improving public transport through technology

On Bus Audio Visual Equipment

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This document is Published.

If there are any comments or feedback arising from the review or use of this document, please contact us at secretariat@rtig.org.uk

1 Introduction

1.1 About this document

1.1.1 This document has been produced for the Real Time Information Group (RTIG). It provides advice and guidance on the customer information requirement, different types of displays and audio equipment, installation and maintenance of on bus audio visual equipment to assist operators in identifying the right solution for their operation and how it needs to be managed and maintained

1.2 Background and context

1.2.1 In 2017, through the Bus Services Act, the government introduced powers to require the provision of audible and visible information on local bus services throughout Great Britain.

1.2.2 When enacted, this will require bus operators to equip their vehicles with display screens to provide next stop information and audio systems to announce the information - using both speakers and induction loops.

1.2.3 Outside London, few buses currently have audio or visual information available. This means that passengers who are unfamiliar with the route, are hard of hearing or visually impaired, are at a loss to know when to get off the bus; and the 2017 Act seeks to address this disparity.

1.2.4 In 2019, the Department for Transport (DfT) launched the 'it's everyone's journey'[1] campaign to highlight the part everyone can play in improving disabled people's experiences when using public transport.

1.2.5 As part of this campaign, the DfT announced a partnership with RTIG to help make buses more accessible for disabled passengers: through a grant to provide funding to small bus operators to fit technology to provide audible and visible on-board information.

Figure 1 DfT It's everyone's journey logo

[1] https://everyonesjourney.campaign.gov.uk

1.2.6 There are existing standards and guidance available for on-street displays that range from physical design through to information formatting guidance. There is, however, little information available from RTIG or other bodies for on-vehicle displays and audio information.

1.3 Scope

1.3.1 This report has no statutory or other legal basis and is purely to provide advice to suppliers, authorities and bus operators who supply or use on-bus audio visual information systems.

1.4 Limitations and The Future

1.4.1 This report reflects the available technology and those practices which have been found to be effective at the date of publication. However, technology and its applications are evolving and it is therefore probable that new technologies, new developments of existing technologies, and new ways to adopt them on buses will evolve, perhaps more rapidly - given that there is now impetus for on bus information systems to be adopted.

1.4.2 RTIG understands that technologies and practices which are not on the market at the time of writing this document will evolve and that such developments should not be excluded from consideration.

1.4.3 Operators and authorities are encouraged to consider new approaches - bearing in mind the general principles promoted in this document

1.5 Acknowledgements

1.5.1 RTIG is grateful to the members of its Working Group for contributing to the construction and validation of this document - in particular: Aesys, Go-Ahead, Journeo, Nexus Alpha, r2p, React Accessibility, Transport for London and VIX.

2 On Bus Information Context

2.1.1 As a public service, buses need to serve the community on a fully inclusive basis. Many improvements in bus services have been made to help people with physical disabilities: low-floor and 'kneeling' buses, buses and bus stops with space for wheelchairs, etc. But it is equally important to ensure that people with invisible disabilities can readily access public transport. This includes those with learning and language difficulties, non-obvious physical disabilities, such as deafness; and mental health issues. The need to deliver this is not merely a matter of good practice, it is a statutory requirement under the Equality Act 2010. Furthermore, these service enhancements will benefit all users - making mobility easier for everyone.

2.1.2 More than 1 in 5 potential UK consumers have a disability - a significant proportion of the potential market for public transport. As the disabled are more likely to not have access to private vehicles, for them , inaccessible buses, poor customer service and a lack of information can make life especially difficult. If you can't be sure you can get around, it's much harder to get to work, meet friends, and live your life independently.

2.1.3 In 2019, two-thirds of disabled people experienced problems travelling[2]. The 'Purple Pound' (the spending power of disabled families) is a significant amount of money, and it has been estimated that public transport providers lose over £400m annually by not catering for their needs. Therefore, ensuring that the accessibility needs of customers are met makes sound business sense as well as being a legal requirement.

2.1.4 An important aspect of providing an accessible journey is to ensure that the information provided is readily available and usable for as many different people as possible.

2.1.5 Improvements in on-bus information reduce the anxiety of all customers - particularly those who are making non-regular journeys - thereby increasing the likelihood of them making journeys on public transport that would otherwise be carried out in private vehicles.

2.1.6 According to Guide Dogs research[3], this lack of accessible transport has led to nearly a third (32%) of people who are blind or partially sighted missing their stop because they were too worried to ask for help. 28% missed a stop because the driver refused to tell them their stop; and 59% of blind and partially

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[2] https://www.scope.org.uk/about-us/impact-report/living-the-life-i-choose/

[3] Guide Dogs, Destination Unknown, 2014

sighted passengers stated that travelling by bus makes visiting places very difficult.

2.1.7 The provision of audio-visual announcements will not only increase the confidence of people who are blind or partially sighted, but will also improve the experience of bus travel for all passengers, including elderly people, people with hearing impairments and learning disabilities; as well as visitors and tourists who are not familiar with the area.

2.1.8 Transport Focus[4] regularly survey passengers to understand their priorities. In their September 2020[5] report on bus passengers' priorities for improvement, they identified a hierarchy of passenger priorities which is set out in the diagram below:

Figure 2 A hierarchy of passenger priorities.

2.1.9 Priority number 14 was 'being told of delays when on board' and 21 was 'More audio-visual announcements of which stop is next.'

2.1.10 Research by OECD International Transport Forum in Norway monetised the customer's value of different improvements to public transport. On-board information with audible and visual information was allocated a value of £0.36 per journey. Other locations have carried out similar work and produced a range of values, the Norwegian example being relatively high, in all instances

[4] https://www.transportfocus.org.uk/

[5] https://www.transportfocus.org.uk/research-publications/publications/bus-passengers-priorities-for-improvement-2/

though the monetised benefit values have contributed to strong cost-benefit outcomes for AV systems.

2.1.11 Research by Transport for London (TfL) in 2019 identified that:

> *Customers experience more pain points at bus stops and/or on the bus than at other parts of their journey*
>
> *There is no way of knowing where you are on an unfamiliar route so you have to listen carefully to the stop announcements*

2.1.12 It is vital that once new audio-visual equipment has been installed, information should be disseminated to raise awareness of the improvements. This should be targeted not just at people already travelling, but also at those who have been put off from travelling by perceived difficulties in accessing services.

2.1.13 The Inclusive Transport Strategy[6] published by the DfT in 2018 includes:

> *'Legislation to ensure the provision of on-board audible and visible upcoming stop and route information is installed on local bus services across Great Britain. We will also provide £2 million of new funding to help bus operators install the necessary equipment more quickly.'*

2.1.14 The Zero Emission Bus Regional Areas scheme – 2021/22 includes a requirement that all buses funded through the scheme:

> *'Incorporate equipment to identify the route, each upcoming stop, and the beginning and end of diversions:*
>
> - *visibly, using at least one screen on any deck, with the lower deck screen visible from all priority seats;*
> - *audibly, with announcements audible on any deck, including in the priority seats and wheelchair space;*
> - *using induction loops, in priority seats and the wheelchair space; and*
> - *providing an induction loop to aid direct communication between drivers and passengers who use a hearing aid.'*

6 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/728547/inclusive-transport-strate.g.y.pdf

2.1.15 Advice on the installation and use of induction loops is provided in a separate topic-specific document.

3 Passenger Information

3.1 Information Priorities

3.1.1 Customers want to know when their bus is arriving and what is happening on route; and this where on-bus information comes into its own.

3.1.2 Customers want information that makes them feel in control of their journey and shows them that the bus operator cares about its customers' travel experience.

3.1.3 Information needs to be easily understood when provided audibly and visually; and it is important that the audio and visual information is as consistent as possible.

3.1.4 There is a multitude of different types of information that can be provided on a display and that is one of their advantages. Such flexibility, however, provides a challenge in choosing what information should be provided?

3.1.5 For many customers, public transport journeys are a low cognitive experience because of the routine involved. However, when something goes wrong or changes then their interest is aroused, and customers need different information. In these circumstances the information provided needs to adapt to meet the new situation.

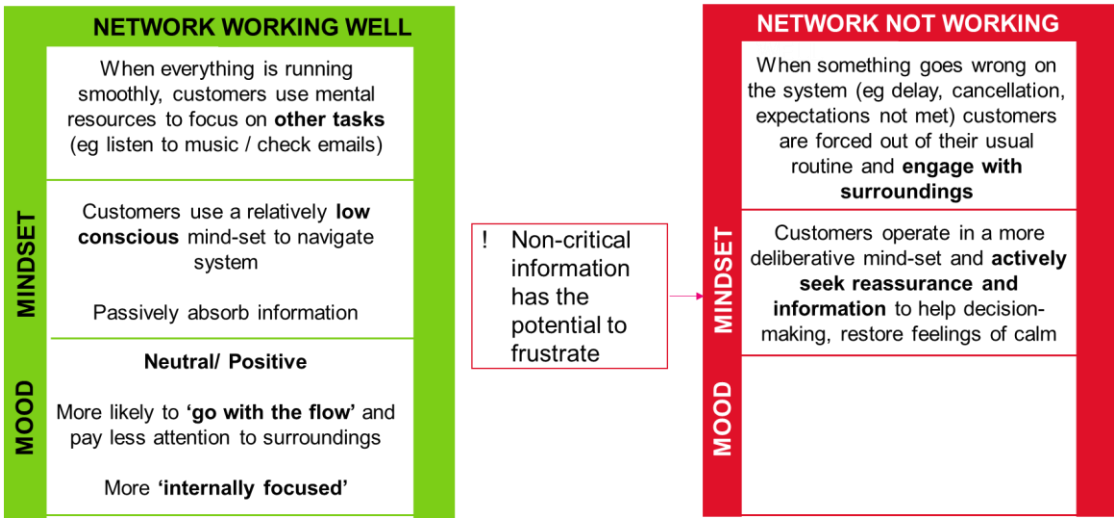


Figure 3 TDM Rail Hierarchy of Information needs 2017

3.1.6 Research by TfL explored passengers' attitudes to the different types of information provided on-bus and at stop: to help inform customer decision-making and put them at ease about onward travel. This research has been

used in part: to describe these attitudes into a hierarchy of information for use on on-bus displays:

INFORMATION TYPE	TOLERANCE	VALUE	RISK
Diversions	High priority and valued	Customers want information that makes them feel in control of their journey and shows them that the operator cares about its customers' travel experience	During service disruptions when customers have high priority information needs there is a risk of frustration and negative customer experience if messages are not clear or "drowned out" by lower priority information
Delays			
Journey Planning			
Safety and Security	Low priority but tolerated	Customer tolerance levels for low priority messages can quickly be shaken in the event of more pressing information needs e.g., service not working well.	There is a risk that low priority messages become rejected and cause for frustration if they are seen to be given precedence over high priority messages
General Messaging			
Sustainable Travel Messaging		Environmental and financial benefit show an operator cares but prioritisation compared to other messaging needs consideration.	
Commercial Advertising	Low tolerance	The lowest tolerance and the number and frequency of messages needs careful management or the use of a dedicated screen.	Inclusion of commercial advertising when there is a need to present higher priority messages risks customers feeling their journey is not important and that money is the most important factor for operators.

3.1.7 The information being presented on displays and announced, needs to consider the customers tolerance for the type of information; and the current operational status of the vehicle and overall transport network.

3.1.8 An example of route specific priority for messaging would be a message about bag security e.g. please do not leave bags unattended at any time. For normal routes this may be a low priority message but it may assume a higher priority on a route that passes an airport.

3.1.9 On-bus delay messages also help customers to stay informed and up to date and are high priority for all passengers (frequent and infrequent). The most important function of delay messages is to enable passengers to decide whether their journey is going to be impacted to the extent that they need to take alternative action, such as taking another route or mode and this particularly applies to diversions, but also to severe delays. A key information need is live journey time information – how long it will take to get from A to B, including any delays.

e.g. Routes 63, 13 and 113 are experiencing severe delays. Journey times may be higher between Finchley Road Station and Golders Green

3.1.10 Safety messages are expected to be more of an infrequent 'nudge' or reminder so their delivery needs to be subtle, timely and not overbearing. They are often best triggered by the driver.

e.g. Please hold the handrail when the bus is moving

3.1.11 Safety messages have the potential to become 'annoying' if played or seen too often – e.g. a campaign in London to announce *'this bus is about to move'* is recalled for being more frustrating than useful.

3.1.12 Customer tolerance levels for low priority messages can quickly be shaken in the event of the absence of messages addressing more pressing information needs e.g. service not working well. Overall, however, there does need to be a balance between the different types of information broadcast – with journey specific messaging taking priority and general messaging used sparingly.

3.2 Presentation of Information

3.2.1 When selecting a technology to be used – and particularly if solutions such as Thin-Film Transistor(TFT) displays are being considered, attention needs to be paid to the formatting and design to be applied on the screen to ensure that:

- fonts are clear and readable;
- font size is appropriate for the size of screen and anticipated viewing distance;
- high-contrast colour schemes are used;
- colour is only used sparingly and not as the only source of information - considering issues such as colour blindness;
- consistent terminology, fonts and colours are used;
- branding is consistent across all media; and
- guidelines on accessibility have been considered.

3.2.2 Section 3 of the RTIG document*: RTIGPR003-D002-1.10: Inclusive passenger information* includes some useful advice on the font size for displays:

- use a minimum character height of 22mm for all critical information such as next stop, final destination, disruption information and emergency information; and
- ensure that character height is at least 1% of the distance at which the message will usually be read.

3.2.3 The RTIG document: *RTIGT036-0.1 'Additional information on RTI signs'* offers advice on the provision of additional and related information - beyond the core requirements, for a typical real time departures display, which can also be applied to on-bus displays.

3.2.4 The German Association of German Transport Companies (Verband Deutscher Verkehrsunternehmen or VDV) also have advice on formatting and content of on-vehicle displays as part of their VDV 435 standard.

3.3 Standardised Language

3.3.1 It is important that the terminology and language used is consistent with other information the customer may have seen/heard or is likely to see or hear.

3.3.2 The RTIG document: *RTIGT035-1.0 'Language and terminology in Real Time Information systems'* prescribes advice for on-bus information.

3.4 Accessibility of Information

3.4.1 RTIG has produced advice on the accessibility requirements and best practice for electronic information which is contained in the document: *RTIGPR003-D002-1.10 Inclusive passenger information - A guide to good practice*. This was originally produced in 2005 and has undergone four revisions - with the latest version being released in 2018. The guide was developed through an RTIG working group similar to that which has produced this document, with assistance and support from Guide Dogs for the Blind. Although the guidance was developed with a focus on static on-street displays, much of it is nonetheless relevant and appropriate for on-bus displays.

3.4.2 When choosing the colour and border for signs, it is important to take into account the materials behind the sign to ensure adequate contrast. Whilst targeted at websites, the Web Content Accessibility Guidelines (WCAG) are valid in many other situations such as content on displays, mobile apps etc.; and their application across all channels helps with consistency of brand and message - whilst ensuring the accessibility of information.

3.4.3 In addition to audio and visual announcements, which are the central focus of this report, consideration should be given to all accessibility requirements. For example, Lothian Buses Airlink vehicles have next stop audio-visual announcements which are supported by British Sign language on an additional display.

Figure 4 BSL on Lothain Airlink (c) @MsEYates

3.5 Disruption Information

3.5.1 Providing up-to-date incident information is important for customers. There is an expectation that if information is displayed electronically then it is ‘live’. This presents a problem if the information is displayed using an automatic playlist without the facility for either the driver or control room to intervene and override it.

3.5.2 Customers do not spontaneously distinguish between different types of audio messages i.e. between driver-initiated and automatic; and some assume that the driver is in control of all on-bus audio messages.

3.5.3 At the simplest level, the driver can turn the automated display and audio off and make audio only announcements through the on-vehicle PA system. At the more complex level, the content of the display and announcements can be overridden by a control centre. Many value voice announcements for a more human touch and the implication that it is relevant, up-to-date information.

3.5.4 When travelling, customers need accurate, up-to-date information relevant to their journey - all else is secondary but tolerated. Tolerance levels can, however, quickly change in the event of disruption when nerves can be come frayed, information needs are heightened, and general information such as safety messaging is less tolerated than journey specific information. In these situations, tolerance quickly falls away if no information is given about the disruption, whilst general messages continue. This can cause instant animosity towards these general messages

3.5.5 How up-to-date disruption information, which ensures consistency with other channels is provided, will be a key decision for the on-bus architecture. Some operators use Twitter to provide the disruptions feed to their website, apps, and on-bus.

3.5.6 For a customer on-vehicle, a warning of a temporary change such as a stop closure ahead, as well as of diversions, are high priority and must be made in a timely manner, as the time available to make decisions on the impact on their journey is reduced compared to when on-street.

3.5.7 Whilst not technically disruptions, from a customer perspective, information about non-standard route sections need as much priority as disruptions to ensure their awareness at the appropriate time: for example , advance notice on the approach to hail and ride, or express sections,

3.5.8 One requirement of the Bus Service Act 2017 is that audio-visual systems will be required to provide information on diversions. At the simplest level, messages such as: *'this bus is being diverted'*, *'this bus is on a diversion'* and *'this bus is now back on its normal route,'* will be expected to be provided.

3.5.9 Provision of information for unplanned diversions is challenging where, as a minimum, off-route detection should remove normal route information. In future it is possible to see how systems could develop to share diversion information so later buses use the information about the originally unplanned diversion. In the early stages of disruption, it may be difficult to do much except indicate that the bus is not going where it would normally.

3.5.10 It is recommended that a policy is formulated for the creation and distribution of disruption information that covers all channels, not just on-vehicle - to ensure consistency over time.

3.6 Marketing, Promotion and Advertising

3.6.1 As it is becoming increasingly possible to provide displays capable of showing mixed content, there is increased interest in revenue generation from advertising. Indeed, once graphic capable displays (TFTs etc.) are fitted on vehicles, the marketing team is likely to want space for their content. This takes careful management and not all examples are good. It is often better to have a second display for marketing, or to use half of a stretch screen dedicated to it, to protect the primary customer information.

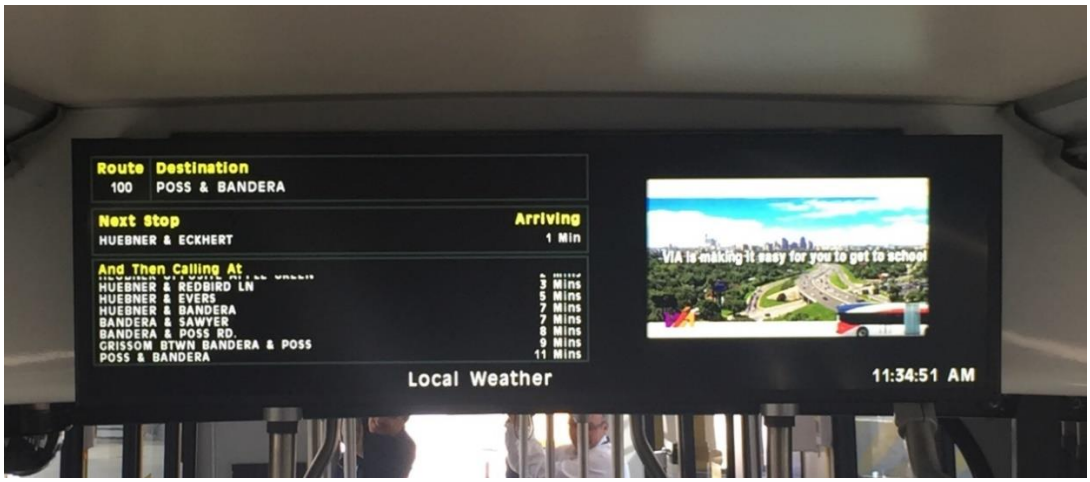


Figure 5 Nexus Alpha stretch display in San Antonio, Texas, USA with information and promotion panels.

3.6.2 Information on future planned events has the potential to be very important but only if it directly impacts on customers' future journeys. For example, messages that relay information crucial to a particular route or journey such as route alterations or upcoming diversions, are important to convey.

E.g. Additional Monday to Friday late evening journeys on route 2 starting Saturday 1 March. Go to website for more information

3.6.3 However, messages that are more 'general' and not specific to customers' journeys are not high priority but are nonetheless important for sustainability.

E.g. New monthly tickets available.

3.6.4 Information regarding proposed or potential changes to bus routes might feel important, but there is a question as to whether on-bus audio is the best way to communicate this information, if used it should only be done so sparingly.

E.g. Public consultation has started on proposed changes to routes in 'location'. Go to website for more information

3.6.5 Pure commercial advertising has little or no relevance to customers' journeys – and is therefore often seen as unnecessary information. We know that there is a very low tolerance for information that is not directly relevant to their journeys; and so if customers are seeing advertising on a display, there is a risk that (due to the information being of little use), they will stop taking notice and therefore miss more important journey-related messages.

'If I saw advertising all over a display then I guess you would stop looking at it and miss important journey information'

3.6.6 Nevertheless, the inclusion of advertising may be important to the overall business case for the investment in on-bus audio visual information; and so in some cases there will have to be a degree of prioritisation within the information hierarchy.

3.6.7 When using displays for material other than that required for their primary purpose, any additional information:

- should not replace the transport data at any stage; and
- should not detract from the primary purpose of the display, whether by being too distracting or by occupying such a large area that it overly reduces the space available for the transport data.

Figure 6 TfT display on a Reading Buses vehicle in the cove card area with advert and next stop information (c) r2p

3.6.8 We recommend that organisations create a policy that outlines the specific hierarchy of customers' needs that are applicable to the operator, area or route, which can then be used to control expectations of how non-journey specific messaging or advertising will be applied.

4 System Architectures

4.1 Business Requirements

4.1.1 The overall system architecture that is appropriate for any operator or vehicle will be dependent on a range of factors that dictate the overall required outcomes including:

- proposed use cases – current and future;
- budget;
- operator resources; and
- business case.

4.1.2 Once the specific factors are understood, it is then possible to identify the most appropriate architecture and technical solutions to achieve the desired outcomes. Some key questions to address when making architectural decisions are set out in 4.2 below.

4.2 Architecture

4.2.1 An on-bus audio visual display(s) solution can't operate in isolation and must have interoperability within its self-contained hardware/software platform and between interdependent solutions. i.e.

- The display hardware must be deployed with compatible software for driving it and shouldn't be selected in isolation, without consideration of the suppliers involved.
- The software must be interoperable: with required incoming data and where appropriate, outgoing data/information requirements and standards.

4.2.2 The level of required interoperability will be dependent upon the scope and scale of deployment; and the required integration with current and future system capabilities and evolving best practice. i.e

- The counting system could be a complete slave to a comprehensive solution providing incoming data/information feeds (that might be on or off the vehicle). For instance, connected to an Electronic Ticket Machine on the vehicle or connected to an off vehicle intelligent server solution.

- The on-bus solution may require some external data but self-generate other parts of the data needed. For instance, it may take NaPTAN and TXC from an external solution but use its own GPS to provide the location to present information on the displays.

4.2.3 Each approach or balance between, will have its advantages and disadvantages across cost, quality of information presented to the public, features and performance, maintenance, redundancy and future proofing.

4.2.4 The on-bus solution (hardware/software) should be selected based upon the purchasing organisation's existing equipment capabilities and future strategy. These may not, however, be totally under the control of the purchasing organisation for a range of reasons including commercial, legislation, standards etc..

4.2.5 Ideally, the expectation should be that a purchasing organisation would have one solution across vehicle types (both old and new) and therefore consideration should be given to the requirements for different vehicle types and ages.

4.2.6 To summarise: the architecture for an on-bus display(s) solution will require inputs from external solutions (NaPTAN, Timetable, Disruptions and other content) which may be fulfilled from other on-vehicle solutions (ETM etc), with the actual audio/visual display(s) having no direct connection off vehicle; or it might be fulfilled in part by its self (i.e GPS for tracking and timings of content presentation) or totally off-vehicle: through a data connection to a central server solution or any mixture in between.

4.2.7 As with any design, pros and cons will exist for each individual architecture - with a blended approach offering enhanced performance and resilience. For example, having the GPS tracking intelligence on-vehicle has a coverage/performance advantage when compared to being dependent upon an incoming communication from an off-vehicle external server to drive the audio/display off-vehicle: where data transmission might be poor due to the network.

4.2.8 An on-bus audio visual display(s) solution can be dependent upon existing on-vehicle solutions (providing a level of cost efficiency by not duplicating functions); or self-contained within the vehicle with an external data/information connection, which whilst possibly duplicating functions, could potentially replace an existing legacy solution or simply provide redundancy)

4.3 Key Questions

4.3.1 What other hardware/software solutions are existing or will be on-vehicle and what data/information/function can they provide?

4.3.2 Off-vehicle communications

- Incoming and outgoing data/information.

4.3.3 On-board vehicle data network

- Data / Communication sharing.

4.3.4 What do other existing or future on-vehicle solutions have and could share with the AV solution – (data/information/functions), or what can could the AV solution provide to other on-vehicle solutions?

- GPS.
- Timetable/Matching.
- Disruptions.
- Door connections.
- Communications from / to BODS timetable / location data

4.3.5 Where will the ‘intelligence’ for determining what the AV solution announces and shows be derived and ‘controlled’ from?

- Within the AV solution itself.
- From an existing on-vehicle source (ETM etc.).
- From an off-vehicle source (BODS or other similar service).

4.3.6 Should the driver have any direct capability to control the AV solution or should it be all be off-vehicle / automated? This will be important for determining how disruption messages are provided. Will they be provided by a central back-office service, or simply by the driver pushing a button that displays and announces that the bus is off-route on a diversion; or by an announcement on the PA system?

5 Next Stop Information

5.1.1 The core requirement of an on-bus audio visual system is to provide basic information on the route and stop points for the journey.

5.1.2 The following types of messages are recommended as core information requirements for Next Stop signs.

- Next stop name
- This stop is…
- Alight here for …
- Time to next stop is …
- Route and final destination
- Bus Stopping
- Clock

5.1.3 If sufficient space is available, for example on multi-line LED or TFT displays, then ‘following stops’ should also become core information.

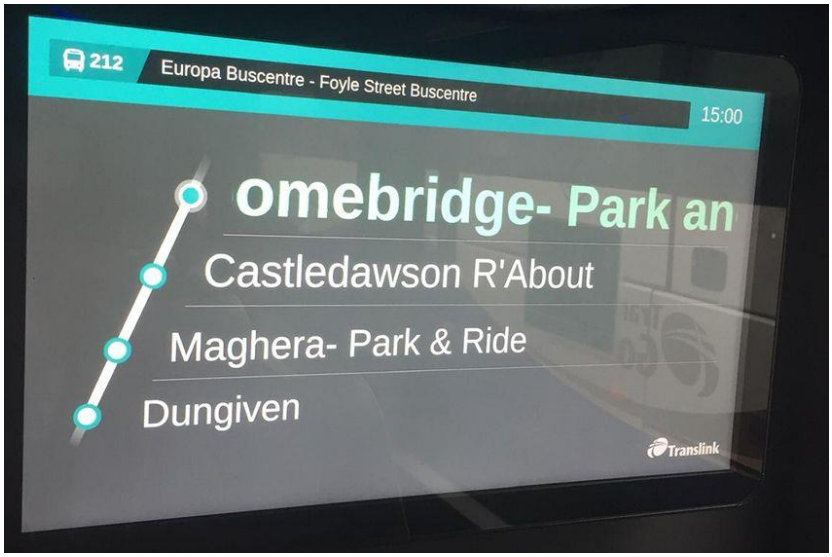


Figure 7 A Journeo double display in a Translink vehicle

Figure 8 An Aesys display 37" ultra-stretch TFT on Hess trolley bus

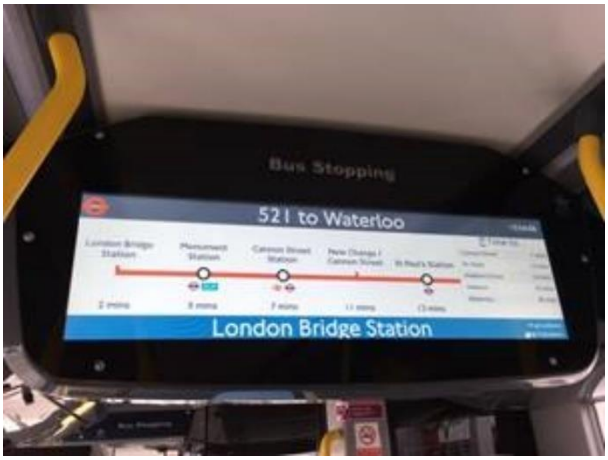


Figure 9 Stretch TfT showing map with interchange information and live journey times (c) Lisa May

5.1.4 Each of the messages must be available in visual and audio formats.

5.1.5 The minimum viable size for next stop announcements is a 19-character single line LED display. This provides only a small number of characters before text needs to be scrolled, and is therefore, something that should be avoided for core information. This means that careful consideration should be given to the length of text required.

5.1.6 Achieving readable size text on a display throughout the cabin cannot necessarily be solved by installing a larger display or increasing font size, as all seats may not have a sight line to the display. It may be more appropriate to use multiple smaller displays to achieve visibility and readability.

5.2 General Rules for Text

5.2.1 Use title case for names e.g., St Mary of Nazareth Church (note that connecting words e.g., of, and, in, alight for are always in small case)

5.2.2 Use sentence case for general information, e.g. No buses are serving Oxford Street. Whole messages should not be written in title case, e.g. No Buses Are Serving Oxford Street.

5.2.3 Capital letters should not be used for whole words or sentences as this makes reading more difficult - particularly for those with visual and cognitive disabilities.

5.2.4 Punctuation should not be used, although apostrophes are included and the symbol '&' is permitted. Brackets and other symbols should not be used.

5.2.5 Abbreviations should generally be avoided. They should only be used for static messages if the character length of the sign has been exceeded and the use of an abbreviation avoids the need for scrolling - otherwise the name should be displayed in full.

5.2.6 The NaPTAN Schema Guide contains a useful set of abbreviations which are recommended for use with next stop information. For ease of reference, these are replicated in Appendix 1: Text Abbreviations. The use of a standardised set of abbreviations is critical with automated text-to-speech systems: to ensure that the correct text is spoken.

5.3 Font and format

5.3.1 A great deal of advice exists on the font and format of signs. Recommendations below are designed to provide clarity and legibility specifically for users with visual and cognitive impairments. However, all users will benefit from having information presented in a fashion which is clear and easy to read.

Do:	use a display of at least 2 lines where practical
	justify information to the left
	avoid right justifying text. A jagged edge is easier for a dyslexic person to keep their place in the text
	put text on a plain background
	use a sans serif font. Some appropriate fonts include: Helvetica, Arial, New Johnston
	keep the number of different font sizes and typefaces on a sign to a minimum
	(for dot-matrix displays) use a character matrix of at least 5 x 7 dots; 7 x 9 is preferred for general applications, and 15 x 21 should be used if displays are to be rotated
	(for dot-matrix displays) ensure that the grid (ie the gaps between dots) of 'non solid' characters are very fine to attain clarity
	use margins
	use a minimum character height of 22mm for all critical information such as next stop, final destination, disruption information and emergency information.
	ensure that character height is at least 1% of the distance at which the message will usually be read, and not normally more than 2%
	ensure signs use a mixture of upper and lower case lettering wherever practical
	ensure that the space between words is greater than that between characters of a word – use word spacing of about one quarter of the font width
	use soft spacing where practical
	ensure that vertical spacing between lines (from bottom of letters without descender to top of ascenders in the line below) is at least

	50% of line height (from top of ascenders to bottom of letters without descender)
	use “true descenders”. A minimum descender depth of 20% of the upper-case character height is recommended
	use characters with a width to height ratio between 3:5 and 1:1
	ensure that the horizontal spacing between characters is 25% to 50%

Do not:	squash ascenders and descenders, or use text with raised descenders
	truncate words unless necessary and do so based on local knowledge until a standard is developed
	write information in capital letters only
	use very long words
	use text which is too expanded or condensed
	underline
	use flashing text
	use punctuation
	use a small font size to get more information onto a sign
	use bold or italic characters

5.4 Route and Final Destination

5.4.1 Consistency of information between what a customer sees on the front of the bus and what is displayed and announced inside, is vital for customer confidence and reassurance that they are on the correct bus. This also goes for information shown at stop and online sources.

5.4.2 For this reason, final scheduled destination point or scheduled end points for short run journeys, should be the same as they appear on the bus blind.

5.4.3 In instances where names exceed the character limit of the signs, abbreviations can be used to ensure destinations do not scroll on signs.

5.4.4 The final destination should be preceded by the route number.

5.4.5 The character limit for bus blinds is normally around 20 characters. In instances where names exceed the character limit of the signs, abbreviations are used to ensure destinations do not scroll on signs.

5.5 Bus Stop Name

5.5.1 It is recommended that operators agree a common name for each bus stop in an area. This will ensure consistency between routes operated by the same or different operators.

5.5.2 Consistency of information between what is displayed at stop and other channels such as apps and on-board, needs to be considered to help customer confidence that they are alighting at the correct location.

5.5.3 For express or inter-urban routes, a different solution may be needed to provide additional context. For example, a combination of locality and stop name or just locality may be appropriate.

5.5.4 Where screen size allows, it is recommended to provide the destination and following stops to enable customers to have a better understanding of where on their route they are; and to help them to be ready to alight at the correct stop.

Figure 10 an INIT display on a NCT bus showing the next stop and following stops.

5.5.5 In Germany the VDV 435 standard requires colour to be used to help customers differentiate between destination and next stops. This example shows 3 lines of LED displays with the colours reflecting the VDV 435 standard.

Figure 11 A 3 Line LED in use in Salzburg, Austria showing line, destination, next stop and following stops.

5.6 'Alight Here For'

5.6.1 If a stop is not named after a local attraction or facility, then an 'alight here for' message can be used. Passenger research has shown that providing 'alight

here for' information on Next Stop signs provides significant benefit to passengers. TfL research shows that passengers regard the concept as extremely useful and would like to see it used extensively.

5.6.2 If a stop landmark field is not named after a nearby local attraction or facility, either because it is named after another attraction/facility or the attraction/facility is out of sight, then the following should be considered.

- Given the proximity of the facility, should the stop landmark field be used for that facility? A name change could be considered if a facility, such as a main hospital, is out of sight but reasonably close to the stop and is the most prominent feature of the local area.
- Given the proximity of the facility, should the facility be appended to an already existing landmark? This may be appropriate if the stop is already named after another facility of equal prominence.
- Should the facilities be referred to at all?

5.6.3 The overall length of the message to be displayed/announced needs to be considered so 'alight here for' names should be kept as succinct as possible.

5.6.4 When 'Alight Here For' is being introduced, it is recommended that the relevant local authority develops guidelines to be used to help resolve any differences of expectation between bus operators and facilities.

5.7 Multi-Lingual Support

5.7.1 The Welsh Language Act 1993 put the Welsh language on an equal footing with the English language in Wales. The Act set up the Welsh Language Board, with the duty of promoting the use of Welsh and ensuring compliance with the other provisions. It also obliged all organisations in the public sector providing services to the public in Wales to treat Welsh and English on an equal basis.

5.7.2 Following the 1993 Act, the Welsh Government has since passed a new Welsh Language Law in 2010. The measure makes Welsh an official language in Wales and obliges public bodies and some private companies to provide services in it.

5.7.3 The implication for the provision of on-bus information is that when operating a bus service in Wales, text and audio information must be provided in English and Welsh.

5.7.4 Where groups of users ask for additional languages on-bus, it is helpful to engage and work with the community to define the most appropriate languages to use and, in the final solution - the correct spelling and pronunciation.

5.7.5 The use of multiple languages brings into play additional considerations over the timing and frequency of messages; and will significantly affect the approach to lower priority messaging (see section 3.1 Information Priorities).

5.8 Audio Announcements

5.8.1 Audio messages should normally follow the text shown on the display but not necessarily at the same point in time.

5.8.2 In London the audio announcement for the next stop is the name of next stop only, not ‘The next stop is…’ This reduces the irritation factor as the message would be heard before every stop.

5.8.3 When developing an audio-visual system, it is good practice to involve relevant user groups. This is particularly important for audio where, for example, Guide Dog for the Blind, or other representative groups or organisations that represent the needs of impacted users - particularly where they have strong local representation, would need to be consulted to ensure that the final design meets customers’ needs.

5.9 Timing of Announcements

5.9.1 Stops need announcing well in advance – to give customers enough time to react to the announcement and find the bell. Drivers need around 20 seconds to stop safely. This is a challenge where stops are close together and road speed is high.

5.9.2 It is common to display the next stop name on a display once the bus has left the previous stop but, in some circumstances, having the audio announcement at that point is not appropriate. This will, therefore, need testing on a stop-by-stop basis to take into account the time taken to travel between stops.

5.9.3 The use of the bell pushes for Bus Stopping signs or door open or close sensors to automatically trigger messaging will be appropriate for some messages; whilst others may be better triggered through the use of a GPS location or geofence - based on the vehicle’s actual location.

5.9.4 An example of timing messages is the message: “Final destination – ‘x (route) to ….’” In the London systems, this is programmed to trigger at every stop eight seconds after door opening. This has been set following testing - to allow sufficient time for several passengers to board and hear the message; and for visually impaired passengers to be given a reasonable chance to react if they realise that they are on the wrong bus.

5.9.5 Customer feedback suggests that stop names should be announced at door opening to provide re-assurance to customers - particularly for those with visual impairments. This will be in addition to any prior announcement of the next stop. In London for example TfL network route and destination are announced 8 seconds after door opening on with stop name on approach to the stop.

5.10 Frequency of Information

5.10.1 Repeating the same or irrelevant information frequently can result in customer frustration; and there have been some notable examples of this whereby the degree of negative customer feedback has resulted in reports appearing in the press.

5.10.2 Safety messages are expected to be more of an infrequent ‘nudge’ or reminder; therefore delivery needs to be subtle, timely and not overbearing e.g. *Please hold the handrail when the bus is moving*.

6 Equipment Selection

6.1.1 There are numerous types of display and audio technologies available - each with different capabilities and suitability for varying locations and conditions.

6.1.2 This report should provide sufficient advice and guidance to help with identifying the specific technical requirements applicable to each individual business case and architecture. There is, however, some generic advice on selecting equipment for an on-bus environment that is worth setting out in this document.

6.2 The Robustness of Equipment

6.2.1 The on-bus environment - with constant vibration and the forces from vehicle movements such as accelerating and braking, is inherently hostile to electronic installations.

6.2.2 In addition, significant fluctuations in temperature - particularly when a vehicle is parked up at a depot without heating or cooling systems running; and the high level of humidity in wet weather, can all provide a challenge to the reliable operation of equipment.

6.2.3 In the light of the above, any equipment deployed on a vehicle must not only be fit for operational purpose but sufficiently robust to ensure that it will continue to work for an extended period in such conditions – without developing faults or requiring excessive maintenance.

6.3 Power Requirements

6.3.1 The power draw of displays and controllers may consume a significant amount of power - particularly on older or electric vehicles. for example two LCD displays on an old double decker will use more power than the entire lighting system.

6.3.2 The on-bus electrical system and its ability to sustain power to a display system over the life of the vehicle and/or equipment, needs to be considered; and the vehicle manufacturer and/or electrical engineering team should be consulted prior to purchase to ensure the proposed equipment will not adversely affect the vehicle’s other electrical systems.

6.4 Cost and Capabilities

6.4.1 The cost of different display types and how they are provided with the requisite information varies significantly, and will undoubtedly be a major factor in procurement decisions.

6.4.2 It will also be important to consider the resources and existing staff skills available to an operator as part of the selection process, as this will dictate the level of ongoing support that will be required of a supplier and therefore, the cost going forward.

6.4.3 For example, if an operator's staff have sufficient data management skills they may be able to keep routes up to date on displays; or if there are electrical skills then some basic fault finding may be able to be done in-house.

6.5 Selection Process

6.5.1 Each organisation will have its own processes and procedures, but all should enable a transparent decision to be made between suppliers: based on objective and consistent criteria.

7 On Bus Displays

7.1 Display Types

7.1.1 The most used on-vehicle technologies are TFT and LED. Within the Bus sector, LED has historically been the most widely deployed display technology at stop and within vehicles. This is primarily due to it providing excellent legibility in direct sunlight conditions, high levels of reliability and long life; and, as a result of wide viewing angles - the ability to convey basic text messages to a number of passengers located at various positions

7.1.2 TFT and similar technologies have become more frequently used in recent years - as the designs become more reliable in harsher environments, the total cost of ownership has reduced, and customers demand more graphical presentation of information.

Figure 13 Traditional Amber LED within moulding on Brighton Buses

Figure 12 Stretch TFT on bus

7.1.3 At the same time, the quality of LED displays has improved - with increased density allowing the display of simple graphics and the development of colour implementations.

Figure 14 High density white LED on a rail platform

The decision on which display technology is most appropriate will be driven by the business requirements, in particular the use cases and budgets. Appendix A of the RTIG document: *RTIGT037 Displaying Transport Information on Public Electronic Signs* provides a comparative analysis of different currently available display types.

7.2 Equipment Location

7.2.1 Any sign on a bus should be positioned in the most obvious place so that a passenger does not have to search for it. In general, it should be facing the largest number of passengers possible. For complete passenger coverage this will, on most vehicles, require more than one sign.

7.2.2 Signs should be sufficiently bright to be clearly visible but should not be positioned such that they cause glare.

7.2.3 Uniformity of illumination and contrast is also important to those with visual impairments.

7.2.4 The RTIG document: *RTIGPR003-D002-1.10 Inclusive passenger information* includes some useful advice on the siting of displays:

Do:	have the longest sight lines feasible
	position signs so that passengers can see them without turning round. Where seats face in more than one direction, it may be necessary to add in extra signs
	position signs with sufficient light for easy legibility
	ensure signs are illuminated evenly, either naturally or artificially
	shield screens from direct or reflected sunlight and artificial light sources
	ensure that the intensity of the display adjusts to lighting conditions where practical. Displays should be visible under day and night conditions
	ensure that artificial lighting is compatible with the electronic display
	position signs in a prominent position where it is obvious and logical to find a sign
	mount signs, especially larger ones, so that they are not hazardous to passengers
	locate signs and speakers in both upper and lower saloons
	consider wheelchair users using a rear facing wheelchair space who would not be able to read the sign placed at the front of the bus
	take account of the colours and acoustic properties of environment, to ensure that they do not adversely affect those viewing/listening to information
	ensure that signs which are located on walls and have a colour which is similar to the background of the sign have a border which contrasts visually with the background of the sign. Ensure that the width of the border is large enough to ensure prominence
Do not:	position displays near or within the same field of view as light sources such that there is glare or deep shadows

	mount signs at points where vibration and movement impair ease of reading
	position signs within the same field of view as a light or such that the ambient light exceeds the level of illumination of the sign.
	position signs such that they occlude any other required signage or important information, or interrupt the driver's line of sight
	position signs where excessive movement is required to read them
	position signs where they become an obstacle for passengers moving through the vehicle

7.2.5 Retrofitting vehicles is a challenge - height clearance on-vehicle is as important as on-street; and there are not many locations on-bus where displays can be installed behind the B pillar. TFTs are more challenging than LEDs. Although stretch displays can help, it nonetheless remains a challenge.

7.2.6 Forward-facing displays can be a problem with reflection onto windscreens. Sometimes, however, an obstruction between a forward-facing display and the windscreen can remove the glare issue.

7.2.7 Reflections from roof windows can cause significant reflection that is difficult to resolve.

7.2.8 Sighting of displays should be given careful thought to ensure they do not disrupt forward view - particularly for seats immediately behind a display.

7.2.9 When using grab rails as mounting points for displays it is best where possible to use the manufacturer's brackets rather than custom ones. As a minimum, the manufacturer should be consulted for advice on fixing: to reduce the risk of damage to, and loss of integrity of, grab rails or other vehicle parts.

7.2.10 Consideration should be given to the potential impact on vehicles along-side and behind the bus if high bright LEDs are to be deployed.

7.3 Lower Deck Locations

7.3.1 Some examples of lower deck display locations are provided:

Figure 15 Metrobus with 1 line LED with external cabling

Figure 16 Translink bus with 2 line LED above front luggage rack.

Figure 18 Metrobus 21.5" TFT

Figure 17 Forward facing 28" Stretch TFT (c) GoAhead

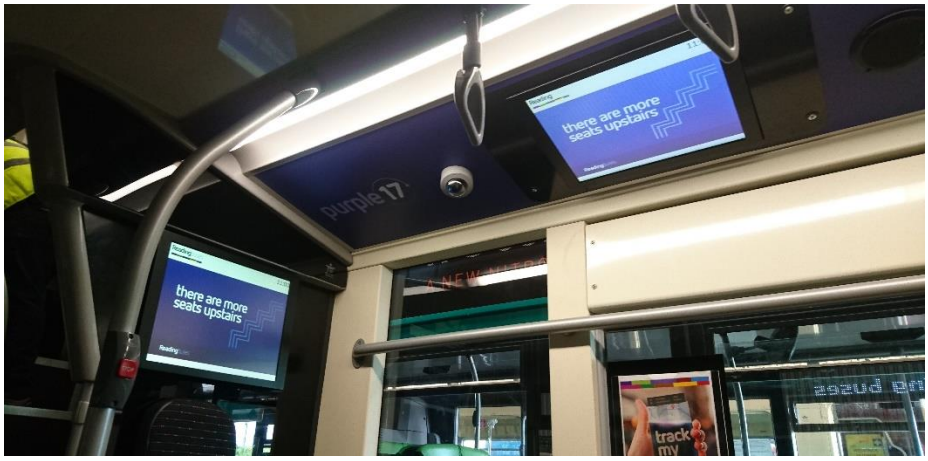


Figure 19 Reading Buses with 2 TFT displays one in the coving for use by passengers in accessible seating area.

Figure 20 TfT on lower deck of TfL bus sized to maintain the height of the old LED characters (35mm upper case, 25mm lower case). © Lisa May

Figure 21 TFT above entrance circulation area (c) Journeo

Figure 22 Enviro400 Transdev 'Witchway' Bus showing wide TfT screen above nearside front wheel-box (c) ADL

Figure 23 ADL Enviro400XLB Lothian double deck buses showing dual screen on stairwell (c) ADL

Figure 24 ADL Enviro200 showing Bus Stopping and double information screen in 'Bridge' © ADL

7.4 Upper Deck Locations

7.4.1 Some examples of upper deck display locations are provided:

Figure 25 Upper deck LED Brighton Buses

Figure 26 A split design stretch TFT Upper deck front (c) Journeo

Figure 27 LED in upper deck front moulding on a TfL bus.

Figure 28 Stretch TfT on upper deck of TfL bus sized to maintain the height of the old LED characters (35mm upper case, 25mm lower case). © Lisa May

Figure 29 TFT at head of stairwell on Stagecoach Yorkshire © SYPTE

Figure 30 ADL Enviro400XLB Lothian double deck buses showing dual screen in upper deck front header above windscreen (c) ADL

Figure 31 ADL Enviro400 – showing Bus Stopping in front header above upper saloon windscreen and Passenger Information Screen at top of Stairwell © ADL

7.5 Cabling

7.5.1 Modern vehicles typically have fewer panels and window frames - making it harder to identify where to run cables for retrofit installations. Where there are spaces, they are usually filled with insulation and sound proofing material – further reducing the ability to retrofit cabling. Early planning for cabling runs during the specification of new build vehicles is required, and manufacturers could proactively provide conduit between key locations

7.5.2 Power supply connectors

7.5.2.1 It is recommended, but not mandated, that a power supply interface compliant with the ITxPT Architecture Specification is used. This expects that MCP type connectors with 6 pins shall be used for power supply interface, an example connector is TYCO reference: 1-965641-1 Blue Code A (vehicle side) or TYCO reference: 8-968970-1 Blue Code A (module side):

Vehicle side	Module side
 **1-965641-1 Blue Code A**	 **8-968970-1 Blue Code A**
Vehicle manufacturers shall deliver power supply **male connector**	**ITS module suppliers shall** deliver power supply wiring harness with related **female connector**.

7.5.2.2 These connectors cannot be connected incorrectly - a key design requirement for any connector design used on-vehicle.

7.5.2.3 Power to TfT displays can be a challenge as the high brightness units can draw a lot of current - so suitable cable sizes need to be installed.

7.5.3 Video Connectors

7.5.3.1 Any connector used needs to be:

- lockable or screw fix to stop vibrations causing disconnection problems;
- unable to be incorrectly inserted to the correct location; and
- unable to be incorrectly inserted into any other connector type.

7.5.3.2 Commonly used video connections on-vehicle for LED displays are RS232 or RS485; and use an appropriately sized D-sub connector with screw locks.

Figure 32 9 Way D-sub Connector

7.5.3.3 TFT displays will typically use either VGA, DVI or HDMI connectors. One important factor in deciding which type of connector will be its robustness; and that it is of a lockable design.

7.5.3.4 Some systems use ethernet connectors for the video - with conversion at either end to/from video connectors. They will use screened CAT5 or 6 cabling to reduce the risk of interference from the vehicle's electrical systems. The use of ethernet allows for smaller diameter and more flexible cables to be used – facilitating easier installation.

7.5.3.5 The connectors used should be as robust as possible. Standard RJ45 connectors are not robust, and the cable entry point is particularly at risk of cable breaks. It is highly recommended that the M12 Ethernet connector is used on-vehicle as it has proven to be sufficiently robust. In addition, it is the recommended connector for use with ethernet by ITxPT in their *S01-Installation Requirements Specifications - v2.1.1 guide*.

Figure 33 M12 8 pin X-coded field plug

8 Audio Information

8.1 Number of Audio Channels

8.1.1 In the UK there are normally two audio channels on a vehicle:

- Number 1 - Passenger area(s)
- Number 2 – vestibule and driver's area: for communication between a boarding passenger and the driver.

8.1.2 In some other countries, a third audio channel is used for the external announcements via external speakers at doors.

8.1.3 Consideration should be given to any driver-to-boarding passenger audio system that may be required, as this would require a third or fourth channel.

8.1.4 Suppliers are therefore recommended to provide audio systems that are capable of supporting sufficient channels, ideally with a simple swap out design for ease of upgrade.

8.2 Amplifier

8.2.1 Amplifiers can be built into other equipment or be separate devices. They should be specified to provide sufficient volume across all areas covered by the speakers: in the worst-case background noise of a vehicle being full under heavy acceleration uphill - without distorting the sound.

8.2.2 Careful choice of speakers and amplifier will be required to ensure that impedances match.

8.2.3 Where the amplifier is built into other equipment, for example in a display management controller, the speaker and cable selection become more important - to protect the equipment overall from excess load.

8.3 Speakers

8.3.1 Speaker selection will be dependent on the choice of amplifier, particularly where it is a part of other equipment.

8.3.2 Some key selection criteria are:

- thin speakers fit better in a wider range of vehicles - as the space in the ceiling voids are small and often filled with insulation; and
- speakers should be resistant to moisture, as passenger compartments are often humid with high levels of condensation.

8.3.3 Typically, a speaker installed as standard in a bus will have a frequency range of 60 to 12,000 Hz. Wider ranges are of course possible, but the operating environment does not require them.

8.3.4 There is a school of thought that Bluetooth or wireless speakers are easier to retrofit than cabled. However, these types of speaker require power to work for any period of time – thereby negating any benefit gained from not needing to run speaker cables. In addition, the electrical noise within a vehicle can be significant; and this presents the risk of interference - leading to poor customer experience.

8.3.5 The speakers and their cabling need to be designed to match the amplifier specification and requirements to ensure optimum performance.

8.4 Voices

8.4.1 There are two ways to provide the audio announcements – recorded or on-the-fly computer generated.

8.4.2 Recorded voice can be generated by a human or by recording the output from a computer text-to-speech system.

8.4.3 Systems using recordings will need to ensure that all necessary audio clips needed for the routes a vehicle will run are downloaded to the vehicle. For large depots or operators with many routes, this can become a significant management task.

8.4.4 The more intelligent audio systems will download voice clips on demand from cloud services when a vehicle logs into a route for the first time, or there is a change to data for that route.

8.4.5 Whilst customers prefer natural human voices over automated sounding ones, in recent years, computer synthesis has become much more natural and realistic sounding and is therefore becoming more acceptable.

8.4.6 Synthesis has the advantage of being able to dynamically respond to changes in message and is the only realistic solution for dynamic disruption messages.

8.4.7 When text-to-speech is being used - either live or recorded, the use of manual overrides for pronunciation of place names helps with the overall quality of output and acceptance by customers. The process for adjustment is currently text-to-speech system specific, meaning any change can require re-work.

8.4.8 Customers prefer to hear a consistent sounding voice; but consideration needs to be given to how the content will be maintained when there are changes to stop names or routes if a natural human voice recording is used. There is no consensus around the choice of male or female voice - different individuals have different preferences. It is recommended that when the choice between human or synthesised voice is made, a test recording is played back on a bus in realistic motion to ensure it is intelligible and achieves the desired impact.

8.4.9 There is an increasing use of regional voices to make passengers feel more comfortable.

8.4.10 Transdev Blazefield, for example, use local TV personalities and more casual language. This encourages buy-in from those who don't need the audio as well as those who do; and has proven popular with customers.

8.4.11 Bus services operating in Wales will need to make sure that the audio is available in both English and Welsh languages.

8.5 Volume

8.5.1 Before finalising the design for the audio system, it is recommended to test locations and numbers with a range of passengers with differing hearing abilities to ensure that the implementation will be fit for purpose

8.5.2 These tests should be carried out both when the vehicle is stationary, and when operating a typical route - to ensure that the audio is audible when the vehicle is accelerating, going uphill and braking. This test will also highlight if there are any interference issues with vehicle electrical systems such as regenerative braking.

8.5.3 The audio volume will need to be adjusted to reflect the route being operated. A hilly route may need a greater volume than a flat route; and a crowded bus will need more than an empty one.

8.5.4 To assist with the shifting volume requirements on some vehicles and routes, the use of ambient noise sensors to automatically adjust the sound level to the external and internal bus noise levels is recommended.

8.6 Speaker Location

8.6.1 The number and location of the speakers has a significant impact on the audibility of information for customers.

8.6.2 To ensure that appropriate volume can be provided to all passengers in all circumstances and occupancy levels, it is better to have more speakers than fewer, and then to adjust the volume on the amplifier to ensure sound coverage without any areas being too loud.

8.6.3 Speakers, or locations for them, are often pre-installed above the seating areas along the length of the bus during manufacture.

8.6.4 Speaker locations have historically varied between vehicles - with some having speakers only in the accessible seating area and others across the full deck. Some have downstairs and not upstairs etc. Full fitting across all decks is highly recommended.,

8.6.5 The accessible information regulations will require speakers on all vehicle decks, and will therefore, require retrofitting where both decks are not currently covered.

Figure 35 a typical ceiling speaker (c) Journeo

Figure 34 a speaker behind the driver (c) Journeo

Figure 36 Upper deck Brighton Buses

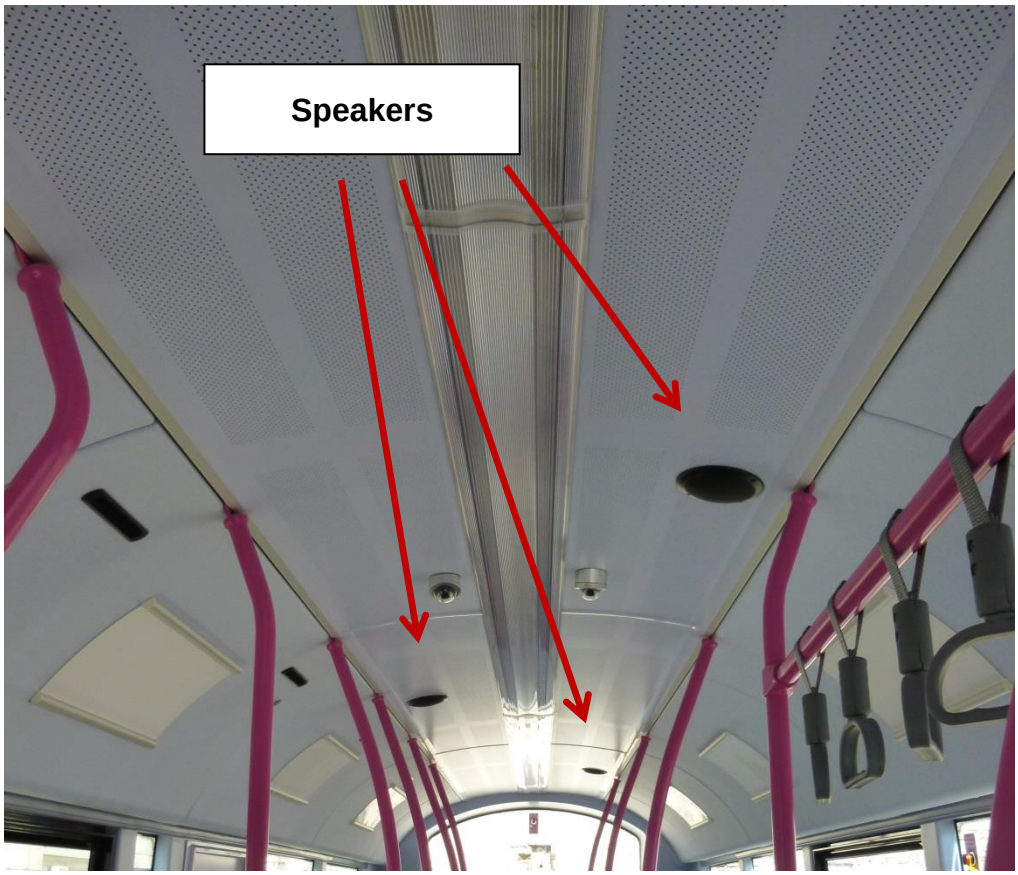


Figure 37 Speakers along the roof of a First Group vehicle

8.7 Cabling

8.7.1 Modern vehicles typically have fewer panels and window frames making it harder to identify where to run cables for retrofit installations. Where there are spaces, they are usually filled with insulation and sound proofing material - further reducing the ability to retrofit cabling. Early planning for cabling runs during the specification of new build vehicles is required, and manufacturers could proactively provide conduit between key locations

8.7.2 Cabling to seating areas and for speakers is difficult - with ambient noise sensors a particular problem.

8.7.3 Power supply connectors

8.7.3.1 It is recommended, but not mandated, that a power supply interface compliant with the ITxPT Architecture Specification is used. This expects that MCP type connectors with 6 pins shall be used for power supply interface, an example connector is TYCO reference: 1-965641-1 Blue Code A (vehicle side) or TYCO reference: 8-968970-1 Blue Code A (module side):

Vehicle side	Module side
 **1-965641-1 Blue Code A**	 **8-968970-1 Blue Code A**
Vehicle manufacturers shall deliver power supply **male connector**	**ITS module suppliers shall** deliver power supply wiring harness with related **female connector**.

8.7.3.2 These connectors cannot be connected incorrectly - a key design requirement for any connector used on vehicle.

8.7.4 Audio Cabling

8.7.4.1 Vehicle manufacturers should supply and install in-vehicle audio amplification /dispatching system, loudspeakers, radio, and driver microphone (including ambient noise management if requested).

8.7.4.2 It is recommended that the audio interface is compliant with the ITxPT Architecture Specification: to ensure ease of management and flexibility in product choice. This expects an MCP type connector with 9 pins to be used for audio interfaces, such as TYCO reference: 1-967626-1 Yellow Code A at vehicle side or TYCO reference: 8-968971-1 Yellow Code A at ITS module side:

Vehicle side	Module side
 **1-967626-1 Yellow Code A**	 **1-968971-1 Yellow Code A**
Vehicle manufacturers shall deliver audio **male connector**.	**ITS module suppliers shall** deliver audio wiring harness with related **female connector**.

8.7.5 PA (Driver – Passenger)

8.7.5.1 Any retrofitted audio system must be fitted in a way that does not interfere with the driver to passenger public address (PA) system.

8.7.5.2 This PA system is an important source of information for customers in times of disruption; and should override any automatic messages that otherwise would have to be announced when the driver is speaking.

8.7.6 External Announcements

8.7.6.1 In some other countries, external announcements are provided via external speakers at doors: to provide information about the Service number and destination for customers waiting to board.

8.7.6.2 Although external announcements have been used previously in the UK, most notably by Reading Buses, they are not currently used in many places in this country. This is, however, likely to change. They are an option for TfL iBus 2 contracts and this may therefore result, in time, in a cascade of equipped vehicles to other areas.

9 Installation

9.1 Planning

9.1.1 There are many different variants of even the most common bus types, with each manufacturer and coach builder providing vehicles to meet the specific requirements of each customer. As a result, vehicles that look very similar from the outside can have quite different internal architecture which has been designed to suit the planned routes for that vehicle.

9.1.2 The implication of this for audio-visual installations is that there is no such thing as a standard installation guide, as each type of bus will have different requirements.

9.1.3 It is, indeed, normal industry practice that each vehicle type for an operator has a separate installation method statement that accurately reflects the necessary work to be carried out on that vehicle.

9.1.4 Each method statement will document how to install the system correctly for each vehicle type: setting out the location of different components, how to access voids, and where cables should be run etc.

9.1.5 The installation described in the method statement will normally be provided to the operator by the supplier carrying out the fitting. This will be provided before installation so that there is mutual agreement between the two parties on the work that will take place.

9.1.6 Each operator and depot will have their own health and safety and risk assessment requirements; and early engagement will enable these to be included in the method statements to ensure installation engineers have all the information they require in one document.

9.1.7 It is likely, even having a vehicle type method statement in place, that there will be some unique differences within individual vehicles of the same type. Installation engineers need to be able to adapt the installation to these differences as they work.

9.1.8 Each bus will, once fitted and tested, need to be signed off by the operator before it is taken back and re-introduced into service.

9.1.9 Access to vehicles for installation will need arranging with the relevant depot in advance. Unless a depot has a large enough stock of spare vehicles, installation work is likely to be carried out during quiet hours after the evening peak and overnight.

9.2 Common Installation Challenges

9.2.1 A project plan that specifies which vehicles will be installed on which day is good practice. However, in reality, it is unlikely that every vehicle will be available on the planned day so the flexibility to change plans at the last minute is essential.

9.2.2 Easy and quick access to pre-built cable looms for each different vehicle will be helpful, so that if a particular vehicle is unavailable on a given day, the installation engineers can quickly switch their attention to another available vehicle.

9.2.3 Bus interior panels can become brittle with age and difficult to remove. Depot engineering staff will have knowledge of which panel types are likely to be a problem on which vehicles. This information can be incorporated into the method statement so as to minimise the need to disturb the panels more likely to cause problems.

9.2.4 Where a hole is needed in an external panel or roof, for an antenna for example, care will be required to avoid water ingress to the vehicle post installation. Equipment suppliers' seals are often insufficient because of the constant vibration and movement of the vehicle, so additional sealing will normally be required to ensure a watertight seal over an extended period.

9.2.5 Once installed, door switches need careful placement and testing to ensure that the switch works correctly and that there is no risk of affecting the closing of the doors.

9.2.6 All cables that run through any panels or along edges will need to be suitably protected from abrasion with grommets: to reduce the risk of failure or exposing the electrical core. The protection will need to be more robust than would be used in fixed location installations because of the near constant vibration and movement of the vehicle.

9.2.7 Cables should be secured in trunking or through the use of cable ties to stop movement causing cable breaks.

9.2.8 All power supply connections must be protected by suitably rated fuses to protect the new installation and the rest of the vehicle's equipment.

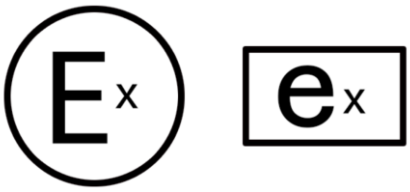
9.2.9 The use of power filters to reduce power spikes and electrical noise should be considered to provide increased protection to the audio-visual equipment.

9.3 Electromagnetic Compatibility

9.3.1 The inherent electronic noise and magnetic fields of the on-bus environment can be challenging for new installations - risking interference with the operation of a device.

9.3.2 All electronics to be installed on-bus, either at manufacture or aftermarket, should be EMC tested and approved for an automotive application (this will be denoted by a UKCA, UKNI and CE mark sticker on the device).

9.3.3 These markings apply to products that meet European standards for that specific class of products. In the case of electronics, it usually states the compliance with LVD and EMC requirements and applies to all electronics sold in Europe (and in the UK until 2023, when it will be replaced by the UKCA). Nevertheless, when the destination of an electronic device is on-board a motor vehicle, then the CE mark is replaced by the “E” mark.



9.3.4 This states the homologation or “type approval” of a product for the automotive industry according to the United Nations Economic Commission for Europe (UNECE) regulation. Such homologation can be issued by any of the participating countries (UK and Europe included) and refers to specific sub-categories. Displays and electronic devices should meet the R10 regulation with regards to the EMC and R118 for fire behaviour.

9.3.5 A CE mark is required, in addition to the E mark, for the on-board devices when these integrate a radio transceiver (e.g. wi-fi, modem). Only in these cases, the CE mark (or the corresponding UKCA mark) is mandatory to state the compatibility of the radio-emitting device to the RED 2014/53/EU Directive

9.3.6 The UKCA mark has the same application criteria as the CE mark. Whilst ever the UK stays in the UNECE WP29[7], the “Type approval” will prevail over the CE mark. Northern Ireland does not have plans to reject CE after 2023. UKNI was introduced for those products that are native UKCA (basically new British products that are not meant for export into EU therefore not CE marked).

9.3.7 For complete assurance, it is appropriate to request the actual certificate issued by an authorised body, such as the VCA in the UK (e11); or the authorised body in the supplier’s country.

9.4 System Commissioning

9.4.1 Achieving a next stop announcement system that performs correctly by providing the correct information at the correct time, is not something that will happen without testing and commissioning.

9.4.2 It is therefore, recommended that a single designated vehicle is equipped with the proposed solution and tested thoroughly before rolling it out to the rest of the fleet.

9.4.3 Sufficient time for this initial testing needs to be built into project plans so that it is done thoroughly and repeated where necessary: where issues have been identified and changes made.

9.4.4 The initial commissioning of the test vehicle will need to encompass testing over a selection of routes: to check basic volume and intelligibility problems; basic announcement and messaging timing; and to include feedback from customers, particularly from any specific user groups such as local disability or language groups.

9.4.5 Once initial commissioning is complete and the general configuration accepted, this can then be used in the wider roll out.

[7] https://unece.org/transport/vehicle-regulations/wp29-world-forum-harmonization-vehicle-regulations-wp29

9.4.6 At this point, local press and other key advocators could be usefully engaged to encourage media coverage of the project and introduce the benefits to a wider audience; and hopefully grow patronage and interest in bus services.

9.4.7 Each route will still need to be commissioned to check for data accuracy – are the stops in the right order, are they announced correctly and at the right time, do destination details match with blinds etc. However, if the general configuration is correct, the route commissioning should be simpler and quicker.

9.4.8 Each vehicle will need some individualised commissioning and testing - to adjust volumes for example, but this should normally be able to be carried out in-depot at the time of installation.

10 Maintenance

10.1 Equipment

10.1.1 Once properly installed and commissioned, the audio-visual equipment should be reliable and require the minimum of maintenance.

10.1.2 Nonetheless, planned maintenance will be important to ensure that equipment is properly checked; fixings are tested to ensure they are still robust; and the insides of equipment are cleaned to stop the build-up of particulate matter.

10.1.3 Many systems will come with a remote monitoring capability to detect problems or potential problems and then to resolve them - either remotely, or by dispatching an engineer.

10.1.4 Even when a system has remote monitoring, this will not detect some faults, - for example, if a screen is defaced, or if speakers have worked loose and are vibrating. Regular manual checks will therefore remain important to ensure that the system is working properly. These could be added to standard vehicle check processes, with faults being passed to the maintenance provider as appropriate.

10.2 Cleaning

10.2.1 Cleaning procedures and processes should be specified by suppliers to ensure that the correct equipment and appropriate chemicals are used to avoid damage to the installation over time.

10.2.2 Most equipment within the passenger cabin will just need a regular wipe as part of the normal cleaning regimes - to remove dust and oils.

10.3 Data

10.3.1 The most challenging maintenance task for on-bus audio visual systems is to ensure that they have the correct data.

10.3.2 Processes need to be developed and put in place to make sure that when a route changes, or the name of a stop is changed, that the data on every affected bus is updated.

10.3.3 These processes should fit within the operator's overall data management and update processes: to ensure that all customer information is updated consistently at the appropriate time.

10.3.4 If graphical messaging or advertising is being used, then these will need to be included in the data management process.

11 Case Studies

11.1 Brighton & Hove Buses

11.1.1 Background

11.1.1.1 Accurate customer information is especially important for Brighton & Hove Buses (a subsidiary of Go-Ahead Group) who operate in a popular tourist and business destination in the UK. A high proportion of customers are unfamiliar with the bus network, therefore ensuring that it is as easy to navigate as possible is a key focus.

11.1.1.2 To assist in achieving this, significant investment was made in tracking and providing real-time information to ensure customers feel confident and informed throughout their journey – which in turn keeps cars off the already congested Brighton roads.

11.1.2 Key deliverables

11.1.2.1 To address this, Brighton & Hove have installed highly effective tracking, communications and audio-visual equipment across their 440-vehicle fleet, which allow passengers to see and hear a range of announcements, such as next stop, diversions and closed stops on departing the previous stop. The systems also allow for announcements relating to other areas of interest, such as the famous Brighton Pier, American Express' EMEA headquarters, and a number of schools. Collaboration has been a key component to the success of these systems by ensuring the GPS trigger points are carefully amended and constantly reviewed. The team also collaborates closely with the local council to provide useful announcements for planned events, such as the Brighton Children's Parade and the Brighton Marathon, as well as planned roadworks.

11.1.3 Key outcomes

11.1.3.1 This highly successful system, provided and supported by Hanover Displays, has been so successful that Brighton & Hove Buses now install the necessary equipment on all new buses as standard. These new systems include service updates from the company's Twitter feed, display rail departures at upcoming interchanges, and even provide a news feed from the BBC.

11.1.3.2 Brighton & Hove Buses continue to be recognised for their contribution to customer information, with on board displays and information provision contributing to national bus operator awards in 2016, 2017, and 2019. Following the fleet-wide rollout in 2016, the local council was also awarded

Transport Authority of the Year at the 2016 National Transport Awards, showing that the collaborative success reflects well on partners.

11.1.3.3 Perhaps most importantly, the investments made are justified by customer feedback. In the 2017 National Bus Passenger Survey, Brighton & Hove saw passengers' satisfaction with on-board information provision increase from 66% to 76%, while perceptions of value-for-money remained steady despite a small increase in farebox charges to contribute. Our Managing Director Martin Harris said: "Our entire fleet (440 buses) is made up of 'talking buses', where passengers can see and hear next stop and other announcements, such as diversions. We introduced them in 2016 after one of our visually impaired passengers told us she had alighted at the wrong stop several times and it was making her anxious. Everybody deserves to feel relaxed and confident while they travel and the best way to make buses more accessible is to keep listening to the experts: our passengers and our communities."

Figure 38 Single line LED on Brighton & Hove Buses

11.1.3.4 Our Accessibility and Communities Manager Victoria Garcia said disabled people accounted for one in five of the UK population, but accessible buses were important for everybody. Victoria said: "We're all going to have an accessibility requirement at some point in our lives, whether that's living well with dementia, becoming pregnant, carrying heavy shopping, or having a short-term injury. Audio-visual technology is also great for people travelling at night or taking a route for the first time and really helpful for tourists and students."

11.1.3.5 Hangleton resident Graham Oulton is registered blind and used to worry about catching the bus by himself in Brighton. Graham has volunteered with Guide Dogs UK since 2014 and helped us fulfil our promise of making 100% of our fleet becoming talking buses. Graham said: "It's tremendous getting on board

a bus and hearing your stops. It's amazing for me because it's freedom. I can go anywhere."

11.2 South Yorkshire[8]

11.2.1 "I love the talking buses on the 120 route in Sheffield. It makes things so much easier. If this was on all buses I would be able to travel a lot more independently, maybe even at night when it's dark" - A visually impaired user of the 120 bus.

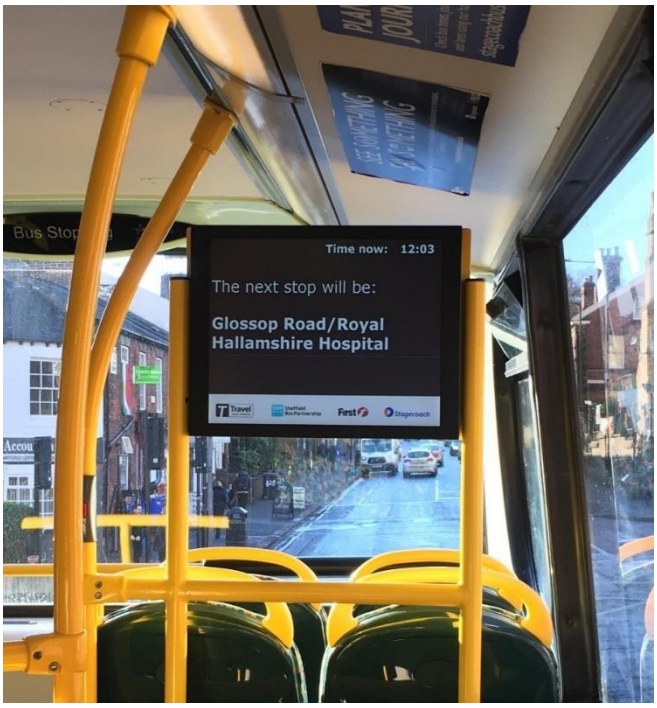


Figure 39 4x3 format TfT on uppe deck above stairs on Stagecoach bus in Sheffield © SYPTE

11.2.2 Audio Visual (AV) equipment on buses can dramatically improve the journey experience of many passengers, and for others it can be the single improvement that gives them the confidence to travel. Audible and visible information can help a range of disabled passengers to feel sufficiently confident to use buses, enabling them to access employment, education, and other services, regardless of the time of day or their familiarity with the route on which they are travelling. It may be of particular benefit to people who are blind or partially sighted, or anyone who might otherwise avoid travelling at night because of the risk of alighting the bus in the wrong location.

11.2.3 In 2017, South Yorkshire Passenger Transport Executive (SYPTE) partnered with their area's two local bus operators (First and Stagecoach) to retrofit AV equipment in 37 buses along the 120 route. This installation project was

[8] From DfT publication "The Inclusive Transport Strategy: Achieving Equal Access for Disabled People"

funded through DfT's BSOG Reform Better Bus Area Grant, to which SYPTE had submitted a successful bid. The scheme promotes the provision of audible and visible information onboard buses ahead of the forthcoming Accessible Information Requirement (AIR) (where AV equipment will be mandatory for the majority of operators), which will soon be consulted on.

11.2.4 Whilst the operators had concerns about how customers would react to the new 'talking buses', these were quickly allayed following an 'after implementation' survey showing a clear increase in customer satisfaction when boarding and alighting following the installation of AV.

11.3 Transport for London - iBus

11.3.1 Contracted in 2005, iBus has provided on-board audio and visual announcements of the Route, Destination, and next stop information from the first installation in 2006 - to being on the whole fleet announcing at every stop since 2009.

11.3.2 In 2011, TfL increased the number of roadside (Countdown) signs to 2500 and made possible the distribution of Live Bus Arrival times to new channels including the Web, SMS alongside the traditional signage. This began the journey of personalised web/app use, the scale of which could never have been predicted during the early years of iBus.

11.3.3 In 2012, iBus data formed part of the Open Data revolution with the publication of Live Bus Arrival data to third parties.

Figure 40 Two line LED on TfL bus

11.3.4 All travel apps with live bus arrival information, such as Citymapper and UK Bus Checker, use the iBus data feed. Channels continue to emerge and evolve, presenting new information opportunities. Digital signs and e-paper for

example, have enabled dynamic presentation formats including the use of graphics to be trialled on buses, at stops and in bus stations.

11.3.5 On-board information has been enhanced throughout the life of iBus. There has been fine tuning of message delivery on-bus to deliver the best possible user experience in response to research, user, and stakeholder group feedback. For example, the timing of the audio and visual messages between stops, additional ‘alight here for’ messages at select locations and a clock on the second line, displayed when the ‘Bus Stopping’ message is not in use.

11.3.6 iBus has been used to for selective announcements covering for example, major fund-raising activities, messaging during the 2012 Olympics, revenue protection, safety and more recently, Covid-19 messaging.

11.3.7 Driver initiated visual and audio announcements are used to create a better journey experience, such as requesting that passengers move down the bus and the availability of seats on the upper deck. They are used to keep passengers informed of any real time changes to the journey, such as destination changes and stop closures.

11.3.8 Enhancements to bus route performance monitoring tools have helped to drive improvements in service reliability and maintain high levels even when faced with more challenging traffic conditions.

11.3.9 Key beneficiaries

11.3.9.1 Passenger research and stakeholder feedback identified the following key beneficiaries:

- All passengers, with particular value given to audio/visual for those making infrequent journeys and for all passengers when journeys are disrupted.
- Disability groups, especially people with visual impairments. Guide Dogs have been campaigning for many years through the Talking Buses campaign, to have next and final stop visual and audio announcements on all buses, as provided in London

11.3.10 Future developments:

Figure 41 Stretch TFT on TfL electric bus on routes 507 and 521

11.3.10.1 Future planning to the system will be made through the iBus2 project (due to be delivered in 2025). The project focuses on asset replacement, but opportunities will be taken where feasible, to utilise new technology to satisfy prioritised requirements which have become apparent from experience of operating the current iBus system. Two areas of interest include better information about service disruptions, especially diversions; and the potential to provide innovative solutions to target the specific information needs of certain disability groups

Appendix 1 Text Abbreviations

The following standard abbreviations are copied from the NaPTAN Schema documentation. They should be used only where it is essential that the full name be abbreviated (to meet constraints of display size or message length for instance).

Terms for Relationship

Relationship	Abbreviation
Adjacent	Adj
Near	Nr
Opposite	Opp
Outside	O/s
Great	Gt

Greater	Gtr
Little	Lt
Upper	Upr
Middle	Mdl
Lower	Lwr
East	E

West	W
North	N
South	S
Saint	St (1)

Topographical Features

Topographical Feature	Abbreviation
Alley	Al
Approach	App
Arcade	Arc
Avenue	Ave, Av
Back	Bk
Boulevard	Bvd
Bridge	Bri
Broadway	Bway
Buildings	Bldgs
Bungalows	Bglws
Business	Bsns
Causeway	Cswy
Centre	Ctr
Church	Chu, Ch
Churchyard	Chyd
Circle	Circ
Circus	Ccus

Topographical Feature	Abbreviation
Close	Clo, Cl
College	Col
Common	Comn
Corner	Cnr
Cottages	Cotts
Court	Ct
Courtyard	Ctyd
Crescent	Cres
Cross-roads	Xrds
Drive	Dri, Dr
Drove	Dro
Embankment	Embkmt
Esplanade	Espl
Estate	Est
Gardens	Gdns
Gate	Ga
Green	Grn, Gn

Topographical Feature	Abbreviation
Grove	Gro
Heights	Hts
Hospital	Hosp
Industrial	Ind
Infirmary	Inf
Interchange	Intc
Junction	Jct
Lane	Ln, La
Manor	Mnr
Mansions	Mans
Market	Mkt
Mews	Mws
Mosque	Msq
Mount	Mt
Orchard	Orch
Palace	Pal
Parade	Pde
Park	Pk
Passage	Pass
Place	Pl
Police Station	Pol Stn
Precinct	Prec
Promenade	Prom
Quadrant	Quad
Road	Rd
Roundabout	Rdbt

Topographical Feature	Abbreviation
Square	Sq
Stairs	Strs
Station	Stn
Steps	Stps
Street	St ([9])
Subway	Sub
Synagogue	Syng
Terrace	Ter, Terr
Temple	Tmpl
Trading	Trdg
Turn	Tn
View	Vw
Villas	Vs
Walk	Wlk
Way	Wy
Yard	Yd

[9] St as prefix means ‘Saint’. St as suffix means ‘Street’

Common Acronyms

Term	Abbreviation
Football Club	FC
Her Majesty's Prison	HMP
Post Office	PO
Public House	PH
Royal Air Force	RAF

Common Adjectives

Adjective	Abbreviation
National	Ntl
British	Brt
Royal	Ryl
Scottish	Sct

Appendix 2 Glossary

ADL	Alexander Denis Limited
AV	Audio Visual
BODS	Bus Open Data Service
BSL	British Sign Language
BSOG	Bus Service Operator Grant
CE	Conformité Européenne" (French for "European conformity")
DfT	Department for Transport
DVI	Digital Visual Interface
EMC	Electromagnetic Compatibility
ETM	Electronic Ticket Machine
GPS	Global Positioning System
HDMI	High-Definition Multimedia Interface
ITxPT	Information Technology for Public Transport
LED	Light Emitting Diode
NaPTAN	National Public Transport Access Nodes
OECD	Organisation for Economic Co-operation and Development
PA	Public Address
RTIG	Real Time Information Group
SYPTE	South Yorkshire Passenger Transport Executive
TfL	Transport for London
TFT	Thin-Film-Transistor liquid-crystal display
TxC	TransXChange

UKCA	UK Conformity Assessed
UKNI	United Kingdom Northern Ireland marking
UNECE	United Nations Economic Commission for Europe
VDV	Verband Deutscher Verkehrsunternehmen
VGA	Video Graphics Array
WCAG	Web Content Accessibility Guidelines