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An Overview of Challenges, Applications and Recent trends of Internet of Things

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Abstract: *The Internet of Things (IOT) is generally thought of as connecting things(devices) to the Internet. These devices are fitted with sensors and actuators so that they can able to sense the data and trigger the action according to it. These "Things" can send and receive the data using communication technologies like RFID, WSN, WIFI, Bluetooth, cellular network etc., It is predicted that there will be 50 billion connected devices by 2020 and in our lifetime we will experience life with a trillion-node network. The Internet of Things (IoT) is rapidly evolving and it is applied for building many smart things in various fields. There is a need to understand the applications, challenges and recent trends of IOT so that we can predict the future directions of IOT and its possible changes in the society.*

Keywords: *Internet of Things, API, AI, Big Data, Cognitive Computing*

I. Introduction

The term Internet of Things(IOT) was invented in 1998 which is a network of networks where large number of objects or sensors are connected through communication and information infrastructure to provide value-added services. Devices are integrated with virtual world of the Internet and interact with it by tracking, sensing, and monitoring objects and their environment. The advancement of communication technologies like RFID, WSN, RF Links, Bluetooth, Wifi, Zigbee, LPWAN and Cellular network makes the IOT object to connect with each other. Such 'smart' objects come in a wide range of sizes and capacities. They can be used in household Appliances, industrial robots, cars, trains, and wearable objects such as watches, Bracelets or shirts. IOT is highly on the rise, it is observed from the areas that are completely under its effect. From smart cities, environment, health, energy, vehicle, transport, public safety to our daily essentials.

II. Challenges To Iot

1. Security Concerns

As the IoT connects more devices together, it provides more decentralized entry points for malware. Less expensive devices that are in physically compromised locales are more subject to tampering. More layers of software, integration middleware, APIs, machine-to- machine communication, etc. create more complexity and new security risks. Expect to see many different techniques and vendors addressing these issues with policy-driven approaches to security and provisioning.

2. Standards and interoperability

If devices from different manufacturers do devices, for example, or sensors positioned in locations not use the same standards, interoperability will be more difficult, requiring extra gateways to translate from one standard to another. In addition, a company that controls different parts of a vertical market (e.g. the acquisition of data, its integration with other data streams, and the use of those data streams to come up with innovative solutions or to provide services) may dominate a market, stifling competition and creating barriers for smaller players and entrepreneurs. Differing data standards can also tend to lock consumers into one family of products: if consumers cannot easily transfer their data when they replace one device with another from a different manufacturer, they will in effect lose any benefit from the data they have been accumulating over time.

3. Trust and Privacy

The possibility of tracking and surveillance of people by government and private agencies increases as the devices are constantly connected to the internet.

These devices collect user data without their permission, analyze them for purposes only known to the parent company. The social embrace of the IOT devices leads people to trust these devices with collection of their personal data without understanding the future implications.

4. Complexity, Confusion and Integration issues

The rapid evolution of APIs will likely consumer unanticipated development resources that will diminish project teams'abilities to add core new functionality. Slowerr adoption and unanticipated development resource requirements will likely slip schedules and slow time to revenues, which will require additional funding for IoT projects and longer runways ‖ for startups.

5. Evolving architectures, protocol wars and Competing Standards

With so many players involved with the IoT, there are bound to be ongoing turf wars as legacy companies seek to protect their proprietary systems advantages and open systems proponents try to set new standards. There may be multiple standards that evolve based on different requirements determined by device class, power requirements, capabilities and uses. This presents opportunities for platform vendors and open source advocates to contribute and influence future standards.

6. Concrete use cases and compelling value propositions.

Lack of clear use cases or strong ROI examples will slow down adoption of the IoT. Although technical specifications, theoretical uses and future concepts may suffice for some early adopters, mainstream adoption of IoT will require well-grounded, customer-oriented communications and messaging around.

III. Applications

1. Smart Wearable

Smart wearable are networked devices that can collect data, track activities and customize experiences to users' needs and desires. Wearable solutions are designed for a variety of functions as well as for where on a different of part of body such as the head, eyes, wrist, waist, hands, fingers, legs or embedded into different element of attire. Wearable devices includes head-mounted(glass and helmet), body-dressed (coat, underwear, and trousers), hand-worn (watch, bracelet, and gloves), and foot-worn (shoes and socks).

2. Smart Home

Smart Home has become the revolutionary ladder of success in the residential spaces and it is predicted Smart homes will become as common as smartphones. The cost of owning a house is the biggest expense in a homeowner's life. Smart Home products are promised to save time, energy and money. With Smart home companies like Nest, Ecobee, Ring and August, to name a few, will become household brands and are planning to deliver a never seen before experience.

Some smart home solutions also focus on assisting elderly Hand (Gloves), Finger(Rings), Wrist(Watch/Bands), Eyes(Glasses), Legs(Socks), Foot (Shoes), Head (Helmet), Body(Cloth), Waist(Band), Chest(Band) people in their daily activities and on health care monitoring. Due to the large market potential, more and more smart home solutions are making their way into the market. From the academic point of view, smart energy and resource management, human– system interaction, and activity management.

3. Connected Cars

A connected car is a vehicle which is able to optimize it's own operation, maintenance as well as comfort of passengers using onboard sensors and internet connectivity. Most large auto makers as well as some brave startups are working on connected car solutions. Major brands like Tesla, BMW, Apple, Google are working on bringing the next revolution in automobiles.

4. Industrial Internet

Industrial Internet is the new buzz in the industrial sector, also termed as Industrial Internet of Things (IIoT). It is empowering industrial engineering with sensors, software and big data analytics to create brilliant machines.According to Jeff Immelt, CEO, GE Electric, IIoT is a "beautiful, desirable and investable" asset. The driving philosophy behind IIoT is that, smart machines are more accurate and consistent than humans in communicating through data. And, this data can help companies pick inefficiencies and problems sooner. IIoT holds great potential for quality control and sustainability. Applications for tracking goods, real time information exchange about inventory among suppliers and retailers and automated delivery will increase the supply chain efficiency. According to GE the improvement industry productivity will generate $10 trillion to $15 trillion in GDP worldwide over next 15 years.

5. Smart Cities

Smart city is another powerful application of IoT generating curiosity among world's population. Smart surveillance, automated transportation, smarter energy management systems, water distribution, urban security and environmental monitoring all are examples of internet of things applications for smart cities. IoT will solve problems faced by the people living in cities like pollution,traffic congestion and shortage of energy supplies etc. Products like cellular communication enabled Smart Belly trash will send alerts to municipal services when a bin needs to be emptied. By installing sensors and using web applications, citizens can find free available parking slots across the city. Also, the sensors can detect meter tampering issues, general malfunctions and any installation issues in the electricity system.

6. IoT in agriculture

With the continous increase in world's population, demand for food supply is extremely raised. Governments are helping farmers to use advanced techniques and research to increase food production. Smart farming is one of the fastest growing field in IoT. Sensing for soil moisture and nutrients, controlling water usage for plant growth and determining custom fertilizer are some simple uses of IoT.

7.Smart Retail

IoT provides an opportunity to retailers to connect with the customers to enhance the in-store experience. Smart phones will be the way for retailers to remain connected with their consumers even out of store. Interacting through Smart phones and using Beacon technology can help retailers serve their consumers better. They can also track consumers path through a store and improve store layout and place premium products in high traffic areas.

8. IOT in Healthcare

Connected healthcare yet remains the sleeping giant of the Internet of Things applications. The concept of connected healthcare system and smart medical devices bears enormous potential not just for companies, but also for the well-being of people in general. Research shows IoT in healthcare will be massive in coming years. IoT in healthcare is aimed at empowering people to live healthier life by wearing connected devices. The collected data will help in personalized analysis of an individual's health and provide tailor made strategies to combat illness. The video below explains how IoT can revolutionize treatment and medical help.

9. IoT in Poultry and Farming

Livestock monitoring is about animal husbandry and cost saving. Using IoT applications to gather data about the health and well being of the cattle, ranchers knowing early about the sick animal can pull out and help prevent large number of sick cattle.

10. Energy Engagement

Power grids of the future will not only be smart enough but also highly reliable. Smart grid concept is becoming very popular all over world. The basic idea behind the smart grids is to collect data in an automated fashion and analyze the behavior or electricity consumers and suppliers for improving efficiency as well as economics of electricity use. Smart Grids will also be able to detect sources of power outages more quickly and at individual household levels like nearby solar panel, making possible distributed energy system.

Recent trends of IOT:

Big Data and AI

Speaking about the data: since there will be more smart devices and we will use IoT much more than we do now, the amount of processed data will grow too. So we will have to work with Big Data a lot and thus we will have to think of resources that would enable us to process and analyze it correctly. Here artificial intelligence and machine learning will come in handy because with these technologies we will be receiving more precise results and analytics in comparison to calculations performed by manpower. Internet of Things has a huge potential and can be used in almost any sphere of our lives. If implemented properly, it can cause incredible changes that will affect both the industries with governmental sectors and lives of single users. Even know IoT is used heavily and a lot of IT companies already offer services related to this technology.

In an IoT situation, AI can help companies take the billions of data points they have and boil them down to what's really meaningful. The general premise is the same as in the retail applications – review and analyzes the data you've collected to find patterns or similarities that can be learned from so that better decisions can be made.

The year 2017 would see Internet of Things software being distributed across cloud services, edge devices, and gateways. The year would also witness IoT solutions being built on modern Microservices (an

approach to application development in which a large application is built as a suite of modular services. Each module supports a specific business goal and uses a simple, well-defined interface to communicate with other modules) and containers (lightweight virtualization) that would work across this distributed architecture. Further, machine-learning cloud services and Artificial Intelligence will be put to use to mine the data that would be coming in from IoT devices.

Personalized marketing platforms

Marketers will be able to place personal advertisements on mobile phones or other platforms depending on user behavior and profile. Such approach will transform the relationship between a user and product owner as more attention will be paid to user needs and business owners will be empowered with a lot of information about the customer, which will be used to develop a maximally efficient approach and offer.
With the help of IOT the smart marketing can be done through the easy exchange of data.

APIs

Application programming interfaces (APIs) and a sound strategy around them is becoming increasingly important to enterprises tapping into the IoT. APIs serve as a bridge to connect useful information and plentiful data to the Internet of Things, making the Internet of Things useful by connecting many disparate things into a powerful network that offers astounding possibilities.

APIs are the market enabler, and Internet of Things devices would be useless without them. By exposing data that enables multiple devices to be connected, APIs provide an interface between the Internet and the things to reveal previously unseen possibilities. In the year to come, the power and importance of APIs will be at the forefront of the conversation around enabling—and more important—monetizing the Internet of Things.

IBM brings the power of cognition to the Internet of Things with Watson APIs. In a physical world in which devices and systems are becoming highly digitized, the capabilities provided by these APIs give IBM clients, partners and developers an ever fuller sense of the data on which they rely:

1. The **Natural Language Processing (NLP) API Family** enables users to interact with systems and devices using simple, human language. Natural Language Processing helps solutions understand the intent of human language by correlating it with other sources of data to put it into context in specific situations.

2. The **Machine Learning Watson API Family** automates data processing and continuously monitors new data and user interactions to rank data and results based on learned priorities. Machine Learning can be applied to any data coming from devices and sensors to automatically understand the current conditions, what's normal, expected trends, properties to monitor, and suggested actions when an issue arises.

3. **The Video and Image Analytics API Family** enables monitoring of unstructured data from video feeds and image snapshots to identify scenes and patterns. This knowledge can be combined with machine data to gain a greater understanding of past events and emerging situations.
4. **The Text Analytics API Family** enables mining of unstructured textual data including transcripts from customer call centers, maintenance technician logs, blog comments, and tweets to find correlations and patterns in these vast amounts of data.

Security

As we rely on connected devices to make our lives better and easier, security must be considered from every aspect. All participants in the IoT ecosystem have a responsibility for the security of the devices, data and solutions. This means that device manufacturers, application developers, consumers, operators, integrators and enterprise businesses all have their part to play to follow best practices.

IoT security requires a multi-layered approach. From a device point of view it should be considered at the blueprint level that starts with design and development and keeps hardware, firmware/software, and data secure through their entire life. The same approach applies if you are a security analyst or operations personnel responsible for IoT solutions. To enable the full potential of IoT, security challenges must be addressed through a combination of interoperability, education and good design—and by taking a proactive, not reactive approach to designing security features, which will result in better products and solutions.

Understanding the intricacies of IoT and the security around it is something that we at IBM have taken very seriously. We have invested and combined the expertise from across the IBM business incorporating thought leaders from IBM Research, Security and IoT to provide a comprehensive overview of IoT Security.

Platforms

IoT platforms received a great amount of attention in 2016 as most major IoT players rolled one out in one form or another. Platforms that have the right elements can provide tremendous value by linking the IoT endpoints to the applications and analytics needed to generate business outcomes. It's the linchpin in a holistic IoT solution as it enables the data generated at the endpoints to be processed and meaningfully used by end users.

An IoT platform must connect devices, must collect data, must handle thousands of vendors, dozens of standards and must be able to scale to millions of devices sending billions of messages. To deliver true value beyond the basics, it must add cognitive, security, privacy, insight generation and close loop automation. With these capabilities and the supporting technology advancements, the IoT platform becomes an agent of transformation for a business.

Cognitive Computing

The Internet of Things is at the threshold of a tremendous opportunity. Connecting things with unique IP addresses has been possible for over a decade, but the commoditization of sensors, processors and memory now make it viable to make everyday things move beyond being just connected, but actually making them intelligent.

Beyond traditional IoT implementations, cognitive computing is increasing the amount of data to improve the learning environment and increase the possibilities of what can be done with edge analytics – making sensors capable of diagnosing

and adapting to their environment without the need for human intervention. Another huge advantage of cognitive IoT is the ability to combine multiple data streams that can identify patterns and give much more context than would be otherwise available.

Cognitive IoT, AI and machine learning are further enabling enterprises to unlock IoT value. An exploding amount of IoT data requires a new approach to gather, analyze and makes sense out of all that data. Such a massive amount of information from sensors and devices can be used to enhance existing data and knowledge, uncovering insights capable of transforming industries. But although making sense out of dark data and edge data is paving our way to revolutionary ideas and technologies, it requires a cognitive approach that can effectively handle increasingly large inputs while generating meaningful output.

Programmable systems thrive on prescribed scenarios using predictable data, and their rigidity can limit their usefulness when addressing the ambiguity and uncertainty of IoT data. Cognitive systems, however, are not explicitly programmed. Rather, they learn from interactions with people and from experiences with their environment. In doing so, they become able to keep pace with the complexity of the Internet of things, identifying data correlations that would otherwise go unnoticed.

Blockchain

Blockchain is playing a major part in the Internet of Things by enhancing security, making transactions more seamless and creating efficiencies in the supply chain.

I expect the coming year will be one in which we see companies start to leverage blockchain in 3 key ways:

1. **Build trust** – blockchain can help build trust between the people and parties that transact together. Watson IOT blockchain enables devices to participate in blockchain transactions as a trusted party. While Person A may not know device B and may not trust it implicitly, the indelible record of transactions and data from devices stored on the blockchain provide proof and command the necessary trust for businesses and people to cooperate.
2. **Reduce costs** – IoT and blockchain can enable participants to reduce monetary and time commitment costs by ultimately removing the "middle man" from the process. Transactions and device data are now exhibited on a peer to peer basis, removing most legal or contractual costs.
3. **Accelerate transactions** – IoT and blockchain enables more transactions overall because the "middle man" is removed from the process. Smart contracts allow for organizations to reduce time needed for completing legal oF contractual commitments.

Blockchain for IoT can transform the way business transactions are conducted globally through a trustworthy environment to automate and encode business transactions while preserving enterprise level privacy and security for all parties in the transaction. IBM Watson IoT Blockchain utilizes blockchain capabilities and enables information from IoT devices to be used in transactions. This allows IoT devices to be used in building blockchain-based solutions to help organizations improve operational efficiency, transform customer experience, and adopt new business models in a secure, private, and decentralized manner, so all participating organizations gain value.

IV. Iot In Future

Consumers can get more personal product or service offers, based on what they actually do or where they are. They can travel more efficiently by avoiding traffic jams based on traffic reported by other vehicles. They can save money by reducing energy usage or by paying lower car .

Businesses can provide better products and services by studying how customers behave; they can also discover needs for new products or services. They can protect buildings via remote security; secure assets like cars and machinery with location trackers and remote locking devices; and ensure that sensitive products (e.g. pharmaceuticals) are consistently stored in correct Conditions. They can become more efficient, as in the case of utilities using smart meters to eliminate waste or loss, or in the case of equipment sellers providing just-in-time preventive maintenance. Farmers can be more productive with smart irrigation that provides water just where and when needed. New business models based on selling final outcomes rather than just equipment may boost business revenues.

Governments and public authorities can also benefit from the IoT. For example, health and long-term care costs can be reduced with better remote support for the elderly in their own homes. Road safety can be improved based on data from thousands of drivers. The efficiency of street lighting can be improved by dimming lights on empty roads[2]. As governments work to deliver quality services in increasingly complex environments, devices that have already begun to make life easier and more efficient for companies and consumers can also help create greater public value.

V. Conclusion

The potential of the IoT appears to be great, despite the range of issues that need to be Addressed. Based on above topics It can be considered that new research problems arise due to the large scale of devices, the connection of the physical and internet worlds , the openness of the systems of systems, and continuing problems of privacy and security.

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