Global Initiative for Inclusive Information and Communication Technologies

Internet of Things:

New Promises for Persons with Disabilities

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July 2015

Internet of Things:

New Promises for Persons with Disabilities

A G3ict Business Case White Paper Series

Researched in Cooperation with AT&T

July 2015

About G3ict

G3ict, the Global Initiative for Inclusive Information and Communications Technologies was launched in December 2006, in cooperation with the Secretariat for the Convention on the Rights of Persons with Disabilities at UN DESA. Its mission is to facilitate and support the implementation of the dispositions of the Convention on the Rights of Persons with Disabilities in promoting e-accessibility and assistive technologies.

G3ict participants include industry, the public sector, academia and organizations representing persons with disabilities. G3ict relies on an international network of ICT accessibility experts to develop practical tools, evaluation methods and benchmarks for States Parties and Disabled Persons Organizations.

Since inception, G3ict has organized or contributed to more than 90 awareness-raising and capacity-building programs for policy makers in cooperation with international organizations such as the ITU, UNESCO, UNITAR and the World Bank. G3ict co-produces with ITU the "e-Accessibility Policy Toolkit for Persons with Disabilities" (*www.e-accessibilitytolkit.org*), which is widely used around the world by policy makers involved in the implementation of the Convention on the Rights of Persons with Disabilities. For additional information on G3ict, visit www.g3ict.org.

G3ict White Paper Business-Case Series

The G3ict White Paper Business-Case Series documents innovative accessibility solutions and good practices with real-world case studies for users and organizations seeking to improve the accessibility of their information technology, applications and services.

Acknowledgments

G3ict wishes to express its sincere appreciation to:
Philip DesAutels, Senior Director of IoT at the Linux Foundation,
Michael Doyle, Lead Product Manager, AT&T Digital Life,
Alain Louchez, Managing Director – Center for the Development and Application of Internet-of-Things Technologies (CDAIT) at Georgia Tech,
Cees Links, CEO of GreenPeak Technologies,
Ryan Maley, Director of Strategic Marketing, ZigBee Alliance,
P G Ramachandran, Program Director, Advanced Technology, IBM Research,
Kurt Reimann, Cofounder of Flatout Technologies, and PR Officer of ROC-Connect,
Sripriya Sridhar, Product Marketing Manager for Cisco Smart+Communities + IoE
Shilpi Kapoor, CEO, BarrierBreak as Accessible PDF Consultant
Editor: Christine Forget-Leblois, Editor
Technical Advisors: Sam Fabens and Kyle Victor, VOX Global

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INTRODUCTION

Objects around us have been connected for decades. Devices like TV remote controls and garage door openers have been part of our domestic landscape for generations. Industrial applications of these technologies—for example, through remote monitoring and control of production—are also nothing new. In fact, even the phrase "Internet of Things" is not a recent invention; it was coined around twenty years ago.

However, recent developments in both networks and devices are enabling a much greater range of connected devices and Internet of Things (IoT) functionalities. Today, the phrase "Internet of Things" refers to the world of smart connected objects and devices. Gone is the remote control, replaced by an intelligent device that will automatically fulfill its task based on its analysis of user behavior. All of this is made possible by the miniaturization of electronic devices, accompanied by a huge increase in the availability of internet connectivity. The potential applications of this new IoT are virtually limitless, and they have the ability to greatly improve quality of life. This paper explores the impact of the Internet of Things on persons with disabilities, for whom we believe the potential quality of life improvements are especially great. This is perhaps most clearly true in the area of home automation, where a person who is blind can monitor and control the thermostat through an accessible smartphone interface, or a person with a mobility-related disability can have his door automatically unlock when he approaches it.

The remainder of this paper is divided into four sections. The first section gives further background on the Internet of Things. The second elaborates on the potential of new IoT applications to improve quality of life for persons with disabilities. The third examines what the current IoT landscape looks like, detailing the companies and stakeholders involved. Finally, the last section addresses some of the remaining challenges in bringing the full benefits of the Internet of Things to persons with disabilities

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"Ubiquitous computing names the third wave in computing, just now beginning. First were mainframes, each shared by lots of people. Now we are in the personal computing era, person and machine staring uneasily at each other across the desktop. Next comes ubiquitous computing, or the age of calm technology, when technology recedes into the background of our lives."

Mark Weiser was chief scientist at Xerox PARC in the United States and is widely considered to be the father of ubiquitous computing, a term he coined in 1988.

THE INTERNET OF THINGS PHENOMENON

The Internet of Things is ushering in a societal revolution: anything and everything can now be connected. While industrial applications like remote management and monitoring have been present in manufacturing for decades (General Electric in particular has over the years developed some standards for industrial uses), the consumer-oriented IoT is a new phenomenon, enabled by the miniaturization of devices, the emergence of the internet as a favored communications method and the proliferation of powerful and smart mobile devices.

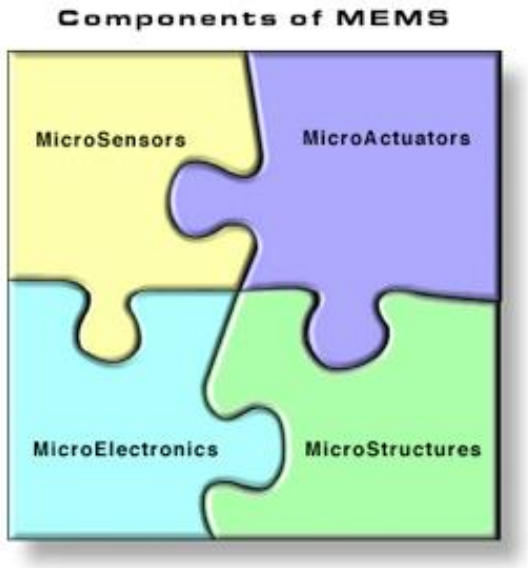
The internet of things is made possible by what Alain Louchez, managing director of Georgia Tech's Center for the development and Application of Internet of Things Technologies (CDAIT), calls "DNA:"

- **Devices**: with miniaturization of sensors and captors
- **Network**: through radio signal, wireless Internet, etc.
- **Applications**

"The killer apps will be in health care and transportation, with wearables for all," declares ***Kurt Reimann, cofounder of Flatout Technologies, and Public Relations Officer of ROC-Connect.*** *"Prices for all these products will fall in the next few years, pushing forward the arrival on the market of new consumer solutions: smart refrigerators, wearables for the visually and hearing impaired, all of this linked with robotics. We will also see smart film, usable as a projection screen, and also smart transportation: taxis that can respond to emergencies, bus lines that advertise their accessible vehicles, etc. Ultimately, IoT will become a robot companion."*

The Devices

Over the past few decades, researchers and industry players have developed Micro-Electro-Mechanical Systems (MEMS). These are miniaturized structures, sensors, actuators and microelectronics, the sizes of which range from microns to several millimeters. Microsensors and microactuators are categorized as "transducers," which are defined as devices that convert energy from one form to another. In the case of microsensors, the device typically converts a measured mechanical signal into an electrical signal.



These new microelements are very powerful: for example, researchers have placed small micro-actuators on the leading edge of airfoils of an aircraft and have been able to steer the aircraft using only these devices, as the industry organization MEM Exchange points out. As the technology evolves, the merger of MEMS with the integrated circuits that power computing will become more common, and will make more complex applications available to the end user.

Source: MEM Exchange

Ultimately, miniaturization will allow any object to be connected, which could have substantial positive impacts for persons with disabilities as more and more products can be controlled from accessible computing platforms.

The number of connected devices is set to explode from 4.9 billion this year, according to the Gartner Group, to 25 billion or even 50 billion by 2020. As Tony Fadell, CEO of Nest, said, "The question won't be what devices are connected – it will be what devices are not connected."

The Network

As important as these advancements in microelectronics are, the Internet of Things refers not just to devices, but also to the connections between them. For IoT applications to work, the sensors and the actuators must be able to communicate with the devices that inform their action, whether it is a smartphone or something as simple as a remote thermometer.

Communication between devices can be established by a variety of different modes, including radio signals, Bluetooth (for devices in close proximity) or an Internet connection (Wi-Fi and wireless broadband for a wider range of communication and for video). And, as our wired and wireless networks reach more and more people*, the potential applications for the Internet of Things will continue to expand.

**83% of the US population has access today to advanced broadband Internet - 25Mbps for download, 3 Mbps for upload - as per the Federal Communications Commission 2015 Report*

The Applications

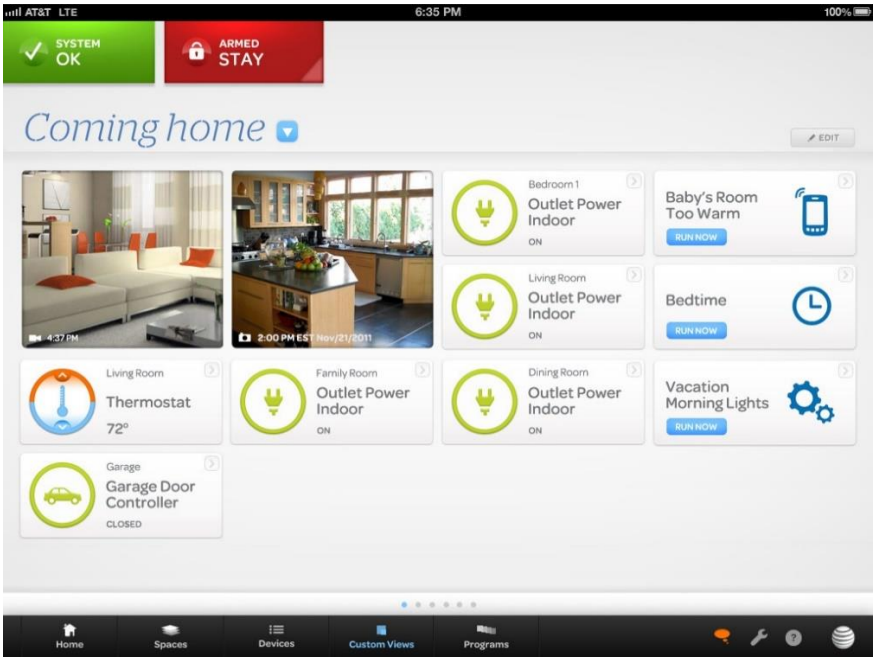
New IoT applications are being introduced to the market every day. While IoT applications are expected to penetrate into many activities—both consumer and industrial—smart home applications seem to be the fastest growing segment. Connected home devices are expected to comprise 25% of all Internet of Things devices shipped this year, according to BI Intelligence, a market currently valued at $61 billion and expected to jump to $490 billion by 2019.

Many of these, as the next section discusses, have potential to improve quality of life for persons with disabilities. Home automation applications and security systems are an obvious example of this. Other examples include self-driving cars that identify traffic and obstacles and remote medical monitoring that makes access to care available to more people in more places.

"Driverless cars will benefit seniors, persons with disabilities but also families" says ***Alain Louchez, managing director – Center for the Development and Application of Internet-of-Things Technologies (CDAIT) at Georgia Tech.*** *"It will be a wonderful help in independent living." Louchez also emphasizes apps related to health control: "Remote health care is one of the fastest growing sectors of the IoT, and will help to make health care more efficient and less costly." He adds a caveat: "Health care through borders, access to health data by health care providers and maybe insurance companies, will have to be studied, and maybe regulations put in place, while keeping in focus the individual." But the Internet of Things will not stop in the home: Louchez works on Low Power networks for the smart city that will generate information on energy consumption, public transportation, etc.*

A Few Examples of IoT Applications

- ***Medtronic's Continuous Glucose Monitoring*** *is a wearable device that displays a constant reading of a diabetic's blood glucose level. A tiny electrode is inserted under the skin, which then transmits the glucose reading via wireless radio frequency to a display device.*
- ***Philips' Hue Light Bulbs and Bridge*** *provide a bridge and connected bulbs that allow the user to control their home lighting from the palm of their hand.*
- ***iRobot's Roomba*** *is a smart vacuum cleaner equipped with iAdapt technology, a system of software and sensors that enables Roomba to find its way around a home of any shape or size.*
- ***Ralph Lauren's Polo Tech Shirt*** *is a shirt with conductive threads woven into it and a small snap-on module that weighs less than 1.5 ounces and relays information like heart rate and breathing data to a Bluetooth-connected iPhone or iPad.*
- ***Ring*** *is a connected doorbell and home security solution used for home automation. It alerts users to motion as soon as it's detected, so they can remotely monitor their door.*

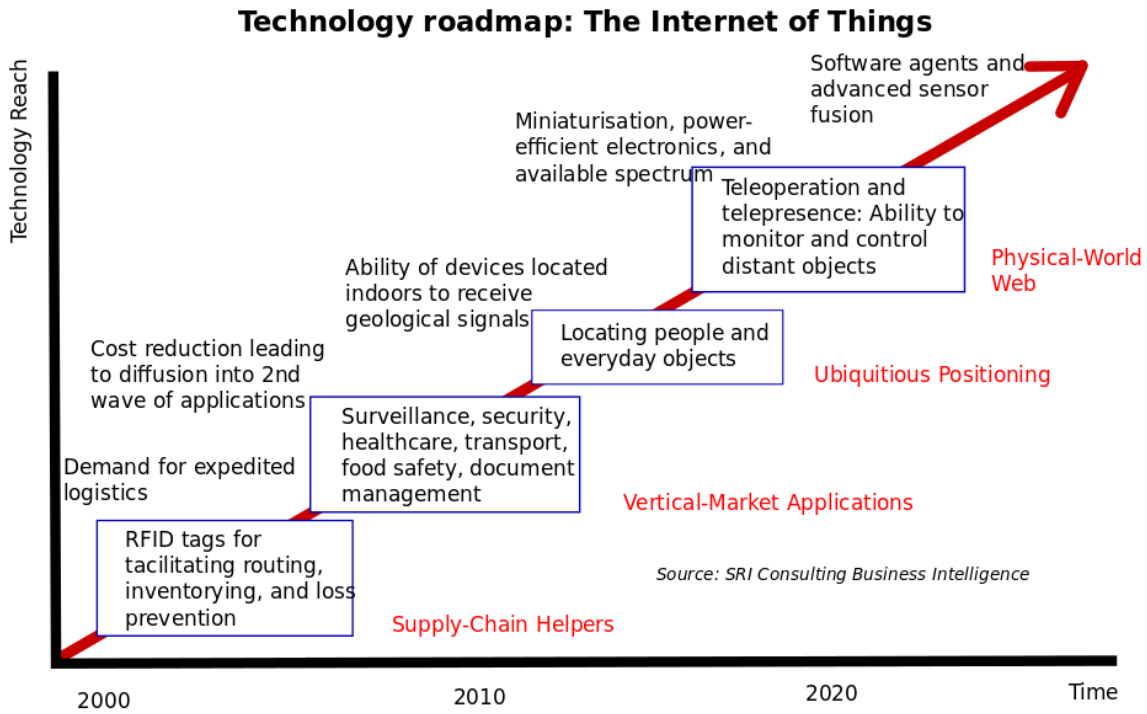


Example of home automation monitoring screen (Courtesy of AT&T Digital Life)

POTENTIAL FOR PERSONS WITH DISABILITIES

Many new IoT applications are comfort and security oriented. These applications enable a user to change his or her thermostat remotely, dim or increase the intensity of lights, control door locks, activate alarm systems, etc. While these applications certainly add a level of fun and convenience for all users, the applications take on a whole new level of importance when used by persons with disabilities and older adults.

Source: SRI Consulting Business Intelligence



Thanks to improved accessibility features, smartphones can now be used by more persons with disabilities than ever before. Many manufacturers have also developed smartphones with easier and more intuitive interfaces. These interfaces facilitate use by older adults whose usage of smartphones may otherwise be impacted by vision or hearing loss or reduced dexterity and mobility. These accessible smart phones are already becoming the remote controls for smart homes, smart transportation and smart cities, giving persons with disabilities a new and flexible instrument to navigate daily life and participate more fully in the economic and social environment.

Industry experts agree that the Internet of Things has tremendous potential to bring benefits to persons with disabilities. Sripriyar Sridhar, product marketing manager for

Cisco Smart + Communities + IoE, says that her company is already focusing on bringing the benefits of the Internet of Things to persons with disabilities. She says, “We see as most beneficial the apps that connect devices at home, allowing the user to automatically switch on these devices based on time and other pre-set preferences of users. The ability to adjust things such as the temperature and brightness of a room may also be helpful for people with limited mobility. Additionally, the IoT has significant potential to improve employment opportunities, facilitate independent living and improve social integration for persons with disabilities.”

PG Ramachandran, program director, advanced technology, IBM Research, emphasizes that the Internet of Things has the potential to improve access to healthcare for older adults and persons with disabilities. “The IoT will have a huge impact, bringing the doctor to the patient, not the other way around anymore.” According to Ramachandran, sensors will detect movement, medications, carbon dioxide emissions, and “create a full picture for the health care provider” which will enable personalized care and allow for more independent living. This will also have a positive impact on the cost of health care in the long term. “Eventually, the cost of the equipment and the infrastructure will come down, with standardization and normalization of the market.” Ramachandran adds, “At IBM, one of our focuses in the present research is indoor location mapping that will allow the user to immediately identify the location of various services, including ramps, accessible services, and escalators and elevators in public places.”

Type of Disability	**Examples of Useful Functionalities Enabled by IoT**
Physical and Dexterity	Remote support and services at home Speech activated devices Automated accessibility functions in public spaces
Visual	Interpretation of user environment for way finding Near field automation Speech activated devices which communicate with speech output
Hearing	Captioning in glasses delivered by beacons Visual cues about status of home devices on mobile device
Cognitive	Localization and orientation Automated reminders Programmable safety processes

Home Automation Technologies

Of all the Internet of Things applications that have the potential to improve life for persons with disabilities, home automation—or "smart home"—technologies are among the most promising. Home automation technologies utilize a variety of connected cameras and sensors to relay information to the user's smart phone, allowing for remote monitoring and control of lights, thermostats, appliances, security systems and more.

Coupled with an accessible smartphone interface, smart home technologies hold enormous promise for persons with disabilities, improving quality of life and facilitating independent living. The examples abound:

- For people who are blind or have low vision, home automation applications allow for easy control of appliances and the home thermostat, all with the touch of a button on a smart phone. It is crucial, however, that these applications be compatible with the smart phone's screen reader or other accessibility features.
- For people with mobility-related disabilities, smart home technology holds the promise of allowing the user to control things in his or her home that may be physically difficult to reach, such as lights, door locks or security systems.
- For people who are deaf or hard of hearing, one benefit of home automation technology is improved security. A deaf person might not be able to hear a break-in, but a smart security system can help compensate for that by providing alerts through the user's phone in the event of suspicious movement picked up by a sensor outside the home.
- Additionally, smart home technology allows the children and caregivers of older adults to monitor their daily routines, promptly alerting children and caregivers in the event that routine tasks are not performed.

Several providers already have smart home platforms on the market today. One such platform is AT&T's Digital Life, which offers the "classic" features including cameras inside and outside the home, remote temperature monitoring and control, remote home light control, remote water detection and control, coded door locks etc.

AT&T Digital Life: From Concepts to Real Life Applications

Conscious of the needs of older adults and persons with disabilities, Digital Life contains features that help promote safe, independent living. Examples include:

- *Sensors placed near the foot of a bed, which can alert a caregiver when a person gets out of bed.*
- *Sensors inside a medicine cabinet or refrigerator that can record when and how many times the door was opened and closed.*
- *Water detectors that will automatically shut off the water main in the event of flooding from a bathtub or sink.*

Smart Homes use a variety of sensors with a central command unit and can be monitored on smart phones or tablets. Courtesy of AT&T Digital Life.

All of these functionalities rely on connected sensors that gather information over a period of time in order to define the user's typical daily routine. Once that is established, it is quite easy to program automatic alerts to relatives, caregivers, neighbors or others in the event of a change in that pattern.

Digital Life is just one of several smart home platforms currently on the market, but it clearly illustrates the potential of the Internet of Things to improve quality of life and facilitate independent living for persons with disabilities, as well as seniors.

CURRENT INDUSTRY PLAYERS

Over the last decade, industry alliances have formed to develop products and protocols in the Internet of Things domain. Each of those alliances has its own purpose, coming at the issue from different angles. Virtually all the major players in the ICT industry have jumped on the IoT bandwagon, joining with a range of consumer products manufacturers, telecommunications companies as well as chip and smart phone manufacturers. Various stakeholders from the information and communications technologies industries as well as consumer product manufacturers and retailers, have joined two major alliances, each of which has already engaged in developing devices and applications that will specifically benefit persons with disabilities.

*"IoT will be a major source of wealth creation in the two decades to come," says **Cees Links, CEO of GreenPeak Technologies**. "We are still clueless about the Internet, in matters of privacy, protection, security, who owns the data? We are learning on the go." "The industry is still engineering driven, a matter of engineering prowess. I see a trend in two directions: the market that used to be oriented towards the younger generations is now focusing on the seniors. And consequently, the industry is learning about the difficulties of user interface with a new type of users who need more focus on a few options rather that multiple (and confusing) features." Links thinks that standards are still at the early stages of development and need to mature and stabilize for costs to go down.*

ZigBee Alliance

ZigBee, one of the oldest alliances in the field, has focused its efforts on wireless sensors for smart home products. Its standard is a semi open standard, with a license for manufacturers. The alliance counts over four hundred members, and has today certified over 1,000 products. ZigBee Home Automation 1.2 and ZigBee Light Link (adopted by major light bulb manufacturers) rely on low energy consumption and are among the popular solutions offered by the alliance members. ZigBee also offers solutions for retailers to optimize the customer's experience in stores and improve the efficiency of their processes through ZigBee Retail Services.

"The IoT is so vast, it will encompass many technologies. Simple devices will need to be standardized, cheap and easy to install, with low battery use, or even no battery. This is what ZigBee focuses on," says ***Ryan Maley, director of strategic marketing, ZigBee Alliance****. "Interoperability will have to be implemented at all levels of communication. A whole new eco system is developing that will address data collection, data analysis and storage, with cloud solutions. Health care monitoring will be a major IoT market, but in the US, we may need some changes in our health care structure, and surely, Medicare and Medicaid need to be involved, as well as senior organizations. Our users in the senior generation will be a whole new group, already familiar with technology. In the long term, we will have smart homes where limited or even no physical action will happen, every element triggered by voice, presence, movement."*

Allseen Alliance

Another industry group, the AllSeen Alliance, has been formed around Qualcomm's AllJoyn open-source technology to connect devices. Products, applications and services created with the AllJoyn open source project can communicate over various transport layers, such as Wi-Fi, power line or Ethernet, regardless of manufacturer or operating system and without the need for Internet access. The software is openly available for developers to download, and runs on popular platforms such as Linux and Linux-based Android, iOS and Windows, including embedded variants.

Google's Nest Labs, meanwhile, has joined with Samsung, ARM Holdings, Yale Security, Freescale Semiconductor and others to form the Thread Group, which hopes to develop a new mesh wireless network standard for the IoT. Thread seeks to expand on the ZigBee networking standard, IEEE 802.15.4.

Many Other Players in the Field

The examples above are just a few of the industry partnerships in the Internet of Things domain, as it seems that a new partnership is born every day. In addition to the two examples above, the Open Interconnect Consortium, launched by Intel, Samsung Electronics, Broadcom and other companies, is working to develop a new standard for device-to-device connectivity. Additionally, companies like Google, Cisco, ARM and IBM have all separately worked with other partners to address various issues.

Regardless of who is collaborating, one thing is for sure: the industry appears ready to invest heavily in this field. IBM has announced plans to spend more than $3 billion over the next four years on a dedicated business unit that will employ several thousand researchers and developers. The company has already firmly positioned itself in the could-based platform realm, for data analysis and processing, notably with its Internet of Things Foundation Service on the BlueMix cloud-based application platform. Additionally, Google purchased Nest, a smart thermostat company, for $3.2 billion; Samsung did the same with a connected home specialist. Intel also has shown interest in technology to complement its own expertise (Intel Gateway) in processing and analyzing data.

Sripriya Sridhar, Product Marketing Manager for Cisco Smart + Communities + IoE*: "The Internet of Everything is a $19 trillion global opportunity over the next decade: Private-sector firms can create as much as $14.4 trillion of value while cities, governments and other public-sector organizations can create $4.6 trillion."*

THE ROAD AHEAD

As we have discussed throughout this paper, the potential for the Internet of Things to improve the quality of life of persons with disabilities is enormous. However, barriers still remain that will need to be addressed before the IoT can become widely adopted and offer the benefits we have discussed.

Accessibility:

Perhaps the most significant barrier to persons with disabilities being able to take full advantage of the Internet of Things is ensuring that all of the players in the ecosystem consider accessibility when developing new products and services. There are a wide variety of companies and organizations that touch the Internet of Things in some way, including device manufacturers, handset manufacturers, networks and application developers. In order to create an Internet of Things that works for everyone, accessibility must be a consideration at each stage of the development process. At a minimum, all parties involved in the development of IoT devices and applications should commit to upholding the principles of universal design.

Broadband Access and Adoption:

All Internet of Things devices must be connected. While the adoption of wired and wireless broadband has exploded in recent years, there are still pockets of non-adopters, many of whom are persons with disabilities or older adults. While the reasons for not having internet access can range from not understanding the value, to not being able to afford it, to not having access to the necessary infrastructure, the end result is not having access to the Internet of Things. And there is no doubt that improving adoption will mean that more people can experience the benefits of these technological advances.

Standardization:

As is often the case with emerging technologies, the multiplicity of IoT technologies that the industry is developing has raised questions about how all of these products are going to communicate.

Several different bodies are already working on standards related to the Internet of Things. One such body is the IEEE Standards Association (IEEESA), which has approved and published about 80 standards relating to IoT applications—including Bluetooth, ZigBee and Wi-Fi—and has at least 40 additional standards in development. Several other major international

standards development organizations are working to advance IoT-related standards, including the Consumer Electronics Association (CEA), whose new standard, ANSI/CEA-2045, encompasses sensors, thermostats and appliances, as well as energy-related equipment such as energy management controllers and residential gateways. CEA has also developed a standard for a better energy consumption management. The ZigBee Alliance has also developed its own standards.

Some see the multiplicity of standards in the market today as a problem. “The biggest issue is too many standards, but we are still at an interim stage,” says Philip DesAutels, senior director of IoT at The Linux Foundation. Likewise, Kurt Reimann, founder of FlatOut Technologies, a smart home company, agrees that “the standard field is for the moment very fragmented.”

Others however, note that the large number of standards in the market today is not necessarily bad, nor unexpected. IoT technology is still at an early stage, and there are many questions and issues around standardization that have yet to be worked out. While common standards and interoperability will be crucial for allowing persons with disabilities to take full advantage of these technologies, we are optimistic that a more streamlined standardization landscape will emerge. As Cees Links, CEO of GreenPeak Technologies said, “It took 10 years to develop a standard for Wi-Fi. That standard was developed at the industry initiative, and keep in mind that your Wi-Fi is free. We will see standards emerging in the next few years, and that will bring down the price of the technology, allowing for a larger market.” The diversity of current standards may in the end be a positive approach, with greater interoperability as a result.

Privacy:

Internet of Things applications will, often by necessity, collect data about their users. A smart home, for example, could measure how a user moves around in his or her daily life, data that enables applications to understand living patterns and give connected devices the information required to predict the user’s needs. Naturally, this degree of information collection raises questions about privacy. It will be important that users of IoT applications—including users with disabilities—be educated about what data will be collected about them by a particular device or system, and be given the opportunity to exercise choices about that collection.

PG Ramachandran, Program Director, Advanced Technology, IBM Research: *"The big brother approach of data collection can create a cultural rejection, and cultural adaptation will be the biggest hurdle."*

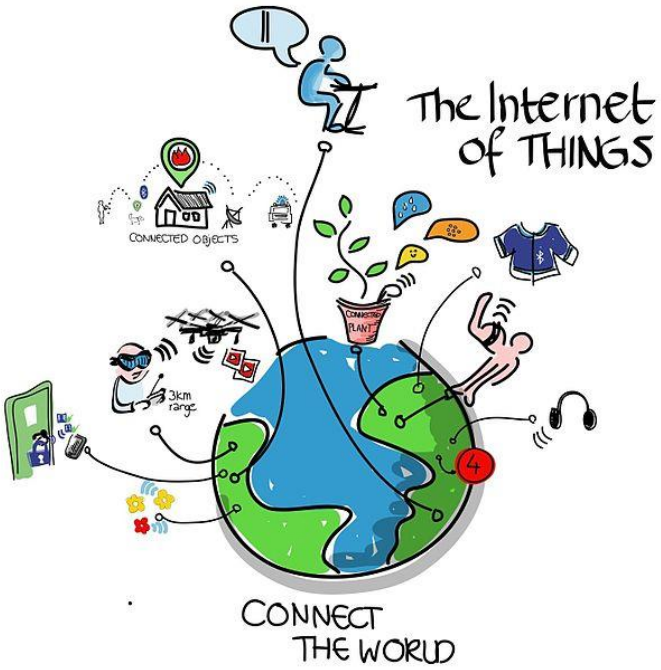
Security:

Finally, the collection and storage of large amounts of personal data also raises questions about the security of that information. While this topic alone is worthy of its own paper, it is certainly a topic that is being discussed and will continue to be discussed and address both within companies and through public-private partnerships.

CONCLUSION

The Internet of Things is still in its infancy, and it will take years before it becomes a part of our daily lives. Significant challenges still remain before the IoT can fulfill its promise to revolutionize the lives of its users—particularly users with disabilities. Many factors will have to evolve, including guidelines for standardization and inteoperatiblity of devices, the extension of broadband internet networks, protection of privacy, improved security of data and a commitment to accessibility by all parties in the IoT ecosystem.

Despite these challenges, it is important not to lose sight of the significant benefits the IoT can bring. If industry stakeholders incorporate universal design and input from the disability community into their development, the Internet of Things will mean more independent living, more personalized care, more flexibility and mobility and better employment and education outcomes through wearable and mobile technologies.



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