improving
public transport
through technology

Why Does My App Show Different Information to the Display?

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This document is Published.

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1 Introduction

1.1 About this document

1.1.1 This report has been produced for the Department for Transport and the Real Time Information Group (RTIG). The purpose of the report is to collate as far as possible – the reasons why information presented to the passenger may be different in different passenger facing outputs.

1.2 Background and context

1.2.1 In recent years, there has been an increasing focus on delivering improved public transport information to passengers. For authorities, this is seen in part, as a means of achieving broader policy objectives such as increasing modal shift away from private car use and thereby easing congestion on the roads; as well as improving the environment. For bus operators, it is seen as a key part of improving the image of the public transport offer.

1.2.2 The result of this focus is that most bus operators are now providing real time data for customers. Indeed, from 2021 bus operators were required under the Bus Services Act 2017 to provide location data to the Bus Open Data Service (BODS) for the majority of their services. This presents a unique opportunity to ensure consistent provision of bus location data to customers.

1.2.3 Previous reports and specifications from RTIG have covered a wide range of topics, and a number of the reports have made reference to the quality and/or accuracy of real time information (RTI): in the form of predicted arrival and departure times. One report specifically addresses the quality and accuracy of predictions. However, up to now, none have specifically covered some of the differences in information the passenger may experience in a multi-channel information environment.

1.2.4 With the near ubiquitous provision of location data for the bus fleet in the UK within reach, it is timely to consider why different information may be presented to the passenger on different outputs. This report sets out to address this gap in understanding through advice from RTIG.

1.2.5 Whilst this report does not explicitly provide advice on solutions for the causes of differences, in many cases these can be inferred from an understanding of why the differences occur.

1.3 Scope

1.3.1 This report has no statutory or other legal basis and is purely to provide advice to suppliers, local authorities and bus operators who operate real time information systems in the bus industry.

1.3.2 All aspects of a real time system: from originating source data through to dissemination channels, are potentially impacted by this report..

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.

1.4.2 RTIG also 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 Department for Transport in encouraging the development of this document.

2 Presenting Real Time Information

2.1 What is Real Time Information?

2.1.1 Real time information is information which provides a ‘live’ view of when a bus will arrive at a given location - rather than when it is planned (timetabled) to arrive.

2.2 Creating a Prediction

2.2.1 The key focus of an RTI system is to create accurate predictions and provide them to your various endpoints: to reliably inform the travelling public about departure times from their chosen stop. The predictions created are exactly that: predictions; and as such, they will rarely be 100% accurate. However, the greater the sophistication of a prediction engine - the better the predictions will be.

2.2.2 The creation of a prediction can possibly be best described through the use of diagrams. A vehicle will progress along its route, aiming to maintain the times contained within the static scheduling data that has been set by the operator. Without any external influences, the timetabled arrival at each bus stop would reflect the static schedule.

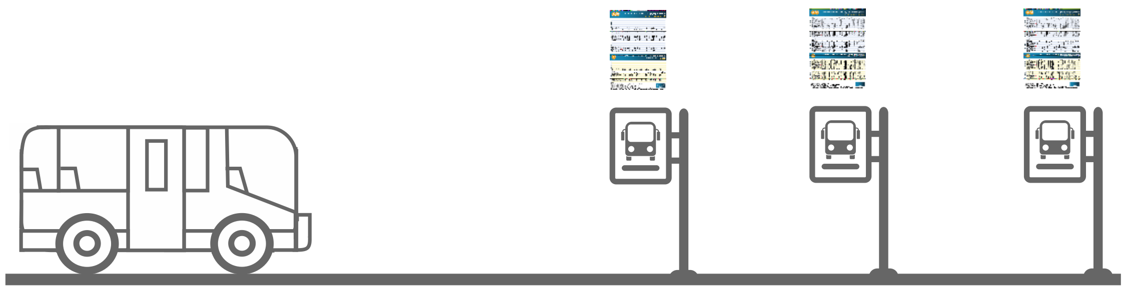

Figure 1 Bus progressing along a road reflecting the timetable

2.2.3 However the progression along the route may be affected by a number of different external influences including:

- traffic congestion;
- the number of passengers boarding and alighting;
- roadworks and traffic incidents; and
- the prevailing weather.

2.2.4 The vehicle will report its location regularly to a prediction engine, which will calculate the alteration to the time at which the vehicle is expected to depart each stop. This prediction is then provided to the various endpoints employed within an information estate - where it will overlay the scheduled time with the actual predicted time of departure.

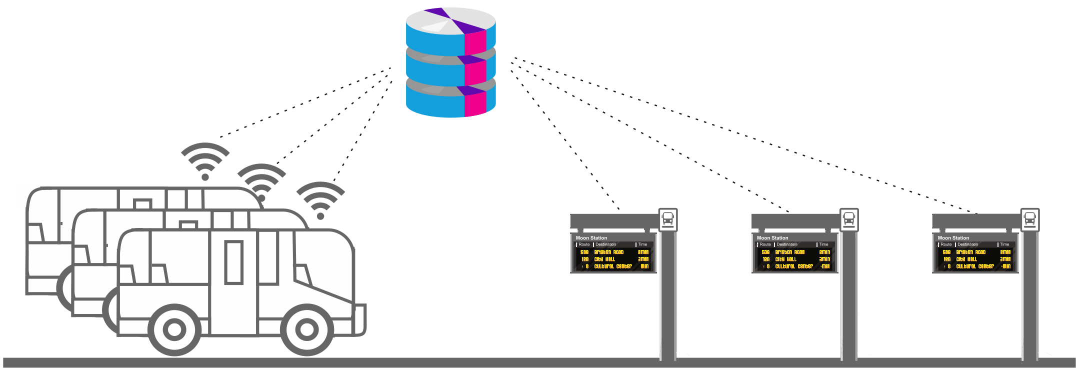

Figure 2 Bus progressing along a road providing location data to enable predicted time to be created

2.2.5 There are a number of factors that can improve a prediction but, at its most base level, a prediction can be best summarised as:

2.2.6

$$\frac{\text{Distance to next or upcoming scheduled points}}{\text{Predicted average speed between scheduled points}} = \text{Predicted time to scheduled point}$$

2.2.7 That is, the distance it has to cover in order to reach its destination - divided by the speed at which it is travelling, will equal the predicted time of arrival at that destination.

2.2.8 Obviously, this is incredibly crude and there are a number of factors that can improve a prediction. Indeed, most modern prediction engines take far more data into account when calculating a prediction. Dependent upon the RTI provider, this may or may not include:

- Schedule periods between stops – how long is the planned journey time between stop points?
- Historical journeys – how long has it actually taken in the past to cover the distance between stops?

- Historical time and day journeys – are the journey times influenced by the time of day – e.g. can it be reliably predicted that travelling into a city centre at 8am on a Monday morning will take longer than at 11pm on a Sunday evening?
- Current traffic conditions – does the prediction engine know anything of current traffic build up?

2.2.9 All of these can affect the information presented to the passenger.

2.3 Displaying Real Time Information

2.3.1 The ‘traditional’ approach to displaying bus RTI has been to show a 'countdown' to represent the predicted time at which a journey that was being tracked would depart the stop. Typically, this would be something along the lines of 5 mins, 4 mins, 3 mins, 2 mins then 'Due'.

Figure 3 A TfT display showing countdown times and a Due.

Figure 4 An LED display showing a mix of clock face and countdown times

2.4 Countdown or Expected?

2.4.1 There are other approaches to presenting information to the customer. These are discussed in the document: '*RTIGT037 1.0 Displaying Transport Information on Public Electronic Signs*'.

2.4.2 Of particular note to this report is the 'railway' style presentation which includes an additional column to present the expected arrival time.

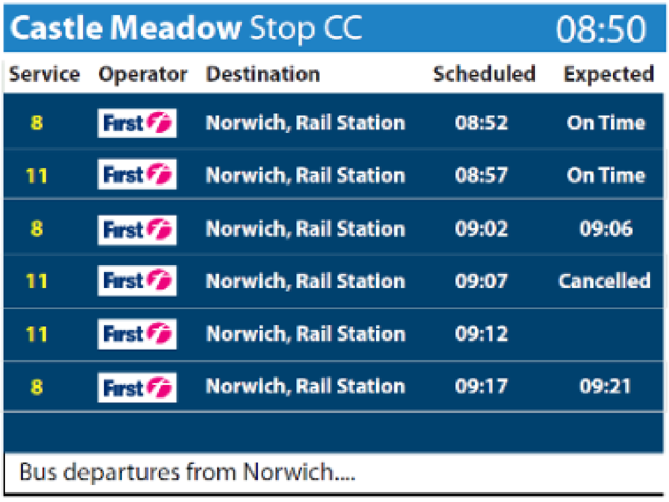

Figure 5 An example display from Norwich showing Scheduled and Expected for bus services

2.4.3 This style of presentation can make it easier for customers to see how accurate a predicted arrival time is - in that it is much easier to see when the service is expected and compare this against the clock – than to calculate what time it will be in 3 minutes.

3 How Are Differences Possible?

3.1.1 Providing information to passengers is carried out by a number of different organisations, who manage data in different ways using different IT systems.

3.1.2 The key organisations, for the purposes of this report, involved in providing information to passengers are:

- Bus Operators
- Local Transport Authorities
- Contracted 3rd Parties
- Open Data Consumers

3.1.3 With each organisation often having their own passenger information systems it is inevitable that there will be some differences between system outputs. In many cases it is possible to work with the different organisations to ensure that differences are minimised. For example a bus operator may contract with a company to provide a smartphone app – the operator therefore has some control over how information is presented and its quality. When *open* data is consumed there is less control over how information is presented.

4 Countdown vs Clock Face

4.1 Why is not all Information Countdown?

4.1.1 Some electronic display systems do only show countdown times.

4.1.2 These could be purely based on schedule times and show the time to planned departure in minutes rather than a clock face time. More often they only show predicted times, where a bus journey is not able to be predicted then the departure time is not shown in the display.

4.1.3 Typically, this approach to providing information has been used on on-street displays rather than apps and web based content.

4.1.4 A more typical approach to showing bus departure information is to differentiate between a predicted time and a scheduled time by using countdown (X mins) or clock face 17:34.

Figure 6 A TfT display showing a mix of clock face and countdown times

4.1.5 There can be a range of causes for a journey not being predicted and this may result in different passenger information between systems

4.2 Prediction Only

4.2.1 Most on street displays will show departure information whether a prediction is available or not.

4.2.2 Some on street displays will only show information which is a countdown time, where a journey has not been matched and prediction is not generated that departure will not be shown.

4.3 Prediction Look ahead

4.3.1 The further into the future a journey is the more opportunity there is for it to be disrupted - resulting in the predicted time being less accurate.

4.3.2 Because of this predictions are not normally generated and presented o the passenger for many hours ahead. The decision on how far ahead predicted information is presented is made on a system by system basis by suppliers in conjunction with operators and or authorities. Typically predictions are not shown more than 30 or 60 minutes ahead.

4.4 Different Timetable Data

4.4.1 Timetables can change on a regular basis, particularly the operational data which will change more frequently than registration data. All systems need to ensure that their timetable data is updated in a timely manner whenever there is a change that necessitates it.

4.4.2 If the departure times or ongoing schedules have changed, the prediction engine needs to know this. If it doesn't it will be attempting to match updates against journeys that have had changed timings or might not even exist anymore. Indeed, a change in the scheduling data by even as little as a minute can throw a prediction out - pushing expected departure times out accordingly.

4.5 Different approaches to matching

4.5.1 To create a prediction, data from the timetable and data about the live operation of a vehicle need to be matched to be able to know if a vehicle is progressing as planned or not.

4.5.2 If data cannot be matched in a simple highly accurate manner through for example unique references to each journey, then techniques need to be employed to work out in real time on which journey a bus is operating.

4.5.3 There are different approaches to this matching used by different systems, resulting in some journeys being matched and therefore being predicted in one system but not in another system.

4.6 Missing operational data

4.6.1.1 Operation data is an addition to the basic timetable data used to provide a printed timetable. This is information used by the operator to manage the bus fleet on a day to day basis and includes information such as which driver duty will drive a journey and which journeys a bus will make during the day.

4.6.1.2 Whilst this is not needed to provide a printed timetable, it is nonetheless important information to help with predicting what is going to happen to future journeys that a bus may make on a given day. One such example is where a bus is running late on its current journey this will affect the bus’s future journeys if there is insufficient time between journeys.

4.6.1.3 If this operational data is not shared between different systems or not used by a system this can result in a lack of predictions for early parts of a route, or different predicted times along the first part of a route.

4.7 Headway vs timetable

4.7.1 High frequency services typically six or more journeys an hour, may be managed to regulate the time between buses that a passenger would experience standing at a bus stop - rather than against a timetable.

4.7.2 Many systems require a timetable to *work* and in these cases a pseudo timetable may be put in place. However this may mean that journeys are not matched and / or journeys in the timetable are cancelled but the customer may not notice because their experience is a bus turning up every X minutes. Not all systems can however cope with this way of managing bus services.

4.8 Bus Bunching

4.8.1 Disruption to high frequency services can lead to confusion as the prediction system cannot represent: ‘bus bunching’ effectively – nor service-run overlaps; and buses running the same service overtaking one-another (predictions on a display do not uniquely identify a bus journey - only the service).

4.8.2 As a result of this, passengers can see services swapping order on displays or applications and at a busy stop this many mean the service they are interested in ‘disappearing’ from an on-street display (where only perhaps three or five departures can be shown) only to re-appear a minute or two later. Apps will typically show more departures so the service remains visible.

4.9 Operator Apps

4.9.1 Where an app or service is developed by a third party (for example traveline or Bustimes) or by a transport authority, all services from all operators will be shown.

4.9.2 Where a bus operator's own app is being used they may choose to only show their own service information, or they can choose to include other operators' services as well. Where other operators' services are shown, these will often be presented as timetable / clock face only as they will not have access to the other operators' prediction data.

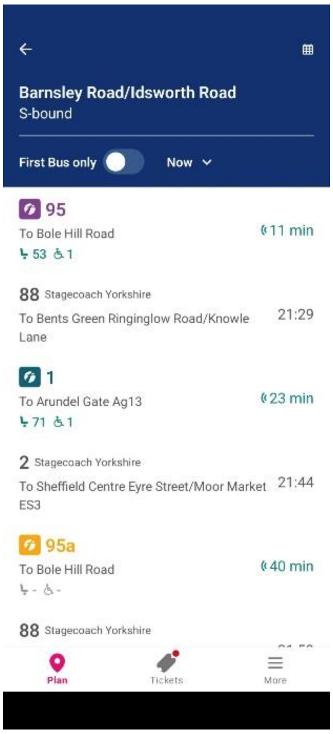

Figure 7 First Group app showing timetable data for other operators

5 Disruptions

5.1 Cancellations

5.1.1 Different systems handle cancellations differently even when an operator cancels a journey in their own IT systems.

5.1.2 There are different approaches to how cancellation information is presented to passengers including:

- Showing ‘Cancelled’ instead of / or alternating with the destination.
- Removing the scheduled time from passenger information.

5.1.3 Cancellation data cannot be shared with some data formats currently in use. In these situations, it is highly likely that the journey will appear on passenger outputs as a clock face time.

5.2 Diversions

5.2.1 Driving off-route because of a diversion due to roadworks or an incident -, thereby causing the bus to be too far away from its expected stops along the route can result in predictions being removed from bus stop displays and outputs. If the bus subsequently returns to the route, a system will often identify this and start to create predictions again;

5.3 Ghost buses

5.3.1 A ‘Ghost Bus’ occurs when a service is shown as predicting on on-line and/or electronic outputs (passenger information display screens, on-line, SMS etc.) but the bus (apparently) never arrives at the stop.

5.3.2 RTIG have a separate report on the topic of Ghost Buses and the causes, some of which overlaps with parts of this report.

https://www.rtig.org.uk/documents/rtigt054-1

6 Arrive vs Depart

6.1.1 Typically, a customer asks one of two questions of predictions: ‘when does my bus leave?’ or ‘when does my bus arrive?’

6.1.2 It is the departure time that is displayed on a bus timetable and this is often how customer outputs from RTI systems are described. In reality, unless there is a layover or it is a timing point, the real time system will often, but not always be, providing a prediction for the arrival time of the bus.

7 Prediction Engines

7.1 Prediction algorithm

7.1.1 Every prediction engine calculates a predicted time in a different way even when the raw data consumed is the same.

7.1.2 Predictions algorithms apply different priority to historical data than more recent data. For example recent journey times between two stops will have a greater impact on a predicted time than the journey times from the day before.

7.1.3 A bus operators prediction engine will only include their own vehicles data, whereas a local authority real time system which will have more than one operators data being processed, can use *any* data from *any* vehicle that has gone along a stretch of road – providing a more up to date journey time.

7.2 Use of track data Vs straight line distance

7.2.1 Some operator data includes track data in their timetables. This provides not only the stops that a journey visits but also includes more information on how the bus will follow the road network. This enables a more accurate distance between bus stops to be calculated, which will change predicted journey times when compared to an 'as the crow flies' distance.

7.3 Overdue Cleardown

7.3.1 When a bus departs from a bus stop displays and apps should no longer show the bus as due to arrive at that bus stop. The information should be "cleared down"

7.3.2 This manifests itself as 'Due' left up too long after the bus has departed because of:

- latency;
- incorrect coordinates for a stop;
- slow traffic;
- incorrect/incomplete dataset for journey times/line-of-route; or
- infrequent prediction update.

Different algorithms and systems handle clear down differently resulting in subtle differences in when a bus clears down.

8 Changing Times

8.1 Due

8.1.1 As a bus approaches a stop the countdown time is often changed to say ‘Due’. The general use case is when a bus is predicted to arrive at a stop – which may vary locally but is intending to mean: ‘too short a time for a minutes-countdown to be meaningful’ or ‘the bus is too close for the customer to consider wandering away’. The more frequent the location updates from a bus - the greater the likelihood of being able to use a shorter Due time. This short period is the most sensitive to disruption – through, for example, traffic lights or congestion; but it is also the time at which customers are most sensitive to the actual arrival of a bus.

8.1.2 The point of change depends on the real time system configuration and the setup of the passengers’ information channel - varying from 90 seconds down to 30 seconds.

8.2 When does 4 minutes become 3?

8.2.1 With a countdown time, when does the number of minutes a bus is away change?

8.2.2 Different systems use different approaches to the decision about when to change from saying 4 mins to 3 mins. Do you say 3 mins when the bus is 3:59 minutes away, or 3:30 or event 3:01?

8.3 Change Before Update

8.3.1 One of the common data formats used to transfer data between systems is SIRI ET (estimated timetable).

8.3.2 With SIRI ET there is a setting: ‘Change Before Update’. This setting controls when an updated predicted time will be sent to downstream systems.

8.3.3 If this were set to 30 seconds, the prediction would have to change by more than 30 seconds for the change to be passed to another system.

8.3.4 For example, when a journey starts, the prediction engine creates a predicted time for a stop half way down the route. If this prediction is accurate and nothing goes wrong (no unexpected congestion etc), and the predicted time at the stop does not change then no additional prediction data will be sent.

8.3.5 If the bus gets stuck in traffic which is not accounted for by the original prediction and is delayed for 20 seconds no update is sent. It is only once the delay increases to more than 30 seconds that a new prediction will be sent.

8.3.6 Different settings of ‘Change Before Update’ will result in different passenger information being presented for short periods of time.

9 IT Infrastructure

9.1 Latency between systems

9.1.1 Latency is the time it takes for data to be transmitted between systems and or the time it takes for a system to process or calculate data. Latency in any data transfer or calculation is never zero.

9.1.2 The amount of data being transmitted or processed will affect the latency - typically, but not always, the more data - the greater the latency.

9.1.3 Scaling a system to handle the amount of data in a timely manner is critical.

9.1.4 Latency is not always in the control of a supplier. For example a bus providing location updates in a highly populated city centre may find that the mobile network is heavily used - reducing the bandwidth available to the bus and slowing down data updates. Likewise, if there is no mobile network available, data will be sent when a network connection becomes available.

9.2 Lack of connectivity

9.2.1 All predictions rely on the original location data from the vehicle, so if there are 2G/3G/4G/5G or GPS black spots that prevent the vehicle from communicating back its position, reliable predictions cannot be generated.

9.2.2 This can be particularly prevalent in rural and coastal areas (which may not have mast overlap); and high-rise parts of built-up cities that suffer from urban canyons. It is an increasing problem with the closure of the 3G mobile networks and areas which did not have problems in the past may have in the future.

9.2.3 A total lack of connectivity will prevent the vehicle being tracked so that predictions cannot be generated; whereas intermittent connectivity may cause the vehicle to flip-flop between being tracked and untracked so that predictions are only created intermittently.

9.2.4 Different systems handle intermittent data differently. For example, missing updates for 5 minutes may mean in one system that a prediction is stopped and information returns to clock face but in another system it may do this after 3 minutes.

9.3 GPS Accuracy

9.3.1 Where there is poor quality or missing GPS data the reported location of the bus can change when the physical bus is not moving.

9.3.2 This changing location can if large enough, trigger a system to think that a bus has left a stop when it has not. Typically, this is at the start of a journey or a layover.

9.3.3 Some systems have tools to manage these problems to stop the false departure but not all do and this will result in different predictions between different systems.

Appendix 1 Glossary

RTIG	Real Time Information Group
GPS	Global Positioning Service
SIRI	Standard Interface for Real-time Information
RTI	Real Time Information