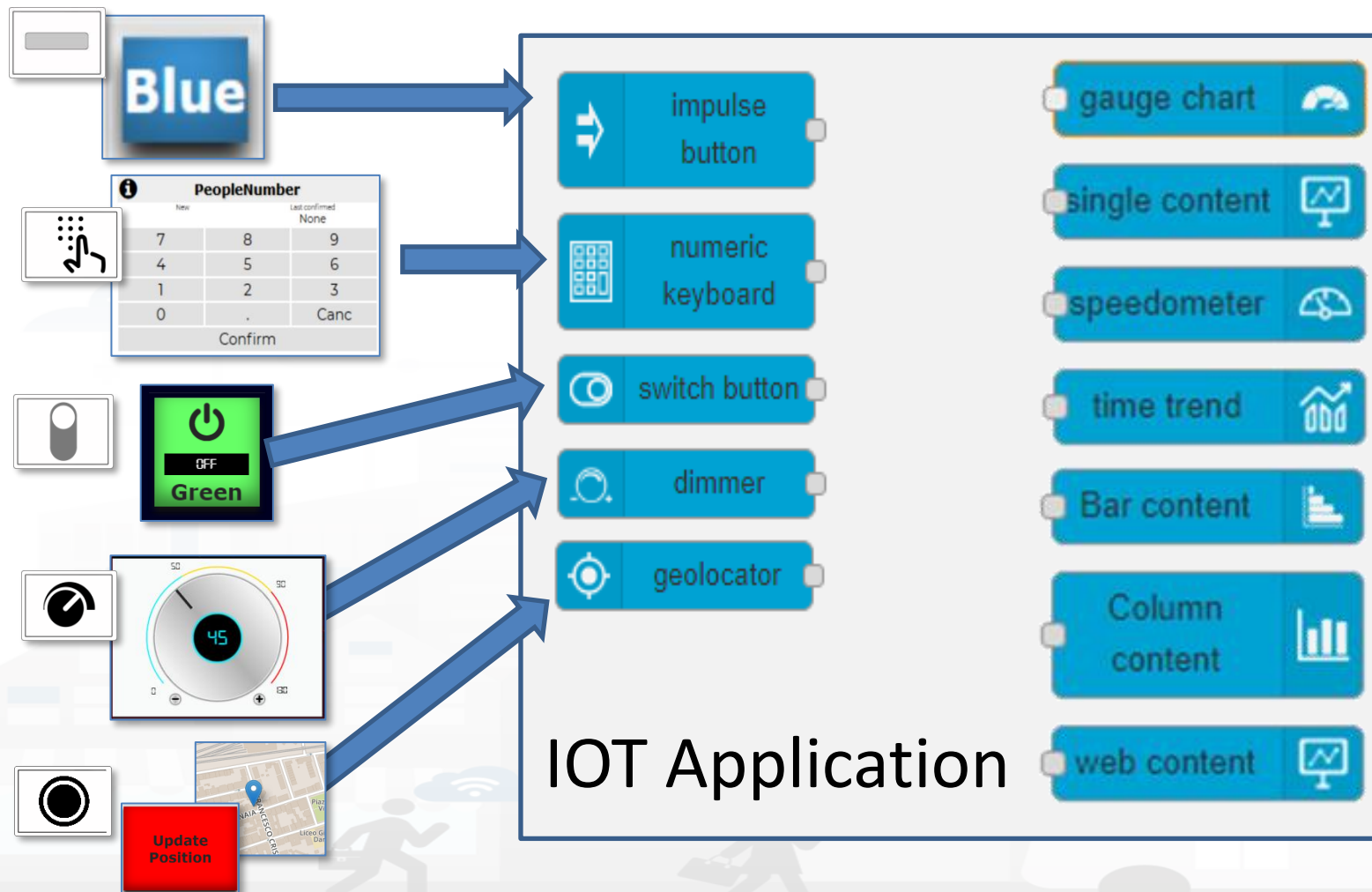


# Dashboard-IOT App

# Nature

From Dashboard to IOT App

From IOT App to Dashboard





# From Dashboard to IOT Devices

- **Widgets:**

- Impulse Button
- Button
- Switch
- Dimer/Knowb
- KeyPad
- geolocator

- **Registered** on some IOT brokers with NGSI mutual authentication

Acting on your systems

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

# Single Content Widget (flexibility)

From Dashboard Editor and IOT Applications, accepts in input:

- Numbers
- String
- HTML code

XX

single content

Helsinki:orio... (9m)

7.4  
µg/m<sup>3</sup>

20.3°C

11440 Utenti WiFi

246 TOT. EVENTI SULLA RETE

COLONNINE RICARICA (8m)

176 INSTALLATE

Messages (9m)

Position Updated,  
press Show My  
Position

AirQualityPM2\_5Average2HourHelsinkiJ (9m)

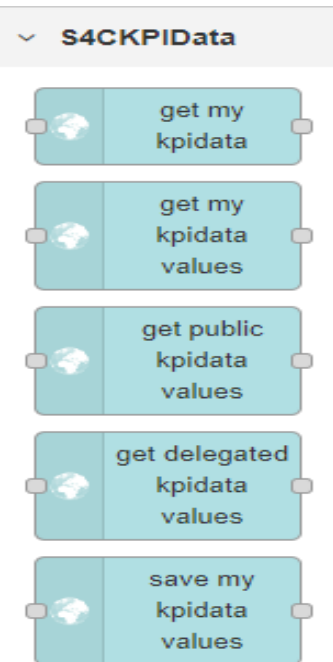
Interpolation and Heatmap Completed 2019-07-01T09:00:00

SO2Average24HourFlorence (8m)

No Available Data for airQualitySO2 : All ServiceUris are empty 2019-06-26T07:00:00

SMN (8m)	BINARIO16 (8m)
39.5 % occupati su 901 posti	73.9 % occupati su 165 posti
LEOPOLDA (8m)	CALZA (8m)
27.7 % occupati su 300 posti	44.6 % occupati su 218

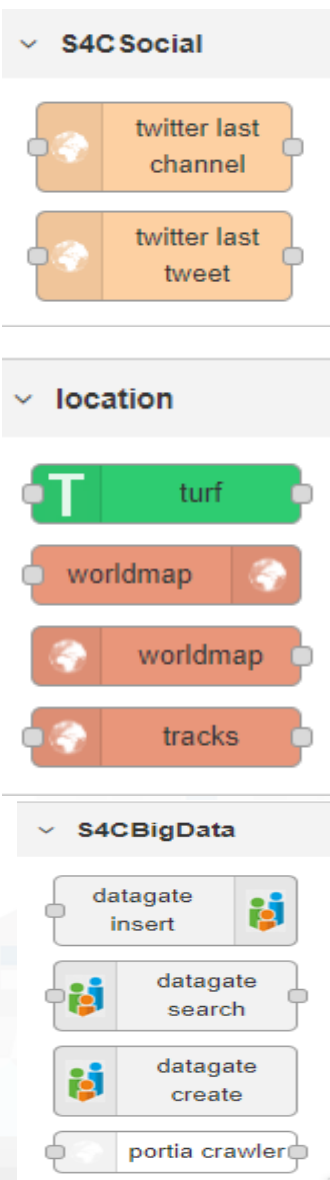
- Save and retrieve MyKPI into the safe personal data storage
- Access to MyKPI and to those that other user have delegated to Me
- **MyKPI are:**
  - Time series of data with GPS coordinates that can change over time
  - Suitable for: moving sensors, trajectories, data from OBU, data from mobile, sensor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



- Request metrics from Twitter Vigilance Channel service and engine of DISIT Lab

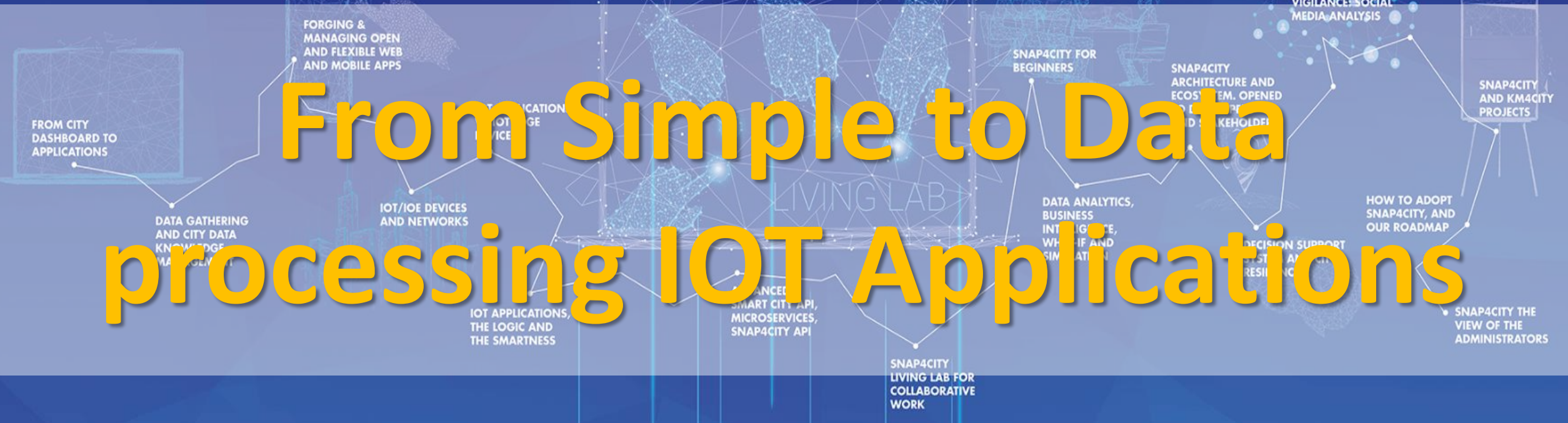
- Location services
- Maps and get position (raw solution)

- Getting data from DataGate/CKAN
- Publishing data to DataGate/CKAN
- Managing time series on DataGate/CKAN



TOP

# From Simple to Data processing IOT Applications

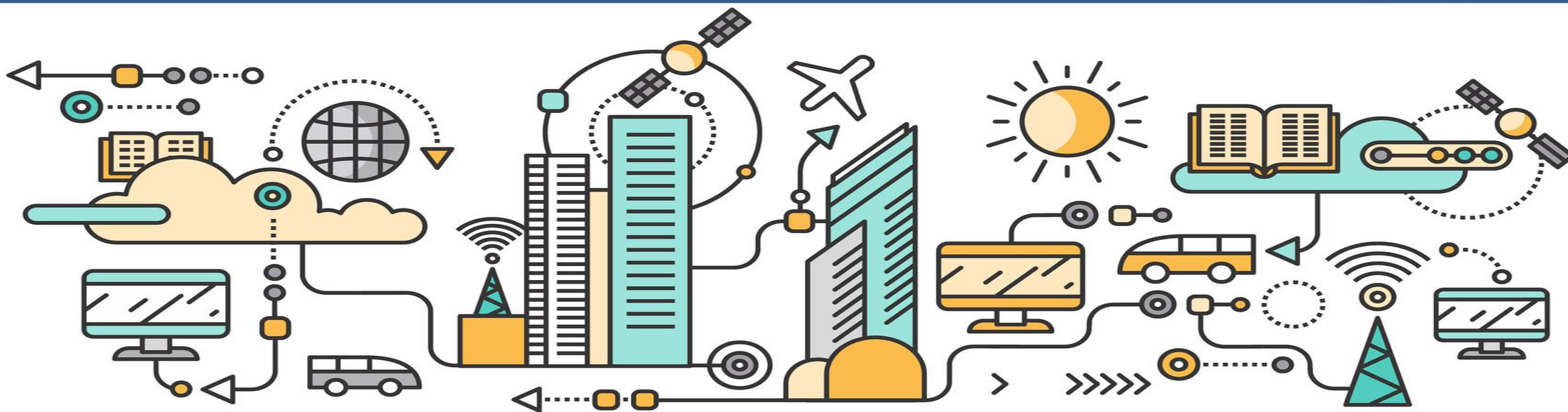


# What we are going to do now!

- Create a Simple IOT Application (Demo)
- Production of IOT Application (Exercitation)
- Data Processing with IOT Application (Demo)
- Processing Data with IOT Applications (Exercitation)



# Create a Simple IOT Application (DEMO)



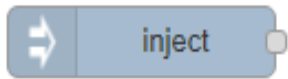
## Demo of Simple IOT Application

In this demo let's create an IOT Application that:

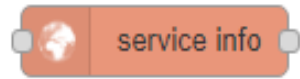
- reads a realtime value of a service and
- publishes it on a dashboard
- sends email to someone



# Nodes for flow



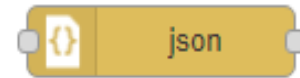
Generates an input for the other nodes. It can be repeated at predefined intervals, entered manually and of various types (string, number, Boolean, json etc.)



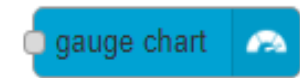
Requests detailed information for a specific service on the platform (such as a car park, hotel, etc.)



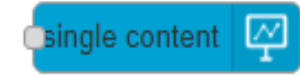
Executes a Javascript code once the input message is received



Transforms the incoming message into a JSON



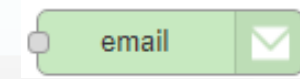
Display values in different modalities on a Dashboard (or on different Dash)



The node called single content accepts strings, numbers and html.



The others only accept numbers.



Send an email to the desired recipient. You must enter the username and password of an active email.



# Step 1

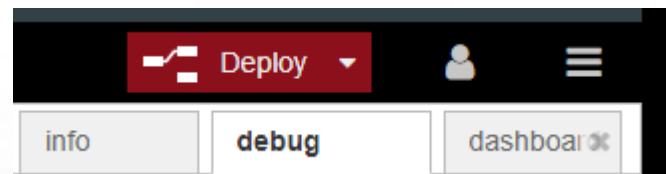


- Inject and Debug



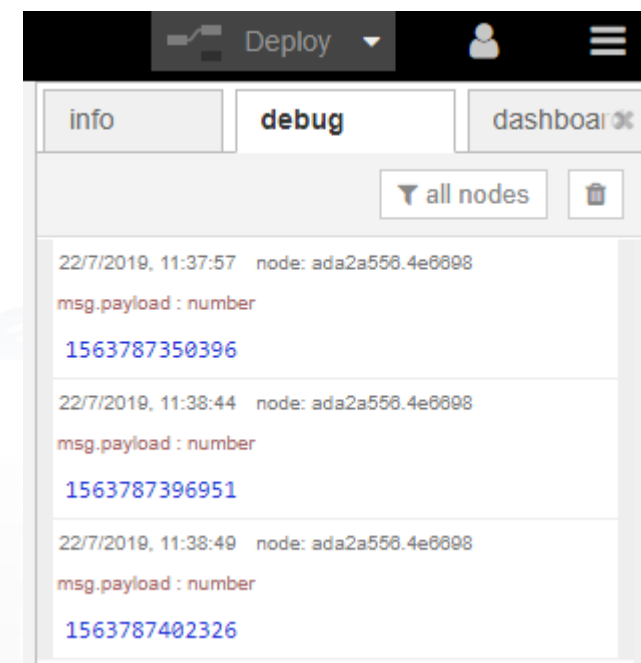
- Connect

- Deploy

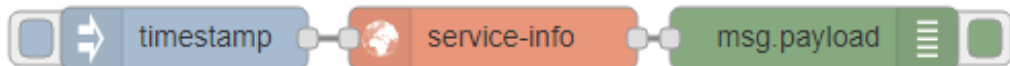


- Click and Observe

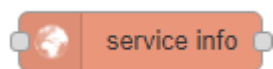
- Play with results



# Step 2



- Service Info
- Connect
- Configure
- Deploy
- Click and Observe
- Play with results



Name

ServiceUri

Language

<http://www.disit.org/km4city/resource/CarParkPieracciniMeyer>

```
22/7/2019, 11:54:10 node: ada2a556.4e6698
msg.payload : Object
  object
    Service: object
    predictions: array[0]
    realtime: object
      head: object
      results: object
        bindings: array[1]
          0: object
            capacity: object
            freeParkingLots: object
              value: "77"
            measuredTime: object
            occupancy: object
            occupiedParkingLots: object
            status: object
            updating: object
        trends: array[84]
```

Copy the path

Copy the value



# Step 3



- Function
- Connect
- Configure
- Deploy
- Click and Observe
- Play with results



Name

```
Function  
1 msg.payload = msg.payload.realtime.results.bindings[0].freeParkingLots.value  
2 return msg;
```

msg.payload = msg.payload.realtime.results.bindings[0].freeParkingLots.value

info | debug | dashboard

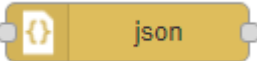
all nodes

```
22/7/2019, 12:29:07 node: ada2a556.4e8698  
msg.payload : string[2]  
"85"
```



# Step 4



- JSON 
- Connect
- Deploy
- Click and Observe
- Play with results

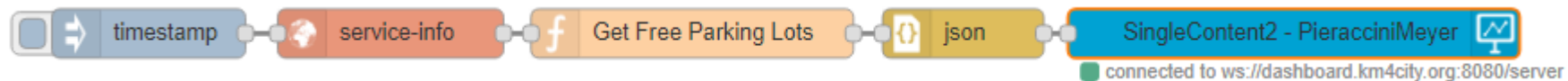
info debug dashboard

all nodes

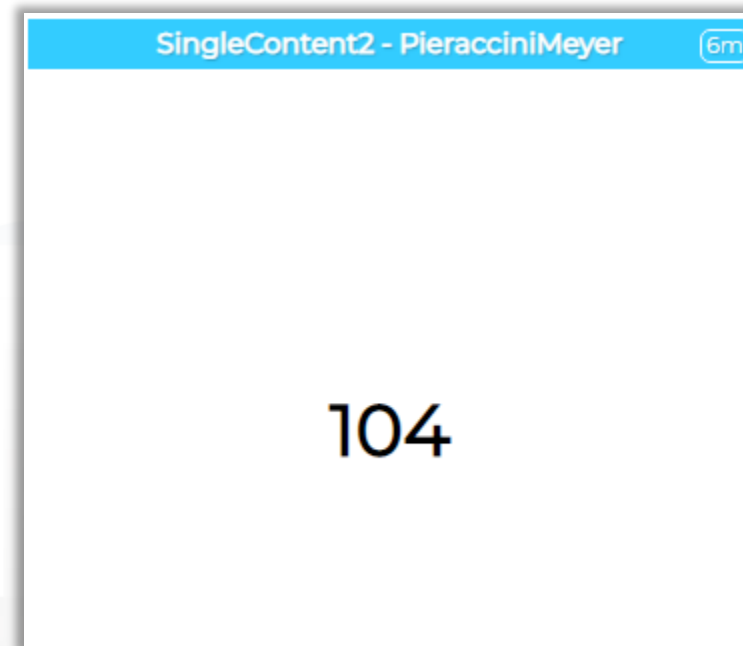
```
22/7/2019, 12:31:00 node: ada2a558.4e8898  
msg.payload : number  
85
```



# Step 5



- Single content
- Connect
- Configure
- Deploy
- Click and Observe
- Play with results



# Step 6



- Email
- Connect
- Configure
- Deploy
- Click and Observe
- Play with results

email

To: Destination Mail

Server: smtp.gmail.com

Port: 465  Use secure connection.

Userid: Userid of your mail

Password: Password of your mail

Change if not GMAIL

SingleContent2 - PieracciniMeyer 6m

104

# Nodes configuration

**inject**

**Payload**

**Topic**

**Repeat**

every

Inject once at start?

**service info**

**Name**

**ServiceUri**

**Language**

**function**

**Name**

**Function**

```
1 msg.payload = msg.payload.realtime.results.  
i 2     bindings[0].freeParkingLots.value  
3 return msg;
```

**gauge chart**

**single content**

**speedometer**

**time trend**

**Dashboard**

**Name**  [Create New](#)

**Widget**

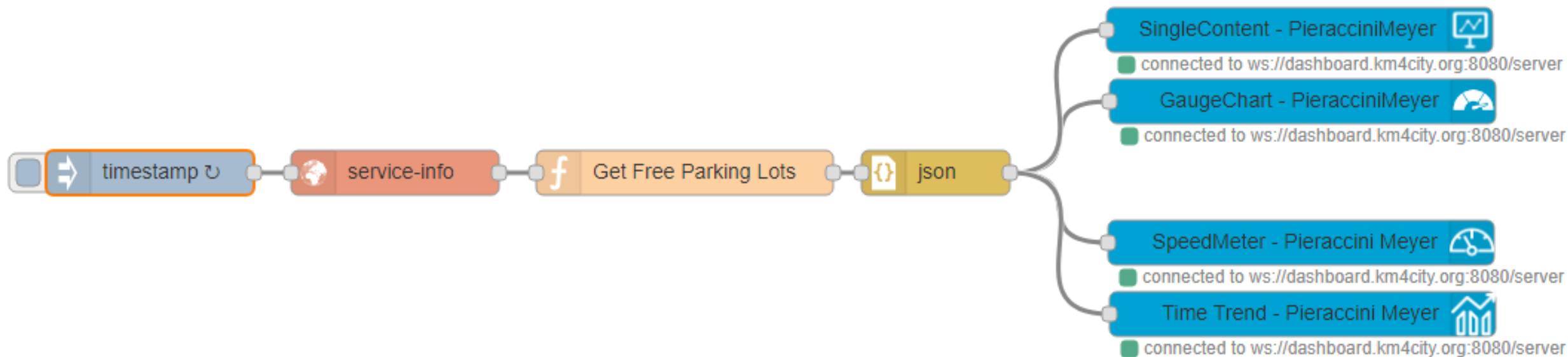
**Name**

[Edit Dashboard](#) [View Dashboard](#)





# Nodes connections

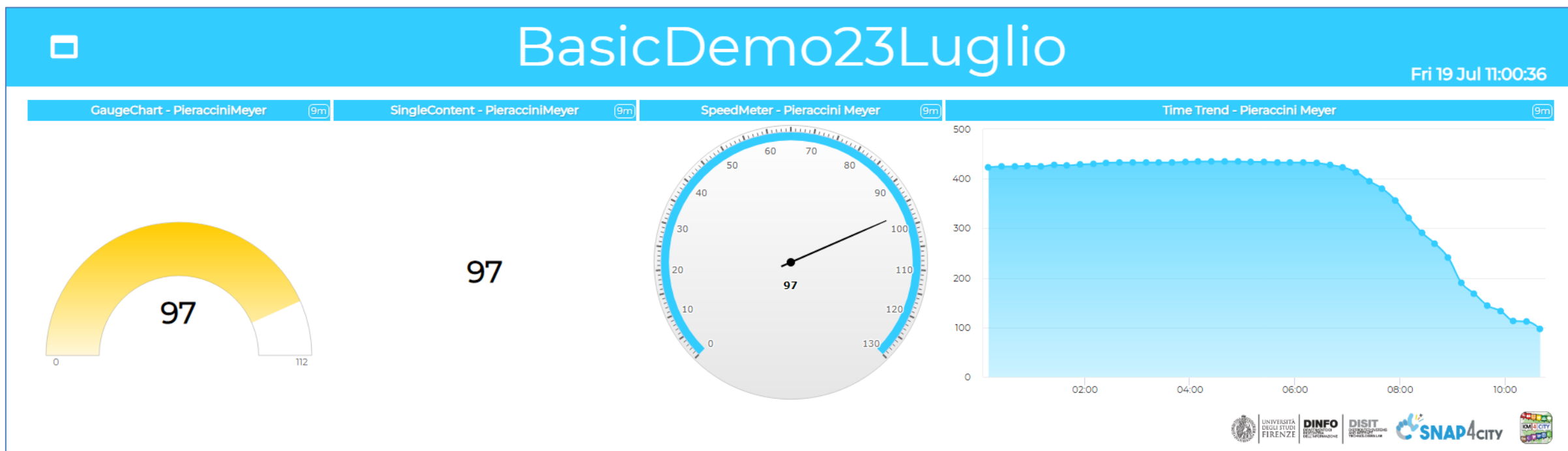


# Explaining: IOT Application Flow

- On Click or Every 15 minutes the **timestamp** node sends a message to the **service-info** node.
- When the message arrives, a request is sent to get details of the service URI entered in the configuration, in this case the **Pieraccini Meyer car park**.
- The details are sent to the node named "**Get Free Parking Lots**", which recovers the value of the current free places and ignores all the other data received in response.
  - The values in output of node **Get Free Parking Lots** is a string.
- THUS ! node **json** may transform it into a number (for those who know JavaScript could be used function `parseInt()` inside the function node). Then a number has been obtained!
- The Number can be sent to Different kinds of nodes to show it on Dashboards Widgets.



# Resulting Dashboard



<https://main.snap4city.org/view/index.php?idashboard=MTk1OQ==>

TOP

# IOT end-2-end Secure Stack

FROM CITY DASHBOARD TO APPLICATIONS

FORGING & MANAGING OPEN AND FLEXIBLE WEB AND MOBILE APPS

IOT APPLICATIONS VS IOT EDGE DEVICES

SNAP4CITY FOR BEGINNERS

SNAP4CITY ARCHITECTURE AND ECOSYSTEM. OPENED TO DEVELOPERS AND STAKEHOLDERS

TWITTER VIGILANCE: SOCIAL MEDIA ANALYSIS

SNAP4CITY AND KM4CITY PROJECTS

HERITAGE AND CITY DATA KNOWLEDGE MANAGEMENT

DATA ANALYTICS: BUSINESS INTELLIGENCE, WHAT-IF AND SIMULATION

DECISION SUPPORT SYSTEM AND CITY RESILIENCE

SNAP4CITY THE VIEW OF THE ADMINISTRATORS

IOT APPLICATIONS, THE LOGIC AND THE SMARTNESS

ADVANCED SMART CITY API, MICROSERVICES, SNAP4CITY API

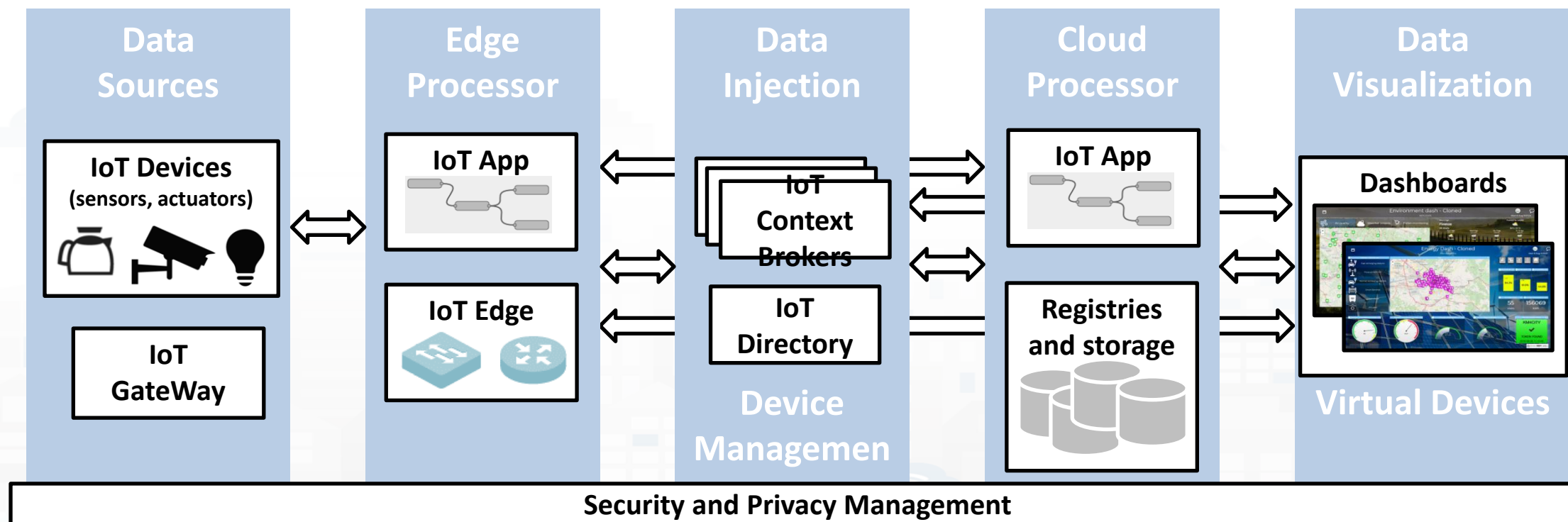
SNAP4CITY LIVING LAB FOR COLLABORATIVE WORK

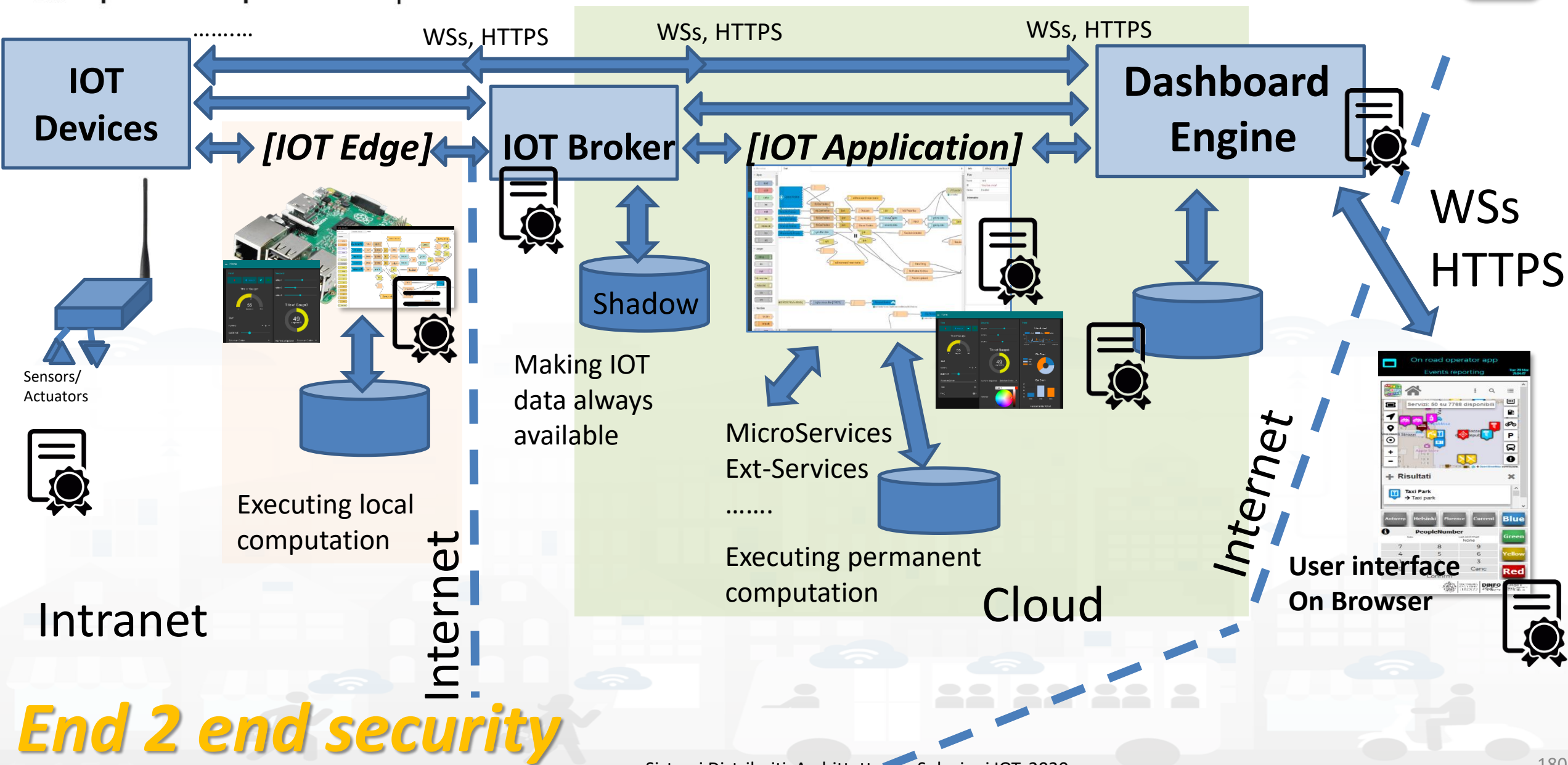


# Complexity in Smart City IOT Platforms

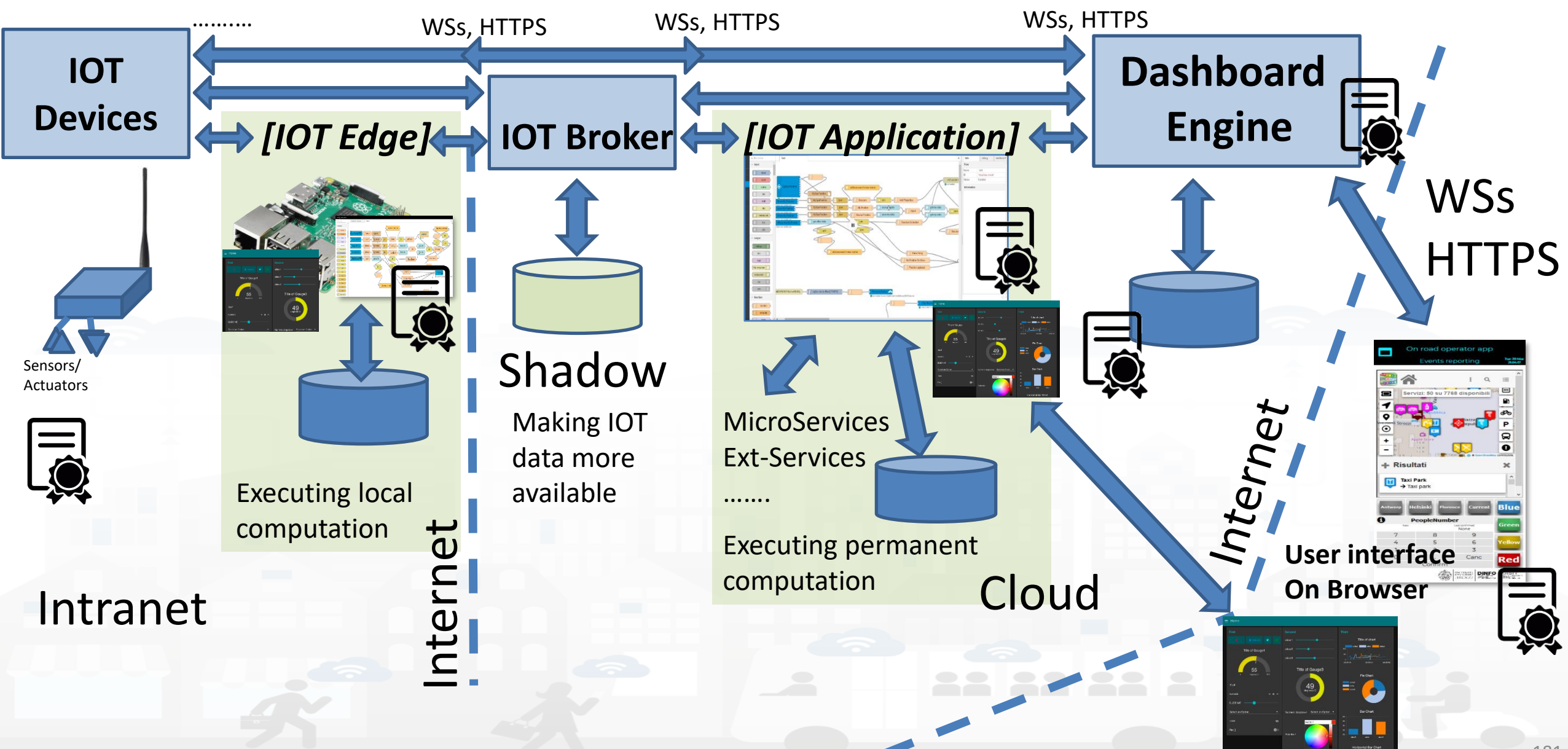
End to End security

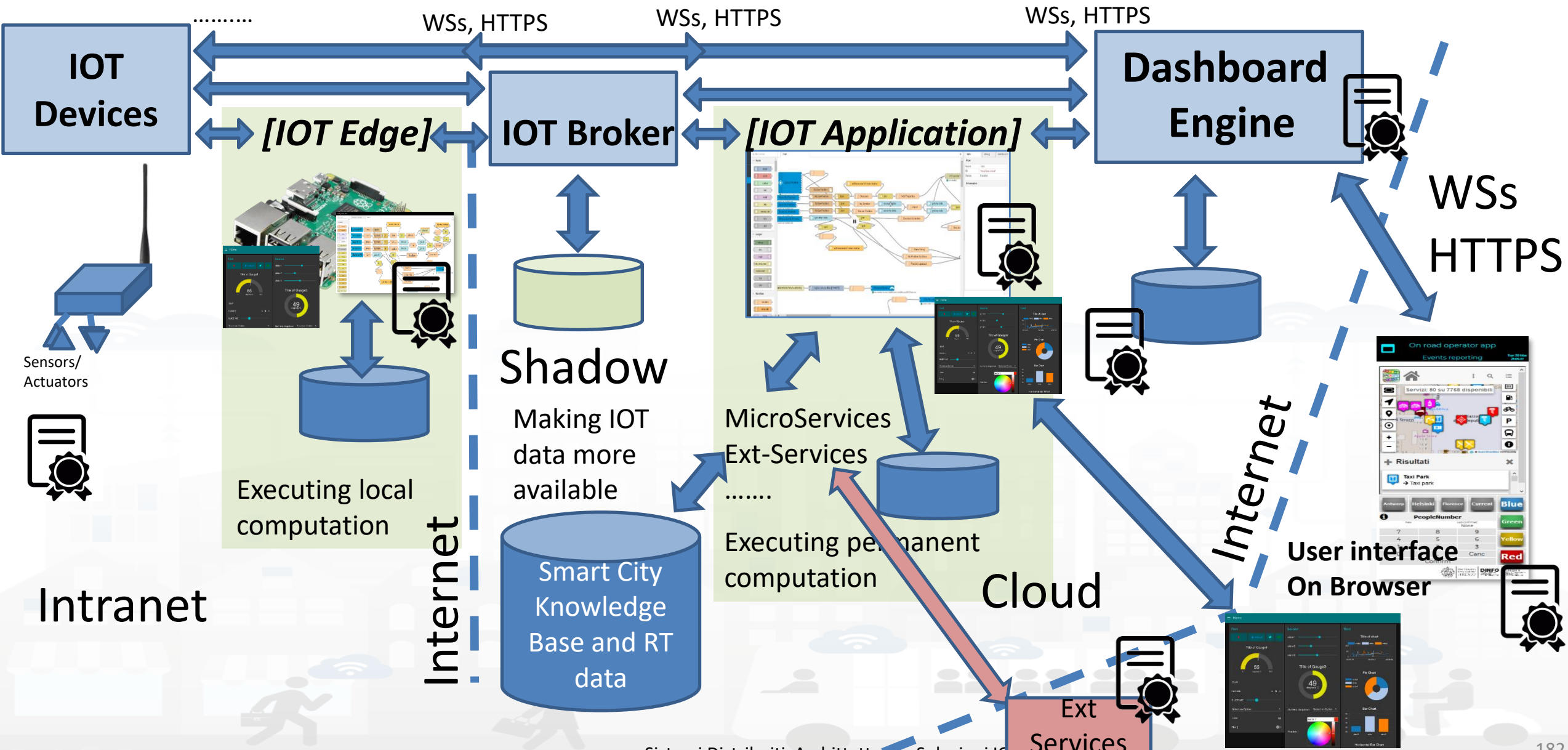
– From IOT Devices to Dashboard (user interface)





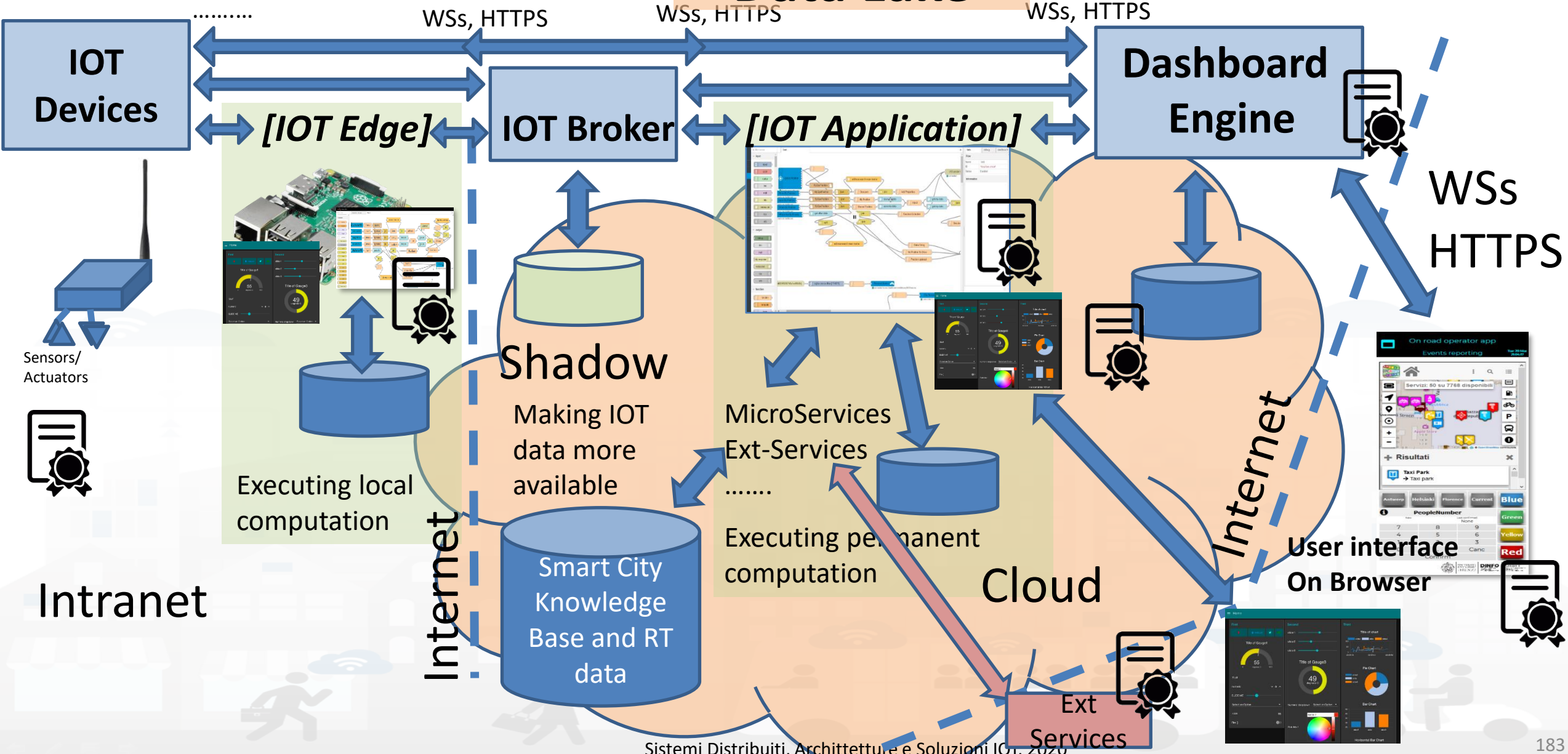
**End 2 end security**



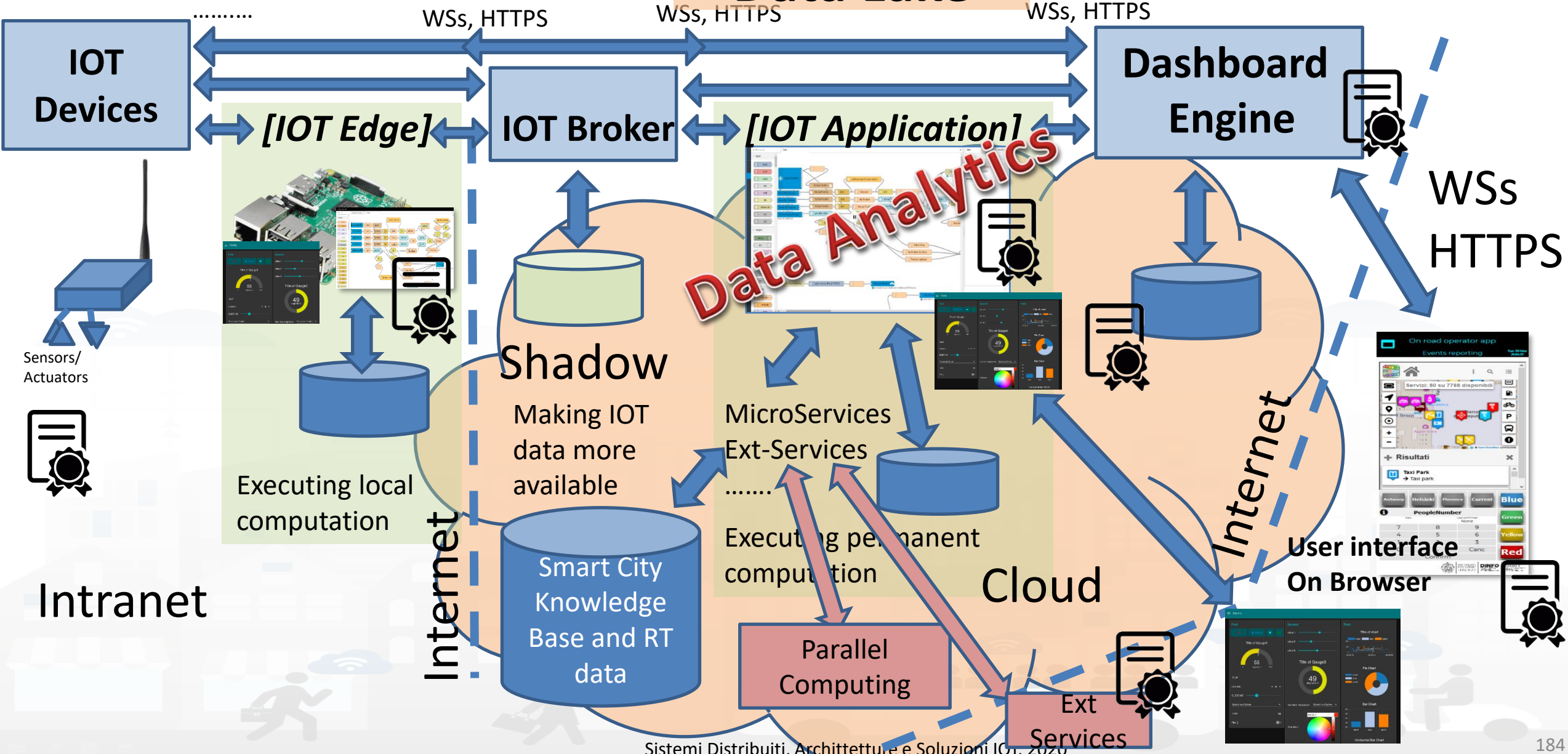




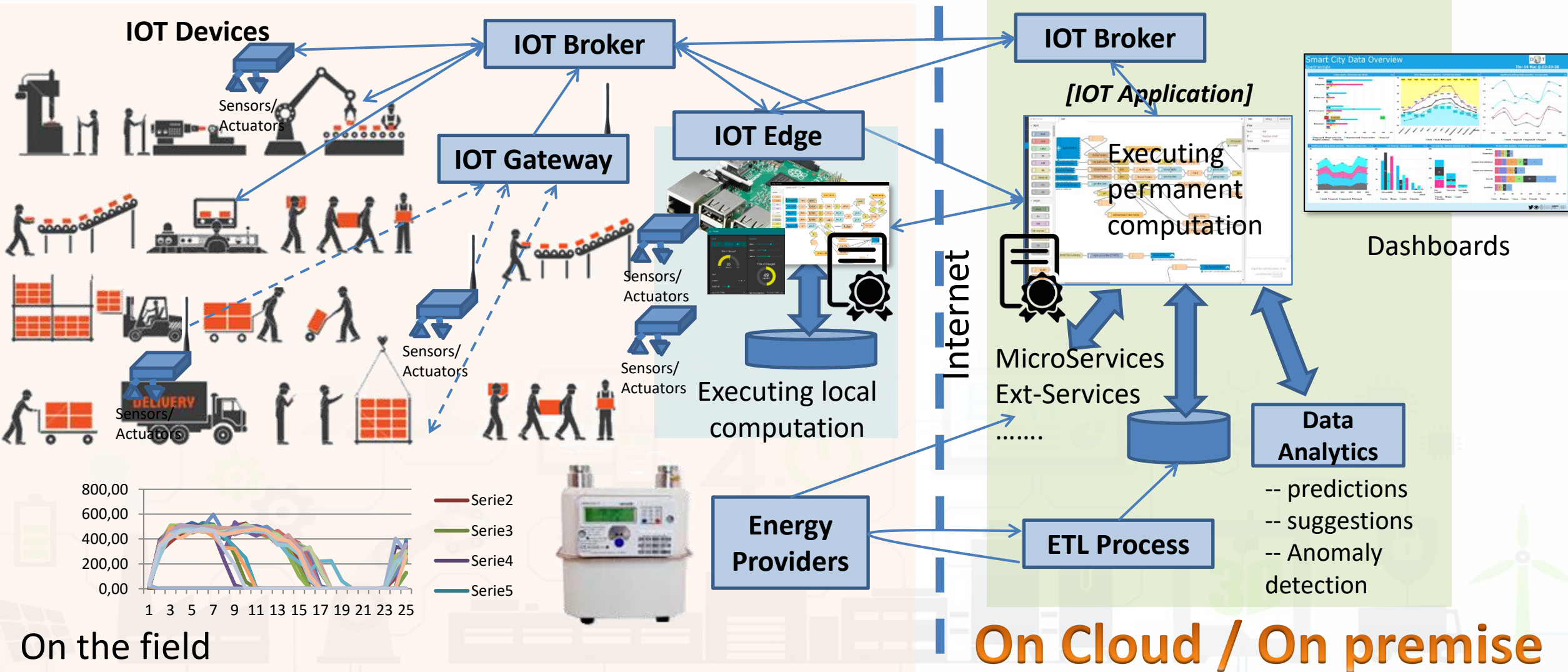
# Grouping on Data Lake



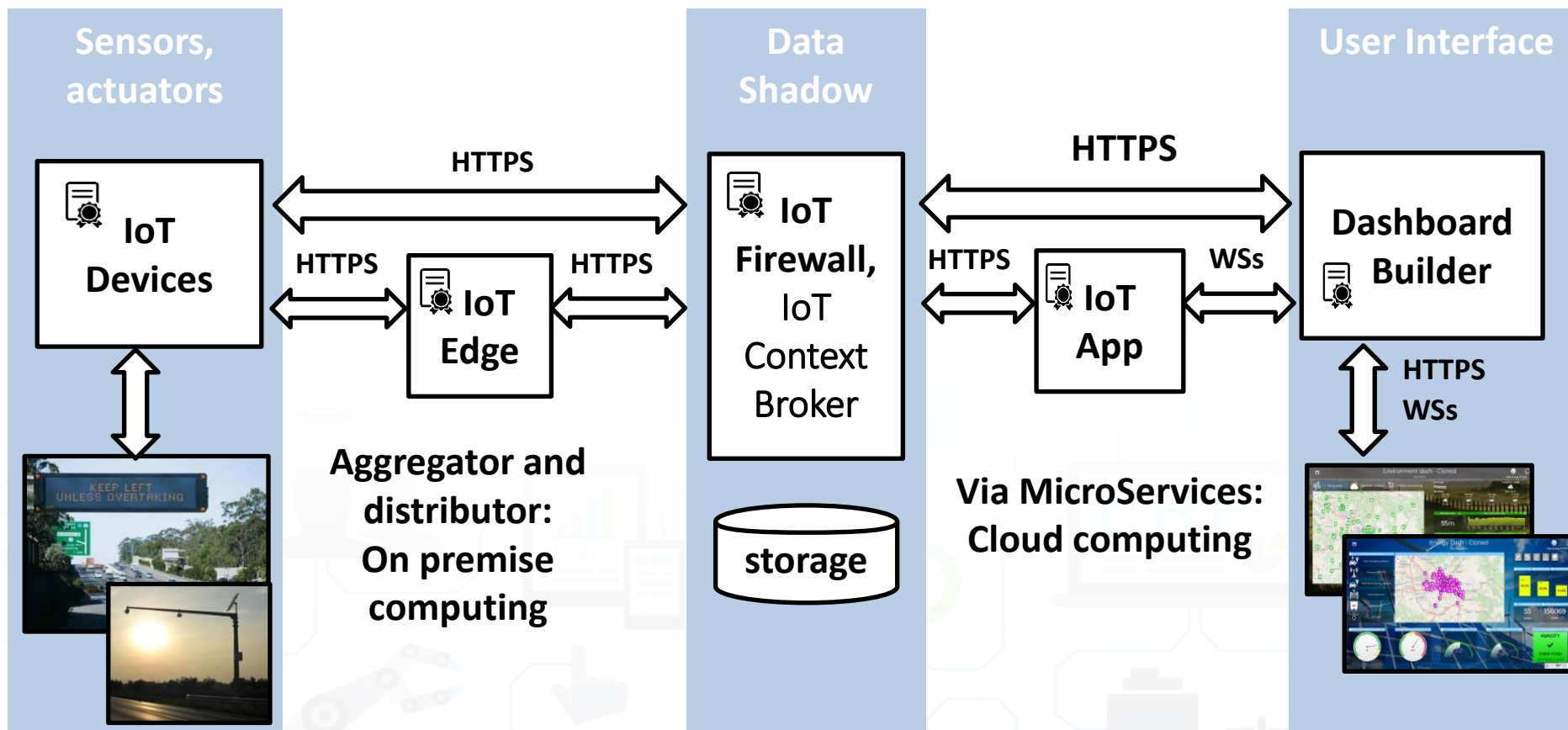
# Grouping on Data Lake



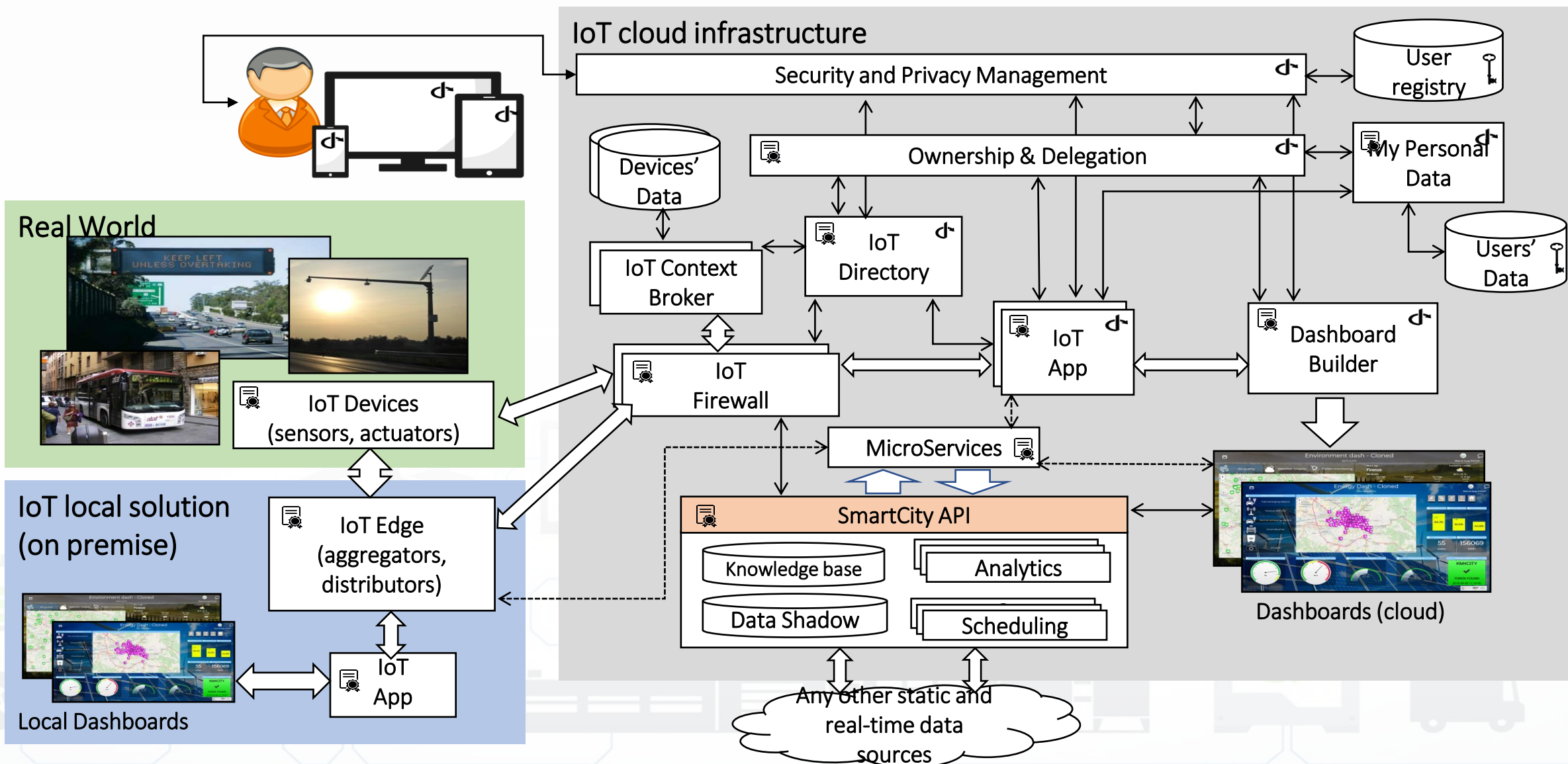
# Industry 4.0 Application



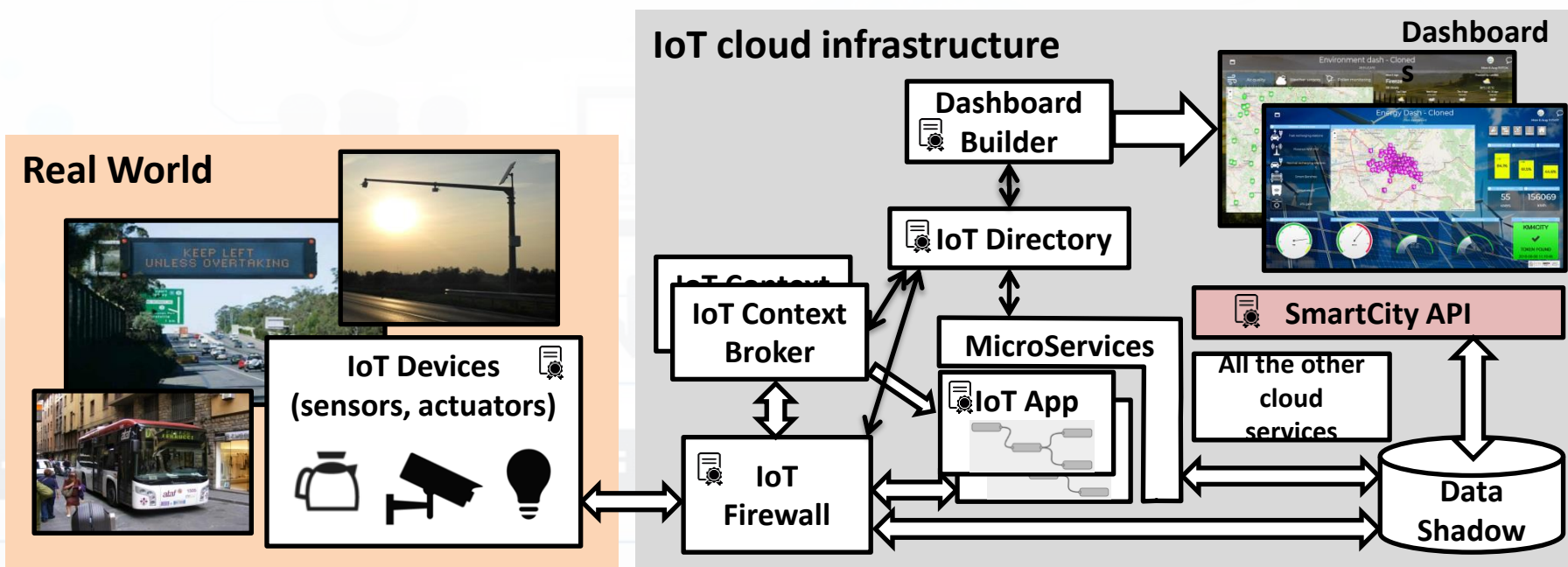
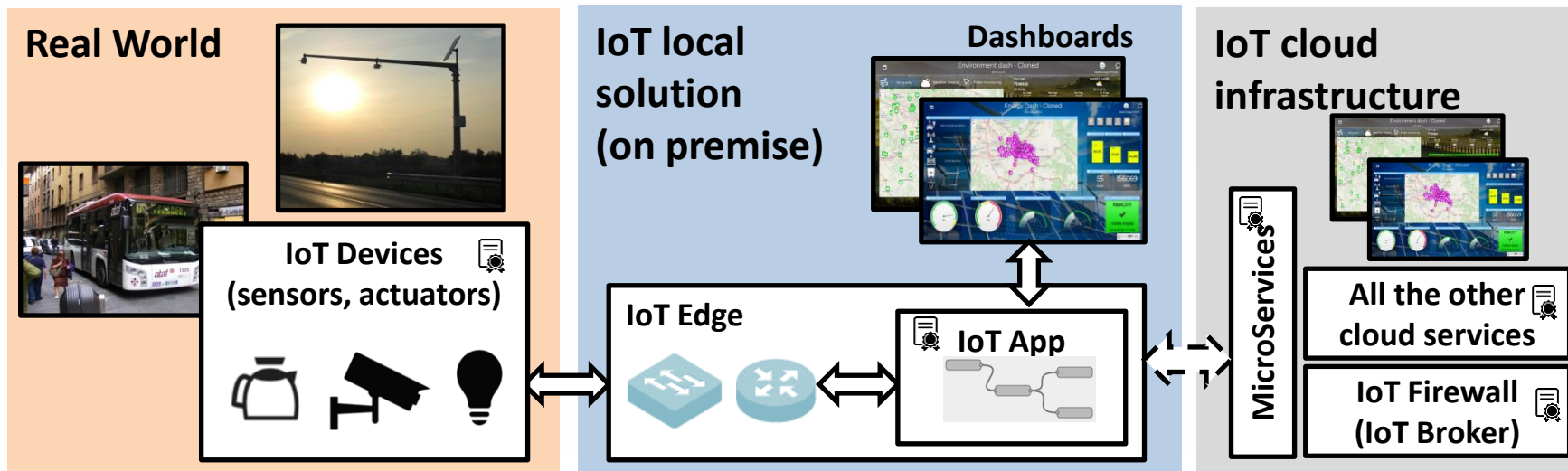
# The secure stack



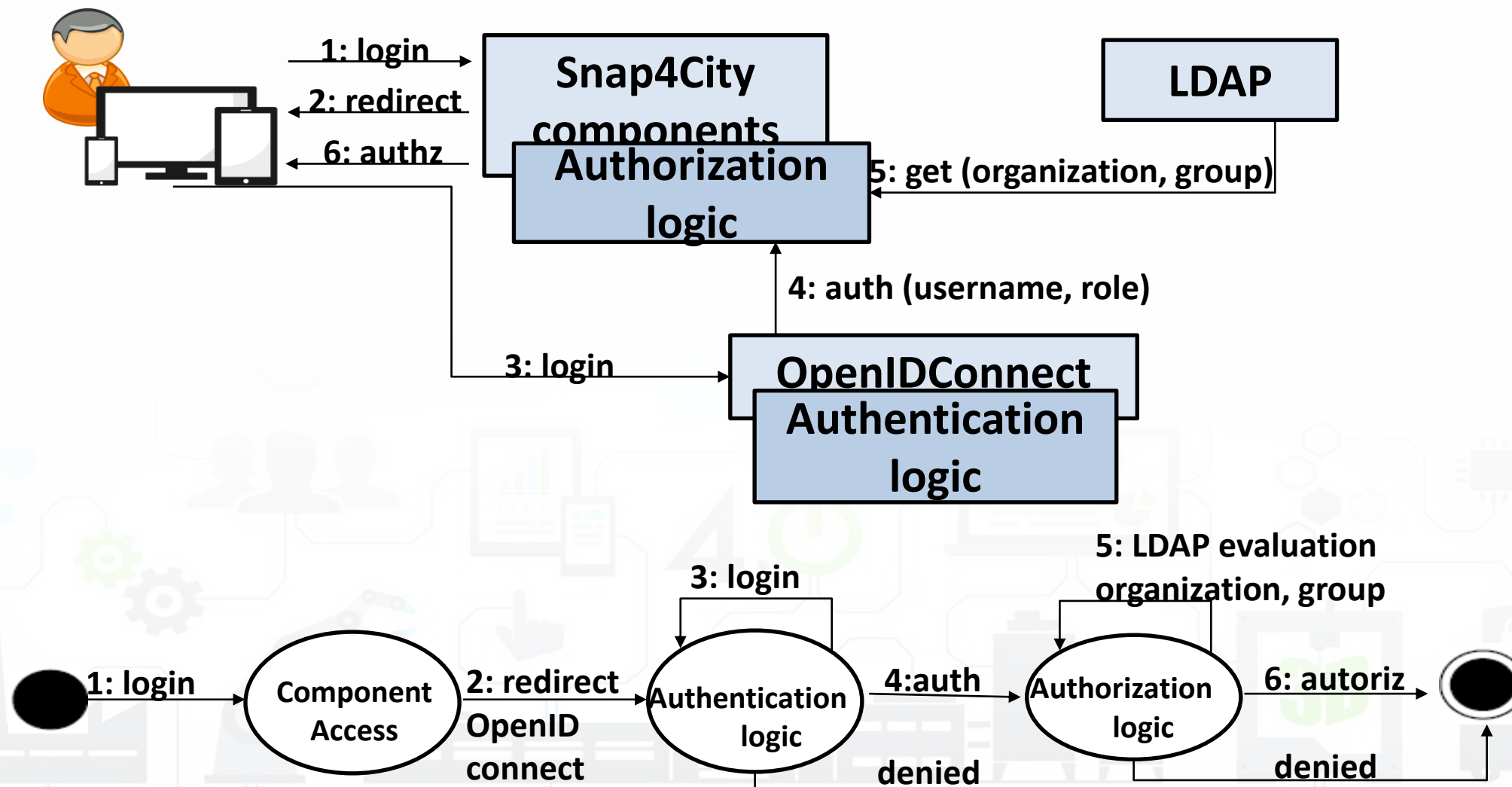
# Secure Architecture

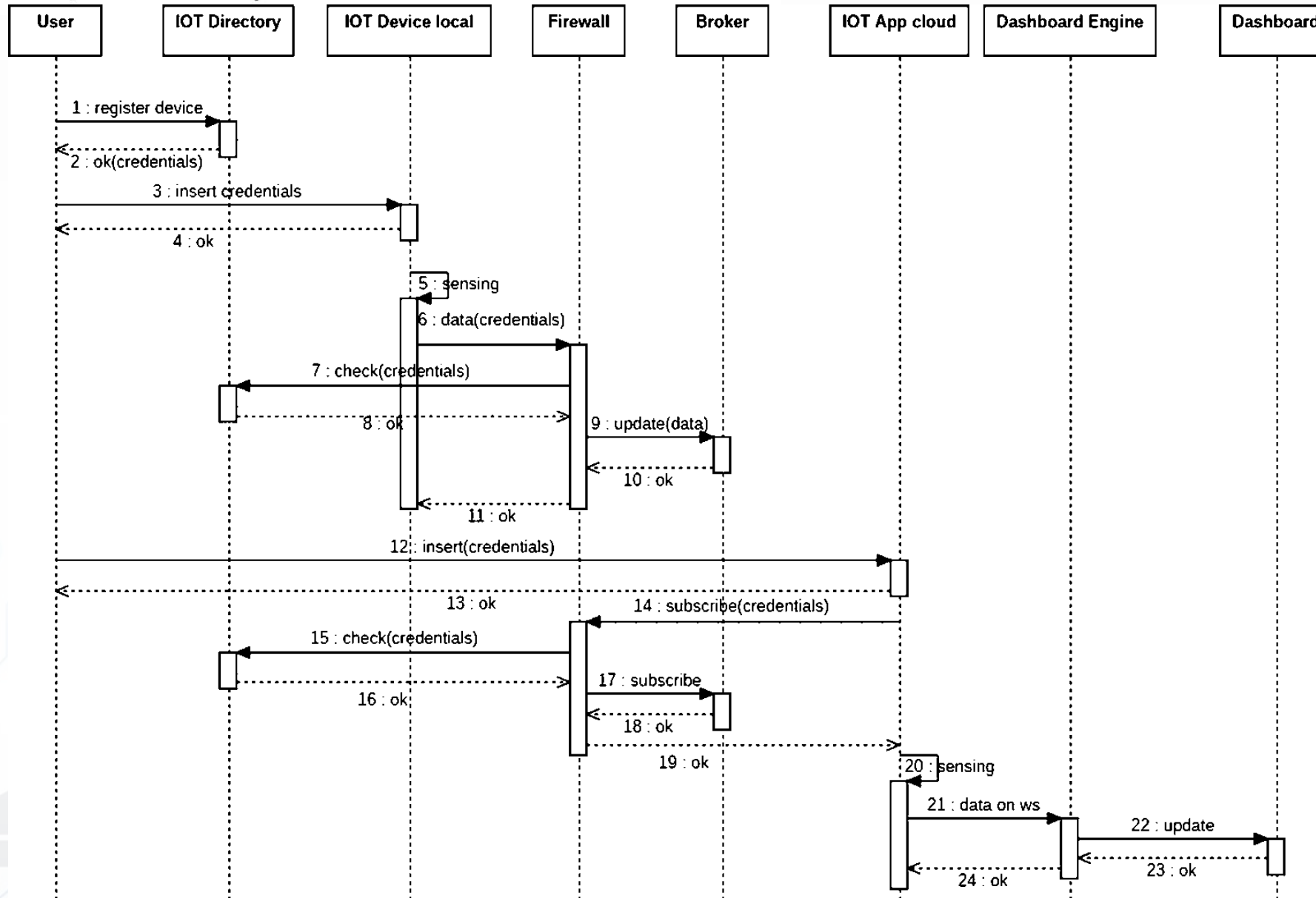


# OnPremise vs Cloud



# Authentication & Authorization



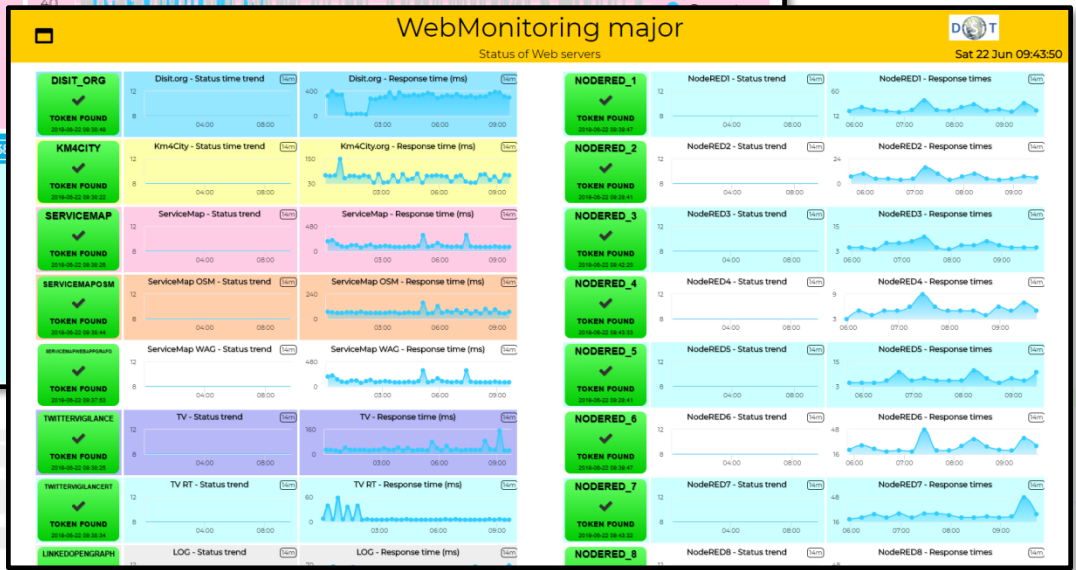
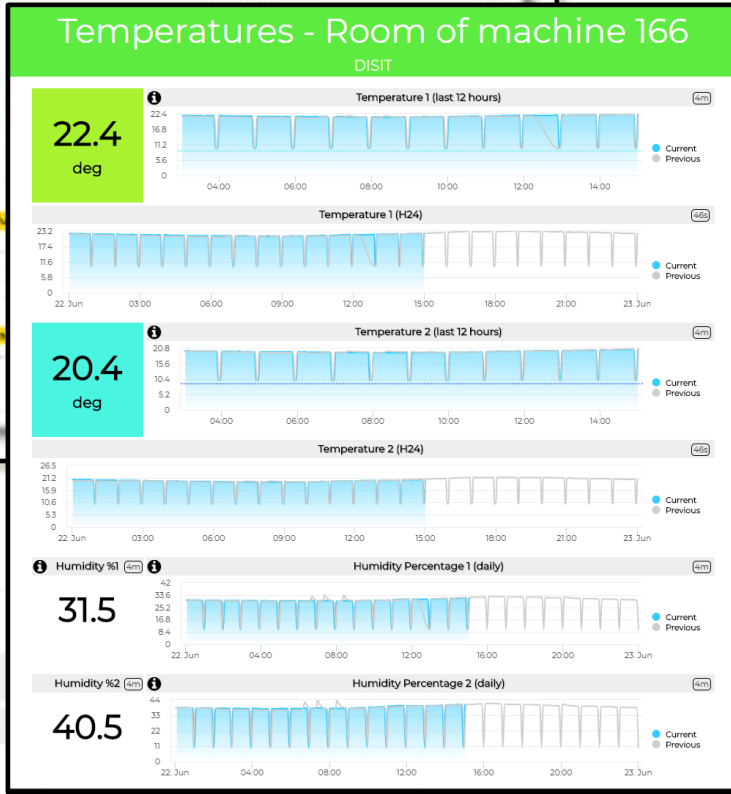
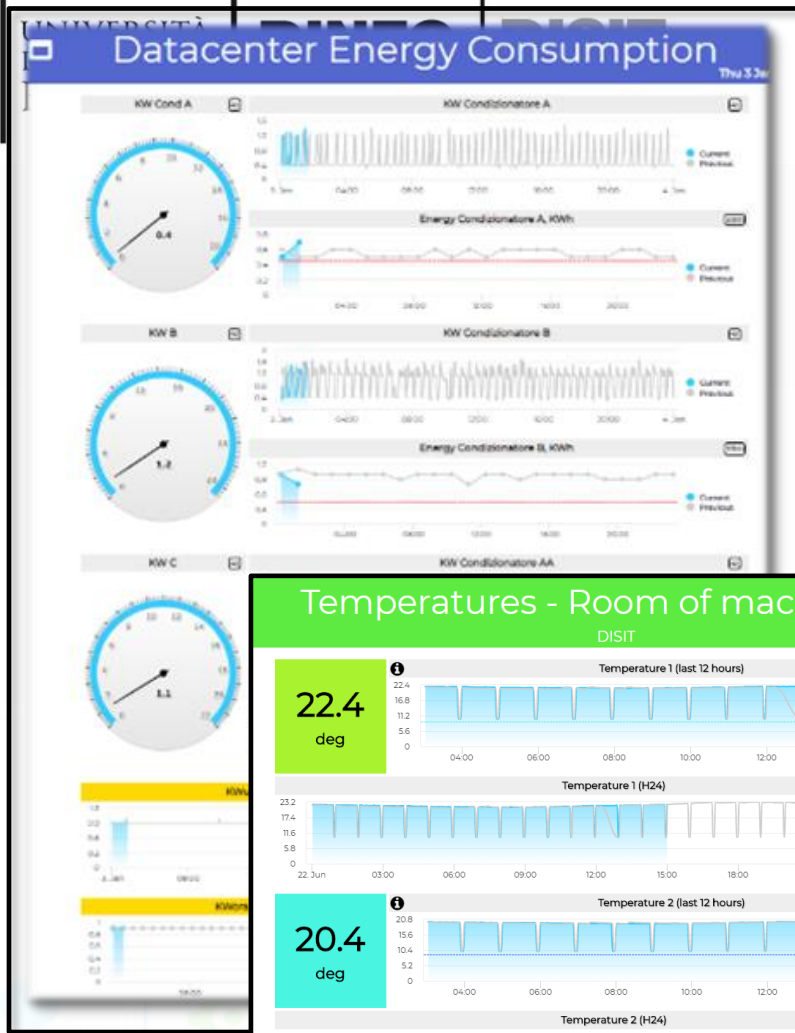




TOP

# Dashboard Overview





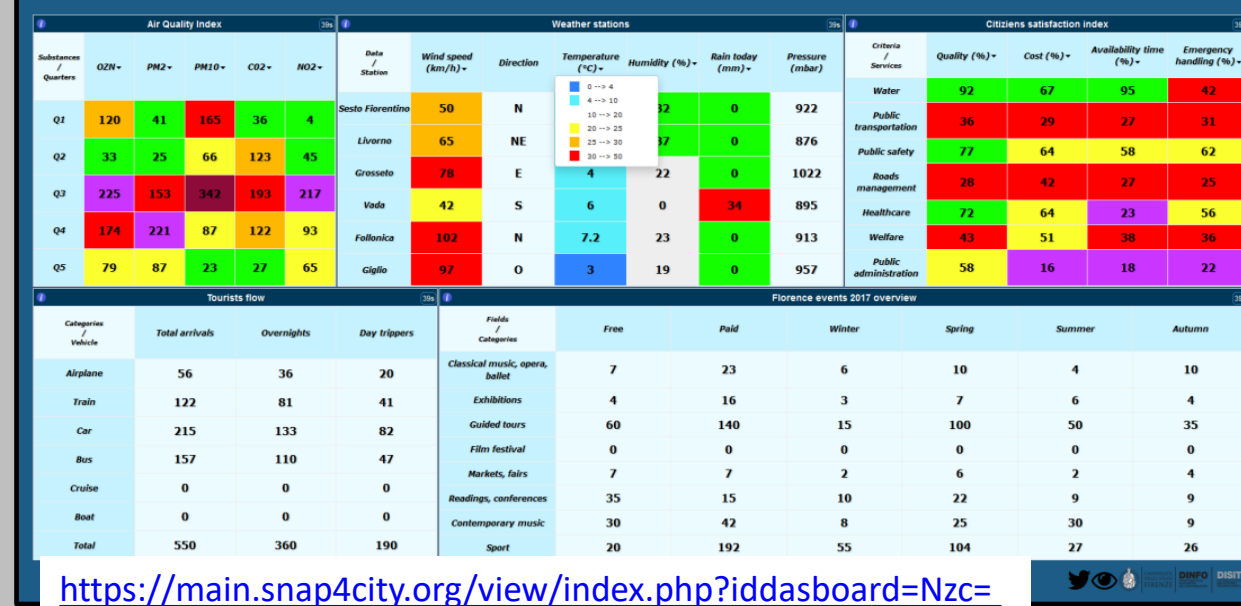
INDUSTRY



# Florence data overview

A table based overview over city main data

Wed 18 Jan @ 19:19:10

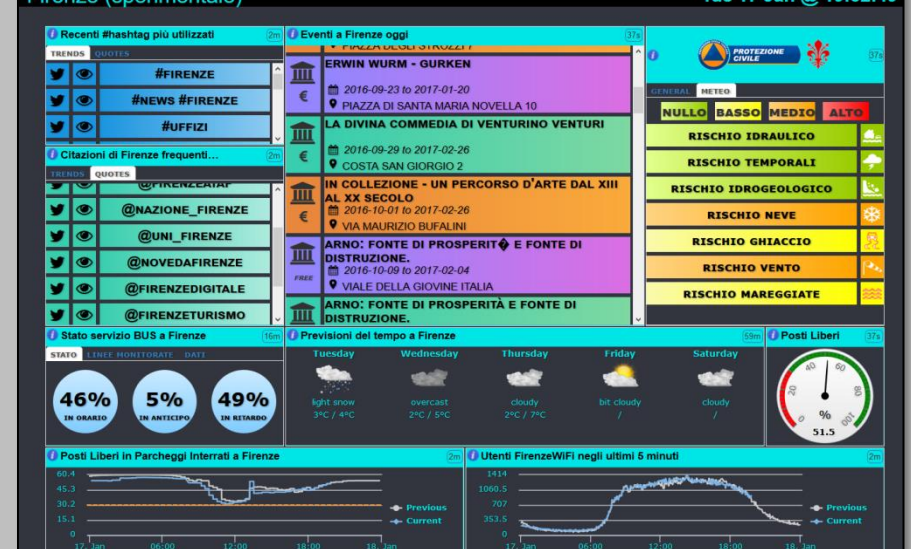


<https://main.snap4city.org/view/index.php?iddashboard=Nzc=>

# Servizi agli Utenti

Firenze (sperimentale)

Tue 17 Jan @ 19:52:49



<https://main.snap4city.org/view/index.php?iddashboard=NjQ=>

# Smart City Data Overview 2

Sperimentale

Thu 16 Mar @ 02:24:52



<https://main.snap4city.org/view/index.php?iddashboard=MTAw=>

# Smart City Data Overview

Sperimentale

Thu 16 Mar @ 02:23:38

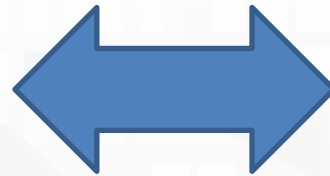


<https://main.snap4city.org/view/index.php?iddashboard=ODM=>

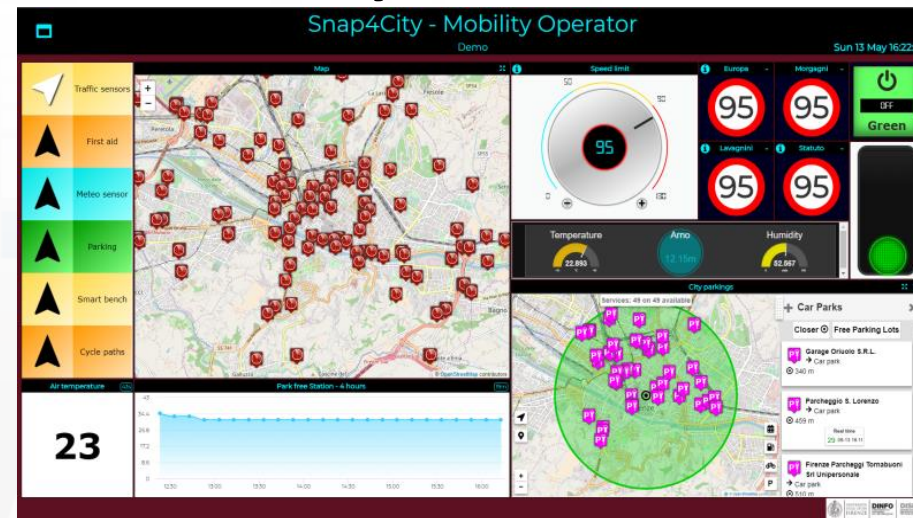
# Level 2 users: Create their own Dashboards

- With smart city data, and
- Sensor/actuator: info/IOT/IOE, if any provided by infrastr. (e.g., Meter)
- → create events/notifications from them

## IOT and City data World



## City Dashboard





# Dashboard List and Editor

Snap4City
Dashboards

User: rootooladmin1, Org: none  
Role: RootAdmin, Level: 7

- Dashboards
- My Dashboards
- Notifier
- IOT Applications
- My Personal Data
- IOT Directory and Devices
- Knowledge and Maps
- Micro Applications
- External Services
- Data Set Manager: Data Gate
- Resource Manager: Process Loader
- Development Tools
- Management
- Settings
- User Management and Auditing
- Help and Contacts
- Documentation and Articles
- My Profile
- Snap4City portal
- Km4City portal
- DISIT Lab portal

Cards
↓ A Z
↓ Z A
🔍
🔄

Prev
1
2
Next

🔍
✕

New dashboard

**DataCenter**  
Passive

disit: Public

Edit Management Clone Delete

**Datacenter Energy Consumption**  
Passive

disit: Public

Edit Management Clone Delete

**DataCenter gas and smoke (desktop)**  
Passive

disit: Public

Edit Management Clone Delete

**DataCenter gas and smoke (mobile)**  
Passive

disit: Public

Edit Management Clone Delete

**FirenzeWiFi**  
Passive

disit: Private

Edit Management Clone Delete

**Florence data overview**  
Passive

disit: Public

Edit Management Clone Delete

**Leonardo - Smart city data 2**  
Passive

Leonardo: Public

Edit Management Clone Delete

**My data and trends**  
Passive

nicola.mitolo: Public

Edit Management Clone Delete

**My data trends**  
Passive

nicola.mitolo: Public

Edit Management Clone Delete

**Notifier monitoring**  
Passive

disit: Public

Edit Management Clone Delete

**Pisa Real Time Data**  
Passive

mitolo: Public

Edit Management Clone Delete

**Real Time Sensors via ServiceMap3D**  
Passive

disit: Public

Edit Management Clone Delete

# Dashboard Development

IOT Applications

Knowledge Base, Km4City

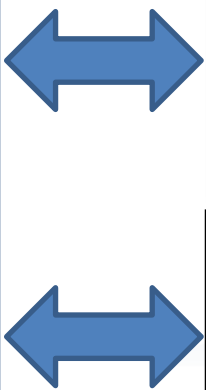
Knowledge and Storage Data from the Field and City



Widget Collection

MicroApplications

External Services



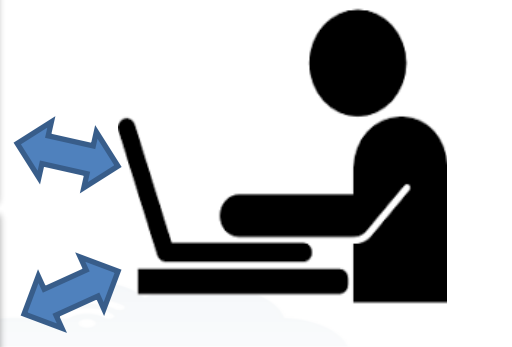
Dashboard Wizard

Dashboard Editor

Dashboard Collection

My Own Dash/App

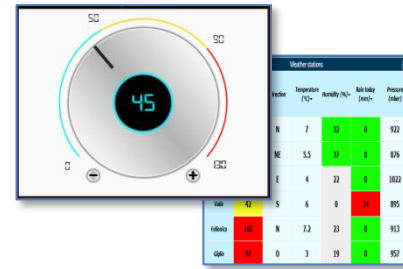
Create, save, load, delegate, grant access



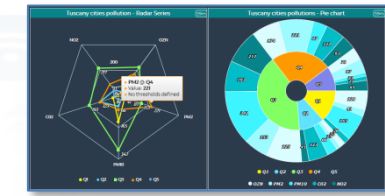
# Dashboard List and Editor

**Snap4City Dashboards**

- DataCenter
- DataCenter Energy Consumption
- DataCenter gas and smoke (desktop)
- DataCenter gas and smoke (mobile)
- FlorenceWiFi
- Florence data overview
- Leonardo - Smart city data 2
- My data and trends
- My data trends
- Notifier monitoring
- Plus Real Time Data
- Real Time Sensors via ServiceMap3D



CRID	2018-000530	S.P.N. 73 DI MALLMANTILE	ISTITUZIONE TEMPORARY TRAFFIC LIGHTS	16/03/2018	00:00:00	5
CRID	2018-000531	S.P.N. 105 DI TORRANCIPRESTAZIONE	TEMPORARY TRAFFIC LIGHTS	12/03/2018	00:00:00	5
<b>INCIDENTI SOLO DANNI</b>						
AGGIUNTA(S)						
	11/03/2018	10:06:12				1
<b>INCIDENTI CON FERTI</b>						
AGGIUNTA(S)						
	11/03/2018	08:30:23				1
<b>INCIDENTI SOLO DANNI</b>						
AGGIUNTA(S)						
	11/03/2018	05:58:48				1
<b>INCIDENTI CON FERTI</b>						
AGGIUNTA(S)						
	11/03/2018	05:38:41				1
<b>INCIDENTI SOLO DANNI</b>						
AGGIUNTA(S)						



**Snap4City - Mobility Operator**

5.1

45 45 45 45

Temperature: 8.8°C

Humidity: 82%

City parkings

Parcheggi

5.1

**Cam Firenze 1**

**Cam Firenze 2**

Antwerp Helsinki Florence Current Blue

**PeopleNumber**

7 8 9

4 5 6

1 2 3

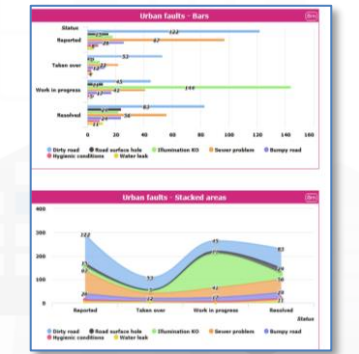
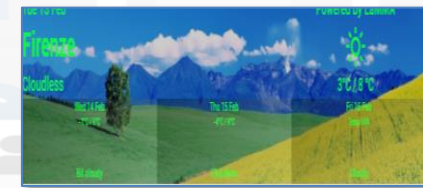
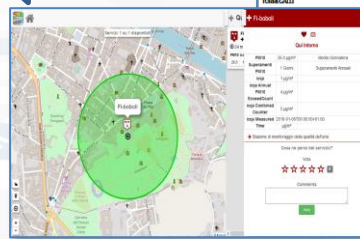
0 . Canc

Confirm

Green

Yellow

Red









# Chemical Plant Dashboard

**Green Impact Capacity (GIC)**  
**Altair Control room**





UNIVERSITÀ  
DEGLI STUDI  
FIRENZE

**DINFO**  
DIPARTIMENTO DI  
INGEGNERIA  
DELL'INFORMAZIONE

**DISIT**  
DISTRIBUTED SYSTEMS  
AND INTERNET  
TECHNOLOGIES LAB

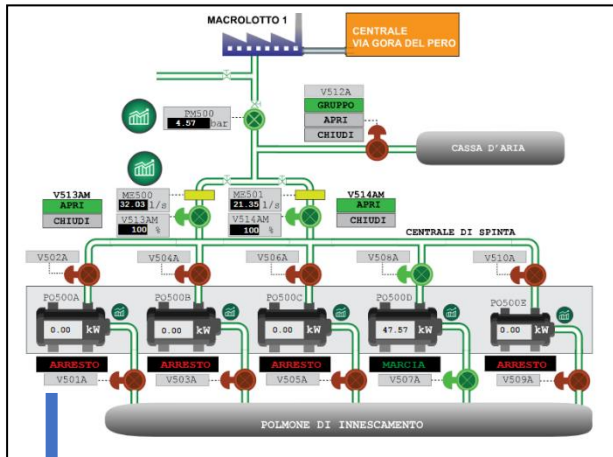
# GIDA set up



GESTIONE  
IMPIANTI  
DEPURAZIONE  
ACQUE S.p.A.



Smart City  
data from  
many  
sources



GESTIONE  
IMPIANTI  
DEPURAZIONE  
ACQUE S.p.A.

IOT Applications

Dashboards and Apps

IOT Data  
Shadow  
Snap4City

Big Data Analytics, Artificial Intelligence



ModBus to  
Snap4City  
Gateway Edge

5G network  
devices



5G



## GIDA 5G demo

Wed 16 Oct 23:01:00

Details Absorption

Full Screen

Mer 16 Ott Powered by LaMMA

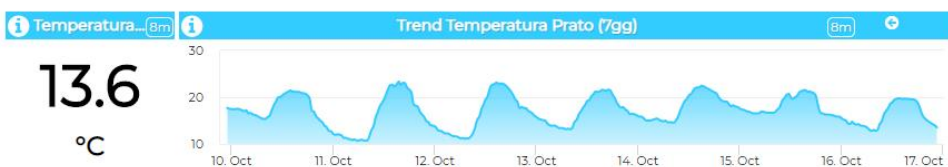
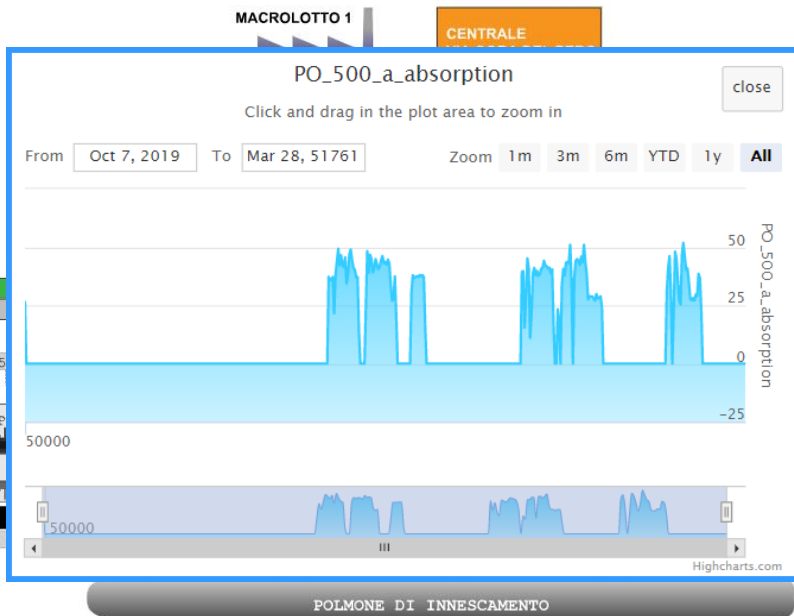
### Prato

Nuvoloso 16°C / 21°C

Gio 17 Ott 12°C / 21°C Nuvoloso	Ven 18 Ott 11°C / 22°C Nuvoloso	Sab 19 Ott Temp N/A Coperto	Dom 20 Ott Temp N/A Pioggia moderata o forte
---------------------------------------	---------------------------------------	-----------------------------------	--

tusc\_weather\_sensor\_o... (8m) | Pressione - GIDA (8m) | Umidità - GIDA (8m)

# 13.4°C 1020 bar 87 %



TOP

# Development Life Cycle for IOT Applications

FROM CITY DASHBOARD TO APPLICATIONS

DATA GATHERING AND CITY DATA KNOWLEDGE MANAGEMENT

IOT/IOE DEVICES AND NETWORKS

IOT APPLICATIONS, THE LOGIC AND THE SMARTNESS

FORGING & MANAGING OPEN AND FLEXIBLE WEB AND MOBILE APPS

IOT APPLICATIONS VS. NOT IOT DEVICES

SMART CITY AND MICROSERVICES, SNAP4CITY API

SNAP4CITY LIVING LAB FOR COLLABORATIVE WORK

SNAP4CITY FOR BEGINNERS

DATA ANALYTICS, BUSINESS INTELLIGENCE, WHAT-IF AND SIMULATION

SNAP4CITY ARCHITECTURE AND ECOSYSTEM, DESIGNED TO DEVELOPE AND MANAGE

DECISION SUPPORT SYSTEM AND CITY RESILIENCE

TWITTER VIGILANCE, SOCIAL MEDIA ANALYSIS

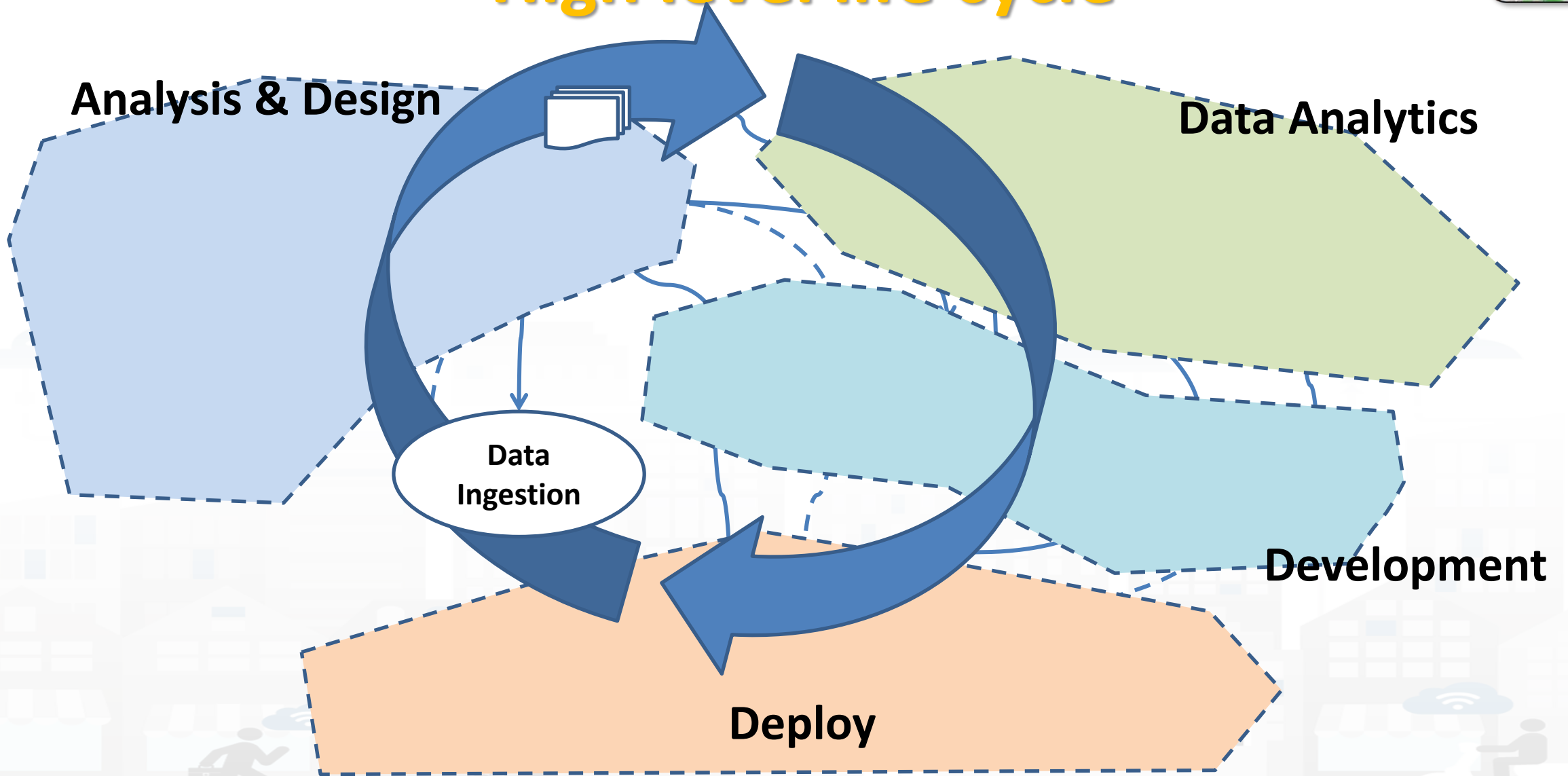
HOW TO ADOPT SNAP4CITY, AND OUR ROADMAP

SNAP4CITY AND KM4CITY PROJECTS

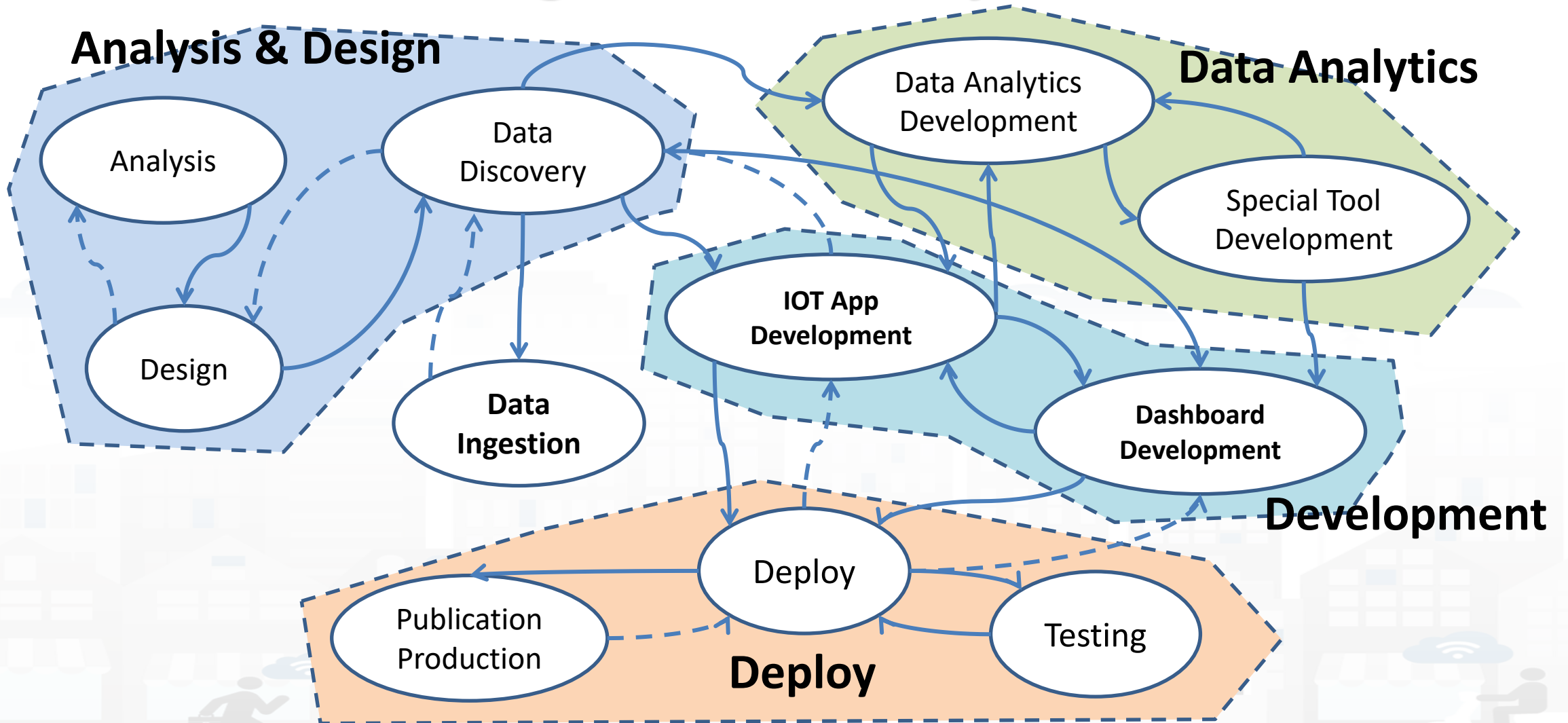
SNAP4CITY THE VIEW OF THE ADMINISTRATORS



## High level life cycle

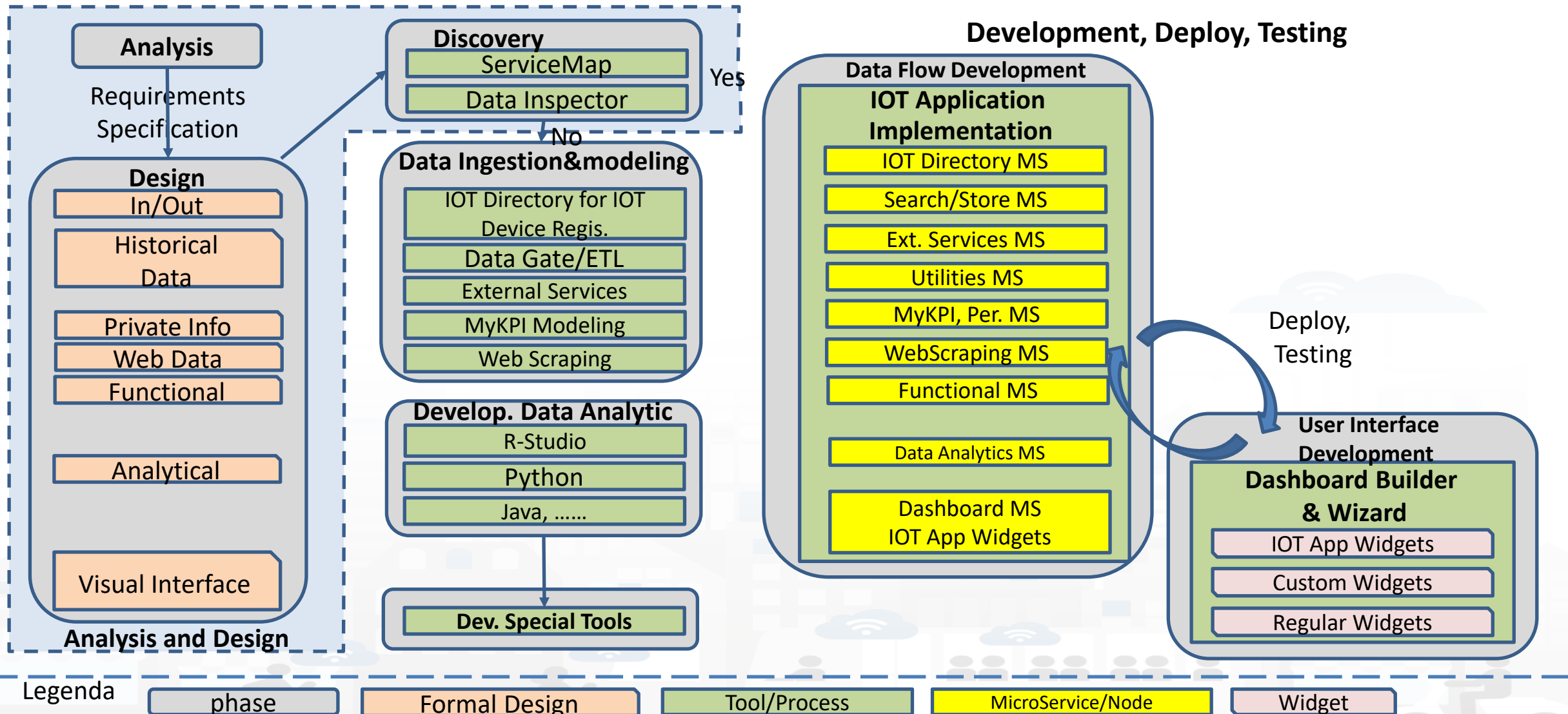


# High level life cycle





# Detailed Life Cycle



Legenda

phase

Formal Design

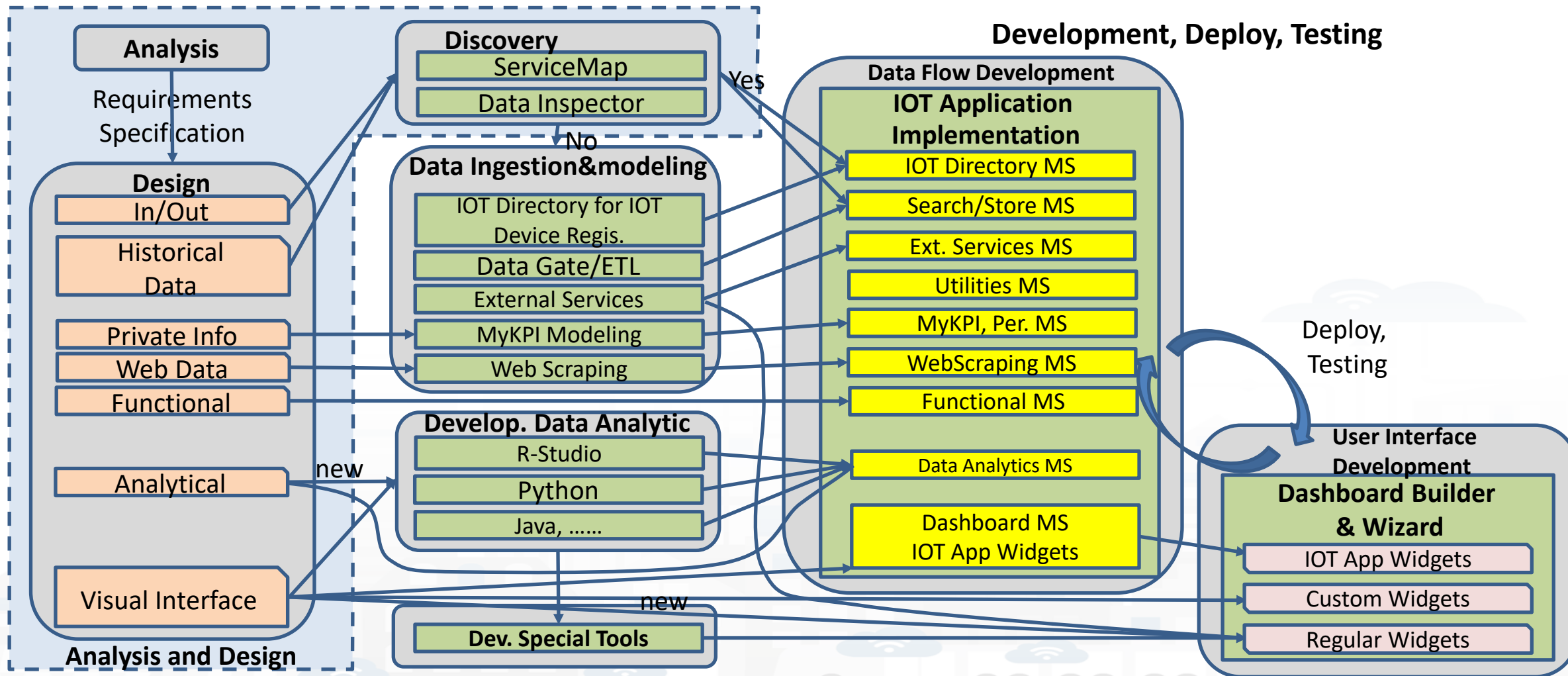
Tool/Process

MicroService/Node

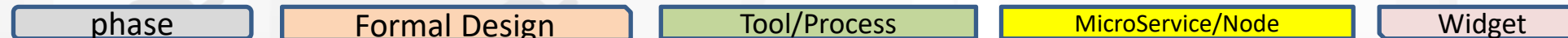
Widget



# Detailed Life Cycle



Legenda





# From Data to Applications and Dashboards



# *Sentient City Control Room*





# FIRENZE



Tue 16 Oct 16:18:39

INDICI DI CRITICITA' DELLA QUALITA' DELL'ARIA (ICQA)

**2**

inviata comunicazione alla cittadinanza

OZONO

**200**  $\mu/m^3$

superata la soglia di informazione

**39492** Utenti WiFi

STATI DI ALLERTA 9m

GENERAL METEO

MINIMO BASSO MEDIO ALTO

**RISCHIO IDRAULICO**

**RISCHIO TEMPORALI**

**RISCHIO IDROGEOLOGICO**

**RISCHIO NEVE**

**RISCHIO GHIACCIO**

Mar 16 Ott  
**Firenze**

Nuvoloso  
19°C / 24°C  
Powered by LAMMA

Mer 17 Ott  
16°C / 24°C  
Nuvoloso

Gio 18 Ott  
15°C / 26°C  
Nuvoloso

Ven 19 Ott  
Temp N/A  
Sereni

Sab 20 Ott  
Temp N/A  
Sereni

TPL

N **14 57 21**

3' 2' 8' 0' 5' 2'

COLONNINE RICARICA 9m

**180** INSTALLATE

**81.1 %** ATTIVE

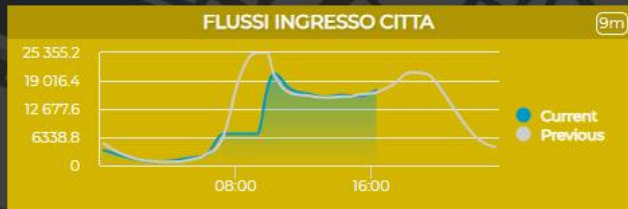
**8.9 %** IN USO

REPLICATE

FLORENCE DASHBOARD

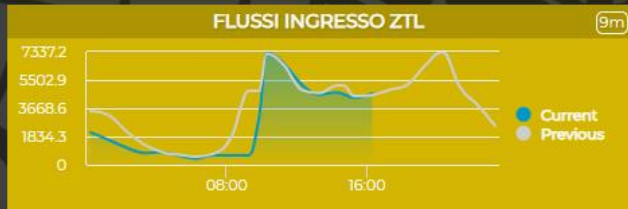
This dashboard is the main entry point to access dashboards realised in the REPLICATE H2020 EC project.

REPLICATE has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No. 691735.



TOTALE 9m

**141608** VEICOLI



TOTALE ZTL 9m

**41146** VEICOLI

SITUAZIONE VIABILITA 54s

**4 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.

**4 TOT. EVENTI SULLA RETE**

SMN <span>9m</span> <b>63.4</b> % occupati su 901 posti	BINARIO16 <span>9m</span> <b>83</b> % occupati su 165 posti	FORTEZZA <span>9m</span> <b>17.9</b> % occupati su 521 posti
LEOPOLDA <span>9m</span> <b>36.3</b> % occupati su 300 posti	CALZA <span>9m</span> <b>69.3</b> % occupati su 218	S.AMBROGIO <span>9m</span> <b>67</b> % occupati su 379 posti
PARTERRE <span>9m</span> <b>64.9</b> % occupati su 106 posti	CAREGGI <span>9m</span> <b>90.4</b> % occupati su 406 posti	BECCARIA <span>9m</span> <b>78.6</b> % occupati su 210 posti

STATO TRIAGE CAREGGI 9m

Red code Yellow code Green code Blue code White code

**3 12 83 37 9**

PM10

**26** superamenti/anno

Riciclo rifiuto

**56%**

Rifiuto per abitante

**0,629** t/pers/anno

PIL residenti

**23.606** euro/pers

Tasso di disoccupazione

**6,8%**

Piste Ciclabili

**19.7%** km ciclabili/km totali

**MAPPA**

Energy Environment

Mobility Social

Resilience

# FIRENZE

9xxxx

Wed 14 Nov 17:22:05

WIFI Utenti connessi

**38665**

Totale utenti WIFI

STATO DI ALLERTAZIONE

GENERALI RISCHI

MINIMO BASSO MEDIO ALTO

**RISCHIO IDRAULICO**

**RISCHIO TEMPORALI**

**RISCHIO IDROGEOLOGICO**

**RISCHIO NEVE**

**RISCHIO GHIACCIO**

14 Nov Firenze

Poco nuvoloso

15°C / 17°C

Dom 15 Nov  
15°C / 18°C

Ven 16 Nov  
14°C / 18°C

Sab 17 Nov  
14°C / 16°C

Dom 18 Nov  
14°C / 16°C

COLONNINE BIORICA

**176 INSTALLATE**

**78.4 % ATTIVE**

**11.4 % IN USO**

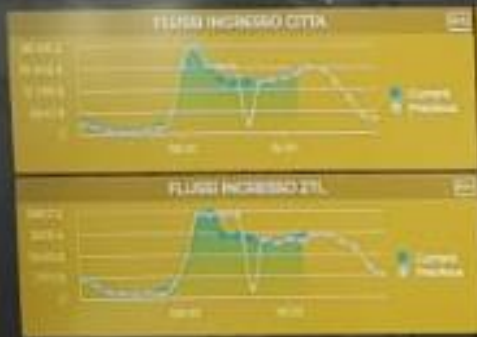
REPLICATI

REPLICATI

FIRENZE DASHBOARD

This dashboard is the main entry point for a data visualization platform in the REPLICATI 10000 SIC project.

REPLICATI has received funding from the European Union's Horizon 2020 Research and Innovation Programme under grant agreement No. 841741.



TOTALE

**188670**

VEICOLI

TOTALE ZTL

**50578**

VEICOLI

SITUAZIONE VIABILITA'

**1 INCIDENTI**

0 CHIUSURE AL TRAFFICO (TOT)

0 CHIUSURE PER CANTIERI

0 PROBL

0 NON PROBL

0 LIMITAZIONI AL TRAFFICO (TOT)

1 LIMITAZIONI PER CANTIERI

0 NON PROBL

0 PROBL

**2 TOT. EVENTI SULLA RETE**

DHN	EDUARDO	FORTEZZA
56.6	73.3	14
LEOPOLDA	CALZA	LAMBECIO
35.7	61.9	59.9
PANTEBBE	CAREGGI	BECCARIA
63.2	61.6	52.9

STATO TRAIFFE CARREGGI

0 22 48 30 5

**MAPPA**

Energy

Environment

Mobility

Social

26 superamenti/anno

56%

0,629 Upers/anno

23.606 euro/pers

6,8%

19,7% km ciclabili/km totali





### FIRENZE

Tue 16 Oct 16:18:39

**STATI DI ALLERTA**

GENERALI: MINIMO BASSO MEDIO ALTO

**RISCHIO IDRAULICO**

**RISCHIO TEMPORALI**

**RISCHIO IDROGEOLOGICO**

**RISCHIO NEVE**

**RISCHIO GHIACCIO**

**CLIMA**

Mar 17 Ott: 16°C / 24°C  
 Gio 18 Ott: 15°C / 26°C  
 Ven 19 Ott: Temp N/A  
 Sab 20 Ott: Temp N/A

**NOVULOSO**

Mer 17 Ott: 14.5 / 24°C  
 Gio 18 Ott: 15°C / 26°C  
 Ven 19 Ott: Temp N/A  
 Sab 20 Ott: Temp N/A

**TPL**

N 14 57 21

**COLONNINE RICARICA**

**180 INSTALLATE**

81.1% ATTIVE  
 8.9% IN USO

**FLUSSI INGRESSO CITTÀ**

09:00 16:00

**FLUSSI INGRESSO ZTL**

09:00 16:00

**TOTALE VEICOLI**

141608

**TOTALE ZTL VEICOLI**

41146

**SITUAZIONE VIABILITÀ**

**4 INCIDENTI**

0 CHIUSURE AL TRAFFICO (TOT)

0 PROG. 0 NON PROG.

0 LIMITAZIONI AL TRAFFICO (TOT)

0 LIMITAZIONI PER CANTIERI

0 NON PROG. 0 PROG.

**4 TOT. EVENTI SULLA RETE**

**SMN** 63.4

**LEOPOLDA** 36.3

**PARTERRE** 64.9

**BINARIO** 83

**CAL** 65.3

**CAREGGI** 90.4

**FORTEZZA** 79.9

**SAMBROGIO** 67

**BECCARIA** 78.6

**STATO TRIAGE CAREGGI**

Red code: 3, Yellow code: 12, Green code: 83, Blue code: 37

**26 superamenti/anno**

**56%**

**0,629 t/pers/anno**

**23,606 euro/pers**

**6,8%**

**19,7% riciclabilità totali**

### Parcheggi Firenze App

Tue 16 Oct 16:20:26

### MAPPA FIRENZE

Tue 16 Oct 16:46:77

### Environment

Air quality, Weather stations, Pollen monitoring

### Citizens Engagement

Tue 16 Oct 16:24:25

### First aids overview - Firenze

Service status of main first aids

Tue 16 Oct 16:20:53

### Energy

Tue 16 Oct 16:23:38

### Total Traffic Count per hour for Firenze

Sat 20 Oct 09:32:09

### Mobility

Sat 20 Oct 09:30:45

### FIRENZE RESILIENCE

Environment, Mobility, Resources

# Firenze Oggi

# 2019



Fri 25 Oct 23:29:38

43666

Totale utenti WIFI

COLONNINE RICARICA < 9m

176 INSTALLATE

71 % ATTIVE

5.1 % IN USO

GENERAL METEO 9m

MINIMO BASSO MEDIO ALTO

**RISCHIO IDRAULICO**

**RISCHIO TEMPORALI**

**RISCHIO IDROGEOLOGICO**

**RISCHIO NEVE**

**RISCHIO GHIACCIO**

**RISCHIO VENTO**

SITUAZIONE VIABILITA 8s

**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 9m <b>28.7</b> % occupati su 607 posti	BINARIO16 9m <b>55.2</b> % occupati su 165 posti	FORTEZZA 9m <b>27.8</b> % occupati su 521 posti
LEOPOLDA 9m <b>36</b> % occupati su 300 posti	CALZA 9m <b>70.3</b> % occupati su 148	S.AMBROGIO 9m <b>99.7</b> % occupati su 379 posti
PARTERRE 9m <b>34</b> % occupati su 656 posti	CAREGGI 9m <b>24.9</b> % occupati su 406 posti	BECCARIA 9m <b>98.1</b> % occupati su 210 posti

## ANALYSIS

Energy

Environment

Mobility

Social

Resilience

## Attesa media alla fermata

Linea 6 9m <b>3</b> min	Linea 13 9m <b>13</b> min
Linea 17 9m <b>4</b> min	Linea 23 9m <b>5</b> min
Linea 31 9m <b>19</b> min	Linea 36 9m <b>2</b> min

FLUSSI INGRESSO CITTA 9m

TOTALE 9m  
**284094**  
VEICOLI

FLUSSI INGRESSO ZTL 9m

TOTALE ZTL 9m  
**57499**  
VEICOLI

Nati Italiani 119m <b>163</b> ultimo mese consolidato	Nati stranieri 119m <b>49</b> ultimo mese	Deceduti 119m <b>395</b> ultimo mese	Matrimoni 119m <b>19</b> ultimi 7 giorni	Unioni Civili 119m <b>0</b> ultimi 7 giorni
Segnalazioni ricevute in attesa 119m <b>1116</b> ultimo mese	In Lavorazione 119m <b>524</b>	Risolte 119m <b>305</b>	Chiuse senza risoluzione... 119m <b>285</b>	
Manutenzioni Stradali 59m <b>54</b> oggi	Verde Pubbl. 59m <b>4</b>	Decoro Urbano 59m <b>6</b>	Relitti 59m <b>3</b>	

<https://www.snap4city.org/dashboardSmartCity/view/index.php?iddashboard=MTQzOA==>

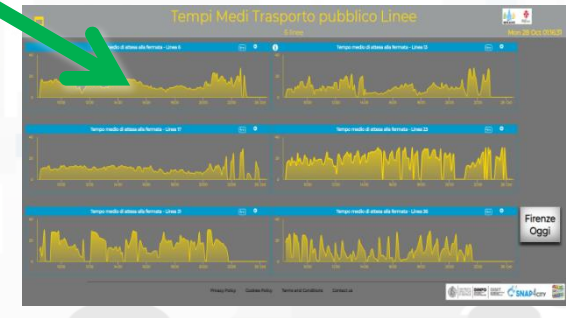
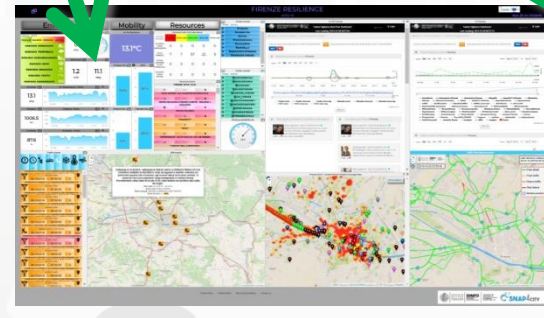
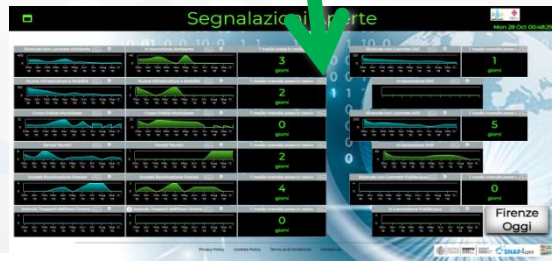
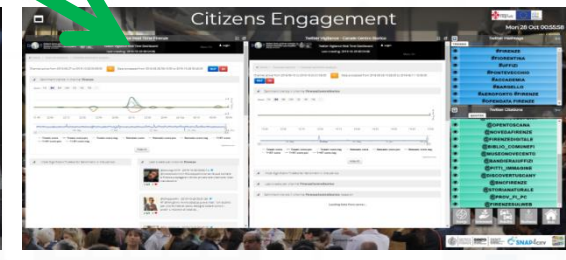
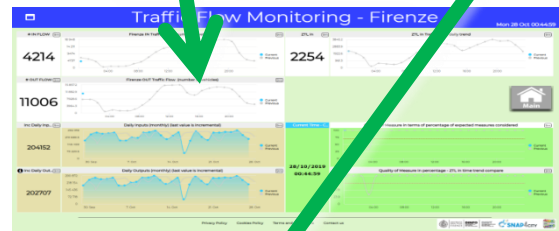
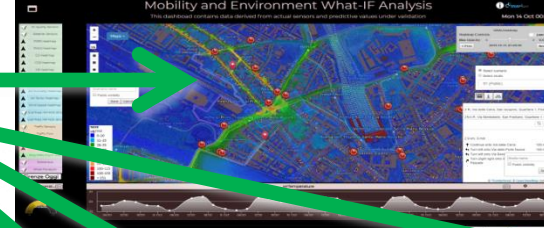
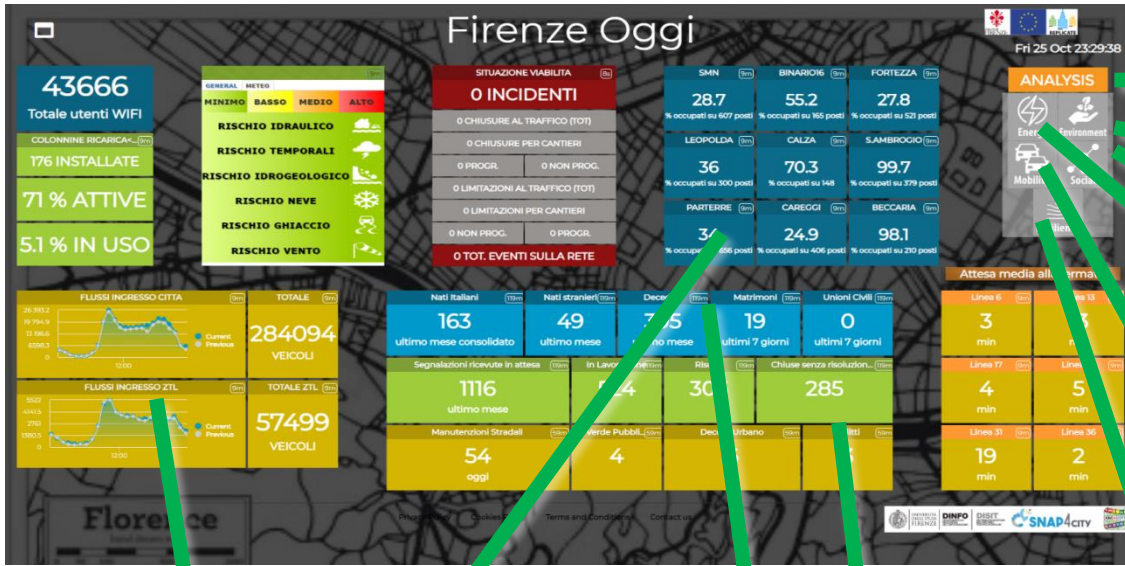


# Smart City Control Room

## a set of dashboards and tools



This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement N° 691735



UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB



# Data Protection, Personal Data vs GDPR







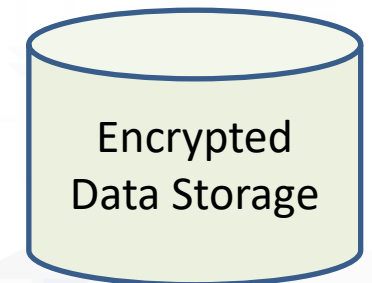
# GDPR: General Data Protection Regulation

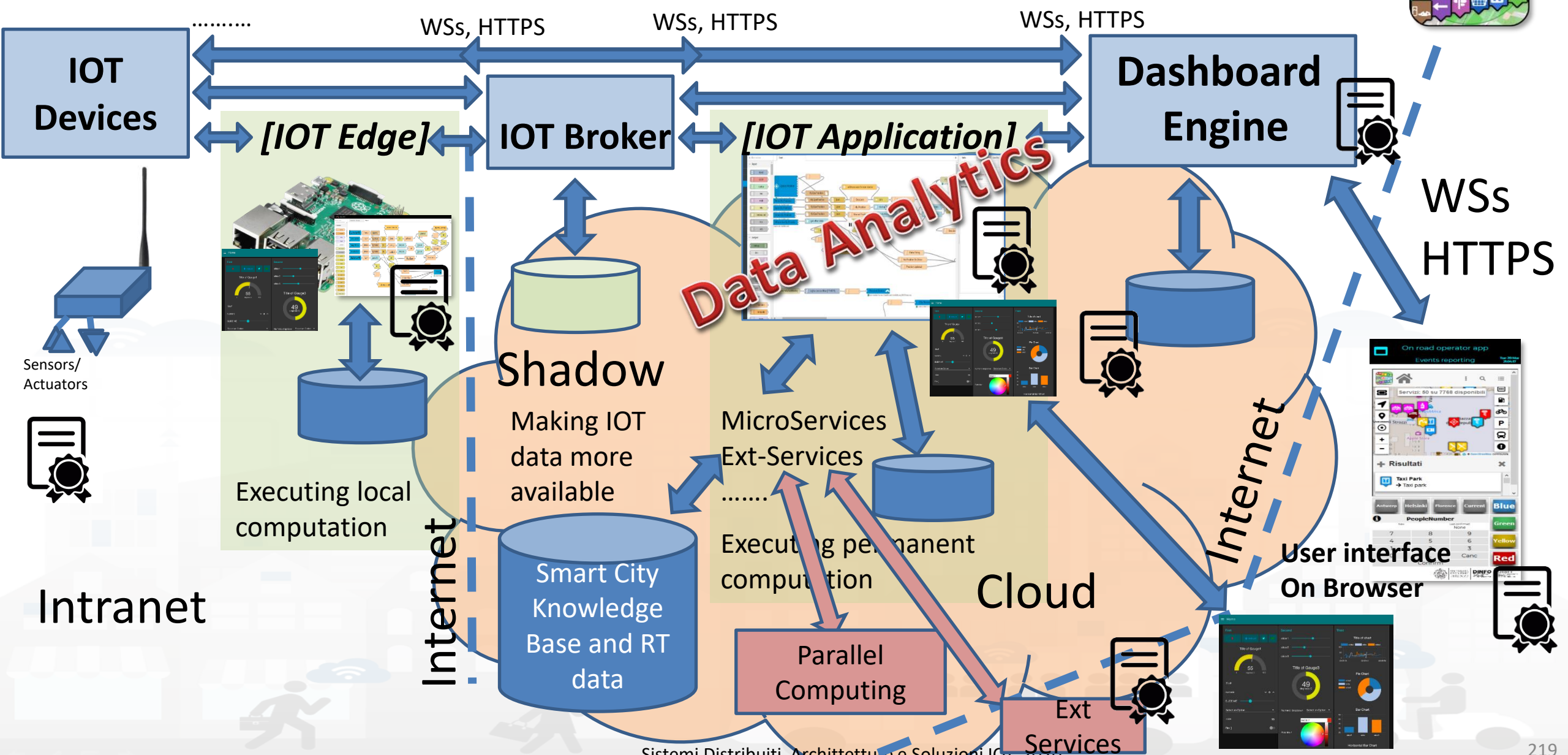
- **Users are going to decide to:**
  - provide access to who, for do what, until we consent
  - accept terms of use by **signed consent for each data management service**, *before was a simple informed consent*
- **from each service, the user has to be capable to**
  - **See** what the provider collect in terms of its Data Type: traces, logs, paths, profiles, accesses, IOT devices, sensors, maps, etc.
  - **Download, delete, inspect** each single Data Type
  - **Auditing and Revoke access or grant** access right to **each single Data Type**
  - **Delete all Data Types in single shot** or singularly (**forget all about me**)
- Correctness
- Transparency
- Security
- Integrity
- Privacy
- Auditing
- ....

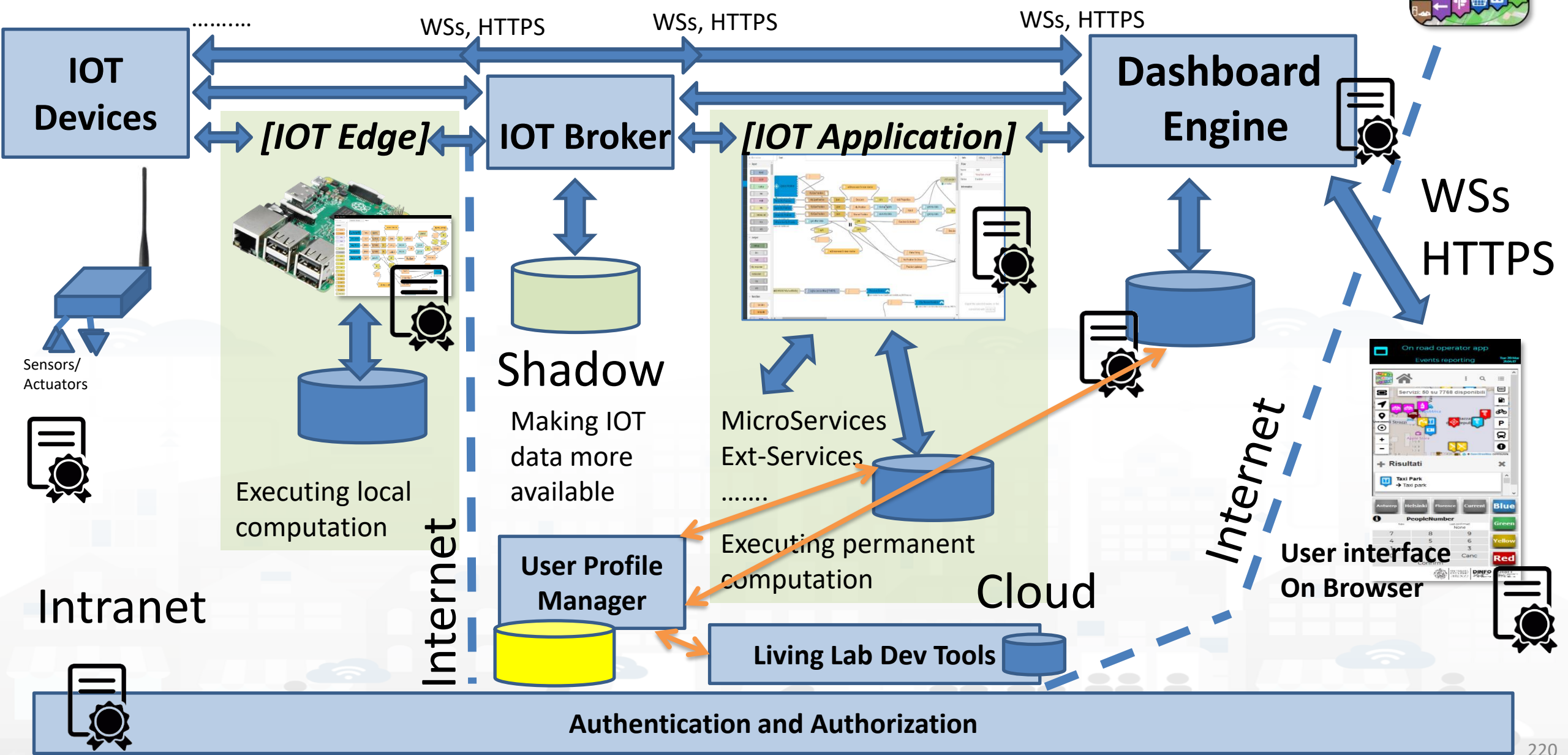


# GDPR: General Data Protection Regulation

- If personal data are **published by the owner**
  - the data have to be **released anonymously**,  
→ also in this case they can be **revoked at any time**:
  - **Complexity reside on:** *distributed vs centralized control, revoke of Votes/scores, comments, .... If they are saved singularly or they already exploited in processing*
- GDPR also imposes **Technical Constraints** such as:
  - **Secure connection** in any private data exchange
  - **Encrypted** data store for all private data
  - **Decoupling** data and personal IDs
  - Allow the **Auditing** of private data usage
- **Relevant taxation** is foreseen when rules are violated, % of turnover









# GDPR Compliant

## My Personal Data Types

- My profile data and Blogs
- [My personal data by IOT App](#)
- My IOT sensor data service URI
- My IOT sensor data service GraphID
- My Annotation data
- My IOT Devices
- My IOT Applications
- My Dashboards
- Auditing Access to My Data

Forget me all!

- Manage Profile and MyPersonalData
- For each Data Type:
  - Start as private → making them public (anonymous) and revoke
  - The Owner is the only one that can: (1) modify values; (2) change the ownership
  - Define/revoke Delegation to Access
  - Delete/forget per Data Type and “me all!”.
  - Auditing

# Managing **MyPersonalData** in secure manner



## Examples:

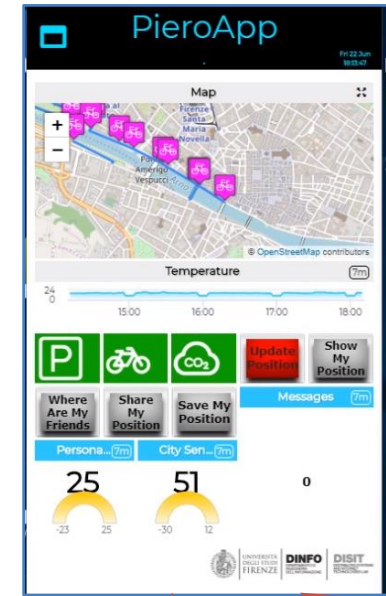
- 1) Social IOT: A group of friends share some data with other according to GDPR: GPS position, Medical parameters as Glucose, etc.
- 2) saving and retrieve personal sensitive information.

The users manage their Personal data via personal mobile Dash and IOT App, and configuration on the portal and/or Mobile App

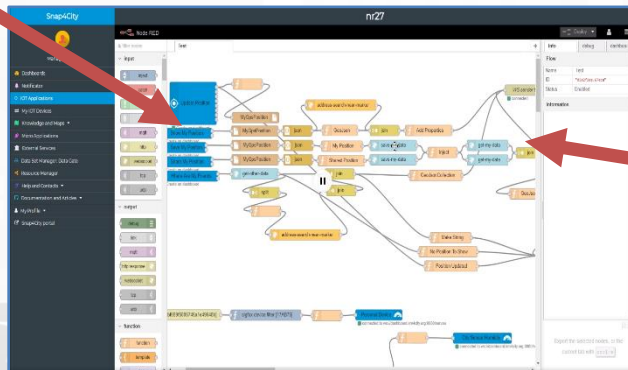
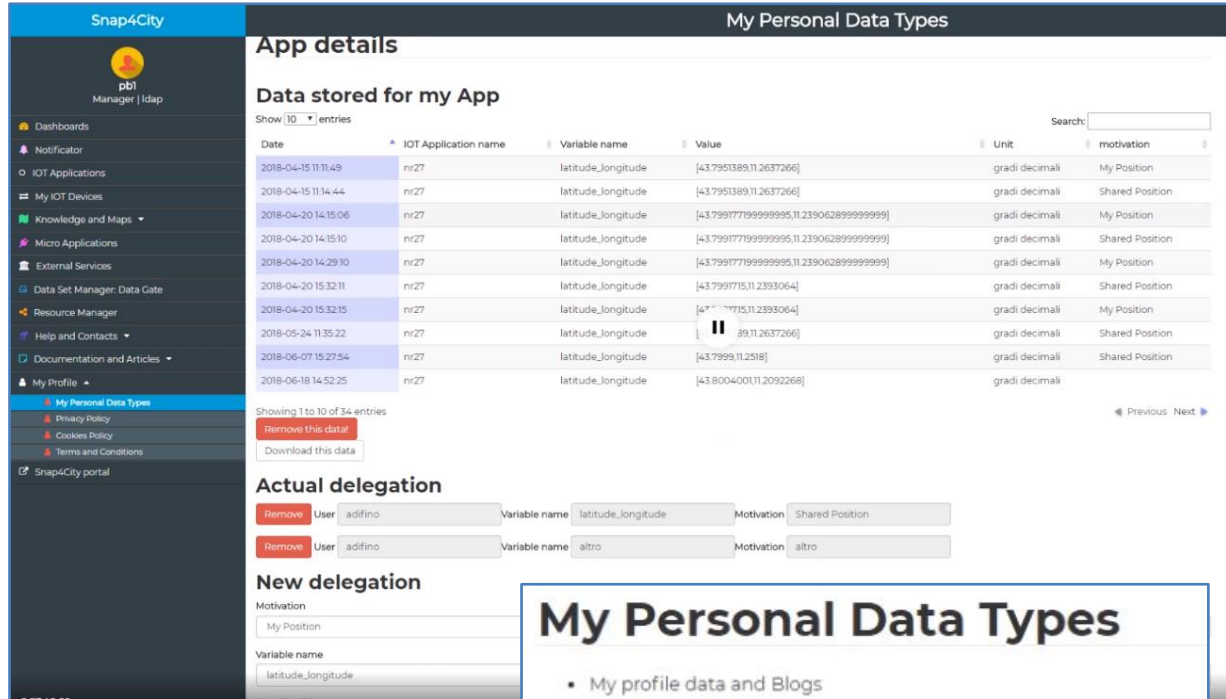
# Managing **MyPersonalData** in secure manner

## Example:

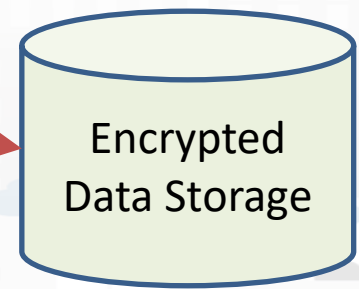
- Piero shares some data with selected friends according to GDPR: GPS data position
- He managed the data via personal mobile Dashboard and IOT Application



Smart City  
Services and  
IOT/IOE

Date	IOT Application name	Variable name	Value	Unit	motivation
2018-04-15 11:11:49	nr27	latitude_longitude	[43.7951389;11.2637266]	gradi decimali	My Position
2018-04-15 11:14:44	nr27	latitude_longitude	[43.7951389;11.2637266]	gradi decimali	Shared Position
2018-04-20 14:15:06	nr27	latitude_longitude	[43.79977799999995;11.239062899999999]	gradi decimali	My Position
2018-04-20 14:15:10	nr27	latitude_longitude	[43.79977799999995;11.239062899999999]	gradi decimali	Shared Position
2018-04-20 14:29:10	nr27	latitude_longitude	[43.79977799999995;11.239062899999999]	gradi decimali	My Position
2018-04-20 15:32:11	nr27	latitude_longitude	[43.79977799999995;11.239062899999999]	gradi decimali	Shared Position
2018-04-20 15:32:35	nr27	latitude_longitude	[43.79977799999995;11.239062899999999]	gradi decimali	My Position
2018-05-24 11:35:22	nr27	latitude_longitude	[43.79977799999995;11.2637266]	gradi decimali	Shared Position
2018-06-07 15:27:54	nr27	latitude_longitude	[43.7999;11.2518]	gradi decimali	Shared Position
2018-06-18 14:52:25	nr27	latitude_longitude	[43.80040011;11.2092268]	gradi decimali	



### My Personal Data Types

- My profile data and Blogs
- [My personal data by IOT App](#)
- My IOT sensor data service URI
- My IOT sensor data service GraphID
- My Annotation data
- My IOT Devices
- My IOT Applications
- My Dashboards
- Auditing Access to My Data

Forget me all!



# Some Consideration on GDPR

- **Complexity of GDPR with end-to-end secure connections**
  - IOT Platforms as AWS, Microsoft Azure, Google IOT, etc. are not compliant yet.
  - Smart city GIS platforms as ESRI ArcGIS are not compliant yet.
  - Many Smart City platforms are not compliant yet.
- **Limitations are usually applied to simplify the solutions**
  - Limiting the number of supported protocols
  - Selling proprietary devices that may be attached on that secure chain
- **Snap4City is resulting platform developed for Helsinki and Antwerp to satisfy the above described requirements in Open Source**



# Further Reading





- P. Bellini, D. Cenni, M. Marazzini, N. Mitolo, P. Nesi, M. Paolucci, "Smart City Control Room Dashboards: Big Data Infrastructure, from data to decision support", accepted for publication Journal of Visual Languages and Computing, 10.18293/VLSS2018-030
- L. Massai, P. Nesi, G. Pantaleo, "PAVAL: A location-aware virtual personal assistant for re-trieving geolocated points of interest and location-based services", accepted for publication on Journal Engineering Applications of Artificial Intelligence, Elsevier, <https://www.sciencedirect.com/science/article/pii/S0952197618301994>
- C. Badii, P. Nesi, I. Paoli, "Predicting available parking slots on critical and regular services exploiting a range of open data", IEEE Access, preprint, 2018, <https://ieeexplore.ieee.org/abstract/document/8430514/>
- P. Bellini, P. Nesi, "Performance Assessment of RDF Graph Databases for Smart City Services", Journal of Visual Language and Computing, Elsevier, 2018. <https://doi.org/10.1016/j.jvlc.2018.03.002>
- P. Nesi, G. Pantaleo, I. Paoli, I. Zaza, "Assessing the reTweet Proneness of tweets: predictive models for retweeting", Multimedia Tools and Applications, Springer, 2018. <https://link.springer.com/article/10.1007/s11042-018-5865-0> <https://link.springer.com/article/10.1007/s11042-018-5865-0>
- P. Bellini, D. Cenni, P. Nesi, I. Paoli, "Wi-Fi Based City Users' Behaviour Analysis for Smart City", Journal of Visual Language and Computing, Elsevier, 2017. <http://www.sciencedirect.com/science/article/pii/S1045926X17300083>
- E. Bellini, P. Ceravolo, P. Nesi, "Quantify resilience enhancement of UTS through exploiting connected community and internet of everything emerging technologies", 2017, <http://hdl.handle.net/2158/1105460>, ACM TRANSACTIONS ON INTERNET TECHNOLOGY <https://dl.acm.org/citation.cfm?id=3137572>
- V. Grasso, A. Crisci, M. Morabito, P. Nesi, G. Pantaleo, "Public crowdsensing of heat waves by social media data", Adv. Sci. Res., 14, 217-226, <https://doi.org/10.5194/asr-14-217-2017>, 2017, [10.5194/asr-14-217-2017](https://doi.org/10.5194/asr-14-217-2017) . <http://www.adv-sci-res.net/14/217/2017/>



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FIRENZE

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DIPARTIMENTO DI  
INGEGNERIA  
DELL'INFORMAZIONE

**DISIT**  
DISTRIBUTED SYSTEMS  
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TECHNOLOGIES LAB  
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Articles



**SNAP4CITY**



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# Articles



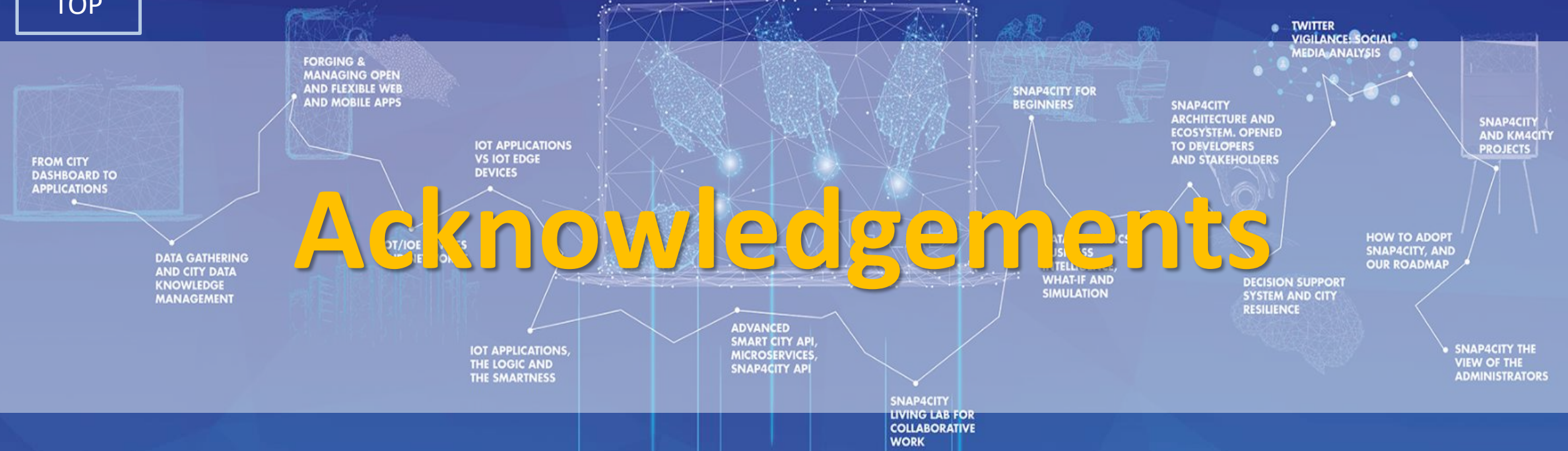
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## references

- <https://www.snap4city.org>
  - It contains about 30 articles, 20 video and 150 Tutorials about the platforms
- <https://www.km4city.org>
  - If contains about video and a number of technical manuals

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# Acknowledgements



# Acknowledgements

- Thanks to the European Commission for founding. All slides reporting logo of **Snap4City** <https://www.snap4city.org> of **Select4Cities H2020** are representing tools and research founded by European Commission for the **Select4Cities** project. **Select4Cities** has received funding from the European Research Council (ERC) under the European Union's Horizon 2020 research and innovation Programme (grant agreement n° 688196)
- **TRAFAIR** is a CEF project. All slides reporting logo of TRAFAIR project are representing tools and research founded by the EC on CEF programme <http://trafair.eu/>
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- **Km4City** is an open technology and research line of DISIT Lab exploited by a number of projects. Some of the innovative solutions and research issues developed into projects are also compliant and contributing to the Km4City approach and thus are released as open sources and are interoperable, scalable, modular, standard compliant, etc.



Horizon 2020  
European Union Funding  
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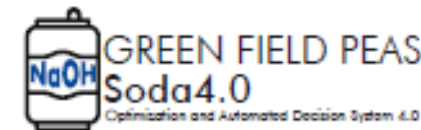
INEA CEF-TELECOM Project  
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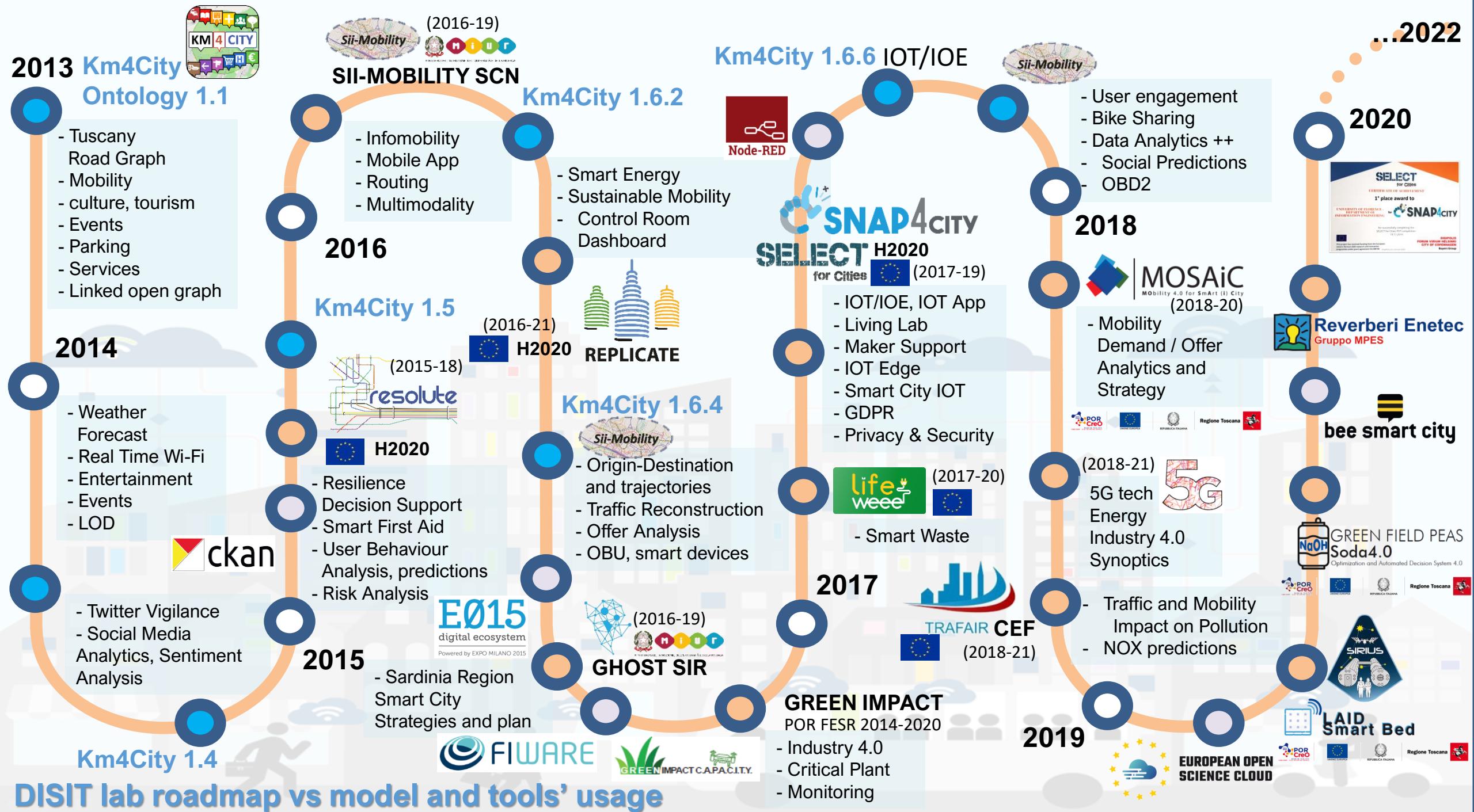


Horizon 2020  
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European Union Funding  
for Research & Innovation





**Km4City 1.6.6 IOT/IOE**



**2018**



**bee smart city**



**SELECT H2020 for Cities** (2017-19)

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



**2017**



**GREEN IMPACT** POR FESR 2014-2020



**Km4City 1.6.4**



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



**GHOST SIR**



**2015**

- Sardinia Region Smart City Strategies and plan



**Km4City 1.5**



**H2020**

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



**REPLICATE** (2016-21)



**SII-MOBILITY SCN** (2016-19)

- Infomobility
- Mobile App
- Routing
- Multimodality



**Km4City 1.4**

**DISIT lab roadmap vs model and tools' usage**



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*Be smart in a SNAP!*

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● **END**