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The Internet of Things (Iot): A Scalable Approach to Connecting Everything

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---------- ABSTRACT ----------
The goal of this paper is to bring the Internet of Things (IoT) technology to the lime light. It is intended to educate in plain and simple terms what IoT is all about and its potential to connect everything that exists in the physical world. IoT represents the next evolution of the Internet and has the ability to gather, analyze, and distribute data that we can turn into information, knowledge, and, ultimately, wisdom. In this context, IoT becomes immensely important with a huge potential to close the gap between the poor and the rich, improve distribution of the world's resources to those who need them most, and help us understand our planet so we can be more proactive and less reactive. IoT will be enabled by Wireless Sensor Network (WSN) technologies which cuts across many areas of modern day living. Considering the far reaching impact the normal Internet already has on all facets of life including education, communication, business, science, government, and humanity, it will be easily understood what greater impact the IoT will have on humanity when fully implemented.

KEYWORDS: *IoT, Web 2, Web 3, Cloud Computing, Internet and Communication*

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I. INTRODUCTION

According to the Cisco Internet Business Solutions Group, IBSG (2011), the Internet of Things, IoT, is simply the point in time when more "things or objects" will be connected to the Internet than people. According to Wikipedia (2014), IoT is the interconnection of uniquely identifiable embedded computing devices within the existing Internet infrastructure. IoT, sometimes referred to as the Internet of Objects, will change everything—including ourselves. This may seem like a bold statement, but consider the impact the Internet already has had on education, communication, business, science, government, and humanity. Clearly, the Internet is one of the most important and powerful creations in all of human history.

Now consider that IoT represents the next evolution of the Internet, taking a huge leap in its ability to gather, analyze, and distribute data that we can turn into information, knowledge, and, ultimately, wisdom. In this context, IoT becomes immensely important. Already, IoT projects are under way that promise to close the gap between the poor and the rich, improve distribution of the world's resources to those who need them most, and help us understand our planet so we can be more proactive and less reactive. Even so, several barriers exist that threaten to slow IoT development, including the transition to IPv6, having a common set of standards, and developing energy sources for millions—even billions—of minute sensors. However, as businesses, governments, standards bodies, and academia work together to solve these challenges, IoT will continue to progress. The goal of this paper, therefore, is to educate you in plain and simple terms so you can be well versed in IoT and understand its potential to change everything we know to be true today.

II. A BRIEF HISTORY OF IoT

As with many new concepts, the root of IoT can be traced back to the Massachusetts Institute of Technology (MIT), from work at the Auto-ID Center. Founded in 1999, this group was working in the field of networked radio frequency identification (RFID) and emerging sensing technologies. The labs consisted of seven research universities located across four continents. These institutions were chosen by the Auto-ID Center to design the architecture for IoT (Wikipedia, 2014). In 2003, there were approximately 6.3 billion people living on the planet and 500 million devices connected to the Internet (U.S. Census Bureau, 2010). By dividing the number of connected devices by the world population, we find that there was less than one (0.08) device for every person. Based on Cisco IBSG's definition (2014), IoT did not yet exist in 2003 because the number of connected things was relatively small given that ubiquitous devices such as smart-phones were just being introduced.

For example, Steve Jobs, Apple's CEO, didn't unveil the iPhone until Jan uary 9, 2007 at the Macworld conference.Explosive growth of smart-phones and tablet PCs brought the number of devices connected to the Internet to 12.5 billion in 2010, while the world's human population increased to 6.8 billion, making the number of connected devices per person more than 1 (1.84 to be exact) for the first time in history (IBSG, 2011)

III. IoT AS A NETWORK OF NETWORKS

Currently, IoT is made up of a loose collection of disparate, purpose-built networks. Today, cars, for example, have multiple networks to control engine function, safety features, communications systems, and so on. Commercial and residential buildings also have various control systems for heating, venting, and air conditioning (HVAC); telephone service; security; and lighting. As IoT evolves, these networks, and many others, will be connected with added security, analytics, and management capabilities. This will allow IoT to become even more powerful in what it can help people achieve. Interestingly, this situation mirrors what the technology industry experienced in the early days of networking. In the late 1980s and early 1990s, Cisco, for example, established itself by bringing disparate networks together with multi-protocol routing, eventually leading to IP as the common networking standard. With IoT, history is repeating itself, albeit on a much grander scale.

IV. THE EVOLUTION OF THE WEB VERSUS THE INTERNET

According to Evans (2011), the web has gone through several distinct evolutionary stages:

Stage 1: First was the research phase, when the web was called the Advanced Research Projects Agency Network (ARPANET). During this time, the web was primarily used by academia for research purposes.

Stage 2 : The second phase of the web can be coined "brochureware." Characterized by the domain name "gold rush," this stage focused on the need for almost every company to share information on the Internet so that people could learn about products and services.

Stage 3 : The third evolution moved the web from static data to transactional information, where products and services could be bought and sold, and services could be delivered. During this phase, companies like eBay and Amazon.com exploded on the scene. This phase also will be infamously remembered as the "dot-com" boom and bust.

Stage 4 : The fourth stage, where we are now, is the "social" or "experience" web, where companies like Facebook, Twitter, YouTube, and Groupon have become immensely popular and profitable (a notable distinction from the third stage of the web) by allowing people to communicate, connect, and share information (text, photos, and video) about themselves with friends, family, and colleagues.

V. IoT AS THE FIRST EVOLUTION OF THE INTERNET

By comparison, the Internet has been on a steady path of development and improvement, but arguably has not changed much. It essentially does the same thing that it was designed to do during the ARPANET era. For example, in the early days, there were several communication protocols, including AppleTalk, Token Ring, and IP. Today, the Internet is largely standardized on IP. In this context, IoT becomes immensely important because it is the first real evolution of the Internet—a leap that will lead to revolutionary applications that have the potential to dramatically improve the way people live, learn, work, and entertain themselves. Already, IoT has made the Internet sensory (temperature, pressure, vibration, light, moisture, stress), allowing us to become more proactive and less reactive. In addition, the Internet is expanding into places that until now have been unreachable. Patients are ingesting Internet devices into their own bodies to help doctors diagnose and determine the causes of certain diseases (Chorost, 2008). Extremely small sensors can be placed on plants, animals, and geologic features, and connected to the Internet (Trout, 2011). At the other end of the spectrum, the Internet is going into space through Cisco's Internet Routing in Space (IRIS) program (Cisco, 2011).

VI. THE IMPORTANCE OF IoT

Before we can begin to see the importance of IoT, it is first necessary to understand the differences between the Internet and the World Wide Web (or web)—terms that are often used interchangeably. The Internet is the physical layer or network made up of switches, routers, and other equipment. Its primary function is to transport information from one point to another quickly, reliably, and securely. The web, on the other hand, is an application layer that operates on top of the Internet. Its primary role is to provide an interface that makes the information flowing across the Internet usable.

We Evolve Because We Communicate : Humans evolve because they communicate. Once fire was discovered and shared, for example, it will not need to be rediscovered, only communicated. A more modern-day example is the discovery of the helix structure of DNA molecules that carry genetic information from one generation to another. After the article was published in a scientific paper by James Watson and Francis Crick in April 1953, the disciplines of medicine and genetics were able to build on this information to take giant leaps forward (NobelPrize, 2014).

It is also important to note there is a direct correlation between the input (data) and output (wisdom). The more data that is created, the more knowledge and wisdom people can obtain. IoT dramatically increases the amount of data available for us to process. This, coupled with the Internet's ability to communicate this data, will enable people to advance even further.

IoT Is Critical For Human Progression : As the population of the planet continues to increase, it becomes even more important for people to become stewards of the earth and its resources. In addition, people desire to live healthy, fulfilling, and comfortable lives for themselves, their families, and those they care about. By combining the ability of the next evolution of the Internet (IoT) to sense, collect, transmit, analyze, and distribute data on a massive scale with the way people process information, humanity will have the knowledge and wisdom it needs not only to survive, but to thrive in the coming months, years, decades, and centuries.

In the world of IoT, even cows will be connected. This will allow farmers to monitor cows' health and track their movements, ensuring a healthier, more plentiful supply of meat for people to consume. On average, each cow generates about 200 megabytes of information a year.

Better Quality of Life for the Elderly : IoT can significantly improve quality of life for the surging number of elderly people. For example, imagine a small, wearable device that can detect a person's vital signs and send an alert to a healthcare professional when a certain threshold has been reached, or sense when a person has fallen down and cannot get up.

BARRIERS TO IoT : Several barriers, however, have the potential to slow the development of IoT. The three largest are the deployment of IPv6, power for sensors, and agreement on standards.

Deployment of IPv6 : The world ran out of IPv4 addresses in February 2010. While no real impact has been seen by the general public, this situation has the potential to slow IoT's progress since the potentially billions of new sensors will require unique IP addresses. In addition, IPv6 makes the management of networks easier due to auto configuration capabilities and improved security features.

Sensor energy : For IoT to reach its full potential, sensors will need to be self-sustaining. Imagine changing batteries in billions of devices deployed across the planet and even into space. Obviously, this is not possible. What is needed is a way for sensors to generate electricity from environmental elements such as vibrations, light, and airflow (Liang, 2009). In a significant breakthrough, scientists announced a commercially viable nano-generator—a flexible chip that uses body movements such as the pinch of a finger to generate electricity—at the 241st National Meeting & Exposition of the American Chemical Society in March 2011 (PhysOrg.com, 2011).

VII. CONCLUSION

Ubiquitous sensing enabled by Wireless Sensor Network (WSN) technologies cuts across man years of modern day living. This offers the ability to measure, infer and understand environmental indicators, from delicate ecologies and natural resources to urban environments. The proliferation of these devices in a communicating–actuating network creates the Internet of Things (IoT), where in sensors and actuators blend seamlessly with the environment around us, and the information is shared across platforms in order to develop a common operating picture (COP).

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