STADIUM : ITS for large events

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ABSTRACT

The Project STADIUM* (Smart Transport Applications Designed for large events with Impacts on Urban Mobility) aims at improving the performance of transport services and systems made available for large events hosted by big cities.
The project demonstrates Intelligent Transport System (ITS) applications at three upcoming major events, i.e. the South Africa World Cup (2010), the India Commonwealth Games (2010) and the London Olympics (2012).
The **India** demonstrator is to be deployed and tested during the **XIX Commonwealth Games (Delhi 2010)** targeting both (i) the Planning of Public Transport services and (ii) the real time supervision of the bus system and its feeder service.
Due to the relevance of the minivan transport sector (Para transit) in **South Africa**, the demonstrator aims to improve its performances trough the development of an ITS application supporting a demand-responsive transport service (DRT). The solution proposed is to be implemented on a fleet of minivan taxis and demonstrated in **Cape Town** during the **FIFA 2010 World Cup**.
The **London** demonstrator will be deployed and operationally tested during the **Games of the XXX Olympics in 2012**. The system is based on a visual scene analysis tool to support the monitoring of localised passenger and vehicle congestion and the propagation of congestion across and within multi-modal transport networks.
Over and above the activities geared to the demonstrations, the ultimate objective of STADIUM is to provide Local Authorities responsible for transport in candidate cities to host large events with a set of guidelines and specific tools to implement the required traffic management system. These will notably feature an interactive data base to serve as a decision support system at different stages of the decision/planning/implementation process, covering domains such as:

- Dynamic traffic management systems & real-time traffic information
- Public transport:
- Tools to optimize operational transport plans according to historic and real-time data;
- Web-based systems to integrate public transport and traffic management operations,
- Travelers services based on mobile communications, for real-time traffic and public transport service information, mobile payment, special event information and booking, etc.
- Demand management strategies and measures to influence travel behaviour.

Keywords: ITS, large events, demonstrators, public transport, traffic management, demand responsive transport, decision support system.

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FULL PAPER

A. Introduction

The Project STADIUM* (Smart Transport Applications Designed for large events with Impacts on Urban Mobility) aims at improving the performance of transport services and systems made available for large events hosted by big cities.
The project demonstrates Intelligent Transport System (ITS) applications at three upcoming major events, i.e. the South Africa World Cup (2010), the India Commonwealth Games (2010)
and the London Olympics (2012).
The project team includes 17 partners, from 4 EU countries (Italy, UK, Germany and The Netherlands), and two ICPC (India and South Africa). In addition, two international organisations linking up cities in Europe, North America and Latin America are involved, thus ensuring effective networking in those areas (POLIS and IMPACTS-Europe). A third international network, ERTICO, represents most of the European industries involved in ITS technologies.

B. The Delhi demonstrator

As in many less developed conurbations, the system of collective transportation in Delhi is strongly based on minivans (Para-Transit), which are responsible for producing more passenger kilometres than all other Mass Transit Systems in the city. Surely the bus transport system will play a large role in New Delhi for the CWG; however, to ensure the success of this system, Para Transit needs to be the main backbone of support, once it is streamlined and properly integrated with the bus network. In the latter, managed by the Delhi Transport Corporation, 200 buses have been equipped with onboard GPS localization systems. The number of buses to be equipped with onboard GPS systems will grow substantially in the next two years. However, service planning and statistics analysis is not supported by significant ITS applications.
Taking into account how Mass Transit systems are presently organised as well as what ITS infrastructure is available to manage Urban Transport needs in Delhi, the **Delhi demonstration** addresses primarily:

- the Planning of Public Transport services, in particular the Bus transport and its integration with feeder services consisting of auto rickshaws: from the mere planning to the optimization of the use of buses and their shifts, to minimise capital costs of maximum service performance
- the supervision of the bus and its feeder service consisting of para transit, interfacing with available GPS localization systems for buses
- the information to passengers, both pre trip and during trips, using multimedia applications based on web and mobiles especially if they can be picked up and dropped back to their doorsteps using para transit urban transport systems.

The demo has been designed to produce an open platform addressing:

- a Public transport data model, including bus service and feeder service route planning and travel time model based on actual trip duration
- a Real time bus / auto rickshaw service supervision module, capitalising on existing onboard GPS control
- a Data dissemination module, i.e. a passenger information system, using various media (web, mobiles, other possible means for "not connected" travellers) to produce pre-trip and along-trip real time information especially if they can be picked up and dropped back to their doorsteps using para transit urban transport systems.
- a Communication systems interface.

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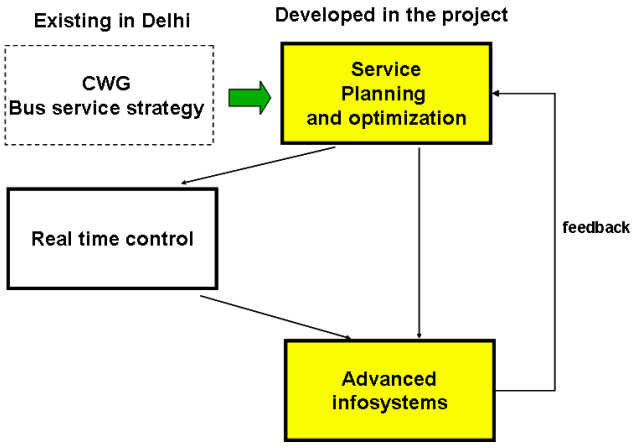


The **Service planning and optimization module** includes a software application using a GIS mapping, allowing to:

- Represent public transport demand – Para Transit / Bus and Metro
- Generate bus transport lines and the network with feeder routes and services based on Para Transit
- Generate flexible and optimised timetables
- Generate bus optimised number and shifts in response to requirements so as to have minimum congestion and passenger inconvenience by ensuring that people are brought in and moved out using effective feeder urban transport consisting of para transit

The bus service planning data generated by this module is passed to the real time bus **service supervision module**. This module interfaces with the existing GPS localization system of the bus fleets as well as all para transit transportation modes which take part to the demo.
Once the planning data is available as a reference (see above point), then the real time GPS data is used to check how the actual bus service is performing and where critical points are due to traffic jams or other road conditions.
The resulting information is used by an **advanced infosystems module** to handle real time passenger information as passengers can be picked up from dedicated para transit lines which can run from homes / offices / shopping complexes, schools etc. and brought to Intermodal Transit Stations and vice-versa.
The infosystems module is based on a web application to provide:

- Pre trip multimodal journey planning using para transit as feeder
- Real time dynamic information about journey
- Journey update and replanning based on real time information about bus service status.

Information focus is on public transport, and if possible – based on actual ITS data at the time of project development, the feasibility to produce some information related to car journey will be eventually explored.

Pre-trip planning is what an unfamiliar traveller would like to do when a new city is approached. As access to the web is ever increasing, it is assumed that people both within and those coming into the city will be able to use internet connections. To this reason a multimodal public transport pre trip journey planning application has been envisaged for the STADIUM Delhi demo and finalised for the CWG scenario. From that, the traveller will obtain reference information for an effective approach to the venues of interest. A generic example is reported below, based on existing European technology.

Multimodal pre trip information from the web, (courtesy Atac)

The web application will also feed other applications which will disseminate dynamic information on other media, such as:

- Onboard buses and para transit, e.g. on video monitors managed by a central unit. Such information may include next stop announcements; connections to other Public Transport services nearby; proximity information; events information.
- On mobile phones and generally other nomadic devices. Such information may include all what is available on the web application and other specific information related to public transport and possibly traffic.

For Delhi, a specific attention is given to which mobile phone technology is actually used by most of the travellers.

Example of infomobility services on smartphones (courtesy of Atac, Rome): 1. menu; 2. congested roads; 3. bus arrival times

In the above figure, an example of smartphone infomobility services is provided. Bus arrival time estimate at a stop is an information that can easily be provided on SMS too, based on bus service real time supervision provided by the supervision module mentioned in the previous paragraph.

Other more advanced forms of mobile services may include real time graphic routing to points of interest (venues, restaurants, historic points, public transport network etc), derived by the web application, and that could be experienced on GPS equipped mobiles, as the next step.
This IT module includes a software application using a GIS mapping, allowing to:

- Represent public transport demand – Para Transit / Bus and Metro
- Generate bus transport lines and the network with feeder routes and services based on Para Transit
- Generate flexible and optimised timetables.
- Generate bus optimised number and shifts in response to requirements so as to have minimum congestion and passenger inconvenience by ensuring that people are brought in and moved out using effective feeder urban transport consisting of para transit

The bus service planning data generated by this module is passed to the real time bus service supervision module that uses this data as the reference pattern to evaluate how the bus service is being run with respect to the planned one as well as its integration with para transit since without that very few shall use Public Transport leading to a traffic chaos at games venues due to excessive dependence on use of personal transport.

C. The SA demonstrator

In **SA cities**, over 127.000 minibus taxis are in service. They provide about 68% of the two billion annual passenger trips in urban areas and a high percentage of rural and intercity transport. Minibus taxis carry about 30% of all workers countrywide. However, about 97.000 of the minibus taxis are old, dangerous and in urgent need of replacement. A top priority programme, known under the name of Taxi Recapitalisation (Taxi Recap), is promoted and co financed by NDoT and the DTI. The aim is to replace the current ageing taxi fleet with new, safer and purpose-built 18 and 35 seats vehicles, through the establishment of taxi cooperatives to liaise with financiers and through the introduction of new vehicles and facilities for a compulsory maintenance programme. The entire programme is expected to take more than seven years to implement, at a cost of 650 M€, with the objectives of:

- improve the quality of service of the taxis,
- improve the safety of travellers,
- meet affordable operations,
- improve the convenience to travellers,
- migrate from a cash-based fare payment system to a cashless fare payment system,

- monitor route operation, usage and revenue,
- monitor critical parameters in the vehicle and report deviations.

Because of the relevance of the minivan transport sector (Para transit) the **SA demonstrator** deals with an ITS application aiming to improve its performances trough the development of a demand-responsive transport service (DRT).
Among the nine South African cities – Johannesburg, Cape Town, Durban, Port Elizabeth, Nelspruit, Polokwane, Bloemfontein, Rustenburg and Pretoria hosting the 2010 FIFA World Cup™ from June 11 to July 11, 2010, Cape Town has been chosen for demonstration purposes in agreement with the SA national authorities. The city forms part of Cape Town metropolitan municipality which encompasses a large urban area with a population of 2,9 million people, where transport services are diversified in Private taxis, Bus lines (Golden Arrow is the local Transport Operator), a BRT under construction and Private 'minibus taxis' (minivan), with the latter playing a major role in terms of number of passengers per annum.

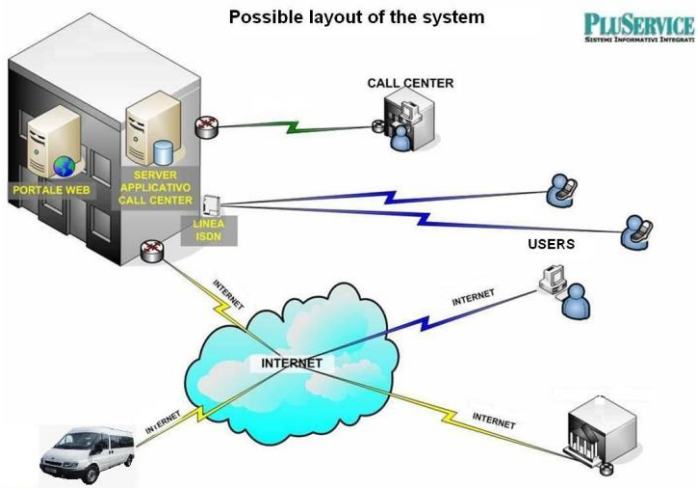
Cape Town has already hosted a number of major events, such as:
- Cape Argus Pick 'n Pay Cycle Tour
- Old Mutual Two Oceans Marathon
- 1995 Rugby World Cup
- 1996 African Cup of Nations
- 2003 Cricket World Cup
- annual Sithengi - SA International Film Festival
- numerous international football, cricket, tennis, rugby, hockey and cycling events.

The solution proposed targets a Demand Responsive Transport (DRT) system to implement the tracking and tracing of the dedicated fleet. The DRT platform is integrated with a system able to provide information for taxis, buses as well as passengers and will be open for future implementation (ticketing, multi modal system, terminal management etc).
The solution proposed is implemented on a certain number of minibus taxis (ca. 50) of different taxi associations in Cape Town. This will provide to the Municipality and to the Department of Transport the possibility to integrate the taxi service to the local public transport with a tool for control and management of the service. This demonstration opens a wide range of possibilities to improve the local transport system providing an innovative technological control centre.

The DRT is an innovative transport system that found a large number of applications in Europe, above all for short distance trips.
It was conceived for "low demand" areas, but today it is applied with success also to areas with high population density. It can be well applied to minibus taxis in a concept of integration with public transport. Actually the South African minibus taxi service could be compared to a Demand Responsive Transport for some aspects:
- Flexible in the route organization and stops
- Flexible in time
- Use of minibus
- Pick up and delivery almost door to door according to the needs of passengers

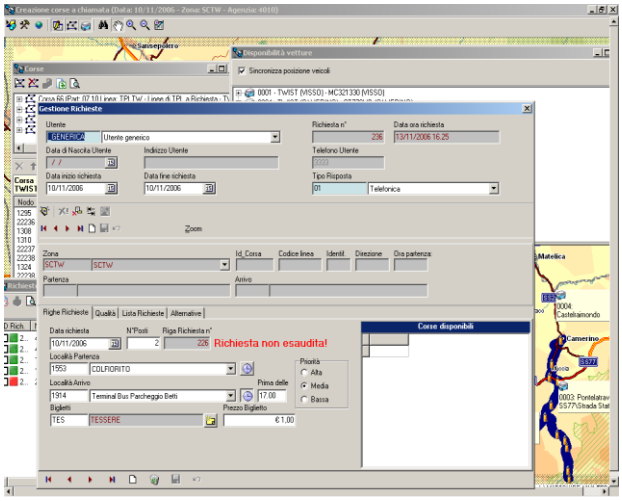
It however differs from a full DRT since it is not organized or managed and therefore cannot be controlled (while control is necessary to guarantee reliability, safety, efficiency and subsidy check).
The minibus taxi service management through a DRT system mainly requires the implementation of some points to modify selected specific aspects of the current service:
- Stops at fixed points along the route
- Transport requests made by phone or internet
- Stop on demand could be maintained only in case of space availability (Priority is given to requests) and only at the registered stops.
- Etc.

The demo design activity has focused on the application of DRT to the minibus taxi system as well as DRT applied to the management of big events to improve mobility service and safety.

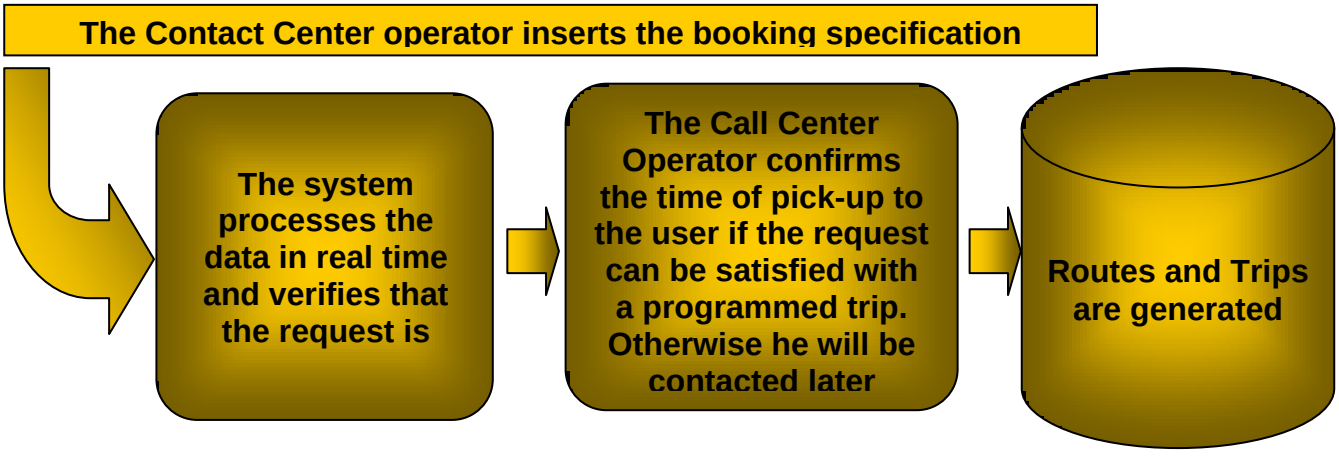


The above picture represents the layout of the system.

The proposed system provides the DRT and Call Centre operator with an interface tool to enter the personal details and requests of Users, as well as allowing real time display on the map of the positions of transport vehicles. Satellite location and GPRS connection of the vehicles make real time interaction possible, so that a call-up service can be organised using a vehicle that is already on the road. Service
Users can also manage and enter their requests via the web.



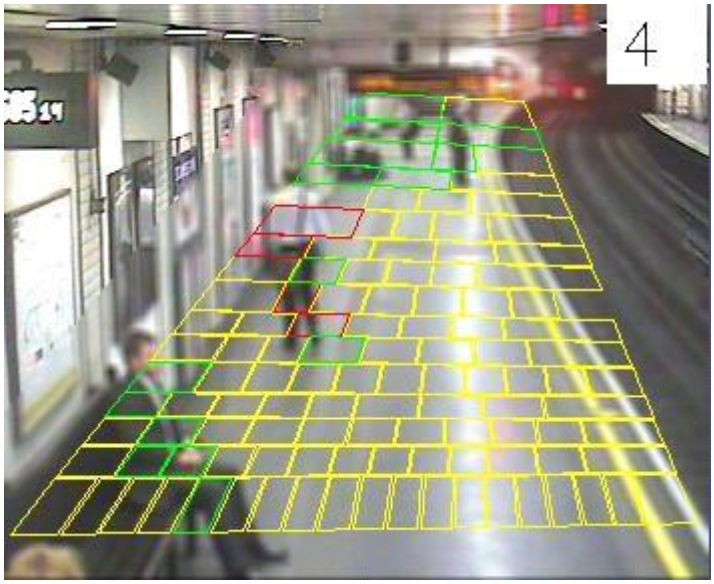
Operator interface



On board the transport vehicles a driver support system is installed, complete with satellite location, graphic interface with information on the stops to be made, the Users to be collected, delays or advances with respect to the timetable, connection to a security system using web cameras.
Local SA partner MMIV provides the on board device with all features required for DRT and security.

D. The London demonstrator

For the **London** demonstrator TfL intends to develop visual scene analysis tools to support the monitoring of localised passenger and vehicle congestion and the propagation of congestion across and within multi-modal transport networks. The proposed demonstrator is to have elements deployed to a number of locations within a cross-section of the TfL transport system.
Initial trials have proven the concept of the proposed demonstrator, but much work is required to develop this for deployment in different environments and for any resultant 'network output' to be centrally co-ordinated to useful ends.
The demonstrator system will 'tap into' existing TfL camera networks to help monitor the level of occupancy (or congestion) of areas of interest across multiple networks and in a variety of situations.
The demonstrator concept and implementation will also support the security requirements. Such areas may be station platforms along a line, bus stops on a route, traffic intersections, major pedestrian paths, road interchanges or actually within vehicles such as train carriages or buses.
The principal of the demonstrator is to capture a 'snapshot' from a number of cameras and for these to be processed locally and measured against a zero occupancy state for that location and the level of congestion calculated.
The following shows a view from a standard TfL station camera with an overlaid grid upon the area of interest:



By processing this content locally, it is possible to reduce data stream needed to accurately define the congestion level literally to bite size. There is also scope within this tiny data package to incorporate additional content such as the presence of a train at the platform and other Meta data such as where peak congestion is within the grid (font, centre, rear, left, centre right, etc).

The following diagram illustrates the capture of data from a single camera at 5 second intervals during a 2 minute period of presence of a train with in and out passengers.

Monitoring of congestion levels over a protracted period may illustrate congestion trends and this in turn may be used for network planning, staffing, and safety measures and so on.

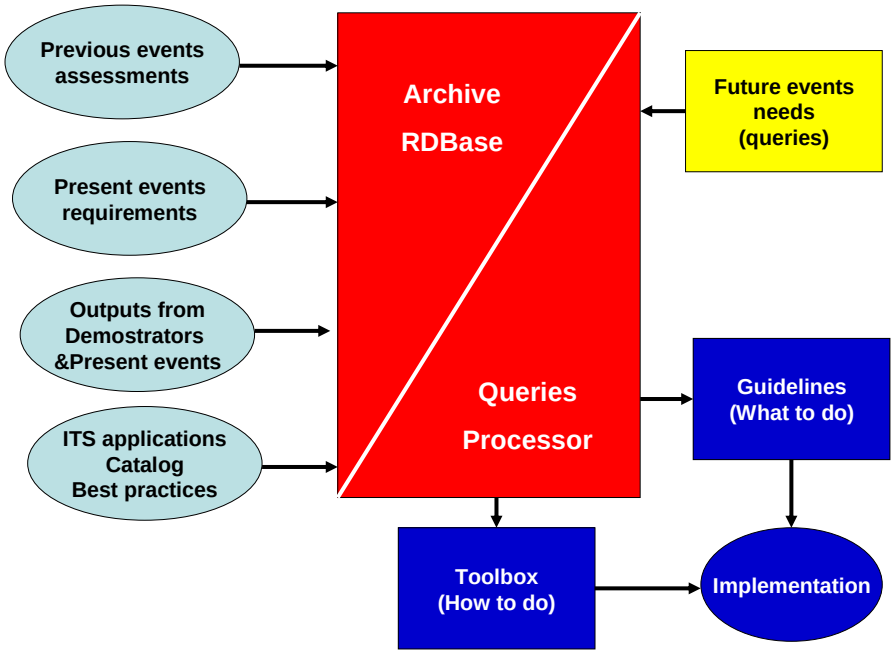
Whilst this early work has allowed a view of a single location, the purpose of the demonstrator development is to view congestion throughout a network. Being able to view this information along a route or at key interchanges with a route will allow the propagation or reduction of congestion to be tracked.
By informing customers about the level of congestion in real time will allow them to make informed decisions about their travel, whether to face the crowds or decide to delay their journey, and informing staff of immanent congestion as it propagates through a network will allow for increased staffing, implementation of safety measures and ultimately increased transport frequency and capacity, by making it available where it is known it is needed or will be imminently.

To achieve the demonstrator each location will require a dedicated PC to interface with the camera system and each camera will require a video interface.

Each PC must interface with either TfL's existing communication network (IP) or have a mobile (GPRS) feed established.
Central processing will be required in an array of servers, one to handle communication and data receipt, one to manage data processing, storage and retrieval and one to manage the rendering applications.

E. The Handbook

Over and above the activities geared to the demonstrations, the ultimate objective of STADIUM is to provide Local Authorities responsible for transports in cities candidate to host large events with a set of guidelines and specific tools to implement the required traffic management system.
Such a tool, defined **handbook** (HB), is in fact being designed and developed as an interactive data base, whose conceptual model is reported in the following figure.



The contents of the HB are being developed along the following steps:

1. Analysis of past events, specifically UEFA 2000, SOG 2004, WOG 2006, FIFA 2006 and including UEFA 2008 and SOG 2008, looking at the organizational issues, the overall performances of the multilayered transport system and the assessment of the supporting ITS applications. Such a review will be accompanied by a specific evaluation activity to derive a set of high level indicators suitable to benchmark the events and set target of performances for the future events.
2. Analysis and formalization of the requirements arising from the events that are expected to occur during the project lifetime, i.e. SA FIFA World Cup, Delhi CG and London 2012. For each of these events ITS applications will be designed, deployed and demonstrated, so as to test in real life the viability of such technologies in less developed environments (SA and Delhi), and to foster innovations in more advanced contexts (London).
3. The results of demonstrators will be evaluated following the formal MAESTRO guidelines; a systematic monitoring of the overall performances of the three events will allow to benchmark the events and their overall indicators.
4. Contents acquired by the previous actions and organized according to the HB architecture will be designed to support future users in their needs of knowing "what to do", whereas this fourth action will supply the detailed information to select, design, deploy, test and put in operation the most appropriate ITS applications meeting the management support system requirements. Contents will be

taken from the best cases developed in the urban contexts, not necessarily drawn from large events examples.

From the users perspective the HB must be seen as a decision support system (DSS) at different stages of the decision/planning/implementation process, covering domains such as:

- Dynamic traffic management systems & real-time traffic information for metropolitan areas;
- Public transport:
    - tracking and tracing, fleet management
    - demand-responsive transport
    - integrated ticketing and information for taxis, buses
    - bus and special vehicle priority;
    - Implementation of inner-city public transport services along major axes, with links to district hubs, modal interchange points and other centers (e.g. stadium, Olympic village etc.);
- Tools to optimize operational transport plans according to historic and real-time demand data;
- Web-based systems to integrate public transport and traffic management operations, and provide sources of data for delivery to mobile users, both private and commercial;
- Travelers services based on mobile communications, for real-time traffic and public transport service information, mobile payment, special event information and booking, etc.
- Demand management strategies based on economics and measures to influence travel behavior (e.g. through education and information campaigns);
- Fleet management mechanisms to ensure good practice in terms of safety (safe speeds, use of seat belts, etc.)

The access to the HB is enabled by structured queries at different levels of qualitative/quantitative insight. Typical examples of possible queries include:

- What has been done in previous events (such as SOGs) to manage special PT lines?
- What options are available to set up a demand responsive transport service?
- How to design a management centre integrating the different components of the transport system under different responsibilities (special fleets, special lines, standard PT)
- How to select ITS applications in term of cost / effectiveness?
- What is the full lifecycle of an ITS system to manage a fleet of N busses using location technologies, i.e. design, implementation, deployment, test, operation, investments and running costs?
- Etc..

The complete set of possible queries will result from the contents available, the requirements set by the cities organizing the events within the project period and the needs coming from cities candidate to host events after 2012. These will serve as the primary input to the detailed development of the HB architecture.