E-Paper Public Transport Information System

Graeme Scott, Colin Wilson and Gareth Tyler, IBI Group

1   Overview

IBI Group has been at the forefront of delivery of intelligent transport technology and systems for more than 30 years, introducing innovation and new technologies throughout that time. In recent years, IBI has been in investigating the use of electronic paper (e-paper) as a new means to improve the accuracy and accessibility of on-street travel information available to passengers and to transform their travel experience by making the transport network easier to understand and use.

Since the introduction of public transport, the generally-accepted method for presenting timetabled information has changed very little and to this day, passenger transport executives, councils and bus operators continue to manually update paper timetable information across their region on a regular basis.   This is labour intensive, has high operational cost and can be onerous to manage. Furthermore, the technologies used for the provision of real-time information on street have not evolved with changes in technology, and the information is similarly limited.

In November 2012, Centro (West Midlands Passenger Transport Executive) commissioned IBI Group to undertake a trial of an e-paper public transport information system. The trial, in which IBI designed, developed, manufactured and installed the system, has demonstrated the potential to deliver efficiencies and cost savings and to reduce carbon emissions. Moreover, it has also provided a platform for delivering an extensive real-time system to provide a much broader range of information across many platforms, supporting greater user convenience and mobility.

The prototype system has been operational since August 2013 where it is has been subject to extensive field trials. In addition to describing the concept and the results from the trial, this paper also sets out the future prospects for what could be the next generation solution for public transport information.

2   Prototype E-Paper Public Transport Information System

2.1   What is Electronic Paper?

E-paper is a display technology which has been designed to mimic the appearance of ordinary ink on paper – it's the technology used within eBook readers such as the kindle and kobo. Unlike conventional backlit flat panel displays which emit light, electronic paper displays reflect light like ordinary paper, theoretically making it more comfortable to read, and giving the surface a wider viewing angle compared to conventional displays.
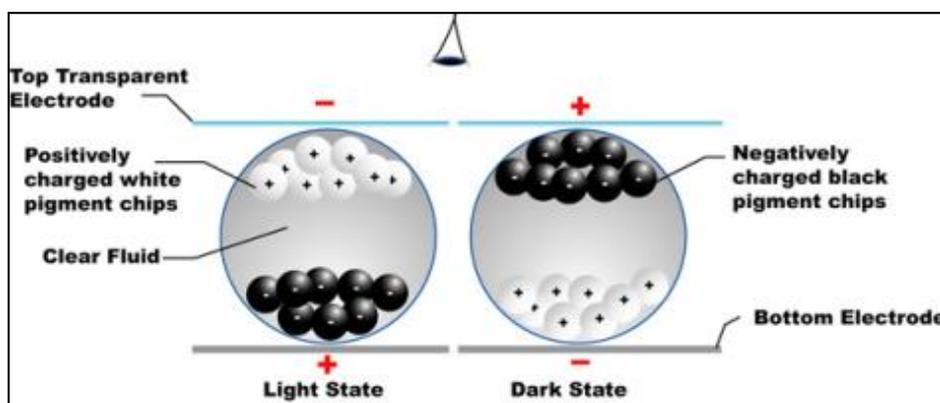

Figure 1 – E-Paper – How it Works

2.2   The Prototype System

Utilising IBI Group's knowledge of Centro's current working practices and systems along with the capabilities of the e-paper display screens, IBI Group and its subcontractors developed the prototype e-paper public transport information system to be trialled at the Oldbury Interchange on one of Centro's main corridors in Birmingham.

The prototype solution comprised two main components:

- Prototype e-paper display unit; and

- Prototype e-paper content management system

2.2.1   Prototype E-Paper Display Unit

The prototype e-paper display unit consisted of 8 x 10.2" e-paper panels, associated electronic components to remotely update the e-paper displays via mobile communications (GPRS) housed inside a custom modified double royal timetable display case.

The 8 e-paper panels are capable of displaying any suitably formatted image file at a resolution of 1024 x 1280 at 160dpi. This display area allows a wide range of information to be displayed, including timetables, real-time information (NextBus), disruption, deviation and diversion Information, local news and other general public information.
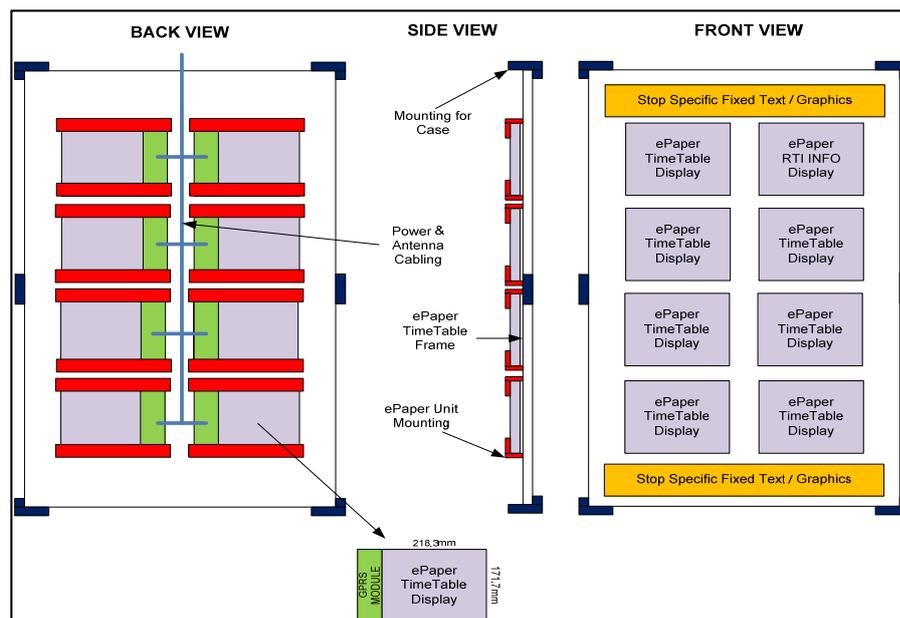

Figure 2 – Indicative Layout of -Paper Public Transport Information Display Unit

2.2.2   Prototype E-paper Content Management System

The prototype e-paper content management system (CMS) is an IBI Group system that provides Centro with the functionality to upload timetable and other images produced by Centro and/or other stakeholders to the e-paper units via mobile GPRS communications. The system has also been configured to link into Centro's Real Time Information (RTI) system, producing and uploading RTI images to a designated panel at a two minute time interval.

Figure 3 - Prototype E-paper Public Transport Information Display Unit

2.3   Near Field Communications

During the development phase of the project, an opportunity arose to utilise Near Field Communication (NFC) within the prototype e-paper display unit to add more functionality to the device and provide additional benefit to public transport users. NFC tags were placed at the bottom right hand corner of each display panel with a unique fixed URL to IBI Group's CMS. The images produced for the e-paper panels were updated to include a NFC icon and to support non-NFC enabled phones a tiny URL was included for customer to follow (sample NFC tag URL http://tinyurl.com/pzpqpa7). IBI Group's CMS also has the capability to dynamically change what information the NFC tag directs the customer to.
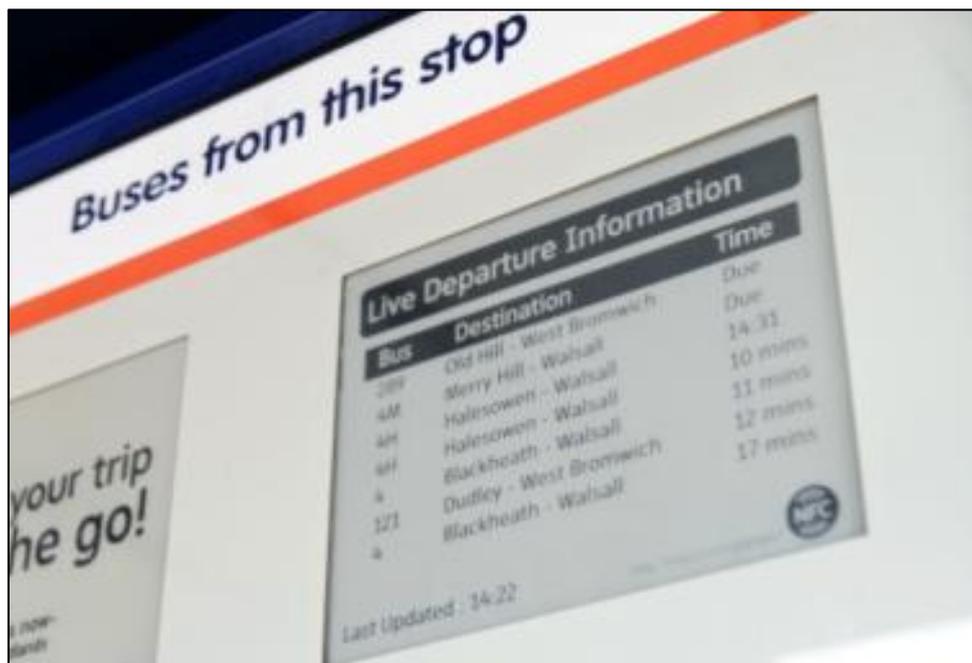

Figure 4 - RTI Display Panel featuring NFC Tag Icon

3   On Street Trial

3.1   Shelter Trial

The prototype unit was installed within an existing shelter in Oldbury Interchange on the 5th August 2013 where it was be trialled for a four month period. The implementation of this technology is believed to be a world's first. The trial period was successful with no unplanned downtime experience and the unit performing to specification.

The system and unit performance is only one element to the trial, with the other being user acceptance. In order that user feedback could be obtained several customer engagement exercises were undertaken:

3.1.1   Customer Relations

One of the display panels was set up to display information about the prototype system and provided information on how to contact Centro's customer relations department if customers wanted to find out any additional information about the prototype unit or to raise any concerns, issues or suggestions.

Figure 5 - E-paper Panel Image Used for Customer Relations Feedback

3.1.2   Customer Survey

During November 2013, Centro conducted a survey with 150 customers using that specific bus stop where the prototype unit had been installed. Customers were asked a total of 25 questions seeking information about their travel habits and their knowledge and views of the prototype e-paper unit installed at the stop.

The survey results were extremely encouraging with 80% of people thinking that this sort of development should continue to expand. The majority of people surveyed confirmed that the text size and clarity of the timetable images and real time information was at least 'about right' and 'quite clear', concluding that providing this information on this format is a viable option.

Several suggestions were also captured in relation to image clarity, lighting, highlighting of information which are being taken into account in the design of future units.

3.1.3   Local Councillor Endorsement

Councillor Keith Linnecor, Centro's Lead Member for the transport network, said: "It's fantastic to see this new technology being used here before anywhere else in the world. It puts the West Midlands right at the cutting-edge of passenger information."

"Using e-paper removes the cost and environmental impact of having to physically replace traditional paper timetables and gives us the chance to quickly provide updates when amendments to timetables are made. Having the screens function in this way also allows us to display important messages when needed and for passengers to access any extra information they might need straight to their smartphones."

The trial was also featured in local BBC news articles which added to the interest of the project - http://www.bbc.co.uk/news/uk-england-birmingham-23910851

3.2   Solar Power Trial

Following the success of the mains powered shelter trial, Centro commissioned IBI Group to undertake a second e-paper public transport information display unit. This implementation was for a smaller four panel unit, pole-mounted and powered via solar energy. At the same time, Centro extended the duration of the mains powered units for an additional six months to run in parallel with the solar trial to allow comparative results to be obtained.

Working with Nexus Alpha Low Power Solutions which has considerable expertise in developing solar solutions for the transport sector, and with street furniture manufacturers, IBI Group developed a solar powered unit featuring four e-paper panels, solar panels and batteries capable of running the unit at zero power costs for the entire life of the unit.

On January 27th 2014, IBI Group successfully replaced an existing stop pole in Oldbury with the e-paper solar pole where it is currently undergoing on street field trials.

Cllr Judith Rowley, Centro's Lead Member for fair, accessible and sustainable transport, said: "*This is the next step in our trial of new passenger information systems and looking at the future of how we work. Using solar power can make a major difference in allowing us to provide digital information at bus stops where it has proved difficult to connect with conventional means. The fact that this represents another world first really demonstrates Centro's commitment to being at the forefront of both passenger information and carbon reduction.*"

Figure 6 – Prototype E-paper Public Transport Information Display Unit – Solar Power Trial

4   Benefits Analysis

4.1   Qualitative Benefits

The utilisation of e-paper technology to display public transport information at the roadside has numerous qualitative benefits to both the information provider and the travelling public:

4.1.1   Timely Information Provision

The current production and distribution process to get new timetables installed at bus stops results in several timetables being installed prior to or after the new timetables become live. This means that information is often incorrectly displayed for a period of time. The e-paper system will remove this issue as all timetables can be updated within minutes of a new service registration becoming live. Advance warning of forthcoming timetable updates can be displayed alongside existing information by using another of the e-paper panels or alternatively, users can be directed to the operator's website containing this information via the NFC tag.

4.1.2   Correct Information Provision

Even with the best systems in place, mistakes such as service registrations incorrectly entered or paper timetables being installed at the wrong location inevitably happen. The e-paper solution can help minimise the impact of these mistakes with an automated system to ensure updates can be quickly and easily made should errors be identified.

4.1.3   Days of Alternative Operation Information Provision

Until now, the idea of integrating days of alternative operations (i.e. bank holiday) timetables into the 'normal' timetable, was unheard of due to the considerable resource and costs implications that this would require. Currently, information on days of alternative operations are either not provided on street or are provided in a very limited fashion via footnotes to the timetable or using flyers posted onto the timetable case.

The e-paper solution allows timetables to be updated and changed when required with updates being made to the on street units within minutes of the service registrations going live. This functionality enables days of alternative operations timetables to be integrated into the timetables on street providing customers with this valued information at the point where they need it.

4.1.4   Additional Customer Information Provision

Currently, Real Time Passenger Information Displays have a very limited amount of space available to display information and are therefore almost always limited to providing details of the next arrival. The provision of additional service information such as expected journey times, destination arrival times or more importantly, disruption, deviation and diversion information and the impact that this has on journeys, is not usually displayed. Where this kind of information is provided, it usually takes the form ofscrolling text which can be difficult for passengers to read.

The e-paper display units are able to show any suitably formatted image. For example, the information provided from RSL's CIS system could easily be formatted into an image that is compatible with the e-paper display units which would enable the RSL CIS information to be displayed direct at the roadside where it would be of most use to the customer.

4.1.5 Safety Benefits

The e-paper display units will be removing the requirement for a resource to drive to each bus stop and replace each timetable poster manually. This represents a significant safety benefit to that resource and other road users / buses of that activity.

4.2 Quantitative Benefits

The wider use of e-paper technology to display public transport information at the roadside will only be viable if it has both qualitative and quantitative benefits. The following quantitative benefits for the trial have been determined.

4.2.1 Operational Costs

Printing and Distribution Costs

The e-paper public transport information system removes the requirements for the printing and distribution of timetable posters. Depending on the number of services, operators and the frequency of service registration updates, this could represent a significant cost saving.

Power Costs

The e-paper display units do not require any power to retain the image displayed and only require a small amount of power (0.5w) to maintain a data connection between the device and the CMS. This means that each prototype e-paper display unit uses significantly less power than a typical three-line LED display unit (90w).

Communication Costs

The system transmits an image file to the units every time an update is required. Even with high frequency updates, data compression ensures costs are kept to the absolute minimum.

Maintenance & System Costs

Whilst still early, initial findings indicate that the maintenance costs are very low, again comparable if not better than that for existing RTI display units and systems. From a system perspective, the system required for publishing the images is proven technology and requires little maintenance.

4.2.2 Carbon Footprint

Birmingham has set itself one of the most ambitious carbon reduction targets in the UK – a 60% reduction in total emissions by 2027 against a 1990 baseline. Implementation of the e-paper public transport display solution has CO_2 emission reductions which will help achieve these ambitious targets as detailed below:

Printing CO_2 Saving

The printing element of the traditional paper based timetable provision has multiple components that would contribute to CO2 emissions (printing power, paper production, ink, waste etc) that would be negated with the use of e-paper.

Distribution CO_2 Savings

The distribution element of paper timetable provision represents a significant amount of CO_2 emissions for Centro in their commitment to provide passenger information to the public. Again, the

introduction of the e-paper display units for timetables will remove the requirement for this element completely and the associated CO_2 emissions.

Power CO_2 Saving

As mentioned earlier, the e-paper display units' low power consumption mean significant power savings compared with conventional three-line LED display units.

5   Conclusions

The trials undertaken have demonstrated that the e-paper timetable system can deliver a wide range of benefits to all stakeholders.

Firstly, for those responsible for such infrastructure, it has the potential for generating considerable cost savings and operational efficiencies as well as contributing to carbon reduction targets. Considering there are in excess of 100,000 public transport stops in the UK and with timetable updates in some cases up to ten times per year, this represents a significant financial and operational challenge. The success of the prototype e-paper timetable system has provided a viable option for addressing this challenge.

Secondly, it provides the platform for delivering more comprehensive real-time information, as well as additional planned service or general transport information. Moreover, it can be an integral part of a holistic approach to provision of comprehensive information utilising various outlets and can take full advantage of the growth in technology and the use of smart devices.

IBI Group believes that the use of such technology can be at the forefront of the next generation of public transport information provision and can play a central role in the continuing drive towards influencing mode choice.

6   Future Application and IBI Group's MOBILITY[IQ]

Going forward, IBI Group has integrated this concept into its MOBILITY[IQ] offering. MOBILITY[IQ] is a suite of transport data management modules. It uses the best available technology to provide an integrated, cost-effective means for Transport Agencies to manage, view and disseminate their information. In particular, MOBILITY[IQ]:

- helps Transport Agencies manage their access to data from a range of sources and view it in a clear and consistent manner

- manages the process of converting the data into useful information

- allows Agencies to manage the dissemination of their information to service operators, to other agencies and to travellers.

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Figure 7 –MOBILITY^{IQ} e-Paper Public Transport Information Display Units