TRANSPORT RESEARCH LABORATORY

Review of developments and technical, institutional and operational requirements for traffic management across jurisdictional boundaries

Prepared for Traffic Management and Tolls Division, Department of the Environment, Transport and the Regions

A Maxwell, K Wood, A Raines and P B Still

TRL REPORT 407

First Published 1999
ISSN 0968-4107

This report has been produced by the Transport Research Laboratory, under/as part of a Contract placed by the Department of the Environment, Transport and the Regions. Any views expressed are not necessarily those of the Department.

TRL is committed to optimising energy efficiency, reducing waste and promoting recycling and re-use. In support of these environmental goals, this report has been printed on recycled paper, comprising 100% post-consumer waste, manufactured using a TCF (totally chlorine free) process.

Transport Research Foundation Group of Companies

Transport Research Foundation (a company limited by guarantee) trading as Transport Research Laboratory. Registered in England, Number 3011746.

TRL Limited. Registered in England, Number 3142272.
Registered Offices: Old Wokingham Road, Crowthorne, Berkshire, RG45 6AU.

CONTENTS

Executive Summary

The UTMC02 project for DETR is investigating traffic management across jurisdictional boundaries. The purpose of this report is to review relevant ongoing research and development and to review the technical, institutional and operational requirements of external system owners for inter-connection with Urban Traffic Management and Control (UTMC) systems. The work has concentrated on the exchange of information between organisations rather than control of one organisation's equipment by a different organisation.

Some relevant developments, particularly studies of the suitability of the American developing NTCIP standards are the subject of other projects within the UTMC programme. Relevant outputs from these other UTMC projects are summarised, as are the relevant activities of the standards bodies ISO and CEN. Within the UK, the Highways Agency has a large programme of work concerned with traffic data and its use and distribution. The QMISS database, Travel Information Highway and Traffic Control Centre initiative are all relevant for traffic management across regional boundaries and the Highways Agency is actively participating in the UTMC02 project.

Other examples of relevant projects are reviewed. The Mattisse project in the West Midlands, which is designed to share information between local authorities, UTC centres, police, motorway control, rail, bus and the RAC. The London Travel Information Service which is designed to be a central service for the Greater London Authority and provide timely, accurate and relevant information to third party information disseminators. The Road Traffic Advisor project, which has a different emphasis being designed to provide information directly into individual vehicles on the motorway. However, although the project testing is almost all on motorways the system is designed to be expandable to other roads.

To determine non-UTMC users' needs and the information that they could supply to others, police, public transport operators, public transport executives, rail authorities and a tolled crossing operator have been surveyed and the results summarised in the report. There was considerable support for the need for a standard specification for data exchange between different authorities information systems.

The conclusions of the report are broken down into four sections: the current research and development; institutional issues; technical issues and operational issues. There is considerable research and development going on in the field of traffic management across jurisdictional boundaries and the sharing of information that will be relevant to the development of UTMC standards. Of particular relevance is the use of CORBA in the Highways Agency Travel Information Highway.

Institutional issues are important. For instance, for a major road incident the police are the experts at dealing with the immediate consequences and the area of the incident, whilst the Highway Authority are better placed to deal with the consequent network disruption. Good institutional arrangements are required for the smooth operation of a joint response.

On the technical issues, there are many working groups looking at possible standards that would be relevant to UTMC02. However, the standards procedure is slow and de facto standards are developing whilst the official standards bodies deliberate. In the USA NTCIP is pressing ahead, but there are ownership problems with the wholesale adoption of NTCIP as an international standard. Current developments as described above, are going ahead and CORBA appears to be the front runner for standard interfaces.

Compatible geographical location systems are essential if different systems are to exchange meaningful information. The HA have built in multiple systems into the QMISS database to enable users to choose the most convenient location system. It is a very flexible system, but carries an inevitable overhead compared with a single location referencing system. Several systems use the Ordnance Survey OSCAR referencing system, which could be considered as a possible standard for the UK, but is not available outside the UK and so would not be suitable for any European or international standard.

One of the most important operational issues is that experience has shown that individual operators must be convinced of the benefits of a system before they will adopt it. Without this support the system will gradually degrade. However, well structured systems can obtain operators' support and it is possible to design systems that impose structure on data entry that are acceptable to operators who are used to free text and no restrictions on what they can enter. The output from the structured systems is normally more relevant and accurate for dissemination to third parties. Many organisations have particular operational and commercial considerations. For instance, bus operators require greater restrictions on operational information that can be seen by their rivals than on information available to their PTE or local authority.

2 Introduction

The UTMC02 project is investigating traffic management across jurisdictional boundaries. This report is the first output from the project. Its purpose is to review relevant ongoing research and development and to review the technical, institutional and operational requirements of external system owners for inter-connection with UTMC systems. The review will form the base for the remainder of the project, the study of architectural models and the identification of application and trial work that needs to be done in the second phase of UTMC02.

The work has concentrated on the exchange of information between organisations rather than control of one organisation's equipment by a different organisation. For instance, if there were an incident on a major urban route downstream of a motorway junction, the UTMC operator would normally request the motorway operator to set an appropriate message on the sign rather than have direct control of the sign. Local arrangements have been made for the ROMANSE office to set some messages on signs on the motorway around Southampton. However, this direct control of another organisation's equipment is exceptional at present, normally only information, not control is exchanged.

Some relevant developments, particularly studies of the suitability of the American developing NTCIP standards are the subject of other projects within the UTMC programme. Chapter 3 of this report reviews the relevant outputs from these other UTMC projects.

Both of the international standards body, ISO, and the European body, CEN, have a considerable programme of work of relevance to UTMC02. The Highways Agency, a partner in the project team, is active in the standards bodies. Chapter 4 summarises the relevant standards activities. It also includes the conclusions of a separate study commissioned by the HA to compare DATEX-Net, DATEX ASN, CORBA and the data dictionary approach to messaging standards for a small set of data elements.

Because of the importance and size of the Highways Agency's development programme, a whole chapter is needed to describe the work. The QMISS database will contain real-time information about conditions on the motorway network. One of the uses of the Traffic Information Highway will be to interrogate and extract data from QMISS. However, the aims of the TIH are broader than just one use and it is designed to be the standard way for members of the Traffic Information Community to exchange data. The third major HA development is the Traffic Control Centre initiative and is described based on the pre-qualification documentation.

Another large development is the Mattisse project in the West Midlands which is designed to share information between local authorities, UTC centres, police, motorway control, rail, bus and the RAC. This project and the lessons learnt are described in chapter 6, followed by three other developments in chapter 7. The London Travel Information Service which is designed to be a central service for the Greater London Authority and provide timely, accurate and relevant information to third party information disseminators. The other project is the Road Traffic Advisor, which has a different emphasis being designed to provide information directly into individual vehicles on the motorway. However, although the project testing is almost all on motorways the system is designed to be expandable to other roads.

Chapter 8 describes the results of surveys of other non-UTMC bodies, police, public transport bodies and a tolled crossing operator, and their needs to exchange data with others. In general these organisations are keen to adopt appropriate standard systems.

Conclusions from the review are drawn together in Chapter 9, followed by two appendices. The first gives details of relevant standards bodies and the second gives the details of the responses of the non-UTMC bodies to our survey.

3 Review of relevant UTMC projects

3.1 UTMC7/17 on data requirements, quality and contents

The UTMC7/17 project provided the basis for data definitions, quality requirements etc for the UTMC programme. UTMC02 needs to consider the requirements for data to be exchanged between centres. Following the principles laid down by UTMC7/17, messages for centre to centre communications will be identified and the data elements specified, in accordance with the DATEX format and message structure. Any messages that are not included in the current DATEX data dictionary, will be identified.

The data elements will be assessed to establish the available and required quality standards of the data, in accordance with the methodology described in UTMC7/17.

Any quality parameters which are not contained within UTMC7/17 will be identified as extensions to the standards of UTMC7/17.

A check will be made to establish whether the source data is of a higher standard than is required in UTMC 02. In such an eventuality, the potentially higher output standard data will be flagged as possible data for inclusion in a common data base, at the higher data quality standard

3.2 UTMC08 and 09 on the suitability of NTCIP for UK UTMC

Projects UTMC 08 and 09 are examining the suitability of NTCIP messaging and protocols within UTMC systems. Outputs to date have tended to concentrate upon messaging and protocols between centre to roadside signal controllers. Work is currently underway in the US on centre-to-centre data exchange.

3.2.1 Introduction to NTCIP

This sub-section provides a brief introduction to the National Transportation Communications for ITS Protocol (NTCIP) to explain its relevance. Much more detail is available from the reports of projects UTMC08 and 09 and the published NTCIP documentation.

NTCIP are sets of communication protocols organised

into ‘profiles’ (Table 1) to suit various communication needs. Further profiles can be developed as required. UTMC09 reports that ‘for several communication profiles to inter-operate on a common communications media, it is necessary that the Physical Layer and the Data Link layers be identical. Different Network, Transport, Session, Presentation and Application layers may be used. If multiple Network Layers are utilised, then unique Initial Protocol Identifiers (IPI) must be used to allow the received packets to be properly processed by the correct communications stack.’

Table 1 Current NTCIP Profiles and protocols

Communications layer	*Communication profile and protocols used*		
	Class A	*Class B*	*Class C*
Application	SNMP & STMP	SNMP & STMP	SNMP, STMP & FTP
Presentation	Null	Null	Null
Session	Null	Null	Null
Transport	UDP	Null	TCP
Network	IP	Null	IP
Data Link	HDLC	HDLC	HDLC & PPP
Physical	RS232 & FSK	RS232 & FSK	RS232 & FSK

Class A addresses the requirements of field devices in a network environment, by providing a Internet Protocol (IP) routing service. User Datagram Protocol (UDP) does not seek confirmation of delivery - ‘fire and forget’. This reduces the protocol overhead. However, IP has a high overhead cost, and means that Class A is not suitable for time critical exchange of information.

Class B profile has been completely defined - to NEMA TS 3.3 standard. Only directly connected devices can communicate using class B (there is no routing service). There are no communication protocols for error checking or recovery. It is intended for polling, command and response type messages only, where delivery time is critical. Its typical use in the UK would be for communication with traffic signal controls.

Class C addresses the requirements of non-time critical devices that need to exchange relatively large files such as Variable Message Signs. UTMC08 indicates that Class C would also support centre-to-centre communication. The File Transfer Protocol (FTP) is well suited to these purposes. FTP provides a degree of security through user authentication procedures – e.g. user name and password. Class C provides a connection-orientated service, meaning that a call-set-up period is needed prior to the actual exchange of information. The profile contains error checking and re-transmission facilities - ‘guaranteed delivery’ – using Transmission Control Protocol (TCP). Internet Protocol (IP) is used for routing functions. Because of the resulting protocol ‘overheads’ the profile is not well suited for low speed lines. Point-to-Point Protocol (PPP) would, presumably, be used on high speed ‘dedicated’ (point-to-point) lines.

The Simple Network Management Protocol (SNMP) message structure has a large overhead. Existing systems, often referred to as legacy systems, generally do not have the available bandwidth to use SNMP for second by second messaging. NTCIP has specified an optional ‘cut-down’ version of SNMP (specific to ITS) called the Simple Transportation Management Protocol (STMP). NTCIP has specified a framework for the application layer called the Simple Transport Management Framework (STMF). The components include SNMP and STMP.

UTMC08 reports that NTCIP are re-defining the profiles to allow more flexibility in substituting protocols, and moving away from the ISO model to an approach which defines three groups of functionality. This is reflected by the proposed UK communications protocols given in UTMC08 (Table 2).

Table 2 Proposed UK communication profiles

Communications layer	*Communications profile*		
	Legacy UTC	*Priority*	*Background*
Application profile	SUPS*	UK STMF (includes SUPS*)	UK STMF/ Any internet
Transport profile	Null	UDP/IP	TCP/IP
Subnet profile	Proprietary	PMPP*/PPP	PMPP/PPP

* *PMPP - Point to Multi-Point Protocol, SUPS - Simple UTC Protocol Specification*

The priority and background profiles are equivalent of NTCIP class A and C respectively.

3.2.2 NTCIP centre-to-centre communications

NTCIP aims to publish a standard for centre-to-centre communications in June 2000. Two documents have so far been published, *Center to center communications requirements and issues* and *NTCIP White Paper: Center-to-Center Communications.* This section summarises the NTCIP documents and the following section draws conclusions on the relevance of the NTCIP developments for the requirements of the UTMC02 project.

Center to center communications requirements and issues

Center to center communications requirements and issues provides a summary of ideas and issues concerning the development of a centre-to-centre protocol for NTCIP.

The centres that are expected to undertake centre-to-centre dynamic data exchange are:

- Surface Street Traffic Management.
- Freeway Traffic Management.
- Transit Management.
- Traveller Information Processing and Dissemination.
- Emergency Services Dispatch.
- Parking Management.

Centres that are expected to participate as data sources or destinations are:

- Data Collection.
- Toll Collection Management (non-financial data only).
- Air Quality Management Agencies.
- Weather Service.
- Railroads.

- Commercial Vehicle Fleet Dispatch.
- Airports.
- Sea Ports.
- Emergency Services (other than dispatch).
- Commercial News, Weather, and Travel Information Services.
- Event Venue Management.

Some of the names used in these lists are obviously American, but have UK equivalents. The lists provide a comprehensive set for UTMC.

The aim is to provide:

- A real-time data service with a one second time constraint.
- A near-time service where information should be delivered as rapidly as possible, but does not have to be delivered within one second and is lower priority than real-time data.
- A static data service which has a higher time latency.

The report listed end user, configuration and operation requirements for centre-to-centre communications. Based on these, protocol design requirements and objectives were devised (Table 3).

Applications not supported

The following user applications are not intended to be supported directly by the center-to-center protocol:

- Full motion video feed (camera and switch control will be at least partially supported).
- Direct remote control of field devices (see note below).
- Financial transactions & accounting data (e.g., tolls, parking charges, transit fares).
- Voice transmission.
- Facsimile transmission.
- Electronic mail.

Table 3 Protocol design requirements and objectives

Category	*Requirement/objective*
General	Use existing standards where appropriate.
Routing	The protocol needs to support routing of messages. Provisions should be included for message packet ordering.
Time constraints	The protocol should enable time-sensitive messages to be delivered within one second under typical conditions. A'time-to-live' capability is desirable. Provide support for time stamping of messages at the application layer for some classes of data.
Subscription management	Allow centres to create and maintain data subscriptions at any other node. Subscriptions should allow filtering by field device, time-of-day, value thresholds, location, etc. Subscriptions should have a limited life and require regular confirmation or refreshing.
Bandwidth efficiency	The protocol should minimise bandwidth requirements for typical networks. Event driven status updates should be supported.
Reliability	Error detection is needed for all messages. Delivery confirmation is needed for some messages. Error correction and/or message retransmission is needed for some messages.
Limit effects of changes	Adding or changing features, devices, or data attributes in one node should not necessitate changes in all nodes.
Security	A fully private network cannot be assumed. Access and privileges restrictions by centre, category of data, field device group, and time-of-day. Support for encryption should be provided. Authentication of message source should be possible by encryption or other means.
Partial and incremental implementation	Enable limited services subsets of the protocol where and while only partial services are needed.
Network management	Adding new users, privileges, devices, and systems should not require rebuilding or restarting existing components. Allow groups of network equipment to be partitioned into different jurisdictions so that control can be assigned to different agencies. Allow network administration from any node with the proper privileges.
Device identification	A network-wide device naming/numbering and registration convention is needed. A global naming system should be used to facilitate network mergers or overlaps.
Technology independence	Should accommodate changes in technology over time.
Product independence	Should be supported by multiple vendors.
Complexity abstraction	Simplify interfacing.
Encapsulation	Should enable grouping and hiding of information. Provide support for encapsulation (tunnelling) of Class A/B messages.
Scalability	Should support different levels of computing capacity and network complexity.
Extensibility	Should be adaptable to unforeseen changes and extensions.
Maintainability	Should have minimum life cycle cost.
Deployability	Should have low technology costs and risks.

- General purpose file transfer.
- Internet access.
- Remote terminal or workstation access to a center.
- Normal office LAN and intranet applications.

'Reasonable alternatives exist, and adding them as a requirement may require an unduly complex or expensive protocol or may compromise the ability of the protocol to provide for rapid automated exchange of relatively small data packets - its primary purpose.'

'The center-to-center protocol needs to enable only limited remote control of field devices. A remote center should be able to request the local center to issue a local command to a particular device. The local center can choose to ignore such commands. Only those control functions important to routine interagency co-ordination need to be supported in this way. These remote commands can be a fairly small subset of the full set of commands supported by a field device and most can be selected from message objects defined for use with the NTCIP Class A and B profiles. It is anticipated that remote terminal or workstation access using a different protocol (e.g., Telnet) will be used if remote control and monitoring of all device functions is required.'

NTCIP White Paper:Center-to-Center Communications

The purpose of the White Paper is to facilitate discussion on centre-to-centre communication protocol development. The paper presents two different approaches in providing centre-to-centre inter-operability:

- 'Communication stack approach'
- 'Application layer approach' using an 'object-orientated' application layer.

Communication stack approach

The International Standards Organisation Open Systems Interconnect (ISO-OSI) seven-layer model is shown in Figure 1. Under the stack approach, communication is undertaken in a stepwise manner. Each layer processes and passes data to the next layer. In order to obtain interoperability, standards are applied to each of the layers.

7. Application layer
6. Presentation layer
5. Session layer
4. Transport layer
3. Network layer
2. Data link layer
1. Physical layer

Figure 1 ISO-OSI seven layer model

This approach has so far been used with Class A, B and C profiles.

Application layer approach

The application layer approach reduces the number of standards required for full interoperability to one.

The presentation and session layer functionality are moved into the application layer. The application layer is completely independent of the lower layer communication protocols (transport, network, data link and physical – referred to as the communication channel). Interoperability is solely dependent on the application layer.

Industry trends show a move towards the use of a 'object orientated' application layer approach (of which CORBA is an example) for distributed systems.

The white paper advocates the use of object orientated message structures stating that; 'Maintainability and reusability is the strongest argument for object technology over procedural technology.' Object technology would avoid 'mandating a detailed data dictionary that would try to define every contingency and be very costly to maintain.' The centre to centre data dictionary could be very large. As the National ITS Architecture data dictionary was compiled it became very large and it was evident that maintaining it was going to be difficult. The same data elements were used in several different 'Market Packages' with no mechanism to update them jointly. Object orientation would overcome this problem because data elements are defined only once, but interact with other 'Market Packages' through defined relationships.

Additionally, standards such as CORBA are designed for the problems of maintaining alignment of distributed system. The CORBA Interface Definition Language (IDL) strictly enforces interface definitions through a language that is strongly typed and independent of the application programming languages and operating systems. IDL is an abstraction of a complex set of Object Request Broker (ORB) bindings and code generation per the CORBA specification. This abstraction of the interface between distributed applications greatly facilitates the management and enforcement of the communication standards. In order for any client to participate on the network, their interface must be IDL and registered with the Interface Repository Object. As new applications with new interfaces are developed, they are reviewed and approved before being added to the Interface Repository.

In addition to the advantages of inheritance and IDL, technologies like CORBA address the problem of maintaining a distributed network through common services that they provide. Network wide security is provided through security services that allow upgrades to the security without redesign to the applications. Naming services provide an interoperable method to pass application object references between systems without regard for differences in computing platforms. Synchronization service allows several clients to connect to a single application server, or a single client can connect to several related servers through group services. Customized services can be developed for transportation needs and become available to the network.'

With regards to performance the White Paper states 'the application layer approach builds its inter-operability environment in the application layer of the communication stack, and therefore must be slower than the pure communication stack approach.'

The White Paper states that if the majority of needs are

satisfied by sharing 'near-time' information 'then maintenance and life-cycle costs are the overriding considerations.' Real-time application needs can be answered by devising another NTCIP class.

Current status of NTCIP – Center-to-Center communications project

Several documents are under development in 1999. Work continues of the refinement of TS 3.AP-DATEX, TS 3.AP-CORBA and ISO/WD 14827-Part2 (DATEX-ASN primary specification). The DATEX-ASN specification has been prepared as an ISO document.

The CORBA standard lacks some services needed for centre-to-centre communications (such as real-time delivery). The Center-to-Center communications project is working with the Object Management Group (OMG) to develop specifications for a real-time CORBA service and is exploring the use of DATEX as a real-time delivery service in association with CORBA.

Its is proposed to expand the current data dictionary efforts to define a comprehensive data model.

3.2.3 Relevance of NTCIP centre-to centre developments for UTMC02

The analysis of protocol requirements and objectives against user, configuration and operational requirements presented in Table 3 is good, comprehensive and directly relevant to UTMC02. Of the applications not supported, the sharing of video is important in UK operations. However, in practice, the sharing of video between centres has been solved. For instance, the Leicester UTC control room has:

- Control of cameras installed for traffic control.
- Control of cameras funded by the home office for town centre security.
- Control of motorway cameras on parts of the M1 and M6.
- Access to images on other motorway cameras further from Leicester on the M5, but no control of the orientation of the cameras.

Control of cameras and viewing of the images is shared with police control rooms, including the motorway control rooms. The sharing of control is set up to give the police priority, that is if the police controller wishes to move a camera and select a particular view, then the UTC control room cannot move that camera until the police release control. The UTC centre can continue to view the image, but not choose the view.

There are still operational problems over the provision of images to the public and information providers, principally the desire to prevent broadcast of details of injuries and removal of victims at accidents. These problems are likely to be solved by specific operational agreements between image suppliers and receivers and UTMC02 will not influence such arrangements. One possibility being considered is that when a camera is zoomed in beyond a pre-set level then the image will be made unobtainable to any potential broadcaster.

For the other applications not supported by NTCIP, their conclusions that reasonable alternatives exist apply equally to the UTMC specification.

The conclusion that a CORBA approach to exchanging data rather than a communication stack approach is in agreement with developments in Europe and the UK as detailed in following sections discussing standards and the Highways Agency work.

4 International and European standards activities relevant to UTMC02

4.1 General overview

There are two international bodies with responsibility for standards that have relevance to the UTMC project. The International standards organisation (ISO) with a technical committee dealing with ITS matters, TC 204 and the equivalent European organisation CEN TC 278. The two bodies work very closely together in the area of ITS and the work is often jointly undertaken under an arrangement known as the Vienna agreement.

These technical committees have a number of Working Groups dealing with different aspects of the subject, but the Working Groups most involved with UTMC are ISO TC 204 Working Groups 1 and 9, and TC 278 Working Group 8. These Working Groups deal with matters relating to the overall architecture of ITS systems and also communications between equipment and to/from control centres. This chapter will consider the work currently being undertaken in these areas. Appendix 1 gives some details of the main Working Groups of interest and a full list of the ISO TC204 and CEN TC278 Working Groups.

4.2 Architecture - data dictionary

The most important aspect of the overall architecture that is currently under development is that relating to data dictionaries. An ad-hoc Working Group has been set up between CEN TC 278 WG8 and ISO TC 204 WG9 (WG9 are the lead Working Group) to consider all current work in this area and produce a common data format that will be acceptable world wide. This work is based upon ISO 11179 and IEE 1489 which prescribes a methodology for representing data elements in an Abstract Syntax Notation format (ASN.1). The ad hoc group are currently working on translating data elements from the CEN DATEX Net data Dictionary into the prescribed ISO WG9 format.

CEN TC 278 WG 8 are responsible for producing a data dictionary standard for Europe this work has been based upon the DATEX Net specifications version 1.2 for interoperability which incorporate the DATEX Data Dictionary version 3.1. This has resulted in a dictionary of terms that has been generated for specific applications in a 'bottom up' fashion and is suited for exchanging information in a message based system, by constructing application messages from data element definitions. The DATEX Net specifications provide a solution to allow common message formats to be exchanged and interoperability between systems. The DATEX Net

Specifications are about to be issued as an ENV and have been adopted by European members in a signed memorandum of understanding for exchanging data across International borders.

In USA a different approach has been made using the ASN.1 format starting with a global view and breaking messages down into logical sectors, thus producing a 'top down' approach.

The US have taken the DATEX Net specifications and transposed the main functionality into a DATEX ASN.1 specification. This concept has been incorporated by ISO when developing standards for communications between control centres. A draft standard for this communications level is currently being developed (ISO 14827) and has been approved at draft level and is currently under revision following comments made at the voting stage.

The Ad-hoc Working Group is therefore building on both these documents and is currently producing a draft dictionary in ASN.1 format that will incorporate all DATEX-NET items and thus be compatible for both 'top down' and 'bottom up' approaches.

4.3 Architecture - data registration

An important aspect of the development of any data dictionary is the registration of items. A standard for this has been produced in draft by ISO TC 204 Working Group 1, this group are defining the methodology for data element registration. However the cost of operating such a register will be substantial and no agreement has been reached about funding or operating this to date. Therefore, although at present the work within the various groups is not in conflict, there is a potential for long term conflict unless a registry is set up, (and funded) in the not too distant future.

4.4 Architecture – National Transportation Communications for ITS Protocols (NTCIP)

Considerable work has been undertaken in USA to develop a national standard for communication across the ITS field. This work is collectively known as NTCIP (this covers both roadside to centre communications and centre to centre) and has been submitted as a basis for producing international standards. ISO TC 204 Working Group 9 have considered these proposals and consider that there is merit in this approach to avoid duplication of effort.

However, there are copyright issues, as the NTCIP documents are owned by organisations within USA. This means that, should ISO adopt these standards, the ownership of the standards would be uncertain. This issue is under discussion at present and is likely to be resolved amicably, but until this is formalised there must be a question mark over the possibility of NTCIP standards becoming available formally for incorporation into international standards. It is also clear that some countries would not wish to adopt NTCIP standards for their own networks and therefore this may inhibit the development of these standards as full international standards.

At present ISO TC 204 WG 9 is incorporating relevant parts of NTCIP (DATEX ASN) into draft standards for Communications between Control Centres, see section 3.2.2, and also into standards for the Communications between Control Centres and Roadside Equipment. This work will be compatible with the data dictionary work being undertaken by the Ad-hoc group and therefore this will form a standard that will be compatible with DATEX-NET, and NTCIP. However it will not necessarily incorporate all features of these schemes, but should enable networks to communicate with each other satisfactorily although some of the facilities available within each network may not be available between networks.

4.5 Conclusions

It would appear that the general architecture of NTCIP, and many features of it, will become an international standard in the near future. This will enable NTCIP to be used as a basis for the intercommunication of networks by those administrations who wish to develop along these lines, and should also ensure that systems are compatible across international boundaries. Similarly the work on Data Dictionaries should ensure that the DATEX-NET specifications and those developed with DATEX ASN.1 should be compatible. It must be assumed that other communications protocols will become available to the ITS community in due course (CORBA is an obvious example). When this occurs there is no fundamental reason why these should not be compatible with the existing work, but inevitably developments and enhancements will need to be incorporated from time to time and it will be necessary to ensure that changes are 'upward compatible' so that established systems can still make full use of the standards and newer systems are not inhibited from developments and enhancements. Both CEN and ISO standards bodies will be working to ensure this occurs. With the introduction of Object Orientated technologies there is a need to develop further standards for representation of data from a common Data Dictionary.

Thus the current work in the standards field relevant to UTMC is concentrated upon Data Dictionaries and the incorporation of NTCIP works, the DATEX Net specifications into communications standards. A full list of all standards currently under development within ISO and CEN is available and the Ad-hoc group work on Data Dictionaries should be made available for discussion later in 1999.

The Highways Agency recently commissioned a study of DATEX-Net, DATEX ASN, CORBA and the data dictionary approach to messaging standards. The results of that study are relevant for UTMC02. They were:

Although DATEX-Net in conjunction with EDIFACT is reasonably established, it is a character based messaging system whose structure is loosely defined and which is more suited to human interpretation than by a computer.

DATEX-ASN imposes a more rigid structure than DATEX-Net and uses the ASN.1 notation to define the data which constitutes messages. ASN.1 is used by a relatively small number of specialists, and if CORBA (which is widely used in the software industry) is to be used for network communications, using ASN.1 would prove to be restricting.

CORBA is a well-established tool for developing object-oriented distributed applications. It is compatible with UML. Using UML and CORBA will result in an object-oriented design which lends itself to reuse of existing objects in new applications and the dynamic addition of new objects in an existing system. Using data modelling will help identify message requirements and eradicate duplication of information.

Once the required messages have been identified, a data dictionary can be produced.

Table 4 summarises the suitability of current standards.

5 Highways Agency developments

The three developments of particular relevance to UTMC02 are the QMISS database, the Traffic Information Highway and the Traffic Control Centre initiative.

5.1 Quantified Motorway Information Supply System (QMISS)

The Highways Agency in England has a strategy for improving the availability of inter-urban traffic information and this strategy forms part of their new role as a network operator. The Quantified Motorway Information Supply System (QMISS) is being developed by the HA as part of this strategy and QMISS will contain real-time information about conditions on the motorway network and details about the physical network. The first version of QMISS will be accessible in the Spring of 1999 and will contain static data and dynamic data. The HA central logger CENLOG will be a main feeder of information to QMISS and the QMISS database will reside on a computer located at Coleshill in the Midlands. CENLOG is a HA facility for collecting data from Police Control Offices. The first implementation of QMISS will concentrate on making information about the setting of signs on the motorway network available. QMISS is a pilot project to develop information systems. It is envisaged that in due course it will be embodied in the Traffic Control Centre initiative.

5.1.1 List of data stored

The QMISS static data relates to information that changes very infrequently and includes the following information:

- Sign and signal locations using OSGRs.
- Network link and node locations using OSGRs.
- Support for Latitude and Longitude and Radio Data System - Traffic Message Channel location references.
- Other network attributes and features.

The Highways Agency has access to the following information sources and there are proposals to make them all available, eventually, on the QMISS database:

- Matrix indicators settings.
- Variable message settings.
- Controlled motorway speed settings.
- MIDAS loop data (Traffic flows/speed).
- Live CCTV images.
- Network models.

The QMISS dynamic data will initially provide information on:

- Current status of matrix indicators.
- Current status of variable message signs.
- Current status of controlled motorway speed limits.

In addition information will be held about when signs were set and details about the quality of the information.

5.1.2 Location referencing system

A flexible and adaptable location referencing system has been developed for QMISS and this referencing system has its origins in the methodology developed for the Radio Data System – Traffic Message Channel (RDS-TMC). The QMISS location referencing system contains many enhancements to improve its flexibility over the simpler RDS-TMC methodology. The QMISS system is based around a database that has two levels: the Highway Level and the Point Level. The Highway Level contains entries for every HA road and the Point Level codes the roads in sufficient detail to meet the requirements of the Traffic Information Community (TIC). On motorways points are defined at every roadside marker-post. These normally occur at 100 metre intervals and are present on both sides of the carriageway. Other points are defined at locations of importance such as merges, diverges etc. A similar process is used on the all-purpose trunk roads but the absence of markers posts on many of them introduces the need to use other points of reference.

At each of these points a unique location number is defined which consists of the Ordnance Survey 100,000m grid square identifier, the 10 metre resolution Ordnance Survey Grid Reference, the carriageway direction and a number differentiating between more than one point at the same OSGR. In addition extra information is held, where appropriate or needed, for each point. The following list illustrates the possible additional information that can be held and the field names are mostly self explanatory: HighwayRef, Roadname, LocType, Locname, HaArea, ControlOffice, County, Longitude, Latitude, StreetMapRef, CHART, RdsTmc, DistToOffset, Loops, TrafMast, CCTV, Phone, Beacon and Sign. The HA is currently measuring the position of all the motorway marker posts to populate the database.

The individual entries in the Point Level database are also given positive and negative offset links to show how the points are linked along the road. Additional fields also give information on links to points on the opposite carriageway, to a parallel carriageway with traffic in the same direction (if it exists) and to another road at a junction. This methodology provides considerable flexibility and allows, for instance, a map of the network to be generated by starting at any defined point.

The HA is currently acquiring the required information from points on the motorway network to populate the location database within the QMISS system. The QMISS database enables different views to be allowed of how

Table 4 Suitability of current standards

Specifications	*Standards body*	*Current status*	*Target use*	*Advantage for data exchange between control centres (UTMC node As)*	*Disadvantage for data exchange between control centres (UTM C node As)*
DATEX Net v1.2 specifications incorporating data dictionary v 3.1.	CEN TC 278 WG8.	With TC 278 WG8 to be circulated for formal voting as ENV.	Interconnection of systems for interoperability and exchange of information between Traffic Information Centres and across International borders.	Allows legacy systems based upon DATEX to be connected using the standard DATEX dictionary. Used in European projects eg Euro Regional projects. MOU signed by 15 European members.	Uses triagram codes EDIFACT, character based protocol,used for point to point communication. Location coding based upon RDS TMC, end to end application not independent of application layer protocol.
DATEX ASN.1.	ISO TC 204 WG9.	Committee Draft 14827 parts 1-2 being prepared as draft standard. Used in US implementations.	Traffic Management Information Centre ((TMIC) to TMIC communication.	Enables networking of applications based upon ASN.1. Uses Internet protocols (TCP/IP). Facilitates computer to computer exchange.	Functional/Application data dictionaries need to be developed.
Data Dictionary Structure.	ISO TC 204 WG1.	With Working Group to determine a standard format for defining and registration of data elements.	Provides structure for other ISO Working Groups, data element registration as in ISO 11179 and IEEE 1489.	Enables standard forms of data exchange.	Data elements need to be precisely defined, to convey unambiguous information.
CORBA.	OMG; not currently Work Item in ISO or CEN. Suited to TC 204 WG9 programme.	Being used in UK research projects, US and Nederlands implementations.	For implementations incorporating Traffic Information Highway concepts allowing exchange of data between multiple users.	CORBA specifies a system which provides interoperability between objects in a hetro-geneous distributed environment transparent to client.	Results awaited for transport applications.
NTCIP.	ISO TC 204 WG9.	Submitted by US as draft standard for roadside to centre standards ISO 15784.	Standard for roadside to centre application.	Provides for OO concepts of software design using profiles based upon internet protocols.	Issues with US standards bodies IPR and dependancies to be resolved.

[1] *Data Dictionary activities now being focused upon ISO TC 204 WG9 ad hoc Working Group formed to produce a standard TICS data dictionary in conjunction with CEN TC 278 WG8. Initial work translates DATEX DD into ISO formats.*

[2] *NTCIP incorporates centre to centre standards (DATEX ASN.1) and roadside to centre standards.*

information is referenced. The methodology permits requests for information from the Traffic Information Highway to be made in a variety of formats such as Latitude and Longitude, Ordnance Survey Grid Reference, chainage along the motorway, marker post number etc. The extensive 'lookup table' approach provides the flexibility required but does carry the necessity for the required fields in the 'lookup table' to be populated by the system operator and kept up to date as time progresses.

5.1.3 Intended uses and users

The Highways Agency is responsible for 'making the best use of the current road network' and one way that this can be achieved is to ensure that people undertaking a journey have the best quality information about current traffic conditions on the network that may affect their journey. By giving them up-to-date information with the minimum of delay they may decide to amend their journey times or perhaps select an alternative mode of transport. People undertaking a journey may gain access to the information using such equipment as phones (fixed/mobile), in-car devices, radio, teletext, television, pagers, Internet terminals etc. Some information may be acquired pre-trip and some may be provided on-trip.

The QMISS system is not intended to provide a direct travel information service to the drivers. The main users of QMISS are expected to be Value Added Service Providers (VASPs) and organisations responsible for controlling traffic such as the proposed Traffic Control Centre Company. At present QMISS is being structured to make the raw data easily accessible, although in the future some calculated services may be made available. Raw data is most suitable for VASPs since they will have the systems necessary to collate this data with other data sources and, after a data fusion process, produce information which is timely, relevant and accurate. The VASPs need access to good quality data if the information they are trying to sell meets a need in the market place. QMISS has the potential to provide a unique source of timely good quality data for use by VASP's. QMISS also has the opportunity to assist in the development of 'Intelligent Agents' independent software modules whose tasks are to find the best means of undertaking journeys given all the possible modes of transport. If the other modes of transport could provide equivalent information to QMISS then an Intelligent Agent would have access to the information necessary to provide advice tailored to the needs of the individual undertaking a journey.

Unrestricted access to data during major disruptions has the potential to create greater community delay than it avoids. It is often argued, by transportation network managers that they need the facility to control and direct information, on occasion, to minimise the overall network delay. Discussions with VASP indicate that they accept this will be necessary and are willing to accept and co-operate. It is of note that a clause to this effect is built into the data sale contract the Paris region has with VASP's in France. The data providers can specifically direct the format to be adopted in passing information to customers. Feedback on how often this is invoked is not readily forthcoming.

Two applications that will be using the QMISS data are the Road Traffic Advisor research project and the recently launched Traffic Message Channel service where the two traffic information centres supporting this service will have access to the QMISS data.

5.1.4 Access methods

QMISS is currently connected by a server at Coleshill to the Internet and authorised users may gain access to the QMISS database using the Internet. Direct access to QMISS via dedicated lines may also be an option in the future should the requirement arise.

The QMISS system is currently set up to allow information to be accessed using a method called Java DataBase Connectivity (JDBC). JDBC is an application programming interface specified in JAVA for making connection to, and retrieving data from, databases. Should the need arise other means of providing access may be provided.

5.2 Traffic Information Highway

5.2.1 Aims of the Traffic Information Highway

There are many opportunities for the private sector to provide selective information services to the public and it is a key part of the Highway Agency's strategy that these are exploited. The data providers, the Value Added Service Providers (VASPs), Local Authorities and the users of the road network can all be considered to be members of a Traffic Information Community (TIC). The members of the TIC all share a common goal of acquiring the best quality traffic information from across the road network, turning the raw data into useful information and then distributing the information to the end users as quickly as possible. In order to achieve this, an effective method of linking the members of the TIC is required together with agreements on how the information is to be exchanged between the various parties. The Traffic Information Highway (TIH) concept provides a vision of how information may be easily exchanged between the members of the Traffic Information Community. The techniques used to exchange information on the TIH can also be used to exchange information between organisations that cross jurisdictional boundaries.

The Highways Agency has commissioned the development of a demonstration Traffic Information Highway and the work is being undertaken by the Transport Research Laboratory and the University of the West of England. The project is scheduled to produce a TIH demonstrator by the summer of 1999.

5.2.2 Traffic information architecture

The goal of the TIH architecture is to provide a framework, which enables services to be delivered to a variety of organisations and users in as open and interoperable way as possible. In order to meet this goal the architecture has been designed *ab initio* with the realisation that its implementation as a potentially large distributed system will require consideration of issues of security, heterogeneity (platform implementation language, operating system and middleware), geographic

separation of components and possible integration with legacy systems. The Object Management Architecture (OMA) from the OMG of which Object Request Broker (ORB) is the central component was chosen as the basis for the TIH architecture precisely because the OMA offers the necessary architectural concepts and implementation technology to handle these issues.

At the computation level, a service is an object that exists on the TIH and which provides a client with a programmatic means of using that service in an application. Examples of applications which use services have already been described but could include anything from simply displaying data provided from a service to complicated data fusion applications which may utilise many services. A service on the TIH is characterised by its interface which is written using the CORBA Interface Definition Language (IDL). The interface hides implementation details of the service from a client. This is an important concept. Services can be implemented on any hardware platform (i.e. language, database, operating system, hardware platform) as long as an ORB implementation exists for the platform. Currently, the ORB market is expanding, with many vendors supplying ORBs for many different platforms. A client is guaranteed to be able to use a service even if it is implemented on an entirely different platform. Services also need to be located on the TIH and this is achieved through the use of Interoperable Object References (IORs) and/or naming services. The use of IIOP guarantees interoperability between clients and services built using ORB implementations from different vendors; interoperability with other distributed systems technology, such as Microsoft's DCOM, can be provided by bridging components.

Looking at the wider context of the TIH, the use of CORBA in the TIH architecture facilitates interoperability between different service providers and their users. Designing systems to interfaces rather than implementation is a powerful architectural concept. As such, the services which implement the interfaces can be thought of as binary ready components which can be used in the construction of new applications. The services themselves can be implemented on top of conventional relational databases, or could be implemented using more object oriented techniques or even consist of wrapped legacy code.

The vision of the Traffic Information Highway is not that it will be a specific dedicated physical link between members of the Traffic Information Community. The use of CORBA and the above TIH architecture allows information to be exchanged so long as the services are available on a network that links all the users.

5.2.3 Services to be provided

The services to be provided on the TIH will depend upon the services that the members of the Traffic Information Community wish to provide. The number and type of services are likely to change over time to reflect market demand and willingness to pay for the services. A list of possible services that VASPs may wish to provide has been prepared and they have been asked to submit any additional ideas for possible services as part of their involvement in the TIH User Group. Examples of services that could be provided include: Traffic problems on a given route, warning when a traffic problem occurs on a route regularly taken at a given time etc. CORBA can also allow legacy wrapping. An example of legacy wrapping would be a service that provides predicted travel times between two nodes in a network and the time of departure which, although offering a CORBA service interface, could well have been implemented by a large model code written in a language such as FORTRAN

Issues relating to the management of the TIH remain to be resolved and a possible scenario is that the Traffic Information Community may appoint one organisation to provide a focal point for information about the services available on the TIH and for promoting and maintaining the standards to be used on the TIH by the participating members.

The TIH project will demonstrate CORBA services derived from the QMISS relational database, The TIH demonstrator will show a CORBA service for Java and Microsoft clients implemented using Java. These worked examples with all the associated software will be made available to organisations wishing to develop their own services. This approach was considered to be the most effective way of encouraging organisations to adopt these new software technologies and gain the resulting benefits.

5.2.4 Protocols and standards

The use of the CORBA software technology guarantees that services can be provided on a network which then allows information to be accessed by users from anywhere on the network and then downloaded onto their own computers.

Issues remain to be addressed regarding the standards and meaning of the data provided by the services. It will be the responsibility of the CORBA service providers to provide information about each of their services using the CORBA Interface Description Language (IDL) and a statement containing the meaning of the data items. It is anticipated that the DATEX data dictionary will be used, where possible, to define the meaning of data made available within a service. When this occurs the service provider will need to make it clear to the users. Additional information would need to be provided on any data items provided by the service which were not covered by the DATEX data dictionary. If required the service provider could use the CORBA service to deliver a DATEX message.

5.2.5 Future development

The TIH demonstration project will allow the concept of open data access using CORBA to be fully evaluated by passing near real-time information between QMISS and the VASP traffic databases. It will demonstrate the flexibility and ease with which users will be able to make use of third party information in their own applications and will allow issues of standardisation to be investigated. To be successful the TIH will additionally need to operate as a market place enabling agreements to be put in place

between data suppliers and users, and providing a charging mechanism for access and data transfer. Testing the concept further will require information from other independent sources to be made available along with user applications collecting information from those sources. As part of the UTMC work the services required to manage traffic across jurisdictional boundaries need to be defined and implemented for evaluation using the Traffic Information Highway.

5.2.6 Conclusion

The development of the Traffic Information Highway by the Highways Agency is seen as an important step forward in making better use of the road network by providing users with high quality real-time information. This improved source of information is expected to enable them to take more informed travel decisions before and during their journeys. The same Traffic Information Highway and associated software technologies may also be effectively used to exchange information across jurisdictional boundaries. This exchange of information is essential if traffic management is to be handled effectively between urban and inter-urban networks.

5.3 Traffic Control Centre(s)

The full procurement specification for the Traffic Control Centre project has not yet been released to potential contractors. Therefore, the following description is based on the pre-qualification document.

5.3.1 Project overview

In seeking to make better use of the Core Network of motorways and selected main roads, the TCC Project has two key objectives:

- To provide roadside information direct to drivers, via a national network of variable message signs, advising them of conditions on the network and/or suggesting alternative routes or modes of transport as appropriate;
- To provide a specified range of quality traffic and travel information to customers both directly from TCC Co. and indirectly via third parties.

The TCC Project will facilitate an improvement in the quality of information available to road users. By working with information service providers, the Project aims to increase significantly the availability of real time travel information.

By improving the knowledge of conditions on the network prior to and during their journey, the TCC Project will assist travellers in making travel and transport choices thus resulting in a better match between demand and road capacity.

To achieve a high quality of information services, the TCC Project will provide infrastructure to monitor traffic in real-time and computer systems to model current and future network performance. The TCC Co. will need to work efficiently with the police service, Local Highway Authorities, other transport network operators and information service providers.

The Agency has direct experience in operating regional driver information systems where ‘control’ is exercised using variable message signs. Operating these systems has demonstrated that it is possible to reduce significantly delays on the network by providing advice on alternative routes.

The principal products of the TCC Project are:

- A strategic traffic management system for the Core Network in England.
- A partnership with the private sector in the provision of real-time traffic and travel information both before and during journeys and both directly and through third parties.
- A platform to improve the level of information exchange between the Agency and other network operators e.g. local authorities, railway and bus operators.
- High quality data provision to increase the Agency’s knowledge of network performance to be used for statistical and planning purposes.
- A relationship with the police service to enable better management of the network in terms of both safety and efficiency during incidents; and
- The provision of information for specific Agency Toolkit initiatives.

5.3.2 Strategic traffic management

The delivery of the strategic traffic management service for the Core Network represents the most important component of the TCC Project. From the point of view of UTMC02 it will also be a major reason for interaction with other authorities. This service includes:

- Monitoring traffic in real time.
- Providing direct traffic management services to the Agency, using real time data processing and network modelling, to report current network performance and to determine response plans to mitigate congestion arising from network events.
- Implementing response plans by providing advice to drivers using variable message signs; and
- Working with other information service providers to improve the quality and quantity of pre-trip and en-route information, with the goal of ensuring that this information is consistent with the Agency’s Network Operator objectives.

Strategic traffic management services will be designed to mitigate the effects of congestion by influencing the choice of route, the time of travel/transport and the mode of travel/transport.

Strategic traffic management services will be focussed on the Core Network, but operating decisions and procedures must take into account the need to integrate trunk roads with local roads. TCC Co. will be required to consider the use of part of the proposed de-trunked network and any existing high standard local roads for specific diversion routes. Designating local roads as diversion routes will require the prior agreement of the Agency and the relevant Local Highway Authority.

The strategic traffic management services provided by TCC Co. will co-exist with existing incident management systems (operated by the police service from Police Control Offices (PCOs) across England). TCC Co. will be required to ensure that the safety related responses associated with incident management are given priority over those proposed for strategic management purposes.

TCC Co. will be required to co-ordinate the planning and implementation of responses to events with appropriate organisations, including the Agency's Area Managers, police services, and Local Highway Authorities.

The TCC Co. will also have to work to agreed liaison procedures with Local Highway Authorities to ensure that the strategic traffic management systems operated by the TCC Co. are integrated, as far as possible, with any traffic management systems operated by the Local Highway Authorities.

5.3.3 Traveller Information Services

An increase in the quality and wider availability of traveller services are important objectives to be achieved by the TCC Project. From the point of view of UTMC02, the traveller information services represent the major exchange of information with other bodies. At the same time, the Agency wishes to ensure that information provided to travellers is consistent with the Agency's Network Operator objectives.

Traveller information is comprised of two components:

- Public information: for which the Agency would require TCC Co. to disseminate a specified set of information via specified delivery media at no charge to the public; and to exchange information with other network operators (e.g. local authorities); and
- Commercial information, which the Agency will wish to ensure, is disseminated on a revenue raising basis.

With regards to public information, the Agency has a view of the level of information that it wishes to ensure is available to the public. TCC Co. will be required to ensure that this level of information is available free of charge to the public at the point of delivery.

It is envisaged that the third parties that will provide commercial information services relating to the Core Network will be privately operated VASPs. The VASPs are expected to serve the various traveller information markets, ranging from information that is free to the public (e.g. real time traffic flow information distributed via the Internet), to information targeted at specific customers (e.g. using data cleaning, patching, validation and historic trends to develop near term forecasts).

Subject to certain limits designed to ensure that information is used constructively, a large variety of information is likely to be made available to VASPs. The ultimate objective of the Agency is for TCC Co. to work closely with VASPs to ensure that travellers receive high quality travel information. The TCC Project has been designed to support the VASP market in this regard, where commercial incentive is an important quality control. However, Tenderers should note that the policy with regards to the sale of video images by TCC Co. is still under review.

The Agency wishes to ensure that all VASPs have equal opportunity to purchase available traffic information regarding the trunk road network. There will be appropriate controls in the Contract to ensure that neither TCC Co. nor any VASP is able to gain any commercial advantage in the market place by virtue of a privileged position. Provision of information to VASP's will be on a non-discriminatory and non-exclusive basis, with appropriate audit arrangements.

The TIH will provide the primary method of information exchange between TCC Co. and VASPs.

6 Mattisse project

The Mattisse project is a major example of co-operation across jurisdictional boundaries of direct relevance to UTMC02.

6.1 Description

The Mattisse (Midlands Advanced Transportation Telematics Information System for Strategies in Europe) system was developed as part of the Fourth Framework project QUARTET+. Mattisse collects and disseminates traffic and travel information from various sources in the West Midlands region. It aims to provide comprehensive up to-date traffic and transport information and to define co-operative management/ control strategies across jurisdictional boundaries. Thus enabling more effective and efficient network management, and also allowing the public to make informed travel decisions.

Mattisse User Terminals (UT's) are located at eight local authorities traffic control centres, and also British Rail Business Systems (BRBS), West Midlands Police, RAC control centre - Bristol, an Environmental Monitoring Unit, a Travel West Midlands depot, Metro News and iTIS, both of whom are VASPs.

The User Terminals are linked point-to-point to a central data exchange and storage system (Integrated Road Transport Co-ordination System (ITECS)) at the Birmingham UTC centre. The ITECS and the UT's use a QNX operating system and a WATCOM SQL database. Information is stored and exchanged in a Data Dictionary format called BLUEPRINT. ITECS maintains a database of the information from the UT's and distributes it to UT's subject to data filtering (data elements to be transmitted) and data co-ordination (to restrict the sending of repeat data). It also logs data access and data change events. A subset of the information held on ITECS is passed to the Mattisse Webb site on the Internet. The ITECS, Internet Server and the Birmingham UT are connected together via an Ethernet. ITECS is connected to the other User Terminals over a BT Flexible Bandwidth Service.

ITECS also has a strategy function designed into it. The aim of the strategy function is to provide sets of advice, instructions, and information to system users in response to predefined incidents. ITECS has the ability to automatically initiate the strategy subject to predetermined triggers. The strategies focus on co-ordinating incident management across jurisdictional boundaries. The use of

this facility is in its infancy, partly due to continuing traditional demarcations of responsibilities. Discussions are ongoing to seek ways of developing this tool.

Information is entered on the UT either manually or automatically from an external system. Mattisse has automatic system interfaces with urban traffic control systems and train passenger information systems. An automatic interface with the West Midlands Police Command and Control System is under trial. In the short term it is planned to have others with an Environmental Monitoring Unit and the Midlands Driver Information System (MDIS). Current automatic interfaces are custom designed. The UT translates data formats between external system and Mattisse. A standard interface, using the UT's RS232 port, to accept data in the BLUEPRINT format has been included in the Mattisse design.

Mattisse uses Ordnance Survey Grid References (OSGR) for location-referencing Mattisse has the potential to use RDS/TMC location codes.

6.2 Automatic system interfaces

In creating the Mattisse system the designers identified that there is a need to automate data entry as much as possible to avoid extra workloads on system operators. The current automatic system interfaces are with urban traffic control systems, car park information in Leicester and rail customer service systems (Table 5). The interfaces are custom designed.

6.3 Manual data entry and planned links

There has been limited active participation of non-UTC authorities. The reasons for this include:

- Mattisse was originally a two year demonstration project and as such some agencies have been following 'a wait-and-see' policy.
- A lack of formal agreements / contracts for providing information.
- Public transport providers have been sceptical as to the benefits of providing real-time service information.
- A lack of available staff resources for manual data entry.

An automatic system interface with the West Midlands police Command and Control incident log is under trial off-line. Automatic interfaces with police force systems are also planned with Leicestershire, Warwickshire Police, and the Police Central Motorway Control Group (including the Midlands Driver Information System (MDIS)).

Discussions with the Mattisse consortium and the three police forces have indicated that the development of the strategy function will take place slowly because of the

Table 5 Current automatic system interfaces

Organisation	*Data input*	*Interface*	*Institutional issues*	*Technical issues*	*Operational issues*
Birmingham CC.	SCOOT messages (SAMS) – queue, congestion and flows above predefined thresholds.	UTC Terminal Server Port.	Inter-agency co-operative agreements have been effective.		
	Congestion.	UTC Terminal Server Port, with indirect connection to Integrated Management System.			
	Car parks.	UTC Terminal Server Port, with indirect connection to Integrated Management System.			
	Fault monitoring.	RS232.			
Leicester CC.	INGRID Car parks Incident management System Fault monitoring.	SCOOT connection SCOOT connection. RS232 SCOOT connection.			
Other UTC centres (inc. Coventry, Wolverhampton & Walsall).	SCOOT messages Car parks Fault monitoring.	UTC Terminal Server Port UTC Terminal Server Port RS232			
British Rail Business Systems.	Customer Information Service TIDES (Train operating co's 'free text' info on problems).	RS232 with X.400 gateway RS232 with X.400 gateway. ASCII data format.	Some train operators believe that supplying delay & cancellation information can have a negative affect on public image.		Rail operators fail to inform about cancelled trains.

need to remove traditional demarcations (Welsh et al, 1998). Welsh states that 'It is impossible to say whether we will ever reach the state where the operational commands to one system are derived from another'

There have been recent developments in the preparation of a new Emergency Plan for Birmingham. These indicate that there is a greater willingness to make effective use of the skills of organisations other than the police in managing a major incident. This may lead to positive development of the strategy function.

It is hoped that there will be collaboration with the Traffic Control Centres (TCC) planned by the Highways Agency. The strategy function element of Mattisse could be developed to provide close integration of traffic management.

Connections with Police and trunk road control centres are seen as by many users and the Mattisse consortium as being a major credibility enhancement.

Public transport information is currently limited to rail information. The Mattisse consortium would wish to secure arrangements with public transport operators and the local Passenger Transport Executive so as to provide comprehensive traveller information.

Table 6 shows participation by organisations, current and planned, and their known requirements and issues.

6.3.1 Findings from the Mattisse Project Review

In 1998 the West Midlands Chief Engineers Planning Officers Group (CEPOG) commissioned Ankerbold International to undertake a review to provide guidance and recommendations as to the future of Mattisse.

Among the findings were:

External stakeholders 'were generally positive or enthusiastic about the Mattisse concept, but were neutral or reserved judgement on its application. This is because Mattisse has some way to go to reach its full potential.' The company iTIS in particular is very interested in the provision of information from the police. The iTIS company is a VASP providing information principally to freight operators. They are prepared to invest heavily to obtain this information. If the data from Mattisse is available and comprehensive, it will ensure that there is no delay in transmission. There is a concern that with the current 'pooling' arrangement, information may not always be passed on to others as quickly as they would wish.

Intellectual property rights may stand in the way of voluntary collaboration by some agencies. Matters that need consideration are the development of an audit trail for information exchange, and 'more formal contractual arrangements dealing with intellectual property rights, public service obligations, and the possibility of fees for supplying information from Mattisse'.

Local authorities are well placed to collect and process traffic and travel information. However, the private sector may be better suited to provide and distribute information. It is recommended that future Mattisse development 'is done in close consultation and possibly a partnership with the private sector.'

The main economic benefits of Mattisse in its present form are from incident management. The incident management features need to be further developed, which requires close inter-agency co-operation. 'The integration of Mattisse with the police control centre incident handling is highly significant and needs to be proven as an effective way of achieving this co-operation'.

'Introducing the Mattisse strategy function (see Section 6.1) to manage incidents will demand attention to inter-agency institutional issues because of the cross-jurisdictional agreements which will be needed to maximise the benefits'.

'A weakness of the communications architecture is its dependence on a single server at the hub of a star network which connects all the sub-centres to the Birmingham UTC centre. This makes it vulnerable if the main server fails. It is also a weakness if the communications to the hub malfunctions for any reason'. It is recommended that the architecture be modified to a ring based communications network.

Mattisse lacks flexible information filtering. It is highlighted that this needs to be developed, information delivery needs to be tailored to the customer. Too much information, or information that is not useful, can affect the credibility of the system. The filter needs to be able to allow the originating centre to give a priority assessment and specific users to receive certain data, for example based on level of priority, area, or type.

The location referencing need of users needs attention. There is a large overhead involved in attaching alternative references for alternative mapping or Geographical Information Systems.

Those closely involved in the Mattisse project see Mattisse as providing a public service. The view of the review is that a self-financing operation is not realistic. (Note the Mattisse consortium has conducted surveys and interviews that established that there is a market for accurate, relevant and up to date travel information. Their analysis indicates that there are enough companies willing to pay for the service to eventually make the system financially viable (Welsh et al, 1998)).

7 Other on-going developments

Various organisations are developing systems for data exchange and dissemination, some of these will be covered in the later section describing the lessons learnt from surveying non-UTMC organisations. Two particularly relevant current developments are described below. Firstly the London Travel Information Service that is being developed for the bodies that will be in the Greater London Authority and to enable them to provide timely, relevant and accurate travel information for third party information disseminators. The second is the Road Traffic Advisor project that is designed to

put information directly into individual vehicles using Dedicated Short Range Communications, although the open architecture allows for the use of other transmission media, such as cellular telephones.

7.1 London Travel Information Service (LTIS)

The London Travel Information System has been developed to meet two needs. Firstly it has been foreseen that the Greater London Authority will need a travel information system. The authority will be responsible for London Buses, the Metropolitan Police traffic functions and the traffic functions of the Traffic Control Systems Unit (TCSU). An overall information system will be needed to co-ordinate all the authority's responsibilities. The second need is to meet commitments to provide travel information to disseminators. Metro and AA Roadwatch currently take information from the congestion log kept by the Metropolitan Police and have access to traffic cameras. The existing free text congestion log and operational procedures cannot meet current requirements for the provision of relevant, accurate and timely information to travellers. Therefore, a modern information system is required to supply data to travel information disseminators.

A pilot project looked at commercially available systems and identified the Canadian TRIS system as the most suitable. The trial of TRIS was successful in demonstrating that a formal reporting system did not put an excessive burden on the police data collators who were used to an unconstrained free text system. A formal windows based data input system that required certain fields to be filled with information selected from a pre-defined list was accepted as the correct approach for a future system. Therefore, the trial provided the basis for the development of a full system. TRIS was not suitable for an operational system in London for two reasons. Firstly it was not designed for the complex road hierarchy and junction layout in London and secondly it is based on ACCESS, which is not powerful enough for a London wide database.

TCSU are developing LTIS based on Oracle databases and Mapinfo software. The individual terminals will have the MapX reduced version, not the full Mapinfo system. It would be too costly and MapX can be customised to provide just the functions required at a terminal. The map system and LTIS database that will replace the congestion log have an Open DataBase Connectivity, ODBC, link to update the graphical information. The data dissemination to Metro and AA Roadwatch has been automated to a push service which sends information on congestion and incidents to Metro and the AA every 20 minutes. For each incident the database holds information on:

- Unique identifier.
- Status (active, scheduled for the future etc).
- Time since reported to the external information users.
- Category.
- Severity.
- Start and end time.
- Location.

7.1.1 Structure of the graphical system

The system being developed allows much more functionality than the linking of the congestion database with a map front end. Paths can be defined to multiple databases from the Mapinfo front end and conditions set on when particular information is displayed. This means that a network path can be defined to a database, maintained by LT buses, that contains route and bus stop information. Any user of the system can then call up a display showing the bus information that they are authorised to access, but responsibility for that data remains with LT buses. TCSU simply provide the path address and do not have to develop the database. Other services, such as timetables can be added in a similar manner.

The geocoding system is a link and node data set based on OSODR. The bus operators can have a separate set of links and node set using bus stops as the nodes and links to define the bus routes. The information will automatically be overlaid on the basic street maps using the OSODR information on the bus link and node data.

7.2 Developments from the white paper – A new deal for transport

The Governments White Paper *A new deal for transport* (DETR, 1998) requires wider availability and provision of information on timetables, route planning and fares; and a national public transport information system by the year 2000 - initially focusing on timetable information.

The White Paper sets-out passenger information needs for journey planning:

- Timetabling.
- Services.
- Fares.
- Interchange details and facilities.
- How to book.
- Delays and engineering works.

Passengers will access a national integrated journey timetable through one enquiry point. Envisaged enquiry points include telephone, kiosk, teletext and the Internet. The White Paper states that 'In partnership with the local authorities operators and user groups, we will seek agreement on the format of information and interfaces between different systems'. It is proposed to require public transport operators to provide service and schedule information electronically in a standard format.

Train operator licensing agreements include the mandatory provision of timetable and fare information to a central database and the operation of the National Rail Enquiry Service. Bus operators have no obligation to provide passenger information. The White Paper states that 'local authorities will have new powers to secure the availability of passenger information where necessary and to recover the costs from the operators.'

The DETR's National Integrated Transport Information Project seeks to steer the provision of pre-trip passenger information. The Internet site *UK Public Transport Information* (www.pti.org.uk/) has been highlighted as an example of what is trying to be achieved. The site has links

Table 6 Mattisse participation and organisations' issues

Organisation	*User terminal*	*Manual input*	*Proposed links*	*Institutional issues*	*Technical issues*	*Operational issues*
Mattisse local highway authorities.	Yes.	Includes: incidents planned road works (excluding street works), road closures, special events, severe weather conditions and public transport disruption. Also automatic interfaces (Table 5).		Inter-agency co-operative agreements have been effective.		
West Midlands Police.	Yes.	Limited.	Automatic interface with incident logs – trial currently being undertaken with WMP. Mattisse access to police CCTV.	Security of system interface. Concerns about the potential sensitivity of some information. Editorial control of CCTV in the case of serious accidents, security surveillance, and crime prevention work.	Creating a secure interface. The forces have differing systems. Requirement for separate custom design interfaces.	Current limited involvement is partially due staff resources. Mattisse seen as a potential means to distribute information about traffic incidents quickly and reliably, and reducing media inquiries about traffic conditions. Police to be tutored to provide consistent entry, and jargon free text. Development of strategy function (see Section x) to take place slowly because of traditional demarcations.
Leicestershire Police.	No.	Null.				
Warwickshire Police.	No.	Null.				
Police Central Motorway Control Group (CMCG).	No.	Null.	Agreed link with Midlands Driver Information Systems (MDIS). CMCG Considering integration of Mattisse data with their own systems.		Will use SCOTIA data dictionary and open communications standards for bi-directional link with MDIS.	
Highways Agency.	No.	Null.	TCCs.			
Travel West Midlands.	Yes.	Limited. Single UT located at one depot.	Timetables. Real time service information.			TWM want WMP link in place and the map updated with the Wolverhampton bus route, before judging benefits. CENTRO maintaining a watch brief. A system that would reduce their timetable inquiry calls would be of benefit. Note, bus de-regulation has made it difficult to provide accurate up to date information. Lack of interest in UTC information.
West Midland Public Transport Executive (CENTRO).	No.	Null.	Network incident reports.			
Other public transport operators (excluding privatised rail companies).	No.	Null.				

BRBS.	Yes.	Automatic interface (see Table 5).		Some train operators believe that supplying delay & cancellation information can have a negative affect on public image.		Rail operators fail to inform about cancelled trains.
Birmingham International Airport.	No.	Null.	Real time service information. Potential links with MDIS VMS.			
Environmental Monitoring Unit.	Yes.	Pollution data.	Agreed automatic system interface.			Data needs to be shown in an user-friendlier format for public information.
NEC & ICC.	No.	None.	Potential links with MDIS VMS.		An effective customer information delivery mechanism is required.	Require an edited presentation, tailored to their own and their visitors needs.
RAC (Bristol). Other commercial travel information on collectors.	Yes. No.	None. Null.	Proposed connections with others. Potential for strategic alliances. Note, Mattisse is RDS/TMC ready.			Generally regard Mattisse as an additional output, but not yet essential. Belief that integration of police messages will be a significant enhancement to Mattisse. Agreement needed on how to best utilise the RDS/TMC potential of Mattisse. Some interest in automating Mattisse data input into their own systems.

to all UK public transport information on the Internet. By 'clicking' on a map, showing the local councils, all available information about transport services in that area is shown. Currently most areas reference enquiry telephone numbers to ring. However, some areas such as Lancashire CC, Buckinghamshire CC, Greater Manchester PTE and West Yorkshire PTE provide comprehensive information, covering:

- Timetables.
- Service maps.
- Multi-modal journey planners.
- Fares and ticketing.
- Interchange details and facilities.
- Service changes.

UK Public Transport Information also provides links to individual transport companies - air, ferry, bus, coach and rail. These tend to supply information only about their own services. Although sites such as Railtrack's interactive train timetable (www.railtrack.co.uk) and *The TrainLine* booking and reservation service (www.thetrainline.co.uk) cover all train operators.

Heralded as the first 'real time' time railway web site First North Western provides station board information over the Internet (nwt.rail.co.uk). The National Integrated Transport Information Project envisages this type of rail service becoming common.

The National Integrated Transport Information Project seeks to facilitate the provision of a comprehensive single point public transport telephone enquiry service. Currently there are many disparate services providing fare and service information. These include very well used services provided by Passenger Transport Executives and some local authorities. There are also national commercial services such as 'Journey call' and 'A2B Travel' which supply rail, bus and coach service and fare information and charge for the service by using a premium rate phone line.

7.3 Road Traffic Advisor (RTA)

The RTA project is a demonstration of providing information into individual vehicles on traffic conditions and at the same time using those vehicles as probes to report on conditions encountered for transmission to following vehicles. The project currently demonstrates communication with equipped vehicles almost exclusively on motorways. It will use the M4 as its demonstration site. However, it is designed with an open architecture so that information could be passed on any roads by whatever communication medium is appropriate. Therefore, potentially it is a user of information from all traffic control centres, motorway and UTMC.

7.3.1 Technical considerations

One of the major technical problems within RTA has been the communications between the roadside and vehicles moving at motorway speeds. Using single 5.8 GHz beacons to cover all lanes in one direction on a motorway means that there is very little time for two-way communications. Therefore, considerable effort has gone into producing messages and header information to make the best use of the available communication. The conclusion for UTMC is that communications to node E may be restricted if a common system is required that will work at high vehicle speeds as well as at lower speeds in urban areas.

The other technical considerations have been concerned with the geographical location system and exchange of data between different parts of the system. The RAC who is providing the application to supply driver information have built on its CATTiS database that uses OSODR location codes. This system has been accepted as the base system for RTA in England, but information from the probe vehicles on road traffic conditions is also to be stored against motorway marker post locations for future analysis.

The RTA project will be the first demonstration of the use of QMISS and TIH to exchange data between different bodies. The RAC will extract information about matrix signs and variable message signs on the test motorway to use as an input to the driver information application. Therefore, successful development of the application will provide valuable practical information about the benefits of the TIH approach to data exchange using CORBA.

7.3.2 Operational and institutional considerations

The commitment of all participants is important for good operational practice. One of the major sources of information that the RAC uses is police information on incidents. There are good working relations, but the police see their major responsibility to be to deal with incidents and do not at present have a universal commitment to provide timely information. Therefore, the RAC is unable to guarantee to the RTA project the timeliness of the information that it supplies to drivers. The experience in London with the pilot LTIS project shows that attitudes are changing and individual police forces are moving to a position of wanting to provide timely, accurate and relevant information.

The provision of timely information is an example of how an operational problem will only be solved when the underlying institutional issue, in this case the priority to be given to information provision, is tackled.

8 Needs of non-UTMC organisations

It is a requirement of the project to consider the needs and developments of all non-UTMC organisations. Non-UTMC organisations, that were not part of the project team, were surveyed for their technical, institutional and operational requirements for system inter-connection with UTMC and their position with respect to the adoption of common communication standards. A summary of the results is given in Table 7.

The survey consisted of interviews, questionnaires and UTMC promotion. The organisations surveyed are:

- Information disseminators.
- Police.

- Public transport operators.
- Passenger transport executives.
- Rail bodies.

8.1 Information disseminators

The RAC have been contacted as an example information disseminator. Good information sources are a high priority for the RAC. It employs an Information Development Manager, working with Local Authorities, UTCs and other bodies, part of whose role is to manage the relationship between RAC Travel News and sources of traffic and travel information and to ensure it is operationally effective. The organisation is involved in many current developments in the traffic information field:

- Radio Data System – Traffic Message Channel.
- Road Traffic Advisor project.
- Provider of an internet route planning service, including current traffic information.

8.1.1 Current data sources

Traffic information can be split into two classes, dynamic information relating to the current situation and how traffic is actually performing and static information about known conditions, principally road works that are likely to effect traffic. The sources currently used are:

Dynamic data sources:

- RAC patrols reporting on conditions that are considered to justify dissemination. The communication is normally by cellphone, but radio is also available.
- Police providing information on abnormal conditions. Different forces and operators will not necessarily report the same incident in the same way, but standard systems are being developed, see section 7.1. Information is received by varies means: phone, fax, Nexus Alpha, telex.
- Trafficmaster information on delays received via Trafficmaster YQ unit.
- Urban Traffic Control centres. Contact by phone to discuss what the UTC operators consider worthy of dissemination.
- MATTISSE user terminal, see section 6.1.
- CEEFAX.
- Telephone hotlines.
- Taxi companies provide information by phone as they think fit.

Static data sources

- Roadworks and events notification from Local Authorities. Information is received by fax, post and Email.
- Highways Agency. Information is received by post.

The RAC consider that Email is not a suitable medium for dynamic traffic information, as messages can get hung up in servers. Fax is currently used but the RAC would like to move away from fax totally.

All information is currently received free of charge, with the exception of the Metropolitan Police. The RAC makes a contribution to the maintenance cost of the 'Met's' CAD system. In future the RAC could pay for quality information, however, the quality of the current information that the organisation *receives* means that the RAC cannot charge for information that it *supplies.*

8.1.2 Standards

Currently the RAC uses RDS-TMC protocols and Alert-C codes with OSODR geo-referencing to manage their data. It would like to maintain the use of these standards in the future and to receive data coded to Alert-C and using OSODR for location. It would also like a standardised set of severity codes for incidents, based on:

- Nature of incident.
- Strategic importance of road.
- Impact on that road (lane/road closure).
- Estimated duration of incident.
- Likely impact on traffic.

8.1.3 Institutional arrangements

The ideal arrangement would be for a 'one stop shop' data source to provide all the information that the organisation desires. It would like to be able to enter into Service Level Agreements (SLAs) with information sources. The RAC would be looking for traffic information for the usual as well as the unusual traffic events / incidents. That is it would require notification of normal congestion and delays due to abnormal events. It would like access to information on all incidents, whether or not the source (e.g. Police or UTC) thinks they are relevant or significant. As a Value Added Service Provider (VASP) the RAC would like to be in a position to make its own judgement on what information it should disseminate.

Information received under the SLA must be accurate, relevant and timely.

Accurate – All reports must be in sufficient detail to enable them to be used by VASPs. Details given must be correct.

Relevant – The RAC would like to be provided with the maximum practicable amount of information. As noted above, it would rather make its own decisions about relevance. Otherwise information wanted by the organisation could be filtered out.

Timely – Real-time information is important to allow a VASP to add the most benefit to any traffic message.

8.2 Technical considerations

The RAC want standard definitions as described above and automatic supply of data from data providers. However, for operational reasons, see below, they do not want the direct input of data into their database by an automatic interface.

Table 7 Summary of Non-UTC bodies current and desired information systems and exchange

Organisation	*Standards currently used*	*Standards intended to be used in future*	*Current information systems*	*Data required/ desired from others*	*Data offered to others*	*Institutional considerations*	*Technical considerations*	*Operational considerations*	*Position on adoption of a data exchange standard*
Police.	No information supplied.	No information supplied.	Command and Control system, including incident log.	No information supplied.	Incident information Access to police CCTV.	Each police force acts individually. Security of system interface. Concerns about the potential sensitivity of some information. Editorial control of CCTV in the case of serious accidents, security surveillance, and crime prevention work.	Creating a secure interface. The forces have differing systems command & control systems.	Would like means to distribute information about traffic incidents quickly and reliably. Reducing media inquiries about traffic conditions. Development of inter-jurisdictional strategies likely take place slowly because of traditional demarcations.	No information supplied
Passenger Transport Executives.	No information supplied.	No information supplied.	Timetables, fares & routes (including some with Internet sites). Limited real time service information & vehicle location data.	All require timetable, fare, route, and major disruptions information from the public transport operating companies. Current service information. Desired UTMC data dependant on PTE, from major incident reports only, to: Real time traffic network monitoring; Traffic/travel advisory messages; Historic traffic network performance and flow counts; Planned road work information; Weather monitoring; Air quality; Restrictions for high sided vehicles.	Timetable, fare & route information As systems expand expect to be able to provide: Current service information; Vehicle location; Driver incident reports.	Real time vehicle location not available to rival operators.	Current real time service and vehicle location data is limited and in some cases unreliable.	No information supplied	Range from ‘desired’ to ‘essential’. Reasons given include: Data exchange with operators; National availability of public transport information and other integrated transport white paper issues; And specifying on-board systems (bus priority).

Public transport operators.									
Motoring organisations.	RDS-TMC protocols with Alert C codes OSODR geo-referencing.	RDS-TMC Alert-C OSODR Manual check Not email for dynamic info Standard set of severity codes.	RAC patrols via cellphone or radio. Police incident log Trafficmaster UTC (phone) Mattisse CEEFAX telephone hotlines Taxi cos. Roadworks.	Accurate, relevant and timely traffic information.	Information disseminator, Value Added Service Provider aiming to sell to end users.	Like to be able to go to one source for all desired information	Want a push service from data providers, not have to ask if there is anything relevant..	Do not want direct automatic data entry into their system. Want their operator to vet first, then accept with one key stroke.	In favour, but want to keep their existing Alert-c and OSODR
Tolled operator facilities – Dartford River Crossing PLC.	No information supplied.	No information supplied.	Classified vehicle counts CCTV monitoring of immediate Network Roadside telephones Overheight vehicle detection Visibility monitoring in Tunnels.	Monitoring of the surrounding network inc. CCTV pictures Incident reporting in surrounding network.	Incident reports Traffic situation reports CCTV pictures of immediate area Currently give weekly flow counts to the HA.	DRC operate on the basis of the concession agreement. Would need to receive a future policy statement before implementing changes to communication or data exchange.	No information supplied.	DRC would want compatible system with any nation wide tolling. Would need to sort out and any transfers of revenues should any future system not be run by a dedicated Dartford crossing operator.	Happy for data exchange standard, and communication specification for new equipment – subject to concession agreement. Need for compliance with systems either side of the crossing.
Railtrack - Level crossing.	No information supplied.	No information supplied.	No information supplied.	Monitoring of the immediate road network may be of benefit at some remote manually operated crossings.	One way links from level crossings.	No information supplied.	No information supplied.	Railtrack will not allow two way links because of the fault potential & have no desire to relinquish absolute control.	As level crossing form a veryl small part of the rail network and potential interaction with UTMC is very limited, Railtrack signalling would not look to adopt UTMC standards.
Railtrack - Incident management.	No information supplied.	No information supplied.	No information supplied.	Railtrack work very closely with the emergency services.	No information supplied.	No information supplied.	No information supplied.	The police manages incident road access.	No information supplied.
Information service.	Customer Information System (CIS) currently uses IBM protocol LEU6.2 with SMTP, however SMTP is deemed too slow (by BRBS).	Potentially FTP and TCP/IP for CIS.	TIDES, current train running with free-text occurrence entry and various front ends including CIS. ‘Train Service Data-base’ feeding into various ystems including CATE computers aided timetable enquiries. Others.	The informed traveller project is likely to define requirements.	Timetable Train running and occurrence details.	No information supplied.	No information supplied.	Operators often fail to inform about cancelled trains. Level of free text input from operators varies considerable.	Encouraging harmonisation and the use of common standards amongst rail operators. Railtrack contractor BRBS very keen to be kept abreast of developments in UTMC02.

8.3 Operational considerations

The requirement of the RAC is for computer aided data entry not direct automatic data entry. The organisation wishes to review all incoming data before it is added to its database. Incoming information would be validated and possibly modified before final entry, probably by a single button entry, to the RAC's computer systems.

8.4 Police

The police play a significant part in traffic control. The Mattisse experience has shown that in order for police participation it is crucial that automatic system interfaces are used to avoid the police undertaking manual data entry, and the automatic interface must be secure. Mattisse is exploring inter-connection with the incident log of police command and control systems. Differing police forces have differing systems that require separate custom design interfaces. The police have concern over the possible sensitivity of some of the incident log information that may be released. Discussions with regards to the employment of a strategy function of Mattisse have resulted in the conclusion that this will be a slow process due to traditional demarcations.

It is not possible at present to give general comments on the technical and operational requirements of the police as each police force acts individually. There are ad hoc arrangements with each police force and the HA office (and presumably with UTC offices). The most advanced arrangements have been formed in the Mattisse and ROMANCE projects.

The Highways Agency have a police liaison officer who is preparing a paper to present to ACPO traffic, proposing the use of the TIH as an opportunity to share information on a win-win basis. The experience of the pilot LTIS system showed that a well structured system for data entry that forces standard working practices and descriptions of events can be accepted by the police and actually assist in their work. Given effective dissemination, it has the potential to reduce their work load, improve response to incident management and provide more timely information.

8.5 Passenger Transport Authorities and executives

The 1985 Transport Act stripped the PTA executives of their powers to operate buses. They continue to operate other services such as ferries (Merseyside, Tyne and Wear), Metro or underground (Strathclyde, Tyne and Wear), and some local rail services (Merseyside, West Midlands). Their public transport functions are: securing the provision services; promoting the use of public transport; provision of comprehensive information; and subsidising non-commercial services considered necessary. The White Paper *New deal for transport* (DETR, 1998) states that Passenger Transport Authorities and their executives are 'well placed to play a leading role in delivering integrated transport objectives'; and they need to closely work with the district councils and Highway Authorities in the production of Local Transport Plans.

The executives collect and disseminate travel information from the various public transport operators. The executives are thus keen for the development of common data exchange and communication standards especially in the light of the *New deal for transport* white paper requirement for a national public transport information system by the year 2000 and the other integrated public transport objectives (see Section 7.2). PTEs have reported a sea change in the attitudes of larger operators, who are now more willing to co-operate and provide the basis for common standards.

Current PTE public transport information systems are generally limited to timetable and fares. All PTEs run telephone enquiry systems. These tend to be very well used. Most have Internet sites. Currently only the Greater Manchester PTE and West Yorkshire PTE Internet sites provide bus timetable information. Both also have multi-modal journey planners. In the future all surveyed PTEs envisage having a much wider range of information systems available and would offer the following electronic information:

- Timetables.
- Fare and ticket information.
- Route and bus stop GIS.
- Real time public transport service information.
- Probe vehicle data from bus location systems.
- Incident reports on the network from bus drivers.

Data envisaged to be required from UTMC systems differ by PTE. While West Midlands PTE (CENTRO) see only major incident information as potentially useful, others such as West Yorkshire PTE (METRO) see benefit in receiving a great deal of information. West Yorkshire PTE conceive that UTMC data could be used to:

- Provide comparative real-time information.
- Devise the effects of road network incidents upon public transport services and relate this information to the public.
- Help prepare Local Transport Plans (LTP).

London Transport

London Transport Buses (LTB) uniquely, for a PTE, determines the bus network, frequency of services, and fares charged. It manages all bus service contracts through franchise agreements. It also managers bus interchanges and stops. Franchising of bus services has led to the contractual requirement upon London Transport Buses to record and provide information about the performance of the service relative to the timetable as a quality measure. London Transport will shortly come together with the police and TCSU to form the Greater London Authority. The London Transport Information System LTIS, section 7.1, will be used to aid information sharing.

LTB are keen for UTMC compliance - subject to performance, need and business case – especially for bus priority and Automatic Vehicle Location. LTB would also aim for complaint, traffic regulation offence, congestion management, CCTV and information systems. However, LTB warn that information on UTMC requirements are needed at an early stage, particularly for bus priority.

8.6 Bus operators

The *Review of Telematics Relevant To Public Transport* (Wilkinson et al, 1998) identified a wide range of bus priority and 'real time' passenger information systems trials in progress. Nearly all involved Automatic Vehicle Location (AVL) technology. These trials have tended to focus on key bus corridors. Only limited work has been undertaken on networks. Current bus priority and 'real time' bus passenger information systems have been introduced by the Highway Authority or the Passenger Transport Authority. Bus priority has been achieved through device to centre, not by centre-to-centre interfaces. However, some systems utilise an electronic timetable database to link schedule deviations with level of priority. West Midlands PTE highlighted that real time vehicle location is not available to rival operators.

The review (Wilkinson et al, 1998) identified that a lack of common specifications and industry-wide standards as being one of the key constraints to adoption of telematics by the bus industry. And in the near future many operators will not contemplate investment due to:

High investment costs.

- Potentially short service life (if other systems are adopted as de facto standards).
- Potential incompatibilities between systems operated in different areas served by the same operator's bus fleet.

Particularly standardisation is needed for:

- Common interfaces between different bus location and priority systems.
- Interfaces between information systems.
- Presentation of timetable information (across all modes) in paper and electronic forms.
- Interfaces between other systems operated by different modes.

Despite all these difficulties, London Transport Buses have a large investment programme in bus location and information systems. LTB buses is very keen for standards to be developed that their investment programme could adopt (see section 8.5). The review also stated that outside London, bus 'operators see no compelling reason to choose to fit equipment for monitoring in real-time the position of the buses on the network' either for operational management or for providing bus passenger information.

Bus operators have no obligation to provide passenger information. Outside London bus timetable information must be registered with the local traffic commissioner and copied to the local authority 42 days before the service commences/ changes. However, Wilkinson et al (1998) identifies that:

- This requirement is not met or subsequently enforced effectively in all areas.
- Information is submitted in a variety of formats and media.
- The traffic commissioner is not required to collate and disseminate this information and, although many local authorities do so, they do not have powers to enforce adherence to the time limit, leading to missing or inaccurate information.
- The information does not have to cover all intervening stops, use common naming conventions or provide fare information.

This undermines the provision of accurate and comprehensive information about bus services. An Interview with West Midlands PTE upheld this, describing difficulties obtaining fare, timetable and bus stop location information - made more difficult by different bus stop naming conventions. Furthermore the information is supplied in a range of formats and media. Note accurate location and consistent naming of stops is essential for any passenger transport information system based on GIS.

With *the new deal for transport* (DETR, 1998) 'local authorities will have new powers to secure the availability of passenger information where necessary and to recover the costs from the operators.' It is also proposed to require public transport operators to provide service and schedule information electronically in a standard format. Additionally the White Paper proposes to increase co-operation between local authorities and bus operators through Quality Partnerships and Quality Contracts. Consultation (DETR, 1998) has shown that public transport operators want to work with the government to implement the *new deal*.

8.7 Rail

When considering co-operation with rail it is important to realise that there is not one rail body to contact. There is not a central point of contact that can currently supply current overall information about the operation of rail services. Different bodies must be contacted for different types of information. The categories of rail organisations are:

- Operating companies.
- Railtrack and its contractors.
- Timetable information providers.

There can be several operating companies providing services at any one station and within a major urban area there will be more than one station, each of which could have a different mix of operating companies. The following information explains how rail organisations could interact with UTMC and indicates the likely relevant organisations.

There are several ways in which rail operations can interact with UTMC:

- Level crossings.
- Information services.
- Rail incidents requiring road access by emergency vehicles.

8.7.1 Interaction at level crossings

Around the country there are a number of sites where traffic signal controllers (TSC) receive inputs from level crossings. There also is at least one red-light running camera to provide evidence for prosecution of drivers who do not stop for the red lights at the crossing.

Connections to TSCs are all hard wire, one way links (from level crossing to traffic signal controller) using a

voltage free contact relay. The connection can be from the wigwags, the barriers, or in the case of unmanned sites from the automatic request (at the barrier) generated by the train. The traffic signal controllers omit stages and / or implement 'hurry calls'. Two-way links are not permitted due to: the potential for traffic control equipment faults affecting operation and; subject to safety, no desire to relinquish absolute priority.

Railtrack expressed a possible interest in signal boxes receiving real-time CCTV pictures or queue monitoring outputs, where traffic regularly tails back to a remote manually controlled crossing. Railtrack CCTV pictures from remote sites tend to be restricted to the crossing. A direct link between the traffic signals at a nearby junction and the automatic barrier controller was not envisaged due to the potential of an external equipment fault, and automatic level crossings are not introduced where vehicles can block back onto the crossing from road junctions.

8.7.2 Rail information services

Train operator licensing agreements include the mandatory provision of timetable and fare information to a central database and the operation of the National Rail Enquiry Service. Railtrack maintain this database, called the 'Train Service Database'. This is fed into various other systems such as CATE Computer Aided Timetable Enquiry used by National Rail Enquiries, and the Railtrack's interactive train timetable (www.railtrack.co.uk) Timetable information is currently supplied to some County Councils.

The Railtrack system TIDES provides current train running information on the entire network, excluding the Isle of Wight. The TIDES system automatic compares train location details from the signalling centres with the schedule. The location information is restricted to signalling blocks and so will not always provide precise information for comparing with the timetable. TIDES also has a 'free text' entry facility. Rail operators can use this to supply information on delays and cancellations. Filtered information is then distributed to various sources including stations, rail operators, the rail travelling public (Customer Information System (CIS)), and the media (Nexus Alpha system). The Mattisse experience has shown that operators often fail to inform about cancelled services. A telephone interview with the BBC travel centre indicated that some operators supply considerable free text information, while others very little.

Customer Information Systems are used by the various operators and Railtrack. There are approximately ten different suppliers of CIS. Generally the systems differ, and use propriety software and protocols. Harmonisation and a standard communication profile using FTP, TCP/IP and message queuing protocols are being encouraged.

Heralded as the first 'real time' time railway web site First North Western provides station board information over the Internet (nwt.rail.co.uk).

'Informed Traveller' is an on-going initiative started in the run up to privatisation by the Secretary of State. A current initiative, as part of a modification to the operator's and Railtrack's licence agreement, is that passengers will be able to know 12 weeks in advance of service changes – for example due to engineering works. The White Paper (DETR, 1998) states that the new overseeing body, the Strategic Rail Authority, will promote the use of the railway within an integrated transport system. Railtrack contractors SEMA group (formally British Rail Business Systems) reported that inter-modal information displayed at stations including incidents on the traffic network and bus information is envisaged.

SEMA group is very keen to be kept abreast of the UTMC02 project, and would consider proposing the adoption of common protocols if suitable.

8.7.3 Incidents that require access by emergency road vehicles

Railtrack keep details of all access points on the network. The information is provided in two paper based documents the 'Zonal Section Appendix' and the 'Hazard Directory'. All access points and signals have Ordnance Survey Grid References. Incidents are reported to the emergency services, usually by a signal operator or the train crew. The police take the initiative and responsibility for access. Therefore, liaison between the police and UTMC about access will be needed. Railtrack are not responsible for the emergency response and so do not see any need for liaison between Railtrack and UTMC for incident response.

8.8 Tolled crossing operators

Dartford River Crossing PLC was interviewed as an example of a tolled facility.

The crossing operator would be interested in information on the traffic monitoring and incident reporting in the surrounding area. In turn the operator has information that could be supplied to a UTMC system on the traffic situation in the crossing controlled area.

Dartford River Crossing PLC operate on a concession agreement. They would be happy to utilise open communication standards, subject to the concession agreement.

One standardisation issue of particular interest to the Dartford River Crossing PLC is that they would want compatibility with any future national road tolling system. The transference of revenues, should the collection system not be owned by the PLC, would need to be resolved.

8.9 Major traffic generators and sinks

British Airports Authority were contacted in relation to another project. In the course of these contacts, the effect of BAA's commitment to reducing the level of car use, at Heathrow in particular, was shown to be relevant for UTMC02. The authority wish to install displays about bus departures in the airport terminal buildings and, therefore, will need to obtain information from bus operators, preferably an automatic input into the display system. In addition one of the operators of bus services to Heathrow is co-operating with the RTA project. It will take information from the standard RTA infrastructure about the expected journey time to the airport and broadcast the information in its coaches. There is also interest in supplying information on flight departures to coaches en route to airports.

The National Exhibition Centre is a major sink and source of traffic during major exhibitions, particularly during the International Motor Show. The operator of the centre wishes to co-operate with the road authorities to provide the best access and egress for its customers. The road authorities have effectively the same aim, but expressed differently, to minimise the effects of the NEC customers on the road network. Possibilities that are being explored include the use of VMS inside and outside the NEC and customised Mattisse terminals in the NEC buildings. The International Convention Centre in Birmingham is also interested in customised Mattisse terminals.

8.10 Adoption of standards

In general the organisations already appreciate the value of standards and would be keen to adopt relevant standards. The challenge for UTMC is to work with system developers who are currently producing systems and setting de facto standards. One example is the extensive use of CORBA in the systems being produced for the HA. Another is the large investment being made in bus location equipment by London Transport Buses. LTB are very keen to specify relevant standards for their equipment, but operational needs are driving their timescales and they cannot wait for the production of a standard.

8.11 Location coding

Different organisations can use different location coding systems. The HA have put considerable effort into location coding for motorways and inter-urban roads, including cross-references to alternative location coding systems. This work has been implemented in the QMISS database, see section 5.1.2. The Agency has extended the work on inter-urban systems to produce proposals to extend the system used in QMISS into urban areas. The suggested system would use OS grid references for each reference point, but include cross-references to other location systems, such as Latitude and Longitude, street maps and RDS-TMC coding. These proposals are for database design and automatic exchange of data between systems the human operators who take calls from the public need to be able to receive other information, such as, 'there is an accident on the High Street outside Woolworths,' and relate that information to the standard location referencing system.

8.12 Summary of the survey of non-UTMC bodies

Table 7 summarises the findings of the survey of non-UTMC bodies. Further details of the surveys are given in Appendix 2.

9 Conclusions

9.1 Current research and development

There is considerable research and development going on in the field of traffic management across jurisdictional boundaries and the sharing of information. Mattisse is an example of a large information exchange system that has been developed to meet the needs of organisations. It has been developed as a bespoke system using commercially available software tools. Other developments could choose to use other, potentially incompatible, tools.

The Highways Agency is developing large information exchange systems. The agency has chosen to use CORBA as its standard. The American NTCIP initiative also currently appears to favour the use of CORBA.

A third approach has been taken by TCSU in developing the London Transport Information Service. That system is based on GIS software (Mapinfo) with links to independent databases, an ODBC (Open DataBase Connectivity) interface in the case of the traffic information that is being developed as part of the project. Each database is the responsibility of the authority that owns it, LT Buses say for bus information, TCSU for traffic signal information. However, by linking to the GIS system, any user of that system can display information from whatever database he or she is authorised to access.

Both the CORBA based systems and the traffic incident database in the LTIS system can be customised to push information to users. In the LTIS system new information on incidents will be sent to information disseminators every 20 minutes. With CORBA individual users can define the services that they require, such as regular updates or instant notification when traffic conditions go outside defined ranges, delay greater than 5 minutes on a link for example.

The Highways Agency's Traffic Control Centre initiative will have a significant impact on traffic management across jurisdictional boundaries:

- The TCC Co. will be contractually bound to integrate its traffic management systems with those operated by Local Highway Authorities.
- It will be required to co-ordinate the planning and implementation of responses to events with appropriate other organisations.
- It will be required to provide disseminate and exchange traveller information, including providing information to VASPs.

Separate developments are taking place in the field of public transport information and have been given extra impetus by the White Paper, *A New Deal For Transport.* Several Web sites provide public transport information and they are being expanded and linked to provide a comprehensive service. In addition, it is intended to develop a single point public transport phone enquiry service.

9.2 Institutional considerations

Local arrangements have been made for the ROMANSE office to set some messages on signs on the motorway around Southampton. However, this direct control of another organisation's equipment is exceptional at present, normally only information, not control is exchanged. For instance, if there was an incident on a major urban route downstream of a motorway junction, the UTMC operator would request the motorway operator to set the sign and it would be expected that it would be set, but only requests

not direct control will be allowed. In a similar way different organisations have different expertise linked to their responsibilities. For a major road incident the police are the experts at dealing with the immediate consequences and the area of the incident, whilst the Highway Authority are better placed to deal with the consequent network disruption. Moreover, when the debris has been cleared there may be ongoing disruption due to damage to the infrastructure. The UTMC centre would take charge as appropriate and use their expertise to develop diversion routes, modified signal control etc. The two organisations would co-operate, but also recognise each others' strengths and act appropriately.

The correct institution must be identified. For instance, although Railtrack are the responsible rail authority for dealing with incidents, the actual control of emergency response is with the police. Therefore, UTMC would co-operate with the police, not Railtrack during a rail emergency. For rail information systems, the split of responsibility between individual train operating companies, who may not wish to publicise late running, and Railtrack creates difficulties in obtaining good current information on train operations.

9.3 Technical considerations

There are many Working Groups looking at possible standards that would be relevant to UTMC02. However, the standards procedure is slow and de facto standards are developing whilst the official standards bodies deliberate. In the USA NTCIP is pressing ahead, but there are ownership problems with the wholesale adoption of NTCIP as an international standard. Current developments as described above, are going ahead and CORBA appears to be the front runner for standard interfaces.

Compatible geographical location systems are essential if different systems are to exchange meaningful information. The HA have built in multiple systems into the QMISS database to enable users to choose the most convenient. It is a very flexible system, but carries an inevitable overhead compared with a single location referencing system. Several systems use OSODR, which could be considered a standard for the UK, but is not available outside the UK and so would not be suitable for any European or international standard.

Potential users of systems are keen to adopt standard systems and solutions. It does not appear to be necessary to sell the idea of a UTMC standard to non-UTMC bodies, just to demonstrate that it is the appropriate standard.

9.4 Operational considerations

Experience has shown that individual operators must be convinced of the benefits of a system before they will adopt it. The forerunner to Mattisse was seen by the police operators as extra work to input the same information into a second system without any significant benefit for them. Consequently they gradually failed to support the system. The Mattisse system has been designed to avoid these problems. Currently the new facilities are being tested with a proving period using the training facility. Well structured systems that impose structure on data entry are acceptable to operators who are used to free text and no restrictions on what they can enter. The output from the structured systems is normally more relevant and accurate for dissemination to third parties.

Individual operators have their own considerations:

Tolled crossing operators are concerned about compatibility of tolling systems and systems for the allocation of tolls

Users of CCTV are concerned about broadcasting unsuitable close-up images in the aftermath of accidents

Railtrack treat the safety of its operation as paramount and will not allow two-way communication with its signalling equipment.

Bus operators require greater restrictions on operational information that can be seen by their rivals than on information available to their PTE or local authority.

Car Park operators require commercially sensitive information to be withheld from their competitors, which may include the Highway Authority, who are also owners of car parks.

10 References

Ankerbold International Ltd (1998). *MATTISE project review*. (Unpublished).

Department of Environment, Transport and the Regions (1998). *A new deal for transport: better for everyone*. The Governments white paper on the future of transport. Stationery Office.

Mosley G and Ristow R (1996). *NTCIP White Paper: Center-to-center communications*. NTCIP Technical paper.

Tighe W (1997). *Center-to center communications requirements and issues*. NTCIP Technical paper.

Welsh P and Gillam W J (1996). *MATTISSE harnessing technology for the traveller*. Traffic Technology International Feb/Mar 1996, pp 82-89.

Welsh P, Glen J and Hunter S (1998). *MATTISSE an integrated transport environment with information delivery via the Internet*. 9th International Conference on Road Transport Information and Control. London: Institution of Electrical Engineers. Conference Publication 454.

Wilkinson I J, Perrett K E, Pickett M W, Wedlock M and Daugherty G (1998). *Review of telematics relevant to public transport*. TRL Report TRL342. Transport Research Laboratory, Crowthorne.

Appendix A: ISO TC204 and CEN TC278 Working Groups

A.1 Synopsis of relevant Working Groups

A.1.1 CEN TC278 Working Group 8 (Convenor Gilbert Batac, SETRA,France)

The work items within this Working Group are concerned with roadside to centre communication, centre to centre communications and data dictionary standards.

Work item roadside to centre protocols is not active at present, initially there were proposals from Germany; France, Netherlands UK on possible standards that could be adopted. However each country had its own proprietary solutions and no formal agreement could be reached on the future need for a standard. A technical report is to be published summarising the situation. There would seem to be scope for introducing the NTCIP approach within this Working Group, however NTCIP is a work item within ISO TC 204 WG9.

Work Item: centre to centre communications; 'DATEX NET Specifications for Interoperability' version 1.2 are currently being proposed as an ENV (experimental standard for 2 year duration). These specifications have been circulated to all member states for comment, the comments made confirmed that the specifications met the short term requirements for current systems. An enhanced version is needed for future more complex systems. The specifications (web site www.datex.org/dxspec.htm) incorporate the DATEX Data dictionary VERSION 3.1.

The Working Group is linked with ISO TC 204 WG9 in producing a common data dictionary format.

A.1.2 CEN TC 278 Working Group 5 (Convenor Terry Sullivan, HA UK)

This Working Group is not active at present, but is responsible for traffic control communication standards the work items did not attract sufficient interest from European members.

A.1.3 ISO TC 204 WG9 (Convenor Max Lay Australia)

This Working Group is responsible for producing standards for Traffic Information Centres (TIC) to TIC communications this work is based upon DATEX ASN with a common data dictionary. The other aspect of the work is developing roadside to centre communication protocols which uses the NTCIP approach.

A.1.4 ISO TC 204 WG1 (Convenor Bob Williams UK)

This Working Group is producing standards for developing data dictionaries and data element registration, the methodology is to be adopted by the other ISO TC 204 Working Groups. WG1 has produced a standard that identifies 32 fundamental services within the Transport Information Control Systems (TICS). Architecture standards are being produced that define the fundamental services using Unified Modelling Language (UML). WG1 has a sub Working Group which haas been formed to provide a European input into the ISO work, this sub Working Group has links with the Karen project.

A.1.5 BSI EPL 278

BSI EPL 278 Committee has been set up to mirror the ISO and CEN Working Groups, it provides panels of experts to link with UK Industry and Government organisations.

A.1.6 Other working groups

A full list of CEN TC278 and ISO TC204 working groups is given in Table A1.

Appendix B: Survey of non-UTMC bodies

B.1 Non-UTMC bodies information systems and exchange

Various non-UTMC bodies were surveyed to determine their current and desired internal information systems and systems for exchanging data with other organisations. The results of the surveys are given in Table B1. The Highways Agency is a non-UTMC organisation but because of the importance of the systems that it is developing the agency was included in the project team and its systems are described in the main body of the report.

Table A.1 Full listing of CEN TC 278 and ICO TC204 working groups

Committee	*Working group*	*Field covered*	*Brief description of work currently undertaken*	*Lead*
TC278	WG1	Automatic fee control and access control	Integrated payment Requirements for automatic fee collection Application interface definitions for automatic fee collection Test procedures for automatic fee collection equipment	CEN
TC278	WG2	Freight and fleet management (Dormant)	Terminology and architecture FFMS data models and data elements Message interchange and interfacing	ISO
TC278	WG3	Public transport	Requirements for public transport applications Definition of interfaces Definition of various on-board vehicle devices	ISO
TC278	WG4	Traffic and traveller information	Conceptual model and terminology Definition of traffic and traveller messages	CEN
TC278	WG5	Traffic control	Conceptual model and terminology Data definitions	ISO
TC278	WG6	Parking management	Dormant	-
TC278	WG7	Geographic road databases	Conceptual model and terminology Geographic Data File (GDF) Requirements specifications for particular applications GRD maintenance rules	ISO
TC278	WG8	Road traffic data/ elaboration, storage, distribution	Data dictionary Exchange procedures, formats and protocol	Open
TC278	WG9	Dedicated short-range communication	DSRC terminology and concept Protocol and interface standards for DSRC layers 1, 2 and 7	CEN
TC278	WG10	Man-machine interfaces	Definition of requirements for various modes of information presentation Evaluation method of MMI Visual and cognitive demand measurement	ISO
TC278	WG11	Sub-system and inter-system interfaces	Dormant	-
TC278	WG12	Automatic Vehicle and Equipment Identification	Architecture and terminology Numbering scheme System and interface requirements	CEN
TC278	WG13	Architecture and terminology	Terminology and glossary of terms Reference model architectures Data modelling for TICs	ISO
TC278	WG14	After theft recovery of stolen vehilces	Data modelling for TICs	
TC204	WG1	Architecture		ISO
	SG1.1	Architecture - Europe		
	SG1.2	Architecture - North America		
	SG1.3	Automatic vehicle and equipment identification		
	SG1.7	European activities		CEN
TC204	WG2	Quality and reliability	Dormant	ISO
TC204	WG3	TICS database Technology		ISO
	SG3.1	Geographic database		
	SG3.2	Physical storage		
	SG3.3	Referencing and updating		
TC204	WG4	AVI/AEI		CEN
TC204	WG5	Fee and toll collection		CEN
TC204	WG6	Fleet management	Dormant	ISO
TC204	WG7	Commercial/Freight	Dormant	ISO
TC204	WG8	Public transport/emergency		ISO
TC204	WG9	Integrated transport information, management and control		ISO
TC204	WG10	Traveller information		CEN

Table A.1 Continued

Committee	*Working group*	*Field covered*	*Brief description of work currently undertaken*	*Lead*
TC204	WG11	Route guidance and navigation		CEN
	SG11.1	Locally determined route guidance		
	SG11.2	Dynamic TICS		
	SG11.3	Centrally determined route guidance		
TC204	WG13	Human factors and HMI Terminated work transferred to ISO TC 22 below		ISO
TC204	WG14	Vehicle roadway warning		ISO
TC204	WG15	DSRC		CEN
TC204	WG16	Wide area communications		ISO
TC204	WG17	Legislation issues	Including video images	ISO
TC22(ISO)	WG13	Human factors and HMI		ISO
TC224(CEN)	WG11	Smart cards		CEN

Table B1 Non-UTC bodies current and desired information systems and exchange

Organisation	*Standards currently used*	*Standard intended to be used in future*	*Current information systems*	*Data required/ desired from others*	*Data offered to others*	*Institutional considerations*	*Technical considerations*	*Operational considerations*	*Position on adoption of a data exchange standard*
Strathclyde PTE.			Timetable. 'Zonecard' ticketing Real time service information & vehicle location data (along one corridor) Electronic and mapping data include route and interchange.	Major and minor incidents on the traffic network Traffic/travel advisory messages Historic traffic network performance and flow counts Planned road work information Timetables Fare and ticket information Real time service and vehicle location.	Timetable information. 'Zonecard' Fare and ticketing information Electronic and mapping data - route and interchange including bus stops.		Real time service and vehicle location data is unreliable 'Zonecard' data is currently unreliable.		'A very sensible idea'
West Yorkshire PTE (METRO).		Currently involved with public transport data exchange protocols in respect to the National Integrated Transport Information Project.	Timetables.	Major and minor incidents on traffic network. Public transport advisory travel messages Real time traffic network monitoring. Historic traffic network performance and flow counts. Planned road work information Air quality Public transport timetable, fare & ticketing information Real time public transport vehicle location Real time weather monitoring Airport and rail information.	Timetables Fare and ticket information Rail and bus real time service and vehicle location information Incident reports on the network Advanced warning of service changes.		Currently only timetable information in electronic form.		'A standard is essential.' 'It is important that such work is co-ordinated with the work going on to develop the national availability of public transport information by the year 2000.'
Centro (West Midlands PTE).		Windows NT or CE on-bus computer system. Common route and fare information for bus ticket machines and Centro information systems.	Bespoke timetable and fare information with manual input.	Timetables and fares from operators. Major disruptions to the road network. Information on current train operation from operating companies.	Probe vehicle data from bus location system.	Real time vehicle location not available to rival operators.	Want standard on-bus systems, including the ability to interface with all AVL systems used in the county to allow freedom of allocation of buses to routes.	Rail operators reluctant to release information on imperfect performance.	Desired.

London Transport Buses.		Transponder based AVL. Real time bus stop information. TRIS Ticketing 'Wayfarer'.	Historic general traffic data e.g. congestion, delays, and flow information (ASTRID). On-line incident, accident, roadwork information. Traffic restrictions for high side vehicles. Pedestrian flow information. Comprehensive mode of travel data (Historic).	Probe vehicle data from bus location system. Network incident information. LTB provides QSI, Wayfarer, bus patronage, bus o/d data bus journey times and reliability data to the Boroughs.	On the whole solved by formation of GLA.	Need more information upon UTMC requirements at an early stage, particularly for bus priority - going out to tendering for AVL equipment May 99. Concern about security of radio LAN for AVL. Would like special transport radio band.	Formation of GLA is leading to a information-sharing environment. Receiving rail information is difficult.	Adoption of UTMC standard is subject to performance (effectiveness of basic systems should not be compromised), and sound business and objectives case. Extremely keen to be UTMC compliant for bus priority & AVL. Also would aim for complaint TRO enforcement, congestion management, CCTV and information systems.
Dartford River Crossing.		Classified vehicle counts CCTV monitoring of immediate Network Roadside telephones Overheight vehicle detection Visibility monitoring in Tunnels.	Monitoring of the surrounding network inc. CCTV pictures Incident reporting in surrounding network.	Incident reports Traffic situation reports CCTV pictures of immediate area Currently give weekly flow counts to the HA.	DRC operate on the basis of the concession agreement. Would need to receive a future policy statement before implementing changes to communication or data exchange.		DRC would want compatible system with any nation wide tolling. Would need to sort out and any transfers of revenues should any future system not be run by a dedicated Dartford crossing operator.	Happy for data exchange standard, and communication specification for new equipment – subject to concession agreement. Need for compliance with systems either side of the crossing.
Railtrack Level crossing.			Monitoring of the immediate road network may be of benefit at some remote manually operated crossings.	One way links from level crossings.				..no…
Incident.								
Information service.	Potentially TCP/IP for Customer Information System.	TIDES, current train running and free-text occurrence entry - front ends Customer Information System/ Nexus Alpha Others.	The informed traveller will input to the requirements.	Train running and occurrence details.				

Glossary of acronyms

Many acronyms are used in the field of data exchange. Those used in this report are listed for ease of reference.

ACPO	Association of Chief Police Officers
ASN	Abstract Syntax Notation
ASTRID	Automatic SCOOT Traffic Information Database
AVI/AEI	Automatic Vehicle Identification/Automatic Equipment Identification
AVL	Automatic Vehicle Location
CCTV	Close Circuit Television
CEN	Comité Européen de Normalisation (European Standardisation Committee)
CIS	Customer Information System (Rail)
CMCG	Central Motorway Control Group
CORBA	Common Object Request Broker Architecture
DATEX	Data Exchange Task Force
DCOM	Distributed Component Object Model
DSRC	Dedicated Short-Range Communication
EDIFACT	Electronic Data Interchange for Administration Commerce and Transport
ENV	European Norm Voluntary
FFMS	Freight and Fleet Management Systems
FSK	Frequency Shift Keying (modem)
FTP	File Transfer Protocol
GDF	Geographic Data File
GIS	Geographical Information System
GLA	Greater London Authority
GRD	Geographic Road Database
HA	Highways Agency
HDLC	High-level Data Link Control
HMI	Human Machine Interface
IDL	Interface Definition Language
IEEE	Institute of Electrical and Electronic Engineers
IIOP	Internet Inter ORB Protocol
INGRID	InteGRated Incident Detection
IOR	Interoperable Object Reference
IP	Internet Protocol
IPR	Intellectual Property Rights
ISO	International Standards Organisation
ITECS	Integrated Road Transport Co-ordination System (Mattisse)
ITS	Intelligent Transport Systems
JDBC	Java Data-Base Connectivity
LAN	Local Area Network
LT	London Transport
LTB	London Transport Buses
LTIS	London Travel Information System
MDIS	Midlands Driver Information System
MIDAS	Motorway Incident Detection and Automatic Signalling
MMI	Man-Machine Interface
NTCIP	National Transportation Communications for ITS Protocol
ODBC	Open Data-Base Connectivity
OMA	Object Management Architecture
OMG	Object Management Group
OO	Object Orientated
ORB	Object Request Broker
OSCAR	Ordnance Survey Centre Alignment of Roads
OSGR	Ordnance Survey Grid Reference
OSI	Open Systems Interconnect
OSODR	Ordnance Survey OSCAR Database Reference
PMPP	Point to Multi-Point Protocol
PPP	Point to Point Protocol
PTE	Passenger Transport Executive

QMISS	Quantified Motorway Information Supply System
QSI	Quality Service Indicator
RDS-TMC	Radio Data System-Traffic Message Channel
RS232	Recommended Standard 232
RTA	Road Traffic Advisor
SCOOT	Split Cycle Offset Optimisation Technique
SNMP	Simple Network Management Protocol
SQL	Structured Query Language
STMF	Simple Transport Management Framework
STMP	Simple Transport Management Protocol
SUPS	Simple UTC Protocol Specification
TCC	Traffic Control Centre
TCP	Transmission Control Protocol
TCSU	Traffic Control Systems Unit
TIC	Traffic Information Centre or Traffic Information Community depending on context
TICS	Transport Information Control Systems
TIDES	Railtrack Train Information and Delays System
TIH	Traffic Information Highway
TRIS	Canadian Traffic incident database system
TRO	Traffic Regulations offence
UDP	User Datagram Protocol
UML	Unified Modelling Language
UT	User Terminal (Mattisse)
UTC	Urban Traffic Control
UTMC	Urban Traffic Management and Control
UTMC7/17	UTMC project on data requirements, quality and contents
UTMC8 & 9	UTMC projects on the suitability of NTCIP for UK UMTC
VASP	Value Added Service Provide
VMS	Variable Message Sign

Abstract

The UTMC02 project for DETR is investigating traffic management across jurisdictional boundaries. The purpose of this report is to review relevant ongoing research and development and to review the technical, institutional and operational requirements of external system owners for inter-connection with Urban Traffic Management and Control (UTMC) systems. Developments are taking place in North America and in the international and European standards organisations. In the UK there have been some demonstration projects, such as Mattisse in the West Midlands and the Highways Agency is actively developing information systems. The needs of non-UTMC authorities and the information that they could provide to other bodies have been surveyed and are reported. The conclusions of the report are broken down into four sections: the likely consequences of the current developments; the institutional; technical and operational issues that will effect the success of any system.

Related publications

TRL362 *The perceived environmental impacts of traffic management schemes: a literature review* by P G Boulter. 1998 (price £35, code H)

TRL361 *Review of tolling and communications aspects of the US National Architecture* by J Holder and A Stevens. 1998 (price £35, code H)

TRL342 *Review of telematics relevant to public transport* by I J Wilkinson, K E Perrett, M W Pickett, M Wedlock and G Daugherty. 1998 (price £50, code L)

TRL240 *UTC strategies for congested networks* by K Wood, J P Palmer, R D Bretherton and S Shearn. 1997 (price £25, code E)

TRL220 *Review of the potential benefits of road transport telematics* by K E Perrett, and A Stevens with contributions by I J Wilkinson and P F Masurel. Editorial support: J M Hopkin. 1996 (Volume 1 Main Report, code Q). (Volume 2 Technical Annex, code Y)

PR41 *Urban traffic control, system review* by K Wood. 1993 (price £35, code J)

CT59.2 Urban traffic control (UTC) update (1995-1998). *Current Topics in Transport: selected abstracts from TRL Library's database* (price £20)

Prices current at June 1999

For further details of these and all other TRL publications, telephone Publication Sales on 01344 770783 or 770784, or visit TRL on the Internet at http://www.trl.co.uk.