Definition of a Smart Street as Smart City's building element

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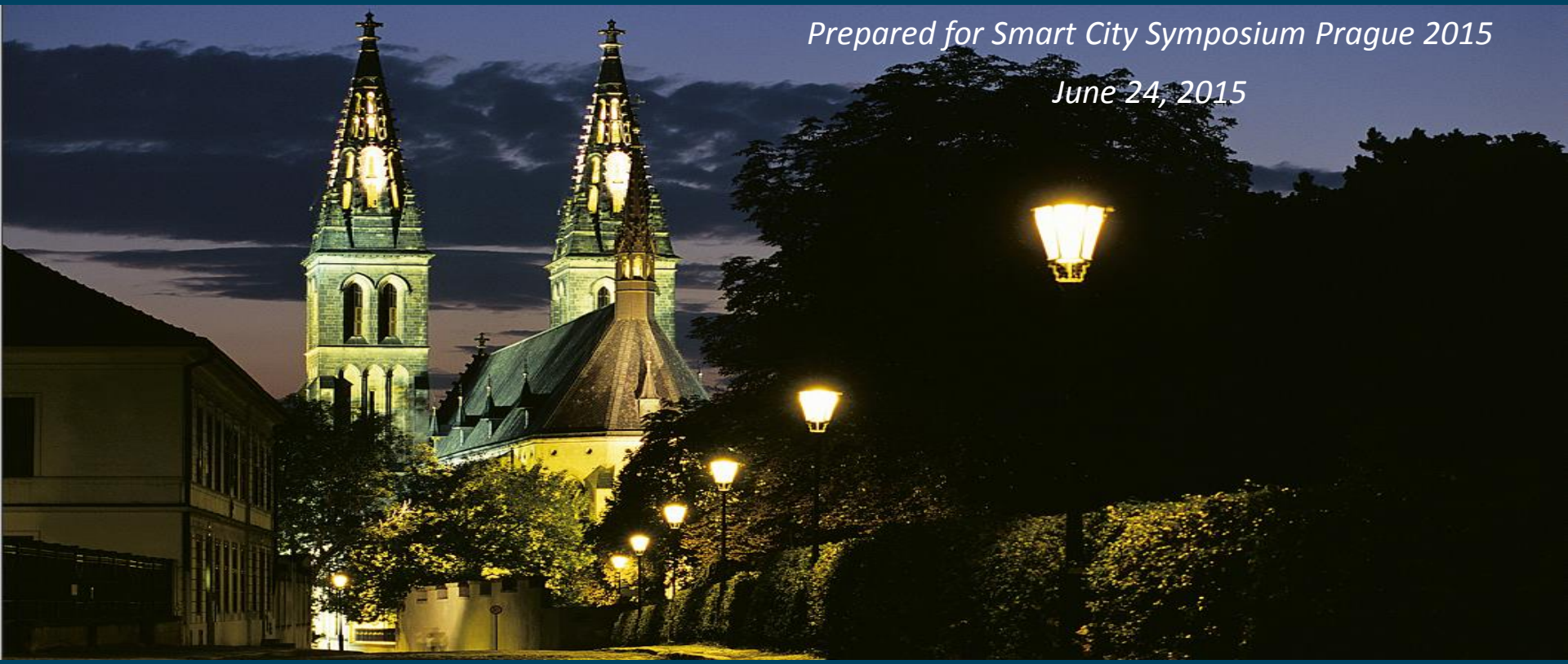

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Motivation

Smart City is a huge complex structure, it is necessary to have manageable building blocks

The basic premise:

- each city is composed by streets
- each street is illuminated
- the poles of lights are connected

} natural networking

Agenda

- Up-to-date SC definition
  - Architecture of this complex system
  - Vulnerability of communication network
- Smart street definition
  - New view on architecture of SC
  - Implication on Quality of Life
- Communication network
- Example
  - Energy efficiency of Smart Streets
- Conclusion

Definition of SC

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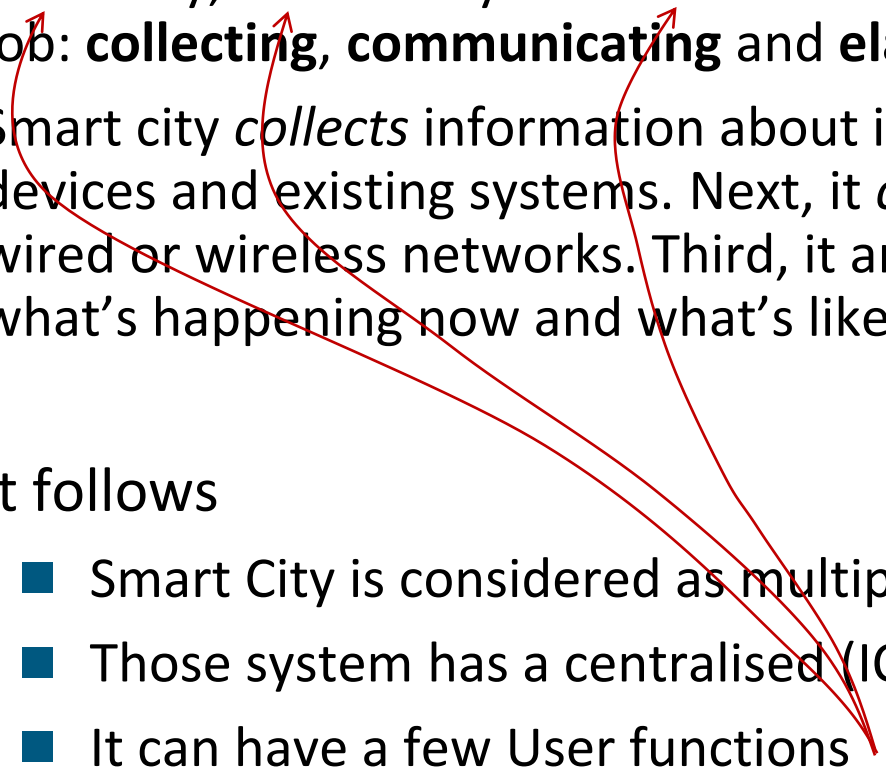
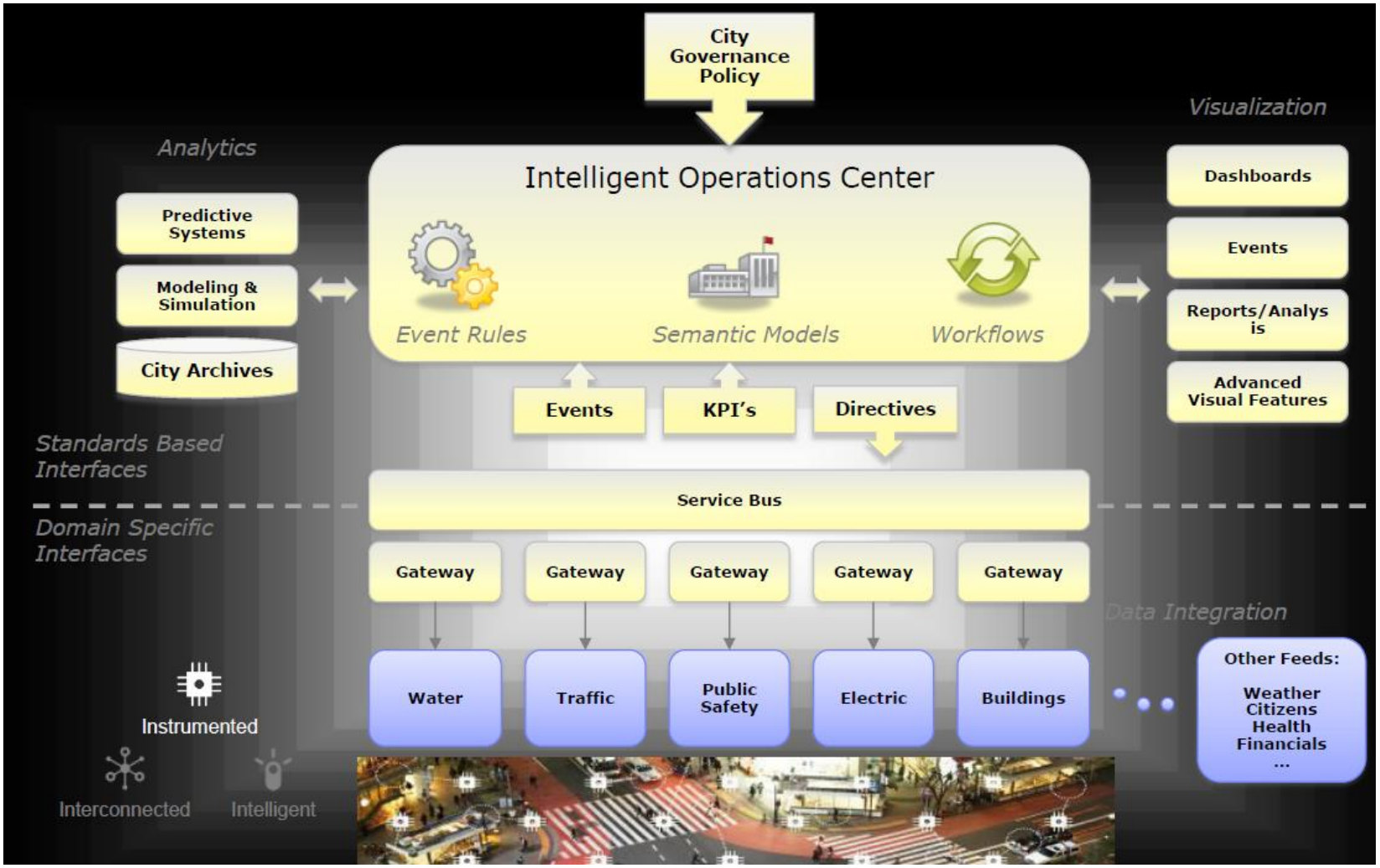
- A smart city uses information and communications (ICT) to enhance its liveability, workability and sustainability. There are three parts to that job: **collecting**, **communicating** and **elaborating**
- Smart city *collects* information about itself through sensors, other devices and existing systems. Next, it *communicates* that data using wired or wireless networks. Third, it analyses that data to understand what’s happening now and what’s likely to happen next.



- It follows
  - Smart City is considered as multiple component system
  - Those system has a centralised (IC) architecture
  - It can have a few User functions (not necessarily fully consistent)

High level architecture

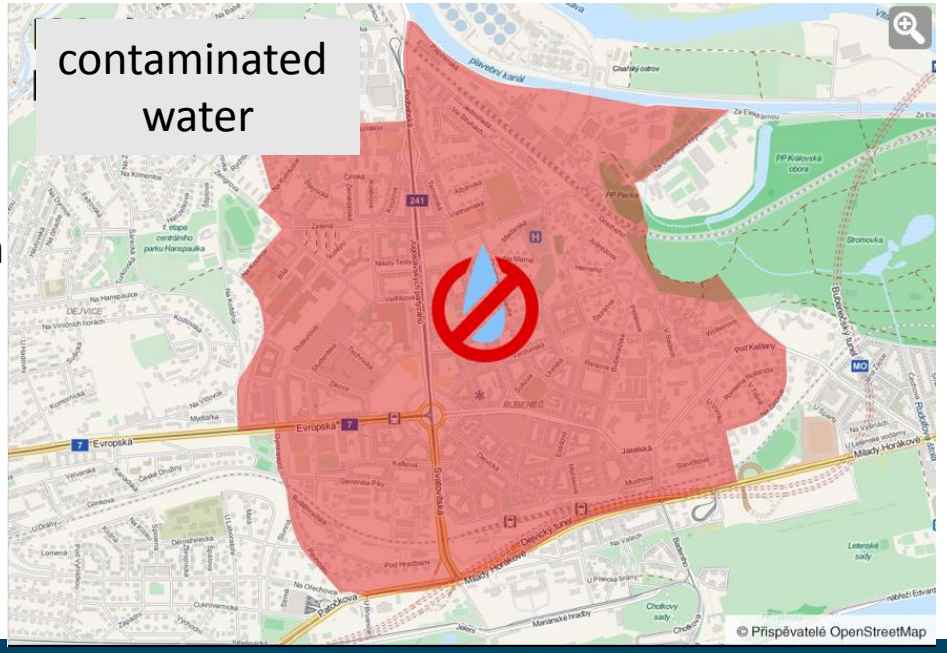


Source: Smarter Cities; 2012 IBM Corporation

Sensitivity of centralised systems

- Expected increase of frequency and severity of climate-related natural catastrophes and an increase of disasters caused by people (terrorism)
- The community is sufficiently resistant to the short emergency situations which take less than 24 hours
- Long term emergency state lead to a social disintegration
  - Auckland: blackout 1998, New Orleans: tornado Katrina 2005, Haiti and Chile: earthquake 2010
  - water infected with bacteria
    - Dejvice. Prague 6
    - 1-3 days insufficient information
      - leaflets on the doors

Society is vulnerable



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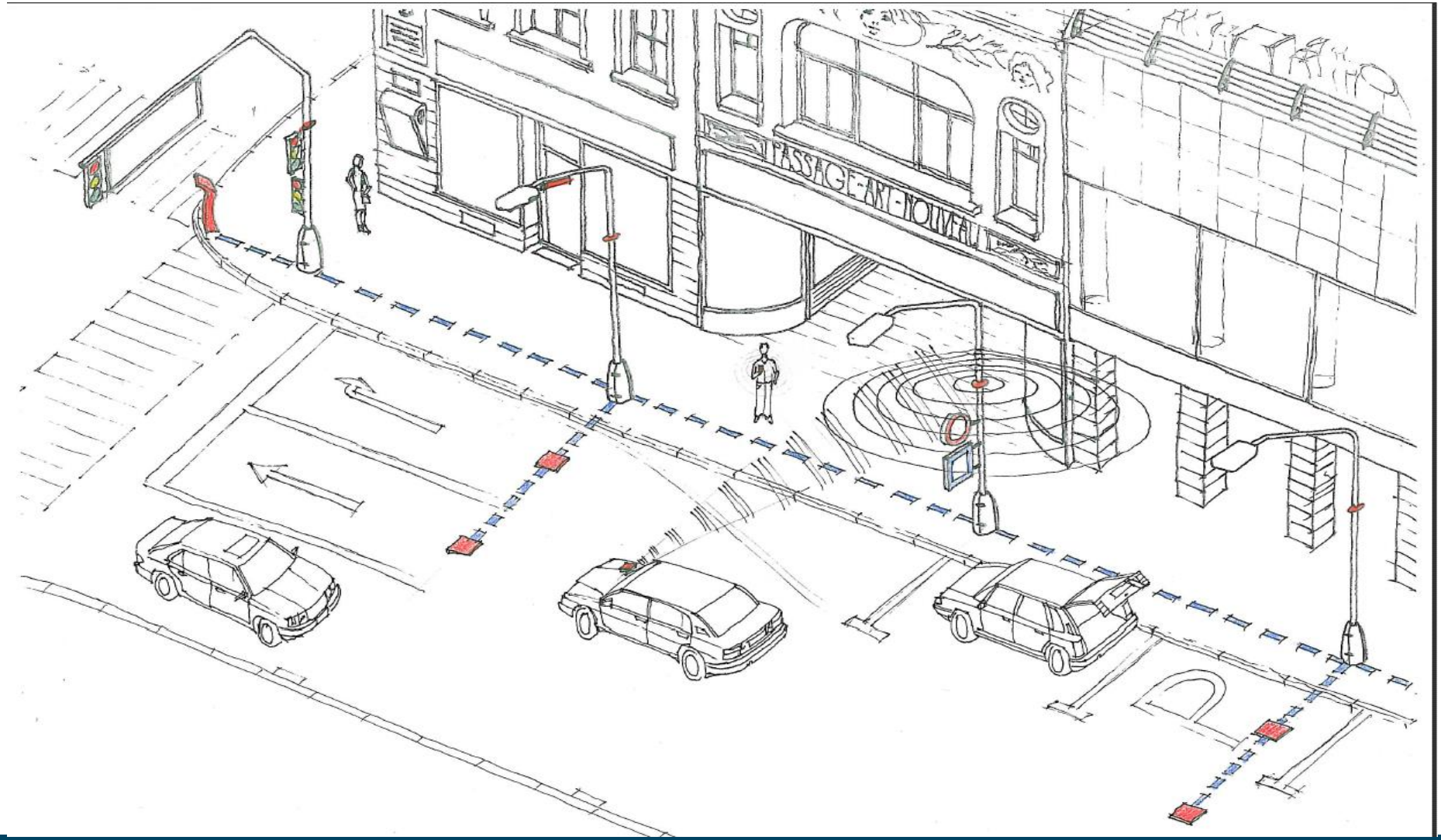
Characteristic of Smart Street

- SS is fundamental entity of SC which **uses the street lighting** system as an infrastructural connectivity backbone
- Using a set of connected environmental, traffic and others sensors it **elaborates and transmits data about the actual situation** on the street and surrounding infrastructure
- It **transmits focused information to the citizens** on the street and for surrounding infrastructure
- Smart Street alone can provide **only limited functionality**, but in connection to other city subsystems can fulfil several objectives from the smart city agenda

Smart Street could be characterised as agent situated in space and time creating multi-agent network in a city

Connecting environment of SS

I2S; S2I; S2P; P2S



Multi-agent system in the smaller city

new view on architecture

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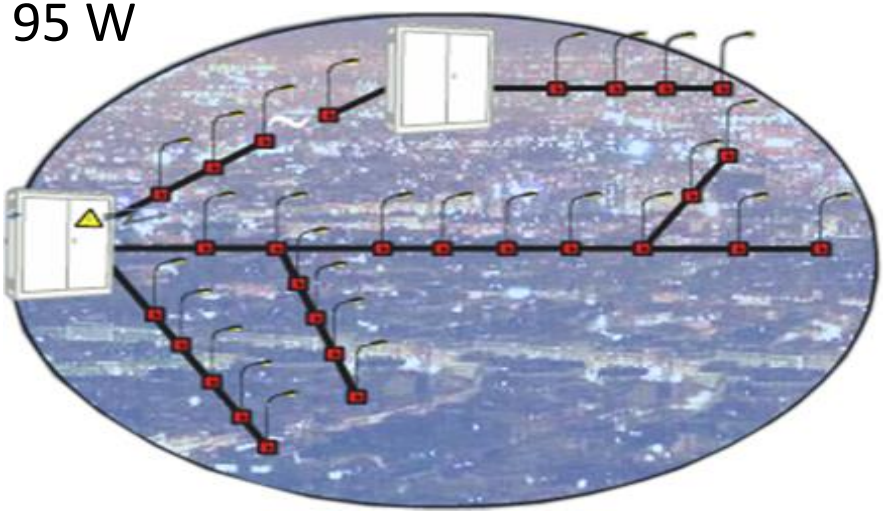
Prague street lighting

- 140 000 lights
  - historical and industrial lighting
- 1500 switching cabinets
  - connecting ≈ 100 lamps
  - average consumption of a lamp is 95 W

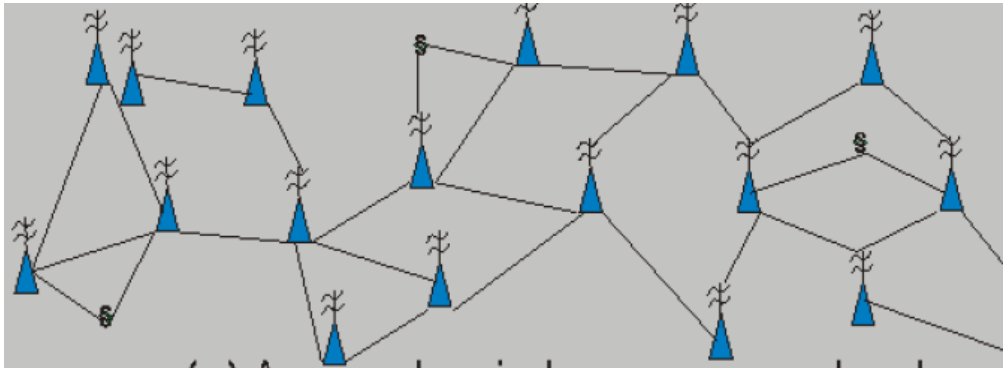


- Topology of network
- Metallic cables
  - pole to pole
  - create fundamental connectivity

for wireless DSRC network of sensors and actuators

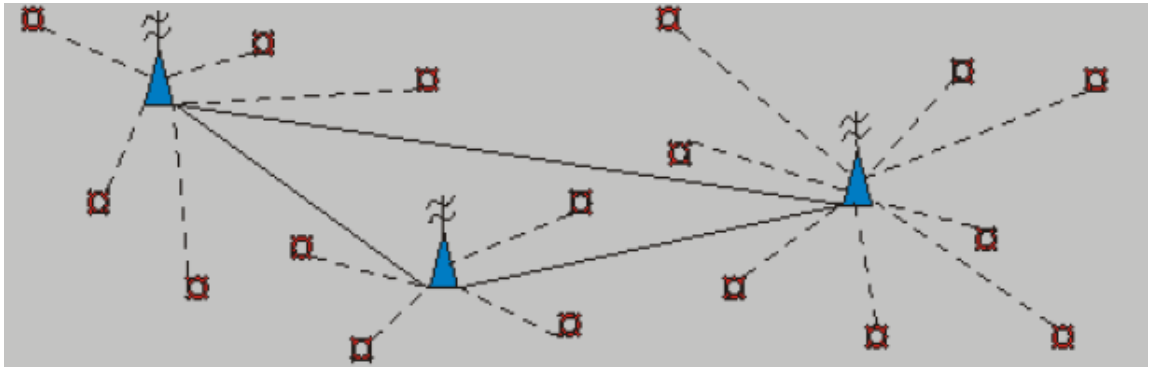
Sensor and actuators network

- The aim: to monitor complex environment in the city
  - sensor dust
- Necessity to use wireless connection



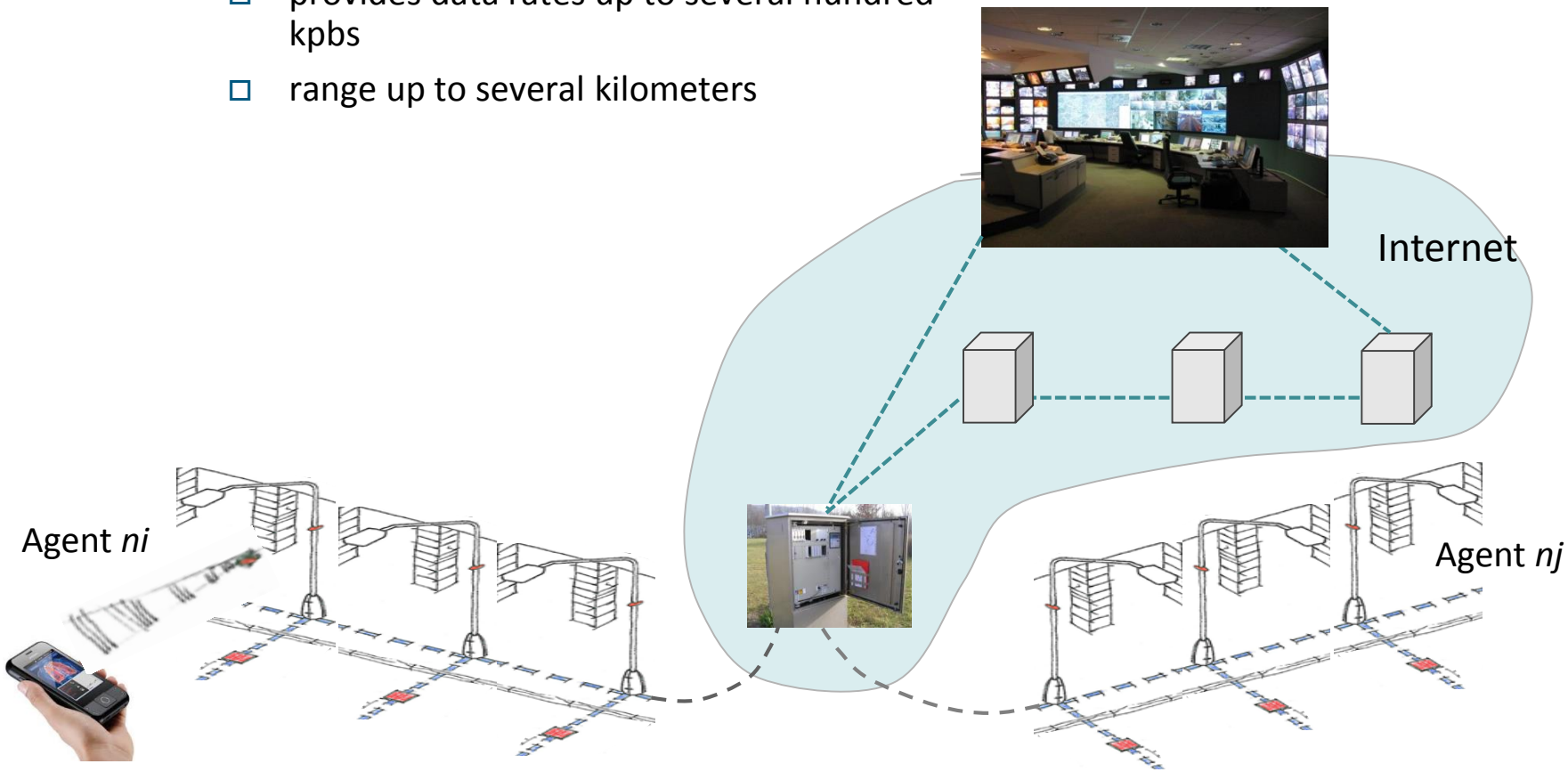
wireless network

cellular network



Solution for communication in SC

- data are sent over existing power cables
  - Power Line Communications (PLC)
    - provides data rates up to several hundred kpbs
    - range up to several kilometers



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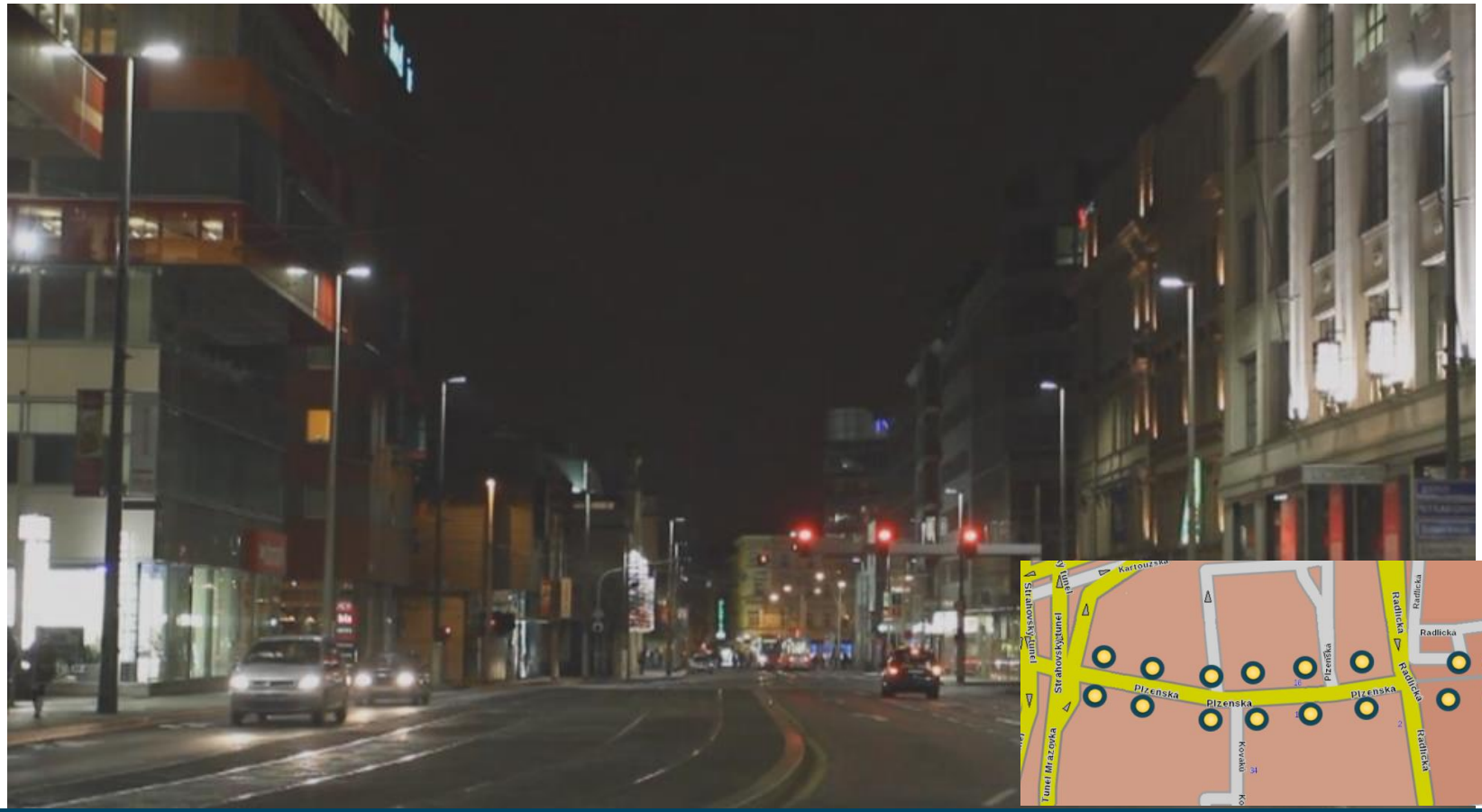
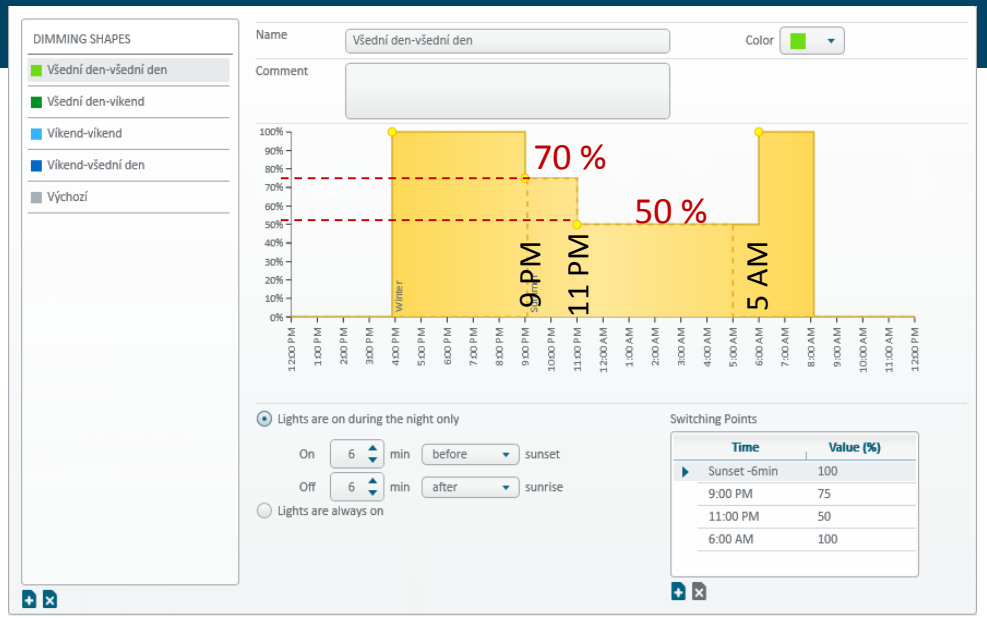
Field test – street lighting control

- Plzeňská street, Prague 5
- 20 pcs lamps - SpeedStar

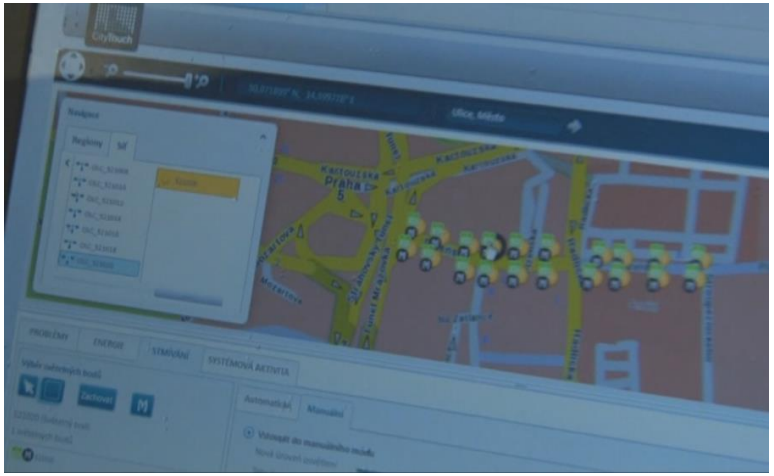


Savings potential

- Test 18.7 - 16.8
- Operating time: 254 hours
- Power consumption:
  - sodium lamps 40 411 kWh
- LED with control: 23 471 kWh



- Saving due to LED and control: 42%



Source: Eltodo, a.s.

Conclusion

- Smart street could be natural cornerstone of connectivity in SC
  - basis is metallic cables network of street lighting
  - street lighting covers all streets in a city
- SS can provide simple tasks – directly on infrastructure
  - the functionality is similar to the agent system
  - set of simple agents creates multi-agent system and collective intelligence
    - feature of the system in which the collective (group) behavior independently of each other "stupid" individuals (agents) causes an additional functionality on a global level
- SC architecture based on SS is robust and less vulnerable
  - costs are lower than for the traditional hierarchical system


Thank you