Internet of Things(IoT): Security Challenges, Business Opportunities & Reference Architecture for E-commerce

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Abstract— The Internet of Things (IoT) represents a diverse technology and usage with unprecedented business opportunities and risks. The Internet of Things is changing the dynamics of security industry & reshaping it. It allows data to be transferred seamlessly among physical devices to the Internet.

The growth of number of intelligent devices will create a network rich with information that allows supply chains to assemble and communicate in new ways. The technology research firm Gartner predicts that there will be 26 billion installed units on the Internet of Things (IoT) by 2020[1].

This paper explains the concept of Internet of Things (IoT), its characteristics, explain security challenges, technology adoption trends & suggests a reference architecture for E-commerce enterprise.

Keywords—Internet of Things(IoT), Sensors, Bluetooth, Security, WiFi, E-commerce, RFID, Connected Devices & Wearables

I. INTRODUCTION

The Internet helped people to connect with static information available but now it's helping to build connection from people to people, people to physical objects and physical objects to other physical objects.

IBM estimates that 90 percent of all data generated by devices like tablets & Smartphone etc are never analyzed. And as much as 60 percent of this data starts loosing value within milliseconds of being generated [2].

As per estimates from IDC report there will be 30 billion Internet connected and sensor enabled devices by 2020[3]. However more than 99 percent of objects in the physical world still remain unconnected[4]. The rapid growth and convergence of Internet data and processes is making networked connections more relevant & valuable. Also it creates exciting business opportunities for industries.

The Internet of Things (IoT) product and services will generate revenue beyond $300 billion Internet of Things (IoT) & add $1.9 trillion in the global economy by 2020 [5].

II. WHAT IS INTERNET OF THINGS(IoT)

The Internet of Things (IoT) is a computing concept that describes a future where everyday physical objects will be connected to the Internet and be able to identify themselves to other devices.

IoT is a network of devices which communicates among itself using IP connectivity without human interference. The Internet of Things (IoT) ecosystem consists of smart objects, intelligent devices, Smartphone & tablets etc. It will use Radio-frequency identification (RFID), Quick Response(QR) codes, sensor or wireless technology to enable inter-communication between devices.
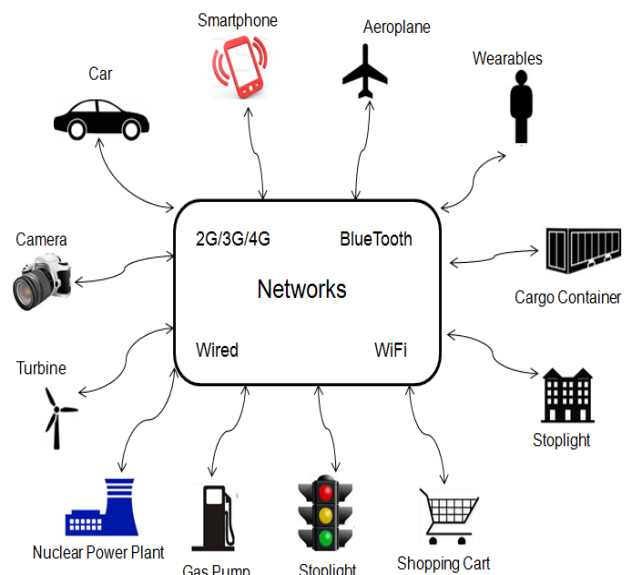

Fig 1: Internet of Things (IoT)

There is a lot of discussion happening around Internet of Things (IoT) these days. Typical examples can be Smartwatch talking to your car or fridge talking to grocery store etc.

Internet of Things(IoT) includes everything from an embedded sensor in a petrol pump, sensors in office building

which can trace your location to display your files on the nearest screen.

III. CHARACTERISTICS OF INTERNET OF THINGS(IOT)

The distributed teams can work across their domains to make tradeoffs in design architectures & business models using Internet of Things(IoT). Some characteristics of Internet of Things(IoT) as listed below [6].

A. Interconnected

It facilitates people to device and device to device interconnection.

B. Smart Sensing

The devices connected with IoT will have smart sensing capabilities. For example use of motion sensors to turn lights on or off. The sensing technology helps to create experiences that reflect a true awareness of the physical world, people & objects.

C. Intelligence

The IoT connected devices can have intelligence attached with them. For example Nest Learning Thermostats are Wi-Fi-enabled, sensor-driven equipped with self-learning capabilities. The Misfit Shine is a fitness tracker with sleep monitoring capabilities. The Misfit Shine can distributes compute tasks between a Smartphone and the cloud.

D. Save Energy

IoT devices like Motion Sensor Light have in-built motion detector which can turn the light on when it senses movement. It can save lot of power energy from wastage and boost energy harvesting & efficient utilization of power.

E. Expressing

IoT connected devices have unique capability to tell the current state to other connected devices in the surrounding. It facilitates better communication flow between human and machines.

F. Safety

IoT connected devices can help ensure safety of individual life. For example a moving car tyres can tell their current sate to car owner having smart car dashboards, it will help prevent accidents due bursting of car tyres due to overheating etc.

IV. WHY INTERNET OF THINGS(IOT)

The aim of IoT is to make our day to day life safer & more efficient. According to research from Business Insider, smart homes will become a $490 billion business by 2019 [7].

More IoT devices means increased efficiency & more interconnected world. Some of the benefits of IoT as discussed below [8].

A. Smarter Analytics

More number of inter-connected devices means more data and applying analytics on all aspects of the business will provide an opportunity to improve strategy and the customer experience. For example Intel IoT Platforms solutions

generate actionable information by running analytics software on data for industrial, retail, automotive industries etc.
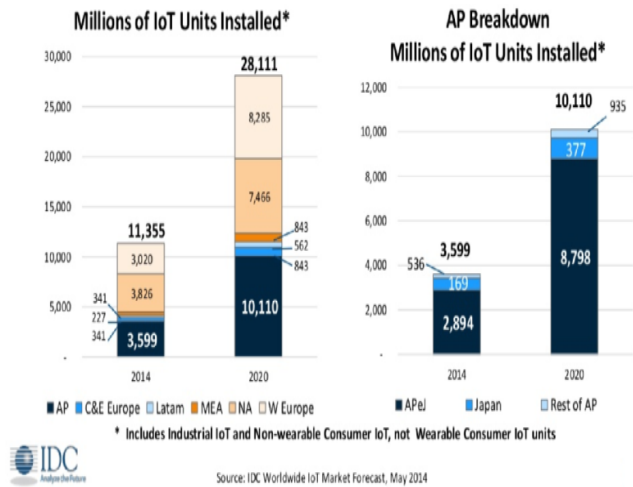

Fig 2: The Internet of Things Market Size (Source- IDC)

B. Enhanced Security

The smart doorbells and surveillance systems will help identify & recognize the person which will boost security.

C. Increased Productivity

IoT will facilitate optimal utilization of resource and time. For example if a printer is running low on ink, it will order more on its own & save precious time. And it will send notification if printer machine is not working properly.

D. Smart Inventory

Businesses will be able to trace goods in the supply chain with Internet-connected inventory. It will provide enhanced in-transit visibility.

E. Safer Travel

The Internet-connected cars can a better sense of real time traffic conditions and vehicle diagnostics which will make travel safer.

F. Real time demand visibility

The tightly coupled warehouse & order system provides better real time demand visibility.

V. INTERNET OF THINGS(IOT) CHALLENGES

The security aspect is the biggest concern of Internet of Things(IoT) connected devices. The IoT application data can be personal, enterprise, industrial or consumer but stored data should be secured against theft, tampering & protected in the transit and at rest. For example an IoT application may stores currents and historical data of individual's health, shopping behavior, location, finances and quantity of inventory, business orders etc.

The IoT encourages a new level of outsourcing but there are concerns around service availability, scalability, response time, price structure & intellectual property ownership etc.

Security is a concern when data is transmitted across the Internet or even secured private networks and VPN tunnels. The Government regulations such as Health Insurance Portability and Accountability(HIPA) Act or restrictions on transporting data across international borders can be applied as safety measures.

The Federal Trade Commission (FTC) report on the IoT highlights some of the risks & suggest some ways to mitigate them.

For example MyQ Garage system device from Chamberlain allows a user to open and close garage door from a Smartphone. But Veracode found that a potential burglar could gain access to the device and use it to find open or closed state of garage door and find opportunity to rob the house [9].

Similarly Wink Relay is a touch enabled controller which can fit into the space of a light switch and allows control of other smart devices in the house. It runs a variant of Google's Android mobile operating system. But Veracode found it was able to take advantage of Android Debug Bridge (ADB) tool to turn on the unit's microphone and record nearby conversations and then download those recordings to a computer. Later Wink disabled the ADB in a subsequent software update [9].

The key IoT security tasks should ensure that proper application level protections like Distributed Denial of Service (DDoS) attack mitigation are in place. It should also incorporate measures to confirm the identity of entities requesting access to any data including multi-factor authentication.

A. Data Privacy

Smart TVs are collecting data about viewing habits and sometimes they beam eavesdropped conversations back to a manufacturer.

B. Data Security

The Internet of Things(IoT) is allowing data to be transferred seamlessly from surveillance devices to the Internet to enable live analytics. But data security still remains a challenge here.

C. Insurance concerns

The autonomous cars are adding insurance industry concerns. But data will make it easier to assess risks & it provides an opportunity for new pricing models. For example insurance premium tuning based on health and driving data.

D. Lack of Common Standards

There is serious lack of unified standard for IoT & achieving an industry wide acceptance of one unified standard is a huge challenge.

E. Technical Concerns

Each IoT device can generate huge amount of data. It is a challenge to store, protect and analyze. The network should be able to handle high volume & density of the devices. Also it should be capable to identify & discriminate between permitted and rogue devices.

F. Social and Legal Concerns

There are no mechanism to address these social and legal concerns. For example who owns the video streaming in from Google Glass and the healthcare-related date streaming from other wearable devices? What will happen when autonomous devices run out of control?

VI.   REFERENCE IoT ARCHITECTURES FOR E-COMMERCE

The proposed Internet of Things(IoT) architecture for E-commerce enterprise is shown below:
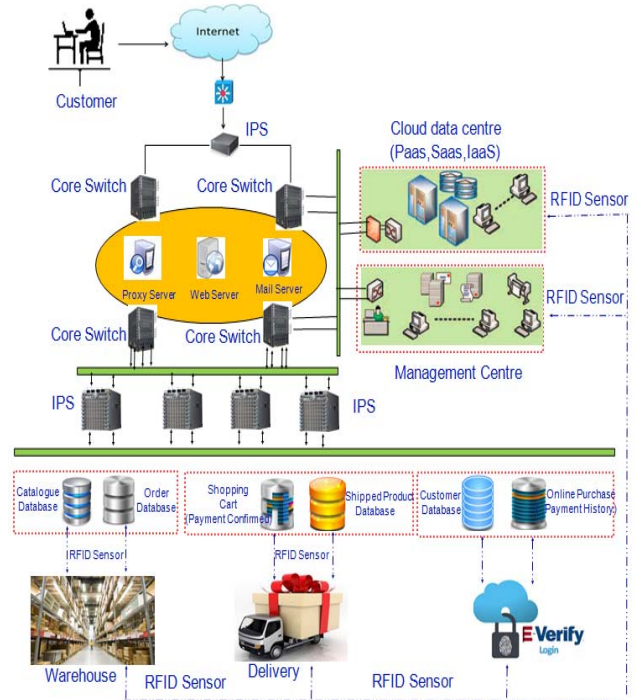

Fig 3: Reference IoT Architecture for E-commerce

The above IoT architecture consists of Warehouse, Management Centre, Cloud data centre (PaaS, SaaS and IaaS), Catalogue database, Order database, Shopping Cart(payment confirmation) database, Shipped Product database, Customer database, Online Purchase(payment history) database.

The request of E-commerce customers passes through Proxy server, Web server or Mail server. And then it go through Management Centre, Cloud data centre (Paas, SaaS and IaaS).

The warehouse is connected through RFID sensors with Catalogue database, Order database, Management Centre, Cloud data centre(PaaS, SaaS and IaaS).

Similarly Delivery is connected through RFID sensors with Shopping Cart(payment confirmation) database, Shipped Product database, Management Centre, Cloud data centre (PaaS, SaaS and IaaS).

And customer logins are E-Verified using Customer database, Online Purchase(Payment History) database which are connected through RFID sensors with Management Centre, Cloud data centre(PaaS, SaaS and IaaS).

VII. BUSINESS OPPORTUNITIES

As per Forbes report Internet of Things(IoT) in healthcare will be $117 billion Market By 2020[10]. The growth of Internet of Things(IoT) creates opportunities for businesses and people with data security, network design & data analysis skills.

The major network providers like IBM, CISCO, GE & Amazon have decided to support IoT with addition of Fog layer and plans to add Swarm layer which will simplify & reduce cost for network connectivity.

GE estimates that Industrial Internet has potential to add $10 to $15 trillion to global Gross Domestic Product (GDP) over the next 20 years[11]. While Cisco Systems report 99 percent of physical objects will eventually become part of a connected network [12].

The retail & logistics sector is a key area where Internet of Things (IoT) will have big impact. The SAP HANA Cloud Platform for the IoT provides the infrastructure to enable businesses to tap into a network of millions of connected devices.

The Internet of Things(IoT) in healthcare domain is redefining patient care, hospital operations, prescription delivery, secure record access etc.

The airlines are investing in the Internet of Things (IoT) which can create a new revolution in the passenger experience. The IoT investments by airlines will be in the areas of check-in, baggage drop & claim. And airport buildings, equipments, bags & trolleys will be connected & communicating to each other. Airlines are using Apple's iBeacons to enhance customer travel experience.

For example- Virgin Atlantic is using iBeacon technology at Heathrow airport and American Airlines is deploying iBeacons at Dallas/Fort Worth (DFW) International Airport [13][14].

The networking giant Cisco is expanding IoT portfolio with 15 new products for network connectivity & security. It's pushing for concept of Internet of Everything since long time & its expanded IoT strategy with the launch of the Cisco IoT system which is a framework to streamline Internet of Things (IoT) deployments [15].

The Internet of Things(IoT) market is projected >$1 trillion for 2020. The managed services will contribute 58%, network services 39% and hardware enablement 4% to overall Internet of Things (IoT) market [16].

VIII. INTERNET OF THINGS(IOT) ADOPTION TRENDS

The Internet of Things (IoT) is at adoption stage quite similar to cloud computing during 2008-10 and big data analytics around 2011-2013.

According to Gartner report there will be a quarter billion connected vehicles on the road by 2020 with in-vehicle services and automated driving capabilities [17]. The Internet of Things(IoT) is taking over Big Data as the most hyped technology as per Gartner Hype Cycle for emerging technologies 2014 [18][19].
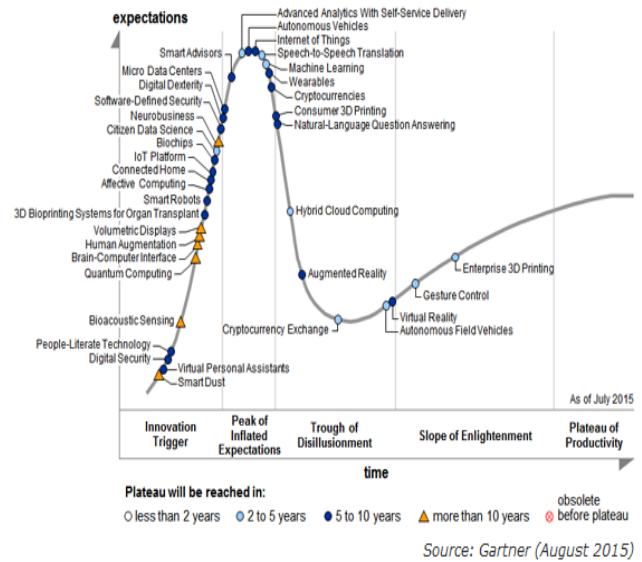

Fig 4: Hype Cycle for Emerging Technologies 2015 [20]

Gartner's 2015 Hype Cycle for Emerging Technologies includes five technologies at the top of the peak of inflated expectations- Autonomous vehicles, Advanced analytics with self-service delivery, Internet of Things(IoT), Speech-to-speech translation & Machine learning[20].

IX. SUMMARY AND CONCLUSION

According to research firm International Data Corporation (IDC) the fast growth of cloud and Internet connected devices is expected to boost IoT market. The Internet of Things(IoT) market is expected to hit $7.1 trillion by 2020 [21].

The VisionMobile Q1 2015 Developer Economics survey data reveals that 53% of mobile developers are working on Internet of Things(IoT) projects. And global population for Internet of Things(IoT) developer's is set to top 4.5 million by 2020 [22].

The only way to make profit in the Internet of Things(IoT) market is to create unique value on top of commodity hardware, connectivity and cloud services. The major markets within the Internet of Things(IoT) field are smart homes and wearable devices.

The analysis suggests that the Internet of Things(IoT) is having vast growth potential & it will be a key revenue driven market.

Acknowledgment

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