.Planning Our Smart Cities In The Internet Of Things Architects, Software Engineers And The Rest Of Us

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Abstract

This paper presents a cloud centric vision for worldwide implementation of Internet of Things that, gives an indication of what to expect of modern day architects and how they are expected to function in the Internet of Thing world to make building of our much taunted smart cities a feasible reality. The key enabling technologies and application domains that are likely to drive Internet of Things research in the near future were also mentioned. The paper focused on the role of architects in Laying such a robust foundation along with a set of design-choices, based on the characterization of the targeted system with respect to various dimensions like distribution, security, real-time, semantics, and so on to make it possible for a system architect to select the protocols, functional components, architectural options, and all other parameters needed to build these Internet of Things systems in developing smart cities for a smarter world

Key Words: Smrt city, smart living,

1.0 Introduction

Smart city is a terminology that we are going to hear a lot about in time to come. A smart city is one that has mobile technology rooted across all functions of the city. A Smart City usually consists of basic infrastructure in an order to provide a good quality of life and a clean and lively environment for a smart living. Smart Cities uses the mobile technology and information and communication technologies (ICT) to improve the quality and performance in order to connect with its people in a more active and efficient manner. [1],[3] The components of a smart City includes smart government services, efficient transport system, smart traffic monitoring, sustainable energy, smart health care, improved water and waste management. [4][16]

The major changes in technology, environment and economy have generated curiosity in building smart cities. The major goals of smarter city applications are improving the governance and transforming the lives in urban areas. A report released by Juniper Research in 2015 named Barcelona as the world's smartest city. [14]The research inspected several aspects like technologies used, transportation systems, buildings, utilities etc. The study also predicted that there would be many more smart cities springing up in the near future.

The world's most wired cities

We're already seeing hints of the potential of the Internet of Things on a large scale today. "Smart cities" like Songdo, South Korea and Masdar in Abu Dhabi offer glimpses into a future of complete connected cities, although, the cities themselves don't exactly look like something out of world. "You look at these cities and they're well designed and very rational, but they typically look like anywhere else because "The Internet of Things is generally invisible." [12][15]

But groundbreaking advances visible or not are being made. Around the world, cities frequently touted as "smart" include Tel Aviv, Barcelona, Copenhagen and London. As for American cities, Los Angeles is the world's first to synchronize traffic lights to reduce congestion, and New York City is working on America's first "quantified community," which will monitor data like foot traffic, waste production and energy usage in real-time. In other words, the future is bright.[20][7][8][18]

Exciting possibilities

"We can't honestly think of a field of human endeavour where this innovation won't have some effect," says Jason Kelly Johnson, cofounder and design partner at Future Cities Lab, an experimental design studio, workshop and architectural think tank in San Francisco. "In architecture, specifically, it will in fact shape public space; it will intersect in a visible and tangible way." [15][4] The impacts of the Internet of Things on our cities don't begin and end with urban buildings everything from the morning commuter to public parks are incorporating Internet of Things technologies.[6][11]

What is this Internet of Things (IoT) ?

Internet of Things (IoT) is a recent communication idea that visualizes a near future, where the objects or devices used in everyday life will be equipped with sensors, microcontrollers, trans-receivers for digital communication, and suitable protocol stacks and network models will make these devices to communicate with each other and with the users, becoming an essential part of the Internet. [12][15] The Internet of Things revolves around increased machine-to-machine communication; it's built on cloud computing and networks of data-gathering sensors; it's mobile, virtual, and instantaneous connection; and they say it's going to make everything in our lives from streetlights to seaports "smart.[22][23]"

The initiative of the IoT (Internet of Things) was developed in parallel to Wireless Sensor Networks, and refers to distinctively identifiable objects in the environment and the object's virtual representations in an "internet-like" model. Though IoT does not follow a particular communication technology, but wireless communication technologies will play a major role in the advancement of the IoT. The development of a technology like IoT will make every part of the world connected. The rural and remote communities will be the key areas that will benefits from IoT the most. [2][28]

Fig.1.

The above figure is a reference model for the Internet of Things which contains 7 layers. • The first layer i.e the Physical Device layer is the first layer which consists of user devices which are equipped with sensors, nodes microchips etc. • The second layer, Connectivity layer consists of several communication protocols and communication models used for inter communication of the devices • The third layer is the edge computing layer which performs data element analysis and data manipulations. • The fourth layer is the data accumulation layer. As the name goes all the data that is collected by the mobile devices is stored here. • The fifth layer is the Data Abstraction layer that performs aggregation on the data. • The sixth layer, Application layer performs operations like displaying analytics and reposting them so that the user can understand the trends and data patterns. • The last layer is the Collaboration and process layer which people and business models and processes. [21][24][30] [31][29][24][25]

What is the Internet of Things in practice?

Maybe the simplest definition is that the Internet of Things encompasses all the embedded devices and networks that are natively IP-enabled and Internet-connected, along with the Internet services monitoring and controlling those devices. [17][27][31] Here we

urn information into action. The Internet of Things oesn't function without cloud-based applications to nterpret and transmit the data coming from all these ensors. The cloud is what enables the apps to go to ork for you anytime, anywhere.[11][14]
ensor is not a machine. It doesn't do anything in the same e that a machine does. It measures, it evaluates; in short, it gathers data. The Internet of Things really comes together with the connection of sensors and machines. That is to say, the real value that the Internet of Things creates is at the intersection of gathering data and leveraging it. All the information gathered by all the sensors in the world isn't worth very much if there isn't an infrastructure in place to analyze it in real time.[7] [24][25][26][32] [39

Fig 2

What is the vision of Internet of Things (IoT).

The vision of the internet of things is to manage objects around us with their own unique IP address. Internet of Things will comprise of billions of devices that can sense, communicate, compute and potentially actuate. Traditional Approach to Automation of Home and Building Management Systems consists of disparate system such as Access control, Fire Alarm, Digital Surveillance, motion and presence detection, energy management, sprinkler irrigation system, entertainment devices etc. These are, sometimes partially integrated by IP gateways but operate with proprietary protocols and standards Recent emergence of Cloud computing has triggered it. Cloud-based applications are the key to using leveraged data. [5][6] [10][13][31][41]

In the vision of the Internet of Things Internet of Things -we want to promote, a high level of interoperability needs to be reached at the communication level as well as at the service and the information level, going across different platforms, but established on a common grounding. The Internet of Things project reckons that achieving those goals comes in two steps, first of all in establishing a common understanding of the Internet of Things domain and second in providing to Internet of Things system developers a common foundation for building interoperable Internet of Things system architectures[24][28][29] [30]

Role of Internet of Things in Building Smart Cities

Until now, the Internet has been used primarily as a medium for the transmitting and collecting the data and information.

Experts of the industry now believe that the next chapter in the "Internet devised for the People" is opened by the rise of the Internet of Things (IoT). Internet of Things is leading to a change in the culture as a huge number of devices, sensors, actuators, and other objects are being interconnected to each other and to next level systems. The connectivity of a huge number of devices that are programmed to collect the data gave rise to an entirely new services and features which form the basis of some important concepts like the "Smart Cities". Internet of Things and big data are both technology-driven developments. [13][14][20]

The applications of Internet of Things for Smart City will bring huge market opportunities and will make lives of the people smarter. Today the devices around us are day by day becoming more intelligent. Furthermore, these developments are bound to change our behaviour and the way we use them. We are in the middle of an era where we are trying to discover new opportunities brought to life by new software and hardware designed to take advantage of the flow of new personal and global data. Cities all over the world are likely to invest about N12, 000 trillion on Internet of Things technologies in the next 20 years. In order to make cities smarter, the

governments have started promoting several startups and other industries in order to work on the Internet of Things technologies so that they can be implemented in several spheres of urban living. Here are some of the areas that the governments must work to achieve their goal of building smart cities. [22][26]

Making Modern Architect and Software Engineer function in Internet of Things (IoT)

For modern day architects and Software Engineers to be functional in Internet of Things and contribute meaningfully in the design and development of our smart cities they must be a good collaboration and keen exchange of ideas. The architect especially must be vast in not only normal architectural design but also in mobile and cloud computing. They must understand that the overall architecture to be followed at the initial stages of Internet of Things research will have a severe bearing on the field itself and needs to be properly software engineering and designed. Most of the work relating to Internet of Things architecture has been from the wireless sensor networks perspective Efficient heterogeneous sensing of the urban environment needs to simultaneously meet competing demands of multiple sensing modalities and this implies that the real architects must have basic knowledge of networking.. This has implications on network traffic, data storage and energy utilization. Importantly, this encompasses both fixed and mobile sensing infrastructure.

Security will be a major concern wherever networks are deployed at large scale. There can be many ways the system could be attacked - disabling the network availability; pushing erroneous data into the network; accessing personal information by physically attacking erected structures and that simply means that these architects need to understand all these and provide diversified security measures. Heterogeneous networks are (by default) multi-service; providing more than one distinct application or service. This implies not only multiple traffic types within the network, but also the ability of a single network to support all applications without Quality of Service compromise people centric sensing offers the possibility of low cost sensing of the environment localized to the user. It can therefore give the closest indication of environmental parameters experienced by the user. It has been noted that environmental data collected by user forms a social currency Extracting useful information from a complex sensing environment at different spatial and temporal resolutions is a challenging research problem in artificial intelligence.

Current state-of-the-art methods use shallow learning methods where pre-defined events and data anomalies are extracted using supervised and unsupervised learning **[40].** The next level of learning involves inferring local activities by using temporal information of events extracted from shallow learning. The ultimate vision will be to detect complex events based on larger spatial and longer temporal scales based on the two levels before. The fundamental research problem that arises in complex sensing environments of this nature is how to simultaneously learn representations of events and activities at multiple levels of complexity

As new display technologies emerge, creative visualization will be enabled and embedded is physical planning and structures. The evolution from CRT to Plasma, LCD, LED, and AMOLED displays have given rise to highly efficient data representation (using touch interface) with the user being able to navigate the data better than ever before. With emerging 3D displays, this area is certain to have more research and development opportunities. However, the data which comes out of ubiquitous computing is not always ready for direct consumption using visualization platforms and requires further processing. The scenario becomes very complex for heterogeneous spatio-temporal data

An integrated Internet of Thing and Cloud computing applications enabling the creation of smart environments such as Smart Physical Structures need to be able to (a) combine services offered by multiple stakeholders and (b) scale to support a large number of users in a reliable and decentralized manner. They need to be able operate in both wired and wireless network environments and deal with constraints such as access devices or data sources with limited power and unreliable connectivity. The Cloud application platforms need to be enhanced to support (a) the rapid creation of applications by providing domain specific programming tools and environments and (b) seamless execution of applications harnessing capabilities of multiple dynamic and heterogeneous resources to meet quality of service requirements of diverse users. [35][36][37] The Cloud resource management and scheduling system should be able to dynamically prioritize requests and provision resources such that critical requests are served in real time. To deliver results in a reliable fashion

The nature of real architectural design

The real architectural design can be visualized as the "Matrix" that eventually gives birth ideally to all concrete architectures. For establishing such a Matrix, based on a strong and exhaustive analysis of the State of the Art, we need to envisage the superset of all possible functionalities, mechanisms and protocols that can be used for building such concrete architecture and to show how interconnections could take place between selected ones (as no concrete system is likely to use all of the functional possibilities). Laying such a robust foundation along with a set of design-choices, based on the characterization of the targeted system with respect to various dimensions like distribution, security, real-time, semantics, and so on it becomes possible for a system architect to select the protocols, functional components, architectural options, and all other parameters needed to build these Internet of Things systems.

The nature of these developed Cities

From good design perspective a well-developed Internet of Things city should have the best availability, manageability and performance of Transport, water, energy, communication and buildings for residence work, entertainment and play. Internet of people with PC and Mobile devices is extending to a large number of specific application domains like Transportation, Energy, Environment, Assisted Living, most of the time pre-fixed with "Smart" sometimes for obvious marketing reasons but also -more generally- in order to emphasize the fact they embed a certain degree of intelligence and global awareness. This new breed of applications exploits Internet of Things related technologies, however, the resulting applications unfortunately appear as plain/flat designs only, meaning specific applications with specific architectures, with little place left for inter-system communication and inter-operation. Actually that is where the real issue lies: the smartness of those new applications can only reach its pinnacle if full collaboration between those plain/flat designs can be achieved.

If we consider also the fact that Internet of Things related technologies come with a high level of heterogeneity, with specific protocols developed with specific applications in mind, it is no surprise that the Internet of Things landscape nowadays appears as highly fragmented. Many Internet of Things enabled solutions exist with recognised benefits in terms of business and social impact; however they form what we could call a set of Intranets of Things, not an Internet of Things!

Conclusion

The Internet of Things is opening new frontiers for improving processes. So now we have sensors monitoring and tracking all sorts of data; we have cloud-based apps translating that data into useful intelligence and transmitting it to machines on the ground, enabling mobile, real-time responses. And thus bridges become smart bridges, cars smart cars and buildings and every item inside it becomes smart. And soon, we have smart cities, and this is a huge and fundamental shift. When we succeeded in making everything intelligent, it's going to be a major engine for creating new products, new services and jobs. The most demanding use of the Internet of Things involves the rapid, real-time sensing of unpredictable conditions and instantaneous responses guided by automated systems. This kind of machine decision making mimics human reactions, though at vastly enhanced performance levels. The building industry, for instance, is stepping up the development of systems that can detect imminent collapse and take evasive action. . What can we achieve when smart buildings in smart city locations start talking to each other when they sense imminent earth tremor and trigger off alarm for immediate evacuations? We're going to have safer cities to live in

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