1.

Literature Review for
Procurement Standards for Accessible Mobile Devices
Hearing Loss Users

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Table of Contents

Best Practices Guide for Designing Mobile Devices for People with Hearing Loss

1 Introduction

People are different. We are short, tall, young, old, quick, and slow. Our abilities to see, hear, react, and move vary between people and with age. By not taking this into consideration, businesses can inadvertently make it difficult for 15% of their potential customers to use their products and services, specifically older adults and people with disabilities. This number is only growing as consumers collectively grow older, but many products and services remain inaccessible to them. An accessible product or service is one which can be used by all its intended users, considering their differing capabilities and abilities.

This document puts forward a framework to allow procurement staff, designers, and suppliers of mobile devices to understand the needs of people with hearing disabilities. It also provides a framework for existing best practices regarding the design of solutions that would accommodate the needs of those people with disabilities. Though the abilities of people with disabilities, whether they have a hearing disability or one of the other 3 main disability categories (sight, mobility, and cognitive) exist along a continuous spectrum, most solutions can be categorized into three main categories (mild, moderate, and severe). There is an overlap in the range of abilities to interact with specific technologies within each of these broader categories.

This document uses three main categories (mild, moderate, and severe) to simplify the task for the designers, manufacturers, and procurement staff. It is possible to use other categorizations, but the authors of this paper have tried to balance the need for usability and choice for the end users with the overall

complexity that would be put on the users of this document if more categories are used.

2 Definitions

- ***Accessibility*** – the "extent to which a consumer or user can obtain a good or service at the time it is needed". Accessibility, as it applies to people with disabilities, recognizes that individuals have differing levels of physical and mental capabilities. Additionally, it recognizes the need to deliver goods or services in an efficient and timely manner that can be easily consumed or used by these individuals. These products and services must take into account those differences.

- ***Disability*** – any restriction or lack (resulting from an impairment) of the ability to perform an activity in the manner or within the range considered normal for a human being.

- ***Handicap*** – a disadvantage for a given individual, resulting from an impairment or a disability, that limits or prevents the fulfillment of a role that is normal (depending on age, sex, and social and cultural factors) for that individual.

- ***Impairment*** – a loss or abnormality of psychological, physiological, or anatomical structure or function.

- ***Appropriateness*** – a measure of how well the assistive technology solution maximizes the user's ability to help them complete the user's intended task in the most efficient manner.

The appropriateness of a solution measures whether the solutions use is obvious, predictable, and consistent, whether the design matches the anthropometric and biomechanical capabilities (essentially the abilities) of users while providing

sufficient feedback, controllability, and responsiveness to meet the users' expectations regarding the efficiency of completing the task.

Appropriateness of a solution can be measured by the following dimensions:

- ***Operability*** – the intended use of the solution should be obvious, predictable, and consistent.
- ***Obvious*** – solution is easily seen, perceived, recognized, or understood.
- ***Predictability*** – solution should match user expectations.
- ***Consistency*** – solution should behave in the same manner when used in similar situations.

- ***User compatibility*** – the design should match the anthropometric and biomechanical capabilities (essentially abilities) of users.
- ***Feedback*** – the device should let the user know when it is responding to the user's actions.
- ***Controllability*** – the device should be responsive to user's actions.
- ***Responsiveness*** – quick to react appropriately
- ***Biomechanical load*** – the force that must be applied to do a task, the duration of the force applied, and the frequency of which the task is performed.
- ***Parallax*** – the apparent displacement of an observed object or point of interest due to a change in the position of the observer.

- ***Suitability for the widest range of use*** – involves designing with the objective of producing solutions that will be useful, acceptable, and available to the widest range of users within the user population. This takes into account their abilities, variations in their capabilities, the diversity of their tasks, and their differing environmental, economic, and social circumstances.

- ***Equitable use*** – ensures that solutions designed to increase accessibility provide the same means of use for all users that are identical whenever possible; equivalent when not. These solutions must not result in loss of privacy, increased risks to personal safety or security, or the stigmatization of individuals.

- ***Robustness*** – involves supporting a wide range of options, both in terms of the features provided by ICT equipment or services and in terms of the ability to connect additional ICT equipment, software, and/or services.

- ***User Interface Layer*** – the user interface layer of the operating system deals with the aspects of the way the user perceives and interacts with the device.

- ***Element*** – a logical representation of a user interface component. Elements can be passive in that the user cannot interact with them, but some useful information is conveyed to the user. Elements can also be interactive so that a user may interact with them. A series of elements are typically combined to create an instance of the user interface. An element could be a single pixel or series of pixels that can make up a logical visual grouping, such as a single point, a button, an icon, an edit field, list box, etc. An element can also be a physical representation of the potential user interactions available, such as an icon.

- ***Point of Interest/Points of Interest (POI)*** – a Point of Interest or a set of Points of Interest is an element or set of elements that make up a logical grouping of elements. A POI can be manipulated or rendered a target for

potential interaction. A POI narrows the scope of potential interactions and perception of the user interface.

- ***Action*** – an action is performed on an element or series of elements. An action may change the status of a single or multiple properties of an element. An action asks an element to perform an interaction.

- ***Shortcuts*** – achieve the same result as an action or series of actions without it requiring that it interact directly with any elements or series of elements.

- ***Properties*** – describe individual parameters that describe an element, such as position (x,y) if it exists, width and height if it exists, and status. The properties of an element depend on the nature of the element. For example, an element may have no visual representation, and therefore, have no height and width data.

- ***State*** – defines the status of a property which has multiple states (i.e., On/Off)

- ***Events*** – changing the status of a property of an element can generate an event that tells operating system of the device that a property (or properties) has changed its state.

- ***Narrow the range of a point of interest*** – an action can narrow the range of a point of interest (i.e., change the number entries in a list box that are highlighted).

- ***Mobile device*** - a device which is typically characterized by a small, portable form factor having communications functionality as its primary purpose, and can be used while in transit (mobility). The device focuses on handling information-based data (including audio, visual, and text-based forms of information) and related tasks. The device allows the user to

perceive the information and interact with it. Typical devices could be feature phones, smartphones, PDAs, and tablets.

2.1 Definition of Accessibility

In its simplest generic form, accessibility is the “extent to which a consumer or user can obtain a good or service at the time it is needed”. Accessibility, as it applies to people with disabilities, recognizes that individuals have differing levels of physical and mental capabilities and skills. To deliver goods or services in an efficient and timely manner, those products and services must consider those differences. In practical terms, it means all users can perceive, understand, navigate, and interact with the technology. From the perspective of a product designer or a procurement staff member without extensive knowledge of the issues faced by people with disabilities, this can appear to be a daunting task, but it does not have to be.

People with disabilities fall into 4 main categories:

- Mobility
- Vision
- Hearing
- Cognitive
- Speech

Within each of these 4 disability groups are people with varying levels of severity, ranging from very mild to very severe. By reviewing the abilities across the range of users, a few types of solutions emerge. These solutions will meet the needs of users with typically only minor adjustments necessary to customize the solution to their needs. People can also have multiple forms of disabilities. Adjusting to make allowance for the requirement of each of the dimensions of an individual's abilities will heavily affect the final choice of best practice the mobile device needs to support. Ensuring that the end user has their preferences reflected in the choice of

mobile device and supporting assistive technology is important in ensuring the technology is not abandoned.[1, 2]

A particular piece of assistive technology (AT) may suffer from a lack of adherence or abandonment if it does not physically fit a user's body or causes long-term discomfort. A few categories of such AT may be something to wear (such as a hearing aid), to sit in (like a power wheelchair), or to hold (say, a joystick). There is also a chance of abandonment if the AT does not permit the completion of some or all the tasks that the user desires but cannot execute without an AT with ease. Research indicates that one of the predictors of abandonment is a change in the needs of users, be it permanent (such as progressively worsening sight conditions), temporary (like, for example, increased Parkinson's tremors that can be alleviated through medication), or fluctuating (such as stress-induced spelling difficulties for people with dyslexia) changes. Technology that is simpler to modify to the changing needs of the user or their circumstance may be able to accommodate such changes. Another predictor that leads to abandonment is trouble with configuring and changing AT settings. The issues associated with abandoning are made worse by the fact that an AT is frequently required rather than desired. AT frequently revolves around performing a task or not; it is not about performing a task more quickly and effectively.[3]

This document breaks the issues down into easy-to-understand concepts, gives a basic understanding of the types of disabilities and the characteristics that define the abilities associated with people with disabilities, and provides guidance

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1. [1] Hongxin Zhao. "Predictors of Assistive Technology Abandonment". 1993, Assistive Technology. https://www.academia.edu/37423321/Predictors_of_Assistive_Technology_Abandonment

[2] Stefan Carmien. "Assistive Technology Abandonment: Research Realities and Potentials". Lecture Notes in Computer Science. https://www.academia.edu/61339073/Assistive_Technology_Abandonment_Research_Realities_and_Potentials

[3] Stefan Carmien. "Assistive Technology Abandonment: Research Realities and Potentials". Lecture Notes in Computer Science. https://www.academia.edu/61339073/Assistive_Technology_Abandonment_Research_Realities_and_Potentials.

on how to identify and design for the needs of these consumers into the design or procurement processes.

2.2 Definition of Impairment

The World Health Organization (WHO) suggested the following definition in 1980 for the term 'disability':

> "Impairment, a restriction of one's capabilities and disabilities, the lack of the ability to perform tasks due to an impairment or impairments, may be temporary or permanent, reversible or irreversible, and progressive or regressive. The situation people find themselves in may determine to what degree a disability is handicapping for them. A handicap can be the result of both an impairment and of environmental conditions. If environmental barriers are taken away, the person will still be impaired, but not necessarily handicapped."

2.3 Categorization of Major Disability Groups

People with disabilities can have varying levels of severity, ranging from very mild to very severe. They can also have multiple forms of disabilities. To simplify the process of categorizing features that can support specific disabilities, we can categorize the disability community into 5 distinct groups:

1. Vision
2. Mobility
3. Hearing
4. Cognitive
5. Speech

To simplify the number of approaches for dealing with the requirements of people with disabilities, with respect to technology, each one of these disability categories

can be further broken down into 3 broader sub-categories of users, based on the level of severity of their disability– mild, moderate, and severe. While the capabilities and skills of any specific individual who has a disability are unique to them, typically the number of feasible and practical technology-based solutions can be classified into these three broader categories of users.

3 High Level Principles for Accessibility

Accessibility is about making a product or service accessible to the widest audience of users. Regardless of the nature of the disability in practical terms it relies on 5 basic concepts:

- Can all users reach the product or service without hindrance?
- Can all users perceive the controls, instructions, output and labeling of the system?
- Can all users understand what to do and what is being conveyed?
- Can all user navigate the content and controls of the system?
- Can all user interact with the content and the controls of the technology?

A product or service will be accessible to the widest possible audience if the above conditions are met.

4 Practical Accessibility – "Best Practices"

A "best practice" as defined in the document is an accessibility solution that lets the user complete all the primary tasks he wants to complete. A primary task is an activity that is associated with the fundamental functions of that device. For a mobile device this might be placing a phone call or sending and receiving a text message or email. Being able to play a game or shop for a product on the device while possible is not a primary task associated with a mobile device, which is a communication tool. This narrow definition is being used in the procurement process. A best practice may be a new solution that is relevant to helping a user with a specific set of abilities complete their list of primary tasks or an established solution that currently exists in mobile devices. Established solutions will typically have an established set of features that most users with those specific abilities expect. Note that a class of solutions define solutions that have similar core functionalities, but each solution may have additional features that are unique to that implementation.

5 The Roles of Tasks in Selecting Relevant Solutions

To characterize and sort relevant tasks, five accessibility operational tasks (perceive, recognize, monitor, reach, operate) can be used **(Table 1**). For people with hearing disabilities, the most frequent task barriers when using their mobile devices are difficulties with the informative tasks, i.e., 'perceiving', 'recognizing', and 'monitoring' events or changes to the mobile device. The most common issues creating these barriers are insufficient visual feedback and a need for far-distance notifications.

Table 1. Definition of accessibility operational tasks.[4]

Accessibility Operational Tasks	**Definition (IEC 63008)**

[4] Lee, J., Kim, Y., Rhiu, I., & Yun, M. (2021). A Persona-Based Approach for Identifying Accessibility Issues in Elderly and Disabled Users' Interaction with Home Appliances. Applied Sciences, 11, 368. https://doi.org/10.3390/app11010368

Perceive	To find the product and its parts required to perform the task
Recognize	To identify/understand the parts required to perform the task
Monitor	To receive feedback on the operation
Reach	Physical access to the parts required to perform the task
Operate	To perform the task

2.

5.1 Specific Tasks the User Wants to Accomplish

The focus of this document is to define the accessibility of mobile devices with a focus on the primary function of a mobile device: communication. Communications include the concept of 'advanced communications.'

'Advanced Communications Services' is a descriptor for newer, internet-based communication systems that were not regulated by existing communications laws. There are four types of Advanced Communications Services covered by the CVAA:

- **Interconnected Voice over Internet Protocol (VoIP) services** allow users to make and receive traditional phone calls. Examples include RingCentral, Vonage and MagicJack, as well as some phone services offered through cable and internet providers.
- **Non-interconnected VoIP services** provide voice-control without traditional telephone systems. Examples include Siri, Alexa, and other voice chat services.
- Examples include Facebook Messenger, IOS voice-to-text, Slack, and Google's Gmail.

- **Inter-operable video conferencing services** provide real-time video communications. Examples include Zoom, Join.me, Google Hangouts, FaceTime, and other video conferencing/video chat services".[5, 6]

The definition above is derived from the American 21st Century Communication and Video Accessibility Act (CVAA). More detail can be seen in Appendix A (which summarizes key points of the Act). Prior to the Act, mobile devices were only defined as voice communicators, and any accessibility requirements thus only pertained to tasks involving voice calling. The CVAA is the first legislative attempt at defining "advanced communications" that go beyond voice calling. The new definition recognizes that mobile phones and their usage patterns have changed over time. The FCC used to be the regulatory power that oversaw the application of accessibility requirements. Therefore, the scope of accessibility requirements applied to communication and broadcast services only more specifically to mobile devices (hardware and software) as it applied to the implementation of advanced communication interactions.

The best practices on how to achieve accessibility are best described for specific use cases. The individual steps that need to be used to complete a task can be generalized to other methods of interaction and other use cases though. They are usually independent of the app being used. For example, making a phone call requires that the user complete the following specific steps or interactions:

1. Locate and identify the phone (by shape or texture)
2. Orientate themselves on the phone so that they can perceive the display and controls (what is the top of the phone)
3. Turn on the device or unlock it (locate and interact with power button, interact with biometric and/or password system)
4. perceive the output and controls of the device
5. Interact with the device applications and controls
6. Launching the Phone app
7. Enter a phone number

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[5] Advanced Communications Services and the CVAA (levelaccess.com)

2. **6.** "Advanced Communications Services (ACS)", Federal Communication Commission of the United States. Retrieved from: https://www.fcc.gov/general/advanced-communications-services-acs

8. Acknowledge a proper connection
9. Communicate with the person being called and responding to the person
10. Terminate the call when finished.

Embedded in these steps are the needs to select a point of interest, set the focus to a point of interest, activate that point of interest, enter data into the point of interest or perceive output for that point of interest and enter data into an appropriate point of interest. Different combinations of these interactions are embedded in commonly performed tasks on a mobile device.

Rather than test for each of these individual interactions for their degree of accessibility compliance for the different personas presented in this document, a series of tests around end-user goals was created. The nature of the interaction may change over time, but the end-user goals will change slowly. For example, voice assistants can now do some tasks or parts of tasks more efficiently than touch-centric interactions for those users that can perform touch interactions.

5.2 Usage Patterns across Mobile Devices

The list of tasks is derived from several research studies looking at the usage patterns of end users. The existing works could be generally categorized into either standard ethnographic and user studies, based on questionnaires, diaries and self-report, or studies based on automatic recording and subsequent analysis of phone activity logs.[7] In the first category, Reid and Reid (2004) study the differences of call and SMS usage preference using an online questionnaire which involved 982 users.[8] Grinter and Eldridge (2001) investigate how British teenagers incorporate text messaging into their daily lives.[9] They collected data by asking the teenagers involved in a study to manually log their texting activity for seven consecutive days. In a more recent example, Barkhuus and Polichar (2011) investigate how users

[7] Do, T. M. T., Blom, J. and Gatica-Perez, D. (2011) Smartphone usage in the wild: a largescale analysis of applications and context. in Proceedings of the 13th international conference on multimodal interfaces: ACM. pp. 353-360.

[8] Reid, D. and Reid, F. (2004) Insights into the social and psychological effects of SMS text messaging

[9] Grinter, R. E. and Eldridge, M. A. (2001) y do tngrs luv 2 txt msg? in ECSCW 2001: Springer. pp. 219-238

integrate multifunctional mobile phones into their everyday lives.[10] The study was based on interviews and daily diaries and involved 21 users over 3 weeks. The study by Mutchler, Shim, & Ormond (2011) shows another recent work based on data collection from interviews to explore the factors that motivate college students in the U.S. to use smartphones.[11] However, the study results discussed above have their limitations. Also, no justifiable conclusion can be derived from their results as the studies were conducted on a small number of subjects. Thus, the ability to collect and record mobile phone usage automatically on a large scale is needed where longitudinal analyses of phone application logs are collected by combining automatic collection of smartphone data and human-centric data analysis.[12] According to the results of studies carried by Parslow, Hepworth, & McKinney (2003), over 93 volunteers were asked to report on the number of their call activities during different periods of time (day, week, or month) and their responses were then compared to log data collected from the mobile phone operators.

There was only a moderate correlation between log data and self-report, indicating that self-report measures do not fully represent actual usage patterns.[13] Verkasalo and Hammainen (2007) use data collected by Symbian-based monitoring to present a study of voice calls, SMS, email, and Bluetooth messages usage based on a population of 562 subscribers, during seven months.[14] Another study by Wehmeier (2012) was done on a larger scale, based on the data collected from 180,000 smartphone users on the Android platform during a period of one month, to analyze the user behavior trends across cellular networks in domestic and roaming scenarios and through Wi-Fi-based access.[15] Shye et al. (2010) present a

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[10] Barkhuus, L. and Polichar, V. E. (2011) Empowerment through seamfulness: smart phones in everyday life. Personal and Ubiquitous Computing, 15(6), pp. 629-639

[11] Mutchler, L. A., Shim, J. and Ormond, D. (2011) Exploratory Study on Users' Behavior: Smartphone Usage. in AMCIS.

[12] Do, T. M. T., Blom, J. and Gatica-Perez, D. (2011) Smartphone usage in the wild: a largescale analysis of applications and context. in Proceedings of the 13th international conference on multimodal interfaces: ACM. pp. 353-36

[13] Parslow, R., Hepworth, S. and McKinney, P. (2003) Recall of past use of mobile phone handsets. Radiation protection dosimetry, 106(3), pp. 233-240

[14] Verkasalo, H. and Hämmäinen, H. (2007) A handset-based platform for measuring mobile service usage. info, 9(1), pp. 80-96.

[15] Wehmeier, T. (2012) Understanding today's smartphone user: Demystifying data usage trends on cellular & Wi-Fi networks: Informa Telecoms and Media

comprehensive analysis of real smartphone usage involving 25 subscribers during a 6-month study of real user activity on the android smartphone. The study covers general usage behavior, power consumption interaction with the battery and network activity.[16] Another study by Rahmati and Zhong (2013) uses logging software that runs in the background to perform a four-month field study of usage of 14 smartphones and reports what applications were used, and how the phones were used.[17] Erman et al. (2011) present summaries of their analysis based on anonymized data set from a tier-1 cellular network provider in the U.S. over a week of how, where, and when smartphone apps are used from spatial, temporal, and user perspectives and attempt to understand the impact of location, time, user, and app interest accordingly.[18]

Other existing studies, like those done by Falaki et al. (2010)[19] and Xavier et al. (2012)[20], have addressed specific aspects of mobile phone design, such as mobility, to enhance user experience under mobility, phone application such as statistics of popular apps and the impact of user activities on the network. However, studies that have been carried out are still unable to gain an adequate understanding of the behavior of smartphone usage. Furthermore, most of the previous studies focused on the usage of specific countries and with limited time and number of users, so the overall picture of smartphone usage is still inadequate. To the best of our knowledge, the authors believe this work will help fill major gaps in forming a better picture of the smartphone usage evolution".[21]

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[16] Shye, A., Scholbrock, B., Memik, G. and Dinda, P. A. (2010) Characterizing and modeling user activity on smartphones: summary. in ACM SIGMETRICS Performance Evaluation Review: ACM. pp. 375-376

[17] Rahmati, A. and Zhong, L. (2013) Studying smartphone usage: lessons from a four-month field study. Mobile Computing, IEEE Transactions on, 12(7), pp. 1417-1427.

[18] Xu, Q., Erman, J., Gerber, A., Mao, Z., Pang, J. and Venkataraman, S. (2011) Identifying diverse usage behaviors of smartphone apps. in Proceedings of the 2011 ACM SIGCOMM conference on Internet measurement conference: ACM. pp. 329-344.

[19] Falaki, H., Mahajan, R., Kandula, S., Lymberopoulos, D., Govindan, R. and Estrin, D. (2010) Diversity in smartphone usage. in Proceedings of the 8th international conference on Mobile systems, applications, and services: ACM. pp. 179-194.

[20] Xavier, F. H. Z., Silveira, L. M., Almeida, J. M. d., Ziviani, A., Malab, C. H. S. and Marques-Neto, H. T. (2012) Analyzing the workload dynamics of a mobile phone network in large scale events. in Proceedings of the first workshop on Urban networking: ACM. pp. 37-42

[21] Amhmed A. Bhih, Princy Johnson, Martin Randles. (2016) Diversity in Smartphone Usage International Conference on Computer Systems and Technologies - CompSysTech'16

A study[22] of 255 users conducted by Falaki, Mahajan & Kandula in 2010 identified the following usage patterns ranked by frequency of usage on Android and Windows devices (outlined in **Tables 2, 3, 4, 5**):

Table 2. Relative rankings – frequency of usage of Tasks for Android devices.

Rank	**Active Process**
1	Alarm Clock
2	Talk
3	Contacts
4	Maps
5	MMS
6	Phone
7	Music
8	Browser
9	Camera
10	Vending
11	Calendar
12	Settings
13	Games - Tetris

[22] Hossein Falaki, Ratul Mahajan, Srikanth Kandula. "Diversity in Smartphone Usage". June 2010. DOI: . 10.1145/1814433.1814453. SourceDBLP. Conference: Proceedings of the 8th International Conference on Mobile Systems, Applications, and Services (MobiSys 2010), San Francisco, California, USA, June 15-18, 2010. Retrieved from:Retrieved from: https://www.researchgate.net/publication/221234363_Diversity_in_Smartphone_Usage

Table 3. Relative rankings – frequency of usage of Tasks for Windows mobile devices.

Rank	Active Process
1	Explorer
2	Gmail
3	Bubble breaker
4	Poker
5	Live Search
6	Calendar
7	Google Maps

Table 4. Break down of percentage usage of process for Android Devices

No. #	Process	Relative Percent of Usage
1	Communications	44%
2	Productivity	19%
3	Other	11%
4	Browsing	10%
5	Media	5%

6	Maps	5%
7	System	5%
8	Games	2%

Table 5. Breakdown of percentage usage of process for Windows Mobile Devices.

No. #	**Process**	**Relative Percent of Usage**
1	Communications	49%
2	Other	15%
3	Browsing	12%
4	Games	10%
5	Media	9%
6	Maps	2%
7	Productivity	2%
8	System	1%

We organize applications into eight unique categories to provide an aggregate view of what consumers do with their cellphones:

a) Communication includes apps for sending and receiving messages (e.g., email, SMS, IM) as well as making voice calls.
b) Browsing the Web, such as through a browser, search engines, and social networking applications;
c) Media consumption and creation (e.g., pictures, music, videos);
d) Calendars, alarms, and software for opening or creating files (e.g., Office, PDF Reader)
e) Changing user preferences or viewing user state (e.g., file explorer)
f) Games

g) Map and GPS systems
h) Any other applications that could not be sorted into aforementioned categories, e.g., because of unknown functionality.

Communication dominates is the most utilized category. Browsing is another extensively used category. Maps, media, and games have a relatively lesser but still substantial portion of user attention. [23]

We note there are limitations to the 2010 study. More recent data from Inside Intelligence suggest that the vast majority of mobile time is spent while connected to the Internet, with 88% of that time within apps.[24]

Distinguishing between the time spent in an app and a browser is still not straightforward. A study published in 2019 by Kargo and Verto Analytics claims that at least 9% of the time users spend on Facebook actually occurs in embedded browsers, outside of their designated application. In addition, advanced websites are largely comparable to apps in terms of experience.[25]

As a result, access to the browser in an accessible way takes on greater significance. Data on App downloads from the Apple App store can also provide additional insight. A link of the most popular App can be found at this link: https://www.statista.com/statistics/270291/popular-categories-in-the-app-store/

From this list, the tasks that are related directly or indirectly to business and productivity related task have been identified and extracted from this list. Tasks such as social media may only apply to a small number of employees tasked with maintaining government accounts and monitoring relevant government related third party accounts. Similarly photos and video are relevant as they apply to the ability to record and document professional development sessions and related government

[23] Hossein Falaki, Ratul Mahajan, Srikanth Kandula. "Diversity in Smartphone Usage". June 2010. DOI: . 10.1145/1814433.1814453. SourceDBLP. Conference: Proceedings of the 8th International Conference on Mobile Systems, Applications, and Services (MobiSys 2010), San Francisco, California, USA, June 15-18, 2010.

[24] Yoram Wurmser. "The Majority of Americans' Mobile Time Spent Takes Place in Apps". Insider Intelligence. Jul 9, 2020. https://www.emarketer.com/content/the-majority-of-americans-mobile-time-spent-takes-place-in-apps

[25] Yoram Wurmser. " The Majority of Americans' Mobile Time Spent Takes Place in Apps". Insider Intelligence. Jul 9, 2020. https://www.emarketer.com/content/the-majority-of-americans-mobile

or work related events. Similarly the ability to play music is related to being able to play audio files from a work related event or activity. There are some tasks with a dual purpose that do not seem business related at first glance but do have applications outside of their category that are directly or indirectly related to work activities.

From that list, the following apps categories have been identified as work related:

Table 6. Work-related application categories.

App Category	**Percent of downloads**
Business	10.7%
Education	8.66%
Utilities	6.39%
Productivity	3.21%
Social Networking	2.33%
Book	2.24%
Music	2.24%
Photo and Video	1.97%
Reference	1.89%
News	1.78%

5.3 Primary Task List for Mobile Devices

The list below lists the primary tasks that people of all abilities should have access to, including people with hearing loss. The list is derived from the tasks identified in the studies above.

Table 7. Primary tasks that people of all abilities should have access to.

#	**Task**
1	Reading the instructions on how to use the device that comes with the device packaging or is available from an online source
2	Setting up the device for the first time
3	Making and terminating a communications session (phone calls, videos call or text message session)
4	Receiving communication session (phone calls, videos call or text message session)
5	Sending text messages to a person in their contact list and to a specific phone number
6	Receiving text messages
7	Send and Receiving email using an app
8	Using a web browser to navigate to a URL, scroll to the end of the URL, interact with the controls on the webpage, enter text in the edit controls on that webpage and the browser controls (reload, forward and back, menu for browser). Sample test URL:
9	Using a calendar including entering a new appointment for a date one month in the future and looking up an appointment already scheduled for this week.
10	Taking pictures/video and save it to the mobile device

11	Watching videos or listening to music including changing volume (to be discuss App or web based??? Caption configurable ?????)
12	Complete a video call or meeting (FaceTime, no equivalent in Android that is shipped with phone - Duo).
13	Receive low battery notification
14	Change setting one the mobile device such as display brighten, default font size
15	Turn on the power to the phone
16	Turn off the power to the phone
17	Turn volume up
18	Turn volume down
19	Charge the mobile device

Note: There are many services and applications that can run on mobile devices that can help individuals with hearing-related issues deal with tasks they may encounter through their daily lives (reading the denomination on money, reading labels, finding something that has been dropped, etc.) While they are important value-added services for the community, they are not considered key elements to making the mobile device accessible but are rather services that can help individuals with hearing-related issues if the mobile device can be accessed. While these applications and services should be accessible through the mobile device, they are not directly related to the accessibility of the mobile device itself and are, therefore, outside of the scope of this document. The end goals of the user must be taken into consideration when selecting a mobile device for their needs though. Personalization and the need to achieve goals that are not directly related to the accessibility of the device are critical in preventing device abandonment.[26, 27]

[26] Hongxin Zhao." Predictors of Assistive Technology Abandonment". 1993, Assistive Technology Journal. https://www.academia.edu/37423321/Predictors_of_Assistive_Technology_Abandonment

[27] Stefan Carmien." Assistive Technology Abandonment: Research Realities and Potentials". Lecture Notes in Computer Science. https://www.academia.edu/61339073/Assistive_Technology_Abandonment_Research_Realities_and_Potentials

6 Definition of an Accessibility Solution

By definition, an “accessibility solution” must allow the user to complete all tasks on the primary task list using only the capabilities of that solution. “Enhancements” are technologies that can help a user complete a part (multiple steps) or a single step necessary to complete a task, but an enhancement cannot complete a full task on its own. An enhancement is used to speed up the process of completing parts of a task. Using a series of enhancements to complete a task is not considered a solution, unless that series of enhancements allows the user to complete all the tasks the user needs to complete.

Similarly, solutions cannot rely solely on enhancements to complete only some steps necessary to complete a task. Launching a navigation App using a pointing device, dictating text into the App for the city to get the map for using voice recognition and then using the pointing device to pick a point of interest on the map would be an example where a solution (the pointing device) completes some of the steps of a task (launching the App and picking a point of interest), but an enhancement (voice recognition to enter the text) completes some of the other steps in the task of navigating to a point of interest. The solution is the pointing device as the user can launch the App, use a virtual keyboard to enter the text and pick a point of interest with only the pointing device. The voice recognition is an enhancement that only speeds up the text entry process but the solution, the pointing device, is capable of doing that step also.

7 Support for Individuals Who Have Multiple Disabilities

An individual may have multiple disabilities and as such, assistive technology (AT) solutions must be able to co-exist and operate on the same device concurrently. The five communities of users identified in this document are:

1. Mobility loss
2. Vision loss

3. Hearing loss
4. Cognitive condition
5. Speech loss

Within each of these communities, we identified three levels of disability:

- Mild
- Moderate
- Severe

While it is difficult to cover every combination of disability, there are combinations of disabilities that are more common, and therefore will be described explicitly. Devices provided under the procurement process should at least be able to support the following combinations of disabilities:

- Mobility Disability and Speech Disability
- Mobility Disability and Cognitive Disability
- Hearing Disability and Vision Disability

Table 8. Prevalent combinations of two disability conditions.

	Mobility	**Vision**	**Hearing**	**Cognitive**	**Speech**
Mobility	X	Aging, Diabetes	Aging	Stroke	CP, MS, ALS
Vision	NA	X	Aging	Traumatic Brain Injury	Usher's Syndrome, Aging, Cerebral Palsy
Hearing	NA	NA	X	Traumatic Brain Injury	Born Deaf
Cognitive	NA	NA	NA	X	Aphasia
Speech	NA	NA	NA	NA	X

and may support the following combinations of disabilities:

For each supported disability type, all levels of severity must be handled. Device manufacturers and suppliers are encouraged to ensure the co-existence of all AT solutions that can be implemented on the mobile device if technically feasible.

[1] "Global Report 2018 Persons with Deafblindness and Inequality". https://wfdb.eu/wfdb-report-2018/deafblindness-and-inequality/

[2] https://www.nhs.uk/conditions/deafblindness/

8 Definition of Hearing Loss

The ear is a cartilaginous structure that lies on the lateral aspect of the head. It is divided into three fundamental structures: the external ear, the middle ear, and the inner ear. The outer ear is composed of cartilage; it is the part with the most contact to the external world. The middle ear contains the bony structures, or ossicles, that transmit vibrations into the inner ear. The inner ear contains the hearing organ cochlea.[28]

[28] Sánchez López de Nava, A., & Lasrado, S. (2022). Physiology, Ear. In StatPearls. StatPearls Publishing. http://www.ncbi.nlm.nih.gov/books/NBK540992/

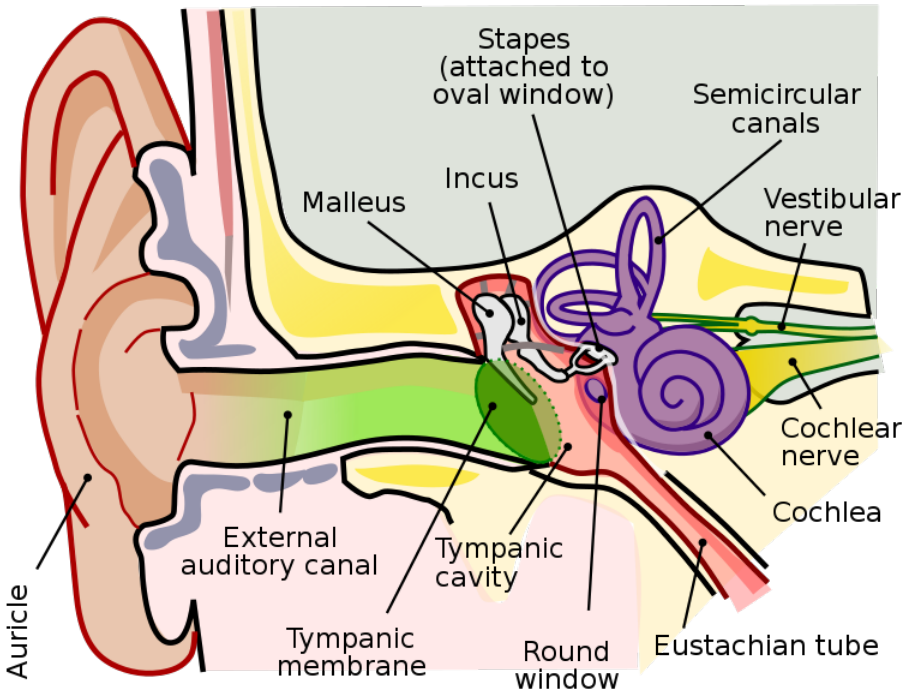

Figure 1. *Structure of the ear.*

Hearing loss refers to a condition in which one experiences a partial or total inability to hear in either one or both ears, either symmetrically or asymmetrically. It is a common condition that occurs when the sound transmission from either the environment or the outer ear to the brain experiences a disruption. There are three different types of hearing loss: conductive, sensorineural, and mixed.[29] Conductive hearing loss occurs when the transmission of sound waves to the cochlea is disrupted. Sensorineural hearing loss (SNHL) is a result of disrupted transmission at or after the cochlea.[5] Usually, people with conductive hearing loss experience diminished sounds, while those with SNHL experience diminishing and distortion in sound perception.[5] Mixed hearing loss is that which combines both conductive hearing loss and SNHL.[5]

[29] Anastasiadou, S., & Al Khalili, Y. (2022). Hearing Loss. In *StatPearls*. StatPearls Publishing. http://www.ncbi.nlm.nih.gov/books/NBK542323/

The term Deafness refers to a condition in which an individual has very little or no hearing, as defined by the WHO.[30] Hearing disability is defined by the WHO as the inability to hear as well as someone with 'normal hearing', i.e., hearing between -10 and 20 dB.[6] The descriptor 'hard of hearing', or HOH, refers to people with hearing loss ranging from moderate to severe.[6] We describe the definitions of mild, moderate, and severe hearing loss below in more detail in section 9.2 Degrees of Hearing Loss.

8.1 Causes of Hearing Loss

Hearing loss can be caused by damage to any portion of the peripheral and central auditory systems.[31] According to Cunningham & Tucci (2017), the main causes of SNHI are age-related degenerative processes, genetic mutations, noise exposure, exposure to therapeutic drugs that have ototoxic side effects, and chronic conditions.[32] In terms of chronic conditions, there are especially strong associations between hearing loss and smoking cigarettes, adiposity, and diabetes mellitus; however, causality remains undetermined[33]. Hearing loss caused by ear disease may be associated with rheumatoid arthritis, systemic lupus erythematosus, Cogan's syndrome, sarcoidosis, or other autoimmune disorders.[34]

Ototoxic medications and substances such as acetylsalicylic acid, aminoglycosides, chloramphenicol, chloroquine phosphate, dihydrostreptomycin,

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[30] Linda, N., Maia, M., Hennen, L., Wolbring, G., Bratan, T., Kukk, P., Cas, J., Capari, L., Krieger-Lamina, J., & Mordini, E. (2018). Assistive technologies for people with disabilities - Part II: Current and emerging technologies. https://doi.org/10.2861/567013

[31] Cunningham, L. L., & Tucci, D. L. (2017). Hearing Loss in Adults. *New England Journal of Medicine*, *377*(25), 2465–2473. https://doi.org/10.1056/NEJMra1616601

[32] Cunningham, L. L., & Tucci, D. L. (2017). Hearing Loss in Adults. *New England Journal of Medicine*, *377*(25), 2465–2473. https://doi.org/10.1056/NEJMra1616601

[33] Cunningham, L. L., & Tucci, D. L. (2017). Hearing Loss in Adults. *New England Journal of Medicine*, *377*(25), 2465–2473. https://doi.org/10.1056/NEJMra1616601

[34] Cunningham, L. L., & Tucci, D. L. (2017). Hearing Loss in Adults. *New England Journal of Medicine*, *377*(25), 2465–2473. https://doi.org/10.1056/NEJMra1616601

ethacrynic acid, furosemide, neomycin, nitrogen mustard, nortriptyline, pharmacetin, polymyxin B, quinine, ristocetin, streptomycin, thalidomide, vancomycin, and viomycin, certain chemotherapy drugs, and loop diuretics can either cause direct hearing loss or, if ingested by pregnant individuals, in hearing loss of their offspring.[35]

McKee et al. (2018) suggest that hearing loss is independently associated with the following conditions: arthritis, cancer, cardiovascular diseases, diabetes, emphysema, high blood pressure, and stroke.[36] Meniere's disease, otosclerosis, acoustic neuroma, and even TBI can cause hearing loss, according to ASHA.

Viruses can also cause hearing loss, as Cohen et al discuss in their review.[37] Cytomegalovirus, rubella, lymphocytic choriomeningitis virus can cause congenital hearing loss.[38] Amongst viruses that cause congenital and acquired hearing loss are HIV-1, and HSV-1 and -2.[39] Viruses that cause acquired hearing loss only are measles (Rubeola), Varicella Zoster Virus, mumps, and West Nile virus.[40]

The occurrence of hearing loss because of prolonged exposure to a noise level greater than 85 dB(A) is well documented in the literature.[41,42] Noise-induced

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[35] Roizen, N. J. (2003). Nongenetic causes of hearing loss. Mental Retardation and Developmental Disabilities Research Reviews, 9(2), 120–127. https://doi.org/10.1002/mrdd.10068

[36] McKee, M. M., Stransky, M. L., & Reichard, A. (2018). Hearing loss and associated medical conditions among individuals 65 years and older. Disability and Health Journal, 11(1), 122–125. https://doi.org/10.1016/j.dhjo.2017.05.007

[37] Cohen, B. E., Durstenfeld, A., & Roehm, P. C. (2014). Viral Causes of Hearing Loss: A Review for Hearing Health Professionals. *Trends in Hearing*, *18*, 2331216514541361. https://doi.org/10.1177/2331216514541361

[38] Cohen, B. E., Durstenfeld, A., & Roehm, P. C. (2014). Viral Causes of Hearing Loss: A Review for Hearing Health Professionals. *Trends in Hearing*, *18*, 2331216514541361. https://doi.org/10.1177/2331216514541361

[39] Cohen, B. E., Durstenfeld, A., & Roehm, P. C. (2014). Viral Causes of Hearing Loss: A Review for Hearing Health Professionals. *Trends in Hearing*, *18*, 2331216514541361. https://doi.org/10.1177/2331216514541361

[40] Cohen, B. E., Durstenfeld, A., & Roehm, P. C. (2014). Viral Causes of Hearing Loss: A Review for Hearing Health Professionals. *Trends in Hearing*, *18*, 2331216514541361. https://doi.org/10.1177/2331216514541361

[41] Berger, E. H., Royster, L. H., & Thomas, W. G. (1978). Presumed noise-induced permanent threshold shift resulting from exposure to an A-weighted Leq of 89 dB. The Journal of the Acoustical Society of America, 64(1), 192–197. https://doi.org/10.1121/1.381984

[42] Dobie, R. A. (1985). Industrial audiometry and the otologist. The Laryngoscope, 95(4), 382–385. https://doi.org/10.1288/00005537-198504000-00002

hearing loss occurs predominantly at higher frequencies (3-6 kHz), with the largest effect at 4 kHz.[43]

8.2 Degrees of Hearing Loss

8.2.1 Measuring sound

Sound intensity is measured in units called decibels (dB), thus honoring the inventor of the telephone and the audiometer Alexander Graham Bell. The modernized version of the audiometer is still used today when diagnosing hearing loss. Unlike many standard measuring devices that are linear (e.g., rulers), the decibel scale is logarithmic. The logarithmic scale in the context of hearing represents how the human ear and brain actually perceive sound intensity. An example of linear measurement would be having a 50-foot-tall building and building another 10-foot floor, thus making the building 20% taller. In comparison, when using the logarithmic decibel scale, if a sound is 50 dB, increasing the volume to 60 dB would make the sound ten times stronger, which would seem twice as loud to the human ear.

There are other variations of decibels, such as dBA, dBB, and dBC. Unlike the dB scale that is only based on sound intensity, A-weighted decibels (dBA) account for the relative loudness perceived by the human ear by adjusting sound pressure level readings to reflect the ear's lesser sensitivity to lower audio frequencies. The dBA scale provides a better idea of what noise levels impact hearing and is, therefore, mandated for use all over the world for hearing damage risk measurements.

Slight increases in dBA levels can lead to huge impacts on hearing health. Damage is more likely to occur if the noise level is:

[43] Abd-Elbasseer, M. (2013). Occupational Noise Exposure and Hearing Effect on Workers in Egyptian Factories. https://www.academia.edu/41073644/OCCUPATIONAL_NOISE_EXPOSURE_AND_HEARING_EFFECT_ON_WORKERS_IN_EGYPTIAN_FACTORIES

- **"85 dBA** and you are exposed to it for at least **8 hours**.
- **100 dBA** and you are exposed to it for at least **14 minutes.**
- **110 dBA** and you are exposed to it for at least **2 minutes."** [44]

8.2.2 Classifications of hearing loss

According to the American National Standards Institute (ANSI), there are five stages of hearing **(**see **Table 10**).[45] Slight hearing loss is included in the ANSI classification systems due to research on adverse effects of minimal hearing loss in early childhood development.

Table . ANSI classification system.

Grade of disability	**Hearing threshold**
Normal hearing	-10 to 15 B
Slight hearing loss	16 to 25 dB
Mild hearing loss	26 to 40 dB
Moderate hearing loss	41 to 55 dB
Severe hearing loss	71 to 90 dB
Profound hearing loss	Over 90 dB

Table 11 outlines the grades of hearing disability as recommended by the World Health Organization (WHO).[46] Olusayana et al. (2019) note that this classification raised concerns, primarily because the prescribed threshold for 'normal' hearing is set at 25 dB, which is contradictory to the literature, wherein the regular hearing threshold is up to 15 dB. In addition, there is concern about whether

[44] https://www.noisyplanet.nidcd.nih.gov/have-you-heard/how-is-sound-measured#:~:text=We%20measure%20sound%20intensity%20(also,person%20can%20hear%20certain%20sounds.

[45] Clark, J. (1981). Uses and abuses of hearing loss classification. *ASHA*, *23*, 493–500.

[46] Olusanya, B. O., Davis, A. C., & Hoffman, H. J. (2019). Hearing loss grades and the International classification of functioning, disability and health. Bulletin of the World Health Organization, 97(10), 725–728. https://doi.org/10.2471/BLT.19.230367

a scientific or rational basis exists for the uneven steps between the various grades of severity. Lastly, the exclusion of persons with unilateral hearing loss and mild bilateral hearing loss is inconsistent with the *International Classification of Functioning, Disability, and Health.*

***Table** . WHO's Grades of hearing disability.*

Grade of disability	**Corresponding audiometric ISO value**	**Performance**	**Recommendation**
No disability	25 dB or less	No or very slight hearing problems. Able to hear whispers.	None.
Slight disability	26 to 40 dB	Able to hear and repeat words spoken in normal voice at 1 m	Counseling. Hearing aids may be needed.
Moderate disability	41 to 60 dB	Able to hear and repeat words using raised voice at 1 m	Hearing aids are usually recommended.
Severe disability	61 to 80 dB	Able to hear some words when shouted into better ear	Hearing aids are needed. If no hearing aids are available, lip-reading should be taught.
Profound disability (including deafness)	81 dB or greater	Unable to hear and understand even a shouted voice	Hearing aids may help in understanding words. Additional rehabilitation needed. Lip-reading and sometimes singing are essential.

The GBD Expert Group on Hearing Loss addressed the concerns raised by WHO's classification in 2008 in their own modified version **(**see **Table 12**)**.** Most notable is the fact that the group did not add the category of slight disability (16 – 25 dB), even though the literature sets the normal hearing threshold at 15 dB.[47] Instead, the group decided not to deviate from WHO's initial classification system, and instead opted to lower the normal hearing threshold from 25 to 20 dB. Olusanya et al. state that this is because persons with hearing sensitivity below 20 dB rarely benefit from or require amplification devices. The unilateral category was introduced based on extensive literature research "on the functional, educational, psychological or social impact" for all age groups living with disabilities.[48] The group also addressed the concern with the uneven steps between individual hearing loss categories, as can be seen in **Table 12**.

Table *. Grades of hearing disability, as recommended by the Global Burden of Disease Expert Group on Hearing Loss.*

Category	**Pure-tone audiometry**	**Hearing experience in a quiet environment**	**Hearing experience in a noisy environment**
Normal hearing	-10 to 4.9 dB	Excellent hearing	Good hearing
	5.0 to 19.9 dB	Good hearing	Rarely experiences difficulty in following/taking part in a conversation
Mild hearing loss	20.0 to 34.9 dB	Does not have problems hearing what is said	May have real difficulty following/taking part in a conversation

[47] Olusanya, B. O., Davis, A. C., & Hoffman, H. J. (2019). Hearing loss grades and the International classification of functioning, disability and health. Bulletin of the World Health Organization, 97(10), 725–728. https://doi.org/10.2471/BLT.19.230367

[48] Olusanya, B. O., Davis, A. C., & Hoffman, H. J. (2019). Hearing loss grades and the International classification of functioning, disability and health. Bulletin of the World Health Organization, 97(10), 725–728. https://doi.org/10.2471/BLT.19.230367

Moderate hearing loss	35.0 to 49.9 dB	May have difficulty hearing a normal voice	Has difficulty hearing and taking part in conversation
Moderately severe hearing loss	50.0 to 64.9 dB	Can hear loud speech	Has great difficulty hearing and taking part in conversation
Severe hearing loss	65.0 to 79.9 dB	Can hear loud speech directly in one's ear	Has very great difficulty hearing and taking part in conversation
Profound hearing loss	80.0 to 94.9 dB	Has great difficulty hearing	Cannot hear any speech
Complete or total hearing loss	95.0 dB or greater	Profoundly deaf, hears no speech or loud sounds	Cannot hear any speech or sound
Unilateral	Less than 20.0 dB in the better ear	Does not have problems unless sound is near poorer hearing ear	May have real difficulty following/taking part in a conversation

9 Proposed classification

Different classification systems, as can be seen above, can be used depending on the granularity required to meet your objective. Different classification systems are used to represent specific sub-groups of users within a disability community. The classifications are typically designed to meet a specific objective. Those objectives may be to better define specific groups of users that may benefit from specific medical intervention, to define groups of users that may benefit from specific therapies, or to better define users affected with specific conditions that lead to specific degrees of hearing loss. For this document, the classifications are used to represent major sub-groups of users within the hearing loss community and the classes of technology solutions they require. Even though hearing loss is defined on a continuous scale that would accommodate all potential levels of hearing loss, the actual number of solution classes is limited, often limited by the technology that is available. Therefore, for the purposes of this document, three levels of classification are used.

- Mild 25 to 40 dB
- Moderate 41 to 80 dB
- Severe 81 dB and higher

The actual levels of each category have been derived from the classification systems above and, as such, they should not be taken as guidance regarding medical diagnoses, but rather as guidelines for when a specific class of assistive technology solution is appropriate. Finally, the selection of specific accessibility features, services, and third-party assistive technologies are typically made by the end-user and an assistive technology professional. Variations on recommended best practices may exist for the final solution or solutions selected by the end-user, as it is highly impacted by the end-user's personal preferences, such as convenience, familiarity, and even cost for solutions that are not provided by the mobile device from the factory or the wireless service provider.

10 Principles of Technology Design for People with Hearing Loss

Universal design is the process of designing environments, services, and products to be usable, insofar as possible and practical, by people with a wide range of abilities.[49] By employing the principles of universal design, accessibility and safety for users can be improved. An environment, product, or service will be accessible to the widest possible audience if the high-level principles are met. Generally, the broader the application of the universal design principles to products, services, and environments is, the less the need for assistive or adaptive technologies will be.

[49] Field, M. J., Jette, A. M., & America, I. of M. (US) C. on D. in. (2007). Assistive and Mainstream Technologies for People with Disabilities. In The Future of Disability in America. National Academies Press (US). https://www.ncbi.nlm.nih.gov/books/NBK11418/

The most widely cited principles in universal design are proposed by Field et al. (2007), adapted from a publication by the Center for Universal Design in 1997.[50] These principles are outlined in **Table 6**. 'Size and space for approach and use', 'tolerance for error', and 'low physical effort' are less so about accommodating hearing loss and more general in their applicability. However, 'equitable use', 'flexibility in use', 'simple and intuitive', and 'perceptible information' are pertinent categories when designing a mobile device for people with hearing disabilities.

Table 12. Principles of universal design (Center for Universal Design, 1997).

Principle	**Definition of principle**
Equitable use	The design is useful and marketable to people with diverse abilities.
Flexibility in use	The design accommodates a wide range of individual preferences and abilities.
Simple and intuitive	Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level
Perceptible information	The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.
Tolerance for error	The design minimizes hazards and the adverse consequences of accidental or unintended actions.
Low physical effort	The design can be used efficiently and comfortably and with a minimum fatigue.
Size and space for approach and use	Appropriate size and space are provided for approach, reach,

[50] Field, M. J., Jette, A. M., & America, I. of M. (US) C. on D. in. (2007). Assistive and Mainstream Technologies for People with Disabilities. In The Future of Disability in America. National Academies Press (US). https://www.ncbi.nlm.nih.gov/books/NBK11418/

	manipulation, and use, regardless of the user's body, size, posture, or mobility.

The Electronic and Information Technology Access Advisory Committee (EITAAC) recommends five principles for identifying whether E&IT provides comparable accessibility to data and information of those who live with disabilities and those who do not, as per the Section 508 of the Rehabilitation Act of 1973. EITAAC cautions that agencies should take the principles into account when endeavoring to implement the requirements of Section. The principles are outlined in **Table 7**.

***Table** . Principles of implementing the requirements in Section 508 of the Rehabilitation Act of 1973, as presented by the Electronic and Information Technology Access Advisory Committee in 1999.*

Principle	**Definition of principle**
Principle of user access and efficiency	Accessibility provisions allow users to independently perform tasks to the best of their abilities.
Principle of technical feasibility	Technical feasibility must be evaluated within a given procurement process. Agencies must exercise judgment and collaborate with the industry and consumers to determine when a requirement has become technically feasible for a particular product, service, or environment.
Principle of proportionality	No standard is applied to go beyond what is necessary to achieve its objective, to mitigate unforeseen inefficiencies and cost increases without significant benefit.
Principle of flexibility	Since different users have preferences or necessities to operate E&IT in different ways, where available, more than one accessibility option should be provided.
Principle of compatibility and adaptability	Agencies have a responsibility to ensure that E&IT and accessibility technologies

	are as broadly compatible as possible without creating an undue burden.

The above are high-level design principles but at the root, people with hearing related losses are dealing with the issues of whether all outputs from the mobile device are "perceivable" and "can be understood". The issues around whether an output is perceivable center around visual-based outputs. The output can be divided into two categories:

1. Issues around audio-related communications
2. Issues around audio-based notifications

One of the primary functions of a mobile device is to facilitate phone calls, which is an **audio-related communication feature**. But if an individual is hard-of-hearing, they may need greater amplification of the mobile device's audio output than people without hearing loss require. If an individual uses a hearing aid, the mobile device may interfere with the functioning of that hearing aid. If the person is Deaf, they cannot use the audio output portion of the phone capabilities of a mobile device at all.

Similarly, many **notifications** on the phone are **audio-based**. Features such as ringing for an incoming phone call, a low battery alert, and text message notifications are a small number of examples.[51]

11 Contextualizing Design Principles within a Performance Metric Framework

When assessing one's hearing performance, focus is put on the three key performance metrics that define the abilities of every user. Those performance metrics are auditory acuity (the sharpness/clarity of hearing and ability to perceive

[51] Martin Pielot, Karen Church, Rodrigo de Oliveira."An in-situ study of mobile phone notifications". September 2014 DOI: 10.1145/2628363.2628364 Conference: the 16th international conference. https://www.researchgate.net/publication/291009197_An_in-situ_study_of_mobile_phone_notifications

sounds with low intensity), the ability to isolate and differentiate between specific sounds or frequencies, and the ability to recognize the directionality of a sound.

Every member of the hearing loss community can be defined by these key performance metrics:

- Auditory acuity
  - the ability to perceive sounds of low intensity
  - the ability to detect differences between two sounds on a characteristic such as frequency or intensity
  - .[52]
- Acoustic acuity in both ears
  - The ability to hear in both ears affects the determination of directionality.
  - Stereo source generates sound that is played over different channels. When using headsets, an individual that has loss of hearing in one ear will not be able to perceive half of the audio playback.
- Ability to isolate specific sounds from background sounds
  - Some people can have problems isolating sounds, like a person's voice from another conversation in a room. This is a typical characteristic of someone with tinnitus.[53, 54]
- Being able to determine the directionality of the sound source.

11.1 Determining directionality factors

Having two ears aids us in determining sound wave directionality. Time lag, wavelength, and tone are determining directionality factors.

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[52] https://www.oxfordreference.com/view/10.1093/oi/authority.20110803095433707

[53] https://www.googleadservices.com/pagead/aclk?sa=L&ai=DChcSEwiXtsT_h7H1AhW5Dq0GHbISDscYABABGgJwdg&ae=2&ohost=www.google.com&cid=CAESQOD25t2DSKqk0AScyBksIqcPnJeKxSKH_GiGoctQakkfA6_M7zX-ATbGW1tby2bJatfgm-vDKspBrDWcGm9f23w&sig=AOD64_3-6odLleO6K3Ubp0ee1-U4ZQzUTg&q&adurl&ved=2ahUKEwiPsrv_h7H1AhWTFjQIHfToDC8Q0Qx6BAgFEAE

[54] Byung In Han, MDa ; Ho Won Lee, MDb ; Tae You Kim, MDc ; Jun Seong Lim, MDd ; Kyoung Sik Shin, MDe . " Tinnitus: Characteristics, Causes, Mechanisms, and Treatments". J Clin Neurol 2009;5:11-19. https://www.academia.edu/20694920/Tinnitus_Characteristics_Causes_Mechanisms_and_Treatments

1 *Time lag* can help us determine so-called impulse sounds, like a click or a bang. If a sound is coming at a person at an angle, it will not reach both ears symmetrically and simultaneously. The difference in the distance the sound waves travel to each ear creates a time lag, which the brain registers and interprets as a direction.
2 *Wavelength* is important in determining sound directionality for light treble sounds (over 1 kHz, with a limited wavelength of less than 30 cm). Hearing sounds of limited wavelengths makes one's head function as a screen. For example, for sounds coming from the right, the head will block the sound waves from reaching the left ear. This is not the case for deep bass sounds with longer wavelengths.
3 If the sound comes from above, below, or directly in front of the face, time lag does not occur. In this case, instead of the cochlea, the outer ear becomes important in determining the *tone of the sound.* If the outer ear is obstructed, for example, if wearing a helmet in traffic, it can be difficult to determine sound directionality, such as where an ambulance is coming from.[55]

11.2 Separating ambient noise from speech

The process of hearing, at a rudimentary level, allows for sound to travel through the ear canal, via the middle ear, into the cochlea, the primary auditory organ. The small hairs within the cochlea vibrate to the different frequencies of sound. The vibration signals produced in the cochlea travel to the brain for processing. If you have a so-called 'normal' hearing threshold, the brain removes ambient noise[56], allowing for focus on the primary auditory source, such as speech. Separating ambient noise from speech becomes a larger issue for an individual whose tiny hair cells in the ear are damaged, especially in very loud environments. People with hearing loss perform somewhat more poorly than normal in steady background sound, but their performance is considerably poorer in a fluctuating background environment. Unlike people with normal hearing, who get considerable benefit from fluctuating background sounds in terms of enhancing speech

[55] HYPERLINK "https://www.hear-it.org/The-direction-of-sound"Direction of sound - direction of sound waves | hear-it.org

[56] Directionality: What Is It and Why Should You Care? (starkey.com)

perception, people with hearing loss benefit from the temporal dips in ambient noise.[57]

A solution for the issue of separating speech from ambient noise is a hearing aid feature called directionality. Just like with two ears, directional hearing aid systems utilize two (or more) microphones that are set at a specific distance apart. The difference in the arrival time of sound to the individual microphones determines which direction the sound is coming from. Usually, directional microphone hearing aids amplify sound directly in front of the wearer.[58] It is important to note that hearing aids are not an appropriate solution for those who have hearing loss confined to above 6 kHz, as most hearing aids have limited high-frequency amplification abilities. [59,60] It is common for hearing-impaired people to have hearing that is normal or almost normal at **low** frequencies. Ambient sounds commonly contain notable amounts of energy below 200 Hz that are continuously stimulating the auditory system, consequently preventing any potential difficulties that can arise from any increased gain. It is, therefore, imperative to make hearing aids in a way that avoids any low frequency blockage.[61]

12 Overview of Various Technical Requirement Standards from Around the World

12.1 Standards harmonization

[57] Christian Lorenzi, Gaëtan Gilbert, Héloïse Carn, Stéphane Garnier, and Brian C. J. Moore“ Speech perception problems of the hearing impaired reflect inability to use temporal fine structure | PNAS

[58] Directionality: What Is It and Why Should You Care? (starkey.com)

[59] Byung In Han, MDa ; Ho Won Lee, MDb ; Tae You Kim, MDc ; Jun Seong Lim, MDd ; Kyoung Sik Shin, MDe . " Tinnitus: Characteristics, Causes, Mechanisms, and Treatments“. J Clin Neurol 2009;5:11-19. https://www.academia.edu/20694920/Tinnitus_Characteristics_Causes_Mechanisms_and_Treatments

[60] Searchfield GD. Hearing aids and tinnitus. In: Tyler RS. Tinnitus treatment. New York: Thieme, 2006;161-175.

[61] Byung In Han, MDa ; Ho Won Lee, MDb ; Tae You Kim, MDc ; Jun Seong Lim, MDd ; Kyoung Sik Shin, MDe . " Tinnitus: Characteristics, Causes, Mechanisms, and Treatments“. J Clin Neurol 2009;5:11-19. https://www.academia.edu/20694920/Tinnitus_Characteristics_Causes_Mechanisms_and_Treatments

Accessibility standards define what characteristics or features are required for ICT technology to be accessible. These standards are used by technology developers, procurement officers, or legal compliance officials (among others) to determine if accessibility requirements for given products have been met.

The harmonization of different accessibility standards is a mutual objective of private companies, advocacy organizations, and governments. If harmonization between standards is not achieved, private companies seeking production of accessible documents face the possibility of non-conformance with a set of standards or the necessity of producing different versions of the same product for various jurisdictions. Therefore, to achieve accessibility, consistency across standards and their individual requirements is key. The three major standards in this document—Section 508 of the U.S. Rehabilitation Act, the European Standard EN 301 549, and Web Content Accessibility Guidelines 2—are harmonized. While Section 508 standards incorporate WCAG 2.0 with respect to web and software, the EU standards were developed to avoid any conflicts with Section 508 and WCAG 2.0.

Section 508 and EN 301 549 are standards; they have been adopted by the U.S. and by the European Union as the governing standards for implementation of ICT accessibility requirements. WCAG 2.0 is referred to as a guideline, developed through a process involving many stakeholders by the Web Accessibility Initiative (WAI) of the World Wide Web Consortium (W3C). The W3C does not necessitate accessibility, but rather puts out standards through a consensus process for adoption by external bodies, such as governments or tech companies.

A spreadsheet comparing the various standards can be found at: Unified ICT Accessibility Standards Compilation - download folder - Google Drive The government of Canada is moving toward endorsing the EN 301 549 standard for its procurement process. This document is using EN 301 549 as the reference and adding modifications, additions and subtractions from the standard to account for the difference between generic ICT designs and mobile device designs. Refer to section xxx for a list of the modifications, additions and submission as it applied to this specific group of users

12.2 Functional performance statements

In this section, functional performance statements of Section 508 [62]of the U.S. Rehabilitation Act and European Standard EN 301 549 [63] are outlined. Functional performance statements are high-level statements that use simple terms to describe the functional performance thresholds necessary to be in place for users with disabilities to be able to locate, identify, and operate ICTs, and to access provided information, regardless of physical, cognitive, or sensory abilities. While there are differences between the American Section 508 and the European EN 301 549 guidelines/standards in terms of verbiage, specifications, and, to a degree, scope, both guidelines/standards put the user at the core of establishing whether a product or service can be located, identified, and operated by persons with or without disabilities. Therefore, both standards contain nearly identical functional performance statements.

12.3 Generic Hearing Performance Statements from EN 301 549

The European Standard 301 549 is intended for procurement by public bodies, this time in the European Union.

12.3.1 W3C WCAG 2.1

The Web Content Accessibility Guidelines (WCAG 2.1) define how to make web content accessible to people with disabilities. It is worth noting that despite its recent release, WCAG 2.1 has been integrated into the updated version of EN 301 549. The specifications in EN 301 549 reference both WCAG 2.0 and WCAG 2.1 for Web content, and it aligns with WCAG 2.1 for non-Web documents and software.

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[62] Home | Section508.gov

[63] https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf

12.3.2 Functional Performance Statements in EN 301 549

The statements set out in Clause 4 of EN 301 549 are intended to describe the functional performance of ICT enabling people to locate, identify, and operate ICT functions, and to access the information provided, regardless of their abilities. Any disability may be permanent, temporary, or situational.

The Functional Performance Statements address, in a simple way, the set of user accessibility needs. They describe the capabilities of how persons with disabilities can interact with an ICT product or service, and the features that the ICT needs to provide when a capability is not available for use. However, the Functional Performance Statements are very high-level, and as such do not contain the necessary detailed and testable requirements.

12.3.2.1 4.2.4 Usage without hearing (severe)

Where ICT provides auditory modes of operation, some users need ICT to provide at least one mode of operation that does not require hearing.

NOTE: Visual and tactile user interfaces may contribute towards meeting this clause.

12.3.2.2 4.2.5 Usage with limited hearing (mild)

Where ICT provides auditory modes of operation, some users will need the ICT to provide enhanced audio features.

NOTE 1: Enhancement of the audio clarity, reduction of background noise, increased range of volume and greater volume in the higher frequency range can contribute towards meeting this clause.

NOTE 2: Users with limited hearing may also benefit from non-hearing access (see clause 4.2.4).

12.3.3 Functional Accessibility Statements

The Functional Accessibility Statements provide more detail than the Functional Performance Statements. Each Functional Performance Statement has a

corresponding set of Technical Accessibility Requirements that describe in detail the features and functions an ICT product or service must have.

12.4 Generic Hearing Performance Statements from Section 508

Section 508 of the United States Rehabilitation Act [64]uses procurement regulations to specify accessibility considerations for federal American agencies that are "developing, procuring, maintaining, or using electronic and information technology" (Abou-Zahra & Brewer, 2019). For the purposes of procuring mobile devices, Section 508 addresses technology compatibility with hearing aids, assistive listening devices, and telecommunications devices for the deaf (TTY). The current version of the standard complies with W3C WCAG 2.0.

The key underlying principle to accommodate people with hearing loss is to provide tactile and visual alternatives to acoustic-based alerts and notifications.

12.4.1 Functional performance criteria of Section 508

12.4.1.1 E301.1 Scope.

The requirements of Chapter 3 shall apply to ICT where required by 508 Chapter 2 (Scoping Requirements), 255 Chapter 2 (Scoping Requirements), and where otherwise referenced in any other chapter of the Revised 508 Standards or Revised 255 Guidelines.

12.4.1.2 E302 Functional Performance criteria

12.4.1.2.1 302.4 Without hearing (severe)

Where an audible mode of operation is provided, ICT shall provide at least one mode of operation that does not require user hearing.

[64] Home | Section508.gov

12.4.1.2.2 302.5 With limited hearing (mild)

Where an audible mode of operation is provided, ICT shall provide at least one mode of operation that enables users to make use of limited hearing.

13 Comparison of Technical Accessibility Requirements

Section 508 of the U.S. Rehabilitation Act and European Standard EN 301 549 both contain many technical accessibility requirements, which offer details that go beyond the high-level functional performance statements. Technical accessibility requirements should describe objective and measurable outcomes for ICTs, without being overly prescriptive. In order to meet a high-level performance statement, an ICT solution must conform to all relevant technical accessibility requirements.

13.1 Checklist of Differences Between Standards

It has been proposed that EN 301 549 should be adopted as the generic, accessible information and communication technology (ICT) standard for all ICT for the government of Canada. Though not official approved as of the writing of this document EN 301 549 potentially will form the baseline specification for any procurement of ICT for the government of Canada when approved. A working group is currently being formed by Accessibility Standards Canada.

The section of the document will highlight exceptions (additions, changes and omissions) being proposed specifically for mobile devices to the individual EN 301 549 requirements as mobile devices are a distinct sub-category of ICT that may not require all the specific individual requirements, may require additional specifications or may require modified version of specification within EN 301 549 standard.

This section is also intended to provide a quick summary of changes being proposed for the modified EN 301 549 standard as it is applied to mobile devices. This section is being provided specifically for procurement staff and regulatory staff from mobile device manufacturers that are tasked with keeping up with new

standards. It is important that procurement and regulatory staff also look at how the standards and the exceptions are applied in the proposed procurement process discussed below in Section 14.

13.1.1 Additions to Standard

The following additions to the standard are being added from the Section 508 guidelines.

408.3 Flashing. Where ICT emits lights in flashes, there shall be no more than three flashes in any one-second period.

411.1 General. Where provided, audible signals or cues shall not be used as the only means of conveying information, indicating an action, or prompting a response.

Paragraph #	**Addition**	**Comments**
Section 508: 408.3 Flashing.	Where ICT emits lights in flashes, there shall be no more than three flashes in any one-second period.	
Section 508: 411.1 General.	Where provided, audible signals or cues shall not be used as the only means of conveying information, indicating an action, or prompting a response.	

13.1.2 Omissions to the Standard

There are no omissions to the standard for the Hearing Loss Community.

13.1.3 Modifications to the Standard

1.

There are no modifications to the standard for the Hearing Loss Community.

14 Best Practices Background

The best practices proposed in this document demonstrate methods of interactions that adhere to the above principles. These examples are being provided to show that it is possible to implement effective solutions that meet the accessibility criteria and may sometimes be desirable to other users.

15 Personas

One of the most effective ways to communicate the needs of specific groups of users is through the use of personas. A personas assumes a defined set of characteristics about a set of users. A fictional person is used to represent the goals, motivations, capabilities, and lifestyle characteristics of a group of users. Personas allow designers and procurement staff to understand the needs of the end users by simplifying the issues. Rather than having millions of individual end users, end users are categorized into a smaller number of end user groups with common characteristics. In most cases, personas are created using data collected from interviews with users. They are captured in 1–2-page descriptions that include behavior patterns, goals, skills, attitudes, and the environment, with a few personal details to make the persona realistic.

Use cases describe the responses of a product or service to a series of related requests from an end user. A use case covers the most common tasks that the user may try to achieve through the product or service. Together personas and use cases help to guide decisions about a product or service such as features, interactions, and visual design. These tools are important to designers and procurement staff as they help to define who will use the end product and service to complete the end goal. In the case of mobile devices it is the use of advanced communication services.

Each persona provides background on a user that can benefit from specific classes of assistive technology solutions. After each persona follows a list of "best practices", or classes of solutions that would benefit a user with that specific set of abilities. Note that to qualify to be a best practice, the user must be able to complete all the tasks in the primary task list detailed in Section xxx of this document. Described with the best practice, where relevant, is a list of enhanced features. "Enhanced Features" are accessibility features that allow the user to interact with some, but not all of the steps of a task on the primary task list. Voice Assistant, for example, is an enhanced feature since you cannot perform all the tasks on the

primary task list using this feature. Scrolling through a long webpage or picking an arbitrary point of interest on a webpage are examples of actions a user cannot perform with a Voice Assistant.

After each Best Practice section is a Technical Discussion section. In this section, technical requirements necessary to implement the Best Practice is discussed. Where possible, the authors have tried to avoid referring to specific implementations of a best practice on specific platforms. Rather, the authors have tried to describe a set of generic features that users have come to expect for the Best Practice. Note that the majority of these best practices currently exist on one or more models of mobile device or brand of mobile device. There are a handful of best practices that have been attempted but are not considered a complete solution yet. In those cases, the Best Practice describes the features and operational procedures of the solution that should be used when the solution is complete and appropriate for the end user.

Also discussed for each persona is the mapping of the best practices back to the relevant specifications for the European EN 301 549 standard. As that standard is being considered as the generic standard for Information and Communication technology in Canada for the federal government, mobile devices will have to conform to many of those specifications. The mapping is being provided in order to demonstrate how each best practice would conform to a procurement process based around the EN 301 549 standard. Most mobile device manufacturers that sell in global markets should be familiar with this established standard. There are additions, modification, and deletions to the standard as it applies to mobile devices, and the details of those additions, modification, and deletions are listed in Section xxx.

For this document, three personas were created to represent the three designated categories of hearing loss (mild, moderate, and severe). These personas have been created to reflect the main methods of access to mobile devices for people with hearing disabilities. The solution for each persona is not restricted to that persona in actual practice. For example, an RTT call that is specified as one of the best practices for a person with a severe hearing disability might also be suitable and/or preferred for a person with a milder level of disability.

Best practices for a specific persona are chosen such that the abilities of that persona can complete all the actions to achieve an end goal (task) from the primary task list (see Section xxx) without switching the method of access. While in practice, the end-user may choose another method of access to complete one of the steps due

to personal preference or better efficiency for their combination of abilities, these alternative methods would be considered productive enhancements as opposed to primary access methods. This is because they cannot typically complete all steps in the task using that alternative method.

16 Mild Hearing Loss Persona – Sam, 55

Figure 2. Sam, mild hearing disability.

16.1 Mild Performance Metrics

Table 14. Performance metrics for mild hearing disability persona.

Performance Metric	**Criteria**
Acoustic Acuity	25 to 40 dB
Acoustic Acuity in both ears	No
Ability to isolate (separate) sounds	No in some situations (a lot of sounds are overlaid on one another especially speech)
Ability to determine the directionality of sound	No

- Only able to hear and repeat words spoken in a normal voice at 1 meter or less.

- Has difficulties keeping up with conversations, especially in noisy surroundings as he cannot separate the voices of the people he wants to pay attention to.
- Uses lip reading to fill in what he does not hear.
- Can hear some sounds, but not others or parts of others. In particular, the softer phonemes, which are usually consonants, may not be heard. It is especially the fricatives that become inaudible with his mild hearing loss, the /f/, /s/, /th/, and /k/.
- He has lost the ability to hear higher frequencies – male voices are easier to hear.
- Good use of legs, arms, and hands

16.2 Use Case

Hearing loss due to exposure to high noise levels, more severe hearing loss in one ear.

Sam is 55 years old. He has worked most of his working life in a pulp and paper mill. Over time, he has lost some of his hearing due to low-frequency recurring noise in the work environment and his habit of not wearing ear protection consistently while at work when he was younger. This is complicated by a natural loss of hearing due to aging. He has a more pronounced hearing loss in his left ear than his right due to his left ear being closer to the mill machinery from where he stood. This condition is known as unilateral hearing loss. A unilateral hearing loss occurs when hearing in one ear is within normal limits, while hearing in the other ear has some degree of reduction in hearing.[65,66] He also has difficulties isolating specific sounds in noisy environments. For example, he has problems following conversations where multiple people are talking. The conversation between two people might be of interest but Sam might struggle to divide his attention between

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[65] " Unilateral Hearing Loss (Single-Sided Deafness) ". Cleveland Clinic. https://my.clevelandclinic.org/health/diseases/21625-unilateral-hearing-loss-single-sided-deafness

[66] Hillary A. Snapp* and Sebastian A. Ausili. " Hearing with One Ear: Consequences and Treatments for Profound Unilateral Hearing Loss". J Clin Med. 2020 Apr; 9(4): 1010. Published online 2020 Apr 3. doi: 10.3390/jcm9041010. Retrieved from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7230949/

the two. The lack of ability to determine the direction and separation of the two speakers from all the other voices in the room makes it difficult for Sam to figure out who to attribute spoken speech to. Sam has tried hearing aids, but he finds them unhelpful as they amplify all sounds and his hearing is not bad enough to benefit from them.

Sam uses reading glasses to read the paper in the evening as he is getting near-sighted as he gets older; otherwise, he normally does not need to wear glasses. He does not wear glasses when he drives though.

Sam has an active social life. He and his wife are members of a bowling league. They also like to travel. Each year, they go on vacation to some exotic and new place. Sam does not use a lot of technology. He does not own a cellphone as he finds the volume on most cell phones is not high enough. He does use a computer on rare occasions to look something up, but he is not a regular user. He uses an amplifier on his dial-up phone at home.

16.3 Best Practices for Mild Hearing Loss

For people with mild hearing disability, the most important classes of solutions that render their mobile devices more accessible are alternative notifications and maximum volume adjustment. The user may also require mono audio which is specific to people that have hearing loss in one ear. Classes of best practices for people with mild hearing loss include:

1. Configurable audio
2. Mono audio

16.4 Technical Discussion for 'Configurable Audio'

According to Mobile Manufacturers Forum GARI [67] initiative, mobile devices should allow users to customize audio parameters such as frequencies and sound from their headphones or other audio output. Additionally, GARI states that users should have access to adjustable maximum volume control, which allows them to change the default volume control limit. Ringer volume should also be adjustable. People with mild hearing disability need all audio aspects of the mobile devices to be adjustable[68] to at least 65 dBA (normal conversations usually occur at roughly 70 dB[69]). Being exposed to noise levels at 85 dBA begins to cause marginal risk of hearing damage, so from a preventive point of view, as long as daily noise exposures do not exceed 85 dBA, the risk of hearing loss is minimal.[70] Warning labels and information regarding hazards of high noise levels are now commonplace with mobile devices if sound level exceeds 85 dBA.[71] Manufacturers must ensure that if a person is listening to audio outputs that are over 85 dB, the mobile device generates a notification that will alert the user (supported by GARI).

16.4.1 Relevant Specifications from Standards for 'Configurable Audio'

Technical standard reference	Conformance requirement	Comments
	See specifications in clauses 5.1.3.11, 8.2.2.1, and 8.2.2.2.	
EN 301 549 - 5.1.3.12 Speaker volume	Where auditory output is provided as non-visual access to closed functionality and is delivered through speakers on	

[67] MWF - Mobile Accessibility (gari.info)

[68] LaForce, S., & Bright, D. (2021). Are we there yet? The developing state of mobile access equity. Assistive Technology, 0(0), 1–9.

[69] Macmillan, R. H. (1990). 74.20 Decibel arithmetic. The Mathematical Gazette, 74(468), 150–153. https://doi.org/10.2307/3619365

[70] Lutman, M. E. (2000). What Is the Risk of Noise-Induced Hearing Loss at 80, 85, 90 dB(A) and Above? Occupational Medicine, 50(4), 274–275. https://doi.org/10.1093/occmed/50.4.274

[71] Loftis, M. (2007). Sources of Noise-Induced Hearing Loss. AAOHN Journal, 55(11), 476–476. https://doi.org/10.1177/216507990705501107

	ICT, a non-visual incremental volume control shall be provided with output amplification up to a level of at least 65 dBA (-29 dBPaA). NOTE: For noisy environments, 65 dBA may not be sufficient.	
EN 301 549 - 5.1.3.13 Volume reset	Where auditory output is provided as non-visual access to closed functionality, a function that resets the volume to be at a level of 65 dBA or less after every use, shall be provided, unless the ICT is dedicated to a single user.	
EN 301 549 - 8.2.1.1 Speech volume range	Where ICT hardware has speech output, it shall provide a means to adjust the speech output volume level.	
EN 301 549 - 8.2.1.2 Incremental volume control	Where ICT hardware has speech output and its volume control is incremental, it shall provide at least one intermediate step of 12 dB gain above the lowest volume setting.	

16.5 Technical Discussion for 'Mono Audio'

If a person is suffering from mild hearing loss in a single ear, mono audio provides an appropriate solution. Stereo recordings usually have distinct tracks for

right and left ears. Mono audio combines both stereo channels into a mono signal played in both ears, which allows for adjustment of sound balance for greater volume in either ear. While with stereo, there are two microphones picking up separate sounds (with some overlap) and two amplifiers, with mono sound, there is only one microphone involved in picking up the sound.

17 Moderate Hearing Loss Persona – Sofia, Early 30s, Requires a Hearing Aid

Table . Performance metrics for a moderate hearing loss persona.

Performance Metric	Criteria
Acoustic Acuity	41 to 80 dB
Acoustic Acuity in both ears	Yes
Ability to isolate (separate) sounds	No, in some situations (a lot of sounds are overlaid on one another, especially speech) [72]
Ability to determine the directionality of sound	No

17.1 Key functional abilities and characteristics

- Able to make out specific sounds and words with hearing aids/cochlear implants
- Good use of legs, arms, and hands

[72] Johanna Hengen, Inger L. Hammarström, Stefan Stenfelt . "Perception of One's Own Voice After Hearing-Aid Fitting for Naive Hearing-Aid Users and Hearing-Aid Refitting for Experienced Hearing-Aid Users Johanna Hengen, Inger L. Hammarström, Stefan Stenfelt". Perception of One's Own Voice After Hearing-Aid Fitting for Naive Hearing-Aid Users and Hearing-Aid Refitting for Experienced Hearing-Aid Users - Johanna Hengen, Inger L. Hammarström, Stefan Stenfelt, 2020 (sagepub.com)

17.2 Use Case

Can only hear low frequency sounds, cannot pick out specific sounds.

Sophia is a stay-at-home mother who is in her early 30's. She has a busy life that revolves around taking care of her 4-year-old daughter and her husband. Sophia had meningitis when she was young and that caused her hearing loss. She usually can tell the direction of where a sound comes from, but she has difficulty picking out specific sounds. She is more sensitive to low frequency sounds. She cannot hear most high frequency sounds, so she cannot hear typical sounds like chirps and beeps. Though the written language is her second language after American Sign Language, she is atypical in that she is quite proficient at it. Her parents are not deaf and even though they learned some sign language, their common method of communication is through written notes.

Most of her day is spent taking her daughter to play dates and doing household chores. She uses the text messaging features in her phone to coordinate with her husband, other parents, and friends. She feels reasonably comfortable around technology. She keeps in touch with her family and friends through social media like Facebook and Twitter on her desktop computer and uses a chat program to have longer conversations.

17.3 Best Practices for Moderate Hearing Loss

Persons with a moderate hearing disability benefit greatly from features that accommodate their hearing aids in a mobile device context. Classes of best practices for moderate hearing disability include:

1. Hearing Aid Compatibility (HAC) rating
2. Bluetooth
3. Messaging

17.3.1 Technical Discussion for 'HAC Rating'

The most important hearing accessibility feature for persons with a moderate hearing disability is the Hearing Aid Compatibility (HAC) rating.[73] The HAC rating is a set of technical standards established by the ANSI and adopted by the FCC. It measures compatibility of mobile devices with acoustic and inductive hearing aids, denoted by an M and T, respectively. To be HAC-compliant, a mobile device must have a user setting designed to reduce issues related to interference buzzing for hearing aid users in telecoil mode so users with hearing aids/cochlear implants do not experience interference, according to GARI. A device should have a dual M/T HAC rating, and ideally, that rating would be M4/T4. However, mobile devices rated M3 or T3 by ANSI (or better) are generally considered compliant with FCC requirements.

GARI additionally recommends that a connection must be available for an Induction Loop. An inductive neck loop is an assistive device that can help hearing-aid users to communicate via the mobile device by providing amplified inductive output for t-coil hearing aids. The neck loop can eliminate interference from the mobile device, amplify the volume, and enable users to hear and speak handsfree. Depending on the neck loop model, it will be equipped with a 3.5 mm jack and/or allow for a connection via Bluetooth or Wi-Fi.

Research, however, suggests that HAC regulations are not strongly effective, with hearing-aid users reporting modest improvement in ease of finding a hearing aid compatible cell phone over the course of implementation of HAC requirements.[74] Current technical requirements in HAC regulations might be too prescriptive, while not achieving the desired results of ensuring that hearing-aid users can find a satisfactory cellphone.[75] Indeed, research suggests that 19% of respondents in an RERC survey about hearing aid compatibility reported that they were unable to use their cellphones with their aids, suggesting that HAC regulations still fall short in

[73] LaForce, S., & Bright, D. (2021). Are we there yet? The developing state of mobile access equity. Assistive Technology, 0(0), 1–9.

[74] Jones, M. L., Morris, J. T., Mueller, J. L., Lippincott, B., & Sweatman, W. M. (2020). Regulating hearing aid compatibility of cell phones: Results from a national survey. Assistive Technology: The Official Journal of RESNA, 32(4), 173–181.

[75] Jones, M. L., Morris, J. T., Mueller, J. L., Lippincott, B., & Sweatman, W. M. (2020). Regulating hearing aid compatibility of cell phones: Results from a national survey. Assistive Technology: The Official Journal of RESNA, 32(4), 173–181.

promoting the compatibility of hearing aids and cell phones.[76] This is reflected in satisfaction with sound quality; 46% of the respondents in the RERC survey reported that they were satisfied or very satisfied with the sound quality of their cellphones.[77] The limitations of the overly prescriptive approach the HAC rating employs are exacerbated by the HAC regulations' application to cell phones only.[78] Researchers claim that a less prescriptive approach would entail encouraging cell phone manufacturers to partner with hearing-aid manufacturers to produce devices that are designed to work together.[79] Though mobile device manufacturers design around the HAC specification, hearing aid manufacturers are not governed by a similar set of standards. As such, some hearing aids are not designed with the HAC in mind.

The quality of sound the end user hears through their hearing aids can affect the mobile device. To limit the amount of interference from the mobile device, standards have been developed that affect how mobile devices are designed and tested for compatibility. In the United State, this is governed by the standards developed under the Hearing Aid Compatibility Act. These details of the standard can be found here: Hearing Aid Compatibility for Wireline and Wireless Telephones | Federal Communications Commission (fcc.gov)

Note that the Hearing Aid Compatibility Act assumes a specific class and design of hearing aid. Non-compliant hearing aids still make up a specific segment of the market. As a result, some individuals might experience poor performance with their specific hearing aid. There is no comprehensive list of which hearing aid works best with which phone. This document makes no claims about the suitability of a specific mobile device with a specific hearing aid. That is outside the scope of

[76] Morris, J. (2014). Hearing Aid Compatibility of Cellphones: Results from a National Survey. Journal on Technology and Persons with Disabilities, 2014, 13–28.

[77] Morris, J. (2014). Hearing Aid Compatibility of Cellphones: Results from a National Survey. Journal on Technology and Persons with Disabilities, 2014, 13–28.

[78] Jones, M. L., Morris, J. T., Mueller, J. L., Lippincott, B., & Sweatman, W. M. (2020). Regulating hearing aid compatibility of cell phones: Results from a national survey. Assistive Technology: The Official Journal of RESNA, 32(4), 173–181.

[79] Jones, M. L., Morris, J. T., Mueller, J. L., Lippincott, B., & Sweatman, W. M. (2020). Regulating hearing aid compatibility of cell phones: Results from a national survey. Assistive Technology: The Official Journal of RESNA, 32(4), 173–181.

this document. End-users need to confirm the compatibility of their mobile device of choice with their hearing aid.

17.3.1.1 Relevant Specifications from Standards for 'HAC Rating'

Technical standard reference	**Conformance requirement**	**Comments**
Section 508 – 412.3 Interference Reduction and Magnetic Coupling; 412.3.1 Wireless Handsets; 412.3.2 Wireline handsets EN 301 549 – 8.2.2.1 Fixed-line devices; 8.2.2.2 Wireless communication devices	Where ICT delivers output by handset or other type of audio transducer that is typically held up to the ear, does ICT reduce interference with hearing technologies and provide a means for effective magnetic wireline and wireless coupling? ICT in the form of wireline handsets, including cordless handsets, shall conform to TIA-1083-B (or ETSI ES 300 381-1) and ICT in the form of wireless handsets shall conform to ANSI/IEEE C63.19-2011 (or ETSI ES 300 381-2).	

17.3.2 Technical Discussion for 'Bluetooth'

A feature that directly feeds into HAC compatibility is Bluetooth. Bluetooth technology is one of the most important hearing accessibility features for people with hearing loss[80,81], as hearing aids can either directly connect via Bluetooth to

[80] Garcia, A., Bright, D., & Laforce, S. (2019). MOBILE PHONE ACCESSIBILITY REVIEW. Wireless RERC.

[81] LaForce, S., & Bright, D. (2021). Are we there yet? The developing state of mobile access equity. Assistive Technology, 0(0), 1–9.

phones or through an intermediary device often referred to as a Bluetooth streamer. This allows the hearing aid wearer to stream all audio, not just for phone calls and to both hearing aids, not just one. Bluetooth-implemented hearing aids improve speech recognition in quiet and noisy environments[82] which has a positive effect on the quality and efficacy of both voice and video calls, as well as on tasks such as streaming music/videos.

17.3.2.1 Relevant Specifications from Standards for 'Bluetooth'

Technical standard reference	**Conformance requirement**	**Comments**
EN 301 549 – 8.1.2 Standard connections Section 508 – 406.1 General	Where an ICT provides user input or output device connection points, does the ICT provide at least one input and/or output connection that conforms to an industry standard non-proprietary format, directly or through the use of commercially available adapters? NOTE 1: The intent of this requirement is to ensure compatibility with assistive technologies by requiring the use of standard connections on ICT. NOTE 2: The word connection applies to both physical and wireless connections. NOTE 3: Current examples of industry standard non-proprietary formats are USB and Bluetooth.	

17.3.3 Technical Discussion for 'Messaging'

[82] Kim, M.-B., Chung, W.-H., Choi, J., Hong, S. H., Cho, Y.-S., Park, G., & Lee, S. (2014).

Mainstream messaging technologies have been massively adapted for use by people with hearing disabilities and are considered one of the fundamental features of a mobile device, as it is a way of advanced telecommunications. According to GARI, one of the messaging options should be the ability to personalize and reuse SMS; the mobile device should allow its users to create standard text messages that can be quickly sent to anyone without having to retype them each time, such as, "I am in a meeting; I will call you back". Additionally, predictive texting should be available to users with hearing disabilities, to aid them in writing text messages faster by predicting words from the first few letters typed. Messaging options such as MMS, IM, and e-mail should be available on top of SMS.

To maintain accessibility to these features for those with a moderate hearing disability, a suitable user interface should offer multimedia messaging, which is a crucial feature for those who use Sign Language as their primary form of communication, especially in emergency situations.[83] In addition, a UI (User Interface) should include a search function, message archives, as well as text-to-speech and speech-to-text capabilities.[84]

17.4 Severe Hearing Loss Persona – Philip, Late 30s, Deaf

Table . Performance metrics for a severe hearing loss persona.

Performance Metric	**Criteria**
Acoustic Acuity	81 dB or higher loss of hearing above the 0 dB threshold
Acoustic Acuity in both ears	No

[83] Liu, C.-H., Chiu, H.-P., Hsieh, C.-L., & Li, R.-K. (2010). Optimizing the Usability of Mobile Phones for Individuals Who Are Deaf. Assistive Technology, 22(2), 115–127. https://doi.org/10.1080/10400435.2010.483649

[84] Chiu, H.-P., Liu, C.-H., Hsieh, C.-L., & Li, R.-K. (2010). Essential Needs and Requirements of Mobile Phones for the Deaf. Assistive Technology, 22(3), 172–185. https://doi.org/10.1080/10400435.2010.483652

Ability to isolate (separate) sounds	No in some situations (a lot of sounds are overlaid on one another especially speech)
Ability to determine the directionality of sound	No

17.5 Key functional abilities and characteristics

- They have total loss of hearing
- They use American Sign Language or Langue des Signes du Quebec as their primary language
- Their writing and reading skill are at a Grade 4 level
- They have full use of their legs, arms, and hands
- They rely on visual and tactile forms of feedback to perceive instructions or status changes

17.6 Use Case: Deaf

Phillip was born deaf. He is in his late 30's and works as an assistant to a local handyman. He usually does labor-intensive jobs like landscaping. His primary form of communication is Sign Language. Since he was deaf since birth and did not attend an integrated school, he only has basic reading and writing skills at a grade 4 level. His father was also deaf, and his mother was fluent in Sign Language so there was less of a need to be fluent in a written language. His written skills are sufficient for him to communicate with his boss at work.

He considers his deafness as making him part of a distinct culture as opposed to a disability. He has an active social life with his friends, most of whom are Deaf. He has a cellphone and uses text messaging to coordinate with his friends. He does not use text messaging extensively though and prefers to communicate in person using sign language or through a video call on his computer at home. He looks at technology as a tool and uses it when it is convenient, but it is not a big part of his life.

17.7 Best Practices for Severe Hearing Loss

For people with a severe hearing disability, imperative features include those that facilitate alternative solutions to methods of advanced communications. The primary class of solutions for people with severe hearing loss build on the requirements to replace notifications to the end-user with an alternative format perceivable with people with severe hearing loss if they are provided by default in an audio format. These required, alternative notification formats apply to any features that are part of the primary activities identified in section Section 12: Tasks of this document. Notifications for features or activities not included in the primary activity list are not required though they are advantageous to people with severe hearing loss. In addition, the best practices suggest that any activity on that list that implements an advanced communication methodology be replaced with an equivalent advanced communications methodology. This typically means replacing voice with text-based formats or video communication formats that allow sign language to be used by the end-user to initiate and carry on a conversation. Classes of best practices for people with severe hearing loss include:

1. Alternative notifications
2. Telecommunications Relay Services
3. Real-time text
4. Two-way video calling
5. Captions

17.7.1 Technical Discussion for 'Alternative Notifications'

Alternative notifications can either be vibrating, visual (flashing), or both. These alerts are an alternate solution for people with mild hearing loss to perceive information about new text messages, incoming voice/video calls, new and sent email, instant messages, voicemail, as well as calendar events. People who are Deaf or DHH especially rely on vibration notifications and cite it as one of the most useful

mobile features and most accessible way of being alerted of new notifications.[85,86] Manufacturers should aim to provide different vibration and visual patterns for distinguishing the type or source of messages [87,88,89,90]. Additionally, if a mobile device is placed in a purse or hung on a belt, for example, the vibration must still be noticeable.[91]

It should be noted that GARI recommends visual indicators to be available on a mobile device display: line status (online/offline), voice mail, volume control (current volume level and any change), network connectivity, and battery strength. GARI also suggests visual alert should be sent for, as mentioned before, incoming calls and any other notifications, the status of the mobile device's battery (e.g., charging, needing recharge, etc.), and an alert for when the user presses the power on/off button (e.g., a light).

All mobile devices **must** have at least the following alternative notifications provided:

Table . Minimum Best Practice Recommendations for Alternative Notifications.

No. #	**Mandatory Alternative Notifications**
1	Incoming audio call
2	Incoming video call

[85] Harkins, J., Tucker, P. E., Williams, N., & Sauro, J. (2010). Vibration signaling in mobile devices for emergency alerting: A study with deaf evaluators. Journal of Deaf Studies and Deaf Education, 15(4), 438–445. https://doi.org/10.1093/deafed/enq018

[86] Power, M. R., & Power, D. (2004). Everyone here speaks TXT: Deaf people using SMS in Australia and the rest of the world. Journal of Deaf Studies and Deaf Education, 9(3), 333–343. https://doi.org/10.1093/deafed/enh042

[87] Garcia, A., Bright, D., & Laforce, S. (2019). MOBILE PHONE ACCESSIBILITY REVIEW. Wireless RERC.

[88] Harkins, J., Tucker, P. E., Williams, N., & Sauro, J. (2010). Vibration signaling in mobile devices for emergency alerting: A study with deaf evaluators. Journal of Deaf Studies and Deaf Education, 15(4), 438–445. https://doi.org/10.1093/deafed/enq018

[89] LaForce, S., & Bright, D. (2021). Are we there yet? The developing state of mobile access equity. Assistive Technology, 0(0), 1–9. https://doi.org/10.1080/10400435.2021.1926372

[90] Morris, J., & Mueller, J. (2014). Blind and Deaf Consumer Preferences for Android and iOS Smartphones (pp. 69–79). https://doi.org/10.1007/978-3-319-05095-9_7

[91] Morris, J., & Mueller, J. (2014). Blind and Deaf Consumer Preferences for Android and iOS Smartphones (pp. 69–79). https://doi.org/10.1007/978-3-319-05095-9_7

3	Incoming text message
4	Confirmation of sent text message
5	Voice mail received
6	New email received
7	Notification of calendar event
8	Status of connections (cellular network, WiFi, Bluetooth)
9	Battery status
10	Power on and off
11	Notification of existence of close caption or alternative format for video media

17.7.1.1 Relevant Specifications from Standards for 'Alternative Notifications'

Technical standard reference	**Conformance requirement**	**Comments**
EN 301 549 – 5.1.5 Visual output for auditory information	Does the ICT provide visual information that is equivalent to the pre-recorded auditory output, where pre-recorded information is needed to enable the use of closed functions of ICT?	
Section 508 – 408.3 Flashing	Where ICT emits lights in flashes, does the ICT emit no more than three flashes in any one-second period?	

Section 508 – 409.1 General EN 301 549 – 5.6.1 Tactile or auditory status; 5.6.2 Visual status	Where a locking or toggle control is non-visually presented, is it discernible by a tactile or visual signal without operating the control?	

17.7.2 Technical Discussion for 'Telecommunications Relay Services'

Traditional TTY technology transmitted over phone lines has fallen to the wayside[92,93], but TTY can still be used in operator-powered Telecommunications Relay Services (TRS). Text relay services for TTY devices translate between text-to-speech or speech-to-text. Another type of TRS is called video relay service (VRS). It enables sign language communication between a person with a hearing disability using a sign language interpreter and a videophone and anyone who owns a regular phone. Requirements for integrating relay services on mobile devices include:

- Calls to or from a person with a hearing disability **must** be automatically connected through to a relay service if desired
- Calls between two users who wish to use the same mode of communication during the call **must** be possible without a relay service
- Relay services **must** work on all commonly used mobile devices
- Relay services **must** not cost more than regular phone calls

[92] Maiorana-Basas, M., & Pagliaro, C. (2014). Technology Use Among Adults Who Are Deaf and Hard of Hearing: A National Survey. Journal of Deaf Studies and Deaf Education, 19. https://doi.org/10.1093/deafed/enu005

[93] Singleton, J. L., Remillard, E. T., Mitzner, T. L., & Rogers, W. A. (2019). Everyday technology use among older deaf adults. Disability and Rehabilitation. Assistive Technology, 14(4), 325–332. https://doi.org/10.1080/17483107.2018.1447609

17.7.2.1 Relevant Specifications from Standards for 'Telecommunications Relay Services'

Technical standard reference	**Conformance feature**	**Comments**
EN 301 549 – 13.1.2 Text relay services	Where ICT is intended to provide a text relay service, does the text relay service enable text users and speech users to interact by providing conversion between the two modes of communication?	
EN 301 549 – 13.1.3 Sign relay services	Where ICT is intended to provide a sign relay service, does the sign relay service enable sign language users and speech users to interact by providing conversion between two modes of communication?	
EN 301 549 - 13.1.4 Lip-reading relay services	Where ICT is intended to provide a lip-reading relay service, does the lip-reading service enable lip-readers and voice telephone users to interact by providing conversion between the two modes of communication?	
EN 301 549 - 13.1.5 Captioned telephony services	Where ICT is intended to provide a captioned telephony service, does the captioned telephony service assist a deaf or hard of hearing user in a spoken dialogue by providing text captions translating the incoming part of the conversation?	
EN 301 549 - 13.2 Access to relay services	Where ICT systems support two-way communication and a set of relay services for such communication is specified, is it	

	ensured that access to those relay services shall not be prevented for outgoing and incoming calls? NOTE 1: Two-way communication may include voice, real-time text, or video, singly or in combinations supported by both the relay service and the ICT system. NOTE 2: The purpose of this requirement is to achieve functionally equivalent communication access by persons with disabilities.	
EN 301 549 - 13.3 Access to emergency services	Where ICT systems support two-way communication and a set of emergency services for such communication is specified, is it ensured that access to those emergency services shall not be prevented for outgoing and incoming calls? NOTE 1: Two-way communication may include voice, real-time text, or video, singly or in combinations supported by both the emergency service and the ICT system. NOTE 2: The purpose of this requirement is to achieve functionally equivalent communication access to the emergency service by persons with disabilities.	

17.7.3 Technical Discussion for 'Real-Time Text (RTT)'

Real-time text (RTT) is a relatively newer feature that provides instant transmission of a message as it is being composed. It is cited as one of the most important features for people with hearing disabilities.[94] The higher-than-average use of RTT among Deaf and DHH individuals suggests this feature has potential for increasing usability and accessibility of mobile devices.[95] A mobile device **must** support RTT capability provided that the network it is operating on also supports RTT, according to GARI.

To provide an RTT service, it is recommended designing the text box with different colors depending on whether you are still typing a message as opposed to having sent a permanent message by pressing the enter key.[96] Another recommendation is using a word-based interface as opposed to a character-based interface, as the word-based interface provides typing correction opportunities; however, the word-based interface may give the impression of 'lagging' or 'buffering' to the receiver.[97] Lastly, usability options should be available, such as a skip animation button, on/off button, fast-forward button, and delete without showing button; these functions would render RTT a hybrid add-on.[98]

17.7.3.1 Relevant Specifications from Standards for 'Real-Time Text (RTT)'

Technical standard reference	**Conformance features**	**Comments**

[94] LaForce, S., & Bright, D. (2021). Are we there yet? The developing state of mobile access equity. Assistive Technology, 0(0), 1–9.

[95] Moon, N. W., Griffiths, P. C., LaForce, S., & Linden, M. (2020). Wireless Device Use by Individuals with Disabilities: Findings from a National Survey.

[96] Kim, C. M., Yi, H.-B., Nam, J.-W., & Lee, G. (2017). Applying Real-Time Text on Instant Messaging for a Rapid and Enriched Conversation Experience. Proceedings of the 2017 Conference on Designing Interactive Systems, 625–629. https://doi.org/10.1145/3064663.3064679

[97] Kim, C. M., Yi, H.-B., Nam, J.-W., & Lee, G. (2017). Applying Real-Time Text on Instant Messaging for a Rapid and Enriched Conversation Experience. Proceedings of the 2017 Conference on Designing Interactive Systems, 625–629. https://doi.org/10.1145/3064663.3064679

[98] Kim, C. M., Yi, H.-B., Nam, J.-W., & Lee, G. (2017). Applying Real-Time Text on Instant Messaging for a Rapid and Enriched Conversation Experience. Proceedings of the 2017 Conference on Designing Interactive Systems, 625–629. https://doi.org/10.1145/3064663.3064679

EN 301 549 – 6.2.1.1 RTT communication	Does ICT support two-way voice communication?	
	Does ICT support RTT?	
EN 301 549 – 6.2.1.1 RTT communication	Does ICT support the use of RTT for one user to communicate with another in the context of two-way voice communication?	
EN 301 549 – 6.2.1.2 Concurrent voice and text	If ICT (or set of ICTs) supports two-way voice and RTT communication, does the ICT provide a mechanism to select a mode of operation allowing concurrent voice and text?	
EN 301 549 – 6.2.2.1 Visually distinguishable display	Does ICT have send and receive capabilities?	
EN 301 549 – 6.2.2.1 Visually distinguishable display	If ICT has send and receive capabilities, is the display text visually differentiated from and separated from received text?	
EN 301 549 – 6.2.2.2 Programmatically determinable send and receive direction	If ICT has RTT send and receive capabilities, and unless the RTT has closed functionality, is the send/receive direction of the transmitted text programmatically determinable?	
EN 301 549 – 6.2.3 Interoperability	Can ICT with RTT functionality interoperate with other ICT with RTT functionality?	
EN 301 549 – 6.2.3 Interoperability	If ICT with RTT functionality can interoperate with other ICT with RTT functionality, do they support at least one of the four RTT interoperability mechanisms below?	

	a) ICT interoperating over the Public Switched Telephone Network (PSTN), with other ICT that directly connects to the PSTN as described in Recommendation ITU-T V.18 [i.23] or any of its annexes for text telephony signals at the PSTN interface b) ICT interoperating with other ICT using VOIP with Session Initiation Protocol (SIP) and using real -time text that conforms to RFC 4103 [i.13]; c) ICT interoperating with other ICT using RTT that conforms with the IP Multimedia Subsystem (IMS) set of protocols specified in TS 126 114 [i.10], TS 122 173 [i.11] and TS 134 229 [i.12]; d) ICT interoperating with other ICT using a relevant and applicable common specification for RTT exchange that is published and available. This common specification shall include a method for indicating loss or corruption of characters	
EN 301 549 – 6.2.4 Real-time	Where ICT utilizes RTT input, is the RTT input transmitted to the	

text responsiveness	ICT network supporting RTT within 1 second of the input entry?	

17.7.4 Technical Discussion for 'Two-Way Video Calling'

17.7.4.1 Relevant Specifications from Standards for 'Two-Way Video Calling'

Technical standard reference	**Conformance features**	**Comments**
EN 301 549 – 6.4 Alternatives to voice-based services	Does ICT provide real-time voice-based communication?	
EN 301 549 – 6.4 Alternatives to voice-based services	Does ICT provide voice mail, auto-attendant, or interactive voice response facilities in concert with real-time voice-based communication?	
EN 301 549 – 6.4 Alternatives to voice-based services	Where ICT provides real-time voice-based communication and also provides voice mail, auto-attendant, or interactive voice response facilities, does the ICT offer users a means to access the information and carry out the tasks provided by the ICT without the use of hearing or speech? NOTE: Solutions capable of handling audio, real-time text and video media could satisfy the above requirement.	
EN 301 549 – 6.2.1.2 Concurrent voice and text	Does ICT support two-way voice communication?	
EN 301 549 – 6.2.1.2 Concurrent voice and text	Does ICT enable users to communicate with another user by RTT?	
EN 301 549 – 6.2.1.2 Concurrent voice and text	Where ICT supports two-way voice communication in a specified context of use and enables a user to	

	communicate with another user by RTT, does it provide a mechanism to select a mode of operation which allows for concurrent voice and text? NOTE: The availability of voice and RTT running concurrently can allow the RTT to replace or support voice and transfer additional information such as numbers, currency amounts, and spelling of names.	
EN 301 549 – 6.6 Alternatives to video-based services	Does ICT provide real-time video-based communication?	
EN 301 549 – 6.6 Alternatives to video-based services	Where ICT provides real-time video-based communication and also provides answering machine, auto attendant or interactive response facilities, does the ICT offer users a means to access the information and carry out the tasks related to these facilities?: a) for audible information, without the use of hearing; b) for spoken commands, without the use of speech; NOTE: Solutions capable of generating real-time captions or handling RTT could satisfy the above requirement.	
EN 301 549 - 6.5.1 General (Informative); 6.5.2 Resolution; 6.5.3 Frame rate Section 508 – 412.7 Video communication	For video communication, does the ICT provide the following performance requirements that support users who communicate using sign language and lip reading?: a) At least Quarter Common Intermediate	

	Format (QCIF) resolution, preferably at least Common Intermediate Format (CIF) resolution b) A frame rate of at least 12 frames per second, and preferably a frame rate of at least 20 frames per second and over, with or without sign language in the video c) A time difference between speech audio and video that does not exceed 100 ms. NOTE: When the resolution is reduced to Quarter Common Intermediate Format (QCIF) and the frame rate drops to 12 frames per second the communication is still usable with some restrictions.[82] [83] [84] [85] [86] [87] [88] [89] [90] A lower resolution causes less disturbance to the perception of sign language and lip-reading than that caused by a lower frame rate. Delay can be a problem in video communication. Overall delay values below 0,4 s are preferred, with an increase in preference down to 0,1 s. Values over 0,8 s are felt to hinder a good sign conversation. Overall delay depends on multiple factors, including e.g., network	

	delay and video processing. For this reason a testable requirement on minimum values for overall delay cannot be produced.	
EN 301 549 – 6.5.4 Synchronization between audio and video	Where ICT provides two-way voice communication that includes real-time video functionality, does the ICT ensure there is a maximum time difference of 100 ms between the speech and video presented to the user?	

17.7.5 Technical Discussion for 'Captions'

The Deaf community as well as individuals who are hard of hearing make use of closed captioning.[99] It is cited as one of the most important accessibility features for people with hearing disabilities.[100,101,102,103] There is evidence to support the claim that text added to auditory signals has the potential to help listeners understand speech.[104] Therefore, mobile devices must support playback of videos with open and closed captioning.

*Video players **must** be able to determine if the video content has alternative formats (closed caption and descriptive audio) and notify the user that those formats*

[99] Andes, S. M., & Castro, D. (2010). Opportunities and Innovations in the Mobile Broadband Economy. Information Technology and Innovation Foundation.

[100] Garcia, A., Bright, D., & Laforce, S. (2019). MOBILE PHONE ACCESSIBILITY REVIEW. *Wireless RERC*.

[101] LaForce, S., & Bright, D. (2021). Are we there yet? The developing state of mobile access equity. *Assistive Technology*, *0*(0), 1–9. https://doi.org/10.1080/10400435.2021.1926372

[102] Raja, D. S. (2016). Bridging the disability divide through digital technologies.

[103] Siebra, C., Gouveia, T. B., Macedo, J., da Silva, F. Q. B., Santos, A. L. M., Correia, W., Penha, M., Anjos, M., & Florentin, F. (2017). Toward accessibility with usability: Understanding the requirements of impaired uses in the mobile context. Proceedings of the 11th International Conference on Ubiquitous Information Management and Communication, 1–8. https://doi.org/10.1145/3022227.3022233

[104] Zhong, L., Noud, B. P., Pruitt, H., Steven C. Marcrum, & Picou, E. M. (2021). Effects of text supplementation on speech intelligibility for listeners with normal and impaired hearing: A systematic review with implications for telecommunication. International Journal of Audiology, 0(0), 1–11. https://doi.org/10.1080/14992027.2021.1937346

are available (See Sec. 203. Closed Captioning Decoder and Video Description capability, (b)(z)(1) of the 21st Century Communications and Video Accessibility Act.)

17.7.5.1 Relevant Specifications from Standards for 'Captions'

Technical standard reference	**Conformance requirement**	**Comments**
Section 508 – 413.1 General	Where ICT displays or processes video with synchronized audio, does ICT provide closed caption processing technology?	
EN 301 549 – 7.1.1 Captioning playback Section 508 – 413.1.1 Decoding ad Display of Closed Captions	Where ICT displays video with synchronized audio, does the ICT have a mode of operation to display the available captions?	
EN 301 549 – 7.1.1 Captioning playback Section 508 – 413.1.1 Decoding ad Display of Closed Captions	Where closed captions are provided as a part of the content, does the ICT allow the user to choose to display the captions?	
EN 301 549 – 7.1.2 Captioning synchronization	Were ICT displays captions, does the mechanism to display captions preserve synchronization between the audio and the corresponding captions as follow?:	

	- Captions in recorded material: within 100 ms of the timestamp of the caption. - Live captions: within 100 ms of the availability of the caption to the player.	
EN 301 549 – 7.1.3 Preservation of captioning Section 508 – 413.1.2 Pass-Through of Closed Caption Data	Can ICT transmit, convert, or record video with synchronized audio in a manner that preserves caption data such that it can be displayed in a manner consistent with the two requirements above? NOTE: Additional presentational aspects of the text such as screen position, text colours, text style and text fonts may convey meaning, based on regional conventions. Altering these presentational aspects could change the meaning and should be avoided wherever possible.	
EN 301 549 – 7.1.3 Preservation of captioning 413.1.2 Pass-Through of Closed Caption Data	Does ICT transmit, convert, or record video with synchronized audio in a way that preserves audio description data such that it can be played in a manner that	
EN 301 549 – 5.4 Preservation of accessibility information during conversion 413.1.2 Pass-Through of Closed Caption Data	Can ICT convert information or communication in a manner that preserves all documented non-proprietary information that is provided for accessibility, to the extent that such information can be contained in or supported by the destination format?	

Section 508 – 414.1 General; 414.1.1 Digital Television Tuners	Do digital television tuners provide audio description processing that conforms to ATSC A/53 Digital Television Standard, Part 5 (2014)?	
Section 508 – 414.1 General; 414.1.1 Digital Television Tuners	Do digital television tuners provide processing of audio description when encoded as a Visually Impaired (VI) associated audio service that is provided as a complete program mix containing audio description according to the ATSC A/53 standard?	
Section 508 – 414.1 General; 414.1.2 Other ICT	Does ICT other than digital television tuners provide audio description process?	
EN 301 549 – 7.2.3 Preservation of audio description; 7.2.1 Audio description playback	Where ICT displays video with synchronized audio, does it provide a mechanism to select and play available audio description to the default audio channel?	
EN 301 549 – 7.2.3 Preservation of audio description; 7.2.1 Audio description playback	Where video technologies do not have explicit and separate mechanisms for audio description, does the ICT enable the user to select and play several audio tracks? NOTE 1: In such cases, the video content can include the audio description as one of the available audio tracks. NOTE 2: Audio descriptions in digital media sometimes include information to allow descriptions that are longer than the gaps between dialogue. Support in digital media players for this "extended audio description" feature is useful, especially for digital media that is viewed personally.	

EN 301 549 - 7.2.2 Audio description synchronization	Does ICT preserve synchronization between the audio/visual content and the corresponding audio description where the ICT has a mechanism to play said audio description?	
Section 508 – 415.1.1 Caption Controls	Where ICT provides operable parts for volume control, does ICT also provide operable parts for caption selection?	
Section 508 – 415.1.2 Audio Description Controls	Where ICT provides operable parts for volume control, does ICT also provide operable parts for the selection of audio description?	
EN 301 549 – 7.3 User controls for captions and audio description	Where ICT primarily displays material containing video with associated audio content, are user controls to activate subtitling and audio description provided to the user at the same level of interaction (i.e., the number of steps to complete the task) as the primary media controls?	
47 C.F.R. 79.103(c)	When ICT provides closed captioning, does it support the capability for the user to modify the display of closed caption data? NOTE: Examples of such capabilities can be: a) *Presentation* – text may be displayed within one or separate caption windows and supporting the following modes: text that appears all at once, text that scrolls up as new text appears, and text where each new letter or word is displayed as it arrives/ b) *Character color* - characters may be displayed in the 64 colors defined in CEA-708 and such that users are	

	provided with the ability to override the authored color for characters and select from a palette of at least 8 colors including: white, black, red, green, blue, yellow, magenta, and cyan. c) *Character opacity* - users are provided with the ability to vary the opacity of captioned text and select between opaque and semi-transparent opacities. d) *Character size* - users are provided with the ability to vary the size of captioned text and shall provide a range of such sizes from 50% of the default character size to 200% of the default character size. e) *Fonts* - fonts are available to implement the eight fonts required by CEA-708 and § 79.102(k). Users must be provided with the ability to assign the fonts as the default font for each of the eight styles contained in § 79.102(k). f) + - the caption background may be displayed in the 64 colors defined in CEA-708 and such that users are provided with the ability to override the authored color for the caption background and select from a palette of at least 8 colors including: white, black, red, green, blue, yellow, magenta, and cyan. g) *Character edge attributes* - character edge attributes may be displayed and users are provided the ability to select character edge attributes including: no edge attribute,	

	raised edges, depressed edges, uniform edges, and drop shadowed edges. h) *Caption window color* - ICT shall implement captioning such that the caption window color may be displayed in the 64 colors defined in CEA-708 and such that users are provided with the ability to override the authored color for the caption window and select from a palette of at least 8 colors including: white, black, red, green, blue, yellow, magenta, and cyan. ICT shall implement captioning such that users are provided with the ability to vary the opacity of the caption window and select between opaque, semi-transparent, and transparent background opacities. i) *Preview and setting retention* - ICT must provide the ability for the user to preview default and user selection of the caption features required by this section and must retain such settings as the default caption configuration until changed by the user.[105]	

18 Enhanced Accessibility Solutions

Some features or solutions that are designed to accommodate the needs of people with hearing loss are not considered primary solutions. Primary solutions are solutions that allow the end user to complete all the tasks on the primary task list without using additional features or solutions that are not part of the solution. The primary task list is detailed in a table in Section 12. These features or solutions are

[105] https://www.law.cornell.edu/cfr/text/47/79.103

considered enhancements if they enhance one or more primary solutions but are not a “complete” solution on its own.

A partial but not complete list is provided below of solutions that exist on mobile devices. It should be noted as these solutions/features are considered enhancement they are not mandatory requirements for the purpose of this document. These enhancements were developed to meet a specific need though and they should not be dismissed as unnecessary. In some cases, the performance may not be sufficient enough to be categorized as a primary solution.

List of Apps for people with hearing loss (need to sort to see what is primary vs enhancement) https://www.hearinglikeme.com/speech-to-text-apps-for-the-deaf-community/

18.1 Transcription applications

18.1.1 App My Ear (iOS only)

App MyEar is a speech-to-text transcription app, only available for iPhones/iPads.

https://deaflifeapps.com/home/

18.1.2 Live Transcribe

Live Transcribe is an app that automatically transcribes speech almost in real-time. This app, like other speech-to-text apps, uses voice recognition to provide users with “captions” of ambient noises and speech. The UI has a blue circle that pulses in reaction to ambient noise levels so that you know where you should position your microphone for the app to be able to pick up on and transcribe the sound better. Interestingly, if somebody starts talking after a period of quiet, the app will vibrate the phone to inform you.

Live Transcribe has finally become accessible to iOS users after being only available on Android mobile devices. With the addition of this app, all smartphone

users have a “live transcribe” option. There are some differences. The Android version can recognize non-speech sounds and is voice-activated. Based on anecdotal reports, the iOS version might need some time to be comparable. Live Transcribe for iOS is a subscription-supported app that costs $4.99/month or $49.99/year. Currently there is a free seven-day trial.

18.1.3 Otter.ai

Otter.ai can be used for one-on-one conversations but is especially popular for other uses like webinars and podcasts. It’s available for both Androids and iPhones. It can also be used in a web browser. One feature now available is shared notes for classes, previously only offered with Microsoft Translator via OneNote Live Captions.

Recently Otter.ai posted an Instagram video that shows how the app can be used to help deaf and hard of hearing people while they are interacting with someone wearing a face mask.

One downside to Otter is the inability to change the font inside the app, at least with an iPhone. Modifications must be made in Settings.

Up to 600 minutes/month is free for individuals. For a team, pricing can be up to $12.50/month.

18.1.4 Ava

Ava touts itself as “live transcription for any conversation.” Perhaps the priciest of all transcription options, Ava has a tiered subscription plan. While it is free for the occasional user (five free hours/month), a premium subscription ($14.99/month) has infinite captioning time and higher caption quality (90-95 percent). If Ava is being used for work or a board meeting, the Pro, Campus, Welcome or Event plan starts at $99/month). This plan boasts the best caption quality and customized vocabulary. Live, professionally-reviewed 99% accurate captions can be requested with Ava Scribe for additional fees.

18.2 Sound Enhancement Applications

18.2.1 Live Listen

A feature that would greatly benefit from mobile device-hearing aid compatibility is Live Listen. Live Listen is an Apple accessibility feature that has been implemented by mainstream phone manufacturers in their more recent mobile device releases. This feature aids people with moderate hearing loss in having more intelligible conversations in loud environments. It allows the microphone of a mobile device to transmit and amplify audio to paired hearing aids or headphones. For this feature to be successful, manufacturers must ensure compatibility between mobile devices and hearing aids.

18.2.2 Conversation Boost

Conversation boost is an Apple accessibility feature that can aid people with mild hearing loss in enhancing intelligibility of speech in loud environments. The feature currently uses earbuds with beam-forming microphones to focus on and amplify a sound with a specific directionality. Moreover, this feature also has the option of lowering ambient noise. If this feature were to be successfully implemented, earbuds must be fiscally accessible to users.

18.2.3 Sound Amplifier

Although not as powerful as hearing aids, Sound Amplifier is a feature that allows you to use an Android phone to alter the quality of your sound environment. You simply plug in headphones (not compatible with Bluetooth or wireless headphones), then navigate to Sound Amplifier in the Accessibility menu within your phone's Settings. A few simple sliders let you adjust what you're hearing, so you can boost quieter sounds and turn down distracting or unwanted noises. You can then toggle it on and off as needed.

Besides that, it only works with wired headphones, Sound Amplifier requires considerable processing power, so it only runs on Android phones using OS 9.0 and up. But on the plus side, you do not need cellular data or WiFi to use Sound Amplifier, since the settings you're creating are "local" to your phone. If you have a brand-new Android, it should be preinstalled, but you can also download Sound Amplifier for free from the Google Play store.

It is also important to consider that while something like Sound Amplifier seems similar to hearing aids, it is not the equivalent. You have to actively adjust the settings as needed, whereas, for example, many of the latest smart hearing aids automatically make those tweaks as the sonic environment changes. Hearing aids do not monopolize your phone to work. It also does not replace some of the new features of hearing aids like fall detection or fitness tracking. If you are experiencing hearing loss, it's important to talk with a hearing specialist to understand all of the options that are available to you.

18.2.4Sound Recognition

Sound recognition is a feature that allows mobile devices to listen for certain sounds and utilizes built-in AI to notify a user when a specific sound is detected in the environment. To personalize this feature, allowing users to record sounds is recommended.

Google can use AI to isolate voices in a crowd - with impressive results
https://www.androidauthority.com/google-voice-isolation-ai-855526/

2.

19 Procurement Process

The goal of this document is to provide a mechanism for procuring accessible mobile devices either for an individual, a group of individuals with a specific class of disabilities, or a mobile device that meets the needs of all users across all disability

communities, to be used by a department, agency, or ministry that is part of the government. The section will explain how to use the various sections of this document within the procurement process of a department, agency, or ministry. Ultimately, any procurement process is intended to produce formal procurement text that can be inserted into a procurement document for potential vendors to review and bid on to provide a product or service. The process is made up of the following steps:

- Identify the end user and determine the needs of the individual or groups of individuals the department is buying the mobile device/devices for
- Confirm the goals of the end users
- Collate the performance metrics and best practice guidance for each of the classes of user the mobile devices are intended for
- Collate the accompanying technical requirements and specifications that define each best practices
- Enter the information on user personas, performance metrics, best practices and technical requirements and specifications into the procurement template for your department
- Acceptance of the Delivered Product
- Functional testing
- End user acceptance process

19.1 Identifying the Stakeholders

The procurement process may be purchasing an accessible mobile device for a specific individual, a group of individuals with the same specific needs, or all potential users within a disability community accounting for the various levels of severity or a mobile device that is intended to meet the needs of a cross section of people from all disability groups and with all levels of disabilities.

Even if purchasing for an individual, the procurement specifications may extend way beyond the accessibility needs of the individual and the mobile device itself. There may be specific needs associated with the infrastructure and policies of the office, department, ministry, or government agency the user works for. Security and privacy concerns, and the type of applications and services the department's

information technology division uses and can support must also be taken into consideration. Similarly, the policies and needs of the office, department, ministry, or agency need to be taken into consideration. It may take time to train the user on a device he is not familiar with. The office or department may use applications that are not available on the mobile device with the recommended accessibility features. All these factors must be taken into consideration when putting together the text for the procurement document.

Make sure to identify all stakeholders related to the usage of the mobile device and make them part of the specification development, testing, and acceptance processes.

The document only deals with the specifications that are necessary to generate the text for the procurement and testing of a mobile device or devices that have the appropriate accessibility features. Procurement personnel will have to work with the other stakeholders to ensure their needs are met.

19.2 Confirming Goals of the End Users

A list of representative tasks is provided in Section 12. That list was intended to incorporate the majority of the individual actions that are required to interact with a mobile device. While the interaction may change over time, the activities the end-user wants to achieve will change at a slower pace. For example, using a voice assistant to compose a text message is distinctly different from:

1. Finding the text message app icon
2. Selecting that icon and activating it
3. Find the contact phone number of the person you want to send a text message to in the contact list
4. Selecting and activating that contact name from the contact list
5. Enter the text of your message
6. Selecting and activating the “send” button or editing the text message again before sending it

Currently both methods are supported but one may fade from usage, or a third method may displace one of them. Correspondingly voice assistants do not work for people who can not speak.

The list is not exhaustive. The individual, office, department, ministry, or agency may have specific applications (apps) or services it wants the end user to be able to interact with. It is important to include those apps as part of the task list. That task list will be used as a part of the testing and acceptance procedures. It is possible to procure a mobile device that is technically accessible but does not allow the user to fully interact with the specific apps. Correspondingly, it is possible to procure a mobile device that allows the user to interact with the specified apps that is not fully accessible to all the features of the phone. It is thus important to reflect all the stakeholder requirements in the procurement document.

19.3 Collate Performance Metrics and Best Practice for Each End Users

Once the end user or end users are identified the personas and best practices for each end user or end users will be the high-level guidance that will be provided in the procurement document. The best practices make up the best classes of solutions identified by the authors as currently implemented in mobile devices that exist today. The best practices are not necessarily associated with one specific brand or model of mobile device. The authors have tried to be agnostic and not be biased to one specific brand or model of device. In some cases, the best of class solutions may exist in different brands and models of mobile devices. The authors have chosen the best practices based on the most effective and efficient solution for the end-users' ability level.

19.4 Collate Technical Requirement and Specifications

Associated with each best practice is a list of technical requirements and a list of prescriptive specifications pulled from existing accessibility standards regarding information and communications technology and which specifically apply or have been modified to apply to mobile devices. Most existing accessibility standards and

guidelines refer to the broader class of information and communications technologies (ICT). ICT encompasses everything from automatic banking machines and fax machines to mobile devices and their respective apps. None of the standards and guidelines are specific to mobile devices. This document has drawn heavily from those guidelines and standards, and applied them specifically to mobile devices and apps, as they apply to the advanced communication functionality of mobile devices. The authors have, where possible, used the existing prescriptive standard or guideline specifications by referencing the appropriate standard, paragraph, and section. Where the standards and guidelines were insufficiently detailed, the authors have made additions to the specification. Where there were competing specifications or parts of specification that were in conflict or offered contradictions, the authors have tried to resolve the issues and make a definite recommendation with a rationale for the change.

Note that the specifications were drawn from accessibility standards around the world. The final specifications included in this document is a combination of mainly the European EN 301 549, Section 508 of the Rehabilitation Act of 1973 (USA), and W3C WCAG 2.1. While these standards should be familiar to most major mobile device manufacturers, they are often treated as a separate regional checklist to be complied with. As the specifications in this document include the most current and relevant specifications from each standard, it is important that potential suppliers not simply defer to one regional standard and assume all the specifications are the same. In Canada the proposed standard for ICT is the EN 301 549. See the checklist in Section 10.1 for additions, omissions and modifications to EN 301 549 to accommodate mobile devices specifically. Each disability community will have a specific set of additions, omissions and modifications that need to be considered in the process.

19.5 Generate Procurement Template

The actual format of the procurement document will depend on the policies and procedure of the particular office, department, agency, or ministry. The major sections have been described above. A sample template of a procurement document

is shown in Appendix B. It is based on the American Section 508 procurement template which can be seen here:

https://assets.section508.gov/files/ART%20Contract%20Language%20Template.pdf

19.6 Acceptance of the Delivered Product

There are three phases to the acceptance process:

- Declaration of Accessibility Compliance by suppliers/manufacturers
- Functional testing to confirm compliance by the purchaser
- End user acceptance process

The Declaration of Accessibility Compliance (DAC) by supplier/manufacturers is based on the American Voluntary Product Accessibility Template (VPAT) 2.0. The DAC is a report attesting to the accessibility of an information and communication technology (ICT) product or service. To maintain a level of compatibility with the long established VPAT, the DAC used many of the same sections, descriptions, and definitions. The goal is to make the transition easier for suppliers and manufacturers to adopt this new format.

The DAC may potentially be adopted as the official document that should be required on all federal solicitations. The DAC combines elements from the standards and guidelines from the American Section 508, the European EN 301 549, the American CVAA, G3ICT and the W3C WAG (ISO/IEC 40500:2012). As detailed in the document the standard combines all the best practices from all the standards and guidelines.

In the DAC, the vendor is asked to provide some basic information:

- Name of Product/Version
- Product Description
- Date
- Contact Information

- Notes
- List of Best Practice Declarations
- Evaluation Methods Used determine compliance with the procurement document specifications
- Applicable Standards/Guidelines
- Terms
- Tables for Each Standard or Guideline

A key portion of this section is the "Notes" field. The DAC instructions provide guidance on this field, which includes:

- Additional information about the product version that the document references
- Any revisions to the document
- Links to any related documents
- Additional information describing the product
- Additional information about what the document does or does not cover
- Information suggested by the WCAG 2.0 Conformance Claim if applicable, at http://www.w3.org/TR/WCAG20/#conformance-claims
- Information needed to satisfy ISO/IEC 17050-1:2004, Supplier's Declaration of Conformity

Note that the procurement language will have "best practices" for each disability community and level of disability. If the supplier product does not contain a solution that implements the recommended best practice for a specific disability community and level of disability they can provide information on an equivalent solution that provides an equivalent level of access. Details on how to determine if a solution provides an equivalent level of access is covered in Section 12: "Test Process for New Accessibility Solutions" of the Accessible Procurement Mobile Device Standards document.

The next key addition is the field, "Evaluation Method Used." The DAC provides the following suggestions as responses:

- Testing is based on general product knowledge
- Similar to another evaluated product
- Testing with assistive technologies
- Published test method (provide name, publisher, URL link)
- Vendor proprietary test method
- Other test method

This section is intended for the supplier to present a purchaser with the significant details of how accessible a product is. For example, when attesting to the accessibility of a product or service the supplier may have used automated accessibility testing. This type of testing may only catch a faction of the accessibility errors for this product or service class. Therefore any declaration that does not include manual and automated testing may require further examination by the purchaser. Suppliers are encouraged to provide as much detail as possible to ensure the product or service is not unnecessarily delayed in the evaluation and acceptance process.

The next key field is "Applicable Standards/Guidelines." It explicitly asks the level of conformance reporting. This typically applies to WCAG 2.0 criteria. WCAG 2.0 asks the supplier to state which sections have been included. For most products, the purchaser will be looking for WCAG Level A or Level AA. Level AAA is a highly specialized category and is not required for most organizations at this time.

Table *. Applicable Standards/Guidelines table for DAC.*

Standard/Guideline	**Included In Report**
Web Content Accessibility Guidelines 2.0, at *www.w3.org/TR/2008/REC-WCAG20-20081211/*	Level A (Yes/No) Level AA (Yes/No) Level AAA (Yes/No)
Section 508 as published in 2017, at *www.Section508.gov*	(Yes/No)
EN 301 549 Accessibility requirements suitable for public procurement of ICT products and services in Europe, at *http://mandate376.standards.eu/standard*	(Yes/No)

Within the "Criteria" column, both the older Section 508 standards and the EN 301 549 are mapped to the WCAG requirement. This is to reduce ambiguity for the vendor when mapping these older standards to WCAG. Within "Conformance

Level," ITI breaks down the components that could conceivably make up a product. It is the vendors responsibility to use one of the following conformance levels on all components that apply:

- **Complies**: The functionality of the product has at least one method that meets the criterion for each level of disability in the required disability communities without known defects or meets with equivalent facilitation.
- **Partially Complies**: Some functionality of the product does not meet the criterion.
- **Does Not Support**: The majority of product functionality does not meet the criterion.
- **Not Applicable**: The criterion is not relevant to the product.
- **Not Evaluated**: The product has not been evaluated against the criterion.

There are various forms of the VPAT supported by the Information Technology Industry Council (ITT). The various formats can be found here:

VPAT - Information Technology Industry Council (itic.org)

VPAT 2.4 Rev 508: Revised Section 508 standards – the U.S. Federal accessibility standard [106]

VPAT 2.4 Rev EU: EN 301 549 – the European Union's "Accessibility requirements suitable for public procurement of ICT products and services in Europe" [107]

[106] https://www.itic.org/dotAsset/7d1524dc-e602-47be-8276-ce32bdd58d6c.doc

[107] 04a7f5e4-cbcb-46d4-8419-fc1ef8789e21.doc (live.com)

VPAT 2.4 Rev WCAG: WCAG 2.1 or ISO/IEC 40500 (equivalent to WCAG 2.0) and WCAG2.1, W3C/WAI's recently updated Web Content Accessibility Guidelines [108]

VPAT 2.4 INT: Incorporates all three of the above standards [109]

- The instructions for the final column, "Remarks and Explanations," attempt to further tighten reporting with the following suggestions:
- When the conformance level is "Supports with Exceptions" or "Does Not Support," the remarks should identify:
    a. The functions or features with issues
    b. How they do not fully support
- If the criterion does not apply, explain why.
- If an accessible alternative accommodation is available, describe it. This is key to responding to this section. A failure without a secondary alternative (accommodation) may at the discretion of the purchaser disqualify the product from consideration.

The final area is "Legal Disclaimer." While the area is vaguely described, we believe vendors will produce good faith language that states that an effort has been made to accurately and completely describe the accessibility of the product, but that there may be minor technical flaws that will not impede the use of the product or service by a person with vision, hearing or mobility challenges. These disclaimers usually contain a clearly stated commitment to ensuring equal access for all users and a summary of the overall level of compliance with accessible technology standards. Key to this section is a wide belief that 100% accessibility is not achievable as there are a myriad of technical failures that would not hinder the use of the product but would violate the WCAG 2.1

Like the VPAT®, the DAC is not a certification of compliance nor is it intended to be a pass/fail tool. The DAC is intended to provide an opportunity for the supplier or manufacturer to provide significant insight into the degree to which

[108] https://www.itic.org/dotAsset/7edcd54d-c6a6-4649-8375-4a0f0c68eff2.doc

[109] https://www.itic.org/dotAsset/ef2cfe78-ce5a-4d39-a057-458ac6e931af.doc

a product will be perceivable and usable by a person with vision, hearing, mobility, or cognitive challenges to the purchasing officer. Completing the form only attests to the degree to which it complies with the prescribed standards or guidelines. The purchaser must evaluate the responses in the DAC and determine if the product as stated meets the accessibility needs of the organization or individuals. It is not a replacement for the next step which is compliance testing by the organization procuring the product or service and a review process by the final end user/users and stakeholders. In the compliance declaration a supplier and/or manufacturer must provide information about the degree of compliance with a standard or guideline, the testing process they used to confirm it and a list for any exceptions in regard to the accessibility of the product or service in very specific test conditions. For the later disclosure it will be up to the organization procuring the mobile device to ensure the exception will not materially affect the intended end user from completing the list of tasks they need to perform their job.

20 Declaration of Accessibility Compliance (DAC) Form

Name of Product/ Version	
Product Description	
Report Creation Date	
Contact Information	

Applicable Standards and Guidelines Used in Report

Standards and Guidelines	Notes
EN 301 549 Accessibility requirements for ICT products and services - V3.2.1 (2021-03)	
Enhanced Mobility Device Framework Criteria (ie.. This document)	

Web Content Accessibility Guidelines 2.1	

20.1 Terms

The terms used in the Conformance Level information are defined as follows:

- Complies: The functionality of the product has at least one method that meets the criterion without known defects or meets with equivalent facilitation.
- Partially Complies: Some functionality of the product does not meet the criterion.
- Does Not Support: The majority of product functionality does not meet the criterion.
- Not Applicable: The criterion is not relevant to the product.
- Not Evaluated: The product has not been evaluated against the criterion.

20.2 Primary Task List Provided by Procurement Agency

Note: This is a sampling only of tasks. Each procuring agency will have a task list that potentially extends beyond this primary list.

No. #	**Task**
1	Reading the instructions on how to use the device that comes with the device packaging or is available from an online source
2	Setting up the device for the first time
3	Making and terminating a communications session (phone calls, videos call or text message session)
4	Receiving communication session (phone calls, videos call or text message session)
5	Sending text messages to a person in their contact list and to a specific phone number

6	Receiving text messages
7	Send and Receiving email using an app
8	Using a web browser to navigate to a URL, scroll to the end of the URL, interact with the controls on the webpage, enter text in the edit controls on that webpage and the browser controls (reload, forward and back, menu for browser). Sample test URL:
9	Using a calendar including entering a new appointment for a date one month in the future and looking up an appointment already scheduled for this week.
10	Taking pictures/video and save it to the mobile device
11	Watching videos or listening to music including changing volume (to be discuss App or web based??? Caption configurable ?????)
12	Complete a video call or meeting (FaceTime, no equivalent in Android that is shipped with phone - Duo).
13	Receive low battery notification
14	Change setting one the mobile device such as display brighten, default font size
15	Turn on the power to the phone
16	Turn off the power to the phone
17	Turn volume up
18	Turn volume down
19	Charge the mobile device

20.3 EN 301 549 Conformance Report

The following specifications from the EN 301 549 standard are used to define the accessibility of mobile devices in a checklist format. Note that the specifications do not necessarily guarantee a specific set of accessibility solutions will be available on

a specific mobile device nor that the solutions that are available will allow a person to complete the list of primary tasks outlined above. Refer to the section on Best Practices in the template for further requirements that reference the Primary Tasklist.

Chapter 4: Functional Performance Statements (FPS)

Notes:

Criteria	Conformance Level	Remarks and Explanations
4.2.1 Usage without vision		
4.2.2 Usage with limited vision		
4.2.3 Usage without perception of colour		
4.2.4 Usage without hearing		
4.2.5 Usage with limited hearing		
4.2.6 Usage with no or limited vocal capability		
4.2.7 Usage with limited manipulation or strength		
4.2.8 Usage with limited reach		

4.2.9 Minimize photosensitive seizure triggers		
4.2.10 Usage with limited cognition, language or learning		
4.2.11 Privacy Chapter 5: Generic Requirements		

Chapter 5: Generic Requirements

Notes:

Criteria	**Conformance Level**	**Remarks/Explanations**
5.1 Closed functionality		
5.1.2 General Heading		
5.1.2.1 Closed functionality	See 5.2 through 13	See information in 5.2 through 13
5.1.2.2 Assistive technology	See 5.1.3 through 5.1.6	See information in 5.1.3 through 5.1.6
5.1.3 Non-visual access		
5.1.3.1 Audio output of visual information		
5.1.3.2 Auditory output delivery including speech		

5.1.3.3 Auditory output correlation		
5.1.3.4 Speech output user control		
5.1.3.5 Speech output automatic interruption		
5.1.3.6 Speech output for non-text content		
5.1.3.7 Speech output for video information		
5.1.3.8 Masked entry		
5.1.3.9 Private access to personal data		
5.1.3.10 Non-interfering audio output		
5.1.3.11 Private listening volume		
5.1.3.12 Speaker volume		
5.1.3.13 Volume reset		
5.1.3.14 Spoken languages		**Canada has two official languages: French and English. For government purposes support outside of those two languages is not mandatory.**

5.1.3.15 Non-visual error identification		
5.1.3.16 Receipts, tickets, and transactional outputs		**Not applicable for mobile devices**
5.1.4 Functionality closed to text enlargement		
5.1.5 Visual output for auditory information		
5.1.6 Operation without keyboard interface		
5.1.6.1 Closed functionality		See information in 5.1.3.1 through 5.1.3.16
5.1.6.2 Input focus		
5.1.7 Access without speech		
5.2 Activation of accessibility features		
5.3 Biometrics		
5.4 Preservation of accessibility information during conversion		
5.5 Operable parts		
5.5.1 Means of operation		

5.5.2 Operable parts discernibility		
5.6 Locking or toggle controls		
5.6.1 Tactile or auditory status		
5.6.2 Visual status		
5.7 Key repeat		
5.8 Double-strike key acceptance		
5.9 Simultaneous user actions		

Chapter 6: ICT with Two-Way Voice Communication

Notes:

Criteria	**Conformance Level**	**Remarks/Explanations**
6.1 Audio bandwidth for speech		
6.2 Real-time text (RTT) functionality		
6.2.1.1 RTT communication		

6.2.1.2 Concurrent voice and text		
6.2.2.1 Visually distinguishable display		
6.2.2.2 Programmatically determinable send and receive direction		
6.2.2.3 Speaker identification		
6.2.2.4 Visual indicator of Audio with RTT		
6.2.3 Interoperability		
6.2.4 RTT responsiveness		
6.3 Caller ID		
6.4 Alternatives to voice-based services		
6.5 Video communication		
6.5.1 General (informative)		
6.5.2 Resolution		
6.5.3 Frame rate		

6.5.4 Synchronization between audio and video		
6.5.5 Visual indicator of audio with video		
6.5.6 Speaker identification with video (sign language) communication		
6.6 Alternatives to video-based services (advisory only)		

Chapter 7: ICT with Video Capabilities

Notes:

Criteria	**Conformance level**	**Remarks/Explanations**
7.1 Caption processing technology		
7.1.1 Captioning playback		
7.1.2 Captioning synchronization		
7.1.3 Preservation of captioning		

7.1.4 Captions characteristics		
7.1.5 Spoken subtitles		
7.2.1 Audio description playback		
7.2.2 Audio description synchronization		
7.2.3 Preservation of audio description		
7.3 User controls for captions and audio description		

Chapter 8: Hardware

Notes:

Criteria	**Conformance Level**	**Remarks/Explanations**
8.1.1 Generic requirements		
8.1.2 Standard connections		
8.1.3 Colour		
8.2 Hardware products with speech output		

8.2.1.1 Speech volume range		
8.2.1.2 Incremental volume control		
8.2.2.1 Fixed-line devices		**Not applicable for mobile devices**
8.2.2.2 Wireless communication devices		
8.3 Stationary ICT		**Not applicable for mobile devices**
8.3.2.1 Unobstructed high forward reach		**Not applicable for mobile devices**
8.3.2.2 Unobstructed low forward reach		**Not applicable for mobile devices**
8.3.2.3.1 Clear space		**Not applicable for mobile devices**
8.3.2.3.2 Obstructed (< 510 mm) forward reach		**Not applicable for mobile devices**
8.3.2.3.3 Obstructed (< 635 mm) forward reach		**Not applicable for mobile devices**
8.3.2.4 Knee and toe clearance width		**Not applicable for mobile devices**
8.3.2.5 Toe clearance		**Not applicable for mobile devices**

8.3.2.6 Knee clearance		**Not applicable for mobile devices**
8.3.3.1 Unobstructed high side reach		**Not applicable for mobile devices**
8.3.3.2 Unobstructed low side reach		**Not applicable for mobile devices**
8.3.3.3.1 Obstructed (≤ 255 mm) side reach		**Not applicable for mobile devices**
8.3.3.3.2 Obstructed (≤ 610 mm) side reach		**Not applicable for mobile devices**
8.3.4.1 Change in level		**Not applicable for mobile devices**
8.3.4.2 Clear floor or ground space		**Not applicable for mobile devices**
8.3.4.3.2 Forward approach		**Not applicable for mobile devices**
8.3.4.3.3 Parallel approach		**Not applicable for mobile devices**
8.3.5 Visibility		
8.3.6 Installation instructions		
8.4 Mechanically Operable parts		

8.4.1 Numeric keys		
8.4.2.1 Means of operation of mechanical parts		
8.4.2.2 Force of operation of mechanical parts		
8.4.3 Keys, tickets and fare cards		
8.5 Tactile indication of speech mode		

Chapter 9: Web (see WCAG 2.x section)

Notes:

WCAG 2.x Report

Conformance with EN 301 549. Applicable sections:

· Chapter 9 - Web

· Sections 10.1-10.4 of Chapter 10 - Non-Web documents

· Sections 11.1- 11.4 and 11.8.2 of Chapter 11 - Software (open and closed functionality)

· Sections 12.1.2 and 12.2.4 of Chapter 12 - Documentation

Chapter 10: Non-Web Documents

Notes:

Criteria	**Conformance Level**	**Remarks/Explanations**

10.0 General (informative)		
10.1.1.1 through 10.4.1.3		See information in WCAG 2.x section
10.5 Caption positioning		
10.6 Audio description timing		

Chapter 11: Software

Notes:

Criteria	**Conformance level**	**Remarks/Explanations**
11.0 General (informative)		
11.1.1.1 through 11.4.1.3	See WCAG 2.x section	
11.5 Interoperability with assistive technology		
11.5.1 Closed functionality		
11.5.2 Accessibility services		
11.5.2.1 Platform accessibility service support for software that provides a user interface		See information in 11.5.2.5 through 11.5.2.17

11.5.2.2 Platform accessibility service support for assistive technologies		See information in 11.5.2.5 through 11.5.2.17
11.5.2.3 Use of accessibility services		See 11.5.2.5 through 11.5.2.17
11.5.2.4 Assistive technology		
11.5.2.5 Object information		
11.5.2.6 Row, column, and headers		
11.5.2.7 Values		
11.5.2.8 Label relationships		
11.5.2.9 Parent-child relationships		**Not applicable for government procurement?**
11.5.2.10 Text		
11.5.2.11 List of available actions		
11.5.2.12 Execution of available actions		
11.5.2.13 Tracking of focus and selection attributes		

11.5.2.14 Modification of focus and selection attributes		
11.5.2.15 Change notification		
11.5.2.16 Modifications of states and properties		
11.5.2.17 Modifications of values and text		
11.6 Documented accessibility usage		
11.6.1 User control of accessibility features		
11.6.2 No disruption of accessibility features		
11.7 User preferences		
11.8 Authoring tools Heading		
11.8.1 Content Technology		
11.8.2 Accessible content creation		See WCAG 2.x section (If not authoring tool, enter “Not Applicable”)
11.8.3 Preservation of accessibility information in transformations		

11.8.4 Repair assistance		
11.8.5 Templates		

Chapter 12: Documentation and Support Services

Notes:

Criteria	Conformance Level	Remarks/Explanations
12.1 Product documentation Heading		
12.1.1 Accessibility and compatibility features		
12.1.2 Accessible documentation		See information in WCAG 2.x section
12.2 Support Services Heading		
12.2.2 Information on accessibility and compatibility features		
12.2.3 Effective communication		
12.2.4 Accessible documentation		See information in WCAG 2.x section

Chapter 13: ICT Providing Relay or Emergency Service Access

Notes:

Criteria	Conformance Level	Remarks/Explanations
13.1 Relay services requirements Heading		
13.1.2 Text relay services		
13.1.3 Sign relay services		
13.1.4 Lip-reading relay services		**Service not available in Canada**
13.1.5 Captioned telephony services		**Service not available in Canada**
13.1.6 Speech to speech relay services		**Service not available in Canada**
13.2 Access to relay services		
13.3 Access to emergency services		

20.4 Enhanced Criteria

Criteria	Source	Conformance	Remarks/Explanations
Section 508: 408.3 Flashing. Where ICT emits lights in flashes, there shall be no more than three flashes in	Home | Section508.gov		

any one-second period.			
Section 508: 411.1 General. Where provided, audible signals or cues shall not be used as the only means of conveying information, indicating an action, or prompting a response.	Home | Section508.gov		

20.5 Best Practice Implementations

To make the selection process easier if your product implements a best practice please declare that here. Refer to Section 11 of this document.

In order for your implementation of a best practice to be considered a solution, it must be able to complete all the tasks on the Primary Task List without reliance on other functions or applications that are not considered directly part of the solution. For example if a specific task on the mobile device requires a gesture to do a screen capture, if the solution does not include a method to explicitly do the equivalent action to activate a screen capture and screen capture is on the primary task list then the solution is not considered an equivalent appropriate solution.

In this section, if the device has implemented one or more of the best practices describe how the solutions have been tested to ensure it can complete every task on the primary task list that has been supplied by the procuring agency. In the case where the procuring agency requires that the mobile device have solutions for all disability communities and groups within each community, a best practice or

equivalent solution must be provided for each group within each community. See section 19 on how equivalent solutions are evaluated and the testing data that is required to be submitted to make a declaration of equivalent functionality.

User Community	**Group within the Community**	**Best Practice**	**Conformance**	**Remarks /Explanations**
Hearing				
	Mild		Does the solution allow users to complete every task on the primary task list? (Yes/No).	Provide testing data.
	Moderate			
	Severe			
Mobility Loss				
	Mild			
	Moderate			
	Severe			
Vision Loss				
	Mild			
	Moderate			
	Severe			
Cognitive				
	Group 1			
	Group 2			
	Group 3			
Speech Loss				
	Low Audio Acuity			
	Alternative and Augmentative			

	Communications User			

20.6 Legal Disclaimer (Company)

Include your company legal disclaimer here, if needed

21 Functional Testing

While the supplier and manufacturer will fill out the DAC. The DAC itself is often not sufficient to guarantee the accessibility of a mobile device in all potential use cases. The supplier or manufacturer may have filled out their declaration wrong or they may have mis-interpreted the criteria. The DAC is unique in that it not only requires the existence of accessible features but that those features be able to complete a specific list of tasks without reference to features not explicitly included as part of the solution for a specific persona.

Third party testing either externally or internally by the purchasing agency is recommended. Each of the proposed solutions for each persona should be tested to ensure they can complete each task on the primary task list. As the testing is task specific, there is no need to evaluate individual features of the solution to make sure they comply with the specification. Where different government agencies are doing independent testing it may be more efficient to share the results. Making sure the results are up to date.

22 End User Acceptance Process

The end user must be part of the testing and acceptance process. They should have been part of the procurement process when the procurement document was created but it is recognized that this is not possible in all cases. As the end user ultimately has to use the device they should be allowed to use the device to try to complete the critical tasks needed in their job role. The department requesting the device also may have expectations on how quickly and efficiently the end user must be able to complete the tasks the end user needs to do to do their job and how much time is allowed for the end user to learn how to use the device. As the testing is task specific no elaborate testing needs to be done to test specific aspects of the accessibility solution.

23 Conformance Testing of Solutions for Compliance with the Guidelines Above

To test if a product complies with the technical requirements that define the accessibility for this community manufacturer and procurement department can use the following procedure: https://www.section508.gov/test/testing-overview

Manual testing is suggested as being more complete and effective. More details are provided in the Section 12: Testing Process for a New Accessible Solution.

24 Testing Process for a New Accessible Solution

Mobile devices are consistently being improved and updated to add new features and services. As their capabilities improve new accessibility solutions may be developed. It is impossible to develop strict, prescriptive criteria that determines the accessibility of a device or the suitability of a new accessibility solution before it is created. As an alternative this section presents a framework for testing a new accessibility solution for a specific device or classes of device for a specific subgroup of a community of users. The sub-groups are determined by the severity levels described in this document as most solutions are not designed to address the consideration of all severity levels.

The testing process is constructed around a list of tasks as described in Section 9.2: Specific tasks for mobile devices. That list is repeated here to make it easy to reference.

No. #	Task
1	Reading the instructions on how to use the device that comes with the device packaging or is available from an online source
2	Setting up the device for the first time

3	Making and terminating a communications session (phone calls, videos call or text message session)
4	Receiving communication session (phone calls, videos call or text message session)
5	Sending text messages to a person in their contact list and to a specific phone number
6	Receiving text messages
7	Send and Receiving email using an app
8	Using a web browser to navigate to a URL, scroll to the end of the URL, interact with the controls on the webpage, enter text in the edit controls on that webpage and the browser controls (reload, forward and back, menu for browser). Sample test URL:
9	Using a calendar including entering a new appointment for a date one month in the future and looking up an appointment already scheduled for this week.
10	Taking pictures/video and save it to the mobile device
11	Watching videos or listening to music including changing volume (to be discuss App or web based??? Caption configurable ?????)
12	Complete a video call or meeting (FaceTime, no equivalent in Android that is shipped with phone - Duo).
13	Receive low battery notification
14	Change setting one the mobile device such as display brighten, default font size
15	Turn up the volume
16	Turn down the volume

17	Turn on the power to the device
18	Turn off the power to the device
19	Plug in the mobile device to charge it

When testing a new class of accessibility solutions, considerations must be taken to address the list of performance metrics supplied with each of the personas that represent levels of severity and correspond to key sub-groups of users within a particular disability community. Combinations of those performance metrics represent the abilities of the sub-groups of users within each community. A particular accessibility solution usually addresses one sub-group of users due to their unique combination of abilities described by the performance metrics. While there may be cases where a solution addresses the needs of multiple sub-groups of users, the appropriateness of a solution as measured by efficiency (time to perform the task) usually helps to define the sub-group of users the solution is most appropriate for. The concept of it being "not impossible" to complete a task using a particular solution historically has led to suppliers creating or providing only a solution for the most severe level of a disability community and assumes anyone with more ability can also use the same solution. The definition of appropriateness takes into the consideration of the end users' abilities so they can complete a task in the most effective and efficient manner possible given their abilities.

For the evaluation process the supplier is assumed to be providing a solution or solutions that meet the needs of each one of the levels of severity described in the personas section. A solution can then be evaluated against users with the combination of performance metrics provided for each severity level. The solution must be able to complete each task in the primary task list plus any additional tasks specified in the purchasing document that are critical to the end user's needs. This will include those needs dictated by the employer of the end user. Examples are applications the end user must complete as part of their job or any technical compatibility issues required by the information technology division of the organization.

To be accepted as a solution for a particular subgroup or sub-groups, a user with the related performance metrics for that sub-group must be able to complete all the tasks on the list without having to resort to additional features of applications that are not directly part of the solution. Completing part of the tasks using one

accessibility solution and another part of the task using another accessibility solution are not considered an appropriate solution that passes the test criteria.

For simplicity the following reporting format will be used.

No. #	**Task**	**Result of test with accessibility solution**	**Notes**
1	Reading the instructions on how to use the device that comes with the device packaging or is available from an online source		
2	Setting up the device for the first time		
3	Making and terminating a communications session (phone calls, videos call or text message session)		
4	Receiving communication session (phone calls, videos call or text message session)		
5	Sending text messages to a person in their contact list and to a specific phone number		
6	Receiving text messages		
7	Send and Receiving email using an app		

8	Using a web browser to navigate to a URL, scroll to the end of the URL, interact with the controls on the webpage, enter text in the edit controls on that webpage and the browser controls (reload, forward and back, menu for browser). Sample test URL:		
9	Using a calendar including entering a new appointment for a date one month in the future and looking up an appointment already scheduled for this week.		
10	Taking pictures/video and save it to the mobile device		
11	Watching videos or listening to music including changing volume (to be discuss App or web based??? Caption configurable ?????)		
12	Complete a video call or meeting (FaceTime, no equivalent in Android that is shipped with phone - Duo).		
13	Receive low battery notification		
14	Change setting one the mobile device such as display brighten, default font size		

15	Turn up volume on device		
16	Turn down volume on device		
17	Turn on power on the device		
18	Turn off power on the device		
19	Plug in device to charge it		

The results of an attempt to complete a task from the list can have one of three outcomes:

- Pass
- Fail
- Pass with exceptions

Pass denotes that the solution could complete each phase of the task without relying on features or applications that are not part of the solution and available to users that do not have the restrictions imposed by the performance metrics of the end user. Fail denotes the solution was not able to complete all phases of the task. Pass with exceptions denotes the solution could complete most but not every phase of the task without relying on features or applications that are not part of the solution and available to users that do not have the restrictions imposed by the performance metrics of the end user. The nature of the exception and the reason the solution failed should be described in detail in the Notes section of the reporting table. Purchases may determine the phone is intended for a subset of the users and there they may deem the exception acceptable to their end users.

25 APPENDIX A: SPECIFICS OF THE CVAA

25.1 What Does the CVAA Mean by "Accessible"?

The CVAA and Federal Communications Commission (FCC) regulations determine accessibility by looking at two things: How the service is used, and the availability of the information to individuals with disabilities. On usability, the FCC determines whether the "input, control, and mechanical functions" are "locatable, identifiable, and operable" to people with disabilities. Service providers must offer at least one function to make their product usable by individuals who:

- Are blind or low vision;
- Have limited vision **and** are deaf or hearing impaired;
- Are colorblind;
- Are deaf or hearing impaired;
- Have limited manual dexterity;
- Have limited reach or strength;
- Use a prosthetic device;
- Are mute or unable to speak; or
- Have limited cognitive skills.

Service providers are also required to make their products usable without time-dependent controls while also ensuring the "information necessary to operate and use the product, including but not limited to, text, static or dynamic images, icons, labels, sounds, or incidental operating cues" are available to users with disabilities. For example:

- Text and other visual information (pictures, charts, etc.) must be available in auditory form and must also be accessible for users with impaired vision or hearing (e.g., high contrast, able to be magnified);
- Moving text must also be available in a static form; and
- Audio must also be provided in visual form (and, if appropriate, in a tactile form) and should also be accessible to users with hearing disabilities (e.g., increased amplification or increased signal-to-noise ratio).

Finally, FCC regulations also require manufacturers to make products more inclusive to people with disabilities by:

- Reducing any flickers that might induce seizures in users with photosensitive epilepsy;
- Providing audio cutoffs for external speakers or headphones through an industry-standard connector;
- Reducing noise interference with hearing aids, cochlear implants, and other auditory-assistance devices to the lowest possible level; and
- Allowing Bluetooth pairing for hearing aids.

The FCC may waive the CVAA requirements for specific features or classes of services, but only in a limited amount of cases. One of them being for basic e-readers. Back in February 2014, the FCC extended the waiver of Advanced Communications Services Accessibility Requirements for basic e-readers that will end February 1st, 2019. It provided a waiver for basic e-readers (such as the Amazon Kindle) under the conditions that the device:

- Doesn't have an LCD screen but still features a screen that is designed to optimize reading.
- The device doesn't have a camera.
- The device is not offered or shipped to consumers with built-in ACS client applications and the device manufacturer does not develop ACS applications for its respective device, but the device may be offered or shipped to consumers with a browser and social media applications.
- The device is marketed as a reading device, and all the promotional material about the device does not tout the capability to access ACS.

The waiver, which ended in February of this year, requires that the E-Reader Coalition submit a report which includes a study of the technological development, marketing, and consumer use trends in the basic e-reader market. After submission, the FCC will decide whether to make any further adjustments to the waiver, including termination. Their decisions will rely largely on if the FCC determines that ACS has become a primary or co-primary purpose of these devices.

25.2 Key Takeaways

- Under the CVAA, providers of Advanced Communications Services are required to be accessible and usable by disabled users.
- Advanced Communications Services is a descriptor for newer, internet-based communication systems that were not regulated by existing communications laws.
- The CVAA and FCC regulations determine accessibility by looking at how the service is used and the availability of the information to individuals with disabilities." [110, 111, 112]

[110] https://www.levelaccess.com/advanced-communications-services-and-the-cvaa/

[111] https://www.fcc.gov/consumers/guides/accessibility-advanced-communications-services-and-equipment

[112] https://www.ecfr.gov/current/title-47/chapter-I/subchapter-A/part-14?toc=1

26 APPENDIX B: SAMPLE PROCUREMENT TEMPLATE

26.1 Revised Accessible Standards Contract Language Template

26.1.1Instructions
When purchasing IT products or services, insert the following language into your procurement documentation (e.g., Statement of Work).

26.2 IT Accessibility Requirements

The Accessible Canada Act provides for the development of accessibility standards and gives the Government of Canada the authority to work with stakeholders and persons with disabilities to create new accessibility regulations that will apply to sectors within the federal jurisdiction.[113] It *requires* (DRAFT VERB ONLY) that when federal agencies develop, procure, maintain, or use information and communication technology (ICT), it shall be accessible to people with disabilities.

1. Products, platforms, and services delivered as part of this work statement that are ICT, or contain ICT, must conform to the Accessibility Standards Canada document xxxx located xxxxx.

26.3 Product or Service Being Procured

Item that contains ICT: [Insert product name]

[113] https://www.canada.ca/en/employment-social-development/programs/accessible-canada.html

26.4 Applicable Functional Performance Criteria

GUIDANCE FOR THIS SECTION: All functional performance criteria apply when using an alternative design or technology that achieves substantially equivalent or greater accessibility and usability by individuals with disabilities, than would be provided by conformance to one or more of the requirements in Accessible Standard Canada document xxxx.

26.4.1Intended Users and Goals

The product will allow the following tasks to be complete:

GUIDANCE FOR THIS SECTION: insert default generic task list plus specific to the office, department, agency, or ministry making the purchase by the following groups of users with the defined performance metrics and user characteristics:

- Mild Hearing Loss
- Moderate Hearing Loss
- Severe Hearing Loss

No. #	Task
1	Reading the instructions on how to use the device that comes with the device packaging or is available from an online source
2	Setting up the device for the first time
3	Making and terminating phone calls
4	Receiving phone calls
5	Sending text messages to a person in their contact list and to a specific phone number
6	Receiving text messages
7	Send and Receiving email using an app

8	Using a web browser to navigate to a URL, scroll to the end of the URL, interact with the controls on the webpage, enter text in the edit controls on that webpage Sample test URL:
9	Using a calendar including entering a new appointment for a date one month in the future and looking up an appointment already scheduled for this week.
10	Taking pictures/video and save it to the mobile device
11	Watching videos or listening to music
12	Complete a video call or meeting

26.5 Best Practices

The suggested best practices for each of the three user groups (mild, moderate, severe) are defined below. The best practices are guidance only but represent classes of methods that currently exist, have been tested, and provide an appropriate solution to each of these user groups. Alternative replacement solutions can be provided if they possess equivalent functionality to the user group the supplier has identified. Testing criteria for equivalent solutions are covered in Section xx of the Accessible Standards Canada document xxxx.

26.5.1 Technical Requirements That Apply the Best Practices for Each User Group

26.5.2 Applicable requirements for hardware features and components

26.5.2.1 Mild hearing disability

<table>
<tr><th colspan="3">Technical requirements for Configurable Audio</th></tr>
<tr><th>EN 301 549</th><th colspan="2">Section 508</th></tr>
<tr><td>See specifications in clauses 5.1.3.11, 8.2.2.1, and 8.2.2.2.</td><td colspan="2">402.3 Volume. ICT that delivers sound, including speech output required by 402.2, shall provide volume control and output amplification conforming to 402.3.</td></tr>
<tr><td>5.1.3.12 Speaker volume
Where auditory output is provided as non-visual access to closed functionality and is delivered through speakers on ICT, a non-visual incremental volume control shall be provided with output amplification up to a level of at least 65 dBA (-29 dBPaA).
NOTE: For noisy environments, 65 dBA may not be sufficient.</td><td colspan="2">402.3.2 Non-private Listening. Where ICT provides non-private listening, incremental volume control shall be provided with output amplification up to a level of at least 65 dB. A function shall be provided to automatically reset the volume to the default level after every use</td></tr>
<tr><td>5.1.3.13 Volume reset
Where auditory output is provided as non-visual access to closed functionality, a function that resets the volume to be at a level of 65 dBA or less after every use, shall be provided, unless the ICT is dedicated to a single user.</td><td rowspan="2">402.3.2 Non-private Listening. Where ICT provides non-private listening, incremental volume control shall be provided with output amplification up to a level of at least 65 dB. A function shall be provided to automatically reset the volume to</td><td rowspan="2">412.2.1 Volume Gain for Wireline Telephones.
Volume gain conforming to 47 CFR 68.317 shall be provided on analog and digital wireline telephones.</td></tr>
<tr><td>8.2.1.1 Speech volume range
Where ICT hardware has speech output, it shall provide a means to adjust the speech output volume level o</td></tr>
</table>

	the default level after every use	
8.2.1.2 Incremental volume control Where ICT hardware has speech output and its volume control is incremental, it shall provide at least one intermediate step of 12 dB gain above the lowest volume setting	*412.2.1 Volume Gain for Wireline Telephones.* Volume gain conforming to 47 CFR 68.317 shall be provided on analog and digital wireline telephones.	*412.2.2 Volume Gain for Non-Wireline ICT.* A method for increasing volume shall be provided for non-wireline ICT.

26.5.2.2 Moderate hearing disability

Technical Requirements for HAC Rating	
EN 301 549	**Section 508**
See specifications below.	*412.3 Interference Reduction and Magnetic Coupling.* Where ICT delivers output by a handset or other type of audio transducer that is typically held up to the ear, ICT shall reduce interference with hearing technologies and provide a means for effective magnetic wireless coupling in conformance with 412.3.1 or 412.3.2.

8.2.2.1 Fixed-line devices Where ICT hardware is a fixed-line communication device with speech output and which is normally held to the ear and which carries the "T" symbol specified in ETSI ETS 300 381 [1], it shall provide a means of magnetic coupling which meets the requirements of ETSI ES 200 381-1 [2]. NOTE: ICT fulfilling the requirements of TIA-1083-A [i.24] is deemed to comply with the requirements of this clause.	*412.3.2 Wireline Handsets.* ICT in the form of wireline handsets, including cordless handsets, shall conform to TIA-1083-B (incorporated by reference, see 702.9.1).	*402.3.1 Private Listening*. Where ICT provides private listening, it shall provide a mode of operation for controlling the volume. Where ICT delivers output by an audio transducer typically held up to the ear, a means for effective magnetic wireless coupling to hearing technologies shall be provided.
8.2.2.2 Wireless communication devices Where ICT hardware is a wireless communication device with speech output which is normally held to the ear, it shall provide a means of magnetic coupling to hearing technologies which meets the requirements of ETSI ES 200 381-2 [3]. NOTE: ICT fulfilling the requirements of ANSI/IEEE C63.19 [i.1] is deemed to comply with the requirements of this clause.	*412.3.1 Wireless Handsets*. ICT in the form of wireless handsets shall conform to ANSI/IEEE C63.19-2011 (incorporated by reference, see 702.5.1).	

Technical requirements for Bluetooth	
EN 301 549	**Section 508**
8.1.2 Standard connections Where an ICT provides user input or output device connection points, the	*406.1 General.* Where data connections used for input and output are provided, at least one of each type of connection

ICT shall provide at least one input and/or output connection that conforms to an industry standard non-proprietary format, directly or through the use of commercially available adapters. NOTE 1: The intent of this requirement is to ensure compatibility with assistive technologies by requiring the use of standard connections on ICT. NOTE 2: The word connection applies to both physical and wireless connections. NOTE 3: Current examples of industry standard non-proprietary formats are USB and Bluetooth.	shall conform to industry standard non-proprietary formats.

26.5.2.3 Severe hearing disability

Technical requirements for Alternative Notifications	
EN 301 549	**Section 508**
5.1.5 Visual output for auditory information Where pre-recorded auditory information is needed to enable the use of closed functions of ICT, the ICT shall provide visual information that is equivalent to the pre-recorded auditory output.	Equivalent requirement not available.
Equivalent requirement not available. EN 301 549 treats issues related to flashing and photosensitivity as a functional performance criterion (4.2.9) and a software criterion (11.2.1.19).	*408.3 Flashing.* Where ICT emits lights in flashes, there shall be no more than three flashes in any one-second period.
5.6.1 Tactile or auditory status Where ICT has a locking or toggle control and that control is visually presented to the user, the ICT shall	

provide at least one mode of operation where the status of the control can be determined either through touch or sound without operating the control.	*409.1 General.* Where provided, status indicators shall be discernible visually and by touch or sound.
5.6.2 Visual status When ICT has a locking or toggle control and the control is non-visually presented to the user, the ICT shall provide at least one mode of operation where the status of the control can be visually determined when the control is presented.	
Equivalent solution not available. EN 301 549 treats issues related to conveying information via multiple modalities as software issues (11.2.1.9).	*411.1 General.* Where provided, audible signals or cues shall not be used as the only means of conveying information, indicating an action, or prompting a response.

Technical requirements for Telecommunications Relay Services	
EN 301 549	**Section 508**
13.1.2 Text relay services Where ICT is intended to provide a text relay service, the text relay service shall enable text users and speech users to interact by providing conversion between the two modes of communication.	Equivalent requirements not available.
13.1.3 Sign relay services Where ICT is intended to provide a sign relay service, the sign relay service shall enable sign language users and speech users to interact by providing conversion between the two modes of communication.	
13.1.4 Lip-reading relay services Where ICT is intended to provide a lip-reading relay service, the lip-	

reading service shall enable lip-readers and voice telephone users to interact by providing conversion between the two modes of communication.	
13.1.5 Captioned telephony services Where ICT is intended to provide a captioned telephony service, the captioned telephony service shall assist a deaf or hard of hearing user in a spoken dialogue by providing text captions translating the incoming part of the conversation.	
13.2 Access to relay services Where ICT systems support two-way communication and a set of relay services for such communication is specified, access to those relay services shall not be prevented for outgoing and incoming calls. NOTE 1: Two-way communication may include voice, real-time text, or video, singly or in combinations supported by both the relay service and the ICT system. NOTE 2: The purpose of this requirement is to achieve functionally equivalent communication access by persons with disabilities.	
13.3 *Access* to emergency services Where ICT systems support two-way communication and a set of emergency services for such communication is specified, access to those emergency services shall not be prevented for outgoing and incoming calls.	

NOTE 1: Two-way communication may include voice, real-time text, or video, singly or in combinations supported by both the emergency service and the ICT system. NOTE 2: The purpose of this requirement is to achieve functionally equivalent communication access to the emergency service by persons with disabilities.	

Technical Requirements for Real-time Text (RTT)	
EN 301 549	**Section 508**
6.2.1.1 RTT communication Where ICT supports two-way voice communication in a specified context of use, the ICT shall allow a user to communicate with another user by RTT.	Equivalent requirements do not exist.
6.2.1.2 Concurrent voice and text Where the ICT, or set of ICT, provided to a user, supports two-way voice communication and enables a user to communicate with another user by RTT, it shall provide a mechanism to select a mode of operation allowing concurrent voice and text.	
6.2.2.1 Visually distinguishable display Where ICT has RTT send and receive capabilities, displayed sent text shall be visually differentiated from and separated from received text.	
6.2.2.2 Programmatically determinable send and receive direction Where ICT has RTT send and receive capabilities, the send/receive direction of transmitted text shall be	

programmatically determinable, unless the RTT has closed functionality.	
6.2.3 Interoperability Where ICT with RTT functionality interoperates with other ICT with RTT functionality (as required by 6.2.1.1) they shall support at least one of the four RTT interoperability mechanisms described below: a) ICT interoperating over the Public Switched Telephone Network (PSTN), with other ICT that directly connects to the PSTN as described in Recommendation ITU-T V.18 [i.23] or any of its annexes for text telephony signals at the PSTN interface; b) ICT interoperating with other ICT using VOIP with Session Initiation Protocol (SIP) and using real -time text that conforms to RFC 4103 [i.13]; c) ICT interoperating with other ICT using RTT that conforms with the IP Multimedia Subsystem (IMS) set of protocols specified in TS 126 114 [i.10], TS 122 173 [i.11] and TS 134 229 [i.12]; d) ICT interoperating with other ICT using a relevant and applicable common specification for RTT exchange that is published and available. This common specification shall include a method for indicating loss or corruption of characters	
6.2.4 Real-time text responsiveness Where ICT utilizes RTT input, that RTT input shall be transmitted to the ICT network supporting RTT within 1 second of the input entry.	

Technical Requirements for Two-Way Video Calling	
EN 301 549	**Section 508**
6.4 Alternatives to voice-based services Where ICT provides real-time voice-based communication and also provides voice mail, auto-attendant, or interactive voice response facilities, the ICT should offer users a means to access the information and carry out the tasks provided by the ICT without the use of hearing or speech. NOTE: Solutions capable of handling audio, real-time text and video media could satisfy the above requirement.	Equivalent requirement does not exist.
6.2.1.2 Concurrent voice and text Where ICT supports two-way voice communication in a specified context of use, and enables a user to communicate with another user by RTT, it shall provide a mechanism to select a mode of operation which allows concurrent voice and text. NOTE: The availability of voice and RTT running concurrently can allow the RTT to replace or support voice and transfer additional information such as numbers, currency amounts, and spelling of names.	Equivalent requirement does not exist.
6.6 Alternatives to video-based services Where ICT provides real-time voice-based communication and also provides voice mail, auto-attendant, or interactive voice response facilities, the ICT should offer users a means to access	Equivalent requirement does not exist.

the information and carry out the tasks provided by the ICT without the use of hearing or speech. NOTE: Solutions capable of handling audio, real-time text and video media could satisfy the above requirement.	
6.5.1 General (Informative) Clause 6.5 (Video communications) provides performance requirements that support users who communicate using sign language and lipreading. For these users, good usability is achieved with Common Intermediate Format (CIF) resolution, a frame rate of 20 frames per second and over, with a time difference between speech audio and video that does not exceed 100 ms. When the resolution is reduced to Quarter Common Intermediate Format (QCIF) and the frame rate drops to 12 frames per second the communication is still	*412.7 Video Communication.* Where ICT provides real-time video functionality, the quality of the video shall be sufficient to support communication using sign language.

usable with some restrictions. [114] [115] [116] [117] [118] [119] [120] [121] [122] A lower resolution causes less disturbance to the perception of sign language and lip-reading than that caused by a lower frame rate. Delay can	

[114] Mantokoudis, G., Dähler, C., Dubach, P., Kompis, M., Caversaccio, M. D., & Senn, P. (2013). "Internet Video Telephony Allows Speech Reading by Deaf Individuals and Improves Speech" Perception by Cochlear Implant Users. *PLoS ONE*, *8*(1), e54770.https://doi.org/10.1371/journal.pone.0054770

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be a problem in video communication. Overall delay values below 0,4 s are preferred, with an increase in preference down to 0,1 s. Values over 0,8 s are felt to hinder a good sign conversation. Overall delay depends on multiple factors, including e.g. network delay and video processing. For this reason a testable requirement on minimum values for overall delay cannot be produced.	
6.5.2 Resolution Where ICT that provides two-way voice communication includes real-time video functionality, the ICT: a) shall support at least QCIF resolution; b) should preferably support at least CIF resolution.	
6.5.3 Frame rate Where ICT that provides two-way voice communication includes real-time video functionality, the ICT: a) shall support a frame rate of at least 12 frames per second (FPS); b) should preferably support a frame rate of at least 20 frames per second (FPS) with or without sign language in the video stream.	
6.5.4 Synchronization between audio and video Where ICT that provides two-way voice communication includes real-time video functionality, the ICT should ensure a maximum time difference of 100 ms between the speech and video presented to the user.	

Technical Requirements for Captions	
EN 301 549	**Section 508**
See requirements below.	*413.1 General*. Where ICT displays or processes video with synchronized audio, ICT shall provide closed caption processing technology that conforms to 413.1.1 or 413.1.2.
7.1.1 Captioning playback Where ICT displays video with synchronized audio, it shall have a mode of operation to display the available captions. Where closed captions are provided as part of the content, the ICT shall allow the user to choose to display the captions.	*413.1.1 Decoding and Display of Closed Captions.* Players and displays shall decode closed caption data and support display of captions.
5.4 Preservation of accessibility information during conversion Where ICT converts information or communication it shall preserve all documented non-proprietary information that is provided for accessibility, to the extent that such information can be contained in or supported by the destination format	*413.1.2 Pass-Through of Closed Caption Data.* Cabling and ancillary equipment shall pass through caption data.
7.1.3 Preservation of captioning Where ICT transmits, converts or records video with synchronized audio, it shall preserve caption data such that it can be displayed in a manner consistent with clauses 7.1.1 and 7.1.2. Additional presentational aspects of the text such as screen position, text colours, text style and text fonts may convey meaning,	

based on regional conventions. Altering these presentational aspects could change the meaning and should be avoided wherever possible.	
See specific requirements below.	*414.1 General.* Where ICT displays or processes video with synchronized audio, ICT shall provide audio description processing technology conforming to 414.1.1 or 414.1.2.
7.2.3 Preservation of audio description Where ICT transmits, converts, or records video with synchronized audio, it shall preserve audio description data such that it can be played in a manner consistent with clauses 7.2.1 and 7.2.2.	*414.1.1 Digital Television Tuners.* Digital television tuners shall provide audio description processing that conforms to ATSC A/53 Digital Television Standard, Part 5 (2014) (incorporated by reference, see 702.2.1). Digital television tuners shall provide processing of audio description when encoded as a Visually Impaired (VI) associated audio service that is provided as a complete program mix containing audio description according to the ATSC A/53 standard.
414.1.2 Other ICT. ICT other than digital television tuners shall provide audio description processing	
7.3: User controls for captions and audio description Where ICT primarily displays materials containing video with associated audio content, user controls to activate subtitling and audio description shall be provided to the user at the same level of interaction (i.e. the number of steps to complete the task) as the primary media controls.	*415.1.1 Caption Controls.* Where ICT provides operable parts for volume control, ICT shall also provide operable parts for caption selection.
	415.1.2 Audio Description Controls. Where ICT provides operable parts for program selection, ICT shall also provide operable parts for the selection of audio description.

Instructions: The following instructions will help vendors properly document how their proposed solution addresses the Section 508 requirements outlined in the previous section. Vendors should include this documentation with their proposal. When explaining how potential offerors should respond to the solicitation, include

these instructions. Caution: These instructions are not 508 requirements, evaluation factors, or acceptance criteria.

26.6 Instructions to Offerors

Provide an Accessibility Conformance Report (ACR) for each commercially available Information and Communication Technology (ICT) item offered through this contract. Create the ACR using the Voluntary Product Accessibility Template Version 2.1 or later, located at https://www.itic.org/policy/accessibility/vpat.

1. Complete each ACR in accordance with the instructions provided in the VPAT template. Each ACR must address the applicable Section 508 requirements referenced in the Work Statement. Each ACR shall state exactly how the ICT meets the applicable standards in the remarks/explanations column, or through additional narrative. All "Not Applicable" (N/A) responses must be explained in the remarks/explanations column or through additional narrative. Address each standard individually and with specificity and clarify whether conformance is achieved throughout the entire ICT Item (for example - user functionality, administrator functionality, and reporting), or only in limited areas of the ICT Item. Provide a description of the evaluation methods used to support Section 508 conformance claims. The agency reserves the right, prior to making an award decision, to perform testing on some or all the Offeror's proposed ICT items to validate Section 508 conformance claims made in the ACR.

2. Describe your approach to incorporating universal design principles to ensure ICT products or services are designed to support disabled users.

3. Describe plans for features that do not fully conform to the Section 508 Standards.

4. Describe "typical" user scenarios and tasks, including individuals with disabilities, to ensure fair and accurate accessibility testing of the ICT product or service being offered.

Instructions: Insert the following language into the Acceptance Criteria section of the solicitation.

26.7 Acceptance Criteria

Prior to acceptance, the government reserves the right to perform testing on required ICT items to validate the offeror's accessibility conformance claims. If the government determines that conformance claims provided by the offeror represent a higher level of conformance than what is provided to the agency, the government shall, at its option, require the offeror to remediate the item to align with the offeror's original conformance claims prior to acceptance.

It is recommended that the procurement officer include the end user and their direct reports in the final acceptance process especially if the mobile device or devices are being procured for specific people. The people may have preferences that may have not been accurately reflected during the procurement criteria collection phase or their preference may have changed now that they have access to the actual device and supporting accessibility solution. Productive is ultimately the goal of procuring the mobile device technology and there are stakeholders in the process in addition to the actual end user/users Familiar with a specific type of mobile device through their own personal experience that is different from the device being procured may affect their ability to be productive quickly. The requirement for specific Apps may be a requirement of the job their department within the organization is expecting.