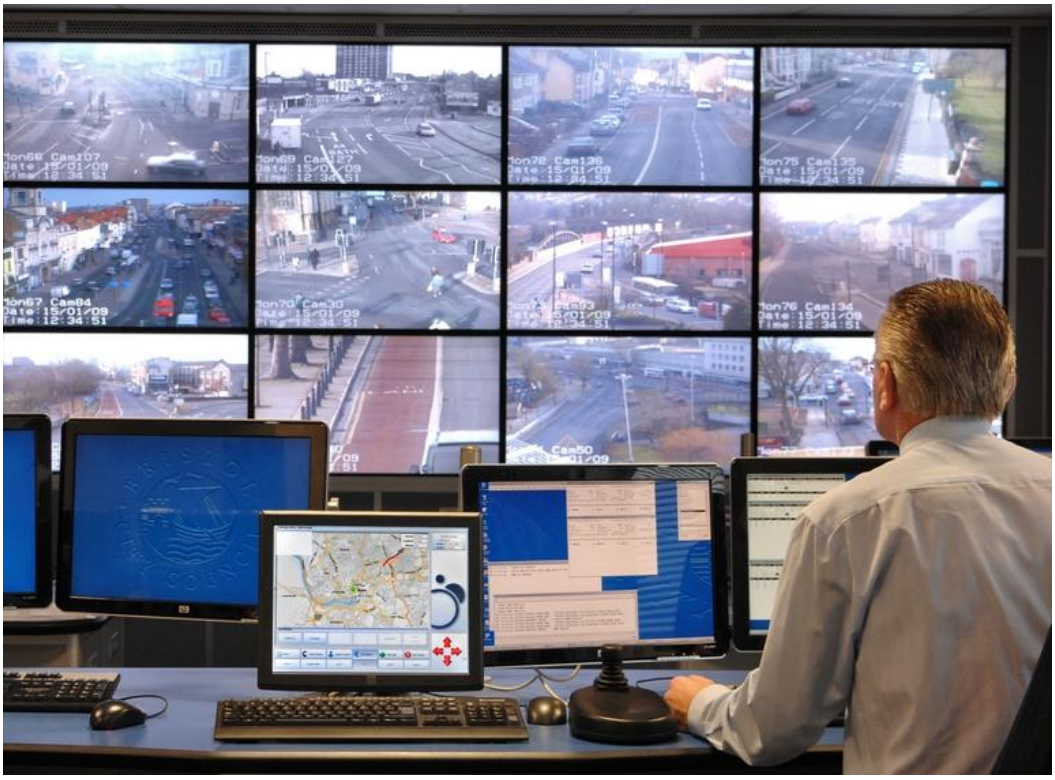
URBAN ITS EXPERT GROUP

GUIDELINES FOR ITS DEPLOYMENT IN URBAN AREAS



TRAFFIC MANAGEMENT

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Abbreviations and Acronyms

Abbreviation	Description
3G / 4G	3rd / 4th Generation mobile telecommunications
AFNOR	National Standard Body
ANPR	Automatic Number Plate Recognition
ASECAP	European association with tolled motorways, bridges and tunnels
BMM	Business Motivation Model
BPMN	Business Process Model and Notation
BSI	National Standard Body
CBD	Central Business District
CCTV	Closed Circuit Television
CEN	European Committee for Standardisation
CVIS	Cooperative Vehicle-Infrastructure Systems
DATEX II	Standard for information exchange (mainly used between traffic management centres& traffic information centres, and increasingly also by service providers)
DIN	German National Standardisation Body
EUROCITIES	Network of major European cities
ERTICO	Intelligent Transport Systems and Services for Europe (public / private partnership)
ETSI	European Telecommunications Standards Institute
GPRS	General Packet Radio Service
GPS	Global Positioning System
HGV	Heavy Goods Vehicle
ISO	International Organisation for Standardisation
IT	Information Technology
ITS	Intelligent Transport System
LEZ	Low Emission Zone
NEN	Dutch National Standardisation Body
OCA	Open Cities Association
POLIS	European Cities and Regions Networking for Innovative Transport Solutions
POSSE	Promoting Open Standards and Specifications in Europe (Interreg. IVC project)
RTPI	Real Time Passenger Information
SBVR	Semantics of Business Vocabulary and Business Rules
SCATS	UTC-based software
SCOOT	UTC-based software

SMS	Text Message
SoaML	Service oriented architecture Modelling Language
TAM	Traffic and Access Management
TCC	Traffic Control Centres
TM	Traffic Management
TMC	Traffic Management and Control
TMP	Traffic Management Plan
UITP	International Association of Public Transport
UPMS	UML Profile and Metamodel Services
UTC	Urban Traffic Control
UTM	Urban Traffic Management
UTMC	Universal Traffic Management Control
V2I	Vehicle To Infrastructure (communication)
V2V	Vehicle To Vehicle (communication)
VMS	Variable Message Signs

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1 Summary

This document outlines how ITS can provide solutions and add value to traffic management policy formulation and operations in an urban environment. Traffic management is a very broad subject area incorporating an extremely wide range of operational tools, many of which are familiar to today's urban traveller (e.g. traffic signals) and some of which are currently still evolving (e.g. vehicle to vehicle communications).

ITS offers a variety of means to manage the road and public transport network in a co-ordinated manner, producing faster and stronger links between the traffic management authority and individual travellers.

The importance of urban logistics within the wider field of traffic management is central to the document. Urban areas are reliant on effective servicing of commercial premises and enterprises for their continuing economic viability. Often there can be potential conflict between initiatives to aid logistics and those to support other policy goals such as environmental zones. ITS have a role to play in co-ordinating and reconciling these apparent conflicts.

There is an acknowledgment in this document that many aspects of ITS are relatively new and can therefore sometimes be a challenging subject area for many people. This document strives to describe technical subject matter in a form of language that is accessible and comprehensible to decision makers, many of whom will have a non-technical background.

Chapter 2 outlines the action that the European Commission has taken in promoting ITS, specifically the production of the ITS Action Plan and Action Plan on Urban Mobility.

Chapter 3 outlines how ITS can aid policy delivery and describes in more detail a wide range of relatively mature ITS applications such as intelligent traffic signal control, satellite tracking of vehicles, CCTV, variable message signs etc. that can be used to manage traffic. Reference is also made to latest developments such as 'cooperative systems' involving vehicle to infrastructure (V2I) communications and vehicle to vehicle communications (V2V) that enable full integration of vehicles in the transport system. The role of ITS in promoting transport safety is also an important aspect of co-operative systems.

Chapter 4 lists the roles of the stakeholders considered as key players for successful formulation of traffic management and urban logistics policies and resulting schemes. It also highlights those agencies which can act as data providers and how data can be most beneficially used to advance ITS schemes. Reference is also made to the desirability for co-operative partnerships, including joint private- public initiatives to further successful implementation.

Chapter 5 describes the impacts that ITS can make on traffic management and urban logistics within an organisational framework that functions on a number of complementary and interconnected levels – policy, tactics, measures and

operations, drawing the conclusion that ITS impacts directly and adds value across each of these levels.

Chapter 6 elaborates on the key factors for success with particular emphasis placed on co-operation, partnership and interoperability. Other issues dealt with include productive project management; organisational issues that need to be addressed; how ITS can be used to provide good quality and targeted information to individual travellers, which, in turn can help to optimise network performance; balancing automated processes with human intervention; and the role of standards and harmonisation.

The recommendations for success are the following:

- The need for effective multi agency co-operation is critical in devising an ITS traffic management project. Any organisation wishing to establish a project should seek the active and productive participation of all relevant organisations, as often ITS projects can be complex and costly to procure and implement in isolation. Political problems associated with policy formulation and project implementation are often more challenging than technical problems.
- Identify, define and allocate those management and project related tasks that are essential to the process of delivering a successful project.
- The most successful ITS traffic management policies, projects and systems are those that are focused on delivering relevant services and information to individual end users. Try to structure projects and channel resources that are bespoke to individual end users. In this way operation of the urban road network will also be optimised.
- The effectiveness of ITS in urban traffic management and logistics can generally be increased by adoption of automated systems which are better equipped than humans to perform basic operational functions. Transport authorities are encouraged to try to identify and select those systems which maximise the potential for automated ITS systems to take on functions such as routine data processing and interpretation, which will allow human participation to be focused at the more strategic level.
- Usage of standards can be beneficial when implementing ITS traffic management projects. Standards are most productively used when they are not onerous but lead to the creation of features such as open platforms for IT technology, which are central to the successful development and future adoption of ITS based traffic management projects. The challenge is to balance the benefits that can be derived from application of standards without those standards being unduly proscriptive and stifling the creativity that ITS solutions can offer.

<u>Logistics</u>

Freight operators face a particular challenge when working in urban areas due to the highway network being at or near capacity throughout much of the working

day, which results in problems in meeting delivery schedules and finding suitable locations to carry out their deliveries. Urban authorities are aware of the potential conflict between projects that they introduce to enhance the environment (e.g. Low Emission Zones and pedestrian zones) and the impact that such initiatives may have on freight operation. ITS has a key role to play in supporting urban logistics, e.g. by identifying priority routing, pre-booking of loading bays, creating and providing operating systems for facilities such as consolidation centres, distribution centres, automated receiving points, which help to reduce the number of larger, more polluting vehicles in city centres and replacing them with smaller, more environmentally friendly vehicles for 'last mile' deliveries.

A particular challenge for urban authorities is to create and sustain a framework which supports logistics, which replicates the support generally given to public transport. Throughout this document there are references and examples relating to urban logistics reflecting its importance in the context of urban traffic management. Emphasis has been placed on the need for decision makers to be mindful of the need to incorporate the requirements of freight operators in policies and projects that they may be introducing.

2 Introduction

Managing traffic in urban areas is a complex, multi-layered and multi-functional process generally involving a range of diverse agencies. In a successful traffic management system each partner will have a clearly defined role, which is distinct yet complementary to those of other partners. ITS can play a key role in supporting and facilitating each partner whilst also being a key technological tool in delivering core output of co-ordinated traffic management policies and projects.

Nowadays, there are a number of challenges lying ahead of the transport system. The idea of a Single European Transport Area, promoted by White Paper for Transport 2011, sets the goals to be achieved by 2050. Transportation has to become more competitive and resource efficient within this time horizon.

The goals for urban transport, in this respect, are to promote usage of sustainable modes; the use of cleaner vehicles and cleaner fuel; to reduce the number of fatalities and incidents. A particular challenge is that the amount of traffic in Europe's urban areas has been increasing inexorably during recent decades. The challenge for people involved in urban traffic management is how best to allocate the scarce resources of road and kerbside space to potentially competing transport modes, within a network that has finite capacity. A more accessible and user friendly public transport system is a key element in urban traffic management. This should also be seen in the perspective of a steady growth in urban population in which mobility is an important asset and should be facilitated as a priority.

Smart technologies and **Intelligent Transport Systems (ITS)**, in particular, have a role to play in achieving the aforementioned goals. ITS can significantly contribute to a cleaner, safer and more efficient transport system, especially in urban areas. The ITS Directive (2010/40/EU) gives the legal framework in order to accelerate the coordinated deployment of innovative transport technologies across Europe. It aims to establish interoperable and seamless ITS services while leaving Member States the freedom to decide which specific systems to invest in.

Two recent European Action Plans include complementary actions on the issue of ITS for urban areas:

- The **ITS Action Plan** (2008) foresees the set-up of a specific ITS collaboration platform to promote ITS initiatives in the area of urban mobility, both people and freight.
- The **Action Plan on Urban Mobility** (2009) foresees that the Commission will offer assistance on ITS applications for urban mobility, possibly in form of a guidance document, to complement the ITS Action Plan.

Resulting from these provisions, the Expert Group "ITS for Urban Areas" was established in December 2010 for 24 months, in order to support the European Commission in its work concerning the aforementioned Action Plans. The Expert Group was multi-modal in its focus, broad in nature and covered the urban region taking into account the interfaces between the urban and inter-urban mobility. Both passenger and freight issues were considered and a dialogue between public and private stakeholders encouraged.

The tasks of the Expert Group have been three-fold: to provide guidance on ITS deployment in urban areas, collect best practices on successful deployment and identify a possible need of standardisation. The group had to develop specific **guidelines** to promote and show the benefits of the use of ITS in urban areas along the individual travellers' mobility chain. The Guidelines, despite the fact that they do not have mandatory character, have the aim to foster interoperability and continuity of services within Europe.

The Guidelines target the organisations in charge of decision making and technical deployment of ITS on local level. For each **key application of urban ITS** a separate document has been issued:

- Traffic and Travel Information
- Smart Ticketing
- Traffic Management

3 Application concepts and context

3.1 How Can ITS Help Decision Makers with Policy Delivery

A critical feature of ITS is the ability it has to deliver significant traffic management benefits often at relatively modest cost. However to achieve this, it is important that policies are adopted with clear goals and definable outputs.

The role of Intelligent Transport Systems (ITS) (NB sometimes 'services' is also included in this definition) is generated from the problems caused by traffic congestion and the development of new information technology for simulation, real-time control, and communications networks, offering the opportunity to address issues such as urban traffic management in an innovative manner. Traffic congestion has been growing as a result of increased use of motor vehicles, population growth, and changes in population density.

Ever increasing urbanisation has led to many larger towns and cities experiencing a level of traffic usage that has seen peak hours spreading from the traditional times of 07.00 – 10.00 and 16.00-19.00 to a situation where roads in the inter peak period of 10.00-16.00 and post peak period after 19.00 are often as congested as traditional peak hours. The result is that road network in many urban areas in Europe is operating at or near capacity throughout most periods of the day and consequently the detrimental effect of congestion becomes greater and the need to mitigate against the consequences of congestion ever more pressing.

Congestion reduces efficiency of transportation infrastructure and has a detrimental impact on travel time and reliability, air pollution, and fuel consumption. Congestion also has a particularly negative effect on the economy and efficiency of distribution services.

Large increases in vehicle use and urbanisation have increasingly put transport policy in the spotlight. Oil will become scarcer in future decades. There is a need drastically to reduce greenhouse gas and NOx emissions in urban areas. Coping with congestion by widely extending road infrastructure is often not a valid option. Promoting independence from oil and creating modern infrastructure and multimodal mobility assisted by smart management and information systems is a challenge. A transport system can be considered as smart if it is capable of dealing with new situations — such as those concerning safety, traffic congestion, or modal integration — by linking all sources of data to produce valuable information for transport users and operators.

ITS include a wide variety of applications in the different modes of transport, for both passengers and the freight industry to help realise broader transport policy goals. This is the case not least in road transport, where ITS applications include electronic tolling, dynamic traffic management (including variable speed limits, parking guidance and reservation, and real-time navigation support), real-time information and other driver-assistance systems such as electronic stability control and lane departure warning systems. ITS can also make it easier to link the various transport modes, for example by means of integrated multimodal

trip planners or tracking services for co-modal freight transport. Such smart transport solutions helping to deal with mobility challenges and meet policy objectives are already being applied across many urban areas of the EU.

3.2 ITS Applications for Traffic Management

There is no universal tool of urban traffic management and a range of applications have been developed over many years. Traffic signals parking controls, pedestrian zones, public transport provision, freight provision and access controls are just some of the typical management applications found in our towns and cities. How the road network is managed can vary greatly from area to area and there will be local, national and international legislation and policies that influence this. National and international standards do apply to some of the management tools used for traffic management, for example traffic signals operate in broadly similar fashion across Europe. However, it is local policy that is likely to have the greatest influence on how urban traffic is managed and effective ITS traffic management needs to fully take into account the needs and expectations of all local stakeholders including residents, businesses and visitors.

ITS have a clear role to play in helping to deliver sustainable transport policy goals at an urban level. Whilst each urban area will have its own transport policies, there is now a considerable degree of uniformity of policy goals to be found in many towns and cities across Europe. The policy goals outlined below are representative of those adopted by many urban areas across Europe:

i) Reduce congestion
ii) Reduce energy consumption and traffic emissions
iii) Improve quality of life in city centres
iv) Increase market share of clean vehicles in private and public fleets
v) Increase efficiency of the transport system
vi) Increase attractiveness of public transport / Encourage modal shift
vii) Facilitate freight delivery and servicing
viii) Enhance road safety
ix) Decrease parking pressure

It is important that ITS is used to support and help deliver clearly thought out and transparent policy goals. ITS can be used to its optimal effect when it is applied within a strategic framework with clear roles distributed among the stakeholders.

Due to an increasing reliance on the private car, urban traffic management is as much about managing congestion as it is about reducing vehicle pollutants and promoting sustainable travel modes such as walking, cycling and public transport. Many of these policy objectives can only be effectively delivered through a well defined urban traffic management strategy supported by an increasing ITS toolbox.

3.2.1 Current Widespread ITS Applications and Technologies

Possibly the longest established ITS application used within the urban environment is **traffic signal control.** Although initially traffic signals did not really include any intelligence, with the advancement in computer technologies junction control has become more sophisticated since the 1980's. Rather than just being a tool that typically separates conflicting movements at an individual junction, microprocessor modules enable modal-based, artificially intelligent, ubiquitous control using data from inductive loops and other detector systems. This has enabled the development of features such as prioritisation of public transport (e.g. through systems that recognise buses, trams etc.) and optimisation of traffic throughput at individual arms of junctions.

Within the urban road network it is often the case that there is a concentration of traffic signal controlled junctions. Central computerised control and management systems enable wider area based network management. When urban traffic control (UTC) systems were first introduced they were based on fixed cycle times allowing linking of junctions to improve vehicle journey times. A further consequence of improved detector technologies and data allows the optimisation of urban regions and areas through UTC based software (e.g. SCOOT and SCATS). **Satellite tracking of vehicles** has existed for some time but mostly used by freight transport operators for their own fleet management purposes. A source of floating vehicle data that may be more accessible to the highway authority is public transport systems such as **Real Time Passenger Information (RTPI)** and systems designed to give private motorists information based on satellite tracking of their route and location. RTPI systems are fundamentally designed to inform users when their next bus/tram/train is due to arrive. RTPI and systems aimed at the private motorist typically use some form of tracking either through GPS (satellite) or DSRC, Bluetooth or GSM (vehicle-to-infrastructure) to identify positioning that can be used to measure delays and congestion in areas of the road network not otherwise monitored.

Access to floating vehicle data and cellular data is a relatively new concept. Where this information is available to the local authority it enhances the view of the urban road network performance and can serve as a source for switching signal programmes to keep traffic flowing in an optimum fashion. In this case, travel time data derived from **probe vehicles** is used to refine traffic signal programmes and could have the added benefit of reducing the need for roadside infrastructure such as local sensors. Cellular data (the tracking of mobile phones) can vary greatly across Europe with some countries allowing it whilst others have legislative restrictions. Cellular data has previously required the co-operation of mobile phone companies and where it is made available no additional roadside equipment is required. However, the raw data often needs to be converted so that it can be used by the highway authority. Bluetooth readers can easily be converted for road side use and the data collected in such a way that it can be used by the urban road authority. This technology is evolving rapidly with the advent of 3G and 4G allowing faster and more precise identification of location of individuals based on their electronic devices. **Automatic Number Plate Recognition (ANPR)** systems for journey time monitoring are widely used in some European urban area whilst again local

legislation in some area does not allow such systems. ANPR is beneficial in identifying traffic location and movement based on vehicle registration plates and has been used productively across Europe. It does, however, tend to be quite labour intensive with significant manual intervention required to verify 'doubtful' vehicle reads.

A tool that enables a visual view of the road network is **CCTV**. CCTV has existed for many years and it is typical to find cameras monitoring the highway network, particularly at critical junctions, linked back to the highway authority traffic control centre. Historically CCTV has enabled the highway authority to view what is happening and intervene through the UTC system based on what is visible. It is often the case that whilst junction specific intervention, based on images received from CCTV cameras will help, it may not be that easy to spread the benefits to the wider road network when incidents and accidents occur. It is preferable to gather a wider range of data sources (detectors, ANPR, CCTV, floating vehicle data, including buses, trams and freight vehicles) and feed these into the UTC system to allow area wide network management to be maintained.

With a wide range of data sources, central control and management systems and strategies, highway authorities are finding it much easier to deal with incidents as they occur. Such developments have also pushed the boundaries on access and control possibilities where congestion and air quality issues continue to persist. **Vehicle detection systems,** as already highlighted, can be used for a variety of purposes from car park management to dedicated parking for just in-time freight deliveries at the kerbside. The potential for ITS to be used to facilitate on-street and off-street parking in urban areas should not be underestimated. Increasingly evidence is emerging that circulating traffic seeking a parking space is a significant contributor to congestion in urban areas. ITS can have a key future role in reducing the negative impact of such traffic by informing drivers of the location of the nearest unoccupied parking space.

Pollution monitors help the highway authority understand the impact of vehicle pollution within the urban environment. Such data fed in real-time into the UTC system can be used to develop strategies that can be implemented to specifically change traffic patterns through signal timings in response to poor air quality.

Variable message signs (VMS) are now common place across larger towns and cities in Europe. Whilst these may be considered to be a tool for delivering travel information to the roadside they are also a valuable traffic management tool. VMS can be used to inform and direct drivers of problems and around incidents when they occur, reducing their impact on the highway network. VMS can also be used to inform on specific reduction in capacity in the network; e.g. when an incident makes it necessary to give priority to public transport or when a major event (sports, exhibition or other) requires implementation of a special parking and traffic management strategy. A further application is to inform the general public on pollution levels caused by traffic.

Through CCTV and ANPR technologies, enforcement is quickly becoming easier to achieve regardless of whether it is undertaken by the police or local road

authority. These tools have made congestion or road use charging an option to achieve a policy of reduced congestion and improved air quality within the largest European cities. **Road user charging** can be challenging to introduce politically but has proved to be very effective in its primary objective in cities such as London and Stockholm of reducing traffic volumes and levels of congestion. **Low Emission Zones (LEZs)** generally aim to improve air quality within a given area by targeting the worst polluters have proved easier to implement. As LEZs directly affect freight operators, their requirements need to be fully taken into account e.g. through exemptions, alternative loading arrangements etc. Revenue raised from access control schemes can also be productively used to further traffic and transportation goals – e.g. in Oslo, revenue from the toll ring systems provides a valuable contribution towards investment in new infrastructure, both road and rail/Metro and running costs for public transport.

Generally urban traffic management initiatives impact all road vehicles. However the strength of the economy of all cities and towns is dependent on business being able to operate effectively. The cost to the economy of congestion and delays is an increasing trend and there is real pressure to improve road based travel. Heavy goods vehicles are a real target for restricted operation, either geographically or by time of day, due to air quality issues and road safety concerns particularly relating to the safety of vulnerable users. Freight traffic does need to be managed separately to general traffic with specific routes, access and delivery facilities likely to be required. Those implementing ITS projects should always be mindful of the need to facilitate city distribution/urban logistics in the Central Business District (CBD).

3.2.2 Evolving Technologies

ITS, by its very nature, is constantly evolving. In the context of urban traffic management development is currently being undertaken on **vehicle-to-infrastructure (V2I)** systems**.** Pilot projects such as the German simTD, with a fleet of 120 vehicles, test and demonstrate the suitability of various V2I systems, amongst them road works information systems, local traffic-adapted signal controls, traffic sign assistants and traffic light assistants. Some V2I data is also collected through extended floating vehicle data to provide updates on weather conditions or the availability of parking spaces. Other examples of pilot projects include research work undertaken by German vehicle manufacturers leading to on-street trials in London, giving drivers information on traffic signal status; the 'Spitsmeiden' project in the Netherlands and the CVIS and related projects that have taken place throughout Europe where communication between vehicle and infrastructure has been a key feature in drivers receiving information about parking spaces, traffic disruption, public transport services etc.

Vehicle-to-vehicle (V2V) technology may still be at the research stage but clearly shows potential to play a significant role in urban traffic management. The capacity for vehicles to communicate with one another, thereby acting as probes or mobile sensors is an exciting concept. The technical interoperability of V2V systems is ensured through the development of standards in the framework

of M/453, initiated by the EU. There is considerable scope for V2V and V2I to play an increasingly prominent role in urban traffic management by providing real time information on location and speed of individual vehicles, with this information being communicated to other vehicles, to traffic signals, traffic control centres and being incorporated in traffic management plans. The information generated can be used in daily decision making which helps to keep traffic flowing. The re-routing of traffic in the case of incidents is important in this respect. The possibility of direct messaging to the navigation systems of freight vehicles will also help to ease the flow of commercial transport.

It is essential that stakeholders involved in initiatives such as V2V and V2I establish and develop productive working relationships with other relevant actors, such as vehicle manufacturers and academic institutions, who are at the forefront of this research. This will be necessary to ensure that traffic management applications flowing from these technologies are fully realised.

Local road authorities often are not in close contact with academic institutions and, particularly, vehicle manufacturers. However, the collaboration of the German regional road authority Hessen Mobil with the automotive industry and various academic institutions can be cited as one practical example of such co-operation in the field of V2V technology. It is highly desirable that the- links between local road authorities, industry and academia are improved. One potential channel may well be the involvement of road authorities in regional and national ITS organisations, who have direct links with vehicle manufacturing sector. Local authority representation on ITS bodies is important in creating and defining an agenda, which furthers the interests of road authorities.

Local road authorities can also influence the development of V2V and V2I in other ways. The roads they control can be an ideal, real life testing ground for new technologies. Offering to host trials can influence how these technologies evolve. Laboratory and off road testing are important but, at some stage, all traffic related technologies need to be tested in a real life situation and urban road networks generally offer the most challenging environment. By hosting technology trials urban authorities maximise their opportunity to influence their development.

Road and telecommunication infrastructure form a key part of V2I technology. Its location and manner of usage should generally be agreed by the local authority, which, in turn, gives that authority leverage over the development process. However, the infrastructure may also be provided by communication suppliers, thereby reducing local authorities' financial input – there is not necessarily a need for the entire infrastructure to be provided by the road authority themselves.

Local road authorities need to be able to gain access to information emanating from V2I and V2V in order to ensure that data arising from these technologies are fully available to the local urban traffic management control system and consequently ensure that these technologies are used to their optimum effect.

4 Stakes and Public Policy

4.1 Identification of Stakeholders

The success of transport policies and traffic management strategies depends to a large extent on local cultural background and mobility practices. Traffic management solutions are often not directly interchangeable between different urban areas or regions. It is, therefore, necessary that they are tailored to local requirements and should be reflective of local priorities and sensitivities. Traffic management requirements often have direct political implications. Thus political decision makers will be fully involved in decision making regarding traffic management strategy and scheme selection.

The formulation, implementation and evaluation of traffic management measures always requires extensive analysis, an essential feature of which is the requirement not only to identify a range of potential project partners but also to articulate the precise role and function that each partner will perform within a given project.

Successful traffic management in an urban area is dependent on efficient and productive partnership working. This is particularly apposite in relation to traffic management projects which are especially reliant on significant ITS elements. ITS features rarely originate from a single source and, even if they happen to, their application is generally beneficial across a range of agencies directly concerned with traffic management provision.

Much ITS data originates in the public sector and many public authorities have taken the decision to release this data free of charge to any legitimate organisation. This has resulted in a proliferation of data source and applications, potentially available for use by the travelling public. The challenge for public authorities is to ensure that the quality of data made publically available is sufficient for the application for which it is intended to be used.

4.2 Stakeholders / Necessary Partners

The list below represents those organisations who could be productive partners in formulating and implementing traffic management policy and subsequent ITS related traffic management projects. The role that each partner could perform is described below:

- **Traffic and Transport authorities and administrations:** Their direct concern is to manage traffic at a local or regional level and they are generally responsible for formulating, publishing and enforcing traffic regulations. They are also generally responsible for providing traffic data in an accurate, appropriate and timely manner. They generally regulate the usage of traffic signals, CCTV cameras, variable message signs etc. and are responsible for implementing measures to enact key policy areas.
- **Police and enforcement institutions:** They can provide real time or near real time information about traffic accidents and incidents. They

generally have expertise in assembling information and data, which can readily inform the decision making processes employed by traffic and transport authorities.

- **Public transport enterprises** at local, regional and even national level. They provide transport services and information about schedules and any perturbations to their published timetables. They can also provide data on their own passenger volumes and sometimes those of complementary modes, e.g. feeder services.
- **Transport industry and transport providers:** These are critical bodies to influence areas such as freight balance, consolidation centre build up. They can provide data that can be used for local area traffic management, including benefits for the use of cleaner vehicles, e.g. electrical vehicles for last mile distribution, when possible. The innovative role that rail can play in freight provision in urban areas should not be overlooked, examples of which can be found in Paris and Dresden.
- **Road / Car park operators:** They can provide information about the capacity, the degree of utilisation, condition of infrastructure, status of dynamic control functions etc.
- **Background information providers:** Publishers of orientation maps, cartographic base maps and other sources of base data.
- **Meteorological information providers:** Weather can have a great impact on travel behaviour, speed and patterns of traffic movement. Accurate weather forecasts can play an important part in reducing the number and severity of traffic accidents and can help to mitigate their impact.
- **Broadcasting companies:** Radio and television companies can act as a highly effective real time conduit of traffic and transport information.

  These channels are now being supplemented by modes of communication based on electronic devices such as SMS texting, twitter etc., which can provide timely one-to-one and one-to-many communications channels.
- **Public and private traveller information service providers:** Providers of in-vehicle satellite navigation devices are also potentially productive partners in traffic management projects, both as sources of traffic data and as channels of communications to their clients about prevailing traffic conditions.
- **Car Sharing and Car Rental service providers:** Providers of car sharing or car rental services can also contribute in releasing data on their car fleet, volume of vehicles on roads at certain times and days (also seasonal data can be useful) and their usage rates, distances travelled, locations etc.

4.3 Additional Discretionary Stakeholders

- **Events' Organisers:** e.g. sporting events, recreational / leisure events, fairs, exhibitions etc.
- **Automotive Industry:** It is essential that organisations and agencies promoting ITS focused traffic management retain and develop links with automotive manufacturers to communicate requirements for in-vehicle communications channels. This is particularly relevant for evolving V2V and V2I technology that is likely to form a core element of future ITS based traffic management.
- **Telecommunications operators sector:** Important partners for reasons similar to those outlined for the Automotive Industry above.
- **Associations representing Freight and Logistics Traffic:** Competition for on-street loading and unloading facilities can often be intense in urban areas. Servicing of retail and business premises needs to be undertaken as efficiently as possible and support from organisations representing the freight industry is beneficial.
- **Emergency Services:** They can be sources of important real time / near real time traffic information but will certainly be users of real time ITS based information to identify locations where emergency intervention is required.

4.4 Other Organisations Which Can Be Productive Partners

- IT infrastructure companies
- Local press
- Organisations representing stakeholders' interests in the field of ITS, urban transportation and traffic management: e.g. ERTICO, UITP, EUROCITIES, POLIS, ASECAP
- ITS community, including national contact points
- Research organisations, universities

It will generally be advisable to seek to involve as wide a range of these organisations as possible. This is important not only to broaden the expertise available to the project but often, as importantly, widening the ownership of a policy or project across more organisations can prove exceedingly beneficial from the perspective of broader political acceptance, which is often a key determinant of success.

Of course, it may not always be possible or practical to gain the active participation of each of these potential partners but even if their involvement is not specifically active, it is worthwhile for as many organisations to have at least an awareness of and passive acceptance of ITS based traffic management projects.

4.5 Role of Partners

4.5.1 Data Providers

Data providers include:

- Infrastructure operators and fee collectors
- Traffic and Transportation Authorities
- Police and Enforcement Agencies
- Transport Enterprises
- Public transport operators
- Fleet managers/Fleet operators (e.g. taxis, public transport, city distribution providers, vehicle manufacturers, navigation device providers).
- Private companies (telecom, media, motorist representative bodies etc.)

The main area of expertise of each of the organisations listed above is not necessarily data generation or collection. However each of them does generate or have access to discrete data streams which can help to provide a comprehensive picture of traffic operation in any given area.

4.5.2 Data Content and Usage

The quality, robustness and appropriateness of data originating from different sources, will vary considerably. There is a clearly defined role for data cleansing and data fusion in order to ensure that data is of the requisite quality and is in a form which can readily be used for (real time) traffic management purposes. Benchmarking and calibration processes are beneficial in helping traffic management practitioners decide on the quality of data that they receive and will facilitate the process of defining the content and form of data presentation that is used in communicating with and informing travellers.

The challenge is to manage the procurement and consequent usage of the data in a co-ordinated fashion. Not only will qualitative decisions have to be made with respect to the choice of data to be procured, there is also a challenge in how this data is then presented to travellers in a way that optimises usage of the network.

As the highway network (and public transport network) in urban areas often operate at or near capacity, any disruption (e.g. an accident) can have a disproportionately significant impact. In the event of an incident or accident it is important that each traveller receives information that is individually targeted as far as possible and is bespoke to their specific circumstances.

It is necessary to evaluate the sources of data available, make a judgement as to their accuracy and pertinence – sometimes traffic volume figures can be extrapolated from data of relatively low observed traffic flows. Data integrity will need to be comprehensively assessed to allow participating organisations to decide whether and how it can be meaningfully used in managing traffic in the urban environment.

5 Impacts of ITS on Urban Management and Urban Logistics

ITS can offer significant added value to urban authorities in the field of traffic management. This ranges from conventional traffic flow management to urban access management, public transport management and urban logistics. The effectiveness and efficiency of conventional traffic management that has been deployed for decades can be augmented and enhanced by ITS, using features such as information and communication technology together with automation, new approaches of modelling and simulation and (technical) interoperability.

Traffic management encompasses several levels (as suggested by the KAREN[1] framework architecture), and ITS based traffic management supports all levels; i.e.

- Transport **policy level**: High level objectives are set that influence the quality of life, living and working conditions, etc.;
- Traffic control **tactical level**: Rules and control scenarios are set according to local conditions;
- Traffic control **measures level**: Explicit measures are defined for each scenario and optimal working points are specified;
- Traffic control **operation**: Defines technical equipment.

For each level the main value provided by ITS can be formulated as follows:

5.1 Support Policy Objectives

Examples of high level policy objectives are outlined in Section 3.2 above. These objectives can be valid for the whole city area or for specific sectors of the urban area. ITS offers tools and methods that readily facilitate policy goals being realised effectively within a limited amount of time.

5.2 Support the Tactical Layer

The tactical layer focuses on creating the local framework within which traffic is managed. Scenarios are created in accordance with policy objectives, taking into consideration the capabilities of ITS supported traffic management. The scenarios can be valid for the whole city area or for certain sections of selected roads only. Examples aiming at the above approaches are:

[1] "Keystone Architecture Required for European Networks"; In September 2000, the project delivered the first version of a European ITS Framework Architecture. This represented the effort to produce a European ITS system architecture, requested by the High Level Group on road transport telematics, and approved by the European Council of Ministers and funded by DGXIII as part of the 4th Framework Programme.

- **Demand management (i)**: A charge is imposed to access the CBD in order to reduce absolute traffic numbers and shift private car journeys to public transport, reduce congestion, improve the city accessibility and reduce pollution.
- **Demand management (ii):** A low emission zone could be introduced for heavily polluting vehicles; green vehicles will generally be granted easier access to the city centre and to parking facilities.
- **Traffic flow harmonisation**: Using traffic signal control in the event of unsustainable levels of congestion, weather conditions or specific major events that lead to adverse traffic conditions and/or emission thresholds being exceeded; shift congestion through queue relocation from highly populated areas to less densely populated or less traffic sensitive locations.
- **Parking Management and Commercial delivery services**: Offer parking and loading bay management in order to avoid unnecessary circulating traffic seeking unoccupied loading / unloading facilities.
- **City access alternatives**: Offer bicycle- and pedestrian options in combination with public transport; enhance the attractiveness with inform/book/pay services on interoperable communication platforms and navigation and information systems.
- **Casualty reduction**: Adoption of tactics aimed to deliver a safer urban road network through increased communication with road users via Variable Message Signs, radio and electronic devices, enhanced real time information and in the future V2V communication.

5.3 Support Traffic Control Measures- How ITS Can Help to Implement Identified Policies

Once the scenarios are determined, explicit traffic control measures can be planned and deployed. This is where ITS and supporting technologies play a major role, making the measures effective, efficient and interoperable. Examples relating to the above scenarios are:

- **Traveller advice**: In an urban environment evidence points to journey time reliability generally being more important than speed. ITS can add value by making the traveller (motorist and public transport user) better informed; giving people journey options, suggesting alternative journeys based on real time situation; for this to happen, the system needs to be able to communicate directly with the individual and be directly relevant to the individual – e.g. potential for using Satnavs, mobile phones etc. as communications devices. In the future this application will be strengthened by the development of V2I and V2V. Those devices could even be used in a reciprocal manner – as probes or sources of floating

vehicle data, making each vehicle a contributor to a common operational traffic picture. ITS offers these capabilities not only for the consumer using private transport but also for public transport, by giving passengers an indication of the arrival time of the next bus/tram/train etc.

- **Enhancement of public transport**: ITS can be used to give pre-emption to public transport at traffic signals. Using transponder technology, public transport vehicles can reduce brake/acceleration cycles, maintain reliable travel times and generally enhance performance in comparison to private cars. Other examples include enhancing the design and consequently attractiveness of public transport interchanges, including Park and Ride.
- **Low Emission Zones**: Restricting the access to urban areas for polluting vehicles can be achieved by driving bans or charges. Both work effectively with fully electronic vehicle registration at the zone boundaries by means of licence plate cameras and/or transponders. Environmentally friendly vehicles can be readily distinguished automatically from conventional vehicles. LEZs can be used to grant incentives as a means to increase their market share. Furthermore, ITS can be used to forward information about eventual dynamic access restriction schemes to travellers.
- **Congestion Charge**: Journeys into or within a designated zone are automatically registered without the need for vehicles to change speed or use dedicated lanes. ITS not only reliably registers accessing vehicles and subsequently classifies vehicles appropriately but also helps to manage the back office procedures such as customer relation management, payment or violation treatment. The design of a Congestion Charge system should take into account the necessary flow of commercial vehicles.
- **Modal Priorities**: The need for predictable flow for public transport and freight transport is important. These transport categories should be given priority over private transport.
- **Green waves**: Co-ordinated traffic signalling can be used to harmonise the traffic flow at congestion or pollution hotspots, reducing the stop-and-go-cycles and consequentially the emissions along the harmonised stretch of road. By using actual environmental measurement data, harmonisation could be made dependent on the actual pollution situation and hence does not distort the traffic system.
- **Parking space management**: Vehicles seeking parking spaces can significantly add to congestion in urban areas. ITS can have a significant role to play in reducing this impact by directing vehicles to unoccupied (off-street or on-street) parking spaces – by use of information and communication technology and satellite technology. This can be used for both informing drivers about available unoccupied parking spaces, booking of spaces and payment of the resulting charges. Authentication and identification technologies can be used to give registered vehicles access

to car parks. Similarly Park and Ride operation at transport interchanges, rail stations etc. is a complex operation that can greatly

- **Loading Bay Management**: Registered vans & lorries may book loading bays in advance, ensuring that capacity is available at the desired time-slots. Satnavs can be used for driver notification and roadside sensors to confirm the legal use of the loading bay and to detect violations in a fully automated operation. Sometimes it may be desirable to extend delivery periods to off peak times including nights.
- **Freight Consolidation Centres**: To maximise the potential of Consolidation Centres as an important urban logistic facility, ITS should be used for 'last miles' deliveries. Efficient urban logistics will help city centres to thrive and help promote them in the competition with larger, 'out of town' shopping centres, which are generally car based.
- **Incident Detection**: Traffic hot spots can be monitored automatically for early indications of severe disturbances; a common operational picture can be introduced, helping traffic managers to resolve disturbances in a timely fashion. ITS can facilitate vision and real time management of the traffic network for traffic managers. A prime example is CCTV camera coverage which is a key ITS tool. ITS is at its most efficient when it minimises the level of human intervention at low level, which can be expensive and time consuming. ITS systems which automatically recognise unusual patterns of movement and flag these up to traffic managers can be particularly helpful in this respect.
- **Targeting accident hotspots:** For instance at locations with high cycling accident records; Sensors can be used to detect the presence of cyclists in cycle lanes who are waiting for a green traffic light. This information can be used at accident hot spots to alert particularly HGV drivers by variable message signs and detector systems to give them better awareness of cyclists near their vehicles.
- **Improvement of Fleet Control Systems**: Freight companies require accurate information about the location of their vehicles in order to plan delivery schedules and make optimum use of vehicles. Development of GPS /DSRC type devices will aid freight this aspect of freight operation.

5.4 Support Traffic Control Operation

The technological baseline of ITS on the operational level consists of sensors, actuators, communication media (wireless and wired), software, handheld devices, human machine interfaces, data, maps, algorithms, models and many more. Technological innovation takes place at this level; sensors get smarter, algorithms get faster, equipment gets cheaper and less power consuming. Innovations continuously offer new opportunities at the measures level, the

tactics level and the policy level. The goals of these levels will determine exactly how the technology is used.

The matrix below summarises and illustrates the sections 5.0-5.4 and offers a cross-referencing of ITS importance for Transport Policy Objectives, Traffic Control – Tactical Level and Traffic Control – Measures Level.

TRANSPORT POLICY OBJECTIVES	TRAFFIC CONTROL - TACTICAL LEVEL	TRAFFIC CONTROL - MEASURES LEVEL
Reduce Congestion	-Demand management (i) - Traffic flow harmonisation - City access Alternatives	- Congestion Charging - Incident detection - Parking space management
Reduce energy consumption / emissions	- Demand Management (ii) -Traffic flow harmonisation - City access alternatives	- Green waves - Enhancement of public transport
Improve quality of life in cities	- Demand management (i) and (ii) - Traffic flow harmonisation	- LEZs - Congestion Charging - Enhancement of public transport
Increase market share of clean vehicles	- Demand management (ii)	- LEZs - Congestion Charging
Increase efficiency of transport system	- Traffic flow harmonisation	- Traveller advice - Green waves - Parking space management - Incident detection
Modal Shift / Increase attractiveness of public transport	- Demand management (i) and (ii) - City access alternatives	- Traveller advice - Enhancement of public transport - Lane priorities
Facilitate freight delivery & servicing	- Commercial delivery services	- Loading bay management -Parking space management - Freight Consolidation Centres - Improvement of Fleet Operations Systems
Enhance road safety	- Casualty Reduction	- Incident detection -Targeting accident hotspots -
Decrease parking pressure	- Demand management (i) and (ii)	- Parking space management - Loading bay management - Freight Consolidation Centres

NB: In addition to the three levels contained in the table (Transport Policy Objectives; Traffic Control – Tactical Level; Traffic Control – Measures Level), ITS also operates across a 4th level; Traffic Control – Operational Level, where the range of ITS operational tools outlined in Section 5.4 are commonly applied to projects aimed at delivering the full range of policy objectives described in the left column of the matrix.

6 Key Factors for Success

6.1 Co-operation, Partnership and Interoperability

A key factor in implementing a successful ITS based traffic management project is actively involving and gaining ownership from as many appropriate partners and stakeholders as possible. It is not desirable to formulate an ITS based policy or to undertake an ITS project in isolation – buy in from a range of stakeholders serves to broaden the political acceptance of an ITS policy or project, adds technical value and generally greatly facilitates acceptance and implementation.

Urban areas are often too small on their own to use ITS to its optimum effect, The majority of trips do not stop at historically defined city or administrative boundaries. From the user perspective the whole transportation network is considered as one entity. Motorists (and public transport passengers) often travel between different highway / traffic authorities even on relatively local journeys, generally without the travellers themselves either knowing or caring that they are crossing administrative boundaries.

Widening the range of stakeholders centrally involved in traffic management policy formulation / development and project implementation can often serve to broaden their geographical area. Regional / sub-regional traffic management policies and projects are usually preferable to those in single, stand-alone urban areas.

Individual local authorities often do not have the administrative processes in place to develop ITS policies or procure the necessary ITS services for traffic management projects simply and efficiently. A disproportionate amount of time and staff resources can be spent on the procurement process if an individual authority is acting is isolation. This can be mitigated by partnership working, whereby a number of potential client authorities can combine together to formulate a procurement process, which has currency across a wider geographical area and across a wider range of potential client authorities.

Partnership working is particularly important for local authorities if they wish to influence the development of evolving technologies such V2V and V2I. Active participation and partnership with vehicle manufacturers and academic institutions through ITS regional and national organisations offers a means of achieving this.

The technical barriers to formulating an ITS based traffic management policy and implementing ITS traffic management based projects tend to be easier to solve than the associated administrative / political barriers. Politicians / decision makers tend to be elected for cycles of four to five years and this timescale tends to set the parameters for the decisions that they take. For this reason it is important that the advocates of ITS based traffic management policies and projects should highlight the short and medium term benefits in addition to longer term benefits.

Against this background one of the main current challenges is not only to overcome historical barriers between "highway" and "urban" road operators, but also between "individual" and "public" transport and between public authorities and private organisations. In this way "cross-border continuity" of ITS services becomes possible, which leads to the intended additional benefit for the conurbational, inter-regional and cross-border intermodal user. The key issue for this desired continuity of ITS-services is **interoperability.**

Interoperability also has direct advantages for the traveller as it provides scope to provide information and traffic management systems to the traveller in a uniform and co-ordinated manner. There are also economies of scale that can be achieved through interoperability, benefits from which can be experienced by both the service provider and end user.

The concept of technical interoperability across ITS policies and projects in different regions should be encouraged to allow ITS to realise its full potential in delivering effective ITS based traffic management.

Annex A outlines a theoretical structure for an ITS based traffic management project, across which interoperability is a key element at all levels, whilst Annex B gives an example of an Inter Agency organisational model.

Recommendation: The need for effective multi agency co-operation is critical in devising ITS based traffic management policies and subsequent project implementation. Any organisation wishing to establish policies and projects should seek the active and productive participation of all relevant organisations. Political problems are generally more challenging than technical problems.

6.2 Essential Tasks for Successful Delivery

The tasks outlined below form a template that can be used to formulate a cooperative, regionally focused, ITS based traffic management project. It goes without saying that successful project delivery leads directly from application of policy goals such as those outlined in Section 3.2 above.

This list is not intended to be proscriptive but to indicate those actions that usually need to be carried out;

1. Form a steering group representative of partner bodies to carry out a feasibility study.
2. Select pilot-partners and pilot-projects and create a draft work programme.
   Present it to selected stakeholders.
3. Establish expertise that each selected partner can contribute.
4. Collect basic data

a) Build a regional, intermodal reference system

b) Create an urban data set

5. Design a final programme and present it to stakeholders,

6. Gain support and ownership from stakeholders for the programme. Identify funding bodies and raise public awareness.

a) Include a sustainable business model in programme.

b) Complete the reference system and the basic urban traffic data set.

Make reference system the fundamental information source for all administrative processes.

7. Implement some fundamental administrative and traffic information processes.
8. Add further partners and processes to programme as appropriate.
9. Continuous review, monitoring and refinement of project. It is particularly important that impacts assessment of ITS are included in this process. Many local authorities are relatively new to the client role in relation to ITS and it is crucial that the benefits arising from ITS implementation are fully recorded, understood and conveyed to opinion formers and decision makers. This is critical in creating a virtuous circle that shows the benefits of current ITS provision and helps to influence future decisions about ITS based policies and projects. A common impacts assessment would be especially beneficial in terms of project evaluation and EU project POSSE (Interreg IVC) could prove to be a useful tool for impacts assessment.

It is generally more practical to work initially with supportive partners and let practice convince the others. Some of the steps outlined above can be undertaken simultaneously.

Recommendation: Identify, define and allocate those tasks that are essential to the process of policy adoption and successful project delivery.

6.3 Targeting Individuals to Optimise Network Performance

In order to formulate successful ITS policies and subsequent successful project delivery, it is critical that accurate information is conveyed to the individual traveller in a timely fashion.

Urban network management can be interpreted as a collective concept as people move around in large numbers, many of whom have similar journey origins and destinations, travelling at similar time of day etc. However when viewing the total journey chain, e.g. from home to work location, it becomes clear that each journey is individual, generally comprising a unique pattern of modes and interchanges. ITS can play a play a key role in synthesising communal / general

information, applying it and making it relevant and comprehensible to the individual traveller.

Individual travellers, whether using private, public or freight transport, almost invariably carry electronic devices, which can act as a medium to convey real time traveller information. Feeding real time traffic information to motorists' navigation devices and public transport users' mobile phone type devices is a prime example of a potentially readily available means of communication with individual travellers.

The challenge for those formulating an ITS based policy or implementing an ITS based traffic management project is not only to tailor travel information to individual travellers but also to ensure that the information that is conveyed to individuals aids the overall management of the network. In urban areas highway networks often operate at or near capacity at peak hours and, in many larger cities, throughout much of the working day. The challenge for ITS providers is to provide bespoke information to individuals, which also takes into account the manner in which the network operates. For example if an incident takes place, which results in a route becoming congested, rather than informing all motorists to take the same alternative diversionary route, which in a urban area could then become very congested itself as a result of the diversion, the most intelligent use of ITS would be to give different messages to different users so that some are advised to take diversionary route 'a', others advised to take diversionary route 'b' and others advised to remain on the original route. In this way ITS will achieve the optimum balance between the needs of the individual traveller and the efficient operation of the network.

Similarly public transport information targeted at individual users will help to optimise network performance by balancing supply and demand more closely.

Recommendation: The most successful ITS traffic management policies, projects and systems are those that are focused on delivering relevant services and information to individual end users. Try to structure projects and channel resources that are bespoke to individual end users. In this way operation of the urban road network will also be optimised.

6.4 Maximising ITS Potential / Minimising Human Intervention at Operational Level

A successful ITS traffic management policy or project should aim to limit the amount of human intervention at basic operational level as this tends to be costly and often time consuming. The role for humans should be focused at a strategic level determining policy and managing processes.

For example camera coverage of traffic and highway networks in urban areas is often comprehensive with many city authorities having a proliferation of roadside cameras that are used to facilitate management of the road network. The challenge for camera operators and traffic managers is to identify which of the often numerous cameras they should view and what action they should take in order to optimise the performance of the network.

ITS techniques such as video analytics are helpful in detecting unusual patterns of movement captured by roadside cameras, sensors, loops etc. These can be used to draw the attention of the camera operator to specific locations where intervention would be beneficial in expediting traffic movement. Currently there is still an element of human intervention inherent within this process but ITS has the potential to offer a wholly automated operational system, which, for example, would introduce a given traffic plan when particular patterns of vehicular movement are detected.

Future development of V2I and V2V systems should also result in the introduction of automated processes, many of which will be carried out in real time or near real time. Their advent will increase the role and relevance of ITS at operational level in urban traffic management.

Recommendation: The effectiveness of ITS in urban traffic management and logistics can generally be increased by adoption of automated systems which are better equipped than humans to perform operational functions. Try to identify and select those systems which maximise the potential for automated ITS systems to take on functions such as routine data processing and interpretation, which will allow human participation to be concentrated at a more strategic level.

6.5 Standards and Harmonisation

Standards and harmonisation are important in delivering effective ITS traffic management projects. They serve to improve the quality of a project and enhance the concept of interoperability. However it is important that standards are used in an appropriate manner in an urban project, as being overly proscriptive could limit technical innovation and undermine the EU subsidiarity principle, which is important in an urban context.

Specifically in the area of Traffic Management the rationale to establish and use standards are quite different.

- Rationale for regional "standards": Reducing procurement costs for field devices and fostering innovation

  Some manufacturers have established a de-facto monopoly situation by providing silo systems for traffic management. Due to missing standardised interfaces of the central systems, field devices have to be procured from the same vendor in order to be connected to the centre ("vendor lock-in"). The resulting absence of competition and lack of exposure to market forces not only leads to high price levels, but also hinders innovation since new, innovative companies are denied access to the market.

- Rationale for supra-regional "standards": Networking centres and enabling data exchange

Networking existing Traffic Management systems and creating new Traffic Management services require interoperability and data exchange from centre to centre. On supra-regional and international level, centre-to-centre data exchange is a mandatory prerequisite for continuity of services. The major benefit of centre-to-centre communication standards therefore lies in the networking capabilities and interoperability of subsystems from different operators and manufacturers. Reducing cost is less important here since the cost of central facilities such as accommodation costs, computing costs, monitoring facilities, software etc. are usually only a fraction of the overall cost of a traffic management system, which would consist of Traffic Management and Traffic Control Systems (e.g. loops, signal controllers, cabling, VMS signs etc.)

Creating interoperability does not nullify the importance of specification or even standardisation of components of ITS Services. This is crucial since each modification (enlargement, modification, new procurement etc.) of IT infrastructure should be based on existing (local, national) or market-available products (protection of investment). Furthermore an approach that stipulates adherence to a rigid standards and harmonisation protocol could well be expensive and time consuming. A key element of a productive approach to standards and harmonisation is the creation of an open platform for ITS services. This allows the advantages of technological interoperability to be captured and applied, whilst allowing individual authorities to maintain autonomy in deciding the precise platform(s), form of technology and services that they wish to use, thereby avoiding potential vendor lock in.

Initiatives such as Universal Traffic Management Control (UTMC) have created open standards and specifications for system to system data exchange. This has led to the creation of an integrated network strategy tool enabling better highway network management and incident detection and response. Open Traffic Systems City Association (OCA) has created an open specification for traffic signals and detector data exchange with the UTC system which offers similar advantages to UTMC. A key feature of UTMC, which broadly operates in cities in English speaking countries and OCA, which broadly operates in cities in German speaking cities, is that they both provide an open platform for progressive traffic signal control. Not only can they each provide a platform for urban traffic control in their own right but urban road and traffic authorities also have the opportunity of interworking the two systems by selecting features of each to meet their own requirements, whilst retaining a common open operating platform. Annex C gives more information about specific standards that may be beneficial when implementing ITS based traffic management projects.

Recommendation: Usage of standards can be beneficial when formulating ITS based policies and implementing ITS traffic management projects. Standards are most productively used when they contribute to the creation of features such as open platforms for ITS technology, which are central to the successful policy formulation and project delivery.

7 Further Information and Contacts

7.1 Best Practices collected within the work of the Urban ITS Expert Group

The Urban ITS Expert Group has collected in a special report a variety of Best Practices. In the area of Traffic Management following Best Practices are presented:

AT – Graphs Integration Platform (GIP) for Austria
CH – Basel - MCH Logistics tool
DE – Munich - Tram and Bus Priority at Traffic Signal, "Green Waves"
DE – Berlin - Inner City Logistic
DE – Stuttgart - Integrated Traffic Management Centre Focuses on Collaboration and Information Sharing
DE – Munich - Public Transport, Information Management System
DE – Cologne - Intermodal Transport Control System for Public Transport
DE – Leipzig - Public Transport Traffic Control and Passenger Information
DE – Intermodal Transport Control Systems for Public Transport
DE – Implementation of ITCS for 250 Light Rail Vehicles and 80 Buses
DE – Networking of Intermodal Passenger Travel Information and Real-time in Public-Transport (ITCS/RBL/FIS/ABF/RBL-Light etc.)
DE – Stuttgart - RBL Light, Intermodal Transport Control System
DE – Dortmund – Public Transport, ITCS/RBL
DE – Logistic V-Info, Professional Tour Planning Information
EL – Online Portal for Transport Data/Content Management and Transportation Services Provision
FR – Lyon - Grand Lyon Urban Traffic Management System (CRITER)
FR – Paris - Passautocar (Coach Parking Pass)
DE – Düsseldorf – Dmotion, Cooperative Traffic Management in the Metropolitan Area of Düsseldorf
IT – Bologna – SIRIO
NL – Rotterdam – Park & Ride Pricing Strategy for Target Groups
NL – Rotterdam -. Truck Parking in Residential Areas
NL – Rotterdam - The Traffic Enterprise (De Verkeersonderneming)
NL – Urban Freight Energy Efficiency Pilot (Helmond Freilot)
NL – Rotterdam - Havenbedrijf (Port of Rotterdam Authority)
NL – Spitsmijden, Avoiding Rush Hour
NL – Brabant – Spitsmijden,Avoiding the Peak
NO – Oslo - Economic Evaluation of an ITS-Based Toll Collection
SE – Gothenburg - Motorway Control System
SE – Gothenburg – ITS4 Mobility
SE – Gothenburg – Attractive Travel Service
UK – Urban Traffic Management & Control (UTMC) Open System Integration
UK – London: Urban Road User Charging
UK – Bristol - Environmental Road Pricing
UK – London - The Low Emission Zone (LEZ)
UK – Leicester - Traffic Information Service Database / Smart Ticketing

7.2 Contact Information

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Traffic Management Guideline - V4.0 - 20121116.docx

ANNEX A - Interoperability at an Organisational Level

Interoperability is not restricted to technical aspects of a traffic management project. Interoperability should be established on all levels of cooperation and collaboration of co-working organisations and their technical system. The following picture - called ITS-pyramid[2,3]- is helpful, as it represents all layers of an ITS service where interoperability has to be established:

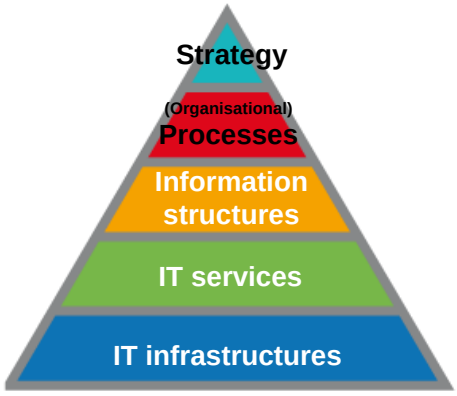

Figure 1: ITS service metamodel

The basic structure of the five layers from top to bottom are described as strategy, processes, information structures, IT services, IT infrastructure.

- The **strategy layer** describes the long-term (visions), and the medium-term objectives (missions) of an ITS service, i.e. the benefits of the ITS service. The strategy is closely related to the business model of an ITS service.

  Interoperability requires: Tailoring the specific strategy of the involved organisations/bodies to the scope of the targeted Traffic Management /Logistics service.

- The **process layer** describes the actions of actors within their business processes and their day-to-day behaviour. Role models enable transferability by providing an abstraction from concrete organisations. Typical ITS service roles are: content owner, content provider, service provider, network provider. Typical role characteristics connected with a specific behaviour are for example public, private, external stakeholders. If networking requirements between actors are defined for the purpose of exchanging information or to act on a common basis (for example as part

[2]FGSV-Forschungsgesellschaft für Straßen und Verkehr 2011, Methodische Empfehlungen zur Entwicklung einer IVS Rahmenarchitektur für Deutschland

[3]EasyWay 2011, EasyWay Deployment Guidelines 2012, Methodological approach to ITS Service harmonization, Version 01-00-01

of a cross-regional or cross-border ITS service), then this is first form of a process description.

Interoperability requires: Development of a cooperation and collaboration model for the involved organisations/bodies.

- The **information structure layer** deals with information that is generated by or processed in (business) processes. Information logistics, i.e. the collection and presentation of information and its distribution to relevant places where it is applicable can only be specified if appropriate information structures are mutually agreed by all stakeholders.

  Interoperability requires: Development and use of uniform ITS service information and domain models (e.g. DATEX II profiles)

- The **layer of IT services** (note: not to be mixed up with ITS services) describes the IT services which have to be available to enable business processes to be "executed" and to implement the agreed information models. It focuses on the question: "How do the functions interact/ communicate with each other (specification of interfaces and data exchange mechanisms)?”. The IT sector has developed proven and robust technologies to provide an abstraction from implementation details, e.g. the Service Oriented Architecture (SOA) approach. Ideally, applications use such an abstract, reusable service mechanism to deliver their functionality.

  Interoperability requires: Development of consistent, harmonised IT service specifications and implementation (e.g. DATEXII protocols)

- The **IT infrastructures layer** describes IT systems needed to ensure the execution of IT services and networking. In the Internet age, the execution of services can happen "somewhere" and is not bound to one specific place. An exception is the IT infrastructure for the delivery and presentation of information to users (terminals).

  Interoperability requires: Networking of the IT infrastructures used to implement ITS Services and the specification of devices that are capable of presenting/displaying information in a harmonised manner to end users. Within the internal structure of the ITS-service IT infrastructure itself is not part of interoperability considerations, maybe with the one notable exception of the presentation of user information on collective and individual devices (Common Look and Feel).

ANNEX B - Inter Agency Organisational Model

In the case of different parties with different roles - both public authorities and private organisations - being involved in providing an ITS-service the development and application of sustainable organisation models becomes crucial. The organisation and the roles of the parties must be clearly defined. That means the service architecture becomes more important:

Traffic management services – beneath the end user - can be deemed to have four main actors necessary for the entire supply chain. These are:

- Data providers
- Content providers
- Service operators
- TCCs - Traffic Control Centres / Service providers

The information and the revenue chain is indicated in the Figure below;

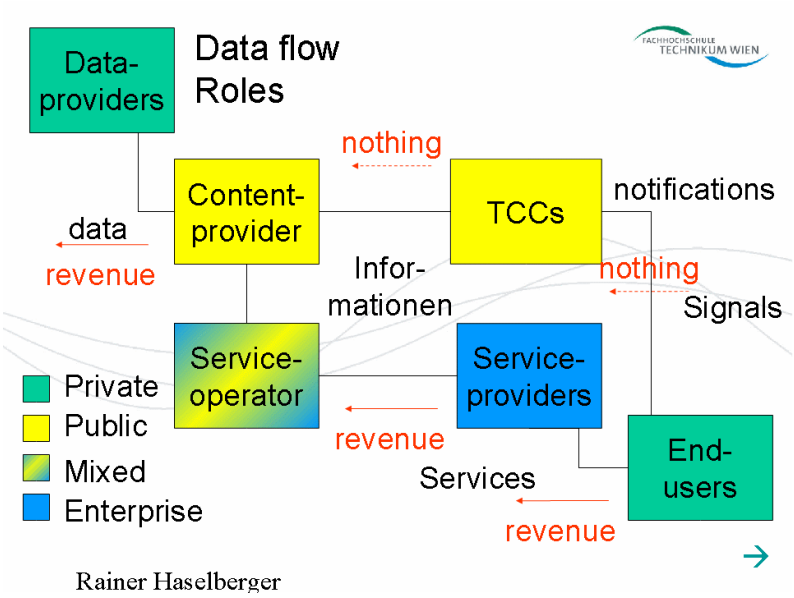

Figure 2: Urban Traffic Management value chain

Addressing key organisational issues

As a general principle, any equipment that is dedicated to a certain partner should be provided and operated by that partner, e.g. roadside equipment by the highway authority; station equipment by the rail operator etc. However

there is generally much core equipment which must be jointly procured or towards which the public sector should contribute for shared use.

Key issues for the model to address include:

- What will the implementation cost be? Who will fund which elements?
- Who contributes to procurement of which assets? Who owns the assets – hardware, licences etc?
- Who owns the data? Who may use the data and for what purposes? Can the data be passed on to anyone and, if so, should this be free of charge?
- Who provides the staff, office space and office services? Whose staff contributes time and advice? Is this contribution financially recognised?
- Who will fund long-term operations?
- Who receives income from services and how is this conveyed to the contributors?
- How and in which configuration should the service be generated?
- Which roles are necessary and by which organisation/partners they can be covered?
- How is the division of work organised?
- Which interfaces and which workflows have to be defined?

It is not possible to define a unique organisation model even for similar services, due to the diverse nature of the services, which are usually defined by local political and operational conditions. Every ITS service has to develop an organisational model to suit its own requirements.

ANNEX C - Standards and Harmonisation (further information)

In order to facilitate the introduction of ITS based traffic management projects, it is recommended that adjustments of existing specifications and already existing ITS service solutions, should be utilised.

This means in detail:

- Creation of a common understanding among the involved parties of:
  - the long term and mid-term objectives as well as the benefit of ITS-Services (strategy)
  - the (rough) functional structure of ITS Services (functional requirements)
  - the (rough) organisational structure of ITS Services (organisational requirements)
- Harmonisation of:
  - the visualisation of information to road users, in some cases also for system operators (Common look & feel)
  - the criteria for assessing the quality of ITS Services from the perspective of road users (level of service quality)
  - technical standards, available or required, beneficial for implementation (technical requirements)

Use of exiting and proven standards can be advantageous

Wherever possible use of existing and proven standards should be encouraged:

- in the service planning and preparation phase → descriptive standards
- in the service deployment and operation and evaluation phase →technical standards

Descriptive standards

The preparation, planning and deployment and operation of traffic management services usually takes place in a situation when completely different organisations and persons from diverse backgrounds have to form a working group which is obligated to cooperate and collaborate for the common strategic goal to create a successful ITS-service.

In this strategically based situation the selection and use of appropriate descriptive standards become crucial. They not only offer well defined linguistic framework but commonly agreed and proven concepts. This helps to provide an objective framework within which projects partners can work.

The following list contains certain standards that could be very useful for strategic considerations.

Title
Business Motivation Model (BMM) Specification; OMG dtc/07-08-03
Business Process Definition MetaModel; Volume 1: Common Infrastructure Version 1.0; OMG Document: formal/2008-11-03; http://www.omg.org/spec/BPDM/20080501
Business Process Model and Notation (BPMN) OMG Document: formal/2009-01-03;
Bon; Service strategy based on ITIL v3- A Management Guide; Van Haaren Publishing, 2008
MDA Guide Version 1.0.1; OMG Document: omg/2003-06-
Information Technology – Open Distributed Processing – Reference Model: Overview ; International Standard ISO/IEC 10746-1:1998(E)
Semantics of Business Vocabulary and Business Rules (SBVR), v 1.0; OMG Document: formal/2008-01-02; http://www.omg.org/spec/SBVR/1.0/PDF/
Service oriented architecture Modelling Language (SoaML) – Specification for the UML Profile and Metamodel for Services (UPMS); Revised Submission; OMG document: ad/2008-08-04
Reference Architecture for Service Oriented Architecture Version 1.0; Public Review Draft 1, 23 April 2008; OASIS Open; http://www.oasis-open.org
Reference Model for Service Oriented Architecture 1.0; Committee Specification 1, 19 July 2006; OASIS Open; http://www.oasis-open.org
Software & Systems Process Engineering Meta Model Specification v.2; OMG Dokument:formal/2008-04-01; http://www.omg.org/spec/SPEM/20070801

BMM and SBVR are suitable for general goals and objectives. The SPEM standard is recommended for the general deliberation of processes. The debate on services is currently subject to great fluctuations, particularly against the Cloud background.

Technical standards

In contrast to linguistic and conceptual standards which aim to improve consensus between organisations and persons, technical standards pursue technical and economic goals.

Technical standards[4]:

- Enable interoperability of systems/services
- Encourage innovation, foster enterprise and open up new markets for suppliers
- Create trust and confidence in products and services

[4] Johan Hedin, Liaison between CEN/TC278 & Urban ITS Expert Group, presentation in the frame of Urban ITS expert group

- Expand the market, bring down costs and increase competition
- Help to prevent duplication of effort
- Support greater confidence in procurement
- Facilitate interoperability of system component suppliers

Technical ITS standards are very diverse, ranging from ISO TC204 on global level, which is responsible for the overall system aspects and infrastructure aspects of ITS to CEN/CENELEC and ETSI standards on European level, which describe data models, from the abstract to concrete and from simple to complex. The more modern ones form a uniform package of data models or exchange format specifications with an integrated service interface.

The standard bodies for ITS started their work in 1992:

- Global level:
  - ISO/TC 204 – Intelligent Transport Systems
  - ISO/TC 22 – Road vehicles
- European level:
  - – CEN/TC 278 – ITS standardisation.
  - – CEN/TC 224 – Personal Identification
  - – CENELEC/TC 226 – Road equipment
  - – ETSI TC ITS
- National level
  - National standards bodies: NEN, DIN, AFNOR, BSI, etc
- Coordination between CEN/ETSI/EC through ITS-CG
  - Intelligent Transport Systems Coordination Group

For further information see:

- CEN/TC278:
  - http://www.itsstandards.eu
  - CEN/TC278 Brochure
- ISO/TC204:
  - http://www.tiaonline.org/standards/secretariats_tags/iso_tc204/index.cfm
- ETSI TC ITS
  - http://portal.etsi.org/portal/server.pt/community/ITS/317