

Architetture Parallele (Class. Flynn)

- **SISD**: Single instruction stream, single data stream
 - E.g.: un computer monoprocesore, moncore
- **SIMD**: Single instruction stream, multiple data stream
 - E.g.: le stesse istruzioni su tutti i nodi computazionali allo stesso tempo, ma lavorando su dati diversi, per esempio GPU su immagini
- **MISD**: Multiple instruction stream, single data stream
 - E.g.: ogni nodo può eseguire processi indipendenti ma sullo stesso stream di dati, un risultato singolo (poco realistico)
- **MIMD**: Multiple instruction stream, multiple data stream
 - E.g.: ogni nodo può eseguire processi indipendenti su dati diversi
 - Tipicamente la soluzione più utilizzata per i sistemi general purpose, cloud, etc.

Classificazione

- **SISD**: Single instruction stream, single data stream
 - Von Neumann
- **SIMD**: Single instruction stream, multiple data stream
 - Vector processor, Array processor
- **MISD**: Multiple instruction stream, single data stream
 - poco realistico



MIMD: Multiple instruction stream, multiple data stream

- **MultiProcessore**
 - Parallelismo interno al calcolatore
 - Memoria condivisa, variabili condivise
 - Sincronizzazioni
 - E.g., Uniform Memory Access: XEON
- **MultiComputer**
 - Cloud, architetture parallele
 - Comunicazione tramite canali dedicati,
 - Message passing, Send e Receive
 - ❑ Hypercubes
- **Sistemi Distribuiti,**
 - Cluster, Massive parallel processor
 - GRID, cloud, ..



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Paolo Nesi, paolo.nesi@unifi.it

Data Lake vs Data Warehouse

<https://www.snap4City.org>

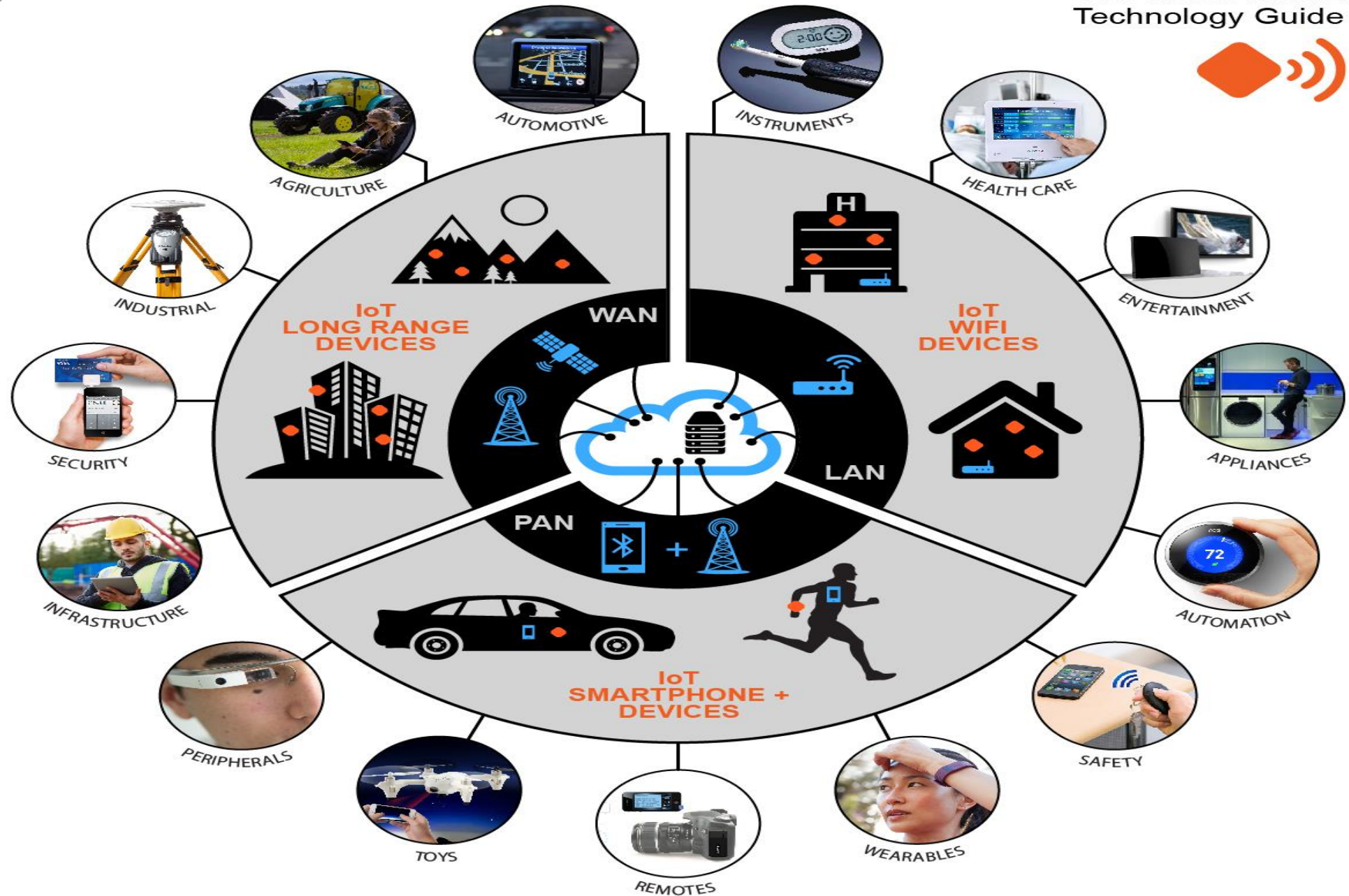
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Parte: 3
(2024)

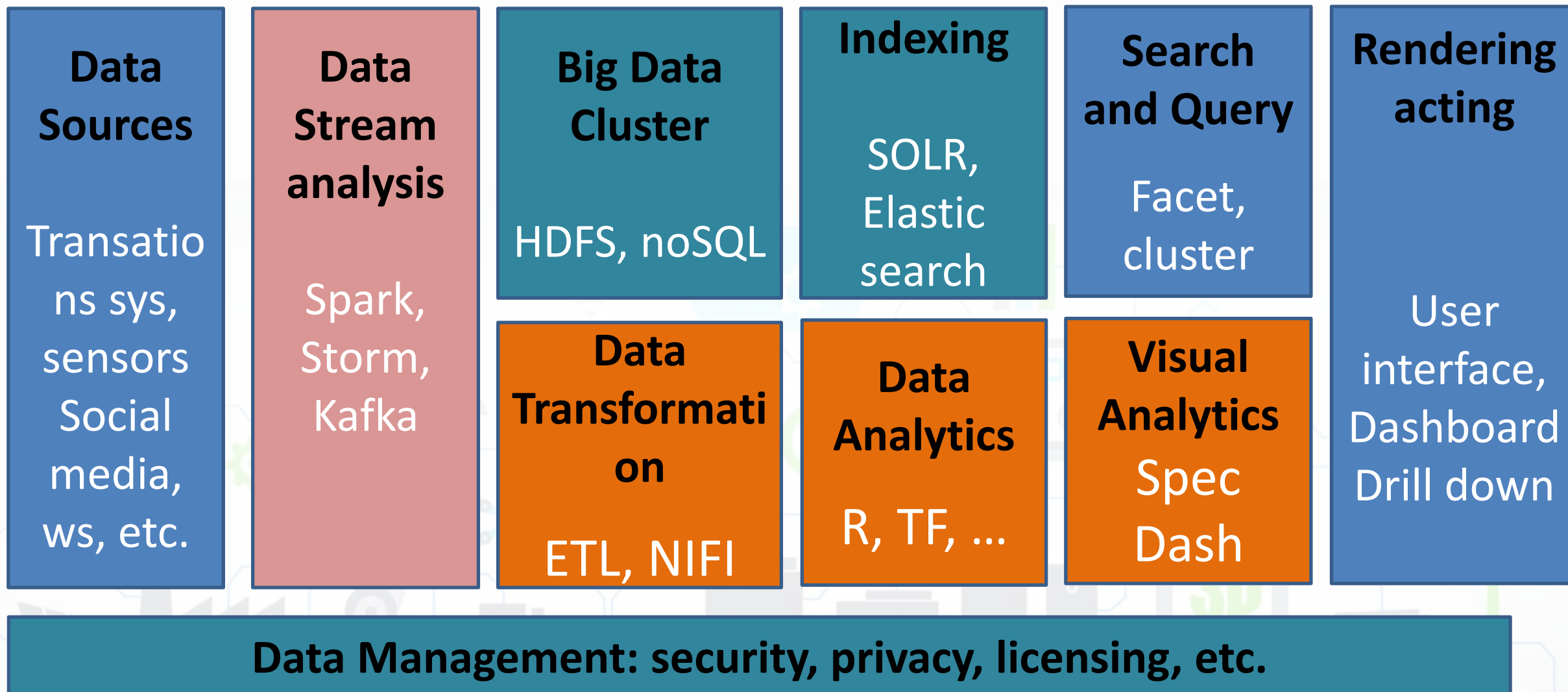




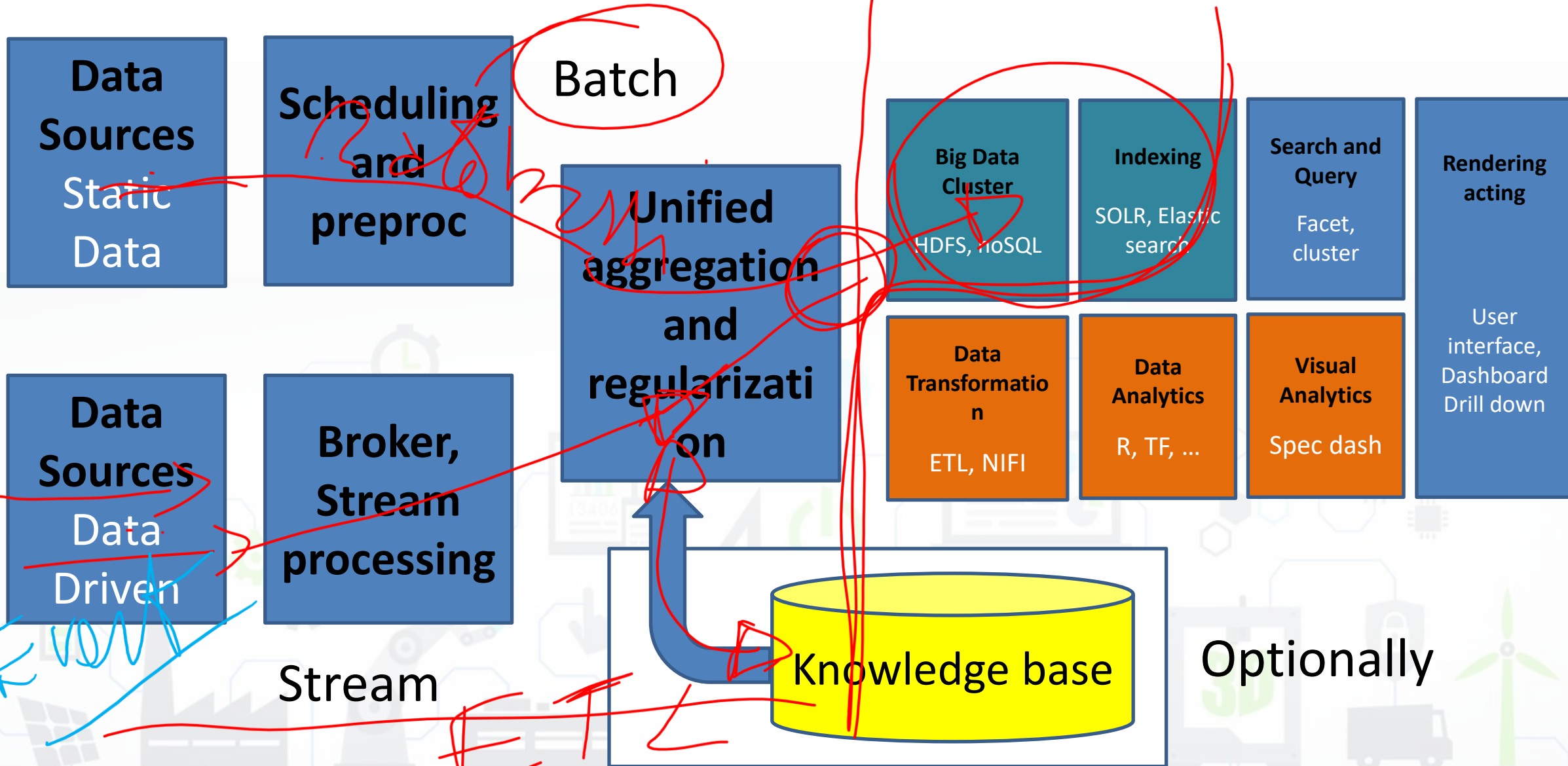
IoT HARDWARE Technology Guide



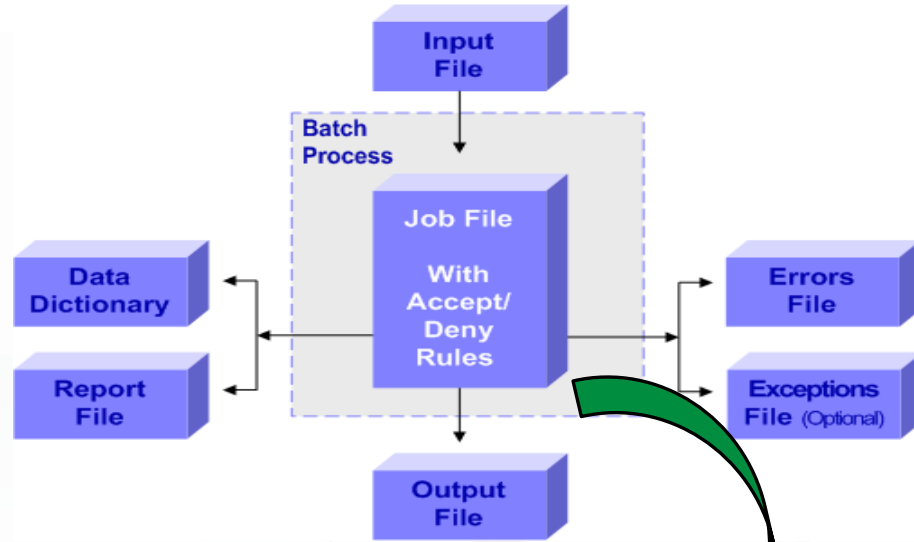
Architettura di base Big Data, IOT, Industry 4.0



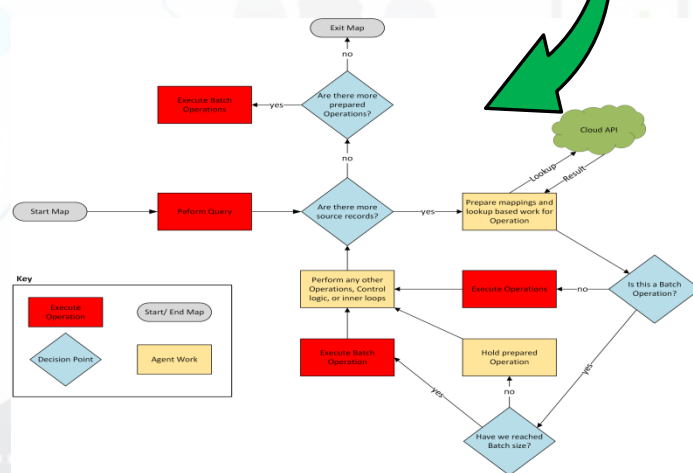
Lambda Architecture



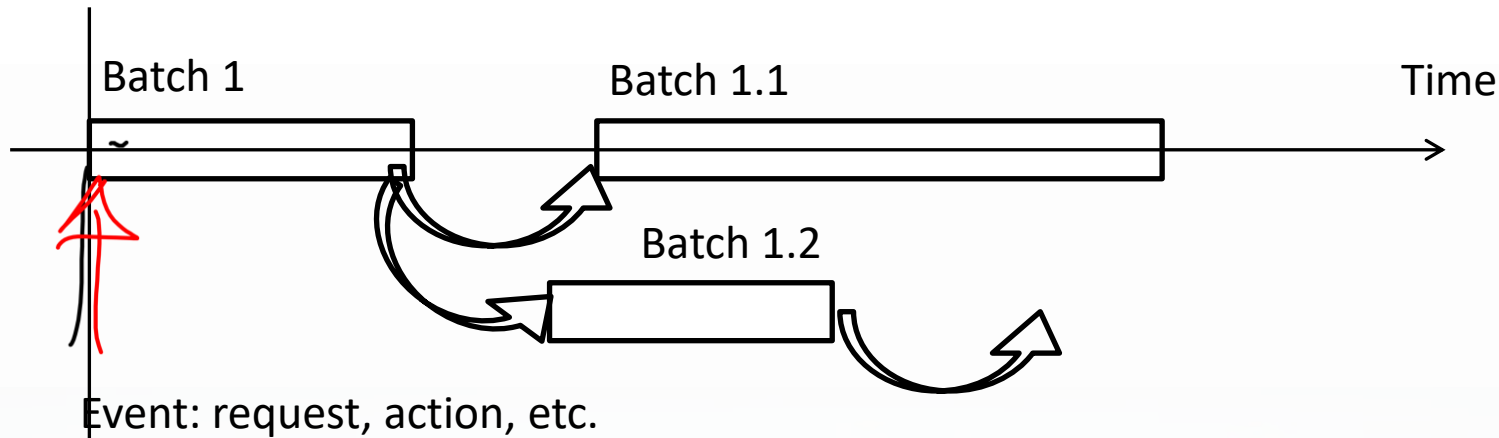
Batch Processing



- Script language
- Smilar to workflow or flowchart
- Sequence of Commands
- Intermediate status on disk or memory
- Executed command driven:
 - On demand, sporadically
 - Periodically

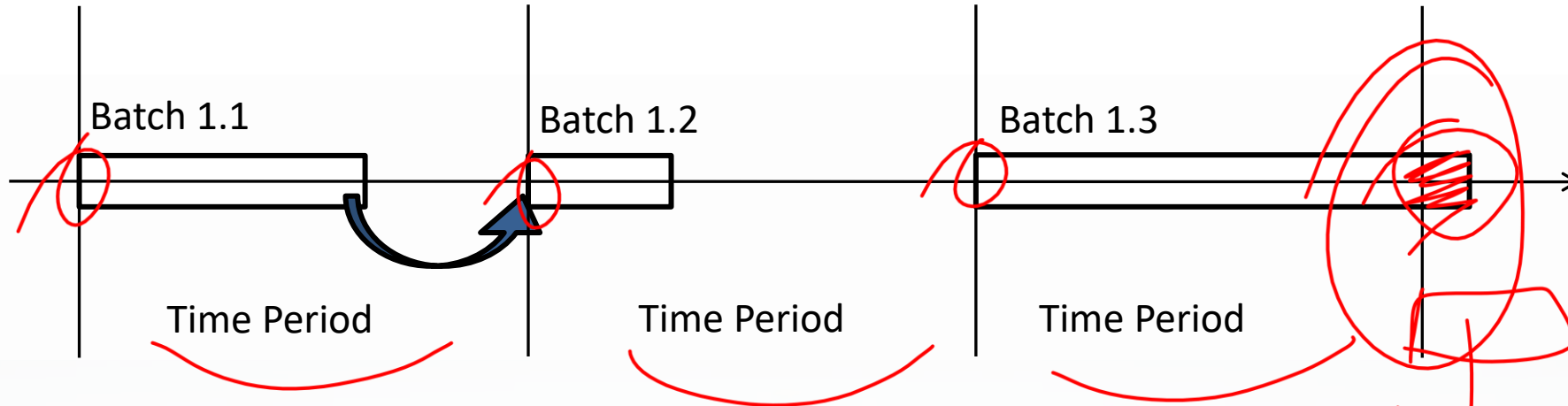


aPeriodic Batch processing



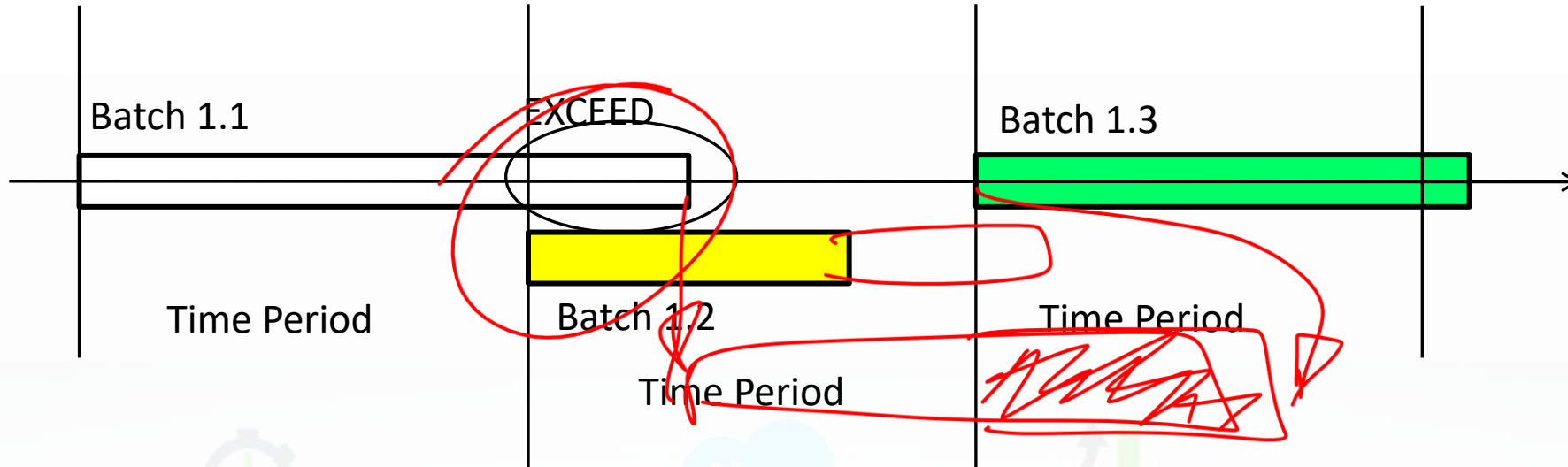
- Activated/Fired/Triggered by events, on demand, etc..
 - Synchronous with something
 - chained or not
- May fire/generate (ask to do or directly do) other jobs/batches:
 - on the same or different computers
 - Identical or different
- Activation may be asked to a third party manager
- Duration of execution depending on data !

Periodic Batch processing



- Scheduled on periodic Firing time event (with a validity period of firing conditions from xx to yy)
 - synchronous
- Execution time duration depending on data or other..
 - Execution may exceed the Time Period
- Each single execution MAY or MAY NOT depend on the preceding one

Periodic Batch processing

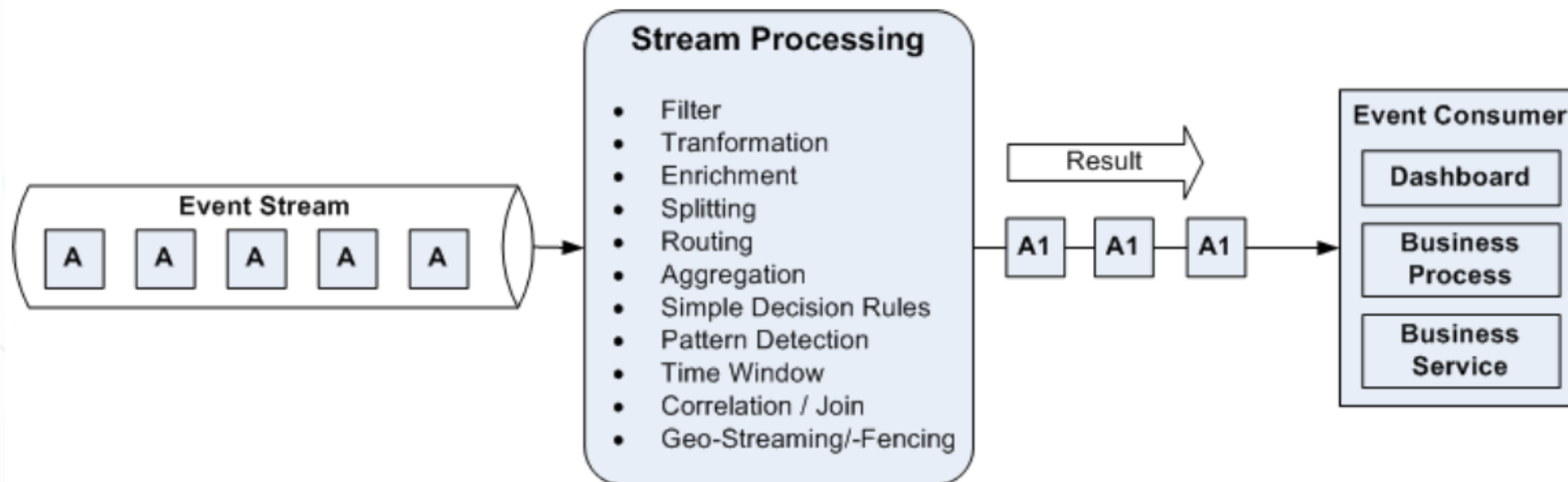


- If the Execution Time Duration exceeds the Time Period
 - A) the successive execution (Batch 1.2) is overlapped (yellow)
 - If it happens systematically: the number of tasks grow indefinitely consuming all resources → until crash
 - B) the successive execution (Batch 1.2) is canceled to wait for the next one (Batch 1.3, green),
 - skipping the second execution, Batch 1.2

- paradigma di programmazione parallela
 - Detto anche di real time processing
- Lavora con:
 - Dati parziali e non su tutto l'insieme dei dati.
 - Per esempio: valutare il contenuto spettrale di un segnale:
 - Su tutto il segnale
 - Su una finestra temporale di 30 secondi, per ogni secondo un nuovo valore, small delay/latency, (but present , see pipeline)
- L'attivazione del processo corrisponde spesso all'arrivo del dato nello stream, nella pipeline,
 - si ha sincronizzazione e comunicazione in un solo colpo.
 - Tipicamente una sequenza di azioni semplici attivate da
 - l'arrivo delle condizioni e dei dati per calcolare i risultati
 - ed in modo asincrono
 - tipicamente senza avere necessità di memorizzare il dato
 - → elimina alcuni problemi della programmazione parallela.

Stream Processing

- Example on languages
 - SISAL (Streams and Iteration in a Single Assignment Language)
 - CUDA (Compute Unified Device Architecture) for NVIDIA GPU, SIMD
- Applications:
 - IOT, media recognition, log processing, social media enrichment, indexing,



Main Purpose

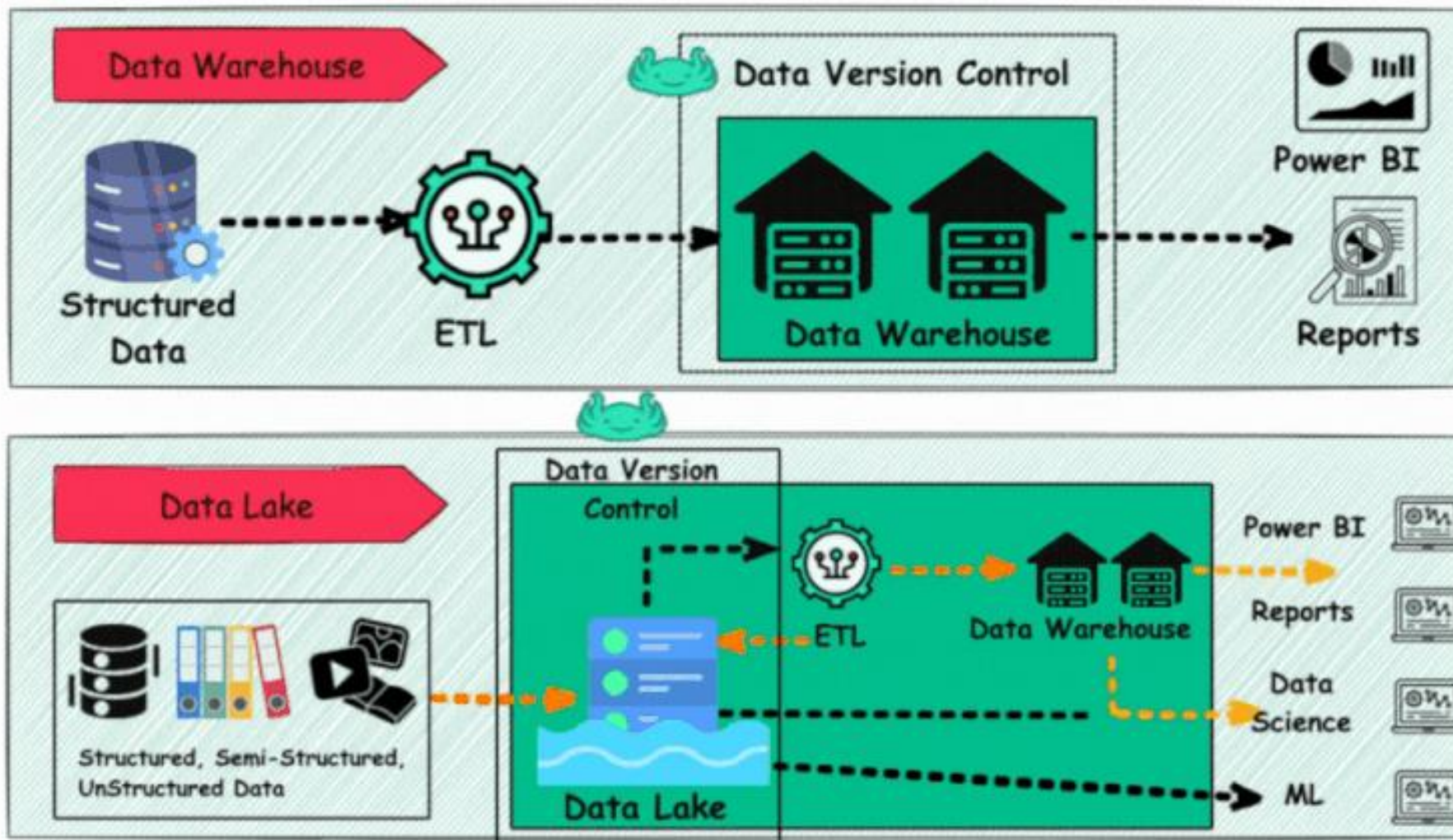
- To store a large amount of data, **big data**, and they can be **structured and un-structured**, several different kind of data:
 - **Direct Data**: Time series, geolocated data, events, shapes, measures, social media posts, video, files, logs, etc.
 - Most of them may have multiple features, e.g.: geolocated events with shape
 - **Derived Data**: predictions, typical trends, trajectories, flows, heatmaps, 3D reconstructions, traffic reconstruction, planning, simulations, etc.
- for **exploiting them** for producing:
 - Deductions, hints, early warning,
 - Derived Data as well, in real time

Main Functions

- **Data Extraction:**
 - gathering, harvesting, ingestion, reception in push,
- **Data Transformation:**
 - Adaptation, mapping, formatting, conversion, enrich
 - Cleaning or leaving as it is
- **Data Loading** and Refreshing: saving in the storage
 - As it is, converted and ready to use, etc.
- **Data Usage:**
 - As it is from Storage (faster, more rigid schema, higher volume in access)
 - Transformed on the fly (slower, more flexible, moderate volume in access)

DW vs DL

- ETL-Usage vs ELT-Usage
- DW:
 - More complex data ingestion
 - Simplify data ingestion for sporadically used data
 - Faster data usage unforeseen patterns/combinations
- DL:
 - Faster data ingestion
 - More complex data rendering since all combinations are unplanned
 - Prepare data rendering for well known patterns



Parameters	Data Lake	Data Warehouse
Storage	In the data lake, all data is kept irrespective of the source and its structure. Data is kept in its raw form. It is only transformed when it is ready to be used.	A data warehouse will consist of data that is extracted from transactional systems or data which consists of quantitative metrics with their attributes. The data is cleaned and transformed
History	Big data technologies used in data lakes is relatively new.	Data warehouse concept, unlike big data, had been used for decades.
Data Capturing	Captures all kinds of data and structures, semi-structured and unstructured in their original form from source systems.	Captures structured information and organizes them in schemas as defined for data warehouse purposes
Data Timeline	can retain all data. This includes not only the data that is in use but also data that it might use in the future. Also, data is kept for all time, to go back in time and do an analysis.	In the data warehouse development process, significant time is spent on analyzing various data sources.
Users	ideal for the users who indulge in deep analysis. Such users include data scientists who need advanced analytical tools with capabilities such as predictive modeling and statistical analysis.	The data warehouse is ideal for operational users because of being well structured, easy to use and understand.
Storage Costs	Data storing in big data technologies are relatively inexpensive then storing data in a data warehouse.	Storing data in Data warehouse is costlier and time-consuming.

Parameters	Data Lake	Data Warehouse
Task	can contain all data and data types; it empowers users to access data prior the process of transformed, cleansed and structured.	Data warehouses can provide insights into pre-defined questions for pre-defined data types.
Processing time	empower users to access data before it has been transformed, cleansed and structured. Thus, it allows users to get to their result more quickly compares to the traditional data warehouse.	Data warehouses offer insights into pre-defined questions for pre-defined data types. So, any changes to the data warehouse needed more time.
Position of Schema	Typically, the schema is defined after data is stored. This offers high agility and ease of data capture but requires work at the end of the process	Typically schema is defined before data is stored. Requires work at the start of the process, but offers performance, security, and integration.
Data processing	use of the ELT (Extract Load Transform) process.	Data warehouse uses a traditional ETL (Extract Transform Load) process.
Complain	Data is kept in its raw form. It is only transformed when it is ready to be used.	The chief complaint against data warehouses is the inability, or the problem faced when trying to make change in in them.
Key Benefits	They integrate different types of data to come up with entirely new questions as these users not likely to use data warehouses because they may need to go beyond its capabilities.	Most users in an organization are operational. These type of users only care about reports and key performance metrics.

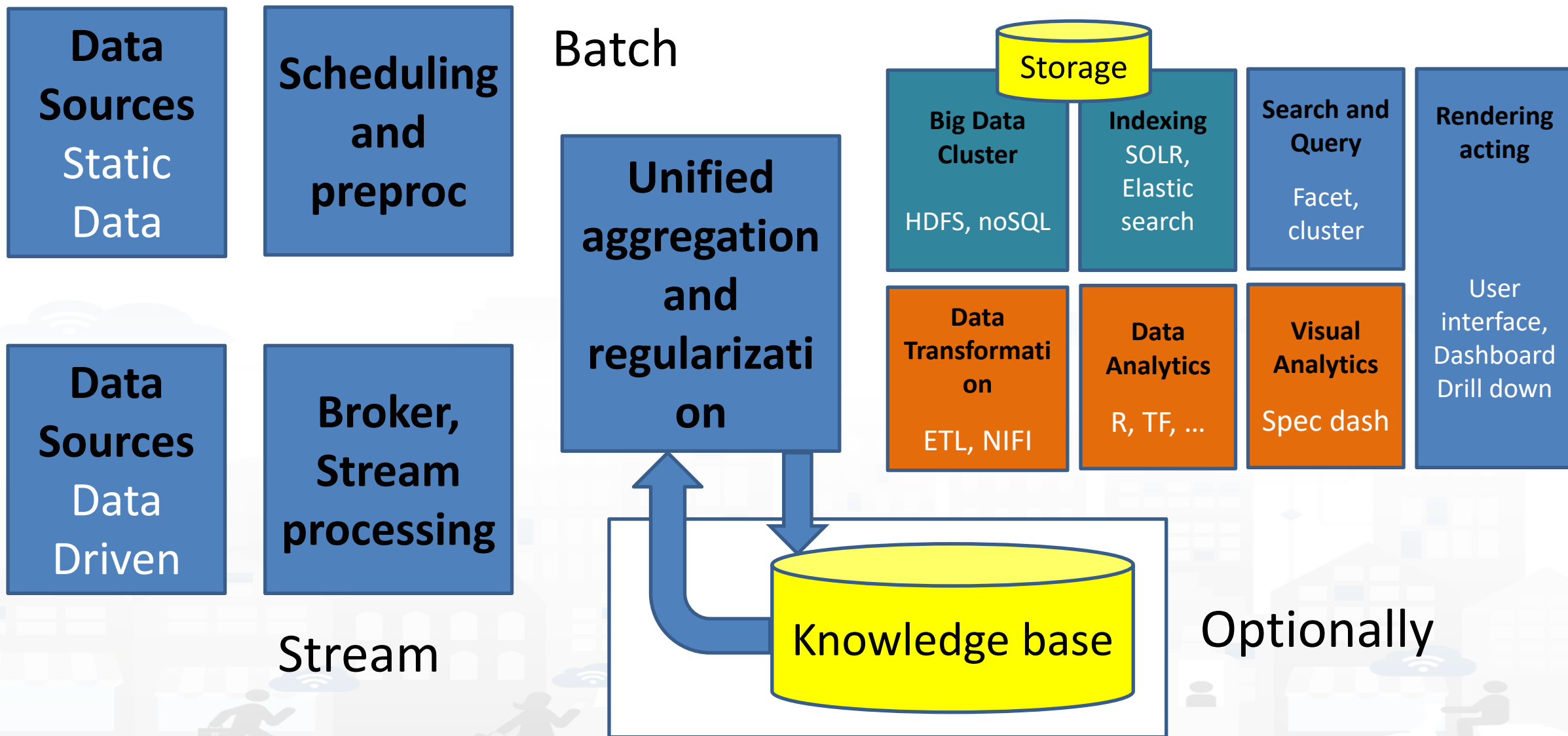
Pros and Cons

- **Data Lake**

- Original data preserved, structured and unstructured
- Lower costs of ingestion
- Lower performance in the usage
- Security: possible control at source
- More difficult to extend in usage, simpler in storage
- More scientist oriented
 - Moderated results in access

- **Data Warehouse**

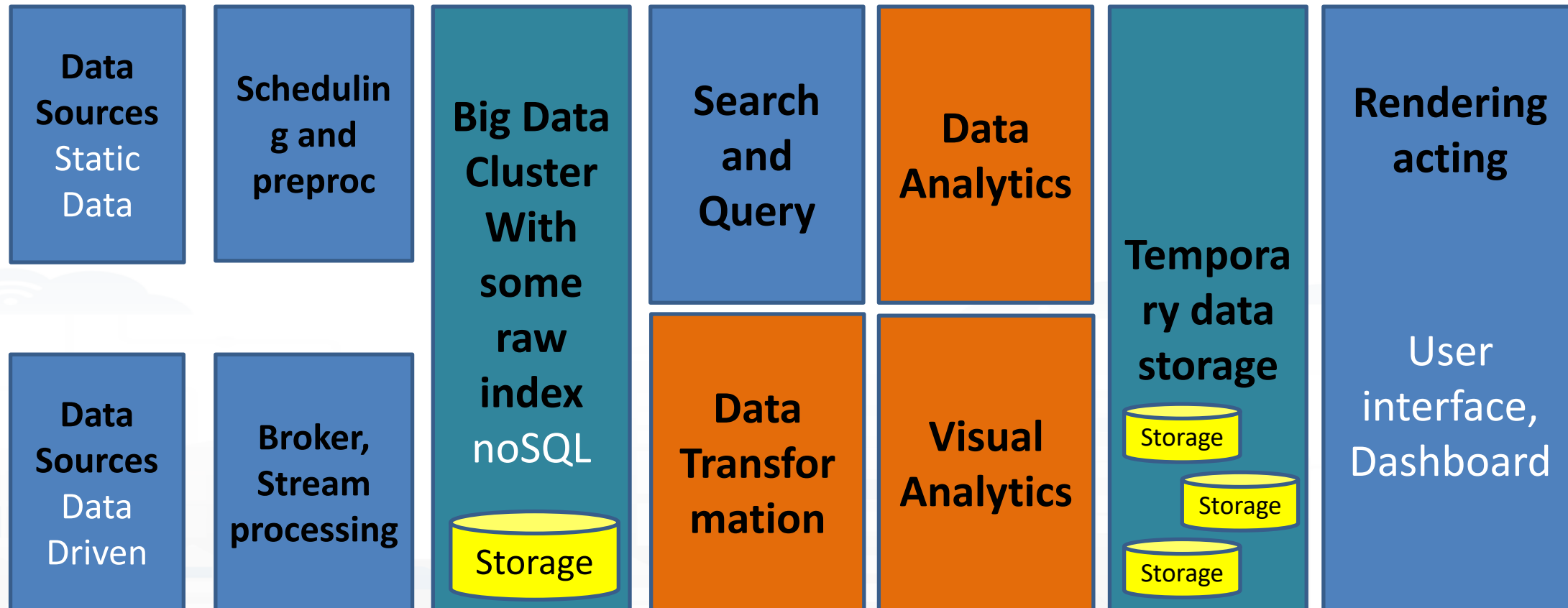
- Original data transformed and prepared for mainly structured or semi-structured
- Higher cost of ingestion
- Higher performance in the usage
- Security: Control on organized data
- More difficult to extend in storage, simpler in usage
- More Business and Purpose Oriented
 - Large volume of accesses



Top Cloud Data Warehouses at a Glance

	Amazon Redshift	Microsoft Azure Synapse	Google BigQuery	Snowflake Cloud Data Platform
Initial Release	2012	2016	2010	2014
Separates Storage and Compute	No	Yes	Yes	Yes
Multi-Cloud	No	No	No	Yes
Query Language	Amazon Redshift SQL	TSQL	Standard SQL 2011 & BigQuery SQL	Snowflake SQL
Elasticity	Yes - Manual	Yes – Manual and Automatic	Yes – Automatic	Yes – Automatic
MPP	Yes	Yes	Yes	Yes
Columnar	Yes	Yes	Yes	Yes
Foreign Keys	Yes	Yes	No	Yes
Transaction	ACID	ACID	ACID	ACID
Concurrency	Yes	Yes	Yes	Yes
Durability	Yes	Yes	Yes	Yes
Automation	No	No	No	No
Website	Link	Link	Link	Link
Free Trial	Yes	Yes	Yes	Yes

Batch



Stream



Data Structure



Purpose of Data



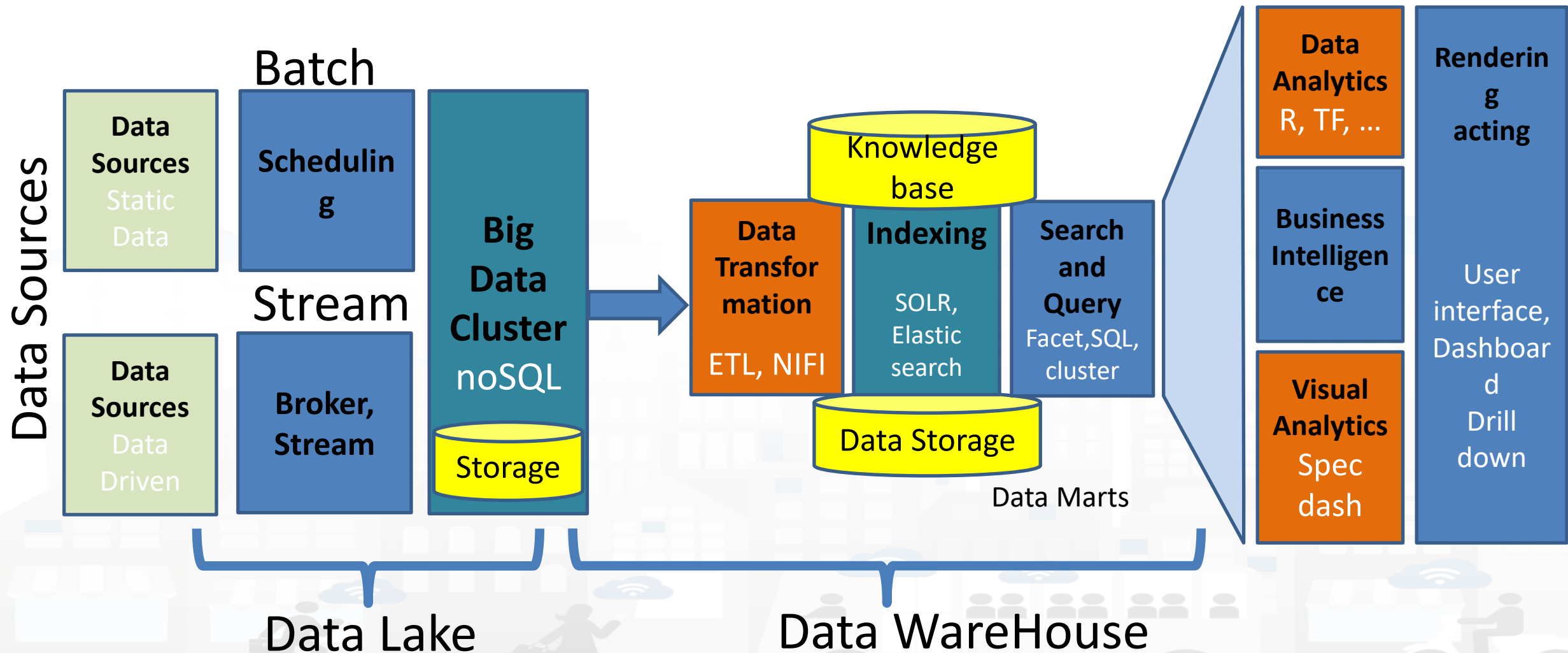
Users



Accessibility

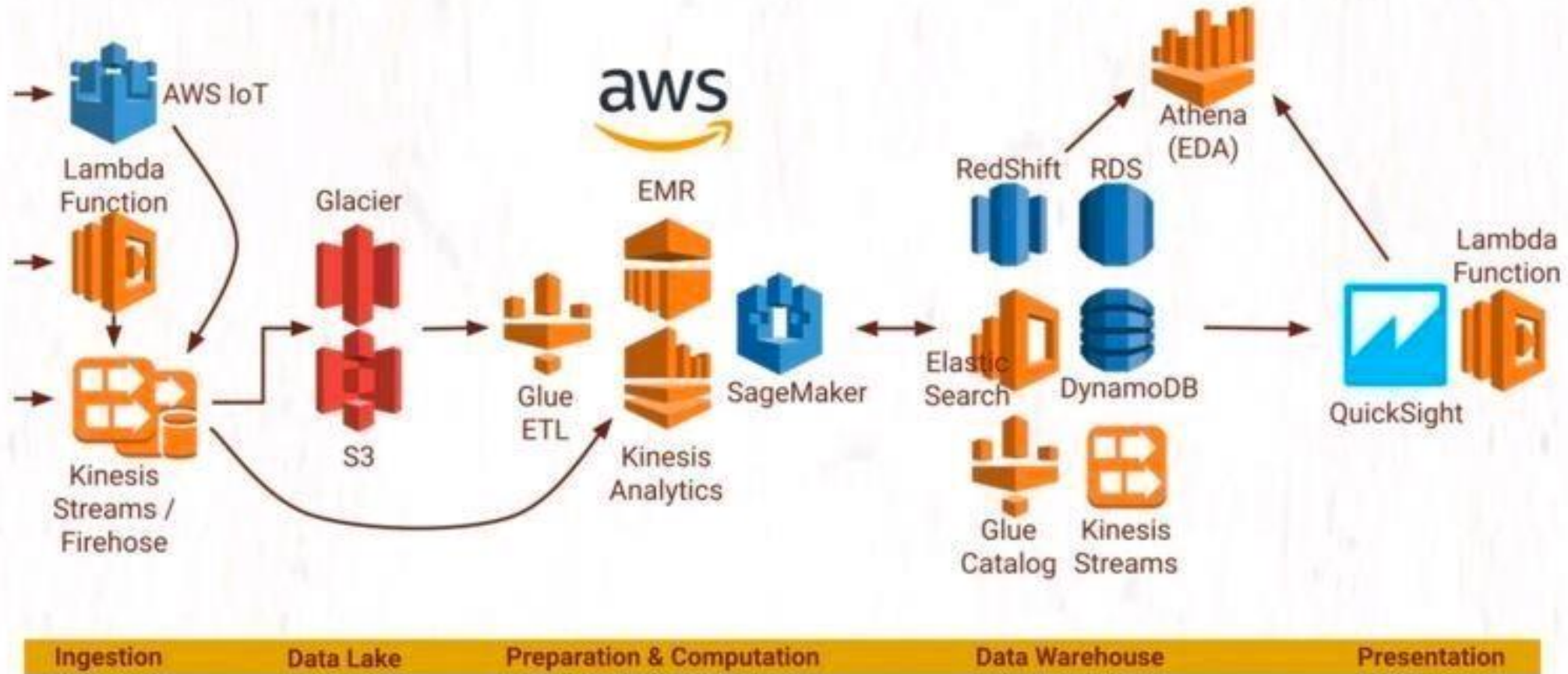
	Data Lake	Data Warehouse
Data Structure	Raw	Processed
Purpose of Data	Not yet determined	Currently in use
Users	Data scientists	Business professionals
Accessibility	Easier to ingest and update unstructured data	More difficult to ingest and update data due to the need for uniformity and structure, but easier to consume

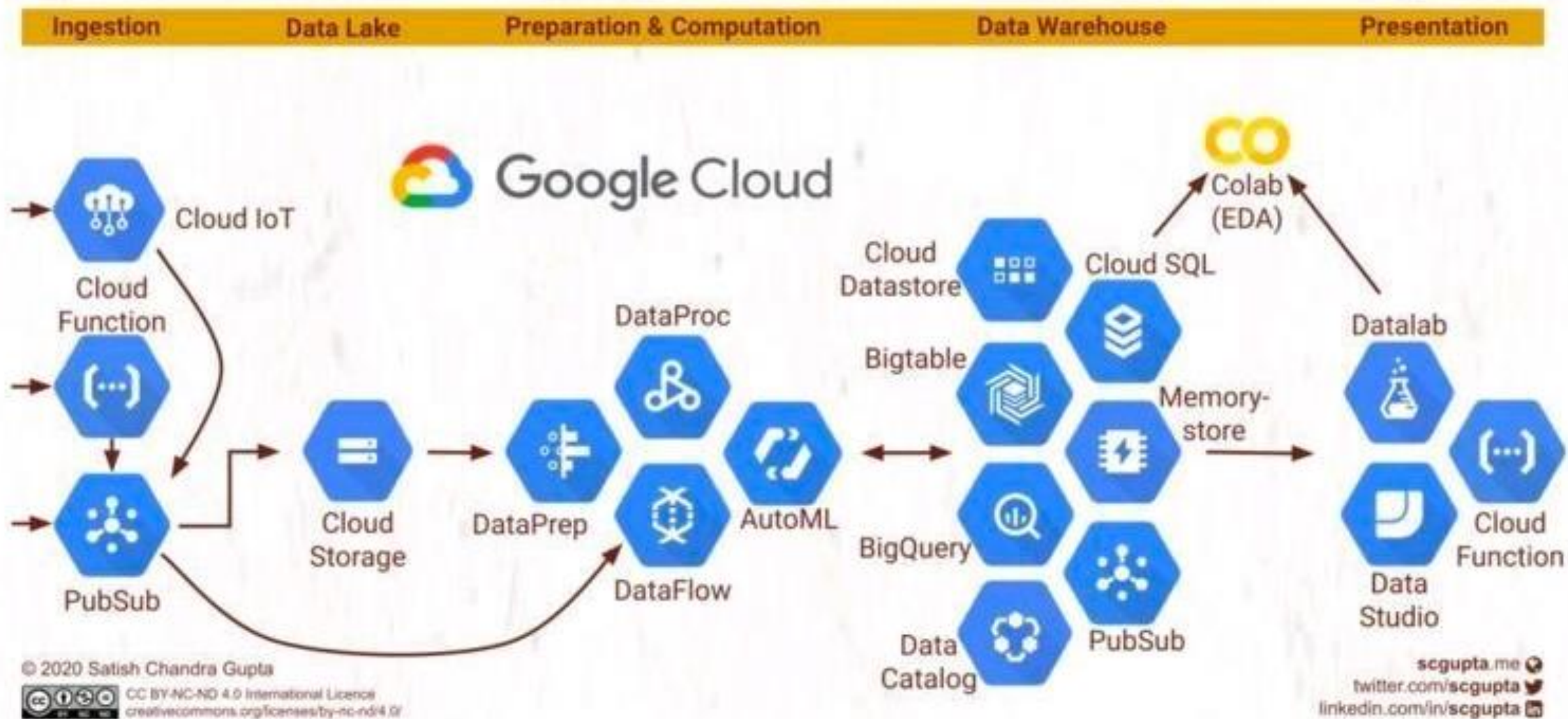
Combined Solutions

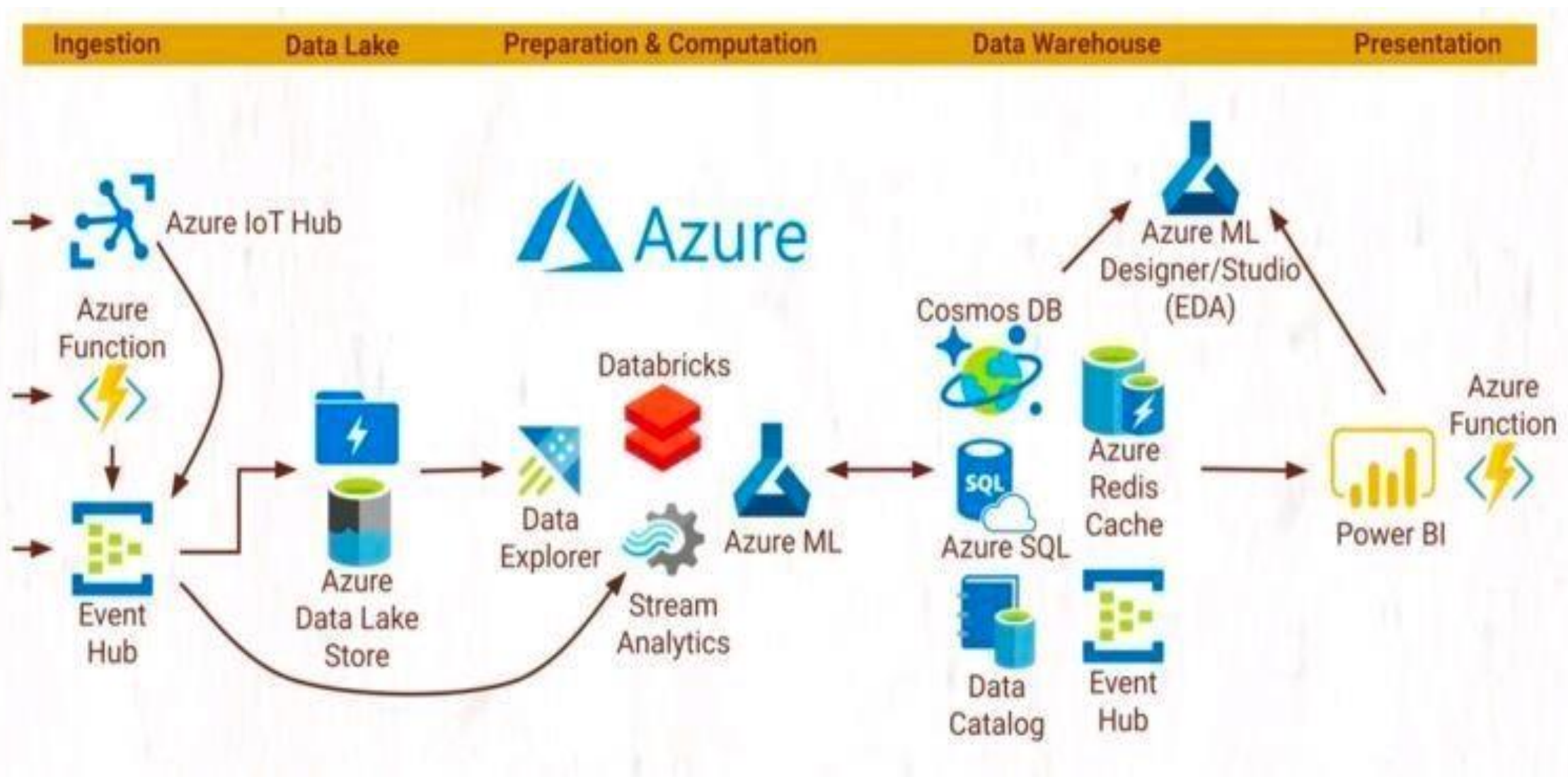


Big Data Pipelines on AWS, Microsoft Azure, and GCP

scgupta.link/big-data-pipeline







CLOUD COMPARISON

AWS VS. AZURE VS. GOOGLE



@simonholdorf



Available Regions

AWS Regions and Zones

Azure Regions

Google Compute Regions & Zones

Compute Services



Elastic Compute Cloud (EC2)



Virtual Machines



Compute Engine

App Hosting



Amazon Elastic Beanstalk



Azure Cloud Services



Google App Engine

Serverless Computing



AWS Lambda



Azure Functions



Google Cloud Functions

Container Support



Elastic Container Service



Azure Container Service



Container Engine

Scaling Options



Auto Scaling



Azure Autoscale



Autoscaler

Object Storage



Amazon Simple Storage (S3)



Azure Blob Storage



Cloud Storage

Block Storage



Amazon Elastic Block Storage



Azure Managed Storage



Persistent Disk

Content Delivery Network (CDN)



Amazon CloudFront



Azure CDN



Cloud CDN

SQL Database Options



Amazon RDS



Azure SQL Database



Cloud SQL

NoSQL Database Options



AWS DynamoDB



Azure DocumentDB



Cloud Datastore

Shap4City (C), October 2024

CLOUD COMPARISON

AWS VS. AZURE VS. GOOGLE



@simonholdorf

aws

Azure



Virtual Network



Amazon VPC



Azure Virtual Network



Cloud Virtual Network

Private Connectivity



AWS Direct Connect



Azure Express Route



Cloud Interconnect

DNS Service



Amazon Route 53



Azure Traffic Manager



Cloud DNS

Log Monitoring



Amazon CloudTrail



Azure Operational Insights



Cloud Logging

Performance Monitoring



Amazon CloudWatch



Azure Application Insights



Stackdriver Monitoring

Administration and Security



AWS Identity and Access Management (IAM)



Azure Active Directory



Cloud Identity and Access Management (IAM)

Compliance



AWS CloudHSM



Azure Trust Center



Google Cloud Platform Security

Analytics



Amazon Kinesis



Azure Stream Analytics

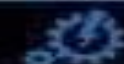


Cloud Dataflow

Automation



AWS Opsworks



Azure Automation



Compute Engine Management

Management Services & Options



Amazon CloudFormation



Azure Resource Manager



Cloud Deployment Manager

Notifications

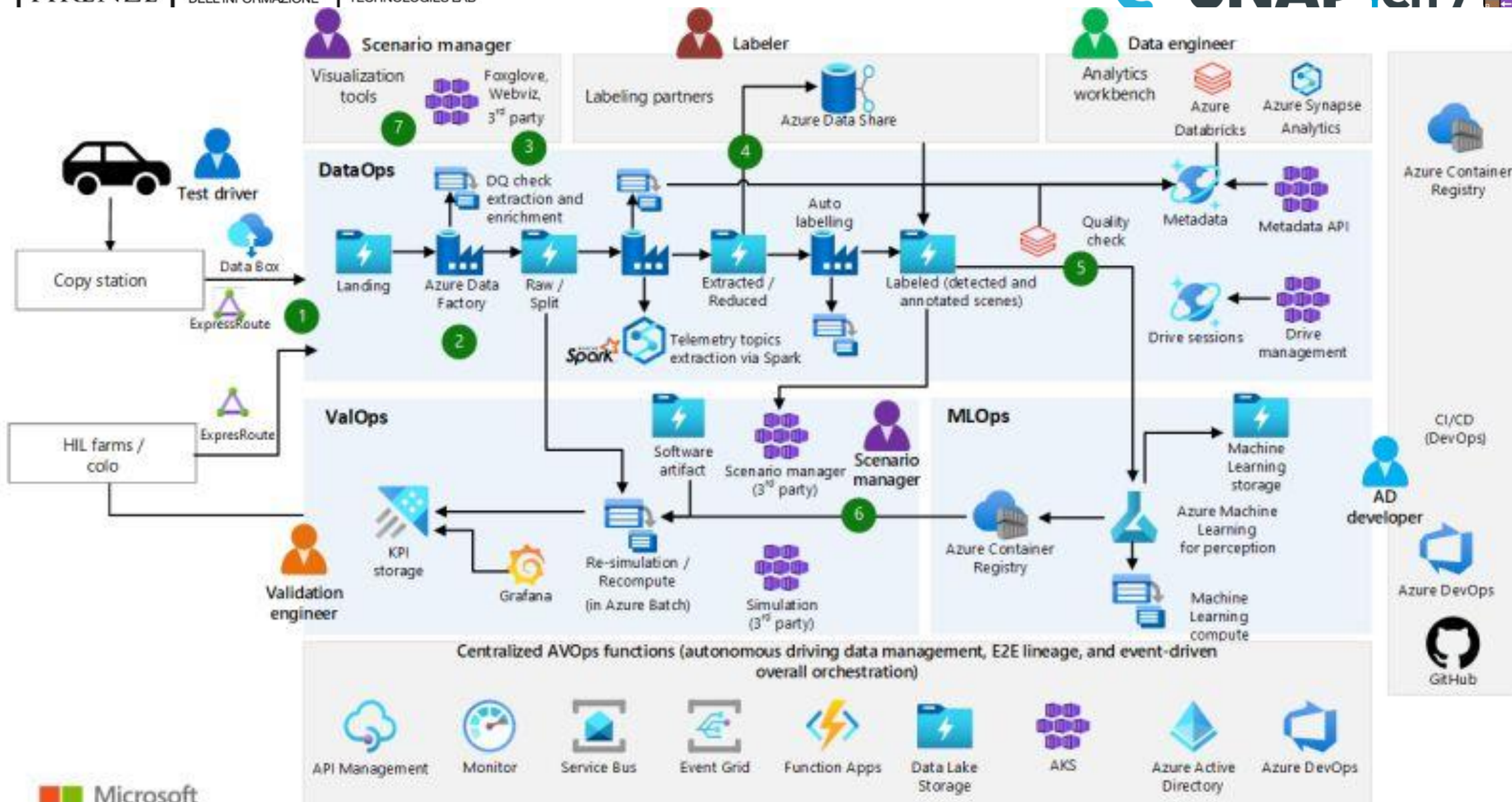


Amazon Simple Notification Service (SNS)



Azure Notification Hub

None





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

Paolo Nesi, paolo.nesi@unifi.it

IoT Architectures

<https://www.snap4City.org>

<https://www.Km4City.org>

Parte: 4
(2024)



Snap4City (C), October 2024

IOT Solutions

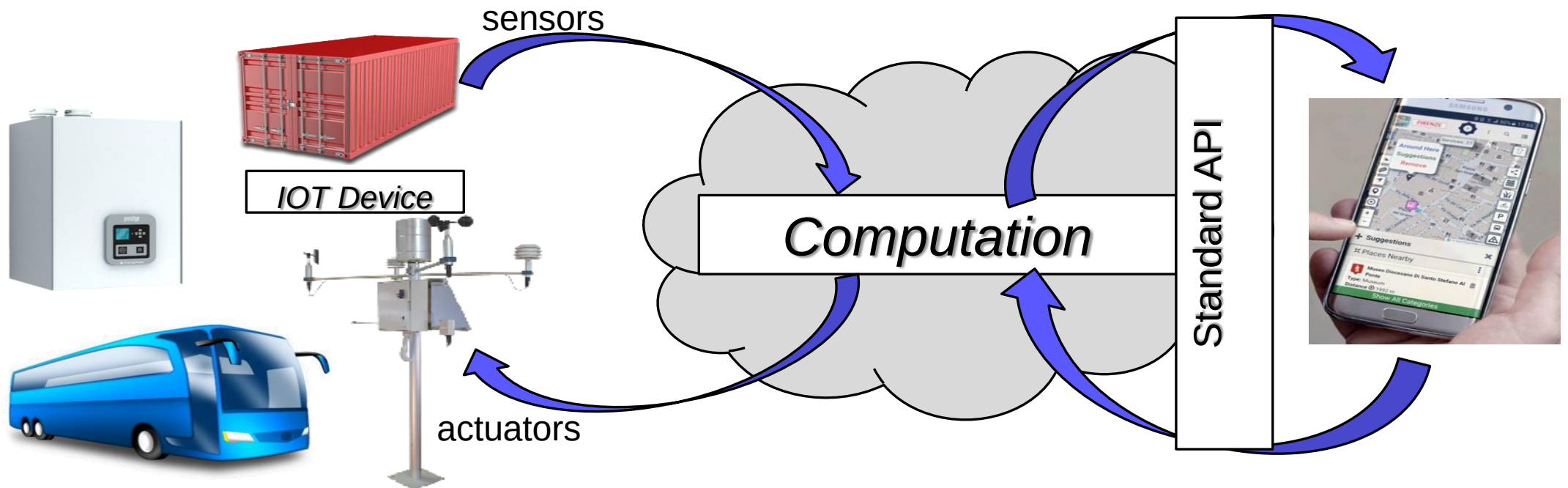




IOT Main Concept

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.

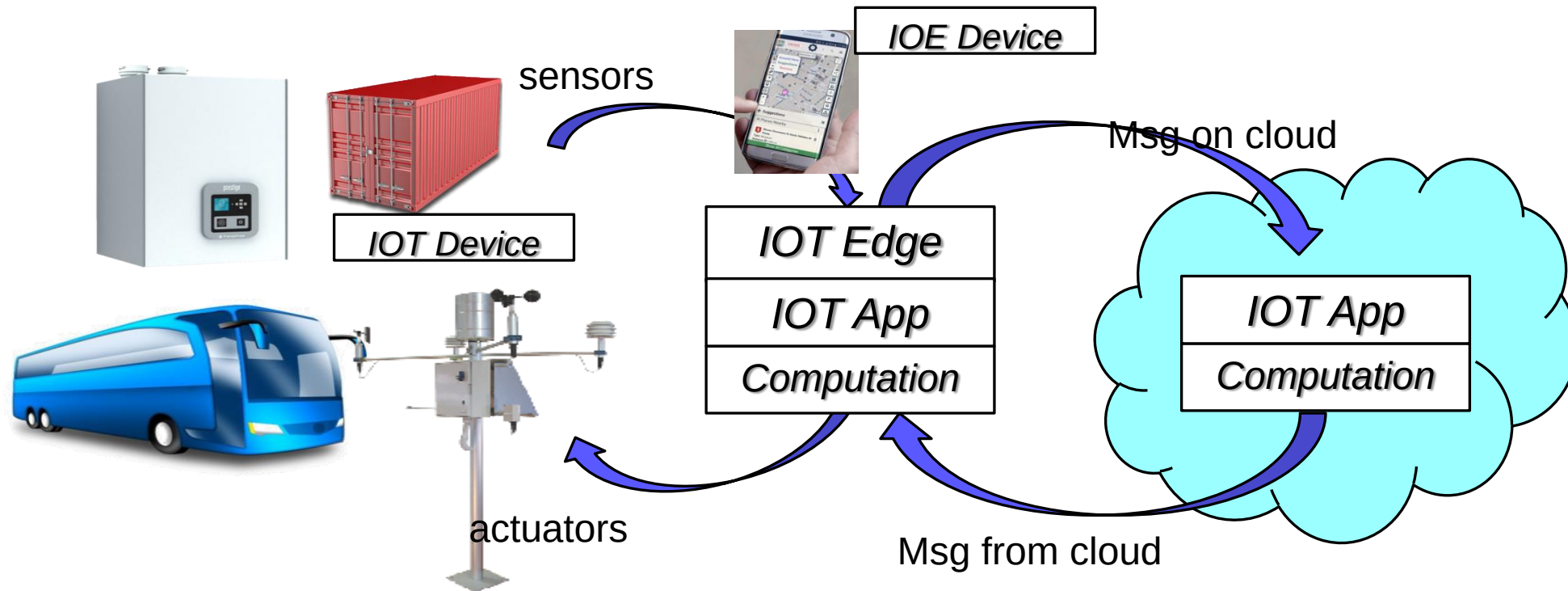




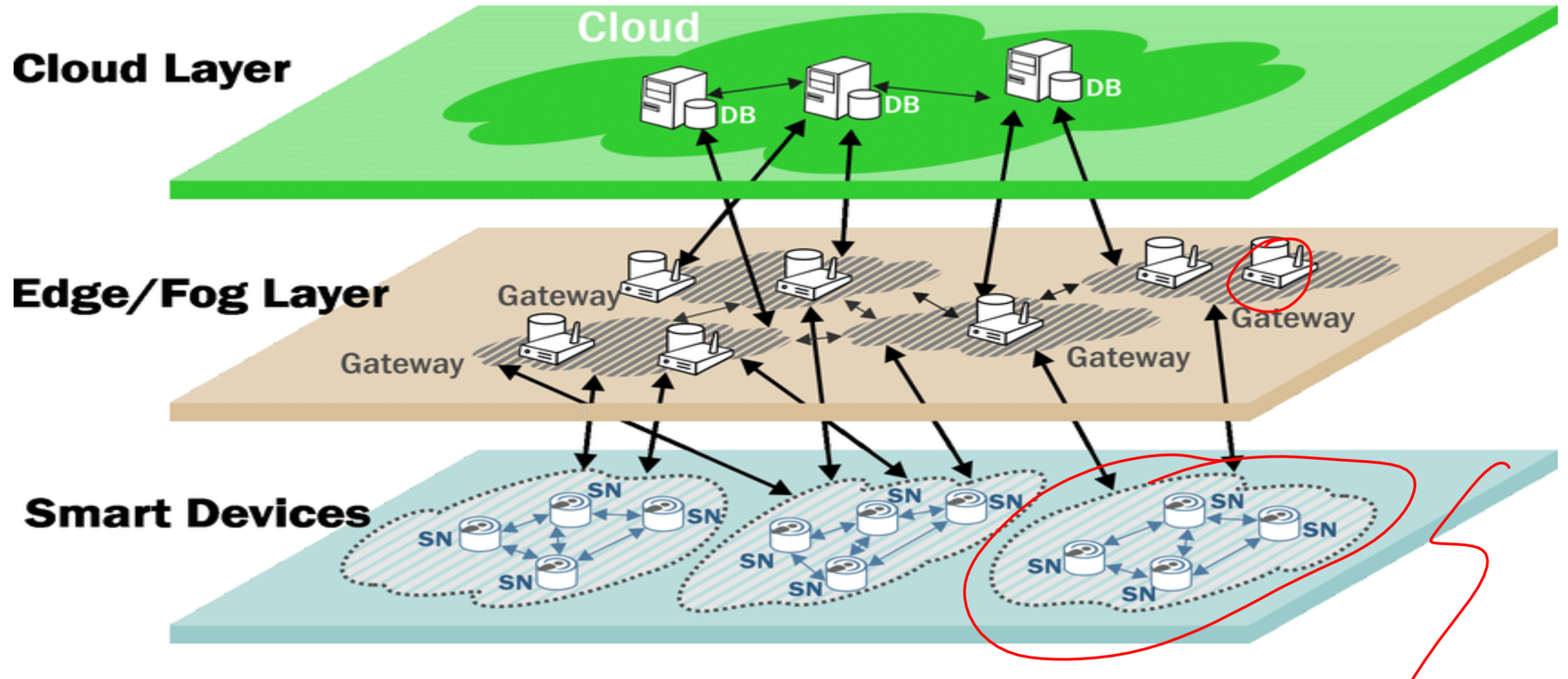
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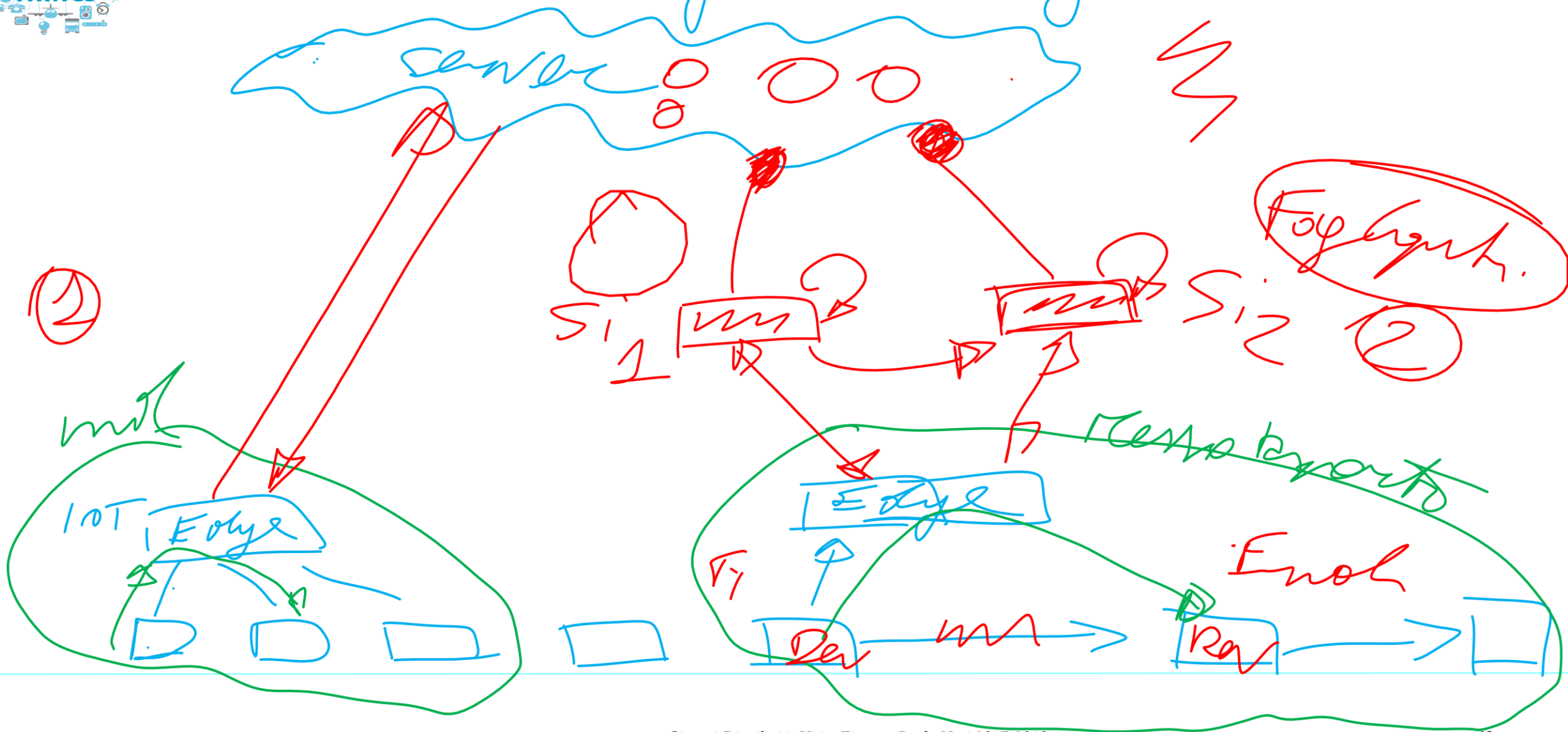
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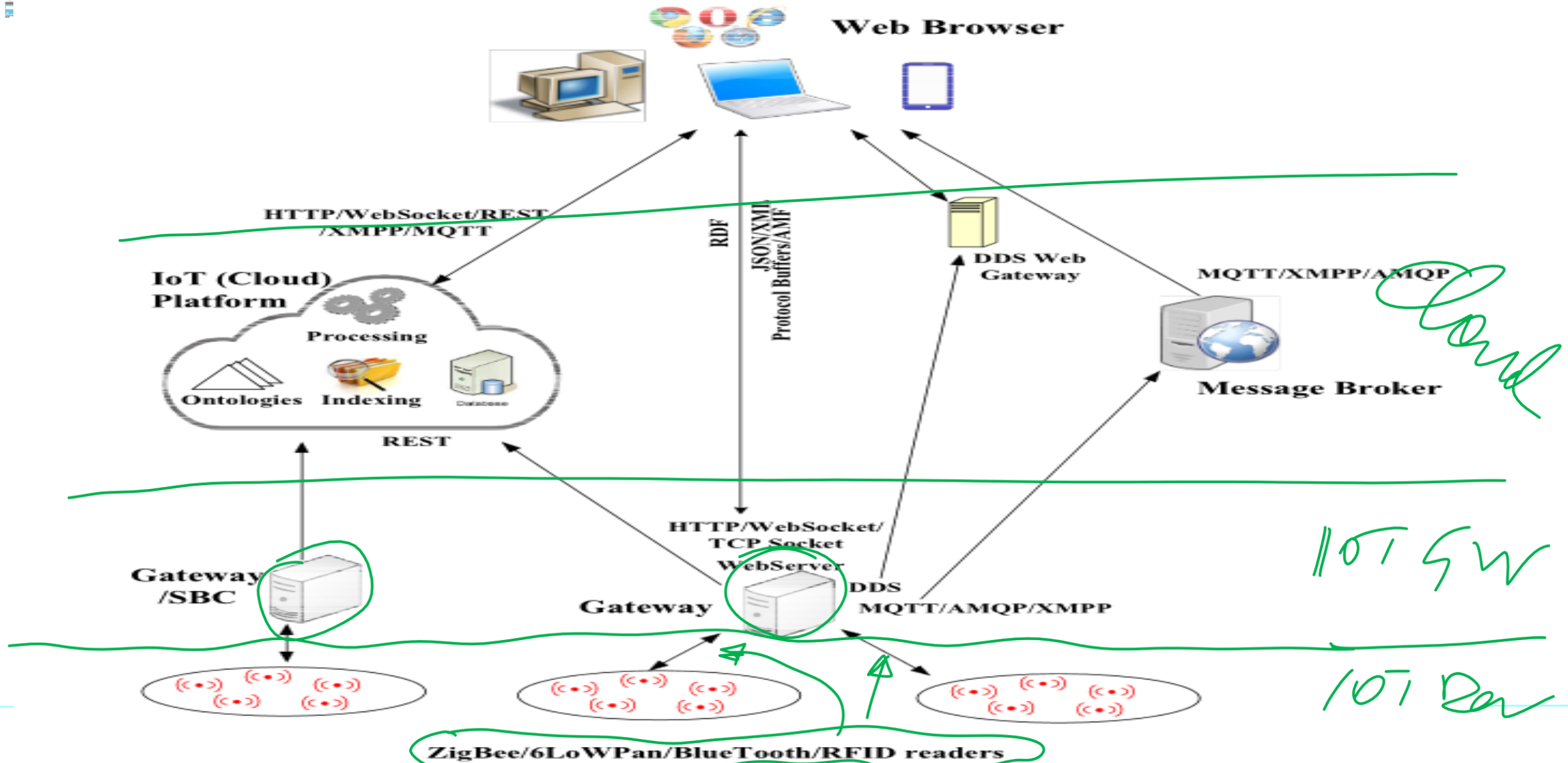
Cloud vs Fog/Edge Computing

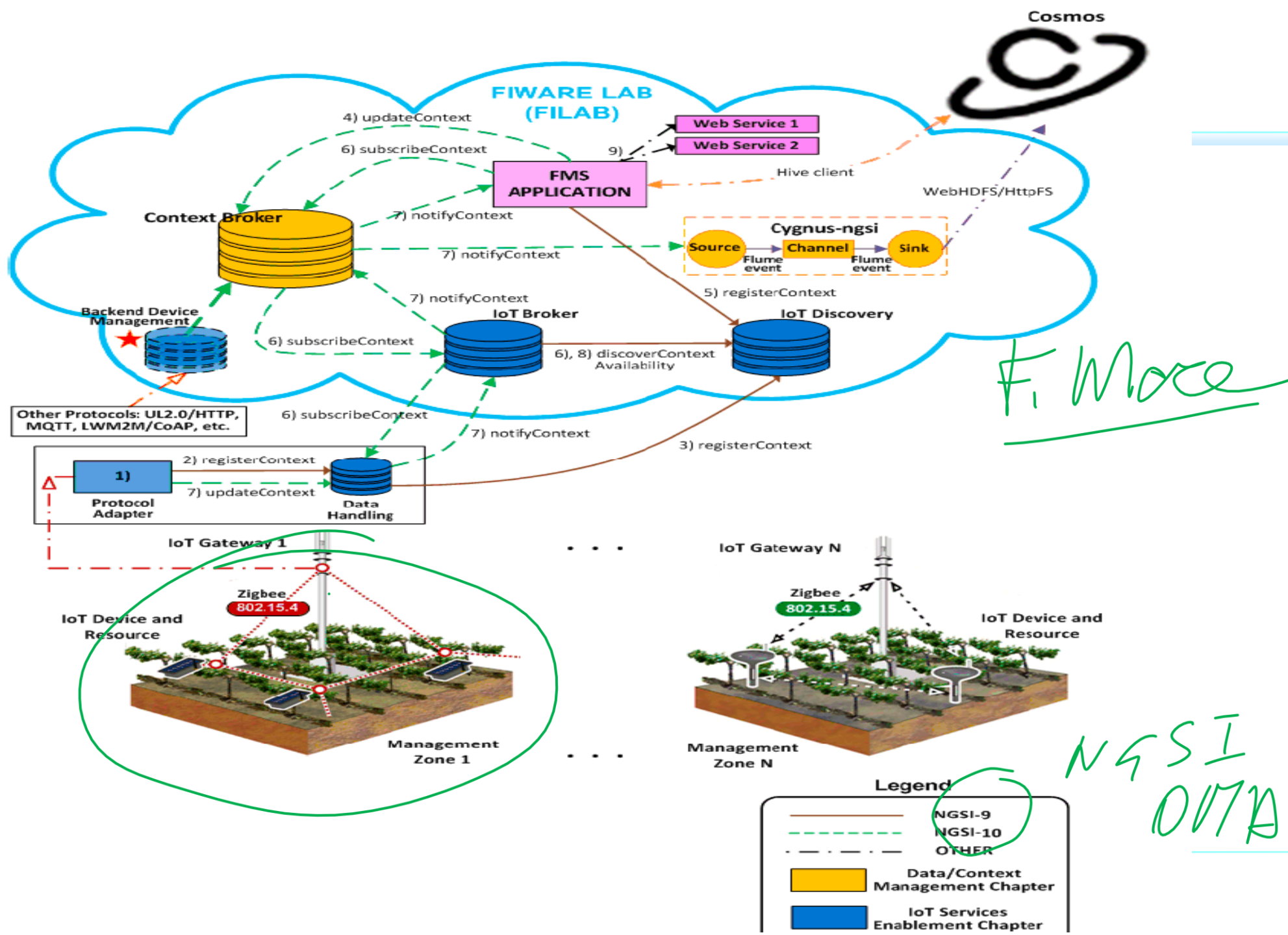


IoT edge vs Fog



Edge Computing, Fog Computing

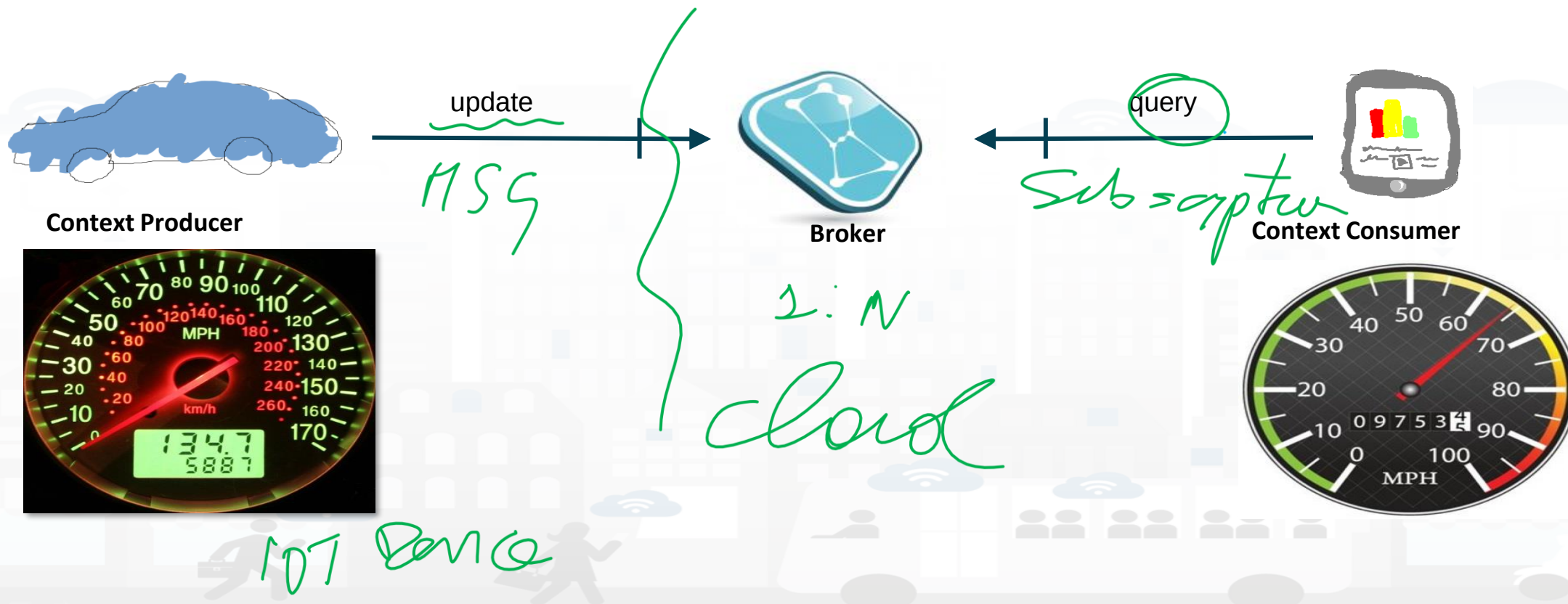




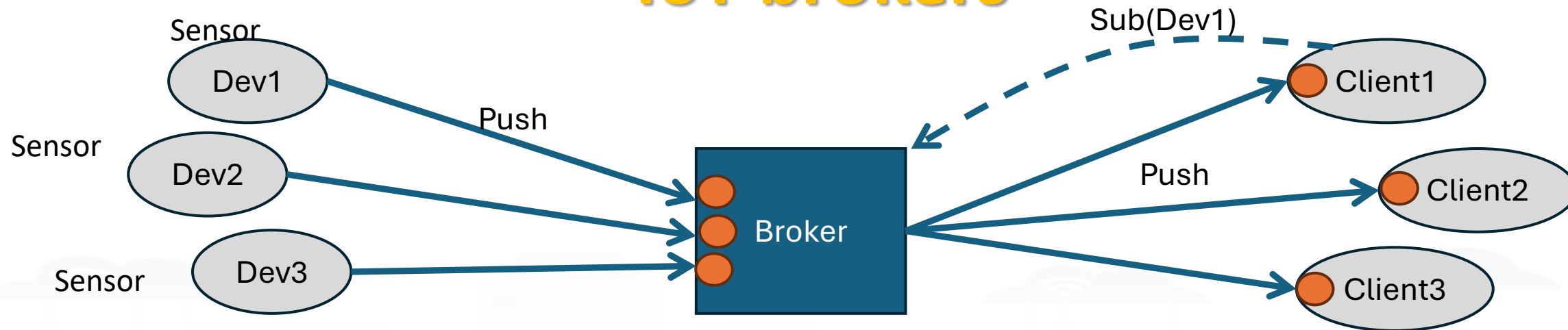
IoT Broker

- 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

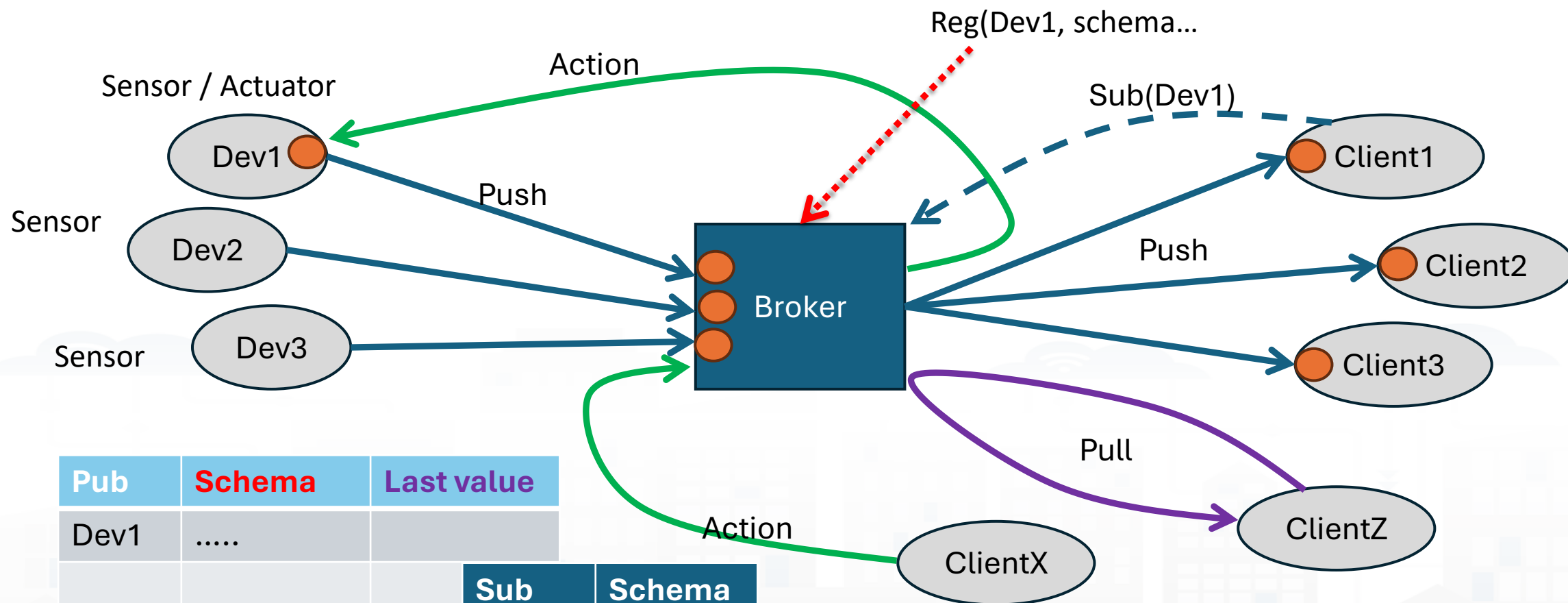


IoT brokers



Pub
Dev1

Sub	Schema
Client1	Dev1
Client1	Dev2



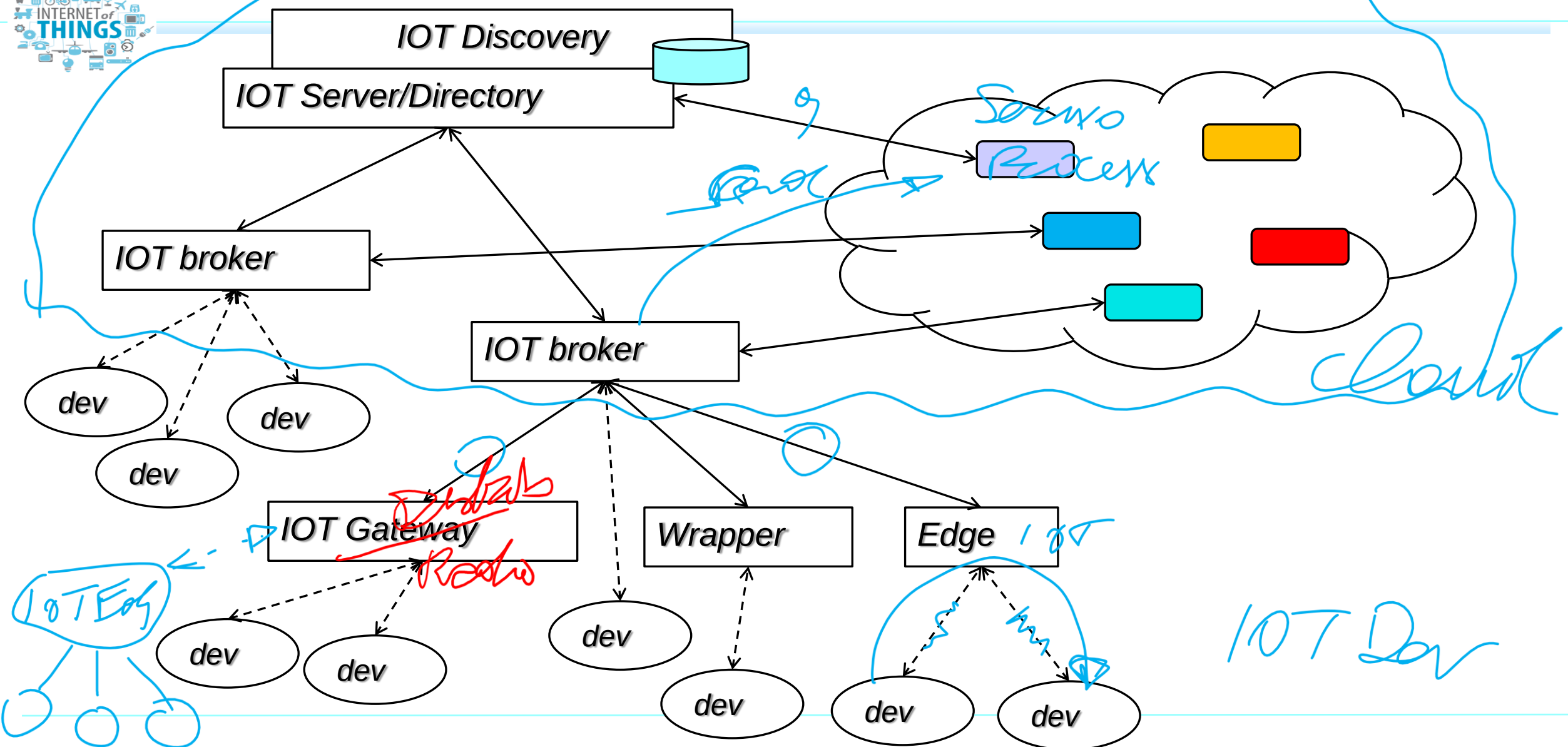
Pub	Schema	Last value
Dev1		

Sub	Schema
Client1	Dev1
Client1	Dev2

IoT Context Brokers

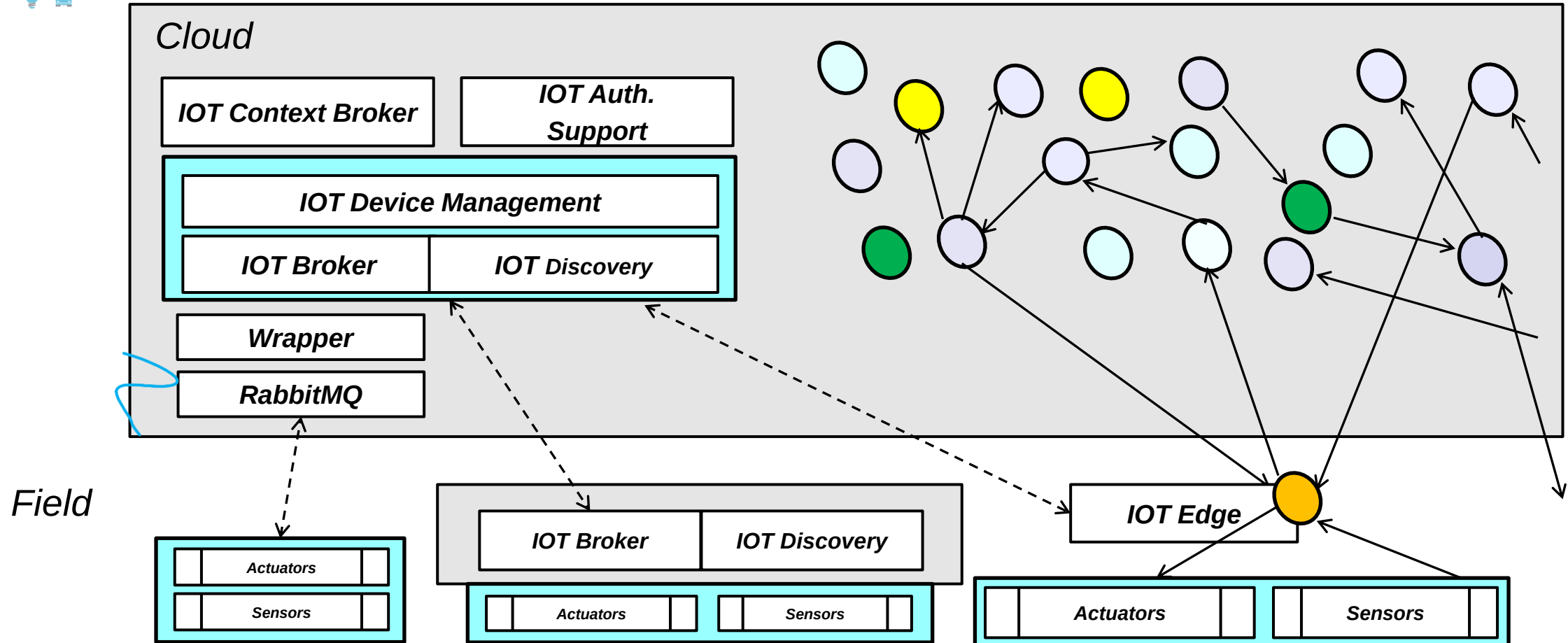
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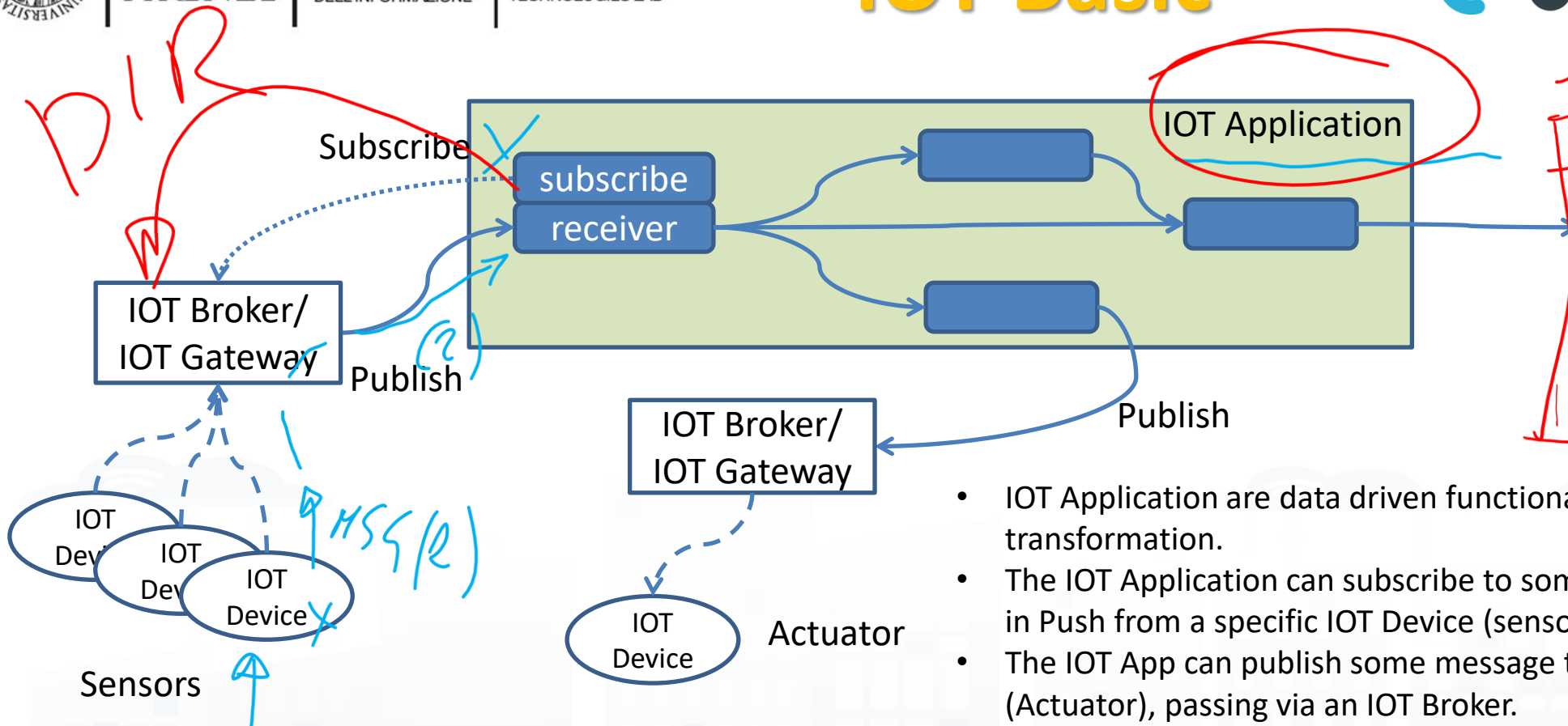




Conceptual architecture



IOT Basic

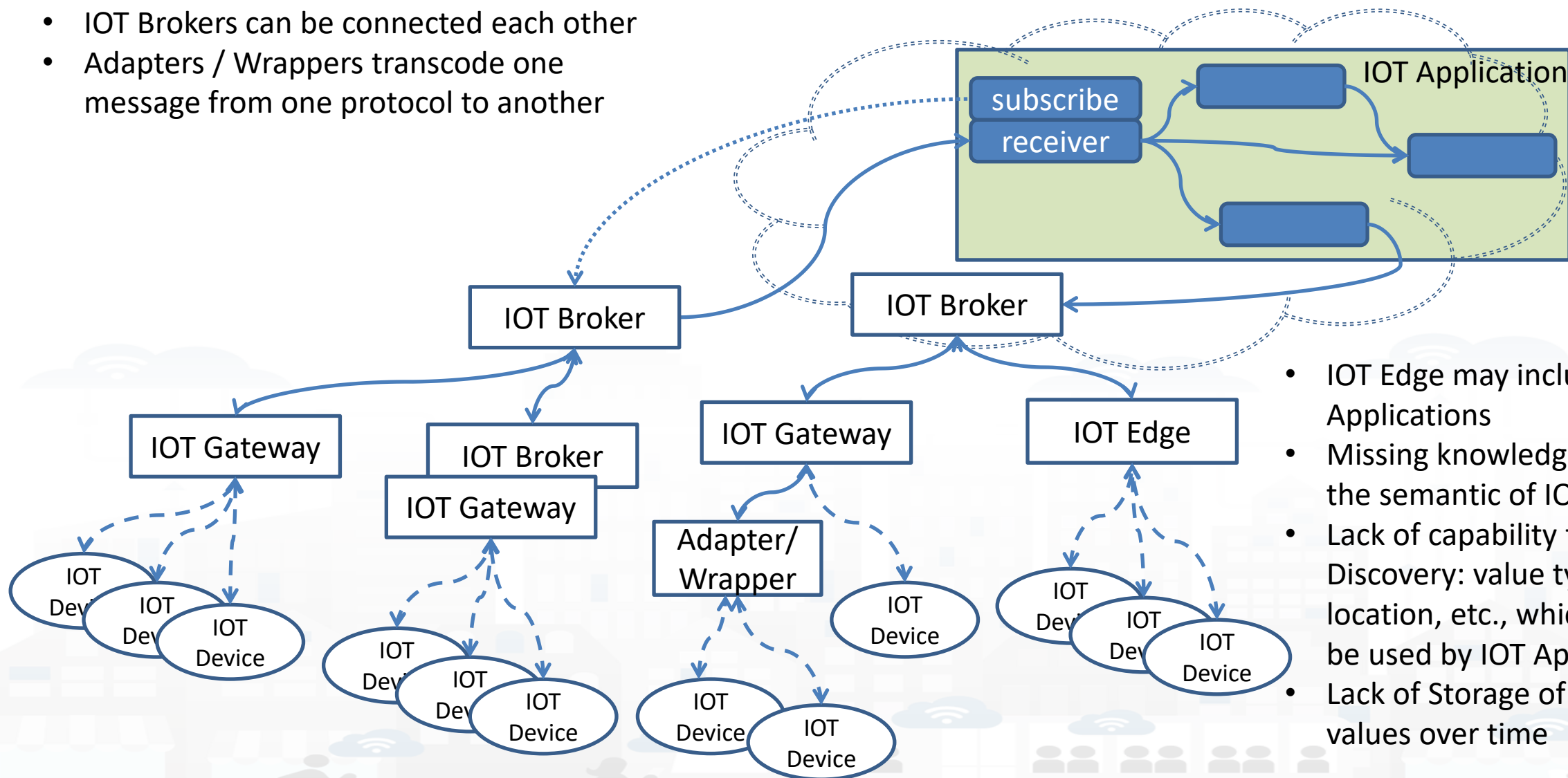


- Sensors are programmed to send data (i) periodically, or (ii) when a relevant change occurs in the sensor value, or (iii) when events occur (for example a change of status of something), etc.
- Actuator perform some action on the field: change of status, reset, turn on something, change setting value,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

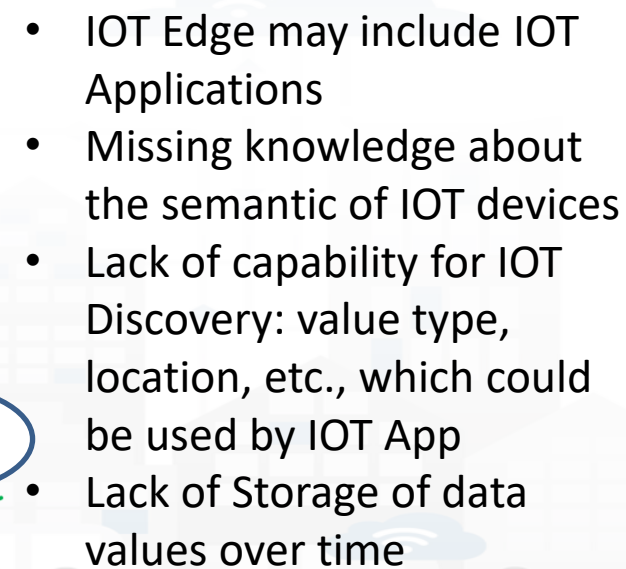
- IOT Application are data driven functional programs for data transformation.
- The IOT Application can subscribe to some IOT Brokers to receive data in Push from a specific IOT Device (sensor)
- The IOT App can publish some message toward some IOT Device (Actuator), passing via an IOT Broker.
- Continuous 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



IOT/IOE Protocols



Communication Patterns

IoT

GW



Discovery

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

Registration



Telemetry

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

Push



Inquiries

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



Commands

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

Bulk action



Notifications

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

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

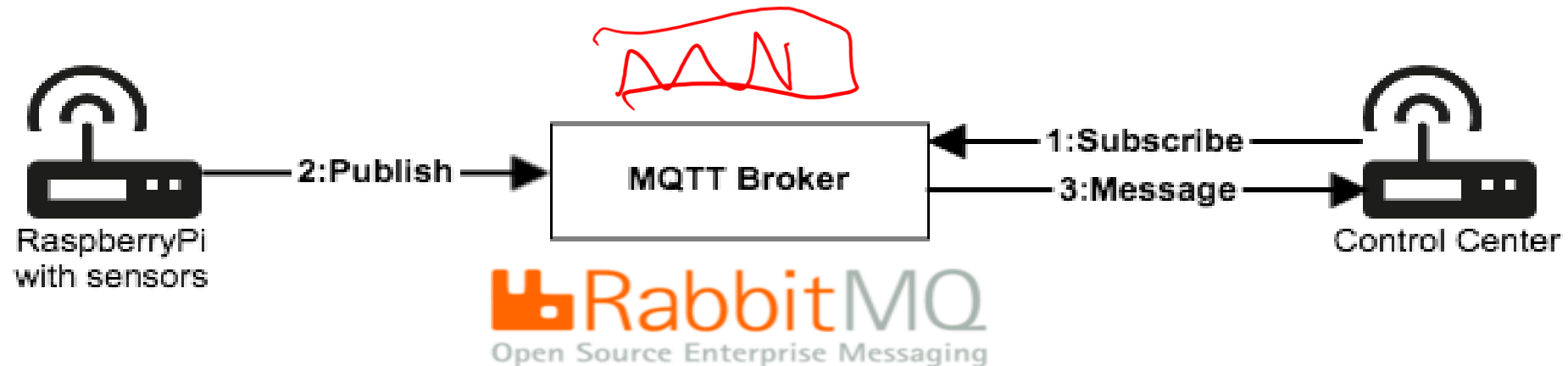
Note on Communication patterns

- Not all Communication Patterns are supported by all Protocols
- Protocols implement Patterns, + formats, + sequences, etc.
- They are referred at level of communications
 - IOT Device $\leftarrow \rightarrow$ IOT Gateway $\leftarrow \rightarrow$ 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, ...	Security	Management
Network	Encapsulation	6LoWPAN, 6TiSCH, 6Lo, Thread, ...	TCG, Oath 2.0, SMACK, SASL, ISASecure, ace, DTLS, Dice, ...	IEEE 1905, IEEE 1451, ...
	Routing	RPL, CORPL, CARP, ...		
Datalink		WiFi, Bluetooth Low Energy, Z-Wave, ZigBee Smart, DECT/ULE, 3G/LTE, NFC, Weightless, HomePlug GP, 802.11ah, 802.15.4e, G.9959, WirelessHART, DASH7, ANT+, LTE-A, LoRaWAN, ...		

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



Comparison high level IOT protocols

AT Rest

0/1/Zone

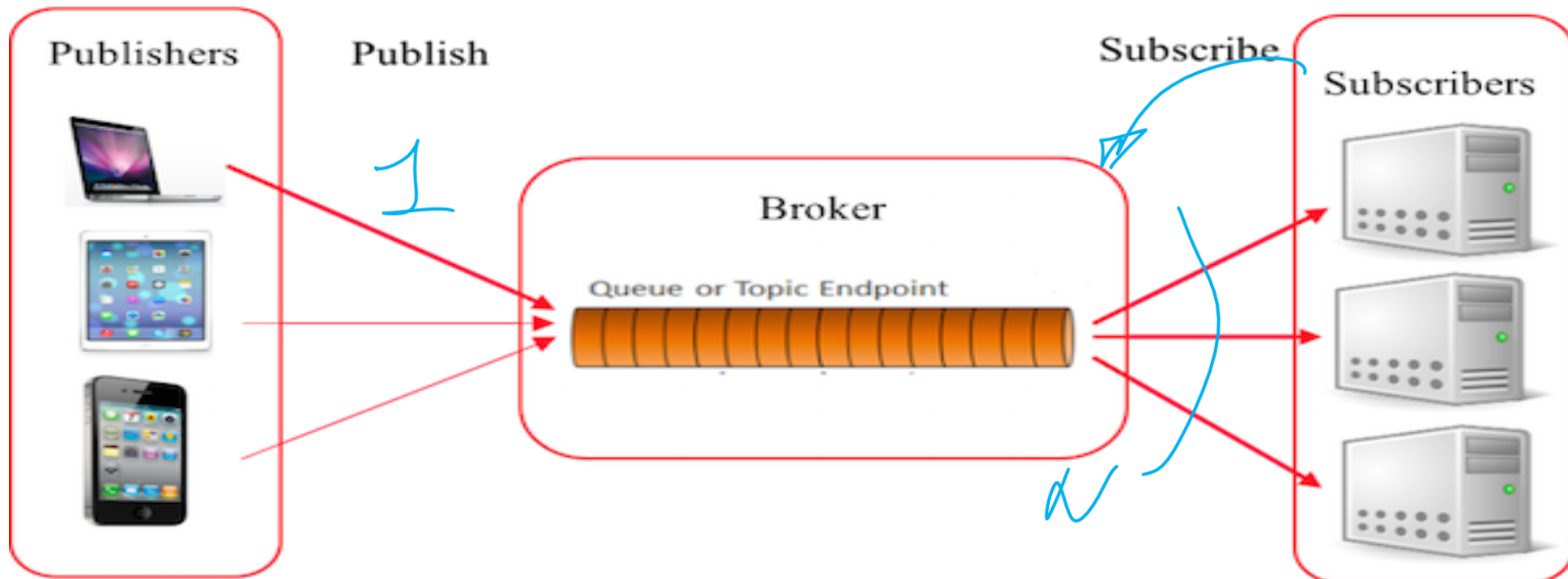
Protocols	UDP/TCP	Architecture	Security and QoS	Header Size (bytes)	Max Length(bytes)
MQTT	TCP	Pub/Sub	Both	2	5
AMQP	TCP	Pub/Sub	Both	8	-
CoAP	UDP	Req/Res	Both	4	20 (typical)
XMPP	TCP	Both	Security	-	-
DDS	TCP/UDP	Pub/Sub	QoS	-	-
NGSI	TCP/IP	pub/sub	QoS	7	—

95000

MQTT: Message Queue Telemetry Transport



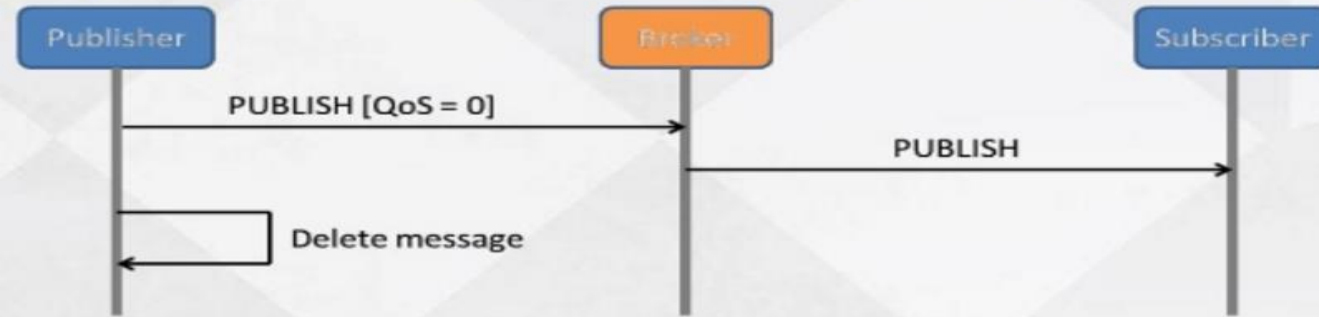
- ❑ security obtained with SSL/TLS since it is over TCP
- ❑ ISO/IEC PRF 20922
- ❑ Over TCP/IP, Async, pub/subscribe,
- ❑ payload agnostic (can be encrypted)



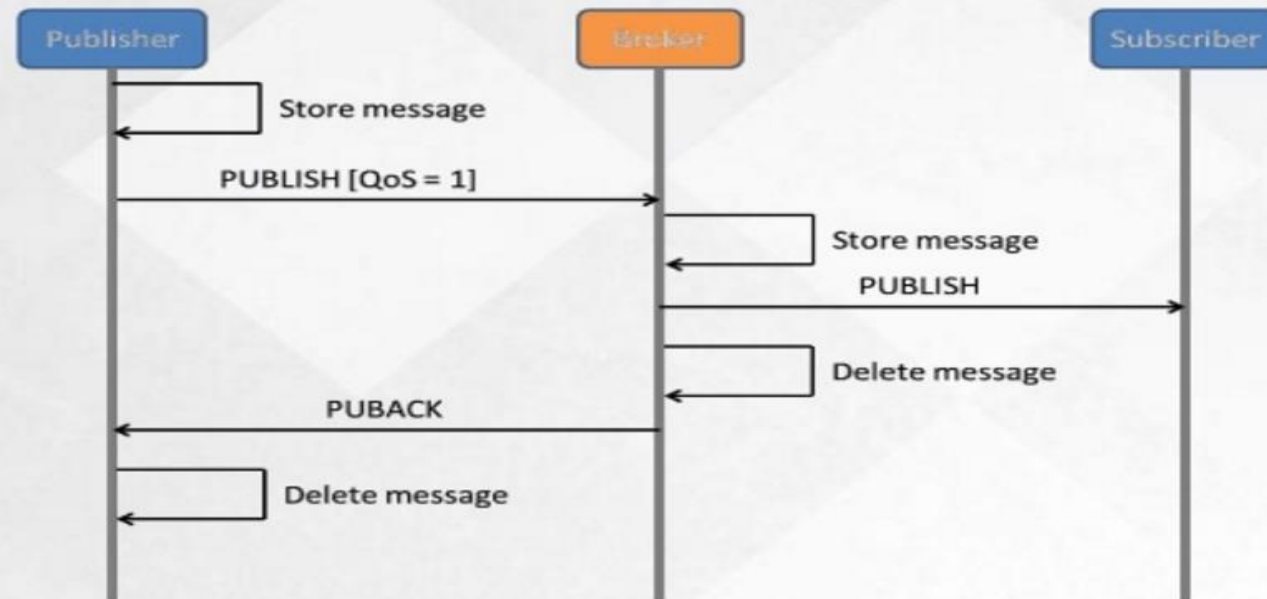
MQTT QoS



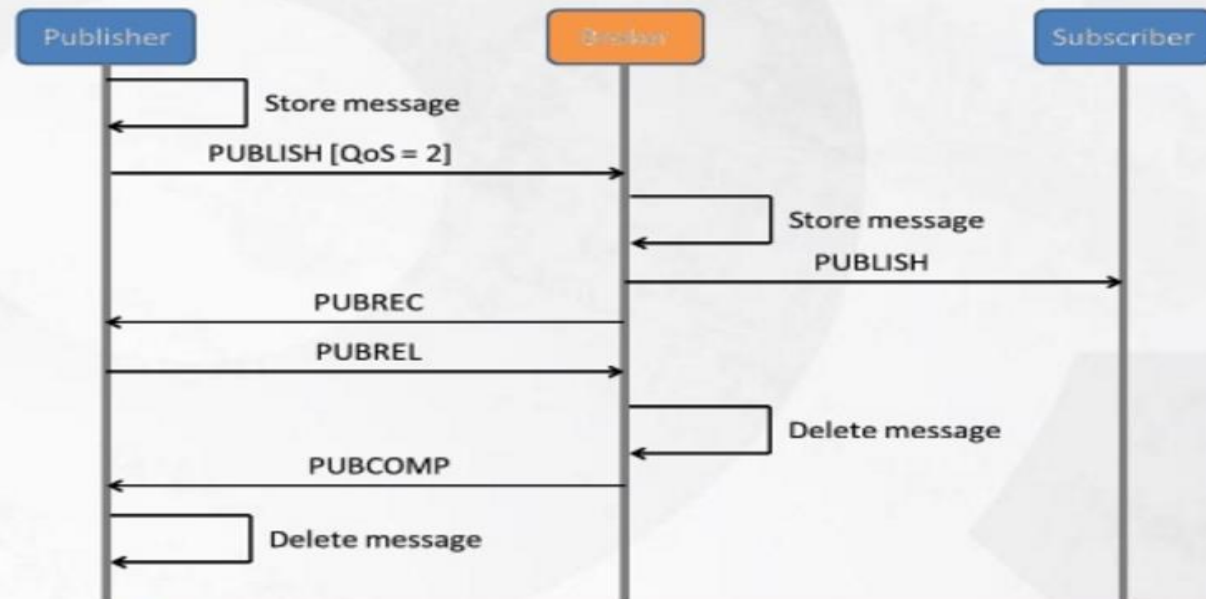
QoS 0 : At most once (fire and forget)



QoS 1 : At least once



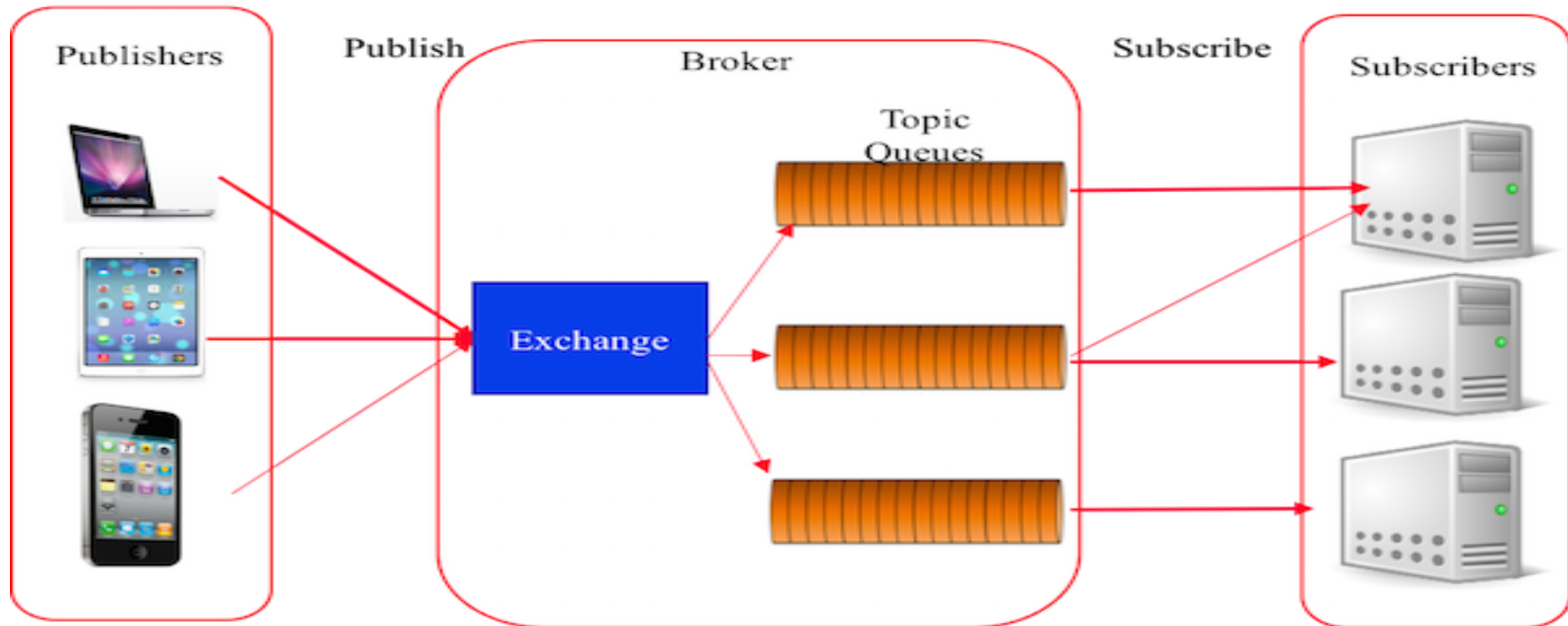
QoS 2 : Exactly once





AMQP Advanced Message Queuing Protocol

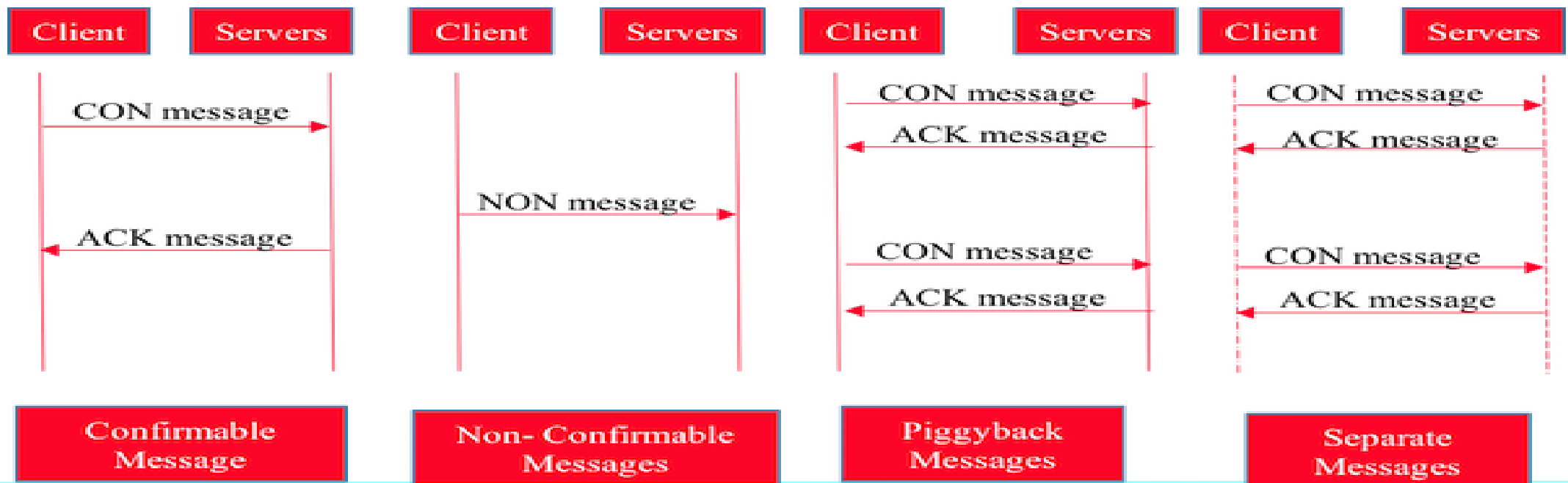
- ❑ Over TCP, binary wire protocol
- ❑ Exchange decoupling



CoAP: Constrained Application Protocol



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



Other protocols



STOMP: Streaming Text Oriented Messaging Protocol

- ♣ Similar to HTTP

□ **XMPP**: Extensible Messaging and Presence Protocol

- ♣ Based on XML, proposed by IETF
- ♣ Over TCP, can use HTTP

□ **WAMP**: Web Application Messaging Protocol

- ♣ WebSocket protocol by IANA
- ♣ Over level 6

□ **SNMP** by IETF, level 7

- ♣ Over UDP, or IP
- ♣ Monitoring status of servers

□ **SigFOX**

□ **OneM2M** AIOTI

- ♣ a strategic enabler for IoT applications and companies developing IoT solutions

Comparison of lowlevel IOT prot.



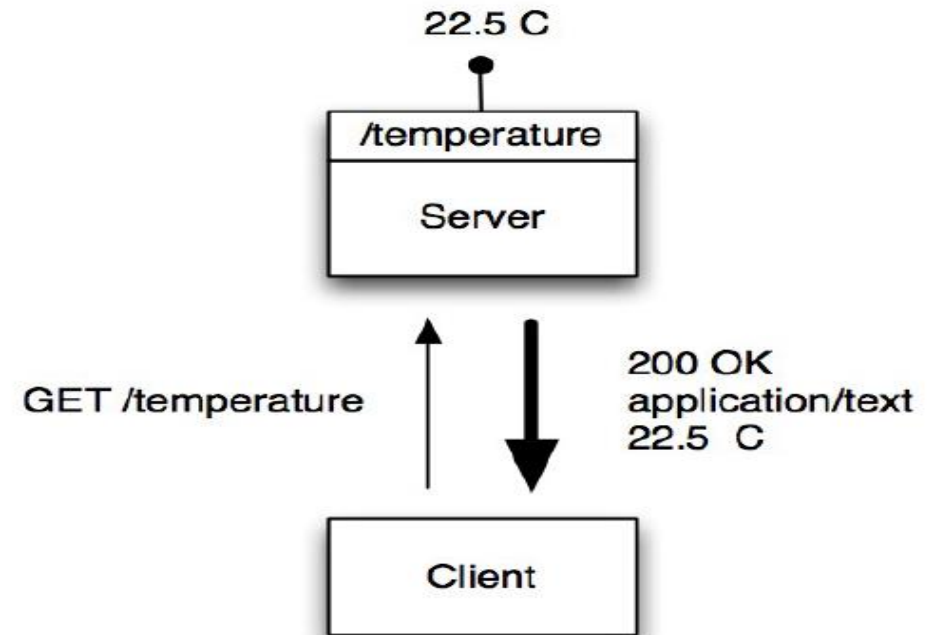
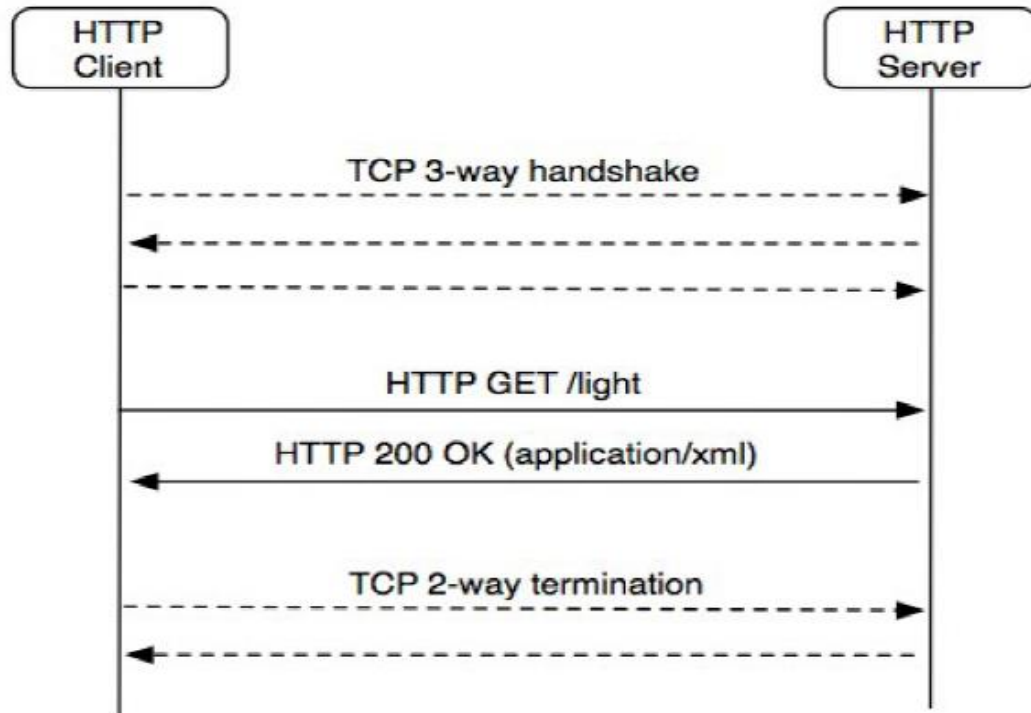
Protocolli IoT	Standard	Frequenza	Range	Data Rates
Bluetooth	Bluetooth 4.2	2.4GHz (ISM)	50-150m (Smart/BLE)	1Mbps (Smart/BLE)
ZigBee	ZigBee 3.0 based on IEEE802.15.4	2.4GHz	10-100m	250kbps
6LoWPAN	RFC6282	(adapted and used over a variety of other networking media including Bluetooth Smart (2.4GHz) or 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) DAR 450m	2-5km (urban environment), 15km (suburban environment) USA	0.3-50 kbps 300m

Main protocols

Create	→	POST	} HTTP Methods
Read	→	GET	
Update	→	PUT	
Delete	→	DELETE	

Protocol	How does It Work?	Use Cases
HTTP		 Web Browsing
HTTP/3 (QUIC)		 IoT Virtual Reality
HTTPS		 Web Browsing
WebSocket		 Live Chat Real-Time Data Transmission
TCP		 Web Browsing Email Protocols
UDP		 Video Conferencing
SMTP		 Sending/Receiving Emails
FTP		 Upload/Download Files

HTTP GET





HTTP Method	Request has body	Response has body	Safe	Idempotent	Cachable
GET	NO	YES	YES	YES	YES
POST	YES	YES	NO	NO	YES
PUT	YES	YES	NO	YES	NO
DELETE	YES	YES	NO	YES	NO
TRACE	NO	YES	YES	YES	NO
OPTIONS	NO	YES	YES	YES	NO
CONNECT	NO	YES	NO	NO	NO
PATCH	YES	YES	NO	NO	NO

HTTP Request Methods



GET

Retrieves data or resources from a specified URL. It is used to retrieve information without modifying it.



POST

Submits data or creates a new resource on the server. It is used to send data to be processed by the server, often resulting in the creation of a new resource.



PUT

Updates an existing resource with new data. It replaces the entire resource with the new representation provided.



DELETE

Deletes a specified resource on the server.



PATCH

Partially updates an existing resource. It is used to apply modifications to a resource, specifying only the changes that need to be made.



HEAD

Retrieves only the headers of a response. It is used to check the status or headers of a resource without fetching the entire content.



OPTIONS

Retrieves the allowed methods and other information about a resource.



TRACE

Echoes back the received request to the client. It is mainly used for diagnostic purposes.



CONNECT

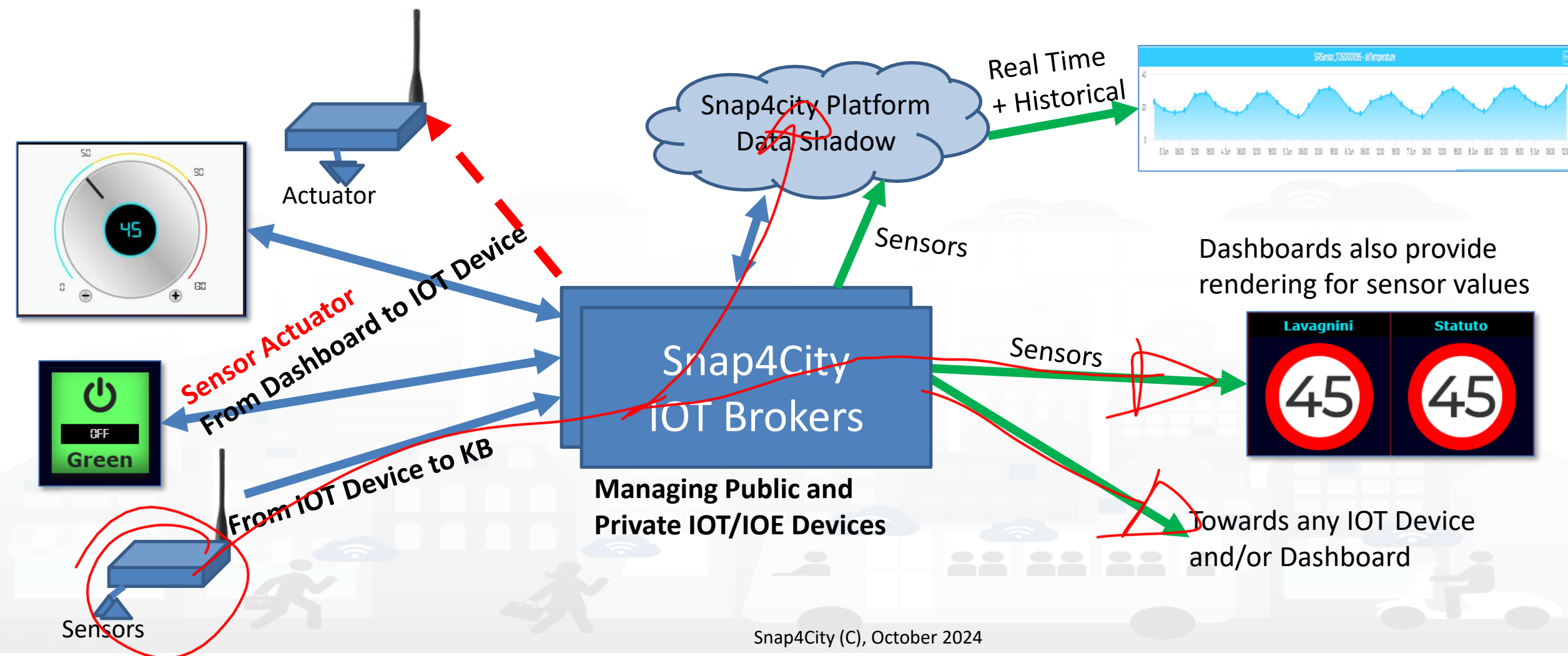
Establishes a tunnel connection to a remote server, typically through a proxy server.



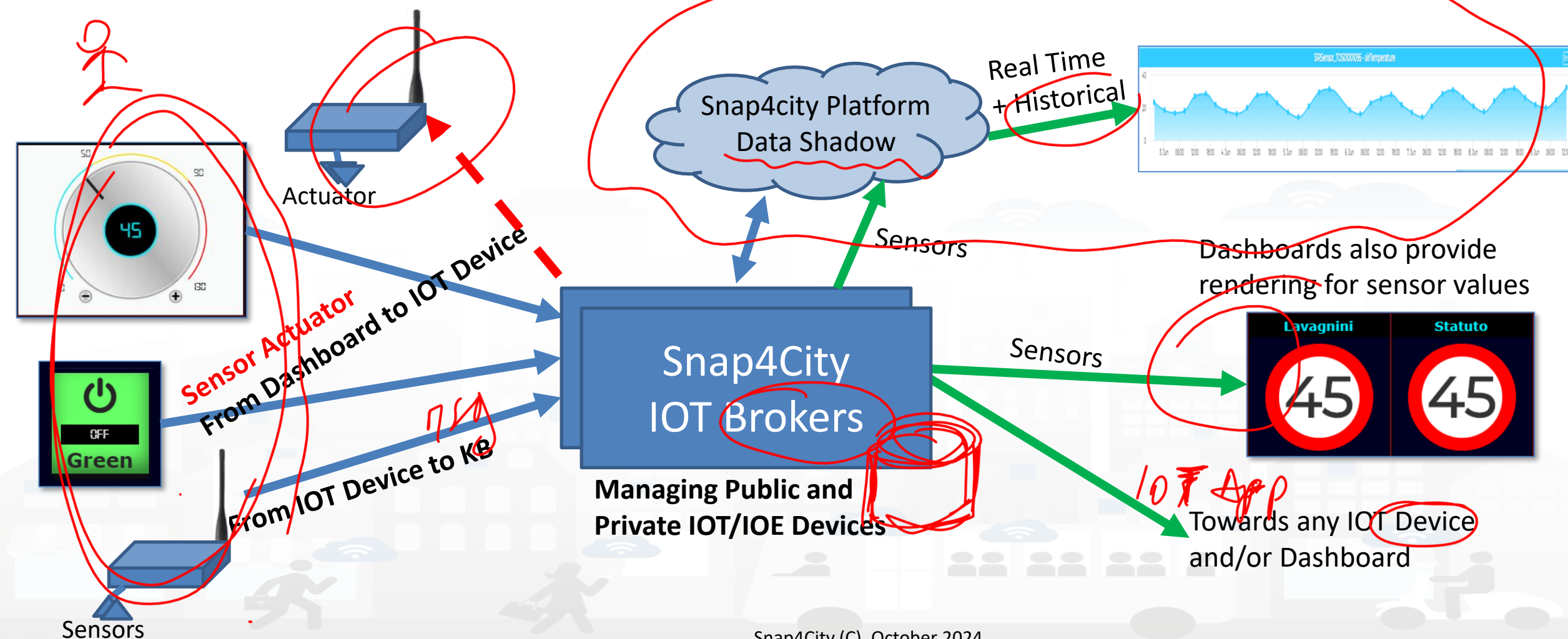
http GET vs POST

	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 Data Driven



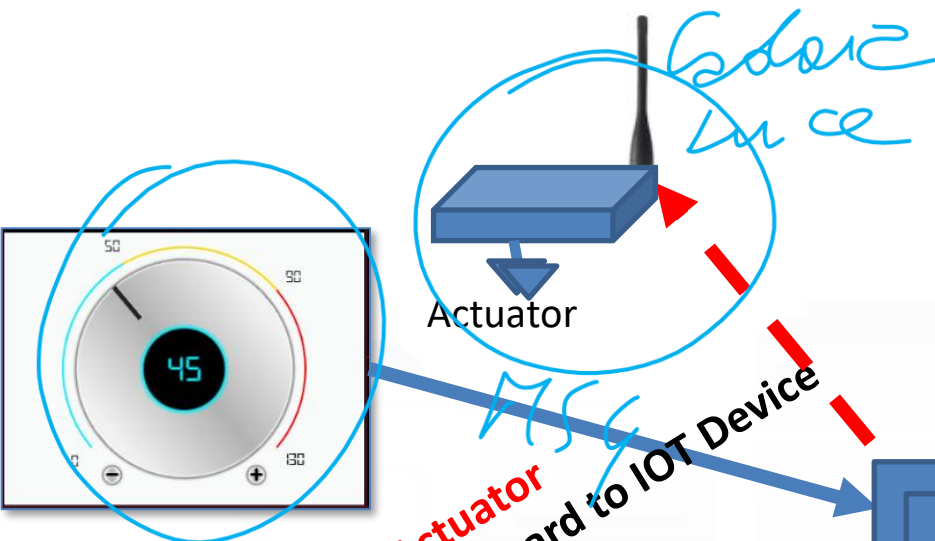
IOT Data Driven



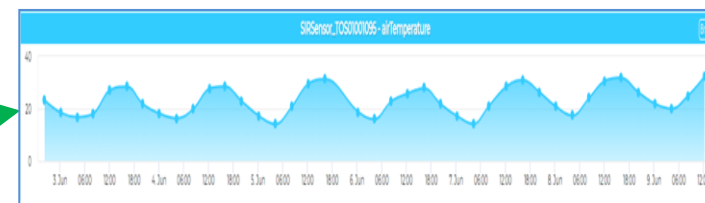
IOT Data Driven

Subscribe all

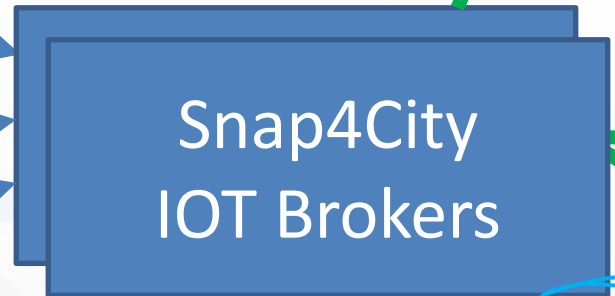
*60012
Lu ce*



Real Time
+ Historical



Dashboards also provide
rendering for sensor values



Sensors

Towards any IOT Device
and/or Dashboard

Sensors

IOT Architectures Comparison



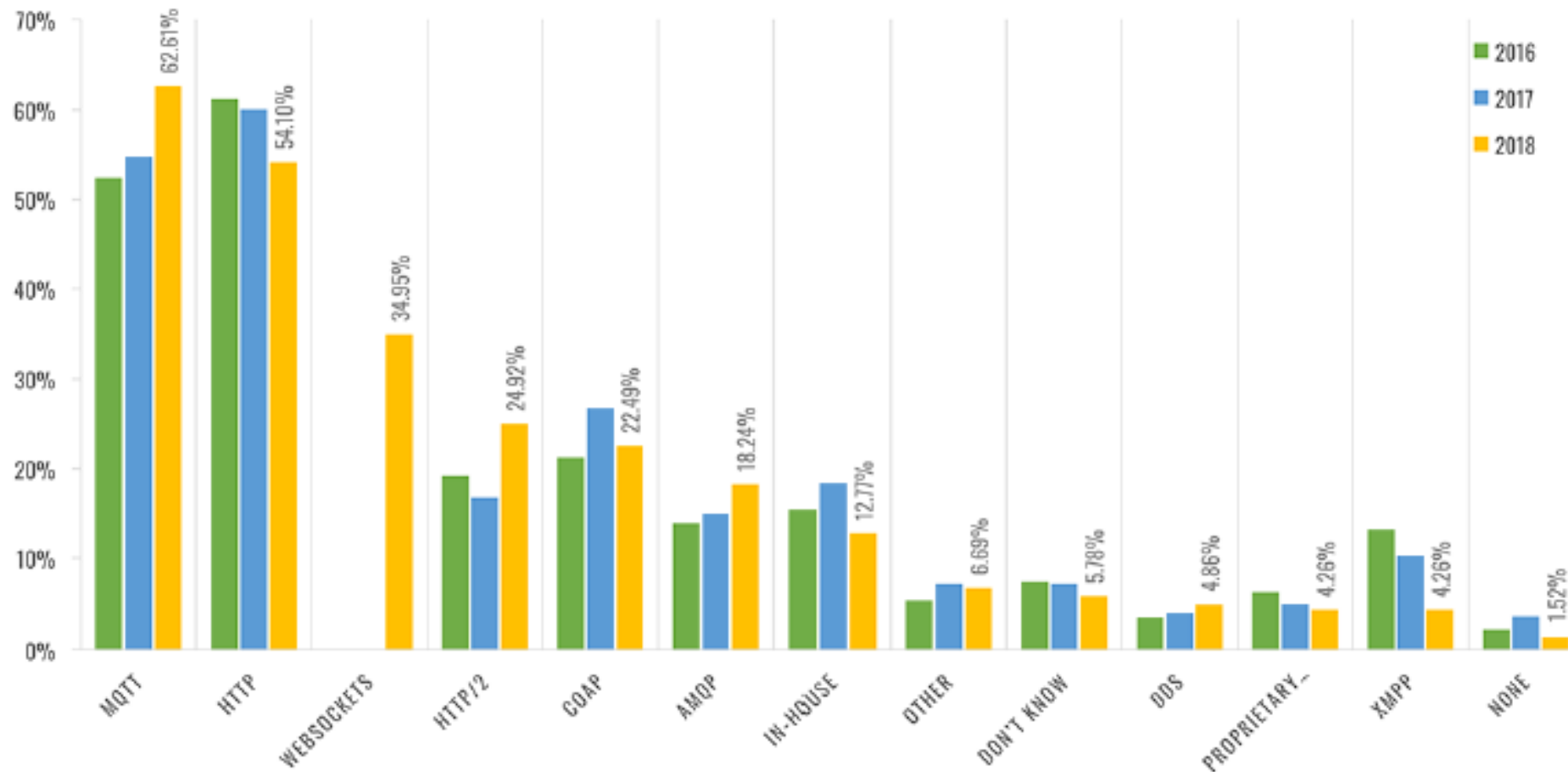
	IoT Discovery Abstraction	Authentication, Authorization, and Security end-2-end, secure on IoT and Dashboards	Open HW and Open SW	Integrated Community management	Data Types: IOT Devices, IOT App, Dashboard, Data	Data Type: Publish/share, Delegation, Consent and change	Data Type: Download and Delete	Auditing 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
Snap4City	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
Thingsboard [55]	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	Y
IOT eclipse.org [56]	N	N	N	(Y)	N	Y	N	N	N	Y	Y	N	N	N	Y	N	N	N
IOT IGNITE [57]	N	Y	N	Y	N	Y	N	Y	Y	Y	Y	Y	N	N	N	N	Y	Y
FIWARE [47]	N	Y	N	Y	N	N	N	Y	N	Y	(Y)	(N)	Y	N	Y	N	N	Y
ARM mbed IoT [48]	Y	Y	Y	Y	Y	N	(N)	N	Y	Y	Y	N	N	N	Y	N	N	Y
Airvantage [51]	Y	Y	Y	Y	N	Y	N	Y	Y	Y	Y	N	N	N	N	N	N	Y
AWS [43]	Y	Y	Y	Y	N	Y	(N)	Y	Y	N	Y	N	N	N	Y	Y	(Y)	Y
Azure IOT [44]	Y	Y	Y	Y	Y	Y	Y	Y	Y	N	Y	N	N	N	Y	Y	(Y)	Y
PTC ThingWorkx [59]	N	Y	Y	Y	Y	Y	N	N	Y	N	Y	Y	N	N	Y	N	N	Y
Bosch IoT Suite [58]	Y	Y	Y	Y	Y	(Y)	(N)	Y	Y	N	Y	Y	Y	N	Y	N	Y	Y
CISCO Jasper [55]	Y	Y	Y	Y	N	(Y)	(N)	N	Y	N	Y	N	N	N	N	--	(Y)	Y
Siemens MindSphere [60]	Y	Y	Y	(Y)	N	Y	(N)	Y	Y	N	Y	Y	N	N	Y	N	Y	Y
Carriots [54]	Y	Y	Y	(Y)	N	Y	N	N	Y	N	Y	N	N	N	--	N	N	Y
Google IOT [45]	Y	Y	Y	Y	Y	Y	N	Y	Y	N	Y	N	N	N	N	N	(Y)	(Y)
Homekit Apple [50]	Y	Y	Y	Y	N	Y	N	N	Y	N	(Y)	N	N	N	N	Y	N	Y
Smarthing Samsung [52]	Y	Y	Y	Y	Y	Y	(Y)	Y	Y	N	(Y)	N	N	N	N	N	N	Y

Solution



Limiting on Data Type Access

	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.

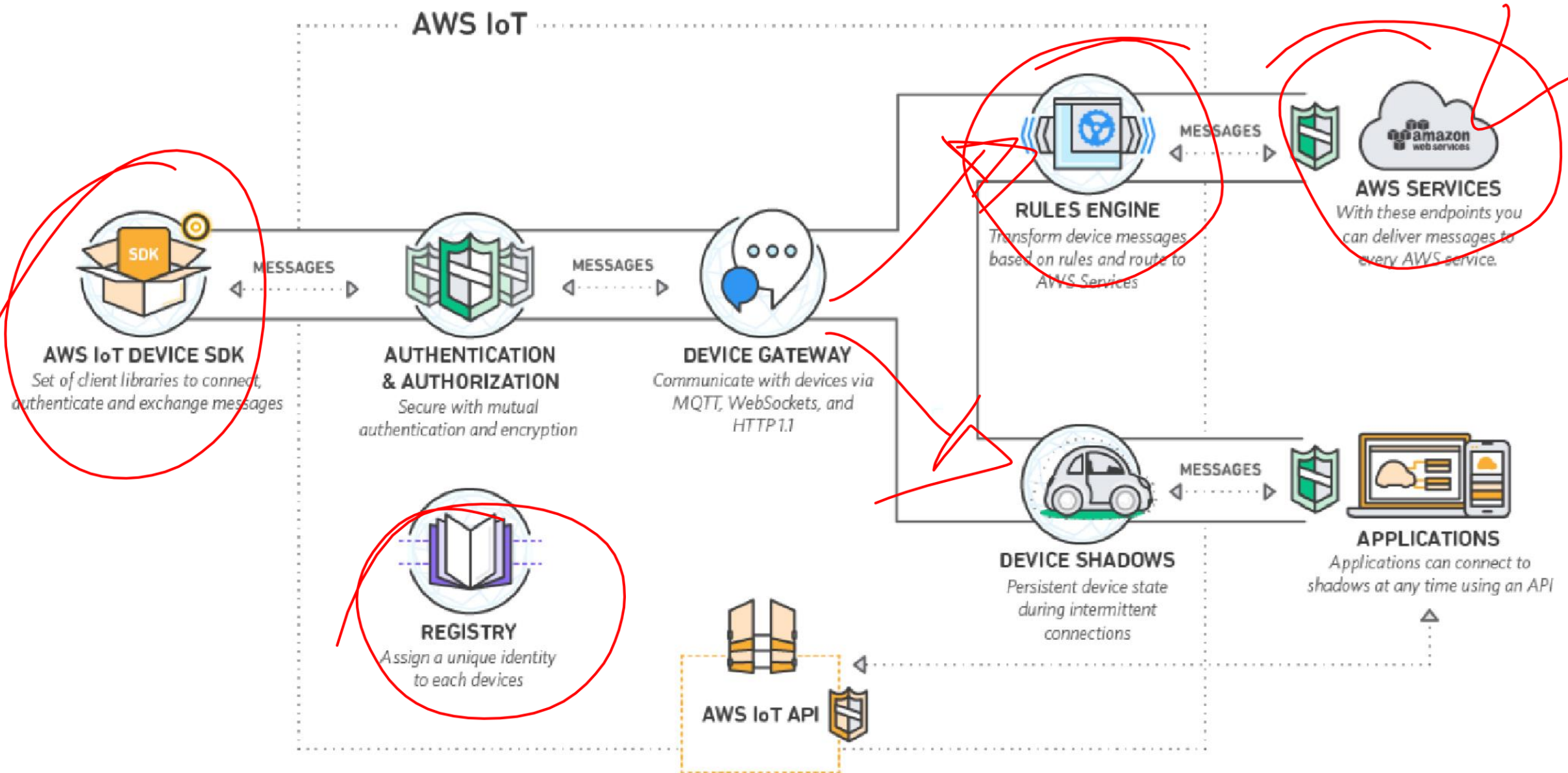
	Azure IoT	AWS	Google IoT
Edge			
Storage	Blob, CosmosDB, SQL		
Big Data			
Data Visualization	Power Bi		
Artificial Intelligence			
Intelligence API	Language, Speech, Vision, Knowledge		

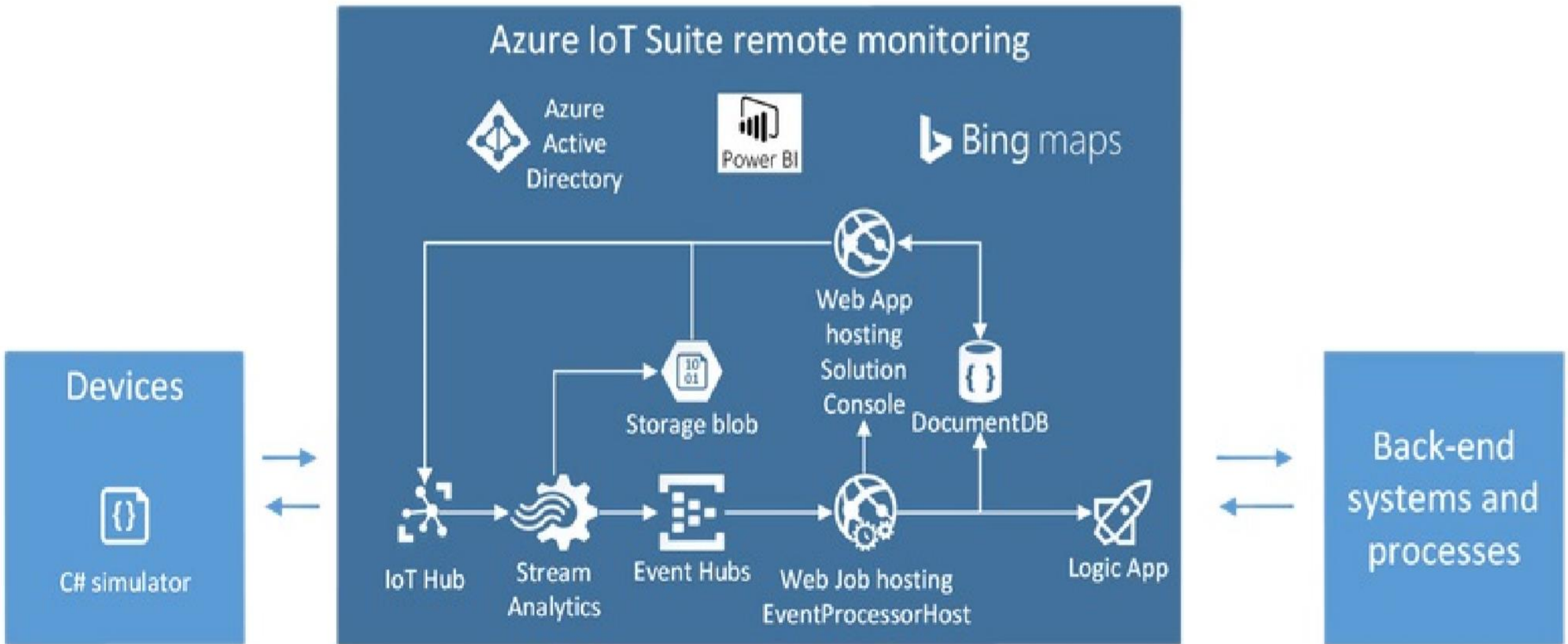
	Azure IoT	AWS	Google IoT
Prezzo	Diverse fasce di prezzo in base al numero di messaggi scambiati	Costo unitario per messaggio e per tempo di connessione del dispositivo	Costo basato sul volume di dati scambiati

	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

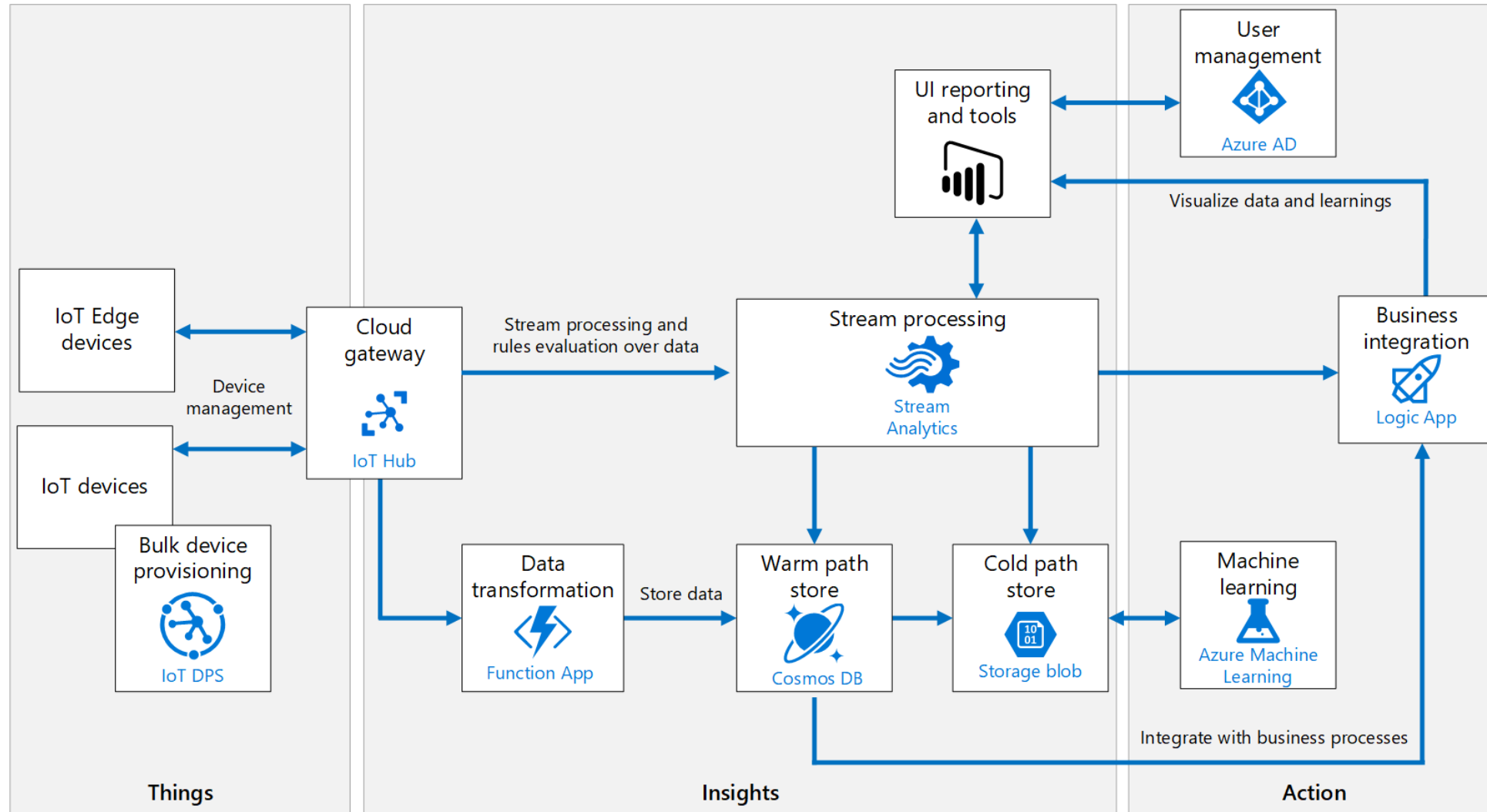
	Azure IoT	AWS	Google IoT
Protocolli	MQTT, AMQP, MQTT on WebSocket, HTTPS, AMQP on WebSocket	MQTT, MQTT on WebSocket, HTTPS	MQTT, HTTP
Communication Patterns	Telemetry, Query, Notification, Command	Telemetry, Query, Notification, Command	Telemetry, Query, Notification, Command

	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%

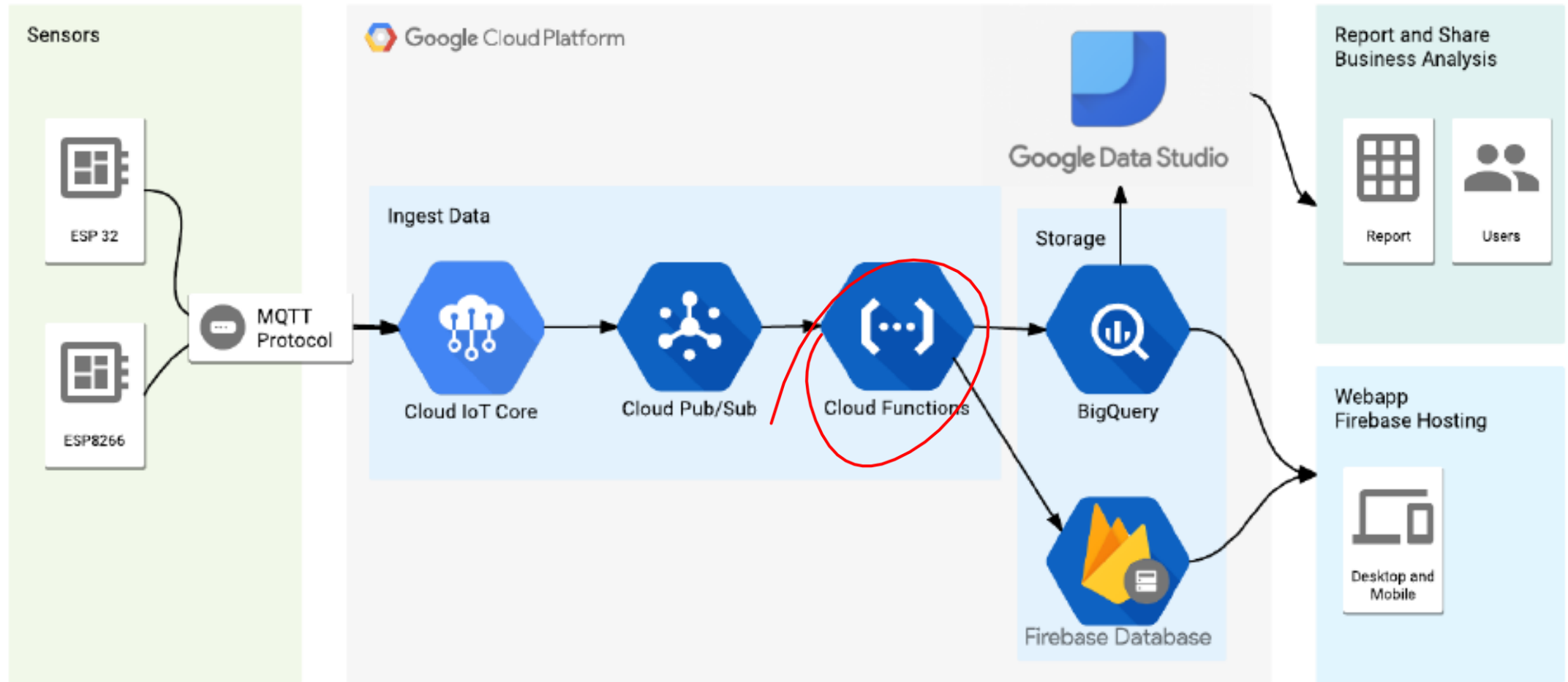




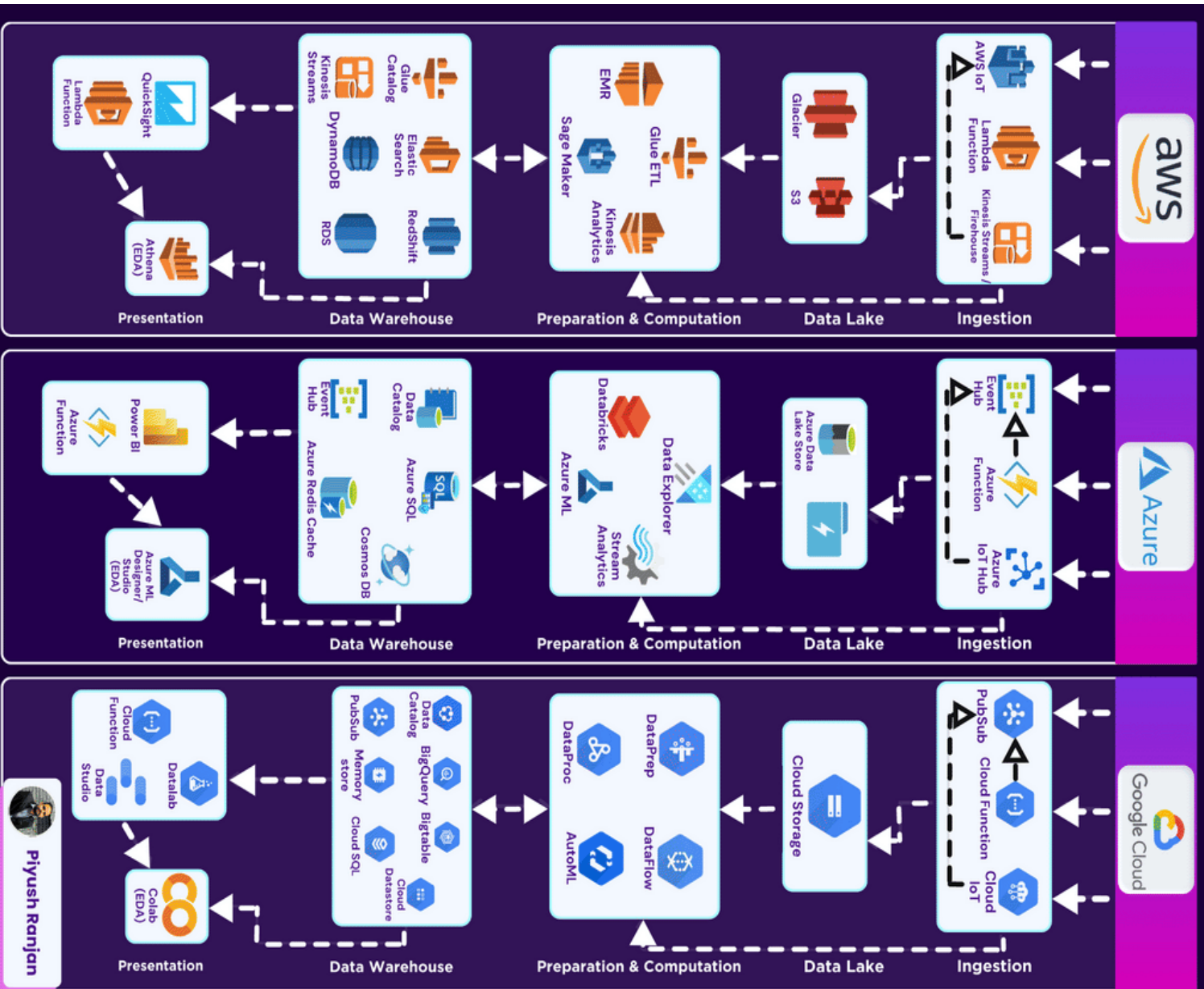
Azure Microsoft IoT (1)

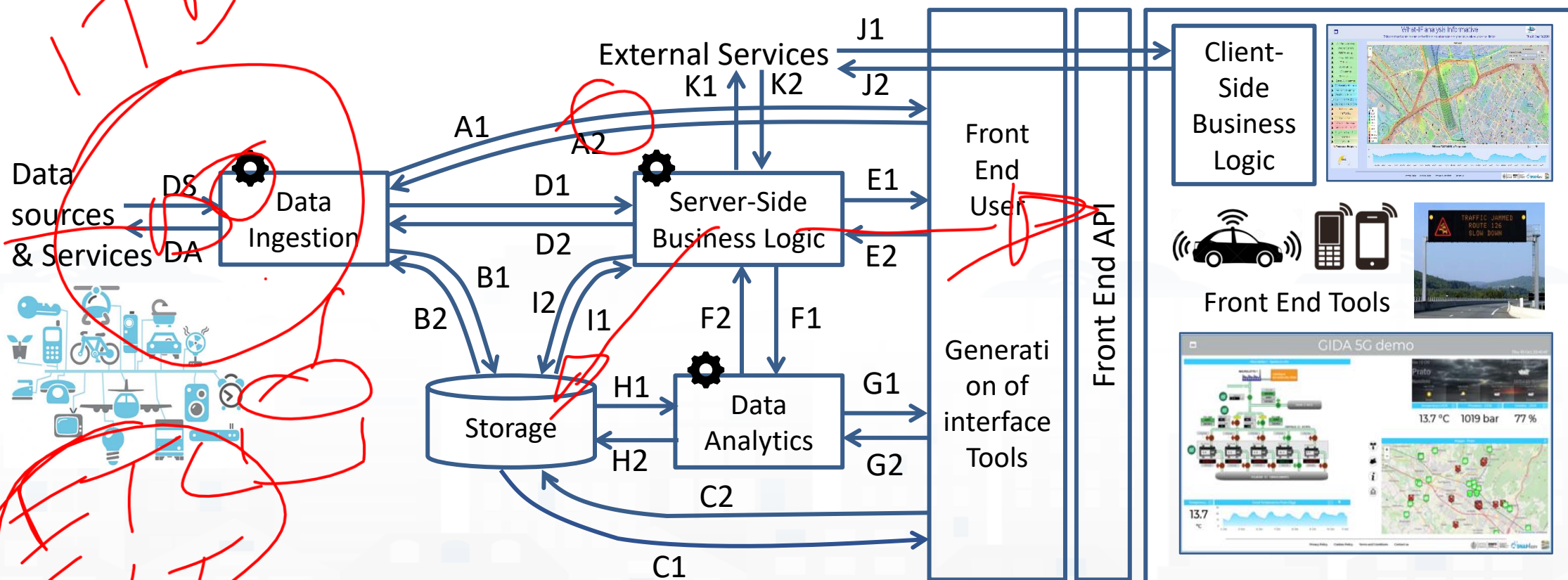


Google IoT (1)



Data Pipelines on AWS, Azure and GCP





Requirements and Objectives

- Serve as a **City Dashboard, App User Interface**, etc.
 - Real time and historical data, any device, sensors and actuators
 - Sensors, KPI, maps, data trends, real time data, charts, etc.
 - Multi domain, smart city + industry 4.0 scenarios
- Referral / **historical data, and Open Data**:
 - shadow, access (API, storage, any protocol), production of OD, export
- **Data Driven Real Time communication & processing**:
 - IOT Applications, IOT edge, multiple operating systems, embedded systems, **MicroServices**
 - in/out data driven from/to the field into: applications, notifications, etc.
- **Data Analytics**: Machine Learning, statistics, reasoning, ...
- **Serve as Living Lab**: open innovation, co-working; collaborative work; sharing: data, processes, dashboard, experiences, solutions,
- Experimented on **large scale cases**

SELECT
for Cities

Non functional requirements

- **Open Source** based 100%
 - Open **Standard** for communication and API for In/Out
- **Interoperability**: protocols, internal API, Smart City API, ca ,
integrate with legacy conditions in place, modular, reusable,...
 - Open to proprietary protocols as well, any protocol, any format
- **Data driven**, for reading and data analytic
- **Scalable, Robust, Distributed** and Decoupled, modular,
Service Oriented, open to external services and data sets, big data
- **Heterogeneous**: any device, private and public, custom and..
- **Security** by Design: HTTPS, TLS, ... compliant with EC
- **User Centric** Design: privacy by Design (and **GDPR**), personalized,
personal data management, ...

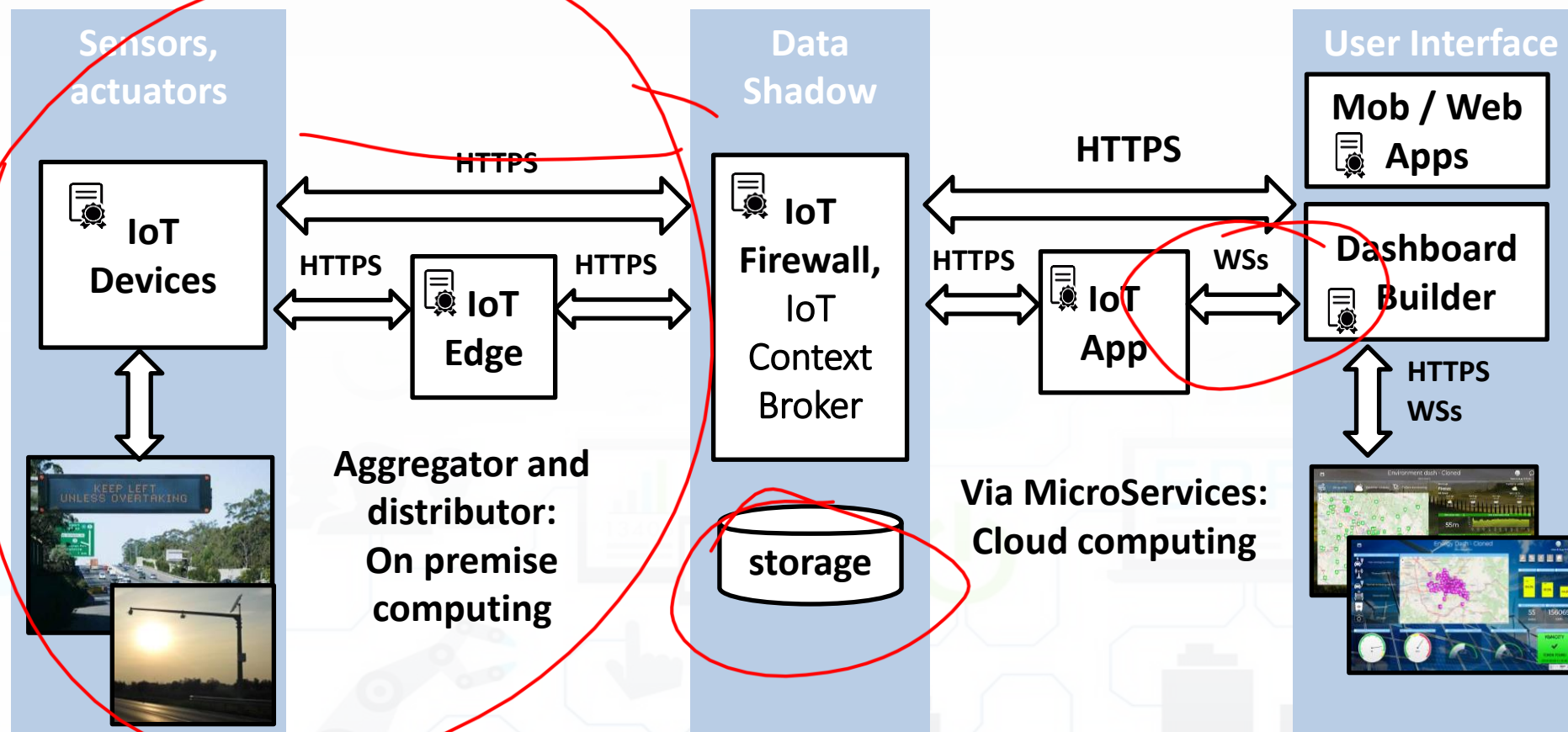


Security/Privacy Requirements



- **Managing** private data together with public data
- **Private data management** according to GDPR
 - Browsing, downloading, controlling rights, delegating access, revoking accesses, etc.
 - Keep them safe
- Secure enough to delegate management of data regarding public security:
 - Data that could be used against us by some terrorist, or anyway by someone with some bad intention, for example to access in our home when we are far away, etc.

The secure stack

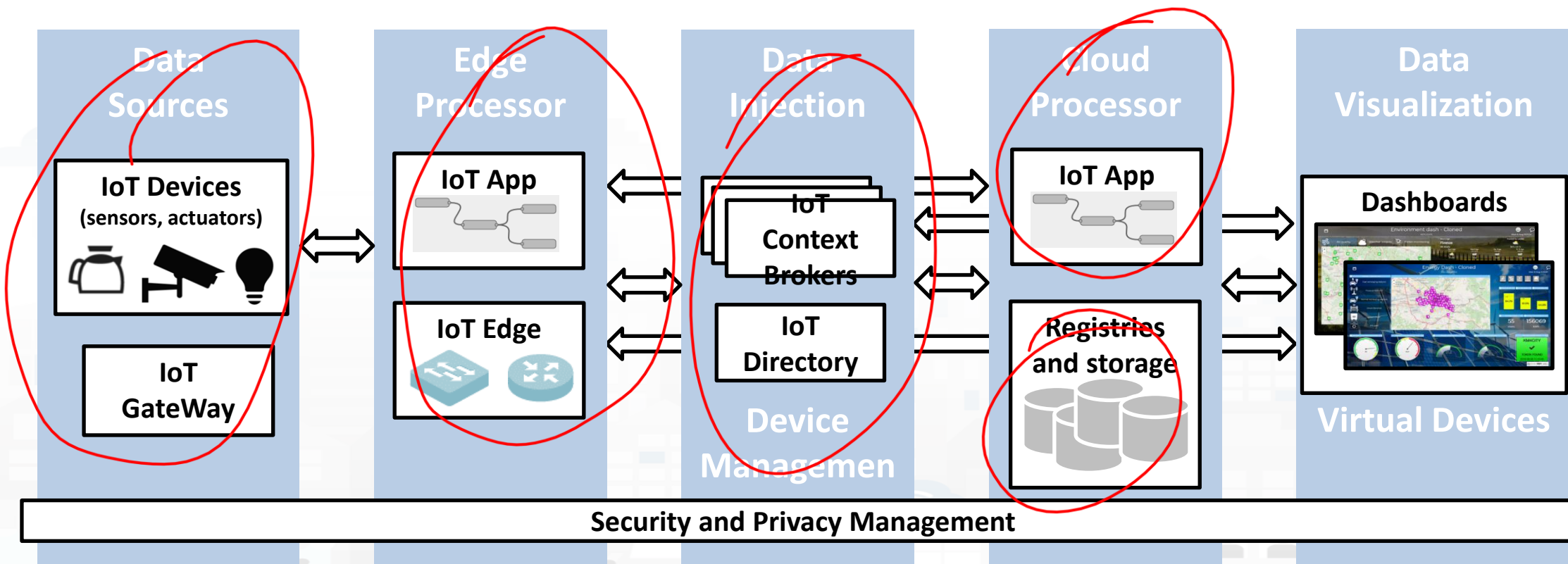


Complexity in Smart City IOT Platforms

End to End security

– From IOT Devices to Dashboard (user interface)

- H2M
- M2M





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DISIT
DISTRIBUTED SYSTEMS
AND INTERNET
TECHNOLOGIES LAB

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

Paolo Nesi, paolo.nesi@unifi.it

Snap4City Architectures

<https://www.snap4City.org>

<https://www.Km4City.org>

Parte: 4b
(2024)



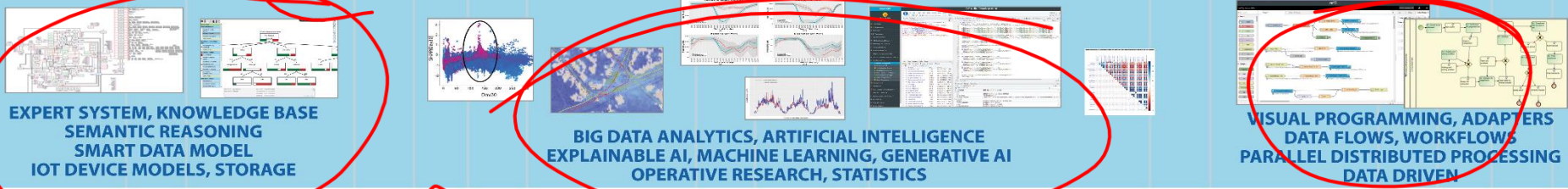
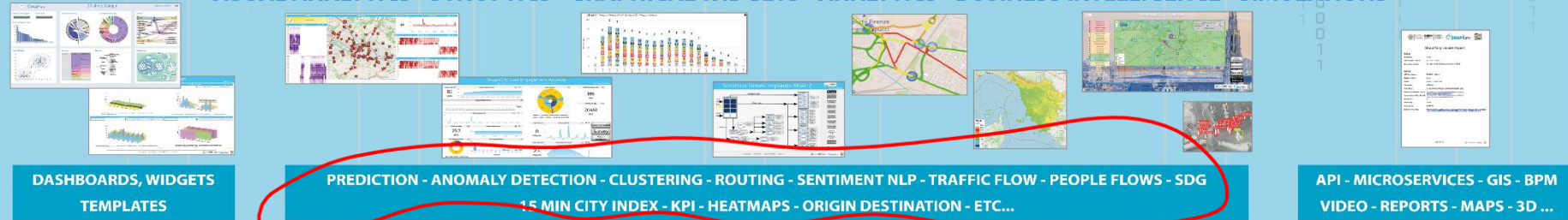


Digital Twin Solutions for Sustainability

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



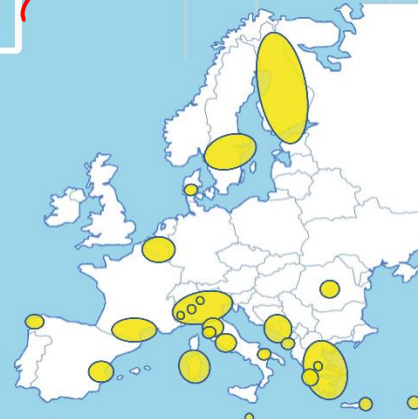
VISUAL ANALYTICS - SYNOPTICS - GRAPHICAL WIDGETS - ANALYTICS - BUSINESS INTELLIGENCE - SIMULATIONS



FULL INTEROPERABILITY, ANY DATA, BROKERS, NETWORKS AND VERTICALS



- DEVELOPMENT ENVIRONMENT AND METHODOLOGY
- VISUAL PROGRAMMING, ML, AI, HPC
- TRAINING COURSES
- LIVING LABS
- GUI CUSTOM STYLES
- FULL APPLICATIONS, DASHBOARDS AND VIEWS
- MOBILE APPS



Powered by
FIWARE

FREE
TRIAL

PEN Test
Passed

EU GDPR
COMPLIANT

SNAP4
Appliances and Dockers
Installations

EUROPEAN OPEN
SCIENCE CLOUD

Node-RED

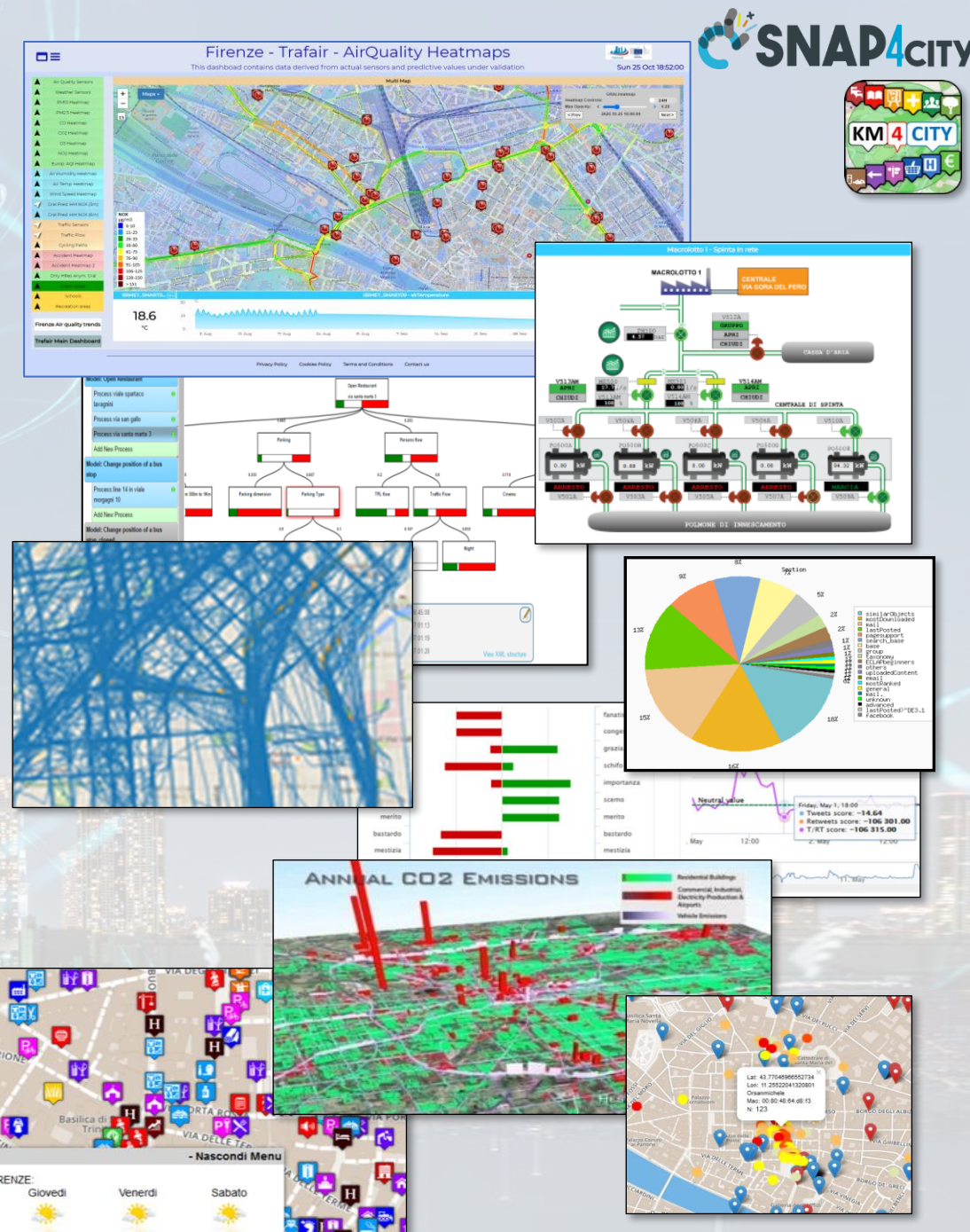
JS Foundation

E015
digital ecosystem

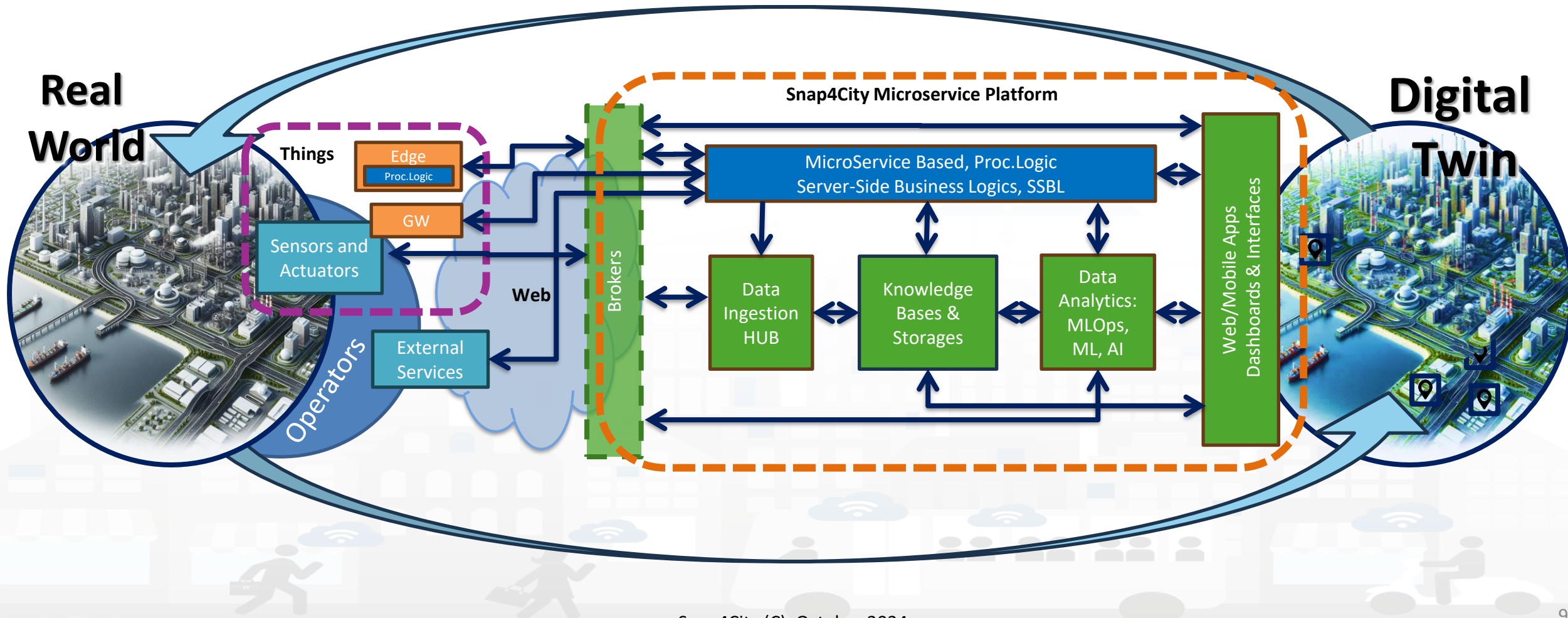
NVIDIA

Data Driven Decision Support

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

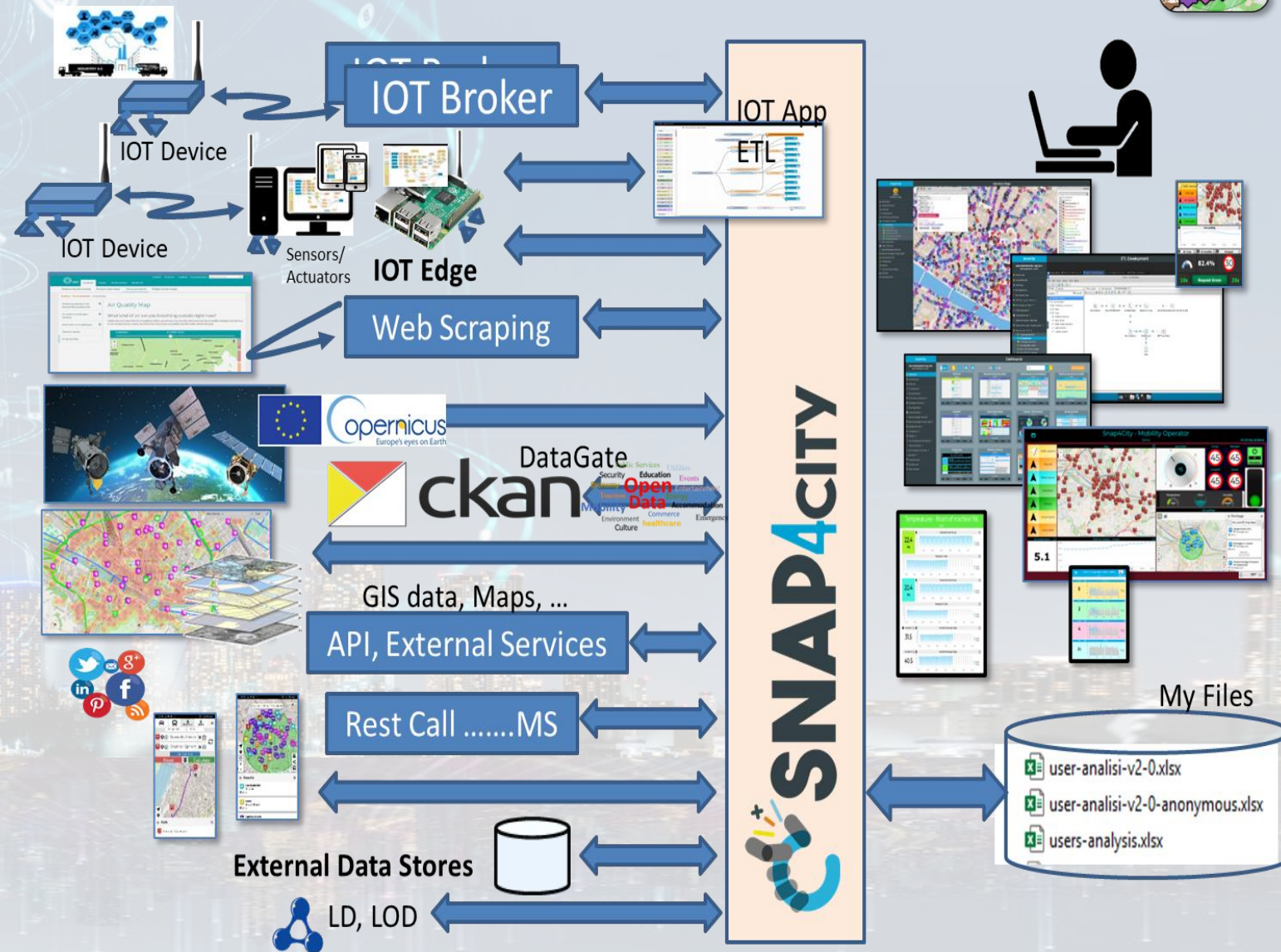


Digital Twin Development Platform



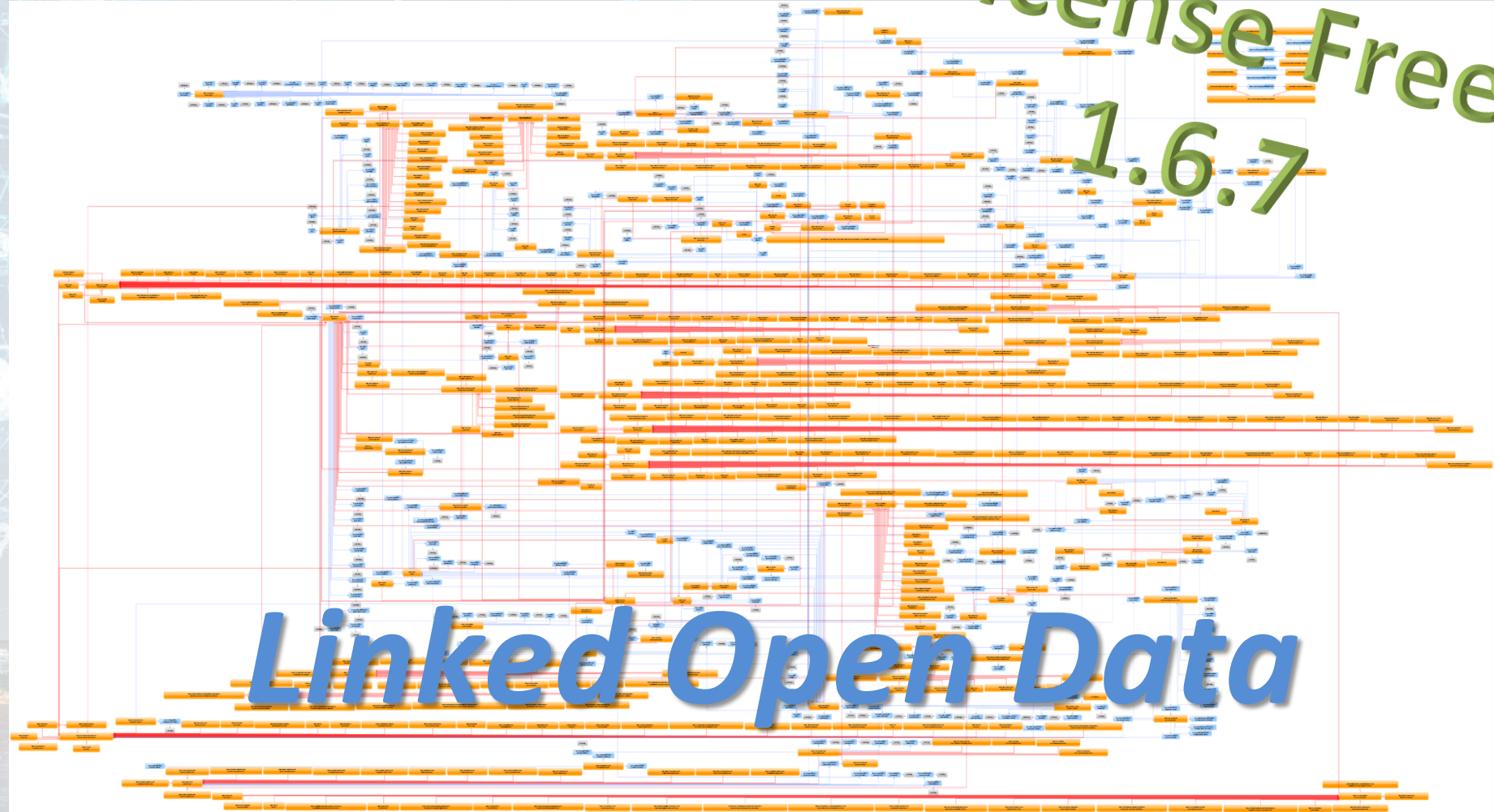
Ingestion, agg. → exploitation

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



Expert System semantic queries

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



<https://www.snap4city.org/19>

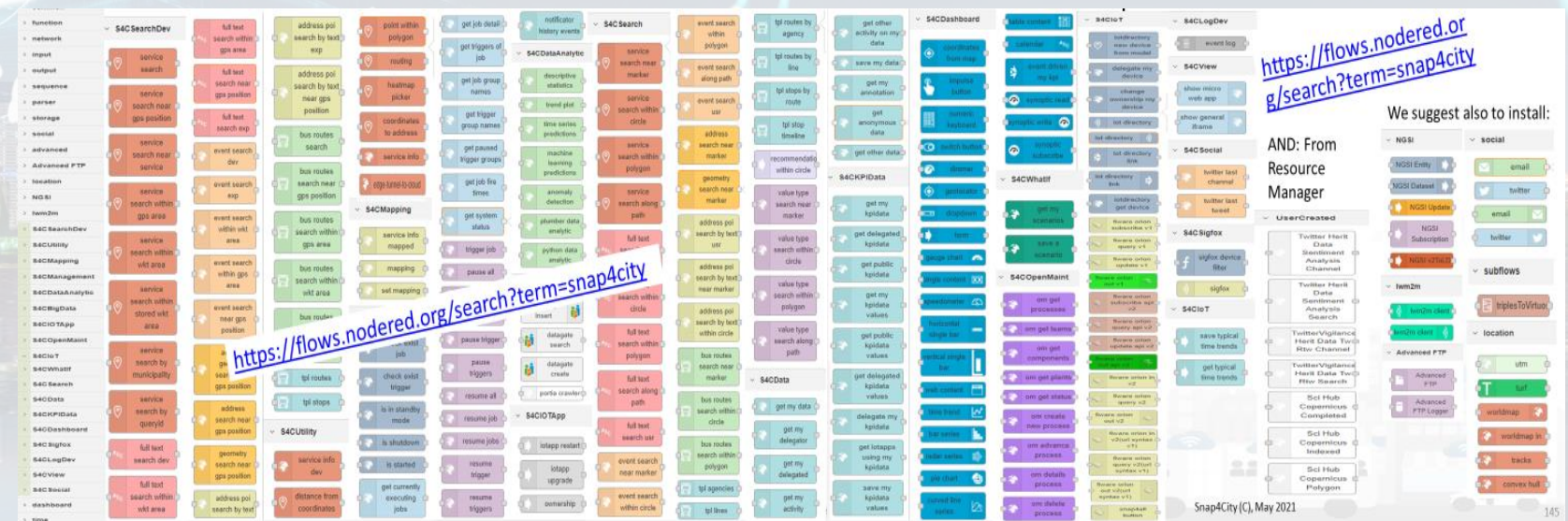
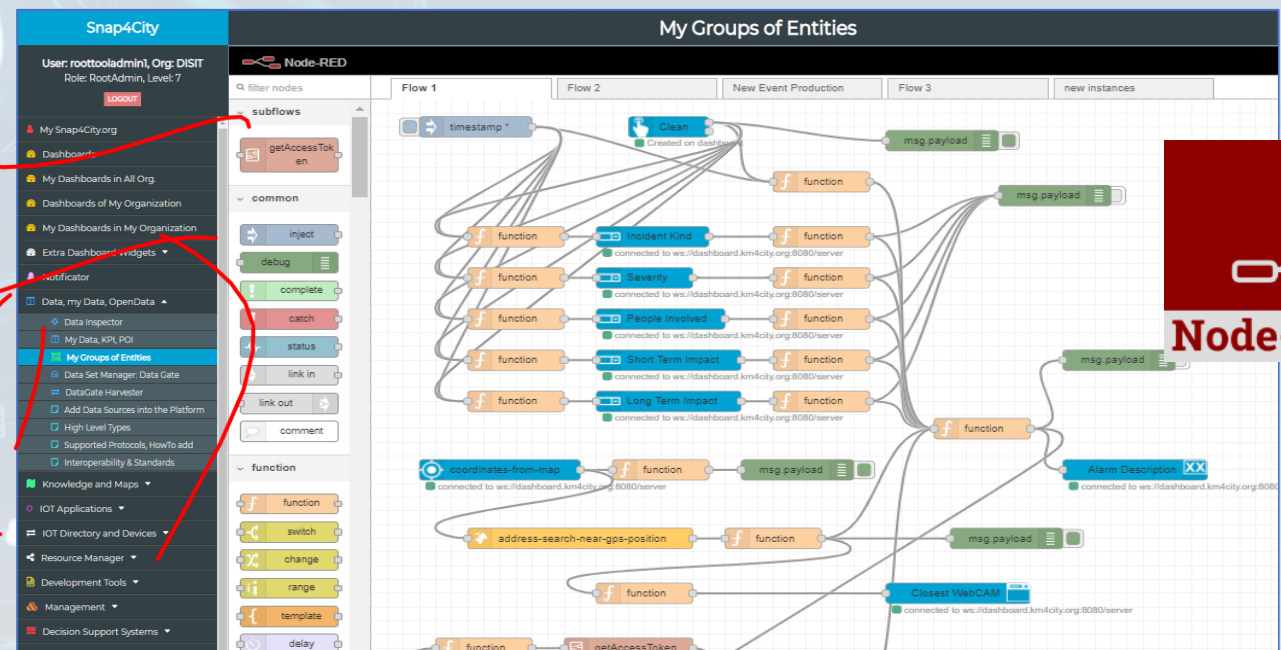
Snap4City (C), October 2024

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



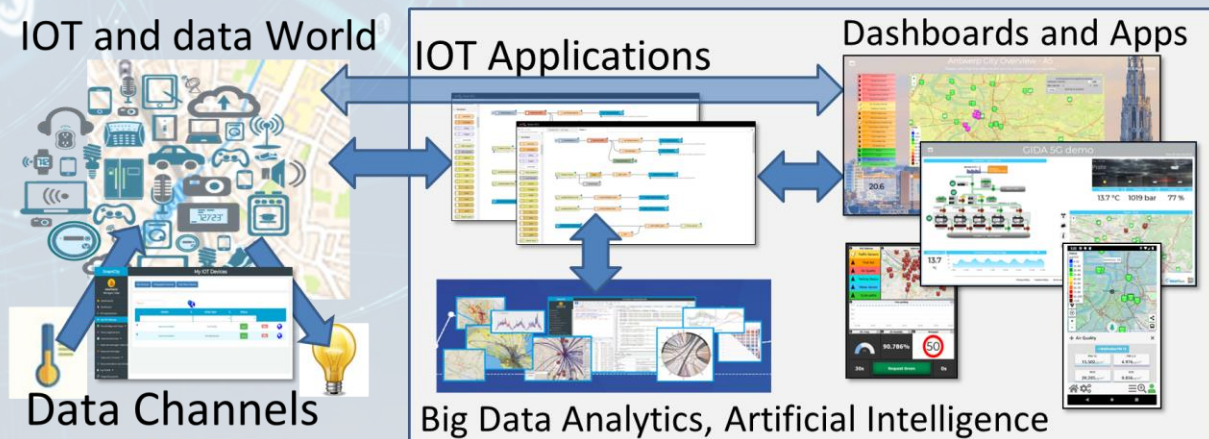
My Groups of Entities

- 
- Node-RED**

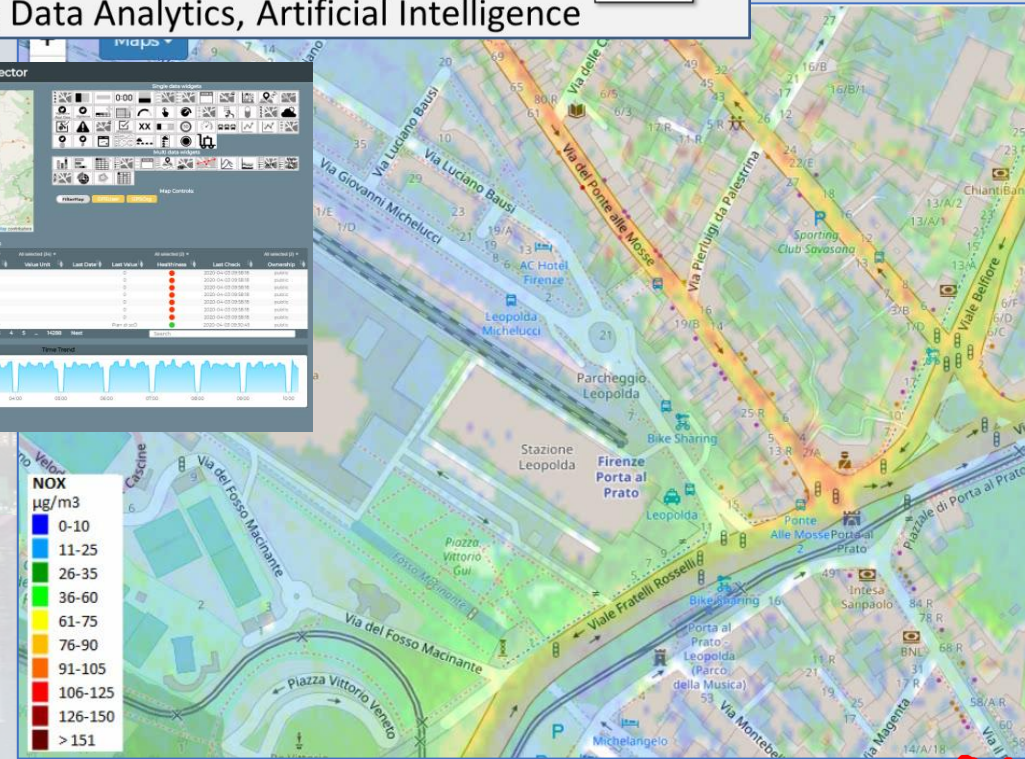
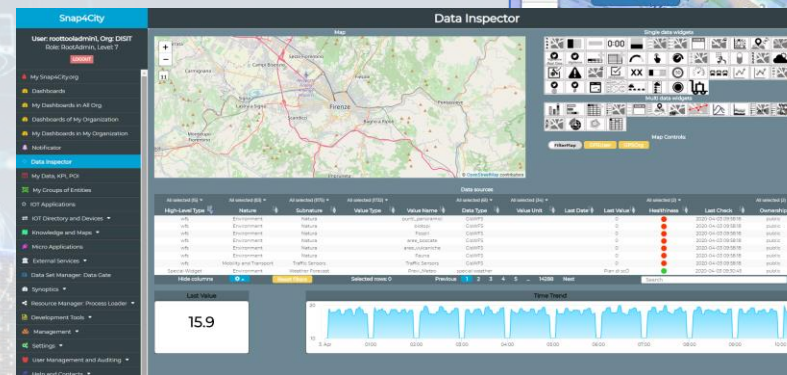


Solutions: reliable, secure and fast to realize

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



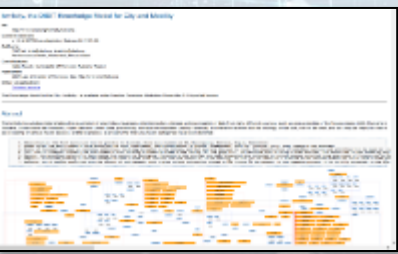
- Smart Solutions results to be
 - Real time data drive
 - Secure end-to-end
 - GDPR compliant
 - Reliable, interoperable
 - Auditable, marketable



Data Analytics on Snap4City platform



Swagger



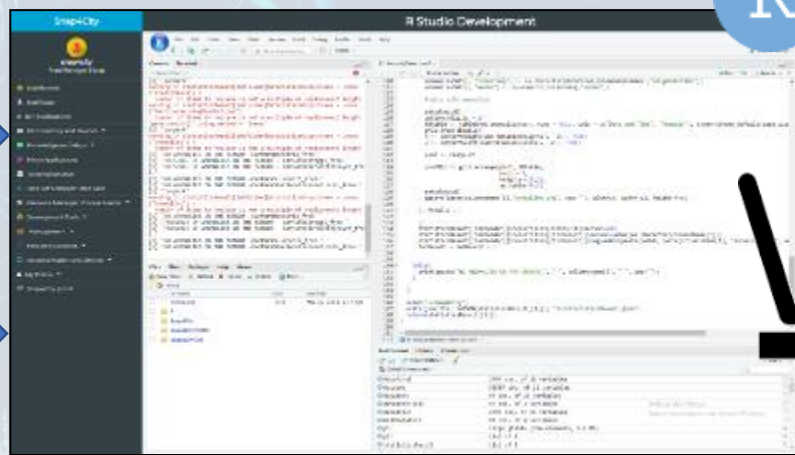
Ontology Schema



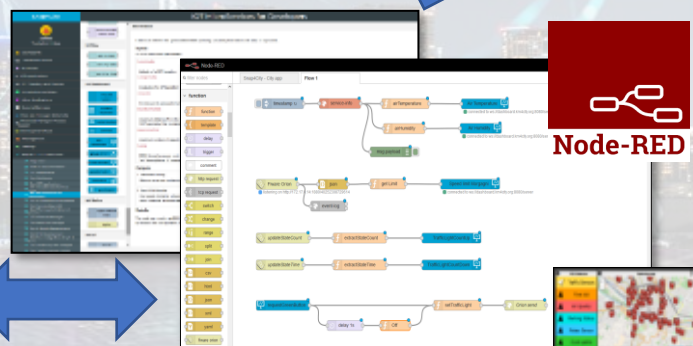
LOG.disit.org



Smart City API from Knowledge Base and other tools



Creating MicroServices

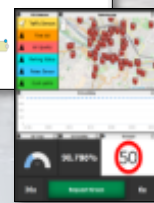


Saving / Sharing reusing

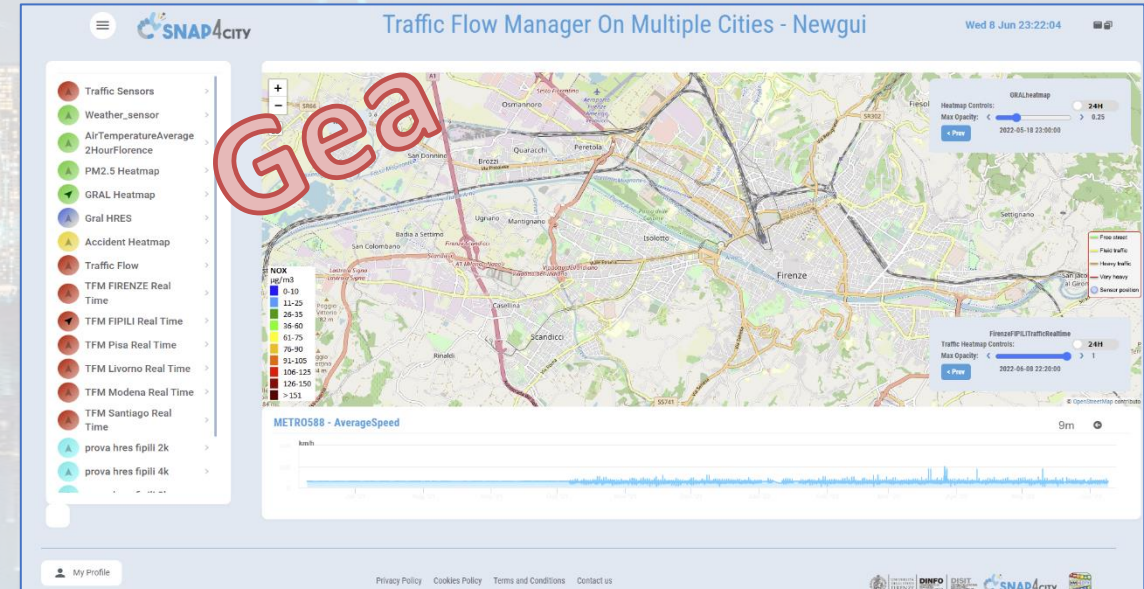
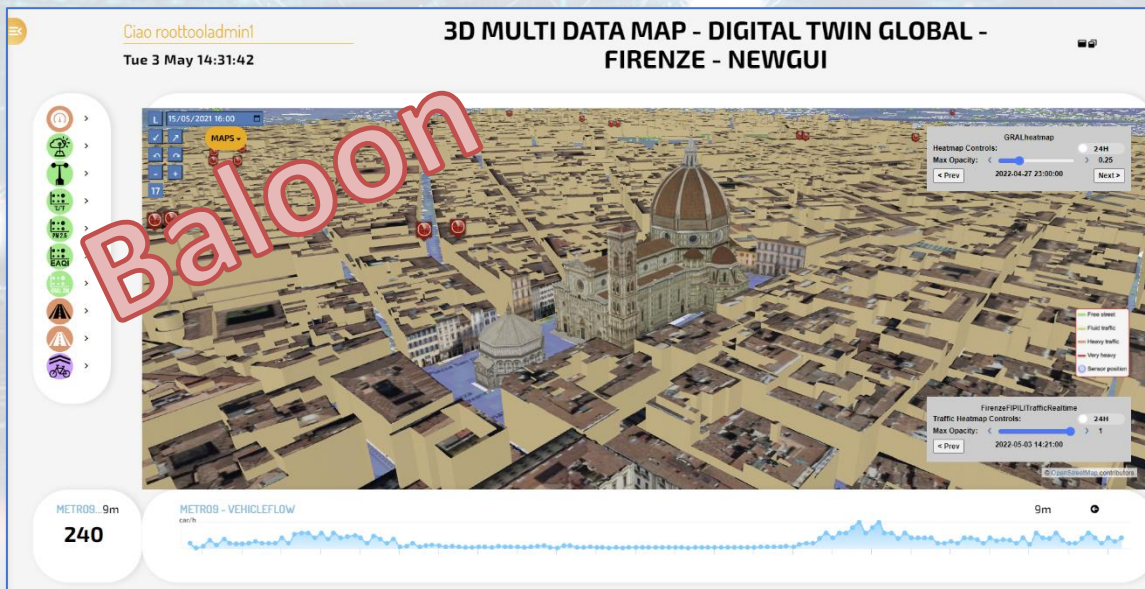
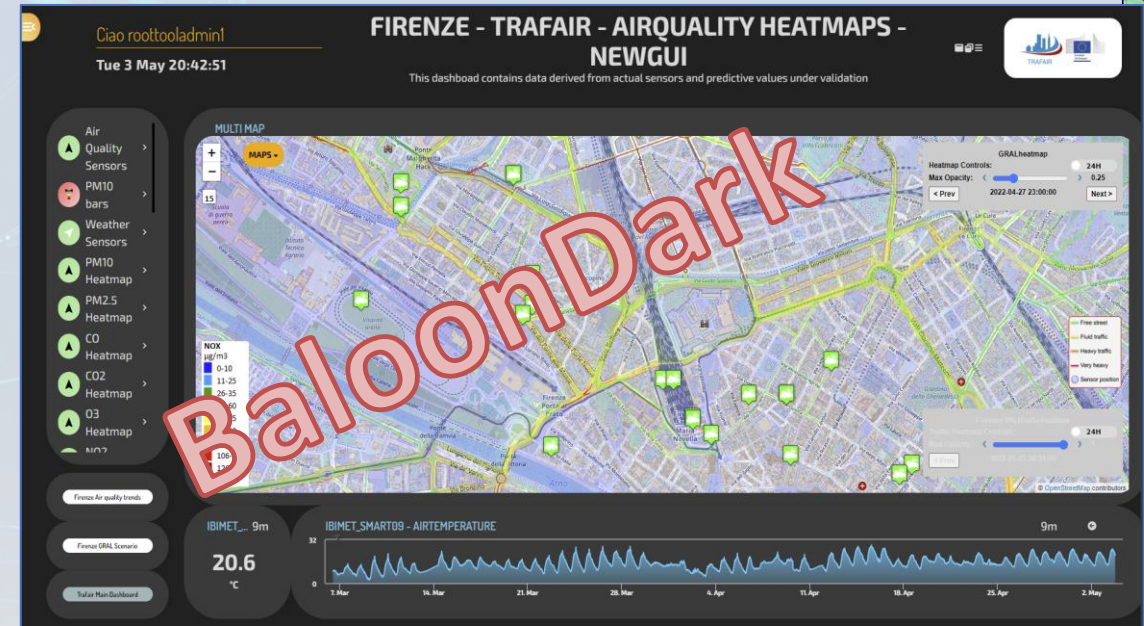
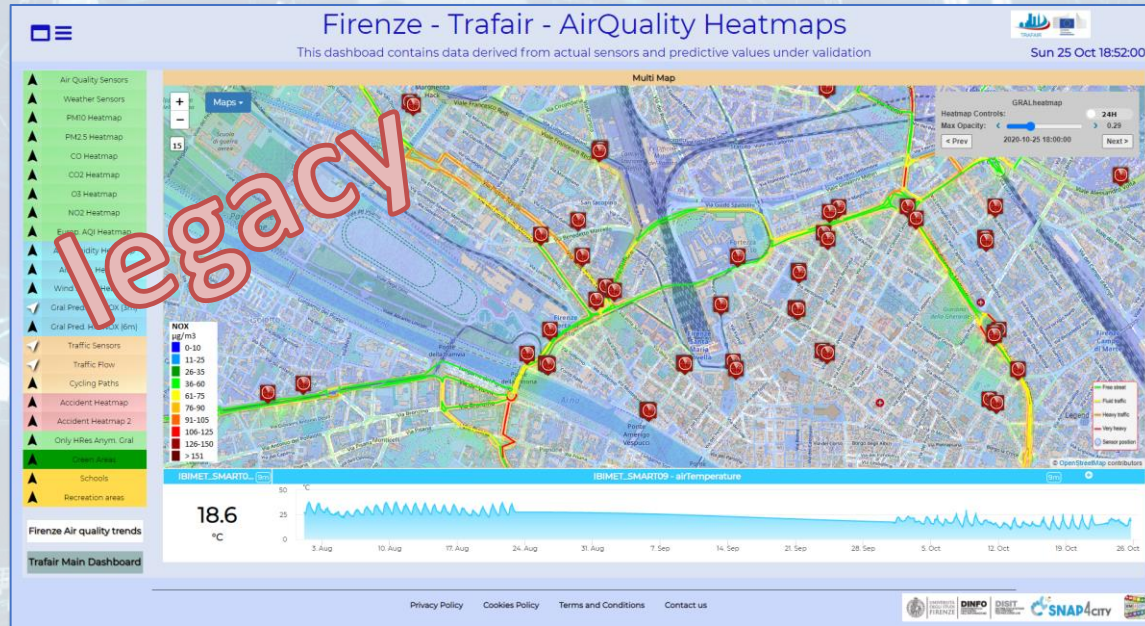


Resource Manager

Using them into IOT Applications



Different Themes



Tech Overview

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



Technical Overview

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

Snap4City:

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

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

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

Development

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



Development Life-Cycle

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

From Snap4City:

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

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

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

<https://www.snap4city.org/944>

On Line Training Material (free of charge)



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



UNIVERSITÀ
DEGLI STUDI
FIRENZE

DINFO
DIPARTIMENTO DI
INGEGNERIA
DELL'INFORMAZIONE

DISIT
DISTRIBUTED SYSTEMS
AND INTERNET
TECHNOLOGIES LAB

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

Paolo Nesi, paolo.nesi@unifi.it

Interoperability

<https://www.snap4City.org>

<https://www.Km4City.org>

Parte: 4b
(2024)



Snap4City (C), October 2024

TOP

From Time Series to complex types

FROM CITY
DASHBOARD TO
APPLICATIONS

FORGING &
MANAGING OPEN
AND FLEXIBLE WEB
AND MOBILE APPS

DATA GATHERING
AND CITY DATA
KNOWLEDGE
MANAGEMENT

IOT/IOE DEVICES
AND NETWORKS

IOT APPLICATIONS
V. APPLICATIONS

IOT APPLICATIONS,
THE LOGIC AND
THE SMARTNESS

ADVANCED
SMART CITY API,
MICROSERVICES,
SNAP4CITY API

SNAP4CITY
LIVING LAB FOR
COLLABORATIVE
WORK

SNAP4CITY FOR
BEGINNERS

DATA ANALYTICS,
BUSINESS
INTELLIGENCE,
WHAT-IF AND
SIMULATION

SNAP4CITY
ARCHITECTURE AND
ECOSYSTEM. OPENED
TO DEVELOPERS
AND STAKEHOLDERS

TWITTER
VIGILANCE: SOCIAL
MEDIA ANALYSIS

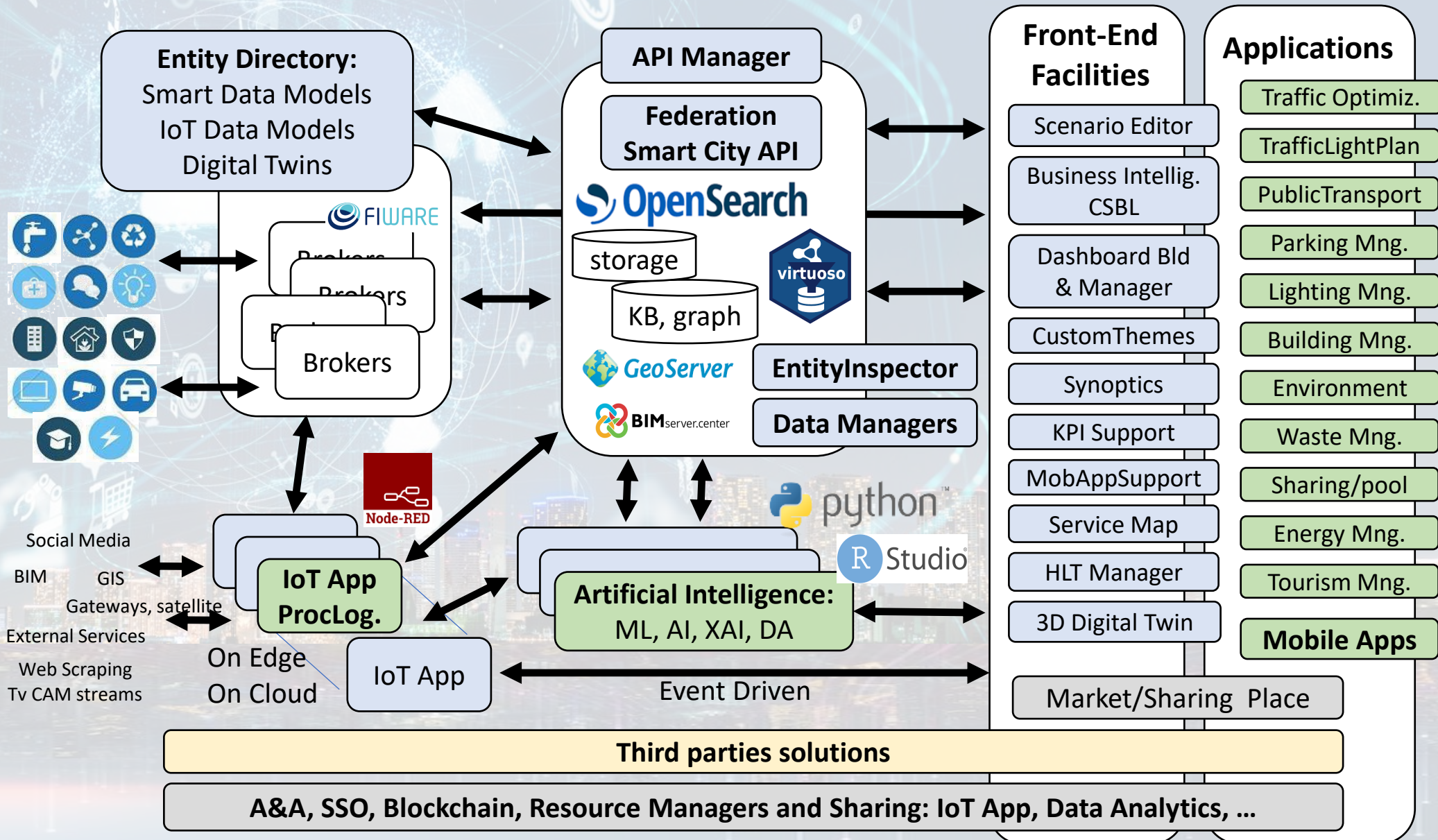
DECISION SUPPORT
SYSTEM AND CITY
RESILIENCE

HOW TO ADOPT
SNAP4CITY, AND
OUR ROADMAP

SNAP4CITY
AND KM4CITY
PROJECTS

SNAP4CITY THE
VIEW OF THE
ADMINISTRATORS

Technical Architecture



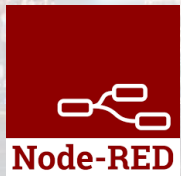
Standards and Interoperability (10/2024)



Compliant with:

- **IoT:** NGSI V2/LD, LoRa, LoRaWan, MQTT, AMQP, COAP, OneM2M, TheThingsNetwork, SigFOX, Libelium, IBIMET/IBE, EnOcean, Zigbee, DALI, ISEMC, Alexa, Sonoff, HUE Philips, Tplink, BACnet, TALQ, Protocol Buffer, KNX, OBD2, Proximus, ..
- **IoT model:** FIWARE Smart Data Model, Snap4City IoT Device Models
- **General:** HTTP, HTTPS, TLS, Rest Call, SNMP, TCP, UDP, SOAP, WSDL, FTP, FTPS, WebSocket, WebSocket Secure, GML, WFS, WMS, RTSP, ONVIF, AXIS TVCam, CISCO Meraki, OSM, Copernicus, The Weather Channel, Open Weather, OLAP, VMS Milestone, TIM, HERE,
- **Formats:** JSON, GeoJSON, XML, CSV, GeoTIFF, OWL, WKT, KML, SHP, db, XLS, XLSX, TXT, HTML, CSS, SVG, IFC, XPD, OSM, Enfuser FMI, Lidar, glTF, GLB, DTM, GDAL, Satellite, D3 JSON, ...
- **Database:** Open Search, MySQL, Mongo, HBASE, SOLR, SPARQL, ODBC, JDBC, Elastic Search, Phoenix, PostGres, MS Azure, ..
- **Industry:** OPC/OPC-UA, OLAP, ModBUS, RS485, RS232, ..
- **Mobility:** DATEX, GTFS, Transmodel, ETSI, NeTEx, ..
- **Social:** Twitter, FaceBook, Telegram, ..
- **Events:** SMS, EMAIL, CAP, RSS Feed, ..
- **OS:** Linux, Windows, Android, Raspberry Pi, Local File System, AXIS, ESP32, etc.

<https://www.snap4city.org/65>



IoT Devices



IoT Device Models



IoT Device

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

IoT Device Variables

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

- Conceptually are IoT Devices with sensors/actuators, IN/IN-OUT

- They are classified in terms of nature/subnature

- For Searching and showing on maps and dashboards

HLT of IoT Devices can be:

- **IoT Device Models**, for example: «personal coffee machine»
- **IoT Device name**, for example: «mycoffemachine1», «CM23»
- **IoT Device Variable**, for example: «Temperature»



IOT Device

What About IoT Devices, Time Series



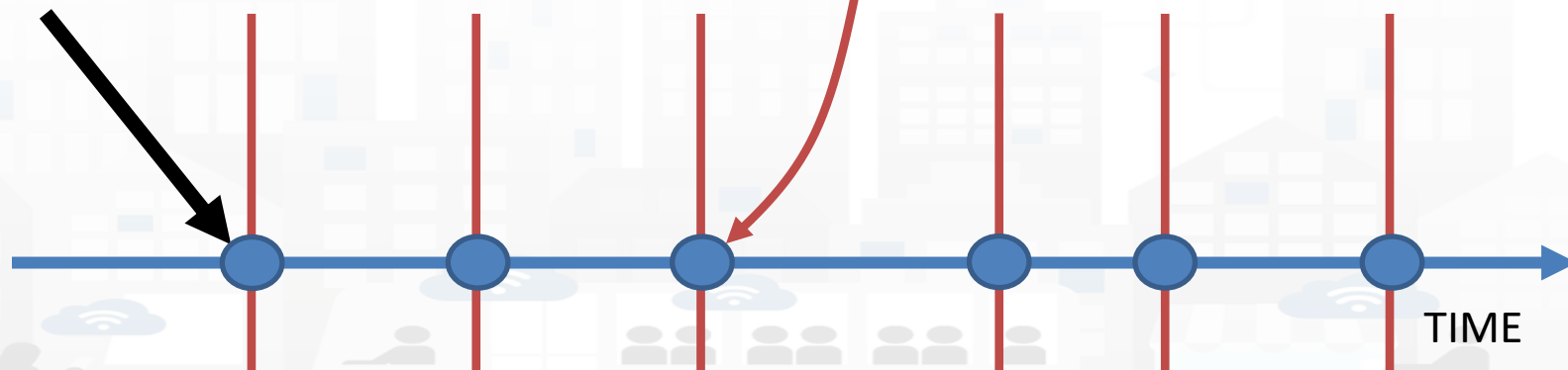
IOT Device

Sends a
message

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

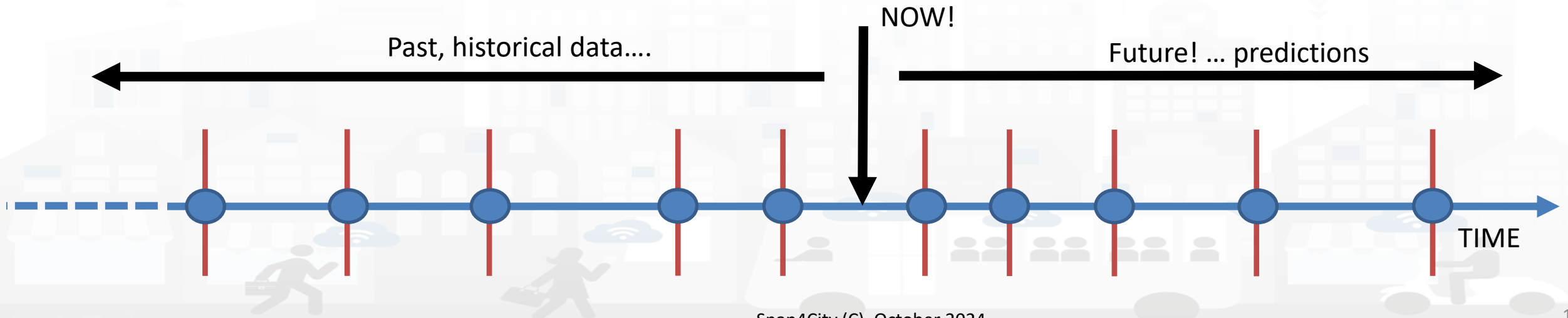
dateObserved	Temp	Humidity
02-04-2020 10:30	34.5	23
02-04-2020 10:40	36.5	24
02-04-2020 10:50	36.0	22.5

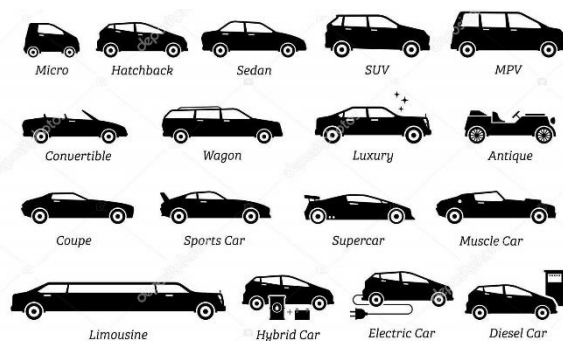
- A set of data coming from an IoT Device with multiple sensor become a time series of values for devices.
 - For example: taking a new measure every 10 minutes (**Red Lines**)
 - Non regular rates can be valid data as well.
- Each new measure in Snap4City is conventionally time located in «**dateObserved**»,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



Time Series: they are data streams

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





Mobile Device Models



Mobile Device

- Name:.....
- Model:.....
- Spec:...

Mobile Device Variables

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

- They are a special case of IoT Devices
 - they are managed as IoT Devices in the system
- They are classified in terms of nature/subnature
- For Searching and showing on maps and dashboards, they are different

HLT of Mobile Devices can be:

- **Mobile Device Model**, for example: «sedan»
- **Mobile Device name**, for example: «BMW JD7356HD», «Ford KO786KK»
- **Mobile Device Variable**, for example: «velocity»



Sensor/Sensor-Actuator



Sensor Device

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

Sensors

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

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



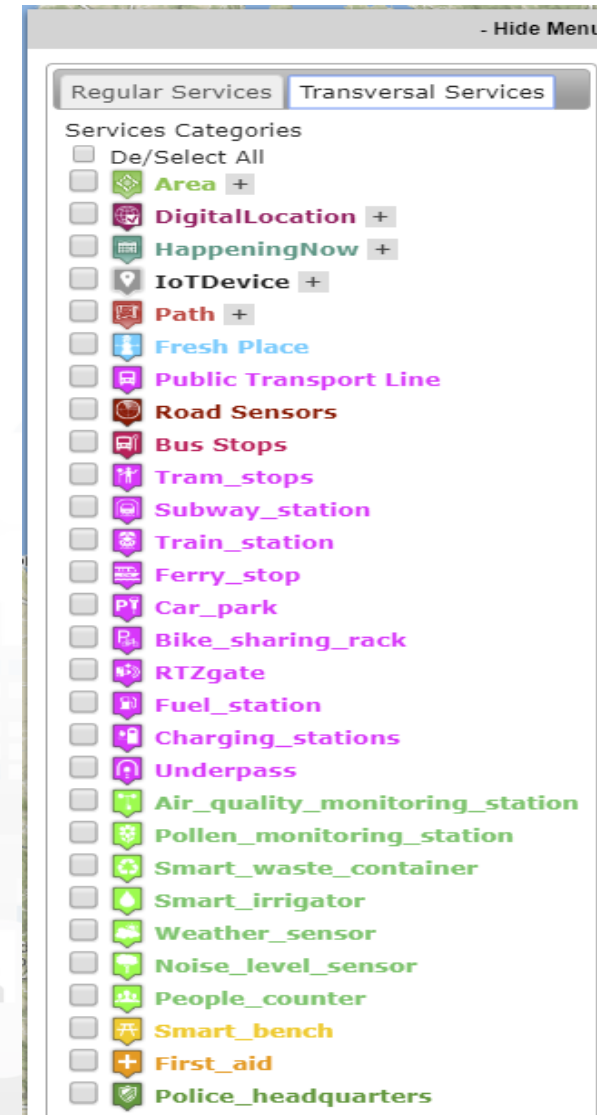
POI, Point of Interest

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



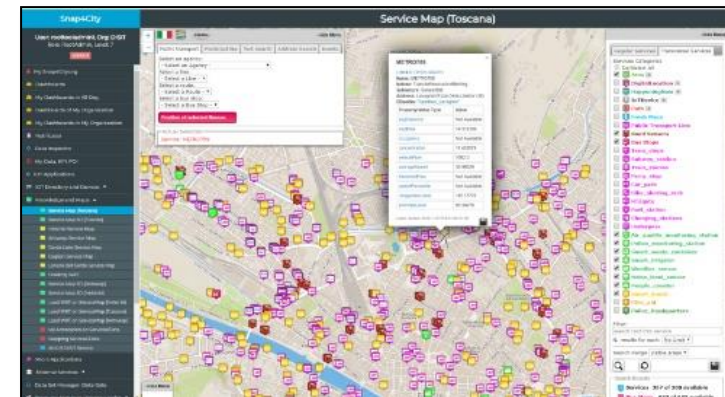
Access to Point of Interest information, POI

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



Data Ingestion Stragey

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



Sends a message

Message {
timestamp: 02-04-2020 at 10:30,
Temperature: 29.34,
Humidity: 35
}

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



- A set of data coming from an IoT Device with multiple sensor become a time series of values for devices.
- For example taking a new measure every 10 minutes (Red Lines)
- Each new measure in Snap4City is conventionally time located in «dateObserved»

Snap4City

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

LOGOUT

- My Snap4City.org
- Dashboards
- My Dashboards in All Org.
- Dashboards of My Organization
- My Dashboards in My Organization
- My Data Dashboard Dev Kibana
- My Data Dashboard Kibana
- Extra Dashboard Widgets
- Notificator
- Data, my Data, OpenData
- Knowledge and Maps
 - Service Map (Toscana)**
 - Service Map 3D (Firenze)
 - Helsinki Service Map
 - Antwerp Service Map
 - Garda Lake Service Map
 - Cagliari Service Map
 - Lonato Del Garda Service Map
 - Valencia Service Map
 - Pont Du Gard Service Map
 - Dubrovnik Service Map
 - WestGreece Service Map
 - Mostar-Bosnia Service Map
 - Svealand Service Map
 - Roma Service Map
 - Pisa Service Map
 - Creating WKT
 - Service Map 3D (Antwerp)
 - Service Map 3D (Helsinki)
 - Producing POI triples for KB
 - Load WKT on ServiceMap (Helsinki)
 - Load WKT on ServiceMap (Toscana)
 - Load WKT on ServiceMap (Antwerp)

Service Map (Toscana)

Public transport | Municipalities | Text Search | Address Search | Events

Select an agency:
- Select an Agency -

Select a line:
- Select a Line -

Select a route:
- Select a Route -

Select a bus stop:
- Select a Bus Stop -

Position of selected Busses

Actual Selection
Service: METRO758

Serviceuri: <http://www.disit.org/km4city/resource/METRO758>

Name: METRO758
Nature: TransferServiceAndRenting
Subnature: SensorSite
Address: Lavagnini dir. Viale Strozzi (38)
DBpedia: "Spartaco_Lavagnini"

Property/Value Type	Value
avgDistance	Not Available
avgTime	14.291604
occupancy	Not Available
concentration	8.25
vehicleFlow	1344.0
averageSpeed	29.613344
thresholdPerc	Not Available
speedPercentile	Not Available
congestionLevel	119.0967
anomalyLevel	101.56052

Latest Update: 2021-01-16T13:...

Regular Services | Transversal Services

De/Select All

- ☒ Accommodation +
- ☒ Advertising +
- ☒ AgricultureAndLivestock +
- ☒ CivilAndEdilEngineering +
- ☒ CulturalActivity +
- ☒ EducationAndResearch +
- ☒ Emergency -
- ☒ Carabinieri
- ☒ Civil_protection
- ☒ Coast_guard
- ☒ Corps_of_forest_rangers
- ☒ Emergency_medical_care
- ☒ Emergency_services
- ☒ Fire_brigade
- ☒ First_aid
- ☒ Italian_finance_police
- ☒ Entertainment +
- ☒ Environment +
- ☒ Fire_service +
- ☒ GovernmentOffice +
- ☒ HealthCare +
- ☒ IndustryAndManufacturing +
- ☒ IoTDevice +
- ☒ MiningAndQuarrying +
- ☒ ShoppingAndService +
- ☒ TourismService +
- ☒ TransferServiceAndRenting +
- ☒ UtilitiesAndSupply +
- ☒ Wholesale +
- ☒ WineAndFood +

Filter:
search text into service

Select value type
N. results: 500

Search Range 2 km
Search Area select...

Weather Forecast for Municipality of: FIRENZE

Saturday	Sunday	Monday	Tuesday	Wednesday
bit cloudy -2°C / 7°C	overcast -2°C / 6°C	cloudless -3°C / 7°C	cloudy -3°C / 6°C	overcast 5°C / 10°C

Latest Update: 2021-01-16T07:57:00+01:00
<http://www.disit.org/km4city/resource/Firenze1610780220000>

IOT Device

Structural information

POI

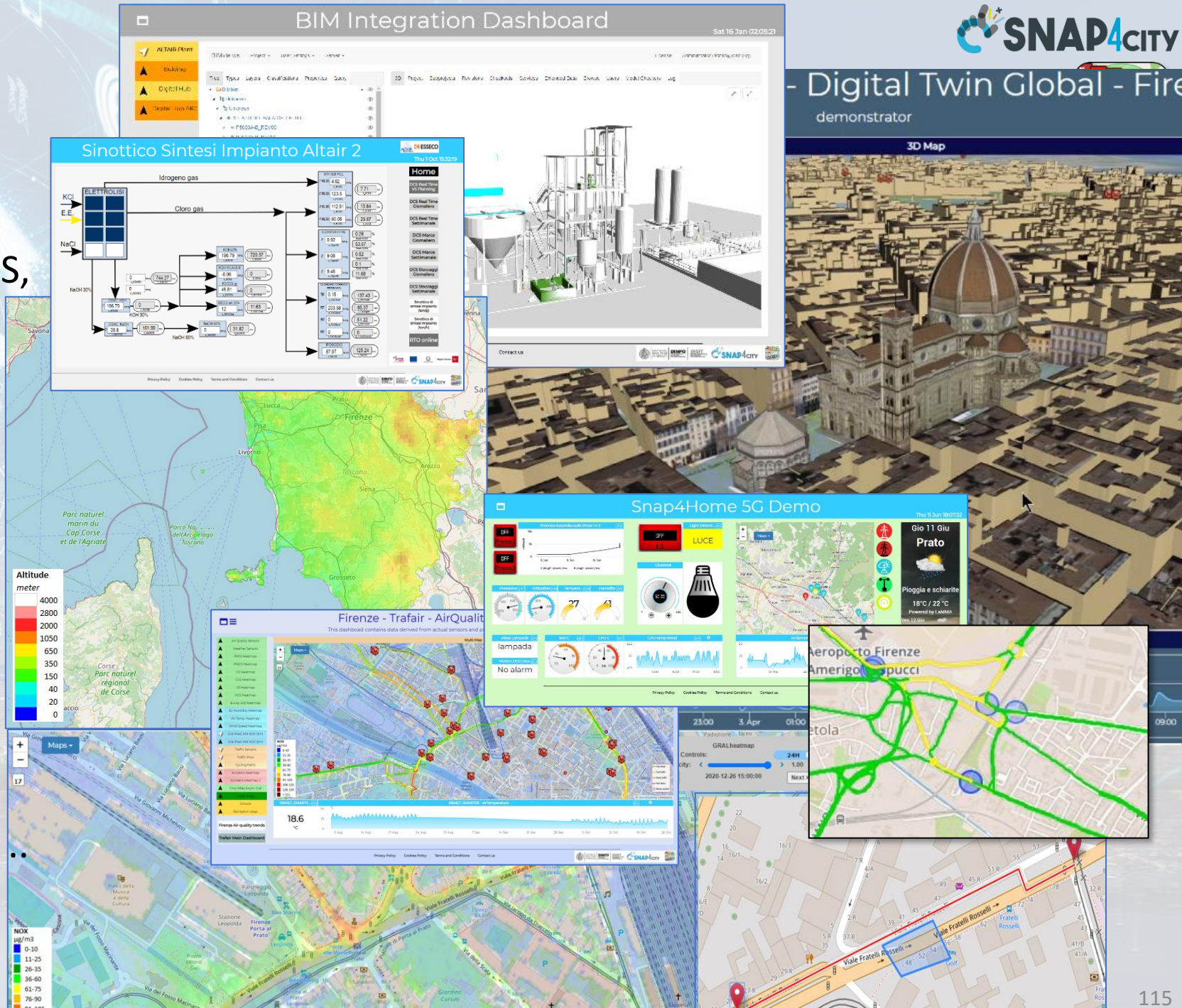
IOT Device

Map: Struct. Information

High Level Types

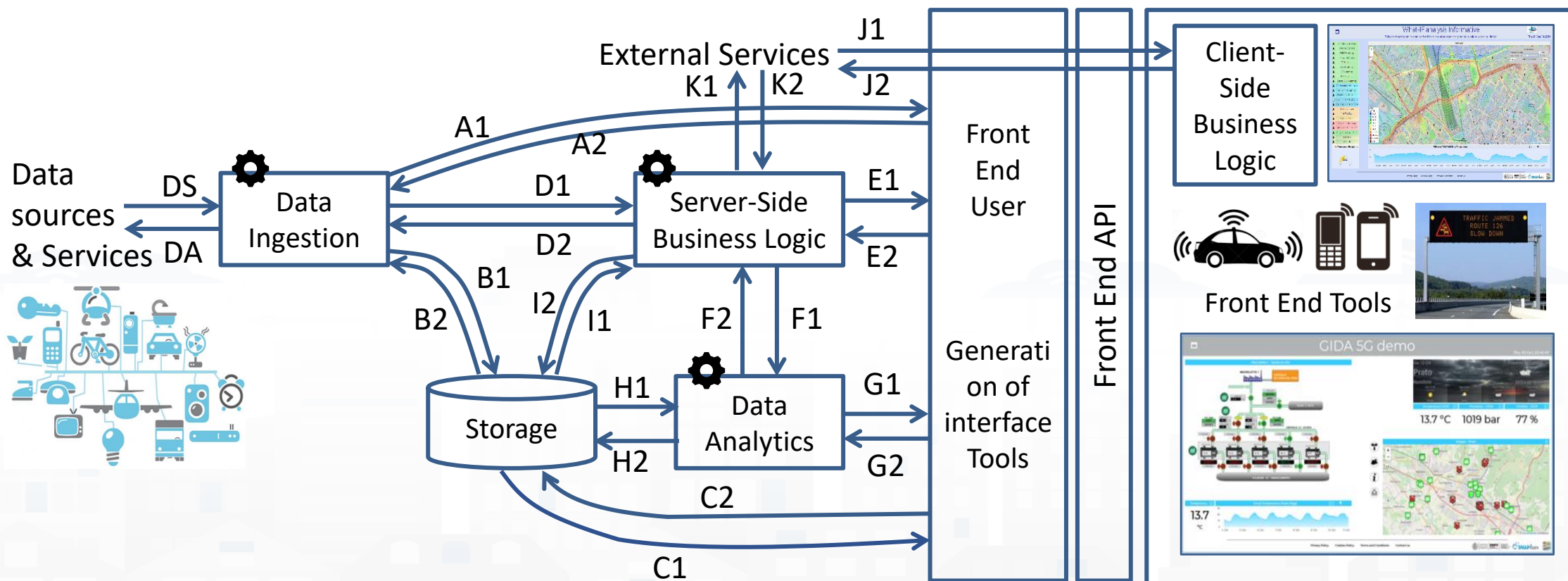
Snap4City (C), October 2024

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

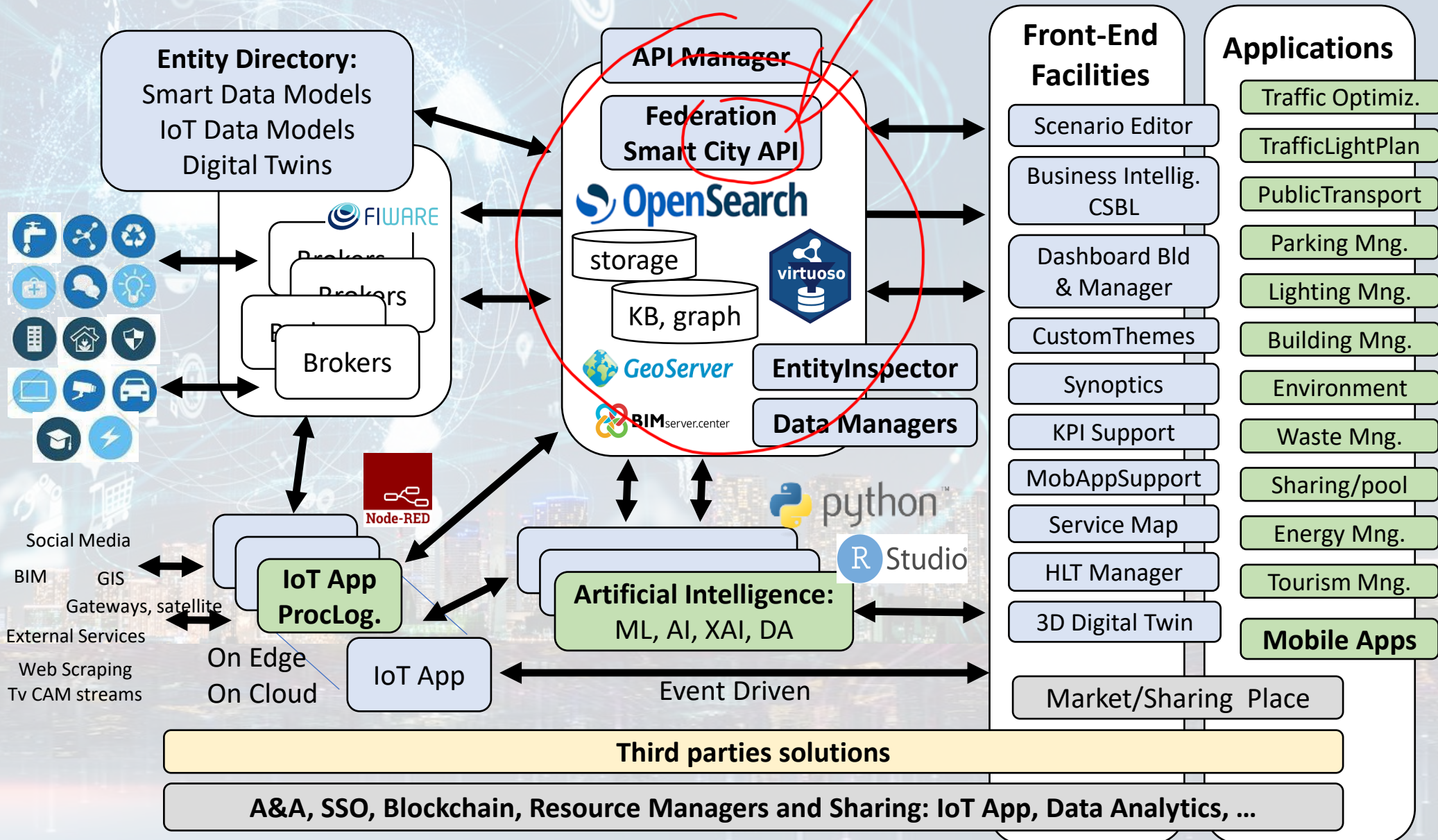


Interoperability of Snap4City Platform





Technical Architecture



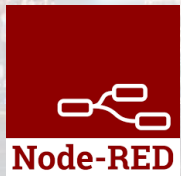
Standards and Interoperability (10/2024)



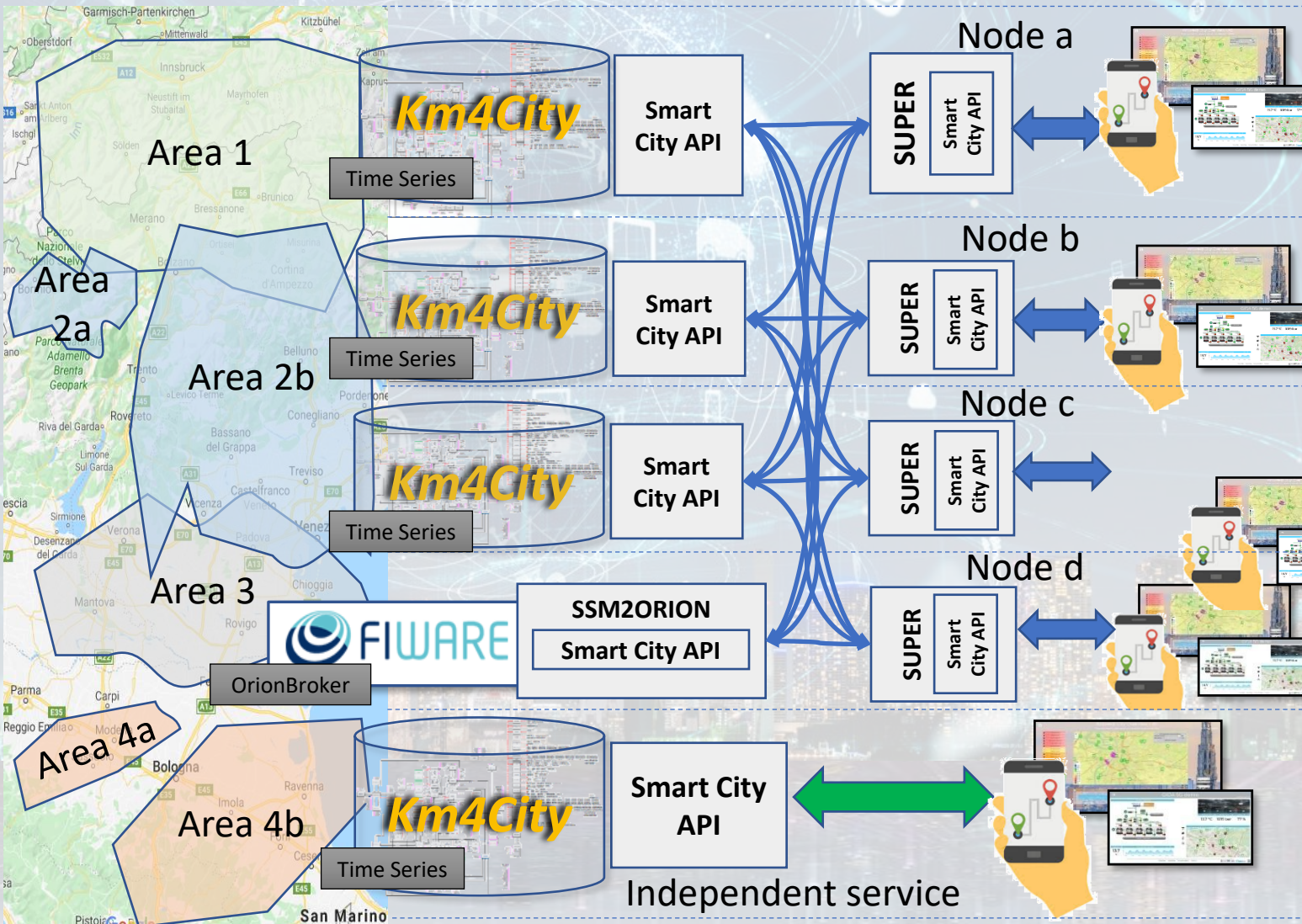
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- **Formats:** JSON, GeoJSON, XML, CSV, GeoTIFF, OWL, WKT, KML, SHP, db, XLS, XLSX, TXT, HTML, CSS, SVG, IFC, XPD, OSM, Enfuser FMI, Lidar, glTF, GLB, DTM, GDAL, Satellite, D3 JSON, ...
- **Database:** Open Search, MySQL, Mongo, HBASE, SOLR, SPARQL, ODBC, JDBC, Elastic Search, Phoenix, PostGres, MS Azure, ..
- **Industry:** OPC/OPC-UA, OLAP, ModBUS, RS485, RS232, ..
- **Mobility:** DATEX, GTFS, Transmodel, ETSI, NeTEx, ..
- **Social:** Twitter, FaceBook, Telegram, ..
- **Events:** SMS, EMAIL, CAP, RSS Feed, ..
- **OS:** Linux, Windows, Android, Raspberry Pi, Local File System, AXIS, ESP32, etc.

<https://www.snap4city.org/65>



Federation of Smart City Services



- **Km4City Semantic Reasoner**
- **ServiceMap** interoperability
- **Seamless for multiple Mobile Apps**
- **Smart City API**

Super:

- distributed access and sharing services
- Each city control its own data
- Final user can pass from one city / area to another in seamless manner: without changing the mobile Apps

TOP

Dictionary for Data Fields

Semantics and Technical Meaning

Resource Manager

- View Resources
- Managing Resources
- Process Models
- Processes in Execution
- Process execution Archive
- Dictionary Editor for Data Fields...
- Doc: Resource Manager



Unified Data and Services Model/Classification

**Semantic
Nature**

SubNature

SubNature

Technical meaning

Value Type

Value Unit

Value Unit

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

Technical meaning

^{Power}
Value Type

Value Unit

mW

Value Unit

KW

Data Type

Integer

Data Type

Float

Link to Friend Sensor as ServiceURI: Value Type

Value Unit

URL

Value Unit

KW

Data Type

String, URL

Data Type

Float

Example of Energy and its Value Units

Snap4City

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

LOGOUT

- My Snap4City.org
- Tour Again
- ダッシュボード
- Dashboards (Public)
- My Dashboards in All Org.
- Dashboards of My Organization
- My Dashboards in My Organization
- My Data Dashboard Dev Kibana
- My Data Dashboard Kibana
- Extra Dashboard Widgets
- Notificator
- Data, my Data, OpenData
- Knowledge and Maps
- IOT Applications
- IOT Directory and Devices
- Resource Manager
 - View Resources
 - Managing Resources
 - Process Models
 - Processes in Execution
 - Process execution Archive
 - Dictionary Editor for Data Fields**
 - Doc: Resource Manager

Dictionary Editor for Data Fields

+ Insert new Dictionary element

Filter by Dictionary type

Show 10

Search:

Value Name	Dictionary Type	Description	Data Types	Parent Value Name	Child Value Name	Controls
Boats_and_shi...	subnature	Boats And Ships Rental		TransferServiceAndRenti...		EDIT DELETE
Bollard	subnature	Bollard		TransferServiceAndRenti...		EDIT DELETE
Bookshop	subnature	Bookshop		ShoppingAndService		EDIT DELETE
bool	value unit	boolean		dali_com_error, dali_dim...		EDIT DELETE
Botanical_Land...	subnature	Botanical & Zoolog. Gardens		CulturalActivity		EDIT DELETE
Boxoffice	subnature	Boxoffice		Entertainment		EDIT DELETE
bpm	value unit	Beat per minute		average_heart_rate, avera...		EDIT DELETE
brightness_flag	value type	Brightness Flag	string		#	EDIT DELETE
broken_bikes	value type	Broken Bikes	integer		#	EDIT DELETE
Building_and_...	subnature	Build. & Indust. Clean. Activ.		Environment		EDIT DELETE

First << Prev 1 ... 9 10 11 ... 89 Next >> Last

Value Type: Energy

Value Units:

- Watt per hour
- KiloWatt per hour
- MegaWatt per hour

Please note on: Data Type

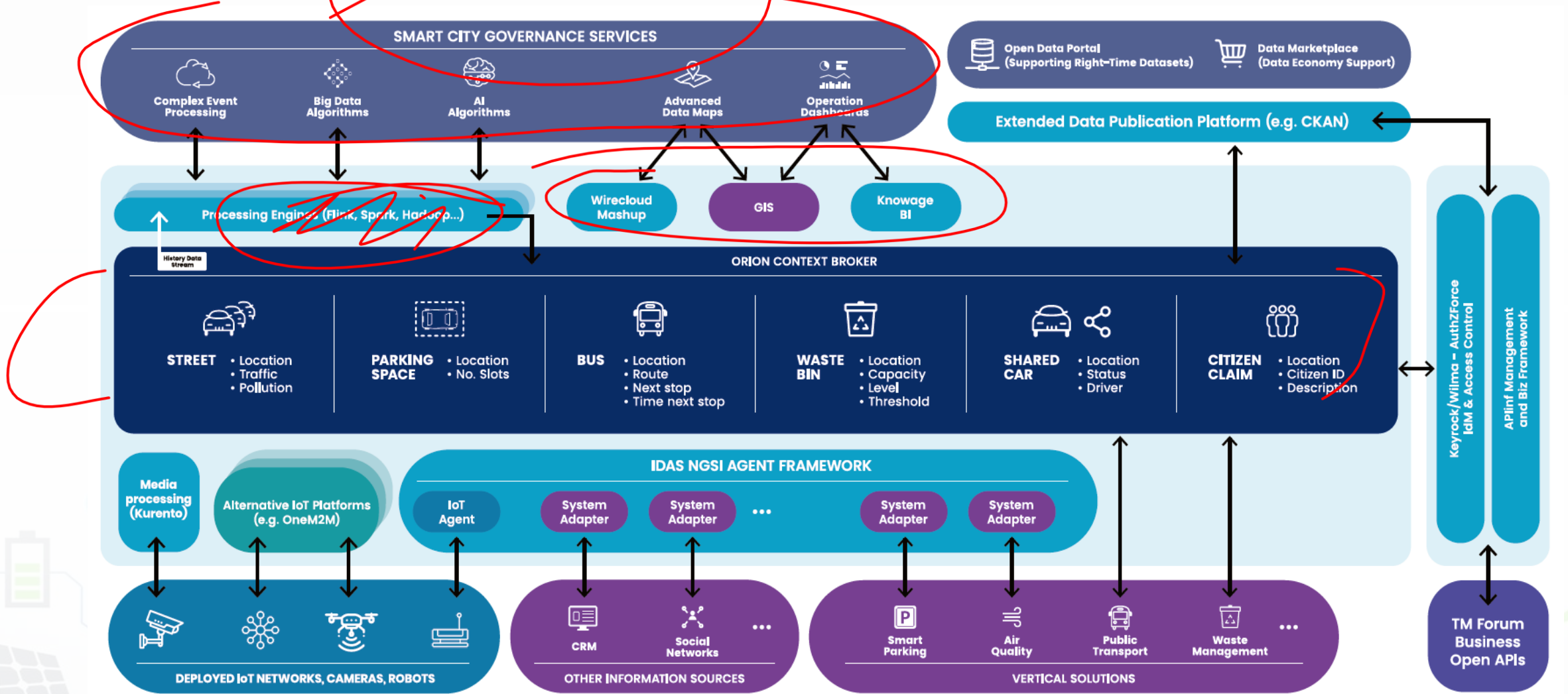
- Value Types have only a few number of **Data Types** because they represent how the data area treated into the system
- Therefore main Data Types are:
 - **Float**: numbers with decimals large as you like, etc.
 - **Integer**: numbers, booleans (0/1), etc.
 - **String**: url, links, names, id, descriptions,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



& Snap4City

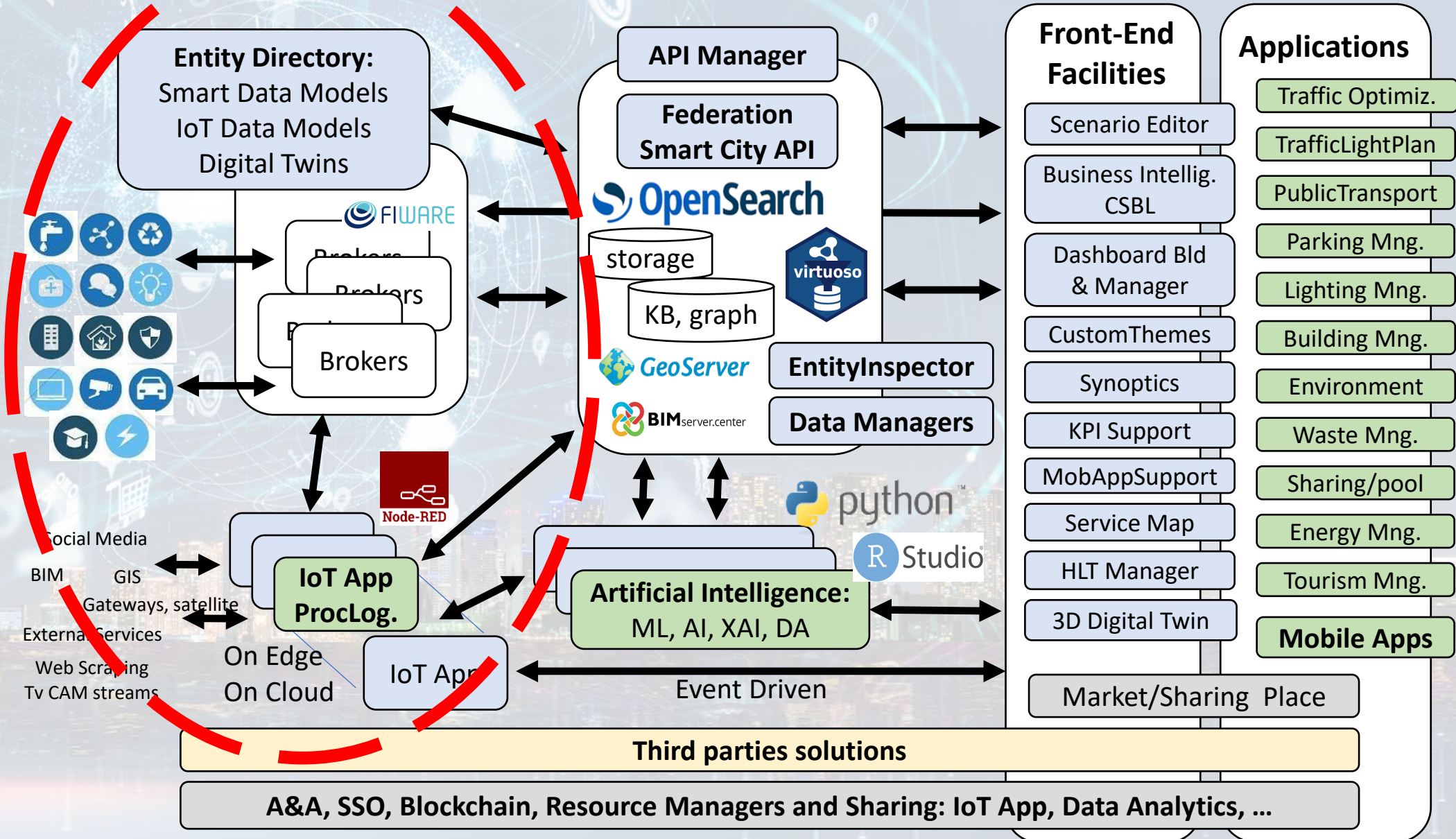


>>> THE FIWARE SMART CITIES REFERENCE ARCHITECTURE

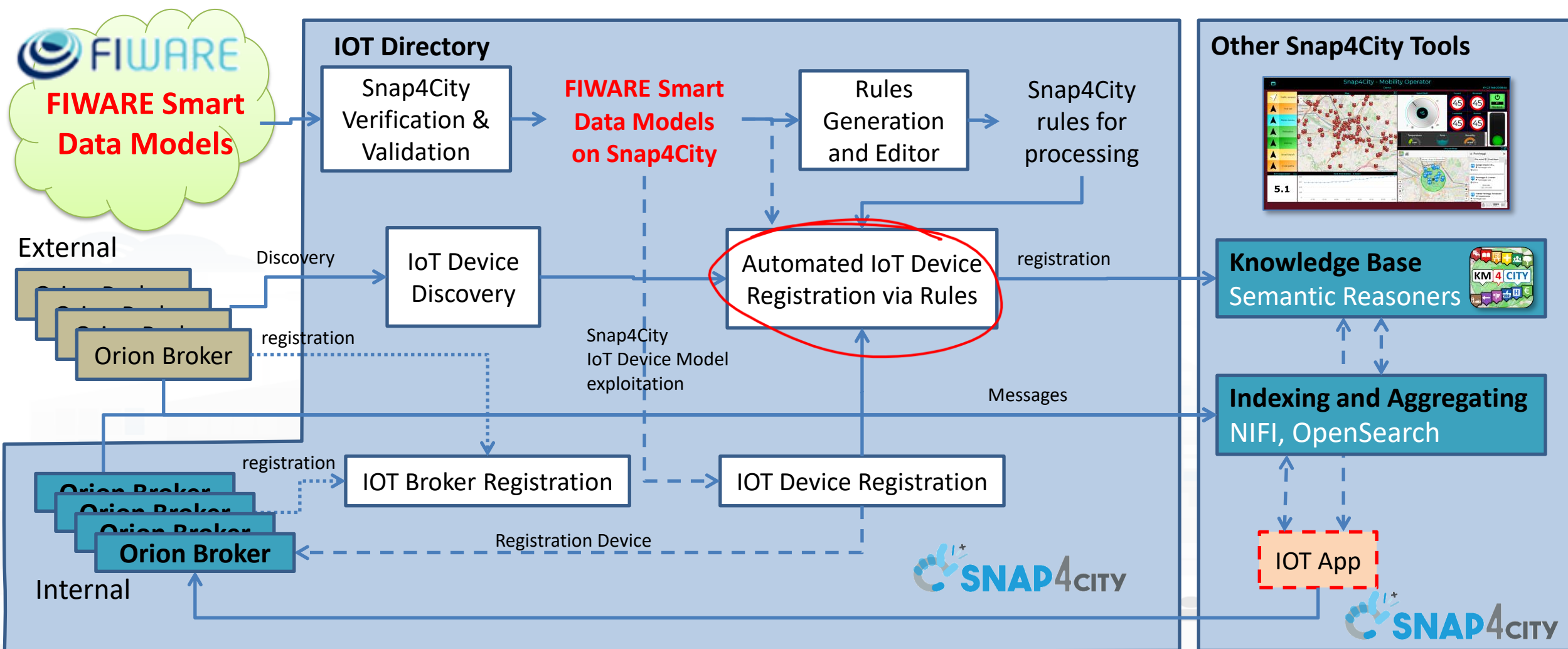


- Snap4City - Powered by [FIWARE](https://www.fiware.org) Solution & Platform:
 - <https://www.fiware.org/marketplace/product-details/?category=powered&id=snap4city-snap4city>
 - NGSI V1, V2 The IOT Orion Broker
 - IOT Orion Broker can connect JSON, MQTT, Lightweight M2M, LoraWAN, OPC, SigFOX, etc. see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

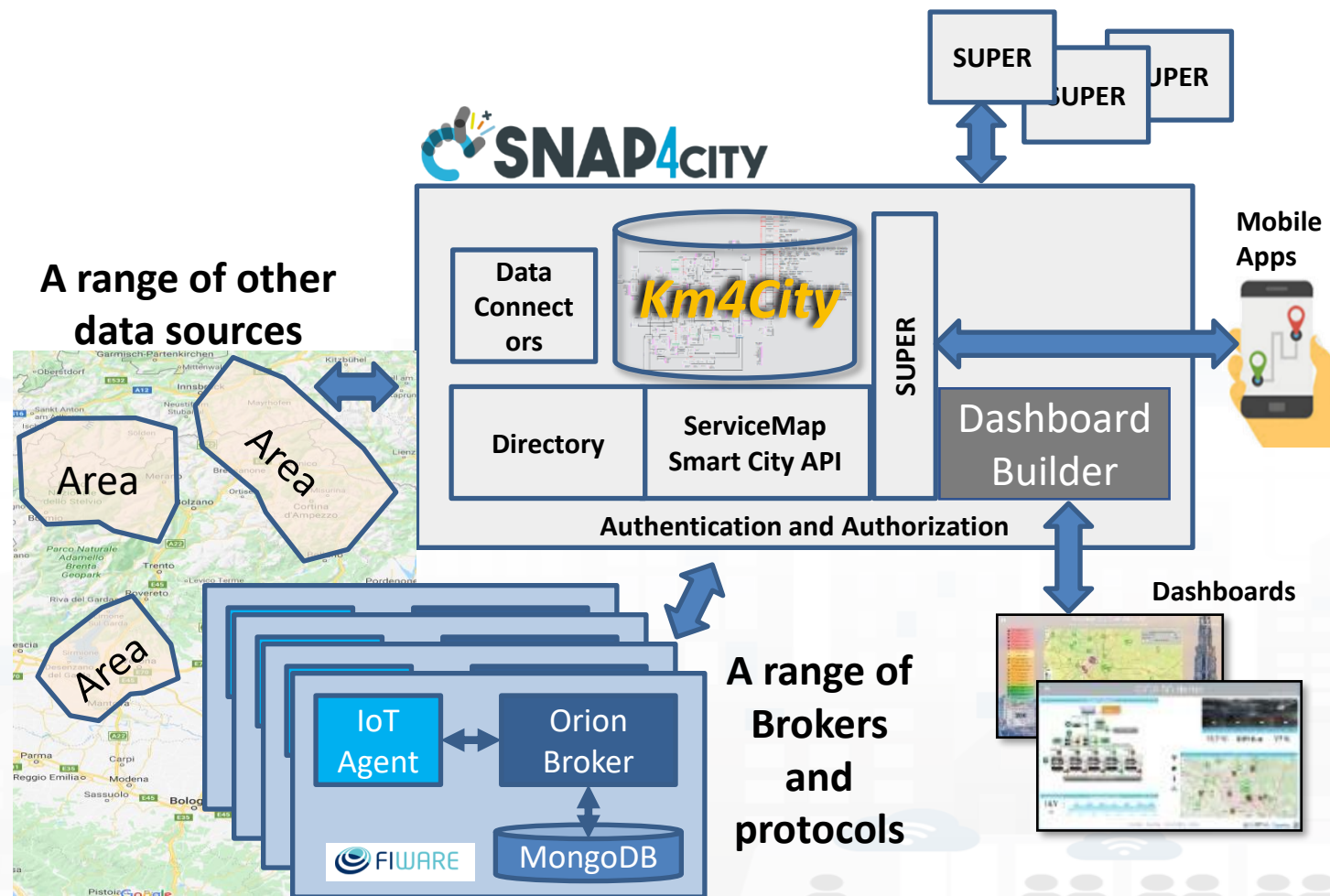
Technical Architecture



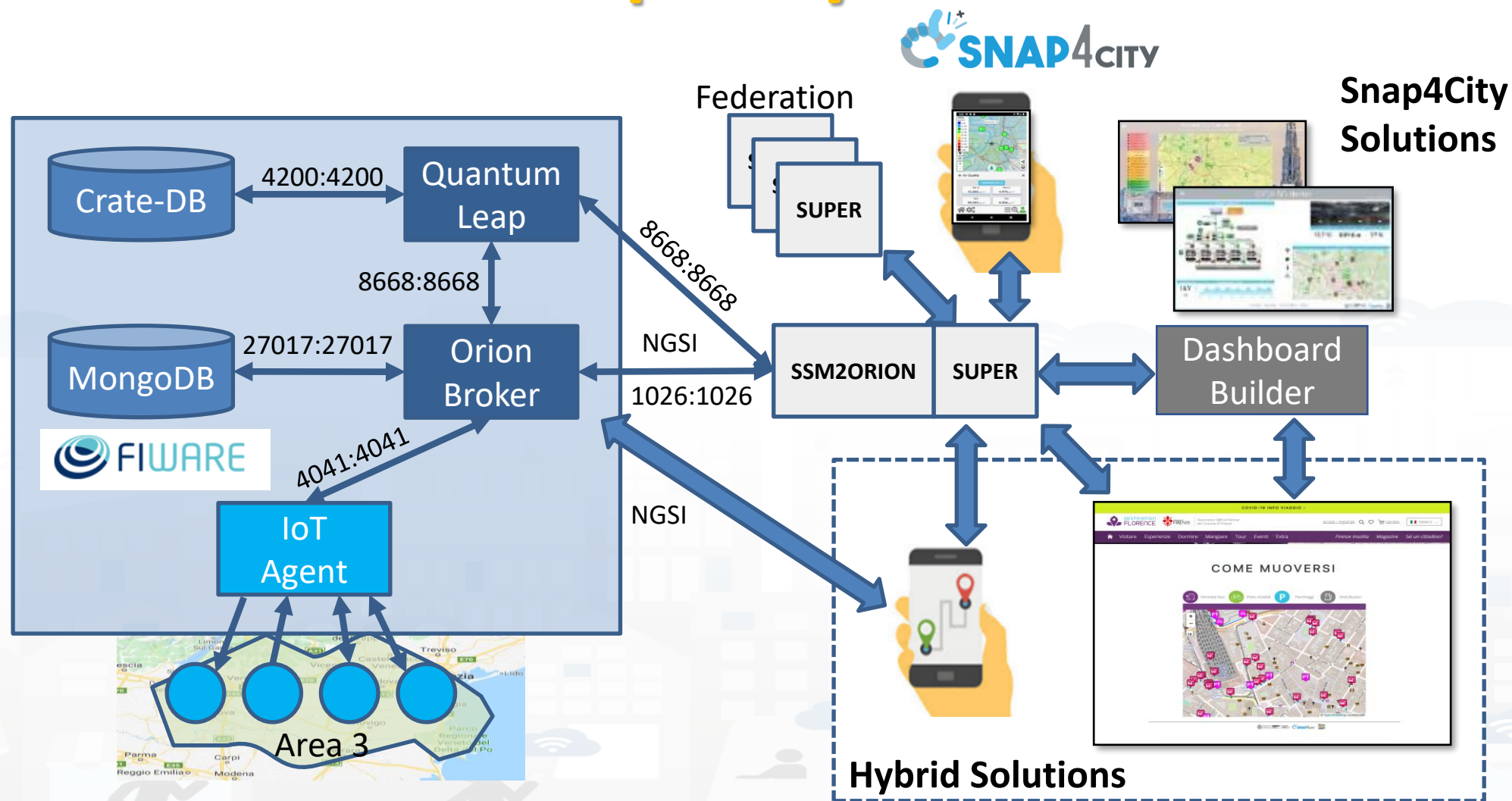
Exploiting FIWARE Smart Data Models



Snap4City IoT Registration and Access



Federation of Snap4City vs ORION Broker





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TECHNOLOGIES LAB

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

Paolo Nesi, paolo.nesi@unifi.it

IoT App / Proc.Logic

<https://www.snap4City.org>

<https://www.Km4City.org>



roottooladmin1
RootAdmin | Idap

Dashboards

My Dashboards

Notifier

IOT Applications

My Personal Data

IOT Directory and Devices

Knowledge and Maps

Micro Applications

External Services

Data Set Manager: Data Cate

Resource Manager: Process Loader

Development: Tools

Management

Settings

User Management and Auditing

Help and Contacts

Documentation and Articles

My Profile

Snap4City portal

Km4City portal

DISIT Lab portal

Node-RED

filter nodes

flow1

Flow 1

input

output

world map

point

service-search-near-marker

transform results

show micro web app

world map

event-log

popopen

msg.payload

timestamp

service-info

vehicleFlow

vehicle flow (car/h)

worldmap

switch

sensor

last temperature

Dashboard

get v

event-log

Temperature

info

debug

dashb

Flow

info

Information

SNAP4CITY

KM4CITY

Node-RED

Data Adapation

Transformation, Conversion

Integration, Interoperability

Business Logic vs Dashboards

Editing IOT Applications

Data Analytics control

Everywhere: Cloud, on IoT Edge Devices

Snap4City (C), October 2024

135

IOT Application Editor: NODE-RED

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

IOT Application Editor: NODE-RED

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

Load Library from Palette

<https://flows.nodered.org/>

The screenshot shows the Snap4City interface with the Node-RED editor. The left sidebar contains a 'common' palette with various nodes like inject, debug, complete, catch, status, link in, link out, and comment. The main workspace shows a 'User Settings' dialog box. The 'Nodes' tab is active, displaying a list of installed nodes including node-red, node-red-contrib-amqp, node-red-contrib-amqp2, node-red-contrib-firmware_official, node-red-contrib-ftp, node-red-contrib-lwm2m, node-red-contrib-md5, node-red-contrib-snap4city-developer, and node-red-contrib-snap4city-user. A red circle highlights the 'Manage palette' option in the top right menu, with a red arrow pointing to it.

The screenshot shows the Node-RED Library website. The top navigation bar includes links for home, about, blog, documentation, forum, flows, and github. The main content area is titled 'Node-RED Library' and features a search bar, a 'Sign in with GitHub' button, and a list of recent nodes and flows. The 'Recent nodes' section includes 'node-red-contrib-ui-time-scheduler', 'node-red-contrib-heatweb', and 'node-red-contrib-tasmota'. The 'Recent flows' section includes 'You Like Big Cocks' and 'SajaBeer02'. The 'Recent collections' section includes 'rramizzle bla' and 'mizbil'. The 'node-red-contrib-heatweb' node is highlighted, showing its details, including version 1.2.7, license Apache-2.0, and a list of pre-requisites and installation instructions.

Two views of the same libraries

Load an IOT application of example



aaa

The screenshot shows the Node-RED web interface. On the left, a 'msg.payload' node is connected to a 'Import s4c' dialog box. The dialog box contains a list of public flows and a JSON payload. The 'Import to' section has two buttons: 'current flow' and 'new flow'. At the bottom are 'Cancel' and 'Import' buttons. On the right, a sidebar menu is open, showing options like 'View', 'Import', 'Export', 'Search flows', 'Configuration nodes', 'Flows', 'Subflows', 'Manage palette', 'Settings', 'Keyboard shortcuts', and 'Node-RED website'. The 'Import' menu item is circled in red, and a red arrow points from it to the 'Import S4C' option in the dialog box.

Import s4c

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

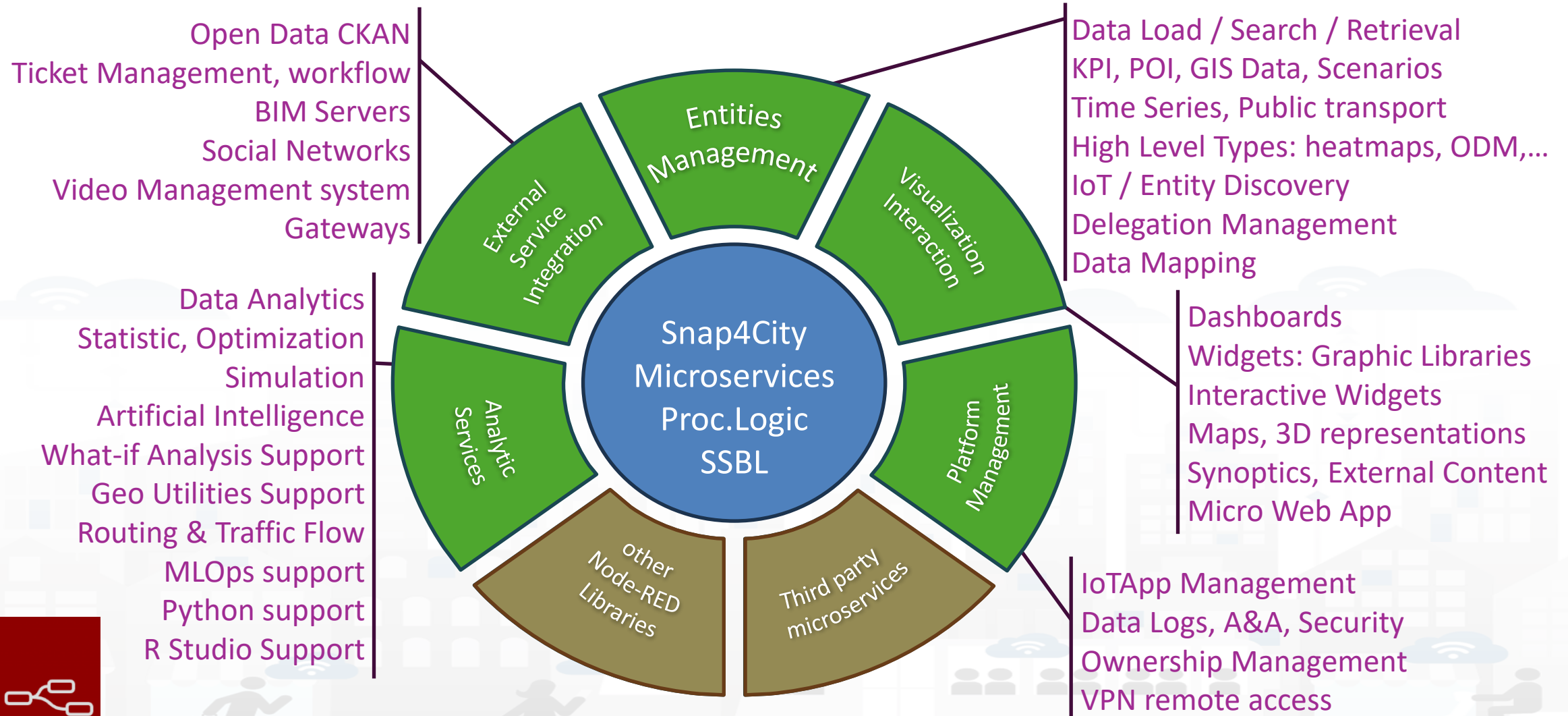
```
{["id":"99d0ceb6.66a7f","type":"json","z":"18bbf2b5.57d68d","name":"","pretty":false,"x":343.00002288818,"y":110.00000953674,"wires":["a65d77fc.50fee8"]],{"id":"3d04d6a4.80e6ea","type":"inject","z":"18bbf2b5.57d68d","name":"","topic":"","payload":{"contacts":[{"contact":
```

Import to

Clipboard
Library
Import S4C
Examples

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

Areas



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.

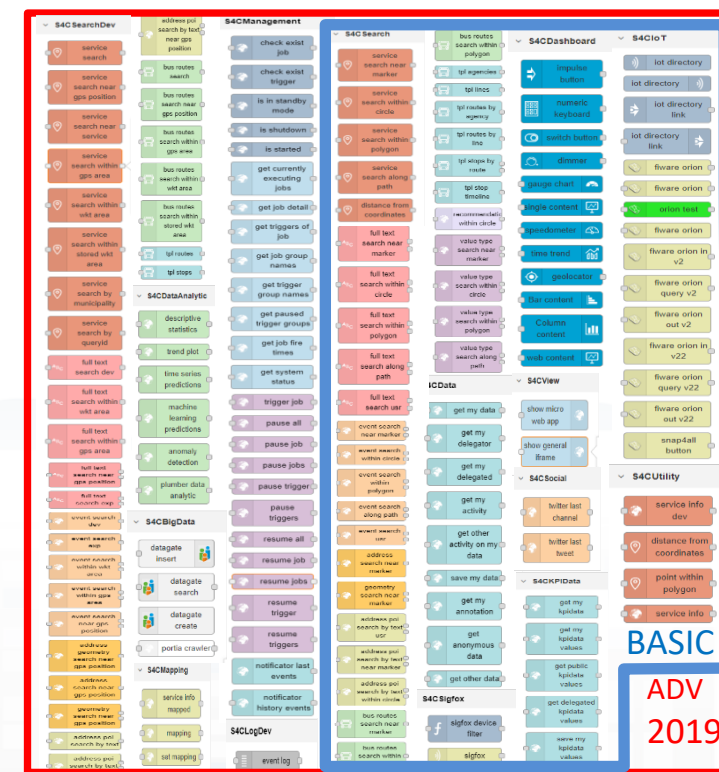
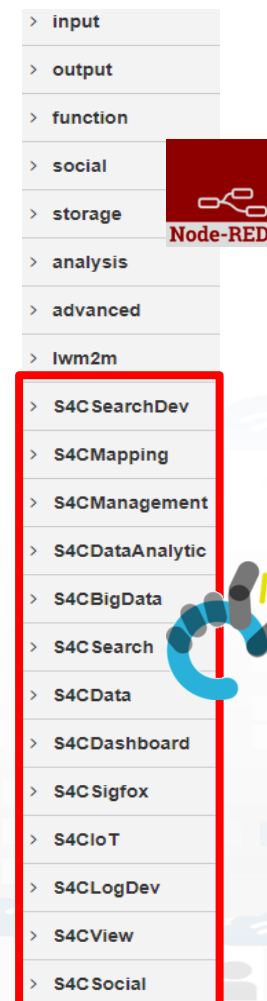


IOT Directory: It should be a single point service for searching, managing and discovering all the IOT Devices which can be connected to the infrastructure by means of a large set of heterogenous IOT Brokers.

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)

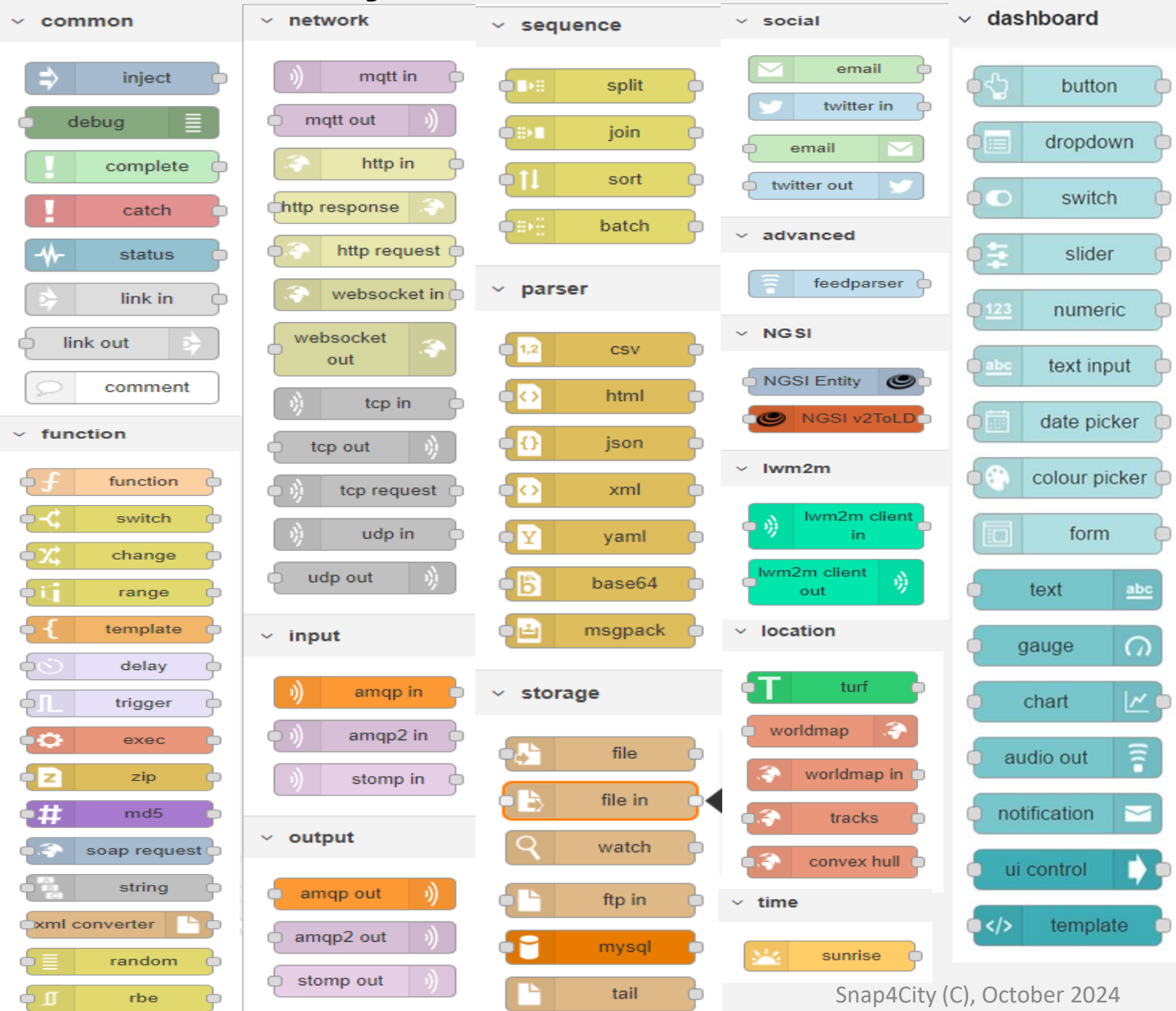
v0.2.0

27

★5.0 (1)

node

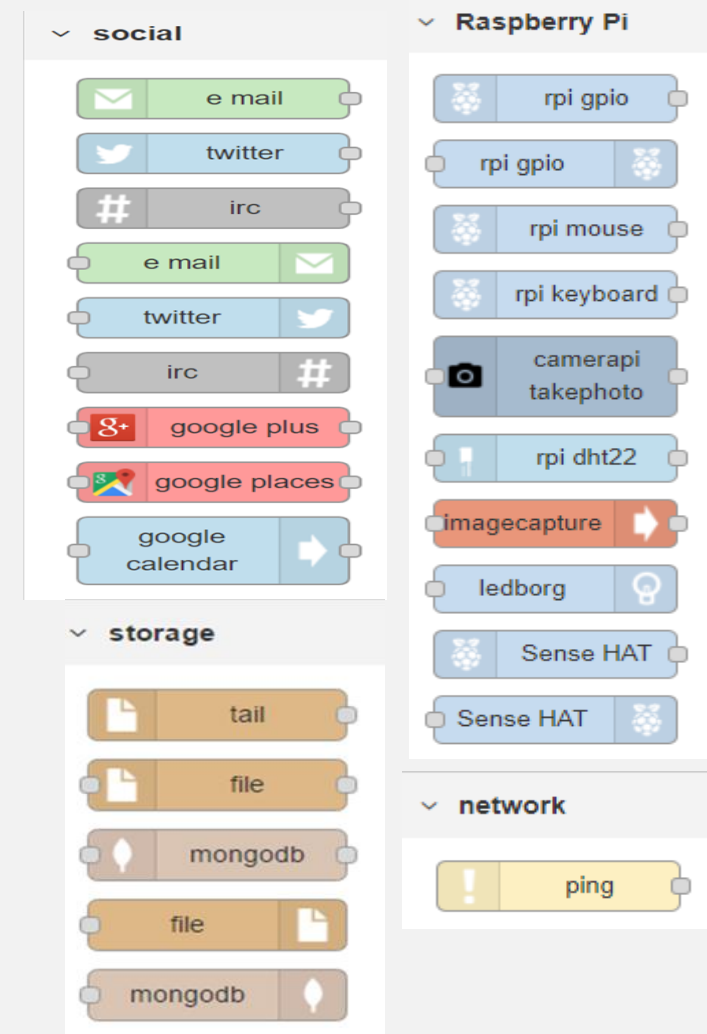
Basic Node.js Blocks on NodeRed on our Advanced IOT Apps



The screenshot displays the Node-RED block palette with the following categories and blocks:

- common**: inject, debug, complete, catch, status, link in, link out, comment.
- function**: function, switch, change, range, template, delay, trigger, exec, zip, md5, soap request, string, xml converter, random, rbe.
- network**: mqtt in, mqtt out, http in, http response, http request, websocket in, websocket out, tcp in, tcp out, tcp request, udp in, udp out, amqp in, amqp2 in, stomp in, amqp out, amqp2 out, stomp out.
- sequence**: split, join, sort, batch, parser (csv, html, json, xml, yaml, base64, msgpack), storage (file, file in, watch, ftp in, mysql, tail).
- social**: email, twitter in, email, twitter out, advanced (feedparser), NGSI (NGSI Entity, NGSI v2ToLD), lwm2m (lwm2m client in, lwm2m client out), location (turf, worldmap, worldmap in, tracks, convex hull), time (sunrise).
- dashboard**: button, dropdown, switch, slider, numeric, text input, date picker, colour picker, form, text, gauge, chart, audio out, notification, ui control, template.

+ on IOT Edge Raspberry



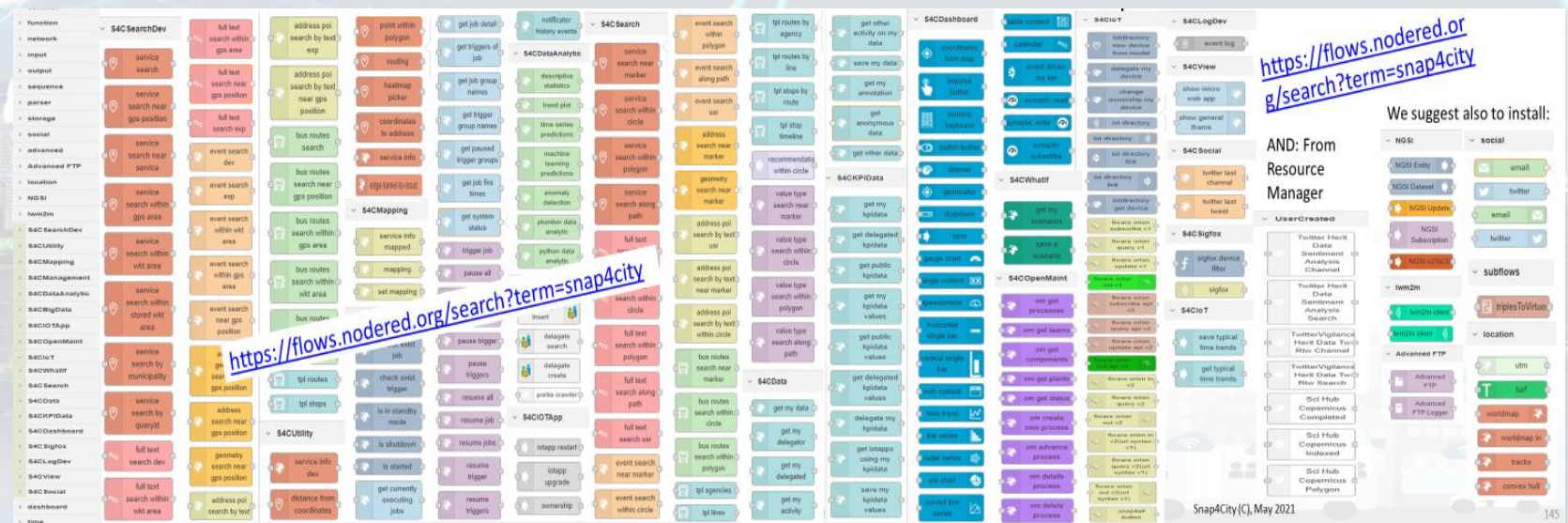
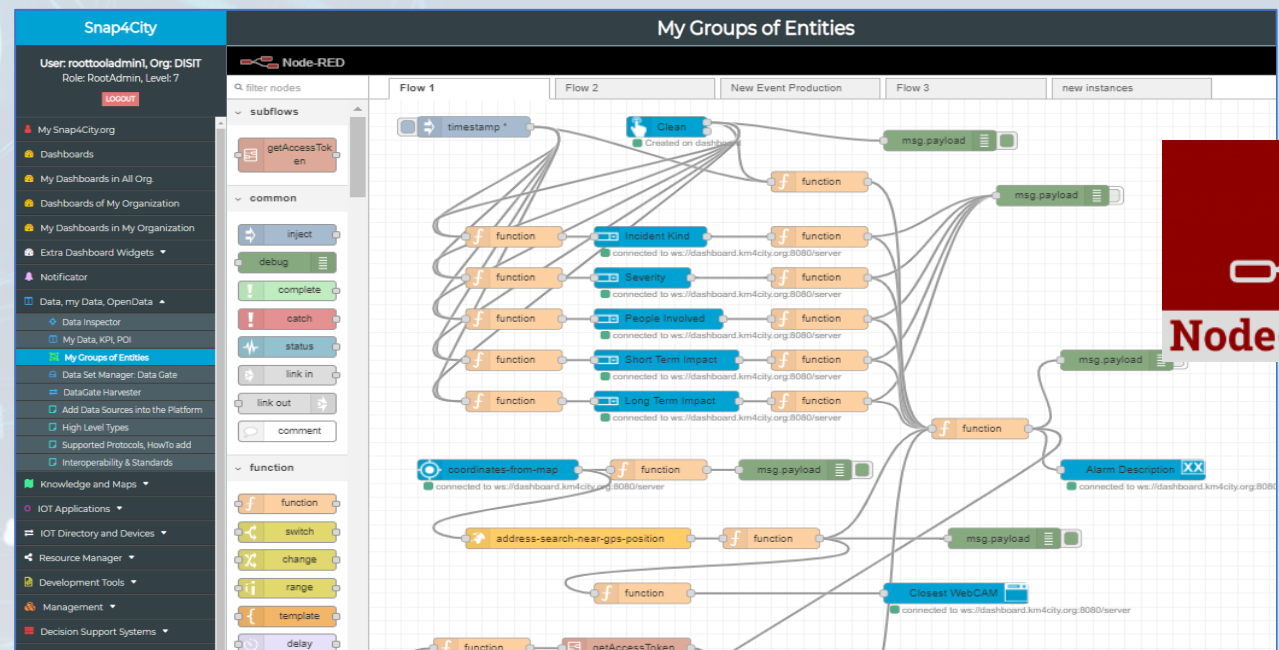
The screenshot displays the Node-RED block palette with the following categories and blocks:

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

IoT Applications

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

- **Edge and Cloud**
- **MicroServices** data driven develop via visual language Node-RED





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2024 collection

Two Snap4City Libraries



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



2024 collection

Two Snap4City Libraries



> common

> function

> network

> input

> output

> sequence

> parser

> storage

> social

> advanced

> Advanced FTP

> location

> NGSI

> lwm2m

> S4CSearchDev

> S4CUtility

> S4CMapping

> S4CManagement

> S4CDataAnalytic

> S4CBigData

> S4CIOTApp

> S4COpenMaint

> S4CIoT

> S4CWhatif

> S4CSearch

> S4CData

> S4CKPIData

> S4CDashboard

> S4CSigfox

> S4CLogDev

> S4CView

> S4CSocial

> dashboard

> time

S4CKPIData

- get my kpdata
- get delegated kpdata
- get public kpdata
- get my kpdata values
- get public kpdata values
- get delegated kpdata values
- delegate my kpdata
- get iotapps using my kpdata
- save my kpdata values

S4CDashboard

- coordinates - from - map
- impulse - button
- numeric - keyboard
- switch - button
- dimmer
- geolocator
- dropdown
- form
- gauge - chart
- single - content
- speedometer
- horizontal - single - bar
- vertical - single - bar
- web - content
- time - trend
- bar - series
- radar - series
- pie - chart
- curved - line - series

S4CIoT

- table - content
- calendar
- speak - synthesis
- selector - to - map
- dashboard - map
- event - driven - my - kpi
- synoptic - read
- synoptic - write
- synoptic - subscribe

S4COpenMaint

- om get processes
- om get teams
- om get components
- om get plants
- om get status
- om create new process
- om advance process
- om details process
- om delete process

S4CIoT

- iotdirectory new device from model
- delegate my device
- change ownership my device
- iot directory
- iot directory link
- iot directory link
- iotdirectory get device
- fiware orion subscribe v1
- fiware orion query v1
- fiware orion update v1
- fiware orion out v1
- fiware orion subscribe api v2
- fiware orion query api v2
- fiware orion update api v2
- fiware orion out api v2
- fiware orion in v2
- fiware orion query v2
- fiware orion out v2
- fiware orion in v2(url syntax v1)
- fiware orion query v2(url syntax v1)
- fiware orion out v2(url syntax v1)
- snap4all button

S4CLogDev

- event log

S4CView

- show micro web app
- show general iframe

S4CSocial

- twitter last channel
- twitter last tweet

S4CSigfox

- sigfox device filter
- sigfox

S4CIoT

- save typical time trends
- get typical time trends

S4CWhatif

- get my scenarios
- save a scenario

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

AND: From
Resource
Manager

We suggest also to install:

NGSI

- NGSI Entity
- NGSI Dataset
- NGSI Update
- NGSI Subscription
- NGSI v2ToLD

social

- email
- twitter
- email
- twitter

subflows

- triplesToVirtuos

location

- utm
- turf
- worldmap
- worldmap in
- tracks
- convex hull

lwm2m

- lwm2m client
- lwm2m client

Advanced FTP

- Advanced FTP
- Advanced FTP Logger

UserCreated

- Twitter Herit Data Sentiment Analysis Channel
- Twitter Herit Data Sentiment Analysis Search
- TwitterVigilance Herit Data Tw Rtw Channel
- TwitterVigilance Herit Data Tw Rtw Search
- Sci Hub Copernicus Completed
- Sci Hub Copernicus Indexed
- Sci Hub Copernicus Polygon

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



Prev 1 2 3 ... 9 Next

Filter



Create new

- 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

2018-09-14T04:44

IOT Edge App

owner: badii

Management

2018-09-21T03:19

IOT Edge App

owner: panesi

Management

2018-10-19T16:07

IOT Edge App

owner: pb3

Management

2018-10-19T17:17

IOT Edge App

owner: pb3

Management

2018-10-22T11:57

IOT Edge App

owner: semolarudy

Management

application

IOT Application

owner: tester5

Management

Bib APP

IOT Application

owner: semolarudy

Management

ChargingStations

IOT Application

owner: comunedashres

Management

Deprecated - SliMobilityControlRoom

IOT Application

owner: badii

Management

SamsungGalaxyS4Barcode

IOT Edge App

owner: badii

Management

esercitazione

IOT Application

owner: tester2

Management

lot-App

IOT Application

owner: tester14

Management

Snap4city Data Ingestion Diagram

storage

Manual or automated
Registration
of Entities/Devices

**Entity/IoT
Directory**

registration
triples

NGSI



Orion Broker

subscription note
NGSI
Real Time

IoT Orion Broker

IoT Orion Broker

IoT Orion Broker

Brokers

Knowledge Base

Semantic Reasoners
Semantic Reasoners

SURI Link

Indexing and Aggregating
NIFI, OpenSearch

Data Managers
Data Managers
Entity Inspector



A number of KB
federated



Federation
Smart City API, ASCAPI

API Manager

Cluster of **OpenSearch**
for storage with in
front a cluster of
NIFI

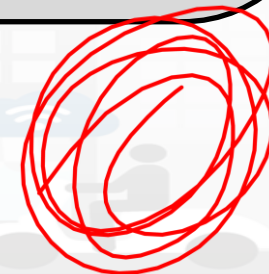
Platform Automation:
IoT Apps, Proc.Logics,
Python, ...



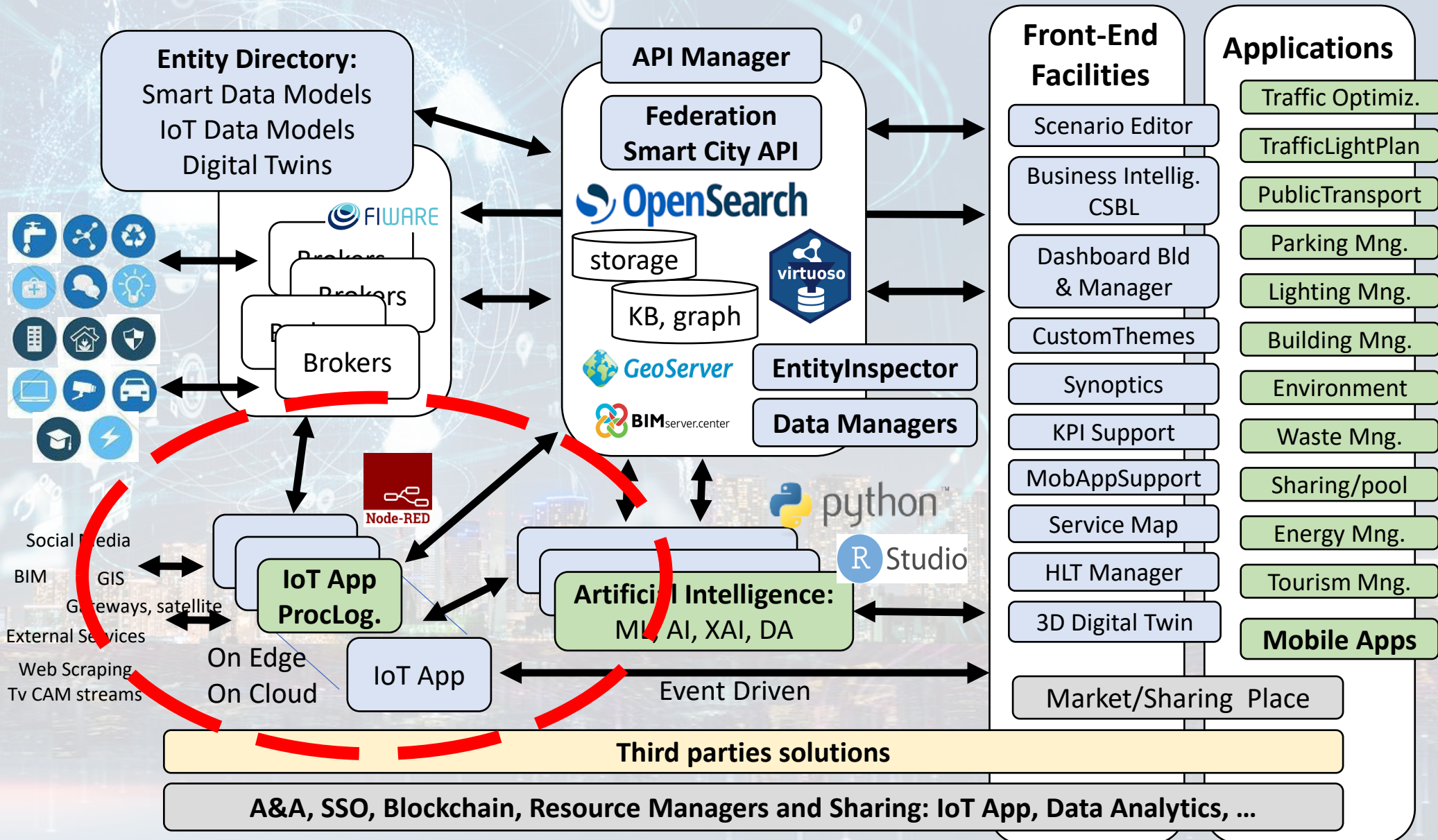
Data Analytics: ML, AI, XAI **python**



Platform Control and Management



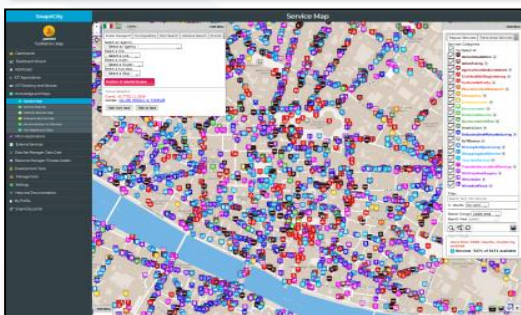
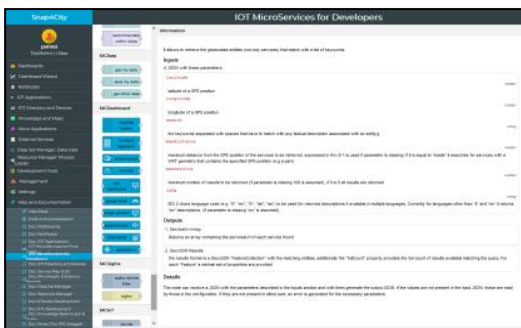
Technical Architecture



Proc.Logic / IoT App Development

IoT Discovering

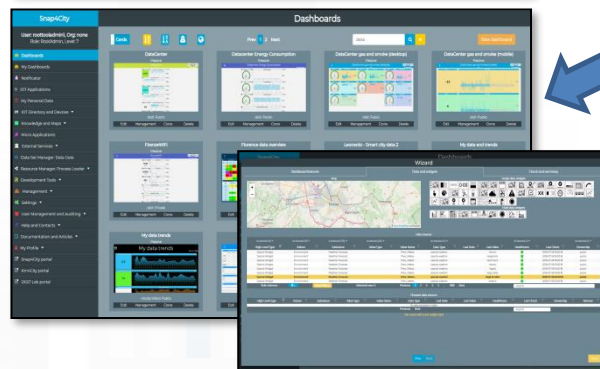
MicroServices collections



ServiceMap Discovery
Knowledge Base, Km4City

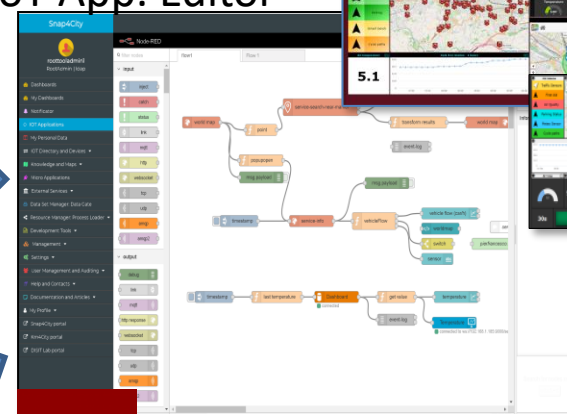


My IoT Applications



Dashboard Collection,
Editor and Wizard

IoT App. Editor



Sharing/saving
reusing IoT App



Resource Manager



Generating IoT App
With Dashboard





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Paolo Nesi, paolo.nesi@unifi.it

Comparisons

<https://www.snap4City.org>

<https://www.Km4City.org>



	Open Source end-to-end	Scalability IOT	Execution scalability	Visual Programming end-to-end applications	Advanced Smart City API,	MicroServices Multi Domain	Semantic Platform	External sevices via API	Standard based Modules and IOT, Open Devices	Integrated Community managment Resoruce Sharing	Referral data management	Security end-2- end	Dashboard H24/7	Falxible and easy dashboard creation	Multi-protocol on IOT
	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
KAA	Y	Y	Y	N	Y	N	Y	N/Y	Y	N	--	Y	Y	N	Y
AWS	N	Y	Y	N	N	N	Y	Y	N	Y	Y	Y	Y	(Y)	Limited
Azure IOT	N	Y	Y	(Y)	N	N	Y	Y	(Y)	Y	Y	Y	Y	(Y)	Limited
IOT IGNITE	Y	Y	N	Y	N	N	Y	N	N	N	--	N	Y	(Y)	MQTT
PTC ThingWorkx	N	Y	(Y)	Y	N	N	Y	Y	N	N	--	Y	Y	(Y)	Y
BEZIRK	Y	N	N	N	N	Y	--	Y	N	N	--	N	N	N	Y
Bosch IoT Suite	N	Y	(Y)	Y	Y	N	Y	Y	N	N	Y	Y	Y	(Y)	Y
FIWARE ref SC arc.	Y	(Y)	N	N	Y	N	N	Y	N	N	N	N	Y	N	Y
CISCO Jasper	N	Y	N	N	N	N	Y	N	--	--	Y	--	Y	--	N
IBM Watson IoT	(N)	Y	(Y)	Y	Y	Y	Y	Y	N	Y	(y)	Y	Y	Y	Y
Siemens MindSphere	N	Y	--	Y	N	N	N	Y	N	N	Y	N	Y	N	Y
Carriots	N	Y	--	N	N	N	Y	--	N	N	--	N	Y	Y	MQTT
Thingsboard	Y	Y	N	N	N	N	N	N	N	N	--	Y	Y	Y	(MQTT, CoAP, http)
IOT eclipse.org	Y	Y	N	N	N	N	Y	Y	N	N	N	N	N	N	Y
Google IOT	N	Y	Y	N	N	N	Y	N	N	N	N	Y	N	N	MQTT, HTTP

Requirements on Broker Interoperability

Requirement	Snap4City	Google IoT Cloud	Azure IoT	AWS Amazon	IBM Watson	Siemens Mindsphere
Manage different kinds of IoT entities	Y	N	Y	(Y)	Y	Y
Connect External and Internal Brokers	Y	Y	Y	Y	Y	(Y)
Use any Data Model with any data type	Y	Y	(Y)	(Y)	Y	(Y)
Verify the correctness of IoT Messages of IoT Devices	Y	(Y)	(Y)	(Y)	(Y)	(Y)
Semantic Interoperability	Y	Y	Y	Y	Y	(Y)
Automatics deploy of Internal IoT Brokers	Y	N	N	N	N	Y
Register External Brokers	Y	N	N	N	N	N
Discover IoT Devices on IoT Brokers	Y	N	(Y)	N	(Y)	N
Easy management graphic interface to list and test IoT entities	Y	(Y)	(Y)	(Y)	(Y)	(Y)
Manage IoT Device Model and Device Data Type ownership and access grant	Y	Y	(Y)	Y	Y	Y

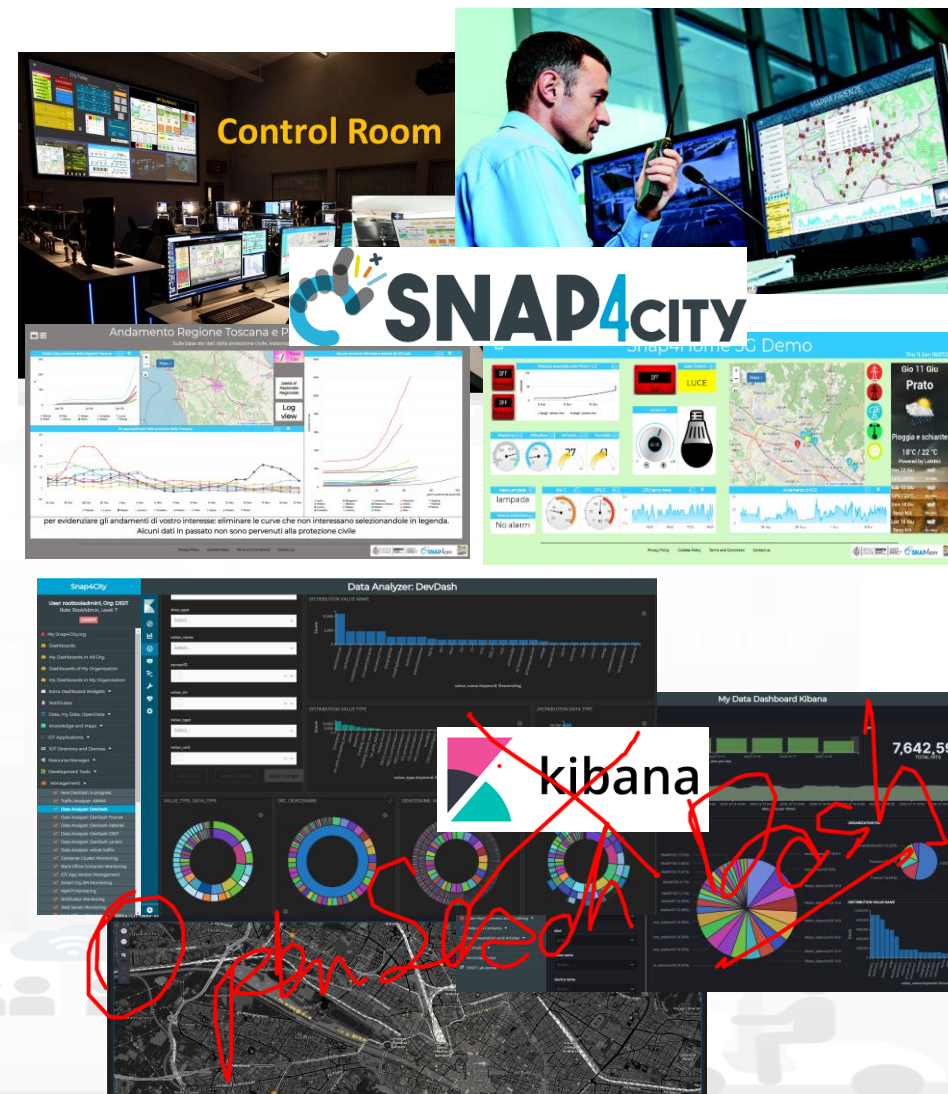
Two Main Lines for Dashboarding are present

- **Dashboard Builder of Snap4City**

- For accessing and browsing data on: OpenDistro x ElasticSearch, Mongo, MySQL, Smart City API, Super and thus from federated Smart City API, etc.
- Supports sensors/actuators: data driven data, maps in extended manner, data driven widgets, large collection of widgets, direct IoT Connections, custom widgets, animated PIN on maps, a large set of panel/widgets, etc.
- Very simple to be used for control room, decision makers, situation rooms, operators, etc.
- Very well integrated with IoT App, Custom widgets, animation, external services.
- Very simple to be customized for non programmers since all the tools are visual.
- Support for GDPR and deep control of access.
- Can integrate Kibana/Grafana Views into a Widget

- **Kibana** (so called **DevDash**, **AMMA** and recently **My Dashboard (Dev)** **Kibana**), also accessible as Grafana

- For accessing and browsing data on OpenDistro x ElasticSearch storage and other sources supported
- No Support for real time event driven widgets/panels, actuators and synoptics, no sophisticated maps, etc.
- Not simple for control room, decision makers, etc.
- Not integrated with IoT App, Custom widgets, animation, external services.
- Oriented to developers, complex production of custom views, etc.
- Partial support of GDPR and deep control of access.



Snap4City Dashboard Builder (2023) vs Kibana/Grafana

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

Functional: FIWARE ref arc wrt Snap4City solutions

	FIWARE ref arc smart city	Snap4City
Multiple Protocols: IoT, Databases, etc..	10 on IOT, Limited on databases, etc.	More than 200, very very wide
Large set of high level types: maps, trends, heatmaps, traffic, trajectories, scenarios,...	No	Yes:
Integration with workflows, BPM	Not Supported	Yes: bidirectional
Integration and Modeling Digital Twin BIM	Not Supported	Yes: bidirectional
Integration with GIS: WFS, WMS	Not fully supported	Yes: bidirectional
Integration with Heatmaps and Satellite	Partially, not calibrated	Yes: fully; calibrate and multiple versions, animations
Integration with Satellite	not supported	Yes: fully
Smart City API	no	Yes
Open Data Management	Partial with CKAN	Yes, Fully automated with CKAN
Federation of platforms	Partial on brokers	Full on Brokers and Knowledge base and API
Semantic model and queries	with NGSI-LD in the future	Yes since 2013
Multiple kinds of IoT Brokers	No, only agents	Yes: NGSI, COAP, AMQP, MQTT, SigFOX, etc.
Data Model	Smart Data Models	Smart Data Models, IoT Device Models
Complex data Model	Not supported	Heatmap, traffic flow, ODM, 3D models, TV Cam, etc.

Interoperability
Openness

Functional: FIWARE refarc. wrt Snap4City solutions

Process

Graphics

Manag.

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

Market Solutions

	OT Discovery Abstraction	Authentication, Authorization	Security end-2-end, secure on OT and Dashboards	Open HW and Open SW	Integrated Community management	Data 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 OT, Open Devices	Resource Sharing	Data Analytics integrated	Dashboard H24/7, protected connection	Multi-protocol on IOT
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

Plataforma	Lenguajes	Recursos	APIs	Despliegue	Observaciones
PROMENADE	Java	Kubernetes, Apache Kafka, Flink	RESTful, WebSockets	Contenedores	Código no disponible en el momento de la prueba
Mi-FIWARE	Java, Node.js	FIWARE	RESTful, NGSI, SocketIO	Contenedores	Seleccionada para Evaluación
VirloT	Python	Docker, Kubernetes, Kafka	RESTful, NGSI	Contenedores	Seleccionada para Evaluación
ITrade	Java, JavaScript	Kafka, Pulsar	RESTful	Contenedores	Pocos proyectos, enfocada en IoT solamente
Snap4City	Python, Java, JavaScript, PHP, Node-RED	Kibana, Km4City, FIWARE	RESTful, WebSockets, NGSI	Contenedores, VMs	Seleccionada para Evaluación
Sentilo	Java, JavaScript	—	RESTful	VMs	Enfoque en gestión de sensores
OpenRemote	Java, Python, C++	UI	RESTful	Contenedores	Pocas implementaciones
Sapparchi	Java, Ruby	Nginx, Kafka, otros	RESTful	Contenedores, VMs	Código no disponible en el momento de la prueba



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

Paolo Nesi, paolo.nesi@unifi.it

From Operation to planning

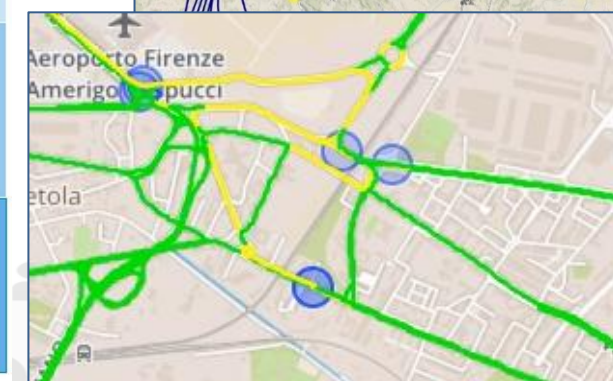
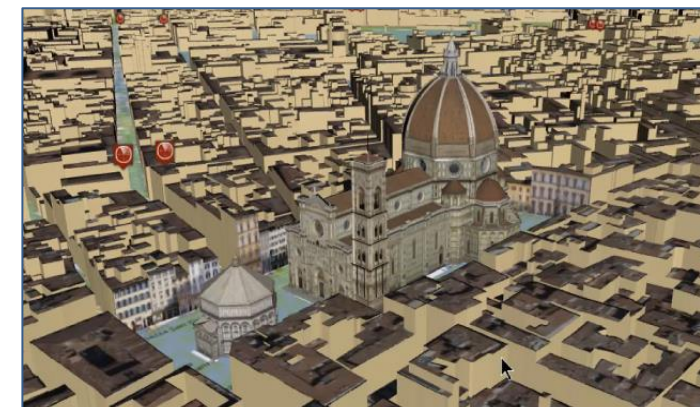
<https://www.snap4City.org>

<https://www.Km4City.org>

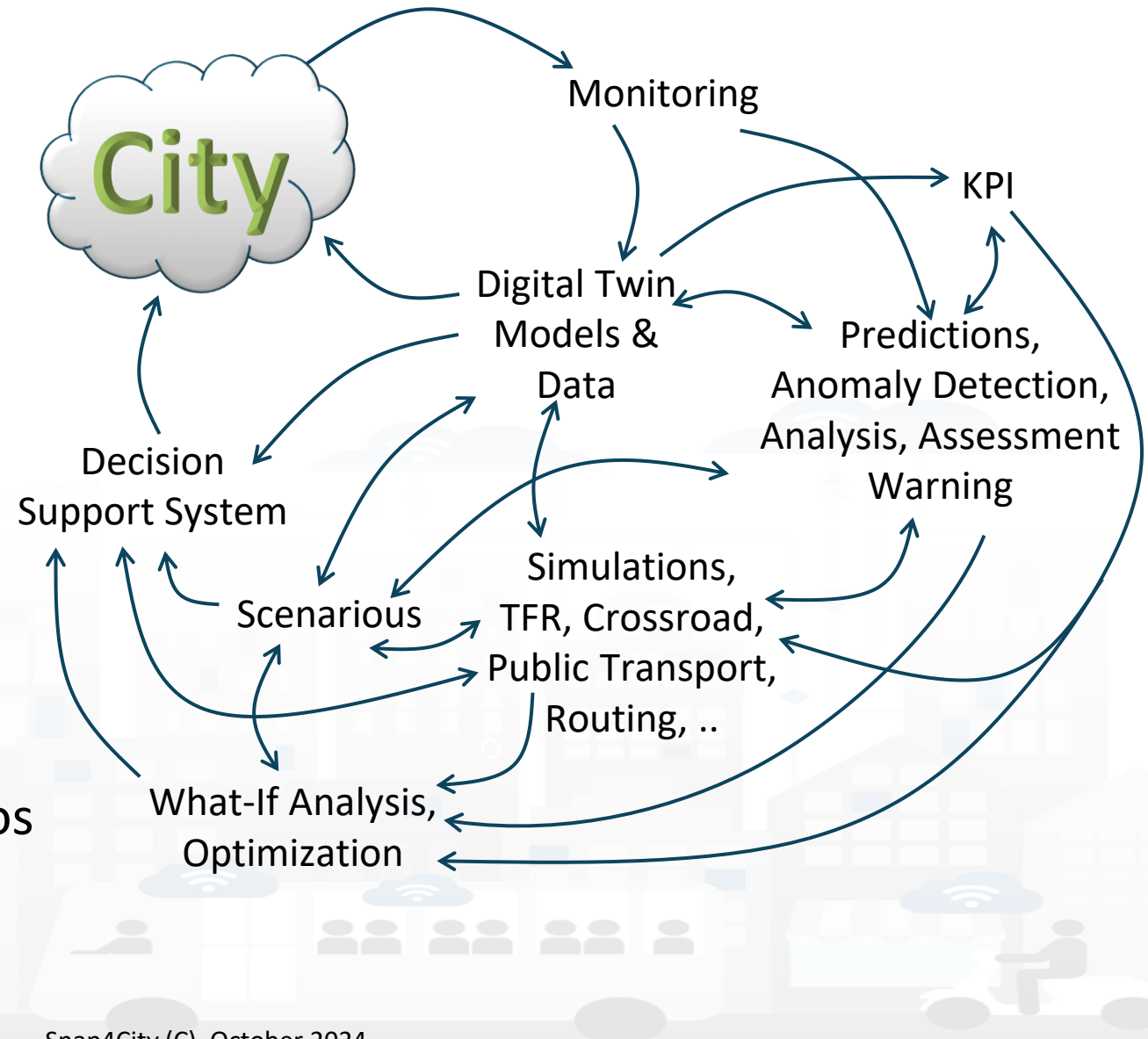


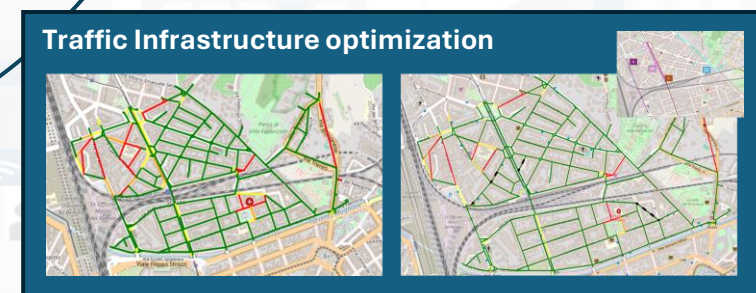
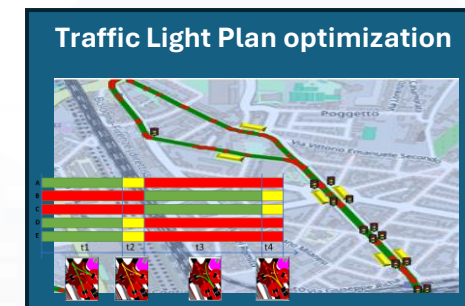
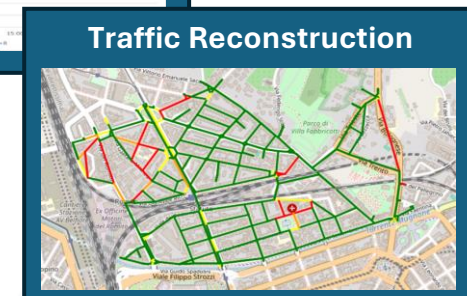
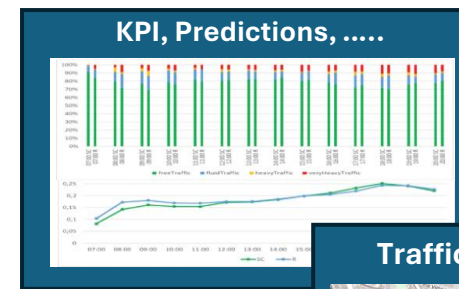
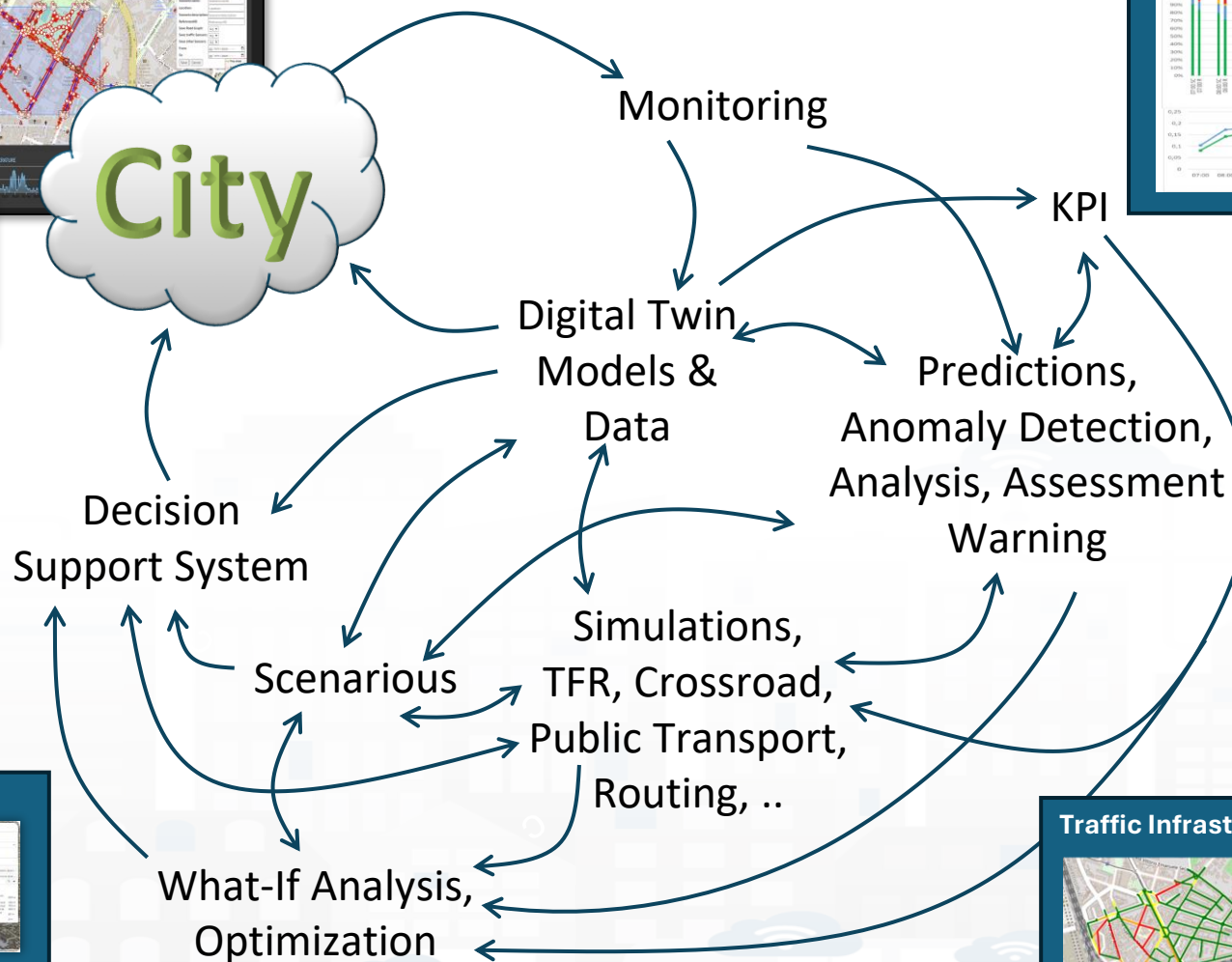
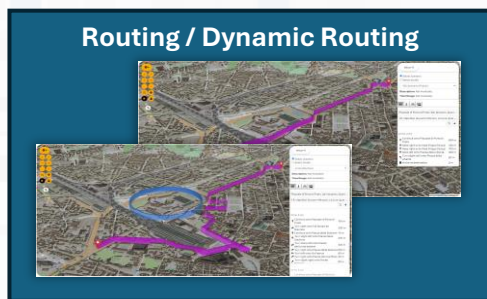
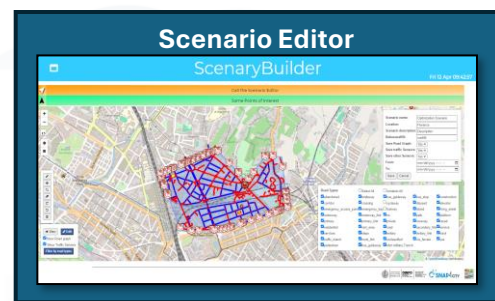
Main Tasks

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

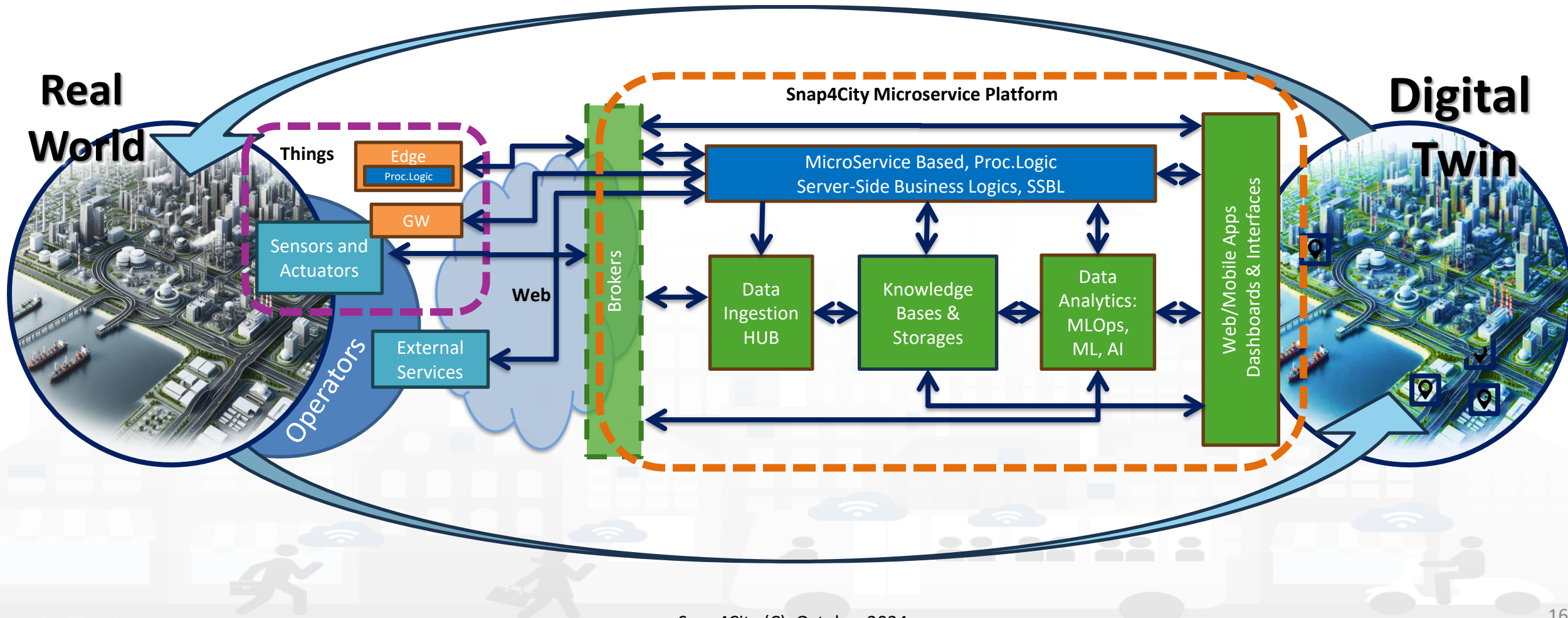


- **Controlling Status:** management, and operational
 - Monitoring via KPI
 - Predictions vs KPI
 - Anomaly detection
 - Neuro-Symbolic analysis
 - Risk assessment
 - Early warning on critical conditions
- **Making plan:** tactic and strategic, medium and long range, micro/macro
 - Simulation & optimization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

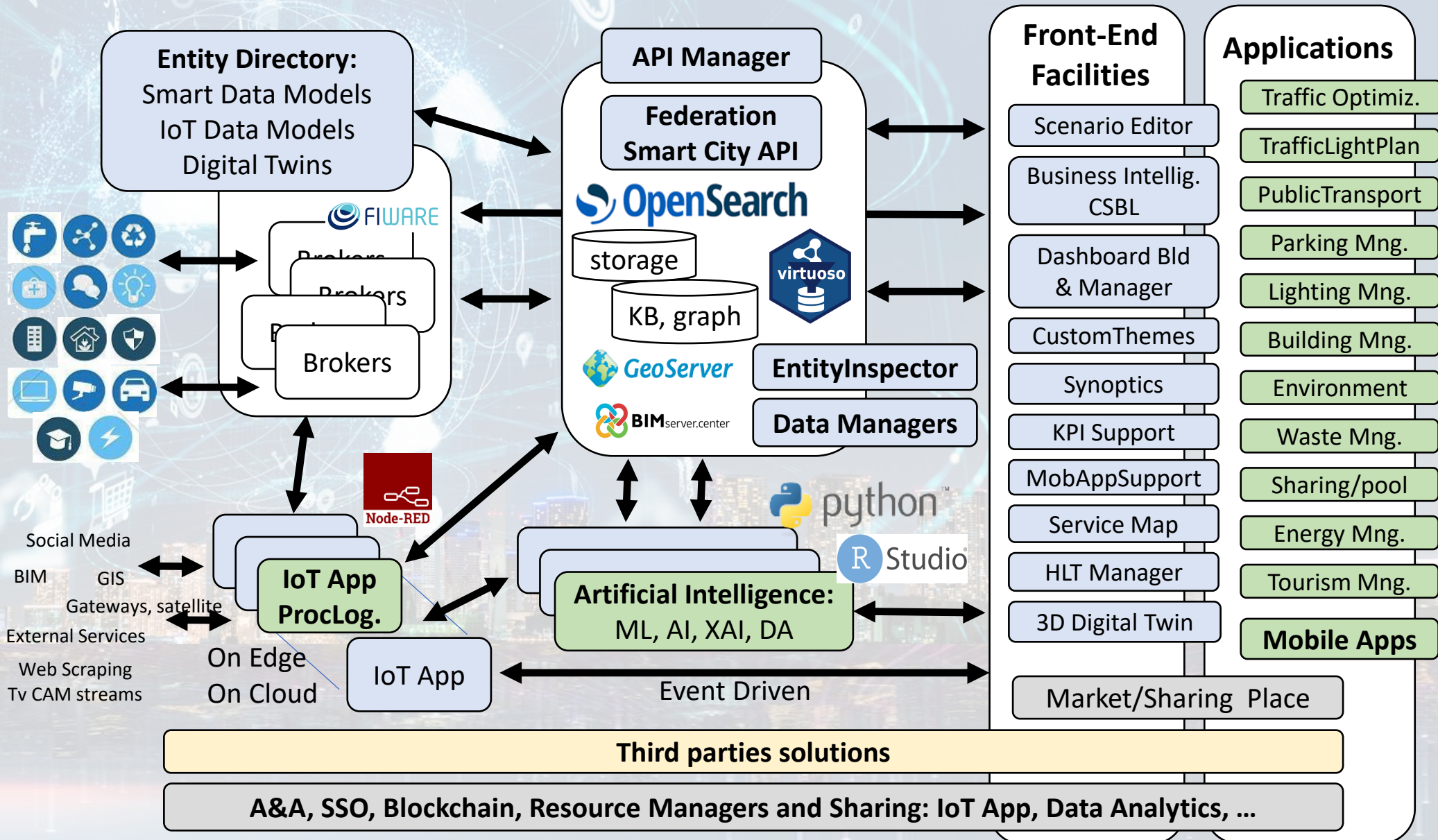




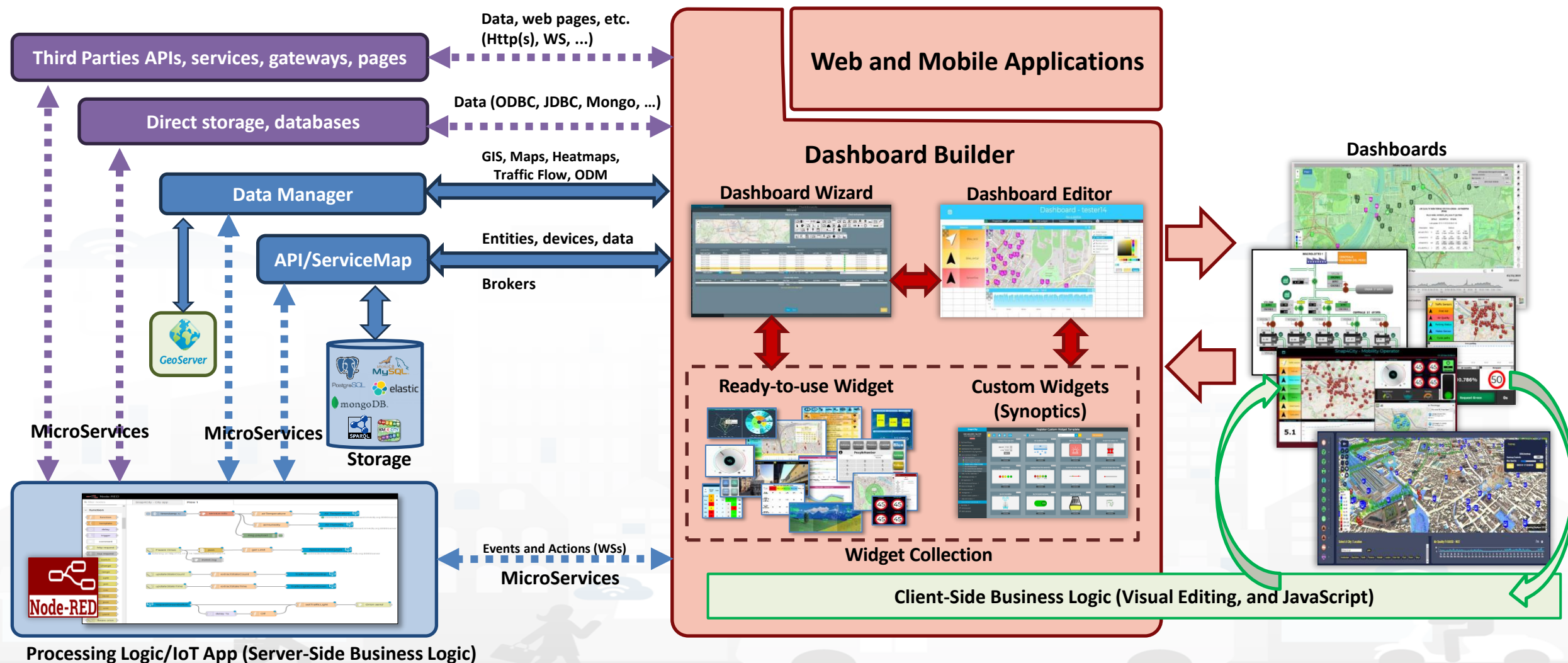
Digital Twin Development Platform

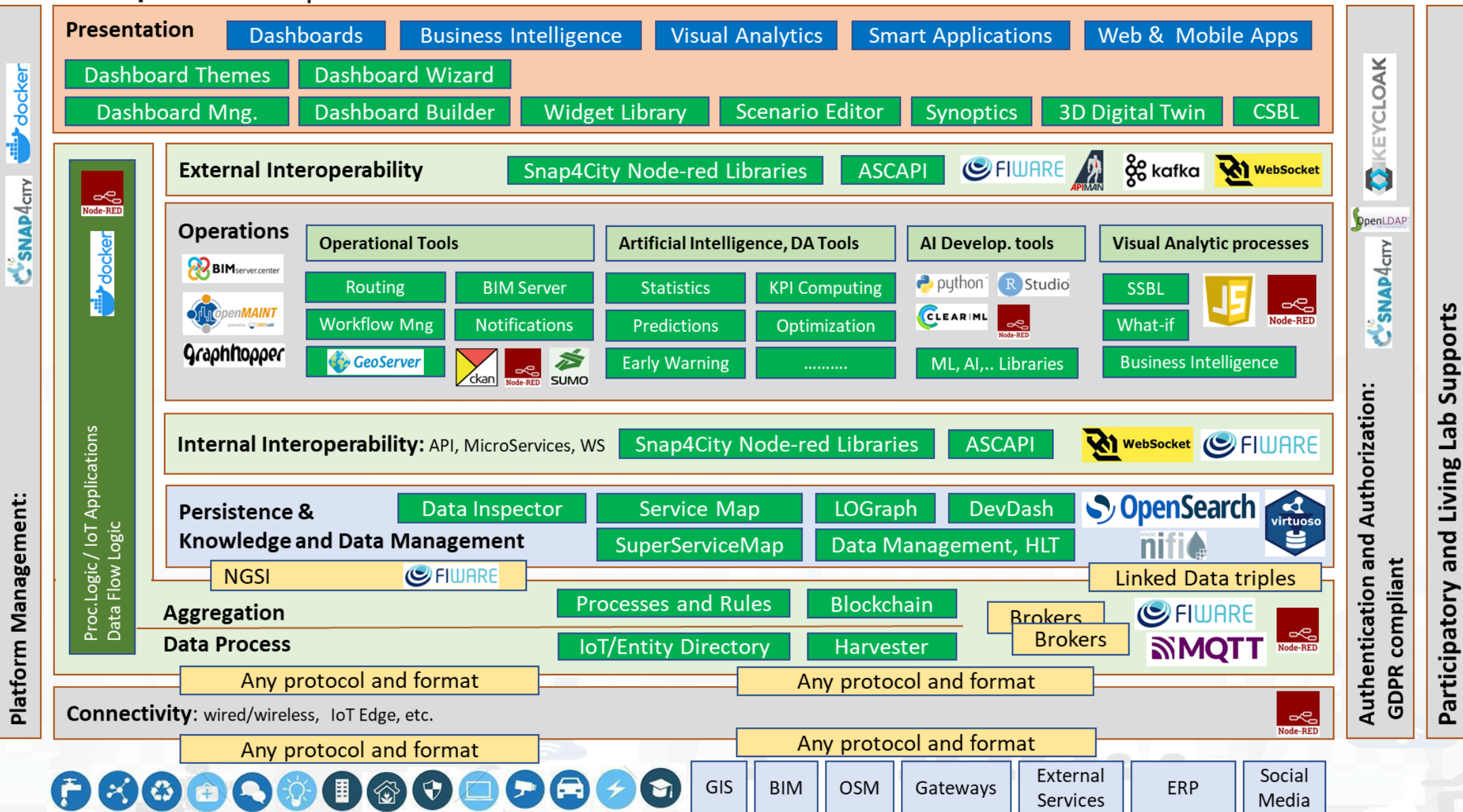


Technical Architecture



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







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Development Life Cycle

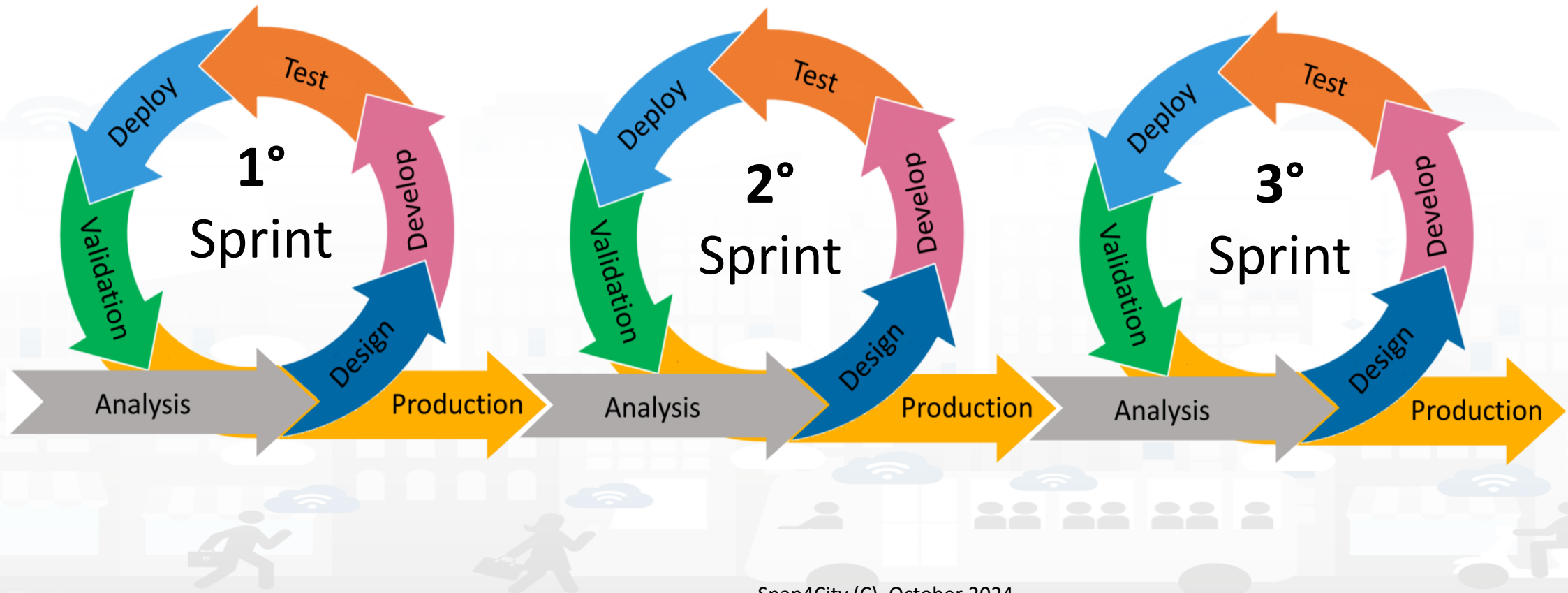
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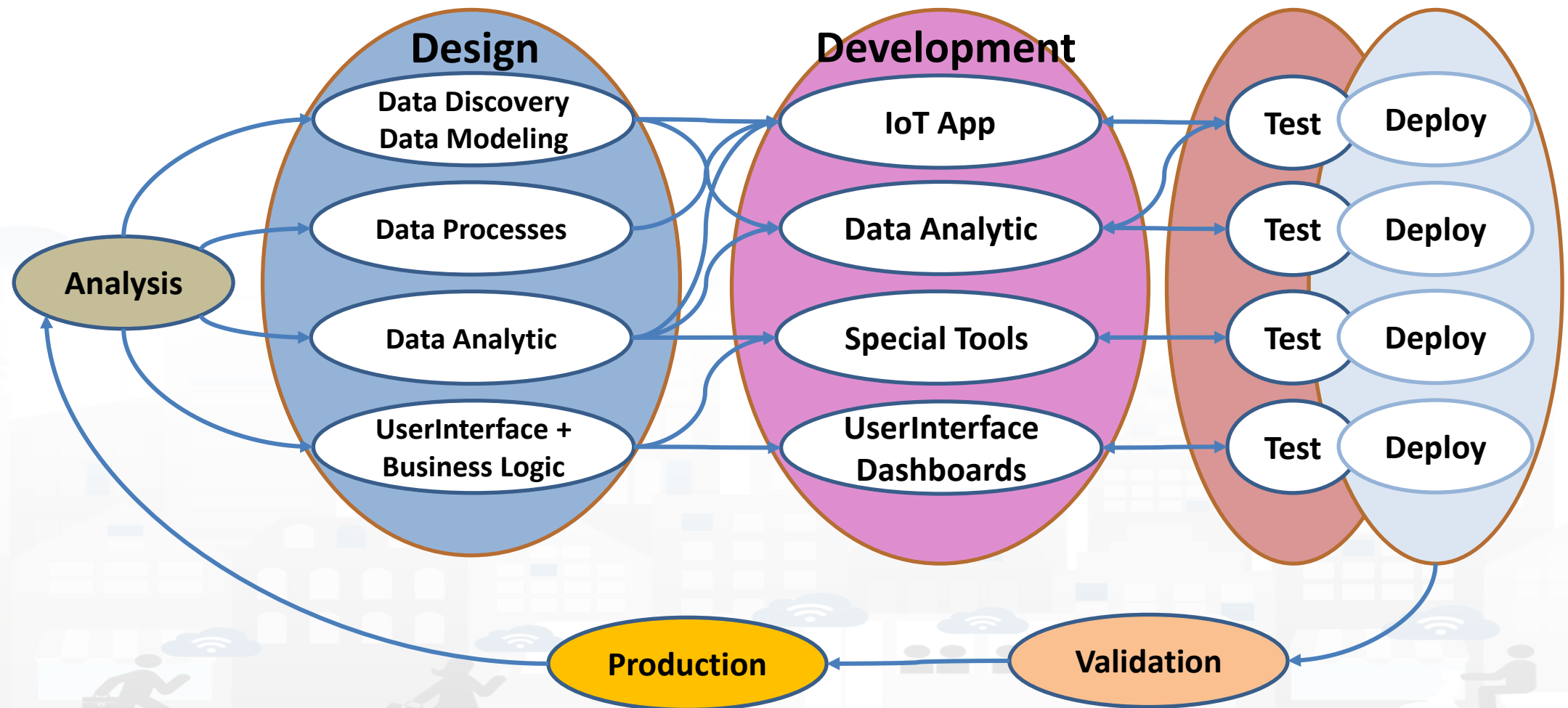




Development Life Cycle Smart Solutions

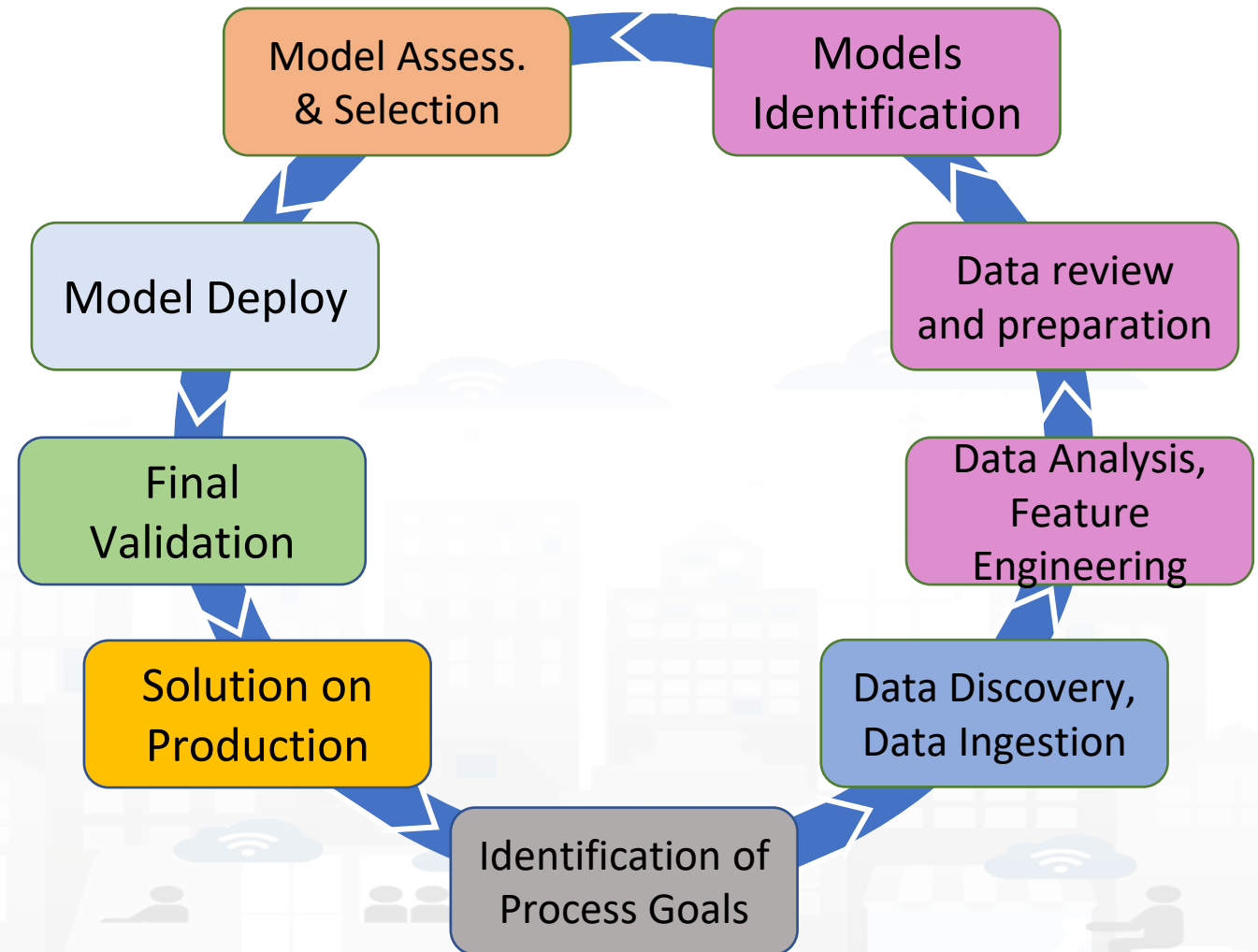
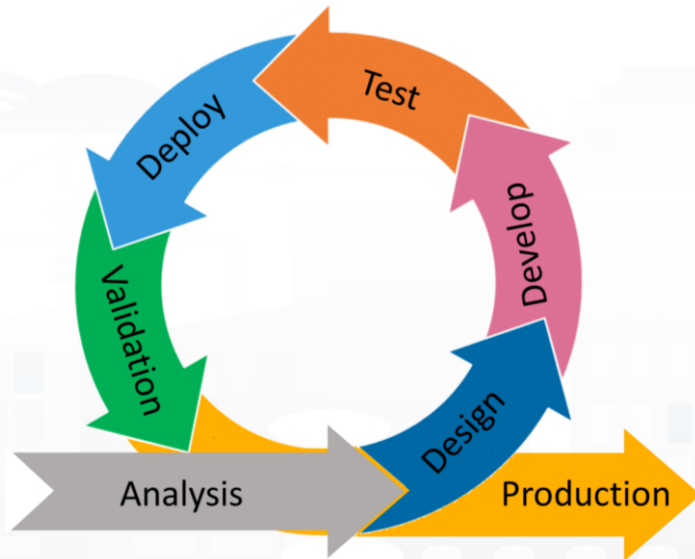


Development Life Cycle Smart Solutions

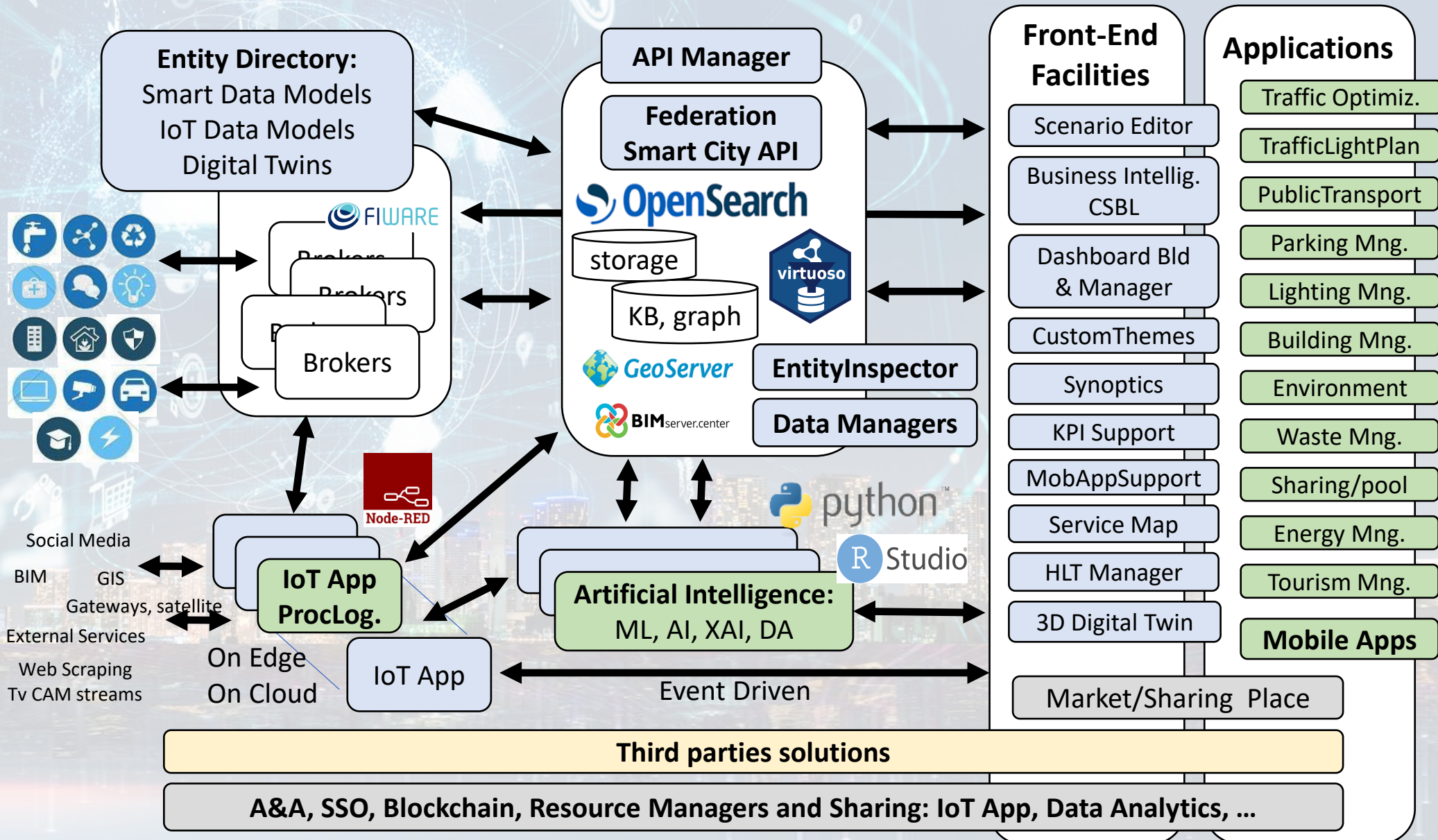


Data Analytics Development Life Cycle

- Detailed development process



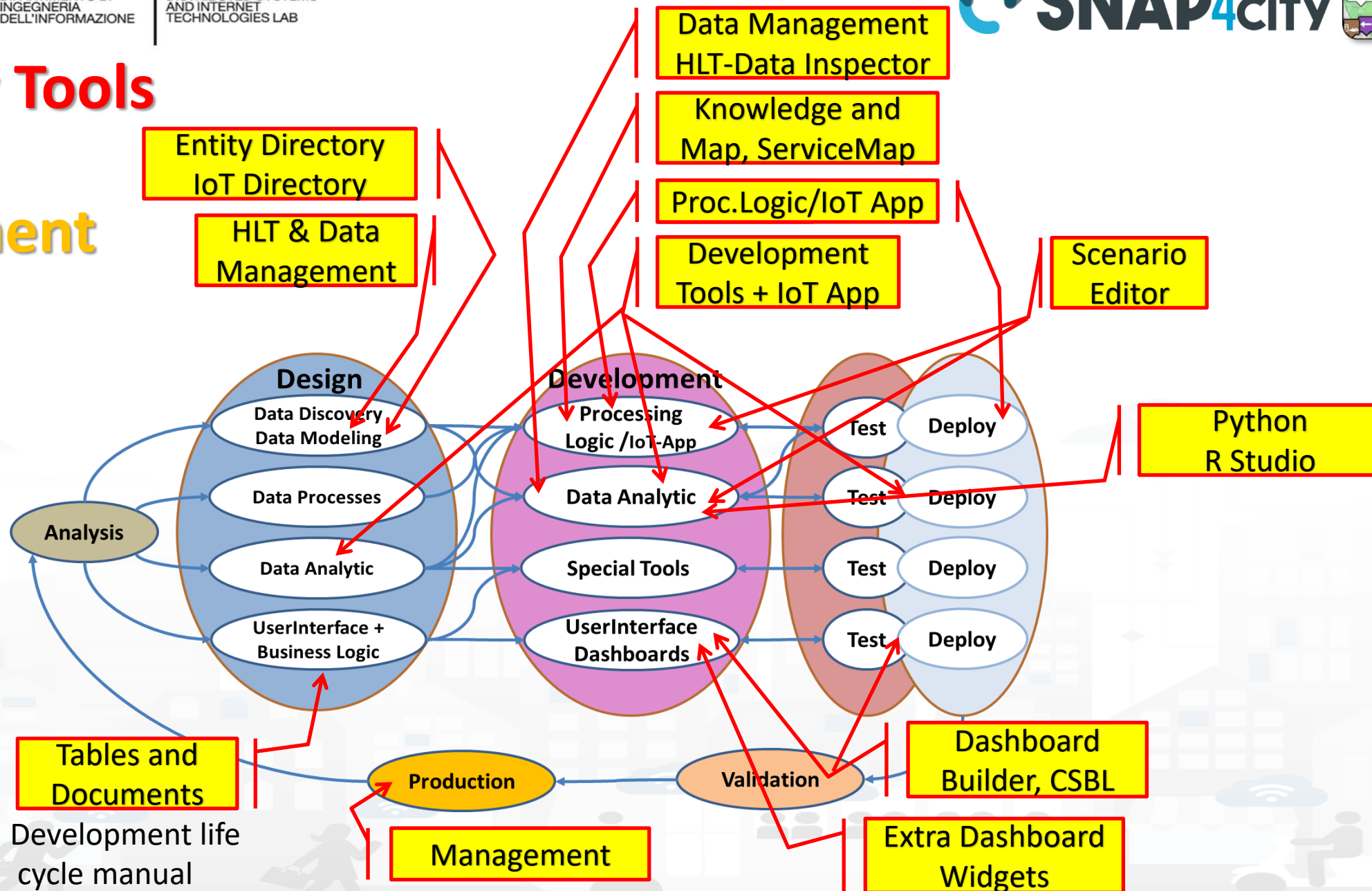
Technical Architecture



Snap4City Tools

vs

Development Life Cycle



Visual Development Tools



Third parties solutions
A&A, SSO, Blockchain, Resource Managers and Sharing: IoT App, Data Analytics

Development

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



Development Life-Cycle

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

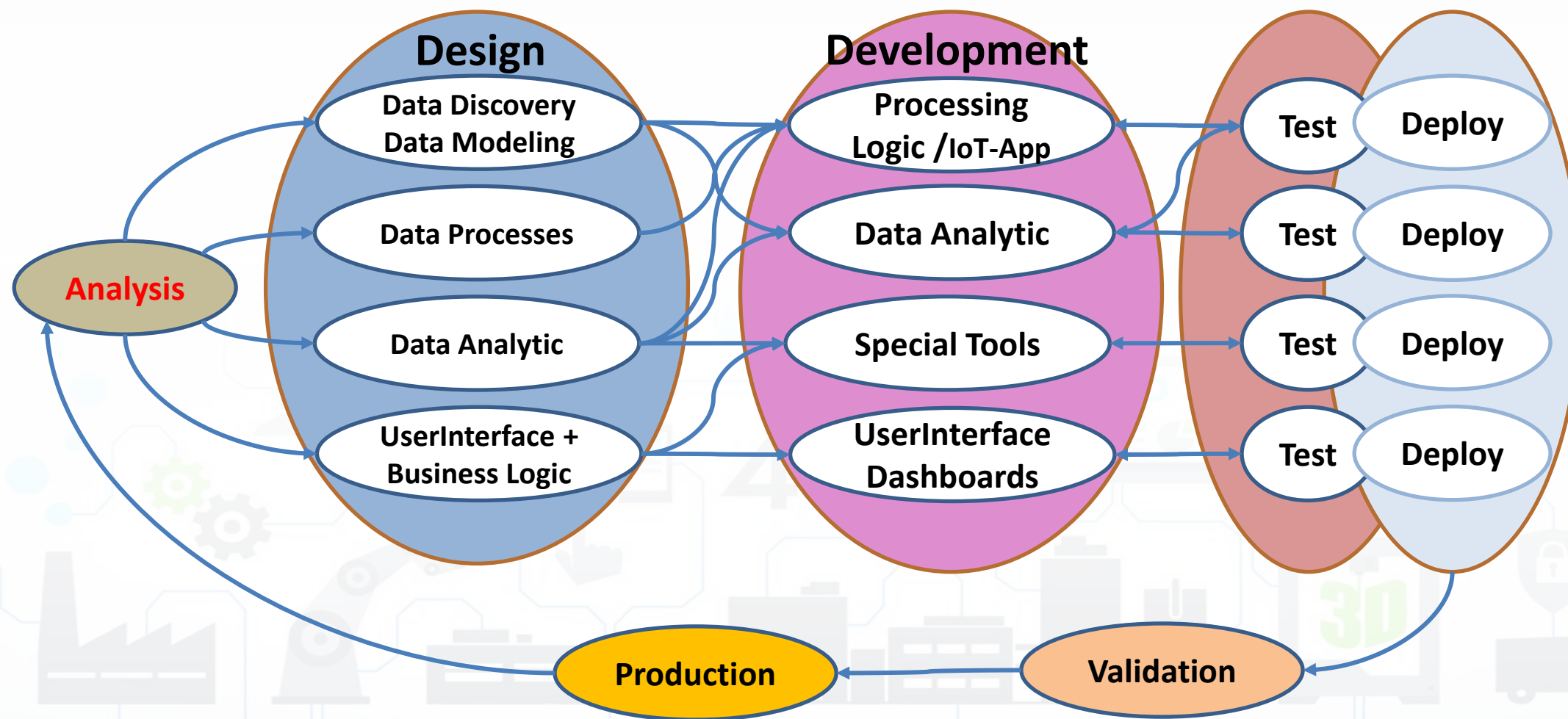
From Snap4City:

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

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

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

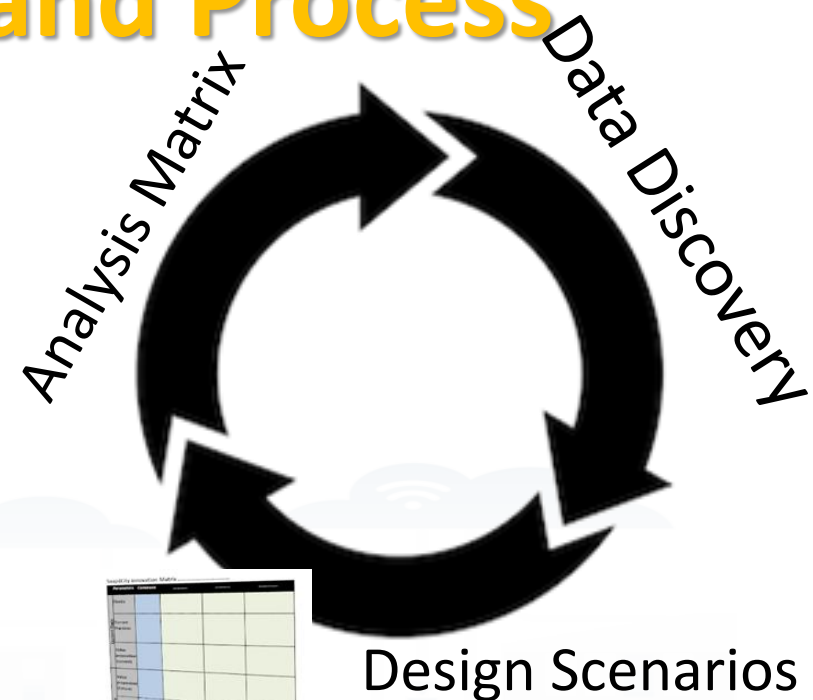
Development Life Cycle Smart Solutions



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

Snap4City Innovation Matrix and Process

Part 6



Snap4City Innovation Matrix

	Parameters	Commons	Operators	360°	Riskors
Current State	Needs	[Sticky Notes]	[Sticky Notes]	[Sticky Notes]	[Sticky Notes]
	Current Practices	[Sticky Notes]	[Sticky Notes]	[Sticky Notes]	[Sticky Notes]
	Value proposition (Current)	[Sticky Notes]	[Sticky Notes]	[Sticky Notes]	[Sticky Notes]
Future State	Value proposition (Future)	[Sticky Notes]	[Sticky Notes]	[Sticky Notes]	[Sticky Notes]
	Solution	[Sticky Notes]	[Sticky Notes]	[Sticky Notes]	[Sticky Notes]
	Value Capture	[Sticky Notes]	[Sticky Notes]	[Sticky Notes]	[Sticky Notes]
	Key Partners	[Sticky Notes]	[Sticky Notes]	[Sticky Notes]	[Sticky Notes]
	Barriers	[Sticky Notes]	[Sticky Notes]	[Sticky Notes]	[Sticky Notes]

Snap4City Innovation Matrix

	Parameters	Commons
Needs		
Current Practices		
Value proposition (current)		
Value proposition (Future)		
Solution		
Value Capture		
Key Partners		
Barriers		



The Dictionary of Entities

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

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

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

- legenda
- Entity Instance
 - Entity Model
 - Entity Messages with dateObserved

Register to
instantiate

Data Model of the Driver

- Name: string
- Surname: string
- Age: number
- Weight: number
- Phone: string
- Email: string
- DriverAnalysisID: ServiceURI
-

Driver: user45

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

Write SURIs to create
cross references

DriverAnalysis: user45driveranalysis

- DriverID: <http://.../user45>
- dateObserved: 12-03-2022T12:00:00
- Status: "none"
- Location: null
- Doctor: null
- Tools: null
-

Register to
instantiate

DriverAnalysis: user45driveranalysis

- DriverID: <http://.../user45>
- dateObserved: 25-04-2022T12:00:00
- Status: "bad"
- Location: truck
- Doctor: null
- Tools: Eyetrack
-

New update on
user45driveranalysis by
sending a message

DriverAnalysis: user45driveranalysis

- DriverID: <http://.../user45>
- dateObserved: 22-03-2022T12:00:00
- Status: "good"
- Location: room45
- Doctor: <https://.....>
- Tools: null
-

New update on
user45driveranalysis by
sending a message

legenda

- Entity Instance
- Entity Model
- Entity Messages with dateObserved

Register to
instantiate

Data Model of the Driver

- Name: string
- Surname: string
- Age: number
- Weight: number
- Phone: string
- Email: string
- DriverAnalysisID: ServiceURI
-

Driver: user45

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

Write SURI to create
cross references

DriverAnalysis: user45driveranalysis

- DriverID: <http://.../user45>
- dateObserved: 12-03-2022T12:00:00
- Status: "none"
- Location: null
- Doctor: null
- Tools: null
-

Register to
instantiate

DriverAnalysis: user45driveranalysis

- DriverID: <http://.../user45>
- dateObserved: 25-04-2022T12:00:00
- Status: "bad"
- Location: truck
- Doctor: null
- Tools: Eyetrack
-

New update on
user45driveranalysis by
sending a message

DriverAnalysis: user45driveranalysis

- DriverID: <http://.../user45>
- dateObserved: 22-03-2022T12:00:00
- Status: "good"
- Location: room45
- Doctor: <https://.....>
- Tools: null
-

New update on
user45driveranalysis by
sending a message

API, External Services

External API						
API name	API url and shape	Kind	parameter	Credentials approach	status	Description, Swagger link, Postman, ...
	GIS...					
	CKAN...					

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

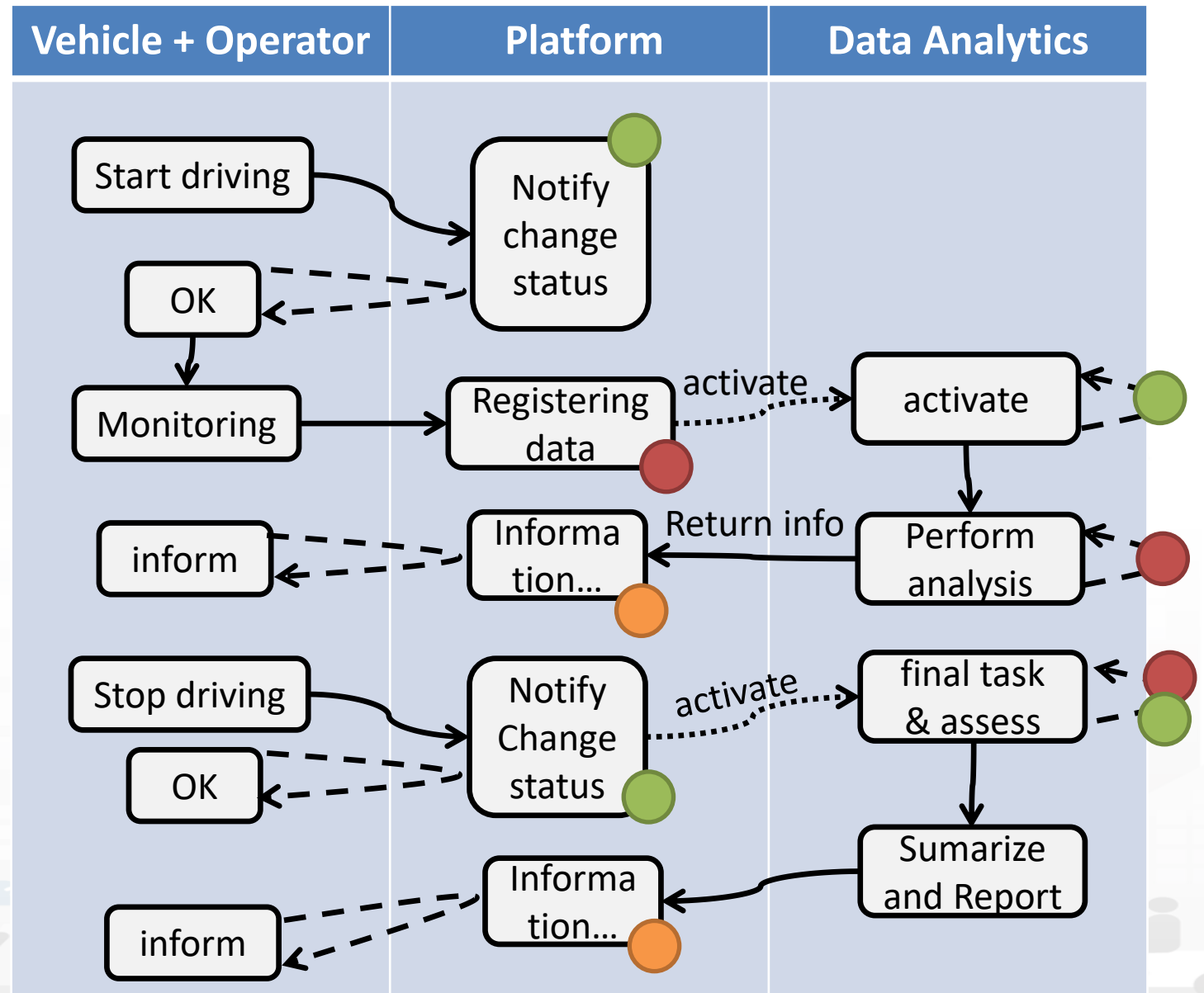
External Services				
URL Web pages	parameter	Description	Nature	Subnature

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

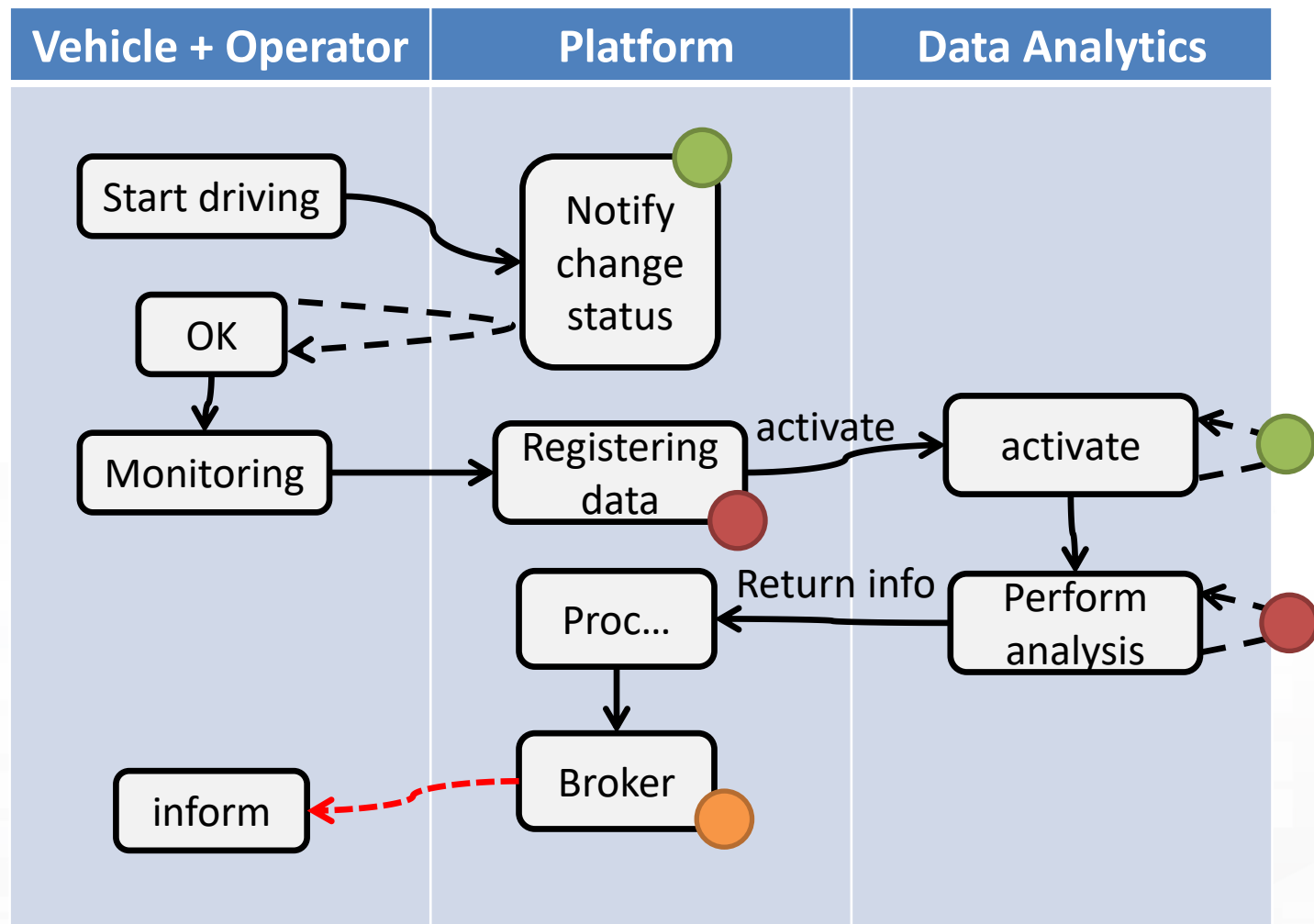
- **Scenarios** describing the application/task, textual definition, with some standard table as UML. The scenarios have to refer to identified entities.
 - <https://www.uml-diagrams.org/activity-diagrams-examples.html>
- **Use Cases** describing the different cases into the single applications, by using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

Example: Activity Diagram

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

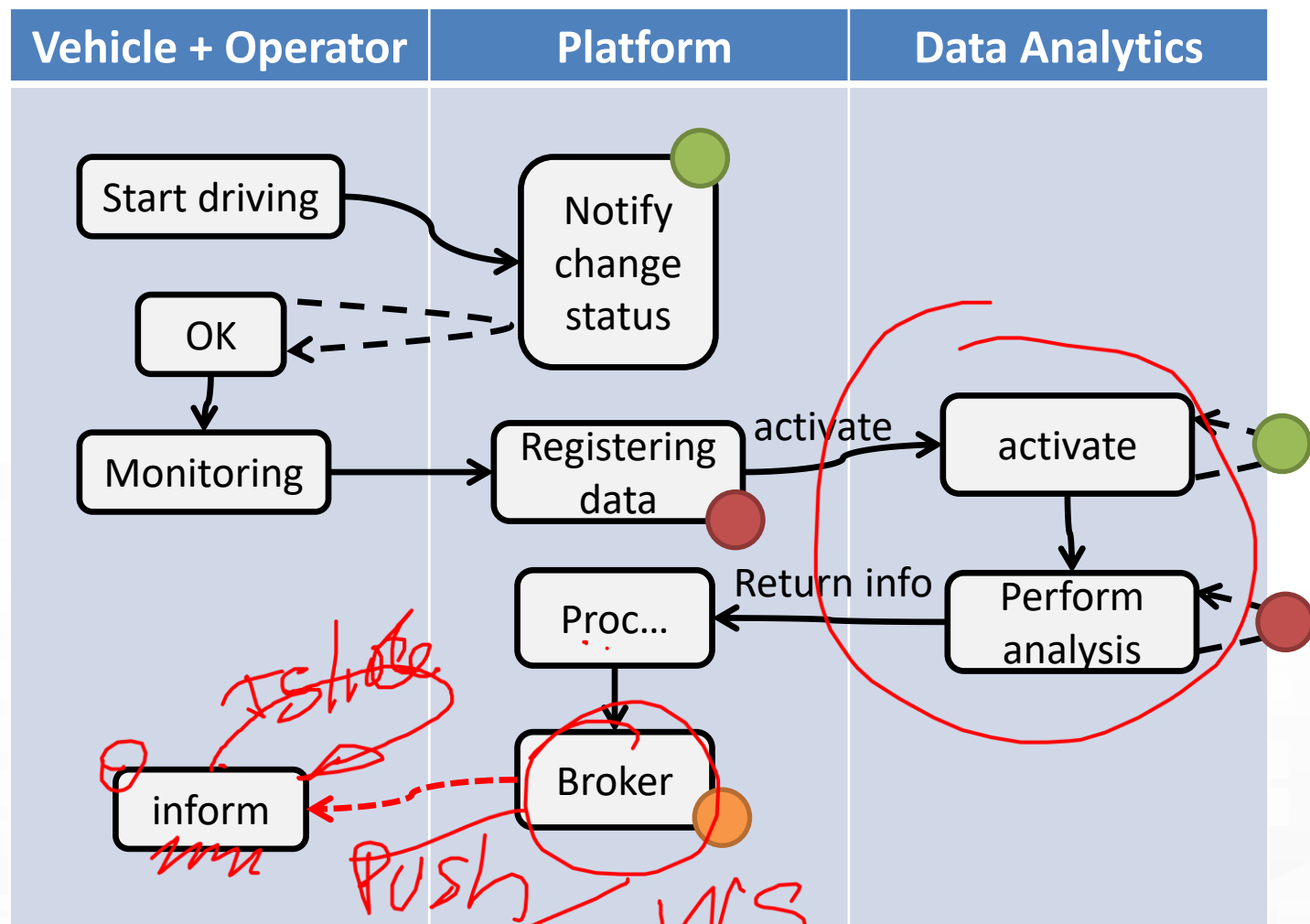


- Every time a data is entered into the Storage an event occurs into the broker
- The server «Inform» can be subscribed from an IoT App to receive in push these changes **(red dashed line)**



A variant

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



The above figure

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

Fun Requirements

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

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

Non Functional Requirements



Somehow related each other

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

All largely covered by Snap4City platform

Be carefull

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

Data analytics

FROM CITY
DASHBOARD TO
APPLICATIONS

DATA GATHERING
AND CITY DATA
KNOWLEDGE
MANAGEMENT

FORGING &
MANAGING OPEN
AND FLEXIBLE WEB
AND MOBILE APPS

IOT APPLICATIONS
VS IOT EDGE
DEVICES

IOT/IOE DEVICES
AND NETWORKS

IOT APPLICATIONS,
THE LOGIC AND
THE SMARTNESS

ADVANCED
SMART CITY API,
MICROSERVICES,
SNAP4CITY API

SNAP4CITY
LIVING LAB FOR
COLLABORATIVE
WORK

SNAP4CITY FOR
BEGINNERS

DATA ANALYTICS,
BUSINESS
INTELLIGENCE,
WHAT-IF AND
SIMULATION

SNAP4CITY
ARCHITECTURE AND
ECOSYSTEM. OPENED
TO DEVELOPERS
AND STAKEHOLDERS

DECISION SUPPORT
SYSTEM AND CITY
RESILIENCE

HOW TO ADOPT
SNAP4CITY, AND
OUR ROADMAP

SNAP4CITY
AND KM4CITY
PROJECTS

SNAP4CITY THE
VIEW OF THE
ADMINISTRATORS

TWITTER
VIGILANCE: SOCIAL
MEDIA ANALYSIS

Available AI Solutions on Snap4City

<https://www.snap4city.org/997>

More than 80 Available Solutions & 300 AI applic.

- **Mobility and Transport**
- **Environment, Weather, Waste, Water**
- **City Users Behaviour and Social analysis**
- **Energy and Control**
- **Tourism and People**
- **Security and Safety**
- **High Level Decision Support Solutions**
 - **Asset management**
 - **Resilience and Risks Analysis**
- **Low level Techniques**

<https://www.snap4city.org/download/video/course/p4/>



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

Scenario Editor

Select map

Zoom

New Scenario

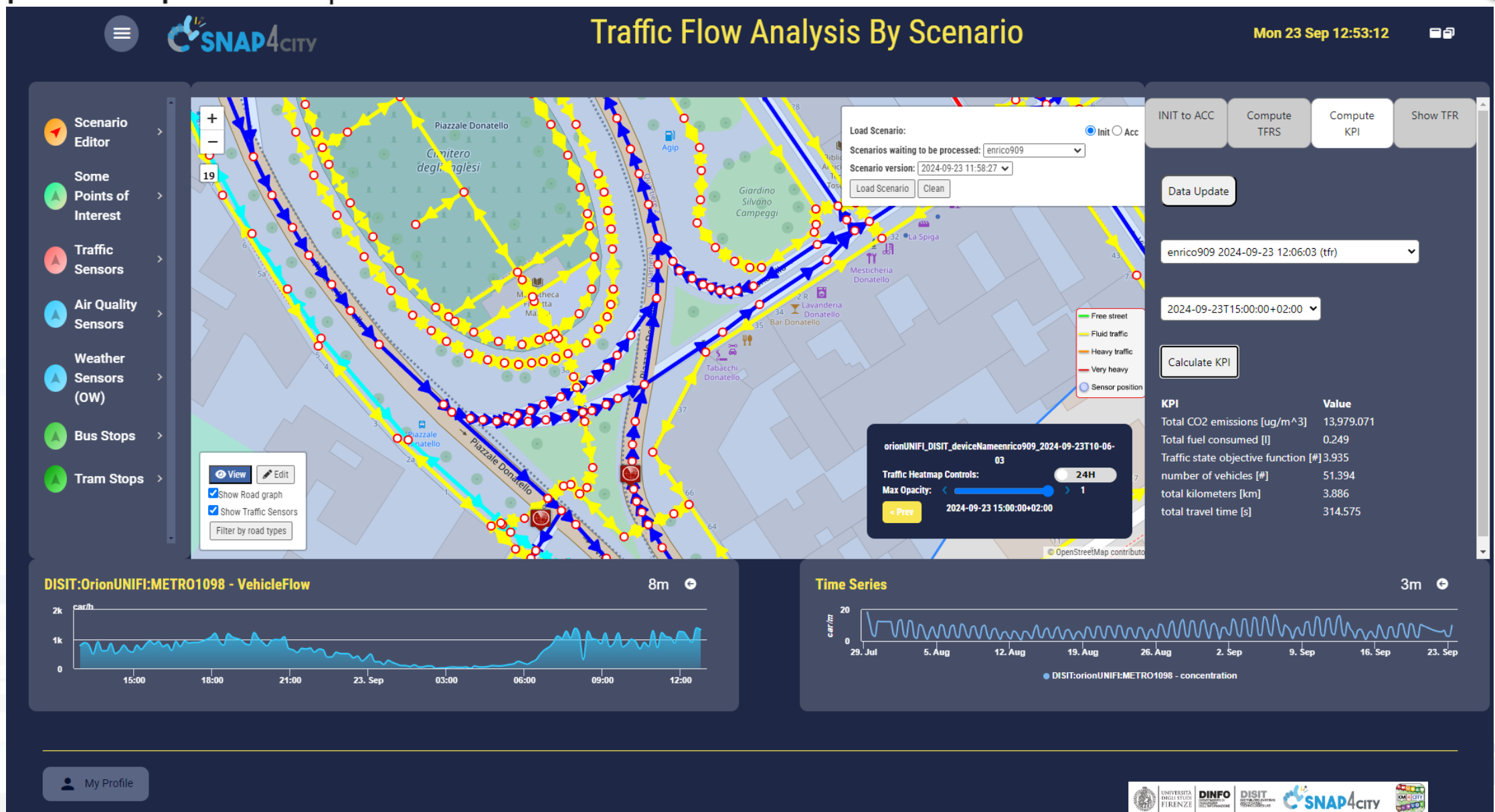
Editing
Drag & drop
Split & Join
Delete
Do and Undo

The main interface displays a map with various road segments. A left toolbar contains icons for map selection, zooming, and editing. A top-right panel allows for scenario configuration, including name, location, description, and sensor settings. A bottom-right panel shows the 'Road Types' selection, with a grid of checkboxes for different road categories like 'abandoned', 'corridor', 'motorway', etc. A bottom-left panel shows 'View' and 'Edit' options, with checkboxes for 'Show Road graph' and 'Show Traffic Sensors'.

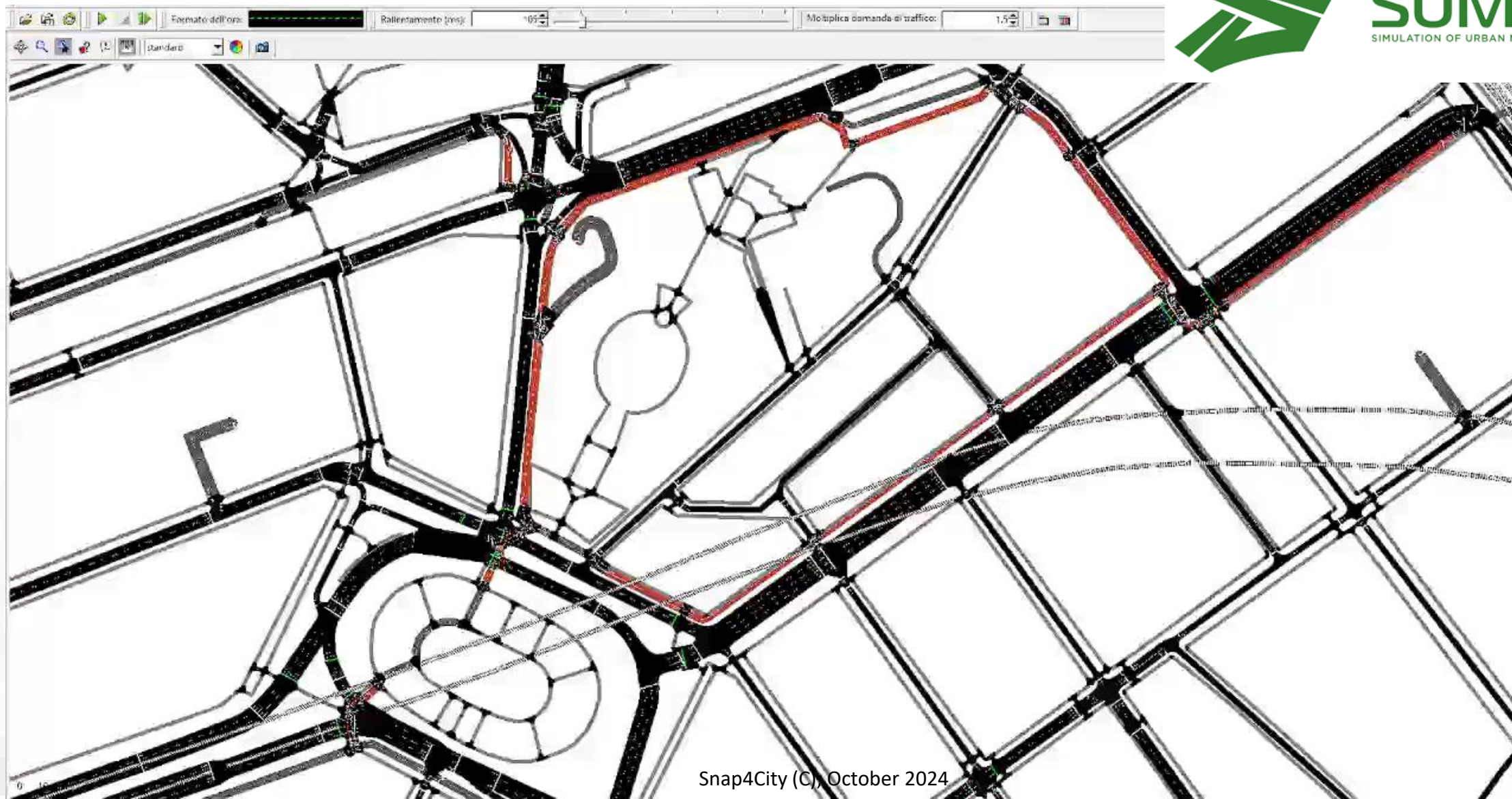
Edit Road
Segment

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

What-if on TFR



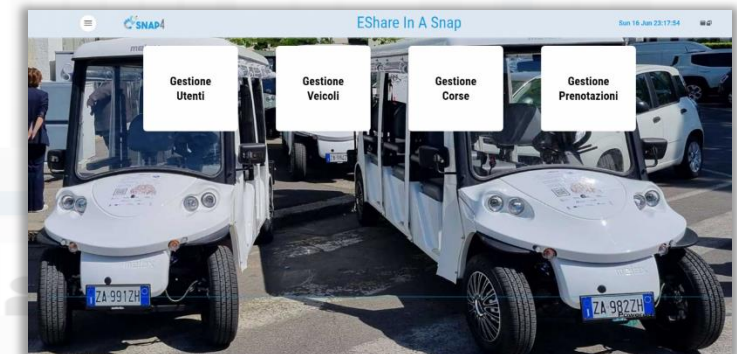
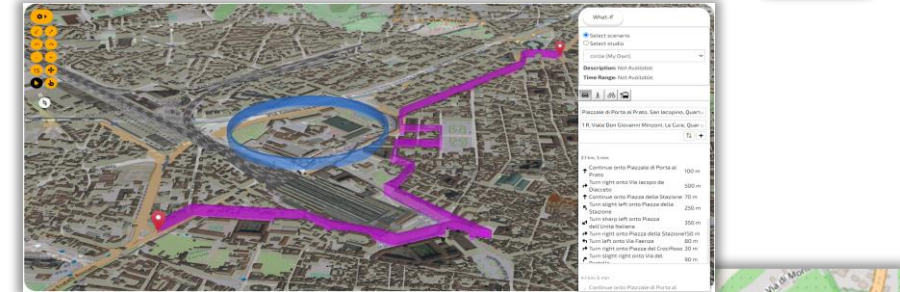
Micro Simulation



Mobility

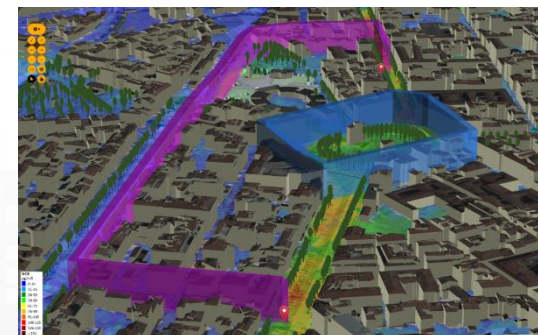


- **Goals:**
 - Decongestion, Decarbonization, costs reductions
 - Improve Accessibility to services
 - Improve Security/Safety of city users
- **Operation and Plan:**
 - Traffic monitoring, prediction, reconstruction, identification of critical conditions (early warning), fleet management, dynamic routing, multimodal routing, city user behaviour analysis
- **Optimization and what-if analysis traffic light, infrastructure**
 - **Reduction:** travel time, waiting time, stops, CO2 emissions, consume fuel, travel time for tramways
- **Public Transport:** analysis of Mobility Demand vs Offer of Transportation
- **Parking Management:** monitoring, prediction, any payments, on/off-road
- **Sharing / Pooling Management:** eShare and mobile app, bikesharing, smart bike, fleet management
- **KPI:** SUMI/SUMP, travel time, emissions, traffic status, accessibility, ..
- **Mobile App:** final users and operators
 - Info Mobility, traffic reconstruction, charging, participation,
 - Parking, payments, overparking, fine reporting, ..
- **Participatory:** problem reporting, ticketing, etc.
- **Data Integration of any kind:** env, weather. Tickets, presences, POI, sat, etc.



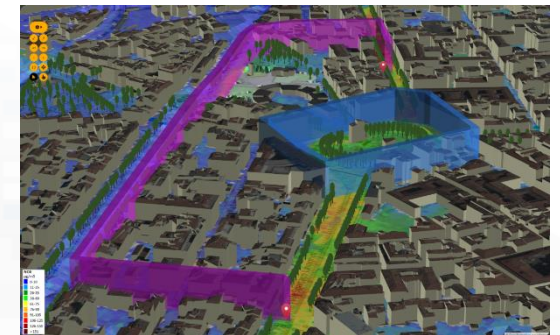
Mobility and Transport Domain (2024/8)

- **Goals:**
 - Decongestion
 - Decarbonization
 - Accessibility to services
 - Security/Safety of city users
- **Solutions for Operation (monitoring, managing, mobile apps, digital signages, control rooms)**
 - Monitoring traffic, parking, people flow, services, boats, ports, beaches, etc.
 - Early detection/warning of critical conditions: traffic, congestion, security/safety
 - Managing Smart Parking, transportation services, fines, etc.
 - Managing fleets: personal, sharing, waste collection, maintenance, etc.
 - Managing E-sharing, pooling services, MaaS, etc.
 - Managing entrances in city areas: restricted areas, touristic busses, etc.
 - Production of suggestions, recommendations, nudging
 - Computing predictions of any kind
- **Solutions for Planning (optimization and what-if analysis)**
 - Reduction of traffic congestion, via optimization: traffic light plans, viability, routing
 - Reduction of Pollutant Emissions, via optimization: traffic light plans, viability
 - Optimization of transportation offers wrt multimodal mobility demand
- **Algorithms and computational solutions, see next slide**

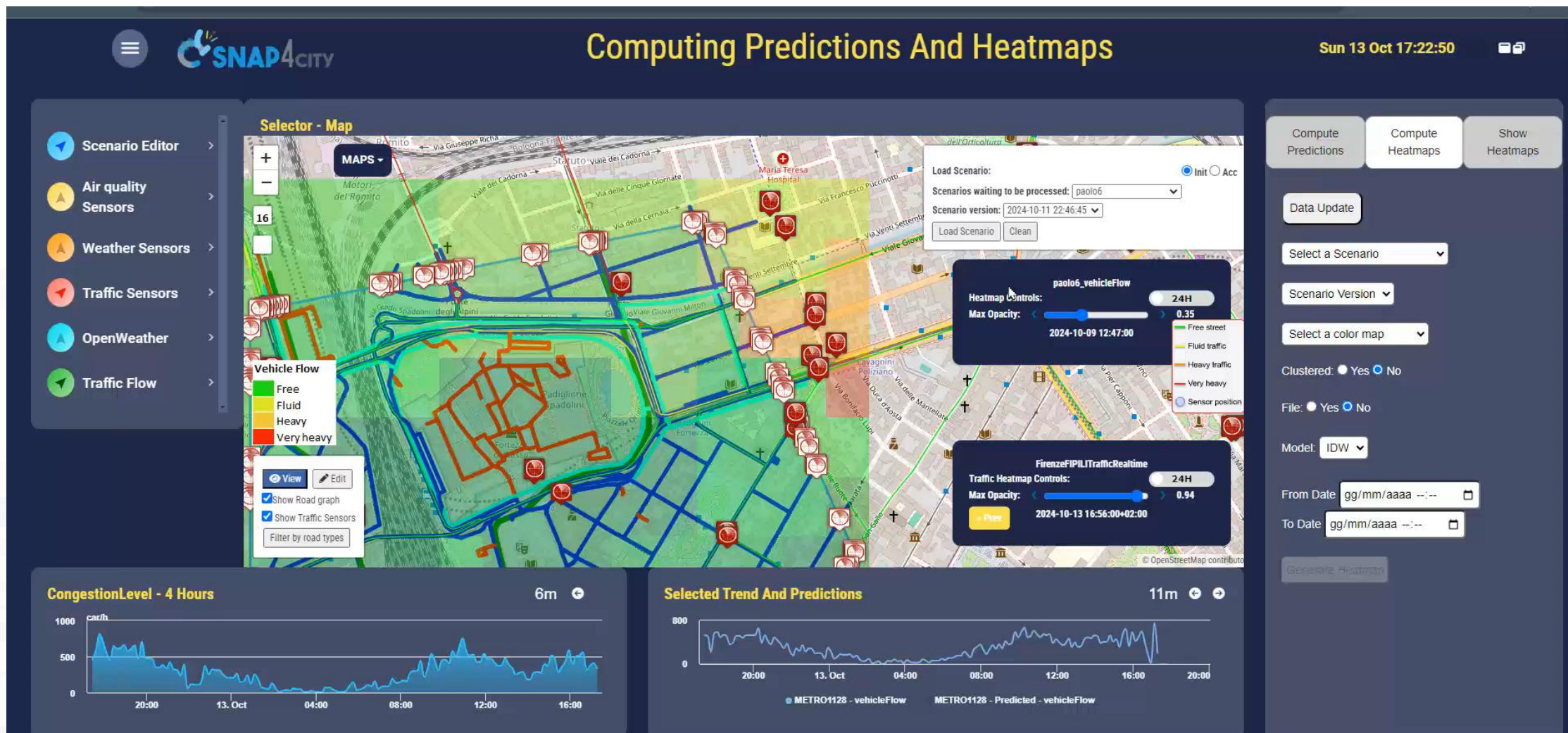


Tools for Mobility and Transport (2024/8)

- Optimisation of viability of an area for reducing congestion, waiting time, stops
- Optimisation of Traffic Light Plans, synchronization, in an area for reducing congestion, waiting time, stops
- Predictions for: traffic flow, smart parking, smart bike sharing, people flows, etc. (ML, DL)
- What if analysis: routing, traffic flow, demand vs offer, pollutant, etc. (Simulation + ML)
- Traffic flow reconstruction from sensors and other sources (simulation + ML)
- Public Transportation: Ingestion and modelling of GTFS, Transmodel, NeTEx, etc. (DP)
 - Analysis of the **demand mobility vs offer transport** of according to public transportation and multiple data sources (Simulation)
 - Assessing **quality of public transportation** (analysis)
- Accidents heatmaps, anomaly detection (analysis, ML)
- Road light controlled by traffic conditions
- Tracking fleets, people, via devices: OBU, OBD2, mobile apps, etc. (DP)
- Routing and multimodal routing (multistop travel planning), constrained routing, dynamic routing (DA)
- Computing **Origin Destination Matrices** from different kind of data (analysis, DP, DP)
- Computing **typical trajectories** on the basis of tracks (analysis, ML)
- Fleet management, monitoring, booking, allocation, maintenance
- Computing Messages for Connected drive (DP)
- Slow and Fast Mobility **15 Minute City Indexes** (analysis, DP, ...ML)
- Computing and comparing traffic flow on devices and at the city border (analysis)
- **Typical time trends** for traffic flow and IoT Time series. (analysis, ML)
- **Impact of COVID-19** on mobility and transport
- Computing SUMI, PUMS, etc. (mainly DP)
- **Definition of Scenarios:** traffic, road graph, conditions, etc.
- Etc.



Predictions and Heatmaps in Real Time

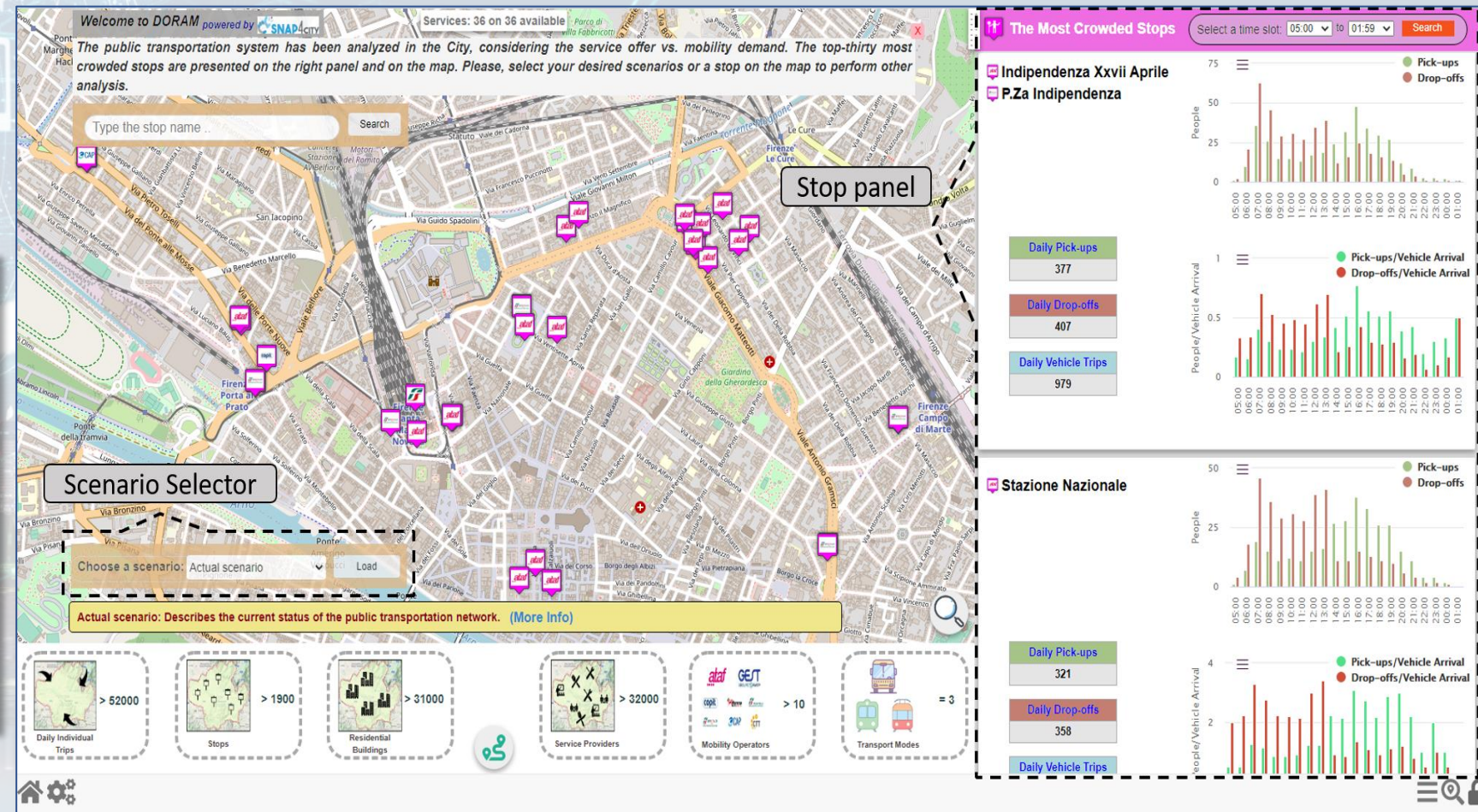
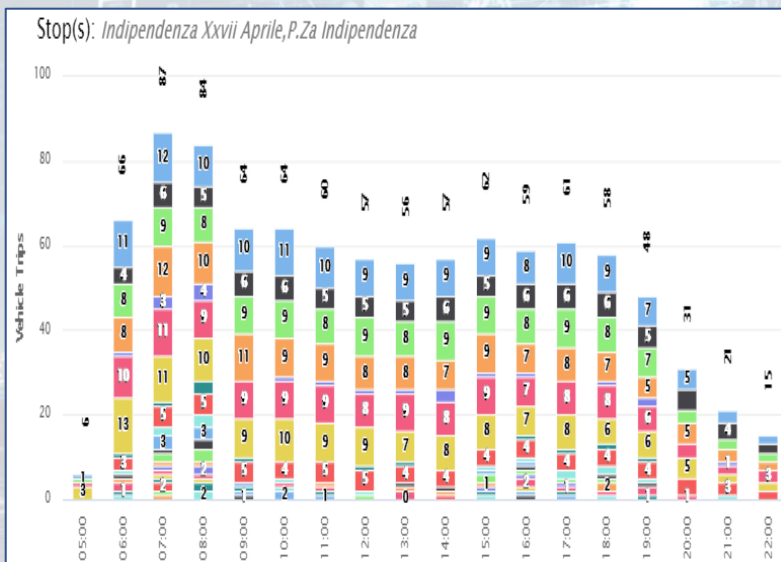


What-if Analysis on Pub Transport



- Simulation / analysis of Demand and Offer of transportation
- Definition of scenarios impact on
 - Traffic, Pollutant, parking, public transport, private flows, etc.
 - KPI analysis

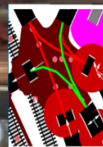
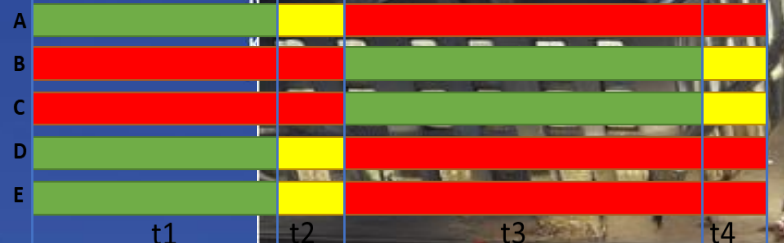
Public Services





Traffic Light Plan Optimization

FROM CITY
DASHBOARD TO
APPLICATIONS



SNAP4CITY
AND KM4CITY
PROJECTS

ADOPT
CITY, AND
ADMAP

SNAP4CITY THE
VIEW OF THE
ADMINISTRATORS

MOST
CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE

11 SUSTAINABLE CITIES
AND COMMUNITIES



<https://www.snap4city.org/1015>

Traffic Light

9:30

Traffic Light Plan Optimisation, Digital Twin

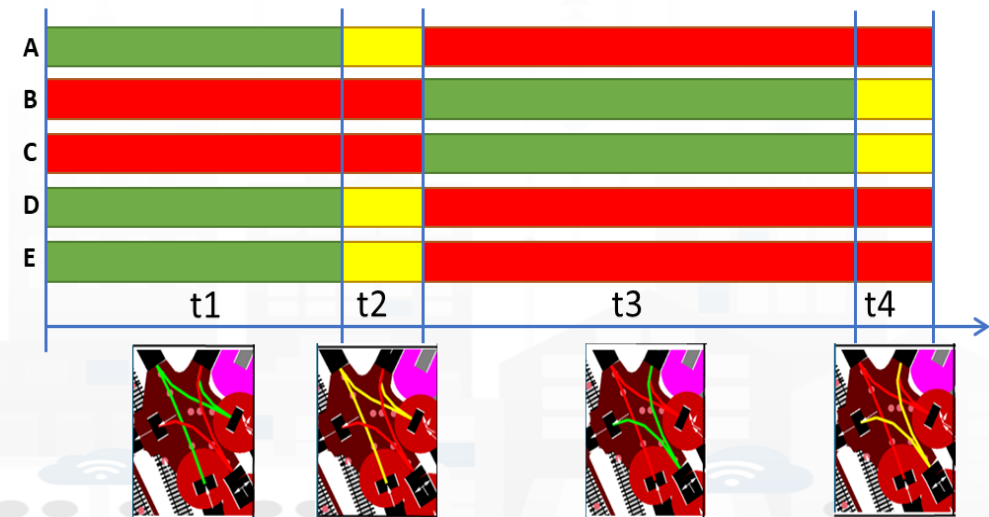
- **Match Multiple Objectives and Synchronization:**

- public and private traffic, tramway priority
- Micro and Macro Scales
- **AI: Genetic Algorithms, Reinforced Learning**
 - Fixed and Actuated Cycles
 - Adjusted on Demand

- **Validation/integ.** with *SUMO* simulation

- Travel Time, waiting time, waiting count, specific travel time on directions, CO2 emissions, etc.

- **Reductions from 5% to 15%**



Snapshot4City

Dashboard Management System

Dashboard Management System

← → ↺ ↻ 🏠 🌐 📄 📱 📺 📷 📹 📺 📷 📹

🔍 snap4city.org/dashboardSmartCity/view/Gea-Night.php?iddasboard=NDI4Mg==

☆ 📄 📱 📺 📷 📹

☰

 **SNAP4CITY**

Traffic Flow Simulation

Mon 14 Oct 19:47:07

Current Scenario: alessandroscen...

CANCEL

PAUSE

HELP

slow

fast

Delay: 30.0 ms

Stats

time: 1172.000 s
payload: 2.6 KB
simulate: 1.67 ms
snapshot: 0.54 ms

Vehicle Summary

car(s): 43

Click Summary

N/A

Quick Find

X,Y (float, float)

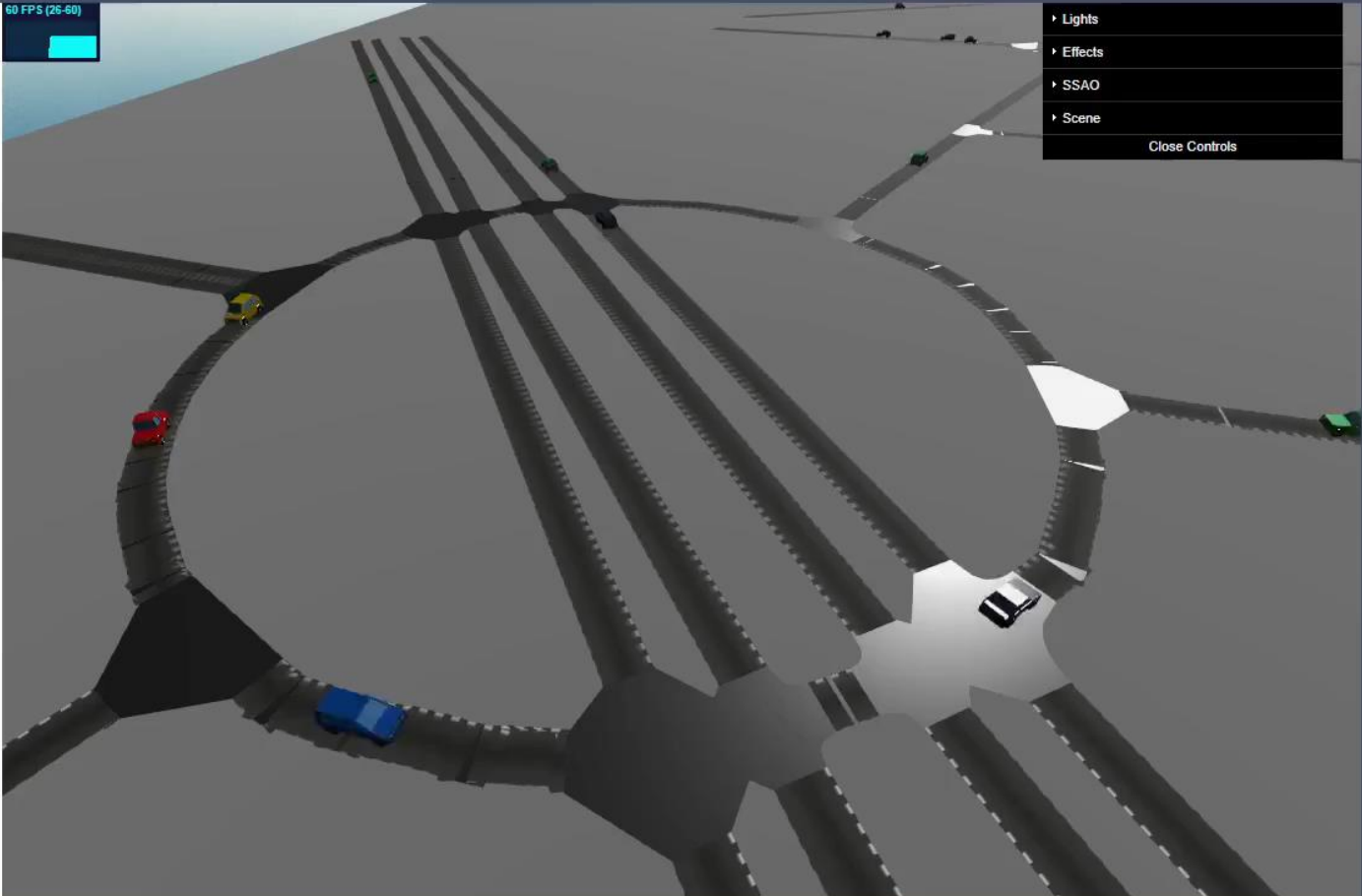
SEARCH

CAR

BIKE

TRAIN

60 FPS (26-60)



▸ Lights

▸ Effects

▸ SSAO

▸ Scene

Close Controls

Widget1

Data Update

AleScenario4 2024-09-05 13:36:17 (acc)

Create Microsimulation

alessandroscenario30-20240926095651

Run Simulation

Mean Travel Time

	Traffic Load	MTTall	MTT dir_N	MTT dir_M	MTT dir_A	MTT TW Careggi	MTT TW Costanza
4TW-NTNS-MWD-P	1.5	3542.50	198.90	242.14	197.64	436.00	427.00
4TW-NTNS-MWD-A	1.5	3242.71	178.33	243.28	195.79	436.00	427.00
4TW-NTNS-MWD-P-A	1.5	3242.71	178.33	243.28	195.79	436.00	427.00
2TW-NTNS-MWD-P	1.5	4538.02	207.40	456.14	615.00	436.00	427.00
2TW-NTNS-MWD-A	1.5	3940.07	179.30	428.67	481.53	436.00	429.75
2TW-NTNS-MWD-P-A	1.5	4380.63	182.05	456.59	654.21	436.00	427.00
SUMO Actuated	1.5	3409.13	280.09	515.34	200.66	497.54	499.81
Webster	1.5	6474.95	465.45	441.93	210.50	1379.25	493.87
WebsterAdjusted	1.5	4035.08	195.82	441.09	205.66	463.87	447.06

4TWD-NTNS-MWD-P-A: optimization by prioritizing traffic **directions**, the normalized number of vehicles stops, *NTNS* , the mean waiting delay *MWD*, for all traffic lights, and post synchronization, with Penalty and Adjust dynamically performed

Traffic Infrastructure Optimization

FROM CITY
DASHBOARD TO
APPLICATIONS

DATA GATHERING
AND CITY KNOWLEDGE
MANAGEMENT

11 SUSTAINABLE CITIES
AND COMMUNITIES



MOST

CENTRO NAZIONALE PER LA MOBILITÀ SOSTENIBILE

TO ADOPT
CITY, AND
ROADMAP

• SNAP4CITY THE
VIEW OF THE
ADMINISTRATORS

<https://www.snap4city.org/1014>



Traffic Infrastructure Optimization

Traffic Infrastructure Optimization

Mon 14 Oct 19:45:10

Scenario Editor

Some Points of Interest

Traffic Sensors

Air Quality Sensors

Weather Sensors (OW)

Load Scenario:

Scenarios waiting to be processed: AlessandroScenario30

Scenario version: 2024-09-26 11:52:20

Load Scenario

Clean

Road Types:

☐ Select All
 ☐ Unselect All

☒ abandoned
 ☒ bus_guideway
 ☒ construction
 ☒ disused
 ☒ emergency_access_point
 ☒ emergency_bay
 ☒ island
 ☒ living_street
 ☒ motorway
 ☒ motorway_link
 ☒ no
 ☒ path
 ☒ platform
 ☒ primary
 ☒ primary_link
 ☒ private
 ☒ raceway
 ☒ razed
 ☒ residential
 ☒ rest_area
 ☒ road
 ☒ secondary_link
 ☒ service
 ☒ services
 ☒ shops
 ☒ tertiary
 ☒ tertiary_link
 ☒ track
 ☒ traffic_island
 ☒ trunk_link
 ☒ unclassified
 ☒ via_ferrata
 ☒ secondary
 ☒ yes
 ☒ pedestrian
 ☒ bus_guideway
 ☒ ohm.military.Trench

View

Edit

Show Road graph

Show Traffic Sensors

Filter by road types

INIT to ACC

Optimize Scenario

Optimization results

Data Update

deviceNameAlessandroScenario30_2024-09-26 09:56:51

v1

Fetch Data

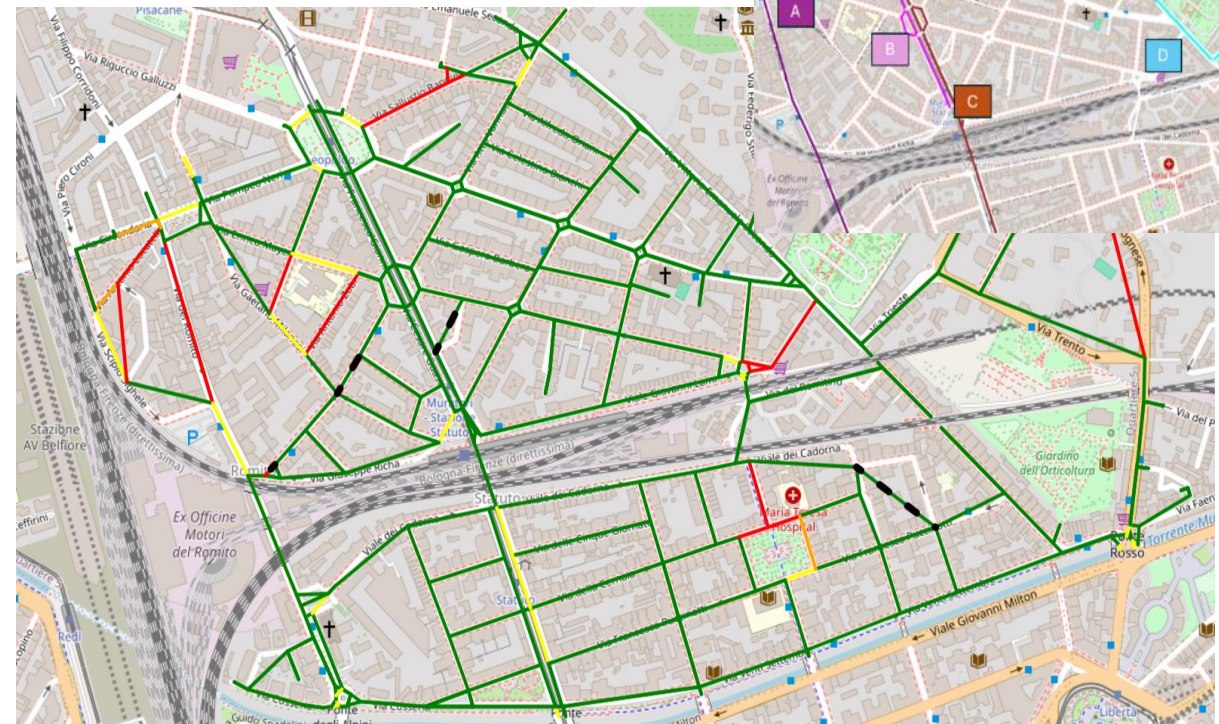
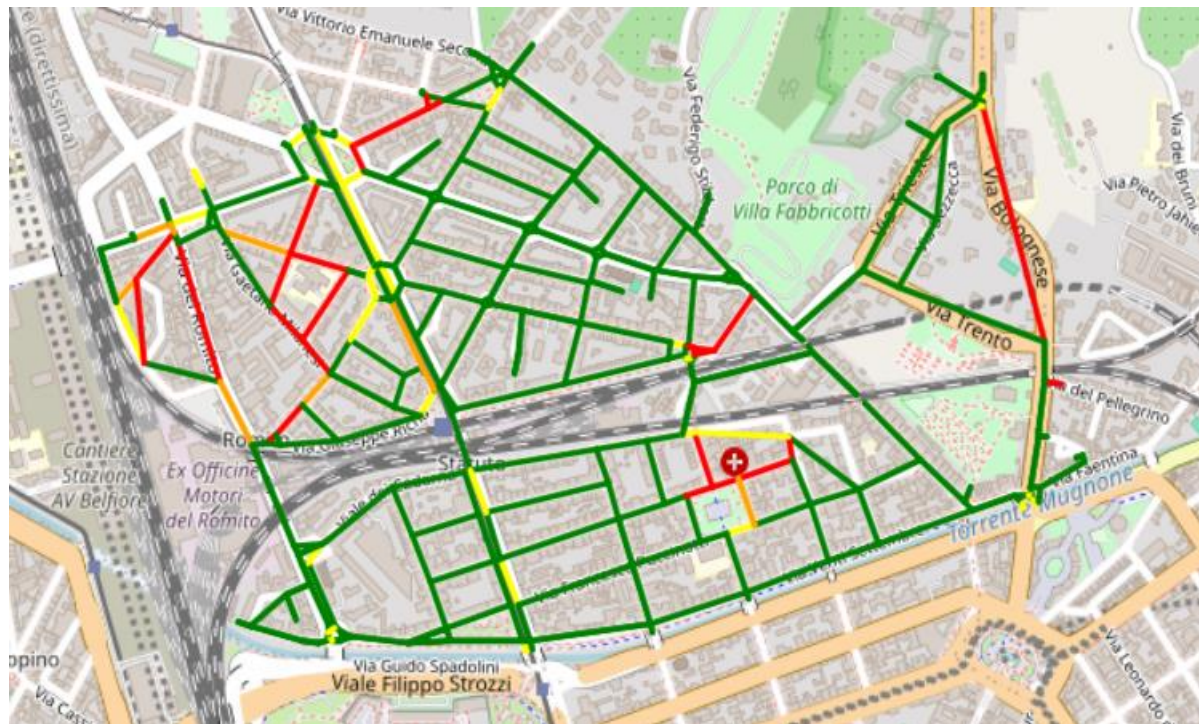
Optimization completed!

Objective	Before	After
Traffic State	5.28	5.1610000000000005
Fuel	0.6710494492002909	0.3491240463440088
CO2	17002.113327545154	13283.979223768334

Before

After

Optimization Results



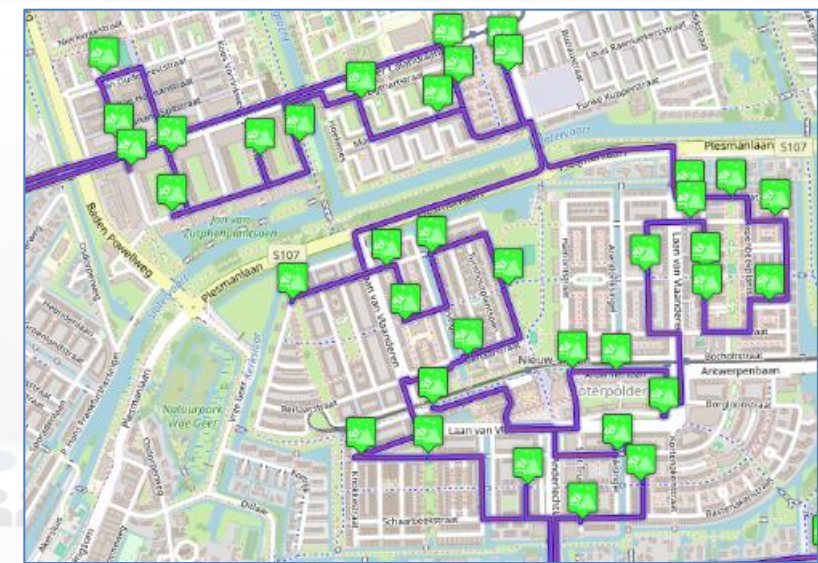
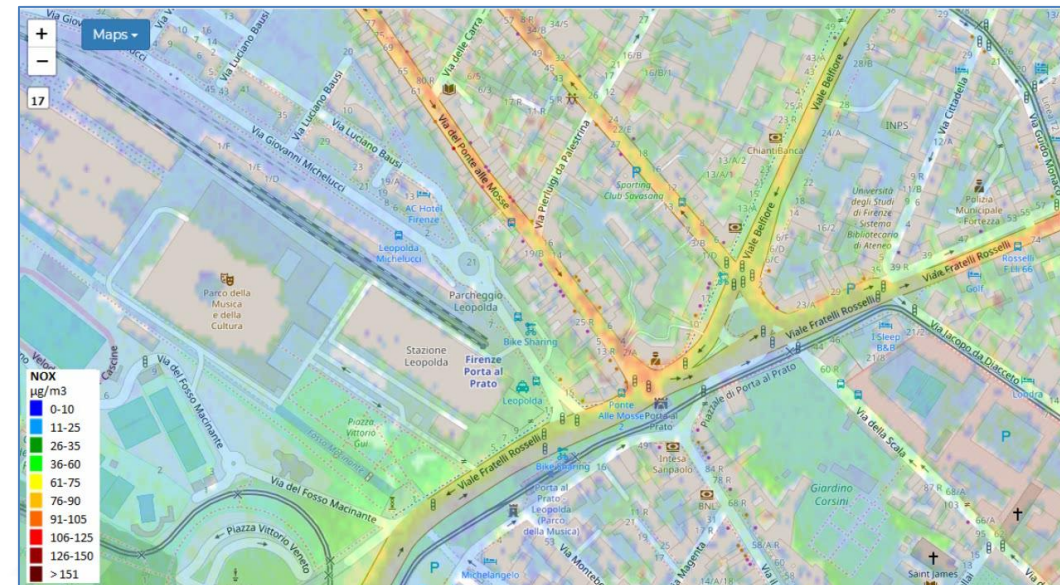
Case max 4 changes	KPI estimation on the best solution		
Optimization Target	Traffic State	Fuel	CO2
Optim 4 Traffic State	91.341 -21%	17.964	128536
Optim 5 Fuel	91.514	16.633 -35%	128227
Optim 6 CO2	92.859	19.192	127876 -23%
Original	115.475	25.680	165822

Travel Time [s]	Path A	Path B	Path C	Path D	Total Time
Original Scenario	183.2	59.6	80.9	132.5	456.4
Optim 4 Traffic State	93.2	60.0	63.7	96.0	313.1
Optim 5 Fuel	89.6	51.2	59.7	96.4	296.9
Optim 6 CO2	89.5	53.2	58.4	100.1	301.3

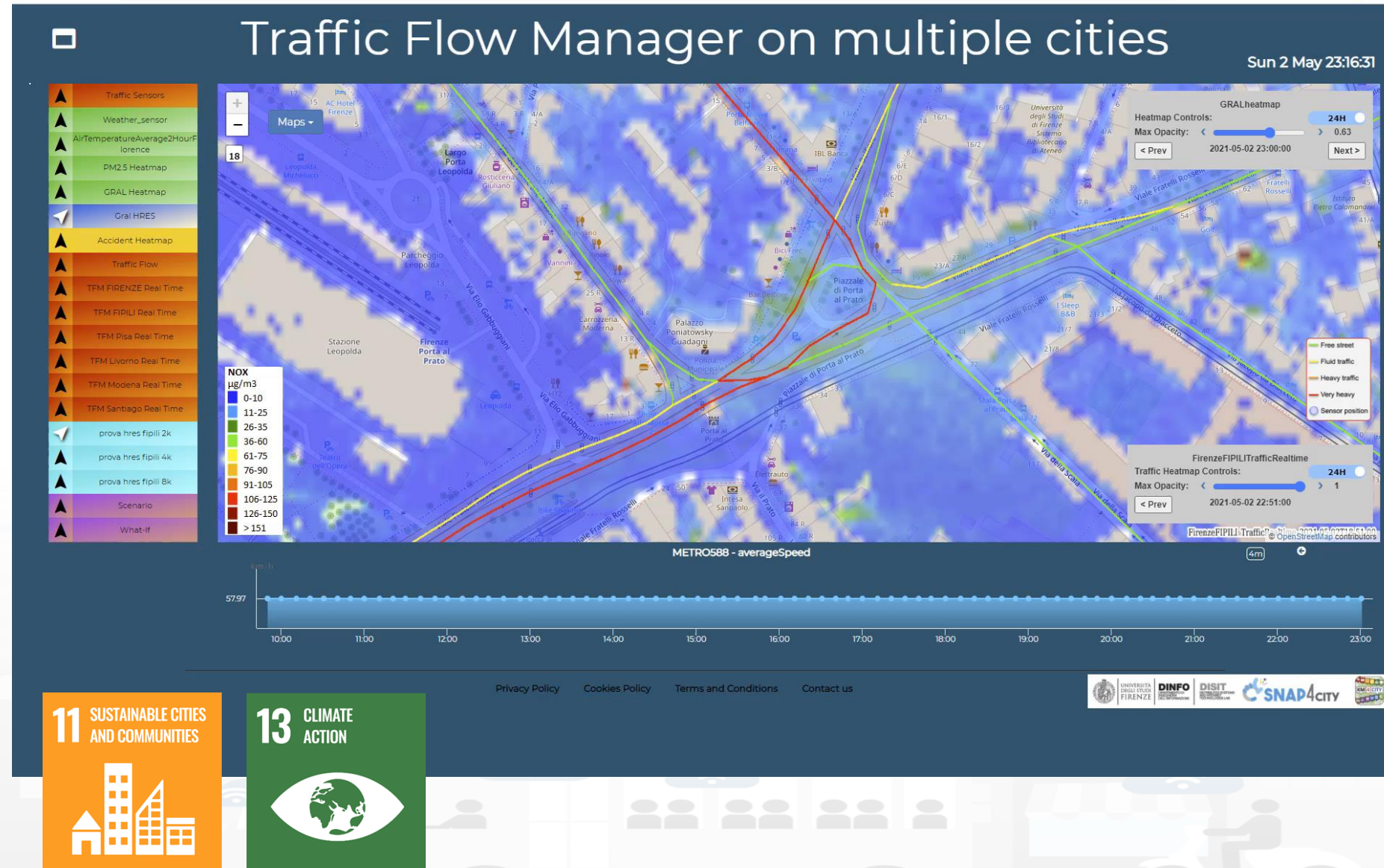
-51% -14% -28% -28%

Environment and Waste

- **Goals:**
 - Reduction of emissions and EC taxations
 - Cost reduction for waste collection,
 - reduction of waste collection impact on mobility
- **Environment Management producing prescriptions:**
 - Monitoring and long and short-term predictions, warning for:
 - GHG, emissions, pollutants, aerosol, chemical plants analysis
 - land slide, coastal erosion (blue economy)
 - Traffic Flow impact emissions, predictions
 - What-if analysis, optimisation tools
- **Waste Management and Optimisation:**
 - costs reduction, optimal routing production, pay as you throw,
 - avoiding out of bins, predictions of waste production on bins, alarms
- **KPI:** SDG, 15MinCityIndex, QOS, costs, Km, collecting time, EC KPI, emissions
- **Mobile App:** final users services/informing and operators
 - Info Waste for operators, participation, optimal routing, RAEE Collection, ..
- **Participatory:** problem reporting, ticketing, etc.
- **Integration of any kind:** env/weather, mobility, ticketing, presences, POI, ..

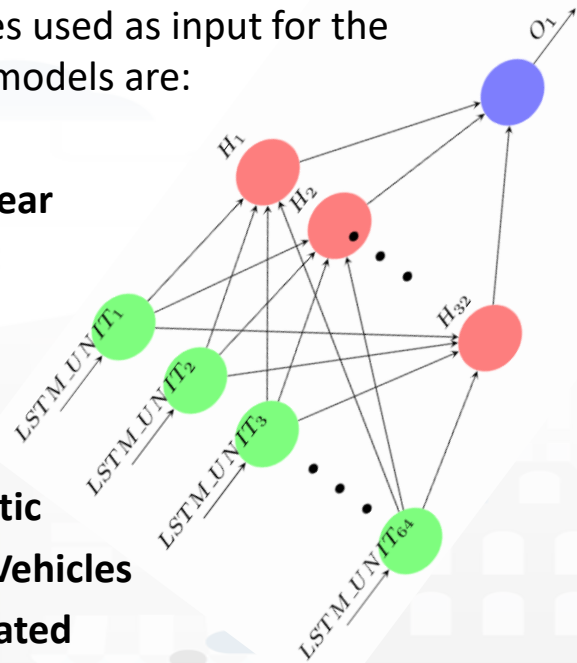
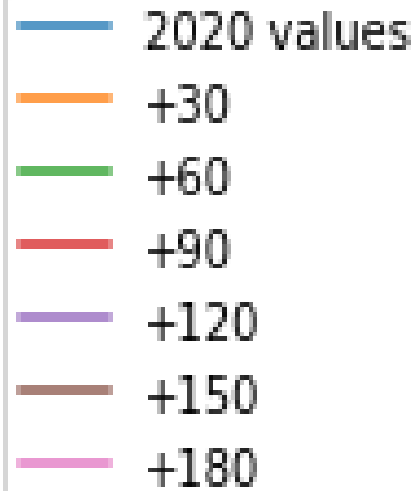
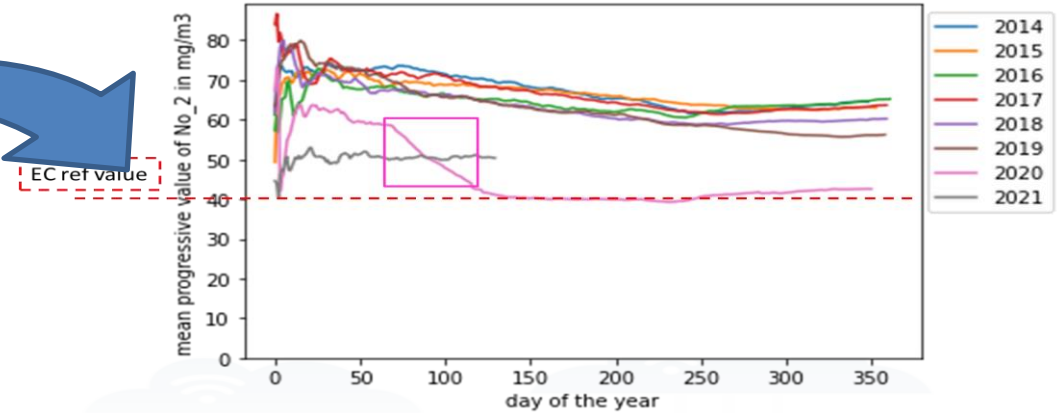


- **Prediction**
 - **NOX Pollutant** diffusion on the basis of Traffic Flow (prediction), weather and 3D structure
 - **NO2 progressive average** (Long term)
- **Project:**
 - **Trafair CEF EC**
 - Mixed solutions of Fluidinamics modeling and AI



Predicting EC's KPI on NO2 months in advance

Deep Learning Long Terms Predictions of NO2 mean values, From 30 to 180 days in advance



Air Quality Directive				WHO guidelines	
Pollutant	Averaging period	Objective and legal nature and concentration		Comments	
PM _{2.5}	One day				99 th percentile (3 days/year)
PM _{2.5}	Calendar year	Target value, 25 µg/m ³	The target value has become a limit value since 1 January 2015	10 µg/m ³	
PM ₁₀	One day	Limit value, 50 µg/m ³	Not to be exceeded on more than 35 days per year.	50 µg/m ³ (*)	99 th percentile (3 days/year)
PM ₁₀	Calendar year	Limit value, 40 µg/m ³ (*)		20 µg/m ³	
O ₃	Maximum daily 8-hour mean	Target value, 120 µg/m ³	Not to be exceeded on more than 25 days per year, averaged over three years	100 µg/m ³	
NO ₂	One hour	Limit value, 200 µg/m ³ (*)	Not to be exceeded more than 18 times a calendar year	200 µg/m ³ (*)	
NO ₂	Calendar year	Limit value, 40 µg/m ³		40 µg/m ³	



Smart Waste – Map view

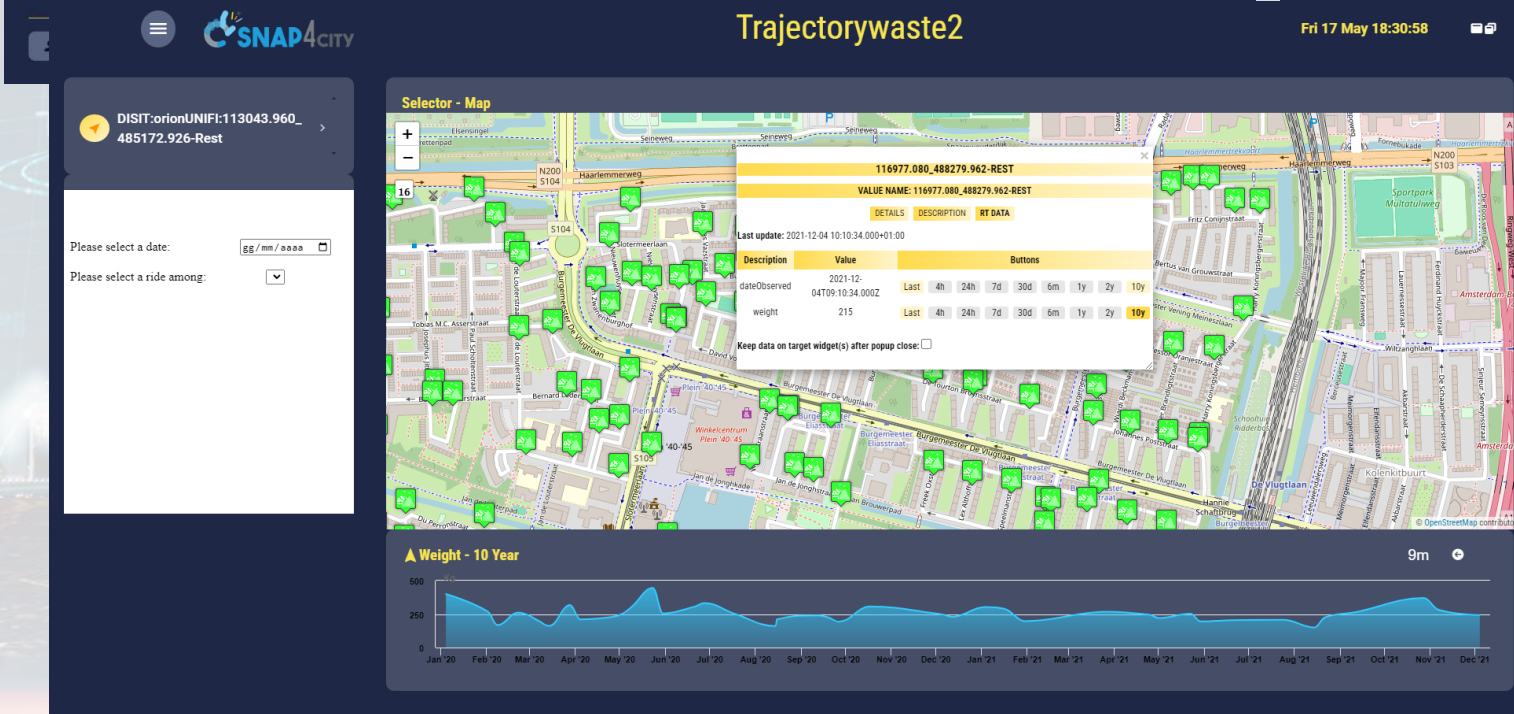
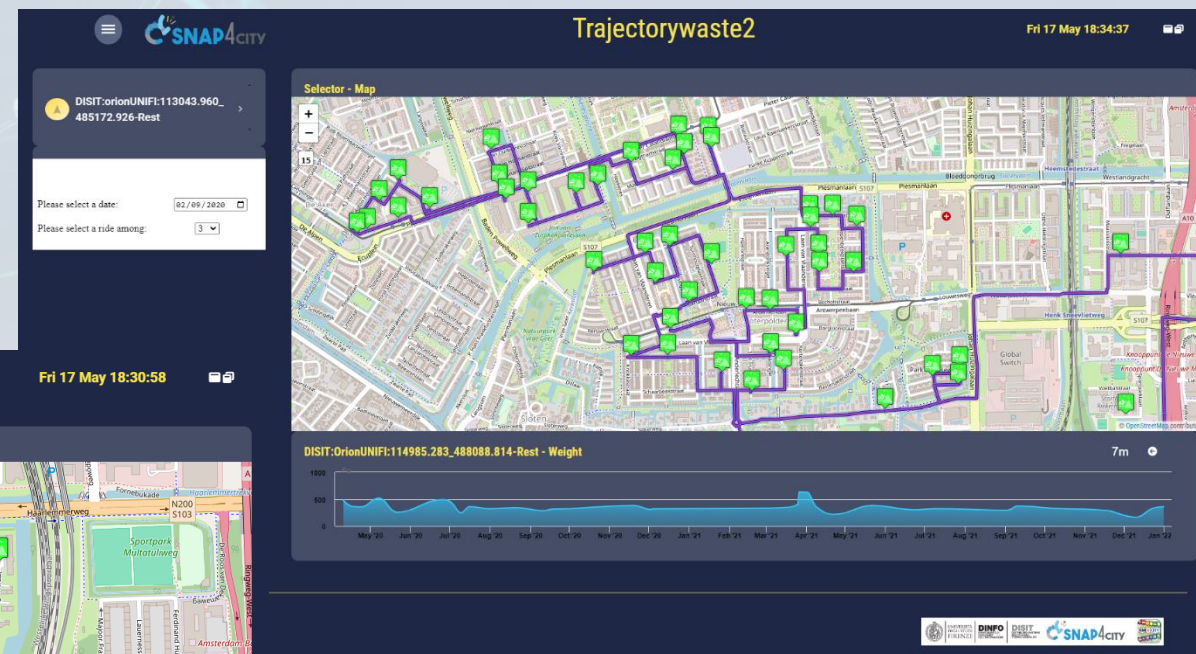
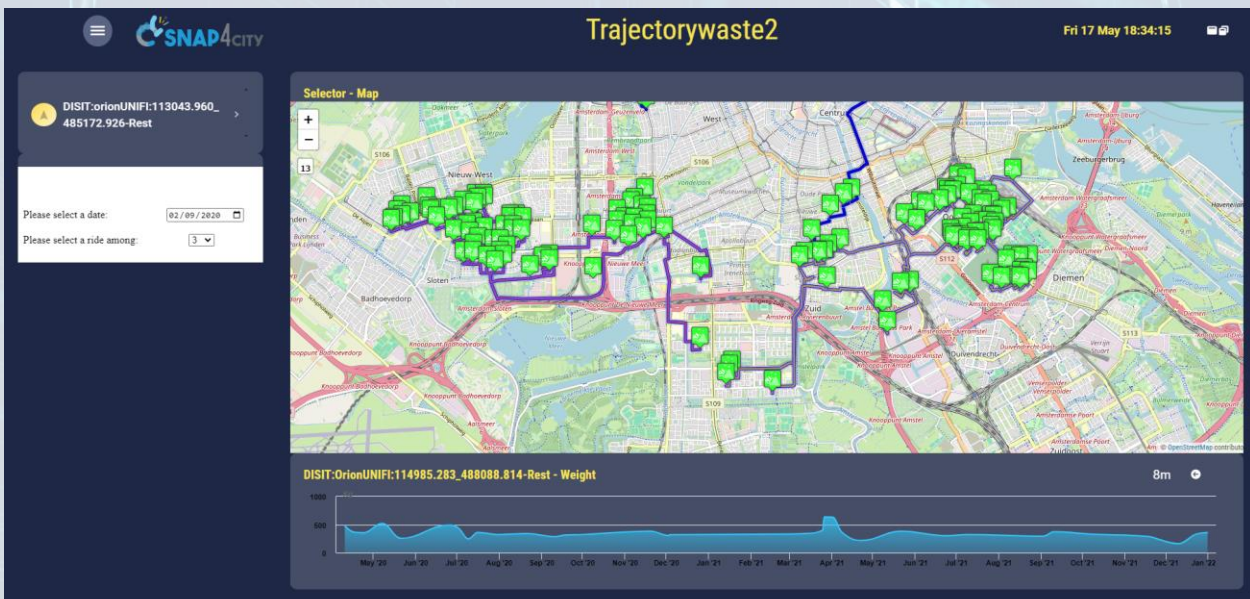


Search bins on map by filtering per:

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

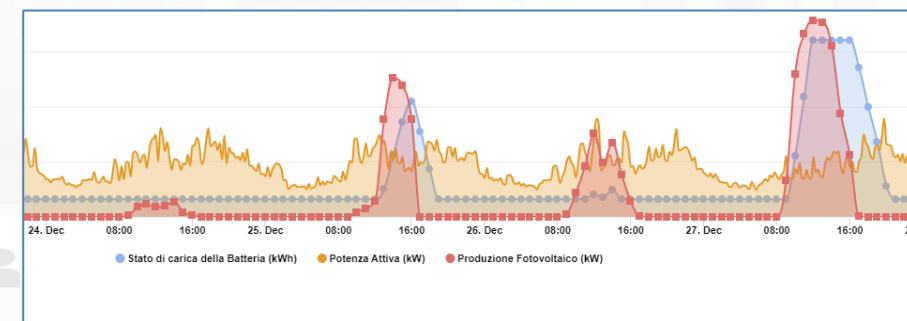
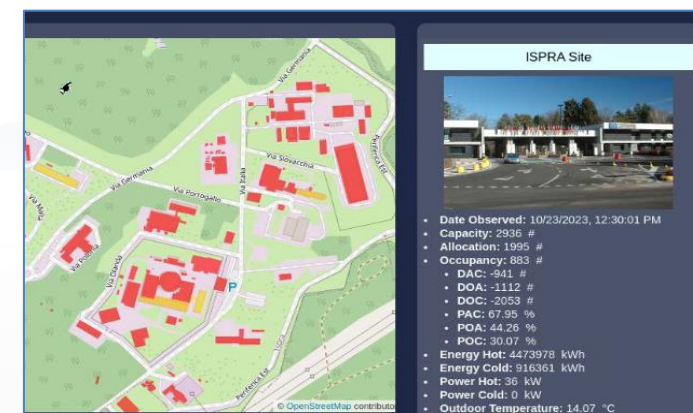
- Reduction of costs for waste collection
 - Optimization of waste collection for the next day, forecast
 - Production of rides and paths for the drivers on waste collection
- Operator:
 - Refine a search by using the filters on the left side
 - Click on a waste bin pin on the map:
 - A popup with real time data is shown
 - The fullness status of the selected group of bins is shown in the synoptic below the map
 - Specific fullness weekly trends are shown below the map
 - Click on the «Table view» button to access the other dashboard





City Energy and Buildings

- **Goals:**
 - Energy consumption reduction, increment of efficiency,
 - Areas and building sustainability
 - Improve accessibility to services, security and safety
- **Energy Monitoring:** Building, floors, rooms, recharging poles, cabinets, Community of Energy, Data centers, Energy for Hot / cold, air condition, energy vs temperature and usage, etc.
- **Energy Management:** Predictions, early warning, identification of critical conditions
- **Smart Light Management:** LED/mixt, cabinets, lights vs traffic, lights vs security, energy saving, luminaries profiling, group management.
- **Smart Building Management:** consumption, number of people, etc.
 - Communities of Energy, Photovoltaic plants, sustainability
 - What-if analysis, optimisation tools
- **KPI: Energy consumption, efficiency, pros/cons**
 - Light profiling and adaptation
 - Autoclave industrial plants simulation, Photovoltaic plant simulation
 - consumption / usage, energy vs temperature
- **Mobile App:** monitoring, info-recharge, eSharing, booking, ..
- **Participatory:** problem reporting, ticketing, etc.
- **Integration of any kind**



Ispra Site, Buildings And Services

Building / Floor / Parking:

Building ▼

All / Single Building:

All ▼

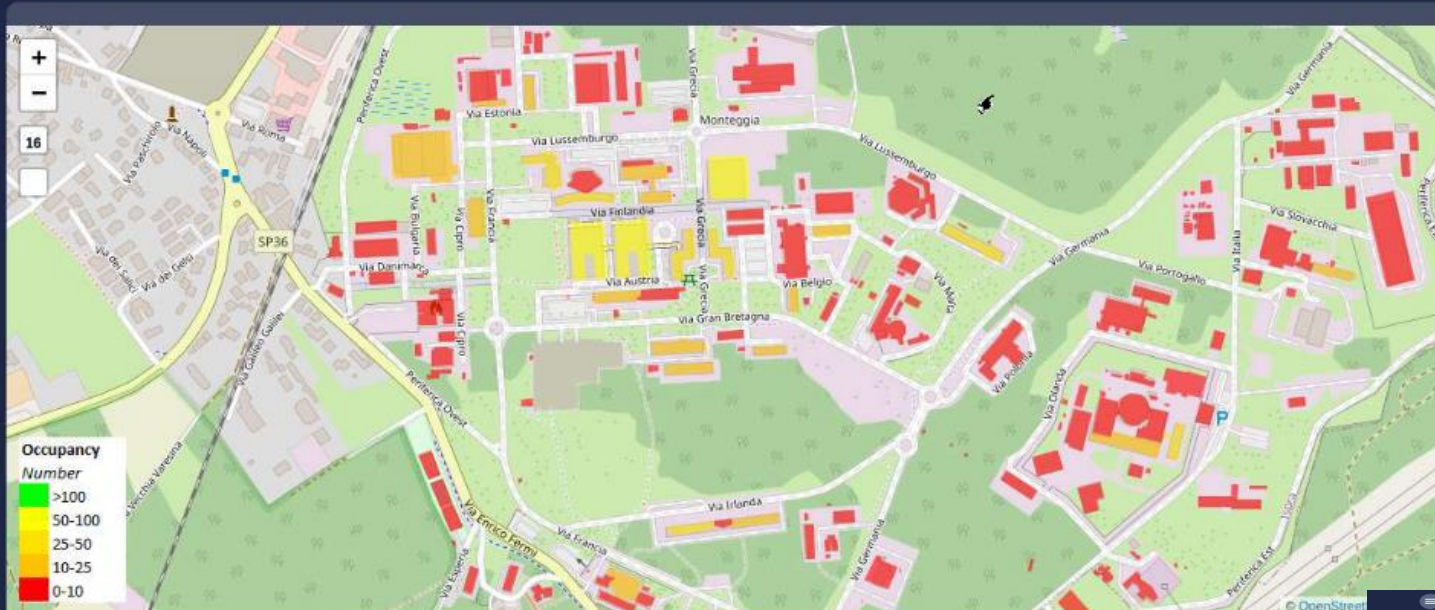
Variable:

occupancy 

Popup on Shape Click

☒

Add To Map



Ispra - Occupancy 8m

883

Ispra - Occupancy



person My Profile

[My Profile](#)

Mon 23 Oct 12:42:28

ISPRAs Site



- **Date Observed:** 10/23/2023, 12:30:01 PM
- **Capacity:** 2936 #
- **Allocation:** 1995 #
- **Occupancy:** 883 #
 - **DAC:** -941 #
 - **DOA:** -1112 #
 - **DOC:** -2053 #
 - **PAC:** 67.95 %
 - **POA:** 44.26 %
 - **POC:** 30.07 %
- **Energy Hot:** 4473978 kWh
- **Energy Cold:** 916361 kWh
- **Power Hot:** 36 kW
- **Power Cold:** 0 kW



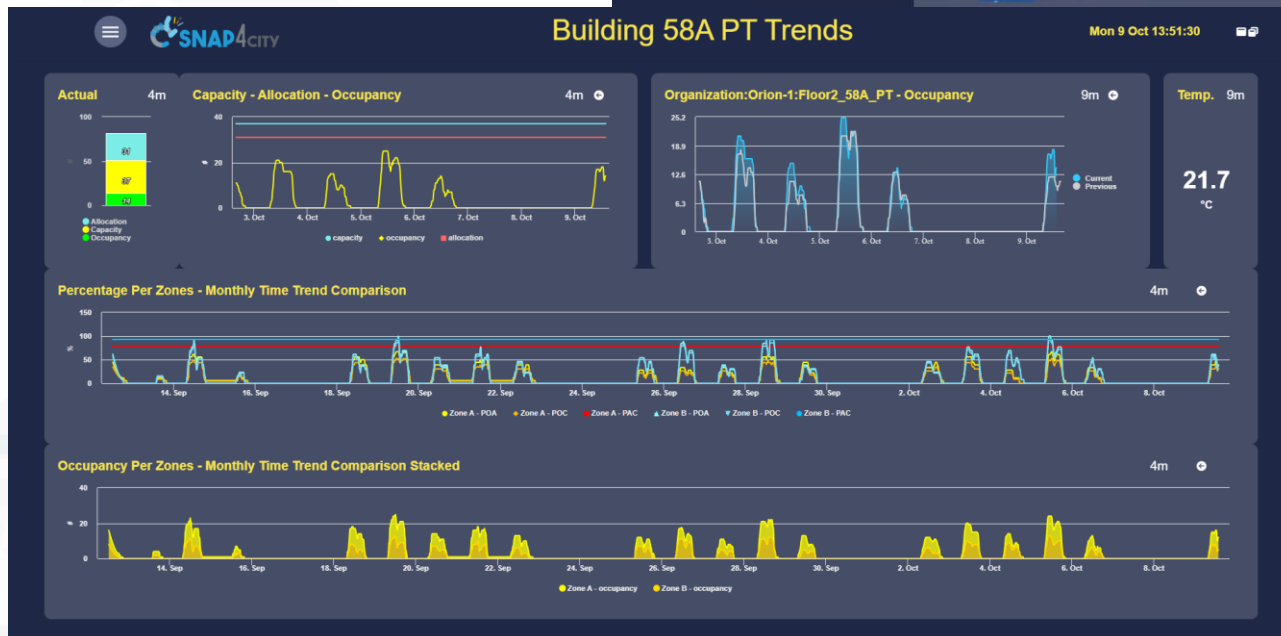
Building 27B Trends

Mon 9 Oct 12:47:14



Floor Details

ISPRA JRC Site



Visual Analytics Business Intelligence

FROM CITY
DASHBOARD TO
APPLICATIONS

DATA GATHERING
AND CITY DATA
KNOWLEDGE
MANAGEMENT

FORGING &
MANAGING OPEN
AND FLEXIBLE WEB
AND MOBILE APPS

IOT/IOE DEVICES
AND NETWORKS

IOT APPLICATIONS,
THE LOGIC AND
THE SMARTNESS

INTEGRATED
SMART CITY APP,
MICROSERVICES,
SNAP4CITY API

SNAP4CITY
LIVING LAB FOR
COLLABORATIVE
WORK

SNAP4CITY FOR
BEGINNERS

SNAP4CITY
ARCHITECTURE AND
ECOSYSTEM. OPENED
TO DEVELOPERS
AND STAKEHOLDERS

DATA ANALYTICS,
BUSINESS
INTELLIGENCE,
WHAT-IF AND
SIMULATIONS

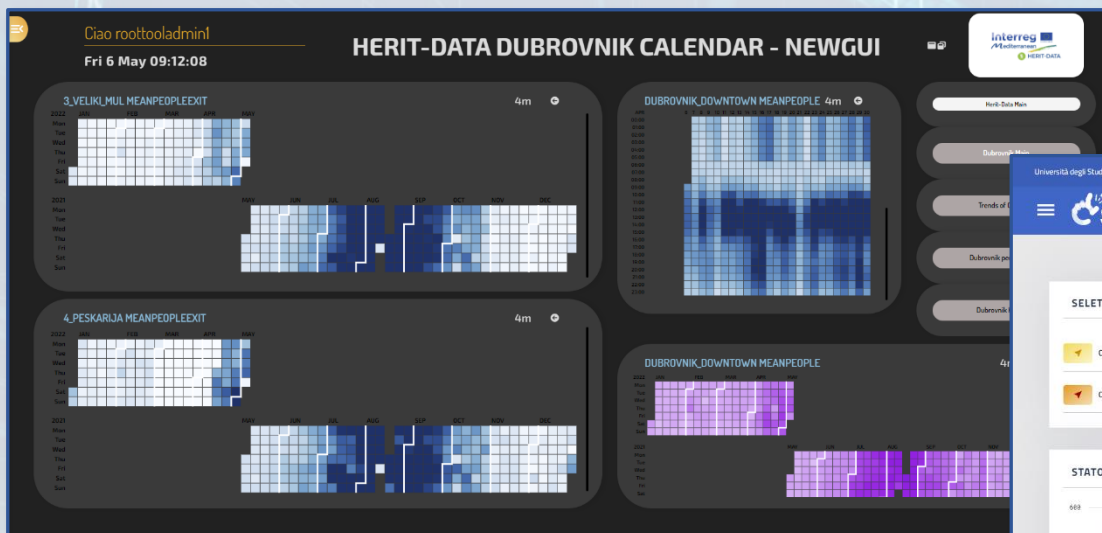
DECISION SUPPORT
FOR CITY
ADMINISTRATORS

HOW TO ADOPT
SNAP4CITY, AND
OUR ROADMAP

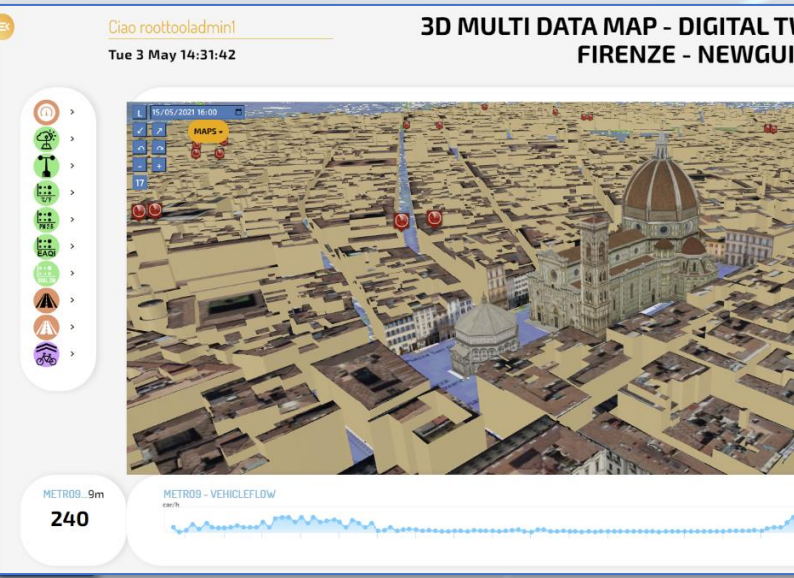
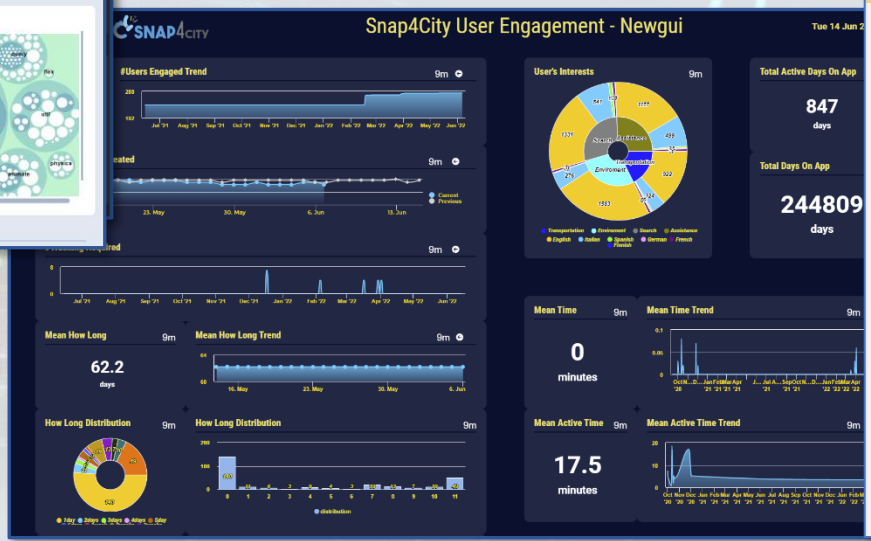
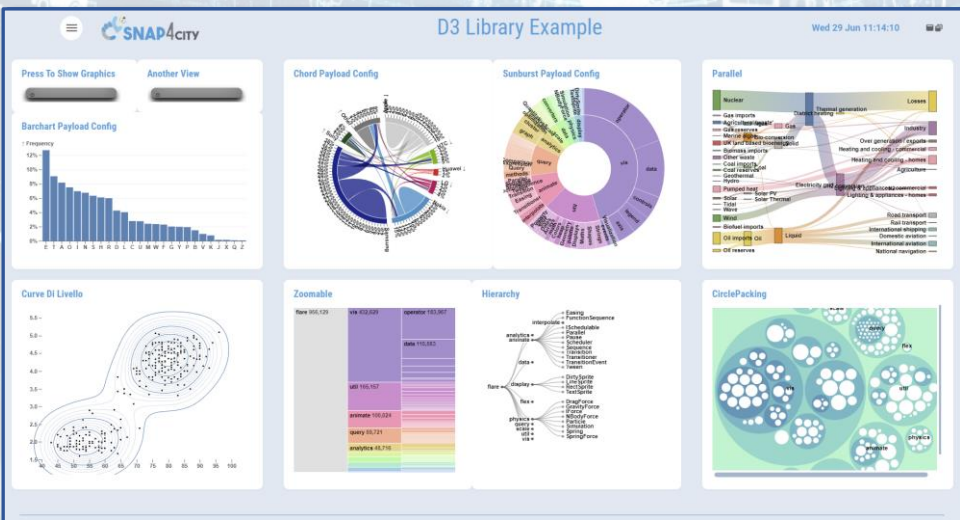
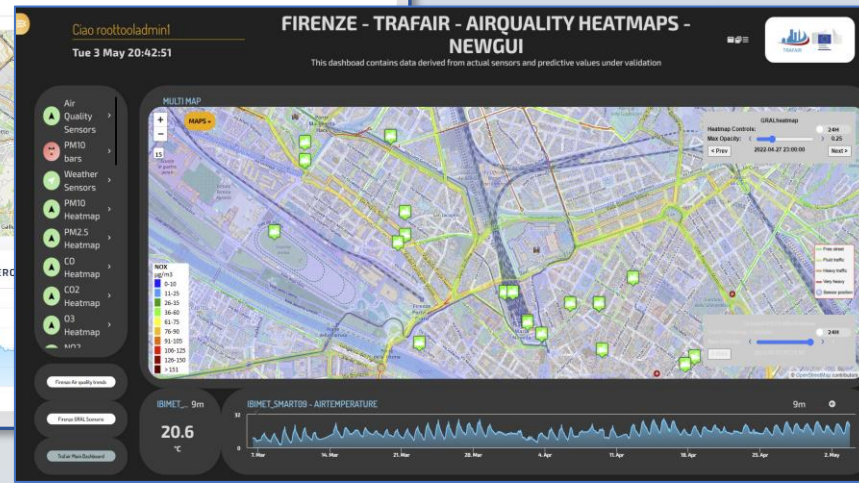
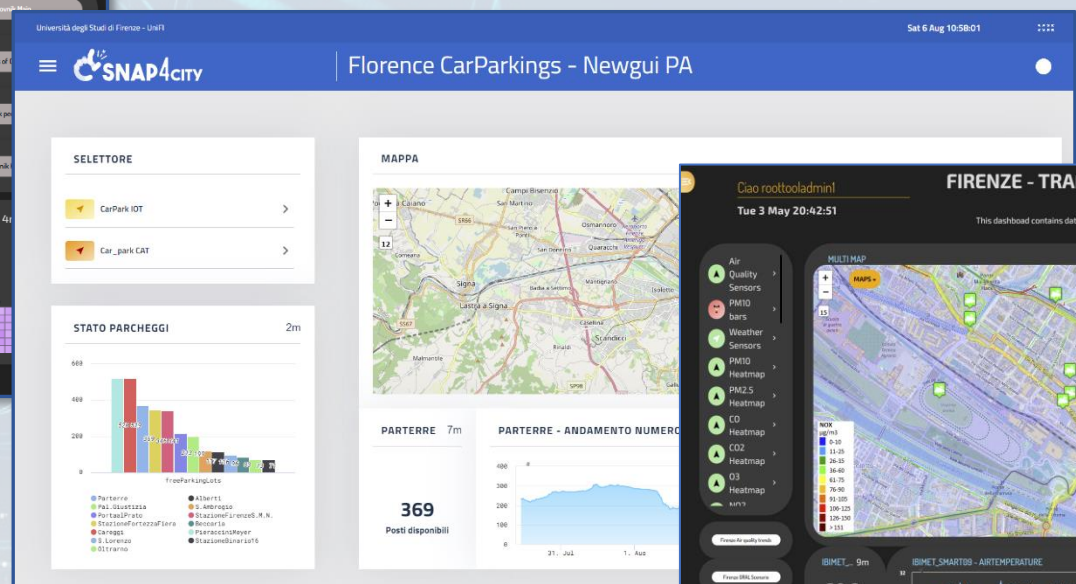
SNAP4CITY
AND KM4CITY
PROJECTS

SNAP4CITY THE
VIEW OF THE
ADMINISTRATORS

TWITTER
VIGILANCE: SOCIAL
MEDIA ANALYSIS



Different Themes

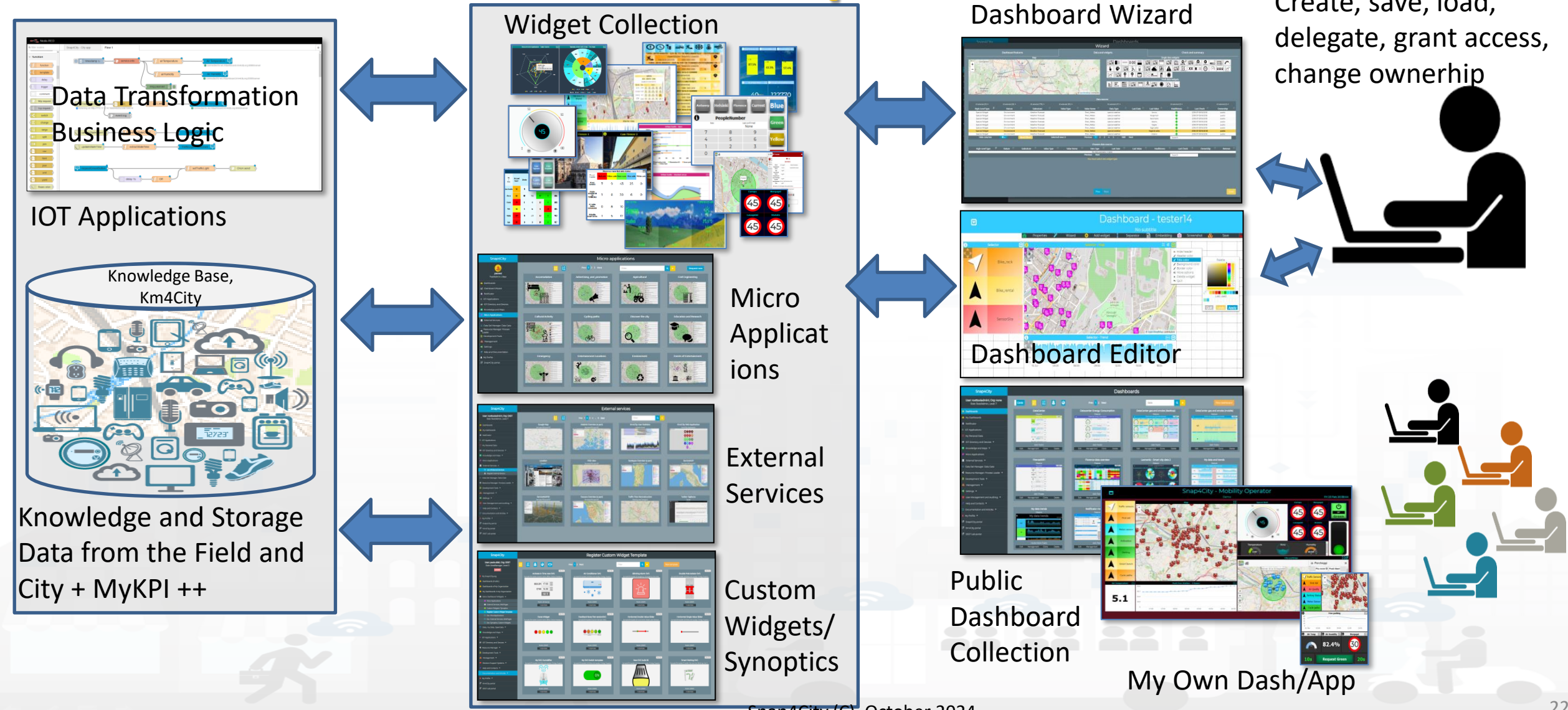


New styles/themes can be developed by specializing a few files from open source
<https://www.snap4city.org/793>

Visual Representations



Dashboard Builder: Development



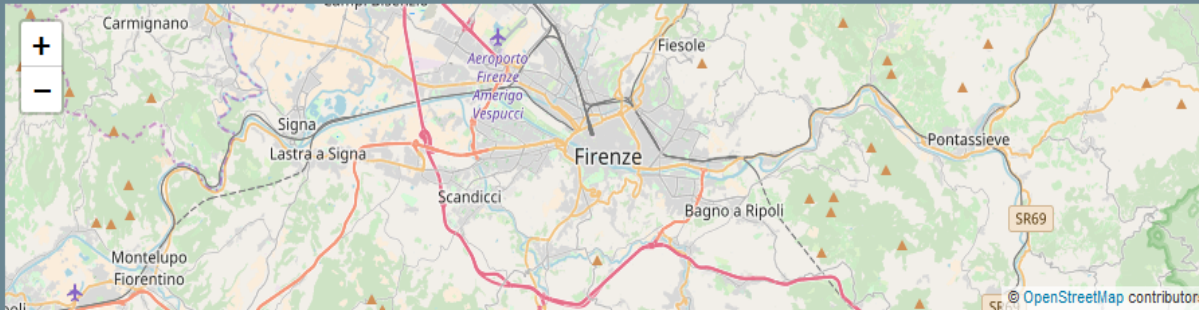
Wizard

Dashboard features

Data and widgets



Map



Single data widgets



Multi data widgets



Data sources

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

- Select the area of your interest: panning and zooming

- Select the

- graphic aspect of your interest, or
- High Level Type of your interest, or
- Make a search if you have a precise idea or
- Act on filters: nature, subnature, type, name, value, date, health, owner, ...
- Combine them as you like

- Select the lines of your interest
- Then click on Next and get the Dashboard by wizard



New Data Inspector/Wizard

Single data widgets

Multi data widgets

Map Controls:

FilterMap GPSUser GPSOrg

Now displaying in Standard Mode

Switch to the Synoptic Mode to select MyKPIs and sensors that you need for your synoptics.

Switch now to the Synoptic Mode

Data sources

Level	Type	Nature	Subnature	Device	Model	Broker	Value Name	Value Type	Data Type	Value Unit	Last Date	Last Value	Healthiness	Last Check	Ownership
DT	EM Devl...	Environment	Weather	DIDA1		Santa Verdiana ...	Mio sensore		webpage		2021-11-23 13:44...			2023-07-18 16:0...	public
DT	EM Devl...	TransferService...	SensorSite	METRO11		Altair-soda	Altair Valve State		webpage		2021-06-05 00:00...			2024-01-10 01:3...	public
DT	EM Devl...	IndustryAndMa...	Computer	AltairStatoPom...		Altair-soda	Altair Pump St...		webpage		2021-05-20 13:51...			2024-01-10 01:3...	public
DT	EM Devl...	Environment	Air	IBIMET_SMART...		Altair-soda	Altair Pump 43...		webpage		2021-06-07 17:3...			2024-01-10 01:3...	public
DT	EM Devl...	Environment	Air	ARPAT_QA_FI...		Altair-soda	Altair valve 541		webpage		2021-06-07 17:3...			2024-01-10 01:3...	public
DT	EM Devl...	TransferService...	SensorSite	METRO514		Altair-soda	Altair Pump 4321		webpage		2021-06-07 00:00...			2024-01-10 01:3...	public
DT	EM Devl...	TransferService...	SensorSite	SI052032FS990...		Altair-soda	Altair Stock sta...		webpage		2021-06-07 00:00...			2024-01-10 01:3...	public
DT	EM Devl...	TransferService...	SensorSite	METRO831		Altair-soda	Altair Pump 92		webpage		2021-06-07 00:00...			2024-01-10 01:3...	public

Search... Search... Search... Search... Search... Search... Search... Search... Search... Search... Search... Search... Search... Search...

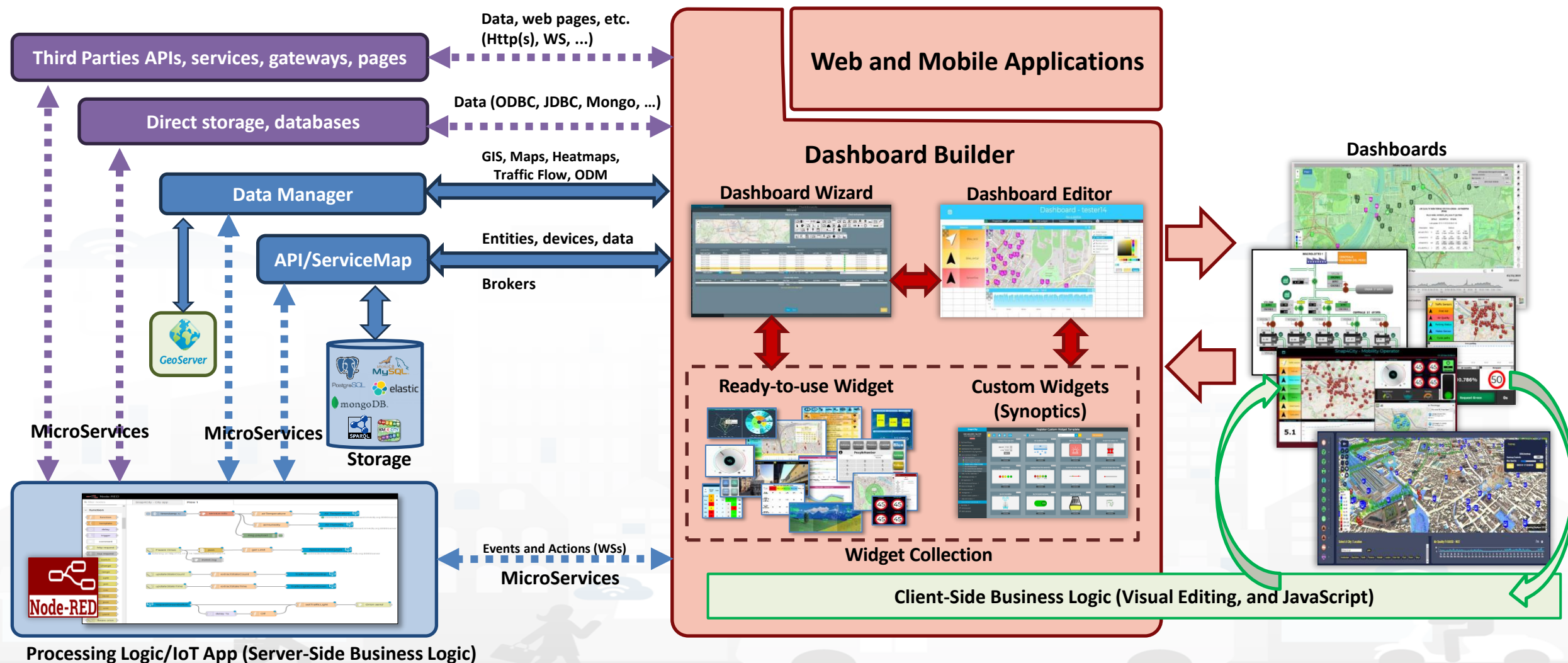
Selected rows: 0 Previous 1 2 3 4 5 ... 45711 Next

Search

163

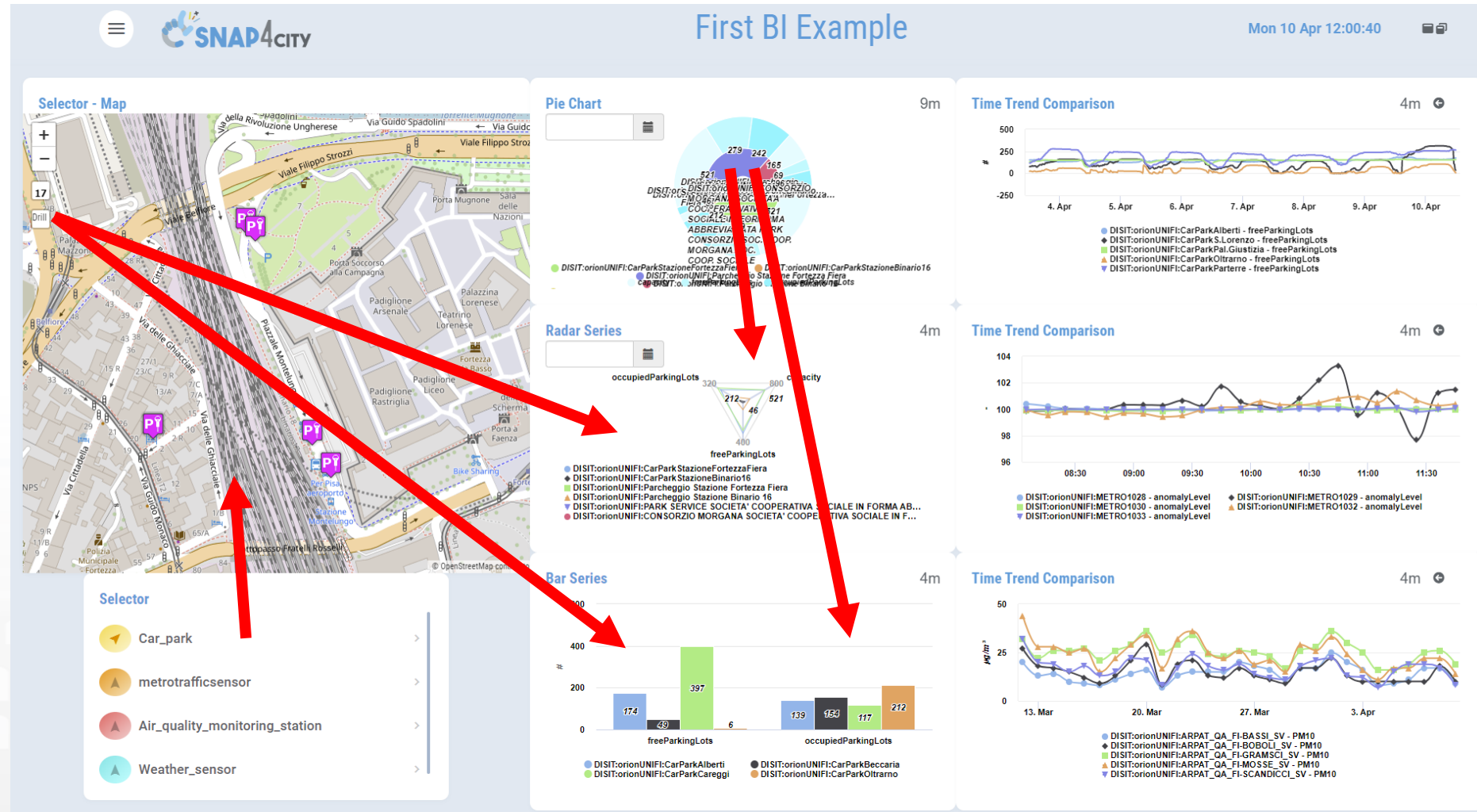
- Filtering/Searching for individual fields (even for some fields not displayed as geographic coordinates)
- Geographic Filtering
- Text Search on all fields
- Menu for choosing the fields to display in the table
- View on Map(via PREVIEW)
- Data and Trend visualization
- Opening Digital Twin
- Pass to Synoptic mode
- Select the graph representation

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

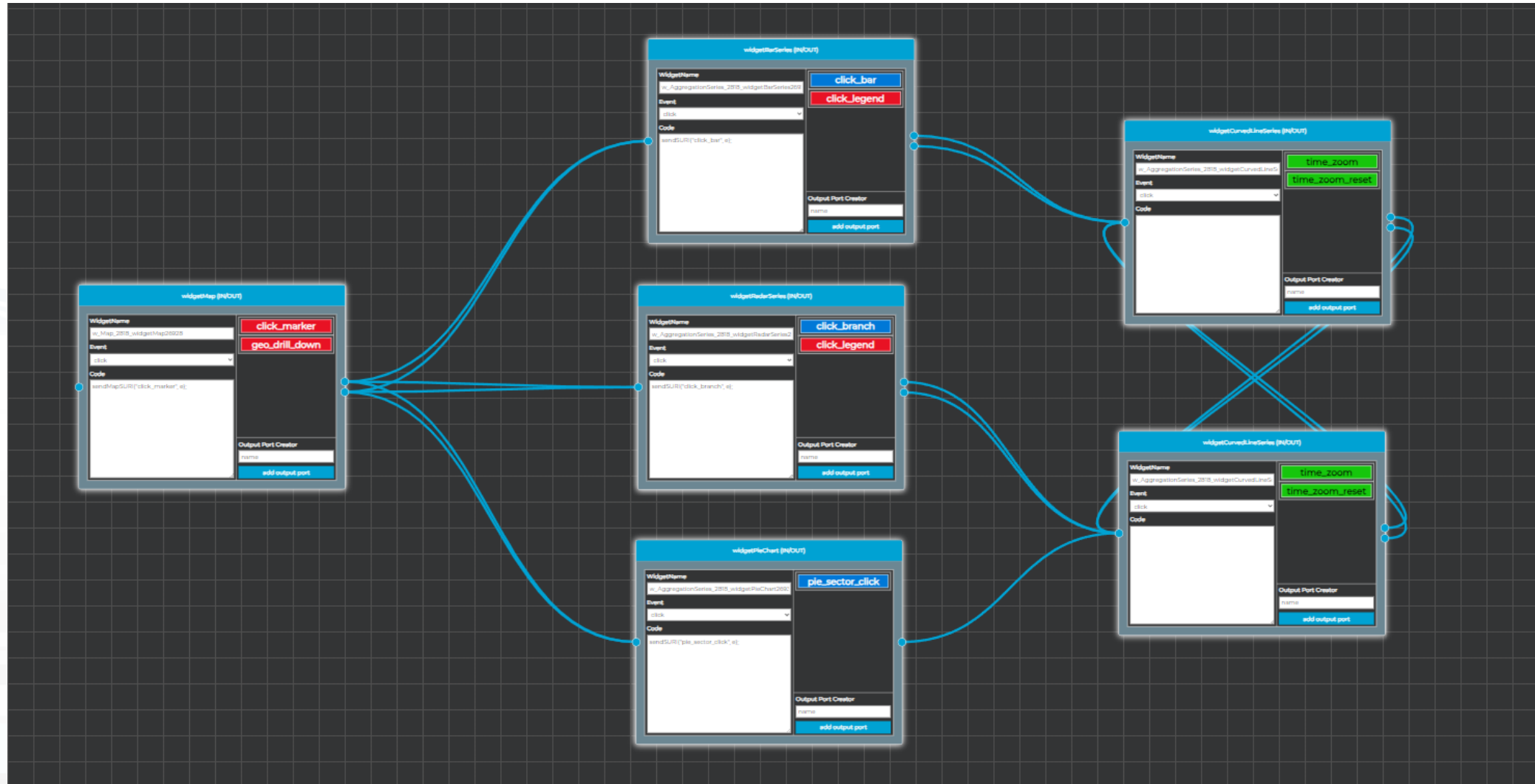


Example: From Map to Graphs (spatial drill down)

- 1) Select the area of interest on map
- 2) Select the sensors kind of interest
- 3) Drill down on map
- 4) The JavaScript CSBL on Map will send data to the programmed Widgets. In this case, arrowed in RED



Visual programming for CSBL, accessible in beta



Client Side Business Logic

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



Client-Side Business Logic Widget Manual

From Snap4City:

- We suggest you read <https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf>
- We suggest you read the TECHNICAL OVERVIEW:
 - <https://www.snap4city.org/download/video/Snap4City-PlatformOverview.pdf>
- slides go to <https://www.snap4city.org/577>
- <https://www.snap4city.org>
- <https://www.snap4solutions.org>
- <https://www.snap4industry.org>
- <https://twitter.com/snap4city>
- <https://www.facebook.com/snap4city>
- <https://www.youtube.com/channel/UC3tAQ09EbNba8f2-u4vanda>

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

Deploy

FROM CITY
DASHBOARD TO
APPLICATIONS

DATA GATHERING
AND CITY DATA
KNOWLEDGE
MANAGEMENT

FORGING &
MANAGING OPEN
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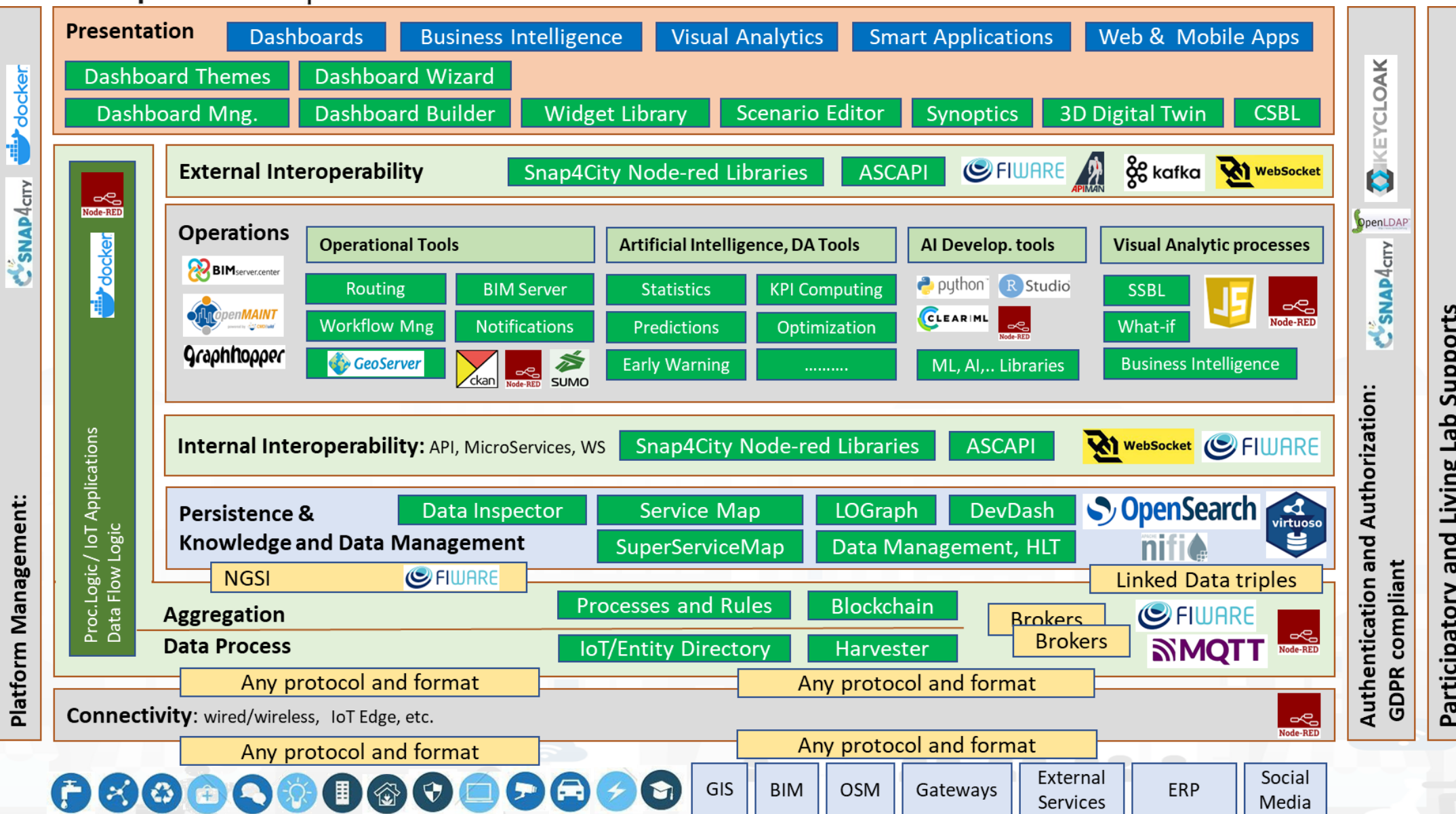
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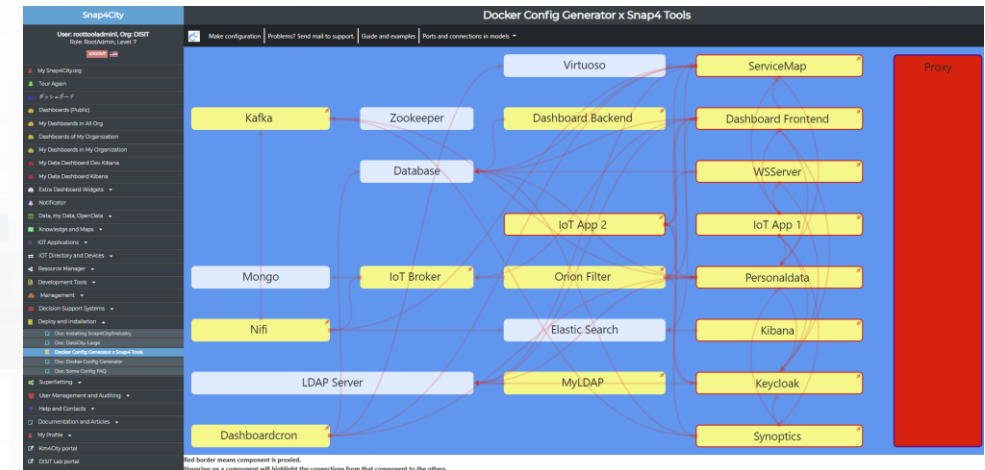
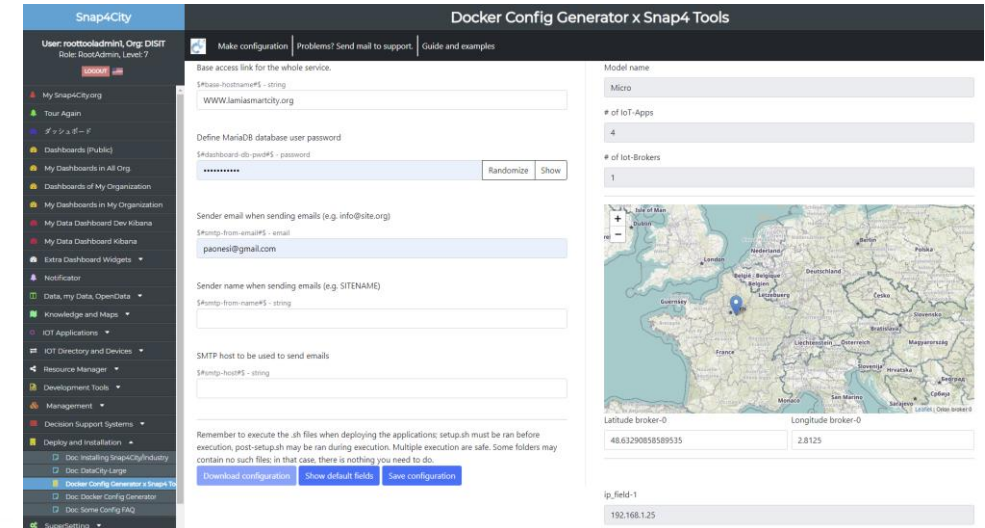
SNAP4CITY
AND KM4CITY
PROJECTS

SNAP4CITY THE
VIEW OF THE
ADMINISTRATORS



Installations, different models a TOOL to get them

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



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

Config Generator Tools

Snap4City

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

LOGOUT

My Snap4City.org
Tour Again
ダッシュボード
Dashboards (Public)
My Dashboards in All Org.
Dashboards of My Organization
My Dashboards in My Organization
My Data Dashboard Dev Kibana
My Data Dashboard Kibana
Extra Dashboard Widgets
Notificator
Data, my Data, OpenData
Knowledge and Maps
IOT Applications
IOT Directory and Devices
Resource Manager
Development Tools
Management
Decision Support Systems
Deploy and Installation

Doc: Installing Snap4City/Industry
Doc: DataCity-Large
Docker Config Generator x Snap4 To
Doc: Docker Config Generator
Doc: Some Config FAQ

SuperSetting

Docker Config Generator x Snap4 Tools

Make configuration
Problems? Send mail to support.
Guide and examples

Base access link for the whole service.

\$#base-hostname#\$ - string

WWW.lamiasmartcity.org

Define MariaDB database user password

\$#dashboard-db-pwd#\$ - password

.....

Randomize

Show

Sender email when sending emails (e.g. info@site.org)

\$#smtp-from-email#\$ - email

paonesi@gmail.com

Sender name when sending emails (e.g. SITENAME)

\$#smtp-from-name#\$ - string

SMTP host to be used to send emails

\$#smtp-host#\$ - string

Remember to execute the .sh files when deploying the applications; setup.sh must be ran before execution, post-setup.sh may be ran during execution. Multiple execution are safe. Some folders may contain no such files; in that case, there is nothing you need to do.

Download configuration

Show default fields

Save configuration

Model name

Micro

of IoT-Apps

4

of IoT-Brokers

1

Latitude broker-0

Longitude broker-0

48.63290858589535

2.8125

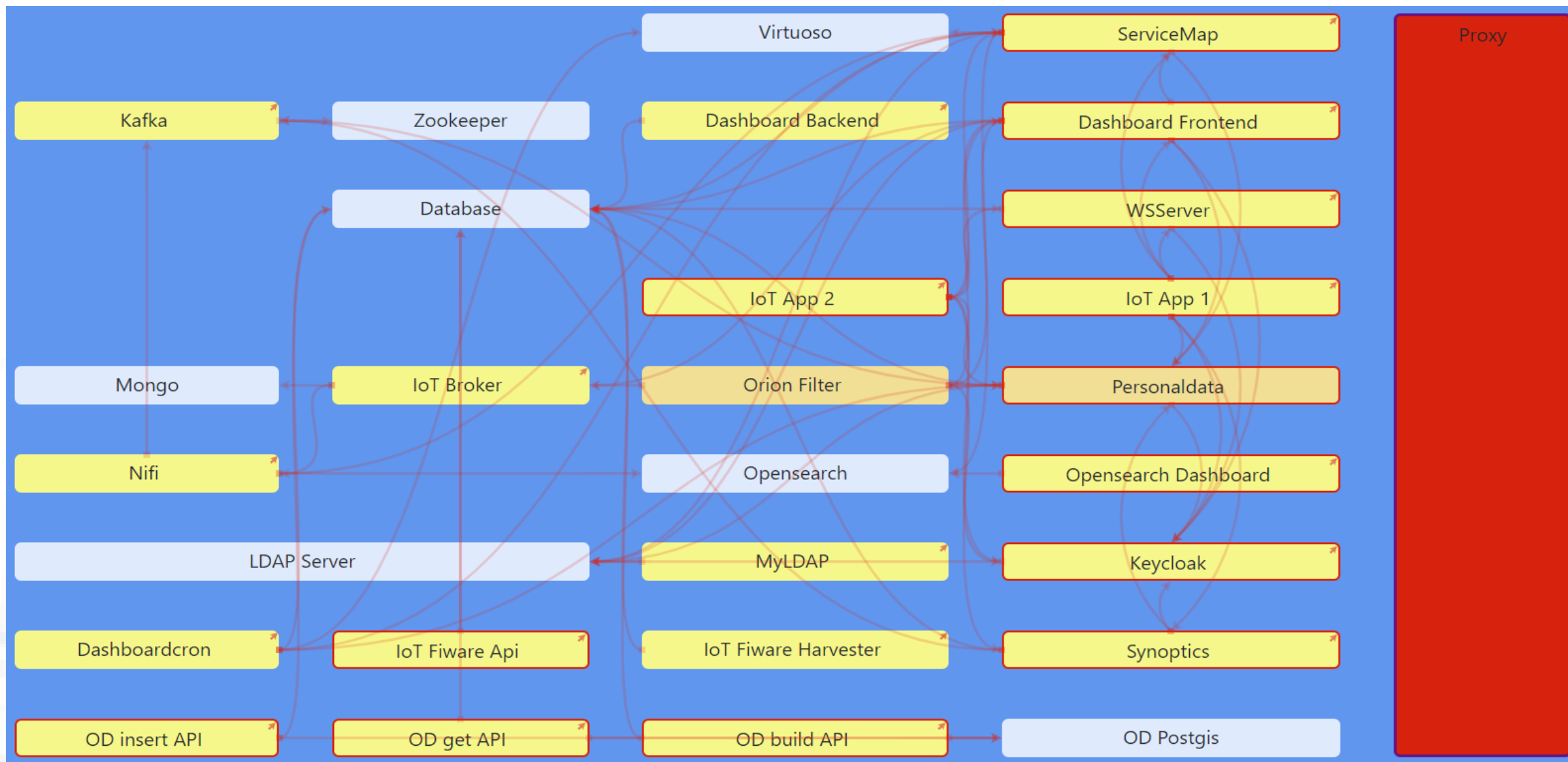
ip_field-1

192.168.1.25

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

Snap4City (C), October 2024

234

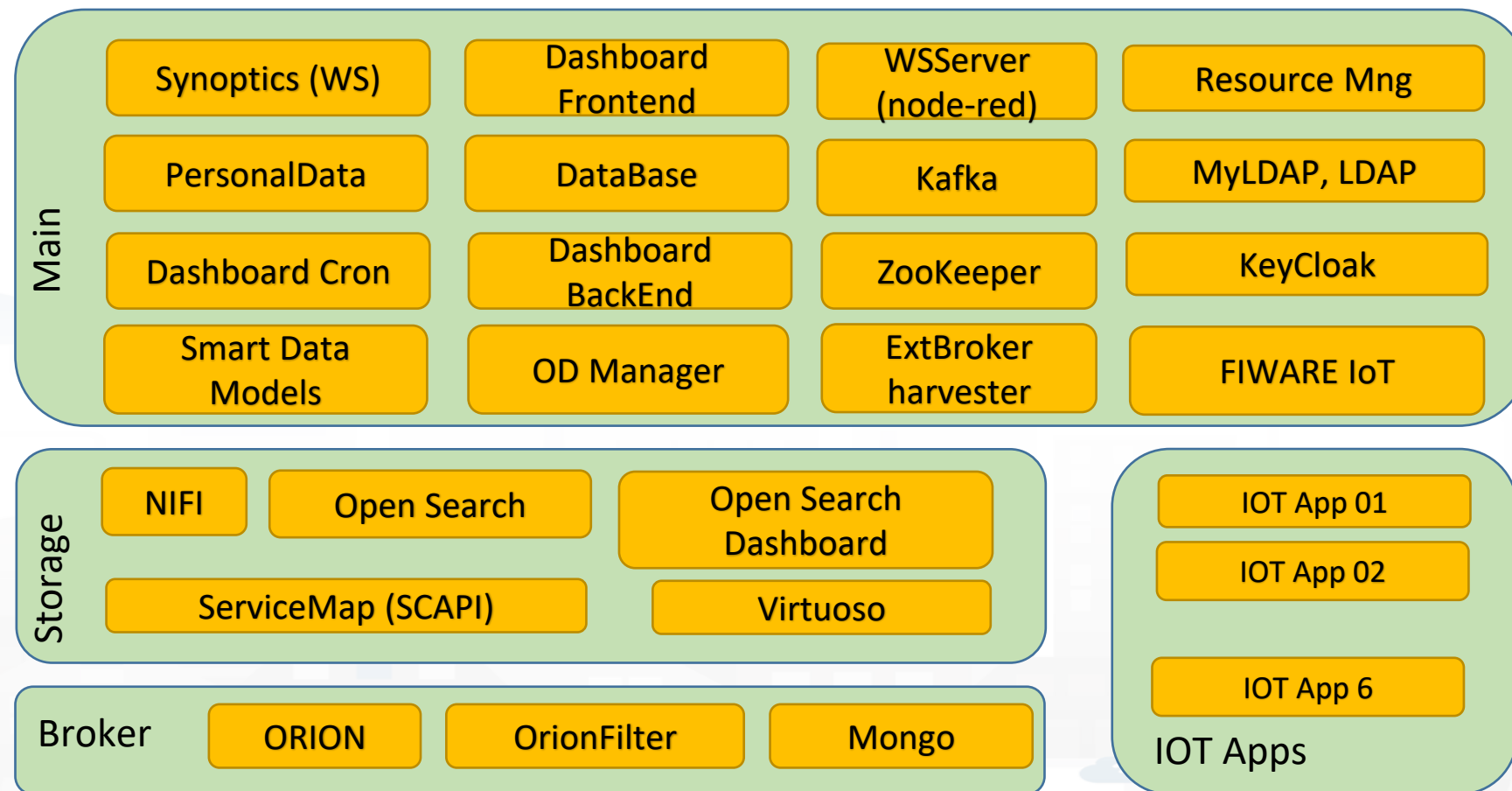


Micro 6 model

Micro 6 (technical)

Web Interface

proxy



DataCitySmall X-2-2

Web Interfaces

