

research report

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Assistive technologies in communications: unmet needs, new technologies and ongoing research and development programmes



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1. Background and introduction

1.1. Goal of review

Ofcom commissioned a study by i2 media research to identify the areas where Ofcom could have the greatest potential impact in supporting the future development and application of new assistive technologies in the communications sector. This study comprised of three parts:

1. A review of currently available assistive technologies, with a view to identifying any unmet needs;
2. A review of ongoing assistive technology developments. These included a review of the ongoing activities funded by the European 7th EU Framework Programme and relevant UK charities;
3. A review of the potential application of recent technological developments that have the potential to improve the accessibility of communications services (e.g., speech recognition, touch screens, smart materials).

1.2. Key Output

The main output of this study is a prioritised list of area(s) where Ofcom involvement, either through support for an existing development, a new Ofcom-led initiative or via an Ofcom-funded small-scale technical development project, could provide the stimulus for industry to develop new assistive products or services.

The study makes two key recommendations:

1. That Ofcom commissions a small-scale technical development project aimed at making voice over IP (VOIP) telephony services more accessible for hearing impaired users. This project will bring together an existing speech to text software package and an open source voice over internet protocol application to provide a speech to text demonstration platform. The use of VoIP will enable a functional system to be created by a small-scale development and could potentially produce a platform that would be of benefit to hearing-impaired users. The performance of this platform will be evaluated against draft ETSI requirements for captioned telephony services, and against user needs (through trials with deaf and hearing impaired users).
2. That Ofcom explores how the development of personalised Web 3.0 entertainment services, including WebTV and radio services, might be exploited in the future to provide personalised user interfaces adapted to different users' needs.

2. Research questions

The research questions identified by Ofcom to be addressed in this project were as follows:

- What are the current identifiable gaps in provision of assistive communication technologies?
- What new technology developments have the potential to enable new assistive techniques? (e.g. improvements in speech recognition, touch sensors, developments in internet-enabled devices)?
- How best might the key gaps in assistive provision be addressed?
- Which gaps might be bridged by an Ofcom initiative, for example promoting a concept with industry or by funding a small-scale technical development?
- Are any of the charities, or organisations funded elsewhere, working on solving these issues?
- What new technology developments have the potential to cause new access constraints for people with different disabilities? (e.g., exclusive reliance on touch screen interfaces/controls, reliance on multimodal, e.g. voice, information)

3. Methods

Two methods (approaches) have been deployed to answer the research questions:

3.1. Desk research

An initial phase of desk research was conducted. The goals of this research were to identify:

- recent and ongoing research and development activities (research projects and product development activities taking place in the UK and internationally); and
- emerging human interface technologies and techniques and to understand or explore how these might be applied to development in assistive technologies for communications services.

An additional goal of the initial phase of desk research was to specify criteria for selecting activities best suited to (potential) support from Ofcom. These criteria are based largely on Ofcom's existing approach, and are described in the next Chapter (Chapter 4).

A summary of the topic areas identified is presented in Chapter 5, evaluated against the criteria described in Chapter 4.

3.2. Interviews with stakeholders and relevant organisations

A second phase of research within the project involved the conduct of a series of nine telephone or face to face interviews with key stakeholders. Stakeholders included representatives from academia, charities, service providers and broadcasters active in relation to accessibility, and software companies.

Interviewees were asked whether they agreed with the topic areas identified through the desk research, whether they were aware of any ongoing activities related to the topic areas, and whether they agreed with evaluation of the topic areas against the criteria described in Chapter 4.

4. Criteria for prioritising needs identified

The research team was aware in advance of commencing the current project of several potential focus areas in relation to unmet needs in assistive technologies for communications. Further it was recognised that several such foci could stand to benefit from development support from Ofcom.

For this reason, an initial activity undertaken within the project was the definition of a criteria list against which each focus/unmet need could be evaluated within the project.

A first criterion applied during the project's desk research was that any focus area identified was only considered if it was relevant to stakeholders or if it resulted from recent and/or forthcoming technical developments and innovations in consumer communications equipment and services.

Four additional steps were defined based on Ofcom's existing considerations against which proposals generated internally or externally to Ofcom are evaluated.

4.1. **Step 1: Relevance to Section 10**

- Activity is related to equipment or services as defined by section 10 of the Communications Act (2003);
- Activity would, in Ofcom's judgement, significantly improve ease of use or availability;
- Activity is related to equipment or services which were in daily use by a wide range of individuals (or are capable of meeting the same purposes of such equipment or services, in such a way as to make a significant improvement to ease of use or availability).

4.2. **Step 2: Would Ofcom make a significant difference?**

- Would the aims of the project be likely to be substantially achieved without Ofcom's participation? Or
- Are the project's aims unlikely to be achievable without an appropriate contribution from Ofcom?
- An important consideration in relation to this step is whether identical or very similar research is being conducted elsewhere.

4.3. **Step 3: Is the project supported by stakeholders?**

- If project proposals meet the criteria in Step 2, Ofcom would assess whether they were supported by a significant number of reputable partners, drawn from industry or the voluntary sector. If not, it is likely that Ofcom would monitor developments but refrain from intervention.

4.4. **Step 4: Impact on a relatively short timescale?**

- Where a project met the criteria in the preceding steps, Ofcom would usually consider whether a cost-benefit analysis could be carried out, so that the results could be used to help determine priorities for participation by Ofcom. This would not preclude a higher priority being given to a project with lower net benefits than another, for example, where the project would make a substantial contribution to ease of use and / or availability by people who were older or disabled. In examining the projected benefits of a project, Ofcom would take account of how soon participation would be likely to lead to the availability of easily usable and widely available apparatus.
- A full cost benefit analysis of Ofcom involvement in each of the focus areas is beyond the scope of the current project. However, in its interviews with stakeholders the project has considered how soon participation would be likely to lead to improvements in easily usable and widely available apparatus.

5. Technology trends relevant to accessible communications

Through the research approach outlined above, several potential focus areas were identified relating to unmet needs in relation to assistive technologies.

5.1. Automated speech to text system(s)

Description of focus area

This topic is essentially focused on the application of speech recognition and automated transcription (speech to text) to communications systems.

If effective, such systems have the capacity to be integrated into voice based communications systems, including fixed and mobile telephone and voice over internet protocol services, to improve access to such systems to people with hearing impairments for example via captioned telephony. Additional applications would relate to automated subtitle production.

The main research question of relevance to this focus area is whether voice recognition is now at a stage where it could be used instead of an operator in speech to text (captioned telephony) applications or could be used to provide a service where use of an operator is not feasible.

Feedback from interviewees

The project's interviews revealed a general consensus that this was an important area of consideration, with substantial potential benefits for large numbers of people. However, most interviewees indicated that they did not think current speech recognition systems are sufficiently sophisticated to permit the replacement of an operator in text-talk applications. Within the interviews other scenarios where automated speech to text systems could be applied in communications services were discussed, including for:

- voice command of domestic communications equipment and services. Additional sub-foci here relate to voice control of communications devices, and non-verbal means of controlling communications devices via voice.
- sending SMS messages via a mobile phone, even if only from a small set of pre-defined messages¹.

Key considerations raised in the interviews related to:

- better performance of speech recognition for speaker dependent systems (compared to speaker independent systems);

¹ There are existing services in this domain. An example is the Spinvox system [www.spinvox.com], though this has the capacity to fall back on a human operator if some element of a specific speech segment is problematic

- recognition needing to take place at the speakers' end (to avoid reducing performance of speech recognition by network introducing artefacts into speech);
- access for people with speech difficulties.

Related research is ongoing to automate translation of natural speech into different languages.

The importance of the topic was also flagged in the context of the amount of audio material on the internet, and its potential high applicability to access in educational contexts.

A general theme from the interviews is that there does not appear to be a current drive to integrate speech recognition further into consumer communications products and services and, as such, some influence from Ofcom in the short term is likely to be valuable to move the field forward.

One question that is potentially important to evaluate is how close to ETSI's standard requirements for Captioned Telephony Services (as described in the draft ETSI standard for Harmonised Relay Services, ETSI ES 202 975 V0.0.6r3², 2008-09), or the requirements of any other relevant standard, would be an automated speech to text conversion system coupled with a VOIP application. The draft ETSI standard requirements suggest a latency of six (6) seconds (between the words being spoken and displayed on a text terminal) for 90% of the words spoken in any given minute, and that a maximum of 10% of all spoken words can be lost or incorrectly transcribed.

With Ofcom support, a small study could couple speaker dependent and speaker independent voice recognition systems with an open source VOIP application and evaluate how far from the ETSI (or other relevant standards) requirements its performance would be. A related question, of equal or higher importance for two interviewees is whether the ETSI criteria are relevant to usability for real people. Importantly, key stakeholders would strongly support an activity focused on this research topic if it included scientifically rigorous user trials with deaf and hearing impaired people - to quantify user needs. Such an activity could then be used to inform the development of draft standards to ensure any thresholds included in them are relevant and matched to user requirements. Several interviewees highlighted the existence of substantial published research in the area, suggesting that a study in this area should build on existing expertise.

A final consideration raised by one interview related to the importance of being able, technically, to couple a voice recognition system with an open source VOIP application to the study's success. To this end it was suggested

² The ETSI standard requirements are in Section 5.5.1 of the draft, available at this url: http://portal.etsi.org/stfs/STF_HomePages/STF325/HF47_20r4Draft%20Relay%20standard.doc

that it may be valuable for a speech recognition software company to be a partner in the project.

5.2. New communications interfaces for deaf-blind people

Description of focus area

For people who cannot benefit from subtitling, captions and deaf loops tactile displays are available. They include dynamic (electronic) Braille displays, and automated text to Braille, and interactive tactile diagrams.

Relevant research questions here include: Do recent developments in materials technologies, for example with 3D printers, support more engaging, satisfying, effective or easy to use communications interfaces for deaf-blind people?

Feedback from interviewees

The project's interviews revealed a general consensus that this is an often under-supported area of research and development. Reasons cited were that whilst deaf-blind people can be very disadvantaged in terms of access to communications services, substantial potential access benefits of any new developments are typically considered to benefit very small numbers of people.

A related topic area mentioned by one interviewee was how to adapt communications products and services to better meet the needs and abilities of cognitively impaired people.

Ideas suggested for research included development of a proof of concept communications interface that could reproduce deaf-blind manual finger spelling. One interviewee pointed out that interactive tactile diagrams, which could help deaf-blind people, could apply to the larger market of blind and visually impaired people more generally.

Because of the substantial difficulties faced by deaf-blind people in accessing communications products and services, and the low likelihood of the communications market delivering substantial access benefits without third sector support, it is recommended that this topic area be treated as medium priority, despite only addressing a small number of users (which would otherwise point to it being of low priority). It is therefore recommended that Ofcom's team in Broadcast & New Media (Strategy & Market Developments) maintain a watching brief on developments in this area with a view to facilitating any possible future developments.

5.3. Interface adaptations to improve access to touch screens

Description of focus area

Because they are dependent on a user seeing and touching on-screen objects, the advent of touch screen interfaces in products such as the mobile phone, MP3 player, cameras and other communications devices, raises new access issues for blind and partially sighted people, and for people with dexterity impairments.

Relevant research questions here include: Are there solutions to improve access to touch interfaces for people with limited dexterity and/or visual impairments? Various solutions suggested in the projects interviews included scaling/ altering the size of objects/areas on a screen, and use of speech output as feedback mechanisms, and use of speech input (see 5.1 above) and accelerometer data as input mechanisms.

Feedback from interviewees

Interviewees' responses to the importance of this focus area were generally that it is one of growing importance, with no easy solutions. Different interviewees provided different preferences in terms of solutions. These included speech in and out to aid use by blind and partially sighted people, and personalised (visual and auditory) display parameters to aid use by different types of user.

Speech control and speech output as topics were raised by two interviewees as features that if they became available could improve access to many of the devices covered by the Communication Act, but would only likely to become a reality with a push from Ofcom. For this reason it could be an important focus in the second part of the work recommended by this study.

Some of the interviewees grouped this item (5.3) with the next (5.4, gesture interfaces) – because gesture based input was cited as another possible solution.

The range of different solutions favoured by different interviewees, suggests that adaptive interfaces (5.3, 5.4) should be seen as a subset of 5.8 (personalisation).

5.4. Gestural interfaces

Description of focus area

As mentioned above, one promising and emerging form of interaction with communications devices is via gesture. Such technologies are based on users' gestures being measured (e.g., via accelerometer, video, Bluetooth) and used as inputs to communications products and services.

Feedback from interviewees

As noted above, several of the interviewees saw gestural interfaces as a subset of adaptive interfaces (5.3). Considerations in relation to gestures raised by the project's interviewees included whether, for example, people with cognitive impairment, or who were blind and partially sighted, were able to learn the input gestures, and whether people with mobility or dexterity impairments could reliably repeat various gestures.

Key issues raised by interviewees were that commercial pressures might limit the extent to which accessibility is properly considered in product and service development that uses gestural interfaces. To this end, a suggested role for Ofcom was in encouraging inclusive product and service development – though it is noted that inclusive (customer centric) product and service development is already the developing model in some companies. Given the range of communications devices with accelerometers available on the market, it may be possible to support a project with relatively limited scope to demonstrate the potential of gesture for a mobile phone use case (e.g., dialling, or navigating phone book) by sponsoring an MSc project.

5.5. Vision based interaction

Description of focus area

Such technologies are based on users' gaze (eye fixation locations) being measured and tracked, and this information (sometimes in combination with other measures, e.g., of blinks) being used as input/control to communications products and services.

Feedback from interviewees

Interviewees were generally lukewarm about the short to medium term benefits to improving access to communications services of vision based interaction. Whilst it was recognised by some interviewees that in the medium to long term, vision based interaction combined with gesture could make interaction with home entertainment and media systems easier for a mass market, it was felt that only small numbers of people could benefit from communications systems that relied substantially on vision based interaction. Essentially, interviewees did not feel there were any immediate or pressing access benefits that Ofcom could facilitate in this domain.

5.6. Emotion access tools for improved communications

Description of focus area

The project identified a broad range of activities ongoing to help people with communication difficulties (for example, people with autism, or Aspergers) to access emotional cues more accurately in mediated interpersonal communications.

Feedback from interviewees

Interviewees recognised the potential of research and development in this domain to help a small group of people in their mediated interpersonal communications. One interviewee pointed out that this focus could help a user group for whom there is surprisingly little investment in terms of accessibility research and development, and could have substantial impacts for the mass market in communications in the medium to long term. The consensus was that all interviewees felt it unlikely that there were substantial accessibility gains to be had in the short to medium term from prioritising activity in this domain.

5.7. Brain computer interfaces

Description of focus area

There is a range of activity currently in progress investigating the potential for measurement of brain activity to be yoked to simple controls for a range of products and services. One focus to date has been interaction with and navigation of virtual spaces (virtual environments).

The concept has already been extended (to proof of concept) to simple control of PDA functions, and so is mentioned here as having potential to improve access to communications services for people with motor, dexterity and mobility impairments.

Feedback from interviewees

The project's interviewees recognised that brain computer interfaces, or direct brain interfaces, had the potential to help a small number of people (for example those with profound motor impairments) substantially, with fairly simple control/input tasks. However, all doubted the scope for large numbers of people to benefit from brain computer interfaces in the short to medium term.

5.8. Higher bandwidths enabling personalised web delivered services (web3.0)

Description of focus area(s)

Higher bandwidth broadband to consumers' homes removes the delivery challenge or bottleneck that has to date limited the extent to which media access services (e.g., audio description, sign language) can be delivered to people who need them without impacting everyone else's media experience.

The trend towards higher bandwidth broadband (and fibre to the home), will mean that rich, interactive and personalised multimedia services can be delivered to consumers. Current examples include the BBC iPlayer, and Sky Player.

The development of higher bandwidth networks will also speed up, and sit neatly alongside, the move towards cloud computing - where the processing intensive actions related to the customisation of media (e.g., games engine, graphics and audio processing) are conducted remotely in server centres. This development means that personalised services will be receivable on relatively thin client devices – as the majority of the processing will take place on powerful, remotely located servers.

This combination of trends raises two research challenges. The first relates to the challenge of production. If accessible services can be delivered to whoever wants them with whatever content, how can content owners be helped to provide access services on all their content?

The second is the development of a standard means of users accessing media according to their personal, stored preferences (this question is dealt with separately, in 5.9).

Feedback from interviewees

All the interviewees recognised these trends, and saw that they were likely to have substantial impact on how people – disabled, and not – interact with communications products and services. A theme raised by two of the interviewees was that in this future environment, access may not depend so much on features of media form or people's ability to use input devices (because they are likely to be matched to people's preferences and abilities) but more on social, cultural, economic and geographic barriers (e.g., not being able to afford services, being unserved by highest speed broadband, having 'old style' mental models of how to interact with and use media products and services.)

A further theme suggested by one of the project's interviewees related to the consumerisation of ICT, and the need to recognise that consumer marketing considerations are influencing the development of ICT products and services more than ever before – a trend the interviewee saw as continuing. This led to the interviewee highlighting the need to encourage good practice in inclusive product and service development.

Because of the strong consensus across interviewees that the trends in 5.8 are occurring, that they will impact on large numbers of people, and that without Ofcom's involvement accessibility may not be built in from the start in this domain justifies Ofcom effort looking forward. The strongest consensus related to focus on supporting the development of personalised user interfaces and service propositions (rather than the services themselves).

5.8.1. Standards, and storage of access preferences across devices

Description of focus area

There is activity ongoing that is focused on supporting interface preferences portable across devices (e.g., ETSI, SNAPI), and of related interest, projects geared towards open standards for accessibility. Both these areas are of interest as recent research suggests that standard means are needed to enable manufacturers and service providers to increase the accessibility of their products and services to older and disabled people, and they are by definition needed in the context of 5.8.

Feedback from interviewees

All interviewees recognised the high importance of this topic area, and its potential as a cure all to help support media products and services that are accessible to people with a wide range of needs.

As mentioned, above, the range of different adaptive alternatives to touch screens suggested by different interviewees (5.3, 5.4) suggests that speech requirements (input and output), visual, auditory and gesture preferences, should all be seen as subsets of 5.9 (personalisation). Encouragingly, there are ongoing standardisation activities in this domain, including through ETSI (European Telecommunications Standards Institute; Draft ETSI ES 202 746 V0.0.9 2008-10 Personalization and User Profile Management; User Profile Preferences and Information), and CEN (European Committee for Standardization; Draft EN 1332-4 Identification Card Systems – Man-Machine Interface – Part 4: Coding of user requirements for people with special needs).

A note of caution also emerged from the interviews, with some keen to avoid access and consideration needs being sidelined with the promise of an accessible web delivered tomorrow, without action today. Another research consideration raised here, related to a need to ensure that it will be easy to update, edit or modify one's media access preferences.

A good initial proof of concept effort in this regard could be to explore the production, standards and network considerations of provision of audio description through web TV portals (e.g., the BBC iPlayer).

6. Summary table comparing the foci against criteria for prioritisation

Focus area	Related to equipment or services	Significantly improves ease of use/ availability	Wide range of individuals (potential # of users)	Comms access benefits somewhat dependent/ facilitations on Ofcom participation?	Supported by stakeholders?	Potential for impact on a relatively short timescale	Overall priority for Ofcom technical/user research focus
Automated speech to text system(s)	✓	✓	✓	✓	✓	✓	✓
New communications interfaces for deaf-blind people	✓	✓	✗	✓	✓	?	? Medium
Adaptive touch screen interfaces	✓	✓	✓	-	?	✓	Low
Gestural interfaces.	✓	✓	✓	-	?	✓	
Vision based interaction	✓	✗	✗	-	?	✗	Low
Emotion access tools for improved communications	✓	✗	✓	✓	✓	✗	Low
Brain computer interfaces	✓	✗	✗	-	?	✗	Low
Higher bandwidths - personalised web delivered services (web3.0)	✓	✓	✓	✓	✓	?	✓ High
- Standards, and storage of access preferences across devices	✓	✓	✓	✓	✓	?	✓ High

7. Research and development recommendations

The project results suggest two recommendations.

Short term research topic – evaluation of automated speech recognition in a VOIP context

First, for a small scale piece of research and development, a question that would be valuable to answer (and scores strongly on Ofcom's evaluation criteria for prioritisation) is how close an automated speech to text conversion system coupled with a VOIP application can come to meeting ETSI's draft standardised requirements for Captioned Telephony Services.

With Ofcom support, a small-scale technical development project could be conducted to couple a speech to text software package with an open source voice over internet protocol (VOIP) application, and to evaluate its performance against draft ETSI requirements for captioned telephony services (or requirements detailed in any other relevant standard), and against user needs (through trials with deaf and hearing impaired users). To date, how far from the ETSI requirements the performance of a speech to text software system (in a range of contexts) coupled with an open source VOIP system would be is an unknown. As revealed by the interviews conducted for this project, an additional unknown which could be usefully explored in this study is how relevant are the draft ETSI standard requirements for captioned telephony to the needs of deaf and hard of hearing people.

Medium and longer term research view

The second is to engage actively in ongoing industry developments related to media delivery over the web, to support the realisation of potential accessibility benefits that will arise from the growing trend towards the delivery of personalised services over high bandwidth broadband (web 3.0).

The high impact medium to long term changes and trends in media delivery related to personalisation (topic areas 5.8 and 5.8.1 in Chapter 5 above) suggest a framework or roadmap through which to monitor developments and support key areas which score well on Ofcom's evaluation criteria for prioritisation.

In the first instance this suggests from 2009/10 focusing on research to explore the production, standards, network and regulatory considerations relevant to the provision of an existing access service (e.g., audio description through web TV portals like the BBC iPlayer), and of access services or augmentations that are currently not present in mainstream products (e.g., speech output demonstrations, for example for user interfaces for internet radio, or web TV).

8. Appendix: interviews discussion scope

An initial draft of this report was distributed to invited interviewees (key stakeholders), and formed the basis of a semi-structured discussion to gather their feedback on what might constitute top priorities for Ofcom to focus on in R&D for accessible technologies.

Main questions asked of interviewees included:

- Do you agree with the topic areas included? Why/Why not?
 - What would you leave out? Why?
 - What else would you include? Why?
- What else is ongoing that you are aware of?
 - Anything you are doing?
- Agree with evaluation criteria?
 - Why/why not?
- Top priorities?