UNIVERSITY OF SHARJAH
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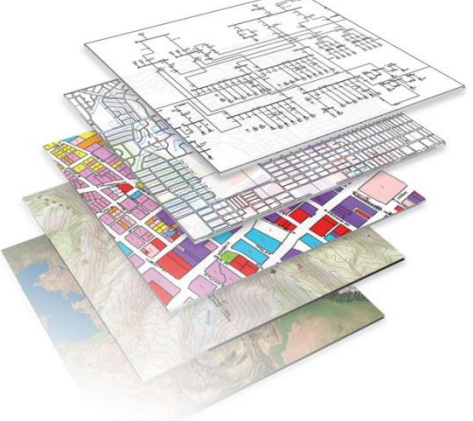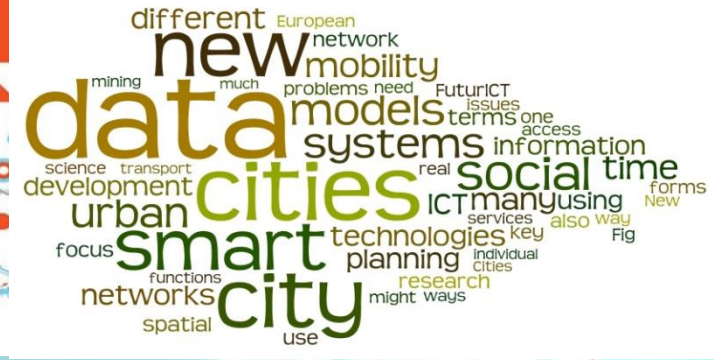Geographic Information Systems Center
مركز نظم المعلومات الجغرافية

GeoSpatial technology, Smart cities and Big Data: Smart Oman (Muscat) Proposal

Dr. Oualid (Walid) Ben Ali

Department of Information System
Founder and Director of the GIS Center
University of Sharjah, UAE

OMAN GEOSPATIAL FORUM

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Oman International Exhibition Centre
Muscat, Oman

Part 1: Smart cities and GeoSpatial Technology: GeoSmart Cities

Introduction: Why we need Smart Cities?

- In 2007, 3.3 billion people live in cities, 50% of the total population (for the first time)

- In 2030, 5 billion

- In 2050, 6.4 billion, 70% of the total population

- Now 70% of the global GDP is generated by cities

- Cities used 75% of the world's energy

There Will be 35 Mega Cities Globally By 2025 - 77% of Mega Cities to be From Developing World

Moscow

London
Paris

Chicago

New York City

Madrid

Los Angeles

Mexico City

Bogotá

Istanbul

Tehran

Cairo

Delhi

Mumbai

Kolkata

Nanjing

Harbin

Beijing

Tianjin

Wuhan

Chengdu

Chongqing

Seoul

Tokyo

Osaka-Kobe

Shanghai
Hangzhou

Guangzhou

Foshan

Shenzhen

Hong Kong

Jakarta

Rio de Janeiro

São Paulo

Buenos Aires

Population in 2025

> 27 Million

18-27 Million

8-18 Million

Note: Mega City is defined as a city with population of over 8 million and GDP of $250 billion or more

Source:: United Nations, Department of Economic and Social Affairs, Population Division (2012), World Urbanization Prospects: The 2011 Revision , Frost & Sullivan, 2012

Challenges

- Urbanization, population growth, climate change, energy use, security, aging, migration, and dwindling resources will bring grand challenges
  - distribution management, demographic and social ecosystems will need to evolve, economics will be under increased pressure; the environment will be challenged; digital and social inclusion needs will grow and healthcare and education provision will demand a new approach.

Cities have aspirations

The well-planned City

Healthy and safe City

The Sustainable Eco-City

The cultural-Convention hub

The City of Digital Innovation

The City of Commerce

Solution???

- What solution should we take in order to tackle these challenges?

Solution: Smart Cities

- Infrastructure operators are looking for intelligent solutions (cities need to become Smarter) to respond to these challenges. Through ICT and automation, we can help to reap the full potential of urban infrastructure such as:
  - Smart grid technologies, intelligent traffic management, building automation systems, intelligent security solutions, transportation management systems, etc.
- We can help optimize existing infrastructure, increase efficiency, reduce operation costs, improve safety and resiliency, and reduce environment burdens

What is a Smart City?

- A "City" *that uses information and Communications Technologies (ICT) to make the critical infrastructure components and services of a city- administration, education, healthcare, public safety, real estate, transportation and utilities- more aware, interactive and efficient* (Forrester 2010)

- The Smart City seeks in part to address the mentioned challenges through instrumentation, interconnection, and intelligence. Typing all of this together is data.

Plug-in City
Wired City
Virtual City
Intelligent City
Smart City

Ron Herron, 1964
Walking City imagines a future in which borders and boundaries are abandoned in favour of a nomadic lifestyle among groups of people worldwide.

Walking City
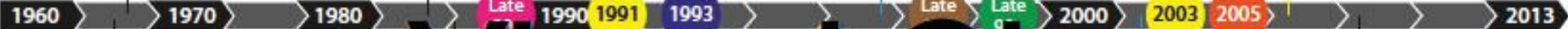
Plug-In City

Peter Cook, 1964
The Plug-in City is set up by applying a large scale network-structure, containing access ways and essential services, to any terrain.

Layered City
Thompson S. (1994)
The city is "both a social and spatial 'coming together' of difference and diversity, chaos and order, fascination and intrigue – a sensual delight, at the same 'time challenging notions of tolerance and feelings of belonging.

Livable Cities
1980s

CCTV
Roberto P. (1980s)
Embedding of CCTV technology into urban

Virtual City   Wired City

Invisible City   Cyberville

Informational City
Castells M. (1992)
The city is an image of society, with all its diversities, processes, contradictions, struggles and asymmetries, and 'The Informational City' is therefore the global city of the information age.

Digital Cities
Emerged early 1990s

Graham S. (1997)
Digital cities can be considered so an attempt to build new secure public spaces and regain some characteristic of the cities as places of communication, interactions, economic operations, and social and cultural activities.

Komninos. 2005
All intelligent cities are digital cities, but all digital cities not intelligent. The difference is in the problem solving capability of intelligent cities, while the virtual digital cities is in the provision of services to digital communication.

Ubiquitous Computing
The term was used by Weiser in his 1991 article "The computer for the 21st century"

Intelligent Cities (ICs)
Emerged in late 1990s

TeleCity
Siembab (1997)
Incorporates the capabilities of information technologies in order to support a high amenity life style that is economically and

Digital City

The first Digital City (DDS) was launched in Amsterdam in 1993. The name was chosen to emphasize the idea of a digital public space where people would meet and communicate.

European Digital Cities
programme launched in
1996

Ambient Cities
Emerged mid 1990s

ISTAG (1999)
People will be surrounded by intelligent and intuitive interfaces embedded in everyday objects around us and an environment recognizing and responding to the presence of individuals in an invisible way.

Smart Cities
Emerged Late 1990s

Komninos. 2002
In order for 'digital' cities to become 'smart' cities they therefore need to incorporate a new category of applications; that of the real community of people and organised in a more immaterised way and with knowledge intensive use.

...difficulate the two by every digital city is intelligent, but every intelligent or 'smart' city has a digital component

Smart Community
Smart Communities 2001
Smart community is an effort to inform technology to work within significant and fundamentally other than incrementally ways.

Urban Computing
The term first used in 2003 by Eric Paulos

Ubiquitous City
Emerged in 2005

Mrung-Je (2003)
The term ubiquitous city was first used by South Korea after adopting the ubiquitous computing concept from the US and deciding to create the world's first U-City.

Korea U-City Association (2003)
U-City for all residents, everyone, not just private customers or residents using personal computers at home, with the aim of enriching life, reducing congestion and enhancing environmental sustainability

Urban Media Façades
An umbrella term for installations in which

Senseable City
MIT. 2004
Transdisciplinary research group that studies the interface between cities, people and technologies and investigates how the ubiquity of digital devices and the telecommunications networks that augment our cities are impacting urban living.

Urban Gaming
The first Urban Gaming Club was founded in 2006.

Smart Grid
Wollenberg B. (2005)
Term 'Smart Grid' is born in September 2005.

IBM Smarter Planet
2008

Amplified City
Falk (1999)
The use of ubiquitous technology in public spaces also enables the city to move beyond mixed or augmented reality environments towards an *amplified* city, where objects express additional information about themselves to other objects, residents and users.

| 1960 | 1970 | 1980 | Late 80s | 1990 | 1991 | 1993 | Late 90s | Late 90s | 2000 | 2003 | 2005 | 2013 |

City model: Functions of Cities

Energy and Environmental care

Metropolitan security

Traffic and public transportation

Public administration

Water/Waste water

Healthcare

Sports, venues, fairs and site

Airports/Harbor

Financial services

Lighting

Building technology

Education

Smart city model: Characteristics and factors

Competitiveness
- Innovative spirit
- Entrepreneurship
- Economic image & trademarks
- Productivity
- Flexibility of labour market
- International embeddedness
- Ability to transform

Transport and ICT
- Local accessibility
- (Inter-)national accessibility
- Availability of ICT-infrastructure
- Sustainable, innovative and safe transport systems

Natural resources
- Attractivity of natural conditions
- Pollution
- Environmental protection
- Sustainable resource management

Participation
- Participation in decision-making
- Public and social services
- Transparent governance
- Political strategies & perspectives

Quality of life
- Cultural facilities
- Health conditions
- Individual safety
- Housing quality
- Education facilities
- Touristic attractivity
- Social cohesion

Social and human capital
- Level of qualification
- Affinity to life long learning
- Social and ethnic plurality
- Flexibility
- Creativity
- Cosmopolitanism/Open-mindedness
- Participation in public life
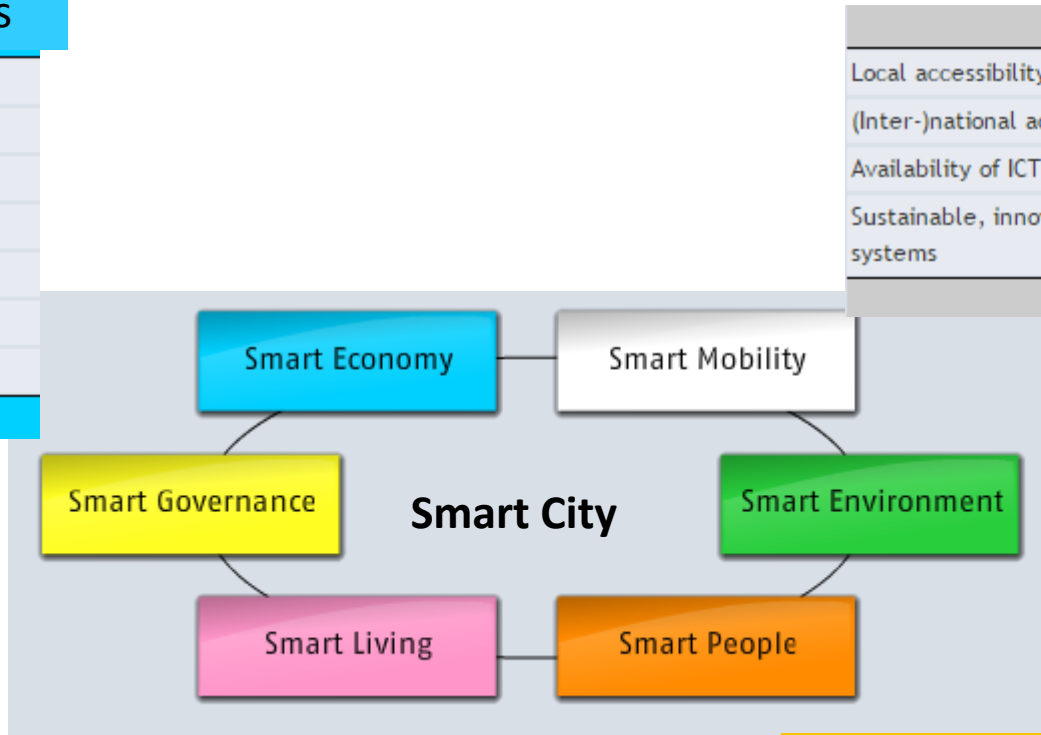
Smart Economy — Smart Mobility

Smart Governance — Smart City — Smart Environment

Smart Living — Smart People

Smart city model: Characteristics and factors
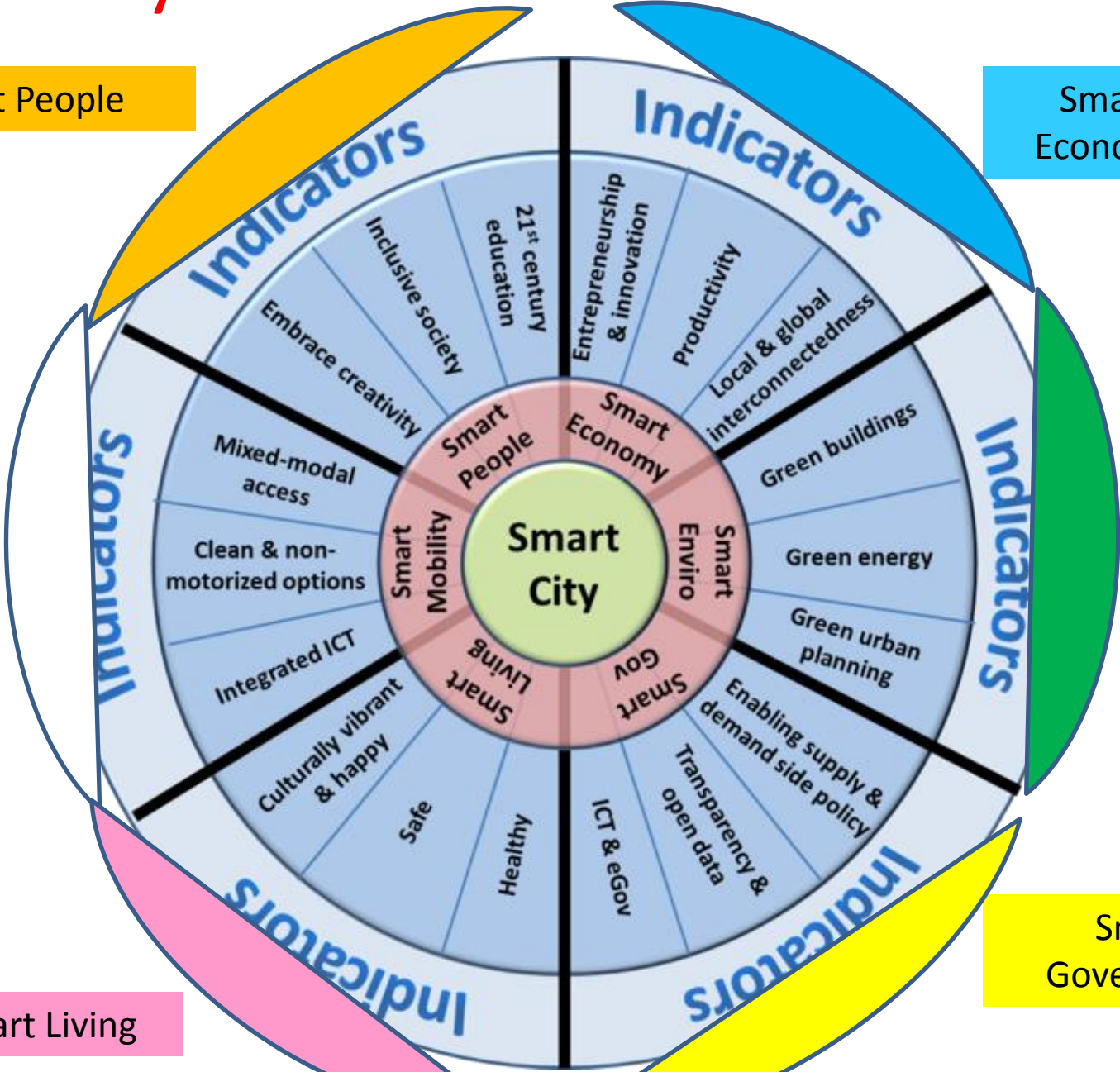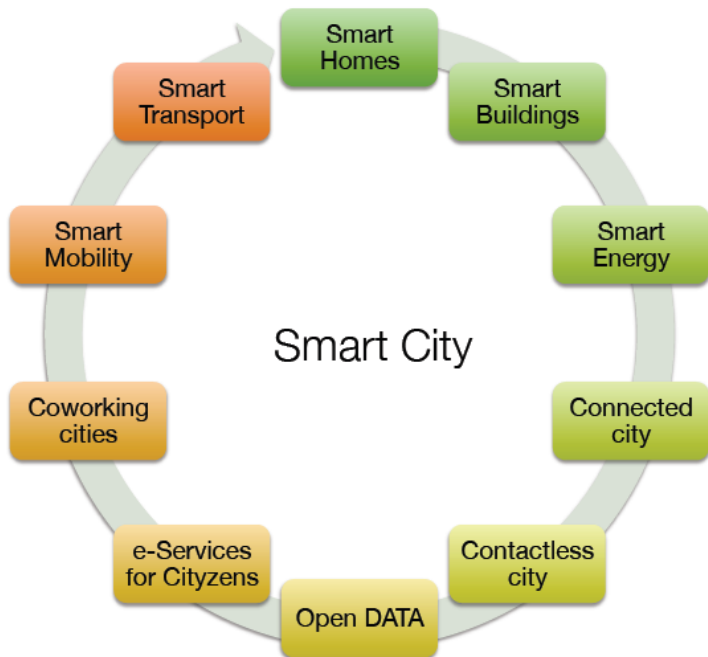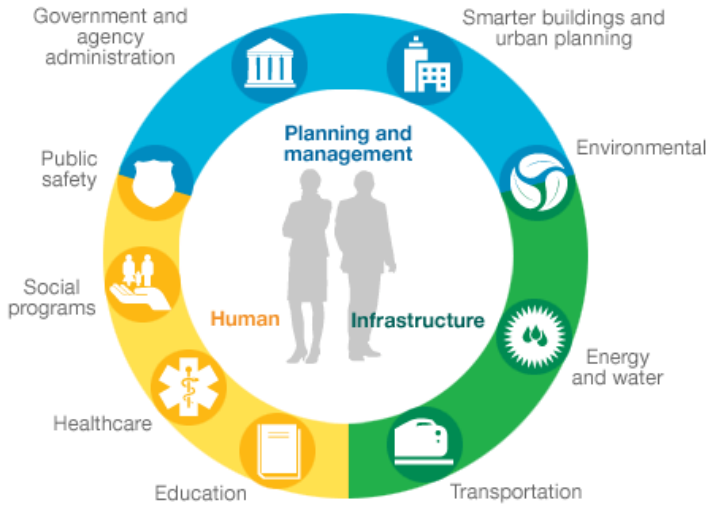
Smart city model: Other models
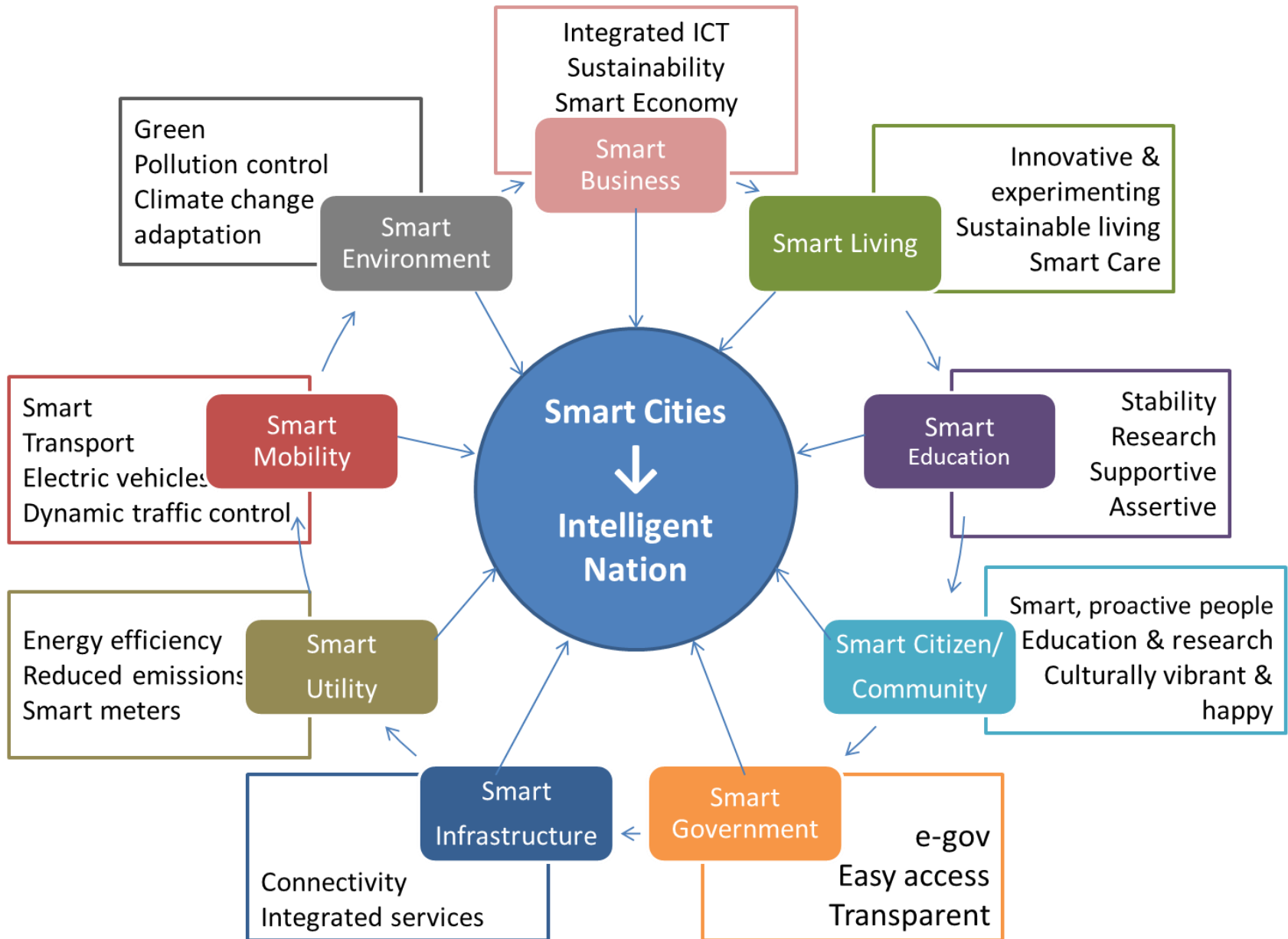
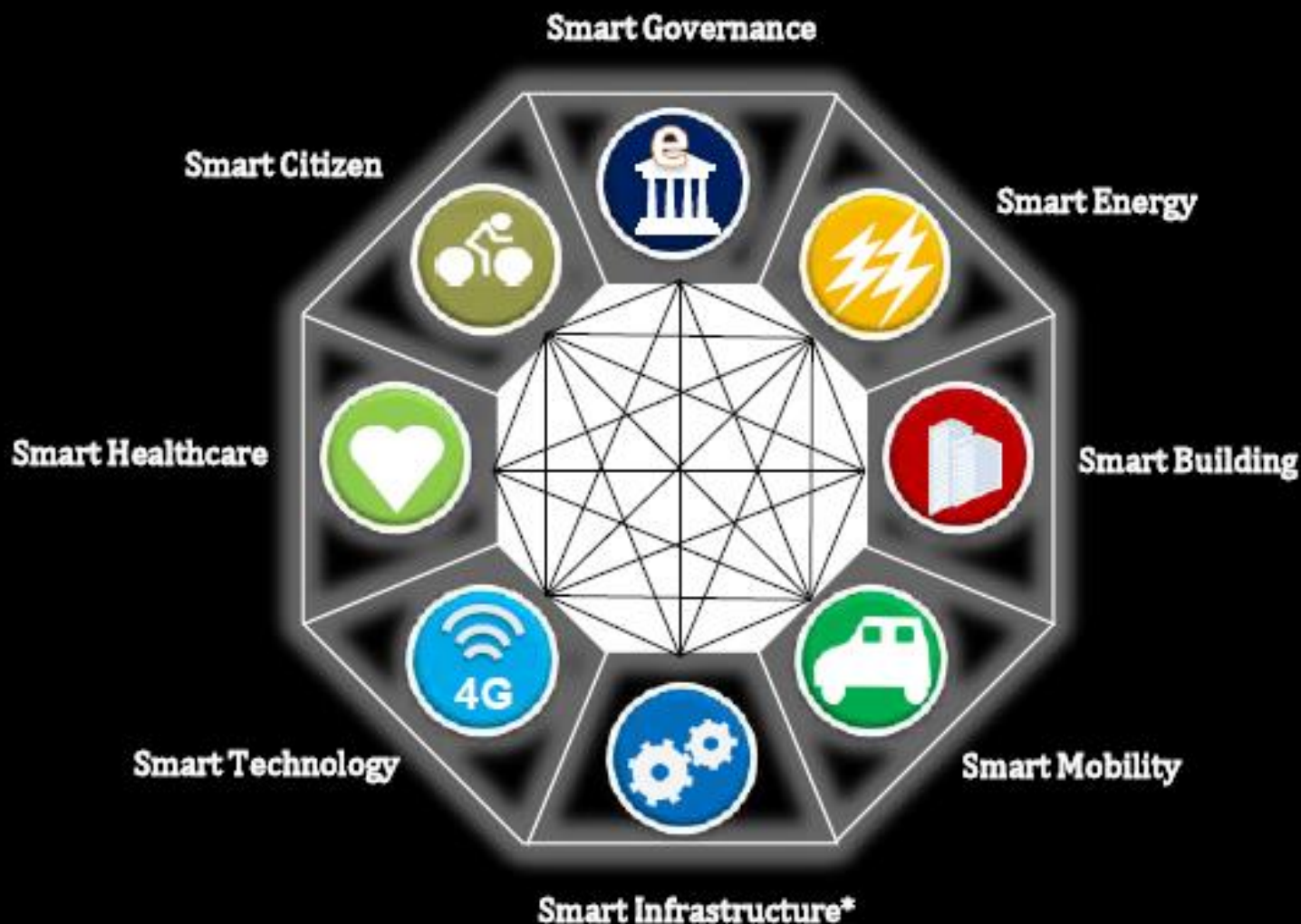# Smart city model: Other models

Smart city model: Characteristics and factors

Smart Diamond that Defines a Smart City

Smart Cities and GeoSpatial technology

- Smart cities are the future to support population growth and urban expansion in a sustainable manner.

- Location is a common dominator in every aspect of smart city.

- Geospatial technology (GIS, RS, GPS, …) has a central role to play in providing a technology platform that forms the backbone since the very beginning including even for ICT planning and deployment

Smart Cities and GeoSpatial Technology
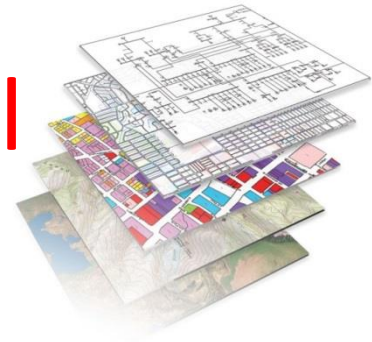
- Location information in Smart Cities: Everybody uses and shares location data
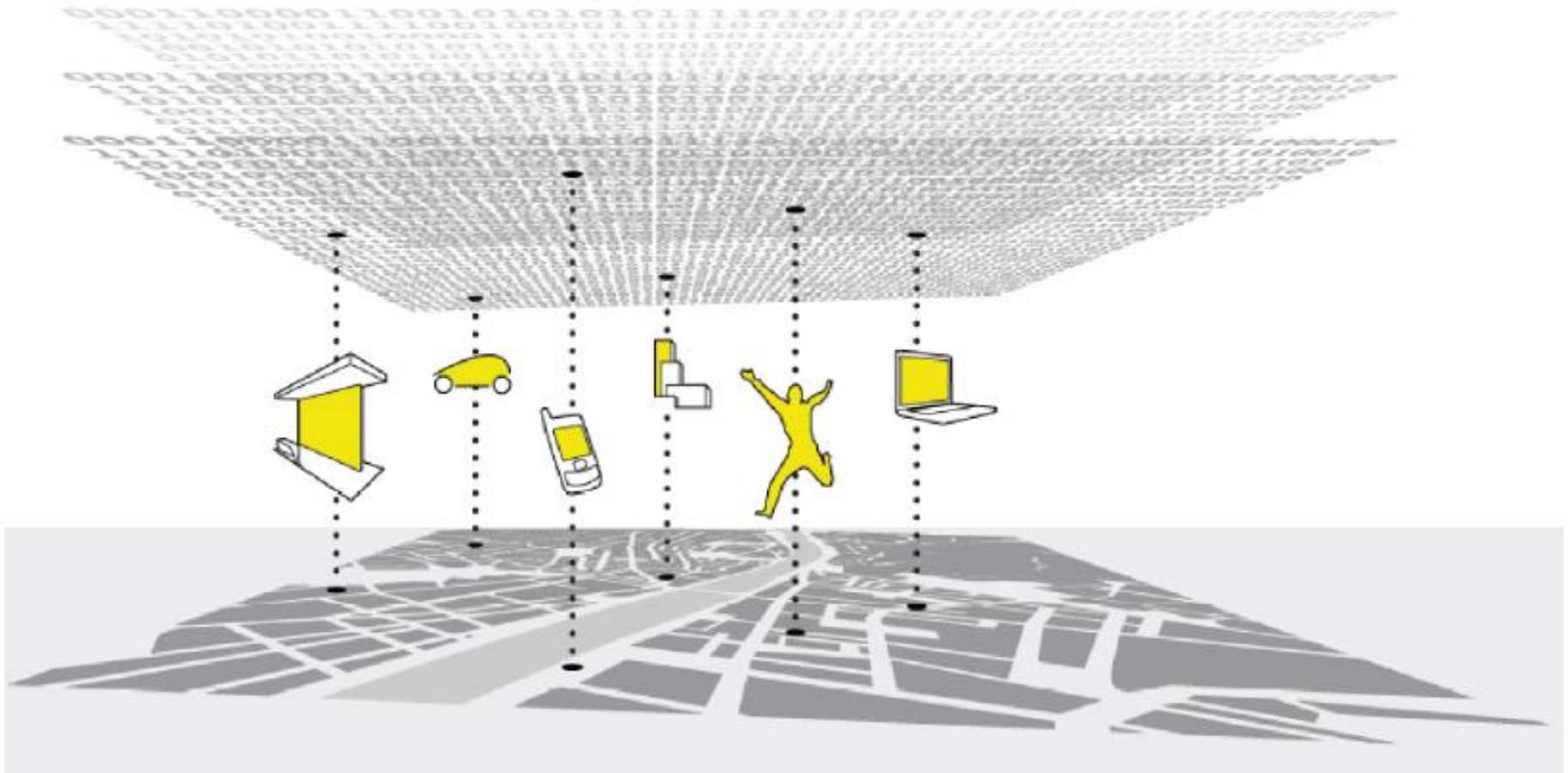
Where is ... How do I get to ...

Find me the nearest ... When is the bus coming?

I have checked in at ... on Foursquare.

Today I'm at GWF 2014

. N 53° 35.469, E 10° 01.261 ... ... N 53° 35.473, E 10° 01.263 ... ... N 53° 35.477

Smart Cities and GeoSpatial Technology

GeoSpatial technology fields

Aid and Development
- Humanitarian Aid
- Sustainable Development

Business
- Insurance
- Retail
- Manufacturing
- Real Estate
- Banking
- Marketing
- Media

Defense and Intelligence
- Military Operations
- Intelligence
- Installations and Environment
- The Geospatially Enabled Enterprise

Education
- Libraries and Museums
- Schools (K–12)
- Universities and Community Colleges

Health and Human Services
- Public Health
- Human Services
- Hospital and Health Systems
- Geomedicine

Mapping and Charting
- Aeronautical
- Cartographic
- Nautical
- Topographic

Natural Resources
- Agriculture
- Climate Change
- Conservation
- Environmental Management
- Forestry
- Mining
- Oceans
- Petroleum
- Water Resources

Public Safety
- Emergency Call Taking and Dispatch
- Emergency/Disaster Management
- Fire, Rescue, and EMS
- Homeland/National Security
- Law Enforcement
- Wildland Fire Management

Transportation
- Aviation
- Highways
- Logistics
- Railways
- Ports and Maritime
- Public Transit

Utilities and Communications
- Electric
- Gas
- Location-Based Services
- Pipeline
- Telecommunications
- Water/Wastewater

Government
- Federal, State, Local
- Resilient Communities
- Architecture, Engineering, and Construction (AEC)
- Economic Development
- Elections and Redistricting
- Facilities
- Land Administration
- Public Works
- Surveying
- Urban and Regional Planning

Smart Cities need a Spatial Data Infrastructure

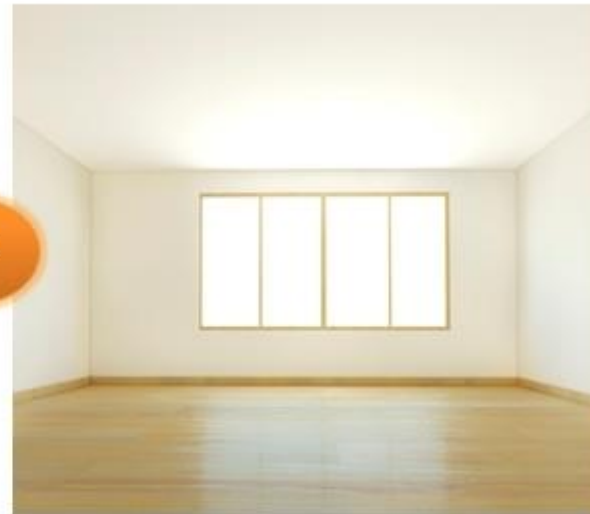- Smart Cities need a Common Spatial Data infrastructure
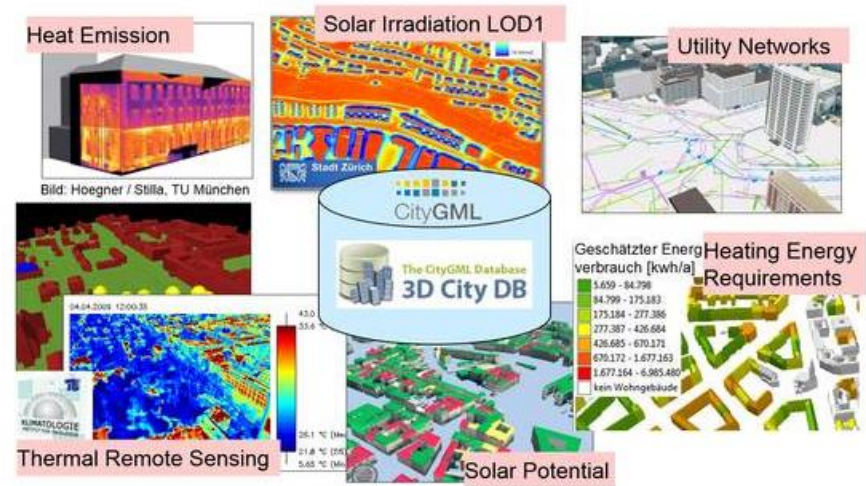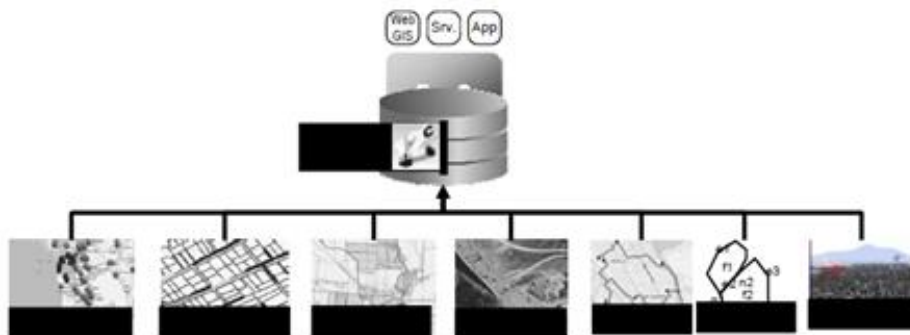
NSDI and Smart Cities

- NSDI is just a component of Smart City
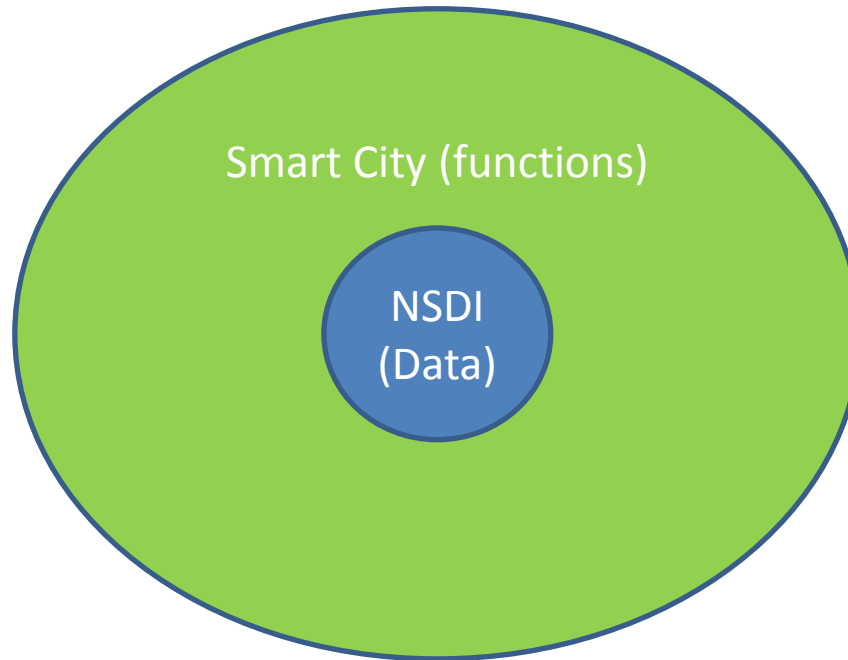- NSDI (Unfurnished house: Infrastructure), Smart City (Furnished house)

Smart City (Focus on Data and Functions)

VS.

NSDI (Focus on Data)

NSDI and Smart Cities

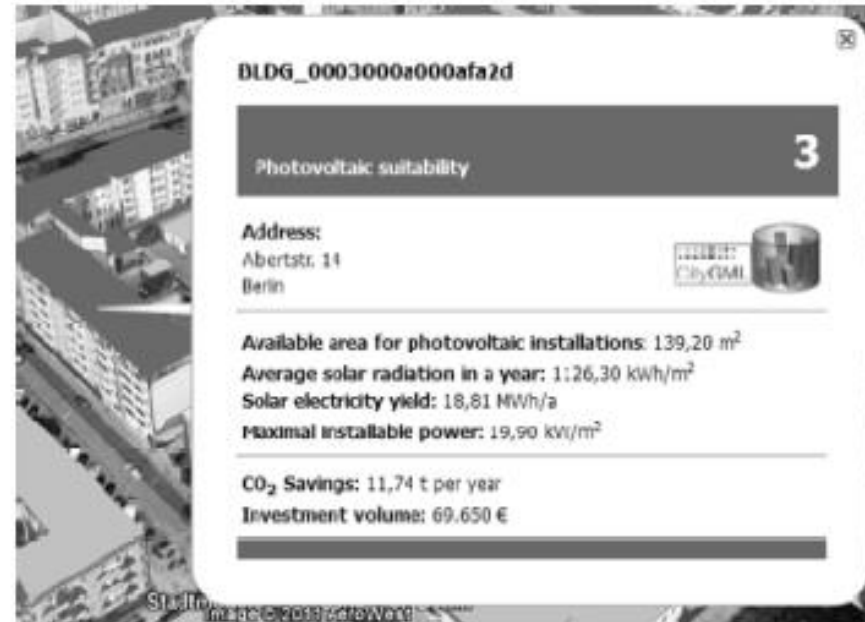

Smart City (functions)

NSDI
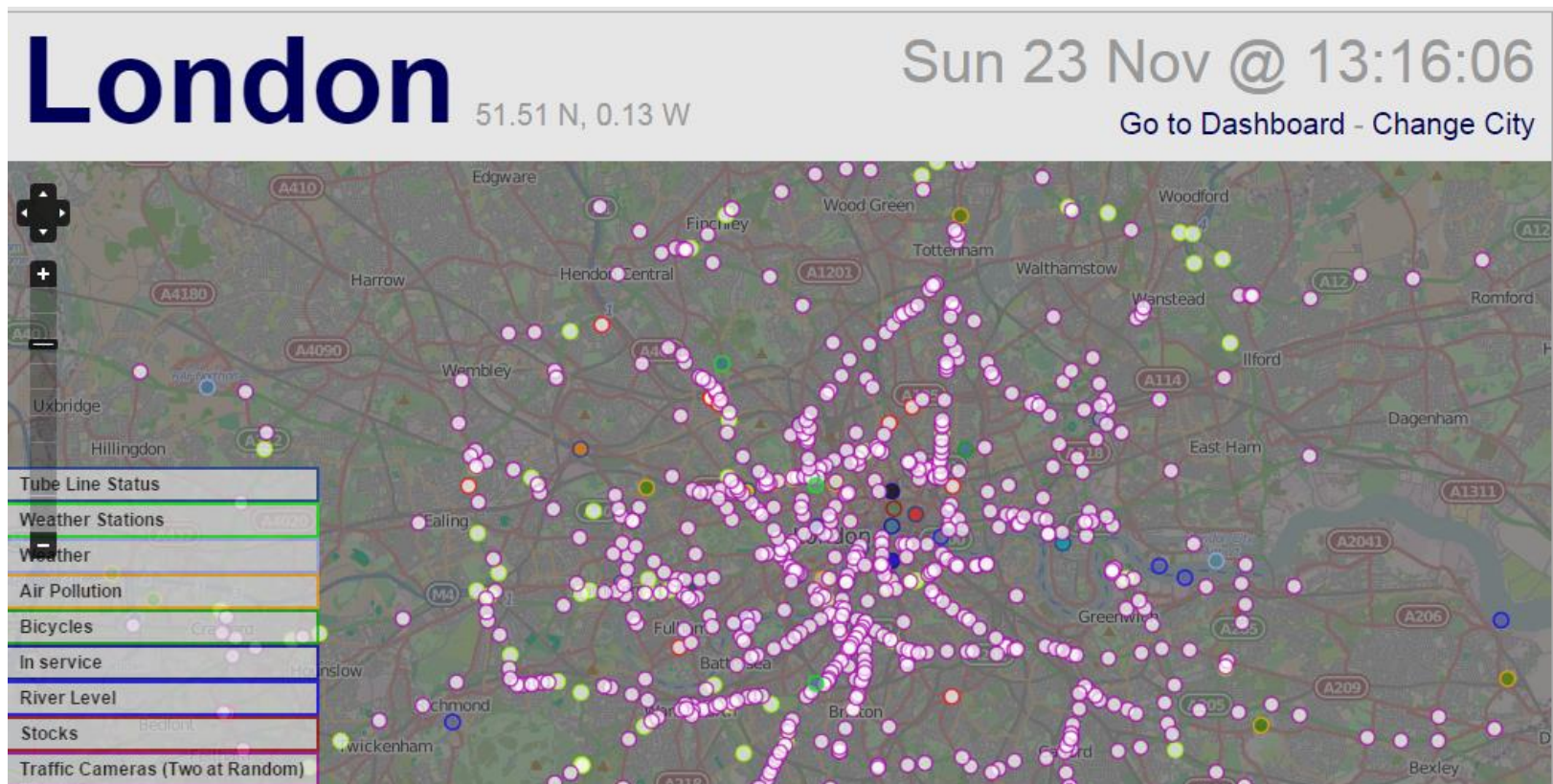(Data)

Example of Smart Cities

- City of Berlin (Implemented by TU Berlin)

- 550000 buildings, reconstructed from 2D cadastre and LIDAR data
- Textures extracted from oblique aerial photography
- Combined with various data sets
- Based on CityGML standard

BLDG_0003000a000afa2d

Photovoltaic suitability — 3

Address:
Abertstr. 14
Berlin

Available area for photovoltaic installations: 139,20 m^2
Average solar radiation in a year: 1:26,30 kWh/m^2
Solar electricity yield: 18,81 MWh/a
Maximal installable power: 19,90 kW/m^2

CO_2 Savings: 11,74 t per year
Investment volume: 69.650 €

City Dashboard: London Real Demo

- http://citydashboard.org/london/

- http://citydashboard.org/london/map/

Smart Cities: Diversity of Projects and Initiatives
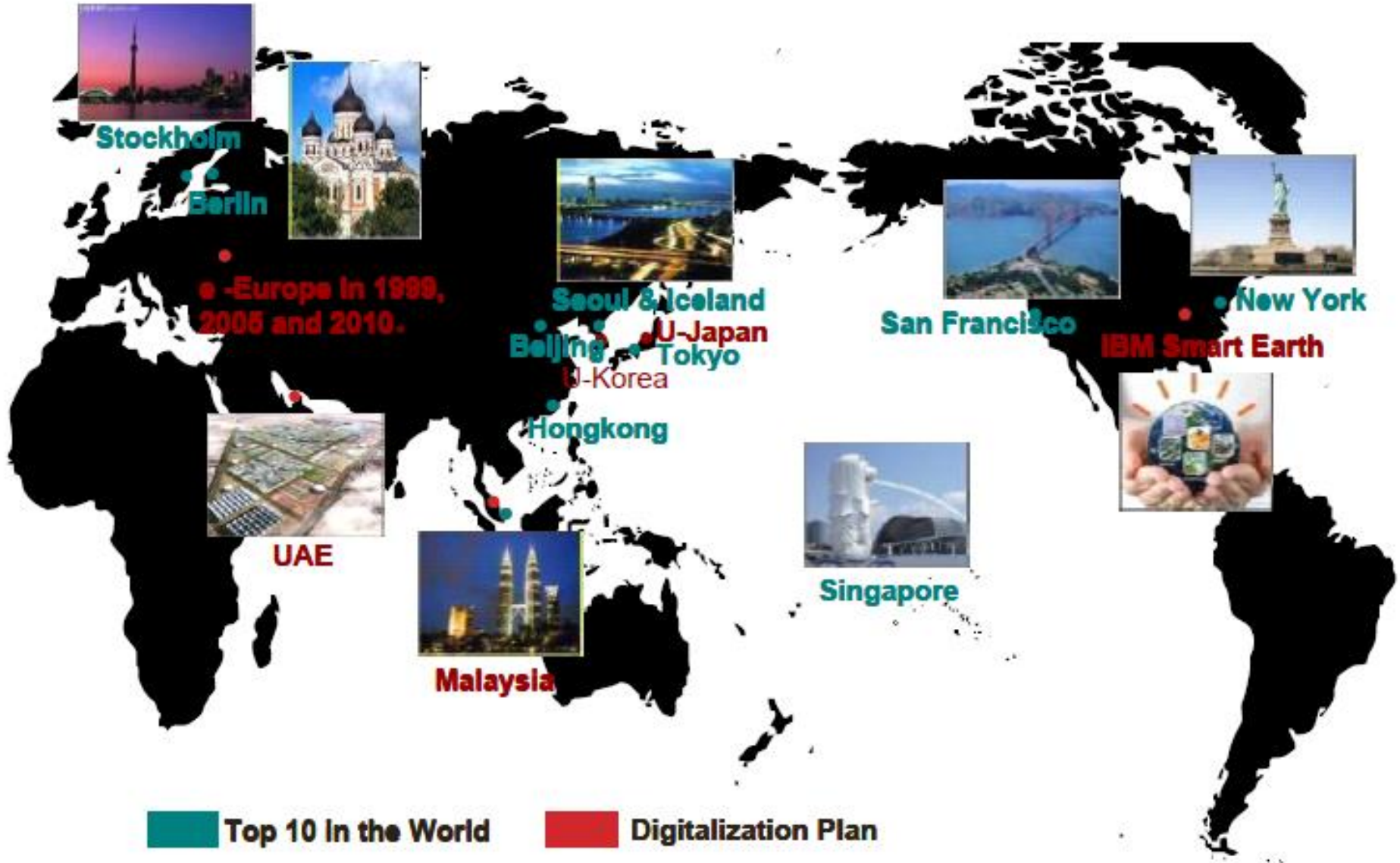
Smart cities in the world (today)

Smart cities in the world (2025)

Global Smart Cities

Over 26 Global Cities to be SMART Cities in 2025 - More than 50% of Smart cities of 2025 will be from Europe and North America
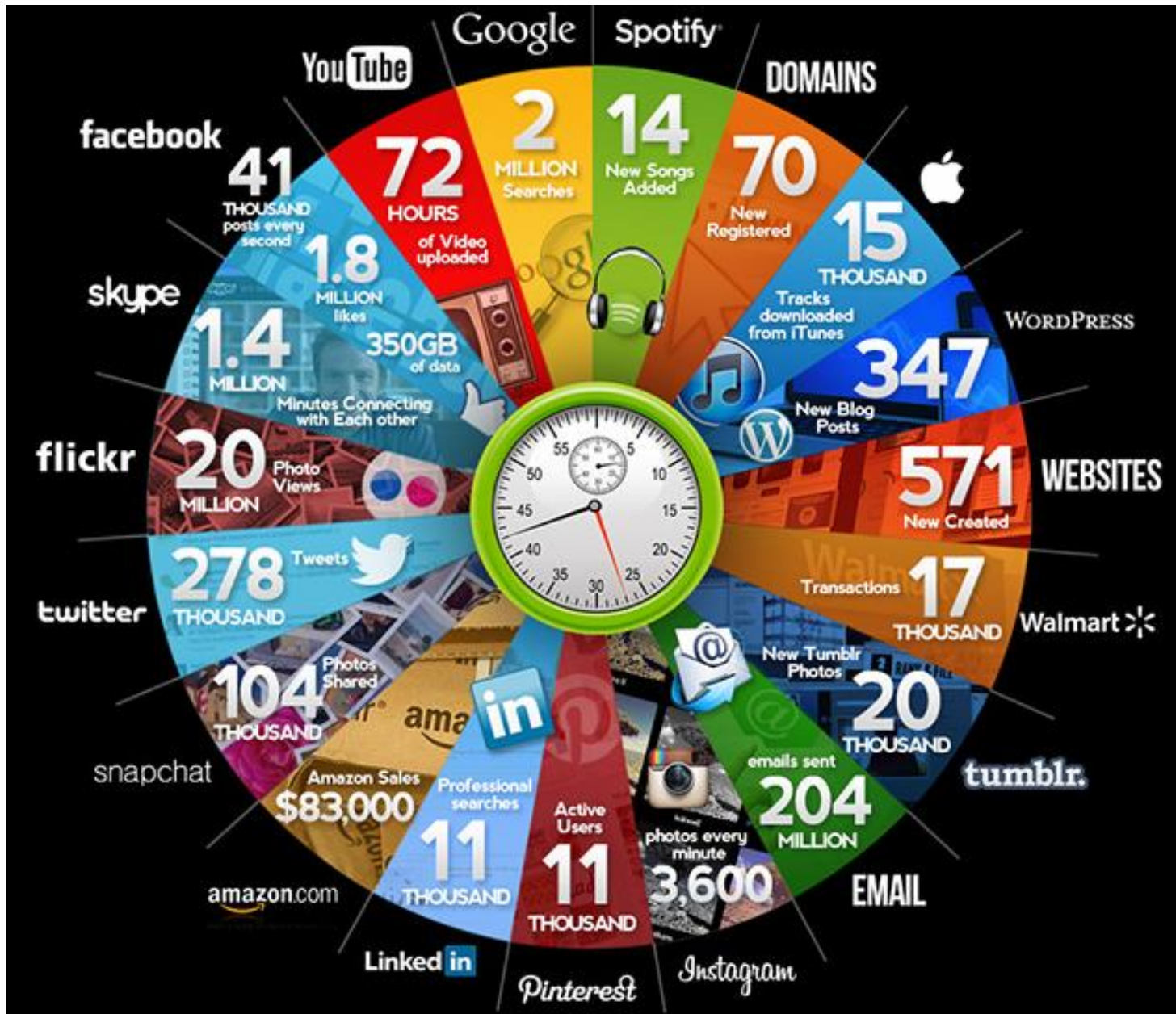
Selected Smart Cities in 2025

Source: Forbes Smart City List, Innovation City Index, Specific Smart Project Websites for Each City, Frost & Sullivan

Smart (Oman or Muscat) Project

- Cities will be at the heart of world development in the next few decades.

- Smart city is a medium-to-long strategic opportunity to the mentioned challenges.

- Dubai (UAE) already started the project Smart-Dubai

- We hope that Oman or Muscat catch up with the pool and have Smart (Oman or Muscat) Project. Through the implementation of many projects.

Part 2: GeoSpatial Big Data

Spatial Big Data

00:00 - 09:00

Europe 24 – an air traffic data visualisation

Big Data

Big Data: Is the Old, New and Future Normal

- 90% of the data in the world has been created during the last two years

- Data comes from everywhere: Sensors, social media, mobile devices, machine 2 machine communications, etc.

- Increasingly geo-located data

- Smart Cities generate Big Data, which is GeoSpatial
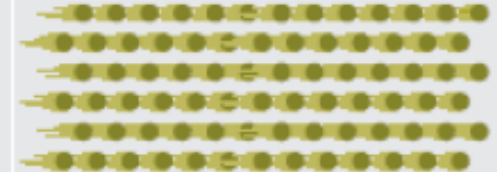
3Vs of Big Data (or 4Vs)

Volume
Data at scale
Terabytes to petabytes of data

Variety
Data in many forms
Structured, unstructured, text, multimedia

Velocity
Data in motion
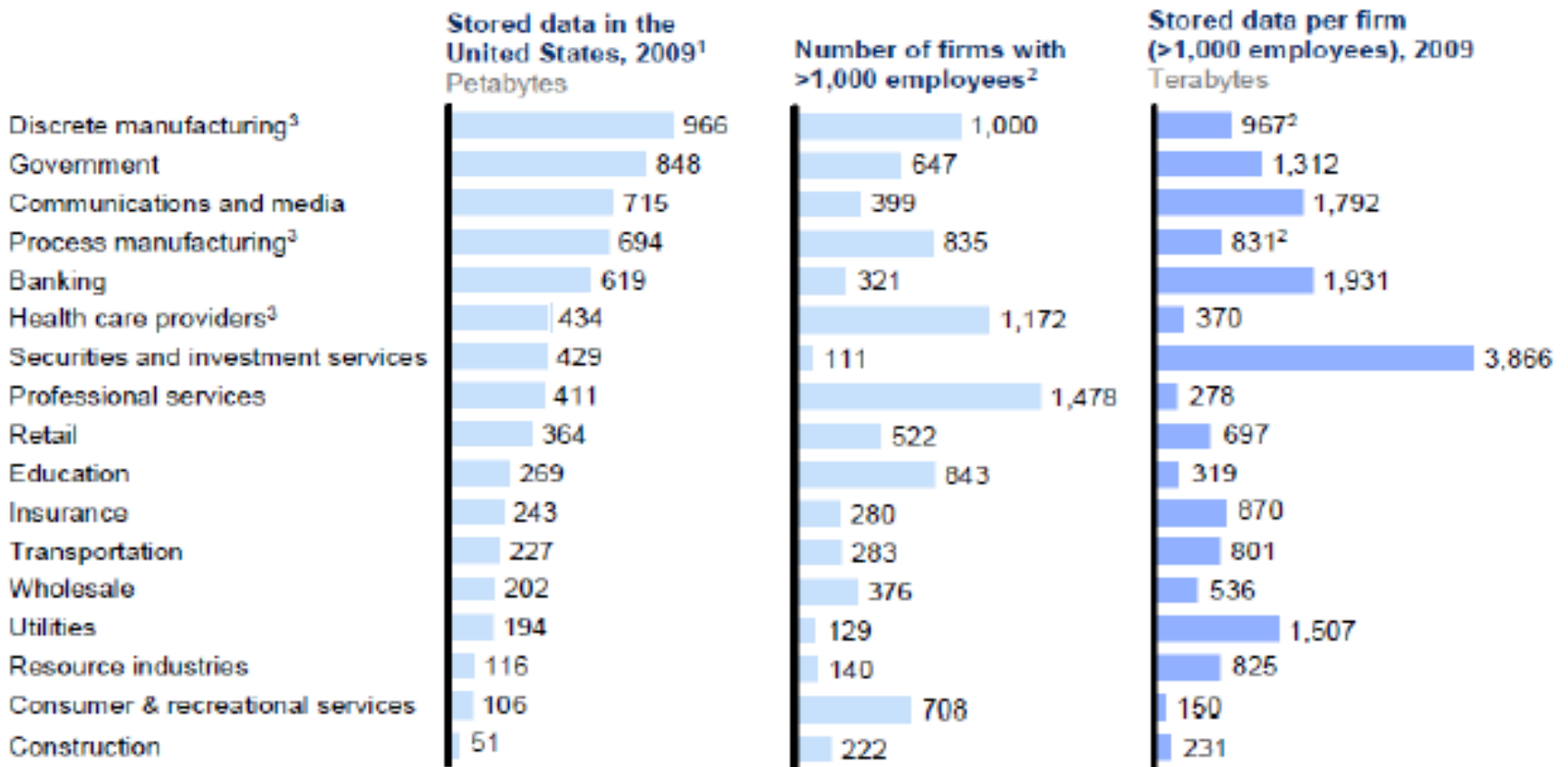Analysis of streaming data to enable decisions within fractions of a second

Veracity
Data uncertainty
Managing the reliability and predictability of inherently imprecise data types

Big Data, everywhere

Companies in all sectors have at least 100 terabytes of stored data in the United States; many have more than 1 petabyte

Sector	Stored data in the United States, 2009[1] Petabytes	Number of firms with >1,000 employees[2]	Stored data per firm (>1,000 employees), 2009 Terabytes
Discrete manufacturing[3]	966	1,000	967[2]
Government	848	647	1,312
Communications and media	715	399	1,792
Process manufacturing[3]	694	835	831[2]
Banking	619	321	1,931
Health care providers[3]	434	1,172	370
Securities and investment services	429	111	3,866
Professional services	411	1,478	278
Retail	364	522	697
Education	269	843	319
Insurance	243	280	870
Transportation	227	283	801
Wholesale	202	376	536
Utilities	194	129	1,507
Resource industries	116	140	825
Consumer & recreational services	106	708	150
Construction	51	222	231

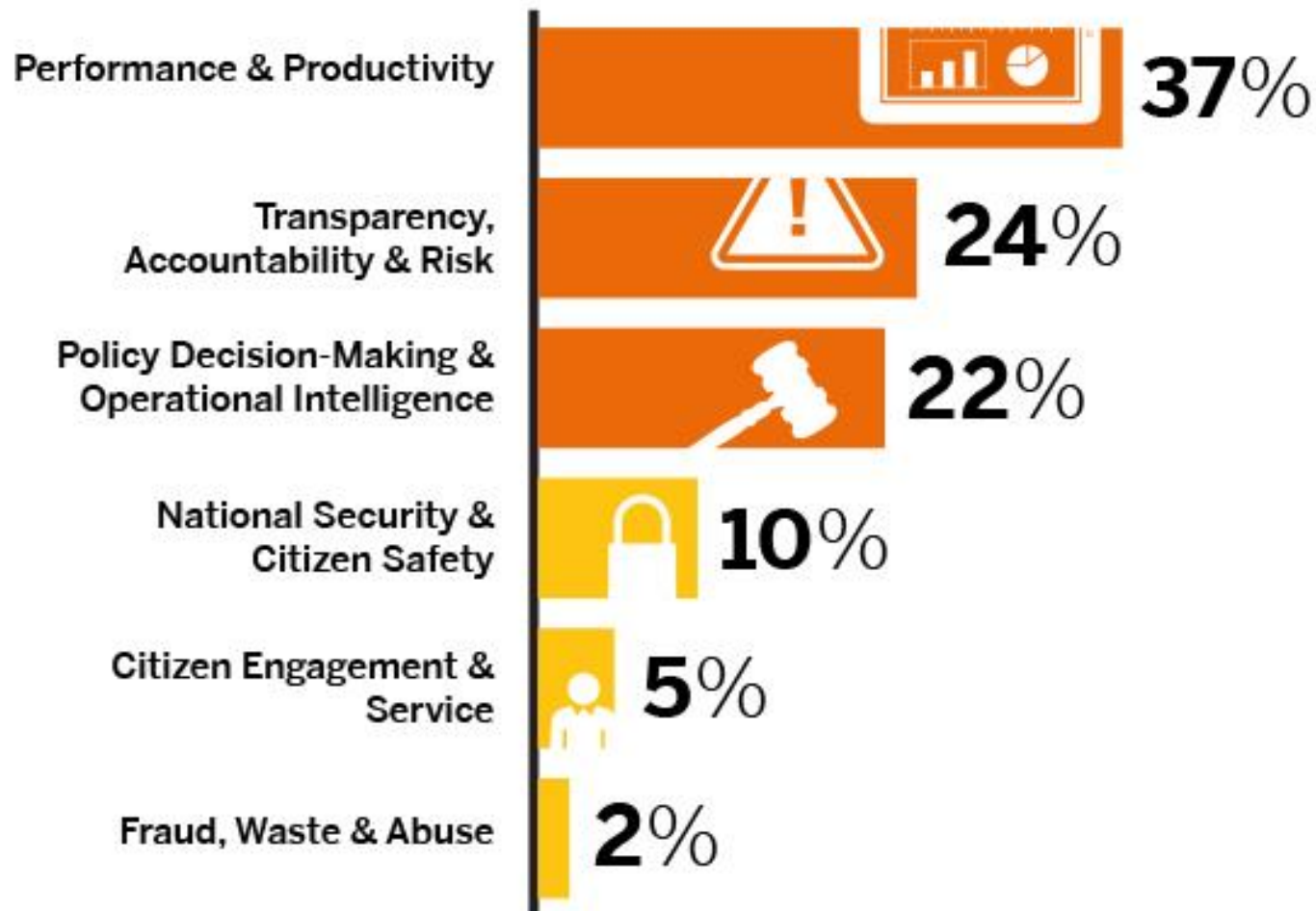1 Storage data by sector derived from IDC.
2 Firm data split into sectors, when needed, using employment
3 The particularly large number of firms in manufacturing and health care provider sectors make the available storage per company much smaller.
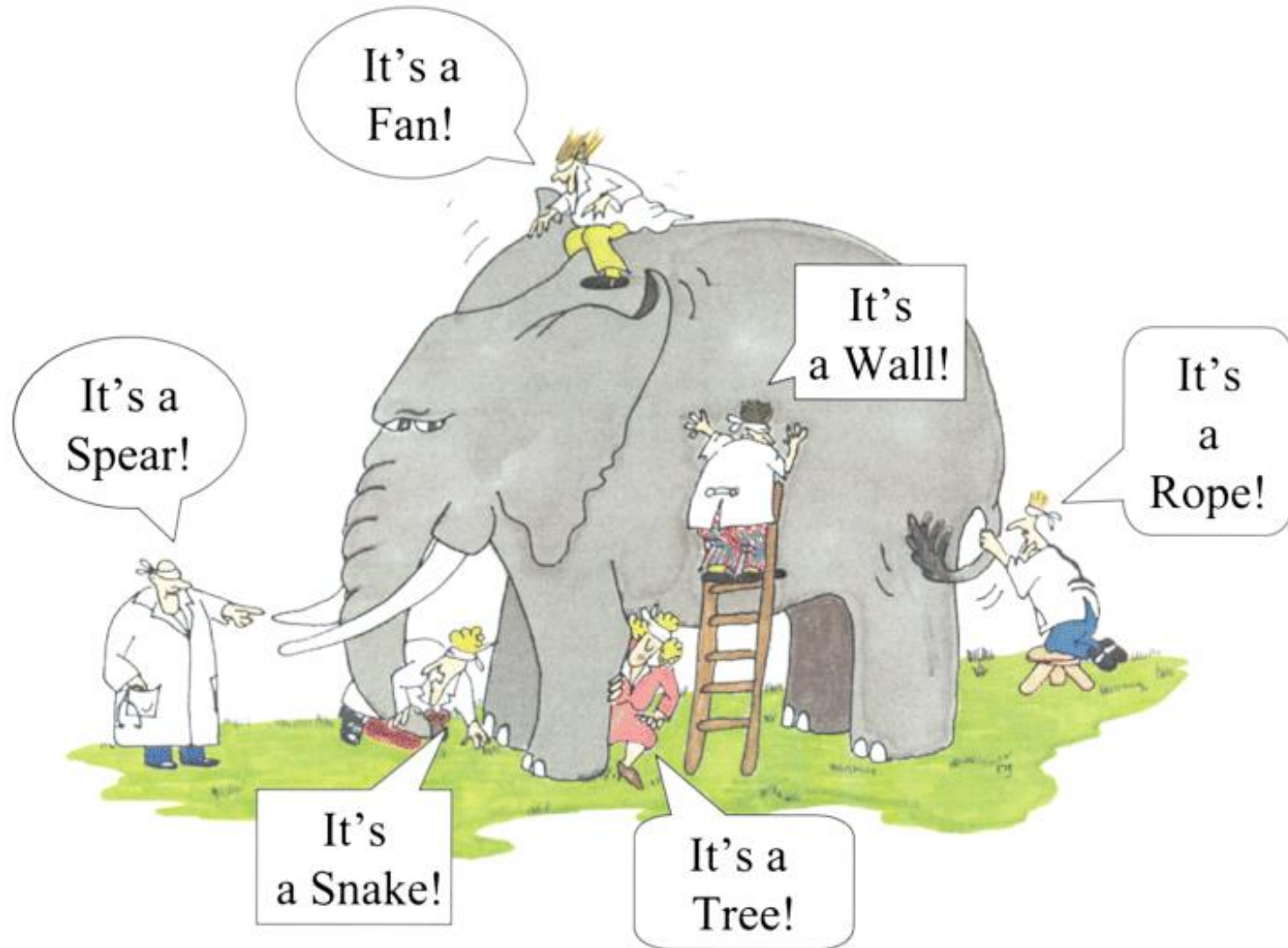
SOURCE: IDC; US Bureau of Labor Statistics; McKinsey Global Institute analysis

Adapted from Big Data: The next Frontier for Innovation, Competition, and Productivity. Mckinsey Global Institute, May 2011

Benefits of Big Data

Category	Percentage
Performance & Productivity	37%
Transparency, Accountability & Risk	24%
Policy Decision-Making & Operational Intelligence	22%
National Security & Citizen Safety	10%
Citizen Engagement & Service	5%
Fraud, Waste & Abuse	2%

Source: SAP Performance Benchmarking (https://valuemanagement.sap.com)

Why we need Big Data?

Big Data Intelligence

Big Data Landscape

Big Data Landscape (Version 2.0)

© Matt Turck (@mattturck) and ShivonZilis (@shivonz) Bloomberg Ventures

Big Data has Spatial component

- Like classical data, Big Data has Spatial component (Spatial Hadoop)
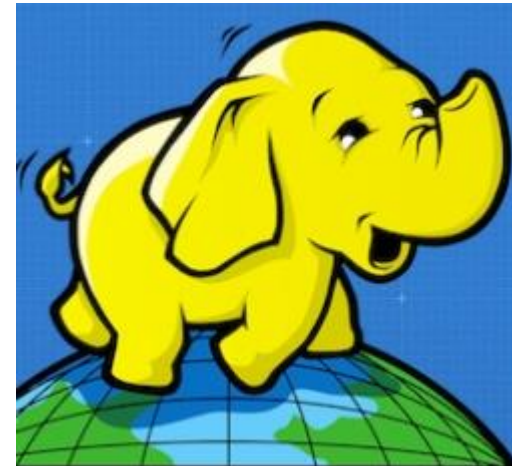
Conclusion

- Nowadays, cities are facing many problems and challenges
- Cities will be at the heart of world development in the next few decades
- In order to tackle these challenges, one solution: Smart Cities
- Geospatial technologies are the backbone of smart cities
- Smart (Oman or Muscat) project agenda, it is the time
- Smart Cities generate GeoSpatial Big Data

Questions

Key Parameters That Will Define a Smart City in 2020

Smart Energy: Digital Management of Energy

- Smart Grids
- Smart Meters
- Intelligent Energy Storage

Smart Buildings: Automated Intelligent Buildings

- Building Automation
- Intelligent Buildings: Advance d HVAC, Lighting Equipment

Smart Mobility: Intelligent Mobility

- Low-emission Mobility
- Integrated Mobility Solutions
- Multimodal Transport

Smart Technology: Seamless Connectivity

- Broadband penetration rate of over 80%
- Location Based Services, Augmented Reality, GPS enabled devices/ phones

Smart Infrastructure: Digital Management of Infrastructure*

- Sensor Networks
- Digital Water and Waste Management

Smart Healthcare: Intelligent Healthcare Technology

- Use of ehealth and mhealth systems
- Intelligent and connected medical devices

Smart Governance: Government-on-the-Go

- e-Government
- e-Education
- Disaster Management Solutions

Smart Citizen: Civic Digital Natives

- Use of Green Mobility Options
- Smart Lifestyle Choices
- Energy conscious