Intelligent Sustainable Systems: Enabling digital transformation from IoT for Smart Management and Governance in Times of Change

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Addressing growing challenges by

Empowering Smart Management in Smart Sustainable Cities with Intelligent Sustainable Systems (**ISS**) supporting effective life processes in enterprises, cities and regions

Growing urban challenges of time

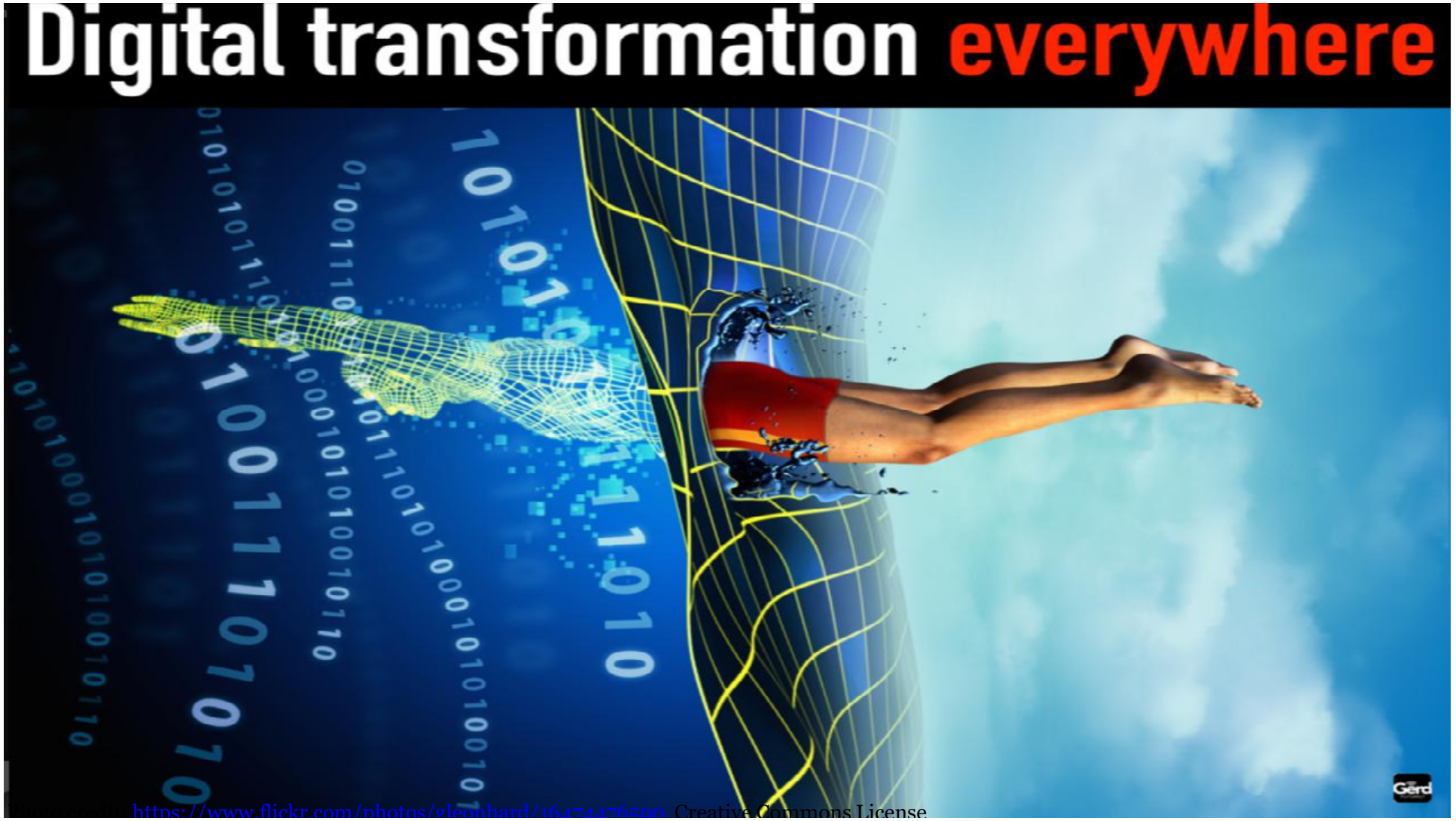
- Accelerating Change in Everything
- Increasing population density
- Urban processes become inter -linked & -dependant
- Processes, systems and infrastructures become more complex while kept running independently in silos

- Increased intelligence of many pervasive devices does not make the whole system sustainable but increase uncertainly
- Lack of holistic vision of SC&C as System of Systems results in inefficiencies, late and costly responses to change and may lead to potentially unsustainable dynamics of the Big System

New instruments for governance

City stakeholders demand new capabilities and capacities supporting them in handling diverse and complex data streams from different sources in real time.

ISS shall enable intelligent transformation of real time data streams from wide range of metropolitan IoT presenting real world processes into custom digital services for all SC&C stakeholders. It shall provide effective and simple advisory instruments based on AI and foster business models for Smart Sustainable Management and Governance.



What are results of Digital Transformation in SC&C?

Energy efficiency? Clean technologies? Circular economy? Intelligent transportation, Safety, Health? Vast information services for citizens? eGovernance? …

Yes, together!

integrated by ISS into simple holistic picture of SC&C as a Big System of Systems and enabled by rich set of information, analytics, predictive and prescriptive advisory services for different stakeholder groups

What assistance such ISS shall be able to provide to city stakeholders?

Some key enabling capacities from the end user point of view

- Know the actual SC&C infrastructure and processes at any time
- Understand and evaluated goals of each subsystem realizing the processes
- Collect and process all relevant data streams about ongoing processes from urban systems, IoT, sensors, actuators, mobiles, …
- Transform ongoing data into simple vision of results for the whole SC&C system and each its subsystem in real time
- Monitor urban processes reliably identifying sustainability statuses (or themes, areas of activity, objects, etc) and necessary controls in real time

Ideal properties of ISS

- Be capable to identify ongoing states of the SC&C as Big System and its subsystems to provide expected / planned level of Quality of Life
- Present comprehensive multidimensional view of urban processes customized to stakeholder roles and authorizations
- Communicate and interact with all SC&C stakeholders using common mobile devices and apps enabling transparency and participation
- Distinguish and predict abnormal developments in any subsystem thus improving big system resilience and optimising performance
- Release stakeholders from necessity to monitor huge number of data streams and routine events freeing up time for other important things

Powerful data driven analytics tools for everyone

- Help to find, predict problems: Where, When, Why it (may) happen and What can (shall) be done to resolve and mitigate its causes
- Notify stakeholders, operators about ongoing and predicted events
- Control critical events that may need prompt response in real time
- Provide evidence based historic results the as reference for the future
- Assist in evaluating possible developments and its future consequences
- Support in development of scenarios for making key decisions and evaluating their performance based on evidence

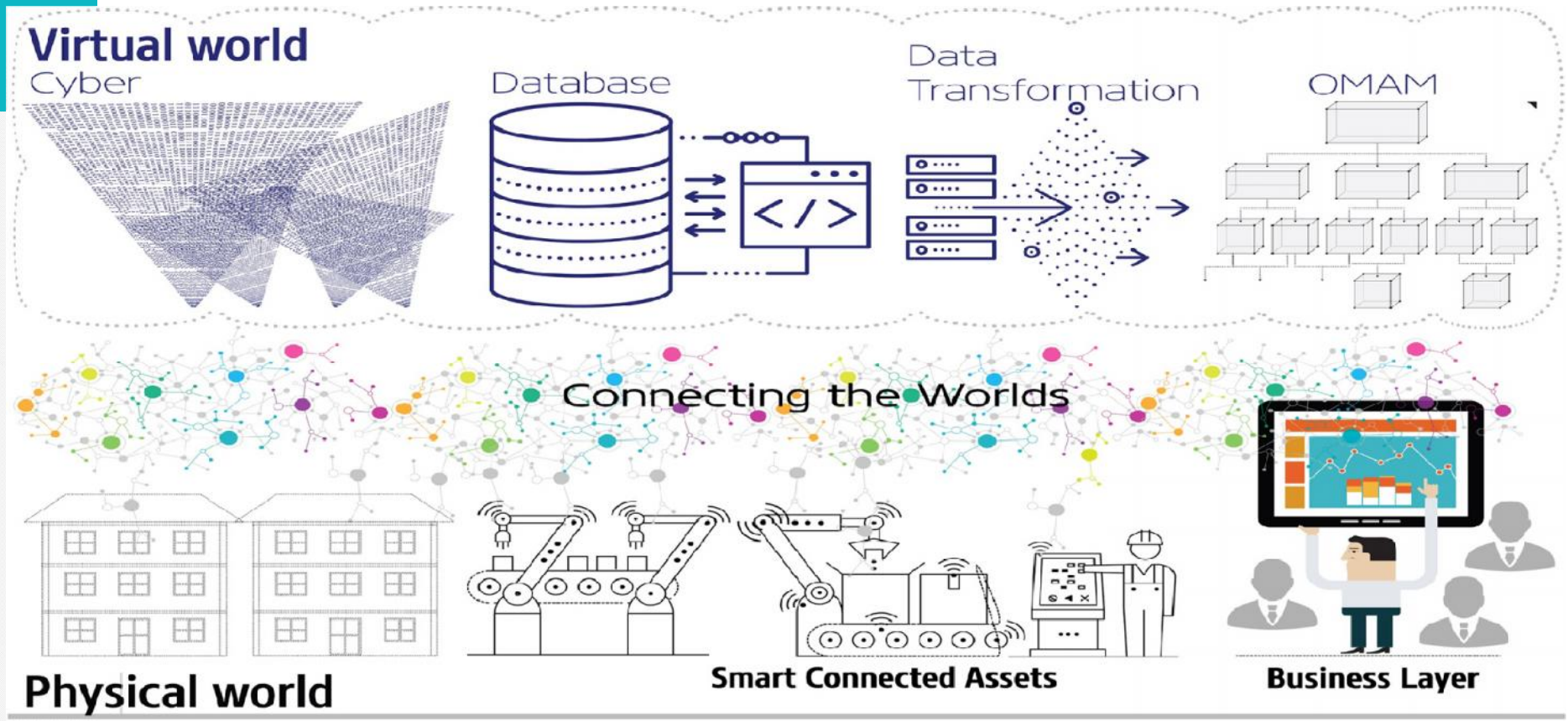
Ideal properties of ISS for daily life

- Present advisory and prescription services for quick solving of complex, routine tasks by users having different levels of knowledge
- Provide management tools based on holistic knowledge of interlinked processes and events
- Allow quick, easy and cost-effective change the virtual SC&C model, adapting it to changes occurring in the real physical world
- Be scalable accommodating complexity of growing SC&C model without complete replacements of services and dramatic costs
- Be reliable and secure in use including crisis and disaster situations

SMART GOVERNANCE, MANAGEMENT and NOVEL URBAN SERVICES ENHANCING STAKEHOLDER'S LIFE RESULT FROM

Digital transformation of big data streams into smart information and apps using custom Open Metropolitan Assets Model (**OMAM**) of SC&C as complex cyber physical system linked with Smart Everything

The generic ISS architecture linking the Worlds



Application Goals:

- Transforming SC&C processes into services easy & least costly
- Providing urban organizations with powerful instruments to make custom OMAMs of their SC&Cs and its upgrading
- Use scientific definition of System Sustainability as data driven combination of its key processes in real time
- Add effective AI supporting operations, citizens interactions
- Apply predictive & prescriptive analytics, condition monitoring to maintenance of urban assets improving quality of life
- Enable AI assisted digital transformation of urban complexity into simple and transparent vision of SC&C

Goals 2:

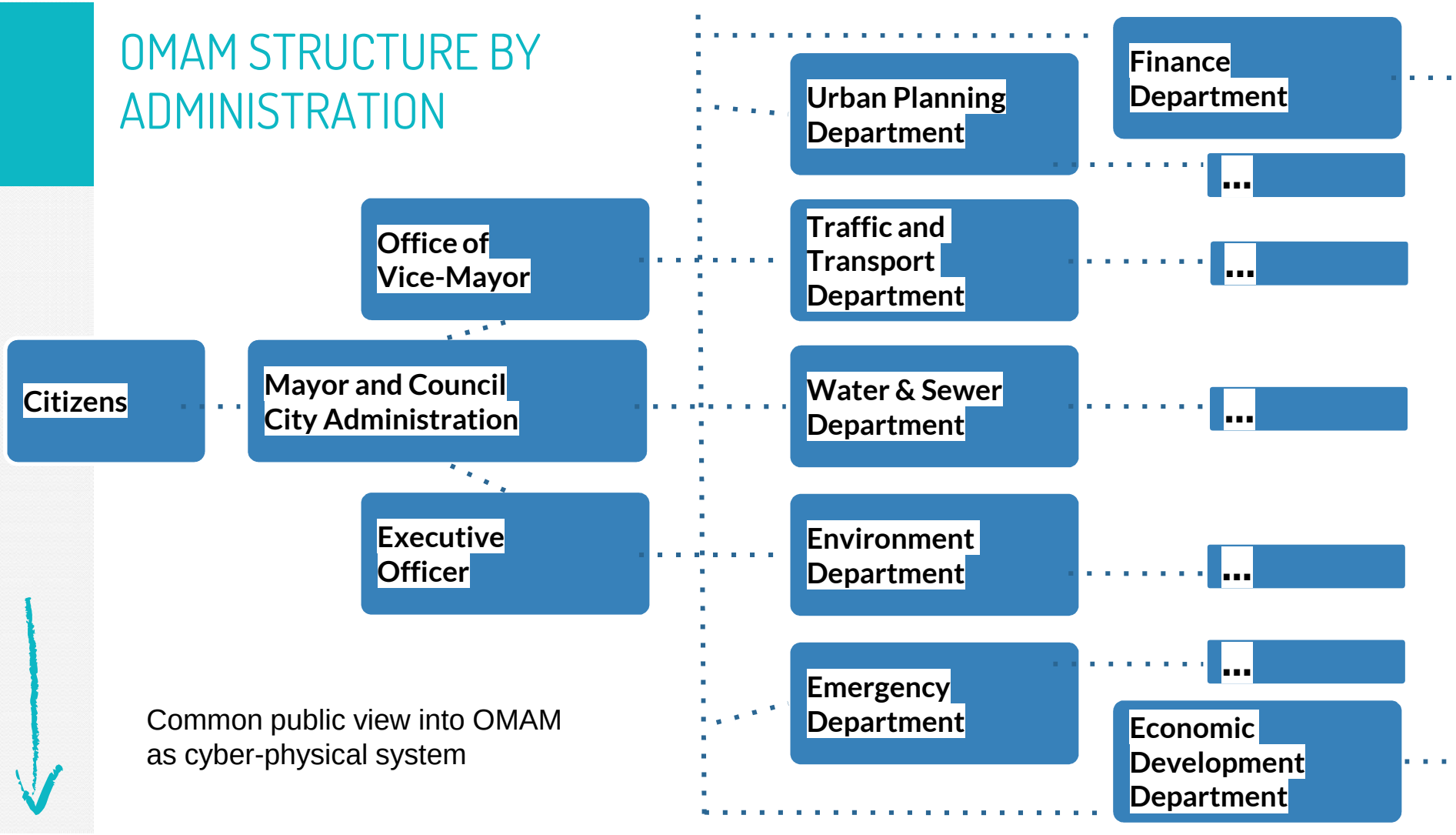
- Providing tools for easy linking to urban IoT and systems, smart objects (mobiles, machines, vehicles, robots, buildings, etc)
- Drill down cause analysis of ongoing processes and results
- Simple AI optimized maintenance, upgrading of infrastructure
- Prototyping innovative solutions with minimum costs & risks
- Experimenting with new business and investment options
- Effective implementation of compliance to newly appearing standards (Quality of Life and Management, Industry 4, etc)

Implementation Examples

The content presented in further pages was implemented in the Smart City Monitor and Smart Enterprise Monitor applications running on Pharos Navigator® platform (PharosN).

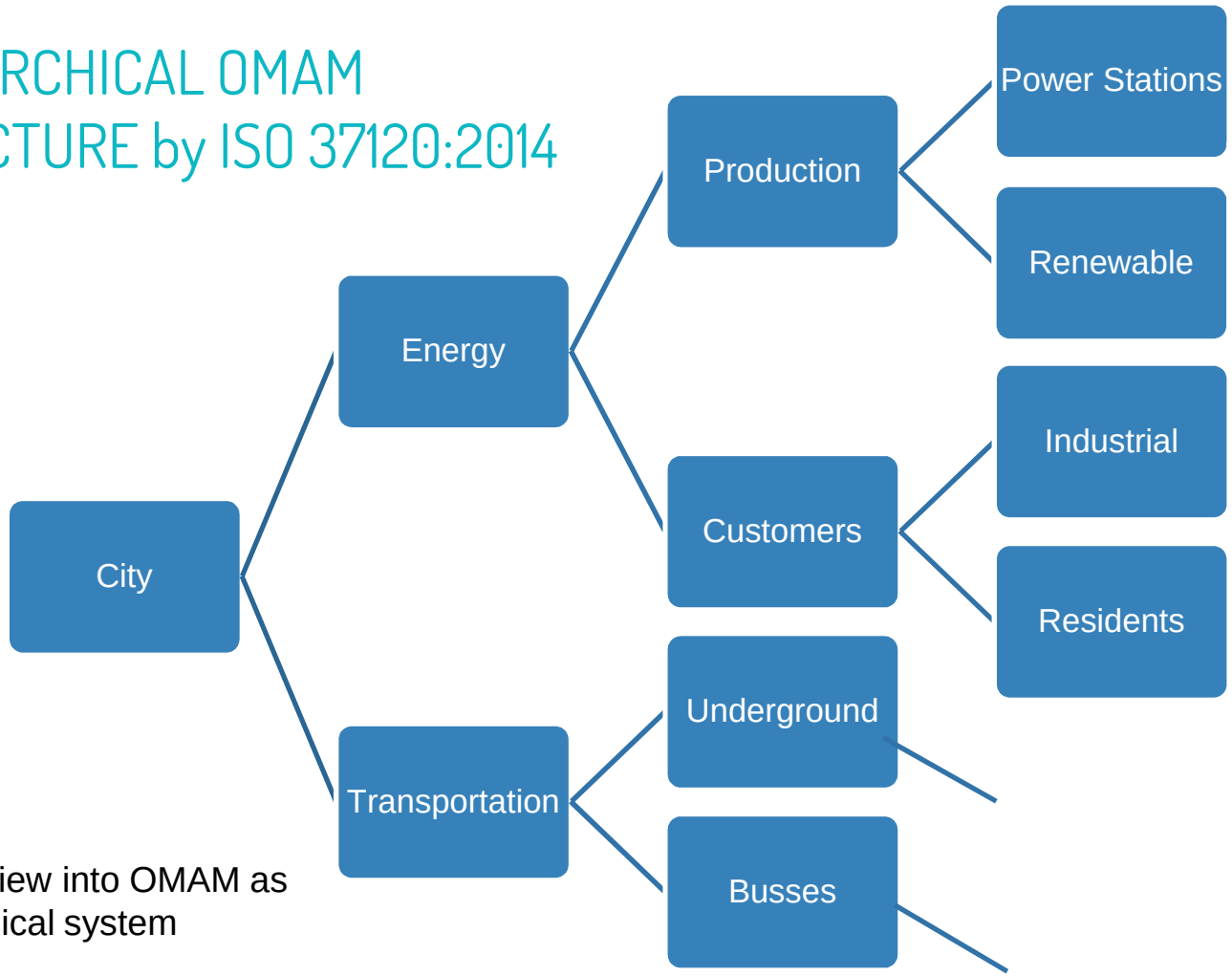
The applications realize basic prototype of ISS as proof-of-concepts and are presented as practical examples based on available achievements.

OMAM STRUCTURE BY ADMINISTRATION



Common public view into OMAM as cyber-physical system

HIERARCHICAL OMAM STRUCTURE by ISO 37120:2014



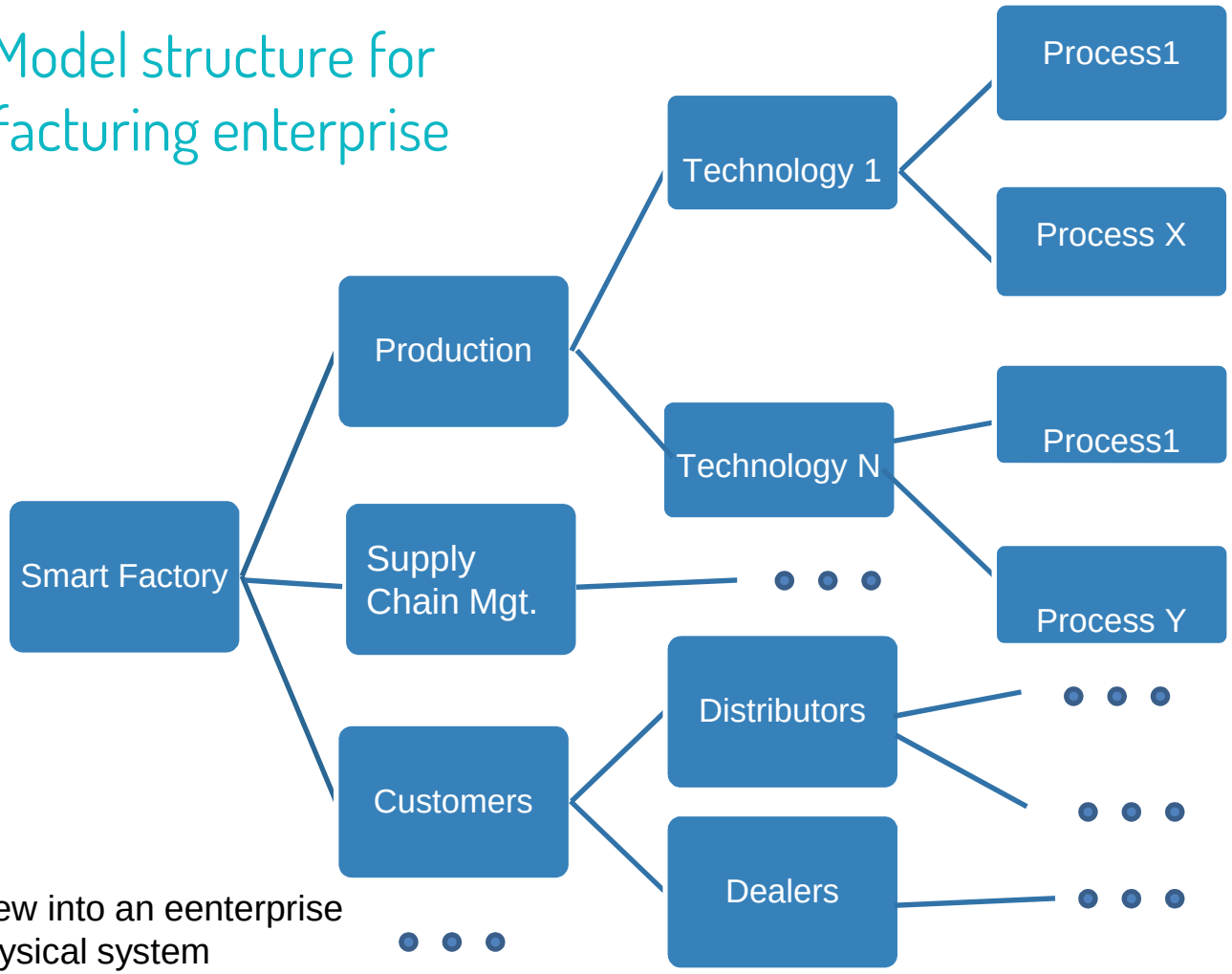
Standard view into OMAM as cyber-physical system

Theme-objects in OMAM by ISO 37120

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

The model structure is open to local definitions of urban infrastructure, life processes, topology, technologies, natural resources, data sources, controls, etc

Open Model structure for manufacturing enterprise



Common view into an eenterprise as cyber-physical system

STANDARD PROPERTIES of THE NODES:

Name as text
Pictures, Videos, Icons, Virtual reality, Augmented Reality
Standards summary
Tags - keywords, attributes, applications
Text descriptors, URL, etc
International Classification
Optional states (e.g. Good, Normal, Bad, Deficient)
Smart sub-objects, inheritance

Indicators
Data elements
Constants: geo-coordinates, tax …
Sensors
Cameras
Energy sources
Reports providing views to processes
Rules of state calculation depending on states of its Indicators and sub-objects

Implementing OMAM in Smart City Monitor

-Starting the City Model by ISO 37120 Themes of City Services and Indicators of Quality of Life

- Its further enhancement accordingly to local requirements, development plans and new standards e.g. 37122, 37123, 37150, 37151, etc

Indicator Name
Total number of citizens
Total number of citizens available as labor force
Total number of unemployed citizens
City's unemployment rate
Value of Commercial property
Value of Industrial property
Value Total of all properties
Assessed value of commercial and industrial properties as a percentage of total assessed value of all properties
Total number of citizens with income below poverty line
Percentage of city population living in poverty

Average life expectancy
Number of in-patient hospital beds
Number of in-patient hospital beds per 100 000 population
Total number of physicians
Number of physicians per 100 000 population
Total number of deaths under age five
Under age five mortality per 100 000 population
Total number of police officers
Number of police officers per 100 000 population
Total number of homicides
Number of homicides per 100 000 population
Total number of people living in slums

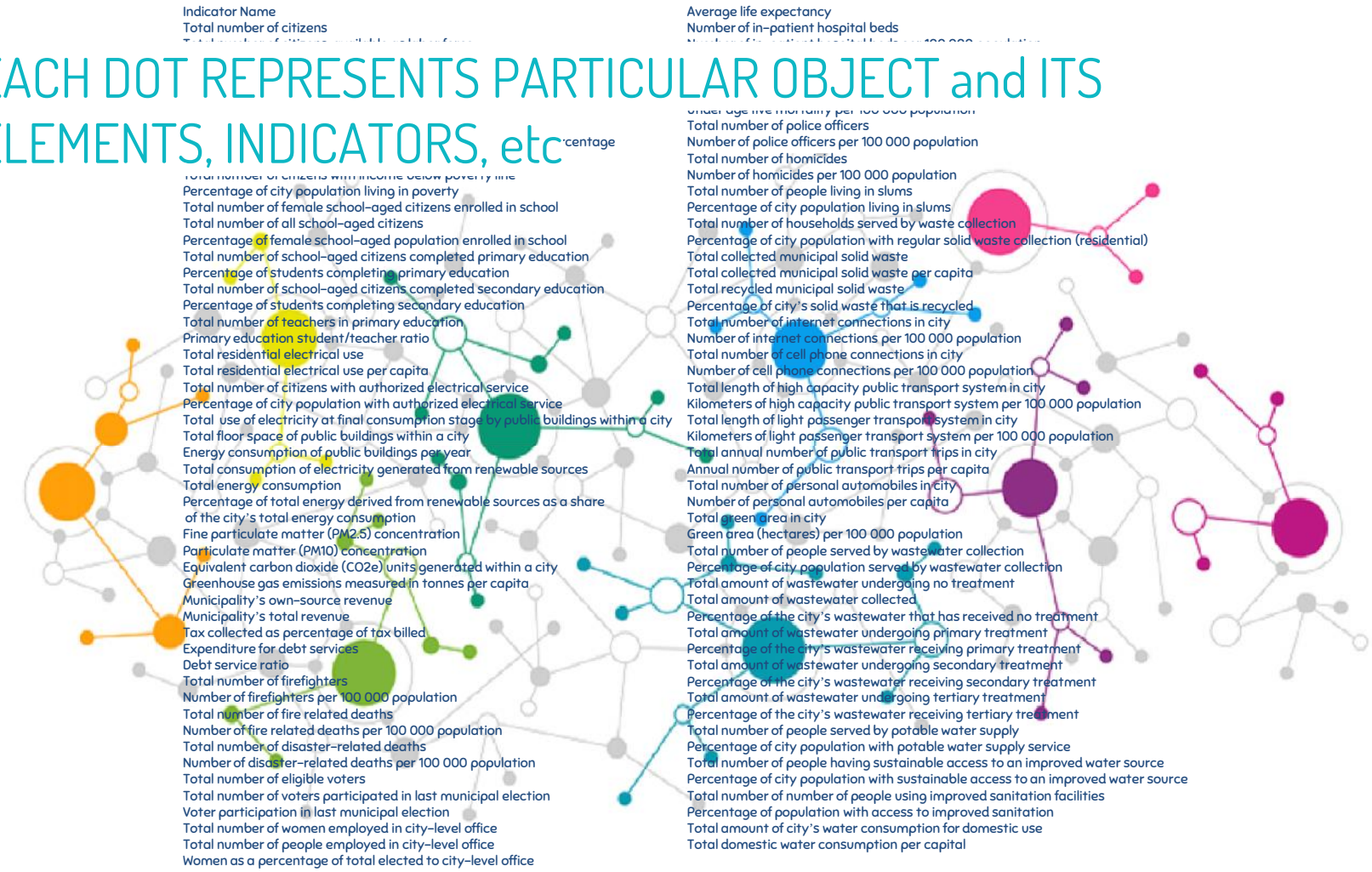
The city model OMAM can have any number of objects, indicators, other elements related to its nodes representing concrete city infrastructure

lation
water collection
wastewater collection
no treatment

Municipality's total revenue
Tax collected as percentage of tax billed
Expenditure for debt services
Debt service ratio
Total number of firefighters
Number of firefighters per 100 000 population
Total number of fire related deaths
Number of fire related deaths per 100 000 population
Total number of disaster-related deaths
Number of disaster-related deaths per 100 000 population
Total number of eligible voters
Total number of voters participated in last municipal election
Voter participation in last municipal election
Total number of women employed in city-level office
Total number of people employed in city-level office
Women as a percentage of total elected to city-level office

Percentage of the city's wastewater that has received no treatment
Total amount of wastewater undergoing primary treatment
Percentage of the city's wastewater receiving primary treatment
Total amount of wastewater undergoing secondary treatment
Percentage of the city's wastewater receiving secondary treatment
Total amount of wastewater undergoing tertiary treatment
Percentage of the city's wastewater receiving tertiary treatment
Total number of people served by potable water supply
Percentage of city population with potable water supply service
Total number of people having sustainable access to an improved water source
Percentage of city population with sustainable access to an improved water source
Total number of number of people using improved sanitation facilities
Percentage of population with access to improved sanitation
Total amount of city's water consumption for domestic use
Total domestic water consumption per capital

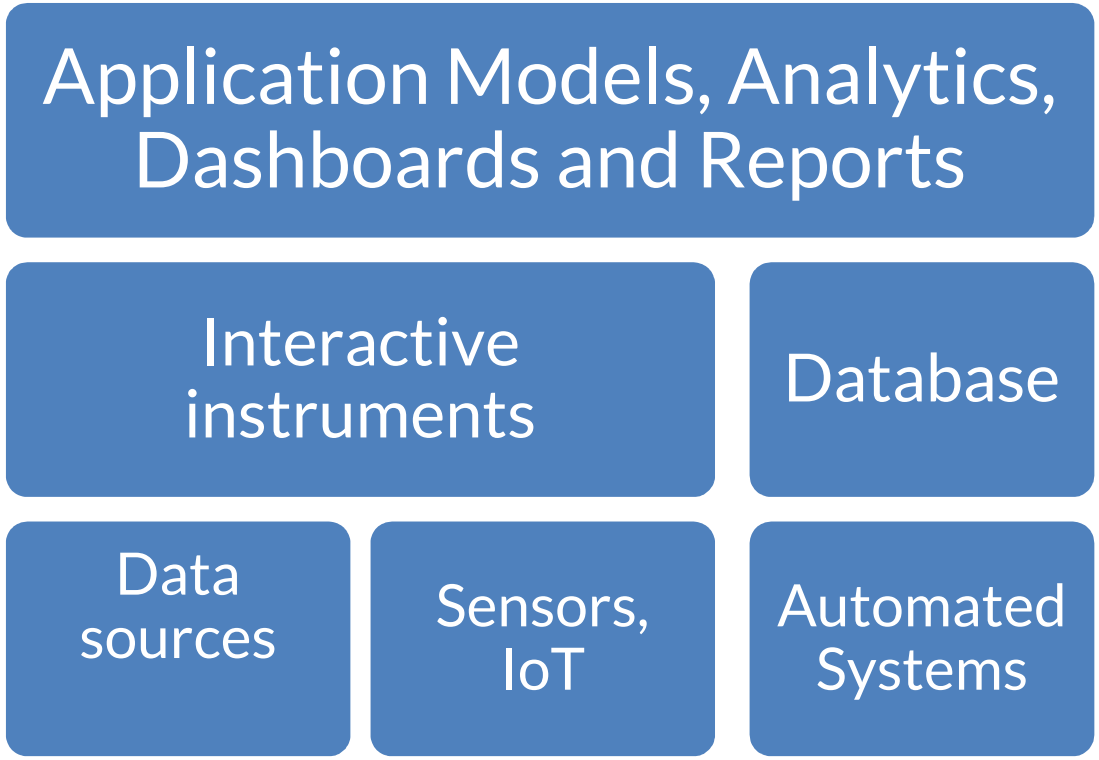
EACH DOT REPRESENTS PARTICULAR OBJECT and ITS ELEMENTS, INDICATORS, etc



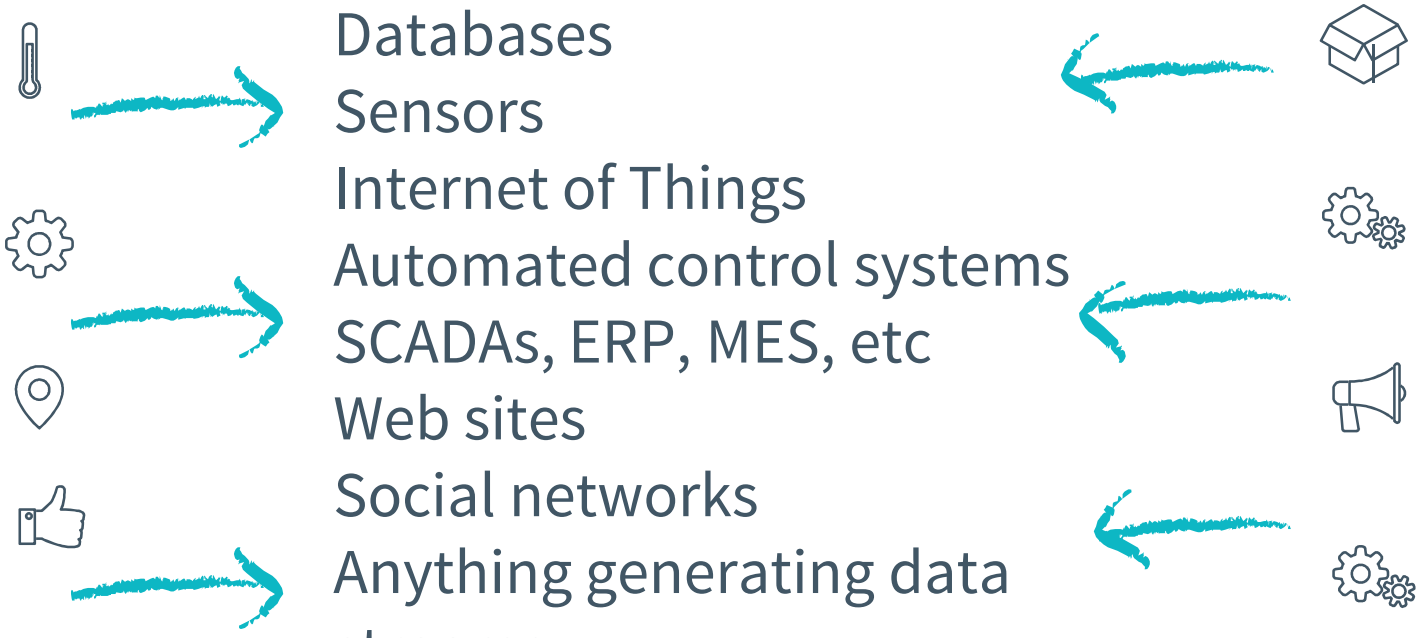
THE SYSTEM MODEL RUNS IN REAL TIME CALCULATING ONGOING STATUSES and PROPERTIES OF EACH NODE

The NODES are defined and act as SMART OBJECTS

Smart City Monitor architecture at a glance



IoT DATA SOURCES LINKING TO THE OMAM



Databases
Sensors
Internet of Things
Automated control systems
SCADAs, ERP, MES, etc
Web sites
Social networks
Anything generating data streams
Smart Connected Assets

Each IoT can be easily logically linked to the relevant node in the model by local connectivity solution using common IoT protocols (RESTful, CoAP, MQTT, etc)

In a Smart SC&C as Complex Cyber-Physical System its big data streams shall be transformed into:

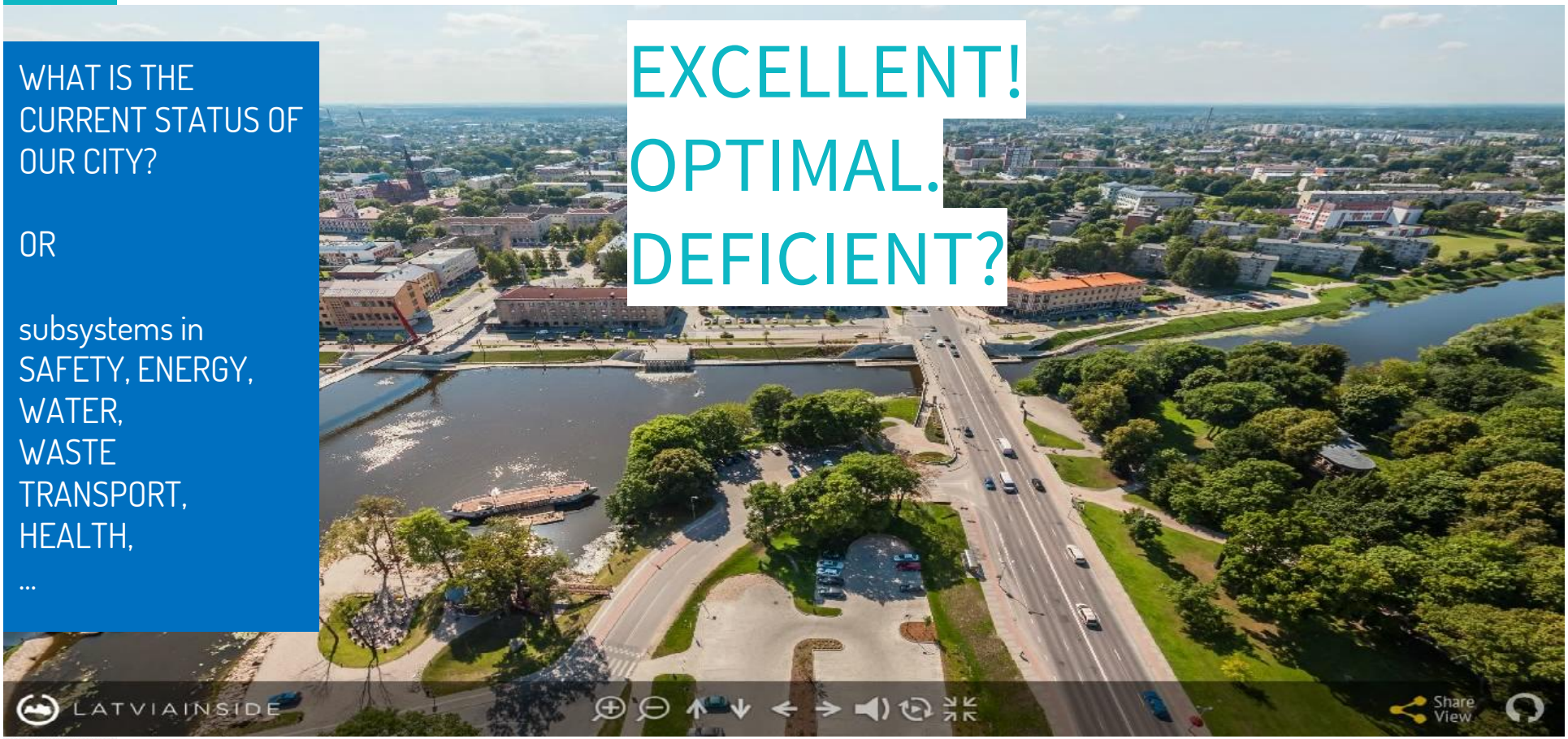
Simple, easy understandable human terms, analytics and images supporting high quality of life and daily activities answering

How are you, my City?

WHAT IS THE CURRENT STATUS OF OUR CITY?

OR

subsystems in
SAFETY, ENERGY,
WATER,
WASTE
TRANSPORT,
HEALTH,
...



Pictures by OCEAN MULTIMEDIA |http://latviainside.com/jelgava-aerial-360-panorama/

Smart Sustainable City demo:
http://smartcity.win2biz.com

Smart City Monitor - SCM

- The digital transformation engines are implemented in 7 European cities in 6 countries as of 2017
- Further developments and implementations are in various R&D projects by Horizon 2020, ENSUF, Interreg, Structural Funds, etc
- Systems open new qualified job opportunities for Smart SC&C projects in large number of small and mid-size cities
- Applied in international programmes as PHAROS suite by UNIDO
- Provides quick development framework for diverse IoT integration solutions and apps
- Effectively supports certification of Cities in compliance with various international standards

TECHNICAL DETAILS of PHAROS NAVIGATOR / PharosN PLATFORM

- Build on Open Source software components only i.e. Linux OS, Apache, node.js, Postgresql, poco, qt5, C++, javascript, jquery, d3.js,
- Clients: MS Windows, Ubuntu etc), Android, IOS (IPhone/IPad)
- Open agile, scalable client-server architecture, docker enabled
- Computing environment: in cloud or at-premises servers
- Interactive reports, dashboards: js/html/css web pages
- Central portal: Self management of own engines by subscribers, automatic engine and client version updates, e-learning
- Connectivity: Internet, local cable and Wi-Fi networks, cellular
- Security: https, websockets, SSL keys 2048 (or more), AES 256
- Scalability vertical (performing) and horizontal (adding hardware)
- Powerful yet simple in use instruments for custom model building, updating and upgrading

The presentation aims

Provide input to the new Focus Group on Data Processing and Management to support IoT and Smart Cities & Communities (FG-DPM) by ITU.

Offer of concrete practical approach to new ISS technology development based on already existing results and achievements

Present real world play ground and use cases for further research, studying characteristics of effective SC&C management systems and urban data driven strategies enabled by AI, data analytics and IoT to support emerging trends including block chain.

Smart Urbana use cases

CPS Labs Horizon 2020 project

- **ASIDEES, Austria – coordinator, technical support GOLEM IMS GMBH**
- **CPSE Labs - UNIVERSIDAD POLITÉCNICA DE MADRID (UPM)**

European cities:

- **Alba Iulia Municipality, Romania**
- **Municipality of Faro, Portugal**
- **Ajuntament de Calviá, Spain**
- **City Hall Nasporeni, Moldova**
- **Municipality of Volvi, Greece**

Real World barriers to be taken into consideration

- Isolated silos in municipalities: The larger city council is, the more separated are its departments' operations from each other
- Legal and organizational hurdles in accessing data sources: Municipalities are barred even by organizations that they own (e.g. water supply), cannot request data from private or state owned utility providers (e.g. electricity, transportation, etc)
- Principal lack of understanding of needs, culture, specialists and budgets for implementing ISS in SC&C (by heads of city councils, utility providers, citizens)
- High costs of large scale solutions that support effective services (IoT, sensors)
- Undeveloped structure of new business models and organization of life that can flourish after effective ISS implementation: Vision of the Future is needed
- Obsolete legislation can block ISS implementation, need strong upgrading efforts
- System security and authorization for ISS shall take into consideration all latest trends in hacking, spamming, ransomware, etc based on worst case scenarios

Service portal and demos online: http://win2biz.com

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