RTIG

UK Real Time Information Group

Approaches to Using Bus RTI to achieve traffic light priority

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1 Introduction

1.1 About this document

1.1.1 This document has been produced for the Real Time Information Group (RTIG) by Centaur Consulting. It is first of two deliverables to be completed under 2004-05 RTIG Government Task 1.3: "Evaluation of implementations". It reviews the use of RTI systems by a number of UK local authorities to implement traffic light priority, explores the value of this to bus operations, and captures plans for the future.

1.2 Background

1.2.1 In order to gain an overall picture of the issues affecting the RTI marketplace, Government and RTIG wish for an understanding about how some specific practical issues are assisted by the implementation and effective use of RTI systems.

1.2.2 Analysis to date has focussed predominantly on providing information to passengers about the running of their service, or on the direct use of bus running information for operational fleet management. However the existence of an RTI system enables a range of newer management practices – in particular, assisting the smooth running of bus services by providing priority at traffic signals.

1.2.3 This use of RTI is a more complex one than the 'traditional' uses, as it requires not only links between LA passenger transport divisions and bus operator(s), but also links with LA traffic management functions.

1.2.4 The aim of this study is to present the experiences of some LAs with direct experience of doing this. This report aims to be informative rather than comprehensive or analytical; it does not aim to recommend a particular approach to bus priority, or determine a particular value for it. It does, however, compare and contrast a number of implementations, draw common threads and indicate some key trends.

1.3 Document structure

1.3.1 The document is structured as follows:

- Section 1: introduction
- Section 2: policy context
- Section 3: overview of practice
- Section 4: conclusions

1.3.2 Annexes A-E provide detailed review of individual implementations. The authors are grateful to staff at Glasgow City Council, Lancashire County Council, Surrey County Council, Transport for London, and Metro (West Yorkshire PTE) for their assistance and review of these annexes.

1.4 Document status

1.4.1 This document is a **full draft** for review by the RTIG Executive and its Government client.

2 About traffic light priority

2.1 Government policy and guidance

2.1.1 Government and local authorities have long been looking at ways of reducing demand for cars and encouraging better use of public transport. The phrase "bus priority" has for some years referred generically to any mechanism that treats public transport vehicles more advantageously in their access to or use of the road network.

2.1.2 The simplest priority mechanism is the bus lane: dedicated roadspace for buses only. In some circumstances this can be very effective, requiring little more than a coat of red paint and some signs, but in many cases it is not practical: either it would require very expensive new lane construction, or it would hobble the capacity of an important route to the point of unacceptable congestion (which would also affect buses).

2.1.3 Where there is network management, this provides a much more sophisticated and targeted way of improving bus journeys. Bus-only signals, and priority at traffic signals, are the result. This requires a means by which a traffic signal can be told a bus is coming, so that it can take the relevant steps: hold a green for longer, phase recall, phase insertion, etc.

The Ten Year Plan

2.1.4 The DfT's White Paper in 2000, the Ten Year Plan or "Transport 2010"set out and costed a long list of specific goals. The Summary includes a number of targets including ("Locally across England") *"extensive bus priority schemes, including guided bus systems and other infrastructure improvements, also benefiting coaches."*

2.1.5 Later (section 6), it is stated that *"Statutory Quality Partnership schemes will give greater confidence for both parties to invest, and will enable quality standards to be set and enforced. They will deliver more new buses and new infrastructure, including improved interchange and waiting facilities, better passenger information services and bus priority measures."*

2.1.6 The Ten Year Plan was perhaps the first major policy paper to describe unambiguously the pervasive and critical role of transport management systems. However it is clear that during 2000 bus priority was still seen substantially as a matter of segregated infrastructure and service operation, and the role of technological tools was not stressed.

A Network for 2030

2.1.7 By the summer of 2004, the policy perspective had not changed much. In July, the Secretary of State presented to Command Paper 6234 on "The Future of Transport: a network for 2030". As a policy statement, this Command Paper stated that "*bus services must be:*

– ***punctual*** *– which means giving buses priority in congested locations and using more pre-paid ticketing to speed boarding;*

– ***good value*** *– for the traveller and the taxpayer;*

– ***frequent and reliable*** *– with up-to-date travel information that is easy to obtain;*

– ***seamless*** *– with good integration of bus services and other travel networks*"

2.1.8 It went on to note that *"we have improved local transport by* [inter alia] *supporting bus use with improved infrastructure. Outside London, over 1,200 kilometres of bus priority schemes were completed last year, helping to make buses a more attractive alternative"*.

Network Management Duty – guidance to LAs

2.1.9 Following the Traffic Management Act 2004, the Secretary of State for Transport issued guidance under Section 18 to local highways authorities in December 2004, on how they should interpret their new statutory duties as network managers.

2.1.10 This guidance says (para 38) that Government policy has led to *"the encouragement of public transport through ticketing schemes or better information, bus priority and quality initiatives, and congestion charging. These can all help to secure the more efficient use of the road network and successful measures can have an impact on its operation."* Although this is no more specific than the earlier policies, it puts bus priority more clearly alongside other technical means of transport information and management. The guidance goes on to say *"They should not be seen as being in conflict with the principles of the duty and it is for the LTA to decide on the most appropriate approach for managing demand on their own network."*

Traffic Advisory Leaflets

2.1.11 Away from the legislative arena, the Department has been much clearer and more specific about bus priority. Two key TA leaflets have been published, one in 1999 and the second in 2003, both under the auspices of Traffic Management Division.

2.1.12 The 1999 leaflet provides *"a summary of findings of research on bus priority"*. It notes that *"a large number of local authorities and bus companies have used Quality Partnerships and Bus Initiatives to invest in bus priority and highway infrastructure or modern vehicles"*, and notes the following as "outcomes":

- *"Greatest bus passenger benefits are obtained from whole route priorities, which may comprise a combination of bus lanes, queue relocation and junction priorities (SCOOT, MOVA, Selective Vehicle Detection, etc.). Congestion along bus routes is often irregular, and buses generally obtain most benefits from measures in the most congested areas. Often such measures cause the greatest delays to other traffic, though these can be diminished with careful planning.*
- *...*
- *"Bus priority is possible at traffic signals, and can use systems already in place for other purposes, e.g., real-time bus information equipment.*
- *"Modelling, confirmed by on street surveys, indicates Bus SCOOT can reduce bus travel times by 2 to 4 minutes on a 10 kilometre bus route, with the variability of travel time improved by up to 16%. Time savings of 1 to 10 seconds per junction (with an average of 4 seconds), and travel time variability improvements of 0 to 20% (with an average of 12%) were achieved."*

2.1.13 Intriguingly, this review compared quantitatively the benefits SCOOT priority (ie traffic light priority granted through the SCOOT UTC system) against bus lanes, and found them to be similar in order (see figure below).

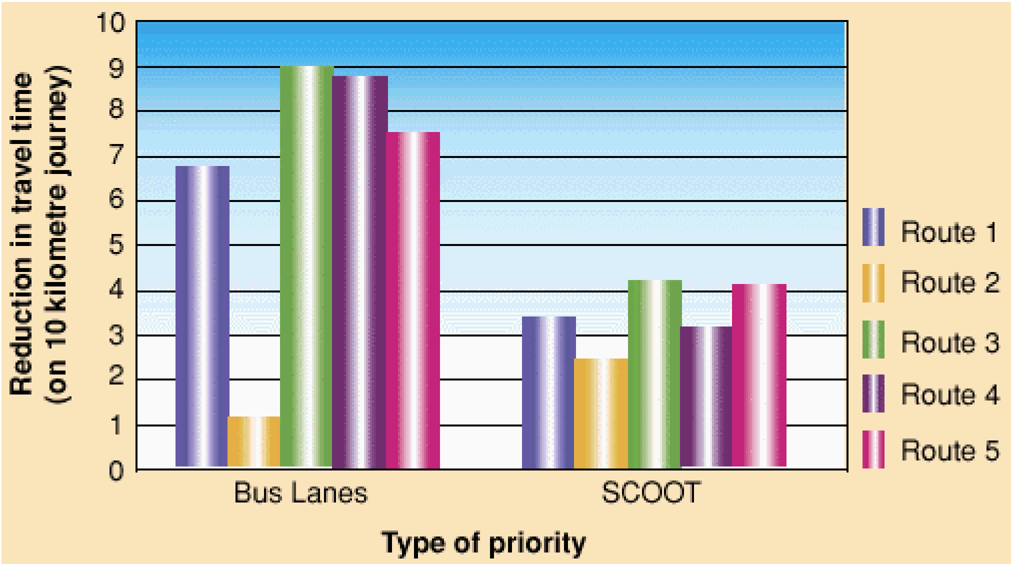

Figure 2-1: Priority through SCOOT and bus lanes compared (source: DfT Traffic Advisory Leaflet, from DfT website)

2.1.14 The 2003 TA Leaflet, produced under the ITS Assist project, was more specific yet. The next section is a direct extract from this leaflet.

2.2 Definition and options for TLP (extract from 2003 Traffic Advisory)

2.2.1 *Network management tools such as Urban Traffic Control (UTC) systems, including those using SCOOT (Split, Cycle and Off-set Optimisation Technique), have functions to enable priority on receipt of demands from vehicles. The UTC systems can dynamically affect traffic signal timings across a number of junctions in response to a demand, and then compensate other vehicles after the priority vehicle has passed. The ability to compensate means that priority is achieved with little increase in delays for other vehicles.*

2.2.2 *Priority systems require knowledge of a vehicle's location to function correctly. Operators can use this location data for other systems such as Real Time Information for public transport users, or for Fleet Management Systems. Therefore, infrastructure can be shared between various systems thus providing better value. Many of the technologies can be added on to existing control equipment, and hence can be installed economically. The DfT's Urban Traffic Management and Control (UTMC) initiative provides a framework for the integration of different traffic management systems through the employment of open system design.*

System Design

2.2.3 *Public Transport Priority can be installed in isolation or as part of a package of measures along a route. It is therefore important that the technology and physical measures are designed to complement each other. The key components of a system are:*

- *Vehicle location equipment;*
- *Communications;*
- *Data processor (local or central); and*

– *Traffic Control Equipment.*

The diagram below illustrates a typical arrangement of the key components of a system.

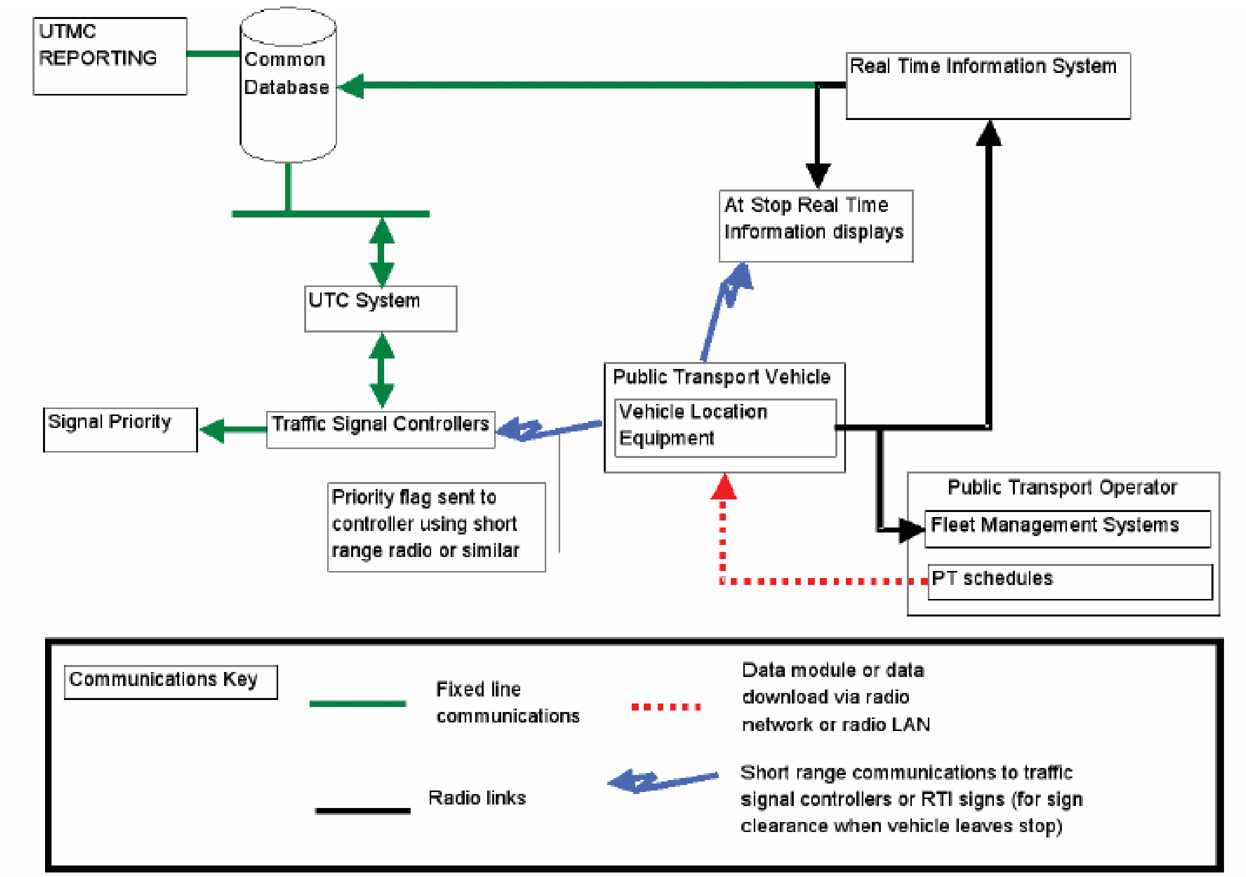

Figure 2-2: Key components of a typical public transport priority scheme
(source: DfT Traffic Advisory Leaflet, from DfT website)

2.2.4 *The location of vehicles on the network can be achieved using a number of technologies, for example:*

– *Detector Loop;*
– *Roadside beacon;*
– *Vehicle profile recognition via inductive loop detection; and*
– *Global Positioning System (GPS).*

2.2.5 *Data processing at the traffic signal controller is generally restricted in capability, as the controller has a limited knowledge of traffic conditions on the rest of the network, even if part of a UTC system. Priority actions are therefore limited to the specific intersection. These actions are usually to:*

– *Extend the green so that the bus can pass before the end of the stage;*
– *Recall a stage more quickly by terminating other stages early;*
– *Call a special stage such as an exclusive right turn; and*
– *Provide compensatory stages to other traffic once the priority vehicle has passed.*

2.2.6 *Centrally based processing can take into consideration a greater range of factors including the degree of congestion not only at the location where priority is demanded but in other areas of the network. This enables more wide-ranging decisions to be made in progressing the vehicle.*

2.2.7 *Studies have shown that the benefits of public transport priority systems are more effective where priority is implemented as part of a package of measures for a whole corridor or route.*

- *In SPRINT in fixed time UTC, a reduction in delay of between 2 and 6.4 seconds per priority vehicle per junction was achieved.*
- *Bus Priority in London using SCOOT UTC resulted in a reduction in delays to buses of between 22% and 33%.*

3 Using traffic light priority

3.1 Background and current practice

3.1.1 Given the long-standing background of policy to encourage the development of high-quality public transport, it is not surprising that local authorities have worked for many years to provide preferential access to the road network to buses relative to private cars. What has changed is the means available to do this feasibly and cost-effectively.

3.1.2 The first moves in this area were developments of the traffic control system, and involved putting a bus detection system upstream of the signals that it was desired to affect. There are various ways of doing this:

- the most popular involves a special loop detector, working in conjunction with identification equipment (transponders or "tags") mounted on the underside of the bus;
- alternative solutions required no tags but used more sophisticated loop signal processing;
- more recently, experiments have used streetside cameras with image analysers to "see" buses.

3.1.3 All of these work; none is especially cheap or reliable. From the local authority position the advantage of the latter two is that they can be done as needed, and do not require complex cooperative working with bus operators; from the operator perspective, they do not have to do anything to gain traffic signal advantage.

3.1.4 Only relatively recently has the question been looked at from the other side: putting bus systems in control. The catalyst has been the development of bus real time tracking systems installed in the first instance, usually, in order to provide passenger information. As RTPI systems have rolled out around the country, and joint LA-operator systems implementation became more normal, it was inevitable that RTI systems should be brought into the traffic light priority equation. Implementations seen by the industry as marking turning points include:

- Kent where, from 1997 onward, a scheme was initiated to use GPR-based bus tracking specifically for TLP – indeed, prior to the consideration of passenger information;
- Cardiff where, from about 2000, an RTI-based TLP scheme first used logic to vary the levels of priority given (rather than just reacting to an "I am a bus" trigger).

3.1.5 The effect, as it now appears, has been a dramatic improvement in the scope and scale of traffic light priority, on the back of passenger-oriented projects. The experience of implementers has been that RTI systems enable much faster, and much more comprehensive, deployment of priority than the older solutions.

3.1.6 From the logical perspective, there are two primary ways of designing a TLP system.

- *Local control.* In this approach, a suitable message is passed from bus to signal controller and the controller takes decisions locally. The bus and, where relevant, the signal controller, may inform their respective area control systems of the actions they have taken. The benefit of local control is that the message is passed and the decision taken quickly, which improves the quality of priority given to the bus.
- *Central control.* Many signal controllers are under the direct supervision of a central system such as SCOOT, which manages the phasing of one junction to 'fit' with what is happening at other junctions. This improves overall network flow. Local control can disrupt this

carefully orchestrated system, so in central control the message from the bus is related to the traffic management centre, and decisions taken; here, not only can priority be given at one junction but also other junctions can be adjusted. This avoids the problems (which can happen with local control) of priority for one bus causing general network congestion which delays other buses.

3.1.7 Which is better depends very much on specific circumstances.

3.2 Who's involved

3.2.1 The key actors in delivering and operating a traffic light priority scheme are typically:

- the bus operator (for on bus equipment);
- the LA's passenger transport department or the PTE (for coordination and associated matters such as passenger information facilities);
- the LA's traffic management department (for configuration and management of traffic light controllers);
- the LA's highways department (for bus lanes and other infrastructure aspects).

3.2.2 Some solutions do not require all of these actors to participate.

3.2.3 Locally, schemes are usually run in the context of a Quality Bus Partnership, where solid working relationships between local authority and operator already exist. Nationally, the issue of TLP is on the boundary of a number of initiatives.

3.2.4 RTIG's role to date has been the production of the technical standard, *Specification for the Radio Link Protocol and Transmission Methodology for RTIG Traffic Light Priority and Display Cleardown* (RTIGT008-1.3). This is intended to provide all necessary information to allow equipment from different suppliers to interoperate.

3.2.5 UTMC has been the main national initiative concerned with the use of technology in traffic management, and has maintained a keen interest in the management if traffic signals to meet multiple policy goals. Bus priority was specially dealt with in an early project (UTMC01, hosted by Leeds). Although UTMC has not specifically sought to exploit this aspect, it has provided the core platform for integrated transport management in places such as York, Lancashire and Glasgow.

3.3 Case studies

3.3.1 Annexes A-E detail the ways in which five areas of the UK – Glasgow City, Lancashire County, Surrey County, London, and West Yorkshire – have explored traffic light priority in the past, and how they are now approaching and exploiting RTI-based priority.

3.3.2 There is much that is common among these implementations. All of the authorities have previous experience in priority through older systems, and are finding the new approach much improved. All of them are finding that this move is very helpful in maintaining a good relationship with their local bus operators. They all have the support of their politicians and (as far as it can be determined at this stage) of the public. And all of them are just at the beginning of what is perceived as a pretty rapid, large-scale rollout.

3.3.3 That said, there are also significant differences between the implementations. The sample represents three metropolitan areas and two shire counties. Each locale has its own organisational issues – for example, London has the special status of London Buses to help it, while in West Yorkshire the PTE has to liaise with five separate LAs for traffic management purposes. Glasgow is dealing predominantly with one large operator, while Lancashire has several, and not all of them want to be part of the process – especially as they are asked to contribute funding.

3.3.4 The figures below provide some comparative views of the schemes that have been reviewed, from the perspectives of timetable, cost, and scale. The picture is one of dynamic development in all areas.

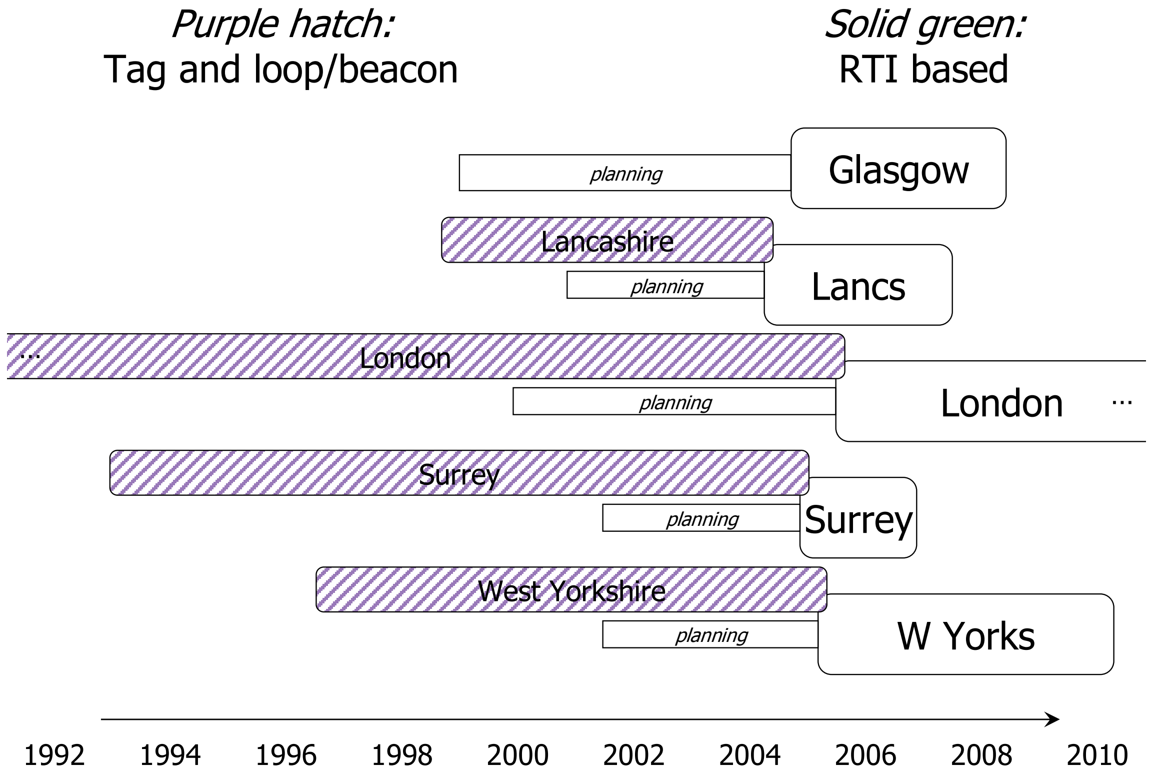

Figure 3-1: History of TLP implementations

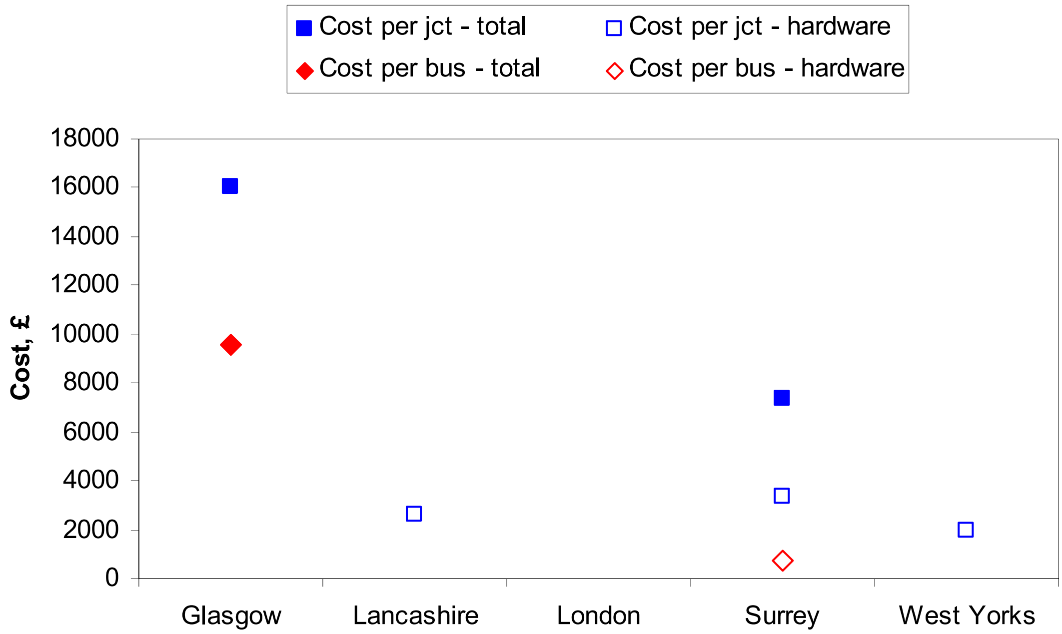

Figure 3-2: Financial comparison of RTI TLP schemes

3.3.5 Note that the Glasgow cost per bus reflects full project costs for the BIAS AVL project, and include not only equipment and implementation costs but also the cost of at stop RTI signage. Figures for London are not yet available.

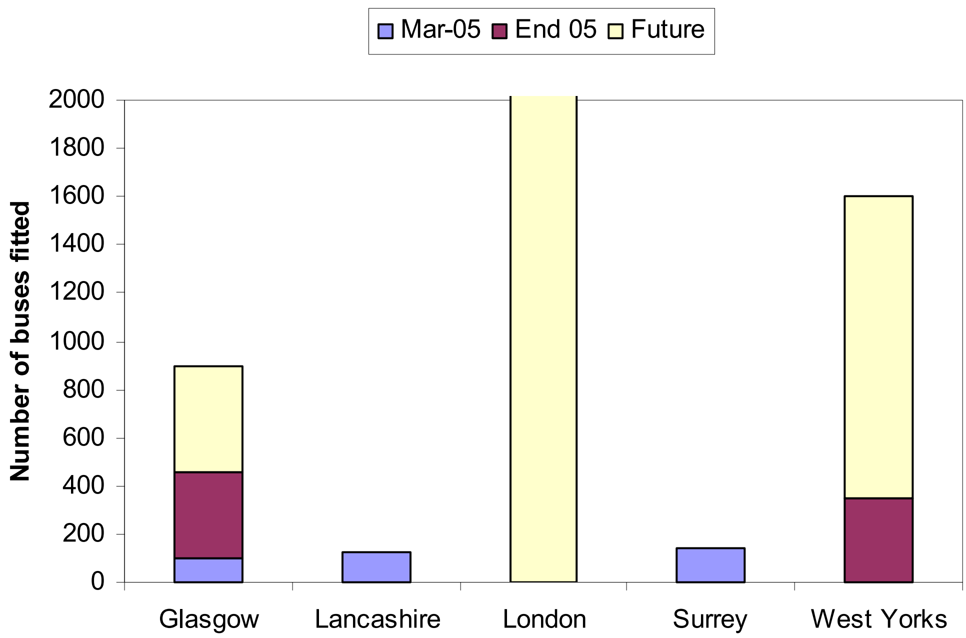

Figure 3-3: Scale of RTI TLP implementations – vehicles

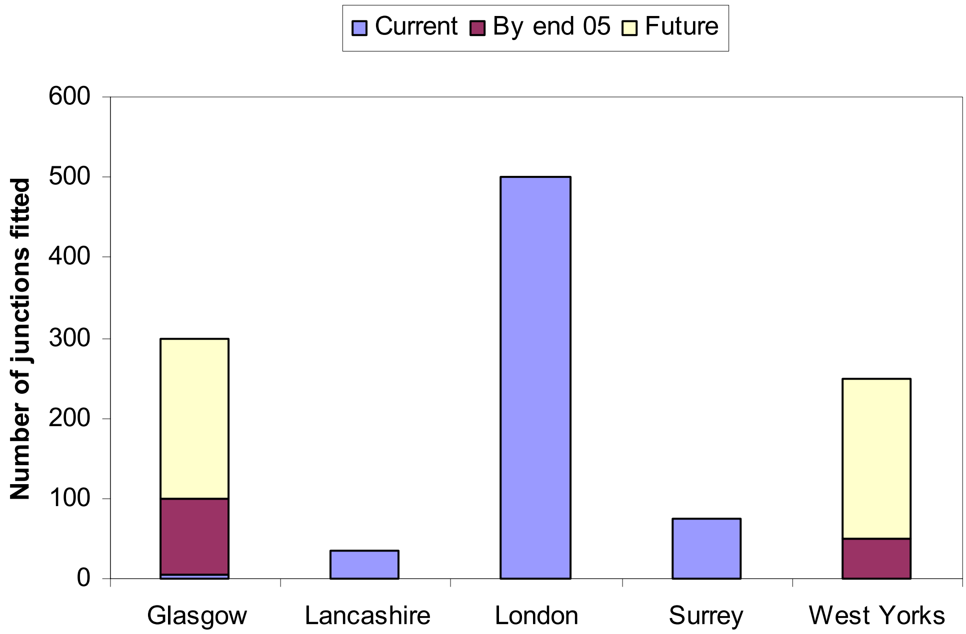

Figure 3-4: Scale of RTI TLP implementations – junctions

3.3.6 In figures 3-3 and 3-4, London is shown as having existing junction installations but future bus fits as it is not clear how much of the existing signal controller configuration (established for the beacon system) will be reusable for the new AVL system currently in procurement.

3.3.7 Furthermore, TLP systems are being asked to become increasingly sophisticated: granting priority based on how late the bus is running depending on which junction, which service, time of day, and in future potentially also passenger loading.

3.4 Key challenges to implementation

3.4.1 As TLP has been considered for a while, many of the issues that trip up ITS implementations – organisational issues, for example, and even issues related to revenue finance – have not proved to be major stumbling blocks in RTI-based TLP. As a facility it has general political backing from LAs and operators, and does not cost excessive amounts of money.

3.4.2 Nor are the details of the priority services normally a great problem. There is a general agreement that priority needs to be implemented intelligently, with due care taken to ensure that priority for buses does not conflict with general congestion management, through choices such as priority for late runners only, time-of-day switches to avoid rush hour problems, etc. Although what is suitable will depend on the nature of individual junctions, and to an extent possibly on local politics, it has generally been straightforward to agree an approach.

3.4.3 Nor, in the technical area, has the RTI-controller interface proved a great problem. It is true that implementers have been frustrated by the time taken to agree an RTIG standard for this, but they have either worked with RTIG timescales or worked around the delays without too much difficulty.

3.4.4 Rather, the key challenges lie in the details of the implementation and management of TLP:

- the configuration of traffic light controllers, or their controlling outstations, to implement the chosen approach to priority;
- the day to day management of what then turns into a very complex distributed computer network: recording what settings have been implemented at a given junction.

3.5 Maximising the net benefits

3.5.1 Having said this, TLP has to date been implemented largely on the basis that it must be a good thing for public transport; there has been very little attempt to date to quantify the benefits, or indeed to determine where the balance tips from "enough priority to be good for buses" to "so much priority that congestion builds". The reason is straightforward:

- few systems yet have the area-wide reach that makes this analysis sensible;
- furthermore, only with RTI-based systems (where detailed monitoring information is readily available) is the analysis practical.

3.5.2 The expectation, therefore, is that the coming year or so will see much more work being done locally to evaluate and 'fine tune' TLP.

4 Conclusions

4.1 The opportunity for TLP in the UK

4.1.1 TLP has a relatively long history in the UK, but only relatively recently – with the advent of RTI systems – has the technology been available to deliver it in the flexible, cost effective and manageable way needed by both local authorities and bus operators.

4.1.2 Through dialogue between implementers and system suppliers, the RTI systems industry is now well prepared to deliver TLP functionality in its products. There is therefore plenty of scope for TLP to be expanded around the country, pretty much wherever RTI exists.

4.2 RTIG's contribution

4.2.1 Common standards and interoperation for bus priority are becoming as important as for any other roaming issue – more so in metropolitan areas, where a single PTE works alongside several traffic management authorities.

4.2.2 Based on this brief review, RTIG has a role in at least the following areas:

- firstly, clearly, it needs to maintain the current specification (putting in refinements identified as necessary), and monitor who is using it.
- secondly, it needs to work with the controller industry – at national level, perhaps through its liaison with the UDG – in order to develop better tools for the configuration of controllers. Of course there may well be many roles for these tools, other than granting priority requests to buses.
- thirdly, it needs to help collate information across the UK on the quantified benefits of RTI-based bus TLP. This is likely to be of significant value in sustaining the RTI market, through facilitating the business case for bus operators.

A Case study: TLP in Glasgow

A.1 Sources

A.1.1 Thanks to Hamilton Purdie for discussing the use of TLP in Glasgow at length on 16 February 2005. Additional input was obtained from previous GCC material on the BIAS project, particularly the presentation given at the 2004 UTMC Annual Conference, and from supplier materials.

A.2 Policy and strategy

A.2.1 Glasgow City Council has been looking closely at opportunities for managing bus transport more effectively for around a decade, since the development of an ITS Strategy for the city in 1996. The Bus Information And Signalling (BIAS) project was created to deliver an "integrated system for the management and operation of Glasgow's Quality Bus Corridors".

A.2.2 Planning and design for the BIAS project, through the Scottish Executive's Public Transport Fund mechanism, occurred during 1999-2002. Following competitive tendering, a contract was awarded for the supply of a SCOOT UTC System to a consortium led by Peek Traffic in 2003, for completion by 2006. Peek managed the signals programme; Mott Macdonald managed the provision a UTMC-compliant Fault Management, Common Database and Integrated Management Facility including Strategy Integrator and Performance Evaluation Modules. Serco, Bridge and AIM were contracted in a separate lot to provide an AVL and RTI System.

A.2.3 TLP is one of a range of facilities delivered by BIAS which provide improvements for public transport. The specific benefit of TLP was seen not so much as an improvement in absolute journey time but as a reduction in the variability of bus arrivals, which was seen as a major disincentive to passengers and potential passengers.

A.2.4 The deployment of TLP in the future involves a broadening of the deployment sites and functional flexibility. The BIAS system architecture provides the facilities for a wide distribution of intelligence, leading to a hierarchy of strategic/tactical control: overall control is maintained by the central SCOOT UTMC system, but Glasgow also wants to use peer-to-peer communication between outstation and the centrally located AVL and UTC management systems (if possible), particularly on arterial routes.

A.2.5 For most sites, priority requests will be based on a message passed from the Serco/ AIM system to SCOOT, which takes signal-setting decisions on an area basis. Non-SCOOT sites (where remote monitoring or fixed time UTC is used), as well as sites where there is a stopping point too close to traffic signals, will make their priority request locally, sending a pre-emption message via the Peek IOUT (intelligent outstation) to the signal controller.

A.2.6 Priority will not be requested on a blanket basis. Degree of lateness will be taken into account initially, so that only buses running particularly late will ask for priority; this feature will be provided within SCOOT. Glasgow is looking actively at further refinements to this, and will consider passenger weighting (using count data taken from the ticketing machine) in the future.

A.2.7 As Glasgow's UTC is being developed in line with the national UTMC integration framework, there are a number of competing policy demands on the system: for instance, in addition to bus TLP, Glasgow is also continuing to provide centrally controlled Fire Engine emergency vehicle priority. For these reasons, the decision to grant priority must lie within the traffic management system (ie SCOOT).

A.3 Deployment

A.3.1 When complete, the Glasgow system will be a fairly large system, and certainly one the largest to offer such full integration between traffic management and bus management systems. However deployment to street is currently at an early stage: out of the 10 sites equipped as part of the initial phase, 6 are SCOOT junctions operating with TLP. The other 4 sites are Pelican crossings, which are not provided with pre-emption facilities.

A.3.2 Currently 12 vehicles are fitted with equipment enabling them to request TLP, but this is set to rise very sharply in the near term – up to 100 by the end of March 2005, and 460 by the end of September 2005. All of these vehicles belong to First Glasgow, which operates 3 large depots in the area, each with 300 vehicles. The 460 vehicles planned for equipment this year represent the vehicles used to serve the majority of Glasgow's QBCs.

A.3.3 Delivery is being phased to implement sensible 'blocks' of service, as follows:

- the initial phase (the "Basic BIAS" system) was deployed to demonstrate and prove functionality;
- the next phases extend the service to QBCs as they become available, taking into account the phased delivery of new vehicles to the First bus fleet – delivery by September 2005;
- provided that the QBCs work well, the intention is to deploy subsequent phases via the remaining 440 vehicles of the First bus fleet.

A.3.4 In parallel with the expansion of vehicle fits, the number of junctions will also be expanded. By the end of the project in 2006, new-style BIAS UTMC will be implemented at 300 signal sites of eight QBCs. Because of the complexity of signal configuration and the physical changes to the road infrastructure, this part of the project will take longer than the vehicle fits.

A.4 Technical choices

A.4.1 The integrated system allows for bus priority requests to get from bus to signal via a number of paths, as described above. The wide-area communications from bus to centre are provided over analogue PMR, using Band III (3 base stations). Instation communications are over standard LAN interfaces and thence via standard SCOOT IP communications to signal controllers (via LAN or Mesh radio).

A.4.2 For local pre-emption, the telecoms radio standard DECT has been used from the bus to the I-OUT. The outstation then sends a message to the SCOOT instation to manage request and recovery.

A.4.3 In terms of technical standards and guidelines, TR2210 has been used in the configuration of traffic signals, and the SCOOT Handbook to configure the SCOOT instation. RTIG technical standards and guidelines have not been used for TLP as:

- SCOOT is managing the priority centrally, and internally;
- the RTIG short-range comms protocol was not in a sufficiently robust state to make use of this when the system was designed.

A.4.4 The principal technical problem was the complexity and cost of configuring the controller for TLP. A standard for an outstation to manage TLP locally would have been a significant advantage in minimising these issues.

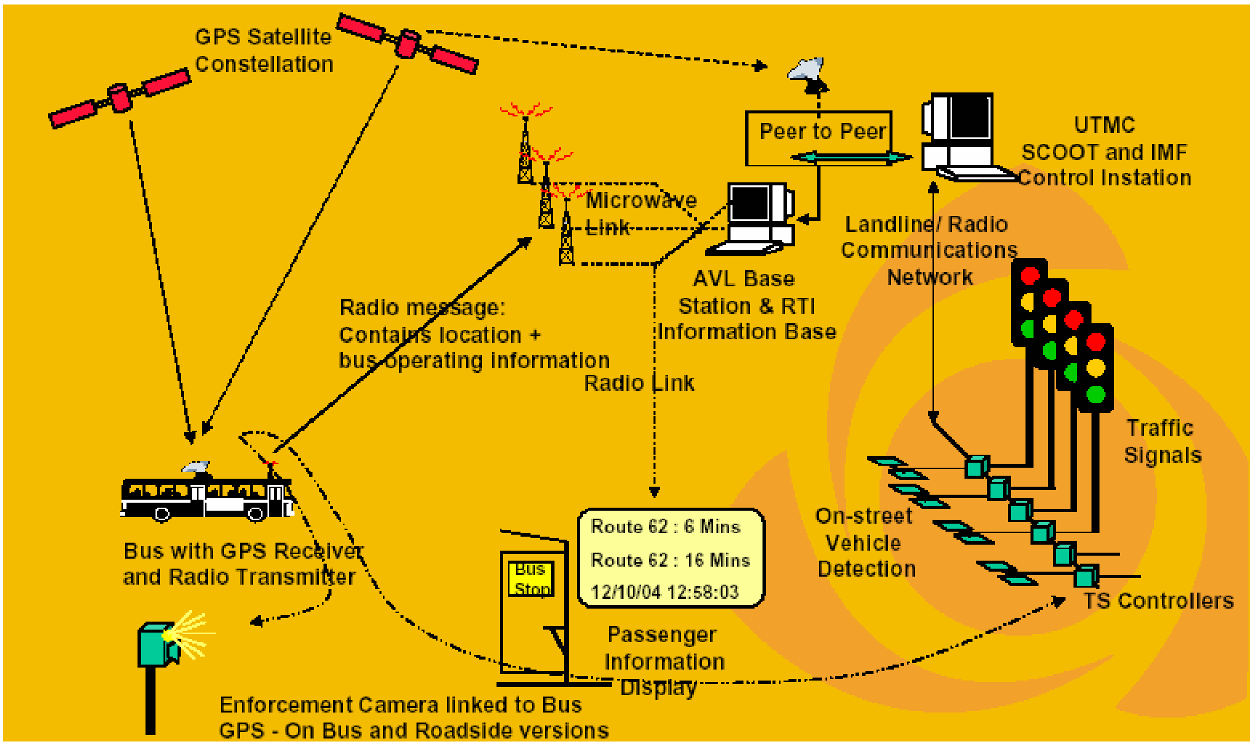

Figure A-1: Glasgow's BIAS – technical diagram (courtesy of Glasgow City Council)

A.5 Practicalities of operation

A.5.1 Operation in Glasgow is relatively straightforward, as there are just two stakeholders that need to work together (GCC and First) – and indeed within GCC, traffic management and passenger transport operations are closely aligned through the BIAS project.

A.5.2 TLP operations are based around a "zone of influence", which is established and managed by the Council through configuration of the settings in both the AVL and the SCOOT UTMC System (and through the deployment of controller facilities). In the context of this zone, the bus company is then able to manage its fleet operations, by equipping and configuring buses and their tracks. The two organisations have worked closely together in establishing strategy and phasing of BIAS implementation.

A.6 Evaluation: costs and benefits

A.6.1 Capital funding for BIAS has come from the Public Transport Fund – effectively, LTP monies – and totals almost £9M:

- the capital cost of the BIAS AVL subproject (on-bus equipment for 460 buses and 200 bus stops with real time information signs) is around £4.4M;

- the capital cost of the BIAS UTC subproject (equipment and configuration of 300 signal sites) is £4.8M.

A.6.2 Revenue costs for the operation and maintenance of the system are difficult to estimate at present, given the early stage of the project. However, configuration control and consistency in both UTMC and AVL systems are significant issues.

A.6.3 To date there has not been any formal evaluation of the scheme, as the AVL implementation in Basic BIAS is not yet signed off, but is hoped to go live in June 2005 and assessment will start then. The results will be fed back into the programme for further rollout.

A.6.4 BIAS UTC has a Performance Evaluation Model within it, but the system is not sufficiently widely deployed (and has not had sufficient time to operate) to make it appropriate to collect and analyse results. Similarly, BIAS AVL has a series of Performance Reports which are available to the bus operator. At present there are no specific parameters that are set for monitoring, but as the general aim is to improve journey time variation this is likely to be where the analysis is initially done. It is hoped to pass bus Journey Time Information from the AVL system and marry this with the SCOOT journey time information in the Performance Evaluation Module of the BIAS IMF.

A.6.5 Although there is political support for the BIAS project, it is too early yet to determine whether TLP will be a public or political success. GCC is very keen not to launch BIAS publicly too early, as this would risk jeopardising public confidence in the quality and value of the data provided – though this affects principally the passenger information signage rather than traffic light priority.

A.7 Other comments

A.7.1 The Glasgow system is unusual in its degree of integration, and the possibilities this opens up of innovation in communications (and, therefore, decision logic). Opportunities include peer-to-peer communication between AVL and UTC instations, the feasibility of combining wide area communications for UTMC and AVL/bus management, and the potential for integrating mesh radio into the overall communications architecture.

A.7.2 RTIG's value as a national body is through setting standards and developing/delivering Best Practise Guides. A number of areas have emerged in the Glasgow system, including:

- the difficulty of long-term configuration management for large complex transport management systems;
- the complexity and sophistication needed in programming controllers to provide TLP in the necessary range of contexts;
- the practicality of integrating bus management and RTI with other systems to provide the most flexible and cost-effective solution.

B Case study: TLP in Lancashire

B.1 Sources

B.1.1 Thanks to Larry Pope for discussing the use of TLP by Lancashire County Council (LCC) during mid-February 2005. Additional items provided at this meeting were publicity material and public project reports relating to LCC's UTMC and RTI projects.

B.2 Policy and strategy

B.2.1 The overarching vision for transport in Lancashire is the concept of a 'total transport network', which uses an integrated programme of physical and electronic means to deliver optimum transport services across the county. Specifically, this brings together public transport improvement with traffic management improvement at all levels from policy downwards.

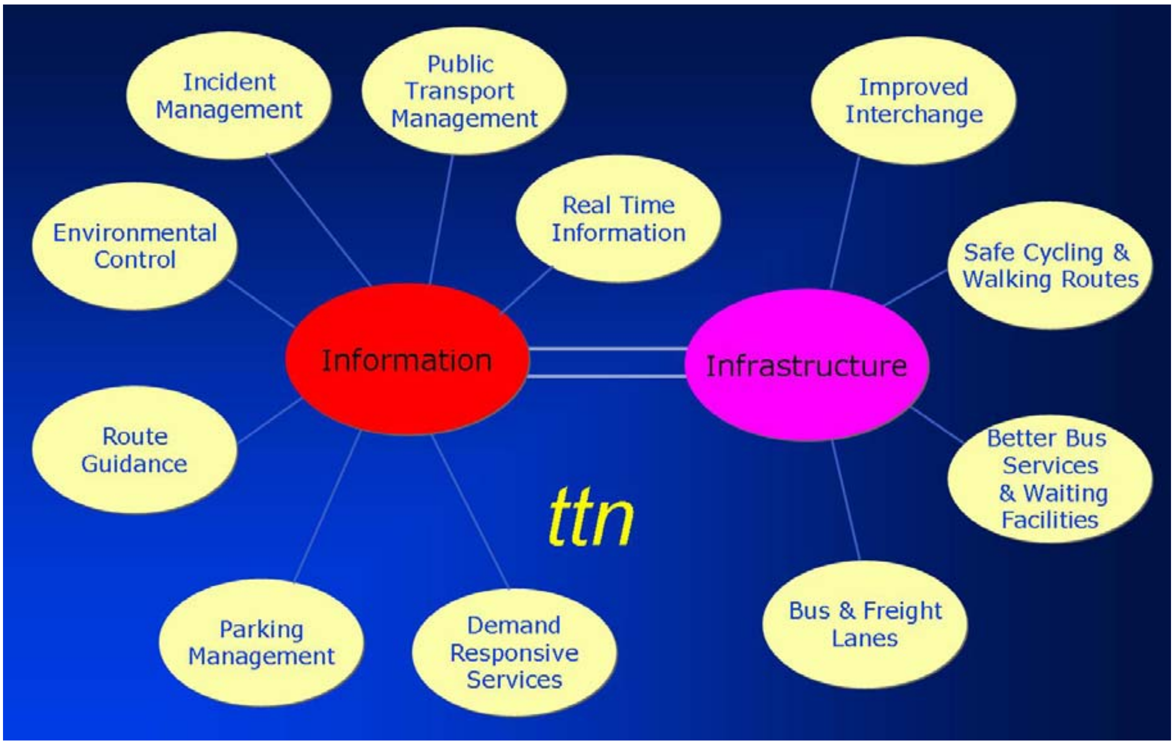

Figure B-1: Schematic of Lancashire's ttn vision (courtesy of Lancashire County Council)

B.2.2 In Lancashire, Traffic Signal Priority was developed to complement the introduction of Quality Bus Routes (QBR). The bus operators were prepared to purchase new low floor buses as part of the introduction of the QBR, but they did want to see some benefit to them. The *quid pro quo* was that Lancashire started to introduce Selective Vehicle Detection (SVD) at all sites on QBRs. Siemens transponders were fitted to all buses on selected QBRs. The first priority junction was operational in Dec 1999.

B.2.3 The argument for TLP was not made separately, but was considered as an integral part of the partnership working in the implementation of QBRs. Low floor buses, provided by the bus operators, provide a limited business benefit but a significant social benefit to the local authority; by contrast, TLP was implemented by the local authority primarily because it was valued by the bus operators.

B.2.4 The feedback to date from the operators, and from their drivers in particular has been very positive. More importantly at a business level, the QBR system has had measurable business benefits: on the first route to go live, patronage has risen by 15%. It is not possible to separate out effects of improved journey time, reliability etc that arise from TLP and those arising from other effects.

B.3 Deployment

B.3.1 Under the new RTI-based TLP system, all bus routes which go through traffic signals will be equipped with TLP and 34 junctions have been modified for this.

B.3.2 To date two operators have equipped their vehicles with RTI, namely Preston Bus with all 124 buses and Fishwicks with 30 buses.

B.3.3 The future of TLP in Lancashire is not the expansion of the tag based system, but the inclusion of TLP features into the Acis RTI system which is now being rolled out. As part of this project, all buses will be equipped with TLP facilities within their RTI.

B.3.4 It was always Lancashire's intention to provide this facility from the launch of the project. However, LCC was keen to ensure that it was operating in accordance with the agreed national specifications. As a result, until the RTIG standard was agreed, and compliant equipment could be installed on the buses and in traffic signal controllers, LCC was not willing to introduce TLP. Fortunately this has now been completed, and the new TLP will be going live within the next 6 weeks.

B.3.5 In keeping with Lancashire vision of the ttn, it is intended that the opportunity for TLP should be extended to all operators. However this would be contingent upon them contributing to the running costs of the system.

B.4 Technical choices

B.4.1 Lancashire has adopted the Acis solution. Buses on their respective routes will, via the Acis system, compare the current location of the bus in relation to the timetable. Only if the bus is late will it request bus priority.

B.4.2 In keeping with its strategic goal of following national guidance, Lancashire has ensured that the on board bus radio equipment uses the RTIG standard for short range communications to make priority requests locally to traffic signal controllers.

B.4.3 It is up to the controller to determine whether and how priority should be granted, in cooperation with the central SCOOT UTC system. Controller configuration is designed on the basis of a feasibility study for each traffic signal junction, taking into account specifically the levels of congestion at peak times. To this end:

- Lancashire uses a 'timer inhibit' via SCOOT so that "we don't make matters worse by constant requests for priority". That is, after priority is granted to one bus, there is an interval during which priority requests will be ignored, so that SCOOT control can re-establish itself;
- on some severely congested junctions, Lancashire also inhibits priority by time of day, on the basis that buses do better if overall flow can be maintained. Otherwise, if one bus is

granted priority, the resulting increase in congestion will disadvantage later buses by more than they benefit from their own priority.

B.5 Practicalities of operation

B.5.1 LCC and the bus operators work closely together in deciding a strategy for TLP. It is the authority that has full responsibility for providing priority, but the operators are consulted to ensure that their requirements and priorities are met as far as possible.

B.5.2 The bus operators are able to use BusNet Live to monitor delays on each individual route, which is of value for their fleet management. LCC and the operators hold regular meetings to discuss QBRs in particular, and performance more generally, and the results of operator monitoring is brought to these meetings. As part of this monitoring, LCC now regularly hears reports from bus drivers regarding a fault at signal junctions if the bus priority system fails.

B.5.3 It is at these meetings that LCC and the operators look together at journey performance and specifically where delays are occurring and why. They can then jointly assess what can be done to improve on performance, in terms of the benefits achievable from TLP in the light of the junction characteristics and the engineering practicalities.

B.6 Evaluation: costs and benefits

B.6.1 The TLP equipment for the first 26 junctions was purchased with the SCA funding provided by the DfT's Transport Direct programme during 2002-2004. The equipment for the other 8 junctions has been purchased with LTP money. The cost is a little over £2.5k per junction for hardware, plus the contractor cost to have the traffic signal controller re-configured.

B.6.2 The costs of operation and maintenance are not yet clear: LCC will know more when the system has gone live and operations have settled down. It is suggested that more data will be available in about 6 months time, and it may be worth looking again at that point.

B.6.3 Although there is as yet no hard evidence of success, Lancashire's politicians are very supportive. Furthermore, LCC have had positive feedback from operators and their drivers. In particular, based on the experience to date on planning and implementing their Quality Bus Routes, bus operators do regard the provision of TLP as sufficiently important to include it in their internal Business Case for participating in such schemes.

B.7 Other comments

B.7.1 One of the difficulties in implementing TLP is where bus stops are near to signal junctions. It can be physically difficult to arrange loops in a suitable place after the stop. By contrast RTI systems are fully flexible in positioning, and 'virtual loops' can be tuned to the best possible position. One of LCC's next goals is to introduce pre-emption and tune virtual loops at such junctions.

B.7.2 RTIG is seen to have a pivotal role in ensuring a coherent approach around the UK, both through its influence with members and through its influence with Government. Lancashire's response states that:

"If we are to have a nationwide system then it is most important that RTIG should help to facilitate this and encourage all authorities [and] PTEs to use the common RTIG standard to achieve this. I do think they should lobby DfT to ensure that the common RTIG standard is adopted and used throughout the UK."

C Case study: TLP in London

C.1 Sources

C.1.1 Thanks to Derek Renaud and Dave Ward for discussing the use of TLP by Transport for London on 7 March 2005. Additional information has been drawn from TfL responses to RTIG questionnaire surveys.

C.1.2 **Special note: TfL is a large and complex organisation and TLP is a function that involves a number of different groups. This note represents the consultants' view and is not formally endorsed by TfL.**

C.2 Policy and strategy

C.2.1 Buses have formed a major component of the capital's transport service for a century. There are many thousands of vehicles and many hundreds of routes, operating from many tens of depots and operated by many tens of bus operating companies. Organising this requires TfL to have a robust and professional system at all levels.

C.2.2 The concept of TLP in London dates back to the late 70s and early 80s. The policy aim was, and has remained, to reduce bus journey time: early evidence, since borne out in practice, suggested an average reduction of around 6 seconds per set of signals where TLP was present.

C.2.3 Policy has been refined over the years, particularly since the London Bus Initiative (LBI) at the end of the 1990s:

- With the earlier implementations, the system was rolled out on an area basis. Under LBI, a depot/corridor based approach has been taken, which has generally been more successful.
- LBI categorised routes into several tiers ("bronze, silver and gold"). In this context, more priority was given to higher-grade routes.

C.3 Deployment

C.3.1 The original 1980s implementation was based on tags and loops. Some 500 junctions were equipped with loops, and the whole fleet (then around 3000 buses) equipped with transponders. This system has worked generally well but with the passage of time, the loops have become unreliable and the tag equipment is beginning to come to the end of its lifetime. Furthermore, as equipment is discrete is has proved difficult to sustain a monitoring and maintenance regime.

C.3.2 More recently, a beacon based TLP system was put in place under the Countdown project in the early 1990s. By then the fleet had grown to around 5000 vehicles, and again pretty much the whole fleet has been equipped (smaller minibus/midibus vehicles, used for peripheral routes and dial-a-ride services, have not been included as schedule issues are generally much less significant for these).

C.3.3 London is now engaged in a major re-equipment programme, and TLP will form an integral part of the current AVL procurement based on augmented GPS, now to go on some 8000 vehicles (with yet further expansion possible). The use of 'virtual loops', where the system triggers a location report whenever the bus passes a software-set point, is seen as having major potential to improvement the management of the service.

C.3.4 However in a deployment as large as London's there are bound to be practical issues. One of these relates to ensuring the operational flexibility of the bus operators, by enabling them to redeploy any vehicle (within a depot) on any route. To achieve this, each bus is loaded with detailed survey data for all of the routes runs from its base depot.

C.4 Technical choices

C.4.1 London operates both simple, local, vehicle actuation (VA) and centralised UTC (SCOOT and Fixed Time). Both operate on a 'first come, first served' basis. The UTC system has the capability to provide differential priority, based on variable levels of importance for specific vehicles. It is anticipated that the future GPS detection solution will be able to take advantage of this facility. London's SCOOT system also includes stage skipping at suitable sites, providing greater priority benefits.

C.4.2 Congestion management in the capital is of course is huge challenge, and the aim in most cases has been to ensure that the effects of TLP on this are minimised. This is achieved in the VA system by an 'inhibit' function: time taken away from a phase by the granting of bus priority is given back to it during the next cycle, so that any additional queueing is cleared quickly. The UTC system includes sophisticated configurable constraints, including degree of saturation and network linking. This minimises congestion impacts and ensures that no approaches are overly disadvantaged during and following priority activity.

C.5 Practicalities of operation

C.5.1 Unlike many other places, bus operators are not involved greatly in planning or implementing TLP in London. London Bus Services provides many of the strategic 'user' functions that are undertaken by operators elsewhere in the country.

C.6 Evaluation: costs and benefits

C.6.1 TLP is believed to have good political backing, as part of the totality of measures to improve bus operations in London. TLP is seen as having contributed to the strategic goals of improving public transport usage in London, and is increasingly integrated into other transport initiatives (for example, the management of London's congestion charging scheme). There is little evidence that public are aware of it.

C.6.2 Performance specification and performance monitoring have not been undertaken to any significant degree during the operation of the tag-based systems, owing to the difficulty of defining or collecting accurate data from these systems. This may well change under the GPS-based system, where much more data will be available, at low cost and in real time.

C.6.3 However the systems have been subject to post-implementation evaluation, which has validated the value of priority (up to 10s average on a VA junction, 6s on a SCOOT junction). Southampton University have undertaken much research on the system.

C.6.4 The total cost of implementation of the beacon-based TLP is estimated to have been around £2m per annum for the past 5-6 years (ie around £10-£12M). Maintenance costs are around £100k per annum for buses, and negligible for central systems.

D Case study: TLP in Surrey

D.1 Sources

D.1.1 Thanks to John Gaff, Pete Davies and Chris Fairhead for discussing the use of TLP by Surrey County Council (SCC) at length on 16 February 2005. Additional items provided at this meeting were extracts from SCC's policy statements.

D.2 Policy and strategy

D.2.1 As part of its commitment to improving the service available through public transport in the County, Surrey County Council (SCC) has been actively involved in traffic light priority for over a decade. Originally conceived as an 'add-on' to the Urban Traffic Control (UTC) scheme in Guildford, the use TLP was rolled out steadily since the early 1990s.

D.2.2 At the beginning TLP was conceived simply as a generally 'good thing' for public transport. As national policy targets have been refined, so have SCC's considerations of policy. TLP is now seen specifically as tying in to SCC policy on dealing with the County's "key challenges":

- *"Surrey is one of the most densely populated counties*
- *"Our traffic flows are twice the national average*
- *"More than 8 in every 10 households owns a car*
- *"We have two major airports on our doorstep*
- *"Meeting the new housing allocations"*

D.2.3 This has led to a number of refinements in system configuration and operation (section D.4 below).

D.2.4 Quantifiable benefits have always been difficult to project, specify, or measure. However there is work underway to begin to address this (see section D.5 below).

D.2.5 The original Surrey TLP scheme was implemented via road loops and under-bus transponders. The first sites and buses were fitted around 1993, and over the next decade this technology was used. However it became clear around 2001-02 that the implementation of bus Real Time Information (RTI) in the County provided an opportunity to roll out farther, faster and more reliably, at lower overall cost.

D.2.6 SCC is now well into this second-generation implementation of TLP, based on its RTI system. On this basis SCC intends to continue its rollout of TLP in the future, implementing at every relevant junction whenever an upgrade project is undertaken.

D.3 Deployment

D.3.1 Tag based TLP is currently implemented at around 20 junctions in various Surrey towns, with around 85 vehicles fitted with transponders. Ultimately the intention is for this system to be withdrawn.

D.3.2 For the RTI-based approach, TLP is currently 'running in' at five junctions for system validation, but within the next month or so will be rolled out to some 60 junctions in Surrey. A further 15 junctions are equipped as part of a cross-boundary arrangement with W Sussex for the flagship "Fastway" project. 140 vehicles are equipped with the relevant Acis equipment, from three main operators (Arriva, Metrobus, Stagecoach and local firm Safeguard).

D.3.3 The focus has been on busy urban services, and the rollout is being phased by town, as towns in Surrey are substantially separate entities for public transport – though some conurbations are cross-boundary. Thus, Guildford is largely complete; the next stage will equip Reigate and Redhill; then Woking and the towns to the east – though there are some complexities with that; and finally areas near county borders: Staines, Farnham, etc.

D.4 Technical choices

D.4.1 In the RTI system, TLP is done purely locally – ie on a radio link from bus to signal controller, not between servers – and is independent of any other communication. The basic plan is for the bus to identify if it is running late, and if so to send a priority request message to the controller. Within the controller configuration, there are a number of ways of delivering priority (through features such as "special conditioning") and SCC are attempting to undertake this in a uniform and planned way. Controller actions are logged by the UTC system, whether the controller is on SCOOT, MOVA or simply remote monitoring. Drivers are advised of the granting of priority through a dashboard LED signal.

D.4.2 The architecture of the system has been refined over time, as technology allowed and as policy choices became clearer. Originally all buses were given immediate priority. However this caused many problems in the broader management of traffic, and the system has therefore been refined:

- Now, only late buses ask for priority. As a result, very few vehicles get priority during the day (except where there are delays caused by roadworks), but around 10-20% of vehicles at peak hours.
- Once a junction has granted priority to one bus, there is a 'dead period' of around five minutes during which traffic management is allowed to recover normal operation. This is particularly important for an adaptive area-wide system such as SCOOT.

D.4.3 SCC operates a competitive procurement environment for both public transport and traffic management systems. Its tag based TLP was originally JMW equipment (transponders and roadside equipment); its RTI system is provided by Acis; it uses Siemens SCOOT and has traffic signal controllers from Siemens, Microsense and Monitron.

D.4.4 SCC is keen to use national technical standards and guidelines as far as possible, believing that this yields a more sustainable and robust solution. However the RTIG standard is not sufficiently well developed, nor sufficiently taken up and proven in products, for this to be practical as yet. Nevertheless, SCC has agreed with Acis that its equipment will migrate to the new standard once it is agreed.

D.4.5 Specifically, the link currently uses the 'old' 433MHz channel, rather than the RTIG standard at 180MHz. Acis have undertaken to obtain the band licence but it would be preferred if RTIG had organised this on a national basis.

D.5 Practicalities of operation

D.5.1 SCC and its bus operators work together well. On a day to day basis everyone keeps an eye out for potential problems – for example, where a driver knows he is running late but is not given priority where he usually is. Having a staff member with bus operations experience who can act as an 'account manager' for the bus operators is very valuable to the more technical parts of the service.

D.5.2 Where (non-technical) problems have arisen they have almost invariably arisen from outside. Specific instances include:

- Cross boundary issues. Many of Surrey's routes cross into neighbouring LA areas – particularly TfL and Hampshire but also West and East Sussex, and beyond them to Brighton & Hove and East Sussex. As Hampshire have a different RTI system, and London are currently procuring a new system the identity of which is not yet known, it is not practical to ensure TLP for their buses inside Surrey.

- Highways issues. Within SCC the passenger transport and traffic management teams work well together. SCC has a programme to bring more groups together via the Network Management and Information Centre in Leatherhead.

- Third party issues. For instance a number of private developers have made use of the tags, buying and using equipment to SCC's specification for functions such as access control (ie tags triggering barriers). These will need to be replaced if the tags are removed, and there are financial implications. SCC is now strongly suggesting a 'fallback' based on a pole based card reader. This system is also being installed at SCC barriers as a fall back system in case of failure. All barriers are planned to work on the same frequency.

D.5.3 System performance has never been specified in a quantitative manner: rather, a system was presented with functionality that appeared to be of clear value, and that system was acquired. For the benefits the system brings, this approach was seen as saving both time and bureaucratic costs.

D.5.4 However it is recognised that this is not really sustainable, and an initiative has been launched by a number of local authorities to consider what might be possible in TLP performance specification and management. This initiative is very new and it is not yet clear how far it will be able to go, or when.

D.6 Evaluation: costs and benefits

D.6.1 Implementation of the old tag-based system became very expensive, owing to the requirement for extensive multiple loop-cutting, and figures as high as £25k per junction (excluding bus and central costs) have been cited. The RTI-based system is much more cost effective, and the overall costs are approximately as follows:

- Junction and centre equipment: around £250k
- Bus equipment: around £100k
- Implementation costs: around £300k
- Operational costs (including staff time): estimated around £50k per year, total

D.6.2 Capital funding has come from a variety of sources:

- LTP: around £200k
- Section 106: around £200k
- DfT special grant (for Fastway): around £150k

D.6.3 These figures cover just the TLP element of the system, of course, not the whole RTI operation. Capital funding includes three years maintenance for all equipment.

D.6.4 There has been no formal evaluation of the old tag-based scheme, owing to the lack of hard data and the fact that it is now being replaced anyway. It is too early to undertake an evaluation of the RTI-based system but it is likely that this will be done once the system is operational. TLP extensions are logged by the SCC UTC system, and SCC are about to appoint a new member of staff whose role will (in part) be the analysis of the data that emerges.

D.6.5 The public is therefore not particularly aware of TLP. However, it is seen very positively by elected members. Improved public transport is a key message from the County politicians and it was noted that a very high proportion of county literature (not just transport related) includes images of bus lanes etc as a tangible presentation of "what we are doing for you".

D.7 Other comments

D.7.1 SCC firmly believe that, whatever TLP scheme is put in place, it needs to be properly managed – not just at implementation but throughout its lifetime. Surrey have found problems arise, particular in respect of the older tag-based system which was put in a little at a time, through poor record keeping, and are determined that these mistakes should not be repeated; the RTI system is therefore being configuration managed much more thoroughly, and the live communications facilities will be used to help maintain this.

D.7.2 Given the nature of the TLP system, which operates after all on 'exceptions', SCC has had to think very carefully about how to acceptance test the TLP system. It is currently intending to do this via taking an out-of-service bus, and using it to 'mimic' late running buses of all services to validate the operation of each junction. This might have to be repeated, say, annually or on a spot-check basis. Other approaches would be expensive or unreliable. SCC believes that determining a standard approach to validation up front (possibly even including it in the tender specification) would be valuable nationally.

D.7.3 In a similar vein, SCC had a technical problem. All its transponder detectors were fitted with alarms, so that if they had not heard from a bus in three days they would alert the centre – the assumption being that there was a fault. However at many sites a three day gap in TLP occurs regularly (say in school holidays when peak traffic flows are much lower) and there were many 'hoax' alarms. SCC believes that it might be valuable to have a 'heartbeat' message from buses, to avoid this problem, and propose that there should be a national discussion.

D.7.4 One are where SCC feels it has benefited is in the thorough 'method statement' produced by Acis: what messages are sent and received by the equipment, under what circumstances, action to be taken in specific cases, etc. A common approach to this – perhaps only a checklist of things to include – would be useful.

D.7.5 RTIG could have a role in all of these, as well as sorting out some of the problems identified above – particularly the difficulties with cross-border operation. The RTIG (technical) protocol for cleardown and TLP needs to be refined, implemented and supported by operational standards (a common method statement would play a role in this).

E Case study: TLP in West Yorkshire

E.1 Sources

E.1.1 Thanks to Martin Siczkowski for discussing the use of TLP in West Yorkshire at length on 21 February 2005. Additional input was obtained from historical material on the UTMC01 project SPRUCE and from commercial product descriptions.

E.2 Policy and strategy

E.2.1 Implementing TLP in a metropolitan area like West Yorkshire is complicated by the fact that while the PTE is responsible for the public transport operations, traffic management is the responsibility of the urban district councils – in the case of West Yorkshire, five of them.

E.2.2 Improving public transport has been a policy goal of West Yorkshire authorities for some time, and traffic light priority has been one of the areas for investigation. The value of these systems was based on a consideration of factors such as:

- the potential for shortening public transport journey times;
- perhaps even more important, the potential for making journey times more consistent;
- the potential for improving the 'feelgood' factor of bus usage.

E.2.3 TLP has never been a separate project area. Rather, it has been seen and used as just one tool in the armoury of transport managers, implemented where appropriate within larger schemes and projects including elements such as new buses, shelter improvements, bus lanes etc.

E.2.4 Like a number of other authorities, West Yorkshire has deployed a limited number of transponder-and-loop based systems. In addition, they have also trialled the 'second generation' loop-based system PRISM, a Peek Traffic product. PRISM does not require on-bus equipment, which streamlines implementation and reduces equipment problems such as undercarriage scraping or vibration damage; however it does require more complex loop cutting.

E.2.5 Sometime in 2000-01, work began on a major system of real time bus information, a project which was accelerated by the opportunity for SCA funding (granted early 2002). From the beginning this was seen as an area wide project, with full coverage of the sub-region the goal. It quickly became clear that the RTI system had the potential for implementing TLP much more economically, and the decision was then taken to make the whole of the West Yorkshire RTI system TLP-capable.

E.2.6 In terms of delivering policy, it is recognised that passenger transport does not exist in a vacuum, and there are other policy imperatives which can put conflicting demands on the various stakeholders. Two of the most important are:

- conflicts with obligations to vulnerable road users: for instance, bus priority at pelicans would actively disadvantage pedestrians.

- conflicts with the obligation to manage congestion: for instance, granting priority to buses on a side road during peak periods might cause unacceptable deterioration of congestion problems on the main road.

E.3 Deployment

E.3.1 TLP based on tags and loops, or based on the PRISM system, is implemented at a relatively small number of sites. In particular, Leeds was involved in the UTMC project UTMC01 (selected vehicle priority), for which PRISM was used and a proprietary database application ("SPRUCE") developed to integrate strategic control into data collection and controller operation.

E.3.2 West Yorkshire is currently in early stage of deploying RTI-based TLP, but has very ambitious plans over the next five years or so for RTI which will extend the reach of TLP very substantially:

- around 400 junctions in West Yorkshire have been identified "for evaluation" for RTI TLP. These are on key corridors as part of the Yorkshire Bus Scheme to be implemented over the coming 5 years or so.

- around 1600 buses in West Yorkshire will be equipped with vehicle equipment that enables them to request priority. This represents some 80-85% of the total fleet in the region and covers a large number of operators.

E.3.3 Note, however, that not all 400 junctions will end up being fitted for TLP, either because of technical reasons that make the junction unsuitable, or for reasons of budgetary of other constraints.

E.3.4 The strategy is to phase the implementation by 'block' treatments, coordinating the various agencies – in particular, negotiating priorities and timetable for implementation with the districts and operators involved (some routes run across district boundaries). The aim is to implement on-bus equipment on a whole depot at a time, and signal controller equipment down a whole corridor at a time. This way the system becomes testable and capable of delivering maximum benefit as early as practicable.

E.3.5 The process is to:

- identify a list of relevant junctions;
- examine each junction for suitability;
- implement necessary hardware – normally just a radio receiver for the bus trigger, interfaced to the signal controller;
- configure the equipment with the relevant logic;
- evaluate the results.

E.4 Technical choices

E.4.1 In a large and busy area like West Yorkshire, buses can be densely packed: there can often be three buses arriving at a single junction (along the same or different arms), even with a relatively short cycle time of 1.5 minutes. Clearly blanket priority is not practical in this environment, and Metro has specified the system:

- to use a 'lateness' threshold, so that only buses running late by more than a certain amount ask for priority;

- to operate on a 'first come, first served' basis, so that a junction will never react to more than one priority request at a time.

E.4.2 Metro has put a lot of thought into designing and contracting for a flexible system capable of delivering maximum benefits in area-wide operation. Among the innovative features specified are the following:

- All the bus equipment is to be capable of triggering all kinds of traffic signals, including junctions controlled centrally, junctions controlled locally and pelican crossings. As pelicans tend to have much simpler design, the RTI system has been specified with the 'latching' functionality (ie activating and deactivating the "priority requested" status).

- The system is architected to be able to work with both local priority granting and central priority granting. Locally this would be achieved through the short range link from bus to a receiver embedded in the signal controller unit, which makes relevant decisions and passes a change signal to the controller. Centrally it would be achieved through a message into the area control system, which then sends out a change message to the signal. Central control is cheaper, but likely to suffer from unacceptable levels of communications latency. (For similar reasons of latency, priority requests cannot be mediated via the bus operator's control centre.)

- The policy is to give as much priority as is technically possible (subject to policy overrides). To achieve this, Metro would like – and have contracted – to vary this lateness threshold both by junction and by time of day. The software developments required for this are not trivial.

E.4.3 Drivers do not get any indication of when priority has been requested or granted. This is seen as a difficult area. On the one hand, it builds confidence and partnership with the operators and their staff if the PTE is seen to be providing active help in this way. However, by giving a 'back door' view of the traffic signals it risks changing driving behaviour, even if not consciously: for instance, drivers may be tempted to 'rush' lights that their dashboard tells them are about to go green.

E.4.4 West Yorkshire has tried to use national specifications agreed by RTIG throughout it projects, and indeed has taken an active part in steering them, as it has very substantial multi-party issues to contend with:

- Districts manage their own traffic signals and are responsible for acquiring the RTI receivers and fitting them into controllers. Although at this early stage of the project receivers are all being procured through Acis, the LAs are keen to ensure an open supply market in the future.

- there are buses that move from West Yorkshire into other areas, and buses from other areas that operate in West Yorkshire, that will still wish to have TLP when out of their home area (for example Harrogate has a small GPRS-based Infocell system). Metro is keen that the receivers in West Yorkshire should be able to receive priority requests from non-Acis-equipped buses.

E.4.5 Specifically, the Metro system will be based on the RTIG 'short range comms' specification, which was designed specifically for use in TLP systems (as well as sign cleardown at stops). The full-power variant will be used.

E.5 Practicalities of operation

E.5.1 The strategic decision to regard TLP as a single tool in a wider toolbox has been valuable. The deployment of TLP (and the RTI system as a whole) is part of a process of engagement between the PTE, the various operators and the districts to improve public transport generally. Typically, and especially in the context of QBCs, a single 'corridor improvement' project will bring together – with mutual value:

- fleet improvements from the bus operator;
- real time information and improvements to shelters, from the PTE;
- TLP, as well as carriageway improvements such as bus lanes, from the districts.

E.5.2 Much of this is done locally – so operators will talk directly to districts about traffic light control and journey time monitoring.

E.5.3 Metro is responsible for acquiring the RTI system, and takes the lead in coordinating its deployment. Operators that make use of the facilities are expected to contribute to the operational costs of running the system. For reasons of fairness, a common commercial 'deal' is offered to operators. Some have elected not to take part, as they do not see a positive total business case for RTI (and TLP); smaller operators in particular may operate much more in a 'pencil and paper' way, and there would therefore be a higher barrier to implementation

E.5.4 Junctions are not always suitable for TLP. Problems are of various kinds. Some are physical – eg the junction is so congested anyway that no (reasonable) amount of bus priority will have a net beneficial impact. Others are technical or economic, as when the existing controller can't interfaced to a TLP receiver and a whole new signal controller would be needed. Still others are strategic or 'political': for instance, trading off the benefits of bus TLP against a slight negative impact on pedestrian phases.

E.5.5 A particular impact of pedestrian conflict is on road safety: where excessive delays are imposed on pedestrians, they might be tempted to 'nip across' on a red signal. (Pedestrians, after all, are not legally obliged to stop for the red and wait for the green, while buses are.)

E.5.6 Technically, the critical phase of the project – the one that takes most time and resource and is subject to the greatest risk on skills availability, timetable and technical success – is the task of programming controllers with the logic to handle different scenarios of inputs. Junctions vary considerably, and each one takes careful thought: Leeds anticipates being able to configure something like one junction per week. This process is managed through the signals maintenance contracts held by the districts.

E.5.7 By contrast, the delivery of the RTI system, and even the interfacing with the receiver/controller, is relatively straightforward. Acis provide data in a specified structured form, with clear functional roles. The difficulty is within the controller, turning these input requirements into responses.

E.6 Evaluation: costs and benefits

E.6.1 Financially, the costs of the scheme are borne between the PTE, the districts and the operators. Capital costs come almost wholly from LTP. The split works roughly as follows, though there are some flexibilities, and it is not always easy to separate out TLP costs where it is implemented as part of a bigger project:

- Metro pays for the capital costs of the on-bus equipment and for the real time passenger information system (signs at bus stops etc);
- districts pay for all signal works including controller receivers and developments, or new controllers where necessary, as well as maintenance of these;
- operators pay for the revenue costs of communications and maintenance of on-bus equipment.

E.6.2 The dominant costs are those of signal controller development. Where this is simple – a small junction, an up to date controller, etc – the cost may be little more than the cost of buying and installing a receiver card, around £2k; for a more complex junction, where much more configuration work is necessary, the costs can be as high as £30k.

E.6.3 Historically the districts have taken the lead in monitoring journey times. This has been expensive, time consuming and only limited reliable as it needed to be done manually. In future, the data emerging from the RTI system will make accurate, complex analyses much simpler and easier, leading potentially to improvements in planning and decision-making at both strategic and tactical levels. As the body responsible for the RTI system, the PTE is likely to play a bigger role in this.

E.6.4 Monitoring how much bus priority is granted is difficult, at present, as there is no record of the priority request/grant exchange itself. There are ways round this (for example investigating UTC logs for triggers) but they all have problems (eg assuming that vehicles in a bus lane are buses, not recognising other reasons for phasing, failing to trap circumstances when multiple buses issue conflicting requests, etc). This is something that it is hoped to address in future software developments.

E.6.5 So far, however, local politicians are "quite keen" on the system – though their attention is focused more on the high visibility passenger displays rather than TLP.

E.7 Other comments

E.7.1 Metro believes that RTIG has a very valuable role to play in developing further the work done to date on TLP. Given the context, and in particular in light of the technical issues relating to controller configuration, this should be done in close cooperation with the UTMC Development Group.

E.7.2 At a less detailed technical level, it would be of great benefit if RTIG could help develop a common, national, 'toolkit' for bus priority of the kind that West Yorkshire has ended up with. This would allow local authorities to understand and evaluate the role of TLP in the wider context of bus lanes and real time information, as well as to identify the best way of planning for and implementing TLP given their particular network structure, operational imperatives, legacy controllers and policy requirements. This would have both educational and standardisation benefits.