International Journal of Scientific Research in Computer Science, Engineering and Information Technology
© 2018 IJSRCSEIT | Volume 3 | Issue1 | ISSN : 2456-3307

Infrastructure Aspects for Smart Cities

GurmeetKaur
Assistant Professor in Computer Sciences Dyal Singh College Karnal, Haryana, India

ABSTRACT

Information Technology is changing the evolution of cities. The notion of "growing" cities based on implementing correct urban planning is being replaced with the idea of making a city "smart". ICT is key driver of smart city initiatives and improving quality of life in urban areas. To do all this an intelligent infrastructure is required which work together to collect multi-source, contextual data, and to carry out integrated functions. These capabilities lead to intelligent infrastructure which should be more cost-effective than its traditional counterparts, as well as significantly more adaptable and useful. This paper describes the various important component of infrastructure to make useful and successful smart city concept.

Keywords :ICT, Smart Cities, IT Infrastructure, M2M Communications, IoT, HVAC System

I. INTRODUCTION

Information Technology is changing the evolution of cities. The notion of "growing" cities based on implementing correct urban planning is being replaced with the idea of making a city "smart". The Internet is changing the traditional urban planning model and compelling planners to not only consider the physical planning of a city but also to consider the use of Information Technology to make the economy, environment, mobility and governance of a city more efficient and effective. Even though the term "smart city" is relatively novel, the development of a smart city can vary dramatically depending on the approach that is taken regarding policymaking for the urban growth of the city (Chourabi, et al., 2012). A number of definitions for the term "smart city" exist. One of the more widely used definitions is outlined by Bakici, Almirall, & Wareham (2013) who define smart cities as "cities that utilize information and communication technologies with the aim to increase the life quality of their inhabitants while providing sustainable development" (Bakici, Almirall, & Wareham, 2013, p. 137). From this definition we can see that ICT plays a pivotal role in making a city more adapted to the contemporary needs of its citizens. Other definitions of smart cities may not place such an emphasis on the central role played by ICT, nevertheless many definitions include some reference to the use of ICT for making modern cities more suited to the needs of citizens (Chourabi, et al., 2012). For example, Caragliu, Bo, &Nijkamp (2009) view cities as smart when "investments in human and social capital and traditional (transportation) and modern (ICT-based) infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory government" (p. 6). Harrison et al (2010) argue that a city is smart when it manages to connect the physical infrastructure, the IT infrastructure, the social infrastructure, and the business infrastructure to leverage the collective intelligence of the city. Regardless of whether ICT takes centre stage in the development of a smart city or not, it is clear it is a key driver of smart city initiatives and thus needs attention from city planners and the various stakeholders interested in sustaining and improving quality of life in urban areas.

II. INTELLIGENT INFRASTRUCTURE

Intelligent infrastructure describes the integration of sensors, networked communications, and computing hardware and software into physical infrastructure. These enhancements to traditional infrastructure of all types have sparked a rapid evolution, and there is is no exception for transportation industry. Infrastructure—from homes to bridges to pipelines to streetlights—that was previously "passive" is becoming controllable or self-controlling, imbued with analytic ability, and able to communicate with other infrastructure elements and humans [1]. Crucially, because intelligent infrastructure components are connected to the Internet, they can often be made to work together—to collect multi-source, contextual data, and to carry out integrated functions [2]. These capabilities lead to intelligent infrastructure more cost-effective than its traditional counterparts, as well as significantly more adaptable and useful.

Intelligent infrastructure is rapidly becoming pervasive. Variously also called the "Internet of Things" or "The Programmable World," among other terms, this concept denotes a world in which our built infrastructure is linked and dynamic, often displaying intelligence via integrated sensors and adaptive controls. For example, raised pavement markers (e.g., reflective dots), which until recently have been among the simplest and "lowest tech" pieces of infrastructure, are gaining intelligence. Applications in other areas of transportation, energy conservation, health care, and food distribution are also available.

III. Key Enablers for the infrastructure

The key enablers for the development of intelligent infrastructure are as follow.

3.1 Smart Object

As the New York Times puts it: "Already billions of processors are embedded in our smart phones, cars, appliances, buildings, and the environment. These sensors can send out streams of data about their surroundings…." [3]

The second aspect for smart city planners to consider when implementing a smart ICT plan for a city is to ensure that the infrastructures and physical space of the city are enriched with embedded systems, smart devices, sensors, and actuators, offering real-time data management, alerts, and information processing for the city administration.

The presence of these devices combined with wireless connectivity throughout a city facilitates a more complex digital space within the city, which in turn can rise the collective embedded intelligence of a city. This collective embedded intelligence allows relevant stakeholders of the city to be informed about the city's physical environment and facilitates the deployment of advanced services like spatial intelligence.[4] It also paves the way for developing other innovative ecosystems that help to link the city with its people and visitors through technology.ICT plays key role for many current models for urban development, such as for revamping a city's critical infrastructure and enabling new ways for city transport management, traffic control or environmental pollution monitoring. Additionally, the extensive and ubiquitous use of ICT is empowering the development of essential services for health, security, police and fire departments, governance and delivery of public services.

As sensors, microprocessors, and wireless networking components become ever smaller and cheaper, the result is that almost any object can collect, send, and receive data. Furthermore, thanks to rapid advances in data storage and computer power, the flood of data from this ever-expanding universe of sensors can be productively analyzed, often in real-time, better than ever before. Since the sensors in question are part of physical objects, we can use our newfound knowledge to exert greater control on the physical world. In other words, computing will have evolved from merely sensing local information to analyzing it

to being able to control it. In this evolution, the world gradually becomes programmable" [3].

The home automation industry provides a good example of this trend. Familiar home infrastructure elements, such as lighting, heating, and door locks can be fitted with network connections and programmable controls. Additionally, networked video cameras, fire/CO detectors, and other types of sensors enable the homeowner to monitor the home remotely. On a more mundane level, networked power outlets that plug into existing wall receptacles allow any existing appliance to be networked and remotely controllable. Smartphone applications make control and monitoring easy.

The dramatic growth in consumer-oriented smart objects in recent years could create the impression that the consumer electronics market is driving the smart object industry, when in fact consumer devices are relative latecomers. Numerous industrial and commercial sensor applications—truly "intelligent infrastructure"—predate the introduction of sensor-enabled consumer devices like smart phones. Commercial agriculture, for example, has been in the vanguard of sensor use for many years. By the early 2000s, there was already a burgeoning market for wireless agricultural sensors. For example, there was growing demand for applications that allow farmers to monitor crop and field conditions, fertilizer application, and production by exact location [5].

3.2 Machine-to-Machine (M2M) Communication

The main objective to objects getting smarter object is to make able to communicate with each other. Machine-to-machine (M2M) communication is not new; it began almost two decades ago, using now mostly defunct private networks that enabled basic monitoring and control functions to be carried out remotely for certain infrastructure elements. The Internet quickly supplanted private networks, lowering the cost and simplifying the deployment of M2M applications. In theory, every object could have its own Internet Protocol (IP) address. One main limiting factor for this vision is the supply of unique addresses. The current stock of approximately 4.3 billion IP addresses, generated via Internet Protocol Version 4 (IPv4) is nearly depleted [6]. Fortunately, development of the successor protocol Internet Protocol Version 6 (IPv6) has been underway for several years, and will solve the IP address supply problem. IPv6 offers "enough potential Internets address to give every atom on the face of the earth its own address" [7].

From the perspective of public infrastructure management, a main aspect of M2M communications over the Internet is that networked objects have from the beginning been designed and implement following the "federated" model familiar in the development of information systems architectures. Federation allows for interoperability and information sharing among semiautonomous, decentralized systems, and applications [8]. For physical infrastructure, federation means that:

. . . New network-friendly devices . . . are able to set, define, install, and debug themselves. In the case of infrastructure, gas valves, telecommunication switches, traffic signals, and other devices could be added to the infrastructure system at any time. The infrastructure management system will be able to understand them immediately and start passing orders and receiving data from them [9].

Developing smart urban spaces, by connecting the embedded systems, sensors and smart devices located across the city together to form a cohesive and integrated ICT infrastructure for the city, is the essential along the way to smarter cities. Smart urban spaces are areas of a city that leverage ICT to deliver more sustainable and efficient services and infrastructures within that specific area. The spaces can sometimes be as large as entire city districts and these districts can include services like electric car charge points, energy-efficient buildings that use 'smart' meters and smart heating and cooling systems. Wi-Fi hotspots and information kiosks that allow people to connect to the Internet on the move

through these districts are also common services available in smart urban spaces. Free Wi-Fi hotspots are becoming more and more common in most European cities. These smart urban spaces comprise a wide range of innovations that can be of enormous economic and environmental and benefit to both the district and the city at large. This allows for the creation of applications, which enable data collection and processing, web-based collaboration, and actualization of the collective intelligence of citizens.

The latest developments in cloud computing and the emerging open data, IoT, semantic web, and future media technologies have much to offer cities looking to become smart. These technologies can assure economies of scale in infrastructure, standardization of applications, and turn-key solutions for Software as a Service (SaaS), which dramatically decrease the development costs while accelerating the learning curve for effective functioning of smart cities (Schaffers, Komninos, Pallot, Trousse, Nilsson, & Oliveira, 2011).

One such EU initiative is a large scale project entitled the Electronic Simple European Networked Services (eSENS) project8. This project aims to develop an infrastructure for interoperable public services in Europe. It intends to support the creation of a Digital Single Market by facilitating the delivery and usage of electronic public services. This topic of e-services is explored in more detail in the next section

3.3 Internet of Things (IoT)

The term "Internet of Things" explains the technological development where all devices have an assigned IP address and networking connectivity, allowing the to send and receive data without interactions from people. The decreasing price of sensors, improved wireless and cloud-based solutions have pushed the development for IoT and each one of us will own many IoT devices in the future. According to forecasts from Grid point; 75 billion units will be connected in 2020 that will help push the development of smart buildings as well.10

In building this means that everything from the HVAC System down to single window will have an assigned IP address that will transfer data and talk automatically to a system. In future buildings one would be able both to measure and regulate every single room in a big office building and it will let the user customize it to individual needs and improve the energy consumption and operational efficiency of buildings.

Recent market forecasts for the IoT from component industry and manufacturer's analysts all predict dramatic growth in the coming years. For example, both Cisco [10] and Ericsson [11] predict at least 50 billion Internet-connected devices in use worldwide by 2020. The McKinsey Global Institute estimates the potential economic impact of the Internet of Things to be $2.7 trillion to $6.2 trillion per year by 2025, with the largest impacts in health care and manufacturing [12]. (Together, urban infrastructure and vehicles—an approximation of total transportation impacts—make up $0.15 to $0.35 trillion of the total.)

The evolution and growth of smart infrastructure comprises an incremental set of developments. First, as technology costs continue to drop, more and more objects will acquire intelligence via integrated sensors, processors, and wireless transmitters. Second, the devices will be networked in a federated model, enabling flexibility and scalability. Third, M2M (along with the appropriate software) will enable smart infrastructure elements to rely on each other to coordinate actions.

This concept of semiautonomous, networked objects has been dubbed the "Internet of Things" (IoT). IoT is a concept industry analyst, futurists, and numerous science fiction books and movies have been forecasting for decades.

Various infrastructure system elements could have similar influence. Whether it is traffic signals that are entirely coordinated and can be dynamically

controlled [13], parking those prices itself based on demand to optimal usage [14], or networked street lights that sense the presence of people or autos as noted above, the ability of intelligent infrastructure to impact the world is clear.

3.4 Big data

As an implication of the many new devices being implemented more data is also being created. Buildings are and have always been large-scale producers of data points. New technologies are able to capture data in real-time and give operators (or intelligent systems) the ability to react instantly. This cloud-based data have created exciting opportunities to economically extract insight form large volumes of data and providing in-depth analysis of building performance.

Combining internal building data with external data (like weather forecasts) it is possible to create a better data mix. This will increase the ability to forecast and adjust building performance. The vast amount of data points does also give the option to measure every single device or unit, making it easier for operators to detect irregularities in the system. In combination with the exponential growth in data points the industry does also see new software tools and programs being developed to analyze and control the data.

Open Government Data (OGD) initiatives, and in particular the development of OGD portals, have become widespread since the mid-2000s both at local and central government levels in Europe and indeed across the globe.

Two civil society movements are campaigning for greater openness of information, documents and datasets held by public bodies. The first is the Right to Information movement, which promotes a public right of access to information from a human rights perspective. The second is the Open Government Data movement, which uses predominantly social and economic arguments to encourage the opening up of government data. The latter claims that putting such information into the public domain can benefit society by creating conditions for more social inclusive service delivery and for more participatory democracy. They also argue that it can stimulate the economy by allowing the possibility for third parties (e.g. individuals, private enterprises, civil society organizations) to create new products and services using public data (Access Info Europe & the Open Knowledge Foundation, 2011).

The OECD has identified 5 benefits to opening government data for a city, region or country:

1. Improving government accountability, transparency, responsiveness and democratic control
2. Promoting citizens self-empowerment, social participation and engagement
3. Building the next generation of empowered civil servants
4. Fostering innovation, efficiency and effectiveness in government services
5. Creating value for the wider economy

These five benefits place a great emphasis upon the need for a city's governing body to engage with its citizens and listen to their needs when developing the city.

3.5 Deployment of Broadband Networks

When considering the implementation of a smart ICT plan for a city, the key step for any policymaker is to foster the development of a rich environment of broadband networks that support digital applications, ensuring that these networks are available throughout the city and to all citizens (Komninos, Pallot, &Schaffers, 2013). This plan for easy access to broadband should include a broadband infrastructure that combines cable, optical fibre, and wireless networks. This will offer maximum connectivity and bandwidth to citizens and organisations located in the city. The latest broadband service is fibre-optic, which is the fastest Internet connection available. However, in many places this type of Internet service

is still in its infancy (Taylor &Schejter, 2013). Expanding this service across the city is main part of any smart city agenda. With these fibre-optic cables connectivity increases in critical areas around the city such as universities, business canters, technical and research institutes, government offices and emergency response units. These fiber optic networks are fundamental in acting as a backbone for ensuring high-speed access to the Internet. Additionally, they facilitate the installation of sensors [15], which are key to the development of intelligent solutions for the city. They also ensure access to any electronic public services that the city plans to offer its constituents (Bakici, Almirall, & Wareham, 2013). In addition to the wired broadband networks that are necessary for smart cities, wireless broadband is becoming ever more in demand, especially with the explosive popularity of mobile applications, Smartphone, the increased connectivity of smart devices, the Internet of Things (IoT), as well as the drop in costs of sensors and radio frequency identification (RFID) technology (Hernández-4 These networks are fundamental to ensuring high-speed access to the Internet and to any e-services that the city plans to offer its constituency Muñoz, Vercher, Galache, Gómez, &Pettersson, 2011). Cities can use broadband wireless networks to enable a wide range of smart city applications that enhance security and safety, improve efficiency of municipal services and hence promote a better quality of life for residents and visitors. This mobile infrastructure has already become an essential element for smart cities.

With new web-based and mobile tools to mange buildings and psychical assets in real-time, the user has better opportunities to make better decisions of the use of energy. The private smart home sector has been driving this development the last couple of years generating many new small devices and features from both small and big companies. This trend is also slowly starting to get into the commercial building sector as well. IoT and cloud based services are the two most important factors that is driving the development down to mobile platforms but the design of the products being developed does also seem to play a very important role in the adaption of products.[16]

3.6 Governmental regulations

Governmental regulation is also helping to fuel the trend of lowering use of energy in building. The Environmental Protection Agency (EPA) runs the ENERGY STAR program to help business and individuals to optimize their energy use.12 The U.S. Green Building Council manages the Leadership in Energy and Environmental Design (LEED) green building certification system that educates people and recognizes best-in-class building strategies and practices for green buildings. [17]

On a local level six U.S. cities—New York, Chicago, San Francisco, Washington, Boston and Austin, Texas—have all passed laws requiring buildings to report their energy use, submit to energy audits and lower their energy consumption.14

Governments are aware of the increasing role technology plays in the business sector and in the economy in general. As a result, they are looking to create digital strategies, which maintain or increase the country or region's competitiveness. One critical element to this strategy is to ensure that their constituents possess the adequate skills to compete in the digital world (Government of Canada, 2010).

Government services may include building management services like smart meters and monitoring devices to help monitor and manage water consumption, heating, air conditioning, lighting and physical security. ICT can also be used in improving the health of citizens through telemedicine, electronic records, health information exchanges and in remote assistance and medical surveillance for disabled or elderly people. When providing public Safety and Security, sensor-activated video surveillance systems can be employed along with location aware enhanced security systems,

and estimation and risk prevention systems (e.g. sensitivity to pollution, extreme summer heating). ICT services can change the way citizens work by providing e-commerce and remote working services for businesses, communications and entertainment for individuals. Integration of the e-services is a key-factor, enabling the above processes to work together and create environments more efficient in collaborative problem-solving and innovation (Komninos N., 2006). Innovative entrepreneurs and start-ups should be encouraged and supported to leverage these original technologies and adapt them to offer novel services to the citizens and businesses of the city.

3.6 Large companies

Another indicator that this is an interesting space is shown by the interest and investments from the large IT companies. Besides the investments and development in the space, companies such as Google and Apple have committed to use 100% renewable for their data centers and want to increase the mix of renewable in the daily operations. A few other examples of the development in the space is provided below.

Apple: Apple has recently announced their platform Home Kit for the development of application to be controlled from your iPhone. The first products for this platform are expected to be released in the start of 2015.[18]

Cisco: – Cisco is taking IoT to the next level and talks about Internet of Everything (IoE). They believe that IoT will also bring together people, process and data.[19] Cisco is of very course interested in this space because the deliver the backbone of the Internet.

Google: Google has entered the IoT and building space space by acquired the company NEST in January 2014. NEST develops “smart" home thermostats and smoke detectors that can program themselves and connect to smart phones.

Samsung: Samsung does already have products that are being used in the home but has also acquired the company Smart thing that is an open ecosystem for smart devices. Samsung has also partnered with the IT giants Intel and Dell to agree on common standards for household devices. [20]

Another trend in the smart home space can be viewed on the crowd funding platforms (Kickstarter.com etc.) where projects in the home automation sector are being backed on a daily basis. It covers all from gadgets to monitoring of animals in the house, security systems to development kits to create own applications. [21]

IV.CONCLUSIONS

As we see Internet is changing the traditional urban planning model and compelling planners to not only consider the physical planning of a city but also to consider the use of Information Technology to make the economy, environment, mobility and governance of a city more efficient and effective. This paper describes how ICT plays a vital role in developing a city as smart city. ICT based technologies like smart objects IOT M2M, Big Data, Broadband W/W, Govt. Policy and many large companies. These all are the big part for developing a city as smart city.

V.REFERENCES

[1]. Lohr, S. "The Internet Gets Physical." The New York Times, December 17, 2011.

[2]. Wasik, B. "In the Programmable World, All Our Objects Will Act as One." Wired, May 14, 2013.

[3]. Smarr, L. "An Evolution Toward a Programmable Universe." The New York Times, December 5, 2011.

[4]. Smart Cities Council. n.d. http://smartcitiescouncil.com/.

[5]. Wang, N., Zhang, N., & Wang, M. "Wireless Sensors in Agriculture and Food Industry - Recent Development and Future Perspective." Computers and Electronics in Agriculture, January 2006. http://www.sciencedirect.com/science/article/pii/S0168169905001572.

[6]. Curran, J. "Notice of Internet Protocol version 4 (IPv4) Address Depletion." ARIN: American Registry for Internet Numbers. April 15, 2009. https://www.arin.net/knowledge/about_resources/ceo_letter.pdf.

[7]. Wood, L. "Today, the Internet - tomorrow, the Internet of Things?" Computerworld, November 9, 2011.

[8]. Oracle. "Database Architecture: Federated vs. Clustered." 2002. http://www.oracle.com/technetwork/database/windows/clustercomp-134873.pdf.

[9]. University of Toronto. Intelligent Infrastructure. n.d. http://www.civ.toronto.edu/intinf/default.htm.

[10]. Evans, D. "The Internet of Things: How the Next Evolution of the Internet is Changing Everything." White Paper, 2011. http://www.cisco.com/web/about/ac79/docs/innov/IoT_IBSG_0411FINAL.pdf

[11]. Ericsson. "More than 50 Billion Connected Devices." White Paper, 2011. http://www.ericsson.com/res/docs/whitepapers/wp-50-billions.pdf.

[12]. Manyika, J., Chui, M., Bughin, J., Dobbs, R., Bisson, P., and Marrs, A. Disruptive Technologies: Advances that will Transform Life, Business, and the Global Economy. Report, McKinsey Global Institute, 2013. http://www.mckinsey.com/~/media/McKinsey/dotcom/Insights%20and%20pubs/MGI/Research/Technology%20and%20Innovation/Disruptive%20technologies/MGI_Disruptive_technologies_Full_report_May2013.ashx

[13]. Vanderbilt, T. (2009). Chapter Four – Why Ants Don't Get into Traffic Jams (and Humans Do): On cooperation as a Cure for congestion. In Traffic: Why We Drive the Way We Do (and What it Says About Us). Vintage, 2009.

[14]. Stross, R. "The Learning Curve of Smart Parking." The New York Times, December 22, 2012.

[15]. Gridaptive Technologies. "Smart Cities: Intelligent Transportation and Smart Grid Standards for Electrical and Lighting Management Systems." White Paper, 2012. http://www.gridaptive.com/whitepapers/Smart_Cities_Intelligent_Transportation_and_Smart_Grid-Standards_for_Electrical_and_Lighting_Management_Systems_.pdf.

[16]. Stott, R. "Without Architects, Smart Cities Just Aren't Smart." ArchDaily, April 2, 2013. http://www.archdaily.com/353281/without-architects-smart-cities-just-aren-t-smart/.

[17]. van Rijmenam, M. "The Los Angeles Police Department Predicts and Fights Crime with Big Data." Big Data-Startups.April 23, 2014.http://www.bigdata-startups.com/BigData-startup/los-angeles-police-department-predicts-fights-crime-big-data/.

[18]. http://www.macworld.co.uk/feature/apple/what-is-homekit-how-apple-iphones-automate-ourhomes-3522416/

[19]. http://www.cisco.com/web/about/ac79/docs/innov/IoE.pdf

[20]. http://www.reuters.com/article/2014/07/08/us-tech-connectivity-idUSKBN0FD09920140708

[21]. www.kickstarter.com

[22]. Chourabi, H., Nam, T., Walker, S., Gil-Garcia, J. R., Mellouli, S., Nahon, K., et al. (2012).

[23]. Understanding Smart Cities: An Integrative Framework. The 45th Hawaii International Conference on System Sciences, (pp. 2289 - 2297).

[24]. Bakici, T., Almirall, E., & Wareham, J. (2013). A Smart City Initiative: The Case of Barcelona. Journal of the Knowledge Economy, 4(2), 135-148.

[25]. Harrison, C., Eckman, B., Hamilton, R., Hartswick, P., Kalagnanam, J., Paraszczak, J., et al. (2010). Foundations for Smarter Cities. IBM Journal of Research and Development, 54(4).

[26]. Schaffers, H., Komninos, N., Pallot, M., Trousse, B., Nilsson, M., & Oliveira, A. (2011). Smart Cities and the Future Internet: Towards Cooperation Frameworks for Open Innovation. In F. I. Promises, J. Domingue, A. Galis, A. Gavras, T. Zahariadis, D. Lambert, F. Cleary, et al. (Eds.), Future Internet Assembly (pp. 431–446).

[27]. Komninos, N. (2006). The architecture of intelligent clities: Integrating human, collective and artificial intelligence to enhance knowledge and innovation. The 2nd IET International Conference on Intelligent Environments. 1, pp. 13-20. Athens, Greece: IEEE.

[28]. Komninos, N., Pallot, M., & Schaffers, H. (2013). Special Issue on Smart Cities and the Future Internet in Europe. Journal of the Knowledge Economy, 4(2), 119-134.

[29]. Government of Canada. (2010, July 13). Building Digital Skills for Tomorrow. Retrieved December 17, 2013, from Industry Canada: http://www.ic.gc.ca/eic/site/028.nsf/eng/00041.html#challenges

[30]. Taylor, R. D., & Schejter, A. M. (Eds.). (2013). European Broadband Spending: Implications of

[31]. Input-Output Analysis and Opportunity Costs. New York: Fordham University Press. The Independent Commission on Good Governance in Public Services. (2004).