Be smart in a SNAP!

Snap4City Development and Deploy

19 January 2021, Course
https://www.snap4city.org/577

SCALABLE SMART ANALYTIC APPLICATION BUILDER FOR SENTIENT CITIES
scalable Smart aNalytic APplication builder for sentient Cities: for Living Lab and co-working with Stakeholders

https://www.Snap4City.org

19 January 2021, Course 
https://www.snap4city.org/577

Paolo Nesi, paolo.nesi@unifi.it
https://www.Km4City.org
https://www.disit.org
Tools for rapid implementation of sustainable Smart Solutions and Decision Support Systems
Snap4City/Industry structure

- The Snap4xxxx solution is released in Open Source, VM and Docker with fully support of MultiTenant/multiple-O rganizations
  - Each Organization may be configured for a separate environment with a set of Maps, Menus, Users, Data, Dashboards, IOT Apps, MicroApplications, Custom Widgets, Models, resources, open data, etc.
- **Https://www.Snap4City.ORG** is the main instance of Snap4xxxx solution managed by DISIT Lab. The main documentation is located and updated on Snap4City.org, GitHub, dockerHub and Node-Red Library. Snap4City.org is where the last tools are tested and news published.
  - Organizations on Snap4City.org have been created with contracts as for **Platform as a Service**, for testing and for providing **SmartCity as a Service** as well as **Industry 4.0 as a Service**
Most of Organizations on Snap4City.org also correspond to companies or institutions that have an installation of Snap4City tools on their Premise, such as: Pisa, SmartGarda Lake, Snap4, ALTAIR, etc.

This double way allows them to:
- test the news,
- share experiences with other groups,
- get visibility,
- work in the collaborative environment, and
- be better supported by Snap4City.org and DISIT Lab personnel.

Each instance of Snap4xxxx solution can decide to join the federation of SmartCity API to exploit shared data. This allows to exploit regional data for city installations applications (web, mobile, dashboards, etc.) without reloading them for example.
How to adopt Snap4City

On your premise

Installation on your premise
- Virtual Machines or Dockers
- Different configurations
  - From small to scalable
  - Exploiting your legacy tools
  - Interoperable with any tool
- No vendor lock-in, No tech lock-in

Mixed solutions! For example:
- Start on Cloud as Smart City as a Service
- Migrate on premise on the fly
- Start on Cloud into a sand box
- Pass to install on premise what you need

Download and deploy

Smart City as a Service
- Supporting Org
- 100% Open Source Platform: Github
- Further developments
- Publishing Appliances and Dockers
- Training courses, docs
- Consulting
- Forums
- Etc.

https://www.snap4city.org

Snap4City (C), January 2022
### On Line Training Material (free of charge)

<table>
<thead>
<tr>
<th>what</th>
<th>1st part (*)</th>
<th>2nd part (*)</th>
<th>3rd part (*)</th>
<th>4th part (*)</th>
<th>5th part (*)</th>
<th>6th part (*)</th>
<th>7th part (*)</th>
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</thead>
<tbody>
<tr>
<td>PDF</td>
<td>General</td>
<td>Dashboards</td>
<td>IOT App, IOT Network</td>
<td>Data Analytics</td>
<td>Data Ingestion processes</td>
<td>System and Deploy Install</td>
<td>Smart City API; Web &amp; Mob. App</td>
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<tr>
<td>Interactive</td>
<td>Video1</td>
<td>Video2</td>
<td>Video3</td>
<td>Video4</td>
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</table>

https://www.snap4city.org/577
Free Trial

- Register on [WWW.snap4city.org](http://WWW.snap4city.org)
  - Subscribe on DISIT Organization

You can:
- Access on basic Tools
- Access to a large volume of Data
- Create Dashboards
- Create IOT Applications
- Connect your IOT Devices
- Exploit Tutorials and Demonstrations

IF you need to go more in deep you can ask us to pass at the next Role becoming full AreaManager with full rights of development, also for Data Analytics, machine learning, etc.
One Snap4City Platform may serve Multiple Cities
A Mobile App may refer to one Smart City API Server (for Area 1) via SUPER and receive data from the Federated SUPERS (Area 2) if navigation, queries, etc. are leading to discover out of the addressed KB.

- SUPER can be used for creating redundant and/or balanced distributed solutions for Federated KB. See Area 2, the two KB in the front.
- Federated SUPER ServiceMap can have overlapped KB even totally.
- A Mobile App can be developed to support multiple Smart City API servers, for balancing and

The usage of Super (ServiceMap) is not mandatory so that separate services can be produced as well.

SuperServiceMap and ServiceMap presents the same Smart City APIs.
General Overview of the full Course 2021

- **1st part:** General Overview
- **2nd part:** Dashboards Creation and Management
- **3rd part:** IOT Applications development, IOT Devices, IOT Networks
- **4th part:** Data Analytics, in R Studio, in Python, how to Exploit and Manage Data Analytics in IOT Applications
- **5th part:** Data Ingestion, Data Warehouse, Data Gate, IOT Device Data ingestion, IOT App for Data Ingestion, Interoperability, etc.
- **6th part:** Snap4City Development, Extension, Administration, and Installation
- **7th part:** Smart city API (internal and external) Web and Mobile App development tool kit

A number of the training sections include exercitations

Updated versions on: [https://www.snap4city.org/577](https://www.snap4city.org/577)

See also courses in ITALIANO: [https://www.snap4city.org/485](https://www.snap4city.org/485)
6th part Agenda

- Snap4City/Industry Architecture
- Snap4City technology for Industry 4.0 → Snap4Industry
- Snap4City & Fi-Ware
- Snap4City vs State of the Art Solutions
- Smart City in a Snap, How to become smart
  - Smart City Development Life Cycle
  - Analysis and Design for Innovation (Co-Creation and Co-Working)
  - Analysis for Innovation, the workshops for innovation, co-creation; Data Discovery
- Snap4City: Overview of Development Tools
  - IOT Network Interoperability
  - Integration via IoT Apps and processes
  - Integration via IoT Apps on IoT Edge
  - Integration with GIS and ArcGIS
  - API, and Federation of Smart Cities via API
  - Linked Open Data
- Platform How to Add new features capability and constraints
- Snap4City/Industry: Smart Solution IOT as a Service vs Consulting and Developing
- Snap4City Living Lab For Collaborative Work
- The view of the Administrator
  - Main menu, User Management, Auditing, Platform Management, Customer Relationship Management and Living Lab
  - AMMA traffic Analyzer, Data Analyzer, Back Office Platform Scalability
  - Monitoring Resources and API Traffic; DISCES; reports
  - Mng. Photos and comments, Mobile App Monitoring, IoT App management, Data-City small example,..
- Installing Snap4City
- Acknowledgement

Snap4City (C), January 2022
Snap4City - scalable Smart aNalytic APPlication builder for sentient Cities

Smart Cities need to set up a flexible Living Lab to cope with the city evolution in terms of services and city users' needs and sustainability. Snap4City solution (https://www.snap4city.org) provides a flexible method and solution to quickly create a large range of smart city applications exploiting heterogeneous data and enabling services for stakeholders by IoT/IIoE, data analytics and big data technologies. Snap4City applications may exploit multiple paradigms as data driven, stream and batch processing, putting co-creation tools in the hands of (i) Smart Living Lab users and developers of solutions to develop applications without vendor lock-in, technology lock-in, (ii) final users customizable / flexible mobile Apps and tools, (iii) city operators and decision makers specialized / sophisticated city dashboards and IoT/IIoE applications for city status monitoring, control and decision support. Snap4City satisfies all the expected requirements of Select4Cities challenge RCP and much more, and it is 100% open source, scalable, robust, respects user needs and privacy; provides MicroServices and easily replaceable tools, compliant with GDPR; provides a set of tools for knowledge and living lab management, and it is compliant with Open Source Foundation (OSF) and European Open Science Cloud (EOSC) guidelines. It is based on the IIIoE, IIoE, IoT, and data and services management technologies, and it is compliant with major open source projects such as Eclipse, Apache, and others.
URBAN PLATFORM: SMART CITY IOT AS A SERVICE AND ON PREMISE

IOT APPLICATIONS - INSTANT APPS
- DATA DRIVEN APPLICATIONS
- REAL TIME PROCESSING
- BATCH PROCESSING
- ANY PROTOCOL & FORMAT

DASHBOARDS & APPLICATIONS
- CONTROL ROOM
- SITUATION ROOM
- OPERATOR
- DASHBOARDS
- BUSINESS INTELLIGENCE
- WHAT-IF ANALYSIS
- DECISION SUPPORT
- SIMULATIONS
- RISK ANALYSIS
- RESILIENCE ANALYSIS

MOBILE & WEB APPLICATIONS
- DEVELOPMENT KIT
- SUGGESTIONS
- MOBILE APPS
- MONITORING PANELS
- PLATFORM UTILITIES
- READY TO USE SMART APPLICATIONS

MICROSERVICES & ADVANCED SMART CITY API

LIVING LAB - DEV TOOLS - COWORKING
- IOT DIRECTORY
- SERVICE MAP
- RESOURCE MANAGER
- DATA GATE
- R STUDIO
- ETL

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

DATA ANALYTICS TOOLS - MICRO-APPLICATIONS

KM4CITY DATA AGGREGATE KNOWLEDGE BASE - EXPERT SYSTEM OF THE CITY – BIG DATA STORE

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

OIS
CITY UTILITIES
OPEN DATA
LEGACY & EXTERNAL SERVICES
PERSONAL DATA
IOT / IOE
BROKERS
KPI
INDUSTRY 4.0
SOCIAL MEDIA
Snap4City Services also on IOT Edge!!!

IOT Networks

IOT Gateways

IOT Brokers

IOT Devices

IOT Edge Devices

IOT Applications

Big Data Analytics, Artificial Intelligence

Dashboards and Apps

Mainly fog computing and NGSI V1, V2 with security
Smart City Functional Architecture

Data Sources, External Services
- Pull Data

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

Data Ingestion, aggregation, regularizatio n, reconcile: IOT Directory, NIFI, special tools

Knowledge base
- Semantic Reasoners

Indexing and aggregating
- OpenDistro x Elastic Search

IOT Applications, Business Logic
- Node-RED + Snap4City MicroServices

Data Analytics, Simulations, Special Tools
- R Studio, Tensor Flow, Python, ...

Federation
- Search and Query, Smart City API, Web Socket Server, GIS, Facet, semantic

Dashboards, visual tools, Web and Mobile Apps
- Rendering Acting, Widgets, Synoptics, MicroApps User interface, Drill down, maps, heatmaps

Authentication, Authorization, Platform & Processes Management, Data Inspector, Digital Twin, ...

Transport systems
- Mobility, parking

Public Services
- Govern, events ...

Sensors, IOT Cameras, Wi-Fi

Environment, Water, energy

Shops, services, operators

Social Media
- Social Media Crawler and Manager
Standards and Interoperability (2022)


https://www.snap4city.org/65
Unique of Snap4City Platform (1)

- Data ingestion and model
  - **Unified data model** (exploited in the Wizard and Knowledge base)
  - **Semantic Reasoner** modelling city entities, supporting semantic search, expert system, digital Twin, etc.
  - **Data loader, accelerators**
  - **IOT Directory** abstracting complexity of IOT Devices, Edge, Brokers, protocols and data formats

- Data Analytics and Data Processes
  - **Flexible and extensible IOT Applications**
  - **Data Analytic**: multiple programming languages, AI, XAI

- Visual Analytics, dashboarding, Apps
  - **Wizard: expert system** for immediate dashboard production matching data vs graphics representation
  - **Dashboards specialized** multidomain for Smart Cities
  - **Integrated Global and Local Digital Twin**
  - **Custom Widgets and Synoptics**
  - **Ready to use Mobile App, instant App, MicroApplication**
  - **Strategies** formalization supports
Unique of Snap4City Platform (2)

• **Openness to any developers**
  – Living Lab support for coworking, sharing, and delegating
  – Advanced Smart City APIs and MicroServices
  – 100% Open Source, open, Open hardware

• **Security and Privacy**
  – End-2-end encrypted communication, on devices, platform, ... dashboards
  – GDPR compliant privacy/security

• **Non functional**
  – on cloud and on premise, your private installation
  – On IOT edge and on cloud/premise
  – Multitenacy, multiple organization
  – Multiple smart solution on a single platform
  – Ready to use Appliance Virtual Machines and/or Containers for a modules and tools, IOT edge, OpenSource code on GITHUB.
  – Flexible, Modular, Elastic, open, scalable and robust

Snap4City (C), January 2022
Avoiding to have a collection of verticals

- Business Dashboard
- Control Dashboard
- Billing system
- AI, Data Analytics
- Accounting system
- Data interface
- Dashboard control
- AI, Data Analytics
- Data interface

Simplifying the development and integration of verticals
**Presentation:** Control Room, Dashboards, Synoptics, Wizards, Widgets, Visual Analytics Applications, Mobile Apps
Telegram, Bot, ...

**Device Layer**
- **GIS**
- **BIM**
- **Gateways**
- **External Services**

**Connectivity:**
- wired, wireless (Lora, 5G, 4G, 3G, Wi-Fi, etc.), IoT Edge, etc.

**Data Collection:**
- data mining, harvesting, integration, transformation, data models,

**Data Management:**
- data modeling, data storage, noSQL, semantic modeling, city entities, aggregation, normalization, knowledge base

**Internal Interoperability:**
- API, MicroServices

**Operation:**
- Reporting
- Simulation
- Heatmapping
- Traffic Flows
- Tip. Time Trend
- Analysis
- WorkFlow
- Tickets BPM
- Sentiment Analysis
- Open to any module and system
- Routing
- Internal GIS
- GeoServer

**Data Flow Logic**
- NGSI V1, V2
- FIWARE
- Linked Data triples

**Presentation:**
- Control Room, Dashboards, Synoptics, Wizards, Widgets, Visual Analytics Applications, Mobile Apps
Telegram, Bot, ...

**External Interoperability:**
- Smart City API, general API and accounting

**Operation:**
- Reporting
- Simulation
- Heatmapping
- Traffic Flows
- Tip. Time Trend
- Analysis
- WorkFlow
- Tickets BPM
- Sentiment Analysis
- Open to any module and system
- Routing
- Internal GIS
- GeoServer

**Data Flow Logic**
- NGSI V1, V2
- FIWARE
- Linked Data triples

**Authentication and Authorization:**
- GDPR compliant

**Any protocol and format**

**Social Media**
Distributed Computing

• The new version of Snap4City Library on Node-RED support the management of Multiple Snap4City Platform Installations

• It is possible to:
  
  – Have in different Blocks, different registrations to different Snap4City Installations or Users
  
  – Get/Send data from/to a Snap4City Installations/Users and send/get to/from another
  
  – Have Multiple Brokers on multiple installations and users
  
  – Creating collaborative distributed processing that work and share data and processing in multiple platforms based on Snap4City or different.
Snap4City Multidomain Applications

Any Snap4City Installation
Different domain
Different user
Different auth./authoriz. System
Etc..

Any Snap4City Installation
Different domain
Different user
Different auth./authoriz. System
Etc..
• **See more** on https://www.snap4city.org/369

• Snap4City technology can be exploited on Industry and IOT solutions:
  
  – **Snap4Industry: Snap4City for Industry 4.0** (SLIDES)
  
  – **Scenario: 5G Enabled Water Cleaning Control**
  
  – **Scenario: High Level Control of Industrial Plant**
  
  – **Custom Synoptics and Widgets for Dashboards**
  
  – **The integration between data and devices: the Snap4City solution**
DCS

SCADA

PLC

RTU

Admin

IoT Broker

IoT Devices/Edge

Industry Plant1.....

IoT Devices/Edge

Industry Plant2.....

IoT Broker

IoT Devices/Edge

SECURE

External Services

Fleet management

IoT Devices/Edge

IoT Broker

Dashboards and Apps

IOT Applications

Big Data Analytics, Artificial Intelligence

Control and Supervision on Multiple Supply Chains

Industry 4.0 as a Service
Snap4City Services also on IOT Edge!!!

IOT Networks

IOT Brokers

IOT Gateways

IOT Devices

IOT Edge Devices

IOT Applications

Big Data Analytics, Artificial Intelligence

Mainly fog computing and NGSI V1, V2 with security
Snap4City, Snap4Industry Architecture, V2

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

Data Ingestion, aggregation, regularization, reconcile:
- IOT Directory, NIFI, Special Tools

Knowledge base
- Semantic Reasoners

Indexing and aggregating
- OpenDistro x Elastic Search

Data Analytics, Simulations, Special Tools
- R Studio, Tensor Flow, Python, ...

IOT Applications, Business Logic
- Node-RED + Snap4City MicroServices

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

Authentication, Authorization, Platform & Processes Management, Data Inspector, Digital Twin, ...

Back-End

Federation
- Search and Query, Smart City API, Web Socket Server, GIS, Facet, semantic

Front-End

Rendering Acting, Acting, Widgets, Synoptics, MicroApps
- User interface, Drill down, maps, heatmaps
GIDA set up

Smart City data from many sources

IOT Applications

Dashboards and Apps

Big Data Analytics, Artificial Intelligence

IOT Data Shadow Snap4City

ModBus to Snap4City Gateway Edge

5G network devices

Telemonitoring Telecontrol

Modbus

SNAP4City

GIDA
GIDA 5G demo

13.6°C

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MjIyNg==
Snap4Altair Decision Support supervision and control, Industry 4.0

- Multiple Domain Data
  - Distributed Control System: energy, flows, storage, chemical data, settings, ..
  - Cost of energy, Orders,
  - Production Parameters
  - Maintenance data

- Multiple Levels & Decision Makers
  - Optimized planning on chemical model
  - Business Intelligence on Maintenance data

- Historical and Real Time data
  - Billions of Data

- Services Exploited on:
  - Multiple Levels, Mobile Apps, API

- Since 2020
Aims

- **Control Room**: Higher level supervision and monitoring (since 2020)
  - Management of Production Plan Optimization
  - Control of Perimeter with drone and sensors
- **Maintenance ticketing** (since 2017)
  - *predictive* (in development)
  - 3D Digital Twin (in development)
MicroService Architecture

- IoT App/DA: Real Time & Stream Processing
- Predictive Maintenance
- Prod. Plan Optimization
- API/MicroServices
- Maintenance Intelligence
- Digital Twin Local / BIM
- Data Storage
- Management, Auth./Autoriz.

DCS Real Time - Settimanale

SNAP4CITY Dashboard Builder
Snap4City/Industry Detailed Architecture

**IoT Edge**

**Snap4City: Smart City API, MicroServices**

- Business Logic
- Data Storage
- KeyCloak, LDAP
- Orion Context Broker
- Snap4City Dashboard Builder
- Data Analytic
  - Predicting
  - Planning
- Orders
- External Services
- IoT Devices
- IoT Devices from the field
- Energy Services
- Transportation

**DCS/SCADA**

**Orders**

**Administra**

**GW-NGSI**

**Energy Services**

**Transportation**

**IoT Devices**

**Production Parameters**

**Dashboards, Visual Analytics, Synoptics, 3D, Maps**

**External Services**

**IoT Directory**

**BPM & BIM**

**GIS and ResM**

**CKAN**

**Management**

**IoT App**
DCS Real Time - Settimanale

Sinottico Sintesi Impianto Altair 2

RTO online

Snap4City (C), January 2022
# Optimized Production Planner

<table>
<thead>
<tr>
<th>Parameters (TabPar)</th>
<th>DCS (OFC-UA)</th>
<th>Administrative data (AS400)</th>
<th>Administrative Consolidated Planning data (AS400)</th>
<th>Energy data</th>
<th>Other Parameters</th>
<th>Planning result</th>
<th>Outcome</th>
<th>In production</th>
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Snap4City (C), January 2022
Snap4City (C), January 2022

Business Logic

Produce Optimized Production Plan

Consolidated

Yes

No

List of Active Orders

Consolidated Orders

Last Params

Take last DCS

Take last Energy

Consolidated Orders

Optimized Production Planner

Possible Plans

Possible Plan

Data Storage

Production Plan

Decision Support
Some Flows
Green Impact Capacity (GIC)
Altair Control room
Workflow for Ticket management

OpenMaint: BPM Workflow management, team assignment, material control, ...

Business Intelligence Maintenance

Dashboards and actions

Consumptions/productions

Events/actions

IOT App, Data event firing, event detection and firing

Critical event management

Snap4City (C), January 2022
Green Impact Capacity (GIC)

- Improve productivity of chemical plant
- Keep GREEN the environmental impact
- Exploiting innovative technologies
- Diversify the production
- Monitoring environmental conditions
• **Snap4City - Powered by **[FIWARE Solution & Platform](https://marketplace.fiware.org/pages/solutions/b8905e91973b420189c972c)
  - 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](https://www.fiware.org)

• **Snap4City - **[FIWARE Training Services](https://marketplace.fiware.org/pages/solutions/03bccd83a0e1b0398ba7a0bf)

• **Snap4City - **[FIWARE 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](https://www.snap4city.org/65)
Overview

• In Snap4City you can chose to connect your devices at Snap4City Platform in different manners:
  – (a) directly to Snap4City with some Broker, or on IOT App, Brokers, MyKPI
  – (b) via an IOT Orion Broker (external IOT Broker or those provided by Snap4City), or
  – (c) via any third party IOT Brokers in any protocol you have.

• Snap4City has
  – Improved IOT Orion Broker with the so called Orion Broker Filter (Orion Broker Filter, NGSI Security Wrapper) which is a secure wrapper for NGSI V1 and V2 protocol for enforcing Mutual Authentication, Security, roles, etc.
  – Produced open hardware and open software NGSI Compliant: as
    • IOT Devices with mutual authentication and security based for NGSI on: Android, Arduino and ESP32, IOT Button, etc.
    • IOT Edge devices with mutual authentication and security based for NGSI on: Raspberry PI, Windows, Linux.
## Functional: FIWARE ref arc wrt Snap4City solutions

<table>
<thead>
<tr>
<th>FIWARE ref arc smart city</th>
<th>Snap4City</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple Protocols: IoT, Databases, etc..</td>
<td>10 on IOT, Limited on databases, etc.</td>
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<tr>
<td>Large set of high level types: maps, trends, heatmaps, traffic, trajectories, scenarios,...</td>
<td>No</td>
</tr>
<tr>
<td>Integration with workflows, BPM</td>
<td>Not Supported</td>
</tr>
<tr>
<td>Integration and Modeling Digital Twin BIM</td>
<td>Not Supported</td>
</tr>
<tr>
<td>Integration with GIS: WFS, WMS</td>
<td>Not fully supported</td>
</tr>
<tr>
<td>Integration with Heatmaps and Satellite</td>
<td>Partially, not calibrated</td>
</tr>
<tr>
<td>Integration with Satellite</td>
<td>not supported</td>
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<tr>
<td>Smart City API</td>
<td>no</td>
</tr>
<tr>
<td>Open Data Management</td>
<td>Partial with CKAN</td>
</tr>
<tr>
<td>Federation of platforms</td>
<td>Partial on brokers</td>
</tr>
<tr>
<td>Semantic model and queries</td>
<td>No, probably with NGSI-LD in the future</td>
</tr>
<tr>
<td>Multiple kinds of IoT Brokers</td>
<td>No, only agents</td>
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<tr>
<td>Function</td>
<td>FIWARE ref arc smart city</td>
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<td>----------------------------------</td>
<td>--------------------------</td>
</tr>
<tr>
<td>Data Transformation</td>
<td>Coding</td>
</tr>
<tr>
<td>Data Analytics</td>
<td>No</td>
</tr>
<tr>
<td>on line development</td>
<td>No, limited</td>
</tr>
<tr>
<td>Dashboard on data</td>
<td>Grafana no LDAP</td>
</tr>
<tr>
<td>Dashboard Widgets</td>
<td>Limited, no custom, coding needed</td>
</tr>
<tr>
<td>Real Time end-to-end from Dashboards to any other channel, event driven</td>
<td>No, very limited</td>
</tr>
<tr>
<td>Multi Data Map</td>
<td>Limited with non OS</td>
</tr>
<tr>
<td>MicroApplications</td>
<td>No</td>
</tr>
<tr>
<td>Auditing, Assessment, accounting</td>
<td>No, no, no</td>
</tr>
<tr>
<td>Multitenacy on data management</td>
<td>No only on broker</td>
</tr>
<tr>
<td>Living Lab for creating/managing communities/groups</td>
<td>Not supported</td>
</tr>
<tr>
<td>Report generation/management</td>
<td>No</td>
</tr>
</tbody>
</table>
• Is a solution and platform of FIWARE
• Is open to the Development of Applications leaving large space and providing a large set of ready to use applicative tools and solutions to build their solutions on top or aside.
• Is fully distributed, any kind of data source can be ingested, automatically to form the Data Shadow.
• Orion Broker is core part of Snap4City and main Brokers. It can be also protected by Snap4City tech, with Mutual Authentication
  • Other protocols and Brokers can be attached to the solution please see the compatibility page https://www.snap4city.org/65
• Visual Flexible IOT processing is provided as IOT App that is Node-RED plus Snap4City MicroServices suites
• Advanced Smart City API are provided on top of Knowledge Base
• Dashboard Builder has been designed for Smart City Data and automated dashboards’ production
• Storage based on OpenDistro x ElasticSearch + Kibana or HBase/Phoenix
• Market Place for promoting, publishing and sharing Open Data, tools, processes, experiences
• Passed PEN test, GDPR compliant, published security on IEEE Access
• Interoperable with huge number of protocols and formats
• Full Support for Living Lab of the city, coworking, tutorials
• Fully support for Multi-tenancy
• Fully support federation of smart cities, smart factories
• Deployed as VM and Dockers, on cloud and on premise
• 100% open Source, including the management and applicative aspects
Data Type Coverage

- POI, IOT, shapes,..
- maps, orthomaps, GTFS, GIS WFS/WMS, GeoTiff, ..
- calibrated heatmaps, ..
- traffic flow, typical trends, ..
- trajectories, events, ..
- 3D, BIM, Workflow, ..
- Dynamic icons/pins, ..
- OD Matrices, scenarios, ..
- prediction models, ....
- decision support, ....
- Synoptics, animations, ..
- social media, Routing, ..
- Satellite data, ..
- KPI, personal KPI,..
- etc.
• Open Data:
  – Data gate, federation of Open Data Portals
  – IOT App, ETL proc (PULL)

• IOT Networks:
  – IOT Application processes, data driven or PULL
  – IOT Brokers (Push) → IOT Shadow

• Web Pages:
  – Web scraping, crawling processes

• Satellite data

• Social media: Twitter, Facebook,..
  – Twitter Vigilance, IOT App

• Mobile Apps
  – Smart City API

• Files upload: CSV, Excel, etc.
  – IOT Applications, ETL

• REST API, WS, FTP, LD, LOD, etc.
  – IOT Applications, ETL

• Data base accesses
  – GIS: WFS, WMS
  – ETL, IOT Application

Any kind of data and flows
Snap4City and FiWare integration

• A) IoT Orion Broker as an External Broker of a Snap4City platform
  – Devices are mainly managed by Orion Broker only
  – IoT Directory can harvest devices on Broker to registered them

• B) IoT Orion Broker is an Internal Broker of a Snap4City platform
  – This implies that Snap4City facilities are exploited for:
    • IoT Devices registration, IoT discovery, Ontology, Bulk registration, optimization of stored data, adaptation, filtering control, etc.
    • All the devices are registered into IoT Directory that performs the registration on both IoT Orion Broker and KB automatically

• C) Federation of an IoT Orion Broker with storage by using SSM2ORION
  – Devices are managed by Orion Broker only

• D) hybrid solutions in which Web and Mobile App can exploit both Orion API and Snap4City services and API
Snap4City IoT Registration and Access

A range of IoT Brokers and protocols

A range of other data sources

IoT Agent
IoT Orion Broker
MongoDB

Km4City
Data Connectors
IoT Directory
ServiceMap
Smart City API

Authentication and Authorization

Dashboard Builder

Mobile Apps
Dashboards
A Mobile App may refer to one Smart City API Server (for Area 1) via SUPER and receive data from the Federated SUPERS (Area 2) if navigation, queries, etc. are leading to discover out of the addressed KB.

- SUPER can be used for creating redundant and/or balanced distributed solutions for Federated KB. See Area 2, the two KB in the front.
- Federated SUPER ServiceMap can have overlapped KB even totally.
- A Mobile App can be developed to support multiple Smart City API servers, for balancing and

- The usage of Super (ServiceMap) is not mandatory so that separate services can be produced as well.
- SuperServiceMap and ServiceMap presents the same Smart City APIs.
Federation of Snap4City vs IOT ORION Broker

Snap4City Solutions

Dashboard Builder

Hybrid Solutions

Crate-DB

4200:4200

8668:8668

MongoDB

27017:27017

4041:4041

IoT Agent

Area 3

Quantum Leap

IoT Orion Broker

Federation

SUPER

8668:8668

NGSI

1026:1026

SSM2ORION

Super

8668:8668

NGSI

Snap4City Solutions

FIWARE

Hybrid Solutions

FIWARE

FIWARE
## Non Functional

### FiWare OS Solutions wrt Snap4City solutions

<table>
<thead>
<tr>
<th>Feature</th>
<th>FiWare</th>
<th>Snap4City</th>
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</thead>
<tbody>
<tr>
<td>Security</td>
<td>TLS</td>
<td>Yes: End to end, TSL and dashboards, event driven, mutual authentication, Access Token, OpenID Connect</td>
</tr>
<tr>
<td>Privacy</td>
<td>Not on all data</td>
<td>Yes: GDPR compliant full stack</td>
</tr>
<tr>
<td>Access Control, authorization</td>
<td>To be done, Partial</td>
<td>Yes: User Roles, and management tools</td>
</tr>
<tr>
<td>Scalability</td>
<td>Limited on data, No on processes</td>
<td>Yes</td>
</tr>
<tr>
<td>Full stack Open Source</td>
<td>No (proprietary applicative levels)</td>
<td>Yes: open source also application level</td>
</tr>
<tr>
<td>Full Modular</td>
<td>Not all modules are Open Source</td>
<td>Yes</td>
</tr>
<tr>
<td>Interoperable</td>
<td>Partial, see previous table</td>
<td>Yes at all levels, in all modules, 100% open source</td>
</tr>
<tr>
<td>Full training course</td>
<td>Partial</td>
<td>Yes</td>
</tr>
<tr>
<td>Examples and code shared</td>
<td>Partial</td>
<td>Yes</td>
</tr>
</tbody>
</table>
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 vs Kibana

<table>
<thead>
<tr>
<th>Features</th>
<th>Snap4City Dashboard Builder</th>
<th>Kibana, Grafana</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large Collection of Widgets</td>
<td>YES</td>
<td>Nothing</td>
</tr>
<tr>
<td>Custom Widgets SVG of any kind, full defined process for customization</td>
<td>YES</td>
<td>Nothing</td>
</tr>
<tr>
<td>Real time event driven widgets and data</td>
<td>YES</td>
<td>Nothing</td>
</tr>
<tr>
<td>Business Logic for data transformation with visual programming: Node-RED</td>
<td>YES</td>
<td>Some coding</td>
</tr>
<tr>
<td>Maps with custom PIN, bubbles, animated and moving, etc.</td>
<td>YES</td>
<td>Nothing</td>
</tr>
<tr>
<td>Maps with paths, shapes, traffic flow, scenarios, routing, heatmaps, what-if, ...</td>
<td>YES</td>
<td>Nothing</td>
</tr>
<tr>
<td>Maps with Orthomaps from WFS, WMS, GIS connection, etc.</td>
<td>YES</td>
<td>Nothing</td>
</tr>
<tr>
<td>TV camera integration and selection</td>
<td>YES</td>
<td>Nothing</td>
</tr>
<tr>
<td>Widgets for business logic integration on real time: buttons, selector, switch, etc.</td>
<td>YES</td>
<td>Nothing</td>
</tr>
<tr>
<td>Kiviat, Spider net, Calendar</td>
<td>YES</td>
<td>Nothing</td>
</tr>
<tr>
<td>Typical Time Trends: day hours, month week, month days, ......</td>
<td>YES</td>
<td>Nothing</td>
</tr>
<tr>
<td>Time Trend Compare: day, eek, month, year</td>
<td>YES</td>
<td>Nothing</td>
</tr>
<tr>
<td>Selectors/Menus: text, icons, etc., also in connection with IOT APP, Node-RED</td>
<td>YES</td>
<td>Nothing</td>
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<tr>
<td>Full control of graphic layout, font, colours, refresh per widget, etc.</td>
<td>YES</td>
<td>Nothing</td>
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<tr>
<td>Iframe integration of third party widgets and web pages, nesting dashboards, embedding Kibana</td>
<td>YES</td>
<td>Nothing</td>
</tr>
<tr>
<td>Connection among multiple Dashboards and Widgets</td>
<td>YES</td>
<td>Nothing</td>
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<tr>
<td>Synchronization with Video Wall, and Operators Views</td>
<td>YES</td>
<td>Nothing</td>
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<tr>
<td>Multiseries, bar lines, charts, pie, donut, simple selectors, trends, etc., also from business logic</td>
<td>YES</td>
<td>Limited</td>
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<tr>
<td>Single content, string, html, any data, etc.</td>
<td>YES</td>
<td>Limited</td>
</tr>
<tr>
<td>Special widgets: Weather forecast, civil protection, road plates, Twitter, etc...</td>
<td>YES</td>
<td>Nothing</td>
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<tr>
<td>Faceted search</td>
<td>possible with selectors</td>
<td>YES</td>
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</table>
Snap4City vs State of the Art Solutions
# Market Solutions

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<tr>
<td>Discovery Abstraction</td>
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<td>Authentication, Authorization</td>
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<td>IOT and Dashboards</td>
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<td>Integrated Community</td>
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<td>Data Types: IOT Devices, IOT App, Dashboard, Data</td>
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<td>Data Type: Publish/share, Delegation, Consent and change</td>
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<td>Data Type: Download and Delete</td>
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<td>Visual Programming end-to-end</td>
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<td>Advanced Smart City API, MicroServices</td>
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<td>Standard based Modules and IOT, Open Devices</td>
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<td>Data Analytics integrated</td>
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<td>Dashboard H24/7, protected Connection</td>
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<td>Multi-protocol on IOT</td>
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</tbody>
</table>

**Notes:**
- Y: Yes
- N: No
- (Y): Partially
- MQTT, coap, http
- Limited

** Companies:**
- Google IOT
- AWS
- Azure IOT
- Snap4City
- Bosch IoT Suite
- Siemens MindSphere
- PTC ThingWorks
- FIWARE
- ARM mbed IoT
- Bosch IoT Suite
- FIWARE
- ARM mbed IoT
- Snap4City
- KAA
- Thingsboard
- IOT eclipse.org
- IOT IGNITE
- FIWARE
- ARM mbed IoT
- Avirantage
- AWS
- Azure IOT
- PTC ThingWorks
- Bosch IoT Suite
- Carriots
- Google IOT
- Homekit Apple
- Smarthing Samsung

**Additional Information:**
- Snap4City (C), January 2022
- [Link to Snap4City](http://www.snap4city.org)
Smart City in a Snap
How to become smart (short version)
Smart City in a Snap Acceleration for Innovation

• **Organization/City analysis**
  – requirements analysis, identification of domains
  – Snap4City Innovation Process → Report of Scenarios vs Data
  – Data Analysis → Report as Data Table

• **Smart City Design for Innovation:**
  – Design of main Scenarios and Tools (Dashboard, SCCR, Apps, IOT Network, new data, etc.) → Report as Mock-up Design

• **Next phases**
  – Data Ingestion and Data Warehouse
  – Scenarios Implementation
Develop Mobile & Web Applications Exploiting Snap4City Smart City Services

Analysis & Design
- Analysis
- Design
- Data Discovery
- Data Ingestion

Data Analytics
- Data Analytics Development
- Special Tool Development
- Dashboard Development

IOT App Development

Deployment
- Deploy
- Testing
- Publication Production

Smart City Services

Advanced Smart City API and MicroServices
- Snap4City Mobile & Web Apps Development Kit
- Application Requirements Analysis
- Application Development

Snap4City Mobile & Web Apps
- Deploy
- Publication Production
- Testing
Smart City Development Life Cycle
Development Life Cycle
Smart City Services

Analysis & Design
Data Ingestion
Deploy

Data Analytics
Development
Development Life Cycle
Smart City Services

Analysis & Design
- Analysis
- Design
- Data Discovery
- Data Ingestion

Data Analytics
- Data Analytics Development
- Special Tool Development
- IOT App Development
- Dashboard Development

Development
- Deploy
- Testing
- Publication Production

Smart City Services
- Snap4City (C), January 2022
Development Life Cycle
Smart City Services

Analysis
- Requirements Specification

Design
- In/Out Functional
- Historical Data
- Private Info
- Web Data
- Functional

Analysis and Design
- Analytical
- Visual Interface

Discovery
- ServiceMap
- Data Inspector

Data Ingestion & Modeling
- IOT Directory for IOT Device Regis.
- Data Gate/ETL
- External Services
- MyKPI Modeling
- Web Scraping

Develop. Data Analytic
- R-Studio
- Python
- Java, .......

Development, Deploy, Testing
- IOT Application Implementation
  - IOT Directory MS
  - Search/Store MS
  - Ext. Services MS
  - Utilities MS
  - MyKPI, Per. MS
  - WebScraping MS
  - Functional MS
  - Data Analytics MS
  - Dashboard MS
  - IOT App Widgets

User Interface Development
- Dashboard Builder & Wizard
  - IOT App Widgets
  - Custom Widgets
  - Regular Widgets

Deploy, Testing

Legenda
- phase
- Formal Design
- Tool/Process
- MicroService/Node
- Widget

Snap4City (C), January 2022
Develop Mobile & Web Applications Exploiting Snap4City Smart City Services

Smart City Services

Analysis & Design
- Analysis
- Design
- Data Discovery
- Data Ingestion
- IOT App Development

Data Analytics
- Data Analytics Development
- Special Tool Development
- Dashboard Development

Development
- Deploy
- Testing
- Publication Production

Advanced Smart City API and MicroServices
- Snap4City Mobile & Web Apps Development Kit
- Application Requirements Analysis
- Application Development
- Publication Production
- Testing

Mobile and Web Apps

Snap4City (C), January 2022
Analysis and Design for Innovation (Co-Creation and Co-Working)
Development Life Cycle
Smart City Services

Analysis & Design
- Analysis
- Design

Data Discovery
- Data Ingestion

Data Analytics
- Data Analytics Development
- Special Tool Development

IOT App Development

Dashboard Development

Deploy
- Publication Production
- Testing
- Deployment
Analysis & Design for Innovation

• Analysis
  – The analysis starts with a number of meetings/interviews with stakeholders
  – The identification of the target stakeholders/actors/users (target Segments) and their definition/description
  – The meetings/workshops are focused on filling the Snap4City Innovation Matrix which is a evolution of the INNOVATRIX approach of IMEC
  – See the schema of the Snap4City Innovation Matrix reported in the next slide, on the basis of the kind of Meeting for example: (a) starting a smart city, (b) starting a smart city Living Lab

• Data Discovery
  – Production of the Data Table (Snap4City)
  – Data discovery is performed on analysis of the: (i) identified scenarios, (ii) data of the stakeholders, (iii) international sources, (iv) Snap4City experience, etc.
  – Performed by following the Snap4City guidelines on Data Search on web and world.

• Design
  – Focused on creating a large number of Use Cases and/or Scenarios for development
  – The design starts by taking into account the Snap4City development life cycles and tools. Thus shortening all the boring activities and following the typical Snap4City rapid prototyping described in these slides!!
## Snap4City Innovation Matrix and Process

**Snap4City Innovation Matrix**

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Commons</th>
<th>Users</th>
<th>Staff</th>
<th>Visitors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Needs</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current Practices</td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>Value proposition (Current)</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Value proposition (Future)</td>
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<tr>
<td>Solution</td>
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<tr>
<td>Value Capture</td>
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<tr>
<td>Key Partners</td>
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</tr>
<tr>
<td>Barriers</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Analysis Matrix**

**Data Discovery**

**Design Scenarios**

Snap4City (C), January 2022
Analysis for Innovation
Snap4City Analysis for Innovation

• Analysis
  – The analysis starts with a number of meetings/interviews with stakeholders
  – The identification of the target stakeholders/actors/users (target Segments) and their definition/description
  – The meetings/workshops are focused on filling the Snap4City Innovation Matrix which is an evolution of the INNOVATRIX approach of IMEC
  – The schema of the Snap4City Innovation Matrix is reported in the next slide,
    • It may be different depending on the kind of action: (a) starting a smart city, (b) starting a smart city Living Lab, (c) both actions at the same time.

• Two main goals:
  – Data Discovery (see later)
  – Identification of User Cases, Scenarios (see later)
- Defined by IMEC for Living Lab according to ENOLL

<table>
<thead>
<tr>
<th>CUSTOMER SEGMENT</th>
<th>What customer segments to focus on? What are key characteristics? What is the use-context?</th>
</tr>
</thead>
<tbody>
<tr>
<td>NEEDS</td>
<td>What are the needs of the customer segment? How do we prioritize these needs?</td>
</tr>
<tr>
<td>CURRENT PRACTICES</td>
<td>Who or what are competitors, alternatives, customer behavior? What are the pains and gains of these current practices?</td>
</tr>
<tr>
<td>VALUE PROPOSITION</td>
<td>What (measurable) impact will you create for this customer segment?</td>
</tr>
<tr>
<td>SOLUTION</td>
<td>What are the components of your (digital) solution? How do these components differ for the different customer segments?</td>
</tr>
<tr>
<td>BARRIERS</td>
<td>What are the barriers for adoption, usage and market entry?</td>
</tr>
<tr>
<td>VALUE CAPTURE</td>
<td>What value (monetary and non-monetary) do I receive in return? What price should I set (and how)?</td>
</tr>
<tr>
<td>KEY PARTNERS</td>
<td>Who are your key partners? How to interact with stakeholders?</td>
</tr>
</tbody>
</table>
Why Innovation Fail....


- Many innovate and good products failed on conquering the market/deploy, due to the psychology of behaviour change.
  - To understand why may fail is the first step.

- One aspects is the **Psychological bias**:
  - Current users overvalue the benefits of what they are using
    - *endowed effect*, which is estimated to be of the 100%.
      The new should be at least twice better than the current to convince to change.
    - *status quo effect*, if the ownership of the current has been for long time (years) it may need a factor of 4 to change.
  - Developers overvalue the benefits of what they have developed, of a factor of 3
### Reasons to remain vs change

- **Attractiveness of the product**
  - Is subjective as perceived value
- **They compare the new with respect to what they know**
  - Any improvement is a Gain, any lack is seen as a Loss
  - Where losses have a larger appearance of gains
- **Cost to change product in:**
  - Learning, Time and Money
- **Rational vs Irrational impulse to change/buy**
  - *Is a Recipes for a disaster*

---

### The Trade-offs Innovations Demand

<table>
<thead>
<tr>
<th>Innovation</th>
<th>What Consumers Gain by Buying</th>
<th>What Consumers Lose by Buying</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electric cars</td>
<td>Clean environment</td>
<td>Easy refueling</td>
</tr>
<tr>
<td>Digital video recorders</td>
<td>Easy recording</td>
<td>Ability to play rented movies</td>
</tr>
<tr>
<td>DVD rentals by mail</td>
<td>Broad selection</td>
<td>Spontaneity</td>
</tr>
<tr>
<td>E-books</td>
<td>Easy portability</td>
<td>Durability</td>
</tr>
<tr>
<td>Online grocery shopping</td>
<td>Home delivery</td>
<td>Ability to select freshest products</td>
</tr>
<tr>
<td>Satellite radio</td>
<td>Broad selection</td>
<td>Free music</td>
</tr>
<tr>
<td>Screw-top wine caps</td>
<td>Loss spoilage</td>
<td>Elegance of the experience</td>
</tr>
<tr>
<td>Segway scooter</td>
<td>Mobility</td>
<td>Health benefits of walking</td>
</tr>
<tr>
<td>Wind turbines</td>
<td>Nonpolluting energy</td>
<td>Unobstructed views</td>
</tr>
</tbody>
</table>

---

**CONSUMERS ARE USUALLY**

- skeptical about a new product's performance,
- unable to see the need for it,
- satisfied with the existing product, and
- quick to see what they already own as the status quo.

**COMPANIES ARE OFTEN**

- convinced the innovation works,
- likely to see a need for the product,
- dissatisfied with the existing substitute, and
- set on viewing the innovation as the benchmark.
The 4 Categories

- **Easy Sells/Accept**
  - Acceptance high but new benefits low

- **Sure Failures**
  - Limited benefits and high changes, hard to be accepted

- **Long hauls, a marathon**
  - May be great new value, but associated with big changes. Consumer resistance is high. It may take time to go (e.g., Linux, mobile phones).

- **Smash hits**
  - Are those that have the major probability to be accepted in short or long term.
  - High benefits and innovations, with limited changes in behaviour
The Workshops for Innovation, Co-Creation
Pre-Conditions

• Motivations identified: domains/thematic-areas, actors/segments,
  – e.g.: Mobility and transport, energy, security, environment, etc.
• The customer Segments describe the position of the different Actors Categories with respect to the same needs, problem, action, scenario..
  – Two examples:
    • the Citizens/Tourists would like to have an overview of what is going on in the area, while the City Officials would be afraid to provide too much information since some information can be sensitive to security issues.
    • the Mobile App users would have this and that….., and the City App Provider would monitor their movements to provide ads, etc.
Schedule of Workshops and activities

• **1st Workshop** finalized to
  – definition of the first version of the **Snap4City Innovation Matrix (Report)**
  – Identification of the **Data Table**

• **Intermediate work on**
  – Knowing the **ICT** infrastructure and viable solutions
  – Refining **Data Table** details by email
  – Improving the **Report** with more descriptive scenarios
  – Presenting **Report** and TABLE 1 week in advance wrt the 2nd workshop (if it is possible)

• **2nd Workshop** finalized to
  – Discussing a reasoned version of the scenarios with problems pending
    • Solving pending aspects of the **Snap4City Innovation Matrix and Data Table**
  – **Identification of the main Scenarios to be developed and feasible according to feasibility and priority**
    • Corresponding consolidation of the development teams

• **Conclusive work on**
  – Refining Data Table details
  – Creating Final Report with Descriptive Scenarios
  – Designing of the Minimum Snap4City architecture to cope with scenarios, scenario feature table wrt to Snap4City modules
  – Development of mock-up for Dashboards with fake data to show the concept

• **Final Meeting**
  – Presentation of the final report with: 1 mock-up of a scenario, early design of the Snap4City solution vs modules according to the scenarios
  – further discussion on the next steps
<table>
<thead>
<tr>
<th>Parameters</th>
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<tr>
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<td></td>
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<td></td>
</tr>
</tbody>
</table>
Meeting Organization

For each table:
- Experts of the domain specific
- Experts of different customers segment
- Operative people
- ICT people
- Decision Makers
- Etc.
Data Discovery and Analysis
Development Life Cycle
Smart City Services

Analysis & Design

- Analysis
- Design

Data Discovery

[Data Ingestion]

IOT App Development

Data Analytics Development

Special Tool Development

Dashboard Development

Deployment

- Deployment
- Publication Production
- Testing

Deployment Phase:
- Analysis & Design
- Data Analytics
- Development
Data Discovery

- Performed by analyzing data from:
  I. identified scenarios from the **Snap4City Innovation Matrix**
  II. main organizations (via interviews)
  III. other stakeholders (via interview and web pages)
  IV. regional, national and international sources:
    I. open data portals, weather sources,
    II. IOT networks, etc. via web pages and sites
  V. Mobile Applications (via Snap4City API)
  VI. Snap4City portal [https://www.snap4city.org](https://www.snap4city.org)
  VII. etc.

- Exploiting Snap4City experience, data and tools
- By following the Snap4City guidelines on Data Search on web and world reported in the training course and on Snap4City.org portal.
Development Life Cycle
Smart City Services

Analysis & Design
- Analysis
- Design
- Data Discovery
- Data Ingestion

Data Analytics
- Data Analytics Development
- Special Tool Development
- Dashboard Development
- IOT App Development

Deployment
- Deploy
- Testing
- Publication Production
Data Ingestion

• For Data Warehouse mechanisms (IOT App, IOT Brokers, ETL, DataGate, etc.) and related tools please see slides of the 5th PART of the Snap4City course.
Design and Control of Smart Applications

only for user with RootAdmin role
Dashboard manager

### Snap4City

#### Dashboards (Public by (ORG))

<table>
<thead>
<tr>
<th>Title</th>
<th>Creator</th>
<th>Creation date</th>
<th>Last edit date</th>
<th># Access Today</th>
<th>Minutes Opened Today</th>
<th>Status</th>
<th>Edit</th>
<th>View</th>
<th>Organizations</th>
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<td>snap4city</td>
<td>2020-02-05 13:22:03</td>
<td>2021-11-03 19:03:10</td>
<td>2</td>
<td>1199</td>
<td>EDIT</td>
<td>VIEW</td>
<td>DSIT</td>
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<td>ALERTS IN FLORENCE REGION</td>
<td>aline</td>
<td>2019-02-28 17:03:49</td>
<td>2020-03-13 17:46:47</td>
<td>1</td>
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<td>EDIT</td>
<td>VIEW</td>
<td>DSIT</td>
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<td>Andamento Regionale Toscana e Province, COVID-19</td>
<td>peolodist</td>
<td>2020-03-16 09:05:35</td>
<td>2020-10-28 15:39:51</td>
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<td>60</td>
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<td>VIEW</td>
<td>DSIT</td>
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<td>2020-04-19 16:46:36</td>
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<td>EDIT</td>
<td>VIEW</td>
<td>DSIST</td>
<td></td>
</tr>
<tr>
<td>Herit-Data - Pont du Gard Main</td>
<td>nicola.pontoguard</td>
<td>2021-05-14 14:27:08</td>
<td>2020-05-06 17:32:12</td>
<td>1</td>
<td>72</td>
<td>EDIT</td>
<td>VIEW</td>
<td>PontDuGard-Occitanie</td>
<td></td>
</tr>
<tr>
<td>DidDa data 2</td>
<td>peolodist</td>
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<td>2021-10-29 17:01:26</td>
<td>3</td>
<td>60</td>
<td>EDIT</td>
<td>VIEW</td>
<td>DSIT</td>
<td></td>
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<tr>
<td>Firenze</td>
<td>disi</td>
<td>2016-09-29 11:15:58</td>
<td>2020-05-09 09:53:29</td>
<td>5</td>
<td>30</td>
<td>EDIT</td>
<td>VIEW</td>
<td>DSIT</td>
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<td>DSIT</td>
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<td>Convention Bureau - Mobility for Integration</td>
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<td>2017-11-12 09:40:50</td>
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<td>4</td>
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<td>VIEW</td>
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<tr>
<td>Herit-Data - Dubrovnik Main</td>
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<td>1</td>
<td>EDIT</td>
<td>VIEW</td>
<td>DSIT</td>
<td></td>
</tr>
</tbody>
</table>
Semantic Reasoning on Smart Applications

- Dashboards have relationships with
  - Org. at which they belong
  - Widgets with
    - data they use, and each of which
      - is connected with the Knowledge Base
      - May be: device, kpi, etc.
  - IoT Apps with
    - Data they use
    - Data Analytic
    - Widget they control
    - ......
Monitoring Cross Road Venaria - (AXIS Camera)

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzI5Ng==
Check Data Analytics Tuscany

Air Quality
- Interpolation and Heatmap Completed 2021-09-30T14:00:00.000
- Interpolation and Heatmap Completed 2021-09-30T14:00:00.000
- Interpolation and EAQI(CEAQI) Heatmap Completed 2021-09-30T14:00:00.000
- Interpolation and EAQI(CEAQI) Heatmap Completed 2021-09-30T14:00:00.000

Weather
- Interpolation and Heatmap Completed 2021-09-30T12:00:00.000
- Interpolation and Heatmap Completed 2021-09-30T14:00:00.000
- Interpolation and Heatmap Completed 2021-09-30T14:00:00.000
- Interpolation and Heatmap Completed 2021-09-30T14:00:00.000

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTk2Mw==

Snap4City (C), January 2022
Sanity Check of Platform Models: Processes and Relationships
SPARQL Query Results

EMPTY_DASHBOARDS
MOST_USED_DASHBOARD
LEAST_USED_DASHBOARD
MOST_USED_DATA
MOST_CRUCIAL_IOTAPP_FOR_DATA
MOST_CRUCIAL_IOTAPP_FOR_DASHBOARD
MOST_ACTIVE_ORGANISATION
PRIVATE_DASHBOARDS
AVG_DATA_FOR_DASHBOARD
MOST_CRITICAL_IOTAPP_FOR_DA
DASHBOARD_COMPLEXITY

<table>
<thead>
<tr>
<th>dashboard</th>
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</tr>
</tbody>
</table>

Snap4City (C), January 2022
Dashboard Structure for all users
Snap4City Overview of Development Tools
• Open Data:
  – Data gate, federation of Open Data Portals
  – IOT App, ETL proc(PULL)

• IOT Networks:
  – IOT Application processes, data driven or PULL
  – IOT Brokers (Push) → IOT Shadow

• Web Pages:
  – Web scraping, crawling processes

• Satellite data

• Social media: Twitter, Facebook, ...
  – Twitter Vigilance, IOT App

• Mobile Apps
  – Smart City API

• Files upload: CSV, Excel, etc.
  – IOT Applications, ETL

• REST API, WS, FTP, LD, LOD, etc.
  – IOT Applications, ETL

• Data base accesses
  – GIS: WFS, WMS
  – ETL, IOT Application

Any kind of data and flows
Snap4City Services also on IOT Edge!!!

IOT Networks
- IOT Brokers
- IOT Gateways

IOT Devices

IOT Edge Devices
- IOT Brokers
- Big Data Analytics, Artificial Intelligence
  Mainly fog computing and NGSI V1, V2 with security

IOT Applications

Dashboards and Apps

Snap4City (C), January 2022
IOT Network Manager vs Final User

Network of IOT Brokers

IOT Broker

Registering

External

Internal

Knowledge Base, Km4City

Knowledge and Storage
Data from the Field and City

IOT Directory

Discovering

Browsing

My IOT Device

Register

Final user Manager

IOT Application

Discovering

Dashboard Wizard

ServiceMap

Knowledge Base
Developing IOT Applications

MicroServices collections

My IOT Applications

IOT App. Editor

Generating IOT App With Dashboard

Sharing/saving reusing IOT App

Resource Manager

Dashboard Collection, Editor and Wizard

Knowledge Base, Km4City

ServiceMap Discovery

IOT Discovering
How it works: HeatMap Manager

GeoTiff

IOT App

Name
ColorMap
Unit of Measure
...

Heatmap Manager

API and MicroServices

https://www.km4city.org/swagger/external/index.html?urls.primaryName=Heatmap%20API

Heatmap GeoTIF
Generation

JSON

GeoServer

WMS
Web Scraping
Web Scraping

My Scraping processes

Web Scraper PORTIA

Generating WEB Scraping

Knowledge Base, Km4City

Sharing/saving reusing Scraping

IOT App. Editor

Resource Manager

Snap4City (C), January 2022
Snap4City vs CKAN

Snap4City Portal and Integrated tools

Advanced Snap4City APIs and Micro Services

Datagate

Harvesting and Publishing

Open or Private External CKAN Data Portals

Automatize:
- Import data from CKAN to Snap4City
- Upload Public Data from Snap4City to CKAN
- Data Harvesting
- Dashboards and Mobile/Web Apps creation
Batch Processing for dynamic data ingestion
Developing ETL, Data Manager

ETL Process

ETL Development Environment

Resource Manager

Saving / Sharing reusing

DISCES scheduler production

Data Gate

Data Set Saving / Sharing

Knowledge Base, Km4City

Knowledge and Storage Data from the Field and City

Data sources

Distributed Back Office

GitHub

Load data or prepare for data ingestion

Schedule Execute

In Yellow alternative & legacy solutions

Snap4City (C), January 2022
Resource Manager: public and sharing
Data Gathering and Knowledge Management

- Data ingestion can be performed by using multiple tools:
  - ETL processes, IOT Applications, Data Gate, WebScraping. We suggest:
    - ETL for static / periodic data in PULL
    - IOT App for real time data and flow, from IOT Brokers/Devices
    - DataGate for Static Data, upload them as files, or collected from other CKAN
    - WebScraper for scraping data from Web Pages, when authorized!

- See how to test cases:
  - **HOW TO: add data sources to the Snap4City Platform**
  - **HOW TO: define privacy rules for personal data, produced by the end-users own device**
  - **US6. Developing and using processes for data transformation**
  - **TC6.1 - Managing DataSets via DataGate: ingest, search, download, upload, annotate, share**
  - **TC6.3 - Creating ETL processes for automated data ingestion and data transformation**
  - **TC6.5 - Managing Heterogeneous File Ingestion via ETL processes**
  - **TC6.9 - ETL processes for multiprotocol and format data ingestion, see on GITHUB for library**
  - **TC9.2 - Managing heterogeneous File Ingestion, protocols, formats via IOT applications, and open standards**
Snap4City is interoperable with:
- ESRI ArcGIS Enterprise, Portal, Pro/MAP, ...
- other GIS tools supporting WFS, WMS, GeoJSON, GML

Snap4City is interoperable since:
- Provides info/data in WFS, WMS
- Exploits data/info from WFS, WMS
- Imports data/info from WFS/WMS

The Snap4City platform can be installed on premise using Snap4City Appliance [https://www.snap4city.org/471](https://www.snap4city.org/471)
- StartSNAP4CITYVM includes the Dashboard Builder that is capable to work with WFS WMS protocols for the integration with GIS platforms as ESRI ArcGIS, QGIS, directly or using Snap4City GIS player.
- KBSSMVM includes the Smart City API and WFS API which can be used to data harvest from any GIS servers and GIS desktop tool.

Snap4City (C), January 2022
Linked Open Data

LOG: https://log.disit.org

Linked Open Graph

Schema: http://www.disit.org/km4city/schema
RDF version: http://www.disit.org/km4city.rdf
Development Life Cycle
Smart City Services

Analysis & Design

- Analysis
- Design
- Data Discovery
- Data Ingestion

Data Analytics

- Data Analytics Development
- Special Tool Development
- IOT App Development
- Dashboard Development

Development

- Deploy
- Testing
- Publication Production
Data Analytics Dev. in R Studio and/or Tensor Flow

- Knowledge Base, Km4City
- Ontology Schema
- LOG.disit.org
- Big Data Store Facility
- Smart City API from Knowledge Base and other tools
- SPARQL, FLINT
- Creating MicroServices
- Resource Manager
- Saving / Sharing reusing
- Using them into IOT Applications
- Swagger
Data Analytics Development in Python,

- Swagger
- SPARQL, FLINT
- ONTLOG.disit.org

Smart City API from Knowledge Base and other tools

- Creating Micro Services
- Saving Sharing Reusing
- Using them into IOT Applications

Knowledge Base, Km4City

Big Data Store Facility

Coding Testing

Resource Manager

Snap4City (C), January 2022
Loading new Node-RED nodes/microservices from external Palet

- Ask to RootAdministrator to have your custom Node-RED nodes/modules added to your IOT Applications
  - [https://www.snap4city.org/drupal/contact](https://www.snap4city.org/drupal/contact)
- A validation of requested Node-RED nodes will be performed to avoid violation of security and privacy for all
- Administrators may load custom Node-RED nodes/modules
- This limitation is not present in your on premise installations of Snap4City

Snap4City (C), January 2022
Development Life Cycle
Smart City Services

Analysis & Design
- Analysis
- Design

Data Discovery

Data Ingestion

Data Analytics Development

Special Tool Development

IOT App Development

Dashboard Development

Data Analytics

Development

Deploy
- Publication Production
- Testing
- Deploy
Dashboard List and Editor
Dashboard List and Editor
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
The Wizard help you in selecting only possible combination of data vs graphic representation.
Dashboard Builder: Development

- **Data Transformation**
- **Business Logic**
- **IOT Applications**
- **Knowledge Base, Km4City**
- **Knowledge and Storage**
- **Data from the Field and City + MyKPI ++**

**Widget Collection**
- **Micro Applications**
- **External Services**
- **Custom Widgets/Synoptics**

**Dashboard Wizard**
- Create, save, load, delegate, grant access, change ownership

**Dashboard Editor**
- My Own Dash/App
- Public Dashboard Collection

**Knowledge and Storage**
- Data from the Field and City + MyKPI ++
Developing new Dashboard Graphic Widget

• The development of new Widget is feasible for programmers
  – in PHP, JavaScript and CSS
    • The starting point is the Core Snap4City Virtual Machine Appliance StartSNAP4CITYVM:
      https://www.snap4city.org/471
    • While the source code is also accessible on GitHub/DISIT
    • see TC3.11 - New graphics widget can be easily created, Dashboard Widget Creation
  – creating a new Graphic widget via SVG and programming: Custom Synoptics and Widgets for Dashboards  https://www.snap4city.org/504
Custom Widget / Synoptic / PIN Development

1. Create and Load a Custom SVG
2. Select/Reuse an SVG
3. Make and Instance of Synoptic by Associate Variables with MyKPI
4. Create on Dashboard a Widget based on Synoptic HLT such as Ext. Srv.: 
   • https://www.snap4city.org/synoptic/v2/synoptic.html?id=xxxx

Inkscape editor on your computer
Create, save a Custom Widget in SVG
Create, save, load, delegate, grant access

SVG Symbols Collection

Dashboard Editor

Knowledge Base, Km4City
Knowledge and Storage Data from the Field and City

IOT Applications

Public Dashboard Collection
My Own Dash/App
- Smart parking
- Smart Energy
- Smart Light
- Smart ...
- Energy View
- Custom Controls
From-To Custom Widgets / Synoptics to Storage in WS

MyKPI

Sensors

Sensor

New Shared Variables

Constant Values

Web Socket Secure
Dashboards

• **Suitable** as: City Dashboard, App interface, and Control Room Dashboards, Situation Room Dashboard, Operator Dashboard

• **Created** visually compounding graphic Widgets
  – Each widget has an autonomous update
  – Each metric/data-source may have associated with an alarm: blinking and sending events to people and machines in different manners

• **Can be**: public or private, private dash can be delegated or passed in ownership


• See the following tutorials
  – **HOW TO**: create a Dashboard in Snap4City
  – **US1.** Using City Dashboards
  – **US2.** Using and Creating Snap4City Applications with Dashboards
  – **US4.** Creating City Dashboards and related Event Monitoring and Actions
Level 1 Users: using dashboards

- TC1.3. Accessing and using Dashboards with any device
- TC1.4. Dashboards Showing Data Real Time and Historical/trends, comparison
- TC1.5. Dashboards showing a range of different High Level Types: KPI, POI, IOT dev, MicroApp, Maps using different kind of Graphics Widget. Monitor city status with Dashboards
- TC1.6. Dashboards using different kind of graphics Widgets matching with High Level Types, Monitor city status with Dashboards
- TC1.12. Dashboard with MicroApplications
- TC4.1. Dashboard and Notificator
- TC4.6. Dashboard with city events, ESB, police, traffic, etc.
Develop Mobile & Web Applications Exploiting Snap4City Smart City Services

Smart City Services

Analysis & Design
- Analysis
- Design

Data
- Discovery
- Ingestion

IOT App Development

Data Analytics
- Analytics Development
- Special Tool Development
- Dashboard Development

Advanced Smart City API and MicroServices
- Snap4City Mobile & Web Apps Development Kit
- Application Requirements Analysis
- Application Development

Development
- Deploy
- Testing
- Publication Production

Deploy

Mobile and Web Apps
- Deploy
- Testing
- Publication Production
Developing Web and Mobile Apps, MicroApps,..

Mobile Apps

Web App HTML5, MicroApplications

Embed into Web pages

Advanced Smart City API

Knowledge Base, Km4City

Snap/Km4City Open Source development tool kit

Swagger

ServiceMap

City User

Developer

Mobile Application Monitoring Administrator

GitHub

Snap4City (C), January 2022
Special Custom Widgets

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

• Virtual Actuators (sensor-actuator)
  – From: Dashboard
  – To: IOT App, MyKPI, other Synoptics

• Virtual Sensors
  – From: MyKPI, Sensors, IOT App, other Synoptics
  – To: Dashboards

https://www.snap4city.org/663

Snap4City (C), January 2022
Alert Registration

Alerting Generation

This dashboard contains data derived from actual sensors and predictive values under validation.

Incident Kind: RIVER FLOODING
Severity: RELEVANT
People Involved: 10
Short Term Impact: PEOPLE DISEASE

Alert Events

Ticket: 1610755283300
Operator: PAOLO DISIT
15/01/2022 14:30:26

Ticket: 1610717428870
Operator: PAOLO DISIT
15/01/2022 14:37:27

Ticket: 1610717479691
Operator: PAOLO DISIT
15/01/2022 14:30:26

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA0OQ==

Snap4City (C), January 2022
How the Dashboards exchange data

Snap4City BigData Storage and KB

IOT Broker Orion Quantum Leap

API, External Services, MicroApp

ServiceMap
Super ServiceMap

- Req. ServiceURI

- Req. KPI, Metric ID

- Req. MyKPI ID

- Traffic Flow, MAPS, Heatmaps
  - GIS, HTTPs URLs
  - ServiceURI (ID)
  - MyKPI, Metric (ID)
  - Dynamic Data, computed into IOT Application
    - Rx. Dynamic Data
    - Event Driven Synoptics
    - Actions, Show
From IOT App to Dashboard
Private ChatRoom per Dashboard

Chat Management
IOT Network Interoperability
IOT Interoperability


https://www.snap4city.org/65
IOT/IOE Protocols

Communication Patterns

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

Broker Gateway

Broker Gateway

Brokers Gateways

Broker Gateway

Broker Gateway

Brokers Gateways

Discovery
Discover, register and “thrust” new devices on the network

Telemetry
Information flows from device to another system for conveying status changes in the device

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

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

Registration

Push

Bulk action

Snap4City (C), January 2022
# IOT Directory Features vs Users Roles (10/21)

<table>
<thead>
<tr>
<th>Entities</th>
<th>what</th>
<th>By using IOT Directory and:</th>
<th>Manager</th>
<th>AreaManager</th>
<th>ToolAdmin/RootAdmin</th>
<th>IOT App microservices</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOT Sensor/Actuator</td>
<td>Browse, use</td>
<td>Several Tools</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Delegate</td>
<td>API, ..</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Discovery</td>
<td>KB, API, ..</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Yes</td>
</tr>
<tr>
<td>IOT Devices</td>
<td>Browse, use</td>
<td>Several Tools</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Yes (use)</td>
</tr>
<tr>
<td></td>
<td>Create, change, delete</td>
<td>API, ..</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Register in Bulk</td>
<td>API, ..</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Delegate, Change Owner</td>
<td>API, ..</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Discovery</td>
<td>KB, API, ..</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Yes</td>
</tr>
<tr>
<td>IOT Device Model</td>
<td>Browse, Use</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>(Yes)</td>
</tr>
<tr>
<td></td>
<td>Create, change, delete</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td>(Yes)</td>
</tr>
<tr>
<td></td>
<td>delegate, change ownership</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>IOT Broker</td>
<td>Browse, use</td>
<td>use</td>
<td></td>
<td>Browse, use</td>
<td>X</td>
<td>Yes (use)</td>
</tr>
<tr>
<td></td>
<td>Register/change/Delete</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Deploy Orion Broker</td>
<td></td>
<td></td>
<td></td>
<td>ToolAdmin</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Delegate</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Periodic Update</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
<td></td>
</tr>
</tbody>
</table>

**Entities**: IOT Sensor/Actuator, IOT Devices, IOT Device Model, IOT Broker

**Roles**: Manager, AreaManager, ToolAdmin/RootAdmin, Delegate, API, Discovery, KB, API, microservices

**Features**: Browse, use, Create, change, delete, Register in Bulk, Delegate, Change Owner, Discovery, KB, API, Delegate, ownership

**IOT App microservices**: Yes, Yes, Yes, Yes (use), Yes, Yes, Yes, (Yes), Yes, Yes (use)
Integration via IoT Apps and processes
IOT Application Listing, they can be

- Basic (white)
- Advanced (red)
- IOT Edge
  - Raspberry Pi
  - Android
  - Win/Linux
- Data Analytic (Plumber)
- Web Scraper (Portia)
Integrated Node-RED development

Event Driven, real time data ingestion
**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.
Two Snap4City Libraries

Snap4City (C), January 2022

http://www.disit.dinfo.unifi.it

http://www.disit.org

https://flows.nodered.org/search?term=snap4city
Two Snap4City Libraries

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

We suggest also to install:

AND: From Resource Manager
Web Scraping

portia crawl police antwerp
Snap4City vs CKAN

**Datagate**

**Snap4City Portal and Integrated tools**

**Advanced Snap4City APIs and Micro Services**

**Harvesting and Publishing**

**Open or Private External CKAN Data Portals**

Automatize:
- Import data from CKAN to Snap4City
- Upload Public Data from Snap4City to CKAN
- Data Harvesting
- Dashboards and Mobile/Web Apps creation
Example of Integrated workflow

- **Consumptions/productions**
- **Events/actions**
- **Business Intelligence Maintenance**

OpenMaint: BPM Workflow management, team assignment, material control, ...

IOT App, Data event firing, event detection and firing

Critical event management

Dashboards and actions
• **Snap4City** can
  - Create new tickets
  - Manage steps, workflow
  - Collecting feedbacks and results from teams
  - Manage all phases of the workflow on the fields via IOT Apps and logics
  - The integration if via API and MicroServices into IOT App.
BIM Integration Dashboard

External REST Call API vs MicroServices

- Each REST Call API can be automatically transformed into a MicroService for the IOT Applications.

https://www.snap4city.org/129
Integration via IoT Apps on IoT Edge
Controlling Energy Power

Measuring Energy Consumption

IOT Edge: Node-RED + Snap4City

Measuring any kind of sensors values

Any kind of notification channel

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

Local Control

DCS

SCADA

Modbus

OPC UA

PLC

ODBC

Administrative Servers

Alexa: Voice Commands

Snap4City (C), January 2022

https://www.snap4city.org/369
Sonoff: Controlling Energy Power

Philips Hue: Controlling Lights

Hue: Motion Control / Alarm

Measuring Energy Consumption

TP Link: Controlling / Measuring Energy Plugs

Alexa: Voice Control

Snap4City (C), January 2022

https://www.snap4city.org/620
IOT Edge Device

IOT Devices

IOT Edge: Node-RED + Snap4City

Access to IoT Edge Maintenance

IOT Brokers

HTTPS

HTTPS

HTTPS

WSs

Remote Access/Control/program to your IOT Applications via secure connection

Other Local Connections

Search and Query, Smart City API
Facet, semantic search
Knowledge base
Semantic reasoners
Indexing and aggregating
Elastic search

Firewall Gateway
Towards internet

Snap4City (C), January 2022
Integration with GIS and ArcGIS

https://www.snap4city.org/drupal/node/368
GIS vs Sna4City

GIS Server can be: ESRI ArcGIS Enterprise, QGIS, GeoServer, ..
GIS Player can be: ESRI ArcGIS Pro, ArcGIS Portal, Snap4City WFS player, ...

• GIS:
  • Geographic Information System
• WMS:
  • Web Map Service
• WFS:
  • Web Feature Services
Snap4City is interoperable with:
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- other GIS tools supporting WFS, WMS, GeoJSON, GML

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- KBSSMVM includes the Smart City API and WFS API which can be used to data harvest from any GIS servers and GIS desktop tool
API, and Federation of Smart Cities via API
Internal and External Smart City API

https://www.km4city.org/swagger/external/index.html
https://www.km4city.org/swagger/internal/index.html
A Mobile App may refer to one Smart City API Server (for Area 1) via SUPER and receive data from the Federated SUPERS (Area 2) if navigation, queries, etc. are leading to discover out of the addressed KB.

- SUPER can be used for creating redundant and/or balanced distributed solutions for Federated KB. See Area 2, the two KB in the front.
- Federated SUPER ServiceMap can have overlapped KB even totally.
- A Mobile App can be developed to support multiple Smart City API servers, for balancing and

- The usage of Super (ServiceMap) is not mandatory so that separate services can be produced as well.
- SuperServiceMap and ServiceMap presents the same Smart City APIs.
Federation of Snap4City vs IOT ORION Broker

Federation of Snap4City vs IOT ORION Broker

- **Crate-DB**: 4200:4200
- **MongoDB**: 27017:27017
- **IoT Orion Broker**: 8668:8668
- **IoT Agent**: 4041:4041
- **Quantum Leap**: 8668:8668

**Connections**:
- Crate-DB to MongoDB: 4200:27017
- Crate-DB to MSI: 4041:1026
- MongoDB to MSI: 27017:1026
- IoT Agent to MSI: 4041:1026

**Services**:
- **SSM2ORION**: 1026:1026
- **SUPER**: 8668:8668

**Hybrid Solutions**

**Snap4City Solutions**

**Dashboard Builder**

Snap4City (C), January 2022
Snap4City IoT Registration and Access

A range of other data sources

A range of IoT Brokers and protocols

Data Connectors

Mobile Apps

IoT Directory

ServiceMap

Smart City API

Dashboard Builder

Authentication and Authorization

IoT Agent

IoT Orion Broker

MongoDB

Area

Area

Area

Area
Linked Open Data
Km4City: Knowledge Base

- Multiple DOMAINS
- Geospatial reasoning
- Temporal reasoning
- Metadata
- Statistics
- Risk and Resilience
- Licensing
- Open and Private Data
- Static and Real time
- IOT/IOE

Ontology Documentation:
http://www.disit.org/6506
http://www.disit.org/6507
http://www.disit.org/5606
http://www.disit.org/6461

Schema: http://www.disit.org/km4city/schema
RDF version: http://www.disit.org/km4city.rdf
Smart-city Ontology km4city

Linked Open Data

https://www.snap4city.org/19
Views of the Knowledge Base

• How pass from ServiceMap to Linked Open Graph, Linket Data view tool

Snap4City (C), January 2022
Linked Open Data

LOG: https://log.disit.org

Schema: http://www.disit.org/km4city/schema
RDF version: http://www.disit.org/km4city.rdf
Linked Open Data

LOG: https://log.disit.org
Platform How to Add new features capability and constraints
Development Life Cycle
Smart City Services

Analysis & Design
- Analysis
- Design
- Data Discovery
- Data Ingestion

Data Analytics
- Data Analytics Development
- Special Tool Development
- IOT App Development
- Dashboard Development

Deployment
- Deploy
- Publication Production
- Testing
- Production
Adding new Features

- **Dashboard Features** --> Custom Widgets, Widgets
- **Connectors, adapters, IoT protocols, data transformations**, etc. --> by creating new MicroServices, new flows or new IoT Apps ...
- **Applications, Modules** --> for management, for verticals, in the core by using
- **IoT Devices** --> for collecting new data kind or acting on the field
- **Processes** --> Data Analytic of any kind, also exploiting machine learning, gpu, etc.
- **Web and Mobile Apps** --> new end-users services
- **Dashboards**
- **IoT Applications**
- **Data ingestion process**, integration, etc.
- **External Services** to be exploited on Dashboards
- etc. etc.
Adding new Features

• **Dashboard Features** --> Custom Widgets, Widgets
  - they can be created by using the Custom Widget SVG approach
    - **TC1.22a**: Create and configure a Snap4City SVG Custom Widget for real-time interaction
    - **TC1.22b**: Create and configure a Snap4City SVG Custom Widget for real-time interaction
    - Custom Widgets: Table explanation, as SVG
    - **TC1.26**: Use customised SVG pins in a map
    - **TC9.19**: Custom Widgets / Synoptics controlled by IOT Applications
  - they can be created by developing new elements programming in PHP, JavaScript, Angular, D3, etc..
    - Custom Synoptics and Widgets for Dashboards

• **connectors, adapters, IoT protocols, data transformations**, etc. --> by creating new MicroServices, new flows or new IoT Apps ...
  - HOW TO: Develop an IOT Application for Data Ingestion
  - they have to be in Node.JS, JavaScript according to Node-RED
    - Snap4City Supported Protocols, adding new protocols
    - how to create a flow and nodes in Node-red: [https://nodered.org/docs/creating-nodes/first-node](https://nodered.org/docs/creating-nodes/first-node)
  - They can be automatically created from API rest call
    - **TC2.25**: Registering external MicroService calling RestCall services, using it on IOT applications
    - business logic behind a dashboard
      - **TC9.19**: Custom Widgets / Synoptics controlled by IOT Applications
Adding new Features

• Applications, Modules --&gt; for management, for verticals, in the core by using
  • any language you prefer, preferably exposing API for integration with other modules
    • https://www.km4city.org/swagger/external/index.html
    • https://www.km4city.org/swagger/internal/index.html
  • See Tutorial on how to transform any REST API in a MicroService
    • TC2.25. Registering external MicroService calling RestCall services, using it on IOT applications

• IoT Devices --&gt; for collecting new data kind or acting on the field
  • HOW TO: add a device to the Platform
  • HOW TO: Manage IOT Network Components on Snap4City
  • you can add to the platform any kind of IoT Device, with any kind of IoT Protocol
  • You can exploit the open source for Android and raspberry for creating your safely connected IoT device with Snap4City using NGSI V1, V2 and exploiting our secure communication approach

https://www.snap4city.org/692
Adding new Features

• **Processes** --> **Data Analytic** of any kind, also exploiting machine learning, gpu, etc.
  • see tutorial on Data Analytics
  • https://www.snap4city.org/download/video/course2020/da/

• **Web and Mobile Apps** --> new end-users services
  • https://www.snap4city.org/download/video/course2020/app/

• **Dashboards: Dashboard Builder and Kibana**
  • https://www.snap4city.org/download/video/course2020/das/

• **IoT Applications in Node-RED**
  • https://www.snap4city.org/download/video/course2020/iot/
  • data ingestion process, integration, etc.
    • https://www.snap4city.org/download/video/course2020/di/

• **External Services to be exploited on Dashboards**
  • by simply registering their URLs on the portal
    • https://www.snap4city.org/55

• **Workflows: via OpenMaint**
  • TC 1.24 – Integrated Ticketing and Facility Management system

• **BIM models** via Bim Editor for IFC production → Bim Server
  • HOW To: Manage BMP and BIM: main features of openMAINT, BMP, BIM
  • etc. etc.
**Constraints**

- **new version modules**
  - to be integrated in the main version, have to be tested and validated by DISIT Lab. They have to:
    - be in Affero GPL
    - do not affect the functionalities of other modules in negative manner
    - provide the needed quality, in terms of test cases, documentation, etc.
  - If they are not part of the core,
    - can be based on proprietary model, and exploit the Snap4City tools via APIs
      - no constraints
    - but forked, they need to be published version on Internet and linked to main according to Affero GPL.

- **Snap4City modules are mainly in Affero GPL**
  - platform rebranding is not allowed
Snap4City/Industry: Smart Solution IOT as a Service
Smart Solution IOT as a Service

• Snap4xxxx applications may exploit multiple paradigms as data driven, stream and batch processing, putting co-creation tools in the hands of:
  – **Smart Living Lab** users and developers a plethora of solutions to develop applications without vendor lock-in nor technology lock-in,
  – **final users** customizable / flexible mobile Apps and tools,
  – **city operators** and decision makers specialized / sophisticated city dashboards and IOT/IOE applications for city status monitoring, control and decision support.

Open to Organizations

• Training and manuals: [https://www.snap4city.org/108](https://www.snap4city.org/108)
• Help Desk: [https://www.snap4city.org/3](https://www.snap4city.org/3)
• SLA: [https://www.snap4city.org/497](https://www.snap4city.org/497)
• Terms of Use: [https://www.snap4city.org/drupal/legal](https://www.snap4city.org/drupal/legal)

Snap4City (C), January 2022
Snap4xxxx as Smart Solution IOT as a Service for

• Who would like to create Living Labs as community exchanging experience with other cities as well;

• Research Institutions, Departments and Projects which would like to perform research and experiments in the area of Smart City and IOT, without the needs of setting up the infrastructure, exploiting open data, collaborating, accessing to Data Analysis on demands, etc. This is the spirit of EOSC, European Open Science Cloud Marketplace at which Snap4City is registered as DISIT Lab, see [EOSC].

• Public Administrations, as small cities that would like to offer smart services and does not have economic power to manage service on their premise from them self.
• https://www.snap4city.org/drupal/contact

• Bug Reporting
  – https://docs.google.com/forms/d/e/1FAIpQLSfDQtKqgLllyycNXiazeYEk1SsRG1YL8Ze4ThD8nZoA5jsoXw/viewform

• For Service Level Agreement see:
  – Service Level Agreement

• Help Desk and Contact:
  – https://www.snap4city.org/3

• Availability rates:
  – https://www.snap4city.org/388
Providing consulting, customization, training, and developments

• Snap4City solution can be installed on premise and one cloud, private and public.

• Snap4City (DISIT Lab and/or Snap4 SRL (INC.), or other companies as well), provide support, if needed, for design and/or Develop, set up:
  – Training and tutoring;
  – Snap4xxxx infrastructures and architectures;
  – data analytics, that could be developed as proprietary solutions for the customer or as open source;
  – data ingestion processes, to enable them to have data into the platform;
  – adaptor for some specific protocol or legacy/third part Tool, that we prefer to release as open source, but if the connection is with some proprietary tool, the buyer could be interested to keep these solutions as private;
  – IOT devices, full solutions, dashboards, specific dashboard widgets, etc.
Data Adapation, Transformation, Conversion
Integration
Business Logic vs Dashboards
Data Analytics control
Everywhere: Cloud, on IoT Edge Devices
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.
Jan. 2022 collection
Two Snap4City Libraries

https://flows.nodered.org/search?term=snap4city
Two Snap4City Libraries

Jan. 2022 collection

We suggest also to install:

AND: From Resource Manager

https://flows.nodered.org/search?term=snap4city
Two Snap4City Libraries

- Search and management of Services, POI, Parking, Public Transport, etc.
- Event management, ticket management
- Routing, Data Analytic, Open Data processing
- IOT adaptation, network management
- Dashboard management
- Personal data management, KPI, etc.

Nov. 2020 collection

Snap4City (C), January 2022
Control Room Operator
- Monitor traffic flow, Environment, Car parking, Cycling, First aid, temp., ...
- Registering Events: classification
- Changing status
- Acting

https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MzA0OQ==
Dynamic Dashboards: changing from IOT App

• Dynamic Creation of Widget Content: BarSeries, trends, maps, single content, etc.

• Temporary data pushed on Dashboards
• provides real time smart city services to Telegram users, geolocalized, when you like, what you like
• active on Tuscany in all provinces and cities according to the data accessible on Https://www.snap4city.org
• Services on
  – Public Transport (more than 10 different operators),
  – bike sharing, parking lots,
  – traffic flow, weather warnings,
  – Air quality, pollutant,
  – find your location, etc.
IOT App of SnapBot: OneShot Services

Exploiting Node-RED Snap4City MicroServices
SNAP4CITY LIVING LAB FOR COLLABORATIVE WORK
Smart City Process

• Many aspects should be taken into account for a successful Smart City transformation

  → The influence of each of them depends on context, attitude of the institutions, internal structure, etc.
    – Parallel actions can conflict, compete ...
    – Spreading of efforts may distance the goals
    – ……

• The process may become sustainable, harmonized and faster with a Living Lab Strategy and Support
The Living Lab
Concepts and Organization
Snap4City tools and Living lab Solution have been Created to satisfy requirements of international organizations as:

- **ENOLL**: [https://www.openlivinglabs.eu/](https://www.openlivinglabs.eu/)
  - European Network of Living Labs

- **EIP-SCC**: European Innovation Partnership on Smart Cities and Communities
  - [https://eu-smartcities.eu/](https://eu-smartcities.eu/)

- **Select4Cities**: Pre-Commercial Procurement Project to develop a data-driven, Internet-of-Everything (IoE) platform for large-scale urban co-creation
  - [https://www.select4cities.eu/](https://www.select4cities.eu/)
1° place award to

UNIVERSITY OF FLORENCE - DEPARTMENT OF INFORMATION ENGINEERING

for SNAP4CITY

https://www.snap4city.org/558

DIGIPOLIS
FORUM VIRIUM HELSINKI
CITY OF COPENHAGEN
Buyers Group
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 scenarious

• **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**
Non functional requirements

• **Open Source** based 100%
  – Open **Standard** for communication and API for In/Out
• **Interoperability**: protocols, internal API, Smart City API, capable to 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.
Aspects of the Living Labs

• Living lab capabilities and supports
  – Organizations are supported in the user management and persecuting their goals
  – Projects can be launched and targeted with groups, hackathons, tools, etc.
  – Individual (user interaction), are supported by tools and training material

• Instruments of the Living Lab
  – Real-life context: data and solutions to be taken as examples, from devices to IOT Applications, and Dashboards. A large set of real scenarios described
  – Multi-stakeholder: mainly apply to organizational, a community from where anybody can take advantage
  – Multimethod: the same results can be obtained by using multiple methods
  – Active user co-creation: the platform cansupports: collaborative work, supervising by the teachers, sharing and delegation.
  – Secure: it is GDPR compliant and passed PENTest and Vulnerability Test
Living Lab Flexibility

Snap4City Satisfies all Requirements of ENOLL Select4Cities and EIP-SCC

- Multiple modalities to perform the same activities
- Tuned for Beginners and Skilled people
- Visual interface and programming tools
- Resources and artefacts sharing for learn acceleration and co-working
- Open Living and co-working Portal: https://www.Snap4City.org
Smart City Start Up vs Living Lab

GO!

Collaborative Platform

Start
Engagement

• Finding the right participants to the Living Lab
  – Campaigns tailored to the right audience according to the role: testing, developers, requirements collections, etc.
    • Finding specific profiles via stakeholders
    • And/OR: Web based recruitments, App Based, etc.
  – Motivation to participate, eventual incentives

• Inform/educate the Participants about the project:
  – after and before testing/validations, etc.

• Protect the Participants privacy, ask to NDA and provide the NDA, GDPR compliant

• Support: during the project, SPOC, Help-Desk, web portal, logistic
The Living Lab
Snap4City Tools
Most of Organizations on Snap4City.org also correspond to companies or institutions that have an installation of Snap4City tools on their Premise,
  – such as: Pisa, SmartGarda Lake, Snap4, ALTAIR, etc.

This double way allows them to:
  – test the news,
  – share experiences with other groups,
  – get visibility,
  – work in the collaborative environment, and
  – be better supported by Snap4City.org and DISIT Lab personnel.

Each instance of Snap4xxxx solution can decide to join the federation of SmartCity API to exploit shared data.
  – This allows to exploit regional data for city installations applications (web, mobile, dashboards, etc.) without reloading them for example.
Who is using the Living Lab of Snap4City today

- **Snap4City.org**: multiple Organizations
  - **DISIT**: Univ. Milano, Univ. Firenze, Univ. Cagliari, etc.
  - **Firenze**: City Firenze, and inhouse companies
  - Multiple Organizations for **HeritData pilots**:
    - Firenze, Valencia, Dubrovnik, Mostar, WestGreece, Pont Du Gard
  - **CAPELON**: Capelon Sweden
  - ...Antwerp, Helsinki, ...

- **Snap4Pisa** on MOBIMART: AEDIT, Pisa, PISAMO, ....

- **SmartGardaLake**: SmartEA, Univ. Brescia
Snap4City: Living Lab supporting tools

• All 100% Open Source
• Snap4City web portal
  – Scenarios with ready to use solutions
  – Organization/Groups and co-working support
  – Developing tools and Documentation, training, tutorials, HOW TO...
  – Self Assessment tools to monitor your progresses to get suggestion
  – Assistants: to get training and problem solving
• Developing tools
  • All of them are Web-Based developing tools (except for the Mobile App on Android and iOS)
• Resource Manager for Sharing:
  • experiences, data warehouse tools, IOT Applications, Data Analytics, etc.
• Hackathons:
  – IOT Apps, Dashboards, Mobile Applications, Data Analytics, etc.
MultiOrganization, Groups and Profiles

Organizations may have their distinct:
• menus and functionalities, GeoArea, Data, Dashboard, Groups of users, managers, Knowledge Base, repositories, etc.

Users may:
• Have personal IOT Devices/Models, Data, IOT brokers, Dashboards, IOT App,..
• Have access to multiple Groups of Multiple Org.
• Delegate them in usage or access
• Change ownership and Clone to pass a copy
• Assesses their usage and themselves, share
Level 1 Users: creating dashboards

See how Dashboards can be created using the wizard: dashboards with selectors, time trends, maps, etc.

- TC1.8. Visual production of Dashboard via Wizard
- TC1.9. Search on Wizard for any kind of data managed into the platform, from POI to sensors, KPI, social, etc.
- TC1.10. Dashboard delegation to access, and passage of ownership, and/or cloning
- TC1.11. IOT Discovery, on Dashboard Wizard
- TC1.13. Dashboard Builder External Services and Widgets

Snap4City (C), January 2022
All Text on the Portal are Hypertext with Links for navigation among major concepts
For the user: different levels of engagement

- **Manager: Final Users**
  - Level 1: create Dashboards
  - Level 2: create Dashboards that get and produce data, act on city
  - Level 3: add your own IOT Device, create Dashboards with them and city data
  - Level 4: create IOT Applications to make smarter your Dashboards, services, notifications, exploiting MicroServices

- **Area Manager: Developers, Researchers, Operators (Level 5):**
  - Developer of complex services exploiting: R Studio, ETL, External Services, ...
  - Creating: MicroApplications, MicroServices, web and mobile application exploiting Advanced Smart City APIs, ...
For the user: different levels of engagement

- Multiple Organizations
- Roles:
  - Managers
  - AreaManagers (developers): special access to computing resources
- Levels for self-assessment
  - Suggestions on next steps to learn on the basis of personal progresses
Self Assessment

Snap4City (C), January 2022

My Personal Statistics and Bounds
Username: snap4city
Role: AreaManager
Level: 4
2016-11-09

User's Limits:
- Dashboards: 100
- IoT Apps: 100
- IoT Devices: 10000

- # Dashboards (public/private): 30 (23/7)
- # Dashboards Accesses: 77
- # Dashboards Runs: 1050

- # IoT devices (public/private): 3216 (70209)
- IoT Rb (Rx/Rx): 9973.79/209.62
- Rb K (Rx/Rx): 13
- CTL Kb: 13

- IoT messages tx (kB) - average 866.2
- IoT Apps (kB) - average 435614
• https://www.snap4city.org/drupal/contact

• Bug Reporting
  – https://docs.google.com/forms/d/e/1FAIpQLSfDQtKqgLlIyycNXiazeYEH1SSRg1YL8Ze4ThD8nZoA5jsoXw/viewform

• For Service Level Agreement see:
  – Service Level Agreement

• Help Desk and Contact:
  – https://www.snap4city.org/3

• Availability rates:
  – https://www.snap4city.org/388
Resource Manager: public and sharing
Living Lab
Snap4City Hackathons
SNAP4CITY HACKATHON
BUILD YOUR APP FOR A CONNECTED CITY

Open from
Jan 21 - Mar 15

CLICK HERE TO SEE THE HACKATHON WINNERS

see interim winner Fast Rabbit
Hackathon Organization

• OnLine Hackathon 2019
  – Call 2019. [https://www.snap4city.org/370](https://www.snap4city.org/370)
  – Multiple Categories to avoid mixing companies with students, professionals with lovers, etc.
  – Locations: Helsinki, Antwerp and Tuscany at the same time
  – Multidisciplinary judges
  – Intermediated checkpoint(s) to help teams to improve and strive them toward the goals.

• Support: 100% online
  – All training already accessible
  – All online tools and support

• Several Teams have been engaged
  – Engagement via social network and on the area

• Multiple selections to refine the solutions, :
  – [https://www.snap4city.org/416](https://www.snap4city.org/416)

• Awards and price of different kinds
  – [https://www.snap4city.org/449](https://www.snap4city.org/449)
Validation with developers

- Helsinki and Antwerp, plus Florence Training, CINI Challenge, ..
- 65 performed operational activities:
  - dashboards, IOT Applications, registering IOT devices, etc.
  - More than the 80% created both Dashboards and IOT Applications, thus validating the solution and the process of engaging them in working on the platform

<table>
<thead>
<tr>
<th>The 65 users</th>
<th>left on platform</th>
<th>Average per day over last 90 days</th>
<th>Total activity 90 days</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of IOT Applications</td>
<td>117</td>
<td>81,6</td>
<td>7341</td>
</tr>
<tr>
<td>Number of private IOT devices</td>
<td>27</td>
<td>25,5</td>
<td>2296</td>
</tr>
<tr>
<td>Number of public dashboards</td>
<td>11</td>
<td>6,2</td>
<td>562</td>
</tr>
<tr>
<td>Number of private dashboards</td>
<td>173</td>
<td>135,1</td>
<td>12159</td>
</tr>
<tr>
<td>Number of accesses to dashboards</td>
<td>--</td>
<td>33,9</td>
<td>3048</td>
</tr>
<tr>
<td>Number of minutes</td>
<td>--</td>
<td>337,1</td>
<td>30337</td>
</tr>
</tbody>
</table>
Data-driven design platform for offline advertising

Built on big data to determine the most popular location for a customer group.
Automatically select billboards with the highest traction. The platform is capable of predicting the reach of every location on a city based on big data analytics.

Skyrocket the traction of offline campaigns
Citizens will run into more relevant advertisements resulting in higher conversion rates and more successful campaigns.
Hackathon Data Focus

https://www.snap4city.org/755

Tuscany region which is a region with more than 3.5 M of inhabitants.
MicroService, API and services for routing and multimodal routing in Tuscany, etc.
regarding:
• Road model for the whole Tuscany, plus routing
• car parking status,
• public transport operators,
• bike sharing,
• Pollutant sensors,
• traffic flow sensors,
• Weather sensors,
• points of interests,
• Pollination sensor,
• Heatmaps of several kind
• picking from heatmaps,
Challenges

• full freedom for creating new and innovative solutions
  • to improve the future of mobility and transportation systems in the cities in which we live.

• For example:
  • sustainable mobility and transport
  • services for ITS
  • addition of devices and data and their usage
  • interesting data analytics on accessible data
  • predictive models and solutions
  • services for the final users in city or rural areas
  • event driven solution and early warning
  • anomaly detections of critical conditions.
  • etc.
THE VIEW OF THE ADMINISTRATORS
Snap4City/Industry Architecture, V1/V2

Data Sources, External Services
- Pull Data

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

Data Ingestion, aggregation, regularization, reconcile
- NIFI
- Tools, ETL, DISCES
- IOT Apps

Big Data Cluster
- HDFS, Hbase, Phoenix

Knowledge base
- Semantic reasoners

Indexing and aggregating
- OpenDistro x Elastic search

Search and Query, Smart City API
- Facet, semantic search

Data Analytics
- R, Tensor Flow, Python, MapReduce, ...

Visual Analytics

IOT Applications
- Node-RED + Snap4City MicroServices

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

In Yellow Alternative Snap4City V1
Roles in Snap4City/Industry solutions

• **RootAdmin**
  – The gods of the specific installation, access to all tools for all Organizations

• **ToolAdmin**
  – The administrators of an Organization with some capabilities on single tools

• **AreaManager**
  – Typical developer capabilities, access to development tools, access to a wider number of resources, IOT with both basic and advanced, IOT Models, etc.

• **Manager**
  – Final users, limited access to development, IOT App development with Basic library.

• **Users of any Role** have full control on their own resources: data, devices, dashboards, IOT App, etc., which may control according to GDPR rules,
  – providing access, revoking, etc.

• **All users start as Manager roles**
  – All users have also a Level (numeric). A score about what they have exploited in the platform. Higher scores correspond to wider exploitation of capabilities.

• **RootAdmin users may**
  – pass Users to higher roles. Ask to snap4city@disit.org to become an AreaManager for testing
  – Provide/grant specific authorizations to data access on Tool usage

• In the Installation onPremise, you become the RootAdmin of it, you decide ALL.
Management by Organization

- **Organizations** may have
  - name, ID, GPS center, a number of Groups on Snap4City.org (living lab support Drupal)
  - users of different kinds and may impose early bounds on the resourced used by users (IOT Dev, IOT App, Dash)
  - on cloud user kinds up to level of Tool Administrator
  - One or more ServiceMap and boundaries for the federation

- **ToolAdmin** users (requested by Organizations) may
  - control processes, consumption of resources, healthiness, etc.
  - manage tools exploited in your configuration

- **24H/7D Help Desk and Assistance**
• RootAdmin on Snap4City.org has a very large set of tools
  – My Snap4City, ....Tour, etc.
  – Dashboards
  – 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
  – Settings
  – User Management and Auditing
  – Help and Contacts
  – Documentation and Articles
  – .......

In this section of the slides, those market in bold are presented.
Extra Dashboard Widgets

- Micro Applications
- External Services, WebPages
- Register External Service, WebPage
- Custom Widgets / Synoptics
- My Data Selection for Synoptics
- Register Custom Widget Template
- Doc. MicroApplications
- Doc. External Services, WebPages
- Doc. Synoptics, Custom Widgets

MicroApplic.

External Services

Synoptics, Custom

Snap4City (C), January 2022
• **Data Inspector**: to understand and see Digital Twin details of data
• **MyKPI, MyData, MyPOI**: to model and save your personal data
• **My Groups of Entities**: to create an aggregation of Snap4City architectures, entities to manage them in one shot
• **Data Table Loader**: fast load Excel file as IOT Devices, IOT Device Model and instances
• **POI Loder**: fast load of Excel file with POI
• **Harvesting**: satellite: to request data from Satellite services and make from them heatmaps
• **Heatmap Manager**: management of GeoTiff heatmaps as sequence of complex data
• **Traffic Flow Manager**: management of Traffic Flows as sequence of complex data
• **Color Map**: to code rendering colors of other Managers
• **BIM**: support 3D for the Digital Twin Local
• **Open Data, CKAN**: harvesting and publishing open data
Managing Groups

• **My Groups of Entities**
  – Licensing group of Entities in One Click

For non admin tools see other Training parts:
https://www.snap4city.org/577
A group may include a number of:

- IOT Devices, Dashboards, MyPOI, MyKPI, Synoptics, IOT DeviceModels, MyData, Synoptics Templates, IOT Brokers, IOT Sensors/actuators,..

Once the Group is created, the group owner can:

- Produce a license to grant access at all the Group Entities in one click
Knowledge and Maps

- A number of ServiceMaps, Knowledge bases, KB
- Tools for creating WKT, shapes
- Access to ServiceMap 3D, if any
- Service for Loading triples on KB
- My Annotations (deprecated)
- Mapping Tool (partial)
- GIS servers, if any
- Static GTFS editor and manager (if any)
IOT Applications

- IOT Applications: a view to manage Containers / IOT Edge Apps: IOT Apps, Data Analytics (R and Python), WebScraping, IOT edge, etc.

Managing also

- MicroServices for IOT App exploiting REST Call
- MicroServices from DataAnalytics

For non admin tools see Training parts 3 and 5: https://www.snap4city.org/577
IOT Directory and Devices

- For non admin tools see Training parts 3 and 5: https://www.snap4city.org/577

- Automated NGSI V2 brokers harvesting and registration

- IOT Device Models and Instances

IOT Directory manages multiple internal and external IoT Context Brokers
• Tools for managing shared resources among Organizations and Users

• For non admin tools see Training parts: https://www.snap4city.org/577
Development Tools

• All these tools are well described into Training parts: https://www.snap4city.org/577
• The Administrators may
  – access to all instances of them
  – Grant access to them at specific AreaManager users

• API and Swagger documentation
• Model Knowledge Base Graphs (LOG.disit.org)
• Python online dev. Environment
• R Studio Online dev. Environment
• WebScraping tool
• SPARQL Editor and tools (custom FLINT)
• ETL OnLine dev. Environment (deprecated)
Decision Support Systems

- All these tools are well described into Training parts: https://www.snap4city.org/577
- Some of these tools need special VM / appliances, services to be activated
- Most of them are accessible to the public at least with guest account
- The Administrators may
  - access to all instances of them
  - Grant access to them at specific AreaManager users
• **Menu Management:** for managing main menu and submenu, on web and mobile, and those of the Organizations on Dashboards

• A number of configurations for the Dashboard Manager (most of them are valid only for OnPremise solutions, and/or V1 infrastructure approach)
Multilingual Support and Translation Management
Multilingual Support, Any Language, UTF8

- Fully supported on CRM (drupal), Node-RED (IOT App)
  - See modules of those tools
- Partially developed for:
  - Dashboard Builder
  - Resource Manager
  - Other Tools...
  - Menu Manager
  - JavaScript Strings

To add a new language use POEDITOR (open version)
Ask for last file to snap4city@disit.org
You can contribute on GitHub https://poeditor.com/

To add a new language use Translation Manager as Administrator
Translation Manager

**Translation manager**

<table>
<thead>
<tr>
<th>Id</th>
<th>Reference Text</th>
<th>Language</th>
<th>Translated text</th>
<th>Edit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Settings</td>
<td>r_IT</td>
<td>Impostazioni</td>
<td>EDIT</td>
</tr>
<tr>
<td>2</td>
<td>Dashboards (Public)</td>
<td>r_IT</td>
<td>Dashboards (Pubbliche)</td>
<td>EDIT</td>
</tr>
<tr>
<td>3</td>
<td>Dashboards</td>
<td>r_IT</td>
<td>Dashboards</td>
<td>EDIT</td>
</tr>
<tr>
<td>4</td>
<td>Notificator</td>
<td>r_IT</td>
<td>Notificatore</td>
<td>EDIT</td>
</tr>
<tr>
<td>5</td>
<td>My Snap4City.org</td>
<td>r_IT</td>
<td>My Snap4City.org</td>
<td>EDIT</td>
</tr>
<tr>
<td>6</td>
<td>Resource Manager</td>
<td>r_IT</td>
<td>Gestore Risorse</td>
<td>EDIT</td>
</tr>
<tr>
<td>7</td>
<td>Data Set Manager: Data Gate</td>
<td>r_IT</td>
<td>Data Set Manager: Data Gate</td>
<td>EDIT</td>
</tr>
<tr>
<td>8</td>
<td>IOT Applications</td>
<td>r_IT</td>
<td>Applicazioni IOT</td>
<td>EDIT</td>
</tr>
<tr>
<td>9</td>
<td>My IOT Devices</td>
<td>r_IT</td>
<td>I miei Dispositivi IOT</td>
<td>EDIT</td>
</tr>
<tr>
<td>10</td>
<td>Documentation and Articles</td>
<td>r_IT</td>
<td>Documentazione e Articoli</td>
<td>EDIT</td>
</tr>
<tr>
<td>11</td>
<td>Micro Applications</td>
<td>r_IT</td>
<td>Micro Applicazioni</td>
<td>EDIT</td>
</tr>
</tbody>
</table>

**Add new translation**

- **Reference Text:**
- **Settings**
- **Language:** ja_JP
- **Translated text:** 設定

**Import menu**

- **Select menu type:** MainMenu
- **Translate in language:** ar_SA

Snap4City (C), January 2022
• Keyworks as Main Tools names should remain in English
• Names of the resources remain in the language in which they have been created/defined
User Management
User Management and Auditing

• All that the RootAdmin needs to manage:
  – User Management: for managing
    • accounts and profiles
    • limits of the users in exploiting resources
    • Accesses and providing special authorization
    • Organization vs Groups of users
    • Users vs Organizations
  – Users vs Web and Mobile Applications
    • Engaging and monitoring users on platform and devices
  – Users on Chats room of Dashboards
    • Managing Users on Chats of Dashboards
  – Auditing of the data and resource accesses
    • Auditing all the activities on the platform (see next section)
    • Personal auditing
User Management

- User Management via Drupal or Local Users Management without CRM.
- User Limits controlling resource consumption
- User Engagement: see mobile App training part
- Roles and LDAP management
- Managing Resources vs Users' Ownership and granted accesses to the resources
- Organizations and their Groups of users
- Users vs Organizations
- AND User Access Authentication via KeyCloak
User Management and Users’ Limits

Controlling exploitation of resources

Managing roles and authorizations

Snap4City (C), January 2022
Auditing Activities

- Auditing Data Access Try-out
- Auditing Elements vs Ownership
- Auditing Personal Data
- Auditing Accesses Authentication
- Auditing User Activities
- Auditing Activities on Queries
- Auditing Activities on Articles
- Auditing IOT Directory Data
Platform Management
• **Tools for Platform Management.**
  – Most of them only accessible for RootAdmin and OnPremise

• **Tools can be grouped in the following families**
  – AMMA Traffic Analyzer as OpenDistro (Elastic Search, Kibana)
  – DataAnalyzer (DevDash): monitoring and browsing data ingested into OpenDistro (ElasticSearch, via Kibana (see on top as My Data ..))
  – Container Monitoring and Management
  – IOT App Version Management of Snap4City tools
  – Smart City API traffic monitoring
  – MyKPI Monitoring
  – DISCES schedulers monitoring and management (V1 infrastructure versions)
  – Mobile Applications Monitoring
  – Management of Images and Comments from Smart City API, Mobile and Web Apps
  – Management of OnLine Helps (not active)
Customer Relationship Manager Integration and Living Lab basic
Living Lab vs DRUPAL

• Based on Drupal 7 and only
  – A Few Custom modules have been adapted and are distribution on GITHUB/DISIT
  – Full Customizable by adding Drupal modules as usual

• User Management registration and mailing
  – LDAP connection for role management
  – KeyCloak connection for SSO / Authentication (OpenID Connect)
  – Management of user profile
  – Authorization to access at the web pages.
  – User profile management for Role and Details + statistics

• Content management for Organizations and Groups
  – Indexing of all content and search
  – Content Distribution: web pages, newsletters, articles, comments, Video, technical notes, training
    • Statistics on their usage
  – Reports and views regarding living lab usage, and web pages
  – Organizations vs Users
  – Organizations vs Groups
  – Tracking and monitoring
  – Production and distribution of NewsLetters

• Open to full contributions and comments
  – Comments on web pages, ...

• Etc.
• Each Organization may have:
  – A number of groups to which the users can subscribe
  – A number of dashboards produced by the users
  – A number of IoT Devices, IoT Device Models,
  – A number of POI
  – Etc.
  – A dedicated Splash Page
    • It can be customized by an user of the Organization
    • Ask to activate one
  – Etc.
Organizations vs Groups vs Users
AMMA Traffic Analyzer
OpenDistro (Elastic Search, Kibana)
**AMMA**

- Managing and Monitoring Data-Traffic in the BackOffice
  - Data Traffic Analyzer
    - Business intelligence
    - Faceted searches
    - Drill down on time
  - Several different views and details on data traffic among the main entities in the platform:
    - IOT APP
    - Storage
    - Data sources,
• There are API for Event Logger, REST API
  – They are automatically used by most of the Snap4City MicroServices
  – They log in standard Rsyslog API
    • https://www.snap4city.org/56

• The Logs regarding messages passed and usage are logged and accessed with the AMMA tools that is based on OpenDistro per Elastic Search and Kibana.
  – Former version was made in Hbase and SOLR, and Banana

• Additional Logs events can be logged by using a dedicated MicroService in Node-RED, IOT Apps
AMMA (1)

Monitor data traffic flows among IoT devices, services, applications etc. and detect potential anomalies.

Unexpected behaviors can be revealed by inspecting the data flow time trend:

a) detecting peaks or valleys in the trend
b) drill-down on data to identify single/more malfunctioning devices and/or services

quantitatively monitoring data/message traffic and flows
AMMA (2)

Make drill-down activities on data related to a single Process ID and check for unexpected behavior in the Time Trend panel:

- **c)** Filtering data by the Process ID (e.g., for example those related to a SmartWaste container)
- **d)** Detect a peak with more data traffic than expected during its scheduled activity, by properly filtering on time, the single data portion corresponding to the unexpected data flow can be viewed
- **e)** Locate on map the single involved device or service
DataAnalyzer (DevDash): monitoring and browsing data ingested into OpenDistro per Elastic Search, via Kibana
DevDash: My Data Dashboard Kibana

My Data Dashboard Kibana

COUNT EVENTS

EVENT COUNTS

FACET FIELDS v1

DEVICE NAME

ORGANIZATION PIE

DISTRIBUTION VALUE NAME

My Snaps
dashboard
My Dashboards in
All Org
Dashboards of My Orga
zation
My Dashboards in My Orga
zation
My Data Dashboard Dev
Kibana
My Data Dashboard Kibana
Extra dashboard widgets
Notifier
Data, my Data, Open Data
Knowledge and Maps
IOT Applications
IDT Directory and Devices
Resource Manager
Development tools
Management
Decision Support Systems
Settings
User Management and Auditing
Help and contacts
Documentation and Articles
My Profile
Km4City portal
DISI Lab portal
Business Analysis Dashboards
For all kind of users: DevDash

- Dynamic Filtering, Adaptable, ...
- Full data details, drill down,...
- Synergic with Data Inspector which addresses data relationships, processing and information
- Only Your Data for
  - Manager and Area Managers
- All Accessible Data for
  - ToolAdmin and RootAdmin
• Multi faceted Search by
  • Devices
  • Organization
  • Drill on Time
  • Drill on Map
  • Value Types
  • Data Type
  • Value name
  • Data table
  • Etc.

• Respect Privacy and GDPR
DevDash Case Study (2)

- Detect potential anomalies or disfunctions by inspecting the DevDash tool time trend
• My Data Dashboards (for Developers and for Managers) can be customized by RootAdmin.
  – Authority for Customization can be also extended to other role on Premise solutions
• Customizations is based on Full editing Capabilities of Kibana OpenDiostro per Elastic Search 7.1, and with multiple indexes of Snap4City
Back office Platform Scalability
Containers Management and Monitoring

- Container Cluster Monitoring
- Container Cluster Intelligence
- Back Office Container Monitoring
- Mesos view
- DISCES-EM
- DISCES-EM tail
Managing Back Office Processes on Containers

- Containers:
  - IOT App,
  - Web Crawling,
  - (ETL processes),
  - Data Analytics in R Studio,
  - Data Analytics in Python

- Elastic management
  - Marathon
  - Mesos
  - DISCES EM

- Possible on Kubernetes
Elastic Scaling: allocating / deallocating

- Allocation/ deallocation, Rebalancing vs compacting
  - Vertical of resources: Docker and/or VM: CPU, Mem
    - NodeJS multi-flow for each Docker, the user request data flows and IOT App, Snap4City allocates them dynamically on demand and perform workload optimization
    - VM: management of Mem, CPU; transparent and automatic in DRS VMware
  - Horizontal of resources of Dockers and/or VM and/or [Host]:
    - Docker: addition of containers, migrations/moving, balancing (per moving) of IOT App
    - VM: on/off

- Monitoring resources:
  - VM via VMware API, Docker via Marathon and Mesos APIs
- Algorithm in Python for scaling, actions via APIs: VMware, Marathon,...
Computational Capabilities of Snap4City

• Managing:
  – Periodic Processes → ETL, IOT App (Node-RED)
  – Asynchronous processes, data driven, real time → Node-RED, IOT Applications

• Scalability
  – Horizontal: Increasing processes performing activities, demand on new processes for new users, for new applications, for new IOT applications: VM, Hosts, clusters, Storage SAN
  – Vertical: Increasing resources on processes: CPU, MEM, Storage, Network
Monitoring on Cloud
Container Cluster Intelligence
via Zabbix → → Kibana
Container Cluster Intelligence via Zabbix

- Via ZABBIX
  - OpenDistro
    - Elastic Search
    - Kibana
- By VM/Host
- By Container
- By CPU, MEM, I/O
- Over time
Container Cluster Intelligence

Graphs showing time series data for various metrics such as I/O Send, I/O Sent, I/O Received, and Memory usage.

- I/O Send: Sum of value_netIo sent
- I/O Sent: Max of value_netIo sent
- I/O Received: Sum of value_netIo received
- I/O Received: Max of value_netIo received
- Memory: Sum of value_ram
- Ram: Sum of value_ram

The graphs display data over time, with metrics on the y-axis and time on the x-axis.
Monitoring Resources and API Traffic

- Smart City API Monitoring
- MyKPI Monitoring
- Notificator Monitoring
- Web Server Monitoring
Monitoring Smart City API Usage


https://www.snap4city.org/dashboardSmartCity/view/index.php?iddasboard=MTY0NA==
Monitoring Resources and Traffic

- Smart City API Monitoring
- MyKPI Monitoring
- Notificator Monitoring
- Web Server Monitoring

Snap4City (C), January 2022

http://www.disit.org/dashboardSmartCity/view/index.php?iddasboard=MTQ4

Monitoring Schedulers via DISCES
Processes and ETL tasks

In Yellow alternative & legacy solutions

- Back Office DWH Sched DISCES
- Back Office DA Sched DISCES
- Back Office DISCES monitor
DISCES: Distributed SCE Scheduler

**Smart Cloud Engine**
DISIT - Distributed Systems and Internet Technologies Lab

<table>
<thead>
<tr>
<th>SCHEDULER NAME</th>
<th>ID</th>
<th>FIRE INSTANCE ID</th>
<th>DATE</th>
<th>JOB NAME</th>
<th>JOB GROUP</th>
<th>JOB DATA</th>
<th>STATUS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SCHEDULER_NAME</td>
<td>1</td>
<td>12345678901234</td>
<td>12/30/2022</td>
<td>JOB_NAME</td>
<td>JOB_GROUP</td>
<td>JOB_DATA</td>
<td>RUNNING</td>
</tr>
</tbody>
</table>

**DISCES: Distributed SCE Scheduler**

<table>
<thead>
<tr>
<th>CPU</th>
<th>CPU Load</th>
<th>Mem Total</th>
<th>Mem Free</th>
<th>Cores</th>
<th>Jobs/h</th>
<th>Jobs Executed</th>
<th>Jobs Failed/Success (24 h)</th>
<th>Jobs Failed/Success (7 days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>244.07 GHz</td>
<td>5.41 GHz (2.22%)</td>
<td>70.41 GB</td>
<td>20.36 GB</td>
<td>84</td>
<td>203.56</td>
<td>94283</td>
<td>221 (4.45%)</td>
<td>2879 (8.41%)</td>
</tr>
</tbody>
</table>

**DISCES: Distributed SCE Scheduler**

**Snap4City (C), January 2022**
DISCES monitoring

https://www.snap4city.org/dashboardSmartCity/view/index.php?id=dashboard=MjE3Mw==

https://www.snap4city.org/dashboardSmartCity/view/index.php?id=dashboard=MjM5Mw==
Report Generation and Management (admin tool)
Report Generation and Management

- **Device/data** owner may have their reports: **monthly or 3-monthly**
  - Ready to use reports are available for:
    - Single Device: ETL and IOT
  - Ask to your RootAdmin to activate the production of reports (and also **hourly** report for testing only).

1. Open data Inspector
2. Click on Device or sensor
3. Click on report
4. Get the Last Report
Take the last report
Report Generation and Management

• **Technically:**
  – Reports are produced on the basis of a Model
  – **Report Models** can be defined and customized in Jasper Studio, an open source standard
  – **Report Manager** is based on Jasper Server, an open source standard

• **Other kinds of reports** can be realized on demand for
  – Dashboards
  – Smart Applications
  – Organizations

Report user manuals:
- [https://www.snap4city.org/720](https://www.snap4city.org/720)
- [https://www.snap4city.org/721](https://www.snap4city.org/721)
How to Customize/Manage the Report Model

Datasources

Servers

Layout elements
Managing Photos and Comments from Web and Mobile Apps
Photo and Comments Management
Mobile App Monitoring and Management
# Mobile App Monitoring and Management

## Mobile Application Monitoring

<table>
<thead>
<tr>
<th>City Users and Stats</th>
<th>Recommendations Log</th>
<th>General Settings</th>
<th>Social Media Group Recommendations Settings</th>
<th>Groups Recommendations Priorities</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="City Users and Stats" /></td>
<td><img src="image2.png" alt="Recommendations Log" /></td>
<td><img src="image3.png" alt="General Settings" /></td>
<td><img src="image4.png" alt="Social Media Group Recommendations Settings" /></td>
<td><img src="image5.png" alt="Groups Recommendations Priorities" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Class Scores</th>
<th>City Users</th>
<th>List of Trajectories Clusters</th>
<th>Heatmap and Trajectories Clusters (User Profile: All)</th>
<th>Heatmap and Trajectories Clusters (User Profile: Citizen)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image6.png" alt="Class Scores" /></td>
<td><img src="image7.png" alt="City Users" /></td>
<td><img src="image8.png" alt="List of Trajectories Clusters" /></td>
<td><img src="image9.png" alt="Heatmap and Trajectories Clusters (User Profile: All)" /></td>
<td><img src="image10.png" alt="Heatmap and Trajectories Clusters (User Profile: Citizen)" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Heatmap and Trajectories Clusters (User Profile: Commuter)</th>
<th>Heatmap and Trajectories Clusters (User Profile: Student)</th>
<th>Heatmap and Trajectories Clusters (User Profile: Tourist)</th>
<th>Heatmap and Trajectories Clusters (User Profile: Disabled)</th>
<th>Heatmap and Trajectories Clusters (User Profile: Operator)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image11.png" alt="Heatmap and Trajectories Clusters (User Profile: Commuter)" /></td>
<td><img src="image12.png" alt="Heatmap and Trajectories Clusters (User Profile: Student)" /></td>
<td><img src="image13.png" alt="Heatmap and Trajectories Clusters (User Profile: Tourist)" /></td>
<td><img src="image14.png" alt="Heatmap and Trajectories Clusters (User Profile: Disabled)" /></td>
<td><img src="image15.png" alt="Heatmap and Trajectories Clusters (User Profile: Operator)" /></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Heatmap and Trajectories Clusters of City Users Together</th>
<th>Real Time City Users: positions and movements</th>
<th>General Stats</th>
<th>Statistics for City Users Types</th>
<th>Interactive People Flow Maps</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image16.png" alt="Heatmap and Trajectories Clusters of City Users Together" /></td>
<td><img src="image17.png" alt="Real Time City Users: positions and movements" /></td>
<td><img src="image18.png" alt="General Stats" /></td>
<td><img src="image19.png" alt="Statistics for City Users Types" /></td>
<td><img src="image20.png" alt="Interactive People Flow Maps" /></td>
</tr>
</tbody>
</table>
IOT Apps Version Management
IOT App Versions Monitor and Upgrade

Snap4City (C), January 2022
Data-City Small example
User Registration for DataCity-Small without Living Lab
User registration

Snap4City (C), January 2022
Installing Snap4City 2021, VM and Containers

https://www.snap4city.org/738
To get an updated version read it!
How to adopt Snap4City

On your premise

Smart City as a Service
- Supporting Org
- 100% Open Source Platform: Github
- Further developments
- Publishing Appliances and Dockers
- Training courses, docs
- Consulting
- Forums
- Etc.

Download and deploy

Installation on your premise
- Virtual Machines or Dockers
- Different configurations
  - From small to scalable
  - Exploiting your legacy tools
  - Interoperable with any tool
- No vendor lock-in, No tech lock-in

Mixed solutions! For example:
- Start on Cloud as Smart City as a Service
- Migrate on premise on the fly
- Start on Cloud into a sand box
- Pass to install on premise what you need
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
Config Generator Tools

Snap4City

Docke Config Generator x Snap4 Tools

Base access link for the whole service.

$Base-name$ - string

WWW.iamsmartcity.org

Define MariaDB database user password

$DBuser-db-pw$ - password

Randomize Show

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

$Email-from-addr$ - email

paones@gmail.com

Sender name when sending emails (e.g., SITE NAME)

$Email-from-name$ - 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 run before the execution of post-setup.sh may be run 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: 48.6290858089535
Longitude broker: 28.125

ip_field: 1

192.168.1.25

Snap4City (C), January 2022
Deployed Small X, Y

- IoT-App (1-50)
- IoT-Broker + Filter (1 or 2)
- Mongo
- Database

- WSServer
- Servicemap
- Virtuoso
- Kafka
- Zookeeper
- Dashboard backend
- Synoptics
- Personal data
- Proxy
- Dashboard
- Dashboard cron

- NIFI
- Kibana
- Elastic Search

- KeyCloak
- MyLDAP
- LDAP server

Snap4City (C), January 2022
**DataCitySmall** X-2-2

### Web Interfaces

- **Main**
  - Synoptics (WS)
  - Dashboard Frontend
  - WSServer (node-red)
  - PersonalData
  - Config Mng.
  - DataInspector
  - MyKPI Mng
  - Management Tools
  - OrionFilter 01
  - OrionFilter 02

- **Storage**
  - Open Search
  - Dash, Kibana

- **Brokers**
  - ORION1
  - ORION2
  - Mongo

- **Knowledge base**
  - ServiceMap1
  - Virtuoso1
  - ServiceMap2
  - Virtuoso2

- **Drupal CMS**
  - GeoServer
  - Heatmap Mng
  - Resource Mng

- **OpenMaint**
  - Report Generator

- **Data Analytics**
  - Analytic 01
  - Analytic 02
  - Analytic N

- **Computing**
  - IOT App 01
  - IOT App 02
  - IOT App X

- **Computing**
  - Analytic 01
  - Analytic 02
  - Analytic N

**KeyCloak**

**MyLDAP**

**LDAP**

**MyIDAP**

**KeyCloak**

**Auth.Author**

Snap4City (C), January 2022
Container Based Installations, different models

- **Micro X**: configurations suitable for solutions for small verticals and industries, single VM, see in the following for the details.
  - it is more complete than the *Alone* configuration of [https://www.snap4city.org/471](https://www.snap4city.org/471)

- **Normal X,Y**:  
  - it is more complete than the *Basic* configuration of [https://www.snap4city.org/471](https://www.snap4city.org/471)
  - 2 VM: X IOT App, Y Brokers

- **Small X,Y**: solutions in which the storage is growing and can be managed into a separate VM, and may be clustered later on.
  - 4 VM: VM1 MAIN:, VM2: authentication and authorisation: LDAP, KeyCloak, ....
  - VM3 STORAGE: NIFI, Open Distro for Elastic Sarch/Kibana,
  - VM4 IOT APPs and Brokers: X IoT Apps, Node-RED, MicroServices; and Y IoT Brokers.
Container Based Installations, different models

- **DataCitySmall X,Y,Z**: more powerful than the 2020 version based on VM
  - suitable for more scalable solutions in which the storage is growing and thus can be managed into a separate VM, also **IoT App** can be managed separately, such as the **IoT Brokers**.
  - It is the perfect starting point for replicating VM for storage, Brokers and IoT according to the needs, and thus for starting point on large MultiTenant solutions.
  - 6 VM, but you can expand later cloning the same VM4-6 and manually configuring clusters

- **VM**:
  - VM1 MAIN: VM2: authentication and authorisation: LDAP, KeyCloak, ...
  - VM3 STORAGE: NIFI, Open Distro for Elastic Sarch/Kibana,
  - VM4: X IoT Apps, **Node-RED, MicroServices**.
  - VM5: Y **IoT Brokers**, secure filter, etc.
  - VM6: Z **KB, ServiceMap**, one for each organization, they can be federated each other.

- For wider and more complete configurations, see the solutions of the 2020
  - [https://www.snap4city.org/471](https://www.snap4city.org/471)
Providing ZIP files with Docker Compose

- Load on Server, one for each VM and follow the instruction for executing the docker compose
- You get the deployed version in fews minutes according to:
  - Your domain
  - Your password
  - Your preferred parameters
• FrontEnd:
  – Creating 192168125_dashboard-builder_1 ... Done, 192168125_dashboarddb_1 ... done
  – Creating 192168125_dashboard-backend_1 ... Done, 192168125_dashboard-cron_1 ... Done
  – Creating 192168125_synoptics_1 ... Done
  – Creating 192168125_wsserver_1 ... done
  – Creating 192168125_kafka_1 ... Done
  – Creating 192168125_zookeeper_1 ... Done

• Storage
  – Creating 192168125_personaldata_1 ... Done
  – Creating 192168125_nifi_1 ... done
  – Creating 192168125_elasticsearch_1 ... Done, 192168125_kibana_1 ... Done
  – Creating 192168125_servicemap_1 ... Done, 192168125_virtuoso-kb_1 ... done

• Authentication and Authorisation
  – Creating 192168125_myldap_1 ... Done, 192168125_ldap-server_1 ... Done
  – Creating 192168125_proxy_1 ... Done
  – Creating 192168125_keycloak_1 ... Done

• IOT
  – Creating 192168125_orionbrokerfilter-001_1 ... done
  – Creating 192168125_orion-001_1 ... Done, 192168125_mongo-001_1 ... done

• IOT APP
  – Creating 192168125_iotapp-001_1 ... done
  – Creating 192168125_iotapp-002_1 ... done
  – Creating 192168125_iotapp-003_1 ... done
Monitoring status

- EARLY: Via an IOT App inside the composition of dockers
- Via specific applications provided
- Via dashboards that can be installed and setup
- Also via Zabbix or Nagios
**Presentation:** Control Room, Dashboards, Synoptics, Wizards, Widgets, Visual Analytics Applications, Mobile Apps

**Device Layer:**
- **GIS**
- **BIM**
- **Gateways**
- **External Third Party Services**

**Connectivity:**
- Wired, wireless (Lora, 5G, 4G, 3G, Wi-Fi, etc...), IoT Edge, etc.

**Data Collection:**
- Data mining, harvesting, integration, transformation, data models,

**Operation:**
- **Reporting**
- **Simulation**
- **Heatmapping**
- **Traffic Flows**
- **Tip Time Trend**

**Data Management:**
- Data modeling, data storage, noSQL, semantic modeling, city entities, aggregation, normalization, knowledge base

**Internal Interoperability:** API, MicroServices

**External Interoperability:** Smart City API, general API and accounting

**Authentication and Authorization:** GDPR compliant

**Presentation:**
- **SNAP4CITY**
- **OpenSearch**

**Platform Management:**
- **IoT Applications**
- **Data Flow Logic**

**Data Collection:**
- **NGSI V1, V2**
- **FIWARE**
- **Linked Data triples**

**Data Flow Logic:**
- **Sentiment Analysis**
- **WorkFlow**
- **Tickets BPM**

**Operation:**
- **Analysis**
- **Artificial Intelligence**
- **Routing**
- **Internal GIS**
- **GeoServer**

**Authentication and Authorization:**
- **GDPR compliant**

**Any protocol and format**

**Public Interoperability:**
- **Smart City API**, general API and accounting
Installing Snap4City 2020, VM based

https://www.snap4city.org/471
To get an updated version read it!
What we suggest since October 2020

• Exploit trial on Snap4City.org of your early solutions and concept, also exploiting the full support of Snap4 experts and community, on DISIT Organization or Multiple Org as you prefer
  – Please note that each Organization need a distinct email address and registration, and applies their own restriction to data and dashboards. So that maximum access to demonstrations is on DISIT Organization into Snap4city.org portal

• Ask/book for an Organization if you would like to test in a separate environment

• Once tested and convinced, start deploy your version on your premise by using «DataCity-Small» on Docker or VM
Snap4City/Industry Architecture, V1, V2

Data Sources, External Services
PULL Data

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

Data Ingestion, aggregation, regularization, reconcile
- NIFI
- Tools, ETL, DISCES
- IOT Apps

Big Data Cluster
HDFS, Hbase, Phoenix

Knowledge base
Semantic reasoners

Indexing and aggregating
OpenDistro x Elastic search

Search and Query,
Smart City API
Facet, semantic search

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

IOT Applications
Node-RED + Snap4City MicroServices

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

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

In Yellow alternative & legacy solutions: snap4city V1
Overview of Snap4City platform, for Buyers, for all

Cluster for Smart Processes container: ingestion, analytics, scraping, etc.

Cluster for big data storage: static and real time, Indexing and search

Snap4City MAIN
Dashboard, User Management, etc.

Knowledge base, semantic Store

HeatMaps and Maps

Living Lab Portal

Mobile Apps, Dashboards

Other Services And Servers

IOT brokers

IOT Networks Social Media CRM ..... GIS

Legacy Platform

Back End

Front End
Overview of Snap4City platform, for Buyers, for all

<table>
<thead>
<tr>
<th>Services</th>
<th>Container Cluster</th>
<th>Snap4City MAIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>CKAN DataGate</td>
<td>MCLSCont, NCLSCont</td>
<td>Dashboard Builder,</td>
</tr>
<tr>
<td>Routing Server</td>
<td>Marathon, Mesos, Zookeeper,</td>
<td>Data Inspector, User Stats,</td>
</tr>
<tr>
<td>Chat Manager</td>
<td>Discses-EM, Executing in Container:</td>
<td>ExternalSrv, Res Manager,</td>
</tr>
<tr>
<td>R Studio Server</td>
<td>IOT App, Web Scraping, R-Studio,</td>
<td>MyKPI, MyPOI, Synoptic, IOT</td>
</tr>
<tr>
<td>ETLSDK Server</td>
<td>Python, Java, ETL, ...</td>
<td>Device Manager, Micro</td>
</tr>
<tr>
<td>Engager Server</td>
<td></td>
<td>Applications, Authorization/Authentication, Roles, ...</td>
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</table>

<table>
<thead>
<tr>
<th>IOTOBFSs</th>
<th>[DataCluster]</th>
<th>KBSSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOTBrokers secure</td>
<td>ETL-VM Phoenix HBASE, HDFS</td>
<td>KB/ServiceMap, ..</td>
</tr>
<tr>
<td></td>
<td>DISCES, ETL support</td>
<td>SmartCity API, WFS,</td>
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</table>

<table>
<thead>
<tr>
<th>Data Shadow Cluster</th>
<th>GISGeoServer</th>
<th>Legacy Platform</th>
</tr>
</thead>
<tbody>
<tr>
<td>IOTDSES</td>
<td>Heatmap Manager,</td>
<td>Social Media</td>
</tr>
<tr>
<td></td>
<td>WFS, WMS</td>
<td>CRM</td>
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<thead>
<tr>
<th>Living Lab Portal</th>
<th>Mobile Apps, Dashboards</th>
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<td>Drupal support CRM, ..</td>
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<th>IOT Networks</th>
<th>Front End</th>
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What is included in the Buyers / Full Platform

- **IOTOBSE**
  - IOT Orion Broker (Snap4City)
- **IOT Edge support**
  - Linux Ubuntu
  - Windows
  - Raspberry Pi
  - Android
- **IOT Devices support**
  - ESP32
  - Arduino
- **IOT Application**
  - Node-RED
  - Snap4City Library of nodes

**Other Services**
- Routing Server
- DataGate CKAN
- Chat as Rocket
- ETL SDK VM
- Engager ..
- ......

**Data Analytics**
- Heatmap production MS Rstudio
- OD production
- Predictions MS RStudio
- Anomaly detection MS RStudio
- ETL Collection
- ......

**MCLSCount, NCLSCount Container[Cluster]**
- Containers models
- DISCES-EM
- Monitoring App

**ETL Server Data[Cluster]**
- DISCES
- Phoenix Drivers
- Hbase Model
- ETL processes

**IOTDSES DataShadow[Cluster]**
- NIFI process, Squid
- OpenDistro
- Elastic Search Model
- Kibana
- AMMA data flow
- DevDash data store

**KBSSM**
- Knowledge Base Km4City
- ServiceMap
- ServiceMap3D
- SuperServiceMap
- LOG/Flint
- OSM2Km4City
- Smart City API
- WFS API

**GIS GeoServer**
- GeoServer
- Heatmap Manager

**Living Lab Portal**
- CRM Drupal
- LDAP Snap4City
- Registration mg
- Etc. etc.

**IOTDSES DataShadow[Cluster]**
- NIFI process, Squid
- OpenDistro
- Elastic Search Model
- Kibana
- AMMA data flow
- DevDash data store

**Snap4City MAIN**
- Dashboard Builder, Wizard
- Dashboard Engine
- Data Inspector, Notificator
- External Srv manager
- Menu Manager
- Ownership Manager
- Authentication and Authorisation
- WS server
- Resource Manager
- User Stats
- JavaScript Web App in a Snap, MicroApplications
- Synoptics, custom Widgets
- IOT device manager: IOT Directory
- Snap4City MicroServices on IOT Applications: basic and advanced
- Snap4City GIS Player
- What-IF tools

All in source code, and most of components in Appliances/VMs
**Platform Maintenance, K3.14**

- **Snap4City modules** are released on GITHUB/DISIT and can be updated from:
  - GITHUB/DISIT into VM Appliance or Servers in which they are installed
    - [https://github.com/disit](https://github.com/disit)
  - Node-RED tool, using official Library regarding: Snap4City Libraries
  - Drupal for the Living-Lab Portal aspects
  - Other tools from their corresponding providers

- **Maintenance** would not be a problem, all users should be capable to perform the updates autonomously

- Updates on new versions will be provided by Snap4City periodically, Notification will be provided on NEWS and GitHub
Keeping Platform at the State of The Art

- **Updates** will be provided by Snap4City periodically and released on GITHUB, and other portals.

- **Snap4City team** is involved in contracts since now, so that this will guarantee that the solution will be evolved to anticipate the state of the art as we have done in Iteration 3, in which we released a number of developments.

  – See also the activity of dissemination and updated roadmap
  – See the presence of Snap4City on EOSC, BeeSmartCity, EO15, etc.
  – See the list of concreate developments
  – See the list of supporters on the Stand with respect to those of the 2018
  – See the planned new developments

Snap4City (C), January 2022
Set-up of Open Source version from Scratch

• Guidelines reported on:
  – https://www.snap4city.org/471

• How to proceed:
  – We have presented 7 Configurations models from A:Alone to F:FullPlatform+LivingLab, but they can be customized as you like.
  – By follow the Configurations the Customers are guided to identify the most suitable according to their needs;
  – Once the most suitable Configuration has been identified, they are supported into the:
    i. Download and deploy of the Appliances provided as Virtual Machines or Containers, or
    ii. Download and install modules from GITHUB according to the recipes for VM/Container and the user manual of the single tools, or
    iii. Mixt of the above (i) and (ii) approaches.
  – IOT Edge can created by (1) installing Node-RED, (2) adding Snap4City library of Nodes from the Palette Manager of Node-RED, (3) registering on Snap4City: https://nodered.org/docs/user-guide/editor/palette/manager

Note that some of the material we are presenting has not been published on the portal yet, for the competition.
<table>
<thead>
<tr>
<th>Configuratio n Kind</th>
<th>Min #/VM</th>
<th>Dockers</th>
<th>IOT Broker Int</th>
<th>IOT Broker Ext</th>
<th>MAP</th>
<th>KBSM</th>
<th>IOT APP, MicroServices</th>
<th>Storage &amp; IOT Data Shadow</th>
<th>SSO, Roles</th>
<th>IOT Security</th>
<th>Dash + Wizard</th>
<th>GIS in</th>
<th>GIS out</th>
<th>Heatmap</th>
<th>Mob. App</th>
<th>ASCAPI</th>
<th>Living Lab Sup.</th>
<th>Options supported by the configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>A: Alone</td>
<td>1</td>
<td>6</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>1 mf</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>(x)</td>
<td>ETL, DG, CM</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>B: Basic</td>
<td>2</td>
<td>7</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>1 mf</td>
<td>Small</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>(x)</td>
<td>ETL, DG, CM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C: CityStart</td>
<td>3-4</td>
<td>8-9</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>1 mf</td>
<td>Small</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>ETL, DG, R, CM, Eng</td>
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<tr>
<td>D: DataCity</td>
<td>Ask</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>70</td>
<td>Mediu m</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>ETL, DG, R, CM, Eng, LL</td>
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<tr>
<td>E: ExtensiveCity</td>
<td>6-8+</td>
<td>Ask</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>70</td>
<td>Scalable</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>ETL, DG, R, CM, Eng, LL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>F: FullPlatform</td>
<td>12-14+</td>
<td>Ask</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Scalab le</td>
<td>Scalable</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>ETL, DG, R, RS, CM, Eng, LL</td>
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<tr>
<td>F: FullPlatform + LivingLab</td>
<td>13-15+</td>
<td>Ask</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>Scalab le</td>
<td>Scalable</td>
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<td>X</td>
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<td>ETL, DG, R, RS, CM, Eng</td>
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</tbody>
</table>

mf: multiple flows for each IOT App
Read next slide for the other notes and legenda
Legenda and Notes on the previous table

- In all configurations you:
  - **have**: Multiple IOT Brokers; unlimited number of data sources; interoperability support; KB
  - **may have**: HA, DRS, FT, Balancing, cloning and configuring additional VM;
  - **may pass** at the next configuration without reinstalling the VM;
  - **may add** one or more Optional Services as VM/Containers: ETL, DataGate, Routing, Engager, Data Analytics, etc. etc.

- From Config. E:ExtensiveCity and upper the number of VMs depends on the volume of DataStorage and the volume of Data Stream in input.
  - These two aspects are managed by two independent clusters of VMs and scale independently each other. This allows to satisfy any different combination of volumes in streams and data storage.

- **We suggest** using Living Lab support only on FullPlatform, while it can be installed on Smaller Configurations with some limitations in terms of features.
Computational and Storage Costs

• **The VM** is considered (appliances are provided) as 16/24 cores 2.2 Ghz, 16-24 GB Ram, 500 GB HD in thin provisioning, with 25-40 GB HD used at the start, in most cases Debian.
  
  – to estimate the needed CPU, RAM, Storage for each configuration it is easy from the #of VM in the configuration.
  
  – Please note that configurations A and B can be executed on 4 cores, 4 GB Ram, ..

• **In solutions**, with a very large number of users on the Front End: Smart City API (mobile App users, Dashboard users, a frontend balancer and more FrontEnd servers would be needed). Please note that the Smart City API are also used by DataAnalytics processes and by MicroServices in the IOT Applications.
  
  – Typically a thousand of simultaneous users on the front end can be sustained for each VM
  
  – More precise estimations can be performed by knowing the actual workload
Ds) DataCity-small Configuration and its evolution in DataCity-Large
Smart City Functional Architecture

Data Sources, External Services
- Public Services, Governance, events...
- Sensors, IoT Cameras, Wi-Fi
- Environment, Water, energy
- Shops, services, operators
- Social Media
- Crawler and Manager

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

Data Ingestion, aggregation, regularizzazione, reconcile:
- IOT Directory, NIFI, special tools

Knowledge base
- Semantic Reasoners

Indexing and aggregating
- OpenDistro x Elastic Search

IOT Applications, Business Logic
- Node-RED + Snap4City MicroServices

Data Analytics, Simulations, Special Tools
- R Studio, TensorFlow, Python, ...

Federation
- Search and Query, Smart City API, Web Socket Server, GIS, Facet, semantic

Back office tool
- Dashboards, visual tools, Web and Mobile Apps

Authentication, Authorization, Platform & Processes Management, Data Inspector, Digital Twin, ...

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

Snap4City (C), January 2022
**D: DataCity-Small**) A small size **Smart City** with a 4 smart applications on cloud and 2 of IOT brokers, limited volume of data entering into the cloud.
**D: DataCity** A medium/large size Smart City with a number of smart applications on cloud and a number of IOT brokers, relevant volume of data entering into the cloud.

For Managing

*Beyond C:CityStart Configuration*

+ A limited number of IOT Applications for data transformation and Analytics
+ A small sized Data Shadow for IOT data management

**Optionally:**

- Data Gate CKAN for Open Data

---

**IOTDSES DataShadow[Cluster]**
- NIFI process
- Elastic Search Model
- AMMA and DevDash

Snap4City (C), January 2022
## Example of Deploy in different configurations

<table>
<thead>
<tr>
<th>Core:Gbyte</th>
<th>Gbyte</th>
<th>Production</th>
<th>Staging/Support</th>
<th>System Integration</th>
<th>User Acceptance Test</th>
<th>Development</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPU MEM HD</td>
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<td>Snap4City Main</td>
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<td>2 24 48 500</td>
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<td>1 12 40 250</td>
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<td>4FT 8 48 200</td>
<td>1 4 24 200</td>
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• CPU are reported in number of Cores at xxx GHz min
• MEM is in GByte
• HD are in GByte are high speed HD or SSD for Production while medium speed for the other configurations
• Red: is the level of redundancy, number of VMs. They can be launched in FT or not
• IOTOBSF could be dockers
• MCLSCount is a cluster with dockers. If the solution has no access to orchestrator VMware, then a VM with Nagios/Zabbix has to installed to control the On/Off of VM from DISCES_EM. The alternative could be to manage the small cluster with always one VM.
• IOTDSES a cluster of federated NIFI on Dockers and their balancer
• ESSTORE VM a cluster of OpenDistro per ElasticSearch and Kibana VMs. The number of VM depends on the size of the global storage which can increase elastically with the need along the operation.
Federation of Snap4City vs IOT ORION Broker

Federation of Snap4City vs IOT ORION Broker

Snap4City (C), January 2022
A) Alone Configuration
A: Alone) For Small Size Business, for example an industry 4.0 application you can need to install only one VM: Snap4CityMAINVM

- **Snap4City MAIN VM**
  - Dashboard Builder, Wizard
  - Dashboard Engine
  - Data Inspector, Notificator
  - External Srv manager
  - Menu Manager
  - Ownership Manager
  - Authentication and Authorisation
  - WS secure server
  - Resource Manager
  - User Stats
  - JavaScript Web App in a Snap, MicroApplications
  - Synoptics, custom Widgets
  - IOT device manager: IOT Directory
  - Snap4City MicroServices on IOT Applications: basic and advanced
  - Snap4City WFS player
  - What-IF tools

- **For connecting data sources to Dashboards onpremise!**
  - **Data driven solution, no large data store**
  - **Industry 4.0**
  - **Small Smart City business, no knowledge basse, no servicemap**
  - **Start with Snap4City platform as seeding element**
  - **Storage: ODBC, JDBC, Mongo, SPARQL, MySQL, etc.**
Snap4CityMAIN: Alone Configuration

• As Virtual Machine:
  – HOW TO: configure/install StartSNAP4CITYVM: starting appliance of Snap4City
  – https://www.snap4city.org/487

• As Container Composer:
  – HOW TO: configure/install StartSNAP4CITYVM: starting appliance of Snap4City
  – https://github.com/disit/snap4city-docker/tree/master/Alone
B) Basic Configuration
B: Basic) Addressing a relevant number of IOT devices/ IOT brokers in your smart city or industry 4.0, a few smart Applications with multiple flows

For managing beyond A: Alone Configuration

+ large number of IOT devices and brokers, any protocol, format
+ IOT Devices
+ IOT Edge
+ Etc.
B: Basic) Addressing a relevant number of IOT devices/ IOT brokers, a few smart Applications

• IOT Edge: local intelligence, processes and Applications located on the field, on premise. Those autonomous smart tools can be implemented by IOT Applications working on IOT Edge:
  • Linux Ubuntu Appliance VM: https://www.snap4city.org/drupal/node/298
  • Android as IOT Edge https://www.snap4city.org/drupal/node/278 and
  • Raspberry Pi as IOT Edge: https://www.snap4city.org/drupal/node/77  You can install Snap4City library in any Node-RED from the official Node-RED library

• IOT Applications = Node-RED + Snap4City libs of Nodes/MicroServices,
  – Available in Snap4CityMAIN VM, so that in any installation
  – any installation of Node-RED add Snap4City Library from the official Library of Node-RED, add new Nodes into the Palette as
    • https://nodered.org/docs/user-guide/editor/palette/manager
  – Snap4City MicroService collection from the JS foundation with full documentation inside https://flows.nodered.org/?term=snap4city
    • BASIC: suitable for Final User
    • ADVANCED: DEVELOPER (you have to install both libraries: basic and advanced)
C) CityStart Configuration
C: CityStart) Addressing a relevant number of GeoLocated Points of Interest, PIN on maps, and eventually heatmaps, a Small Smart City with a few smart IOT applications on cloud and many on edge

For managing Beyond B:Basic Configuration

+ Large number of GEO elements on maps
+ Heatmaps
+ Geo shapes
+ GIS, ....
C: CityStart) Addressing a relevant number of GeoLocated Points, heatmaps, ...

- **KMSSM VM:**
  - Knowledge base, KB, positioning elements on maps, enabling geo-spatial and temporal reasoning
  - Ingestion OSM to load on KB, ServiceMap and reasoning on it
  - GeoReverse data, from street to data and vice versa
  - WFS export and import

- **GIS GeoServer VM:**
  - Producing and providing heatmaps
  - Managing Heatmaps colour maps.
  - WMS, WFS export, distribution
D) DataCity Configuration
D: DataCity) A medium/large size Smart City with a number of smart applications on cloud and a number of IOT brokers, relevant volume of data entering into the cloud.

Services
- CKAN DataGate
- Routing Server
- Chat Manager
- R Studio Server
- ETLSDK Server
- Engager Server
- .... Server

Snap4CityMAIN
- Dashboard Builder
- Wizard, Widgets, IOT App1
- MyKPI, MyPOI, Synoptic IOT Device Manager

IOTOBFSs
- IOT Context Broker
- ProxyFilter Security

IOTDSES
- Open Distro for Elasticsearch
- nifi

GIS, GeoServer

Snap4City (C), January 2022
D: DataCity) A medium/large size Smart City with a number of smart applications on cloud and a number of IOT brokers, relevant volume of data entering into the cloud.

For Managing

Beyond C:CityStart Configuration

+ A relevant number of IOT Applications for data transformation and Analytics
+ A small sized Data Shadow for IOT data management

Optionally:

- Data Analytics in R Studio, Tensor Flow (NVIDIA)
- Hbase / Phoenix Big Data Store
- Data Gate CKAN for Open Data
- Chat Manager on Dashboard
- Routing Solutions
E) ExtensiveCity Configuration
E: ExtensiveCity) A Large size Smart City with smart applications on cloud and a number of IOT brokers, large volume of data streams entering in the cloud.
E: ExtensiveCity) A Large size Smart City with smart applications on cloud and a number of IOT brokers, large volume of data streams entering in the cloud

For Managing

**Beyond D:DataCity Configuration**

- A relevant number of data streams entering in the platform
- A scalable Data Shadow for IOT data management

Optionally:

- Data Analytics in R Studio, Tensor Flow (NVIDIA)
- Hbase / Phoenix Big Data Store
- Data Gate CKAN for Open Data
- Chat Manager on Dashboard
- Routing Solutions

- IOTDSES
- DataShadow Cluster
  - NIFI process
  - Squid cache on SCAPI
  - OpenDistro
    - Elastic Search Model extended API
    - Kibana
  - AMMA data flow
  - DevDash data monitor
- ...
F) FullPlatform Configuration
For huge scale Smart City with a huge number of smart applications and processes on cloud (thousands), any number of IOT brokers.
F: FullPlatform) For Huge scale Smart City with a Huge number of smart applications and processes on cloud (thousands), any number of IOT brokers

- MCLSCount
- NCLSCount
  Container[Cluster]
  - Marathon, Mesos Cluster
  - Containers models
    - IOT App
    - Web Scraping
    - Data Analytics
    - ETL
    - Python
    - ...
  - DISCES-EM
    - Elastic management of containers
  - Monitoring App

For Managing

Beyond E: Extended City Configuration

+ A scalable huge number of Containers including different kind of processes: IOT, ETL, data analytics, scraping
+ A scalable Data Shadow for IOT data management

Optionally:

- Data Analytics in R Studio, Python, TensorFlow (NVIDIA), etc.
- Hbase / Phoenix Big Data Store
- Data Gate CKAN for Open Data
- Chat Manager on Dashboard
- Routing Solutions
F+) LivingLab Configuration
F-LivingLab: FullPlatform + LivingLab) For Huge scale Smart City as Full Platform plus Living lab Support

Services
- CKAN DataGate
- Routing Server
- Chat Manager
- R Studio Server
- ETLSDK Server
- Engager Server
- ...... Server

Container Cluster
- MCLSCont, NCLSCont
- Marathon, Mesos, Zookeeper,
- Disces-EM, Executing in Container:
- IOT App, Web Scraping, R-Studio,
- Python, Java, ETL, ...

Data Shadow Cluster
- IOTDSES
- NIFI, OpenDistro, DevDash, Amma

Snap4City MAIN
- Dashboard Builder,
- Data Inspector, User Stats,
- ExternalSrv, Res Manager,
- MyKPI, MyPOI, Synoptic, IOT
- Device Manager, Micro
- Applications, Authorization/
- Authentication, Roles

[DataCluster]
- ETL-VM
- Phoenix HBASE, HDFS
- DISCES, ETL support

GISGeoServer
- Heatmap Manager,
- WFS, WMS

KBSSM
- KB/ServiceMap, SmartCity API, WFS,
- ServiceMap3D, LOG/FLINT,
- SuperServiceMap, Virtuoso

IOTOBFSs
- IOTBrokers, secure

Engager Server
- IOTBrokers, secure
- IOTDSES
- NIFI, OpenDistro, DevDash, Amma

Living Lab Portal
- Drupal support CRM

Legacy Platforms
- Networks
- Social Media
- CRM
- ...... GIS

Mobile Apps, Dashboards

Snap4City (C), January 2022
Living Lab Portal
- CRM Drupal
- LDAP Snap4City
- Blogs, Articles, comments, etc.
- Multiple Organization
- Multiple Groups
- SSO with Snap4City tools
- Automated Registration management
- SOLR indexing on content
- Monitoring activity
- Reporting and statistics

For Managing

Beyond F:FullPlatform Configuration
+ Providing Living Lab Support, a full CRM for stakeholder, co-working, collaborative work, discussion environment, chart, forum, etc.

Strongly suggested:
- Data Analytics in R Studio, Python, Tensor Flow (NVIDIA), etc.
- Hbase / Phoenix Big Data Store
- Data Gate CKAN for Open Data
- Chat Manager on Dashboard
- ETL SDK servers
- User Engagement Server
- Routing Solutions

Snap4City (C), January 2022
Acknowledgements
2013 Km4City Ontology 1.1
- Tuscany, Road Graph
- Mobility
- culture, tourism
- Events
- Parking
- Services
- Linked open graph

2014
- Weather Forecast
- Real Time Wi-Fi
- Entertainment
- LOD
- Twitter Vigilance
- Social Media Analytics, Sentiment Analysis

2015 Km4City 1.4
- Resilience Decision Support
- Smart First Aid
- User Behaviour Analysis, predictions
- Risk Analysis

2016 FIWARE Km4City 1.5
- Infomobility
- Mobile App
- Routing
- Multimodality

2017 GREEN IMPACT
- PDR FESR 2014-2020
- Industry 4.0
- Critical Plant
- Monitoring

2018 Km4City 1.6.2
- Origin-Destination and trajectories
- Traffic Reconstruction
- Offer Analysis
- OBU, smart devices

2018-20 Km4City 1.6.4
- Mobility Demand / Offer Analytics and Strategy

2018-21 5G tech Energy Industry 4.0 Synoptics

2019 IOT/IOE Km4City 1.6.6
- User engagement
- Bike Sharing
- Data Analytics ++
- Social Predictions
- OBD2

2019 CEF (2018-21)
- Traffic and Mobility Impact on Pollution
- NOX predictions

Winner of Select4Cities PCP

DISIT lab roadmap vs model and tools’ usage
2021
- Smart Ambulance (2021-22)
- Enterprise (2021-22) Industry 4.0
- Almashuda Industry 4.0 (2021-22)
- AMPERE (2021-22) Industry 4.0

2020
- PC4City (2020-21) Monitoring Terrain
- CAPELON - Smart Light - Sweden
- Km4City 1.6.7

Winner of Open Data Challenge of PC4City (2020-21)

Industry 4.0
- Smart City
- Smart Mobility
- PISA, PUMS
- Living lab

Smart Ambulance (2021-22) Industry 4.0

Almashuda Industry 4.0 (2021-22)

AMPERE (2021-22) Industry 4.0

SYN-RG-AI SmartCity

Enterprise (2021-22) Industry 4.0
Main Organizations/areas

- Antwerp area (Be)
- Capelon (Sweden: Västerås, Eskilstuna, Karlstad)
- DISIT demo (multiple)
- Dubrovnik, Croatia
- Firenze area (I)
- Garda Lake area (I)
- Helsinki area (Fin)
- Livorno area (I)
- Lonato del Garda (I)
- Modena (I)
- Mostar, Bosnia-Herzegovina
- Pisa area (I)
- Pont du Gard, Occitanie (Fr)
- Roma (I)
- Santiago de Compostela (S)
- Sardegna Region (I)
- SmartBed (multiple)
- Toscana Region (I), SM
- Valencia (S)
- Venezia area (I)
- WestGreece area (Gr)
Overview

Snap4City Platform

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

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Access Level: Public.
Date: 05-04-2021
Version: 5.3

Main running instances (11/21)

- Sii-Mobility → mobility and transport, sustainability
- REPLICATE → ICT, smart City Control room, Energy, IOT
- RESOLUTE → Resilience, ICT, Big Data
- GHOST → Strategies, smart city
- TRAFAIR → Environment & transport
- MOSAIC → mobility and transport
- WEEE Life → Smart waste, environment
- Smart Garda Lake → Castelnuovo del Garda, SMARTEA
- 5G → Industry 4.0 vs SmartCity
- Green Impact → Industry 4.0, Chemical Plant, control and plan
- SmartBed (Laid) → smart health
- Green Field Peas (Soda) → Industry 4.0, Chemical plant
- MobiMart and PISA Agreement → data aggregation, mobility and transport, Living Lab
- Lonato del Garda → smart parking, environment
- Herit Data → tourism, culture and management
- ISPRA JRC → site management and services
- Capelon (Sweden) → smart light solutions
- PC4City → land slide monitoring and predictions
- Italmatic → industry 4.0 production control

Snap4City (C), January 2022
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• Km4City is an open technology and research line of DISIT Lab exploited by a number of projects. Some of the innovative solutions and research issues developed into projects are also compliant and contributing to the Km4City approach and thus are released as open sources and are interoperable, scalable, modular, standard compliant, etc.