# Contents

1. Executive Summary ........................................................................................................... 1
2. Introduction ......................................................................................................................... 5
   2.1 Background .................................................................................................................... 5
   2.2 Purpose of the Report .................................................................................................... 7
   2.3 Structure of the Report ................................................................................................. 8
3. ITS Strategy Delivery Methodology .................................................................................. 9
   3.1 Requirements Capture ................................................................................................. 10
   3.2 ITS Tool Identification ............................................................................................... 10
   3.3 ITS Component Matrix .............................................................................................. 11
   3.4 ITS Work Package Identification .............................................................................. 11
4. ITS Tool Description ......................................................................................................... 13
   4.1 Urban Traffic Control (UTC) ....................................................................................... 13
   4.2 Remote Monitoring ...................................................................................................... 16
   4.3 SCOOT Control ........................................................................................................... 19
   4.4 MOVA Control ............................................................................................................ 22
   4.5 Public Transport / Emergency Vehicle Priority ......................................................... 25
   4.6 UTMC Common Database .......................................................................................... 29
   4.7 Automatic Vehicle Location / Real Time Passenger Information ............................. 32
   4.8 Journey Planning .......................................................................................................... 36
   4.9 Information / Data Collection .................................................................................... 40
4.10 Information / Data Delivery ..................................................................................43
4.11 CCTV ...................................................................................................................45
4.12 Car Park Management and Guidance .................................................................47
4.13 Variable Message Signs ......................................................................................49
5 Development of ITS Packages ..............................................................................53
  5.1 Introduction ..........................................................................................................53
  5.2 Objectives Matrix .................................................................................................54
  5.3 Consolidation of Mechanisms .............................................................................60
  5.4 Geographical Rationalisation ..............................................................................60
6 Package 1 – Traffic Signal Control .....................................................................60
  6.1 Traffic Signal Installations ....................................................................................60
  6.2 Urban Traffic Control ...........................................................................................60
  6.3 Remote Monitoring System ................................................................................60
  6.4 Selective Vehicle Detection and Priority ..............................................................60
  6.5 Indicative Cost Estimate ......................................................................................60
7 Package 2 – Inter-urban Monitoring ..................................................................60
  7.1 Automatic Traffic Counter Classifiers ................................................................60
  7.2 CCTV ...................................................................................................................60
  7.3 Automatic Number Plate Recognition (ANPR).....................................................60
  7.4 Indicative Cost Estimate ......................................................................................60
8 Package 3 – Urban Monitoring ..............................................................................60
8.1 Bus Time Monitoring (Using RTPI) ........................................................................60
8.2 CCTV .............................................................................................................60
8.3 INGRID ..........................................................................................................60
8.4 Environmental / Air / Noise Quality Monitoring .................................................60
8.5 Indicative Cost Estimate .................................................................................60
9 Package 4 – AVL / Real Time Passenger Information ........................................60
  9.1 Indicative Cost Estimate .................................................................................60
10 Package 5 – Traffic and Travel Information ......................................................60
  10.1 Interurban Variable Message Signs ..............................................................60
  10.2 Urban Variable Message Signs ....................................................................60
  10.3 Car Park Management and Guidance (CPMG) ...............................................60
  10.4 Vehicle Activated Signs (VAS) ......................................................................60
  10.5 EPIPs ...........................................................................................................60
  10.6 Indicative Cost Estimate .................................................................................60
11 Package 6 – Integrated Transport Control Centre ..............................................60
  11.1 Requirements Capture ..................................................................................60
  11.2 Business Case Development ........................................................................60
  11.3 Recommendations .......................................................................................60
  11.4 Indicative Cost Estimate .................................................................................60
12 Package 7 – Advanced Communications Rationalisation ..................................60
  12.1 Across all Network Users ..............................................................................60
12.2 For ITS Assets .....................................................................................................60

12.3 Indicative Cost Estimate ......................................................................................60

13 Package 8 – UTMC Common Database ...........................................................60

13.1 Indicative Cost Estimate ......................................................................................60

14 Next Steps and Recommendations ..................................................................60

15 Appendix A .........................................................................................................60

List of Tables

Table 4.1 - The annual benefits arising from reduced delays against installations costs of MOVA........................................................................................................... 24
Table 5.1 - Objectives to mechanisms matrix ............................................................ 59
Table 5.2 - Consolidating mechanisms to packages................................................. 60
Table 6.1 - A summary of the numbers of traffic signal installations, their control systems, and identifies if they are remote monitored................................. 60
Table 11.1 - Estimated cost for an Integrated Transport Control Centre (ITCC). ..... 60
Table 13.1 - Indicative cost estimates for a UTMC common database and adapters. ........................................................................................................................... 60
1 Executive Summary

In order to assist Hertfordshire County Council to meet its Local Transport Plan (LTP) objectives a base Intelligent Transport Systems (ITS) strategy was adopted in July 2008. The ITS Strategy 2008/9 – 2010/11, outlines the way ITS tools can contribute to achieving Hertfordshire County Council’s LTP objectives. Hertfordshire Highways have developed an ITS inventory; ranked package of works and a deployment plan to achieve the objectives set out in the LTP.

This document identifies ITS products which will help the County Council meet LTP objectives and consolidates these tools into work packages.

Effective ITS tools have been reviewed at length in terms of the objectives the tool fulfils, how they integrate with other systems, key cost drivers, identified costs, benefits and interdependencies between systems.

Following an analysis of the options available and of the ITS tools currently in operation a matrix was developed in order to facilitate the identification of appropriate ITS tools or mechanisms to meet given objectives. After careful evaluation these mechanisms have been consolidated into a matrix of work packages / measures for possible deployment. These packages are summarised, but not prioritised, below:

Package 1 – Traffic Signal Monitoring and Control

The Traffic Management Act 2004 (TMA) states that a local traffic authority (LTA) must ensure the “expeditious movement of traffic”. Thus, the expansion of remote monitoring and the improvement of control mechanisms is recommended to optimise junctions, enhance fault detection and reduce congestion. Provision should be made to upgrade appropriate vehicle actuated traffic control sites, especially junctions, in order to meet these aims.

Package 2 – Interurban Monitoring

Data generated by monitoring major links on the interurban network can provide valuable information for traffic flow monitoring, incident detection and for informing drivers of road conditions ahead. Further use of CCTV and the automation of data collection from traffic counter classifiers are recommended for enhanced network coverage. This will allow higher resolution data to be gathered thus facilitating the provision of more accurate information to road users who can then make better informed decisions on their route choices and journey plans.

Package 3 – Urban Monitoring

Traffic managers require a high level of visibility of the road network in order to effectively manage prevailing traffic conditions and to respond appropriately during...
incidents. Congested links have been identified and an increase in CCTV coverage is recommended for all congested roads. Increased utilisation of the Integrated Incident Detection (INGRID) system is also advised to aid in incident detection. The proposed migration of all appropriate vehicle actuated traffic controlled sites to urban traffic controlled systems, within Package 1, will help achieve better control, coordination and reduce congestion.

**Package 4 – Real Time Passenger Information**

Hertfordshire County Council have already completed extensive work investigating and planning for the provision of an integrated automatic vehicle location / real time passenger information system. The recommendations as detailed within the AVL and RTI Design Services Contract – Interim Report (No. RT/ A034195 / 02) provide a robust methodology and the project is now at procurement stage for Phase 1 implementation. Once fully deployed it will enable Hertfordshire County Council to meet its LTP goal of providing real time passenger information to public transport users and will facilitate a modal shift towards public transit.

**Package 5 – Traffic and Travel Information (Urban and Inter-urban)**

The provision of information to road users via variable message signs (VMS) is an important step towards effective traffic management within the county. Strategically located signs help maximise and manage major road networks by providing timely information to users. Hertfordshire Highways (HH) have already developed a strategy for VMS. This is detailed in the report Variable Message Sign Strategy for Hertfordshire. Feasibility studies need to be completed in order to identify optimum locations.

VMS and car park monitoring and guidance (CPMG) systems are important tools for managing and reducing congestion within urban centres. The VMS Strategy report as identified in Package 5 includes proposals for the deployment of strategic, first and second level VMS. A car park occupancy report addressing CPMG within Hertfordshire’s urban centres has also been developed. Vehicle activated signs (VAS) are also considered for deployment to improve road safety. Detailed study is required to determine the requirements, specifications and locations for VMS, CPMG and VAS deployment.

**Package 6 – Integrated Transport Control Centre (ITCC)**

An Integrated Transport Control Centre (ITCC) would form the cornerstone for assisting HCC reach its LTP objectives. It would enable network managers to proactively manage the road links within Hertfordshire to reduce congestion, improve incident response times and enhance safety. The ITCC would enable efficient coordination with the Highways Agency and neighbouring local authorities thus allowing road users to make smooth journeys across urban-interurban boundaries. The construction of an integrated transport control centre is a vital step in order to future proof the management of HCC’s road networks.
Package 7 – Communications Rationalisation

Hertfordshire County Council needs to rationalise its ITS communisation systems to create a fully integrated communications infrastructure.

Corporate IT have been consulted to determine the viability of shared data networks, however they want Hertfordshire Highways communications network to be kept separate. Mesh was installed on the University of Hertfordshire campus as a localised internal trial. A communication decision support tool has been adopted by HCC and is being validated as part of the wireless communications trial which will be undertaken in Watford. The results of the wireless communications trial should be carefully assessed to determine the feasibility of its usage in other areas within Hertfordshire.

Migration towards IP based communications within a UTMC framework is recommended due to the high cost of leased telecommunications circuits and the withdrawal of support of analogue based circuits which many UTC installations rely on. A decision has already been made to migrate isolated UTC sites to IP communications (outside of the Watford trial area).

Package 8 – UTMC Common Database

A UTMC common database (UTMC CDB) provides the framework into which a range of ITS tools can be integrated to produce a powerful transport system management tool. It is recommended that Hertfordshire assess the benefits of differing options and deploy a UTMC CDB in advance of the wider ITS strategy to ensure future developments make use of the UTMC based architecture.

Conclusions

The development and deployment of the UTMC CDB should be the first priority for Hertfordshire County Council as this will provide the structure to integrate and link the ITS tools recommended within this report. In addition the UTMC CDB will allow Hertfordshire to develop well connected links with the Highways Agency, neighbouring local authorities, Transport for London and bus and train operators. The UTMC CDB also supports the development of the ITCC and facilitates the implementation of a traffic and travel website.

A decision has already been taken to deliver Package 4 and implement the RTPI/AVL project, this will help the council meet its LTP objectives by driving a modal shift towards increased public transport usage.

The Integrated Traffic Control Centre is the next stage in ensuring road management within Hertfordshire is future proofed. It will allow the various ITS tools already within Hertfordshire to be drawn together in one central location, which in turn will allow the proactive management of Hertfordshire’s road networks. A visible, quick win for the
council would be the implementation of the VMS strategy and car park guidance and management strategy.
2 Introduction

2.1 Background
Hertfordshire County Council (HCC), acting in their role as highway authority and in the delivery of the Local Transport Plan (LTP), has already invested in a number of Intelligent Transport Systems (ITS). These systems have enabled them to efficiently manage their road network and will continue to play a key role in the delivery of the current second Local Transport Plan 2006 – 2011.

ITS will help achieve the objectives of Hertfordshire’s LTP by:

- Reducing congestion and decreasing journey times through the efficient management and monitoring of networks.
- Improving road safety by quickly detecting and efficiently managing incidents, thus allowing road users to be alerted to incidents or hazards as soon as they occur, as well as providing increased protection to vulnerable road users.
- Ensuring the transport network is efficiently managed and maintained.
- Encouraging increased use of, and a mode shift towards, public transport by providing reliable services, up to date information and journey planning facilities.
- Informing public transport users and private road users before and during their journeys of any potential impacts upon their journeys.
- Providing a sustainable network capable of managing traffic growth, integration with future developments and reducing the network’s impact on the environment.

To achieve these objectives, Hertfordshire County Council have adopted its ITS Strategy 2008/09 - 2010/11 and have articulated a clear vision for the deployment and operation of Intelligent Transport Systems. That vision is:

“Hertfordshire County Council will use Intelligent Transport Systems to provide safe, efficient, environmentally friendly and affordable multi-modal transport facilities and choices that allow access for all to everyday activities. By 2011 Hertfordshire will have an integrated transport system and improved traffic and travel information for all modes of transport. The increased mobility and improved transport of people and goods on its road networks will benefit individuals, businesses, quality of life and the economy alike.”

Hertfordshire’s detailed strategic goals can be found within the ITS Strategy 2008/9 – 2010/11, and also within the ITS Vision Statement which was produced as an earlier part of this commission.

2.1.1 Existing ITS assets within Hertfordshire
Hertfordshire County Council (HCC) have a large number of ITS tools in operation, however they are not fully integrated which is resulting in a loss of potentially derived benefits. Existing assets include: adaptive urban traffic control (UTC), vehicle
actuated signalised junctions and pedestrian crossings (Toucan, Pelican and Puffin), CCTV installations, remote monitoring systems (RMS) for traffic signal installations, rising bollard and signal controlled access systems, variable message signs, and vehicle actuated signs.

Other standalone ITS tools which should be considered as part of Hertfordshire’s asset base for future management include:

- Winter maintenance monitoring and tracking equipment.
- Baldock Tunnel monitoring and management control systems.
- Hertfordshire Highways’ own workforce; vehicle location, vehicle dispatch and communications network.

Consideration should also be given to improving the resilience of Emergency Plans and incident response, which currently rely on public voice networks.

Despite the large range of ITS tools currently in operation, Hertfordshire have not invested to the same level as many authorities, a large proportion of which have less congested networks and lower traffic flows.

Site specific detail and full ITS asset assessment is located within the Report on Inventory of Existing ITS Assets and Planned Developments.

### 2.1.2 Planned and / or Committed ITS Developments

HCC is already committed to a number of ongoing ITS developments in order to achieve the goals set out within the current LTP. These developments include:

- A new HCC ITS inventory database, which is currently being developed.
- A wireless communications trial is being undertaken in a part of Watford to validate a ‘decision support tool’.
- 4 new CCTV installations for evidential recordings at rising bollard sites have been commissioned.
- An upgrade of the Peek and Siemens remote monitoring systems (RMS) is planned.
- A trial of a new Traffic Signals UK (TSUK) RMS is underway.
- A Framework contract has been finalised (with Dambach) and is now in operation for the provision of future Variable Message Signs (VMS), Vehicle Actuated Signs (VAS) and Over-height Detection systems.
- HCC has commissioned for the provision of a replacement UTC system.
- HCC has commissioned the procurement of an UTMC Common Database (CDB) installation.
• Two additional rising bollard installations are being implemented by Hertfordshire Highways and two additional sites are under construction by developers as part of section 278 agreements.

• New traffic signal controlled installations are planned as part of ongoing deployment of road infrastructure.

• A forward works traffic signals refurbishment programme has been prepared.

• The trialling of traffic signal priority for blue and yellow light vehicles has been undertaken to demonstrate the technology. However, at this stage it has been determined that it is not cost feasible to roll out further.

Full detail is available in the Report on Inventory of Existing ITS Assets and Planned Developments.

2.2 Purpose of the Report

This report forms one element in the overall delivery of the Hertfordshire ITS Strategy. The full methodology for the strategy is outlined further in Section 3 of this report.

This report forms one document from a suite of ITS Strategy reports, as shown in Figure 1.

Figure 1 - ITS Strategy Suite of Documents

The suite of ITS Strategy reports consists of the following;

• The ITS Inventory which details the ITS assets within Hertfordshire

• The Transport Network Inventory which details the transport network within Hertfordshire
• The ITS Vision details the vision for ITS within Hertfordshire
• The VMS Strategy details the strategy for VMS deployment within Hertfordshire
• The ITS Package Report which details the ITS packages proposed within Hertfordshire
• The ITS Deployment Plan which outlines a strategy of deployment for the proposed work packages.

This report identifies the ITS packages which are recommended for deployment within Hertfordshire to deliver the Authority’s vision for ITS. The report:

• Identifies and examines a number of ITS tools available in the marketplace
• Summaries the objectives and requirements for ITS and identifies the most appropriate tools to meet those requirements
• Identifies packages of measures to be deployed to meet the Authority’s transport objectives.

2.3 Structure of the Report
Section 3 of this report summarises the overall process being adopted in the delivery of the ITS Strategy. Section 4 describes the available ITS tools and packages which can be adopted in the delivery of ITS. Section 5 links the application of the tools to meet the agreed ITS Vision and sections 6 to 13 identify the ITS packages.
3 ITS Strategy Delivery Methodology

The methodology being used to deliver the HCC ITS strategy closely follows that identified by the Department for Transport (DfT) in respect of ITS planning and deployment. The approach used is a combination of The City Pioneers approach and DfT ITS Tool Kit, which is a proven and robust methodology that has been successfully applied elsewhere.

The ITS City Pioneers approach has been successfully implemented on numerous projects, best practice schemes include:

**Barcelona, Spain** – During the 1992 Olympic Games Barcelona installed a modern access control system using physical barriers to protect residential areas near the Games site; it was further extended in 1995. The system allows access to residents and people working in the area (temporarily or permanently) and is linked to a staffed control centre which monitors all entry points. The system is self-enforcing and does not cause traffic queues on the main road networks. The scheme has reduced traffic entering by one-third, increased parking availability by 15% and has been welcomed by two-thirds of residents.

**Athens, Greece** – Like many cities Athens suffer from air pollution caused by traffic which is damaging to the health of the occupant of the city. Under certain conditions weather conditions combined with congestion caused levels of damaging pollutants to reach dangerously high levels. City authorities installed the “Apollon” system to measure roadside air and can predict pollution episodes. Traffic managers can now divert traffic away from congested areas to prevent predicted problems arising. Variable message signs are used to give alternative routes. The result is reduced congestion and improved air quality.

**Cologne, Germany** – To reduce traffic in the city centre a parking guidance system was introduced. It monitors the number of free spaces in 29 car parks by automatically counting the vehicles entering and leaving each car park. This information is then processed and displayed in real time to 74 dynamic direction signs (and also through a website) which relay to drivers the number of spaces available parking management. The system has reduced the number of traffic searching for parking spaces by 30%.

**Turin, Italy** – Turin’s 5T (Telematics Technologies for Transport and Traffic in Turin) project is a supervisory system responsible for the management of urban traffic in real time. It can detect traffic flow and density, predict traffic behaviour, integrate environmental data, and decide on appropriate traffic control strategies. It was developed as an open system to allow existing systems to be integrated without losing their autonomy and without the need to change existing hardware and technology.
**Midlands, UK** – Eight local authorities collaborated to provide the “Mattisse” system which offers real time traffic and travel information. The system allows travellers to obtain a wide range of facts about congested stretches of roads, planned road works, severe weather conditions, and major disruptions to the public transport networks.

### 3.1 Requirements Capture

The first stage in the methodology is to undertake an identification and analysis of the needs of the transport network and its users. This has been undertaken through:

- Hertfordshire County Council liaising with key stakeholders
- An examination of the needs of the overall transport network, largely based on the Local Transport Plan process, and encapsulated within the Transport Network Inventory
- An assessment of the type and condition of the existing ITS tools within the area.

The results from the stakeholder consultation and user needs analysis were used to develop an ITS Vision for Hertfordshire. This vision draws upon not only the information from the requirements capture work, but also the overarching national and regional transportation objectives, and distils all the requirements into a number of objectives.

### 3.2 ITS Tool Identification

Following agreement of the ITS Vision, its delivery is facilitated through the deployment and implementation of identified mechanisms, tools and actions by the specific application of ITS technology. This ensures targeted use of technology only where appropriate, ensuring effectiveness of operation and clarity of approach.

These technology components are defined in terms of their objectives and characteristics, along with their costs and contribution in terms of benefit to the overall delivery of transport objectives. Specific consideration is given to:

- Tool objectives
- Tool description
- Integrated systems
- Cost drivers (capital / revenue)
- Identified costs (capital / revenue)
- Benefits – system component contribution to objectives.

Interdependencies are identified for the range of technologies in order to assist in the packaging and prioritisation of deployment into deliverable schemes.

Whist existing applicable ITS technology and techniques are considered, it is recognised that there will be emerging technology and techniques which may
contribute to the overall objectives and vision identified through the strategy development process.

Emerging technology is more difficult to define within the adopted approach, and particularly in terms of the quantifiable cost and contribution to objectives in terms of direct benefit.

3.3 **ITS Component Matrix**
The matrix enclosed in Section 5 demonstrates the relationship between Hertfordshire County Council’s transportation objectives and the tools identified within Section 4.

High level and detailed objectives are identified along with suitable mechanism for the delivery of these objectives. Identified against each mechanism are a number of ITS components and/or subsystems which provide the “toolkit” for delivery.

The identification of the relationship between objectives and technology in this way provides a clear picture of the contribution of ITS tools and allows for the prioritisation of the technology deployment based on the overview of contribution across a range of objectives, rather than a narrow view of specific objectives.

Grouping overall objectives through the adoption of those high level objectives identified by the ITS Vision provides increased clarity and a framework.

3.4 **ITS Work Package Identification**
Sections 6 to 14 of this report identify the specific work packages which can be used to deliver the objectives defined in Section 5.
4 ITS Tool Description

4.1 Urban Traffic Control (UTC)

4.1.1 Tool Objectives
Adaptive traffic signal control systems enable traffic signal controlled junctions to interact with each other. The key objectives are:

- Enhancing economy/efficiency by reducing delay, through better optimised signal timings, so improving journey times and reducing journey time variability.
- Enhancing economy/efficiency through the application of adaptive control providing for automatic variation of green split, offset and cycle times to reflect changes in traffic distribution and volume as a result of an incident or specific event occurring.
- Enhancing the environment by reducing congestion, thus reducing emissions of greenhouse gases and local air quality pollutants.

4.1.2 Tool Description
Urban traffic control (UTC) allows the operation and timing of predetermined groups of traffic signals, known as regions, to be coordinated. The application of UTC operation can be undertaken in two ways.

- Firstly the application of fixed time UTC with coordinated and synchronised signal timing plans predetermined for known and expected scenarios and time periods. These can be timetabled for operation or applied by operator intervention.
- Secondly, adaptive traffic signal control. Adaptive traffic signal control removes the need for development of specific fixed time plans for every eventuality, or time period. The system provides signal change responses based upon historic traffic data, measured traffic activity or operator input.

Tools for adaptive traffic signal control include the Split Cycle Offset Optimisation Technique (SCOOT) and Microprocessor Optimised Vehicle Actuation (MOVA).

Adaptive traffic signal control systems seek to optimise network performance by considering traffic flow within an identified region rather than on the basis of a single junction's performance. This area wide approach can bring significant traffic management benefits including reduced congestion and certainty of journey times. Where junctions are isolated or in remote locations MOVA has been proven to provide best performance.

Urban traffic control systems can be configured to introduce 'gating' strategies. These strategies hold traffic at a cordon on the edge of an area, reducing traffic congestion within the area. This is a form of access control.

As well as providing signal control there are also bolt on tools designed to assist traffic managers in ensuring their network operates efficiently. The first of these tools
is the Automatic SCOOT Traffic Information Database (ASTRID), which is a
database that stores historic data that UTC collects on a daily basis from its roadside
equipment, such as vehicle flows and traffic patterns. It also has the power to
manipulate and use the data should roadside detectors fail, as well as providing
predictive traffic modelling. The second tool is the Integrated Incident Detection
(INGRID) algorithm. This can provide alerts when either there is a sudden change in
traffic patterns detected by the SCOOT loops or when there is a large variation
between SCOOT data and reference data stored in the ASTRID database.

4.1.3 Integrated Systems
Older versions of SCOOT required second by second communications, which meant
that analogue leased lines (multi-drop circuits) were needed to facilitate the
communications between the instation and outstations due to the time critical nature
of the data. Recent revisions to the specification have resulted in SCOOT MC3
which has time stamped data. This allows IP based communications to be used, as
the data can be correctly ordered when it arrives at the instation for processing and
removes the need for dedicated communications links.

Adaptive traffic signal control tools are often integrated with Public Transport Priority
and Emergency Vehicle Priority tools, in order to provide different levels of priority at
traffic signal junctions for different types of user.

Increasingly, the data collected by adaptive traffic control systems is held in an
Urban Traffic Management and Control (UTMC) common database for shared use
by other tools.

4.1.4 Key Cost Drivers
The key capital costs of UTC systems are associated with:

- Hardware and software costs.
- Installation works including ducting to facilitate the installation of inductive
  loops.
- Inductive loop cutting and associated traffic management costs.

The key operational (revenue) costs of UTC systems are associated with:

- Communications links between the roadside equipment and the urban traffic
  control instation.
- Maintenance and inspection costs.
- “Knockdown” and other repair costs.
- Software upgrade and development costs.
Allowances for reflecting network enhancements and alterations in adaptive signal control software.

4.1.5 Identified Costs

Capital Costs:

- UTC Instation: £30k - £80k depending on the size and type of installation.
- Roadside controller: £2.5k – £3.5k
- Reconfiguration of controller: £400
- SCOOT detector card: £220
- Loop slot cutting: £150 per junction arm (dependant upon layout and configuration)

NB - Additional system design and configuration costs are likely to be incurred in proportion to the scheme’s size.

Operational Costs:

- Leased EPS42 Circuits: these costs are usually managed by the Council and vary according to the length of the circuit.
- UTC maintenance: £12,000 /year

Allowance must be made for ongoing operational costs which will depend on the scale of the operation.

The implementation and operation of UTC and SCOOT increases the need for dedicated staff resources to manage the system. Staff resources will also be required to facilitate proactive traffic management to maximise the benefits to Hertfordshire’s transport users. The required skill sets to manage the system and proactively manage the network may not already exist within the organisation and may require commitment to training and development of existing or new staff.

4.1.6 Benefits

UTC provides a wealth of benefits to a traffic manager even in fixed time configuration, as signal plans can easily be updated and changed in a coordinated and centrally administered approach. Traffic signal installations can be remotely monitored for faults, leading to a proactive maintenance regime. Adaptive signal controls making use of SCOOT have been shown to provide approximately 20% reduction in delays compared with fixed time systems. This also leads to environmental benefits, such as a reduction in the emissions of CO₂, NOₓ and particulates.
UTC also allows greater coordination of groups of signals allowing strategies and plans to be implemented for specific purposes, such as traffic gating on the approach to town/city centres in order to prevent gridlock occurring within the centre.

Hertfordshire Highways (HH) have decided that major signalised junctions and signalised roundabouts (including motorway junctions under HH control) should operate under UTC and SCOOT control, because of the superior graphical user interface that allows non-signal specialists to monitor status and choose/implement incident scenarios.

4.1.7 Interdependencies
UTC is a standalone traffic management tool, but requires suitable roadside equipment for the chosen mode of operation, i.e. adaptive signal control (SCOOT) or fixed time operation. The former of these requires the junctions to be equipped with vehicle detection technology either in the form of loops or microwave detectors and an appropriate communications connection.

With the advent of PC-based UTC systems, SCOOT MC3 facilitates the use of alternative communications bearers, such as private fibre networks or wireless technologies. These options may be considered to reduce revenue costs associated with BT leased lines. Replacement of existing circuits can be undertaken in a staged approach.

UTC also facilitates the application of selective vehicle priority at junctions and pedestrian crossings, either through a local communication from the vehicle to the roadside controller or via the UTC instation using location data from an AVL/RTPI system.

4.2 Remote Monitoring
4.2.1 Tool Objectives
The key objectives of remote monitoring are:

- To provide a tool for monitoring the status of signal installations that are not on UTC.
- Allow maintenance requirements to be assessed.
- Providing a low cost monitoring alternative for non-critical signal installations based upon comparatively low cost communications media

4.2.2 Tool Description
Remote Monitoring allows traffic signal installations to be monitored and also allows the collection of traffic statistics. A suitably equipped traffic signal controller (i.e. one with an Outstation Monitoring Unit (OMU) and available communications) monitors the actual operation of the installation against the specified operation (the specification of the desired operation and control methodology of the controller is documented in a TR2500 form). Additionally fault information identified through the application of controller-based monitoring is passed by the controller to the OMU for transmission to a Remote Monitoring System (RMS) instation either as a specific
notification or as part of a structured programme of “pre-timed calls” during which all non urgent fault information can be collated and transmitted.

Where a site is configured to collect traffic statistics the instation can be set to dial up the traffic signal installation on a timetabled basis to collect the information. These statistics can be fed into a central database which can form a repository for all automatic and manual traffic survey data.

Advanced RMS systems have the ability to provide remote strategic control, thus providing a basic fixed-time UTC function, which is often referred to as “Dial-up UTC” This type of installation is well suited to the control of smaller networks of junctions, up to groups of 32, due to the relatively low cost of installation and communications costs. The controllers are linked using the cableless link facility (CLF), but the plans are held within the instation computer and are downloaded to the outstations as necessary. Making modifications to plans is therefore simplified. The systems are designed to be easy to use and configure with a map based operator interface.

Trigger conditions can also be set within the outstations, which then alert the instation and an appropriate plan is downloaded to implement a strategic response.

The RMC requires infrequent connections and minimal data transfer with the outstations. As such, RMS communications can be via PSTN or GSM.

4.2.3 Integrated Systems
Remote monitoring can act as a standalone system where a network of non-linked signal installations exists. However, it is often linked to a fault management system, which allows fault information received by the RMS to be managed, recorded and passed on to the fault management system for issue to a maintenance contractor, who will then take the necessary action to rectify the fault.

4.2.4 Key Cost Drivers
The key capital costs of remote monitoring are associated with:

- Hardware and software
- Telephone line installation

The key operational (revenue) costs of remote monitoring are associated with:

- Maintenance
- Communications costs

4.2.5 Identified Costs
Capital Costs:

- OMU £3,000 - £4,000
- PSTN dial up line (provision and interconnection installation costs £400 - £500 – prices assume circuit availability adjacent to controller, if not allow £75 - £150/ metre dependent upon pavement construction)
- GSM capital equipment costs attract a modest premium but with zero cost for service implementation
• A wireless trial in Watford is allowing additional communications options to be explored

Operational Costs:
• Maintenance: approx £250 / annum
• Telephone line rental and call costs approximately £250 / annum
• GSM: approximately £50 per annum

4.2.6 Benefits
In order to ensure continued performance of the highway asset and specifically the performance and continued availability of traffic signal installations which do not form part of the Urban Traffic Control system, remote monitoring can be implemented.

The visibility of the operational status of non UTC installations ensures that corrective action, particularly to significant fault conditions which lead to safety and capacity issues are dealt with in a timely and appropriate manner. Unmonitored vehicle actuated (VA) Puffin crossings can be particularly problematic and can cause significant disruption when a failure occurs. All Puffin crossing should have a RMS in place to improve management and assessment.

Coupled with effective fault management process and systems RMS can ensure effective management and assessment of signal infrastructure, which in turn allows targeted renewal and development to be undertaken as required.

Advanced systems using dial-up UTC provide reduced traffic delays over conventional traffic signal installations by implementing a more adaptive management technique.

4.2.7 Interdependencies
Whilst remote monitoring can be installed as a stand alone system it is generally linked to a fault management system (FMS) which facilitates the automatic reporting and tracking of maintenance requirements, as well as monitoring of running costs. FMS ensures that fault notification and resolution is managed and auditable, and provides an opportunity for developing business cases for renewal of assets which prove problematic in operation or become unreliable. HH has a requirement for the FMS to migrate into its new Confirm Highways Management System.

The availability of communications bearers to the roadside equipment is an important consideration in the deployment of RMS, as installation costs may be prohibitively expensive depending on the proximity of these.

A number of communications options are suitable for the implementation of RMS. Typical implementations utilise either the Public Switched Telephone Network (PSTN) or the GSM network. GSM provides a cost effective and easily deployable option, but is limited in terms of its bandwidth availability, restricting the capability for monitoring MOVA sites specifically. PSTN, whilst providing greater bandwidth
potential is more costly (both in terms of implementation and running costs) and in remote areas services can be problematic to achieve.

4.3 SCOOT Control

4.3.1 Tool Objectives

The key objectives of the adaptive signal control algorithm SCOOT are to:

- Provide coordinated control of groups of traffic signals
- Reduce delays to road users
- Provide environmental benefits by reducing congestion and stationary traffic
- Provide emergency service vehicle and bus priority
- Facilitate incident detection
- Achieve remote control of signals if needed for incident / network management

4.3.2 Tool Description

Split Cycle Offset Optimisation Technique (SCOOT) is an algorithm for calculating signal timings in real time by monitoring actual traffic conditions. It was developed by TRL in the late seventies. A system using the SCOOT algorithm comprises of:

- A traffic detection mechanism, typically inductive loops cut into the road surface, which detect vehicle presence and flow
- Suitably equipped traffic signal control equipment at the roadside, including an Outstation Transmission Unit (OTU)
- Communications links, to allow data to be transferred in real time, or near real time, between the roadside equipment and a central UTC computer
- A central UTC computer, which processes and uses the traffic flow information received from the roadside to generate adjusted signal timings. Suitable timings are sent to the roadside controllers to optimise traffic flow and coordinate groups of adjacent junctions.

SCOOT responds automatically to traffic conditions, altering signal settings to optimise junction operation so expensive updating of fixed time signal plans is unnecessary. Changes to signal timings are monitored by the system and if an improvement in the performance of the junction is found then these changes are retained; otherwise the junction continues to adjust the settings incrementally until an optimum set of parameters is found. This makes SCOOT an efficient tool for managing traffic on roads that use traffic signals.

Emergency green wave routes may be specified and can be implemented by remote request from an emergency service control room. Most commonly these are used by the fire and ambulance services. The green wave provides a rolling sequence of green signals on successive junctions along a predefined route, to provide the
emergency vehicle with maximum priority. The usual method of calling the green wave is by a push button, direct link in the fire station to override a discrete series of signals. It is also possible to have a direct link from the fire service and other emergency control room to the UTC computer which in turn implements a given plan to provide a wider coordination of signals.

Emergency green wave priority may be useful during other nationally important events such as the 2012 Olympics. Hertfordshire is hosting the White Water Rafting Venue; green wave priority could provide benefit for traffic management, particularly in emergency situations.

SCOOT systems can also:

- Be used to give priority to buses - in order for priority to be given; SCOOT must be informed about the location of buses.
- Accept instructions from an external source to implement predetermined diversions, for example in response to a recurrent bridge closure.
- Operate fixed time plans where required.

**4.3.3 Integrated Systems**

SCOOT is an algorithm used for setting signal timings, cycles and offsets, which requires data input, a processing facility and control over traffic signal installations, thus requires a UTC based system on which to operate. The minimum requirements for SCOOT to operate are: traffic signal junctions with appropriate controller hardware and software, detectors on each junction arm to monitor demand, a near real time communications system and the central control system.

**4.3.4 Key Cost Drivers**

The key capital costs associated with SCOOT are:

- UTC instation Hardware
- On-street equipment
- SCOOT licence
- ASTRID / INGRID licences
- Configuration
- Training costs

The key operational (revenue) costs associated with SCOOT are:

- Software updates / reconfiguration
• Communications links between the roadside equipment and the urban traffic control instation.

4.3.5 Identified Costs
Capital Costs:

• UTC hardware costs are identified in section 4.1.5.
• £12,000 for SCOOT licence for up to 50 nodes
• £2,000 for an additional SCOOT licence to 100 nodes
• £3,500 for ASTRID / INGRID licence
• £2000 - £3000 / site (OTU installation on site and reconfiguration of existing traffic signal controller to provide UTC interface, including testing (FAT and SAT) and updated firmware (PROM))
• £5,000 - £12,000 for staff training (system configuration, operation and management)

Operational Costs:

• Leased EPS42 Circuits: £ 2000/year
• ADSL Circuits : £ 500/year (HCC have chosen a specialist ADSL provider)
• UTC maintenance: £12,000 /year

4.3.6 Benefits
The benefits of SCOOT compared to fixed time methods of control have been well documented through the assessment of specific case studies. These case studies have been reviewed and endorsed by the Department for Transport and include the following examples:

• Journey time surveys in Worcester and Southampton found that SCOOT control reduced delays substantially compared with vehicle actuated (i.e. non co-ordinated) signal operation. Typical reduction in delay was 23% in Worcester and 30% in Southampton.
• Reductions in delay in Glasgow was 12% and in Coventry 27%.

SCOOT also allows remote control / manual override.

On average, it is estimated that SCOOT reduces delays by approximately 12% when compared to up to date fixed time traffic signal plans and in typical cases where signal plans have not been recently reviewed reduction in delay can be as much as 20%.
4.3.7 **Interdependencies**

SCOOT requires a suitable UTC platform to which it can be applied and this needs to be powerful enough to support the number of traffic installations within the required control area as well as to process information within the Automatic SCOOT Traffic Information Database (ASTRID) and Integrated Incident Detection (INGRID) software packages.

In order for SCOOT to operate based on real time traffic conditions it requires communications links to on-street equipment. This is to facilitate the transfer of detector information to the instation and for the application of control to the local controller to achieve timing, cycle and offset changes whilst in operation. Historically, this has been done via leased analogue circuits (classified as EPS 42) provided by British Telecom to facilitate the second by second communications requirements of data transfer, however with the advent of SCOOT MC3, IP-based communications can be utilised as the data is now time stamped, allowing it to be correctly ordered at the instation.

SCOOT also requires suitable on-street equipment, to facilitate the integration of the traffic signal controller to the UTC instation. This equipment referred to as the Outstation Transmission Unit (OTU) transmits and receives data, and interfaces to any traffic signal controller compliant with the TR2500 specification. Data generated from inductive loop (and sometimes overhead) traffic detectors, is transmitted back to the instation with relevant status information relating to the signals and their operation. The OTU receives control data from the instation which is then relayed to the traffic signal controller to implement the signal timing changes on street.

For the purposes of fault identification and management UTC systems can be integrated with fault management systems to enable faults to be automatically processed and passed directly to the relevant maintenance contractor.

4.4 **MOVA Control**

4.4.1 **Tool Objectives**

The key objectives of Microprocessor Optimised Vehicle Actuation (MOVA) are to:

- Improve traffic throughput at junctions on high speed roads where adaptive control is required but UTC is considered inappropriate
- Reduce the number of accidents associated with traffic signal junctions on high speed roads
- Provide priority for public transport vehicles and emergency services.
- Provide pedestrian facilities.

Hertfordshire Highways intend to use MOVA at pedestrian crossing on higher speed roads and on roads with heavy vehicle / pedestrian flows in order to make the crossings more responsive to pedestrians.
4.4.2 Tool Description
Microprocessor Optimised Vehicle Actuation (MOVA) was conceived and developed by TRL during the 1980s, and is now a well established technology for the control of traffic light signals at isolated junctions – i.e. junctions that do not require coordination with adjacent traffic signal junctions. It can also be used at stand-alone pedestrian crossings, i.e. Puffin and Pelicans. Although MOVA was originally designed for isolated junctions, its use in the development of “linked MOVA” schemes is increasingly common.

MOVA is designed to cater for the full range of traffic conditions, from very low flows through to a junction that is operating at or beyond capacity. For the majority of operation before congestion occurs, MOVA operates in a delay minimising mode, where signal timings are optimised in order to reduce the delay at the junction to its minimum possible value. However, if any approach becomes overloaded the system switches to a capacity maximising procedure, during which the objective of operation switches from minimising delay to maximising capacity irrespective of delay. MOVA is a suitable application for a wide range of situations, from simple junctions and crossings with minimal sequences (stages) to complex multimode junctions.

4.4.3 Integrated Systems
MOVA is utilised by most traffic authorities, and is a requirement on new signal installations and major refurbishments undertaken on trunk roads and for signalised motorway junctions where the local network does not require the benefits of UTC operation. Hertfordshire Highways intend to use UTC and SCOOT at signalised motorway and trunk road junctions instead of MOVA. MOVA can be used in conjunction with any controller conforming to Departmental Specification TR2500 and it is available in one of the following forms:

- A retro-fit hardware unit that connects to the traffic signal controller via the standard UTC interface
- A retro-fit ‘semi integral’ hardware unit where MOVA and the traffic signal controller are separate but have a dedicated serial communication link
- An integral function where the MOVA software is incorporated into the traffic signal controller (although MOVA still effectively remains a separate software component requiring separate license).

4.4.4 Key Cost Drivers
The key capital costs associated with MOVA are:

- Hardware and software costs
- Installation works including ducting
- Inductive loop cutting and associated traffic management costs.

The key operational (revenue) costs associated with MOVA are:
• Maintenance and inspection costs
• “Knockdown” and other repair costs
• Software upgrade and development costs
• Allowances for reflecting network enhancements and alterations in adaptive signal control software
• Remote monitoring costs.

4.4.5 Identified Costs

Capital Costs:

• Typically £15,000-£20,000 for hardware including configuration and installation of hardware and loop based detection.

Operational Costs;

• £150 per loop for replacement (approximate 10 year lifespan). Each approach has 3 loops at predetermined distances from the stop line.

4.4.6 Benefits

MOVA, through trials, has been shown to reduce delays by an average of 13% compared to early vehicle actuated based systems, as well as demonstrating a reduction in injury accidents at signalised junctions on high speed roads. When major high flow high speed junctions were examined, a 30% reduction in injury accidents was found to be achieved with a 90% statistical confidence. It also performs better than SCOOT at isolated junctions.

With vehicle actuated or fixed time systems, in order to minimise high speed vehicles running through red signals at the termination of a green signal, it is necessary to install speed discrimination or speed assessment detectors and equipment. MOVA requires its own speed detection and removes the need for separate speed discrimination or speed assessment, thereby reducing the total number of loops required.

Table 4.1 shows the annual benefits arising from reduced delays against installation cost, based on 1989 prices.

<table>
<thead>
<tr>
<th>Junction Size</th>
<th>Av. 12 Hour Throughput (Vehicles)</th>
<th>Benefits (£)</th>
<th>Cost (£)</th>
<th>Payback Time (Weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small</td>
<td>23,700</td>
<td>30,000</td>
<td>12,200</td>
<td>21</td>
</tr>
<tr>
<td>Medium</td>
<td>34,800</td>
<td>60,000</td>
<td>12,200</td>
<td>11</td>
</tr>
<tr>
<td>Large</td>
<td>49,700</td>
<td>141,000</td>
<td>19,800</td>
<td>7</td>
</tr>
</tbody>
</table>

Table 4.1 - The annual benefits arising from reduced delays against installations costs of MOVA.
The costs identified include staff time for planning and commissioning the sites as well as completion of all directly related installation. The fourth column shows the payback time in weeks based upon expected time savings.

### 4.4.7 Interdependencies

MOVA makes use of a TR2500 compatible traffic signal controller and can be implemented in three ways:

- As an add-on unit that connects to the controller via the standard UTC interface.
- 'semi-integral' where MOVA and the controller are separated, but have a dedicated communications link.
- Fully integrated within the controller.

MOVA requires some modifications from standard vehicle actuated (VA) signal sites: specifically the numbers and positioning of the detector loops. At urban sites, loops are positioned 40m and 100m upstream of the junction compared with 12m, 25m and 39m at a VA site. Whilst at high speed inter-urban sites, detectors are positioned further from the junction (40m and 155m) to give additional warning of the arrival of vehicles.

### 4.5 Public Transport / Emergency Vehicle Priority

#### 4.5.1 Tool Objectives

The key objectives of Public Transport / Emergency Vehicle Priority are to:

- Provide improved journey times and journey time reliability for public transport.
- Reduce stopped time for public transport vehicles.
- Improve public transport schedule adherence through the application of priority to delayed services specifically.
- Encourage modal shift through the increased reliability, and perception of service level, associated with public transport.
- Provide “clear runs” for emergency service vehicles.
- Enhance and improve emergency service provision and public safety when responding to blue light calls.
- Reduce stress and provide greater certainty for drivers of emergency vehicles.
• Help maintenance vehicles, such as gritters, to keep moving. Vehicle priority helps improve service delivery, reduces salt wastage and enhances safety by reducing braking on potentially ice roads.

4.5.2 Tool Description

Selective priority systems are characterised as follows:

• Bus priority – public transport vehicles can be provided priority at key junctions and traffic signals on their routes. Vehicle priority control can be provided by UTC central control, VA local or MOVA local control. The bus priority facility can extend the green period beyond its normal maximum time to allow a detected bus through or alternatively recall the green signal to a bus approach. Selective vehicle detection (SVD) of buses can be carried out by either fitting a small device on each bus, called a tag or transponder, using GPS or by using special detection equipment at the roadside which requires nothing on the bus.

• Emergency vehicle priority – this is sometimes an adaptation of a public transport priority scheme, with the emergency vehicle receiving a higher level of priority. In the case of fire stations there is often a control panel and a route is selected simply by pressing a button. The UTC computer is then alerted to which route is required and changes the signals to a predetermined sequence on that route, after a set time the signals are returned to normal control.

• The term ‘green wave’ normally refers to interventionist priority systems where the normal signal sequence is interrupted at a series of nodes, and timings are introduced that provide a series of green signals co-ordinated with the speed of a selected vehicle. In addition, the term is sometimes applied to a co-ordinated UTC system that provides a succession of green signals under normal operation. The normal application of interventionist green wave systems is for emergency vehicle priority, but there are limited documented examples of green waves for public transport vehicles.

4.5.3 Integrated Systems

The introduction of priority systems can be locally implemented (at each signalised junction or crossing) or via manipulation of UTC operation.

The detection of a vehicle requiring priority is achieved through one of the following mechanisms:

• The detection of a vehicle equipped with a transponder or tag, the identity of which is determined by a street based reader and associated loop antenna or beacon.
• Integration to a vehicle tracking system, such as that implemented within a real time passenger information (RTPI) system, coupled to an appropriate processing capability and data communications service. In this scenario the on-vehicle unit, knowing its location and status makes its own priority request. This request can be achieved through short range radio transmission to a locally based module within a specific traffic signal controller, or via the trunk communications infrastructure of the associated RTPI system. In the latter case, the application of priority is then achieved via subsequent integration of RTPI and UTC instation servers.

• Within Hertfordshire, Herts-Tags (Hertstags) are currently deployed at junctions with highest bus flows. All tagged buses get an element of priority. These will remain until replaced by a new ‘intelligent’ bus priority system which is planned for deployment through the AVL project. A series of phased rollouts will allow the whole county to be covered in due course.

4.5.4 Key Cost Drivers
The key capital costs associated with Public Transport / Emergency Vehicle Priority are:

• Hardware and software, for central processing, road side detection and on-vehicle systems.

• System configuration.

• Traffic signal reconfiguration.

The key operational (revenue) costs associated with Public Transport / Emergency Vehicle Priority are:

• Maintenance of physical works.

• Communications (depending on system configuration and requirements).

4.5.5 Identified Costs
Capital Costs:

• Tag based implementation of selective vehicle priority typically costs £3,500 per site exclusive of loop cutting costs. Loop installation costs are highly variable dependant upon required location. Typically loop installation could be achieved for £1,000 per site assuming that loops are cut (rather than ducted) back to the core ducted network which already exists, and that two way operation of priority is required.

• HCC budget £10,000 per approach plus £10,000 for controller kit, installation and communications.

• Tags typically cost between £5 and £100 depending upon functionality. Hertstags currently cost £50 each.
• RTPI based implementation of selective vehicle priority typically requires only configuration of facilities resident within the RTPI system. No physical installation is required.
• In the case of both Tag and RTPI implementations, it is reasonable to expect an element of traffic signal reconfiguration to be required. Typical costs would circa. £500-£800.

Operational Costs

• Maintenance of physical works associated with the implementation of selective vehicle priority are typically budgeted as 10-15% of the capital implementation.
• Maintenance of data and configuration associated with the implementation of selective vehicle priority can be reasonably expected to be absorbed within typical operational costs associated with the core integrated systems.
• Communication costs are highly variable depending on the solution employed.

4.5.6 Benefits

The provision of selective vehicle priority at traffic signal junctions offers a number of benefits to both the bus passengers and the operators of those vehicles given priority. Taking bus passengers first, the advantages are mostly the speed of the service, which may be quicker than by private vehicle and the adherence to published timetables, meaning less unnecessary waiting at bus stops and stations. It also allows late running services to make up time and improve punctuality.

For the vehicles given priority the advantages are dependant on the type of priority they are provided. Bus operators are able to provide quicker and potentially more frequent services, by reducing the amount of stop and delay time a vehicle experiences on its journey. This is advantageous from economic and environmental perspectives. Also, priority provision allows buses to maintain their quality of service.

With regard to emergency service vehicles, the primary advantage is reducing delays in the response to 999 calls by providing a corridor of green lights. Second to this is an improvement in safety to both the emergency service vehicle(s) and other road users, by reducing the number of junctions where a vehicle has to pass through a red light.

The benefits of selective vehicle priority have been established through the publication of case studies undertaken by and on behalf of DfT. Examples of the benefits identified by these case studies as being provided by selective vehicle priority include:

• Route 220, London:
  o 1993-1995 14.5% reduction in journey time.
Patronage increased by 10%.

3.7% of new passengers transferred from car.

- Bath Road, Bristol, bus lanes 1992:
  - Before average journey time 21 minutes 4 seconds, after 12 minutes 3 seconds.
  - Standard deviation down from 5 minutes 5 seconds to 1 minute 38 seconds.

- Recorded decline in accident rate for emergency vehicles.
- Public transport priority can provide substantial benefits to public transport vehicles with negligible disbenefit to other traffic.
- Selective vehicle detection (SVD) activation data can be collected and analysed for system and policy monitoring purposes.
- Journey time reliability and increased predictability.

### 4.5.7 Interdependencies

There are a number of interdependencies for Public Transport / Emergency Vehicle Priority, including:

- Urban Traffic Control – the requirement for priority requests and restoring network operation “post priority” requires control and coordination functions that UTC provides. Whilst priority can be provided at standalone junctions, it is less efficient in its implementation and within dense highway networks it can have significant impact upon adjacent junctions.

- Detection system – in order to provide priority at a junction, it is necessary to be able to detect the vehicle approaching. This can be done through the use of a tag and beacon based system, using vehicle classification loops or through an automatic vehicle location (AVL) system typically available as an integral part of an RTPI system. With the first two detection systems the local traffic signal controller will transmit a request back to the UTC for new signal timings, whereas with an AVL based system the priority requests will be fed into the UTC instation and new timings assigned to the junction in question.

- UTMC Common Database – where an AVL based system is used to provide priority requests, the UTMC common database (CDB) provides a link between the AVL system and the UTC.

### 4.6 UTMC Common Database

#### 4.6.1 Tool Objectives

The key objectives of a UTMC Common Database (CDB) are:

- The linking of disparate ITS tools to form a powerful transport management system.
• To provide a central repository of data from the ITS tools allowing information to be exchanged, combined and compared, which in turn can be used for automated or informed strategy selection.

• To enable transport network managers to make best use of their networks and achieve the objectives set out by the Network Management Duties in the Traffic Management Act 2004.

The UTMC approach specifically accommodates exchange of information between systems and supports centralising intelligence or distributing the intelligence around a system. This maximises design flexibility.

4.6.3 Tool Description

The UTMC Common Database is a centralised information warehouse that uses common software and IT architecture to integrate transport subsystems in order to generate greater accrued benefits and flexibility. The UTMC architecture uses Common Object Request Broker Architecture (CORBA) based adapters to communicate with existing traffic management tools. Through the use of strategy management techniques a wider range of source data can be utilised upon which predetermined traffic management strategies can be implemented. By sharing data across systems strategies can be created to invoke action when certain conditions occur, such as a low air quality alert causing signal timings to change preventing further traffic from entering the key areas of the network. Such strategies can be either automated or user implemented depending on the type of strategy and the objectives and requirements of the traffic manager.

The CDB also provides a user front end, allowing data from a range of systems to be displayed on a single user interface. Many examples use a map based (GIS) system, which is preferred due to its ease of use within an often pressured control room environment. This single user interface typically has the ability for command and control of all related subsystems, meaning that access is possible from a single control position within the control room rather than multiple engineering terminals. Additionally this makes the provision of remote command and control more achievable.

Finally, as well as providing a hub for local systems the UTMC CDB enables data sharing with external systems and other organisations including traffic and travel websites, neighbouring authorities, the Highways Agency, the Emergency Services and the media.

4.6.4 Integrated Systems

Due to its nature the UTMC CDB provides best value and flexibility when integrated to all existing transport network related subsystems. These would include, but not be limited to:

• Urban Traffic Control
• Remote Monitoring
• Fault management
• Variable Message Signs
• Car Park Management and Guidance
• Real Time Passenger Information
• Traffic Data Outstations
• ANPR
• Traffic information for road users, such as via a website or radio/tv distribution.

4.6.5 **Key Cost Drivers**
The key capital costs associated with a UTMC Common Database are:

• Hardware and software
• Configuration
• Training

The key operational (revenue) costs associated with a UTMC Common Database are:

• Hardware and software maintenance
• Software licensing
• Communications costs

4.6.6 **Identified Costs**
Capital Costs

• £32,000 - £60,000 depending on the complexity of the installation.

• Up to £10,000 for training.

Operational Costs

• Approximately 10 – 15% of capital cost for annual maintenance and software licensing.

4.6.7 **Benefits**
Some of the advantages of a UTMC Common Database are:

• Operational efficiency due to a single operator interface.
• An accurate picture of network conditions is created by combining information from different sources.

• Incidents and breakdowns can be identified more quickly and easily.

• Strategies can be developed to deal with recurrent congestion at specific locations.

• Consistent information is provided to operators and the public.

• Different organisations (e.g. HA, Police) can exchange data automatically.

• Transport authorities can work together better to improve traffic flow.

• It enables interoperability between equipment from different suppliers.

• Reduced implementation and maintenance costs associated with new schemes.

4.6.8 Interdependencies

Hertfordshire County Council are planning to provide a UTMC common database (CDB) installation together with a new UTC system. The CDB will form the central hub for future traffic information gathering and distribution within the county. The CDB will provide a platform for managing traffic growth and creating a sustainable, efficient transport network capable of tapping into future technological developments.

4.7 Automatic Vehicle Location / Real Time Passenger Information

4.7.1 Tool Objectives

The key objectives of Automatic Vehicle Location (AVL) / Real Time Passenger Information (RTPI) are:

• To track and manage vehicle fleets.

• To provide benefits to the operator, such as vehicle management, voice radio network and staff panic alarms.

• The measurement of performance and enforcement of schedule adherence.

• Provision of real time passenger information, encouraging members of the public to make informed choices about the way they travel.

• Provide a better journey environment by removing the uncertainty in waiting for and travelling on public transport, this can be through the provision of arrival times, journey times, changes of stop / platform and traveller information.
• To better enable travellers to plan their journey confidently, including taking any necessary steps in the event of delays. This helps to encourage greater use of public transport, a key transport priority nationally.

4.7.2 Tool Description

Automatic vehicle location (AVL) is a concept for determining the geographic location of a vehicle and transmitting this information to a system or systems that require it.

There are two ways of providing AVL: the first is by using differential Global Positioning System (GPS) technology, and the second by using a beacon based system. Most bus AVL systems in the UK allow the location of a bus to be compared against a schedule and, in this way, priority can be provided depending on a bus’ adherence to its schedule. In the Cardiff system, for instance, it is possible to give priority only to those buses that are running behind schedule.

Information can be provided to public transport users about the nature and state of a public transport service, though visual or audible media. Real time passenger information systems use predictions based on AVL input to show the expected arrival and departure times of public transport services. Additional information such as interruptions to services or travel information can also be disseminated.

Information may be delivered via any electronic media including:

• Display screens at public transport terminals, stations or stops.

• Digital voice announcement (DVA) at public transport terminals, stations or stops.

• Telephone (either a manned bureau service or an automated answering system).

• Touch screen kiosks for self service (e.g. in customer offices).

• Internet through a website, such as a multi-modal county transport website e.g. an online journey planner (potentially facilitated by an Integrated Transport Control Centre).

• PDA or mobile phone (typically using SMS or WAP).

4.7.3 Integrated Systems

AVL / RTPI systems can be purchased as a stand-alone package that requires no other systems to function, however, enhancements can be attained by linking to:

• UTC to provide bus priority facilities (refer to earlier commentary).

• Access control systems to provide dedicated bus routes.

• Websites to provide passenger information to a wider audience.
4.7.4 **Key Cost Drivers**

Typical AVL / RTPI schemes can be very expensive, especially in regard to ongoing maintenance costs, and the success of the scheme is heavily dependant on accurate surveys being conducted. It is often the case that Local Authorities can schedule the capital costs with some certainty, but underestimate the ongoing revenue burden.

The key capital costs associated with AVL / RTPI are:

- Provision of the central system, including software, installation and commissioning.
- Provision of the communications system, including radio base station(s) where required for Private Mobile Radio (PMR) systems.
- Radio licences (typical PMR based systems require 4 or more radio channels).
- Radio base station communications network.
- Outstation hardware / software, including installation and commissioning (including at bus depot(s)).
- On-board units for fleet vehicles.
- Bus shelter displays.
- Digital Voice Announcement (DVA) functionality.
- Local area network (LAN) extensions.
- Creating timetables and the associated data entry.
- System configuration.

The key operational (revenue) costs associated with AVL / RTPI are:

- System maintenance.
- Communications costs if GPRS / leased lines are used for bus stop / station displays.

4.7.5 **Identified Costs**

**Capital Costs**

- £40,000 - £60,000 for the central system.
- £70,000 for each base station for PMR.
- £20,000 for outstation hardware.
- £2,500 for hardware per equipped vehicle.
- £4,500 per equipped bus shelter.
- £3,500 - £4,000 per PMR Licence.
- £10,000 - £15,000 for communications extensions for the LAN and radio base stations.

Operational Costs

- Revenue Costs are typically 15 – 20% of the scheme implementation cost per annum.

4.7.6 Benefits

Benefits that are likely to be realised through AVL / RTPI include:

- More informed travellers.
- Increased patronage of public transport services.
- Quicker journey times through bus priority at signalised junctions.
- The ability to monitor service delivery and the transport network using schedule adherence reporting and analysis facilities.
- Improved fleet management: when managing a fleet of vehicles, knowing the real time location of all drivers allows management to meet customer needs more efficiently. Vehicle location information can also be used to verify that legal requirements are being met. For example, that bus drivers are taking rest breaks and obeying speed limits.
- Enhanced understanding of network issues within Bus Improvement Partnerships.

4.7.7 Interdependencies

RTPI can in many cases be considered independent and free standing systems. However when considered in the context of broader ITS deployment certain synergies with other systems become apparent.

A key requirement of RTPI is the communications infrastructure. IP-based communication systems are becoming increasingly commonplace, and the opportunity for sharing infrastructure is rapidly increasing.
The implementation of selective priority at traffic signal sites requires integration with either individual sites or the UTC instation directly. It is also likely to require the reconfiguration of the traffic signal controller itself, to ensure the required operation.

Operationally, within the vehicle, a driver interface is required which includes integration of the existing ticket machine. Data must be derived from the ticket machine in order to ensure that the bus is correctly identified as being on a specific service trip.

Key to the deployment of RTPI is the availability of data relating to bus service operation, and is typically made available as a structured output from scheduling software in a recognised industry data format such as “ATCO CIF" or “Transxchange”.

4.8 Journey Planning

4.8.1 Tool Objectives
The key objectives of (pre-trip) journey planning are to:

- Influence traveller behaviour, in particular modal choice, route choice and the time at which journeys are made.

- Make travel more efficient, better informed and remove the ‘uncertainty’ of one’s journey, leading to an improved perception of travel.

- Help drivers find the best route to their destination including providing information on where to park and enable travellers to plan their journeys in advance fully informed of road traffic and travel conditions so that they have a choice of the time and mode of travel.

- To make multi-modal journeys easier by improving the process of planning and implementing journeys. This can be achieved by providing a ‘one-stop shop’ for trip planning, regardless of destination and selected mode(s) of transport.

- Make transitions between modes much easier by providing comprehensive, reliable and real time information to travellers about each of the modes that are available at a modal interchange. Such information will make it easier for travellers to switch between modes and encourage travellers to use alternatives to the private car at least for some of their journey.

4.8.2 Tool Description
Journey planning is a means by which travellers are provided with information to allow them to make informed choices about how, when and where they travel. This can be through interactive websites, telephone services, SMS, information displays and kiosks or through TV services. Transport Direct is an important receiver of Hertfordshire’s data and a principal delivery channel by providing door to door multi-modal travel information.
The types of Information that can be made available include:

- Public transport timetables.
- Map based real time information and destination identification.
- Traffic conditions (including historic, real time and predictive).
- Car park occupancy and on-line booking.
- Road works information.
- Park and ride booking.
- Major events.

4.8.3 Integrated Systems

Journey planning is likely to require the integration of a number of systems, including but not limited to:

- RTPI
- UTC
- Car park monitoring

Thus, because of its ability to integrate systems, a UTMC Common Database would form a pre-requisite to providing journey planning.

4.8.4 Key Cost Drivers

The key capital costs associated with Journey Planning are:

- Development and configuration of a travel and transport information portal.
- Integration with UTMC CDB to secure data from other integrated systems.
- Provision of a journey time server.
- An interface to the worldwide web, such as the Siemens eMerge software.
- Deployment of any new information kiosks.

The key operational (revenue) costs associated with Journey Planning are:

- Web hosting of the portal.

4.8.5 Identified Costs

Capital Costs
• £15,000 - £30,000 for a portal.
• £25,000 - £30,000 for a Journey Time Server.
• £20,000 - £60,000 for a UTMC Common Database.
• eMerge interface to Web £30,000 - £40,000.

Operational Costs
• Web hosting is dependant on the size of the website and volume of traffic.
• Communications cost dependant on the chosen solution.

4.8.6 Benefits
An Inter-modal Journey Planner (IJP) integrates a number of different types of data about the planned services for the Public Transport system, including:
• Information to identify and navigate bus / train stops, stations and other transport interchanges.
• Information about the origins and destinations that users may want to travel to and their relation to stops and stations. For example, places of interest and their access points, from within towns and cities.
• Information about the topography of a county and its relation to transport systems.
• Information about the network topology and the routes and lines.
• Schedules for different modes of transport.
• Schematic maps of transport interchanges.
• Schematic maps of the transport network.
• Maps of the county and of the area around stops.
• Information about facilities at stops and stations.
• Information about fares, tariff zones and fare products.
• Information about the carbon footprint costs of using different modes.

In order to develop data sets that can be integrated economically and robustly, data standards and conceptual models, such as Transmodel are used.
An IJP also integrates a number of different types of data about the transport networks which can be made available for use by private vehicles and pedestrians. For example:

- Road transport network topology.
- Footpath, cycle path and bridleway network topology, with accessibility information.
- Topographical maps.
- Contour profile data.
- Information about facilities for the motorist.
- Information about speed restrictions.
- Information about road works and disruptions.
- Information about average journey times.
- Information about fuel usage.
- Information about the carbon footprint of usage of different vehicle types.

4.8.7 Interdependencies

In order to deploy a journey planner there are a number of other systems that need to be in place, configured and the data verified for accuracy. Depending on the complexity of the journey planner, systems that may need to be accessed include:

- A mapping system with the transport network details provided such as one-way streets, bus stops / stations, public transport interchanges, speed limits, etc.
- Real time and scheduled public transport information, i.e. buses, trains, ferries, etc.
- Car Park Management and Guidance Systems.
- Real time and historic traffic information, real time passenger information.
- Street Works licensing systems (EXOR or similar).

Information from these systems will need to be collated in one central location, most likely a UTMC Common Database with appropriate communications infrastructure, to allow the data to be interrogated for publication on a live website.
4.9 Information / Data Collection

4.9.1 Tool Objectives

The key objectives of information / data collection are to:

- Allow traffic managers to understand what is occurring on their networks that affects how people move within a conurbation.

- Enable informed decisions to be made regarding the implementation of interventions and strategies to manage movement.

- Collect sufficient, accurate and timely information for monitoring of traffic conditions, dissemination of network status and implementation of transport strategies.

- Detect and manage incidents to minimise their impact on travel within the local transport network.

- Analyse the demand for the use of the different transport modes available and to actively manage and promote those that provide the most efficient form of transport.

- Identify progress towards transport objectives as a result of specific scheme or policy implementation.

- Monitor network performance in execution of the Network Management Duty (NMD) as defined within the Traffic Management Act 2004.

- Monitor environmental impact of schemes and facilitate management of Air Quality Management Areas (AQMAs).

4.9.2 Tool Description

Information / data collection can, and often does, include a wide variety of sources. Whilst specific technology deployments targeted at the collection of specific data sets remain valid, data available within existing ITS sub-systems is increasingly valuable and can prove cost effective. Data is derived typically from the following sources:

- UTC and RMS statistics

- Automatic traffic counter classifiers (such items can also provide speed data)

- Car park occupancy

- CCTV

- ANPR (It is not HCC policy to invest in ANPR itself. HCC has agreed with the Police to allow installation of ANPR on highways in return for access to information.)
• AVL / RTPI
• Environmental monitors
• Stakeholders / neighbouring authorities
• Street works database and licensing system
• Third party, commercially available in vehicle travel time data sources.

Dedicated traffic-counter-classifiers are the only source of data outlined above that requires specific deployment under this section. Such items are typically most successfully deployed using proven loop based technology. Communications options include GSM, GPRS, radio and fixed PSTN telephony. Installations either use mains power connections or use solar power technology coupled with battery support for overnight operation and at times when insufficient energy is derived from solar sources.

4.9.3 Integrated Systems
The collection of information for the purposes of traffic management can be achieved on a system by system basis depending on how the data will be used. However, by combining / comparing information from multiple systems greater certainty and a greater understanding of how the network is operating can be attained.

Whereas in the past traffic managers may have had to consult a number of systems individually, the advent of UTMC standards and the common database has facilitated the linking of multiple systems and storing their data in a single repository. This has the advantage that only one system has to be consulted and the data can be processed and combined to provide a number of outputs.

4.9.4 Key Cost Drivers
The key capital costs associated with information / data collection are:

• On-street detection equipment
• Instation processing facilities
• On-vehicle AVL systems
• UTMC Common Database
• UTMC CORBA adaptors
• Links to neighbouring authorities via CDB integration (XML or DATEX II)
• Link to Highways Agency via Traffic Information Highway (DATEX II)
• System configuration
The key operational (revenue) costs associated with information / data collection are:

- Communications costs for links to on-street and on-vehicle equipment.
- Communications costs for links to neighbouring authorities / stakeholders.
- Ongoing maintenance.

4.9.5 Identified Costs

Capital Costs

- Automatic Traffic Counter Classifiers – typically costing £4,500 - £6,500 per site dependant upon requirements for lane coverage. However, Hertfordshire Highways have a desire to relocate traffic counters to nearby traffic signal installations where possible, with the aim of reducing these costs.

- Costs associated with integration to other data sources (as identified above) are assumed to be covered within costs identified for UTMC CDB implementation.

Operational Costs

- Automatic Traffic Counter Classifiers – typical maintenance and operational costs are 10%-15% of capital implementation dependant upon communications costs and choice of power provision.

4.9.6 Benefits

The provision of high quality information allows traffic managers to make informed decisions as to the best measures and interventions to apply in order to ensure network efficiency. The collection of information also allows the traffic manager to understand the impact of any interventions they apply, thus providing them with a feedback mechanism, which can be used to refine network management strategies and policies.

Data collection additionally provides sources of data which potentially has value (in some cases commercial) due to its applicability in the following areas:

- Real time journey planning.
- Real time satellite navigation and incident avoidance.
- Freight logistics and planning.
- Public transport operations.

4.9.7 Interdependencies

The nature of data collection within an ITS driven environment means that UTMC CDB deployment is key to the collation of information and data from disparate
sources. The requirement for a CDB is implicit in order to assimilate and integrate collected data for optimal usage.

The deployment of dedicated infrastructure as outlined above, for the collection of near real time traffic data, results in a dependency upon communications infrastructure and upon the CDB functionality to monitor and manage the data derived from it.

4.10 Information / Data Delivery

4.10.1 Tool Objectives

The key objectives of information / data delivery are:

- To provide travel information to the public such that they can make informed decisions about how they travel.
- To provide information to the travelling public about their journeys to improve the environment in which they travel and to reduce traveller stress.
- To provide network managers with a means by which to manage their networks.
- The sharing of information / data with stakeholders for the purposes of maintenance requirements.

4.10.2 Tool Description

Information / data can be delivered through various media including internet, VMS, mobile phones, information displays and information kiosks. Data is of value not only to the travelling public but also to stakeholders such as bus and other transport operators, car park operators, highway maintenance contractors, neighbouring authorities and the emergency services (including LA emergency planning teams).

Information / data can provide detailed information about:

- Journey times and delays
- Diversion or preferred routes
- Event information
- Highways works
- Car park occupancy and status
- Public transport timetables, variations and real time information
- Traffic count data identifying busy routes
• Network availability and performance.

4.10.3 Integrated Systems
Information / data delivery can occur from each system that has integration potential to a UTMC CDB. It is likely that data from many systems will need to be combined and packaged for delivery in order for it to be more usable and appropriate for a wider audience, and such functionality can be readily provided through the implementation of a CDB.

The tools associated with the delivery of information include:

• VMS (both strategic VMS and car park guidance VMS)
• Web based portal for public information provision
• UTMC CDB for stakeholder information provision (including TV and radio)

4.10.4 Key Cost Drivers and Identified Costs
The delivery of information utilises technology deployment identified elsewhere within this section of the report, bringing greater benefit from the investment made in technology for other purposes.

The cost drivers and identified capital and revenue costs are identified against each element of technology elsewhere within this section.

4.10.5 Benefits
The benefits associated with information / data delivery include:

• More informed travellers
• Better use of the road network
• Modal shift from private to public transport or other sustainable modes
• Improved traveller environment
• Quicker resolution of faults
• Better management of incidents

4.10.6 Interdependencies
The core dependency for information delivery relates to existing or planned technology deployments that provide data sources and mechanisms for data delivery.

Data delivery is dependant upon the availability of:

• A web based portal
• Variable Message Signs (strategic and hybrid)
• UTMC CDB (providing infrastructure control and dissemination to stakeholders)

4.11 CCTV

4.11.1 Tool Objectives
CCTV is a widely utilised tool within network operations providing visual confirmation of network status.

The key objectives of CCTV are to enable authorities to:

• Detect congestion and identify incidents.
• Monitor their network in real time.
• Understand the impacts that an incident or intervention is having.

4.11.2 Tool Description
Closed circuit television uses cameras to transmit moving images to a display in a remote location to allow something to be monitored in real time. When used on a road network there are usually a number of cameras connected to a switching matrix allowing multiple locations to be seen concurrently. Cameras are either of fixed orientation or are controllable to allow their orientation to be adjusted remotely as required to track subject matter. This latter form of camera is referred to as Pan-Tilt-Zoom (PTZ).

4.11.3 Integrated Systems
CCTV can be combined with processing to provide a number of applications including ANPR, incident detection and virtual detector loops for use in traffic control systems.

ANPR can be used to monitor the flow of traffic between two camera locations. As well as traffic monitoring this data can also be used for more advanced security, surveillance, and traffic law enforcement applications by linking the systems to external databases. Current HCC policy is not to invest in ANPR, but to allow the police to deploy ANPR on the network in return for access to the data.

CCTV requires communications infrastructure in order to facilitate the transfer of images to a remote location where they can be monitored, processed and recorded.

4.11.4 Key Cost Drivers
The key capital costs associated with CCTV are:

• Camera deployment – civils works, infrastructure and equipment
• Communications
• Instation control, monitoring and recording infrastructure

The key operational (revenue) costs associated with CCTV are:

• Communications and maintenance costs

### 4.11.5 Identified Costs

#### Capital Costs

• £2,000-£5,000 per CCTV camera head dependant upon specification.

• £500 - £1,000 for civils and infrastructure (e.g. poles and mounting).

• Communications costs are highly variable depending on the solution employed.

#### Operational Costs

• Communications costs are dependant on the chosen solution.

• Maintenance costs associated with CCTV infrastructure are typically 10% of the capital implementation costs.

### 4.11.6 Benefits

CCTV has the ability to allow the transport network and public spaces to be monitored in real time which can provide a number of benefits including:

• Identifying incidents and congestion.

• Improving safety and security of the travelling public and transport operators.

• Better compliance with road traffic regulation orders.

### 4.11.7 Interdependencies

The implementation of CCTV requires a control room function to be established to enable the correct and proper monitoring of images in a controlled environment that meets with ergonomic requirements.

All remotely monitored and recorded CCTV systems require communications infrastructure. The bandwidth requirements vary according to the standard of image and frame rate required.

A policy and procedural framework is required to ensure that the use of CCTV, the resulting recorded images and the associated data are all legal. The regulatory framework includes, but is not limited to:

• Data Protection Acts (1984 and 1998)
• Human Rights Act (1998)
• Civil Contingencies Act (2004)

4.12 Car Park Management and Guidance
4.12.1 Tool Objectives
The key objectives of Car Park Management and Guidance (CPMG) systems are:

• To reduce the amount of traffic circulating within the network searching for
  car parking spaces by guiding them to facilities with adequate capacity and
  providing information on those which are full or closed.

• Encourage the use of preferred parking facilities, thus providing
  improvements to environmentally sensitive areas and removing traffic from
  congested areas.

• Improve the use of park and ride facilities by encouraging their use.

4.12.2 Tool Description
A parking management and guidance system has four essential elements:

• Car park monitoring
• A communications sub-system
• An instation control system and graphical user interface
• Hybrid Variable Message Signs

Car park occupancy data is collected at the site itself, using one or a combination of
the following:

• Loop based detectors or barrier interface on the entry and exit points
• Space occupancy detectors
• ANPR
• Ticketing machines

This information is transmitted back to a central location or instation where it is
compared with the number of spaces and the car park status, at which point the
space availability is calculated. This data is then output to its associated variable
message sign(s), which are located at appropriate decision points on the network
and present the information to road users. These VMS generally show the number of
vacant spaces or status information such as “Spaces”, “Full” or “Closed”. Car parks
are often grouped into zones to reduce the information that has to be presented to
drivers on each sign along a given route.
4.12.3 Integrated Systems
Car park guidance systems can be used as standalone applications; however they are often combined with a wider VMS system that is used for route guidance and providing other information to road users. They can also be combined with UTC systems to make use of the associated detection and communications infrastructure.

Through adoption of the UTMC architecture, and the implementation of a UTMC CDB, it is possible to develop CPMG systems using equipment from a range of suppliers. This provides greater flexibility in procurement and brings associated economies. Furthermore maintenance and expansion of systems developed in this way are more readily achieved, whilst maintaining competition in procurement at each stage.

4.12.4 Key Cost Drivers
The key costs associated with developing Car Park Management and Guidance systems are:

- UTMC Common Database
- Variable Message Signs (hybrid VMS)
- Car park outstations
- Communications infrastructure
- Civils and electrical infrastructure

The key operational (revenue) costs associated with CPMGuidance systems are:

- Count site maintenance
- VMS maintenance
- Communications costs

4.12.5 Identified Costs
Capital Costs

- £10,000 - £20,000 per VMS dependant upon specification
- £9,000 per car park outstation
- £3,000 for civils / electrical works

Operational Costs
• Maintenance is dependant on the size / type of the system, typically 10% of capital implementation costs per annum.

• Communications costs are dependant upon option selected. GPRS is typically utilised and costs per communication node are approximately £100 per annum.

4.12.6 Benefits
Car parking management and guidance can improve network efficiency significantly; reported benefits include:

• A reduction in time and distance travelled in searching for appropriate car parking coupled with a corresponding reduction in traffic and emissions.

• Efficient use of off-street parking as appropriate, thus improving accessibility to short-stay on-street parking.

4.12.7 Interdependencies
The implementation of CPMG requires the following elements which may be provided as part of an overall ITS package of deployment:

• UTMC CDB – providing functionality for monitoring car park outstations.

• Communications infrastructure – where IP based communications infrastructure exists, this can be utilised for data transmission between the car park and CDB, and also CDB and VMS. Core infrastructure may be available through other ITS or IT implementations thereby removing the need for dedicated communications infrastructure for CPMG specifically.

Specifically where GPRS is implemented, fixed communication infrastructure linking instation deployment to the GPRS service providers network is required, along with Cisco or similar routing capability supporting fixed IP addressing.

4.13 Variable Message Signs
4.13.1 Tool Objectives
The objectives of using variable message signs are to:

• Provide drivers with information about specific network conditions

• Warn of traffic congestion, accidents, incidents, roadworks

• Give parking guidance and information systems to guide drivers to available car parking spaces (this is detailed within the preceding section of this report on Car Park Management and Guidance)

• Direct drivers to follow strategic and tactical diversion strategies

• Advise of anticipated trip characteristics such as journey time.
4.13.2 Tool Description
Variable Message Signs (VMS) are dynamically configurable signs that can display a variety of messages in response to changing circumstances or requirements. VMS are typically placed at key locations along primary transport corridors, where provision of information has value to the network user and specifically enables informed decisions about route selection and modal choice. Information provided through the use of VMS allows informed decisions to be made on the part of the network user.

VMS are used to display network messages and inform road users of any incidents that may have occurred or any hazards to approaching traffic. Strategic VMS can be used to divert traffic away from areas affected by incidents, mitigating where possible the congestion caused and reducing the likelihood of secondary incidents occurring.

VMS systems can be, and have historically been, implemented as stand alone systems, or as an integral part of Urban Traffic Control systems. However the advent of UTMC allows a more integrated and elegant deployment architecture. As with many ITS tools, the implementation of a UTMC CDB allows VMS equipment from a range of manufacturers to be controlled and monitored through a single command and control interface.

The use of VMS as a network management and information delivery tool requires data to be combined from a range of sources. Through the use of a strategy supervisor which forms part of a CDB implementation, this information can be delivered to the VMS for provision to the user. UTMC CDB provides the full range of functionality required to achieve this.

4.13.3 Integrated Systems
In order to deliver a flexible VMS system it is necessary to deploy a UTMC Common Database to provide the required control and monitoring facilities along with integration to other ITS subsystems.

As with most ITS deployments communications infrastructure is required as an integral component of the VMS deployment. This requirement exists between the command and control functionality (provided by the UTMC CDB) and the individual VMS deployed on-street.

4.13.4 Key Cost Drivers
The key capital costs associated with Variable Message Signs are:

- Deployment of the VMS on street
- Implementation of the communications infrastructure

The key operational (revenue) costs associated with Variable Message Signs are:

- Maintenance of the VMS
• Communications costs associated with data transmission and system monitoring.

4.13.5 Identified Costs
Capital Costs

• £10,000 - £20,000 per VMS dependant upon the specification and speed classification of the highway at the location of deployment.

• Communications implementation costs are minimal assuming use of GPRS. This assumes that costs associated with the implementation of GPRS is shared across a number of ITS deployments. Typical costs associated with the implementation of GPRS are approximately £20,000 and represent a single cost across all ITS deployment.

Operational Costs

• Maintenance of VMS can be budgeted as approximately 10% of capital implementation cost per annum.

• Communications costs are dependant upon the option selected. GPRS is typically utilised and costs per communication node are approximately £100 per annum.

4.13.6 Benefits
By providing real time information about the transport network, VMS can improve road user's route selection, reduce travel times and mitigate the severity and duration of incidents, thus leading to improved performance of the network.

4.13.7 Interdependencies
VMS deployments based upon the UTMC systems architecture require the deployment of a UTMC CDB to provide monitoring and control functionality.

For the communications infrastructure, joint use of an IP based communications network is the desired solution. Where possible, this should be utilised for data transmission between the car park and CDB, and also CDB and VMS. Core infrastructure may be available through other ITS or IT implementations thereby removing the need for dedicated communications infrastructure specifically for VMS.

Specifically where GPRS is implemented, fixed communication infrastructure linking instation deployment to the GPRS service providers network is required, along with Cisco or similar routing capability supporting “fixed” IP addressing.
5 Development of ITS Packages

5.1 Introduction
The purpose of this section is to demonstrate the process of forming links from Hertfordshire's transport objectives to appropriate mechanisms that facilitate their delivery. The high and detail level objectives stem from the adopted ITS Strategy for Hertfordshire. With detail level objectives identified, tools as detailed in Section 4 are then applied. These take into account the current technology infrastructure that exists in the region, which are detailed in the Report on the Inventory of Existing ITS Assets and Planned Developments, delivered as part of the overall ITS Strategy.

With the mechanisms defined a process of consolidation can be undertaken, bringing together the common elements to form packages. These identified packages are then developed in Sections 6 to 14.
### 5.2 Objectives Matrix

Table 5.1 below shows the mapping of HCC’s LTP objectives to mechanisms.

<table>
<thead>
<tr>
<th>HCC Objectives</th>
<th>Sub-Objectives</th>
<th>Mechanisms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Use ITS to efficiently and proactively manage transport networks.</td>
<td>Ability to monitor traffic on transport networks.</td>
<td>Automatic Traffic Counter Classifiers</td>
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<tr>
<td></td>
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<td>CCTV</td>
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<td>Urban Traffic Control</td>
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<td></td>
<td>Remote Monitoring System</td>
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<tr>
<td>Ability to efficiently manage and control transport networks</td>
<td>Urban Traffic Control</td>
<td>MOVA and Dial up Strategic Control (DUSC)</td>
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<td>Car Park Management and Guidance (CPMG)</td>
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<td>Variable Message Signs</td>
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<td></td>
<td></td>
<td>Integrated Transport Control Centre</td>
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<tr>
<td>To improve road safety particularly where hazards exist or accident risk is high.</td>
<td>Ability to detect and effectively manage incidents.</td>
<td>CCTV</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Automatic Traffic Counter Classifiers</td>
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<td></td>
<td>Urban Traffic Control</td>
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<td></td>
<td>UTMC Common Database</td>
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<tr>
<td>Ability to ensure speedy resolutions to incidents and inclement weather conditions.</td>
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<td>Integrated Transport Control Centre</td>
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<td></td>
<td></td>
<td>Selective Vehicle Detection and Priority</td>
</tr>
<tr>
<td>HCC Objectives</td>
<td>Sub-Objectives</td>
<td>Mechanisms</td>
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<tr>
<td>Ability to alert users to road conditions caused by incidents and adverse weather.</td>
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<td>Variable Message Signs</td>
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<td>CCTV</td>
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<td></td>
<td>Transport Control Centre</td>
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<td>UTMC Common Database</td>
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<td></td>
<td>Media Information Distribution (Radio/TV)</td>
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<td>Traffic and Travel Website</td>
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<td></td>
<td></td>
<td>Kiosks and Display Screens</td>
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<tr>
<td>Ability to expedite emergency service response to incidents by UTC Green Wave</td>
<td></td>
<td>Urban Traffic Control</td>
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<td></td>
<td></td>
<td>Selective Vehicle Detection and Priority</td>
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<tr>
<td></td>
<td></td>
<td>UTMC Common Database</td>
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<tr>
<td>Ability to provide increased protection to vulnerable road users at crossings and accident hot spots.</td>
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<td>CCTV</td>
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<td></td>
<td>Variable Message Signs</td>
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<td></td>
<td>Vehicle Activated Signs</td>
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<tr>
<td>Ability to warn goods vehicles of low and/or narrow railway bridges and other network structures.</td>
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<td>Freight Management Strategy</td>
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<td></td>
<td>Vehicle Activated Signs</td>
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<td>HCC Objectives</td>
<td>Sub-Objectives</td>
<td>Mechanisms</td>
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</tbody>
</table>
| Improve traffic management in towns. | Provide effective monitoring of traffic on the urban road network. | Integrated Transport Control Centre  
UTMC Common Database  
CCTV |
| Ability to control traffic on urban road networks to tackle congestion, reduce delays and increase reliability of journey times. | | Urban Traffic Control  
UTMC Common Database  
MOVA  
Variable Message Signs  
Integrated Transport Control Centre |
| Ability to restrict access to sensitive areas. | | Access Control  
Selective Vehicle Detection and Priority |
| Effectively maintain the transport network | Collect, process and deliver information about travel conditions, planned works, events and incidents to the travelling public. | CCTV  
Traffic and Travel Website  
Media Information Distribution (Radio/TV)  
UTMC Common Database  
Integrated Transport Control Centre |
<table>
<thead>
<tr>
<th>HCC Objectives</th>
<th>Sub-Objectives</th>
<th>Mechanisms</th>
</tr>
</thead>
</table>
|                | Delivery of information to network and system maintainers for effective fault management and performance monitoring. | Urban Traffic Control  
UTMC Common Database  
Integrated Transport Control Centre  
Remote Monitoring Systems |
|                | Provide real time information about different modes of transport. | UTMC Common Database  
Real Time Passenger Information  
Traffic and Travel Website |
| Informed Travellers | Integrate ITS tools to allow travellers to be informed of journey conditions and parking availability. | UTMC Common Database  
Integrated Transport Control Centre  
Variable Message Signs  
Car Park Management and Guidance (CPMG) |
|                | Provide ability to interact with bus and train operators, neighbouring LAs and the HA in order to ensure smooth flow of traffic at multi-modal interchanges and jurisdictional boundaries. | UTMC Common Database  
Integrated Transport Control Centre  
Remote Monitoring Systems  
Automatic Vehicle Location |
<table>
<thead>
<tr>
<th>HCC Objectives</th>
<th>Sub-Objectives</th>
<th>Mechanisms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Promote Multi-Modal Travel, Improve Public Transport Services and Increase Accessibility</td>
<td>Ability to effectively manage public transport services</td>
<td>Integrated Transport Control Centre</td>
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<td></td>
<td>UTMC Common Database</td>
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<tr>
<td></td>
<td></td>
<td>Establish linkages with neighbouring Local Authorities</td>
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<td>Provide public transport priority at signalled junctions.</td>
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<td>Automatic Vehicle Location</td>
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<td>Selective Vehicle Detection and Priority</td>
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<td></td>
<td></td>
<td>Integrated Transport Control Centre</td>
</tr>
<tr>
<td>Provide real time information to public transport users at key locations.</td>
<td></td>
<td>Real Time Passenger Information</td>
</tr>
<tr>
<td>Ability to deliver information to public transport users before and during their journeys.</td>
<td></td>
<td>Traffic and Travel Website</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Real Time Passenger Information</td>
</tr>
<tr>
<td>Enable automatic location of public transport vehicles.</td>
<td></td>
<td>Automatic Vehicle Location Systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>UTMC Common Database</td>
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<td></td>
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<td>Integrated Transport Control Centre</td>
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<tr>
<td>HCC Objectives</td>
<td>Sub-Objectives</td>
<td>Mechanisms</td>
</tr>
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<td>-----------------------------------------------------</td>
<td>-------------------------------------------------------------------------------</td>
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</tbody>
</table>
| A sustainable transport network                     | Mitigate and monitor the effect of transport on the built and natural environment, as well as personal health. | Urban Traffic Control  
Variable Message Signs  
Environmental / Air / Noise Quality Monitoring  
UTMC Common Database |
| Enable smooth journeys across urban/inter-urban boundaries through close coordination with adjoining LAs and the HA. | Automatic Vehicle Location  
Real Time Passenger Information  
UTMC Common Database  
Integrated Transport Control Centre  
Linkages to neighbouring Local Authorities and the Highways Agency |                                                            |
| Provide ability to cope with traffic growth and new developments to 'future proof' systems. | UTMC Common Database  
Integrated Transport Control Centre  
Integrated Communications Network  
Urban Traffic Control |                                                            |

*Table 5.1 - Objectives to mechanisms matrix*
5.3 **Consolidation of Mechanisms**

Table 5.2 below consolidates the mechanisms identified to deliver Hertfordshire’s objectives and rationalises them into appropriate packages.

<table>
<thead>
<tr>
<th>Mechanisms</th>
<th>Packages</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCTV, Automatic Traffic Counter Classifiers, Environmental / Air / Noise Quality Monitoring</td>
<td>2. Inter-urban Monitoring</td>
</tr>
<tr>
<td>Automatic Vehicle Location (AVL), Real Time Passenger Information (RTPI)</td>
<td>3. Urban Monitoring</td>
</tr>
<tr>
<td></td>
<td>5. Traffic and Travel Information</td>
</tr>
<tr>
<td>Mechanisms</td>
<td>Packages</td>
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<tr>
<td>----------------------------------------------------------------------------</td>
<td>---------------------------------------------------</td>
</tr>
<tr>
<td>Integrated Transport Control Centre</td>
<td>6. Integrated Transport Control Centre</td>
</tr>
<tr>
<td>Urban Traffic Control*</td>
<td></td>
</tr>
<tr>
<td>UTMC Common Database*</td>
<td></td>
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<tr>
<td>Remote Monitoring System*</td>
<td></td>
</tr>
<tr>
<td>Automatic Vehicle Location*</td>
<td></td>
</tr>
<tr>
<td>Linkages to Neighbouring Authorities and the HA*</td>
<td></td>
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<tr>
<td>Integrated Communications Network</td>
<td>7. Communications Rationalisation</td>
</tr>
<tr>
<td>Urban Traffic Control*</td>
<td></td>
</tr>
<tr>
<td>Traffic Control Centre*</td>
<td></td>
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<tr>
<td>UTMC Common Database*</td>
<td></td>
</tr>
<tr>
<td>Remote Monitoring*</td>
<td></td>
</tr>
<tr>
<td>UTMC Common Database</td>
<td>8. UTMC Common Database</td>
</tr>
<tr>
<td>Traffic and Travel Website</td>
<td></td>
</tr>
<tr>
<td>Media Information Distribution (Radio/TV)</td>
<td></td>
</tr>
</tbody>
</table>

* - Note: Packages 7 and 8 add value and additional benefits by making better use of the mechanisms listed against them. The mechanisms identified with a * would be expected to be delivered as part of other packages listed above.
5.4 Geographical Rationalisation
This strategy covers a geographical area with a mix of both dense urban conurbations and large rural areas. The packages for monitoring and informing will be developed separately for the urban and inter-urban networks. The reason for undertaking such a process is to ensure an appropriate deployment of ITS tools is undertaken to achieve the differing requirements for the networks in these areas.
6 Package 1 – Traffic Signal Control

The Traffic Management Act 2004 (TMA) states that a local traffic authority (LTA) must ensure the “expeditious movement of traffic”. If this does not happen satisfactorily, the government has powers to take over the function of the LTA. Traffic within the TMA includes almost all road users, including; pedestrians, cyclists, cars, buses and commercial vehicles.

Package 1 focuses on the expansion and improvement of traffic signal control encompassing all aspects of the system from the instation computer to on-street equipment, as well as links to external systems, such as bus priority mechanisms. It is expected that improvement to these systems will help HCC meet the obligations and requirements as set out in the TMA.

6.1 Traffic Signal Installations

HH are concerned about the effectiveness and reliability of puffin crossings and following an initial survey and report, wish to undertake further work to recommend the best way forward for the provision of new crossings. There appear to be very few locations in Hertfordshire where puffins deliver worthwhile benefits to vehicles compared to the simple and more reliable pelican crossings. Where puffins are retained, they need upgrading to RMS to improve the detection of faults on street. It is recommended that a supplementary review should be undertaken to compare the findings in Hertfordshire against the rest of England. The review should identify any remedial actions or policies that should be adopted in Hertfordshire. HCC currently have no documented policy in respect of puffin crossings.

HH are currently investigating how pedestrian crossings can be made more efficient to reduce pedestrian waits without adding unnecessary delays when vehicles are present.

Data obtained from Hertfordshire County Council, as of the August 2009, shows that there are 613 traffic signal installations within the county. 118 of these are junctions and 433 are crossings, each controlled and monitored using different systems. 116 junctions and crossing are operated and monitored via Hertfordshire’s UTC with 99 using SCOOT to provide adaptive control.

The two RMS systems supplied by Peek and Siemens, respectively, are configured to provide monitoring of a further 112 installations. 44 of the junctions are operated using MOVA, effectively as standalone nodes with some monitoring and controlled by DUSC. This leaves a total of 22 signalised junctions and 342 pedestrian facilities that are unmonitored and under basic vehicle actuation or fixed time control, which is less than ideal.

Table 6.1 provides a summary of the numbers of traffic control installations, their control mechanisms and identifies if they are remotely monitored.
### Table 6.1 - A summary of the numbers of traffic signal installations, their control systems, and identifies if they are remote monitored.

It is therefore recommended that a programme of upgrades to the unmonitored sites be implemented to allow remote monitoring of the sites, either via UTC or RMS. The sites will need to be prioritised based on their location and the severity of impact on the network should a failure occur.

At present there are 20 junctions under VA control without RMS and a further 30 with RMS; consideration should also be given to the migration of standalone traffic signal junctions from VA to MOVA, which will provide capacity benefits at more congested locations. This would ensure all junctions within Hertfordshire meet the current requirements for new installations, as outlined in section 4.4.3. HH have already decided to implement MOVA controlled crossings on all 40mph and higher speed roads as policy.

#### 6.2 Urban Traffic Control

Currently HCC operate a Peek UTC instation making use of SCOOT for the majority of the junctions that are under UTC control. The platform is due for renewal and a draft procurement strategy has been prepared in readiness for this. The new system should provide capacity for an increase in the number of junctions under UTC.
control. It should also make use of the latest platform and developments in SCOOT to provide the greatest flexibility and maximum benefits in terms of traffic management.

6.3 Remote Monitoring System
HCC operate two RMS instations, one from Peek and the second from Siemens to monitor 105 traffic signal installations. In rationalising the RMS provision in Hertfordshire, there are two options:

- Migrate all traffic signal installations currently monitored via RMS to a single RMS instation. This may require an upgrade of roadside equipment and instation equipment to UTMC compliance and facilitate the use of IP based communications.

- The second option necessitates the installation of a UTMC common database and an upgrade to the RMS instations with a UTMC CORBA adapter to allow the data from both systems to be pooled in one repository for monitoring and action. With this option it would still be prudent to undertake a hardware upgrade to facilitate the use of IP-based communications, such as DSL, GPRS or other wireless bearer.

The expansion of RMS coverage will allow improved fault identification, improved optimisation of junctions, and more efficient maintenance of systems.

6.4 Selective Vehicle Detection and Priority
Traffic signal control installations along bus routes are in the process of being reconfigured to allow SVD and traffic signal priority functions.

Priority is currently only given to passenger transport buses. HCC have trialled alternative modes of operation of SVD for emergency and winter maintenance vehicles to demonstrate the technology. However, it is not cost feasible at this stage to roll out.

The SVD methods used in Hertfordshire are the Peek Prism method at 15 sites, and the Siemens Sietag method at 35 sites. The priority control systems are VA local control, MOVA local control, Siemens RMS and UTC central control.

Vehicle priority control by VA is not ideal for the introduction of priority control and it is recommended that important VA nodes along bus and emergency vehicle routes be identified for upgrade to UTC or MOVA control as part of ongoing refurbishments.

Bus schedule adherence can also be monitored using AVL and buses can be given signal priority to help ‘make up’ time when running behind schedule. Late running buses can be indicative of congestion problems and information gained from monitoring schedule adherence in relation to congestion should be analysed.
There are currently 3 operational rising bollard sites. Also 2 additional rising bollard sites are being implemented by HH, and 2 additional sites are being constructed by developers as part of section 278 agreements.

6.5 Indicative Cost Estimate

6.5.1 UTC

Costs for UTC renewal are detailed in the UTC Procurement Strategy report. Indicative costs are:

- Instation equipment – up to £100,000
- Outstation equipment - £2,600 per unit. For 37 units, plus contingency, this amounts to approximately £125,000.

The estimated total budget for the UTC renewal including consultancy fees and validation and on the basis of re-using existing outstation equipment is approximately £350,000 plus VAT.

6.5.2 RMS

Costs for the expansion of RMS coverage are dependent on the communications infrastructure, hardware and software already available at any given location.

Estimated costs to provide RMS coverage of 356 non-monitored pedestrian sites are as follows:

Indicative Costs:

- £2,600 per OMU
- £250 / annum for maintenance
- £300 / annum recurring costs

Total for 356 sites: £ 1,121,400 (ongoing costs of £ 195,800 / annum)

RMS Migration: Option 2 - £40,000
7 Package 2 – Inter-urban Monitoring

Package 2 is aimed at gathering traffic information on the major links that form the inter-urban network within Hertfordshire. A review was undertaken of the road network as part of the Network Inventory Report. The following links were identified as being the major traffic carrying routes:

Prime Transport Corridors:

- M1 from near Harpenden to near Borehamwood
- M25 from near Rickmansworth North and East towards Cheshunt
- A1 Letchworth towards Borehamwood
- A41
- A414
- A505
- A10

Major Traffic Carrying Routes:

- A1 (M) between Letchworth and Welwyn Garden City, and Hatfield and Borehamwood
- A602 between Stevenage and Ware
- M25 between Borehamwood and Potters Bar
- A505 between Letchworth and Hitchin
- A120 North of Bishops Stortford towards the A10 and Standon
- A1184 North of Sawbridgeworth towards Bishops Stortford
- A414 Hertford Road
- M1 Watford and St Albans/Hemel Hempstead Sections
- A4161 from Hemel Hempstead towards Milton Keynes
- A5183 and A5 from St Albans towards Milton Keynes
- A5183 between Borehamwood and St Albans
- A404 from the M25 through to Rickmansworth towards Pinner

These locations have been identified in the Network Inventory Report and VMS Strategy Report.

There are a number of potential options for monitoring these links, ranging from low cost traffic counter classifier loops through to an extensive deployment of CCTV or automatic number plate recognition camera systems. These tools unlock the
potential to use the data generated for traffic flow monitoring, incident detection, and for monitoring and informing road users of the road conditions ahead at strategic decision points.

This section explores these options to allow an informed decision to be made on the most appropriate solution. It is also recognised that it would be beneficial to have CCTV deployed at major junctions for incident detection purposes.

7.1 Automatic Traffic Counter Classifiers
Traffic counter classifier loops are relatively cheap to install, operate and maintain, but will not provide true journey time information. HCC have 177 in-road automatic traffic counter classifiers, which use inductive loops connected to roadside cabinets to count traffic at strategic locations. In addition to these sites, 67 temporary manual count sites are in operation (sites are identified in Appendix A). HH are working with HCC traffic survey section to increase the number of continuous sites. Initial discussions with the Survey Manager have identified that the main issue is that staff visits to collect data from traffic count sites is not sustainable and data collection needs to be via a communications network. As at present, operatives have to physically visit roadside cabinets to download data to a PDA; this is a labour intensive activity which HCC would like to eliminate.

In addition to increasing the number of permanent automatic sites, HH wish to use signal controllers to provide traffic counts instead of counter sites where possible. Thus there is an inherent independency with the Package 1. The remaining counter sites require upgrading to allow the use of wireless communications to get real time traffic counts. Wireless communications options for automatic traffic counter classifiers include; GSM, GPRS, 3G and radio.

It is recommended that HCC:

- Remove the need to collect data from the roadside and determine the best communications mechanism, e.g. converting existing equipment to 3G, GSM or GPRS, depending on data requirements, connection speeds, etc.
- Prioritise the upgrading of temporary manual count sites to automatic counts, evaluate the requirements for additional traffic count sites and determine their communications requirements.
- Utilise traffic signal controllers to provide automatic traffic count data.
- Review what traffic data is currently being used for, any council aspirations or other potential uses and determine whether additional sites are actually required or if they can be rationalised.
- The overall communications strategy needs to encompass mechanisms used to count and classify traffic.
The HA controlled M25, M1 and A1(M) are monitored through HA MIDAS detectors. It would be beneficial for HCC to be able to consolidate HA data with HCC data to provide more detailed analysis of traffic flows throughout the county. It is recommended that collation of data from the HA is considered as part of the deployment of work package 8, the UTMC Common Database.

7.2 CCTV
The installation of CCTV at critical junctions and strategic nodes on the inter-urban network would allow incidents to be identified and junction performance to be efficiently monitored. Staff in an Integrated Transport Control Centre (ITCC) would be able to monitor congestion and proactively prevent or alleviate traffic congestion by manipulating the traffic signals. Initial suggested locations for CCTV would be on the major road networks in the vicinity of:

- Watford
- Hemel Hempstead
- St Albans
- Hatfield
- Hertford
- Bishops Stortford
- Stevenage

The recommended type of CCTV installation will be dependant on the level of coverage and quality required, as well as the availability of suitable power supplies, communications network and civils infrastructure.

Critical nodes, interchanges and regions requiring coverage need to be scouted and feasibility studies undertaken. As an example a minimum of 7 cameras would be required to provide monitoring of each major link entering the town of St Albans. It is recommended that a detailed analysis, on a location by location basis, is undertaken to accurately determine the extent, requirements and application of CCTV with HCC. These new cameras should be capable of working on the existing central CCTV equipment, as an extension of the existing system.

CCTV systems should integrate with a UMTC framework to allow monitoring and intervention from an ITCC. It would be beneficial to investigate the possibility of utilising HA CCTV camera images and feeding them into the ITCC.

7.3 Automatic Number Plate Recognition (ANPR)
As previously stated, it is not HCC policy to invest in ANPR, however should this policy change, ANPR would allow actual journey times to be measured and used not only as an indicator of network performance, but also for providing information to the travelling public so that they can make informed decisions on route choice. For a basic system each link would need an entry and exit ANPR camera in each direction to measure journey time.
It should be noted however, that there will be a delay in the journey time data equal to that of the last journey time measured. For incident detection purposes intelligent processing can be used to look for large changes in journey time, however, due to the length of some of the monitored links the time taken to detect a significant change in journey time may still be inappropriately high post incident. Thus for incident detection additional ANPR cameras within the link would be required if the alert time is not considered adequate with an entry and exit camera alone.

ANPR is significantly more costly than loop based traffic counter classifiers and due to the length and complexity of links within Hertfordshire a significant number of cameras would be required to provide accurate monitoring. ANPR cameras themselves and the communications infrastructure required to link them are expensive.

However; local boroughs, including St Albans, Stevenage and Watford, already own and operate ANPR enforcement systems in co-operation with the Police. There may be scope to utilise these existing systems by linking to a common database for data collation, analysis and management at an Integrated Transport Control Centre. Hertfordshire are currently working with the police to provide power for mobile ANPR sites. These sites could potentially be utilised for fixed ANPR locations or for powering other ITS tools such as CCTV cameras. These sites should also be evaluated to determine how data is currently being used and whether data from these sources can be linked to the UTMC CDB.

7.4 Indicative Cost Estimate

Automatic traffic counter classifiers typically cost £4,500 - £6,500 per site dependant upon requirements for lane coverage. For example, should the Council identify 40 temporary sites to upgraded to ATCs, then capital cost estimates are £180,000 – £260,000. This does not include the provision of an appropriate wireless communications bearer.

CCTV:

- Approximately £10,000 per site for a PTZ CCTV camera, pole and civils.
- Communications costs between £500 per site for ADSL and £3,300 for low latency 3G, per year

Thus an estimate of 7 CCTV cameras for St. Albans would cost between £73,500 and £93,100. Assuming all seven key urban areas identified above require a minimum of 7 cameras, an indicative cost of £514,500 - £ 651,700 is estimated.

ANPR:

- Approximately £7,000 per site for non-enforcement ANPR camera and pole (excluding processing hardware)
- Approximately £25,000 for a Journey Time Server and £10,000 for an ANPR instation.
Automatic Counter Classifiers:

- Approximately £4,500 per site, thus for approximately 40 new sites the cost for installation and equipment would be in the region of £180,000.
8 Package 3 – Urban Monitoring

It is recognised that traffic managers require visibility of the road network to understand the current traffic conditions and identify incidents with the starting point for deployment being at congestion points within urban areas. The following urban links have been identified as part of the network inventory as problem areas.

Urban Links:

- A1170 Hoddesdon to Cheshunt
- A115 in Stevenage
- A416 Kingshill Way in Berkhamsted
- A411 in West Watford
- A4125 in South East Watford
- A1000 Hertford Road, Welwyn Garden City
- A1000 South of Hatfield to B157
- A409 between A411 and A4140

These locations have been identified in the Network Inventory Report and VMS Strategy Report.

8.1 Bus Time Monitoring (Using RTPI)
Full utilisation of real time information (RTI) from automatic vehicle location (AVL) devices on buses can be used to monitor how well buses are keeping to set timetables. The failure of buses to keep to schedule is often indicative of congestion problems along bus routes.

8.2 CCTV
The deployment of CCTV on all key junctions on the identified congested links will allow greater coverage, monitoring and control of these important links from a centralised location. Operators would be able to monitor congestion and identify incidents allowing the prevention and alleviation of problems and providing quicker resolutions to incidents.

It is recommended that CCTV coverage of congested urban links be prioritised to allow extensive remote monitoring within HCC. This would enable improved incident detection and traffic management capabilities.

8.3 INGRID
The use of INGRID may prove a very cost effective method of detecting incidents. INGRID allows the operator to make enquiries regarding the severity of an incident at a site and take appropriate action. Preset plans and changes of signal timings can be introduced to automatically manage incidents; however it is recommended that
careful monitoring by the operator still takes place to ensure that interventions are suitable for the prevailing conditions.

The expansion of remote monitoring systems coverage is required to fully capture data at traffic control installations. Currently data collected from traffic control installations is often under optimised and not fully utilised. Full optimisation and utilisation of data is needed in order to effectively manage networks within the county.

As further UTC deployment / refurbishment within HCC is already planned, it is recommended that INGRID is used as the primary monitoring tool. At present HCC has 444 VA traffic signal controlled sites spread disparately throughout the county. At present the following modes of operation are used at these key locations:

- **St. Albans**: 36 VA; 3 MOVA; 15 SCOOT UTC; (2 of which are VA controlled junctions)
- **Watford**: 32 VA; 2 MOVA; 48 SCOOT; 10 UTC; (6 of which are VA controlled junctions)
- **Hemel Hempstead**: 40 VA; 1 MOVA; 4 SCOOT UTC; (3 of which are VA controlled junctions)
- **Hatfield**: 11 VA; 4 MOVA; 8 SCOOT; (1 of which is a VA controlled junction)
- **Bishops Stortford**: 24 VA; 6 MOVA; (6 of which are VA controlled junctions)
- **Stevenage**: 10 VA; 1 MOVA; 1 UTC; (4 of which are VA controlled junctions).

HCC should aim to migrate VA traffic controlled signals to UTC in order to achieve better control, co-ordination and throughput of traffic at congested sites. UTC also provides the capability for effective fault management and monitoring. Existing UTC communications links should be made use of to minimise costs and enable expansion from present UTC core regions into new areas.

### 8.4 Environmental / Air / Noise Quality Monitoring

At present Hertfordshire only have 9 Icalert monitoring sites which are located in the following areas:

- **Icalert - A120 Bishop Stortford, By-pass**
- **Icalert - A4147 Hemel Hempstead, Maylands**
- **Icalert - Tring Wharf**
- **Icalert - A505 Lilley**
- **Icalert - A505 Offley Road**
- **Icalert - B1368 Hay Street**
- **Icalert - A119 Stapleford**
- **Icalert - B847 Redbourn, Hemel Hempstead**
• Icealert - Old A10 High Cross

A review of all existing environmental monitoring equipment should be undertaken followed by a feasibility study of areas which require further monitoring. Existing equipment should be integrated into the UTMC CDB.

8.5 Indicative Cost Estimate

8.5.1 CCTV

Assuming all 8 urban links cited above require monitoring via CCTV, estimated costs are as follows:

• Approximately £10,000 per site for a PTZ CCTV camera, pole and civils.
• Communications costs between £500 per site for ADSL and £3,300 for low latency 3G, per year

Assuming that 8 cameras are installed on each link: £84,000 - £106,400 per link.

Total for 8 cameras on all 8 key links: £676,000 – £851,200.

Given the potential costs, there is a clear need to undertake research to validate the feasibility of utilising CCTV. A study should be commissioned to determine the requirements, the extent of deployment, and optimal locations to install cameras.

ANPR:

• Approximately £7,000 per site for non-enforcement ANPR camera and pole (excluding processing hardware)
• Approximately £25,000 for a Journey Time Server and £10,000 for an ANPR instation.

Environmental Monitoring:

• Costs to integrate existing environmental monitoring equipment are estimated to be in the region of £30,000 - £40,000.
Package 4 – AVL / Real Time Passenger Information

The provision of real time passenger information (RTPI) is an important goal in Hertfordshire’s ITS strategy to achieve LTP goals. It will allow real time information to be delivered directly to passengers before and during their journeys. RTPI is a key driver for influencing modal choice and for encouraging residents to switch to public transport. The automatic vehicle location and control (AVLC) system will permit operators to actively manage adherence of bus services to timetables.

A contract for Phase 1 was signed in July 2010 and design work for the project has commenced with INIT UK Limited, a subsidiary of INIT AG GmbH of Germany, for the supply of a central system and equipment for 142 buses.

Since the signing of the contract, the Department for Transport announced changes to the Bus Service Operator Grant (BSOG) which has the potential to change to the scope of the project. The Government is committed to a ‘Smart and Integrated Ticketing Strategy’ with the aim increasing both the coverage of smart ticketing infrastructure and the integration of ticketing on public transport in England.

The Government believes that smart and integrated ticketing can make ticketing arrangements better for passengers, encouraging modal shift away from private vehicles towards public transport; and make more efficient use of existing transport networks and infrastructure.

The Department for Transport has therefore provided an incentive to operators to invest in smart ticketing infrastructure through changes to the Bus Services Operator Grant (BSOG). BSOG will be 8% greater for buses equipped with ITSO smart ticketing equipment, up to a limit of £800 per year per bus. To qualify, smart ticketing equipment will need to accept all English concessionary travel passes. Bus operators would need to provide specific data to Local Authorities and the DfT.

BSOG will change further in future years eventually taking the form of a per passenger payment (subject to the necessary approvals). The new incentive per passenger arrangements will rely on accurate recording of passenger numbers. This will require audited data of the sort that can be best provided through the use of ITSO smart ticketing equipment. The move to per passenger payments will therefore be underpinned by the delivery of this strategy.

As well as smart ticketing, from April 2010 operators also receive a higher rate of BSOG for buses equipped with AVL/RPTI equipment as part of a real-time information scheme, on condition that they make available the resulting data. This equipment and data can be used to deliver real time information to passengers.
The supplier chosen for the AVL/RTPI scheme was able to offer a smart-card capable electronic ticketing machine integrated with the on-board computer that is required for the AVLC and RTPI functionality.

Currently HCC provides 19 scheduled departure systems at busy interchanges around the county. These will be integrated with the RTPI system to show departures in real-time. Additional systems are planned to be installed at other busy interchanges. Information will also be provided to passengers via a live traffic and travel information website, via email and mobile phone.

The initial scope of the system will include:

- Fitting of approximately 142 vehicles with AVLC equipment;
- Deployment of 30 RTPI displays in addition to displaying real time passenger information on existing displays;
- Installation of bus priority at 50 junctions;
- The ability to exchange data with other real-time information schemes;
- A web site and mobile phone application that will provide information for all bus stops in Hertfordshire.

The system has been specified so that in time it will be able to support approximately 480 buses that operate on routes in Hertfordshire, 100 passenger information signs and 150 bus priority locations.

9.1 Indicative Cost Estimate
The scheme has been re-designed post Contract Award to reduce costs. The principal change has been the substitution of trunk radio with GPRS. This has also permitted the deletion of the wireless LAN equipment in bus depots. However additional functionality has been included to enable smart ticketing.

The estimated capital cost including price inflation for the 142 vehicle scheme is £3.47M (including project management and web development cost). Operators will also contribute £1,400 to the cost of the on-board units, thus reducing the capital cost to Hertfordshire County Council to £3.23M. The total capital costs for 142 buses are as follows:

- System Hardware And Software – £1,218,610
- On – Bus System – £1,069,092
- RTPI Signs (30 new plus conversion of existing) – £267,103
- Bus Priority – £131,222
• Communications – £43,439
• Project Management – £745,026
• Operator capital contribution – £198,800
• Capital total – £3,233,133

Revenue costs comprise equipment maintenance and communications carrier costs and will be offset by financial contributions from relevant bus operators of £600 per vehicle per annum. Additional revenue funds accrue due to increased passenger volumes on contracted services.

Progress towards the ultimate scope of the scheme is contingent on the continuation of central government funding of smart ticketing and real time passenger information schemes through the Bus Service Operator Grant. Financial risk analyses have been carried out and several revenue price points have been calculated for differing numbers of buses in the scheme.
10 Package 5 – Traffic and Travel Information

For the purpose of this package consideration has been given only to information delivery to road users via variable message signs. Other forms of information dissemination, such as traffic websites, media broadcasts or in-car devices are considered as part of a wider information provision strategy facilitated by the implementation of a common database and Integrated Transport Control Centre.

10.1 Interurban Variable Message Signs

The provision of driver information at key nodes on the inter-urban corridors would provide the ability to manage the movement of traffic around the county. The signs would be used to display incident and event information with the potential to provide journey time information, where a suitable monitoring system is implemented.

HCC already has developed a VMS strategy, as detailed in the Variable Message Sign(s) (VMS) Strategy for Hertfordshire document. Hertfordshire Council has recognised the importance of the role VMS play in helping meet their LTP objectives.

VMS will help manage and maximise Hertfordshire’s road networks, by providing timely information to road users. They also help reduce congestion and improve incident recovery times by informing road users of divisions away from incidents and directing them to alternate routes.

Strategically located signs should be placed on key routes into and out of Hertfordshire and also on key junctions where information about the status of travel routes can be delivered. The VMS strategy report details proposed locations.

Proximity to Highways Agency managed trunk roads needs to be taken into account. Two-way linkages should be established between the HA VMS system and HCC VMS.

The VMS strategy report estimates that 27 strategic level signs in growth towns are required to provide basic route management; however, it is prudent to provide more signs either as repeaters or to give a greater spread of information across the county. These are addressed as part of Package 6.

In addition to the signs themselves, a suitable control system will be required to set messages on the signs. This control system should have UTMC compliant interfaces, not only to the signs but also to a common database. The former will allow a suitable choice of communications bearer(s) to be chosen, such as GPRS, with the latter facilitating the automated setting and shared control of the signs.

10.2 Urban Variable Message Signs

The priority locations for VMS are the 9 key growth towns as identified in the Regional Spatial Strategy and VMS Strategy Report, these towns are: Bishops
Stortford, Hatfield, Hemel Hempstead, Hertford, Hitchin, Letchworth, Stevenage, Welwyn Garden City and Ware.

The VMS Strategy report identifies that:

- 44 first level VMS are required in growth towns and 17 in other towns. First level signs will provide information regarding road conditions around and through towns to road users on routes into and out of towns.
- 28 second level VMS are required in growth towns and 15 in other towns on lower class roads which experience heavy traffic.

The separate VMS Strategy report identifies specific locations for first and second level VMSs in the key growth towns and other locations.

The VMS strategy identifies 131 locations throughout Hertfordshire requiring the placement of VMS. The type and specification of VMS is still to be identified as further work following on from the VMS Strategy Report.

It is recommended that the actions in the VMS Strategy report are implemented. Given the number of strategic road networks within HCC it is advised that links be made with the Highways Agency and consideration given to adjoining counties in the deployment of any VMS strategy.

10.3 Car Park Management and Guidance (CPMG)

A Car Park Occupancy (Ref – VMS Parking in draft) report has been developed to cover the provision of Car Park Guidance and Monitoring. There are current plans for the provision of 6 VMS in St Albans which will provide both car park and travel information. 5 car parks will submit car park data via ADSL to a VMS control centre in Highways House. GPRS will most likely be used to allow communication between the VMS control system and the individual VMS.

The VMS Strategy Report identifies that Bishops Stortford, St Albans and Watford require extensions to their existing car park guidance and monitoring VMS systems.

New car park guidance and monitoring systems are planned in Borehamwood, Hatfield, Hemel Hempstead, Hertford, Hitchin, Letchworth, St Albans, Stevenage, Waltham Cross and Welwyn Garden City.

The VMS Parking Report estimates that 65 Car Park Management and Guidance (CPMG) VMS will be required.

10.4 Vehicle Activated Signs (VAS)

At present there are 95 VAS within Hertfordshire. The majority of these VAS are speed detection devices which encourage drivers to reduce their speed. One installation detects over height vehicles on the approach to a low railway bridge and a few have been linked to signal controllers on pedestrian crossings to display a warning when the crossing sequence has been initiated.
HH is currently evaluating these VAS to determine the need to upgrade them and to collect site specific and equipment information. The VAS should be integrated in the UTMC common database (CDB) and ITCC, and upgraded where appropriate to meet current standards.

A trial of VAS by TRL on roads in Norfolk, Kent, West Sussex and Wiltshire found that VAS are very effective in reducing speeds and demonstrate a substantial reduction in accidents. VAS should only be deployed where appropriate as per DfT guidelines. Accident black spots and high risk areas should be identified and VAS trialled.

10.5 EPIPs
A programme of annual refurbishments of existing Electronic Passenger Information Point (EPIP) terminals and information screens is planned to ensure the ongoing operation and success of the Herts OnTime system. These refurbishments will also contribute to ensuring that existing screens can be used with the new AVL/RTPI system.

10.6 Indicative Cost Estimate
According to the VMS Strategy for Hertfordshire report indicative costs for VMS deployment are as follows (VAS costs are not included):

131 strategic, first and second level VMS:

- Costs are estimated at £1,048,000 - £1,965,000 assuming each signs costs between £8,000 and £15,000.

- Operations and Maintenance - £750 per sign/year, so allow approximately £100,000 per year if all 131 signs were to be installed.

65 parking VMS:

- Costs are estimated at £520,000 – £975,000 assuming each sign costs between £8,000 and £15,000.

- Operations and Maintenance - £750 per sign/year, so allow approximately £50,000 per year if all 65 signs were to be installed.

A VAS/VMS Framework contract has been let to Dambach UK to install and maintain VAS/VMS within Hertfordshire. Under the framework contract, the following new VAS will be provided early in 2009, provided that the funding can be secured:

- Chipperfield: One VA sign - approximate cost £6,400 (including installation of VA sign and re-location of existing static signage)

- Markyate: One VA sign - approximate cost £5,700 (including installation of VA sign and re-location of existing static signage)
• Berkhamstead: One VA sign - approximate cost £5,700 (including installation of VA sign and re-location of existing static signage)

• Hertford: Two VA signs - approximate cost £15,000 (including installation of both VA signs and re-location of existing static signage)

EPIP Refurbishment:

• An estimated £300,000 will be needed for the refurbishment of EPIPs and display screens over the next 3 years.
11 Package 6 – Integrated Transport Control Centre

The preparation of a business case for an Integrated Transport Control Centre (ITCC) is beyond the scope of this document, however, it is recognised that it forms a keystone in Hertfordshire’s aspirations to manage its network efficiently and effectively. An ITCC will help Hertfordshire Highways meet its Network Management Duty and help HCC comply with the Traffic Management Act 2004. The purpose of this section is to outline the process to be followed and considerations that will need to be taken into account to justify a large capital outlay, with not insignificant revenue implications.

11.1 Requirements Capture
The initial stage of developing an outline brief for a project such as an Integrated Transport Control Centre is a requirements capture exercise. Such an exercise will identify and bring together all the stakeholders that have involvement in the management of the transportation network within Hertfordshire. The purpose of this is to capture all the requirements to establish common themes and ensure that what is eventually implemented is fit for purpose. Likely stakeholders include the Emergency Services, Highways Agency, public transport operators and, of course, the council itself. For example, the ITCC should also house Hertfordshire Highways Partners relocated from the current Amey Lafarge Control room, which deploys HH resources.

11.2 Business Case Development
Once the full scope of requirements has been identified a detailed business case must be developed in order to secure funding and scheme acceptance into the capital programme. As part of this process a costed outline scheme proposal needs to be developed in order to facilitate the assessment of a cost / benefit analysis. Only at this stage can the validity of such a scheme be demonstrated.

It is accepted that it is unlikely that a positive cost / benefit ratio is likely to result from such an assessment for an Integrated Traffic Control Centre (ITCC) due to the complexities of demonstrating monetary benefits. It is, therefore, important that the softer benefits be highlighted and brought to the fore identifying the cost of benefits associated with such gains.

An ITCC would be the hub for proactive transport network control in Hertfordshire. It would provide a centralised location for traffic management and control within Hertfordshire. It would also bring about a range of other benefits, by combing other functions to bring synergies to the operation of the Hertfordshire road network; including the potential to have a 24 hour control centre, a place to issue permits and allowing the Network Management Group (NMG) to function very effectively.
11.3 **Recommendations**

All tools available to operators, as and when they are implemented, should be incorporated into the ITCC. It is envisioned that this would include the following systems:

- UTC
- UTMC common database
- RMS
- CCTV
- RTPI/AVL
- Car Park Management and Guidance
- Environmental monitoring
- Robust communications system

Linkages with the Highway Authority and neighbouring councils should be deepened to enable smooth journeys across urban/inter-urban boundaries. Close co-ordination is essential in order to ensure efficient network management in the future as traffic volumes grow.

11.4 **Indicative Cost Estimate**

Estimated costs for this project include capital (start-up) costs to obtain and fit out suitable premises and ongoing revenue costs for running of the facility.

The costs identified are indicative of likely costs and make the assumption that a suitable building (and hence actual build-out costs) has not yet been identified.

There are four possible solutions with regard to identifying a suitable building:

- Use of an existing building in the property portfolio (the Fire Brigade Control and Resource Control Centre in Stevenage is being made vacant in 2010.)
- Cohabitation with Highways Agency Regional Control Centre (RCC) at South Mimms, subject to sufficient space being available.
- Acquire a lease on a suitable building.
- Acquire the freehold of a suitable building.

Table 11.1 below provides an insight into the indicative costs of an Integrated Transport Control Centre, based on a floor area of around 800m². The full requirements, specifications and costs for an ITCC for Hertfordshire need to be examined in greater detail and are beyond the scope of this ITS strategy report.
<table>
<thead>
<tr>
<th>ITTC</th>
<th>Existing Building</th>
<th>Co-locate</th>
<th>Lease</th>
<th>Purchase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property acquisition and adaptation</td>
<td>500,000</td>
<td>*</td>
<td>500,000</td>
<td>1,500,000</td>
</tr>
<tr>
<td>Infrastructure</td>
<td>450,000</td>
<td>*</td>
<td>450,000</td>
<td>450,000</td>
</tr>
<tr>
<td>Professional fees</td>
<td>300,000</td>
<td>*</td>
<td>300,000</td>
<td>300,000</td>
</tr>
<tr>
<td>Relocation of systems</td>
<td>90,000</td>
<td>*</td>
<td>90,000</td>
<td>90,000</td>
</tr>
<tr>
<td>Sub Total</td>
<td>1,340,000</td>
<td>*</td>
<td>1,340,000</td>
<td>2,340,000</td>
</tr>
<tr>
<td>Optimism Bias (40%)</td>
<td>536,000</td>
<td>*</td>
<td>536,000</td>
<td>936,000</td>
</tr>
<tr>
<td>Contingency (20%)</td>
<td>268,000</td>
<td>*</td>
<td>268,000</td>
<td>468,000</td>
</tr>
<tr>
<td><strong>Total Cost (£)</strong></td>
<td><strong>2,144,000</strong></td>
<td>*</td>
<td><strong>2,144,000</strong></td>
<td><strong>3,744,000</strong></td>
</tr>
<tr>
<td>Revenue Costs (£/annum)</td>
<td>60,000</td>
<td>*</td>
<td>60,000</td>
<td>30,000</td>
</tr>
</tbody>
</table>

* The costs involved with co-locating at a HA RCC such as South Mimms are unknown at present.

Table 11.1 - Estimated cost for an Integrated Transport Control Centre (ITCC).
12 Package 7 – Advanced Communications Rationalisation

12.1 Across all Network Users
The implementation of IT based systems across many service areas beyond transport related applications has led to most local authorities deploying highly developed and geographically widespread communications networks covering most council owned assets, such as council offices. Such assets are often only utilised for specific periods of the day and can be utilised effectively by others bringing tangible cost saving to the authority as a whole. Consultation took place within the council with the Corporate IT department to determine the viability of sharing communications infrastructure.

12.2 For ITS Assets
Hertfordshire is a large county requiring a lot of infrastructure to be deployed across a significant area. The variation of urban and inter-urban areas makes the task even more complex. ITS systems in urban locations are significantly easier to integrate into existing communications networks than in rural areas. Thus differing communications bearers are needed depending on location. For example, inter-urban areas are not usually economically viable to service with cabled communications links, which makes ANPR difficult and expensive to integrate. In these areas GPRS mobile communications are recommended. Traffic loops for example can use GPRS as the data usage is relatively low.

Both urban and inter-urban systems need to be linked to an ITCC so that they can be accessed, monitored and manipulated remotely. For example if the current UTC were to remain located in Welwyn Garden City a communication link to the ITCC would be essential.

The increasing use of IP based communications within UTMC based ITS deployments and CCTV takes ITS into the realm of standard IT network based communications. This coupled with the high cost of leased telecommunications circuits and the withdrawal of support for analogue based circuits that many UTC installations rely on mean that migration is inevitable. Plans are in place for the migration of UTC sites to IP based communications (not including Watford).

The existing wired communications arrangements work quite effectively, however the operating cost of 24/7 EPS42 data lines are high. High cost EPS42 circuits, which only serve one or two sites, are planned to be switched to ADSL.

HCC have developed a communications ‘decision support tool’ to facilitate the rationalisation of communications infrastructure within Hertfordshire.
12.3 Indicative Cost Estimate
The costs to rationalise the communication network will be highly dependant upon the existing network arrangements and solutions that are chosen. Indicative costs cannot be calculated until a decision is reached on the way forward.
13 Package 8 – UTMC Common Database

It is recommended that Hertfordshire deploy a UTMC CDB in advance of the wider ITS strategy to ensure that future developments make full use of the UTMC based architecture. This in turn will help future proof the transport management system.

The UTMC common database will provide the framework into which numerous ITS tools can be integrated to produce a powerful transport system management tool. It will also facilitate the desire for the ITCC, by allowing information sharing across systems and an effective interface for traffic managers. Potential applications which can be facilitated through the implementation of the UTMC CDB, to meet the councils’ objectives include:

- Provide a coordinated, centralised approach to effectively monitoring and manage traffic incidents and congestion in the region.

- A traffic and travel website, which collates and disseminates information from all council owned traffic management systems, as well as from external parties such as public transport operators to allow the travelling public to make informed decisions about when and how they travel.

- Distribution of transport information via the media (Radio/TV).

- Support for the implementation of the Integrated Transport Control Centre, by providing a consolidated, single interface to allow users to be able to incorporate and access all monitoring, informing and controlling tools.

- Enable close co-ordination with adjoining Local Authorities and the Highways Agency to facilitate smooth journeys across urban/inter-urban boundaries.
13.1 **Indicative Cost Estimate**

Table 13.1 provides an indication of the likely cost range for procuring a UTMC common database and adapters.

<table>
<thead>
<tr>
<th>Element</th>
<th>Cost (£)</th>
</tr>
</thead>
<tbody>
<tr>
<td>UTMC Adaptors (£3,000 to £5000 each. It is estimated 8 will be required)</td>
<td>24,000 - 40,000</td>
</tr>
<tr>
<td>Hardware</td>
<td>3,500</td>
</tr>
<tr>
<td>Training</td>
<td>3,500 - 10,000</td>
</tr>
<tr>
<td>Recurring Annual Costs</td>
<td>3,500 - 6,500</td>
</tr>
<tr>
<td><strong>Total (£)</strong></td>
<td><strong>34,500 - 60,000</strong></td>
</tr>
</tbody>
</table>

*Table 13.1 - Indicative cost estimates for a UTMC common database and adapters.*
14 Next Steps and Recommendations

It is recommended that the next steps should be as follows:

- Development of a Deployment Plan for the ITS packages developed within this report
- The prioritisation of work packages
- A detailed design phase to develop these packages into individual projects or feasibility studies.
Appendix A

Traffic count sites and their associated traffic flows within Hertfordshire:

2007 Traffic Flows

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95
Related documents

The ITS Strategy is a Daughter Document to the Local Transport Plan 3 which can be accessed directly via the Herts Direct website:

www.hertsdirect.org/ltp

Further Daughter Documents will be published for consultation in 2011:
- Bus Strategy and accompanying Intalink Strategy
- Rural Strategy
- Speed Management Strategy (the current version can be found under the LTP2 link below)
- Inter Urban Route Strategy

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February 2011