The accessibility of cloud computing

Current and future trends

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INCLUSION THROUGH TECHNOLOGY

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About Media Access Australia

Media Access Australia is Australia's only independent not-for-profit organisation devoted to increasing access to media for people with a disability. We promote inclusion by providing information and expertise on the accessibility of mainstream technologies to government, industry, educators, consumer organisations and individuals.

We work as a catalyst for change across television, video, cinema, the arts, education, digital technology and online media, with a primary focus on people who are blind or vision impaired, or Deaf or hearing impaired.

Media Access Australia grew out of the Australian Caption Centre (ACC), which was founded in 1982. As the ACC we provided captioning services for all Australian television networks, as well as the captioning of live theatre, videos and DVDs. The captioning and other commercial operations of the ACC were sold to Red Bee Media in 2006.

About the author

Dr Scott Hollier, Media Access Australia's Manager, Major Projects, is a leading authority in the area of access to computers and the internet for people with disability. Dr Hollier authored a doctoral thesis titled *The Disability Divide: a study into the impact of computing and Internet-related technologies on people who are blind or vision impaired*. He can also provide a personal perspective as he has a lived experience of disability through being legally blind and reliant on assistive technology. Dr Hollier represents Media Access Australia on the advisory committee of the World Wide Web Consortium (W3C).

He is the author of Media Access Australia's *SociABILITY: social media for people with a disability* resource which is now used by the United States Government to help agencies improve the accessibility of social media. He is also author of the Service Providers Accessibility Guide, funded by Department of Families, Housing, Community Services and Indigenous Affairs to assist DisabilityCare providers in making their communications accessible for clients and employees using mainstream technology.

Dr Hollier is also co-lecturer of the Professional Certificate in Web Accessibility, an industry course for web professionals, run jointly by the University of South Australia and Media Access Australia.

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Introduction

By Alex Varley, Chief Executive Officer, Media Access Australia

This is the second in the ongoing series of white papers produced by Media Access Australia covering important and topical issues in access to information and media through technology. These white papers are integral to Media Access Australia's role as a leader and catalyst for change. In keeping with our usual approach, this white paper takes a practical view of the issue of cloud computing accessibility.

The author is my colleague Dr Scott Hollier, who has a wealth of experience in the field of web accessibility generally, and more specifically in dealing with cloud issues. The genesis of this white paper was a presentation that Dr Hollier gave at the Cloud + NBN Forum in 2012 (organised by the then Department of Broadband, Communications and the Digital Economy) where the level of immediate audience interest made it clear that this issue was going to become a major talking point in the IT industry.

The first point about cloud computing is that it has entered our everyday lives somewhat by stealth. The average person would deny engaging with cloud computing (or its more friendly description simply as 'the cloud'), yet as this paper outlines, it has been with us for many years. Without the cloud smartphones and tablets would not have the same functionality and social media would grind to a halt, yet it is generally consigned to a background function, much like the mysterious operating systems that drive the same devices.

More recently, services such as Dropbox have appeared, offering convenience of file sharing at no cost to the end-user. This is more obviously a cloud service and in consumer terms prompts discussions about the nature of the cloud and how we are using it. At a business level the cloud discussions are more mature. Storing data or using cloud-based software offer many advantages, but come with some potential costs to control and security.

In all of this, the missing part of the discussion has been accessibility issues. For a chief information officer, developer, IT support manager, programmer, in fact anyone engaged at a commercial or public level with the cloud, this conversation is essential. Like its (barely)

older cousin, website accessibility, cloud accessibility is lagging behind the wave of uptake. But postponing the conversation is more likely to shut a door and potentially give an advantage to a competitor or more savvy rival. This paper outlines the issues that should most concern professionals working in this area. It covers the real-life experience of people with a disability as hungry consumers already embracing cloud-based products, albeit with some modifications to assist their use. Furthermore, the reality of the future remote workplace, which provides greater flexibility and adaptability for organisations, will need to properly engage people with a disability as employees, particularly as the workforce ages and age-related disability has an impact.

The underlying goal of the white papers is to provoke discussion, reflection and then action to incorporate accessibility into the equation. As ever, the recommendations of the paper are practical and clearly focus the issues for governments, commercial providers and consumers. As the cloud grows and more competition is injected into the market, accessibility becomes a major issue to ensure both a level-playing field and proper coverage of the market. Put bluntly, if your work involves the cloud, then you need to understand this issue.

Media Access Australia interacts and collaborates with a wide range of companies, governments, consumer organisations, regulators and industry bodies. The generous support of the Australian Web Industry Association (AWIA) for this paper builds on AWIA's strong commitment to accessibility and seeing it as part of the essential toolkit of any developer. We look forward to building on this relationship and working with AWIA's members across Australia.
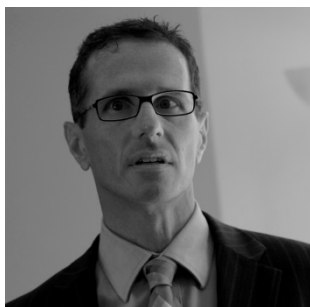
Foreword

By Bret Treasure, Chairman, Australian Web Industry Association (AWIA)

AWIA welcomes the opportunity to support Media Access Australia in providing valuable research for the Australian web industry on how people with disabilities are engaging with cloud technology, and how web industry professionals need to evolve their practices to meet this growing market.

AWIA recognises the importance of making the web accessible across the board. At our 2013 AWIA Awards we made changes to ensure that web accessibility is viewed as a fundamental requirement of good web design, not a niche or special interest. We are keen to generate conversations about accessibility that impact developers and their clients.

As AWIA members know, cloud services and the web are intimately connected. Cloud-delivered services are an expanding part of the web and therefore an expanding part of all people's normal daily lives.

For everything from internet banking and shopping, purchasing insurance and superannuation, paying bills, registering cars, paying your tax, through to email, social media, video and messaging apps, the cloud is an essential component.

The choices made by AWIA's members - developers, designers, hosts, consultants, SEO, social media and marketing experts, sys admins, and content providers - strongly affect whether cloud services are accessible.

For those reasons AWIA is supporting this important white paper, its author and the organisation behind it. We acknowledge the great work that Media Access Australia is doing in this area.

The white paper itself is grounded in facts and in-depth research and takes a no-nonsense approach to identifying the implications of inaccessibility and the required components for accessible cloud services. I believe the paper will be a valuable toolkit for AWIA members and other developers in understanding the real-world implications of cloud computing.

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The white paper's author, Dr Scott Hollier is a leader in web accessibility and is an accessibility judge in the AWIA awards. He is a W3C member, a lecturer on accessibility, and has travelled the globe presenting on accessibility issues.

The organisation behind the white paper, Media Access Australia, has a reputation for analysing the issues and drawing out the practical implications. Its independence and dedication to accessibility advocacy are well known.

From a personal and business perspective, I'm an enthusiastic user of online, remote and cloud-enabled services. From a web industry viewpoint, we choose to remind clients and developers of their capacity to make a difference in the lives of disabled and disadvantaged people who rely on cloud services.

And we encourage our members to make their ability to deliver accessible services a 'point of difference' as a provider of web services. This paper will help them and others better implement cloud accessibility.

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1 Executive summary

Cloud computing is generally defined in relation to its software, platform and infrastructure services, yet business and consumers have fundamentally different needs from it. While for business the decision to move to the cloud is a matter of weighing up the cost benefits and workforce flexibility with the security and privacy concerns, for consumers the cloud is an essential service due to the limited storage space on popular consumer devices.

For people with disabilities the cloud has the potential to offer more than the sum of its parts. With initiatives such as Global Public Inclusive Infrastructure (GPII), the cloud promises an always-on, always-accessible environment through the storage of cloud profiles on which an interface can be automatically customised based on user preferences. While an inclusive cloud infrastructure represents a goal for the future, in today's cloud there are already benefits available to people with disabilities. The business cloud and its workplace flexibility enable people with disabilities to use their own assistive technology and preferences to engage with the workforce, while in the consumer cloud Microsoft has provided the ability to synchronise its cloud accessibility preferences in the most recent version of Windows.

However, there are a number of issues relating to cloud accessibility that need to be addressed. While the consumer cloud offers some benefits, consumers face accessibility issues in relation to the accessibility of cloud-based services in relation to their apps and web-based services. Consumers need to be careful about which ecosystem they choose as while many cloud storage options are across all platforms, the choice and accessibility of apps and availability of web solutions varies from platform to platform. As a result, industry needs to improve access to the cloud by ensuring that their cloud services aren't limited to their own ecosystem and are following the W3C web accessibility requirements based on WCAG 2.0, ATAG 2.0 and WCAG2ICT. The role of government is also key to ensuring that cloud services are effectively integrated in both the public and private sectors. It can play a vital role by ensuring that cloud service rollouts also incorporate the relevant web standards, and that high speed broadband is provided to ensure the effectiveness of cloud services. While a fully integrated inclusive cloud may still be elusive, cooperation by consumers, industry and government can lead to significant and positive change in the independence and participation of people with disabilities.

2 Defining the cloud

The formal definition of cloud in computing is provided by the US National Institute of Standards and Technology (NIST) in *The NIST Definition of Cloud Computing* (NIST Special Publication 800-145). The NIST (2011) definition lists five essential characteristics of cloud computing:

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- On-demand self-service
- Broad network access
- Resource pooling
- Rapid elasticity or expansion
- Measured service

Within these characteristics, cloud computing contains three service models:

- Software as a Service (SaaS)
- Platform as a Service (PaaS)
- Infrastructure as a Service (IaaS)

Furthermore, the NIST cloud computing paper also identifies four deployment models which identify how cloud services can be delivered. They are:

- Private
- Community
- Public
- Hybrid

For business, all three cloud services are directly relevant. Instead of having to purchase storage, servers or network equipment, IaaS provides businesses with the ability to rent these out via the cloud on demand, in a pay-as-you-go model (IBM, 2014). SaaS can provide business with access to online applications, often subscription-based (Griffith, 2013), and PaaS is generally considered a virtual development space to create software. However, in recent times the distinction between these three levels has become more blurred, particularly with PaaS which often has elements related to the other two cloud services (Bridgewater, 2013).

For consumers, the cloud is generally considered in the much simpler terms of storage, settings and software. This equates to a simple definition of the cloud as a place for storing and accessing data and programs over the internet instead of on a computer's hard drive (Griffith, 2013). While this consumer definition of cloud is still essentially presenting IaaS through the storage element and SaaS through software, two important distinctions for the consumer are that the fundamental cloud services are free or low-cost, and the way in which the cloud synchronises with a device is largely seamless for the user, keeping cloud interaction simple (Mitroff, 2014).

In essence, the cloud represents the way in which internet-connected devices interact with online services in a relatively seamless way for the end user. In practical terms this enables

us to use files, settings, applications and development platforms that are hosted on the internet but appear as if they were hosted on our own device.

3 The cloud today

3.1 The business cloud

In many respects cloud computing is a relatively new phenomenon, particularly in the consumer space where the small amount of storage available on mobile devices sparked a need for access to photos, music, videos and documents without necessarily storing them locally. For business, however, SaaS has been available for around 15 years in areas such as email and internet banking (Burton, 2014). The primary reason why the cloud has received particular attention from business in recent years is that it ultimately saves money (Grady, 2014; LaManna, 2013; Microsoft, 2014a; Singh, 2012), primarily due to savings on infrastructure and the subscription-based model of cloud services.

3.2 The consumer cloud

Prior to the cloud, consumers were used to storing all their data on large hard drives in desktop computers (Arthur, 2011). This thinking changed when the Apple iPhone, arguably the first internationally popular smartphone (Slivka, 2012), was released. With its powerful processing capabilities for the time, almost limitless capability due to its rapidly evolving app library and always-on mobile broadband combined with very limited storage space that couldn't be easily upgraded, the solution for data services needed to move beyond the device and onto the cloud (Slivka, 2012). With the release of the iPad, a device with similar benefits and limitations to the smaller iPhone, the reliance on the cloud to supplement storage and data continued to increase.

To highlight its impact, at the close of 2013, just six short years after the first iPhone, global smartphone penetration had reached an estimated 22 per cent worldwide, with most of that rise consisting of approximately 1.3 billion smartphones in the last four years. Meanwhile tablets have reached the same level of global ownership in two years that it took smartphones to reach in four years. This translates to the equivalent of one in every five people owning a smartphone and one in every 17 having a tablet (Heggestuen, 2013). In Australia the saturation is higher with data in 2012 suggesting that half of all Australian adults owned a smartphone and about a quarter had a tablet. These figures are likely to be significantly higher now based on global growth trends.

With all major mobile device manufacturers following similar trends of having limited storage in their devices compared to the amount of storage in desktop or laptop computers, the push to integrate cloud storage became essential for such devices to work properly. In

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short, cloud is helpful to business, but the need for particular elements of the cloud such as storage and the ability to access personal data are essential for consumers.

3.3 Business cloud benefits

3.3.1 Online infrastructure

For business, the benefits of the cloud (Grady, 2014; LaManna, 2013; Microsoft, 2014a; Singh, 2012) are generally framed to encourage business to move away from infrastructure and systems they are likely to already be using. Aside from the direct financial benefits, there is a focus on the economies of scale and upgradability of information and communication technology (ICT) infrastructure. Essentially, if storage and software are all handled by the cloud, expensive servers are no longer required, there is no need to guess how much data storage needs to be purchased as the amount can be changed at any time, upgrades are automatically implemented by the cloud service provider, and setting up office computers becomes much easier as many cloud services have an auto-detect feature, such as Microsoft's Office 365, which eliminates the need to network servers and import settings internally. Security is also considered an improvement as data is hosted by companies that have greater capabilities to protect it, and localised issues such as a fire or natural disaster destroying the data are minimised due to its off-site location and always-on nature of the cloud (providing data is always backed up). With the whole office using one system and upgrades happening automatically, the need for training is reduced as the environment remains consistent, and there is less risk of downtime due to server issues or maintenance.

3.3.2 Workplace flexibility and reduced costs

Outside of the general infrastructure replacement benefits, the cloud offers many other benefits, with one of the most notable being that everything can be accessed from anywhere as if in the office. This provides greater flexibility for employees who wish to work from home, including people with disabilities, who no longer need to use Virtual Private Networking (VPN) to access files on a particular network. There are also environmental benefits with less power being consumed by internal servers.

3.4 Consumer cloud benefits

3.4.1 The essential cloud

While for business the choice is between the cloud or the more traditional client-server system, for consumers it is more a choice between different cloud services or no cloud at all. As such, the benefits of the cloud (Apple, 2014; Art Systems, 2012; Gavin, 2014; Nuez, 2013), are framed so they focus on bringing in and keeping consumers locked into an ecosystem.

3.4.2 Choice of cloud service providers

While cost remains an important factor for consumers, the emphasis is on how much easier and more seamless the cloud is if the cloud services used are the same as the ecosystem of the device. This means using the iCloud for Apple devices, OneDrive (formally SkyDrive) for Microsoft devices/systems, and Google Drive for Google and/or Android devices. Dropbox takes a different tack in that while it argues the same point about keeping files in the one place, it aims to enable any device to access Dropbox in the same away, assuming that people will use different devices and operating systems but want the same one-stop-shop experience. While all the major consumer cloud providers have apps for their services across different ecosystems, they emphasise the benefits of staying within the ecosystem of the device.

3.4.3 Sharing the cloud with family and friends

The other benefits for consumers include a greater focus on sharing. While business tends to keep its files private, consumers view the cloud as an opportunity to share their data via social media, so the ability to quickly push specific types of data such as photos, music and documents to the cloud is of great benefit. The ease in which this can be achieved is also important to consumers using the cloud. Interacting with the data on the cloud, such as using Google Docs to view data kept in Google Drive, substantially increases the appeal of the 'access anything from anywhere' argument.

3.5 Cloud risks

3.5.1 Security

While the cloud has many benefits for business and consumers alike, the biggest concern for both groups is security (ACCAN, 2014; Grimes, 2013; Jeffers, 2013; Marx, 2013). The cloud offers security in terms of disaster recovery, but the concept of storing confidential data online, particularly for businesses which do not intend to share it, is troubling, and the always-on nature of the cloud also means it is always available for cyber-attacks and hacking attempts. For consumers, security also remains a key issue but for different reasons: the loss or theft of smartphones and tablets can often result in direct unauthorised access to personal information in a way that would be more difficult if personal files were kept on a desktop computer in the home. However, while businesses have the choice to engage with the cloud and choose between a public or private cloud solution, consumers need to consider their personal security in addition to the threats of the public cloud.

3.5.2 Data ownership

Additional cloud risks relate to the location where the data is physically stored, and the laws that govern data ownership. Given the seamless nature of the cloud, it is often difficult to determine exactly where data is being hosted, and if any problems arise with the cloud

service provider there can be problems accessing the data if it's hosted in a foreign country, or with the ownership of the data depending on the laws of the country.

3.5.3 Privacy

A related issue that also highlights potential risks is privacy. For business, storing data in the cloud means essentially trusting a third party to look after it, and depending on the agreements and trustworthiness of the cloud providers, this may result in a breach of privacy. Consumers are generally more open to the idea of sharing content on the cloud via tools such as social media, but do not always appreciate that what is shared with a few may inadvertently become available to a global community.

In essence, security is the most significant risk for both business and consumers, but whereas business has the ability to choose whether or not to risk the cloud, consumers need to consider their personal security and the potential implications of sharing data.

Table 1: Benefits and risks associated with the business and consumer cloud

CATEGORY	BUSINESS	CONSUMER
Priority of cloud use	Optional	Essential
Benefits offered by the cloud	- Choice between local and online infrastructure - Workplace flexibility - Reduced costs	- Storage beyond the limitations of mobile device - Choice of cloud providers - Free or low-cost services - Share data with family and friends
Issues and risks associated with the cloud	- Privacy - Security - Data ownership	- Privacy - Security - Data ownership

While the cloud environment may be beneficial for business and consumers as summarised in Table 1, it is particularly important to consider how these benefits and risks relate to people with disabilities and the additional consequences that may be associated with its broad implementation, particularly for consumers where cloud access is essential to product use. It is therefore necessary to examine how the cloud can benefit people with disabilities, which web standards are applicable to cloud accessibility, the level of government involvement required and the work done in the leading free cloud services provided by Microsoft, Apple, Google and Dropbox.

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4 The impact of the cloud for people with disabilities

4.1 The potential of an accessible inclusive infrastructure environment

While the interaction of the internet and devices across SaaS, PaaS and IaaS are relatively distinct today, the ongoing blurring of the lines between device and cloud infrastructure offers significant potential to people with disabilities. Imagine the potential of a simple, consistent identification method across different devices that can ensure that consumers with disabilities can quickly gain access to any device, any time, with immediate access to their required accessibility tools regardless of whether they have used the device before, gaining even greater device functionality and independence.

Taking the idea of accessibility synchronisation to a more advanced level is an initiative called the Global Public Inclusive Infrastructure (GPII) that is striving to provide a greater, platform-independent solution that would automatically configure any internet-connected device to meet the needs of individual users with disabilities.

Developed by Raising the Floor, a consortium of non-government organisations, businesses and educational institutions, the project hopes to build an on-demand, personalised and accessible on-ramp to the internet (Price, 2014).

The concept featured on the [GPII website](#) shows an example of a ticket machine in which users are identified by the machine, their preferences are obtained from the cloud and the interface is formatted based on them. For example, a person who is blind may have a screen reader started with a simple 'explore by touch' interface, whereas a person using a wheelchair may have the standard touch screen buttons moved to a lower height for easy reach (Raising the Floor, 2014).

While the GPII represents great hope and ambition for cloud accessibility in the future, there are a number of elements that must be put in place for such an initiative to happen. In order to assess this, it is necessary to assess the benefits of and risks of the cloud today and what is required to move forward into a GPII-like system.

4.2 Accessibility of the business cloud

The business benefits of the cloud extend to people with disabilities. The ability to connect to the office from anywhere means that a person with a disability could use their own assistive technologies and accessible interface to connect to the relevant work infrastructure, providing an accessible environment for the employee with a disability. In

addition, employees could potentially already have their necessary tools set up, meaning that the business would not have to invest in assistive technologies.

While the GPII-style environment is more targeted at the consumer using the public cloud, employers could also consider integrating some of the benefits associated with future cloud initiatives and in turn there is a requirement for solution providers offering cloud-based virtual office solutions to consider the disability needs when designing and implementing these products.

4.3 Accessibility of the consumer cloud

Given that the cloud is essential to the functionality of mobile devices, it is essential that the difficulties people with disabilities have gaining access to internet-related technologies do not increase with cloud reliance. The significance of the issue has recently been highlighted by the Australian Communications Consumer Action Network (ACCAN, 2014) which listed in its position paper on cloud computing that the first priority of any cloud service is access, stating that it 'should be accessible to all consumers. Companies should use the WCAG 2.0 guidelines to ensure that people with disability are able to navigate all aspects of the service.'

4.4 Selecting an accessible consumer device and ecosystem

In order for the cloud to progress towards an inclusive infrastructure environment, two accessibility aspects must be addressed: the accessibility of the user device and the accessibility of the cloud interface itself, be it via a web browser or device-specific apps. As highlighted earlier, consumers are given little choice but to use the cloud due to the limited storage size of devices, so it is therefore imperative that consumers with disabilities are well placed to make a wide and effective purchasing decision relating to the cloud.

While the popular platforms of Apple, Microsoft and Google dominate the market, only Microsoft offers some cloud-specific accessibility. Microsoft services synchronise accessibility preferences by using its Windows 8, 8.1 and RT operating systems. Daniel Hubbell (2014) from Microsoft describes the use of the cloud in this context as 'virtual glue that connects a user's devices. It can hold preferences and settings, including accessibility tools, and allow those features to follow a user from device to device.'

In practical terms, such features are made possible by using the same Microsoft login account, such as an outlook.com address, across all devices owned by a user. This allows the setting of accessibility preferences, such as using a high contrast colour scheme or setting Magnifier to start on boot up, as something which can be synchronised across all devices. It also works in real time: changing a desktop computer, for example, will almost

immediately change an online device such as a Microsoft Surface tablet to the same theme without user interaction.

Table 2: Consumer device ecosystems and cloud features

CATEGORY	MICROSOFT	APPLE	GOOGLE	DROPBOX
OS	Windows 8+	iOS 8+	Android 4.2+	NA
Cloud accessibility features	Yes – preference synchronisation	No	No	No
Cloud storage	OneDrive	iCloud Drive	Google Drive	Dropbox
Storage support on other OS	iOS, Android	Windows	Windows, iOS	Windows, iOS, Android
Free storage capacity	15GB	5GB	15GB	2GB
Storage web portal	Yes	No	Yes	Yes
Document web portal	Yes (view/edit)	No	Yes (view/edit)	Yes (view)
WCAG 2.0 compliance of web portal	No – some issues present	NA	No – some issues present	No – significant issues present

While Microsoft may be the only popular cloud provider to currently offer accessibility-specific cloud benefits, all of the three major ecosystems – Windows, iOS and Android – provide effective accessibility tools such as screen readers, screen magnifiers, on-screen keyboard support and captioned video playback. If a consumer is already locked into an ecosystem, cloud accessibility may come down to a choice between specific accessible cloud-based office applications and storage apps. An assessment of the Apple iCloud, Microsoft OneDrive, Google Drive and Dropbox cloud storage options, cloud-based office software provided by Microsoft and Google, and their accessibility on particular devices is summarised in Table 2 with further details in the Appendix.

4.5 Sharing data via social media

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Many consumers rely on the cloud storage services of popular social media tools such as Facebook and YouTube. They provide a permanent storage place for photos and videos, while also allowing this content to be shared with others.

Using the cloud to share pictures, videos and other personal data may be difficult for people with disabilities and prevent the full utilisation of these services. Media Access Australia published a report titled *SociABILITY: social media for people with a disability* which outlines some of the key accessibility issues across popular social media tools (Hollier, 2012).

SociABILITY provides specific information on how people with disabilities can overcome barriers of social media participation across tools such as Facebook, Twitter, YouTube, LinkedIn, blogging and Skype. Issues addressed include the challenges of signing up to the services' basic functionality. While social media accessibility has improved in recent times, many accessibility issues remain.

Particular issues relating to the use of social media as a cloud storage sharing mechanism include the need to ensure that YouTube videos are captioned and that images in Facebook contain text descriptions.

Governments are increasingly using social media to engage the public, as well as expanding cloud services into areas such as e-health and e-learning. This makes it all the more essential that the consumer cloud is accessible, so that these services can be effectively utilised by people with disabilities.

4.6 Challenges preventing a move towards an inclusive cloud

The implementation of Microsoft's cloud accessibility synchronisation services mirror in many ways the dream of an inclusive cloud infrastructure environment. However, the practical reality at this point is that the implementation of GPII remains elusive, and both benefits and risks must be considered if a path towards a more inclusive cloud infrastructure is to be realised.

To use Australia as a case study, there was some discussion relating to the possibility of a GPII-style trial in Australia at the Cloud + NBN forum (Hollier, 2012). There are both benefits and risks associated with such an endeavour. The benefits are essentially a combination of the business and consumer benefits, given that it would require 'buy-in' from government, business and consumers alike for the process to happen. Such benefits include people with disabilities only needing to input their details and preferences once to the cloud, after which any device would be instantly set up to their needs; there would only be one interface to learn; a global rollout of updates would significantly reduce costs long-

term for ICT staff due to the consistency of the system; and the use of the interface would in turn always be consistent for the user.

Table 3: Business and consumer cloud benefits and risks for people with disabilities

CATEGORY	BUSINESS	CONSUMER
Priority of cloud use by people with disabilities	Optional	Essential
Disability-specific benefits	- Workplace flexibility allows for connection of user-controlled accessible environment to private cloud - Potential to incorporate consumer benefits from public cloud	- Synchronisation of accessibility preferences creates device independence - Preferences used to customise user interface instantly - Consistency in assistive technology support - Less training due to only needing to learn one interface - Global rollout of updates reduces local ICT costs
Disability-specific issues and risks	- Potential to incorporate consumer-related risks from public cloud - Disability users' needs potentially a minor consideration in purchase decision - Business tendency to customise off-the-shelf systems may result in inadvertent removal/depletion of built-in accessibility systems	- Security concerns about storing disability information on the cloud - Privacy concerns relating to identification based on disability profile - Lack of infrastructure such as broadband may prevent benefits from being realised - Localised device accessibility issues may prevent cloud services from working - Social media accessibility may

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			prevent use of popular tools such as Facebook and YouTube from being viable cloud sharing options • GPII-style setup, training and support requires high level of support from government and industry

As summarised in Table 3, it is clear that the risks associated with the cloud currently outweigh the benefits of its use by people with disabilities. The primary issues are the initial setup cost and a lack of fast broadband. To establish a platform-independent system across Australia, or even a small trial system, would involve a significant cost to one entity, meaning that there would need to be a consortium of support to ensure its implementation. Even if this hurdle were overcome, the broadband speeds currently available in Australia would make it difficult to identify individuals, download their preferences and set up their particular accessibility tools in real time.

Beyond the wider issues of support there are also issues relating to whether people with disabilities are comfortable sharing information about their needs in an online environment, and how secure such data would be. Until the broader security issues of the cloud are addressed this restricts the benefits of an inclusive cloud service environment. There is also an issue of training, which may prove expensive and time-consuming if appropriate processes are not put in place.

In short, the accessible cloud of tomorrow cannot be reached until these key challenges are addressed. In the meantime, there are practical external factors that are affecting the accessibility of today's cloud which need to be addressed first.

5 External factors that impact on current cloud accessibility

5.1 International web standards

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Given the current and potential benefits that the cloud can provide to people with disabilities, it is imperative that a supportive environment is created so that external factors such as the use of appropriate web standards, government policy and effective infrastructure are positioned to effectively support an inclusive cloud.

As highlighted in the Appendix, the accessibility of the cloud today hinges greatly on the implementation of web and application accessibility standards. The definitive standard relating to the accessibility of web content is the World Wide Web Consortium (W3C) Web Content Accessibility Guidelines (WCAG) 2.0, also known as ISO 40500. This features 12 guidelines which are highlighted in the 'WCAG 2.0 at a Glance' (W3C, 2008) document as follows:

Perceivable

- Provide text alternatives for non-text content.
- Provide captions and other alternatives for multimedia.
- Create content that can be presented in different ways, including by assistive technologies, without losing meaning.
- Make it easier for users to see and hear content.

Operable

- Make all functionality available from a keyboard.
- Give users enough time to read and use content.
- Do not use content that causes seizures.
- Help users navigate and find content.

Understandable

- Make text readable and understandable.
- Make content appear and operate in predictable ways.
- Help users avoid and correct mistakes.

Robust

- Maximize compatibility with current and future user tools.

While WCAG 2.0 is at the heart of all web accessibility development, there are a number of other W3C standards and techniques particularly applicable to the cloud designed to extend the use of WCAG 2.0 in an application development context. This includes the 'Authoring Tool Accessibility Guidelines' (ATAG) 2.0 (W3C, 2013b) currently in a near-complete draft form.

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ATAG has significant parts to it: Part A focuses on ensuring that people with disabilities can use an authoring tool while Part B focuses on ensuring that content produced by an authoring tool is accessible. To use a well-established cloud application like Google Docs as an example, ATAG would require that a person with a disability could use the program to create a document, and also ensure that the document created was accessible.

The 'Guidance on Applying WCAG 2.0 to Non-Web Information and Communications Technologies' (WCAG2ICT) (W3C, 2013) is another W3C publication which provides guidance on the applicability of WCAG 2.0 in the development of documents and software. This is aimed at non-web development and is particularly applicable in explaining which parts of WCAG 2.0 are applicable when developing software for particular devices, such as smartphone and tablet apps.

The combination of WCAG 2.0, ATAG 2.0 and WCAG2ICT effectively addresses accessibility across all sectors of the cloud, be it pure web content, a web-based authoring tool or an app hosted on a smartphone or tablet. Once ATAG 2.0 is formally released, all three have the potential to be adopted into government and corporate frameworks to ensure current and future cloud accessibility development.

5.2 Role of government in driving adoption

For government to create an environment in which cloud accessibility can be pursued, several criteria need to be implemented. The first is the adoption of the previously discussed international web standards; the second is the need to ensure that high speed broadband is available to provide the appearance of seamless always-on functionality to the user.

Internationally, the adoption of WCAG 2.0 is generally incorporated into a variety of policy and legislative frameworks. Countries that have adopted WCAG 2.0 include Australia, Canada, New Zealand, the European Union, the USA, India and Japan (Powermapper, 2014). The European Union and the USA have both made significant changes to provide a more inclusive WCAG 2.0 framework. This is likely to improve access to the cloud by making accessibility a consideration in government procurement (Huffaker, 2014).

However, in broad terms, the take-up rate of accessibility by government is slow, with recent reports by the European Commission (Kubitschke, L., et. al., 2014) and G3ICT (2013) indicating that the implementation of relevant web accessibility standards and the general improvement and implementation of ICT standards remain relatively slow.

Governments also have an important role in promoting the widespread use of new services such as the cloud. The Australian Government in particular has been very proactive in this area, particularly as part of its digital business campaigns. However, there has been little or no discussion around the issues of accessibility and the cloud, and this oversight needs to be included to assist a broader understanding of the need for inclusive services.

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Finally, governments have a role as a customer for services, particularly in emerging markets. By adopting cloud accessibility requirements into their purchase requirements, governments can provide early markets to assist the move to a broader commercially viable market. This works in both scale (i.e. making a market large enough for it to attract commercial interest) and as a test-bed for accessible products.

5.3 Broadband speeds

Another factor vital to the effectiveness of cloud access is broadband speeds. In order for cloud storage and the provision of accessibility features in real time to be effective, high speed broadband is required. If broadband is unavailable or speeds are slow, the effectiveness and reliability of the cloud no longer becomes a viable option for people with disabilities.

Broadband speeds vary significantly between countries, based on millions of Ookia speed tests recorded from mid-April to early May 2014 and calculated using a rolling mean (Netindex, 2014). The top 20 countries listed all feature significantly high levels of broadband speed starting with Hong Kong at a speed of 78Mbps, while by comparison Australia, in 56th place, was rated at just over 14Mbps. Most commentators believe the broadband speeds of the top ten countries are the minimum required for a fully accessible cloud.

While an inclusive infrastructure solution may not require the broadband speed levels of the top countries to work effectively, the current speeds of the slower countries would prevent effective real time cloud accessibility solutions.

5.4 Practical steps for government to address cloud issues

The provision of effective web standards, supporting government policy and high speed broadband, are vital in creating an environment in which cloud accessibility can succeed. However, currently there are significant issues that are preventing people with disabilities from realising the full potential of the cloud.

While the techniques required to build accessible cloud applications are largely complete through the provision of WCAG 2.0, ATAG 2.0 and WCAG2ICT, internationally governments have tended to only incorporate WCAG 2.0 into their policies, meaning that the critical information on how to interpret WCAG in relation to web-based and device-based cloud applications remains largely unknown. This means that vital government cloud services are likely to lack accessibility.

In relation to current initiatives by government, there is also concern about the effectiveness of existing policies. To take Australia as an example, there has been a strong push with the

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recent announcement of a government-wide content management system (GovCMS) to help eliminate duplicated, fragmented and sub-scale activities across agencies (PSNews, 2014). Yet despite the push towards implementing a significant cloud rollout, by the end of its 2012 WCAG 2.0 Level A target, only 26 per cent of Federal government websites could be confirmed as Level A compliant (Australian Government Information Management Office, 2013), meaning that even the minimum accessibility requirement for government information was largely lacking.

In regards to broadband, it is clear that there are many countries in the world that are well equipped to explore and implement the potential of cloud accessibility. In Australia, the importance of broadband is certainly acknowledged, with research published by the Australian Communications and Media Authority (2013) titled *The economic impacts of mobile broadband on the Australian economy, from 2006 to 2013* revealing that mobile broadband in particular has dramatically improved productivity and overall economic growth, leading to a $33.8 billion increase in Australia's economic activity in 2013.

However, despite the highlighted importance of high speed broadband to the economy, and the inference that the cloud is moving to become an essential service, Australian broadband languishes behind many other countries.

For cloud-based accessibility initiatives to succeed there needs to be more consistency in the implementation of broadband and accessibility standards, particularly as governments continue to implement cloud-based resourcing solutions.

The role of promotion and information is also critical. Governments can be powerful communicators of what is expected in servicing a market and what is considered to be best practice. The Australian Government has undertaken extensive promotion of the cloud as a solution for its own needs (in areas such as e-health and benefit payments) and in encouraging businesses to take up cloud solutions (via the digibusiness initiatives). This information also needs to include discussion of accessibility issues and their solutions.

6 General conclusions

The rapid increase in the usage of smartphones and tablets that have limited storage and rely heavily on synchronising data with the cloud indicates that it is becoming an essential service. As such, it is vital that people with disabilities are able to effectively access it, and government, industry and consumers all have a role to play in this.

For government

Governments have a very important role in nurturing the adoption of the cloud, especially in areas where commercial markets or segments are not fully-formed or commercialised.

Accessibility is a key example of this. The initial work that governments have undertaken in adopting the WCAG 2.0 international web accessibility standards has provided a vital role in highlighting the importance of these for websites generally. A similar task needs to be undertaken around cloud accessibility, particularly the ATAG 2.0 and WCAG2ICT requirements. In doing so governments can provide early markets to help accessibility of cloud services become commercially viable and also provide real-world platforms for accessibility issues to be tested and refined. This will help foster competition in the marketplace, leading to genuine consumer choice (which is currently hampered by a lack of universal accessibility) and drive costs of accessible cloud-based solutions downwards. Governments also need to ensure that key infrastructure such as fast broadband is provided as this is essential to both cloud services in general, and accessibility in particular.

For industry

The role of industry is to ensure that the implementation of cloud accessibility is taken seriously at the coal face of product innovation. Suppliers and vendors of cloud-based services need to take a more systematic approach to issues of accessibility, rather than the current ad hoc method. This includes building cloud products to incorporate the international accessibility requirements of WCAG 2.0, ATAG 2.0 and WCAT2ICT, much like the approach to websites. Similarly, the general inclination to try and capture markets through locking consumers into particular ecosystems can be problematic. Consumers are likely to choose devices based on their accessibility features and compatibility with particular cloud services. This means that vendors and developers that work across ecosystems will improve their chances of gaining market share in the disability market. Furthermore, consumer perception based on limited understanding of the role of the cloud and how it relates to their device is a particular challenge – it is important for industry to understand that consumers are aware that their device is accessible and expect that apps and other services accessed via that device will be equally accessible. Finally, the needs of disabled employees, including the ability to work remotely or via virtual offices, are key to a consideration of office-wide cloud systems.

For consumers

There are clearly benefits from using cloud-based services, and in many situations, there is little choice, as the devices and software rely on the cloud to function properly. In the public cloud, accessibility is still inconsistent and consumers need to carefully think about their needs in terms of which ecosystem is likely to deliver the most benefits to them. There is a role for consumer advocates to encourage and promote the need for accessibility to be incorporated into cloud-based product decisions. Furthermore, general information targeted at a consumer level, showing the various accessibility features of different cloud solutions, will help expand this market and reduce the current consumer focus on the built-in accessibility features of hardware. In the private cloud, the flexibility that cloud computing offers in the workplace means that people with disabilities can work in a range of

environments and accessibility costs can be reduced. However, consumers need to ensure that accessibility needs and considerations are part of discussions taking place in workplaces around the adoption of cloud-based work solutions.

The underlying goal is to achieve an always-on, always accessible interface, but this is likely to remain elusive for some time to come. However, the adoption of the practical steps outlined would assist with significant progress to this ultimate measure of truly independent, cloud-enabled access. A catalyst for this could be the commissioning of a specific trial looking at these issues, particularly if it was a step removed from the normal commercial competitive pressures and undertaken with the genuine involvement of government, industry and consumers all learning from each other.

7 Recommendations

For government

1. Governments should incorporate cloud-related W3C accessibility standards into their policy requirements, in particular the use of WCAG 2.0, ATAG 2.0 and WCAG2ICT.

2. Governments should ensure that the implementation of cloud-related policies is effectively resourced, implemented and promoted.

3. Government and industry need to recognise that the speed of fixed and mobile broadband and its availability are essential elements in ensuring access to cloud services and should cooperate to improve this.

For industry

4. Cloud service providers need to ensure that W3C standards are implemented on their operating systems, web portals and device-based apps.

5. Developers building apps should ensure that W3C accessibility standards are incorporated into their work practices.

6. Synchronisation of accessibility preferences across multiple devices via the cloud is a major consumer benefit and strong factor in consumer choice. Companies should look at this carefully when incorporating access into their products and services.

For consumers

7. Consumers with disabilities should consider carefully which ecosystem they wish to use before purchasing a device, as this will dictate to some degree its functionality with cloud services.

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8. Consumer advocates should encourage the promotion and discussion of accessibility of cloud-based services and acknowledge and publicise products that achieve this.

All stakeholders

10. A GPII-style trial should be considered to properly explore the issues in a non-competitive environment with a sharing of the results. This would be best centred around making a government service accessible, and should have equal involvement of government, industry and consumers.

Appendix: Comparison of cloud storage services

While the environment created by government through its adoption of web standards and high-speed broadband initiatives plays an important role in creating a supportive environment for cloud accessibility, it is ultimately the responsibility of the popular free cloud accessibility providers to ensure that consumers are able to effectively access their services.

The integration of the cloud into popular consumer mobile devices has been a key factor in determining which cloud services to evaluate. While there are a variety of cloud services available on different devices, particularly in relation to storage, there is a close relationship between the operating system of a device and the cloud service used by consumers, particularly in relation to synchronising of contacts and settings which are often locked to the particular operating system. The strong connection between the operating system on a device and its default cloud service provides a helpful guide to which connected devices favour particular cloud services.

As of March 2014, the W3Counter (W3C, 2014) indicated that in the worldwide use of all online devices, Microsoft's operating systems accounted for 59.31 per cent of online use, with its OneDrive and synchronisation cloud service embedded into recent versions of Windows and Windows Phone operating systems. Apple's OSX and iOS operating systems represent 19.12 per cent of global usage (of which iCloud is an integrated cloud service), and Google Android represents 7.86 per cent (of which Google Drive and synchronisation services are linked). While the Android figure may seem low when compared with Apple's iOS mobile operating system, it represents approximately 44 per cent of the total mobile operating system market between the two operating systems. With a combined reach of over 86 per cent of all online operating systems, it is likely that the cloud services of these operating systems will feature heavily in the use of the cloud by consumers.

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Given that the synchronisation features of cloud services are closely aligned with a particular operating system and company ecosystem, consumers will generally need to consider whether they want to use an Apple, Google or Microsoft service prior to purchase. However, in relation to cloud storage, there is much greater flexibility.

Most cloud storage services have apps which allow access to files across all the major platforms and in many cases also generally have web portals allowing files to be accessed, and in the case of Microsoft and Google viewed on virtually any device with a web browser. However, the use of apps and web portals to access cloud services beyond the operating system leads to additional accessibility considerations.

As previously highlighted in the section relating to web standards, apps and web portals require that development complies with the WCAG 2.0, ATAG 2.0 draft and WCAG2ICT standards and techniques, with WCAG 2.0 being relevant to web content, ATAG 2.0 focusing on web application-based authoring tools and WCAG2ICT providing advice on the relevance of WCAG 2.0 in the creation of software such as device apps. As such, it is vital that the large corporations providing cloud services via device-based apps or web portals ensure that their cloud service complies with these standards to ensure that people with disabilities are able to use them effectively.

The most popular free cloud storage at this time is Dropbox which has successfully integrated its cloud storage client across numerous operating systems using apps on both desktop and mobile. It focuses on providing a similar 'look and feel' to the cloud, regardless of a particular ecosystem or operating system. Praised for its ease of use, Dropbox has over 200 million users and has been one of the top 10 most downloaded apps on the iPhone of all time, demonstrating the consumer choice around cloud storage services despite the more integrated Apple iCloud (Constine, 2013).

For people with disabilities, the availability of a consistent service across multiple ecosystems such as Dropbox can be highly advantageous as it has the potential to provide a consistent user experience providing the apps on each platform are accessible. A web portal can be even more advantageous if built to the correct web accessibility standards as it provides flexibility beyond particular ecosystems to any device with a web browser.

To assess the effectiveness of the four cloud storage services on offer, Media Access Australia has conducted an examination of some of their apps and web portals, based on the recommendations in the WCAG 2.0, ATAG 2.0 and WCAG2ICT requirements, and using the SortSite automated tool, various screen readers on different platforms and visual checks.

Microsoft OneDrive

OneDrive, formally named SkyDrive, is Microsoft's cloud offering. If users are accessing OneDrive through a Windows desktop using Windows 8 or later, OneDrive is completely integrated into the File Explorer through the desktop or as a OneDrive app. OneDrive is also integrated with the recent version of Office 2013, providing the ability to save documents directly into OneDrive, and users are given 15GB of storage for free. Automatic synchronisation of files in the Microsoft ecosystem is available and the service is available with a subset of features on Mac, iOS and Google Android.

Beyond storage, Microsoft also offers the ability to view documents in its OneDrive web portal directly in the browser using a cloud-based version of popular Office applications. Furthermore, as discussed earlier, the ability to synchronise accessibility settings across recent versions of the Windows operating system is of particular benefit to people with disabilities.

While the integrated desktop OneDrive provided a good way to interact with files and apps on other platforms, the [OneDrive web portal](#) had a large number of web accessibility issues. The screen reader could navigate around the website relatively effectively, but the lack of labelling often made it difficult to understand the location of elements and a user's position relative to the overall page. Missing label elements included document titles, links, frame elements and form elements. While some accessibility consideration has been implanted with a captioned welcome video and a fairly uncluttered and intuitive interface, people with disabilities using assistive technologies are likely to face challenges uploading and accessing their files via the web portal.

The next step was to open and edit a document in the Word Online cloud web app. Surprisingly, in contrast to the OneDrive page, the interface was relatively accessible despite the greater complexity of representing a word processor editing window with tools in a web browser. There were some minor issues with labelling and keyboard navigation but broadly speaking it was possible to edit the document using the web portal. The interface was also well presented in a high contrast colour scheme.

Apple iCloud

The iCloud is primarily for Apple devices such as Mac OSX computers and iOS devices such as the iPhone and iPad. While earlier versions of iCloud were primarily limited to backing up content purchased through Apple's portals such as iTunes, there is 5GB of storage in iCloud Drive allowing for personal data storage. For mobile devices it can also be useful in that it can store app data as well providing a relatively simple way to get up and running again if the device is damaged. However, while automatic synchronising of particular apps data and user content is available, the ability to seamlessly integrate non-Apple data to the cloud is limited. There is no readily available option to view iCloud data through a web portal, but clients are available for various Apple devices and iCloud Drive access can be set up in Windows.

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The iCloud has no readily available web-based cloud portal, and it can be argued that this is in itself a significant accessibility oversight. With calendar appointments, contacts, documents, music and photos likely to be stored in the iCloud, the inability to access such information across other operating systems and devices is likely to prove restrictive for people with disabilities regardless of the accessibility available in Apple products.

Google Drive and Google Docs

Google's synchronisation services are similar on the Android platform to the iCloud but its storage service, Google Drive, is a relatively new addition. Google Drive provides 15GB of free storage, has automated synchronisation on the Android platform and is also available on Windows and as an app for the Apple iPhone and iPad. One of the advantages of this, particularly to Android users, is its integration into Google Docs which is a well-established web-based word processer with a suite of other cloud-based free web apps.

The Google Drive interface at drive.google.com could not be processed by SortSite, but WAVE and the other checks indicated that there are some accessibility errors relating to language declarations, labelling and scripting issues. There were also some issues using a high contrast colour scheme in which some of the buttons became invisible. While navigation of the website with assistive technologies was generally possible, the errors may prevent some people with disabilities from effectively using the interface.

Editing a document in Google Docs at docs.google.com provided similar results as the interface is closely aligned with the Google Drive interface. The high contrast scheme issue became particularly noticeable as the editing options could not be seen and therefore prevented much of the functionality from being viewed.

Dropbox

While Dropbox is a separate cloud service from any of the major ecosystems, it remains extremely popular despite its relatively low 2GB of free storage space. This is primarily due to its ease of use and versatility in the platforms in which files can be accessed. Dropbox clients and apps are available for Windows, Mac, iOS, Android, Linux, Blackberry, Windows phone and through a web browser.

For people with disabilities, the sheer volume of platforms that Dropbox is available on increases the chances of finding a platform in which assistive technologies can work effectively with the cloud storage software. However, its web and document viewing portal www.dropbox.com contains a large number of errors making it challenging to use for people with disabilities. A lack of alternative text, labelling issues, links that cannot be accessed by keyboard, form issues, heading errors and specifying a new window as a target link are some of the major accessibility issues, with many others also present.

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The accessibility issues of Dropbox demonstrate that while the focus of the service is to ensure that users can effectively use and share their files across a range of platforms, the most ubiquitous of all, the web, largely prevents access to files for people with disabilities.

Issues with current cloud service providers

The analysis has highlighted that the large corporations that provide the most popular operating systems for mobile devices appear to have an ad-hoc approach to cloud accessibility. While Microsoft offers some encouraging steps forward in providing cloud synchronisation services for its accessibility preferences, all four companies have limited implementation of the key WCAG 2.0, ATAG 2.0 and WCAG2ICT W3C standards and techniques. Furthermore, Apple does not feature an easily accessible web portal to access its cloud services which reduces the options for people with disabilities to access their data outside of the Apple ecosystem.

Developers for these platforms should also carefully consider relevant accessibility standards when creating apps, portals and authoring tools to ensure that people with disabilities can use their services.

In essence, consumers with disabilities should be mindful of the limitations of each cloud service provider to ensure that their cloud experience is as accessible as possible.

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Glossary

Android A mobile operating system developed by Google. It is based on Linux and is widely distributed by many hardware manufacturers, primarily for smartphones and tablet devices.

ATAG 2.0 The Authoring Tool Accessibility Guidelines 2.0 is a draft standard being developed to support developers in creating authoring tools that can be used by people with disabilities and produce accessible content.

Dropbox A cloud file storage and viewing service available via apps across a number of operating systems and web portals.

Google Docs A cloud file viewing and editing suite providing word processing and other document editing services via a web service or device-based app.

Google Drive A cloud storage service provided by Google, available on a variety of operating systems and web services.

GPII The Global Public Inclusive Infrastructure is an initiative designed to create automated configurable user interfaces to support the accessibility needs of people with disabilities in real time.

iCloud A cloud-based data storage service provided by Apple, primarily for Apple products

iOS A mobile operating system developed by Apple and distributed exclusively for Apple hardware such as the iPhone and iPad.

NIST The USA's National Institute of Science and Technology, the federal technology agency that works with industry to develop and apply technology, measurements, and standards.

OneDrive A cloud storage and file viewing service provided by Microsoft and available across a variety of operating systems and web services.

OS X Also known as Mac OS X, a computer operating system developed by Apple exclusively for Apple desktop and laptop computers.

W3C The World Wide Web Consortium is the main international standards organisation for the World Wide Web.

WCAG 2.0 The Web Content Accessibility Guidelines 2.0 is the definitive web and ISO standard. It consists of 12 guidelines designed to support the development of accessible web content.

WCAG2ICT   A W3C document providing guidance on applying WCAG 2.0 to non-Web information and communications technologies such as documents and software.

Windows   A computer operating system developed by Microsoft primarily for desktop and laptop computers.