Multimodal solutions to foster accessibility in digital products and services

The DIGITALEUROPE study for the European Accessibility Resource Centre

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Accessible centre EU

European Commission

AccessibleEU is one of the flagship initiatives proposed by the European Commission Strategy for the Rights of Persons with Disabilities 2021-2030. It is a resource Centre on accessibility working on areas such as built environment, transport, information and communication technologies to ensure the participation of persons with disabilities in all areas of life on equal basis with others.

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1. Executive summary

The study

This study has been carried out as part of the Accessible EU project with the objective to provide an overview of the state of the art of multimodal accessibility, based on policy and legislation analysis, desk research and stakeholders involvement activities.

The report begins with the background and definitions, as well as the methodology used for the study. Then the results of the desk research and stakeholders consultations are presented. After that follows an overview of policy and legal aspects on multimodality and examples of innovative solutions. The final parts of the report contain conclusions and recommendations, as well as references.

The methodological approach combines several research tools, to ensure a thorough investigation of the topic of multimodal accessibility. The methodology encompasses desk research, surveys, interviews, and workshops with experts to provide a holistic understanding of the subject matter.

Multimodality means, in the context of this study, that the users may choose the way they want to interact with the ICT.

Results

Based on desk research and stakeholders consultations, the main results of the study are as below.

From the end user perspective, the selected mode may depend on:

- the ability of the user,
- the personal preference(s) of the user, or
- the specific situation, environment, or context the user is currently in.

The same individual may therefore choose different modes of operating the same interface depending on what is most efficient.

From the industry perspective, the cross-over between User Experience (UX) and Accessibility is clear; where the strive for good UX is often the background or reason for offering multimodality as a feature.

Multimodal solutions in products and services can be:

- developed to meet specific accessibility needs,
- emanating from accessibility requirements, but beneficial to a wide range of users,
- inherent to the technology itself, that is completely mainstream, with a substantial impact on accessibility.

This means that implementation of multimodal accessibility solutions is not always considered separately, but rather as an integral part of product design and development.

The technical requirements that are currently being updated to act as presumed conformance to the European Accessibility Act (EAA) can be divided into three categories when it comes to multimodality:

- Direct multimodality, requiring an alternative mode of presentation or operation.
- Indirect multimodality, requiring making it possible to render the alternative mode of presentation with client-based assistive technology.
- Personalization, requiring that the presentation is adjustable by the individual user.

The standards also contain requirements that are not specifically targeting multimodality, but a substantial part of the EN 301 549 standard on accessibility requirements for ICT products and services is related to it.

Accessibility subject matter experts and end users with disabilities consider multimodality a key aspect of accessibility.

Non-accessibility specialist designers and developers are generally not aware of the term multimodality, but the concept is understood when explained.

Representatives from the industry in scope of the EAA focusing on accessibility, compliance or standardization, are generally positive to the concept of multimodality and expect the further awareness the directive brings to make it more of a standard feature. These solutions may, however, be very costly, technically difficult to provide and/or require complex cross-industry collaboration.

Conclusion

From a policy perspective, **the concept of multimodality as an essential accessibility feature needs to be more explicit and better explained in the existing European policy and law texts.**

Multimodal solutions are offered in a variety of domains, usually because it is considered beneficial to satisfy general customer needs, sometimes specifically to meet accessibility requirements.

Multimodal solutions are abundant in many sectors within and outside of the scope of EAA: in education, medicine, engineering, product design and marketing, service provision, and in social media, to mention some. The development of solutions is fast, supported to some extent by immersive technology and AI.

The legislation most clearly focusing on multimodality is the EAA, requiring for certain products and services to maximise their foreseeable use by persons with disabilities, and information being made available via more than one sensory channel.

Even though competition may be a more important driver than legislation in some cases, low-cost products, would most probably not offer multimodal solutions without a legal requirement. Legislation tends to help getting focus on and budget for accessibility improvements, including multimodal solutions.

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2. Introduction

2.1 Definition and scope

Multimodality refers to the use and combination of multiple modes of communication to convey meaning or information. A mode is a distinct channel or means through which meaning is represented or expressed. Common modes include verbal (written or spoken language), visual (images, symbols, graphs), auditory (sound, music), gestural (body language, facial expressions), and spatial (arrangement of elements in physical or digital space).

Multimodality acknowledges that human beings have different needs and preferences when it comes to understanding content. Some people easily read complex information, where others struggle with text. Some people immediately grasp maps or blueprints, where others struggle with directions or spatial interpretation. When it comes to the diverse needs of people with disabilities, offering multimodality is often the essence of inclusion, as the opportunity to choose a suitable format means that the individual can enjoy flexibility without self-identifying as having an impairment.

Multimodality is also a way to select the most suitable format or channel for different kinds of content, where for example information and instructions may require different modes to convey meaning in the most efficient way. To provide an example: it is quite difficult to explain how to tie a tie with only words. Images, illustrations, animations or a video are much more suitable for that type of content.

Multimodality means giving everyone the choice on how they want to receive and understand content, and interact with it.

Multimodality in different domains

Multimodality serves several valuable purposes and offers numerous benefits in various contexts. For persons with disabilities, multimodality is key.

In general, multimodality is often considered to enhance communication, as by combining multiple modes of communication (such as text, images, and audio) it can lead to richer and more engaging messages. This can improve comprehension and retention of information, making communication more effective no matter the target audience.

When it comes to accessibility, multimodal communication can cater to diverse audiences, including those with different learning styles, cognitive abilities, or sensory impairments. Offering alternative formats helps ensure that information is accessible to a broader range of individuals.

In educational settings, multimodal approaches can facilitate better learning experiences. Incorporating visual aids, interactive elements, and multimedia content can enhance student engagement and their understanding of complex topics.

Multimodality allows individuals to convey emotions and contextual information more effectively. Emoticons, emojis, and other non-verbal cues enable people to express feelings in text-based communication.

- In **marketing and advertising**, multimodal approaches can create more compelling and persuasive messages. Combining visuals, audio, and text can make advertisements more memorable and impactful. Multimodality provides creative opportunities for artists, writers, and content creators to experiment with different modes and craft unique experiences for their audiences.
- In **digital product design**, multimodal interfaces can enhance the user experience by providing multiple ways for users to interact with the product or system (e.g., touch, voice commands, gestures).
- In digital services, multimodal ”storytelling” can be used to combine different media formats, thereby creating more engaging and dynamic stories.
- Multimodal data representation, such as combining data points with graphs and other visual elements, can help make complex datasets more accessible and understandable.
- In fields like **medicine, engineering, and aviation**, multimodality is used to integrate information from various sources (e.g., sensors, monitors) to provide comprehensive insights for decision-making.
- Multimodality in **online communication and social media** allows people to connect and express themselves in diverse ways, promoting a sense of community and identity.

Overall, **multimodality offers users alternatives, which is a key element of accessibility and therefore improves inclusivity in communication, design, and interaction.** Multimodality can meet the complexity of human cognition and perception, enabling more effective and engaging products and services across various domains.

2.2 Policy background

Within the European Union (EU), around 87 million people have some form of disability, facing challenges in access to education, employment, infrastructure, products, services, information and other aspects of life. This lack of equal opportunities can and often does lead to discrimination and social exclusion.

Challenges faced by persons with disabilities in the EU include lower employment rates, higher risk of poverty or social exclusion, limited access to higher education, and feelings of discrimination. In response, the EU and its Member States have committed to improving the social and economic situation of persons with disabilities.

EU policies on disabilities are based on the **United Nations Convention on the Rights of Persons with Disabilities (UNCRPD)**[1] – the first international, legally binding instrument, setting minimum standards for rights of people with disabilities, and the first human rights convention to which the EU has become a party. The Convention entered into force for the European Union on 22 January 2011, becoming an integral part of its legal order. It has been ratified by the European Union and all its Member States.

The UNCRPD seeks to ensure that the rights of people with disabilities are protected and promoted on an equal basis with those of others, and to enhance their full and effective participation in society. It enshrines (among others) the right of access to information and the right of people with disabilities to participate in cultural life on an equal basis with others.

The **Charter of Fundamental Rights of the European Union**[2] , proclaimed on 7 December 2000 and with full legal effect since the Treaty of Lisbon entered into force on 1 December 2009, brings together the fundamental rights of everyone living in the EU. The Charter supports the right of persons with disabilities to benefit from measures designed to ensure their independence, social and occupational integration, and participation in the life of the community, as guaranteed in its Article 26.

The Strategy for the Rights of Persons with Disabilities 2021-2030[3] aims to enhance accessibility alongside many other legislative and non-legislative measures. The main legislative elements are the **Audiovisual Media Services Directive**[4], the **Web Accessibility Directive**[5] and the **European Accessibility Act**[6].

The **Audiovisual Media Services Directive (AVMSD)** requires Member States to ensure that audiovisual media services are made continuously and progressively more accessible to persons with disabilities. The **Web Accessibility Directive (WAD)**, harmonizes Member States' legislation on the accessibility of the websites and mobile applications of public sector bodies. Finally, the most recent accessibility legislation, the **European Accessibility Act (EAA)**, covers certain products and services, requiring that they comply with the accessibility requirements set in the Act. Among others, it provides accessibility requirements for products and services where accessibility obligations are already foreseen in other EU legislation in general, without further details or specific requirements. (For further reference, it is useful to mention that the EAA is also a Directive, which means that it needs to be transposed and implemented into the legislation of Member States.)

1 https://www.ohchr.org/en/instruments-mechanisms/instruments/convention-rights-persons-disabilities
2 https://eur-lex.europa.eu/eli/treaty/char_2007/oj
3 https://ec.europa.eu/social/main.jsp?catId=1484&langId=en
4 http://data.europa.eu/eli/dir/2018/1808/oj
5 https://eur-lex.europa.eu/eli/dir/2016/2102/oj
6 https://eur-lex.europa.eu/eli/dir/2019/882/oj

While none of these laws explicitly mention the term multimodality, it is a key principle in accessibility and Annex 1 of the EAA on accessibility requirements clearly states the aim for products and services to "maximise their foreseeable use by persons with disabilities". Each section requires that information, instructions, communication, etc be "made available via more than one sensory channel", and several requirements are based on the concept of providing alternative formats.

Thereby, the directive, as well as other policy initiatives based on the same understanding of accessibility being based on choice, have implications for the adoption and integration of multimodal digital technologies in the EU.

Examples of policy areas that may have an impact on the development of multimodality:

Digital Single Market

The EU aims to create a single digital market that facilitates seamless digital services and cross-border data-flow within the EU. This can have implications for the adoption of multimodal digital services, such as e-commerce, e-learning platforms, and digital healthcare, across Member States.

Data Strategy

The EU is focusing on ensuring the secure and responsible use of data while encouraging data sharing for innovation. The availability of data can support the development of innovative multimodal digital solutions and services.

Connectivity

The EU aims to provide high-speed and reliable digital connectivity, including 5G networks and broadband, to enhance digital accessibility and inclusivity. Improved connectivity can support the seamless delivery of multimodal content and services.

Artificial Intelligence

The EU is investing in research and innovation in artificial intelligence (AI) to promote trustworthy and ethical AI systems. AI technologies can enable multimodal interactions and personalised services based on user behaviour and preferences.

Digital Skills

The EU emphasizes the importance of developing digital skills to empower citizens and businesses to fully participate in the digital economy. Digital skills are vital for effectively using multimodal technologies and services.

Trust and Security

The EU prioritizes ensuring trust and security in the digital world, including protecting personal data and promoting cybersecurity. Trustworthy digital systems are essential for the successful adoption of multimodal solutions.

By promoting digital innovation, connectivity, data sharing, and AI research, the EU is laying the groundwork for the development and deployment of multimodal solutions that can enhance user experiences, accessibility, and efficiency across various sectors within the EU.

2.3 Terminology

Policies aimed at making sure that as many individuals as possible can use, understand, handle and enjoy products and services started in the US in the 1950s, and have gradually spread to the rest of the world, including the EU. Today, there is an abundance of similar or related concepts that are sometimes used synonymously, sometimes to differentiate between methods, underlying philosophies or perspectives. It is becoming increasingly difficult to distinguish between, let alone achieve consensus on the exact meaning of design for all, integral accessibility, accessible design, inclusive design, barrier-free design, transgenerational design, universal design, accessibility for all etc.

The main concepts are similar but differ in their focus and methods.

2.3.1 Design for all

Design for all aims to enable all people to have equal opportunities to participate in every aspect of society. To achieve this, everything that is designed and made by people to be used by people must be accessible, convenient for everyone in society to use and responsive to evolving human diversity. The practice of design for all makes conscious use of the analysis of human needs and aspirations and requires the involvement of end users at every stage in the design process.

The European Institute for Design and Disability (EIDD)[1] has defined design for all as "design for human diversity, social inclusion and equality".

2.3.2 Universal design

Universal design is an approach that aims to create products, services and environments that can be accessed, understood and used to the greatest extent possible by all people regardless of their age, size, ability or disability. The goal is to design products, services and environments that meet the needs of "all people", as opposed to a special requirement for the benefit of only a minority of the population.

There are seven principles of Universal design[2]

1. Equitable Use

The design is useful and marketable to people with diverse abilities.

2. Flexibility in Use

The design accommodates a wide range of individual preferences and abilities.

3. Simple and Intuitive Use

Use of the design is easy to understand, regardless of the user's experience, knowledge, language skills, or current concentration level.

4. Perceptible Information

The design communicates necessary information effectively to the user, regardless of ambient conditions or the user's sensory abilities.

1 https://dfaeurope.eu/
2 https://universaldesign.ie/what-is-universal-design/the-7-principles/

5. Tolerance for Error

The design minimizes hazards and the adverse consequences of accidental or unintended actions.

6. Low Physical Effort

The design can be used efficiently and comfortably and with a minimum of fatigue.

7. Size and Space for Approach and Use

Appropriate size and space are provided for approach, reach, manipulation, and use regardless of user's body size, posture, or mobility.

Universal design is focused on creating an inclusive product, service, or environment from the start, without the need for adaptations or modifications.

In the Irish Disability Act from 2005[1], Universal design is defined as follows:

1) The design and composition of an Environment so that it may be accessed, understood and used

- to the greatest possible extent,
- in the most independent and natural manner possible,
- in the widest possible range of situations, and
- without the need for adaptation, modification, assistive devices or specialised solutions, by any persons of any age or size or having any particular physical, sensory, mental health or intellectual ability or disability, and

2)Means, in relation to electronic systems, any electronics-based process of creating products, services or systems so that they may be used by any person.

2.3.3 Inclusive design

Inclusive design is an approach that aims to create products and services that enable people of all backgrounds and abilities. It may address accessibility, age, culture, economic situation, education, gender, geographic location, language, and race.

The focus is on fulfilling as many user needs as possible, not just covering as many users as possible.

The idea behind inclusive design is that every design decision has the potential to include or exclude people. Inclusive design is about making informed design decisions, by better understanding user diversity, which helps to include as many people as possible, empathizing with users and adapting interfaces to address the various needs of those users. User diversity covers variation in capabilities, needs and aspirations.

1 https://www.irishstatutebook.ie/eli/2005/act/14/enacted/en/html

Inclusive design does not suggest that it is always possible (or appropriate) to design one product to address the needs of the entire population. Instead, inclusive design guides an appropriate design response to diversity in the population through:

- Developing a family of products and derivatives to provide the best possible coverage of the population.
- Ensuring that each individual product has clear and distinct target users.
- Reducing the level of ability required to use each product, in order to improve the user experience for a broad range of customers, in a variety of situations.

The British Standards Institute defines inclusive design as:

"The design of mainstream products and/or services that are accessible to, and usable by, as many people as reasonably possible [...] without the need for special adaptation or specialised design."[1]

2.3.4 Overlap and limitations

Universal design aims to create one experience that can be accessed and used to the greatest extent possible by as many people as technically possible. The goal is one single design solution without need for adaptations or specialized design. Criticism towards the concept of universal design includes that it is not always possible to create one single solution for everyone.

Inclusive design accepts and embraces multiple design variations so long as they achieve the desired outcome. Focus is on choosing an appropriate target market for a particular design and making informed decisions to maximise the 'Product performance indicators' for that target market.

Criticism towards the concept of inclusive design includes that the word 'reasonably' in the definition seems to suggest that inclusion of people with disabilities can be disregarded if considered too difficult to achieve or too costly.

2.3.5 Multimodal accessibility

In the field of accessibility, multimodality has been recognized as a way to reach wider audiences including persons with disabilities. For example, the **UN disability-inclusive communications guidelines**[2] include a section on multimodality, explaining that providing information through different mediums ensures that everyone can receive the information regardless of their abilities. Multimodal approaches therefore address accessibility by offering multiple ways or modes for individuals to interact with or access information, products, services, or environments. This approach recognizes that people have diverse needs, preferences, and abilities and therefore provides various options for them to access content or services accordingly.

The essence of multimodal accessibility is providing alternatives and letting the user choose.

The term multimodality used to describe multimodal accessibility is well-known in the accessibility community, but less so in other sectors.

1 The British Standards Institute (2005) standard BS 7000-6:2005: 'Design management systems - Managing inclusive design' defines inclusive design and provides guidance on managing it. It can be purchased from the BSI website.
2 https://www.un.org/sites/un2.un.org/files/un_disability-inclusive_communication_guidelines.pdf

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3. Methodology

3.1 Overall methodological approach

This study is applying a methodological approach that combines several research tools, to ensure a thorough investigation of the topic of digital multimodality. The methodology encompasses desk research, a survey, interviews, and a workshop to provide a holistic understanding of the subject matter.

The diverse nature of the research problem necessitates the integration of various methods to collect rich and multifaceted data. Each research tool brings unique strengths and advantages, contributing to a comprehensive analysis and insightful findings.

Desk research

Desk research serves as the foundation of the study. It involves gathering existing data and information from a wide range of sources, including academic journals, research papers, reports, books, articles, websites, government publications, databases, and other accessible materials related to digital multimodality. Through desk research, we have identified existing knowledge, assessed prior studies, and uncovered key trends and insights to inform our analysis of multimodality in the context of accessibility and inclusion.

Survey

In preparation for the workshop, an online survey was distributed to members of **DIGITALEUROPE**.

Interviews

In-depth interviews were conducted with key stakeholders, experts, and individuals directly involved in or affected by digital multimodality. These interviews offer a deeper understanding of the nuances, motivations, and experiences related to the subject matter. The interviews were conducted with selected stakeholders representing major players in scope of the European Accessibility Act. By engaging in one-by-one discussions, it was possible to gather qualitative data and gain insights into diverse perspectives.

Workshop

The workshop involved key stakeholders, industry experts, and representatives from Organisations representing Persons with Disabilities. The workshop was divided into two groups, focusing on policy and technology.

Data integration and analysis

Data collected from each research tool has been integrated, ensuring a comprehensive analysis of the research problem. Qualitative data from interviews and the workshop has been thematically analysed to identify patterns and themes. Quantitative data from the survey underwent statistical analysis to reveal trends and correlations. The integration of diverse data sources has enriched the findings and contribute to a robust interpretation of the research outcomes.

By employing a combination of desk research, survey, interviews, and the workshop, this research methodology aims to provide a more comprehensive understanding of the state of the art and future potential of digital multimodality. The integration of various research tools enhances the validity and reliability of the findings, ensuring a well-rounded exploration of the subject matter.

3.2 Desk research: methodology

The study employed a scoping review as the most appropriate approach for conducting literature reviews in a diverse and varied context, encompassing academic literature, as well as grey literature at national, EU and international levels.

Stage 1

We identified research questions, and defined inclusion and exclusion criteria, including time period, geographic area, and basic criteria for source selection.

Two main research questions were set up for the desk research:

Research Question 1

What is the existing research/studies on the multimodality and accessibility related to the digital environment?

Research Question 2

In the existing body of literature on multimodality and accessibility, what kind of solutions are proposed to support inclusion and access for persons of all abilities in digital environments?

Inclusion criteria	
Time period	Published after 31st December 2014. Research or studies published prior to this date to be considered for theoretical background but not as solutions unless highly relevant
Language and geography	Primarily English language sources. Studies covering the EU Member States to be prioritised. Sources from outside the EU to be included only if sources are available in English.
Type of publication	Articles from peer reviewed journal; Conference papers; Grey literature from academic, public and private sectors; Results and papers from research projets commissioned by EU and national government, or the private sector; publications from industry, practitioners and organisations representing users
Relevance of content for the review	Contains key words linked to the research questions OR References recommended by participants in the study (from interviews and workshops)

Stage 2

Involved pilot testing of search terms and inclusion/exclusion criteria, followed by the development of the initial pool of literature. In the initial phase, 50 + sources were identified, the majority of which derived from academic literature.

Stage 3

Focused on the selection of relevant sources by reviewing titles and abstracts against the inclusion/exclusion criteria. A snowballing approach was employed by reviewing bibliographies of identified literature to discover additional sources.

English-language literature was being prioritised, and key literature was selected based on the analysis of topics tackled and relevance of the publication, including its impact factor, if any.

Sources from grey literature without identified authors were filtered out as were sources with no clear connection to users in digital environments. After the filtering, approximately half of the sources identified were put forward to stage 4.

Stage 4

Involved data extraction, where literature was reviewed, relevant content identified, and feasibility criteria assessed. The main criterium of feasibility for inclusion in the study was whether the solution described had been developed and tested in at least a prototype stage (technology readiness level 3 and up), as opposed to merely being a theoretical possibility or concept.

The relevant evidence and associated contextual information were extracted and documented.

By utilizing the scoping review and desk research methodologies, the study aims to comprehensively capture diverse and relevant information on multimodality across the EU and beyond.

3.3 Stakeholder consultation: methodology

Validation workshop

In order to validate the study on multimodality a workshop with industry experts, policy makers, Organizations of Persons with Disabilities (OPDs) and accessibility expert companies was carried out on 27 September 2023 in Brussels.

The workshop was preceded by an online survey directed at all participants, and sent to an extended contacts list, including OPDs, accessibility experts (IAAP members) and representatives of the industry (using DIGITALEUROPE's network from the e-Inclusion Working Group and wider member pool).

During the workshop, the preliminary results from the desk research and the survey were presented and then discussed in smaller groups with relevant stakeholders.

The workshop activated two focus groups with industry experts, divided by professional profile: one group discussed the policy and legislative aspects of multimodality and the other, more technical, discussed innovative multimodal solutions to foster accessibility.

The participants contributed to the workshop with their respective perspective, being allocated to the 2 groups according to their expertise, sector and preferences.

Interviews

After the workshop, **interviews were conducted with selected representatives from EAA-relevant industries.** These interviews allowed for in-depth, one-on-one interactions with stakeholders. This approach provides a comprehensive understanding of the perspectives, needs, concerns, and expectations of industry representatives, which might be challenging to achieve through other methods.

In the interviews the study team asked tailored questions based on the stakeholder's role and sector. This ensures that relevant and detailed aspects and perspectives from different parts of the industry are taken into account. The interviews were conducted as a meaningful dialogue between experts, leading to a richer understanding of the issue at hand.

In order to collate relevant input from a small number of interviews that is widely applicable, the interviews did not focus on specific products or services. To make sure stakeholders feel comfortable sharing information, no direct quotes were to be attributed to specific individuals or companies.

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4.State of the art

In order to get an overview of the state of the art of multimodal solutions to foster accessibility, **the study team conducted a literature review of existing relevant scientific and non-scientific sources.** The methodology for the review is provided more in detail in Chapter 3.

This chapter presents the results of the review in terms of:

- Sources identified,
- Multimodal solutions identified in the literature,
- Classification of the main results obtained, considering multimodal solutions in different sectors.

4.1 Research sources

Three main types of sources have been considered in the desk research:

a) Literature review of the impact factor journals (JCR) and open journals aon the subject,

b) Grey literature review,

c) Review of other relevant sources at policy and technology level.

Most of the sources stem from the first category. Within the literature, there are different scientific communities conducting research on multimodality. This also means that the term has slightly different meanings for different communities. In Human-Computer Interaction research, the term is related to the practical solutions (tools) regarding the action itself of communicating information from a person to a computer (input modalities) or vice versa (output modalities). Media research and semantics is more concerned with how different modes of communication impact the meaning of the information.

In the desk research we have considered various aspects of multimodality stemming from different theoretical frameworks of research. The main criteria of relevance for inclusion in the research has been that the solution should have a bearing on the requirements of the European Accessibility Act, namely:

- Be related to accessibility in terms of providing room for adapting to the needs of users,
- Include a reference to alternative or complementary formats,
- Provide a potential for personalization that could be useful for adapting to individual needs.

Sources included do not necessarily need to comply with all three criteria.

Concerning the grey literature, sources include EU-funded innovation projects with a potential for supporting accessibility. Other relevant sources at policy and technology level have been integrated in the chapters on policy (Chapter 6) and innovative solutions (Chapter 7).

4.2 Multimodal solutions identified in the literature

This section provides an overview of the multimodal solutions found in the literature, according to the areas of application. Section 4.3 includes a classification of the solutions presented in this section in relation to use cases in policy, technology, and the market, for different groups of users.

E-commerce

One topical area of research looks into how multimodal techniques are used in contexts of personalization and personal preferences of consumers, in particular in the context of e-commerce and online services.

Examples of research studies related to multimodal solutions for consumers include:

- A study on multimodal search for fashion items on an e-commerce platform. The study develops and tests a search model that is based on both visual and textual input (Laenen et al 2018).
- The development of a model to learn about user preferences on different modalities in micro-videos, to enhance recommendations based on users' interests (Lei F et al 2023).
- Research into multimodal ways of communication between retailers and consumers and their consequences for retailers gaining insights on consumer preferences (Grewal D et al 2022). The study is in particular concerned with user-generated content and how the modality of consumer's messages impact other consumers' image of the retailer.

A common theme for this research is that consumers are, to a large extent, already using different modes in their interaction with e-commerce and retailers, and there is a gap in how retailers can capture and use the multimodal information to the benefit of their business and the customer service.

Communication

Another area of research related to multimodality in communication is social semiotics. Social semiotics studies refer to how people make meaning in their dissemination of messages, and the different modes of communication used and developed by people in their understanding of the world (Bezemer, Jewitt 2009).

Within this area of research, Gunther Kress pioneered a new approach to understanding communication through multimodal analysis. Kress emphasises that to understand the meaning of messages, it is increasingly important to consider how multiple modes of communication interact in a message, including visual, verbal and spatial information (Kress 2009). Kress research constitutes the foundation of research into multimodality in communication. The initial studies in the topic have since then developed into a large body of literature, thus underlining the importance of the concept in information and communication analysis.

In the past decade, multimodal analysis in the context of social semiotics has become increasingly concerned with modes of communication in the digital world.

For example, one study investigates how users of the social media platform Pinterest form their messages through combinations of text and images, and how their forms of expression

in terms of both text and images are being shaped by the choices provided by the platform (Jewitt, Henriksen 2016).

Education

There is an extensive body of literature on multimodality in education, with several strands investigating different aspects of the topic. Research in multimodal learning is concerned with how educators can use a variety of visual, auditory, and kinesthetic methods when teaching a concept. Research in multimodal literacy focuses more specifically on how students make meaning out of interacting with and producing multimodal texts and multimodal communication.

Recent research in the area of multimodal learning investigates the possibilities provided by digital technologies to offer a variety of ways to present and explore educational content. A paper on emerging trends in multimodal learning notes that multimodality has a high potential for customizing learning strategies to suite learners with diverse needs. It follows that one important area of use for multimodal learning is within Universal Design for Learning which is built on offering flexibility and multiple means and modes for students to take in educational material, engaging with the material, and expressing what they have learned (Bouchey et al, 2021). The authors note that multimodal learning can enhance inclusion and also self-agency among students, as they are given more choices that encourages a higher level of engagement within the learning experience. However, a possible challenge could be that the choice of modes becomes overwhelming for students and therefore a distraction to the learning process (ibid).

XR technology

Immersive technologies, and in particular extended reality, has been highlighted in the literature as one area where multimodality can both enrich the user experience as well as provide new possibilities for expression for creatives and users alike. For example, some researchers argue that experimental multimodality is key to a meaningful use of the technical possibilities offered by immersive environments. In this context, multimodal experiences involving different senses can provide new possibilities to not only experience reality in new ways but also to make sense of it by expanding the imagination. Multimodal experimentation with the senses for creative purposes can be applied to both XR (Extended Reality) for leisure such as gaming, and in educational contexts. (Young, Dawkins 2023)

Despite the increasing availability of XR solutions for use by industry, scientific communities, and consumers, there is still a gap of knowledge on how to fully make use of the possibilities of multimodality in VR (Virtual Reality), for example. A recent survey of multimodality in VR showed that most of the research studies included in the survey used a combination of two modalities. Studies rarely included the combination of three or more modalities. The researchers behind the survey argue that further research on how different modalities interact can support the development of improved VR solutions, with better virtual experiences for users (Martin D et al, 2022).

Human-Computer Interaction

Conversational user interfaces (CUIs) allow users to communicate with the computer in natural language, either through text (using chat-bots) or voice (via voice assistants). CUIs have been identified as a technology with potential for providing services in accessibility, since they present alternative modes of communication. Voice assistants such as Apple's Siri and the Google assistant that are available in consumer products already provide support to users in daily errands that can be performed through their smartphones or smart home systems. Commercial websites are increasingly adopting chatbots with varying success in terms of accessibility.

However, up to now there has not been much research into how CUIs and in particular voice assistants could be of support in performing administrative tasks. A study conducted by the Open University in the UK designed and tested a virtual assistant to support students in filling in a web-based disability support form (Iniesto F et al 2023). The virtual assistant used both text and voice-based alternatives and guided the students throughout the process of answering questions about their needs and preferences with regards to, for example, alternative formats or communication modes with tutors. The study showed that a majority preferred using the virtual assistant compared to filling out the form themselves.

It identified three main ways in which CUIs can be beneficial to accessibility:

- Flexibility of being able to choose input and output mode (text or voice).
- Support in the process and the possibility to ask questions to gain a better understanding in an interactive way.
- Support to focus as the CUI separates a set of questions and sorts them out in a logical way in a dialogue.

Although the study concludes that there is a potential for CUI assistants to enhance accessibility through multimodal interaction, there is still research to be done on how the assistants can be designed to best meet the needs of different users.

Digital accessibility

Another potential use of multimodal technologies for the benefit of persons with disabilities lies in the provision of alternative formats. Graphical information is usually conveyed in text alternatives to persons with no or low vision. The text method can pose a challenge for richer and more complex images where there is a risk that meaning is lost in the translation. A Canadian research team has tackled this challenge by creating a system for exploring new solutions to providing richer multimedia representations of graphic content (Regimbal et al 2022). The system, called Internet Multimodal Access to Graphical Exploration (IMAGE), is not designed to replace screen readers, but to be used together with assistive technology to enhance the conveying of graphical information. To provide a richer rendering of information, the system supports various possible outputs such as speech audio, non-speech audio and force-feedback haptics. The system can be used with different graphic inputs such as maps, charts and photographs. It is an open-source framework, and the researchers hope that it can be used by both developers and researchers to create new solutions for users (ibid).

An on-going EU-funded project also uses multimodal technologies to tackle the same challenge regarding the conveying of graphical images, but in a slightly different manner.

The Ability project, led by the CEA in France, aims at developing a haptic tablet that provides multisensory feedback and interactions so that users can experience digital images through a combination of tactile and auditory output. (Ability project, 2023). The prototype is still in its early stages of development since the project started in 2022 and will run to 2025.

Assistive technology

Emerging trends in assistive technology are also exploring the potential offered by multimodal techniques. A few examples from the past few years include:

A tablet with a multimodal interaction system designed to support persons with multiple disabilities, involving special needs in communication, mobility, and learning impairments. The system is based on an app that runs on the tablet and that integrates with a smart home system, as well as allowing for multimodal communication based on SMS. (Realinho et al 2021)

There are a number of different solutions in the field of multimodal navigation systems for persons with visual impairments. One includes a framework that provides instructions for navigation through three different modalities: aural, tactile, and visual, using a bone conduction headset, a smartphone, and a smartwatch. Other solutions include multimodal feedback, haptic or auditory which can be integrated with a white cane. A literature review of different technologies in this field concludes that there are many solutions with a promising potential, but more research is needed to understand the preferences of users and which systems are useful in different real-life contexts. (Kuriakose B et al, 2020)

An ongoing UK-funded research project aims to develop a new type of hearing aid that uses information collected from different sensors including visual information, to enhance speech. The multimodal hearing aids are cognitively inspired to also make use of remote lip-reading techniques. The project COG-MHEAR is conducted at the Edinburgh Napier University and runs from 2021 to 2025. (UKRI, 2023)

4.3 Classification of solutions according to use cases

The solutions identified in the literature represent different strands of innovations that are either in development in the scientific and technological domain or already out in the market – either in the consumer market or in the public sector.

As can be seen from the classification table, most of the identified solutions are still in the Research and Development (R&D) phase and have yet to reach the market. Partly this is because scientific literature tends to focus on new technological innovations rather than analysing already existing solutions. Nevertheless, it is also a sign that there are multimodality innovations in the R&D domain that are yet to be fully implemented in the market.

Some of the identified R&D solutions with potential for supporting different user groups in terms of accessibility are already applied in sectors related to the European Accessibility Act, for example E-commerce. Other solutions that have been developed in sectors such as education and assistive technologies could be transferred to use cases in sectors related to EAA. More research is needed to identify which solutions have a potential to support the EAA more directly, and to find ways to make the transfer in an efficient way.

Sector	User group	Domain	Solution
E-commerce	General public	Market	Multimodal search for fashion items
E-commerce	General public	R&D	Enhance recommendations in micro-videos
E-commerce	General public	R&D	Communication between retailers and consumers
Communication	Researchers	R&D	Social semiotic research (theoretical framework)
Education	Students, students with disabilities	Public sector	Multimodal learning methodologies
Multiple sectors	General public	R&D, market	Multimodality applications in XR solutions for education, leisure and medical applications
Multiple sectors	General public, persons with disabilities	R&D, market	Multimodality applications in XR solutions for education, leisure and medical applications
Web accessibility	General public, persons with disabilities	R&D	Multimodal access to graphical content
Web accessibility	General public, persons with disabilities	R&D	Multisensory feedback on a haptic tablet
Assistive technology	Persons with disabilities	R&D	Multimodal communication and support system
Assistive technology	Persons with disabilities	R&D, market	Multimodal navigation support systems
Assistive technology	Persons with disabilities	R&D	Multimodal hearing aid

4.4 Classification with EAA relation

Products and services covered by the EAA can use multimodal communication to make instructions, user interfaces, and customer support accessible to individuals with various disabilities. Multimodal interfaces can enhance accessibility by providing users with multiple ways to interact with products and services, such as through touch, voice, or keyboard inputs.

The EAA requires that certain products and services meet specific accessibility requirements and offer information in alternative formats upon request. Multimodality facilitates the provision of alternative formats, such as audio descriptions, text-to-speech functionality, or Braille, to cater to the diverse needs of individuals with disabilities.

The EAA promotes inclusive design, aiming to “maximise the foreseeable use” of products and services by making them accessible to all users, regardless of their abilities. Multimodal design aligns with this principle, as it allows for the integration of various accessibility features that benefit individuals with disabilities.

Multimodality complements the use of assistive technologies that some individuals with disabilities rely on. By providing content in various modes, products and services may benefit users who do not use client based assistive technology (i.e., closed functionality), at the same time as the modes need to be compatible with a wide range of assistive devices and technologies.

The technical requirements that are currently being updated to act as presumed conformance to the EAA can be divided in three categories:

1) Direct multimodality

2)Indirect multimodality

3)Personalisation

4.4.1 Direct multimodality

There are accessibility requirements that establish multimodality directly, through an alternative mode of presentation or operation, e.g., text alternative for images, captions for audio or audiovisual content, audio description for video content. Many of these solutions make it possible to render various different alternative modes of presentation. For example, the alternative text for an image can be read out loud by a text-to-speech application or a screen reader, presented in Braille by a refreshable braille display, or presented as text.

Some examples

- **Non-text content:** non-text content that has a text alternative that serves the equivalent purpose.
- **Captions:** captions are provided for audio content in synchronized media.
- **Audio description:** audio description is provided for prerecorded video content in synchronized media.
- **Sensory characteristics:** instructions provided for understanding and operating content do not rely solely on sensory characteristics of components such as shape, colour, size, visual location, orientation, or sound.
- **Preservation of accessibility information during conversion:** converted information or communication preserves information that is provided for accessibility.

4.4.2 Indirect multimodality

Other accessibility requirements make it possible to render the alternative mode of presentation with client-based assistive technology. For this to work in real life, not only the interface need to function as laid out in standards and policy, but also the provision of assistive technology including training, support and updates.

Some examples

- **Meaningful sentence:** a correct reading sequence is established for assistive technology when the sequence in which the content is presented affects its meaning.
- **Identify input purpose:** the purpose of each input field collecting information about the user can be presented by assistive technology.
- **Language of page:** the default human language of the content is defined.
- **Visual indicator of Audio with Real-Time Text (RTT):** if the ICT provides two-way voice communication, and has RTT capabilities, the ICT provides a real-time visual indicator of audio activity on the display.

4.4.3 Personalisation

There are also accessibility requirements that ensure that the presentation can be adjustable by the individual user. These requirements do not aim at a different presentation mode, rather a higher level of accessibility can be achieved within the same presentation mode, via individual settings or characteristics.

Some examples

- **Orientation:** presentation and operation is not restricted to a single display orientation, such as portrait or landscape.
- **Use of color:** color is not used as the only visual means of conveying information, indicating an action, prompting a response, or distinguishing a visual element.
- **Contrast:** text and images are visually presented with enough contrast between them and their background.

5. Stakeholder consultation

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5.1 Workshop

In order to validate the interim results of the study, a half-day workshop was carried out in Brussels. Participants included representatives from end user organisations, accessibility experts and the industry. Workshop participants were divided into two groups focusing on policy and technology respectively.

5.1.1 Workshop results

Focus group on policy

The policy discussions focused on the following areas:

- End user involvement
- Awareness raising for several groups
- Skills and expertise
- Harmonisation and collaboration

Below is a summary of the conclusions from the discussions.

Workshop participants suggested **a clear policy that mandates inclusion of diverse user groups in all stages of ICT product development.** This would ensure that the development of multimodal accessibility is based on real user needs and empower the disability community. It would also contribute to raising knowledge and awareness in the ICT industry.

Another aspect of end user involvement that was highlighted is the **need for transparency and learning from others.** When companies understand user needs and share knowledge in a collaborative way, they can compete with the most innovative solutions.

The benefits of multimodality for users in general, not only users with disabilities, needs to be better explained, preferably underpinned by statistics on the **market impact.**

Connecting the topic to **UX-design** may make it easier to raise awareness and ultimately "sell" the concept to product teams.

There is a very **significant lack of professionals** in the industry who understand access needs. Not only is there a demand for subject matter experts that the market has so far been unable to meet, but even more importantly, the basic knowledge among generic ICT professionals is scarce.

Furthermore, **end users with disabilities are often unaware of existing multimodal accessibility solutions.** Accessibility skills in the target audience would create new job opportunities for people with disabilities, a group that has a higher unemployment rate than the general population.

To enhance the situation, **higher education needs to include accessibility in the curriculum for all courses covering the ICT profession:** content providers, UX-designers, graphical designers, developers, testers, project managers and so on. This would lead to a stepwise improvement of the situation, with new generations having basic knowledge desperately needed in the market.

Promoting industry standards is a way to cut costs with harmonization, and at the same time beneficial to end users as interfaces would behave in predictable ways. A concrete suggestion was to have a single access point for all accessibility features, helpful for users, industry, and surveillance authorities.

Focus group on technology

The technical discussions focused on the following areas:

- Terminology and understanding
- Customer focus
- Using the technology already out there
- Immersive technology and innovation

Below is a summary of the conclusions from the discussions.

Workshop participants agreed that **multimodality is something rarely explained or defined,** and several participants said that the term was new to them, even if the concept as such was known. This makes it hard to work across teams in companies. **The complexity of the standards** was also mentioned as a challenge for product teams who lack accessibility expertise.

Accessibility requirements are often seen as binary when in reality (for the users), they are not. The concept of multimodality, focusing on choice rather than “checkbox compliance”, can support that understanding. Therefore, it would be beneficial to promote and explain multimodal accessibility more broadly.

It was generally agreed that **multimodality is easier to obtain in software than hardware,** and that mostly the combination of the two is needed to make sure that the result is beneficial for the user. Multimodality can be used to attract more customers and to make existing customers more satisfied, supporting their preferred way of communicating.

TVs have been multimodal for decades, but it isn’t enough for the hardware to provide the possibility to enable accessibility solutions, the content providers also need to do their part. Quite a lot of the functionalities needed to provide multimodal solutions are built-in already, it is more about making it a higher priority and understanding how to implement the solutions. At the same time, TVs could also have a camera to allow for gesture control. In any way, the end users are not always aware of existing solutions.

The way accessibility problems are being deployed and/or remediated today is slow and inefficient and simply will not scale. Individual experts or teams are trying to solve the same issue in countless places. APIs could provide a common user interface to, for example, all TV-sets / all interfaces. Individual preferences could then be set. Another example is the many interfaces that are triggered by apps, working differently, as they are not standardized. The whole ecosystem must work together on implementation (and standards) for the result to be useful to the end user. There is a need for industry standards, collaboration, and knowledge sharing. This lack of harmonization makes it even harder for users to understand and use the technology.

AI has the potential of facilitating multimodality, if used correctly. It can already turn complicated texts into plain language or instructions. Participants agreed that AI has great potential, but there are problems with bias, security, and data privacy. Therefore, a human should always be involved for quality assurance and support. AI with less accurate results may be ok to use in some cases, for example when the user is trying to understand a specific topic, but when they are to sign a contract or similar, manual quality assessment is necessary.

5.2 Interviews

In order to collate important aspects on multimodal accessibility from the industry, a number of semi-structured interviews has been carried out. Respondents selected to cover key parts of the products and services in scope of the EAA include Neil Milliken, ATOS, Richard Moreton, Samsung, Christopher Patnoe, Google, Shadi Abou-Zahra, Amazon and Peter Lanigan, TP Vision, Bianca Prins, ING Bank and Hector Minto, Microsoft.

5.2.1 Interview results

The interviews covered questions about the term multimodality, how it is used and understood, to what extent multimodality is provided in current products and services, multimodality in relation to the EAA, and possible barriers and opportunities.

5.2.2 Terminology

In the accessibility community, the term ‘multimodality’ is well-known and often used. Nevertheless, there are variations in its precise definition, even among accessibility experts, mainly depending on language, region and focus area, UX-designers being the group most familiar with the term.

Among economic operators in scope of the EAA (“the industry”) there is a difference between professionals working specifically with accessibility, who often use the term (“multimodality is essential, it is the ’how’ we do accessibility”, “it is part of our training and design standards”) and other parts of the companies, where the term can be anything from totally unknown, to more factual technical descriptions (“this product comes with touch screen and keyboard“).

When explained, the concept is usually well-understood by all stakeholders, but it does not seem likely that general ICT professionals always make the connection between multimodality and accessibility; neither in relation to the EAA nor in general.

5.2.3 State of the art

Among industry representatives, multimodality is generally perceived as a very positive, useful and “natural” part of product design. This is true not only when it comes to accessibility, but rather because of general customer expectations. For example, a frequent type of question is that if I can do this on my computer, why can’t my TV do the same thing? When users to become more inquisitive, it puts pressure on designers to come up with even better ideas.

Well-designed multimodality solutions mean less demand for diagnosis and assessment of abilities, which empower the users. There is also an increased acceptance in society for various needs and modes of in- and output. On the other hand, mainstreaming may have negative effects if it leads to less funding for the assistive technology needed to complement the built-in solutions.

There is also a clear business benefit when proper multimodal solutions are developed, as they result in lower costs than delivering multiple platforms and services. Providing users with the opportunity of choice and customisation raises the probability for them to complete a transaction or interaction with and through technology. Furthermore, there is a (not always measured) cost and dissatisfaction for not being able to carry out a specific task.

All industry representatives claim to provide multimodality in their products and services. This is even more true when it comes to products that are used in many different situations and environments.

The approach can be divided in three main categories, where multimodality solutions can be:

- developed to meet specific accessibility needs,
- emanating from accessibility requirements but beneficial to a wide range of users,
- inherent to the technology itself, being completely mainstream.

In the first category belong, for example, the opportunity to connect specially designed switches that are easy to use for people with motor impairments, or multimedia content that also provide audio descriptions for visually impaired users.

In the second category, we find for example remote controls with a microphone so that the user can talk to the TV instead of clicking through the menu, or products that automatically providing spoken self-guiding instructions, or captions. These features were initially developed to meet accessibility needs, but have proven highly useful for, and appreciated by, many customers.

In the third category, we find for example products where voice control is the main mode of operation, but where settings are provided on a touch screen or smartphone, where sound, image and haptics are part of the standard offering.

Another way of looking at multimodality is having a more philosophical approach, where it becomes a goal or a concept for product design: “Multimodality is considered best practice; it is the expectation that all teams should aim for it. It is a key design or UX-design perspective.”

The wide range of user preferences, often manifested in using different modes of operation when performing the same task depending on context or situation, is well-known and recognized. How you want to interact with a product or service depends on many things, and not least, where you are and what you want to do more or less simultaneously. For example: people who usually read their text messages may want to have them read out loud while driving. In this specific situation, it is deemed as a more effective way of interacting, rather than just a preference. This kind of user expectation and behavior makes offering multimodal solutions a way to sell more and make customers more satisfied.

Offering multimodality is also mentioned by several industry representative as a potential competitive advantage; in a situation where all market players meet the legal minimum requirements. Going beyond the basic requirements, offering more flexibility to users is a clear goal for a majority of the industry representatives.

5.2.4 Relation to the EAA

The perspective on how legislation is or will be affecting the industry varies a lot depending on both the specific sector, and where in the eco-system the organization is operating.

Self-service terminals and Customer service are mentioned as areas where multimodal solutions have a potential to be disruptive.

When it comes to, for example, audio-visual products and services, multimodality, and indeed accessibility as such, can only be achieved when all parties in the value chain meet their part of the requirements. The TV manufacturer must provide the possibilities for content providers to broadcast captions, sign language and audio description. The TV itself doesn’t provide the multimodal solutions, on the other hand, the broadcasters cannot provide the multimodal solutions without the hardware allowing them.

This particular part of the market is also evolving quite slowly, as TV-sets are on average replaced only every 7 years. As a comparison, Microsoft 365 released 22 updates during January-September 2023.

The need for collaboration makes it both complex and time consuming to achieve improvements, and industry standards are, of course, key.

At the other end of the spectrum, product development is pushed through so fast that lack of user testing (or even general quality assessment) often leads to accessibility failures when it comes to mainstream products, at least in the early releases.

That said, industry representatives do not foresee a big change in their way of approaching accessibility or multimodality because of the EAA. The law has been very effective in drawing attention to the topic, and it is no longer possible not to bother about accessibility. Nevertheless, it is important to note that the stakeholders consulted for this study are very engaged and knowledgeable in the topic of accessibility, and therefore they are not a representative selection of average economic operators in scope of the EAA.

5.2.5 Possible barriers and challenges

All industry representatives mention cost as a barrier, especially when it comes to low-cost hardware products. Thorough end user involvement and testing in different languages to ensure sufficient quality is time consuming and resource demanding. The earlier mentioned need for collaboration and agreement between various actors in the eco-system makes development both complex and slow. It can be hard to find solutions that add multimodal alternatives without cluttering the interface with confusing numbers of alternatives.

Some of the industry representatives see challenges in the “checkbox mentality” that legal requirements inevitably lead to. If you look at user interaction as task-based, it is less important how the specific product or service fulfils the EAA, as long as the user can achieve its goal. It will be interesting to see whether innovations around intermediaries to bridge accessibility needs will be legally accepted.

For example, for some user groups, it would likely be easier to operate self-service terminals with a smartphone, provided they would all be operable with the same app(s), than for each hardware manufacturer to come up with their own multimodality accessibility solutions. For the user, the point is not to be able to use a specific terminal, but to accomplish something. Another example could be a perfectly compliant payment terminal that is placed in a way that wheelchair users cannot reach them. Here an alternative mode of operation with a device the user selects might also be a possible work-around. Will this be seen as a beneficial multimodal approach or dismissed as non-compliance? Will market surveillance authorities consult with people with disabilities before assessing new solutions?

In large organisations, each team often focuses on one specific, sometimes tiny piece of a product or service. This makes it hard to have a multimodal approach and puts pressure on systematic coordination at management-level for the solutions to be useful on their own as well as fitting into a broader pattern of alternative modes.

Another challenge mentioned is the need to support many different languages. With each modality added comes a demand for a wide coverage of languages, which can quickly become resource demanding.

Communication is mentioned as one of the more difficult parts of multimodality. Design processes around product and service development are generally well-documented and teams know the drill, which makes it at least theoretically feasible to introduce and follow up on

multimodal features. When it comes to customer service, support, and general communication, they rely on human interaction much more, and require continuous training, manuals and in some cases specialist suppliers.

Making users aware of existing accessibility features and modes is a key issue that all industry sectors struggle with. Training and exposure to technology in the workplace could be one way of increasing discoverability.

5.2.6 Innovation and opportunities

In general, industry representatives are positive when it comes to multimodal accessibility innovation, looking forward. They find it important that innovation is driven by users' needs, and that end users are involved to make sure the result is beneficial for them. Authentic realization happens with persons with disabilities, not for them. It was also mentioned that the product needs to be useful without personalisation, it has to be able to stand alone but be even more powerful/powered by the users' choice.

Some of the future possibilities mentioned are:

- **Attention:** products like glasses that do what you want them to do – for example alert you when there is a sound behind you.
- **Individual settings:** taking privacy into account, there is potential in setting users' preferences once, and then letting all products and services provide the mode of operation that the individual prefers.
- **Voice input:** many users seem to get used to voice input quickly, despite the products still being far from perfect. When this technology becomes more accurate and can handle more languages, dialects, accents, and speech impairments, many more tasks can be carried out using voice.
- **XR or immersive technologies:** so far these solutions have mostly been niche products and services, but the technology has potential to augment experiences beyond human abilities. They are already, and will increasingly be so integrated in our daily lives that we don't even think about it – opening up for even more multimodal accessibility. Natural language processing is mentioned as a specific area of interest.
- **Open APIs:** to foster innovation across the value chain, de facto-standards and harmonisation within the industry will facilitate multimodal solutions.

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6. Policy and legislative analysis of multimodality

European policy and legislation recognise the need to use different channels and to address different senses for communication: for presenting information and for interacting with the users. Requirements either address it directly (e.g., non-text content needs to have a text alternative, thus providing an alternative mode of presentation) or indirectly, by making it possible to render the alternative presentation by assistive technology (e.g., text content should be encoded so that assistive technology can read it in the correct reading order).

However, they do not use the term multimodality, using instead expressions like the need to make content "available via more than one sensory channel" and similar concepts. This requirement of accessibility goes hand in hand with the concept and aim to ensure a multimodal way of conveying information and of interaction.

6.1 Analysis of key policy context

6.1.1 Multimodality as a policy concept

Multimodality, as such, is a core concept of accessibility, but the term is used in different ways in different policy areas, which can lead to confusion.

For example, the term multimodality is used in EU policy in relation to transport, with a different meaning: referring to the availability of different transport modalities. Furthermore, accessibility also often has a different meaning in this context, referring to the easy availability of transportation services. An example for such an accessibility indicator: "proportion of people within 10 minutes walk of a 5/10/15 minute bus service". (Vorraa 2007)

Multimodality is beneficial, and even crucial for a number of persons with disabilities. Therefore, it is important that the term and concept is used clearly in policy, ensuring the definition and the execution of initiatives that would lead to innovative ways of ensuring seamless multimodality.

Some of the future possibilities mentioned are:

- methods and means to prepare information so that it either provides multimodality directly, or allows for a wide range of presentation modes (often by an assistive technology),
- mechanisms providing the optimal mode of presentation (personalisation or individualisation).

This is described in the **CEN-CENELEC GUIDE 6 "Guide for addressing accessibility"**[1], which aims to provide guidance for developing standards that address accessibility – either focusing on accessibility, like standards that accessibility legislation refers to, or considering accessibility among other requirements.

The guide among others, sets the goal to support individualisation, where "the components, functions or operations of a system can be tailored to meet the needs of individual users".

"This goal recognizes that a single system design is seldom optimal in meeting the needs of every user and context of use and it can be important to provide users with choices in how to interact with a system. While various types of systems or system components (e.g. the built environment) are not modifiable by users, individualization can be accomplished if the users can individualize the way in which they interact with the system.

1 CEN-CENELEC Guide 6:2014. Guide for addressing accessibility in standards. Edition 2, December 2014. https://www.cencenelec.eu/media Guides/CEN-CLC/cenclcguide6.pdf

Individualization focuses on providing each user with means of obtaining the best possible solution for that user. This can be accomplished by providing users with a choice in their methods of interacting with a system (such as alternative sets of operations or interactions, alternate modalities of interacting or operating, or cognitive strategies) and/or by providing alternative means or formats of interaction matched to that individual's needs in that context or by implementing other accessibility strategies."[1]

6.1.2 Standards supporting accessibility legislation

As described in the policy background in Section 2.2, the right to accessibility is enshrined at different levels, from the UNCRPD through the EU Charter of Fundamental Rights to the EU disability strategy, and EU legislation.

European accessibility legislation focusses on the sectors affected ("who") and the scope of what should be accessible ("what"). The technical requirements for "how" to make something accessible, is stated in the European standards.

The key document for ICT accessibility is **European Standard EN 301 549 v3.2.1 "Accessibility requirements for ICT products and services" (EN 301 549).**[2]

1 CEN-CENELEC Guide 6:2014. p14

2 Harmonised European Standard EN 301 549 V3.2.1 (2021-03) Accessibility requirements for ICT products and services. ETSI-CEN-CENELEC, March 2021. https://www.etsi.org/deliver/etsi_en/301500_301599/301549/03.02.01_60/en_301549v030201p.pdf

This harmonised standard contains the presumed conformance to the Web Accessibility Directive, meaning that if a website or mobile application conforms to this standard, it can be presumed that they comply with the accessibility requirements of the directive. EN 301 549 is a comprehensive standard that covers hardware, websites, non-web documents, software (including mobile applications), ICT two-way communication, documentation, and support services – among others. EN 301 549 is, together with other standards, being revised under Mandate 587 to also act as presumed conformance to the EAA.

EN 301 549 is focusing on multimodality in the functional performance statements as well as the technical requirements.

Chapter 4 of the standard describes the user needs and provides an overview of what the requirements aim to provide: a multimodal approach to accessibility.

The functional requirements cover different user needs and describe how to support them. For example:

> **"4.2.1 Usage without vision**
>
> Where ICT provides **visual modes** of operation, the ICT provides **at least one mode of operation** that does not require vision. This is essential for **users without vision** and benefits many more users in different situations."

> **"4.2.4 Usage without hearing**
>
> Where ICT provides **auditory modes** of operation, the ICT provides **at least one mode of operation** that does not require hearing. This is essential for **users without hearing** and benefits many more users in different situations."

> **"4.2.6 Usage with no or limited vocal capability**
>
> Where ICT requires vocal input from users, the ICT provides **at least one mode of operation** that does not require them to generate vocal output. This is essential **users with no or limited vocal capability** and benefits many more users in different situations."

For users with cognitive impairments, the functional performance statement prescribes simplification, but not necessarily as an alternative mode of operation – it may be made easy by default:

> **"4.2.10 Usage with limited cognition, language or learning**
>
> The ICT **provides features and/or presentation that makes it simpler and easier to understand, operate and use.** This is essential for users with limited cognition, language or learning, and benefits many more users in different situations."

One of the notes highlights multimodality as one way of meeting the user need: “Providing audio output of the text is an example of providing support for people with limited reading abilities.”

But user needs are neither black-or-white nor static, human abilities are gradual, changing and dependent on context, situation, environment etc. Therefore, the functional performance statements are not solely focusing on providing alternative modes of operation, but also enhancements. For example:

> **”4.2.2 Usage with limited vision**
>
> Where ICT provides **visual modes** of operation, the ICT provides features that enable users to **make better use of their limited vision.** This is essential for users with **limited vision** and benefits many more users in different situations.”

One of the notes highlights multimodality and personalisation as a way of meeting the user need: “Magnification, reduction of required field of vision and control of contrast, brightness and intensity can contribute towards meeting this clause.”

The technical requirements of the subsequent chapters (5-13) are describing how these functional performance statements can be supported or met.

Apart from these two parts, EN 301 549 also provides a mapping that shows how the user needs of chapter 4 relate to the technical requirements in chapters 5-13.

The mapping provides an overview of how the requirements can be used to support different user groups at primary or secondary level, thus facilitating the implementation of multimodality.

It is important to note that the requirements do not equally cover all usages, and do not cover all user needs. The standard, at this point, has limited requirements for cognitive accessibility, most of them are primarily address other user needs, and have only a secondary relation to “usage with limited cognition”. A prominent example: alternative text is required to describe meaningful images, but images complementing written text, helping cognitively structuring and understanding the textual information are not a requirement.

Another example is that it is required to make sure that assistive technology can interpret and present headings (chapter titles, sub-chapter titles, section titles) if they exist, thereby providing the possibility of non-visual presentation of the content structure. Nevertheless, it is not required to have that structure in a document, at the first place, even though, such structure makes the content easier to process for all users, but especially for users with cognitive impairments.

All in all, the multimodal solutions are primarily supporting physical impairments, while solutions that primarily serve cognitive accessibility are less prominent.

Another one of the standards in Mandate 587 is **European Standard EN 17161 “Design for All – Accessibility following a Design for All approach in products, goods and services – Extending the range of users” (EN 17161)**[1], which is currently being revised to act as presumed conformance to the EAA.

1 European Standard EN 17161:2019 Design for All - Accessibility following a Design for All approach in products, goods and services - Extending the range of users. CEN-CENELEC Joint Technical Committee, March 2019. https://www.cencenelec.eu/areas-of-work/cen-cenelec-topics/accessibility/design-for-all/

According to the standard, “a Design for All approach takes account of human diversity to extend the range of users”. The aim is to incorporate inclusivity from the outset, rather than making adaptations or modifications afterward. The concept emphasizes the importance of considering diverse user needs and preferences during the design and development process.

EN 17161 provides an organisational and procedural approach, to ensure that an organisation adopts an overall, process-driven Design for All approach, covering the design, development, and manufacturing phases.

The standard addresses multimodality by defining the activity of producing solutions to meet the user requirements.

As examples for outputs of the design activities, it lists the following:

b) “The ways in which multiple means of information presentation and operation will be provided, are identified.”

c) “Decisions are made about whether and where a single solution can be adopted without potential for adjustment and where individualization to meet specific user needs will be implemented.”

From the above, it can be seen that the European accessibility standards include the concept of multimodality as one of the key concepts but do not use the term.

6.2 Analysis of key legislative context

The **Audiovisual Media Services Directive (AVMSD)** addresses accessibility in a generic way meanwhile the **Web Accessibility Directive (WAD)** focuses on accessibility and defines its main principles (perceivability, operability, understandability and robustness) without detailing its components and referring to the relevant European Standard for technical details. But the most recent legislation, the **European Accessibility Act (EAA)**, addresses multimodality more directly.

The **EAA** has a broader scope than other European accessibility legislation, providing accessibility requirements for various products and services. The EAA also uses standardisation to define technical accessibility requirements, following which can be used for the presumption of conformity. At the same time, the requirements are presented already in the legal text, as opposed to the previous directives. Annex 1 contains general requirements for all products and all services respectively, as well as specific requirements for some of the particular products and services in scope of the directive (such as for example e-books or self-service terminals). The annex also lists the functional performance statements from EN 301 549 (here called ‘Functional performance criteria’) as an alternative to the technical specifications in certain cases. As an overall approach, the EAA uses the concept of “maximising foreseeable use by persons with disabilities”, which indirectly calls for multimodality.

Many of the requirements in the directive address multimodality – even if without using that exact term. As an example, the general accessibility requirements related to the products (Annex 1 Section 1) call for the following, among others, describing or directly serving multimodality:

Information/instructions shall be

- "made available via more than one sensory channel; [...]
- presented to users in ways they can perceive";
- with regard to content, "made available in text formats that can be used for generating alternative assistive formats to be presented in different ways and via more than one sensory channel; [...]
- accompanied by an alternative presentation of any non-textual content".

User interface and functionality design "shall contain features, elements and functions, that allow persons with disabilities to access, perceive, operate, understand and control the product by ensuring that:

- when the product provides for communication, including interpersonal communication, operation, information, control and orientation, it shall do so via more than one sensory channel; this shall include providing alternatives to vision, auditory, speech and tactile elements;
- when the product uses speech it shall provide alternatives to speech and vocal input for communication, operation control and orientation;
- when the product uses visual elements it shall provide for flexible magnification, brightness and contrast for communication, information and operation, as well as ensure interoperability with programmes and assistive devices to navigate the interface; [...]
- when the product uses audible signals to convey information, indicate an action, require a response or identify elements, it shall provide an alternative to audible signals; [...]
- the product shall provide an alternative to biometrics identification and control; [...]
- the product shall provide software and hardware for interfacing with the assistive technologies".

The directive has similar requirements on information/instructions regarding the services in its scope. EU law also provides an example of synchronized multimodal communication and operation, covering a specific solution. The **European Electronic Communications Code**[1] requires emergency services to be equally accessible to end-users with disabilities, in particular deaf, hearing-impaired, speech-impaired and deaf-blind end-users. This means that they need to be in accordance with Union law harmonizing accessibility requirements for products and services (i.e., the EAA).

In this regard, the EAA requires:

- real time text[2] in addition to voice communication;
- total conversation[3] where video is provided in addition to voice communication;
- that emergency communications using voice, text (including real time text) is synchronised and where video is provided is also synchronised as total conversation.

1 https://eur-lex.europa.eu/eli/dir/2018/1972/2018-12-17

2 "Real time text" means a form of text conversation in point to point situations or in multipoint conferencing where the text being entered is sent in such a way that the communication is perceived by the user as being continuous on a character-by-character basis. EAA, Article 3(14)

3 "Total conversation service" means a multimedia real time conversation service that provides bidirectional symmetric real time transfer of motion video, real time text and voice between users in two or more locations. EECC, Article 2(35)

The **Marrakesh Directive**[1] addresses another, legal aspect of multimodality. As an implementation of the Marrakesh Treaty, the directive establishes a copyright exclusion in order to facilitate access to alternative, accessible format copies of certain works. 'Accessible format copy' is defined as the presentation of a work in an alternative manner or form, giving access to a blind, visually impaired or otherwise print-disabled person. Thus, this legislation does not create accessibility requirements or supports techniques of multimodal presentation (for example: digital text, audiobook, easy to read format), but focuses on creating a legal background that facilitates multimodal presentation. It might be an important aspect for other content that is not born-accessible.

Legislation	Domain	Multimodality
Charter of Fundamental Rights of the European Union (2000)	Fundamental rights	Establishes the right of persons with disabilities to integration. No reference to multimodality.
Web Accessibility Directive (WAD, 2016)	Websites, mobile applications and online documents (public sector)	Defining the four principles of accessibility and referring to European Standard with requirements that support multimodality.
Marrakesh Directive (2017)	Copyright exception (benefitting print-disabled persons)	Provides legal background for creating alternative presentations. Uses the term: "an alternative manner or form that gives a beneficiary person access".
Audiovisual Media Services Directive -amended (AVMSD, 2018)	Audiovisual media services	Requires the accessibility of audiovisual media, but technical details supporting multimodality are provided only via the EAA.
European Electronic Communications Code (EECC, 2018)	Electronic communication	Requires the accessibility of emergency communication. The supporting technical details are set in the EAA, prescribing synchronised multimodal communication and operation, covering a specific solution
European Accessibility Act (EAA, 2019)	Certain products and services, emergency communication	Accessibility requirements presented in the legal text, address multimodality (without using that exact term). Uses the terms "maximising foreseeable use by persons with disabilities", "generating alternative assistive formats to be presented in different ways and via more than one sensory channel" and "accompanied by an alternative presentation", among others.

1 https://eur-lex.europa.eu/eli/dir/2017/1564/oj

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7. Innovative multimodal solutions to foster accessibility

7.1 Some innovative multimodal solutions

Multimodal accessibility features have been around for a long time, ranging from hardware like ATMs or headless devices with the possibility to connect earphones, touch screens or assistive technology to more advanced solutions.

Among the innovative solutions on the market today, content simplification using AI is an example of a solution fostering multimodality that is already on the market in English, but where the potential for further development is huge. This technology cannot only transform content to the reading level suitable for the user, but also add explanations and translations where needed.

Input control, including specially designed switches and voice-controlled interfaces provide new opportunities supporting a variety of user needs and preferences. These types of technologies are still evolving quickly to become more mainstream and accurate, as well as bringing on a wider use case when more languages are supported.

Some TVs offer the possibility to give spoken commands as an alternative to clicking through very long menus with a remote control. As this requires Bluetooth rather than infrared communication between the remote control and the TV, it is not included in cheaper models.

Instructions and manuals have improved a lot over the years, using multimodality to move from text only to illustrations and videos. Currently, self-guiding processes for installation, where the product starts to use voice output if you wait long enough, is a good example of a multimodal accessibility solution that has proven to be very beneficial for a wider audience.

In the tourism and entertainment sector, multimodal XR technology is used to augment the experience of historic sites or buildings by adding digital information and graphics onto the physical world. In live events, visual effects that enhance the performance on stage, lyrics of songs can be shown on individual smartphones, and interactive experiences can be provided. When created with accessibility in mind, these features can also be beneficial to persons with various user needs.

7.2 Future-looking solutions

Several stakeholders from various sectors have mentioned, during the stakeholder consultations, the need for open APIs to enhance the opportunities for multimodal accessibility solutions and to maximise the foreseeable user needs supported. It would enable industry to build innovative and competing services using APIs, without active participation by every single stakeholder in the value chain. From the user perspective, the possibility to select the preferred mode of interaction via a device or assistive technology without being overwhelmed by all imaginable alternatives, would severely simplify the UX.

Another sought after solution among stakeholders is enhanced individual settings and preferences, that enables users to focus on the actual content, which is always presented the way the user wants. Even though semi-automated personalisation features do entail caveats when it comes to privacy and security, but the potential ease of use makes it relevant to keep looking into.

An interesting perspective on possible future innovation is the need for human involvement in technology offerings. Part of this stems from the broadly agreed view that AI needs human quality assessment, at least for now. But there is also an expectation by society at large, increasingly asking for human intervention to balance digital-only services, like chatbots.

An example of a movement in the opposite direction is ‘Be My AI’, which is adding machine learning to the original Be –My Eyes service – a mobile app where a community of sighted

volunteers help recognising items in photos or videos sent by blind or visually impaired users. In addition to relying on individuals providing multimodality (text descriptions) manually, the app can now provide AI-based responses, faster and at any time of the day, in any time zone, no matter how many volunteers happen to be online. The app is currently being Beta-tested.

7.3 Mapping of solutions with the EAA

7.3.1 E-commerce

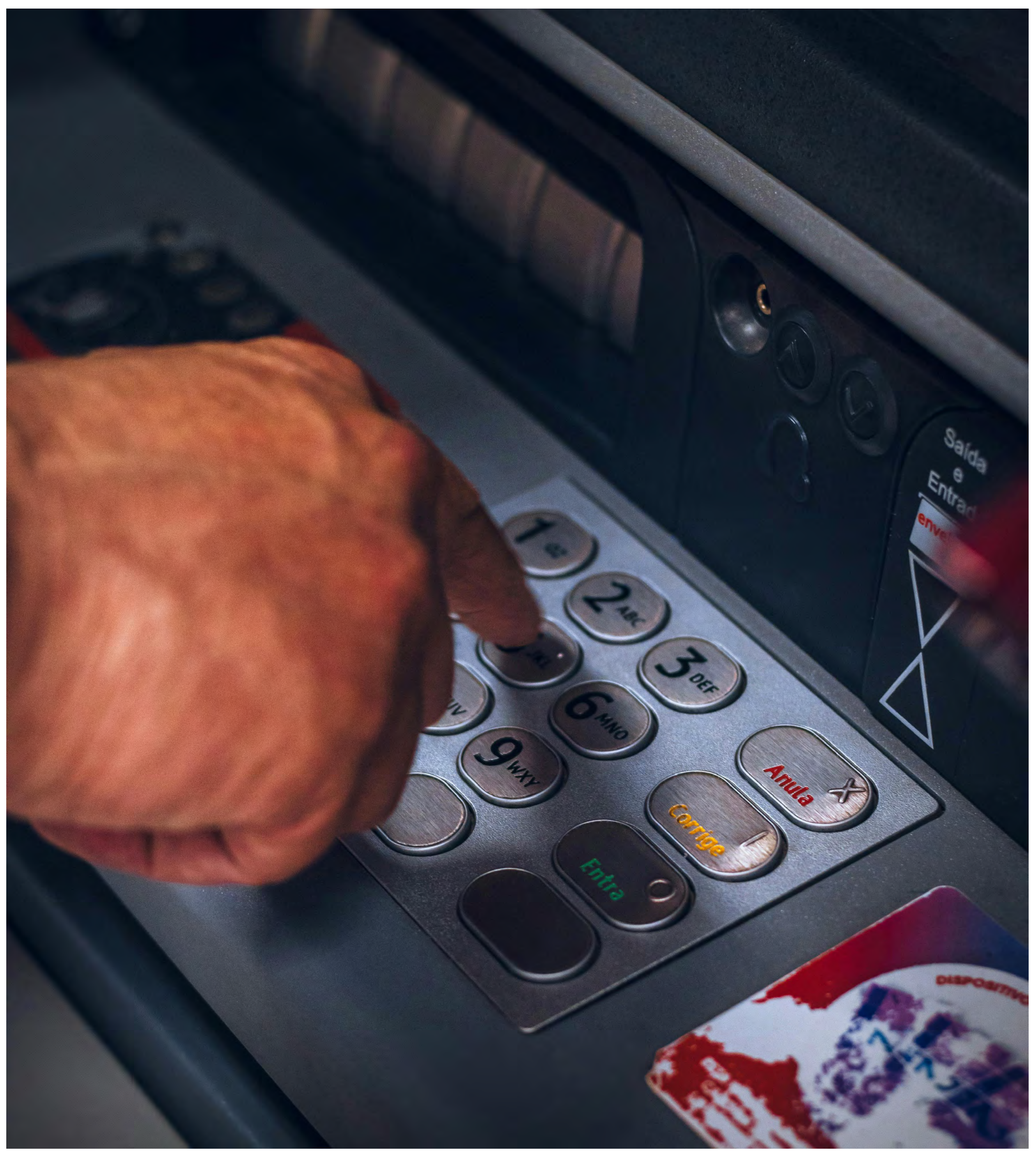
Multimodality solutions in e-commerce are inherent to the shopping experience, aiming to resemble as much as possible the experience of shopping in real life. In general, multimodality solutions are not specifically targeting accessibility needs, but rather overall customer satisfaction.

Some examples of multimodal solutions found in many e-commerce are:

- Product Images and Galleries
- Product Videos
- Customer Reviews and Ratings
- Interactive Product Configurators
- 360-Degree Product Views
- Augmented Reality (AR) Try-On
- Chatbots and Virtual Assistants
- Interactive Shopping Carts
- Interactive Size Guides
- Personalised Recommendations
- Gamified Shopping Experiences

7.3.2 Consumer banking

Banks have been exposed to accessibility requirements including obligations to provide multiple channels for customer service long before the EAA. Complex services around a topic that many users struggle with understanding, in combination with legal requirements around authentication and security make multimodality in banking interfaces extra important.



Examples of multimodal banking services include:

- Mobile Banking Apps
- Online Banking Portals
- Chatbots and Virtual Assistants
- Interactive Voice Response (IVR) Systems
- Video Banking
- Augmented Reality (AR) for Branch Interactions
- Wearable Banking
- Social Media Banking
- QR Code Payments
- Personalised Digital Financial Advisory

7.3.3 E-books

Digital multimodality in e-books enhances the reading experience by combining different modes of communication, such as text, images, audio, and interactive elements.

Some examples of how e-books utilize multimodality:

- Interactive Graphics
- Audio and Video Narration
- Image Galleries
- Quizzes and Assessments
- Dictionary and Glossary
- Animations
- Augmented Reality (AR)
- Interactive Maps
- Social Media Integration
- Customizable Content

7.3.4 ATMs and self-service terminals

Multimodality in self-service terminals may enhance user interactions, simplify processes, and improve accessibility.

For example a combination of:

- Socket for attaching assistive devices
- Touchscreen Interface
- Multilingual Support
- Voice Guidance
- Visual Instructions
- QR Code Scanning
- Near Field Communication (NFC)
- Receipt Options
- Biometric Authentication
- Text-to-Speech
- Visual Confirmation
- Help and Support Features
- Mobile App Integration

7.3.5 Computers and operating systems

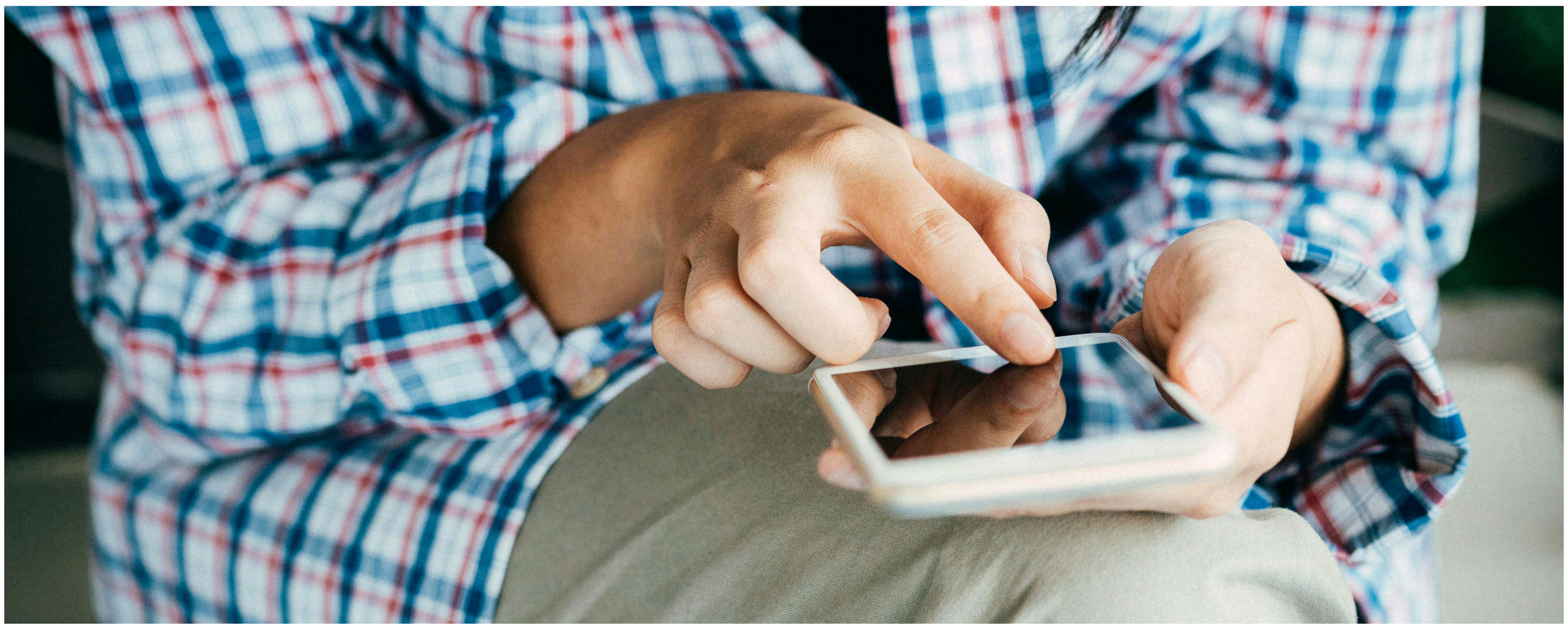
Multimodality is integrated into computers and operating systems to enhance user interactions, accessibility, and overall user experience.

There are plenty of examples:

- Voice Recognition and Virtual Assistants
- Gesture Controls
- Speech-to-Text and Text-to-Speech
- Multi-Monitor Support
- Screen Magnification and Zoom
- High-Contrast Themes
- Pen and Stylus Support
- Haptic Feedback
- Virtual Reality (VR) and Mixed Reality (MR) Integration.
- Adaptive Interfaces
- Audio and Video support

7.3.6 Smartphones

Smartphones are equipped with a wide range of multimodal features that enhance communication, accessibility, and user experience. The technology is mainstreaming accessibility features in a way that has profoundly changed the way assistive technology is being defined.



Accessibility enhancing multimodal features in smartphones include:

- Text Messaging (SMS)
- Multimedia Messaging (MMS)
- Voice Calls
- Video Calls
- Voicemail
- Visual Voicemail
- Voice-to-Text Transcription
- Predictive Text
- Voice Commands and Virtual Assistants
- Caller ID
- Rich Communication Services (RCS)
- Haptic feedback
- Augmented Reality (AR) and Virtual Reality (VR)
- Biometric Authentication
- QR Code Scanning
- GPS Navigation
- Personalised Recommendations
- Health and Fitness Tracking

7.3.7 Audio-visual media services

Technology supporting multimodality is very common in audio-visual media services, which has the potential to deliver engaging, interactive and accessible content to users, but the actual content of the functionality is not always provided:

- Subtitles and Closed Captions
- Audio Descriptions
- Interactive Video Features
- Interactive Storytelling
- Second Screen Experience
- Augmented Reality (AR) and Virtual Reality (VR)
- Enhanced Playback Controls
- Multiple Audio Tracks
- Personalised Recommendations
- 360-Degree Videos
- Live Interaction and Chat
- Audio-Visual Effects

7.3.8 Support services

Multimodal customer service involves providing customer support and assistance through multiple communication channels and modes. Multimodality may be beneficial, for example in providing:

- Live Chat with Chatbots
- Virtual Assistants
- Social Media Support
- Video Support
- Email Support with Rich Media
- Self-Service Portals
- Voice Support with Interactive Voice Response (IVR) systems
- In-App Messaging
- Visual Guides and Tutorials
- Webinars and Video Support Sessions

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8. Conclusions

Multimodality is a key concept for achieving accessibility. It is based on the fact that people have diverse needs, abilities and preferences – and that context, situation and environment often influence how people interact with digital interfaces.

When it comes to the term itself, however, the issue becomes more complex. Neither EU policies nor ICT-professionals in general use the word in the above sense – it seems to be more of **a technical term used among accessibility subject matter experts.**

There are various similar or related concepts to multimodality, e.g., design for all, integral accessibility, accessible design, inclusive design, barrier-free design, transgenerational design, universal design, accessibility for all, to mention some. The different terms are sometimes used synonymously, sometimes to differentiate between methods, underlying philosophies or perspectives.

But no matter by which term they are referred to, **multimodal solutions are abundant in many sectors (within and outside of the scope of EAA):** in education, medicine, engineering, product design and marketing, service provision, and in social media, to mention some. The development of solutions is fast, supported to some extent by immersive technology and AI.

The available research confirms that multimodality and multimodal techniques are used in a wide array of domains, such as e-commerce, communication, education, XR/VR, Human-Computer interfaces, digital accessibility and assistive technology. They address personal preferences and personalisation in order to better serve consumers, research how multimodality can enrich the user experience and contribute to better access, understanding and performance, or aim to otherwise understand better the use and added benefits of multimodal communication.

In line with the research focus and findings, from a business perspective **multimodality is often provided not because of accessibility considerations but because of its expected benefits to satisfy diverse customer needs**, and offering more flexibility to users in order to achieve higher customer satisfaction. **Connecting the issue to UX-design may make it easier to raise awareness and ultimately "sell" the concept all through business organisations.** This can contribute to general awareness and innovations in the multimodality domain. It needs to be mentioned that multimodality is sometimes specifically used to meet accessibility requirements, which also comes with a potential competitive advantage by going beyond the basic requirements.

Some of the innovative multimodal solutions found in literature are on the market or otherwise available for the public, but most of them are in different phases of R&D – showing that there is a pipeline of multimodality innovations, even though they still need to overcome some barriers. For example, speech recognition technology has strong potential to facilitate multimodality, but for small languages it still struggles with accuracy.

The stakeholder consultations showed that on the industry side, apart from developing multimodal solutions in general, a main challenge is to **collaborate across value-chains** (e.g., it is not enough if a TV offers the possibility of adding captions, if the broadcaster does not provide them – and the other way around), a most advanced and forward-looking form of which would be to **develop open APIs to enable common innovation in user interfaces.**

Even though competition may be a more important driver than legislation in some cases, low-cost products would most probably not offer multimodal solutions without a legal requirement. EU policies and legislation at the EU and national levels tend to help getting focus on and budget for accessibility improvements, including multimodal solutions.

The stakeholder consultation suggests that **clear policy mandating inclusion, promoting multimodality and addressing the lack of knowledge and skills in the area would come with various advantages.**

It could:

- ensure that the development of multimodal accessibility is based on real user needs, at the same time empowering the disability community;
- foster the development of innovative multimodal solutions, resulting in higher accessibility as well as decreased costs compared to delivering multiple parallel platforms and services to satisfy customer needs;
- contribute to raising knowledge and awareness in the ICT industry, and creating more subject matter experts;
- raise knowledge and awareness of existing multimodal accessibility solutions among users with disabilities, contributing to creating new job opportunities for people with disabilities, as well as providing more experts satisfying the increased demand for accessibility knowledge.

The analysis shows that more recent EU legislation and European standardisation have the concept of multimodality in their core – even without using the word. The accessibility requirements therein can be classified according to the different levels they relate to multimodality: they may establish multimodal presentation directly, facilitate indirectly the rendering of alternative modes of presentation, or ensure adjustments to individual user needs without focusing on a different presentation mode.

The legislation most clearly focusing on multimodality is the EAA, requiring for certain products and services to maximise their foreseeable use by persons with disabilities, and information to be made available via more than one sensory channel.

Nevertheless, without labelling it clearly, the visibility of multimodality and multimodal solutions is low for having a focused policy development and for creating initiatives that support concentrated efforts in the commercial market.

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9. Recommendations at policy, technology and market levels

The desk research and stakeholder consultations indicate a set of necessary or anticipated actions that would help realise the potential of multimodality. They are set forth below as recommendations for policymakers, technology development and market actors.

Recommendations

Policy recommendations

1) Clarify the term and concept in policy, ensuring the definition and the execution of initiatives facilitating the creation of innovative ways of ensuring seamless multimodality.

2) Develop policy for inclusion of diverse user groups in all stages of ICT product development, ensuring that the design of multimodal accessibility is based on real user needs and empowering the disability community. Close collaboration with and involvement of end users would also contribute to raising knowledge and awareness in the ICT industry.

3) Support the training and certification of accessibility professionals that understand access needs and how multimodal solutions can address them.

Technology recommendations

1) Make sure products and services function for as many users as possible as stand alone, and then add personalisation options and individual settings.

2) Ensure that AI solutions supporting multimodality (either by changing the mode of presentation or adjusting the content along individual settings or characteristics using the same presentation mode) are accompanied with human quality assurance and support where accurate results are important or where there might be problems with bias, security and privacy.

Market recommendations

1) Industry to collaborate across value-chains to ensure that facilitators of multimodality, technical solutions and the alternative presentations provided work seamlessly for a better, more accessible user experience.

2) Industry to develop open APIs to provide common multimodal user interfaces, that each competitor can customise meanwhile keeping the same core functionalities and modes of operation – and that users can also personalise to their needs.

3) Industry to share knowledge in a collaborative way to support general innovation across the value chain. For example, by agreeing among content creators in broadcasting as well as TV manufacturers how improved captioning services could be provided to users.

4) Develop and promote industry standards on multimodality, creating a culture of catering for user choice instead of legal compliance.

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10. References

As the topic of digital multimedia covers a wide range of sectors and areas, desk research has included scientific, peer-reviewed research papers, academic journals, conference proceedings, grey literature and project websites.

Ability project (2023) Project website: www.ability-project.eu

Bezemer J, Jewitt C (2009) Social semiotics. In Handbook of pragmatics online. Vol 13(200) pp 1-14. https://doi.org/10.1075/hop.13.soc5

Bouchey, B., Castek, J., Thygeson, J. (2021). Multimodal Learning. In: Ryoo, J., Winkelmann, K. (eds) Innovative Learning Environments in STEM Higher Education. SpringerBriefs in Statistics. Springer, Cham. https://doi.org/10.1007/978-3-030-58948-6_3 https://doi.org/10.1007/978-3-030-58948-6_3

Iniesto F, Coughlan T, Lister K, Devine P, Freear N, Greenwood R, Holmes W, Kenny I, McLeod K, and Tudor R. 2023. Creating 'a Simple Conversation': Designing a Conversa- tional User Interface to Improve the Experience of Accessing Support for Study. ACM Trans. Access. Comput. 16, 1, Article 6 (March 2023), 28 pages. https://doi.org/10.1145/3568166

Jewitt C, Henriksen B.(2016) Social Semiotic Multimodality. A chapter in Klug N-M, Stöckl H (eds) Handbook of Language in Multimodal Contexts. De Gruyter, 2016.

Kress G (2009). Multimodality: A Social Semiotic Approach to Contemporary Communication. Routledge 2009.

Kuriakose B, Shrestha R, Sandnes FE. Multimodal Navigation Systems for Users with Visual Impairments—A Review and Analysis. Multimodal Technologies and Interaction. 2020; 4(4):73. https://doi.org/10.3390/mti4040073

Laenen K, Zoghbi S, and Moens M-F. 2018. Web Search of Fashion Items with Multimodal Querying. In Proceedings of the Eleventh ACM International Conference on Web Search and Data Mining (WSDM '18). Association for Computing Machinery, New York, NY, USA, 342–350. https://doi.org/10.1145/3159652.3159716

Martin D, Malpica S, Gutierrez D, Masia B, and Serrano A. 2022. Multimodality in VR:A Survey. ACM Comput. Surv. 54, 10s, Article 216 (September 2022), 36 pages. https://doi.org/10.1145/3508361

Realinho V, Baptista L, Dias R, Marmelo D, Páscoa P, Mourato, J. (2021). Multimodal Assistive Technology for the Support of Students with Multiple Disabilities. https://doi.org/10.1007/978-3-030-72657-7_45

Regimbal J, Blum JR, Cooperstock JR. 2022. IMAGE: a deployment framework for creating multimodal experiences of web graphics. In Proceedings of the 19th International Web for All Conference (W4A '22). Association for Computing Machinery, New York, NY, USA, Article 12, 1–5. https://doi.org/10.1145/3493612.3520460

UKRI. Presentation of research grant: "COG-MHEAR: towards cognitively-inspired 5G-IoT enabled multi-modal Hearing Aids". https://gtr.ukri.org/projects?ref=EP%2FT021063%2F1

Vorraa, T. (2007). Accessibility Analysis Of Multimodal Transport Systems Using Advanced GIS Techniques. In: WIT Transactions on The Built Environment, Vol 96, Urban Transport XIII: Urban Transport and the Environment in the 21st Century, 655-666. https://www.witpress.com/

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11. Project team DIGITALEUROPE

The project team involved on the ACCESSIBLEEU study on Multimodality features 2 experts on the topics of digital accessibility and a project coordinator. The team is enriched by the coordinator of the Working Group on eInclusion of DIGITALEUROPE, Martina Piazza.

The team

José Martinez Usero, PhD.

Role: Scientific revision

Jose is Interim Director of Research and Innovation Projects at DIGITALEUROPE. José has more than 15 years experience as project coordinator of EU projects and several major European Studies on the fields of eGovernment, eInclusion and AHA (Active and Healthy Ageing).

In his professional career, Jose has combined managerial work for ICT consultancies (ONCE Foundation ICT company and Funka) and teaching at several universities, such as, Leeds Metropolitan University, Carlos III University of Madrid, Complutense University of Madrid and Universidade Portucalense. He has also been the Academic Director of the UOC-ONCE Foundation Master on Accessible Technologies. For many years Jose has been participating as expert in ICT standardisation processes, such as the UNE Head of Interoperability Working Group, CEN CENELEC Project Team Leader in the context of Mandate 376.

Jose is a renowned speaker in international conferences and scientific events. He has written several books and a wide range of scientific articles in ICT related fields (some of them with impact factor).

José holds a Computer Science degree and a Master in Telecommunications, both degrees from Polytechnic University of Valencia. Moreover, he holds a PhD in Business Administration from Carlos III University of Madrid. In more recent times, he has also received training on Organisational Strategy by the London School of Economics.

Susanna Laurin

Role: Main researcher

Susanna Laurin is Senior Project Expert at DIGITALEUROPE mainly for the topics related to digital inclusion and ICT accessibility. She is also the Chair of the Funka Foundation, a practical Research and Innovation Centre of excellence focusing on end user involvement, disabilities, empowerment and accessibility. She has been a thought leader in the field of digitalisation, inclusion and e-government for more than 20 years and she is a frequent international lecturer and debater. Susanna is the Chair of the ETSI/CEN/CENELEC Joint Technical Body on eAccessibility, responsible for the development and update of the EN301549, to reflect presumed conformance of the Web Accessibility Directive and the upcoming European Accessibility Act. As one of the leading experts in EU policy and legislation on accessibility, Susanna is leading strategic assignments and research projects on EU level, nationally and across the world.

Recent assignments for the European Commission include the formal review of the Web Accessibility Directive and a study on cognitive accessibility. Susanna is a co-founder, Representative to the EU and Past Honorary Chair of IAAP, the International Association of Accessibility Professionals, as well as the Representative to the EU for the UN-initiative G3ict.

Eleonora Censorii

Role: Project coordinator

Eleonora is a Senior Project and Communications Manager with in-depth experience on projects in the fields of digital humanities, accessibility for cultural institutions, accessible travel and digital skills. She has collaborated with the University of Florence and the Italian Association of Ethnographic Museum Professionals on ethnographic research campaigns and projects focused on the digitalisation of audiovisual archives.

She has held trainings on Social Media marketing and has given a number of talks on the topics of accessibility in museum and cultural institutions, both aimed at heritage professionals in Italy.

Since 2018, she runs a company focused on accessible travel.

Since 2015 she has worked as communications and events manager for European associations; for DIGITALEUROPE she has been managing the communications and community building of the Digital Skills and Jobs platform of the European Commission.

Eleonora holds an MA in Cultural Anthropology from the University of Rome.

Martina Piazza

Role: Coordinator of the DIGITALEUROPE Working Group eInclusion

Martina is Policy Officer for the Digital Technology & Innovation team at DIGITALEUROPE. She is responsible for managing the Research & Innovation, Audiovisual and e-Inclusion working groups, as well as assisting overall with the DTI PG work.

Martina comes from INATBA, a trade association for blockchain applications, where she worked on many digital policy files. She previously did an internship at the Commission (CINEA, the climate executive agency), the German UnternehmerTUM and PubAffairs.

Martina holds a degree in European politics from KU Leuven, as well as in International relations at the university of Venice and a bachelor's degree in Linguistics.

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