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INTERNET OF THINGS

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ABSTRACT

This paper discusses the vision, the challenges, possible usage scenarios and technological building blocks of the "Internet of Things". In particular we will look at the complete analysis of few of the technical papers on "Internet of Things".

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INTRODUCTION

The Internet has been in existence for over forty years and the term 'Internet of Things' has been in use since the large scale adoption of RFID began a decade ago. So what is creating this new excitement about IoT? There are several factors. Today you have low cost but highly capable sensors, and advances in wired and wireless communication technology and network protocols that permit you to better connect sensors to the Internet. You have an array of tools, platforms, and analysis techniques that can process large amounts of sensor data and present meaningful insights. You can send data and receive insights through various devices such as your mobile phone, a tablet on your fridge, your car, or your computer. A close connection between things and humans, the cyber world and the physical world, has thus been established via sensors and devices. And that is why the potential for transformation is immense. Every industry will create new business models and offer new services to customers with the Internet of Things. As depicted in Figure 1, several layers of technology help IoT drive transformations to the business. Currently, IoT services are largely provided by device manufacturers. However, businesses need to engage with different devices and applications.

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How can such complexity be handled? We believe that a strong backbone that enables many functions is crucial to the delivery of IoT services. If your company wants to offer sensor based services, such as healthcare monitoring, or help your transport and logistics department trace vehicles or packages, you need a platform that allows device monitoring, application development, and data management. If there are value added services – such as analytics - on top of these that would be a boon.

Architecture and dependencies

As trillions of things (objects) are connected to the Internet it is necessary to have an adequate architecture that permits easy connectivity, control, communications, and useful applications. How will these objects interact in and across applications? Many times, things or sets of things must be disjoint and protected from other devices. At other times it makes sense to share devices and information. One possible architectural approach for IoT is to borrow from the smartphone world. Smartphones employ an approach where applications are implemented and made available from an appstore.

This has many advantages including an unbounded development of novel applications that can execute on the smartphones. Various standards and automatic checks are made to ensure that an app can execute on a given platform.

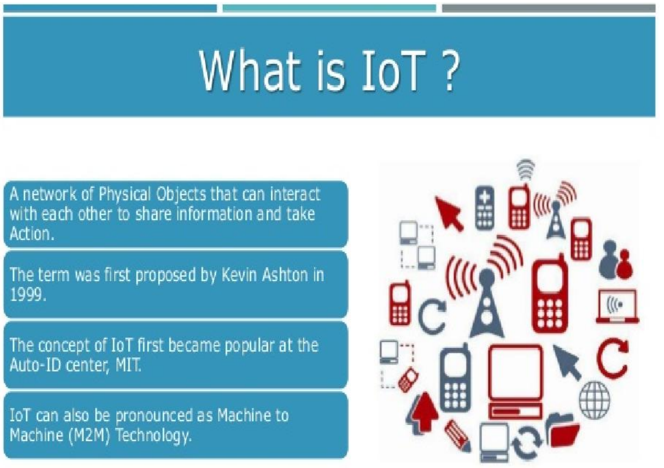


Diagram No 1.

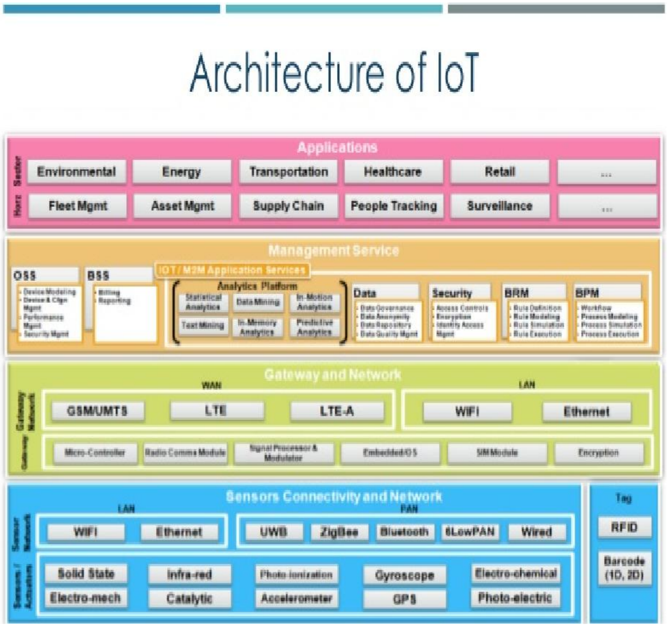
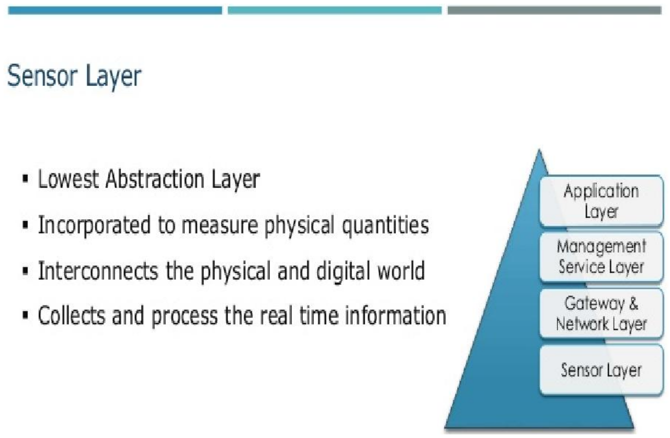


Diagram No 2.

For example, the correct version of the underlying OS and the required sensors and actuators can be checked when the app is installed. A similar architectural approach for IoT would also have similar advantages. However, the underlying platform for IoT is much more complicated than for smartphones. Nevertheless, if IoT is based on an underlying sensor and actuator network that acts as a utility similar to electricity and water, then, different IoT applications can be installed on this utility. While each application must solve its own problems, the sharing of a sensing and actuation utility across multiple simultaneously running applications can result in many systems-of-systems interference problems, especially with the actuators. Interferences arise from many issues, but primarily when the cyber depends on assumptions about the environment, the hardware platform, requirements, naming, control and various device semantics. Previous work, in general, has considered relatively simple dependencies related to numbers and types of parameters, versions of underlying operating systems, and availability of correct underlying hardware. Research is needed to develop a comprehensive approach to specifying, detecting, and resolving dependencies across applications. This is especially important for safety critical applications or when actuators can cause harm. Let's consider a few examples of dependencies. Assume that we integrate several systems responsible for energy management (controlling thermostats, windows, doors, and shades) and home health care (controlling lights, TVs, body nodes measuring heart rate and temperature, and sleep apnea machines). If information can be shared, this would allow the energy management system to adjust room temperature depending on the physiological status. Also, integration will allow avoiding negative consequences. For example, the integrated system will not turn off medical appliances to save energy while they are being used as suggested by the home health care system. In addition to these advantages, all the systems can share sensors and actuators, which will reduce cost of deployment, improve aesthetics of the rooms, and reduce channel contention. However, integrating multiple systems is very challenging as each individual system has its own assumptions and strategy to control the physical world variables without much knowledge of the other systems, which leads to conflicts when these systems are integrated without careful consideration. For example, a home health care application may detect depression and decide to turn on all the lights. On the other hand, the energy management application may decide to turn off lights when no motion is detected. Detecting and resolving such dependency problems is important for correctness of operation of interacting IoT systems.



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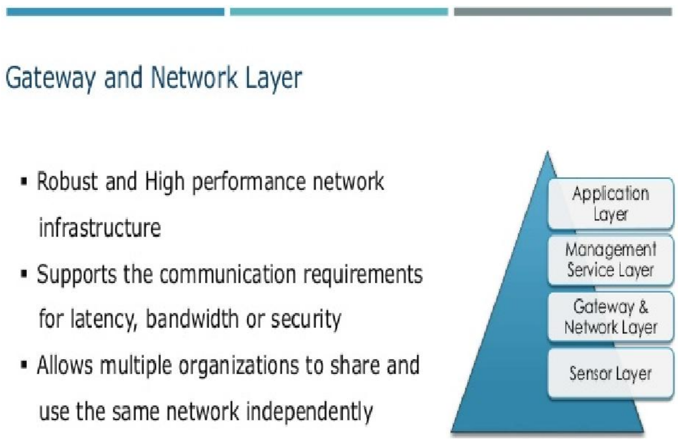

Diagram No 4.

Table 1. Analysis Table

Sr.No.	Paper	Methodology	Accuracy
1	Unlocking the Value of the Internet of Things (IoT) – A Platform Approach, by PrateepMisra Research Area Manager, TCS Innovation Labs.	1. Features • Sensors • Actuators 2. Applications • Utilities (energy, water, gas) • Manufacturing • Healthcare • Insurance • Consumer goods and retail • Transportation 3. Challenges • Device management • Device diversity and interoperability • Integration of data from multiple sources • Scale, data volume, and performance • Flexibility and evolution of application	93%
2	Research Directions for the Internet of Things John A. Stankovic, Life Fellow, IEEE	1. Features • sensing • actuation coverage • communication platform 2. Applications • Massive Scaling • Creating Knowledge & Big Data • Security • Humans in the Loop 3. Challenges • The need for a comprehensive understanding of the complete spectrum of types of human-in -the-loop controls. • The need for extensions to system identification or other techniques to derive models of humanbehaviors. • Determining how to incorporate human behavior models into the formal methodology of feedback control.	98%
3	Research Directions for the Internet of Things John A. Stankovic, Life Fellow, IEEE	1. Features • Networks of networks. 2. Applications • Holy Cow! • Mumbai: A Tale of Two Cities. 3. Challenges • Deployment of IPv6. • Sensor energy Standards	NA
4	From the Internet of Computers to the Internet of Things Friedemann Mattern and Christian Floerkemeier Distributed Systems Group, Institute for Pervasive Computing, ETH Zurich	1. Features • Communica-tion and cooperation • Addressability • Identification • Sensing • Actuation • Embedded information processing • Localization • User interfaces 2. Challenges • Scalability • "Arrive and operate" • Interoperability • Discovery • Software complexity • Data volumes • Data interpretation • Security and Personal privacy • Fault tolerance • Power supply • Interaction and short- range communications • Wireless communication	NA

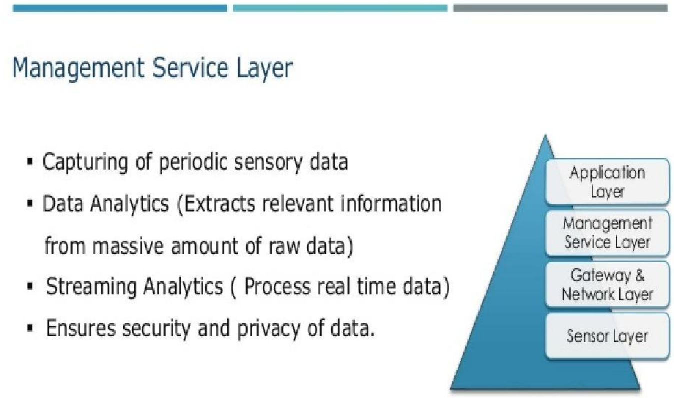

Diagram No. 5

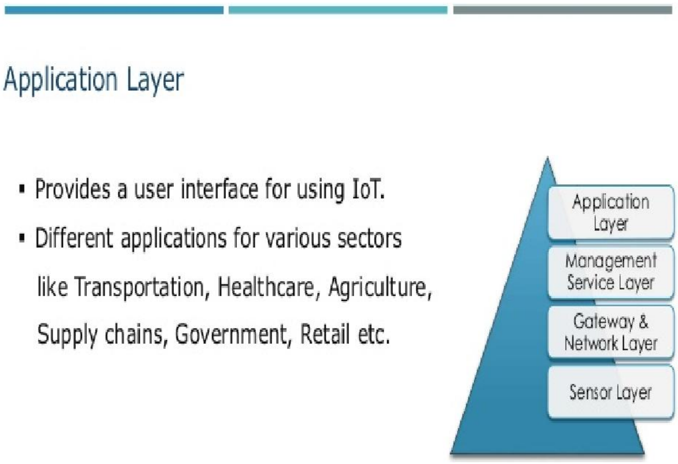

Diagram No. 6

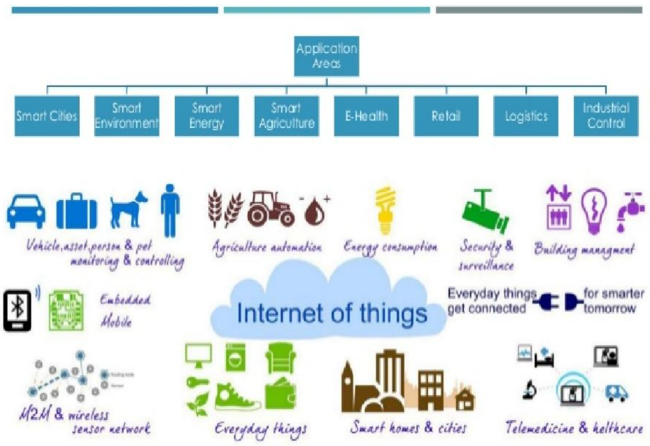

Diagram No. 7

Literature Survey

In one of the IEEE paper known as 'Research Directions for the Internet of Things John A. Stankovic, Life Fellow, IEEE. It states that Many people, including author, hold the view that cities and the world itself will be overlaid with sensing and actuation, many embedded in "things" creating what is referred to as a smart world. But it is important to note that one key issue is the degree of the density of sensing and actuation coverage. Author believes that there will be a transition point when the degree of coverage triples or quadruples from what we have today. At that time there will be a qualitative change. For example, today many buildings already have sensors for attempting to save energy; home automation is occurring; cars, taxis, and traffic lights have devices to try and improve safety and transportation; people have smart phones with sensors for running many useful apps; industrial plants are connecting to the Internet; and healthcare services are relying on increased home sensing to support remote medicine and wellness. However, all of these are just the tip of the iceberg. They are all still at early stages of development. The steady increasing density of sensing and the sophistication of the associated processing will make for a significant qualitative change in how we work and live. We will truly have systems-of-systems that synergistically interact to form totally new and unpredictable services. What will be the platform or platforms that support such a vision? One possibility is a global sensing and actuation utility connected to the Internet. Electricity and water are two utilities that can be used for a myriad of purposes. Sensing and actuation in the form of an IoT platform will become a utility. IoT will not be seen as individual systems, but as a critical, integrated infrastructure upon which many applications and services can run. Some applications will be personalized such as digitizing daily life activities, others will be city-wide such as efficient, delay-free transportation, and others will be worldwide such as global delivery systems. In cities perhaps there will be no traffic lights and even 3D transportation vehicles. Smart buildings will not only control energy or security, but integrate personal comfort, energy savings, security and health and wellness aspects into convenient and effective spaces. Individuals may have patches of bionic skin with sensing of physiological parameters being transmitted to the cloud which houses his digital health, and to the surrounding smart spaces for improved comfort, health, efficiency, and safety. In fact, smart watches, phones, body nodes, and clothes will act as personalized input to optimize city-wide services benefiting both the individual and society.

Consequently, we will often (perhaps 24/7) be implicitly linked into the new utility. Some examples of new services include immediate and continuous access to the right information for the task at hand, be it, traveling to work or a meeting, exercising, shopping, socializing, or visiting a doctor. Sometimes these activities will be virtual activities, or even include the use of avatars or robots. Many outputs and displays for users may be holographic. Credit cards should disappear and biometrics like voice or retinas will provide safe access to buildings, ATMs, and transportation systems. A sensing and actuation utility will not only exist in public spaces, but also extend into the home, apartments, and condominiums. Here people will be able to run health, energy, security, and entertainment apps on the infrastructure. Installing and running new apps will be as easy as plugging in a new toaster into the electric utility. One app may help monitor and control heart rate, another perform financial and investments services, another automatically ordering food and wine, or even predicting a impending medical problem that should be addressed early to mitigate or even avoid the problem. Humans will often be integral parts of the IoT system. The Industrial Internet is also a form of IoT where the devices (things) are objects in manufacturing plants, dispatch centers, process control industries, etc. Consequently, in the future the scope of IoT is enormous and will affect every aspect of all our lives. In another technical paper referred as 'Unlocking the Value of the Internet of Things (IoT) – A Platform Approach' by Prateep Misra Research Area Manager, TCS Innovation Labs. It states about Sensor Data Acquisition and Management that, the core of your IoT application is sensor data. A platform's APIs should allow sensors, devices, gateways, proxies, and other kinds of clients to register sensors in the system and then insert sensor observations. The platform must be highly scalable since the number and type of sensors you may use and the observation capture rate may become very large over a period of time. You may be running a number of applications related to your sensor based devices. It is important to have access to your data and to be able to manage your application database on the platform. Once you have a bunch of apps running on the platform, huge volumes of data start flowing in. To realize the potential of an IoT platform you need an analytics engine to mine the data and offer insights. Analytics could include everything from traditional Business Intelligence (BI) to data mining, machine learning, statistical processing, predictive analytics, and time series analysis on stored sensor data. Real-time analytics on sensor streams include rule based processing, complex event processing, pattern detection, correlation, and more. You should be able to offer insights to end-users in the form of rich visualization. Apart from standard graphs, bars, and charts, sensor data may be overlaid on top of maps or presented in gadgets or info graphics. Visualization services may be provided via GUI based tools or APIs, or both.

Analysis Study

We will study and compare various factors of Internet of Things like its features, applications, and also various technical challenges that can occur while implementation from few technical and research papers as mentioned below in the tabular format:

Conclusion

In summary, one vision of the future is that IoT becomes a utility with increased sophistication in sensing, actuation, communications, control, and in creating knowledge from vast amounts of data. This will result in qualitatively different lifestyles from today. What the lifestyles would be is anyone's guess. It would be fair to say that we cannot predict how lives will change. We did not predict the Internet, the Web, social networking, Facebook, Twitter, millions of apps for smartphones, etc., and these have all qualitatively changed societies' lifestyle. New research problems arise due to the large scale of devices, the connection of the physical and cyber worlds, the openness of the systems of systems, and continuing problems of privacy and security. It is hoped that there is more cooperation between the research communities in order to solve the myriad of problems sooner as well as to avoid re-inventing the wheel when a particular community solves a problem.

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