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| The Neil Squire Society |
| Procurement of Accessible Mobile Devices |
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| 9-23-2022 |

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# Introduction

This document was developed to create a procurement process for mobile devices that meet the needs of people with disabilities. The goal of this document is to document accessibility best practices and to address some of the issues and limitations that have been identified in existing procurement processes for accessible information and communication technology (ICT) from multiple jurisdictions around the world. The document also proposes a way to evaluate the level of compliance with this procurement process for new accessibility solutions that may be created in the future.

# Scope

This document specifies the accessibility requirements applicable to mobile devices and outlines test procedures and evaluation methodology for each accessibility requirement in a form that is suitable for use in public procurement within a Canadian context. It is primarily intended for use by providers and procurement staff, but designers and end users can also benefit from the information within. This document references standards from several standardization organizations, more specifically ETSI, the European Standards Organization (ESO), and the World Wide Web Consortium (W3C).

The present document contains the necessary functional requirements and provides a reference document such that if the procedures are followed, the results of testing are similar, and the interpretation of those results is clear.

# References

## Normative references

The following referenced documents are necessary for the application of the present document.

1. ETSI EN 301 549 (V3.2.1) (March 2021): “Accessibility requirements for ICT products and services”.

NOTE: Available at [[EN 301 549].](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf)

1. W3C Recommendation (December 2008)/ISO/IEC 40500:2012: "Web Content Accessibility Guidelines (WCAG) 2.0".

NOTE: Available at [[WCAG 2.0].](https://www.w3.org/TR/WCAG20/)

1. W3C Recommendation (June 2018): "Web Content Accessibility Guidelines (WCAG) 2.1".

NOTE: Available at [[WCAG 2.1].](https://www.w3.org/TR/WCAG21/)

1. 21st Century Communications and Video Accessibility Act (CVAA).
2. Section 508 of the Rehabilitation Act of 1973 (29 USC § 794d).

NOTE: Available at [[Section 508].](https://www.section508.gov/ict-accessibility/)

This document also builds on the normative references from [[Section 2.1 Normative references](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=11)] in the European Standard for Digital Accessibility (EN 301 549).

## Informative references

This document builds on the informative references from [[Section 2.2 Informative references](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=12)] in the European Standard for Digital Accessibility (EN 301 549).

# Definitions

This document defers to all the definitions of terms, symbols, and abbreviations laid out in [[Section 3 Definition of terms, symbols and abbreviations](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=15)] of the European Standard for Digital Accessibility (EN 301 549). Certain definitions that EN 301 549 does not include are outlined below.

* *Accessibility* – For a definition, refer to [[EN 301 549, Section 3.1].](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=15)
* *Action* – 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 a asks an element to perform an interaction.
* *Advanced Communication* – This term is derived from the description proposed in the American Communications and Video Accessibility Act (CVAA).[[1]](#footnote-2) The CVAA uses the term Advanced Communications Services to describe newer, internet-based communications systems that were not regulated by existing communications laws.

There are four types of Advanced Communications Services covered by the CVAA:

* + Electronic messaging services, which offer real-time or near real-time text-based messaging, including text messaging, instant messaging, text-based chat, and email. Examples include Facebook chat, Apple’s Messages app, Slack, and Google’s Gmail.
  + Interconnected Voice over Internet Protocol (VoIP) services, which allow users to make and receive traditional phone calls. Examples include Vonage and MagicJack, as well as some phone services offered through cable and internet providers.
  + Interoperable video conferencing services, which provide real-time video communications. Examples include Skype, Google Hangouts, Apple’s FaceTime, and other video conferencing/video chat services.
  + Non-interconnected VoIP services, which provide voice-based communication, but do not use the traditional telephone system. Examples include Skype, Google Talk, and other voice chat services.
* *Appropriateness* – measures 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 measure by the following dimensions:

* + *Consistency* – it should behave in the same manner when used in similar situations.
  + *Operability* – its intended use should be obvious, predictable, and consistent.
  + *Obvious* – easily seen, recognized, or understood.
  + *Predictability* – it should match user expectations.
  + *User compatibility* – the design should match the anthropometric and biomechanical capabilities (essentially, abilities) of users.
* *Best Practice –* the best in-class solution available.
* *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.
* *Controllability* – the device should be responsive.
* *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.
* *Enhancement* – a feature that aids with completing a task more efficiently.
* *Equitable use* – Achieving equitable use will ensure that solutions designed to increase accessibility do not result in loss of privacy, increased risks to personal safety or security, or the stigmatization of individuals, and that solutions provide the same means of use for all users that are identical whenever possible; equivalent when not.
* *Events* – changing the status of a property of an element can generate an Event that tells operating system of the device that a property has, or properties have, changed their state.
* *Feedback* – the device should let the user know when it is responding to the user’s actions.
* *Impairment* – a loss or abnormality of psychological, physiological, or anatomical structure or function.
* *Mobile device* – a device that provides advance communications functions including smartphone, cellular phone, mobile phones, or tablets
* *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).
* *Parallax* – the apparent displacement of an observed object or point of interest due to a change in the position of the observer.
* *Point of Interest/Points of Interest (POI)* – an element or set of elements that makes up a logical grouping of elements. Point of interest can be manipulated or are a target for potential interaction. A POI narrows the scope of potential interactions and perception of the user interface.
* *Properties* – describe individual parameters that describe an element such 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. An element may have no visual representation, for example, and there for have no height and width data.
* *Responsiveness* – quick to response or react appropriately.
* *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 2
* *Shortcut* – achieves the same result as an action or series of actions without it requiring that it interact directly with any elements or series of elements
* *Solution* – a proposed method of solving an accessibility problem.
* *State* – defines the status of a property which has multiple states (i.e., On/Off)
* *Suitability for the widest range of use* – 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, taking account of their special abilities, variations in their capabilities, the diversity of their tasks, and their differing environmental, economic, and social circumstances.
* *User Interface* – for a definition, refer to [[EN 301 549, Section 3.1](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=18)].
* *User Interface Element* – for a definition, refer to [[EN 301 549, Section 3.1](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=18)].

# Functional Performance Statements

A functional performance statement describes what can be done with a device given the abilities of a specific user. The functional performance of any ICT must enable equitable conveyance of information for all ability levels, as well as provide users with the ability to locate, identify, and operate any ICT. For the purposes of this document, this document defers to the EN 301 549 standard for all functional performance statements. For a functional performance statement that describes the user needs of people with disabilities, refer to [[EN 301 549, Section 4.2 Functional performance statements](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=20)].

# Performance Metrics Framework

In addition to the functional performance statements described in Section 5, the concept of “performance metrics” is being introduced. Performance metrics are measurable characteristics or dimensions of a person or process. The performance metrics for each severity level represent degrees of limitation along each of the performance metrics used to define the community.

A more in-depth discussion of performance metrics can be found in Section 8.4. Specific performance metrics for each disability community will be specified below in Sections 10 – 14. Personas will be presented for each disability community with a specific severity level of their condition defined by performance metrics.

# Checklist of Modifications to the EN 301 549 Standard

It has been proposed that the European Standard for Digital Accessibility (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 this adoption has not been officially approved as of the writing of this document, EN 301 549 will potentially 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 to work towards adopting this standard.

This section of the document will highlight exceptions (additions, revisions, and deletions) being proposed specifically for mobile devices to the individual EN 301 549 requirements. 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 versions of the specifications within the EN 301 549 standard.

This section is intended to provide a succinct summary of proposed changes 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. This is discussed below in Section 14. For information on where the recommendations originate, refer to the Overview and Technical Discussion under each Best Practice for each Persona. The recommendations are presented here without reference to the specific Personas and Best Practices, to keep this part of the document focused and simple for readers only interested in new specifications applicable to their design or procurement process.

The five tables below refer to existing EN 301 549 specifications, using their reference number in the original document. The EN 301 549 standard can be accessed here: [[ETSI EN 301 549 - V3.2.1 - Accessibility requirements for ICT products and services]](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf). The modifications will be grouped by disability community to preserve context. There may be specifications that affect more than one community. In those cases, the modification will be repeated for each community that it affects.

## Generic Modifications Applicable to All Mobile Devices and Disability Groups in the EN 301 549 Standard

Table 1. Generic modifications that apply to all mobile devices and disability groups in EN 301 549.

|  |  |  |
| --- | --- | --- |
| **Modification type** | **Description** | **Comments** |
| Deletion | [[Section 8.3 Stationary ICT](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=38)] and all its subsections from [[8.3.1 Forward or side reach](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=38) to [8.3.5 Visibility](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=43)] do not apply to mobile devices. | These sections apply to physical access to kiosks with information and communications technology (ICT) installed. These sections cover the height of a terminal in the kiosk and other specifications that do not apply to mobile devices since they are not stationary in nature. |

## Modifications to Mobility Loss ICT Solution Requirements in the EN 301 549 Standard.

Table 2. Modifications to Mobility Loss ICT solution requirements covered in the EN 301 549 standard.

| **Modification type** | **Description** | **Comments** |
| --- | --- | --- |
| Revision | [[Section 8.4.2.2 Force of operation of mechanical parts](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#=44)]  Where a control requires a force greater than 3 N to operate it, an accessible alternative means of operation that requires a force less than 3 N shall be provided. | This is a revision of [[Section 8.4.2.2 Force of operation of mechanical parts](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#=44)]. Modified from 22.2 N of force to 3 N of force. Mobile devices require lower amounts of force to interact with. |
| Addition | Where software provides a user interface and it also provides sufficient modes of operation that utilize user preferences for platform-wide font settings, the user must be able to adjust the height of the letters (measuring using the letter “H”) up to a least 8.4 mm except for software that is designed to be isolated from its underlying platforms. | Supplementation criteria to [[Section 11.7 User preferences](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=82)].  This is also a variation of [[Section 5.1.4 Functionality closed to text enlargement](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=26)], but with a known maximum distance of usage, which is arm’s length. Average arm’s length is 0.68 metres.[[2]](#footnote-3)  There is similar guidance for a closed stationary system in [[Section 8.3.5 Visibility](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=43)]. |
| Addition | Where a pointer with a cursor is available, the maximum speed of the cursor must be adjustable up to a speed of at least 87 mm per second.[[3]](#footnote-4)  This assumes touch interactions are separate from cursor interactions. |  |
| Addition | Where software provides a user interface and it also provides sufficient modes of operation that utilize user preferences for platform-wide focus cursor size settings, the user must be able to adjust the height of the cursor up to at least 8.4 mm, except for software that is designed to be isolated from its underlying platforms. |  |
| Addition | Where a pointer with a cursor is available, the cursor should be outlined by a border that contrasts with the color of the body of the cursor. The color contrast between the cursor body and the outlined border of the cursor must be at least 7:1. |  |
| Addition | All physical interactions should not rely solely on the user being able to accurately and consistently target a point of interest that is less than 12 mm square in dimension. Where an interaction with a target less than 12 mm x 12 mm is required, an alternative that does not rely on consistently targeting a point of interest less than 12 mm x 12 mm must be provided. | 12 mm x 12 mm is the average size of the end of a fingertip. |
| Addition | NOTE 4: The definition of a standard connection includes the definition of the connection medium, the connectors with signal levels if required, and protocols necessary to support the interfacing of a peripheral or remote device with the mobile device. | This is an addition to [[8.1.2 Standard connections]](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=37).  It was unclear whether the protocols were supported in this requirement using the current definition in EN 301 549. |
| Addition | The mobile device must support an external keyboard interface through a standard connection as defined by Section 8.1.2. | This is an addition to [[Section 8.1.2 Standard connections](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#=37)]. |
| Addition | The mobile device must support an external switch interface for a single and dual switch through a standard connection as defined by Section 8.1.2. | There still is currently no standardized hardware connection specification and protocol for connecting a switch to a mobile device. There is only a convention currently. |

## Modifications to Cognitive Community ICT solution requirements covered in the EN 301 549 standard.

Table 3. Modifications to Cognitive Community ICT solution requirements covered in the EN 301 549 standard.

| **Modification Type** | **Description** | **Comments** |
| --- | --- | --- |
| Addition | 9.3.1.3 Audio Equivalent of Text  Where ICT is a webpage, text on the webpage will also be available in audio format  NOTE 1: An example would be the implementation of a Text-To-Speech solution for those who have difficulty reading written text. | The new Section 9.3.1.3 Audio Equivalent to Text is an addition for web content under [[Section 9.3 Understandable](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=49)] and [[Section 9.3.1 Readable](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=49)].  Note that a Text-to-Speech system is distinct from a Screen Reading solution that is typically used for persons with vision loss. A screen reader will also reveal and understand the underlying structures of what is on the webpage. For example, a screen reader will announce that a table is being read while a Text-to-Speech solution will only read the text within a cell in the table. |
| Addition | 10.3.1.3 Audio Equivalent to Text  Where ICT is a non-web document, the text in the document will also be available in audio format.  NOTE 1: An example would be the implementation of a Text-To-Speech solution for those who have difficulty reading written text. | The new Section 10.3.1.3 Audio Equivalent to Text is an addition for non-web documents under [[Section 10.3 Understandable](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=60)] and [[Section 10.3.1 Readable](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=60)]. |
| Addition | 11.3.1.3 Audio Equivalent to Text  Where ICT is non-web software, text within the non-web software will also be available in a compatible audio format.  NOTE 1: An example would be the implementation of a Text-to-Speech solution for those who have difficulty reading written text. | The new Section 11.3.1.3 Audio Equivalent to Text is an addition for web content under [[Section 11.3 Understandable](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=74)] and [[Section 11.3.1 Readable](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=74)]. |
| Addition | 12.2.4.1 Where a web format is available, in addition to text-based documentation, access to video format documentation with chapter marks will be provided for the use of the primary tasks of the mobile device. | The new Section 12.2.4.1 is an addition to [[Section 12.2.4 Accessible documentation](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=85)]. |
| Addition | 12.2.4.2 Where a non-web format is available, in addition to text-based documentation, access to video format documentation with chapter marks will be provided for the use of the primary tasks of the mobile device. | The new Section 12.2.4.1 is an addition to [[Section 12.2.4 Accessible documentation](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=85)]. |

## Modifications to Vision Loss ICT solution requirements covered in the EN 301 549 standard.

Table 4. Modifications to Vision Loss ICT solution requirements covered in the EN 301 549 standard.

| Modification type | Description | Comments |
| --- | --- | --- |
| Addition | The height of the default system font must be a height of at least 8.4 mm (0.33 inches) for the letter “H” for a closed system and adjusted up to at least a height of 8.4 mm (0.33 inches) for the letter “H” for an open system. | This is a modification of [[Section 5.1.4 Functionality closed to text enlargement](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=26)]. For mobile devices, the maximum distance that the phone will be positioned relative to the user is the equivalent of an arm’s length. The average maximum arm’s length based on anthropometricstudies is 0.68 metres (see Section 10.4.4). |
| Revision | [[9.1.4.4 Resize text](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=47)]  Where ICT is a web page, it shall satisfy the requirement that the height of the default system font must be a height of at least 8.4 mm (0.33 inches) for the letter “H” for a closed system and adjusted up to at least a height of 8.4 mm (0.33 inches) for the letter “H” for an open system. | This is a revision of the existing [[Section 9.1.4.4 Resize text](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=47)].  [[Web Content Accessibility Guidelines (WCAG) 2.1 (w3.org)](https://www.w3.org/TR/WCAG21/#resize-text)] |
| Revision | [[10.1.4.4 Resize text](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=54)]  Where ICT is a non-web document, it must satisfy the requirement for the height of the default system font to be a height of at least 8.4 mm (0.33 inches) for the letter “H” for a closed system and adjusted up to at least a height of 8.4 mm (0.33 inches) for the letter “H” for an open system. | This is a revision of [[Section 10.1.4.4 Resize text](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=54)]. The previous requirement was that [[text](https://www.w3.org/TR/WCAG21/#dfn-text)] can be resized without [[assistive technology](https://www.w3.org/TR/WCAG21/#dfn-assistive-technologies)] up to 200 percent without loss of content or functionality.”  There was no baseline text height so being able to increase the text size by 200 percent is undefined regarding the required range of text heights. |
| Revision | [[11.1.4.4.1 Resize text (open functionality)](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=68)]  Where ICT is non-web software that provides a user interface and that supports access to enlargement features of platform or assistive technology, it shall satisfy the requirement that the height of the default system font to be a height of at least 8.4 mm (0.33 inches) for the letter “H” for a closed system and adjusted up to at least a height of 8.4 mm (0.33 inches). | This is a revision of [[Section 11.1.4.4.1 Resize text (open functionality)](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=68)]. |

## Modifications to Hearing Loss ICT Solution Requirements in the EN 301 549 Standard

Table 5. Modifications to Hearing Loss ICT solution requirements in the EN 301 549 standard.

|  |  |  |
| --- | --- | --- |
| **Modification type** | **Description** | **Comments** |
| Addition | There should only be three flashes in any one-second interval if the ICT produces lights in flashes. | Addition originates from an existing requirement in [[Section 508: 408.3 Flashing].](https://www.section508.gov/ict-accessibility/#e411_1:~:text=408.3%20Flashing.,conform%20to%20408.3.) |
| Addition | If an ICT emits an audible signal or cue, it should not be the only mode of prompting a response or action or conveying information. | Addition originates from an existing requirement in [[Section 508: 411.1 General].](https://www.section508.gov/ict-accessibility/#e411_1:~:text=411.1%20General.%20Where%20provided%2C%20audible%20signals%20or%20cues%20shall%20not%20be%20used%20as%20the%20only%20means%20of%20conveying%20information%2C%20indicating%20an%20action%2C%20or%20prompting%20a%20response) |

## Modifications to Speech Loss ICT Solution Requirements in the EN 301 549 Standard

Table 6. Modifications to Speech Loss ICT solution requirements in the EN 301 549 standard.

| **Modification type** | **Description** | **Comments** |
| --- | --- | --- |
| Reinforcement | [[4.2.11 Privacy](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=22)] | This is not a specific modification but reinforces the need to have private conversation when the user is on the phone. |
| Addition | [[4.2.6 Usage with no or limited vocal capability]](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=21)  Added the following notes:  NOTE 3: Where a voice assistant is supported on the device, a method of controlling the voice assistant without using voice is required and the method must be accessible to third party hardware. | This is an addition to [[4.2.6 Usage with no or limited vocal capability].](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=21)  Note 3: Support the best practice of a direct command feature described in Section 14.5.3.3 of this document. |
| Revision | [[4.2.7 Usage with limited manipulation or strength]](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf" \l "page=21)  Added the following notes:  NOTE 4: Where the user has limited or no use of their hands and have limited or no hand strength , the mobile device must support the capability to mirror the display of the mobile device on a remote terminal through a standard connection and provide the ability to send keyboard and pointer interactions from the remote terminal to the mobile device to control features and programs using the standard connection used to mirror the display of the mobile device. | This is a revision of [[4.2.7 Usage with limited manipulation or strength](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=21)]. Refer to the discussion in Section 14.5.3.3 Direct Commands in this document. |
| Addition | The mobile device must provide a mechanism to route the audio output of an external AAC device to the audio input channel of the phone (not via speaker phone mode) on the mobile device and to the audio input of the voice-activated features of the mobile device if available. At the same time, the mobile device must preserve the ability to use the existing audio channel to hear the caller at the other end of the line using the existing audio channels on the device. This must include hearing the caller at the other end through the existing phone speaker when in handset mode, and through the speaker of the AAC device. This will facilitate private conversations when the user requires it. | Refer to the audio routing feature described in Section 14.5.3.4 |
| Addition | Added the following notes:  NOTE 4: The definition of a standard connection includes the definition of the connection medium, the connectors with signal levels if required, and protocols necessary to support the interfacing of a peripheral or remote device with the mobile device. | This is an addition to [[Section 8.1.2 Standard connections](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=37)]  There is no standard connection hardware or protocol to mirror or remotely control the mobile device from another terminal or device. There are currently only proprietary conventions. |
| Addition | 9.1.5  Where the ICT is a web-based document, the mobile device must have the capability to mirror that content on a terminal remote to the device while adhering to the requirements in [[Section 8.1.2 Standard connection](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=37)]. | This is an addition to [[Section 9.1. Perceivable](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=45)]. This addition exists to support the best practices for Speech Loss Persona 3. |
| Addition | 10.1.5  Where the ICT is a non-web document, the mobile device must have the capability to mirror content on a terminal remote to the device while adhering to the requirements in [[Section 8.1.2 Standard connection](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=37)]. | This is an addition to [[Section 10.1 Perceivable](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=52)]. This addition exists to support the best practices for Speech Loss Persona 3. |
| Addition | 11.1.5  Where ICT is a non-web software that provides a user interface and that supports access to assistive technologies, and where the mobile device must have the capability to mirror that content on a terminal remote to the device while adhering to the requirement [[Section 8.1.2 Standard connection](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=37)]. | This is an addition to [[Section 11.1 Perceivable](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=65)]. This addition exists to support the best practices for Speech Loss Persona 3. |
| Addition | 9.2.1.5  Where the ICT is a web document and where the mobile device provides the capability for mirroring its content on a remote terminal, the mobile device must have the capability to send keyboard input from the remote terminal to the mobile device using the same connection as used to implement the mirroring. | This is an addition to [[Section 9.2.1 Keyboard accessible](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=47)]. |
| Addition | 10.2.1.5  Where the ICT is a non-web document and where the mobile device provides the capability for mirroring its content on a remote terminal, the mobile device must have the capability to send keyboard input from the remote terminal to the mobile device using the same connection as used to implement the mirroring. | This is an addition to [[Section 10.2.1 Keyboard accessible].](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=56) |
| Addition | 11.2.1.5  Where ICT is a non-web software that provides a user interface and that supports access to assistive technologies, and where the mobile device provides the to mirror its content on a remote terminal, the mobile device must have the capability to send keyboard input from the remote terminal to the mobile device using the same connection as used to implement the mirroring. | This is an addition to [[Section 11.2.1 Keyboard accessible].](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=70) |
| Addition | 9.2.5.5 Pointer interactions  Where the ICT is a web-based document and where the mobile device supports mirroring of its content on a remote terminal, the mobile device must support the ability to send pointer interactions from the remote terminal to the mobile device using the same connection as used to implement the mirroring. | This is an addition to [[Section 9.2.5 Input modalities].](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=49) |
| Addition | 10.2.5.5 Pointer Interactions  Where the ICT is a non-web-based document and where the mobile device supports mirroring of its content on a remote terminal, the mobile device must support the ability to send pointer interactions from the remote terminal to the mobile device using the same connection as used to implement the mirroring. | This is an addition to [[Section 10.2.5 Input modalities](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=59)]. |
| Addition | 11.2.5.5 Pointer Interactions  Where the ICT is non-web software content that provides a user interface and supports access to assistive technologies, and where the mobile device supports mirroring of its content on a remote terminal, the mobile device must support the ability to send pointer interactions from the remote terminal to the mobile device using the same connection as used to implement the mirroring. | This is an addition to [[Section 11.2.5 Input modalities](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=74)]. |

# Accessibility Framework

## Personas

One of the most effective ways to communicate the needs of specific groups of users is through the use of personas. A persona 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 their 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 one- to two-page descriptions that include behaviour patterns, goals, skills, attitudes, and their environment, with a few personal details to make the persona realistic and relatable.

The personas used for the purposes of this document are referred to as mild, moderate, and severe, depending on the level of severity. Each persona provides background on a user that can benefit from specific classes of ICT solutions. The proposed personas are a part of the checklist used with the new procurement process that introduces novel evaluation criteria for compliance, described in Section 14 below.

## Best Practices and Enhancements

To each persona belongs a respective list of best practices, or classes of solutions that would benefit a user with those specific set of abilities. Note that to qualify as a best practice, the user must be able to complete every task on the Primary Task List (detailed in Section 8.3 of this document) using only that best practice. Where a solution can complete only one step or only a few of the steps necessary to complete a task, it will be considered an enhancement. The terminology enhancement is used as these solutions often are used to speed up or enhance a best practice but on their own cannot complete a task or all tasks on the task list.

## Use Cases or Primary Tasks

Use cases describe the responses of a product or service to a series of related requests from an end user. A list of use cases exists for the most common tasks that the user may try to achieve through the product or service. Together, personas, the task list and the use cases help to guide decisions about a product or service, such as features, interactions, and visual design. These parameters are important to designers and procurement staff as they help define who will use the end product and service to complete the end goal. In the case of mobile devices, the end goal is to use of advanced communication services to complete the primary tasks. The use cases describe the response of the mobile device to the user’s required to complete the tasks in the primary task list below. The primary tasks are not intended to cover every potential task the user might want to complete on the mobile device but rather are chosen to cover the range of steps or intermediate interactions that are necessary to complete a task. Setting the focus to a point of interest, entering data in a point of interest, and getting the device to process the data are examples of 3 steps that are necessary to complete interactions with an edit data field as an example.

Table 7. List of primary tasks on mobile devices.

| **#** | **Primary 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 communication session (phone calls, videos calls, or text message sessions) |
| 4 | Receiving a communication session (phone calls, videos calls, or text message sessions) |
| 5 | Sending text messages to a person in their contact list and to a specific phone number |
| 6 | Receiving text messages |
| 7 | Sending and receiving e-mail 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/videos and saving them to the mobile device |
| 11 | Watching videos or listening to music in a Web-based browser, including changing volume |
| 12 | Watching videos or listening to music in an App, including changing volume |
| 13 | Completing a video call or a meeting (FaceTime, no equivalent in Android that is shipped with phone - Duo). |
| 14 | Receiving a low battery notification |
| 15 | Changing settings one the mobile device (such as display brightness, default font size) |
| 16 | Turning on the power to the phone |
| 17 | Turning off the power to the phone |
| 18 | Turning volume up |
| 19 | Turning volume down |
| 20 | Charging the mobile device |

## Performance Metrics Framework

Performance metrics are measurable characteristics or dimensions of a person or process. They are typically used as an objective way to measure a person’s ability to complete a task, or series of tasks or a process. There is no absolute set of performance metrics that can be used for all situations. Usually, the performance metrics are selected to represent key dimensions or characteristics of what needs to be measured for a specific task or series of tasks. In this document, the metrics have been selected to represent interactions with mobile devices. A combination of performance metrics can be used to represent the abilities of the sub-groups of users within a community. Subsequently, a particular accessibility solution usually addresses one subgroup of users grouped by their unique combination of abilities as described by the performance metrics. While there may be cases where a solution addresses the needs of multiple subgroups 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 definition of appropriateness takes into consideration the end users’ abilities so that they can complete a task in the most effective and efficient manner possible given their abilities.

## Using Design Principles and Performance Metrics to Identify Best Practices

The most widely cited universal design principles were developed by Field et al. (2007)[[4]](#footnote-5); an abridged version is outlined in **Table 8** below.

Table 8. Principles of universal design, originally proposed by Center for Universal Design (1997), adapted by Field et al (2007).

|  |  |
| --- | --- |
| **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. |

It is possible to use the six universal design principles above to help identify best practices that are appropriate to each of the persona subgroups. It is important to use those principles along with the key performance metrics to define the abilities of the users within a community needed to interact with that technology. Where possible, the abilities are distilled down to a small number of critical performance metrics that dictate the ability of the user to successfully complete the interactions necessary to complete all primary tasks.

# Considerations and Best Practices for Setup

## Considerations

In this document, “Setup” is the required first interaction of the user with the mobile device that must be completed before the device can be used for its intended purpose. After powering on the device for the first time, the user is typically required to set up their language of choice, their region of usage, the time and date, and information about their wireless provider of choice. The actual elements that need to be configured may vary depending on the device. The goal for the purposes of this document is to provide a mechanism for users of all abilities to be able to independently complete the setup process. The limitations will be discussed in more detail below.

Since users of all abilities need to be supported during the setup phase, there will not be a specific section on setup for each disability type. Guidance will be provided for the complete setup process which will support a range of abilities (mobility, vision, hearing, speech loss, and cognitive).

One of the unique aspects of the setup phase is that all capabilities of the device will likely not be used during this step. And when a capability is not used, there is no need for a corresponding accommodation. For example, when Setup does not require the user to speak, accommodations for that form of alternative input is not required.

## Best Practices

Rather than have a best practice as it applies to each disability group and persona, the best practices for the setup process are being described as a process that must support all disability groups and all personas simultaneously during the setup process. At least one best practice for each persona must be implemented and be available for the user during the setup process.

It is a common industry practice to provide a minimum of written instructions with the device. The user typically—but not exclusively—needs to access those instructions through a website link. The instructions on the website must be provided in an accessible format, as defined by the World Wide Web Consortium (W3C) Web Content Accessibility Guidelines (WCAG) 2.1. Refer to [[Section 9.3.3.2 Labels or instructions of EN 301 549](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=50)] for explicit guidance. Videos that demonstrate the steps in the setup process are also required to support users with cognitive impairments. In addition, close captioned and video with sign language must be provided. This requirement is covered in [[EN 301 549 Section 12 Documentation and support services](https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf#page=84)].

Where possible, each one of the personas from each disability group should have at least one best practice implemented for the setup process. The current set of best practices for the mobile device setup process has **at least** the following properties:

* Uses a font with the appropriate font size and weight for users with low vision and reading difficulties; see Section 10.4.4 of this document.
* Uses a text font to background color contrast with a ratio of at least 4.5 to 1.[[5]](#footnote-6)
* Each page of the setup process will have a menu with a simple and prominent icon and navigational ease to provide “to do” instructions regarding the interaction on that page.
* Enables users with vision loss to start the screen reader and/or the screen magnifier in the first screen of the setup process by use of pre-defined and unique interactions, such as gestures.
* Once a language and country are selected, additional built-in assistive technologies are made available through a menu. Those assistive technology accommodations include:
  + Support for at least one mode of switch control (external switch (USB/wireless), head movement switch control, utterance, screen tap, head movement)
  + Support for external keyboard customization:
    - Slow keys – makes the device wait before accepting a keystroke (default: 1 second)
    - Bounce keys – this option allows the device to ignore a keystroke when you press the same key more than once with a set time limit (default: 0.5 second)
    - Repeat keys – the rate at which the character on the key is repeated if continually pressed (default: 0.3 seconds)
    - Sticky keys – the ability to hit a modifier key like shift and have the modification apply to the next key hit. The intent is to eliminate the need to hold multiple keys down at the same time.[[6]](#footnote-7)
  + Text-to-speech mode for users with a low literacy level and difficulty reading.
  + No use of gestures that require multiple points of contact except to turn the screen reader on/off and to operate the screen magnifier.
  + Both visual and non-visual (tactile and audio) forms of output should be supported, if appropriate for the content.[[7]](#footnote-8)

### Third Party Assistance During the Setup Process

It is recognized that during the setup process that there may be steps that cannot be completed by the user due to the limitations of their abilities. Though not inclusive of all potential cases, the following exceptions where a third party and, in some cases, a trusted third party is required are allowed to complete that step:

* Taking the mobile device out of the box and turning it on for the first time if the user does not have the dexterity to do so.
* Setting up and pairing the device with an external switch, if required.
* Entering the password for the Internet connection (typically Wi-Fi) if required and if the user has problems remembering the password for the network, as is the case for people with memory issues or problems understanding procedures.
* Creating and entering a password or alternative user identification validation process (facial recognition, fingerprint identification, etc.) for the device for people that have memory issues or problems understanding procedures

### Accessibility Settings Persistence after Setup

The setting used during the setup process should persist after the setup process is complete to the configuration of the running mobile device.

# Mobility Loss Personas

## Definition of Mobility Loss

Mobility loss can involve conditions that affect functioning of the legs and feet or the arms, hands, and fingers, or both. Reduced function of legs and feet implies dependency on a wheelchair or other mobility aids to help walking (e.g., crutch or stick). People who use walking aids may have difficulties with travelling long distances and uneven or unpredictable surfaces. Reduced function of arms and hands includes the lack of motion in the arms or hands, or a reduced ability to use them due to reduced strength or co-ordination. For a person who lacks both arms, or the functional use of both arms, activities related to moving, turning, or pressing objects are often impossible, or may have to be replaced by other methods. A person who can only use one arm will not be able to use equipment that requires the simultaneous use of both hands. For people who cannot move their fingers independently, all fine motor skills will be affected.

Lack of strength can hinder actions such as lifting, pressing, pushing, etc. People with severely reduced strength may be unable to use the keyboard or the keypad of a telephone. People with moderate loss of strength may be able to lift and move only very small objects, and to hold them for only a limited time. People with muscular dystrophy, or other conditions that affect the muscles or muscle control, often have reduced strength.

Reduced coordination of the arms and hands is usually a result of damage to the nerves due to cerebral palsy or Parkinson’s disease, for example. Reduced coordination of the arms and hands will influence all activities that require manipulation of objects or equipment. Lack of coordination may also increase the probability of hitting and breaking things, and to make errors when operating equipment. For example, a person with cerebral palsy or Parkinson’s disease may be unable to write a message or dial a telephone number.

## Specific Performance Metrics for Mobility Loss Personas

The performance metrics for each severity level represent degrees of limitation along each of the performance metrics used to define users in the community. When assessing abilities of users from the mobility loss community, focus is put on the two key performance metrics that define the abilities of every user. Those performance metrics are:

1. Ability to consistently target a defined area with a part of their body to complete touch-centric interactions.
2. Ability to consistently apply up to 2 Newtons of force with a part of their body to a targeted, defined area.

### Range of Motion

Currently most mobile devices are designed around interactions that use touch to interact with either a point of interest on a touch screen or a physical button. The [[Success Criterion 2.5.5 Target Size](https://www.w3.org/TR/WCAG21/#target-size)] in the Worldwide Web Consortium (W3C) Web Content Accessibility Guidelines (WCAG) states that an appropriate minimum size for a point of interest or physical button is 44 by 44 CSS pixels. This translates into a physical target size of 0.458 inches square or 11.64 mm square, which is approximately the average size of a person’s fingertip.[[8]](#footnote-9) [[9]](#footnote-10) [[10]](#footnote-11) For simplicity, the target area is defined as 12 mm by 12 mm. People with a moderate loss of mobility typically are interacting with physical objects using the side of their hands or the palms of their hand. To accommodate this the target size a minimum target size of 30 mm is recommended.[[11]](#footnote-12)

### Activation Force

For the purposes of this document, the minimum activation force the user must be able to achieve is 2 Newtons. Some devices require 3 Newtons to activate the Power button. The lack of dexterity of some users with moderate mobility loss prevents them from accessing that button, as it recessed to prevent accidental activation, as well as other physical buttons on the mobile device. If the phone is consistently charged, the requirement to interact with the power button can be minimized, though not eliminated, as access to the Power button is required to reset the device in case of an issue (also known as a hard reset). It is important to note that the activation force is intended to be combined with the ability to target a specific area. The ability to apply force without control and intent is not a useful ability.

## Persona 1: Mild Mobility Loss Persona

### Performance Metrics for a Mild Mobility Loss Persona



Figure 1. A mild mobility persona.

Table 9. Performance metrics of a mild mobility loss persona.

|  |  |
| --- | --- |
| **Performance Metric** | **Level of Performance** |
| Range of Motion - Ability to consistently target at least a square area 12 mm x 12 mm with a part of the body | Yes |
| Activation force - Ability to consistently apply 2 newtons of force on a 12 mm by 12 mm area | Yes |

### Other Abilities and Characteristics of a Mild Mobility Loss Persona

* Stiffness in the shoulders, elbows, and wrists
* More than 10-degree loss of range of motion of the arms, wrist, and fingers
* Pain and tingling in the hands
* Partial lost of sensation in her ring finger and pinky fingers
* Reduced strength – can apply at maximum 3 Newton of force at the fingertips
* Can accurately and consistently target and area of 13 mm or more
* Experiences pain in their wrist and hands when they must do repetitive motions quickly (less than 1 second between actions)
* Able to walk and stand normally without any issues

### Use Case: Repetitive Strain Injury

Frances (age 36) has repetitive strain injury due to working as a typist for the last 18 years. She has stiffness and aching muscles that affect her shoulders, arms, wrists, and hands. In addition, she has a dull aching pain and tingling sensation in her fingers. There are times when she has partial loss of sensation in her ring finger and pinky finger that makes it uncomfortable for her to grasp and hold things in her hand. In addition, there is a dramatic reduction in the strength of her fingers and wrist due to issues with the tendons in her hands. She can apply pressure but finds it difficult to apply more than 2 Newton of pressure with her fingers. She has no problems getting around on her own and can walk normally as her condition only affects her upper body. She is re-training to take on an administrative role in human resources at work so that she does not have to type as much. She is using a voice recognition system to help her type and enter data for the times when she needs to send an email or fill out paperwork as part of her job. In her new role she will have to work out of the office more and she will need a mobile device to coordinate her day.

### Best Practices for a Mild Mobility Loss Persona

Users with mild mobility loss retain much of the abilities necessary to interact with mobility devices through touch interactions. Touch interactions currently are the methods most mobile devices are designed to be used for users without disabilities. These user’s interactions are typically limited by their range of motion (because of pain and a physical limitation of the range of motion of their fingers, wrists, lower arms, and upper arms) or strength. Some users have a combination of these conditions. Ultimately, they can complete the tasks from the Primary Task List with their abilities, but it will take longer, or they may not be able to repeat them multiple times quickly due to their abilities. Since these users can use the intended touch interaction, with some limitations, the solutions described below are “enhancements” and not accessibility solutions by themselves.

The following key accessibility principles should be implemented when considering best practices for users with mobility loss.

* All physical interactions should have an alternative method of interaction that does not require more than 2 newtons of force to activate.
* All physical interactions should not rely solely on the user being able to accurately and consistently target a point of interest that is less than 12 mm square in dimension.
* In general, time limits should not be imposed on activities unless the activity by its nature requires a time limit. Interactions should not time out or the user should have the option to extend the time if the interaction is about to time out up to 10 times the default or an alternative method of interaction that does not rely on timed interactions should be provided
* Interactions should not require the user to complete an action or series of actions within a specified time or the user should have the option to extend the time if the interaction is about to time out to 10 times the default or an alternative method of interaction that does not rely on timed interactions should be provided.
* Any interaction that requires multiple touch points must have a single touch point alternative.
* If the acceptance of an input is reliant on the duration of time of the interaction, then the duration of the interaction should be able to be customizable up to 10 times the default, i.e., a long and short tap.
* The assistive technology solution should be implemented using the resources of the mobile device without the need for peripheral devices, if possible.

Three best practices for a mild mobility loss persona discussed below are:

1. Slide Type Input Methods

2. Alternative Menus for Actions

3. Voice assistants

#### Slide Type Input Methods

##### Overview of Slide Type Input Methods

The sliding type input method is a form of virtual keyboard where the input is determined by the path traced out by the user instead of relying on the user being able to accurately target keys on the keyboard. Sliding text input methods consists of three major components that contribute to its accuracy and speed: an input path analyzer, word search/word prediction engine with corresponding database, and optionally, a learning algorithm that improves the word search/word prediction algorithm. Rather than help the user spell out a word one letter at a time, the software uses the path drawn between keys on the keyboard (usually QWERTY) to predict the word that is being spelled out. Entry rate of up to 55 words per minute has been achieved with these types of keyboards.[[12]](#footnote-13), [[13]](#footnote-14)

##### Technical Discussion of Slide Type Input Methods

The sliding text input method is not an accessibility solution by itself. The method lets users input text without reliance on accurately targeting a point of interest (less than 12 mm square) on the device, is not time reliant regarding how and when a text input is accepted and does not rely on multiple touch points. However, the device itself still needs to rely on the design incorporating low force activation (less than 2 newton) for all interactions.

The sliding text input method, such as incorporated in third party commercial virtual keyboards, should have the following properties:

* The sliding text input method should rely on the touch screen for input which typical has an activation pressure of less than 2 Newtons
* The sliding text input method does not rely on the user being able to accurately and consistently targeting an area of 12 mm square in dimension. It relies on the path drawn by the users that approximate connecting lines between a series of letters on a keyboard layout.
* The sliding text input method does not rely on the user completing the path in a specified time period. It determines the text being entered by the user by tracing the path from the initial point of contact to when the user removed his finger from the touch screen the input is accepted
* The sliding text input method does not rely on multiple touch points. The interaction can be completed with one finger.
* It is not possible to totally remove repetitive actions from the text input process as some words have letters that repeat sequences. Sliding text input method keyboards minimize the number of repetitive actions.

A sliding input method keyboard must come installed in the mobile device and be one of the optional keyboards the user can choose. Where that is not possible, the mobile device must support the ability to install a sliding input method keyboard and provide the resources necessary to support the sliding input method keyboard (usually in the form of additions to the operating system and supporting application programming interfaces (APIs)).

##### List of Mandatory Features for Slide Input Methods

* Provide at least a QWERTY keyboard version of a slide input method keyboard
* Optionally be able to load custom keyboards that support the slide input method

#### Alternative Menus for Actions

##### Overview of Alternative Menus

An alternative menu for actions is an alternative means for user with mild mobility loss to perform actions that they can not do with their hands such as gesture-based interactions. Typically, these users may not be able to perform specific gestures such as pinching in or out with two fingers or swiping with multiple fingers at the same time due to restriction of their range of motion of their fingers or pain when they do specific motions. These interactions typically have to be performed another way. A menu that allows the user to launch an App or action that performs the same interaction is an alternative and equivalent way of performing these interactions. The App or action can perform interactions such as zoom in and out on what is displayed on the screen or taking a screenshot.

##### Technical Discussion of Alternative Menus

Many implementations of the Alternative Menu assume the menu icon has the property that it always be one top so that it is always visible no matter what the active application is. The location of the menu icon in some implementations can be set by the user. Since the menu icon occupies space on the screen, what is underneath the icon is obscured. The user needs to be able to move the Alternative Menu icon as it is not always possible to scroll the underlying screen image to expose the obscured part of the screen image. The use of an icon for the Alternative Menu is a specific implementation; other activation actions can be used. The action is only limited by the abilities of the end user. Some gestures are hard to be performed by users with mild mobility loss.

The other implementation of the alternative menu is to have an icon appear at the bottom or the top of the mobile device screen. There is no preferred method for providing access to the alternative menu. It should be obvious and consistent in presentation so the user can easily recognize it. The icon should meet the criteria that it is be greater in 12 mm square in size to allow easy activation.

The actions represented in the Alternative Menu need to be performed programmatically. The application programming interface (API) of the operating system needs to support that. Actions that are controlled by gestures typically can also be performed programmatically, provided the operating system has exposed those capabilities.

While the example refers to an Alternative Menu implementation, it is not necessarily the only implementation that can address the needs of this and other users. The implementation does not necessarily have to be a menu. The main goal is to provide mechanisms other than gestures or actions that require multiple touch points to complete actions. While this best practice is being highlighted in the context of someone with the abilities of a person with a mild loss of mobility, the need for alternative ways to complete the actions listed above also applies to users with moderate and severe mobility loss.

##### List of Mandatory Features for Alternative Menus

* Have a method of launching the alternative menu that is persistently available no matter the content being shown on the display of the mobile device
* Provide access to at least the following functions:
  + Activate the Home button
  + Go to the previous screen
  + Turn the screen off
  + Adjust the volume up or down (some mobile devices do not have a software equivalent to control the volume and the volume can only be control through the hardware buttons on the phone)
  + Take a screenshot
  + Activate the notification panel on the device (downward swipe on some devices)
  + Pinch zoom in or out
  + Power on menu
  + Access the menu setting for the alternative menu (allows the alternative menu to be repositioned or appear at a static position on the screen and turn the alternative menu off). On some mobile devices the menu choices can be configured by the user. If there is a predefined list of gestures, the corresponding action must be mapped to an alternative menu choice.

#### Voice Assistants

##### Overview of Voice Assistants

Voice Assistants are purpose-built applications that allow users to interact with a specific number of curated applications on the mobile device without having to utilize the traditionally structured method required to select an application icon, launch that application, and then activate a feature within that application. Voice assistants are designed to recognize key spoken or written phrases that handle all the steps required to access a specific feature within an application. An example of this is dictating a text message using a Voice Assistant: “Hey Voice Assistant, send a text message to George Jones” launches the text messaging App, enters the phone number for George Jones from the contact list on the mobile device, and then sets the focus to the text edit field so a text message can be entered.

Voice Assistants are not a complete solution on its own. Though Voice Assistant technology can allow users to access specific features within an application and operate common actions of the operating system as well as applications with exposed features, they cannot be used to navigate within an application’s menu structure and screen User Interface (UI) elements if those elements have not been exposed as an API. Switching between edit fields and controls in an application or other points of interest on the screen using only voice commands, for example, are not typically supported. As a result, full hands-free control is not supported but for individuals with mild mobility loss, voice assistants are an enhancement that reduces unnecessary physical interactions which might cause pain or be difficult to do.

##### Technical Discussion of Voice Assistants

Voice assistants currently still may require physical interactions from the user in the form of touch interaction with the screen or interaction with buttons to turn the Voice Assistant on for the first time and to complete some steps within applications. Voice Assistants typically only work with applications that have exposed their features through the programming framework for the applications or have applications programmer interfaces (APIs) specifically exposed to allow interactions with the Voice Assistant. Different operating systems will have different degrees of access by the Voice Assistant.

##### List of Mandatory Features for Voice Assistants

* Support the language of the region (French and English for Canada)
* Provide a single action to turn on the Voice Assistant if possible (keyword, button, or icon as examples)
* Provide access to as many of the task on the Primary Task List as possible

## Persona 2: Moderate Mobility Persona

### Performance Metrics for a Moderate Mobility Loss Persona



Figure 2. A moderate mobility persona.

Table 10. Performance metrics of a moderate mobility loss persona.

|  |  |
| --- | --- |
| **Performance Metric** | **Level of Performance** |
| Range of Motion - Ability to consistently target a square area with a part of the body | At least 30 mm x 30 mm in size |
| Range of Motion – not able to twist their wrist | No |
| Activation force - Ability to consistently apply 2 Newtons of force to that square area | Yes |

### Other Abilities or Characteristics of a Moderate Mobility Loss Persona

* Has no ability to move the fingers on his hands.
* Fingers on the user’s hands lack strength so they can not apply pressure to a surface.
* No ability to rotate their wrists.
* Can raise their arms up to shoulder height
* Full range of motion in their forearms
* Has the ability to move their arms with a high degree of control and able to consistently target a square region of 30mm or more in length and width
* Activates physical controls using the side of their hand using the knuckle on their, pinky finger, or the palm of their hand
* Uses an electric wheelchair to get around

### Use Case: Partial Spinal Cord Injury – C5 Quadriplegic

Michael (aged 25) is a software programmer. He has a partial spinal cord injury at the C5 level. He was in a skiing accident when he was a teenager. The injury to his spinal cord means that he has no conscious use of the fingers on his hand. He can move his arms with a high degree of control but cannot raise them above his shoulders. He cannot rotate this wrist and is not able to grasp anything in his hands without using a custom split. He is not able to use his legs, so he gets around in an electric wheelchair. He has exposure to a wide range of technology at work and in his personal life and is always looking to try the next new thing. He does most of his work on a desktop PC and uses a trackball mouse due to his inability to control a conventional mouse with his hand and fingers. He slides the base of his right palm across the top of the trackball to move the cursor on the screen. He uses the side of his right hand to active the buttons on the trackball. He has a custom split on his left hand, as he is left-handed, which is attached to a pen that he uses to activate the keys on the keyboard. He owns a smartphone and uses it to keep in contact with his friends through email and text messages. He has problems using the keyboard on his smartphone though, so he usually only reads emails and messages on his phone and then answers when he has access to a desktop computer.

### Best Practices for Moderate Mobility Loss Persona

User with moderate mobility impairments represent a group of users who cannot necessarily use the existing, default interface on their mobile device. Typically, they do not have the level of dexterity of their fingers and range of motion of their wrist or forearms to easily interact with a touch method of interaction for entering data or selecting a point of interest. Their mobile device may be mounted to their wheelchair using a mounting arm attached to the side of the wheelchair, the arm rest, the frame at the back of their wheelchair, or the headrest of the wheelchair. Alternatively, the mobile device could also be positioned on a stand on a tray mounted in front of them. For people without disabilities, they normally hold their mobile device 12 and 14 inches on average, and some people as close as 7 inches. [[14]](#footnote-15) [[15]](#footnote-16) [[16]](#footnote-17) [[17]](#footnote-18) People with moderate mobility loss typically have their mobile device positioned further away from their face since their mobile devices are mounted to their electric wheelchair. There is not one position that is optimal for each user, but it is possible to define a range of distances where the phone may be positioned relative to the person face. Nominally, the device will not be mounted more than one average arms length away from the user’s face. Based on anthropometric data provided by the United Nations, the average arms length is 0.5 to 0.7 meters.[[18]](#footnote-19) It should be noted that there are differences between a male’s and female’s average reach distance, the longer value attributed to males is used in this document when calculating factors for related accommodations.[[19]](#footnote-20)

Corresponding to the increase in view distance is a need to increase the minimum font size of text displayed on screen. There is a formula for calculating this distance based on work published in the EN 301 549 V3.1.1 (2019-11): Accessibility requirements for ICT products and services, as follows: [[20]](#footnote-21)

*Minimum Text Height = 0.01233 \* Viewing Distance*

Using the data above related to the range of average arm lengths (0.5 to 0.68 m) and assuming the visual acuity of 20/40, the **minimum text height ranges from 6.2 mm to 8.4 mm. (0.24 inches to 0.33 inches).**

The two recommended best practices for a moderate mobility persona discussed below are:

* + 1. External keyboards
    2. External pointing devices

#### External Keyboards

##### Overview of External Keyboards

Expanded keyboards are essentially keyboards with larger keys than are available on a commercial QWERTY keyboard. Expanded keyboards can help in situations where it is difficult for the user to accurately target a normal-sized key. The larger size gives more area to "aim at". Keys of up to 30 mm by 30 mm are available on assistive technology keyboards.[[21]](#footnote-22) Given the abilities of this group of users (no dexterity, some restriction of wrist motion, good forearm and upper arm range of motion and strength), they can the use external keyboards more efficiently.

##### Technical Discussion of External Keyboards

Many expanded keyboards have “built-in guards”, essentially an overlay with holes above each key, with the letters slightly sunk beneath the surface of the keyboard to prevent unintentional activation of one or more keys at a time. Well-spaced, enlarged, and slightly recessed keys allow the user to stabilize part of their limbs on the keyboard without activating keys unintentionally. In the context of mobile devices, physical keyboards may not exist on the device, replaced by a virtual keyboard displayed on the device’s screen. The screen itself can also be a limitation if the required size of the keys to facilitate accurate targeting of the keys makes it difficult or impossible to display all the keys in a QWERTY-style keyboard. While a T9 (telephone-style keypad) can avoid the issues created by having limited space on the display to show a full keyboard, the repetitive motion of a T9 keyboard can sometime cause issues for users with specific conditions where repetitive motions are difficult to perform. With more than a hundred relatively small and crowded keys and their small printed and sometimes low-contrast labels, a standard computer keyboard is a relatively complex device. Operating it can be troublesome for users with limited arm, hand, or finger movement abilities. Physical keyboards on mobile devices, intended for able-bodied users, still do exist, and can be preferred over virtual keyboards by some users as they provide positive tactile feedback and, depending on the user, a more reliable text entry method. Physical keyboards built into mobile devices obviously lack the ability to scale beyond a specific size without affecting the size of the mobile device.

Providing a standardized interface for external keyboards to mobile devices is mandatory. External keyboards are supported currently through the Universal Serial Bus (USB) Human Interface Descriptor (HID) profile or the equivalent wireless Bluetooth HID profile. The actual style, type, and manufacturer of the keyboard is up to the end user to procure. The use of these two standardized ways of connecting a keyboard make the compliance process easier. Assistive technology manufacturers will typically follow the existing consumer standards. Given the current practices, it is suggested that mobile device manufacturers support both methods of connection.

##### List of Mandatory Features of External Keyboards

* Size of the keyboard keys improve targeting for those with gross motor movement in their hands and arms but without fine motor. Up to 30 mm x 30 mm keys may be used. These are known as expanded keyboards.
* Timed based interactions and functions such as auto repeat of keys when held down for a specific period of time need to provide options for the user to change the duration of the feature, with a range of up to 10 times slower than the default setting. Other time related features of keyboards are:
  + - Slow keys – makes the device wait before accepting a keystroke (default: 1 second, adjustable up to at least 15 seconds)
    - Bounce keys – this option allows the device to ignore a keystroke when you press the same key more than once with a set time limit (default: 0.5 second, adjustable up to at least 15 seconds)
    - Repeat keys – the rate at which the character on the key is repeated if continually pressed (default: 0.3 seconds, adjustable up to at least 15 seconds)
* Interactions that require multiple keys to be activated at the same time need to provide alternative activation modes.
  + One way to do this is to allow sequences of keystrokes. Instead of pressing multiple keys at a time, the keyboard or mobile device operating system allows the user to press and release a modifier key, such as the Shift key, and render it continuously active until any other key is pressed.
  + Most mobile device applications do not require interactions that require keystroke sequences. The most common is the Shift key in combination with another key. Ctrl, Alt, and Del keys which are on most external keyboards typically do not have a required equivalent within an App. Most virtual keyboard on mobile devices do not have the Ctrl and Alt key present. There may be exceptions for browser-based Apps or webpages though, so it is important to support the keystroke sequence capability on the mobile device. The support for keystroke sequences must be supported in the operating system on the mobile device.

#### External Pointing Devices

##### Overview of External Pointing Devices

Users with moderate mobility loss cannot typically store their mobile devices in their pockets and pull them out easily, as they lack the dexterity. This group of users normally uses electric wheelchairs with their mobile devices mounted to the wheelchair so they can operate them with no dexterity and limited arm and shoulder movement. Common locations for mounted mobile devices are to the side of the wheelchair, on the armrest of the wheelchair, on a tray in front of them (also called a lap tray) or, less commonly, to the backrest headrest of the wheelchair.[[22]](#footnote-23)

Correspondingly, a mobile device may be mounted further away than the device is normally viewed by a person without a disability. Typically, the device may be mounted closer to waist level. This is approximately equivalent to an arm’s length for most people. As discussed above, for the purposes of this document, the assumption is that the mobile device can be placed up to one arm’s length away from the user’s face. Based on anthropometric data provided by the United Nations, the average arms length is 0.5 to 0.7 meters. For the purposes of a calculating an appropriate font and cursor height at this extension, this document assumes at a 0.7-meter viewing distance.

##### Technical Discussion of External Pointing Devices

The distance of the positioning of the mobile device is determined by the need to not block the field of view of the user in the wheelchair. A display mounted closer to the person’s face blocks the field of view of the user and, therefore, makes it more difficult for the user to drive their wheelchair, especially in a cluttered environment.

Correspondingly, with the increase in viewing distance of the mobile device display is the requirement to increase the font size. A formula has been created to calculate the minimum character height for best legibility at specific viewing distances – **Minimum Text Height (H) = 0.01233 \* Viewing Distance**. Using the longest viewing distance described above and an average visual acuity of 20/40, the character height should be 6.2 mm to 8.4 mm (0.25 inches to 0.33 inches). For the purposes of this document, the cursor size of the pointing device should also adjustable up to a height of 8.4 mm. The outline of the cursor should be in a different color than the body of the cursor so that it can be easily seen on different backgrounds. The ratio of the contrast of the outline to the body of the cursor should by 7:1.

Users with moderate mobility impairment, as defined in this document, lack the fine motor control of their fingers to target the small area (7 to 9 mm square) that makes up a typical interactive point of interest available on mobile devices. The side of their hand or their palm represents a contact area larger than that specified above and increasing the size of the interactive area typically means less information can be displayed on the screen. As a result, external pointing devices provide an alternative method of interaction.

With the assumption that the font size will increase to improve the recognition of the text on the screen, if the mobile device is placed further away, there is the need to determine the minimum cursor size to be displayed in conjunction with the external pointing device. Many mobile devices today, if they support external pointing device, support only one size for the pointing device cursor or only default cursor size and large cursor size. To simplify the discussion, the critical characteristics for the cursor will be extrapolated from guidance provided for font design for low vision users. The key characteristics are shape, contrast, and size.[[23]](#footnote-24),[[24]](#footnote-25),[[25]](#footnote-26) The shape has been dictated by convention. Most users expect an arrow shaped cursor where the active region is the tip of the arrow. The cursor can be a solid body or a simply an outline of an arrowhead. The characteristic of contrast dictates which of these choices are used and the color or the arrow outline or body. A minimum cursor height has been recommended for a mobile device at a full arm’s length extension, but it would be more effective to allow users to select cursors of different sizes to accommodate situations where the mobile device is positioned closer to the user’s face.

The “I” beam cursor that appears in the Word Editing field is typically proportional to the size of the mouse cursor. This set of guidelines recommend a “I” beam cursor not to exceed the height of the letter “H” in the font used systemically.

##### List of Mandatory Features for External Pointing Devices

* + The ability to adjust cursor speed on the mobile device so the use can move the cursor at a rate of at least of 2.54 mm per second (0.1 inches per second) when drawing a horizontal line to a high speed of 84 mm per second (3.3 inches per second) when move the cursor quickly across the screen diagonally.[[26]](#footnote-27)
  + The ability to adjust cursor size on the device for better visibility
    - Provide the ability to adjust the cursor height up to at least 7.6 mm or 0.33 inches.[[27]](#footnote-28)
    - Outline the cursor in a color that contrasts with the body of the cursor and provide color contrast of the body of the cursor to the outline of the cursor of 7 to 1.[[28]](#footnote-29)

## Persona 3: Severe Mobility Loss Persona

### Performance Metrics for a Severe Mobility Loss Persona



Figure . Persona with severe mobility loss.

Table 11. Performance metrics for a severe mobility loss persona.

|  |  |
| --- | --- |
| **Performance Metric** | **Level of Performance** |
| Range of Motion - Ability to consistently target an area of at least 25 mm by 25 mm square with a part of the body | No |
| Range of Motion – ability to twist their wrist | No |
| Activation force - Ability to consistently apply 3 Newtons of force on a 11 mm by 11 mm area | No |

### Other Abilities and Characteristics of a Severe Mobility Loss Persona

* The user has no ability to move their legs, arms, hands, and fingers.
* Still has control of their head and facial muscle though so they can sip, puff, and move their eyes independently.
* They have problems with their speech, so they use an augmentative and alternative communications (AAC) device that generates synthetic speech when they type in a sentence or phrase.
* They use an electric wheelchair to get around which they can control through a pneumatic switch by sipping and puffing.

### Use Case: Muscular Dystrophy – no use of extremities

Larry (age 55) is an architecture professor at a university. He spent the early part of his career in private practice as an architect. Larry has muscular dystrophy which has caused progressive muscle weakness in his body. The weakness has progressed to the point where he cannot walk anymore so he uses an electric wheelchair. He has also lost the independent use of his arms and hands as the muscles no longer have the strength and coordination to allow him to control them. He uses an electric wheelchair that he controls by a series of pneumatic switches which are mounted to his wheelchair. He sips and puffs on the switches to control his chair. He still has good control of his head and facial muscles, but he is unable to speak clearly, so he uses an augmentative and alternative communications device to generate synthetic speech from what he types. He can independently move his eyes and has good 20/20 vision when he wears his glasses.

Larry makes extensive use of technology. He uses a laptop computer to do the preparation for his lectures at school. His laptop is mounted to his wheelchair on a tray that goes over his lap, and it goes everywhere with him. He controls his computer using a pneumatic switch which uses Morse code to enter commands. He also owns a smartphone which he controls through his computer and a special software program. In addition to making phone calls and texting, he also uses the smartphone for checking his email, and updating Facebook on the go. If he is near a Wi-Fi hotspot, he will use his laptop to do some of these tasks instead of his mobile device.

### Best Practices for the Severe Mobility Persona

The two recommended best practices for a severe mobility loss persona discussed below are:

1. Fully Capable Voice Recognition – end to end support
2. Switch Interface for Mobile Devices

#### Fully Capable Voice recognition – end-to-end support

##### Overview of Fully Capable Voice Recognition

There are two classes of voice recognition interactions. The first are voice assistants, discussed previously in this document. The second class of voice recognition interactions are more complex and provide the capabilities to initiate the interactions necessary to set the focus to points of interest, activate and interact with the features and properties of that point of interest. Selecting an icon, activating the icon, selecting a menu with the application launched, selecting an arbitrary point on a map, interacting with a control, and entering and editing text are examples of common interactions that the voice system would have to be able to perform.

While voice assistants are usually tightly integrated with the features, applications and organizational structures of the operating system and some applications, they are not able to provide the same level of access and interaction with third party applications as they have no prior knowledge of the application’s user interface and internal application structure. (Note that there are attempts to resolve this, but they rely on the application developer exposing specific properties of their application which while currently suggested is not mandatory for application developers and there are limitations to what actions can be accomplished).[[29]](#footnote-30) Voice assistants rely on the applications having a specific structure to operate with the application. That is why the second class of voice interactions is required. It is impossible to know the way the exact user interface will be designed for third party applications.

A more generic method is required to launch icons, select menu items, scroll, enter text, and pick an arbitrary point of interest. This is called ‘Fully Capable Speech Recognition’ in this document as it handles all aspects of an interaction with the mobile device using only speech recognition. On some mobile devices, some interactions for example are implemented through gestures and there is no equivalent method to initiate that interaction using only voice assistants. In addition, the Fully Capable Speech Recognition system must provide a mechanism to interact or control features that have no displayed user interface (UI). A side swipe with the side of the hand on the screen to capture an image of the screen is an example of an action with no visible UI.

To be a solution for people with severe mobility impairments, fully capable speech recognition must provide “Equivalent Access” for all features and functions on the mobile device through voice interaction only. Equivalent Access must include access to features on the phone that are typically accessed through interaction with buttons, touch screen or other physical interfaces provided on the device. Controlling the volume programmatically using speech recognition would be an example that is often overlooked. The Fully Capable Speech Recognition interaction must not require any additional physical interaction with the device or peripheral supporting hardware, so that only voice input is required. The sequence of steps the user takes through voice recognition does not have to be the same as he would have taken through touch, but the same end goal of the interaction must be achieved. For example, going through a series of menus to dial a phone number from his address book can be equivalently achieved when using speech recognition by a single voice command (such as, “Call Susan Smith”), with the same end result, that the number is dialed.

Ideally, the speech recognition technology will work equally well whether the voice is a person’s typical, natural voice, a person’s natural but dysarthric voice, or a prosthetic voice, (such as an electrolarynx or a synthesized voice from an AAC device) and with a synthetically generated voice (see Section 14 on Speech Loss)

For a Fully Capable Speech Recognition system to be considered a solution, it must perform every step required to interact and complete the tasks in the Primary Task List. What is missing in many implementations on mobile devices is the ability to pick an arbitrary point of interest. On desktop implementations, this interaction is performed by sequentially picking a series of smaller and smaller regions on the screen until the appropriate point of interest is selected using voice commands. For example, the screen can be divided into 4 sectors and the user will pick the sector that contains the point of interest desired. That sector is then divided into 4 sectors. The user keeps picking sectors till the sector containing only the point of interest is contained within it. The user can then interact with that point of interest. This is not only approach to achieve this though.

##### Technical Discussion of Fully Capable Voice Recognition

It is important to note the speech recognition does not typically have a visual user interface for the user to interact with except when setting up the system or adjusting setting related to the system. The system must have a way to turn on the active recognition mode of the system without needing to physically interact with the mobile device. “Key word spotting” or listening for a word or phrase to activate the system so that it is actively listening for a command phrase is an example. The speech recognition system needs a mechanism to interact with the operating system so that it can programmatically control features and interfaces to applications directly (for example, insert text in an edit field or interact with a control such as a button or menu). In the case of applications, the speech recognition system should be able to interact with all applications that are on the phone that refer to the primary task list (see Section 8.3) and which are on the phone when it is shipped from the supplier to the consumer. The speech recognition system is not required (though it might) to interact with third application installed by the consumer. Games for example that may have modes of operation that may be difficult to deal with using voice recognition capabilities is an example of interactions that is not a mandatory requirement for the purposes of this document.

In addition, the system should provide the user access to the speech recognition system when a network connection is not available. Many speech recognition systems rely on the recognition process being executed on cloud-based services so they can not work without the presence of a network.

There are two mode of speech recognition that are common: speaker independent and speaker dependent. Speaker independent mode requires no training to use by the user. Speaker dependent mode requires training by the user to use the system and the recognition accuracy improves with usage. One or both modes can exist on a single device depending on the recognition accuracy required or the mode of operation. Speaker independent mode being active when the system has no network connection and speaker dependent mode being active when a network is present would be one potential example.

##### List of Mandatory Features for Fully Capable Speech Recognition:

* Ability to set the focus to an arbitrary point of interest using voice commands only
* Ability to interact with the point of interests (edit fields, radio buttons, checkboxes, etc.) using voice commands
* Ability to switch voice recognition on and off using pre-defined keywords
* Ability to access features or Apps that are typically accessed through gestured using voice commands only
* Ability to support regional languages (French and English for Canada)
* Supports a connected and a not internet connected mode of operation
* Ability to enter text into text fields using voice recognition

#### Switch Interface for Mobile Devices

##### Overview of Switch Interfaces for Mobile Devices

The use of a single or two switches is another way for a user with a high-level mobility impairment to interact with a mobile device. Switches are devices for making and breaking the connection in an electric circuit. For people with high mobility loss, switches represent one of the ways or in some cases the only way to interact with a mobile device. The switch can control a scanning method on the device that allows the person to pick a point of interest or enter text.

“ROW-COLUMN scanning is a technique used by individuals with severe disabilities for entering text and other data into computers and augmentative communication devices. It is an important method because it can be used with as little as one switch for input. A common implementation of row-column scanning with one switch requires three switch hits to make one selection from a two-dimensional (2-D) matrix of letters, numbers, symbols, words, or phrases. The ﬁrst switch hit initiates a scan through the rows of the matrix. Each row of the matrix, beginning with the ﬁrst, is highlighted in turn until the second switch hit is made to select the highlighted row. Each column of the row is then highlighted in turn until the target is highlighted. When the third switch hit is made the target is selected. Variations on this theme are abundant and include column-row scanning and continuous row scanning, which eliminates the ﬁrst switch hit needed to initiate row scanning”.[[30]](#footnote-31)

When one switch is used, the rate at which the focus moves from one row or column to the next is based on a predetermined rate. The rate can be set by the user and can typically range from 25 milliseconds to 15 seconds. Up to 15 seconds is sometimes needed to accommodate a person who has allow some limited range of motion of one part of their body but where a lack of stability in the motion makes it hard to target the switch. As a result, it can take longer to activate.

When two switches are used, the activation of one of the switches may be used to advance focus for the rows. The other switch will be used to select the row desired when it has the focus. The first switch can then be used to advance the focus through the columns. When the appropriate row and column index in the matrix is reached, the user will then use the second switch to select that matrix entry.

In the example, the technique for scanning an array of entries like letters of the alphabet or a numeric keyboard was explained. The same technique can be used to scan the array of pixels that make up the elements of the mobile device screen to pick an arbitrary point of interest on the screen like a specific point on a map or a hot spot in an image. The position of the scan is typically indicated by a horizontal or vertical line. In order to make the scanning more efficient, the width of the line for scanning the rows and columns is many pixels wide and each advancement of the scan moves the line the predetermined width of the line. So, a mobile device screen with a size of 2960 x 1440 px at 570 ppi might use a line width of 50 pixels in order to create a matrix of 60 x 29 elements.

A rudimentary ROW-COLUMN scanning technique has been described, but there are various techniques that can be used to speed up the rate at which input is generated. Various techniques are described in papers by Rivera 2009[[31]](#footnote-32) and Biswas 2008[[32]](#footnote-33). This list does not cover all techniques, it is just a sampling of approaches. ROW-COLUMN scanning must at least be implemented on the mobile device.

##### Technical Discussion of Switch Interfaces for Mobile Devices

This section will describe the actual implementation of the switch interface – physical connect, operating system implementation and UI implementation factors.

The implementations of the switch interface between the various operating systems are very similar. This section will describe a generic implementation, focusing on the common elements between operating systems. While there may be differences between the generic description provided here and the actual implementations on the various operating systems, the key underlying principles will be the same and the system requirements will be the same.

##### List of Mandatory Features for Switch Interfaces for Mobile Devices

There are specific expectations established from users of switch access methods that come from switch use with computers and laptops. The following is a list of some of these expectations:

* The ability to connect an external single switch or two switches to the mobile device through a standardized connection method
* Ability to use the capabilities build into to the device as activation modes – touch screen (using portions of the touch screen as the switch active areas) and the mobile device camera (using head movement as the switching method)
* The ability to select single and dual switches as the input method
* The ability to switch between automatic scanning (stepping of the rows or columns proceeds automatically based on a timer) and manual scanning (scanning by using one switch to advance the focus by detecting the switch closure created by the user and using another switch to select the row, column, or desired element)
* The ability to control the scanning rate for automatic scanning from (25 milliseconds to 15 seconds)

A minimal set of scanning adjustments has been described, but there are many other scanning adjustments that can be used to improve the customization of the scanner to the abilities and needs of the user. A couple of examples are an adjustable time that the switch must be closed before the scanner interprets this as a deliberate closure, and an adjustable time that the switch must be opened before the scanner interprets this as a deliberate opening. These two settings allow the scanner to filter out accidental clicks and releases of the switch and may reduce the user’s error rate significantly. Various techniques are described in research papers.[[33]](#footnote-34) [[34]](#footnote-35) [[35]](#footnote-36)

###### Physical Connection

The switch needs to be connected to the mobile device though some sort of physical interface. That connection can be through a physical port on the device, or a wireless interface implemented on the device. Currently, the Apple and Android platforms use the wireless Bluetooth interface for the connections. There is no dedicated, standardized interface for the switches on the device such as a physical port. All the existing ports on the mobile device such as the USB port, the Lightning port and the 3,5 mm jack do not have a specific mechanism for supporting switches and in many cases, they may be in use while the switch interface is active (e.g., using the switch interface to dial the phone while talking and listening though the 3.5 headphone jack). A dedicated physical interface is required between the switch and the mobile device.

Most switches provide mechanical switch closures as outputs. The physical interface from the switch is typically a 3.5 mm mono or stereo phono-jack. To interface the mechanical switch closures to the wireless Bluetooth interface of the mobile device, a conversion module is required. The conversion module converts the mechanical switch into a wireless signal that the mobile device operating system needs to interpret. There are also switches or switch interfaces that provide a connection through a USB cable.[[36]](#footnote-37) The switches or switch interfaces produce either mouse clicks (either Left Click, or Right Click), or keyboard keystroke combinations (Space, Enter, Tab, and Arrow keys: Up, Down, Left and Right or combination of keys).

For the Android operating system, the following switch or switch-like interfaces are provided:[[37]](#footnote-38)

* connection through a USB port using simulated keystroke combinations (HID Profile)
* Bluetooth connection using simulated keystrokes
* The physical keys on the mobile device (volume up and volume down keys)[[38]](#footnote-39)

For Apple iOS devices, the following switch modes are provided (Voice Over needs to be activated first):

* External via Bluetooth with simulate keystrokes
* Touch screen
* Camera - Move your head to use the iPhone’s front-facing camera as a switch. You can also use the camera as two switches: One when you move your head to the left, and the other when you move your head to the right. [[39]](#footnote-40)

Switches connected by ways of a wireless interface use the Bluetooth HID profile. The keyboard configuration for that profile is used. Keystroke combinations are sent to the mobile device to represent the code to produce the equivalent of a switch closure interaction on the mobile device. There is currently no standard that covers this process. It is rather a convention that has been adopted by some mobile device manufacturers and some assistive technology manufacturers. A limitation is that you lose the ability to use the specified keystroke combinations for other purposes as they need to be reserved to indicate switch activations. Alternatively, some mobile devices support using the mouse configuration of the Bluetooth HID Profile and use the left and right mouse click protocols to represent switch closures. There is a need for a more formal standard. Both the mouse and keyboard approaches require that the operating system (OS) know that the interaction is a switch interaction, and the keystroke combinations need to be interpreted as switch closures and be able to handle the events appropriately to interact with the mobile device. Section 8.1.2. on EN 301 549 requires a standard connection for assistive technology so this is currently an unmet requirement.

The USB and Lightning connector [[40]](#footnote-41) [[41]](#footnote-42) hardware ports use similar HID Profile with the keyboard and mouse protocols as methods of representing switch closures.

###### Operating System Implementation

The operating system implementation is composed of a number of distinct functional blocks:

* A block to convert the wireless or hardware protocol to information for the operating system to interpret
* A block to interpret the information from the wireless or hardware protocol block and turn that into an action the operating system can act on
* A block to execute the action from the interpreter block, to convert that action into a system implementation. The action could comprise a change to the user interface (activate an icon) or some system event such as changing the point of interest on the screen or scheduling an event for the operating system to act on at some appointed time.

From a user interface perspective, the switch interaction must be able to at least:

* Set the focus to a point of interest on the screen
* Activate a point of interest on the screen
* Provide the ability to scroll what is on the screen
* Provide alternative access method to gesture based commands or commands that require simultaneous actions to complete

##### List of Mandatory Features for Switch Scanning

* The ability to connect an external single switch or two switches to the mobile device through a standardized connection method
* The ability to use the capabilities build into to the device as activation modes – touch screen (using portions of the touch screen as the switch active areas) and the mobile device camera (using head movement as the switching method)
* The ability to select single and dual switches as the input method
* The ability to switch between automatic scanning (stepping of the rows or columns proceeds automatically based on a timer) and manual scanning (scanning by using one switch to advance the focus by detecting the switch closure created by the user and using another switch to select the row, column, or desired element)
* Implementation of at least one ROW-COLUMN scanning strategy
* The ability to control the scanning rate for automatic scanning from (25 milliseconds to 15 seconds)
* The ability to control the delay between when the switch is press and when the action is registered on the mobile device (delay should range from 1 second to 15 seconds)

# Cognitive Community Personas

## Definition of Cognitive Community Members

For this document, the term “Cognitive Impairment” is used to describe individuals that have conditions that may affect some aspect of their cognitive functioning such as aging, stroke, learning disabilities, and traumatic brain injury. Functional abilities that may be affected are perception, problem solving, development and articulation of concepts, reading difficulties, thinking, putting items or steps in sequence, and remembering things. People with cognitive conditions may have difficulties with [[42]](#footnote-43):

* Reading
* Writing
* Spelling
* Listening
* Speaking
* Thinking
* Performing sequential tasks
* Doing arithmetical calculations
* Responding to directions/supervision
* Concentrating with direction
* Coordination
* Distinguishing left from right
* Balance
* Spatial orientation
* short and long memory

Cognitive conditions can also include conditions such as depression and bipolar disorders. These conditions relate to emotional issues. Emotional issues typically refer to the control of the expression of emotion, the ability to detect and understand emotions, and the tolerance of frustration.2 For the purposes of this document, however, emotional issues are not included as currently the detection of those states by technology is not possible.

For the purposes of the accessibility of mobile device, these difficulties are being put into five broader categories to make the discussion simpler. Those five categories refer to:

* Written literacy
* Spoken literacy
* Short term memory
* Long term memory
* Ability to learn a new task

### Terminology within the Community

There is some resistance to using academic and medical models to describe individuals with cognitive conditions. This resistance arises because the measures used in these models have historically been used to determine access to social services and to restrict the rights of individuals from the community.

The controversial discourse around the term ‘disability’ or ‘impairment’ in literature often centers on the contention between the medical model – that frames ‘disability’ as a physical and mental impairment – and the social model that ‘pigeonhole’ people who have physical and mental differences within a given sociocultural context as ‘disabled’ resulting in deliberate segregation which precludes them from accessing services and causes further isolation.3,4

As a result, this document is proposing an alternative way to describe the abilities of individuals in the community by using functional definitions for their abilities as they correspond to daily activities that they need to perform to live in the community. It is not the only way to help define groups within the community, but this method is designed to make the characteristics easy to understand and relate to by people who are not assistive technology professionals nor immersed in the community.

### Conditions affecting literacy

Literacy is defined as the ability to communicate in either written (reading and writing) or spoken format. The degree of literacy of an individual can vary greatly in this group of users. Literacy assumes an intent to communicate a concept or desire between the individual and another party or parties.[[43]](#footnote-44) A person should be able to read the words in a document and grasp its arguments or concepts. A person should be able to write or type sentences, but they must be able to express complete and coherent thoughts. Alternatively, a person must be able to communicate using spoken words if they lack written literacy. Similarly, a person might be able to communication only using a written format and not speak depending on their abilities. These abilities are not mutually exclusive as many people also possess written and spoken literacy. Conditions that can affect literacy are dyslexia, aphasia, and traumatic brain injury. The conditions related to the natural aging of individuals cause individuals to have difficulties in these categories also.

Each of the individual language skills (reading, writing, and verbal) can be impacted by conditions that affect these abilities in varying degrees. This document will not try to address all the conditions that may be reflected in this group of users, but it will try to focus on conditions that illustrate the need for specific classes of solutions that can be used to address varying degrees of abilities within these difficulties. These difficulties are not binary in nature and an individual may have varying degrees of ability within each of these categories. A typical user may have only one or a combination of one or more of these difficulties.

### Conditions Affecting Memory

For the purposes of this document, the focus is only on the concepts of short- and long-term memory. In regard to operating mobile devices, short-term memory applies to being able to remember an email address long enough to read it from a contact list and then type it into a data entry field in an email App as an example. Short term memory typically refers to something that is remembered for only a few seconds. Long-term memory would apply to remembering how to use a program you learned to use a few weeks ago or remembering the name of a person you need to contact from a meeting you attended a few days ago. Long term memory typically refers to being able to remember something from more that 30 minutes ago. There are other models of memory that involve additional parameters, but the focus is on these key aspects of memory. Conditions that can affect short-term memory loss include dementia, brain tumors, traumatic brain injuries, depression and anxiety, Post Traumatic Stress Disorder (PTSD), Parkinson’s disease, Huntington’s disease, and infections in or around the brain. Conditions or causes of long-term memory loss are traumatic brain injuries, severe brain infections, brain tumors, stroke, hypoxia, severe cases of epilepsy, and dementias like Alzheimer’s disease.

### Ability to Learn a New Task and Repeat It

The “ability to learn a new task and repeat it” is a very high-level concept. It is unique in that it involves the ability of several characteristics of the individual to work together to achieve the end goal. Unlike memory which involves one specific characteristic and has a defined and measurable success criterion, the “ability to learn a new task and repeat it” may involve some or all these abilities:

* Procedural memory (remember steps)
* Ability to put items into categories
* Ability to see cause and effect relationships
* Ability to understand abstract concepts
* Ability to generalize and apply previously learned information
* Ability to focus attention (or concentrate)
* Ability to be aware of passage of events Ability to recognize spatial relations: know left from right Ability to discriminate - perceive differences and similarities Ability to organize and interpret what's perceived Ability to perceive and utilize sequential events or items - retain and recall series in order

For the purposes of using a mobile device the main criteria are to be able to learn how to complete a new task and then repeat it 30 minutes later or longer. The concept of longer may involve repeating the task weeks or months later.

## Specific Performance Metrics for Cognitive Personas

The performance metrics for each level of abilities represent degrees of performance along each of the performance metrics used to define users in the community. When assessing abilities of users from this group of users, focus is put on thee five key performance metrics that define the abilities of every user. Those performance metrics are:

* Literacy - ability to encode and decode written text
* Speech/Language - ability to speak and understand speech to carry on a conversation
* Short term memory
* Long term memory
* Ability to learn a new task and repeat it

## Strategies for Mobile Device Design Solutions for the Cognitive Community

Several accommodation strategies for people from the cognitive community were suggested in a research paper by Francik (1999).[[44]](#footnote-45) They looked at the accommodations for people who were labelled as having an intellectual disability, people who acquired cognitive conditions as they age, people with learning disabilities and people with traumatic brain injuries. The accommodation strategies below are outlined below.

### Redundant, User-Controlled Modality of Information

The intent of this requirement is to present information in the formats or formats that are easiest to consume by the user. Often that is in text and audio format, but it can also include these formats:

* Using visual aids in tandem with textual information, like diagrams, icon, or drawings
* For all auditory outputs, provide a visual complement
* For all visual outputs, provide an auditory complement
* When providing a visual and auditory output, ensure that user can choose either mode for any element
* Provide the ability to read text aloud using synthetic speech
* Provide support for interfaces to alternative devices
* Provide descriptions for all visual aids, like pictures and diagrams
* Provide captions or subtitles for all audio tracks
* Provide audio descriptions for any videos
* Provide multiple ways of locating and identifying controls, such as through size, texture, shape, color, customizable labels, customizable keycaps, and auditory output to announce different elements[[45]](#footnote-46)

### Provide streamlined, user-controlled amount and rate of information

This class of strategies provides support for people with all types of cognitive abilities to both manage their selective attention as well as to reduce perceptual and memory loads. These strategies have been found to be effective through research into learning disabilities and brain injury.[[46]](#footnote-47) Some of the recommendations in this paper that specifically apply to mobile devices are:

* Provide with the ability to control the size, placement, and appearance of display elements: contrast, print, numbered bullets, highlighting, placement of elements on either side of the display, etc.
* Provide user control of volume, pitch, rate, and repetition of auditory information.
* Provide support for screen magnification.
* Use simple interface layouts
* Use standard, simple layouts for controls.
* Layer functionality; hide less frequently used functions; let the user customize the environment to foreground frequently used functions. (However, the risk is that some people may not look for “hidden” functions – out of sight, out of mind.)
* Make the product self-adjusting.
* Use orientation-independent connectors and media. Use wireless connection strategies. Ensure that connectors and media cannot be inserted improperly.
* Provide ways in which the user may recognize, rather than be required to recall, information.
* Avoid the use of flashing or display refresh rates that could induce epilepsy
* Do not delete message notifications until the user dismisses them
* Provide a mechanism to speed up, slow down, or repeat information until it is acted upon
* Provide adjustable timing
* Avoid functions that need two or more conjunct actions to activate or operate.
* Provide a way to ‘Select’ and ‘Confirm selection’ to avoid mistakes in navigation
* Let the user set the pace of interaction with the system.
* Reduce system lag and response time.

### Use Procedural Support in the Form of Use Prompts for Procedures and Support Decision-making

Some of the strategies are:

* Provide structure for tasks and outline instructions, cue sequences
* Provide definite feedback cues in the form of visual, acoustic, and touch input
* Use concrete indications rather than abstract ones.
* Instead of using relative reference controls, use absolute ones.
* For menu prompts, use a goal or action framework.
* Provide support for “wizards” that provide assistance, streamline configuration, and assist with sequences.
* Complex sequences, such as system backup, program launch, and user registration, should be automated.
* Provide defaults and simplify their re-establishment.
* Provide support for integration with calendar or reminder software
* If necessary, reduce the number of calculations required or provide calculation assistance[[47]](#footnote-48)

Studies have shown the prompting or providing hints/instructions through audio, video or pictures form help individuals with intellectual disabilities individuals learn new tasks and maintain that knowledge.[[48]](#footnote-49)

Research suggests that picture prompts help people with intellectual disabilities learn and generalize complex skills (Johnson & Cuvo, 1981 [[49]](#footnote-50); Thine sen & Bryan, 1981 [[50]](#footnote-51); Wacker & Berg, 1983[[51]](#footnote-52)). Participants in these studies were taught to replicate the performance of a picture depicting each phase of a complex task, and subsequently to finish the task on their own using these photos. Furthermore, individuals who were taught to use visual prompts have expanded their use of photos to other tasks.[[52]](#footnote-53)

Individuals can be assisted without relying on another adult, supervisor, or teacher to complete steps of a task by using self-operated, permanent prompting systems, such as graphics or aural cassettes. Students can learn tasks in a simulated setting and generalize the abilities to untrained and novel tasks by using visuals and audio cassettes (Briggs et al., 1990).[[53]](#footnote-54)

### Support Content Strategies. Bear in mind that training format matters less than careful design of materials.

Content strategies include the formatting of the content to organize it in easy to consumer blocks or “chunks” of information that easier to concentrate on. It also includes making the content easy to present in multiple formats usually audio and text of user adjustable sizes. These strategies are especially helpful for people who have language or learning disabilities (Day and Edwards, 1996; Lewis, 1998; Raskind and Higgins, 1998).[[54]](#footnote-55) Content strategies also address product documentation (TAAC, 1997, 1999; EITAAC, 1999).[[55]](#footnote-56)

Typically, this means providing information in audio and well as text format. As examples, these studies provide examples were alternative formats improved the comprehension of text. People who struggle with written text can benefit from hearing something spoken out loud, and vice versa. One typical study examined 39 people with dyslexia who could scan printed materials into an optical character recognition device with speech synthesis improved their reading speed and comprehension (Elkind, Black, and Murray, 1996, in Raskind and Higgins, 1998) [[56]](#footnote-57). In another study, incorporating speech into text had a rehabilitative effect, doubling the rate at which students learned to decode (read) (Wise and Olson, 1994, in Lewis, 1998).[[57]](#footnote-58)

There are slight variations on how these themes are implemented on information and communications technology depending on the cognitive abilities of the individuals, but the underlying principle remains the same across the cognitive conditions.

Except when documentation is presented, the fourth strategy class—content organization— is rarely included in guideline publications that center products and services. Document content and reading tools are explored in research on learning disabilities. Accessible structuring of Web content is receiving more attention.[[58]](#footnote-59)

There was also a recommendation that applied to the process to learn how to use technology:

* Provide self-paced training and consider an adaptive trainer.

Learning how to use technology is outside of the scope of this document.

### Tolerance of Errors

Another feature that is important to minimize confusion is to design the systems to have better “tolerance for error”. Individuals with intellectual disabilities may make frequent mistakes. If the mistake causes an unrecoverable error, the user will often become confused and fail to complete the task. Choosing the wrong button when given the choice to save the data and then exit—or simply exiting—is an example of a situation where making the wrong choice results in an unrecoverable error.

With increased complexity and features a device has, the probability of making unexpected errors also rises. Identifying less sophisticated devices with less available features that facilitate improved reliability can be of greater importance at times. Furthermore, many devices include a kind of one-strike policy, in which a single mistake (such as pressing the wrong key or button) results in a user’s session being terminated.[[59]](#footnote-60)

## Persona 1 - Helen: A Young Adult Who Has Dyslexia and ADHD



Figure 4. Helen - Persona 1.

### Performance Metrics for Persona 1

Table 12. Performance metrics for Cognitive Persona 1.

|  |  |
| --- | --- |
| **Performance Metric** | **Level of Performance** |
| Literacy - ability to encode and decode written text | Limited |
| Literacy - ability to speak and understand speech to carry on a conversation | No problems |
| Short Term Memory | No problems |
| Long Term Memory | No problems |
| Ability to learn a new task and repeat | Limited through reading and listening |

### Other Abilities and Characteristics of Persona 1

* No unusual physical characteristics
* Able to learn practical life skills
* Able to blend in socially
* Functions in daily life

### Use Case

* Problem processing text-based information
* Problem learning by listening alone
* Problem organizing and planning for tasks

Helen loves fashion and spends most of her free time socializing with her friends who describe her as creative, full of energy and passionate about everything. She knows living with her parents is temporary and intends to share an apartment with her best friend once she can afford to live on her own. Working in the fashion industry would be a dream come true, however Helen lacks the confidence to apply for an internship after struggling to graduate from secondary school. Classroom learning did not work for her, especially the lectures, reading and tracking assignments. She couldn’t understand the textbooks no matter often she reread them, struggled to get started on projects, and frequently failed to turn them in on time.

Luckily her current boss gets her. She takes the time to explain things and provides opportunities for hands-on learning. Helen now understands she learns best with concise instructions and by seeing and doing. Her work ethic has blossomed as a result. Reading remains a challenge though. A good friend showed her how to make the phone read to her and now Helen uses this feature all the time. She loves her mobile phone, especially the smart assistant which she uses to dictate text messages, emails, and social media posts.

### Best Practices for Persona 1

The best practices for this sub-group of users are not made up of a set of standalone solutions like in the other disability communities. It is rather made up of a suite of solutions that in combination form the best practice. It is difficult to remove or separate any one solution from the suite as it then results in the user not being able to complete one or more tasks in the primary task list. In addition to the solutions there are recommendations that affect the way Apps are presented and the content displayed through the Apps as it applies to Apps on the task list and information and communications technologies. The solutions are divided into 3 categories: Literacy, Memory, and the Ability to Learn a New Task. This particular group of users covered by the Group 1 Persona have issues to be addressed in Literacy and the Ability to Learn a New Task categories.

### Literacy

#### Text-to-Speech

##### Overview of Text-to-Speech

Text to Speech systems speak the text selected by the user on the mobile device display aloud for the user using synthetic speak generated by the device. The text can be selected by highlighting text or a region on the display. Highlighting the region can happen through a number of mechanisms. TTS helps individuals with low written literacy skill understand text by having it spoken aloud to them. [[60]](#footnote-61) The TTS system allow the user to change the voice of the speaker (male/female), the language, the rate of speed, the volume of the speech.[[61]](#footnote-62) These features help the user understand what is spoken better. In addition to speaking portions of the screen the ability to speak all the text on the screen will makes the process easier for users.

TTS Systems unlike screen readers do not describe the structure of the content on the page. Elements like the nature of tables, list boxes and edit fields are not described by the TTS. The navigation features of text on specific pages are also limited. TTS are not able to navigate by headings and links in the content for example.

The challenges that this sub-group of users face is being able to understand and interact with elements on the mobile device, typically the text. This group of users do not have problems perceiving the elements, but they may have problems in understanding what they are seeing. In the case of users with dyslexia, the letters of the text can appear to be scrambled, written backwards and out of order, and even appear to jump off the page. The effect they see depends on the severity and nature of the effects of their dyslexia. Note that while the focus is on Dyslexia in this section, the findings apply to other groups of users that have written literacy challenges.

Text-to-speech (TTS) capabilities are often referred to as a technology solution or aid for people who have dyslexia. TTS is becoming a frequent accommodation/support for students with reading problems who want to improve their reading skills.[[62]](#footnote-63) A review of the literature in 2019 by Oberembt [[63]](#footnote-64) indicates that TTS increases the reading rate of people with reading disabilities.

Text-to-speech is a type of software that allows people to listen to printed information while having the passage highlighted on the screen so they can follow along.[[64]](#footnote-65) It is a type of speech synthesis that translates text on a page into spoken voice output, such as a help file or a web page. TTS can be used to read a text message to someone who is driving or to read computer display information to someone who is visually impaired. It can convert any text-based message into a spoken one that is easily comprehended. While TTS does not have the emotional expression that a human voice does, the speech synthesis is usually rather accurate.

TTS may be use for:

* People with dyslexia
* Readers that are moving
* People who multitask and need things read aloud to them, such as a baker with a recipe
* Elderly readers
* People who have visual impairments
* Foreign-language students[[65]](#footnote-66)

##### Technical Discussion of Text-to-Speech

The speech engine of the text to speech system needs to be available anywhere on the system and accessible no matter where the text is available (text in document, text on webpage, text in popup dialog etc. …). The change in voice gender, language and speed also need to apply to the speech engine system wide. The system should allow the loading of voices not shipped with device so the user to customize the language to a voice that the user easily understands and prefers.

##### List of Mandatory Features for Text-to-Speech

* Ability to select text:
* A word
* A phrase
* A sentence
* A paragraph
* All text on the screen
* Ability to select a region containing text to be read aloud
* Ability to read all text on the screen
* Ability to select at least a male and a female voice
* Ability to select the rate at which the text is read aloud from at least two seconds per word to 7 words per minute

##### List of Optional Features for Text-to-Speech

* Ability to load and select voices not shipped with the mobile device from the factory
  + in male and female gender
  + with regional accents

##### Other Considerations for TTS

TTS is often used a part of a therapeutic plan to improve the reading comprehension for people with Dyslexia. In this case, TTS technology is being used as an adaptation to help the user complete a task on the mobile device. The impact on the reading comprehension of the user without the TTS technology is not the primary goal of the technology.

Users with dyslexia can benefit from the organization of the content. They may have difficulty reading long pages, which can be alleviated if the design promotes the ability to scan through the text quickly through the use of headings as described above. Selecting hypertext anchors with high information content will assist these users, as well as blind users, in scanning for intriguing links (do not use phrases like "click here").[[66]](#footnote-67)

The requirement regarding content organization is beyond the scope of this document, as mobile device manufacturers do not directly control the content of authors for most content. Mobile device manufacturers do control the text in supporting documentation for the device which typically is in electronic format. They also control indirectly the help and support features of the Apps that are shipped with the mobile device. Help documentation and support documentation that is shipped with the device or is necessary to be accessed after the fact via the internet must adhere to these content guidelines.

##### Distinction between Text-to-Speech and Screen Reading Technology

There is a distinction between text to speech (TTS) technology and screen reading technology. TTS is intended to read the text content on the screen only. A screen reader on the other hand is intended to support blind or moderate vision loss users. It helps the blind user navigate the content on the screen, reading out menus, icons, and graphics in addition to the text on the screen.[[67]](#footnote-68) TTS technology has been historically labelled as the solution for readers with dyslexia and learning disabilities.[[68]](#footnote-69)

#### Autocorrect

##### Overview of Autocorrect

Auto correct is a program feature that identifies misspelled words, uses algorithms to identify the words most likely to have been intended, andedits the text accordingly. Auto correct is commonly a feature included in word processors and messaging platforms of various types. Though the correct word is not always identified it can help users with low written literacy compose sentences more effectively and efficiently.

##### Technical Discussion of Autocorrect

Autocorrect can be implement system wide via the use of the virtual keyboard. The virtual keyboard will correct what the user is typing in the advance communications Apps and other Apps. While this feature is supported by many major operating system it is not support by all major brands currently as a mandatory feature. [[69]](#footnote-70) [[70]](#footnote-71)

##### List of Mandatory Features for Autocorrect

* + Exist on the device
  + By part of the virtual keyboard so it can be accessed anywhere on the device

#### Spell/Grammar Check – word prediction

##### Overview of Spell/Grammar Check

Spell check feature highlights words that are spelled incorrectly and provides suggestions for how to fix the spelling error. Grammar check feature highlights a portion of written text to indicate grammatical errors and offers suggestions for how to fix the grammatical error. Word prediction generates word suggestions as the user starts typing the first few letters of the word. These features allow individuals with cognitive conditions to compose text correctly and accurately by informing them of possible spelling or grammatical errors, offering them suggestions for how to fix the errors, and improving the quality and speed of their typing. Individuals with disabilities such as dysgraphia, dyslexia, dyspraxia, executive functioning impairments, and learning impairments will find these features beneficial. [[71]](#footnote-72) [[72]](#footnote-73) [[73]](#footnote-74)

##### Technical Discussion of Spell/Grammar Check

Spell checking and grammar checking are usually implemented on software/word processor level. Word prediction can either be implemented in virtual keyboards, or on software/word processor level. The end user is expected to be able to perform communication tasks and receive clear, understandable, and distinctive prompts when making spelling or grammatical errors. The end user is also expected to be able to use word prediction either within the software, or as a part of the virtual keyboard, after typing the first few letters of a word. Suggestions made by the word prediction feature should be identifiable as suggestions, and not be confused with what has already been typed. The end user should be able to identify how to select one of the suggested words. The word prediction feature needs to be adaptive, and adjust the suggestions based on the frequency of the words previously typed by the user, to enhance access to the commonly used words in the user’s vocabulary. Word prediction must only use single word prediction (as opposed to phrase prediction, predict ahead, etc.), and must generate predictions by following syntax rules. [[74]](#footnote-75)

##### List of Mandatory Features for Spell/Grammar Check

* + - Be available in any field that requires text
    - Show a menu with at least the 4 most likely words
    - Allow the user to pick the appropriate word from the menu and replace the word in the data field

#### Dictation for Primary Apps

##### Overview of Dictation for Primary Apps

Dictation or speech-to-text is a feature that allows users to convert spoken language to written text, using speech recognition. People with cognitive and learning disabilities can benefit from speech-to-text, and it has been shown to significantly increase their performance in their activities of daily living.[[75]](#footnote-76) [[76]](#footnote-77) [[77]](#footnote-78)

##### Technical Discussion of Dictation for Primary Apps

The virtual keyboard should allow the activation of the dictation feature with a dedicated and distinct button, normally on the virtual keyboard layout. The end user must be able to easily identify when the dictation feature is active and when it is not. The conversion of speech to text needs to happen relatively simultaneously, e.g., each word is typed immediately as it is stated, instead of waiting for the end of the sentence to type out the entire sentence. The simultaneous conversion of speech to text allows for individuals with cognitive disabilities to identify any problems with speech recognition immediately and correct the mis-identified words as they speak, which in turn improves the quality of their dictation. The speech recognition engine needs to be fully functional while offline.

##### List of Mandatory Features for Dictation for Primary Apps

* Have a dedicated button, icon and/or action to turn it on
* Support the main language of the region (French and English in Canada)
* Recognize a word at a time
* Able to function without a data connection

#### Do Not Disturb/Focus Mode

##### Overview of Do Not Disturb/Focus Mode

This group of users can be easily distracted while they are learning or focusing on other tasks. [[78]](#footnote-79) Being able to put the mobile device in “do-not-disturb” mode help eliminate a distraction from the mobile device when it is unwanted. The do-not-disturb mode is typically controlled through the setting menu. For some user it will take time to learn and remember the settings to active the mode. For this specific groups of users, it is advantageous to be able to have an icon that can be placed in the home screen menu that activates the mode.

##### Technical Discussion of Do Not Disturb/Focus Mode

The do-not-disturb mode must be support by the system level features. The are no other technical considerations in regard to this feature that goes beyond what is required of Apps and the existing system features in most devices.

##### List of Mandatory Features for Do Not Disturb/Focus Mode

* Optionally have an icon that activates the mode

#### Replayable First Run Tutorials

##### Overview of Replayable First Run Tutorials

This group of users can benefit for video orientations for the setup process for the device and the use of the advanced communications Apps and features of the device. Some of these users have low written literacy so can benefit from a presentation that involves visual demonstration of the App or features accompanied with an audio description.  [[79]](#footnote-80) Often these users need to see the video more than once for the concept to be remembered.

##### Technical Discussion of Replayable First Run Tutorials

These videos do not have to be hosted on the mobile device. They can be hosted externally on a medium such as a website that allow streaming or downloading of the videos. The media source must be easy and straight forward to discover.

##### List of Mandatory Features for Replayable First Run Tutorials

* Focus on visual presentation
* Have chapter marks

#### Undo Action

##### Overview of Undo Action

The ability to undo an action within a mobile App is helpful for users in this group. Rather that re-doing the action using a single action to un-do the action makes the process simpler for users in this group and reduced frustration. If they delete an item or insert the wrong text it should be possible to “undo” that action where possible for the advanced communication Apps shipped with the mobile device from the factory. Refer to the W3C WCAG criteria for cognitive conditions for more details: [[80]](#footnote-81)

Help Users Avoid Mistakes and Know How to Correct Them

Objective: [[Help Users Avoid Mistakes and Know How to Correct Them](https://www.w3.org/WAI/WCAG2/supplemental/objectives/o4-minimize-mistakes/)]

Design Patterns:

* [[Ensure Controls and Content Do Not Move Unexpectedly]](https://www.w3.org/WAI/WCAG2/supplemental/patterns/o4p01-unexpected-movement/)
* [[Let Users Go Back]](https://www.w3.org/WAI/WCAG2/supplemental/patterns/o4p02-back-undo/)
* [[Notify Users of Fees and Charges at the Start of a Task]](https://www.w3.org/WAI/WCAG2/supplemental/patterns/o4p03-declared-charges/)
* [[Design Forms to Prevent Mistakes]](https://www.w3.org/WAI/WCAG2/supplemental/patterns/o4p04-supportive-forms/)
* [Make it Easy to Undo Form Errors]
* [[Use Clear Visible Labels]](https://www.w3.org/WAI/WCAG2/supplemental/patterns/o4p06-clear-labels/)
* [[Use Clear Step-by-step Instructions]](https://www.w3.org/WAI/WCAG2/supplemental/patterns/o4p07-step-instructions/)
* [[Accept different input formats]](https://www.w3.org/WAI/WCAG2/supplemental/patterns/o4p08-input-formats/)
* [[Avoid Data Loss and “Timeouts”]](https://www.w3.org/WAI/WCAG2/supplemental/patterns/o4p09-data-loss/)
* [[Provide Feedback]](https://www.w3.org/WAI/WCAG2/supplemental/patterns/o4p10-status-feedback/)
* [[Help the user stay safe]](https://www.w3.org/WAI/WCAG2/supplemental/patterns/o4p11-user-safety/)
* [[Use Familiar Metrics and Units]](https://www.w3.org/WAI/WCAG2/supplemental/patterns/o4p12-familiar-metrics/)

##### Technical Discussion of Undo Action

It is technically not possible to undo every action that can be performed on the mobile device. Typically, the actions that can be undone are within Apps where the programmer has purposefully built that capability into the App.

##### List of Mandatory Features for Undo Action

* + At least support ability to undo the last action for text-based fields

##### List of Optional Features for Undo Action

* + - Undo the last action

#### Availability of media alternatives for help text and instructions

##### Overview

Some people with learning disability understand information better if it provided in a video format with an audio narrative. Videos formats to provide instruction on how to achieve a task should be provide for the setup.

##### Technical Discussion

The media files do not have to be hosted on the mobile device. They can be available through a web-based interface provided it is easy to discover where the media files are available.

##### List of Mandatory Features for Availability of media alternatives for help text and instructions

* Provide visual centric presentation with minimal text
* Provide chapter marks

#### Video Chapter Marks

##### Overview of Video Chapter Marks

Where help and support videos are provided to help the user setup or navigate the mobile device the videos must contain chapter marks. Video Chapters break up a video into sections, each with an individual preview. Video chapters add info and context to each portion of the video and let you easily rewatch different parts of the video or easily access the portion of the video that is important to user.

##### Technical Discussion of Video Chapter Marks

The video player shipped with the mobile device must be able to show the chapter marks embedded in a video if they are available. [[81]](#footnote-82) The user can then choose from the chapter marks displayed so that that can play only the relevant portion of the video.

##### List of Mandatory Features for Chapter Marks

* + Provide chapter marks compatible with video player standards

#### Ability to Learn

##### Interactive Transcripts

###### Overview of Interactive Transcripts

Where a video call App is available on the phone, the App should allow for an interactive transcript of the call the be initiated during the call and for that transcript to be available for the user to refer to after the call is completed. Some users have problems process information and require more time to absorb and understand the information being communicated.

###### Technical Discussion of Interactive Transcripts

The transcription of the audio content of a video call or meeting already exists some context. Video meeting mobile device-based Apps and web-based Apps already supply live transcription with the ability to review the transcript after the meeting has concluded.

###### List of Mandatory Features for Interactive Transcripts:

* Support the language of the region (French and English for Canada)
* Optionally have an icon that activates the mode for phone conversations

##### Contact Info for Device Support

###### Overview of Contact Info for Device Support

This best practice referred to having information on how to contact a human (customer service rep) for help that is easily accessible and apparent on the mobile device. This can take the form an icon that displays the information when it is activated.

The key issue here is that late of written literacy skill will prevent the user from reading the information in a printed format. Web based formats will be difficult for some users to find and navigate through.

###### Technical Discussion for Device Support

There are no technical issues that should prevent this from being implemented. The ability to interact with the phone number shown and launch the dialer using the phone number with a touch interaction would be more convenient and remove the steps required to cut and paste the phone number to the dialling App.

###### List of Mandatory Features for Contact Info for Device Support

* Be available in the languages of the region (French and English)

##### Voice-Based Intelligent Personal Assistants

###### Overview of Voice-Based Intelligent Personal Assistants

Voice-based Intelligent Personal Assistant can help the users with Dyslexia deal with interacting with the content when data entry is required. They can say what they need to enter even if they have issue with writing. As mentioned before, there are variations of the intelligent personal assistant that are available, including text-based systems.

###### Technical Discussion of Voice-Based Intelligent Personal Assistants

For the purposes of this document, users are assumed to have one class of restriction on their ability. The user is assumed to be able to interact with the physical elements of the touch-centric screen and perceive, understand, and interact with the visual elements on the screen, such as interactive touch points. Change in graphic elements to indicate changes in status are not a confusing issue for this group of users specifically. This does cause an issue for Group 2 users, and it is recommended that the best practices for Group 2 users be followed for this feature in order to maintain consistency.

###### List of Mandatory Features for Voice-Based Intelligent Personal Assistants

* Support the national languages of the region (French and English for Canada)

##### Cut, Copy, and Paste

###### Overview of Cut, Copy, and Paste

For written data, cutting refers to the action of removing the original content to be moved to a new location. Copying refers to the action of duplicating existing content to be moved to a new location. Pasting refers to the action of placing either cut or copied content in the new location. While these actions by themselves are straightforward, the user interface implementation may create various challenges that increase the cognitive and memory load.

The GARI website lists copy and paste functionality for text entry as one of the features that support people from the cognitive community. If a person has problems understanding the text this feature can make the process more efficient in specific cases, as the user does not have to type in the text. In the case of complicated string in label of URLs saying the type into a voice base intelligent personal assistant may be difficult as the user needs to remember what was spoken by the TTS system.

###### Technical Discussion of Cut, Copy, and Paste

Tapping and holding on the text that the user wants to copy or cut should highlight the text and bring up highlight handles that allow the user to adjust the range of content they would like to cut or copy. Simultaneously, a context menu should appear to allow the user to select the action they want to take with the highlighted text (cut or copy). This context menu should reappear consistently every time the user adjusts the range of content by manipulating the highlight handles, and it should appear near the highlight handle that has been manipulated most recently. Copying or cutting text should present a prompt on-screen that informs the user that content has been copied or cut. Similarly, while pasting content, the user should be able to tap and hold on the text entry field into which they would like to paste content, and the context menu should appear to allow the user to select the “Paste” action. The user should be able to move the curser around, if text already exists in the text entry field, and decide where they would like to paste the content. Context menu should be context sensitive, and prompt for either of these actions only when they are available. If a text field cannot be copied, it should not be able to be highlighted. The “Cut” or “Copy” actions should appear in the context menu only when the selected text can be cut or copied, respectively. The “Paste” action should only appear in the context menu only if compatible content has already been cut or copied. It is highly recommended to present the user with an overview of the cut or copied content before it is pasted, so they can remember what they have copied or cut and decide whether it is appropriate to paste it.

##### Simplify Display

###### Overview of Simplify Display

All users can benefit from the elimination of visual clutter and complex menu structures within the operating system and Apps on a mobile device. Implementing a Simplify Display is one of the accessibility features intended for users from the cognitive community. For this document the definition of a simplified display is fairly limited in scope. It requires that the mobile device be able to allow the user to disable or conceal unneeded features/programs or icons.

###### Technical Discussion of Simplify Display

The operating system needs to provide the ability to hide programs and features. Many mobile devices currently provide this capability.

## Persona 2 - Scott: A Community Volunteer with Down’s Syndrome



Figure . Scott - Persona 2.

### Performance Metrics for Persona 2

|  |  |
| --- | --- |
| **Performance Metric** | **Level of Performance** |
| Literacy - ability to encode and decode written text | Not able to read or write |
| Literacy - ability to speak and understand speech to carry on a conversation | Limited at a grade 3 level |
| Short-Term Memory | They have short term memory issues especially if requires remembering and understanding steps in a task |
| Long-Term Memory | Difficulty remembering complex procedures |
| Ability to learn a new task and repeat | They need multiple repetitions to learn a basic task and require prompting to complete complex task of 3 or more steps. |

### Other Abilities and Characteristics of Persona 2

* Understands spoken instructions but cannot typically communicate on complex levels
* Noticeable developmental delays (i.e., speech, motor skills)
* Can communicate in basic, simple ways
* Able to learn basic health and safety skills
* Can complete self-care activities
* Can travel alone to nearby, familiar places
* They may have difficulty in social situations and problems with social cues and judgement.

### Use Case

Scott was born with Down’s Syndrome and is 38 years old. He can do many daily tasks on his own such as bathing, dressing himself and making the daily trip to his job. He needs a consistent routine, or he can easily get confused. He has a bright and cheerful deposition and usually is quite open and engaging even with strangers. Nothing seems to every get him down. He works at a local charity putting together gift baskets that are sold through a regional gift store. He understands spoken instructions and can remember them if it involves one or two steps. For more complex tasks, he needs someone to prompt him on what to do for the next step. There is a digital reminder in his workspace. Every time he finishes a step, he pushes a button, and it prompts him in recorded voice to tell him what do next. He is a very productive worker and his boss like his dedication to getting it right.

He lives with his sister who is also his guardian. He cannot read or write, but can recognize some words, like his name. He is essentially functionally illiterate.

He has a cellphone that he carries that provides reminders of where he needs to be and what he needs to do. It also allows him to contact his sister if he gets lost or confused. There are images of the people he knows on the phone instead of names and contact numbers. He initiates a call by pressing the images of the person he wants to call. There are also simple games on his phone that he likes to play in his spare time. His interactions on the phone outside of these tasks are limited. He does not use social media or Apps that involve text.

Persona 2 is unique in that they will not typically be able to complete all the tasks on the Primary Task List by themselves. A trusted third party often has to do some steps or all of the steps in a task for them. Where a third party needs to complete all the step in a task, that task has been removed from the task list. The table below keeps the numbering from the previously discussed Primary Task List, so it is easy to see what has been removed. In a handful of instances, a task has been modified to make it easier to completed by this user

| **#** | **Task** |
| --- | --- |
| 1 | Making and terminating a communications session (phone calls, videos call or text message session) |
| 2 | Receiving communication session (phone calls, videos call, or text message session) |
| 3 | Modified: Sending text messages to a person in their contact list and to a specific phone number  to  Sending text messages to a person in their contact list and to a specific phone number – via voice/smart assistant |
| 4 | Receiving text messages |
| 5 | Send and Receiving email using an app – sending a reply or creating a new email is via voice/smart assistant |
| 6 | Modified from: 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.  To set a reminder by using a voice/smart assistant |
| 7 | Taking pictures/video and save it to the mobile device |
| 8 | Watching videos or listening to music including changing volume in an App and in a web-based environment |
| 9 | Complete a video call or meeting (FaceTime, no equivalent in Android that is shipped with phone - Duo) |
| 10 | Receive low battery notification |
| 11 | Turn on the power to the phone |
| 12 | Turn off the power to the phone |

### Best Practices for Persona 2

Users within the cognitive community are unique in that the solutions for them have to build on each other, as the restrictions on their abilities increase. Unlike the other disability communities where each severity level has a primary set of solution classes, more severe levels of cognitive loss benefit from the solutions of the lower level of severity but requires additional accommodation to lack of ability with along the primary performance metrics. As a result, the best practices for this persona build on the solutions for Persona 1.



#### Voice Notes/Recordings

##### Overview of Voice Notes/Recordings

* + - * One of the default applications shipped with the mobile phone should be a voice recording app. This application should allow the user to record audio and audio notes, store them locally, find and organize recordings, and share recordings.

According to the Collins dictionary, a voice note is a reminder or note created by speaking into an electronic device.[[82]](#footnote-83) It is referred to differently on various platforms for mobile devices. Voice notes are referred to under different names on different mobile device platforms. “Voice Memos” and “Voice Notes” are used on two of the major platforms. Voice notes are intended for people who better remember things by recording an audio note as opposed to having to write them.[[83]](#footnote-84) [[84]](#footnote-85) On some platforms, it can be represented as a “widget” while on other platforms it is an “application”. For the purposes of this document, a widget is typically a shortcut to an application (App) or specific features of an App.[[85]](#footnote-86) It is typically represented by an icon on a separate screen reserved for short cuts on a mobile device. For some users, representing the voice note feature as a widget as opposed to an App among many Apps simplifies the list of tasks the user needs to deal with.



##### Technical Discussion of Voice Notes/Recordings

* + - * The voice recorder needs to be capable of omnidirectional audio recording for up to 3-5 meters. If the phone is not capable of omnidirectional audio recording and is optimized for using one of the microphones available on the device or recording with a specific polar pattern (cardioid, supercardioid, bi-directional, etc.), the stock audio recording application should notify the user of which microphone should be pointed at the sound source for optimal recording quality. Either before or after the recording is complete, the user should be able to change the file name. If the user does not specify a name for the recording, the app should save the recording with an appropriate name automatically (e.g., date and time of recording as file name).

#### Find My Device

##### Overview of Find My Device

* + - * The ability to locate their phone when it is lost is a feature that allows users to track their lost mobile phone, play a sound on the lost phone to assist with locating it, erase the data on the phone remotely, or see the last known location of the device if it is offline. This feature can be very beneficial for people with short term memory impairments or attention disorders, who may forget where they have placed their phones. [[86]](#footnote-87) [[87]](#footnote-88)

##### Technical Discussion of Find My Device

* + - * This feature should either be activated by default, or the user needs to be prompted to set it up while going through the initial phone setup. Users should be able to ask their home virtual assistant (e.g., Apple Home Pod, Google Home), if applicable, to ring their phone to assist with locating it, or use a web interface on a computer or another device to log into their account and use the “Find My Device” feature. This feature should allow users to locate the physical location of the phone or its last known location on a map using the onboard GPS module and allow them to ring the phone to assist with locating it indoors. For this feature to work successfully, mobile phones need to have GPS, Wi-Fi, or Cellular Data, and allow users to use their phone account credentials to log into the web interface.

#### Wayfinding

##### Overview of Wayfinding

* + - * Wayfinding allows users to search for and select a particular destination on the map and plan their route to that location using their preferred method of transportation.
      * While not directly related to advanced communications, the ability to relay the position of the user of a mobile device to another party may reflect directly of user if they have specific cognitive conditions that affect their spatial abilities, their ability to deal with new situations (i.e., lost in an area they have not been before) or their ability to communicate that they need help or are in distress.

##### Technical Discussion of Wayfinding

* + - * Mobile phones should ship with one map application, and allow users to install their preferred map application if they are more comfortable with a different app. The stock map application should allow users to search for a location, select a location, identify their preferred method of transportation (driving, bus, taxi/rideshare services, walking, biking, etc.), and see the route they will need to take using that method of transportation. The map application needs to be capable of updating the route based on the real-time location of the user and provide clear notifications ahead of time to inform the user of upcoming turns, bus stops, etc. if applicable. This feature would require mobile phones to have GPS and Cellular Data connection.

##### List of Mandatory Features for Wayfinding

* The Mapping App on the device can update in real time (less than 70 millisecond latency)

##### List of Optional Features for Wayfinding

* Optionally, it should allow third-party mapping Apps to be loaded on the mobile device

#### Timers and Scheduled Reminders

##### Overview of Timers and Scheduled Reminders

Timers (countdown timers, stopwatches, etc.) are cuing mechanisms that allow individuals to keep track of time for various tasks and activities. [[88]](#footnote-89) [[89]](#footnote-90) [[90]](#footnote-91) A user may decide to dedicate an hour to a particular task, and if not prompted, forget whether they have spent more or less time than an hour on that task. By setting a countdown timer for an hour, this user will be able to see exactly how much time they are spending on their task and receive a prompt when the time is up, and they need to move on to a different activity. A stopwatch starts counting from 0 and keeps track of time practically indefinitely, until the user stops the timer. If a user needs to keep track of how long an activity takes, they may use a stopwatch. Timers are crucial in assisting people with executive function loss (working memory, concentration, planning, and performance monitoring) such as individuals with autism, ADHD, etc.

All text alerts and other reminders that are displayed on the screen use simple, easy to understand language. This feature is a specific accommodation only some individuals within the community. Unexpected pop-up alerts may be confusing to some users that have problems understanding a change of status, especially if it was not asked for directly or in response to an explicit interaction. Built-in schedule reminders with audio, visual and vibrating alerts help users to remember future events and to perform tasks.

* + - Another GARI feature recommended for the Cognitive Community is Simple Reminders. Simple reminders are defined as all text alerts and other reminders that are displayed on the screen use simple, easy to understand language. Reminders are a subset of the concept of prompts. While the GARI feature only references text-based prompts, spoken prompts would be more appropriate for this group of users. Beyond prompting within Apps, prompts or reminders of activities can be effective at helping users successfully engage in daily activities.[[91]](#footnote-92)

##### Technical Discussion of Timers and Scheduled Reminders

* + - * While using the countdown timer, users should be able to indicate how much time they would like to set for the timer, receive visual feedback on how much time is left from their timer, and receive an alert when the time is up. While using the stopwatch, users should be able to start, pause, stop, and reset the stopwatch.

##### List of Mandatory Features for Timers and Scheduled Reminders

* The mobile device should have the ability to see a reminder based on date and time.
* The mobile device should support a count down timer which shows how much time is left.

#### Smart Assistants

##### Overview of Smart Assistants

* + - * Smart Assistants or Virtual Assistants are software installed on mobile devices and allow users to find quick answers for their questions, open various applications, change various phone settings, set up alarms, timers, and reminders, and manipulate their Environmental Control Units in different environments (i.e., smart devices and appliances). Smart Assistants are usually accessed by using a particular “Wakeup Phrase”. Alternatively, users may access the smart assistant on their phone by pressing or holding a particular button or performing a specific gesture on the screen. Users can usually interact with their Smart Assistants through speech, however, if speech is impractical or impossible, users may opt to use the virtual keyboard to type in their requests. Research shows that people with cognitive and learning disabilities can benefit from using Smart Assistants and find them to increase their convenience in performing daily tasks, as long as they maintain a minimum level of cognitive function and are able to repeat sentences if necessary.[[92]](#footnote-93),[[93]](#footnote-94)
      * The GARI website defines an intelligent personal assistant as a device that has/supports a digital personal assistant for opening apps and conducting shortcuts to communication tasks like text messages and making calls.
      * Intelligent personal assistant is a variation of intelligent agents. Intelligent agents look for and deliver information from the Internet. Such software automates data extraction using predefined criteria, keywords, or other information input.
      * Intelligent agents or assistants have evolved over the years. One of the earliest was the Office Assistant implemented by Microsoft. The Office Assistant, now discontinued, was an intelligent agent that used interactive characters to provide help content in the Microsoft Office suite for Windows (versions 97 – 2003), in Microsoft Publisher and Microsoft Project (versions 98 – 2003), Microsoft FrontPage (versions 2002, 2003), and Microsoft Office for Mac (versions 98 – 2004).[[94]](#footnote-95) This intelligent agent looked at what was being entered as text from the keyboard and the context of the action being executed (cut and pasting text, copying, and pasting text, formatting text, etc.) to help the user with completing desired action or actions.
      * An intelligent personal assistant can be defined as a software that helps people with executing basic tasks, communicating information in simple terms. They retrieve information from online sources, such as, e.g., mapping directions, weather, and other information-based queries.[[95]](#footnote-96)
      * Researchers at Microsoft envision intelligent personal assistants more broadly as a tool for many new functions, such as understanding the world around us and leveraging context to inform actions, while interacting with users in a natural and effective manner. Microsoft’s Contextually Intelligent Assistants project, according to the company, has been improving contextual intelligence of next-generation assistants by developing task intent versus task description understanding, modeling crucial contextual signals (e.g., time and location), capturing information quickly and in context, improving proactive and reactive retrieval of information, and providing intelligent notifications.[[96]](#footnote-97)
      * The GARI initiative does not formally define the requirements for an Intelligent Personal Assistant. The focus seems to be on “voice assistants” which utilize voice recognition to complete specific tasks. Current voice assistants like “OK, Google” and “Hey, Siri” concentrate on the voice recognition interface to users. While text-based equivalents are possible, they are not easy to access by inexperienced technology users.[[97]](#footnote-98) Text-based and icon-based access to the same features as the voice assistant would be appropriate for users that lack the ability to speak as well as having a cognitive condition.
      * One study provided evidence for the benefits of text-to-speech, simplified instructions, and simple display. This is a conference paper that conducted a study on accessibility issues for the elderly. It looked at 3 MNAs (mobile native apps) and tested them on accessibility based on guidelines provided by Android, W3C, and a study by Panayiotis et al. (2005).[[98]](#footnote-99) Three mobile apps were compared for accessibility issues. The users graded the mobile phones on a scale on 1 to 5. This experiment was not controlled or randomized. The study showed evidence for text to speech (G3ICT), simplified instructions and simple display (GARI).

##### Technical Discussion of Smart Assistants

* + - * The Wake Phrase and/or Gesture for the Smart Assistant should be communicated clearly and directly to the user through the initial phone setup. Users should also be able to train the speech recognition engine to recognize their particular way of speaking and change the voice profile of the Smart Assistant to a voice and accent they feel comfortable with. By using the Smart Assistant, users should be able to open apps, change phone settings, set timers, alarms, and reminders, control their smart devices, make phone calls, send text messages, and find an answer from the web to their questions. The Smart Assistant should be accessible on all screens, and should prompt the user when activated, as well as when the user’s speech is unintelligible, and the user needs to repeat what they said.

##### List of Mandatory Features for Smart Assistants:

Support the language of the region (French and English for Canada)

Have a consistent activation phrase

Be available when not connected to the network

Be able to access at least all the Apps on the Primary Task List

#### Single App Mode (App Pinning)

##### Overview of Single App Mode

* + - * For some users they can only concentrate or focus on one activity at a time. For those users that have problems focusing on more than on action at a time the ability to lock the mobile device so that only one App is accessible in important. This is known a “Single App Mode” or “App pinning”. Through the “Setting Menu” of the device the person doing the setup can select and exiting App on the phone and make it be the only App accessible through the Home Screen. Single App Mode is often initiated by a third party, turning the mobile device into a single function device. What App is show on the screen for the Single App Mode is selected to meet the more appropriate need of the user.

##### Technical Discussion of Single App Mode

* + - * The operating system needs to support the feature to only present the display of a single App on the screen. The implementation of the feature must allow the user to set the App which is displayed on the main screen of the mobile device. There must be a mechanism to shut off the Single App Mode and return the phone back to it original status before the feature was activated.

#### Do Not Disturb/Focus Mode

##### Overview of Do Not Disturb/Focus Mode

* + - * This group of users can be easily distracted while they are learning or focusing on other tasks. [[99]](#footnote-100) Being able to put the mobile device in “do-not-disturb” mode help eliminate a distraction from the mobile device when it is unwanted. The do-not-disturb mode is typically controlled through the setting menu. For some user it will take time to learn and remember the sets to active the mode. For this specific groups of users, it is advantageous to be able to have an icon that can be placed in the home screen menu that activates the mode.

##### Technical Discussion of Do Not Disturb Mode

* + - * The do-not-disturb mode must be support by the system level features. The are no other technical considerations in regard to this feature that goes beyond what is required of Apps and the existing system features in most devices.
      * Input feedback

#### Visual confirmation the device received the user’s input.

##### Overview

* + - * Where the user is required to provide input or interact with a control the action of completing the input should be accompanied by a visual or audio confirmation. The change of status can be handled by changing the color of the control or some other visual mechanism and providing a tone to indicate the action has been complete.

##### Technical Discussion

* + - * There are no considerations over and beyond over and above what is normally required to develop an App.

#### Alternative Launchers

##### Overview of Alternative Launchers

* + - * A launcher is an Apps that is used to replace the home screen and display a number of custom user selected Apps. In the context of this group of users a launcher is designed to present a stripped-down presentation with a minimum number of App icons (typical 5 or less) without unnecessary design elements such as background graphics. The launcher should allow the user to select the Apps they want displayed on the launcher. While launcher comes in many designs the goal for this user is to simplify the presentation of the Apps to users. Apps with a similar theme should be organized together in chuck.[[100]](#footnote-101) Only the Apps absolutely required by the user should be presented. The launcher may have larger replacement icons for the Apps and larger text on the launcher. [[101]](#footnote-102) The mobile device should have the capability to have a launcher mode or facilitate the installation of third party developed launcher. Even if the mobile device has a launcher as an option, it must provide the capability to install third party launchers.

##### Technical Discussion of Alternative Launchers

* + - * The ability to install a third-party launcher is required so that the end user can have a launcher that is tailor to their preference and abilities if the default launcher is not appropriate for them. Currently most mobile device provides this facility.[[102]](#footnote-103),[[103]](#footnote-104),[[104]](#footnote-105),[[105]](#footnote-106)

##### List of Mandatory Features for Alternative Launchers

* Be able to support up to 5 Apps
* Be able to replace the default launcher if shipped with the device from the factory with a third-party launcher of the user’s choosing

#### Photo Dialing

##### Overview of Photo Dialing

* + - * Users with various cognitive and learning disabilities (Alzheimer’s disease, dyslexia, dementia, etc.) may find the task of going through a long list of contacts daunting and impractical. They may not be able to remember the names, or quickly find an individual with whom they are frequently in touch. The Contacts app on mobile phones (either as a standalone application or as a part of the “Phone” app) should allow users to save contacts with their photos and tag some contacts as their “favorite” for ease of access. This will allow users to find the contacts quickly and effectively they interact with the most. Mobile phones should also allow adding contacts directly to the home screen for quick access (either to call or message) without the need for opening the Phone or Contacts applications. Enabling user with cognitive and learning disabilities to use these features has been proven effective in significantly increasing their success with communication using mobile phones. [[106]](#footnote-107),[[107]](#footnote-108),[[108]](#footnote-109),[[109]](#footnote-110),[[110]](#footnote-111)
      * You can add photos of people next to their numbers in your contact list (a personal ‘telephone book’ you create in the phone).
      * This feature by itself is not a complete solution for the task of making a phone call to a specific person. It assumes the user can first navigate the telephone book or contact list. It assumes they can get the telephone book to come up and it assumes that the user can recognize the faces or other image used to represent a specific person or contact. A picture of their home might be a substitute for their home phone number as opposed to the specific face of someone who takes care of them that lives there.

##### Technical Discussion of Photo Dialing

* + - * Users should be able to save contacts with their corresponding photos or add photos to their existing contacts. Users should also be able to mark certain contacts as “Favorite” and have a separate section of the Phone or Contacts app dedicated to Favorite contacts to improve access. The operating system should allow users to add specific contacts to home screen (as a shortcut or widget) for quick texting or dialing.

##### List of Mandatory Features for Photo Dialing

* Be able to insert a picture in the contact list on the mobile device in addition to a person name and phone number.
* Be able to use a picture taken with the camera on the mobile device for the contact list photo.

#### Emergency Services and Location

##### Overview of Emergency Services and Location

* + - * Emergency services and location are important to individuals within the community that have difficulties remembering where they are going or have poor spatial skills. It is important for their safety that people in their support network be able to locate them and correspondingly for that individual to be able to ask for help when they need it, and they cannot get help from people around them. The value in having access to emergency services and location data is covered in this paper.[[111]](#footnote-112)

##### Technical Discussion of Emergency Services and Location

* + - * The technical consideration for this feature is not different from the requirements to locate any user of a mobile device during an emergency, such as a 911 call. These requirements are covered in the standards developed to address the requirements for mobile device usage during 911 calls.

#### No Screen Timeout

##### Overview of No Screen Timeout

No screen timeout refers to the instance when the phone displays an alert or a question that requires you to give an answer, e.g., by clicking a “Yes” or “No” button or by typing in your PIN number. With no screen time out, the system will wait for your response rather than time out after a specific period of time. People with certain cognitive conditions may take more time to process information and respond.[[112]](#footnote-113),[[113]](#footnote-114) Using time-based events does not allow for the reaction times to be variable.[[114]](#footnote-115)

##### Technical Discussion of No Screen Timeout

This functionality needs to be built into the design of the individual Apps. There is no global mechanism to create this functionality on third party Apps not shipped with the phone. It should be part of the best practice recommendations for developers on each of the operating systems, but it is realized that not developers adhere to the best practice design guidelines published by the operating system developers and that it is difficult to enforce this requirement.

# Vision Loss Personas

## Definition of Vision Loss

Vision loss often is defined by the visual acuity that a person has. Visual acuity is a measure of how clear and sharp your vision is. To standardize this, it is measured at different distances so that the results from many people can be averaged together. It is often measured using a Snellen chart, a chart of different letters and different sizes using a sans serif font.

Using the Snellen chart, vision is measured as a ratio. Standard vision is given the ratio of 20/20. The top number of the ratio is the distance the individual being tested can see the letters of a specific row of the chart with. The bottom ratio is the distance that the standard person without an acuity issue can see the specific row of letters at. So, a ratio of 20/20 means the individual can see at 20 feet what the standard person without vision issues can see at 20 ft. A ratio of 20/40 means the person needs to be at 20 ft to see what the standard person can see at 40 feet. Note that the ratio was historical expressed in feet. If using meters, the normal ratio is 6/6. 6 metres is approximately 20 feet.

## Degrees of Vision Loss

According to the World Health Organization, The International Classification of Diseases 11 (2018) divides present-day vision impairment into two categories: distance and near.[[115]](#footnote-116)

* 1. Distance vision impairment

Table 13. Distance vision impairment.

|  |  |
| --- | --- |
| **Vision range** | **Description** |
| 6/12 – 6/18 | Mild |
| 6/18 – 6/60 | Moderate |
| 6/60 – 3/60 | Severe |
| Less than 3/60 | Blindness |

* 1. Near vision impairment – Near visual acuity worse than N6 or M.08 at 40cm.

The classification of levels of severity can be subjective and can vary slightly depending on the organization but they follow similar major trends.

The following categories of vision impairment are used by the World Health Organization, when the best glasses correction for the superior eye's vision is available: [[116]](#footnote-117)

Table 14. A severity classification of visual disability according to the World Health Organization.

|  |  |
| --- | --- |
| **Vision range** | **Description** |
| 20/30 – 20/60 | Mild vision disability; near-normal vision |
| 20/70 – 20/160 | Moderate vision disability; moderate low vision |
| 20/200 – 20/400 | Severe vision disability; severe low vision (in the US, anyone with 20/200 or worse better is considered legally blind) |
| 20/500 – 20/1000 | Profound vision disability; profound low vision |
| Less than 20/1000 | Near-total vision disability; near-total blindness |
| No light perception | Total vision disability; total blindness |

There are various degrees of visual impairment based on the loss of the visual field (peripheral (side) vision loss for example). A person is deemed legally blind in the US if they have a residual vision field loss of 20 degrees or less.[[117]](#footnote-118)

Common causes that lead to vision loss or visual impairment include injury to the eye, inherited conditions, and infections. This can result in loss of visual acuity, partial loss of some of the field of view (loss of the centre region or peripheral region are examples), clouding of the lenses of the eyes or total vision loss.

## Causes of Vision Loss

The most common classes of vision loss are:

* Central vision impairment – blind spot in the center of vision.
* Peripheral vision impairment – the inability to perceive objects above, below, or to either side of eye level. Central vision, however, remains intact.
* Nocturnal blindness – the inability to see in dimly lit spaces like theatres and at night outside.
* Blurry vision – both close-up and distant objects appear blurry.
* Hazy vision – there appears to be a film or glare covering the entire field of view[[118]](#footnote-119)
* Color blindness – makes it hard to tell the difference between certain colors[[119]](#footnote-120)
* Photophobia – an extreme sensitivity to light[[120]](#footnote-121)

Most common causes of vision loss include:

* Eye injuries
  + Injuries to the cornea are the most common cause within this class
* Inherited conditions of blindness and vision impairment
  + Retinitis pigmentosa is the most common cause of inherited blindness
* Eye infections
  + Prenatal viral infections in a pregnant person (e.g., German measles) can be transmitted to fetus, causing congenital blindness or visual impairment in the newborn
* Trachoma due to Chlamydia trachomatis can damage eyesight
* Amblyopia
  + Impaired vision in one eye due to lack of use in early childhood
* Cataracts
  + Vision impairment due to clouding of part or the entire lens of the eye and consequent obstruction of light that focuses on the retina
* Diabetic retinopathy
  + Vision impairment due to damaged small blood vessels in the retina
* Glaucoma
  + Vision impairment due to raised pressure within the eyes that damages the optic nerve
* Age-related Macular Degeneration
  + Progressive vision loss due to damage to the macula (the most sensitive part of the retina)[[121]](#footnote-122)

For low vision, logarithmic charts may be used in place of the Snellen charts (Bailey Lovie, ETDRS, or Thomas). [[122]](#footnote-123) The advantages to these charts are:

* Equal number of letters per line
* Regular spacing between lines and letters
* Uniform progression of letter size
* Final score base precisely on letters read
* Improved test/re-test reliability

In addition, there are conditions that affect the visual field of view of the individual. This may show up as a black spot centre of what the person sees resulting in the loss of the central field of view. Alternative it could show up as a loss of peripheral vision in which case the person sees only within a small cone. Random black spots that obscure the field of view in selected areas may also be a condition experience by a person who experiences a loss of field of view. In addition, some conditions may result in the distance at which the person’s eyes can focus can be reduced, effectively reducing the distance at which the user can effectively use the mobile device.

For these standards it is assumed that the field of view is consistent with the average field of view of people without any vision related issues. Critical criteria will be derived from the assumptions laid out here and above to determine the minimum range of adjustment needed for font height, height of a point of interest and contrast. The minimum size setting to a point of interest is not intended to be a fixed dimension. Fonts and points of interest such as icons should scalable up to at least the minimum recommended height. A person’s range of vision can be modelled in the shape of a cone when the person’s head and eyes are stationary. The field of vision increases the further the object is from the person’s eyes. Most mobile device are not used more than one arm’s length away from the person’s eyes (76.2 mm) Where the individual’s effective distance where they focus on the screen of the mobile device is less that the assumed maximum distance of 76.2 mm (30 inches), the desired font or point of interest height and width will actual be reduced so as not to block or exceed the field of view. What height you may need to distinguish a point of interest at 30 inches may totally block the field of view of the user at 3 inches.

Some people also have limited color vision. Though not consider a form of vision loss it does affect the perception of people that have some of the vision loss conditions described above. Most people with limited color vision cannot see specific colors. The most common form of limited color vision is red-green. This does not mean that people with this condition cannot see these colors, they simply have a harder time differentiating between them, which can depend on the darkness or lightness of the colors. Other combination of colors that people have a hard time perceiving also exist. Another form of limited color vision is blue-yellow. People with blue-yellow insufficiency typically also experience red-green blindness, this is a more uncommon and severe kind of colour vision loss than only red-green deficiency.[[123]](#footnote-124)

People with limited color vision often see neutral or gray areas where color should appear. People who have a form of limited color vision that involves a totally color deficiency have a condition called achromatopsia. They can only see things as black and white or in shades of gray. Limited color vision can range from mild to severe, depending on the cause. It affects both eyes if caused by a biological condition or just one if it is caused by injury or illness.

Limited color vision is usually inherited but certain conditions can cause limited color vision. These conditions include:

* Diabetes
* Glaucoma
* Macular Degeneration
* Alzheimer's disease
* Parkinson's disease
* Multiple Sclerosis
* Chronic alcoholism
* Leukemia
* Sickle Cell Anemia

Another condition that affects vision loss users is light sensitivity in which bright lights hurt your eyes. Another name for this condition is photophobia.

## Proposed Classification

Table 15. A proposed severity classification for visual disability, for the purposes of this document.

|  |  |
| --- | --- |
| **Vision range** | **Description** |
| 20/30 – 20/60 | Mild vision disability; near-normal vision |
| 20/70 – 20/160 | Moderate vision disability; moderate low vision |
| 20/200 – 20/400 | Severe vision disability; severe low vision (in the US, anyone with 20/200 in the better is considered legally blind) |
| 20/500 – 20/1000 | Profound vision disability; profound low vision |
| Less than 20/1000 | Near-total vision disability; near-total blindness |
| No light perception | Total vision disability; total blindness |

### Specific Performance Metrics for Vision Loss Personas

The performance metrics for each severity level represent degrees of limitation along each of the performance metrics used to define the community. Users from the vision loss community can be defined by five key performance metrics that define the abilities of every user. Those performance metrics are:

* Visual acuity
* Vertical field of view
* Horizontal field of view
* Color vision
* Photophobia

For simplicity of this document, only the loss of visual acuity is referenced to classify users as having a mild, moderate, or severe levels of vision loss. Depending on the visual acuity of the remaining field of vision, similar solutions would also apply to those individuals that have a condition that results in the loss of field of vision.

#### Visual Acuity

Visual acuity is the sharpness of vision, measured by the ability to discern letters or numbers at a given distance according to a fixed standard.[[124]](#footnote-125) The standard is the Snellen eye charts that you typically are in an optometrist’s office. It is read from a distance from 10 feet away. [[125]](#footnote-126) A person with 20/20 vision can see what an average individual can see on an [[eye chart](https://www.aao.org/eye-health/tips-prevention/eye-chart-facts-history)] when they are standing 20 feet away.

#### Vertical Field of View

The field of view of the area of coverage that a person with two functional eyes can see. The field of view is typically expressed as an angle and in degrees. [[126]](#footnote-127) Typically, it is described as a cone of vision. An angle is used as the coverage area increase depending on the distance the object being viewed is located away from the viewer. The field of view in the horizontal direction is different from the field of view in the vertical direction. The field of view assumes that the eyes are stationary when the measurement is taken. The effective field of view increases when you account for the ability of the eyes to move side to side and up and down.

#### Color Vision

Color vision is the ability to distinguish among various wavelengths of light waves and to perceive the differences as differences in hue regardless of the brightness or polarization.[[127]](#footnote-128),[[128]](#footnote-129) There are typically three types of color blindness:

##### Red-green color blindness

The most common type of color blindness makes it hard to tell the difference between red and green.

##### Blue-yellow color blindness

This less-common type of color blindness makes it hard to tell the difference between blue and green, and between yellow and red.

##### Complete color blindness

If you have complete color blindness, you can’t see colors at all. This condition is quite uncommon.[[129]](#footnote-130)

#### Photophobia

Photophobia is eye discomfort in bright light. Symptoms of photophobia include:

* Sensitivity to light.
* Aversion to light.
* A sense that regular lighting appears excessively bright.
* Seeing bright colored spots, even in the dark or with your eyes closed.
* Difficulty reading or looking at pictures or text.
* Pain or discomfort when looking at the light.
* Squinting one or both eyes

The remainder of Section 12 will be a discussion of the personas for mild, moderate, and severe levels of vision-related issues.

## Persona 1: Mild Vision Loss Persona

### Performance Metrics for a Mild Vision Loss Persona



Figure 6. Frank - a mild vision loss persona.

Table 16. Performance metrics for mild vision disability persona.

|  |  |
| --- | --- |
| **Performance Metric** | **Level of Performance** |
| Visual Acuity | * 20/50 vision or better   Can see letters if they are 8.4 mm or bigger at 60 cm without the aid of any assistive technology Note: Also refer to font height recommendation for people with mobility impairments as there viewing distance is typically further away if looking for one recommendation to cover multiple disability communities.  Note 2: 20/30 to 20/60 is considered mild vision loss, or near-normal vision [[130]](#footnote-131) |
| Field of View Vertical | * 15 degrees vertical |
| Field of View Horizontal | * 30 degrees from the centre line of the face in the horizontal direction left and right |
| Color Vision | * Limited color vision * Red/green color blindness [[131]](#footnote-132) |
| Contrast | * Can see lettering if the luminance contrast ratio is greater than 4.5:1 (as measured on a contrast checker comparing the foreground font color and background color) |
| Photophobia | * Yes |

### Other Abilities and Characteristics of a Mild Vision Persona

* Has average hearing
* Range of Mobility: Full function of the hands, wrists, and arms
* Cannot read or write Braille

### Use Case

*Color perception impairment with age-related farsightedness and mild visual acuity impairment with light sensitivity.*

Frank (63) has Protanopia, Presbyopia, and early Cataracts. Protanopia causes Frank to have problems seeing the color red. Presbyopia is the gradual loss of your eyes' ability to focus on nearby objects. It usually happens to **everyone** as they age and becomes noticeable in your early to mid-40s and continues to worsen until around age 65.[[132]](#footnote-133) Cataracts are the clouding of the lens of your eye, which is normally clear. Most cataracts develop slowly over time, causing symptoms such as blurry vision. A more formal definition of cataract is available from the Mayo Clinic.[[133]](#footnote-134) The farsightedness can be corrected with reading glasses, but the blurriness from early Cataracts is starting to reduce acuity at all distances. The cataracts are causing a sensitivity to light and a need for greater contrast.

Frank is an executive at a Fortune 500 company. He has always had trouble distinguishing between some shades of red and green, but rarely mentions it. He is hesitating on Cataract surgery since he is currently “too busy” and it is “not that bad” so far, but he is using various accommodations.

Those close to Frank have long known to avoid use or mention of color to differentiate content. And his team has learned that red/yellow/green for a scorecard needs to also be supplemented with shapes. For most presentations, he has asked his team to use a template with a dark background so he can avoid the “glare” from presentations using the old template. He limits his rare driving to daytime and demonstrates his “environmental conscience” by walking and taking public transportation when he is not away on business.

To reduce use of his reading glasses (that are working less well with cataracts), he makes use of large font and dark theme settings on his mobile devices. He uses the voice assistant extensively to make calls, reply to texts, compose short email replies, and other simple tasks.

### Best Practices for Mild Vision Loss

Persons with a mild vision disability benefit from alternative ways of perceiving and interacting with content generated as an output on mobile devices, usually in the form of modified visual form. Classes of best practices for mild vision disability include:

1. Outputs
2. Inputs

#### Outputs

##### Technical Discussion of Outputs

As specified in the personas above, this group of users typically requires larger fonts and points of interest heights and widths to make it easier for the user to perceive the outputs on the device screen. The recommendation for the minimum large font size and point of interest height specified above represent lowest value of the maximum height and width for point of interest elements. Higher values of heights and width may be used. The point of interest height and contrast should be variable so the user can customize the point of interest elements to achieve comfortable and easy perception.

To ensure that an increase in font size is “big enough”, a formula is used, based on work published in the EN 301 549 V3.1.1 (2019-11): Accessibility requirements for ICT products and services. [[134]](#footnote-135) The formula is as follows:

*Minimum Text Height = 0.01233 \* Viewing Distance*

The average arm length ranges from 0.5 to 0.68 m and assuming the visual acuity of 20/40, the **minimum text height ranges from 6.2 mm to 8.4 mm. (0.24 inches to 0.33 inches).**

Increasing the system font to make the text more readable is only one part of the solution. Changing that setting typical changes the font size and style for the content support within each of the applications. It typically does not change the font size or style for the menus within the applications and the font size or style of buttons, labels, and static text content (text content that does not change) within the applications. The text within icons is also not changed. This can be problematic for this group of users.

##### List of Mandatory Features for Low Vision Output

Adjustable font

* Able to see the system font to a height of at least 8.4 mm measure for the letter “H”.
* Able to see the contrast between the system font and the default background color at 4.5 to 1.

Background setting

* Have the ability to implement a dark background as the default which should adhere to the 4.5 to 1 contrast requirement.

#### Inputs

##### Technical Discussion of Inputs

In regard to interacting with points of interest, this group of users typically have the dexterity to interact with points of interest such as selecting and activating icons, text boxes, and URL fields with the touch screen resources provided. The recommendation regarding minimal maximum height and width are achieved (must be adjustable to *at least* those maximum recommended heights and widths).

While this group of users can use on-screen keyboards available on a typical mobile device, some may prefer physical keyboards (either T9 or QWERTY with a joystick/puck interface) for efficiency. Examples are BlindShell[[135]](#footnote-136) and the Lucia Phone (RAZ Mobility). [[136]](#footnote-137),[[137]](#footnote-138) Where they are using on-screen keyboards, this group requires keyboards which allow them to change the contrast between foreground and background elements with at least a 3:1 ratio. Being able to invert the foreground and background colors is also necessary. Examples of this type of keyboard is the Google keyboard. [[138]](#footnote-139) On-screen keyboards with larger keys are also preferred if physical keyboards are not available. On large mobile devices (Phablets and tablets) larger full QWERTY keyboards are possible though they keys may not be large enough to accommodate the recommended large font height. Physical keyboard for computers can have keys are large as 30 mm high and wide to accommodate the height and width of the large size font. This is not practical for a mobile device due to the size of the resulting keyboard. Other alternative keyboard layouts that allow larger keys for more efficient interactions are the T9 keyboard, where multiple letters and number are represented on the familiar numeric telephone keypad. Chorded keyboard such as the Senorita [[139]](#footnote-140),[[140]](#footnote-141),[[141]](#footnote-142) and the Gestype[[142]](#footnote-143) are other alternative examples. Chorded keyboards typically use a combination of between 2 to 10 keys to encode the alphabet, numbers, and symbols. Pressing a specific combination of keys produces the desired character.

Senorita is a two-thumb virtual chorded keyboard used for mobile devices. Based on letter frequencies and the shape of the thumbs, it organizes the letters on eight keys in a single row at the device's bottom edge. It gives visual cues to do chording motions sequentially rather than simultaneously. Because of its small size and proximity to the edge of the screen, it allows for eyes-free text entering. Research into Senorita suggests that, generally, it is considered effective and simple to learn. In terms of performance, one longitudinal study found that Senorita put out an average of 14 words per minute, while another short-term study reported an average figure of 9.3 words per minute. Senorita surpasses QWERTY performance in another longitudinal study with an average of 3.7 words per minute with blind users and 5.8 words per minute with low vision users.[[143]](#footnote-144)

A variation on this is Gestype.[[144]](#footnote-145) In this implementation, two buttons are displayed on the screen. Left, right, up, down motions on each of the two buttons represent specific letters. By combining gestures on both buttons, more letters, numbers, and symbols can be represented.

While these keyboards are not necessarily providing a full solution, as they cannot be employed in every use case, they can be considered enhancements that improve the efficiency of the existing assistive technology. The full AT solutions are hardware keyboards, high contrast keyboards, and keyboards with large and high contrast keys. Handwriting recognition[[145]](#footnote-146) and voice assistants can add extra functionality. In handwriting mode, the virtual on-screen keyboard is replaced with an entry field where the user can write the text they want to enter. The system then uses digital character recognition to convert the writing to text which is inserted in the text entry field. Voice assistant recognizes a phrase spoken by the user and launches a specific App and in some case pre-populate field like the phone number of a contact in the case of a command to “Send a text message to Fred”. Example of voice assistants are Google Assistant and Siri.

#### List of Mandatory Features for Input for Mild Vision Loss

* Ability to adjust the contrast of the letter to background color of the keys on the keyboard to 3 to 1
* Ability to have a keyboard alternative that supports keys of at least 30 mm in height and width or provide an input alternative that does not rely on the user being able to view the letters on the keys

#### Enhancement Features for Mild Vision Loss

Examples of programs that can enhance the capabilities of the larger font size are:

* Big Launcher – uses free replacement icons
* Big Font
* Big Phone
* Big SMS Application

##### Big Launcher

Big Launcher ([http://biglauncher.com](http://biglauncher.com/)) replaces the user interface of a mobile device with enlarged buttons and text. It is designed to provide maximum readability and ease of user by simplifying the presentation. It can be controlled by single touches which reduce errors. It is easily customizable to match the user’s needs. It allows the user to put the shortcuts for apps, websites, contacts, widgets and more directly on the home screen. It allows the user to add more screens and access them by swiping or pushing the buttons. The user can find the apps quickly with instant search or recent apps list on the top. It hides the apps the user does not want to use to protect users from getting lost in the navigation.

##### Big Font

Big Font creates custom scalable font up to 1/5 of phone screen. It also changes font in some Apps that are difficult to change fonts in. It works in Facebook App. It does have some limitation as it has problems in File Manager App. The text of the menu items overlaps on each other.

##### Big Phone

Big Phone (BIG Phone for Seniors - Apps on Google Play) replaces the default phone application on the phone with a dialer with large text, large buttons and large icons. It provides basic phone functions (including enlarged dialer) which is accessible in a simple interface. It provides large texts and color-coded icons help you to easily distinguish between items. It allows quick access to the user’s favorite contacts from a single menu. It allows the user to pick up an incoming call easily thanks to the simplified call screen.

##### Big SMS Application

The Big SMS ([BIG SMS for Seniors – Apps on Google Play](https://play.google.com/store/apps/details?id=name.kunes.android.launcher.bigmessages&hl=en_CA&gl=US)) application is similar to Big Phone, Big SMS large font and different colors used to display the message thread. It makes replying easily to any message with the easy-to-use SMS editor. There is an optional full-screen SMS notifications allow you to rapidly call back or reply to the message. Multimedia messages (MMS) are not supported in the current implementation, but they need to be supported in future implementation.

## Persona 2: Moderate Vision Loss Persona

### Performance Metrics for a Moderate Vision Loss Persona



Figure 7. Paula - a moderate vision loss persona.

Table 17. Performance metrics for a moderate vision loss persona.

|  |  |
| --- | --- |
| **Performance Metric** | **Level of Performance** |
| Visual Acuity | * 20/160 vision * Can see letters if they are 7.3 mm or bigger at 60 cm without the aid of any assistive technology (see Section 10.4.4)   Note: Also refer to font height recommendation for people with mobility impairments as there viewing distance is typically further away if looking for one recommendation to cover multiple disability communities. |
| Vertical Field of View | * 15 degrees vertical |
| Horizontal Field of View | * 30 degrees from the centre line of the face in the horizontal direction left and right |
| Contrast | * Can see lettering if the contrast ratio is greater than 4.5:1 (as measured on a contrast checker comparing the foreground font color and background color) |
| Color Vision | * Not applicable |
| Photophobia | * No |

### Other Abilities and Characteristics of a Moderate Vision Loss Persona

* Has average hearing
* Range of Mobility: Full function of the hands, arms, and wrists

### Use Case

*Central vision loss, light, and shape perception*

Paula is in her early 30’s. She is an executive at a regional bank. She has a form of Macular Degeneration. Macular Degeneration, (MD), is a condition that can cause vision loss in the area of the eye responsible for sharp, central vision. The person’s eyes have problems focusing and the central area of the visual field may be fuzzy. MD is a progressive disease that primarily begins later in life (usually after the age of 55) and impedes vision, sometimes to the point of legal blindness. In Paula’s case she had Juvenile Diabetes when she was younger, and the effect of that condition was the Macular Degeneration. Her condition means the centre part of his vision is cloudy and she has problems with light and shape perception.

Paula is still highly active and has a hectic schedule as she still needs to attend many meetings and conference calls during her business day. She normally gets around by taxi when she needs to attend a meeting and she commutes to work every day using rapid transit. She also has an active social life as she and her husband like to go ballroom dancing.

She has a cellphone that she uses to keep in touch with the office during the day if she is out of the office at a meeting. She prefers to deal with emails while in the office. She has her secretary screen her emails and alert her of urgent emails if she is out of the office. Most colleagues know she prefers a phone call to email if the issue is urgent. She also uses email to keep in touch with her friends but has never gotten around to using social media.

### Best Practices for Moderate Vision Loss

Moderate vision loss is a type of visual impairment that impedes everyday functioning and cannot be rectified with surgery, medication, or prescription eyewear. Presentations of low vision include:

* Loss of sharpness or acuity (varying from 20/70 to 20/400
* Tunnel vision
* Near-total blindness
* Smaller field of vision
* Peripheral/central vision impairment
* Blurry vision
* Excessive light sensitivity

There is no all-encompassing assistive technology for people with low vision, as there are so many different manifestations of this impairment. However, research suggests that magnification can assist people with different low vision conditions, and especially those experiencing loss of sharpness or fuzzy vision. Magnification software can encompass other enhancements of, for example, edge, color, or contrast. People with moderate vision loss can utilize magnification with computer devices in the form of screen magnifiers (e.g., ZoomText, MAGic, Zoom, Magnifier, etc.)

#### Screen Magnification

##### Overview of Screen Magnification

A screen magnifier is a software application that increases the size of everything on the screen. A simple screen magnifier may increase the size of text, icons, and graphics by up to 16 times of the original. When installed on your computer, a screen magnifier is like having a magnifying glass hovering over your screen, enlarging everything for easy reading. For example, if a user is writing an email, the screen magnifier enlarges words as they are typed. The screen magnifier also changes views with the movement of the cursor or when using keyboard short cuts, for example. Different magnification modes are available, where users can choose to enlarge the whole screen, or particular sections as they scroll, as well as smaller areas of interest as they move the cursor. [[146]](#footnote-147) [[147]](#footnote-148)

Screen magnifiers can also highlight a particular area on a screen using different colors or shading. The cursor can also be customized. When zooming in on particular words, a screen magnifier smooths out the edges for easier legibility. The screen magnifier app can also invert screen colors for reduced glare (helpful for individuals with macular degeneration).

##### Technical Discussion of Screen Magnification

Before investing in a mobile device, consider the following inquiries, according to the American Foundation for the Blind:

* Does the mobile device come with screen the operating system of your computer compatible with the magnification software?
* What is the highest level of magnification?
* Does the screen magnifier include a setting for inverting colors? [[148]](#footnote-149)

A screen magnifier is very customizable, from choice of what to magnify, highlight, or sharpen, to screen size and clarity. [[149]](#footnote-150)

People who have moderate vision loss and use screen magnifiers (LSUs) have problems with watching digital content with frequent dynamic changes (videos, movies, etc.). LSUs have to pan and zoom rapidly in tandem with the rapidly changing content. Particularly, LSUs have to constantly monitor the various regions of interest (ROIs) and manually move their cursor to these regions, which can be difficult and impractical with a fast-paced and perhaps lengthy medium such as a video. Accessibility of videos for LSUs has not been discussed widely in literature. Videos can be made accessible for people with low vision impairments with the use of accurate audio descriptions, but this is mainly a feature generally designed for blind users. Additionally, writing and embedding the audio descriptions can be a lot of work.[[150]](#footnote-151)

An important feature, especially when used with a touch screen, is a way to quickly “zoom out” to orient to the full screen (100%), then re-center in another part of the screen and “zoom in”. This can be achieved as simply as a gesture to turn off the magnifier, and then turn it back on with a new center as specified by the “turn on” gesture.

Magnification factor can typical be between 10 to 15 times. The exact range of magnification required and the steps between magnification setting is hard to determine because it depends on the size of the mobile device screen and the resolution of that screen. A low-resolution screen may not benefit from a high magnification factor as the screen elements can become pixelated at the high magnification level. Even at high screen resolutions at some point the magnified elements that make up the screen become too large in the mobile device screen for the user to identify what is being displayed. The extreme corner of the letter “N” looks exactly like the letter “M” when it is extremely magnified.

##### List of Mandatory Features for Screen Magnifiers

* Have magnification factor of up to at least 15 times
* Have the ability to magnify everything on the mobile device screen
* Have to ability to present a window of a region a screen where the user places their finger and provide a magnification of up to 15 times that region under the user’s finger
* Ability to reverse the background and foreground colors from dark text on a light-colored background to light colored text on a dark background with 3 to 1 contrast ratio
* Ability to quickly “zoom out” to orient to the full screen (100%), then re-center in another part of the screen and “zoom in”. This can be achieved as simply as a gesture to turn off the magnifier, and then turn it back on with a new center as specified by the “turn on” gesture.

###### Cooperation with Screen Readers

Some people with a moderate vision impairment may only have that visual acuity for part of the day. So, they may use a screen magnifier part of the day, or for certain tasks and then use a screen reader for less visually intensive tasks. Therefore, it is important that both assistive technologies can operate at the same time, such that the magnification shows the speaking location of the screen reader.

## Persona 3: Severe Vision Loss Persona

### Performance Metrics for a Severe Vision Loss Persona



Figure 8. Lauren - a severe vision loss persona.

Table 18. Performance metrics for a severe vision loss persona.

|  |  |
| --- | --- |
| **Performance Metrics** | **Level of Performance** |
| Visual Acuity | No visual acuity – loss of all vision |
| Field of View Vertical | No vertical field of view – loss of all vision |
| Field of View Horizontal | No horizontal field of view – loss of all vision |
|  | No visual acuity – loss of all vision |
| Color Vision | None |
| Photophobia | No |

### Other Abilities and Characteristics of a Severe Vision Loss Persona

* Has average hearing
* Range of Mobility: Full function of the hands, wrists, and arms
* Reads and writes in Braille proficiently

### Use Case: Blindness

Lauren (16) has had total vision loss since she was a child, but she is an active teenager with a busy social life. She contracted Measles when she was young, and the blindness is a result. [[151]](#footnote-152)Like any teenager her social life revolves around her digital online presence. She regularly sends and receives SMS and instant messages and keeps up with her family on Facebook and plans after school activities through SnapChat.

Lauren learned Braille as other children learned to read. She grew up around a lot of technology. There has never been a time when she has not used technology in her everyday life. She uses a braille notetaker in school and to interact with her computer and mobile device. She uses text to speech when reading on the go and for entertainment. And is pleased that her smartphone recently enabled her to “type” Braille instead of the slower “hunt and peck” on the touch keyboard. This allows her to keep up with her friends who also have technology embedded in their lives. To go to activities, she takes public transport (using an accessible app) or rides with her parents or friends.

Lauren has discovered many mobile apps that help her independence in her daily life. For example, she has an app to help her:

* Identify colors,
* Read preparation instructions on packaging,
* Identify paper currency that is all the same size,
* Read bar codes to distinguish same-size canned goods,
* Take photos.

### Best Practices for a Severe Vision Loss Persona

#### Screen Readers with Audio or Tactile Output

##### Overview of Screen Readers

Screen reader software is a digital text-to-speech converter. Users can hear written content using a keyboard to navigate. This is a particularly useful feature for users who are blind or have low vision, providing them with an independent and private way of accessing IT. People with some cognitive or learning disabilities and users who prefer audio over text can also reap the benefits of a screen reader. Screen readers are not only compatible with web-content, but also with documents, spreadsheets, and an operating system interface.[[152]](#footnote-153)

##### Technical Discussion of Screen Readers

When using a screen reader, one can expect the following characteristics:

Experienced users of screen reader typical can perceive and understand the output of a screen reader spoken at a rate faster than normal conversational speech. The speaking rate of an auctioneer is about 250 words per minute.[[153]](#footnote-154) This speaking rate is considered fast for most people, but an **experienced** screen reader user can accommodate these faster speeds and, in some case, even faster word per minute rate.

For navigating web-based content, users typical have a number of different strategies. Since content from a web page is perceived in a liner format, one element of content at a time and in order, by a screen reader user some users preferred to read all the content on a page first to determine what is there and then go back the section they are interested in to read it in more detail. Other screen reader users prefer to read a list of the headings and links on a web page first to determine the nature of the content on that web page and then go directly the section that has the content they are interested in. As a result, being able to read a list of heading and links and being able to navigate to the next heading and link or go directly to a heading or link is a preferred method of navigation for web content.

##### List of Mandatory Features for Screen Reader

* Ability to use at least a male and female voice for the screen reader out
* Ability to have voices at least in the accent of the official regional languages (French and English for Canada) for the screen reader out
* The screen reader should have the ability to navigate the content by headings, links, and other control types
* The screen reader should be able to present the name, value, and role of controls.
* The screen reader should be able to present status messages.
* The screen reader should be able to present focus when changed by the application or the user.
* The screen reader should be able to activate programmatically exposed actions.
* The screen reader should be able to present info and relationships of controls.
* Ability to adjust the volume of the screen reader output
* Ability to adjust the speed of the screen reader output up to 250 words per minute
* Ability to read a letter at a time, a word at a time, a sentence at a time, and all the text on a page using the screen reader
* Ability to control the screen reader via an attached keyboard
* Ability to control the screen reader via an attached braille display
* Ability to read the contents of SMS messages
* Ability to play media with available audio descriptions
* Ability to identify caller by non-visual means
* Ability to perceive output from the screen reader via an attached Braille display

##### Accommodating Differences between Screen Readers

Although all screen readers have similar functionality and capabilities, there are variations between them, such as in shortcuts, voices, and the manner of vocalizing links. These variations often have little effect on coding methods because users will be used to the norms of their favored screen reader. The most important thing is to adhere to commonly recognized accessibility standards and best practices. [[154]](#footnote-155)

###### Linear Content

Audio interfaces have linear content organization, where users are presented with information bits one at a time. In contrast, most sighted users interact with visual interfaces by scanning the whole screen at once, absorbing the content’s overarching structure, aesthetic, and other macro elements. This cannot be done with a screen reader, so the fact that audio interfaces linearize web content is an important guiding point for any web-developers design process. [[155]](#footnote-156)

###### Navigating Content

Although audio interfaces are linear in nature, users can navigate the content faster when using a screen reader through the use of a couple features.

###### Links and Form Controls

One way to navigate content more quickly using a screen reader is by using the Tab key to go between different links provided on the interface. This can be useful when looking for a specific link. Another method like the use of the Tab key is to have an alphabetically arranged list of provided link. However, using these methods can result in the user missing other content that may be important to them. For more information, see[<http://webaim.org/techniques/hypertext/>]. Any provided link should be read out in a way that makes sense without its context.

Note that the TAB key is only available on an external keyboard or Braille Display.

###### Headings

Jumping from heading to heading is an additional strategy for getting a general sense of the content of a page. Users can listen to an overview of the page's key concepts before going back to the sections of interest. This method's biggest flaw is that it depends on headings, which far too many pages don't have. See more information at<http://webaim.org/>. Web developers and authors should use headings to give a text or a website structure. The titles should, to the greatest degree feasible, accurately summarize the content.

###### Landmarks and page sections

Users can make use of ARIA landmarks and HTML5 section elements like <nav>, <header>, <main> to navigate the contents of an audio interface. Implication: Web developers and authors should use ARIA landmarks and HTML5 section elements appropriately.

###### Paragraphs and page elements

Users can skip through from one paragraph to the next by listening to the opening sentence of each section, similarly to how users interact with visual interfaces by scanning the page and then choosing a pertinent area. A similar way of interacting with an audio interface is to jump from element to element (<div> tags, form elements, itemized lists, links, and other content units). The defining information of a paragraph should, whenever possible, be included in the opening sentence.

###### Others

Screen reader users use tables, buttons, forms, images, lists, links, etc. to navigate any audio interface content. Use HTML semantic structure properly, with appropriately marked elements.

##### Mobile screen readers

Most screen readers do not connect external keyboards to their mobile devices despite the existing possibility. Instead, they navigate in two distinct ways:

* Touch navigation – dragging a finger across the screen and having the information directly under the finger read out.
* Swipe navigation – swiping right and left to move between items, similar to what the Tab key would do on an external keyboard.

Users often switch between these navigation methods. Swipe navigation provides a more thorough insight with the focus being set on specific items, but it is also the **lengthier method.[[156]](#footnote-157)**

## Persona 4: Seizure-inducing Visual Stimulus Persona

### Performance Metrics for a Seizure-inducing Visual Stimulus Persona



Figure 9. Jim - persona with seizures.

Table 19. Performance Metrics for Seizure-Inducing Visual Stimulus Persona.

|  |  |
| --- | --- |
| **Performance metric** | **Level of Performance** |
| Visual Acuity | Normal (20/20) |
| Field of View Vertical | * 15 degrees in the vertical direction |
| Fied of View Horizontal | * 30 degrees from the centre line of the face in the horizontal direction left and right |
| Contrast | Normal |
| Color Vision | Not applicable |
| Photophobia | Yes |

### Other Abilities and Characteristics of a Seizure-Inducing Visual Stimulus Persona

Table Other Characteristics Persona 4: Seizure-Inducing Visual Stimulus.

|  |  |
| --- | --- |
| **Characteristic** | **Level of Performance** |
| Hearing | Normal |
| Range of Mobility | Full function of the hands, wrist, arms |

This user can have normal or impaired vision, yet their perception of some moving or flashing stimuli can cause a seizure. If this happens at the wrong time or place, the vulnerable person experiencing a seizure can be severely, or even fatally injured.

### Use Case: Photosensitive Epilepsy

Jim did not even know he had an issue until he woke up on the floor after a video game session. After waking up with a headache and subsequent extensive testing,he was told he has Photosensitive Epilepsy.[[157]](#footnote-158) Now, he must limit his video game choices to minimize the possibility of flashing content. He also looks for standards-compliant software and web sites after learning that they also avoid the presentation of flashing content.

### List of Mandatory Features for Photosensitive Epilepsy

* No visual element will have no more than three **general flashes** and / or no more than three **red flashes** within any one-second period; or
* The combined area of flashes occurring concurrently occupies no more than a total of .006 steradians within any 10 degree visual field on the screen (25% of any 10 degree visual field on the screen) at typical viewing distance[[158]](#footnote-159)

# Hearing Loss Personas

## Definition of Hearing Loss

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.[[159]](#footnote-160) When discussing hearing loss, the descriptor ‘hard of hearing’, or HOH, refers to people with hearing loss ranging from moderate to severe.[[160]](#footnote-161) The term Deafness refers to a condition in which an individual experiences profound hearing loss, i.e., has very little or no hearing, as defined by the WHO.[[161]](#footnote-162)

Hearing loss can be caused by damage to any portion of the peripheral and central auditory systems.[[162]](#footnote-163) 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.[[163]](#footnote-164) In terms of chronic conditions, there are especially strong associations between hearing loss and smoking cigarettes, adiposity, and diabetes mellitus; however, causality remains undetermined.[[164]](#footnote-165) Hearing loss caused by ear disease may be associated with rheumatoid arthritis, systemic lupus erythematosus, Cogan’s syndrome, sarcoidosis, or other autoimmune disorders.[[165]](#footnote-166) Viruses can also cause hearing loss.[[166]](#footnote-167) Cytomegalovirus, rubella, lymphocytic choriomeningitis virus can cause congenital hearing loss.[[167]](#footnote-168) Amongst viruses that cause congenital and acquired hearing loss are HIV-1, and HSV-1 and -2.[[168]](#footnote-169) Viruses that cause acquired hearing loss only are measles (Rubeola), Varicella Zoster Virus, mumps, and West Nile virus.[[169]](#footnote-170)

The occurrence of hearing loss because of prolonged exposure to a noise level greater than 85 dB(A) is well documented in the literature.[[170]](#footnote-171),[[171]](#footnote-172) Noise-induced hearing loss occurs predominantly at higher frequencies (3-6 kHz), with the largest effect at 4 kHz.[[172]](#footnote-173)

## Specific Performance Metrics for Hearing Loss Personas

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 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:

* Ability to determine the directionality of the sound source.
* 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.[[173]](#footnote-174)
* 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.[[174]](#footnote-175)

### Determining Directionality Factors

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

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 base 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.[[175]](#footnote-176)

### 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[[176]](#footnote-177), 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 perception, people with hearing loss benefit from the temporal dips in ambient noise.[[177]](#footnote-178)

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.[[178]](#footnote-179) It is important to note that hearing aids are not an appropriate solution who have hearing loss confined to above 6 kHz, as most hearing aids have limited high-frequency amplification abilities.[[179]](#footnote-180),[[180]](#footnote-181) 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 is 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.[[181]](#footnote-182)

## Persona 1: Mild Hearing Loss Persona



Figure 10. Sam - a mild hearing loss persona.

### Performance Metrics for a Mild Hearing Loss Persona

Table 21. Performance metrics for a mild hearing loss persona.

|  |  |
| --- | --- |
| **Performance Metric** | **Level of Performance** |
| Acoustic Acuity | 25 to 40 dB |
| Acoustic Acuity in both ears | No |
| Ability to isolate (separate) sounds | Not in some situations (such as when several sounds are overlayed on one another, especially speech) |
| Ability to determine the directionality of sound | No |

### Other Abilities and Characteristics of a Mild Hearing Loss Persona

* 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 phenomes, 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.

### 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 ear due to his left ear being closer to the machinery in the mill from his positioning at this workstation on the floor of the mill. 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.[[182]](#footnote-183),[[183]](#footnote-184) He also finds that he has problems picking out specific sounds in noisy environments or while multiple people are talking at the same time. His hearing is not bad enough that he can benefit from hearing aids. He has tried hearing aids but finds that they amplify all sounds. He still has a problem distinguishing unique sounds if there is a high level of background noise, so he does not find the hearing aids useful. He especially has problems following conversations if he is in a room with multiple people talking. The conversation between two people might be of interest but the listener might struggle to divide his attention between 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 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 like to travel, and they go away each year 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 cellphones 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 regular dial-up phone at home.

### Best Practices for a Mild Hearing Loss Persona

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

#### Configurable Audio

##### Overview of Configurable Audio

According to Mobile Manufacturers Forum GARI, initiative, mobile devices should have configurable audio to allow users to customize specific audio parameters by allowing them to adjust frequencies and sound from their headphones or other audio output.[[184]](#footnote-185) 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.

##### Technical Discussion for Configurable Audio

People with a mild hearing disability need all audio aspects of the mobile devices to be adjustable[[185]](#footnote-186) to at least 65 dBA (normal conversations usually occur at roughly 70 dB[[186]](#footnote-187)). 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.[[187]](#footnote-188) Warning labels and information regarding hazards of high noise levels are now commonplace with mobile devices if sound level exceeds 85 dBA.[[188]](#footnote-189) 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).

#### Mono Audio

##### Overview of 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.

##### Technical Discussion of Mono Audio

If a user is experiencing unilateral hearing loss, mono audio must be included as an implementation on the mobile device. Implementing mono audio requires at least 1 microphone and 1 speaker. Users must have the option to turn mono audio on or off, as well as to adjust the balance between Left and Right stereo.

## Persona 2: Moderate Hearing Loss Persona

### Performance Metrics for a Moderate Hearing Loss Persona



Figure . Sophia - a moderate hearing loss persona.

Table . Performance metrics for a moderate hearing loss persona.

|  |  |
| --- | --- |
| **Performance Metric** | **Level of Performance** |
| Acoustic Acuity | 41 to 80 dB |
| Acoustic Acuity in both ears | Yes |
| Ability to isolate (separate) sounds | No, in some situations (such as when several sounds are overlayed on one another, especially speech)72 |
| Ability to determine the directionality of sound | No |

### Other Abilities and Characteristics of a Moderate Hearing Loss Persona

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

### 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 Sophia’s day is spent taking her daughter to playdates 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.

### Best Practices for Moderate Hearing Loss Personas

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

#### Hearing Aid Compatibility (HAC) Rating

##### Overview of Hearing Aid Compatibility Rating

The most important hearing accessibility feature for persons with a moderate hearing disability is the Hearing Aid Compatibility (HAC) rating.[[189]](#footnote-190)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.

Research suggests that current HAC regulations are not strongly effective, with hearing-aid users reporting modest improvement in ease of finding a hearing aid compatible cellphone over the course of implementation of HAC requirements.[[190]](#footnote-191) 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.[[191]](#footnote-192) 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 promoting the compatibility of hearing aids and cellphones.[[192]](#footnote-193) 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.[[193]](#footnote-194) The limitations of the overly prescriptive approach the HAC rating employs are exacerbated by the HAC regulations’ application to cellphones only.[[194]](#footnote-195) Researchers claim that a less prescriptive approach would entail encouraging cellphone manufacturers to partner with hearing-aid manufacturers to produce devices that are designed to work together.[[195]](#footnote-196) 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.

##### Technical Discussion of Hearing Aid Compatibility Rating

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.

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.

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 device and 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)](https://www.fcc.gov/consumers/guides/hearing-aid-compatibility-wireline-and-wireless-telephones)].

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

#### Bluetooth

##### Overview of Bluetooth

A feature that directly feeds into HAC compatibility is Bluetooth. Bluetooth is a wireless technology that uses radio frequency to share data over short distances. Bluetooth technology is one of the most important hearing accessibility features for people with hearing loss[[196]](#footnote-197),[[197]](#footnote-198), as hearing aids can either directly connect via Bluetooth to 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[[198]](#footnote-199) 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.

##### Technical Discussion of Bluetooth

If ICT is providing user input or output connection points, Bluetooth must be provided, either directly or using commercially available adapters.

#### Messaging

##### Overview of Messaging

Text messaging is the act of composing and sending electronic messages. 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.

##### Technical Discussion of Messaging

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 must be available on top of SMS.

To maintain accessibility to these features for those with a moderate hearing disability, a suitable user interface must offer multimedia messaging, which is a crucial feature for those who use Sign Language as their primary form of communication, especially in emergency situations.[[199]](#footnote-200) In addition, a UI (User Interface) must include a search function, message archives, as well as text-to-speech and speech-to-text capabilities.[[200]](#footnote-201)

## Persona 3: Severe Hearing Loss Persona

### Performance Metrics for a Severe Hearing Loss Persona

A picture containing person, wall, indoor, purple

Description automatically generated

Figure . Phillip - a severe hearing loss persona.

Table 23. Performance metrics for a severe hearing loss persona.

|  |  |
| --- | --- |
| **Performance Metric** | **Level of Performance** |
| Acoustic Acuity | 81 dB or higher loss of hearing above the 0 dB threshold |
| Acoustic Acuity in both ears | No |
| Ability to isolate (separate) sounds | No in some situations (a lot of sounds are overlayed on one another especially speech) |
| Ability to determine the directionality of sound | No |

### Other Abilities and Characteristics of a Severe Hearing Loss Persona

* 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

### 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.

### Best Practices for a Severe Hearing Loss Persona

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, alterative notification formats apply to any features that are part of the primary activities identified in Section 8.3 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

#### Alternative Notifications

##### Overview of 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.[[201]](#footnote-202),[[202]](#footnote-203)

##### Technical Discussion of Alternative Notifications

Manufacturers must provide different vibration and visual patterns for distinguishing the type or source of messages.[[203]](#footnote-204),[[204]](#footnote-205),[[205]](#footnote-206),[[206]](#footnote-207) Additionally, if a mobile device is placed in a purse or hung on a belt, for example, the vibration must still be noticeable.[[207]](#footnote-208)

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 must 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). If visual indicators are provided in flashes, there should be no more than three flashes per one second interval.

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

1. Incoming audio call
2. Incoming video call
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, Wi-Fi, Bluetooth)
9. Battery status
10. Power on and off
11. Notification of existence of close caption or alternative format for video media

#### Telecommunications Relay Services

##### Overview of Telecommunications Relay Services

Traditional TTY technology transmitted over phone lines has fallen to the wayside[[208]](#footnote-209),[[209]](#footnote-210), 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.

##### Technical Discussion for Telecommunications Relay Services

Requirements for integrating relay services on mobile devices include:

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

#### Real-Time Text (RTT)

##### Overview of 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.[[210]](#footnote-211) 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.[[211]](#footnote-212)

##### Technical Discussion of Real-Time Text (RTT)

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, ICT must visually differentiate between typed text, sent text, and received text; it can be fulfilled by 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.[[212]](#footnote-213) 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.[[213]](#footnote-214) 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.[[214]](#footnote-215) The mobile device must also support two-way voice communication to support voice calls concurrent with an RTT messaging service. Any RTT input must be transmitted to the ICT network supporting RTT within 1 second of input entry.

#### Two-Way Video Calling

##### Overview of Two-Way Video Calling

Two-way video calling is the multipoint reception and transmission of audio and video signals by people in different locations for real time communication.

##### Technical Discussion of Two-Way Video Calling

Mobile devices must provide real-time voice- and video-based communication. Additionally, a mobile device must provide access to an answering machine that is accessible to persons with a hearing disability. The frame rate requirement for two-way video calling is at least 12 frames per second, and preferably 20 frames per second. The resolution requirement for two-way video calling is at least Quarter Common Intermediate Format, and preferably at least Common Intermediate Format. The audio and video have to be synchronized within 100ms. 12 frames per second with Quarter Common Intermediate format resolution

#### Captioning

##### Overview of Captioning

Captions are a form of written text embedded into a video, intended to transcribe dialogue, and describe other relevant audio for viewers who cannot hear (rather than not understand the audio); they can be closed or open. The Deaf community as well as individuals who are hard of hearing make use of closed captioning.[[215]](#footnote-216) It is cited as one of the most important accessibility features for people with hearing disabilities.[[216]](#footnote-217),[[217]](#footnote-218),[[218]](#footnote-219),[[219]](#footnote-220) There is evidence to support the claim that text added to auditory signals has the potential to help listeners understand speech.[[220]](#footnote-221)

##### Technical Discussion of Captioning

Mobile devices must support playback of videos with synchronized audio with open and closed captioning. When displaying videos with synchronized audio, the user has a choice to display the captions or not. The controls for enabling and disabling captions must be clearly visible. The synchronization between the captions and the audio must be maintained within 100ms of the caption time stamp. The user also must have the capability to modify the display of closed caption data. The following modes of text presentation have to be supported: 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. The characters of captions as well as the caption window color may be displayed in a palette of at least 8 colors, including white, black, red, magenta, green, cyan, blue, and yellow; additionally, users may have the ability to override the original color of characters and caption window. Users have access to changing the opacity of captioned text, with the choices ranging from opaque to semi-transparent. Users are provided with the ability to change character size of the captioned text, with ranges from 50%-200% of the default character size. Different fonts are provided to the users to choose from.

# Speech Loss Personas

## Definition of Speech Loss

For the purposes of this document, the following definition of speech loss derived from the American Speech-Language Hearing Association (ASHA) definition is being used. The definition focuses on a subset of what ASHA defines as conditions covered under the Definitions of Communication Disorders and Variations.[[221]](#footnote-222)

“A speech loss is an impairment of the articulation of speech sounds, fluency and/or voice.

An articulation disorder is the atypical production of speech sounds characterized by substitutions, omissions, additions, or distortions that may interfere with intelligibility.

A fluency disorder is an interruption in the flow of speaking characterized by atypical rate, rhythm, and repetitions in sounds, syllables, words, and phrases. This may be accompanied by excessive tension, struggle behavior, and secondary mannerisms.

A voice disorder is characterized by the abnormal production and/or absences of vocal quality, pitch, loudness, resonance, and/or duration, which is inappropriate for an individual's age and/or sex.”[[222]](#footnote-223)

Members of the speech loss community are typically defined by the characteristics of their voice, or more specifically, their acoustic volume, intelligibility, consistency of their speech and speaking rate of their speech. Intelligibility, consistency, and speaking rate are typically measured through listening test and a standard list of vocabulary words, phrases, and sentences. There is no widely accepted, predominant, standardized test for these dimensions. Several testing methods and validated tests exist, but the actual test used varies by the speech and language pathologist training and regional norms.

## Specific Performance Metrics for Speech Loss Personas

Rather that focus on tests that are administered and interpreted by trained speech and language pathologists, this document takes a more pragmatic view and applies two functional definitions that are more useful for people that know little or nothing about the field.  These two functional definitions will be used to define the key performance metrics for members of the community. The two performance metrics are:

1. Acoustic Intensity
2. Effective Rate of Communication

### Acoustic Intensity

Acoustic intensity is measured in dB or dBa. If the individual cannot generate speech with an acoustic intensity equivalent to a whisper (20 – 30 dB) that can be heard and understood at 1 metre, that individual is classified as not having sufficient acoustic intensity to carry on a conversation without assistive technology.[[223]](#footnote-224)

### Effective Rate of Communication

Even though there are specific tools to measure intelligibility and the rate of speech, this document takes a pragmatic view. The concept of Effective Rate of Communication will refer to the rate at which a listener can understand the speech of someone who is speaking. The Effective Rate of Communication will be measured as the average words-per-minute that the speech of a speaker can be understood by an unfamiliar listener, i.e., someone who is not used to the speech of the speaker. The Effective Rate of Communication is affected by the intelligibility, consistency, and rate of speech. In any given instance, a combination of those factors can affect the Effective Rate of Communication. The Effective Rate of Communication can also vary depending on the situation. Around people who are used to your speech patterns, even if the intelligibility or consistency may vary, the Effective Rate of Communication can be higher than in a situation with unfamiliar listeners. Generally, the rates of conversation using Augmentative and Alternative Communication (AAC) systems, including word prediction and letter abbreviation, were found to be 12–18 WPM.[[224]](#footnote-225),[[225]](#footnote-226) Natural speech from someone who has no speech loss issues has a rate of 125–185 words per minute (WPM). Direct selection techniques, including eye gaze systems, where what the user is looking at is tracked, are found to provide conversational rates of about 8–10 WPM. Similarly, mechanically activated AAC switches and keyboards also affect conversation rates. The automatic, step, and inverse activation of switches often requires the users to wait until the desired selection is displayed, introducing conversation delays. Scanning methods are reported to allow communicative rates of around 2 WPM.

## Persona 1: Low Acoustic Intensity Persona

The first category of users is affected by Low Acoustic Intensity. This group is defined by the fact that the volume of their speech is difficult to hear if they speak in their normal voice. They typically have an auditory intensity of less than 30 dB. the level of a whisper.[[226]](#footnote-227)



Figure 13. Simon - Persona 1.

### Performance Metrics for Persona 1

Table 24. Performance metrics for a Low Effective Rate Communication Persona.

|  |  |
| --- | --- |
| **Performance Metric** | **Level of Performance** |
| Acoustic Volume measure at 1 metre (decibels) | 30 dB or less |
| Effective Communication Rate | Greater than 18 words per minute |

### Use Case

Simon (54) had throat cancer a few years ago. As a result of the treatments, his vocal cords were damaged. He can speak intelligibly and has a consistent ability to articulate words, but the volume of his speech is low. He speaks at the volume of a whisper (30 dB), so you need to be very close to hear him speak. In other words, in a quiet room and a listener with average hearing, the listener’s ear must be within 12 inches of Simon's mouth to understand what he is saying. (When testing, the listener should close their eyes or look away to avoid lip reading.)

Simon was an executive at a technology company before his cancer but has taken early retirement as a result of the speech loss which was caused by throat cancer. He and his wife live downtown in a condo as their children left home a long time ago. They still enjoy the activities available as a result of living downtown in a vibrant city, but they are not as active as they were before his speech loss.

Simon spent most of his life around technology, so he keeps in touch with his children and their families using messaging, social media, and weekly video calls. He does this on his smartphone and on his personal computer.

Simon carries a small personal amplifier device (examples can be found at https://www.luminaud.com). By using a headset, he can speak using his natural voice and his voice is amplified so people around him can hear him.

When Simon is making a phone call while he is out of the house, he needs to use speakerphone mode on the phone as the phone has problems picking up his voice when he is not using the amplifier device. Though not always necessary, there are times when he is talking to his doctor, financial advisor, or a close family member on the phone where it is important to him to have a degree of privacy. In those situations, he needs to have the phone in handset mode and swap between listening through the handset and holding the phone up to the speaker of his voice amplifier to speak to the person at the other end of the line. It is an inconvenient but somewhat pragmatic approach to completing a semi-private conversation that is similar to what people without a speech loss issue sometimes use.

Simon owns a Smartphone and uses it to keep up with his personal emails and phone calls throughout the day. He also uses text messaging to keep in touch with his children and close friends. His children, who live in distant cities, text him every day.

### Best Practices for Persona 1

#### Voice Amplifier

##### Overview of Voice Amplifiers

A voice amplifier might be used as an accommodation for an individual who has difficulty speaking loudly enough to be heard by nearby communication partners or in certain environments such as classrooms, auditoriums or outdoors, or in noisy environments. Amplifiers can be personal, portable, hand-held, or body-worn, or much larger commercial systems. Examples of voice amplification systems can be seen at [[https://www.luminaud.com]](https://www.luminaud.com/). The device referred to in this document only focuses on personal hand-held or body worn systems to use with a mobile device. Most personal voice amplifiers are designed for the person to wear a headset, but someone who can communicate easily with nearby communication partners might benefit more from a handheld microphone they pick up when needed, or from a microphone mounted on their wheelchair. Also, not everyone tolerates things they must wear. A person who has had part or all of their larynx removed may use a Larynx Speech Aid. The most common artificial voice source for post-laryngectomy speech rehabilitation is the handheld buzzer or electrolarynx (EL) [[227]](#footnote-228). EL speech is often described as mechanical sounding (robotic), and typically lacks pitch variation, making it monotonic and unnatural. There is also a degree of variability in the intelligibility of the speech.

##### Technical Discussion of Voice Amplifiers

Depending on coexisting disabilities, the person may have other considerations that need to be addressed. If the Low Acoustic Volume is due to a stroke, the stroke may have also affected their ability to process information, for example, so they may need additional accommodations that are covered in the section on Cognitive Impairment.

The person described in the persona can perform all tasks from the primary task list without any additional accommodations except for having a private phone call, but private phone calls can be accommodated without making modifications to the design of the phone.

When privacy is not needed, in speaker phone mode, the user can use the output of the speech amplifier to create their end of the conversation. They can hear the person they are calling as the person at the other end of the line will have their voice spoken aloud through the speaker phone.

In the case of semi-private conversation, the individual with the speech loss can use a typical phone by coordinating their call similar to a communication system where only one person can speak at a time. The individual with the speaker amplifier can hold the mobile device up to the speaker amplifier to speak. The user at the other end of the line will need to pause briefly to give a chance for the caller to then switch the mobile device to their ear in order to hear the caller at the other end of the line. Using a cable, or wireless connection, that routes the output of the phone to a headset without disabling the microphone on the phone, so the phone can still hear output from the speaker amplifier, would be another alternative.

In the case where a totally private conversation is required, the individual must find a private room or location where people outside of the room cannot hear the conversation, just like typical phone users who do not have characteristics that adversely affect their speech.

A secondary consideration is how synthetically generated speech of the voice amplifier or electro-larynx device interacts with voice assistants such as Alexa, Siri, etc.

“The electro-larynx device (EL) offers the possibility to re-obtain speech when the larynx is removed after a total laryngectomy. Speech produced with an EL suffers from inadequate speech sound quality, therefore there is a strong need to enhance EL speech. When disordered speech is applied to Automatic Speech Recognition (ASR) systems, the performance will significantly decrease. ASR systems are increasingly part of daily life and therefore, the word accuracy rate of disordered speech should be reasonably high in order to be able to make ASR technologies accessible for patients suffering from speech disorders. Moreover, ASR is a method to get an objective rating for the intelligibility of disordered speech. In this paper we apply disordered speech, namely speech produced by an EL, on an ASR system which was designed for normal, healthy speech and evaluate its performance with different types of adaptation. Furthermore, we show that two approaches to reduce the directly radiated EL (DREL) noise from the device itself are able to increase the word accuracy rate compared to the unprocessed EL speech.” [[228]](#footnote-229)

There have been recent advances in the field, but the speech recognition rate is still lower than for people who do not use assistive technology to help them speak. For those users that want to use voice assistants, the accuracy of the speech recognition may affect their ability to successfully use that class of solutions. In addition, having a private phone conversation is currently not seamless. Voice amplifiers and electro-larynxes currently do not provide a way to interface directly to the voice input channel of the mobile device. By alternating between listening and holding the mobile device up to the speaker of the voice amplifier or Electro Larynx it is possible to have semi-private conversation, but it requires some coordination.

## Persona 2: AAC User – Low Effective Communication Rate Persona, AAC Hosted on a Mobile Device

The second category of users is the Low Effective Communication Rate persona, as their effective communication rate with the use of assistive technology is well below that of speakers without an loss of ability to speak. As mentioned above, these users’ communication rates with the use of augmentative and alternative communication (AAC) solutions are typically between 12 and 18 words per minute. This may be slower than the rate they can achieve using their natural voice, but they choose to use AAC because it is more intelligible than their natural voice or is less fatiguing typically.



Figure 14. Phillip - Persona 2.

### Performance Metrics for Persona 2

Table 25. Performance Metrics for a Low Acoustic Intensity Persona.

|  |  |
| --- | --- |
| **Performance Metric** | **Level of Performance** |
| Acoustic Volume measure at 1 metre (decibels) | Greater than 30 dB |
| Average understandable Speaking rate | Less than 18 words per minute |

### Use Case: Intermediate Stages of Cerebral Palsy

Phillipa is an active sixteen-year-old with cerebral palsy (CP). She was born with the condition, and it affects her motor skills. She has a spastic form of CP so her muscles are stiff, her movements can be awkward, and spasms cause her arms to jerk or flail uncontrollably sometimes. She uses an electric wheelchair to get around as she does not have the coordination to walk by herself. She has enough gross motor control of her forearms so that she can drive the electric wheelchair using a joystick on the wheelchair. Her speech is slurred so she has difficulty articulating certain words and sounds and her speech is not always consistent. Most people have a difficult time understanding her, but her family and close friends who are around her a lot have learned to understand most of what she is saying.

She has an AAC device which she uses to communicate with people outside of the close circle of people, who can understand her when she speaks. Communicating with her can be frustrating for strangers, and for Phillipa, so she uses her AAC device mainly in those situations.

She has some use of her right hand, wrist, and arm. She uses that range of motion to drive her electric wheelchair using a joystick and to control her AAC solution which she uses to help her communicate. The AAC solution is an application that runs on her phone. She controls her phone using the pointing device support that is on the mobile device. The pointer is controlled by the joystick on her wheelchair via a Bluetooth link. She can independently switch the joystick from controlling her wheelchair to generating Bluetooth mouse output to the mobile device.

Phillipa attends a high school for teenagers with special needs. She attends classes regularly every day and spends a good deal of her time doing class work on her computer. Like most teenagers, she has an active social life which revolves around her smartphone and many social media communities like TikTok. She is on Facebook as her grandparents use that platform to connect with their family members. She is also an active email and text message user. Her parents use text messaging to keep in touch with her throughout the day and to coordinate activities such as when to pick her up from her extracurricular activities.

When making a phone call, she has to use the AAC application on her mobile device, which uses the audio channel on the phone, unless the phone call is to someone within his close circle of friend that understands her natural speech patterns.

### Best Practices for Persona 2

#### AAC Application

##### Overview of AAC Application

This individual is using the mobile device to host an AAC application, as well as performing typical mobile device functions. The AAC application may use a keyboard to allow the user to type their message and then use text-to-speech to speak those words, phrases, or sentences aloud. Alternatively, the AAC application (App) may use icons or symbols to represent common words, phrases or sentences the user might want to say. She controls the AAC App using the pointer controlled from her wheelchair joystick. The symbolic system in some cases is faster when using rate-enhancing features such as word prediction to type.

The mobile device needs to have the capability to run the features of the App. Typically, the technical requirements are no different from typical applications that run on the mobile device and support text-to-speech capability. There are many text-to-speech voices on the market, so a user can almost always select a voice built into the phone that is easy for other people to understand. There are many choices of voices that may sound more like the way the user would like to sound, such as providing for various ages, genders, body types, foreign languages, accents, etc. Some mobile devices are limited to the voices supported by the operating system’s text-to-speech capabilities. A few entry-level consumer or business mobile phone devices may not yet support text-to-speech capabilities or may be dedicated to specific purposes that do not require text-to-speech.

##### Technical Discussion of AAC Application

The mobile device must support the routing of the output of the AAC application to the audio channels of the phone so the recipient of the phone call can hear the output of the AAC application, especially routing into the microphone circuitry of the mobile device for use in online meeting apps such as such as Facetime, Zoom, Teams and Voice over Internet Protocol (VoIP) calls. The AAC output can potentially be used to control voice-assistant-enabled features on the phone. Many mobile devices suppress sounds from the device such as alerts in order to not interfere or disrupt the phone call via their noise cancellation algorithms. The one implementation of this that exists today has the limitation that the AAC App can only use the default text-to-speech voices on the mobile device. Third-party text-to-speech voices are not supported on that mobile device. The requirement to use the default text-to-speech voice may be due to the fact they have known acoustic properties that can be compensated for in the noise suppression algorithms built into the implementation of the phone system on the mobile device.

##### List of Mandatory Features for AAC Apps on mobile devices:

* + Be able to support at least a male and female voice
  + Be able to support voice with the accent of the language of the region (French and English in Canada)
  + Be able to route the output of the AAC App to the audio circuitry of the phone and the mobile device to allow the completion of phone calls and use of voice enable features on the mobile device using the AAC output as described in Section 14.4.3.1.2.1 of this document

###### AAC App Audio Passthrough Requirement

In a typical assistive configuration, the mobile device has an AAC app installed. Typing in the text input field in the AAC App will cause a sentence to be read out. Wired or Bluetooth earbuds may be connected for the user to monitor what the AAC App is saying on the user’s behalf.

Mobile phone operating systems must provide public APIs for developers to route text-to-speech audio into phone calls. The AAC App’s audio speech output must either be internally routed into the microphone input or directly merged with the call’s digital audio stream. In addition, the AAC App’s audio speech output must be capable of being routed to other Apps on the phone such as voice assistants.

For the AAC app to be used in private, semi-private and public conversations, public APIs are needed to toggle between sending audio to the phone’s speakers or the phone’s TRRS jack, if it has a TRRS jack. This toggle needs to allow audio to be played on the phone’s speakers even when headphones are connected. This toggle must be easily accessible on-screen with a tap, with switch scanning, and with one press of an external switch.

|  |  |
| --- | --- |
| Graphical user interface in an application for setting up audio output. | Graphical user interface, application  Description automatically generated |

Figure 15. Example of a software-based audio toggle switch

Mobile phones without a headphone jack must provide a way to connect a wired headset for monitoring. This can be done by supporting an adapter that allows TRRS headsets to be used. If the headset has a mic, it must be usable during the call as well.

The mobile device operating system must support text-to-speech capability and have the ability to support multiple voices and languages. Where the operating system does not support text-to-speech capability it must allow third party text-to-speech functionality to operate as part of the functionality of an AAC App.

## Persona 3: AAC User – Low Effective Communication Rate Persona, AAC Device Hosted External to Mobile Device

A person with red hair

Description automatically generated with low confidence

Figure . Sophia – Persona 3.

### Performance Metrics for Persona 3

Table 26. Performance Metrics for a Persona using AAC external to mobile device.

|  |  |
| --- | --- |
| **Performance Metric** | **Level of Performance** |
| Acoustic Volume measure at 1 metre (decibels) | Not applicable |
| Average understandable Speaking rate | Not applicable |

### Use Case: ALS

Sophia is 42 years old and has amyotrophic lateral sclerosis (ALS). ALS is a progressive nervous system disease that affects nerve cells in the brain and spinal cord, causing loss of muscle control. ALS is often called Lou Gehrig's disease, after the baseball player who was diagnosed with it. ALS often begins with muscle twitching and weakness in a limb, or slurred speech. Eventually, ALS affects control of the muscles needed to move, speak, eat, and breathe. It is characterized as bulbar onset ALS if speech muscles are affected first or spinal onset if muscle control of the limbs comes first. For instance, some people with spinal onset ALS may experience loss of use their limbs while retaining the ability to talk for several years.

Sophia was a schoolteacher before she exhibited any of the symptoms of ALS. ALS symptoms typically do not appear in childhood or young adulthood. Sophia was diagnosed at age 40. Her first symptom was weakness in her legs and her condition progressed quickly after diagnosis such that she required a wheelchair within weeks. A few months later, her speech became difficult to understand as control of her speech muscles began to decline, but there were complications related to loss of the ability to breathe independently that led to a tracheostomy to install a ventilator, that completely stopped her from speaking.

She now needs to use an AAC device to communicate. She scans an array of letters, words and phrases organized in rows and columns on the AAC device’s screen, using a switch plugged into the AAC device that is activated by the blinking of her eyes.

She blinks to start the scanning process. Each row in the array is highlighted in sequence. When the row with the letter, word, or phrases she wants is highlighted, she blinks again. Each column in that row is then highlighted sequentially. When the right row and column cell is highlighted, she blinks again to activate the cell. If that cell contains text, that text is added to a buffer of text she is building, or that text can be injected into any other App running on the AAC device. Though this method, she can assemble words, phrases, and sentences, to speak, text message, email, add to a longer document she is editing, send to a mobile device, etc.

There is usually a cell in the row-column array that corresponds to a “Speak” command, and when she selects this cell through the row-column scanning process, the text she has collected is then spoken aloud using a text-to-speech synthetic voice. The audio speech output of the AAC device is routed to audio input on the mobile device in order for her to carry on a phone conversation and to control the voice assistant features on the mobile device. Having her AAC device command the voice assistant on the mobile device is a more effective way for her to do certain tasks, such as calling her husband by simply making her AAC device say, “Call Jim,” just as using the voice assistant is often more efficient for nondisabled users.

### Best Practices for Persona 3

She can also control the mobile device through her AAC device through multiple mechanisms:

* Screen mirroring
* Voice assistant
* Direct commands
* Audio routing

#### Screen Mirroring

##### Overview of Screen Mirroring

The mobile phone allows her to mirror the display of the mobile device on the display of her AAC device. She can then interact with the representation of the mobile device screen on her AAC device using her scanning method. When she activates a point of interest or enters data into a control on the represented mobile device screen, that activation information is sent to the mobile device and the equivalent action occurs on the mobile device. She can launch applications, place a phone call, and send and receive a text message or email on the mobile device through this mechanism.

##### Technical Discussion of Screen Mirroring

The mobile device must provide a way to mirror the screen of the mobile device on the screen of an AAC device.

Screen mirroring means that you see content on your phone mirrored onto a larger screen like a TV, monitor or personal computer PC. Whatever action your do on your phone will appear on the other screen in real time.

Screen mirroring works by turning one device into the sender and the other the receiver. In most cases, your smartphone acts as the sender and your smart TV or PC as the receiving device.

These three technologies all allow you to see one screen on another in some way, but they have differences

Screen mirroring acts just like when you look in a mirror. Whatever you see on one device is exactly what you see happening on the other in real time. Screen casting is similar to mirroring except that you no longer see it on both. For example, content casted from your phone to your TV will only appear on your TV. Screen sharing is most similar to screen mirroring, but instead of displaying content from one device to another in the same room, the content displays from one device to another in a separate room or remote location.”

In Sophia’s case, the mobile device’s screen is mirrored onto her AAC device’s screen, not to a TV. A wired or wireless interface is typically provided using a USB cable, Bluetooth, or Wi-Fi.

##### List of Mandatory Features for Mirroring, Casting, and Sharing

* Displays the device screen
* Performance: >30 fps update rate, depending on the device
* Support screen quality of 1920×1080 or higher
* Low start-up time: <1 second to display the first image
* Low latency: <70ms lag for continuous images
* Non-intrusiveness: Nothing is left installed on the device
* Bidirectional control: Operations performed on the mirrored image are conveyed back to the mobile device and operated on as if they were activated locally on the mobile device

The image of the screen must be able to update with at most 700 milliseconds of lag to provide an up-to-date image of the state of the mobile device and allow real-time, bidirectional interaction from the user to the AAC device to the elements on the mobile device screen and back.

A command set or API must be provided that allows a device to remotely control the phone features, specifically, being able to pick and activate a point of interest represented by the mirrored image of the phone display and being able to enter data on a virtual representation of the keyboard on the device. Through this interaction method the user must be able to perform all the tasks on the Primary Task List including making and receiving a telephone call and interacting with voice -activated features on the phone via the external AAC device.

#### Voice Assistant

##### Overview of Voice Assistants

Sophia can generate words and sentences on her AAC device that she can then speak using the text-to-speech capability of her AAC device. The spoken output may consist of commands to her mobile device’s voice assistant, and the mobile device will follow her instructions as it would for an able-bodied user.

The mobile device’s voice assistant must be able to understand synthesized speech, and the local environment must be sufficiently noise-free. This is usually not a problem. A more common problem is that synthesized speech out of AAC devices is often not loud enough to trigger a mobile device’s voice assistant. However, since Sophia has both her AAC device and her mobile device mounted to her wheelchair in proximity, this is not a problem for her.

##### Technical Discussion of Voice Assistants

Though synthetic speech is improving every year, it is unclear how that has impacted the recognition accuracy of voice assistance with the synthetic speech of AAC systems. There are no publicly available studies that have looked at the recognition rates of voice assistants with the synthetic speech of AAC systems. There are anecdotal reports of AAC speech out being used to control voice assistants though by people with disabilities with mixed levels of success.

“Voice recognition systems today work best for people who use fairly “standard” speech. They don’t do nearly as well decoding heavy accents, regionalisms, or even speakers with stuffy noses. Unless you’re using a system that has been painstakingly trained on your voice, you can expect no more than 80-85% accuracy.”[[229]](#footnote-230)

“Most devices with speech recognition today pass a voice spectrogram to the cloud to be processed; moving this processing out of the cloud takes the bottleneck out of response time and enables the development of voice control interfaces for specific applications that will be much more accurate than the experience today.”[[230]](#footnote-231)

For people with disabilities this means they may have better recognition accuracy when their mobile device has access to a network and no access or poorer recognition accuracy when their mobile device is not connected to the network. In the last few years mobile devices have a speech recognition capability when connected to the network and when not connected to the network. When not connected the mobile device uses speech recognition technology hosted on the mobile device. The recognition systems hosted on the mobile devices have improved as the mobile device hardware capabilities have improved but they still have not reached the level of accuracy of network hosted implementations. While people without disabilities have other ways to access the same features and services on their mobile device the person with a disability may not.

One of the key issues to be addressed is improving the accuracy of the speech recognition systems hosted on devices. It is important to also recognize that data minutes to transfer the spectrograms from the mobile device to the network hosted servers to process the speech is not always cheap or unlimited. In many cases the person with a disability is at an economic disadvantage if they have to rely on a connected speech recognition system to be the only way to access the mobile device.

#### Direct Commands

##### Overview of Direct Commands

For Sophia, another very effective means of controlling her mobile device is for her AAC device to send the mobile device direct commands, such as through a Bluetooth Hands-Free Profile.

A sample situation in which this is her best means of accessing the phone might be calling her husband, a repetitive task, or calling the 911 emergency line, a time-critical task. Using screen mirroring to perform either of these tasks takes significant time and effort to make multiple selections. Using voice assistant to perform either of these tasks also takes significant time and effort to make multiple selections and has the additional chance that the voice assistant will not interpret the command correctly, such as in a noisy room.

Using a direct command interface between the AAC device and the mobile device allows Sophia to activate a pre-set selection on her AAC device which sends a direct command of one or more steps to the mobile device to dial the given phone number.

Direct commands must be able to accomplish at least basic operation of the phone (dialing, answering, hanging up, etc.). It would be of additional benefit for direct commands to be able to control text messaging and emailing on the mobile device. Direct commands must be able to perform every task on the primary task list to be considered a best practice. One possible implementation of this would be for the direct commands to send text directly to the mobile device’s voice assistant rather than through audio channels. Command line base access to voice assistants is available on some mobile devices. Note that this is not the only implementation of this approach. Direct commands using the Voice Assistant interface is only being proposed as an example of a solution.

##### List of Mandatory Features for Direct Commands

* Allow for the connection of a remote device to the mobile device through a standardized connection
* Provide a standard command set to control features and Apps on the mobile device
* Provide a trusted mechanism to perform the remote control of the device

##### Technical Discussion of Direct Commands

There is no standardized way for a remote device to control a mobile device. On some mobile devices it is possible to type in the same phrase that is spoken to execute a command for the voice assistant. That currently requires some custom programming to execute.

It is possible to create an App that listens for data on a USB, Bluetooth, or Wi-Fi port similar to the convention currently used to connect switches to mobile devices and then have the App programmatically send a text query to the voice assistant. There may be some privacy and security issues associated with this implementation, but they can be overcome by using security keys or hardware validation techniques for the remote device controlling the mobile device.

#### Audio Routing

##### Overview of Audio Routing

The mobile device must provide a mechanism to route the audio output of an external AAC device to the audio input channel of the phone (not via speaker phone mode) on the mobile device and to the audio input of the voice-activated features of the mobile device. At the same time, the mobile device must preserve the ability to use the existing audio channel to hear the caller at the other end of the line using the existing audio channels on the device. This must include hearing the caller at the other end through the existing phone speaker when in handset mode, and through the speaker of the AAC device. This will facilitate private conversations when the user requires it.

Note that this is different from the technical requirements of the persona of Phillip, the teenager with cerebral palsy who requires routing of audio from Apps on the mobile device to other Apps and the telephone audio circuitry of the mobile device, also on the phone. Phillip’s AAC App and other Apps only need to communicate within the phone, whereas Sophia requires bidirectional routing of audio between her AAC device and her mobile device, either through wireless means or through physical cables.

##### Technical Discussion of Audio Routing

There are certain configurations that mobile phones need to support in order to facilitate semi-private or private phone conversations using augmentative and alternative communication (AAC) devices. The following standards will ensure AAC users have consistent ways to make private phone calls across all major mobile phone manufacturers.

These configurations will enable equal or better level of access for AAC users compared to nondisabled users in regard to private phone calls. “Equal level of access” is defined for semi-private calls as bystanders in the same room as the AAC user being able to hear the AAC device side of the conversation, but not hear the called party, a level of privacy that nondisabled users also experience when making a semi-private call. “Better level of access” is defined as bystanders not being able to hear either the AAC device or the called party.

###### Y-Splitter Cable with Mic & Headset

This solution uses a 3.5-millimeter tip, ring, ring, sleeve (TRRS) Y-splitter cable that follows the American Headset Jack (AHJ) standard. The cable splits a TRRS input into separate headset and microphone inputs.

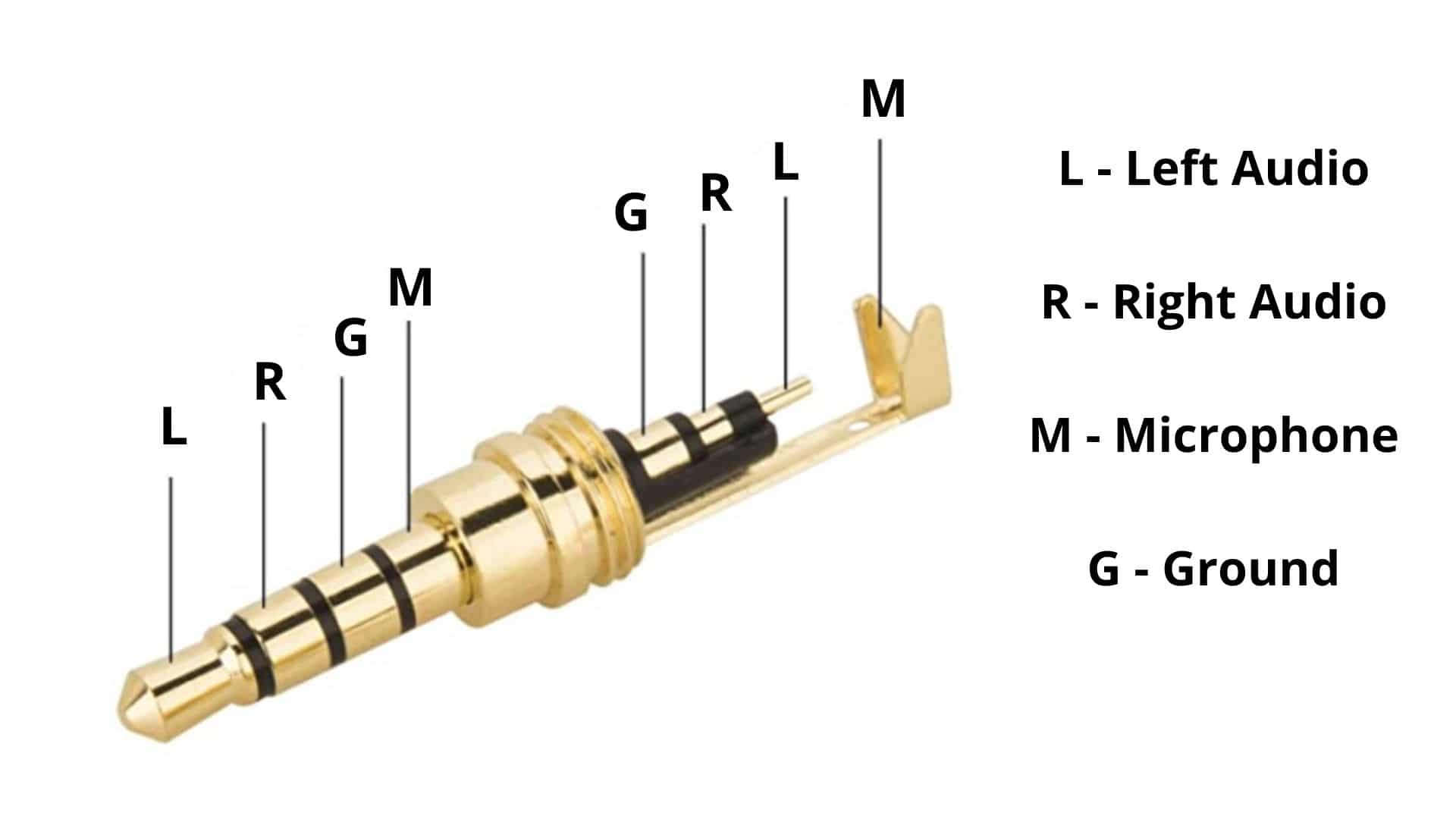
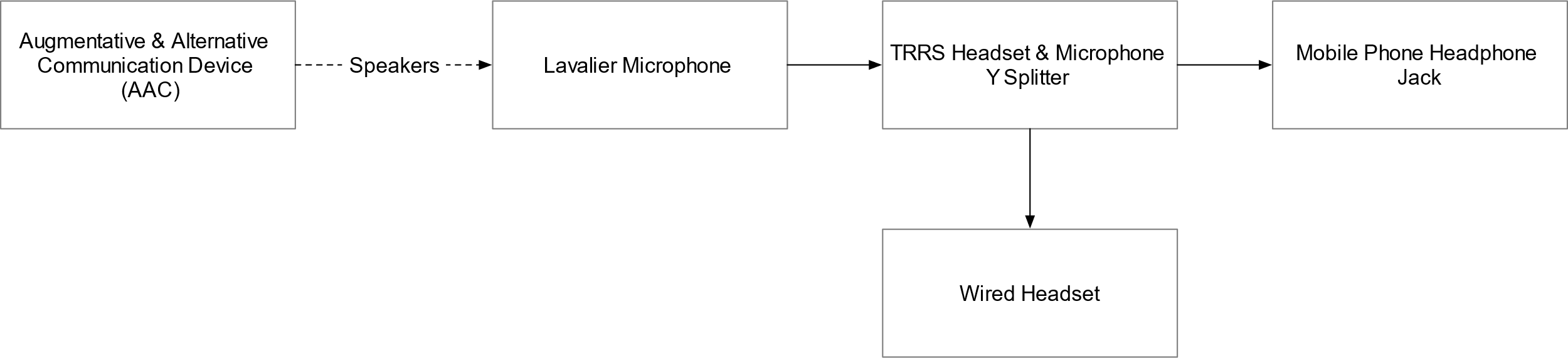


Figure 17. AHJ 3.5 mm TRRS configuration



Figure 18. TRRS headset & mic Y-splitter.

Speech output from the AAC device is captured by a lavalier microphone attached to the Y-splitter’s microphone input. A wired headset is attached to the Y-splitter’s headset output for monitoring.



This configuration allows the AAC device to be used for both private and public conversations. A caveat is that only the audio of the called party is private, which is equivalent to the way an able-bodied person has a semi-private phone call.

Mobile phones without a headphone jack must enable equivalent functionality. This can be accomplished using a wired connection, such as by including an adapter, such as a Lightning-to-TRRS adapter or USB-C-to-TRRS adapter, that allows the TRRS Y-splitter to be used. Or it can be accomplished wirelessly by including a Bluetooth-to-TRRS transceiver (transmitter & receiver) to allow the microphone and headset to communicate with the phone wirelessly at the same time. If the headset has a mic, both mic inputs of the Y-splitter cable must be usable concurrently.

###### Y-Splitter Cable with Mic Passthrough & Headset

This solution uses a 3.5-millimeter tip, ring, ring, sleeve (TRRS) Y-splitter cable that follows the American Headset Jack (AHJ) standard. The cable splits a TRRS input into separate headset and microphone inputs.

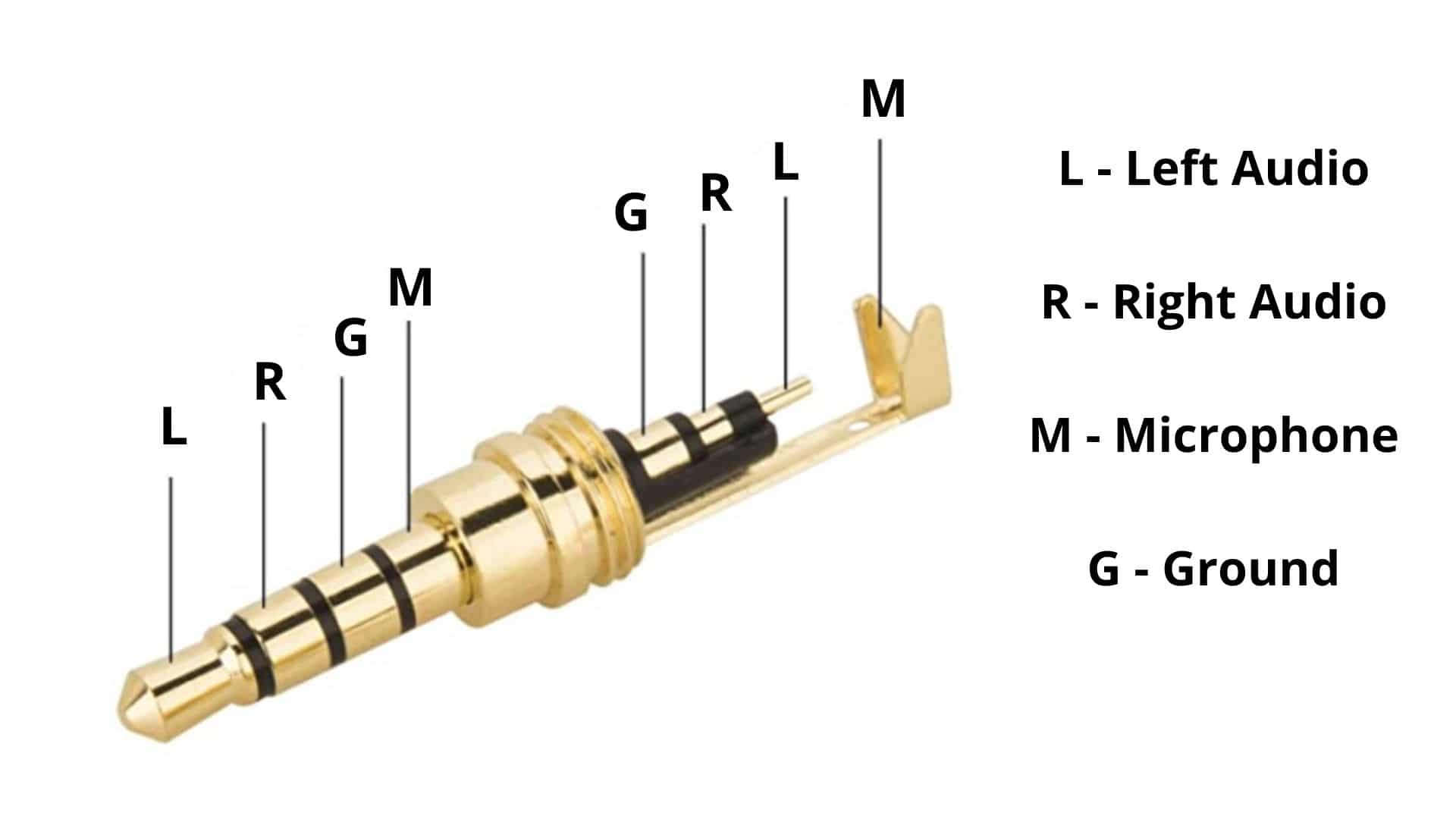


Figure 19. AHJ 3.5 mm TRRS configuration.



Figure 20. TRRS headset & mic Y-splitter.

Speech output from the AAC device is redirected to the mobile phone as microphone input using a Y-splitter cable. A wired headset is attached to the headset output in the Y-splitter cable for monitoring.

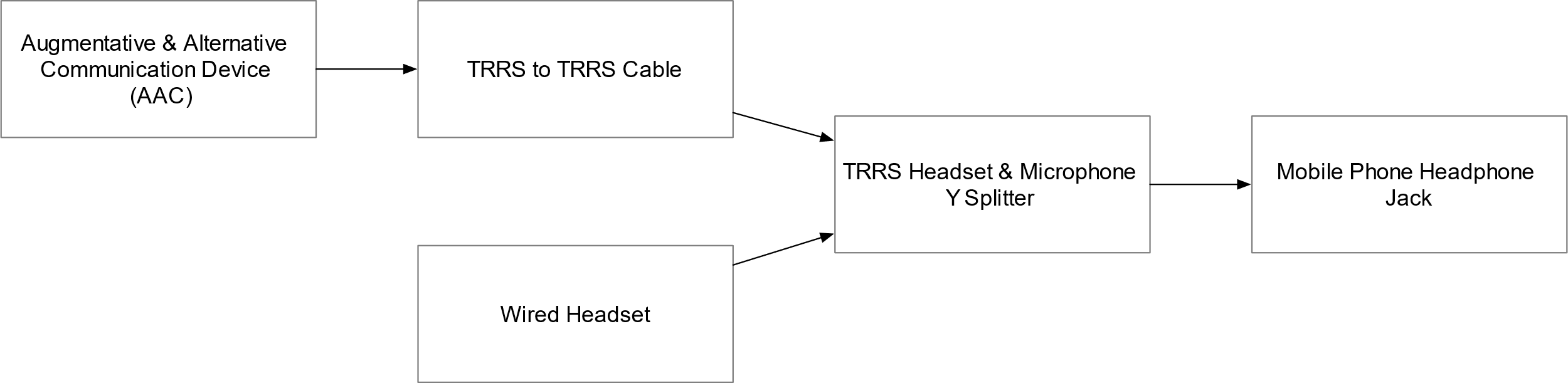


Figure . A flow chart of connecting an AAC device to a mobile device using a Y-splitter cable.

To allow for easy switching between using the AAC for private conversations and public conversations, AAC devices must have a software toggle to switch between sending audio to the TRRS jack or to the AAC’s speakers. This toggle needs to allow audio to be played on the phone’s speakers even when headphones are connected. This toggle must be easily accessible with an on-screen tap, with switch scanning, and with one press of an external switch.

|  |  |
| --- | --- |
| Graphical user interface, text, application, chat or text message  Description automatically generated | Graphical user interface, application  Description automatically generated |

Figure . Example of a software-based audio toggle switch.

Mobile phones without a headphone jack must enable equivalent functionality. This can be accomplished using a wired connection, such as by including an adapter, such as a Lightning-to-TRRS adapter or USB-C-to-TRRS adapter, that allows the TRRS Y-splitter to be used. Or it can be accomplished wirelessly by including a Bluetooth-to-TRRS transceiver (transmitter & receiver) to allow the microphone and headset to communicate with the phone wirelessly at the same time. If the headset has a mic, both mic inputs of the Y-splitter cable must be usable concurrently.

## Persona 4: Low Effective Communication Rate Persona, AAC User with a Cognitive Condition

### Performance Metrics for Persona 4



Figure 23. Wendy – Persona 4.

Table 27. Performance metrics of AAC User with a Cognitive Condition.

|  |  |
| --- | --- |
| **Performance Metric** | **Level of Performance** |
| Acoustic Volume measure at 1 metre (decibels) | 30 dB or less |
| Effective Communication Rate | Less than 18 words per minutes |

### Use Case: Aphasia

Wendy is 30-year-old professional that used to work in human resources. She had to recently leave her job and go on long term disability because she was in a severe car accident. In the car accident she got a head injury. One of the effects of her head injury is Aphasia. Aphasia is a disorder that affects how you communicate. It can impact your speech, as well as the way you write and understand both spoken and written language.

Wendy used to be very articulate and chatty person, but the Aphasia has affected her ability to communicate. She now:

* speaks in short or incomplete sentences
* speaks in sentences that don't make sense
* substitutes one word for another or one sound for another
* speaks unrecognizable words
* has difficulty finding words
* at times can not understand other people's conversation
* can not understand what she reads
* writes sentences that don't make sense

She is frustrated with her current ability to communicate but is getting better with therapy. She is motivated and is determined to get back what she has lost. She religiously works on her exercises each week and is supported by her husband and their extended families. She is making progress, but progress is slow, and she needs to remember to be patient.

She needs to use an AAC device with symbols to help her communicate currently. The symbols help her compose phrases without taxing her cognitive abilities. She is using a large tablet based AAC device as she has a lot to say but she can just can not always figure how to say it. Her AAC device is connected to her mobile phone so that her husband can check in with her through the day. They keep connected through voice calls. Her AAC device helps her compose what she wants to say through a series of symbol which give her time to gather her thoughts. She is still struggling to write and read written text. Being connected through her AAC and mobile device gives her and her husband a sense of security. She can contact her husband if she is confused and needs so help.

### Best Practices for Persona 4

#### Overview

This group of users use external AAC devices based on large tablets or laptops. They need to use symbols rather than written words to communicate because of the lack of language skills. They may still be talkative and have a lot to say but their condition affects their ability to select the right words. They use symbols to reduce their cognitive load, but they need a large number of symbols because they want to have more than just a rudimentary conversation.  Screen mirroring, mentioned above, imposes a particularly high cognitive load, as the user has to understand the relationship between the AAC device and the phone, and use the accessibility features of the AAC device to access the mirrored screen of the phone. Not all users are capable of the level of cognition needed to make use of screen mirroring, and would only use the other two modes, voice assistant and direct commands.

The AAC device uses large images arranged into rows and columns, that the user touches to activate. Pictures can be used individually or in combination to produce words, phrases, or sentences. One such picture for a young student might be a picture of the student’s mother talking on the phone. When the student touches this picture, the picture could command the mobile device to call the student’s mother in several ways:

* The picture could speak the sentence, “Siri, call Mom,” from the AAC device’s voice synthesizer. This would be heard by the mobile phone’s voice assistant and the voice assistant would dial the student’s mother on the speakerphone.
* The picture could send a direct command consisting of the text, “Siri, call Mom,” through Bluetooth or another means, and Siri, which has a text mode, would interpret the text, and dial the student’s mother on the speakerphone.

Pictures can also be used to execute pre-programmed functions on the mobile device (controlling device in their local environment using the voice assistant features or placing a phone call to a specific person). The picture could send a direct command consisting of a hands-free phone dialing command containing the mother’s phone number, and the hands-free profile on the mobile device then dials the student’s mother on the speakerphone. This group of users have a reduced list of tasks from the primary task list. Due to their lack ability to read and understand text they are limited to the task they can complete. The primary task list for this group of users can be reduced to:

Table 28. Reduced primary task list for Persona 4.

|  |  |
| --- | --- |
| **#** | **Task** |
| 1 | Making and terminating a communication session (phone calls, videos calls, or text messages) |
| 2 | Receiving communication session (phone calls, videos calls, or text messages) |
| 3 | Sending pre-composed text messages to a person in their contact list and to a specific phone number |
| 4 | 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. |
| 5 | Taking pictures/videos and saving them to the mobile device |
| 6 | Watching videos or listening to music including changing volume |
| 7 | Completing a video call or meeting (FaceTime, no equivalent in Android that is shipped with phone - Duo) |
| 8 | Receiving low battery notification |
| 9 | Changing settings on the mobile device (such as display brightness, default font size) |
| 10 | Turning on the power to the phone |
| 11 | Turning off the power to the phone |
| 12 | Turning volume up |
| 13 | Turning volume down |
| 14 | Charging the mobile device |

This task list has been modified. Regarding task #2 and receiving a text message, the text message may have to be spoken aloud for the user to perceive and understand it. Regarding task #3, the user is only able to send pre-composed text messages as they can not write due to their Aphasia.

#### Technical Discussion

Refer to section on “direct commands” for Persona 3.

# 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 type and severity of disability, 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 groups of users 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

## 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 and to ensure compliance with accessibility requirements.

## Confirming Goals of the End Users

A list of representative tasks is provided in Section 8.3 (Primary Task List). 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.

## Collate Performance Metrics and Best Practice for Each End User

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 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. Where possible, bias towards one specific brand or model of device was avoided. In some cases, the best of class solutions may exist in different brands and models of mobile devices. The best practices were chosen based on the most effective and efficient solution for the end-users’ ability level.

## 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 encompass everything from automatic banking machines and fax machines to mobile device 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. Where possible, the existing prescriptive standard or guideline specification were used by referencing the appropriate standard, paragraph, and section. Where the standards and guidelines were insufficiently detailed, additions to the specification were made. Where there were competing specifications or parts of specification that were in conflict or offered contradictions, an attempt was made 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 7 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.

## 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 this link which shows the American Section 508 procurement template.

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

## Acceptance of the Delivered Product

There are three phases to the acceptance process:

* 1. Declaration of Accessibility Compliance by suppliers/manufacturers
  2. Functional testing to confirm compliance by the purchaser
  3. End user acceptance process

The Declaration of Accessibility Compliance (DAC) by suppliers/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 version of 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](https://docs.google.com/document/d/1mOH_VepFm1B7LqVDv0bLb6zxmgp8k3Zv/edit#bookmark=id.28h4qwu)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 15.13: “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 in 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 fraction 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 on to WCAG 2.0 criteria but also can apply to the specification with EN 301 549. 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 29. 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/*](http://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*](http://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*](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 Comply**: 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)](https://www.itic.org/policy/accessibility/vpat)

VPAT 2.4 Rev 508: Revised Section 508 standards – the U.S. Federal accessibility standard 126

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” 127

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 128

VPAT 2.4 INT: Incorporates all three of the above standards 129

* 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:
  1. The functions or features with issues
  2. 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, the hope is that 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 cognitive, speech loss, 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 or other accessibility standard requirements.

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 a product will be perceivable and usable by a person with vision, hearing, mobility, speech loss, 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.

## 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 (i.e., This document) |  |
| Web Content Accessibility Guidelines 2.1 |  |

### 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.

### Primary Task List Provided by Procurement Agency

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

| **#** | **Primary 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 |

## EN 301 549 Conformance Report

The following specifications from the EN 301 549 standard are used to define the accessibility of mobile device 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 Task List.

Chapter 4: Functional Performance Statements (FPS)

Notes:

| Criteria | Conformance Level | Remarks/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 officials 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

| 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

| 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

| 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

| 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

| 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 |  |  |

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 any one-second period. | [Home | Section508.gov](https://www.section508.gov/) |  |  |
| *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](https://www.section508.gov/) |  |  |

## Best Practice Implementations

To make the selection process easier if your product implements a best practice, please declare that here. Refer to Best Practices Sections 9 – 14 of this document to learn more about what best practices are required for each disability group.

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 a direct 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 without using a gesture and a 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 15.13 on how equivalent solutions are evaluated and the testing data that is required to be submitted to make a declaration of equivalent functionality.

### Ranking System for Best Practices Implementation

A ranking system has been implemented in this document to quickly screen the conformance report for compatibility and accessibility of mobile devices. The ranking system establishes a way to rank mobile device in terms of the number of best practices implemented and the completeness of the implementation. It should be noted that the ranking system should not be used as a strictly rigorous set of criteria, but instead an initial ranking process for the purposes of sorting proposals. The appropriateness and acceptance by the end users are the most important criteria. If a specific group of users or severity level are not relevant to the end use case, it is more important to consider this than the overall ranking of a mobile device.

The ranking system contains three levels. If rank 0 is achieved, that means no best practices have been implemented. Rank 1 indicates that best practices have been implemented with exceptions. Rank 2 signifies that all best practices have been implemented. All points are totaled to receive a score. If two products are equal, the higher score get preference, though this score system should not provide the sole criteria. If support is not needed for a specific disability group, then low scores in those sections are irrelevant.

#### Mild Hearing Loss

| **Best Practice** | **Conformance Statement**  Solution lets user do all primary tasks? (Yes/No) | **Remarks /Explanations**  Give testing data for conformance statement | **Rank** |
| --- | --- | --- | --- |
| **Configurable audio** | | | |
| Feature #1 Adjustable audio to at least 65 dB |  |  |  |
| Feature #2 Warning labels if audio output exceeds 85 dB |  |  |  |
| **Mono Audio** | | | |
| Feature #1 At least 1 microphone and 1 speaker |  |  |  |
| Feature #2 On/Off Toggle for Mono Audio |  |  |  |
| Feature #3 Slider to adjust Left and Right stereo balance |  |  |  |

#### Moderate Hearing Loss

| **Best Practice** | **Conformance Statement**  Solution lets user do all primary tasks? (Yes/No) | **Remarks /Explanations**  Give testing data for conformance statement | **Rank** |
| --- | --- | --- | --- |
| **HAC** | | | |
| Feature #1 Interference reduction |  |  |  |
| Feature #2 HAC rating M3/T3 or better |  |  |  |
| Feature #3 Induction Loop connection availability through a 3.5 mm jack and Bluetooth or Wi-Fi |  |  |  |
| **Bluetooth** | | | |
| Feature #1 Provide Bluetooth directly or using commercially available adapters |  |  |  |
| **Messaging** | | | |
| Feature #1 MMS, IM, e-mail available on top of SMS |  |  |  |
| Feature #2 User Interface must include a search function |  |  |  |
| Feature #3 User Interface must include message archives |  |  |  |
| Feature #4 User Interface must include text-to-speech and speech-to-text capabilities |  |  |  |

#### Severe Hearing Loss

| **Best Practice** | **Conformance Statement**  Solution lets user do all primary tasks? (Yes/No) | **Remarks /Explanations**  Give testing data for conformance statement | **Rank** |
| --- | --- | --- | --- |
| **Alternative notifications** | | | |
| Feature #1 No more than three flashed per one second interval with visual notifications |  |  |  |
| Feature #2 Different vibration and visual patterns |  |  |  |
| Feature #3 Strength of vibration – vibration must be noticeable in purse/on a belt |  |  |  |
| Feature #4 At least the following notifications must be provided:  Incoming audio call  Incoming text message  Confirmation of sent text message  Voice mail received  New email received  Notification of calendar event  Status of connections (Wi-Fi, Bluetooth, cellular network)  Battery status  Power on/off  Notification of existence of close caption or alternative format for video media |  |  |  |
| **Telecommunications Relay Services** | | | |
| Feature #1 Calls to or from must be connected automatically to relay service if desired |  |  |  |
| Feature #2 Same or different mode of communication between two users must be provided through conversion |  |  |  |
| Feature #3 Relay services must work on all commonly used devices |  |  |  |
| **Real-Time Text** | | | |
| Feature #1 RTT support exists |  |  |  |
| Feature #2 Differentiation between typed text, sent text, and received text |  |  |  |
| Feature #3 Support for two-way voice communication concurrent with RTT |  |  |  |
| Feature #4Transmission to ICT network within 1 second of input entry |  |  |  |
| **Two-way video calling** | | | |
| Feature #1 Provision of real-time voice- and video-based communications |  |  |  |
| Feature #2 Access to answering machine |  |  |  |
| Feature #3 Frame rate of at least 12 fps, preferably 20 fps |  |  |  |
| Feature #4 Resolution of at least QCIF, preferably at least CIF |  |  |  |
| Feature #5 Synchronicity of video and audio within 100ms |  |  |  |
| **Captions** | | | |
| Feature #1 Support for playback of videos with synchronized audio with open and closed captions |  |  |  |
| Feature #2 Choice to display captions |  |  |  |
| Feature #3 Clearly visible enabling/disabling caption controls |  |  |  |
| Feature #4 Text presentation modes that must be supported include: text that appears all at once, text that scrolls up as new text appears, text where each new letter or word is displayed as it arrives |  |  |  |
| Feature #5 Characters of captions as well as the caption window color may be displayed in a palette of at least 8 colors: white, black, red, magenta, green, cyan, blue, yellow |  |  |  |
| Feature #6 User ability to override original color of characters and caption window |  |  |  |
| Feature #7 User access to changing opacity of captioned text with the choices ranging from opaque to semi-transparent |  |  |  |
| Feature #8 User ability to change character size of the captioned text, with ranges from 50% to 200% of default size |  |  |  |
| Feature #9 Users have multiple choices of fonts for captioned text |  |  |  |

#### Mild Mobility Loss

| **Best Practice** | **Conformance Statement**  Solution lets user do all primary tasks? (Yes/No) | **Remarks /Explanations**  Give testing data for conformance statement | **Rank** |
| --- | --- | --- | --- |
| **Slide Type Input Method Keyboard** | | | |
| Feature #1 Must support keyboard for the regional languages (French and English in Canada) |  |  |  |
| **Assistant Menu** | | | |
| Feature #1 Provides a software equivalent to the HOME button on the device, screenshot, volume control (up and down), cursor control |  |  |  |
| Feature #2 Provides an alternative to the volume up and down keys if there is no existing software equivalent to these keys in the Settings menu or alternative in an App on the device |  |  |  |
| Feature #3 Provides an alternative to all actions that can be only access through a gesture: screenshot, pinch zoom in, pinch zoom out, software cursor control, screen control (scrolling) access to notifications, power off menu, menu setting for the menu assistant, back, recent |  |  |  |
| **Menu to control cursor** | | | |

#### Moderate Mobility Loss

| **Best Practice** | **Conformance Statement**  Solution lets user do all primary tasks? (Yes/No) | **Remarks /Explanations**  Give testing data for conformance statement | **Rank** |
| --- | --- | --- | --- |
| **External pointing device** | | | |
| Feature #1 Supports an external pointing device through a standardized connection |  |  |  |
| Feature #2 Support an adjustable cursor size with a height of at least 8.4 mm |  |  |  |
| Feature #3 Support an adjustable cursor speed with at least 87 mm per second |  |  |  |
| Feature #4 Support an adjustable system font height of at least 8.4 mm as measure for the capital letter “H”. |  |  |  |
| **External keyboard** | | | |
| Feature #1 Support an external keyboard through a standardized connection |  |  |  |
| Feature #2 Mobile must support sticky key and bounce keys (at up to at least 10 seconds), repeat keys (up to at least 10 second and shut off) |  |  |  |

#### Severe Mobility Loss

| **Best Practice** | **Conformance Statement**  Solution lets user do all primary tasks? (Yes/No) | **Remarks /Explanations**  Give testing data for conformance statement | **Rank** |
| --- | --- | --- | --- |
| **Switch scanning** | | | |
| Feature #1 Supports switch scanning as input through a standardized connection |  |  |  |
| Feature #2 Support dual and single switch scanning with at least the row-column scanning strategy described in Section 10.5.4.2.1 |  |  |  |
| Feature #3 Ability to switch between automatic scanning mode to manual scanning mode |  |  |  |
| Feature #4 Support scanning speed of 25 milliseconds to 15 seconds |  |  |  |
| Feature #5 Support input delay up to at least 10 seconds |  |  |  |
| **Fully Capable Voice Recognition – end-to-end support** | | | |
| Feature #1 Ability to set the focus to an arbitrary point of interest using voice commands only |  |  |  |
| Feature #2 Ability to interact with the point of interest using voice commands |  |  |  |
| Feature #3 Ability to switch voice recognition on and off using pre-defined keywords |  |  |  |
| Feature #4 Ability to access features or Apps that are typically accessed through gestures using voice commands only |  |  |  |

#### Low Vision

| **Best Practice** | **Conformance Statement**  Solution lets user do all primary tasks? (Yes/No) | **Remarks /Explanations**  Give testing data for conformance statement | **Rank** |
| --- | --- | --- | --- |
| **Adjustable font** | | | |
| Feature #1 Able to set the system font to a height of at least 8.4 mm measure for the letter “H”. |  |  |  |
| Feature #2 Able to see the contrast between the system font and the default background color at 4.5 to 1. |  |  |  |
| **Background setting** | | | |
| Feature #1 Have the ability to implement a dark background as the default which should adhere to the 4.5 to 1 contrast requirement. |  |  |  |

#### Moderate Vision Loss

| **Best Practice** | **Conformance Statement**  Solution lets user do all primary tasks? (Yes/No) | **Remarks /Explanations**  Give testing data for conformance statement | **Rank** |
| --- | --- | --- | --- |
| **Screen magnification implementation #1** | | | |
| Feature #1 Magnifies the complete image of the display |  |  |  |
| Feature #2 Provide an adjustable magnification factor |  |  |  |
| Feature #3 Provide a magnification factor of up to 15 times[[231]](#footnote-232) |  |  |  |
| **Screen magnification implementation #2** | | | |
| Feature #1 Has a window that shows a magnified view of the mobile device display in the region under the user’s finger |  |  |  |
| Feature #2 Provide an adjustable magnification factor |  |  |  |
| Feature #3 Provide a magnification factor of up to 15 times |  |  |  |
| Feature #4 The magnifier can follow focus |  |  |  |
| Feature #5 The magnifier can be used concurrently with the screen reader and follow speech progress[[232]](#footnote-233) |  |  |  |

#### Severe Vision Loss

| **Best Practice** | **Conformance Statement**  Solution lets user do all primary tasks? (Yes/No) | **Remarks /Explanations**  Give testing data for conformance statement | **Rank** |
| --- | --- | --- | --- |
| **Screen reader** | | | |
| Feature #1 Ability to use at least a male and female voice for the screen reader out |  |  |  |
| Feature #2 Ability to have voices at least in the accent of the official regional languages (French and English for Canada) for the screen reader out |  |  |  |
| Feature #3 The screen reader should have the ability to navigate the content by headings, links, and other control types |  |  |  |
| Feature #4 The screen reader should be able to present the name, value, and role of controls. |  |  |  |
| Feature #5 The screen reader should be able to present status messages. |  |  |  |
| Feature #6 The screen reader should be able to present focus when changed by the application or the user. |  |  |  |
| Feature #7 The screen reader should be able to activate programmatically exposed actions. |  |  |  |
| Feature #8 The screen reader should be able to present info and relationships of controls. |  |  |  |
| Feature #9 Ability to adjust the volume of the screen reader output |  |  |  |
| Feature #10 Ability to adjust the speed of the screen reader output |  |  |  |
| Feature #11 Ability to read a letter at a time, a word at a time, a sentence at a time, and all the text on a page using the screen reader |  |  |  |
| Feature #12 Ability to control the screen reader via an attached keyboard |  |  |  |
| Feature #13 Ability to control the screen reader via an attached braille display |  |  |  |
| Feature #14 Ability to read the contents of SMS messages |  |  |  |
| Feature #15 Ability to play media with available audio descriptions |  |  |  |
| Feature #16 Ability to identify caller by non-visual means |  |  |  |
| Feature #17: Ability to perceive output from the screen reader via an attached Braille display |  |  |  |

#### Photo-sensitive Epilepsy

| **Best Practice** | **Conformance Statement**  Solution lets user do all primary tasks? (Yes/No) | **Remarks /Explanations**  Give testing data for conformance statement | **Rank** |
| --- | --- | --- | --- |
| **Flashing notifications** | | | |
| Feature #1 No visual element will have no more than three **general flashes** and / or no more than three **red flashes** within any one-second period |  |  |  |
| Feature #2 The combined area of flashes occurring concurrently occupies no more than a total of .006 steradians within any 10-degree visual field on the screen (25% of any 10-degree visual field on the screen) at typical viewing distance |  |  |  |

#### Cognitive Group 1

| **Best Practice** | **Conformance Statement**  Solution lets user do all primary tasks? (Yes/No) | **Remarks /Explanations**  Give testing data for conformance statement | **Rank** |
| --- | --- | --- | --- |
| **Text-to-Speech** | | | |
| Feature #1 Ability to select text:   * A word * A phrase * A sentence * A paragraph * All text on the screen   Ability to select a region that contains text |  |  |  |
| Feature #2 Ability to select a region containing text to be read aloud |  |  |  |
| Feature #3 Ability to read all text on the screen |  |  |  |
| Feature #4 Ability to select at least a male and a female voice in the regional languages (for Canada French and English) |  |  |  |
| Feature #5 Ability to select the rate at which the text is read aloud from at least two seconds per word to 7 words per minute |  |  |  |
| Feature #6 Ability to highlight what is being spoken at the time:   * A word at a time * A phrase at a time * A sentence at a time |  |  |  |
| **Autocorrect** | | | |
| Feature #1 Have the ability to add customized words to the dictionary |  |  |  |
| **Spell/Grammar Check – word prediction** | | | |
| Feature #1 To have a dictionary in the official language of the region (in Canada: French and English) |  |  |  |
| Feature #2 Have the ability to add new words to the dictionary |  |  |  |
| **Dictation for Primary Apps** | | | |
| Feature #1 Integrated with the virtual keyboard on the device as opposed to being application specific |  |  |  |
| Feature #2 - Virtual keyboard should have a function to turn on the dictation (speech to text) mode |  |  |  |
| **Do Not Disturb/Focus Mode** | | | |
| Feature #1 - Function to turn on and off |  |  |  |
| **Re-playable First Run Tutorials** | | | |
| Feature #1 Have chapter marks in the videos |  |  |  |
| Feature #2 Keep language at a grade 5 level if possible |  |  |  |
| **Undo Action** | | | |
| **Availability of media alternatives for help text and instructions** | | | |
| Feature #1 Have chapter marks in the videos |  |  |  |
| **Video chapter marks** | | | |
| Feature #1 Video player should support video chapter marks |  |  |  |
| **Interactive Transcripts** | | | |
| Feature #1 Ability to save the transcript under a customized name for the file |  |  |  |
| **Contact Info for Device Support** | | | |
| Feature #1 Binary feature: either present or not |  |  |  |
| **Voice-Based Intelligent Personal Assistants** | | | |
| Feature #1 Necessary to be able to complete all primary tasks |  |  |  |
| **Cut, Copy, and Paste** | | | |

#### Cognitive Group 2

| **Best Practice** | **Conformance Statement**  Solution lets user do all primary tasks? (Yes/No) | **Remarks /Explanations**  Give testing data for conformance statement | **Rank** |
| --- | --- | --- | --- |
| **Voice Notes/Recordings** | | | |
| Feature #1 Ability to give the recordings a specific name |  |  |  |
| Feature #2 Ability to automatically name the recording as a default |  |  |  |
| **Find My Device** | | | |
| Feature #1 Binary feature: either present or not |  |  |  |
| **Wayfinding** | | | |
| Feature #1 Has turn by turn navigation with audible instruction |  |  |  |
| **Timers and Scheduled Reminders** | | | |
| Feature #1 Ability to set a reminder using the voice assistant |  |  |  |
| **Smart Assistants** | | | |
| Feature #1 Ability to use the Smart Assistant to complete all the primary tasks with the following exceptions |  |  |  |
| **Single App Mode (App pinning)** | | | |
| Feature #1 Binary feature: either present or not |  |  |  |
| **Do Not Disturb/Focus Mode** | | | |
| Feature #1 Binary feature: either present or not |  |  |  |
| **Visual Confirmation the Device Received a User Input** | | | |
| Feature #1 Should be available for all the Apps that implement the primary tasks |  |  |  |
| **Alternative Launchers** | | | |
| Feature #2 Binary feature: either present or not |  |  |  |
| **Photo Dialing** | | | |
| Feature #1 ability to use customized photos for contacts |  |  |  |
| **Emergency Services and Location** | | | |
| Feature #1 Binary feature: either present or not |  |  |  |
| **No Screen Timeout** | | | |
| Feature #1 Binary feature: either present or not |  |  |  |

#### Alternative & Augmentative Communications (AAC) User

| **Best Practice** | **Conformance Statement**  Solution lets user do all primary tasks? (Yes/No) | **Remarks /Explanations**  Give testing data for conformance statement | **Rank** |
| --- | --- | --- | --- |
| **AAC Device Hosted on Mobile Device** | | | |
| Feature #1 AAC App on the phone should support at least one male and at least one female voice |  |  |  |
| Feature #2 AAC App need to have setting to customize the voice which include:   * Pitch * Rate of speaking |  |  |  |
| Feature #3 Support the AAC App Audio Passthrough Requirement in Section 14.4.3.1.2.1 |  |  |  |
| Feature #4 Support the ability to route the output of the AAC App to the phone circuitry of the mobile device in speaker phone mode |  |  |  |
| #5 Support the ability to route the output of the AAC App to the phone circuitry of the mobile device even when a headset is attached |  |  |  |
| **AAC Device Hosted Externally to Mobile Device** | | | |
| Feature #1 Ability to mirror the display of the device to a remote terminal using a standard connection |  |  |  |
| Feature #2 Ability to control the pointer abilities of the mobile device using the same standard connection that provides the mirroring capability |  |  |  |
| Feature #3 Support the direct command feature described in Section 14.5.3.3 |  |  |  |
| Feature #4 Support the audio routing feature describe in Section 14.5.3.4 |  |  |  |

Legal Disclaimer (Company)

Include your company legal disclaimer here, if needed.

A rank is given for each best practice implemented and for each feature implemented for that best practice. While the exact scoring system may vary depending on the procurement agency/department, equal weighing is assumed for each best practice and feature in this document. It is possible to weigh specific best practices and features more heavily if specific end users require specific best practices and features. As a quick screening criterion, the device with the highest score when all the ranks are added up will rank higher in the selection process than competing devices that have a lower score.

## 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 to complete all the primary task required by the end user. 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 affect the effectiveness of the evaluation process and eliminates the need to duplicate the testing processes.

## 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 they need 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.

## 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 more effective. More details are provided in the Section 15.13: Testing Process for a New Accessible Solution.

## 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 sub-group 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 accessibility barriers of all severity levels.

The testing process is constructed around a list of tasks as described in Section 8.2 of this document. That list is repeated here to make it easy to reference.

| **#** | **Primary 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 abilities 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 some 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 taking into the consideration 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 abilities described in the personas section. A solution can then be evaluated against users with the combination of performance metrics provided for each ability 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 is 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 sub-group or sub-groups, a user with the related performance metrics for that sub-group must be able to complete all the tasks on the primary task list without having to resort to additional features or 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. The results are for a specific disability group and ability level.

| **#** | **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. Purchasers may determine the mobile device is intended for a subset of users and then they may deem the exception/exceptions acceptable to their intended end users.

# Appendix A: List of Alternative Texts

Figure 1. A person holding their wrist with a pained expression. They are on a laptop.

Figure 2. Person in a power wheelchair with an assistant sitting on a bench next to him.

Figure 3. A person wearing glasses and a mouth joystick is sitting in a power wheelchair.

Figure 4. A person sitting by a window, smiling and holding a hand to her face.

Figure 5. A person with Down's syndrome listening to music through corded over-ear headphones attached to their phone.

Figure 6. An elderly person wearing glasses is holding their phone at an arm's length, looking at it.

Figure 7. Two people are sitting next to each other; both of them are looking at the screen of a laptop together.

Figure 8. A person with a white cane and dark glasses is sitting on a park bench.

Figure 9. A person smiling and typing on their phone.

Figure 10. A person with glasses holding their phone to their ear.

Figure 11. A person with a hearing aid smiling down at their phone in their hand.

Figure 12. A person smiling while using Sign Language.

Figure 13. A person wearing glasses pinching their trachea, with a pained expression on their face.

Figure 14. A person in a wheelchair smiling.

Figure 15 and 22. Graphical user interface in an application for setting up audio output.

Figure 16. Person sitting in a wheelchair.

Figure 17 and 19. A labeled drawing of an AHJ 3.5mm TRRS configuration.

Figure 18 and 20. A close-up of a TRRS-headset & a mic Y-splitter.

Figure 21. A person looking down at their phone, smiling.

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