![SNAP4INDUSTRY logo]

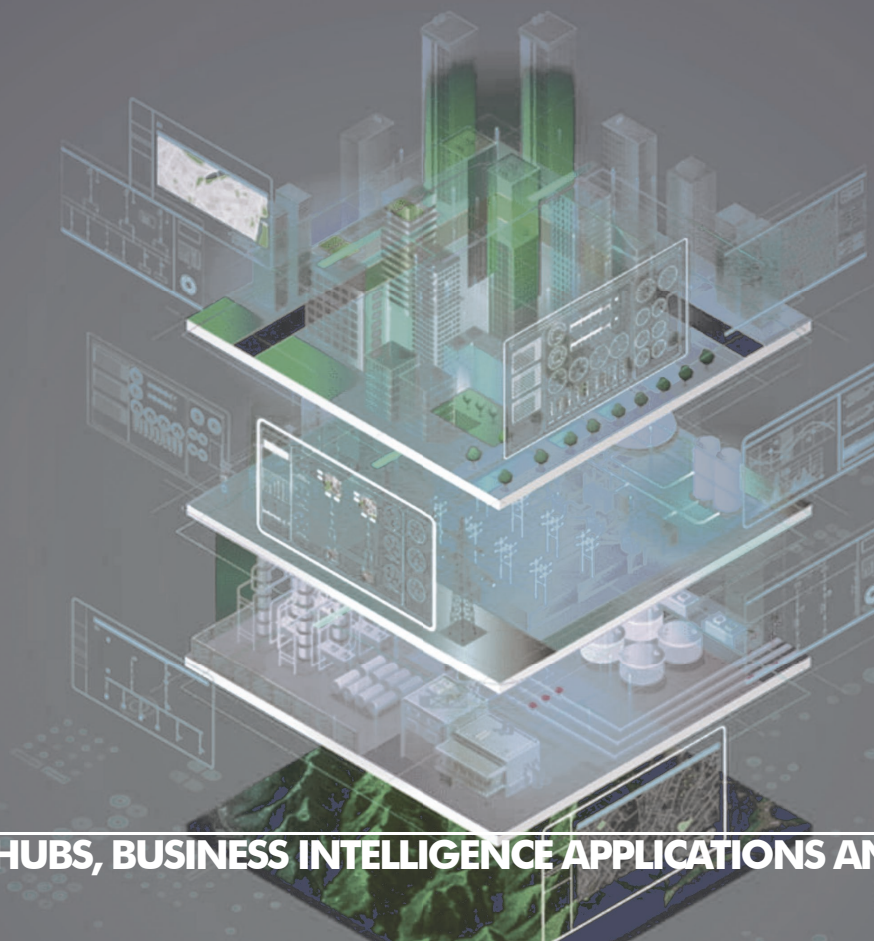# SNAP4INDUSTRY

www.snap4industry.org

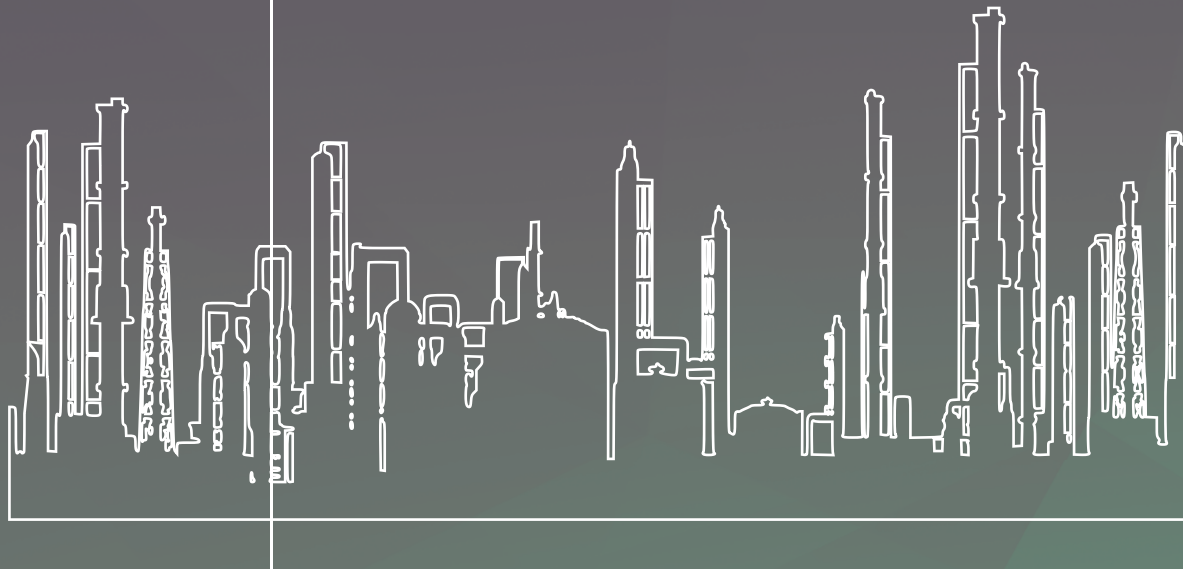**SMART DATA HUBS, BUSINESS INTELLIGENCE APPLICATIONS AND SERVICES**

UNIVERSITÀ DEGLI STUDI FIRENZE

DINFO DIPARTIMENTO DI INGEGNERIA DELL'INFORMAZIONE

DISIT DISTRIBUTED SYSTEMS AND INTERNET TECHNOLOGIES LAB

SNAP4INDUSTRY

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INTRODUCTION

Data Hubs, Business Intelligence Applications and Solutions are instruments to address marketing industrial evolution, economic challenges and control. Integrated Business Intelligence and Smart solutions are replacing traditional applications being capable of exploiting a huge range of data channels, getting smarter, and cross exploiting data with Artificial Intelligence techniques. A flexible AI based highly interoperable platform is needed to increase reactivity, sustainability, profit and full control of operational objectives, fully exploiting and overcoming legacy solutions, integrating administrative, marketing and productive aspects and indicators. Combining AI with Web/Internet of Thing allows to overcome the approaches based on single data sources to rapidly becoming aware of actual data, trends, and forecasts and this on needed actions exploring multiple possible directions in few seconds and capabilities of the Digital Twins for modelling and simulating all aspects of complex physical systems which becoming digital provide integrated data for their understanding, forecast and control.

The use of the AI and data modelling as WoT/IoT are pervasive in all fields: smart city, industry 4.0, smart home, smart building, smart energy, smart farm, smart city, smart waste, smart lighting, smart parking, etc. Snap4 technology with its platform and large experience on AI solutions from classic machines learning, ML, to deep learning, generative AI, and XAI, can be make the difference in your domain. The integrated approach of AI and data modelling determined a change of paradigm, pushing towards the Digital Twins, also attributing to objects/things a large set of values and features in the digital world that enhance their capabilities beyond the limitations of their physical counterpart to be: simulated, manipulated, composed, viewed, transformed, copied, controlled, lend, etc., and to use them as instruments in other contexts. For example, the tags for tracking, the mobiles devices as sensors, the post on social media as sensor values, the dashboards and Apps as receiver of action as actuators, etc.

Snap4Industry has transformed the intelligence level of the applications and solution. To this end, the powerful platform allows you to exploit smart data Hubs, business intelligence applications and services thanks to:
- integrated artificial intelligence support, and ethics in multiple layers, producing prescriptions, suggestion and prediction about a large range of your industry applications,
- easy integration support among different industry plants/sectors and productive scenarios in real time, harmonizing heterogeneous control systems, product life cycles, etc.
- solutions to respect privacy, GDPR compliance, exploit end-to-end secure solutions,
- the usage of powerful graphic business intelligence and simulation tools including dashboards, synoptics, notification, etc., accessible in any your place and device, to create from very simple to powerful applications.

With **Snap4Industry**, multiple domains are enforced enabling operation, management, plan and strategic views for **distribution, energy, environment, management, security, safety**, asset management for waste, lighting, parking, people flow, etc. **Snap4Industry** provides real-time and offline solutions to support decision makers to their daily operational actions on Digital Twin, grounded on ethical and explainable artificial intelligent, XAI/AI, solutions, deductions and assessments. It provides a complete understanding of the conditions, producing early warning, providing suggestions, enabling simulations and plans as what-if analysis. It is used to suggest strategic and real time interventions to improve services.

Snap4Industry is a 100% open-source platform used in many cities and areas, includes Km4City ontological and semantic model (https://www.km4city.org) to guarantee the data interoperability. It is an official FIWARE Platform (https://www.snap4city.org/467, https://www.fiware.org/), compliant with FIWARE Smart Data Models, IoT Data Models, and a large range of High Level Types, official EOSC Platform, official Node-RED Library, official E015 API, etc. **Snap4Industry** is provided "as a Service" or installed in your location (from yourself, as well as using a number of certified companies), no licence fee is needed.

The platform facilitates a wide range of applications in the integrated domains: defining strategies, implementing control rooms, realizing ethics and explainable artificial intelligent solutions, computing key performance indicators, setting up solutions, harmonizing any legacy solution in place, producing prescriptions, suggestions, predictions, and performing what-if analysis.
From security and privacy aspects, Snap4Industry is GDPR compliant, and passed PENTest. With Snap4Industry you can create your certified entities, and sequences of events using the provided Blockchain support. End-3-end secure connections are established from devices to dashboards. Snap4Industry is compliant with OpenID Connect, SSO, European Identity Card, SPID, EU Login, etc. On several installations on cloud and on premise for industrial applications. An easy tool for Docker based installations of the platform is provided: https://www.snap4city.org/738

SNAP4INDUSTRY SOLUTION

Snap4Industry platform can cope with any data and information covering multiple domains / scenarios (https://www.snap4city.org/4) in integrated Digital Twins, 3D digital twin representations single plant, for management, simulation, what if analysis, and strategic plannings:

- **Industry (4.0)**: production plants (monitoring industry plant, control and optimization, digital twin), predictive maintenance, simulating production, integrated life cycles among different industry plant, managing the quality of production process, optimisation of delivering. Such as on ALTAIR chemical plant; https://www.snap4city.org/369;
- **Energy**: monitoring energy production and consumption, forecasting production and consumption and thus optimization, computing optimal parameters for communities of energies and for single photovoltaic plants;
- **Environment**: monitoring pollutant, computing CO2, computing pollutant predictions, NOx prediction, NO2 very long-term predictions of annual average KPI, CO2 reduction, CO2 estimation from traffic and production, smart waste and management, water optimization, decarbonization;
- **Delivering**: mobility and transport optimizing routing, feet control and optimisation, smart parking, smart governance, smart waste, smart health, traffic flow, people classification and counting, etc.;
- **Plant Automation**: home automation, integrating with virtual assistants, commercial and custom devices and standards.

Interoperability: In this enormous range of solutions, Snap4Industry is compliant with more than 180 protocols, file formats, and modalities of work https://www.snap4city.org/65 for example:

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

Snap4Indutry/City provides open-source code for implementing Arduino, ESP32, Raspberry Pi, Linux, ARM, and Windows devices and solutions compliant with the platform and communicating in secure manner via TLS, HTTPS, WSs.

Snap4Industry relies on FIWARE Compliance and exploits FIWARE Context Broker with its relies on FIWARE Compliance and exploits FIWARE Context Broker with its NGSI-V2/LD protocols, supporting: Smart Data Models, automated deploy, protected communications and multiple broker connections. The interoperability and modularity of Snap4Industry enables the creation of applications in a wide range of scenarios such as those mentioned above. Snap4Industry enables the creation of federations of solution via API. All Snap4City APIs are accessible and well documented for developers, allowing customization.

Security and Privacy: Snap Snap4Indutry 4City platform passed the penetration and vulnerability tests and has been proven to be GDPR compliant. Snap4Indutry provides end-2-end event-driven secure applications with real time connections from devices to dashboards and vice versa, including data processing, storage and data analytics. https://www.snap4city.org/549.

Smart Solutions and Decision Support Systems

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CONTROL ROOMS - DECISION SUPPORT SYSTEMS - WHAT-IF ANALYSIS - BUSINESS INTELLIGENCE - SIMULATIONS - SMART APPLICATIONS
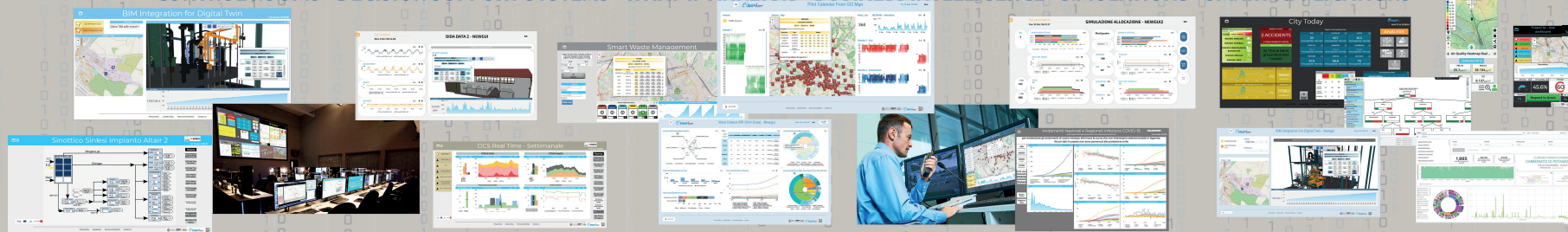
DASHBOARDS - VISUAL ANALYTICS - SYNOPTICS - DIGITAL TWIN - GRAPHICAL WIDGETS - ANALYTICS - GUI CUSTOM STYLES - VISUAL PROGRAMMING
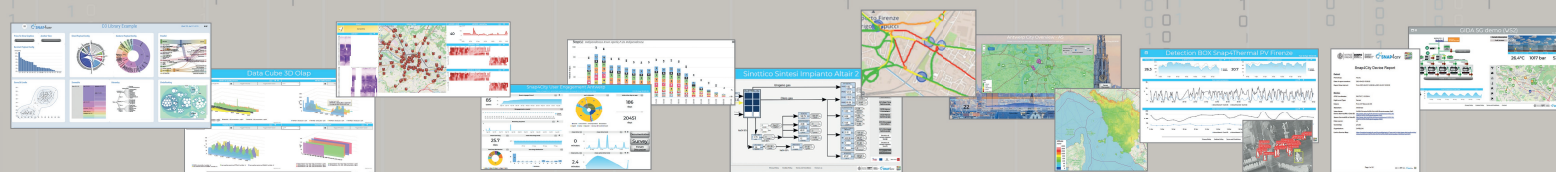
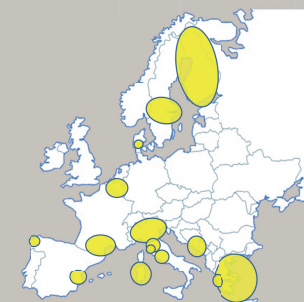| DASHBOARDS, WIDGETS TEMPLATES | PREDICTION - ANOMALY DETECTION - CLUSTERING - ROUTING - SENTIMENT NLP - TRAFFIC FLOW PEOPLE FLOWS - SDG - 15 MIN CITY INDEX - KPI - HEATMAPS - ORIGIN DESTINATION - ETC... | API - MICROSERVICES - GIS - BPM VIDEO - REPORTS - MAPS - 3D ... |

ANY: DATA, BROKER, NETWORK AND VERTICAL

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

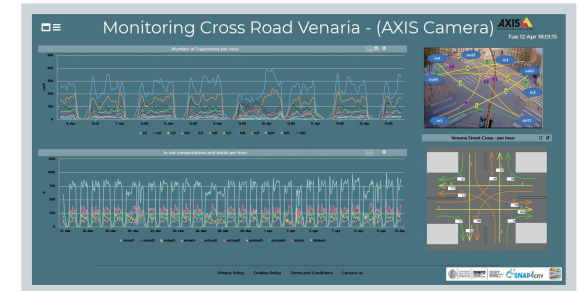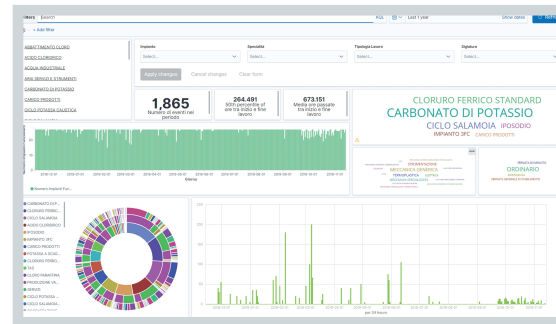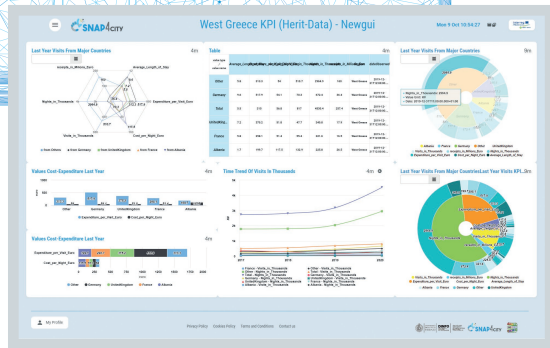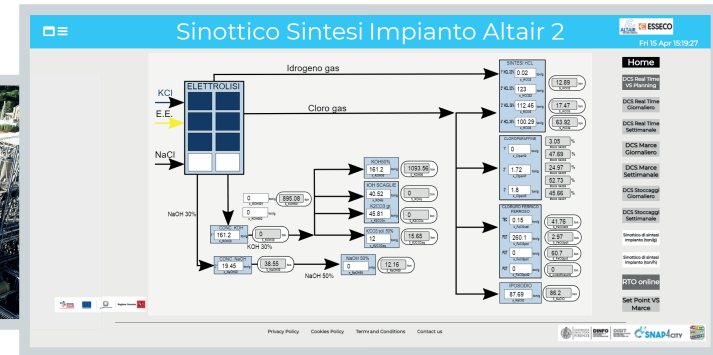**BIG DATA ANALYTICS, ARTIFICIAL INTELLIGENCE EXPLAINABLE AI, MACHINE LEARNING OPERATIVE RESEARCH, STATISTICS**

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

METHODOLOGIES LIVING LABS COURSES AND COMMUNITY DEVELOPMENT TOOLS

CONTROL ROOM — ADMIN — MAINTENANCE — PLC — SERVER — DCS/SCADA — MES — LOGISTICS — WASTE — DRONES — ENERGY — CO_2 — ENVIRONMENT

HOW IT WORKS

Snap4Industry provides a consolidated number of tools to manage the several different data channels, data sources and devices connected and of the several data types in a unified and very effective manner:

- data channels (administrative server, OPC-UA, ModBUS, social media marketing data, rest call, etc.) of any kind connected via IoT Brokers, Gateways and directly to IoT App in Push and Pull (Discovery, Telemetry, Inquire, Commands and Notifications).
- multiple brokers, devices, Mobile Devices and edge devices can be connected and managed via the Directory.
- Internal and external IoT Brokers managed and harvested by the **Directory**.

- Remote IoT Edge Devices can be maintained, also updating the logic of control and data processing based on Node-RED.
- **Digital Twin**: representing 3D shapes of building, production plat, internal and external navigation, association of 3D elements to devices, real time data, etc. https://www.snap4city.org/716
- open and private data for each domain and organization.
- **Edge**: supporting the installation of **Snap4Industry** pprocesses and interfaced in embedded systems, such as Linux based, windows based, Arm, AXIS cameras, Raspberry Pi, Android, etc.

Snap4Industry IoT Apps are processes in Node-RED plus
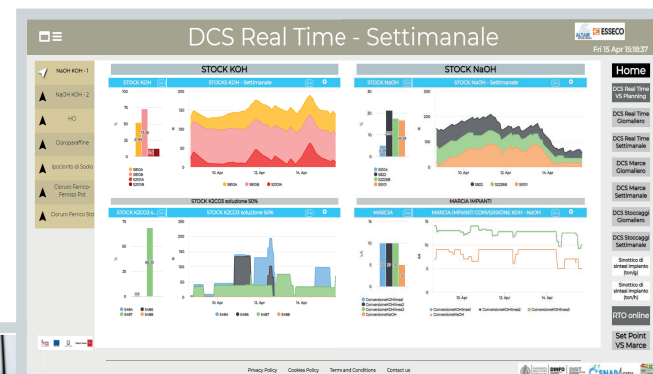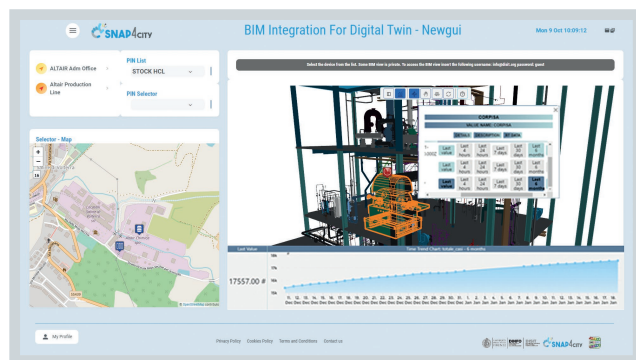
Snap4City library fSnap4Industry process logics are processes in Node-RED/node.js plus Snap4City library freely accessible on Node-RED library listed as: user, advanced and tunnelling. The processes can be executed periodically, or on demand, event driven in real time and/or quasi real time as Agents, Business Logics, data back-office automations, event driven data management. It includes processes to produce data with respect to gateways, devices, brokers, services, Edge devices, etc., by using some protocol and format (such as JSON, XML, encoded, binary)..

The **Snap4Industry/City** Palette on Node-RED is based on MicroServices. Thus, Process Logic / IoT Apps are developed in visual programming data flow and/or data driven flows in Node-RED exploiting Palette of more than 180 MicroServices covering areas of: data ingestion, data conversion, Directory, storage, AI, dashboards, protocols, data conversion, communications, workflow integration, event driven, data analytics, social media, maps, geo reverse, routing, tunnelling via IoT edge, etc., and are used to implement:

- **processes** for: data gather, ingestion, harvest, crawl, aggregate, translate, transform, covert, collect, adapt, integrate, normalize, enrich, establish data entity relationships, complete, according to push and pull protocols.
- **migrations and transformations** of data among different installations and/or users of different Snap4 platforms and derived platforms.
- **business log of event driven** user interface behind smart applications and dashboards via: Regular widgets as: single trend, time trends, Kiviat, barseries, buttons, knob, switches, donut, etc.; Custom Widgets and Synoptics.
- controls of **Data Analytics** as ML and AI processes: parametrizing, scheduling, planning, optimization, early warning, predictions, simulations, etc.
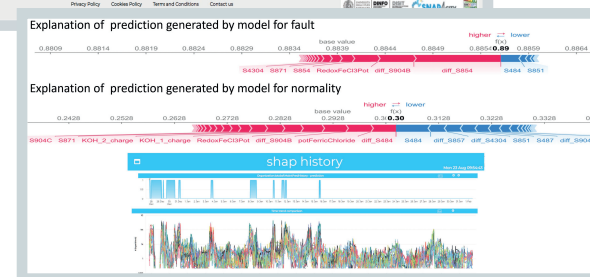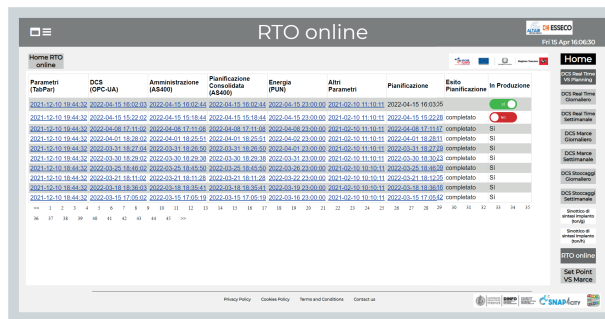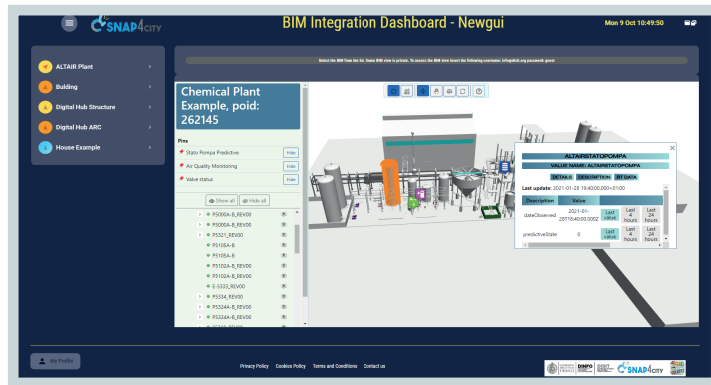
Snap4Industry also supports the most recent solutions for **Global Digital Twin**: representing and navigating in 3D, with shapes of the building, heatmaps and animations, devices, POI, KPI, etc. **Local Digital Twin**: representing 3D shapes of building, internal and external navigation, association of 3D elements to devices, etc. https://www.snap4city.org/716
The Snap4Industry Dashboard Builder provides a wide range of graphic rendering tools to show and play with a variety of complex interactive data and graphic representations: maps, Orthomaps, tables, time trends, heatmaps, heatmap sequences/animations, traffic flows, origin destination matrices and animations, traffic flow sequences/animations, typical trends, calendar heatmaps, Kiviat, hierarchies, sunburst, bubbles, scatterplot, treemaps, ven circle packing, chords, stream graphs, radial, barseries, custom widgets, animations, scenarios, routing, multimodal routing, public transport time line, weather forecast, BIMs, buttons, 3D shapes on local (building) and global Digital Twins, synoptics of any kind, dynamic PIN on maps, trajectories, etc.
Dashboard are easily created by means of the **Wizard** in a very easy manner to create solutions, along with complex applications with multiple dashboards and tools, up to complex control rooms, e.g., in Florence for Smart City, in

ALTAIR for Industry Plant. They realize event-driven solutions working in real time and provide interactive web tools and mobile Apps, for operators and final users.

In addition, Snap4Industry fully supports the development of **real time data analytic processes** through machine learning, artificial intelligence, ethic explainable artificial intelligent (XAI) and statistical languages such as Python, Java, R-Studio, also exploiting Tensor Flow, Keras, and any kind of library for data analysis, machine learning and deep learning. Snap4Industry is distributing a number of Open Source data analytics tools and algorithms for: prediction, anomaly detection, heatmap production, clustering,

classification, demand vs offer of transportation, and many others have been published on international top level journals for Smart Parking, Smart Biking, traffic flow reconstruction, traffic flow prediction, NOX prediction, NO2 prediction, people flow analysis, public transportation analysis, routing, etc. Data Analytics can be fully integrated into What-IF analysis tools in control rooms and for operators.

Security and Privacy: Snap4Industry passed the penetration and vulnerability tests and has been proven to be GDPR compliant. Snap4Industry provides end-2-end event-driven secure applications with real time connections from devices to dashboards and vice versa, including data processing, storage and data analytics. https://www.snap4city.org/549

ADOPTION OF SNAP4TECH FOR INTEGRATORS

Trial for single users is open on Snap4City.org portal via direct registration.

Snap4Industry/City multitenant multidomain platform can be adopted by requesting the installation on your premise or on public cloud, or requesting smart city services from our cloud.
We can customize your Snap4City instance, integrate your legacies or preferred third party modules of any kind (they can be open source or proprietary). We provide H24 help-desk, maintenance according to consolidated SLA. Training for the adoption and usage of the Snap4City tools is provided and freely accessible on web.

Integrators can access to the catalogue of modules and services to compose their preferred version of Snap4 platforms. **Snap4Industry multitenant multidomain modular platform based on microservices** which can be installed on-cloud, on-premises and on hybrid solutions; via VM, dockers and Kubernetes, on AWS, Ms Azure, etc. - all modules are licence free. An easy tool for container-based installations is provided: https://www.snap4city.org/738. The solution is entirely distributed open source including the application layer, multitenancy aspects, assessment and auditing, resource management, user management, auditing, reporting, etc. Snap4 provides a number of configurations from small standalone solutions to very large scalable installations. If you start small the platform can be extended with simple proc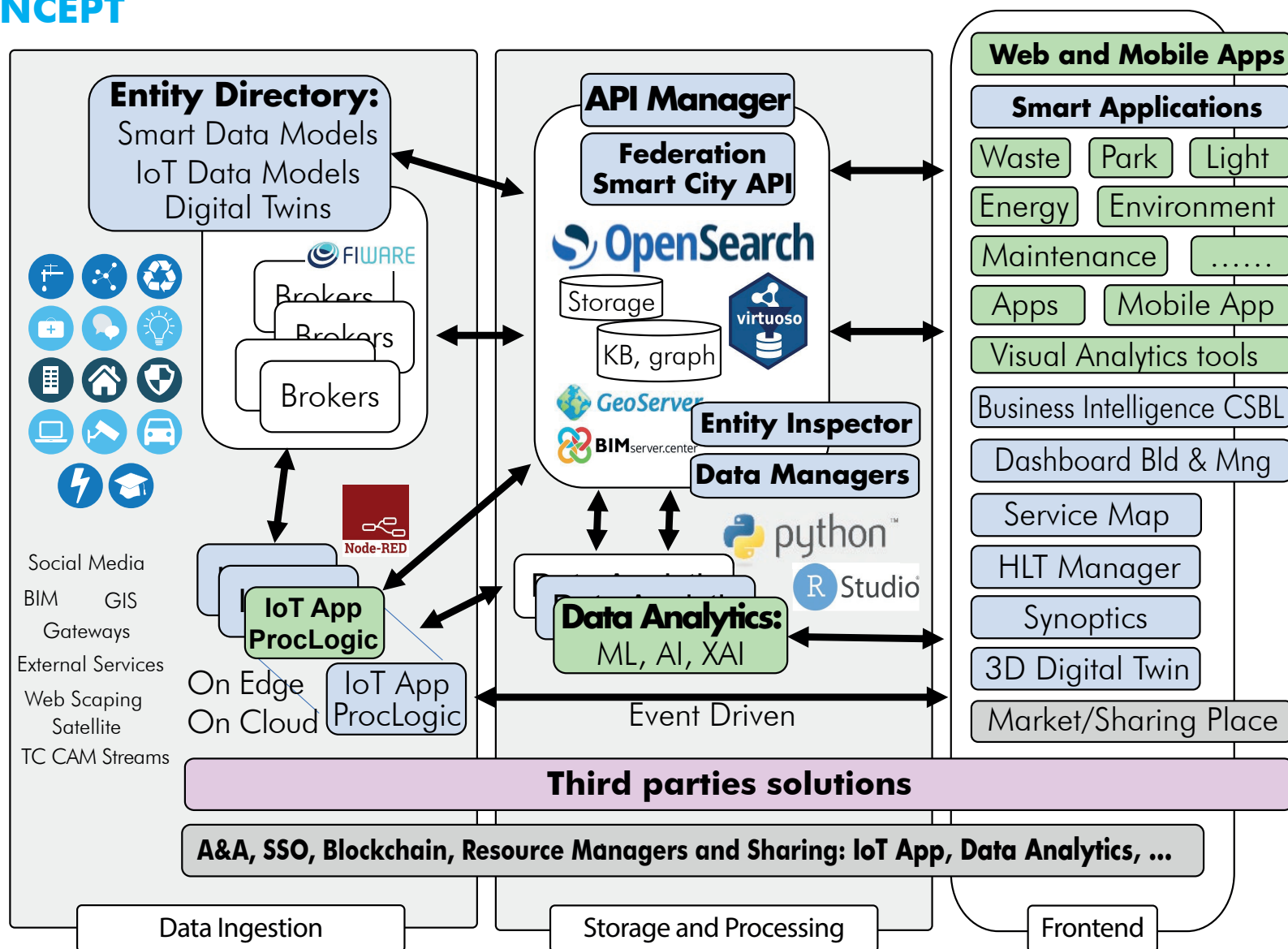edures. Snap4 provides all needed management tools for user management, organization management, resource accounting, process management, high level type management, reporting, multilingual support, multitenant support, scheduling, alerting, quality control, data inspection management, Digital Twin support, smart application management, dashboard control and usage, business intelligence, etc. https://www.snap4city.org/471 For the list of installed platforms see: https://www.snap4city.org/661 which use the Powered by Snap4Tech logo in their installations. We provide H24 help-desk, maintenance and second level maintenance for distributors and integrators worldwide. All the installed versions of Snap4City includes also the development environment which allows you to develop data processes, data analytics and dashboards.

Training and Hackathons: The Snap4 community of developers and users is a source of stimulus and innovations. Snap4 provides an open, free of charge and comprehensive training course and on-line development open platform for testing and using the solution. The course is provided on slides, interactive slides and videos, and includes case studies from: https://www.snap4city.org/577 See also the 2023 course. In most cases, for stimulating a larger local collaboration of stakeholder, Hackathons have been launched, for example with Sii-Mobility, Select4Cities, and IEEE Intelligent Transportations Systems societies.
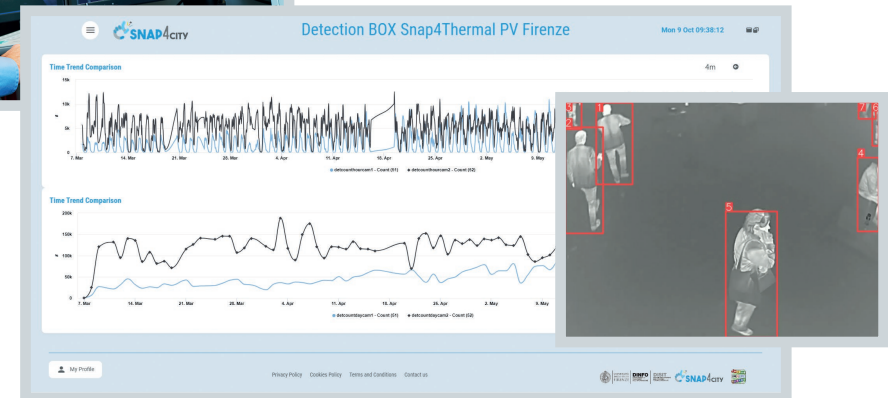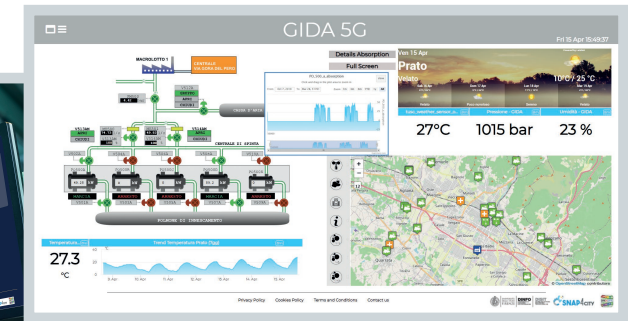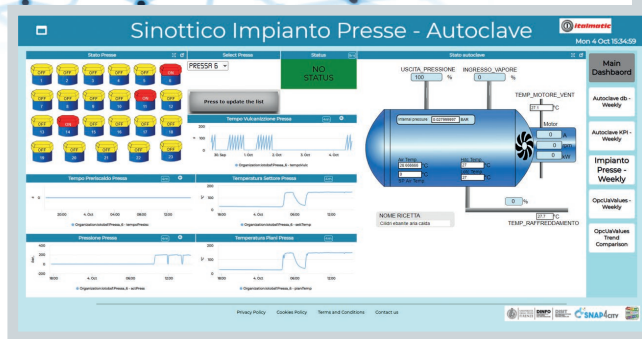
Special program for research institutions: Research no-for-profit institutions or foundations can set up agreement with DISIT Lab for exchanging researchers and/or becoming experts lab of Snap4City in your area. A setup support if provided free of charge to help them starting using the platform. The results produced are promoted according to different channels including the users' network and mailing lists.

Living Lab and working support with stakeholders
Snap4City provide a support for setting up Living Labs.
The largest is on Snap4City.org portal. A consolidated methodology based on quadruple helix helps you setting up your smart city engaging stakeholders and final users.

CONCEPT

Entity Directory:
Smart Data Models
IoT Data Models
Digital Twins

FIWARE

Brokers
Brokers
Brokers

Node-RED

IoT App ProcLogic

On Edge
On Cloud

IoT App ProcLogic

Social Media
BIM   GIS
Gateways
External Services
Web Scaping
Satellite
TC CAM Streams

API Manager

Federation Smart City API

OpenSearch

Storage

KB, graph

virtuoso

GeoServer

BIMserver.center

Entity Inspector

Data Managers

python

R Studio

Data Analytics:
ML, AI, XAI

Event Driven

Web and Mobile Apps

Smart Applications

Waste | Park | Light
Energy | Environment
Maintenance | ……
Apps | Mobile App

Visual Analytics tools

Business Intelligence CSBL

Dashboard Bld & Mng

Service Map

HLT Manager

Synoptics

3D Digital Twin

Market/Sharing Place

Third parties solutions

A&A, SSO, Blockchain, Resource Managers and Sharing: IoT App, Data Analytics, …

Data Ingestion   Storage and Processing   Frontend

BENEFITS AND IMPACT

The usage of Snap4Industry has brought about improvements and has been of great benefit to a wide range of situations where it has been adopted. The very low costs for the adoption and implementation of changes, since they can be performed directly by operators, has impressed many users. Snap4Industy tools can be freely installed on premise with its full solution components. Its impact has been demonstrated in a wide range of solutions, pilots, and trials, including:

- **Industry, home and area monitoring and security**: a large set of sensors/actuators and devices working on event driven, with a wide range of possible widgets for dashboards, for reporting events and creating reactions towards actuators;
- **Energy**: recharging stations monitoring, smart light control, monitoring energy production and consumption in real time, computing indicators, simulation of community energy and of photovoltaic plants, sending alarms;
- **Strategic planning**: performing what-if analysis with respect to critical conditions, planning production, system thinking on smart decision support systems, SDG, etc.;
- **Environment**: predicting NOX and long term NO2, computing and predicting CO_2, monitoring pollutants of any kind and alerting, informing users, waste management, landslide predictions;
- **Management**: predicting maintenance interventions, multichannel alerting, anomaly detection as early warning, service reputation, etc., for resilience and control room;
- **Security and People flow:** monitoring, measuring, and alerting on critical cases.
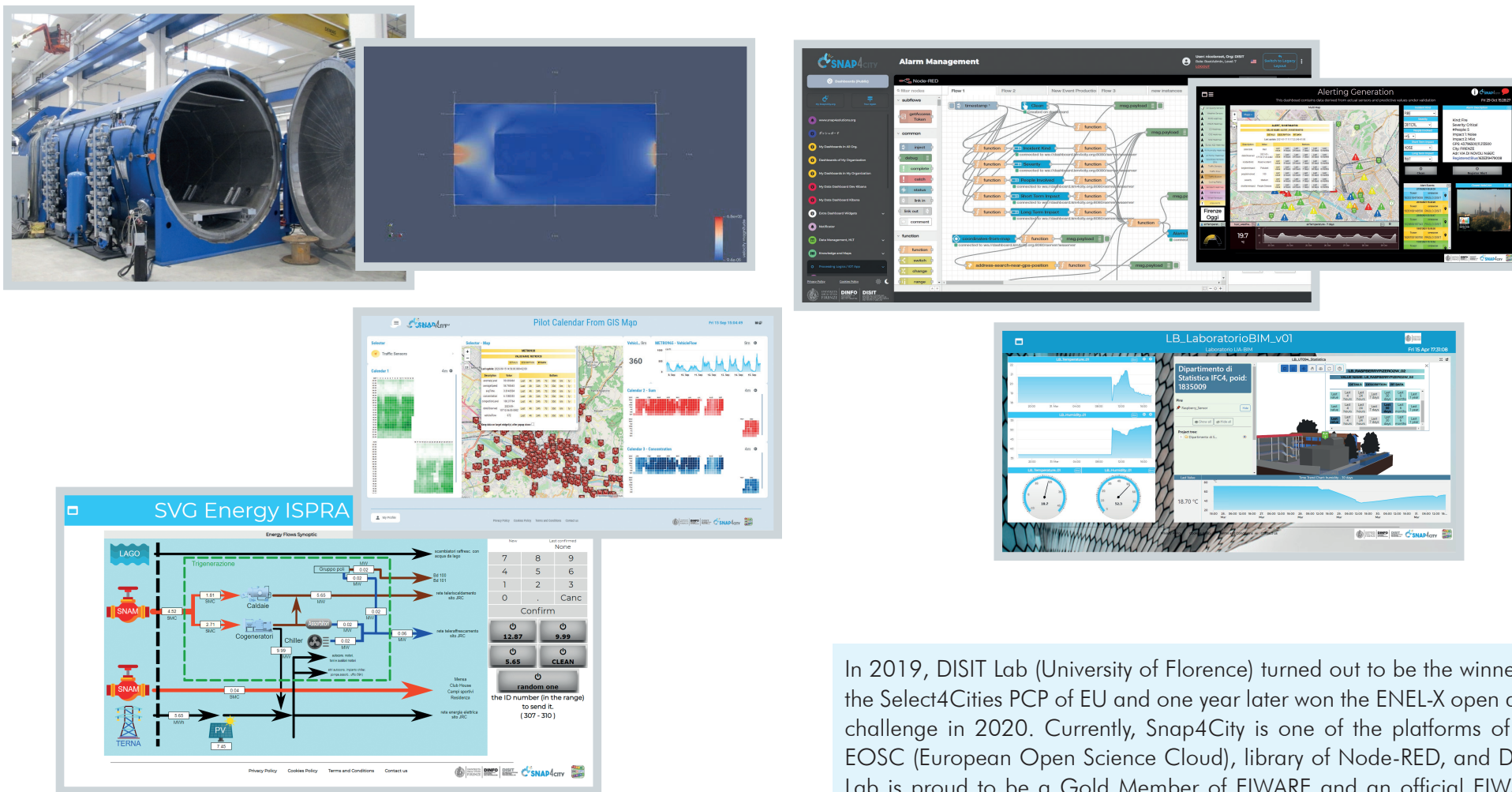
Its capability and compliance at European level allowed to perform a huge number of integrations in several cities and in a number of Industry plants: chemical plants, production plants, planning events and production, energy vehicles production plants, robber production plants, etc. In a number of projects: REPLICATE H2020, RESOLUTE H2020, TRAFAIR CEF, Sii-Mobility MIUR, SODA4.0 of ALTAIR, 5G MIUR, MOBIMART Interreg, HERITDATA Interreg, Life Weee, AMPERE, Enterprise, Smart Ambulance, Italmatic, DIDA, and PC4City.

In 2019, DISIT Lab (University of Florence) turned out to be the winner of the Select4Cities PCP of EU and one year later won the ENEL-X open data challenge in 2020. Currently, Snap4City is one of the platforms of the EOSC (European Open Science Cloud), library of Node-RED, and DISIT Lab is proud to be a Gold Member of FIWARE and an official FIWARE Platform and Solution, certified Consultant, certified Trainer, provides two certified FIWARE Experts; and awards from DMS, ICCSA. DISIT Lab and other partners participated providing Snap4City solutions and a strong number of innovations in a number of EC projects (RESOLUTE, REPLICATE, TRAFAIR, MOBIMART, Select4Cities, Snap4City, WEEE, Panacea, Impetus, Tuscany X.0 EDIH, etc.), and national/regional (Sii-Mobility, MOSAIC, ALMAFLUIDA, SODA, Pretto, Enterprise, ES THE, CN MOST, etc.), and in many direct contracts.

● NOTES

www.snap4industry.org

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- **DEVELOPMENT LIFE CYCLE**
  https://www.snap4city.org/download/video/Snap4Tech-Development-Life-Cycle.pdf

- **TECHNICAL OVERVIEW**
  https://www.snap4city.org/download/video/Snap4City-PlatformOverview.pdf

- **SNAP4CITY FIWARE IMPACT STORY**
  https://www.snap4city.org/drupal/sites/default/files/files/FF_ImpactStories_Snap4City.pdf

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