The internet of things

Technology, Internet

The internet of things Dave Evans, " Chief Futurist" at Cisco, is confident that the internet of things will change everything. In a report published under Cisco Internet Business Solutions Group, Evans explains that as more sensors are added to the Internet, almost anything can be connected to the Internet, revolutionizing the state of the Internet. All that it is asking for is giving up privacy and information, in exchange for unlimited knowledge and a creation of a " global brain. " What is the Internet of things? The internet of things is the point in time when more " things or objects" were connected to the Internet than people. So, when did the internet of things emerge? If we look at the data provided by Cisco IBSG in April 2011, in 2003, the world population was 6. 3 billion, and connected devices stood at 500 million. By dividing the numbers, we get that the number of connected devices per person is less than one. Starting 2010, the number of connected devices per person increased to more than 1. Hence, the Internet of things was " born. " In real terms though, that number is way more, because not all of the world population is connected to the internet. According to Cisco IBSG, the number of connected devices will reach 25 billion in 2015, and 50 billion in 2020, which means that there will be more than 6 connected devices per person! Brain scientist and entrepreneur Jeff Stibel draws parallels between the internet and the brain. In an interview with the BBC, he explained that the internet is starting to develop intelligence, which in turn results in the creation of a global brain. In the same way that the brain functions, there are ways to add sensors to the internet. Technological advances and initiatives such as Cisco's Planetary Skin and HP's Central Nervous System for the Earth (CeNSE) could potentially add millions of sensors to the Internet, thereby

connecting anything and almost everything to the Internet. That means anything ranging from appliances, roads, water pipes, to people, plants and animals could be connected to the Internet. According to Evans' report, this revolutionary leap could change the way people live, learn, work and entertain themselves. " It's about a holistic approach across industries, " Evans explained in an interview with TTKKTKT once. The implications are overwhelming, as Evans anticipates IoT to revolutionize everything from medicine to retail and finance. Imagine a future where a connected car can connect to other cars, receiving warning signs from the roads that are also connected. This can help solve problems of congestion, as cars could send messages to other cars, suggesting they take a different route. Or imagine a refrigerator that orders groceries once it runs out of supply. From a medical standpoint, the internet of things could mean that doctors can insert connected devices in patients' bodies to better diagnose. In a special report in the Economist, 2010, the idea of connected cows was introduced. Sensors are implanted in the cattle's' ears, allowing farmers to track movement and monitor their heath. This results in a healthier supply of meat for people. The Downside There's a huge downside to all of this, though. Although Evans fails to admit it, the internet of things has major security issues in terms of privacy, governance and trust, especially if the data is stored in insecure locations. Also, the data collected can identify, label and define us without our approval or knowledge. The European Union Commission acknowledged that legislation would not be able to keep up with the Internet of things: " The technology will have moved on by leaps and bounds by that stage; the legislation simply cannot keep up with the pace of technology. " BOX OUT:

Figure 1. The Internet of Things Was " Born" Between 2008 and 2009 White Paper Source: Cisco IBSG, April 2011 BOX OUT 2: Cloud The concept of the Internet of Things relates to the ever growing number of objects that, in addition to containing internal sensors and processors, are also directly connected to the web, streaming their data online. While home automation is probably the " top of mind" application for this concept - the refrigerator that orders milk from the grocery store whenever its running out - the scope is, in fact, much larger. We could have toys that interact with each other independently, offices that automatically order new supplies as needed, without our intervention, even sensors on our clothing and bodies streaming our health data to our doctors in real time. This kind of machine-to-machine (M2M) communication is at the crux of the Internet of Things. We Evolve Because We Communicate Humans evolve because they communicate. Once fire was discovered and shared, for example, it didn't 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. 13 This principle of sharing information and building on discoveries can best be understood by examining how humans process data (see Figure 3). From bottom to top, the pyramid layers include data, information, knowledge, and wisdom. Data is the raw material that is processed into information. Individual data by itself is not very useful, but volumes of it can identify trends and patterns. This and other sources of

information come together to form knowledge. In the simplest sense, knowledge is information of which someone is aware. Wisdom is then born from knowledge plus experience. While knowledge changes over time, wisdom is timeless, and it all begins with the acquisition of data. Figure 3. Humans Turn Data into Wisdom Source: Cisco IBSG, April 2011 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. White Paper Cisco Internet Business Solutions Group (IBSG) Cisco IBSG © 2011 Cisco and/or its affiliates. All rights reserved. Page 6 IoT: Critical for Human Progression As the planet's population 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. IoT Applications: What Cows, Water Pipes, and People Have in Common When we crossed the threshold of connecting more objects than people to the Internet, a huge window of opportunity opened for the creation of applications in the areas of automation, sensing, and machine-to-machine communication. In fact, the possibilities are almost

endless. The following examples highlight some of the ways IoT is changing people's lives for the better. Holy Cow! In the world of IoT, even cows will be connected. A special report in The Economist titled " Augmented Business" described how cows will be monitored (see Figure 4). Sparked, a Dutch start-up company, implants sensors in the ears of cattle. This allows 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. 14 Figure 4. Even Cows Will Have Sensors. Source: The Economist, 2010. White Paper Cisco Internet Business Solutions Group (IBSG) Cisco IBSG © 2011 Cisco and/or its affiliates. All rights reserved. Page 7 Mumbai: A Tale of Two Cities While greater efficiencies and new business models will have a positive economic impact, the human aspect, in many ways, will provide the most important benefit of IoT. One of the areas where IoT can make a significant difference is in closing the poverty gap. Dr. C. K. Prahalad's book, The Fortune at the Bottom of the Pyramid: Eradicating Poverty Through Profits, provides some mind-boggling statics comparing Dharavi (the poorest neighborhood in Mumbai) to Warden Road (the better side of the city just blocks away). The amount people from Dharavi pay for municipal-grade water is $1. 12 per cubic meter. This compares to $0. 03 for residents of Warden Road. The injustice is clear: the poor people of Mumbai pay 37 times more for water (a basic human necessity). 15 The main source of the disparity is the higher cost of delivering utility services to poorer neighborhoods because of infrastructure inefficiencies, problems such as leaks, and theft. According to an article in The Wall Street Journal, " Seven years ago, more than 50

percent of the power distributed by North Delhi Power Ltd. wasn't paid for by customers. A key challenge for power companies is reducing theft by India's poor. " Figure 5. Electric Utility Inefficiencies in India. Source: The Wall Street Journal, 2009. IoT, because of its ubiquitous sensors and connected systems, will provide authorities with more information and control in order to identify and fix these problems. This will allow utilities to operate more profitably, giving them extra incentive to improve infrastructures in poorer neighborhoods. More efficiency will also allow for lower prices, which, in turn, will encourage those taking services for free to become paying customers. 16 White Paper Cisco Internet Business Solutions Group (IBSG) Cisco IBSG © 2011 Cisco and/or its affiliates. All rights reserved. Page 8 Better Quality of Life for the Elderly The world's population is aging. In fact, approximately 1 billion people age 65 and older will be classified as having reached " non-working age" by the middle of the century. 17 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 can't get up. Challenges and 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 offers 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 isn't possible. What's needed is a way for sensors to generate electricity from environmental elements such as vibrations, light, and airflow. 18 In a significant breakthrough, scientists announced a commercially viable nanogenerator–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. 19 " This development [the nanogenerator] represents a milestone toward producing portable electronics that can be powered by body movements without the use of batteries or electrical outlets. Our nanogenerators are poised to change lives in the future. Their potential is only limited by one's imagination. " Zhong Lin WangLead Scientist, Georgia Institute of Technology Standards. While much progress has been made in the area of standards, more is needed, especially in the areas of security, privacy, architecture, and communications. IEEE is just one of the organizations working to solve these challenges by ensuring that IPv6 packets can be routed across different network types. It is important to note that while barriers and challenges exist, they are not insurmountable. Given the benefits of IoT, these issues will get worked out. It is only a matter of time. Next Steps As often happens, history is repeating itself. Just as in the early days when Cisco's tagline was " The Science of Networking Networks, " IoT is at a stage where disparate networks and a multitude of sensors must come together and interoperate under a common set of standards. FP: Are

there applications at the consumer level? DE: What if you drove into a supermarket parking lot and a low cost sensor in the asphalt sent a notification to cashiers saying there's an increase in traffic so the staff could respond. In the coming years, sensor communication technology may become so cheap that a can or box may communicate with other things in your shopping cart. Maybe you have allergy considerations. If you take a product off the shelf it may communicate with your smart phone to let you know it contains peanuts. FP: What about the potential on a national or global scale? DE: Connectivity is the great equalizer. It provides temporary transparency to the plight of people in a way that we've never seen before. We can bring education to people that couldn't previously be reached. We can remotely connect people to physicians over video connection. That physician will be able to do check-ups using IP enabled diagnostic equipment. FP: One of the things that caught my eye was Cisco's planetary skin, the idea of having sensors on trees, in the ocean, and throughout the environment to develop a comprehensive data collection. DE: I think we will see two things occur. One, we will literally be able to put our finger on the pulse of what's going on with the planet and examine it from a climate perspective, a pollution perspective, and a resource perspective. We will also be able to create model scenarios. We will be able to see what happens when we drive up the temperature two degrees. How will that impact crops, or water, or energy consumption? As you have more data you have the opportunity to do more " what if" analysis and learn from that. FP: What are the barriers and challenges at this point? DE: I don't believe there are any true barriers. Establishing standards that will ensure devices can talk to one

another presents a challenge. They need to be based on IP and able to share information amongst themselves, basically speak the same language. Energy is another significant challenge as we create more and more devices, especially sensing type devices in remote areas like the ocean or jungle. Nobody wants to run around and change batteries. These devices need to be able to harvest energy from the environment, either through solar or kinetic generation. FP: Is a shift to IPv6, the latest version of internet protocol that would allow for more addresses, more or less inevitable? DE: Absolutely. It's how we are going to go from a few billion devices today to tens or hundreds of billions tomorrow. It's how every one of these devices is going to connect. FP: Are there any drawbacks or negative consequences that come from this level of connectivity? DE: There are some questions that arise around security and privacy. We need to build security into the network fabric so any device connected to the network can take advantage of next generation security capabilities from a holistic network and intelligence perspective. In terms of privacy, the concern some folks have is that sensors well sense everything. Do I have to worry about privacy when I walk down the street? Are cameras constantly taking pictures of my face? We want to balance privacy considerations against end user benefits. I don't think one should compromise the other. We need services where you opt into the service versus having to opt out. That way people feel comfortable about how their information is being used and we don't have an erosion of privacy. White Paper Cisco Internet Business Solutions Group (IBSG) Cisco IBSG © 2011 Cisco and/or its affiliates. All rights reserved. Page 9 White Paper This effort will require businesses, governments, standards organizations, and

academia to work together toward a common goal. Next, for IoT to gain acceptance among the general populace, service providers and others must deliver applications that bring tangible value to peoples' lives. IoT must not represent the advancement of technology for technology's sake; the industry needs to demonstrate value in human terms. In conclusion, IoT represents the next evolution of the Internet. Given that humans advance and evolve by turning data into information, knowledge, and wisdom, IoT has the potential to change the world as we know it today–for the better. How quickly we get there is up to us.