

Challenges in Meeting Accessibility Needs in a fast-evolving Digital Environment

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Abstract. This article explores the evolving landscape of assistive technology in the digital age, where accessibility features are increasingly integrated into mainstream products and services. Technical advancements in Artificial Intelligence and Virtual Reality are contributing to more sophisticated user support. Despite these strides, the gap between the theoretical accessibility of interfaces and the actual user experience persists. Tech giants are competing to enhance accessibility, yet surveys reveal that many users, especially those with disabilities, face challenges in utilising digital interfaces. The article delves into the nature and consequences of this accessibility gap, emphasising the need for systematic research.

The article highlights challenges posed by frequent software updates, impacting interoperability and user experience. Reluctance to update software is common, creating accessibility obstacles. Training and support are crucial components of AT provision, yet there is a lack of continuity in ongoing support. The need for continuous training, considering individual needs and evolving technologies, is underscored. Case studies, such as the Swedish "Funkabutiken" project, demonstrate the efficacy of gamified training platforms for users with varying abilities.

In summary, while accessible features in mainstream software offer promise, challenges persist in findability, user choice, and support structures. The article calls for strengthened support systems, emphasizing continuous training, and addressing challenges associated with updates to ensure the actual perceived accessibility by users of assistive and accessible technology.

Herausforderungen bei der Erfüllung der Anforderungen an die Barrierefreiheit in einem sich schnell entwickelnden digitalen Umfeld

Zusammenfassung. Dieser Artikel befasst sich mit der Entwicklung von Assistiven Technologien (AT) im digitalen Zeitalter, in dem barrierefreie Funktionen zunehmend in Standardprodukte und -dienste integriert werden. Der technische Fortschritt in den Bereichen Künstliche Intelligenz und Virtual Reality trägt zu einer ausgefeilteren Benutzer*innenunterstützung bei. Trotz dieser Fortschritte besteht eine Lücke zwischen der theoretischen Barrierefreiheit von Schnittstellen und der tatsächlichen Nutzererfahrung.

Die Technologiekonzerne bemühen sich Barrierefreiheit zu verbessern, doch Umfragen zeigen, dass viele Nutzer*innen, insbesondere Menschen mit Behinderungen, bei der Nutzung digitaler Schnittstellen auf Schwierigkeiten stoßen.

Der Artikel hebt die Herausforderungen hervor, die sich aus den häufigen Software-Updates ergeben und die Interoperabilität und das Benutzererlebnis beeinträchtigen. Die Abneigung, Software zu aktualisieren, ist weit verbreitet und schafft Hindernisse für die Barrierefreiheit. Schulungen und Unterstützung sind wichtige Bestandteile der Bereitstellung von AT, doch mangelt es an Kontinuität bei der laufenden Unterstützung. Die Notwendigkeit einer kontinuierlichen Schulung unter Berücksichtigung der individuellen Bedürfnisse und der sich weiterentwickelnden Technologien wird hervorgehoben. Fallstudien wie das schwedische "Funkabutiken"-Projekt zeigen die Wirksamkeit von gamifizierten Trainingsplattformen für Nutzer mit unterschiedlichen Fähigkeiten.

Zusammenfassend lässt sich sagen, dass barrierefreie Funktionen in gängiger Software zwar vielversprechend sind, es aber nach wie vor Probleme bei der Auffindbarkeit, der Auswahl und den Unterstützungsstrukturen gibt. Der Artikel ruft zu verstärkten Unterstützungssystemen auf, wobei der Schwerpunkt auf kontinuierlichen Schulungen und der Bewältigung von Herausforderungen im Zusammenhang mit Aktualisierungen liegt, um die tatsächlich wahrgenommene Barrierefreiheit von Nutzer*innen von Assistiver- und barrierefreier Technologie zu gewährleisten.

1 Introduction

Digitisation offers fantastic possibilities for people with disabilities to study, work and participate in society. Today, both hardware and software usually include accessibility features. Many built-in functions that were originally developed in the context of assistive technology, such as responsive interfaces, are now being mainstreamed to all devices and are hardly thought of by users as accessibility features (Ladner 2016). Emerging technologies like Artificial Intelligence (AI) and Virtual Reality (VR) are contributing to the development of more advanced user support with features that felt like science fiction less than a decade ago and show great promises for even more tailored support. A recent study on patents for the use of emerging technologies in the field of assistive technology lists solutions ranging from sign language to voice/text devices, hand wearables that can sense the environment and translate, for example, computer keyboards into braille (Abdi et al. 2021).

As accessibility has become a 'must-have' because of increased legal requirements and societal change, tech giants are competing to provide users with innovative accessibility features in mainstream software. For some user groups, such as persons with visual disabilities, it has been reported that built-in accessibility features in mainstream software have started to replace traditional assistive technology in certain user cases, for example, object identification and navigation (Martiniello et al. 2022). Despite all these technical advances, numerous surveys show that users still have difficulties handling digital interfaces and that they are not using accessible or assistive technology, either because they are not aware of its existence, or they do not know how to use it. A survey conducted by Wu et al. (2021) reports that of 100 mobile phone users, 15,7 % realise that they could check whether there were accessibility features on their phone if they should need it, and only 12,1 % could identify effective settings for accessibility in a hypothetical scenario where their eye-sight had deteriorated and they needed to make the content on the screen larger. This points to a mismatch on a systemic level with regard to assistive and accessible technology: There is a huge gap between the theoretical accessibility of an interface (compliance to laws and standards) and the perceived accessibility (the actual user experience).

From a scientific point of view, there is a lack of systematic research on the nature, extent, and consequences of this gap. Many studies focus on the users' experience of specific technologies, devices, and apps to investigate the characteristics and user experience of different solutions. The basic problem definition of these types of studies focuses on the features of the specific solution in relation to the needs of specific user groups. There is, however, a lack of studies on the connection between developing accessible features and solutions and ensuring that these solutions are easy for the user to find, understand, and sustainably use over time. This is true for all user groups, particularly for users with cognitive impairments.

How does the ongoing development towards more integrated solutions for accessibility in mainstream software impact the actual experience of users when it comes to accessibility? And what lessons can be drawn from the current user experience of finding and using assistive and accessible technology when it comes to the future organization of the provision of assistive technology?

In this paper, we examine the current status of assistive technology provision in the light of the trends in the availability of built-in mainstream accessibility features. The

paper reviews relevant key factors to the actual user experience in terms of accessibility and raises questions with regard to gaps in the evidence base concerning the user experience. It contributes to a higher understanding of assistive and accessible technology as being part of a system of support rather than stand-alone devices. The paper starts by reviewing the current assistive technology provision on a general level. The following section presents, firstly, developments in mainstream accessible technologies and, secondly, challenges that users face in using both assistive and accessible technologies.

2 Current Assistive Technology Provision Driving Demand for Alternative Solutions

In this section, we look at what AT is, how users obtain the AT they need, and the various systems supporting the individual testing and supply of AT.

2.1 Assistive Technology Access

Assistive technology (AT) refers to tools used by individuals with disabilities in order to perform functions that might otherwise be difficult or impossible. The legal definition of AT in the European Accessibility Act is “any item, piece of equipment, service or product system including software that is used to increase, maintain, substitute or improve functional capabilities of persons with disabilities or for, alleviation and compensation of impairments, activity limitations or participation restrictions” (European Union 2019).

AT can be used for many types of impairments and by people of all ages. It ranges from very simple, low-tech devices to highly complex, expensive products. Some AT have easy-to-use settings, while others must be tailored to the individual.

AT includes wheelchairs and white canes as well as a wide variety of items related to digital access, for example:

- Special hardware switches, keyboards, and pointing devices
- Voice or eye control with a virtual keyboard
- Text-to-speech and speech-to-text tools
- Screen readers, magnification software, braille displays
- Communication boards
- Spelling programs and dictionaries
- Prosthetics, mounting systems, and positioning devices

The World Health Organization (WHO) (2024) widens the definition of AT to include both assistive products and the systems and services related to the provision of these products, including support and training.

In a report from 2022, WHO estimates that approximately one in three people, or more than 2.5 billion globally, need at least one assistive product (World Health Organization 2022). Worldwide, nine out of ten people who need AT do not have access to it, which has a negative impact on everything from education and work opportunities to health and well-being of individuals, families, communities, and societies. The same study claims that many individuals often need more than one assistive product.

In the WHO report, both physical and digital tools are considered. Representative self-reporting surveys from 29 countries show that:

- the most common barriers to accessing assistive products are high costs, low availability, and lack of support.
- the majority of people obtained their assistive products from the private sector, paid for either by themselves or with financial support from family and friends (World Health Organization 2022).

Almost 100 % of the 70 countries included in the survey have legislation related to access to AT in place in some form. However, just about 60 % of the countries have training and education on AT for all functional domains, at least on a partial level. The result is that access to assistive technology is unequal and patchy (World Health Organization 2022).

The patchiness is also present in countries in parts of the world where the provision is organised centrally on a national level. A study on AT provision in four European countries (Germany, Hungary, Portugal, and Sweden), compares the provision to a lottery where the outcome depends on where you live (Bratan et al. 2020).

According to a user study in Austria, Sweden, and the UK focusing solely on digital assistive technology, in particular for cognitive accessibility, only 15 % of end users with disabilities (or their caregivers) claim it to be easy to find the right AT (Murillo Morales et al. 2022). This means that 85 % struggle one way or the other. Half of the users who do not use AT today claimed they do not know how to find a tool or how to find the right tool for them. As these three countries are at the upper end of the scale when it comes to both disability policies and IT maturity, the results are quite alarming.

2.2 Shifting Models of Provision

The provision of AT in the EU is defined by the interaction of demand (people with disabilities) with supply (producers and distributors of AT). This interaction has traditionally been mediated in the member states by what is called Service Delivery Models (SDM): the approach to implementing support schemes for people with disabilities to acquire AT based on public funds.

The three types of Service Delivery Models are:

- the Medical Oriented Model,
- the Social Oriented Model, and
- the Consumer Oriented Model.

The medical model perceives disability as a personal issue resulting from disease, trauma, or other health-related conditions, that need personalised medical intervention by healthcare professionals. The management of disabilities within this framework typically targets either a cure of the underlying condition or fostering the individual's adaptation and behavioural change. Medical care is regarded as the primary focus, with political responses often oriented toward the adaptation or reformulation of healthcare policies to address the needs of individuals with disabilities (Disabled World n. d.).

Contrastingly, the social model of disability sees the matter predominantly as a construction of societal origin, emphasising the importance of integrating individuals fully into society. Disabilities are not seen as a trait of individuals but rather as a series

of circumstances, a significant portion of which is created by the environment. Consequently, addressing this issue requires social initiatives, with the collective responsibility resting upon society to make the environmental adjustments to include persons with disabilities across all areas of social life (Disabled World n. d.).

The EU member states use different service delivery systems (SDMs), often featuring multiple systems concurrently, making it difficult to provide a comprehensive description. Nonetheless, common procedural steps can be found across these systems. These fundamental steps typically involve:

- the initiative to acquire AT (the person with a disability themselves or an intermediary (e.g., employer, education institution),
- an assessment of the user needs,
- a taxonomy of available assistive solutions,
- the selection of the most suitable AT,
- provision of financial support,
- the delivery of the AT,
- basic training (Deloitte and AbilityNet 2011)

This type of assistive technology (AT) provision is predominantly based on seeing individuals with disabilities as either 'patients' or passive recipients of charitable and social welfare measures, rather than active consumers. Nonetheless, a transition toward a more consumer-centric model in the provision of AT is observed in various member states (Murillo Morales et al. 2022).

Within the consumer model, the end-user consumer interacts directly with a retailer to obtain their assistive technology (AT), bypassing any intermediaries that might restrict their choice of solution. This approach is gaining traction in Europe, primarily due to escalating costs and administrative complexities associated with traditional systems. By giving users greater decision-making authority, this model holds the promise of enhancing the autonomy and empowerment of individuals with disabilities. However, it also places significant responsibility on the individual to navigate a market characterised by a diverse array of offerings lacking immediate categorisation or selection criteria, potentially leading to decision-making challenges.

At the same time, accessibility features that were developed in the context of AT are now increasingly making their way into mainstream consumer products in the IT sector. For example, features such as closed captioning, speech recognition, or assistive listening were originally developed for AT users and are now becoming integrated into mainstream products and services. These advances have led some observers to argue that consumer products with accessibility features and functions can play a major role in bridging the gap in AT provision (Banes and Lobnig 2023). In the next section of this paper, we will take a closer look at how mainstream software and devices could advance accessibility for users of assistive technology.

3 Moving from Assistive Technology to Accessible Technology

The general trend of “shifting left” has had an impact on accessibility, where basic tools take on the role of solving accessibility issues at the source rather than fixing them afterwards.

3.1 Reaching New User Groups through Accessible Mainstream Technology

In recent years, tech companies have increased their efforts in releasing new accessibility features in mainstream software, both operating systems and apps. For example, all major browsers these days offer built-in text-to-speech technology, high contrast/dark mode, and features that eliminate distractions. The Internet browsers Edge and Firefox also provide the possibility to change fonts. The major mobile operating systems come with text-to-speech and speech-to-text, magnification, adjustable colours, text size, and light, as well as a variety of switch controls. In addition, there is a wealth of supporting apps providing all sorts of accessibility features.

An advantage of integrating accessibility features in mainstream hardware and software is that it can potentially reach more public and support persons who could benefit from the technology but who, for different reasons, do not have access to traditional AT. The size of these user groups is difficult to measure but it is probably quite large and include users who would not necessarily see themselves as AT users, as well as persons having difficulties accessing traditional AT. One typical target group here are people with dyslexia in Sweden, where only four out of 21 regions allow this target group to apply for AT via the public-funded system for provision. Another example is older people, who experience an impairment related to age. For most ageing people, a reduction in visual, hearing, and motor abilities is considered a natural part of ageing, which means that the user does not all of a sudden identify themselves as “disabled”.

A crucial precondition for using the technology is knowing it exists in the first place. Research shows that older adults are often not aware of the existence of AT, and with age, it may be increasingly hard to “re-learn” how to use technology in a new way or use a new feature (Yusif, Soar, and Hafeez-Baig 2016). That is not unique to this target group. Interviews with users conducted by the authors of this paper in several different research projects in recent years show that users with or without disabilities are not aware of the existence of accessibility features that are built into their operating systems or software.

The development towards built-in accessibility features in mainstream products and services has great potential but is also a risk at a policy level. First results of interviews with Organisations representing Persons with Disabilities across the EU in a currently ongoing study show a rising concern that the provision of AT is decreasing. The fact that part of the support needed already exists in mainstream products is sometimes used as an argument for not providing AT. However, the built-in features in mainstream products cannot support all users, either because it is insufficient or unsuitable for some. At the same time, it is very rarely possible to receive a mainstream product free of charge via the AT provision system, as they are not covered by the disability rights legislation. As some of these devices are expensive, this leads to further exclusion.

3.2 Ubiquitous Access and Personalised Solutions

An important driver of the trend to move from specialised AT towards mainstream accessible technology is ubiquitous computing. The term refers to a shift in the use patterns of computer technology. In the early days of the digitalisation of society,

people generally accessed computers in one form – the personal computer, available at home or work. However, with the spread of smartphones and connected Internet-of-Things (IoT) devices, access to user interfaces is no longer restricted to PCs nor to one specific environment.

The ubiquitous access to the internet provides new possibilities but also new accessibility challenges, including for persons who use AT. To be able to live an independent life in the increasingly digitalised society, it is no longer sufficient to be able to access the internet through your home PC, as other day-to-day activities such as shopping and errands with authorities increasingly involve handling digital interfaces. The variety of user interfaces that people are faced with on a daily basis makes it difficult to know the accessibility settings of the system you are interacting with at each given point in time.

A potential solution is the concept of ubiquitous accessibility, which refers to a broad availability of AT, across different devices or multiple applications. For example, a screen reader user should be able to access user interfaces wherever they are, regardless of whether it is on a smartphone, public computers, at work or at home.

A study from 2017 showed that, at the time, ubiquitous accessibility was far from being realised. Users with visual impairments were asked about their experience using screen readers on different devices, including public devices and at work/school. The interviews brought up a series of problems where things that work well in one environment did not work at all in another environment. In some instances, the incompatibilities had serious consequences, such as losing an employment opportunity or failing a course (Billah et al. 2017). One of the issues highlighted in the study was the importance of a consistent user experience so that the user does not need to learn new settings for every new situation. Though not unique, this insight has an important bearing on the roll-out of AT and of training – if the user learns how it works in one setting, how likely are they to understand and be able to transfer this learning to other settings that may be slightly or very different?

Personalised settings on the mobile phone have been put forward as one potential solution to the consistency issue in different settings and situations. A mobile phone could, for example, be used as a remote control for interacting with IoT objects and provide support for accessing objects such as ticket vending machines and ATMs (Aizpurua et al. 2019). Being able to bring a personalised mobile phone with you would, in this case, be a way of ensuring that accessibility support is ready at hand. However, it is not a universal solution to accessibility issues. Firstly, not all ubiquitous computing environments will be compatible with a mobile phone. Secondly, the accessibility features of mobile phones vary widely, and users will be forced to learn new settings when they change the model or update the operating system. Thirdly, not everyone can afford a smartphone. In this context, the increase of choice and variety in models of different devices and operating systems and software has expanded the number of possibilities to receive accessibility support in a personalised way. But it can be argued that the increase in choice has also created new accessibility issues for users because of the persistent lack of consistency between devices and models. An American study on accessibility in mobile phones notes that while mobile phones are getting increasingly more accessible, features vary between models, and gaps persist (LaForce and Bright 2022). There is a risk that updates in software, either on the side of the phone (operating system), the app communicating with the IoT or

the IoT software itself, will create a breach in the experienced accessibility on the user's side.

4 Updates

Client-based AT needs to be updated just like every other software, but it may not be as straightforward as with mainstream technology. Furthermore, personal settings in the AT may change or need to be re-initiated when browsers and apps are updated. The situation is made even more complicated by the pace of the updates. Operating systems and many of the most commonly used AT provide an update at least once per year. For example, the screen reader Jaws has yearly new releases, while NVDA had three updates in 2023. Texthelp's Read&write released six updates in one year. The pace is even higher on the side of mainstream software, with Chrome releasing nine versions between January and September 2023 and Microsoft 365 releasing 22 updates in the same period. Not all updates have an impact on the user or the compatibility with other software, but for the user, it is difficult to know beforehand what the impact will be. Furthermore, updates in mainstream software are also driving updates in AT. For example, as Windows ceases to support older versions of their operating systems, AT providers are following suit, thus forcing their users to upgrade both the Operating System and the assistive technology software.

Beyond the impact on interoperability, the updates also impact on the user experience and perceived accessibility. Updates may involve features changing place or new features replacing old ones, adding to the confusion. Anecdotal evidence collected from Zoom and Teams meetings the authors have attended during and after the pandemic show that at least 15 % of the meetings, there have been some delay or interruption due to one or several of the persons in the meeting having problems connecting due to updates in the software. In most cases, the issue can be resolved quickly. However, in other cases, users were completely unable to connect to the call because they had difficulties handling the change in the interface. In these cases, the connection issues lead to further disruptions such as the abandoning or rescheduling of digital user tests.

The frequent software updates, therefore, impose on users not only challenges of interoperability and compatibility but also cognitive load. Users need to keep up to date with developments and learn how to handle new software versions at regular intervals. For users with difficulties remembering and learning new procedures, the updates in themselves constitute an accessibility obstacle. As a result, users may avoid updating software which in itself can lead to access problems due to compatibility with newer devices/apps or that older versions eventually stop working properly. Reluctance to updating software is already widespread and not unique to persons with disabilities.

According to a global survey commissioned by cybersecurity company Kaspersky, 50 % of the 15.000 respondents delayed software updates, citing time constraints as the main reason. 62 % of the respondents report that they help their older relatives or children with the updates (AO Kaspersky Lab 2021).

AT provision is being debated, and (parts of) the system is criticised more or less by different user groups in many countries. One of the criticisms concerns the lack of coordination and support when it comes to the compatibility of AT with mainstream

software and the consequences of updates. The AT providers should, in a perfect world, be up to date not only when it comes to thousands of AT offerings and each of their specific features covering an enormous range of user needs and preferences but also how each of these works together with the specific version of computers, tablets and smartphones preferred by the users, a wide variety of browsers and operational systems. It is self-evident that not all AT providers can keep up to date with all possible user needs, functionality, and updates. However, the lack of support is evident. Even if the user has access to IT support via their employer or university, most IT support staff are clueless when it comes to AT. This means that it is often up to the user to understand and determine what will potentially happen when pushing an “update” button, mostly without having had any training to help them feel confident to deal with these kinds of issues. In the next section, we take a look at the status of training and support in the context of the provision of AT.

5 Training and Support

According to the WHO definition of AT, the term encompasses not only the technology itself but also the services provided around it, including training. The WHO notes that without proper training, the benefit of the AT may be lost, or in the worst case, using the assistive device could do more harm than good (World Health Organization 2024). Accordingly, most government/Disabled Persons Organisation-organized provision of assistive technology contains some kind of initial training. However, the continuity of the support and training is often lacking. When it comes to users of AT, 25 % claim they need help to use it – but support after the initial training is scarce (World Health Organization 2022).

The reported lack of training and support is abundant in interviews with DPO’s across Europe and beyond. Both individual users and organisations representing persons with disabilities point to challenges when it comes to ongoing support; after the initial training on how to use the AT is provided, the user is often left alone. For students or employed, it is often very hard to get support from the regular IT-department, as they are rarely experts on AT. For users who are neither studying nor working, it becomes even more challenging to get help.

Research projects on AT often promote training as a success factor for implementing AT solutions. For example, a systematic review of ICT-based innovations for persons with cognitive impairments concluded that users should receive training on how the solution works, and that where possible the solution should be tailored to the needs of the individual user (Brandt et al. 2020).

However, less attention is paid in both research and AT provision to what form of training is most effective. In research projects, as in the provision of AT discussed above, the training takes place at the same time as the user receives the AT. This presupposes that the user is able to assimilate all knowledge he or she needs to use the AT at the beginning of their usage, and that they remember the information for as long as the user needs the AT. This may work for some persons and some technologies, but many users, in particular persons with memory problems or learning difficulties, may need reminders further down the road. This is especially true for more complex AT where a user may not use all functionalities on a daily basis. In addition, the regular updates imply that the user needs to continue to learn how to handle the

updates and ensuing compatibility issues and how to use the AT as features may change between versions.

In other words, there is a need for training that takes place continuously rather than in one go at the beginning. One example of such training is the Swedish nationally funded research project “Funkabutiken”, which started as a winner of the Post and Telecom Authority’s Innovation Competition 2020 and was awarded the Zero Project 2023 Award. The project started with in-depth interviews, showing that older adults, people with cognitive impairments and “careful” users who do not consider themselves tech-savvy, do not shop or pay invoices online because of two main reasons:

- a feeling of insecurity and
- a lack of motivation.

This led the research team to the conclusion that a safe environment where users can try, fail, and learn without losing money would be beneficial. There is a lot of information out there, but we did not find any “trial and error”-type website educating users on shopping and payments. The development of a motivating and safe online training platform was therefore seen as the solution.

The training platform that was developed as a result of the project consists of gamified training at different levels, where the users can play and learn individually or in a group. The pedagogical game provides instructions and support in each step of the training. The most important part of the experience is that the user can go back and try again until the concept is clear. This feature is complemented by in-depth information on security, credit card payments and delivery options, as well as a dictionary and guidance (Funka 2022).

6 Summary and Discussion

As shown by the research and examples cited in this paper, the provision of AT is still leaving people behind in several ways:

- The devices are not made available to persons who need them.
- Where available, it is difficult for the users to choose and get hold of the device that is right for their personal needs.
- The support structures are lacking, making it difficult to actually use the assistive devices. Notably, training is scarce and not adapted to updates or other challenges that may arise with continued use.

Accessible features in mainstream software have made much progress in later years. They can, according to the literature cited in this article, provide a valid alternative to traditional AT to at least some user groups. However, the challenges users face in finding and choosing the right accessibility features and the issues around support, training and updates remain important obstacles for users whether they choose accessible mainstream software or traditional AT.

The trend towards more integrated accessibility solutions has increased the supply of accessibility support and opened up the possibility of support to groups that would not have access to, or even consider themselves a target group for, AT. However, the actual impact on users on a broad scale is unclear. The literature provides examples of promising solutions, but studies investigating the real-life use of accessible technologies and assistive devices are scarce. There is a lack of both longitudinal studies

following users of accessible and assistive technologies over time and a lack of studies focusing on support systems and factors impacting the use of accessible and assistive software and devices.

In terms of improving access to assistive technology, in whatever form it may come, the support systems should be strengthened to pay more attention to aspects such as continuous training, how to handle updates and ensuing issues of interoperability. This will be essential both to ensure accessibility in practice and the sustainability of the provision in the long term.

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