Digitising the disabled billion
Accessibility gets personal

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Executive summary

There are roughly a billion people in the world with disabilities

To put these numbers into some perspective, if all the world's disabled people lived in one country, it would be the third most populous country on earth, behind China and India, and around three times the population of the USA. If just people with physical disabilities formed a country on their own, it would be roughly equal in population to the UK.

Looking at the economic side, the spending power of disabled people is over $3.5 trillion, and more than doubles to $8 trillion when combined with the spending power of friends and family around them. Due to a lack of accessible technology, the disabled generally do not have access to the online world and hence miss out on the benefits of shopping, banking and generally living online.

Breaking the billion down into age bands throws up a ticking time bomb: 4% of children are disabled, 10% of working age and an enormous 77% of people over the age of retirement. As one person put it to me, "think of the market being made up of disabled, and not yet disabled!" So, most of us have a vested interest in making lives more accessible when it comes to digital living.

Unemployment amongst disabled people varies by category but can be as high as 80% for severely disabled. Even for those in employment, we estimate that they earn on average only 60% of their able-bodied peers.

The confluence of assistive technology, better education/training, communications services, applications/content development and consumer electronics can bridge this gap, improving earnings and tax income as well as reducing the cost of supporting the disabled. Fundamentally, mainstream technology in many forms is allowing sensory replacement for both input and output from a disabled person. The mobile device is at the heart of this step change. The services on these devices, coupled with input from wearables and a smarter

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environment around us, allow people to communicate in alignment with their limitations as well as interact with the digital world around them. We called it Artificial Intelligence (AI) in the 1980s. The dream of a computer translating from one language to another is now a reality. The knock-on benefit of such algorithms is also evident in assisting senses that are impaired, as well as bringing a vast array of information to help with daily processes for pleasure or work. Simply put, the individual is now at the centre of a hugely connected series of personal, environmental, societal and business flows.

Education and training are needed at every link in the value chain. We talk about ecosystems and value chains; the same applies for the disabled community. Unfortunately, the fragmentation within individual disability segments compounds the challenge of getting everyone up to speed with available technology and solutions.

- *Education age:* ensuring educators and carers are well versed in the technical possibilities will make disabled young people more employable when they leave the education sector. However, it is also essential to spread the word across specialist educational establishments, as well as mainstream schools with disabled children attending.
- *Working age:* educating employers and colleagues about people with disabilities, or those acquiring a disability whilst working, is critical. The better-educated youth entering potential work will help, but a cultural change in employing disabled people is also called for.
- *Retirement age:* support from family, charities and social services will be required to get digital services into older people's lives. There will still be some need for specialist, simpler interface devices for the elderly to join in the digital lifestyles.
- *Government and public bodies:* building a smarter environment around the better- connected digital individual also requires a fundamental change. One organisation told me how they tried to source information about public toilets to help disabled people find them when out and about. A council here, a city authority there and even a state-wide initiative - but no consistency. Such a simple but effective source of information but Local and central government authorities need to join up their thinking.

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We are generally moving away from dedicated, expensive equipment offering single functionality. The platform is now a standard smartphone, tablet, laptop or television. Some specialist add-ons will always be required for the final bit of customisation but the platform is generic. Built-in accessibility to the operating system of the device, as well as to the apps and web content, renders the device accessible to the individual whatever sensory replacement is involved. And, since we are talking Internet economics, the cost to the individual and family, or business or state supporting them, is down to a dramatically reduced level.

Availability of smartphones at the sub-$50 level means that this is true for the emerging economies as well as the so-called more mature Western economies. The age of assistive equipment costing tens of thousands of dollars is, for the most part, gone. 'Free' algorithms designed to interpret images, sounds and gestures (but perhaps not yet brainwaves) are now available, as academia gets closer to mimicking the human.

When it comes to apps, interface and product design, it is simple: design for all; inclusivity, accessibility and simplicity built into the end-to-end process of designing and maintaining apps and web sites; and tagging content properly. This will improve everyone's experience. It means that accessibility gradually becomes part of personalisation, rather than an expensive and often cumbersome 'add-on' as an afterthought.

Innovation is coming from a much wider range of sources. Incubator groups within the mobile and telco operators are producing disability-oriented solutions alongside mainstream ones without any special encouragement. This is perhaps part of the democratisation of applications and product development brought about by the Internet, mobile platforms and a more open computing environment. We are also beginning to see the disabled community itself producing apps appropriate for their peers. After all, who is best placed to design an app for a particular impairment? Interestingly, it is not all end-to-end automation. The communications revolution means that we can find helpful people, paid or volunteers, who are willing to be at the receiving end of a picture, video or other content and 'describe' that content in an appropriate way to the disabled person. This form of remote assistance

is a great indicator of the strides we have made with mobile at the heart of delivering assistance.

In the report last year we talked about self-drive cars for disabled people. If a car can have hundreds of sensors helping it drive around successfully, why can't I, as a visually-disabled person, have a similar level of sensor-based help to help me navigate my way through life?

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1. Introduction

The worlds of disability and technology coming together is another example of convergence of formerly very separate markets. As we have seen in many converging technology markets, there are benefits to the end users and challenges for the value chain and routes to market.

This report looks into the details of the disability market, its breakdown by age and employment, as well as by disability, and puts it into the context of economic activity. Changes in technology are increasingly allowing the disabled community to join in the benefits of the digital age, whether that be online shopping, home automation, smart city services or employment.

In addition to analysing further the available statistics from many national and international bodies, we talked with stakeholders, from the technology players to the disability groups, as well as polling disabled people themselves. A momentum is building within different disabled communities to seek to learn the benefits and ways of joining in the digital economy. Activities around wearables and smart cities join those of more accessible mobile devices at the heart of our personal activities to create all-embracing experiences.

Fundamentally, technology in many forms is allowing sensory replacement for both input and output from a disabled person. We called it Artificial Intelligence (AI) in the 1980s. The dream of a computer translating from one language to another is now with us. The knock-on benefit of such algorithms is also evident in assisting senses that are impaired, as well as bringing a vast array of information to assist in daily processes for pleasure or work. Simply put, the individual is now at the centre of a hugely connected series of personal, environmental, societal and business flows.

The report also outlines the economic position of disabled people, including their spending power, and reviews the technology developments that are improving their interaction with technology and the economy. Putting it all into a business context, we then look at the value chain and channels to market in order to bring these benefits to the economy as a whole.

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There is a call to arms to all stakeholders in order to make this work, and move accessibility from a disabled issue into part of the personalisation that the mobile industry has promised us for many years.

Chris Lewis (appendix D) the author of this report, has over 30 years experience of researching and analysing telecoms and adjacent technology sectors. Throughout this time, Chris has been registered blind and has been using assistive technology. The smartphone in particular has changed his life giving him access to a wealth of services. This report has deepened Chris knowledge of all disabilities and covers accessibility from a pan-disability perspective.

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2.   Economic impact of a more accessible world

Views of the world's economists are sought regularly throughout all of the media. One thing I always keep in mind is a Chief Economist friend of mine who says that economics is as much an art as it is a science. The economic impact of making the world a more accessible place brings an enormous number of factors together. In this section we take a look at the global level; the assumptions we outline can be adapted and modified for any country.

In the same way as it is as much an art as a science, the application of any model needs to be tempered with a lot of local flavour when it comes to an individual country. Having said that, the trends concerning getting more and more disabled people into mainstream digital activities is evident from the richest developed country down to the poorest emerging market. Luckily, the relentless progression of commoditisation of consumer electronics components, combined with the flourishing and ever-more powerful mobile networks, means that the control is in the hands of almost everyone.

We have built a model of the disability community and its segmentation, income by disability, age, and economic zone (see A). The model behind this section was built using United Nations/ World Health Organisation statistics on disability, and supplemented through sources from different countries and disability organisations in order to round out the information. It seems strange, but these statistics are neither consistent for a country nor for the different disability categories. And we have to assume that the numbers presented are, in fact, not the absolute truth, as many people with some form of disability neither get themselves registered, nor acknowledge their status as being with some impairment.

The billion people identified in the statistics represent 1 in 7 of the world's population

Their family and friends, who are inextricably involved in the lifestyle of those billion, should also figure in the economic activity, as they may either execute the activity on behalf of the individual, accompany them or just share in the activity.

We estimate that disabled people's spending power is in the order of over $3.5 trillion and doubled when friends and family are included

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As with all statistics relating to disability, accurate numbers are difficult to come by. It is indisputably an enormous amount. The question is often whether a disabled person gets the same access to deals and cross-selling opportunities today as the most connected and tech-savvy individual.

The good news is that the tide is turning, and all of the accessible solutions discussed in the following sections demonstrate how the digital market for the disabled is expanding

Better than that, if we get all of the implementations right, and drive all of the stakeholders together, accessibility will become part of the oft-talked-about personalisation of the digital world.

The digitisation of many processes in healthcare and social services should allow us to get more efficient services in place and reduce the cost, or at least allow us to use the same amount to support more people. However, the picture is more complex than it might first appear. 80% of the costs are borne by advanced economies, simply because they have the wealth to be able to spend on the disabled. In contrast, only about 0.5% of the costs of supporting the disabled is spent by developing nations because they do not have sufficient wealth to spend more.

The 'business case' for reducing disabled support costs is therefore strongest in developing economies and this raises some interesting ethical questions, similar to those around the availability of drugs to fight AIDS. Clearly if we rely simply on a business case for helping the disabled, the vast majority of disabled people will not benefit from our actions because they don't 'cost in' to the equation.

According to our research, the $3.5 Trillion of earnings in the disabled community is significantly below that of their able-bodied peers. This is, of course, for a wide variety of reasons including education and employment opportunities, as well as possible discrimination. We estimate the gap is something like 40% below their peers' earnings.

The 10% challenge
Part of the discussion that follows assumes that leveraging technology will allow us to move the needle in favour of disabled people getting better access to the digital world. But, perhaps more importantly, it will enable disabled people to join in the employment component of the economic activity and, as stated above, increase potential earnings;

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through better access to technology they will become more useful and expose their skills to their workforce.

If we were able to reduce the costs of supporting the disabled by10% by moving them into employment, and increase the overall earning power by 10%, what would this look like? The reduction in state support would be in the order of $116 billion, and the newly employed people would pay something like $50 billion in taxes and add around $275 billion to the spending pot.

Segmentation

In order to identify the key economic factors, the disabled billion needs to be broken down into those of school/education age, those of working age, and those of retirement age. Each category has its economic and disability issues. Some of these come about through lower educational achievement due to barriers of accessibility, and employment certainly suffers from a lack of opportunities to break into the workforce and then exploit skills.

We have broken down the numbers of disabled people into three age ranges:

- Children   76 million
- Working age adults   454 million
- Retirement age adults   436 million

In absolute terms, the numbers of disabled working age adults and retirement age adults are about the same. However, as a percentage of their respective age ranges, the numbers tell a different story, as also demonstrated by the data at figure 1 below.

4%   of children suffer from a disability

10%   of working age adults have a disability

77%   of people over retirement age have a disability

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Figure 1 – Disabled % as part of global population
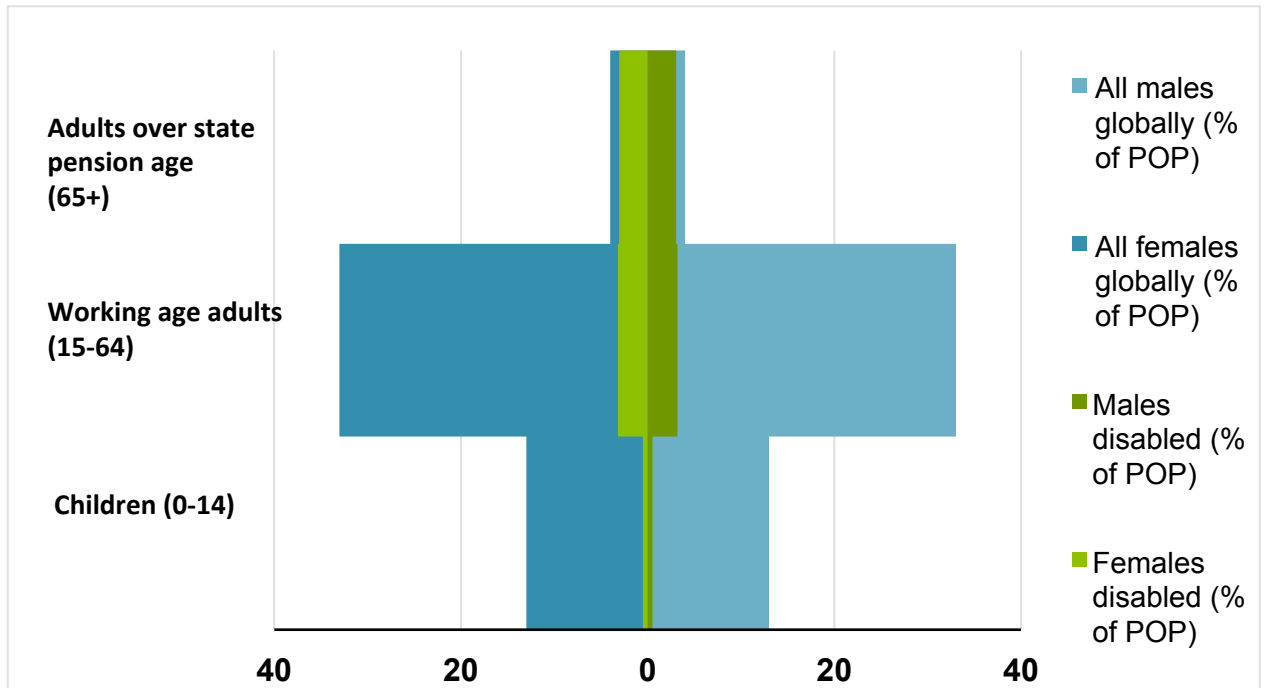
It is true to say that the great majority of people who end up with a disability acquire it in later life, which raises unique challenges when we consider using technologies to help them. Douglas Adams' theory about technology adoption runs like this:

"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 works. Anything that's invented between when you're 15 and 35 is new and exciting and revolutionary and you can probably get a career in it. Anything invented after you're 35 is against the natural order of things."

The 4% of children who have a disability might in some ways be the easiest people to help, since they will find adapting to technology less difficult than the rest of us.

Education age: obviously not income-generating but may require special education, especially those with multiple disabilities. Integration in mainstream education requires specialist support assistance and training, as well as education of the school staff in assistive technology, let alone in dealing with different disabilities. Integration does have the

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advantage of non-disabled children seeing disabled kids at first hand, not stuck away in special schools. This has a positive impact later in life as people come across others with disabilities.

Working age: employment has been an issue with the disabled community. Barriers in terms of educational achievement, prejudice from employers against disability, and self-esteem all contribute. Additional in this category are people who gradually become disabled while of an employable age. The impact of losing the ability to drive, read or do a physical job can be devastating, and adapting to the new situation requires a lot of rehabilitation. Support in terms of government grants do help the situation by taking away the burden of extra costs from the employer to make adjustments to accommodate the disabled person.

Employers' awareness of legislation and policy relating to employing disabled people is patchy. In a recent Gartner survey almost half of the employers in Germany and the US were unaware of the policies relating to disabled employment (see appendix B). This suggests that a major education as well as training programme is required across all industries. We also need to dispel the stereotypical view that disabled people are only suitable for certain relatively low-level jobs, such as blind people working on switchboards or basket weaving!

Retirement age: income is very dependent on working history and pension arrangements in a particular country. Generally, however, income drops by as much as three quarters during retirement.

The major issue for this group is their ability to adopt, and adapt to, new technology as their hearing, sight, dexterity, etc begin to deteriorate. We get Luddites in every segment but the retired segment is Luddite central.

Technological aptitude of segments

The digital capabilities of the different segments will change over time. Children today, increasingly educated through laptops and tablets, are gaining rapid access to the digital world despite many disabilities. As we all know only too well, learning something new – like the Internet, online shopping, texting, or social media – gets harder with age, with increasingly fumbling fingers being just one issue.

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The digitisation of people will gradually wash through the whole of society, bringing more digital skills to each segment over time. And, with the advances in different means of interfacing with the Internet (possibly speaking, in particular), the uptake of digital services will increase. This is, however, something of a long-term effect in that people who have not gone through school with a mobile device always struggle to understand 'young people's attitudes to communications'.

At the same time as digital confidence improves in general in all segments, the world of wearables and the Internet of Things (IOT) enhance the assistive technology deployments, and bring more and more of the disabled community up to speed. This requires a wealth of different factors to work – such as getting the accessible devices to the people, training them, and identifying the best apps to enhance an individual's lifestyle. This is non-trivial as it requires many agencies, friends and family, community groups and peers to be on top of keeping the individual up to date.

Another important factor in educating/training disabled people is the digital awareness of the people doing the training. We talk often about 'digital natives' and those most comfortable with new technology. The teachers in schools and further education and the advisors in work-related help organisations, as well as people dealing with the elderly, are generally not those exposed to the latest services and technology themselves. Hence, a fundamental raising of overall education about what IT can do, and how we can all leverage it, is absolutely essential. Assuming we can get the 'right' technology to the individual disabled person, it requires some significant training to get the most out of it.

Income/spending power

Our calculations from the research show that the billion disabled people in the world have some $3.5 trillion of spending power behind them

If we add friends and family spending to this then the figure rises to over $8 trillion. The 3.5 trillions of dollars behind the billion disabled people also include an element that needs addressing. Once again, absolute

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statistics are impossible to come by, but anecdotal and individual country-level information suggests that at least half of the world's severely disabled people are unemployed. In the more mature markets this results in government benefit providing the income. In the poorer countries it often means no government benefit, and the family carries the burden of the individual. Furthermore, the relatively poor education that the disabled receive also means that those who are in employment are generally doing lower paid jobs.

We estimate disabled people globally have $2.3 trillion from employment that they currently undertake. That sounds like a lot of money, but bear in mind that if disabled people all earned the same as their non-disabled counterparts, they would earn $3.6 trillion, an earnings gap of $1.3 trillion.

Disabled people on average earn 62.5% of their able-bodied counterparts. Is there a disabled glass ceiling?

Employment

My own experience 30 years ago, as a person with visual impairment, was of a world of barriers to becoming employed. Prejudice, in the true sense of the word, plays a major role, as most employers have never met let alone worked with people with different disabilities.

There are also many myths around employing disabled people. While blind people were traditionally pushed towards jobs such as piano tuning, I have found one working in Big Data analytics in a healthcare company and another running the technology part of an IT company. These are the exceptions however.

Opening employers' minds to the possibilities of disabled people being valuable employees is one thing; bringing the people through education and early employment with the right skills to be valuable is another. The great news is that the explosion of mobile and laptop based apps, combined with some specialist peripherals and wearables, means that accessing the main business systems is getting easier.

The assumption about employment levels in the disabled community gives us a trigger point. If it is 50% of severely disabled people then the

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goal of shifting that needle by10%, taking people off the unemployed support structure and into employment, reduces government support spend and increases disposable income for the individual – a win/win!

As the sophistication of accessible design permeates through the majority of personal and business applications, the value of that disabled person in the company increases. Consequently, barriers to using all of the facilities and systems, and communicating and interacting with fellow colleagues, suppliers and customers, decrease dramatically.

Imagine a scenario where a person with no practical speech is working in a customer care centre. With the omnichannel approach to customer service today, many interactions start with email or chat. The speech impaired person is perfectly capable of communicating through these channels, and would only need to hand over to someone who can speak with the customer if it escalates to that need. Will the customer ever know? No.

Social care and healthcare

A further economic component is the cost of looking after the disabled. As mentioned above, in poorer countries this will be done by the family. In the so-called more mature economies it is part of the state's budget. And, for the lucky ones, models often combine a portion of public sector with private insurance.

The cost of supporting disabled people is about $1.2trillion globally, roughly equivalent to the GDP of Mexico

Thus, if we could reduce the costs of supporting disabled people by 10%, the world would save about $120 billion per year.

However, the picture is more complex than it might first appear. 80% of the costs are borne by advanced economies, simply because they have the wealth to be able to spend on the disabled. In contrast only about 0.5% of the costs of supporting the disabled is spent by developing nations, because they do not have sufficient wealth to spend more.

Thus the 'business case' for reducing disabled support costs is strongest in developing economies, and this raises some interesting

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ethical questions, similar to those around the availability of drugs to fight AIDS. Clearly if we rely simply on a business case for helping the disabled, the vast majority of disabled people will not benefit from our actions because they don't 'cost in' to the equation.

Segmenting the billion

It should once again be noted that detailed breakdowns of the main categories covered in the UN statistics shown at figure 2 are difficult to ascertain. Of the 285 million people with a visual impairment, 39 million are severely restricted and are, in fact registered blind. And 34% of those with a hearing impairment are severely affected. The issue is important, as accessibility requirements will be more restrictive for those with little or no sight, hearing or physical movement. A table of the different disabilities, broken down by severity of disability, is included at appendix A.

Figure 2: one billion disabled in the world by disability
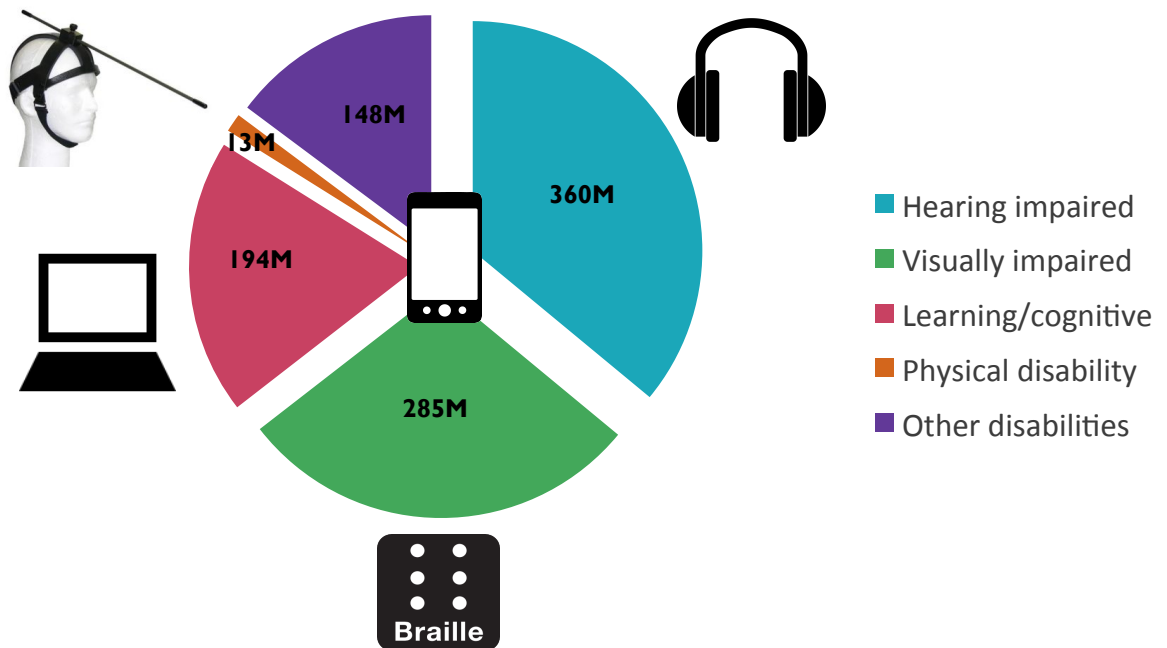
Earlier we segmented the billion into those of school age, working age and retired. The spending power of each sub-segment, along with their propensity to adopt new technology, differs, as does the ability to control their income. One assumption regarding school age is that this

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group will be exposed to the majority of the technology that will allow full access to the digital world.

Those who acquire their disability during working age will be less 'digital native' but, over time, this lack of digital awareness and skill will wash through the whole market.

People of retired age and above will be the most difficult to bring up to digital speed. It is important to note that the digital world will live alongside the real world, and that people, whether physically present or remote, will still play a role in supporting those with disabilities. This combination of technology and people may well suit a large proportion of the target market of retirement age and over, and probably a proportion of the other categories to boot.

The aging population is a regular topic of discussion in many conversations around coping with the time bomb of old age. Someone recently said to me that there are disabled people and those not yet disabled!

Living longer (nearly ten years more in 2010 than in 1970) brings a variety of deterioration in our functions

Sight and hearing problems are amongst the most common but lack of mobility and dexterity are also common. Hence, the more accessible we can make services, the easier we will be able to support the aging population – both themselves via accessible devices, but also via third-party monitoring and assistance.

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3.   So many more means of interacting

The interactive cycle of communications

We started out communicating with each other through gestures and evolved to speech. Funnily enough, our interaction with computers has also had gestures before speech! From a multiple-choice perspective, early interactions with computers were analogue, taking a thought process, putting it into a digital form and coding it (initially to break codes during the Second World War – very topical). As the computing has got more powerful and more miniaturised, the means of interacting with these devices has exploded. Who would have thought we would have tapped and gestured our way to digital heaven.

In short, the evolution of the computing, communications and software industries have brought us to a situation where many choices are open to people as to how they want to communicate and interact with the digital world. Hence, when a disability comes into play, it is merely reducing one channel into the digital world. It is no longer shutting the door on a disabled person to join the digital excitement.

This is real personal computing. Think about it in terms of information/input flowing into and out of the brain, where various levels of processing /cognition are carried out. As has been demonstrated by many completely paralysed people, the brain remains active, so providing some technology to allow this input, processing and output is the key. The great news is that the emerging digital world is expanding the number of possibilities, from mobile devices through cameras and sensors, and enhanced by the power of processing on the person and out there in the cloud. Taking it to an extreme, a paralysed person can now fly a drone around their garden or manoeuvre a robot around a museum, controlling the navigation with minor eye movements!

As we have noted previously, parallel developments in accessible or assistive technology have been accompanied by massive change in the cost of computing and communications. So today we have many more options of processing data, analysing enormous amounts of both structured and unstructured in order to identify patterns of behaviour. The jump from the Kurzweil reading machine costing £50,000 in the 1980s to a free mobile app today is just staggering.

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Many changing factors bring the accessibility into mainstream markets:

Miniaturisation of components: even down to patches or tattoos on the skin being able to monitor activity and transmit information via NFC initially, but inevitably via cellular out to a mobile device and app.

Virtualisation: the cloud gets mentioned in every IT activity today. The availability of enormous processing and storage capacity somewhere out there in a virtual data centre gives the economics of computing large amounts of data a new lease of life. Combined with the miniaturisation above, the end point does not need to be a powerful computer in its own right.

Analytics and Big Data: the IT industry is buzzing around the possibilities of Big Data analytics. The origins of computing with Turing and Von Neuman were around building algorithms to solve cryptography issues. Today we have a vast array of structured and unstructured data that analytics needs to consider before identifying a problem or, indeed, a solution.

Communications: we are approaching saturation with mobile devices in many countries. With the cost of devices coming down to below the $50 level, less-affluent people can now readily afford to have a device. That is just the first few billion. The next tens of billions of devices will leverage the low cost of cellular but, more importantly, build on Low Energy Bluetooth, NFC Infrared and other unlicensed spectrum to establish the IOT.

Power battery life: this is one of those 21st century issues that just niggles at us all. As devices such as patches on the skin and even sensors left inside people after medical procedures shrink, power is advancing to the extent that a device could stay in you for a year after the procedure. We are also seeing research in the use of ambient power, as well as more novel ideas such as the movement of your feet generating power.

High quality: the impressive improvements in bandwidth and quality of service also mean that higher quality voice and video can accompany the swathes of data. This is important to allow someone with diminished

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hearing or vision to use residual sight or hearing to abstract meaning from the communications. This, combined with cloud, can allow for remote processing of images or sign language, by the computer or human cloud, to return information to the individual.

Automation: having said that the big compute power is in the cloud, we should acknowledge that mobile devices have considerable compute power themselves. A combination of this power at the edge working with the cloud means that many processes such as pattern recognition can be automated.

Processes: in many ways we see the computing and communications aspects of business or personal processes disappearing into the process itself. This is a reversal of the previous situation where the process was forced into the computing structure. Compute is now so flexible that it will embed itself into activities. The implications for accessibility are enormous as long, as it is done in an open and accessible way from the start.

Things interacting with the individual

Figure 3 demonstrates just how many different means are now potentially open to the individual, whatever their particular disability. As an exercise, think of everything that you do on a daily basis and break it down into input and output and processing of information. These devices and services, combined with local and remote processing, can provide an electronic service to support that activity.

Figure 3: Multiple means of communicating

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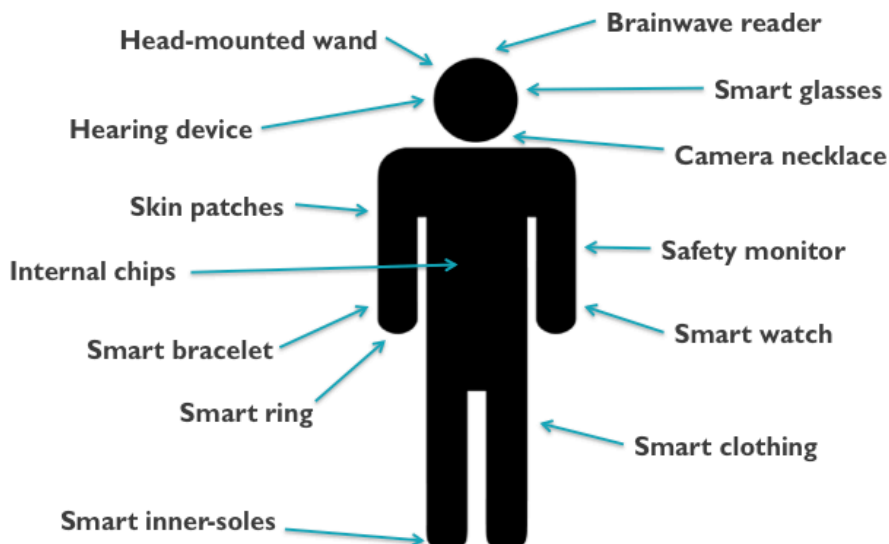
As Stephen Hawking has so admirably demonstrated, being severely restricted to interaction via letterboards and word selection via a monocle or switch device doesn't mean the brain isn't working (indeed, solving some of the world's trickiest physics problems!) So the question is, how do we get information into and out of the brain?

The evolution of computing, and especially mobile, helps enormously. The move to gesture-based interaction with a smart phone has become an everyday occurrence. Our hands actually encode things to build memory, based on their crucial role in evolutionary development. For those without the hands to create the gestures, a bracelet or patch on another part of the body can allow this interaction.

Research in this area is known as Peri-personal space research. It's the space around our bodies. Brain power isn't just the thing in your head; cognition is spread throughout the body, hence muscle memory when playing golf, cricket or football. And, given the advent of wearables and sensors on our bodies, this extended capability is enhanced by technology. As in many aspects of accessibility, this is not just applicable to disabled people but to the population in general.

Implications for the accessibility market

This emerging scenario has some major implications for the accessibility market. In the past we had discrete devices addressing different needs in the disabled world. What we have now is a potential platform upon which many of the common requirements can be built artificially and enhanced for the particular impairment.

Economies of scale always get the attention of industry. Well, there is a massive economy of scale here with the mobile device acting as a focal point for many different support services. The emphasis shifts away from discrete equipment towards blending different devices, applications and support services to fit around a disabled person's needs.

In as much as people use their mobile devices and their wealth of apps to help live their daily lives, disabled people will increasingly do the same. The suite of apps that anyone uses will become accessible as the mobile devices build accessibility into the core of their product. Mainstream apps will become accessible, and specialist apps focused

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on specialist needs of disabilities will be developed to top up the existing digital life styles.

There will be less dependency on dedicated devices and more of an ecosystem of devices, wearables, applications and associated services that will fit around the individual – hence accessibility getting personal.

One way of putting this into context is to think of the translation services available today through companies like Skype and Google. You speak in one end in English, and Spanish, for example, comes out of the other device. If we can build systems to do this translation to fit in with a Spanish or English speaker, then we can absolutely translate the content into sign language, some form of taptic output, larger images or words/symbols.

Conversion of text-to-voice and voice-to-text have massive implications for different disabilities: hearing impaired receiving the script of actors in the theatre, lecturers speaking at university, and real-time access to what people are saying on conference calls all demonstrate the power. In the past we have needed significant pre- or post-editing of the content. The power and proximity of the mobile phone and the power of processing distributed in the cloud, coupled with the learning power of AI, all contribute to this being a realistic prospect.

Applications and additional interaction

Wrapping this vast range of technology around the individual to enhance or, indeed, create the individual digital persona also requires access to applications and content. If the range of options seems enormous around the body, then the explosion of an application for everything is of an even greater order of magnitude. These applications fall into several categories:

- Personal management
- Navigation
- Health monitoring
- Health monitoring, closed loop, with a doctor/hospital
- Business applications
- Entertainment
- Specialist disability applications

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Searching in any app store shows just how many people have attempted to solve a particular problem through designing an app. One of the aims of raising awareness and education/training of accessibility must be especially for the next generation of disabled people, developing apps from a level of understanding of a disability that the able-bodied cannot truly grasp.

The mobile as a conduit for services: so many choices for everyone, preference or enforced

The advent of wearables, IOT and smart cities raises a key point in relation to delivering services of another type to the disabled community. We talk about 'up-and- down' speeds when it comes to our fixed or mobile broadband. Well, that in-and-out channel to and from an individual in a home, apartment or business – or, indeed, out and about – can provide a vital, literally lifeline support. Set up correctly, the extended personal digital entity can feed information to a variety of applications, authorities and charities who can combine to provide daily support. Given the volume of data created around this new digital personage – analysing the information using Big Data techniques and contextualising the information around the disability – many benefits can be brought to the table.

The aging population is putting more and more of a strain on the healthcare system and social services. Leveraging accessible services will reduce some of this burden. Reducing visits to hospitals and monitoring people's behaviour can help streamline processes and improve the quality of life.

Since healthcare and other social services are increasingly provided through a mix of public and private sector organisations, it should also be pointed out that this is another opportunity for entrepreneurs looking at this market.

The more services that can be built onto a common platform, the more economies of scale can be derived. After all, the key assets of patient/citizen monitoring, information sharing, storage and analytics all contribute to this more efficient approach to public services overall. If the accessibility side is executed properly, the disabled portion of the population will also be able to leverage these multiple communications

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channels to help improve their own lives, rather than just being recipients of the services.

This does smack somewhat of Big Brother. Ownership of data and respecting privacy and personal wishes all need to be considered carefully. However, there are benefits of friends and family, social services or a private organisation keeping an eye on the data flowing out of a household with, for example, a person with Parkinson's or Alzheimer's. When the regular pattern of activities is broken, first a remote, then an actual intervention can be triggered. Just imagine if the pattern shows that the fridge has not been opened, kettle not been boiled and front door not opened in a couple of days. Holidays aside, the monitoring function would trigger an alarm and instigate the relevant procedure.

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4. Mobile device and other technology developments

The smart phone, and its role connecting the individual to the digital world, is at the heart of the accessibility issue. We all live in fear of misplacing this device which has become our companion, source of information and means to communicate with people, let alone run our lives.

The evolution from the original feature phones to the smartphone filled many disabled people with trepidation. How would a blind person interact with a touch screen? How would a deaf person adapt the device to work with hearing aids, etc? In many ways these problems have been solved by building accessibility into the devices. We are well down the road of moving away from installing third party software on the device to make it accessible. Apple has led the way with *Voiceover*, but Android has improved its *TalkBack* significantly, with different releases of the operating system, and Microsoft has finally brought *Narrator* to market with version 8.1.

Is it perfect? Certainly not, but it is major progress from where we were five years ago, if not even one year ago. In the same way that this report argues for accessibility becoming part of personalisation, so the peripherals that different disabled groups employ to facilitate their access to the smartphone and its apps/content should also be seen as peripherals.

Apple does stand out as the leader from an accessibility point of view. The important message, however, is that there is a choice out there, although this tends to be at the higher end of the market. As was noted in the summary of the disabled statistics, a large proportion of disabled people come from low income parts of society. The recent release of smartphones in the sub-$50 range begin to make accessibility for this group much more feasible. Apple is unlikely to go down to this part of the market, but Microsoft has already launched its $29 device and others are showing a lot of interest in it.

With this element of accessibility well on the road to being sorted, the emphasis shifts to the applications that people access on a daily basis.

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Wearables

Smartwatches are the latest fad, whether you were in Las Vegas for CES or at MWC in Barcelona; everyone seems to be bringing out a smartwatch. It is too early to judge the impact of these devices on the general market let alone on the disability/accessibility one. Suffice it to say that for some people a wrist-mounted device could indeed be of major benefit. The question for the smartwatch manufacturers is what accessibility features are going to be built in: voice activation, taptic output (and how sophisticated), speaker output, variety of input, and so on? Few of the current ranges on the market cover all or even most of these aspects.

Interestingly, the availability of peripherals – Bluetooth ear pieces, mini Bluetooth keyboards and other accessories – will increasingly allow the device itself to stay in the pocket, attached to the wheelchair or embedded in a vehicle. The wearables side is truly beginning to make the service fit around the individual's preferences and requirements.

According to IDTech[1], the increasingly merging 'Healthcare, Medical, Fitness, Wellness' sector has the greatest potential of all of the sectors they looked at. Advances in wearable technology will lead to it being increasingly invisible and intelligent, with lower power components supported by increasingly sophisticated ambient energy harvesting. They forecast that "in 2025, the 'Healthcare, Medical, Fitness, Wellness' sector will account for over $21 billion of the total $70 billion opportunity in wearable technology."

We should be careful not to assume that this vast array of information being generated from the wearables and other IOT devices will all be out there in the public domain. The individual, disabled or not, will sometimes be at the centre of the information loop and sometimes at the end of it from a healthcare or other business application. Some information, especially the most sensitive, is likely only to exist in a closed loop with a medical professional, government office or employer. There will, of course, be a lot of public personal information as we interact with our environments, but the choice to make information flows, as well as actual data about ourselves, personal will remain key.

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1 Source IdTechEx
2 https://www.gari.info/index.cfm?lang=eng

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This is all additional input possibilities for the disabled person, and allows some, if not all, access to the world of applications – as long as the app is designed inclusively and allows for switch access at a minimum.

Smart cities

While the explosion of personal devices changes the nature of the individual and their ability to communicate, the emergence of smarter cities adds an invaluable component to the disabled person's ability to interact more with literally 'society'. Investing in a more joined-up set of infrastructures for a city should lead to one in which disabled people are freer to participate.

Much of the smart city discussion is around saving the costs of infrastructure, reducing the cost of lighting, integrating transport systems and making public services more readily accessible on a digital basis.

Pockets of initiatives spring up but real holistic thinking about how the city could be better connected for citizen services are few and far between. One accessibility executive I recently talked to mentioned a project looking to identify where public toilets were. One city had an initiative, one state, one local authority, but no overall joined-up thinking. The message is clear: link services together based on a more intelligent city infrastructure and open up this new combined information set to *all* citizens to allow for more efficient and inclusive services.

The GARI initiative from the Mobile Manufacturers Forum (MMF)

With the pivotal role of the mobile device in mind, the MMF has developed GARI (Global Accessibility Reporting Initiative) [2]. It is a repository of information about mobile devices and applications, and their accessibility and suitability for different impairments. Several mobile operators, including AT&T and Telstra, have already taken the subset of devices they carry and source the GARI information, so people in their retail outlets and call centres can be armed with relevant

[2] https://www.gari.info/index.cfm?lang=eng

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information when dealing with a disabled person. This shortcuts an enormous amount of data gathering and quickly assists the person seeking a more accessible device.

GARI works because this is a global initiative, and it scales. The MMF is able to draw on its members' participation to gather all of the information together. It is a good example of the global nature of the IT and communications industry. The local service element from the mobile or multi-play provider is not global but, by definition, local and hence subject to the state of an individual market and the approach of the service providers. Once again, education and training of people on the retail front line and customer support is essential to assist the disabled people find the right device and package for their needs.

When it comes to applications and special equipment there is a vast range to be navigated. Special equipment has often been associated with high prices and limited supply. Luckily, the world of mobile apps is a much more open market. Mainstream apps can be rendered much more accessible by following the guidelines in the Mobile Developers Guide to the Galaxy (see more below). Specialist apps are generally designed with accessibility in mind so do not need this additional layer in development or refresh cycles.

Peer-to-peer recommendation does seem to be the main channel of referring people to new apps. Charities and NGOs do often publish lists of apps suitable for a particular disability, but we know that the world of apps is a moving feast, and today's favourite is tomorrow's recycle bin.

Examples of accessibility equipment and apps

As we move from the world of specialist equipment into that of personalisation, mainstream apps and some specialist apps, it becomes ever more difficult to present a summary list of what is available. No doubt the mobile device (phone or tablet) is emerging as the engine of accessibility, supported by wearables and the ever better connected environment around us. In the table at appendix C we have taken a few examples of accessibility from each of the major disability groups, just to demonstrate how things are developing.

A few examples that should make us all think of how this market has accelerated in the last few years would include:

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- The paraplegic flying a drone around his or her garden through the eye movement captured by a set of goggles
- A deaf person using a signing service through a video connection, with the mobile device at the start point and a bank of signing people remotely
- A severely disabled wheelchair-based person using a switch access to the tablet to manage their home environment in terms of lights, heating, television, etc
- A blind person using the camera feature on their phone to send a picture to either a person or an AI system to help identify a location or product
- Someone with learning difficulties using specialist software on a tablet to gain access to educational programmes
- Virtual reality headsets allowing someone to virtually feel a product created in front of them!
- Someone using Bluetooth headsets with information being fed from an iBeacon infrastructure to identify locations for someone with cognitive problems
- A person using a ring or other body-mounted device to 'write' in the air, and the device converting the graphology into text input.

What is fascinating, possibly for the first time in the history of accessibility, is that most of these examples have equally valid applications in mainstream domestic or business activities. It is the beginning of the blending of disability requirements into the overall personalisation of services.

Sources of innovation

Innovation is one of the most discussed topics when it comes to the IT industry. The innovator's dilemma is indicative of the problem that many pioneers face when it comes to further innovation. Telecoms has been accustomed to doing a lot of its innovation/Research & Development (R&D) behind closed doors – and only when ready exposing it to the outside world. Agile IT, the Internet, mobile and the Digital Society have all moved the innovation game to be a much more open process. The ability to write an app for a smartphone, even on different platforms, means that they can be brought to market within a matter of weeks. Combine that with the processing power available in the cloud and the increased levels of connectivity and communications, and the innovation options expand hugely.

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As noted in previous sections, developing things dedicated to a particular disability has been a narrow focus in the past. What is interesting to witness is that the new sources of innovation, incubation and entrepreneurialism are naturally bringing examples of disability-related applications to the market. Why? Because people developing the apps can bring them to market, either free or paid for, very quickly. Even people with the disability are developing and bringing apps to market; in many ways, those with a particular impairment are the best people for the job.

Telefonica's Wayra Academy has received some 25,000 submissions over the last five years to be part of the telco's incubator/innovation programme, external to the company's own R&D activities. Some of the disability-related ones to appear include:

Company Name	Disability	Product description	Website
Usound (NewBrick)	Hearing impaired	Usound is a software for smartphones that allows them to function as a digital hearing aid or a streaming system for hearing impaired people	http://usound.com.ar
Insane Logic	Learning/cognitively impaired	Educational ipad app for people with speech and learning difficulties	www.mychoicepad.com
Lingoing	Hearing impaired	Connects people with trustworthy language service providers -interpreters, translators, note-takers, lip-speakers, reporters and more	www.lingoing.com
Virtually Free	Learning/cognitively impaired	Designs and develops therapeutic multi-platform games to improve and prevent mental health problems	http://virtually-free.com/
Give Vision	Visually impaired	Adapting Google Glass technology to act as eyes for blind and visually impaired people. Give Vision technology is designed to enable blind people to interact more with the world around them, receive visual information and make them mobile, independent and confident	www.givevision.net

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The more open ecosystem means that potential applications can come from any number of players, such as chip manufacturers, wearables, mobile devices, or consumer electronics. And, of course the source of many innovations, space programmes and the military. Some of the heads-up displays for fighter pilots are providing the basis for enhancing images and information flows to disabled people. US military research looking at how best to get information to soldiers on the ground and under fire provides an interesting by-product: understanding how to get information to people with disabilities.

One other important area comes from business itself and the broader industry. We see disruptive business models being launched in almost every sector. Taxis have been revolutionised by *Hailo* and *Uber* amongst others, healthcare is seeing major shifts in patient care and interaction and, as we all know, retail has changed beyond our grandparents' recognition. It is incumbent on business leaders and their innovation thinking, to be sure to include the accessibility angle, not for CSR reasons, but with the economic power of the disabled and their friends and family that we covered in the opening section.

We cannot emphasise enough the shift from dedicated, controlled solutions – such as CCTVs and relay services – that are now emerging as free or paid apps in the different stores.

It is also important to note that mainstream apps properly labelled according to ISO guidelines are becoming increasingly accessible. They are literally life changing, as people get access to services hitherto completely out of reach to different disability groups. A simple but powerful example would be the ability for me, as a blind person, to hail a cab from my smartphone where I was previously unable to do so from the pavement.

So, innovation is coming from:
- Device manufacturers
- Specialist disability technology providers
- Charities and NGOs
- Wearables
- Mainstream applications

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- Apps developers bringing information sources from the web into a consumable format for the disabled
- Disabled people themselves
- Vertical industries themselves

Add to this the mix of crowd-sourcing, where information such as object description can be provided by paid or volunteer individuals, and we have a fantastic array of innovation prospects.

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5. Building accessibility into the development cycle

The advent of mobile devices with built-in accessibility has, as we have seen, had a dramatic effect on people with limitations in gaining access to the abundant world of applications and content, let alone keeping in touch with colleagues, family and friends.

Mobile has also had a major impact on the way in which companies think about the development cycle for applications and services. In the good old days, a project was spec'd out and the task handed over to the IT department or a third party to develop the software. Mobile has demanded that the development cycle adjust to the timescales of mobile and its apps.

As disabled people are aware, accessibility was mostly thought of, if at all, as an afterthought and retro-fitted into the software. The more agile approach to software development not only requires a more flexible team of programmers, but also an integrated view of accessibility.

Under the old model the accessibility was thought of afterwards, and on a disability-by-disability basis. So, vision impaired, hearing impaired, etc were all dealt with separately. Under the inclusive accessibility approach the kernel of software is developed with accessibility in mind. The personalisation around the individual is then more easily implemented within the software, but with additional wearables for the individual and through a more holistic approach in applications development in the home, office and city environments. In reality, this is just a bit of joined-up thinking that will result in massive benefits for everyone – not just the disabled billion.

Raising awareness from senior management to individual developers

Interestingly, when we refer to a business becoming more agile in the digital world, we often talk of having a Digital Board, and representatives of all stakeholders in the business – Finance, HR, IT, Line of Business, etc. The marketing element is even more important when thinking about building the accessibility thinking into the cycle, as they should represent the customer!

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Standards from the Mobile Developers Guide to the Galaxy

Given the temporary, situational disability that people face during their daily lives, providing a number of ways to interact with an app will enhance everyone's 'enjoyment', and will certainly not impede it. Thinking of the different ways in which we all interact with our mobiles and computers, some prefer a full keyboard, some prefer swiping, some increasingly prefer talking to their personal digital assistant. All of these are forms of substitutional interaction and can help the disability angle enormously.

And, my favourite issue, when a company has developed a fundamentally accessible app – no names, no pack drill – they then outsource the development of the next iteration of the app and fail to stick to the same rigorous accessibility standards. In my case, this has resulted in a lot of "button, button" when I know that a function exists that I need. And since I am not of the new generation of users, I am afraid to push the button and see what happens!

So the lesson to be taken on board is that this is a continual cycle of development from a software perspective. It is more frequent than the old IT regime, and if we build accessibility thinking into the cycle then we won't lose sight of it in the next iteration.

Developers need to be aware of the different ways in which the range of disabled people will interact with their preferred device and hence through to the app. Some gestures in Apple's *Voiceover*, for example, change compared to the usual gesture set. A more limited access through a switch device or magnified graphic may also impact performance and execution.

Since the user is relying on graphics of different sorts, artificial speech being generated off a button or graphic, and so on, the developer needs to leverage the appropriate toolkit to produce relevant support text, speech or taptic output to inform the user of an action or interaction.

In the same way that web developers use standards like WCAG 2.0 to make websites accessible, so mobile developers need to adopt

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standards such as the ISO 9241-171[3]. This is a useful standard as it is platform agnostic. In the Mobile Developers Guide to the Galaxy[4] there is a chapter on accessibility that developers will find useful.

In short, the devices are increasingly more accessible with their built-in features, and getting into an apps store does carry some requirements to adhere to accessible standards. The apps that disabled people use include many mainstream apps as well as those developed for disabled people specifically. Keeping accessibility in mind when developing the app and testing its performance will help all users have a better experience. As mentioned previously, the kernel of accessibility is now part of the general modus operandi of the mobile device. Ensuring that the app performance is equally good for a disabled person using their particular accessibility tools will help apps producers tap into the massive disability market.

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[3] ('The Ergonomics of Human-system Interaction: Guidance on Software Accessibility' | [http://www.iso.org/iso/iso_catalogue/catalogue_tc/catalogue_detail.htm?csnumber= 39080

[4] http://wip.org/download/MobileDevGuide_14th.pdf

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6. The business of accessibility

Having identified the macro economic issues surrounding the untapped billion, and outlined the major shift in accessible technology, it is important to point out the business opportunity. It is certainly not the same as the accessibility market has offered in the past. We touched upon the expensive equipment that people were obliged to use previously, and how the mobile revolution has opened up new, more accessible platforms for people with all disabilities.

The mobile computing revolution means that disabled people now have a powerful device at their disposal. This device, coupled with some specialist equipment and services, will help make this group of people appealing not only from an increased employment proposition, but also as active participants in the digital society. That may be as a purchaser of services, participant in social media, or as part of a public service ecosystem such as health or local/central government.

It should perhaps be put in terms of being another segmentation of the population in a particular country, region or city. Just the same as allowing for certain ethnic groups within a community. In the mobile and broader telecoms industry we have talked about the move towards personalisation of service. Surely this is the ideal opportunity to build the disability component into that personalisation. At the end of the day, the spending power of the disabled community is, as we have seen, around $8 trillion, and should therefore be treated as a major market segment.

So, what are the business opportunities:

Mobile devices, tablets: for the most part, disabled people want to have regular devices, not ones designed specifically for the disabled.

Mainstream applications: designed properly and implementing the standards covered in section 5, there is no reason why the vast majority of the disabled community should not be using regular apps. When I recently did a straw poll of friends with disabilities, the vast majority of apps mentioned were things like Skype, weather and navigation apps – not specialist disabled apps. It should also be noted that while people

love the free apps, paying for a very useful app is also perfectly acceptable.

Specialist apps: having said that mainstream apps are a great business opportunity, there is also room for the specialists. Interestingly, the spectrum of specialist apps is expanding, along with the mobile device and the enhanced communications and storage offerings we are witnessing in the 4G era. Add to the better, more accessible devices and applications the wearables and peripherals, and the individual is now armed with a wealth of additional input devices. So when out and about, the individual can seek help from the apps on their device with video or audio input from the different cameras on the body, and receive appropriate input via audio, video or tactic to assist the situation. And, perhaps most importantly in a time when we obsess about automation, communications also allows us to interpose a human being – the human cloud – to interpret data, video, etc and feed back to the individual appropriately.

Employing disabled people: accessible devices and applications make disabled people more readily employable. There is already significant legislation to encourage employers to take on disabled people, but easing the path to their gaining full access to company systems and processes can only help smooth the way to more disabled people being employed. Current estimates suggest that only half of the severely disabled people in the more mature markets are actually employed. Estimates for emerging markets are difficult to acquire, but anecdotal information implies the figure of unemployed is much higher. Making the disabled more technology aware and broadening their skillsets is one aspect; educating the management in a company as to employment possibilities for disabled is another (as demonstrated by the Gartner survey at appendix B).

Improving efficiency from a services perspective: as mentioned throughout the report, the mobile device is a two-way street when it comes to services. Many disabled people do require assistance in daily activities. The better-connected individual will rely increasingly on their mobile device and broadband. Supporting the billion in their homes, at work, and out and about fulfilling their daily personal and business activities, can also be supplemented by services:

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*Local and central government and healthcare (depending on the healthcare model in a particular country):* the wearables/IOT market can provide the sensors to simplify a lot of interactions with the individual in whatever capacity: monitoring health conditions, remote consulting with specialists, or social care (from family or state using a mix of voice and video or gesture).

Entertainment: subtitles have helped many able-bodied people enjoy TV and film content in languages other than their own. They additionally help hearing impaired people enjoy the media. Audio description adds enormously to the pleasure visually impaired people get from the media as well. There is no reason why the mobile device could not be used, leveraging over the top services to deliver a service embracing both subtitles and audio description so that the user can choose how to consume the additional information. Add to this the enormous library of audio books, podcasts and RSS feeds and you become aware of the power of the mobile device to bring content to the disabled population in a format suitable for the individual.

The accessibility value chain

Summarising the different components and how they hang together in a value chain is relatively straightforward, as shown at figure x. It shows that there are roles for specialists as well as mainstream technology providers and channels. The key change is the blending of services to fit in with the increasingly complex requirements of the disabled billion. As we have stated previously, they do not want to be seen as a separate industry, but instead benefit from the mobile device and wearables revolution as well as the apps that everyone else uses, supplemented by some specialist apps where relevant.

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Figure 4: the accessibility value chain
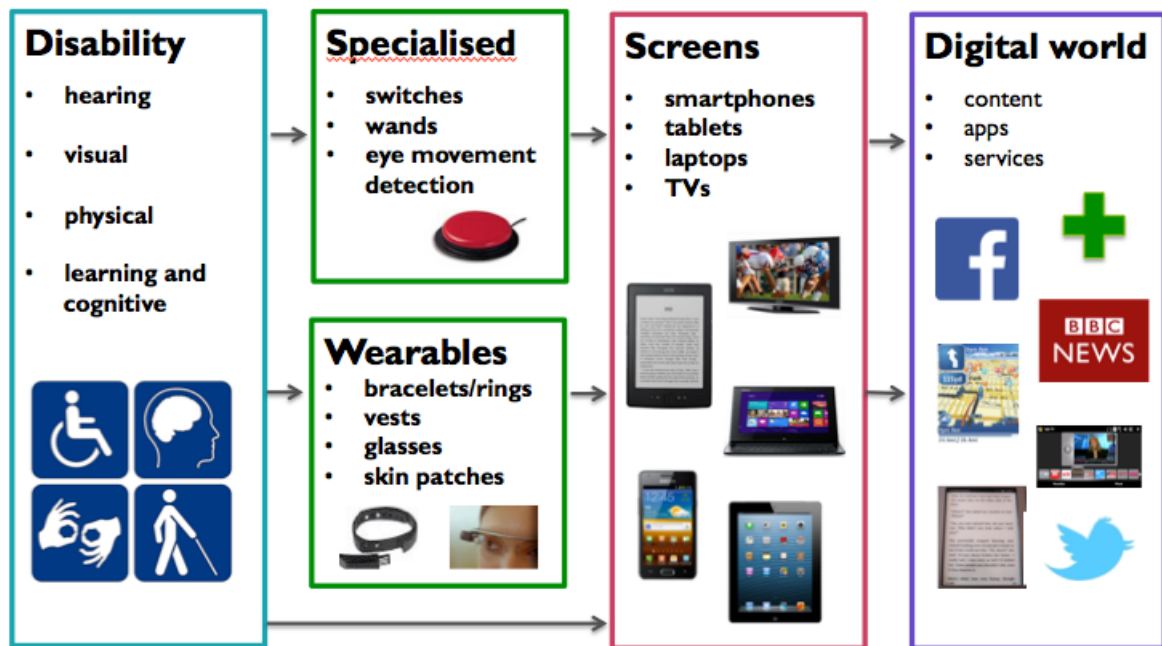
The fact that individual disabilities have had their own medical and charitable organisation activities has meant that few economies of scale have come to play. This analysis shows that if we treat all of the disability requirements, where possible, as part of the emerging digital demands of everyone, then we can scale the common elements and add on specialist pieces as and when appropriate. It also means that the innovators looking at the market from their own perspectives can bring the benefits of the digital world – devices, apps, content and service – to the disabled community on a platform suitable for the individual. Awareness of mainstream and specialist technologies and services is, of course, essential; but at least beginning to look outside of a narrow individual charity, for example, will bring benefits to the disabled person.

This has major implications for the charitable sector in particular. They compete for our donations so want to remain independent but actually need the scale of joining together in order to leverage the benefits outlined here. Governments also fund some of the accessibility market through grants for people in work or special cases at home. There is a possibility of the charitable sector being disintermediated if governments fund the individuals directly rather than through the charities.

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Channels to Market

For some reason, when it comes to disability and accessibility, the traditional discussions of product portfolio, channels to market and customer experience seem to be non-existent. Too many moving parts, or too many cooks spoiling the broth?

The many developments covered in this report show that the technology has improved dramatically, price performance come down significantly, and the end-user is becoming more and more aware of the mobile-centric digital world through smartphones, tablets and laptops. So perhaps we should think more about some classic channels to market and distribution models in order to ramp up the push for accessibility throughout the different age segments and across all disabilities. It is going to be complicated since it involves both profit-oriented businesses, such as government bodies and local authorities, as well as the charitable organisations/NGOs who have traditionally been the focal point for the individual disability areas.

Figure 5 Channels to market: education and training at every stage

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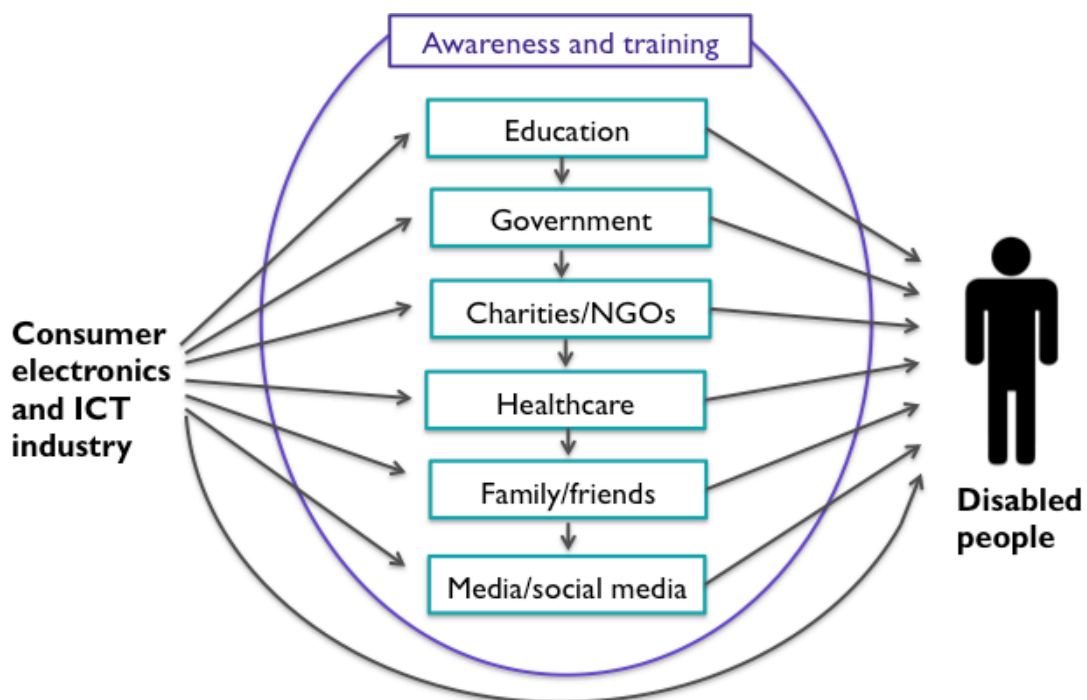
To follow current business thinking, if we are truly to put the customer at the centre of things rather than merely at the end of the value chain, we also need to make sure that the billion are armed with the right information as well as the can-do attitude to embrace this digital reality.

For mainstream mobile devices such as those covered above:
- Mobile operators
- High street retails
- Online consumer electronics
- Charities
- Local support groups

In order to support the devices in the field, don't assume that people rule out a particular source of information due to their disability. Blind people regularly 'watch' videos and hearing impaired people do listen to podcasts. The availability of higher quality voice and video means that a higher proportion of people with these particular disabilities can get some information out of media traditionally not open to them.

Thanks to the insights provided during this research from educational establishments, it is evident that the awareness and training of even our educational establishments needs driving to another level. The fact that children with a single disability are more generally educated in mainstream schools means that their assistants need to be aware of the solutions. Information sharing such as the GARI website for mobile devices or the International Association of Assistive Professionals (IAAS) can all help, as long as everyone in contact with the disabled child or employee is aware of them. Given the ticking time bomb of our aging and increasingly disabled population, the social services, support groups and family members caring for the aged also need to be aware of what is possible as different faculties diminish.

The great news is that multi-channel access to content, whether that be newspapers, TV shows, films or books, can be enjoyed through different means as our hearing, eyesight or mobility reduces.

As with any channel discussion, the right information needs to be disseminated to all parties in the ecosystem, and they also need to be incentivised to join in the broader delivery of services rather than trying to control their particular part of the chain. Initiatives such as the MMF's

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GARI initiative are a good example of removing the heavy lifting from identifying all accessible devices and their applicability to different disabled groups. Yet how many charitable organisations are aware of the initiative?

In any market, the issue is money at the end of the day. The customer wants to get the best deal while addressing their particular needs, the channel players want to optimise their position. Looking at many of the charitable organisations in particular, there is a need to leverage more of the services and support on offer around them rather than trying to re-invent the wheel again and again and again. And, at the risk of repetition, providing the right training and education around how to deal with different disabilities and technology and service solutions open to people cannot be emphasised enough. The technology is increasingly there at an affordable price point for the customer. Let's get the services publicised and draw a significant proportion of the billion into the digital age.

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7.   Conclusions and actions

The economic argument for driving more accessibility for the world's billion disabled people is compelling. The technology developments we witness daily make more and more options available both from a hardware miniaturisation and software sophistication angle. But the fundamental angle is to make it easier for disabled people to communicate more effectively with other people, and engage in the digital world for personal and business as well as societal benefits.

The mid to long-term goal is to have the term 'accessibility' disappear into the personalisation of services for the individual. The advent of wearables for the individual, and IOT for the environment around us, means that this not a pipe dream but an ever-closer reality. However, it requires joined-up thinking and action from all stakeholders, accompanied by a major cultural appreciation of disability within every aspect of life.

Fundamentally, technology in many forms is allowing sensory replacement for both input and output from a disabled person. The availability of parallel channels such as text, email and instant messaging all co-exist with voice to allow different channels to be substituted. Information and input provided via gesture and movement (but possibly not brainwaves) can act as a means of improving input and output to expose the individual to the world. We called it Artificial Intelligence in the 1980s. The dream of a computer translating from one language to another is now a reality. The knock-on benefit of such algorithms is also evident in assisting senses that are impaired, as well as bringing a vast array of information to help with daily processes for pleasure or work. Simply put, the individual is now at the centre of a hugely connected series of personal, environmental, societal and business flows.

In order to raise awareness of the disability angle, we have concluded that the spending power of disabled people is over $8 trillion when including earned income, support from the state, and spending power of friends and family. Due to many historical reasons, disabled people tend to earn significantly below their able-bodied peers - we estimate somewhere in the region of 40%. Unemployment rates amongst different disabled groups can be as high as 80%. Even a shift of 10% from unemployed to employed will bring major benefits to the individual, the state and society as whole.

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In the same way that we recommend disability accessibility moves out of the CSR Sustainability compartment of today's businesses, it also needs to be on government agendas to help embed it in broader policy agendas, rather than being treated in isolation.

Examples of individuals overcoming the barriers of disability always work best. However, there are so many different disabilities competing for charitable donations and government funding that the sector has been massively fragmented. Technology can be one of the unifying factors. Mobile especially, as it relates to individuals and their activities and can act as the platform for much of this inclusive revolution of design and execution.

We do still need some specialist equipment and software, and indeed applications. However, if we drive the adoption of accessible standards into mainstream applications development cycles, then the specialist equipment will drive a lot more productivity as it interacts with the broader digital world.

A call to arms for all stakeholders

We have described the value chain from specialist devices combined with mainstream technology, through education, charitable organisations and social care, to get the disabled world better connected into digital services. This actually touches many more parts of society and business than people might think.

Hence, there is a call to arms for all of us:
- *Promote broader understanding of all disabilities across society:* in schools, the workplace, wherever we are.
- *Applications and content designers:* include accessibility as a basic component of the design process, conforming to standards and ensuring it is included in refresh and new releases.
- *Policy makers:* be practical; help those implementing accessibility to do their jobs.
- *Charities:* individual charities do not carry clout; they have got to get together to raise awareness and promote accessibility.
- *Communities:* need to be organised to support the disabled across the board.
- *Mobile providers and telcos:* accessibility needs to be built into product development and marketing, not isolated in the CSR Sustainability pot.

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- *Shifting thinking:* towards embracing the disabled inside the digital economy.
- *Innovation:* can come from any number of places: hardware, software, charities, disabled people themselves often open up the channels of innovation.

The technology is increasingly available to deliver this future. The need to educate both the disabled and the people helping them identify the solutions available is the biggest challenge we face. Education and training at every step of the way should be encouraged. Even here we have the benefits of social media and the digital world to help us. So, spread the word. We should be aiming to bring the disabled billion inside the digital firewall and exposing them to the benefits of the digital world. The payback for business and society will be enormous.

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Appendix A - Models of disabled community

I. Total number of disabled people

Total Number of Disabled People	Hearing Impaired (Million):	Visually Impaired (Million):	Learning and Cognatively Impaired (Million):	Physically Impaired (Million):	Other (Depression, alcohol dependency, dementias) (Million):
Children	31.3	18	19.24	1.18	6.67
Working Age Adults:	164.4	80.24	65.36	17.02	126.73
Adults over State Pension Age:	164.4	186.2	19.14	46.02	20.7
Total: 966.6 (Millions):	360.1	284.44	103.74	64.22	154.10

II. Number of disabled people as % of global population

Number of Disabled People as % of Global Population	Global Pop (Millions)	Total Disabled	Total Number of Disabled People as a % of Global Pop	Hearing Impaired as % of Total Pop	Visually Impaired as % of Total Pop	Learning and Cognatively Impaired as % of Total Pop	Physically Impaired as % of Total Pop	Other Disabilities (Depression alcohol dependency ,dementias) as % of Total Pop
Children	1852.37	76.39	4.12	0.44	0.25	0.27	0.02	0.09
Working Age Adults	4702.17	453.75	9.65	2.31	1.13	0.92	0.24	1.78
Adults Over State Pension Age	569.96	436.46	76.58	2.31	2.61	0.27	0.65	0.29
Total	7,124.50	966.6	13.57	5.05	3.99	1.46	0.90	2.16

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III.   Number of disabled people, by disability

Number of Disabled People, By Disability	Hearing Impaired (Million)	Vision Impaired (Million)	Learning and Cognatively Impaired (Million):	Physically Impaired: (Million):	Other (Inc. Depression, alcohol dependency, dementias) (Million):
Children	31.3	18	19.24	1.18	6.67
Working Age Adults:	164.4	80.24	65.36	17.02	126.73
Adults over State Pension Age	164.4	186.2	19.14	46.02	20.7
Total:	**360.1**	**284.44**	**103.74**	**64.22**	**154.1**

IV.   Severity of different disabilities (in millions)

	Total population	Children	Working age adults	Adults state pension age
Hearing impaired less severe	235.8	20.96	107.75	107.42
Hearing impaired moderate and severe	124.2	11.04	56.75	56.58
Visually impaired low vision	246.04	17.52	74.46	154.04
Visually impaired blind	39.37	1.42	15.21	22.23
Learning/Cognitively impaired less severe	82.99	15.39	52.28	15.32
Learning/Cognitively impaired moderate and severe	20.75	1.42	15.21	22.23M
Physically impaired less severe	58.24	1.02	15.45	41.77
Physically impaired moderate to severe	5.98	0.16	1.57	4.25

	Total population	Age 0-59	Age 60+
Other disability less severe	139.27	120.56	18.71
Other disability moderate and severe	14.83	12.84	1.99

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V.   Number of disabled people by economy type

Number of Disabled People by Economy Type	All Disabilities (Million):		
	Advanced Economies	Middle Tier	Developing Economies
Children:	10.70	48.10	13.55
Working Age Adults:	70.32	197.57	57.52
Adults over State Pension Age:	96.95	355.93	115.97
Total:	**177.97**	**601.60**	**187.04**

VI.   Cost of support (per annum)

Cost of Support (Per Annum)	ALL Disabilities (US$ Millions)			
	Total Benefits All Ages	Total Benefits - Children	Total Benefits - Working Age Adults	Total Benefits - Adults over State Pension Age
Advanced Economies	959,183.02	57,669.79	379,004.68	522,508.55
Middle Tier	230,997.45	18,469.51	75,860.55	136,667.39
Developing Economies	5,468.22	396.12	1,681.66	3,390.44
Total:	**1,195,648.69**	**76,535.43**	**456,546.89**	**662,566.38**

VII.   Earning power of disabled - by economy type (per annum)

Earning Power of Disabled - by Economy Type (Per Annum)	ALL Disabilities (US$ Millions)			
	Total Earning Power All Economies	Employment	Benefits	Family Support
Children:	204,020.01	0.00	76,535.43	127,484.58
Working Age Adults:	5,486,100.40	1,863,558.07	456,546.89	3,165,995.44
Adults over State Pension Age:	2,655,117.89	385,354.35	662,566.38	1,607,197.16
Total:	**8,345,238.30**	**2,248,912.43**	**1,195,648.69**	**4,900,677.18**

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VIII.   Spending power of disabled - by economy type (per annum)

Spending Power of Disabled - by Economy Type (Per Annum)	ALL Disabilities Spending Power (US$ Millions)			
	Total - ALL Economies	Advanced Economies	Middle Tier	Developing Economies
Children	204,020.01	76,923.47	52,342.47	9,937.37
Working Age Adults	5,486,100.40	1,744,651.33	1,481,713.79	447,367.03
Adults over State Pension Age	2,655,117.89	943,051.56	713,262.23	189,313.47
Total:	**8,345,238.30**	**2,764,626.35**	**2,247,318.49**	**646,617.87**

IX.   Total number of disabled people in employment

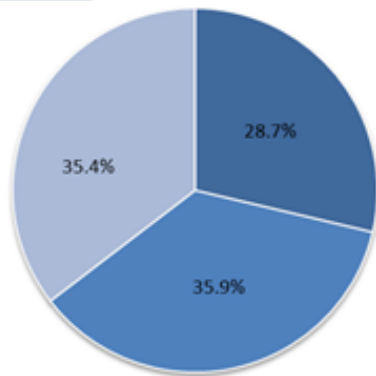| Total Number of Disabled People in Employment	ALL Disabilities (Millions)			
	Total Employed All Ages	Total Employed - Children	Total Employed - Working Age Adults	Total Employed - Adults over State Pension Age
Advanced Economies	65.48	0.00	57.40	8.08
Middle Tier	113.08	0.00	89.94	23.14
Developing Economies	36.17	0.00	28.77	7.40
Total:	**214.74**	**0.00**	**176.11**	**38.63**

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Appendix B – Awareness of workplace accessibility
Source Gartner Consumer and Employee Survey on Technology Use
August 2014

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Appendix C - Examples of assistive technology applications

Disability	Brand name	Description
Physical	Iris Bond/Looks That Talk	An advanced alternative communication system that lets you control your computer with your eyes, accurately and intuitively.
Physical		Switch or voice recognition to access smartphone; touch and hold delay
Physical	MouseTrack	TherapyBox: App to utilise the headmouse (I think?)
Physical	Servus Environment Control	Enables control of a wide range of devices around the home or other location.
Physical/senior	Doro Liberto® 820	Smartphone designed with physical and emotional needs of seniors in mind
Hearing	TTY/Sprint	Relay service via telephone line
Hearing		Sign Language video service
Hearing		Smartphones hearing aid compatible, 'LED Flash for Alerts', 'Phone Noise Cancellation', vibrate for alerts
Hearing	OtoSense	A sound recognition software, learns most important sounds of environment, notifying users via flash, vibration, visually on screen and third-party notification, turning smartphones and tablets into adaptable, portable and useful assistive alerting devices
Hearing		iOS and Android to switch on subtitles and captioning
Hearing	Google Glass	Transcribes speech, allowing hearing impaired to follow the conversation
Visual	Be My Eyes	Voluntary service
Visual		Smartphone screen settings
Visual		Scanner for Labels
Visual	APP Blueway	Indoor navigation system with Bluetooth wireless. Guides the user until reaching the destination in indoor places such us subway stations, airports or museums
Visual	Loud Steps	Provides an indoor micro-location determination service using the Bluetooth Low Energy (BLE) Beacons
Visual	See Clearly	Uses everyday consumer technology to alter, filter and adapt images filmed live with camera on mobile device, before displaying them on your TV.
Visual	Claria Zoom	Suite of approx 20 apps, advanced magnification, contrast and speech features offering intuitive way to customize reading experience and make it really comfortable.
Visual	Screen Reader/ synthetic speech	iOS 'VoiceOver', Android 'TalkBack', Windows 'Narrator'
Visual	BlindSquare	City guide
Visual	Google Glass	Enables users to receive audio descriptions of objects in front of them

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Visual	Claria Vox	Designed to make smartphones easy and accessible
Cognitive		Smartphone colour option settings and voice recognition
Cognitive	Scene & Heard	TherapyBox: Visual Scene Display educational communication tool
Multiple	Samsung Galaxy Core Advance	Offers equal possibilities for everyone. Combines Samsung's powerful Galaxy user experience with convenient usability functions and enhanced accessibility features for disabled and visually impaired users.
Multiple	ChatAble	TherapyBox: Grid and screen based communication app (physical and visual)
Multiple	Robots for Humanity	Adaptive robotic technology to help disabled people navigate the world
Multiple	Grid 2	Communication and computer access software which combines all the different styles of communication aid into a single program for both text and symbol users. Everyday thousands of people across the world communicate using Grid 2 in almost 20 different languages.
Speech	Predictable	TherapyBox: text based Augmentative and Alternative Communication (AAC) app
Speech	Proloquo2go	AssistiveWare: symbol-supported communication app
Speech	My Doro Manager	The app that makes smartphones easy for everyone
Speech	MyChoicePad	Brings together proven speech and language therapy techniques and market leading technology to deliver measurable language development via tablet computers.
Various	GARI (Global Accessibility Reporting Initiative)	Online database for accessible mobile phones, tablets and accessibility related apps.
Various	World Without Barriers	Disabled people can find, mark and add accessible and less accessible public places via this app.

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Appendix D - About the author

Chris Lewis (http://www.lewisinsight.com) is a highly regarded and experienced Industry Analyst covering the depth and breadth, demand and supply of the ICT sector on a global basis for 30 years and more latterly, developing specialist knowledge of accessibility for the disabled world. He is one of the few industry analysts who can draw together the many varied technology and business components helping shape telecoms in the context of the future digital marketplace.

In addition to his commentary on the industry, Chris is a frequent public speaker at industry and client events around the world. His dynamic and engaging presentation style, coupled with in-depth industry knowledge, has resulted in keynote addresses, chairing panels, workshop facilitation and coaching of high level executives at many of the world's top telcos and ICT companies.

With a reputation for honest, sometimes irreverent, insight built on unparalleled understanding of industry evolution and dynamics, Chris is proud of long term key stakeholder relationships developed around the world with leading players. He has accumulated a vast network of contacts in the analyst and consulting communities from tenures at IDC, Logica, Yankee Group and Ovum.

Chris also sits on several Boards in the Visually Impaired charity sector. Having been registered blind for over 30 years, he now brings his technology knowledge to help the RNIB and Vision 2020 leverage telecoms and communications technology for the blind and partially sighted community. In 2014, Chris was commissioned by Telefonica to author The Untapped Billion, a report into the state of accessibility and the role of mobile. He has also spoken on the subject of accessibility around Europe.

More recently, Chris co-founded The Great Telco Debate (www.telcodebate.com), a unique conference to give independent industry analysts a platform for debating the future of the industry with key stakeholders.

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