International Journal of Pure and Applied Mathematics
Volume 118 No. 24 2018
ISSN: 1314-3395 (on-line version)
url: http://www.acadpubl.eu/hub/
Special Issue

http://www.acadpubl.eu/hub/

IOT BASED SMART CITY: A SURVEY

Tanuja S.Dhope[1], Dina Simunic[2],
[1]Department of Electronics and Telecommunication, [2]FER,
[1]G.H.Raisoni College of Engineering
Management,Pune,Maharashtra,India,
[2]University of Zagreb,Croatia,
tanuja_dhope@yahoo.com,
Dinasimunic@fer.hr

May 28, 2018

Abstract

ICT is key to the success of city to work as intelligent/ smart and providing sustainable environments. IoT is one of the key enabling technology that handles many smart city applications comprising of smart objects network. The IoT based applications transforms the city into smart-city by improving transportation, traffic congestion, infrastructure, waste management, providing green environment by uplifting the endowment of human vitality. In this article the author summarizes the IoT based taxomony, initiatives worldwide taken for IoT platforms freely (open source) available for intelligent/smart cities.

***Key Words*:**smart city,IoT based smart city,open-source IoT based platform,ICT.

1 INTRODUCTION

According to UN report ,the population lived in urban areas will be increased to 5 billion by 2030[1].The unparalleled urban growth

rate originates an exigency to hunting intelligent ways to manage the escorting challenges faced by the city for example-air pollution, economic risks of unemployment, health issues etc. So it is very essential to manage the city in an intelligent or smarter ways. Smart City is a city which provides the optimum utilization of available resources uplifting service quality given to the people with least administrational and operational cost. Various definitions of smart cities can be found in [2-3]. With the advances in technology and emergence of information and communication technologies (ICT), goal of the Smart city has been extended, taking help of ICT to uplift urban life keeping people in the center, in 5 planes viz , governance, economy, transport/mobility, livihood and environment.ICT aimed to build cities more sustainable, attractive, providing unique places for entrepreneurship and innovation. The Internet of Things (IoT) interconnects different communication networks and devices with internet [4]-[6].Smart city applications utilizing IoT can be classified based on communication protocol, enterprises, coverage, utilities, flexibility, scalability, network type, heterogeneity, service provider, consumer involvements and repeatability. For e.g. applications related to mobility include waste management, transportations, traffic management, logistics, e-healthcare connecting home with a person via body area

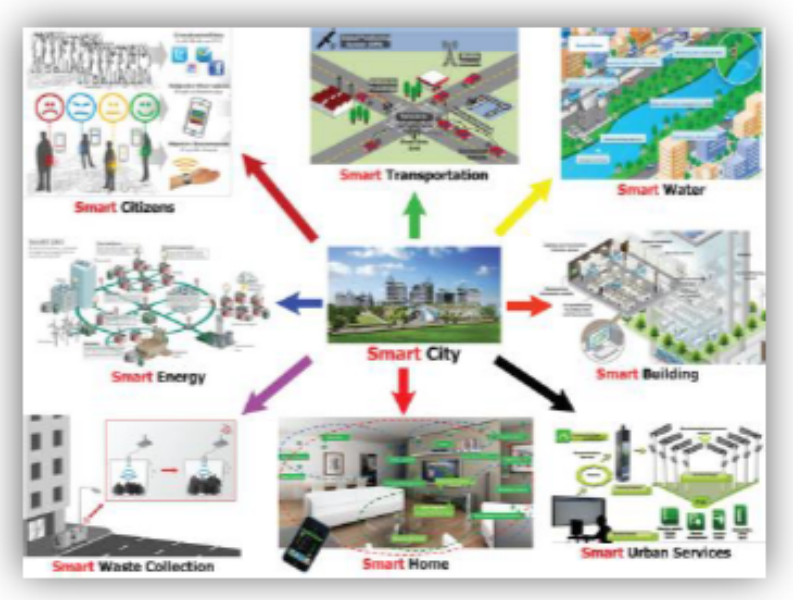

Figure 1 Various components of IoT based Smart City [7]

network (BAN) and applications based on utility comprises of surveillance, water network monitoring, smart metering monitoring and smart grid. Various components of IoT-based Smart city like intelligent buildings- infrastructure-transportation -healthcare-energy-governance-education and technology described in Figure1 [7]. The paper is organized as follows. IoT- based smart city communication protocol, enterprises, coverage, utilities, flexibility, scalability, network type etc is described in section II. section III compares the various IoT based open source platforms followed by conclusion in section IV.

2 IOT FOR SMART CITY

IoT-based smart city applications can be classified based on communication protocol, enterprises, coverage, utilities ,service provider ,involvement of standard bodies ,flexibility, scalability, network type, heterogeneity, end-user involvements and repeatability[8]-[10].

A. Communication Protocols

Short-and wide-range communication protocols used for smart city implementation, for transferring information between servers and devices.
Short Range Protocol: WiMAx,IEEE 802.11p,Wi-Fi ,Bluetooth, Zigbee utilized for vehicular systems, e-healthcare, smart metering.
Wide Range Protocol: LTE,GSM, GPRS and LTE-Advanced are exploited in smart grid, mobile e-healthhcare, vehicle-to-infrastructure (V2I), e-healthcare and docutainment services.
LoRa Alliance launched LoRaWAN protocol for ensuring interoperability. SIGFOX provides eminently scalable and low power consumption universal network for accomplishing smart city applications.Table1 reflects comparative summary of various communication protocols[9].

B. Service Providers

Nokia ,Ericson,Vodafone , DOCOMO, SK Telecom,Telefonica, Orange, ATT etc. are the major market players for providing smart city based applications .

C. Network Types

Diverse network topologies are key element to realize a wholly self-governing environment. The selection of a particular network type is based on data, size, capacity, coverage and latency requirements as well as applications based on distance.
short range applications: For home automation, street lighting WPAN, WLANs, BANs are suitable.
long range applications : ITS,e-waste management, environment monitoring, smart transportation WANs, MANs and mobile communication networks are most suitable.

TABLE I Summarization of Advanced Communication Protocol in IoT- based Smart City

Technology	Operating Frequency	Data rate	Coverage	Latency	Topology	Usage of Power	Application
Zigbee	2.4GHz,868GHz ,915MHz	250 kb/s	50-100m	16ms	Mesh	Low	Indoor, e-health, smart metering
Bluetooth	2.4 GHz	25Mb/s	10 m	100 ms	Point to point	Low	e-health, Indoor
Wi-Fi	2.4Ghz,5GHz ,802.11n	54Mb/s,0.6 Gb/s	140-100m	46ms	star	Medium	automtion, energy monitoring & management, Waste management, docutainment.
IEEE 802.11p	5.85-5.925 GHz	6Mb/s	100m	-	-	Low	V2V, infotainment
6LoWPAN	2.4GHz,868,915 Mhz	250 kb/s	100m	-	-	Low	Waste management, e-metering, ITS,automation
LORAWAN	433,868,780,915 MHz	50kb/s	2-5Km	-	star	Low	Waste management ITS,smart metering , docutainment, logistics
GSM/GPRS	850,900,1800, 1900MHz	80-384 kb/s	5-30km	15-3s	star	High	Waste management ,ITS, docutainment, Logistics,smart metering, docutainment,
3G	850Mhz	3Mb/s	5-30km	100ms	Mesh	High	Waste management ,ITS, docutainment, logistics, smart metering
LTE/LTE advanced	700,750,800, 1900,2500MHz	1 Gb/s, 500Mb/s	5-30km	5ms	Star,point to point	High	Waste management ,ITS , docutainment, logistics, smart metering

D. Involvement of Standard Bodies

One M2M, IEEE, Open Mobile Alliance (OMA), Internet Engineering Task Force (IETF), 3GPP and ETSI are engaged in establishing standards for smart city applications on a huge quantity.

3 OPEN SOURCE IOT PLATFORMS

Implementation of Open source platforms attracted not only vendors but also consumers in exchanging information for achievement of muti-vendor inter operability. Throughout the world, following

in Table 2 are the fast, easy and prime development open source platforms for smart city.

TABLE II Summary of Open Source Platforms

Open Source platform for IoT	**Description**	**Pros/cons**
FIWARE[11]	It is equipped with an enriched Open Stack-based cloud environment which includes open APIs associated to the IoTs, process and evaluate real time, Big data or assimilate leading edge features for user interaction. FIWARE enablers are classified into: • context-Aware Applications • Real time processing • Big data analysis • Publications of context aware events	Pros: powerful and simple APIs very useful for development of IoTs based applications. Cons:Unavailability of complete set of functionalities.
Contiki [12]	• Powerful IoT communication to microcontrollers. • Extremely low power • Least cost • It supports 6LowPAN,CoAP mobile networks and wireless (low power) • supports IPv4 and IPv6 protocols .	Pros: • Easy to develop smart city applications. • Highly efficient memory allocation
KAA [13]	• It facilitates protected, near real-time interoperability between assorted infrastructure systems, sensors, devices. It enables full freedom in private cloud deployments and source code modifications	Pros: • much faster and with full freedom to customize applications. • integrate with anything else Workshow, Event Processing, Object Store feature is not included.
PTC: ThingWorx IoT Platform [14]	• It trusted on a advanced networking infrastructure platform that facilitates integration of intelligent devices for improved decision making. • It supports a protected ,reliable and flexible multi-application solution on various scale for smart cities projects.	• Application Flexibility • Comprehensive Security • Proven Scalability
Com-iot[15]	• It provides secure connections, monitors and manages the devices while steady collecting and maintaining data. • It supports third party integration, granting	• Easy for implementation

	programmed actions to be provoked when particular thresholds are met.	
OM2M[16]	• It integrates 1M2M and intelligent M2M standards. • The heart of OM2M is a horizontal service common entity (SCE) . • SCE integrates enabling an application, setting up a triggering event, notifying to other entity, trust and security, persistence, device management and interworking.	• Peaceful process of organizing groups, registration, authentication, authorization, access rights , discovery of resources, Synchronous or asynchronous communication strategy and re-targeting.
Open DayLight IoT Data Management[17]	• Act as Middleware for information as an IoT Broker manageable with 1M2M. • Authorization to applications for recover of uploaded data by IoT devices. • Interaction among IoT devices and applications is done through CoAP,HTTP, CoAP, Message Queue Telemetry Transport (MQTT).	-
OCEAN [18]	• By providing global partnership, new innovative services and products can be devised. • Several one M2M-based platforms for devices, gateways, and servers released by OCEAN.	• New innovative Platforms

4 CONCLUSION

In this article the overview of smart city, its definition, various IoT based applications based on communication protocol, enterprises, coverage, utilities, service provider, involvement of standard bodies, flexibility, scalability, network type have been summerized. Selection of particular communication protocol based on type of application in smart city has been discussed. Further various open source IoT platform for smart city has been discussed.

References

[1] Taewoo Nam Theresa A. Pardo. Conceptualizing Smart City with Dimensions of Technology, People, and Institutions. 12th Annual International Conference on Digital Government Research, June 1215, 2011.

[2] Vito Albino, Umberto Berardi and Rosa Maria Dangelico. Smart Cities: Definitions, Dimensions, Performance, and Initiatives. Journal of Urban Technology, 2015.

[3] Leonidas Anthopoulos,Marijn Janssen Vishanth Weerakkody. Comparing Smart Cities with Different Modeling Approaches. International World Wide Web Conference Committee (IW3C2), May 1822, 2015.

[4] Andrea Zanella, Nicola Bui, Angelo Castellani,Lorenzo Vangelista, and Michele Zorzi. Internet of Things for Smart Cities. IEEE INTERNET OF THINGS JOURNAL, FEBRUARY 2014.

[5] Hafedh Chourabi, Taewoo Nam, Shawn Walker,J. Ramon Gil-Garcia, Karine Nahon,Sehl Mellouli ,Theresa A. Pardo, Hans Jochen Scholl. Understanding Smart Cities: An Integrative Framework. 45th Hawaii International Conference on System Sciences, 2012.

[6] Federico Montori, Luca Bedogni, Luciano Bononi. Collaborative Internet of Things Architecture for Smart Cities and Environmental Monitoring. IEEE Internet of Things Journal, 2017.

[7] Zhiyi Li, Shay Bahramirad, Amin Khodaei. A Hierarchical Framework for Intelligent Traffic Management in Smart Cities. IEEE Transactions on Smart Grid, 2017.

[8] Yasir Mehmood, Farhan Ahmad, Ibrar Yaqoob, Asma Adnane, Muhammad Imran, and Sghaier Guizani. Internet of Things Based Smart Cities: Recent Advances and Challenges. IEEE Communications Magazine, September 2017.

[9] Ibrar Yaqoob, Ibrahim Abaker Targio Hashem, Yasir Mehmood, Abdullah Gani, Salimah Mokhtar, and Sghaier

Guizani. Enabling Mobile and Wireless Technologies for Smart Cities: Part 1 IEEE Communications Magazine, January 2017.

[10] Ammar Gharaibeh, Mohammad A. Salahuddin, Sayed Jahed Hussini, Abdallah Khreishah, Issa Khalil, , Mohsen Guizani, and Ala Al-Fuqaha. Smart Cities: A Survey on Data Management,Security, and Enabling Technologies. IEEE Communication Surveys Tutorials, 2017.

[11] [11] https://www.fiware.org/ accessed on 24,April 2018.

[12] [12] http://www.contiki-os.org/ accessed on 24,April 2018.

[13] [13] https://www.kaaproject.org/overview/ accessed on 24,April 2018.

[14] [14] https://www.ptc.com/en/resources/iot/report/think-big-move-fast/ accessed on 24,April 2018.

[15] [15] https://www.com-iot.com/ accessed on 24,April 2018.

[16] [16] https://www.eclipse.org/om2m ,accessed on 24,April 2018.

[17] [17] https://www.opendaylight. org/,accessed June 5, 2016.

[18] [18] http://www.iotocean.org/, accessed on 24,April 2018.