INSTANT
Contract for Design Services

D504 – Final Report (Implementation Strategy)

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Preface

The European Commission (EC) has provided funding to the National Roads Authority (Republic of Ireland) and the Department for Regional Development (Northern Ireland) Roads Service for staged Scoping, Feasibility and Design Studies regarding the implementation of Intelligent Transport Systems (ITS) on the Dublin to Belfast corridor. This report is the Implementation Strategy proposed by the Design Study.

The objectives of the INSTANT project are predicated on enabling the delivery of pre-trip and on-trip information to the end user, and the development of enhanced traffic management capabilities in the Traffic Control Centres in Dublin and Belfast. Fundamentally this requires the gathering of data, moving it between systems and processing it. Within the Design Study pilot demonstrations of suitable methods of data exchange using the internet and the development of a common location referencing based on the European Broadcasting Union TPEG methodology have taken place. Continued development and use of this methodology is proposed, with the possibility of moving to a subscription based service in the medium-long term.

The level of available data for current conditions on the corridor is low. To overcome this problem, the report makes specific recommendations for defined levels of deployment (based upon the research of other EC projects, notably STREETWISE and VIKING) of on-road infrastructure, dependent on traffic conditions in the ten year period to 2014 for:

- Traffic and Meteorological Data Collection and Incident detection;
- Verification of conditions using CCTV and the possible use of Highway Patrols;
- Dissemination technology (Variable Message Signs); and
- Control and Management Technologies for traffic management, enforcement and control centre development.

The strategy has proposed options for the communications for implementing this infrastructure. Wherever possible, deployment of the technology should be part of road construction schemes. A spreadsheet based cost model has been produced.

With a baseline deployment of data acquisition schemes in place, the deployment of information services is possible. Work during the Design Study has set up a portal web site www.instanttravel.info bringing together existing sources of information across modes and across the border. Further development, giving the portal XML functionality is proposed. Data conforming to the XML schema (format) defined can be used by and sourced from third parties. The development and use of password protected extranet services for subscribing “members” e.g. broadcasters to access CCTV pictures, VMS settings etc is also encouraged. Use of the XML enabled portal is highlighted as the possible basis for automated dissemination of information on travel information radio. The report proposes that low cost, low power localised Highway Advisory Radio is a feasible option; and that in the medium to long term development of TPEG-DAB (digital radio) should be chosen rather than RDS-TMC services for national travel information via broadcast radio.

The Feasibility Study made recommendations for NRA and RS to become “ITS Champions” and lead the institutional framework to deliver INSTANT. The Design Study Report expands upon this and makes recommendations for the organisation of stakeholders meetings and the required technical monitoring. It provides guidance to NRA and RS on how best to deliver their roles and responsibilities.

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Executive Summary

Introduction

The INSTANT corridor between Belfast and Dublin is the most important economic artery of the island of Ireland. The governments of each country continue to make massive investment in new infrastructure. By 2007 the route will be motorway or high standard dual carriageway throughout. More than 40% of road and rail traffic on the corridor is making end to end journeys between the two cities. A sizeable proportion is freight headed for ports and airports and bound for Great Britain or mainland Europe.

Road traffic growth in both the Republic of Ireland and Northern Ireland is above the EU average. This is giving rise to significant problems within the city conurbations. Traffic density and flows at either end of the corridor are far greater than those on it. Around the world road administrations have turned to Intelligent Transport Systems (ITS) as a way of addressing similar issues. In many situations the deployment of ITS systems will be led by the needs of the city regions. However, the strategic importance of the Belfast-Dublin route requires that its users should be provided with a level of ITS service similar to that expected elsewhere on the Trans-European Road Network (TERN) of which it forms a part. Thus the inter-urban road authorities, the National Roads Authority (NRA) in RoI and Roads Service (RS) in NI), with the support of the European Commission DG-TREN have chosen to consider this in detail within the INSTANT project.

The INSTANT vision is about creating a multimodal traffic management and information system involving the best appropriate technology for the cross-border corridor. Specifically the consultancy commission to produce this report has been geared to the provision of:

- Pre-trip information tool(s);
- Creation and dissemination of on-trip information;
- Various levels of traffic control and management.

In the Feasibility Study carried out in 2001/02 the potential technologies and methodologies for realising the vision for INSTANT were set out. The Design Study has taken this forward to define what should be implemented to deliver the level of service required.

The INSTANT Corridor

Work of the Design Study

The Feasibility Study made the following recommendations:

- Creation of national ITS Organisational Frameworks led by Roads Service and National Roads Authority as "Champions";
- A series of core technical projects to standardise on common location referencing, data formats and data exchange between the two authorities. This would also facilitate the development of a core information resource for Travel Information Services such as web sites and RDS-TMC, and provide a "sink" for multi-modal information from other parties (e.g. air and sea departures / arrivals);
- Improving the already high levels of control and management systems in the Belfast area, and extending them south towards the border;
- Consolidation of the Dublin City Council Traffic Control Centre as the corridor control centre in RoI;
- A series of projects to implement Variable Message Signing, traffic and incident management and monitoring on a localised basis;
- Highest standards of Traffic Signal control and monitoring to be provided;
- ITS installation to be co-ordinated with road construction / improvement wherever possible e.g. the design and construction of the Cross Border route; and
- Progress Feasibility Study to Design Study stage.

To take these recommendations forward the Design Study has been active in five areas:

1. Consideration and expansion of the concepts for Institutional and Organisational agreements and operations to support the roll-out of the INSTANT strategy.
2. Determination of a programme of on-road and control centre infrastructure provision and the triggers for justification of implementation of deployment packages at three levels of increasing equipment density over short, medium and long timeframes to 2014.
3. Researching Data Exchange and System Architecture requirements and subsequently implementing a pilot demonstration and creating a location referencing methodology.
4. Examining the scope for the provision of Travel information Radio – research in the Feasibility Study stage showed that users feel that this is the most trustworthy and reliable way of receiving on-trip travel information.
5. Research into and provision of a web portal to provide travel information about the corridor and onward connections, and as a potential conduit for the provision of XML data to and from other information applications (e.g. radio, third party operations).

The ITS Context for INSTANT

ITS on the INSTANT corridor cannot be isolated from the management and strategies of the traffic control rooms in Belfast and Dublin. Their existing motorway and urban traffic control systems are the main driving force for the current types of system and on-road deployment. INSTANT systems should either expand on their capabilities or point the way for upgraded performance. What is different about the corridor systems is that they will be, by and large, monitoring; informing (including at arms length through web sites); usually automated unless by exception when there is an incident or planned event. There are technical issues regarding the best communications solutions and the distribution of intelligence (all at control centre, or with some on site?). INSTANT should also be a catalyst for wider deployment throughout the road networks of Northern Ireland and the Republic of Ireland.

Once clear of the main city conurbations the INSTANT corridor runs through areas of low population density. The maritime peripherality of Ireland means that the corridor is regarded as either a route in Ireland, or part of an inter-modal route out of Ireland to the rest of Europe. It has no function as a

European diversion route, nor is it likely to attract great numbers of users external to the island of Ireland because of its high standard of infrastructure. All this means that current levels of ITS – information gathering and provision, emergency service response, fixed data quality (e.g. location referencing) is far below the standards envisaged by the TEN-T Expert Group on ITS for Road Traffic Management when they reported on guidelines and strategic priorities for ITS on the European Road Network in April 2000[1].

Taking this baseline the following SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis can be carried out for ITS on the INSTANT corridor:

Strengths	Weaknesses
Road Administrations have strong awareness of ITS and its potential benefits. Suitable existing control rooms Traffic Control Room Experience gained from urban/peri-urban systems Vast experience across Europe to call upon	Little or no ITS on corridor means third parties unlikely to develop value added services until significant data is available reliably Lack of existing information channels outside conurbations Emergency Service not electronically linked into the ITS infrastructure at present
Opportunities	**Threats**
Existing Systems available that could be expanded along the corridor “Clean sheet” for design on corridor Able to use latest technology	Institutional framework (other than RS/NRA as “ITS Champions”) could delay delivery if not set up Lack of human resource at right levels in right organisations under the right contract conditions to deliver strategy. Too much or too little ITS provision delivered for the conditions resulting in public distrust of information delivered

Across Europe there is developing a wide ranging impetus towards standardisation and interoperability. In the time frame of the INSTANT Strategy the Galileo satellite location system will be launched and is expected to be the cornerstone of many ITS services including active navigation and lorry charging. The floating vehicle location data that could be available has the potential to revolutionise the monitoring of Europe’s highways. Mechanisms such as TPEG-DAB (Digital radio) receivers will become standard fit in-vehicle items enabling content-rich geographically and directionally targeted information to be delivered directly to the driver. Public transport data for journey planning, real time data and fares will be easily accessible electronically.

The driver from Germany, Italy or France will expect similar levels of advice and information in their car wherever they are, and their vehicle will be of a generic European specification. INSTANT is therefore important in that it will help realise a generic EC level of service on a TERN route, and help develop seamless ITS service as a whole in RoI and NI.

Putting this into practice - Infrastructure

Without collecting data, information cannot be processed or provided, either to road users or to control centres and emergency services. If information cannot be provided, third parties have nothing on which to build services. So, deploying ITS infrastructure is fundamental. But this raises the question as to what degree, and to what benefit? Over the last decade various research has been published around the world that recommends the package approach. Here a number of appropriate technologies are concurrently installed bringing greater benefits than piecemeal deployment of the individual technologies.

Other research has been undertaken in the EC TEMPO Programme in the VIKING and STREETWISE projects to classify routes within a hierarchy of three or four levels of ITS they should contain. This is based on the traffic flows they carry, and factors such as meteorological conditions they experience

[1]europa.eu.int/comm/transport/themes/network/ english/its/pdf/report%20final%20final.pdf

(e.g. snow, fog). STREETWISE has introduced the concept of a “Category P” for strategic, but not necessarily highly trafficked routes such as the Dublin-Belfast corridor.

In INSTANT the work has been adapted and taken further to consider a level of service based on the normal and peak hourly traffic flows. As well as considering the general efficiency (i.e. throughput/effective capacity) of the route, it has also taken into account the potential benefits to be gained in terms of safety (i.e. accident prevention) and mobility (i.e. reliable journey time and or delay information).

The “Levels” of ITS deployment and the traffic conditions that determine which is appropriate is summarised in the table below.

			Column A	*Column B*	*Column C*
	Safety ▶	Accident Rate ▶	Low	Average	High
	Mobility▶	Congestion ▶	None/Minor	Some/Moderate	Major
	Efficiency (Throughput) ▼				
	AADT/lane ▼	Peak ▼			
Row 1	<8000	<1000 v/l/hr	Level 1	Level 2	Level 2
Row 2	8K-15K	1000 -1800 v/l/hr	Level 2	Level 2	Level 3
Row 3	>15000	>1800 v/l/hr	Level 2	Level 3	Level 3

A simplified table of the deployment technologies and densities is given in the table below:

Technology	Level 1	Level 2	Level 3
Traffic Monitoring sites	Every 5km	Every 2km	Every 500m = AID system
Meteorological sites	Every 20km. Levels of technology may be increased, e.g. to include pollution monitoring sensors		
CCTV	Known problem locations only	As Level 1 + Key interchanges	80-90% coverage of route
ANPR + Journey time VMS *	Every 15-20km	Every 8-10km	
Strategic VMS	Single sign at decision point	Signs at decision points, possibly in pairs	
Communications	Low speed data network (e.g. GPRS)		High speed WAN (e.g. fibre backbone)
* Journey Time VMS only implemented when NRA/RS are satisfied base data is robust			

The levels of deployment and the technological options are discussed in detail within the main report and the appendices. At the detailed design of Implementation Stage some decision will have to be made about the exact technology e.g. loop or above ground detection, analogue or digital CCTV. In Appendix D the potential communications options are discussed.

It must be made clear, however that this methodology does not propose a single ITS scheme for the corridor. The levels of deployment methodology should be regarded as a slide rule. In Deliverable D501 the “Level 1 Implementation Strategy” for the lengths south of Sprucefield, across the border from Newry to Dundalk (where implementation is planned as part of the road upgrade schemes), and the Dublin Airport – Swords section are examined. Defined schemes to Preliminary Design level taking into account the local conditions are presented, in much the same way as the Feasibility Study envisaged.

The deployment methodology does not preclude the installation of other technologies such as ramp metering, weight in motion sensors and speed control warning and / or enforcement cameras. Each will need to be considered on its own merits. The Institutional arrangements proposed allow for annual updating of the conditions rating for points along the corridor and the introduction or detailed investigation of individual localised schemes as necessary.

The INSTANT Implementation Strategy is based upon the provision of core services for Traffic Management and Traveller Information Services, defined in the brief for the project and also from analysis of KAREN architecture considerations undertaken in the Feasibility Study. However, it is essential, not only for courtesy and institutional reasons to consider policing, in particular the concept of equipped Highway Patrols as a potential part of the Strategy. Research from the US has indicated that there are significant cost benefits to be gained and that they are popular with the public.

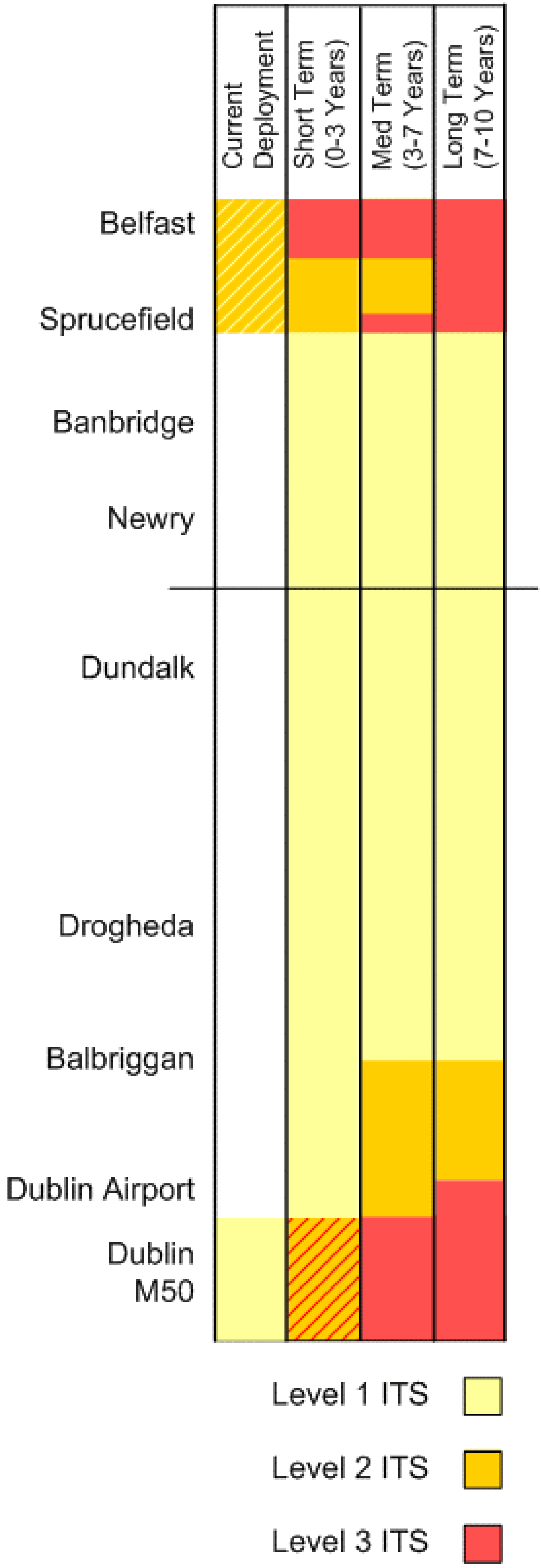
Where to deploy?

The diagram opposite shows the proposed levels of deployment throughout the corridor. North of Sprucefield and south of Dublin Airport are also subject to other schemes outside of the INSTANT remit. The approach is holistic, determining the minimum level of deployment along the corridor. A cost model using kilometerage of deployment at a certain level has been produced.

As can be seen, there is minimal ITS over large sections of the corridor at the present time. This means that the equipment deployed to provide a minimum of Level 1 coverage by 2007 will, in the majority of cases need to have either new instation control systems, or require modification or expansion of existing systems.

To handle the large amounts of data being collected it is proposed that each control centre is equipped with a "common database" (or datastore). This system would take raw data from the various sub systems (traffic monitoring, ANPR etc.) and convert it into a common format. The common format would describe each piece of data using the same geographical referencing, relate all events to a common timeframe, and be able to be processed to provide an overall view of current conditions, or predicted conditions based on stored historical data. This last functionality is described as the INSTANT Incident Manager and is envisaged as a richly featured GUI (Graphical User Interface) able to present information on maps, show trends, send out alerts and warnings, and potentially act as a fault management interface.

Creation of the common databases is the central action in enabling data exchange between control centres, emergency services, and public facing information outlets. Everyone using the INSTANT systems can be considered to be using the same map, with the same key and have all the clocks synchronised.



Putting this into Practice - Information Data Exchange

The infrastructure described above and the collation of data within the common database will allow travel information to be disseminated to the end users by the TCC's through VMS, but also through other systems, some operated by third parties.

Anything set up to cover the INSTANT corridor must be able to involve any potential source of information / data, for example, public transport operators, Information providers (e.g. AA Roadwatch), and radio broadcasters. Standardisation of how to add information to the "data pool" through the definition of published XML schema will make this easier to implement.

There are two approaches to information dissemination:

A Here is the raw data we have: **- this is the format it is in** **- use it how you want** **- but with these conditions**	**B Here is the information we have created from the raw data:** **- use it how you want** **- but with these conditions**
This is the method to be used by the most trusted entities, i.e. within and between control centres. Further processing will be necessary to make sense of the data Security and responsible use need to be ensured End-users may be able to control some functions	This is the method to be used to provide third party information systems, or control centres that require pre-processed information Levels of security and access may be set: • some information may be public domain through a web-site • some information may only be available via password protected areas Some users may want information pre-processed in a particular way before they will purchase information XML schema can simplify the process

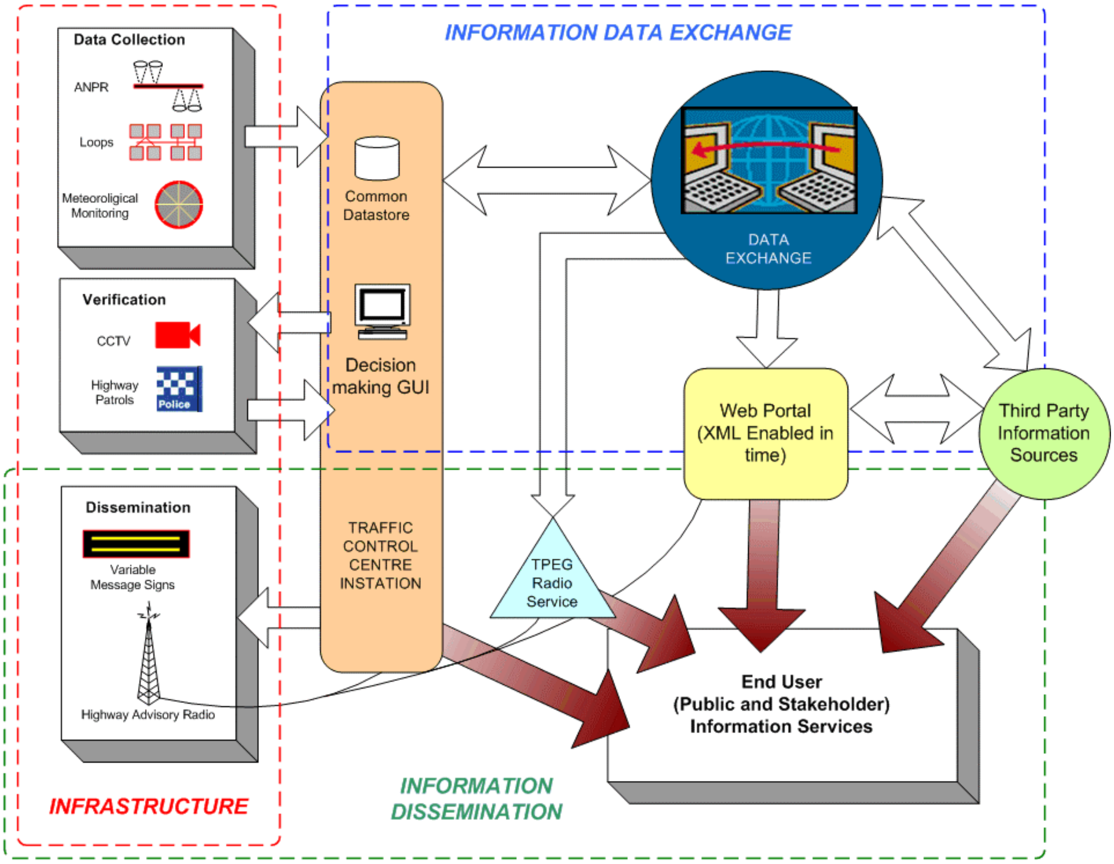
The recommendation of the Design Study is that methodology B is sufficient in the short to medium term to provide the data exchange facility currently needed by the Belfast TICC and Dublin TCC. As part of the design study a pilot demonstration to exchange traffic and weather information typical of that available in each control centre is being exchanged using a "web services" approach. This means that data is being acquired by small software applications running on servers in each control centre. It is then processed within a structured "object layer" of the system architecture to comply with the data model developed by the latest EC sponsored research project in this area, TRIDENT[2]. Then, using the internet, information is requested by the system that wants to receive information and it is sent, using an XML schema that can be understood by the requesting system.

As the quantity of data available to exchange increases consideration of developing a subscription service approach using CORBA (or similar) should be made. This is a more technical and higher cost "always on" connection method that does not need the request and retrieval mechanism of the web services option.

One of the most important recommendations of the Design Study is that the TPEG-Loc method for describing point locations is adopted by NRA and RS. This is compatible with STREETWISE recommendations, excepting that RDS-TMC code field is not used.

[2] www.ertico.com/activiti/projects/trident/public_d.htm

The following diagram illustrates how the three components of the implementation strategy (Infrastructure, Information Data Exchange, and Information Dissemination are linked together. It is important to note that the dissemination hinges on successful data exchange.



Putting this into Practice - Information Dissemination

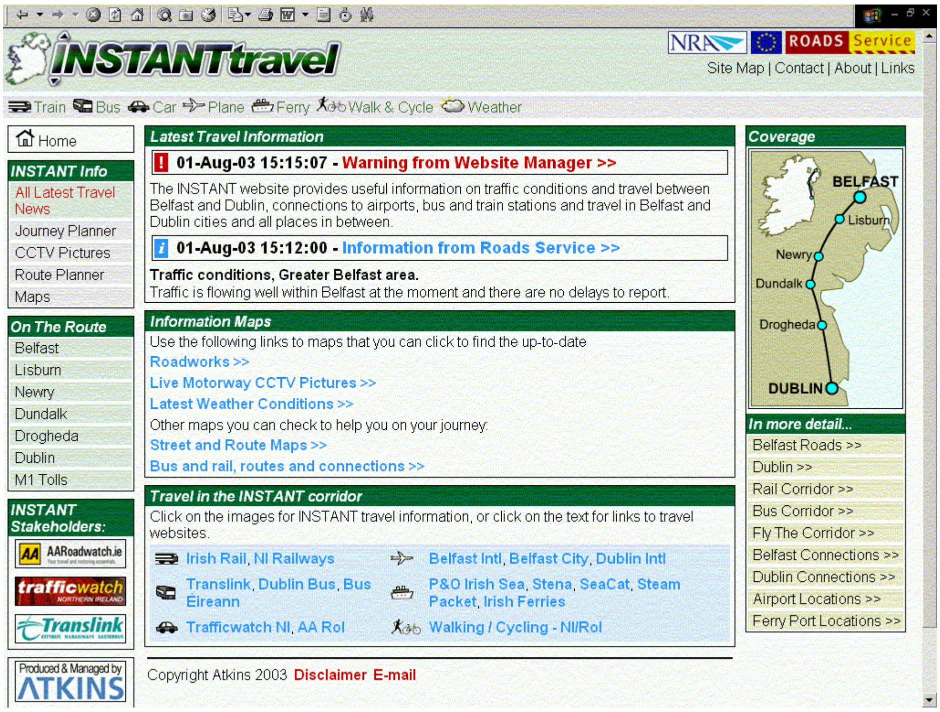
The role of an INSTANT Web Portal

Delivering information via the internet is visible and relatively easily achieved. Creating a "web portal" provides a common entry point to information generated through INSTANT systems and a seamless gateway into information available from others – known as "web stakeholders". The Design Study has developed an embryonic web portal – www.instanttravel.info. This uses cascading stylesheets to create a common look and feel that can easily be updated and meets accessibility and design criteria. A test home page is shown overleaf:

The experience of taking the web portal design to this stage has highlighted two key issues:

(a) Stakeholders are enthusiastic but require direction from the ITS Champions (i.e. NRA and RS) to become fully involved. Atkins, as a contractor, has not had the authority to enter into necessary agreements, some financial, to ensure all the envisaged content is available. If the web portal is to be fully exploited memoranda or agreements need to be put in place;

(b) Where sources of information are to be mixed (e.g. travel bulletins, timetables, mapping and directions) to give a "seamless" service, enabling the web site through an INSTANT XML schema (eXtensible Mark-up Language) is required. Costs for specifying and implementing an XML schema have been estimated at €252,000 (£180,000). Further costs will be incurred depending on the agreements for licensing of mapping, routing and other content, and for secure and appropriate web server hosting.



There are two types of end user the web portal can serve:

- The public user wanting the best quality travel information to, from, and within the corridor. The current design of the site provides for this, and for it to grow and become further integrated across modes and stakeholder supplied information;
- The member user – an organisation such as a radio station or third party information supplier who wishes to access information made available by the "INSTANT system" (e.g. quick refresh CCTV, VMS settings) either for their own purposes or to process and then disseminate to their customers / listeners / viewers / web site visitors.

The development of an online Roadworks database / register for use by members taking advantage of the mapping and other development work undertaken in the Design Study is estimated as costing €40,000 (£28,571), dependant on scope defined by NRA/RS.

Use of Radio

INSTANT Corridor users told the Feasibility Study market researchers that they trusted and used Radio traffic broadcasts more than any other form of traffic information. A Scoping study has been undertaken in the Design Study to look at the opportunities for improving the quality of broadcasts and the use of new technology to provide localised, targeted information by radio. As well as improving the journalistic content, automated broadcasts, the use of the Radio Data System Traffic Message Channel (RDS-TMC) [comparable to a teletext service on FM broadcasts] to send language independent and geographically appropriate information to equipped users, potential for using Digital Radio and TPEG recommendations, and localised, low power Highway Advisory Radio (HAR) have been investigated.

RDS-TMC does not currently exist for either NI or RoI. Hence the location referencing code recommendation. At some point in the future commercial RDS-TMC services might exist: a UK licence has been granted to ITIS that covers NI, but nothing is known to be planned in RoI. Through its TPEG (Transport Experts Protocol Group) the EBU (European Broadcasting Union) examined how to overcome some of the shortcomings of RDS-TMC and improve the quality, accuracy and technical ease of broadcasting travel information.

TPEG has made recommendations for

- making location referencing recommendations which do not require users to subscribe to location database updates;
- the construction of language independent message sets;

- Integration of TPEG messages into DAB (Digital Audio Broadcasting) which can transmit data at a much faster rate than RDS-TMC; and
- Message Sets for both Road and Public Transport.

TPEG services may be delivered via data exchange to broadcasters via the Web Portal or through a dedicated data feed,

For the corridor (and subsequently on a national basis), it is strongly recommended that the feasibility of developing TPEG services for the medium to long term is examined with broadcasting authorities, the BBC (who strongly support TPEG) and RTE. NRA and RS should encourage commercial RDS-TMC services, but make it clear to their proponents that their long term goal is for a TPEG service.

Highway Advisory Radio

Highway Advisory Radio, a local, the use of dedicated traffic broadcast stations, is popular in North America and the Far East, but less so in Europe. In Dublin a service known as Travel FM with automated announcements has been trialled, and the back office system continues in use as a simple method of travel information exchange between participating organisations. However, licensing issues associated with the use and power of the broadcast have prevented the service becoming permanent.

The Scoping study has found that automated low-power HAR systems could be purchased for less than €100,000, i.e. less than a pair of Variable Message Signs. When coupled with flashing beacons on fixed signs displaying the tuning frequency, information warnings could be broadcast in the vicinity of key interchanges, toll plazas, or the border crossing. Some discussions with licensing bodies will be necessary to ensure legality, but current regulations do not seem to contain any major hurdles to implementation. FM, rather than AM is recommended as RDS features such as automated retuning and station identification can also be implemented. A Feasibility Study is recommended to take this work forward with the Broadcast Commission of Ireland in RoI and OfCom in NI, and to specify locations and performance requirements.

Institutional Issues

The Strategy recommends the establishment of three levels of Stakeholder meetings under the frameworks of ITS Partnerships in each country:

(a) **SM1 – International Corridor**: Concerned with high level issues such as realising the vision, agreeing Memoranda of Understanding, involving Public Transport authorities, agreeing control strategies

(b) **SM2 – National Traffic Management:** Separate meetings for each country involving emergency services, information providers, and in RoI City and County Councils and Toll Road Concessionaires.

(c) **SM3 – National Travel Information:** Involving all interested parties to ensure a coordinated approach to the provision of travel information, including agreements, planning and issues to be passed to SM1 meetings.

As well as leading the Stakeholder Meeting processes NRA and RS should:

- Continue involvement in relevant research at national and European level;
- Ensure that European and International standards are adopted;
- Put in place monitoring and evaluation programmes to show the benefits of ITS deployment on the INSTANT corridor;
- Provide continuous monitoring and development of System Architecture; and
- Encourage the market for in-car systems (navigation, Traffic information etc.) in Ireland.

It is essential that NRA and RS have sufficient resources to be able to deliver the INSTANT strategy. This may be through recruitment, secondment, consultancy and partnering, but must be addressed by the end of 2004. Other stakeholders will want to see active leadership by NRA and RS to give them the confidence to commit to what should be seen as a flagship project.

Financing the Deployment

The deployment of the infrastructure and information systems to realise INSTANT will to large extent require national funding through initiatives such as the National Development Plan (2000-2006) (NDP) in RoI, and the NI Regional Transportation Strategy (2002-2011). These funds could provide matched funding for EC grant aid through the ERDF (European Development Fund), INTERREG III Cross-border cooperation programme, and the TEMPO projects such as STREETWISE.

It may be possible to raise some investment through the private sector, i.e. some form of PPP. However the overall cost of limiting risk for involving private sector innovation and efficiency might be outweighed by the desire of NRA and RS to ensure quality of service, and ultimately not provide a long term value for money scenario.

Contracting private sector VASP's (Value Added Service Providers) to deliver information services in partnership with NRA/RS and in turn provide their own information into the INSTANT system may result in a greater net investment in information services.

Costs

A spreadsheet based cost model based on standard costs per item and km or deployment has been created. This has identified costs in the short, medium and long term for design, procurement and deployment and for maintenance and operation. Summary tables are presented in Chapter 10 of this report and a printout of the full cost model. The table below details costs for Design, Procure and Install.

£ Sterling	Northern Ireland	Republic of Ireland	Total
Level 1 ITS (2004-2007)	£2,147,466	£2,223,278	£4,370,744
Level 2 ITS (2007-2010)	£70,000	£788,609	£858,609
Level 3 ITS (2011-2014)	£70,000	£314,328	£384,328
Other Projects (min cost)			£280,000

€ Euro	Northern Ireland	Republic of Ireland	Total
Level 1 ITS (2004-2007)	€3,006,452	€3,112,590	€6,119,042
Level 2 ITS (2007-2010)	€98,000	€1,104,052	€1,202,052
Level 3 ITS (2011-2014)	€98,000	€440,059	€538,059
Other Projects (min cost)			€392,000

Maintenance costs estimated in the region of £100,000 / €140,000 per year in each country.

1 Introduction

1.1 Vision for INSTANT

The overall vision of the INSTANT project is to develop:

- a multi-modal traffic management and information system for cross-border traffic between the Republic of Ireland and Northern Ireland, based on information from:
- The Dublin – Belfast route;
- Main routes between the other major ports and cities on the island of Ireland;
- Ferries to Scotland, England, Wales and France;
- Routes in Great Britain that are relevant alternatives to the above ferries and the main connections between Great Britain and Continental Europe; and
- involving best appropriate technology such as enhanced message signs, variable message signs, RDS-TMC, GSM and the Internet.

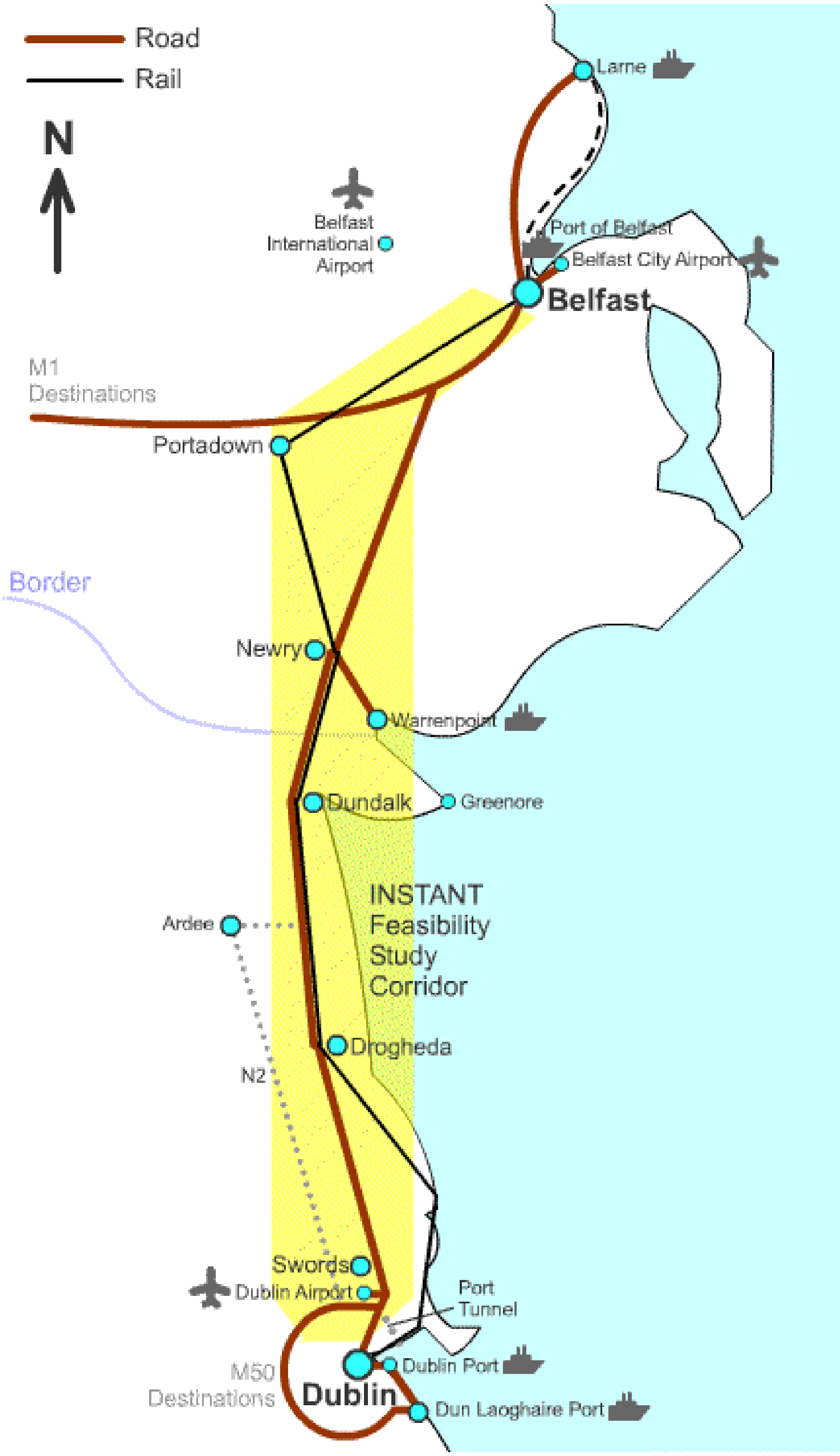
The specific objectives for the development of INSTANT are to:

- assist in the economic development of both the Republic of Ireland and Northern Ireland;
- assist in the exchange of goods and services between both parts of Ireland and also between Ireland, Great Britain and Europe;
- enable freight operators to make informed choices on routes;
- enable passenger traffic to make informed choices on routes and modes;
- increase traffic safety; and
- reduce the negative impact of incidents on the routes on overall transport efficiency.

1.2 Scope of the INSTANT Project

The map overleaf shows schematically the area being addressed by the Implementation Strategy. It is pointed out that the metropolitan areas of Dublin and Belfast are not part of the primary work of INSTANT, although full cognisance of the issues, control regimes, infrastructure and planned developments is taken.

Figure 1-1 : INSTANT Coverage (Design Study Corridor)



1.3 Related Work

Included below is a summary of related INSTANT reports which are referenced in this report and are of specific relevance to this long term strategy.

Deliverable	Description of Work
Feasibility Phase	
F-03	Technical Feasibility Report
F-08	Draft Implementation Plan
F-11	Final Feasibility Report
Work Package 1 – ITS Infrastructure	
D-112	Preliminary Design Report - Sprucefield to Border
D-122	Preliminary Design Report - Border and Approaches
D-132	Preliminary Design Report - Dublin Airport to Swords
Work Package 2 – Web Site	
D-205	Web Portal Design Report
Work Package 3 – Data Exchange	
D-302	Data Exchange Report
D-303	Location Referencing Report
Work Package 4 – Radio Communications	
D-402	Scoping Study for Travel Information Radio Services
Work Package 5 – Implementation Strategy	
D-501	Inception Report
D-502	Level 1 ITS Implementation Report

1.4 Glossary

Term	Description	Term	Description
AA	Automobile Association	LED	Light Emitting Diode
AADT	Annual Average Daily Traffic	LOS	Level Of Service
AID	Automatic Incident Detection	MoU	Memorandum of Understanding
ANPR	Automatic Number Plate Recognition	MIDAS	Motorway Incident Detection and Signing
ARTIMIS	Advanced Regional Traffic Interactive Management and Information System	MPEG	Motion Picture Expert Group
BBC	British Broadcasting Corporation	NATA	New Approach To Appraisal
BSI	British Standards Institute	NDP	National Development Plan
CCD	Charge Couple Device	NMCS	National Motorway Communications System
CCTV	Closed Circuit Television	NRA	National Roads Authority
CEN	European Committee for Standardisation		National Road Authority
COBS	Central Office Base System	OTAP	Open Traveller Information Services Access Points
CODEC	Coder/Decoder	PFI	Public Finance Initiative
CORBA	Common Object Request Broker Architecture	PPP	Private Public Partnership
DAB	Digital Audio Radio	PSTN	Public Switched Telephone Network
DATEX	Data Exchange Standard	PT	Public Transport
DBFO	Design Build Finance Operate	RDS-TMC	Radio Data System - Traffic Message Channel
DG TREN	Directorate General for Energy and Transport of the European Commission	RF	Radio Frequency
DOT	Department of Transport	RLAN	Radio LAN
DP	Decision Point	RoI	Republic of Ireland
DSL	Digital Subscriber Line	ROMANSE	ROad MANagement System in Europe
DSP	Digital Signal Processing	RS	Roads Service
DVD	Digital Video Disk	RTPI	Real-time Passenger Information
DVR	Digital Video Recorder	RTS	Regional Transportation Strategy
EC	European Commission	SCATS	Sydney Coordinated Active

EMI	Enhanced Matrix Indicator	SCOOT	Split Cycle Optimise Technique
EMS	Enhanced Message Sign	STREETWISE	Seamless Travel Environment for Efficient Transport in the Western Isles of Europe
ERT	Emergency Roadside Telephone	SQL	Simple Query Language
EU	European Union	TCC	Traffic Control Centre
FFS	Free Flow Speed	TELTEN	Telematic Implementation on the Trans-European Road Network
FHWA	Federal Highway Administration	TICC	Traffic Information Control Centre
FVD	Floating Vehicle Data	TIH	Traffic Information Highway
GDP	Gross Domestic Product	TPEG	Transport Protocol Experts Group
GIS	Geographic Information System	TRIDENT	TRansport Intermodality Data sharing and Exchange NeTworks
GML	Graphical Markup Language	TTI	Traffic and Travel Information
GPRS	General Packet Radio Service	UK	United Kingdom
GPS	Global Positioning System	UTC	Urban Traffic Control
GSM	Global System for Mobile Communications	UTMC	Urban Traffic Management and Control
GUI	Graphical User Interface	VASP	Value Added Service Provider
HA	Highways Agency	VCR	Video Cassette Recorder
HAR	Highway Advisory Radio	VIH	Video Information Highway
HGV	Heavy Goods Vehicle	VMS	Variable Message Sign
HSCSD	High Speed Circuit Switched Data	VPN	Virtual Private Network
I/C	Interchange	VRN	Vehicle Registration Number
INSTANT	Information and Management Systems for Multimodal Transport in the Republic of Ireland and Northern Ireland	WAN	Wide Area Network
IP	Internet Protocol	WERD/DERD	Western European Road Directors / Deputy European Road Directors
ISDN	Integrated Services Digital Network	WIM	Weigh In Motion
ISO	International Standards Organisation	WLAN	Wireless LAN
ISU	Intelligent Signal Unit	WP	Work Package
ITS	Intelligent Transport Systems	XML	Extensible Markup Language
JTS	Journey Time System		
LA	Local Authority		
LAN	Local Area Network		

1.5 Purpose and Structure of Report

The primary objective of this report is to discuss the range of ITS technologies and applications that can be effectively utilised on the INSTANT corridor over the next ten years. An ITS deployment model is presented in section 4.3 to provide guidance on when these technologies should be deployed and what conditions will trigger the deployment. The model will reflect the fact that some technologies may be implemented early with limited coverage or functionality but with a defined upgrade path to higher levels as the conditions demand.

The report will investigate the technologies and trends in the following groups:

- Information gathering and dissemination using traditional ITS infrastructure;
- Information dissemination through a project website and by radio communications directly to the motorist; and
- Information sharing by way of data exchange.

Some of the key institutional issues and changes necessary to fully support the technology deployment will be discussed as will the funding options and the potential for third party revenue.

A 10 year ITS deployment programme for INSTANT will be put forward along with associated cost estimates and options for procurement.

2 Current Setting

2.1 Network Description

The central focus of the INSTANT Implementation Strategy is the road route from the M1/M50 junction north of Dublin, north to the M1 junction 1, south of Belfast city centre as shown on Figure 2-1: INSTANT Coverage (Design Study Corridor).

However the study also includes:

- The interface with the existing traffic control regimes covering the metropolitan areas of Belfast and Dublin;
- The Dublin – Belfast rail route;
- Any flexible road diversionary routes; and
- Interface with airports and ferry ports and links with Great Britain and mainland Europe.

2.2 Road Construction Programme

A significant programme of road construction and upgrade is underway on the INSTANT corridor by both the NRA and the Roads Service. This will essentially provide a minimum two lane carriageway over the full route and to predominantly motorway standard in the ROI.

This work is largely being funded by the respective road authorities although in the RoI, the section of M1 from Drogheda to the beginning of the Dundalk Western By-pass will be tolled, raising finance for the construction of the by-pass.

The impact of this ongoing road construction is two fold:

- Motorists using the corridor may be subject to delays associated with the various construction projects between Dundalk and Loughbrickland for the next five years. Although this report is primarily aimed at permanent deployment of ITS following construction, there is an implied need to provide ITS monitoring and information through the construction phase; and
- Deployment of the permanent ITS technologies on these new projects need to be included within the scope of the relevant construction contract.

The location and programme for current and future road construction plans are summarised in the table below:

Table 2.1 - Current and Future Road Construction

Name	Description of Work	Construction
Northern Ireland		
A1 Loughbrickland to Beech Hill	Upgrade to dual carriageway with hard shoulders on existing alignment (70 mph). Reduction in the number of at grade junctions.	2004-2006
A1 Beech Hill to Cloghogue, Newry	Upgrade to dual carriageway with hard shoulders on mix of new and existing alignment (70 mph). Reduction in the number of at grade junctions and top include some grade separated junctions. Preferred route to be set late 2003	2006-2008
A1 Newry to Dundalk Link Road	Upgrade to two lane all-purpose dual carriageway (70mph), with hard shoulders. On a new alignment with fully grade separated junctions.	2004-2006/7
Republic of Ireland		
A1 Newry to Dundalk Link Road	Upgrade to two lane all-purpose dual carriageway (60 mph), with hard shoulders. On a new alignment with fully grade separated junctions.	2004-2006/7
M1 Dundalk Western Bypass	New motorway construction	2003-2005
M1 Drogheda Bypass	New motorway construction – Toll road (PPP)	Completed June 2003
M1 Lissenhall to Balbriggan	New motorway construction	Completed June 2003
M1 Cloghran to Lissenhall	New motorway construction	Completed June 2003

2.3 INSTANT Schematic

A schematic representation of the INSTANT corridor is appended (Appendix A : INSTANT Road Schematic).

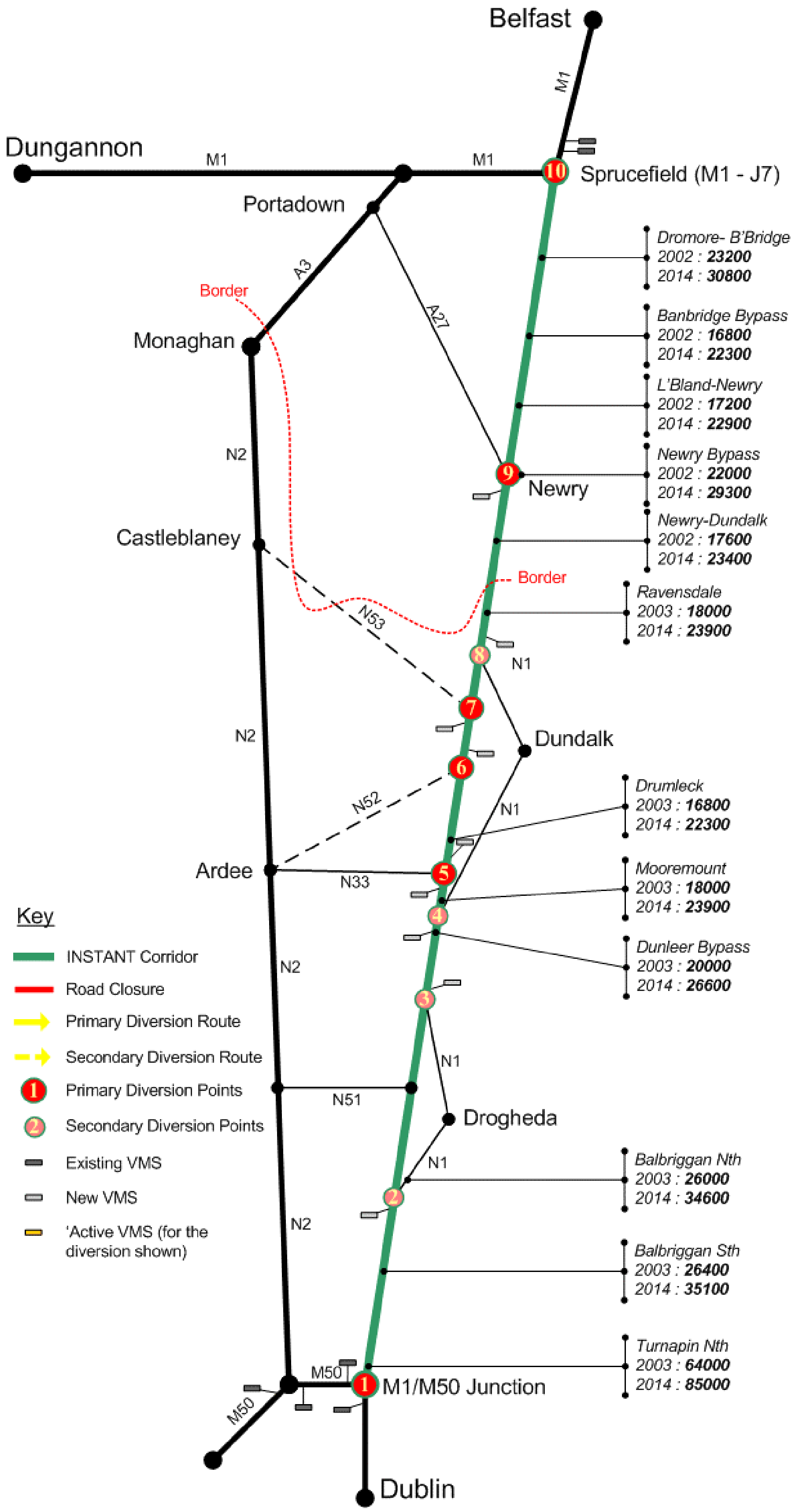
This schematic is used to show:

- The layout of the current network and key feeders in a link/node layout;
- The probable coverage of infrastructure deployment at three levels of concentration: Level 1 ITS / Level 2 ITS / Level 3 ITS; and
- The proposed type and location of the above ITS Infrastructure (CCTV, VMS, Traffic Monitoring sites etc).

2.4 Network Traffic Flows

The current AADT flow figures and projected AADT figures for 2014 (10 year timeframe) are shown for the INSTANT corridor overleaf.

Figure 2-1 : INSTANT AADT Flows



2.5 Existing ITS Deployment Summary

ITS has been deployed on the Belfast motorway network for a number of years and is reasonably well developed and established. The use of ITS in the Republic of Ireland is fairly new and is concentrated on the M50 around Dublin.

An outline summary of the ITS infrastructure and control systems for each is provided below.

2.5.1 Republic of Ireland

The Dublin TCC (managed by the Dublin City Council on behalf of the NRA) is the hub for all existing ITS in the Republic of Ireland. A number of standalone systems are operated from here and include:

- A SCATS based Urban Traffic Control (UTC) system covering the greater Dublin area;
- A CCTV network covering the M50 and immediate approaches; and
- A number of VMS on the M50 and approaches.

These VMS and CCTV utilise a fibre optic communications backbone along the M50 to link the field equipment and control systems at the TCC. Some sites off the immediate fibre route use wireless communications to join the backbone (RF for VMS and microwave for CCTV).

In addition to these primary systems, a number of trials are ongoing into other ITS technologies:

- A small trial of ANPR technology has been undertaken to gather journey time information and for bus lane enforcement; and
- A trial of video detection technology is underway on sections of the M50.

At present, there is no central system/instation and no real degree of integration between the above standalone systems. Although there are plans to provide greater system integration, they were still under development during the production of this report.

2.5.2 Northern Ireland

In Northern Ireland, all strategic management of traffic on the urban roads and trunk road/motorway network is undertaken from the Traffic Information and Control Centre (TICC) in Belfast by the Roads Service. From this location the following primary control systems are operated:

- Central Office Based System (COBS) including:
  - Message Signs – for information dissemination to motorists using motorway lane control matrix signals and Variable Message Signs (VMS); and
  - Automatic Incident Detection (AID) over sections of the motorway network.
- Integrated with the above is a SCOOT based Urban Traffic Control (UTC) system for dynamic management of the urban traffic signals in Belfast. A satellite SCOOT system is also operational in Newry; and
- CCTV traffic surveillance on the urban and motorway networks with full motion video where fibre is available and 'slow scan' video otherwise.

Where the above systems include field equipment on the motorway network, then communications between this equipment and the control system utilises a fibre/copper based NMSC2 communications network.

Information on traffic conditions and incidents monitored by the above systems are made available on the Trafficwatch website (www.trafficwatchNI.com) and through a traffic information telephone service.

In addition to these primary systems, a number of other ITS technologies are being implemented, including:

- Real Time Passenger Information (RTPI) for GPS based tracking of buses on quality bus corridors in Belfast, including provision of arrival information to patrons at bus stops and other locations; and
- ANPR based journey time monitoring on the motorway network.

3 Assessing how INSTANT might be delivered

3.1 Introduction

INSTANT is a multi-faceted initiative. Triggers, be they driven by traffic growth, technical maturity, economic affordability, political desirability, or infrastructure completion, will determine the ability to implement as described in this document during the next 10 years. When a trigger is reached, it should be an essential requirement that no unforeseen additional barriers lie in the way. To a greater or lesser extent these barriers or issues have been encountered in the Feasibility and Design Studies.

In this chapter a review of what those barriers are / could turn out to be is made, and the steps that should be taken within the Implementation Strategy to ameliorate their effects is discussed.

3.2 Potential obstacles to meeting INSTANT's objectives

INSTANT is envisaged as comprising three principal objectives:

- The development of a pre-trip planning tool;
- The creation and dissemination of real-time traveller information; and
- Various levels of traffic control and management.

Each overlaps the other in different ways. The traveller will reference their journey to the network the traffic network controller is to manage. The information used by the traffic controller to manage their network will, in some part, be disseminated in real time using on-trip information channels. The information given to those already travelling can be provided to those planning a journey, perhaps with other processed historic information derived from the traffic network controller's system records. And so on and so forth.

In considering what barriers or issue that might exist that could affect INSTANT three headings are proposed:

- Infrastructure;
- Information; and
- Institutional.

3.3 Institutional

The Feasibility Study recommended that ITS Partnerships in NI and RoI should be set up with RS and NRA respectively as their champions and leaders. Operation of these Partnerships is dealt with in more detail in Chapter 7. However there are a number of sub-issues that the RS and NRA should address to ensure the success of INSTANT:

- Staff resource limitations within the road authorities;
- Easy mechanisms to engage consultants and contractors;
- Formal Agreements with LA agents, (and Toll concessionaires?);
- Formal Agreements with PT info providers;
- Agreements (& payment?) with private sector partners e.g. AA Roadwatch Ireland; and
- Cross Cutting initiatives with An Garda Síochána and the Police Service of Northern Ireland.

3.3.1 Staff resource limitations within the road authorities

It has been clear during the INSTANT Design Study that staff resources within the client organisations has been stretched at times. Other projects (e.g. STREETWISE) and day-today responsibilities impinge on the availability of staff to attend meetings. The demands of simply reading reports and providing comments within tight timescales are difficult to meet. Furthermore there is the institutional leadership needed within the ITS Partnership envisaged in the Feasibility Study and taken further within this Implementation Report: Long term agreements must be made with the authorities not their consultants for successful partnerships.

Clearly if INSTANT is to be rolled out there will be a need for the client organisations (NRA and RS) to have sufficient staff resource to support and deliver the programme, and service their existing, and expected to grow, ITS responsibilities. The assumption is that this will mean, in some way more staff at their disposal. In broad terms this probably means one person's worth of effort per year, with the ability to call on specialist skills or assistance (e.g. contract, finance, civil engineering) as required.

There are several models that could be employed:

a) **Recruit a new member of staff:** The simplest way, though in these days of government departments generally wanting to contract their staff base it might not be easy. This new person would have as their main duty the implementation of INSTANT and STREETWISE technology within that country.
b) **Long-term secondment:** For government departments and agencies secondment from a consultancy, contractor, or other public agency can be a cost effective way of quickly mobilising sustained effort on a specific topic or activity for a fixed length of time. Unlike a new member of staff, the secondee leaves the employ of the department when their job is done. Seconders may set some conditions on the secondment to ensure that they remain in touch with their employees, e.g. some working at home base rather than the clients office. For INSTANT this is unlikely to be a major problem.
c) **Appoint a Programme Manager:** This would entail the use of an agent or consultancy contract to run the delivery process, but not actually be part of the delivery. In effect the Programme Manager should be regarded as an extension of the authority.
d) **Devolve responsibility to an Agent Authority:** This would be an option for RoI with, for instance, Dublin City Council, though not, in the current arrangements for RS in NI. On behalf of the authority the agent would have the responsibility to ensure sufficient staff resource would be available.

3.3.2 Easy mechanisms to engage consultants and contractors

As well as having sufficient resources to manage the implementation programme, it will be essential to be able to call upon the resources of consultants and contractors to design, construct, test and deliver the ITS proposed, and to carry out appropriate research to support programme activities.

Contracts could be awarded on an "as required" basis, but this will result in inefficiency due to delays in award processes, and through possible learning curves and mobilisation delays.

Framework consultancies and / or rolling contracts are mechanisms that can be used to reduce the problems of approach (i) as they bring:

- Performance related benefits – if you do well you will continue to get work;
- Being on a Framework list means consultant / contractor is focussed on a better chance of winning work than in the open market; and
- Pro-active partnership approach easier to develop.

Road Service already have framework consultancy arrangements in place enabling them to quickly appoint consultants who have pre-qualified to be on a tender list for the provision of various design or support services. This system provides staff at defined rates for defined grades and experience.

In RoI a mechanism(s) would need to be set up with the consultant/contractor working directly to the NRA or to its agent DCC. For the second case a similar model to that used in Scotland where Glasgow City Council are the agents for the Scottish Executive may be appropriate:

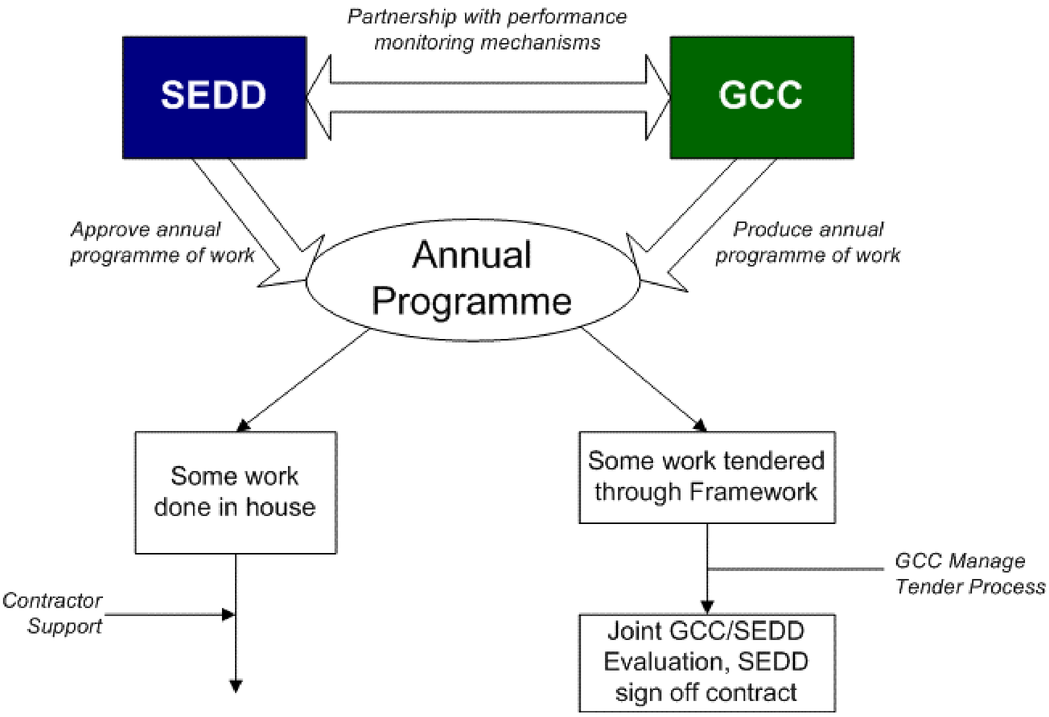


Figure 3-1: Scottish Executive / Glasgow CC Framework mechanism

Consultant/Contractor support contract: This would be a PPP or near PPP solution whereby a consultancy/contractor team operate on an exclusive basis for a period of years. The contract might have a cut off date when it might be re-tendered, or may be on a rolling basis with stringent annual KPI targets. This second method might appoint for three years with KPI's are measured at the end of each year. If they are exceeded the contract is extended a further year, if not the contract will be put out to tender with the intention of making a new appointment at the end of the next year or next but one year.

All of these contract options could be on a regional / county basis if required

3.3.3 Formal Agreements with LA agents (and Toll concessionaires?)

In NI RS are the agent authority and there are currently no tolled sections of road on the INSTANT corridor in NI.

In RoI road construction and maintenance responsibilities are devolved out to the County Councils. On the Main M1 route the Toll Concessionaire maintains the route north of Balbriggan. Currently Dublin City Council is being used as the agent for ITS infrastructure, even though no motorway falls within its boundaries. It is essential that a defined formal agreement with the NRA is put into place to ensure that the chain of responsibility is strong and focussed. If not, there is a risk that DCC's own operational objectives will take precedent over those that they are supplying to the NRA.

During the INSTANT Design Study the NRA have stated that they believe the contractual agreements with the PPP toll concessionaires will allow the installation and operation of ITS infrastructure. It is recommended that this assumption is formally confirmed, and maintenance responsibilities for ITS assets determined, otherwise problems may arise in the future.

Taking on board outputs from the European National Road Authorities' WERD/DERD subgroup on ITS for what they refer to as the "Big Shift" (from road construction to road operational management) should also be considered.

3.3.4 Formal Agreements with PT info providers

INSTANT, by its name (Information and Management Systems for Multi-modal Transport in the Republic of Ireland and Northern Ireland) should include public transport information within its deployment strategy. To progress this initiative agreements will be needed north and south of the border. Every effort should be made to ensure the desires for interoperable PT information systems stated by various agencies are realised.

In NI Translink, who operate all public transport (road and rail) in the province, are a part of the DRDNI, as is the Roads Service. Translink have co-operated in the setting up of the INSTANT web portal. However, some of the interaction has not been as smooth as it could have been. This appears to stem in the main from lack of understanding of the objectives and reasons behind INSTANT, and that the INSTANT web site is not intended to usurp Translink's own site. Clearly Translink and RS can work together. Translink will in time become a supplier and a customer for INSTANT information. For successful implementation of INSTANT, and subsequent roll-out of similar initiatives throughout NI, regular contact between RS and Translink in essential to keep momentum going and trust high.

In RoI information on services is currently the responsibility of the service provider. The vast majority of services are provided through CIE group companies (Irish Rail, Bus Éireann and Bus Átha Cliath – Dublin Bus). On 7 November 2002 the Minister of Transport, Séamus Brennan TD made a Statement on Public Transport Reform[3] which may result in some regulatory changes, particularly in the Greater Dublin Area. The Department of Transport is currently considering how integrated public transport travel information can be fully realised. Whatever the results, there needs to be interaction between the interests of INSTANT championed by the NRA and those of the DOT for PT information.

3.3.5 Agreements (& payment?) with private sector partners

Within the development of the INSTANT web portal AA Roadwatch Ireland have expressed great interest in furthering the objectives of the INSTANT project by being an information supplier, and in the fullness of time an information customer. However, they have indicated that they place a commercial value on the information they collate and which would be supplied to INSTANT systems.

Agreements need to be reached between the RS and NRA (as appropriate on a national basis) with private sector organisations that may be able to enhance the quality of the information contained within and disseminated by INSTANT systems. However it is important that the two-way exchange of data with these organisations is recognised, INSTANT will improve their knowledge of conditions through its own deployment.

3.3.6 Cross Cutting initiatives with Police Services (An Garda Síochána and the Police Service of Northern Ireland)

During the Feasibility and Design Study An Garda Síochána and the Police Service of Northern Ireland have been involved in various discussions about INSTANT. There are several common areas:

- Reduction of Road Fatalities:
  - Through enforcement; and
  - Through better incident management resulting in quicker responses across all emergency services.
- Better information on current road conditions;

[3] (http://www.transport.ie/viewitem.asp?id=2823&lang=ENG&loc=845)

- Better facilities to contribute to the pool of information of road conditions;
- Improving communication of road restrictions and closures; and
- Answering of roadside emergency telephone calls.

Whilst it is evident that there is good co-operation between the police and road authorities, particularly in the city conurbations, it is clear that for the corridor which is mainly rural in nature, improvements can be made. Currently the telephone is the main method of communication. Consideration should be given to use of the internet to access and exchange information securely, common location referencing, and creation of new and improved methods of inputting information by the police into the INSTANT system. Some or all of these issues will need high level consideration as there maybe police system security consequences to be addressed.

In RoI the DOT has announced in 2003 that, in conjunction with the Department of Justice Equality and Law reform and the Garda authorities, it is considering establishing a dedicated Traffic Corps. The NRA should encourage the deployment of the Traffic Corps on the M1, and their involvement in the ITS Partnership process. Their strategic role should make them able to contribute to the development and specification of INSTANT systems.

3.4 Infrastructure

All of INSTANT's objectives require infrastructure deployment to be realised. This deployment cannot be instantaneous, but through a steady and co-ordinated programme.

Much of this document is concerned with the deployment of infrastructure to collect and disseminate information to the road user, and the reasoning behind the choices of technology packages and the locations at which they should be installed. It goes without saying that unless good quality sources of data are available, good quality information cannot be collated and disseminated. In the worst case this could mean the installation of expensive VMS about which no one can have any real indication of when and what to display when an incident occurs, because no nearby CCTV or loop detection has been installed.

Infrastructure also needs to be deployed within the control centres. This could mean new systems or upgrades to old systems. The importance of building to a system architecture cannot be over emphasised.

3.5 Information

INSTANT will result in a range of public facing information services. It will also make available information that could be used by third parties to provide value added services. It will be important to ensure that the information chain is not constrained unnecessarily through:

- Traffic Control Centres wrongly seeing themselves as the best provider of travel information;
- Lack of channels for others to use to exploit the information available; and
- The entire systems failing because a common location referencing system is not in place.

3.5.1 Traffic Control Centres need not be a public information provider

The distinction between Traffic Control Centre (TCC) and Travel Information Centre (TIC) has been identified for many years. There is no reason why a TCC cannot also be a TIC (as in Belfast), but if so, recognising the difference is crucial to the success of the joint operation. TIC functions are media facing enquiry and information providing whilst TCC functions are network management and control. The needs of the network manager for the INSTANT system are different from those of the radio station / web site / mobile messaging service.

Consequently it will become increasingly important that as the amount of available traffic and travel information increases, the objectives for providing them are user focussed, and not the best guess of the TCC as to what should be provided.

When INSTANT information services are approaching the levels of quantity and quality required it may well be beneficial to commission specific research, or staff to identify the information required, who it is required by, and how it should be delivered. Given the limitations of potential numbers of users (island location, rural corridor outside conurbations) and the stronger potential for commercial services within the city areas, it may well be that INSTANT information services will always be subsidised through the TCC operation.

3.5.2 Set up channels of delivery for others to use

Information cannot be delivered to the public without information formats being common and communication slinks being robust enough. It is essential for the success of INSTANT systems that they use techniques such as:

- Appropriate communications links to on-road devices;
- Standardised message construction including:
  - XML for formatting data to be transferred; and
  - TPEG (or possibly RDS-TMC) for language independent radio messages.
- High refresh rate CCTV pictures over broadband internet; and
- Standard location referencing.

IT industry standard methodologies and techniques will resulting in a more open and flexible system that can be extended, both in area of coverage and facilities and services provided.

3.5.3 Common location referencing needed for success

A common method of referring to any location, feature or direction on the road network is a pre-requisite for a data driven information service (e.g. M1 _3km north _J5_on-slip _lane 1 _northbound direction [incident details] _grid ref 12345678_98765432).

As stated above, common location referencing is one of the essential features that INSTANT should develop with a view for its use by the police.

In the longer term travel information services throughout Ireland will need to be driven by a common location referencing method in order to grow in complexity, and encourage the market for ITS information receiving devices (Satellite Navigation, Multi-media services (MMS) to mobile devices, DAB etc.).

4 ITS Benefits and Deployment Model

The motorways and trunk roads in Ireland provide the backbone to the economy and well being of the communities in both the North and South. These roads will continue for the foreseeable future to make a major contribution to the mobility of people and goods. Clearly, the efficient and safe management of the traffic on them is an essential task.

This chapter will:

- Outline the benefits realised by ITS and provide the justification for the deployment of new and updated ITS systems on the INSTANT cross border corridor;
- Summarise some of the conclusions on ITS deployment reached in parallel by related Euro-Regional project studies;
- Present a simple and flexible model for ITS deployment on the Irish road network and the strategic INSTANT corridor; and
- Use the above model to provide an assessment of likely ITS deployment levels on the INSTANT corridor over the next ten years.

4.1 The benefits from ITS

The benefits and cost effectiveness of ITS have been proven over the last decade in numerous national, European and American projects and programmes. Examples can be found in the Area Reports published in 2000 from the 'Telematics Applications for Transport within the 4th Framework Programme 1994-1998'[4] or the more recent publication from the US Federal Highway Administration (FHWA) entitled 'Intelligent Transport Systems Benefits and Costs: 2003 Update'[5] which collects and reports results from around the world.

For INSTANT the main benefits from ITS can be categorised under the headings of efficiency, safety, accessibility, environment, economy and integration. These are described below;

4.1.1 Efficiency

ITS has become a major contributor to modern traffic management. It is used currently in both Belfast and Dublin City TCCs to make better use of the road infrastructure by managing traffic to facilitate mobility and accessibility. It also contributes substantially to ensuring efficient and environmentally sensitive operation of the road network, and to keeping drivers informed about road and traffic conditions. Incident and emergency management are an integral and significant part of traffic management, and are required to ensure safety through the rapid detection and solution of problems, particularly in congested conditions.

Calculations undertaken for the feasibility study indicated that positive benefits will be obtained from improved consistency in journey times and more rapid detection of incidents. The European Commission White Paper (European transport policy for 2010: time to decide) noted that;

> ***'The potential impact of intelligent transport systems has been assessed both during research and in the early stages of deployment. Journey time reductions of up to 20% and increase in network capacity of 5-10% have often been achieved in various combinations. Safety improvements have often been estimated at around 10-15% for certain specific types of accidents (rear end collisions) thanks to coordinated information and control strategies, while survival rates have also increased thanks to automatic incident detection systems for the management of emergency***

[4] www.cordis.lu/telematics/tap_transport/research/10.html
[5] www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/13772.html

situations'

4.1.2 Safety

ITS systems contribute to improved safety through better traffic and incident management, by speed management, by warning drivers of problems and particularly the tail end of queues. Additionally in the future, vehicles will be equipped with ITS systems that can monitor speed limits and detect obstructions ahead, and slow down automatically, so further increasing safety for all road users.

Work in the Feasibility Study illustrated that earlier alerting of emergency services increased the chances of saving lives.

In work for the US Federal Highways Administration McKeever[6] summarised the potential benefits of ITS 'counter measures' below. Of these counter measures, the infrastructure based measures such as incident detection, ramp metering, video enforcement (speed cameras and red light cameras) and weather monitoring can all provide potential benefits for INSTANT.

Table 4.1 : ITS Countermeasures (McKeever 1998)

ITS Technology Type	ITS Countermeasure	Traffic Impacted	Crash Type Impacted	Crash Reduction Factor	
				Value	Level of Confidence
Infrastructure-based	Ramp Metering	Urban Freeways	All	24%	H
	Incident Detection	Urban Freeways	All	18%	M
	Video Enforcement	Urban Arterials	All	20%	M
	Grade Crossing Enforcement	Railroad Crossings	All	78%	L
	RWIS (snow/ice)	Rural roads, inclement weather	All	40%	L
	RWIS (fog)	Rural roads, foggy conditions	All	85%	L
Vehicle-based	Rear-end CAS	All	Rear-end crashes	48%	M
	Lane change CAS	All	Lane change/merge crashes	37%	M
	Roadway Departure CAS	All	Single vehicle, run-off-road crashes	24%	M
Cooperative	In-Vehicle Navigation Systems	Urban Arterials	All	1%	L
	Emergency Response (Mayday)	Rural roads, fatal only	All	7%	M/L
	Intelligent Speed Control	Urban Freeways	All	20%	L

Additional benefits are suggested by the FHWA Benefits and Costs report which gives examples of the benefits that should be available using VMS in congested conditions.

'In Amsterdam, traffic surveillance, lane control signs, variable speed limits and dynamic message signs have led to a 23 % decline in the accident rate'

and

'In England, variable speed limits supplemented with automated speed enforcement have reduced rear end collisions by 25 – 30%.'

6 McKeever 'Estimating the Potential Safety Benefits of ITS' November 1998 [http://plan2op.fhwa.dot.gov/pdfs/Pdf2/Edl08883.pdf]

4.1.3 Accessibility

Pre-trip traveller information systems are growing in importance in support of traffic management, both to inform drivers about conditions on the road network, and more generally to inform travellers about the accessibility of both road and public transport networks. The 'informed' travellers can then decide how, when and even if to travel; while drivers can plan routes to avoid congestion.

An encouraging result from the FHWA Benefits and Costs report shows;

'In a survey of drivers using the Advanced Regional Traffic Interactive Management and Information System (ARTIMIS) telephone traveller information service in Cincinnati, 99% said they benefited by avoiding traffic problems, saving time, reducing frustration and arriving at destinations on time'.

Additionally, the USDOT Metropolitan Model Deployment Initiative[7] noted that;

'Simulation modelling suggest that access to pre-trip traveller information, such as that on the TxDOT website, reduces users crash risk by as much as 8.5% in the face of a major freeway accident'

and

'In San Antonio, modelling conducted by evaluators and supported by local data collection revealed that website users could expect to experience delay reductions of approximately 5% per year'

4.1.4 Environment

ITS roadside systems will be able to help through managing and controlling traffic and speeds in environmentally sensitive areas and by diverting vehicles away from congested areas. The pre-trip information systems will be able to encourage the use of public over private transport modes when road conditions are bad. These actions will together help control noise and exhaust emissions.

Supporting results from the FHWA's Benefits and Costs report include:

'European studies found 30 – 90% of travellers notice dynamic message signs, and a survey in Glasgow found 40% of respondents changed route as recommended

while for pre-trip information systems, in the Cincinnati study quoted above;

'99% said they benefited by avoiding traffic problems, saving time, reducing frustration and arriving at destinations on time'.

4.1.5 Economy

Improvements in the efficiency of traffic management operations that reduce congestion and delays, and save accidents, lead in turn to community benefits that can be valued in financial terms. Such cost benefit analyses are traditionally the major justification for both new road schemes, and the use of ITS for managing traffic on them.

Calculations undertaken during the INSTANT Feasibility Study estimated the benefit to cost ratio of the ITS to be implemented in the corridor. The most cost effective (with the benefit to cost ratio in parenthesis) were:

[7] Deploying and Operating Integrated Intelligent Transportation Systems - 2001

- Traffic management (3.78);
- Incident management (1.97); and
- On-trip traffic information (1.23).

More detailed analyses have been difficult to substantiate. First, because the before accident data on the Irish road network is largely invalidated by the extensive road construction programme currently taking place; and second, because traffic flows on the corridor are currently too low to cause frequent and serious congestion and delays. However, the ITS systems and services that are to be implemented can confidently be expected to produce accident savings. Also, planned events (such as football matches and concerts), and unplanned incidents (such as bad weather conditions or accidents) will occur from time to time, that will cause congestion and will need ITS to help monitor, manage and control the traffic. Further, traffic is forecast to grow by 33% over 10 years, and clearly, the systems will become increasingly valuable as the traffic flows, and hence problems, increase.

By way of an example of the benefits that could be available, the Benefits and Costs report from the FHWA quotes;

> ***'Studies of the benefits of implementing incident management systems in Minnesota, Colorado and Indiana have produced delay savings worth $1.2M – $1.8 M'***

Accompanying savings in accidents would increase the value, for example, if the INSTANT systems led to a single fatal accident being saved each year, this would alone result in a benefit worth about 1.4M€ (Ref. DfT COBA 11).

Some encouraging results for the economic value of ITS are also available from the evaluation of the ROMANSE project in Hampshire UK (Ref. Cassidy 1996) which showed the average time savings needed per road user for the various ITS systems to pay for themselves. The results are summarised below (making reasonable assumptions about whole life costs):

Table 4.2 : Times savings needed per user to recover costs of ITS systems in ROMANSE

ITS System	Time Saving Needed
Trip planning kiosks	just over 3 mins per journey plan
Route Guidance VMS	3 mins per driver per diversion event
Traffic message broadcasting	4 mins per year

The benefits of the web based information system to be deployed in INSTANT will clearly be greater than for kiosks, as it will offer much wider accessibility and for less outlay; so that benefits could approach those shown for traffic message broadcasting. It should also be noted that the benefits from Route Guidance VMS take no account of the potential for saving accidents. In all other respects, the benefits seem wholly achievable and similar values will apply for the similar systems to be deployed in INSTANT.

4.1.6 The European dimension

Further justification for implementing ITS on the corridor is provided by the EU who are seeking a minimum standard of deployment of ITS on all the strategic roads that comprise the Trans European Road Network. This is aimed at providing a minimum level of information for drivers across Europe, and minimum level of interoperability of systems.

In 1998 ERTICO published the TELTEN guidelines for implementation of ITS on the roads of the TEN-T. In 2000 this was taken forward by the TEN-T Expert Group on ITS for Road Traffic Management (drawn from road administrations across the EU) produced a report on the deployment of ITS on the TERN. In doing so, they clearly recognise that ITS can make a major contribution to increasing road transport efficiency, safety and sustainability which is a major objective of the European Union's Transport policy. The adoption of the guidelines gave birth to a number of projects, including INSTANT; all of which are designed to ensure the complete continuity of services, even beyond frontiers.

The DG TREN web site on ITS[8] states:

> ***'As populations grow and mobility management presents an increasingly difficult challenge, public authorities and private entities alike seek new solutions to the problems faced on today's Trans-European Transport Network. The network includes high-quality road and rail routes as well as ports, airports and inland waterways.'***

As major infrastructure investment is reaching its limits, the European Commission sees ITS - Intelligent Transport Systems and Services — as a viable solution to make the movement of people and goods more efficient and economical for all transport modes. The White Paper on Common Transport Policy adopted in September 2001 identifies the alleviation of congestion and of transport bottlenecks as top priorities for the 10 years to come and promotes the use of ITS to solve these critical issues.'

4.1.7 Conclusion

It is clear there is a substantial body of evidence worldwide to illustrate the valuable benefits of ITS. These are obtained because ITS enables traffic on the networks to be managed better. This in turn leads to increased efficiency in the operation of the network; increased safety and reduced accidents; reduced environmental impacts from traffic; economic benefits from savings in accidents, congestion and delays; increased accessibility in particular to information about the road and public transport networks; and increased opportunities to develop integrated transport solutions.

Improving accessibility to information about PT will also provide wider benefits by increasing mobility for the rural communities and the disadvantaged, as well as for visitors and tourists.

In addition, ITS systems and services can help not only to achieve, but also to monitor performance and hence show national government's progress towards objectives in areas such as improving safety, environment, economy, accessibility and integration; and also to monitor progress towards achieving other key objectives such as: improving journey time reliability; increasing options for people to travel to work or school; reducing road casualties; and monitoring freight movements.

Further, the benefits will increase as traffic grows; and in the meantime, there is a requirement to implement a minimum level of ITS on the roads of the TERN to ensure drivers can enjoy similar levels of traffic management, information and interoperability of in-vehicle systems throughout Europe.

Consequently, and despite the lack of a formal cost benefit analysis, it is recommended that there are sufficient valuable benefits and justification to proceed with the proposed ITS implementations.

4.2 Related Studies on ITS Deployment

Guidance for the levels of deployment of ITS roadside infrastructure are provided by the other longer standing Euro-Regional projects supported by the EC DG TREN, and the resulting TEL TEN Guidelines.

[8] http://europa.eu.int/comm/transport

4.2.1 STREETWISE

In parallel with INSTANT, the STREETWISE Euro-Regional project has been looking at the categorisation of the Great Britain and Irish road networks in each of the five participating countries, and the level of ITS monitoring that should be associated with each road category. The report 'STREETWISE – Monitoring Status 2001-2006 – Version 1E' dated August 2002, recommends:

- Adoption of a three tier road hierarchy based primarily on traffic flow as follows:

Table 4.3 : Streetwise Road Categories

Category	AADT
A	43000 - 168000
B	24000 - 43000
C	0 - 43000

Another Category P denoting roads of strategic importance that may have lower traffic flows is also proposed. This would allow a higher monitoring status on parts of the network with relatively low flows that are still of strategic pan-European importance.

- For each category, an associated level of ITS monitoring was proposed. For incident detection, the following 'Target Incident Detection Times' were proposed. Of interest is the assumption that effective incident detection needs monitoring at 500 metre intervals along with CCTV for verification. The high cost of this perceived minimum monitoring led to the conclusion that Category B and C roads would only be served by manual reporting of incidents.

Table 4.4 : Streetwise Detection Times

Category	Detection Time
A	<5 min
B	<30 min
C	<30 min

Additionally, possible adoption of journey time monitoring was proposed. The technology to undertake this was not prescribed although accuracy limits were suggested. Of interest to INSTANT is the implication that all roads, regardless of traffic volume, need some form of journey time monitoring.

Table 4.5 : Streetwise Journey Time Monitoring

Category	Journey Time Accuracy
A	± 10%
B	± 20%
C	± 30%

4.2.2 VIKING

The VIKING Monitoring Guidelines 2002 address the provision of ITS monitoring systems for use on the Nordic road network. Although the emphasis is on weather related monitoring, guidelines are also provided for other monitoring, including traffic monitoring, incident detection and CCTV.

The following tables summarised from the report provide recommended deployment levels based on both the operating environment and the intended use of the information (management service).

Table 4.6 : Minimum Recommended Levels - Traffic Monitoring Sites

Operating environment	Traffic management services*	Station density (km)	Update frequency
C1 critical or black spots, local flow-related traffic and/or critical weather problems	CR	1	Online
	EI (VMS)	1	Online
	ER	0.5	Online
	IW	0.5	Online
	LC	1	Online
	RR	1	Online
	SH,SM	1	Online
	EI	20	<10 min
T1 motorway (link), No flow-related traffic problems, no critical weather problems	EI (VMS)	10 or each link between major junct.	Online
T3 motorway (link), Daily flow-related traffic problems, no critical weather problems	EI (VMS)	1	Online
	LC, SH, SM	1	Online

*CR = Closure of roads, bridges etc., EI = Event Information, EI (VMS) = Event Information via Variable Message Signs, ER = Emergency Response, IW = Incident warning (incl. local warnings for ice, elks, etc.), LC = Lane control, RR = Rerouting, SH = Speed harmonisation, SM = Speed management, WM = Winter maintenance.

In summary, traffic monitoring is recommended at close spacing (0.5 to 1 km) in problem areas, otherwise extending to 10 km (or one site per link). All sites are expected to be 'online' or continuously reporting data.

Table 4.7 : Minimum Recommended Levels - Incident Detection

Traffic management service	Operating Environment	Incident detection requirements
Event information	C1, T1 - T4, T8, T10	Manual, within 15 minutes
Event information	T6	Manual, within 30 minutes
Emergency response	C1, T1 – T4, T8, T10	Manual, within 15 minutes
Emergency response	T6	Manual, within 30 minutes
Incident warning	All	Automatic, within 3 minutes
Lane control	All	Automatic, within 1 minute
Rerouting	C1, T1 – T4, T8, T10	Manual, within 15 minutes
Rerouting	T6	Manual, within 30 minutes
Speed harmonisation, speed management	C1, T3, T4	Automatic, within 3 minutes
Speed harmonisation, speed management	T8, T10	Automatic, within 5 minutes
Speed harmonisation, speed management	T2, T6	Manual, within 15 minutes

In summary, automatic incident detection is only demanded by incident warning, lane control and speed management applications.

Table 4.8 : Minimum Recommended Levels - CCTV

Operating environment	Traffic management services*	Camera density (km)	Image update frequency
C1 critical or black spots, local flow-related traffic and/or critical weather problems	CR	1/bridge	20 min
	EI	1/spot	20 min
	ER/IW	1/spot	online
	LC	1/spot	0.3 sec
	SM, SH	1/system	20 min
	WM	1/spot	20 min
T1 motorway(link), no flow-related traffic problems, no critical weather problems	EI		
T3 motorway(link), daily flow-related traffic problems,	EI		
	LC		
	IW		

no critical weather problems	SM, SH		
seasonal flow-related traffic problems, critical weather problems	EI	80	60 min
	ER/IW	1/spot	on demand
	SM, SH	1/system	30 min
	WM	40	30 min

*CR = Closure of roads, bridges etc., EI = Event Information, EI (VMS) = Event Information via Variable Message Signs, ER = Emergency Response, IW = Incident warning (incl. local warnings for ice, elks, etc.), LC = Lane control, RR = Rerouting, SH = Speed harmonisation, SM = Speed management, WM = Winter maintenance.

In summary, CCTV sites are only deployed to problem sites. There is no real recommendation for systematic deployment of CCTV to non-problem sections of road.

4.3 ITS Deployment Model

The basic drivers of ITS deployment on any road network are:

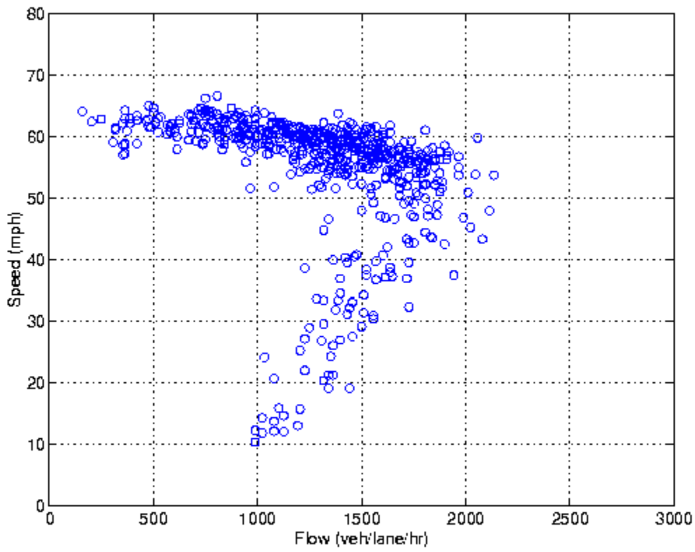
- Safety (fatalities/injury accidents);
- Mobility (travel time, delay and reliability); and
- Efficiency (throughput, effective capacity).

In addition to these tangible drivers, there is also a need to meet the current and future expectations of motorists in regard to travel information and services provided. A fundamental objective of ITS deployment in Europe is to provide a consistently high level of information to the motorist and consistency in presentation within a country and across national borders.

As a means of deriving a long term implementation programme for ITS deployment, we have developed a generic deployment model for the INSTANT corridor driven by the key drivers identified above and taking into account other European ITS deployment initiatives.

The most direct and quantifiable drivers in describing flow conditions on the road are speed and flow. The widely used speed/flow curve (example below) demonstrates how the average vehicle speed at any one location reduces steadily with increasing flow until a point is reached where the flow becomes unstable and the average speed drops dramatically. From the point stable flow is lost, demand exceeds capacity and congestion results. Stable flow will only be re-established once demand has dropped off for some (often significant) period of time.

Figure 4-1 : Typical Speed Flow Curve



The speed/flow relationship has been extended further (primarily in the USA) to determine the associated Level Of Service (LOS). The LOS describes the quality of traffic operations within a traffic stream and at a given location. This quality is generally described in terms of speed and travel time, freedom to manoeuvre, traffic interruptions, and comfort and convenience.

Figure 4-2 : Level of Service Description

Level of Service	Description	% Capacity
A	This is a condition of free flow, accompanied by low volumes and high speeds. Traffic density will be low, with uninterrupted flow speeds controlled by driver desires, speed limits, and physical roadway conditions. There is little or no restriction in manoeuvrability due to the presence of other vehicles, and drivers can maintain their desired speeds with little or no delay.	33
B	This condition has stable flow, but operating speeds are beginning to be restricted somewhat by traffic conditions. Drivers still have reasonable freedom to select their speed and lane of operation. Reductions in speed are not unreasonable, with a low probability of traffic flow being restricted	55
C	This condition still has stable flow, but it is susceptible to congestion due to slow moving and turning vehicles. Most of the drivers are restricted in their freedom to select their own speed, change lanes, or pass.	75
D	This condition has unstable flow. Platoon sizes of 5 to 10 vehicles are common and drivers may be delayed by platoons up to 80% or 85% of the time. Travel speeds are lowered and turning vehicles and roadside distractions cause major shock waves in the traffic stream. Drivers have little freedom to manoeuvre, and comfort and convenience are low.	88
E	This condition has unstable flow, with operating conditions difficult to predict. Flow is unstable, and there may be stoppages of momentary duration. This level of service is associated with operation of a facility at capacity flows. Platooning is intense and travel speeds are low.	100
F	This describes a forced-flow operation at low speeds, where volumes are below capacity. Speeds are low and in the extreme, both speed and volume can drop to zero. Traffic demand has exceeded capacity.	<100

A primary goal of ITS is to maintain as much spare capacity on the network as is possible at any time.

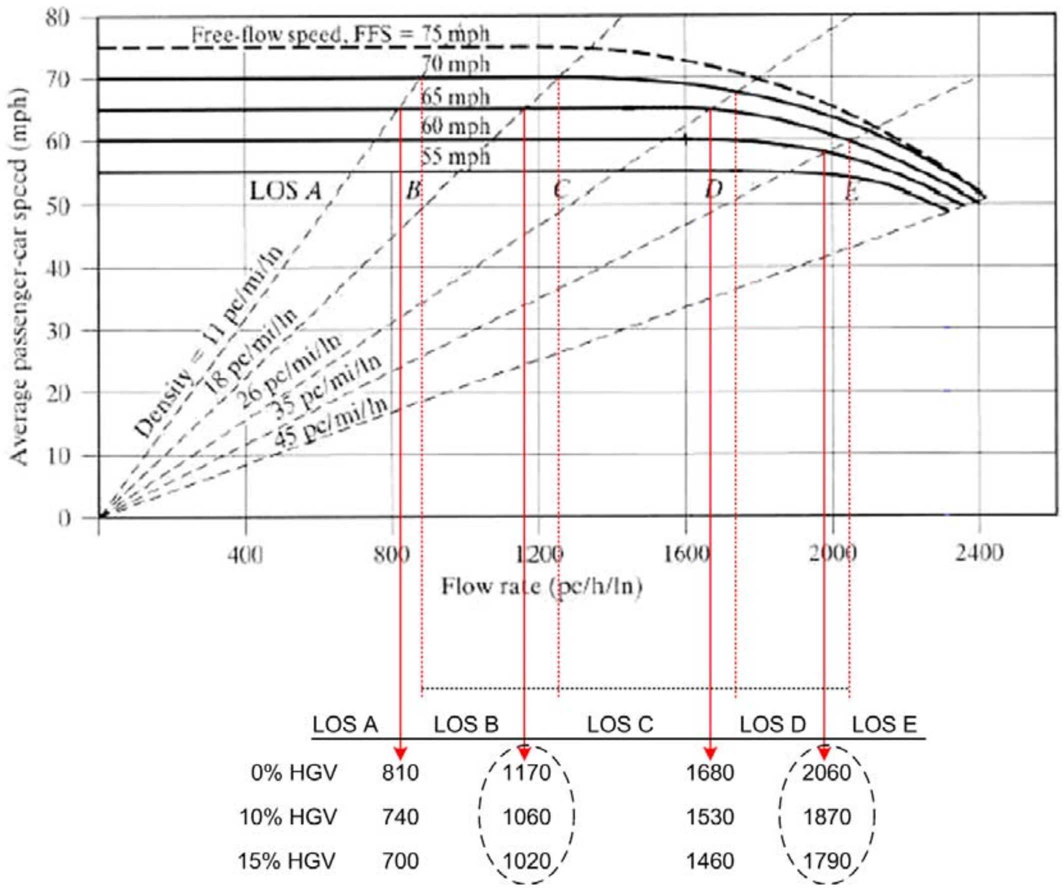
Two key transition levels are shown in the table above:

- **LOS B** to **LOS C** Congestion and driver restrictions become an issue; and
- **LOS D** to **LOS E** Unstable flow and severe congestion occur.

It is proposed that these transitions form the basis for progressing from one level of ITS deployment to the next. The process for deriving the flow figures associated with each transition is shown below

(Note – a multilane factor is applied to take the FFS down from 70 mph to 65 mph and a %HGV flow adjustment is also shown).

Figure 4-3 : Speed/Flow/Level of Service Relationship



Most of the INSTANT corridor is subject to relatively high HGV volumes (between 10% and 15%). Therefore the transition flows proposed are:

- LOS B to LOS C 1000 veh/lane/hour; and
- LOS D to LOS E 1800 veh/lane/hour.

These quantitative flow figures are then combined with a more subjective assessment of congestion/accident levels for each road link to derive a corresponding level of ITS infrastructure.

Table 4.9 : ITS Deployment Table: Normal Routes

			Column A	*Column B*	*Column C*
	Safety ►	Accident Rate ►	Low	Average	High
	Mobility►	Congestion ►	None/Minor	Some/Moderate	Major
	Efficiency (Throughput) ▼				
	AADT/lane ▼	Peak ▼			
Row 1	<8000	<1000 v/l/hr	-	Level 1	Level 2
Row 2	8K-15K	1000 -1800 v/l/hr	Level 1	Level 2	Level 3
Row 3	>15000	>1800 v/l/hr	Level 2	Level 3	Level 3

It is envisaged that the deployment table would be used as follows:

- Any one road link on the INSTANT corridor (or series of links) is assessed in terms of the key drivers of peak flow, accident rate and congestion;
- The peak flow figure is used to establish which row of the table is to be used;

- The accident rate and/or congestion value is used to establish which column of the table is appropriate (these may be the same column or different columns); and
- The most appropriate level of ITS deployment would be given by the intersecting cell.

For example, a given link may have a peak flow of 1200 veh/lane/hour (*Row 2*) with a low accident rate and minor congestion (*Column A*). This would give a resultant *A2* cell reference and a recommended deployment of Level 1 ITS.

It is further proposed to extend the above model by introducing an additional ITS driver, namely the 'Strategic' route (or Category P as proposed by STREETWISE). This additional driver would apply to routes which include:

- roads designated as on the Trans European Network and serving international journeys;
- severe climatic conditions; and
- a high percentage of freight traffic.

For routes where these conditions apply, it is proposed the standard ITS deployment table is modified by an earlier deployment of the Level 1/2/3 infrastructure at the lower peak flows as shown below.

Table 4.10 : ITS Deployment Table: Strategic (Category P) Routes

			Column A	*Column B*	*Column C*
	Safety ►	Accident Rate ►	Low	Average	High
	Mobility►	Congestion ►	None/Minor	Some/Moderate	Major
	Efficiency (Throughput) ▼				
	AADT/lane ▼	Peak ▼			
Row 1	<8000	<1000 v/l/hr	Level 1	Level 2	Level 2
Row 2	8K-15K	1000 -1800 v/l/hr	Level 2	Level 2	Level 3
Row 3	>15000	>1800 v/l/hr	Level 2	Level 3	Level 3

Using the previous example (peak flow of 1200 veh/lane/hour with a low accident rate and minor peak congestion), this would give the same *A2* cell reference but a corresponding deployment of Level 2 ITS on a strategic route.

It is worth observing that the move from one level of ITS deployment to the next can be triggered by increasing traffic flows (which are easily monitored) or by increases in accident rates and/or congestion at the same flows. Assessment of the latter triggers is likely to be more subjective than the former.

It is proposed that the 'Normal' route model and deployment table would apply to most roads within Ireland whilst the 'Strategic' route model and deployment table would apply specifically to the INSTANT corridor and other roads designated as on the Trans European Road Network.

4.4 INSTANT ITS Deployment

4.4.1 Short Term (0-3 Years)

Over this short term time frame, the INSTANT corridor is expected to be categorised by generally low accident rates and very limited lengths affected by recurrent congestion (Column A of Table 4.10).

Current peak hourly flows along the route are presented overleaf in Figure 4-4. These show that most of the corridor has relatively low peak flows of between 300 veh/hr/lane and 600 veh/hr/lane (Row 1 of Table 4.10). Higher peak flows of up to 900 veh/lane/hr are observed immediately north of the M1/M50 Junction in the RoI.

Using the ITS deployment table for Strategic routes (Table 4.10), the whole INSTANT corridor can be categorised *A1* and therefore requiring Level 1 ITS deployment over its full length.

4.4.2 Medium Term (3-7 Years)

In the medium term, peak flows along the corridor are expected to increase largely in line with overall increases in the AADT. However, on the whole these peak flows will remain below the trigger level for Level 2 ITS deployment.

In the RoI, the town of Balbriggan is being developed as a major new satellite town to Dublin with a significant contribution of commuter traffic in and out of Dublin. In conjunction with normal traffic growth on the corridor, this is expected to push peak flows over the 1000 veh/lane/hr trigger level (Row 2 of Table 4.10) with some resulting peak hour congestion (Column B of Table 4.10). In either case, this will require the deployment of Level 2 ITS over the affected length.

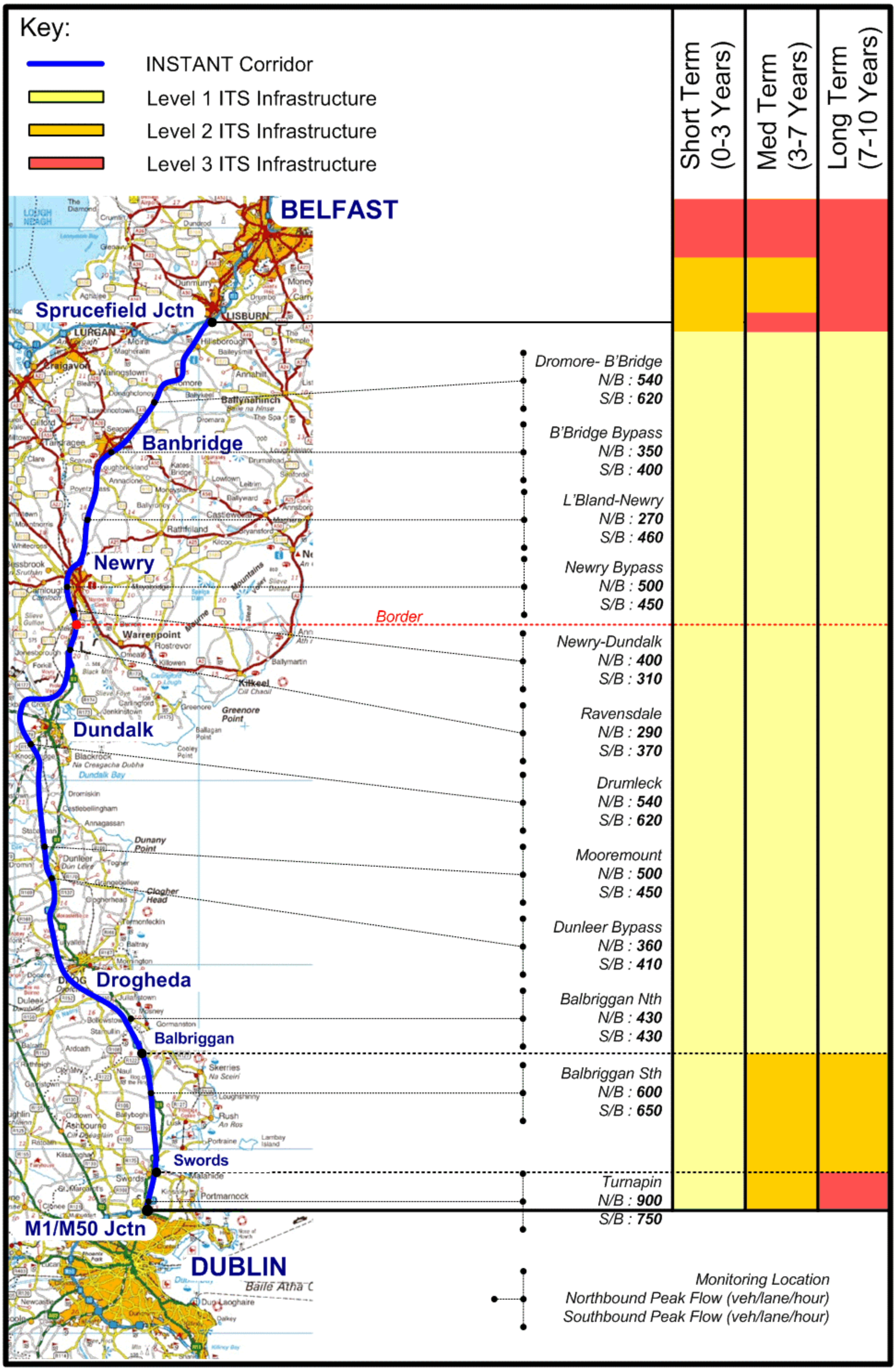
More data collection and modelling will be required during this timeframe to confirm these assumptions. The earlier deployment of Level 1 ITS traffic monitoring sites will be a key source of this data.

4.4.3 Long Term (7-10 Years)

In the long term, Level 1 ITS deployment is expected to remain appropriate for most of the INSTANT corridor. Level 2 ITS will continue to be deployed on the M1 south of Balbriggan and possibly also on some shorter lengths of the corridor to the north where local congestion becomes a problem (the latter are not shown on the map overleaf).

Continuing increases in peak flows and recurrent congestion can be expected on the M1 up to Dublin Airport and Level 3 ITS deployment may be required to effectively manage this.

Figure 4-4 : ITS Infrastructure Deployment



5 ITS Infrastructure

5.1 Definition and Purpose

For the purposes of this report, ITS 'infrastructure' is defined as the combination of field equipment hardware, communications hardware and control subsystems required to implement a specific ITS technology.

On the INSTANT corridor, these infrastructure assets will typically be owned and maintained by the appropriate road authority (e.g. NRA or RS). The elements of the proposed INSTANT ITS infrastructure are discussed below in the following four functional categories:

♦ Data Collection and Incident Detection	*What is going wrong?*
♦ Verification	*How bad is it?*
♦ Information Dissemination	*How do we inform the users?*
♦ Control and Management	*How do we fix it?*

5.2 Data Collection and Incident Detection Technologies

5.2.1 Traffic Monitoring

5.2.1.1 Purpose

The purpose of traffic monitoring is to obtain the appropriate level of accurate traffic data such that traffic behaviour along the corridor can be measured and analysed.

The basic data requirements for traffic monitoring sites are:

- Vehicle presence/counts - used over a given time period to derive volume (flow) – vehicles/lane/hr;
- Vehicle length - used to derive vehicle type or classification (e.g. % HGV traffic); and
- Vehicle speed.

As real time incident detection becomes a necessary output of the traffic monitoring system, then the data above is typically supplemented by;

- Vehicle Occupancy - a representation of traffic density.

The above traffic data is used through all stages of an evolving ITS infrastructure deployment and there is no reason why the traffic monitoring equipment from Level 1 ITS cannot go on to become part of a Level 3 ITS Incident Detection system.

The fundamental change in traffic monitoring as it progresses from Level 1 to Level 3 is in the increased frequency of data collection at the monitoring site and the real-time communications of this data back to the central monitoring system at the TCC.

5.2.1.2 Technologies

The most widely used technology for traffic monitoring is inductive loops. Pairs of inductive loops installed in each lane at a monitoring site are capable of detecting the magnetic signature of a vehicle as it passes over. A local outstation then takes these loop signals and derives the above flow/speed and classification (magnetic length) for each vehicle/time interval.

For the purpose of this report it has been assumed that because of its proven accuracy and ease of installation loop based technology is the standard traffic monitoring technology to be deployed. However, other detection systems exist, and it is feasible that their performance (and cost) could make them viable alternatives if not now, within the 10 years of the INSTANT Programme.

For example, alternative 'above ground' technologies such as video detection or side-fired radar (microwave) could also be considered for traffic monitoring. Both systems create a 'virtual loop' across which vehicles pass and then process the information generated by the change in conditions detected. The primary advantage of these technologies is that they do not require regular maintenance to replace/repair failed loops. However, whereas loop technology will give close to 100% detection and categorisation rates, above ground technologies do not (at present) provide this degree of accuracy, though they can be used for general incident detection. Also, they can be affected by poor visibility and/or image shake (depending on the support structure).

5.2.1.3 Level 1 ITS Traffic Monitoring

At this level, 'non real-time' data is used to build up a picture of traffic flow, speed and vehicle type at regular intervals along the route. This data would be used as the basis for expansion to 'real-time' Level 2 ITS and Level 3 ITS as appropriate.

It is recommended that loop based traffic monitoring sites are installed along the full length of the INSTANT route at nominal five kilometre intervals. These sites should be capable of measuring vehicle counts/speed/classification data on a lane by lane basis as described above. The data shall be collated into five minute intervals through possible peak flow periods (nominally 0600 to 1000 hours and 1500 to 1800 hours) and fifteen minute intervals otherwise. Data retrieval is envisaged to be undertaken daily using GSM/PSTN 'dial-up'. Sufficient data storage shall be provided such that one weeks data can be held without data loss.

5.2.1.4 Level 2 ITS Traffic Monitoring

Level 2 ITS traffic monitoring is an incremental expansion to Level 1 ITS in that the traffic data is 'streamed' to the subsystem in real-time using GPRS (or similar). This real-time data can then be used by the traffic monitoring subsystem at the TCC to generate rudimentary incident alerts (or receive such alerts from 'intelligent' monitoring outstations).

This provision of real-time incident alerts would typically be supported by an increase in the frequency of traffic monitoring sites. A nominal two kilometre spacing (rather than five kilometres for Level 1 ITS) between sites is recommended.

As there is no increase in capital costs to achieve the 'real time' data functionality, early adoption of GPRS as part of Level 1 ITS deployment may be considered.

5.2.1.5 Level 3 ITS Traffic Monitoring

This level of traffic monitoring is characterised by full Automatic Incident Detection (AID) and is typically deployed on critical sections of heavily loaded motorway with monitoring sites at nominal 500 metre intervals.

A key data element in most incident detection algorithms is that of 'occupancy'. This parameter is only accurately measured by loop based detectors at this time. Any move to offer alternative detection technologies for incident detection should ensure occupancy is accurately measured.

5.2.1.6 Communications Implications

There is a significant impact on the communications requirements and solution as monitoring treatment moves from Level 1 ITS to Level 3 ITS. The following technologies are considered most appropriate for the specific constraints of the INSTANT corridor:

- Level 1 ITS – Dial-up links using GSM to sites at 5km intervals. Early adoption of GPRS should be considered;

- Level 2 ITS – Continuous links using GPRS to sites at 2km intervals enabling rudimentary incident alerts from suitably equipped detection outstations; and
- Level 3 ITS – Continous links to sites at 500 metre intervals to enable full AID. Sites will typically share fibre optic/WLAN backbone communications installed for CCTV applications.

5.2.2 Meteorological Monitoring

5.2.2.1 Purpose

Meteorological monitoring for the INSTANT Corridor is aimed at obtaining useful quality data on weather conditions at key locations along the corridor. Anecdotal evidence suggests that heavy rain, poor visibility and snow are commonly experienced by motorists using the INSTANT route. Information on the extent and scale of this problem will be gathered to build up an understanding of weather influences along the route and will ultimately be used to warn drivers of inclement driving conditions (through websites and en-route VMS).

The key meteorological conditions influencing driver behaviour and safety should be monitored. These include:

- Wind speed and direction;
- Precipitation type (rain/snow), presence and intensity; and
- Visibility.

5.2.2.2 Level 1 ITS Meteorological Monitoring

It is recommended that meteorological monitoring sites are installed along the full length of the INSTANT route at nominal twenty kilometre intervals. These sites should be capable of measuring wind speed/precipitation/visibility data as described above. The equipment should be of similar specification to the existing Vaisala stations used by NRA and RS. Location of sites should be decided through consultation with the equipment supply company and/or national Meteorological agencies. The data shall be stored locally with retrieval to be undertaken daily using GSM/PSTN ‘dial-up’ means. Sufficient local data storage shall be provided such that one week of data can be held without data loss.

5.2.2.3 Level 2 ITS Meteorological Monitoring

Level 2 ITS meteorological monitoring requires a functional expansion of Level 1 ITS monitoring to allow the data to be ‘streamed’ to the subsystem in real-time using GPRS. There may be a small increase in capital costs to achieve this and ongoing GPRS call costs will be incurred (although they are expected to be relatively low).

Additional sites may be added to improve the accuracy and relevance of weather information disseminated to the motorist.

5.2.2.4 Level 3 ITS Meteorological Monitoring

Level 3 meteorological monitoring may require the functional upgrade of some Level 1/2 sites or new sites to include additional sensors as required to target specific problem locations or to meet environmental monitoring needs. Such sensors may allow monitoring of:

- Water depth (flooding); and
- Carbon dioxide levels (in urban areas).

5.2.2.5 Other Weather Information Sources

It would be desirable if other sources of weather data could be utilised to complement the dedicated INSTANT monitoring sites.

The RoI have a large weather monitoring network of 52 sites distributed throughout the country with equipment and services provided by Met Eireann/Vaisala. These sites are primarily aimed at supporting the road salting programme and are polled hourly for data on temperature (air, road surface, subsurface), precipitation, humidity and surface condition. Three of these sites are of possible use to INSTANT:

- Dublin Airport;
- M1 Drogheda Bypass (new site); and
- M1 Dunleer Bypass.

A similar network is in place in Northern Ireland with one site on the INSTANT corridor:

- A1 Dromore.

Basic information from these sites will certainly be useful to INSTANT for dissemination by the project website (as is already done in the ROI on http://www.nra.ie/RoadWeatherInfo/Map/).

More targeted use of this information for dissemination on roadside VMS will depend on the type of data being collected at these sites and the frequency of data collection.

5.2.3 ANPR Journey Time System

5.2.3.1 Purpose

Time is a concept that everyone understands without interpretation. As such, the provision of accurate 'pre-trip' and 'en-route' journey time that reflects the real state of the traffic along the route is of major value to the motorist.

The information will typically be disseminated en-route to the motorist using roadside Variable Message Signs (VMS). Under normal conditions, the information provided on the VMS will be the remaining journey time (from the location of the VMS) to one or more downstream locations e.g. 'Dromore – 15 min'/'Belfast – 60 min'.
When an incident on the road ahead means that there are delays to the 'usual' journey time, then the location/duration of the delay may be displayed (providing a suitable VMS is available). This will give the motorist the ability to make their own decision on continuing, taking another route or perhaps stopping for a break. This information may take the form 'Congestion'/'10 min delay'/'Newry to Dundalk'.

Discussion of the options for en-route journey time dissemination using VMS is included in Section 5.4.1. Information on journey times for pre-trip planning will be made available primarily through the project website (Section 6.2.1)

A secondary benefit of a well designed journey time system is the ability to offer a simple form of incident detection. This functionality would require the journey time subsystem at the TCC to store historical link journey times in a database. Current journey times for each link would be compared with the historical 'norm' and incident alerts triggered when these were exceeded by a configurable threshold.

5.2.3.2 Technology Options

There are three primary means of monitoring journey times along a route. These include:

- The use of Floating Vehicle Data (FVD);
- Derivation of journey times using vehicle speed at traffic monitoring sites; and
- Automatic Number Plate Recognition (ANPR).

A discussion of these options is in Appendix B1. The most appropriate solution for INSTANT is considered to be ANPR as this provides a direct and accurate measure of a vehicles journey time between two points.

5.2.3.3 Level 1 ITS ANPR Sites

It is recommended that ANPR journey time sites are installed at nominal 15-20 km intervals along the full INSTANT corridor to provide real-time journey times and delay information. Each site shall be fitted with ANPR cameras/illuminators monitoring each lane of traffic (in both directions). Data from each site shall be held locally for no more than 3 minutes before 'real-time' transmission to the JTMS subsystem using GPRS (or similar).

Journey time information would be disseminated to drivers en-route using 'journey time' VMS co-located with the ANPR equipment and by the INSTANT website for pre-trip planning.

5.2.3.4 Level 2 ITS ANPR Sites

Level 2 ITS would double the density of ANPR sites along the corridor by reducing the nominal interval to 8-10 km.

The objective of providing additional sites would primarily be to improve the accuracy of the journey time predictions. Provided the Level 1 ITS ANPR sites were fitted with 'journey time' VMS, there would be no need to provide the additional Level 2 sites with such VMS.

5.2.3.5 Level 3 ITS ANPR Sites

Level 3 ITS journey time monitoring may see the ANPR based journey times from Level 2 ITS supplemented by FVD systems although the very high flows associated with Level 3 would provide very good journey times from the ANPR system in isolation.

5.2.4 UTC Systems

Once the new road construction programme is complete, the INSTANT corridor will effectively bypass most towns with any form of UTC system.

It should be noted however that many of the proposed diversion strategies in ROI could utilise the old N1 route through Drogheda and Dundalk. In this case, it will be necessary to integrate the UTC in these locations such that unexpected volumes of traffic associated with a diversion can be managed.

5.2.5 Emergency Roadside Telephones (ERT)

The use of mobile phones by the travelling public can be a valuable source of incident information. This information is provided to the Police/Garda for accidents or to radio stations who pass information received on delays and congestion back to their listeners.

On motorways, the implementation of ERT's is a design standard requirement. It would be possible to extend this requirement beyond motorways to cover the rest of the INSTANT corridor and this should be considered.

5.3 Verification Technologies

5.3.1 Closed Circuit Television (CCTV)

5.3.1.1 Purpose

The primary means of incident verification has always been the use of Closed Circuit Television (CCTV). It can provide the TCC operator with immediate visual confirmation of the incident impact and possibly the incident cause.

5.3.1.2 CCTV Camera Technology Options

A detailed discussion of the CCTV technology options and issues is in Appendix B2. Careful consideration of these key design factors is necessary to ensure user needs (primarily TCC operators) are met in terms of the quality of the surveillance video image and flexibility in site selection.

5.3.1.3 CCTV Architecture and Transmission

Traditional CCTV surveillance networks are typically pure analogue systems where the image from an analogue camera is transmitted over a point to point link back to the central video matrix and displayed on one or more analogue monitors at the TCC. As might be expected, the digital revolution is starting to make some impact on this traditional solution. Analogue cameras now include Digital Signal Processing (DSP) and digital transmission options are becoming more common with the advent of IP based codecs and Ethernet/IP based LAN/WAN's.

The discussion in Appendix B considers the merits of analogue and digital approaches, and as appropriate for the INSTANT corridor focuses on getting CCTV coverage in 'remote' sites where obtaining high bandwidth communications is a major problem. Where sites can be serviced by end to end fibre optic cabling in major urban areas, then there is often no real need to compromise on many of these factors.

5.3.1.4 Value of CCTV Images

The decision between analogue video and digital video is often limited to an evaluation of their relative image quality/cost merits i.e. which option provides the best image quality to the operator at the least cost.

However, the debate could be extended to cover the other potential uses of the CCTV footage. Two of the more recent MPEG formats (4 and 7) offer more facilities than just video compression and transmission;

MPEG-4 is an extension of MPEG-2. As well as an improvement in compression and video quality, it offers:

- Multimedia functionality with object coding – In a MPEG-2 environment, any text or graphics must be forced into the live video stream for encoding (which is why you can sometimes watch recorded 'live' sports games). MPEG-4 authoring however allows these text and graphics to be coded separately. This in turn allows interaction to take place with these objects (e.g. it is possible to turn an object on or off or change its colour etc). In short, MPEG-4 will allow the sort of interactivity currently possible with DVD's to be delivered across a broadband network. It also means that the objects within the video stream can remain sharp even at high compression rates; and
- Support for Profiles – In its most basic form, this allows the MPEG-4 video to be re-broadcast on the fly in a range of different formats (size/frame rate/resolution and with or without text/graphics objects) to any number of other users.

MPEG-7 is a recently finalized standard for description of multimedia content. It will be used for indexing, cataloguing, advanced search tools, program selection, smart reasoning about video/multimedia content and more. The standard comprises syntax and semantics of multimedia descriptors and descriptor schemes. MPEG-7 is an important standard because it allows the management, search and retrieval of ever-growing amounts of content locally stored, on-line and in broadcasts.

In summary, the use of digital video transmission and storage using these developing standards could significantly add to the value of the surveillance video as an information source. Rather than being buried deep within TCC systems, pre-defined video sources can be distributed securely to other parties in a format they can use directly or as a re-packaged service (with potential revenue generation).

5.3.1.5 Field Equipment

The minimum camera specification will likely include:

- Colour CCD ½" 480 TV line camera;

- 10:1 zoom lens or greater;
- DC variable speed Pan and Tilt Unit – IP66;
- Environmental Housing – IP66;
- Wiper unit;
- Presets facility; and
- Alarm input capability.

The cameras will typically be mounted on 15 metre support poles in order to maximise the field of view, although existing structures may be used where appropriate in order to save costs.

5.3.1.6 Level 1 ITS CCTV

The recommended deployment of CCTV for Level 1 ITS is to provide CCTV monitoring to known locations where there is a history of accidents, incidents or congestion. Given the significant road building programme underway in both ROI and NI at present, it is difficult to predict these key locations in advance. Once these new roads have been operating for some time, CCTV location selection for new sites will become more straightforward.

The following sites have been selected for Level 1 ITS CCTV deployment:

Table 5.1 : Level 1 ITS CCTV Sites

Site	Distance (km)	Inter-distance (km)	Location Description
Northern Ireland			
CCTV NI -1	3	3	Hillsbrough Nth
CCTV NI -2	4.5	1.5	Hillsbrough Sth
CCTV NI -3	10	5.5	Dromore Nth (B2/A1)
CCTV NI -4	21	11	Banbridge Nth (A26/A1)
CCTV NI -5	42	21	Newry Nth
CCTV NI -6	48	6	Newry Sth (Cloghogue I/C)
Republic of Ireland			
CCTV ROI -1	73	25	Dundalk Sth
CCTV ROI -2	134	61	Lissenhall I/C (N1/M1)
CCTV ROI -3	140	6	Airport I/C

5.3.1.7 Level 2 ITS CCTV

Level 2 ITS will provide more systematic coverage of the route with CCTV deployment at all major intersections/interchanges where the trigger conditions are met or exceeded.

On the basis that Level 2 ITS deployment in the RoI will ultimately extend to the Balbriggan interchange, this will mean one additional CCTV site at this interchange (M1/R122 junction).

5.3.1.8 Level 3 ITS CCTV

Subsequent deployment of CCTV with Level 3 ITS will further extend surveillance coverage of the corridor. CCTV sites for Level 3 ITS would be designed to achieve 85-90% coverage (at a sensible zoom level) of the main carriageway and interchange ramps.

For the purposes of costing, one CCTV site every kilometre has been assumed to achieve this level of coverage.

By 2014, the deployment model has Level 3 ITS extending only over the M1 in RoI between the M1/M50 junction and the Airport. Over this two km length, one new CCTV site would be required.

5.3.2 Highway Patrols

Although not strictly ITS, the use of dedicated highway patrols can serve a detection, verification and management role complementary to the use of ITS infrastructure.

These service patrols are roving vehicles that move continuously over the road network to provide motorist assistance and to handle minor incidents. They may initially operate only during the day (say 6:00 am and 8:30 pm) but could expand and start providing 24 hour operations, 7 days a week as demand increases.

5.3.2.1 UK Proposals

The HA is currently introducing Incident Support Units (ISU) through their existing area maintenance contracts. The purpose of an ISU is to minimise disruption to road users, by providing a safe and timely response to incidents, whilst also reducing the time taken to remove any restriction on the road network.

The functions of an ISU during an incident are to:

- make the incident scene safe, through application of local traffic management measures;
- assess the incident scene and request additional resource requirements;
- manage local traffic at the scene of the incident, to relieve congestion and remove any debris or hazards from the carriageway;
- provide a communications link between the scene of the incident and the control/management centre; and
- where possible undertake any infrastructure repairs.

The functions of an ISU during periods when they are not attending to incidents are to:

- patrol the network and provide status reports to the control/management centre;
- report on or repair any highway infrastructure which is unsafe or is causing a risk to the health and safety of road users; and
- undertake any minor maintenance activities.

5.3.2.2 USA Experience

Highway patrols have been established in the USA for more than 10 years.

The table below[9] summarises the benefits from incident management programmes where freeway service patrols have proven to be very successful at reducing incident detection time and duration. With a high benefit-cost ratio (ranging from 2:1 to 36:1), programmes such as these are becoming more popular with the motoring public, politicians, and the agencies that support/operate them.

[9] Freeway Services Patrols: A State of the Practice - Fenno and Ogden – 1998

Table 5.2 : Results of Service Patrol Benefit-Cost Studies

LOCATION	PATROL NAME	YEAR PERFORMED	B/C RATINGS
Charlotte, NC	Incident Management Assistance Patrol	1993	3:1 to 7:1
Chicago, IL	Emergency Traffic Patrol	1990	17:1
Dallas, TX	Courtesy Patrol	1995	3.3:1 to 36.2:1
Denver, CO	Mile High Courtesy Patrol	1996	20:1 to 23:1
Detroit, MI	Freeway Courtesy Patrol	1995	14:1
Fresno, CA	Freeway Service Patrol	1995	12.5:1
Houston, TX	Motorist Assistance Program	1994	6.6:1 to 23.3:1
Los Angeles, CA	Metro Freeway Service Patrol	1993	11:1
Minneapolis, MN	Highway Helper	1995	5:1
New York & Westchester Co., NY	Highway Emergency Local Patrol	1995	23.5:1
Norfolk, VA	Safety Service Patrol	1995	2:1 to 2.5:1
Oakland, CA	Freeway Service Patrol	1991	3.5:1
Orange Co., CA	Freeway Service Patrol	1995	3:1
Riverside Co., CA	Freeway Service Patrol	1995	3:1
Sacramento, CA	Freeway Service Patrol	1995	5.5:1

5.4 Information Dissemination Technologies

5.4.1 Introduction

The EC TROPIC[10] project recognised that Variable Message Signs (VMS) are a crucial element of traffic information provision, since the VMS information is presented to all passing motorists and the VMS allow remote control of traffic by directing or restraining orders. VMS are especially important in the operation of the Trans European Road Network (TERN). In both NI and RoI VMS are already used, or will soon be operational. VMS are expensive (£100k / €140k typical cost for a large sign) and need good control and management systems to be successful. Various evaluation studies have shown that VMS can provide benefits to road users and road managers.

This section considers VMS as part of the ITS infrastructure implementation package. However, other technologies, notably radio broadcasting and the use internet technology and in-car systems should also be seen as part of the INSTANT information dissemination strategy. These other systems do not need the on road deployment of VMS. Radio and web technology are dealt with in later sections of this report.

5.4.2 Variable Message Signs (VMS)

Variable Message Signs (VMS) continue to be the most commonly used and accepted means of disseminating information to the motorist whilst en-route. VMS are commonly used on the motorways around Belfast and are currently being deployed around Dublin on the M50. They are a key technology for deployment along the INSTANT corridor.

[10] http://europa.eu.int/comm/transport/extra/tropicia.html

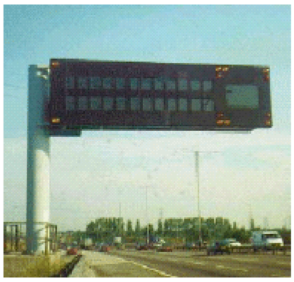
5.4.2.1 Sign Technology Options

Strategic VMS

Traditionally, the main purpose of VMS has been to get text based messages across to the motorist whilst en-route. As the message type and complexity has increased, there has been a desire to supplement the primary text message with a basic graphics capability.

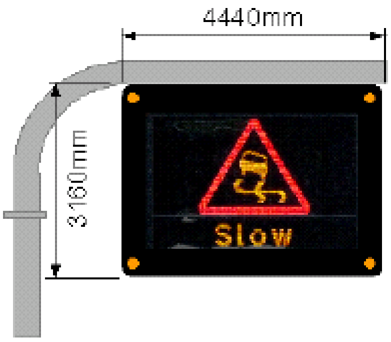
A typical VMS (MS2) widely used on UK motorways is shown opposite. These types of VMS (MS2 and MS3) are single colour LED signs commonly deployed in two configurations:

- Strategic - Three lines of 18 characters (plus small graphics panel or EMI); and
- Tactical - Two lines of 12 characters (plus small graphics panel or EMI).



More recently, the Highways Agency and Welsh Assembly Government has begun to implement a new type of VMS (MS4) with a stronger emphasis on graphics display capability and a dual colour display as shown on the right. This is expected to provide

- More flexibility in message options (text and pictograms);
- Smaller, less obtrusive signs;
- Easier installation and maintenance; and
- Lower cost (volume dependant).



Journey Time VMS

While the 'Strategic' VMS are providing general incident/event information to motorists, 'Journey Time' VMS co-located with the ANPR sites are expected to provide specific journey time information at frequent intervals along the route.

These VMS will also be LED based but significantly smaller and less expensive. Additional information and options for each VMS type are appended (Appendix B3)

5.4.2.2 Location Selection

The criteria for locating a VMS is largely dictated by its intended primary use, either for route diversion as part of a wider incident management strategy or for display of general route information (e.g. journey time, road conditions etc).

Where the primary use for the VMS is route diversion in the event of a major incident, the location should be in advance of the possible diversion exit. Current HA practice in the UK uses VMS 'pairs' in this situation to ensure the motorist has time to take on board the necessary information which may be split across the two signs.

Where the VMS is just used to present journey information (e.g. journey time, road conditions etc), the message size is typically small enough to be presented on a single VMS and the expense of a VMS 'pair' may not be warranted. The location of this single VMS relative to exits is not critical and the site should be chosen on other criteria (e.g. sight distance, use of existing structures etc)

5.4.2.3 Level 1 ITS VMS

The use of 'Strategic' VMS is primarily dictated by incident warning and associated route diversion needs. The route diversion options and VMS locations for the INSTANT corridor are outlined in Section 5.5.1.2.

It is recommended that all VMS associated with primary decision points are implemented as part of Level 1 ITS deployment. This will provide a total of five new Strategic VMS along the corridor as highlighted in the shaded cells:

Table 5.3 : Strategic VMS Deployment Summary

VMS	Status	Decision Point	Location Description
Northern Ireland			
DP10S	Existing pair	Primary	Southbound on the M1 immediately north of the Sprucefield Interchange (Junction 7)
DP9N	new	Primary	Northbound on the A1 immediately south of the A1/A27 junction (Note : this length of road is subject to new construction – Beech Hill to Clogugue 2006-2008)
Republic of Ireland			
DP8S	new	Secondary	Southbound on the M1 immediately north of the M1/N1 junction north of Dundalk
DP7N	new	Primary	Northbound on the M1 immediately south of the M1/N53 junction (Note : this length of road is subject to new construction – Dundalk Western Bypass 2003-2005)
DP6S	new	Primary	Southbound on the M1 immediately north of the M1/N52 junction southwest of Dundalk (Note : this length of road is subject to new construction – Dundalk Western Bypass 2003-2005)
DP5S	new	Primary	Southbound on the M1 immediately north of the M1/N33 junction near Dunleer (Note : this section of road is managed by the private toll operator for the Drogheda Bypass)
DP5N	new	Primary	Northbound on the M1 immediately south of the M1/N33 junction (Note : this section of road is managed by the private toll operator for the Drogheda Bypass)
DP4N	new	Secondary	Northbound on the M1 immediately south of the M1/N1 junction at Dunleer
DP3S	new	Secondary	Southbound on the M1 immediately north of the M1/N1 junction between Drogheda and Dunleer
DP2N	new	Secondary	Northbound on the M1 immediately south of the M1/N1 junction between Balbriggan and Drogheda
DP1N	existing	Primary	A number of existing VMS on the M50 provide all the necessary information/diversion advice

At this stage, we are not proposing the use of VMS 'pairs'. A second VMS can be added at a later date to create a 'pair' if there is a need to so.

Although not strictly necessary from a diversion management viewpoint, other Strategic VMS sites (already identified in WP1 work) are also proposed.

VMS	Status	Decision Point	Location Description
Northern Ireland			
	new	N/A	Southbound on the A1 immediately north of Newry – to provide en-route information between VMS sites DP10S and DP8S (which are over 50 km apart)
	new	N/A	Northbound on the A1 immediately south of the Sprucefield junction – to provide information to northbound traffic regarding conditions on the M1

If adopted, this will provide a total of seven new Strategic VMS along the corridor.

5.4.2.4 Level 2 ITS VMS

If not already implemented in Level 1 ITS deployment, the VMS associated with secondary decision points would be implemented as part of Level 2 ITS deployment.

This would provide a far greater degree of future diversion control by using the 'old' N1 for tactical diversion. It would also significantly bolster the overall capability for information dissemination along the route.

This Level 2 deployment will provide a total of four new Strategic VMS along the corridor, all within the ROI.

5.4.2.5 Level 3 ITS VMS

No further deployment of VMS is currently forseen for Level 3 ITS. However, traffic volumes associated with Level 3 are significant and in times of heavy traffic with a high freight component, it is possible for single VMS to be obscured from motorists.

In this specific situation, existing single VMS could be upgraded to VMS 'pairs' in accordance with current HA practice.

Where gantry fixed signing is either in place or proposed consideration of the addition of a VMS could be made.

5.4.2.6 Communications Implications

Control of the 'strategic' VMS may be achieved by conventional 'dial-up' means (e.g. PSTN/ISDN/GSM) as their use is relatively infrequent (at least for Level 1 ITS).

Control of the Journey Time VMS needs to take place in real-time to allow the journey time subsystem to update link times automatically on the signs. This will necessitate continuous low bandwidth communications to which GPRS provides the most appropriate solution.

5.5 Control and Management Technologies

5.5.1 Traffic Management Strategy

5.5.1.1 Role of TCC

It is envisaged that the existing Traffic Control Centres at Belfast and Dublin may evolve into national centres responsible for TCC (Control) and TIC (Information) functions covering the road network throughout Northern Ireland and the Republic of Ireland.

5.5.1.2 Route Diversion

A key role of the TCC is to implement route diversion in the event of an incident along the corridor. This diversion can take two forms:

Passive Diversion — Drivers are alerted to the incident ahead through all available means of information dissemination. For a major incident, an alternative route is typically advised and provided on a VMS immediately prior to the exit point. Once the vehicles are off the primary route, they are left to their own devices to find an alternative route. Only vehicles fitted with vehicle navigation systems are well supported in this event, particularly if the navigation system is being fed with real-time data on the incident location and status.

Active Diversion — In addition to the above, the alternative route is actively signed from the point the driver leaves the primary route. This is typically achieved using a mix of static and VMS signs along the alternative route.

Diverting traffic off the primary route is typically a last resort for the operational manager. In addition to the difficulty of signing the alternative route, the manager needs to consider:

- The capacity of the alternative route to handle the diverted traffic flow;
- The possible effect on safety for the drivers (alternative routes do not typically meet the same design standards); and
- The potential time delays incurred by drivers taking the alternative route (as opposed to waiting for the incident to clear).

Related to the above is the ability for the manager to manage an incident within the bounds of the primary corridor i.e. ensure the incident is managed such that traffic can pass the incident without the need for diversion.

On the INSTANT corridor, completion of the current road building programme will provide a significant degree of spare capacity along the primary route in the short term. This is particularly true in the ROI where much of the corridor is of motorway standard with two lanes in each direction plus hard shoulders.

However, as traffic volumes build up in the medium to long term, this spare capacity will be continually eroded. The impact of any major incidents will be increased as will the need for active diversions.

Additionally, there will always be incidents which cannot be managed within the confines of the road corridor. Major incidents (e.g. multiple fatality accidents, chemical spillages and natural disasters (flooding)) will often necessitate closure of the road in one or both directions for a significant period. In this event, implementation of a diversion plan is unavoidable.

Study of the INSTANT corridor shows that effective diversion routes are few and far between. Although the primary end to end diversion option utilises the ‘parallel’ N2/A3 to link Dublin and Belfast, there are a number of other possible combinations and links back to the M1/A1 to consider.

Figure 5-1 : Route Diversion Schematic overleaf shows the main diversion route options and the associated Diversion Points (DP). This schematic has been prepared primarily as a tool for evaluating possible locations for ‘strategic’ VMS:

- Primary diversion points are shown for diversion of traffic off the M1/A1 and onto the N2;
- Secondary diversion points are shown for possible diversion of traffic off the M1 and onto the old N1 route; and
- Potential VMS locations are shown to match the above diversion points (Note that existing VMS are shaded darker).

In order to further evaluate the diversion options, a series of simulated road closures on the INSTANT corridor has been undertaken. The extent of each closure and potential diversion routes are appended (Appendix B : INSTANT Diversion Plans)

The diversion plan for a southbound closure between Diversion Points 5 and 6 is also shown overleaf. This shows a number of possible diversion options for this simulated event:

- Traffic could be directed off the M1 early at DP8 to use the old N1 route through Dundalk;
- Traffic could be directed to use the N2, exiting at DP6 and taking the N52;
- In the latter case, traffic could be brought back to the M1 via the N33 (for destinations off the M1 south of Dundalk) and/or continue south along the N2 (for destinations around or south/west of Dublin); and
- VMS used to support these diversions are shown in orange.

It is worth noting that both diversion options discussed above would result in traffic being temporarily diverted off the Drogheda Bypass. This would possibly impact on revenue collection on this tolled road and would need to be discussed with the operating consortium.

It is also important that any implementation of diversions is coordinated between the two TCC, each of which directly controls their own strategic VMS. Many of the diversion options shown will have a significant 'cross border' impact as traffic is diverted onto roads outside the operational control of the respective TCC. In these situations, it is essential that each TCC runs a diversion strategy that has been agreed with the other TCC.

Once the common database and inter-TCC data exchange has been implemented, it will be possible to implement 'integrated' diversion plans and associated VMS setting.

The diversion table below provides some indication of the potential increase in journey length and time associated with the simulated closures (assuming a normal average speed of 100km/hr and a 'diversion' speed of 80 km/hr).

Table 5.4 : Diversion Distances/Times

Link Closure	Diversion Route	Add. Length (km)	Add. Time (min)	Add. Time %
Northbound				
DP1 – DP2	M50/N2/A3/M1	53	60	53
	M50/N2/N33	15	20	46
DP2 – DP3	N1	-0.5	3	22
DP3 – DP4	M50/N2/N33	15	20	46
DP4 – DP5	N1	-3	2	12
DP5 – DP6	N1	-3	2	12
	N33/N52	10	9	69
DP6– DP7	N1	-3	2	12
DP7– DP8	N1	-3	2	12
	N53/N2/A3/M1	61	55	74
DP8– DP9	N53/N2/A3/M1	61	55	74
DP9– DP10	A27/M1	17	19	54
Southbound				
DP10 – DP9	M1/A27	17	19	54
DP9 – DP8	M1/A3/N2/N53	61	55	74
DP8 – DP7	N1	-3	2	12
DP7 – DP6	N1	-3	2	12
DP6 – DP5	N1	-3	2	12
	N52/N33	10	9	69
	N52/N2/M50	10	18	38
DP5 - DP4	N1	-3	2	12
	N33/N2/M50	15	20	46
DP4 - DP3	N52/N2/M50	10	18	38
	N33/N2/M50	15	20	46
DP3 - DP2	N1	-0.5	3	22
DP2 - DP1	N52/N2/M50	10	18	38
	N33/N2/M50	15	20	46

It is apparent from the above table that the majority of these proposed diversions require significantly increased journey times for those affected. Only major events would justify such diversions.

Figure 5-1 : Route Diversion Schematic

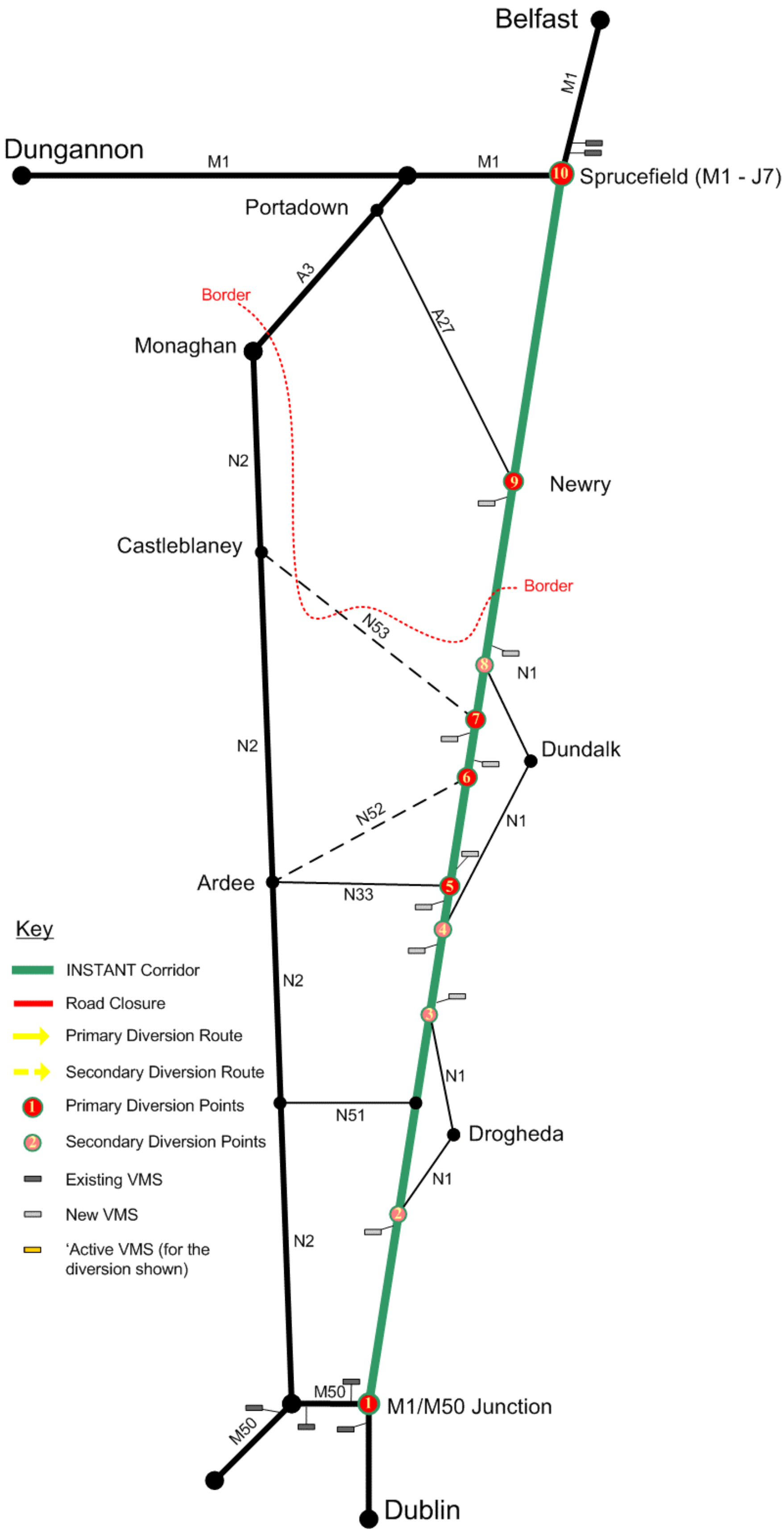
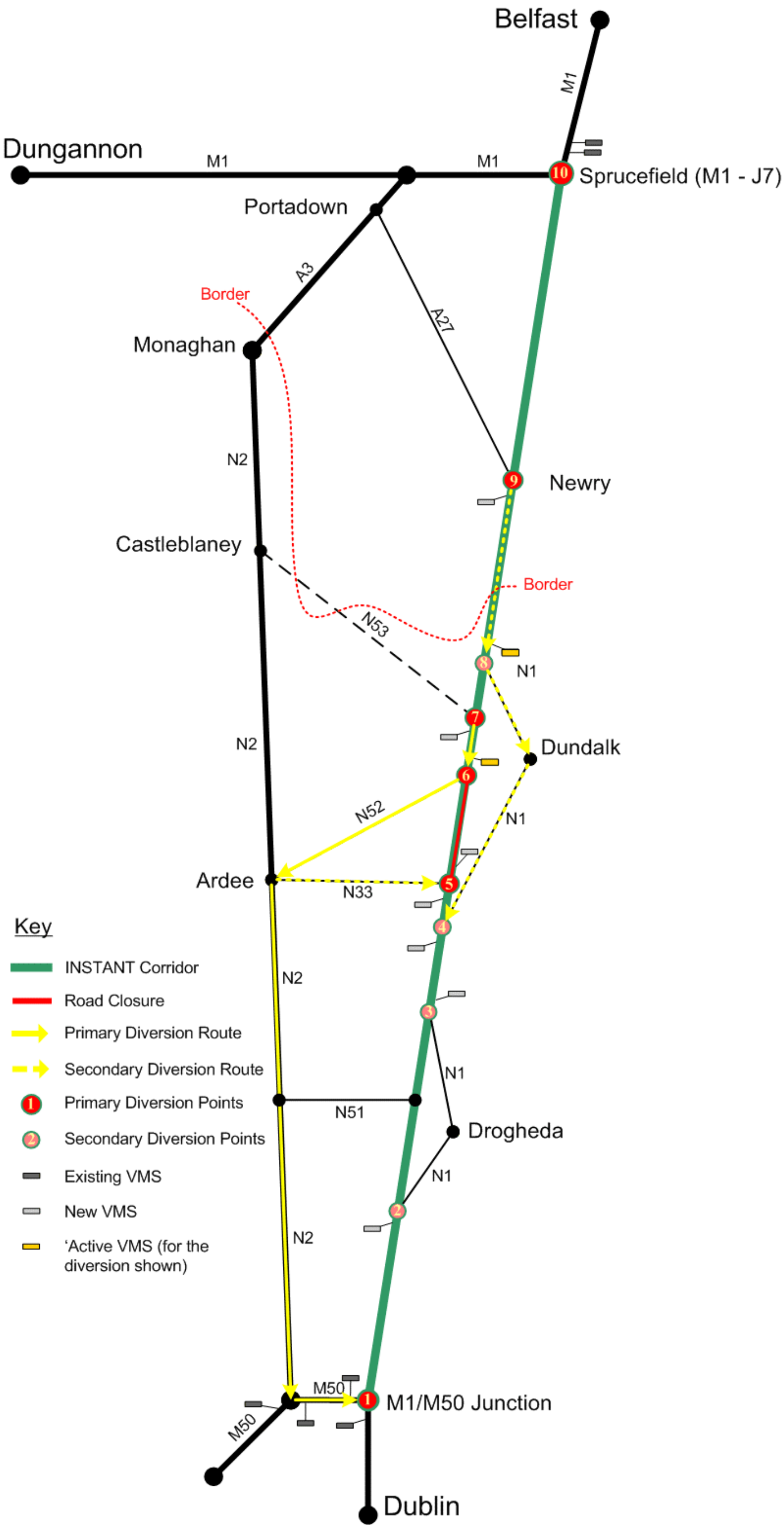


Figure 5-2 : Simulated Closure (DP6-DP5 Southbound)



5.5.1.3 Speed Management

Active speed management using overhead lane signals is a widely used approach on controlled motorways in the UK and Europe. The objective of such systems is to improve traffic flow, improve journey times and reduce accidents by delaying or preventing the onset of unstable flow. This is done by continuous monitoring of traffic flow and speed (using an AID/queue detection system such as MIDAS) and setting speed limits such that traffic is always working at the upper band of LOS E but never moving into LOS F (see Section 3.3).

Speed management as described above can be considered a Level 3 ITS technology. Its use is not proposed within the 10 year timeframe of this strategy but should be reassessed in the medium term.

Figure 5-3 : Overhead Speed Control - Germany

Issues to consider before deployment of this technology include:

1. Should the speeds shown be advisory (successful in mainland Europe) or mandatory (with associated enforcement)?
2. Is it necessary to locate the speed signals above each lane of overhead gantries? Single post mounted signals on each side of the motorway have been successful in Australia at a far reduced cost.
3. Are there any legal obstacles to be overcome?

5.5.1.4 Ramp Metering

The objective of ramp metering is to reduce congestion and to improve traffic flow on motorways by controlling the flow of vehicles joining from on ramps.

Ramp metering is widely used in the United States (>3,000 sites installed) where it is considered one of the more successful ITS technologies. It is also used in France and Holland. In the UK it has been used on the M6 near Birmingham since the late 1980's, there are sites in Hampshire and Glasgow. Ramp metering is seen as one of the tools to be used in the HA ATM (Active Traffic Management) projects that are beginning to be rolled out on congested parts of the English motorway network.

Like speed management, ramp metering is designed to work on heavily loaded motorways during peak hours. It is therefore considered a Level 3 ITS technology.

In brief, detection sensors upstream and/or downstream of the on-ramp are continuously monitoring flow on the motorway. When traffic is at critical flow, traffic signals on the on-ramp control the number of vehicles that may enter the motorway such that critical flow is never exceeded. This controlled access is typically only operated at peak travel times.

For the motorist, ramp metering can provide:

- A reduction in bottlenecks at junctions;
- Less congestion and improved traffic flows;

- Smoother and more reliable journey times;
- Reduced accident risks for drivers entering motorways from on-ramps, and for drivers already travelling on motorways; and
- Environmental improvements i.e. reduced traffic noise, vehicle emissions and fuel consumption.

In the USA, where ramp metering systems have been in operation for more than 15 years, a good record of their tangible benefits has been obtained[11]:

- Accident rate reductions of 24 to 50%;
- Increased throughout of 17 to 25%; and
- Increased mainline (motorway) speeds of 16 to 62%.

The large scale implementation of ramp metering in Minneapolis/St Paul (Twin Cities) where over 400 ramps are metered has been extensively evaluated and a cost/benefit figure of 15 determined[12].

The types of ramp metering systems can be broadly categorised as follows:

Table 5.5 : Ramp Metering System Types

Type	Description
Fixed Time Operation	This operation performs the basic functions of breaking up platoons into single-vehicle entries and setting an upper limit on the flow rates that enter the freeway. The metering rate is based on average traffic conditions at a particular ramp at a particular time. This type of operation provides the benefits associated with accident reductions, but is not as effective in regulating freeway volumes because there is no input about motorway traffic. Pre-timed control can be implemented on any number of ramps, and is often implemented as an initial operating strategy until individual ramps can be incorporated into a traffic responsive system.
Traffic Responsive Operation	The next level of control, traffic responsive, establishes metering rates based on actual motorway conditions. The local traffic responsive system determines both the mainline flow in the immediate vicinity of the ramp and the ramp demand to select an appropriate metering rate. Traffic responsive control also permits ramp metering to be used to help manage demand when incidents occur on the freeway, i.e. reduce the metering rate at ramps upstream of the incident and increase the rate at ramps downstream.
System wide control	System-wide control is a form of traffic responsive control but operates on the basis of total motorway conditions. Centralized systems can handle numerous ramps in a traffic responsive scheme and feature multiple control programs and overrides. Control strategies can also be distributed among individual ramps. A significant feature of system control is interconnection that permits the metering rate at any ramp to be influenced by conditions at other locations.

Factors to consider before implementation of ramp metering include:

- Impact on the local road network needs to be carefully considered from both a technical and political viewpoint:
  - local queues can develop back from the ramp onto local streets with adverse impact on local 'non-motorways' users. Queue detection on the ramp can allow the system to release vehicles 'early' in this situation;
  - diversions by motorway users to avoid metered ramps can lead to increased flows and possibly delays on local roads; and

[11] USDOT Report (DOT-T-95-17) Ramp Metering Status in North America - 1995
[12] Twin Cities Ramp Meter Evaluation – Final Report – February 2001

  - o true integration of the ramp metering system with the UTC could mitigate many of these impacts.
- ♦ Sufficient storage needs to be provided at the ramp (see above). This may involve provision of extra ramp lanes and associated civil works;
- ♦ Ramp merges need to consider the fact that on-ramp traffic now needs to accelerate to motorway speed from standing;
- ♦ Enforcement may be needed to manage 'red light running'; and
- ♦ Public relations is a crucial aspect to ensure the motorists are aware of the overall benefits when all they will notice are perceived delays at the new metered ramps.

5.5.2 Enforcement

5.5.2.1 Overview

Enforcement is a separate category within the KAREN system architecture guidelines. The responsibility lies with the Police Service of Northern Ireland and An Garda Síochána. Whilst enforcement technology may have a dual use within the information architecture to provide travel information and traffic management, detailed consideration has not been with in the main remit of the of the INSTANT Design Study.

Under the aegis of the WERD group, seminars have taken place with TISPOL, the European Traffic Police Network. The current situation can be summarised as follows:

- ♦ There is considerable scope for co-operation between road authorities and traffic police to work together in the interests of an integrated road safety policy
- ♦ TISPOL has a strategy to increase the awareness of ITS amongst its members
- ♦ TISPOL has a focus on a digital, pan-European enforcement concept

For the INSTANT corridor Stakeholder meetings are proposed between Road Authorities and Emergency Services (see 7.5.2). Through this forum the WERD/TISPOL ideas can be progressed.

5.5.2.2 Fixed Image Camera Technology

Cameras are increasingly used to automatically detect errant motorists who are speeding, running red lights or driving in unauthorised lanes. In recent years the technology has begun to move away from wet film to digital storage/download which increases the flexibility. However, the more motorists caught, the more resources for back office processing are required – though fines may cover costs.

ANPR technology could provide warnings that journeys are being made faster than the speed limit allows. It is recommended that the legal position is checked before this is initiated as enforcement technology. As the police will be the enforcer swift mobilisation to catch the perpetrator may be needed.

5.5.2.3 Use of CCTV cameras

CCTV cameras may be used by the police as a tool in enforcing traffic regulations in conjunction with patrol cars, or potentially ANPR and video recordings. A typical application would be dangerous driving. VMS could be used to warn or instruct particular vehicles.

5.5.2.4 Weigh in Motion

A number of manufacturers offer weigh in motion detection packs for installation in the carriageway. With the INSTANT route being a key trade route for HGV's many of which will be headed to ports. Situating a WIM upstream of a calibrated weighbridge would help the police pre-select vehicles to direct for a full inspection.

5.5.2.5 Customs and Excise issues

Subject to legal approval ITS systems and infrastructure could have uses for customs and excise purposes, e.g. tracking of loads, vehicles.

5.5.3 TCC Control System Development

Each of the roadside technologies and associated field equipment described above requires a central control subsystem (or Instation). This subsystem will be capable of communicating with the field equipment on an automatic basis or as required by the operator. The functionality required will range from simple one way manually instigated data retrieval to fully automated two way control and configuration.

Each subsystem typically includes its own operator terminal or GUI. Options exist for providing a common GUI across these subsystems either as part of the INSTANT Instation or by extending existing TCC operator GUI functionality as appropriate.

It is envisaged that existing subsystems at the Dublin and Belfast Traffic Control Centres should be able accept the new INSTANT infrastructure with little development and just minor configuration (at least for Level 1). Ongoing development (e.g. M50 Management and Control in Dublin, the implementation of a Traffic Management Database facility in Belfast) may justify new (sub)systems or GUI's. Other subsystems will require a new standalone control system with defined interfaces for integration with existing systems and operator terminals. These issues will need to be considered by NRA and RS on a case by case basis.

The basic functionality required by each subsystem is briefly outlined below as a starting point for subsequent detailed design.

5.5.3.1 Traffic Monitoring Subsystem

For Level 1 ITS traffic monitoring, it is envisaged that a simple control application will be provided by the supplier of the monitoring field equipment. This would be installed on a new or existing TCC workstation and undertake daily data retrieval from each site by PSTN or GSM dial-up. Data would be held on a local database for analysis (with supplied software tools) or for export to existing traffic analysis packages.

At Level 2 ITS, the subsystem design would need to incorporate the ability to handle real-time streaming of data/alerts from the monitoring sites. This information could then be 'pushed' to the INSTANT Instation/common database for analysis/action and onwards to the web portal (where traffic flows and speeds along road links could be represented, either in text form or graphically (e.g. colour coded green/yellow/red).

At Level 3 ITS, traffic monitoring has extended to full Automatic Incident Detection (AID).

5.5.3.2 Meteorological Subsystem

For Level 1 ITS meteorological monitoring, it is again envisaged that a simple control application will be provided by the supplier of the monitoring field equipment. This would be installed on a new or existing TCC workstation and undertake daily data retrieval from each site by PSTN or GSM dial-up. Data would be held on a local database for analysis by included software tools.

Level 2 ITS would again need the subsystem design to incorporate the ability to handle real-time streaming of data from the monitoring sites. This information could then be 'pushed' to the INSTANT instation/common database for analysis/action (e.g. roadside VMS setting – 'wet roads'/'high winds') and onwards to the web portal (where locations that motorists may expect wet roads, snow or high winds can be represented).

5.5.3.3 Journey Time Subsystem (JTS)

The JTS control subsystem will be a significant new addition to the respective traffic control centres. Its functionality would be unchanged from Level 1 ITS through to Level 3 ITS (only the ANPR site density is increased). It will:

- Receive real time VRN data (hashed) from the ANPR outstations;
- Undertake matching of VRN from adjacent sites and derive link journey time information for individual vehicles; and
- Hold this information in an online database (where it can be pushed to the INSTANT common database).

An important differentiator of this subsystem over the previous traffic and meteorological subsystems is the necessity to provide an interface to other subsystems at the TCC. This interface is necessary so that the VMS subsystem can automatically set journey time messages on the roadside VMS under normal flow conditions. The journey time system can also be used to provide basic incident detection by comparing current journey times with historic journey times for that link and time period. When given thresholds are exceeded, then the delay message may be set on the VMS, either manually, or automatically as part of an established plan.

It is likely that this extended functionality is best achieved by a new subsystem within each TCC. In this case, it will simply be a requirement on the design of the JTS to provide the necessary 'hooks' into its database for data exchange.

5.5.3.4 CCTV Control

In the short term, it will be both cost effective and technically feasible for the existing CCTV control subsystems at both the Belfast TICC and Dublin TCC to take the additional ISDN camera feeds from the new Level 1 ITS CCTV sites. This is, however, subject to any limitations new CCTV outside of the INSTANT corridor put on the existing systems.

The recommended medium to long term move to IP communications and video over IP will require changes to the CCTV control at each TCC. Subject to the age and type of outstation equipment, the choice of supplier, and the inbuilt capabilities of a new control system, the possible development of interfaces between the old analogue video matrix and new video server may also be required.

Should funds be available, and it is part of a CCTV upgrading strategy for a wider area, the IP option should be adopted as the short term solution.

5.5.3.5 VMS Control

The existing VMS control subsystems at both the Belfast TICC and Dublin TCC are capable of controlling the additional 'strategic' VMS sites proposed as part of Level 1 ITS deployment. In NI the additional VMS are within 2.5km of the Sprucefield junction on M1 and can be connected to the existing NMCS2 message control sub-system. For other VMS, e.g. around Newry, options such as radio control may need to be considered. This will be an issue for the outline design contractor.

In RoI it is understood that the VMS control system for the M50 can be expanded up the M1. Again radio options should be considered during outline design.

It is important to note that it may be more cost effective to procure a new VMS control system specifically designed to set journey time information on the 'journey time' VMS on the corridor. This move would be largely dependant on how readily the existing VMS control systems could be modified to accept automatic message settings from the INSTANT instation and to set signs advising delays according to predefined 'plans'.

5.5.3.6 INSTANT Instation and Common Database

For Level 1 ITS deployment, there is little need for unnecessary system sophistication. Most of the technologies and required functionality can be implemented either using new standalone subsystems or extensions to existing subsystems. There is a very low level of subsystem integration required to control the INSTANT field equipment although there is a strong need to 'share' information collected (and disseminated) by this equipment.

The one new technology that requires a degree of integration is the journey time system. This needs 'instation' functionality to allow the journey time to be automatically set on the roadside 'journey time' VMS. Any reliance on operators to undertake this function manually would limit the effectiveness of the overall system.

There will be a need to achieve a higher degree of system integration at the TCC as the other data collection systems (traffic and meteorological monitoring) start to deliver real-time information as part of Level 2 ITS. This move from historical data gathering to real time 'incident detection' also requires 'instation' functionality to interpret the data and disseminate the information (e.g. VMS, web portal) accordingly. There is significant benefit to be gained in early adoption of elements of Level 2 ITS.

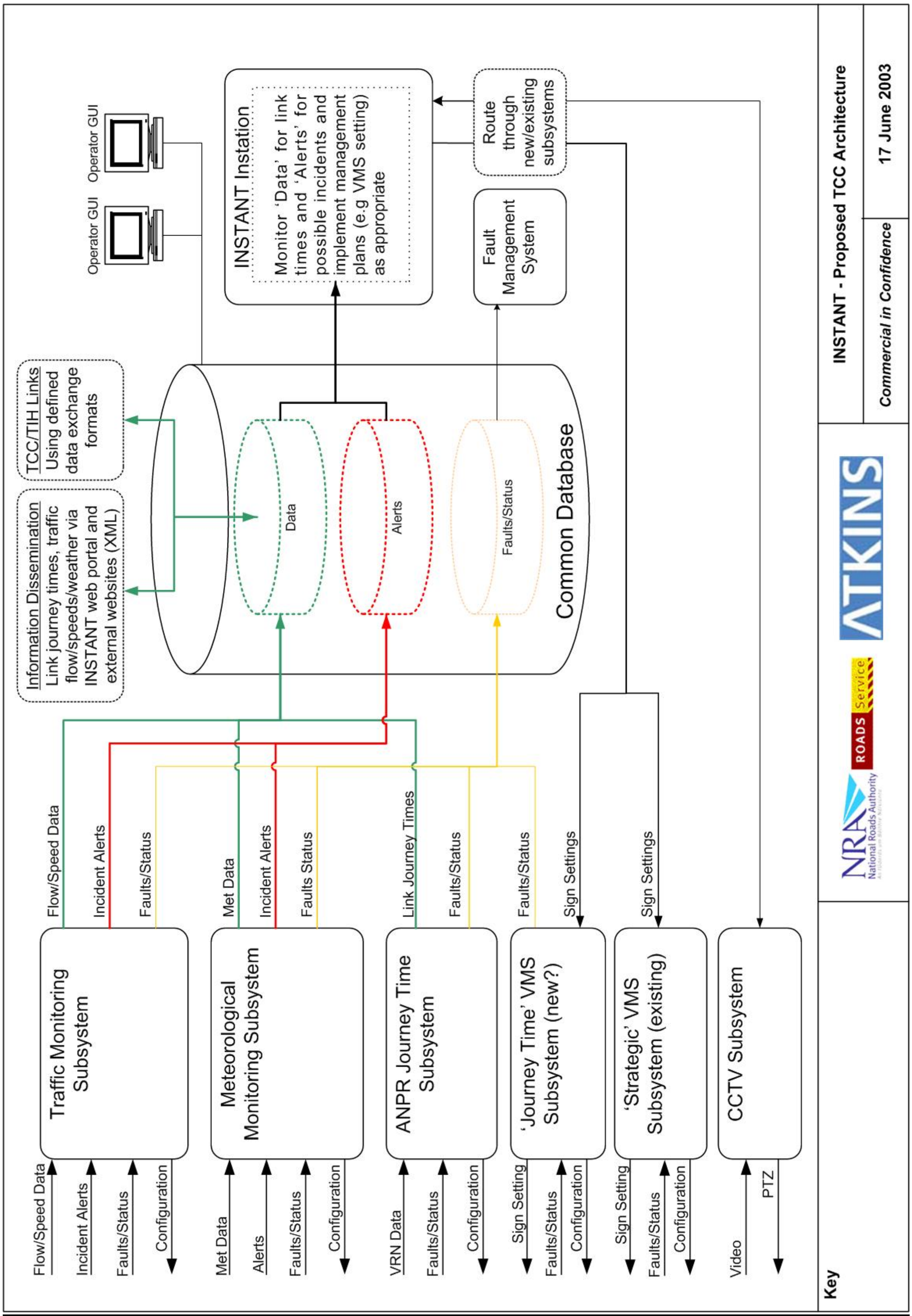
The Belfast TICC has an existing COBS and this could be developed to support the INSTANT functional requirements but probably at a cost premium to a dedicated INSTANT instation. Dublin TCC does not yet have such a system (although some development is planned) and requires INSTANT instation functionality.

One of the benefits of moving this design forward is the possible impact on other INSTANT work packages and development of the associated 'Common Database' or shared information store at each TCC. This architecture could be developed along the principles of the UK UTMC programme and guidelines. This approach could significantly assist in TCC-TCC data sharing as well as meet the broader data exchange needs.

A proposed schematic control architecture that could be applied in both the Dublin and Belfast control centres is shown overleaf to show the main information flows. This proposal should be reviewed as necessary as part of the detailed design process. Key points include:

- Although each subsystem will collect and store a significant volume of data, only a small subset of this is 'useful' in an operational sense. This useful data will be 'pushed' to the common database for dissemination and/or action by the INSTANT 'Incident Manager' application;
- The 'Data' store in the common database holds hard data on road conditions which may be suitable for automatic dissemination by the INSTANT website and/or external websites (XML feeds);
- There is benefit in sharing some of this data (e.g. VMS settings and flow conditions immediately each side of the border with the other INSTANT TCC). Other data must be shared for effective functioning (e.g. link journey times). This sharing will be achieved using the defined data exchange formats as will any information transfer with other national TCC's (e.g. Scotland/Wales) and the TIH;
- Both the traffic monitoring and meteorological systems are capable of providing real-time 'incident' alerts from the field equipment provided the communications network is in place. The journey time system can also generate alerts although this is done at the subsystem level; and
- The function of the INSTANT 'Incident Manager' application is to continually watch for changes in the common database 'Data' and 'Alerts' stores. These will be assessed for reliability and severity and appropriate management plans initiated in accordance with predefined rules.

Figure 5-4 : Proposed TCC Architecture



5.6 Communications Options

5.6.1 Required Services

All the ITS field equipment recommended above for deployment on the INSTANT corridor is centrally managed and controlled from the control systems at the respective national TCC's. As such, there is a need to provide some form of communications between these remote sites and the TCC.

The basic requirements for these communications links to each roadside technology are summarised below. Broadly speaking, there are two services required:

- Low bandwidth data services to support most roadside equipment and either:
  - 'Dial-up' connections for occasional control (commonly used for VMS message setting); and
  - 'Always on' connections where continuous control is needed or desired.
- High bandwidth services to support transmission of CCTV video and/or high speed data between TCC's.

Table 5.6 : Required Communications Services

ITS Technology	Information	Bandwidth	'Always on' Link
Low Bandwidth Links			
Traffic Monitoring	data	<9.6K	Desirable (Level 1 ITS) Mandatory (Level 2 ITS)
Meteorological Monitoring	data	<9.6K	Desirable (Level 1 ITS) Mandatory (Level 2 ITS)
'Strategic' VMS	data	<9.6K	Desirable
ANPR	data	<9.6K	Mandatory
'Journey Time' VMS	data	<9.6K	Mandatory
AID	data	<9.6K	Mandatory
High Bandwidth Links			
CCTV	video/data	>128K (minimum) >1Mb (desirable)	Desirable
TCC to TCC links	video/data	>10Mb	Mandatory

5.6.2 Low Bandwidth Options

5.6.2.1 Low bandwidth 'dial-up' options

Dial-up PSTN services are generally available along the route but providing the service to individual sites would come under the 'non-served premises' heading and therefore subject to additional site specific construction costs (largely dependant on the distance from existing services). Although PSTN would meet the performance requirements for most ITS implementation, it does not offer enough flexibility in site selection to be considered further.

GSM is a good alternative 'dial-up' solution. Coverage of GSM services is good over the corridor and provides excellent flexibility in site selection. The costs of installation are low and ongoing call costs are reasonable for most applications.
One major disadvantage of the service is its reliability and specifically the availability of the service when an emergency (e.g. a major traffic accident) occurs in the vicinity of an ITS equipment site. Such an incident is likely to result in an increase in the number of mobile phone users within the local GSM network cell and the possibility of local network unavailability. This is a low likelihood occurrence but could for example result in the inability to use VMS to advise motorists of a problem because that problem has itself disrupted communications.

5.6.2.2 Low bandwidth 'always-on' options

A number of proposed ITS technologies require an 'always on' connection for which GPRS is the most appropriate solution. As GPRS is an enhancement to the GSM service, they share many of the advantages and disadvantages of the technology. Coverage and availability of the service is good. It is a low cost technology to implement and call charges (volume based) are reasonable for the application.

As for GSM, the primary disadvantage is the reliability of service under heavy 'non project' loads. In addition, GPRS is a packet data service and therefore also susceptible to some delay in message transmission. These delays are not significant and manageable for the intended application.

5.6.3 High Bandwidth Options (CCTV)

A study of the communications options to support CCTV applications was undertaken as part of this report. A full copy of this study is provided in Appendix D, from which the following conclusions are derived.

There are a wide range of communications options available to support CCTV deployment (and other less demanding ITS equipment) along the INSTANT corridor. These options can be used in isolation or mixed and matched to suit the specific site requirements and TCC integration constraints.

5.6.3.1 Existing third party wireless services

Although significant improvements in video compression continue to be made, the video quality from the low bandwidth GSM/GPRS and even HSCSD wireless services is currently unacceptable for traffic surveillance purposes where other options exist.

The order of magnitude improvement in bandwidth offered by 3G will overcome this quality issue. However, these services will only be commercially available in the medium term into urban locations and even longer to the rural locations typical to much of the INSTANT route.

It should also be borne in mind that both GPRS and UMTS 'always-on' services will require data traffic transit via an ISP and the Internet. The associated additional overhead of the OSI layer protocols required for the link, and the use of video streaming can mean the effective bandwidth that gets delivered is as low as 10-30% of the headline rate.

5.6.3.2 Third party landline services

The traditional landline services such as PSTN and ISDN are available along much of the corridor. However, PSTN has similar quality limitations to the above wireless services and can be discounted for this project.
Basic Rate ISDN service such as BT's ISDN 2e or Eircom's 'Hi-Speed', delivering 128Kbps using a bonded MLPPP connection would provide the best value for money. This service currently meets the lowest acceptable quality of video to the TCC and is easily integrated with existing control systems.

The newer ADSL and digital leased circuit technologies can already provide significantly better video quality than is possible with ISDN. However, these services are not currently available to most of the INSTANT corridor and the costs in establishing the service to many remote locations will be prohibitively expensive. In addition, the annual costs associated with the lower bandwidth leased circuits are high when compared with on-demand services offering similar data throughputs, such as ISDN.

5.6.3.3 Satellite based communications

The use of satellite communications can provide an ISDN quality of video to any CCTV site along the corridor without the need for any significant installation costs and location constraints (although power is required). The solution requires significant investment in hardware at the CCTV site and TCC but offers a very high level of flexibility in deployment. It is also an IP based solution and ideally suited for digital CCTV transmission.

At this time, equivalent video quality is available at lower cost along the INSTANT corridor using ISDN services. However, the use of satellite technology should be considered for other locations in Ireland requiring CCTV coverage where these services do not exist or for possible mobile 'trailer mounted' CCTV deployment.

5.6.3.4 Fibre and Microwave Infrastructure

Both customers have already made a significant investment in their own fibre optic communications network. Coverage of this fibre network is typically limited to the heavily loaded sections of motorway immediately around Dublin and Belfast respectively. Of particular relevance to INSTANT is the extension of this fibre backbone in the RoI some 16 km north from the M1/M50 junction up the M1 motorway.

Where fibre is available at a roadside CCTV site, there is no better option than to have end to end fibre connectivity between the camera and TCC. Fibre can support broadcast quality video without the need for compression and is the ideal CCTV video bearer.

The use of microwave technology to extend the reach of these existing fibre networks to offer high bandwidth CCTV services (and links to other ITS equipment) should be seriously considered. A Point of Presence or node would be established on the existing fibre from which a series of microwave links could provide very high bandwidth services to points at intervals along the INSTANT corridor. These links may be up to 10 km apart and matched with proposed CCTV locations at key intersections/interchanges. From these microwave 'nodes', WLAN technology could then be used to provide wireless connectivity to ITS field equipment (including CCTV) at roadside locations between the nodes.

5.6.3.5 Managed IP WAN services

Rather than become involved in the detailed design, procurement and maintenance of communications infrastructure for INSTANT (and other ITS project sites), it is possible for the RS and/or the NRA to take a less 'active' role. There are real advantages in 'partnering' with a communication service provider who could be contracted on a long term basis to deliver a managed IP service to all future ITS (and existing) equipment sites.

In this regard, it may be worthwhile further evaluating the 'Business IP+' managed IP service from Eircom. This will be likely be more expensive than using straightforward leased-lines but does provide a simple interface with the combined security of a managed service and SLA contract. Data rates can be provided to give good CCTV video performance as the infrastructure has been designed specifically for this media and Eircom do have POP nodes available close to many locations along the Ireland INSTANT route.

Esat (BT) do not currently provide this type of service in Ireland, but they are planning its deployment.

5.6.4 Communications Network

The traditional NMCS2 communications infrastructure for ITS in the UK, and used on the NI motorway network is proprietary. It has been a good solution for major purchasers like the HA, RS and WAG. However, there have been major advances in communications technology since NMCS2 was conceived in the early 1980's, and it has an inherent lack of open systems connectivity. It is strongly suggested that NMCS2 is unlikely to be a recommended model to follow for deploying the next generation ITS services as might be seen on the INSTANT corridor by 2014. Other key purchasers the HA and WAG, are moving to implement IP based networks using either ATM or Ethernet (e.g. NRTS). This approach is also consistent with ITS deployment in the USA where NTCIP has been well established for over 10 years now and in the UK where the use of IP is a cornerstone of the developing UTMC standards.

In RoI, Dublin CC have adopted IP communication solutions for the M50 control systems. The reasons for IP include:

- An open architecture with standard 'off the shelf' hardware and associated savings in procurement and support;
- Standard equipment interfaces and reduced dependence on proprietary suppliers; and
- Easier configuration and support of roadside equipment (e.g. SNMP for remote support).

Two protocols, Asynchronous Transfer Mode (ATM) and Internet Protocol (IP) over Ethernet, have been widely adopted for carrying video (along with voice and data) over digital networks.

ATM is a broadband network technology, allowing very large amounts of data to be transmitted at a high rate (bandwidth). It does this by establishing "virtual circuits", which connect points in the network as if by a physical wire, and can maintain many such links on a single network. These features have important implications for transmitting high quality video with a guaranteed Quality of Service.

IP (Internet Protocol) is an addressing convention. IP addressing is not limited to any particular type of network, and data on the internet will often travel over different types of network (e.g. ATM and Ethernet) as it moves from one IP address to the next. Over 90% of all LAN/WAN networks are IP-enabled.

Ethernet is now the most common type of data network. Over 80% of all Local Area Networks are Ethernet based where data is sent in packets and reassembled at the receiving point. Some network products use techniques to manage and prioritise data/video packets and so are able to deliver a defined Class of Service. Whilst this does not guarantee the excellent quality that is achievable with ATM, it can achieve good results within a well managed network.

Whilst there are many technology and/or service options for meeting the communications needs of INSTANT, the recommended approach is to adopt the IP Ethernet solution wherever possible.

5.6.5 Level 1 ITS Communications

Short term Level 1 ITS deployment is characterised by single isolated equipment sites located at intervals along the corridor. As such, the communications needs are best met by:

- GPRS communications to most field equipment; and
- ISDN links to support single site CCTV.

5.6.6 Level 2 ITS Communications

Medium term Level 2 ITS deployment is characterised by an increasing density of equipment sites located at intervals along the corridor. Some sites will As such, the communications needs are best met by:

- Continue with GPRS communications to most field equipment;
- Implement IP based links to single/multiple CCTV sites (in conjunction with a move to video over IP); and
- Consider IP based communications to support field equipment 'concentrations' (groups of more than one equipment site or technology in close physical proximity).

5.6.7 Level 3 ITS Communications

Long term Level 3 ITS deployment is characterised by a high density of equipment sites located at regular and closely spaced intervals (~500 metres) along the corridor. As such, the communications needs are best met by:

- A continuous longitudinal IP based communications backbone along the corridor using fibre optics and/or WLAN bearers to deliver services to all ITS field equipment.

5.7 Local ITS Schemes

5.7.1 Definition

For the purpose of this report, local ITS schemes are defined as deployment of a single technology or mix of technologies at a site where the underlying cause and location of the problem can be specifically identified and treated.

As such, it does not cover widespread deployment of technologies along a corridor e.g. automatic incident detection on a motorway, ANPR journey time systems, overhead lane control and/or speed management, emergency telephones etc

It could be argued that Level 1 ITS deployment of CCTV and VMS into known trouble spots and potential route diversion locations are in fact local ITS schemes. They only become national or corridor treatments when they are deployed more systematically according to established rules and guidelines.

Aside from the above, no local ITS schemes are proposed for INSTANT. Some of the following examples show how local schemes can be deployed where the nature of the problem is very apparent or can be well defined.

Another common feature of these schemes is the concept of local intelligence and/or control. Rather than relying on the national TCC for control, these systems commonly rely on local communications and control to link the various detection/dissemination technologies. This approach is typically implemented where the sites are geographically remote from the TCC and the speed and/or cost of communications to the TCC would compromise the scheme performance.

5.7.2 Example Local Schemes

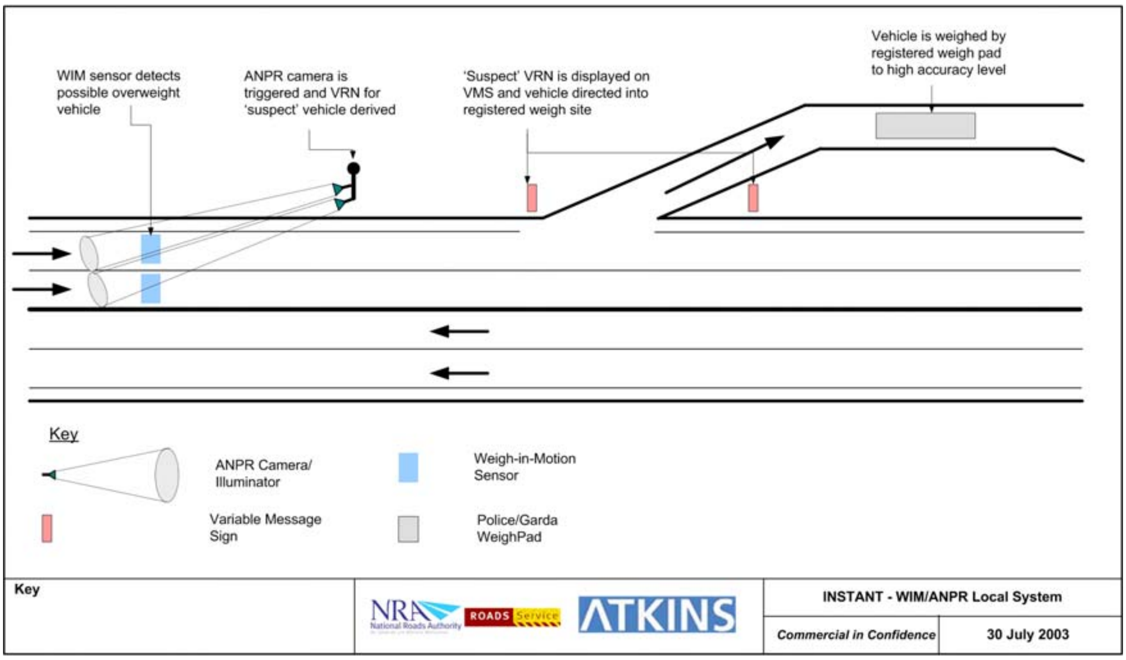
5.7.2.1 Heavy Vehicle Enforcement

This example from Queensland in Australia utilises a number of different ITS technologies in a 'local' control configuration to aid enforcement of HGV traffic:

- Weigh In Motion (WIM) equipment in the road pavement outputs axle loads in real-time for vehicles travelling at open speed limit;
- Where these axle loads exceed defined limits, the ANPR system takes a snapshot of the 'suspect' vehicles number plate and derives the VRN;
- The VRN is displayed on a roadside VMS and the 'suspect' vehicle is directed into the off-road registered weigh pad (Police staffed); and
- The vehicle is formally weighed for compliance against local axle load limits.

The primary aim of this local ITS is to support targeted checking of overweight HGV's. As only suspect vehicles are required to be formally weighed, legal traffic can proceed without unnecessary delay and Police manpower is significantly reduced.

Figure 5-5 : WIM/ANPR System Schematic



5.7.2.2 Road Construction Safety Advisory and Warning System

This example from Nebraska in the USA, uses microwave speed detectors and trailer mounted VMS to improve worker safety during road construction projects:

- A microwave speed detector and VMS is mounted on a trailer upstream of the work site (with an associated speed restriction);
- When a vehicle travelling faster than the posted speed is detected, the VMS is triggered to display a 'slow down' type of message. This can be backed up with a enforcement speed camera; and
- A very high vehicle speed can also trigger a horn to alert workers to the hazard.

5.7.2.3 Advisory Speed Warning

A number of local ITS schemes in Europe, Australasia and the USA have been developed to improve safety on sections of road that are inherently less safe than is desired and/or become unsafe during certain conditions (typically inclement weather). The specific hazard in these cases may include:

- An unusually tight curve;
- A long steep descent, with or without a low speed curve at the bottom; and
- Poor sight distance (e.g. an intersection or traffic queue just over the brow of a hill).

These types of hazard are typically addressed by static signing. ITS allows the road authority to add a degree of dynamic management to the problem as follows:

- Vehicles approaching the hazard at an excessive speed can be identified and individually advised (by VMS) to reduce speed;
- The driving conditions can be monitored in real time and an advisory safe speed set to match these conditions;
- Sensors can measure wet road surfaces, high winds and/or poor visibility; and
- Local intelligence will apply rules to these parameters and set progressively lower speeds/aggressive warnings when these are exceeded.

5.7.3 TCC Integration Requirements

Many of these local schemes operate completely independently of the national TCC. In this situation, the TCC may not have access to any real-time information on the local system or roadside device settings and there is little need for integration (aside from receiving alerts perhaps)

In other local schemes, the roadside devices such as VMS may be used in a dual purpose role i.e. they operate independently within the local scheme but are also used for strategic purposes in the event of major incidents. In this situation, the integration of the local scheme into the TCC must be carefully considered so that the system performs well in both the local and strategic role.

5.8 Summary of Level 1/2/3 ITS Infrastructure

Table 5.7 : ITS Summary Table

ITS Component/Technology	Level 1 ITS	Level 2 ITS	Level 3 ITS
DATA COLLECTION AND INCIDENT DETECTION			
Traffic Monitoring Potential technologies include loops, video or above ground wireless systems	Flow/Classification monitoring at nominal 5 km intervals (and at key locations). Non 'real time' data retrieval on a daily basis. Data primarily used for analysis and problem definition for future ITS	Extend Level 1 solution by decreasing nominal site spacing to 2 km and provision of data in near 'real time'. This will provide a coarse form of incident detection (comparison of current flows/speeds against historical to generate alert).	Provision of full 'real time' monitoring sites (flow and occupancy) at 500 metre spacing to provide full incident detection.
Meteorological Monitoring	Detection of wind speed and visibility at nominal 20 km intervals (and/or known problem areas). Non 'real time' data retrieval on a daily basis. Data primarily used for analysis and problem definition for future ITS	Extend Level 1 solution by provision of data in near 'real time' to allow meteorological conditions to be advised to motorists via automatic information dissemination	Possibly capture additional data (e.g. presence of surface and/or ice snow on road surface and provide additional sites. Need will be driven by outputs from short/medium term data analysis
Journey Time Potential technologies include ANPR and FVD	Link journey time measurement (using ANPR) at nominal 15-20 km intervals. Data collection in near 'real time' for automatic information dissemination (via website and journey time VMS)	Extend Level 1 solution by decreasing nominal site spacing to 8-10 km. This will improve accuracy of journey time predictions and allow coarse incident detection (comparison of current link times against historical to generate alert)	Depending on performance of ANPR system, investigate use of Floating Vehicle Data (FVD) to supplement ANPR derived link times
Communications Implications	*The use of third party wireless data services such as GSM/GPRS is considered most appropriate. These services exist over the full INSTANT corridor and provide adequate bandwidth for the above detection systems at a reasonable cost.*	*The continued use of the Level 1 communications technologies will still be appropriate. The move to near 'real time' data collection and incident detection will necessitate adoption of 'always on' data services such as GPRS if not already adopted)*	*The adoption of full incident detection with increased sites and data flows will typically require a continuous roadside data backbone. This has typically been achieved using fibre optic but ongoing advancements in wireless LAN (WLAN) technology will provide a cost effective alternative.*
VERIFICATION			
Closed Circuit Television (CCTV)	Digital CCTV to meet current standards for traffic monitoring (full PTZ, zoom, pole mounting etc) to be installed at known black spots and congestion zones	Extend the Level 1 coverage to provide CCTV sites at all key interchanges and intersections	Level 3 CCTV should provide >90% coverage of the road network (including immediate approaches and ramps)
Communications Implications	*The use of third party communications infrastructure is most appropriate at this level. Required image quality at the TCC will require 128 Kb/sec bandwidth which can be achieved using ISDN and other technologies*	*The communications technology at this level is going to be exclusively video over IP (the investment has already been made in digital CCTV hardware). The IP data services may be procured through a mix of third party services and some investment in Level 3 infrastructure*	*This density of CCTV will necessitate continuous longitudinal communications (see above). Both fibre and/or WLAN will provide the required bandwidth*
EN-ROUTE INFORMATION DISSEMINATION			
Roadside Signing			
Strategic Variable Message Signs (VMS)	Standard single MS3 VMS should be installed at key route decision points along the corridor. These will be used for incident management (incident alerts/diversions by manual control) and to automatically display link journey times.	Extend Level 1 treatment to provide VMS 'pairs' at some route choice locations (if considered necessary). Traffic flow and meteorological information can now be automatically displayed when triggered by connected field equipment	Add new locations as required
'Strategic' Enhanced Message Signs (EMS)	The additional graphics capability of EMS are not required at this level	The additional graphics capability of EMS are not required at this level	Possible use of EMS to supplement/replace existing VMS as required
'Journey Time' VMS	Smaller lower cost VMS to be installed at all Level 1 ITS ANPR sites for display of journey times and possibly limited incident information.	Install along with new ANPR sites as required (dependant on public reaction to Level 1 VMS – i.e. are they perceived as useful?)	
Communications Implications	*The use of third party wireless 'always on' data services such as GPRS is considered most appropriate. These services exist over the full INSTANT corridor and provide adequate bandwidth for VMS control at a reasonable cost.*	*The continued use of the Level 1 communications technologies will still be appropriate. Any IP data services procured for CCTV could be used to support local VMS as appropriate*	*A continuous communications network will be in place to support the above detection/verification requirements. This can be used to support VMS control and eliminate the need for ongoing data costs associated with GPRS*

Figure 5-6 : Level 1 ITS Schematic

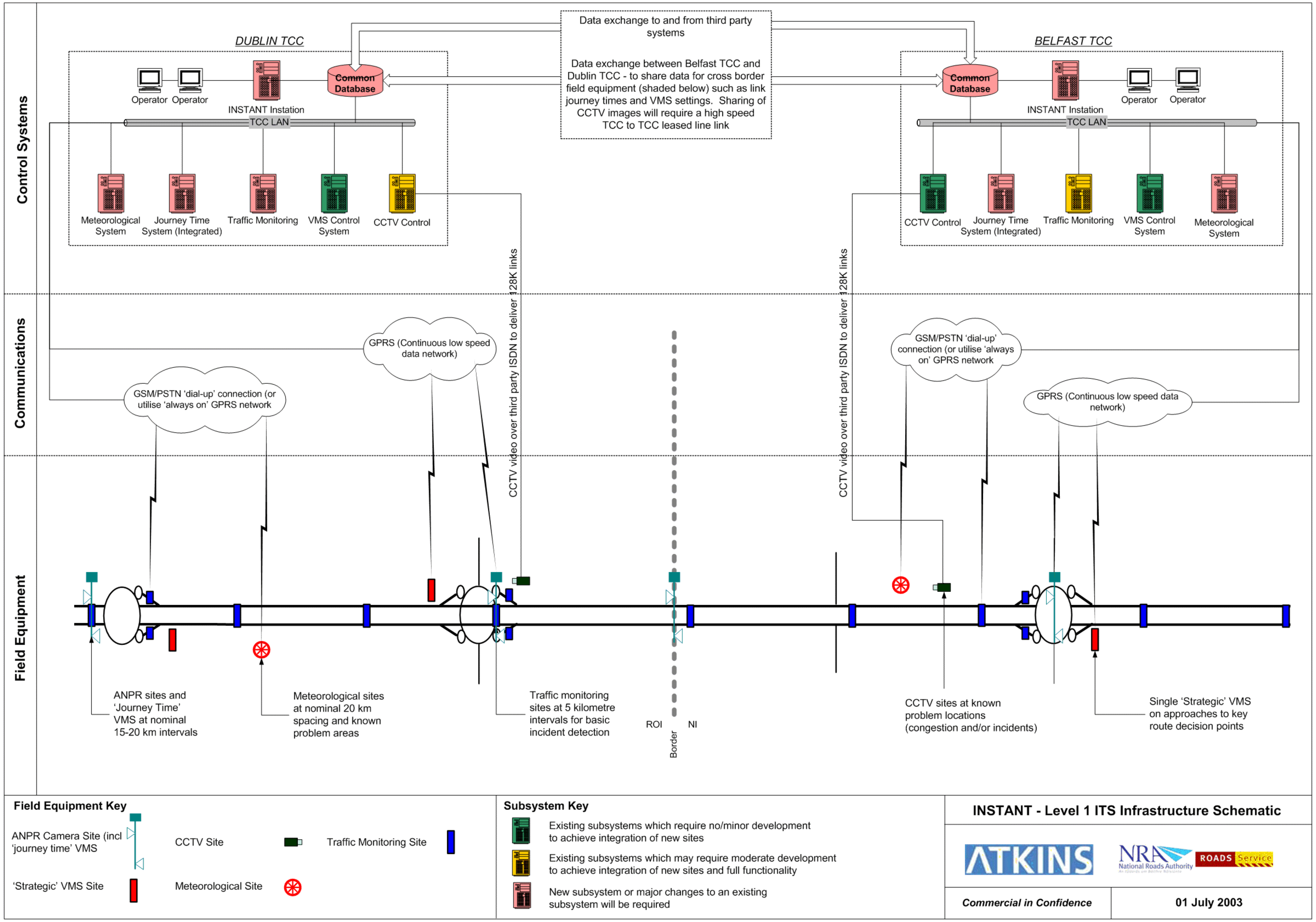


Figure 5-7 : Level 2 ITS Schematic

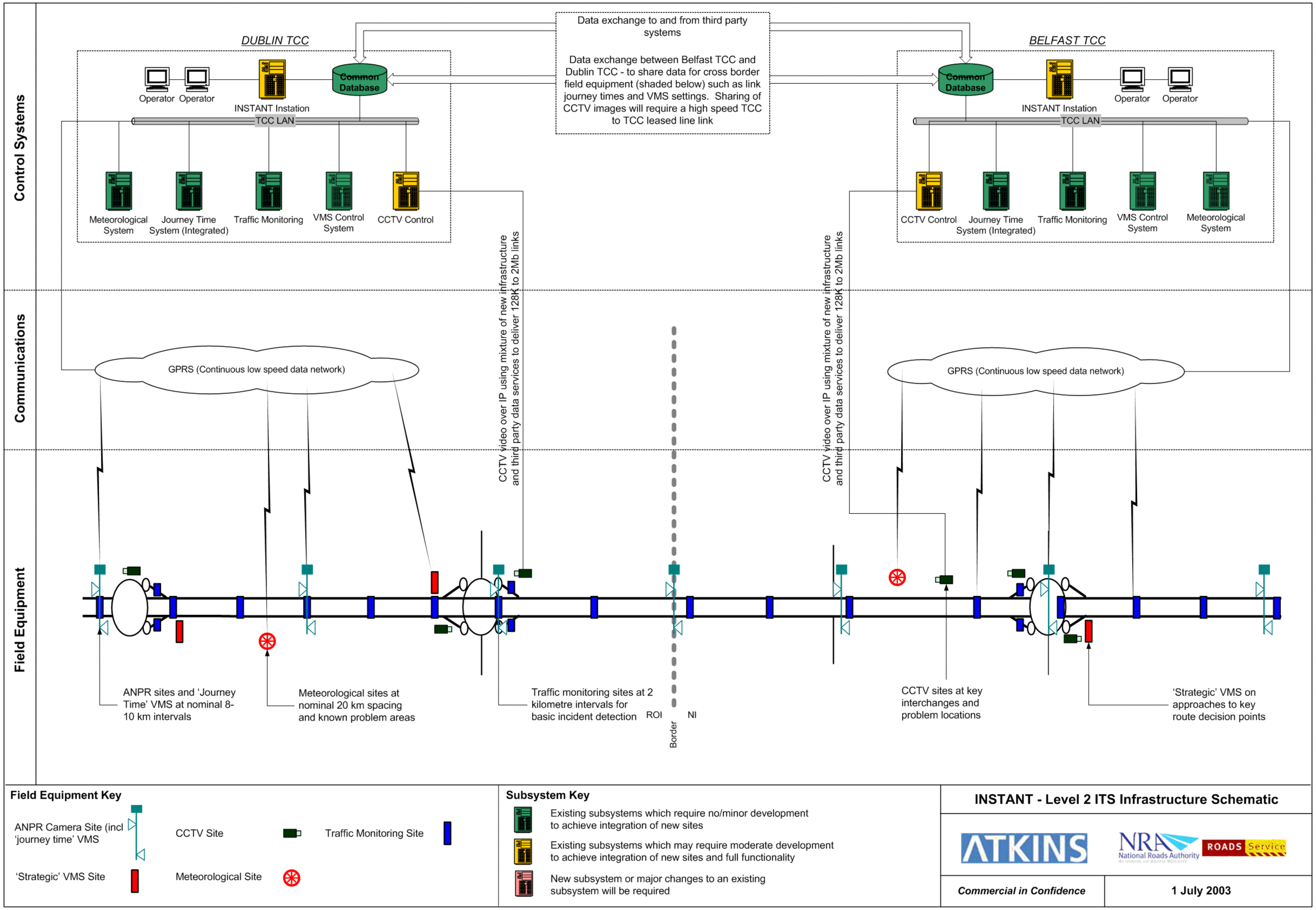
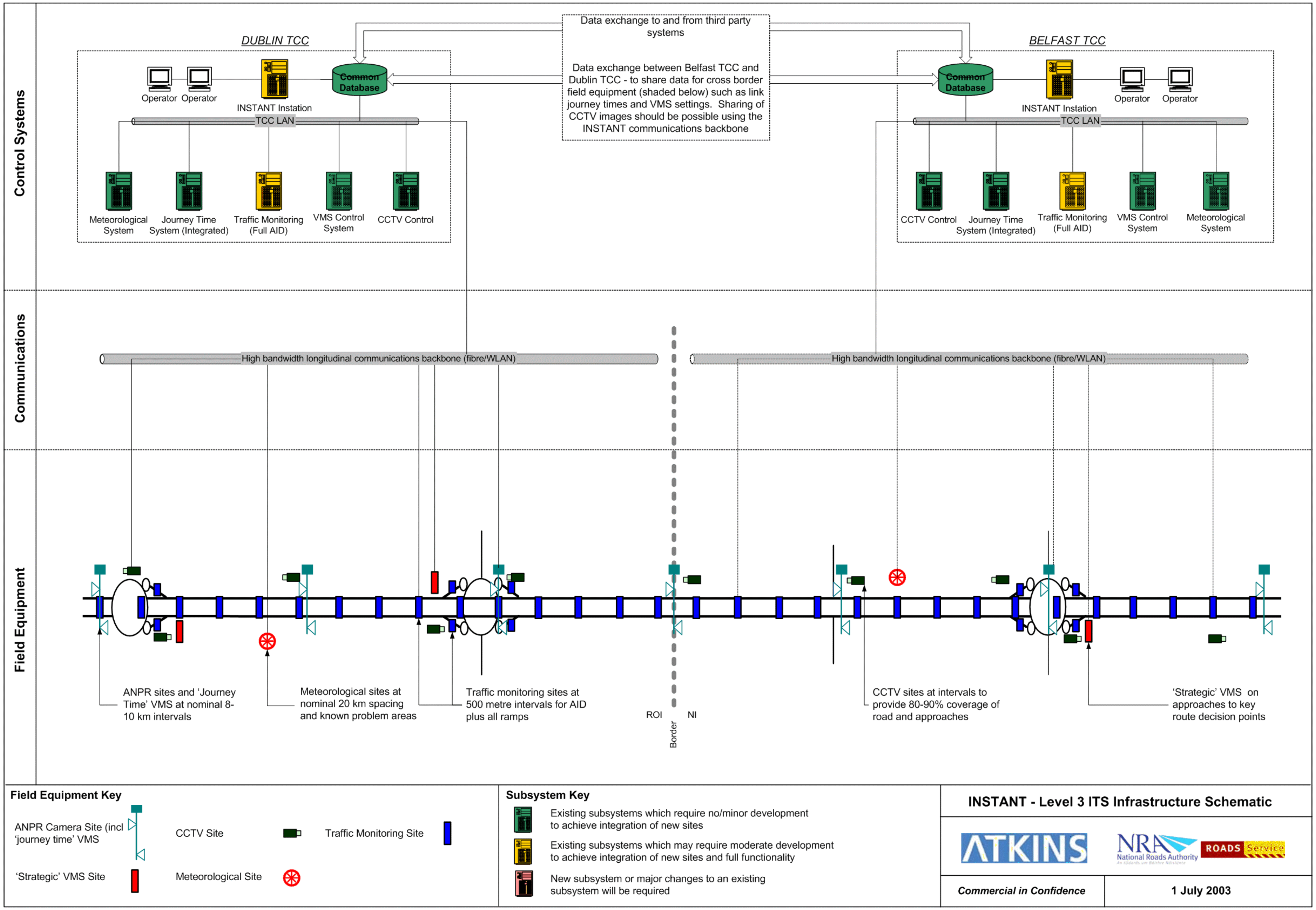


Figure 5-8 : Level 3 ITS Schematic



6 Information Services

6.1 Common Database and Data Exchange

6.1.1 Common Database

Both the Belfast TCC and Dublin TCC have implemented (and will continue to implement) a range of various computer systems for the management and control of traffic on the road network. These systems are procured to undertake specialist data gathering and dissemination tasks and typically operate independently from one another. Each system or application has its own proprietary database and there is little opportunity for data sharing between applications or for access to the data within an application.

At each TCC, it is recommended that a higher level information store or 'Common Database' sits above these individual subsystems. The Common Database is not intended to replace proprietary databases but it will be introduced in addition to these. Each existing TCC application will be required to supply data to the Common Database if another application is identified which could benefit from access to its data. In this way information that was previously locked into the internal data of individual applications is exposed and made available for other purposes. Applications that supply data to the Common Database do not need to be 'aware' of which applications use the data. In fact, it is likely the number of 'consumer' applications could increase over time, with no impact on the supplier application.

Adoption of this approach will allow a new level of system integration to be achieved:

- The sharing of data between systems that were previously unconnected can deliver new functionality; and
- The development of an open interface to the common data will allow private/public access to this information.

6.1.2 Data Exchange

(Reference Work Package 3 – Deliverable D302 'Discussion of System Architecture')

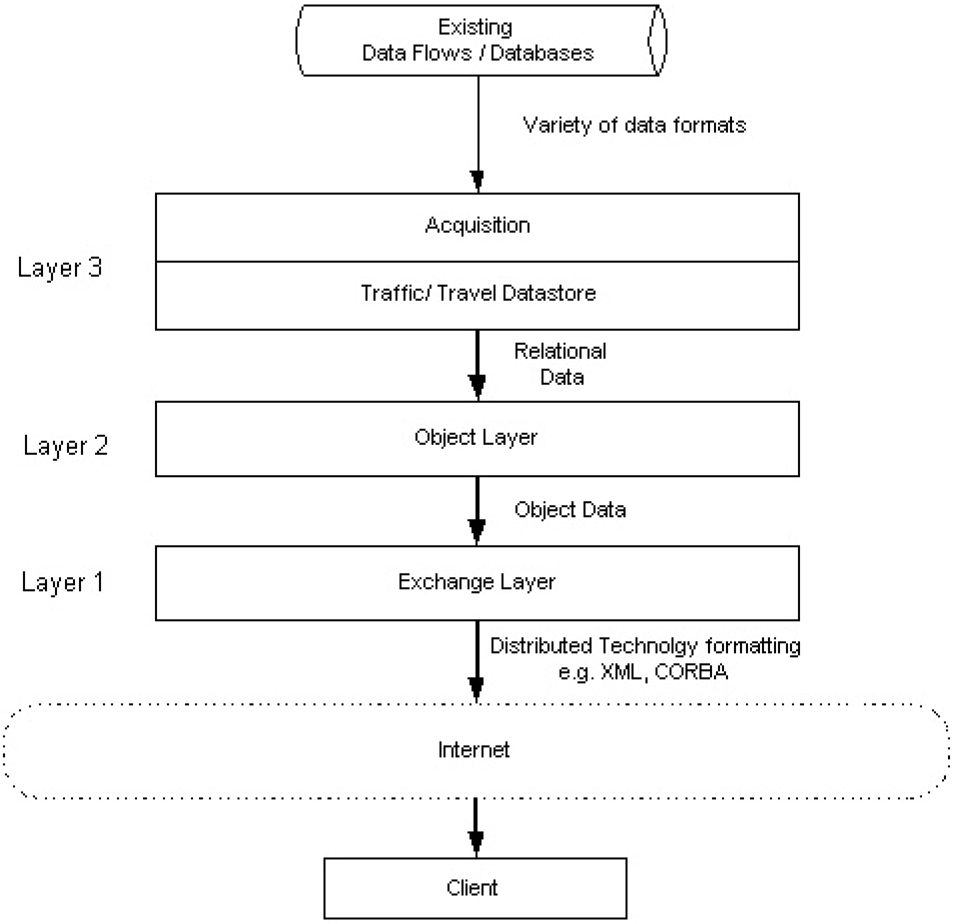
Allowing access to TCC data held in the Common Database has many advantages, but there are also fundamental issues which must be considered:

- The existing and new TCC systems will generate considerable volumes of data. The great majority of this data is only necessary for proper functioning of that system and will be of limited value to any other system or to the wider public. Additionally some of this data may be private and not appropriate for any form of dissemination; and
- The data in the TCC will come from a number of systems, each procured from a different supplier and each with proprietary data stores and interfaces. A way of acquiring this data needs to be devised so it can be offered through the single interface in a unified format.

The objective is to allow other systems to access the data, whilst providing a secure interface that is simple to use.

It is proposed that a data exchange mechanism using a three layer approach is adopted with each layer performing specific responsibilities to achieve the data transfer. The three layer model is a standard object oriented model to which all modern data exchange methods conform.

Figure 6-1 : Three Layer Approach to Data Exchange Mechanism



The three layers shown relate to the following elements in the mechanism:

Layer 3: Data storage and acquisition;

Layer 2: Object representation; and

Layer 1: Exchange interface.

This modular approach offers a very efficient design structure, as each layer is effectively independent in action, allowing new layers to be added to offer new functionality without having to change other layers. For example, a new object layer can be added to offer different object representations of the data, but still use the database and exchange mechanism. This structure maximises extensibility and reusability for future development whilst minimising costs for the implementation and maintenance of the system.

Figure 6-2 : Data Exchange Layers

Purpose	Recommendation
Layer 3 - Data Storage and Acquisition	
The data that is needed for transfer comes from different areas/ systems; these can be original databases or flows of data that are continuously updating monitoring software, but become lost after use. The aim of this element is to take all these sources, cache data as necessary and provide a unified interface to supply the object layer. The interface can be in the form of a new database, designed to collate the information or one that acts as a virtual database to what is in reality a combination of existing databases and flows of data.	A new 'common database' is to be procured with a data structure similar to the data that will be acquired from the TCC systems. Interfaces to existing TCC systems to be developed.
Layer 2 – Object Layer	
This element takes the data from the store and assembles it into structures that represent the real life entities that relate to the data. The use of existing standards should be used when possible (e.g. existing traffic/travel data models such as DATEX or TRIDENT) to provide the object structure or data dictionary. The more recognisable the data structure is, the less work a future client will have to do to understand and use the data.	Adoption of the TRIDENT model
Layer 3 – Exchange Interface	
The responsibility of the exchange interface element is to allow remote computer systems access to the data. There are two principal ways in which this can be achieved. The data user can simply request data from the data mechanism, which returns the data which is available at that point ('pulling' the data). Alternatively the supplier can automatically send the data when it becomes available and some predefined criteria has been met ('pushing' the data or a subscription service). A distributed programming technology such as XML or CORBA may be used to transfer the data objects to the requesting computer and also have the responsibility to validate users and the requests they make. If a push service is offered, then ideally the interface should allow a client to define criteria for the data they receive so updates can be automatically sent by the mechanism.	Apply the OTAP principle through the use of a request/response web server approach using XML

6.1.3 Location Referencing

(Reference Work Package 3 – Deliverable D303 'Location Referencing for INSTANT')

The value of any traffic/travel information held in the Common Database is only fully realised when this information includes some form of location reference. Location referencing issues in connection with data exchange to and from the Common Database include:

- How information is geo-referenced for internal purposes;
- How referencing used for locating data can be made available through a data exchange system; and
- Defining the process to convert (if necessary) from an internal format to a format suitable for transmission.

Figure 6-3 : Location Referencing Requirements/Recommendations

Requirements	Recommendation
Layer 3 - Data Storage and Acquisition	
The location references for layer 3, data acquisition and storage, are determined by the type of data being stored, so they are fixed	
Layer 2 – Object Layer (Internal)	
• Be flexible to support different applications –electronic, easy to manipulate and be in format that can be presented in many different ways (i.e. not just a nice picture). • Information should be extractable – Besides providing different ways of presenting the information, the GIS solution should provide ways to analyse, process and spatially query the geo-referenced information. Included in this, the GIS should be a suitable input for the automatic generation of location codes used for data exchange. • Provide definition of road network layout and easy integration with maps – allow identification of the road network under the jurisdiction of the TCC together with the location of assets and monitoring sites and integrate with visualisation tools.	Geography Markup Language (GML) or Geographic Data Files (GDF) if costs permit. Otherwise TPEG-Loc
Layer 3 – Exchange Interface	
• Standardised – To encourage the uptake of any data exchange service, it is important that the location referencing follows a standardised approach. Proprietary systems would limit the uptake of the service by users and reduce the effectiveness in providing an open data exchange mechanism. • European Initiatives – There is a need to share information with other European countries and the standard adopted should fit with European initiatives. • Covers both trunk and urban network – Traffic and travel information is available both on urban and trunk networks. As neither the traveller or information provider differentiates between these types of networks, the location referencing model adopted should be suitable for both types of network and provide uniformity of service. • Decoding and Integration tools available – Depending on the complexity of the coding, it is essential that tools are available to support understanding the location referencing and how this could be integrated into GIS of the receiver (if there is one available). Again this is essential to encourage users to take up the service. • License free visualisation aids – Especially for cross border applications, tools to provide a basic map to visualise the locations of incoming data without the need to buy a license would again encourage other users to subscribe to the available data services.	TPEG-Loc

Within the INSTANT project, all three aspects need to be considered and recommendations made because neither internal location referencing in electronic format nor any specification for exchange currently exists at either TCC.

Typically, the requirements for locating information for internal purposes are different from those for exchange. Referring to Section 6.1.2 above, the internal referencing corresponds to layer 2 of the process and exchange to layer 1.

Typically, the location referencing for internal (layer 2) needs to have higher granularity, the accuracy needs are higher and it should be suitable to develop services from. Underlying these requirements is the need to integrate into tools to visualise the network on which information is gathered.

For exchange (layer 1), the granularity of the location referencing does not typically need to be as high and there is no real requirement to directly visualise the information because in most cases it will be integrated within another GIS at the data user end. The main requirement is standardised (not proprietary) and unambiguous representation to enable easy integrated with other GIS.

Although a format for each of the application layers (internal and exchange) could be selected independently, it is important that a process can be developed to link both together.

6.2 Information Dissemination

6.2.1 INSTANT Website

6.2.1.1 Introduction

Delivering information via the internet is visible and relatively easily achieved. Creating a "web portal" provides a common entry point to information generated through INSTANT systems and a seamless gateway into information available from others – known as "web stakeholders". During the Design Study the Web Portal has progressed from a simple web site listing links to useful information to a prototype portal site that integrates content from other "web stakeholder sites" and has "glue content" between themes, modes and places. www.instanttravel.info has been reserved for the web-site when it goes public. The site uses cascading stylesheets (CSS) to create a common look and feel that can easily be updated and meets accessibility and design criteria. It has been designed with an eye to it becoming part of an enhanced XML driven portal.

The home page of the completed Design Study site is shown below

Figure 6-4 : INSTANTtravel homepage

6.2.1.2 Considerations for successful long term operation of web site

If there is to be long term operation of the INSTANT portal it is essential that:

- The INSTANT portal is championed as the authorities preferred gateway.
- The INSTANT portal has a recognised manager who is charged with ensuring compatibility, implementing improvements, and liaising with the operators of both public and private sector "stakeholder" web sites.
- Development of existing resources, e.g. TrafficWatch NI should take account of the requirements of the INSTANT portal.
- Consideration is given to the development of INSTANT either as a monolithic site covering all of the island of Ireland or as part of a family of related and linked sites.

The experience of taking the web portal design to this stage has highlighted two key issues:

(a) Stakeholders are enthusiastic but require direction from the ITS Champions (i.e. NRA and RS) to become fully involved. Atkins, as a contractor, has not had the authority to enter into necessary agreements, some financial, to ensure all the envisaged content is available. If the web portal is to be fully exploited memoranda or agreements need to be put in place;

(b) Where sources of information are to be mixed (e.g. travel bulletins, timetables, mapping and directions) to give a "seamless" service, enabling the web site through an INSTANT XML schema (eXtensible Mark-up Language) is required.

There are two types of end user the web portal can serve:

- The ***public user*** wanting the best quality travel information to, from, and within the corridor. The current design of the site provides for this, and for it to grow and become further integrated across modes and stakeholder supplied information;
- The ***member user*** – an organisation such as a radio station or third party information supplier who wishes to access information made available by the "INSTANT system" (e.g. quick refresh CCTV, VMS settings) either for their own purposes or to process and then disseminate to their customers / listeners / viewers / web site visitors.

In both cases the user wants a traffic and travel *information* service, the function of a TIC, not a TCC. It is very important that the TCC's understand this role fully or a sub-standard or under-developed service will result. Any development or service provision under the INSTANT banner should be capable of extension to the rest of Ireland, avoiding duplication of effort.

One relatively inexpensive action that could be implemented, if common location referencing and a map based tool is available, is the provision of a centralised roadworks register. Members would locate the works on a map and then enter in the details (lanes closed, duration etc) and this would be saved in a database on the web server. Costs of €40,000 (£28,571) have been estimated for this work, but this is dependant on the scope of the full specification required by NRA/RS.

To satisfy the public user work has to be done to improve sources of information and the compatibility between them. The work of the UK Transport Direct project in defining roles and responsibilities, and producing technical specifications and schema could provide useful reference points. Whilst public transport information for Northern Ireland has de facto standardisation because of the role of Translink, there is not a parallel situation in RoI. The Irish Department of Transport is encouraged to establish such standards.

The NRA and RS must decide on the issues of ownership, branding and further development of the INSTANT portal. They, and the public transport authorities, have (or will have once the recommendations of this report are enacted) at their disposal very large depositories of travel information. Through collaboration and cooperation, and key stakeholder agreements for the purchase of services such as mapping and road journey planning ***the*** transport information portal for the island of Ireland could be instigated. Alternatively NRA/RS (or their governmental funding departments) could engage the private sector to deliver the service to their specification (outline or detailed), but with their full support and cooperation. Whichever option is chosen engagement and full support of those involved is essential to avoid unnecessary delays through convoluted administrative approvals, commercial sensitivities, and/or institutional lethargy.

6.2.1.3 Developing a "Member Site"

Developing services for the member user through extranet facilities is potentially of major benefit. Design considerations need not be as stringent, functionality is the key. The member site is conceived as a secure front end for the data exchange activities. Some levels of access will require a minimum level of communication speed, and/or specific client applications to operate.

The member site can operate as a two-way communication medium. Typical outputs available to subscribing members might include:

- Fast load / refresh CCTV images
- VMS settings
- Graphical / data representations of speed flow
- Access to historical data / predictive sequences
- Live Message Board from TCC

Typical inputs to the TCC's might include:

- Roadworks register – a common format, geographically correct trans-national urban and inter-urban resource
- Live message board from subscribers for TCC to validate (validation may not be necessary if information is from a trusted source)
- Information from members own intra/inter/extranet systems

Examples of similar members sites can be found in Wales and Scotland[13].

6.2.1.4 Development of XML functionality

Extensible Markup Language (XML) is the universal format for data on the Web. XML allows developers to easily describe and deliver rich, structured data from any application in a standard, consistent way. XML does not replace HTML; rather, it is a complementary format.[14]

XML functionality is a part of the web services data exchange methodology. Within the web portal provision this can be extended considerably to process and present a wide range of travel information. The XML approach is in wide use for many differing applications. It would be very unlikely that information services on the INSTANT corridor would not naturally migrate to XML during the next 10 years.

An XML web portal has many advantages over a conventional web portal. These advantages are as follows:

- The integration of services and content from different sources enable the service provider to generate value-added services. A simple but useful example is the provision of comparative multi-modal routing, whereby car and public transport travel times can be compared.
- Information from external sources can be imported into the site and presented to the user in a familiar layout/format.

[13] www.traffic-wales.com, www.nadics.org.uk
[14] A useful article on XML from Microsoft is at http://msdn.microsoft.com/library/default.asp?url=/library/en-us/dnxml/html/understxml.asp

- The services on the site can be delivered to any type of end device: in car device, WAP, 3G phones etc.
- The XML interface will simplify the integration of new services into the portal.
- It is possible to integrate complex data (e.g. public transport routing data) into the system and/or simple content (e.g. name of petrol station and its map co-ordinate)
- A decentralised system can be provided by the XML solution, guaranteeing a high level of reliability for the whole portal.
- A data provider can provide the level of content they feel comfortable with – further levels of detail would then be obtained by visiting the provider's site.

It is recommended that functional specification of the XML portal is progressed and XML enabling implemented. A development / design cost of €250,000 (£180,000). Hosting and Maintenance costs of €14,000 (£10,000) are estimated. Ongoing development costs will be incurred as more services and information becomes available, though it is not possible to provide estimated costs at this point.

6.2.2 Radio Communications

For more information please refer to Deliverable D402 'Scoping Study for Travel Information Radio Services'.

6.2.2.1 Introduction

Within the INSTANT Design Study a Scoping Study on the potential for Travel Information Radio Services on the INSTANT corridor between Dublin and Belfast has been carried out. During the Feasibility Study market research suggested that the majority of road users trusted radio broadcasts and would welcome improvements in their accuracy and quality.

To achieve these improvements will require the availability of good quality information and either special in-car equipment and/or dedicated broadcast channels to deliver traffic information on the INSTANT corridor when and where the user requires.

6.2.2.2 Corridor Length Options

Corridor length options are suitable for expansion across both RoI and NI and this should be taken into account in any decision to implement.

Overall, Ireland can be regarded as a "green field" for traffic information radio (as for all TTI – Traffic and Travel Information services). Unlike most of the rest of Europe it does not have RDS-TMC services based on an outdated technological approach. There is no user base with RDS-TMC receivers, although in-car navigation units are increasingly being fitted to higher end vehicles with this functionality.

There is enthusiasm for DAB, and therefore the potential for adopting the new TPEG standards for radio information service is high. There are attractions in selecting a DAB / TPEG combination (as championed by the European Broadcasting Union), not least that in-car DAB units should be able to use the data channels available to advise at the local level of traffic conditions sourced from Traffic Information Centres. The promotion of DAB traffic service through the public service broadcasters (BBC/RTE) should be encouraged.

However, across Ireland currently there is no location referencing system in place, and the quantity of processed and distributed traffic data available is low outside of the city conurbations. Elsewhere (in the Data Exchange recommendations and the data gathering infrastructure proposals) these issues are being addressed by INSTANT. By 2007 the data needed to support TPEG DAB services may exist, and the broadcasters may well have the infrastructure in place to seriously consider roll out. It is unlikely to be before 2010 before full DAB services are in place.

Clearly, though, RDS-TMC is proven technology and services could be set up without much technical risk within a few years. The Scoping Study has concluded that Road Authorities should encourage development by others but make it clear that their goal is for a TPEG based service.

Table 6.1 : Radio Dissemination Options

Radio Type	Comment
Journalistic Bulletins	In both NI and RoI travel radio is currently in the format of journalistic "slots" on radio stations at fixed times. The BBC Travel Unit in NI and the AA Roadwatch Service in RoI are the clear market leaders.
RDS-TMC	RDS-TMC has not been implemented anywhere on the island of Ireland However, the company iTIS, who provide RDS-TMC services in Great Britain, have the exclusive licence for RDS-TMC broadcasting in the UK, and include NI within their longer term business plan.
DAB	Digital Audio Broadcasting (DAB) is being championed by the BBC in NI and there is also a strong take up from the commercial sector. No decision has been made in RoI about the provision of DAB, but the Department of Communications are currently examining the implications (e.g. transmitter networks)
Dedicated Highway Advisory Radio (HAR)	In the Greater Dublin Area the Office of the Director of Traffic has trialled a dedicated traffic information radio service "Travel FM". It works by utilising the Alert-C protocol and a drag and drop interface to construct messages, and a synthesised voice output. It is planned that this service will become permanent. Special licenses will be needed to replicate this service elsewhere on the corridor

6.2.2.3 Localised Highway Advisory Radio

The relatively low traffic flows on the corridor for the standard of road infrastructure means that provision of systems such as VMS can be difficult to justify on a cost benefit basis. Also there are specific points along the corridor where it has been identified that provision of information is likely to be of more benefit to travellers (e.g. the M1/M50 interchange, M1 Drogheda by-pass, M1 near Dundalk, the border, Newry, and the Sprucefield interchange). A potential method could be low powered AM or FM Highway Advisory Radio (HAR)

Figure 6-5: Typical HAR advisory sign with warning beacon

Picture Copyright of Transportation Intelligence Inc.

HAR, using low-power transmitters broadcasting over a small area (e.g. <5 km radius), although popular in the USA is rarely if at all used in Europe. However, the technology is comparatively cheap to set up and licensing regulations would seem to suggest that implementation of HAR is possible in both NI and RoI. No special equipment is needed to receive the broadcasts, just a car radio.

Localised HAR using FM is preferable on the INSTANT corridor as it will allow RDS-EON functionality to make tuning easier. Using figures derived from US based suppliers systems using signs as shown above could be implemented for under €100,000 per site and would cover both directions of traffic, advance warning of conditions further down the corridor. The existence of just one system would be beneficial to the testing of enhanced services such as DAB which might be expected to replace the systems after 7 to 10 years.

6.2.2.4 Recommendations

Development of Low Power HAR

In the short to medium term low-power AM or FM broadcasts under restricted service licences appear to be (compared with infrastructure such as VMS) a low cost and effect way of disseminating traffic information on the corridor. FM has some advantages in that RDS functions such as station identification and RDS-TA can be used.

It is recommended that work is carried out to:

- Specify outline positions of appropriate sites for low-power antennae on the INSTANT corridor, including the potential for mobile units, and advisory signs with warning beacons;
- Specify how and when messages should be sent to HAR stations;
- Specify message formats and location reference rules to be used;
- Reach outline agreement with the BCI in RoI, and the RA (Ofcom from late 2003) in NI on the conditions under which licences would be granted; and
- Specify operational performance of the systems based on these conditions.

Development towards TPEG and DAB based services in the long term

- The NRA and RS should make a public statement that it is their intention to make TPEG the underlying base for the traffic and travel information services they intend to develop or commission to encourage receiver purchase and service development by others;
- NRA should make clear to the Department of Communications, Marine and Natural Resources that they wish to see TPEG services on DAB realised in the RoI;
- If deemed appropriate RS should open dialogue with the BBC to accelerate the provision of TPEG-DAB in Northern Ireland; and
- A common TPEGloc location database should be developed for all of Ireland.

Encouragement of RDS-TMC

It is clear that across Europe there is great momentum in RDS-TMC built up over many years. RDS-TMC does not necessary mean the creation of a speech based service, it can be a component of another service, often one led by the private sector. RDS-TMC will need quality information if it is to be viable. The NRA and RS should encourage RDS-TMC development by others, but make it clear that their goal is for a TPEG based service.

TTI Strategy

It would be helpful to agencies, suppliers, and probably to themselves if the NRA/DOT and RS/DRD were to publish TTI Strategies to aid the process of developing TTI services in Ireland.

7 Institutional Issues

7.1 Definition and purpose

This section identifies the stakeholders concerned with the operation and use of the INSTANT corridor and the ITS systems and services to be deployed. It considers the institutional issues, the implications and needs for liaison with and between stakeholders, and the organisations and arrangements needed to cope.

7.2 The Big Shift

The Big Shift[15] initiative of the WERD/DERD (Western European Road Directors/Deputy European Road Directors) aims to provide strategic recommendations for members concerning the deployment of ITS. It recognises 'that ITS is synonymous with the concept of providing smarter, smoother, shorter and safer integrated services across all modes of transportation' and defines the Big Shift as 'the change in emphasis within National Road Administrations from road building and maintenance towards road network operations and the consequent change in organisation and process required to deliver high quality network services'.

It makes recommendations in five areas which it considers important for National Road Administrations to apply. These relate to:

- Customer and service focus – working continuously with customers to identify (changing) demand and to deliver appropriate and seamless services;
- Multiple stakeholders and partnerships – a variety of stakeholders could be involved from both the public and private sectors. Appropriate partnering arrangements will be required;
- Role changes within National Road Administrations;
- Service implementation and operation – consider policy and strategic objectives and search for optimisation and coordination; and
- Information management – good quality real-time information is essential for the success of ITS.

These provide valuable background to this chapter on institutional issues.

7.3 The Job of INSTANT

The main job of INSTANT is to manage traffic on the international corridor and provide multi-modal travel information and advice. To do this effectively requires that information is collected about conditions, problems and incidents are quickly detected; that appropriate plans are implemented to manage the road traffic efficiently, and that information is disseminated to inform and advise users.

Increasingly, a growing number of organisations are concerned in the information chain in order to provide comprehensive multi-modal and inter-modal travel information. The participants include the TCCs and police at the core but will also potentially the public transport operators, private road network operators as well as freight operations and VASPs (Value Added Service Providers). New institutional arrangements are needed to ensure the full range of actors who can help with gathering and disseminating information are organised to work together.

[15] WERD/DERD Subgroup Telematics Big Shift Final Report Outline 16 May 2003

Two main requirements from INSTANT for establishing potentially new institutional arrangements are:

(i) To provide the organisation, liaison and where appropriate Memorandums of Understanding (MoUs) with and between stakeholders and to agree and put in place necessary procedures to ensure:
- high quality, accurate, reliable and timely information is collected about conditions, events and incidents that are likely to affect the network
- proper plans and arrangements are available or can be made and put in place quickly for managing the network efficiently, and
- the correct information and advice is prepared and disseminated to keep users informed and advised.

(ii) To define how the RS and NRA will interact and work together:
- to share information and coordinate responses for traffic management on the corridor
- to fund, maintain and develop the corridor in the future
- to monitor advances in technology and ensure the full potential of ITS for developing integrated transport solutions can be exploited for the INSTANT corridor.

7.4 Stakeholder Roles

The activities that must be undertaken in order to manage traffic on the corridor involve:

Problem forecasting, planning and management for:
- Roadworks (by road managers and utility companies);
- Exceptional loads;
- Events (Fetes, football matches, concerts, strikes etc);
- Inclement weather forecasts (Met Office); and
- Public transport disruptions (trains, buses, ferries, air).

Incident detection and management for:
- Problems detected at the TCC using the ITS infrastructure and systems implemented (incident detection, ANPR, CCTV);
- Calls from the public over emergency roadside telephones or mobiles;
- Reports from others e.g. LAs, AA patrols;
- Police offices/patrols; and
- PT disruptions reported by train, bus, ferry, air operators.

Management responses:
- TCC operations for managing traffic;
- Emergency services deployment (police, fire, ambulance); and
- PT operators may need to arrange for increased services.

Dissemination of information and advice:
- To other TCC/TICs;
- Using roadside VMS;
- By radio broadcast;
- Through the internet; and

- Through VASPs.

Information is needed for each problem, event or incident to describe:

- type;
- description;
- location;
- estimate of (remaining) duration;
- likely level of disruption (i.e. increased travel time on link, delay, queue length); and
- other (optionally) e.g. road/number of lanes closed, contra-flow operating, diversion in force, advice etc.

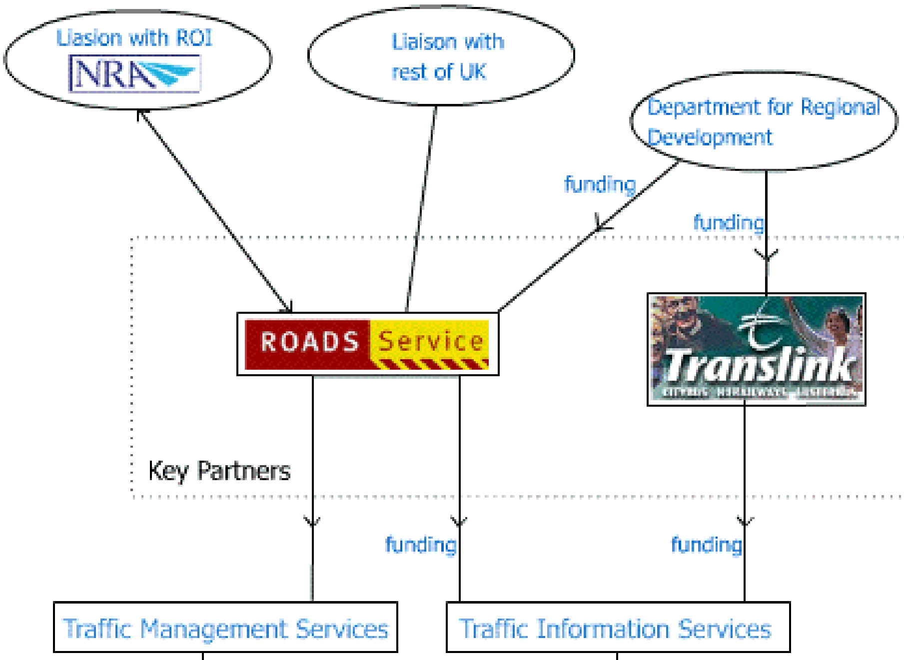
Data fusion methods are needed at the TCCs to ensure new data is integrated with existing to provide enhancements and updating, and to avoid duplication.

7.4.1 ITS Partnerships for INSTANT

7.4.1.1 Northern Ireland

The main stakeholders and proposed arrangement for the ITS partnership in Northern Ireland are shown below;

Table 7.1 : ITS Partnership in NI



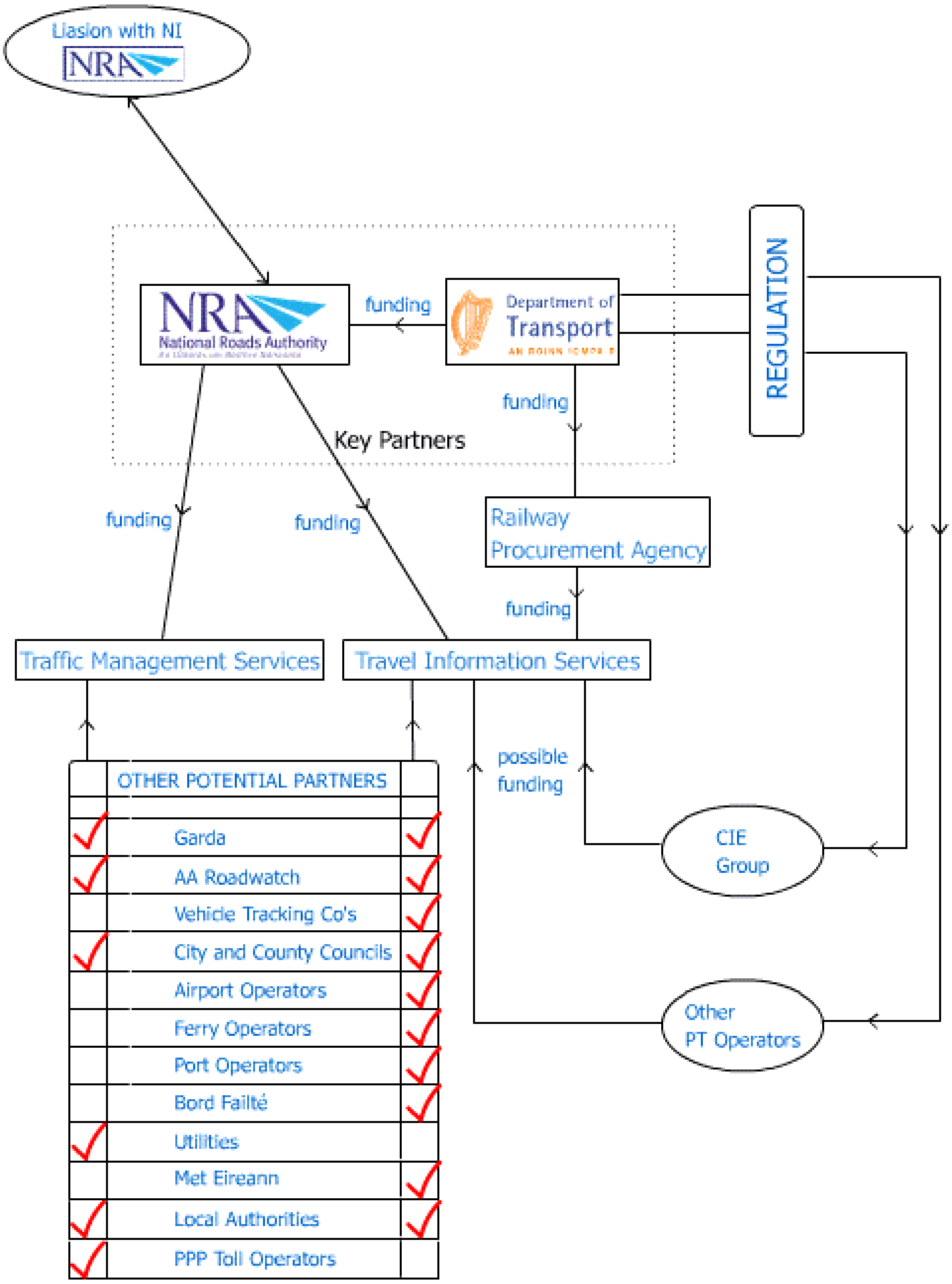
	OTHER PARTNERS	
✓	Police Service NI	✓
	Port Operators	✓
	Airport Operators	✓
	Ferry Operators	✓
	BBC Travel Unit	✓
	Vehicle Tracking companies	✓
	NI Tourist Board	✓
✓	Utilities	
	Met Office	✓
✓	Local Authorities	✓

Roads Service act as the prime partner and champion with Translink involved as the key public transport information funder.

7.4.1.2 Republic of Ireland

The main stakeholders and proposed arrangement for the ITS partnership in the Republic of Ireland are shown below;

Table 7.2 : ITS Partnership in ROI



The prime partner and champion is the NRA with the Department of Public Enterprise via their regulatory role and their status as the funding department for the Railway Procurement Agency, as the other key partner.

7.5 Stakeholder Organisations and Meetings

It is recommended that three levels of Stakeholder Meetings (SM) are implemented;

7.5.1 SM1 - The International Corridor.

The main participants involved here are RS and NRA for traffic, with other partners to represent public transport interests.

Terms of Reference:

- Set and maintain the Vision for ITS in the international corridor;
- Direct the development, operation and maintenance of the corridor;
- Ensure integration and the European dimension;
- Agree an MoU to capture requirements for ongoing co-operation;
- Oversee requirements for publicity;
- Oversee requirements and mechanisms for financing, PPPs; and
- Monitor advances in technology and the new opportunities provided .

Stakeholders:

Northern Ireland	Republic of Ireland
RS	NRA
Translink	PT representative (RoI
Others may be invited as required	

Meetings to be held quarterly initially.

RS and NRA may prefer to involve the PT interests by invitation only. They are needed only to ensure a proper multi-modal dimension, but not to manage traffic.

For traffic purposes, RS and NRA will need to develop an agreement or MoU to define the way in which their respective TCCs share information and coordinate traffic on the corridor. This should specify:

- General description of (and types of) information to be exchanged;
- Situations and circumstances in which information is exchanged;
- Quality and timeliness considerations;
- Procedures for exchange and for confirming receipt; and
- Agreement on how the information is handled in terms of who sets VMS and disseminates what information through other means.

7.5.2 SM2 - National Traffic Management

Two sets of stakeholders will need to be organised to manage and handle traffic in the corridor, one for each country. The main objective will be to coordinate the interests and activities of the various government bodies along the corridor.

Terms of reference:

- To keep stakeholders in each country informed of progress and plans;
- To ensure quality and timely data is exchanged with the TICs; and
- To ensure the systems, procedures and operation of the corridor is complementary, compatible and integrated with national and local requirements.
- To inform about and progress enforcement technology deployment as envisaged by TISPOL/WERD groupings

Stakeholders:

Northern Ireland	Republic of Ireland
RS	NRA
Police	Garda
Fire	Fire
Ambulance	Ambulance
	AA Roadwatch
	City and County Councils

Meetings to be held quarterly initially.

Agreements or MoUs will be needed to specify:

- General description of (and types of) information to be exchanged;
- Situations and circumstances in which information is exchanged;
- Quality and timeliness considerations;
- Procedures for exchange and for confirming receipt;
- Agreement on how the information is handled in terms of who reacts and how; and
- Agreement to pass international issues to SM1.

7.5.3 SM3 - National Traveller information

Two sets of stakeholders will need to be organised to manage and handle traffic and travel information in the corridor; one for each country. A main objective will be to coordinate the interests and activities of the various bodies with interests in the corridor.

Terms of reference:

- To keep stakeholders informed of progress and plans;
- to ensure the accessibility and usability of information for end users;
- to ensure multi-modal travel information is available to agreed standards of quality, including accuracy, timeliness etc and in the required formats; and
- establish MoUs to capture ongoing requirements for co-operation.

Stakeholders

Northern Ireland	Republic of Ireland
RS	NRA
Translink	Garda
Police	Bus/Coach/Train operators
Port operators	Port operators
Airport Operators	Airport Operators
Ferry operators	Ferry operators
BBC Travel Unit	AA Roadwatch
Vehicle tracking Cos	Veh Tracking Cos
NI Tourist Board	RoI Tourist Board (Bord Failté)
	City and County Councils

Plus potentially, representatives from:

- ITS industry;
- Telecoms Companies;
- Financial institutions;
- End users (e.g. Freight Companies);
- Met Office;
- Vulnerable road users;

- Road concessionaires;
- Utilities (water, gas, electricity); and
- LAs.

Meetings to be held quarterly initially. These could be reduced to 4 and then 6 monthly as the corridor matures, and at some stage perhaps, combined.

Agreements or MoUs will be needed to specify:

- General description of (and types of) information to be exchanged;
- Situations and circumstances in which information is exchanged;
- Quality and timeliness considerations;
- Procedures for exchange and for confirming receipt;
- Agreement on how the information is handled in terms of who reacts and how; and
- Agreement to pass international issues to SM1.

7.6 Private Funding

Special agreements may be needed in the case where third party organisations (VASPs) wish to contribute information from other sources and infrastructure (such as TrafficMaster or ITIS) and/or buy and sell information on to third parties. The agreements will depend on circumstances, and will need to be negotiated at the time.

7.7 ITS Participation and Research

The RS and NRA are already engaged in research through involvement with projects promoted by the national Governments and the EU, notably STREETWISE which is concerned with the deployment of ITS on the Trans European Road Networks. Other national and EC sponsored activities relate to the development of standards for ITS and a System Architecture.

These activities will contribute substantially to the research needed to support the application of ITS, and 'integrated transport' in the future. This includes determining categories of all purpose roads suitable for different levels of equipment, and refining national standards for location and network referencing. Studies may also be needed of the organizational, legal and institutional frameworks for supporting the sharing of information, infrastructure and equipment between local and regional governments as network authorities and the private operators of public transport and freight operations. The Governments should therefore continue involvement in EC projects such as Streetwise and the UK's Transport Direct and UTMC initiatives.

Research should also proceed on the development of road-vehicle communications, as in the EC's RTA and MARTA projects, with a view to the longer term potential particularly for getting safety related e.g. speed limit and warning information to drivers directly in their vehicles. Similarly, developments in vehicle control systems should be supported for their potential to be influenced from the roadside and increase safety.

7.7.1 Standards

The national governments should also be involved with work to develop Standards which are needed to support ITS implementation and integration, and are under development at national (e.g. BSI), European (CEN) and international (ISO) levels.

The standards provide advantages for industry and users alike in that they provide openness, reduce wasted development activities, lead to economies of scale in production, and ensure that procurers and users can get a quality product from a range of different suppliers. Further development of standards is required in the areas of data management, communications and vehicle location.

7.7.2 Monitoring and Evaluation

ITS systems and services can also help both to achieve, and to monitor national government's requirements for improved monitoring and evaluation.

ITS systems can be used not only to monitor the NATA criteria of safety, environment, economy, accessibility and integration; but also to monitor progress towards achieving other key objectives such as:

- Improving journey time reliability;
- Increasing options for people to travel to work or school;
- reducing road casualties; and
- monitoring freight movement.

7.7.3 ITS Systems Architecture

The systems and services discussed in this report are mainly effective over the next 10 years. But at the same time, the national governments must keep in mind the 2030 opportunities and the need for the strategy to encompass these in the longer term.

For this a systems architecture or Framework for ITS is needed to help:

- show how the different systems fit together, and where the interfaces occur;
- show the opportunities for integration (in terms of synergy) from sharing data, infrastructure or decision rules and so help identify the potential for cost savings and benefits (e.g. from a common infrastructure for information and charging);
- show the impacts and ramifications of introducing each (new) system or scheme, including;
- impacts on legal, organisation and institutional issues;
- identify who is affected (i.e. stakeholders) and how;
- identify who needs to be consulted e.g. LA's (local authorities), Police, private sector, DBFO road operators, VASPs in order to understand their perspective and needs;
- review new developments in a structured way;
- assess the risks associated with introducing (or not introducing) system; and
- monitor progress, developments and implementation;

Additional benefits include:

- an aid to managing complexity;
- provides a common language for describing systems and attributes;
- allows Interoperability of equipment with different infrastructures;
- ensures compatibility and consistency of information delivered to end users through different media;
- allows better integration and co-ordination of services;
- provides solutions that meet the wider needs of the community;
- provides more choice for users;
- allows multiple use of data and infrastructure;
- means reduced risks for industry in developing new products against national/Euro/international standards;
- opens up a wider (world) market offering economies of scale in production; and
- shows the stakeholders that the national governments have thought through the problem and issues arising.

8 Financial

8.1 Overview

This section identifies the potential funding mechanisms available to contribute towards the delivery of the INSTANT Implementation plan. It builds on the Feasibility Study deliverable F-07 System Finance Report.

8.1.1 Republic of Ireland

The national non-primary road transport network in the Republic of Ireland is the direct responsibility of the Department of Transport. The mandate for the Department derives from the commitment in the Agreed Programme for Government to establish a Department of Transport with responsibility for the national roads programme, aviation and public transport.

The Department has a wide range of functions in relation to roads. These include:

- policy development;
- promotion of legislation;
- negotiation of national and EU funding;
- acting as lead Department for Transport Operational Programme 1994-99;
- overseeing activities of implementing agencies (The National Roads Authority (NRA), the Dublin Transportation Office (DTO), the National Safety Council, local authorities);
- promotion of road safety; and
- driver testing.

The Dublin Transportation Office was established to coordinate the implementation by relevant agencies, including the Departments of Transport and Environment and Local Government, of an agreed integrated transport strategy for the Greater Dublin Area, namely the Dublin Transportation Initiative which was adopted as government policy in 1994.

The NRA has statutory responsibility for the management of the National Development Plan and for the allocation of grants to specific projects on the national roads network. The Plan, which will involve a total investment of over €50 billion over the period 2000-2006, seeks to ensure Ireland's continued economic and social development.

8.1.2 Northern Ireland

In Northern Ireland the responsibility for the transport network rests with the Department for Regional Development, a department of the Northern Ireland Executive. The Roads Service, an agency with the Department, is the sole road authority in Northern Ireland. Its funding comes largely from central government, with the Comprehensive Spending Review determining the overall level of funding available. Additional funding associated with the implementation of the Good Friday Agreement has been established for public service improvements, including transport infrastructure improvements.

The Road Service are responsible for implementing the Regional Transport Strategy for Northern Ireland, which identifies a £3.5 billion investment in strategic transportation schemes and considers potential funding sources and affordability of planned initiatives over the period 2002/03 to 2011/12.

8.2 Funding Sources

8.2.1 Republic of Ireland

The National Development Plan (2000-2006) (NDP) is laying the foundation for Ireland's further economic and social development. The Plan commits to an investment of €5.6 billion (1999 prices) to deliver the national roads improvement strategy over the period 2000-2006 identifying the following sources of capital funding for the strategy.

Table 8.1 : RoI Funding Sources

	1994/99 €b (1999 Prices)	2000/06 €b(1999 Prices)
EU (Cohesion Fund and ERDF)	1.13 (61%)	0.762 (14%)
Irish Exchequer	0.72 (39%)	3.555 (63%)
Private		1.270 (23%)
Total	**1.85**	**5.587**

8.2.2 Northern Ireland

The Regional Transportation Strategy (RTS) assumes a total investment of £3500 million, of which £1370 million is additional to current levels of transportation spend. This investment is not "ring fenced" over the period 2002/03 to 2011/12 as the financial needs of other Departments will also be accounted for. Over the 10 year period the following sources of capital funding are identified.

Table 8.2 : NI Funding Sources

Assumed Additional Funding Sources and Private Finance Contributions	Assumed Funds (£m) over period 2002/03 to 2011/12
Public Expenditure (Includes Executive Programme Funds and EU)	510
Reinvestment and Reform Initiative (excluding Executive Programme Funds)	425
Increased Developers' Contributions	100
Sale of assets	20
In year additional Public Expenditure	15
Private Finance (Highways)	150
Private Finance (Public Transport)	150
Total	**£1,370 million**

8.2.3 European Funding Sources

The main Community objective in relation to Transport is to deploy transport networks, to interconnect them and to make sure that they operate smoothly. In support of this objective this year alone the Commission has a budget of around EUR 550 million for transport and is seeking to fund projects which will contribute towards:

- removing obstacles at frontiers and creating a smoother traffic flow;
- protecting the environment and sustainable development;
- To reach agreements with non-member countries on which the European Union depends for its security of supply, to open up access to their markets and to develop stronger transport links; and
- To step up technological development and innovation.

Within this broad EU funding context the following specific funding opportunities within each country can be sourced.

8.2.3.1 The European Regional Development Fund (ERDF)

Funding from the European Union comes in many different forms and accessing these funds is now a major part of the activities of many European regions.

The first step in applying for EU funding involves identifying which type of assistance is most relevant and under which system this operates. Broadly speaking, EU funding falls under the following categories:

(i) Structural Funds packages which are drawn up between the European Commission and regional authorities, in order to identify the needs and priorities particular to that area. They are managed at regional level and projects are based in the region in question.

(ii) Community Initiatives which are special forms of assistance which aim to tackle problems which the European Commission has identified as being common throughout the EU. They are financed by the Structural Funds and managed at regional level.

(iii) EU Funding programmes which have a thematic aspect to them and correspond to many of the EU policy areas, for example education, vocational training, Research and Development. They are managed by the European Commission's Directorates-General and all projects must be trans-national in nature.

(iv) Ad-hoc calls for proposals issued by various Directorate-Generals of the European Commission.

Alongside the Structural Funds, the Cohesion Fund provides additional structural assistance to the four least developed Member States (Portugal, Spain, Greece and Ireland) by financing projects concerning the environment or transport infrastructure.

The Cohesion Fund provides money for environmental and trans-European transport network projects in the Member States of the Union whose GDP is less than 90% of the EU average. The Cohesion Fund has at its disposal resources amounting to about €2.5 billion per year from 2000 to 2006, for a total of €18 billion (at 1999 prices).

8.2.3.2 INTERREG III

INTERREG III is the new Community Initiative for the ERDF over the period 2000 to 2006. The main objective of INTERREG III is to strengthen economic and social cohesion in the Community by promoting cross-border, trans-national and international co-operation and balanced development of the Community territory. This will be facilitated by promoting integrated regional development within neighbouring regions.

INTERREG III comprises of 3 strands:

A. **Cross-border cooperation** between adjacent regions aims to develop cross-border social and economic centres through common development strategies.

B. **Trans-national cooperation** involving national, regional and local authorities aims to promote better integration within the Union through the formation of large groups of European regions.

C. **Inter-regional cooperation** aims to improve the effectiveness of regional development policies and instruments through large-scale information exchange and sharing of experience (networks).

INTERREG III has a total budget of €4,875 billion (1999 prices) of which €81 million has been allocated to Northern Ireland and €84 million allocated to the Republic of Ireland.

Strand B may be the most likely source of INTERREG III funding for INSTANT as one of the main priorities of this strand is the promotion of effective and sustainable transport systems, together with better access to the information society. Projects qualifying for strand B funding also need to display appropriate trans-national criteria. In this context, we believe that the INSTANT project is a prime candidate, as it is not just a cross-border project. INSTANT's implementation will create a co-operative multi modal transport information system on the entire Belfast to Dublin corridor, assisting with the economic development of both the Republic of Ireland and Northern Ireland.

8.2.4 Public/Private Partnering

8.2.4.1 Republic of Ireland

The Government's National Development Plan (NDP) 2000-2006, identifies Public Private Partnerships (PPPs) as being essential in helping to deliver the much-needed infrastructure required on the national road network.

The Government have set a target of securing €1.27b private finance for PPP projects on national roads which represents 23% of the total road investment programme. This reflects the importance of securing the injection of private finance in order to accelerate the delivery of the public capital programme designed to remedy Ireland's infrastructure deficit. Without €1.27b of private finance the 2000-2006 roads programme would be substantially incomplete and current deficiencies, which threaten regional development and economic growth would fail to be addressed.

It is clear from the NDP that the PPP priority is in the roads sector. The Authority must ensure that PPP projects are implemented successfully, as they are integral to the delivery of the targets set for improvement of the national road network. Without the successful completion of the substantial PPP element, the overall 2000-2006 roads programme would remain substantially incomplete.

8.2.4.2 Northern Ireland

The RTS identifies that 22% of the additional £1,370 million will be sourced through PPP this amounts to £300 million over the 10 year period. The application of PPP/PFI requires the Department to commit to payments beyond the 10-year period of the RTS.

Whilst it has been estimated that PPP/PFI would improve the affordability of the RTS by a total of £300 million, in 2002/03 prices, around £31 million per year for 25 years (in 2002/03 prices) would be required beyond 2011/12. Ultimately, however, projects can only proceed if the private sector's innovation, efficiencies and acceptance of risk can ensure value for money.

There are however differing views on the use of PPPs to deliver public services and the ability of PPPs to deliver quality services and value for money has recently come under critical examination. Although savings have indeed been made in some road projects, the UK transport sector in general has experience of poorly performing PPPs and ineffective private sector participation in project management. The application of PPPs in the ITS field needs careful consideration to ensure value for money whilst maintaining quality.

9 ITS Implementation Programme

9.1 Introduction

This section of the report presents a 'picture' of what ITS deployment is envisaged over the next ten years and the associated tasks and programmes to achieve implementation. The ten years will be broken down into three relevant time frames:

♦ Short Term	0 to 3 years	2003 - 2006
♦ Medium Term	3 to 7 years	2006 - 2010
♦ Long Term	7 to 10 years	2010 - 2013

The context of INSTANT development in respect to external factors such as the take up of technology, relevant legislation is shown in Figure 9-2.

For each of these time frames, an outline of what systems are expected to be in place will be presented in the following functional areas:

- ITS Infrastructure and Control;
- Information Data Exchange;
- Information Dissemination; and
- Institutional and Organisational;

In Figure 9-1 a top level representation of the outlook for deployment in these four areas is given. The tasks necessary to achieve the above will be presented in two phases:

- Procurement and Implementation; and
- Operation, Maintenance and Training.

Finally, an overall summary project programme will be shown detailing the timeframe for each of the above tasks, the party responsible and the various task interdependencies.

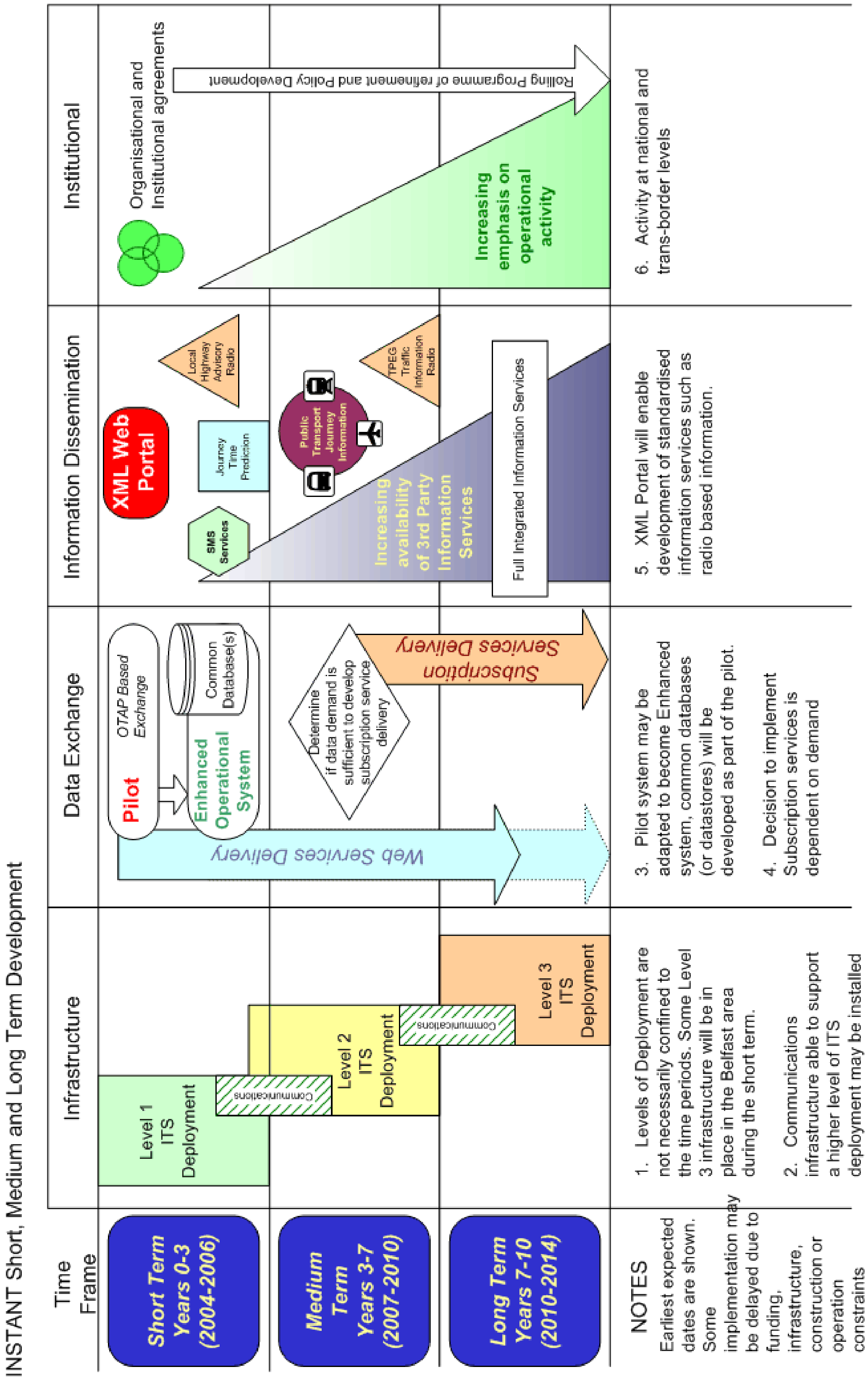


Figure 9-1 : Outlook for INSTANT Development in Short, Medium and Long Term

9.2 Technology Watch and External Influences

INSTANT's long term implementation programme will be influenced by technological advancements and other unknown external influences. This section presents a 'best guess' long term view on how ITS may be deployed over the INSTANT corridor. Although this sort of forward planning is essential to successful deployment, the programme will be significantly influenced by a wide range of external factors outside the control of the project. These include:

- Continuing rapid changes in ITS related technologies by manufacturers (e.g. IP based CCTV and 3G communications);
- Changing requirements of the road authorities (e.g. colour VMS with graphics capability);
- Increasing demands of motorists for new information services (e.g. real time location specific incident information to the mobile phone);
- Implementation of new information gathering services (e.g. FVD data from ITIS);
- Implementation of new information dissemination services (e.g. incident dissemination using DAB); and
- The availability of new services with improved functionality (e.g. highly accurate vehicle tracking using Gallileo GPS).

It is almost impossible to predict how these changes will impact on INSTANT but change is inevitable and the project needs to have processes in place to ensure these are tracked and their impact assessed.

9.2.1 External Influences

Some potential external events and developments over the 10 year timeframe have been identified and are shown overleaf in a timeline form. Possible influences of these events on the INSTANT project are shown:

- Systems or services on the left provide information to the Information Store (or Common Database);
- The Information Store holds, processes and analyses this data;
- Systems or services on the right disseminate the processed information to the user; and
- Known external events are highlighted in red.

9.2.2 Technology Watch

The RS and NRA will need to monitor these advances in technology and ensure the full potential of ITS for developing integrated transport solutions can be exploited for the future.

Examples of particular current European developments to watch include:

- Provision of multi-modal travel information in real time (as in the UK's Transport Direct initiative);
- Road user charging in its various forms:
  - as implemented for motorway tolling in RoI;
  - HGV charging to be introduced in the UK in 2006 and a standard Europe wide systems possibly by 2010; and
  - urban pricing systems (congestion charging) as currently implemented in London.

- Developments in Smartcards for multi-purpose applications including tolling, parking and through ticketing;
- The potential of vehicles to act as 'probes' as a consequence of the growing trend to equip vehicles with devices which combine satellite location (GPS) and mobile communications (GSM/GPRS) systems for 'ambient intelligence' and emergency warning services; and
- Exploitation of CCTV surveillance through initiatives like the HA Video Information Highway (VIH).
-

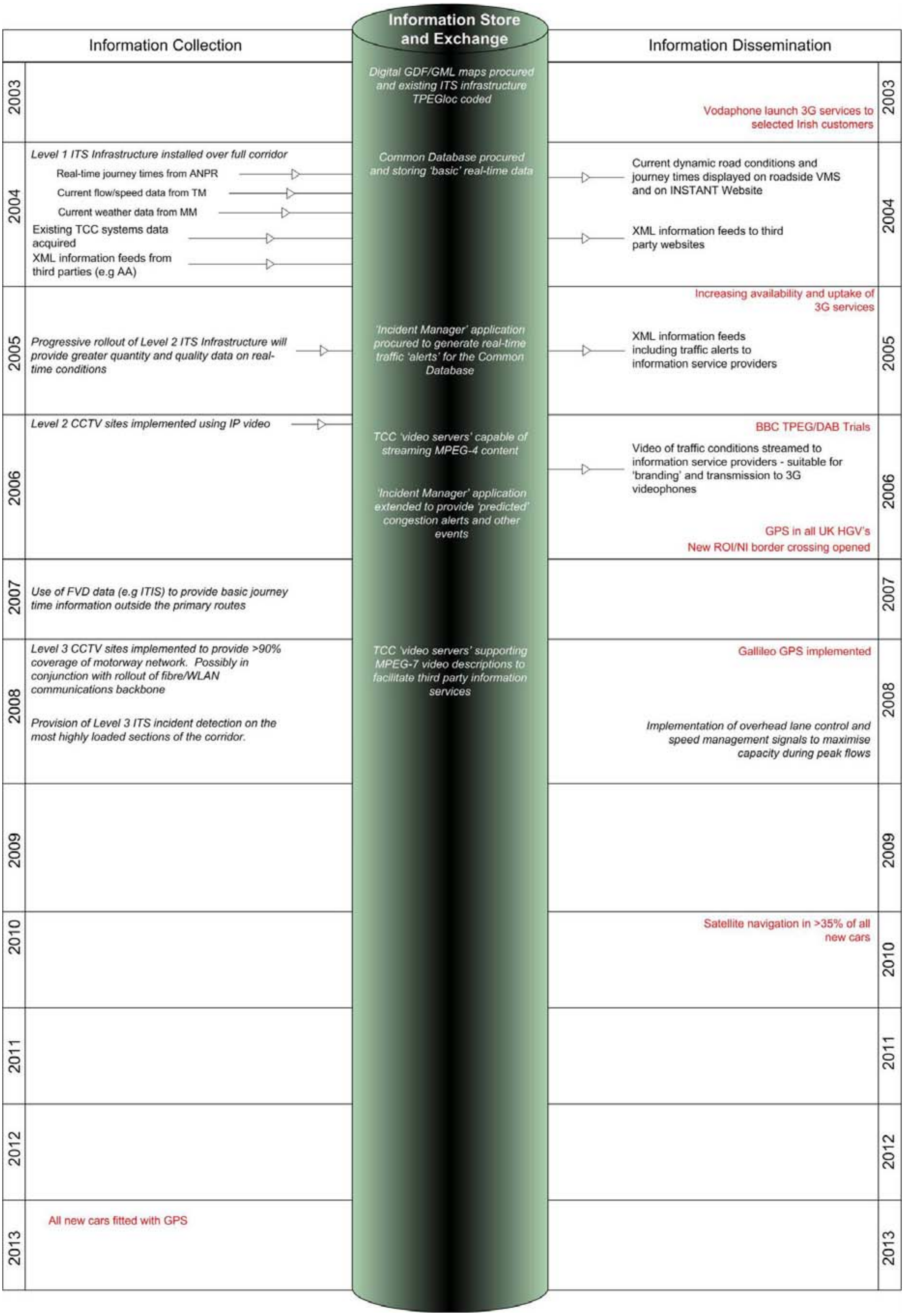


Figure 9-2 : INSTANT Development and potential external influences 2003 - 2014

9.3 Short Term ITS (0-3 Years)

Over the next three years, the current road building programme on the INSTANT corridor will be largely complete. The only outstanding construction project will be the Beech Hill to Cloghogue scheme (Newry Bypass) in Northern Ireland.

9.3.1 ITS Infrastructure and Control

In accordance with the ITS deployment table (see Section 4.3), Level 1 ITS infrastructure will have been implemented over the entire INSTANT corridor. This will have included the deployment of:

- Strategic VMS and CCTV into key locations;
- ANPR and associated journey time VMS at nominal 15 km intervals;
- Traffic monitoring sites at nominal 5 km intervals; and
- Meteorological monitoring sites at nominal 20 km intervals.

Additionally, Level 2 ITS real-time communications will be provided to the Level 1 ITS traffic monitoring and meteorological monitoring sites such that 'incident alerts' can be received from this equipment at the TCC.

At each TCC, the above infrastructure will be controlled by discrete subsystems as follows:

- Strategic VMS and CCTV will be controlled by existing subsystems;
- New standalone subsystems will be controlling the ANPR, Traffic Monitoring and Meteorological Monitoring infrastructure; and
- Interfaces will be developed for each standalone subsystem above to allow data to be supplied to the INSTANT 'Common Database'.

An INSTANT 'Common Database' and map based GUI will be operational at the TCC. The database will be storing data/settings directly from the INSTANT infrastructure and any other third party data sources. This information will be presented on an object oriented map based GUI to the operator. Detailed information on each object will be readily accessible by simple 'point and click'. Detailed data analysis will be achieved through a mixture of standard reports and specific SQL queries on the database content.

An 'Incident Manager' application will have been developed as the first component of an INSTANT Instation. This application will examine the common database for unconfirmed 'alerts', verify these and confirm as 'incidents' where possible. VMS can then be set automatically or with manual input as appropriate (two VMS types each sent different information to display). This process will be automated as far as possible although some operator intervention will be necessary for incidents and confirmation of proposed sign settings.

9.3.2 Information Data Exchange

The Common Database will have been procured and established as the primary information hub at each TCC. Direct information feeds from the above INSTANT infrastructure subsystems will be providing the Common Database with:

- real time information on traffic flows and specifically incidents that may be affecting motorists;
- real time information on weather conditions along the route and specifically their impact on driving conditions (high winds, wet road surface etc);

- real time information on link journey times and specifically unusually long journey times that may indicate an incident; and
- information confirming sign settings on the roadside VMS (strategic VMS and journey time VMS).

Interfaces will have been developed with existing 'non-INSTANT' systems at each TCC such that these systems can also provide useful information to the Common Database. In the short term, these interfaces could include:

- Flow and incident data from any Urban Traffic Control (UTC) sites close to the INSTANT corridor (e.g. Newry);
- Flow data from traffic monitoring sites on the motorway north (M1) and south (M50) of the INSTANT corridor; and
- VMS sign settings for sites on the motorway north (M1) and south (M50) of the INSTANT corridor.

Additionally, it is envisaged that the Common Database will be exchanging relevant data with other TCC's, third party information and service providers using the OTAP principle. The structuring of the information will be according to TRIDENT data models.

To make the useful for service providers and other TCC's, each element will be location referenced. The location referencing shall be according to TPEGLoc standard covering INSTANT corridor, Belfast and Dublin urban area.

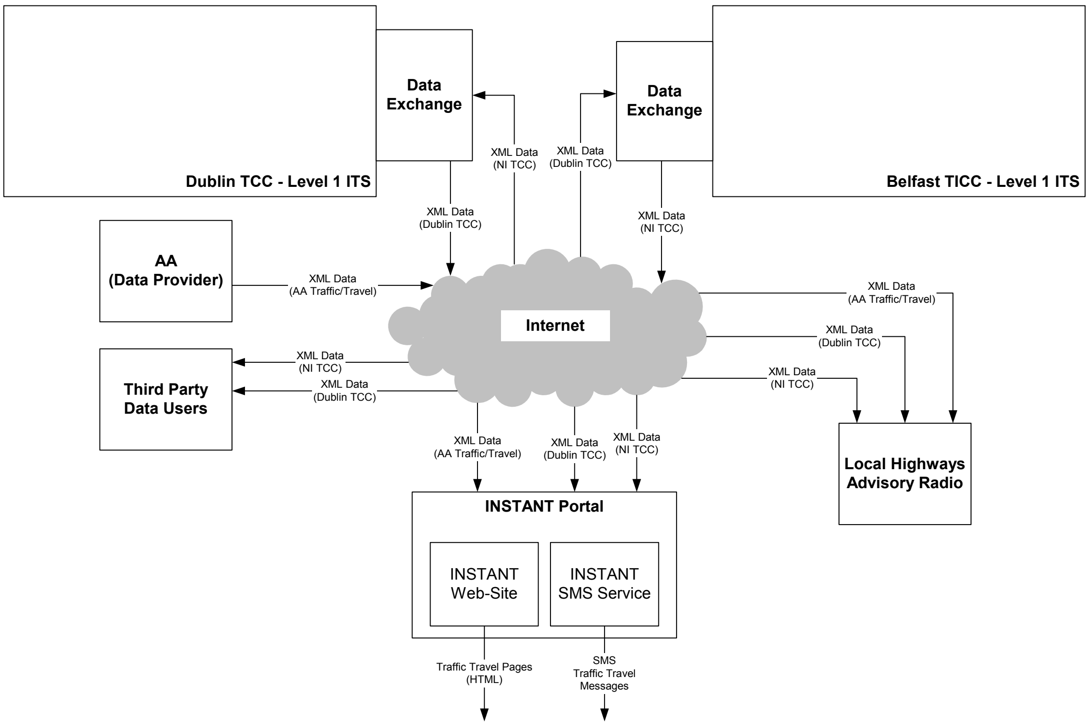


Figure 9-3 : Short term Data Exchange

9.3.3 Information Dissemination

In addition to the en-route information provided to the motorist by roadside VMS (and possibly HAR), the INSTANT project website will be providing valuable real-time pre-trip information on route conditions to the motorist.

The web site shall provide travel information covering all modes of transport: car, rail, light rail, coach, bus, ferry, train and air plus information such as road conditions and, the weather. Other associated information will also be available such as tourist and local information. Selected travel information will be available via a SMS subscription service.

The scope of the travel information will include bus and ferry timetables, links to existing web based journey planners and real time journey condition information. The web site shall provide access to real time incident information, flow and speed data, CCTV pictures and meteorological data on the route.

9.3.4 Institutional and Organisational

A number of 'non technology specific' ITS measures and processes are required by the Roads Service and the National Roads Authority to get the most out of the ITS deployment:

- All recommended Memorandums of Understanding between INSTANT project stakeholders will have been agreed and implemented;
- Quarterly stakeholder meetings will be underway in three key areas;
    - SM1 – International Corridor;
    - SM2 – National Traffic Management; and
    - SM3 – National Traveller Information.
- Relationships with potential third party service providers will be established;
- Active and ongoing research by both the RS and NRA will continue in;
    - ITS standards development;
    - Monitoring and evaluation of existing ITS benefits; and
    - Development of a trans-national ITS architecture.
- First of the biannual reviews of traffic flows/congestion and accident rates along INSTANT links for use in the ITS deployment model; and
- TCC INSTANT operators employed and trained.

9.4 Medium Term ITS (3-7 Years)

9.4.1 ITS Infrastructure and Control

Within this timeframe it is envisaged that Level 2 ITS infrastructure will be implemented over some 22 km of the M1 corridor between the M1/M50 junction and Balbriggan in the Republic of Ireland.

This will extend Level 1 ITS infrastructure over this section of INSTANT as follows:

- CCTV will be installed at all major intersections/interchanges;
- ANPR sites (with or without associated journey time VMS) will be supplemented to obtain a nominal 8 km spacing between sites;
- Traffic monitoring sites will be supplemented to achieve nominal 2 km intervals;
- Additional strategic VMS will be installed at secondary decision points (M1/N1 junctions) to aid in diversion management; and
- Meteorological monitoring sites will be installed or existing sites enhanced as required to meet specific information needs.

Any of the above equipment not already implemented with real-time communications in Level 1 deployment will now be provided with this functionality.

No new subsystems or significant changes to existing INSTANT subsystems will be required to handle the Level 2 ITS infrastructure.

By this time, the INSTANT Incident Manager application developed for Level 1 ITS will have been developed and refined to become a key operational tool at the TCC. This would be an opportune time to undertake a review of the application functionality and performance and agree any further development to meet changing needs.

9.4.2 Information Data Exchange

The common database will be further extended with information when new systems become available on the road. The automatic incident detection and congestion information will be available for the whole INSTANT corridor and each of the TCC's.

Because of the higher volume of information available for the TCC's, more efficient subscription services will have been developed between TCC and service providers. The higher data quality at the TCC is expected to have generated a market where value added services are provided based on TCC information.

The subscription service will also generate a much more tighter client-supplier relationship which will be based on proper commercial footing i.e. TCC will generate a revenue stream from data which is stored in common database.

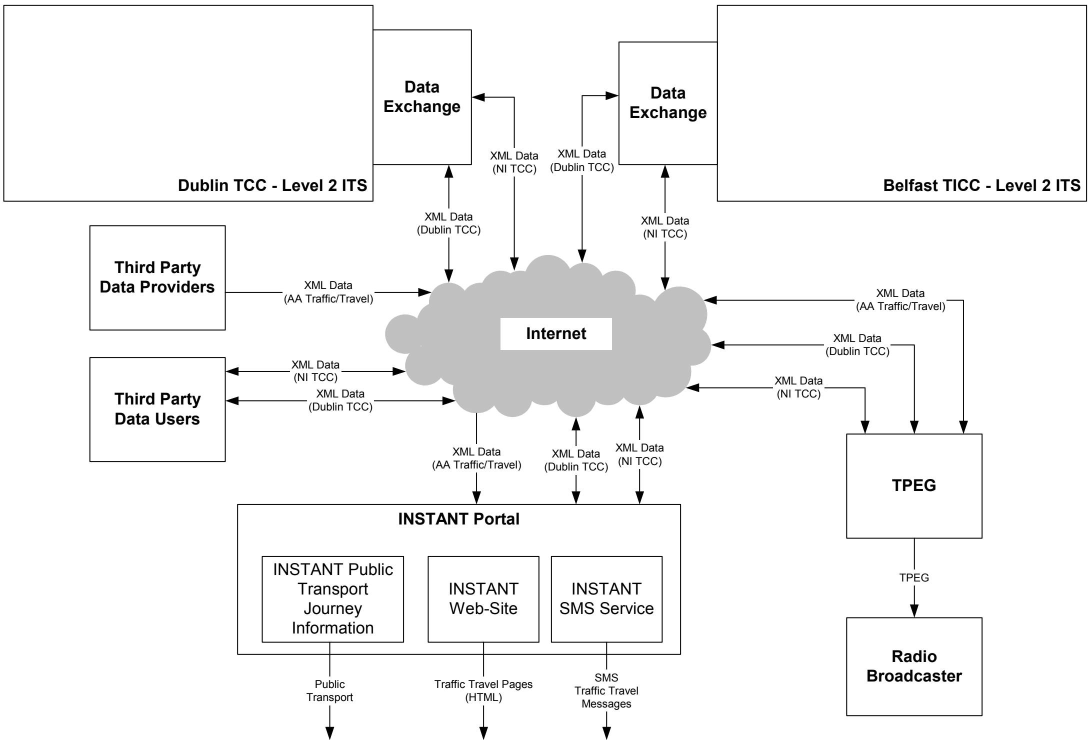


Figure 9-4 : Medium Term Data Exchange

9.4.3 Information Dissemination

The quality and quantity of historical and real time data within the common database is expected to support the development of standardised information services implemented by VASPs and other 3rd parties.

The common database will increasingly be populated with real time public transport journey information, which will provide the foundation for new information services to be developed.

Digital radio broadcast services using TPEG shall commence providing language independent traffic and travel information primarily by the Digital Audio Broadcast radio data channels.

9.4.4 Institutional and Organisational

The institutional and organisational arrangements described above will continue to be refined and supporting policies developed. New agreements and memorandums of understanding will be created as new travel information services are developed. During this period there will be increased emphasis on operational activities.

Development of a systems architecture or Framework for ITS, over the next 30 years will have commenced.

9.5 Long Term ITS (7-10 years)

9.5.1 ITS Infrastructure and Control

Within this timeframe it is envisaged that Level 3 ITS infrastructure will be implemented over some 2-3 km of the M1 corridor between the M1/M50 junction and Dublin Airport/Swords in the Republic of Ireland.

Level 3 ITS will extend Level 2 ITS over this section of the INSTANT corridor as follows:

- CCTV will be installed to achieve 80-90% coverage of the motorway and approaches (nominal 1 km spacing between sites); and
- Traffic monitoring sites will be 'in filled' to achieve typical Automatic Incident Detection (AID) at 500 metre intervals.

The above density of CCTV and AID roadside equipment will necessitate a move to a high bandwidth continuous longitudinal communications backbone, delivered by fibre optic cable and/or WLAN technology.

It will be necessary at this stage to undertake detailed design and procurement of a new incident detection subsystem. This will extend the basic incident detection capability of the Level 1/2 traffic monitoring subsystem to provide full Automatic Incident Detection (AID) from the Level 3 traffic monitoring sites.

By this time the INSTANT Incident Manager application developed for Level 1 ITS will have been refined and developed as a key operational tool at the TCC. This would be an opportune time to undertake a review of the application and agree any further development to meet changing needs.

At this stage, the data exchange will be fully established and it is not expected that changes will be required. The only evolution is that more data will be exchanged and that more third party users will be utilising the infrastructure.

9.5.2 Information Dissemination

Dissemination of multi-modal travel information will, by this stage, be delivered through a fully integrated INSTANT web portal and a combination of Levels 1, 2 and 3 infrastructures deployed throughout the corridor.

9.5.3 Institutional and Organisational

The institutional and organisational arrangements will continue to develop in accordance with the services being delivered. New policy objectives may introduce opportunities and initiatives requiring further development of INSTANT. Having an ITS Framework/Architecture in place will ensure that INSTANT remains flexible to incorporate any new technologies or services in the future.

9.5.4 Information Data Exchange

In the longer term, if the amount of data increases it may be necessary to move to a subscription "always on" data exchange method e.g. CORBA or .NET technology type approaches. However the web services method does allow richer content to be produced, and there are likely to be developments in this type of technology by the end of the decade. Figure 9-5 shows the potential data exchange model in 2010.

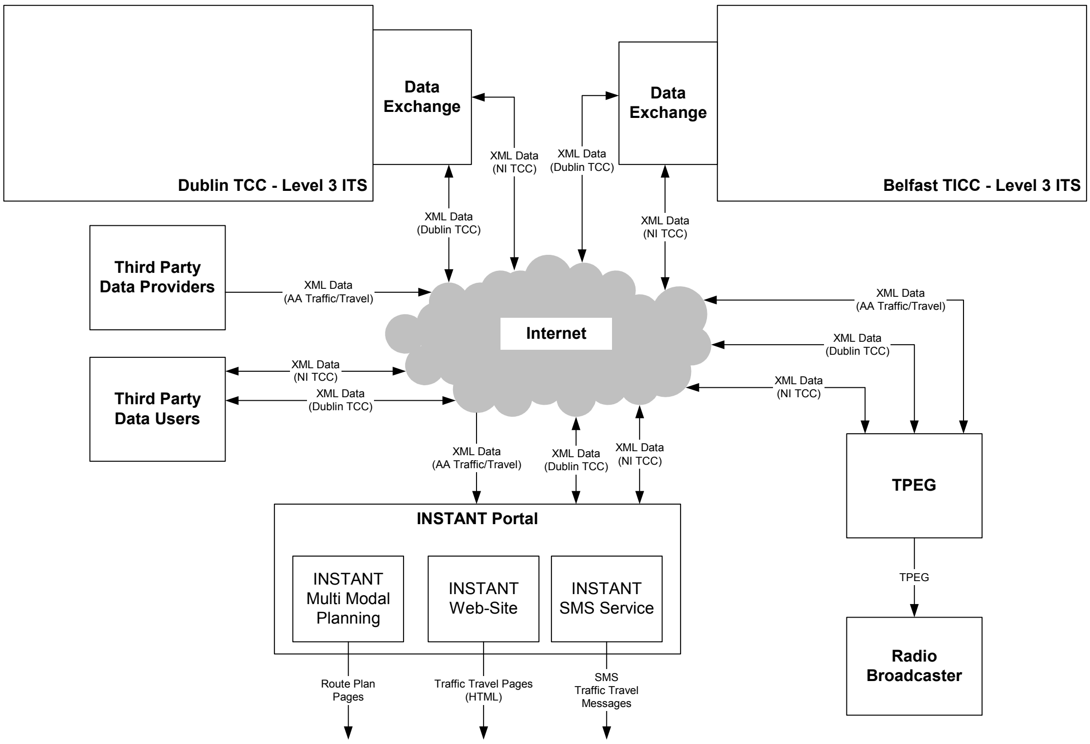


Figure 9-5 : Long Term Data Exchange (Web Services)

9.6 Design Tasks

9.6.1 Additional Investigation

Although this report has attempted to address the main design issues relating to deployment of ITS along the INSTANT corridor, it is only a starting point and there are a number of outstanding issues that require further investigation and reporting. These include:

- More detailed traffic modelling in order to more clearly define the limits of Level 1/2/3 ITS over the 10 year timeframe. This is particularly relevant in the RoI where the current ITS ‘boundaries’ are based on a limited data set. Any model would need to be able to assess likely growth in peak flow traffic volumes as well as the usual AADT growth; and
- Further investigation as to the merits of digital CCTV transmission and storage over the existing analogue approach is recommended. There would appear to be a strong case to move strongly along the digital video path but this should be confirmed, possible by engagement of specialist consultants with contributions from the leading manufacturers of this developing technology.

9.7 Procurement and Deployment Tasks

Procurement of ITS systems has historically been undertaken using contracts that were designed for traditional road and bridge design and construction. There are only rare examples of procurement processes designed specifically for ITS. Often, traditional procurement processes do not adapt well to ITS, which can require flexibility to accommodate innovation and alternative technology solutions.

ITS is different from traditional road and bridge projects. The key differences relate to the following factors.

9.7.1 The Maturity of the Technology

Technologies for ITS are relatively new and rapidly changing. In contrast, roads and bridges have been constructed using recognised procurement vehicles for many years. The technology initially needed at the beginning of an ITS project may require to change by the end.

ITS projects are often implemented relatively quickly when compared to traditional civil engineer contracts. This short implementation time for ITS requires responsive management procedures and adaptable procurement processes.

9.7.2 Design Criteria and Standards.

ITS projects in general do not have design manuals or standards to guide implementation. Contrast this to the manuals available for traditional civil engineering projects. As a result, ITS projects can have a high level of uncertainty and risk. The ITS designer therefore needs to apply contracting methods that suits the level of uncertainty and risk expected. Risk need to be managed, assigned appropriately or mitigated.

9.7.3 The Ability to Innovate

ITS projects commonly include new software, components that have never been integrated before, new communications methods and new institutional processes. Innovations, by their very nature, are uncertain. It is not possible to predict the final design requirements, the actual final software and hardware outcome, or the usefulness of the innovation in any institutional context. Innovative ITS projects require management processes that are adaptable and responsive to changes as the project evolves. An appropriate contracting method needs to be used to encourage innovation when it is required.

These features of ITS projects are no different from technology projects implemented in other sectors. However, these features are significantly different from traditional public sector procurement projects.

9.7.4 Procurement Options

INSTANT needs to be procured in separate contract packages, split on the basis of associated risk and required innovation. Some elements of INSTANT will be “off the shelf” designs carrying little risk or requiring no innovation, others, particularly software development have significant risks and demand innovative thinking.

ITS procurement is in general most suited to design and build contracts. These contracts allow some degree of flexibility, whilst maintaining the opportunity for innovation and adequate allocation of risks.

In determining the appropriate method of award of an ITS contract, the following should be followed:

- If the system required to be procured can be defined in detail, the outcome is measurable and fixed (i.e. “off the shelf” systems), then fixed cost should be used for tender award; and
- If the system required to be procured has significant uncertainties, such as development of software etc. then quality attributes should determine award of the contract. In this instance time and materials/target cost using performance incentives may be considered.

If multiple contracts are to be used, an important design stage task will be to develop a detailed procurement programme, identifying the appropriate implementation contract packages. This needs to be undertaken on the basis of an understanding of the technology and software risks. Uncertain/risky elements of the INSTANT system need to be identified and where possible consideration needs to be given to procuring these separately or mitigating the risk in another way, such as:

- removing the risk element through a re-design;
- replace with something of lower risk;
- defer the risk element; and
- break the risk element down further.

Selection of the appropriate contracting methods should be undertaken based on method of award and basis for payment linked to uncertainty and risk.

9.8 Operation and Training Tasks

Creation of the INSTANT system provides the opportunity for the NRA and RS to provide a fully integrated corridor management and travel information system. Operation of this system, from the control centres in Dublin and Belfast will require careful training and development of resources. Working partnerships, both formal and informal are required, integrating operations and maintenance tasks in order to make the best use of the technology assets to provide efficient responses to incidents and real time multi-modal travel information services.

Introducing INSTANT into the Belfast and Dublin control centres, may require additional operators, due to the greater length of road network which requires to be managed and the increase in the scope of services provided.

Adequate training and resource development programmes will need to be introduced and maintained to ensure operators are fully trained in advance of any new services or technologies being introduced. The extensive range of technologies and services INSTANT could provide means that:

- staff will require an extensive range of skills;
- the complete range of skills will not be required from day one but will need to be developed through training programmes; and
- any recruitment needs to be focussed on specific skill bases.

9.8.1 Road Network Operations

Introduction of INSTANT presents the opportunity for both the NRA and RS to provide an enhanced level of network management, in particular when dealing with minor incidents not requiring police attendance. Significant improvements in the time taken to clear incidents can be obtained if INSTANT operators:

- are empowered to make decisions relating to the road network; and
- can communicate directly with on street maintenance resources to manage incident clearance activities.

INSTANT will provide many other opportunities to provide enhanced levels of travel information service, along with the core function of network operations. INSTANT clearly has the potential to embrace the Big Shift initiative.

9.9 Summary Programme

The summary programme of works is provided overleaf.

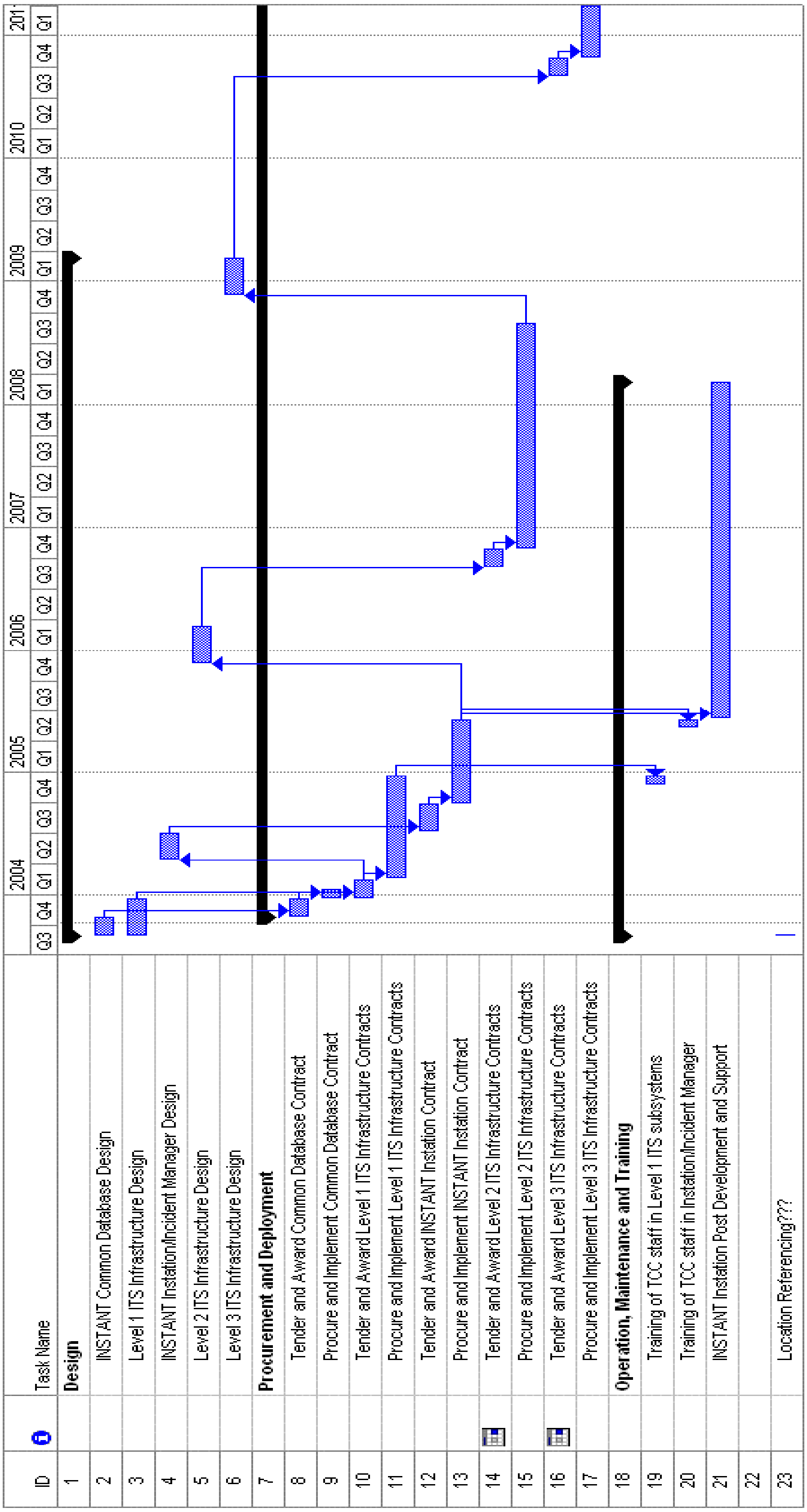


Figure 9-6 : Top Level Programme

10 Cost Estimates

The tables on the following pages are taken from the cost model (Appendix E).

The following assumptions are made:

- Design costs are estimated at 15% of the procurement and deployment cost.
- Annual maintenance costs are estimated at 5% of the procurement and deployment cost.
- Annual maintenance costs are lower in the period they are deployed because of warranties, and because the infrastructure deployment is phased across the period.
- **Short Term 2004 - 2006:** 100% deployment of Level 1 ITS over the INSTANT corridor in NI and ROI (145 km).
- **Medium Term 2007 – 2010:** Deployment of 22 km of Level 2 ITS in RoI
- **Long Term 2011 – 2014:** Deployment of 2 km of Level 3 ITS in RoI.

Summary of Design, Procure and Install Costs (inclusive of contigencies)

Northern Ireland	Sterling Level 1	Level 2	Level 3	Total	Euro Level 1	Level 2	Level 3	Total
Traffic Monitoring	£177,375	£0	£0	£177,375	€ 248,325	€ 0	€ 0	€ 248,325
Meteorological Monitoring	£132,575	£0	£0	£132,575	€ 185,605	€ 0	€ 0	€ 185,605
ANPR Journey Time System	£516,980	£0	£0	£516,980	€ 723,772	€ 0	€ 0	€ 723,772
Variable Message Signs	£490,350	£0	£0	£490,350	€ 686,490	€ 0	€ 0	€ 686,490
Closed Circuit Televison (CCTV)	£275,100	£0	£0	£275,100	€ 385,140	€ 0	€ 0	€ 385,140
INSTANT Instation	£325,000	£62,500	£62,500	£450,000	€ 455,000	€ 87,500	€ 87,500	€ 630,000
Total Procure and Install costs	£1,917,380	£62,500	£62,500	£2,042,380	€ 2,684,332	€ 87,500	€ 87,500	€ 2,859,332
Design Costs	£230,086	£7,500	£7,500	£245,086	€ 322,120	€ 10,500	€ 10,500	€ 343,120
Total Overall	**£2,147,466**	**£70,000**	**£70,000**	**£2,287,466**	**€ 3,006,452**	**€ 98,000**	**€ 98,000**	**€ 3,202,452**

Republic of Ireland	Level 1	Level 2	Level 3	Total	Level 1	Level 2	Level 3	Total
Traffic Monitoring	£276,875	£76,625	£173,000	£526,500	€ 387,625	€ 107,275	€ 242,200	€ 737,100
Meteorological Monitoring	£202,625	£81,050	£0	£283,675	€ 283,675	€ 113,470	€ 0	€ 397,145
ANPR Journey Time System	£679,720	£91,240	£0	£770,960	€ 951,608	€ 127,736	€ 0	€ 1,079,344
Variable Message Signs	£342,300	£342,300	£0	£684,600	€ 479,220	€ 479,220	€ 0	€ 958,440
Closed Circuit Televison (CCTV)	£158,550	£50,400	£45,150	£254,100	€ 221,970	€ 70,560	€ 63,210	€ 355,740
INSTANT Instation	£325,000	£62,500	£62,500	£450,000	€ 455,000	€ 87,500	€ 87,500	€ 630,000
Total Procure and Install costs	£1,985,070	£704,115	£280,650	£2,969,835	€ 2,779,098	€ 985,761	€ 392,910	€ 4,157,769
Design Costs	£238,208	£84,494	£33,678	£356,380	€ 333,492	€ 118,291	€ 47,149	€ 498,932
Total Overall	**£2,223,278**	**£788,609**	**£314,328**	**£3,326,215**	**€ 3,112,590**	**€ 1,104,052**	**€ 440,059**	**€ 4,656,701**

INSTANT Corridor	Level 1	Level 2	Level 3	Total	Level 1	Level 2	Level 3	Total
Traffic Monitoring	£454,250	£76,625	£173,000	£703,875	€ 635,950	€ 107,275	€ 242,200	€ 985,425
Meteorological Monitoring	£335,200	£81,050	£0	£416,250	€ 469,280	€ 113,470	€ 0	€ 582,750
ANPR Journey Time System	£1,196,700	£91,240	£0	£1,287,940	€ 1,675,380	€ 127,736	€ 0	€ 1,803,116
Variable Message Signs	£832,650	£342,300	£0	£1,174,950	€ 1,165,710	€ 479,220	€ 0	€ 1,644,930
Closed Circuit Televison (CCTV)	£433,650	£50,400	£45,150	£529,200	€ 607,110	€ 70,560	€ 63,210	€ 740,880
INSTANT Instation	£650,000	£125,000	£125,000	£900,000	€ 910,000	€ 175,000	€ 175,000	€ 1,260,000
Total Procure and Install costs	£3,902,450	£766,615	£343,150	£5,012,215	€ 5,463,430	€ 1,073,261	€ 480,410	€ 7,017,101
Design Costs	£468,294	£91,994	£41,178	£601,466	€ 655,612	€ 128,791	€ 57,649	€ 842,052
Total Overall	**£4,370,744**	**£858,609**	**£384,328**	**£5,613,681**	**€ 6,119,042**	**€ 1,202,052**	**€ 538,059**	**€ 7,859,153**

Estimated Costs for other projects

	Sterling	Euro
Per site for FM Highway Advisory Radio (Full Feasibility Study Required)	£71,429	€ 100,000
XML Specification and Schema for Web Portal	£180,000	€ 252,000
Creation of Geographic Common Roadworks register	£28,571	€ 40,000

Yearly Maintenance Costs

	Sterling Level 1	Level 2	Level 3	Euro Level 1	Level 2	Level 3
Northern Ireland	£95,869	£3,125	£3,125	€ 134,217	€ 4,375	€ 4,375
Republic of Ireland	£99,254	£35,206	£14,033	€ 138,955	€ 49,288	€ 19,646