LEWISINSIGHT

UNRAVELLING TELECOMS & THE DIGITAL FUTURE

Accessibility for the Disabled in the Increasingly Mobile World

'The Untapped Billion'

February 2014

Prepared for: Mike Short, Sofia Fernandez, Gema Esteban Garrido of Telefonica

Prepared by: Chris Lewis
Tel: +44 7824 360747
email: chris@lewisinsight.com
twitter: @chr1slew1s

Table of Contents

1. Executive Summary

According to The World Health Organisation there are approximately a billion people in the world today who have some form of disability. The figure is approximate as it is difficult to get absolute figures for every part of the world and for every possible condition considered to be a disability. According to Gartner " they and their immediate friends and family have an annual disposable income of over $8 trillion".

These disabilities fall into 5 categories:

- Hearing impaired – 360 million
- Vision impaired – 285 million
- Learning & cognitive impaired - 194 million
- Physically impairment – 13 million
- Other (including depression, alcohol dependency, dementias) – 148 million

The first four categories amount to 852 million, 12% of the world population. Why is this important from the point of view of the mobile industry? Because many of the services that are taken for granted when reaching for the latest mobile devices are simply not available to this disadvantaged group on account of their lack of touch, motor skills, cognitive capacity, hearing or sight. In short, accessibility to the modern mobile world is often restricted.

In the past, the different areas were approached in isolation while expensive, condition-dependent technology was developed. As the ICT world moves to a more software centric position, and as multiple screens become the norm for accessing services for our business and personal lives, access is facilitated on a much wider scale and at a much lower price point. Ask any disabled person and they will tell you that they want to be part of this; to benefit from developing technology, have the latest device and live in the real digital world - not in an artificial disabled isolated pocket of the world.

The signs are promising: from Turing and von Neumann's beginnings of the computing industry we have moved to massively virtualised computing infrastructure, coupled with a range of devices with flexible input and output facilities which can be enhanced, where necessary, with peripherals appropriate to an individual disability. This is a complete volte face from the disability specific designed equipment of the last 30 years. Fundamentally, the content and applications are digitally accessible, and the question is simply how to adapt the interface for a particular condition or series of conditions. Interestingly, we have gone full cycle from the analogue processes of early computing/code breaking, to return to the use of analogue speech and gesturing to interact with the computing world.

The fact that the processing and storage are virtualised across devices and infrastructure (in the cloud) means that a relatively low cost, even low power device in our hands, on our heads or wrapped around our bodies, can leverage the vast compute power of the Internet to support our daily lives.

The permutations are endless whatever the disability. The hearing impaired can use video services to sign to each other, receive real time text messages and potentially have video lip read for them in the future. People with cognitive problems such as Asperger's could have their wearable camera process the faces of people in the room and feedback whether they are happy, sad, angry or neutral.

So what's missing?

- Accessibility on all devices needs to be made readily available to all disability categories
- Web sites, applications and content need to be correctly designed and labelled to allow ease of navigation for accessibility software such as screen readers
- Interlinking of peripherals (wearables), smart phones, tablets, laptops and televisions needs to be made straight forward
- Education is required on several fronts.

This last point is possibly the most important. The various disabled groups need to be educated as to what is available to them assuming the previous points are executed correctly. Many disabled people today are unaware of the possibilities of interacting with the ICT world. This has traditionally been as a result of a lack of accessibility but also combined with a relatively high price tag. The more embedded the accessibility becomes, the broader the market appeal. It is also important to point out that an increasing proportion of the disabled people are elderly. Exact figures do not exist for most categories but it is evident that disability grows with age. The time at which people become disabled is vitally important as our ability to take on new technology declines dramatically with age!

And there is a surprising benefit to the remaining 85% of the world's population. The better annotated applications, content and web sites become, the easier they are for so-called 'normal' people to navigate with the range of tools available. The better the speech input and text to speech output, the less likely drivers are to pick up their mobiles while driving. In the world of unified communications, the better the translation between text, Instant Messaging, video, email and the various social apps, the easier people will communicate via their preferred means. Innovation from apps developers, service providers, device manufacturers all play their role in enhancing the accessible world.

More open mobile platforms can become the gateway for the untapped billion to gain access to the digital world. Some additional peripherals will be required, such as earphones or some form of tactile display, but a great benefit will arise for the disabled and a significant market opportunity will be presented.

It all comes to a head in the world of automotive. The 'self-drive car' promoted by many of the automotive manufacturers today represents a fantastic combination of accessible Machine-to-Machine service. Able-bodied people look forward to the self-drive car option when trying to finish off a presentation or have a rest. Be assured, disabled people who are currently unable to drive, look forward to the fully self-drive car with glee!

Article 21 of the United Nations Convention on the Rights of Persons with Disabilities details that "*people with disabilities have the right to express themselves, including the freedom to give and receive information and ideas through all forms of communication, including through accessible formats and technologies, sign languages, Braille, augmentative and alternative communication, mass media and all other accessible means of communication*".

The mobile industry can play a major role in facilitating and accelerating this accessibility revolution. Working with the device manufacturers, applications and content providers, but most importantly, with the various disability groups, educating all parties as to what the digital world can bring to the untapped billion for their home lives, on the move, but perhaps most importantly, in an expanded possibility of contributing to the workforce.

2. Introduction

Most take it for granted that they can pick up a smart phone or sit at a computer and surf the web to find a piece of information or buy something. Imagine if you couldn't operate a mouse, see what's on the screen or understand the graphics or language being used.

This report looks at the issue of accessibility to the increasingly digital world and analyses the way in which the billion disabled people have traditionally had (or not had) equal access, how that is changing along with the main technologies impacting the whole world population in terms of mobile devices, applications and content. And, in drawing these formerly separate worlds closer together, the conclusion of what the industry needs to do in order to open the world up to the untapped billion. According to Gartner " they and their immediate friends and family have an annual disposable income of over $8 trillion".

The document has been prepared by Lewis Insight and is based on primary and secondary research with stakeholders in academia, telecom industry, charities, NGO's and healthcare sectors around the world. It aims to summarise the market situation relating to the evolution of disabled access and the associated changes in the IT industry as well as the actions needed by all parties. Data and references are located in the Appendix.

3. Disability demographics

According to the World Health Organisation (WHO) there are a billion people in the world with some form of disability. This amounts to some 15% of the world population, perhaps a surprisingly high figure for many. And, possibly because of the range of disabilities and the degree of disability, it is difficult for the remaining 85% of the global population to truly understand the needs of this diverse group and how they interact with the real and the digital world. Some of the disabilities are self-evident such as those in a wheelchair or carrying a white stick. However, many have less visible conditions, be they related to learning or cognitive difficulties, hearing and visual impairments and where the individual chooses not to carry any form of symbol to inform the outside world of their difficulty.

The figure below shows how the billion breaks down into different disabilities. It should be noted that within each condition, the degree of impairment varies dramatically. For instance of the 285 million visually impaired, only approximately 14% are considered blind.

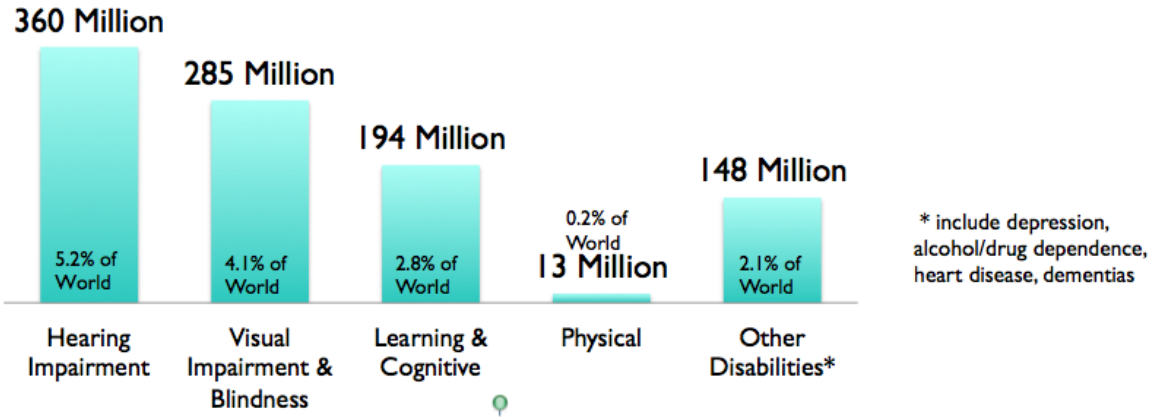

Figure 1. Estimated Prevalence of Disabilities in World Population of 6.9Bn (Source: World Health Organisation 2010)

The statistics available at a world, regional and country level vary significantly in their availability. It is difficult to give consistent data on every disability and its penetration in a particular country. What is evident from the different sources is that there is another dimension to the disability discussion that is growing in importance: It is the issue of age. As one medical person described it, disabilities tend to 'multiply' as we get older.

- 57% of the world's blind population is aged 65 and over
- 33% of those with hearing disabilities is aged 65 and over
- Nearly three-quarters of all strokes (the biggest cause of Acquired Brain Injuries) occur in people over the age of 65

4. Background to Assistive Technology

Accessibility aids for those with different disabilities and conditions are often referred to as 'assistive technology'. In the past such devices and services were defined around the individual disability or combination of disabilities and were often developed in isolation for a particular condition, often with different solutions for different countries or parts of the world. Today, assistive technology is benefiting from the computing revolution and is increasingly based on standard computer platforms and devices.

For example, in the late 1970's, Kurzweil developed a reading machine, the size of a large photocopier that cost around £50,000. It scanned text from an open book placed on the top of the device, which carried out Optical Character Recognition (OCR) and spoke the text out in a clunky computer voice. That same functionality today is now available in a portable device or even an as app on your smart phone. Likewise we had the development of the expensive and unwieldy Braille machines and books, which are now superseded by a cheaper 'candy bar' braille display that can be plugged into your iPhone or iPad.

It should also be emphasised that the understanding of the different conditions and degrees of disability have developed significantly over the last few decades. At the same time the

technology industry has gradually been moving towards the more powerful computer platforms.

Add-ons and peripherals have also been developed to allow for a more accessible core set of products, functions and features. Switches for people to use with their head, mouth or eye movement to link to computers, hearing aids and so on. These changes mean that these disability specific devices and services are now likely.

Fig 4.1. Kurzweil reading machine approx 1978

Fig 4.1. Text to speech apps and software today

Fig 4.2. Perkins Brailler Machine

Fig 4.2. Braille Sense U2 Communicator

5. Assistive Technology Today

The enormous variety of devices, technologies and services available to assist the billion people who are disabled is often regarded as mind-blowing to the remaining 85% of the population because so there is often so little understanding and awareness of the myriad of disabilities.

Technology for the Hearing Impaired

Paradoxically deaf people are often not helped by 'listening' devices. Devices that are more useful to deaf people change auditory information to visual information. Flashing lights or vibrators can be used for alarms, doorbells or telephone ringers. Text telephones and captioning for television programs provide typed-out messages instead of sound.

Several types of Assistive Listening Devices (ALD's) are available to improve sound transmission for people with hearing loss. Some are designed for large facilities such as classrooms, theatres, places of worship, and airports. Other types are intended for personal use in small settings and for one-on-one conversations. All can be used with or without hearing aids or a cochlear implant. ALD's systems for large facilities include hearing loop systems, frequency-modulated (FM) systems, and infrared systems.

Technology for the Visually Impaired

Screen Magnification software is commonly used amongst people with low vision as it works together with the operating system and web browser to enlarge the content. The degree of magnification can vary according to the preferences of the person using it and many will also change the contrast and colour settings to make it easier to read. For example, they may set a black background with white text to make it stand out more. The main drawback is that if you have large areas of blank space between text, the need to scroll through large areas of blank space can make it very difficult for someone to find elements in a page with ease. Also, images also do not scale well, and often become blurred and pixelated when magnified – this can be particularly problematic if GIFs are used as links.

Screen readers, are also known as audio output and speech output, are used by people who are blind to 'listen' to web pages and other digital documents by outputting verbally what you would otherwise see. This includes everything from start up screens, desktop and tool bars, all software packages and browsers.

Screen readers with refreshable braille displays are sometimes combined into one software package. To use the braille output, braille keypad hardware is attached to the length of a keyboard and small pins are pushed up to output the content in braille.

Users rely solely on the keyboard to navigate around a page using various keyboard commands. (Being a non-visual medium it is not possible to use a mouse cursor.) It is vital for **screen reader users that websites obey the highest standards of coding** for headers, links, and other page elements. These are championed by The World Wide Web Consortium (W3C) is an international community led by Web inventor Tim Berners-Lee with a mission to lead the Web to its full potential. See www.w3.org for further information.

Popular screen readers and refreshable braille displays are Jaws, Window-Eyes and Hal.

Technology for the Speech Impaired

Augmentative and Alternative Communication (AAC) devices are available for communicating face-to-face. Keyboards, touch screens, and sometimes a person's limited speech may be used to communicate desired words.

Some devices employ a text display. The display panel typically faces outward so that two people can exchange information while facing each other. Spelling and word prediction software can make it faster and easier to enter information.

The simplest AAC device is a picture board or touch screen that uses pictures or symbols of typical items and activities that make up a person's daily life. For example, a person might touch the image of a glass to ask for a drink. Many picture boards can be customized and expanded based on a person's age, education, occupation, and interests.

Speech-generating devices go one step further by translating words or pictures into speech. Some models allow users to choose from several different voices, such as male or female, child or adult, and even some regional accents. Some devices employ a vocabulary of pre-recorded words while others have an unlimited vocabulary, synthesizing speech as words are typed in. Software programs that convert personal computers into speaking devices are also available.

To communicate by telephone, for many years people with hearing loss used text telephone or telecommunications devices, called TTY or TDD machines. This same technology also benefited people with speech difficulties. A TTY machine consists of a typewriter keyboard that displays typed conversations onto a readout panel or printed on paper. Through a relay service, a communications assistant served as a bridge between two callers, reading typed messages aloud to the person with hearing while transcribing what's spoken into type for the person with hearing loss.

With today's new electronic communication devices, however, TTY machines have almost become a thing of the past. People can place phone calls through the telecommunications

relay service using almost any device with a keypad, including a laptop, personal digital assistant, and cell phone. Text messaging has also become a popular method of communication, skipping the relay service altogether.

Another system uses voice recognition software and an extensive library of video clips depicting American Sign Language to translate a signer's words into text or computer-generated speech in real time. It is also able to translate spoken words back into sign language or text.

Technology for the Physically Impaired

Physical impairments come in many forms and can generally be classified as a loss or limitation of function in muscle control or movement or a limitation in mobility. This may include hands that are too large or small for a keyboard, shakiness, arthritis, paralysis, and limb loss.

There is a wide range of assistive technologies available to help with all these impairments. Below are some of the most popular ones.

- **Mouth stick** - a device that enables users to control input through a stick that they manipulate with their mouth.
- **Head wand** - Head wands are very similar in function to mouth sticks, except in this case the stick is strapped to the head.
- **Single-switch access** – for people with very limited mobility. For instance, if a person can move only the head, a switch could be placed to the side of the head that would allow the person to click it with head movements. This clicking would then be interpreted using special software.
- **Oversized trackball mouse** - A trackball mouse has the rollerball on top rather than underneath the mouse. Instead of moving the mouse to control movement, you move the rollerball. Some users find this easier to control. It also works well in conjunction with other devices, for example, head wands or mouth sticks.
- **Adaptive keyboard -** There are a wide range of alternative keyboards on the market to help motor-impaired users including compact, expanded, ergonomic, on-screen, concept, rubber and ABC keyboards.
- **Eye tracking** - Eye tracking devices can be a powerful alternative for individuals with no control, or only limited control, over their hand movements. The device follows the movement of the eyes and allows the person to navigate through the web with only eye movements.
- **Voice recognition software** - Voice recognition programs enable the user to enter text and, in some cases, carry out common computer tasks simply by speaking into a microphone – that is, without having to use a keyboard or a mouse. In case of text

entry, the computer analyses the user's voice, tries to recognize the words, and types them - instead of the user - as he or she speaks

- **"Sticky Keys"** - a method of typing where modifier keys, such as Shift, Control, Command, and Alt/Option, will "stick" down and apply to the next keystroke, so that only one key needs to be pressed at a time. This is extremely useful for people who have motor impairments that make it difficult to press combinations of keys.
- **"Slow Keys"** - a keyboard feature that prevents keystrokes from registering until a key has been held down for a certain period of time. This is extremely useful for people with motor impairments that make it difficult to target keys accurately or that cause unpredictable motion.

Technology for the Cognitively Impaired

Assistive Technology for Cognition (ATC) is the umbrella term used to describe technology that augments and assists with cognitive processes such as attention, memory, self-regulation, navigation, emotion recognition and management, planning, and sequencing activity. Examples of ATC vary from systems which prompt users to take medicine to systems allowing people with Learning Difficulties to communicate their emotions and needs. Many of the technologies described in the previous section will be equally used by this group.

6. Developments in Assistive Technology

The words of academia and technology are exploring all boundaries of assistive technologies. Here are just three examples that demonstrate the possibilities.

More Natural Synthesized Speech

Scientists are developing a personalized text-to-speech synthesis system that synthesizes speech that is more intelligible and natural sounding to be incorporated in speech-generating devices. Individuals who are at risk of losing their speaking ability can prerecord their own speech, which is then converted into their personal synthetic voice.

Brain–computer Interface Research

A relatively new area of study is called brain-computer interface research. Scientists are studying how neural signals in a person’s brain can be translated by a computer to help someone communicate. For example, people with amyotrophic lateral sclerosis (ALS, or Lou Gehrig’s disease) or brainstem stroke lose their ability to move their arms, legs, or body.

They can also become locked-in, where they are not able to express words, even though they are able to think and reason normally. By implanting electrodes on the brain's motor cortex, some researchers are studying how a person who is locked-in can control communication software and type out words simply by imagining the movement of his or her hand. Other researchers are attempting to develop a prosthetic device that will be able to translate a person's thoughts into synthesized words and sentences. Another group is developing a wireless device that monitors brain activity that is triggered by visual stimulation. In this way, people who are locked-in can call for help during an emergency by staring at a designated spot on the device.

Remote Monitoring of Vulnerable Patients

The Enhanced Complete Ambient Assisted Living Experiment (eCAALYX) is funded by the European Commission to manage the development of ICT-based solutions for the prevention and management of chronic conditions of elderly people. One of their projects was to develop a 'wearable body system' vest with built-in sensors with an accompanying smartphone app which can be used to gather and present the data. Trials conducted for this project indicate that the app can detect if the wearer is lying down, standing, sitting or walking and take measurements of pulse, blood pressure, respiration and body temperature.

7. IT evolution from Turing to Touch

History of Computing

Having described the 'untapped billion', the range of their disabilities and the evolution of assistive technology, we now need to consider parallel developments in the IT and communications worlds in order to draw the two together.

The IT industry has been on a fascinating journey from the early days of Turing and von Neumann and its roots in code breaking and the cyphers of the Second World War. Computers were those unbelievable 'systems' that sat in special buildings and only people in white coats had access to their enormous processing engines. The challenge in the early days was how to get the instructions into the giant machine and how to then manipulate information sets. These mainframe computers were rare and certainly not accessible to the masses. Interestingly we then went through the mini and micro computer and saw the beginnings of the mass computer revolution when the Personal Computer was born in the 1980s. The interface to the processing power was still clunky and machine like in its language.

What has happened in the intervening 30 years is that the language we use to interact with these computers has become more and more human. The sequences from Star Trek in the 1960s when Captain Kirk spoke to the computer on the Enterprise seemed a pipe dream, but it is becoming a reality.

Convergence

Through massive increases in compute power we now arrive at a situation where we can, literally, speak instructions to these now virtualized machines. In addition, with the advent of the smart mobile devices and tablets without keyboards, we can also use pointers, gestures, tapping as well as speech, to open up the applications that we find indispensable to our life styles.

The implications for all users, let alone disabled ones, are enormous. Basically, we can control a vast amount of compute power, search swathes of information and access vast quantities of content stored around the world through a variety of interactive methods.

We now have a range of devices from the pocket sized smart phone, through the tablets and laptops through to the reducing number of desktop computers. And we also need to include television screens. Behind all of these devices comes an increasingly rich set of fixed and mobile connectivity services that allow the content of these screens to be of a higher and higher quality. Refresh rates and pixel densities mean that the quality of images flowing across these multiple screens are breath-taking compared to the fuzzy images of the early televisions or personal computers. The operating systems and applications that were formerly unique to a particular brand are now settling into a series of eco systems that allow the applications and content players to spread their wares more readily across all screens.

This provides us with the platform for converged services of all types. And, perhaps most importantly for the ‘untapped billion’, it means that the barriers to entry for accessible solution for a large majority of people, are significantly reduced. The new digital era is born. As this evolves, the dedicated hardware of the past is replaced by virtualised servers in data centres spread across the world. The engine of the future becomes the combination of these data centres, fixed and mobile networks but, most importantly, the software that drives these infrastructure resources and the applications that manipulate the information and the content that we need to run our lives.

Furthermore, the move to ‘wearables’ such as glasses, bracelets, body suits with the potential to connect to the wealth of compute devices and services above, all bring the digital world literally into our hands, on our heads and on whatever part of the body necessary. This gives new access to a vast array of databases including mapping, picture and video libraries as well as real-time recognition software which takes advantage of the camera mounted in the glasses.

The Shift to Digital

There is a fundamental move for the IT industry from hardware-based to software-centric solutions. This is because the platforms that we use in business and our personal lives are becoming more standardised, commoditised and indeed virtualised. Hence processing is more distributed between the device, the network and the many data centres around the world. The processing capabilities of an individual machine like a mobile phone can now be complemented by processing capacity and information away from the device. This is the shift to digital.

The ICT industry is developing its infrastructure to underpin both business and society with services. The permutations are astonishing. Imagine that all of the computing and phone devices in your possession are now complemented by the emerging range of peripherals and wearables (e.g. Google Glass). Then consider the compute and communications possibilities open to be exploited.

8. Linking the IT industry, Assistive Technology and the Untapped Billion

The previously unlinked worlds of assistive technology and IT are now converging to the benefit of all.

The Benefit for Assistive Technology in Smart Phones and Tablets

The individual is increasingly in a position to adapt their computing devices to suit their particular needs. This is partly due to miniaturisation, but most importantly to the software-centric nature of the IT world today. Part of this miniaturisation also means that assistive technologies can be built into the operating system of the devices rather than being added on (often in an unwieldy fashion) as a piece of software, additional screen or device. The camera facilities on today's mobile devices also offer additional potential for adding video and image based analysis tools to help with daily life.

Smart phones in particular have begun to build features into their operating systems that allow access not only to the wealth of available applications, but also allow core screen reading and text to speech facilities to assist the user. In short, the smart phone has become an incredible compute platform for the disabled individual. The possibility of speech-in and speech-out, combined with the touch and gesture interaction makes them functionally useful

in many diverse situations. The power in your pocket, or in your hand, is complemented by some heavy lifting compute power provided behind the applications and the service providers supporting the devices.

Smart phone accessibility is increasingly taken for granted. Apple led the way with its Voiceover and other accessibility features built into iOS. Android has followed suit. Since these two operating systems represent over 90% of smart phones being shipped in the world today, a more accessible platform is in place for the untapped billion assuming that some peripherals are also added for special assistive interfacing.

Applications and Content

As well as the shift to more powerful smaller devices to bring the compute power into hands the disabled, the applications and content we consume on these devices is key. Formats of books, television programmes and films have all developed within their own particular industries. As part of the move to digital, books can now more easily be consumed via a specialist reading device such as a Kindle or indeed via an app on a smart device. With changes in the intellectual property laws worldwide, most new titles can be accessed on the preferred device or media. Digital is seen as another way to market for the publishers and not the ruin of their former physical business model. Video content is more challenging as is tagging the 'content' of a programme or film. Having said that, the content is increasingly available, depending on intellectual property (IP) issues on these multiple devices.

Access to this wealth of services and content is made simpler by web interfaces and the increasing range of applications available. Apps merely take the 'service' and make access easier, rather than ploughing through endless web links. In some ways, we have reached a situation where the technology behind the scenes is allowing us to get straight to the 'service' we are looking for, whether that is news, access to airline booking system, shopping online or a thousand other activities. Hiding the technology from the customer is the best way of exposing the benefits of technology!

From a disabled access point of view this opens up some enormous opportunities. If books are available in a digital format, then they can be converted into the spoken word on a device such as a Kindle or smart phone. Television and film can benefit from an audio description describing activity on the screen that is interspersed amongst the dialogue. And, with the correct tagging of web sites and applications, access is possible to all features available to non-impaired users.

More open mobile platforms can become the gateway for the untapped billion to gain access to the digital world. Some additional peripherals will be required, such as earphones or some form of tactile display, but a great benefit will arise for the disabled and a significant market opportunity will be presented.

Opening Up Opportunities: Home, Business and All Points In Between

In the home, smart devices are likely to become the hub for domestic services, linking to domestic appliances, televisions and home functions such as heating, lighting and security. (The Internet of Things). Since these devices are becoming more accessible, this means that all of these domestic services are now available to all people whatever their impairment.

As just an example, imagine how Google Glass might act as a hub for processing visual information coming in through the built-in video and fixed camera to feed audible and/or visual information back to the wearer.

Another throwback to the science fiction of the 1960s is seeing the resurrection of the robot. Perhaps not the clunky devices envisaged in television and films of that decade, nor even the companions in Star Wars, but a wide range of tiny, small, medium and large robots that can assist with every day tasks. With an ever-increasing ageing and ailing population, these may become essential to assist with vital care services.

Disability and the Propensity to Adopt Technology

When mapping the disabled population to the digital world, it is important to consider that the numbers increase significantly in the older age group. (In the world population 57% of those with visual impairment and 33% of those with hearing disabilities is aged 65 and over).

Children born with disabilities, or whose disabilities develop in formative years, are more likely to adapt to their circumstances with assistive technology being provided to them as part of their education.

Conversely, the ageing disabled population, having grown up in the ‘real world’ often struggle to accept the need to embrace assistive technology and are less likely to have awareness of what is available to them.

In The Salmon of Doubt, the author Douglas Adams has an interesting theory about how we embrace technology according to our age:

- *"Anything that is in the world when you're born is normal and ordinary and is just a natural part of the way the world work.*
- *Anything that's invented between when you're fifteen and thirty-five is new and exciting and revolutionary and you can probably get a career in it.*
- *Anything invented after you're thirty-five is against the natural order of things."*

For those whose disability starts early in their lives, there is now a much greater chance of acquiring some skills to access the digital world. This is not just dependent on the education system but also on care services and charities associated with a particular disability.

For those whose conditions develop later in life, according to the Douglas Adams theory, embracing new technology can be a challenge. This is, of course, true for people without a disability, but is accentuated when some special equipment might be required to open up the access.

Importance of Accessibility for the Disabled Population

Access to the digital world for this billion people is important from several perspectives:

- It will allow the disabled to benefit from the social media revolution to keep in touch with life around them – especially important for people who are isolated or find it difficult to leave their homes without assistance

- For those of working age, it will allow them to enter the workforce and contribute to their economy on a more even footing than has previously been possible

- It will allow everyone the opportunity to enjoy the benefits of being part of the mobile commerce revolution.

And, from another perspective, it provides 'authorities' with a platform for reaching into the household and down to the individual. It offers a unique link into the vast majority of individuals through fixed and increasingly mobile connectivity to the device in their hand whether as customers or citizen.

Another dimension to the changing world of accessibility is that of maps. Magnified or Tactile versions of maps were expensive and awkward to use. Specialist devices were developed that leveraged GPS and map information to help with guidance but they too suffered from lack of scale as well as cost. Maps are now being developed in digital form that even extend into buildings and across non-road routes. And, from the accessibility perspective, these maps along with endless characteristics of the environment around, are easily accessible from the mobile device with various outputs (including through peripherals) to assist the traveller. And, the sheer scale of the mapping business, means that the cost to the end user is minimal.

Take this one stage further, and buildings, shopping centres, parks are tagged with transmitters. Navigation suddenly becomes plausible for all, finding a route without steps, finding shops, even finding an aisle within a shop.

9. The Role of the ICT Industry in Enabling Accessibility

The building blocks are in place to leverage our 'untapped billion'; we have plenty of processing, storage, networking power available spread across the increasingly virtualized infrastructure of the world's ICT industry. Indeed, we have a more and more software-centric series of providers either related to the infrastructure or, the so-called 'Over The Top (OTT) providers who are positioning to exploit this wealth of compute power. In addition, we are witnessing the collapsing of many infrastructures and processes that were formerly kept separate by different industries. Financial transactions are now much closer to the individual, removing the need for physical cash. Logistics and distribution mean that an order placed via a smart device is often fulfilled by the following day. Embedding compute and communications services into every industry's business processes and flows facilitates the digital economy.

Given the developments in assistive technology described above, we require a standard approach from the different players. Be they device manufacturers, connectivity providers, IT services or applications and content suppliers, these standards are essential in order for the computerized and simplified set of assistive technologies to offer the option of choice to the different segments of the untapped billion.

Innovation in terms of development cycles and new business model development are emerging every day. We even recently saw the proposition of a screen reader being delivered along with Microsoft's Office 365. The possibilities are endless.

Standards in Assistive Technology

With assistive technology having been developed through a combination of academic and industry research & development in pockets around the world, it is not surprising that many of the pieces do not 'fit together' when it comes to a converged approach. The common platform of the mobile phone, tablet, PC/laptop and TV, combined with the world of web sites and applications development, mean that there is more common ground to work with. Less and less adaptation of mainstream computing devices is needed to build the solutions previously done on a proprietary basis. Specialist peripherals that give different disabled groups access to this new mobile compute platform need to link to the IT world but this is a small task for the researchers and developers. In simple terms, these peripherals for disabled people need to behave in a similar way to the explosion of peripherals and wearables that the majority of the user base will be using.

There are many instances where multiple disabilities need to be addressed and open standards are essential to facilitate the integration of multiple assistive technology devices. The eminent scientist Professor Stephen Hawking is a well-known example of how this can work. He has amyotrophic lateral sclerosis (ALS), a neurological disease that causes patients to lose control of their voluntary muscles.

At the opening ceremony of the Paralympics in London in 2012, from his wheelchair in the middle of the stadium, said:

" Obviously, because of my disability, I need assistance. But I have always tried to overcome the limitations of my condition and lead as full a life as possible. I have travelled the world, from the Antarctic to zero gravity. Perhaps one day I will go into space."

How did he 'say' this? On a screen attached to his wheelchair, commonly used words flash past him. With a cheek muscle, he signals an electronic sensor in his eyeglasses to transmit instructions to the computer. In this way he slowly builds sentences and the computer transforms them into the famous metallic, otherworldly voice. In effect he is benefiting from the combination of software and devices developed for several conditions.

Adhering to Best Practice

The frameworks and standards for the industry to follow are largely in place. Guidelines for web site labeling and application button tagging will all help the apps and content world make itself openly accessible to the 'untapped billion', whether for the billion to consume content and applications themselves or to help their care givers and health community providing services. The need for adhering to best practice in building web sites, labeling and tagging applications and content also needs to be extended to all industries as they build the future interface for all customers. The telecoms industry talks a lot about building the customer experience. Here is a classic example of having the multiple pieces in place that could offer truly life changing services to the 15% of the world's population who have previously struggled with many of the new technologies.

The United Nations Convention on the Rights of Persons with Disabilities is clear about the duties of each participating country. Article 21 specifies that *"people with disabilities have the right to express themselves, including the freedom to give and receive information and ideas through all forms of communication, including through accessible formats and technologies, sign languages, Braille, augmentative and alternative communication, mass media and all other accessible means of communication"*

The following organisations are amongst those playing a key role in setting these standards for manufacturers and providers:

- W3C led by Tim Berners, has mission is to lead the World Wide Web to its full potential by developing protocols and guidelines that ensure the long-term growth of the Web. Accessibility for all is a key feature of this organisation's work

- G3ict (The Global Initiative for Inclusive Information and Communication Technologies) is an advocacy initiative launched in December 2006 by the United Nations Global Alliance for ICT and Development. Its mission is to facilitate and support the implementation of the dispositions of the Convention on the Rights of Persons with Disabilities on the accessibility of ICT and assistive technologies. G3ict relies on an international network of ICT accessibility experts to develop and promote good practices, technical resources and benchmarks for ICT accessibility advocates around the world.

10. So What Are The Barriers?

Education and Awareness

There is extremely important role for the digital world: that of educating the remaining 85% 'not disabled' population how to best interact with the 'untapped billion'. Because of the way in which disabled people have been educated in the past, mostly in specialist schools, few older people have experienced studying with, let alone working with disabled people.

An understanding of how different categories of disabled people can be helped by the wider public would help enormously. Interestingly, several charitable and research groups now talk about people being 'temporarily disabled' (Abilitynet) or 'situationally disabled' (Gartner). This refers to the times in the daily lives of the 85% when people cannot use the full range of digital services at their disposal. This could be while driving, having hands full with shopping, or perhaps when a discrete text-based exchange on a train is more appropriate than an overheard conversation! The massive leaps in technological advancement we have seen are also going to benefit this majority as well as releasing the potential for the billion disabled.

In many ways the requirements on industry to make their products, applications and services more accessible are in reality just good practice. Evidence from the cleaner, simpler mobile apps world shows that people find them more usable. Fundamentally the industry needs to develop:

- Clear interfaces on the multiple screens: smart phones, tablets, PCs/laptops & televisions
- Applications clearly labelled with meta data to facilitate accessibility of all sorts
- Web sites and content clearly labelled
- Information on accessible solutions made available though the omnichannel retail solutions that are increasingly open to people

11. Go To Market

Analysing any market ends up with the Go-To-Market strategy. The structure of the evolving digital industry is such that it has a series of formerly separate supply and value chains collapsing into the world of smart devices and applications. The question is therefore, how does the industry get these accessible devices and applications into the hands of the untapped billion at an affordable price?

Educating all parties who potentially touch the different disabled groups is a challenge. Who provides the daily support to the untapped billion? Often it is left to family or carers from charitable organisations as well as those in the health care community and local or central government. The fact that the penetration of mobile devices is over 100% in most countries means that we have a new link into this community. It should be pointed out that it's not 100% of the disabled community, but with the advances in accessibility available, it will be approaching that figure in the near future.

There is an opportunity for the mobile operators to build disable access into their services offering and it will be a valuable addition to the education and awareness of the 'untapped billion'

The Mobile Manufacturer's Forum (MMF) is running an initiative called The Global Accessibility Reporting Initiative (GARI). This is a project designed to help consumers learn more about the various accessibility features of mobile phones and to help them identify phones with the features that may assist them with their particular needs. As it's a web site, it can be directed to the many physical and virtual retail outlets as well as to the carers and helpers working with the individual. Mobile operators can take the information on the GARI web site and present their own devices subset to their customers or potential customers.

Sharing this knowledge with the people working in the mobile outlets and with those operating call centres will facilitate the knowledge being spread throughout the community.

In short all stakeholders have a role to play:

- The industry needs to keep developing more and more accessible devices
- The health care sector needs to keep up with these technical developments and encourage people to try out the new accessible devices and services
- The voluntary sector can keep up to speed with the devices and, since these are generic, should be in a position to help disseminate the information

This is not a legislation issue. Yes, the global and local legislation needs to be in place as a framework but this is a much more practical requirement. As mentioned previously, the building blocks are in place. It is merely a question of making sure all touch points with the untapped billion are aware of the possibilities and can contribute to the education process.

However, the nature of the telecoms and IT industry is such that the global initiatives, combined with the many national and state organisation working with the disabled community, coupled with the telecoms and IT industry, is how we will bring the services down to the individuals. And, extremely importantly, the vast array of volunteers who help in

individual communities also need to be helped to understand the potential for the connected disabled billion.

It should also be pointed out that, despite all of the technology and services that have been identified in this report, it is still essential to have the human touch and some local, on-the-ground support. The vast majority of 'things' can be replaced by some form of digital service, but the human touch is the final one that will make the digital future for the untapped billion.

12. Conclusion

In the past, overcoming a disability to lead a 'normal' life was seen as exceptional – even extraordinary. (Think Professor Hawking, the blind Stevie Wonder and the deaf Ludwig Van Beethoven).

Point solutions to individual problems was the historical approach. A more centralised, digital-based approach of inclusive access to applications and content for personal and business use means that the peripherals required to adapt that content and applications to the individual requirements, whatever the disability, is now a much more straight forward and cheaper process.

There is a requirement to educate:

- The ICT industry about embracing the benefits of embracing disability
- The disabled themselves about the relative simplicity of accessing the digital world
- All of the touch points in between the industry and the 'untapped billion' including health sector, families and charitable organisations.

Remember, disabled people want to live in the real world and not in some artificial disabled world. They want the latest devices, want to watch the latest TV and film and want access to the latest books and news feeds. Oh, and they want to participate in the social media revolution as well!

Mobile operators have an individual relationship with the customer. This relationship can be used to make the smart device the hub for accessing the digital world, leveraging the built-in assistive technology, at a much lower price point than we have experienced in the past.

In order for this to succeed, all stakeholders in the digital marketplace need to ensure that websites are designed correctly, applications are tagged properly to facilitate this accessibility revolution.

And, this is a win/win for everybody. The more accessible the digital world, the less disability will be seen as a drain on society, the more the 'disabled' potential will be unlocked and many so-called able-bodied people will also find access to the digital world much simpler and rewarding.

Where does this end? Well, interestingly, the revolution of Machine-to-Machine (M2M) surging around the world currently has already given us a so-called 'self-drive' car. Regular drivers love the idea of being able to hand over to the car's systems, linked with navigation and smart city systems, the car is capable of driving itself. Well, this brings us close to the reasonable possibility of a disabled person 'driving' that car. Whenever this is raised with

regular drivers, that the person in the car next to them can't see or has no arms, the regular drivers are somewhat put out. But, if society trusts a car to drive a regular bodied person while they do their Power Point final edits or join a video conference, the systems have got to be sufficiently reliable to allow for that blind person or physically impaired person to be the responsible adult in the car. Surely we wouldn't allow children to be in charge of the car, would we?

Appendices

Appendix 1. Data

In 2011, The World Health Organisation together with The World Bank produced a report entitled 'World Report on Disability'. This is the report which gave rise to frequently quoted figure of 1 billion people with disabilities in 2010. This report was largely based on 2004 data on the prevalence of disabilities together with 2010 estimates of world population from the UN Population Prospects, which are produced each year for the preceding year. It produced estimates of between 785 million and 975 million adult people (15 years and over) living with a disability giving a figure in excess of 1 billion when the data for children (0-14 years) are added in.

Included in the global figure are many disabilities which are less likely to be addressed by assistive technology – these are classified as 'other' in this paper.

- Depression
- Alcohol dependence
- Infertility due to unsafe abortion and maternal sepsis
- Heart disease
- Bipolar disorder
- Asthma
- Schizophrenia
- Alzheimer and other dementias
- Drug dependence and problem use

Excluding the above and taking data for disabilities which are considered more likely to be addressable by assistive technology, we have achieved what we believe is an estimate of the population living with disability more useful as a guide to the potential market for assistive technology – 850 million or 12.3% of the total population of the world. These estimates are shown below:

Disability	**Estimated Prevalence (%) in World Population of 6,942 million (2010)**	**Estimated Population Living with Each Disability (Million)**
Disabling Hearing Loss	5.2	360
Visual Impairment & Blindness	4.1	285
Brain Injury (TBI and ABI)	1.8	125
Autism and learning difficulty	1.0	69
Loss of hands/arms (congenital, accident, war, leprosy*, amputation)	0.19	13
TOTAL	**12.3**	**852**
* Prevalence of leprosy is 0.34% world wide, with the highest rate in South East Asia, however the disease does not necessary lead to loss of hands or arms		

Breakdown of Population of Blind People by Age

Age Group	Percentage of All Blind People	Estimated Number of Blind People(Million)	World Population in Each Age Group (Million)	Blind People as % of Each Age Group

PREVALENCE OF VISUAL IMPAIRMENT AND BLINDNESS, 2010							
		Prevalence %			Estimated Number (Million)		
Region	Estimated Population In 2010 (Million)	Low Vision	Blind	Vision Impaired	Low Vision	Blind	Vision Impaired
Africa	857	2.5	0.7	3.2	21	6	27
Americas	939	2.6	0.4	3.0	24	4	28
Europe	900	2.9	0.3	3.2	26	3	29
Eastern Mediterranean	608	3.2	0.8	4.0	19	5	24
South East Asia	1,830	4.4	0.6	5.1	80	11	91
Western Pacific	1,808	4.2	0.6	4.8	76	10	86
WORLD	**6,942**	**3.55**	**0.5**	**4.11**	**246**	**39**	**285**
Source: WHO Visual Impairment & Blindness, 2010							

0 to 14	4	1.56	1,842	0.085
15 to 44	7	2.73	3,234	0.084
45 to 59	32	12.48	1,075	1.16
60 and over	57	22.23	791	2.81
ALL AGES	**100**	**39.00**	**6,942**	**0.56**
Sources: Lighthouse International (% of Blind People); UN World Population Prospects, 2012				

Blind people of working age (15-59) represent 0.35% of the world population of that age group.

Disabling Hearing Loss

Definition of Disabling Hearing Loss (DHL): Hearing loss greater than 40dB in the better hearing ear in Adults (15 years and older) and greater than 30dB in the better hearing ear in children (0-14 years).

WORLD POPULATION OF DHL PEOPLE BY REGION				
Region	Percentage of All	Estimated Number of	Population of Each	DHL People as

	DHL People	DHL People (Million)	Region (Million)	% of Population in Each Region
High Income Countries				
Western Europe, Canada, US, Japan, S. Korea, Singapore, Brunei	11	37.8	1,095	3.4
Middle & Lower Income Countries				
North Africa & Middle East	3	11.2	432	2.6
Sub Saharan Africa	9	36.8	631	5.8
Latin America & the Caribbean	9	30.6	596	5.1
Central/Eastern Europe & Central Asia	9	31.1	487	6.4
South Asia	27	100.3	1,681	6.1
East Asia	22	74.6	1,418	5.3
Asia Pacific	10	37.4	602	6.2
		322		
WORLD TOTAL	**100**	**359.8**	**6,942**	**5.2**
Sources: WHO Global Estimates on Prevalence of Hearing Loss, 2012 UN World Population Prospects, 2012				

DHL shows the lowest prevalence in children typically between 1% and 2% (overall mean 1.7%), DHL in children is lowest in High Income Countries (0.5%) and highest in South Asia (2.4%).

In adults aged 15 years or more it is higher (7% overall and rises to almost 33% in adults older than 65.

Brain Injury

The Brain Injury Association of America published the following statistics.

BRAIN INJURY STATITICS FOR THE UNITED STATES, 2011		
Type of Injury	**Annual Incidence**	**Number of People Living with Long-term Disability as a Result**
Traumatic Brain Injury (TBI) caused by RTAs, falls, etc.	1,700,000	5.3 million
Acquired Brain Injury (ABI) caused by:	917,000	
Stroke	795,000	1.1 million
Tumour	64,530	
Aneurysm	27,000	
Viral Encephalitis	20,000	
Multiple Sclerosis	10,400	
TOTAL	**2,617,000**	**6.4 million**
Source: Brain Injury Association of America, 2013; data comes from a variety of sources and relates to various years from 2005 to 2012		

From the above statistics for the US and from data for UK, Ireland, Australia and New Zealand it is possible to estimate the prevalence of people living with the long term effects of brain injury.

PREVALENCE DATA ON TBI AND STROKE FROM VARIOUS COUNTRIES				
Country	Type of Brain Injury	Total Population 2010 (Million)	Number of People Living with Long-Term Disability as a Result (000)	Prevalence (%)
USA	TBI	312	5,300	1.7
	Stroke	312	1,100	0.35
Europe	TBI	740	8,000	1.1
United Kingdom	TBI	62	500	0.8
	Stroke	62	450	0.7
Australia	Stroke	22	220	1.0
New Zealand	Stroke	4.3	45,000	1.0
Sources: Various National Health Authorities and Associations				

Learning Difficulty and Autism

Statistical data on the incidence of learning difficulty and autism are very sketchy and largely confined to the High Income countries.

Thus the USA children with autism spectrum disorder represent 1.1% of the population (according to the Centers for Disease Control & Prevention - CDC). Also from the CDC comes a figure of 16.7% for children considered to have a development disability, ranging from mild disabilities such as speech and language impairment to serious development disabilities such intellectual disability, cerebral palsy and autism.

In the UK The Foundation for People with Learning Disabilities reports that:

- Approximately 1% of the population has an autism spectrum condition. The percentage is higher for men (2%) than for women (0.3%)
- Of people with autism 60-70% will also have a learning disability
- Among single men the autism percentage rises to 4.5%
- 286,000 children aged 0 to 17 have a learning disability, which represents a prevalence of approximately 2.2%
- Only 6.6% of adults with a learning disability are in paid employment, the majority of whom are in part time employment.

Loss of Hands and Limbs

In the high income countries around 90% of limb loss is acquired and only 8-10% is congenital. The major cause of acquired limb loss in the high income countries is vascular disease especially diabetes and in non-diabetic smokers. Amputation of upper limbs represents only some 20% of all acquired limb loss and here accidents (RTAs and work related in the main) leading to trauma are in the majority (77%) with congenital absence or deformity account for 9%, tumour for 8% and disease for 6%.

In the rest of the world a significant factor is loss of hands and arms as a result war or land mines in the aftermath of war. We estimate that the prevalence of hand and arm loss from all causes is around 0.1% in high income countries and 0.2% in middle and lower income countries giving a total of approximately 13 million people world wide, and a prevalence rate of 0.19%.

Appendix 2 – Bibliography and Research Sources

- Gartner Report: Market Trends: New Technologies Benefit Employees and People With Disabilities – 20 September 2013
- Ability Net report – Mind the Digital Gap November 2012 http://www.abilitynet.org.uk/mindthegap
- Universal Citizen Access, Universal Consumer Access - A New Approach http://www.abilitynet.org.uk/sites/abilitynet.org.uk/files/Universal Citizen and Customer Access Kevin Carey October 2012.pdf
- National Institute on Deafness and Other Communications Disorders (NIDCD) http://www.nidcd.nih.gov/Pages/default.aspx
- International Paralympic Committees Guide on Accessibility http://www.paralympic.org/sites/default/files/document/130902143349868_IPC+Accessibility+Guide_2nd+EDITION_FINAL.pdf
- UN Convention on the Rights of Persons with Disabilities http://www.un.org/disabilities/convention/conventionfull.shtml
- UK Department of Health Report - Research and development work relating to assistive technology July 2013 - July 2013 http://www.dh.gov.uk/publications
- General Medical Council UK http://www.gmc-uk.org/
- G3ict http://g3ict.com/
- W3C http://www.w3.org/
- ITU
  - http://itu.int/en/ITU-T/studygroups/com16/accessibility
  - http://itu.int/en/ITUT/studygroups/com16/accessibility/Pages/achievements.aspx
  - http://itu.int/pub/T-TUT-FSTP-2006-TACL/en
  - http://itu.int/rec/T-REC-F.790
  - http://itu.int/ITU-D/sis/PwDs/Documents/e-accessibility_Ver_03.pdf
  - http://itu.int/ITU-D/sis/PwDs/Documents/Mobile_Report.pdf