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Internet of Things for Industries and Enterprises

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Abstract - *The Internet of Things which is called as Internet of Everything is a new technology paradigm enriched as global and local network of devices. The Internet of Things is recognized as one of the most important areas of future technology and gaining vast attendance from a wide range of industries. Today, in the age of technology and high-end machines, the internet of things (IoT) has bring a revolution by which a global network of high-tech machines and large devices are capable of interacting with each other bringing digital innovation in industries and enterprises. In the light of growing enterprises IoT and broad research scope, this paper presents an IoT evolution, ecosystem, architecture, applications and challenges model for selection and installation of IoT services in enterprises and industries. Also, this paper illustrates about how the IoT services can be developed to innovate organization, industries and enterprises.*

***Key Words*: Internet of Things, IoT Ecosystem, IoT Architecture, IoT Applications, Enterprise, Platform, Business Model, Value Proposition**

1. INTRODUCTION

The Internet of things brought a paradigm shift that is radically changing ways of doing of business by enabling enterprise to develop value added efficient services with their network of machines and devices, improve their service business models, and enhance their sustainability and optimization. By analyzing the data generated by the devices, enterprises can create a favorable brand image and engage in effective communication.

The growth of the Internet of Things technology has been phenomenal in terms of sales volume and the number of enterprise and individual adopters and subscribers. The combined markets of the IoT will reach about $520 billion in 2021, more than double the spending in 2017. Enterprise IoT, also called corporate IoT, refers to all connected devices used for various business purposes in the enterprise setting. Enterprise IoT is the largest of the three main IoT sectors - enterprise, home, and government. According to research most companies include enterprise IoT initiatives such as improving service operations, increasing visibility into operations, enabling new business models, and creating new product and service offerings, getting feedbacks and implementing them. While large enterprises and industries have been the early explorer, researcher, adopters and beneficiaries of the IoT innovations and technology systems, an increasing number of small and medium-sized enterprises and industries (SMEs) are also leveraging the IoT services to better serve customers, improve productivity, extend a market base, and stay competitive.

The need for effective development of IoT applications under realistic conditions has generated various ecosystems of methodologies and integrated IoT platforms. Many technology and for-business companies are developing various IoT platforms to help enterprises rapidly develop and deploy IoT services for their business operations, improvement and revenue increase purpose. These developed platforms have become a key source for enterprises which have not employed technically capable engineers of the various fields of the IoT. IoT platforms provide basic functionalities and development tools for a variety of enterprise applications to be developed without expensive and time-consuming designing, developing and the programming efforts. A compound annual growth rate for IoT platforms is expected to be 39% between 2018 and 2023, with annual spending surpassing US$22 billion by 2023. Enterprise software and service companies and IoT start-ups account for the largest portion of IoT platform companies (22% and 32%, resp), followed by industrial technology providers (18%), Internet companies, and telecommunication firms.

The main aim of enterprise and industrial IoT is to create value for business firms and customers through IoT services. New IoT platforms are constantly emerging day by day and provide potential opportunities and challenges for enterprise and industrial IoT. For enterprises and organization, developing enterprise IoT services with various platforms provided by vendors are often preferred to in-house development. However, there is a lack of studies on the IoT ecosystem and IoT architecture pertaining to the development of enterprise IoT. For example, we still do not fully understand what the elements of the enterprise IoT ecosystem and architecture are and how they facilitate the development of specific enterprise IoT services. In light of the gap in research in the enterprise IoT sector, this paper presents an enterprise IoT ecosystem and architecture essential for deployment of successful IoT-enabled services. Then, this paper discusses how enterprises can plan IoT services with the use of the IoT service business model.

1.1 Objectives

- To study predefined IoT evolution and ecosystem.
- To learn about IoT architecture and various layers.

- To research about the IoT business model and revenue generation activities.
- To present a holistic approach that will give brief idea about use of IoT applications to enhance value.
- To describe challenges in current system of IoT development and present necessary remedies on it.

1.2 Problem Statement

This Internet of Things for enterprises and industries should provide a solution which will increase, enhance and give boost to IoT business service model increasing efficiency and reliability of system.

2. METHODOLOGY

2.1 Evolution

	2010-15	2015-20	Future and around 2020-25
Network System	Sensor network location transparency	Network Context Awareness	Network cognition and Self learning, self-repairing networks
Software and Algorithms system	Large scale-open semantic software, Next Gen IoT based on social software	Goal oriented software and distributed intelligence problem solving	User Oriented software, Invisible IoT and Easy to deploy IoT
Hardware	Multiprotocol and more sensors	Smart Sensors	Nano-tech
Data processing	Energy, frequency spectrum aware data processing and generation	Context aware data processing and response	Cognitive processing and optimization

Fig-1: Evolution over the years

Figure 1 shows projected evolution in the area of foundational IoT technologies which are Network systems, software and algorithms systems, hardware, and data processing. The network is the backbone of the IoT. It refers to uniquely identifiable things and their virtual representations in an Internet-like structure. Network technology is moving to unobtrusive wire free communication technology that allows device to-device applications to be deployed more flexibly. Network technology is evolving towards autonomous and machine learning approach.

2.2 Ecosystem

The Ecosystem for IoT industries and enterprises can be given as follows:

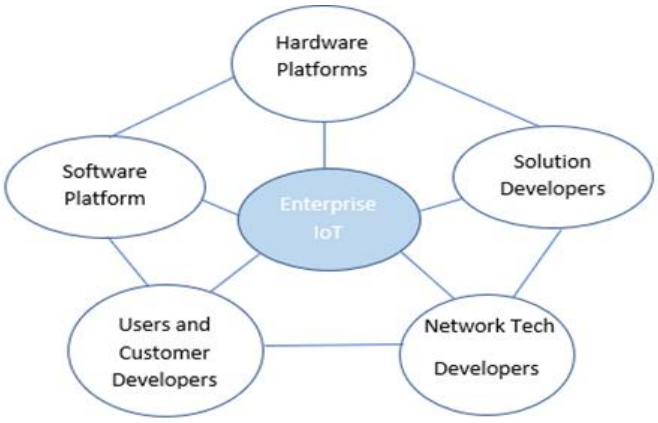

Fig-2: Ecosystem of IoT for Enterprises

Hardware Platform Developers- Board manufacturers, Controller developers, Gateway device manufacturers, Sensor and device manufacturers

Software Platform Developers- Data platform developers, Security developers, Cloud Service providers, OS Platform developers

User and Customer Developers- Corporate customers, Individual customers, Corporate users

Network Technology Developers- Telecommunication Companies, Connectivity data developers, Network equipment manufacturers

Solution and Application Developers- Data Analytics developers, Business Intelligence Analyst, Application developers, Software Analysers and System Integrators.

2.3 Architecture

Service Management Layer/ Business Layer
Application/ Solutions Layer
Network Layer
Processing Layer
Perception Layer

Fig-3: Layered Architecture

Architectural aspects of the IoT is an actively studied and researched area. A well-structured architecture of the IoT will help enterprises and industries create innovative and state of the art services. The enterprise IoT ecosystem discussed in the previous section provides the technology platforms needed for the implementation of the architecture of the IoT. While there is no agreed architecture of the IoT among researchers, they typically employ a multi-layered approach, with each layer dedicated to certain functions such as acquiring, communication/sensing, data processing, and knowledge processing/reasoning and output generation. For successful IoT service development, IoT architecture needs to be established and updated continuously to commission and decommission various IoT assets and services. With the advances in the IoT, researchers proposed five-layer architectures. The five-layer architecture adds a processing layer and a business layer or service management layer on top of the three-layer architecture.

The above mentioned five-layer architecture presents common layers for many domain areas. However, the five-layer architecture does not reflect the nature of the enterprise or industrial IoT environment. The five-layer architecture of the enterprise IoT represents an abstract architectural view for a myriad of the enterprise IoT systems.

The architecture of the enterprise IoT consists of a perception layer, a network layer, a processing layer, an application layer, and a service management layer or business layer. The architecture of enterprise IoT enhances the usability of the architecture for enterprises and industries and ensures that a variety of enterprise applications seamlessly connect a myriad of enterprise IoT devices and can be accessible to users, customers, consumers and subscribers.

2.4 IoT Business Service Model

1) Value Proposition

Value proposition refers to a substantial value of a products or services to a target customer for which the customers and consumers are willing to pay. The value proposition of the IoT services needs to be compelling to users and customers, achieve cost savings, and contribute to revenue generation. To find the value proposition is the most important component of the IoT business model and identify the following as important types of value proposition such as convenience or usability, getting the job done, performance, possibility for updates, and comfort.

2) Networked Activities

A network refers to a network of platform developers, partners, device suppliers, and other enterprises that adds value to the holistic development of the IoT services. To identify software developers, launching customers, data scientists, machine learning engineers, and hardware producers as important participants in the network. Value is co-created by the activities of the participants in the network. Therefore, participants in the value network should be concerned about improvement of any networked activities. The significance and weight of network participants are measured based on the magnitude of their value addition to the IoT service development.

3) Resources

This component allows enterprises and industries to assess sustainable and developmental resources and to examine these resources in terms of the opportunities and threats for establishing a competitive advantage from the IoT service development. From a resource-based view, every enterprise or industries has a unique set of resources that the firm can leverage to exploit opportunities and counter threats. Two important questions for enterprise or industry to develop the IoT service are:

(A) Kinds of existing resources the enterprise can leverage to deliver the IoT services

(B) Resources it needs to differentiate itself from the competitors.

The key resources of enterprises and industries include the employees, technologies, products, services, facilities, equipment, marketing channels, and brand.

4) Sustainability

To meet the stakeholders and investors needs in the future, sustainability is concerned with managing triple bottom lines, frequently referred to as profit, people, and planet. Sustainability is becoming an integral part of business models in a drive to achieve long-term corporate growth and profitability and to fulfil environmental and social responsibilities at the same time. Therefore, the development of IoT services should take into consideration the impacts on people, planet, and profit. For example, to balance people, planet, and profit, sustainable enterprises need to consider the impact of manufacturing IoT services on environments to achieve less waste production, a less polluted environment, and socially responsible business practices.

2.5 IoT Applications to Enhance Value

1) Monitoring and Control

Monitoring and control systems collects data on equipment performance, energy usage, and environmental conditions, and allows managers and automated controllers to constantly track performance in real time anywhere, anytime. Next level of monitoring and control technologies gives idea of potential improvement, or predict future outcomes and optimize operations, leading to lower costs and higher productivity and efficiency.

2) Business Analytics

IoT devices and machines with embedded sensors and actuatorsgenerateenormousamountsofdata andtransmit it to business intelligence analytics tools for humans to make the decisions. These data are used to discover and resolve business issues such as changes in customer behavior and market analysis to increase customer satisfaction and to provide value added services to customers. Business analytics tools may be added into IoT devices such as wearable health monitoring sensors so that real-time decision-making take place at source of data.

3) Information Analysis, Sharing and Collaborations

Information sharing and collaboration in the IoT can occur between people and things, and between things. Sensing is a predefined event which is usually first step for information sharing and collaborations. In domain of supply chain area, information sharing and collaboration enhance situational awareness and avoid information delay and distortion. For example, if sensors are placed throughout a retail store where refrigeration is necessary, alerts can be sent to the store manager's mobile device whenever the refrigerator malfunctions. The manager can then check the employee status report to see who is available and send task assignment to that employee via his IoT enabled mobile device.

2.6 Challenges in IoT Development for Enterprises

1) Data Management Challenge

IoT sensors and devices are generating massive amounts of data that need to be processed and stored. The current architecture of the data center is not prepared to deal with the heterogenous nature and extreme sheer value of personal and enterprise and industrial data. Few enterprises and industries would be able to invest in data storage sufficient to house all the IoT data collected from their networks. Hence, data centers will become more distributed to improve processing efficiency and response time as IoT devices become more widely used.

2) Data Mining Challenge

As more data are available for processing and analyzing, the use of data mining tools becomes a necessity. Data consists not only discrete data but also streaming data generated from digital sensors in industrial equipment, automobiles, electrical meters. These streaming data are about the location, movement, vibration, temperature, humidity and chemical changes in the air. These data mining tools can invoke the corrective processes to address immediate operational issues or inform managers of discoveries regarding competitors' strategic moves and customers' preference change that will impact business activities.

3) Privacy Challenge

Smart health equipment and smart care emergency services, IoT devices can provide a vast amount of data on IoT users' location and movements, health conditions and purchasing preferences all of which can spark significant privacy concerns. Protecting privacy is often counter productive to service providers in this scenario as data generated by IoT is key to improving the quality of people's lives.

4) Security Challenge

As a growing number and variety of connected devices are introduced into IoT networks, the potential security threat escalates. Although the IoT improves the productivity of enterprises and industries the quality of people's lives, the IoT will increase the potential attack surfaces for cyber criminals. Security challenges may be resolved by training developers to incorporate security solutions into products to utilize IoT features that are built into devices.

5) Chaos Challenge

The evolution of IoT technologies is in hyper accelerated innovation cycle that is much faster than the typical consumer product innovation cycle. If not designed carefully, multi-purpose devices and collaborating applications can turn our lives into the chaos. To prevent chaos in the hyper connected IoT world businesses make every effect to reduce the complexity in connected systems, enhance security and the standardization of applications and guarantee the safety and privacy of users anytime and anywhere.

CONCLUSIONS

The internet of things IoT is such a recent development, there is still a paucity of studies on the social, behavioral, economic, and managerial aspects of the IoT. This makes it very challenging for companies to make informed decisions as regards to IoT adaption or implementation. This research paper discusses IoT evolution, IoT ecosystem and IoT architecture.

This research article is one of the first studies on a conceptual model of IoT applications for enterprises or industries. In this article, I presented IoT business service model and also classified various IoT applications to enhance

value such as monitoring and control, business analytics and information analysis, sharing and collaborations. Finally, I discussed five challenges in the implementing in IoT applications for enterprises and industries.

FUTURE SCOPE

The future scope includes research on IoT system for enterprises and industries for better efficiency and stable IoT system and also this will give boost to next generation high technology enabled production, designing and the modelling of IoT systems will take the IoT systems for enterprises and industries to a next level making the life of mankind very advanced and smart.

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