Smart City Monitor: Digital Transformation ICT

Novel ICT platform that enables unified digital transformation for smart management and governance for improvement of Quality of Life in Sustainable Urban Communities

The Smart City Monitor (SCM) is a cutting-edge high level application running at Pharos Navigator® ICT platform (PharosN). It helps communities and utility providers to deal with increasing complexity, accelerated change and diverse linkages to smart everything supporting improved quality of life, new jobs, business models, learning, lifestyle and operations.

The essence of the novel technology

1. Making custom models of a city as cyber-physical system (**CPS**) in all necessary detail of local infrastructure
2. Linking the urban CPS model to available data sources providing information about multiple diverse processes (physical, environmental, economic, financial, etc) such as sensors, smart meters, IoT, databases and various automated information and control systems (management of Assets, Water, Waste, Energy, Transportation, others, SCADAs, ERPs, robotics, social networks)
3. Integrating and digitally transforming real time big data streams into custom information services, mobile applications and controls for specific stakeholder groups (e.g. management, operators, utilities, general public) accordingly to recommendations of quality management standards (e.g. ISO 37120 and others)
4. Enabling holistic view of the physical and virtual processes and relevant objects, managing overall metropolitan system sustainability and performance in simple and common way similar to answering the question "**How are you my City?"** (or District, Street, Building, etc) along with rich custom analytics for condition monitoring, operational performance, decision simulation, cause analysis and predictions.
5. Providing the stakeholders in municipalities, utility operators and businesses with interactive tools for customizing and upgrading own CPS models of their application systems to accommodate ongoing change and to address new use cases and eliminate non-productive data processing for reporting.

The application areas

Smart Governance and Management of cities and utility services for communities, including Energy, Water, Waste, Transportation and other utilities and public services, Management of Smart Connected Assets in Cities and Factories, Smart Enterprises, Smart Hospitals, Smart Universities and Schools, Quality and Environment, Education and eLearning, Experimentation and Innovations in smart green technologies with IoT applications.

The implementations of the new technology take place in several European mid-size cities of Greece, Latvia, Moldova, Portugal, Romania and Spain (status on 1.10.2017).

The urban CPS is presented by Open Metropolitan Assets Model (OMAM) as the hierarchical structure that initially can be based on definitions of ISO 37xxx series of standards for Sustainable development of communities. The template structure of urban CPS to start with is made accordingly to ISO 37120 "Sustainable development of communities — Indicators for city services and quality of life" having the following structure:

- Number of theme-objects: **17**
- Theme-objects: **Economy, Education, Energy, Environment, Finance, Fire and Emergency Response, Governance, Health, Recreation, Safety, Shelter, Solid Waste, Telecommunications and Innovation, Urban Planning, Transportation, Wastewater, Water and Sanitation**
- Total number of indicators for all theme-objects: **102**
- Total number of core indicators: **46**
- Total number of auxiliary indicators: **56**
- Total number of data sources used in the 37120 template as MS Excel files: **60**

The OMAM is open to further custom upgrading and detailing related to actual local city infrastructure and objects, processes, topology, technologies, data sources and controls. In particular the model can be focused

and represent focus application area relevant for the business of organization providing specific community services e.g. Energy, Waste, Water, Transportation, Safety and Security, Leisure, Tourism, etc.

The ongoing sustainability status of any object in the city CPS model is calculated in real time. It may include large number of various city objects operating in energy, waste and water, environment, transportation, economy, buildings, vehicles, telecommunication, health, education, food and leisure, resilience, etc.

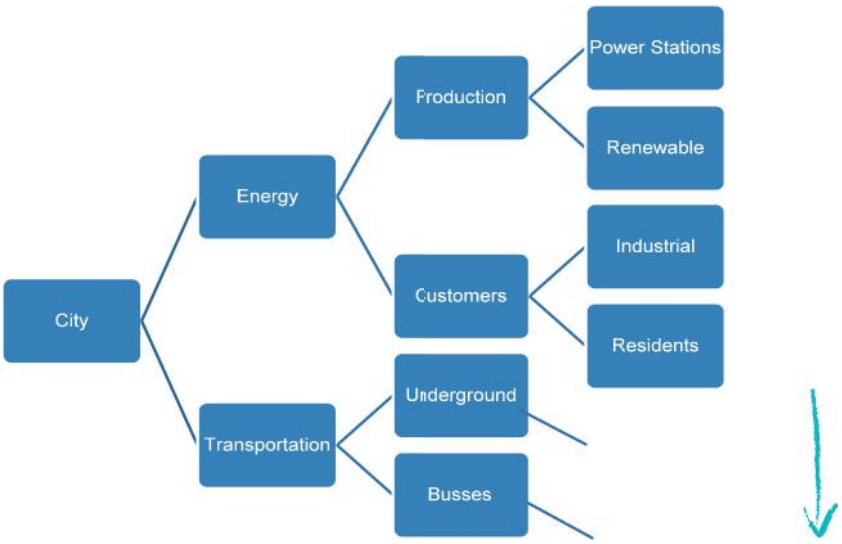

Figure 1. The structure of Open Metropolitan Assets Model (OMAM) by ISO 37120

The default object statuses are "Excellent" in green, "Optimal" in blue, "Deficient" in red colour while the names are customizable. The rules for the automatic object state calculation are custom defined for each object. The system supports multiple use cases providing automatic data collection from large number of information sources and transforming into comprehensive holistic vision of ongoing processes. It includes wide range of applications from simple measurements of city pollution, city noise, traffic congestion in diverse locations, etc to comprehensive evaluation of current or predictable statuses and performance of different community objects delivering services to citizens. SCM provides city stakeholders with web and mobile applications having various interactive widgets, presentation of objects on City Maps and dashboard monitor, interactive reports and personalized events as well as various advanced high level analytic tools. The resulting digital transformation reveals information about the sustainability status of a city and its urban objects as well as each urban process KPI in real time.

SCM introduces new generation of Smart Sustainable Information Systems assisting citizens and community management in improvement of quality of life, supporting new vision and ways of urban life by offering transparency and simple holistic presentation of complex processes and events, awareness and practical instruments for sustainable development in the city municipalities and communities. It facilitates compliance to the relevant international standards that address economic growth and efficiency, ecological and infrastructural construction, environmental protection, social and welfare progress. The municipalities obtain own control and transparency over community processes presenting local businesses and services, cultural places, public and private service providers, life of citizens and relevant events. The core of such control is ownership and copyrights of communities and utility providers for own OMAM models developed by local teams and responsible city subcontractors that can accommodate local content, its change and serve as community knowledge base as well as the digital transformation engine for all its stakeholders.

Using existing data sources: The SCM automatically imports diverse data into its city OMAM from **any electronic data source**. It includes city databases or spreadsheet files (e.g. MS Excel) prepared by municipality staff or relevant departments or service providers thus decreasing non productive work in reporting. SCM can be linked to existing automatic control and information systems used in management of relevant services such as Economy and Finance, Energy, Transportation, Waste, Water, Safety/Security, Fire, Environment, Education (e.g. daily attendance in schools and universities), Health (major statistics of operations in hospitals), etc.

Linking to sensors and IoT: The OMAM can be linked to different types of sensors and IoT providing specific measurement data (e.g. CO2, NOx, radiation, sound level, transportation, number of passengers/visitors, amount of waste by categories, energy/water supply-demand, etc) in different urban areas. It allows transforming data streams from actual sensor and meter networks into real time values of necessary indicators of quality of life and public services. The city planners are supported by new simulation options for city growth scenarios that combine past evidence data with future estimations while prototyping of new smart city services for citizens and planning new city objects (e.g. shopping center or residential area).

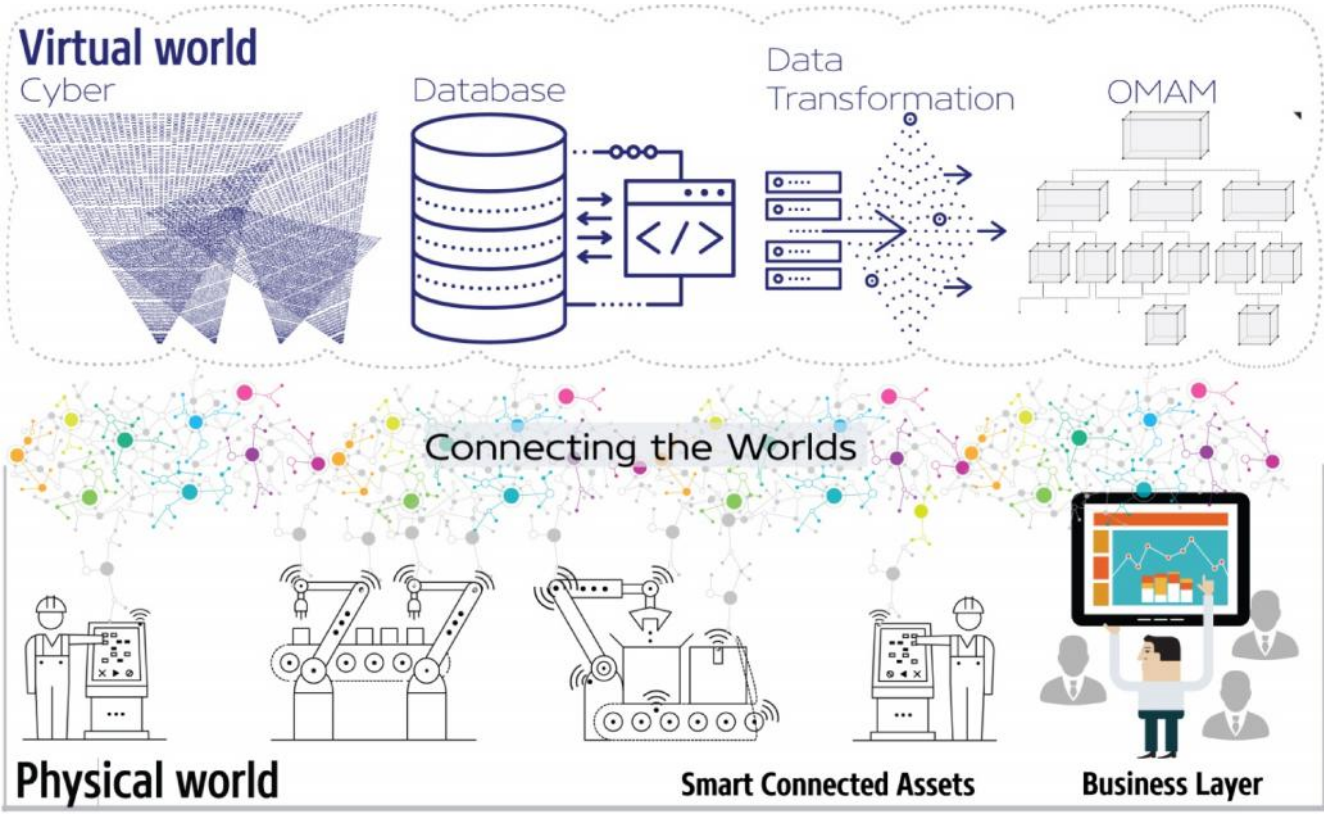

Figure 2 Generic city infrastructure as complex cyber-physical system existing in physical and virtual worlds

Engines location: SCM engines running urban CPS models for each city are hosted on dedicated cloud servers in European Union. Alternatively the engines can be installed in cities running in municipality house or city Operational Information Center or Utility provider premises. Each engine can serve large number of sessions by stakeholders from city administration, service providers, citizens providing interactive dashboards, widgets and reports presenting the city objects, their locations, statuses and operational indicators on City Map as well as information services about actual performance of different city objects in any necessary detail accordingly to available source data streams and CPS model content.

The technology: SCM is the backend software running OMAM as large scale application linked with **multiple data sources and automated and information systems** via Internet using secure protocols (https, RESTful, CoAP, MQTT, OPC, etc). It is implemented in C++ and JavaScript using only **open source components** such as Linux, docker containers, postgresql, apache, QT5, poco, C++ and JavaScript libraries, in compliance to international security standards for https (SSL/TLS), websockets and ISO/IEC 18033-3 resulting in decreased cost of SCM services for communities. The platform is available in different languages.

Smart City Monitor online demo is available at http://smartcity.win2biz.com supported with additional descriptions. The overview of relevant international applications is presented at http://unido.org/pharos.

The demo provides realistic vision of real world urban processes in a city of 60,000 inhabitants running the simple OMAM developed accordingly to the international standard ISO 37120:2014.

Implementation in Smart City projects: The SCM is available for **city councils and urban utility providers** as contractual service. The implementation includes the following stages: (1) The project preparation, (2) Training of local personnel, (3) OMAM build-up and support for business applications. The optional ISO 37120 certification is available after ISO 37120 model implementation at city SCM engine linked to local data sources.

Legal: SCM is available as a service for customers such as city administrations, utility providers and local businesses. The customer has own copyright for its locally developed OMAM. After the project implementation the customer can run its SCM engine independently. Data access and authorisation are administered by the customer. Support and upgrading services are available under additional agreements.

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