Making Intelligent and Smart Cities SMARTER

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Outline

- Overview of development of Intelligent and Smart Cities
- Country examples
- Supporting technology and sensors
- How to make intelligent and smart cities smarter ?

1. The emerging and definition of intelligent city

1.1 The emerging of intelligent city concept

- Since 1980s, the development of information technology (IT) are gradually changing transportation, planning system and the whole understanding on cities.
- This kind of understanding help to propose many concepts such as 'invisible city' (Batty 1990a), 'information city' (Castells 1989).



1. The emerging and definition of intelligent city

1.1 The emerging of intelligent city concept

- Inspirations from Singapore National's goal of goal of 'intelligent island' (NCB 1986).
- Batty (1990b) proposed the use of 'intelligent city' in cities using information networks to gain competitive advantage.



1. The emerging and definition of intelligent city

1.2 The definition of intelligent city concept

- Initially, intelligent cities have been used as virtual reconstructions of cities (Droege 1997).
- "...so-called information or intelligent city initiatives means a wide range of experiments with both wired and wireless modes of information conveyance..."
- Following this line, the Intelligent Cities were virtual and interactive spaces that bring computation into the physical environment: the surroundings in which we live, travel and work created from the combination of IT, sensor systems and physical world (Steventon and Wright 2006).



2.1 The evolution of intelligent city concept

- The concept the Intelligent Cities is gradually extended through to other major movements, like Smart Communities (2001) and the intelligent community forum (2006).
- Intelligent Community Forum 2006 five indicators toward broadband economy:
 - (1) significant deployment of broadband;
 - (2) effective education, training and workforce able to perform knowledge work;
 - (3) policies and programs that promote digital democracy;
 - (4) innovation and efforts to fund the development of new businesses;
 - (5) attract talented employment and investments

2.1 The evolution of intelligent city concept

- Understanding intelligent city from two perspectives –

 (1) innovative environments
 (2) the planning of digital cities (Komninos, 2006).
- It is the overlapping of innovative clusters and digital cities.



2.1 The evolution of intelligent city concept

- Komninos (2002, 2006, 2008) extended the ICs' definition into a multidimensional territorial system of innovation
 - (1) knowledge-intensive activities,
 - (2) institutions for cooperation in learning and innovation,
 - (3) digital spaces for communication and interaction.
- From information technology to human, collective, and artificial intelligence within a city (Komninos 2006, pp 17-18; Komninos 2008, pp 122-123).



2.2 The definition of smart city

- The concept of intelligent cities is further evolved to become smart cities.
- Smart city has similar origin with intelligent city. Both of them emerged from the context of the development of information and communication technologies (ICTs).
- Smart cities goes beyond the use of ICT in developing a city.

2.2 The definition of smart city

- There are six characteristics of smart city according to the definition in *Smart Cities Ranking of European Medium-Sized Cities (Giffinger et al. 2007):*
 - (1) smart economy,
 - (2) smart mobility,
 - (3) smart environment,
 - (4) smart people,
 - (5) smart living,
 - (6) smart governance.

- <section-header>
- Its main focus is still on the role of ICT infrastructure, but emphasis is also given to the role of human capital/education, social and relational capital and environmental interest as important drivers of urban growth.

Country Examples

3.1 European Union's Smart City Strategy

- It is the EU that extends the concept of 'intelligent city' into a wider meaning of 'smart city'
- 'smart city' was mentioned again in the European Strategic Energy Technology Plan Set –Plan(SET-Plan). This initiative will support 25 to 30 'smart cities' that take pioneering measures to progress towards a radical reduction of greenhouse gas emissions through the sustainable use and production of energy.



3.1 European Union's Smart City Strategy

- In Europe 2020 the EU's growth strategy for the coming decade published in 2010, smart, sustainable and inclusive growth have been defined as three key tasks.
- On 10 July 2012, the European Commission launched the Smart Cities and Communities European Innovation Partnership. The partnership proposes to pool resources to support the demonstration of energy, transport and information and communication technologies (ICT) in urban areas.





3233rd ENVIRONMENT Council meeting

Brussels, 21 March 2013

3.1 European Union's Smart City Strategy

 Overall, the European smart city construction practices are more focusing on particular themes of intelligent applications rather than the overall planning of the city.



3.2 US' Smart City Strategy

- 'smart city' strategy tends to be private and commercial oriented.
- IBM first announced the 'Smarter Planet' in 2008
- In 2009, the report The Digital Road to Recover: A Stimulus Plan to Create Jobs Boost Productivity and Revitalize America by IBM and ITIF was confirmed by Obama's government.
- Many initiatives containing 'smart transportation' and 'smart health care', were proposed in more than 130 smart city projects.









3.3 Singapore's Smart City Strategy

- Singapore began its smart strategy since 1980s by a series of plans proposed by the National Computer Board (NCB).
- The most representative plan is A Vision of an Intelligent Island: IT2000 Report (NCB, 1992): apply IT to enhance national competitiveness and the quality of life.

3.3 Singapore's Smart City Strategy

- The IT2000 is regarded as a great success.
- In 2005, Singapore government published iN2015 Masterplan to grow the info-comm sector and to use ICTs to enhance the competitiveness of key economic sectors and build a wellconnected society:.



3.3 Singapore's Smart City Strategy

- With the implementation of this plan, the role of Singapore infocomm industry in the national economy has becomes increasingly prominent.
- The development of the infocomm industry ranked first in Asia and also located in the top 10 in global range. In the IMD World Competitiveness Yearbook 2010, Singapore is located as the first.

Ranking	2006 rank	2007 rank	2008 rank	2009 rank	2010 rank	70 60	45.42	51.68	58.10
WEF Global IT Report	2	3	5	4	2	40	40.42		
EIU e-Readiness	13	6	6	7	NA	30			
EIU Benchmarking IT Industry Competitiveness Report	NA	11	9	9	NA	20			
Waseda University World e-Government Ranking	3	2	2	1	1	0			
WEF Global Competitiveness Report	5	7	5	3	NA		2006	2007	2008
IMD World Competitiveness Yearbook	3	2	2	3	1	Growth	19.9%	13.8%	12.4%

Total Infocomm Industry Revenue, 2006-2009, Annual

62.74

8.0%

S\$Billior

3.4 Japan's Smart City Strategy

- Japan did not propose the 'smart city strategy' directly. However, two policies, 'U-Japan' and 'I-Japan' contains many features of 'smart city'.
- The "U" in "U-Japan" represents the "U" in not only "ubiquitous," but also in "universal," "user oriented," and "unique." I-Japan Strategy emphasizes the perspective of enabling everyone to enjoy digital technologies and was adopted with a focus on the following points



July 6, 2009 IT Strategic Headquarters



Steps taken in Japan on IT strategies

3.4 Japan's Smart City Strategy

- The construction of smart city has been widely supported through focusing on people's daily life to make sure the public can get tangible benefits.
- The creation of "smart home examples" demonstrates the benefits of smart life to local residents



3.5 Korea's Smart City Strategy

- U-KOREA Master Plan was proposed in the information white paper in 2006
- The will of the government to adapt to the fast-changing information environment and strengthen Korea as the IT leader's position.
- In 2009, new concept of Ubiquitous-City (U-City) was proposed as a further development of 'u-KOREA',



3.6 China's Smart City

 Until 2012, 154 Chinese cities claimed their plan to build smart cities. Planned gross investment has exceeded 1,000 billions RMB (US\$163 billions)



3.6 China's Smart City

- 90 smart cities as 1st around cases have been published by the Ministry of Housing and Urban-Rural Development In January, 2013
- The National Smart City (district, town) index system (国家智慧城市 (区、镇)试点指标体系) & The National Smart City (district, town) management rules (国家智慧城市试点 暂行管理办法) are published at the same time.
- **80 billions** RMB's (US\$14.5 billions) funding





3.6 China's Smart City

• The National Smart City (district, town) index system (国家 智慧城市(区、镇)试点指标体系)



- 3. Intelligent city and smart city: strategy of urban development
- 3.6 China's Smart City
- Main objectives of Smart City: Smart city as a new way of urbanization
- optimize urban environment
- enhance the city's innovation ability
- improve the public well-being and create sustainable urban development
- increase the efficiency and smartness of urban governance

The National Smart City (district, town) management rules

- Selected smart cities should submit an annual self-evaluation report to the Ministry of Housing and Urban-Rural Development every year.
- A leading group will be created to assess the achievements, which will be graded as one, two and three stars from low to high.

The 2nd around of smart cities will be selected in the end of June, 2013

Smart Cities

- Evolution from :
 - Digital Cities (computer and information network)
 - Intelligent Cities (digital cities plus sensors plus decision making)
 - Smart City (intelligent cities plus smart decision in achieving smart objectives)
- Backbone of Smart Cities Digital Cities (Sensor + IT)

Sensors, information and related IT and applications is the heart of smart cities

Sensors Applications

Position Sensors Smart Navigation Motion Sensors Smart Transportation Video Camera Smart Surveillance **Bio-Sensors** Smart Health **Other Sensors Smart Building**

Position Sensors

Position sensors are any device that permit position measurement. It can either be an absolute position sensor or a relative one.







Motion Sensors

A motion sensor is a device that detects objects moving:

- Accelerometer
- Gyroscope



Wearable MEMS Based Motion Sensors

The advancement of MicroElectro-**Mechanical Systems** (MEMS) technology enables the realization of low cost, low power, very small motion sensors which are even wearable.



Wearable Motion Sensors

Video Cameras



Video cameras are used to monitor situations in application like transportation and surveillance. Usually, cameras are connected to digital video recorders, and advanced image process technology enables the intelligent processing capabilities to detect abnormal situations.

CCTV Systems



Bio-sensors are widely used in health domain. With sensors attached to one's body, either internally or externally, it is possible to monitor an individual's vital signs remotely:

- Glucose
- Cholesterol
- Oxygen in blood
- Urea
- Immunosensor
- Biomass



Other Sensors

- Force
- Gas/ IonType
- Temperature
- Flow
- Magnetic
- •

Sensors in Smart Navigation

Assisted GPS improves standard GPS performance with additional information (sometimes require Internet access). For example, Precise Point Positioning (PPP).


Sensors in Smart Navigation



Indoor Navigation with Coded Target



Lost Find with Active RFID Tags

Sensors in Smart Transportation



Autonomous car

Passive RFID Tags

Sensors in Smart Surveillance







Abnormal situations determination

Sensors in Smart Health

Wearable sensors (e.g. Accelerometer, gyroscopes and Biosensors) are used in health applications including:

- Fall Detection
- Medical Status
- Daily Living



Sensors in Smart Health

Accidental falls are among the leading causes of death over 65.

Accelerometers and gyroscopes are used to identify sudden falls for elderly people.



Sensors in Smart Buildings

In an effort to promote green living and sustainability, there are various initiatives to decrease energy consumption in buildings.



Temperature Sensor



Humidity Sensor

Sensors in Other Applications



Pipeline Monitoring

Large numbers of cheap and small sensors (like flow sensors, pressure sensors and vibration sensors) are Integrated with WSN and incorporated into the pipe to help continuous monitoring the pipeline

Sensors in Other Applications

Wireless sensor nodes installed on the critical equipment of the smart-grid system to provide vital monitoring parameters.

Electricity Monitoring



Big Data

Big data includes data sets with sizes beyond the ability of commonly used software tools to capture, curate, manage, and process.

It is a rich informative data source for city studies.

- GPS Trajectories Data
- Mobile Data
- Smart Card Data

GPS Trajectories Data

GPS trajectories data is usually used in transportation field. It is also very valuable for many applications, such as urban, business and human behavior analysis.



Mobile Data

Mobile data have been widely applied in human mobility pattern research.



Smart Card Data

Smart card data have been used to identify commuting pattern. This data can also be used to study city spatial structure.



Self-Learning Artificial Intelligence (Machine Learning)

The Case Based Reasoning (CBR) Cycle



Yeh, A.G.O. and X. Shi (1999), "Applying Case-Based Reasoning(CBR) to Urban Planning - A New PSS Tool", *Environment and Planning B: Planning and Design*, Vol. 26, No. 1, pp. 101-116



Evaluation Result





Physical Space contains municipal infrastructure, roads, governments, shops etc. that exist physically in cities.

Cyber Space contains information or services such as internet, cellar phone, GIS etc that exist virtually in cities.

Digital City is the overlapped part for a city.

Along with development of information technology, the scope of digital city will continue to grow.

Digital City – Interaction of Cyber and Physical Spaces

• An example - shopping



Digital City – Interaction of Cyber and Physical Spaces

Visiting Places (shops, government offices, tourist areas)



Digital City – Interaction of Cyber and Physical Spaces

Delivery of Goods and Services



Why do we still get lost in Digital, Intelligent and Smart Cities ?



Physical Navigation in a City Clues and Direction Signs

- District Zone
- Street
- Street Blocks
- Building









City – Shopping Mall Clear and Well Located Direction Signs















Design of Direction Signs Should be Incorporated into the Whole Framework of Urban Design and Urban Planning



Building Location ?



Address Matching and Geocoding

- Use of address matching and geocoding, please see Goldbreg, Wilson, Knoblock (2007)
- Present Process



- Present Problems
 - expensive and time consuming
 - at least 20% errors (due to improper provision of address by users and address coding system)
 - we need smarter method
Design Principles of Georeferenced Building Code

- 1) Each building should have a unique code
- 2) Easy to remember by user
- 3) Easy to generate

Two Methods of Georeferenced Building Code : 1) Simple Centroid Method

2) Postal Code + Centroid Method

Method of Georeferenced Building Code

- 1) Simple Centroid Method
- 2) Postal Code + Centroid Method

(1) Simple Centroid Method

• Georeferenced Building Code from x,y of building centroid.



x,y = 1201234, 0231740

• Example : x = dddmmss = 1201234 y = dddmmss = 0231740

Building Code = 1201234-0231740

Problem – difficult to remember

(2) Postal Code + Centroid Method



Postal Zone Window MinX, Min Y = $P_x=120^{\circ}21'05''$ $P_y=23^{\circ}17'24''$ Building Centroid = $B1x=120^{\circ}21'34''$ $B1y=23^{\circ}17'40''$ Building Centroid – Postal Code Window = Xdiff = 34-5=29 Ydiff = 40-24=16 Postal Building Code = 100118-29169 last digit = check sum

Government Gazette - Web

Building Name	Stanadrd Building Address	Postal Building Code	Postal Building QR Code	Geocode– X, Y
B1	Addr-1	PostalCode- Geocode-1		Geocode-1x,y
B2	Addr -2	PostalCode- Geocode-2		Geocode -2x,y
B3	Addr -3	PostalCode- Geocode-2		Geocode -3x,y

GIS Map Query from Government Web



Building Name	Stanadrd Building Address	Postal Building Code	Postal Building QR Code
B1	Addr-1	PostalCode- Geocode-1	

Resident Card

xx大厦



标准建筑物地址: XX市XX区XX路XX号



邮政建筑物编码: 100118-29169

Name Card

Name : Standardized Address : Postal-Building Code:

Tel :

Email:



Building Plate with Postal-Building Code



Flexible Rezoning and Redistricting



How to Make Intelligent/Smart Cities Smarter ?

- Self-learning Artificial Intelligence
- Better integration of cyber city with physical city
- Integration of direction signs in urban planning and design
- Government standardization and coordination in geocoding

Thank You