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

SNAP4CITY

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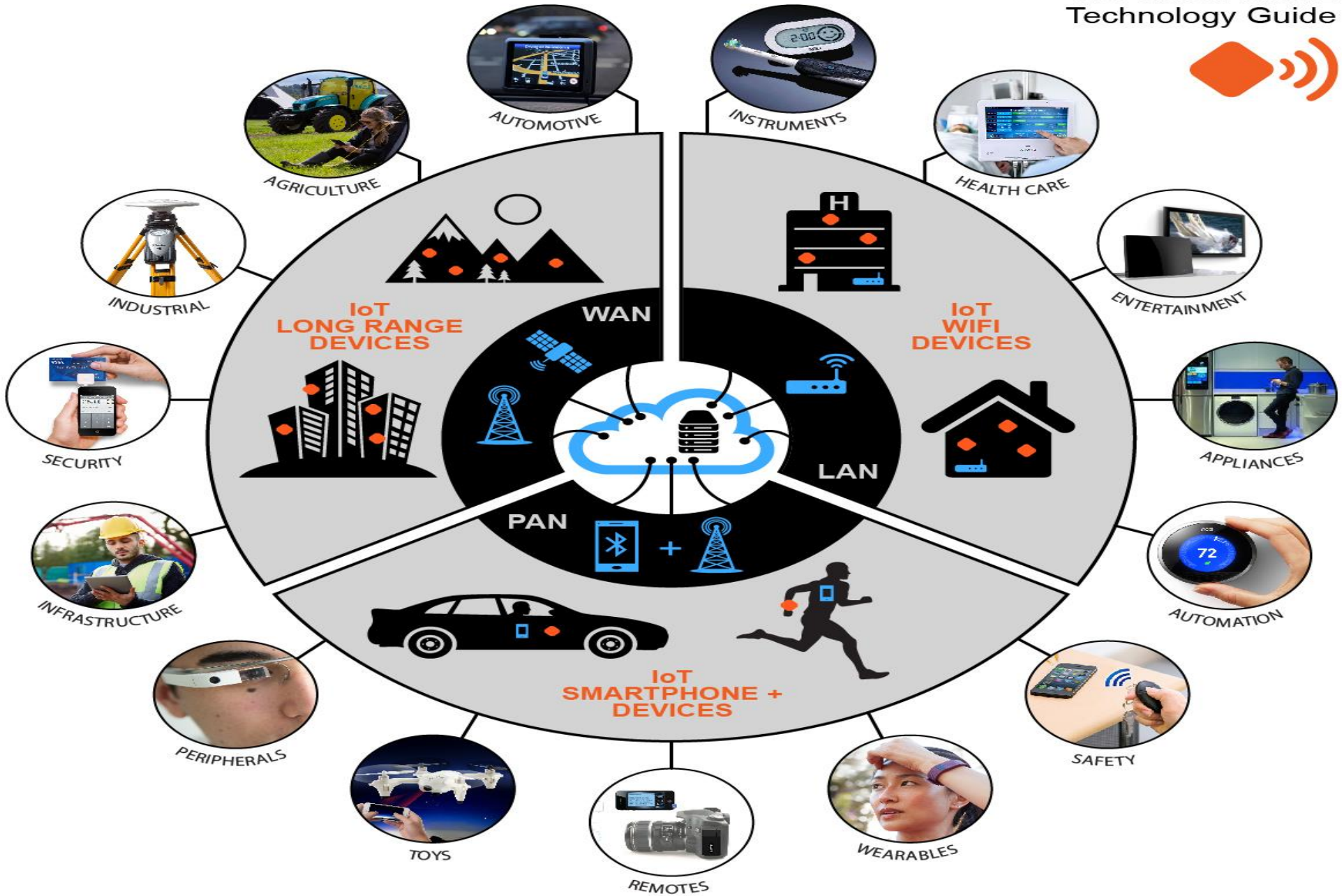
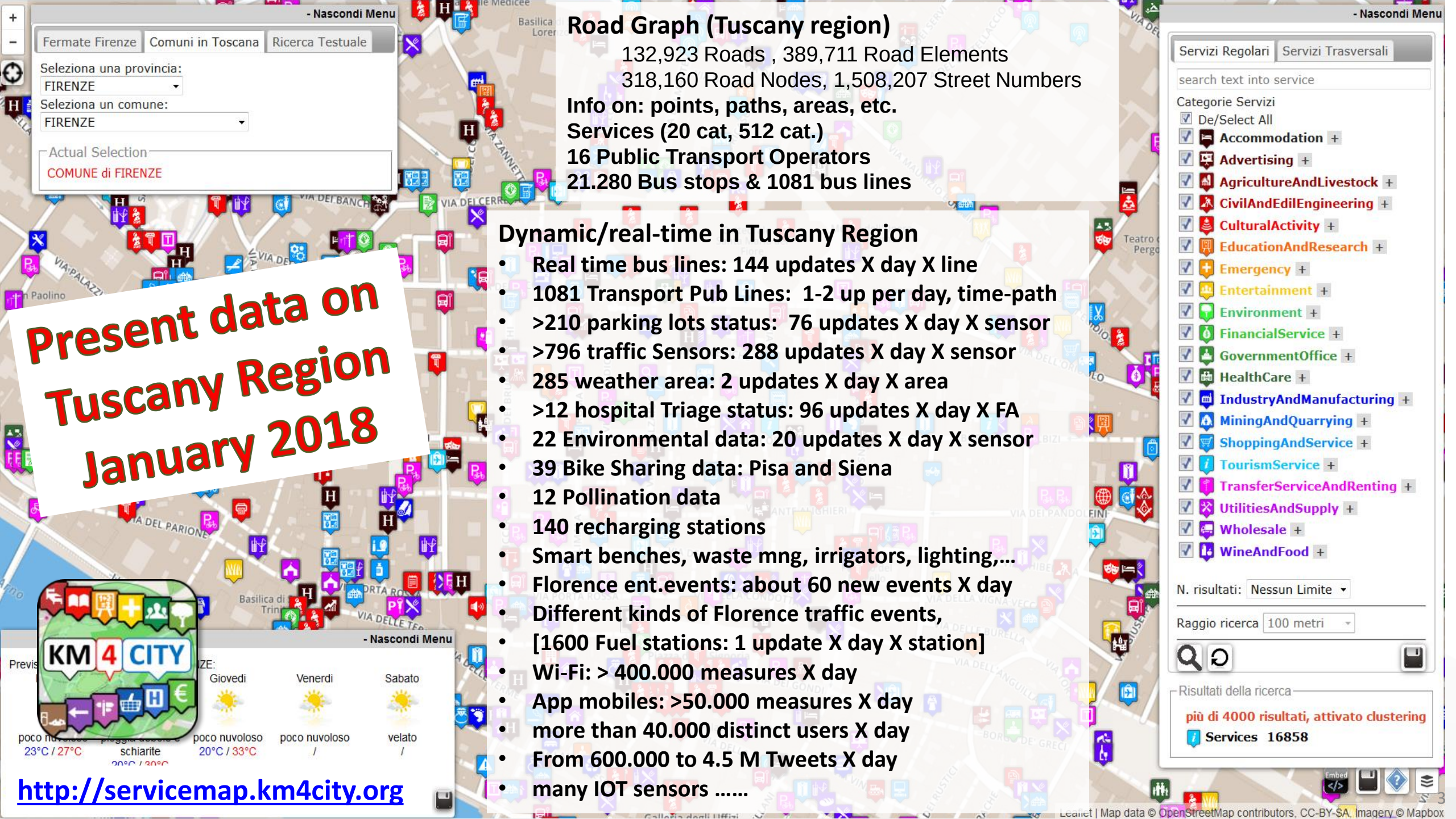
Sistemi Distribuiti, Architetture e Soluzioni IOT

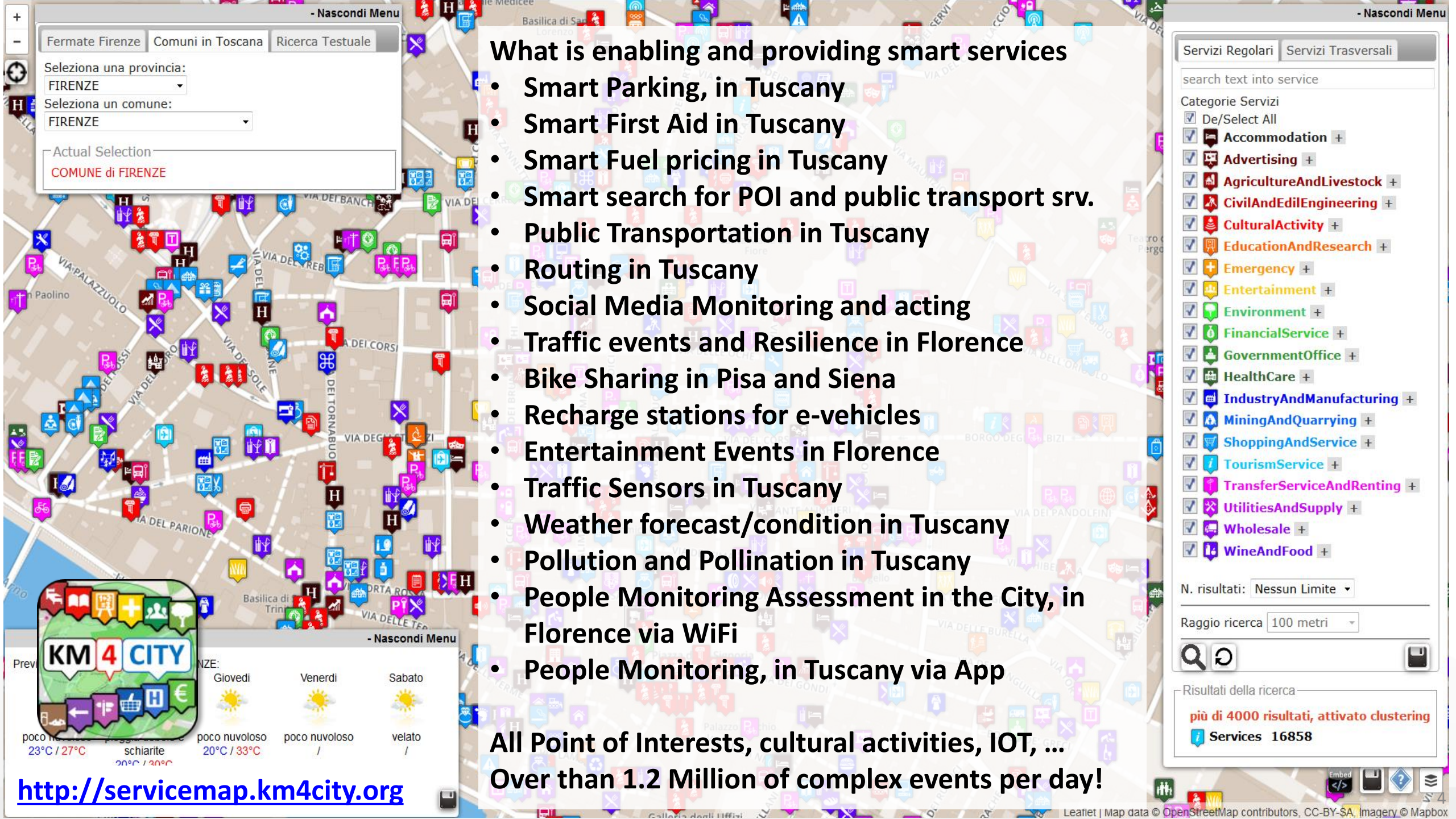
https://www.snap4City.org https://www.Km4City.org

https://www.disit.org/

Paolo Nesi, paolo.nesi@unifi.it


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


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



What is enabling and providing smart services

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

All Point of Interests, cultural activities, IOT, …

Over than 1.2 Million of complex events per day!

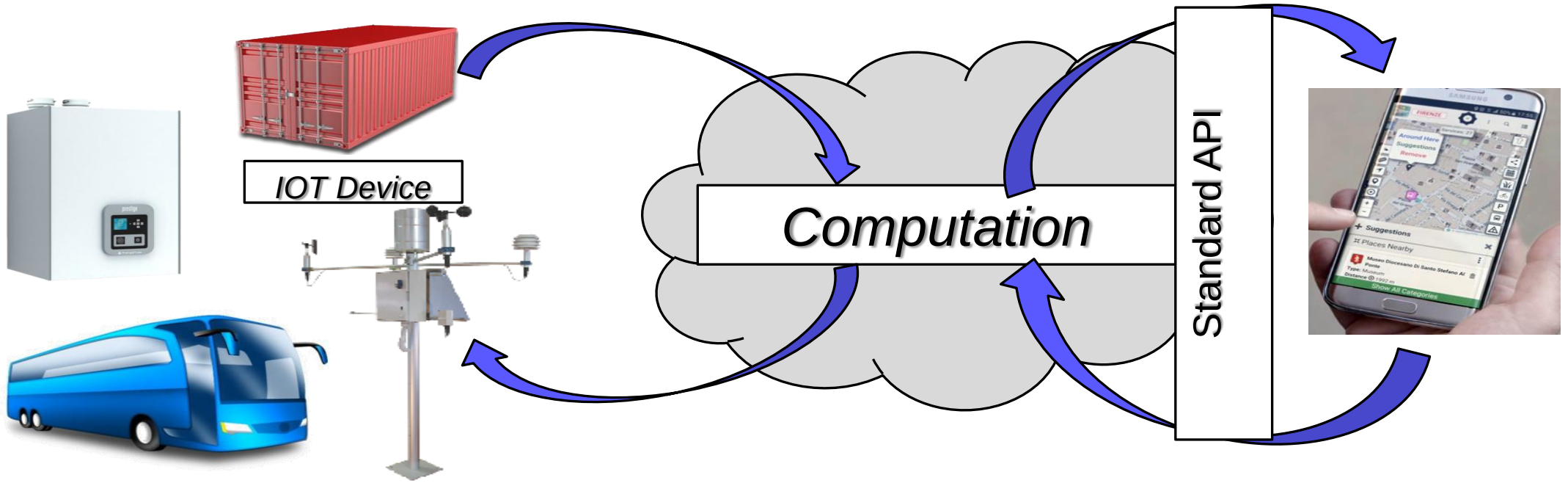
http://servicemap.km4city.org

IOT Solutions

IOT Main Concept

The implementation of smart services may implies the:

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



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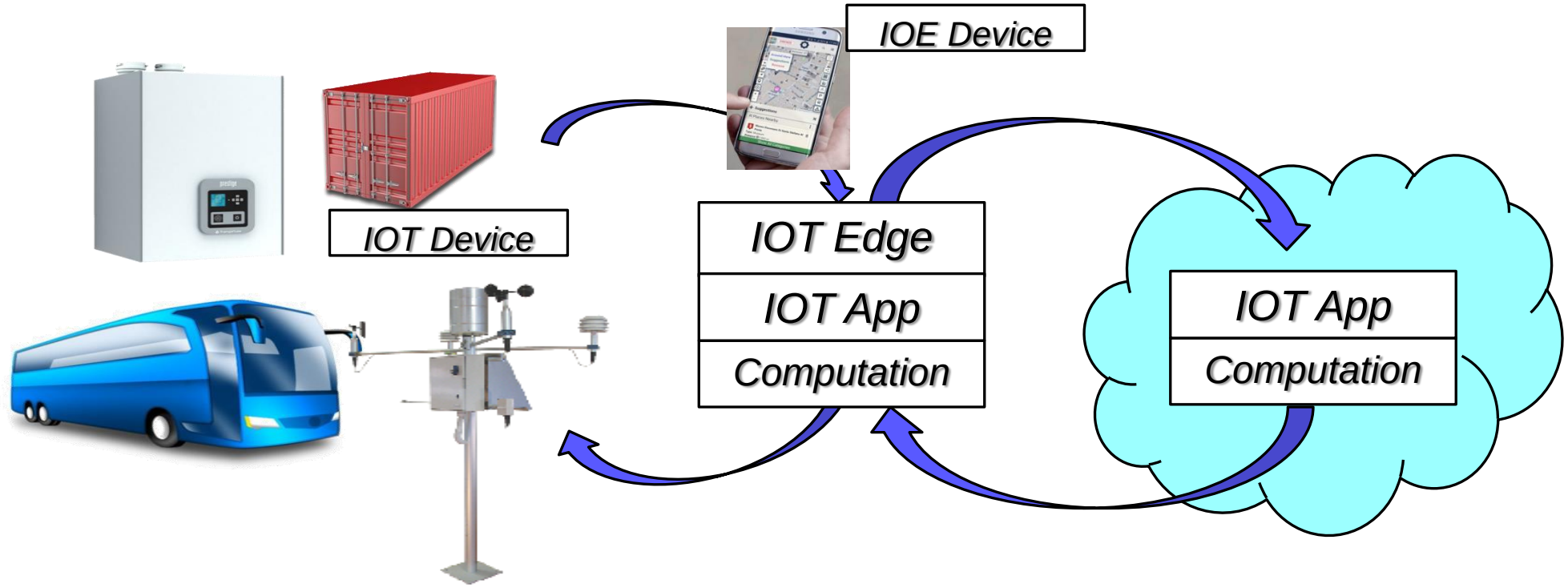
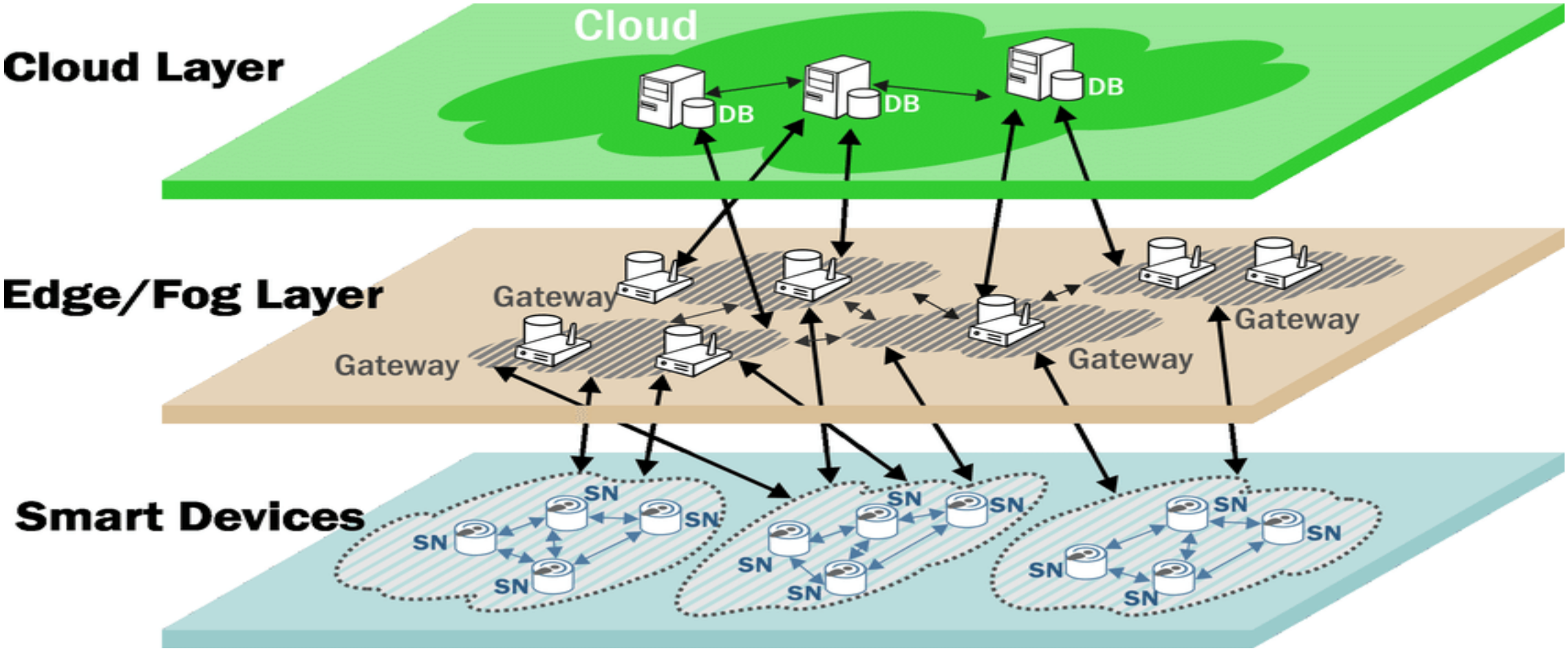
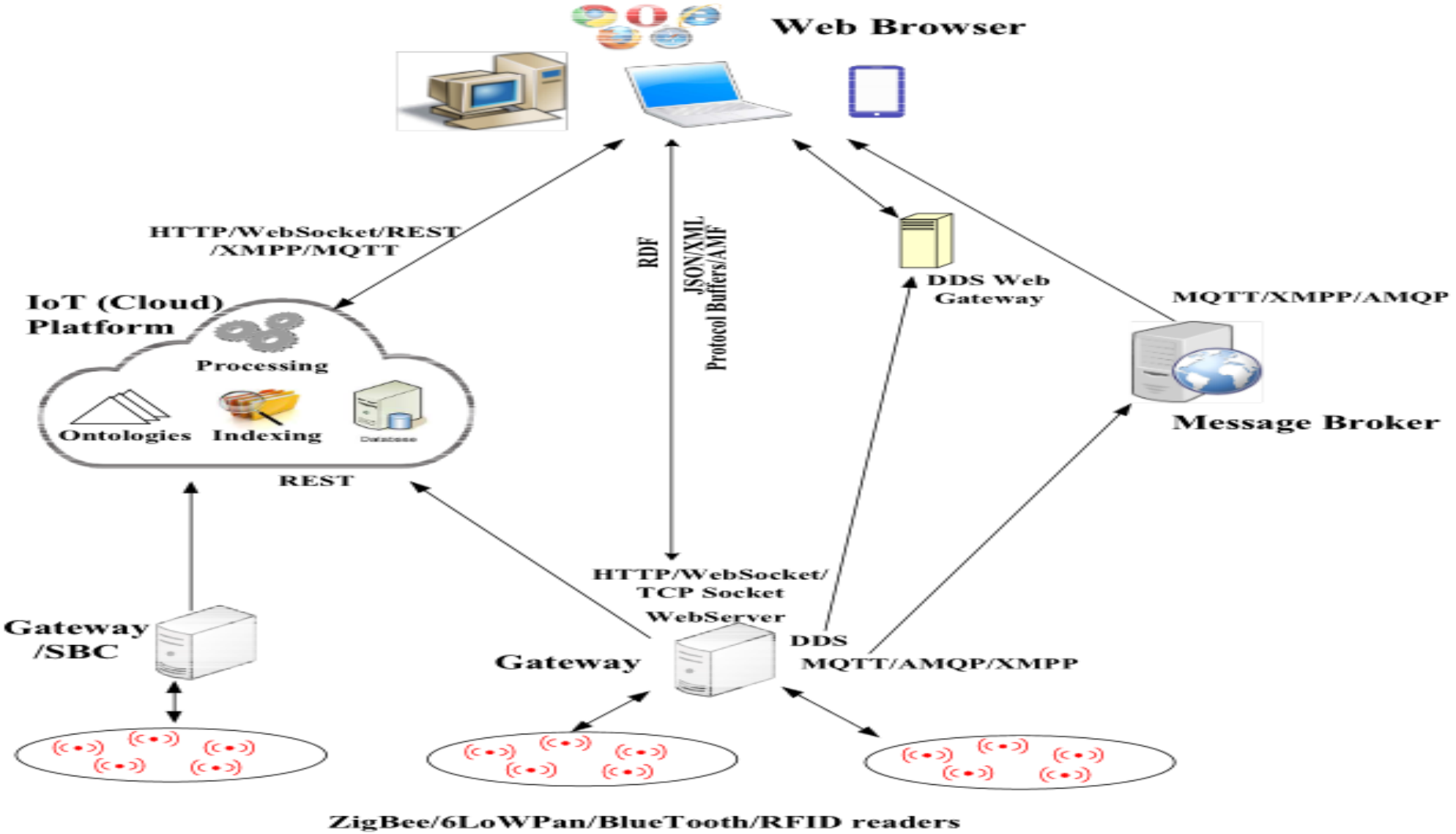
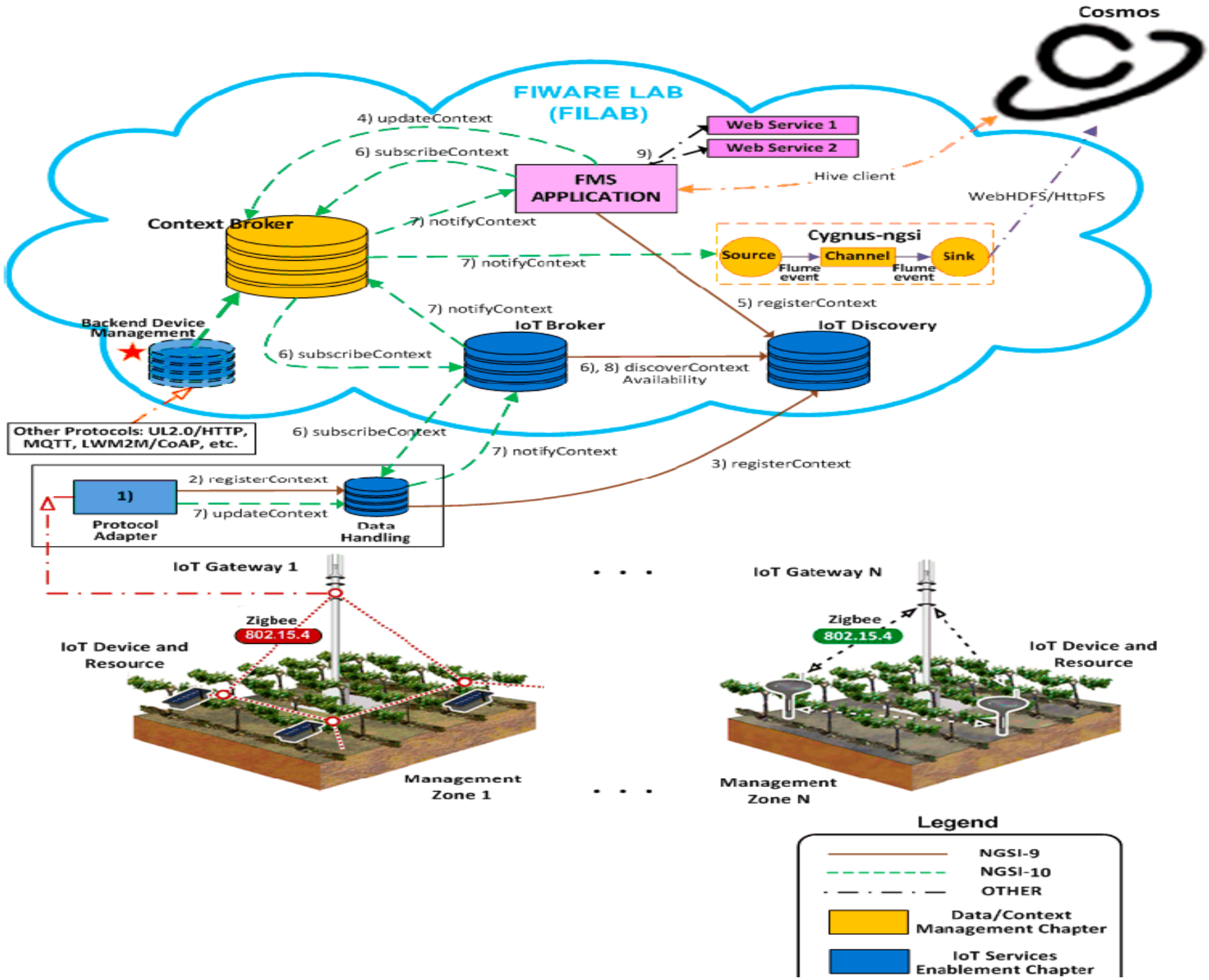


Cloud vs Fog/Edge Computing



Edge Computing, Fog Computing

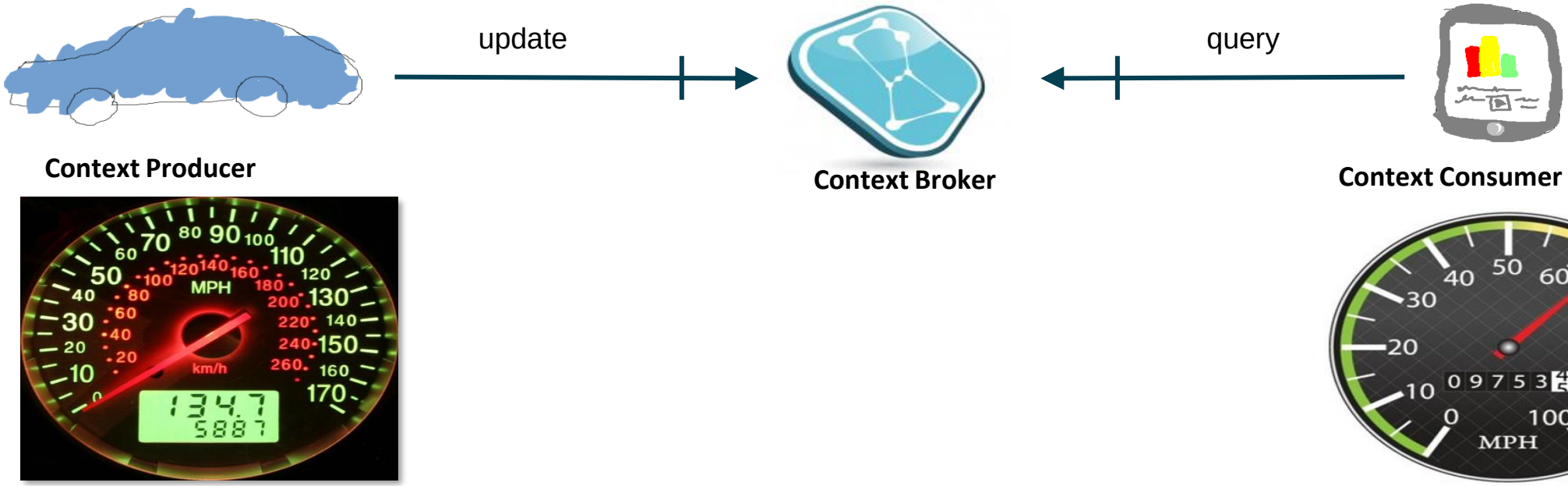



Cosmos
FIWARE LAB (FILAB)
4) updateContext
6) subscribeContext
9)
Web Service 1
Web Service 2
FMS APPLICATION
Hive client
WebHDFS/HttpFS
Context Broker
7) notifyContext
Cygnus-ngsi
Source
Channel
Sink
Flume event
Flume event
5) registerContext
Backend Device Management
IoT Broker
IoT Discovery
6), 8) discoverContext Availability
Other Protocols: UL2.0/HTTP, MQTT, LWM2M/CoAP, etc.
2) registerContext
1)
7) updateContext
Protocol Adapter
Data Handling
3) registerContext
IoT Gateway 1
IoT Gateway N
Zigbee 802.15.4
IoT Device and Resource
Management Zone 1
Management Zone N
Legend
NGSI-9
NGSI-10
OTHER
Data/Context Management Chapter
IoT Services Enablement Chapter

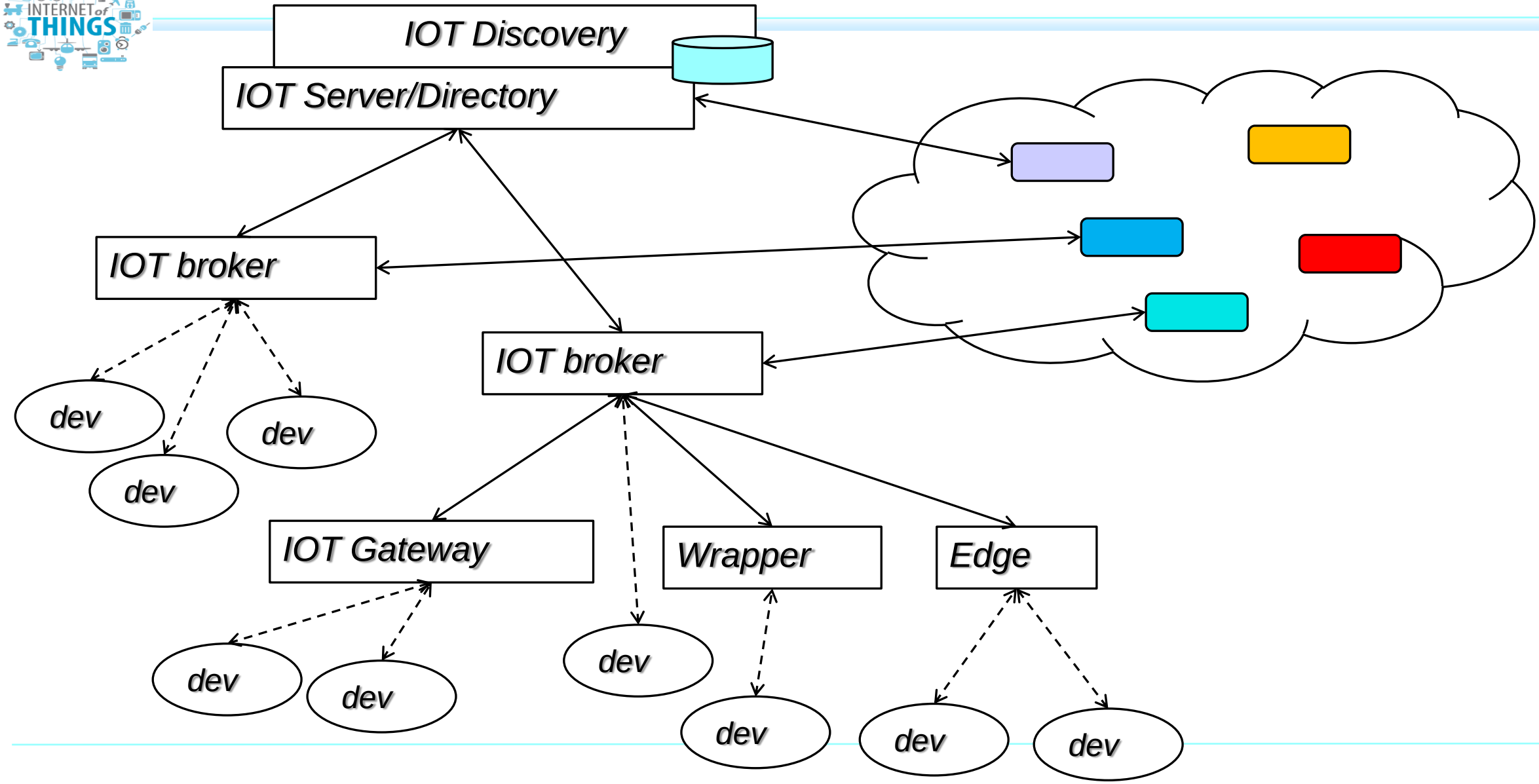
IOT Context Broker

Context Broker operations: create & pull data

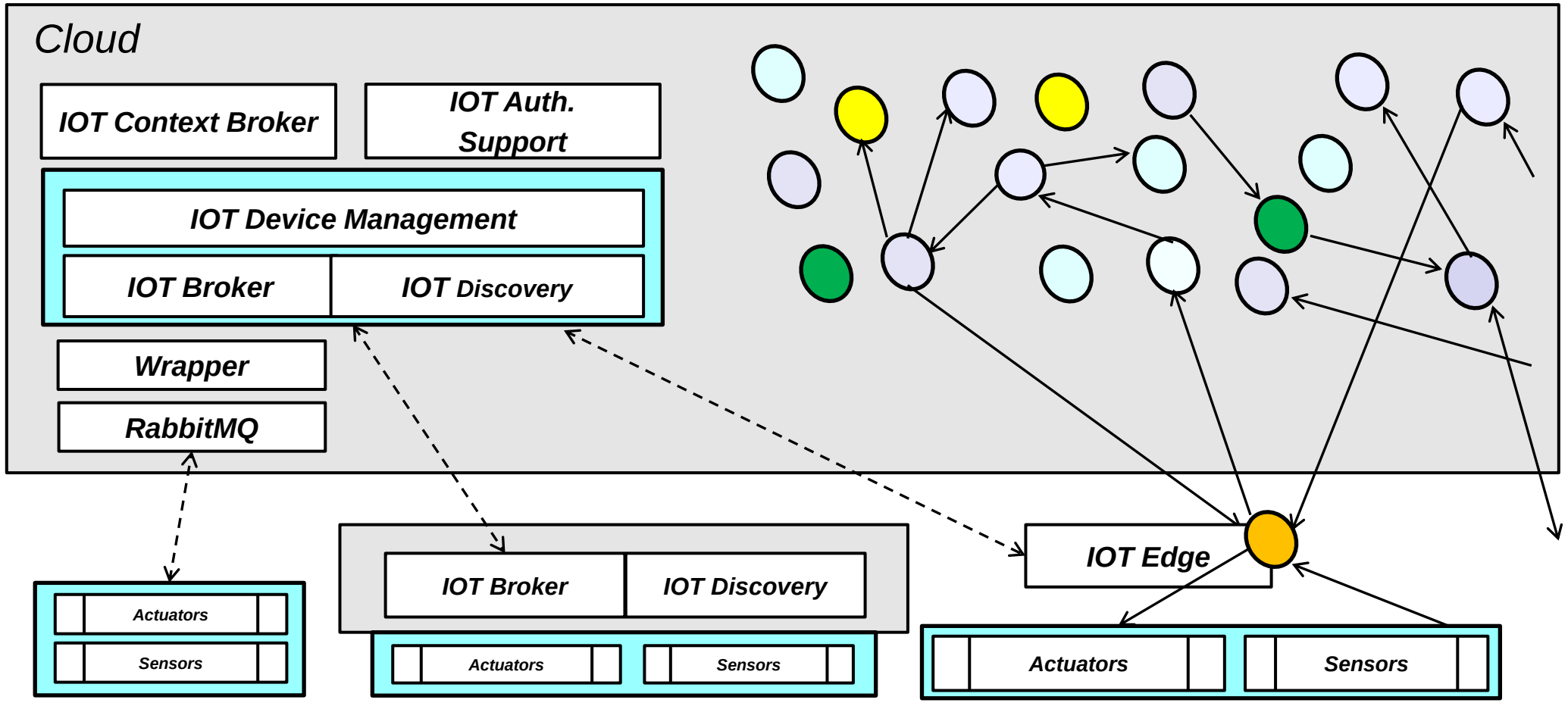
- **Context Producers** publish data/context elements by invoking the **update** operations on a Context Broker.
- **Context Consumers** can retrieve data/context elements by invoking the **query** operations on a Context Broker



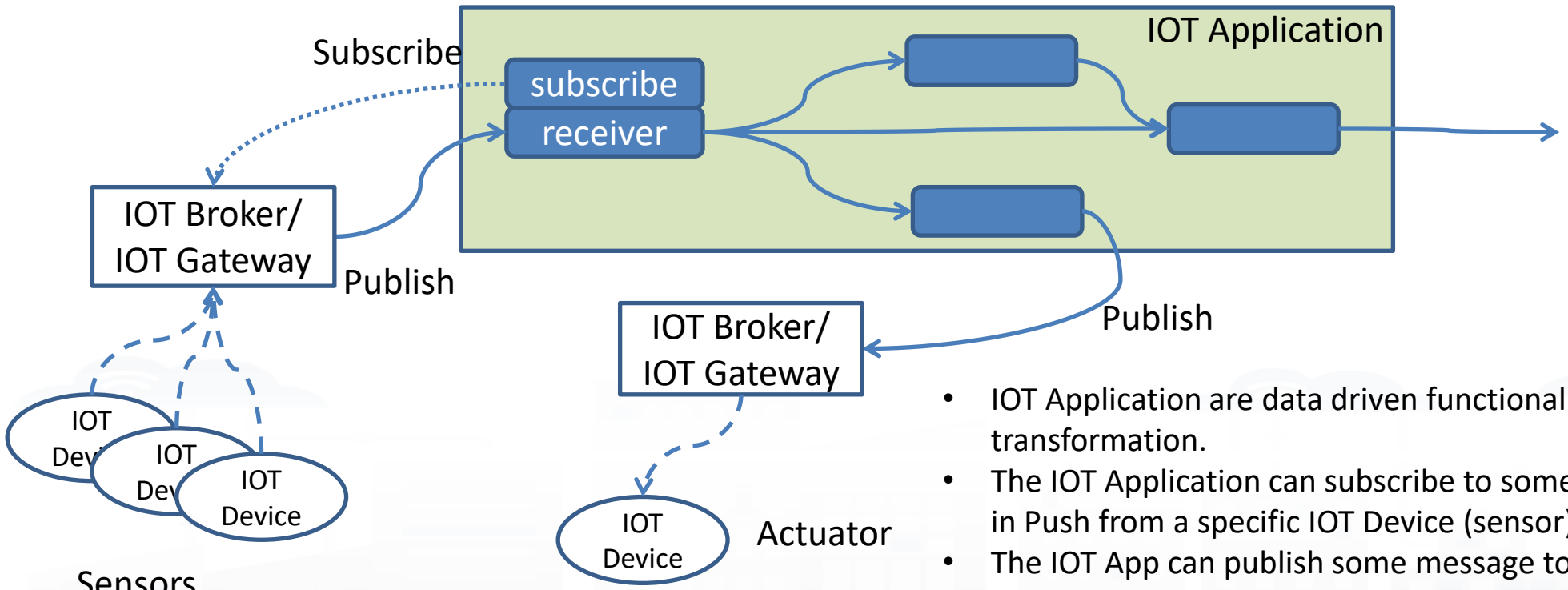
architettura



Conceptual architecture



IOT Basic

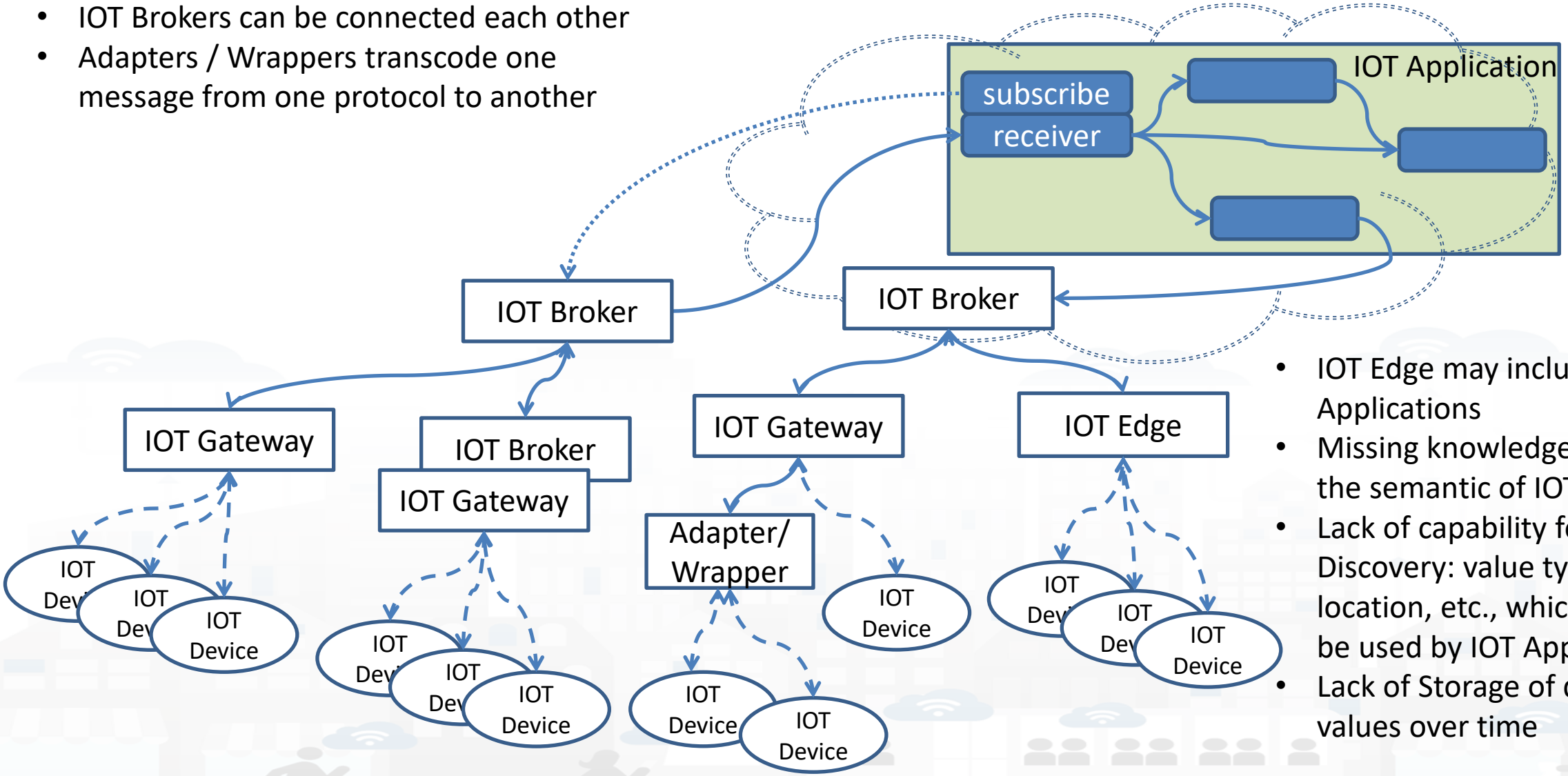


- Sensors are programmed to send data (i) periodically, or (ii) when a relevant change occurs in the sensor value, or (iii) when events occur (for example a change of status of something), etc.
- Actuator perform some action on the field: change of status, reset, turn on something, change setting value,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

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

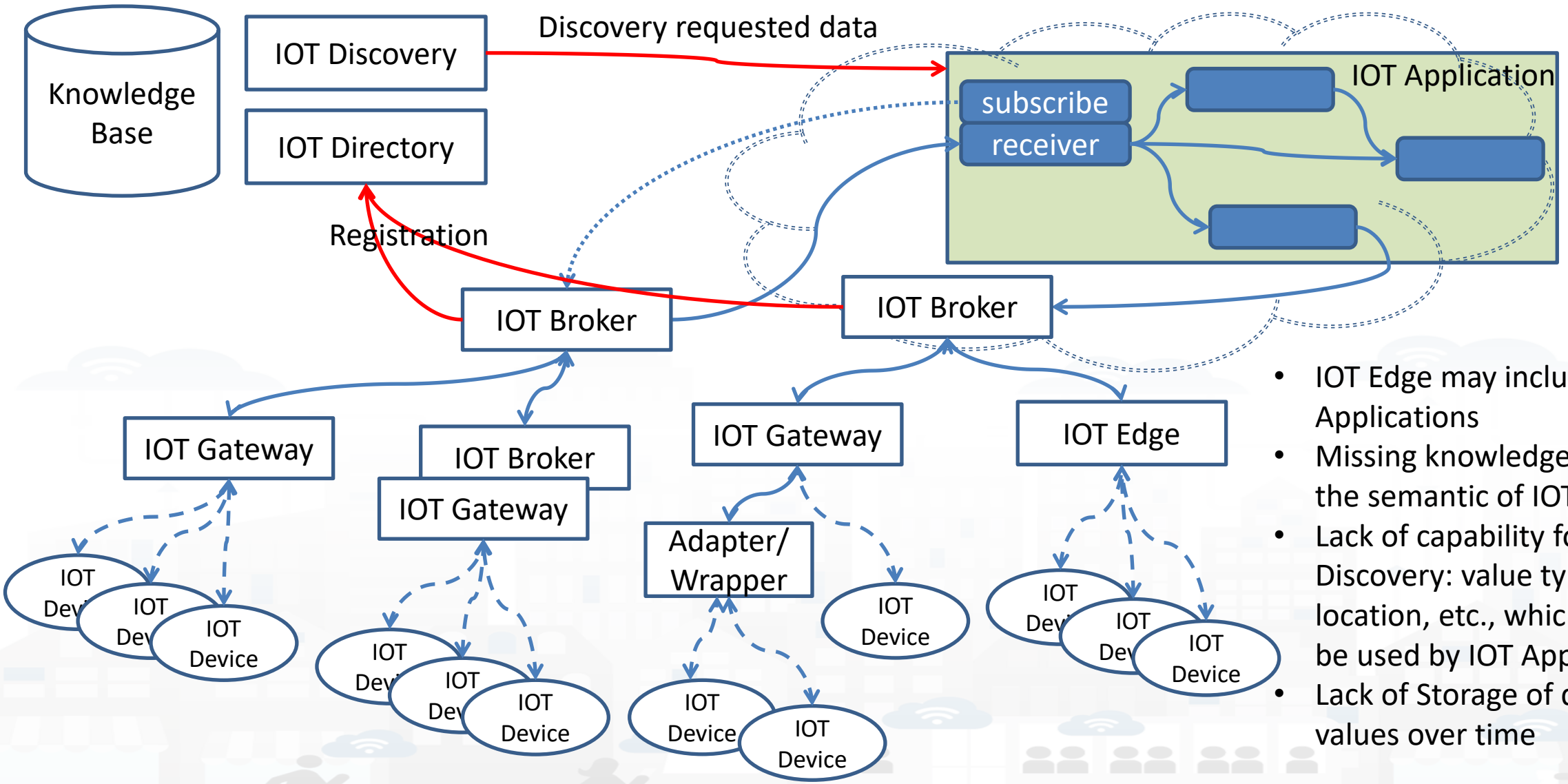
Definitions

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



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

Definitions



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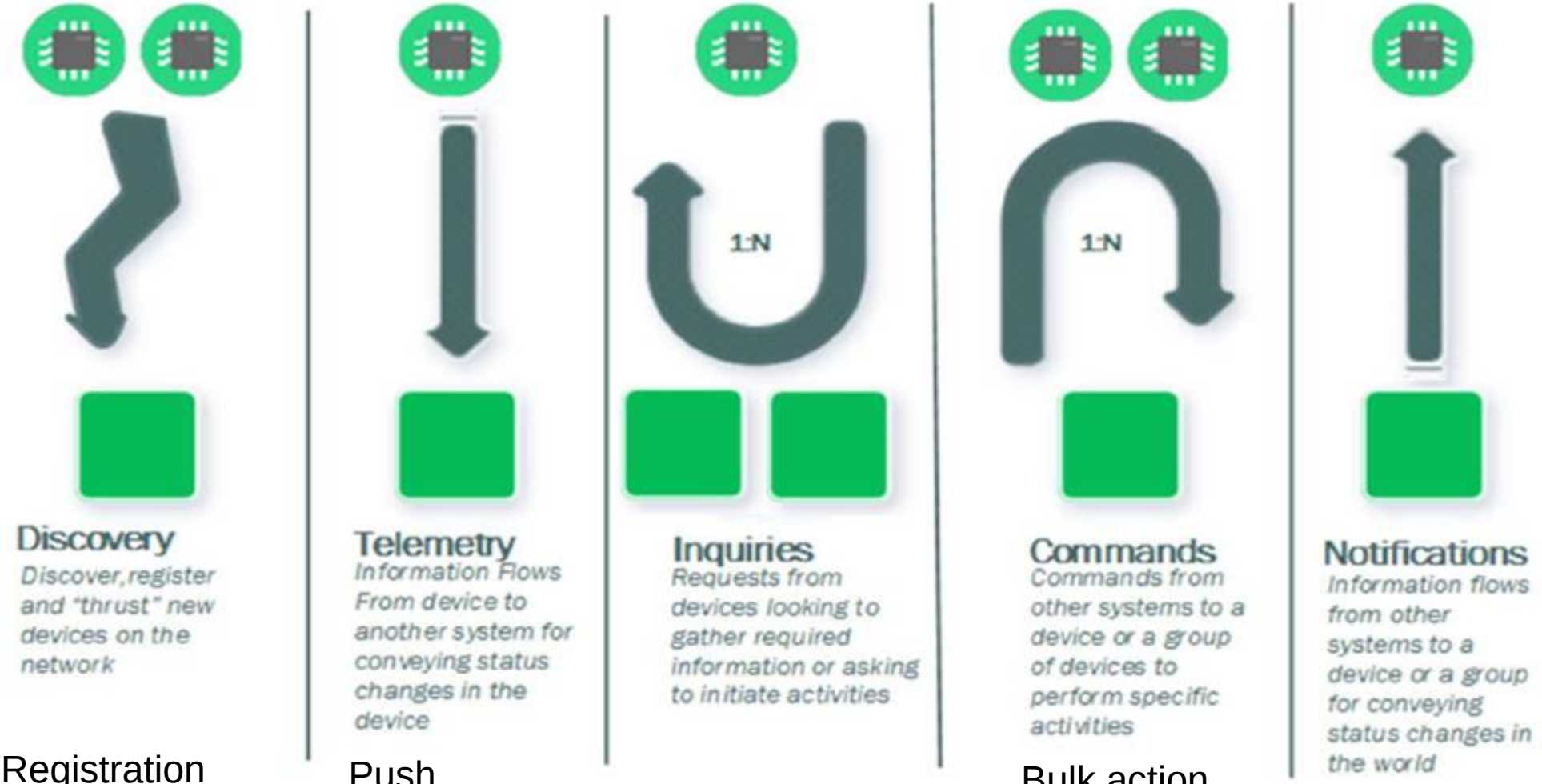
- Missing knowledge about the semantic of IOT devices
- Lack of capability for IOT Discovery: value type, location, etc., which could be used by IOT App
- Lack of Storage of data values over time

IOT/IOE Protocols

Communication Patterns



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

Registration

Push

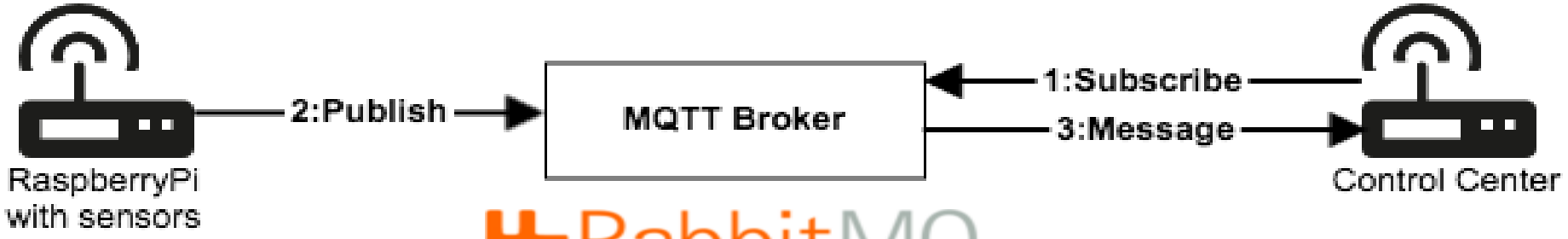
Bulk action

Note on Communication patterns

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

IOT Brokers

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



IOT stack protocols

Session		**MQTT, SMQTT, CoRE, DDS, AMQP , XMPP, CoAP, …**
Network	**Encapsulation**	**6LowPAN, 6TiSCH, 6Lo,** Thread, …
	Routing	**RPL, CORPL, CARP, …**
Datalink		WiFi, **Bluetooth Low Energy, Z-Wave, ZigBee Smart, DECT/ULE,** 3G/LTE, NFC, **Weightless, HomePlug GP, 802.11ah, 802.15.4e, G.9959, WirelessHART, DASH7,** ANT+, **LTE-A, LoRaWAN, …**

Security
TCG, Oath 2.0, SMACK, SASL, ISASecure, ace, DTLS, Dice, …

Management
IEEE 1905, IEEE 1451, …

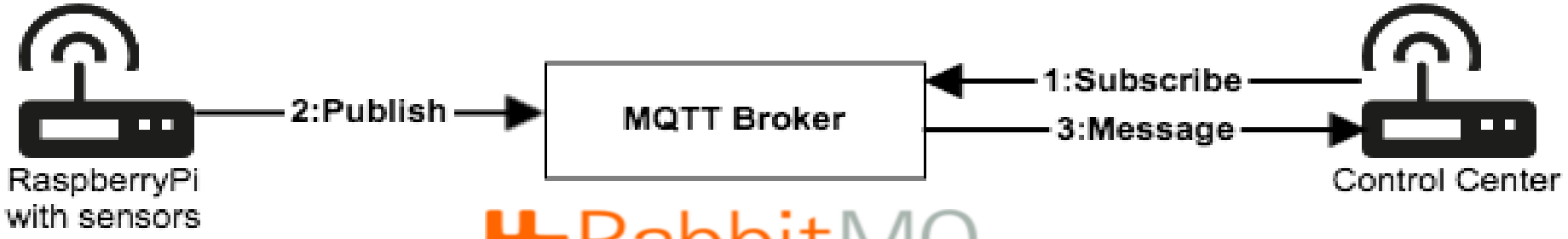
https://www.cse.wustl.edu/~jain/cse570-15/ftp/iot_prot/

http GET vs POST

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

IOT Brokers

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

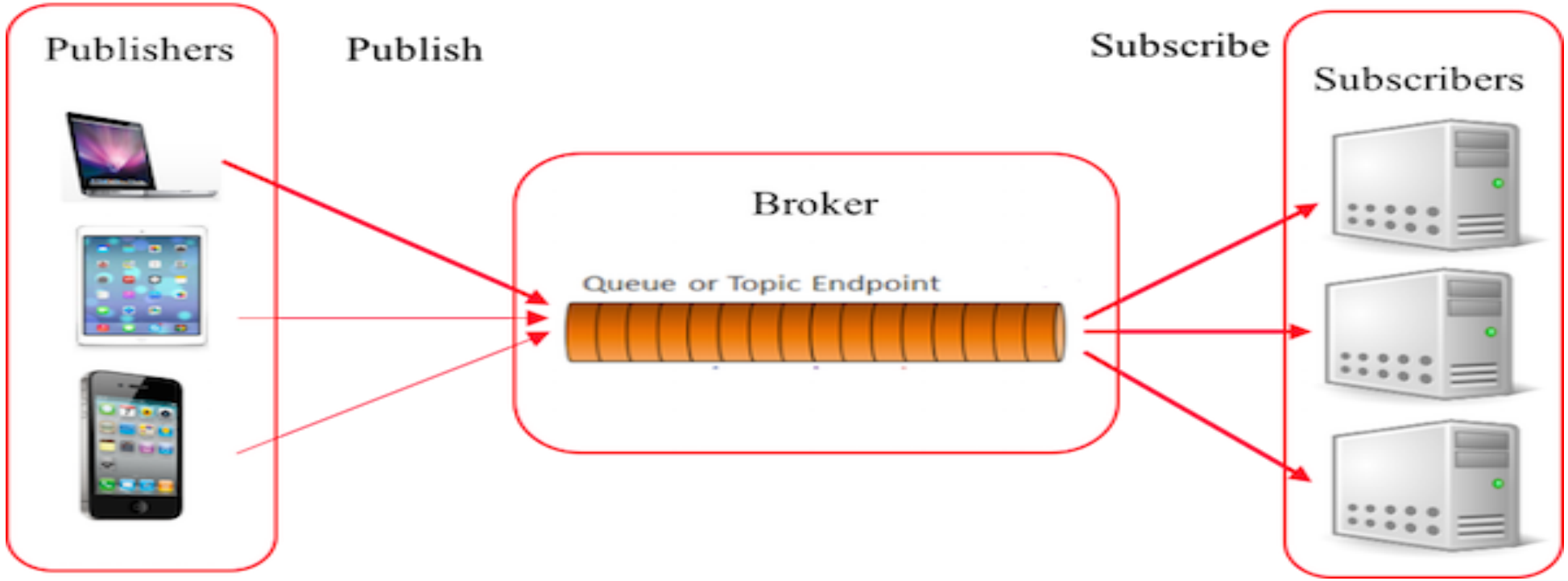


Comparison high level IOT protocols

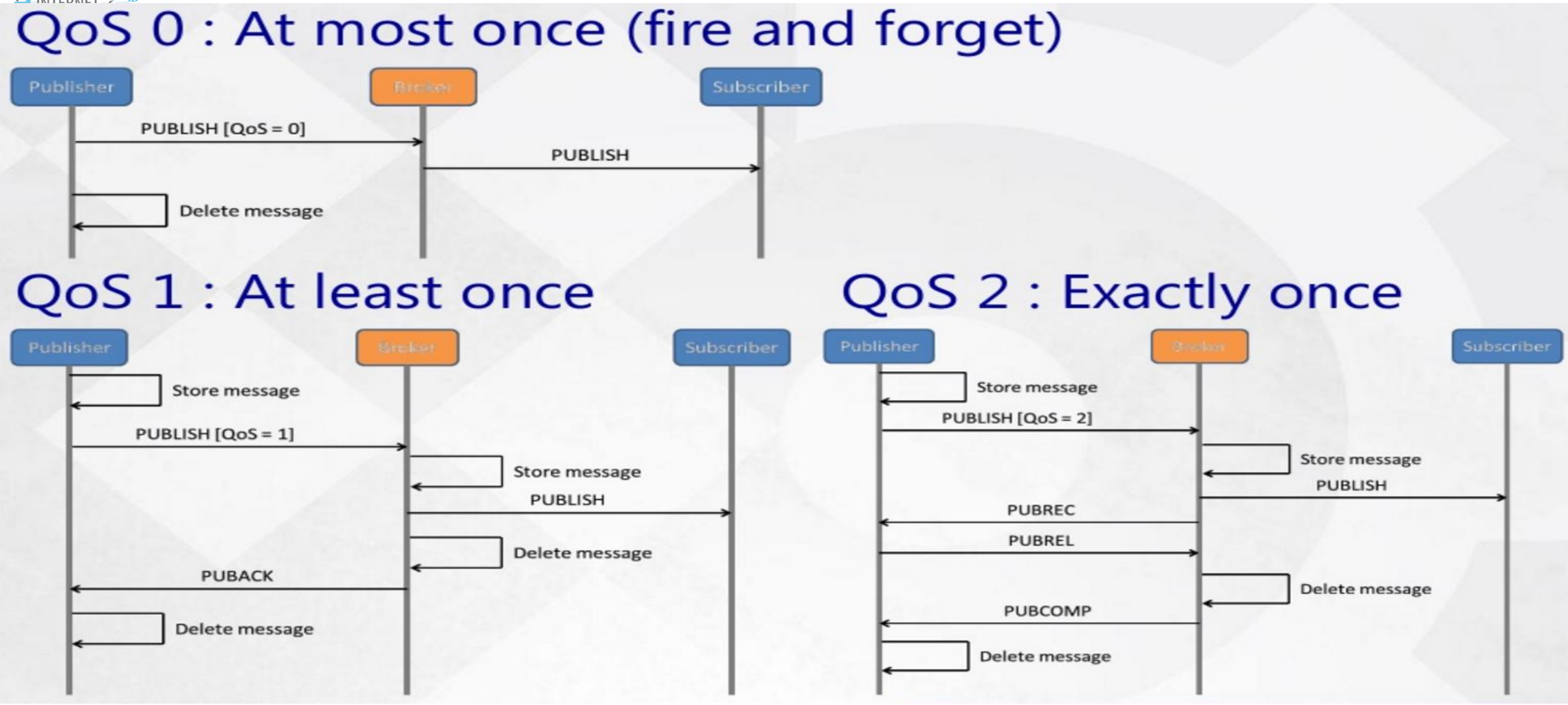
Protocols	UDP/TCP	Architecture	Security and QoS	Header Size (bytes)	Max Length(bytes)
MQTT	TCP	Pub/Sub	Both	2	5
AMQP	TCP	Pub/Sub	Both	8	-
CoAP	UDP	Req/Res	Both	4	20 (typical)
XMPP	TCP	Both	Security	-	-
DDS	TCP/UDP	Pub/Sub	QoS	-	-
NGSI	TCP/IP				

MQTT: Message Queue Telemetry Transport

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

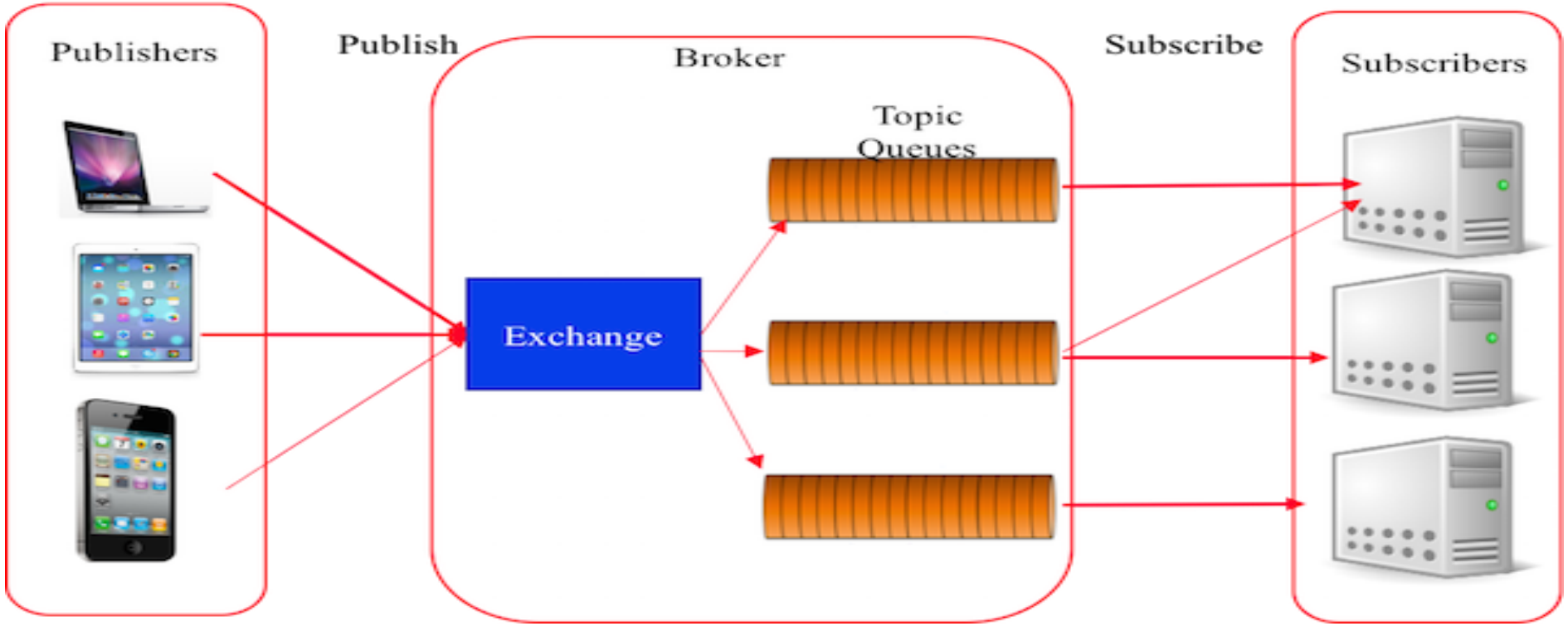


MQTT QoS


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

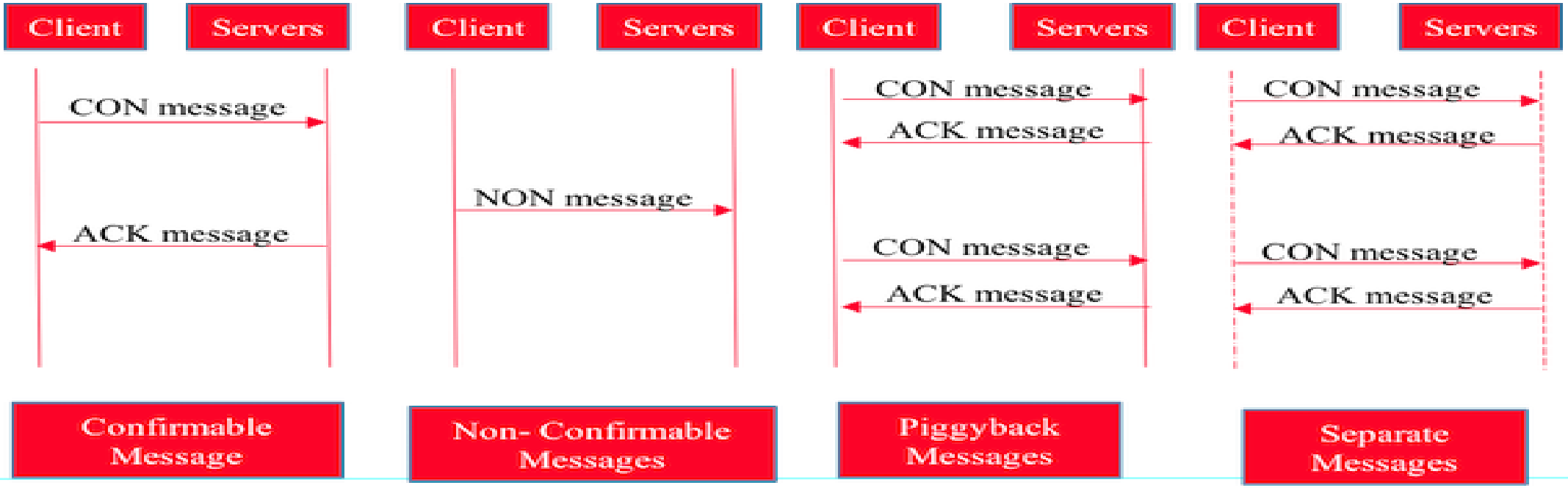
AMQP Advanced Message Queuing Protocol

- Over TCP, binary wire protocol
- Exchange decoupling



CoAP: Constrained Application Protocol

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



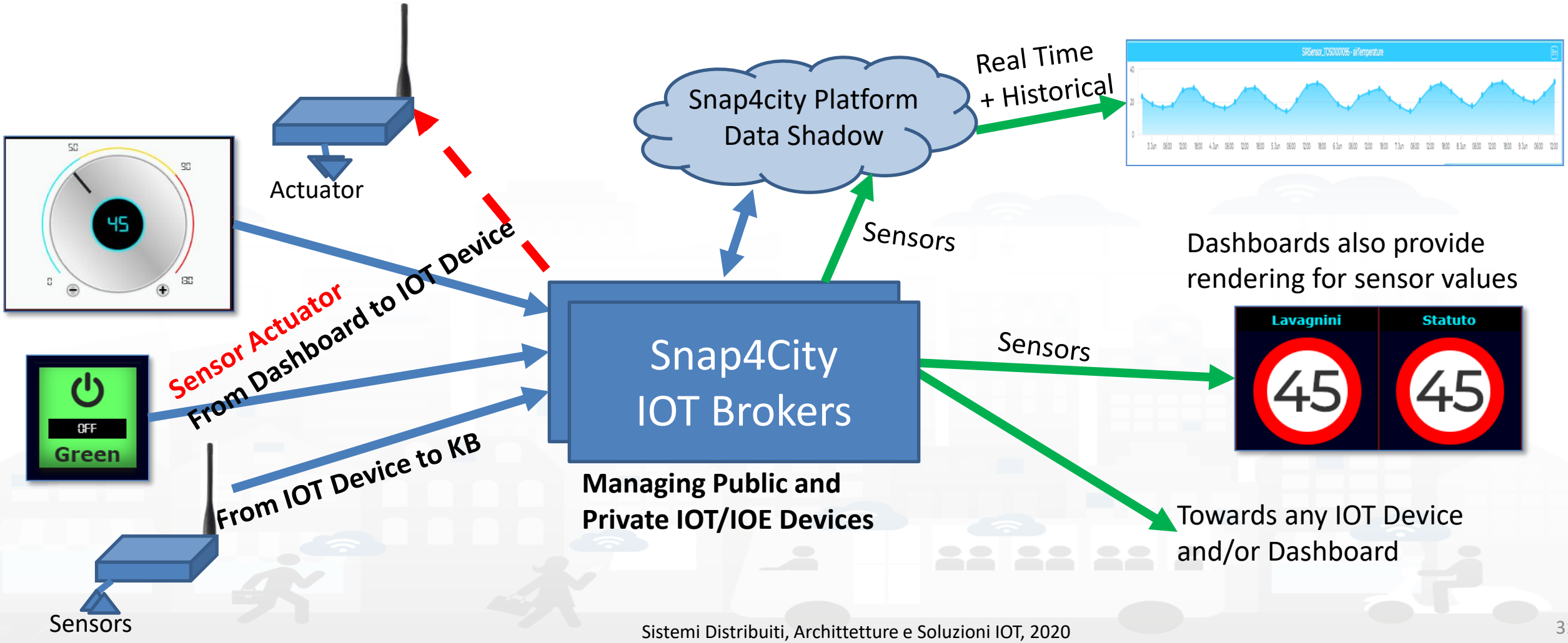
Other protocols

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

Comparison of lowlevel IOT prot.

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

IOT Data Driven

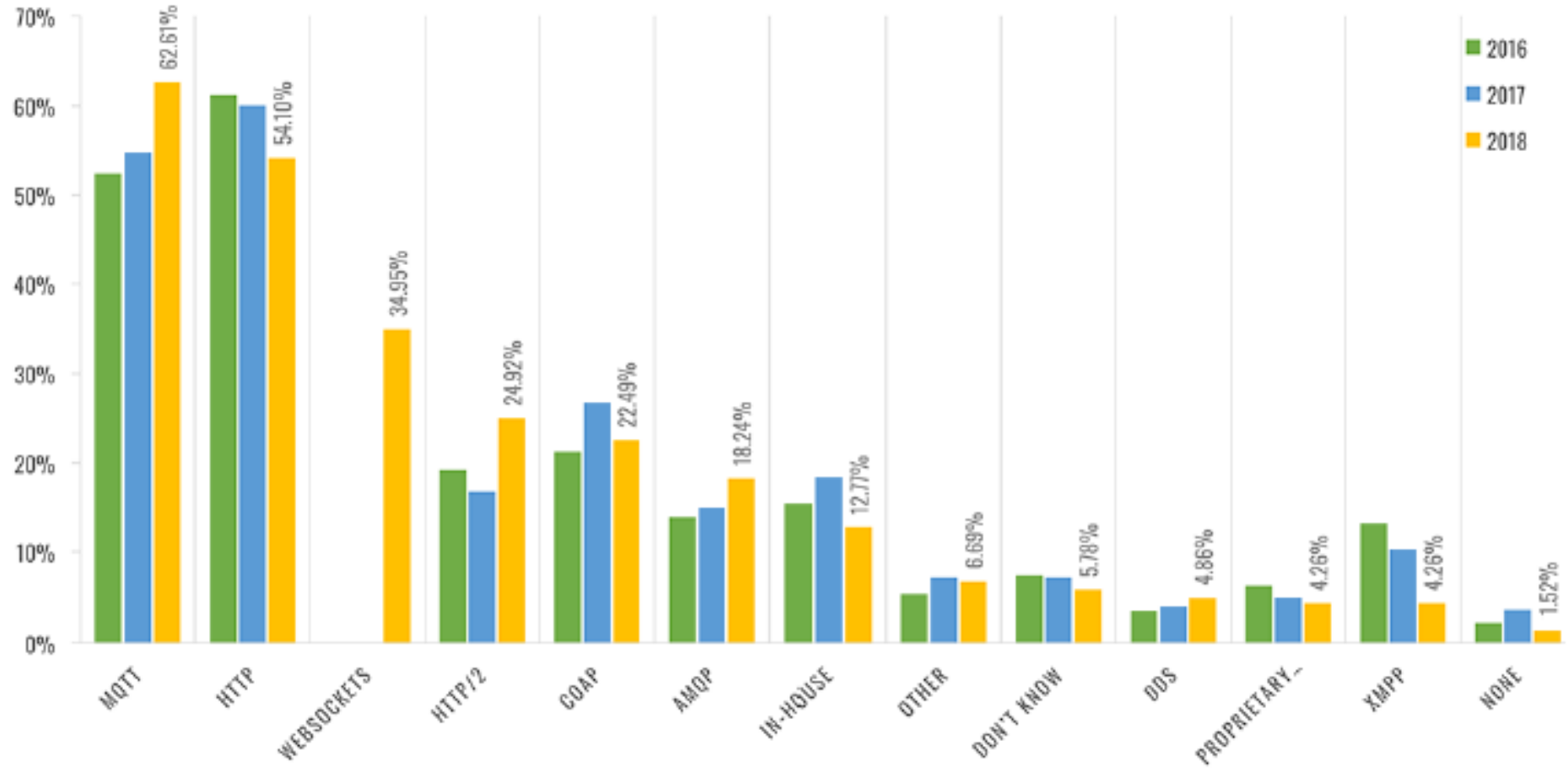


IOT Architectures Comparison

Market Solutions

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

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



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

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

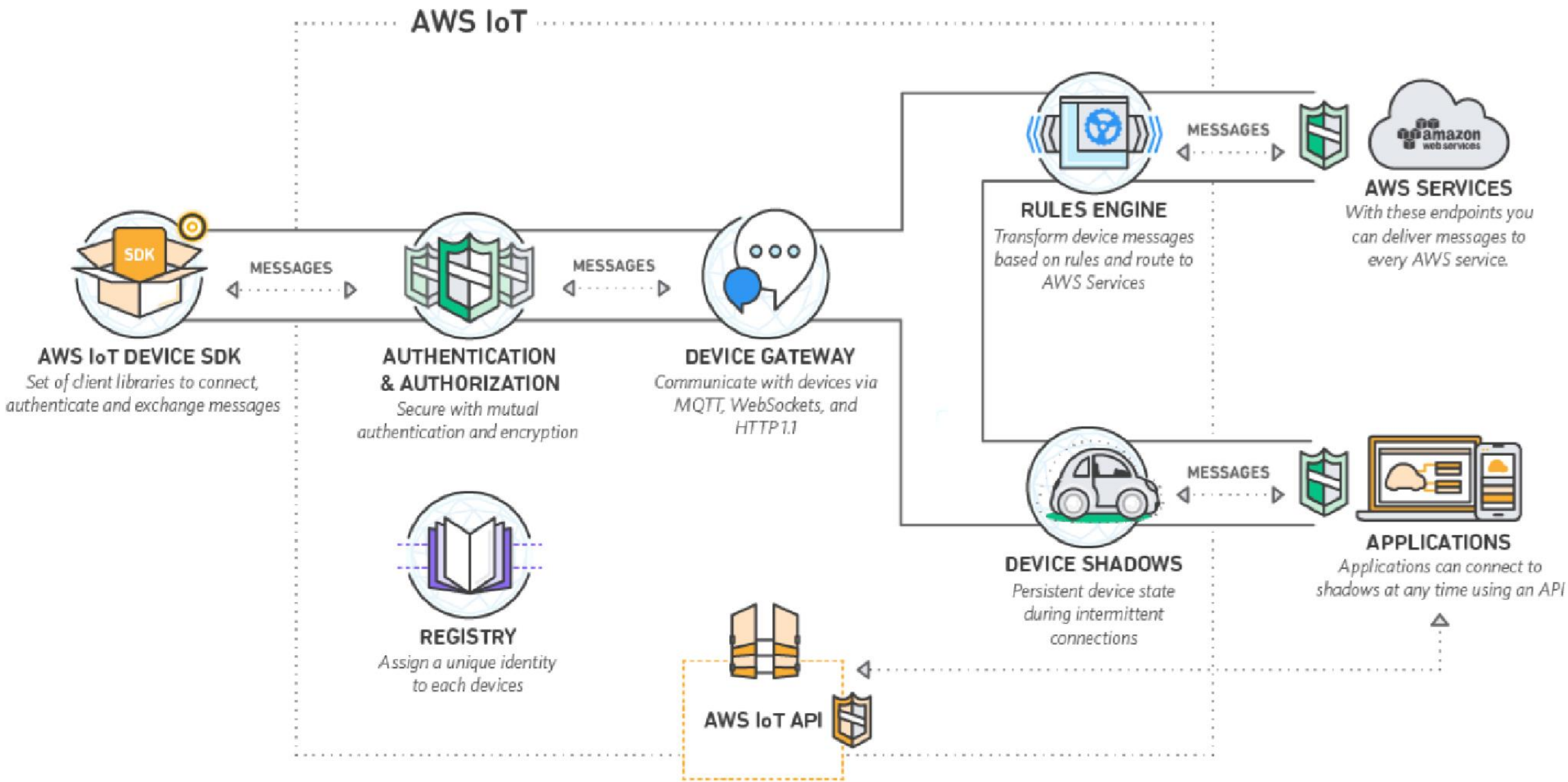
	Azure IoT	AWS	Google IoT
Edge			
Storage	Blob, CosmosDB, SQL		
Big Data			
Data Visualization	Power Bi		
Artificial Intelligence			
Intelligence API	Language, Speech, Vision, Knowledge		

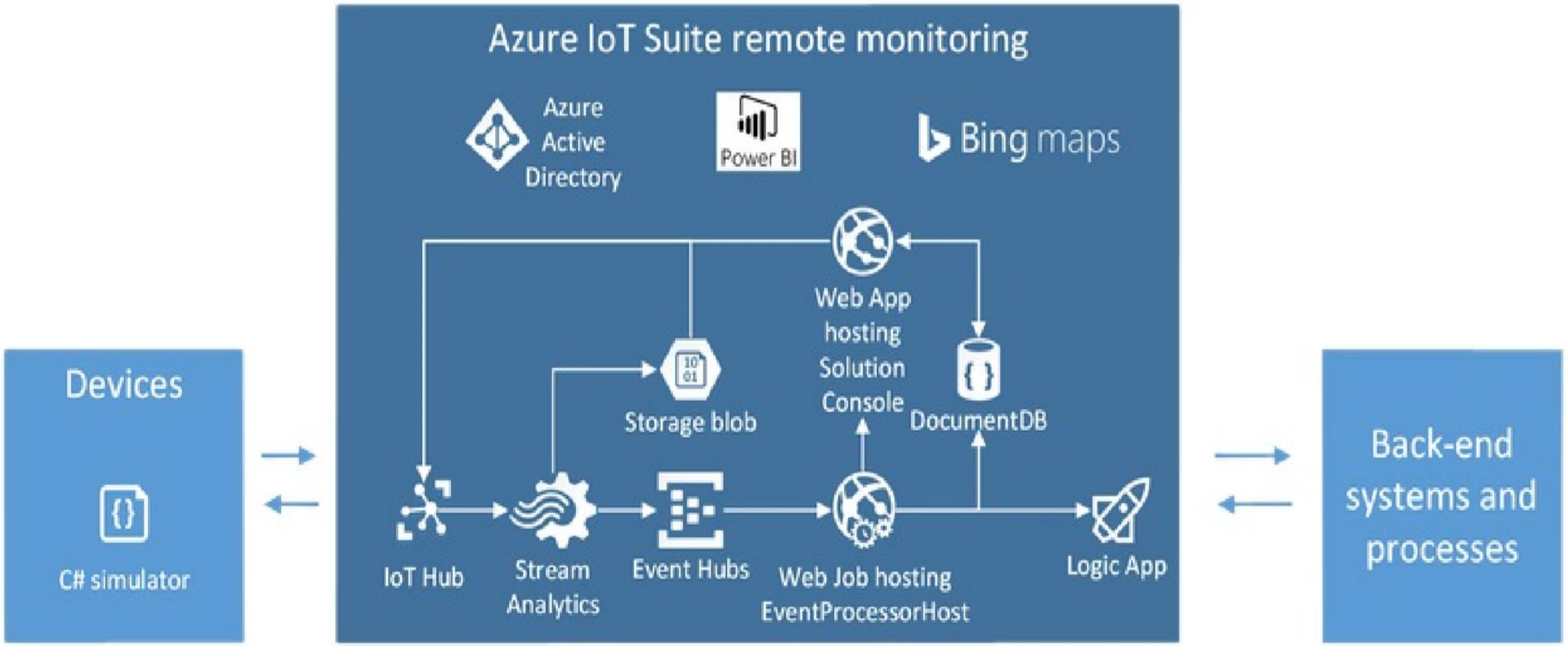
	Azure IoT	AWS	Google IoT
Prezzo	Diverse fasce di prezzo in base al numero di messaggi scambiati	Costo unitario per messaggio e per tempo di connessione del dispositivo	Costo basato sul volume di dati scambiati

	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

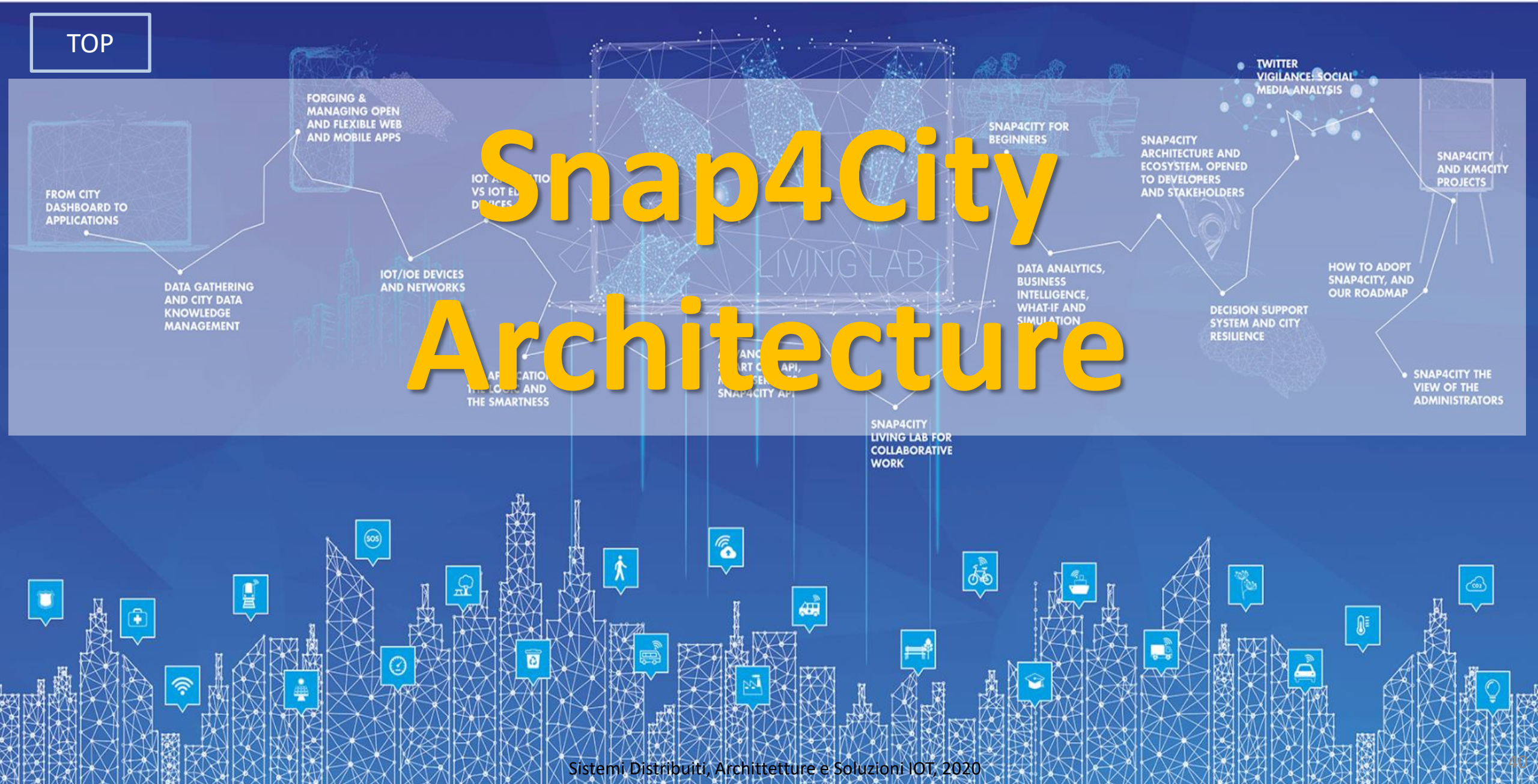
	Azure IoT	AWS	Google IoT
Scalability	Scaling da configurare mediante funzione	Servizio di scaling automatico	Servizio di scaling automatico
Rimborsi	10% di rimborso fino al 99%, al di sotto viene rimborsato il 25%	10% di rimborso fino al 99%, al di sotto viene rimborsato il 30%	10% di rimborso fino al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


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


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

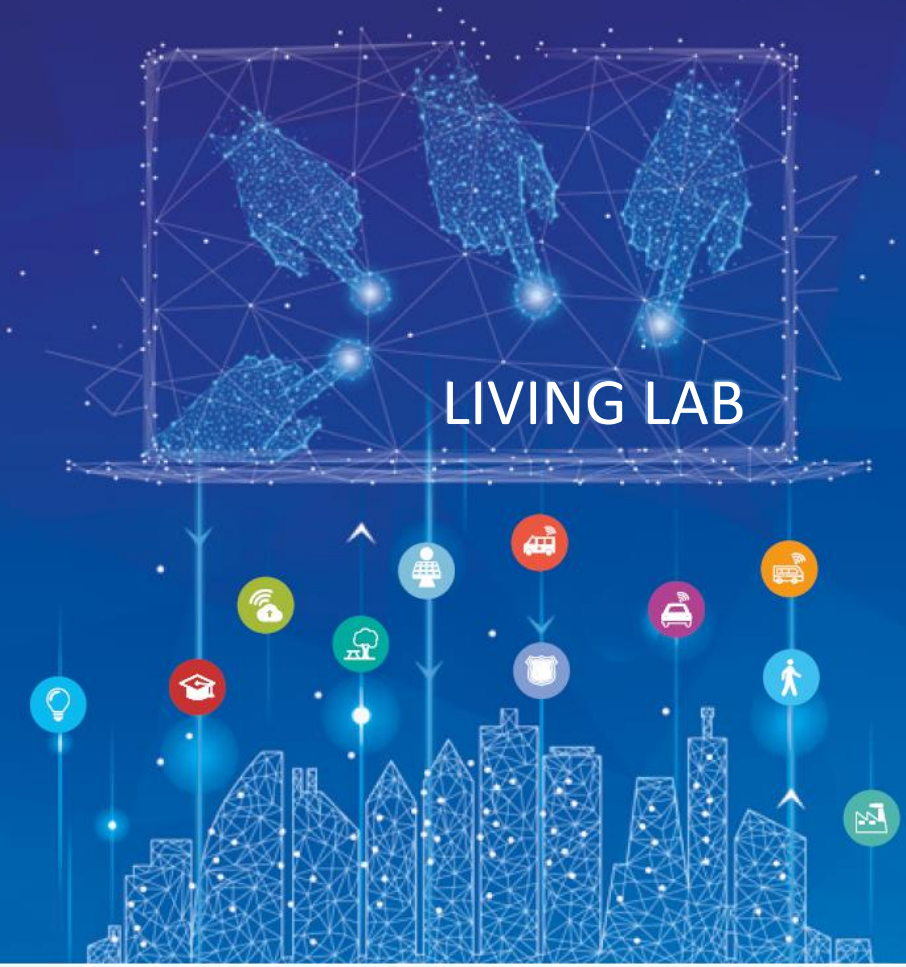
TOP

Snap4City Architecture



SNAP4CITY

KM4CITY



LIVING LAB

SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES

SELECT for Cities

Horizon 2020
European Union Funding
for Research & Innovation

UNIVERSITÀ DEGLI STUDI FIRENZE | DINFO | DISIT

www.Snap4City.org

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

100% OPEN SOURCE

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, SCENARIOUS, VIDEOS, HACKATHONS
- OPEN SOURCES, COMMUNITY OF CITIES
- TRAINING TUTORIALS, COMMUNITY MANAGEMENT

IOT APPLICATIONS - INSTANT APPS

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

DASHBOARDS & APPLICATIONS

CONTROL ROOM • SITUATION ROOM • OPERATOR DASHBORDS • BUSINESS INTELLIGENCE • WHAT-IF ANALYSIS • DECISION SUPPORT • SIMULATIONS • RISK ANALYSIS • RESILIENCE ANALYSIS

MOBILE & WEB APPLICATIONS

DEVELOPMENT KIT • SUGGESTIONS • MOBILE APPS • MONITORING PANELS • PLATFORM UTILITIES • READY TO USE SMART APPLICATIONS

MICROSERVICES & ADVANCED SMART CITY API

LIVING LAB - DEV TOOLS - COWORKING

IOT DIRECTORY • SERVICE MAP • RESOURCE MANAGER • DATA GATE • R STUDIO • ETL

BIG DATA - DATA ANALYTICS

DATA ANALYTICS TOOLS - MICRO-APPLICATIONS

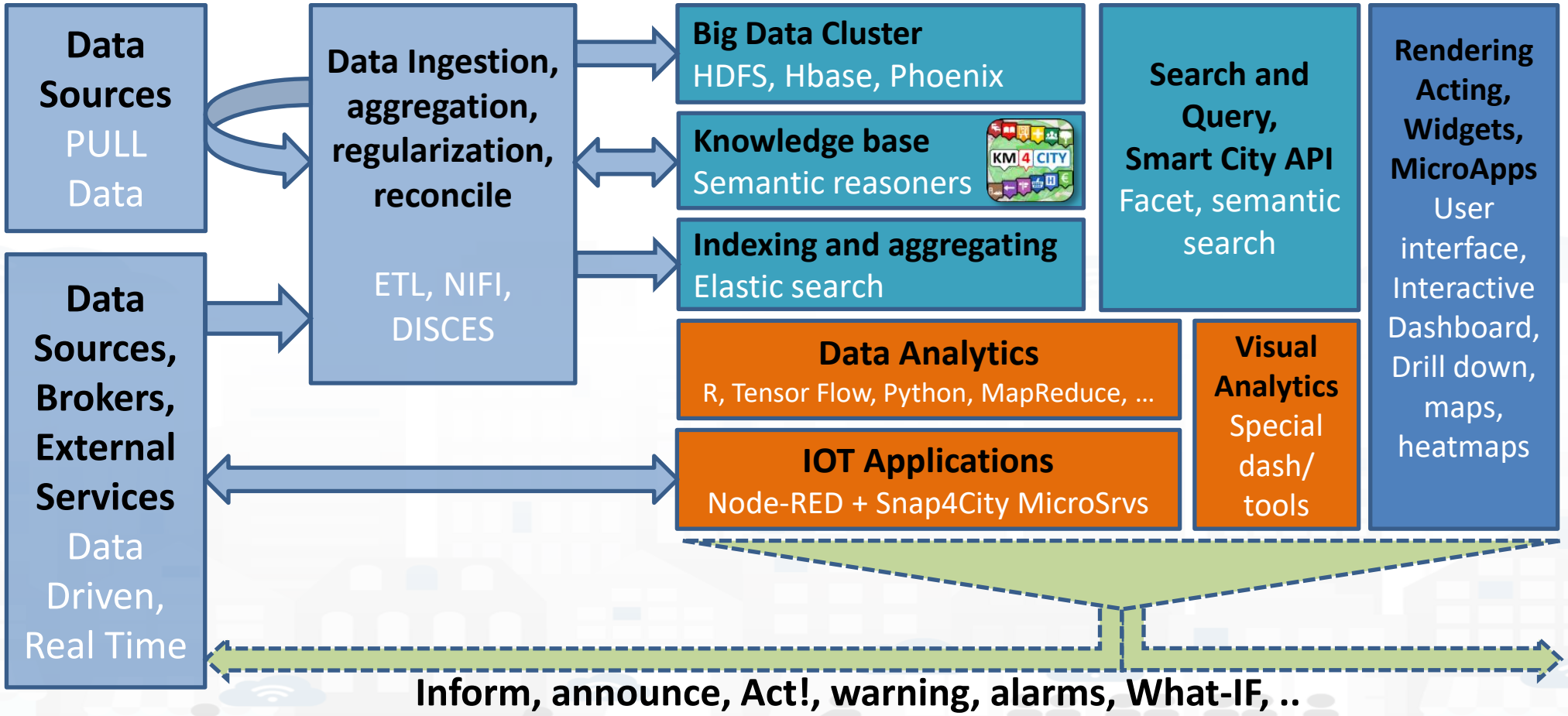
PREDICTIONS • ANOMALY DETECTION • WHAT-IF ANALYSIS • TRAFFIC FLOW RECONSTRUCTION • ORIGIN-DESTINATION MATRICES • SOCIAL MEDIA ANALYSIS • OFFER VS DEMAND ANALYSIS • ENVIRONMENTAL DATA ANALYSIS AND PREDICTIONS • REAL TIME HEATMAPS • ROUTING • ALERTING • EARLY WARNING • PERSONAL AND VIRTUAL ASSISSTANTS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

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 ...

GIS	CITY UTILITIES	OPEN DATA	LEGACY & EXTERNAL SERVICES	PERSONAL DATA	IOT / IOE	BROKERS	KPI	INDUSTRY 4.0	SOCIAL MEDIA

Snap4City as a Lambda Architecture



Snap4Industry as a Lambda Architecture

Data Sources PULL Data

Data Sources, Brokers, External Services Data Driven, Real Time

Data Ingestion, aggregation, regularization, reconcile

ETL, NIFI, DISCES

Big Data Cluster
HDFS, Hbase, Phoenix

Knowledge base
Semantic reasoners

Indexing and aggregating
Elastic search

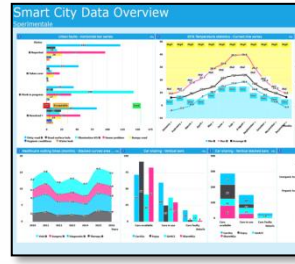
Data Analytics
R, Tensor Flow, Python, MapReduce, …

IOT Applications
Node-RED + Snap4City MicroSrvs

Search and Query, Smart API
Facet, semantic search

Visual Analytics
Special dash/ tools

Rendering Acting, Widgets, MicroApps
User interface, Interactive Dashboard, Drill down, maps, heatmaps



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

Smart City Functional Architecture

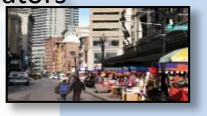
Transport systems Mobility, parking

Public Services, Govern, events, …

Sensors, IOT Cameras, Wi-Fi

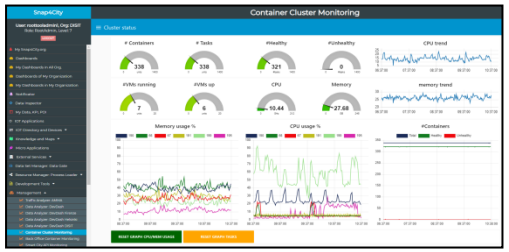
Environment, Water, energy

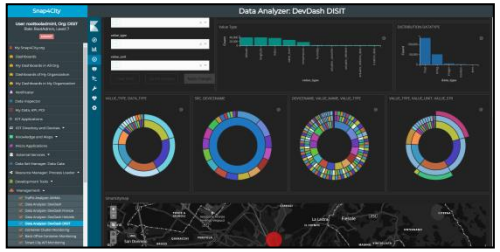
Shops, services, operators

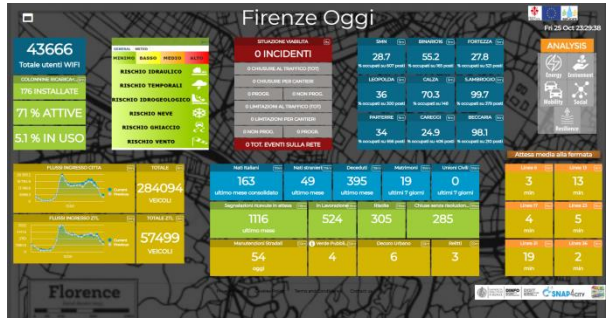


Social Media

Social Media Crawler and Manager







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Data Ingestion, aggregation, regularization, reconcile ETL, NIFI, DISCES

Big Data Cluster HDFS, Hbase, Phoenix

Knowledge base Semantic reasoners

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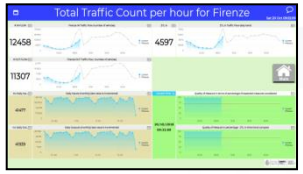
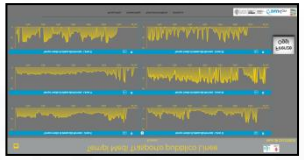
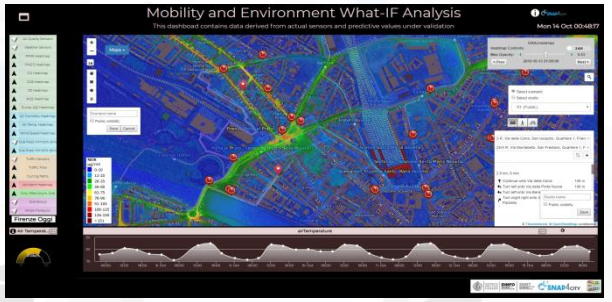
Search and Query, Smart City API Facet, semantic search

Visual Analytics Special dash/ tools

Rendering Acting, Widgets, MicroApps User interface, Interactive Dashboard, Drill down, maps, heatmaps







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

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

Snap4City - scalable Smart aNalytic APplication builder for sentient Cities

Tutorials Scenarious Innovations Interoperability Installations What People say

Mobile Apps IOT Devices IOT Applications Data Analytics Dashboards Living Lab Smart City API

Smart City Ontology Articles

SMARTCITY EXPO WORLD CONGRESS 19-21 Nov. 2019 *See you at Stand A118*

SNAP4CITY on EUROPEAN OPEN SCIENCE CLOUD MARKETPLACE

SNAP4CITY HACKATHON BUILD YOUR APP FOR A CONNECTED CITY

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

Login

Registration

- New Registration
- Request a new password

Search

Search

-Any-

Training Snap4City from Data to Sentient Cities in a Snap
Program and Interactive Slides

Powered by www.km4city.org

FI-WARE Node-RED

Virtual Assistant

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.

Node-RED
JS Foundation
FI-WARE
E015 digital ecosystem
bee smart city
sigfox partner network
ckan
GJL
LABGEO
esri Italia THE SCIENCE OF WHERE
EUROPEAN OPEN SCIENCE CLOUD MARKETPLACE

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

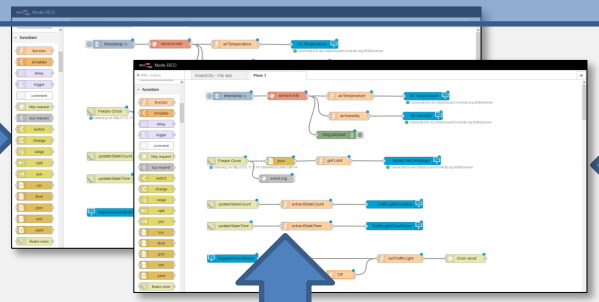
Registration of My IOT Devices

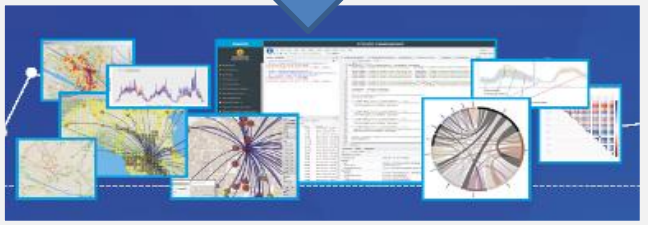
Sentient Solutions

Dashboards with data driven IOT Applications enforcing intelligence

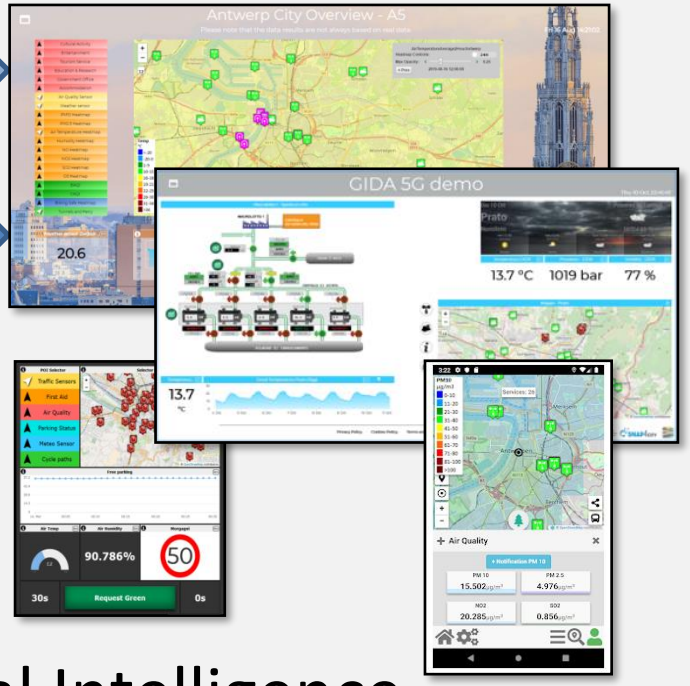
IOT and data World

IOT Applications



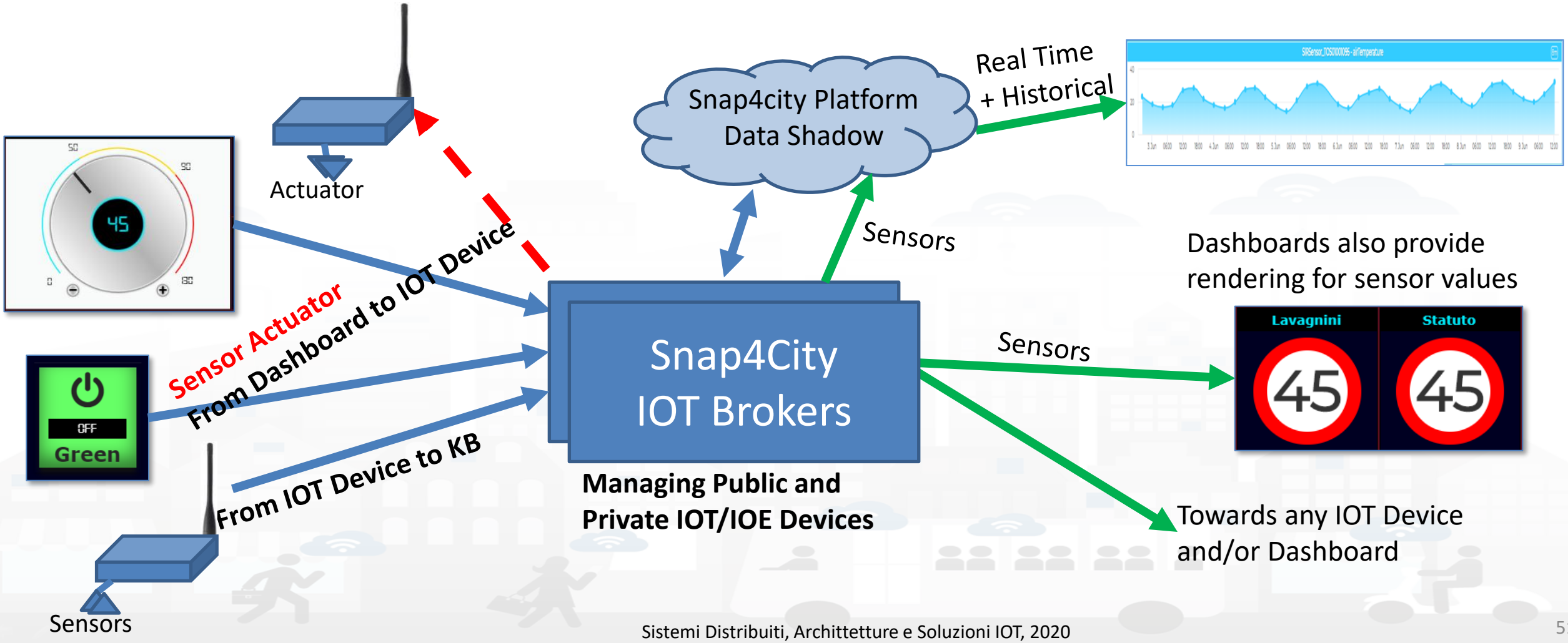


Dashboards and Apps



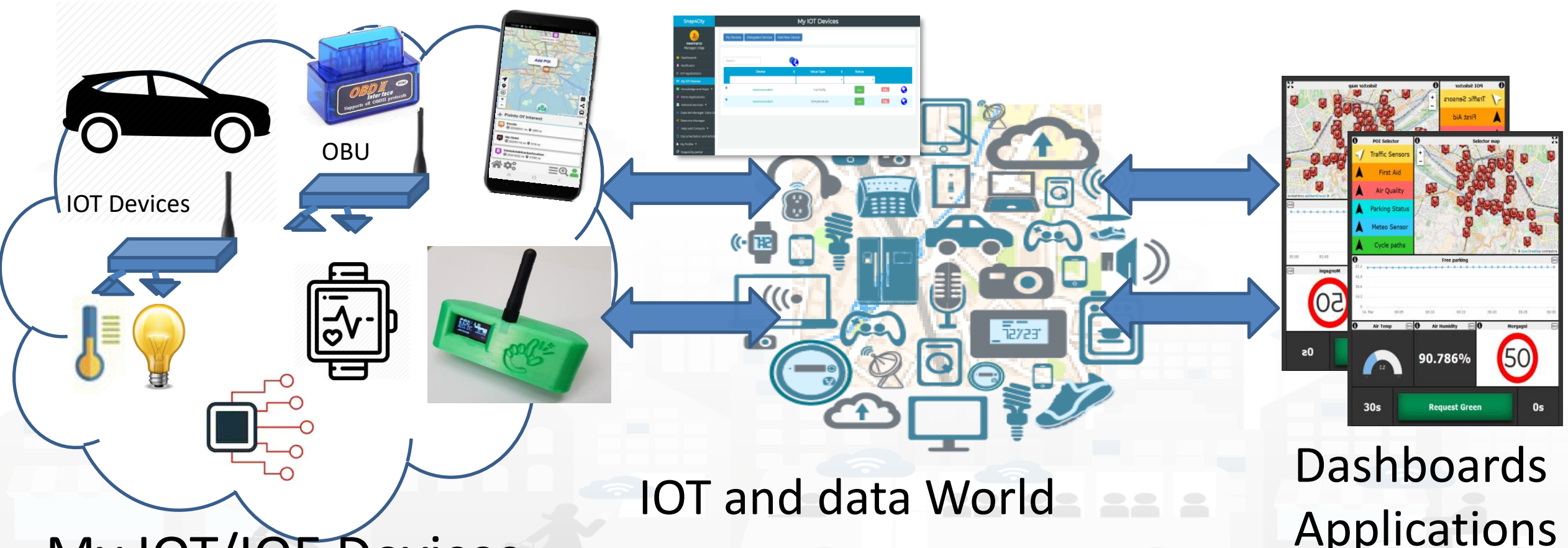
Big Data Analytics, Artificial Intelligence

IOT Data Driven



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!!!



My IOT/IOE Devices

IOT and data World

Dashboards Applications

IOT Architecture

IOT Device

IOT Device

IOT Device

IOT Device

FI-WARE IOT Orion Broker

AMQP

COAP

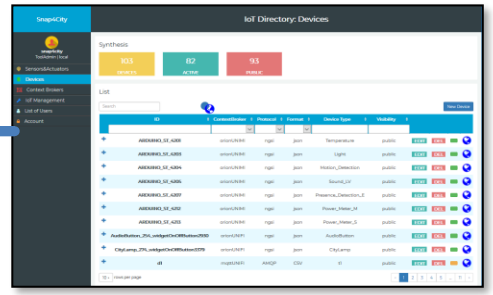
sigfox

THE THINGS NETWORK TheThingsNetwork

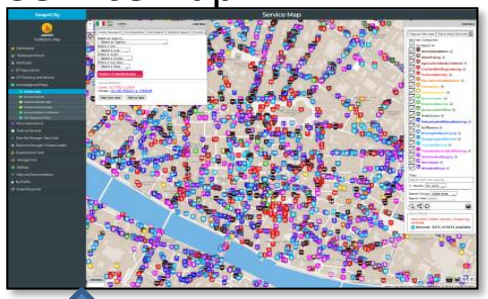
One M2M

.....

IOT Directory



ServiceMap



Registering
Discovery

Browsing
Discovering

Data Shadow,
Elastic Search

Knowledge Base,
Km4City

Advanced Smart City API

Snap4City MicroServices Node-RED

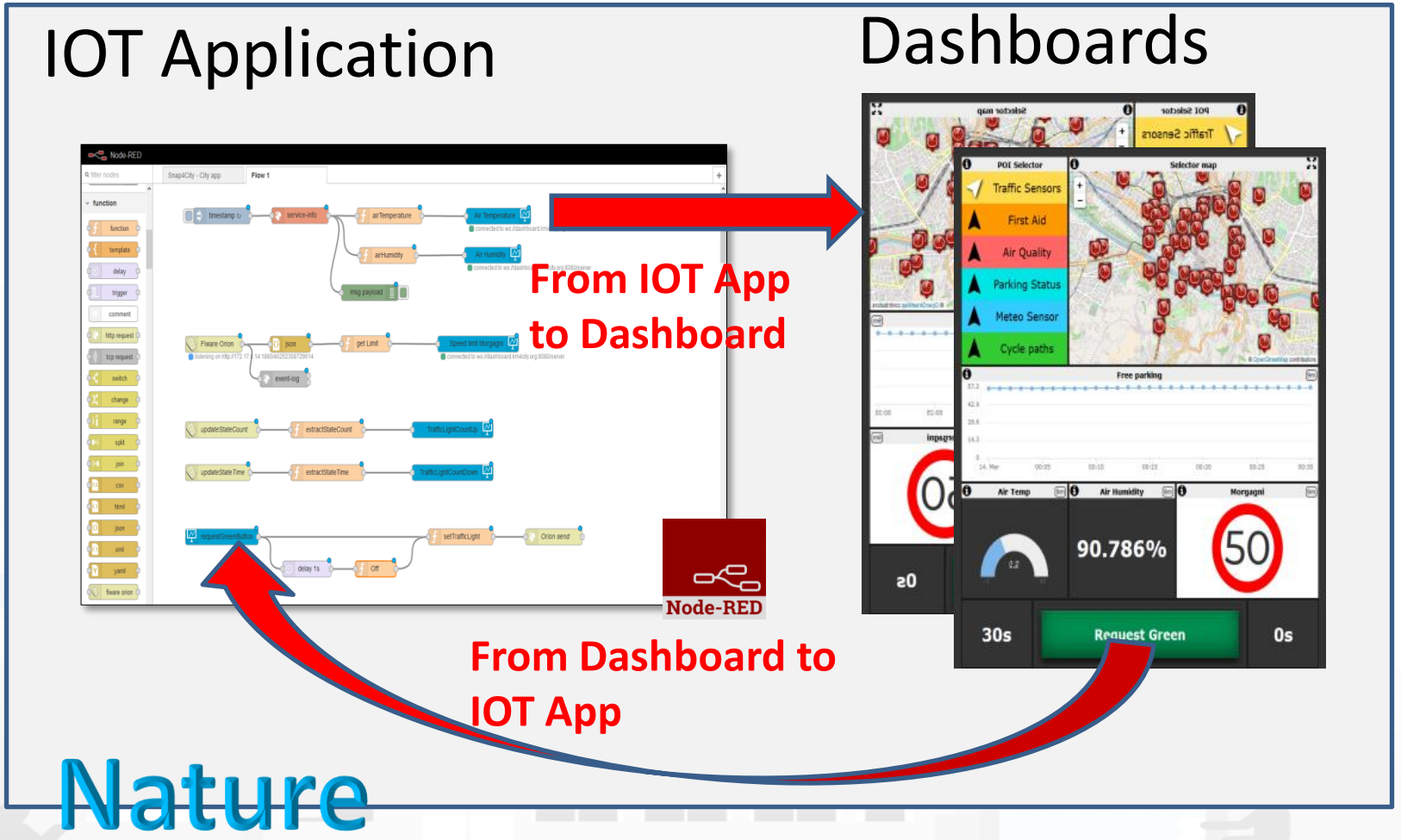
Elastic Management of IOT Applications

Dashboard

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)**
- **Sensor**
- **Sensor Actuator**
- **Special Widget**
- Wfs (GIS)



IOT Directory

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

SNAP4CITY

IOT/IOE on the field

On Cloud

(1) Registration

(0) Sensors & Actuators

Raspberry pi

Sensors/ Actuators

IOT Directory

(2) Discovery

Sensors/ Actuators

Sensors/ Actuators

-- PC: Win, Linux

Sensors/ Actuators

Internet

IOT Edge
With IOT App distributed

(1) Registration

Sensors/ Actuators

IOT Button

IOT Brokers

Mobiles

Sensors/Actuators

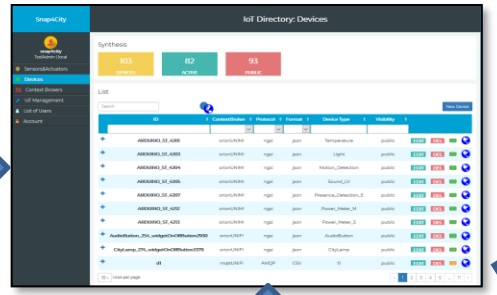
IOE Devices

IOT Network Manager vs Final User

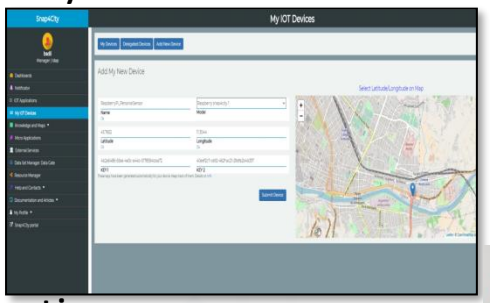
Network of IOT Brokers

IOT Broker

IOT Directory



My IOT Device



Register

IOT Network Manager

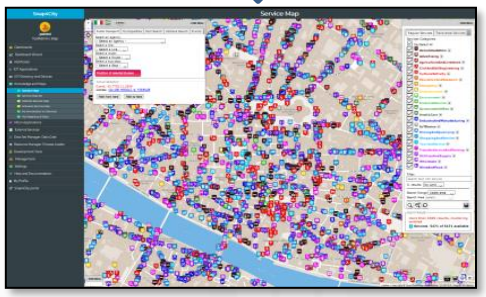
Registering

Discovering

Knowledge Base, Km4City

Knowledge and Storage
Data from the Field and City

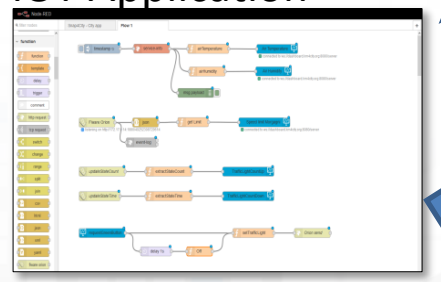
Browsing



ServiceMap Knowledge Base

Discovering

IOT Application



Final user Manager

Dashboard Wizard

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
- **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
- **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.
- **Manages Ownership and Delegation** for
  - IOT brokers, IOT devices, IOT Device Values

IOT Directory Features vs Users Roles

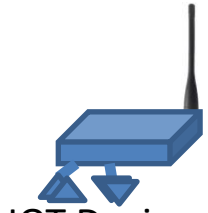
Entities	what	By using	Manager	AreaManager	ToolAdmin/RootAdmin
IOT Sensor/Actuator	Browse, use	Several Tools	X	X	X
	Delegate	IOT Directory	X	X	X
	Discovery	KB, API, MicroServices	X	X	X
IOT Devices	Browse, use	Several Tools	X	X	X
	Add/change/Delete	IOT Directory, API, ..	X	X	X
	Add in Bulk	IOT Directory, 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			X
	Delegate	IOT Directory			X
	Periodic Update	IOT Directory			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

In which case you are?

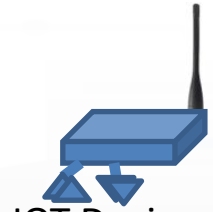
https://www.snap4city.org/drupal/node/474



IOT Broker — SNAP4CITY — Case B2

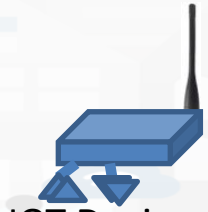
IOT Broker → SNAP4CITY — Case B1

i) Registered IOT Broker on Snap4City



a) Registered IOT Device on Broker

IOT Broker — SNAP4CITY — Case A1.2



a) Registered IOT Device on Broker

IOT Broker → SNAP4CITY — Case A2

i) Registered IOT Broker on Snap
ii) Registered IOT Device on Snap

How to setup and IOT Data Stream

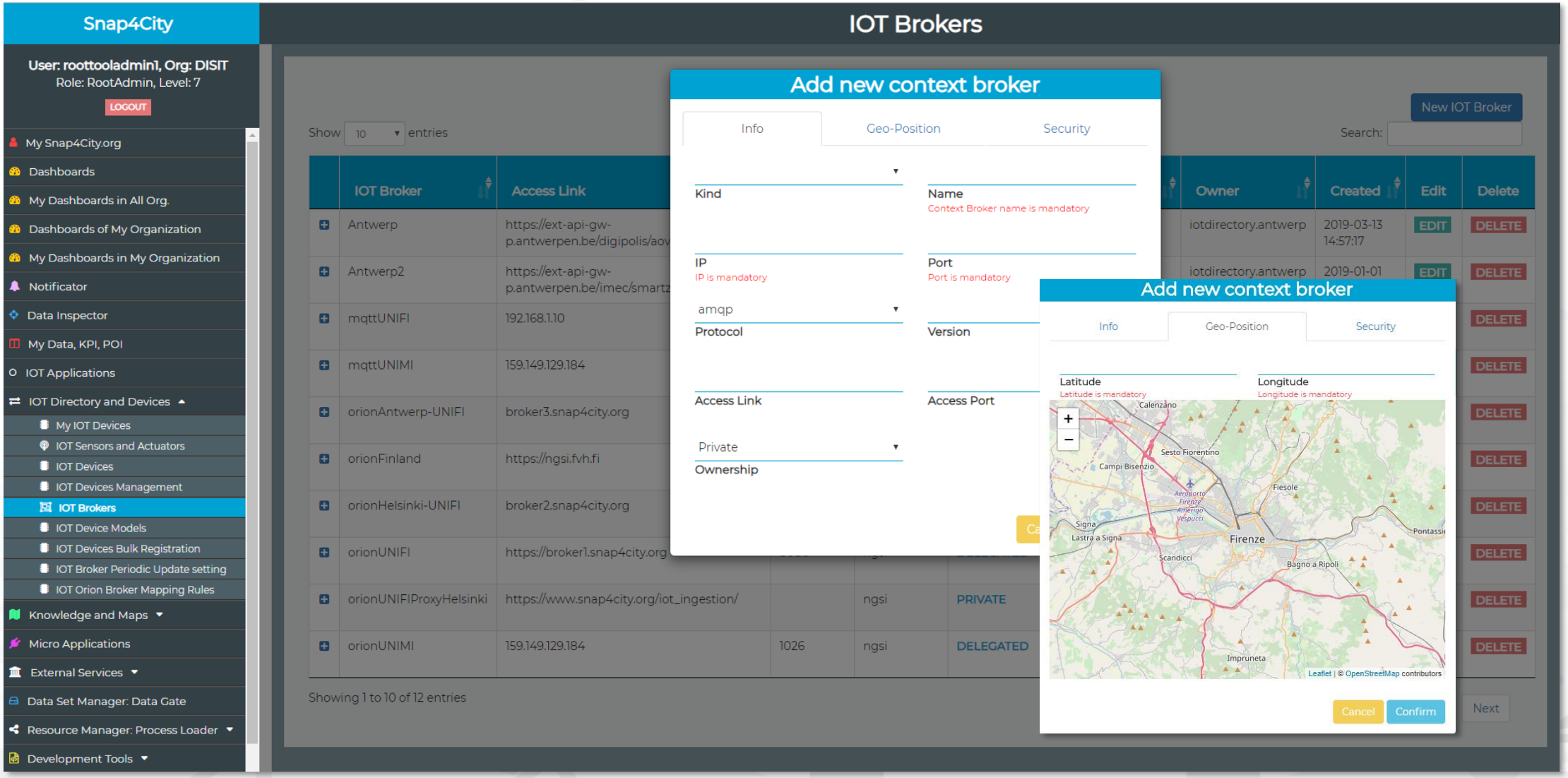
Managers/AreaManagers:

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



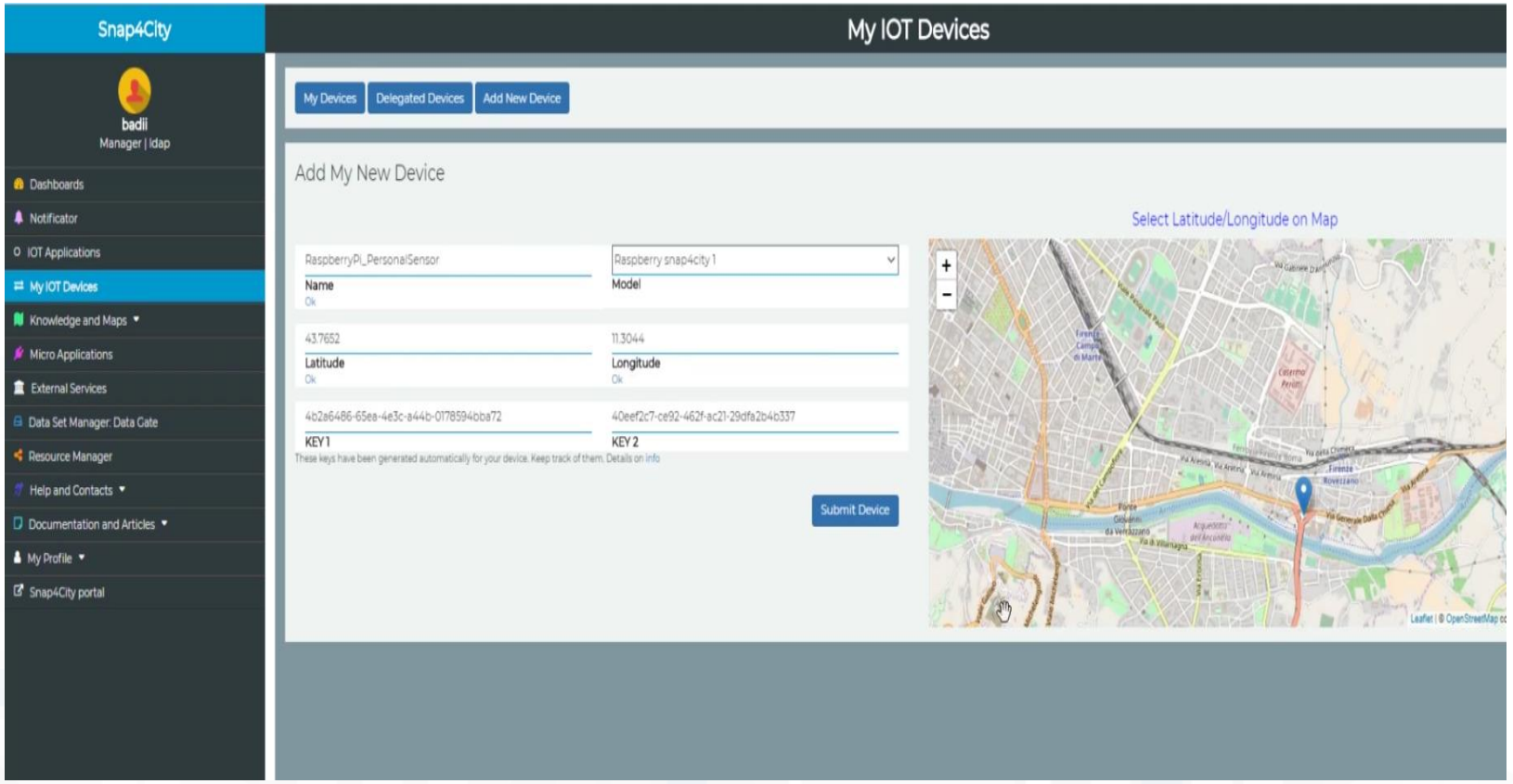
Add IOT/IOE Devices

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

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

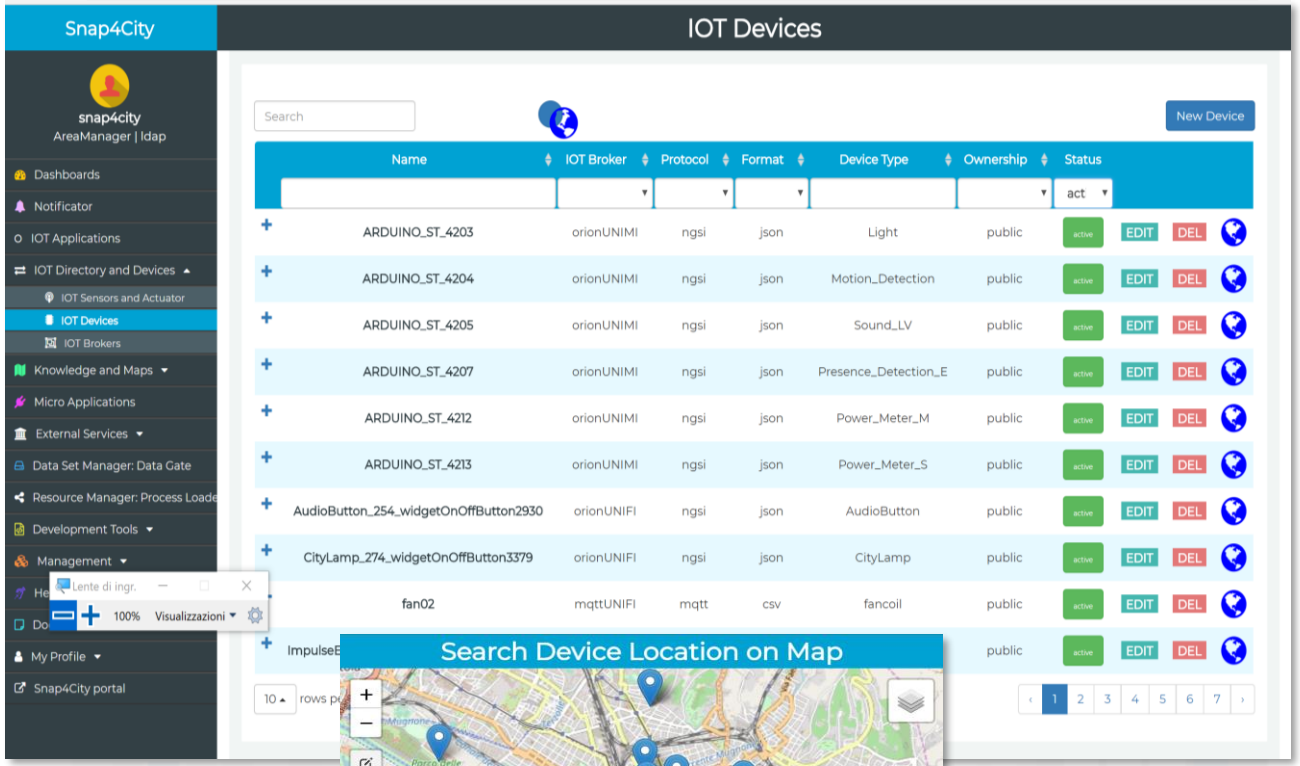
Create your own devices:

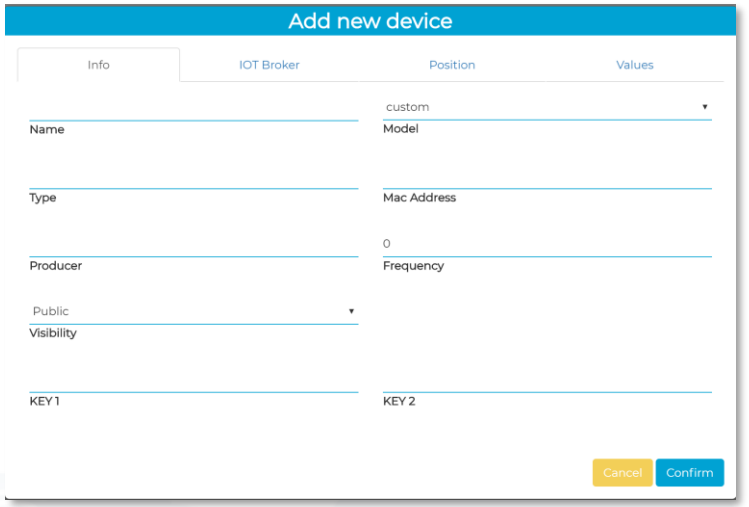
- Arduino,
- Raspberry,
- Android,
- LoraWAN + Arduino,
- etc.

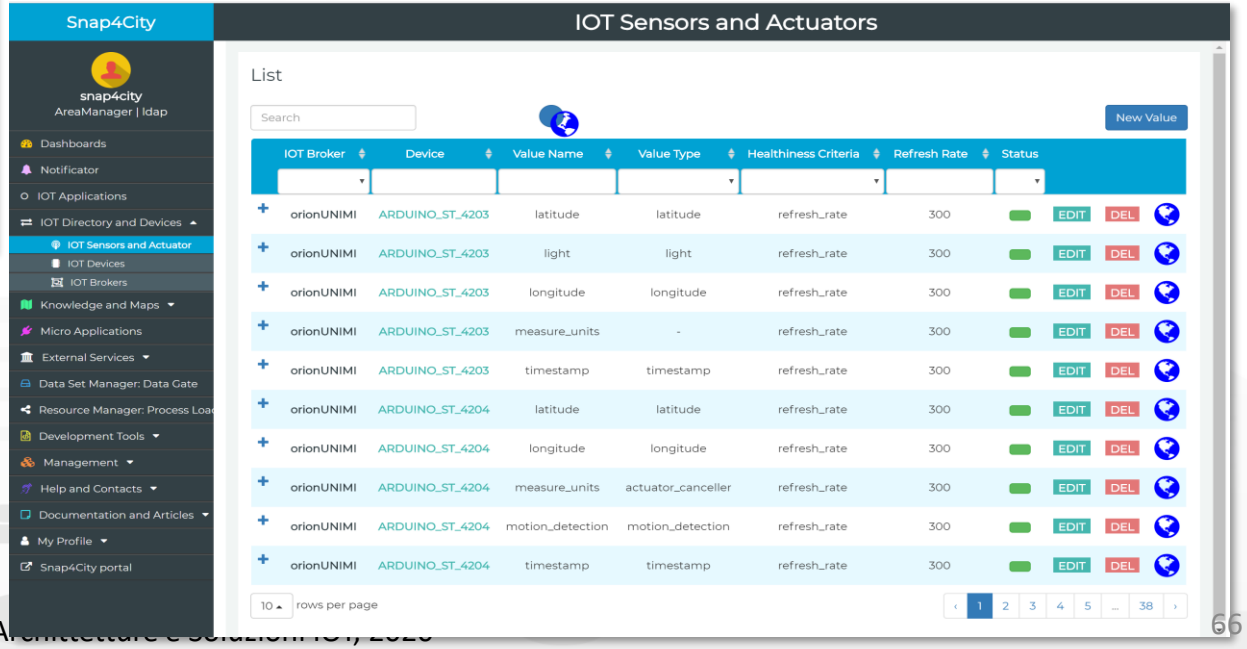


Secure Communication: HTTPS, TLS (K1, K2), Certificates

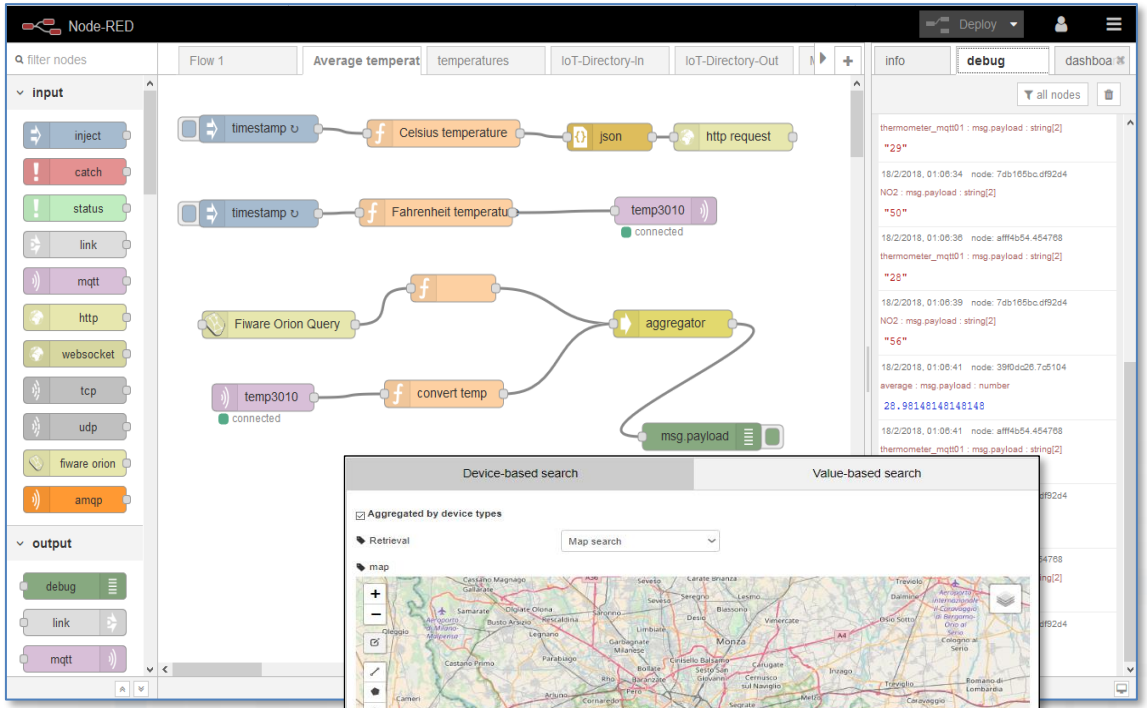
IOT Directory

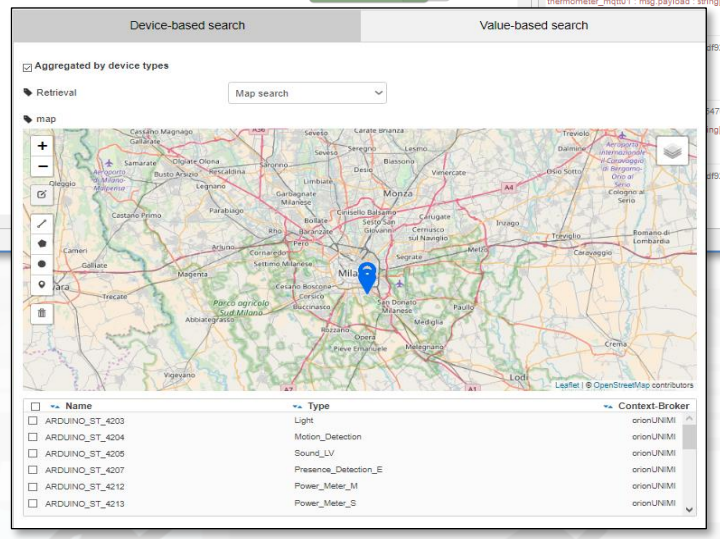


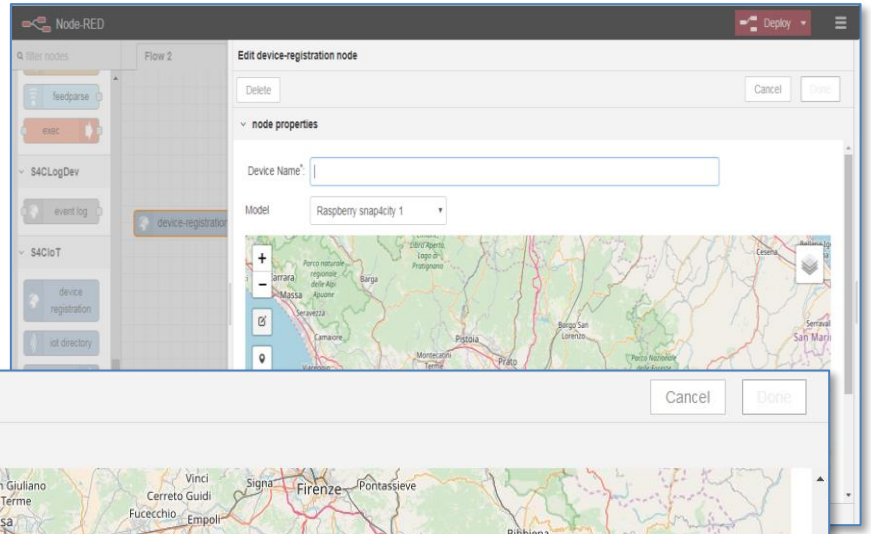


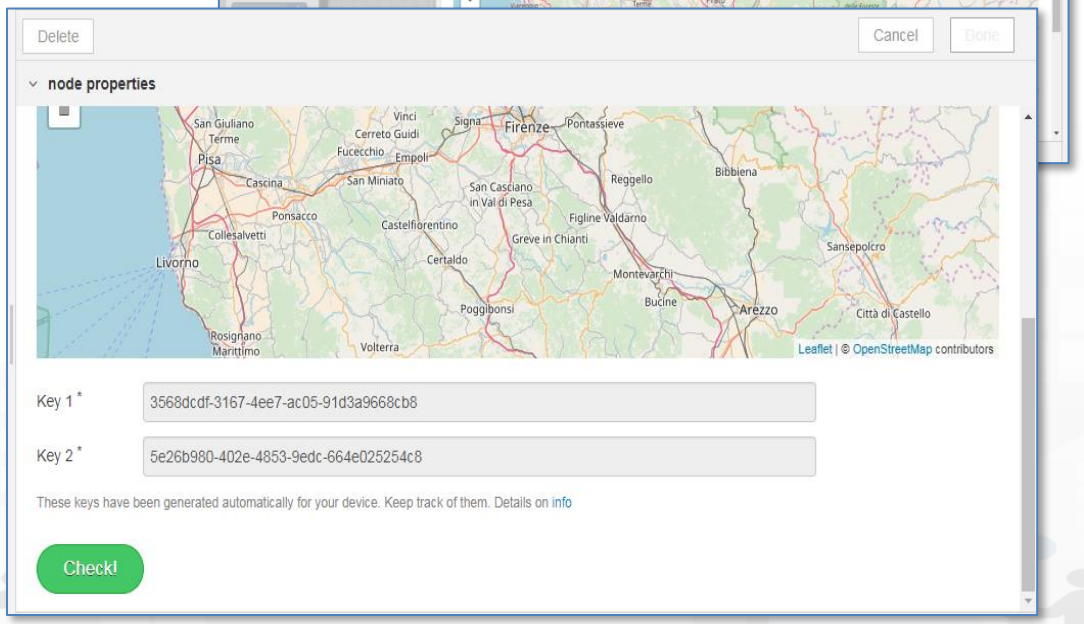


IOT Discovery on IOT Application Development









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

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

FI-WARE

SMART CITIES REFERENCE ARCHITECTURE

VS

SNAP4CITY

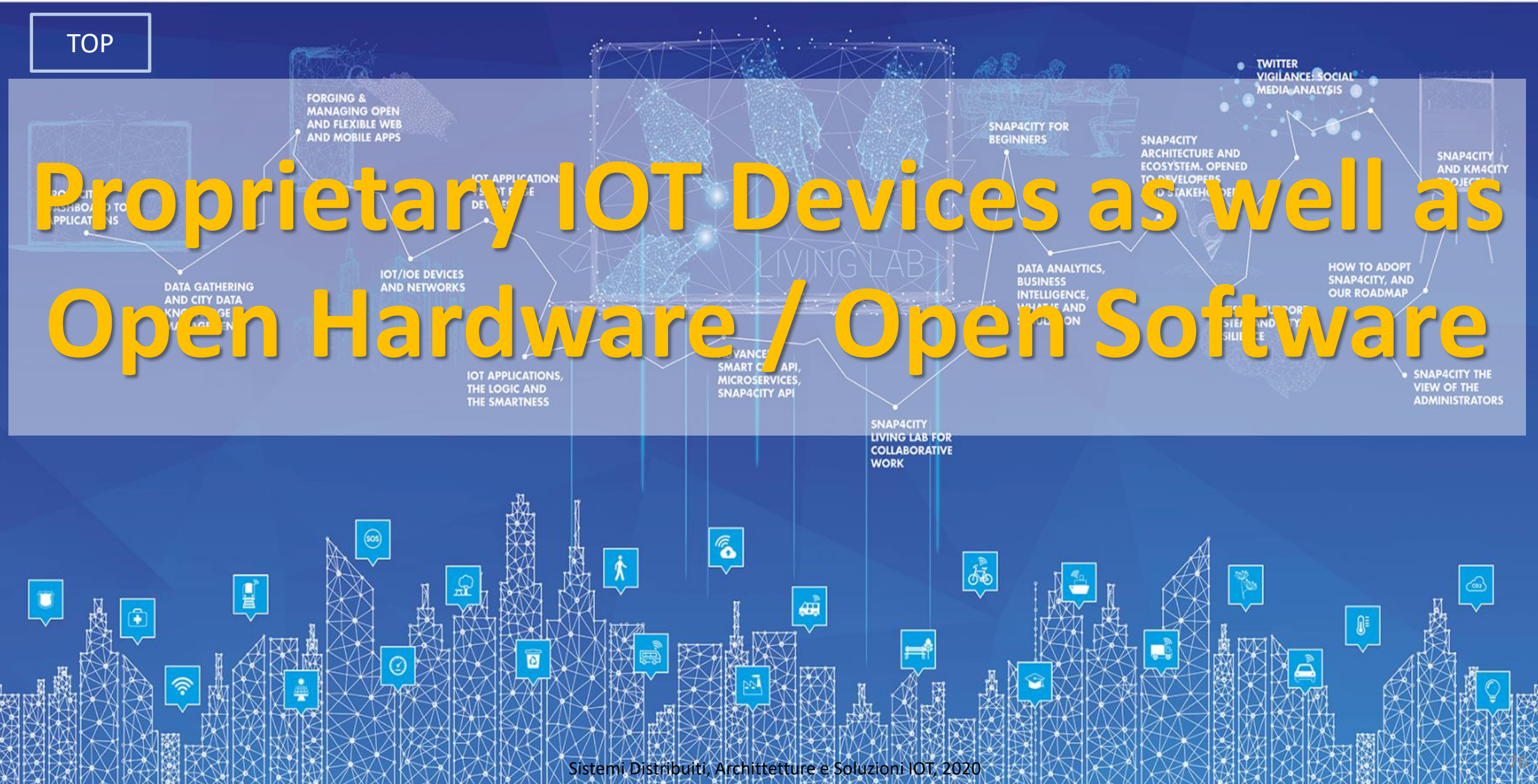
- Is open to the Development of Applications leaving large space to developers
- Is cantered on the Orion Broker that result central in the architecture: any Broker or data source is sending data to Orion
- Security level is not clear, partially demanded to developers
- Visual Flexible IOT processing 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

- 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.
- **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
- **Advanced Smart City API** are provided on top of Knowledge Base
- **Dashboard Builder** has been designed for Smart City Data and automated dashboards' production
- **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

- **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.
- **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
  - (b) via an IOT Orion Broker (external IOT Broker or those provided by Snap4City), or
  - (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



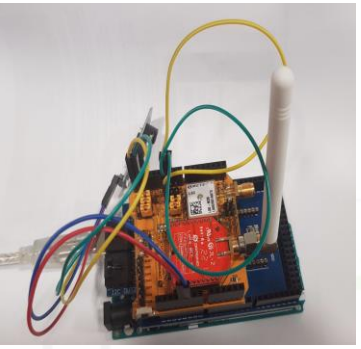
Proprietary IOT Devices as well as Open Hardware / Open Software

IOT Devices

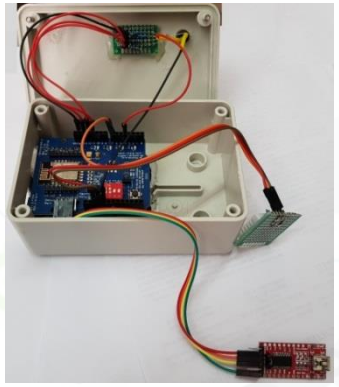
Sensors/
Actuators

IOT Edge Devices

LoraWAN +
Arduino +
I2C, NGSI



Arduino,
Wi-Fi, NGSI

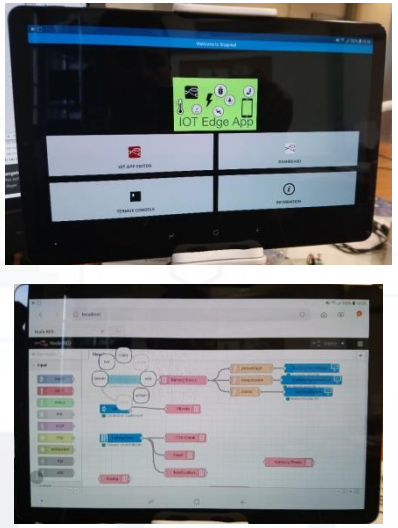


Snap4All
IOT Button
ESP, NGSI,
Wi-FI, BT

Snap4All PAX
Counter
LoraWAN
WIFI, NGSI,
GPS

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

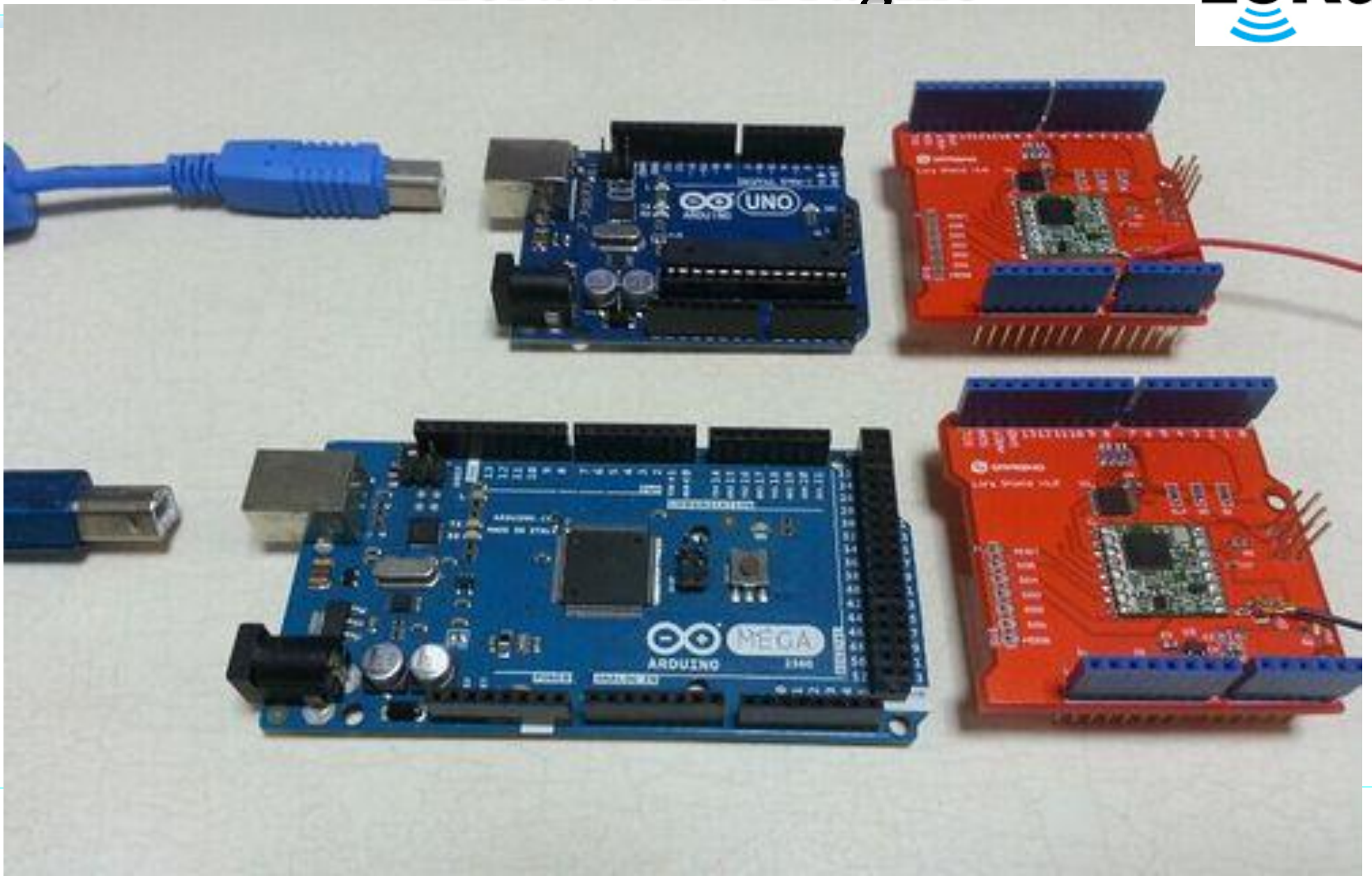
IOT Edge
NodeRED:
Android, LINUX,
Windows, …



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

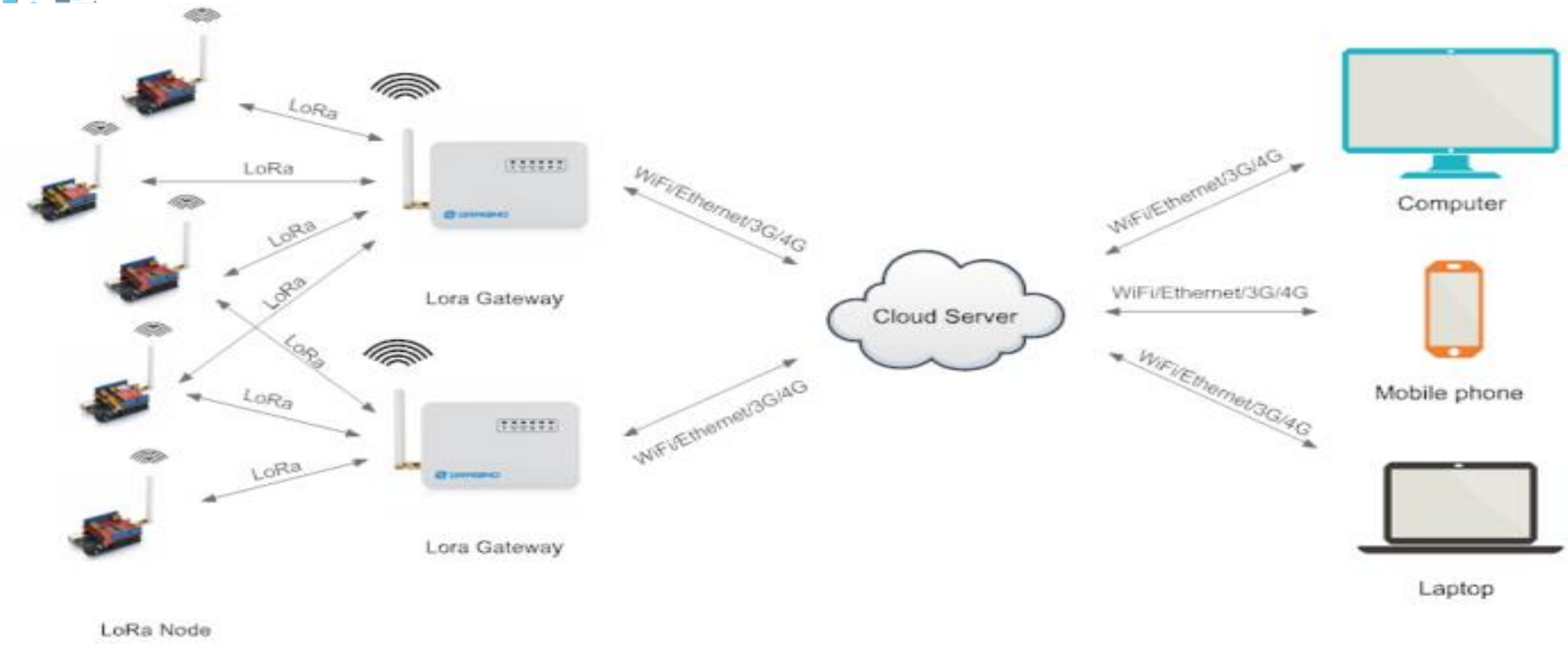
Any Sensor / Actuator
Open to other protocols

LoraWAN Dragino

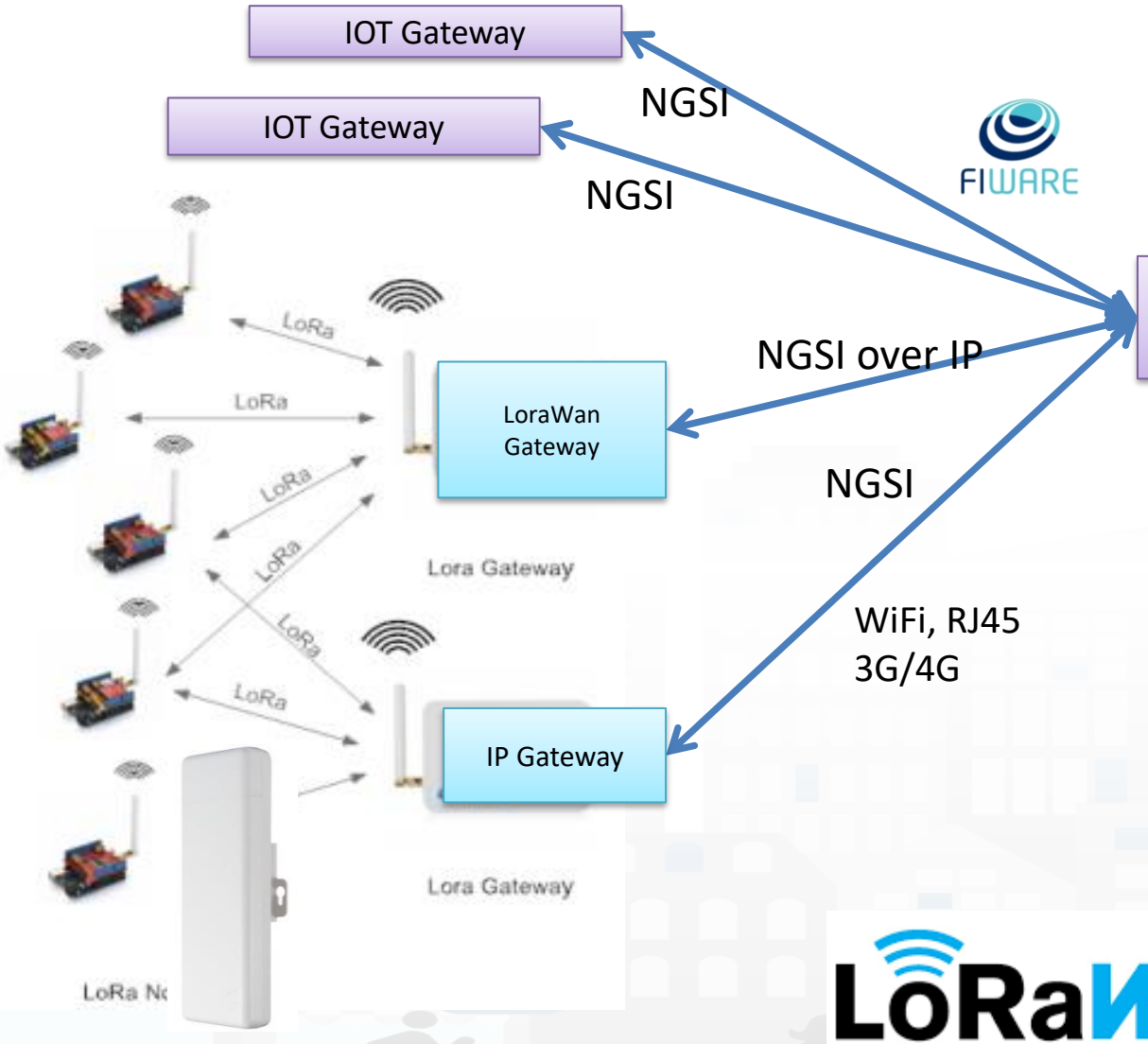


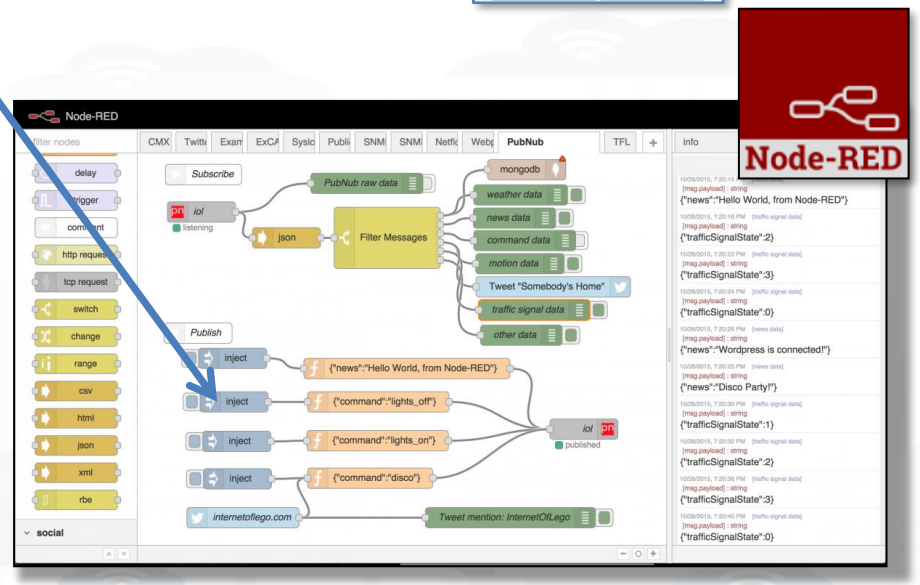
LoraWAN Dragino (Arduino)

LoRaWAN™



IOT Management

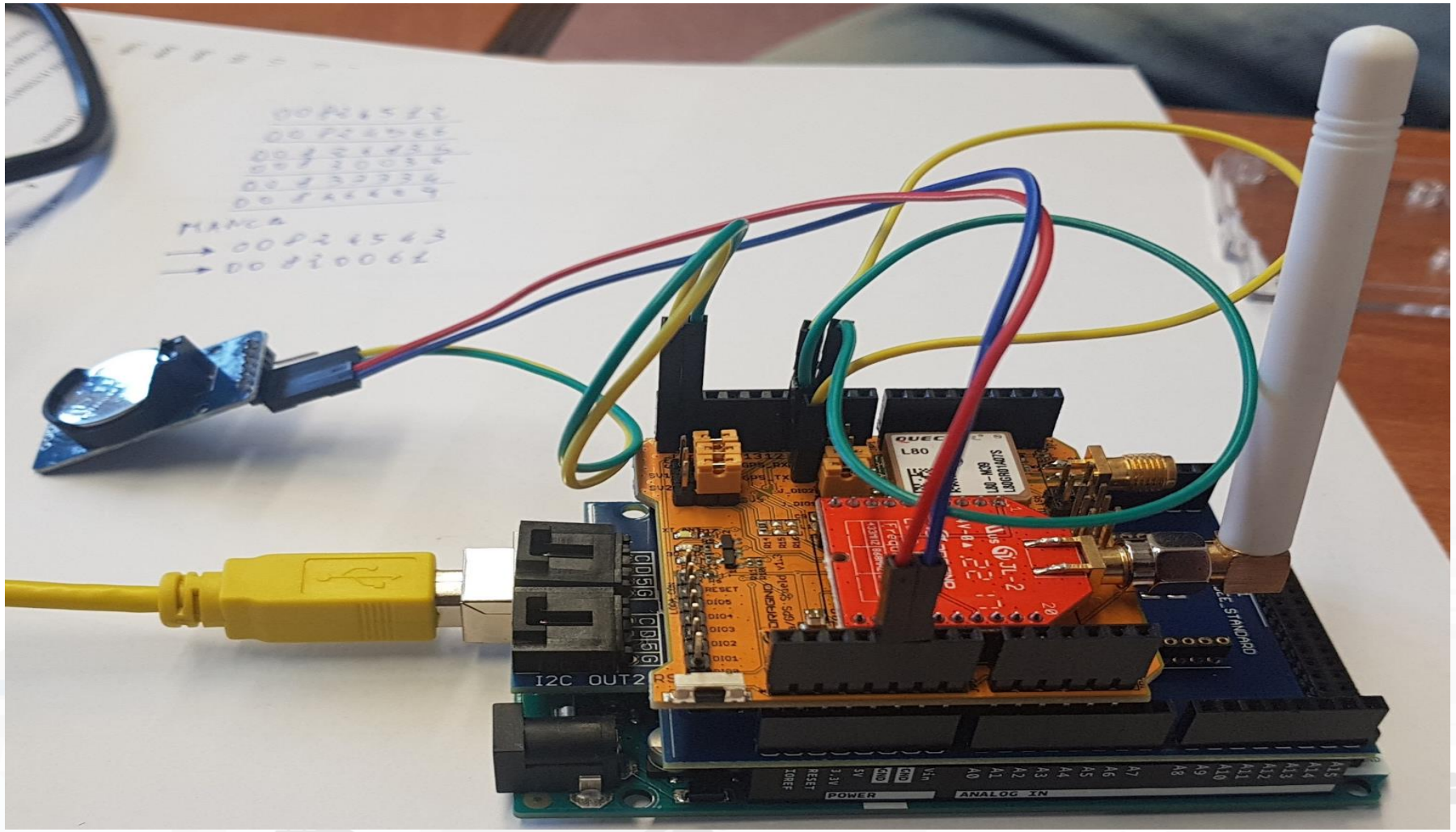




LoRaWAN™

Dragino……

Piattaforma di sviluppo per LoraWan

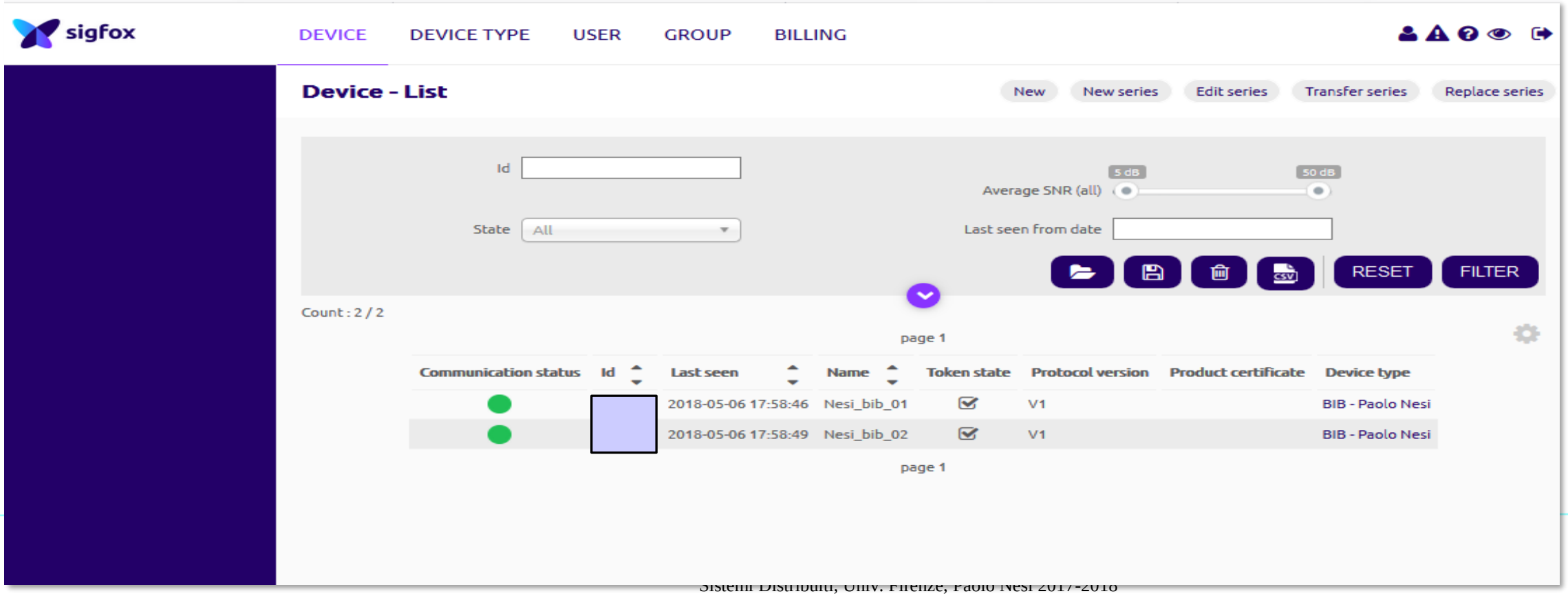


LoRaWAN™

SigFOX Server Side

sigfox

- 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

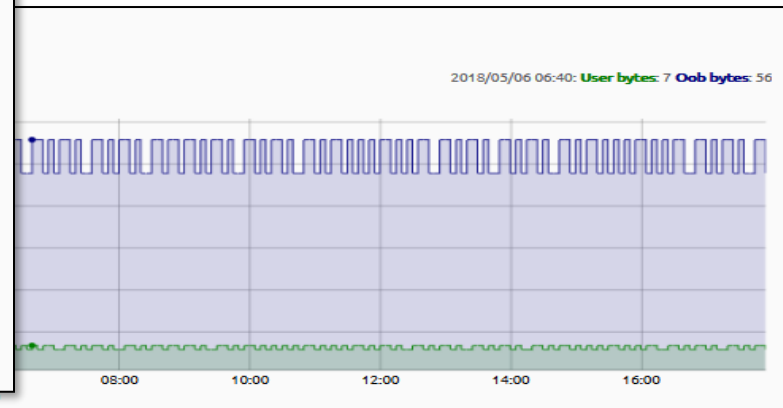


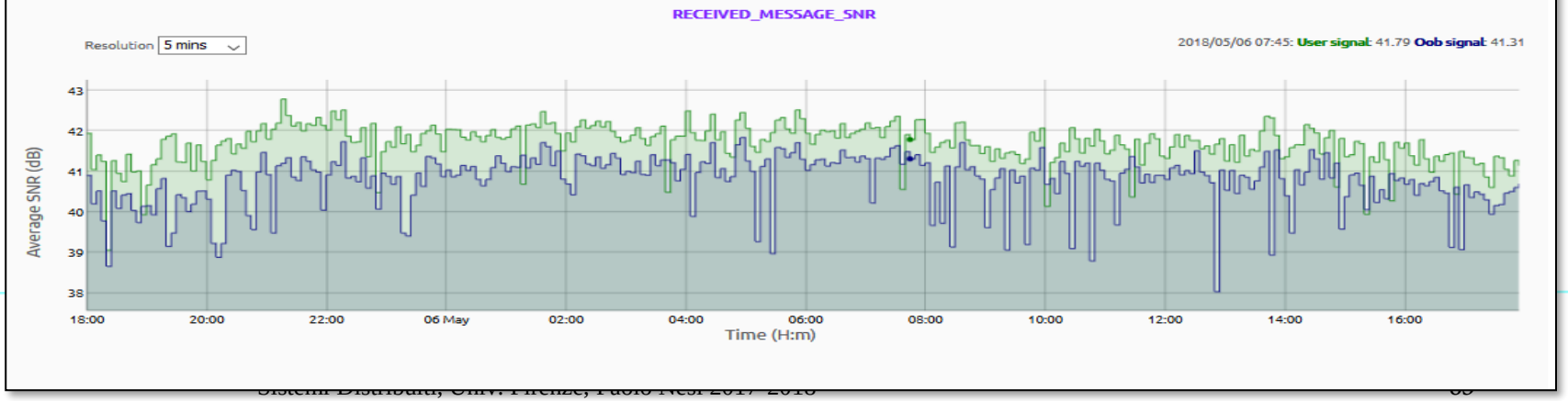
SigFOX

page 1

Frame reception time

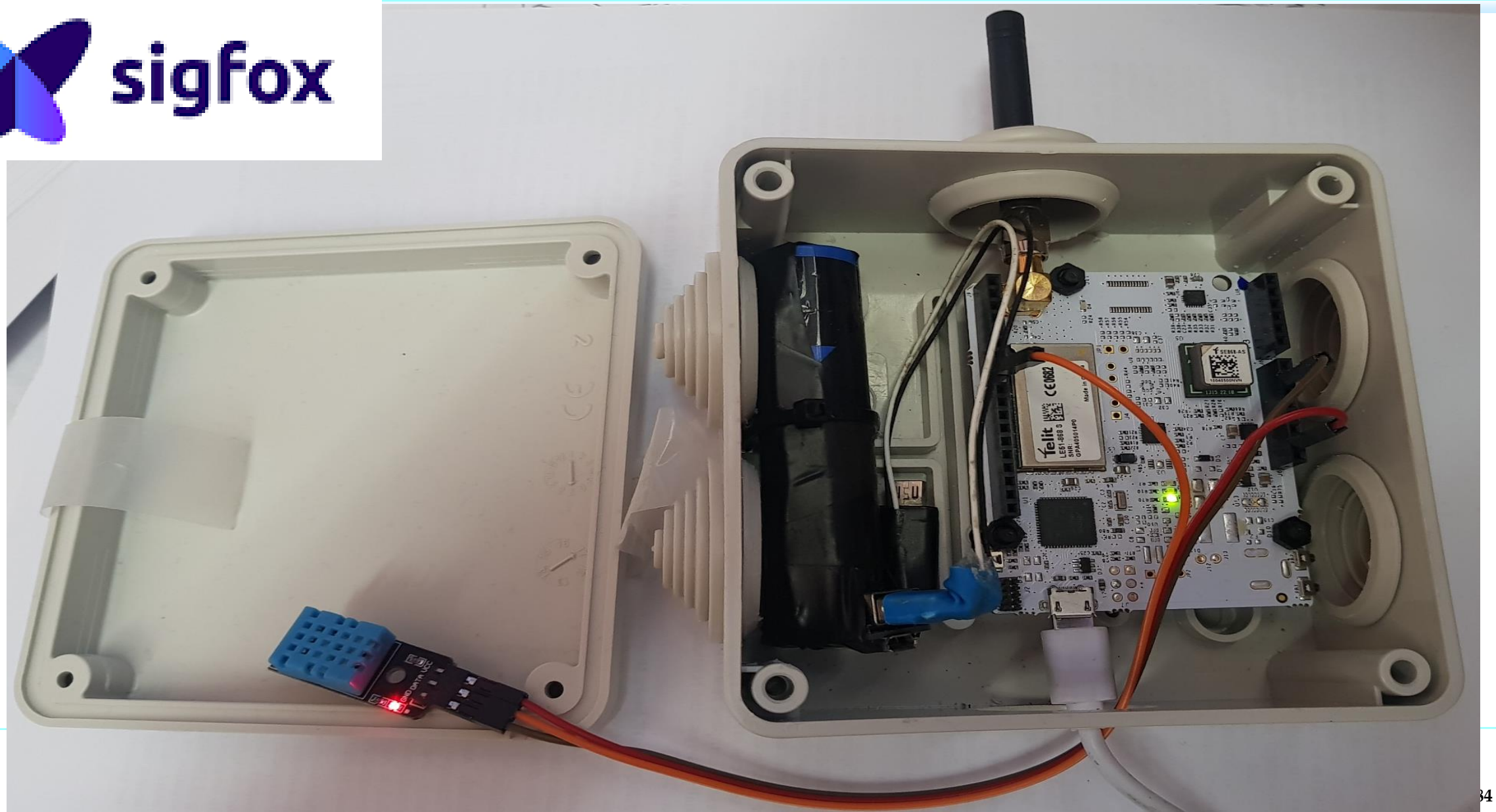
Time	Delay (s)	Header	Data / Decoding	Location	Base station reception attributes: Base station	RSSI (dBm)	SNR (dB)	Freq (MHz)	Frames	Callbacks
2018-05-06 18:03:27	< 1	0000 ack required	24		28A8	-122.00	29.40	868.1491	3/3	
					2896	-136.00	15.60	868.1420	3/3	
					25F2	-119.00	32.03	868.1373	3/3	
2018-05-06 18:03:25	< 1	0010	09dd0b4f0b040103 Temp: 26.0 °C VDD idle: 3.037 V VDD tx: 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 tx: 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 piattaforma di sviluppo

sigfox

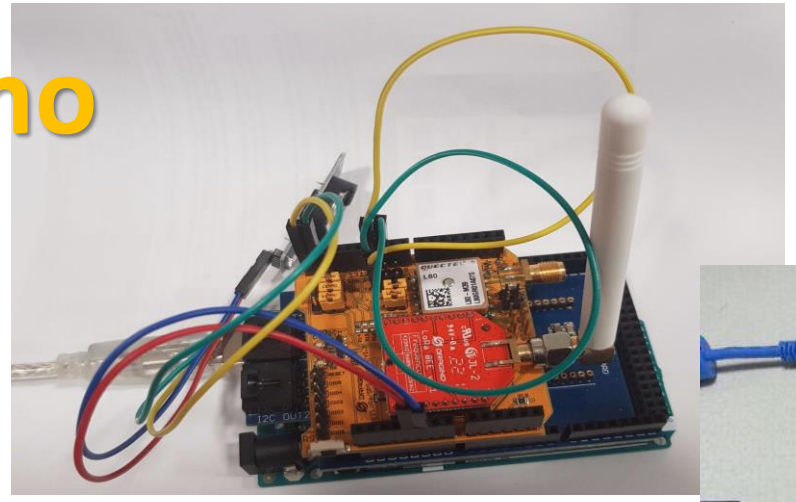


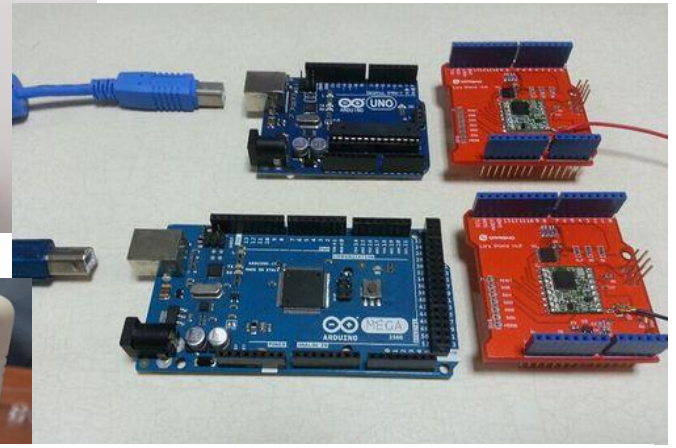
IOT Dev Management: activities

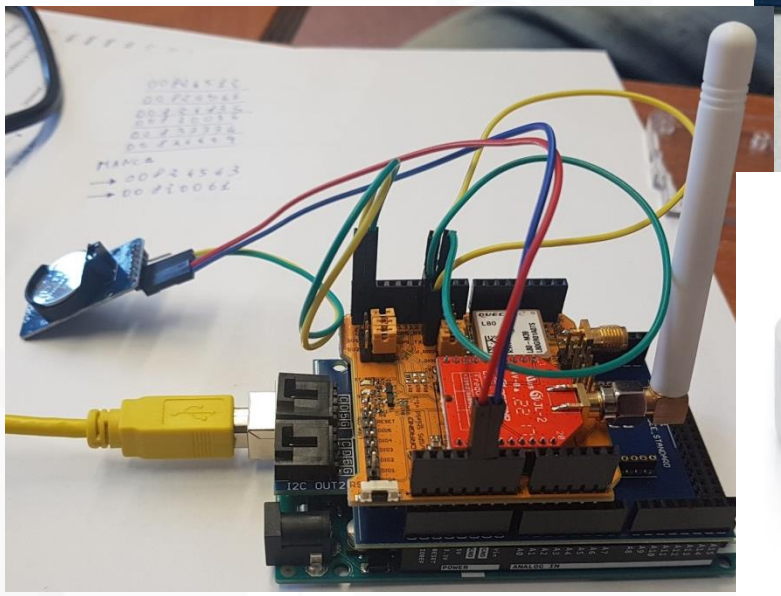
- **IOT Devices can be open or proprietary**
- **IOT Devices**: a large range of protocols, formats and kind
  - IOT Devices (single or in bulk) are **registered** on IOT Directory and thus according to Knowledge base are registered to be used in IOT Applications, Dashboards, etc. with Shadow values, 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



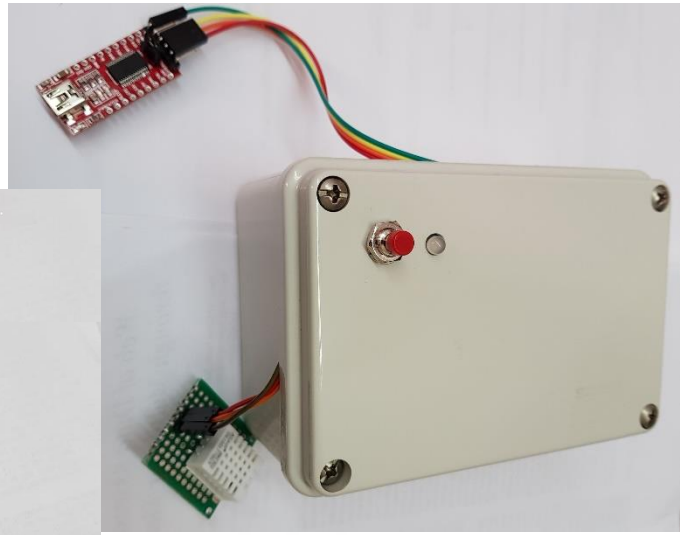


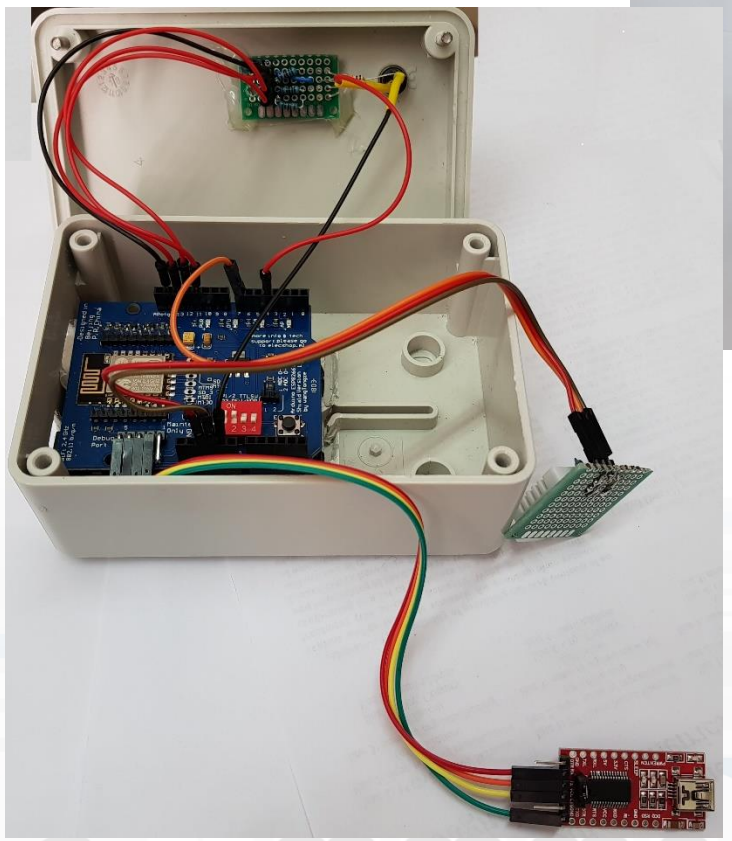


https://www.snap4city.org/drupal/node/216

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

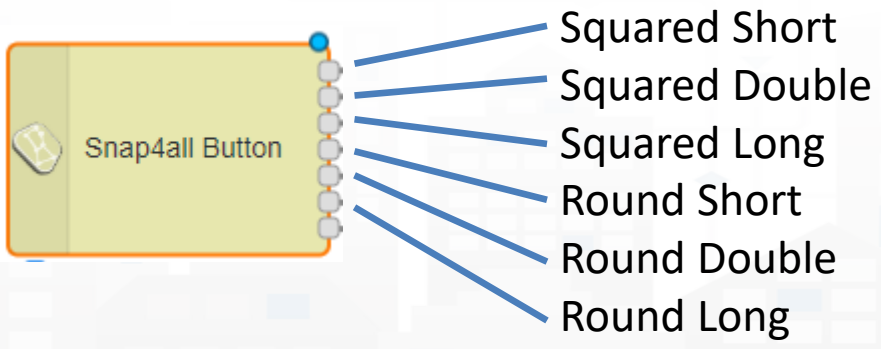




Snap4All IOT Button

- 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

version: 3



https://www.snap4city.org/drupal/node/276
https://www.snap4city.org/drupal/node/297 help config

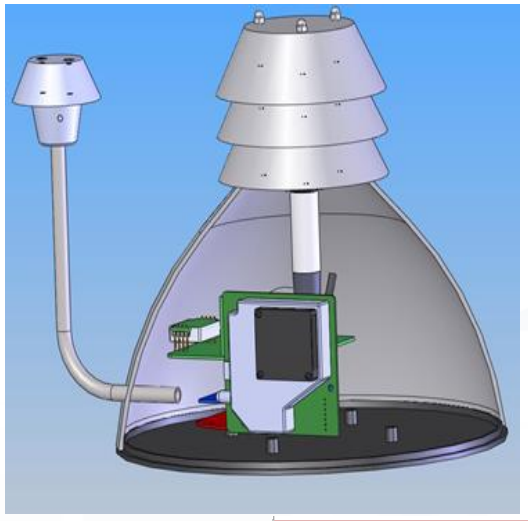
Consiglio Nazionale delle Ricerche

CNR IBE AirQuino

AirQuino

- 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_2, O_3, NO_2, CH_4),
  - 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.

Consiglio Nazionale delle Ricerche

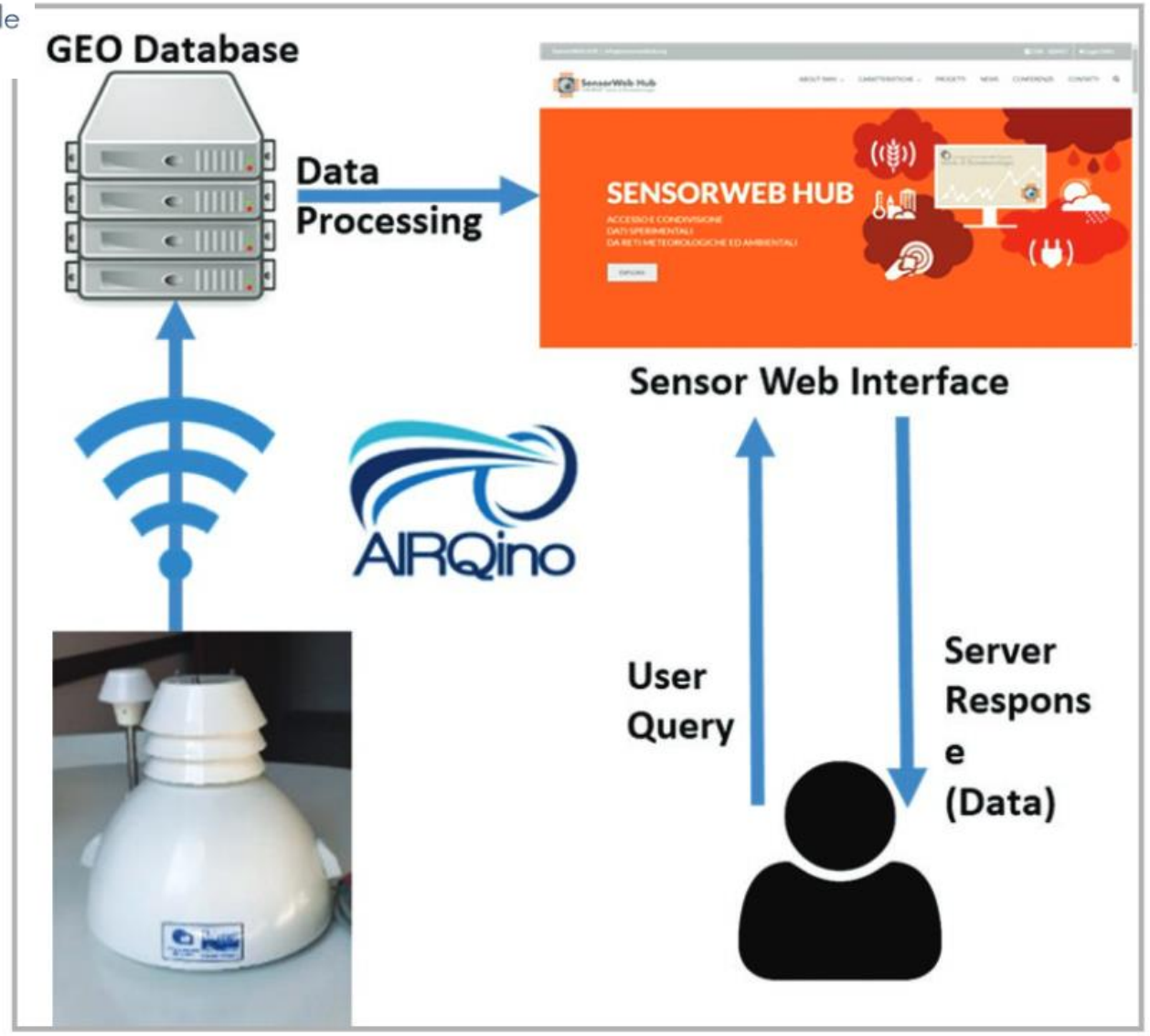


Parameter	Unit	Range
Temperature	°C	-40 – 80
Relative Umidity	%	0 – 100
CO2	ppm	0 – 2000
O3	ppb	0 – 400
NO2	ppm	0.05 – 5
CO	ppm	1 – 30
PM	µg/m3	0 – 999
VOC	ppm	1 – 100

https://www.snap4city.org/drupal/node/508

https://www.snap4city.org/download/video/tn/ARQuino-CNR.pdf


T2 Peretola Aeroporto
1012
GEST


GEO Database
Data Processing
SENSORWEB HUB
Sensor Web Interface
AIRQino
User Query
Server Respons e (Data)

Libelium Sensors

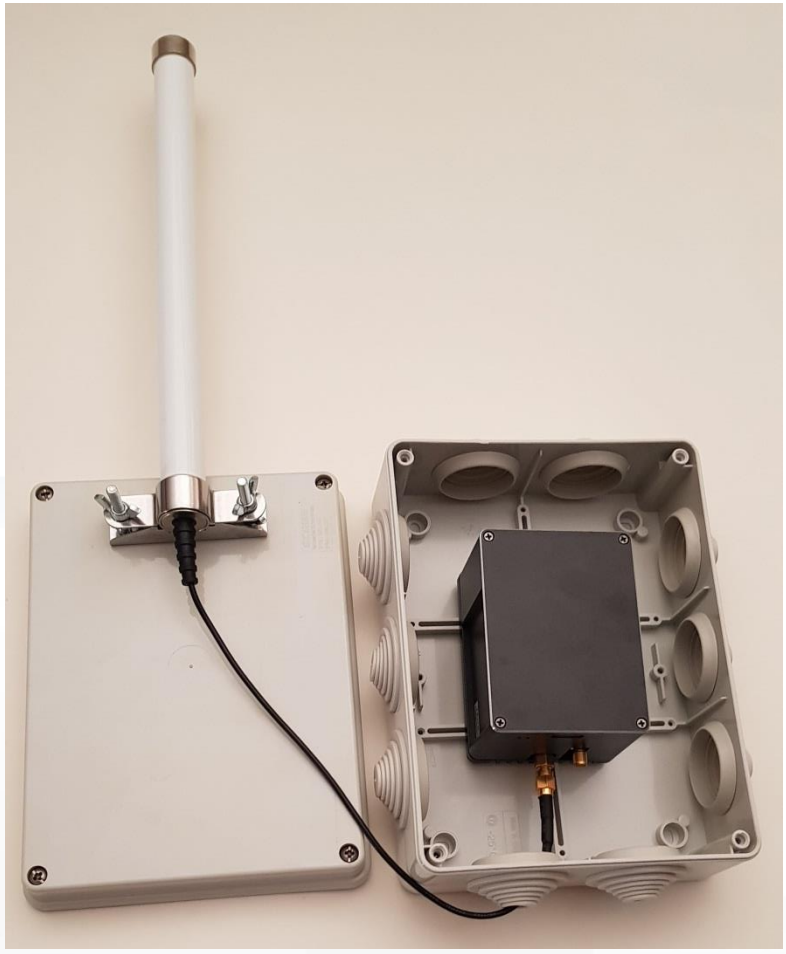
Libelium

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

IOT Gateway / IOT Edge

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

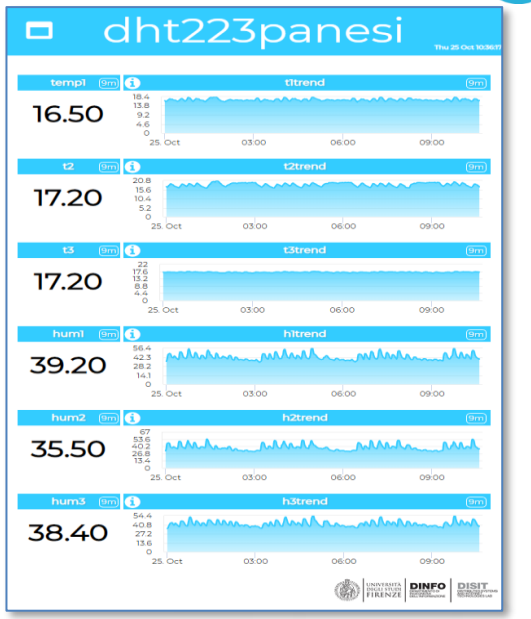


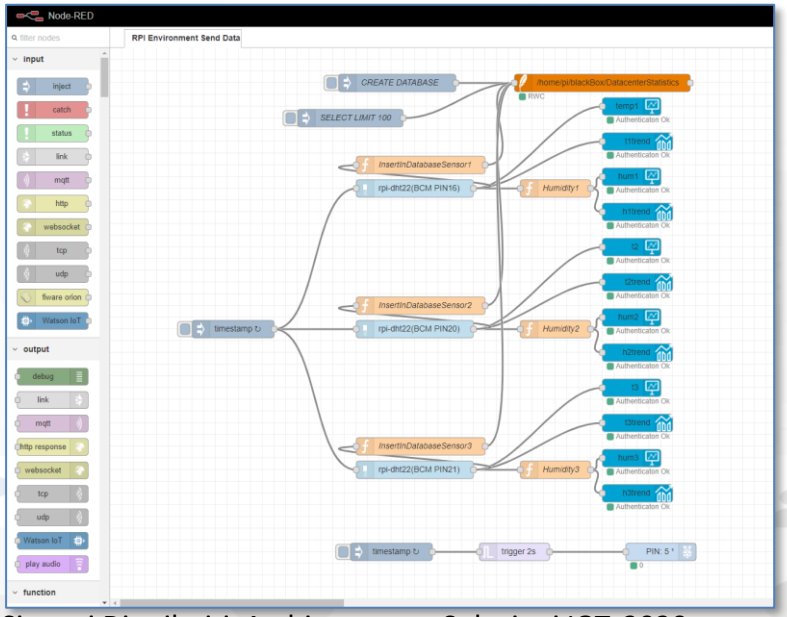
FIWARE LoRa Wi Fi

IOT Edge

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**





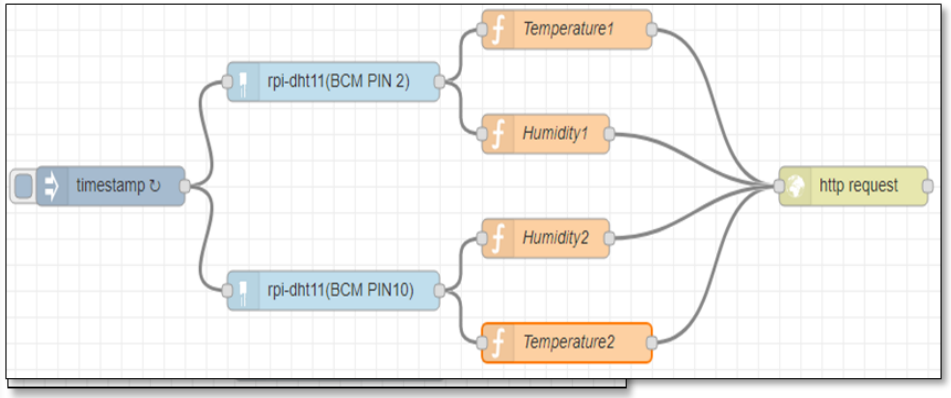
MicroServices:
- DHT
- ModBus
- any shield
- etc....

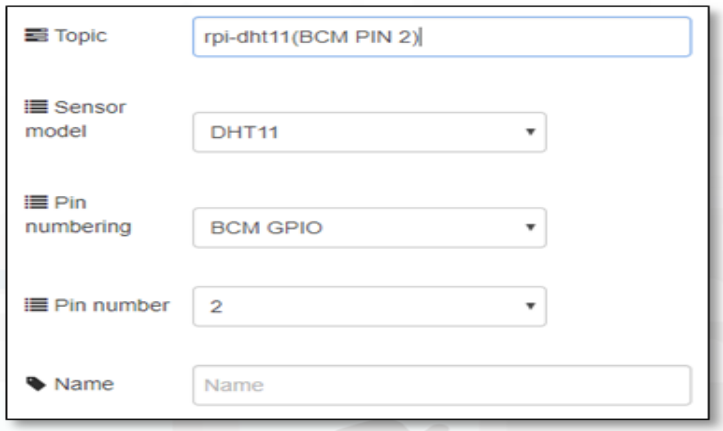
FIWARE

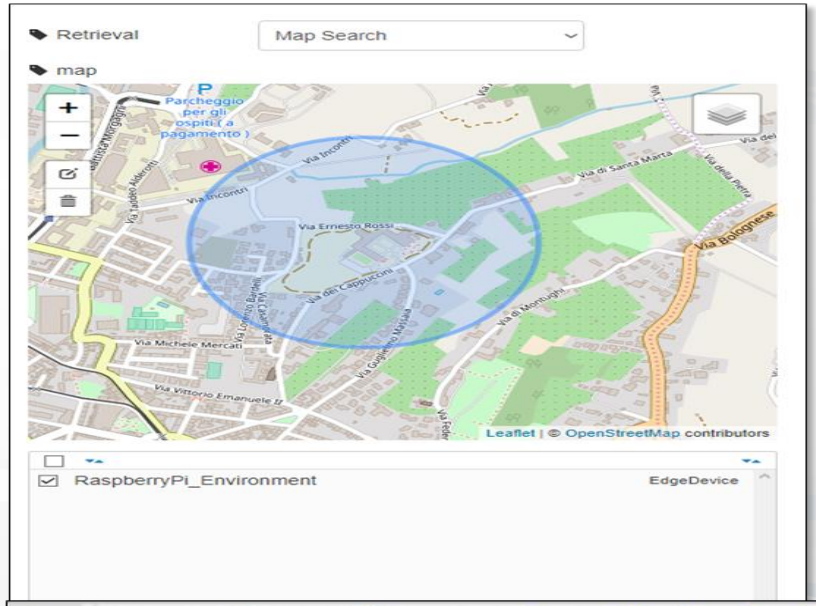
Wi Fi

Raspberry for Edge

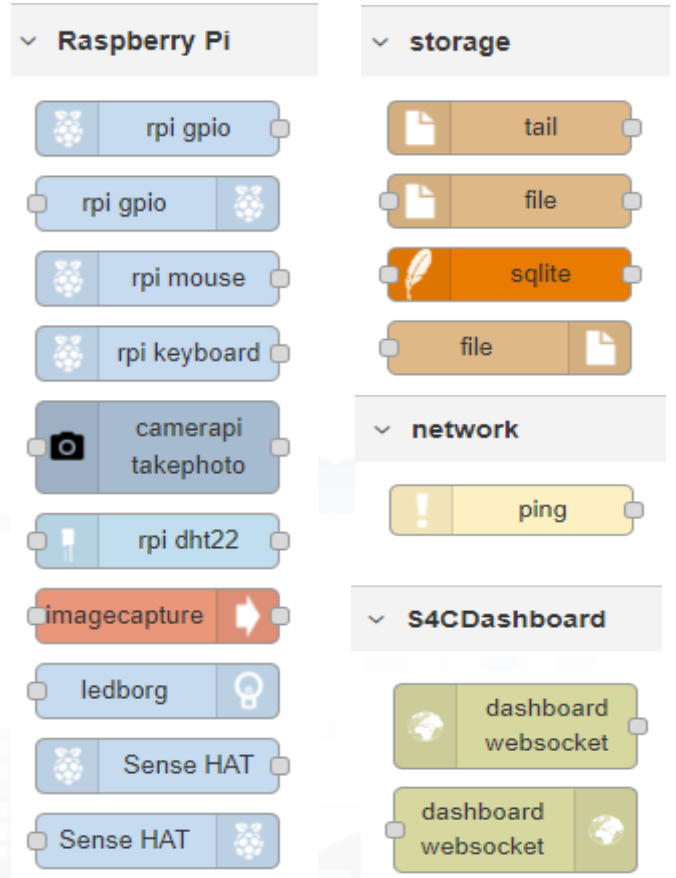
3.3V Power - 1	2 - 5V Power
SDA1 - GPIO02 - 3	4 - 5V Power
SCL1 - GPIO03 - 5	6 - Ground
GPIO04 - 7	8 - GPIO14 - TxD
Ground - 9	10 - GPIO15 - RxD
GPIO17 - 11	12 - GPIO18
GPIO27 - 13	14 - Ground
GPIO22 - 15	16 - GPIO23
3.3V Power - 17	18 - GPIO24
MOSI - GPIO10 - 19	20 - Ground
MISO - GPIO09 - 21	22 - GPIO25
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;
```



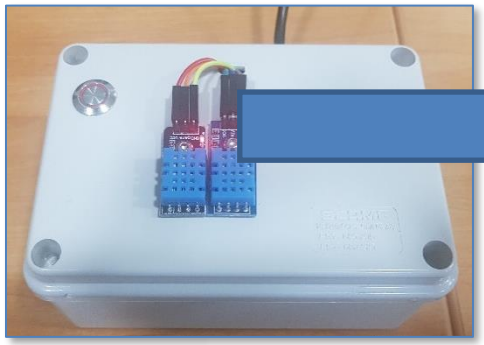
Snap4City on Raspberry Pi, IOT edge

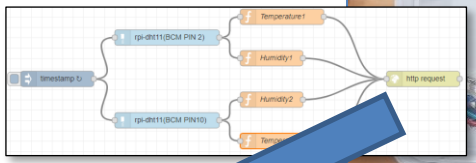
IOT Edge Computing

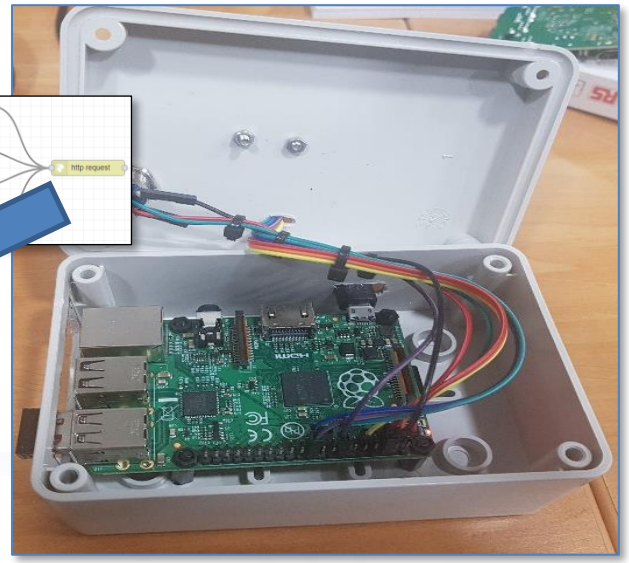
City user

Would like to:

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





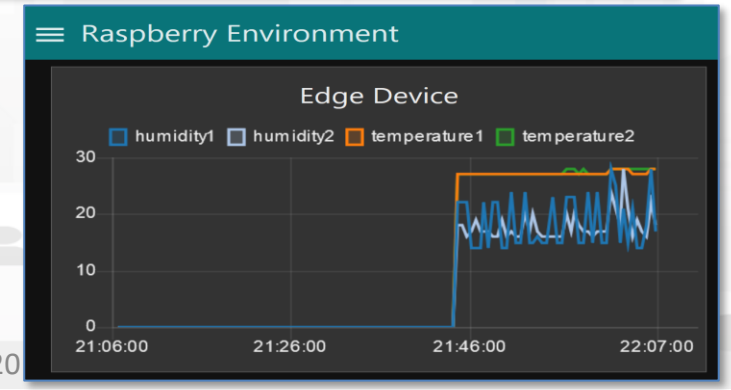


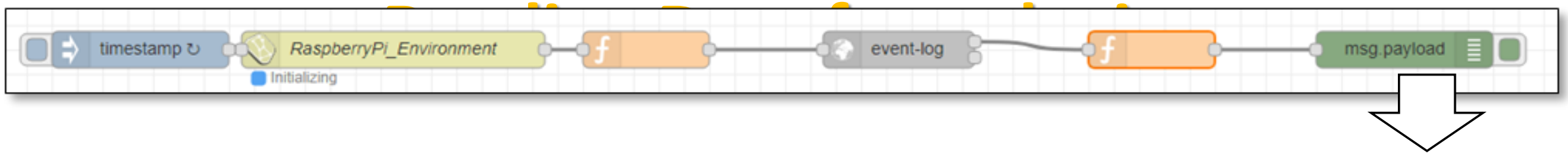
IOT Broker

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":
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{"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]
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{"name":"humidity1","type":"Float","value":"30.00"},
{"name":"humidity2","type":"Float","value":"35.00"},
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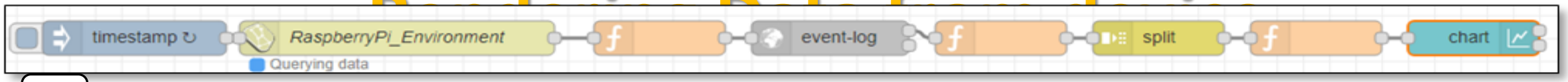
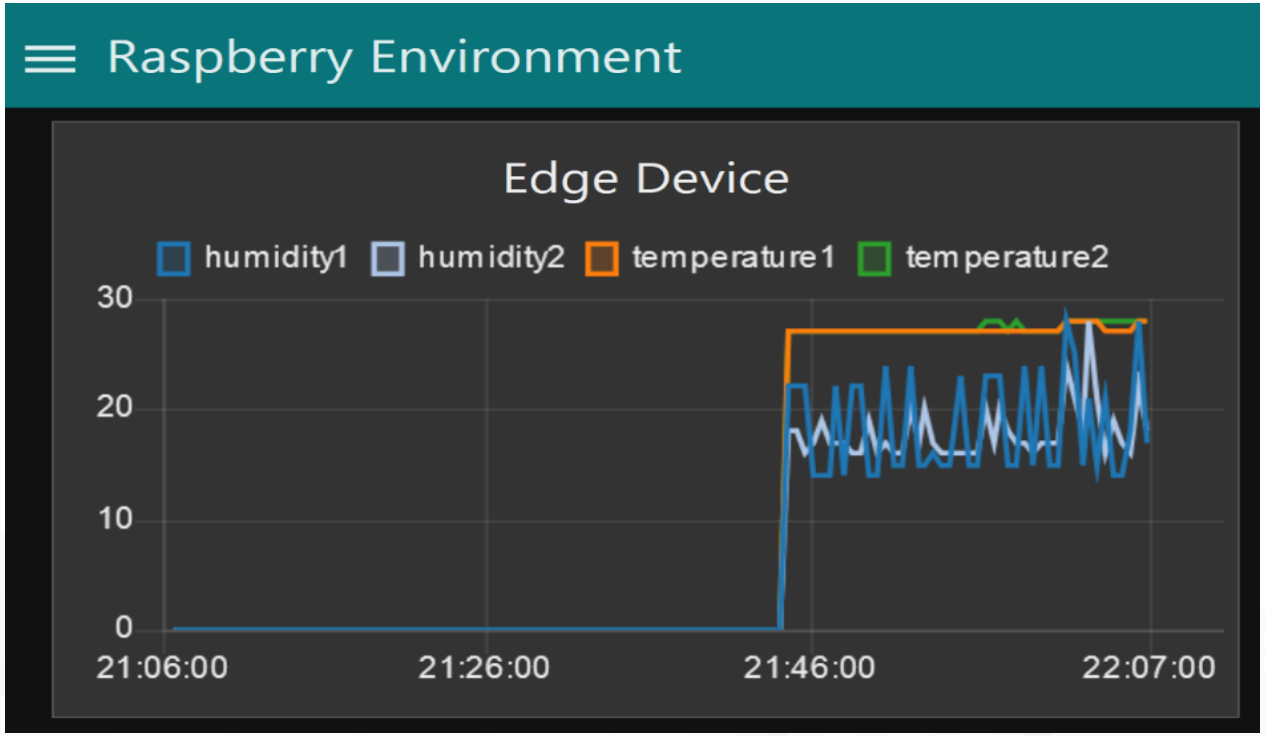
{"name":"temperature1","type":"Float","value":"26.00"},
{"name":"temperature2","type":"Float","value":"26.00"}]}]"

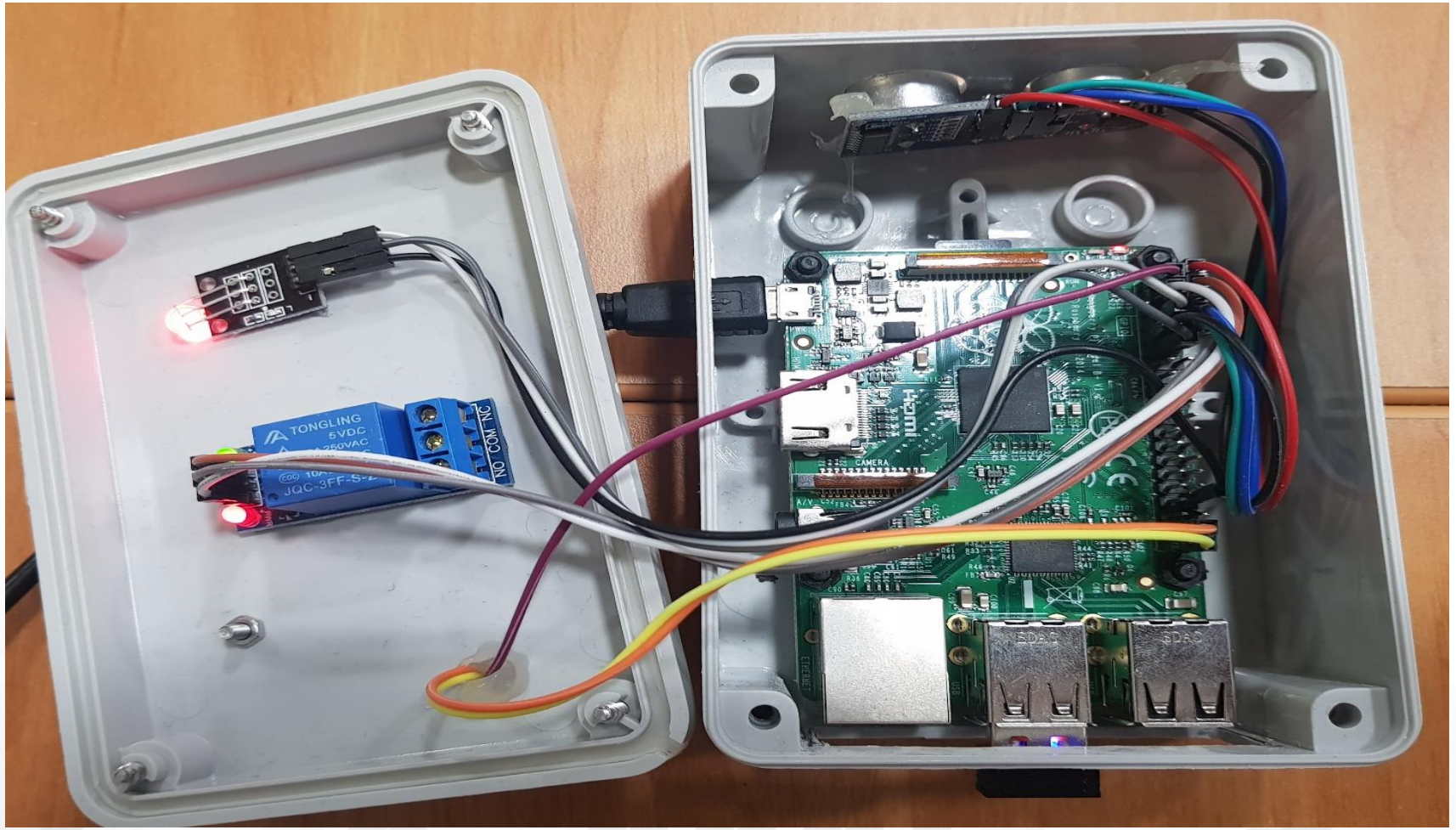

timestamp
RaspberryPi_Environment
Querying data
event-log
split
chart

a

b


Raspberry Environment
Edge Device
humidity1
humidity2
temperature1
temperature2
30
20
10
0
21:06:00
21:26:00
21:46:00
22:07:00

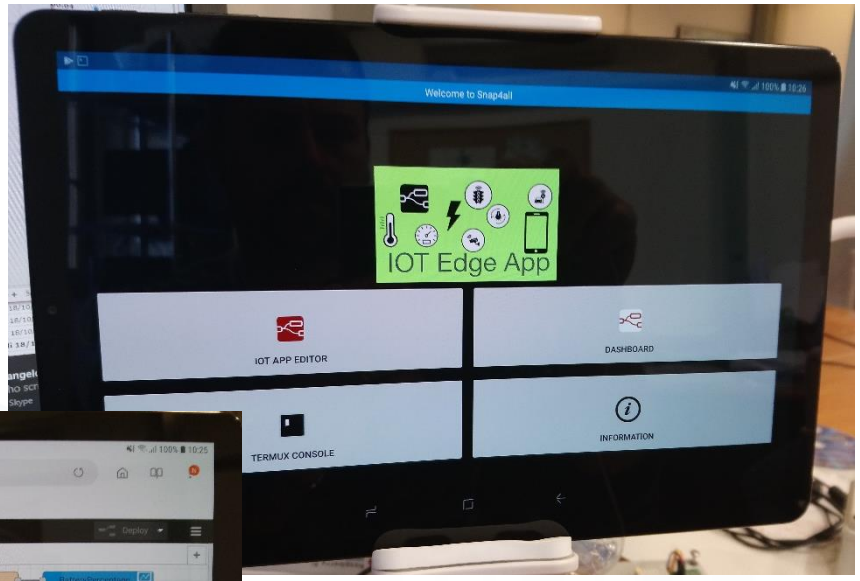
Altro device: distanza, temperatura, attuazione

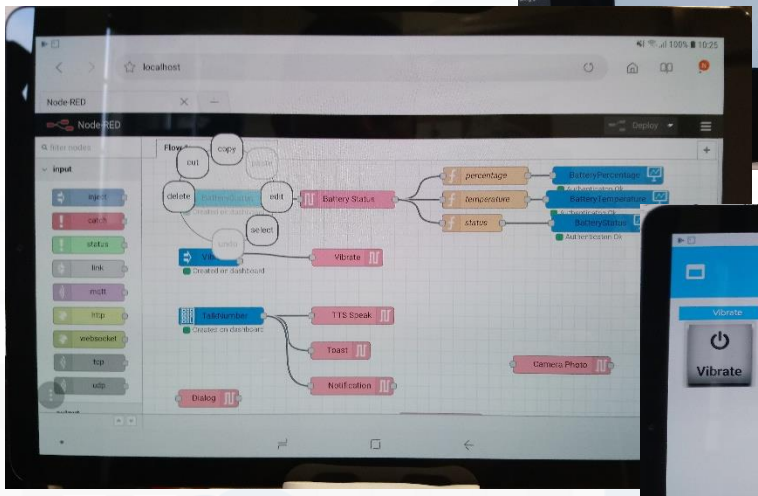


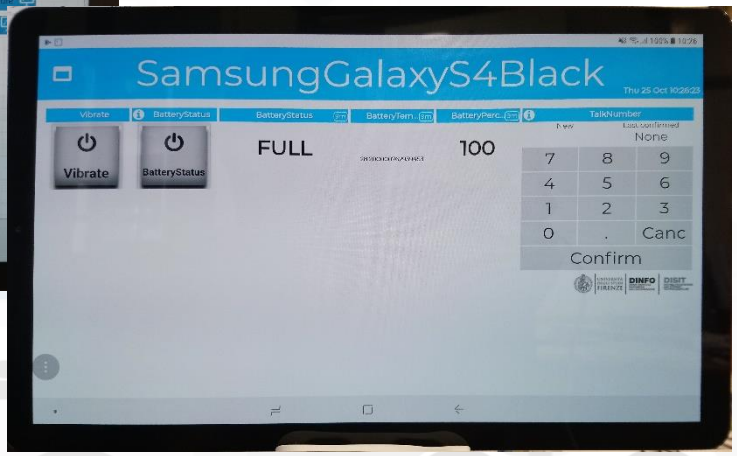
IOT Edge on Mobiles

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**



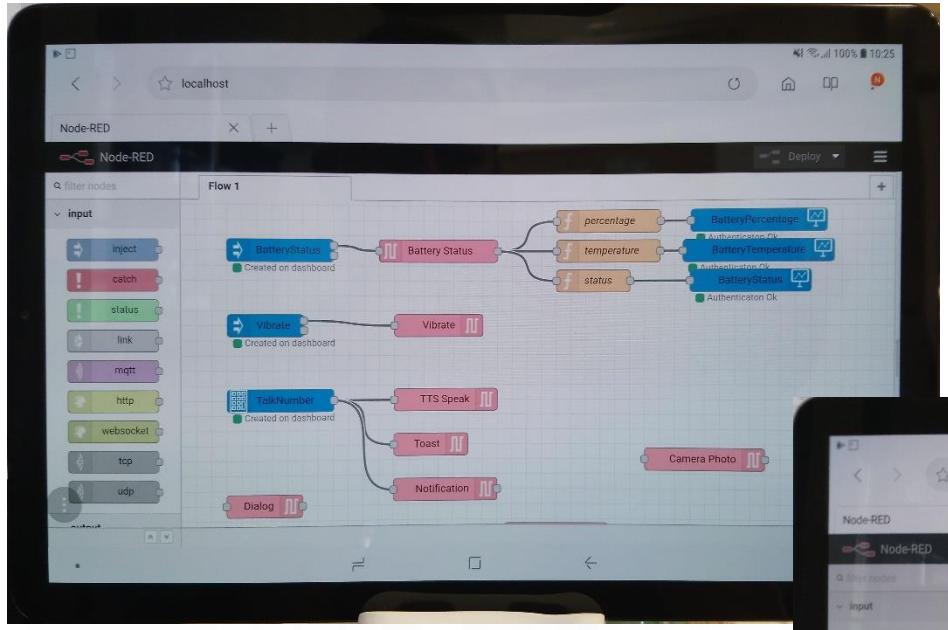


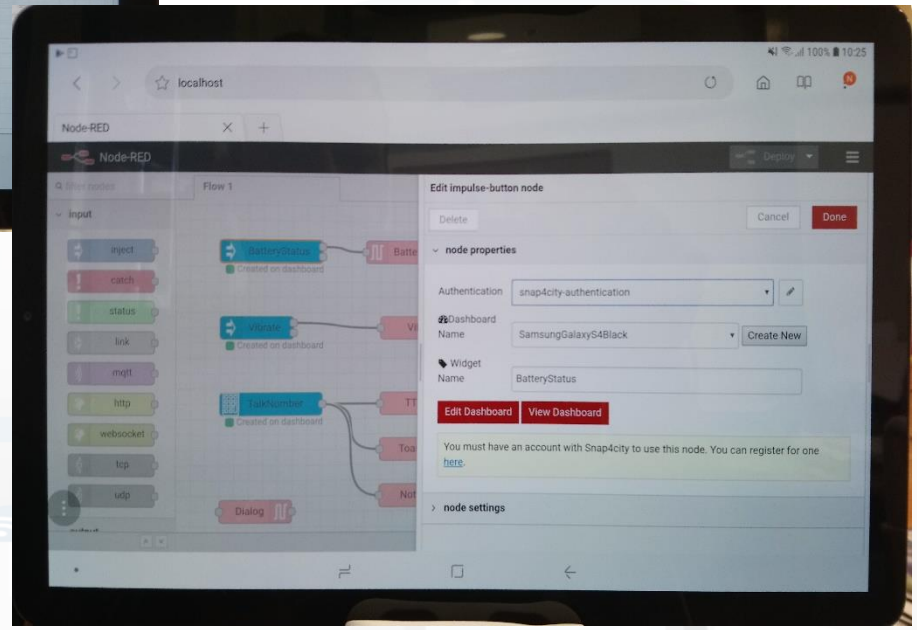


https://www.snap4city.org/drupal/node/278

IOT Edge Snap4All App for Android

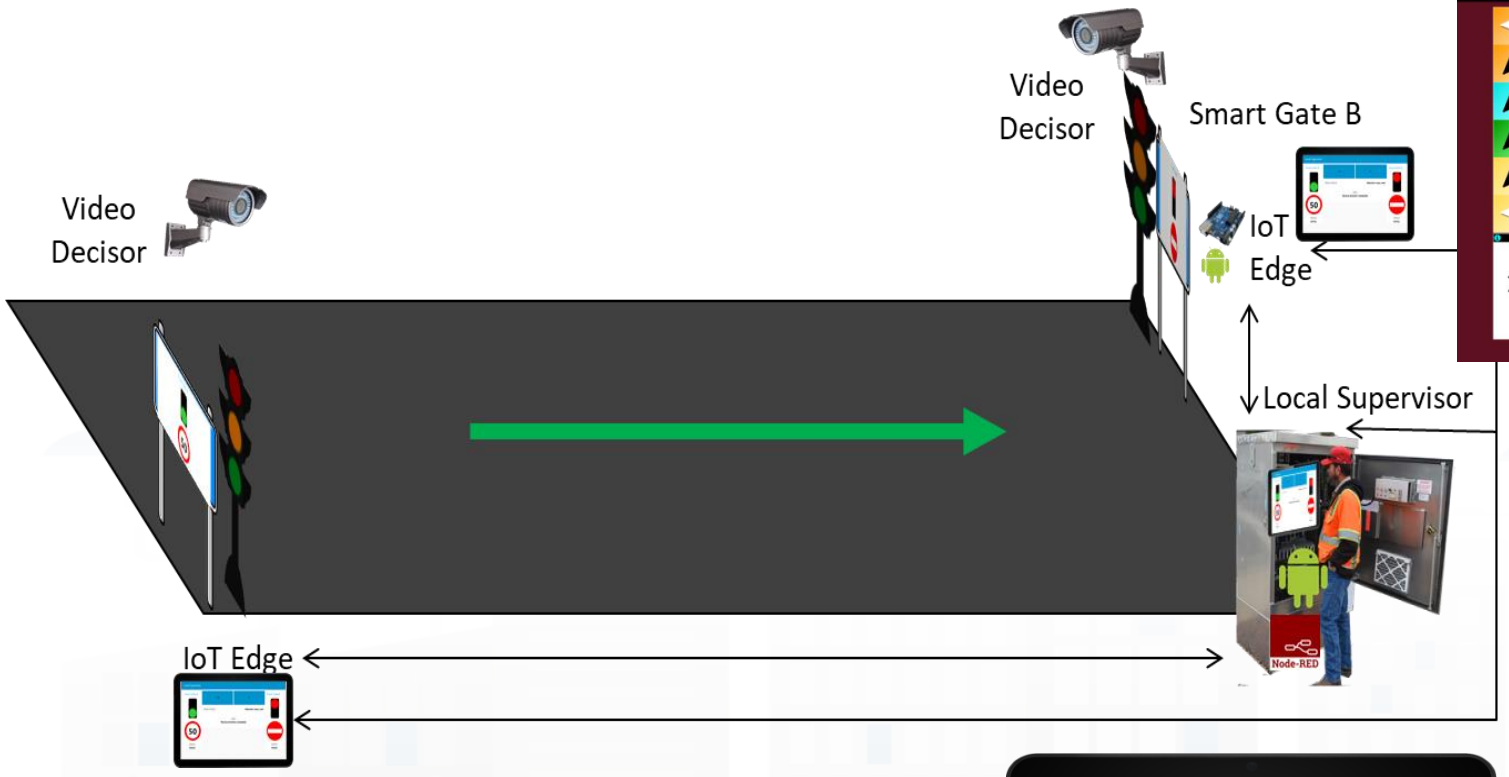
- termux-battery-status
- termux-camera-info
- termux-clipboard-get
- termux-contact-list
- termux-telephony-cellinfo
- termux-telephony-deviceinfo
- termux-tts-engines
- termux-camera-photo
- termux-clipboard-set
- termux-dialog
- termux-download
- termux-location
- termux-tts-speak
- termux-vibrate
- termux-sms-inbox
- termux-toast
- termux-sms-send
- termux-share
- termux-notification
- termux-wifi-connectioninfo
- termux-wifi-scaninfo

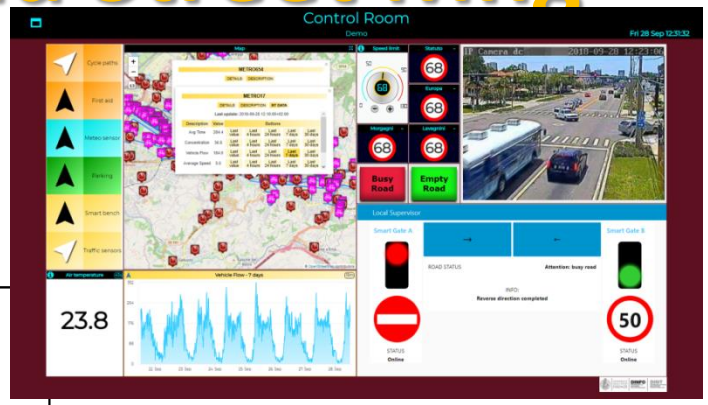




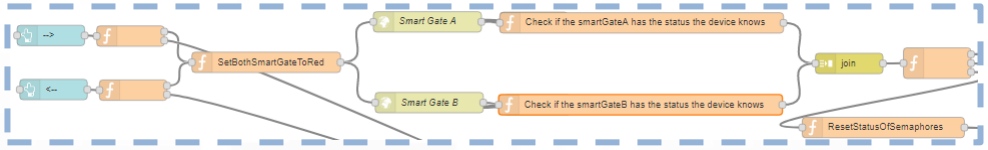
MicroServices:
- Snap4City
- Termux Snap4City specific
- etc.

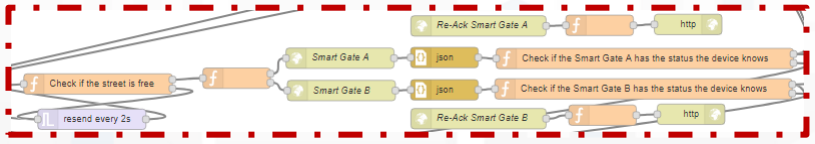
Sii-Mobility: Dynamic Signage and Street Mng

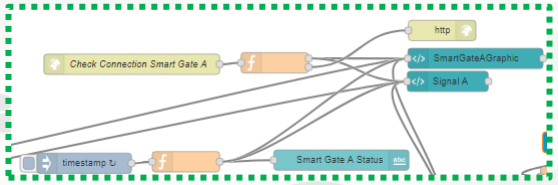




Control Room





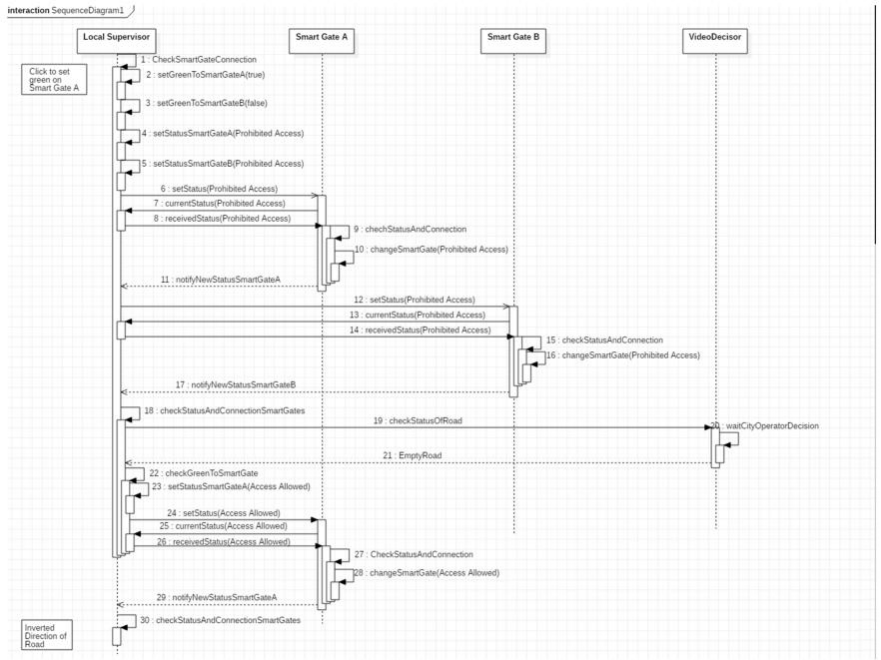


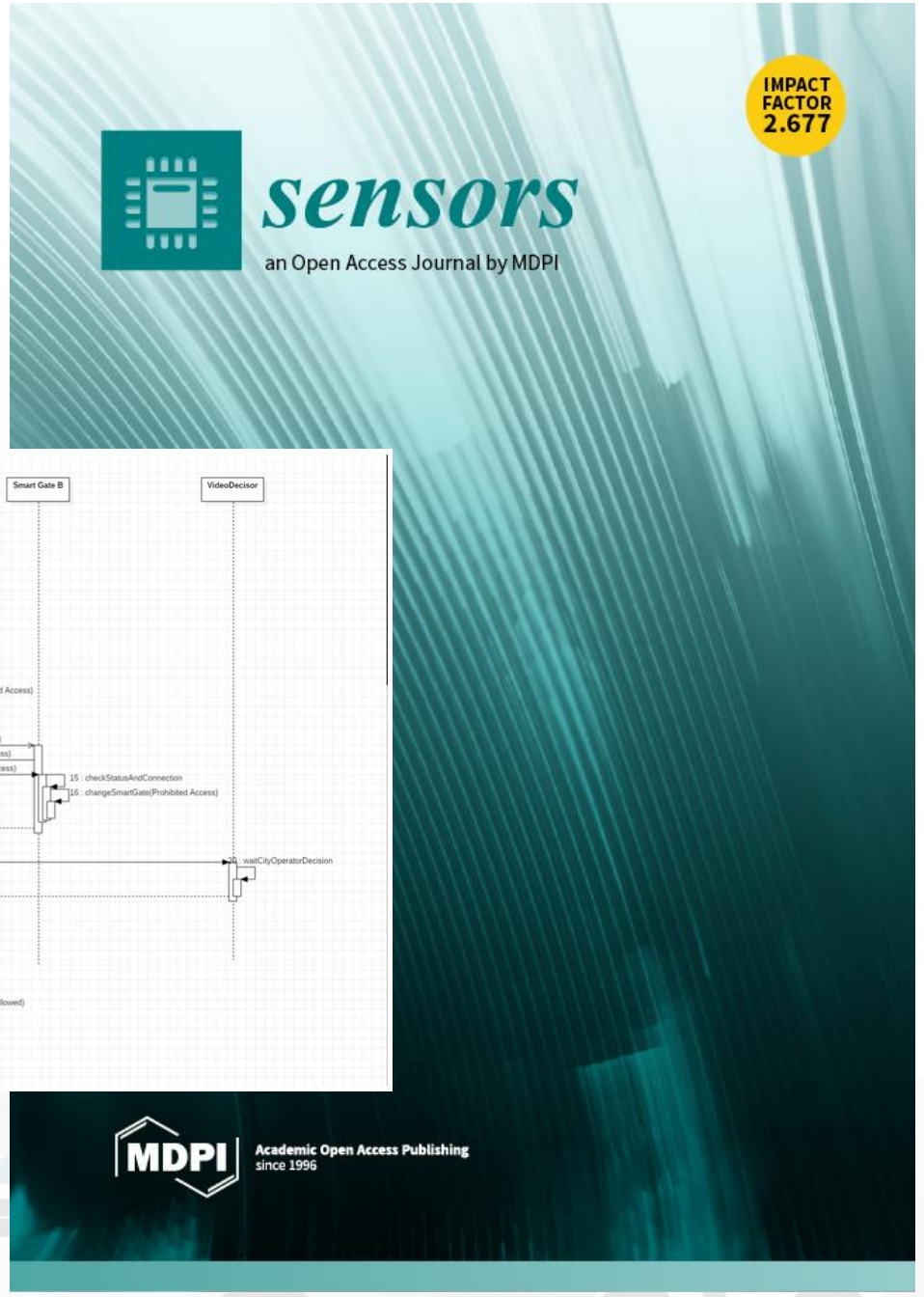
Local Control Dashboard

Safe and resilient solution manging 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





IOT Tracking Devices

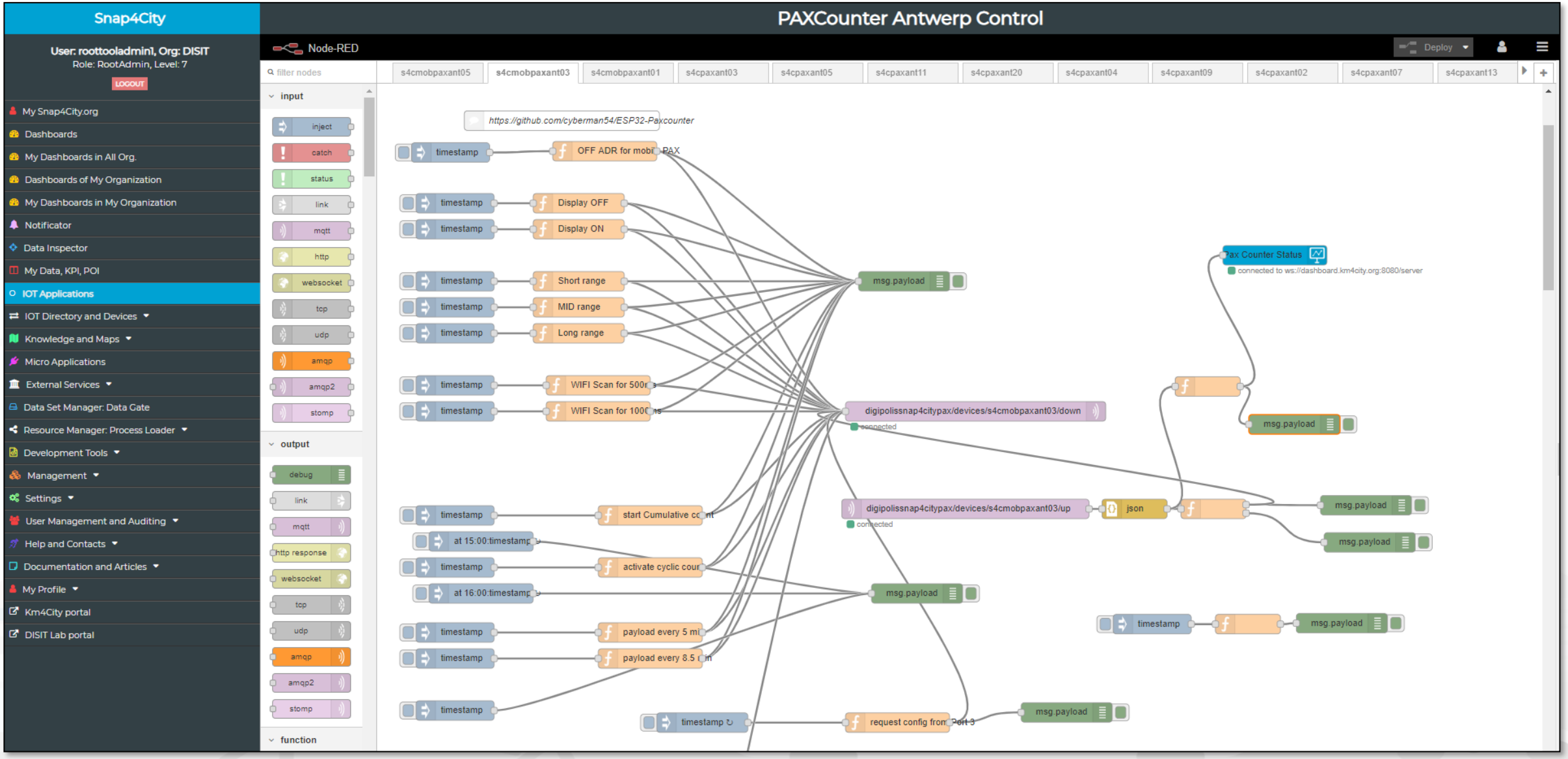
PaxCounter devices

- 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

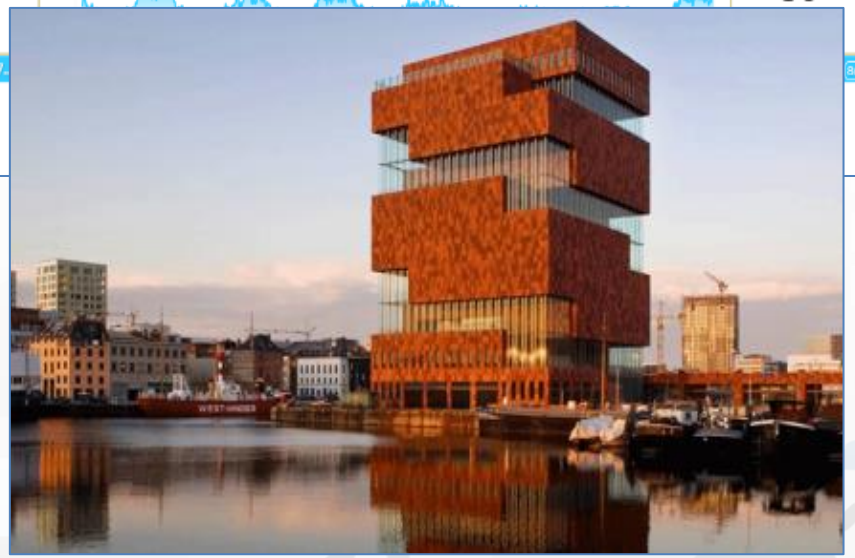
Iot app behind



PAXCounter real time and trend

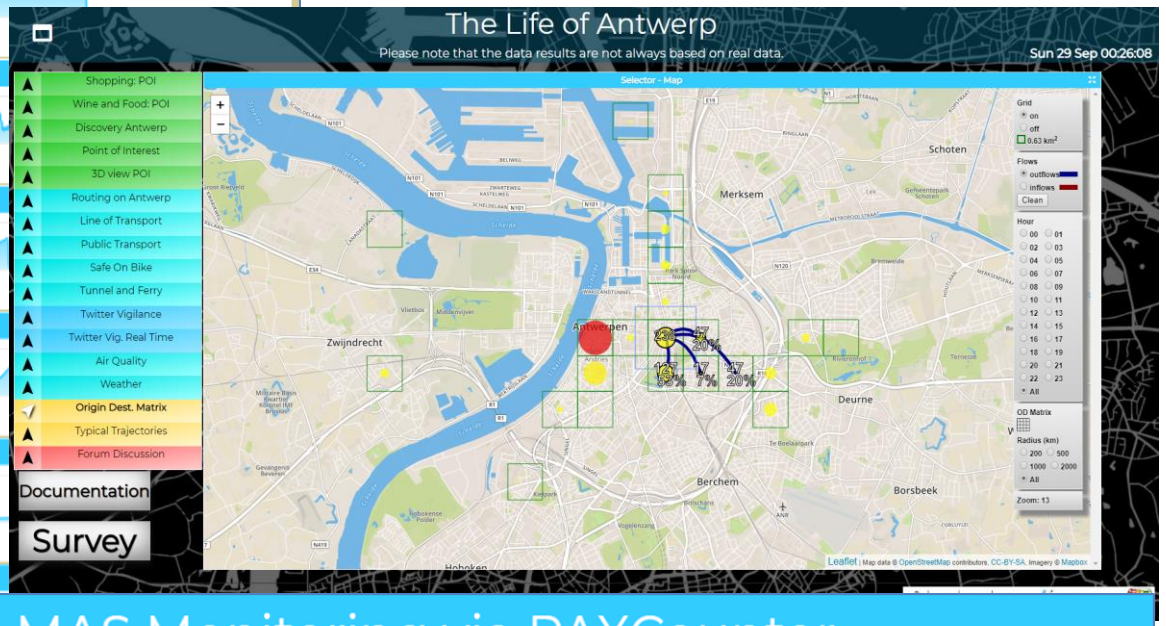
Mon 30 Sep 17:18:48

s4cpaxant01	3	s4cpaxant11	72
s4cpaxant02	1157	s4cpaxant12	15
s4cpaxant03	17	s4cpaxant13	295
s4cpaxant04	7	s4cpaxant14	13
s4cpaxant05	4	s4cpaxant15	59
s4cpaxant06	17	s4cpaxant16	30
s4cpaxant07	952		



SNAP4CITY

KM4CITY

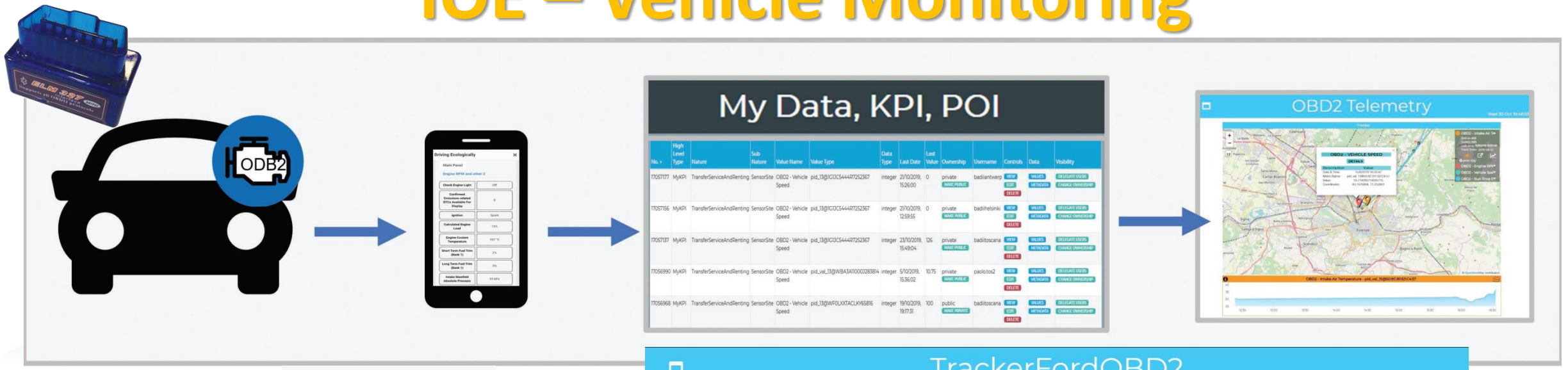


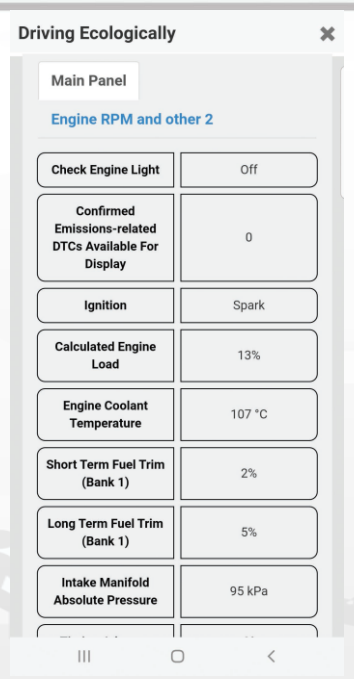
MAS Monitoring via PAXCounter

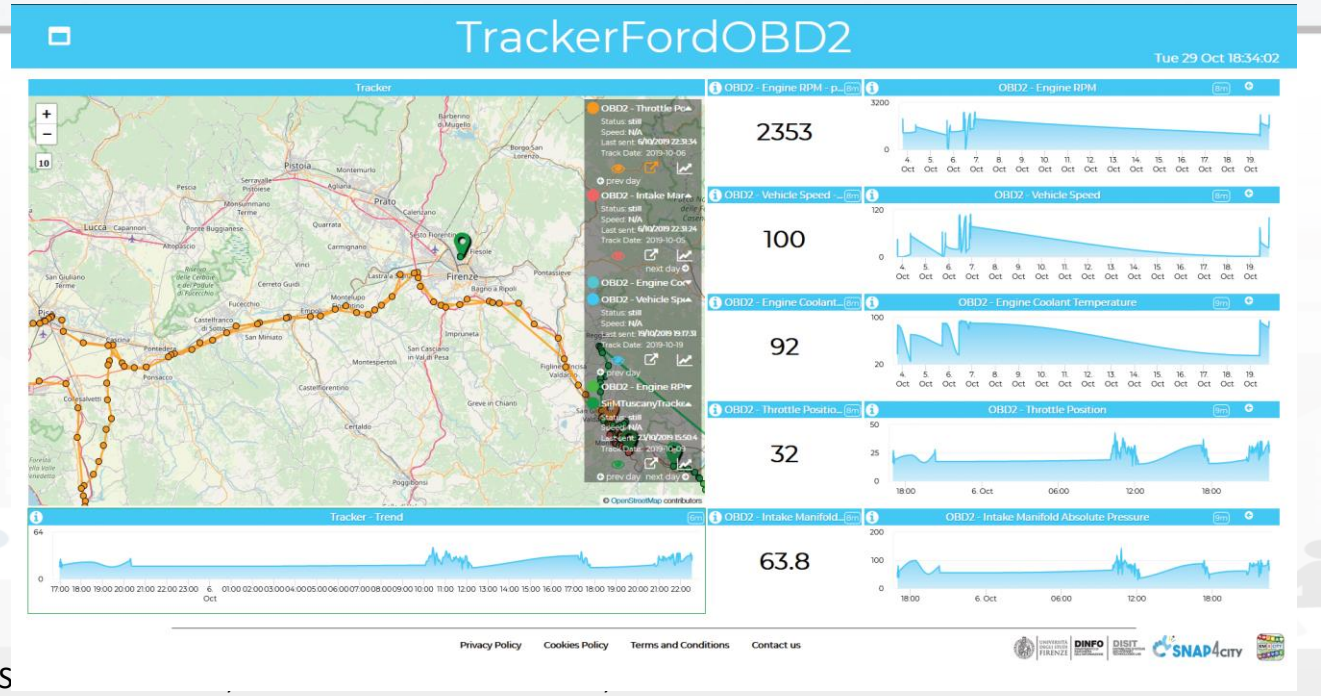
Mon 30 Sep 17:31:32

pax03 in	17	s4cpaxant03 - ingang gelijkvloers balie	s4cpaxant03 - wifi / s4cpaxant03delta - wifi
pax05 8ste	9	s4cpaxant05 - 8ste verdieping, ingang	s4cpaxant05 - 8ste ingang H24 / s4cpaxant05 change on passages
pax20 2de	13	s4cpaxant20 - 2de verdieping, uitgang	s4cpaxant20 - 2de uitgang H24 / s4cpaxant20delta - change on passages
pax11 4de	74	s4cpaxant11 - 4de verdieping, uitgang	s4cpaxant11 - 4de uitgang H24 / s4cpaxant11delta - change on passages

IOE – Vehicle Monitoring







MyKPI: Tracking of Devices and Mobiles

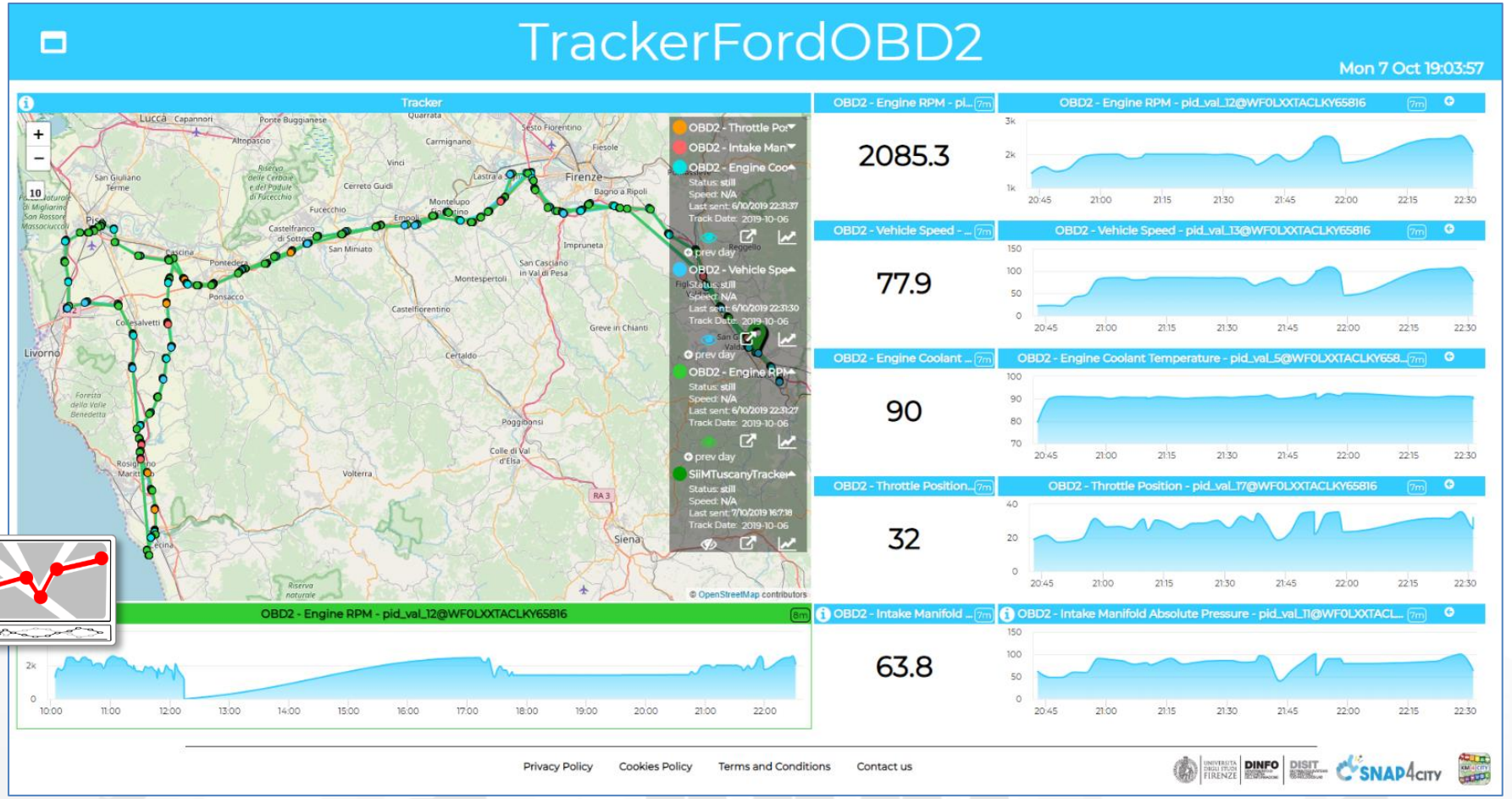
- Real Time Trajectories for
  - Mobile Phone
  - Moving IOT Devices
  - OBU, Vehicular Kits
  - Multiple tracks
  - Day by day
- Micro Application

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)

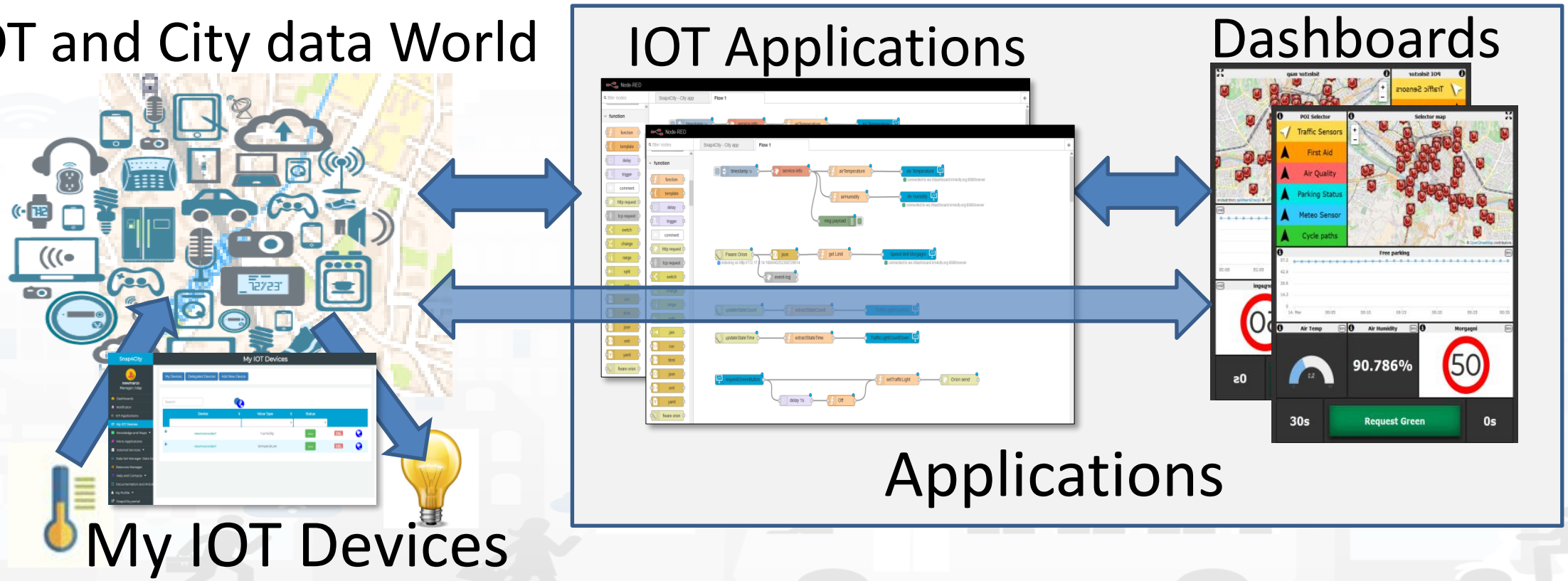
- **A large range of Devices** can be used on Snap4City:
  - Proprietary or Open HW/SW.
  - Devices of/for makers on which we provide Open source code
- **Documentation and instructions:**
  - TC9.4 - IOT application exploiting Edge computing with Raspberry
  - TC9.7 - Connection from LoraWan Dragino/arduino 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

IOT APPLICATIONS, THE LOGIC AND THE SMARTNESS

Dashboard with intelligence App

Dashboards with IOT Applications for enforcing smart and intelligence into them

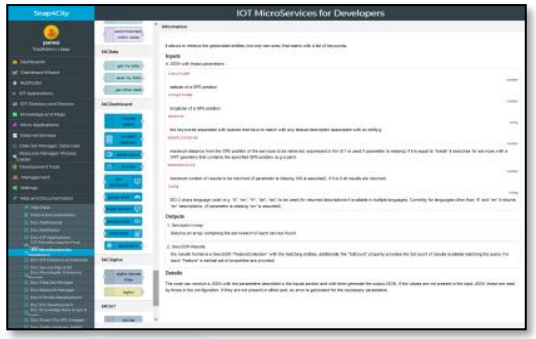
Dashboard-IOT App



IOT Applications Development

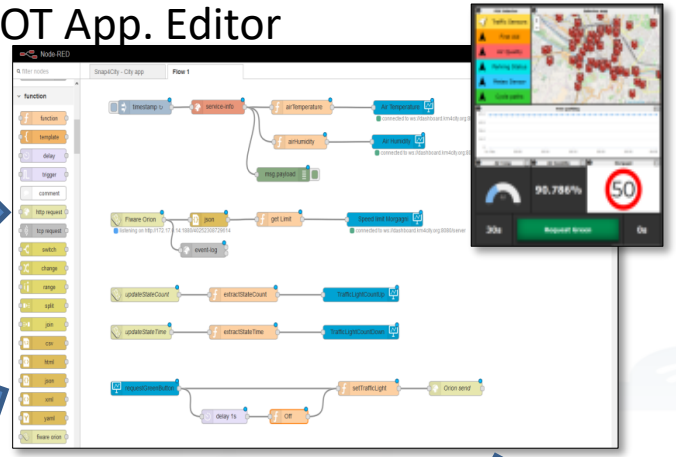
IOT Discovering

MicroServices collections

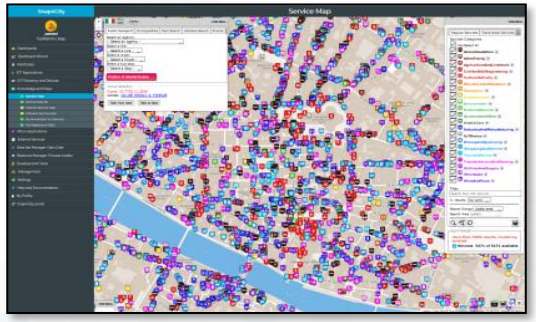


My IOT Applications

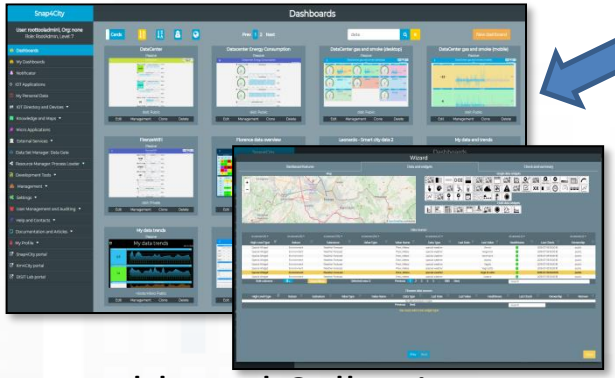
IOT App. Editor



Generating IOT App With Dashboard



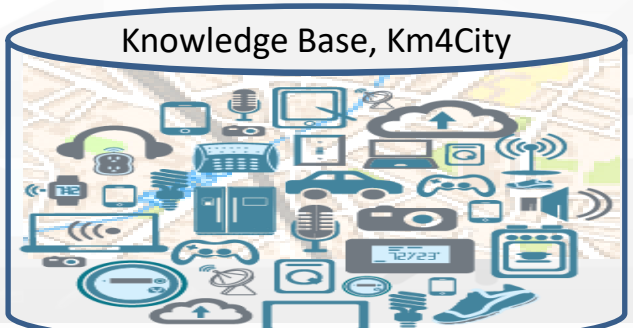
ServiceMap Discovery



Dashboard Collection, Editor and Wizard

Sharing/saving IOT App

Resource Manager



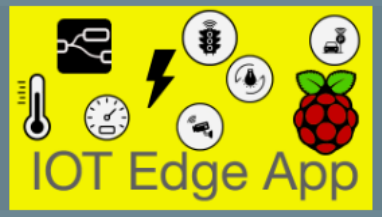
User: roottooladmin1, Org: DISIT
Role: RootAdmin, Level: 7

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

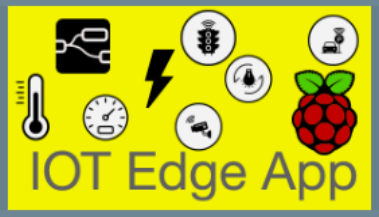
Prev 1 2 3 ... 9 Next

Filter

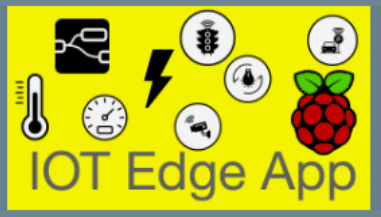
Create new

2018-09-14T04:44


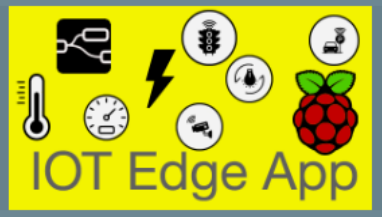
owner: badii
Management

2018-09-21T03:19


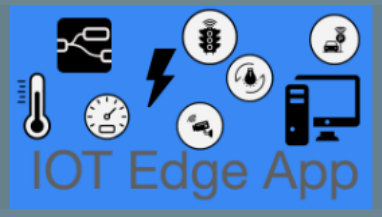
owner: panesi
Management

2018-10-19T16:07


owner: pb3
Management

2018-10-19T17:17


owner: pb3
Management

2018-10-22T11:57


owner: semolarudy
Management

application


owner: tester5
Management

Bib APP


owner: semolarudy
Management

ChargingStations


owner: comunedashres
Management

Deprecated - SiiMobilityControlRoom


owner: badii
Management

SamsungGalaxyS4BarCode


owner: badii
Management

esercitazione

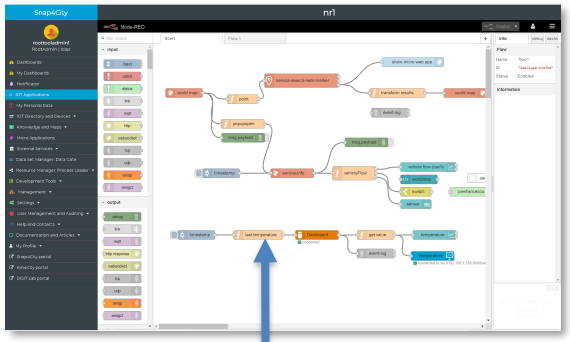

owner: tester2
Management

Iot-App

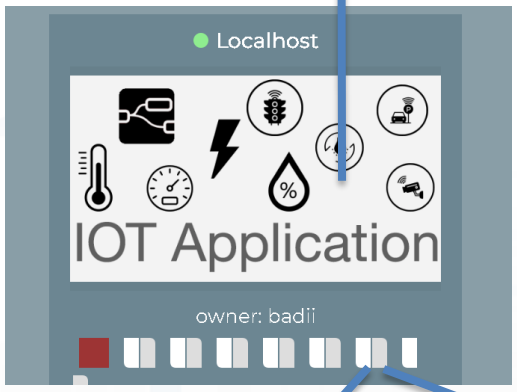

owner: tester14
Management

IOT Applications

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

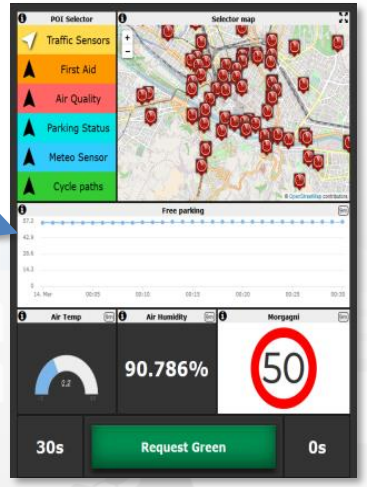


EDIT IOT APP



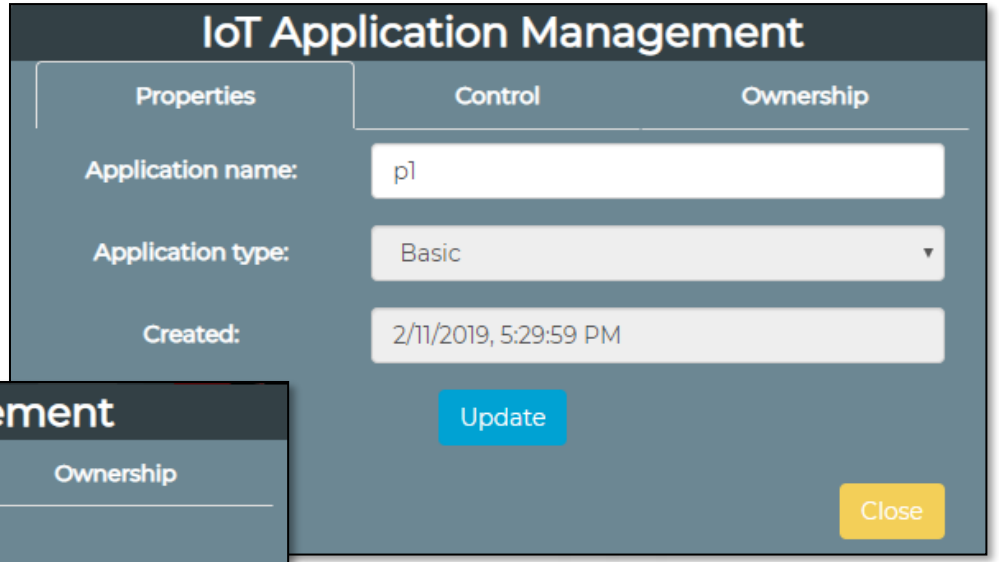
VIEW

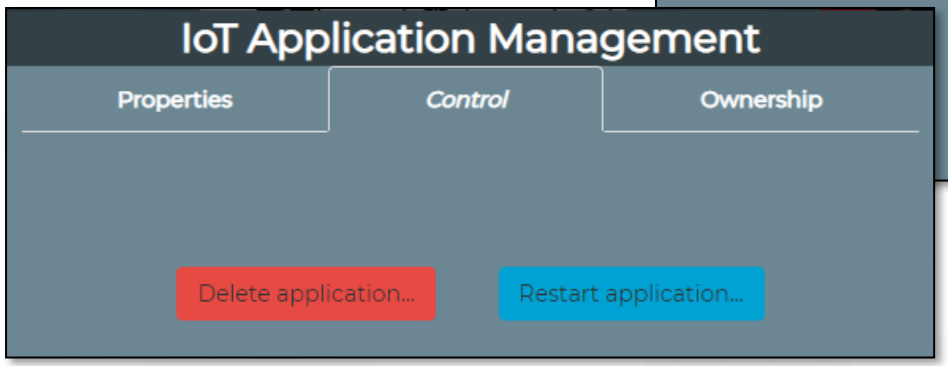
EDIT

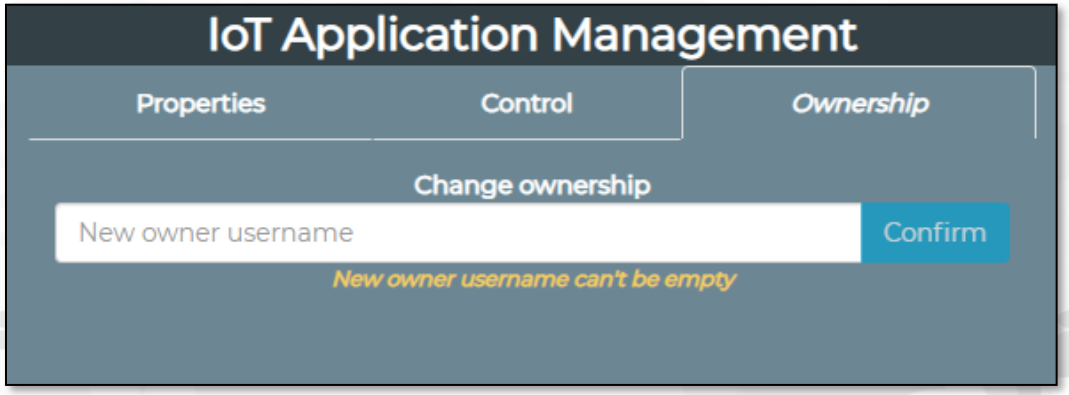


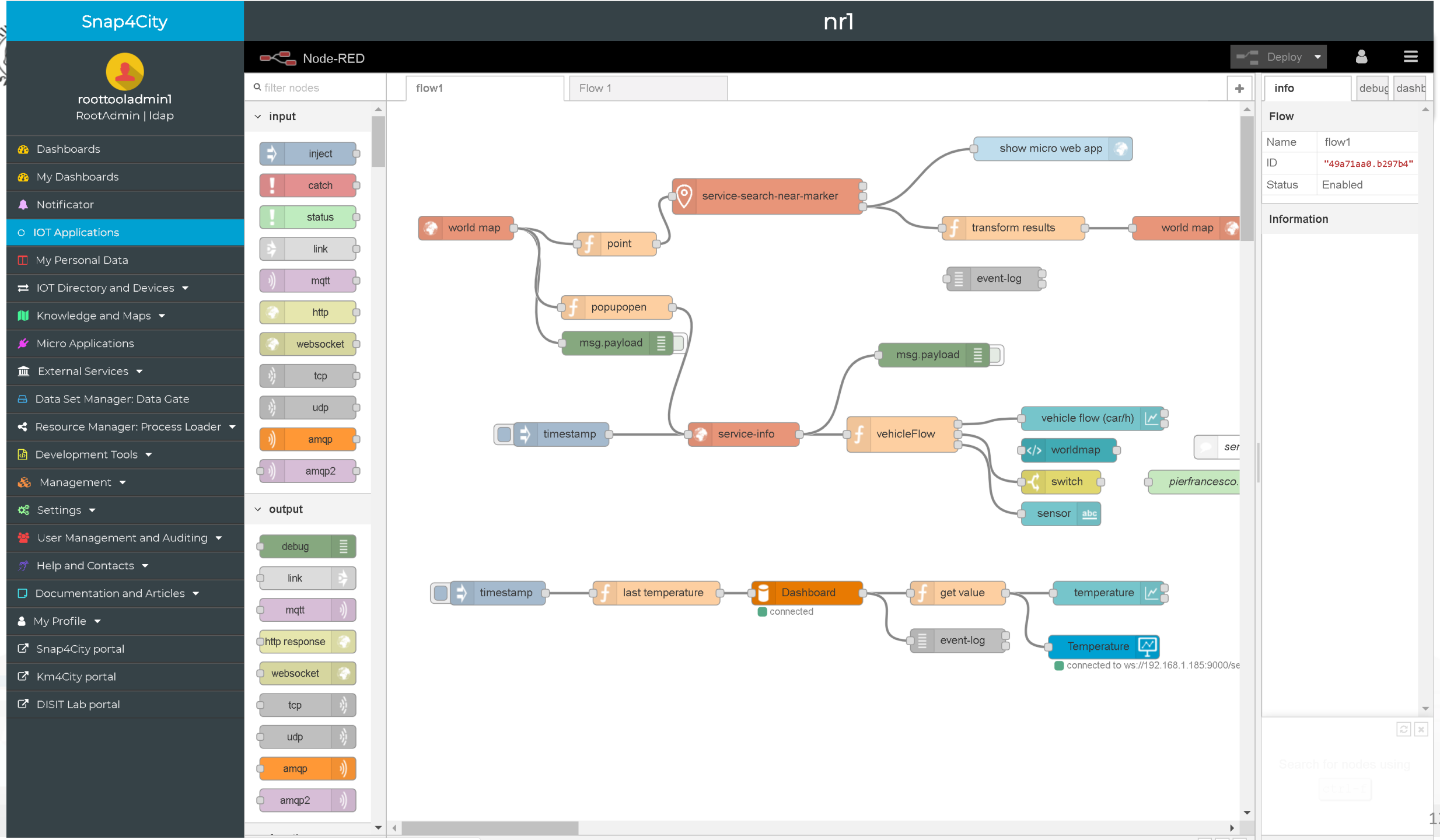
IOT Application Management

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








Snap4City
nr1
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
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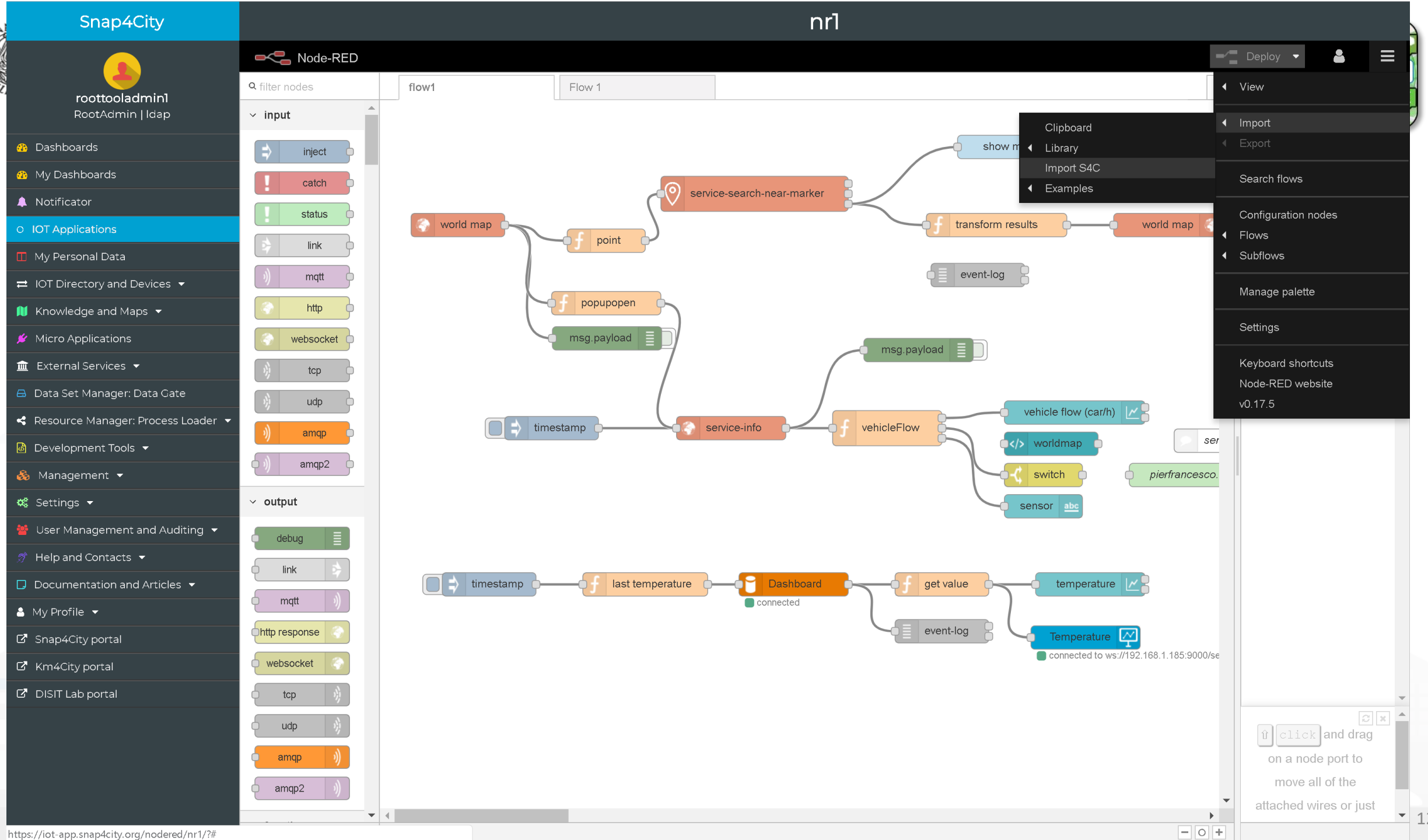
My Profile
Snap4City portal
Km4City portal
DISIT Lab portal
Node-RED
Deploy
filter nodes
input
inject
catch
status
link
mqtt
http
websocket
tcp
udp
amqp
amqp2
output
debug
link
mqtt
http response
websocket
tcp
udp
amqp
amqp2
flow1
Flow 1
world map
point
service-search-near-marker
show micro web app
transform results
world map
event-log
popupopen
msg.payload
msg.payload
timestamp
service-info
vehicleFlow
vehicle flow (car/h)
worldmap
switch
sensor
timestamp
last temperature
Dashboard
connected
get value
temperature
event-log
Temperature
connected to ws://192.168.1.185:9000/se
info
debug
dashb
Flow
Name
flow1
ID
"49a71aa0.b297b4"
Status
Enabled
Information
Search for nodes using


Snap4City
roottooladmin1
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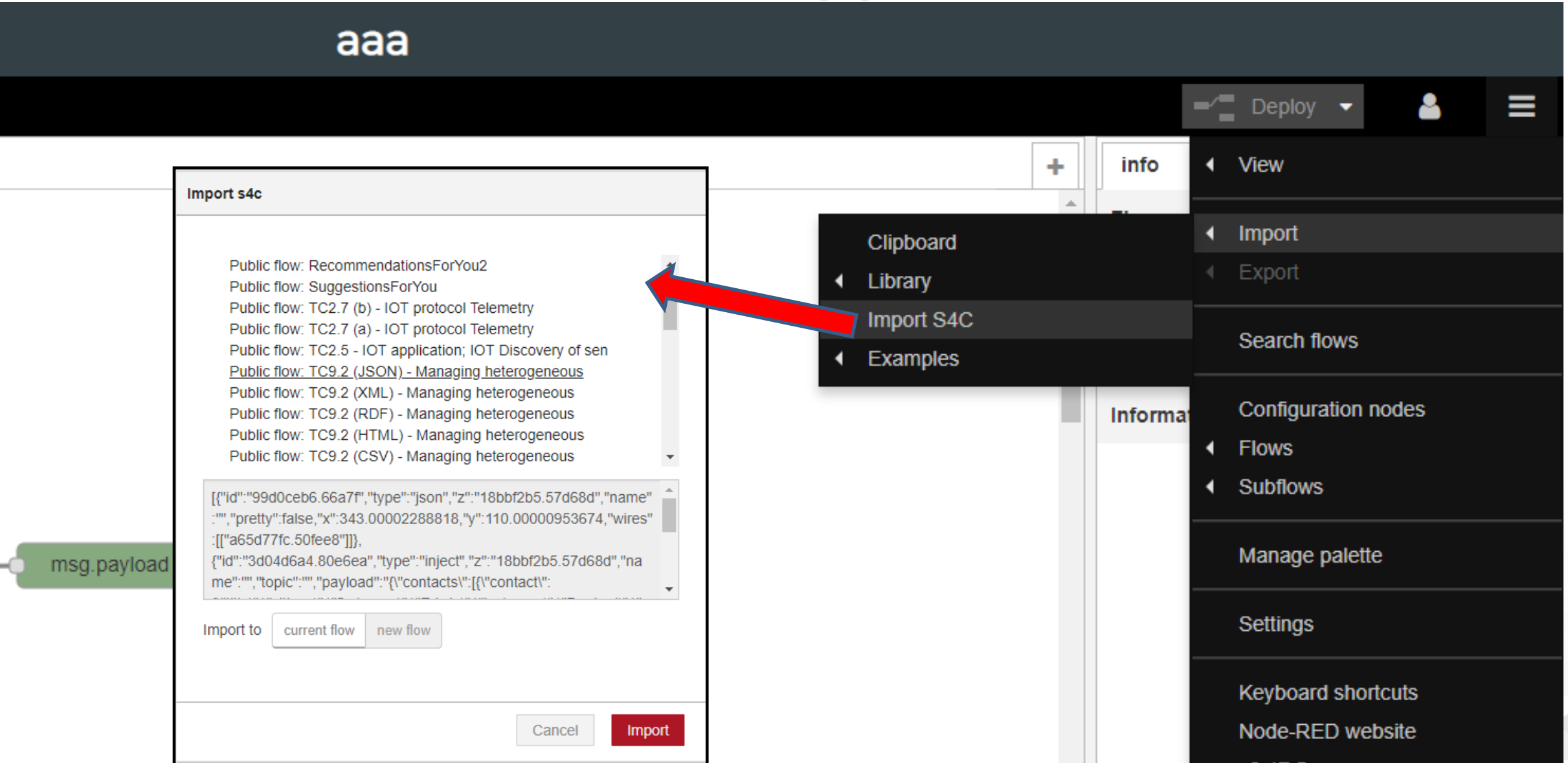
nr1
Node-RED
Deploy
filter nodes
input
inject
catch
status
link
mqtt
http
websocket
tcp
udp
amqp
amqp2
output
debug
link
mqtt
http response
websocket
tcp
udp
amqp
amqp2
flow1
Flow 1
world map
point
service-search-near-marker
transform results
world map
event-log
popupopen
msg.payload
msg.payload
timestamp
service-info
vehicleFlow
vehicle flow (car/h)
worldmap
switch
sensor
timestamp
last temperature
Dashboard
connected
get value
temperature
event-log
Temperature
connected to ws://192.168.1.185:9000/se
Clipboard
Library
Import S4C
Examples
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
https://iot-app.snap4city.org/nodered/nr1/?#

IOT Application Editor: NODE-RED

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
  - ..

Load an application

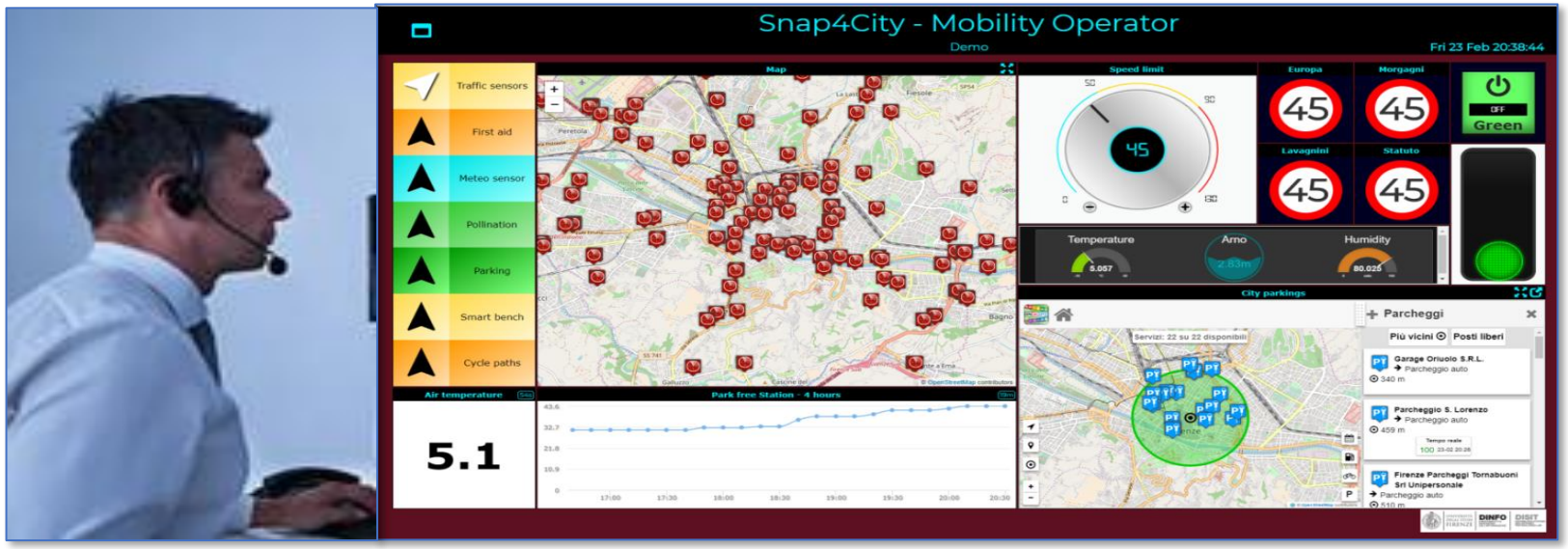


City Dashboard + IOT App

Control Room Operator

Would like to:

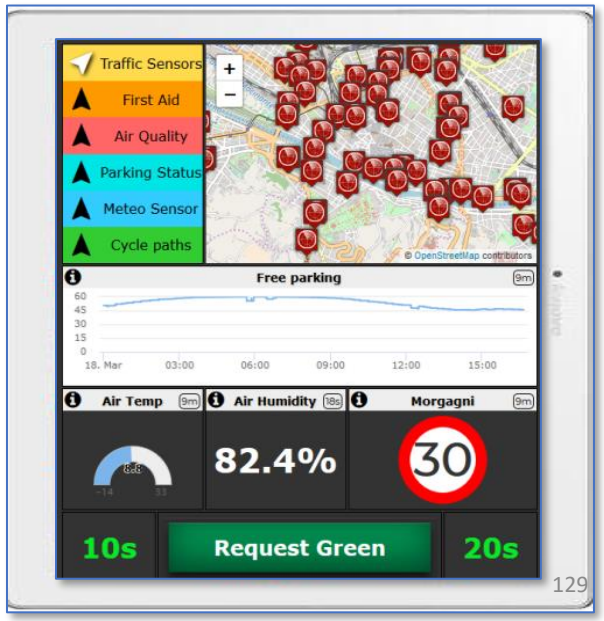
- **Monitor** traffic flow, Environment, Car parking, Cycling, First aid, temp., ..
- **Act and** monitor Dynamic Plates
- **Act and** monitor red lights



Driver, Policeman

Would like to:

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



Dashboards with city data and your data/actuators

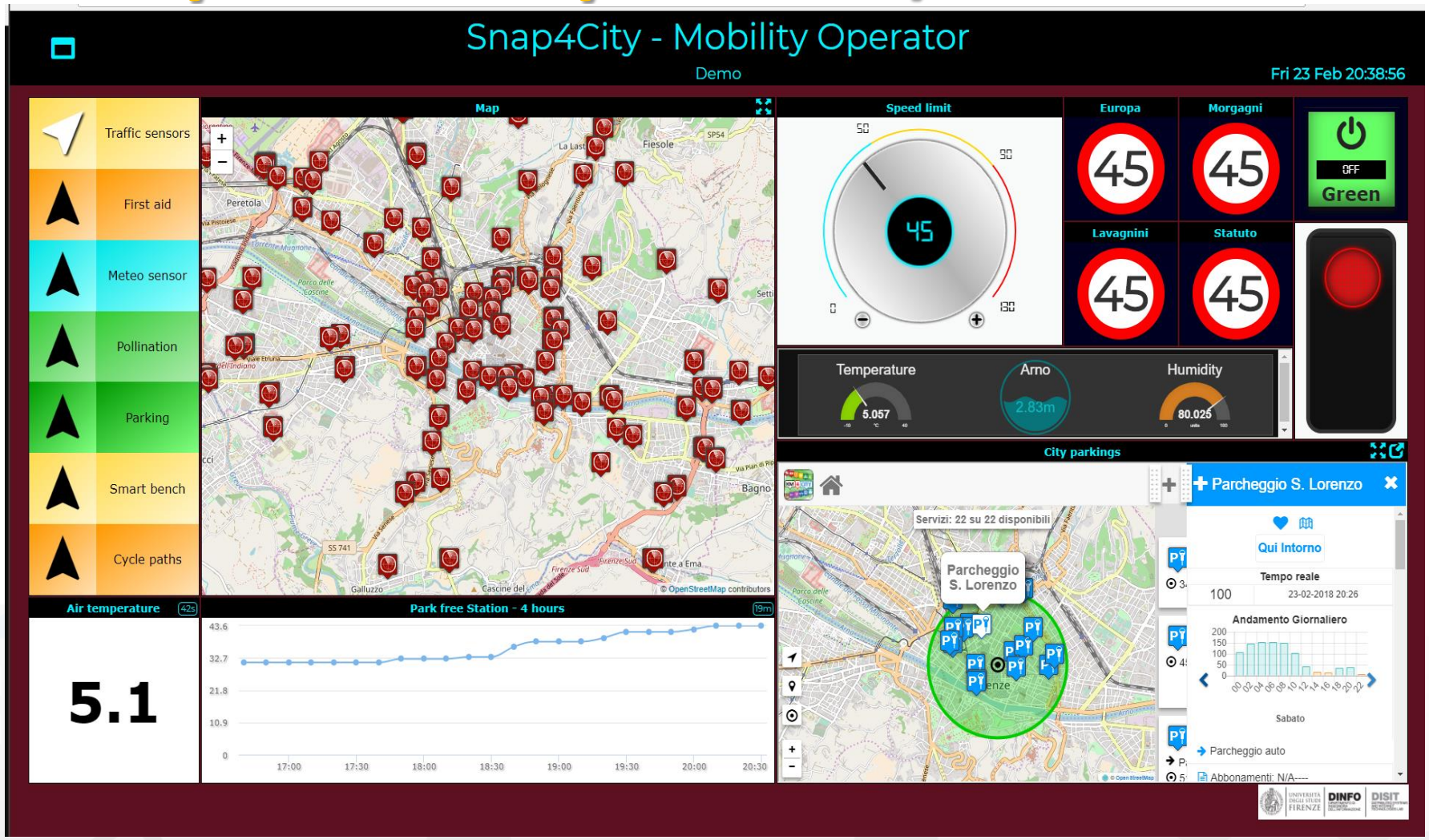
Sensors:

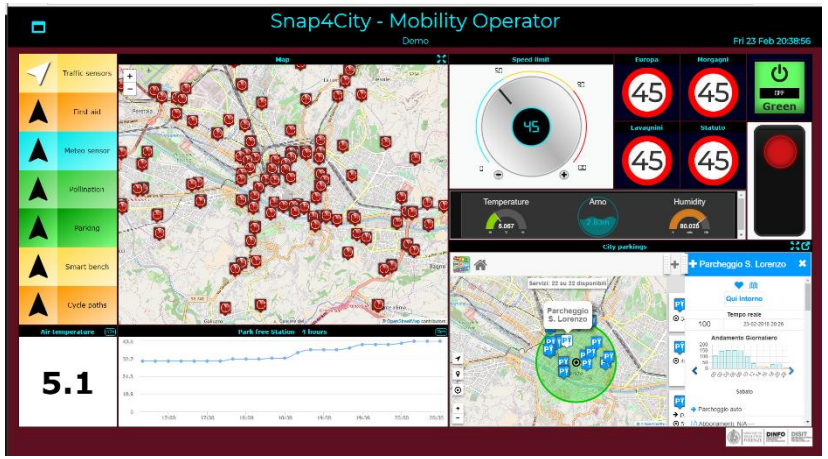
- Values
- Status

Actuators:

- Buttons
- Dimers
- Etc.

Virtual Sensors and Actuators

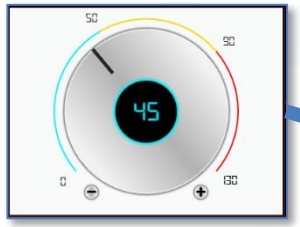




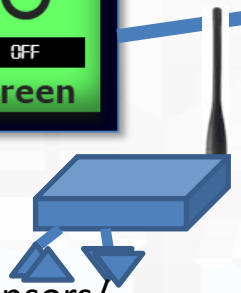
Dashboard vs IOT Devices

Dashboards also provide rendering for actuator-sensor values

Snap4city Platform



Actuator device on Dashboard are regarded as Virtual Sensors



Sensors/ Actuators

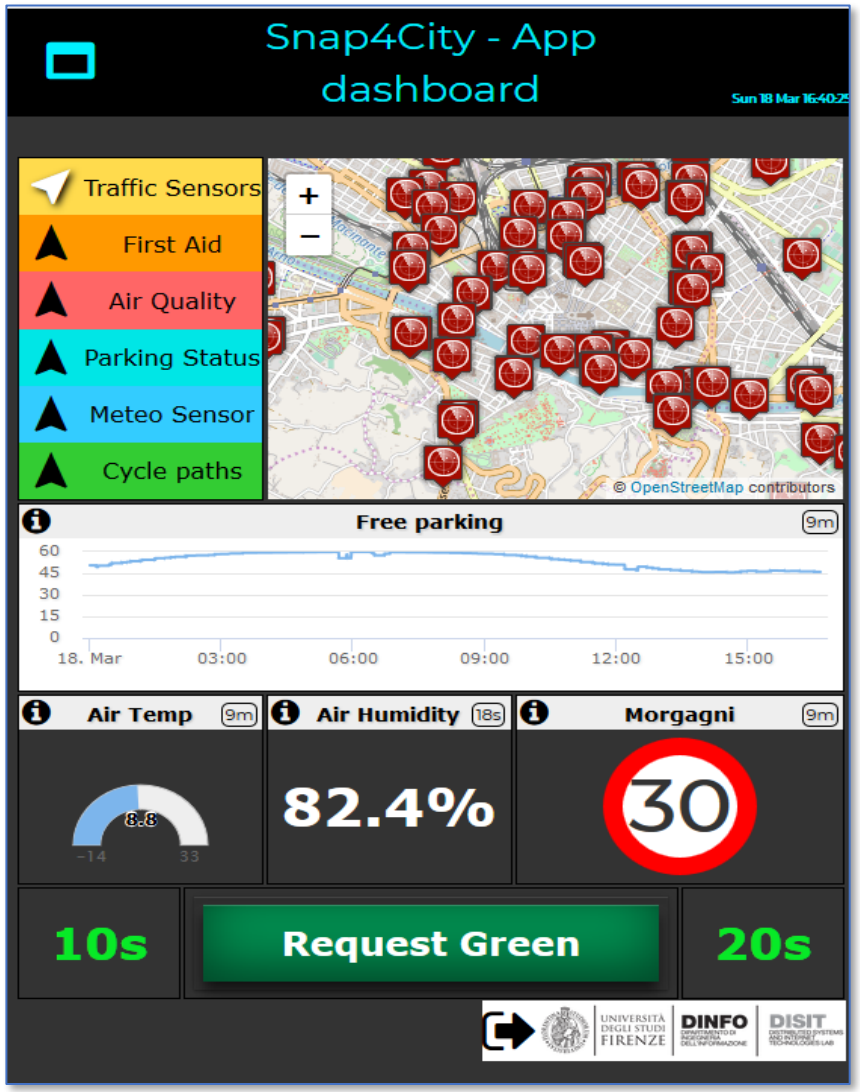
From any IOT Device and/or Dashboard

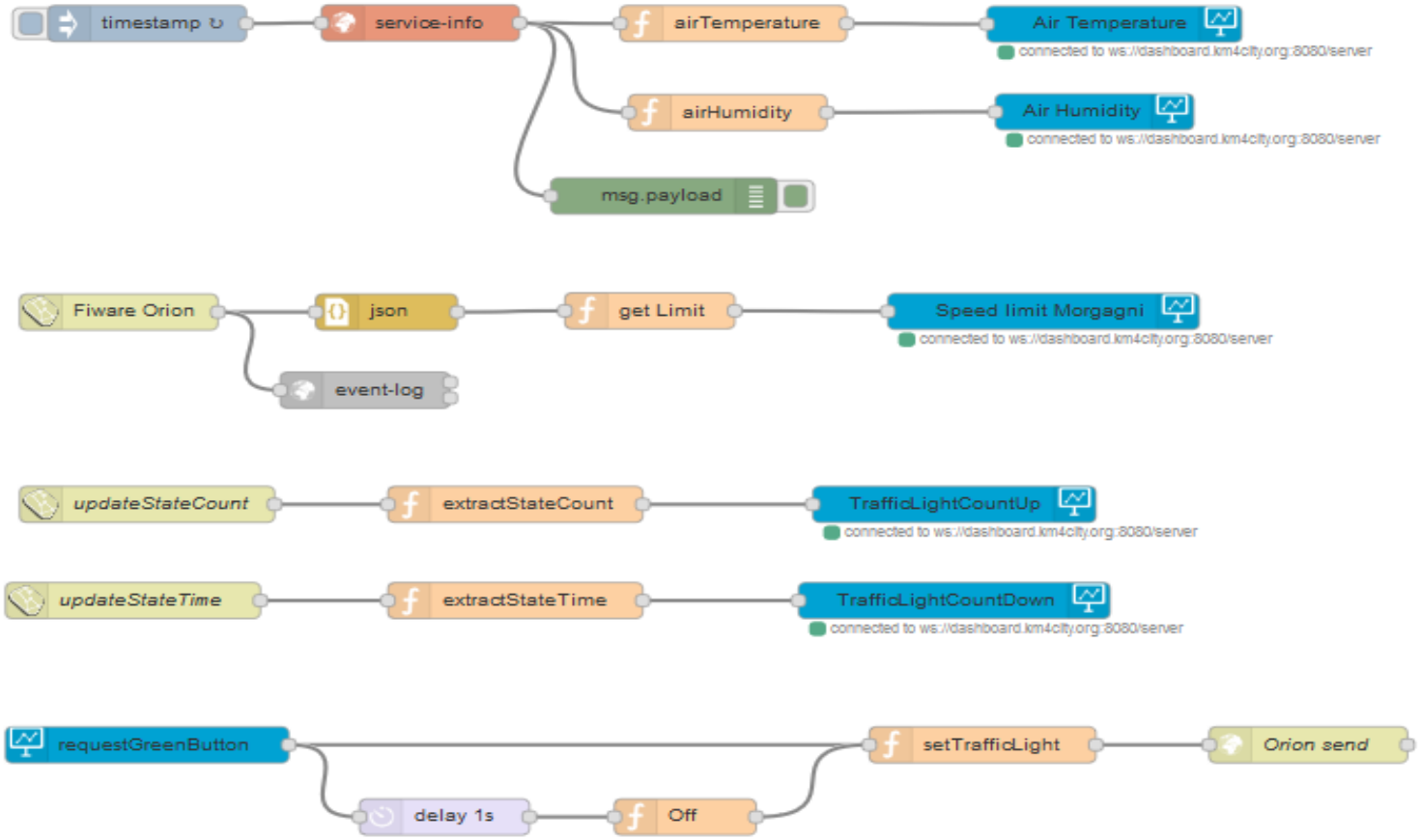
Snap4City IOT Brokers

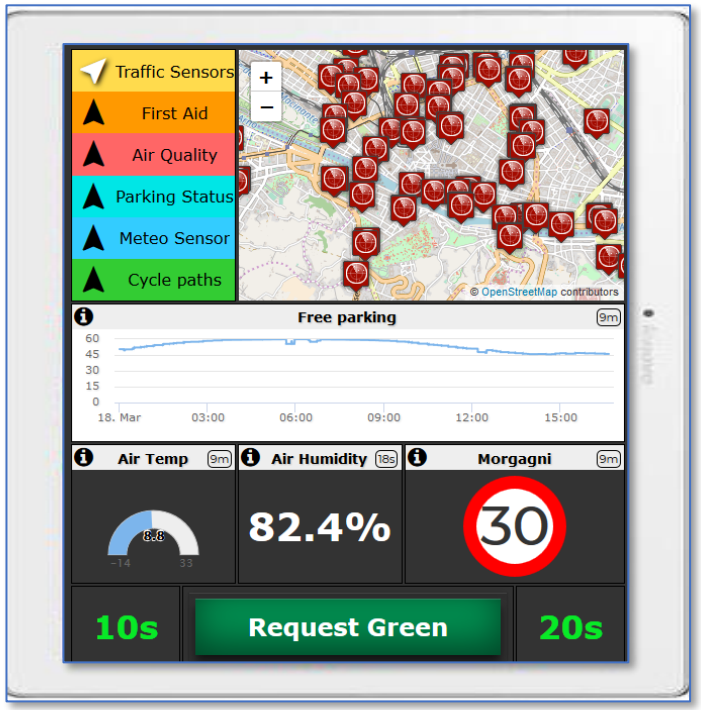
Managing Public and Private IOT/IOE Devices

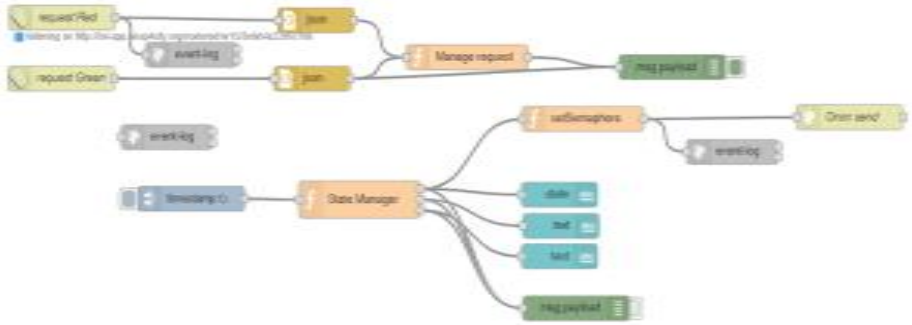
Towards any IOT Device and/or Dashboard

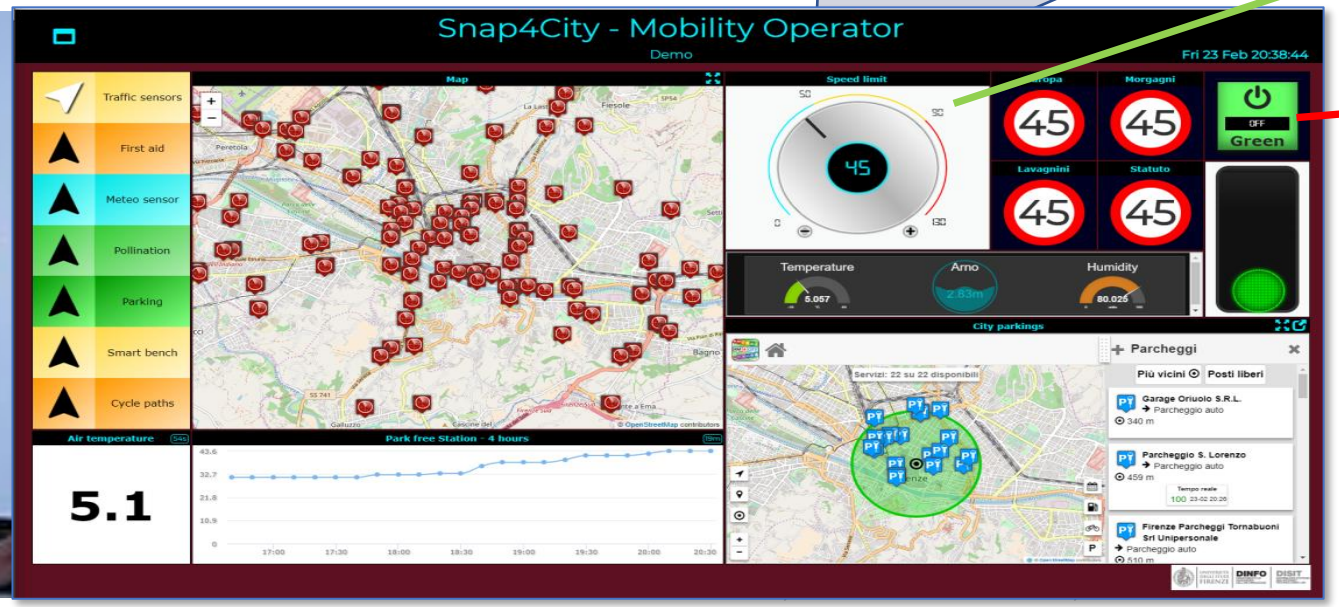
IOT Application with City Dashboard simple development

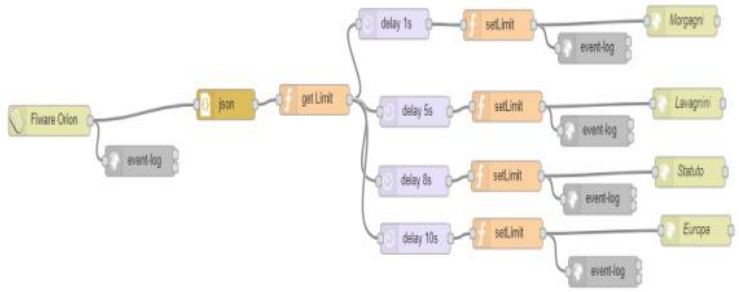





Traffic Sensors
First Aid
Air Quality
Parking Status
Meteo Sensor
Cycle paths
© OpenStreetMap contributors
Free parking
9m
60
45
30
15
0
18. Mar
03:00
06:00
09:00
12:00
15:00
Air Temp
9m
Air Humidity
18s
Morgagni
9m
82.4%
30
10s
Request Green
20s




Snap4City - Mobility Operator
Demo
Fri 23 Feb 20:38:44
Traffic sensors
First aid
Meteo sensor
Pollination
Parking
Smart bench
Cycle paths
Map
Speed limit
45
Europa
45
Morgagni
45
Lavagnini
45
Statuto
45
OFF
Green
Temperature
6.057
Arno
Humidity
80.025
City parkings
Parcheggi
Più vicini
Posti liberi
Garage Oriuolo S.R.L.
Parcheggio auto
340 m
Parcheggio S. Lorenzo
Parcheggio auto
459 m
Firenze Parcheggi Tornabuoni Srl Unipersonale
Parcheggio auto
510 m
Air temperature
5.1
Park free Station - 4 hours

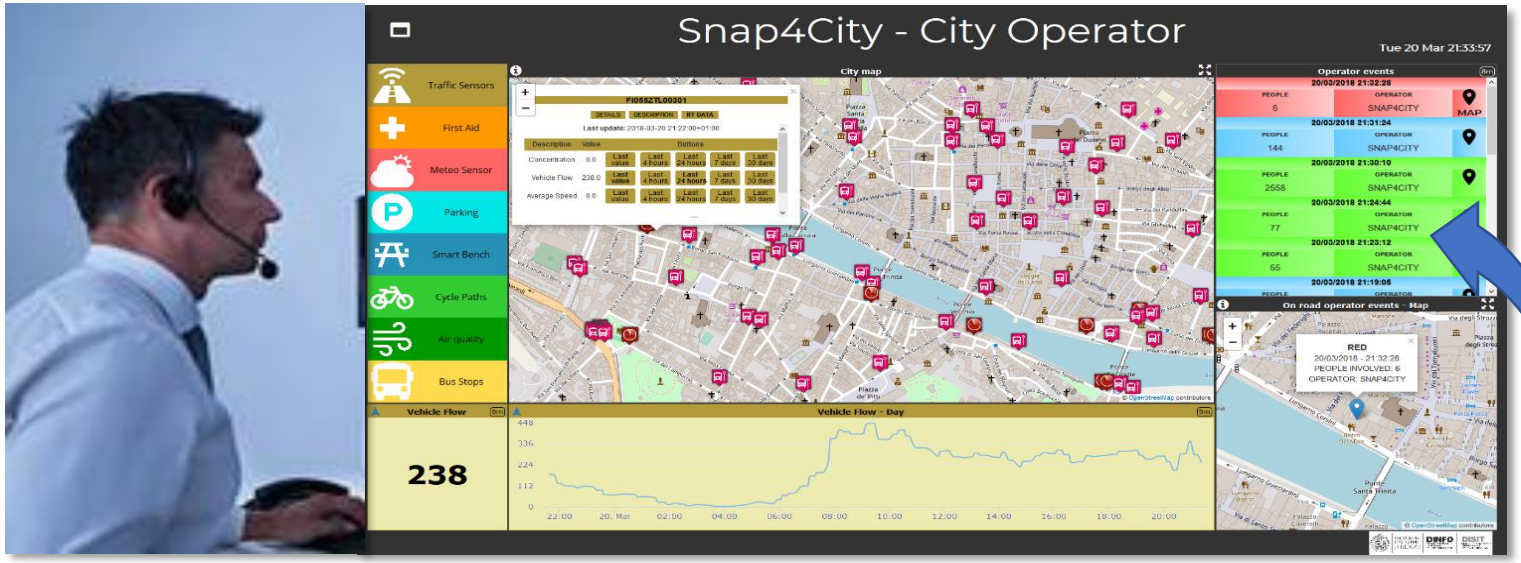

Fiware Orion
event-log
json
get Limit
delay 1s
setLimit
event-log
Morgagni
delay 5s
setLimit
event-log
Lavagnini
delay 8s
setLimit
event-log
Statuto
delay 10s
setLimit
event-log
Europa

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

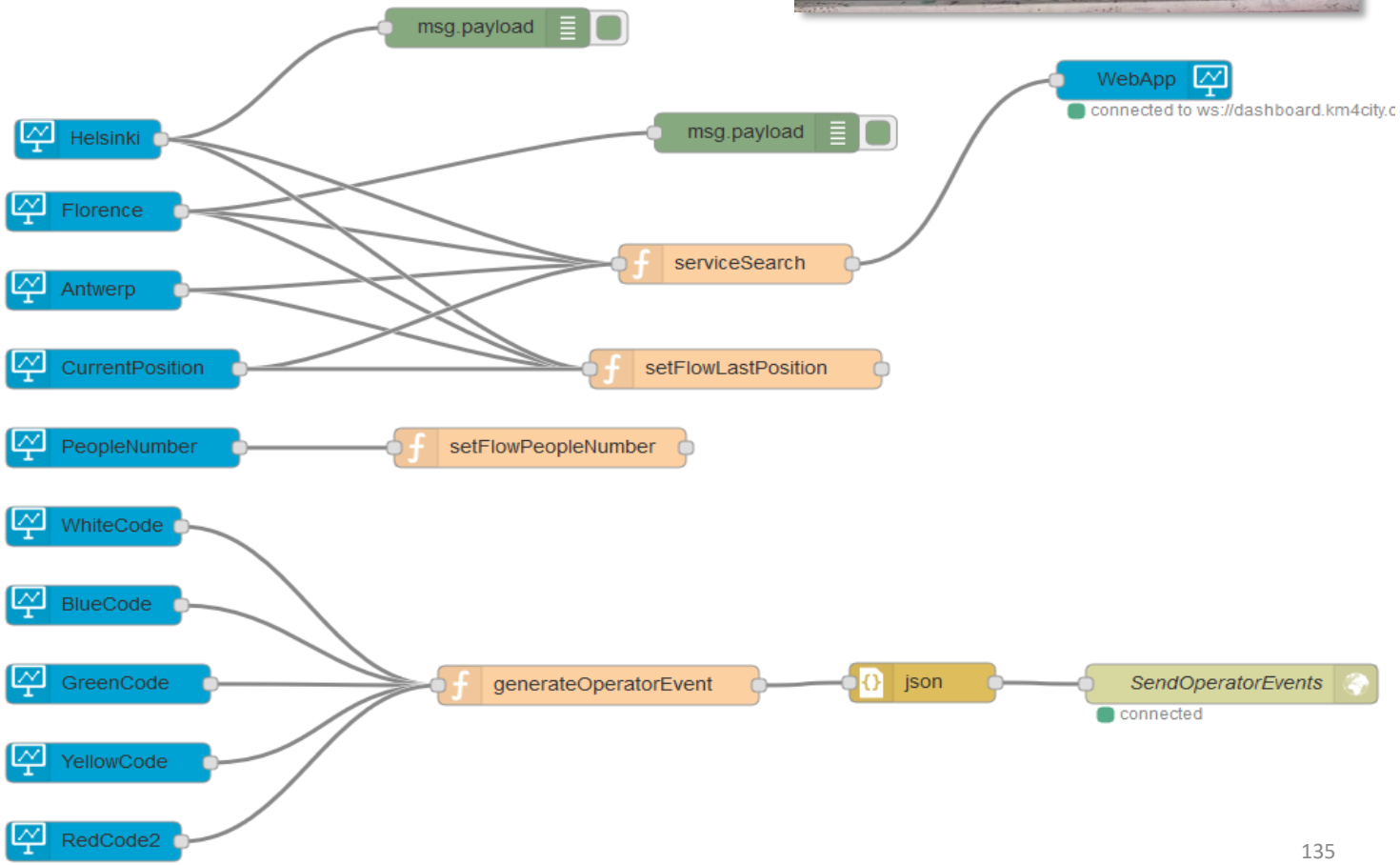


On the road operator

Would like to:

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

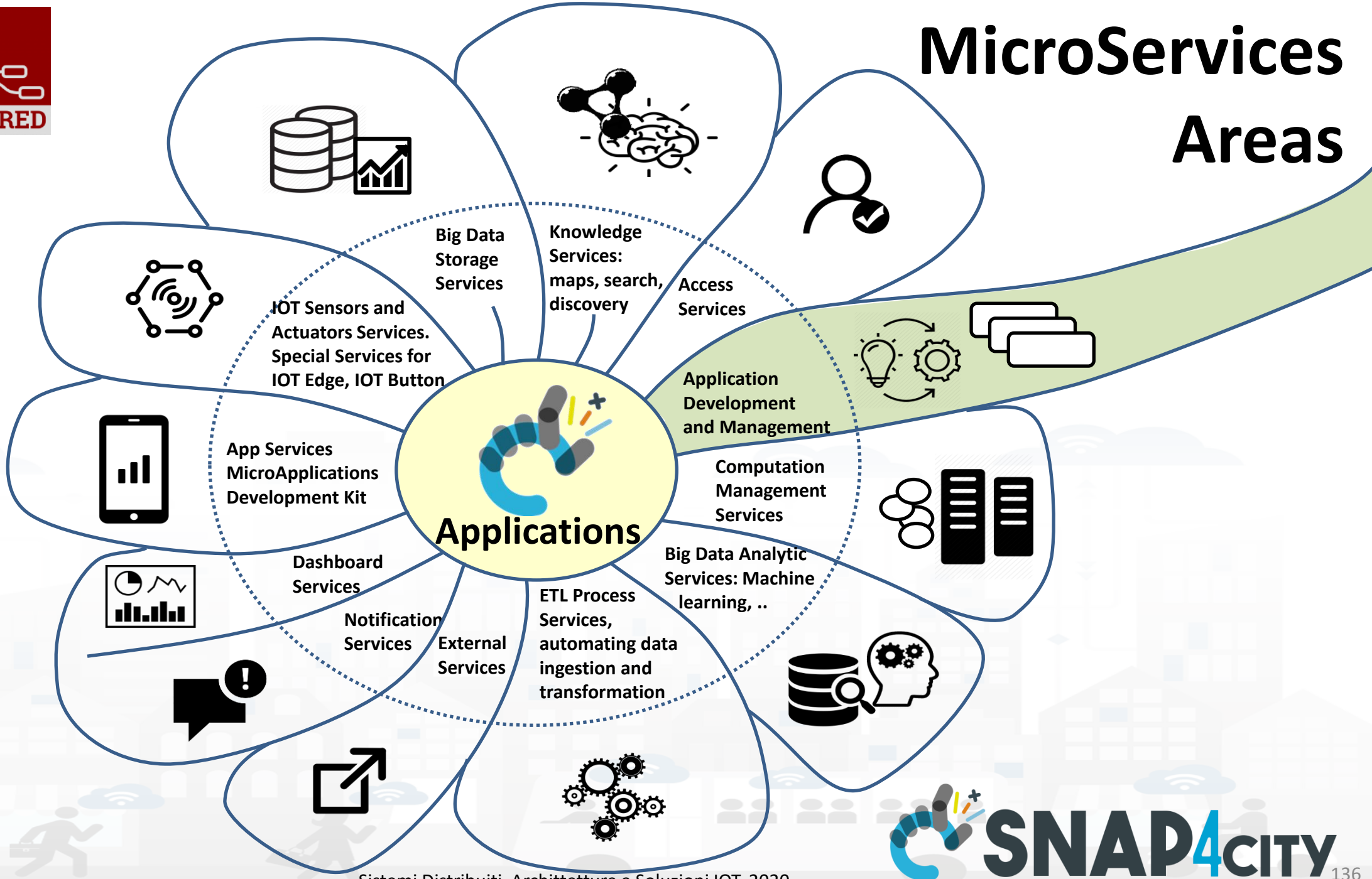
IOT Application with City Dash simpler development



MicroServices Areas

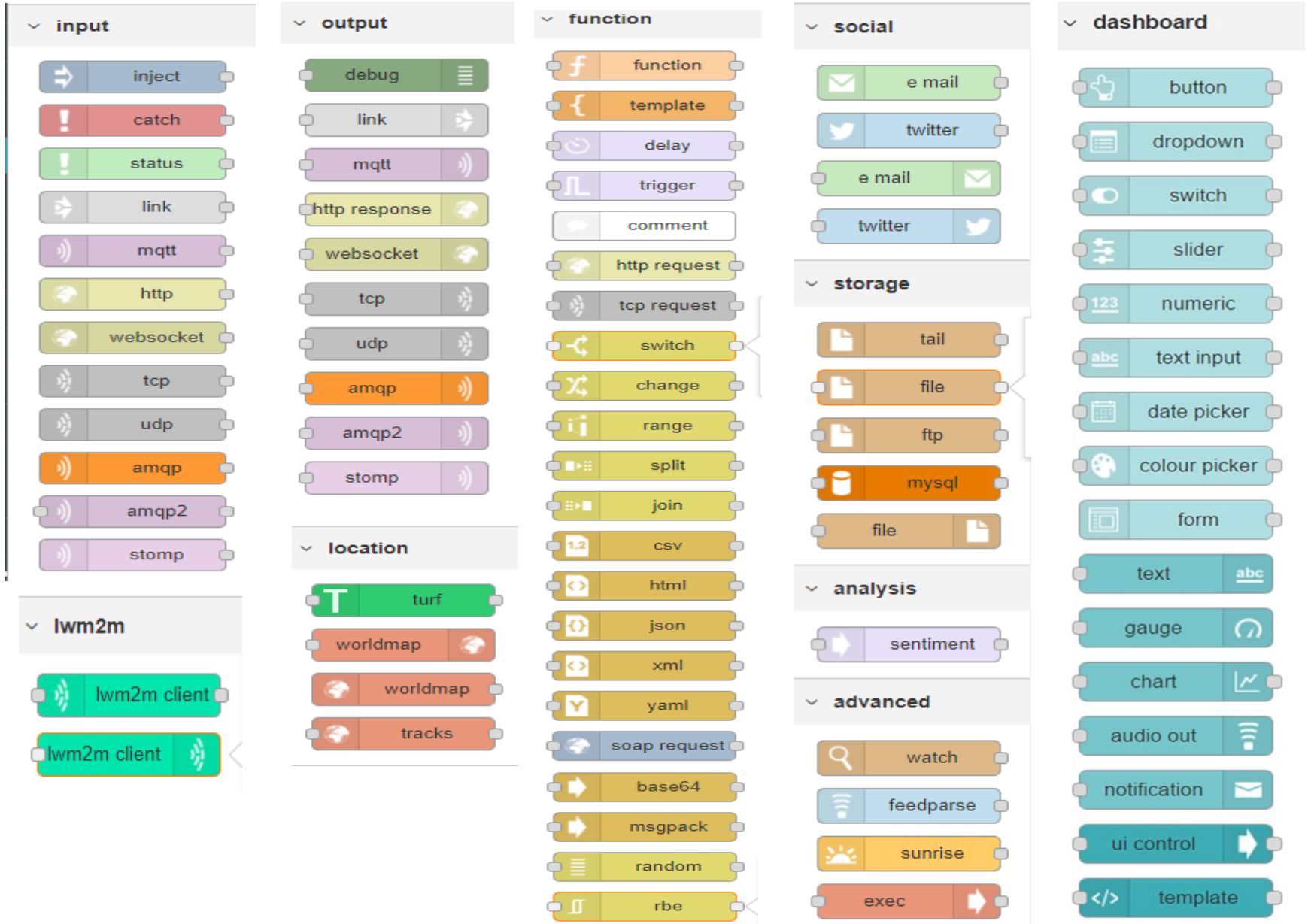
- input
- output
- function
- social
- storage
- analysis
- advanced
- lwm2m
- S4CSearchDev
- S4CMapping
- S4CManagement
- S4CDataAnalytic
- S4CBigData
- S4CSearch
- S4CData
- S4CDashboard
- S4CSigfox
- S4CIoT
- S4CLogDev
- S4CView
- S4CSocial
- location
- dashboard

Node-RED

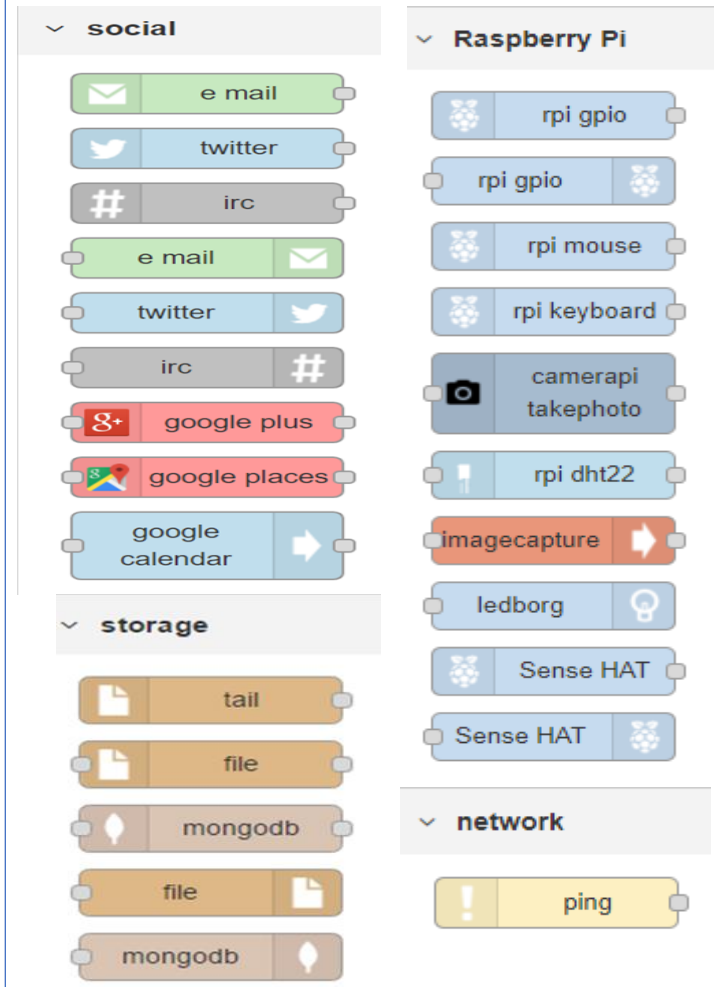


SNAP4CITY

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



+ on IOT Edge Raspberry

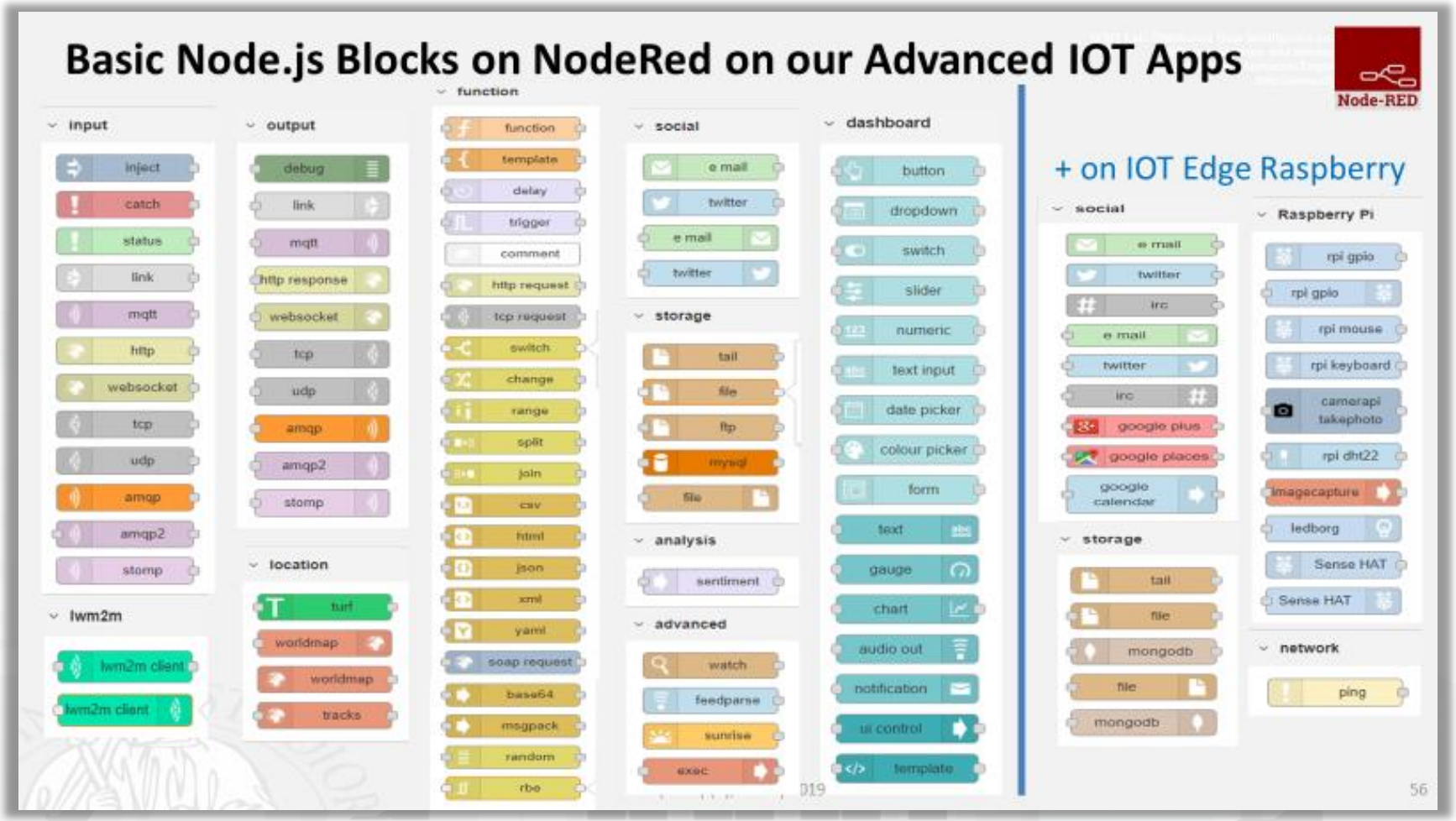


Node-RED Basic Blocks

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

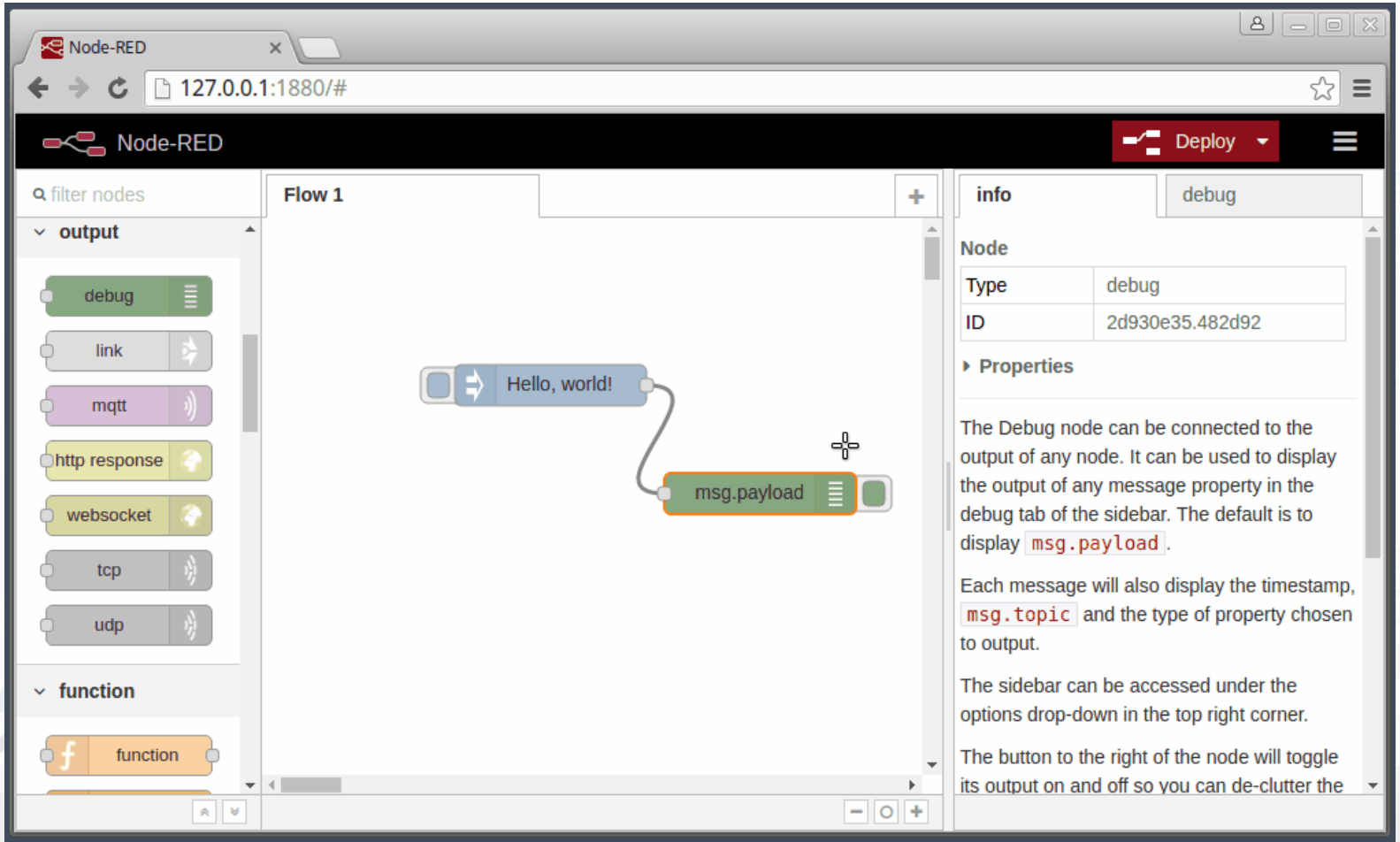
Despite to its diffusion, for the usage in the context of Smart City it was **not powerful** to cope with the **basic requirements** of the domain.

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



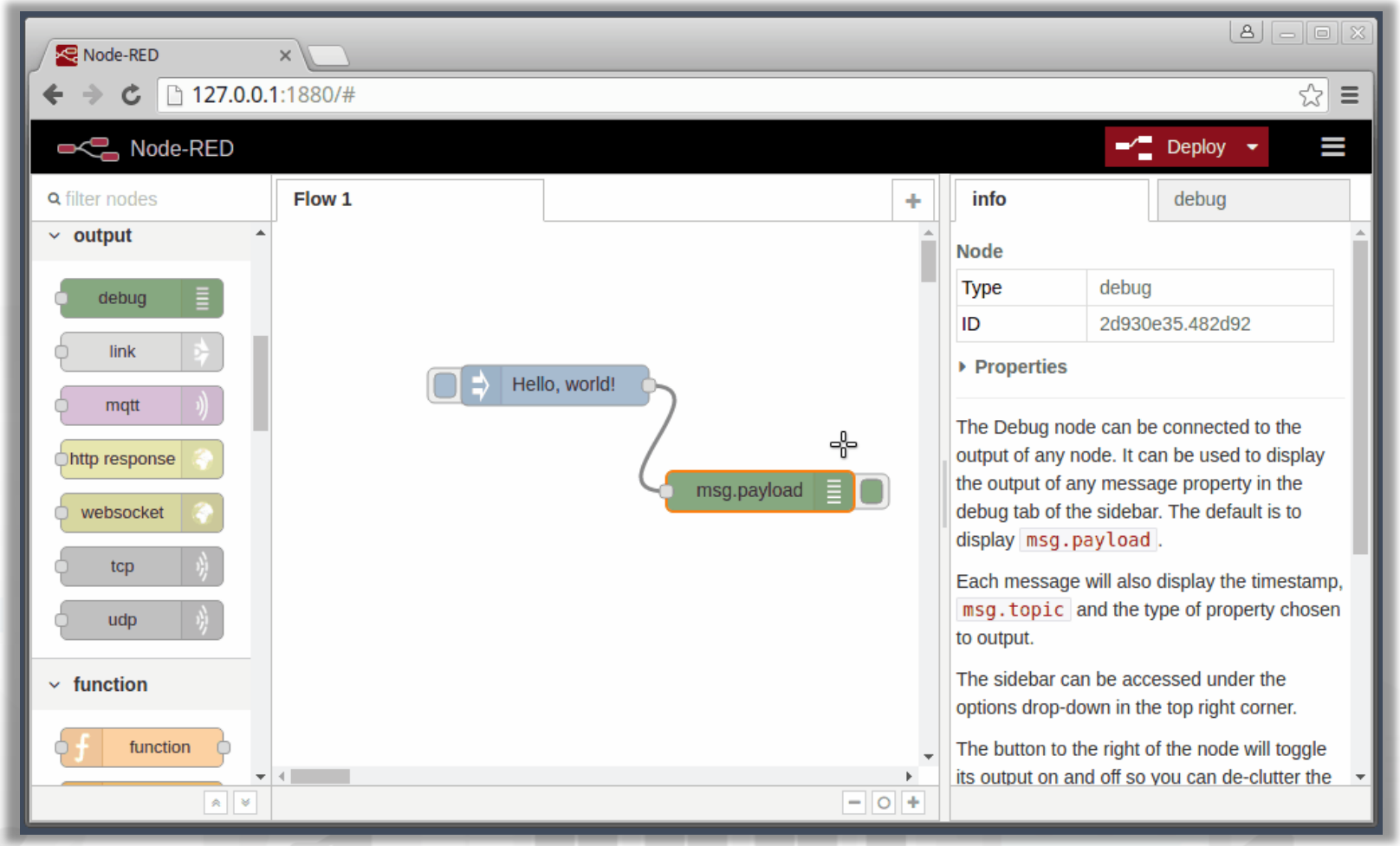
Hello World of Node-RED

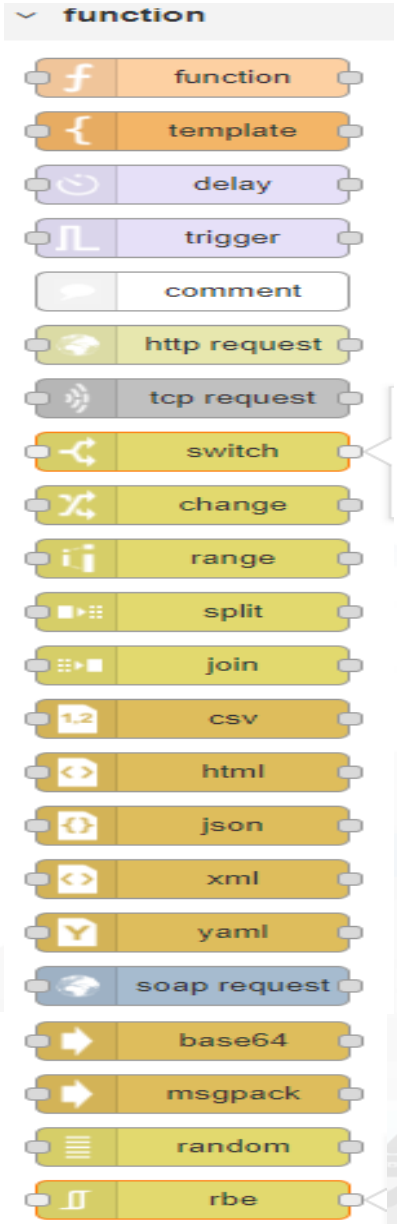
- http://developer.opto22.com/nodered/general/getting-started/node-red-hello-world/

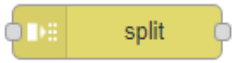


Node-RED

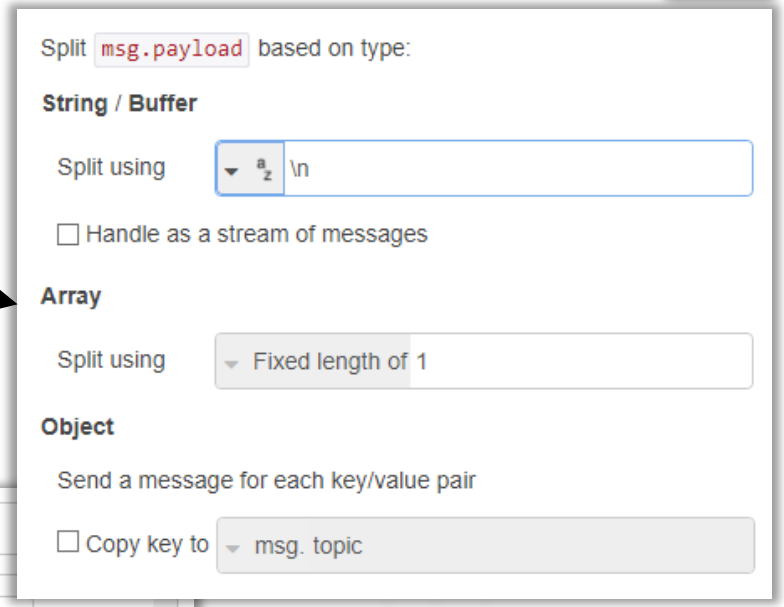
- Node-RED is a **flow-based** development tool for visual programming proposed by **JS Foundation**
- The Node-RED approach is a mix of **visual composition** of **nodes/blocks** to compose the so-called **flows** that are concurrently executed by an engine **Node.js**.
- It is quite diffuse being also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

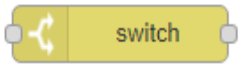




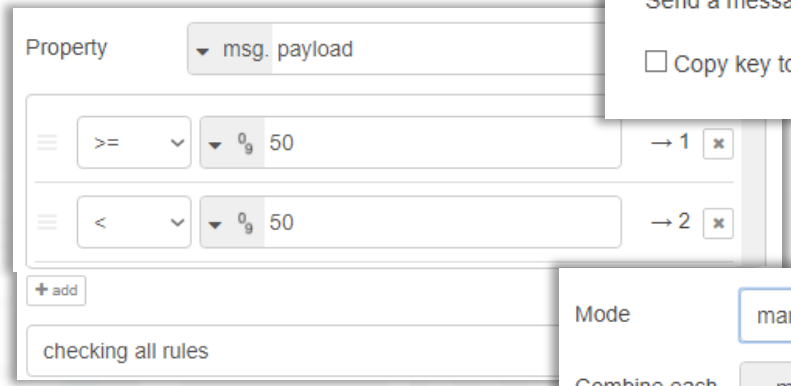


Divides the input message into multiple messages as indicated in the configuration. If you have an array at the input, you can configure it to send each element of the array individually at the output.

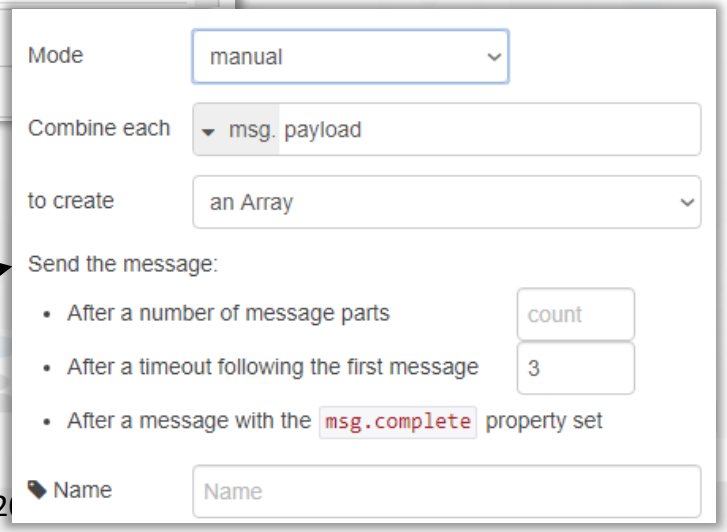




Treads the input message on possible different outputs based on a comparison made on the input message.



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



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.

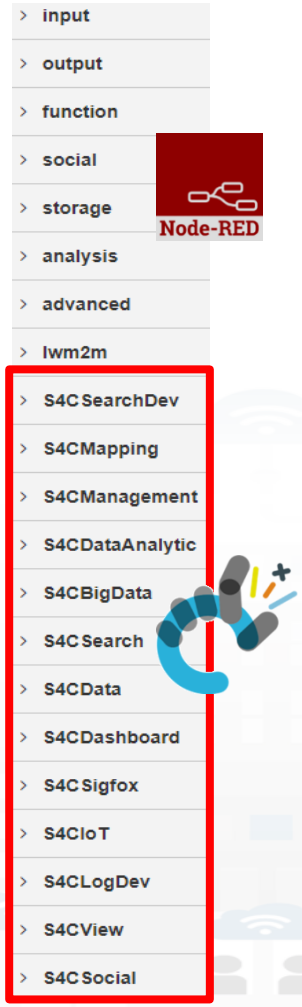
IOT Device Connection: This means that the developers expect to have the possibility of using nodes for connecting to a large set of IOT devices using different protocols, and thus connecting to different kind of IOT brokers.

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

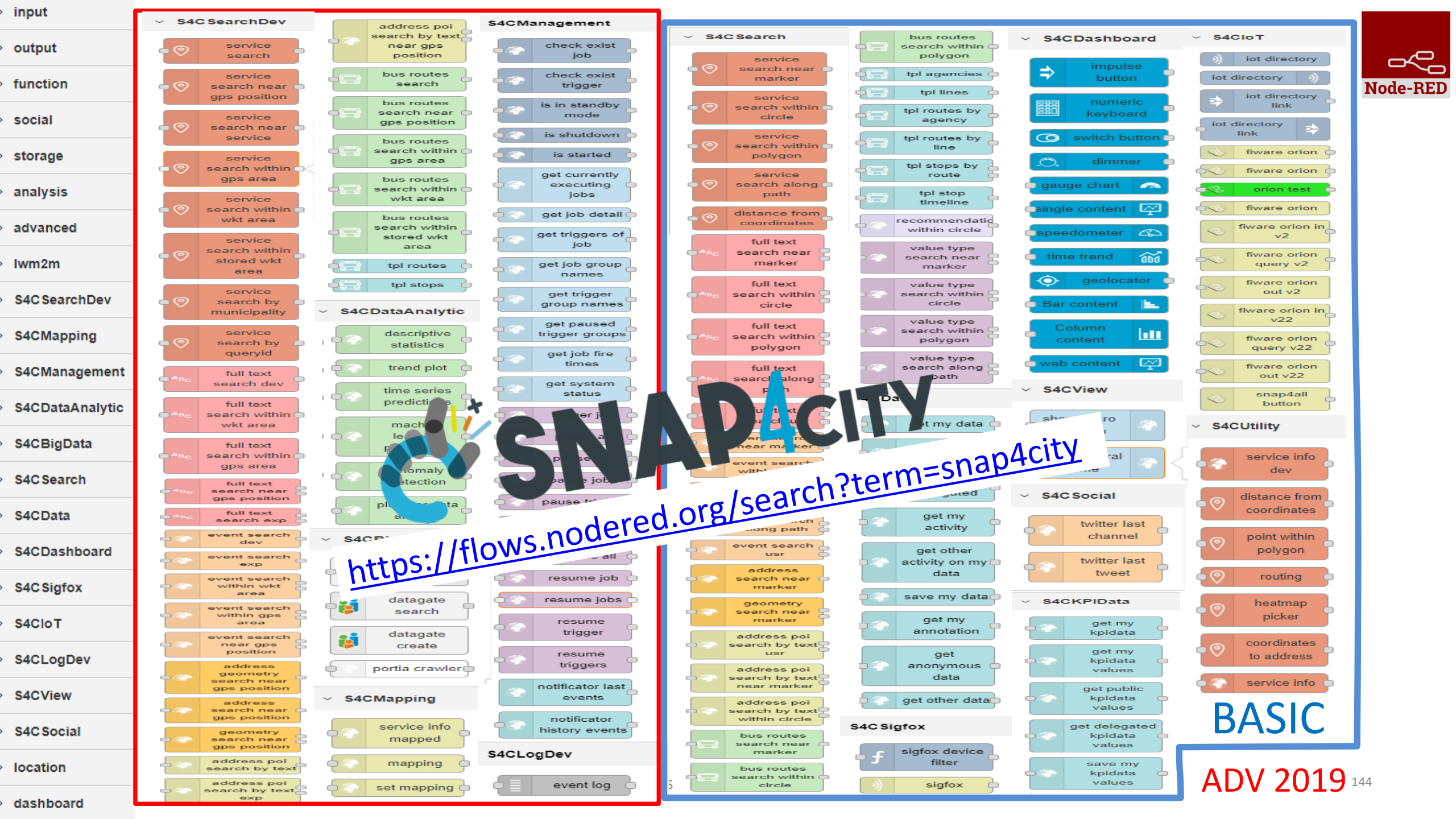
- A collection of more than **150 MicroServices** have been developed covering the above-mentioned requirements and much more.
- The issue was not only to formalize the MicroServices, but also to create the infrastructure that enable their usage. In many cases, the simple MicroServices hide very **complex** 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

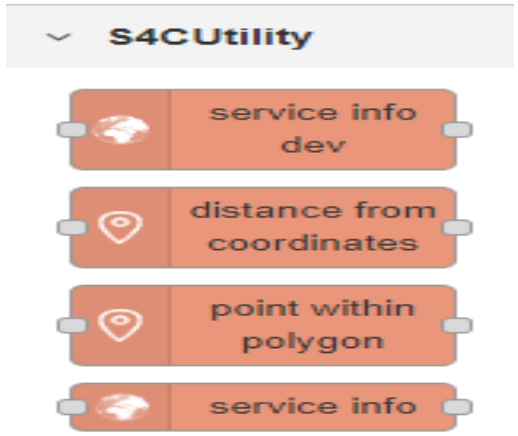
node-red-contrib-snap4city-developer
Node-red nodes for developing IoT applications for smart cities. These nodes are
v0.1.5 18 node

node-red-contrib-snap4city-user
Nodes for Snap4city project, targeted to standard user (no developer)
v0.2.0 27 ★5.0 (1) node

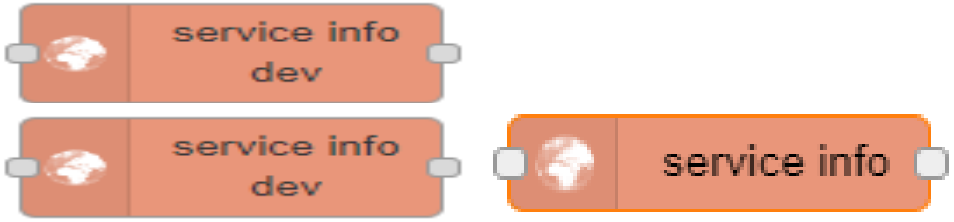

input
output
function
social
storage
analysis
advanced
lwm2m
S4CSearchDev
S4CMapping
S4CManagement
S4CDataAnalytic
S4CBigData
S4CSearch
S4CData
S4CDashboard
S4CSigfox
S4CIoT
S4CLogDev
S4CView
S4CSocial
location
dashboard
service search
service search near gps position
service search near service
service search within gps area
service search within wkt area
service search within stored wkt area
service search by municipality
service search by queryid
full text search dev
full text search within wkt area
full text search within gps area
full text search near gps position
full text search exp
event search dev
event search exp
event search within wkt area
event search within gps area
event search near gps position
address geometry search near gps position
address search near gps position
geometry search near gps position
address poi search by text
address poi search by text exp
address poi search by text near gps position
bus routes search
bus routes search near gps position
bus routes search within gps area
bus routes search within wkt area
bus routes search within stored wkt area
tpl routes
tpl stops
descriptive statistics
trend plot
time series predictions
datagate search
datagate create
portia crawler
service info mapped
mapping
set mapping
check exist job
check exist trigger
is in standby mode
is shutdown
is started
get currently executing jobs
get job detail
get triggers of job
get job group names
get trigger group names
get paused trigger groups
get job fire times
get system status
resume job
resume jobs
resume trigger
resume triggers
notificator last events
notificator history events
event log
service search near marker
service search within circle
service search within polygon
service search along path
distance from coordinates
full text search near marker
full text search within circle
full text search within polygon
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
get my data
get my activity
get other activity on my data
save my data
get my annotation
get anonymous data
get other data
sigfox device filter
sigfox
impulse button
numeric keyboard
switch button
dimmer
gauge chart
single content
speedometer
time trend
geolocator
Bar content
Column content
web content
twitter last channel
twitter last tweet
get my kpidata
get my kpidata values
get public kpidata values
get delegated kpidata values
save my kpidata values
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 info dev
distance from coordinates
point within polygon
routing
heatmap picker
coordinates to address
service info
SNAP4CITY
https://flows.nodered.org/search?term=snap4city
Node-RED
BASIC
ADV 2019
144

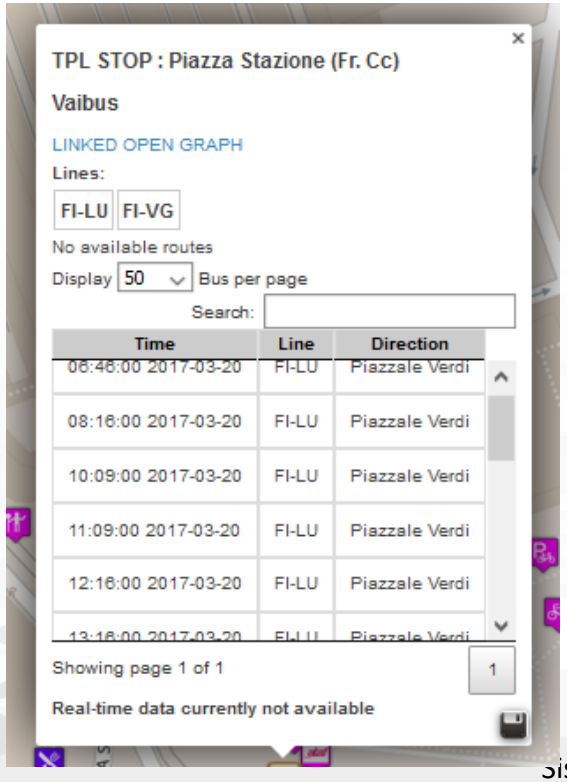
S4CSearch

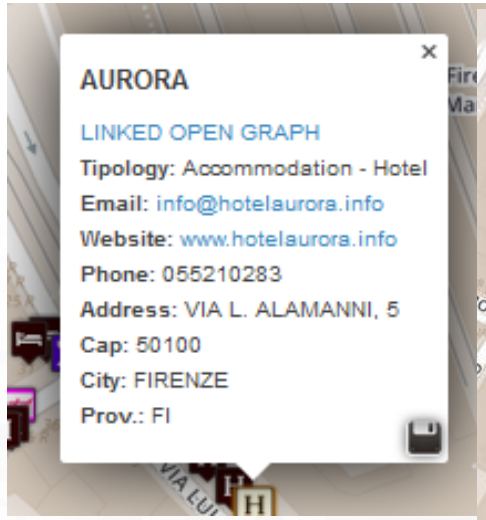
Node-RED

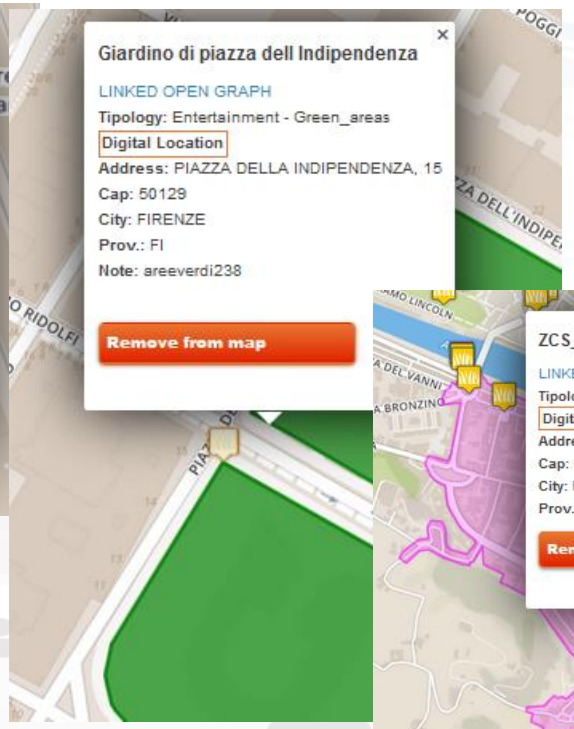


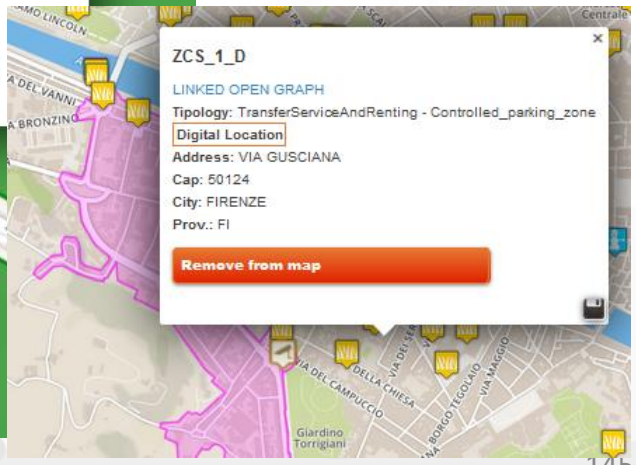
- ANY kind of sensors
- **To Get DATA of a Service / POI /sensor**
  - Historical and real time
  - Real Time





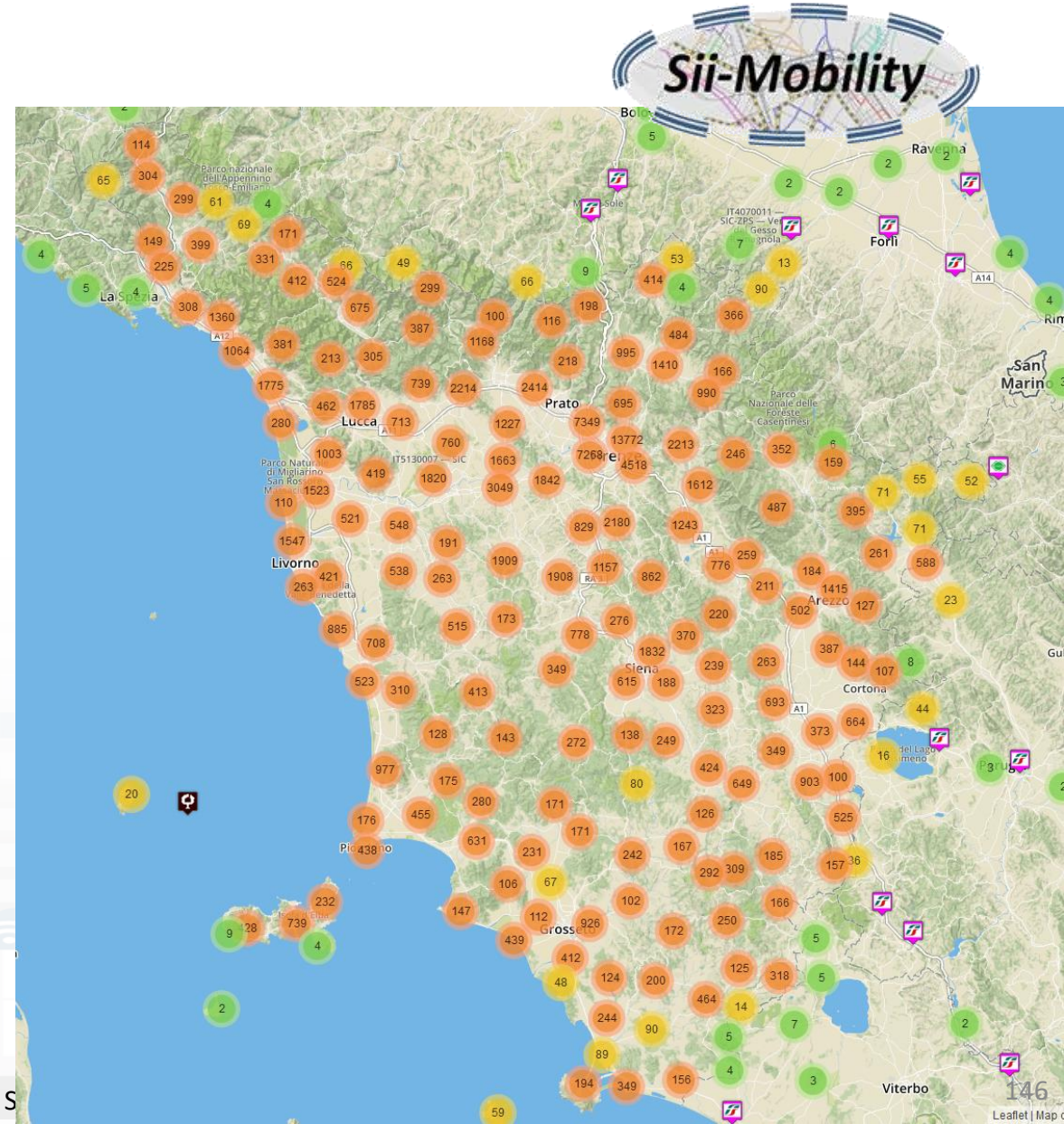






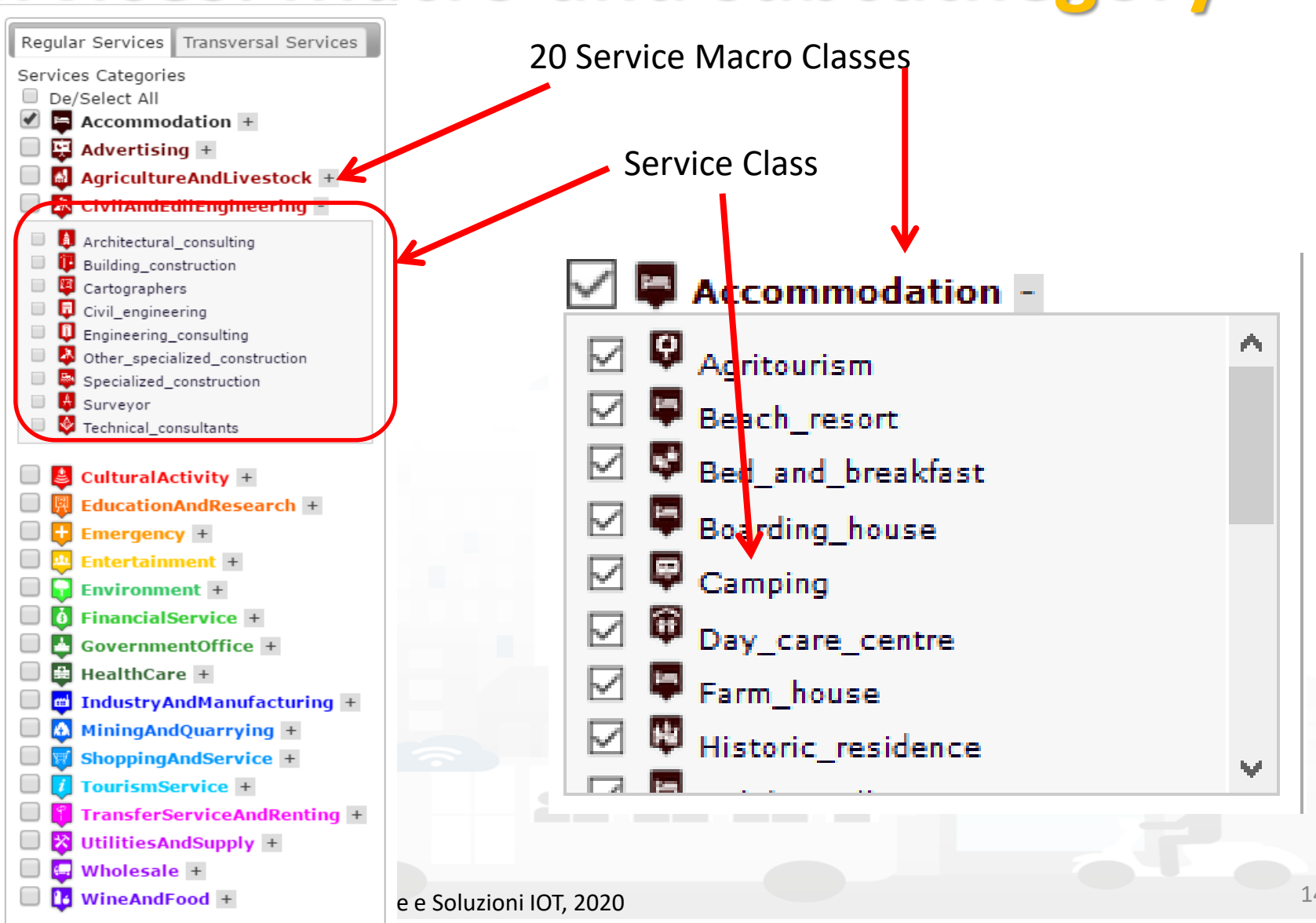
Data Domains

- **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, …



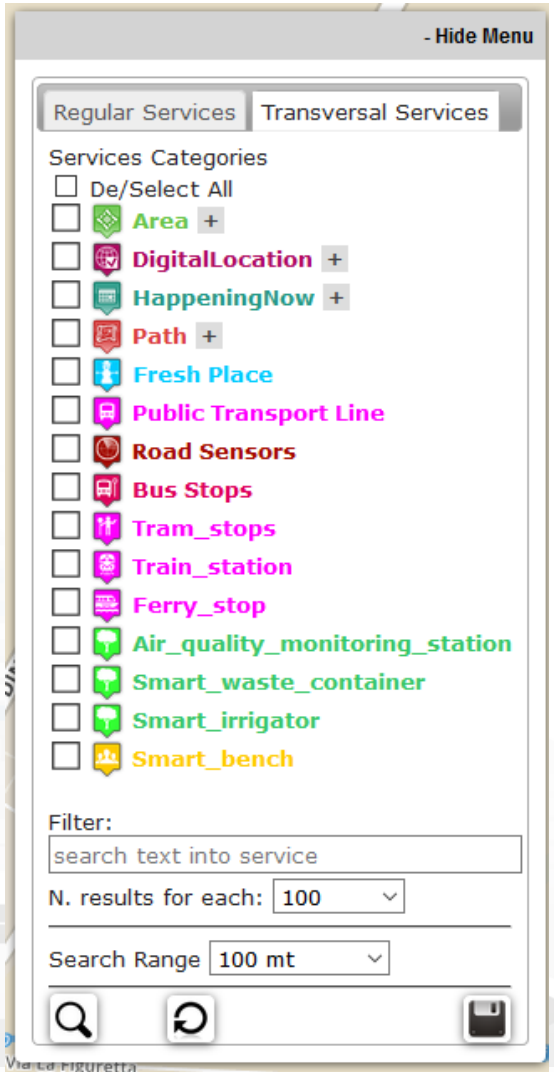
Concepts of Services: Macro and subcathegory

A SKOS area into the Km4CIty Ontology and Knowledge base for modeling POI and any element on map

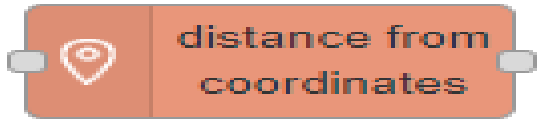


Access to Point of Interest information, POI

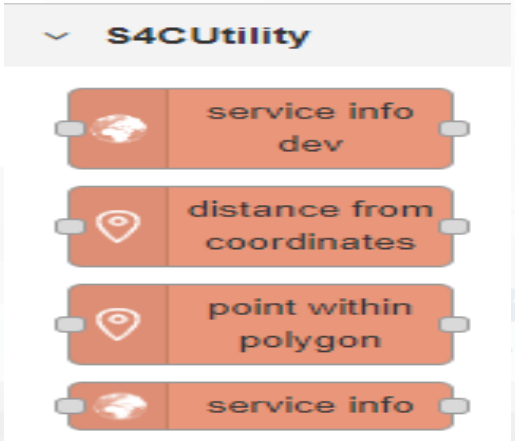
- **POI**: point of interest
- **type**: macro and subcategories
- **Position**: GPS, address, telephone, fax, email, URL, …
- **Description**: textual, multilingual, with images, …
- **Link** to dbPedia, Linked Open Data
- **Links to other services**
- **Real time data if any:** sensors data, timeline, 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**



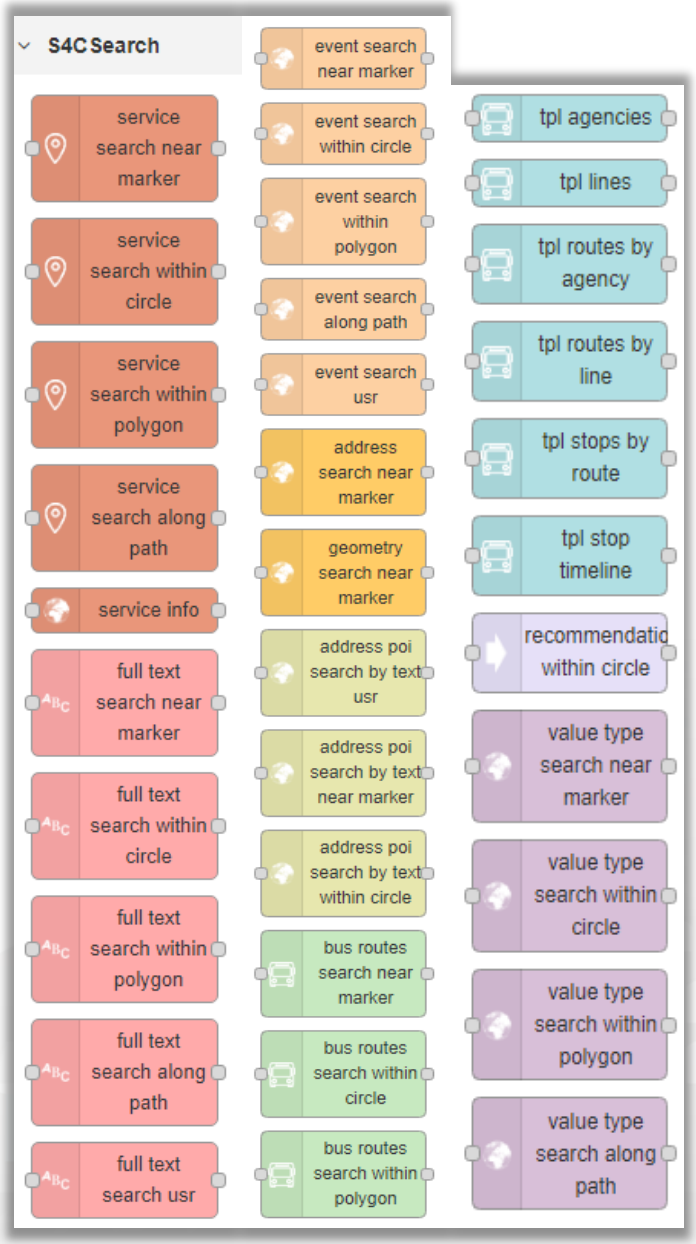
- **Point is in Polygon ?**



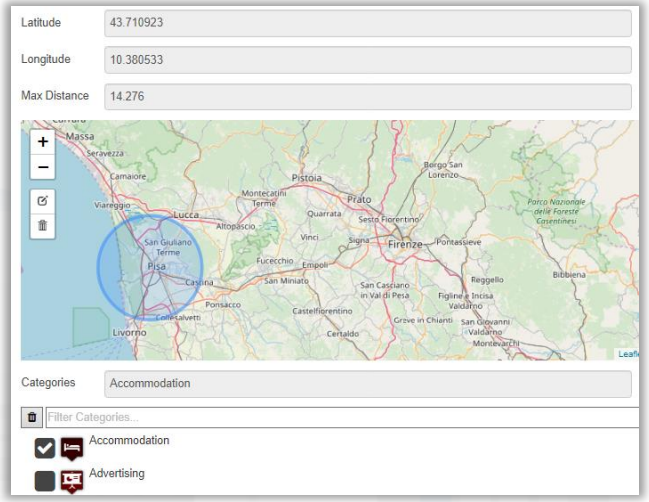
S4CSearch

Smart City Entities Search

Simple and Fast



- **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



S4CSearch

- **For example to search for:**
  - POIs:
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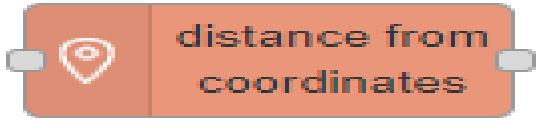
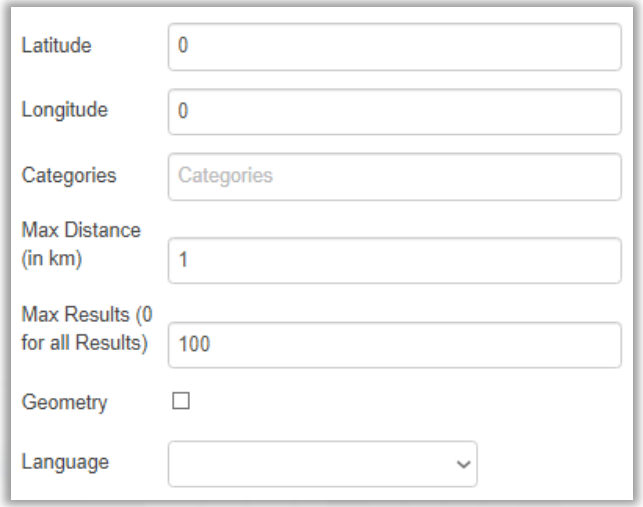
  - Suggestions
  - Public Transport Means Routes/Paths
  - Events in the area
  - Value Type (kind of data)
  - Etc.
- **To Get DATA of a Service / POI /sensor**
  - Real Time
  - ANY kind of sensors
- **Distance from GPS point**

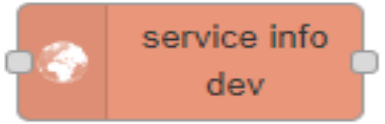


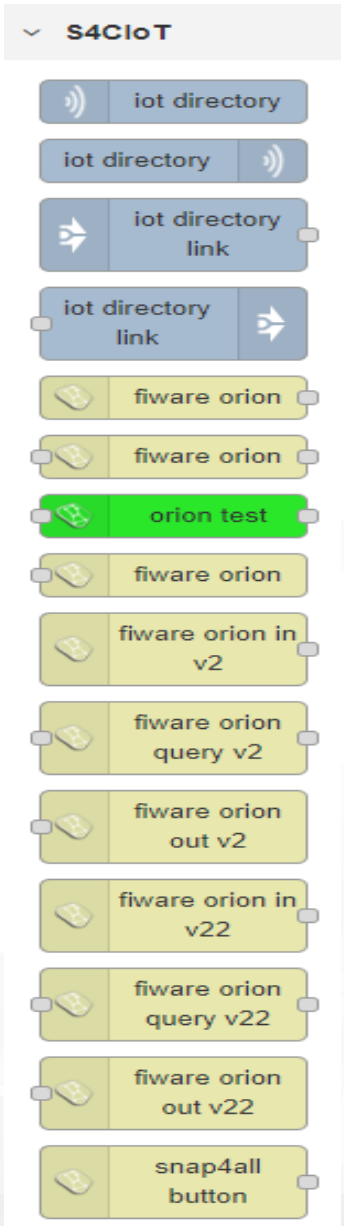
Smart City Entities Advanced Search

Flexiblity

- 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

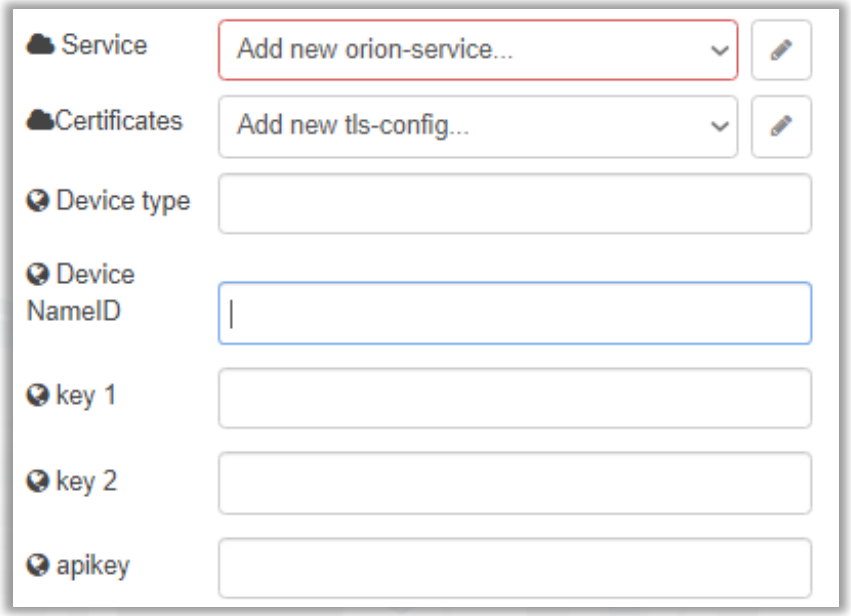






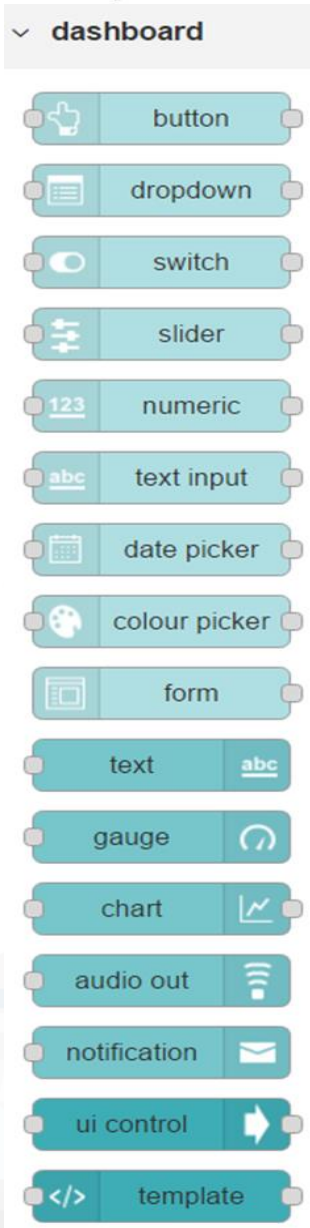
- **Search** for IOT Devices in a given area, or for kind (temperature, model, location, producer, Broker, …)
- **Subscribe** to one or more IOT Devices independently on their protocol, broker, owner, etc.
- **Send** data to IOT devices
- Establish with IOT Devices **Secure** certified Connections

Node-RED



- Please note that many other protocols can be also added, adding mode nodes, or registering IOT brokers to the Snap4City IOT Directory

Dashboard Native Local or Snap4City

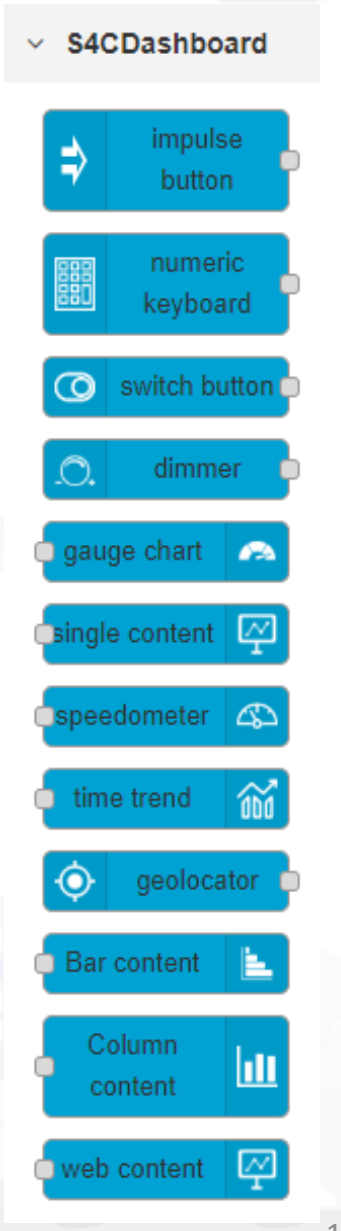


- Input/output
- non secure
- Limited in graphics
- No authentication
- No HLT
- No integration
- Etc..

- Local on IOT Edge

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

- Remote for IOT Edge via WebSocket Secure

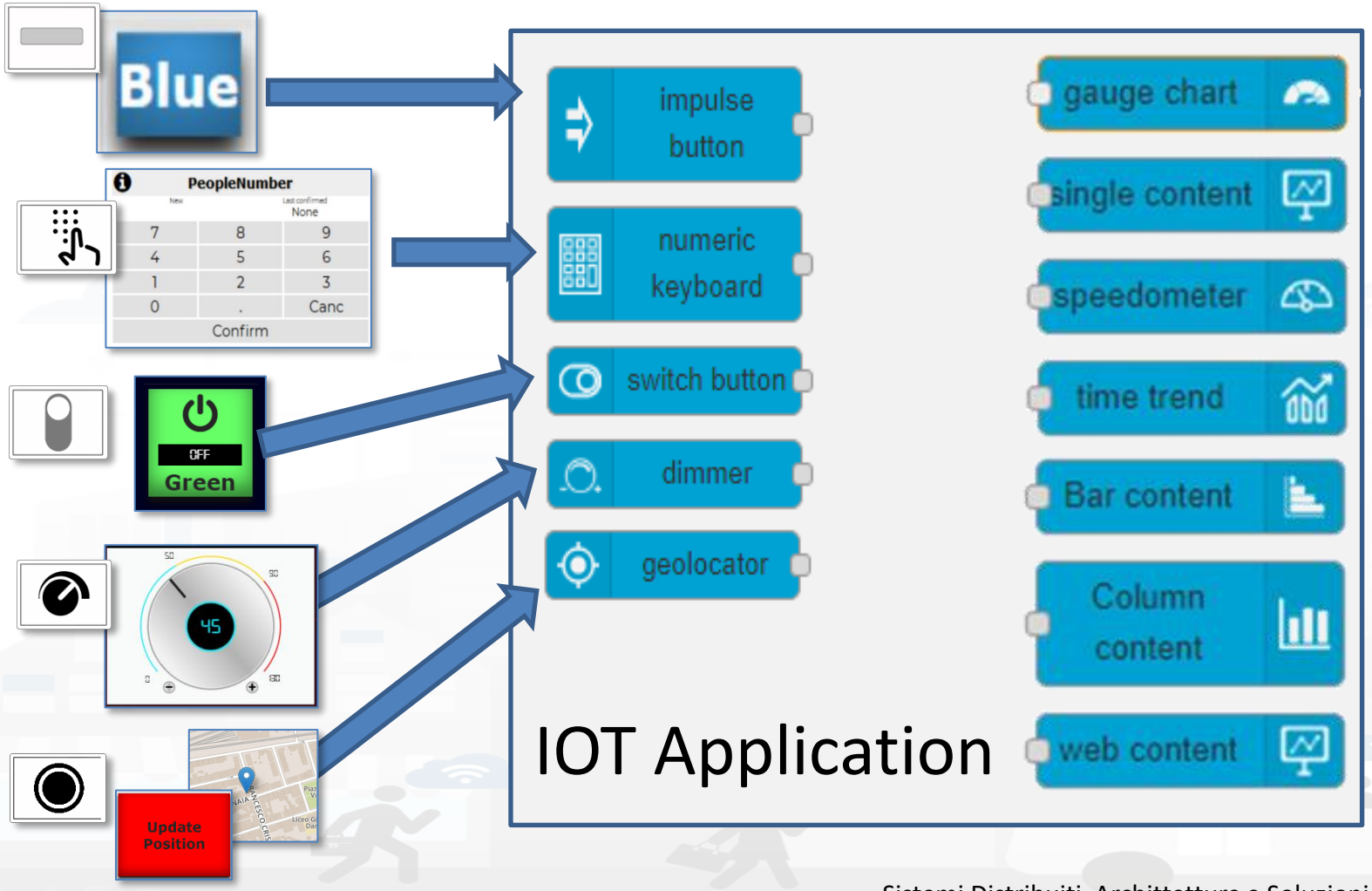


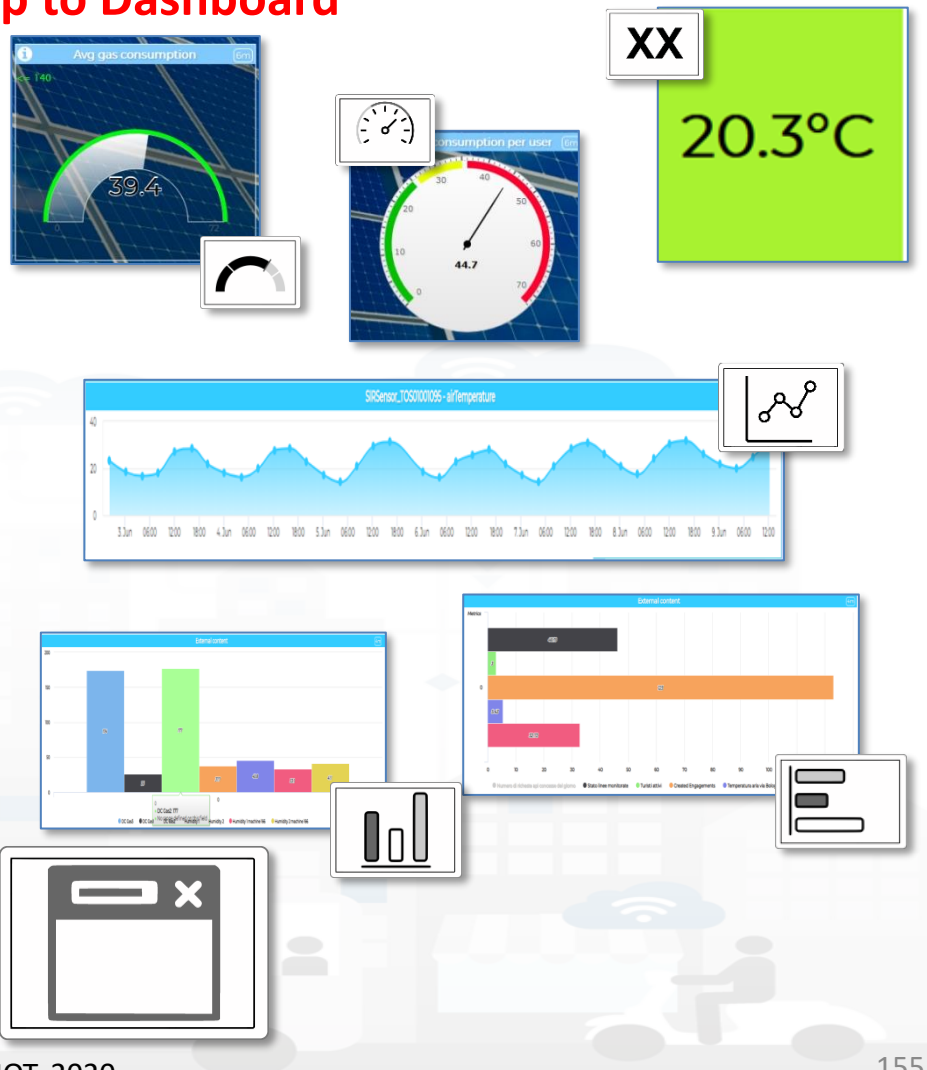
Dashboard-IOT App

Nature

From Dashboard to IOT App

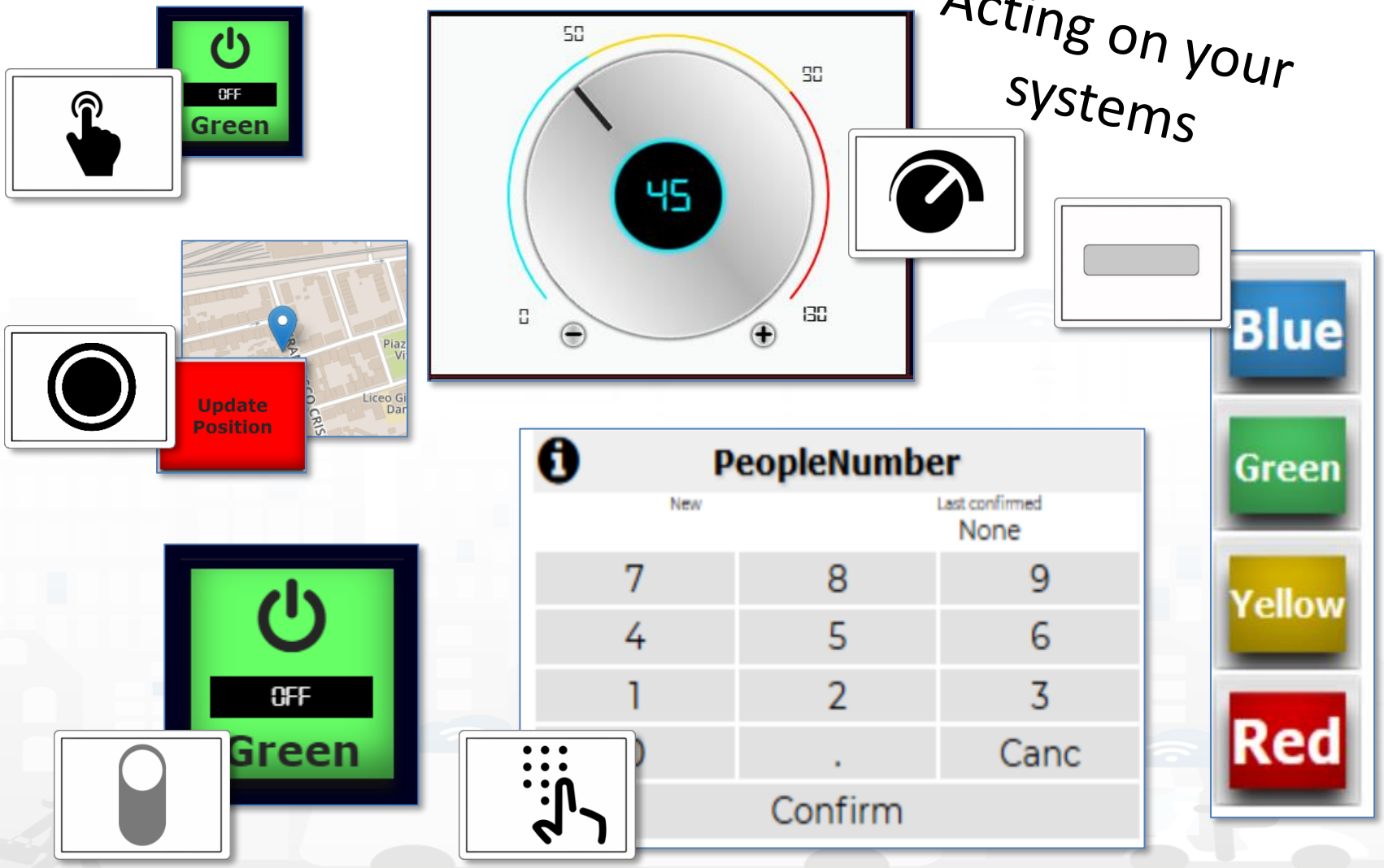
From IOT App to Dashboard





From Dashboard to IOT Devices

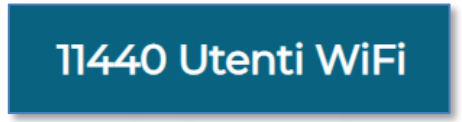
- **Widgets:**
  - Impulse Button
  - Button
  - Switch
  - Dimer/Knowb
  - KeyPad
  - geolocator
- **Registered** on some IOT brokers with NGSI mutual authentication



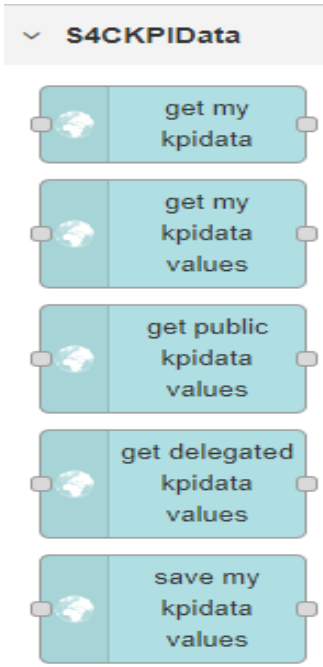
Single Content Widget (flexibility)

From Dashboard Editor and IOT Applications, accepts in input:

- Numbers
- String
- HTML code

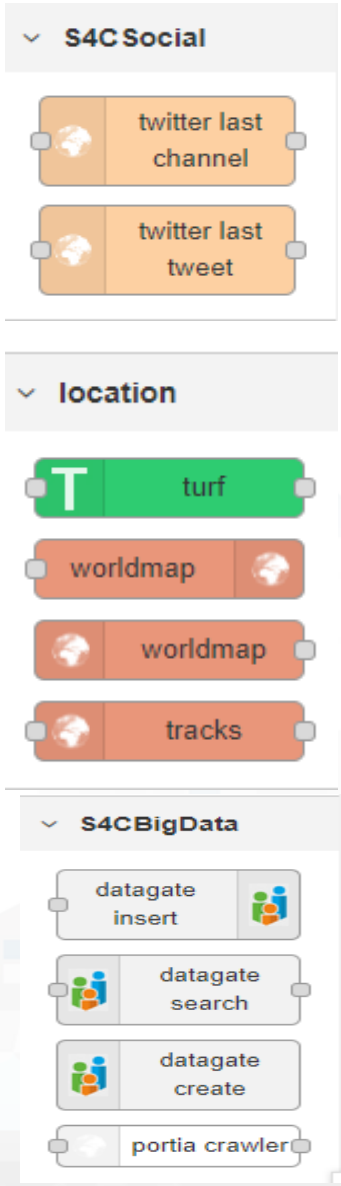


S4CKPIData



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

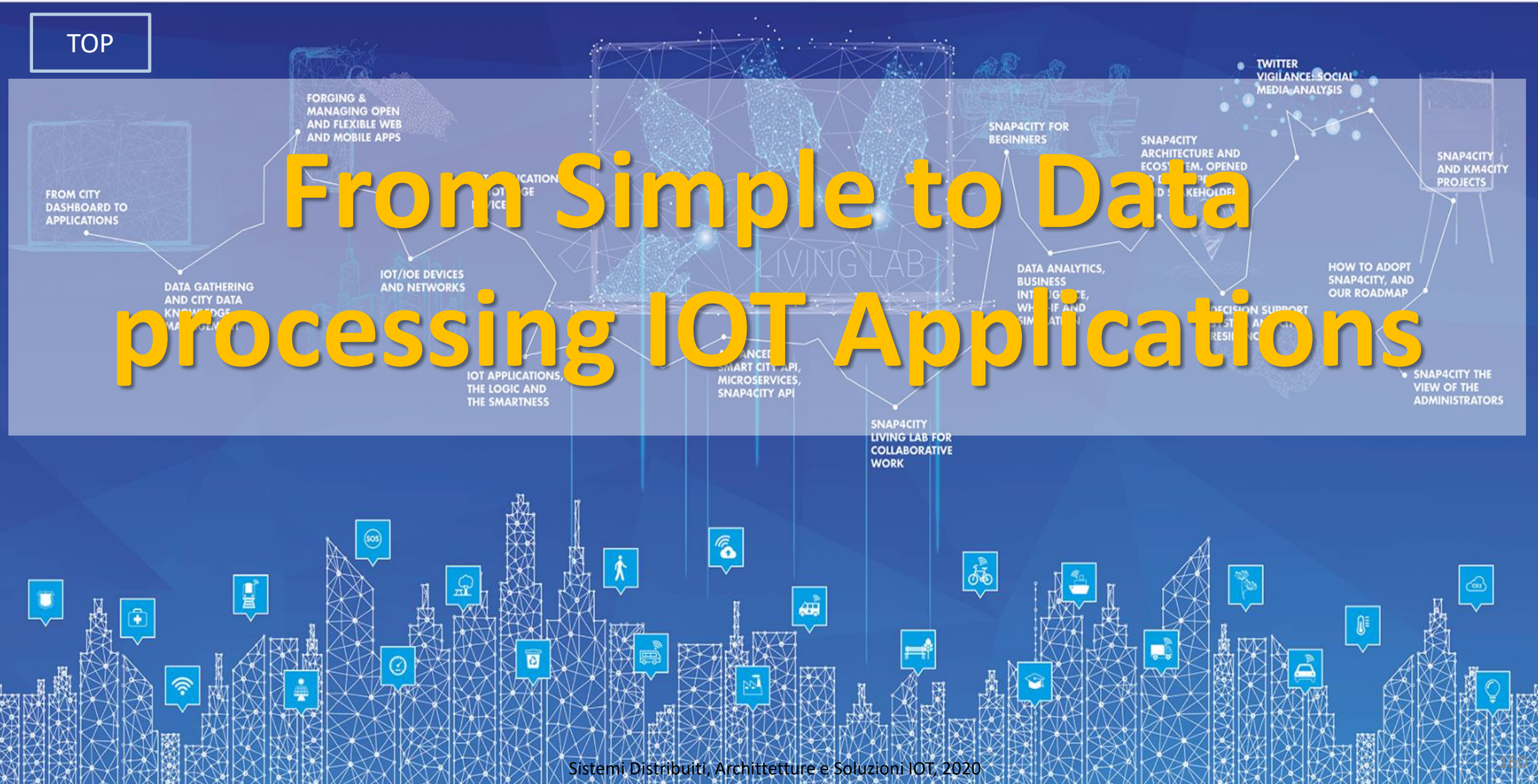
Mixt



- 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



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)

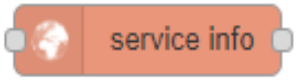
Demo of Simple IOT Application

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

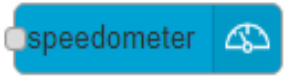
Generates an input for the other nodes. It can be repeated at predefined intervals, entered manually and of various types (string, number, Boolean, json etc.)



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

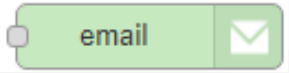
Transforms the incoming message into a JSON



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

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

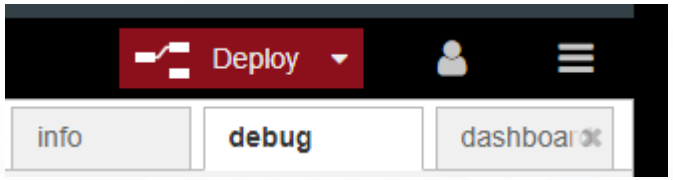
The others only accept numbers.



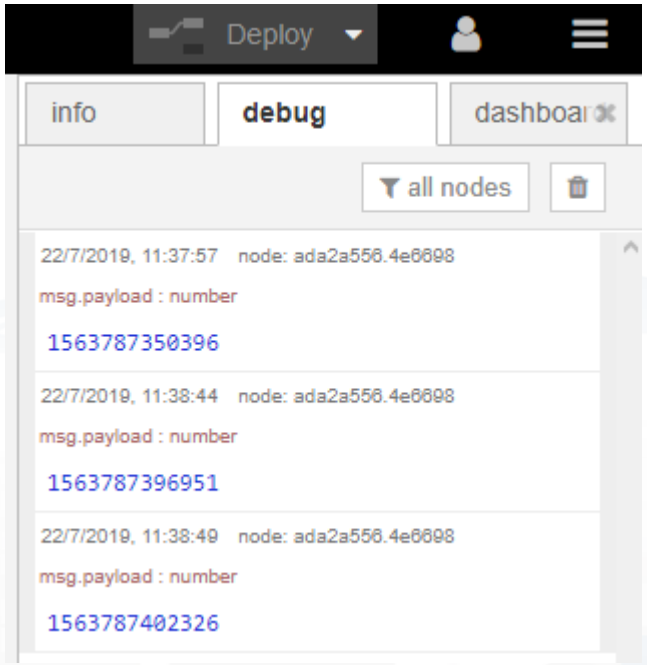
Send an email to the desired recipient. You must enter the username and password of an active email.

Step 1

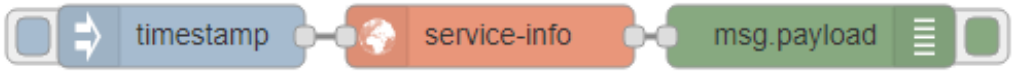
- Inject and Debug 

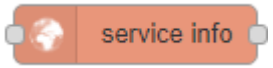
- Connect
- Deploy 

- Click and Observe
- Play with results



Step 2



- Service Info 

- Connect
- Configure

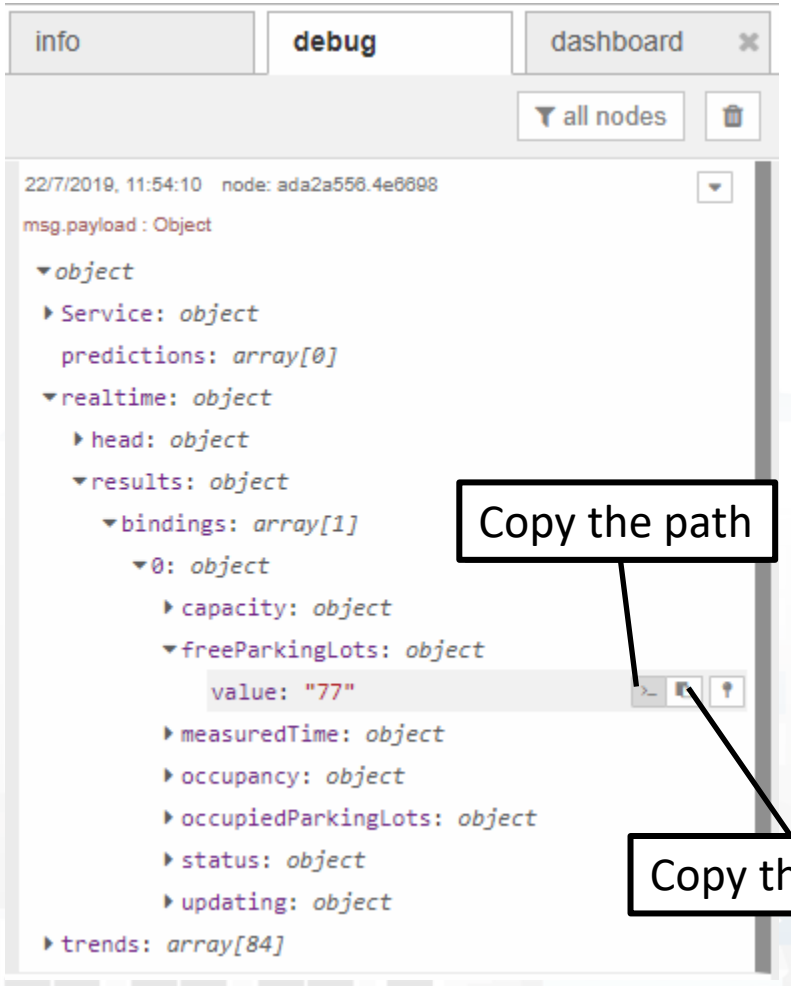
Name: Name

ServiceUri: http://www.disit.org/km4city/resource/CarParkPieraccinMeyer

Language: Italian

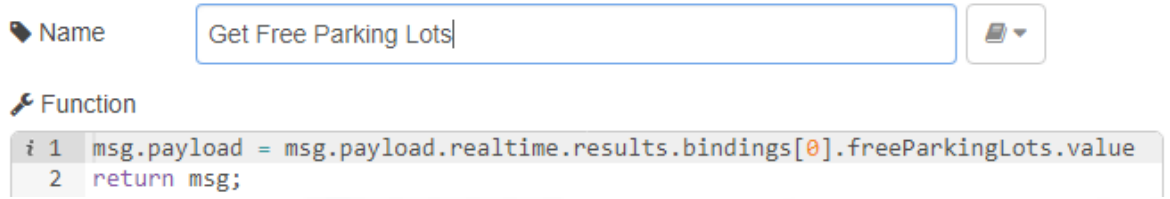
http://www.disit.org/km4city/resource/CarParkPieraccinMeyer

- Deploy
- Click and Observe
- Play with results



Step 3

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

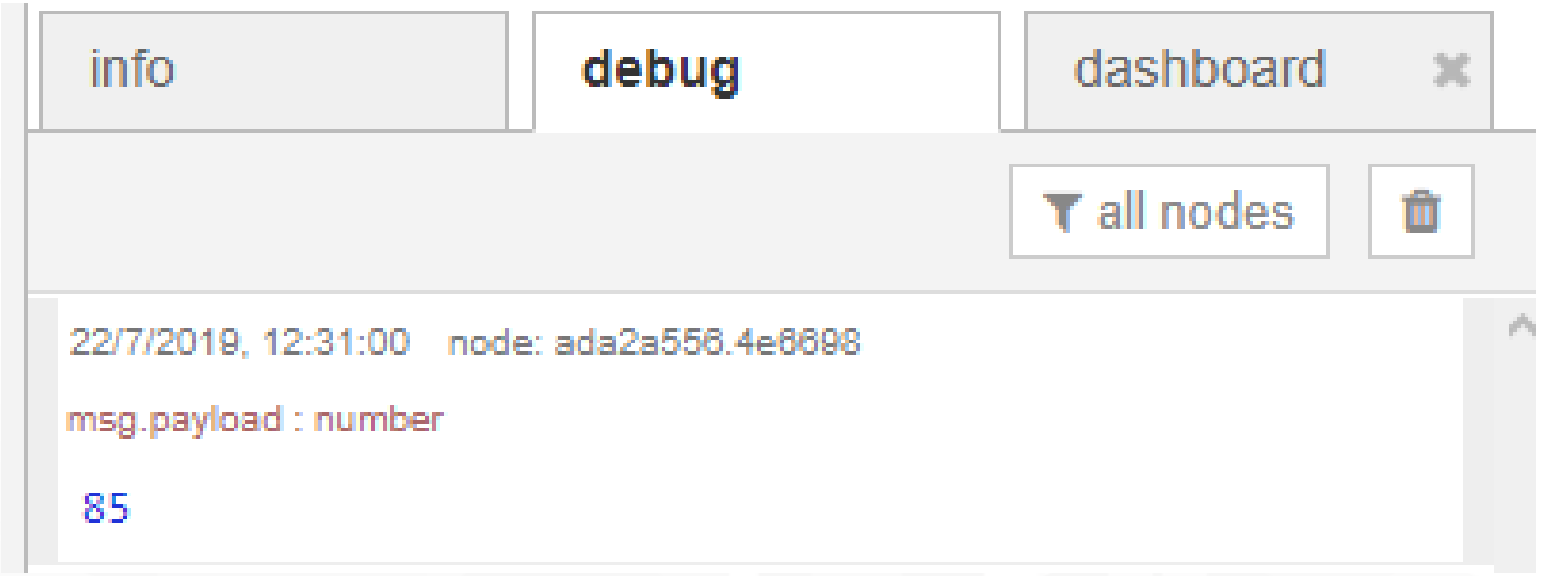


msg.payload = msg.payload.realtime.results.bindings[0].freeParkingLots.value

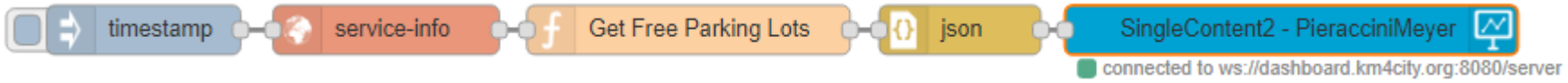
Step 4

- JSON 

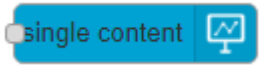
- Connect
- Deploy
- Click and Observe
- Play with results

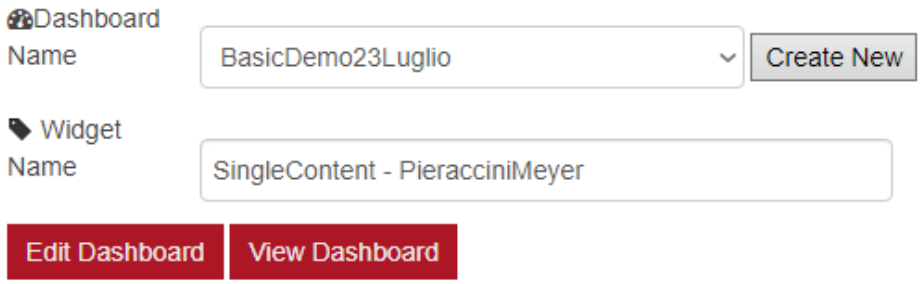


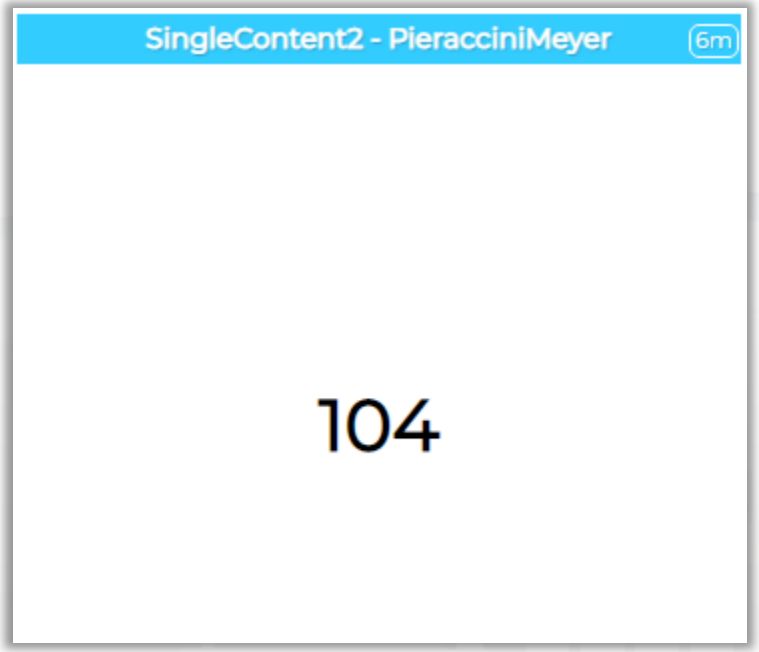
Step 5



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

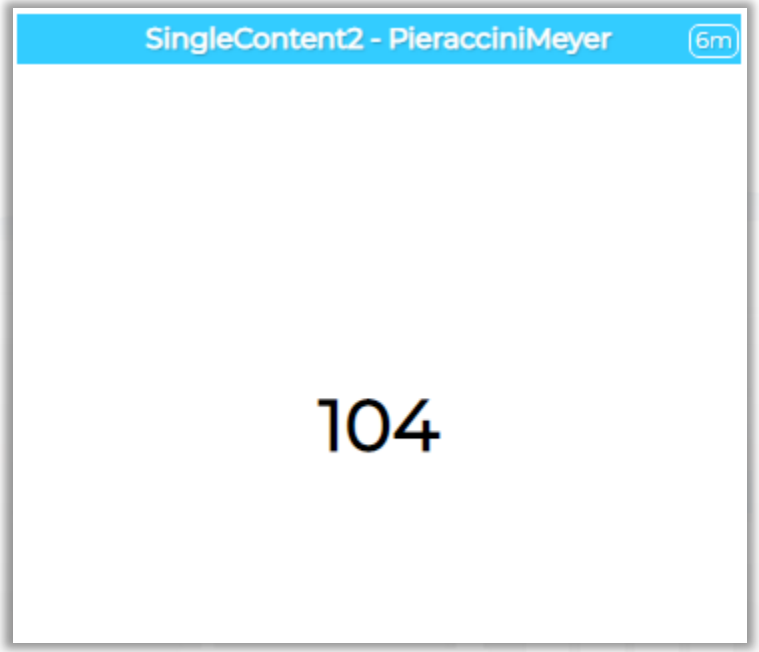




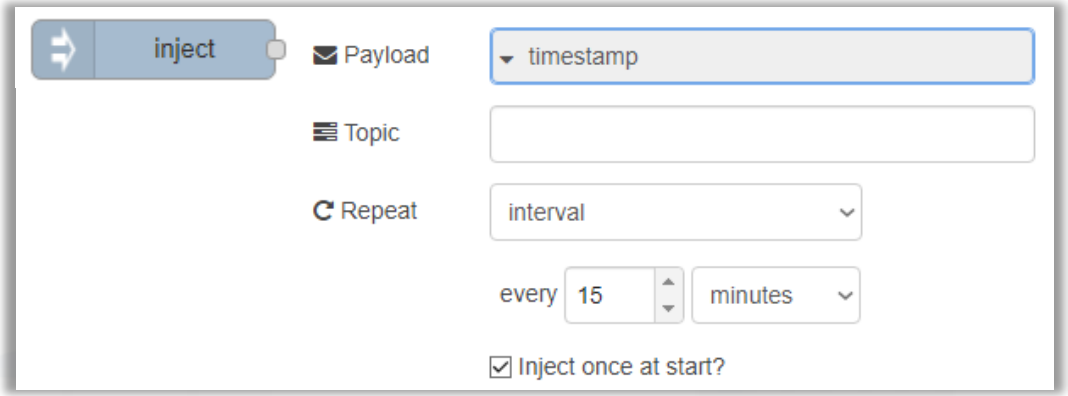


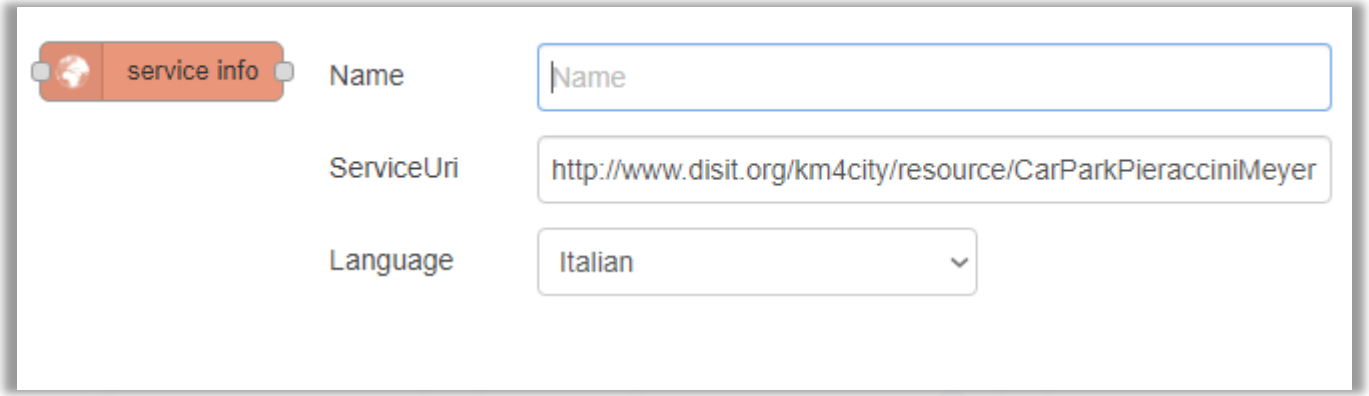
Step 6

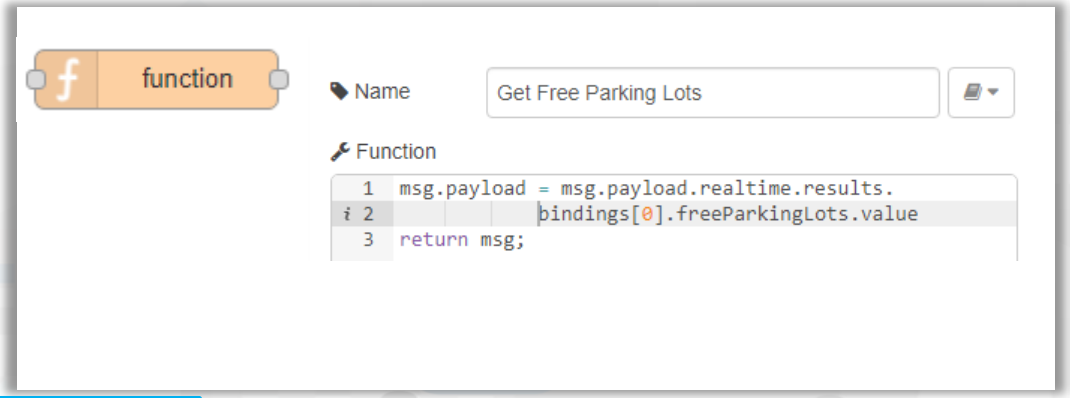
- Email
- Connect
- Configure
- Deploy
- Click and Observe
- Play with results

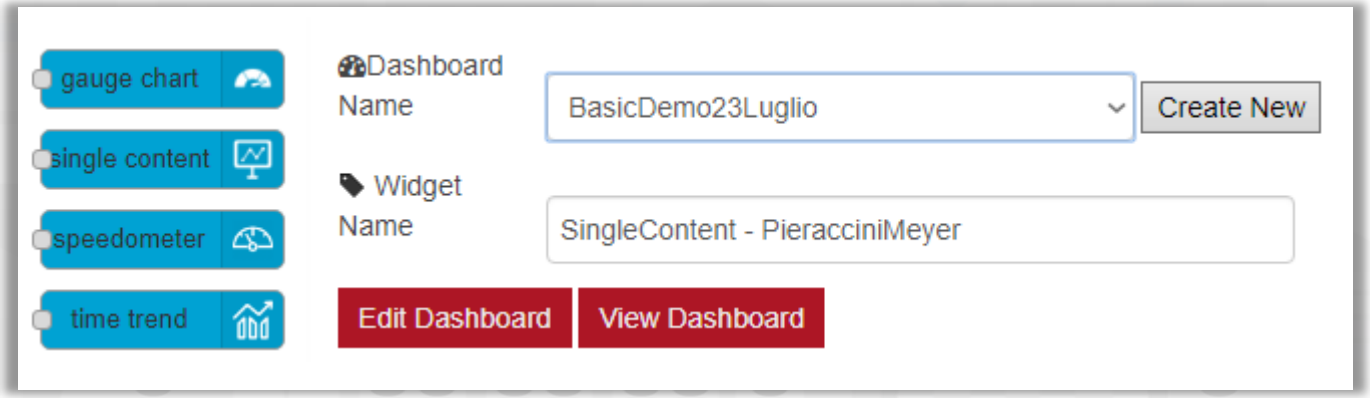


Nodes configuration









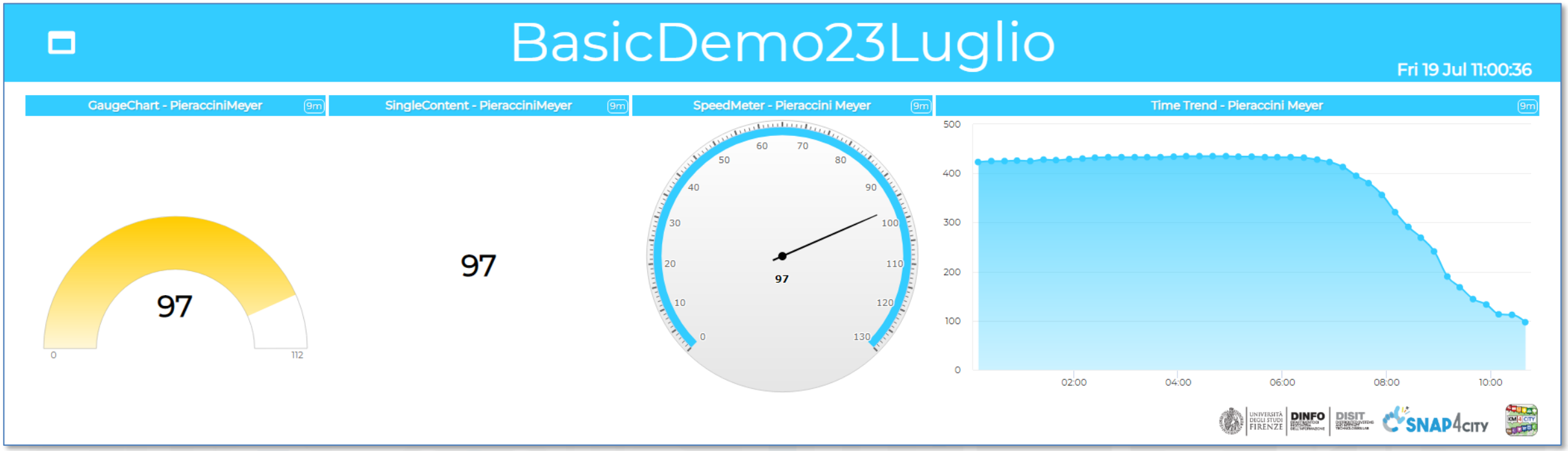
Nodes connections

Explaining: IOT Application Flow

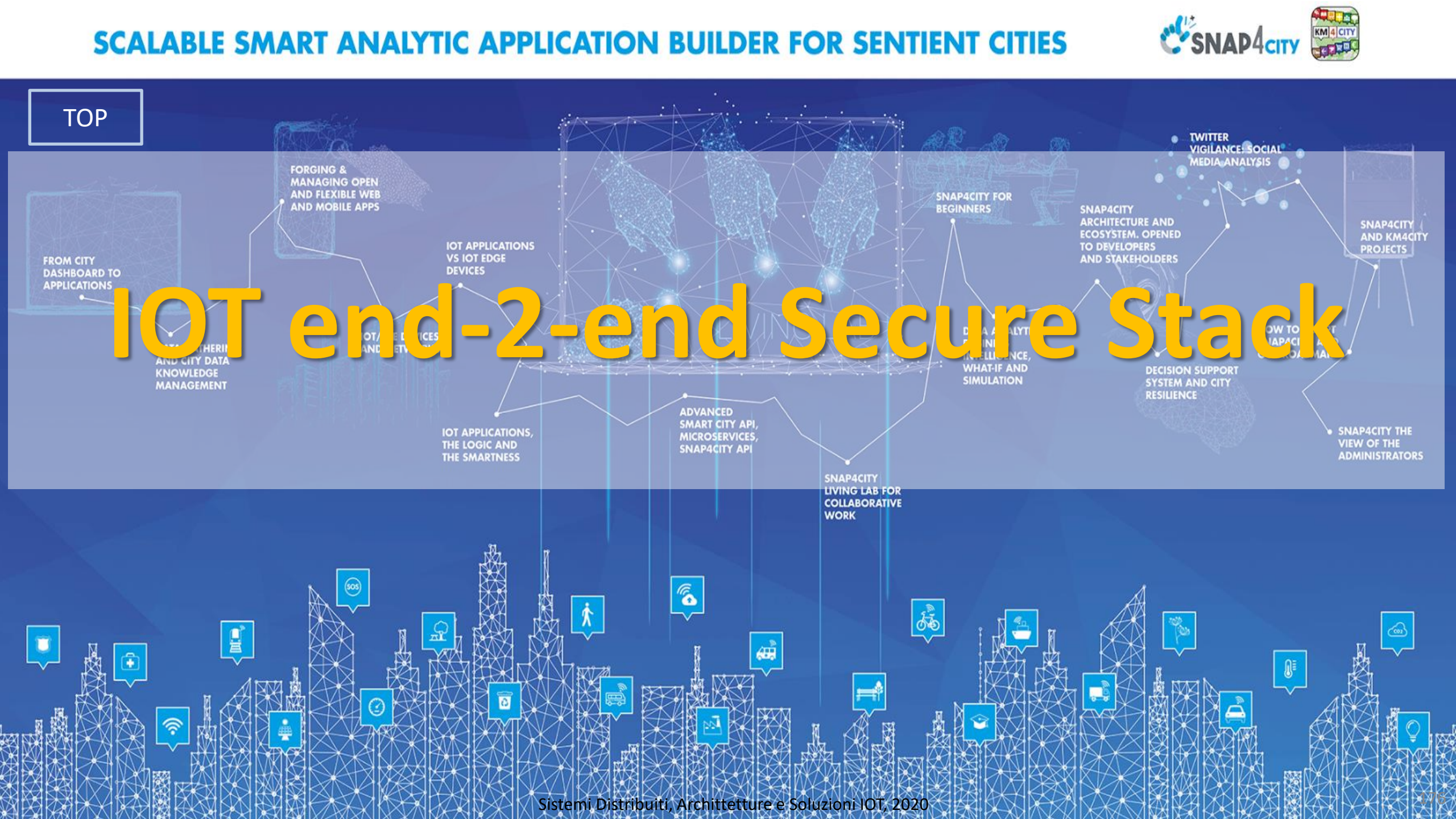
Node-RED

- 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



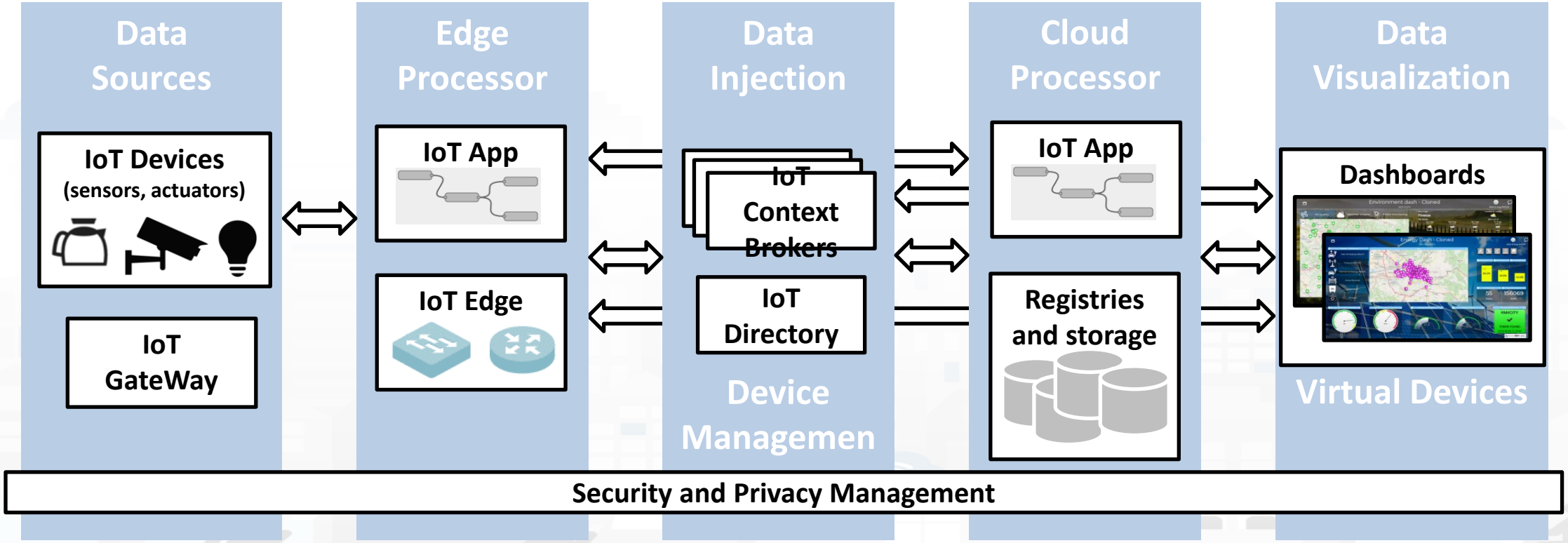
https://main.snap4city.org/view/index.php?iddasboard=MTk1OQ==

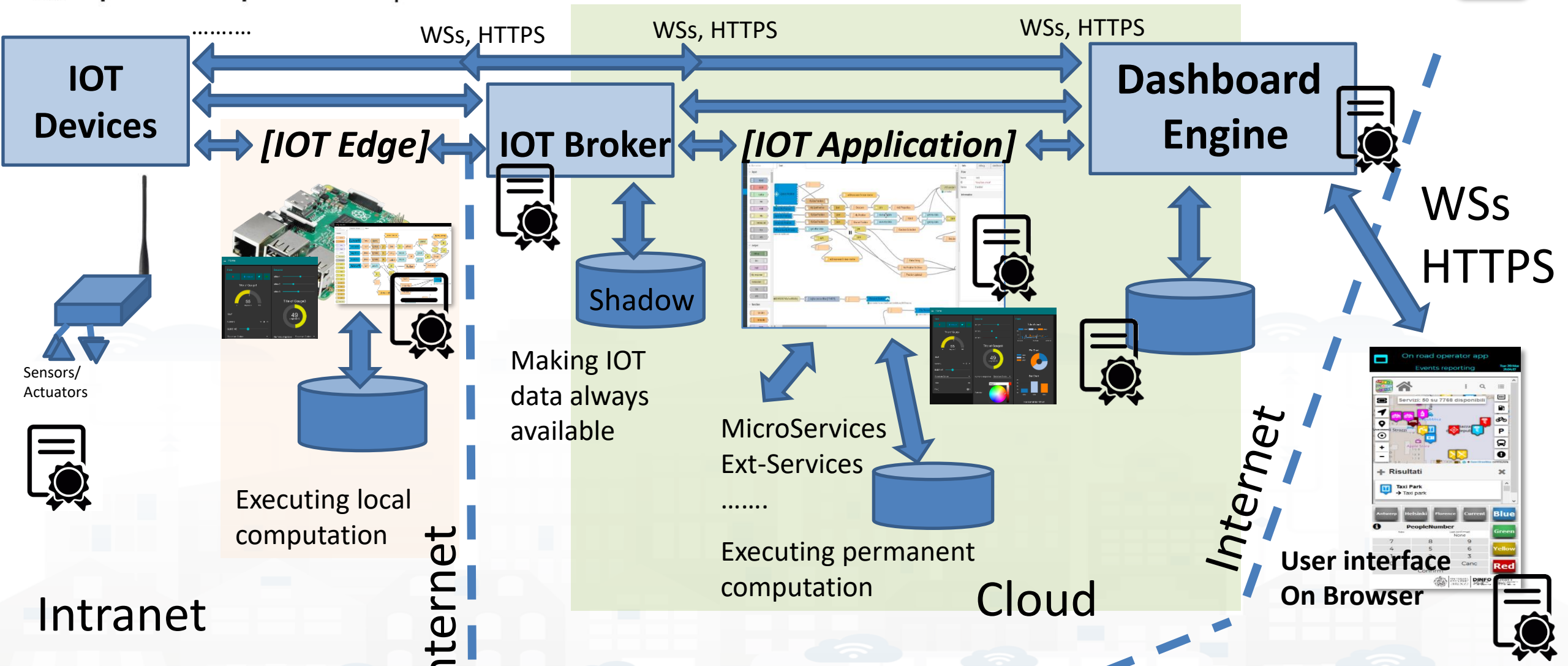

SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES
SNAP4CITY
KM4CITY
TOP
FORGING & MANAGING OPEN AND FLEXIBLE WEB AND MOBILE APPS
FROM CITY DASHBOARD TO APPLICATIONS
IOT APPLICATIONS VS IOT EDGE DEVICES
SNAP4CITY FOR BEGINNERS
TWITTER VIGILANCE: SOCIAL MEDIA ANALYSIS
SNAP4CITY ARCHITECTURE AND ECOSYSTEM. OPENED TO DEVELOPERS AND STAKEHOLDERS
SNAP4CITY AND KM4CITY PROJECTS
IOT end-2-end Secure Stack
AND CITY DATA KNOWLEDGE MANAGEMENT
WHAT-IF AND SIMULATION
DECISION SUPPORT SYSTEM AND CITY RESILIENCE
IOT APPLICATIONS, THE LOGIC AND THE SMARTNESS
ADVANCED SMART CITY API, MICROSERVICES, SNAP4CITY API
SNAP4CITY THE VIEW OF THE ADMINISTRATORS
SNAP4CITY LIVING LAB FOR COLLABORATIVE WORK

Complexity in Smart City IOT Platforms

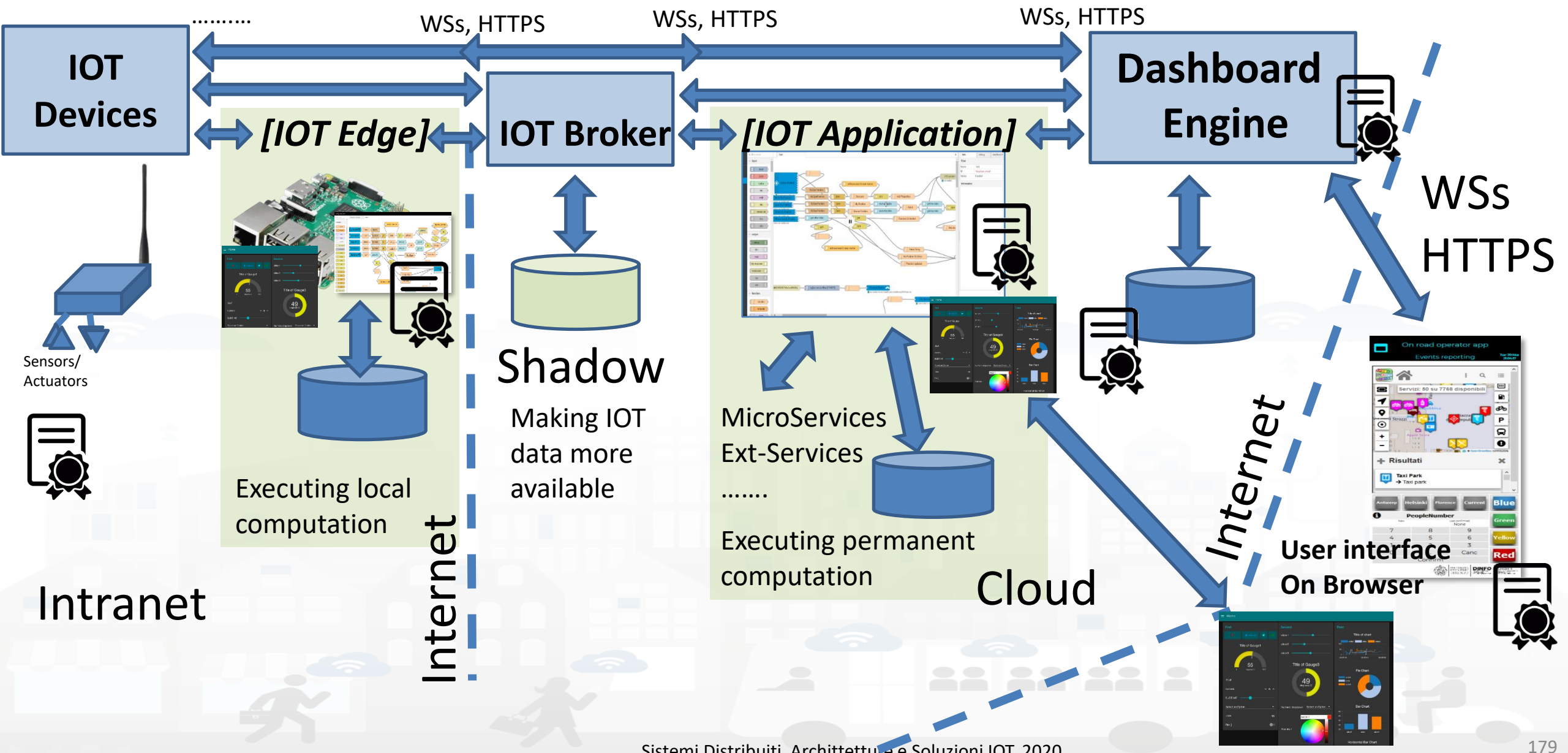
End to End security

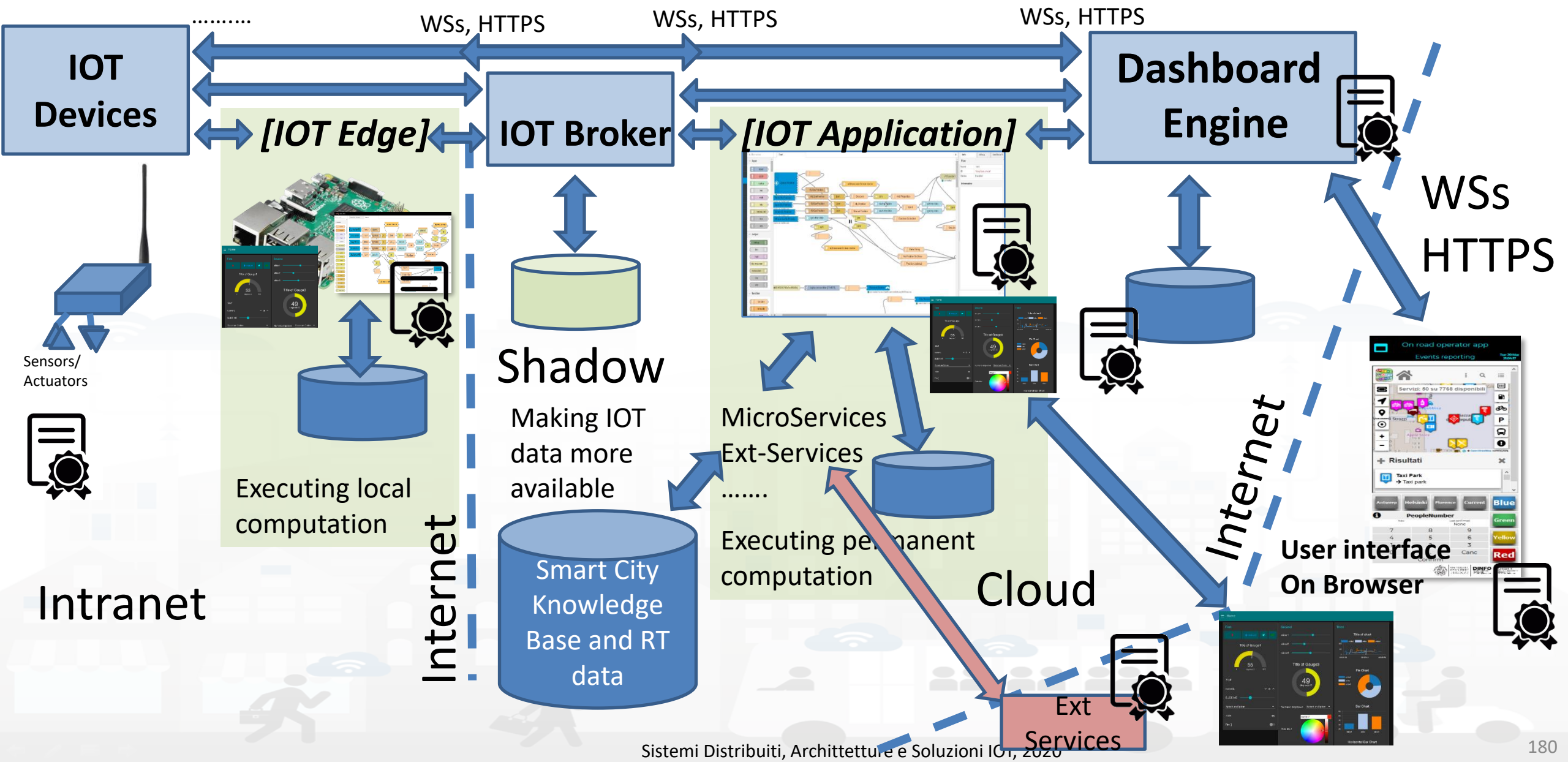
– From IOT Devices to Dashboard (user interface)



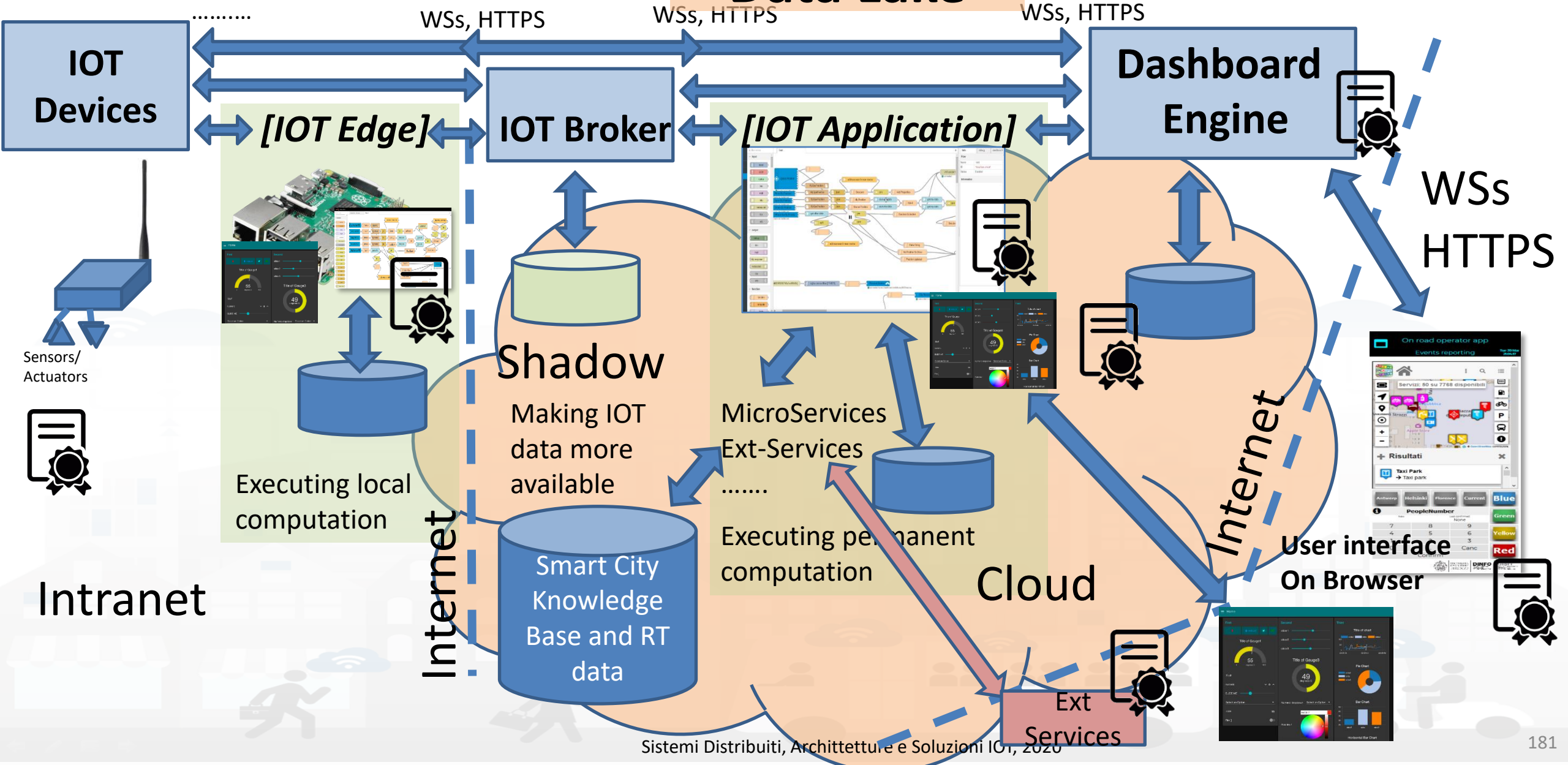


End 2 end security

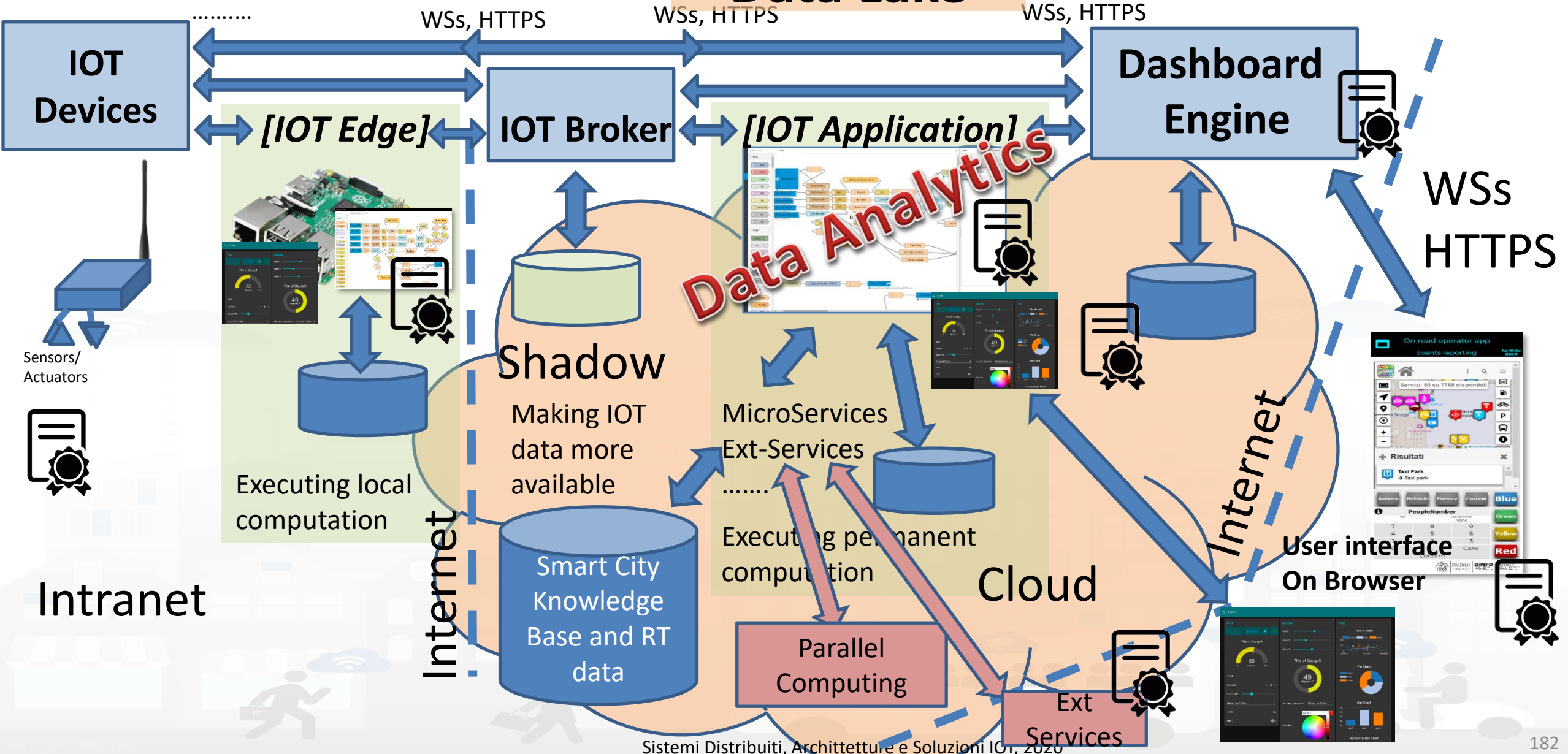

.....
WSs, HTTPS
WSs, HTTPS
WSs, HTTPS
IOT Devices
[IOT Edge]
IOT Broker
[IOT Application]
Dashboard Engine
WSs
HTTPS
Sensors/
Actuators
Executing local computation
Shadow
Making IOT data more available
MicroServices
Ext-Services
.....
Executing permanent computation
Internet
Internet
Intranet
Cloud
User interface
On Browser


.....
WSs, HTTPS
WSs, HTTPS
WSs, HTTPS
IOT Devices
[IOT Edge]
IOT Broker
[IOT Application]
Dashboard Engine
WSs
HTTPS
Sensors/
Actuators
Executing local computation
Shadow
Making IOT data more available
MicroServices
Ext-Services
.....
Executing permanent computation
Internet
Smart City Knowledge Base and RT data
Cloud
Internet
Ext Services
User interface On Browser
Intranet

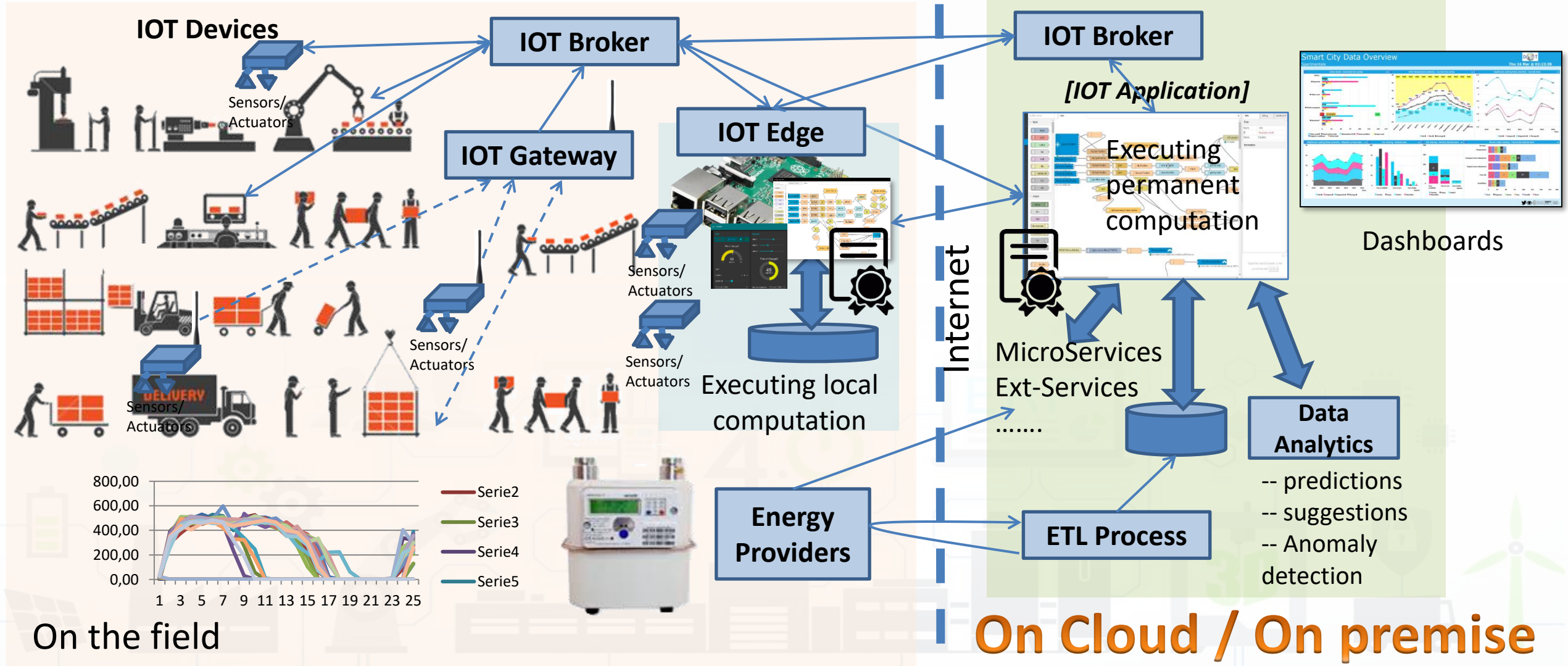
Grouping on Data Lake



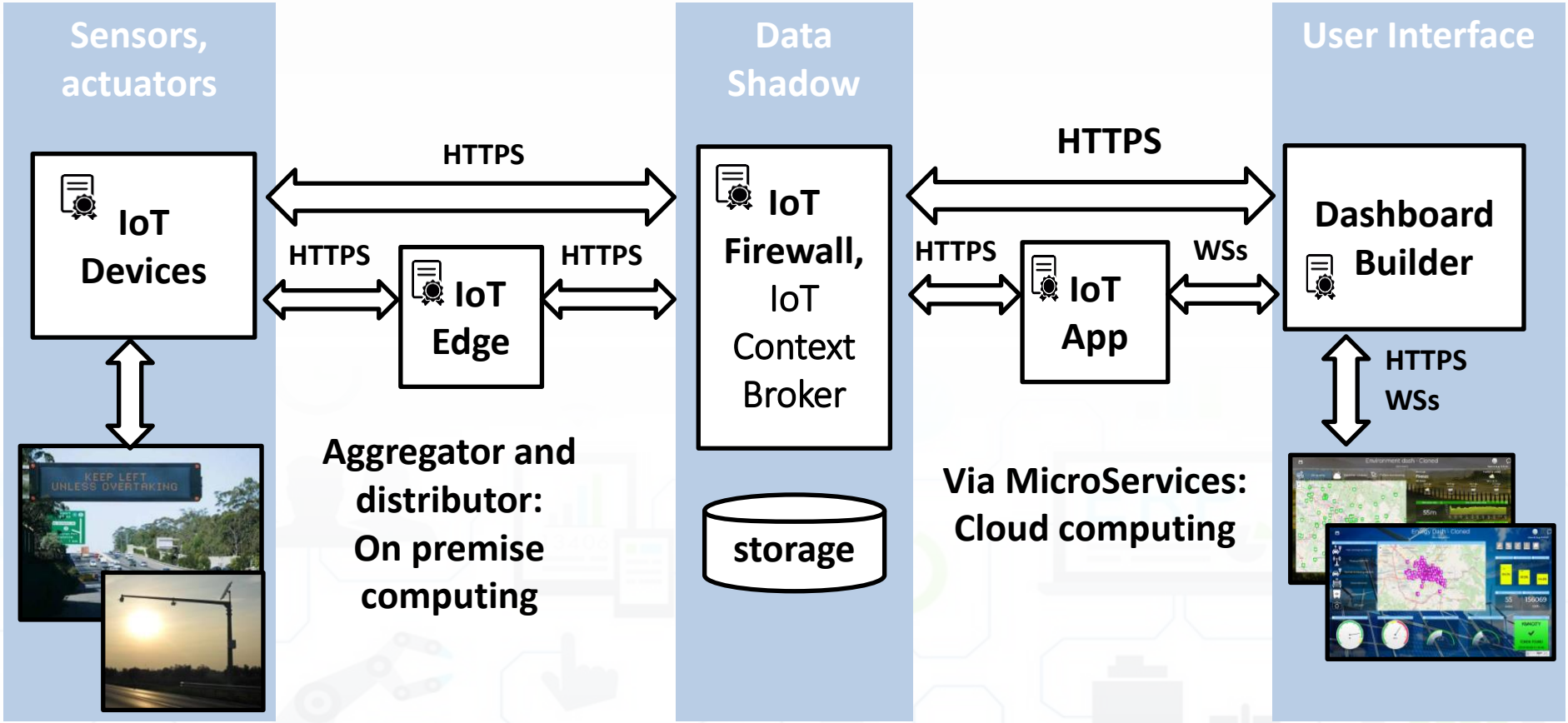
Grouping on Data Lake



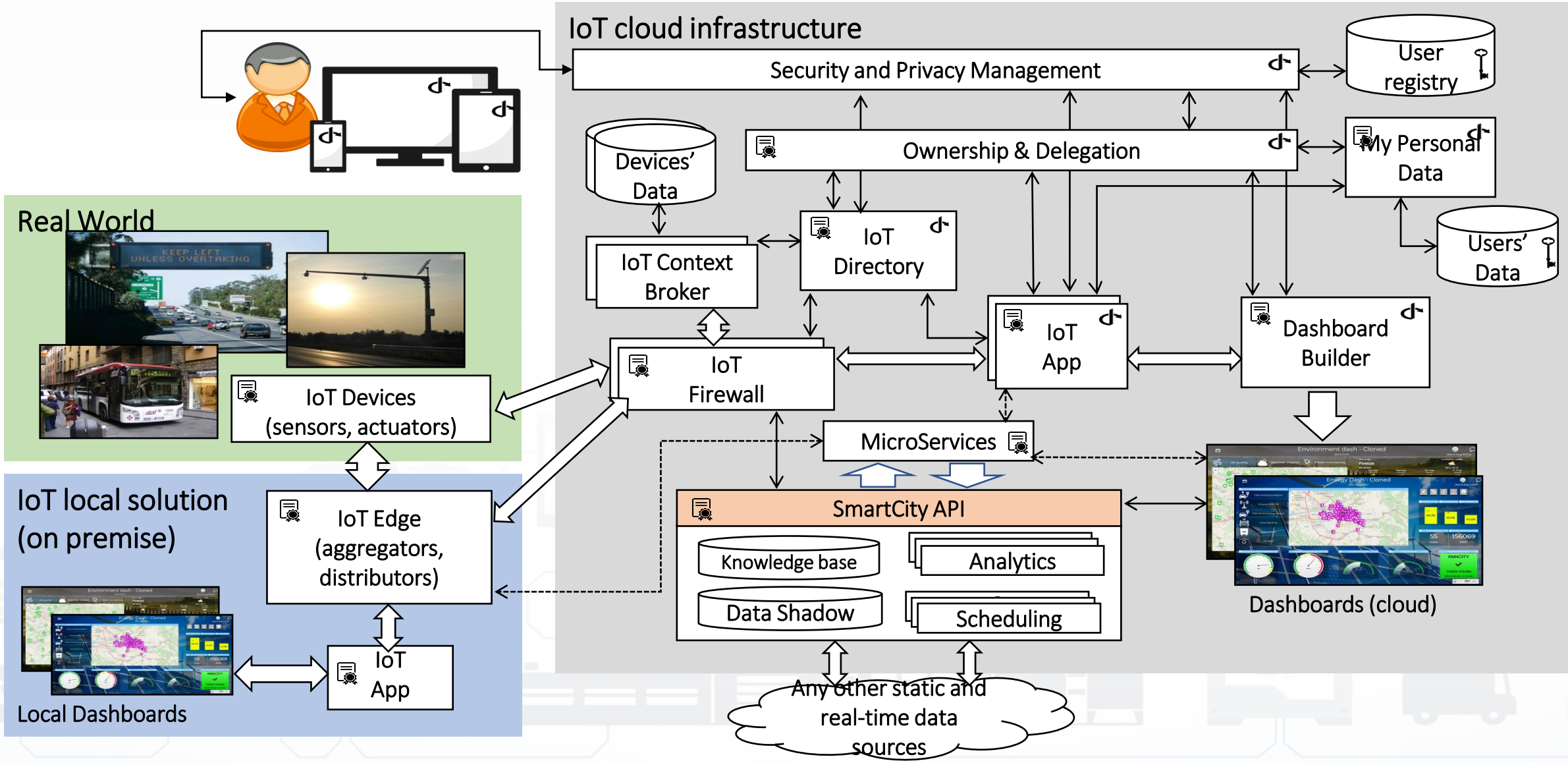
Industry 4.0 Application



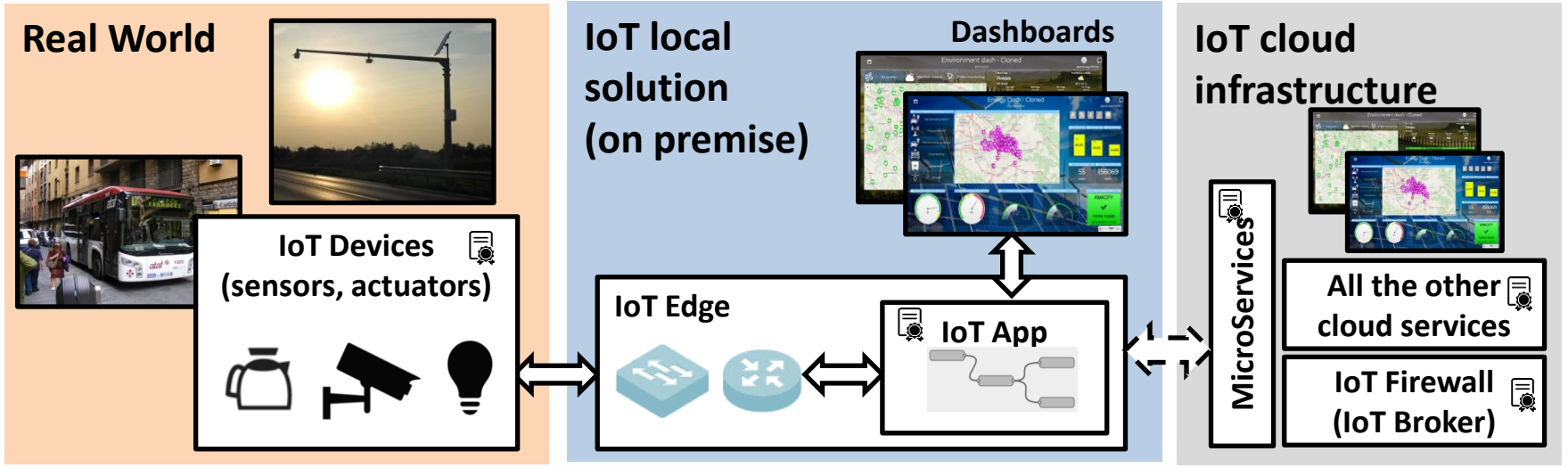
The secure stack

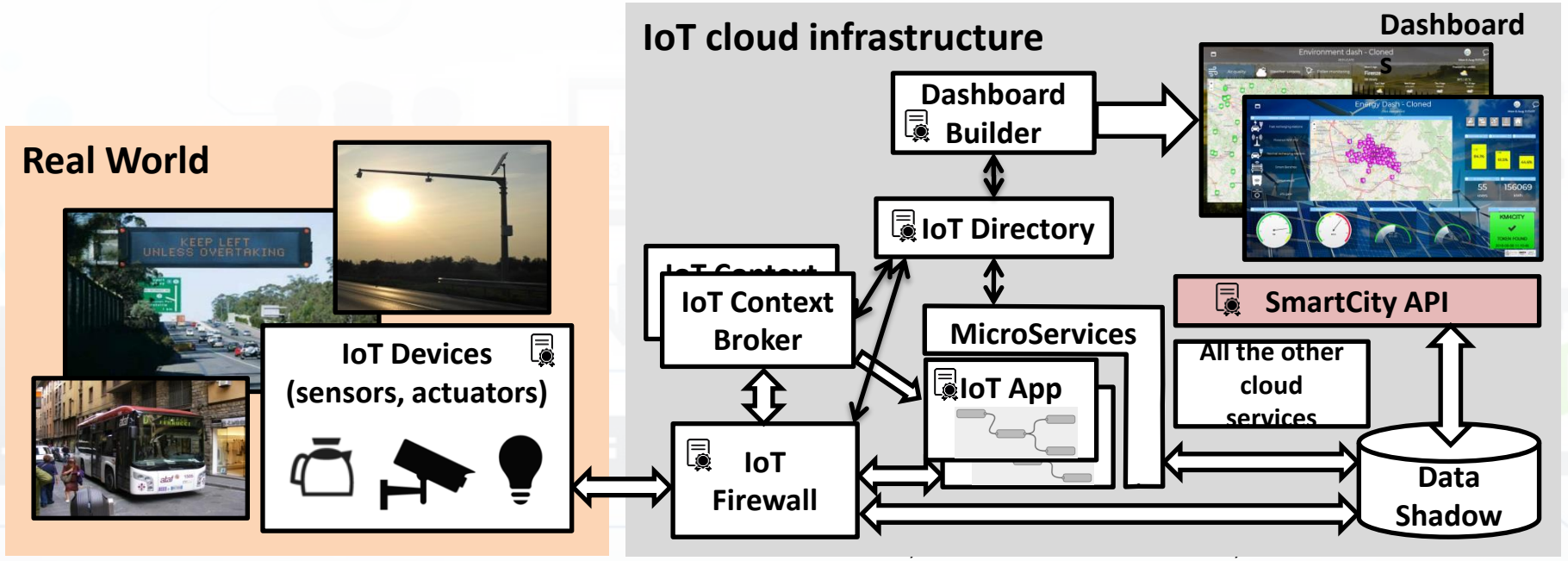


Secure Architecture

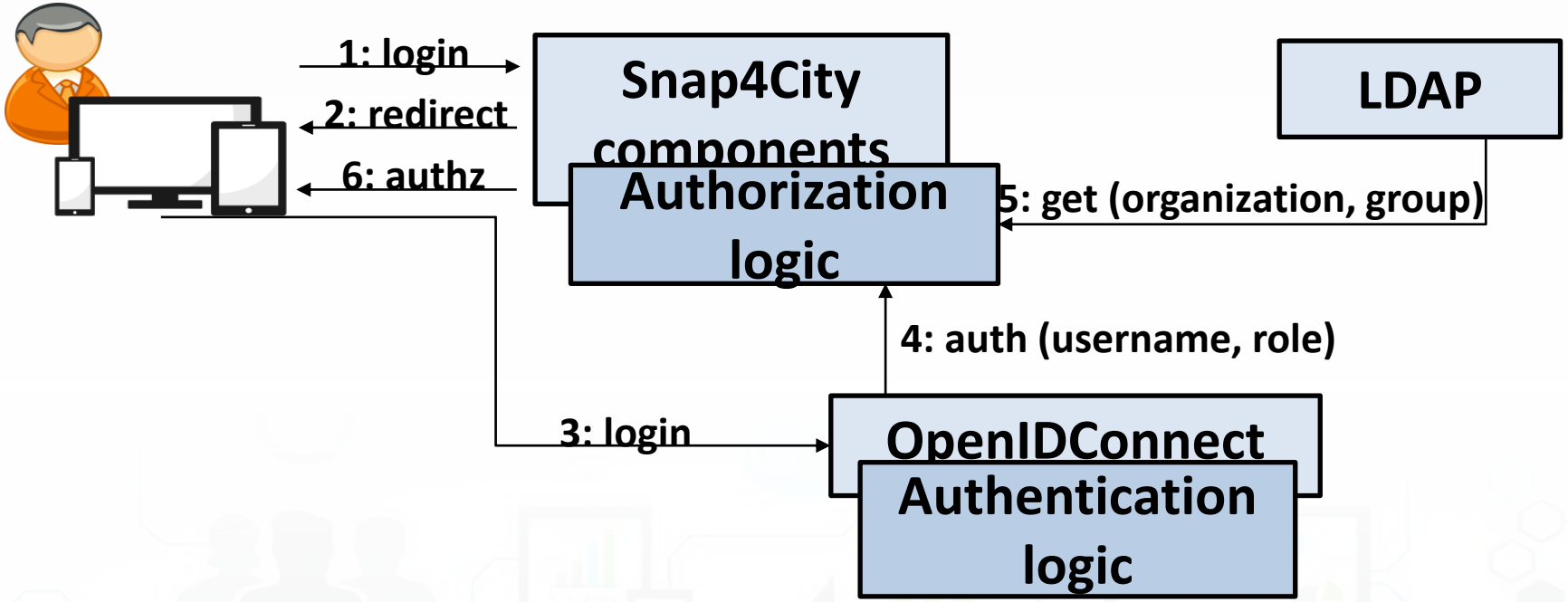


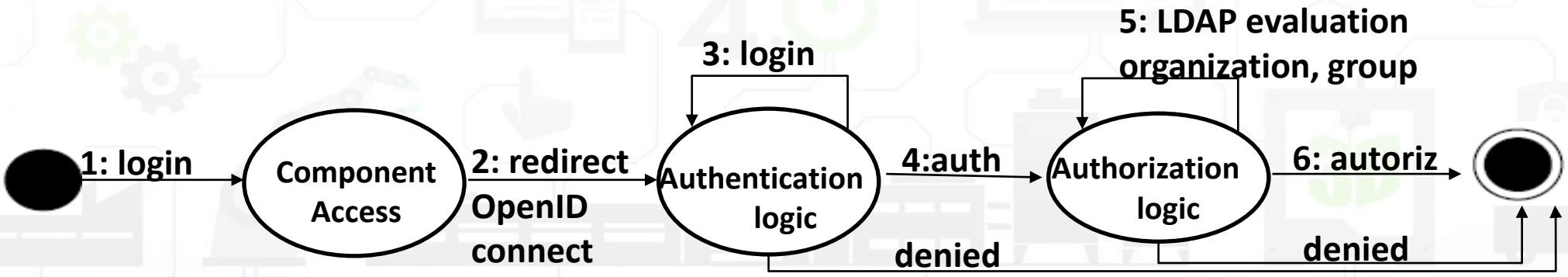
OnPremise vs Cloud

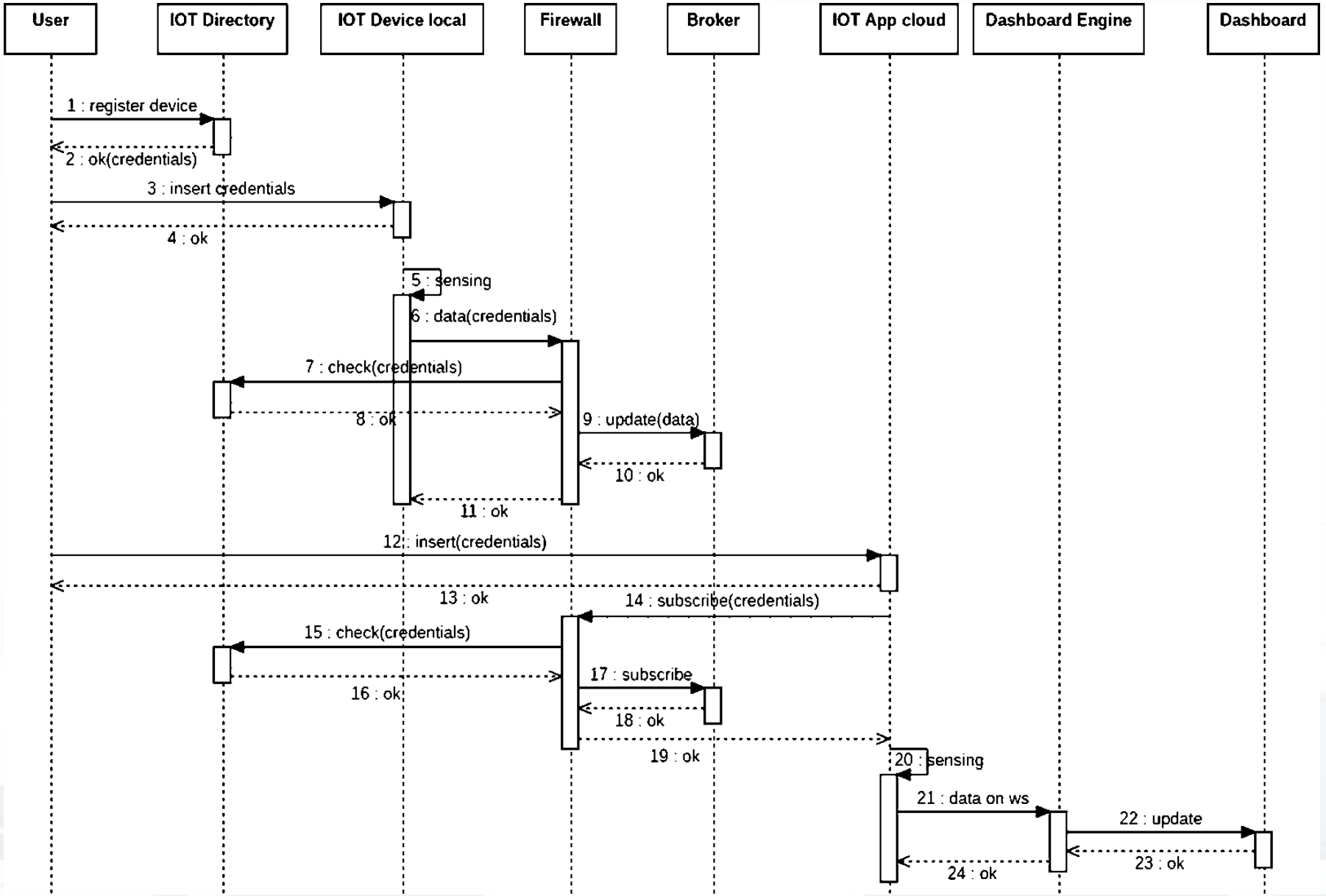


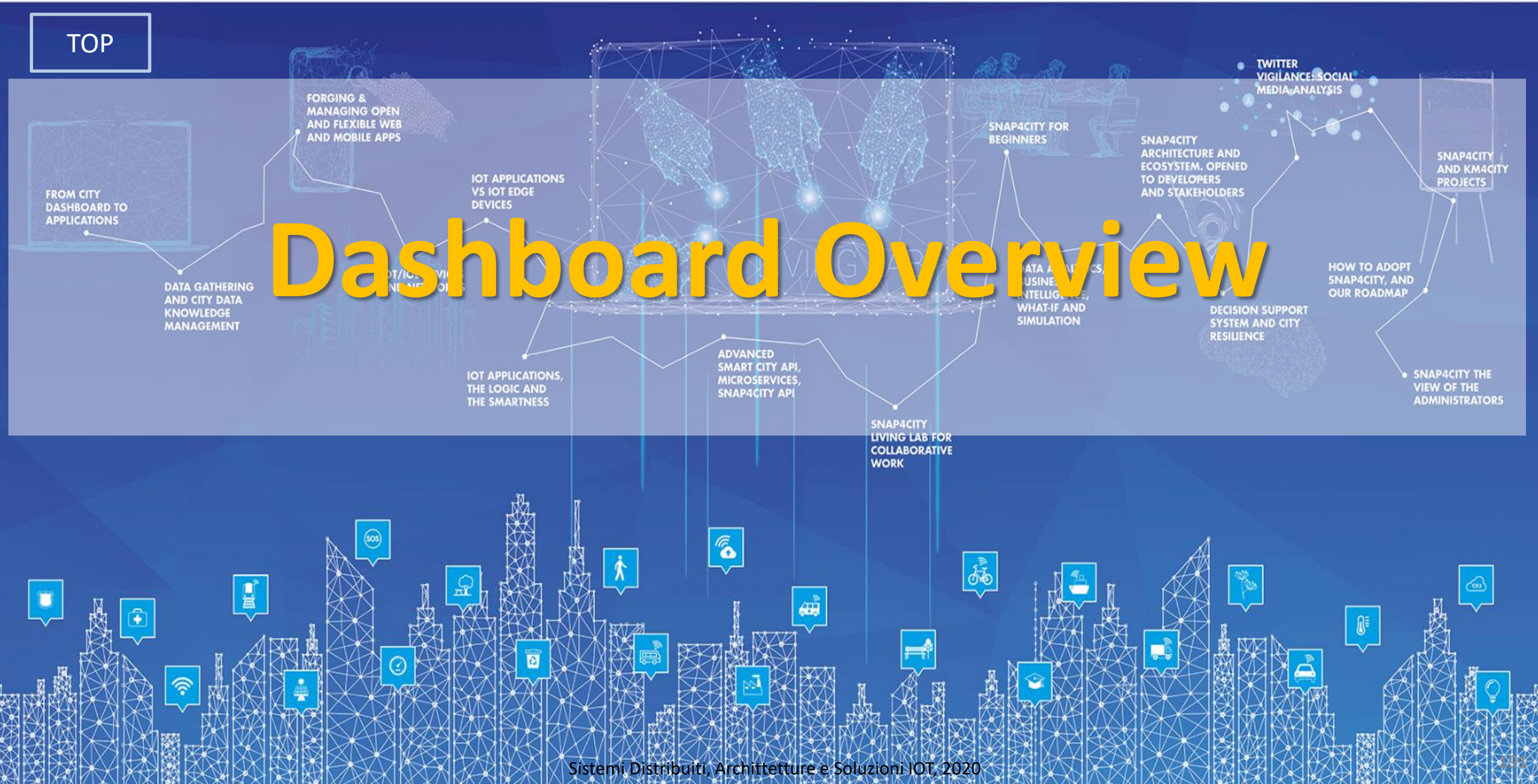


Authentication & Authorization



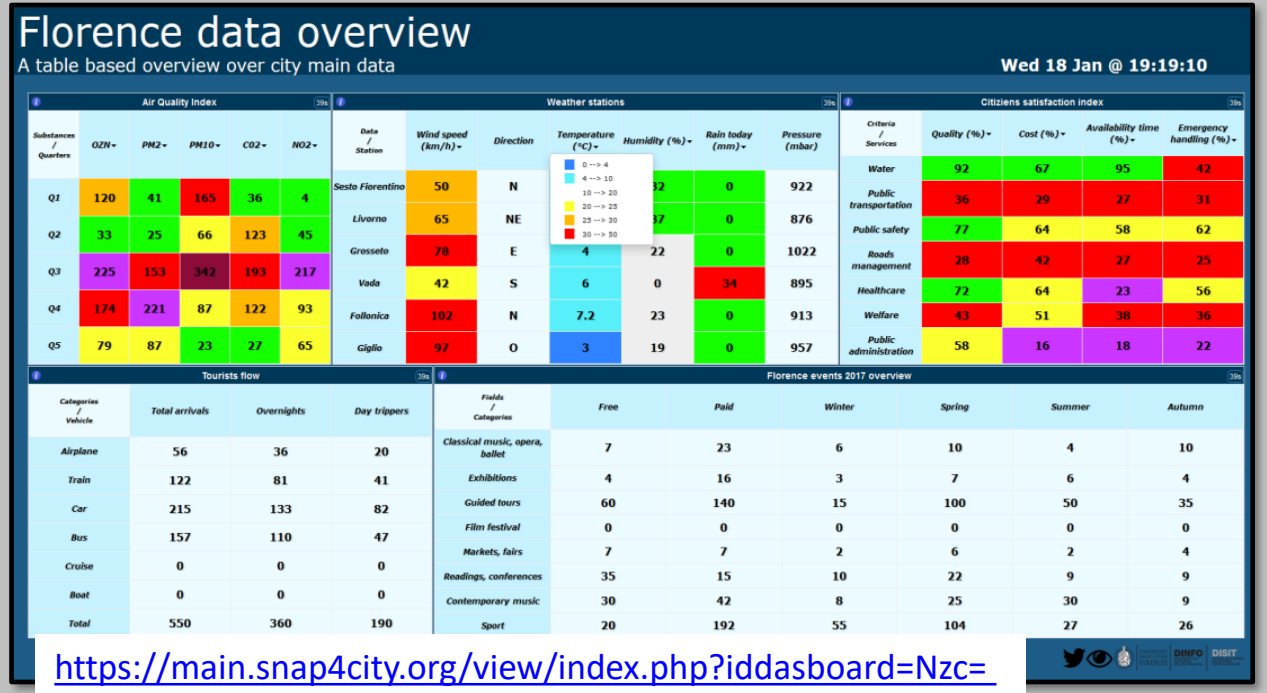



User
IOT Directory
IOT Device local
Firewall
Broker
IOT App cloud
Dashboard Engine
Dashboard
1 : register device
2 : ok(credentials)
3 : insert credentials
4 : ok
5 : sensing
6 : data(credentials)
7 : check(credentials)
8 : ok
9 : update(data)
10 : ok
11 : ok
12: insert(credentials)
13 : ok
14 : subscribe(credentials)
15 : check(credentials)
16 : ok
17 : subscribe
18 : ok
19 : ok
20 : sensing
21 : data on ws
22 : update
23 : ok
24 : ok

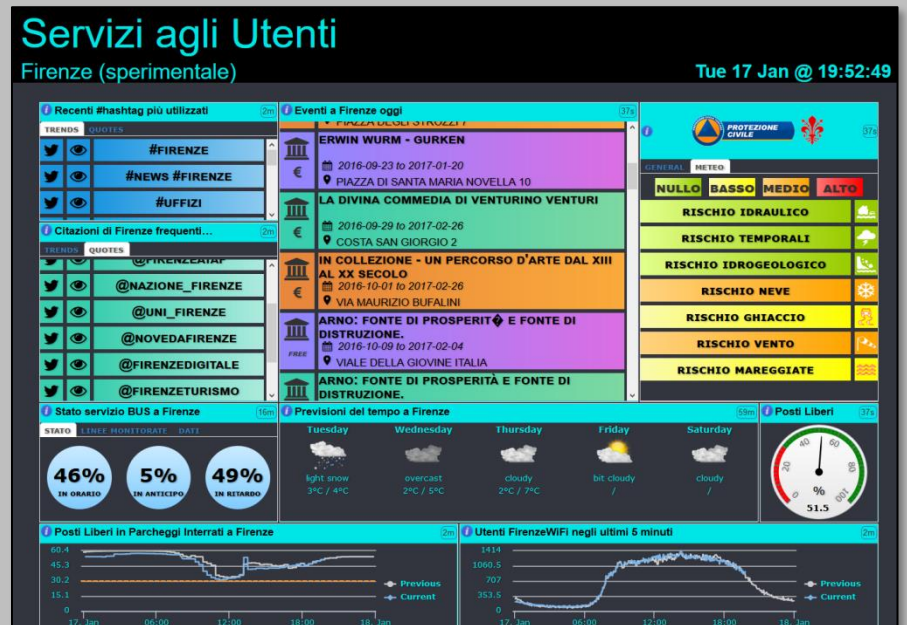


Dashboard Overview


Datacenter Energy Consumption
DataCenter gas and smoke (mobile)
DISIT
Sat 22 Jun 09:40:02
Smoke1
6
Smoke1 (day)
Smoke2
3
Smoke2 (day)
Smoke3
4
Smoke3 (day)
Gas1
36
Current
Previous
Temperatures - Room of machine 166
DISIT
22.4
deg
Temperature 1 (last 12 hours)
Temperature 1 (H24)
20.4
deg
Temperature 2 (last 12 hours)
Temperature 2 (H24)
Humidity %1
31.5
Humidity Percentage 1 (daily)
Humidity %2
40.5
Humidity Percentage 2 (daily)
WebMonitoring major
Status of Web servers
Sat 22 Jun 09:43:50
DISIT_ORG
KM4CITY
SERVICEMAP
SERVICEMAPOSM
TWITTERVIGILANCE
LINKEDOPENGRAPH
NODERED_1
NODERED_2
NODERED_3
NODERED_4
NODERED_5
NODERED_6
NODERED_7
NODERED_8
TOKEN FOUND



https://main.snap4city.org/view/index.php?iddasboard=Nzc=



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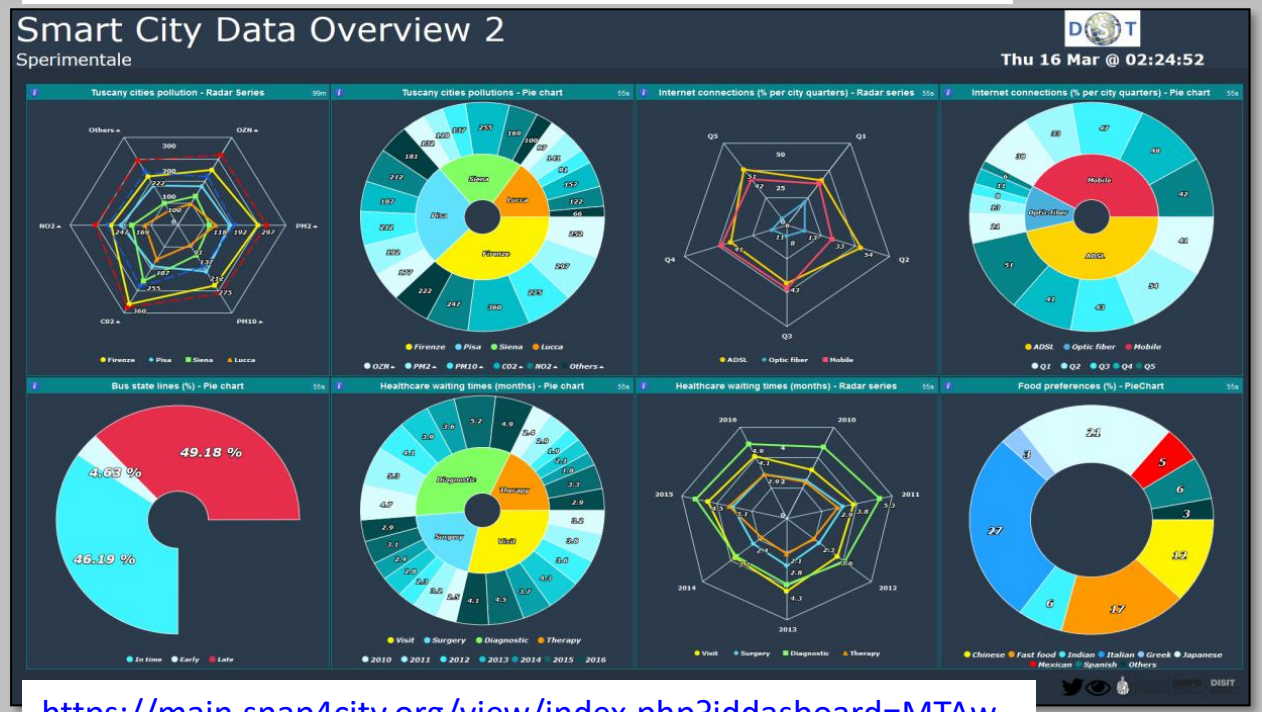
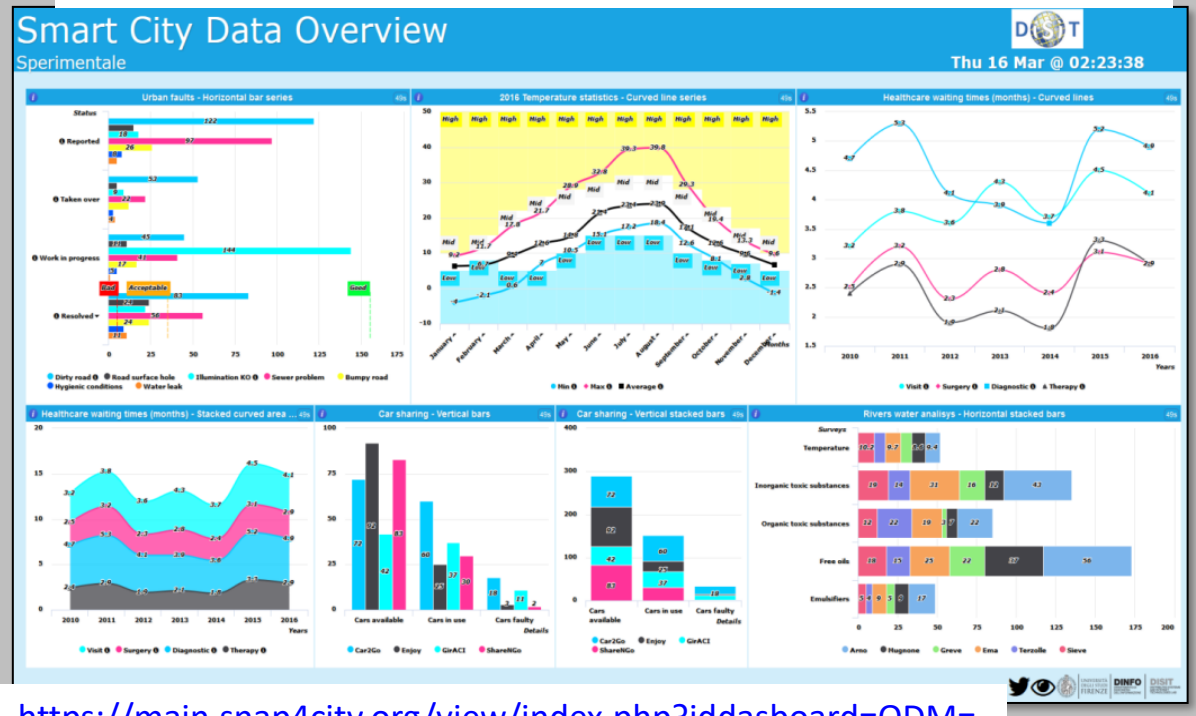


https://main.snap4city.org/view/index.php?iddasboard=MTAw



https://main.snap4city.org/view/index.php?iddasboard=ODM=

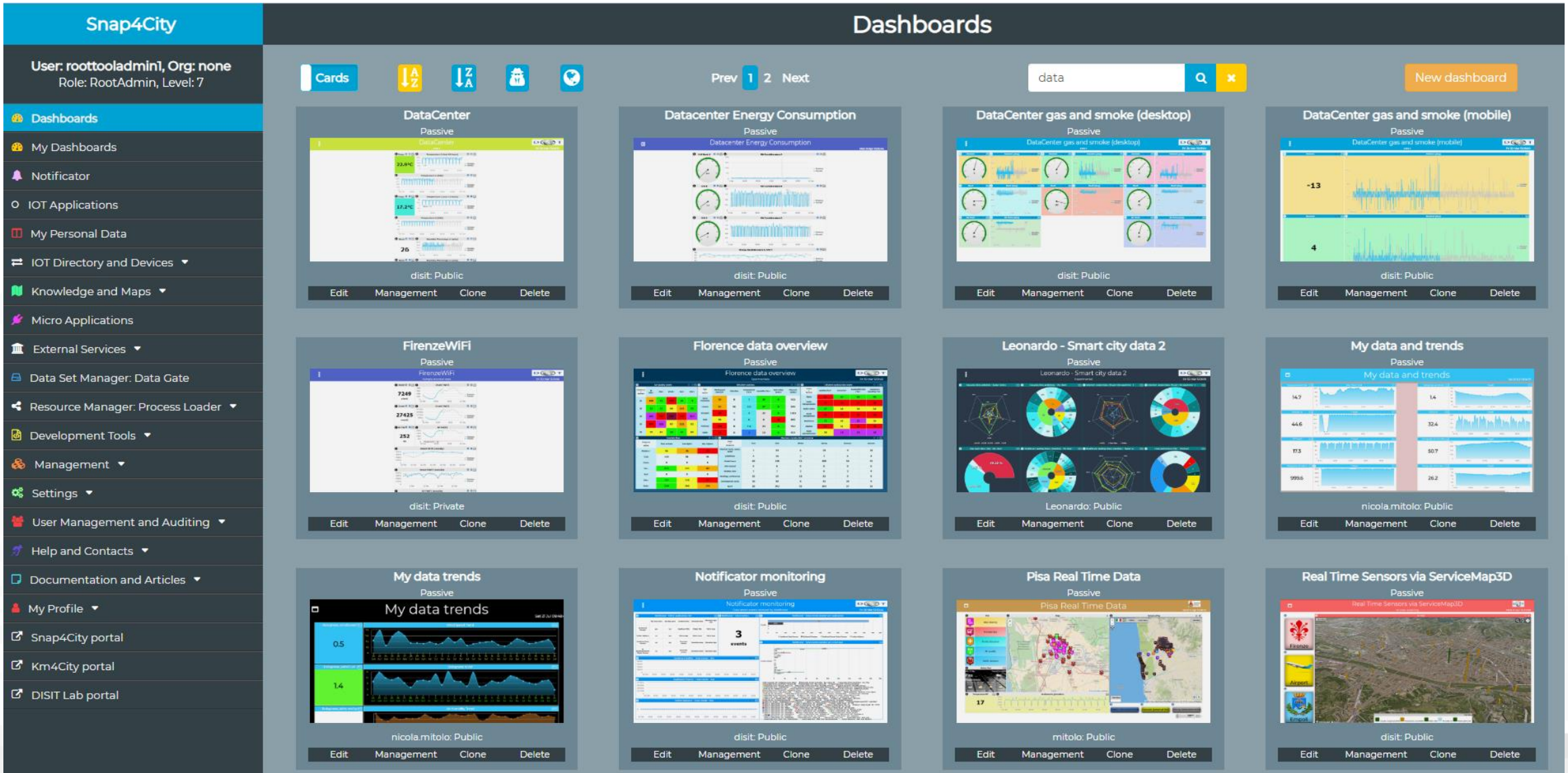
Level 2 users: Create their own Dashboards

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

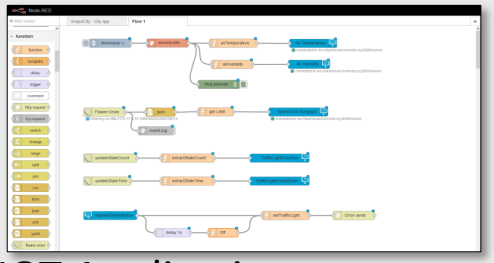
IOT and City data World

City Dashboard

Dashboard List and Editor



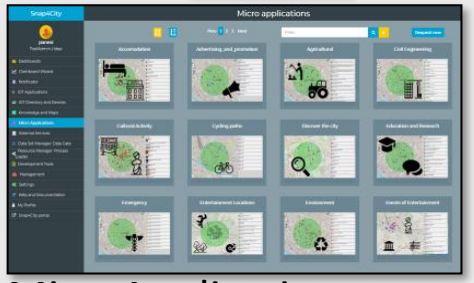
Dashboard Development



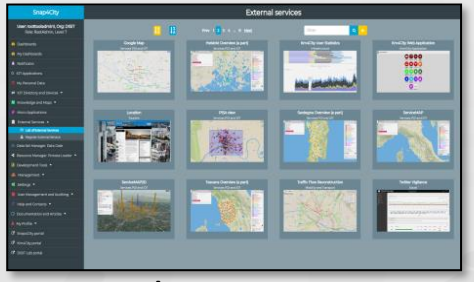
IOT Applications

Knowledge and Storage
Data from the Field and City

Widget Collection

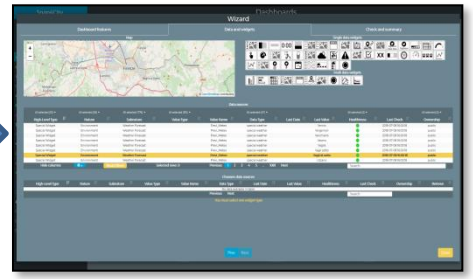


MicroApplications

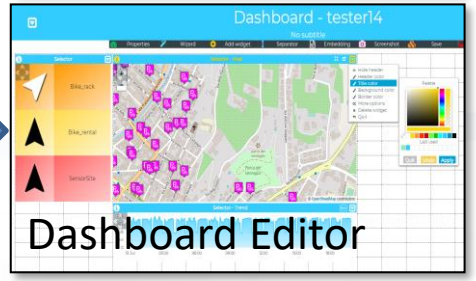


External Services

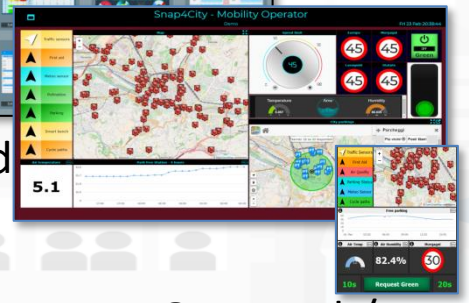
Dashboard Wizard



Create, save, load, delegate, grant access



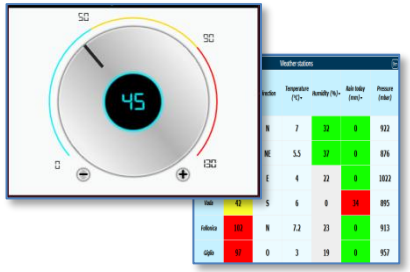
Dashboard Editor

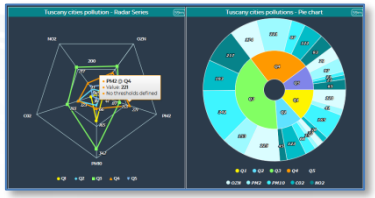


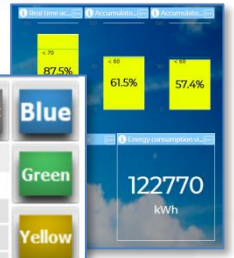
Dashboard Collection

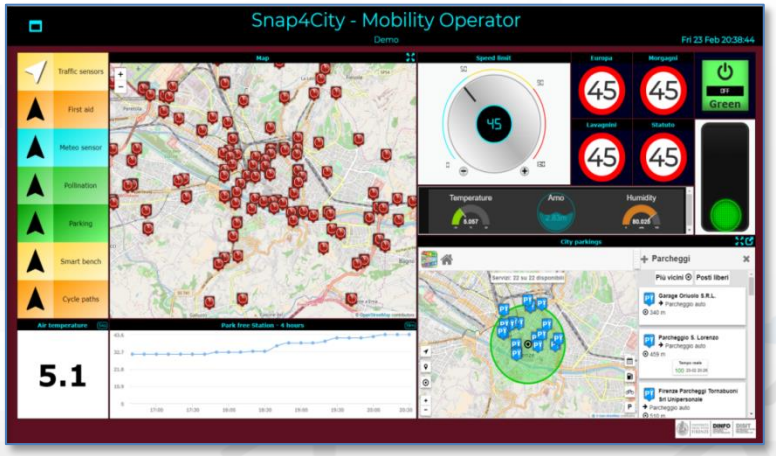
My Own Dash/App

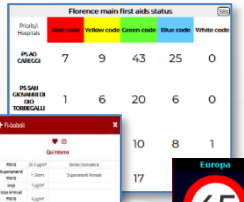
Dashboard List and Editor

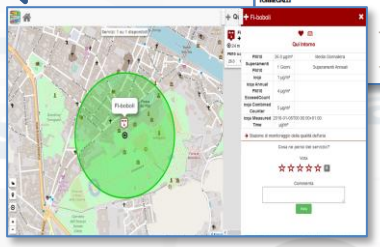


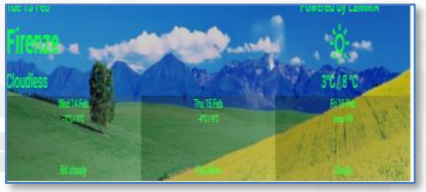


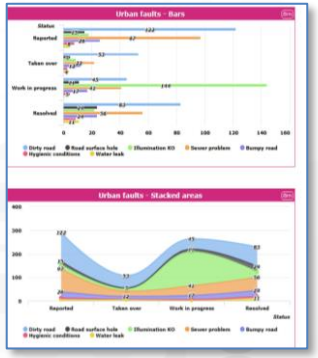




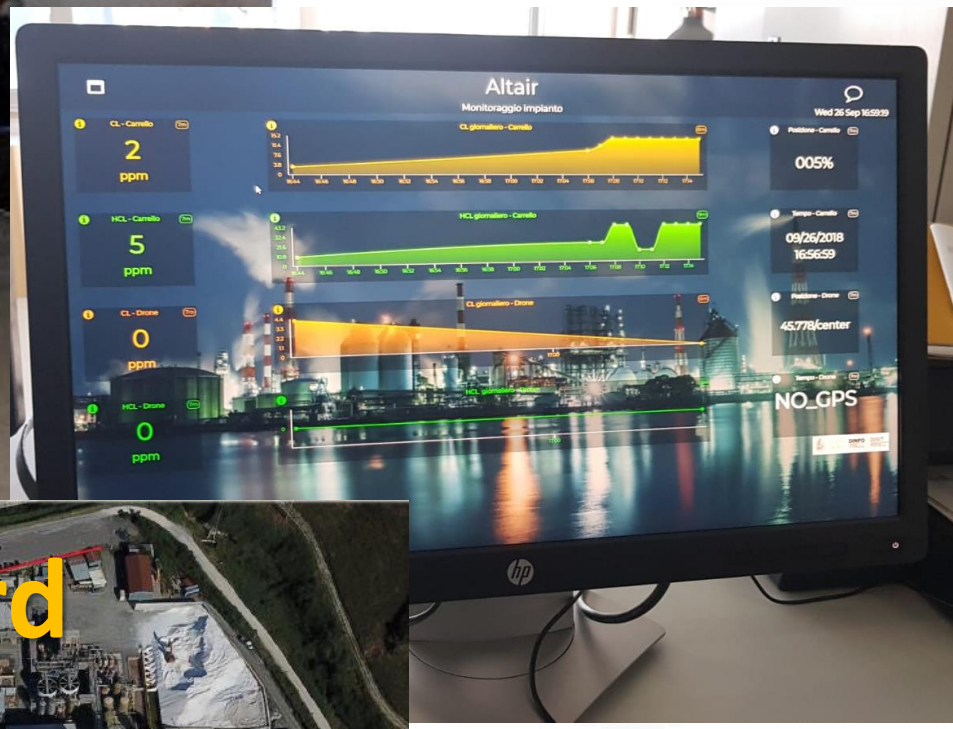









Altair
Monitoraggio Impianto
Wed 26 Sep 16:59:09
CL - Camello
2
ppm
CL giornaliero - Camello
005%
HCL - Camello
5
ppm
HCL giornaliero - Camello
09/26/2018
16:56:59
CL - Drone
0
ppm
CL giornaliero - Drone
45.778/center
HCL - Drone
0
ppm
NO_GPS



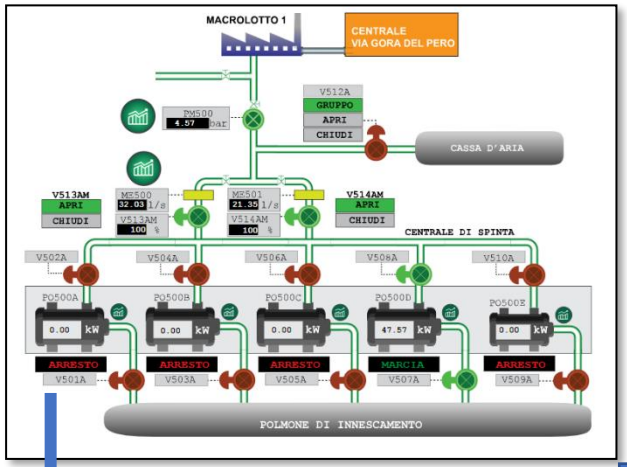
Chemical Plant Dashboard

Green Impact Capacity (GIC)

Altair Control room

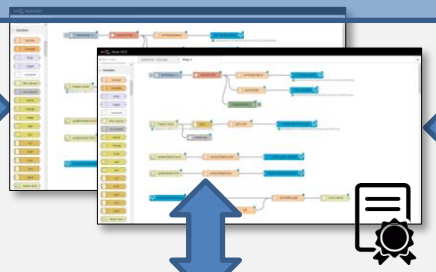
GIDA set up

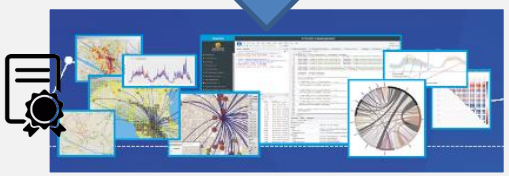
Smart City data from many sources



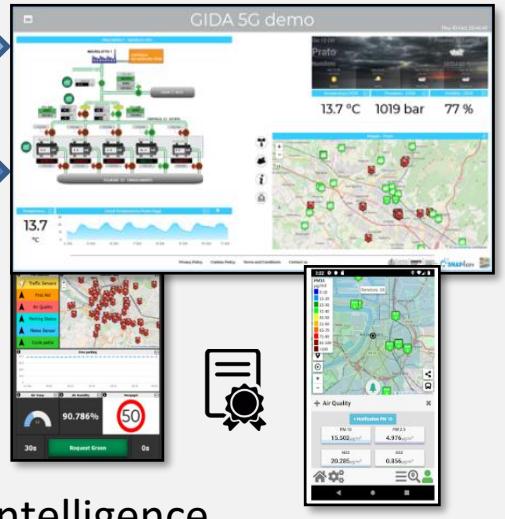
IOT Data Shadow Snap4City

IOT Applications





Dashboards and Apps



Big Data Analytics, Artificial Intelligence

ModBus to Snap4City Gateway Edge

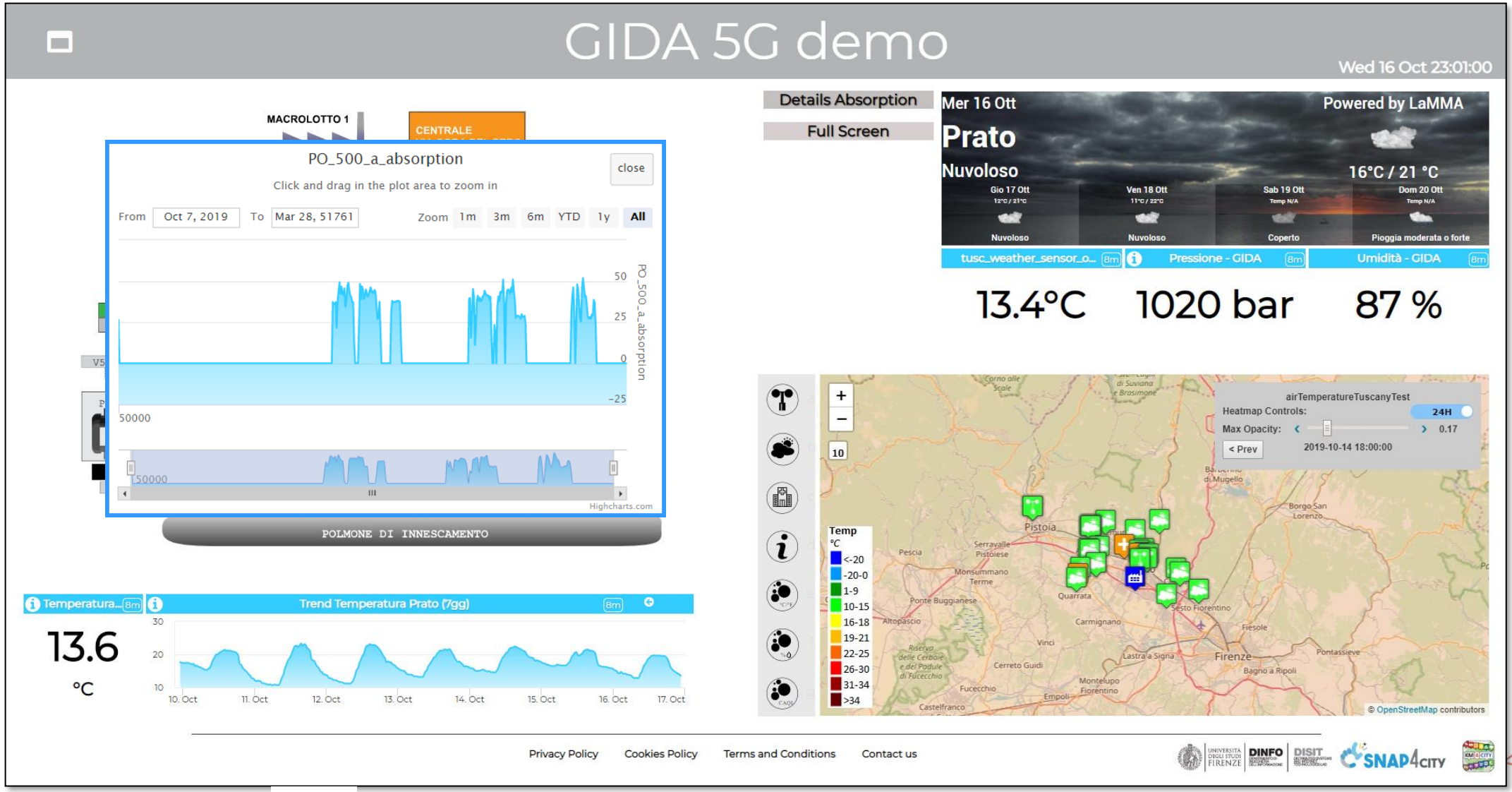
5G network devices

Modbus

5G

open fiber WIND 3 ZTE

Demo UC5 GIDA



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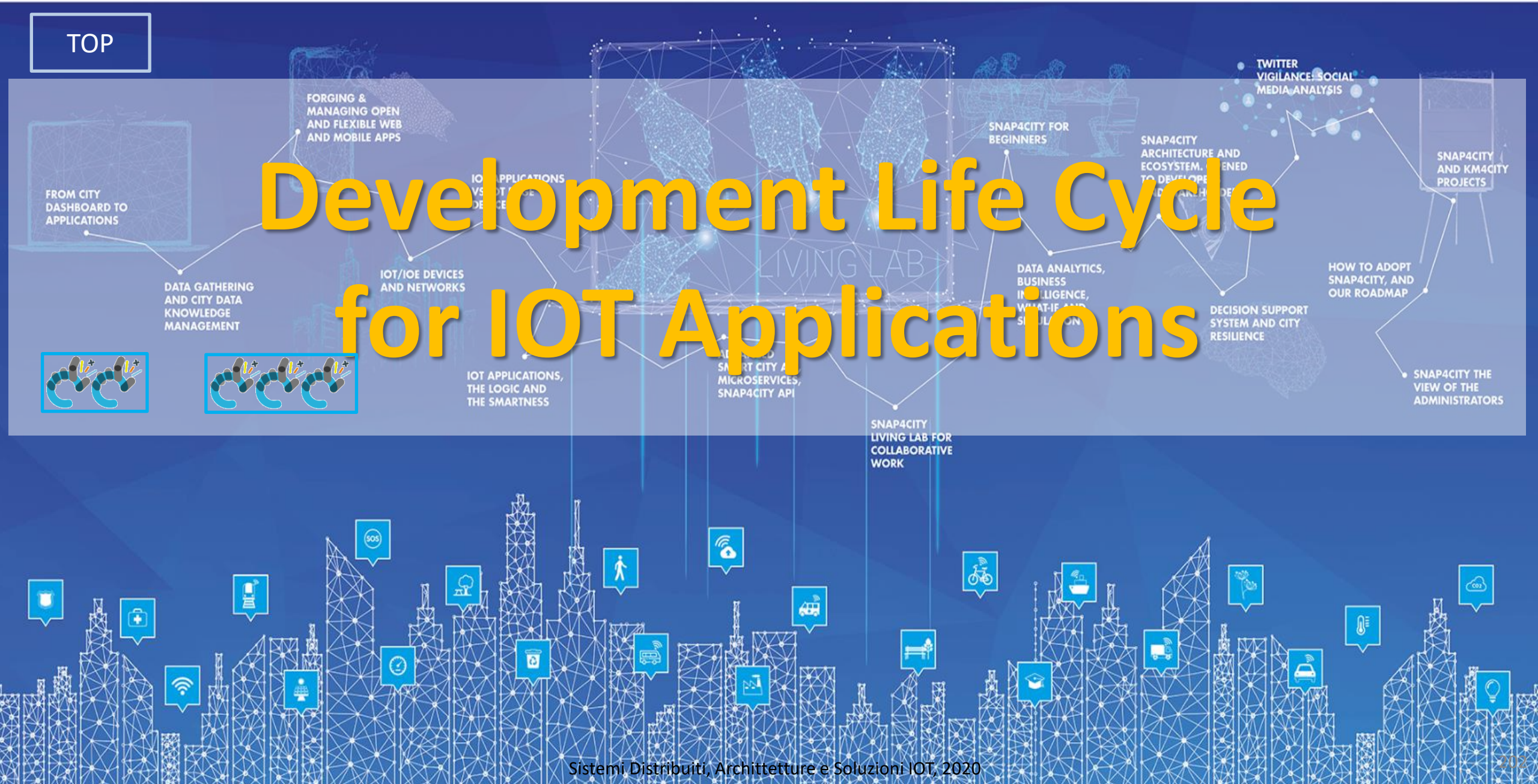
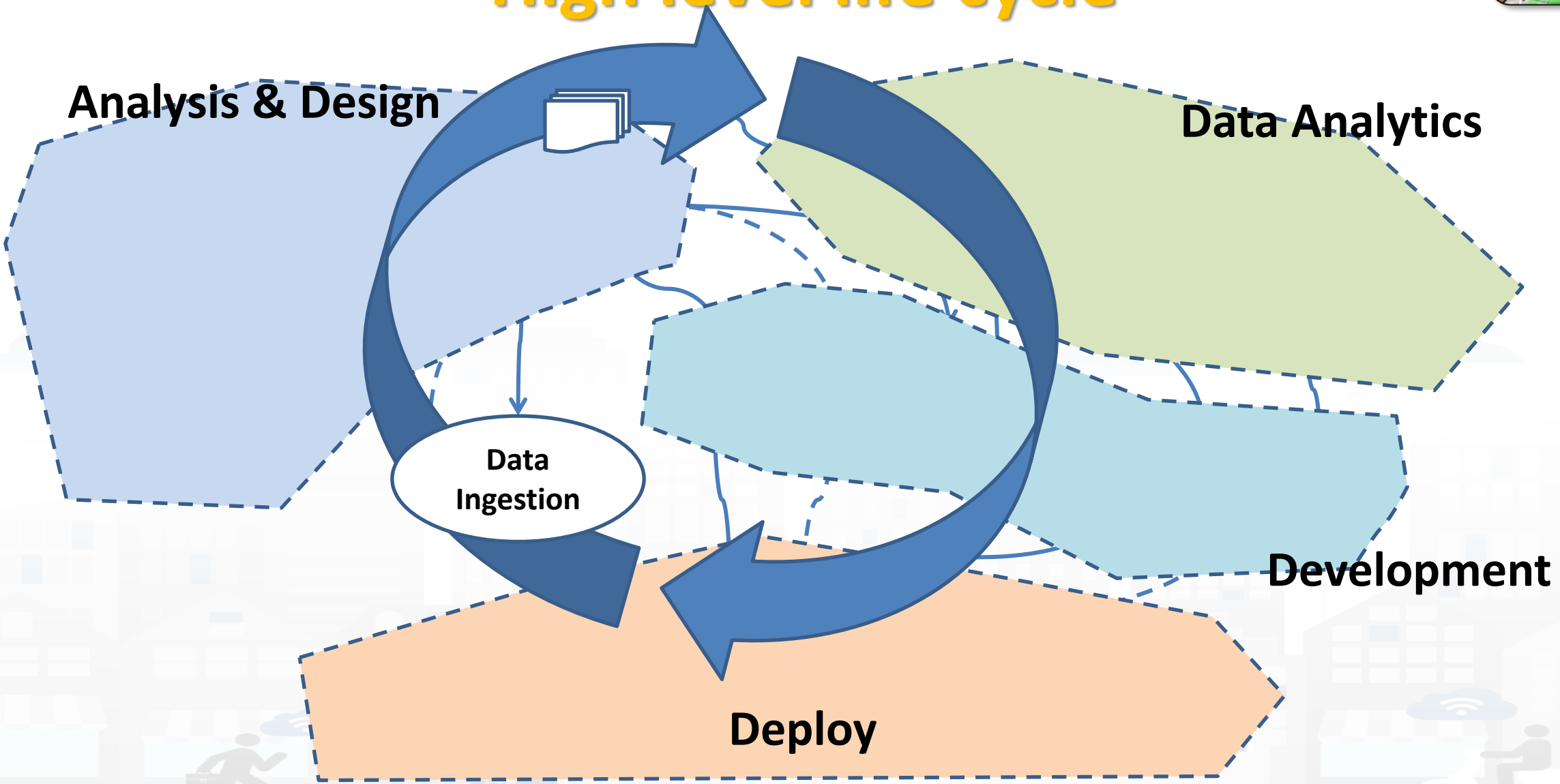
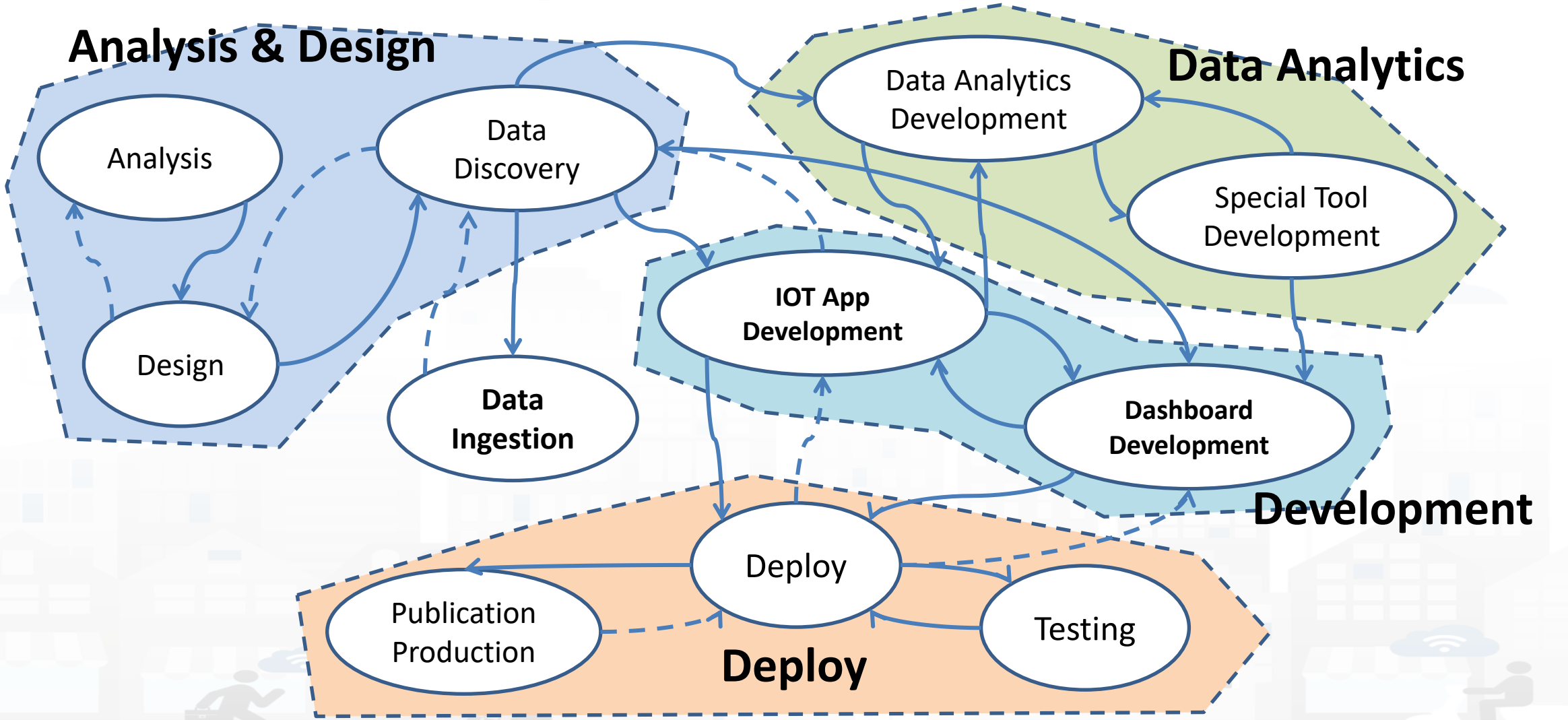


Development Life Cycle for IOT Applications

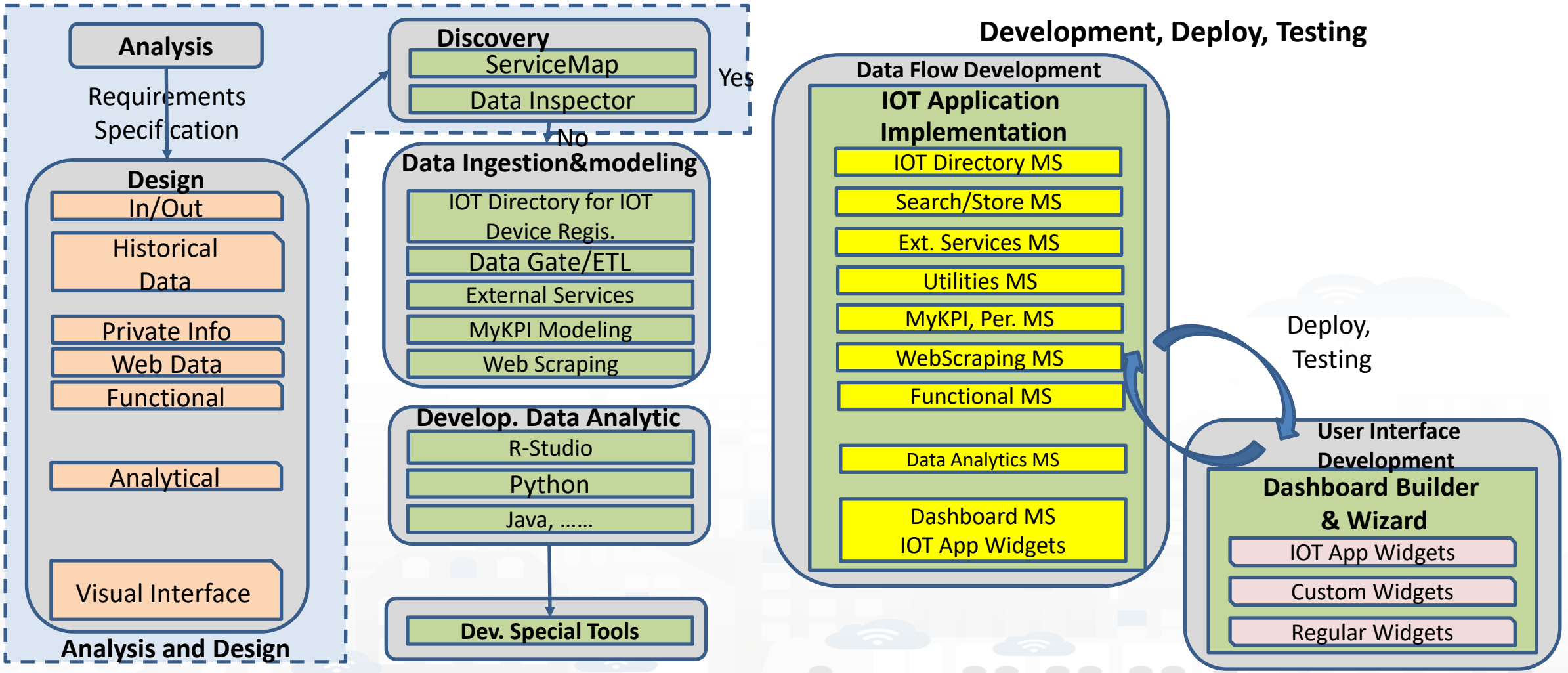
High level life cycle



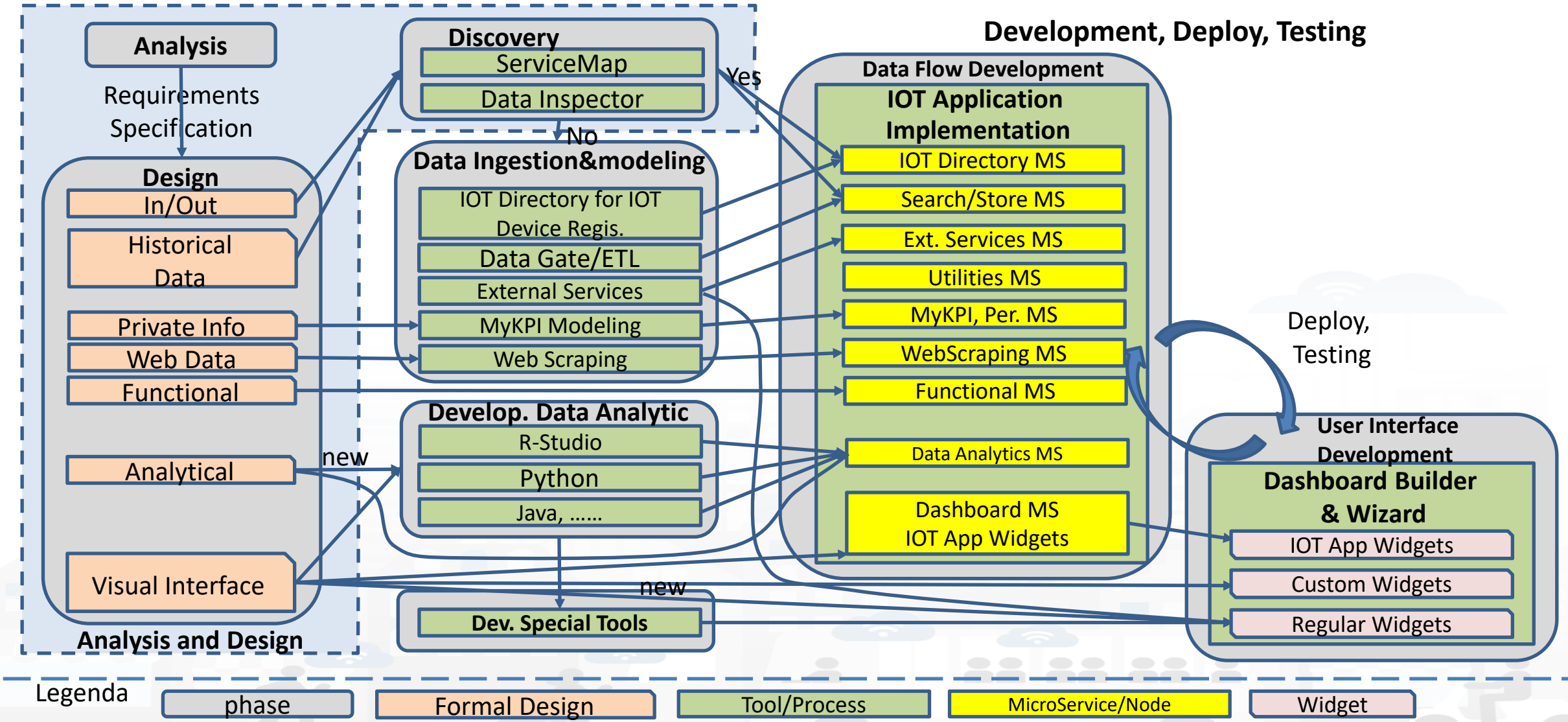
High level life cycle



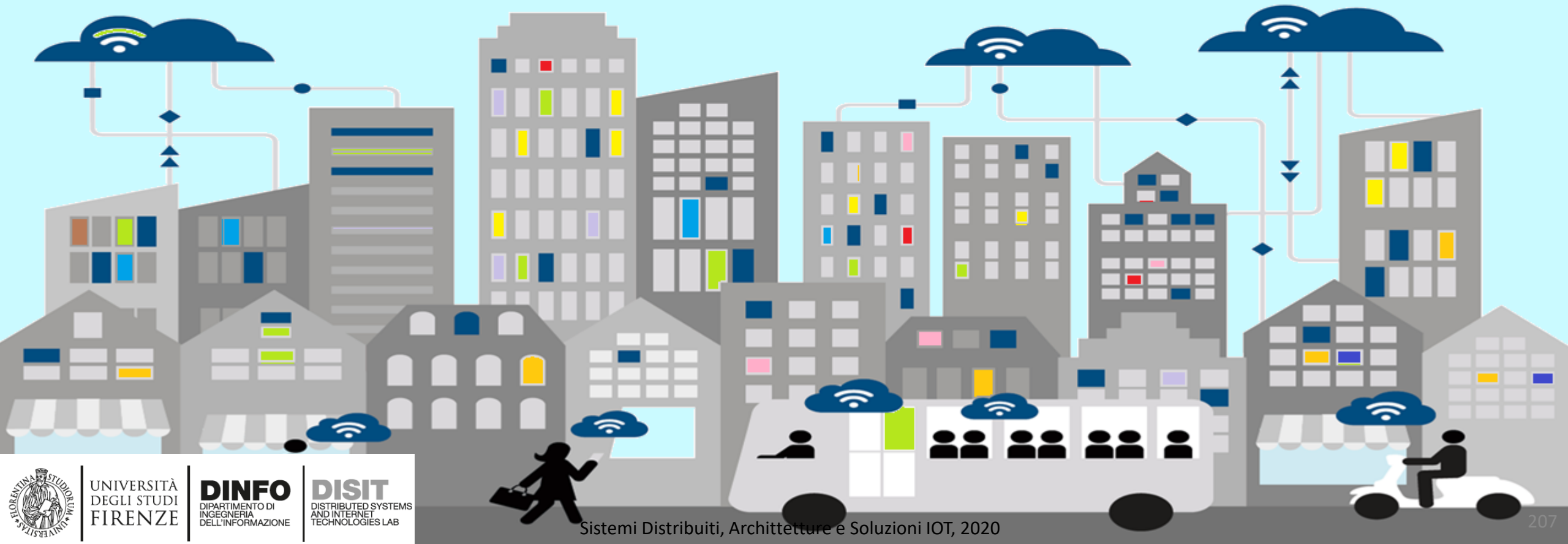
Detailed Life Cycle



Detailed Life Cycle



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 µ/m³ — 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	Sereno
Sab 20 Ott Temp N/A	Sereno

TPL

N	14	57	21
Attesa	3'	8'	5'
Ritardo	2'	0'	2'

COLONNINE RICARICA 9m

180 INSTALLATE

81.1 % ATTIVE

8.9 % IN USO

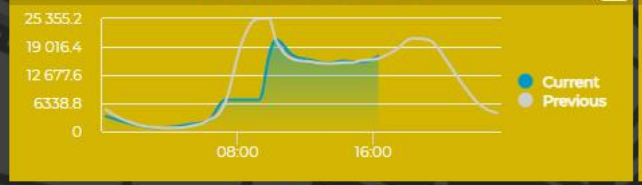
REPLICATE — DISIT

FLORENCE DASHBOARD

This dashboard is the main entry point to access dashbaords 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.

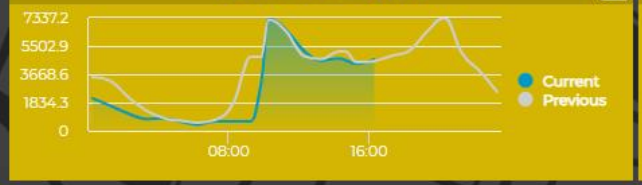
FLUSSI INGRESSO CITTA 9m



TOTALE 9m

141608 VEICOLI

FLUSSI INGRESSO ZTL 9m



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

STATO TRIAGE CAREGGI 9m

Red code	Yellow code	Green code	Blue code	White code
3	12	83	37	9

MAPPA

Energy | Environment | Mobility | Social | Resilience

PM10	Riciclo rifiuto	Rifiuto per abitante	PIL residenti	Tasso di disoccupazione	Piste Ciclabili
26 superamenti/anno	56%	0,629 t/pers/anno	23.606 euro/pers	6,8%	19.7% km ciclabili/km totali

http://www.darionardella.it/il-sindaco-dario-nardella-in-missione-a-madrid-e-barcellona/

UNIVERSITÀ DEGLI STUDI FIRENZE

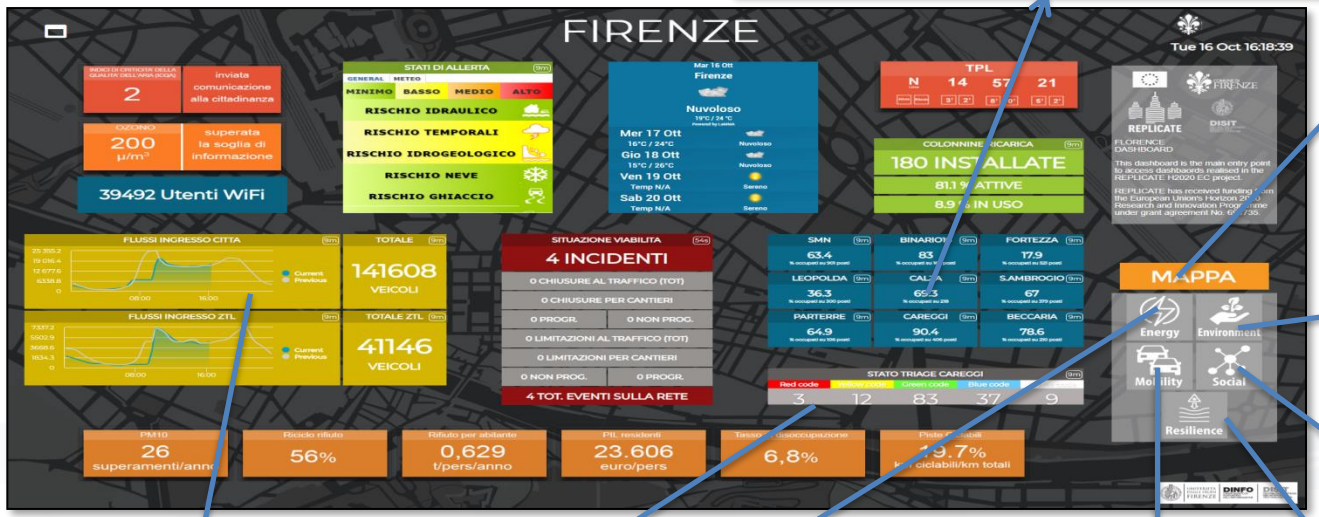
DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

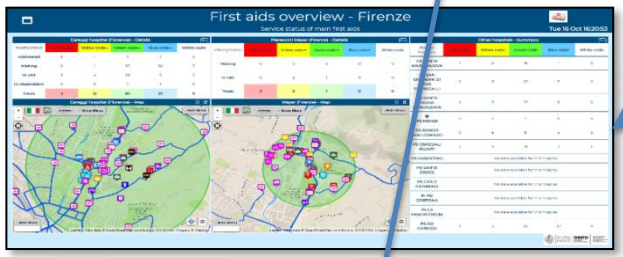
DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

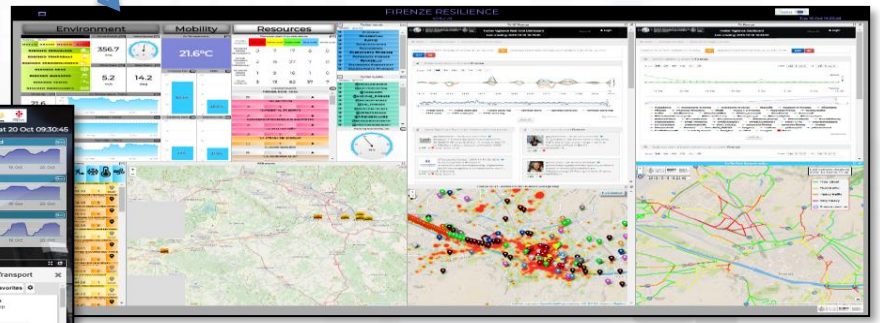
http://www.disit.org

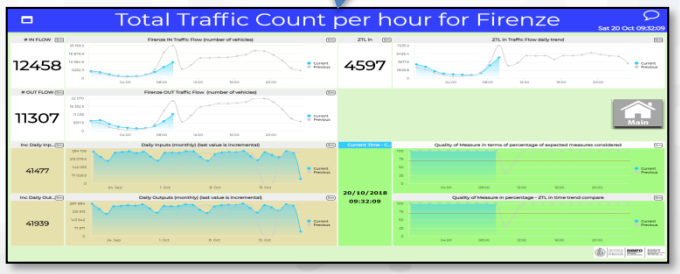
REPLICATE

KM4CITY









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

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

ANALYSIS
Energy | Environment | Mobility | Social | Resilience

FLUSSI INGRESSO CITTA 9m
26 393.2 / 19 794.9 / 13 196.6 / 6598.3 / 0
12:00
Current / Previous

TOTALE 9m
284094
VEICOLI

FLUSSI INGRESSO ZTL 9m
5522 / 4141.5 / 2761 / 1380.5 / 0
12:00
Current / Previous

TOTALE ZTL 9m
57499
VEICOLI

Nati Italiani 119m	Nati stranieri 119m	Deceduti 119m	Matrimoni 119m	Unioni Civili 119m
163 ultimo mese consolidato	49 ultimo mese	395 ultimo mese	19 ultimi 7 giorni	0 ultimi 7 giorni

Segnalazioni ricevute in attesa 119m	In Lavorazione 119m	Risolte 119m	Chiuse senza risoluzion... 119m
1116 ultimo mese	524	305	285

Manutenzioni Stradali 59m	Verde Pubbli... 59m	Decoro Urbano 59m	Relitti 59m
54 oggi	4	6	3

Attesa media alla fermata

Linea 6 9m	Linea 13 9m
3 min	13 min
Linea 17 9m	**Linea 23 9m**
4 min	5 min
Linea 31 9m	**Linea 36 9m**
19 min	2 min

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

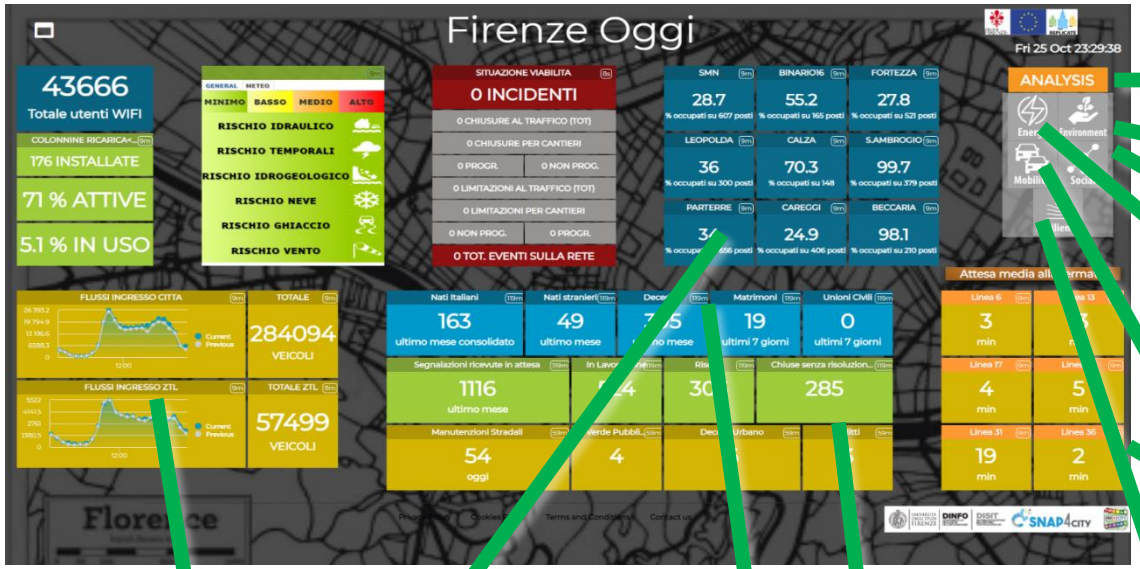
Smart City Control Room

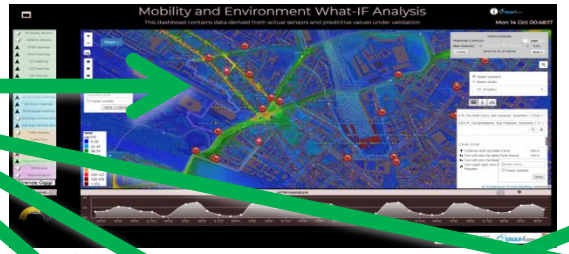
a set of dashboards and tools

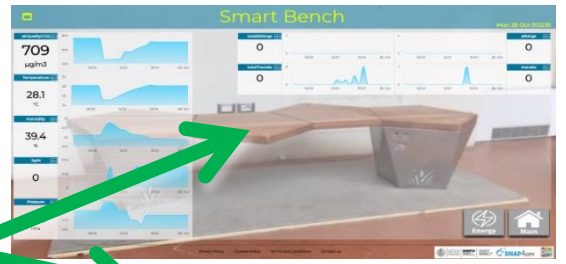
This project has received funding from the European Union's Horizon 2020 Research and Innovation Programme under Grant Agreement Nº 691735

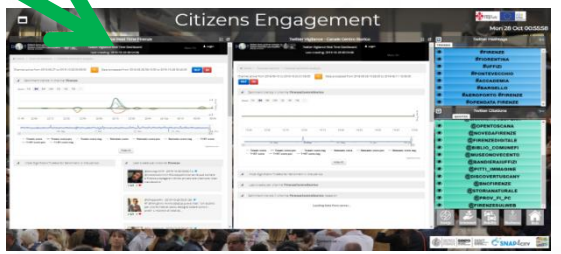
REPLICATE

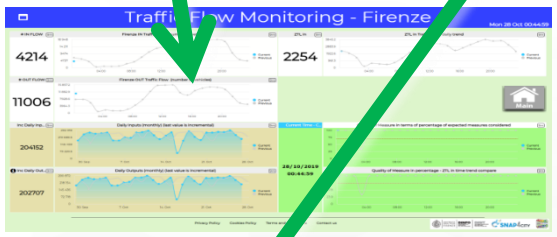
FIRENZE CITTÀ FARO

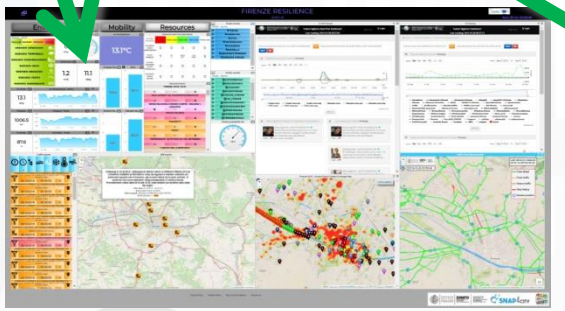


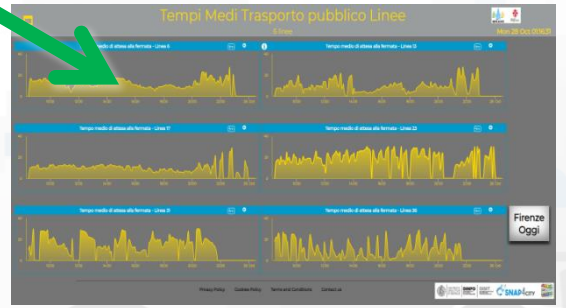












Data Protection, Personal Data vs GDPR

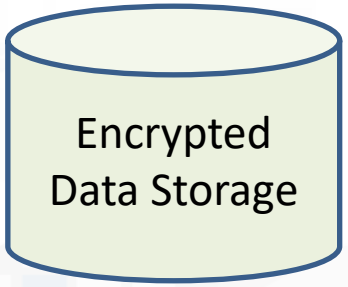
GDPR: General Data Protection Regulation

- **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**)

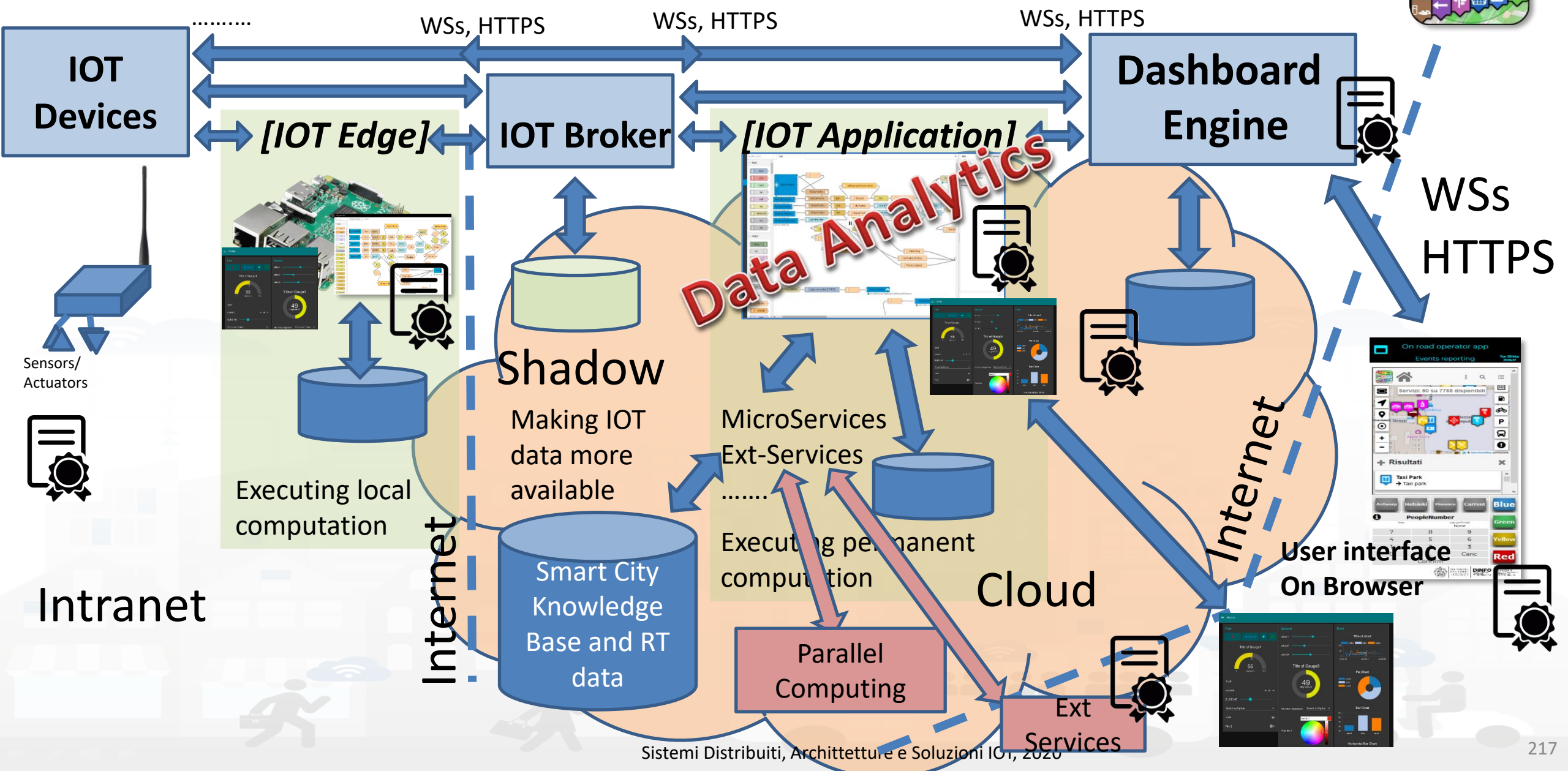
- Correctness
- Transparency
- Security
- Integrity
- Privacy
- Auditing
- ….

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




KM 4 CITY


.....
WSs, HTTPS
WSs, HTTPS
WSs, HTTPS
IOT Devices
[IOT Edge]
IOT Broker
[IOT Application]
Dashboard Engine
WSs HTTPS
Data Analytics
Sensors/ Actuators
Executing local computation
Shadow
Making IOT data more available
MicroServices
Ext-Services
.....
Executing permanent computation
Internet
Smart City Knowledge Base and RT data
Parallel Computing
Ext Services
Cloud
Internet
User interface On Browser
Intranet

.....

WSs, HTTPS

WSs, HTTPS

WSs, HTTPS

IOT Devices

[IOT Edge]

IOT Broker

[IOT Application]

Dashboard Engine

WSs HTTPS

Sensors/ Actuators

Executing local computation

Shadow

Making IOT data more available

MicroServices
Ext-Services
.....

Executing permanent computation

Internet

Internet

User Profile Manager

Living Lab Dev Tools

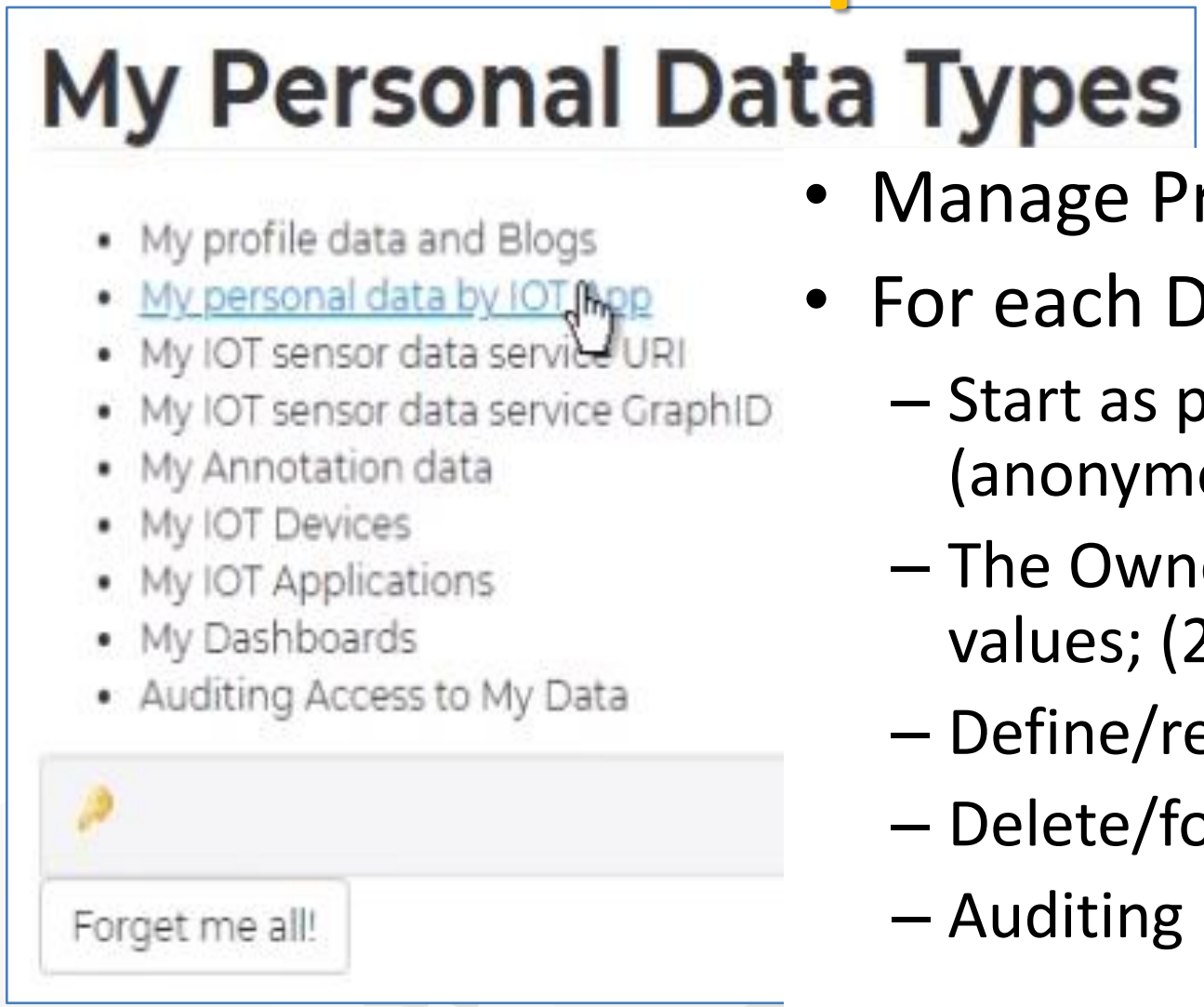
Cloud

Intranet

User interface On Browser

Authentication and Authorization

GDPR Compliant



- 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

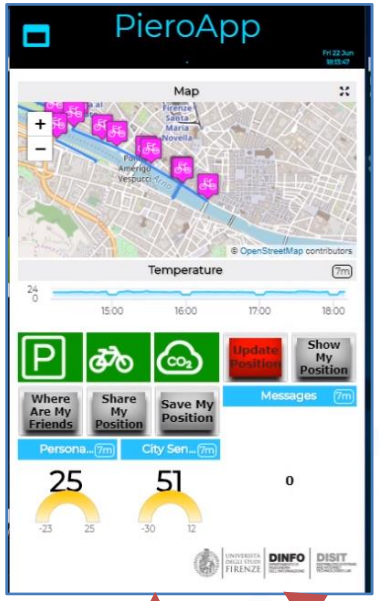
Managing MyPersonalData in secure manner

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.

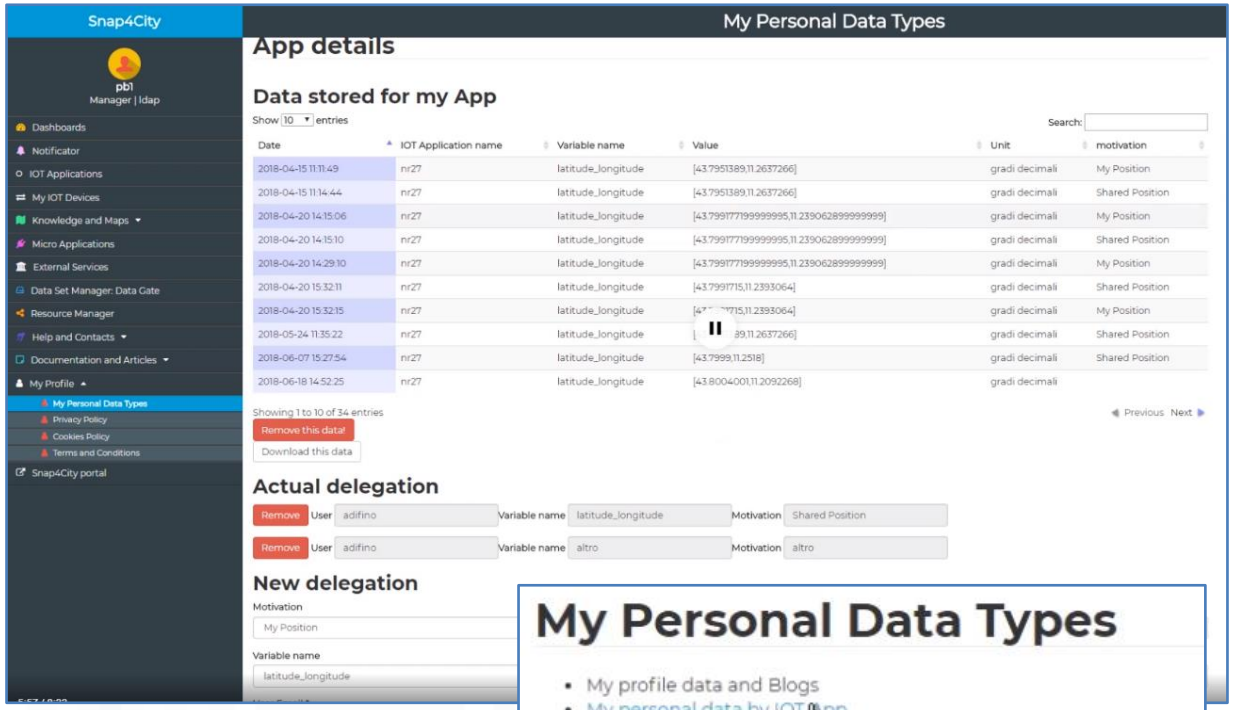
The users manage their Personal data via personal mobile Dash and IOT App, and configuration on the portal and/or Mobile App

Managing MyPersonalData in secure manner

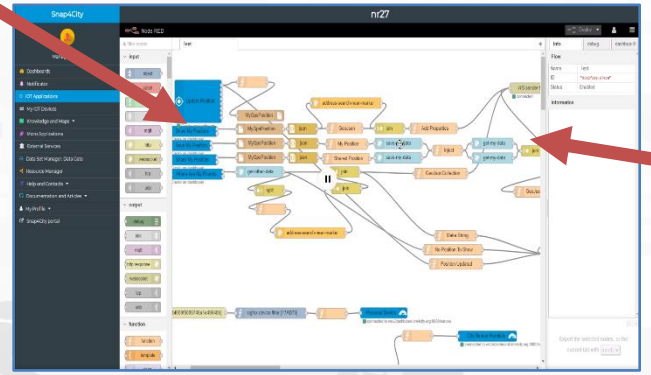


Example:

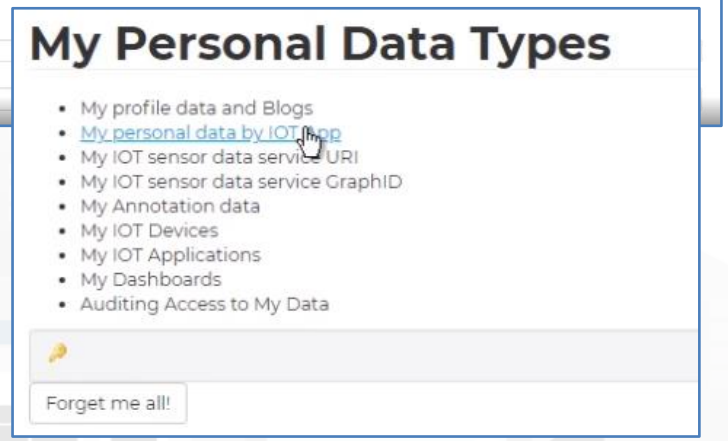
- Piero shares some data with selected friends according to GDPR: GPS position
- He managed the data via personal mobile Dashboard and IOT Application



Smart City Services and IOT/IOE



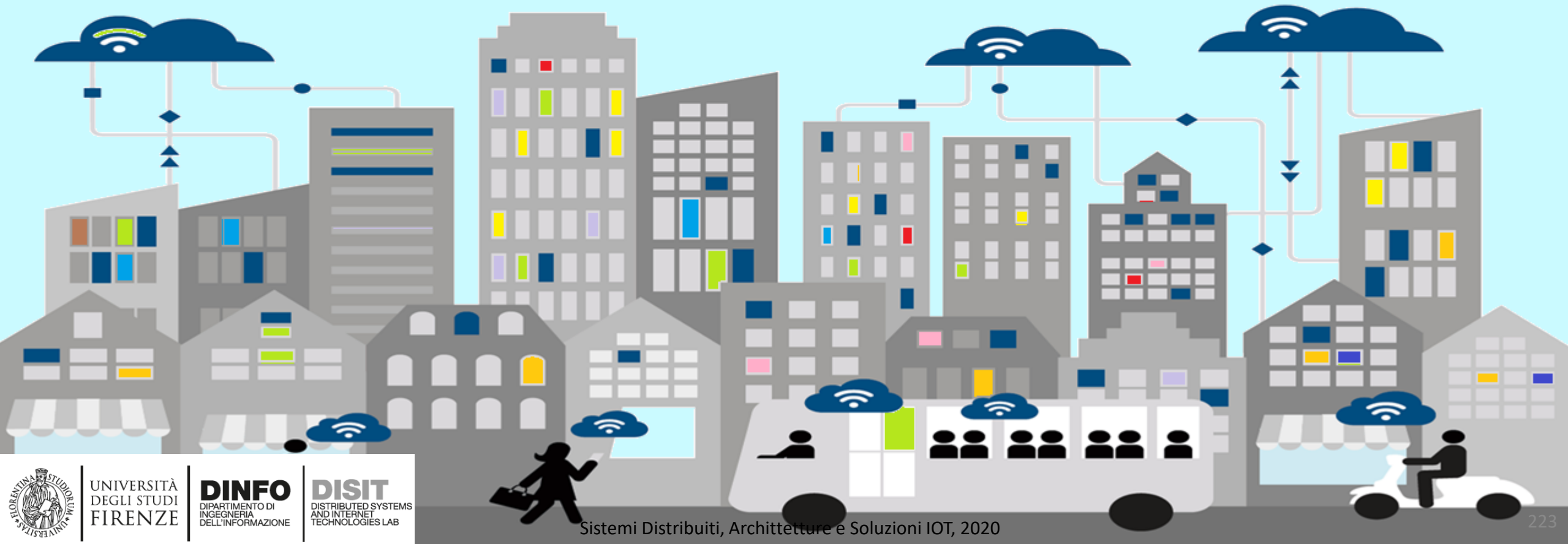
Encrypted Data Storage



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



Articles

- 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 . http://www.adv-sci-res.net/14/217/2017/

Articles

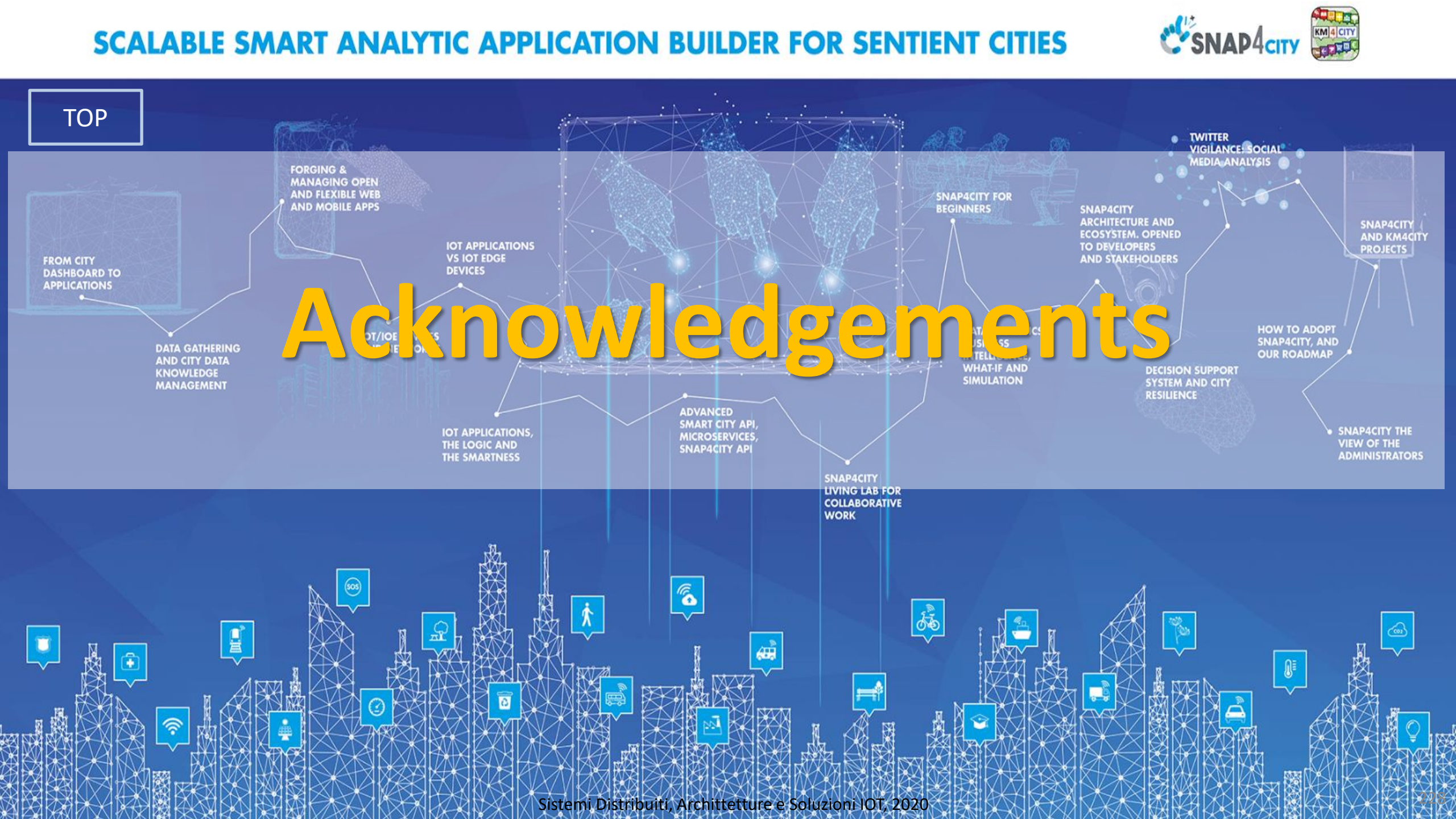
- A. Crisci, V. Grasso, P. Nesi, G. Pantaleo, I. Paoli, I. Zaza, "Predicting TV programme Audience by Using Twitter Based Metrics", Multimedia Tools and Applications, springer. 10.1007/s11042-017-4880-x, 2017 https://link.springer.com/article/10.1007/s11042-017-4880-x
- C. Badii, P. Bellini, D. Cenni, A. Difino, P. Nesi, M. Paolucci, Analysis and Assessment of a Knowledge Based Smart City Architecture Providing Service APIs, Future Generation Computer Systems, Elsevier, 2017, http://dx.doi.org/10.1016/j.future.2017.05.001
- P. Nesi, G. Pantaleo, M. Tenti, "Geographical Localization of Web-Visible Human Activities by employing Natural Language Processing, Pattern Matching and Clustering Based Solutions", Journal: Engineering Applications of Artificial Intelligence, Elsevier. 10.1016/j.engappai.2016.01.011 http://dx.doi.org/10.1016/j.engappai.2016.01.011
- P. Bellini, I. Bruno, P. Nesi, N. Rauch, "Graph Databases Methodology and Tool Supporting Index/Store Versioning", JVLC, Journal of Visual Languages and Computing, Elsevier, 2015doi:10.1016/j.jvlc.2015.10.018 http://www.sciencedirect.com/science/article/pii/S1045926X15000750
- P. Nesi, G. Pantaleo and G. Sanesi, "A Hadoop Based Platform for Natural Language Processing of Web Pages and Documents", JVLC, Journal of Visual Languages and Computing, Elsevier. 11-11-2015, http://dx.doi.org/10.1016/j.jvlc.2015.10.017
- P. Bellini, M. Benigni, R. Billero, P. Nesi and N. Rauch, "Km4City Ontology Building vs Data Harvesting and Cleaning for Smart-city Services", International Journal of Visual Language and Computing, Elsevier, 2014, http://dx.doi.org/10.1016/j.jvlc.2014.10.023,
- P. Bellini, P. Nesi, A. Venturi, "Linked Open Graph: browsing multiple SPARQL entry points to build your own LOD views", International Journal of Visual Language and Computing, Elsevier, 2014, DOI information: http://dx.doi.org/10.1016/j.jvlc.2014.10.003 ,

Articles

- P. Bellini, S. Bilotta, D. Cenni, P. Nesi, M. Paolucci, M. Soderi, "Knowledge Modeling and Management for Mobility and Transport Applications", IEEE TeC4C'18, 1st International Workshop on Technology Convergence for Smart Cities, Philadelphia, PA, USA
- P. Nesi, G. Pantaleo, M. Paolucci, I. Zaza, "Auditing and Assessement of data traffic flows in an IoT Architecture", IEEE TeC4C'18, 1st International Workshop on Technology Convergence for Smart Cities, Philadelphia, PA, USA
- C. Badii, E. G. Belay, P. Bellini, D. Cenni, M. Marazzini, M. Mesiti, P. Nesi, G. Pantaleo, M. Paolucci, S. Valtolina, M. Soderi, I. Zaza, "Snap4City: Smart City IOT/IOE Platform", Int. Conf. IEEE Smart City Innovation, Cina 2018, IEEE Press.
- P. Bellini, S. Bilotta, P. Nesi, M. Paolucci, M. Soderi, "Real-Time Traffic Estimation of Unmonitored Roads", IEEE-DataCom'2018, Athen, 2018
- M. Azzari, C. Garau, P. Nesi, M. Paolucci, P. Zamperlin, "Smart City Governance Strategies to better move towards a Smart Urbanism", The 18th International Conference on Computational Science and Its Applications (ICCSA 2018), July 2 - 5, 2018 in Melbourne, Australia in collaboration with the Monash University, Australia.
- P. Nesi, M. Paolucci, "Supporting Living Lab with Life Cycle and Tools for Smart City Environments", The 24th International DMS Conference on Visualization and Visual Languages, DMSVIVA 2018, Hotel Pullman, Redwood City, San Francisco Bay, California, USA, June 29 - 30, 2018
- P. Bellini, D. Cenni, M. Marazzini, N. Mitolo, P. Nesi, M. Paolucci, "Smart City Control Room Dashboards Exploiting Big Data Infrastructure", The 24th International DMS Conference on Visualization and Visual Languages, DMSVIVA 2018, Hotel Pullman, Redwood City, San Francisco Bay, California, USA, June 29 - 30, 2018
- P. Bellini, S. Bilotta, P. Nesi, M. Paolucci, M. Soderi, "Traffic Flow Reconstruction from Scattered Data", IEEE SMARTCOMP, IEEE international conference on smart computing, 18-20 June, Taormina, Sicily, Italy. 2018
- P. Nesi, P. Bellini, M. Paolucci, I. Zaza, "Smart City architecture for data ingestion and analytics: processes and solutions", IEEE BigDataService 2018, Bamberg, Germany, March 26 - 29, 2018.
- D. Cenni, P. Nesi, G. Pantaleo, I. Zaza, "Twitter Vigilance: a Multi-User platform for Cross-Domain Twitter Data Analytics, NLP and Sentiment Analysis", IEEE international Conference on Smart City and Innovation, 2017, San Francisco.

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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- **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.*

DISIT lab roadmap vs model and tools' usage

2013 Km4City Ontology 1.1

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

2014

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

ckan

- Twitter Vigilance
- Social Media Analytics, Sentiment Analysis

Km4City 1.4

2015

- Sardinia Region Smart City Strategies and plan

FIWARE

Km4City 1.5

(2016-21) H2020

REPLICATE

(2015-18) resolute H2020

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

E015 digital ecosystem Powered by EXPO MILANO 2015

2016

SII-MOBILITY SCN (2016-19) MIUR

- Infomobility
- Mobile App
- Routing
- Multimodality

Km4City 1.6.2

- Smart Energy
- Sustainable Mobility
- Control Room Dashboard

Km4City 1.6.4

Sii-Mobility

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

(2016-19) MIUR GHOST SIR

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

Km4City 1.6.6 IOT/IOE

Node-RED

SNAP4CITY

SELECT for Cities H2020 (2017-19)

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

life weee (2017-20)

- Smart Waste

2017

TRAFAIR CEF (2018-21)

GREEN IMPACT POR FESR 2014-2020

- Industry 4.0
- Critical Plant
- Monitoring

2018

Sii-Mobility

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

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

- Mobility Demand / Offer Analytics and Strategy

(2018-21) 5G

5G tech
Energy
Industry 4.0
Synoptics

- Traffic and Mobility Impact on Pollution
- NOX predictions

2019

EUROPEAN OPEN SCIENCE CLOUD

2020

SELECT for Cities 1° place award to SNAP4CITY

Reverberi Enetec Gruppo MPES

bee smart city

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

SIRIUS

LAID Smart Bed

…2022

TOP

Be smart in a SNAP!

CONTACT

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

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

www.snap4city.org

Email: snap4city@disit.org

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

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