Access Services
for digital television

Frans de Jong
EBU Project Group P/AS

The number of disabled people in the European Union is growing. Currently 10% of the population is estimated to have a disability [1], including a large number of people with sensory disabilities. By the year 2020, it is estimated that 25% of the inhabitants will be over 60 [2], with the largest increase in the 75+ age band, where disability is most prevalent.

This article outlines the choices available to broadcasters when starting access services over digital television platforms.

Public service broadcasters have a particular duty in providing services to the whole community – including minorities and those with sensory disabilities. Broadcasters seeking to provide these services face questions related to the technological choices for production and delivery, as well as to their costs.

"The EBU started the P/AS Group to help answer questions on access services' technology and costs"

To help answer these questions, the EBU established the P/AS Project Group in summer 2003. Its task: to study the deployment of access services in digital television broadcasting environments and to share the best practices.

The Group's final report is now available and includes many recommendations for the deployment of access services. This article provides a summary.

Access Services – which and for whom?

The most common access services are:

1) Subtitling;
2) Spoken subtitling;
3) Audio description;
4) Signing.

"The EBU regards access services as essence"

To those who rely on them, these services complement the programme vision and sound, and have comparable importance. Therefore access service components should be considered as ***essence*** (instead of as ***metadata***).

The provision of access services can be a tool to increase audience share and audience appreciation.

However, access services do not have a single audience. Requirements and preferences may differ widely between groups with different abilities and even within groups. For example: the preferred size of the subtitles varies amongst different interest groups. So it is important to investigate the audience's specific requirements. Be prepared to balance sometimes conflicting requirements.

Access services can be provided as either open services (provided to all) or as closed services (which can be turned on/off by the user). People who are not users, frequently dislike the use of open services, such as open signing. Digital technology offers opportunities to provide services in a closed fashion and prevent unfavourable scheduling of, for example, signed programmes.

Subtitling

Television subtitling has now been around for more than 25 years and is used by many millions of people around the world, either for the translation of the foreign spoken word or as same-language subtitling (our focus here).

Guidelines for good subtitling practice are well-established [3][4][5][6] and the technical implementations are relatively stable. With recent (digital) developments and growing market competition, this has changed and broadcasters now have a number of choices for the provision of subtitling services.

Authoring

There are two main technological advancements in subtitling authoring:

1) **The availability of speech-recognition**, not for automatic recognition of the programme sound, but to allow subtitlers to (re)speak the words to be subtitled. The use of controlled acoustic conditions takes away most of the problems caused by background noise. At the same time, the recognition constraints are eased, because the software can be trained for the subtitler using it, and specialised vocabularies can be selected to optimize recognition (e.g. a "sports - cricket" vocabulary).
2) **Networked authoring**. Using standard PCs and common IT-network technology, subtitles can be authored from diverse locations, including "from home", for example via an ISDN connection. Software allows the subtitler to choose the channel to work for, and enables seamless handover from one subtitler to another.

By combining both of the above, the "human costs" for authoring subtitles can be optimized and the training requirements lowered. For example: the training period for subtitlers can be brought down from 3 - 4 years for stenographers to a couple of months for "respeakers" [1].

File formats

The file formats used for subtitling authoring, exchange, playout and archiving differ per broadcaster and equipment manufacturer. The EBU Subtitling Data Exchange format [7] provides basic functionality and is typically used for Teletext-based subtitling. Extended functionality (colours, placement, etc.) have led to many proprietary formats although, in practice, devices typically can import/export most formats.

With the introduction of new file formats for authoring and exchange (AAF and MXF) and the introduction of new publication types (e.g. low bitrate Internet streaming), a number of new formats is being worked on *(see Table 1)*.

1. This is based on BBC experience, using a system for live-subtitling. The software was developed by BBC R&D, based around a commercial speech-recognition package.

Table 1
Overview of format initiatives relevant for subtitling

Organization	Target area	Comments
W3C Timed Text	authoring	Extensive format suitable for subtitling and various other purposes
SMPTE D27-SDE	exchange/distribution	XML representation for distribution in facilities
ProMPEG/SMPTE	exchange/distribution	generalised support for XML in MXF
AAF Forum	post-production	support for subtitling in AAF
SMPTE DC28	cinema	subtitling format for digital cinema

The scope of this work differs widely. Some work may also be useable for other access services (such as audio description). Project Group P/AS has welcomed the work of W3C and has input general requirements on access services to both the Pro-MPEG Forum [8] and the SMPTE [9].

"Subtitling support in new file formats – such as MXF – is being developed, but is not ready yet"

EBU Members have already started implementing MXF-based workflows, but there have been concerns about a lack of support for subtitling in the new file formats. This has led the EBU, AAF [10] and Pro-MPEG Forum [8] to help trigger a special initiative, bringing together parties (broadcasters & industry) who are interested in progressing the support for subtitling in AAF and MXF. A first meeting was held in August 2004 and showed promising consensus on the way forward. At the time of writing, the W3C Timed Text work is being evaluated for its suitability as a core data model.

Broadcast standard

Another format choice concerns the technical standard used for broadcasting the subtitles. In the DVB system, there are basically two standards for providing closed subtitling:

1) DVB Subtitling [11]
2) DVB Teletext [12]

"The EBU recommends DVB Subtitling for new installations"

The EBU recommends the use of DVB Subtitling for new installations [13]. This format allows broadcasters to determine the font (style & size), position and spacing – ensuring the same

Tackling the bitrate myth

Whilst at first sight DVB Subtitling might appear to require a higher delivery bitrate than Teletext subtitles in digital broadcasting, various factors make bitrate comparisons more favourable:

- Teletext implementations usually require a constant transmission of Teletext data on each service to keep analogue Teletext decoders working reliably (two VBI lines per picture, requiring a minimum of 37.6 kbit/s of DVB Teletext).
- DVB subtitles only require data transmission when there is something to send. BBC R&D measurements, over extended periods of transmission, demonstrate that for a 4-service DTT multiplex with subtitling on each service, the bitrate used in any one second for DVB subtitling never exceeds 100 kbit/s (i.e. an effective peak rate of 25 kbit/s per service). For a single service with prepared subtitles, the average subtitle bitrate over any 5 seconds has been shown to be less than 10 kbit/s.
- With DVB Subtitling, unused bitrate capacity can be redeployed using opportunistic multiplexing techniques, for example to enhance time-non-critical services such as EPG data, receiver software downloads, data carousels, etc.

legibility on all compliant receivers. Special characters, scripts and icons are also supported without any concern for receiver legacy issues, supported character sets, etc.

In principle, it may also be possible to use other methods for the delivery and presentation of subtitles (e.g. via MHEG, DVB-MHP applications or MPEG-4). However, their suitability for subtitling has yet to be demonstrated.

Spoken subtitling

In some countries where a substantial part of the programming is in a foreign language (e.g. 30%), synthetic speech is generated automatically from translation subtitles. This makes the material accessible for people who have difficulty reading the subtitles (e.g. visually impaired and dyslectics). This service is commonly called “Spoken subtitling” or “Audio subtitling”.

The potential audience in Sweden, for example, is estimated at 10% of the population (1 million people) while, in The Netherlands, about 5 - 10% of the population could benefit from such a service (0.8 - 1.6 million people).

Usability studies

In 2003, SVT conducted a usability study of the spoken subtitling system. Sixteen visually-impaired people, aged 22 to 85, volunteered to test the system. The primary goals were to examine how the group reacted to the synthetic speech, and to determine whether the spoken subtitling should be mixed with the programme sound at source, or if the users preferred to control the mixing themselves.

The study showed that people adapt to a synthetic voice fairly quickly. The most important elements for the majority of subjects were a uniform voice quality, a high degree of intelligibility and that the voice is as neutral as possible. The test subjects’ response to mixing was unanimous:

- They wanted to be able to mix the spoken subtitling and programme sound themselves;
- They wanted to be able to adjust the mixing for different situations.

The volume levels they selected were both personal and age-related. Viewers who spoke the original language wanted to hear the original dialogue and use the spoken subtitling only as an aid. For those who did not know the original language, the original dialogue was secondary; the important thing was to be able to hear the spoken subtitle.

Automatic and cost-efficient

The authoring of spoken subtitling is automatic, as it uses software to create synthetic speech from the available subtitles directly *(see Fig. 1)*.

Arguments for generating the speech at the broadcaster’s side instead of in the receiving equipment, include:

- Costs (licensing) are kept low for the consumer.
- Software updates are easier (single location, completely under broadcaster's control).

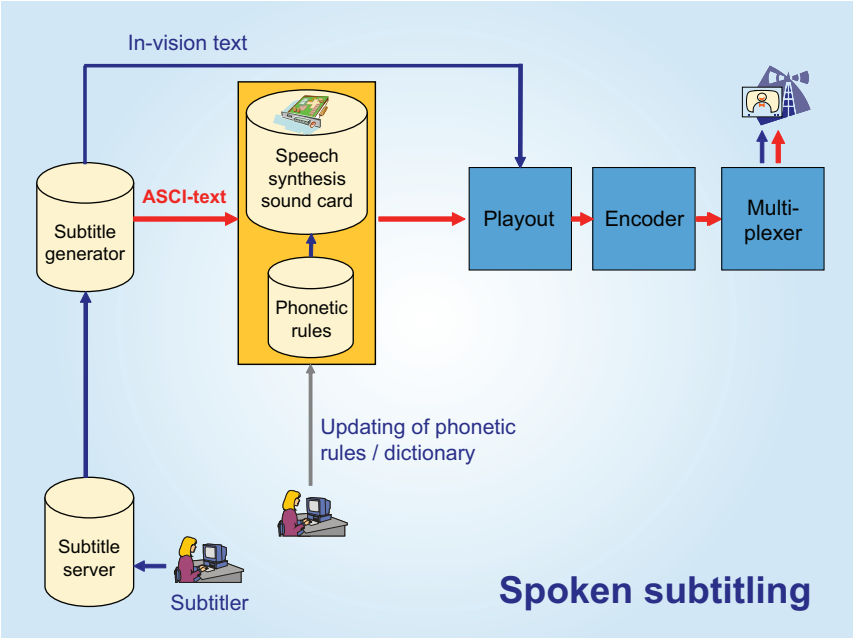

Figure 1
Sketch of the Spoken Subtitling generation process (SVT)

- Legacy problems are prevented (e.g. when more sophisticated synthesizers become available).

"Spoken subtitling is an automatic, cost-efficient service"

Delivery

The current spoken subtitling implementation in The Netherlands uses the traditional "analogue" Teletext service for delivery of the speech information as data in the VBI lines. These data are decoded by a special receiver at the consumer side.

For digital broadcasting, the use of DVB Teletext is expected to decline. Thus, spoken subtitling will have to be delivered as either:

1) An extra DVB audio channel (pre-mixed);
2) DVB receiver-mix audio.

The first is simply an extra audio channel, carrying the spoken subtitling mixed with the programme sound. The second is an audio channel, including fade and pan information, where the audio is mixed in the receiver. The receiver-mix audio option allows the user control over the resulting audio balance and image, and also is more bandwidth efficient (as it only carries the synthesized speech).

Where bitrate is at a premium and/or user control is important, the EBU recommends the use of receiver-mix audio description for digital spoken subtitling applications.

Burnt-in subtitles

The spoken subtitling application is currently limited to situations where subtitles are provided separately and not "burnt in" to the picture. It is expected that OCR (Optical Character Recognition) software should be able to allow automatic extraction of subtitling in these cases.

Also, with the arrival of file formats like MXF, the need for burnt-in subtitles in pre-production may ultimately disappear, resulting in the separation of video and subtitles as separate components, e.g. in a single file.

Audio description

People with visual impairments can still enjoy television, particularly when the visual elements are described for them, and communicated through an additional audio track using "audio description" (AD). Note that audio description is a much more elaborate service than spoken subtitling, which is limited to "reading the subtitles".

Laborious authoring

The authoring for audio description services is a laborious task, which can take up to 10 times the programme's duration. For this task the describer needs to be familiar with the video that he/she is describing, which requires a lot of preparatory work.

Using, for example, a computer workstation, the describer creates an audio track with the description, which is typically stored separately from the programme sound (e.g. on audio tracks 3 & 4), together with control information containing fade and pan parameters.

Delivery

Currently analogue audio description is provided in Germany, using a single channel of a stereo audio-pair, thus forcing the normal programme to be broadcast in mono. Since April 2001, RAI in Italy has broadcast audio description via AM radio to its audience.

For digital delivery, there are two options available, the same as for spoken subtitling:

1) an extra DVB audio channel (pre-mixed);
2) DVB receiver-mix audio.

The pre-mixed solution typically uses 192 - 256 kbit/s rather than the 64 kbit/s used for the mono description channel, to maintain the audio clarity of the programme sound. This makes it unpopular for use in DTT which has greater bandwidth limitations than DSAT. Also it may be traded against other services; for example, the capacity of multiple AD channels may instead be used to enhance or add a video channel.

So which to choose?

Although receiver-mix can be seen as the more elegant solution – as it allows the user control over the resulting audio pan and fade parameters, and also is more bandwidth efficient – current services commonly use the pre-mixed solution (e.g. the Sky DSAT platform). The main reason for this is the lack of receiver-mix capable set-top boxes [2].

As the addition of receiver-mix functionality can nowadays be a software-only task, cost differences between capable and non-capable boxes are becoming smaller or non-existent and the expectation is that more receiver-mix boxes will become available in the near future. All described services on UK DTT (Freeview) use receiver-mix AD.

"The EBU recommends receiver-mix audio description, when bitrate is at a premium and/or user control is important"

The EBU recommends the receiver-mix solution, where bitrate is at a premium and/or user control is important.

Signing

Sign language is a language in its own right and for people who were born deaf or who became deaf at a very early age, it typically is their first language. For this audience, subtitling cannot adequately convey the same depth of information. Signing offers a great involvement and understanding of television, particularly for news and information programmes.

Sign languages:

- differ between nations;
- may consist of many different dialects (as in Italy for example);
- are relatively "living", e.g. frequently are extended with new signs or sign combinations;
- differ much from written languages, making interpretation necessary (instead of translation).

Unsocial scheduling

Unlike subtitling and audio description, sign language on television is only comprehensible to the small proportion of the viewing audience who themselves can sign. In-vision signing is generally not

2. In the UK at the time of writing, only two consumer products were capable of receiving receiver-mix AD.

well received by people who are not deaf or who have no contact with deaf people. People dislike the idea of the picture being partly obscured or shrunk. Therefore signed programmes are often scheduled at unsocial hours.

Thus there is a strong need to provide deaf signing as a closed (elective) service component on digital TV channels. This would also obviate most of the re-versioning which current in-vision interpretation requires.

Current practice

The current production of signed programmes basically consists of creating a special version of the programme, in which the original picture is shrunk and the interpreter is added using chroma-keying. The delivery of this version then requires the same bandwidth as the original and, depending on the schedule constraints, can be done simultaneously via a second TV channel.

Development progress

The development of closed signing is ongoing. There are two basic approaches:

1) Coding the interpreter as an additional vision component + compositing in the receiver;
2) Capturing his/her movements and facial expressions to generate an avatar in the receiver.

"Closed signing development is promising, but not yet ready for deployment"

Figure 2
Avatar-signed programme (BBC R&D)

For the first option, the latest vision-coding techniques (such as MPEG-4) promise encoding rates of between 200 and 400 kbit/s per service. These rates may not be enough to solve constraints on the scheduling of signed programmes, as more than one service to be signed per multiplex (at any one time) seems unlikely.

For avatar signing, bitrates of 50 kbit/s have been reported. Such a bitrate could restore scheduling freedom in a multichannel world and provide the deaf-signing viewer with a substantially greater choice of programmes. One potential issue with avatars, which has seen great improvements recently, is a limited facial expressiveness.

The ability to deliver unconstrained sign language which is transparent to the user still needs to be tested for both of the above methods. Also both new methods require relatively powerful set-top boxes to generate the overlaid picture at the receiving side.

Other considerations

EPGs

With the spread of digital TV, EPGs are becoming more and more common. There is currently no standard on EPG design, which means the presentation of EPGs varies widely. For people with disabilities, the increasing use of graphics, combined with the lack of a common approach, is bad news.

A positive factor is that the information, in principle, should be easy to parse as, typically, it is sent as text instead of as video. This leads to the concept of the "talking EPG" [14], which basically would

Figure 2
Screenshots of two EPGs for the same morning, taken from two makes of UK DTT set-top boxes

require a text-to-speech converter (synthesizer) at the user's end, plus an agreed data format from the broadcaster. This requires active involvement from both the broadcasters and the CE manufacturers and is an area where work such as that developed in TV-Anytime may proove very relevant [15].

"New services are not automatically an improvement. Broadcasters and CE manufacturers have a joint responsibility in making them successful"

Digital text services

There are specialist consumer products available which take the textual data from traditional Teletext magazine information services and generate synthesized audio for visually-impaired users.

Digital television offers new opportunities for delivering such information services, but often through new more creative and flexible technologies (e.g. OpenTV, MHEG-5 and MHP) rather than Teletext.

EXAMPLE: Teletext readers stop working

In the UK, the switch from Teletext to a more powerful data service based on DTV, together with the Teletext reader devices not being updated, led to complaints from the audience who suddenly experienced their system stop working. Although the solution (adapting the Teletext reader) was technically relatively trivial, without the involvement of the CE party this was not possible. For the end-user, the switch to a more powerful service was thus experienced as a negative event!

In principle, new commercial products can be designed to perform, with digital text, a similar function to the Teletext "readers". The major challenge will be for the designers of new text services to ensure that the navigational structure for any new digital text service (which is now typically menu-driven rather than accessible by page number) will not preclude easy and user-friendly access to information of specific interest to the visually-impaired user [3].

New display resolutions

Services delivered to display devices with different display resolutions are under development within Europe (DVB-H, HDTV), but it is not clear what capabilities for access services these will have. For

3. A simple example of related functionality is audible information when switching channels, including the name of the programme switched to.

example, it may be difficult to read subtitles on low-resolution portable displays; similarly, the current DVB Subtitling spec. does not yet directly support HD display image sizes. Steps will need to be taken by the EBU and its Members to ensure that accessibility is considered early in the development of these new services or platforms.

Figure 4
Current screen formats and especially "smart" user settings already lead broadcasters to be creative with their subtitle positioning (SVT)

Service monitoring

For viewers or listeners – who rely on any of the access services described above – to understand and enjoy a television programme, reliable delivery to the home receiver is particularly important. Any unexpected absence of an access service therefore significantly reduces the enjoyment of the viewer/listener, leading to dissatisfaction and to complaints to the broadcaster or service provider [4].

Frequently the relevant access service is provided only for a small proportion of programmes, in which case a failure affecting only one programme has an even greater impact. If the intended proportion represents a regulatory quota, then that one failure can cause considerable embarrassment to the broadcaster / service provider. When there are regulatory requirements to carry an access service, the regulator may also require the broadcaster / service provider to take steps to reduce the incidence of delivery failure.

Responding to customer and/or to regulatory complaints [5] is an expensive and non-productive overhead. Executive monitoring of access services – particularly where it leads to prompt action to rectify a fault – is therefore a better long-term investment. As a useful by-product, reliable monitoring could also provide statistics on the volume of access services delivered.

Unfortunately, whilst techniques exist to automatically identify significant faults in the programme vision and sound elements of a digital television signal (e.g. detect a frozen frame or silence), little effort has yet been invested in monitoring access service components. The problem is compounded by the increase in the number of services that digital television platforms can deliver. Operational monitoring areas now frequently have to deal with all the services in several multiplexes and it is not practicable to expect these areas to constantly monitor subtitles, spoken subtitling, audio description and signing.

To date there are few commercial products available which allow, for example, monitoring of DVB subtitles. Some experimental work is underway and there appears to be some merit in using inferential rather than explicit techniques. For example useful metrics can be inferred from the bitrate usage of DVB subtitles (successfully distinguishing between no subtitles, apology pages, live and prepared subtitles) [16]. It seems likely that such an inferential approach will provide monitoring information that is as helpful as when using more elaborate and/or explicit techniques.

4. Such an absence might be caused by a failure to meet a deadline to deliver (e.g. the master tape arrives too close to the transmission time to allow subtitles to be authored) or by equipment failure in the broadcast signal distribution infrastructure.
5. Members remarked that for the audience, broadcasters are the "obvious" point to contact in case of problems with using access services, even if the problems are caused by e.g. incompatible set-top boxes.

A cost-effective means of "unattended" executive monitoring of each type of access service is urgently required and the EBU should try to find ways of sharing knowledge in this field and stimulating the commercial development of suitable techniques.

"Automatic access-service monitoring is important, but often not implemented. The EBU may help to stimulate its development"

Closing remarks

We have outlined the choices that broadcasters encounter when starting access services over digital television platforms. The P/AS Group found that questions on this topic varied considerably:

- from relatively easy to answer – which subtitling standard?
- via the contentious – which audio description method should we use?
- to "wait for the moment, no solution now" – closed signing.

One reason why access services are not an easy topic is that it involves the whole end-to-end chain, from broadcaster to CE equipment manufacturer. There is no point in providing services which cannot be received, while new technology in receivers makes no sense when no services are provided.

From the consumer perspective however, it mostly is the broadcaster who is seen as the one responsible for the service's functioning. This is where adequate service monitoring is of extra importance.

There is much more to say on access services, especially on social influences and, of course, on costs. Technological developments, such as new publication media (DVDs with audio description), file-based production (which facilitates author once, publish many times) and more efficient coding techniques (e.g. for closed signing) can offer cost benefits to broadcasters and help increase the amount of access services provided.

However, it is almost paradoxical that the same technological developments pose a risk of divergence (for example in presentation styles and user control of functionality), making it harder for both abled and disabled consumers to access these services. The P/AS report therefore also touches on "accessibility of access services".

But for that ... you'll have to read the report itself. We at least hope to have whetted your appetite.

"Read the full report! [17]"

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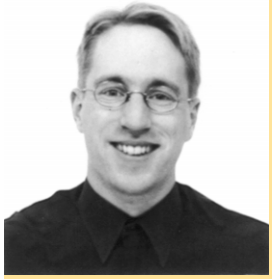

Frans de Jong was born in The Netherlands in 1974. He studied Electrical Engineering at Delft University of Technology, specialising in Information Theory, and his thesis was on "keyframe extraction for video-indexing". During and after his study period, he worked as a video editor and was involved in developing a Newsroom system for TV broadcasters. After that he moved to NOB (Dutch Cross Media Facilities) as a systems architect, working in various projects including the European myTV and Share it! projects. He also contributed substantially to the phase 1 work of TV Anytime, especially focussing on the Metadata Group's segmentation specification. Before coming to the EBU, he worked as a consultant for NOB on, amongst others, the "Digital Facility" project – which is creating a file-based environment for the contribution, playout and archiving of all three Dutch Public TV channels.

Currently Mr De Jong works as a senior engineer in the EBU Technical Department. He is the secretary of the P/AS (Access Services) and P/MDP (Middleware) Project Groups. He also is project leader for the EBU MARS Project (Metadata Administration and Registration Services).

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Terminology

Access service	A service provided with broadcasts, to improve accessibility by people with disabilities.
AD	Audio Description
Audio description	Provision of recorded speech, describing what is visible in the video
Audio subtitling	Other name for 'spoken subtitling'
Authoring	The process of creating a programme or service, for example: typing in the subtitles
Avatar	Virtual human figure
BSL	British Sign Language
CE	Consumer Electronics
Closed service	The access service is available to the audience, with the option to turn it on or off
Delivery	The process of publishing and transporting the programme/service to the audience example: broadcasting the subtitles in the DVB Subtitling format
DSAT	Digital Satellite Broadcasting
DTT	Digital Terrestrial Television, broadcasting method using earth-based transmitters
EPG	Electronic Programme Guide
Elective service	See closed service
Exchange/distribution	The process of moving the created programme/service within or between broadcast parties. Example: moving a signed programme on a videocassette to the play-out centre
Hard of hearing	People with a hearing disability, who are not deaf however
Hearing impaired	All people with a hearing disability, including deaf persons
HH	Hard of Hearing
IDTV	Interactive Digital TV, basically a 'television with built-in set-top box'
IPR	Intellectual Property Rights
Monitoring	Verifying that the correct access service data is broadcast with the correct programme
Must carry	Legislation requiring distributors to carry broadcast programmes and related services
OCR	Optical Character Recognition
Open service	The access service is presented to the whole audience, it can not be turned off
PMC	Project Management Committee (EBU)
Presentation	The process of presenting the programme/service to the audience Example: a decoder box makes the audio description of a programme audible
Same-language subtitles	Subtitles providing a summary of the (spoken) audio (may include short audio descriptions)
Set-top box	Decoder used for the reception of digital TV transmissions and the presentation of those on a television, can contain many additional features (EPG, data services, hard-disk, etc.)
Signing	Provision of a sign language presentation of the spoken audio of the programme
Spoken subtitling	Provision of synthesized speech, based on standard subtitles. Also called “audio subtitling”.
Subtitling	Provision of overlaid text summarizing the (spoken) audio of the programme
Translation subtitles	Subtitles providing a translated summary of the spoken programme sound
VBI	Vertical Blanking Interval, part of the picture which is normally invisible to the viewer, but can be used to transport data, such as subtitles and programme IDs.
Visually impaired	All people with a vision disability, including blind persons

Recommendations from the report

General

- Access service components shall be considered as essence
- Consider access services as an opportunity
- Listen carefully to your audience
- Consider including access services as part of the programme budget
- Prioritise service provisioning
- Trade carefully between quality and quantity
- Lobby for mandatory 'must carry' regulation
- Discuss with interest groups how to improve awareness
- Provide consistent access service identification
- Make access services part of your archiving strategy
- EBU to watch over and contribute to new file formats
- EBU should investigate access services monitoring
- Ask manufacturers for PDRs which record access services
- Access services should be available under a single button
- Learn about any IPR issues with your services

Subtitling

- Consider the need for thorough editing of subtitles
- Methods for improving readability of subtitles
- Think about the user interface
- Share understanding of graphic safe areas
- Watch and contribute to new subtitle (file) formats
- Use DVB Subtitling for new digital services
- Learn from EBU Member colleagues
- Repurpose subtitling for DVD publications
- Reducing costs in subtitling production planning and logistics
- Reducing costs in subtitling authoring
- Reducing costs in subtitle distribution and play-out
- Consider using speech recognition to save costs
- Exchange subtitles as a separate component rather than burnt into the programme video
- EBU to investigate setting up a subtitling database
- Skills to look for in subtitlers
- Offer your subtitlers variety
- Provide a separate area for broadcasting work
- Consider having your subtitlers work from home
- Make sure subtitlers have early access to programme material

Spoken subtitling

- Study the possibility of identifying different speakers
- Investigate the use of OCR for spoken subtitling
- Involve commercial broadcasters
- Study the transition path for analogue spoken subtitling
- Use of Receiver-mix AD
- Choose open standards
- Creative licensing

Audio description

- Produce Audio Description during production
- Use of Receiver-mix AD
- Repurpose AD for DVD publications

Signing

- Share understanding of graphic safe areas
- Understand the cultural background of signing
- Follow the developments BUT keep an open mind on delivery
- Stimulate development of signing delivery mechanisms

Other services

- Access services should be included early in services development