Smart City – what and how?

Sabidur Rahman

Network Research Lab

UC Davis

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krahman@ucdavis.edu   http://www.linkedin.com/in/kmsabidurrahman/

Agenda

- What makes a city smart?
  - Definition
  - Services
  - Applications
  - Indicators and initiatives

- How to make a city smart?
  - Key enabling technologies
  - Evolution of smart city architectures
  - Communication networks characteristics

- Summary and future work

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What makes a city smart?

Smart city: definition

- "There is neither a single template of framing a smart city, nor a one-size-fits-all definition of it"
- California Institute for Smart Communities was among the first (1990s) to focus on how communities could become smart and how a city could be designed to implement information technologies
- Harrison et al. (2010), in an IBM corporate document, stated that the term "smart city" denotes an "instrumented, interconnected and intelligent city."
- "Instrumented" refers to the capability of capturing and integrating live real-world data through sensors, meters, appliances, personal devices, and other similar sensors
- "Interconnected" means the integration of these data into a computing platform that allows the communication of such information among the various city services
- "Intelligent" refers to the inclusion of complex analytics, modelling, optimization, and visualization services to make better operational decisions

Albino V, Berardi U, Dangelico RM. Smart cities: Definitions, dimensions, performance, and initiatives. Journal of Urban Technology. 2015 Jan 2;22(1):3-21.

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Smart technologies and services

- This research is focused on the local governments of municipalities that are labeled as "Smart Cities" and are members of the EUROCITIES network
- This network is together the local governments of over 180 of Europe's largest cities and 40 partner cities, 130 million citizens across 35 countries
- Types of e-service (% of cities offering that service)
  - Civil registry (57.14%)
  - Business (48.81%)
  - Waste Management (55.95%)
  - Tourism (50.00%)
  - Financial affairs (66.67%)
  - Health services (32.14%)

Macau Smart City – Alibaba Cloud
https://www.youtube.com/watch?v=l-PcPTNmIvM

López-Quiles JM, Bolívar MP. Smart technologies for smart governments: A review of technological tools in smart cities. In Smart Technologies for Smart Governments 2018 (pp. 1-18). Springer, Cham.

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Smart city: infrastructure

Musa S. Smart cities-a road map for development. IEEE Potentials. 2018 Mar;37(2):19-23.

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Smart city: applications

Fig. 3 IoT applications in Tel Aviv Smart City

Madakam S, Tripathi S, Arora RK. Internet of Things Applications@ Urban Spaces (Tel Aviv Smart City: A Case Study). In Information and Communication Technology for Sustainable Development 2018 (pp. 1-11). Springer, Singapore.

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Smart city: applications

Domain	Sub-domain	Description
Government (more efficient)	E-government Transparent government Public service Public safety City monitoring Emergency response	Improving the internal and external efficiency of the government; enabling citizens and other relevant organizations to access official documents and policies; ensuring that public services work efficiently; monitoring and managing public safety; responding quickly and effectively in emergency situations.
Citizen (happier)	Public transport Smart traffic Tourism Entertainment Healthcare Education Consumption Social cohesion	Traveling and moving more efficiently; accessing contextualized, precise, real-time information in daily life; high-quality essential public services such as education, healthcare and sport; enriching spare time activities, communicating and sharing more with others.

Yin C, Xiong Z, Chen H, Wang J, Cooper D, David B. A literature survey on smart cities. Science China Information Sciences. 2015 Oct 1;58(10):1-8.

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Smart city: applications

Domain	Sub-domain	Description
Business (more prosperous)	Enterprise management Logistics Supply chain Transaction Advertisement Innovation Entrepreneurship Agriculture	Improving inter management efficiency and quality; using more efficient logistics and supply chain platforms and methods; advertising more widely and accurately; expanding trade partners and customers; facilitating entrepreneurship and investment; upgrading the business activity in a city, such as production, commerce, agriculture and consulting; fostering innovation.
Environment (more sustainable)	Smart grid Renewable energy Water management Waste management Pollution control Building Housing Community Public space	Delivering more sustainable, economic and secure energy and water supplies by taking into account citizens' behavior; using more green or renewable energy; recycling and treating waste efficiently and safely; reducing and preventing pollution in the city; offering mobility, telecommunication, information and all other facilities in different city spaces.

Yin C, Xiong Z, Chen H, Wang J, Cooper D, David B. A literature survey on smart cities. Science China Information Sciences. 2015 Oct 1;58(10):1-8.

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Smart city: indicators

smart economy: Public expenditure on R&D, Public expenditure on education, GDP per head of city population, Unemployment rate, . . .

smart people: Percentage of population with secondary-level education, Foreign language skills, Participation in life-long learning, Individual level of computer skills, Patent applications per inhabitant, . . .

smart governance: Number of universities and research centers in the city, e-Government on-line availability, Percentage of households with Internet access at home, e-Government use by individuals, . . .

smart environment: ambitiousness of CO_2 emission reduction strategy, Efficient use of electricity, Efficient use of water, Area in green space, Greenhouse gas emission intensity of energy consumption, Policies to contain urban sprawl, Proportion of recycled waste, . . .

smart living: Proportion of the area for recreational sports and leisure use, Number of public libraries, Total book loans and other media, Museum visits, Theater and cinema attendance

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Criteria of smart city index system: infrastructure

Dimension	Criteria	Explanation
Smart infrastructure (A)	Information network communication facilities (a_1)	• Number of smart phone holdings per hundred persons • Number of computers per hundred householders • Cable TV two-way digital transformation rate • Cable broadband and fiber access rate • Urban Internet bandwidth per rate • Wireless broad network coverage
	Information-sharing infrastructure (a_2)	• Communication network coconstruction and sharing • Government data center • Four basic databases • Information security construction of disaster preparedness

Lessons learned from the development of Chinese cities Weihai and Qingdao

Liu Y, Wang H, Tzeng GH. From Measure to Guidance: Galactic Model and Sustainable Development Planning toward the Best Smart City. Journal of Urban Planning and Development. 2018 Aug 24;144(4):04018035.

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Criteria of smart city index system: economy

Dimension	Criteria	Explanation
Smart economy (B)	Economic strength (b_1)	• Total regional production • Economic growth rate • Per capita disposable income
	Smart industry (b_2)	• Information industry investment and development level • Added value of the third industry of GDP • Software service outsourcing production of GDP • Research and development production of GDP • Development of strategic emerging industry • On average every 10,000 yuan GDP energy consumption • On average, each staff to create the added value of agriculture, forestry, animal husbandry, and fishery • Preceding designated size industrial added value proportion and added value of high-tech manufacturing

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Criteria of smart city index system: environment

Dimension	Criteria	Explanation
Smart environment (C)	Environmental forecasting and management (c_1)	• Accuracy of weather forecast • Usage of natural disasters forecast system • Town life pollution water disposal rate • Hazard-free treatment rate of household garbage • Comprehensive utilization rate of industrial solid waste • Comprehensive utilization of three wastes product output
	General environment quality index (c_2) Intelligent natural resource use (c_3)	• Air quality index • Surface water quality index • Pollution sources monitoring index • Intelligent water dispatching project number • Intelligent water meter usage rate • New energy utilization rate • Renewable energy utilization rate

Liu Y, Wang H, Tzeng GH. From Measure to Guidance: Galactic Model and Sustainable Development Planning toward the Best Smart City. Journal of Urban Planning and Development. 2018 Aug 24;144(4):04018035.

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Criteria of smart city index system: management

Dimension	Criteria	Explanation
Smart management (D)	E-government (d_1)	• E-government platform coverage • Online management level of administrative examination and approval items • Short message service function coverage
	Public safety (d_2)	• Social emergency linkage information support ability • Transport monitoring rate of the hazardous chemical • Food security supervision • Emergency system construction rate • Violent death rate • Personal safety satisfaction • Crime rate

Liu Y, Wang H, Tzeng GH. From Measure to Guidance: Galactic Model and Sustainable Development Planning toward the Best Smart City. Journal of Urban Planning and Development. 2018 Aug 24;144(4):04018035.

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Criteria of smart city index system: transportation

Dimension	Criteria	Explanation
Smart transportation (E)	Smart traffic management and control (e_1)	• Camera coverage rate • Main traffic component sensing device coverage rate • Logistics vehicle real-time monitoring system coverage rate • Traffic jam processing rate • Road network capacity • Traffic accident handling rate
	Intelligent transportation information service (e_2)	• Information network of city roads • Traffic jam information transmission rate • ATIS coverage rate • Effective utilization rate of parking spaces • Registration vehicle information improvement rate
	Intelligent public traffic (e_3)	• Construction of public transport facilities improvement rate • Intelligent sensor terminal installation rate • Intelligent bus station construction level • Taking person-time • Traffic intersection waiting time

Liu Y, Wang H, Tzeng GH. From Measure to Guidance: Galactic Model and Sustainable Development Planning toward the Best Smart City. Journal of Urban Planning and Development. 2018 Aug 24;144(4):04018035.

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Criteria of smart city index system: living

Dimension	Criteria	Explanation
Smart living (F)	Education (f_1)	• Per million people with higher education • Number of scientific and technological personnel per million people • Information industry workers accounted for the proportion of workers in the whole society • Degree of sharing education resources • Proportion of per capita educational expenditure of urban residents • Network teaching proportion • Education quality and benefit improvement level
	Smart healthcare (f_2)	• Medical grade network coverage • Electricity clinical history rate • Citizen electronic health records rate • Per capita number of beds
	Intelligent buildings (f_3)	• Family smart meters installation rate • Smart home • Family information interaction rate
	Smart consumption (f_4)	• Per capita e-commerce transactions • Per capita information consumption coefficient • RFID tag usage of goods

Liu Y, Wang H, Tzeng GH. From Measure to Guidance: Galactic Model and Sustainable Development Planning toward the Best Smart City. Journal of Urban Planning and Development. 2018 Aug 24;144(4):04018035.

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Smart city initiative: Seattle, WA, USA

Seattle.gov portal with 20+ language support
data.seatle.gov allows open data and open government
Community Technology Planner
Equitable Justice Delivery System
Communities Online
Puget Sound-Off
Smart Grid
Automated Metering Infrastructure
Pacific Northwest Regional Demonstration Project
Fiber to the premise
GigU seeks to accelerate the deployment of ultra-high-speed networks to
leading U.S. universities and their surrounding communities
Supervisory Control and Data Acquisition
Drainage and Waste Water System
Rain Watch Program
Field Operations Management System
Common Operating Picture
IT Cloud
Electronic Plan Review System
Digital Evidence Management System

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Smart city initiative: Quebec City, Canada

Quebec City, CA   Zap Quebec providing Wi-Fi internet access
                    Text messaging service of snow cleaning information
                    Snow cleaning management project: providing sensors at each snow cleaning machine
                    Inter-cities network: connecting with major cities of the province of Quebec
                    Mobile homepage: developing a mobile version of the city's website
                    Infrastructure management system: integrating different information systems to coordinate activities related to infrastructure management
                    Open data initiative: making city data open
                    Online transportation control system

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Smart city initiative: Friedrichshafen, Germany

GPS distress signal, in an emergency, people can send a signal by touching their cell phone

Mobile Clinic system enables the interactive remote monitoring of patients with chronic heart conditions

KatCard E-ticketing project enables the non-cash purchase of tickets

Edunex is a web-based educational platform for schools

Secured EduKey allows secure access to Edunex biometrically

Smart Metering provides customers with information about their electricity and gas consumption.

Digital picture frame has an integrated wireless module and receives digital photos via the Deutsche Telekom network

CityInfo allows requesting short info on various topics via the SMS information service.

Multimedia Stations provide information and services free of charge in the areas of city

Hearing impaired telephones for deaf people access to a sign language interpreting service, using special video telephones

SZ News adds a local dimension to the Internet Protocol Television information services.

Tourism portal www.friedrichshafen.info compiles all important information required for a stay in Friedrichshafen.

With G/On, employees can access their work stations securely from anywhere in the world.

dDesk allows applications and data are stored on the cloud on a central server.

T-Mobile emergency number supports the coordination of rescue services in Friedrichshafen.

Albino V, Berardi U, Dangelico RM. Smart cities: Definitions, dimensions, performance, and initiatives. Journal of Urban Technology. 2015 Jan 2;22(1):3-21.

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How to make a city smart?

Key enabling technologies

Internet of Things

Hardware (Sensors and Actuators)

Middleware

Data Collection

Big Data

Data Processing

Data Storing

Data Analyses
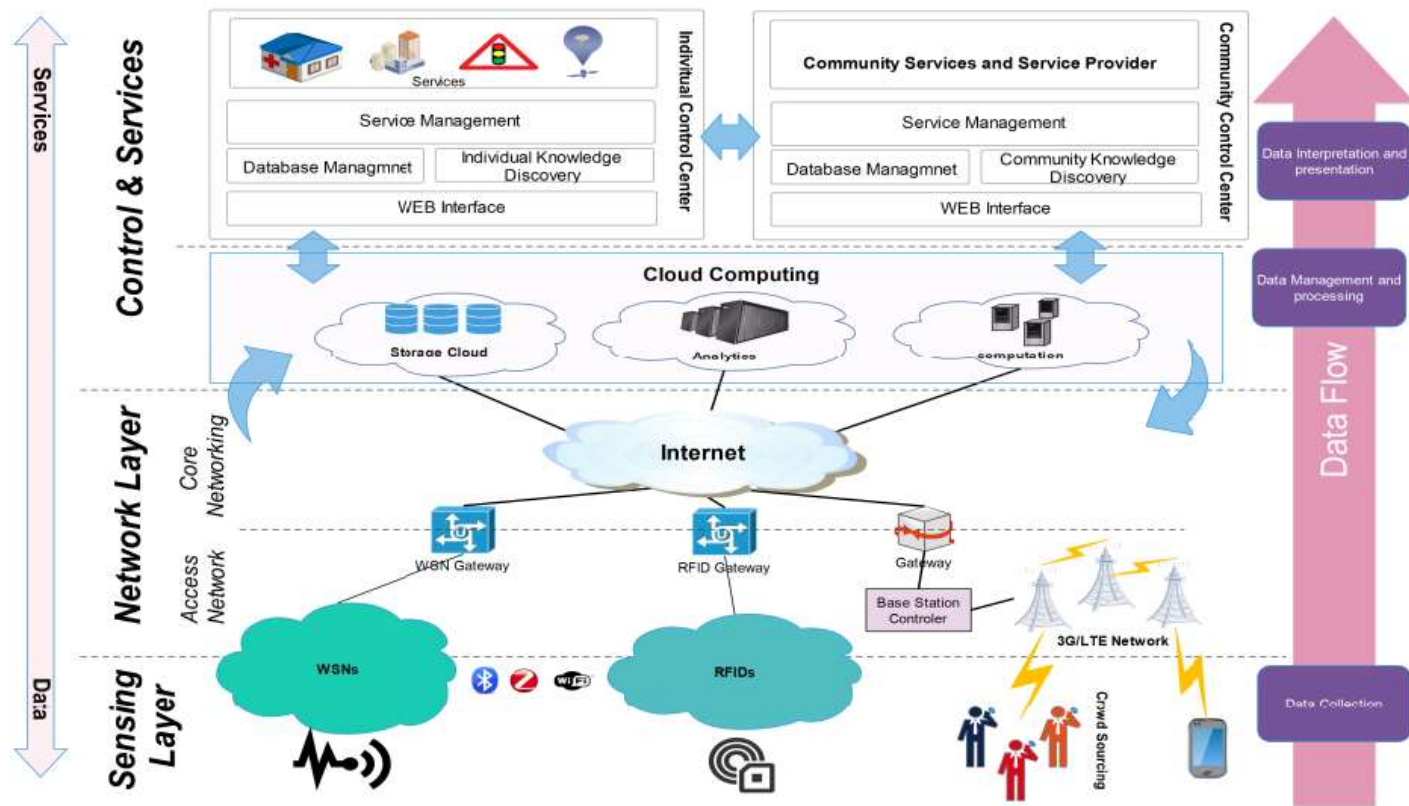
Data Visualization

Cyber Physical Systems

Computation in Physical Systems

City Actuation

Cloud Computing

Hosting Services

Hosting Storage and Computation

Elasticity and Scalability

Santana EF, Chaves AP, Gerosa MA, Kon F, Milojicic DS. Software platforms for smart cities: Concepts, requirements, challenges, and a unified reference architecture. ACM Computing Surveys (CSUR). 2018 Jan 12;50(6):78.

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Evolution of Smart City Architecture (1)

Jalali R, El-Khatib K, McGregor C. Smart city architecture for community level services through the internet of things. In Intelligence in Next Generation Networks (ICIN), 2015 18th International Conference on 2015 Feb 17 (pp. 108-113). IEEE.

Evolution of Smart City Architecture (2)
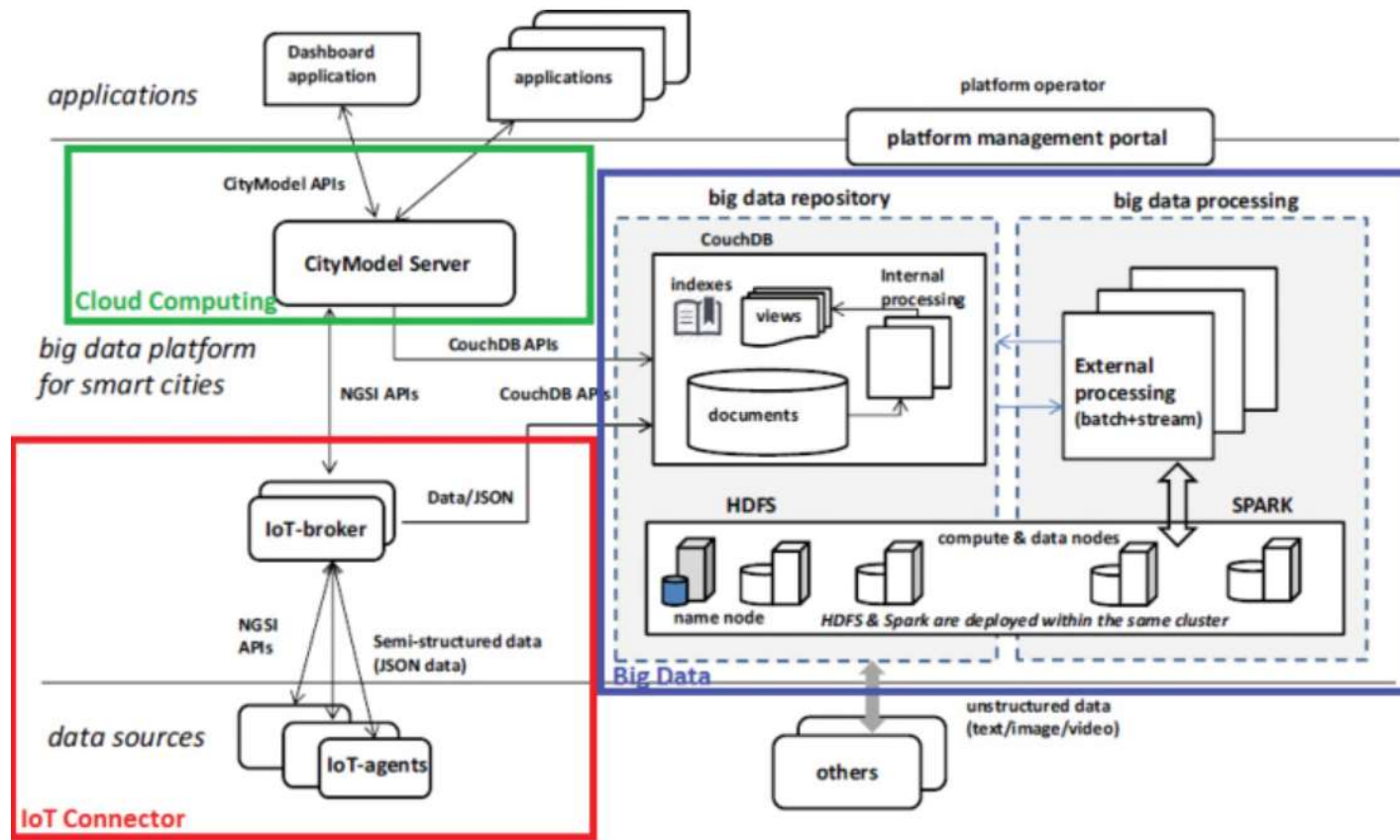
Cheng B, Longo S, Cirillo F, Bauer M, Kovacs E. Building a big data platform for smart cities: Experience and lessons from santander. In Big Data (BigData Congress), 2015 IEEE International Congress on 2015 Jun 27 (pp. 592-599). IEEE.

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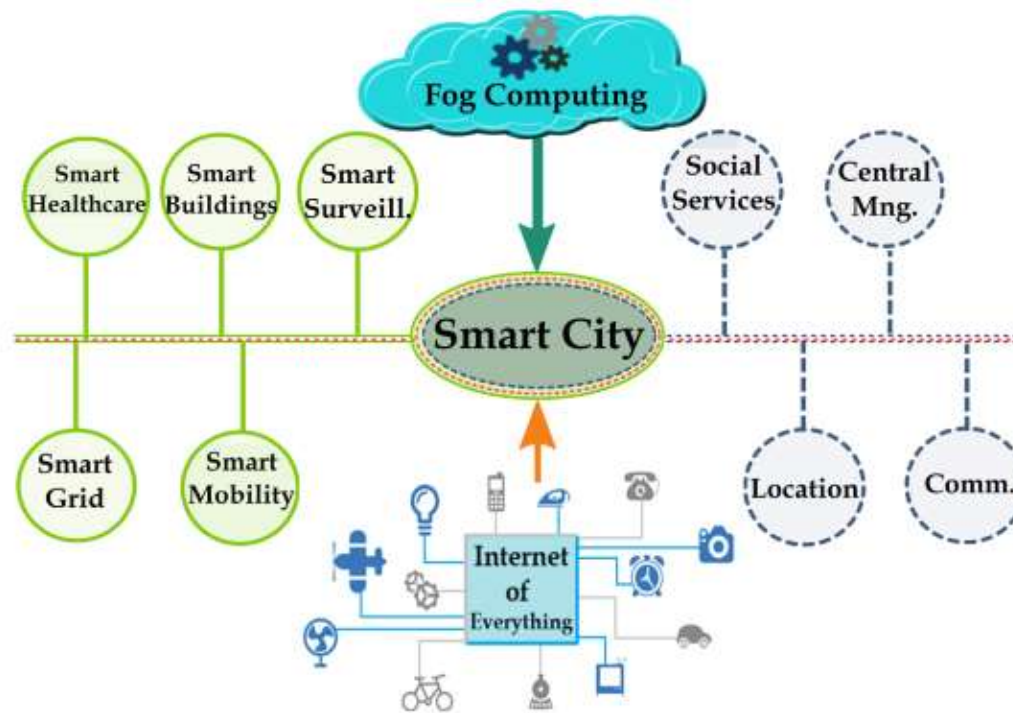
Evolution of Smart City Architecture (3)
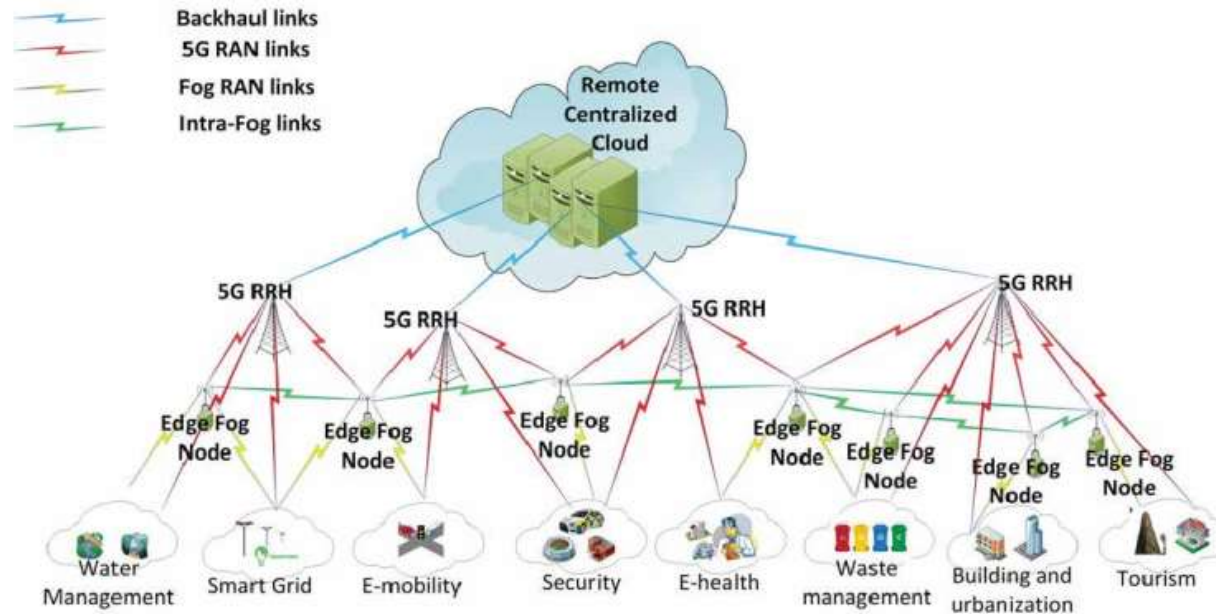
Andrisano O, Bartolini I, Bellavista P, Boeri A, Bononi L, Borghetti A, Brath A, Corazza GE, Corradi A, de Miranda S, Fava F. The Need of Multidisciplinary Approaches and Engineering Tools for the Development and Implementation of the Smart City Paradigm. Proceedings of the IEEE. 2018 Apr;106(4):738-60.
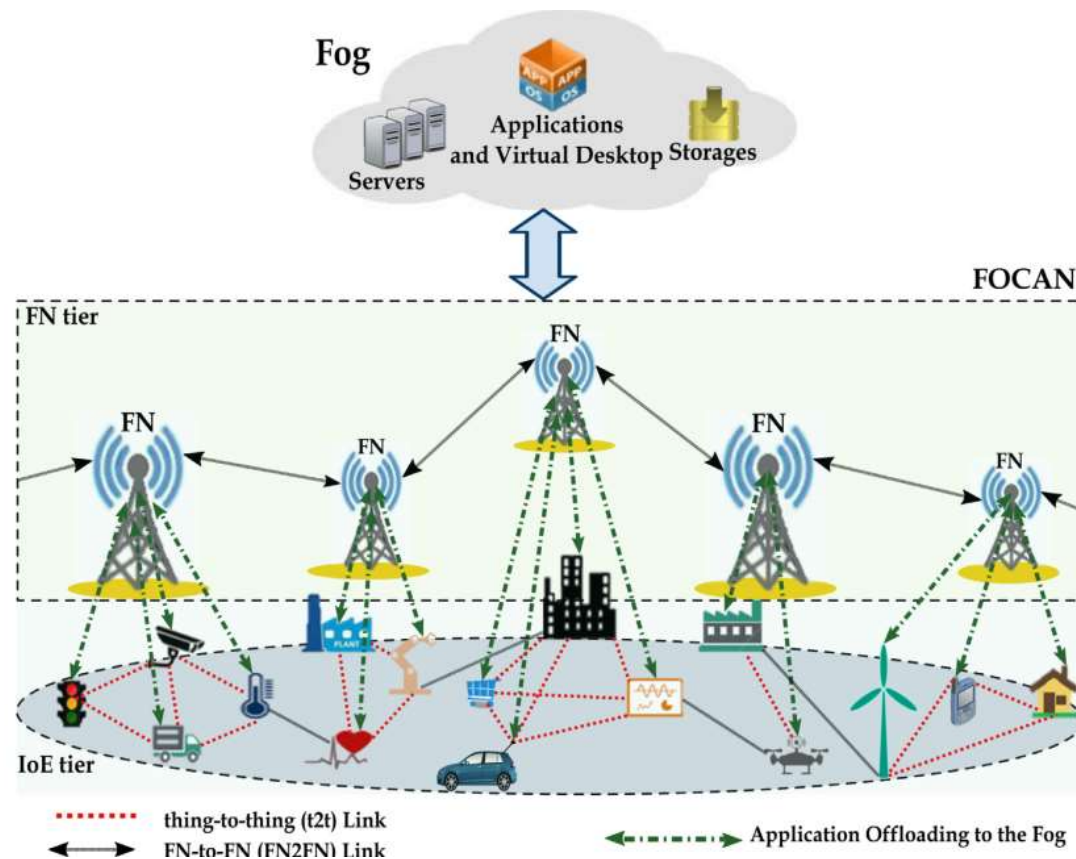
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Evolution of Smart City Architecture (4)

Naranjo PG, Pooranian Z, Shojafar M, Conti M, Buyya R. FOCAN: A fog-supported smart city network architecture for management of applications in the internet of everything environments. Journal of Parallel and Distributed Computing. 2018 Jul 7.

Evolution of Smart City Architecture (4)

Naranjo PG, Pooranian Z, Shojafar M, Conti M, Buyya R. FOCAN: A fog-supported smart city network architecture for management of applications in the internet of everything environments. Journal of Parallel and Distributed Computing. 2018 Jul 7.

Smart city: communications characteristics

FOCAN communication characteristics.

	Primary	Interprimary	Secondary
Architecture	Centralized	Centralized	Distributed
QoS	High	High	Very high
Access medium	Fixed/wireless	Fixed/wireless	Fixed
Technologies	WiFi/3G/ 4G-LTE	WiFi/ Bluetooth/Zigbee	WiFi/3G/ 4G-LTE/5G
Mobility	Yes	Yes	No
Heterogeneity	Yes	Yes	Yes
Bandwidth	Medium	High	Low
Latency	Low	Very low	Low
Delay Jitter	Very low	Very low	Low
Stream applications	Yes	Yes	Yes
Pervasive applications	Yes	Yes	Yes
Storage	Yes	No	Yes
Protocols	CDMA/TDMA/FDMA/OFDM/GSM		

Naranjo PG, Pooranian Z, Shojafar M, Conti M, Buyya R. FOCAN: A fog-supported smart city network architecture for management of applications in the internet of everything environments. Journal of Parallel and Distributed Computing. 2018 Jul 7.

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Thanks!

krahman@ucdavis.edu

http://www.linkedin.com/in/kmsabidurrahman/

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