IoT Market Size and Demand

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1. Introduction

Internet of Things (IoT) envisages that everything in the physical world is seamlessly connected and securely integrated via the Internet infrastructure. Data can be collected and converted into useful information as things respond to the environment or stimuli, which can be used in different application domains such as automated home appliances, smart grids, smart manufacturing, etc.

IoT is a combination of wireless sensor network (WSN) technology, communication technology, sensor technology, and the Internet. The ability to connect, communicate with, and remotely manage a limitless number of networked, automated devices via the Internet is becoming pervasive, from the commercial kitchen to the residential basement room to the arm of the fitness buff. The background of the Internet of Things (IoT), which covers numerous fields such as ubiquitous positioning, biometrics, energy harvesting technologies, and machine vision, allows researchers perform in-depth studies in these individual technologies.

Besides devices and connectivity, IoT is a complex solution encompassing all aspects of the Internet; including data analytics, cloud computing, applications, security and much more. Technologically, connecting things to the Internet can be achieved by the presence of three critical components of technology which are; connected things with embedded sensors, connectivity and infrastructure, and analytics and applications.

According to Chaudhary et al. [1], there were four significant layers in the architecture of IoT; application layer, management service layer, gateway and network layer, and sensor connectivity and network layer. All of these layers are shown in Figure 1. Table 1 shows the examples of these layers in IoT applications and Table 2 shows the domain services of IoT and its services. In this application layer, various applications from industry sectors can use IoT in multiple areas such as environmental, transportation, healthcare, and military. As stated by Kamalinejad et al. [2], IoT aims to make the Internet ubiquitous and pervasive.

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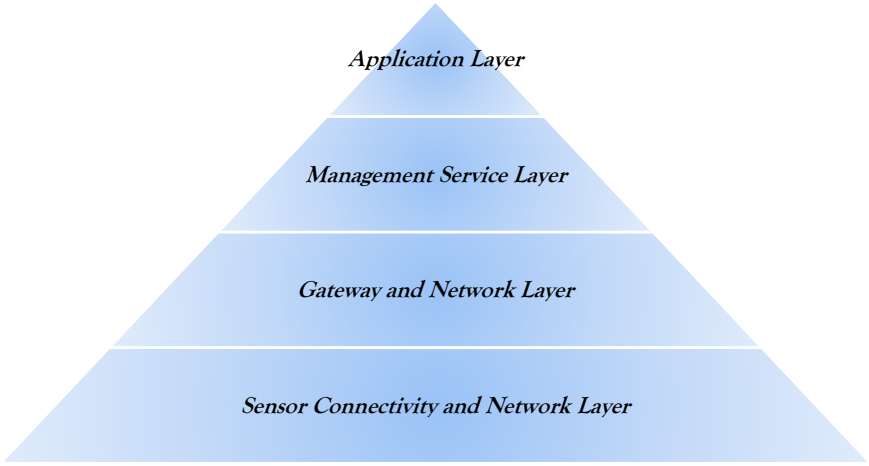

Figure 1: IoT architecture [1]

Table 1: IoT application [1]

	Smart home	Smart office	Smart city	Smart agriculture	Smart transportation	Smart military
Network size	Small	Small	Medium	Medium/large	Large	Large
Network connectivity	WPAN, WLAN, 3G, 4G, Internet	WPAN, WLAN, 3G, 4G, Internet	RFID, NFC, WLAN, 3G, 4G, Internet	WLAN, satellite communication, Internet	WLAN,3G, 4G, satellite communication	RFID, NFC, WPAN, WLAN, 3G, 4G,
Bandwidth requirement	Small	Small	Large	Medium	Medium-large	Medium-large

Table 2: IoT smart applications and its services

Service domain	Services
Smart home	Entertainment, Internet access
Smart office	Secure file exchange, Internet access, VPN, 2B2
Smart city	City management, resource management, police network
Smart agriculture	Area monitoring, condition sensing, fire alarm, trespassing
Smart transportation	Read condition monitoring, traffic status, monitoring, navigation support
Smart military	Command and control, communication, sensor network, military networking

2. Technology Trends

The Internet has had a massive influence on almost every aspect of our lives. It is the gateway to new ideas, innovation, communication and knowledge. It has evolved to influence how we communicate, run a business, conduct teaching and learning, and operate day to day life. The Internet grows. It is an ever more omnipresent and vital infrastructure underpinning global society and commerce. Since the launch of Tim Berners-Lee's World Wide Web (a method of publishing information on the Internet) in 1990, the Internet became the largest source of information. Since then, the number of websites and webpages has exploded.

As a consequence, the Internet graduated from a mere point of access to information. Online and offline once created two very distinct worlds. Yet with the increase of e-commerce and mobile e-commerce of particular, the distinction between online and offline is increasingly blurring. Through digitizing the business cycle, the Internet has moved economic operations from the real world into the virtual world. In the mid-1990s, e-commerce exploded upon the scene. The Internet has subsequently become increasingly mobile, and a socializing platform for businesses and individuals seeking connectivity and convenience.

The next phase of the Internet is on its way. In essence, a world of networked smart devices equipped with sensors, connected to the Internet, all exchanging information with each other without human interference, known as the Internet of Things (IoT).

Key markets signal the increase of connected devices or things globally attributed to signify the presence of IoT. It is estimated that there are about 1 billion mobile phones and 1.5 billion PCs that are Internet-enabled [3]. By 2020, it is estimated that 50 to 100 billion devices connected to the Internet, including smartphones, PCs, and ATMs to manufacturing equipment in factories and products in shipping containers [4]. This indicated that the number of Internet-connected devices surpassing the global population, as shown in Figure 2.

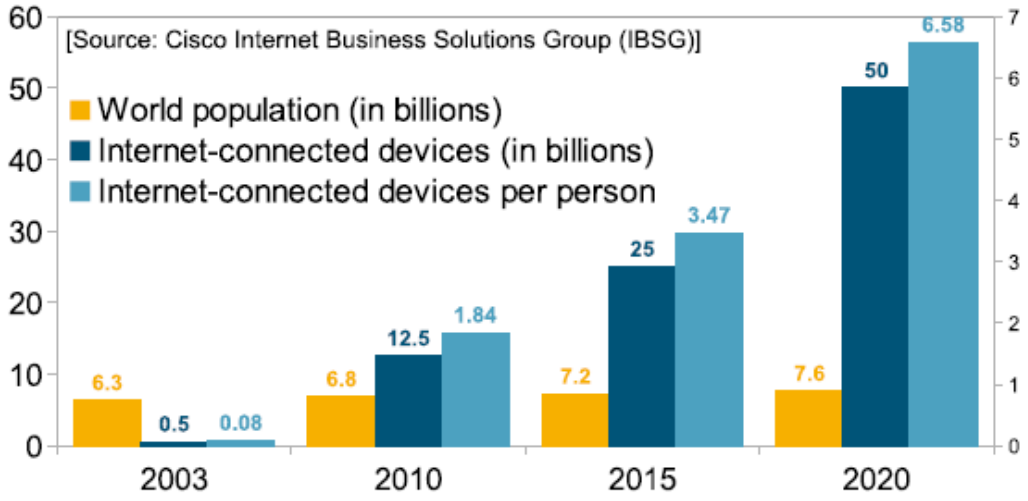

Figure 2: Growth in Internet-Connected Devices [5]

With the rise in the number of connected devices and connected people or individuals, market experts forecast that four interconnected technology pillars would drive and shape IoT. The four components are big data technology, cloud computing, social media, and mobile devices and things [6].

2.1 Big Data Technology

Big data technology is the cornerstone in extracting meanings and perspectives from the vast, immense and continually growing data and information gathered by things and sensors, enriching user experiences and creating new business processes and models. The detailed and useful data-derived knowledge would open up possibilities for new methods and functions previously considered unfeasible. Big Data intelligence can perform complex tasks, including remote control, tracking, monitoring sensing, decision-making, and responding to different situations.

2.2 Cloud Computing

Cloud computing is to act as a medium for providing users with information and functionality. The technology will allow access to and distribution of information and knowledge to everyone, at anytime and anywhere.

2.3 Social Media

The social media changes people's interaction and communication in new and unexpected ways. The information sourced from physical activities and online interactions can promote interconnected societal engagements, information exchange, collaboration and innovation.

2.4 Mobile Devices and Things

Mobile devices and things, i.e. physical objects, are platforms in both living and working environments for social contact and networking. IPv6's readiness will be crucial to driving the proliferation of IoT-enabled things across industry-specific activities. With the rising cost of devices driving the sensors and connected things revolution, data collection can no longer be restricted by location or confined to a single dimension. The process of data collection can be scaled and multidimensional variables can be collected simultaneously within a given environment.

3. IoT Markets in Malaysia

In general, due to the high number of Malaysians being Internet users, Malaysia has a good starting point for fostering and spurring IoT within the domestic market. Domestic ICT consumption was estimated at RM 118.6 billion in 2015 and is expected to hit 176.9 billion by 2020, with an annual compound growth rate (CAGR) of 8.32 per cent between 2105 and 2020 [6] as shown in Figure 3.

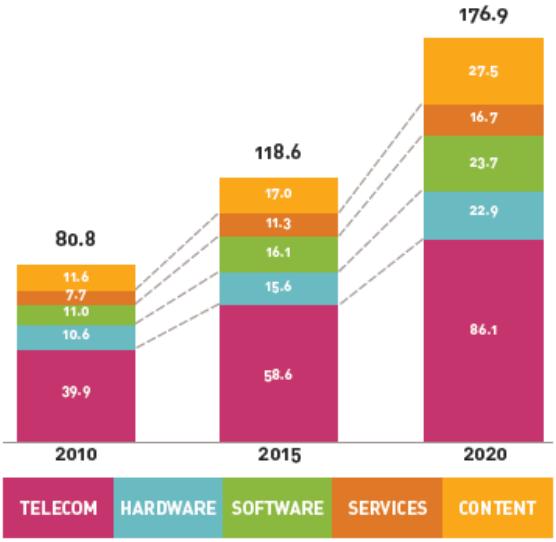

Figure 3: Malaysia ICT spending [7]

The number of Internet-connected devices is growing worldwide and is estimated to range between 26 billion and 50 billion in 2020. In the case of IoT, people will not only be interacting with other people and things, but things will also interact with each other themselves. With growing usage of mobile devices and more extensive penetration of the Internet, Malaysia will become fertile ground for implementing IoT. Following this, the Malaysian digital landscape expands exponentially, as depicted in Figure 4.

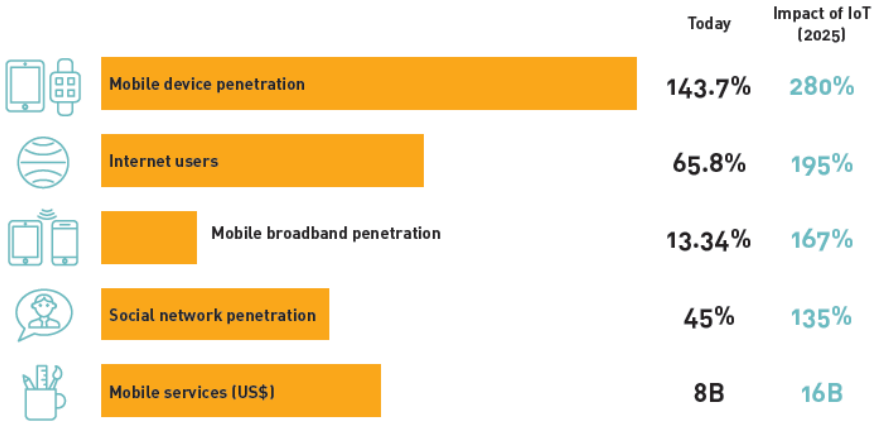

Figure 4: IoT-accelerated Internet usage [7], [8]

Malaysia's initial IoT potential is projected at around RM 9.8 billion in 2020, complementing conventional ICT business values and leveraging existing economic initiatives such as the Economic Transformation Program (ETP), Government Transformation Program (GTP), Digital Malaysia (DM), and Digital Lifestyle Malaysia (DLM) [6]. Supported by ongoing advertising campaigns and strengthened by market value appreciation, IoT is expected to rise rapidly in Malaysia beyond 2020 and hit RM32.7 billion by 2025, as shown in Figure 5.

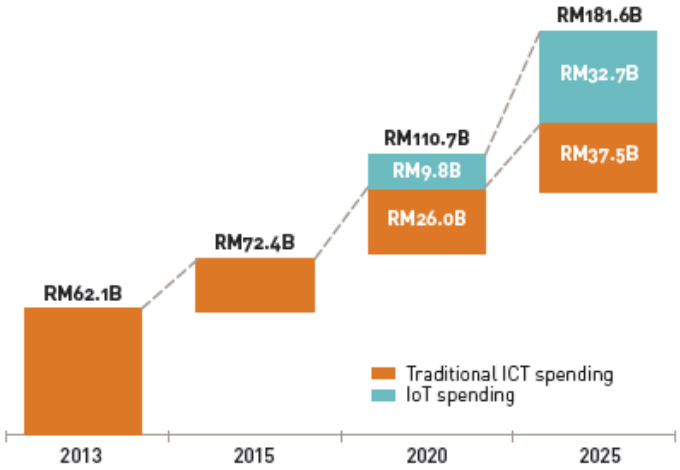

Figure 5: Malaysia IoT opportunities [7], [8]

Technology opportunities that IoT can generate in Malaysia are focused on application and services, and analytical-related technologies, with forecast technology opportunities as high as RM 34 billion by 2025, compared to RM7.5 billion in 2020. Second to the application and services, and analytics technologies are the revenue generated by device producers which are projected at RM4.3 billion as depicted in Figure 6.

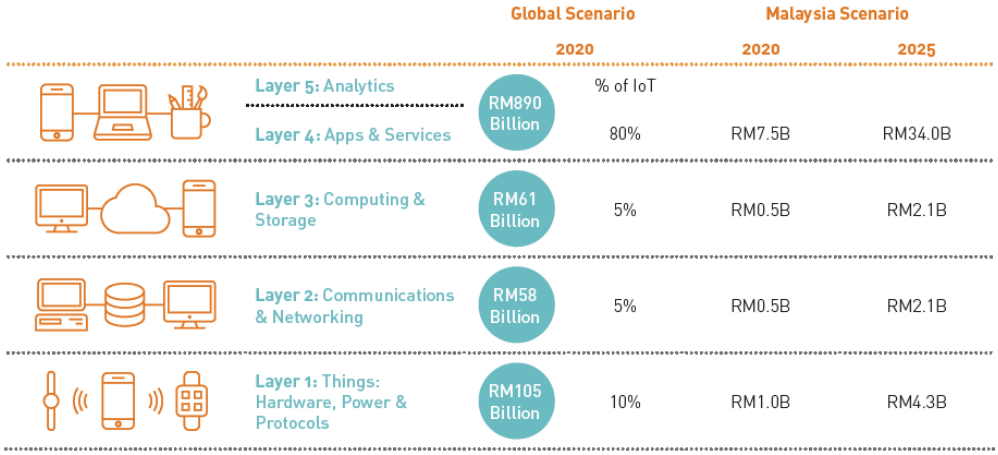

Figure 6: IoT technology opportunities [8]

In addition to providing the nation with economic effects, IoT's ability will serve as an excellent platform for the research community to market R&D outputs. Furthermore, IoT growth in the Malaysian market is expected to create a total of 14,270 highly skilled job opportunities by 2020 [6].

Entrepreneurs that build unique value in addition to standard hardware, connectivity and cloud services can gain IoT profits. The demand for IoT technology does not come from a single killer app, but from thousands of unforeseen new use cases by solution developers pulling information from data that is central to making IoT a primary, profitable business [9].

4. IoT Challenges

Although recognizing the advantages of convergence of IoT technology, many challenges should be tackled to encourage the acquisition by Malaysian industry players of new competencies, skills and business opportunities so that a higher IoT growth rate can be achieved.

4.1 Infrastructure

The first challenge is infrastructure. Infrastructure is the catalyst for creating an interoperable, trustable, mobile, distributed, valuable and powerful enabler for emerging applications such as smart cities, smart grid, smart buildings, smart houses, smart transportation systems, and ubiquitous healthcare, to name a few. The massiveness of sensors and smart things to be connected to the Internet will pressure the spectrum and availability of IPv6.

Here, for current IPv6 deployments, the presence of smart things in the Internet domain and people living in a connected world would pose new challenges. IoT's connectivity, reliability, security and mobility should accelerate and propagate the use of IPv6, which is considered to be an essential technology for IoT, as it provides scalability, flexibility; and has been tested, extended, ubiquitous, open, and end-to-end connectivity [10].

Enabling all things for infrastructure means that devices and objects may communicate and interact with each other. Still, they may have some physical limitations in terms of memory space, processing power, energy autonomy, and communication capabilities. This offers cloud providers the next big business opportunity for computing power, storage, and interconnecting.

By collecting, analyzing, storing and accessing information in useful ways, cloud technology needs to synergize with all data generated. Taking advantage of the true potential of the interface with sensors between mobile, cloud and smart objects would also increase the market room for cloud computing to build on further.

4.2 Information

The second challenge is data and information. Through the vastness of things connected to the Internet, individuals and companies will be able to collect more accurate information. The IoT will extend the data collection types and quantities, managing everything from location information to demographic, psychographic and social details.

Sensor proliferation would promote the self-tracking of data outside the standard and conventional form of data collection. Self-tracking data can provide accurate measurements of daily activities and lifestyles and can fill the holes in current typical high-quality data collection. For the advancement of science and technology, it is therefore essential to collect and maintain self-tracking data.

With so much data streaming in from potentially millions of different sensors and stuff, the complexity and accuracy of world information can reach a new level unimagined before. The difficulty then lies in processing and handling the large and wildly diverse data. Big data applications are now being implemented to find interest in the data exhaust as of today–something that can be easily consumed and processed for further use by companies. It is essential to see the value of the data. Analytics-enabled data is one of the tools IoT is looking for to use.

4.3 Security and Privacy

The third challenge lies in security and privacy. Connected devices are capable of communicating with consumers, transmit data back to companies, and compile data for third parties such as researchers, analyst, healthcare providers, or even other consumers.

Findings from the TRUSTe Internet of Things Privacy Index show that the comfort rates of consumers varied greatly depending on responsibility, ownership and usage of collected personal data. Privacy and security issues along the information supply chain would be a possible obstacle to IoT market development, as only 18-percent of respondents agreed that the advantages of smart devices were outweighed any privacy concerns [11].

4.4 Talent

Talent is the biggest challenge in making the greater benefits of IoT come true, where industry players' ability to produce innovative and differentiated products rapidly would be a primary determinant of their success.

Human capital challenges can be divided into two specific categories, namely strategic issues, e.g., initiatives to promote IoT implementation success stories and tactical matters, e.g., identifying pools of IoT talent, attracting IoT talent participations, and finding niche areas for attracting talent throughout various disciplines.

5. Conclusion

IoT, the city's global interaction with the complexities of technology built for hyperconnected things, is likely to be one of this century's big technological advancements, providing "value to all" through embedded and ubiquitous intelligence. More specifically, IoT naturally takes shape and radically transforms the lives of people and societies. In addition, increasing numbers of business communities around the world are venturing into using IoT to improve daily operations, and IoT-related products and services are streams in the pipeline.

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