



UNIVERSITÀ  
DEGLI STUDI  
FIRENZE

**DINFO**  
DIPARTIMENTO DI  
INGEGNERIA  
DELL'INFORMAZIONE

**DISIT**  
DISTRIBUTED SYSTEMS  
AND INTERNET  
TECHNOLOGIES LAB

 **SNAP4CITY**  
<https://www.Snap4City.org>



# *Industry 4.0 Synoptics Controlled by IoT*

## *Applications in Node-RED*

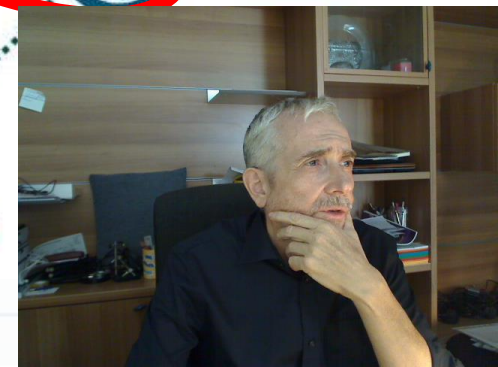
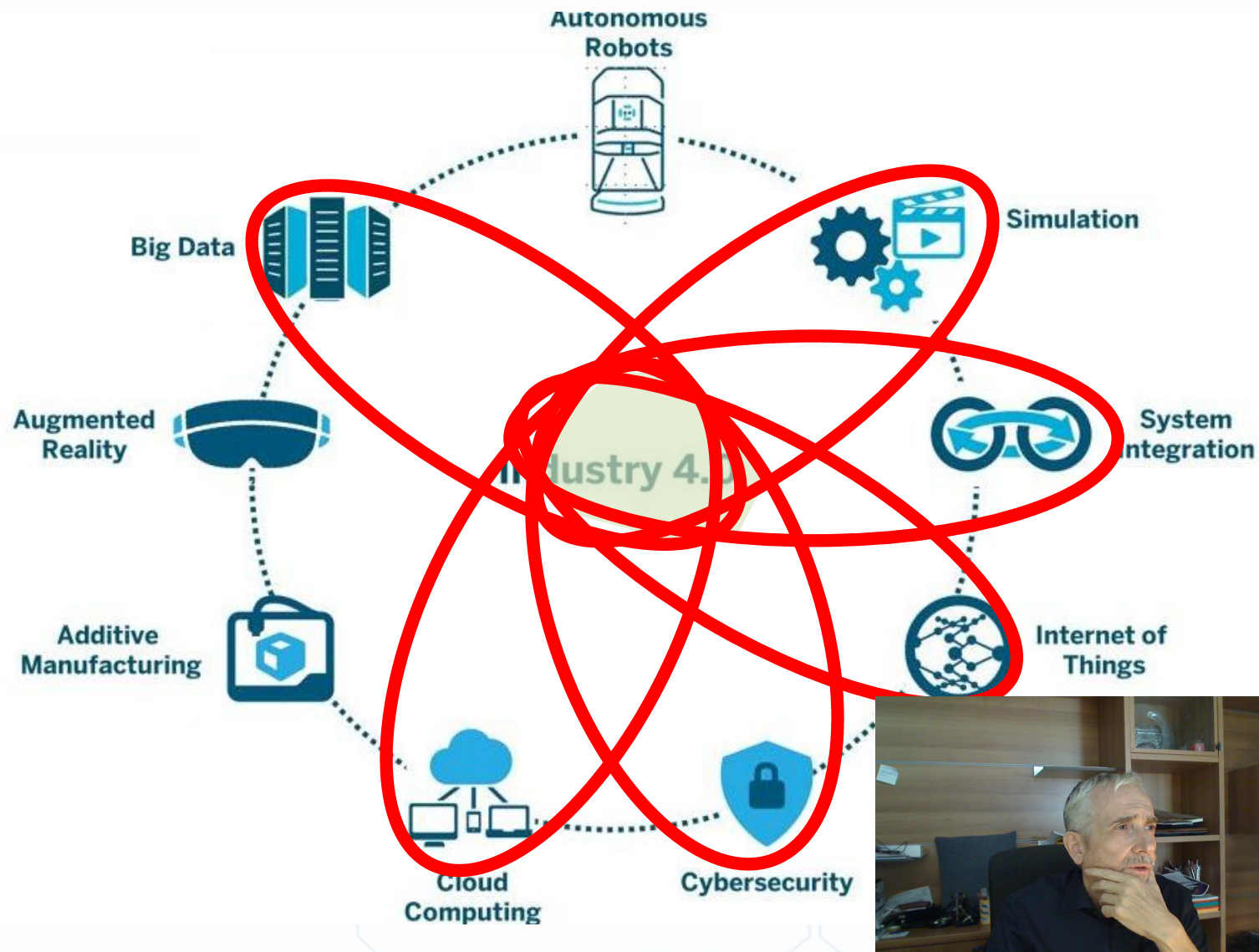
Claudio Badii, Pierfrancesco Bellini, Daniele Cenni, Nicola Mitolo, Paolo Nesi, Gianni Pantaleo, Mirco Soderi  
*Department of Information Engineering, DISIT Lab, University of Florence, Florence, Italy*

<name>.<surname>@unifi.it, <https://www.disit.org>, <https://www.snap4city.org>

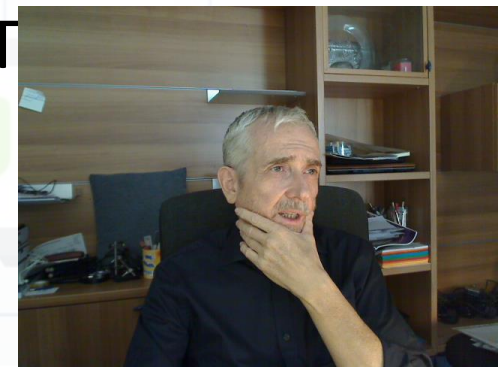


# Industria 4.0 vs DISIT Lab

- Big Data
- Cloud Computing
- Cybersecurity
- IOT/IOE
- System Integration
- Simulation
- +
- Data Analytics



- Integration of the above mentioned aspects
  - Node-RED can be an instrument if augmented with effective MicroServices
- We have leveraged **Node-RED to create IOT Applications:**
  - Big Data: MicroServices for data access and retrieval, discovery
  - Cloud Management on dockers and scalability
  - SSO and security
  - Privacy with GDPR compliance
  - High integration with IOT Networks and IOT Directory for IOT abstraction
  - **Synoptics via Secure WebSockets, custom widgets**





External  
Services

Fleet  
management



IoT Devices/Edge

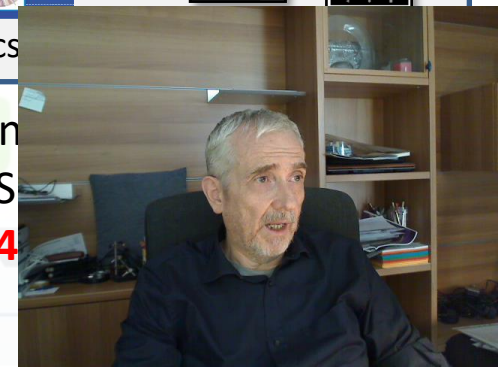
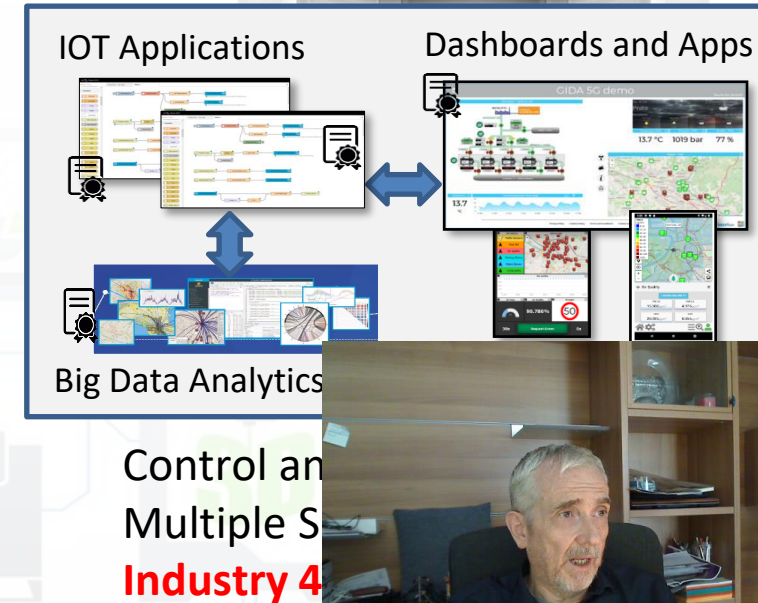
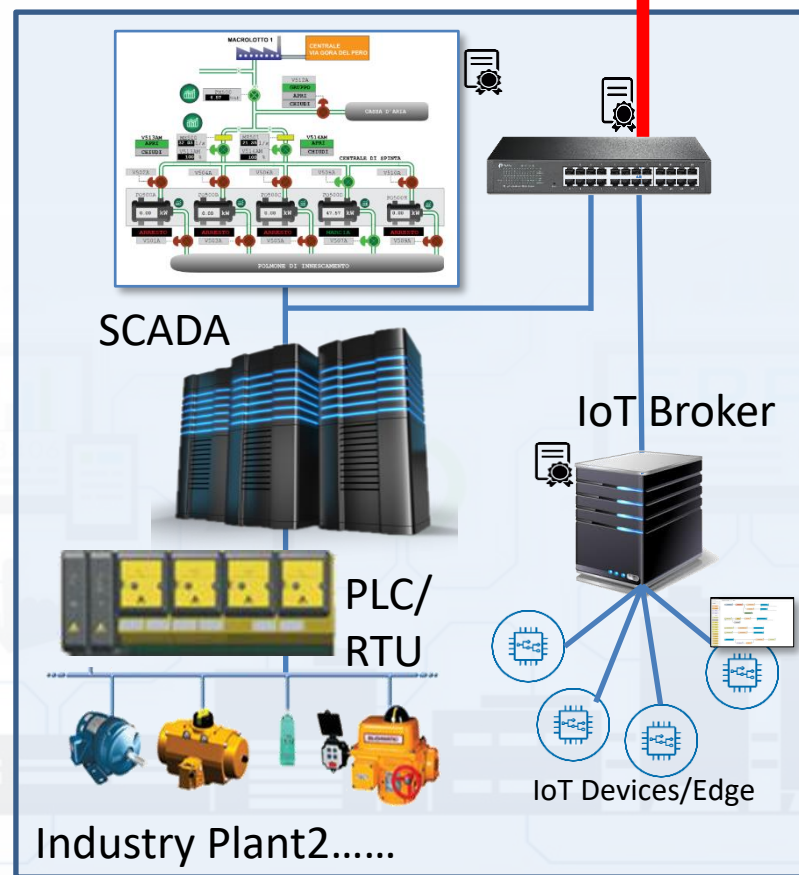
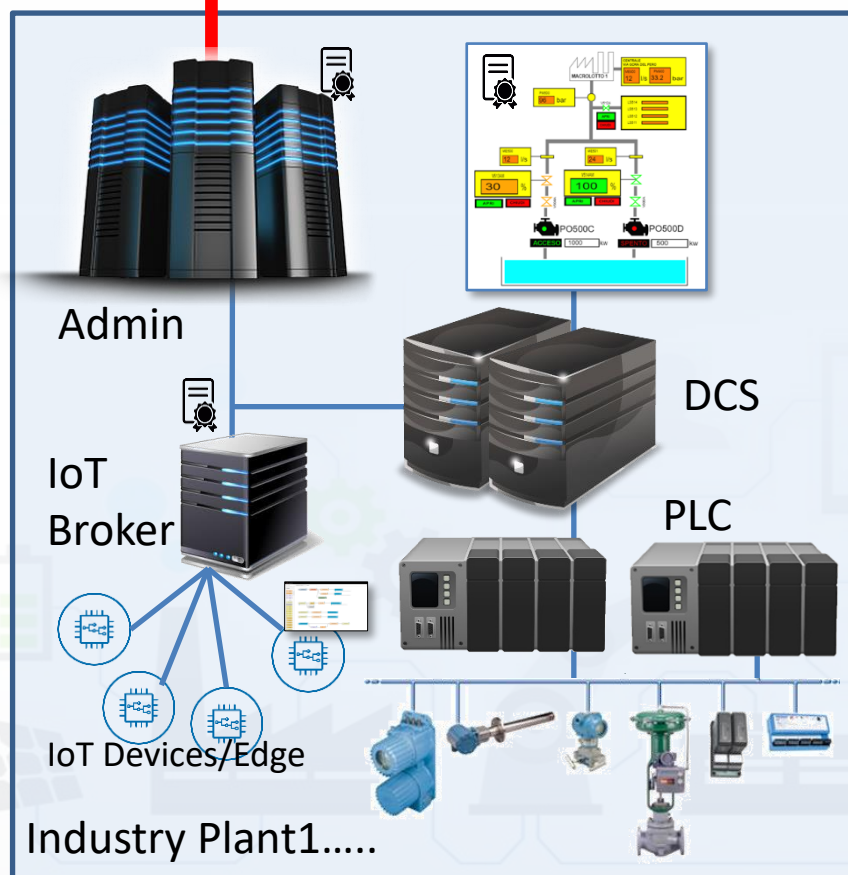
IoT Broker



**SECURE**



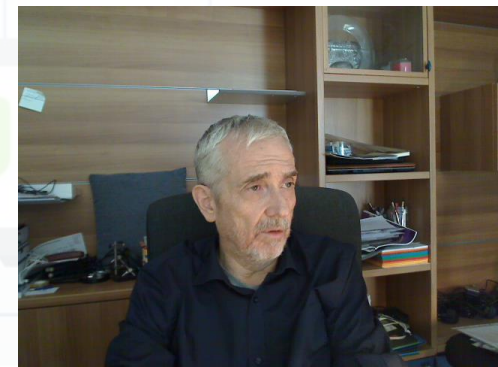
Internet



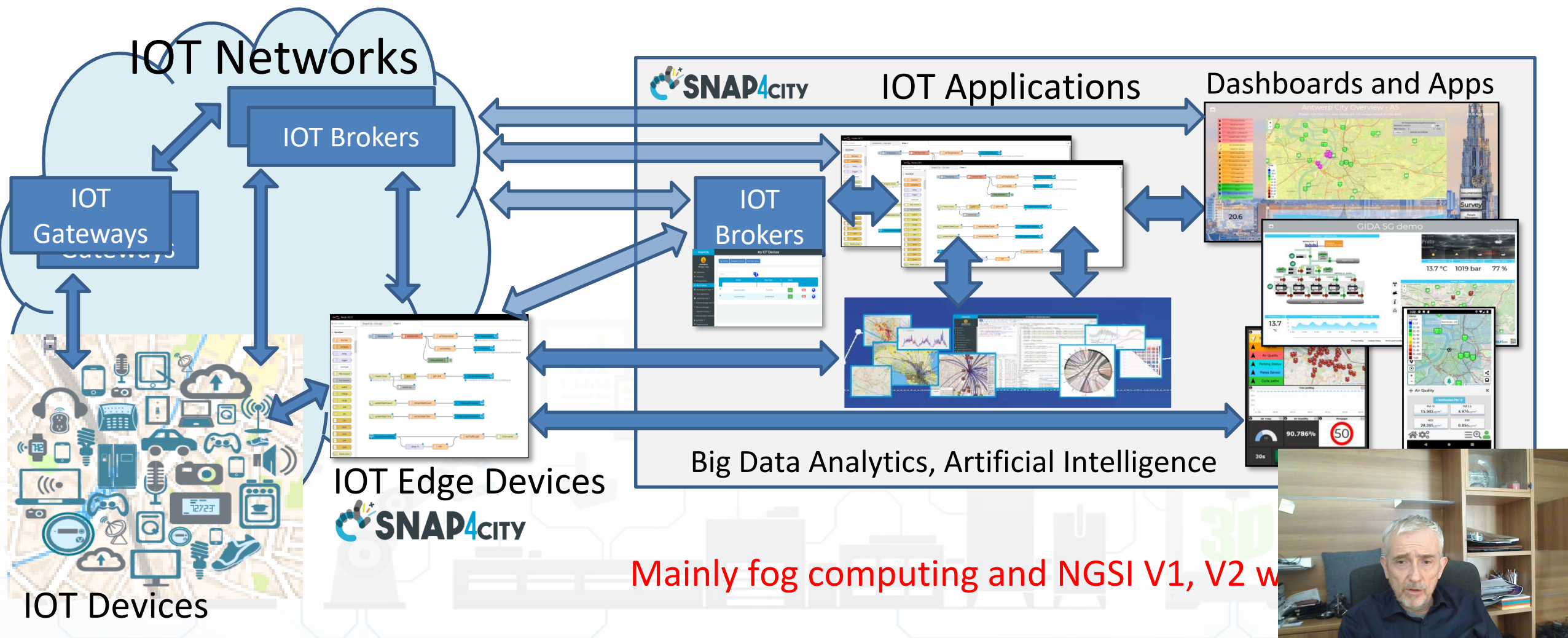


# Additional Requirements

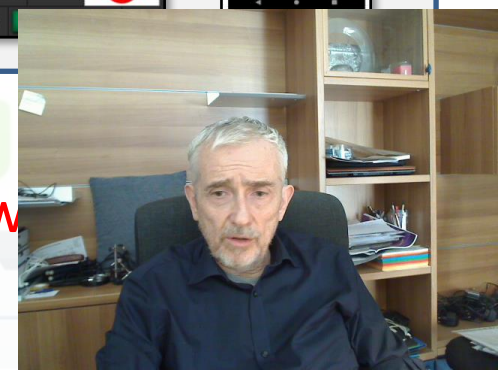
- Integration of SCADA (Supervisory control and data acquisition), DCS (Distributed Control Systems), RTU (remote terminal units) concepts
  - Usage of Industry 4.0 protocols
- Usage of Node-RED as IOT Edge, **controllable/editable from remote**
- **Abstraction of IOT Devices** (Edge) on IOT Directory and IOT App
- **Exploitation of Data Analytic** on Edge and Cloud, from Edge and Cloud
- **Secure connection** for Data and Dashboards: SSO, TLS
- **Synoptics via Secure WebSockets, custom widgets**



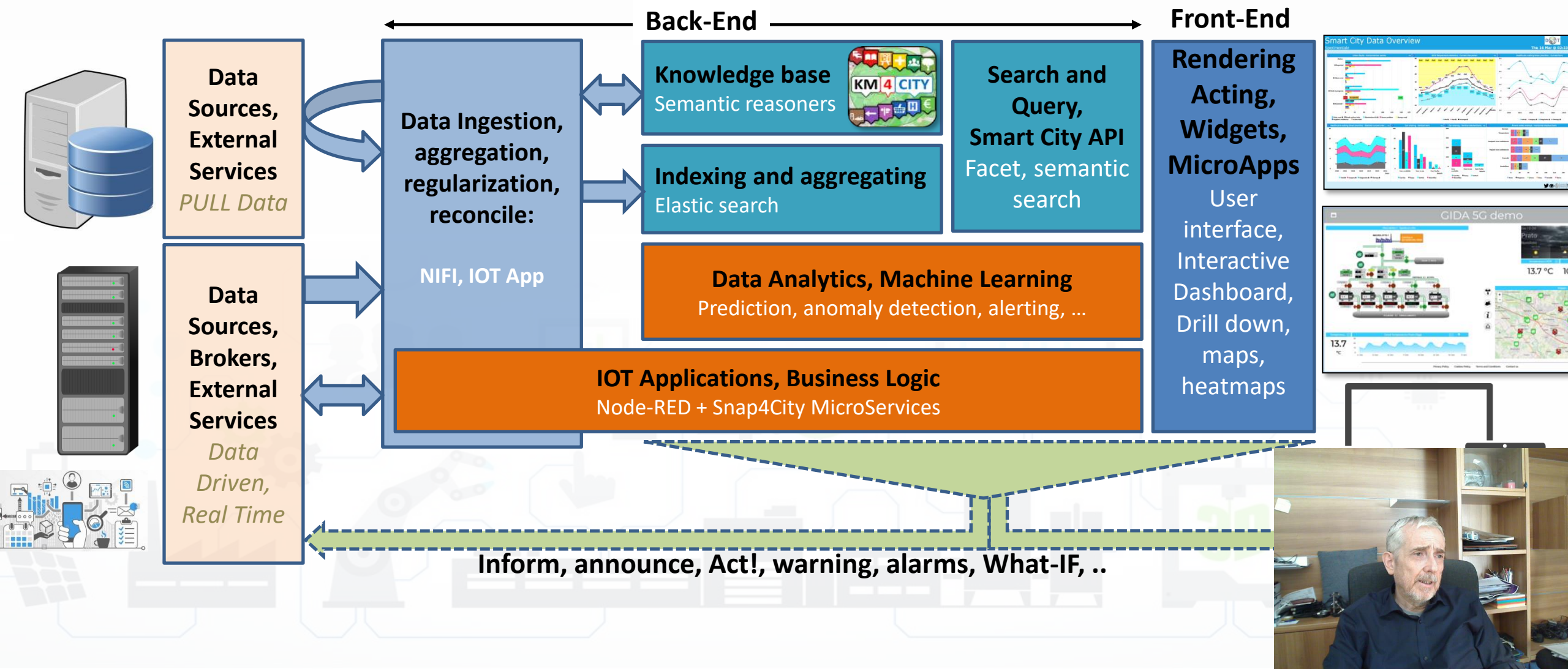
# Snap4 Services also on IOT Edge!!!



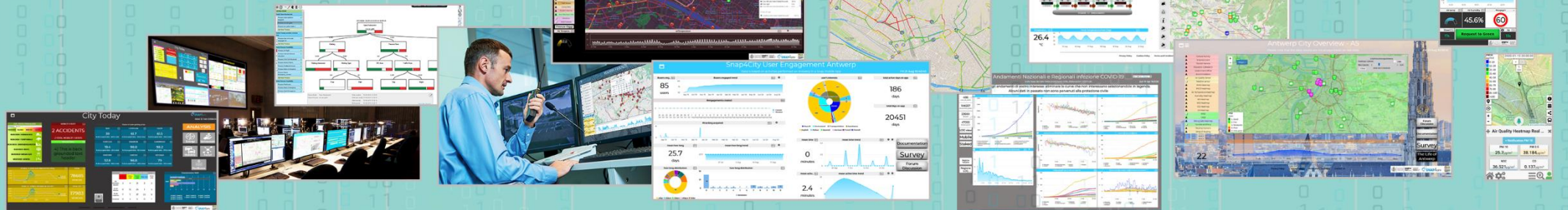
Mainly fog computing and NGSI V1, V2 w



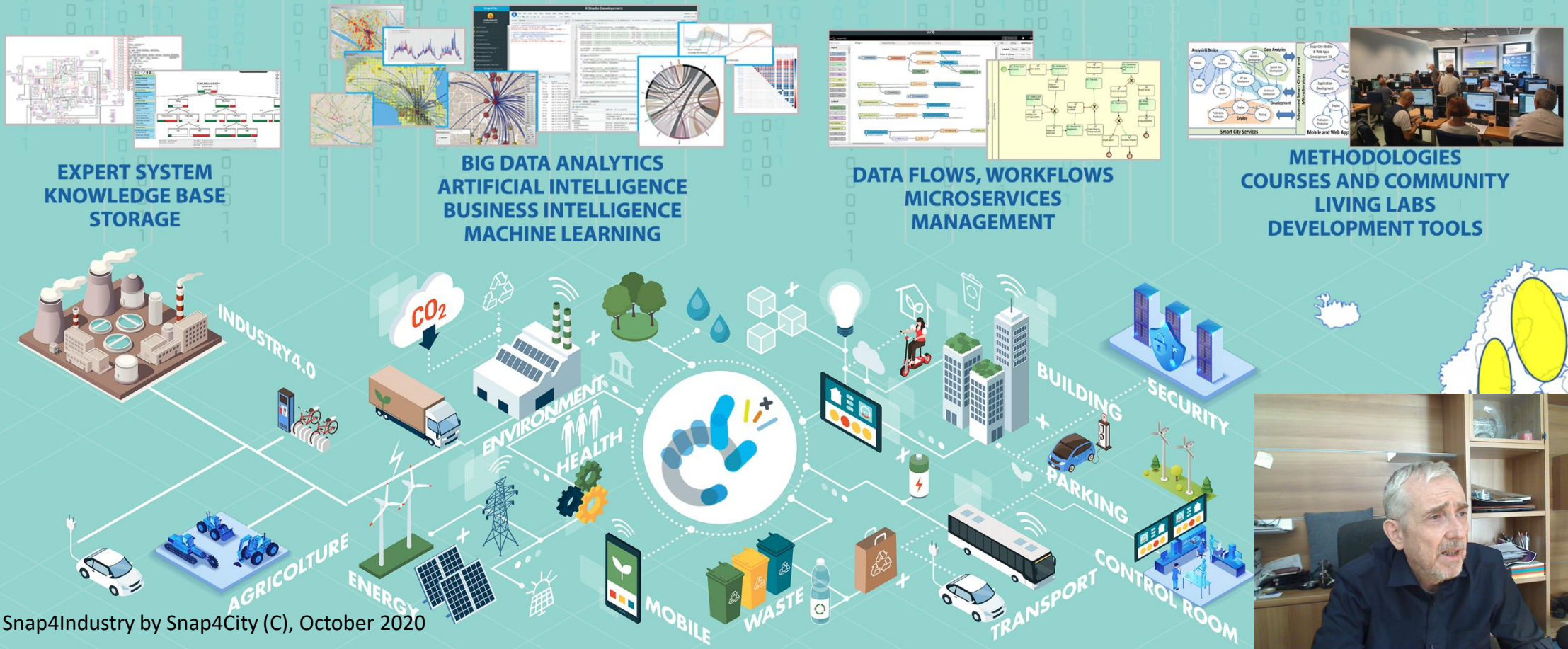
# Snap4Industry Architecture, V2







## DASHBOARDS AND APPS - CONTROL ROOMS - DECISION SUPPORT SYSTEMS - WHAT-IF ANALYSIS

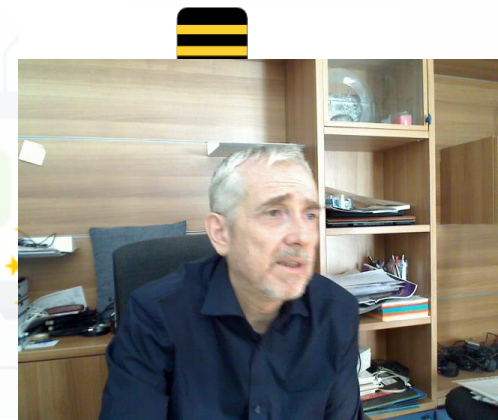




# Standards and Interoperability

**Compliant with:** AMQP, COAP, MQTT, OneM2M, HTTP, HTTPS, TLS, Rest Call, SMTP, TCP, UDP, NGSI, LoRa, LoRaWan, TheThingsNetwork, SigFOX, DATEX II, SOAP, WSDL, Twitter, FaceBook, Telegram, SMS, OLAP, MySQL, Mongo, HBASE, SOLR, SPARQL, EMAIL, FTP, FTPS, WebSocket, WebSocket Secure, ModBUS, OPC, GML, RS485, RS232, WFS, WMS, ODBC, JDBC, Elastic Search, Phoenix, XML, JSON, CSV, db, GeoJSON, Enfuser FMI, Android, Raspberry Pi, Local File System, ESP32, Libelium, IBIMET/IBE, OBD2, SVG, XLS, XLSX, TXT, HTML, CSS, KNX, EnOcean, Zigbee, DALI, ISEMC, Alexa, Sonoff, HUE Philips, Tplink, etc.

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





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TECHNOLOGIES LAB

# Aug 2020 collection

## Two Snap4City Libraries

**SNAP4INDUSTRY**



**input**

**output**

**function**

**social**

**storage**

**analysis**

**advanced**

**NGSI**

**Iwm2m**

**S4C SearchDev**

**S4CUtility**

**S4CMapping**

**S4CManagement**

**S4CDataAnalytic**

**S4CBigData**

**S4CIOTApp**

**S4C Search**

**S4CData**

**S4CKPIData**

**S4CDashboard**

**S4C Sigfox**

**S4CIoT**

**S4CLogDev**

**S4CView**

**S4C Social**

**location**

**dashboard**

**S4C SearchDev**

- service search
- service search near gps position
- service search near service
- service search within gps area
- service search within wkt area
- service search within stored wkt area
- service search by municipality
- service search by queryid
- full text search dev
- full text search within wkt area

**S4C Search**

- full text search within gps area
- full text search near gps position
- full text search exp
- event search dev
- event search exp
- event search within wkt area
- event search within gps area
- event search near gps position
- address search near gps position
- address search near gps position
- geometry search near gps position
- address poi search by text

**S4CMapping**

- address poi search by text exp
- address poi search by text near gps position
- bus routes search
- bus routes search near gps position
- bus routes search within gps area
- bus routes search within wkt area
- bus routes search within

**S4CDataAnalytic**

- point within polygon
- routing
- heatmap picker
- coordinates to address
- service info
- edge-tunnel-to-cloud
- service info mapped
- mapping
- set mapping

**S4CManagement**

- get job detail
- get triggers of job
- get job group names
- get trigger group names
- get paused trigger groups
- get job fire times
- get system status
- trigger job
- pause all
- pause job
- pause trigger
- pause triggers
- resume all
- resume job
- resume jobs
- resume trigger
- resume triggers

**S4CSearch**

- notifier history events
- service search near marker
- service search within circle
- service search within polygon
- service search along path
- full text search near marker
- full text search within polygon
- full text search along path
- full text search usr
- event search near marker
- event search within circle
- event search within polygon
- event search along path
- event search usr
- address search near marker
- geometry search near marker
- address poi search by text usr
- address poi search by text near marker
- address poi search by text within circle
- address poi search by text within polygon
- value type search near marker
- value type search within circle
- value type search within polygon
- value type search along path

**S4CIOTApp**

- datagate insert
- datagate search
- datagate create
- portia crawler
- iotapp restart
- iotapp upgrade

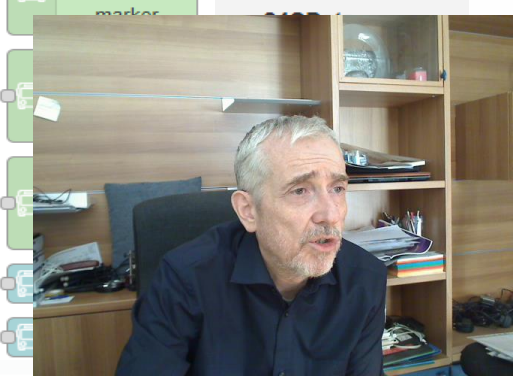
**S4CUtility**

- service info dev
- distance from coordinates
- check exist trigger
- is in standby mode
- is shutdown
- is started
- get currently executing jobs

**S4CBigData**

- tpl routes by agency
- tpl routes by line
- tpl stops by route
- tpl stop timeline
- recommendation within circle
- value type search near marker
- value type search within circle
- value type search within polygon
- value type search along path

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







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## Two Snap4City Libraries

**SNAP4INDUSTRY**



The image displays a comprehensive library of Snap4City components, organized into several main categories. The 'S4C Dashboard' category is highlighted, showing sub-categories like 'S4C KPIData', 'S4C OpenMaint', and 'S4C IoT'. The 'S4C IoT' category is also expanded, showing sub-categories like 'S4C LogDev', 'S4C View', 'S4C Social', 'S4C Sigfox', and 'UserCreated'. The components are represented by colorful icons and labels, such as 'get other activity on my data', 'save my data', 'get my annotation', 'get anonymous data', 'get other data', 'impulse button', 'numeric keyboard', 'switch button', 'dimmer', 'geolocator', 'gauge chart', 'single content', 'speedometer', 'horizontal single bar', 'vertical single bar', 'web content', 'time trend', 'bar series', 'radar series', 'pie chart', 'curved line series', 'table content', 'coordinates-from-map', 'event driven my kpi', 'synoptic read', 'synoptic write', 'synoptic subscribe', 'location', 'turf', 'worldmap', 'tracks', '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', 'iotdirectory new device from model', 'delegate my device', 'change ownership my device', 'iot directory', 'iot directory link', 'iotdirectory get device', 'fiware orion subscribe v1', 'fiware orion query v1', 'fiware orion update v1', 'fiware orion out v1', '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', 'event log', 'S4CView', 'show micro web app', 'show general iframe', 'S4C Social', 'twitter last channel', 'twitter last tweet', 'S4C Sigfox', 'sigfox device filter', 'sigfox', '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', 'xml', 'yaml', 'rbe', 'md5', 'soap request', 'string', 'xml converter', 'zip', 'base64', 'msgpack', 'random', 'NGSI', 'NGSI Entity', 'NGSI Dataset', 'NGSI Update', 'NGSI Subscription', 'NGSI v2ToLD', 'social', 'email', 'twitter', 'subflows', 'lwm2m', 'triplesToVirtuo'. The 'S4C KPIData' category is also expanded, showing sub-categories like 'get my kpdata', 'get my kpdata values', 'get public kpdata values', 'get delegated kpdata values', 'get iotapps using my kpdata', 'save my kpdata values'.

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

We suggest also to install:

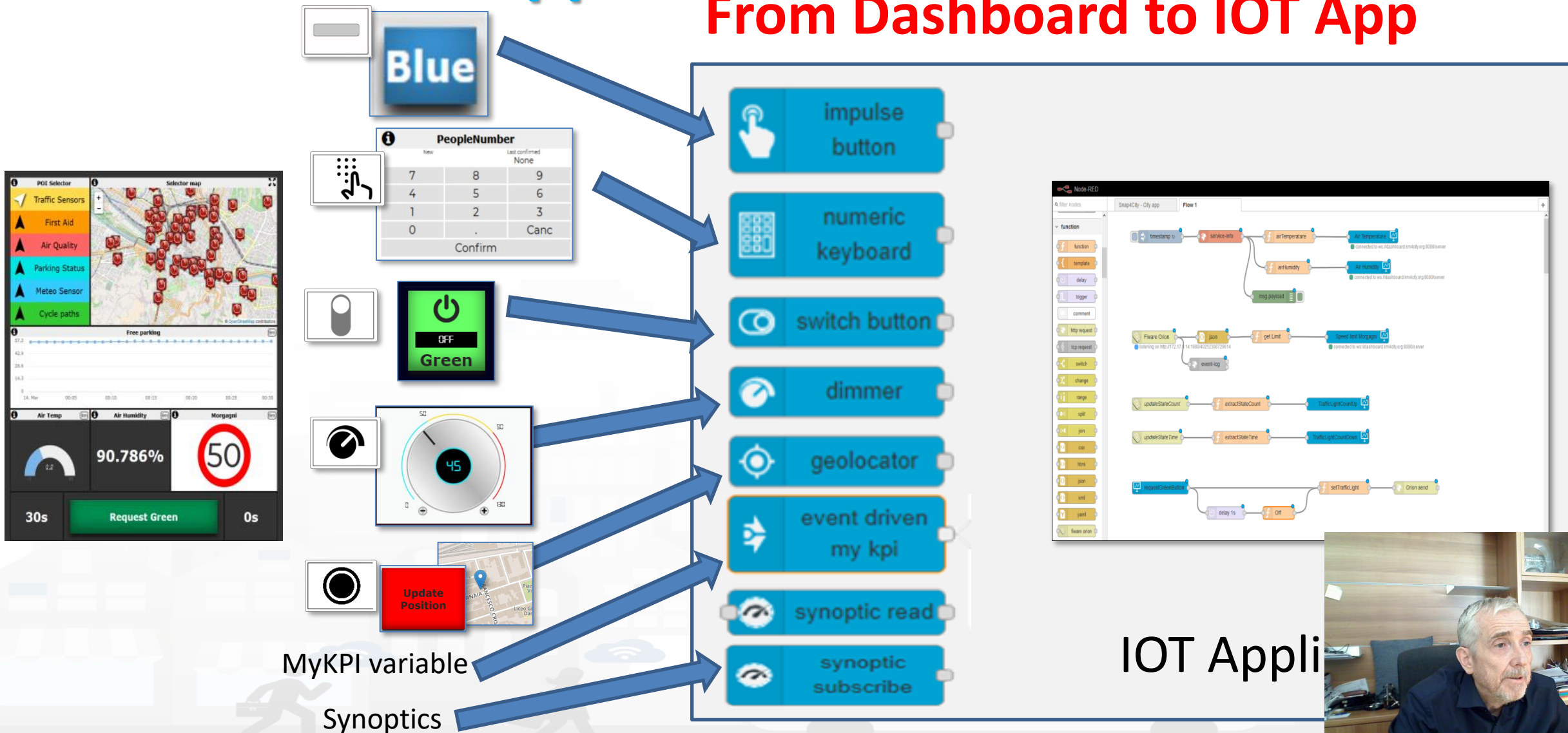
The image displays a collection of Snap4City components, organized into several main categories. The 'xml' category is highlighted, showing sub-categories like 'yaml', 'rbe', 'md5', 'soap request', 'string', 'xml converter', 'zip', 'base64', 'msgpack', 'random', 'NGSI', 'social', 'subflows', 'lwm2m', and 'triplesToVirtuo'. The 'NGSI' category is also expanded, showing sub-categories like 'NGSI Entity', 'NGSI Dataset', 'NGSI Update', 'NGSI Subscription', 'NGSI v2ToLD', 'social', 'email', 'twitter', 'subflows', 'lwm2m', and 'triplesToVirtuo'. The 'social' category is also expanded, showing sub-categories like 'email', 'twitter', 'subflows', 'lwm2m', and 'triplesToVirtuo'. The 'lwm2m' category is also expanded, showing sub-categories like 'lwm2m', 'triplesToVirtuo', and 'triplesToVirtuo'.

Snap4Industry by Snap4City (C), October 2020

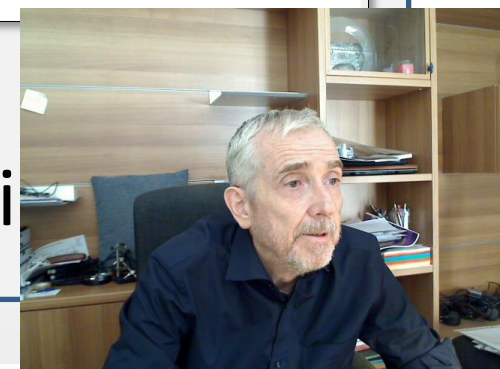


# Dashboard-IOT App

## From Dashboard to IOT App

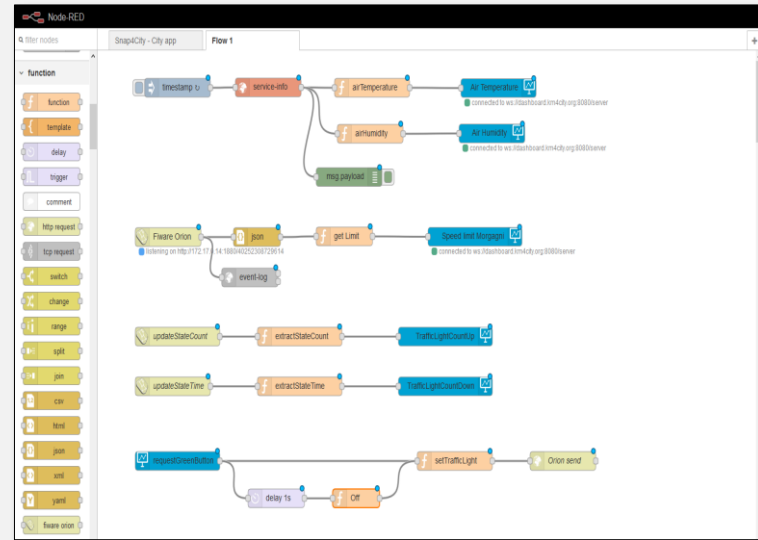


IOT Appli



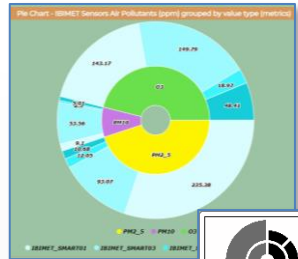
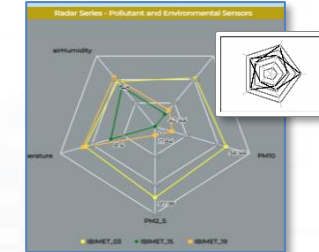
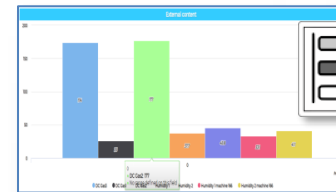
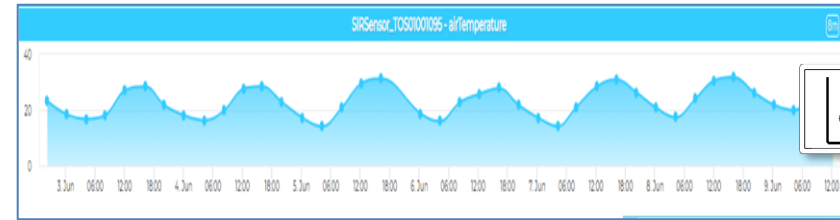
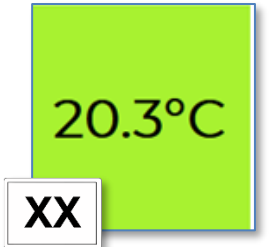
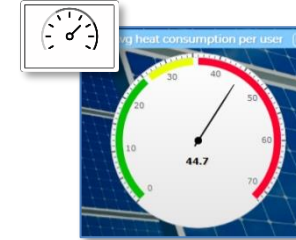
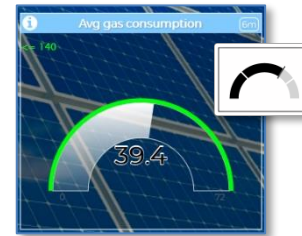
# Dashboard-IOT App

## From IOT App to Dashboard

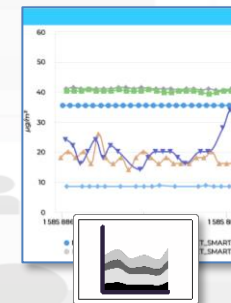


- gauge chart
- single content
- speedometer
- horizontal single bar
- vertical single bar
- web content
- time trend
- bar series
- radar series
- pie chart
- curved line series
- table content
- synoptic write

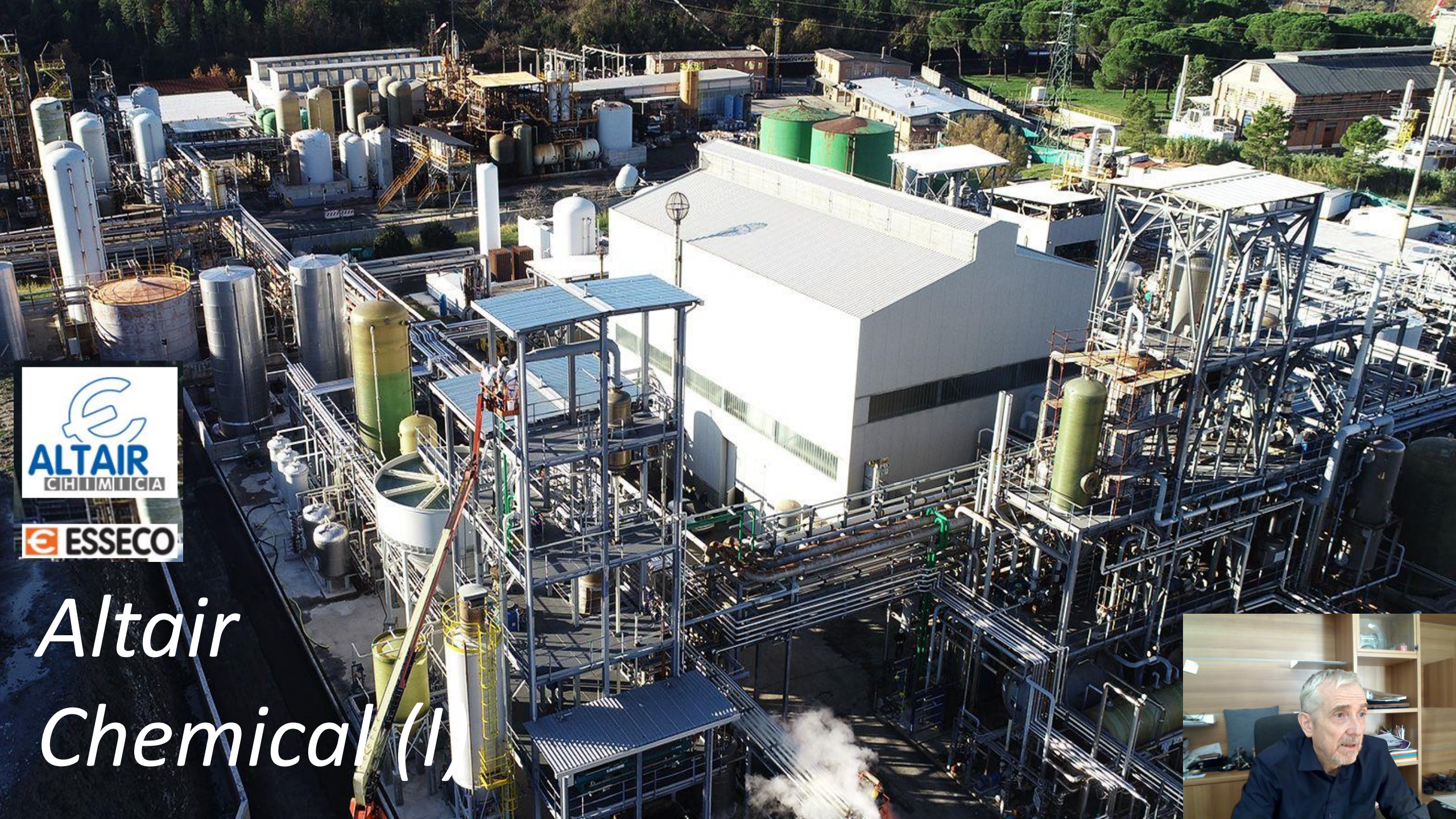
IOT Application



value type	humidity	airTemperature	PM2.5	PM10	CO2
humidity	65.0	15.0	25.30	100.00	0.10
airTemperature	15.0	15.0	25.30	100.00	0.10
PM2.5	25.30	15.0	25.30	100.00	0.10
PM10	100.00	15.0	25.30	100.00	0.10
CO2	0.10	15.0	25.30	100.00	100.00







# Altair Chemical (I)

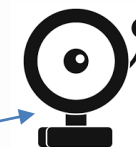
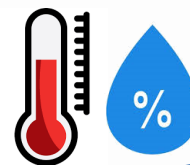




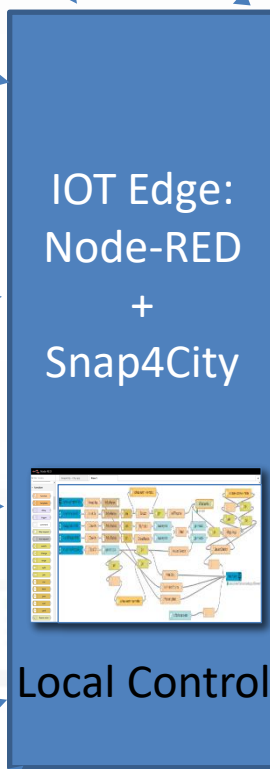
Measuring any kind of sensors values

Controlling Energy Power

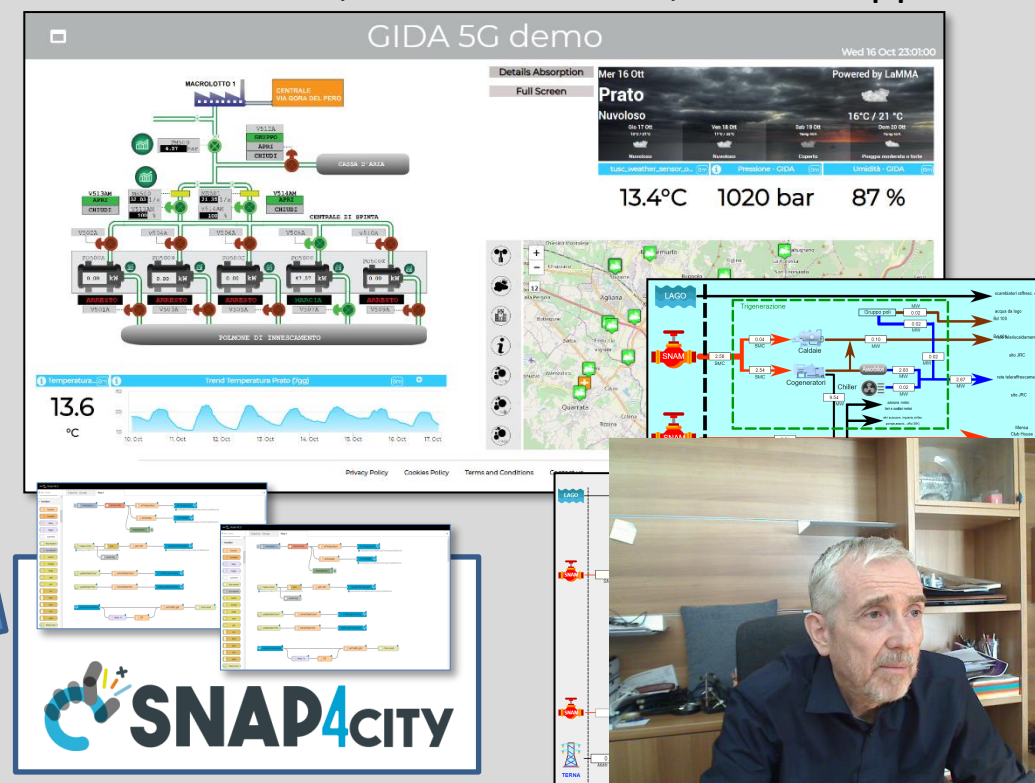
Measuring  
Energy Consumption



Any kind of notification channel



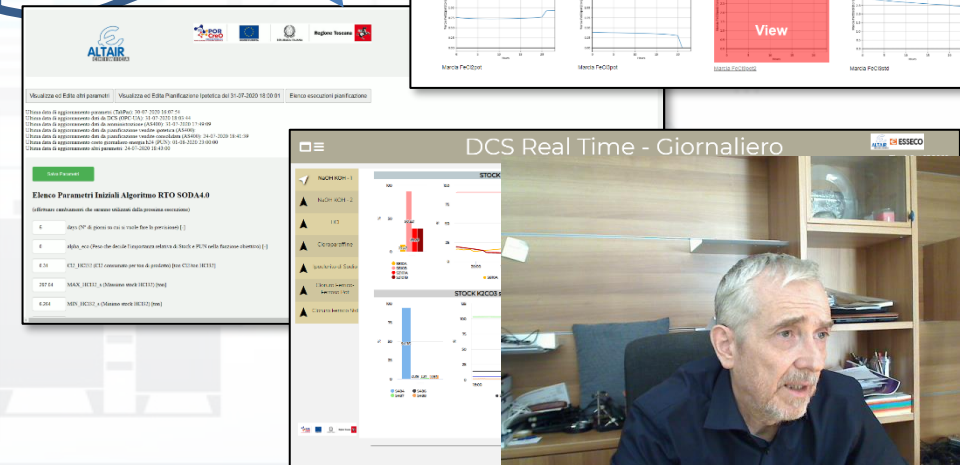
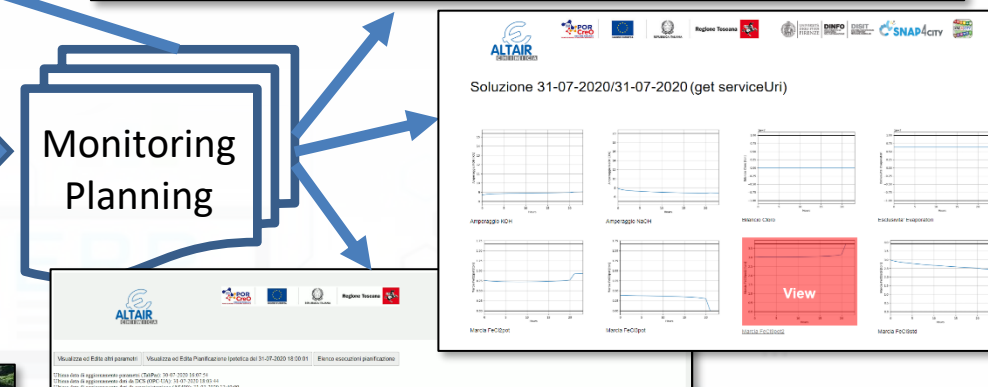
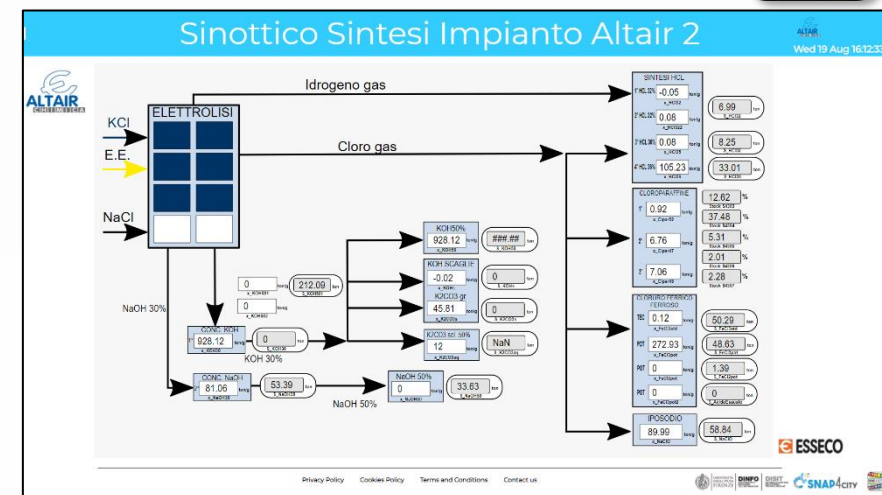
Contextual (smart city/home) data, Data Analytics  
Historical Data, Remote Control, Mobile App



Alexa: Voice Commands

Snap4City (C), October 2020





## Parameters

# Snap4Altair

## Monitoring Planning

AS400 (orders)

PUN (energy)

Snap4Industry by Snap4City (C), October 2020



# DCS Real Time - Settimanale



Thu 1 Oct 15:25:11

Home

DCS Real Time  
VS Planning

DCS Real Time  
Giornaliero

DCS Real Time  
Settimanale

DCS Marce  
Giornaliero

DCS Marce  
Settimanale

DCS Stoccaggi  
Giornaliero

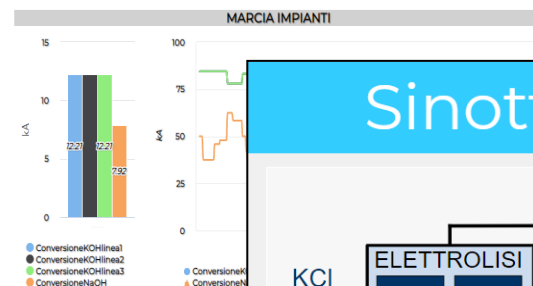
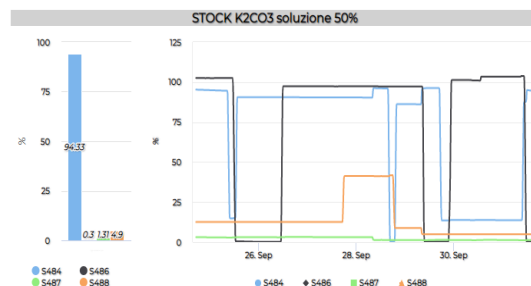
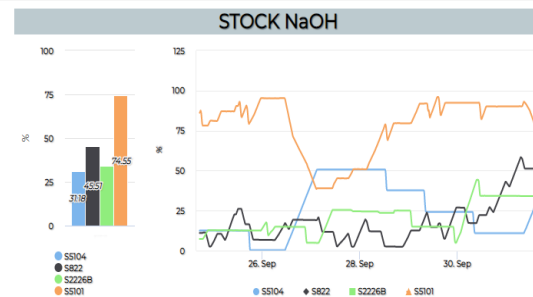
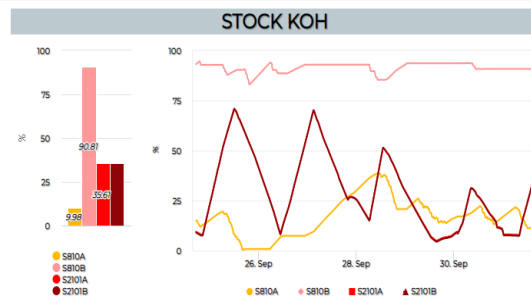


SNAP4INDUSTRY



SNAP4ALTAR

- NaOH KOH - 1
- NaOH KOH - 2
- HCl
- Cloroparaffine
- Ipcloclorito di Sodio
- Cloruro Ferrico-Ferroso Pot
- Cloruro Ferrico Std



## Sinottico Sintesi Impianto Altair 2



Thu 1 Oct 15:32:19

Home

DCS Real Time  
VS Planning

DCS Real Time  
Giornaliero

DCS Real Time  
Settimanale

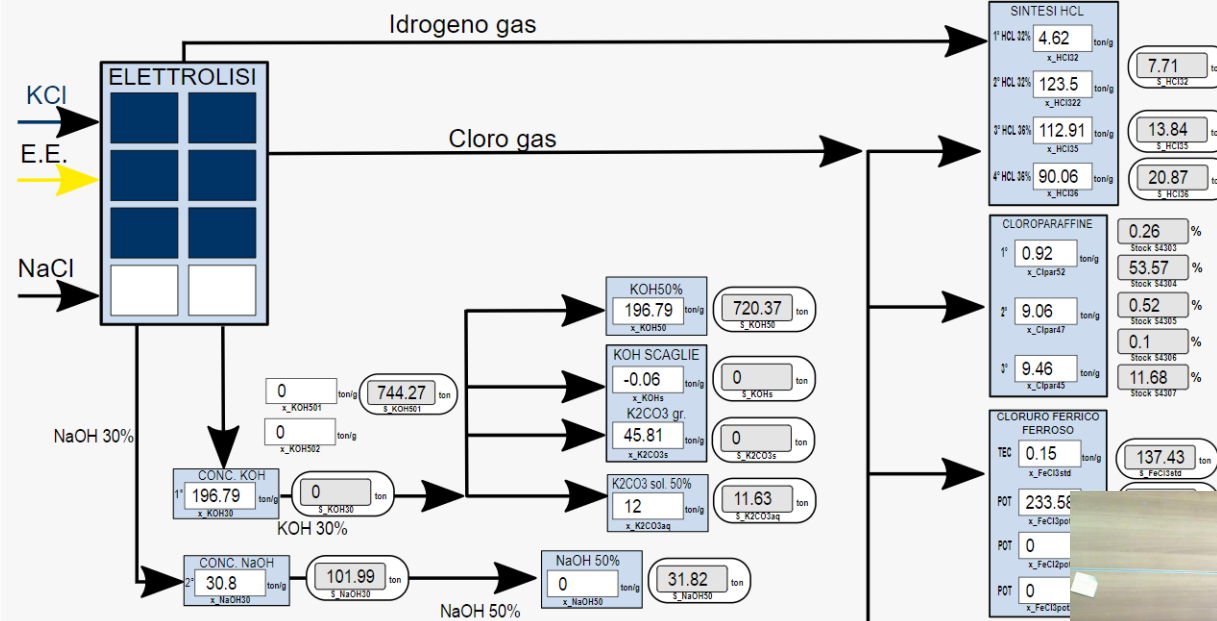
DCS Marce  
Giornaliero

DCS Marce  
Settimanale

DCS Stoccaggi  
Giornaliero

DCS Stoccaggi  
Settimanale

Sinottico di



## RTO online

Home RTO  
online

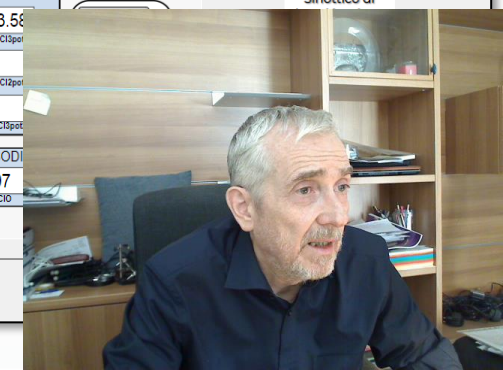
Parametri (TabPar)	DCS (OPC-UA)	Amministrazione (AS400)	Pianificazione Consolidata (AS400)	Energia (PUN)	Altri Parametri
2020-09-25 18:47:36	2020-10-01 09:33:01	2020-10-01 09:32:54	2020-10-01 09:32:54	2020-10-01 23:00:00	2020-07-24 18:43:00
2020-09-25 18:47:36	2020-09-30 17:20:02	2020-09-30 17:20:50	2020-09-30 17:20:50	2020-09-30 23:00:00	2020-07-24 18:43:00
2020-09-25 18:47:36	2020-09-30 16:27:02	2020-09-30 16:24:57	2020-09-30 16:24:57	2020-09-30 23:00:00	2020-07-24 18:43:00
2020-09-25 18:47:36	2020-09-30 14:56:02	2020-09-30 14:54:11	2020-09-30 14:54:11	2020-09-30 23:00:00	2020-07-24 18:43:00
2020-09-25 18:47:36	2020-09-30 13:43:02	2020-09-30 13:43:47	2020-09-30 13:43:47	2020-09-30 23:00:00	2020-07-24 18:43:00
2020-09-25 18:47:36	2020-09-29 19:03:01	2020-09-29 19:03:27	2020-09-29 19:03:27	2020-09-30 23:00:00	2020-07-24 18:43:00
2020-09-25 18:47:36	2020-09-28 18:30:02	2020-09-28 18:30:13	2020-09-28 18:30:13	2020-09-29 23:00:00	2020-07-24 18:43:00
2020-09-25 18:47:36	2020-09-28 17:57:02	2020-09-28 17:57:14	2020-09-28 17:57:14	2020-09-29 23:00:00	2020-07-24 18:43:00
2020-09-25 18:47:36	2020-09-28 15:50:02	2020-09-28 15:50:21	2020-09-28 15:50:21	2020-09-28 23:00:00	2020-07-24 18:43:00
2020-09-25 18:47:36	2020-09-25 18:47:02	2020-09-25 18:46:02	2020-09-25 18:46:02	2020-09-26 23:00:00	2020-07-24 18:43:00

<< 1 2 3 4 5 6 7 8 >>

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Sinottico di  
sintesi impianto

per 2020







# *Prato Smart City vs Industry 4.0*







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**DINFO**  
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**DISIT**  
DISTRIBUTED SYSTEMS  
AND INTERNET  
TECHNOLOGIES LAB



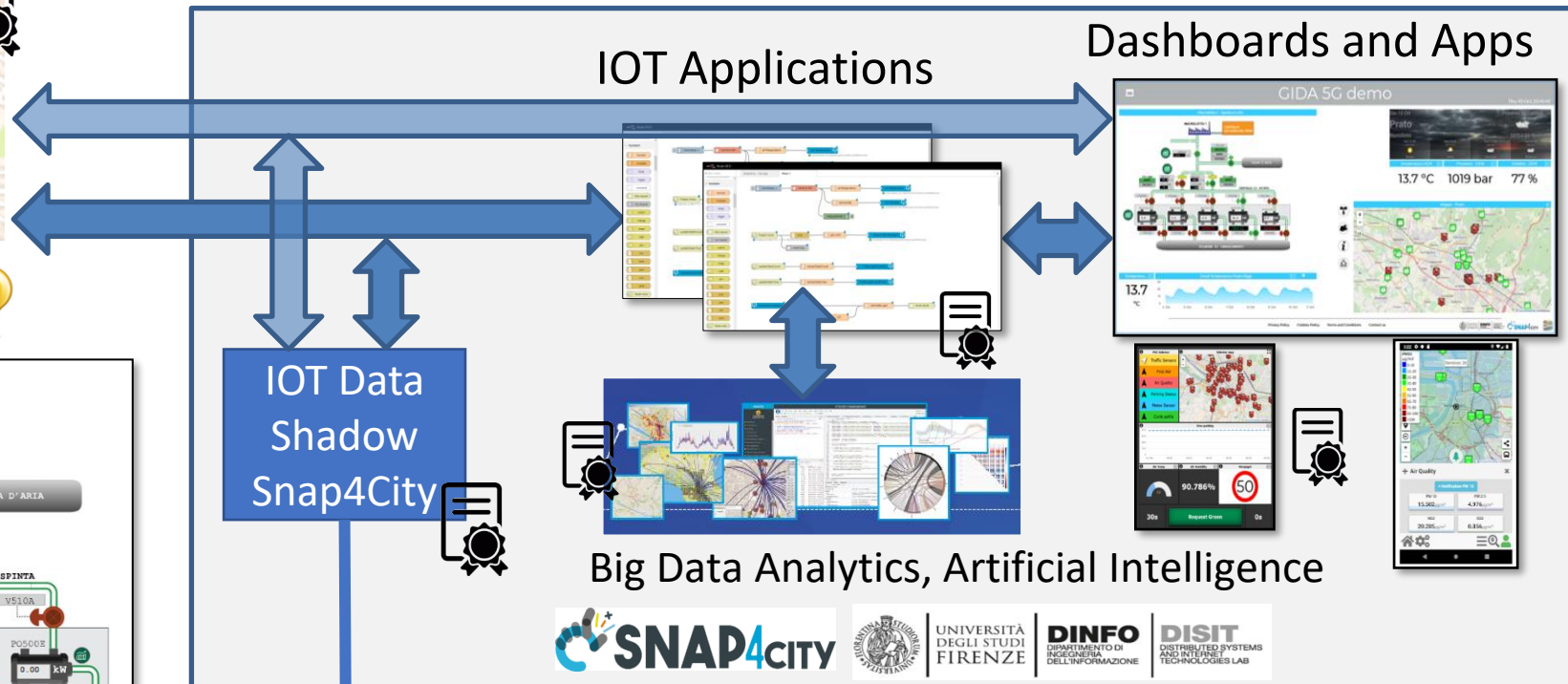
# GIDA set up



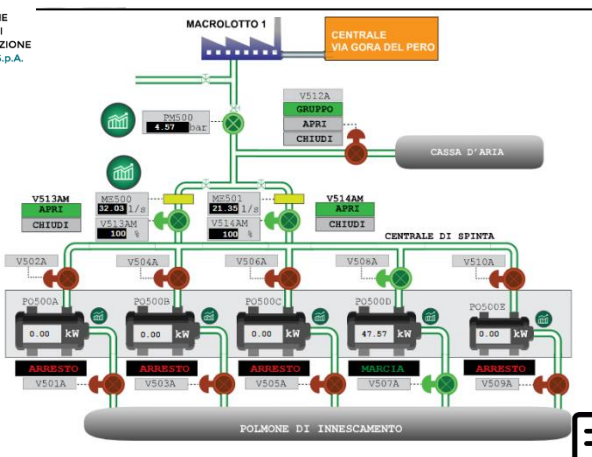
GESTIONE  
IMPIANTI  
DEPURAZIONE  
ACQUE S.p.A.



Smart City  
data from  
many sources



GESTIONE  
IMPIANTI  
DEPURAZIONE  
ACQUE S.p.A.



Big Data Analytics, Artificial Intelligence



UNIVERSITÀ  
DEGLI STUDI  
FIRENZE

**DINFO**  
DIPARTIMENTO DI  
INGEGNERIA  
DELL'INFORMAZIONE

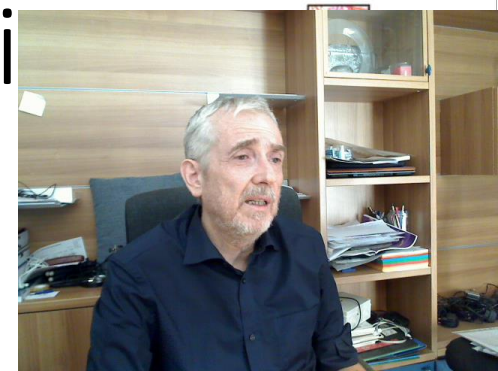
**DISIT**  
DISTRIBUTED SYSTEMS  
AND INTERNET  
TECHNOLOGIES LAB



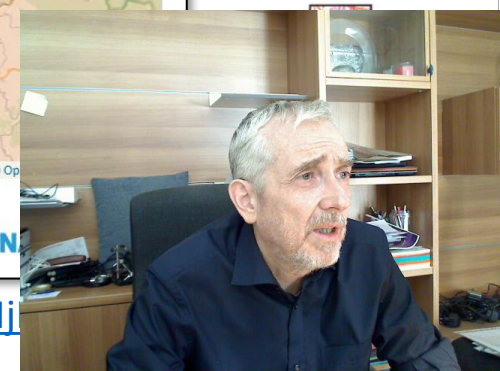
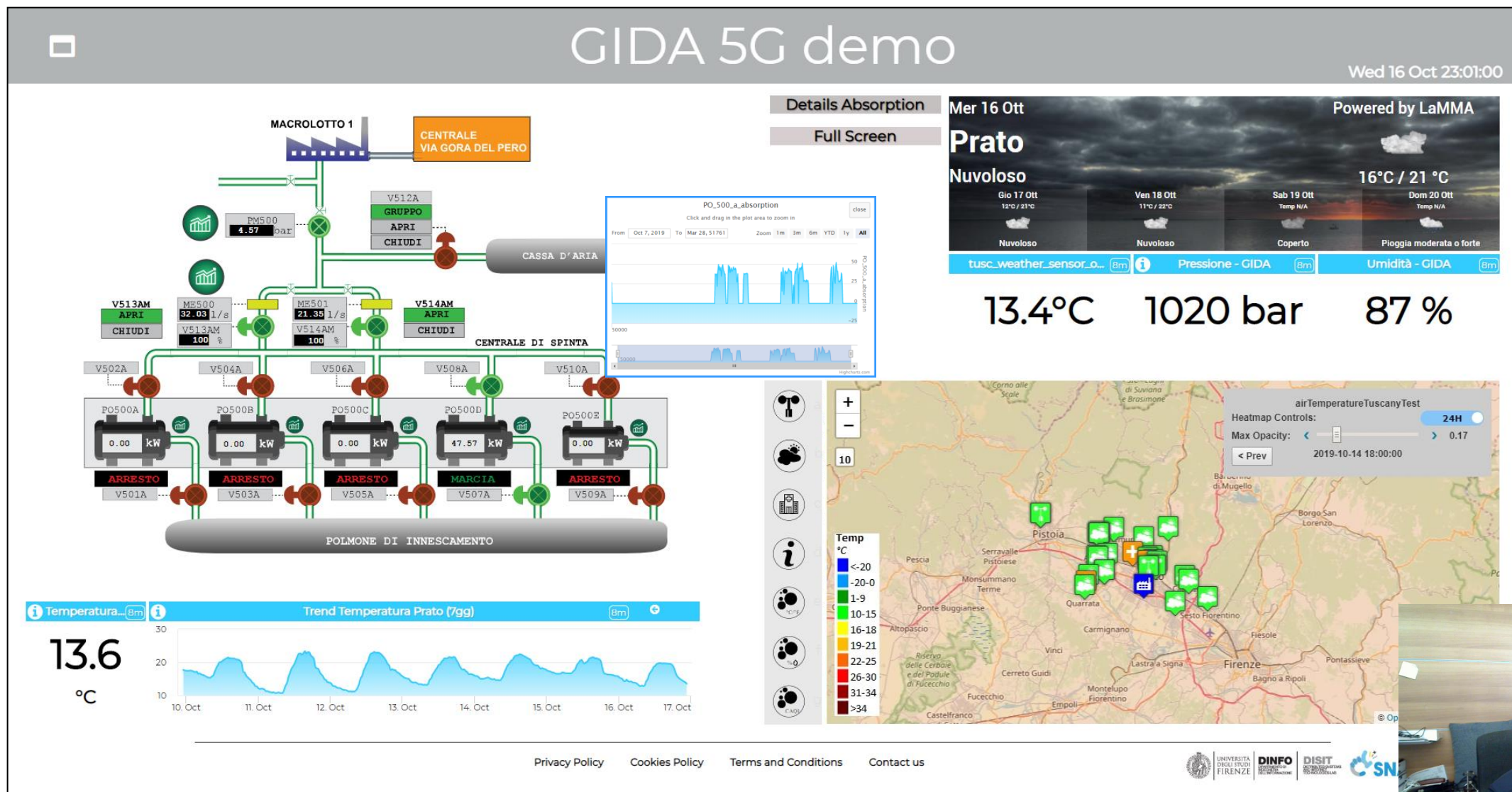
ModBus to  
Snap4City  
Gateway Edge

5G network  
devices

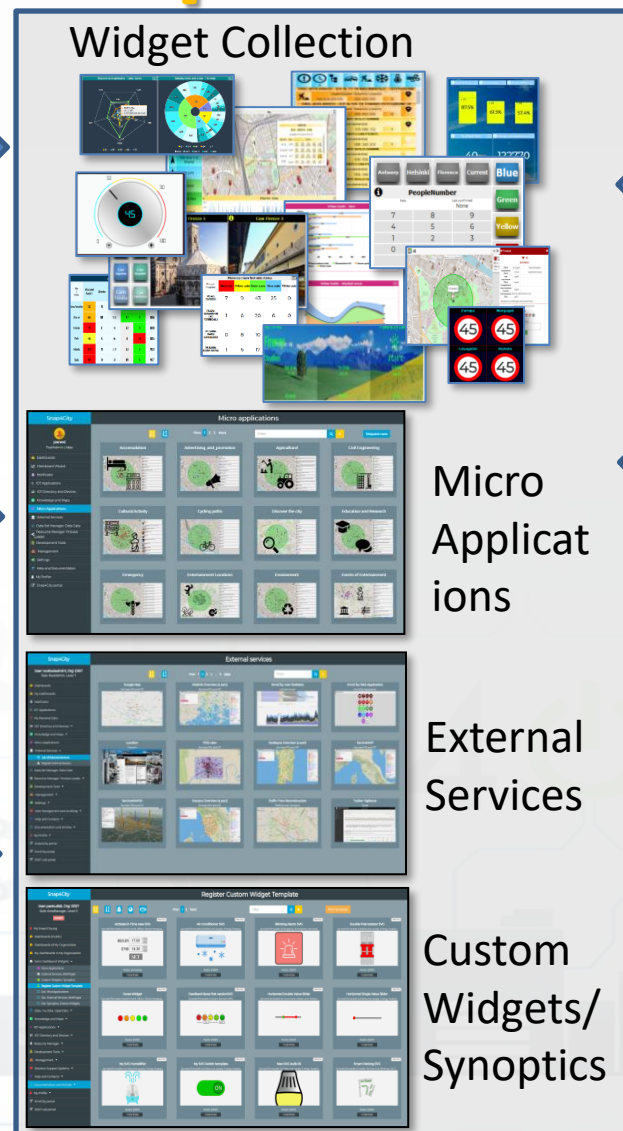
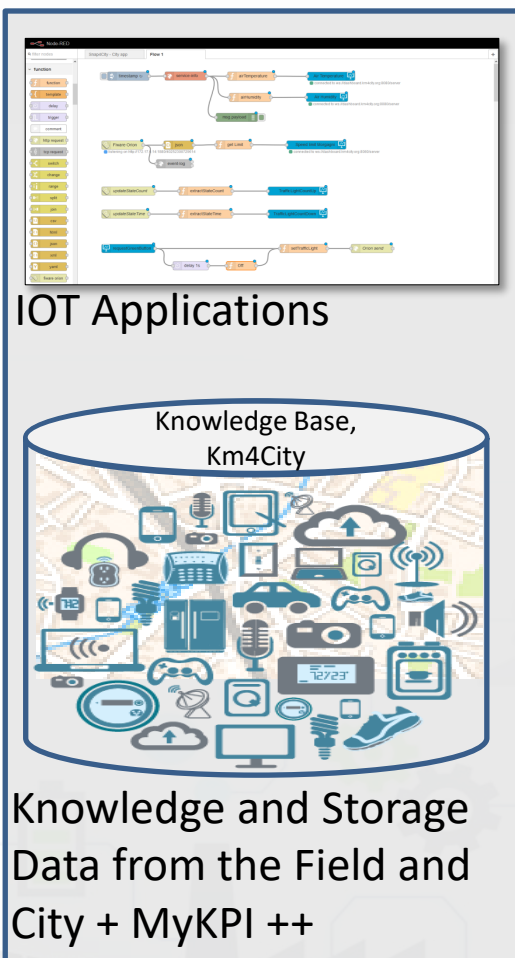
## Telemonitori Telecontrol



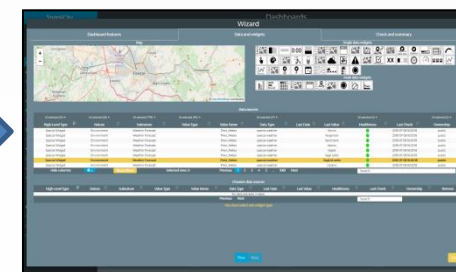




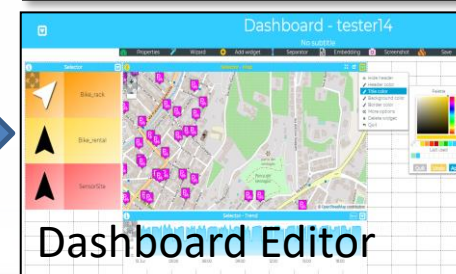
# Dashboard Development



## Dashboard Wizard



Create, save, load, delegate, grant access



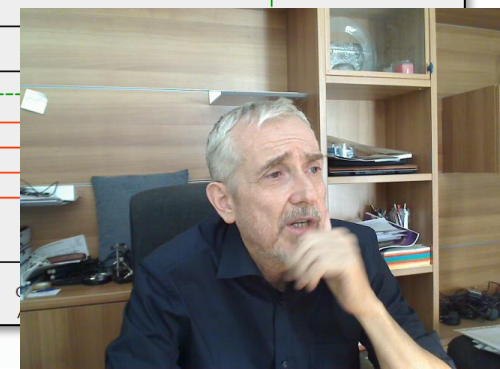
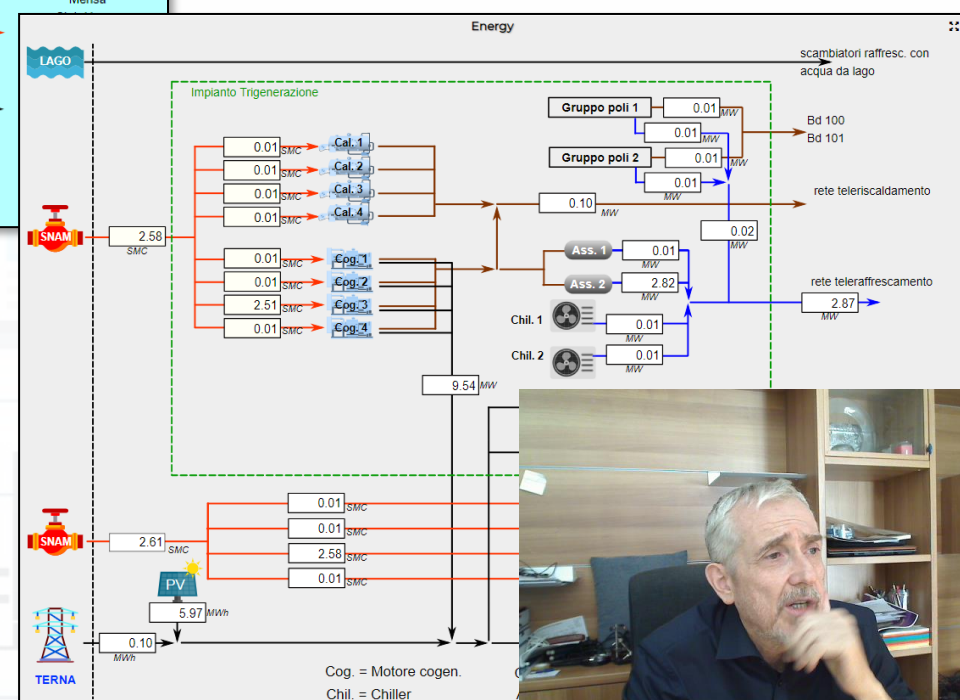
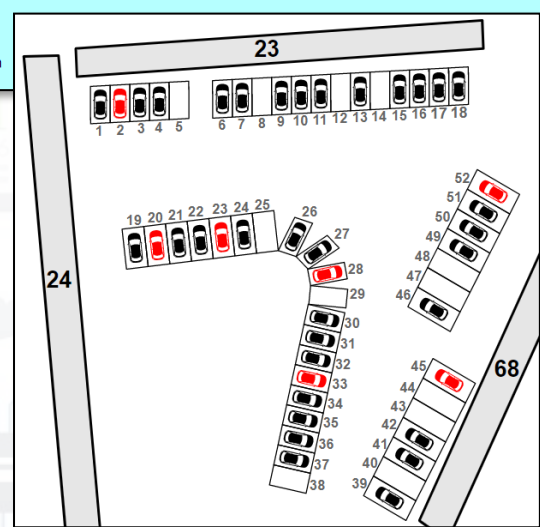
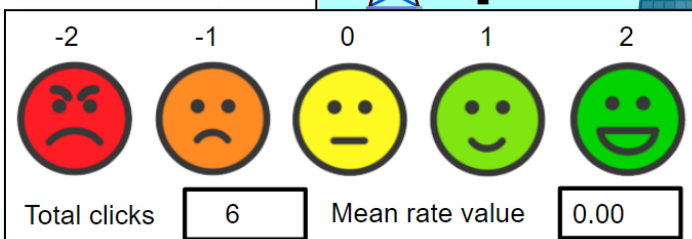
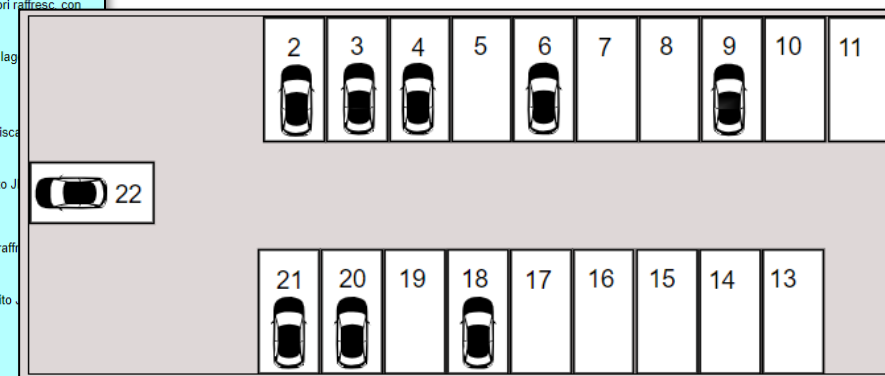
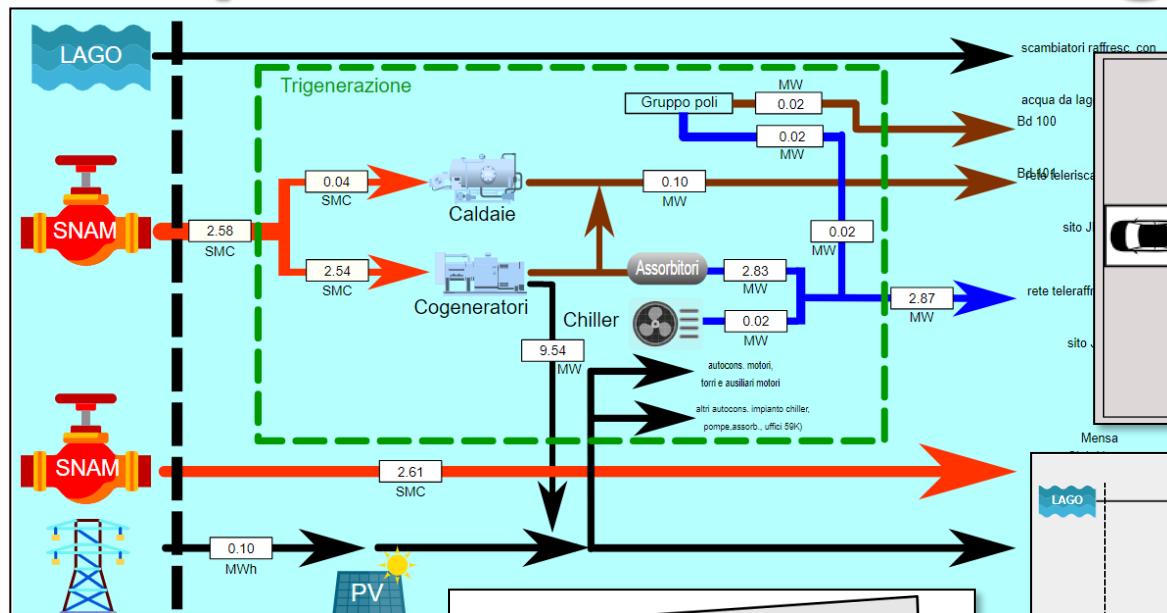
**My Own Dash**





# Special Custom Widgets

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

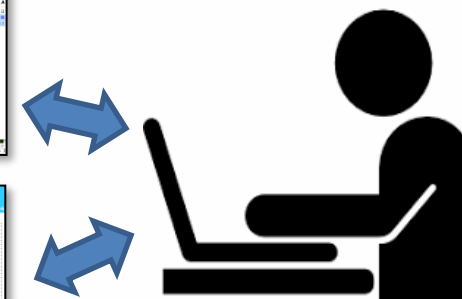


# Custom Widget / Synoptic Development

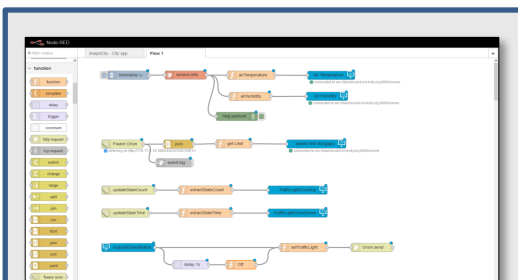
Inkscape editor on your computer



Create, save a Custom Widget in SVG



Create, save, load, delegate, grant access



IOT Applications

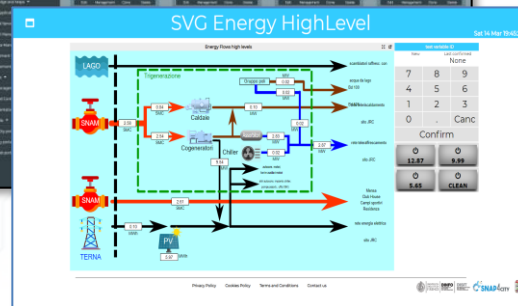


Knowledge and Storage Data from the Field and City

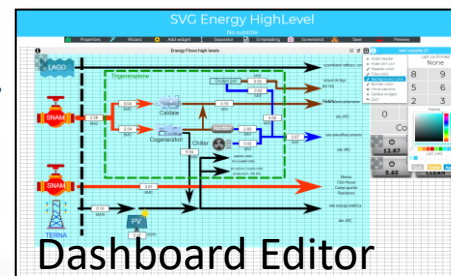
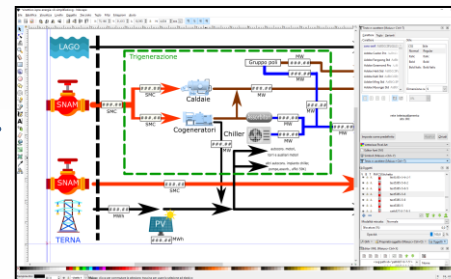
SVG Symbols Collection



Public Dashboard Collection

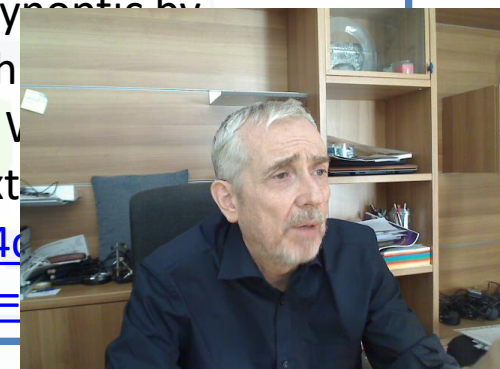


My Own Dash/App



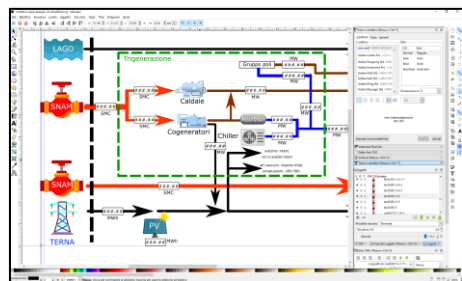
1. Create and Load a Custom SVG
2. Select/Reuse an SVG
3. Make and Instance of Synoptic by Associate Variables with
4. Create on Dashboard a V Synoptic HLT such as Ext

• <https://www.snap4city.com/2/synoptic.html?id=>

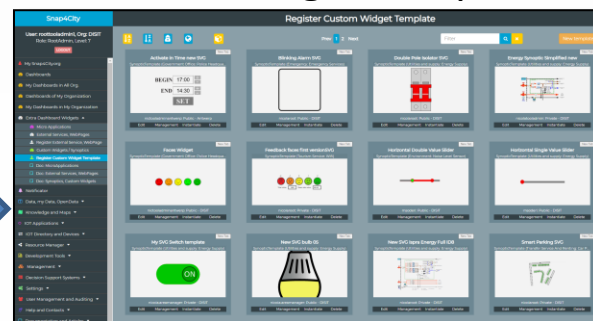




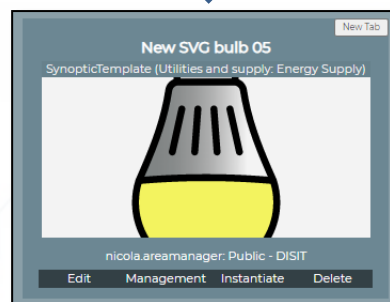
**Create, save a Custom  
Widget in SVG**



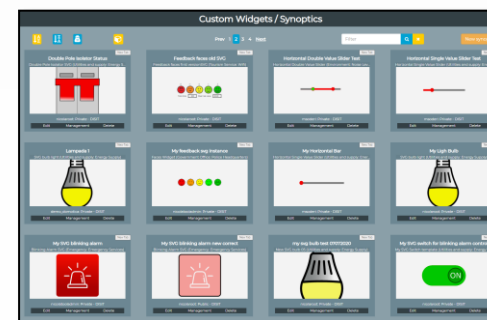
**Upload as  
Custom Widget Template**



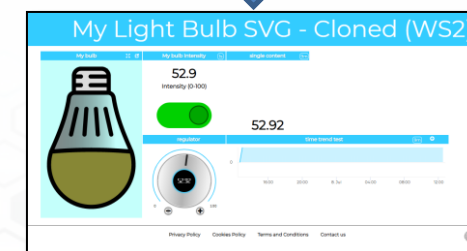
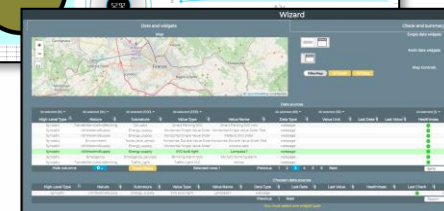
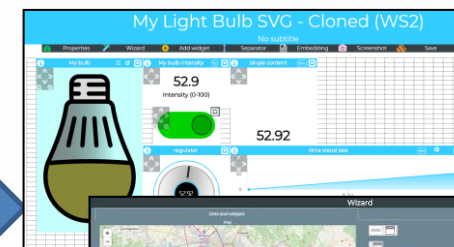
select



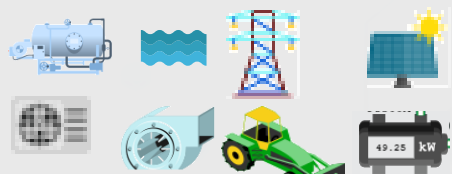
**List of Custom  
Widgets / Synoptics**



**Dashboard Editing**

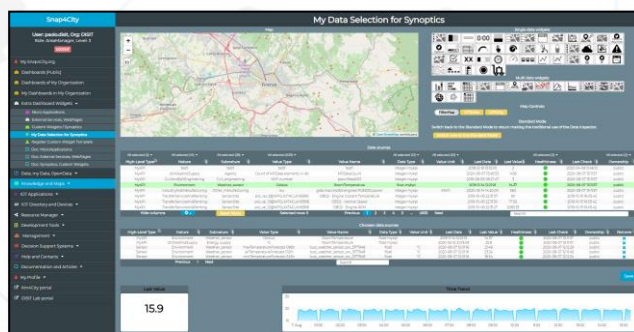


**SVG Symbols Collection**



From any open library

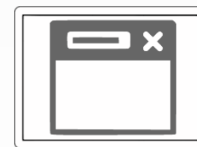
**Select MyKPI and  
Sensor Data for  
Synoptics cases**



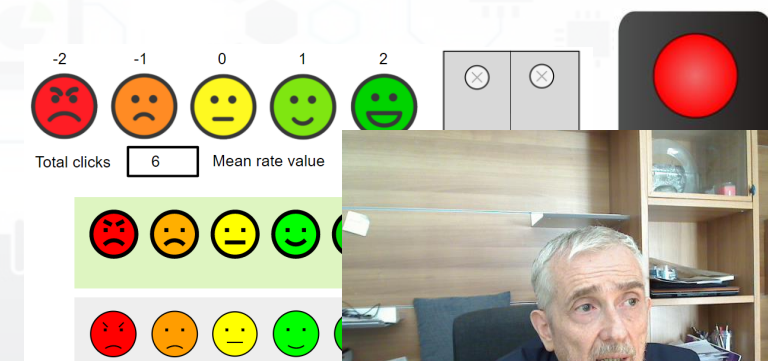
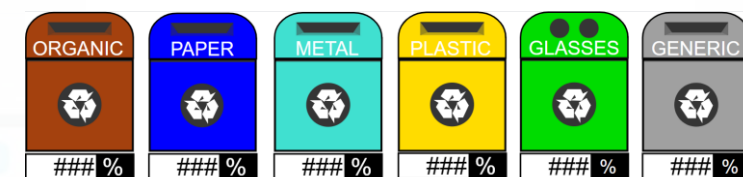
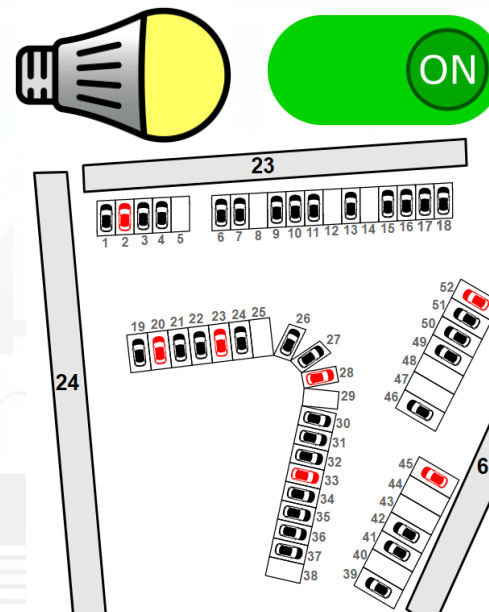
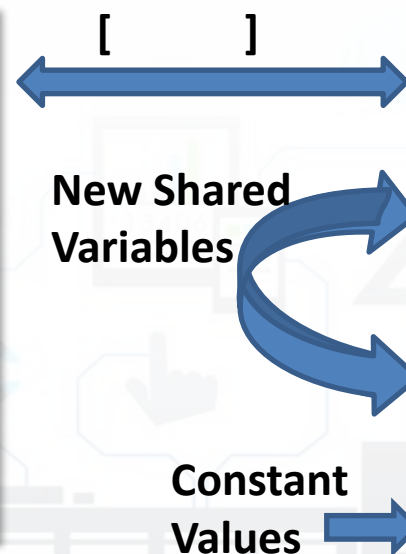
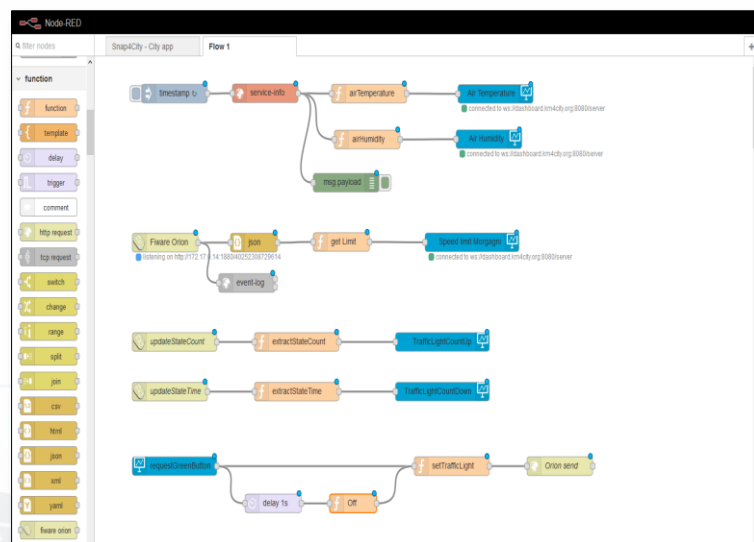
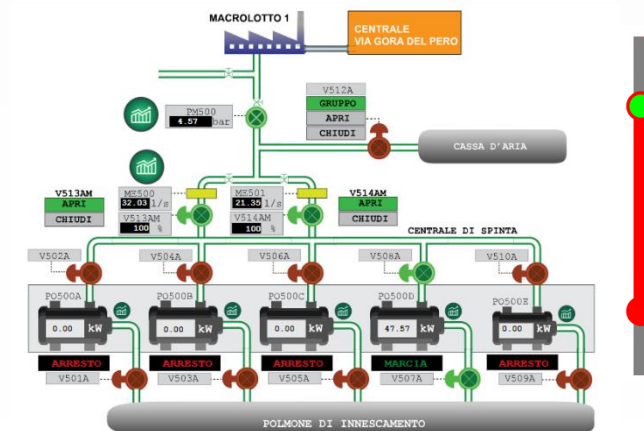
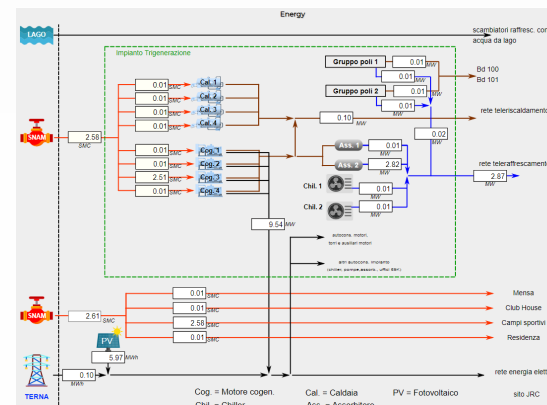
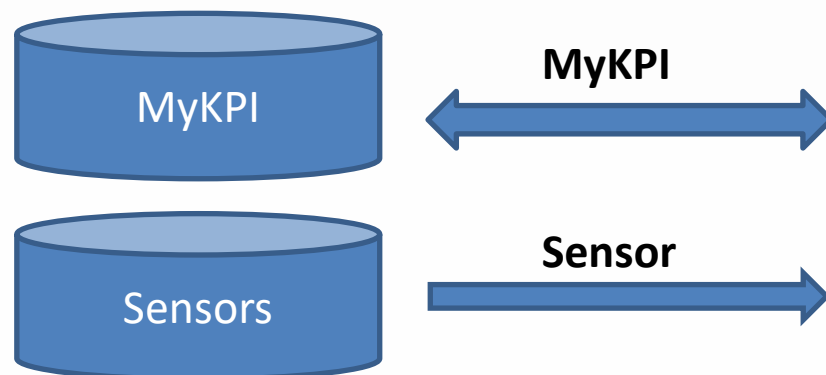
**Instantiate as  
Custom Widgets /  
Synoptics  
Connect with  
WebSockets**

**Final Dashboard**



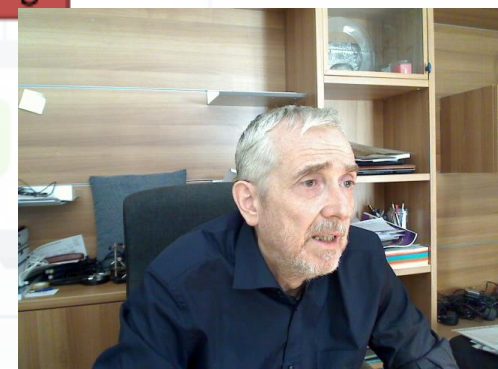
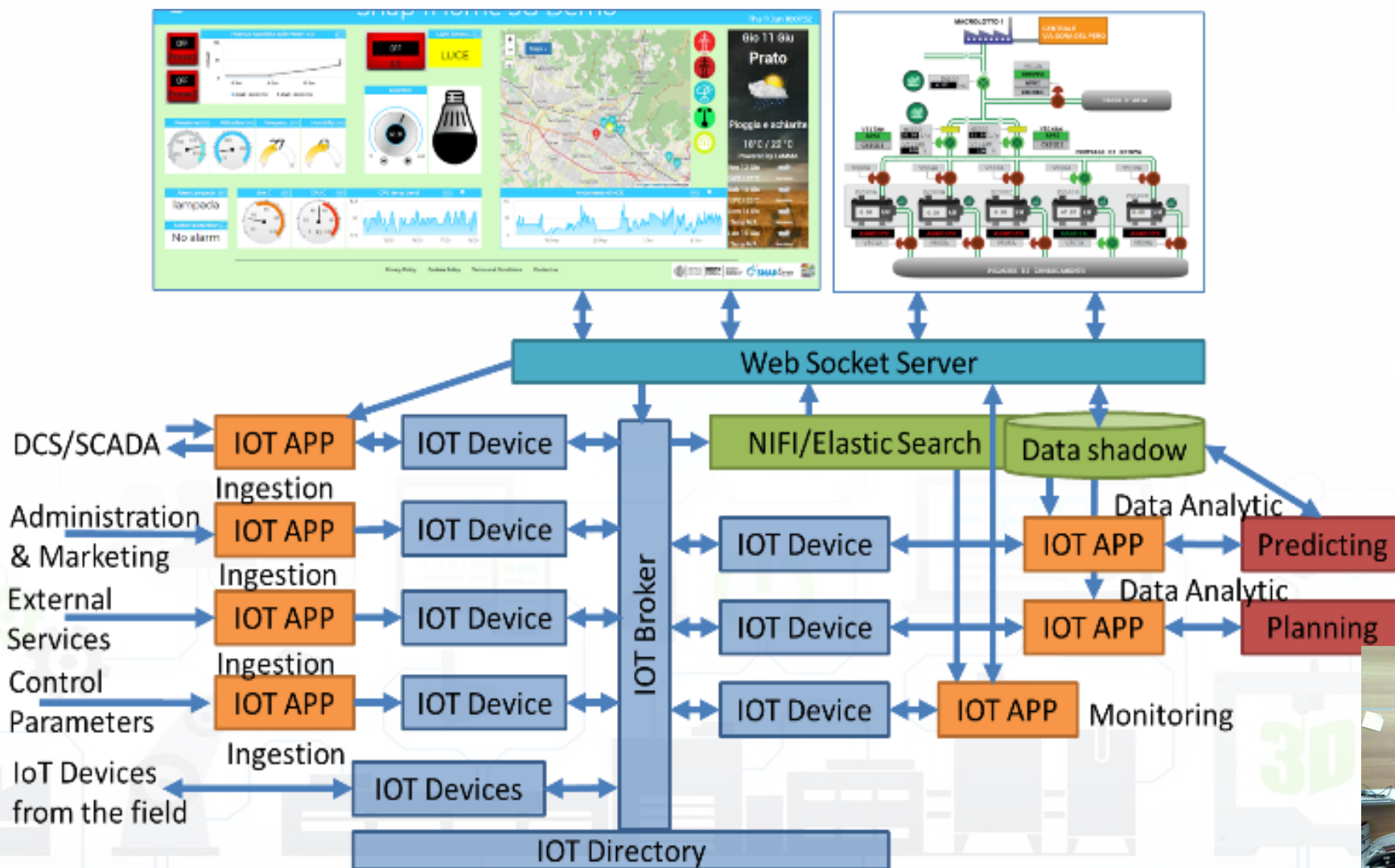


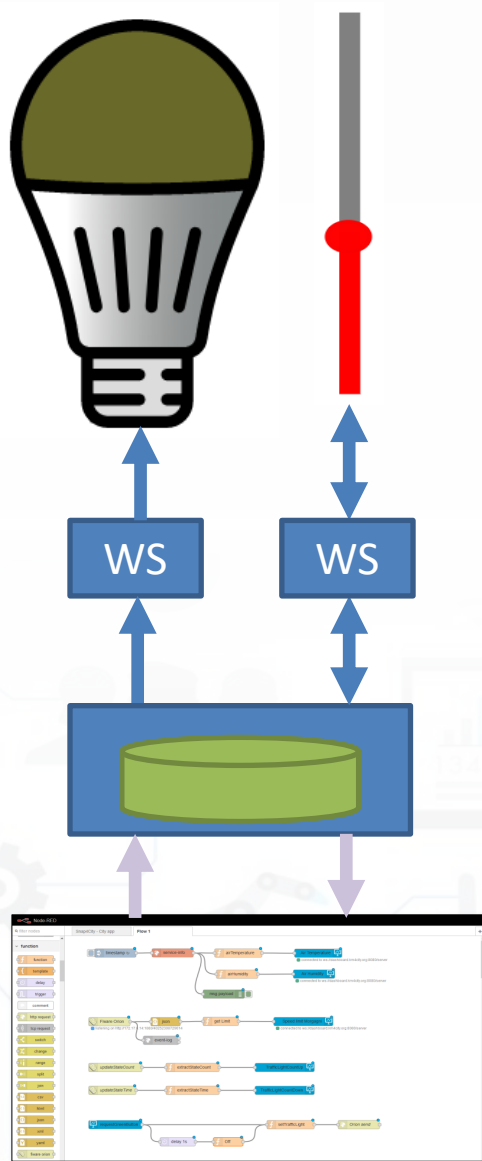
# From-To Custom Widgets / Synoptics to Storage in WS



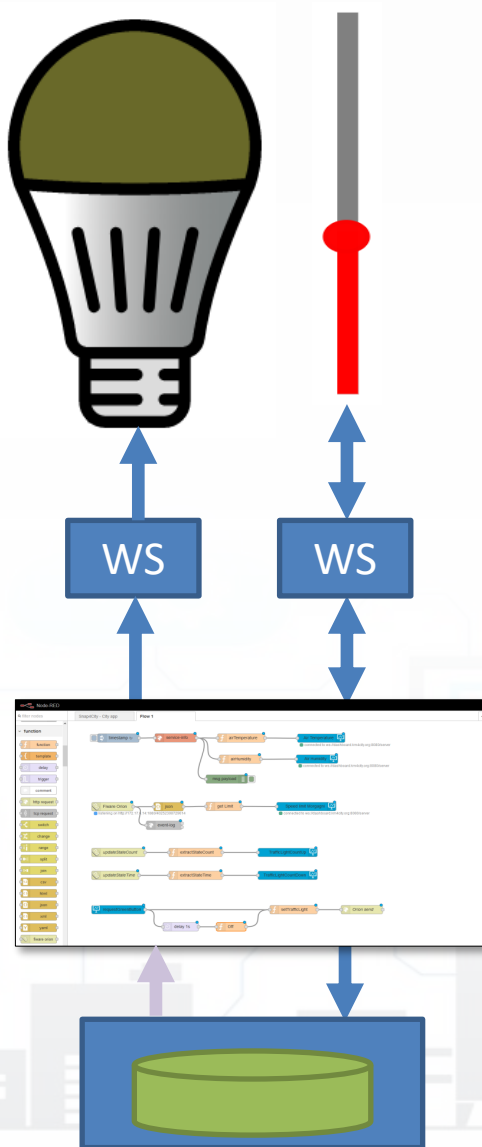


# Stress Testing Conditions

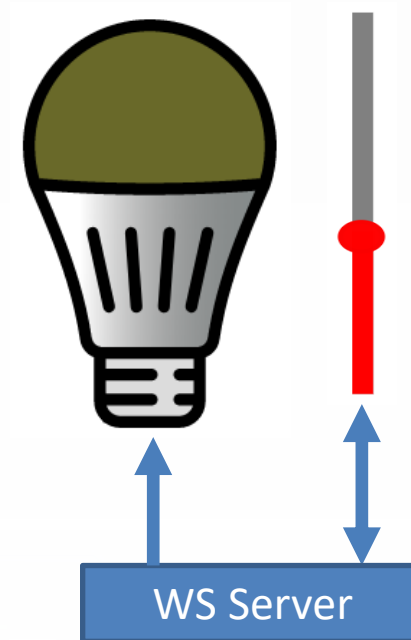




## Case 1

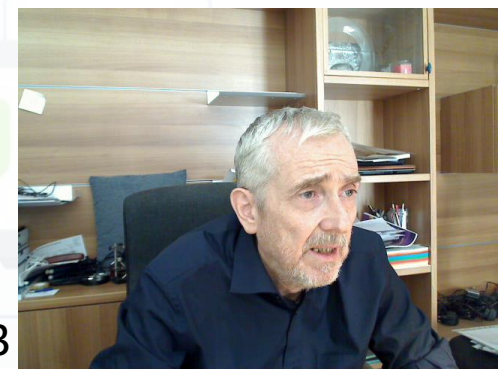


## Case 2



2500 messages per second

### Case 3





## Case 1 SVG ws3

<https://www.snap4city.org/dashboardSmartCity/view/index.php?iddashboard=Mjc4NA==>

Emergency\_services

slider value

9m

Energy\_supply

34.66563913330602

Emergency\_services

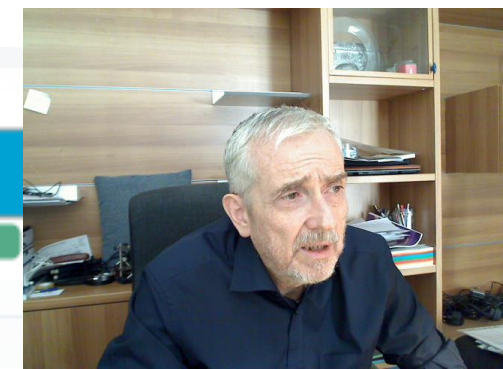


10 WS messages per second

button1

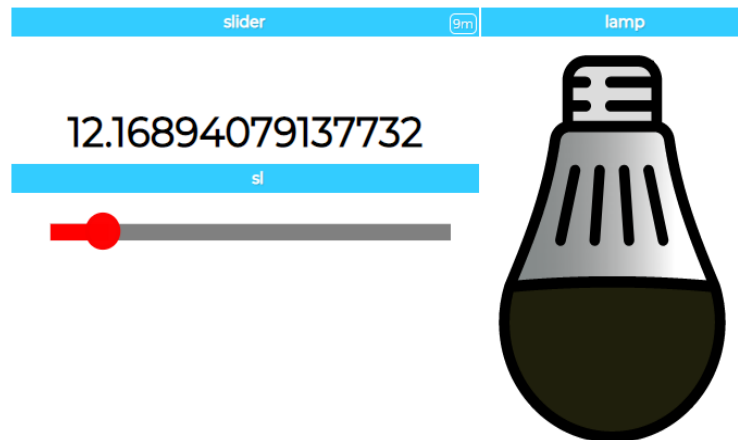
ON

button1



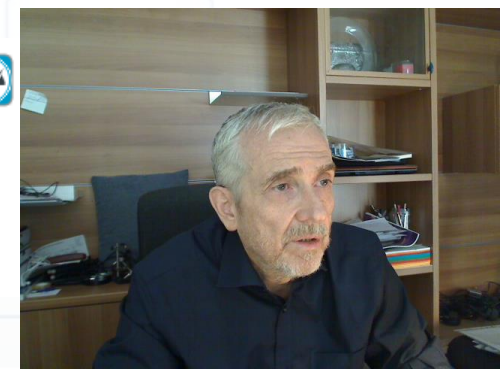
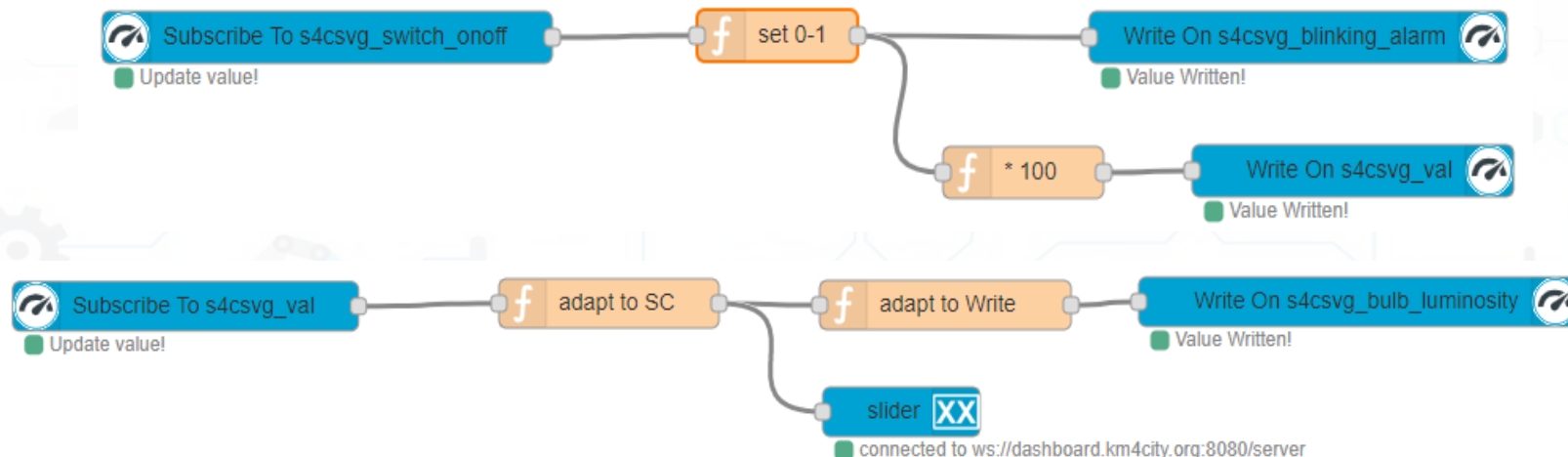
# Case 2: Event Driven 100%

## case 2 SVG WS3



<https://www.snap4city.org/dashboardSmartCity/view/index.php?iddashboard=Mjc4NQ==>

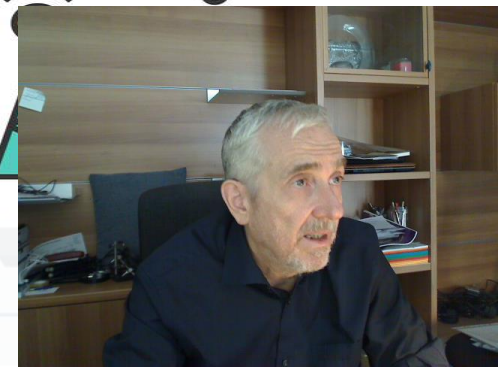
40 messages per second



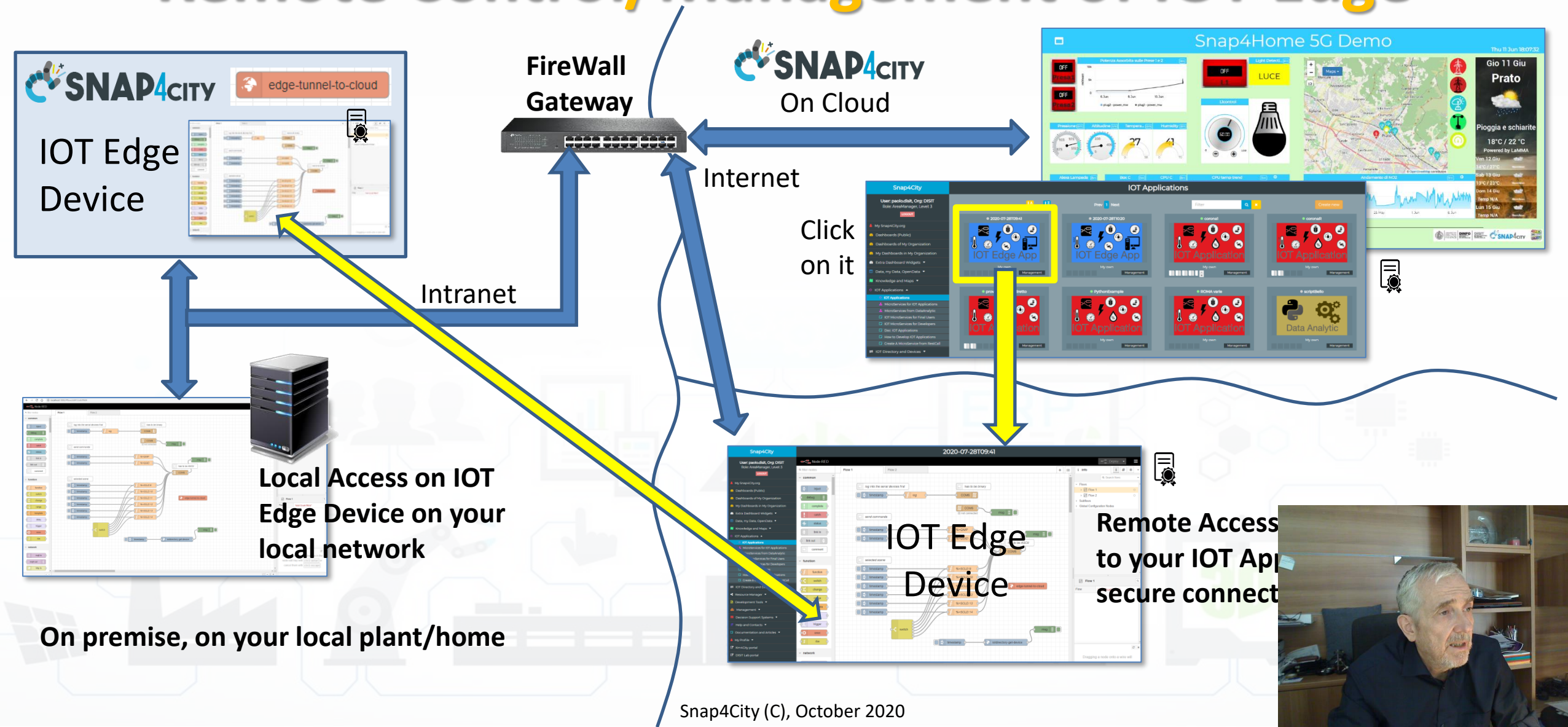


TOP

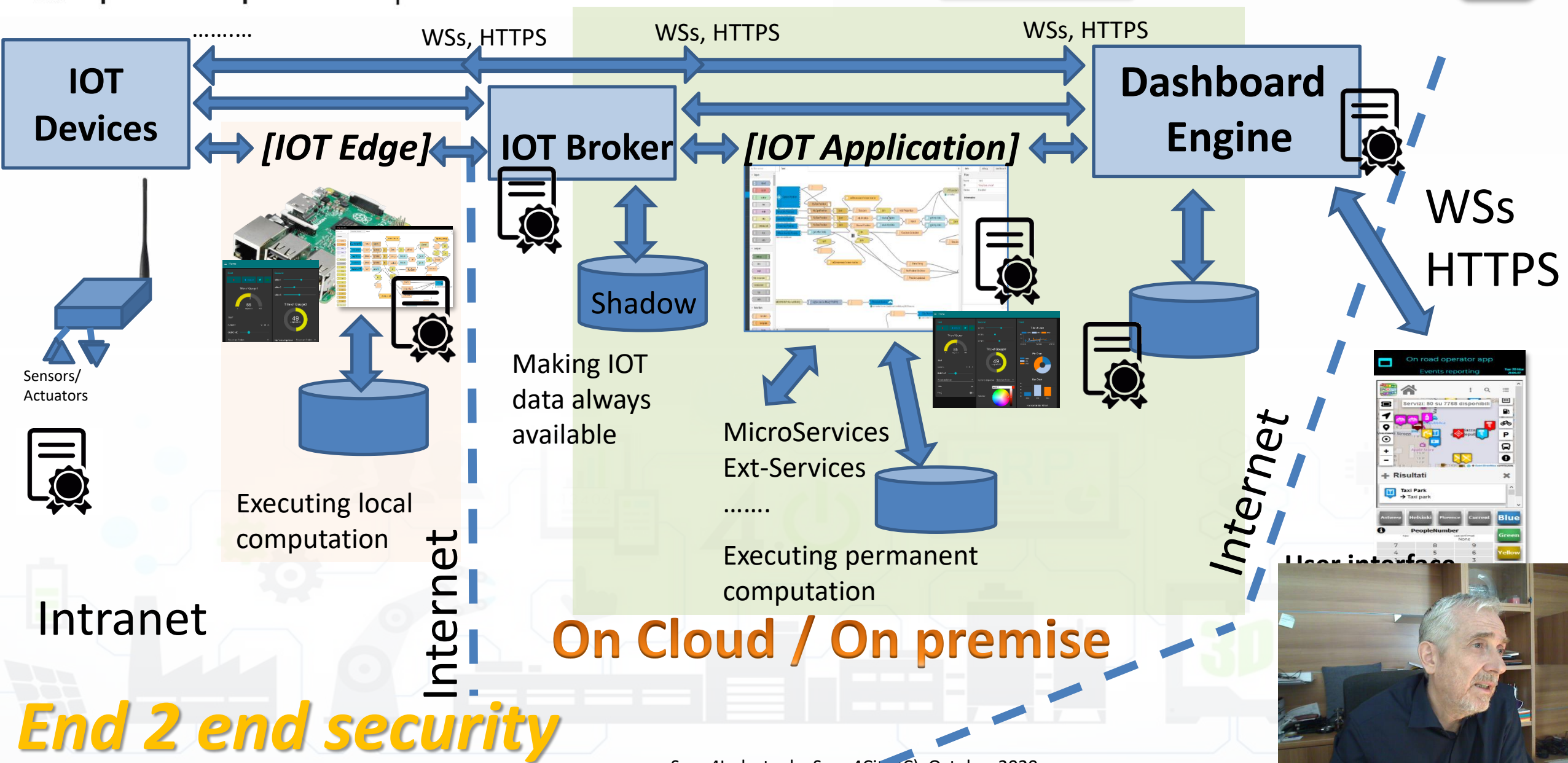
# *Remote Control of IOT Applications on IOT Edge Devices*



# Remote Control/Management of IOT Edge







# Conclusions

- The leverage of Node-RED to an **instrument for Industry 4.0** has been performed with the addition of:
  - MicroServices, Security, BigData, Synoptics, Secure Dashboarding and connections, etc.
- The **performance** have been assessed via WebSocket Secure in the different cases
- **It is not going to substitute DCS nor SCADA** but can play the role of **supervision and glue** in most of the Industry 4.0 solutions and for non high performance applications.
- **Snap4Industry** has been obtained by using Snap4City technology and solution and is released **100% open source**





# Acknowledgements

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