World Road Association (PIARC)
Cycle 2012-15

Technical Committee 2.2

Improved Mobility in Urban Areas

PIARC XXVth World Road Congress

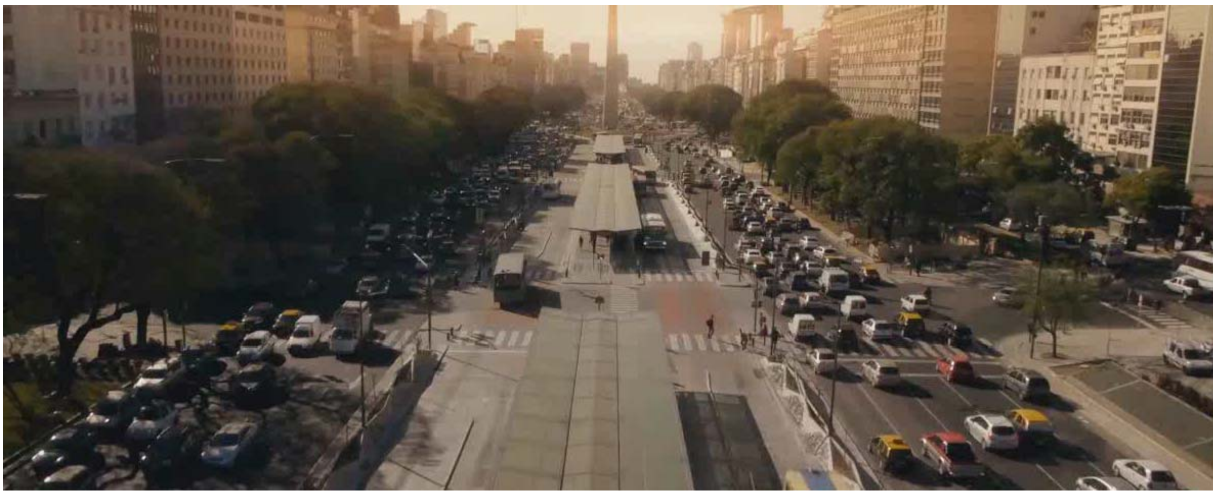
Seoul, 2-6 November 2015

KEY ISSUES FOR IMPROVING MOBILITY STRATEGIES IN LARGE URBAN AREAS

4th of November 2015 (pm)

Appendix to the technical report

Summery of HOV, HOT, BRT case studies collected



Content

This report is a annex to the final report set up by the TC 2.2 "Improved Mobility in Urban Areas" for the final conference in Seoul (November 2015).
It was set up by the sub-group 2 : Design of transport infrastructure for multimodality in urban areas.

1. USA

1.1 The project "HOT" lane, state Virginia - 2012

Background / context

The "495 Express Lanes" project involved the reconstruction of a 14-mile segment of I-495 from the Springfield Interchange to a point north of the Dulles Toll Road. The Virginia Department of Transportation (VDOT) signed an agreement with two private companies in April 2005. A contract was finalized on December 20, 2007, and construction began in the summer of 2008.
During construction, the existing eight-lane (four lanes per carriageway) Beltway was widened to a 12-lane facility consisting of four general-purpose lanes per side and two high-occupancy/toll "Express Lanes" per side located to the left (from a driver's perspective) of the general-purpose lanes.

Description of the main system components

Construction required replacement of more than 50 overpasses and bridges and the reconstruction of ten interchanges. The project added a number of new entry and exit points to and from I-495's new Express Lanes; it also added direct connections between the Capital Beltway and the Shirley Highway reversible HOV carriageway. The project was controversial due to concerns over its cost-effectiveness and the environmental effects (such as surface runoff and use of park land) of widening the Capital Beltway.
The lanes opened on November 17, 2012. Buses, motorcycles, and vehicles with three or more people are able to use the express lanes for free; other vehicles must pay a toll. The toll rates change dynamically according to traffic conditions, which in turn regulates demand for the lanes and keep them operating at high speeds. Tolls are collected solely via electronic means using **E-ZPass transponders**. No cash toll booths are offered. All vehicles using the Express Lanes, including those traveling free under the HOV provision, must have a transponder; in order to travel free, vehicles need an E-ZPass Flex switchable transponder so the driver can indicate whether the vehicle qualifies for free passage.

Rules of the Road

- HOV-3+ free with E-ZPass Flex (cars and public transport)
- Hybrids must pay toll if not HOV-3+
- Motorcycles free, no E-ZPass required
- Two-axle trucks allowed
- 18-wheel trucks prohibited
- Trailers prohibited

Expected Toll Prices

- Prices vary based on real-time traffic and distance traveled
- Models show averages of $3- $6 during rush hours; $1 - $2 during non-rush hours
- Could be more or less depending on trip length and on-road conditions
- Expected toll rates are comparable to other regional toll roads (ICC, Dulles Toll Road, Dulles Greenway), but usage patterns will be different

The dynamic display that indicates the price you will be in charge, at real time.

Cost and financing sources if available (in €)

Nearly $2 billion transportation improvement project:

- 80-year partnership agreement
- Approximately $1.5 billion in private equity and debt
- Key risks transferred to private partner
- State grant and use of innovative federal loan programs to finance project

Some performance data and results

Achieving Public Benefits:

- Added 50% capacity to manage congestion
- First major improvement to the Capital Beltway in a generation
- First-time opportunity for ride-sharing, carpooling and use of mass transit on Capital Beltway in Virginia
- Connects four major commuter routes to create seamless HOV and transit network
- Three new access points to major retail and employment centers including Tysons Corner and Merrifield

What are the civil penalties for violating on the Express Lanes? For refusal to pay a toll or falsely claiming carpool status, under Virginia law a judge can choose to issue the following civil penalties:

- $50 for a first offense,
- $250 for a second offense,
- $500 for a third offense within a period of two years of the second offense,
- $1,000 for a fourth and subsequent offense within a period of three years of the second offense.

Success factors / strengths

Barriers / weaknesses /points to monitor

Lessons learnt

- Use as expected
- good level of respect

References and contacts for further details

1.2 Houston HOT networks, Texas (2012 / 2013)

Background / context

	Population (2010 US Census)	Surface
City	2,099,451(4th U.S.),	1,505/km2
Urban area	3,822,509 (10th U.S.)	
Metropolitan area	5,946,800 (6th U.S.)	

84 miles of High Occupancy Vehicle (HOV) lanes will be converted into High Occupancy Toll (HOT) lanes, when fully implemented. Houston Metro president and CEO George Greanias says the existing HOV lanes are practically empty around 80 percent of the time.
We enhanced METRO's High Occupancy Vehicle Lanes (HOV Lanes) to give people driving solo in cars the option to pay a small toll to use the lanes.

Description of the main system components

Overview

Current HOV Lane users will see only one significant change: a lane for verification of the number of occupants in the vehicle.
Drivers without passengers are allowed to use the system by paying a toll with an authorized toll tag.
Traffic monitoring systems will help METRO maintain traffic speeds to ensure optimal travel times for existing HOV Lane users, as well those using the METRO HOT Lanes.
Conversion of the HOV Lanes to make them compatible for METRO HOT Lanes allows for the following improvements:

- Automated remote-controlled gates at entrances and exits to the HOV Lanes allow for quick opening and closing of the lanes
- Camera monitoring systems
- Enforcement monitoring booths
- Traffic flow monitoring systems

The Metro decision set a $75 fine for toll evasion and a court citation for SOV violations. Enforcement will be the Metro police and will make use of randomly staffed observation booths near toll points, plus cameras and police cruiser.
Carpools, vanpools and motorcycles are still able to use the HOV Lanes for free

The IH 45 South (Gulf Freeway) METRO HOT Lane is open! Other METRO HOT Lanes corridors will come online throughout the year (completing by Winter 2013).
Anticipated opening dates:

- US-59 South – Spring 2012
- IH-45 North – Summer 2012
- US 290 – Fall 2012
- US-59 North – Winter 2013

Cost and financing sources if available (in €)

Some performance data and results
Tolls for **METRO HOT Lanes**
Tolls are based on time of day and the congestion level of each of the METRO HOT Lanes corridors. METRO will publish the toll rate for specific corridors prior to opening, and tolls will be prominently displayed along each corridor.

Benefits of METRO HOT Lanes

- Provides new options for commuters
- Increases safety and promotes quick response to accidents and issues in the lanes due to additional camera monitoring
- Improves air quality by reducing traffic congestion
- Better utilizes existing HOV Lanes
- Offers increased enforcement of the HOV Lane system

Success factors / strengths

Barriers / weaknesses /points to monitor

Lessons learnt

References and contacts for further details

- http://www.ridemetro.org/Services/HOTLanes.aspx
- http://www.ihatehoustontraffic.com/hot_lanes.html
- http://transportationnation.org/2010/11/04/houston-hot-lanes-traffic-142/

1.3 HOV to HOT - MnPass Express Lanes - Minneapolis, Minnesota, USA

Background / context

The MnPass Express Lanes were introduced along the radial I-394 and I-35W highways on the suburbs of Minneapolis.

In both cases, High-Occupancy Vehicle (HOV) lanes were converted to High-Occupancy Toll (HOT) lanes to optimize their use and to offer a faster trip for commuters.

In 2005, the State of Minnesota decided to convert the I-394 HOV lanes to HOT lanes, with free access for high occupancy vehicles (transit buses, carpools and motorcycles) and dynamic tolls for other vehicles. Building on the success of the I-394 conversion, the State then decided in 2009 to extend the experiment to I-35W.

Figure 1- View of the MnPass Express Lanes in Minneapolis, Minnesota, USA

Description of the main system components

On I-394, HOT lanes cover 18 km stretching from the western suburbs to downtown Minneapolis. From west to east, in either direction, a first 13 km section has one left-hand HOT lane separated by a double solid line from two general-purpose lanes. Intermediate entries and exits are marked by broken lines. The following 5 km section is made up of two reversible HOT lanes and three general-purpose lanes in either direction. Along this section, the HOT lanes are separated from the general-purpose lanes and are only accessible from their eastern and western end points.

On I-35W, HOT lanes cover 25 km from the southern suburbs to downtown Minneapolis, with a left-hand HOT lane in either direction along most of the section. The HOT lanes are separated from the general-purpose lanes by solid double line. The intermediate entries and exits are marked by broken lines.

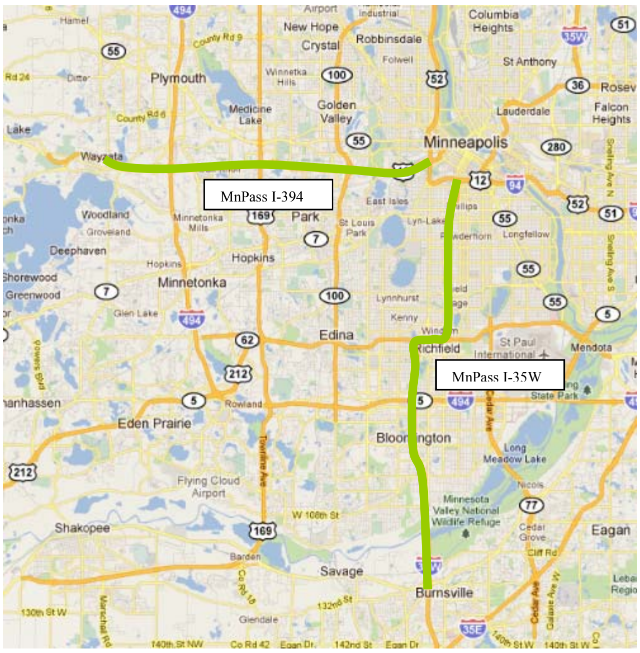


Figure 2 - MnPass Express Lanes on the I-394 and I-35W highways in Minneapolis, Minnesota, USA.

How does it work?

The MnPass Express Lanes optimize the capacity of road infrastructure by maintaining:

high level of service into the lane through dynamic pricing,
high travelers throughput by promoting public transport and carpooling.
The HOT lanes are accessible to all vehicles. Only single-occupancy vehicles are required to pay a toll. Indeed, to encourage high vehicle occupancy and optimize travelers throughput in the HOT lanes, vehicles with at least two occupants are exempted from the toll.
Tolls are adjusted every 3 minutes, and fees are based on traffic levels in the express lanes. Tolls range from $0.25 to $4, with a maximum of $8 during peak periods. Outside operating hours, HOT lanes are open to all vehicles free of charge.
Tolls are paid without stopping by means of a "free flow" electronic toll system. Many gantries are installed on the various sections making up the system; and single occupancy vehicles traveling in the MnPass Express Lanes are required to be equipped with an electronic transponder.
From the side of the road or within the traffic flow, the police use mobile devices to confirm that valid transponders are mounted in single-occupancy vehicles. Vehicle occupancy is checked visually. A single-occupancy vehicle traveling in the MnPass Express Lanes without a transponder or crossing the double solid line is in violation and subject to a fine of $142.

Some performance data and results

Since the conversion of the I-394 HOV lanes to HOT lanes, no interference has been observed between buses, carpool vehicles and single occupancy vehicles. The operation of the HOT lanes has continued to support growth of buses ridership. In 2010, more than 5,000 people rode buses using the HOT lanes during the morning peak period.
On I-394, during the morning peak hour, the HOT lanes outperform the general-purpose lanes, carrying twice as many travelers into Minneapolis with a reliable trip time. As shown in Table 1, HOT lane capacity in the inbound direction is about 3,500 travelers per hour during the morning peak hour, without reaching saturation.

Table 1: Throughput per lane between 7 and 8 a.m. on I-394.

People moved per lane	2010 Q1	2010 Q2	2010 Q3	2010 Q4	2011 Q1
HOT lane	3 737	3 507	3 506	3 506	3 833
General-purpose lane	1 924	2 054	1 985	1 729	1 898
Difference	1 813	1 454	1 521	1 778	1 935

Source: I-394 HOV Lanes traffic data quarterly reports

Success factors / strengths

This dynamic toll system has proven effective in regulating single-occupancy vehicles demand and maintaining traffic speed over 80 km per hour 98% of the time.
Social acceptability
On average, MnPass Express Lanes are used 10 times per month by single occupancy vehicle drivers, what accounts for $12.

Cost and financing sources if available (in €)

Gouvernance:
MnPass Express Lanes are managed by Minnesota Department of Transportation (MnDOT). In August 2007, MnDOT was awarded $133.3 million for congestion management and transit projects from the USDOT as part of the Urban Partnership Program. The project contains a HOT lane component on I-35W south of Minneapolis.
Financial data:
The cost of converting the existing HOV lanes to HOT lanes on I-394 is estimated at $12 million, or about $670,000 per km (2010 value). In 2010, toll revenues balanced operating costs [1]. A socio-economic study carried out by the Humphrey Institute of Public Affairs found a benefit-cost ratio of 2.27, which takes account of the safety benefits [2].
In addition, all net profits from tolls must be reinvested in developing the corridor to support public transport and in improving road infrastructure.

Barriers / weaknesses /points to monitor

Lessons learnt
The good way to manage and to insure the level of service required for this lane.

References and contacts for further details
[1] Urban Partnership Agreement, Report to the legislature, Minnesota Transportation Department, January. 2011.
[2] Xinyu (Jason) Cao, Benefits and cost analysis of MnPass: Preliminary results, Humphrey Institute of Public Affairs, July 9, 2010

1.4 Buses on freeway shoulder - Minneapolis - Saint Paul, Minnesota, USA

The Twin Cities have a history of strong transit priority programs. In 1991, bus-only-shoulders were tested for freeway express buses. Buses are allowed to use the shoulders only when mainline traffic speed drops below a threshold of 56 kph. Douma et al. (2008) describes the design and operation of these lanes and summarizes the ridership and cost benefits as follows:

"Shorter, more predictable travel times and fewer missed transfer connections have increased ridership.

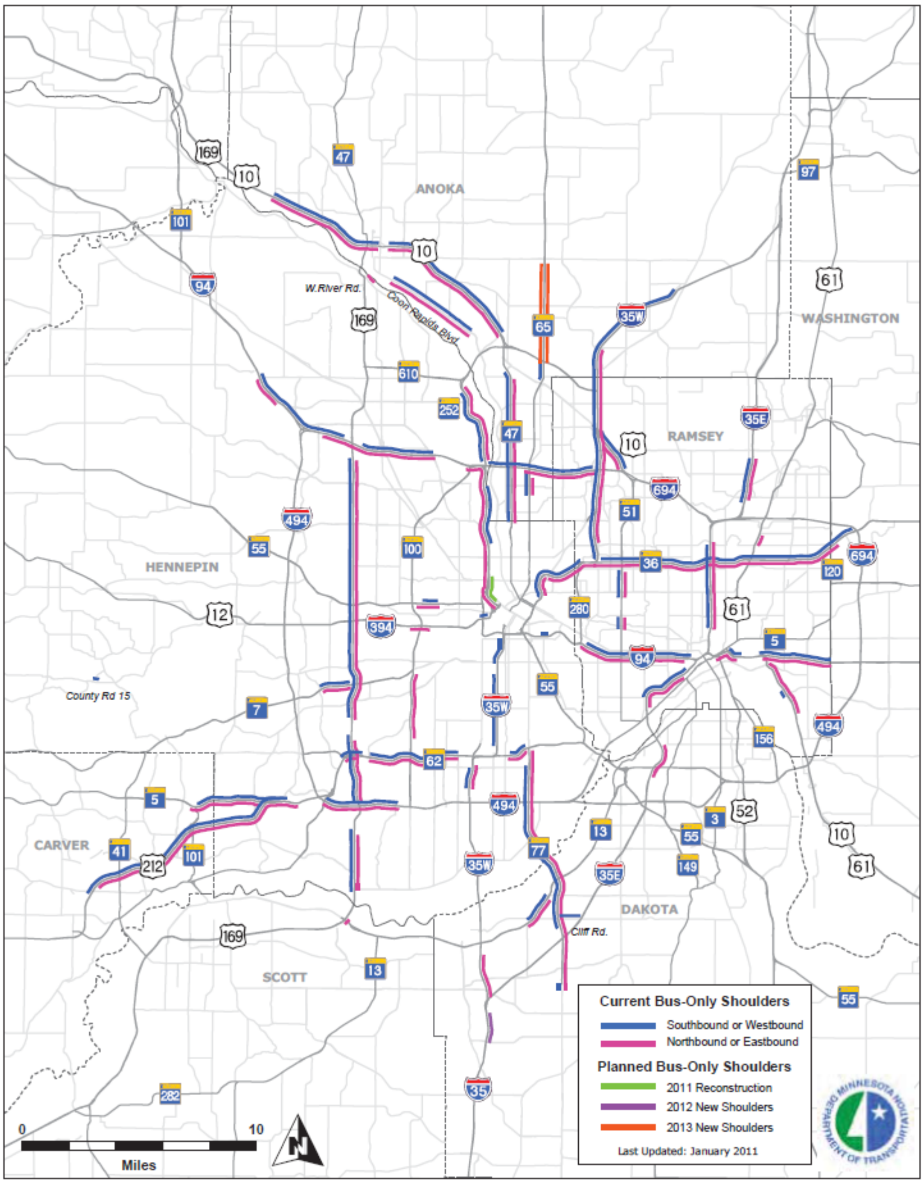
Operational costs have decreased because more reliable travel times result in less driver overtime.

Although the traffic speed as well as the speed of buses may be minimal when corridors are heavily congested, passengers' perception of time saved is considerable...Metro Transit determined respondents overestimated the actual amount of time saved by two to three times (Douma et al., 2008)."

Bus Only Shoulder operations (Douma et al., 2008)

Passengers value the higher speeds relative to cars and the reliability benefits from these lanes. The network has since expanded to over 480 km (see Figure at the end of this description), some of which serve not only commuter express routes, but also local routes. The Snelling corridor, for example, detailed in figures 81 to 84 and 122 to 123, is permitted to use bus-only-shoulders for 12% of its route length.

Current and Planned Bus-Only Shoulders:



The 480-km. network of Bus Only Shoulders in the Twin Cities
(Minnesota Department of Transportation)

Using a federal Urban Partnership Agreement, MnDOT and Metro Transit have transitioned some of these shoulder operations into median-running HOT lanes. Such a transition on Interstate 35W substantially improved average speeds (see Table below), further strengthening mode shift for commuters from outlying areas.

Average Speed (kph)	April 2009	April 2011
Northbound		
MVTA buses	40	88
Metro Transit buses	50	94
Southbound		
MVTA buses	74	88
Metro Transit buses	75	88

Average speed of buses in the 2.6 km segment of I-35W between I-494 and 46th St.

The median running ways are also conducive to in-line stations that make these improvements accessible to residents living closer to the downtown core. One such station, at 46th St., was opened in December 2010, and it will eventually be integrated with the proposed Orange Line BRT service.

Downtown, dedicated bus lanes offer additional reliability benefits, especially during peak hours. The Nicollet Mall was an early effort at prioritizing transit downtown. The Marq2 project, a couplet of two peak period bus-only lanes in each direction on Marquette Avenue and 2nd Avenue South implemented in late 2009, has been a recent success

Transit signal priority has also been implemented in some corridors. Liao (2012) describes the benefits from a TSP project along Central Avenue. The priority projects described above have helped improve the attractiveness of transit, even in an area with low densities and high rates of auto ownership.

While the region has made sustained progress in prioritizing transit over the past two decades, its first designated BRT service was inaugurated in June 2013. The first phase of Dakota County's Red Line BRT project includes seven stations along Cedar Avenue's bus-only shoulders, a transfer to the southern terminus of the Blue/Hiawatha light rail line (see Figure 21), all-door boarding, and bike racks. Free rides on the line's first weekend helped promote new ridership.

The corridor's clear, simple identity, its all-day service, and the strong reputation built by Metro Transit through past priority projects make it attractive to discretionary riders. Even in an exurban area, the Red Line is closely tied to new development:

> *"Opportunities for real estate development abound around the four current stations in Dakota County, and some of it is already under way. Baltimore-based Paragon Outlet Partners is building a 409,000-square foot outlet mall near the Cedar Grove BRT station in Eagan, the largest current retail development project in the Twin Cities, according to Finance & Commerce. Opening is expected next year.*
>
> *In addition, vacant land around the three Apple Valley BRT stations is ready for commercial or residential development, city planners say. Job development can be tough for a far suburb such as Apple Valley, but "one of the game-changers we have is having the right tools," community development director Bruce Nordquist told F&C.*
>
> *Good transit can be one of those tools. Maybe that's why the 100,000-square foot Apple Valley Business Campus that opened this year a mile west of the 147th Street Red Line station is already 60 percent leased, with the rest expected to be occupied by December (DeFiebre, 2013)."*

While it is too early to draw definitive conclusions about the Red Line, developers seem to be demonstrating confidence in its success. There may be noteworthy results about the relationship between the Red Line service and the preexisting freeway express services. The latter are being maintained, rather than truncated as was the case for the Los Angeles Silver Line.

Success for the Red Line could help sustain momentum for proposed future corridors, including the Orange Line along I-35W as well as arterial BRT service on Snelling, Chicago, and other high ridership corridors.

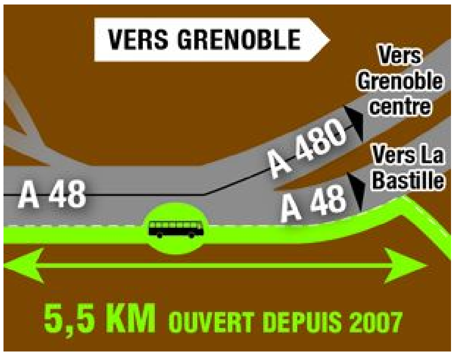
Lessons learnt

Reliability benefits are more important (coupled with priority in downtown) for attractivity than speed gain.

2. France

2.1 Busses on hard shoulder on the A48 (Grenoble)

Background / context



Grenoble is a 400,000 inhabitants city in south-eastern France with only three main access with motorways. Consequently, traffic is very heavy on these roads during the peak hours, and congestion occurs every working day.
For improving travel times by buses, without decreasing the traffic capacity, the idea was to use the hard shoulder only for busses, only at congestion hours (entrance of Grenoble only).
The project was elaborated between 2002 and 2007 and was opened under the status "experimental".
Since it runs safely with high benefits for public transport, an extension on to the 4.5 km upstream section, with the same technical choice, has recently been opened (April 2014).

Description of the main system components :

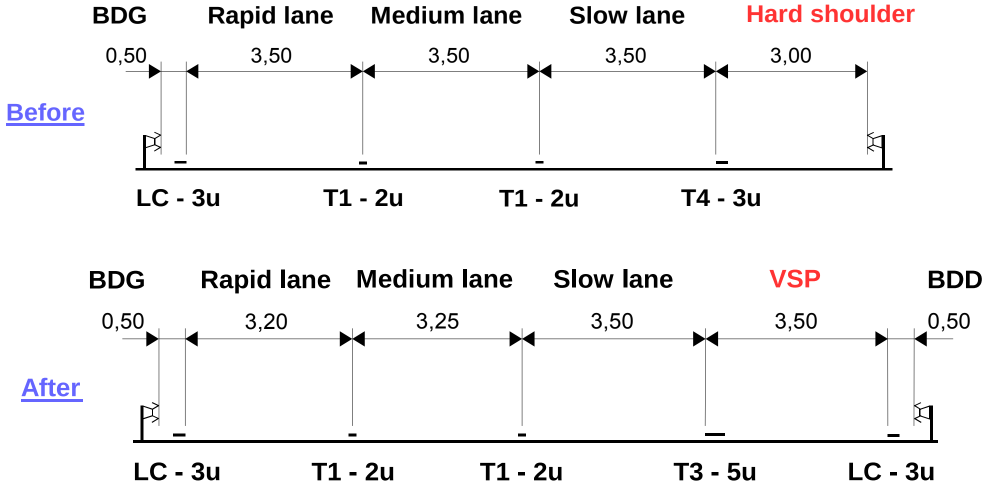
Opening/closure of the lane

The lane is opened during morning peak hours for buses going into Grenoble: buses are only allowed to go on the bus lane if the measured average speed is less than 50 km/h. The decision to open the bus lane is taken by an operator at the Grenoble traffic management centre: the operator has to check with traffic data and cameras that there is no incident on the hard shoulder. If so, the lane is not opened to buses.
Once the decision has been taken, the operator has to indicate to bus drivers with Variable Messages Signs (VMS) if the bus lane is open or closed. The latest means that the bus has to go on the main carriageway, with the whole traffic. At the end of the bus lane, i.e when buses have to go back onto the main carriageway, traffic signals give priority to the bus.

Characteristics of the "hard shoulder / bus lane"

The hard shoulder has been painted in red so that car drivers can pay attention to the fact that it is not a normal hard shoulder.

Below, the two drawings shows how the cross section has been re-shared for implementing the "hard shoulder bus lane", by decreasing the width of the rapid and medium lanes.



Cameras have been deployed all along the section every 250 meters. Automatic incident detection is also in operation: it allows the traffic management centre to close the lane to bus traffic quickly in case of an incident (e.g. car breakdown). Then, all buses are required to go back immediately to the main carriageway. The information is given to bus drivers by flashing lights implemented every 500 meters on the right-hand side of the lane.

Operating modes

Three different modes are in operation depending on the measured traffic speed:

1. If traffic speed is more than 50 km/h:
   - bus lane is closed (buses go on the main carriageway),
   - speed limit is 90 km/h.
2. If traffic speed is between 30 km/h and 50 km/h:
   - bus lane is open,
   - speed limit is 50 km/h for the whole traffic.
3. If traffic speed is less than 30 km/h:
   - bus lane is open,
   - speed limit is 30 km/h for the whole traffic.

Intermodality with the existing mobility network:

All bus lines are converging to the main interchanges, where are connected 2 tramway lines and the rail station, located in city centre.

Cost and financing sources if available :

2M€ / km (surface structure, signalisation, automatic incident detection)

Some performance data and results :

The status "experimental" was justified for 2 reasons, to open a lane with two functions (bus lane + emergency space), to introduce some new sign. A specific traffic order has been taken so that the hard shoulder could open to bus traffic. This traffic order specifies the mandatory characteristics for the control and monitoring of the section. Specific dynamic equipments have also been implemented so that bus drivers as well as car drivers could understand the speed limit that applies and whether they could go or not on the bus lane.

Ridership:

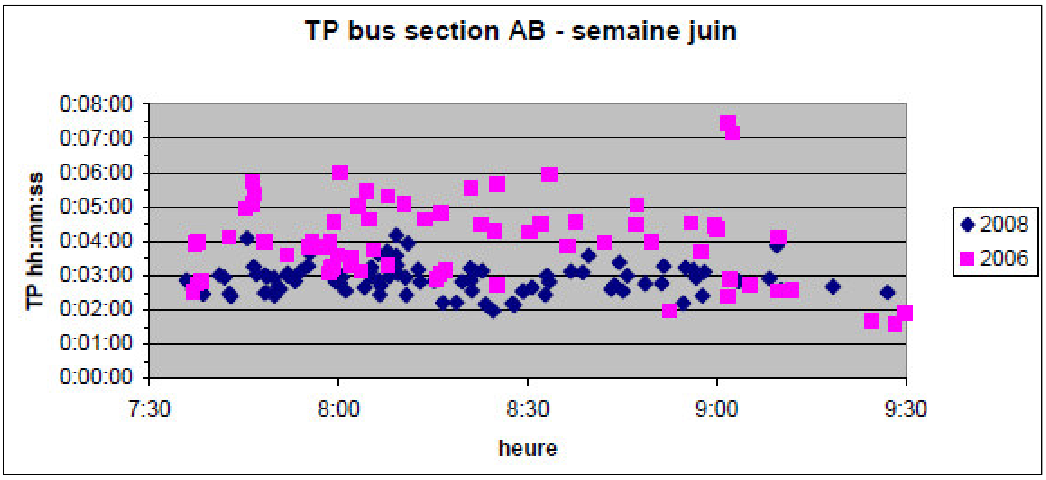
The most important line carries now 5000 passengers/day (2000 before 2007)

9 bus lines are autorized on this "hard shoulder bus lane", they form a capacity of 30 bus/hour, that reaches a higher level, 46 buses/hour, with the same quality of service.

Bus passengers: 26 % are new users; Among them, 56 % have changed their mode of commuting ; 90 % think the measure should be extended to other sections.

Impacts on bus travel time:

The first result is that bus travel time are about 15 % less with the hard shoulder bus lane in operation. Bus speed has increased from 45 km/h before (2006) to 52.6 km/h after (2008). But the most interesting result of this evaluation deals with travel time variability: if the bus travel time has been reduced by about 50 seconds on the 4.5 km-long section, the travel time variability has been reduced from 6 minutes to 3 minutes. The figure 5 (below) illustrates the impacts of the bus lane on the bus travel time on the most congested section (Saint-Egrève Nord/ZI Saint-Egrève - © ZELT):



Comparison of bus travel time before (2006) and after (2008) the opening of the hard shoulder bus lane on the A48 most congested section (ZELT).

Success factors / strengths:

The hard shoulder bus lane in Grenoble has now been opened for more than 7 years, and the results of the evaluations (safety also) are encouraging. First, buses are faster and their travel time is more reliable than before. Second, bus clients are highly satisfied with the hard shoulder bus lane and most of them want this measure to be extended.

Barriers / weaknesses /points to monitor:

Always under the experimental status, since 2007 .

Some improvements of the concept have been done (a better visibility of the traffic lights at ramps) and should be done :

- An operational mode into two sections, so that the bus can exit of the hard shoulder at the divergent A48 / A480, as it occurs that the congestion could collapse two km later after the entrance, and, then, the bus stays limited at 50km/h...
- A flexible entrance into the hard shoulder: to let the bus driver the decision to enter where he feels the best (the congestion length is variable).

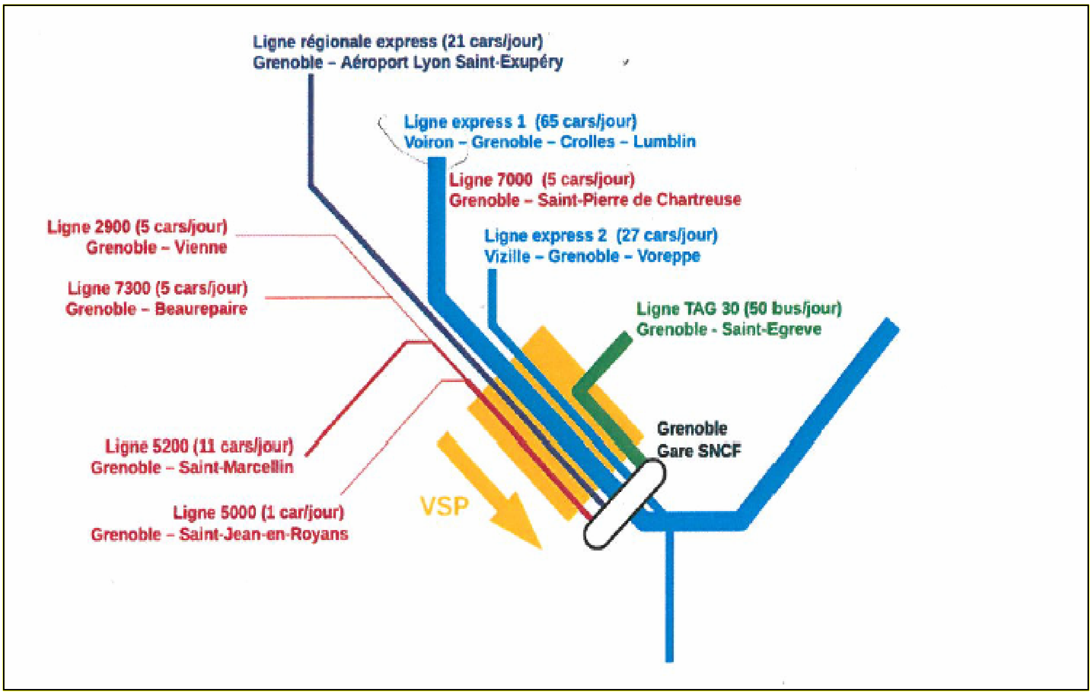
The ministry is now asking for a last evaluation of the two parts (section 2007, new section 2014), to be afterwards on the way to integrate these new rules and signalisation into our road regulation, in order that such concept could be deployed more widely in France.

Lessons learnt:

- The regularity of the whole line is the key issue to get attractiveness.
- Such a system should not to be so rigid for buses.
- Enforcement measures should be developed during the project, and be ready before opening the system.

References and contacts for further details:

Hervé Monnet - CG38 - herve.monnet@cg38.fr
François Rambaud - CEREMA - francois.rambaud@cerema.fr



9 bus lines are autorized on this "hard shoulder bus lane" called "VSP" on this graph, they form a capacity of 30 bus/hour, that can be higher.

2.2 Trends in Île de France (Paris region)

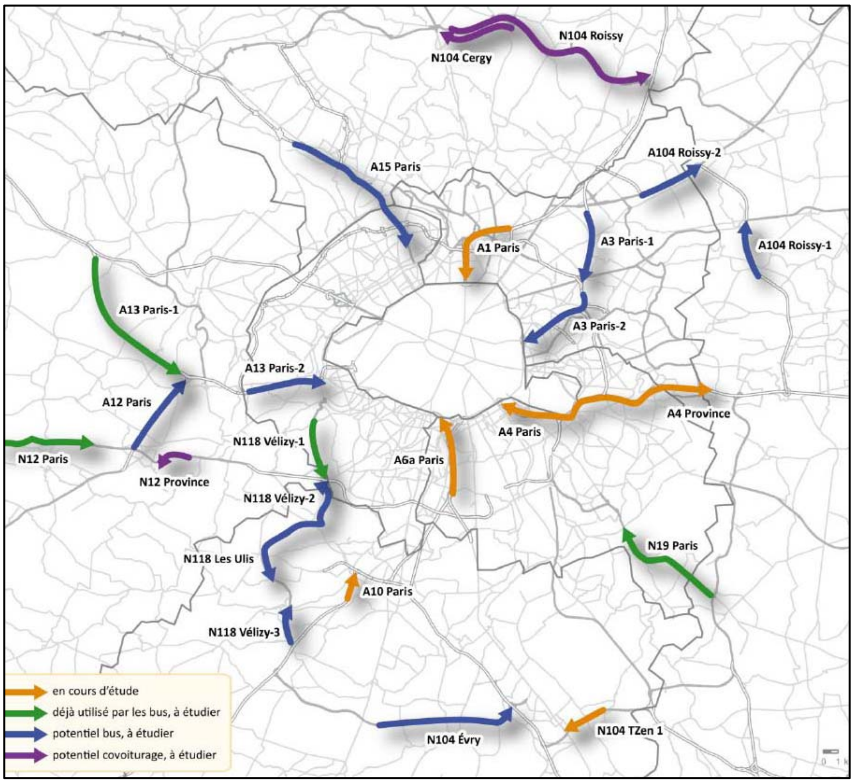
Background / context

The Île de France Region has 12,000 km2, with 11.9 million inhabitants, contributes at 29% of French GDP and employes 5.5 million people. There were around 8 million trips occurring in the region each day. Due to insufficient capacity in the rail network with lines currently carrying around 1 million passengers per day, a project for a new rail ring with 200 stations and modernisation of existing lines is on the way.

On the other hand, in 2013, the region île de France has set up a pre-feasibility study that points all the current potential motorway corridors where a dedicated lane for public transport, taxis, or carpooling, appears to be possible and interesting.

The objectives are :

- To offer an efficient structured bus feeder network, complementary to the heavy network (corridors non equipped and little dense, where heavy lines are not affordable).
- To encourage and develop carpooling.
- To improve taxis traffic conditions (travel time regularity).



Region Île de France : the 18 coloured potential motorway corridors for a dedicated lane.

As seen into the map above, 18 motorway corridors are concerned for a total length of 83 km and a total estimated cost of 210 M€ .

At this time, the first corridors chosen, which study is on progress, are :

- A6a : a temporary dedicated lane for bus and taxis implemented instead of the slow lane (4km), during the morning peak hours.
- A10 : a permanent dedicated lane for buses only (2.2km), implemented as an additional lane on the left side of the rapid lane.
- A1 : a temporary dedicated lane for bus and taxis implemented instead of the rapid lane (5km), during the morning peak hours.

Description of some current experiences that are already on service

- The bus station already implemented in Briss-sous-Forges, opened in 2006 - highway A10 - 35 km in south of Paris

This new intermodal site allows to link a non-dense sub-urban sector which were not connected to an efficient PT lines. This station comprises a Parc and Ride, with 5 feeder local bus lines.
The results are great : more than 320 000 passengers in 2013 per year, per direction (200 000 in 2007).

Bus station on A10 (one on each direction) - visited during the TC 2.2 meeting in Paris 2014 - technical visit

Aerial photo of the interchanges of Briis-sous-Forges.

Objectives of the trips:

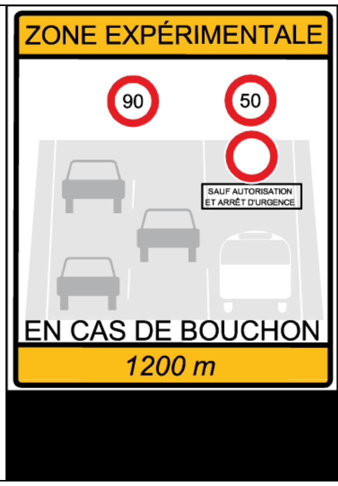
- 76 % for working
- 21 % for studying

Feedbacks from passengers :

- One passenger by 2 is thinking he wins between 10 to 20 minutes each trip;
- One passenger by 3 is thinking, he wins between 50 to 100 euros per month;
- Trips that are comfortable (seating places);
- Convenience and quickness into the interchange and its access.

- Dedicated lane for buses only on hard shoulder (1,4 km), on service since 2007 - highway A10

This short test has been implemented without dynamic signalisation, as simple as the design process is observed in Netherlands or in USA. The bus drivers are authorised to take this lane as soon as congestion occurs (that means a traffic speed < 50km/h).



Dedicated lane for buses only on hard shoulder (1,4 km), on service since 2007 - highway A10

- For all case studies of the Ile de France region:

Benefits / Success factors / strengths

Studies on progress

Barriers / weaknesses /points to monitor

Difficulties to analyse impacts on general traffic.

Need to refine the method to evaluate the value of the regularity gain of all buses involved.

New signalisation is needed, that implies discussion, as the signalisation chosen in Grenoble is always under experimental status.

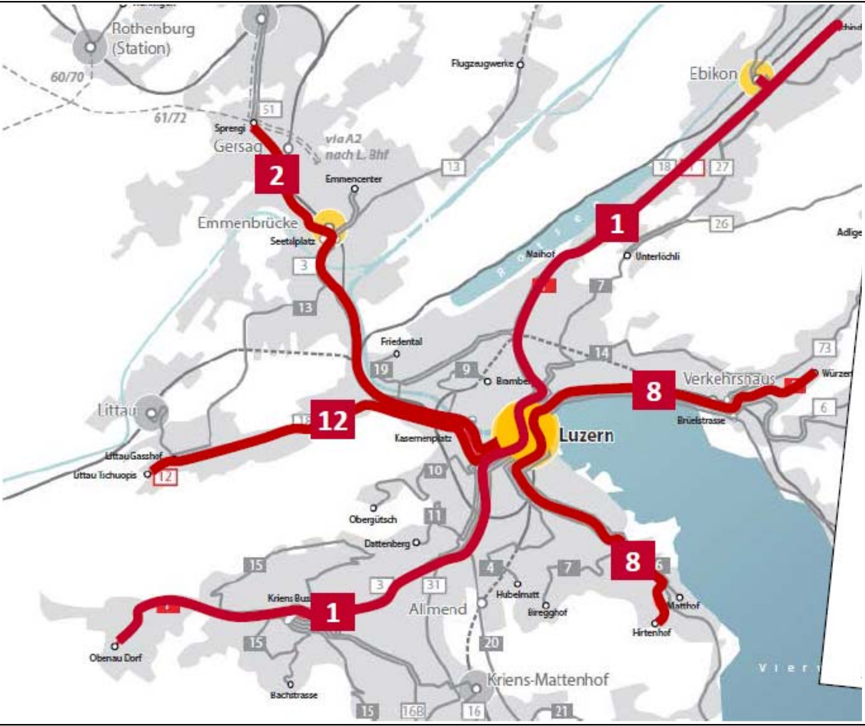
Lessons learnt

Importance of a network approach for public transport (connexion with the existing network).

3. Switzerland - Lucerne - the Rbus network program

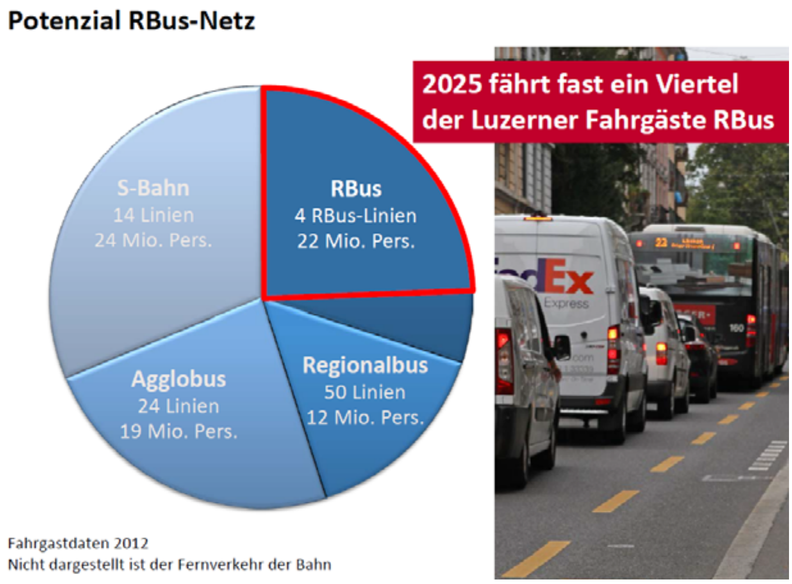
A BRT-Project in Lucerne is planned to create the first BRT-Line (called Rbus line) until 2018 (Line 1 Kriens - Lucerne - Ebikon, 11.3 km, 12 Million Passengers a year, a double-articulated bus every 7.5 minutes)

Later on, three more Rbus lines, N° 2, 8 and 12, are planed and expected in 2025, as seen into the map below.



The RBus network planed for 2025

The vehicle chosen : a bi-articulated trolleybus



The RBus network market exoected in 2025 : a quater of the PT mobility

For more information , the web link in German :
http://www.vvl.ch/fachinformationen/rbus/konzept/

4. Korea

4.1 The HOV trends in Korea

We do not have separate carpooling lanes, however we treat the HOV lanes as being equal. Vans with more than a certain number of passengers are restrictively permitted to use exclusive bus lanes on highways.

- Typologies developed (mixed traffic with other mode, or not ?)
Exclusive bus lane on highways allow 13 passenger vans and 9-12 passenger vans (when you board 6 or more passengers). Exclusive bus lane on non-highways allow vehicles with 36 or more passengers, commercial vehicles with 36 or less passengers (e.g. town shuttles), school buses, 16 passenger vehicles for commuting purposes only, special purpose vehicles (commissioner's specification required), and tourist buses with 25 or more passengers (commissioner's specification required)

Exclusive bus lanes in downtown Seoul, 207.1km

- What are the key successes, the difficulties ?
Shorter travel time by allowing HOV to use exclusive bus lanes.

- what about the safety ?
Separating larger vehicles like buses and vans from smaller vehicles had an effect on reducing the relative speed between large and small vehicles.

- What about your regulation / design rules evolution ? N/A

Problems, regulation issues, safety goals,…

- Problem : illegal parking, car accident, drunk driving, etc.
- Regulation issues : watching DMB while driving, drunk bike riding, etc
- safety goals : reduce car accident, guaranteed pedestrian right, bike lane safety, etc.

4.2 The BRT program in City of Seoul

Background / context

The Metropolitan Region that includes Seoul has grown into the Mega City Region (MCR) with the population of 24 million people, which is over the half of Korea's total population. However, due to the lack of efficient public transportation network in the Metropolitan region, a large number of people prefer to drive their own vehicle to move around within the region.
According to study data reported by Korea Transport Institute, the traffic congestion cost (time value cost + vehicle operation cost) in the Metropolitan Region for the year 2007 was estimated to be 14.3 trillion Won, or 58.3% of the nation's total traffic congestion cost. The greenhouse gas emission in the Metropolitan Region for that same year was found to be 45 million TCO2, or 44.7% of the nation's total greenhouse gas emission. These results suggest that a plan to improve the traffic and environmental conditions in the Metropolitan Region is urgently needed.
To decrease the use of private vehicles and promote the use of public transportation, we are building a transportation system that efficiently links the cities in the Metropolitan Region. In addition, we are

also developing various policies related to the transportation demand in the Metropolitan Region to effectively prepare for global warming and high oil prices.
We are designing a plan to implement supply-side policies that include specific projects such as pilot BRT (Bus Rapid Transit) construction project of Seoul~Hanam and Gangseo~Cheongna lines, BIS (Bus Information System) construction project, transit center construction project, and intercity bus parking lot construction project. We are also designing a plan to implement regulatory policies related to low carbon green transportation.

City and country: Seoul, Korea (Y2012)

Inhabitants of the urban area	10,442,426 people
surface area (km2)	605.21 km²,
Average density	17,254people/ km²

The percentage that the following means of transportation represent in relation to all traffic (Y2012):

- bus: 26.4%
- subway: 20.2%
- car: 27.5%
- pedestrian: 20.4%
- etc.: 5.5%

How many lines?, kilometers ? : Exclusive bus lanes in downtown Seoul, 207.1km
What are the key successes, the difficulties ? : The connection of median exclusive bus lane using buses and major stations in Seoul

Usefull internet link.
http://stat.seoul.go.kr/index.jsp etc.: 5.5%
http://mta.go.kr

<u>City : Cheongna Area in Korea</u>
Along with Songdo and Yeongjong, Cheongna international city make up the Incheon free economic zone. It is developed as a center of international affairs and leisure activities.

Inhabitants of the urban area	60,845 people
surface area (km2)	17.8 km²
Average density	3,418people/ km²

It is a new public transportation method to connect new towns that were limited in railway and bus lanes to Seoul and metropolitan areas.
Agency announced that the first step of the BRT project from Cheongna district to Gangseo district will be partly completed, with the exception of the entry ramps of the Cheongna district. For a start, the agency will deploy 10 High-end CNG buses and begin operation on July 11th at 5pm.
It was partially opened to address residents' inconveniences due to the lack of thoroughfares from Cheongna district and Jakjeon station to Seoul.

Bimodal trams were test run for Sejong City's BRT, however were replaced by CNG buses due to frequent breakdowns.
In the case of Incheon's Cheongna district BRT, CNG buses were run from the beginning and yielded a decrease in their commercial speed, continuing in a similar level as regular buses.

What are the mobility problems, that have been to be solved?

- In the case of Incheon's Cheongna district, a new BRT traffic system was applied to alleviate residents' traffic inconvenience due to a lack of transportation to Seoul and metropolitan areas.
- In the case of Gyeongbu median bus lane, the implementation of M and Red buses for Dongtan-Seoul relieved rush-hour traffic congestions and increased public transportation distribution factor.

Description of the main system components

Name of the line / system: : in Incheon ~ Gangseo in Seoul / BRT
Name of the Authority: Incheon Transit Corporation
Operator: Incheon Transit Corporation
Construction period: 2010 - 2015 (2nd phase)

Infrastructure:
  Length: 19.8km (2 step plan: 23.1km)
  Station spacing: 15 Stations
  Types of road crossings: Median exclusive bus lanes
Buses: number, types, length, capacity: No.7700, CNG Bus, 45passengers/veh
Fare collection system: smart card, cash
ITS tools implemented (for operator, passengers,…): BMS, BIS and smartphone applications using other IT technologies (route information, operation time, arrival time, shortest route, etc)

Intermodality with the existing mobility network:

Focus on good practice regarding the intermodal stations, **Sadang station in Seoul**

- Typologies developed (type of modes involved, type of operation, TOD?): TOD development of subway and bus
- How many passengers per day ? : Subway: 86,502 passengers per day (get on), 82,806 passengers per day (get off), Bus: 51,307 passengers per day (get on), 63,255 passengers per day (get off)
- How many lines are concerned / per PT mode ? :2 subway lines, bus (general, main, local, express, outer city, airport)
- What are the key successes, the difficulties ? : direct connections to various commercial facilities, accessibility, intermodal transfers between subway, trains, bus, taxi and etc.

Lesson learnt

- Transfer plans are being considered, but most are not because public transport network efficiency and route modifications for improving utility are not so simple.
- This BRT system was recently partially opened.
- It is a new transportation system that combines bus priority signal system, center bus-only lanes, and bus arrival information system to the existing bus.
- After the opening of the BRT, BRT effectiveness, management issues, and user satisfaction will be comprehensively analysed through periodic monitoring.

Cost and financing sources if available (in €)

- Average total investment cost per km: The BRT, but the cheaper one than (city rail, light rail, etc.) to other means of transport in 0.14 million€ ~ 3 million€ construction cost per km.
- Operating costs per km: 60 million€ annual average
- Financing sources if available: The Incheon Transport Corporation fund. The Incheon Transport Corporation is requesting support regarding the financial deficit, but the ministry of Land, Infrastructure and Transport's position on this issue is not supportive.

Some performance data and results

- Ridership: 930 passengers / day estimated because it was recently opened, and the number of passengers is low
- Headways: 15minute (peak time), 20minute (off peak hours)
- Schedule span: 5:30 ~ 23:05
- Commercial speed[1]: 20~25km/h

[1] the commercial speed is the speed average between the two terminals, with "passengers", including the dwell time at stops, but not the standing time at terminals, without passengers

- Accidents / safety : Safety (because it was recently opened, there are no accidents.)

Success factors / strengths

- Solution to traffic problems such as the impossibility of building new roads, deterioration of quality services, traffic congestion, and air pollution.
- According to a transportation card data aggregation from March 2009, the number of daily commuters per km in metropolitan area was on average 3,755 person(s)/day/km (minimum 734 and maximum 10,699), showing potential for sufficient bus demands.
- In addition, constant increase in the number of vehicles is expected to worsen traffic congestion, and thus it is necessary to adopt the BRT system for preventive reasons.
- Construction cost of the BRT per km is 2.5~30% of the LRT, and is at least 50% or more lower than the urban railway while it can provide a more flexible public transportation service.

Barriers / weaknesses /points to monitor

- Rather than the recognition of the new public transport, it is easy to recognize in the existing bus system.
- difficulty in improving lane efficiencies due to civil complaints.
- therefore new routes are being added, but existing bus lanes are stayed unmodified.
- however, service complications followed the addition of buses, causing opposing arguments against adding bus routes from outside Seoul to inside Seoul.
- It was initially expected to complete the whole distance in 40 minutes, but it actually took about 1 hour when measured by the Incheon Transportation Authority.

Lessons learnt

- Though the initial support and subsidy to revitalize public transportation successfully led the bus system, continuous addition of bus routes and subsidy expenditure with no efficiency is straining Seoul's finance.
- Thus the establishment of an integrated organization to adjust bus and railway routes, akin to France's RATP, is being argued for in the academia.
- Including the sections that are currently being expanded, more routes are anticipated to be built in the future. The development of the TOD type will also be possible with the increased usage of the new transportation system.

References and contacts for further details

http://www.mta.go.kr/main.jsp

http://www.mta.go.kr/english/brt/cg_brt.jsp

Some pictures:


BRT
Rapid Transit

5. Spain

5.1 Madrid - A6 Corridor BUS-HOV System

Name of the infrastructure: A-6 Corridor BUS-HOV System
Name of the Authority: Consorcio Regional de Transportes de Madrid (Authority responsible: Ministry of Works)

Background / context

By mid 90´s the area along the A-6 highway to the northwest of Madrid was experiencing a considerable increase of population and employment, a trend which has continued. The increase of congestion raised a problem, which would get worse due to the characteristics of the population in the area: high income level, high motorization rate and low density.
Thus, the initiative was to implement a BUS-HOV lane (Bus and High Occupancy Vehicles) in 1995, providing both promotion of Public Transport in the corridor, as well as a mean to increase car occupancy, reaching environmental objectives through infrastructure management.
The BUS-HOV system consists in a 16 km length infrastructure in the middle of the A-6 motorway, extending from the metropolitan village of Las Rozas, 18 km from Madrid city, to the urban district of Moncloa, ending at an interchange station. Concrete barriers from the rest all-purpose lanes physically separate it, and it has a reversible operation: traffic heading towards the city of Madrid in the morning, and towards the suburbs in the afternoon and evening.
The access points to the BUS-HOV system are located at its two end points (beginning and end) and via 3 intermediate tunnel access points or “embarkments”. It can be used by buses, vehicles with two or more people, motorcycles and emergency vehicles.

Description of the main system components

Infrastructure:
Length: 16.1 km = 3.8 BUS Only section + 12.3 BUS-HOV
Width of bus lanes: Section BUS-HOV (12.3 km): two lanes 3.5m + shoulders 1.5m
Section BUS Only (3.8 km): one lane 5m + shoulders 0.5m
Station spacing: No stations along the infrastructure
Road crossings: No crossings, special underground “embarkments” for the access of vehicles

Buses:
Type: No special buses. Infrastructure used by all types of interurban buses running on the highway corridor
Length: All lengths, mainly standard 12 m and articulated 18 m
Capacity: All kind of buses, average of 54 seats+30 standing

ITS tools:
AVMS under implementation in the interurban bus fleet in the whole Region of Madrid (2,000 buses).
For passengers: At station: Dynamic Passenger information under implementation (at this moment 4 LED displays in Majadahonda + 1 stop provided with bluetooth); SMS Real time information service
On board: buses provided with LED screens with real time info

For drivers: At station: idem
On board: AVMS Driver Display
For regulator: At station: idem
On board: in the operator traffic control center the AVMS control system

Identification:
No special image/brand on the bus, the running ways and at the stations

Cost and financing sources if available (in €)

Average investment cost per km: 52.6 M€ (Bus-HOV Infrastructure) + 13.2 M€ (Moncloa Interchange)
Cost of a bus: Not applicable, only infrastructure investment
Operating costs: Not applicable, only infrastructure investment

Some performance data and results

Ridership: 44 interurban bus lines and 112,000 passengers a day use the infrastructure, with 185 buses at rush hour
Headways: From 10 minutes to 30 minutes, depending on the line and the hour
Schedule span: From 5.00 A to 0.00 AM plus night services
Regularity:
Average commercial speed: Not available for the system (as example, the line 651 have a commercial speed of 28.5 km/h on peak time, 33.5 km/h out of peak)
Accidents: 545 acc/year (Inside: 43 minor, 373 material / Outside: 2 minor)

Success factors / strengths

Results obtained from its inauguration have been very positive:

- during morning peak hour 60% of people entering Madrid through this corridor use the BUS-HOV infrastructure
- the modal split on buses increased from 17% (1991) to 26% (1997) and 28% (2008)
- modal shift to PT: the use of cars decreased from 56% (1991) to 48% (1997) and 50.4% (2008)
- reduction on travel time: in 1996, average gain of time in rush hour between 6 and 15 minutes (BUS-HOV vs conventional lanes)
- increase on car occupancy (from 1.36 in 1991 to 2.00 in 1997)
- more people are using buses than suburban railway in the corridor, in the mobility to Madrid

The key success elements are four:

1. The Bus-HOV stretch = 12.3 km
2. The only-Bus stretch = 3.8 km
3. The underground interchange point in Moncloa
4. Good connections with metro lines and urban buses routes

Barriers / weaknesses /points to monitor

- Need of urban space (not always available) to implement such infrastructure
- Need of coordination of different administrations, also taking into account the needs/worries of citizens
- Need of important amount of economic resources for such big investment

Lessons learnt

Intermodality is a key factor in public transport systems. Interchanges are a key element to favor the use of public transport and the ease of connections among modes (including private vehicles) are decisive for the modal shift.

References and contacts for further details

Contact person (CRTM): Laura Delgado; **E-mail:** laura.delgado@crtm.es

5.2 Barcelona (interurban services, C-31, C-58)

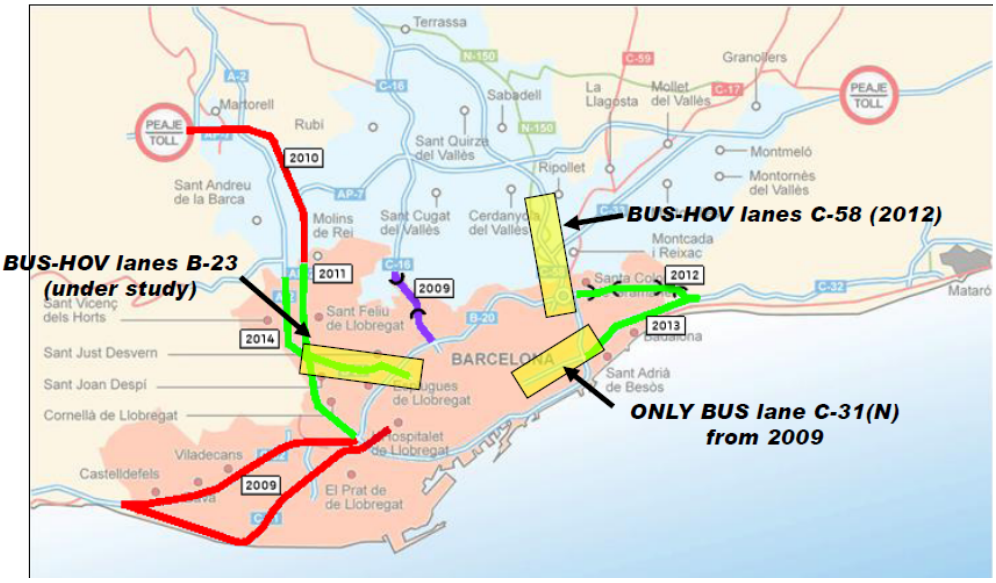
Background / context

	Barcelona metropolitan region	Barcelona city
Inhabitants of the urban area	5 052 000	
surface area (km2)	3 239 km2	101 km2
Average density	1 560 inhabitants / km2	16 050 inhabitants/ km2

	Barcelona metropolitan region:	Barcelona city
modal share by PT	18.6%	29.2 %
modal share by cars	27.4%	9.7 %
modal share by pedestrian	49.3 %	54.7%
modal share by bicycle	1.2%	2.7 %
modal share by motor cycle	3.5%	3.6 %

In Madrid, A6 was opened in 1995 as the first of a number of "carril bus VAO" projects aiming at the provision of reserved lanes for interurban buses and highly occupied private vehicles on motorway accesses to main Spanish cities.

The 2012-2024 Infrastructure Transportation Plan (PITVI) of the Spanish Ministry of Public Works does not include any specific programme to build additional "bus VAO" lanes. The Plan only aims at the introduction of bus reserved lanes on service roads (see PITVI, page II.221).



Position of the different projects in Barcelona

Description of the main system components

These two new case studies are "suburban" lines.

The C-31 bus dedicated lane concept was developed when the works of the reurbanization/pacification project of C-31 (agreed upon with citizen organizations) had already begun. The extra cost for the inclusion of the bus lane in the C-31 section was negligible and did not induce any congestion of standard road traffic as side effect.

Picture regarding the C-31

The bus lane (entrance of Barcelona), on the left is permanent
No hard shoulder on the right

The C-58 bus VAO lane was targeted by the 2001 - 2010 Master Public Transport Infrastructure Plan of the Barcelona metropolitan region. Opened in 2012 within the alternative first solution (entrance in Barcelona on the morning, exit on the afternoon), after some months it was abandoned and opened as permanent dedicated lanes, one for each direction, that gives more capacity (+5%).

With this first solution, the types of vehicules authorised are BUS, HOV+3, motorcycles, electric and low emission vehicles, and public vehicles.

In the beginning of the use of BUS-HOV lanes, there were a very low rate of the use of such infrastructure. For this reason, there has been an evolution in the BUS-VAO configuration with the aim to increase the number of vehicles using the infrastructure. This evolution is shown in this table:

PHASE	FROM	TO	DESCRIPTION (work days)
1	OCT 2012	17/03/2013	**BUS-HOV+3** (2 REVERSIBLE LANES: 7 hours ENTRANCE in the MORNING, 6 hours EXITTING in the AFTERNOON)
2	18/03/2013	09/02/2014	**BUS-HOV+2** (2 LANES ONLY ENTRANCE to BCN for 16 hours from Monday to thursday)
3	10/02/2014	03/08/2014	**BUS-HOV+2** (2 LANES ENTRANCE to BCN for 16 hours) , different time-table for Friday.
4	14/09/2014	up to NOW	**BUS-HOV (1+1 PERMANENT CONFIGURATION for 24 hours)**

Comparative description of these two projects

	C-31	C-58
Opening date	2006	2012
length of the BHLS described (km)	2.4	6.8
% of dedicated lane	27% of the travelled way section is occupied by the bus dedicated lane	100% physically segregated lane
dedicated lane shared with other modes	Only for buses	Buses, hightly occupied cars, low emission cars, cars steered or used by handicaped people, motorcycles, emergency vehicles, taxis
position of the dedicated lanes	Left	2 segregated lanes protected with varying position
type of signalisation	Standard	Variable to allow alternative circulation
specific design of the shelter	Standard	Improved
Intermodal integration	Weak	Weak
Specific services for users	No	No
P+R (number of place)	No	No
type of bus	Standard interurban (some of them articulated)	Standard interurban
specific design	No	Special "express bus" branding for 4 lines
type of fuel	Diesel and biodiesel	Diesel and biodiesel
Branding / Identity of the line	No special branding	Special branding only for 4 "express lines"
Intermodality with the existing mobility network	Walking is the main connection mode. For trips arriving in Barcelona, underground is the most important public transport connection mode	Walking is the main connection mode. For trips arriving in Barcelona, underground is the most important public transport connection mode

Cost and financing sources if available (in €)

	C-31	C-58
Cost M€/ km (infrastructure only)	Total cost of infraestructure for the urban integration of C-31: 20.8 M€/km Extra cost for the construction of the bus dedicated lane: 0.003 M€/km	11.8 M€/km
Total investment cost	Total cost of infrastructure for the urban integration of C-31: 50 M€ Extra cost for the construction of the bus dedicated lane: 0.006 M€	80 M€
Bus cost (€)	No specific investment linked to the project	No specific investment linked to the project

Some performance data and results

	C-31	C-58
trips/day	Trips per labour day of bus lines using the C-31 bus dedicated lane (2010): 20 500	Trips per labour day of bus lines using the C-58 bus VAO lane (2013): 9 300
ridership increase before / after	Average yearly increase (2006-2010): +5.3%	Yearly increase (2012-2013): +15.8%
frequency	445 bus services per day	700 bus services per day
commercial speed	50 km/h on the bus dedicated lane	90 km/h on the bus VAO lane
schedule span	All day	6:30h - 22:00 h
Trips coming from the car	22.8%	Less than 10%

Intermodality with the existing mobility network	Walking is the main connection mode. For trips arriving in Barcelona, underground is the most important public transport connection mode	Walking is the main connection mode. For trips arriving in Barcelona, underground is the most important public transport connection mode

Success factors / strengths

C-31	C-58
Remarkable travel time savings for bus users plus external cost reductions at an extremaly low infraestructure marginal cost needed to introduce the bus dedicated lane	Yet to be assessed

Barriers / weaknesses /points to monitor

C-31	C-58
- Penetration of the bus dedicated lane to BCN city center - Northward extension of the bus reserved lane	- Too little use of the bus VAO lane by highly occupied cars - Low modal share of bus in the C-58 corridor (Vallès Occidental)

Lessons learnt

C-31	C-58
Opportunities to obtain substantial socioeconomic and environmental benefits from a low cost investment	Need to revise the bus VAO infrastructure concept

References and contacts for further details

ATM - Barcelona - Serrano Sadurní, Luís - lserrano@gencat.cat

Some pictures

Picture regarding the C-58

The 6,7 Km BUS-HOV with 2 lanes in the middle of C-58, on a separate road - The reversibility has been abandonned

Entrance into the Bus-VAO

Annonce : the Bus-VAO is opened

Two entrances are possible

End of the Bus-VAO section

End of the bus corridor


In the middle of the Bus-VAO section : by-pass at each side, for control operation by police

6. Australia

Melbourne does not have a traffic-segregated busway. Other states have developed segregated busways, the most emblematic are as follows:

Adelaide, South Australia (since 1986)

Adelaide O-Bahn is a guided busway that used a concrete track to guide the busses. The system provides a high-speed bus link to the northern suburbs of Adelaide. Busses using the O-Bahn operate using on-street mixed traffic running at each end of the track to provide network coverage, whilst the concrete track provides guided high speed bus operation for the trunk section of the routes.

http://www.adelaidemetro.com.au/Timetables-Maps/Special-Services/Adelaide-O-Bahn

Sydney, New South Wales (since....)

Three traffic-segregated BRT systems existing in Western Sydney under the name of ‘T way’. The T-ways have made use of undeveloped road and utility reserves to provide a higher speed express bus service. Whilst running on the T-ways is segregated from other traffic, intersections are at grade.

http://www.rta.nsw.gov.au/roadprojects/projects/bus_priority_program/sydney_t_ways/index.html

Brisbane, Queensland (since ...

A network of three traffic-segregated BRT busways exist in Brisbane. The three routes extend from inner Brisbane towards the South East, Northern and Eastern Suburbs. These routes comprise of totally grade separated operation, and train-like station facilities. The BRT network carries approximately 70 million passengers year over a 25 km network.

http://translink.com.au/about-translink/what-we-do/infrastructure-projects/busways

6.1 Melbourne

Background / context

Greater Melbourne has a population of 4 million people in an area of 7,700km^2 at an average density of 4 people per hectare. Greater Melbourne Journey to Work Data from 2011 Census:

- public transportation:18%
- cars: 65%
- bicycles:1.3%
- pedestrian: 3%
- motorcycles: 0.4%
- didn’t travel/worked at home: 10%
- not stated: 3%

Melbourne was established in the 19th Century. Early growth was situated around the central business area and was developed with pedestrian scale terrace houses and strip shopping. In the later part of the 19th and early 20th century the city spread along rail and tram corridors, with development and activity generally remaining within walking distance of public transport.

Since World War 2 car-based development has occurred in areas distant from the rail network, characterised by detached housing. The last 30 years have seen a dual pattern of development of suburban growth the outer fringes of the city into areas formerly used for farming, and the gentrification of inner city areas into highly desirable neighbourhoods. The city has an extensive suburban rail network, the world’s largest tram network, and a urban bus system.

What are the mobility problems, that have been to be solved?

Provision of high quality public transport in suburbs not served by rail or tram. Melbourne’s bus system has traditionally provided poor frequency and hours of operation compared to the city’s trains and trams. The Doncaster area was developed post war, and is not served by trains or trams. Bus services to the area where peak-focussed providing little or no service at other times.

If there was a comparison with a rail solution during the decision process, please to provide the main reasons that led to this choice of this bus system.
The DART bus upgrade was proposed as an alternate to a heavy rail line. A train line to Doncaster has been proposed at various times, leading to public criticism about the lack of 'real' public transport in the Doncaster area. Studies have determined that heavy rail to Doncaster would be very costly and would have limited benefits over an upgraded bus system

If not, what were the main reasons for this choice?
The bus system was chosen for several reasons:

- Much lower cost than heavy rail.
- It allowed coverage across the dispersed area of Doncaster, whereas a rail line could only cover a limited area and would need feeder busses.
- The existing rail network is capacity constrained, meaning that a new line to Doncaster would need costly upgrade to address capacity concerns in order to cater for the new Doncaster services.
- A bus system offered faster 'door to door' journey times compared to a train based system that required interchange.
- Lack of an existing rail reserve in a fully built up area.
- Doncaster is a hilly area. This presents engineering challenges for a railway that significantly add to the project cost.

<u>The bus system implemented (urban – sub-urban systems) :</u>

Name of the line / system: Doncaster Area Rapid Transit – (DART)
Name of the Authority: Public Transport Victoria

Description of the main system components :

<u>Infrastructure:</u>
DART operates on four routes 905, 906, 907, 908 routes. These busses operate on the existing road network. The service span of these routes is improve to 19 hours on weekdays, and 18 hours on Saturdays and 14 hours Sundays. Total system route length is 107 kilometres.
Weekday bus services were doubled from previous levels on these routes, with operating hours extended to as 5am and midnight.
The frequency of services is 7-10 minutes during peak periods and every 15 minutes off peak.
More than 250 bus stops were be upgraded to SmartBus standards.
Station spacing: approximately every 500 m
Types of road crossings: all at grade.
<u>Buses</u>: number, types, length, capacity: Busses are standard route bus used in Melbourne with a capacity of about 60.
<u>Fare collection system</u>:
Smartcard ticketing known as myki. Ticketing is fully integrated with Melbourne's trains, tram busses and some regional services, allowing free interchange between modes. Fares are zonal, with two hour, daily and longer period ticket types available.
<u>ITS tools implemented (for operator, passengers,…):</u>
<u>Identification / branding trend if any :</u>
Busses are branded 'SmartBus' and are painted in a grey livery. The SmartBus brand is used to differentiate higher frequency services from ordinary suburban bus routes. Stops have SmartBus branding, with some stops being provided with real time countdown information.

Intermodality with the existing mobility network:

What modes are concerned?
Melbourne has a network comprising of Train, Tram and Bus

Who operates?
All services are operated by private operators under contract to Public Transport Victoria.
Is there a TOD approach? If yes, please to explain the process, and the results achieved.
No.
Measures for promoting the use of bus system (reorganization of bus network, P&R, bicycle parking, etc.)
Most stops are street side stops showing real time information. A major park and ride is provided at Doncaster for 400 cars. Secure bicycle parking is also provided at Doncaster.
What are the difficulties for achieving a good "intermodality" quality?
Service co-ordination. Historically different transport modes developed in an un-coordinated competing fashion. Over time the route patterns and operating practices of various operators became entrenched making it difficult to re-arrange services to encourage interchange. Public Transport Victoria was recently established to take overarching coordination responsibility of the system and to progressively re-arrange services to improve connectivity and coverage.

Cost and financing sources if available :

Total project budget was $112.1m (AUD). This included new busses, stop upgrades, limited roadworks, introduction of some bus priority measures, and coverage of operation costs for the start-up years.

Some performance data and results :

Ridership: passengers / day
Patronage has grown in two years by more than 50%
Headways: peak, off peak hours
every 15 minutes
Schedule span:
19 hours on weekdays, and 18 hours on Saturdays and 14 hours Sundays.

Success factors / strengths:

DART has upgraded infrequent and limited hours bus services to create an all-day service with frequency that is equivalent to Melbourne's tram and train network. This has dramatically improved off-peak levels of service, and boosted patronage by over 50% in the first two years of operation.

Barriers / weaknesses /points to monitor:

Delays caused by road traffic and lack of bus priority.
Hoddle Street is heavily trafficked, leading to bus delays particularly in the PM peak when no bus priority is provided.

Lessons learnt:

The introduction of the DART service has shown that Melbournians will use bus services that are frequent and provide a good range of operating hours.
Public acceptance of bus priority measures is a fought process. There has been considerable local opposition to new bus lanes on the basis of lost kerb carparking.

References and contacts for further details:

Chris O'Toole , Senior Fleet and Infrastructure Planner, Network Planning Public Transport Victoria.
chris.otoole@ptv.vic.gov.au - 61 3 9027 5063

Some pictures :

SmartBus stop showing information and real time display as used by DART busses.
SmartBus Livery as used by DART busses.

System Map :

7. Japan

7.1 Different BRT types

From the presentation by Toshiro KONO

Guide way Bus (Shidami)

Key Route Bus (Shindeki-machi)

Use of disused rail track (Ishioka)

7.2 Nagoya City

Background / context

Population: 2,262,176 persons (as of April 1, 2013)
Area: 326.43 km^2
Population density: 6,930 persons/km^2

Percentages of modes of transportation (%)

Public transport	Cars	Bicycles	Pedestrians	Motorcycles
29.6	42.7	12.1	14.6	1.0

Noteworthy characteristics of the city
http://www.city.nagoya.jp/kankou/category/33-2-0-0-0-0-0-0-0-0.html

A) **Issues in mobility**

While high transportation demand requiring subway construction is not expected, there is a lack of core transportation means; therefore, early establishment of new core transportation means was planned in areas requiring transportation means that could replace subways.
Primary reasons why the bus system was selected after comparison with the solution by railway:

- As compared with other large cities, construction and improvement of roads are relatively progressed and several broad arterial roads were present in the city, making it possible to suppress the construction cost by utilizing existing roads.

- With short-term construction, it can respond to the intermediary demand between subways and buses and it can transition to other systems or subways in accordance with demand increase in the future.
- The system with the conventional bus technology is highly reliable.
- Construction cost was relatively low with the utilization of existing roads, while punctuality and rapidness equivalent to subways were secured by constructing a dedicated elevated track for the segment with traffic congestion.
- While securing profitability of the system to meet immediate demand, it can respond to future demand increase by gradual construction in accordance with the progress in the development of areas along the line.

B) Implemented Bus System (City – Suburban System)

- Route/System Name

Key Route No. 1 / Key Route Bus Toko Line
Key Route No. 2 / Key Route Bus Shin-Dekimachi Line

- Background/Contents

As the Key Route Bus System operates in a designated lane, it is less susceptible to traffic congestion; it could also be expected to have the function of a key transportation means in terms of transportation capacity, rapidness, and punctuality, required low construction cost with the use of existing roads, and could be established in a short term.
Accordingly, it can be introduced early in areas where high transportation demand requiring subway construction is not expected but there are insufficient key transportation means and means substituting subways are urgently required. The introduction of a new key transportation means could elevate the level of public transportation services.

- Overview of Selected Measure Type

Key Route No. 1 (Toko Line)
Roadside running system (express operation passing some of the existing stops)
Key Route No. 2 (Shin-Dekimachi Line)
Center running system (running in a lane at the center of the road)

Description of the main system components

- Primary Components of the System

(System extension)
Key Route No. 1 (Toko Line)
Sakae–Takatsuji–Hoshizaki 10.46 km
Sakae–Takatsuji–Naruoshako(Naruo bus depot) 11.81 km
Sakae – Takatsuji – Kasadera Station 8.62 km
Bus lane (roadside running system) included in above lines 2.7 km
Key Route No. 2 (Shin-Dekimachi Line)
Sakae–Chayagasaka–Hikiyama 10.21 km
Nagoya Station–Chayagasaka–Hikarigaoka 10.60 km
Nagoya Station–Chayagasaka–Itakashako(Itaka bus depot) 11.30 km
Sakae–Chayagasaka–Shikenya 12.36 km
The bus lane (central running system) included in above lines9.20 km
[Distance between stops]
Key Route No. 1 (Toko Line) : Average distance between bus stops: 700 m
Key Route No. 2 (Shin-Dekimachi Line) : Average distance between bus stops: 600 m (eastbound), 640 m (westbound)

- Connection to existing mobility network

Target transportation means:
Key Route No. 1 (Toko Line)

City bus (Transportation Bureau, City of Nagoya)
Subway (Transportation Bureau, City of Nagoya)
Railways (Central Japan Railway Company, Nagoya Railroad Co., Ltd.)

Key Route No. 2 (Shin-Dekimachi Line)

City bus (Transportation Bureau, City of Nagoya)
Subway (Transportation Bureau, City of Nagoya)

● Issues in achieving high-quality "intermodality"
(Related measures being taken to promote usage)

- Implementation of a transit connection discount with city subway and bus
- Implementation of speedy boarding/exit and fare payment with IC card ticket and sharing lines with other operators

Cost and financing sources if available (in €)

● Cost and financial resources

(Unit: 10 million yen)

Business description		Key Route No. 1 (Toko Line)		Key Route No. 2 (Shin-Dekimachi Line)	
		Business expense	Subsidy	Business expense	Subsidy
Transportation business	Cars, Bus depots, Bus route total management system	42	13.6	98	10.9
Road improvement	Intersection improvement, Traffic island construction, Color painting, Bus bay	20	-	146	21.7
Total		62	13.6	244	32.6
Business expense per km		6.0		23.6	

Some performance data and results

● Business performance data and results
Key Route Bus System (2012)

		Key Route No. 1 (Toko Line)	Key Route No. 2 (Shin-Dekimachi Line)
Ridership		8,915 passengers/day	18,004 passengers/day
Headway		Peak time : 4 to 5 min. Off-peak time : 10 min.	Peak time : 2 to 3 mins (1 to 2 minutes including jointly-operated Nagoya Railroad Bus) Off-peak time : 5 to 6 min.
Operation hours		First bus 6:06 Last bus 22:42	First bus 5:48 Last bus 23:30
Time required		Peak time Plan: 42 min. Actual: 46 to 47 min. Off-peak time Plan: 42 min. Actual: 43 to 50 min.	Peak time Plan: 37 to 41 min. Actual: 35 to 45 min. Off-peak time Plan: 39 to 44 min. Actual: 36 to 50 min.
Scheduled speed (before implementation -> after implementation)		13 km/h -> 16 km/h	15 km/h -> 17 km/h
Number of accidents		2.40 accidents per 100,000 km	
Balance of payment in business	Operating revenue (gov. compensation, etc)	525,350,000 yen (—)	1,076,368,000 yen (—)

	Sales expense	501,319,000 yen	1,075,913,000 yen

* The figures are estimates of the financial closing of FY2012.
* Peak time, from 7:00 a.m. to 8:59 am on weekdays; off-peak time, 10:00 a.m. to 4:59 p.m. on weekdays
* Time required is the time required between Sakae and Hoshizaki for Key Route No. 1, and between Sakae and Hikiyama for Key Route No. 2
* The number of accidents is the total number of city bus accidents

Success factors / strengths

Barriers / weaknesses /points to monitor

1. Issues in Key Route No. 1 (Roadside running system)

- Impact of entry of cars making left turn and parked vehicles
- Impact of traffic congestion between Sakae and Marutamachi where there is no bus lane.
- Reduced rapidness as it became necessary to make additional stops at the bus stops that were passed due to express operation.

2. Issues in Key Route No. 2 (Central running system)

(1) At the time of construction: Measures associated with the establishment of bus lane and traffic island

- Increased entry of general vehicles to residential roads along the bus route
- Difficulty in parking and stopping of general vehicles on the roadside (Impact on attracting customers, etc., at stores)
- There are intersections where general vehicles became unable to make right turns due to restrictions in road width.

(2) At present: Issues in operation

- During rush hours, buses merging from branch lines are unable to operate as scheduled due to delay, etc., resulting in operation order reversal in some cases. (The operation order cannot be corrected in the bus lane.)
- Due to the large number of passengers getting off, it takes time for discharging customers at bus stops connecting to subways, which sometimes leads to a line of buses waiting to discharge passengers in the bus lane.
- Even in front of bus stops, general vehicles sometimes remain in the bus lane and pass in front of waiting passengers or stop for signal changes in front of the bus stop platform.
- Due to the intersection-style form where the lane for general vehicles to make right turns is sandwiched between the bus lane and the straight lane, inexperienced general vehicle drivers sometimes stop waiting to make a right turn in the bus lane, preventing bus operation.
- In the intersection where the bus lane is winding in an S-shape, it is difficult for large-size vehicles including buses to pass each other. In the intersection with a road winding in an S-shape, there is an increased risk of slippage due to color painting.
- For the segment with a narrow width in the bus lane segment (one-side two-lane road), the police does not allow the construction of bus stops for the general route.

Lessons learnt

While the Key Route Bus Investigating Committee of City of Nagoya announced the policy that it is ideal that a central running system will be introduced to future routes of the Key Route Bus, it will be necessary to examine alleviation measures including running systems for the routes which will have great impact on automobile traffic.

References and contacts for further details

****

7.3 Route/System Name : GuideWay Bus System Shidami Line

Background / context

In the GuideWay bus system, route bus cars equipped with a mechanical guiding device running along the guiderail on the designated track, thus the structural object for the track is compact and requires low costs for construction. In addition, its characteristic is the dual mode system realizing continuous operation on general non-elevated roads.
Accordingly, development of the system called the dual mode system, progressed relatively well in the area near the urban area and the construction of roads have completed. An elevated structure constructed over the center of the road for a dedicated track for the segment with severe traffic congestion due to a bridge over a river or railroad crossing where a certain degree of demand is expected. Where buses continuously run on non-elevated roads as traditional route buses, it was introduced to the segments in suburbs where the construction of roads are still in progress and high demand is not expected at this stage while population is expected to increase in the future.
These made it possible to function as a key transportation means with punctuality and rapidness in the elevated track segment, while contributing to the alleviation of traffic congestion. In the non-elevated segment in suburbs, it became possible to respond to flexible route setting according to the progress of development and to the extension of elevated track segment in stages for future demand increase after development.

Description of the main system components

- Overview of selected measure type
  Corridor accompanying multiple lines (Total 4 lines)
  Operation in elevated track segment only: 1 line
  Continuous operation in elevated track and non-elevated segment: 3 lines (One of them is a branched route)
  No express services

- Primary components of the system
  [Infrastructure]
  System extension: Elevated track segment: Approximately 6.8 km
  Non-elevated segment: Approximately 9.2 km at maximum (Including 3.5 km where a bus lane is constructed)
  Distance between stops: Elevated track segment: Approx. 0.5 to 1.1 km
  Non-elevated segment: Approx. 0.5 km
  Type of road crossing: Elevated track segment: Overhead crossing
  Non-elevated segment: leveled crossing with signals
  [Bus cars]
  Number of cars: 25 cars
  Type: Hybrid bus cars were remodeled according to the specifications of GuideWay bus
  Length of car: 10,525 mm
  Capacity: 70 persons
  [Implemented ITS tool]
  Elevated track segment
  For operator: Operation monitoring system
  For passengers: Bus location system
  Non-elevated segment
  For passengers: PTPS (Public Traffic Priority System)
  [Brand setting]

Route name: “Yutorito” Line
Others: Special color, special logo

● Connection to existing mobility network (Intermodality)
Target transportation means (Operators):
Subway (Transportation Bureau, City of Nagoya)
Railroad (Central Japan Railway Company, Nagoya Railroad Co., Ltd.)
Route bus (Transportation Bureau, City of Nagoya)
Related measures being taken to promote usage
· Establishment of bicycle parking near the entrance/exit of stations in the elevated track segment (4,424 bicycles)
· Establishment of park-and-ride parking at the station (Obataryokuchi Station) changing from the non-elevated segment to the elevated track segment (22 cars)
· Implementation of a transit connection discount for city subway and bus.
· Implementation of speedy boarding/exit and fare payment with the introduction of IC card tickets and sharing lines with other operators
Issues/keys in achieving high-quality intermodality
· Decrease in the sense of a high price resulting from transfer

Cost and financing sources if available (in €) - Elevated track segment
Construction cost (Construction period: 1996 to 2001) [Financial resources breakdown]
Approx. 37.5 billion yen [Government, 10 billion yen; municipalities, 23.4 billion yen; operator 4.1 billion yen]
Construction cost per kilometer [Financial resources breakdown]
Approx. 5.5 billion yen/km [Government, 1.5 billion yen; municipalities, 3.4 billion yen; operator 0.6 billion yen]
[Breakdown]
Infrastructure department cost: Approx. 32 billion yen [Government, 10 billion yen; municipalities, 22 billion yen]
Project cost per kilometer: Approx. 4.7 billion yen/km [Government, 1.5 billion yen; municipalities, 3.2 billion yen]
Non-infrastructure department cost (bus cars): Approx. 5.5 billion yen [Municipalities, 1.4 billion yen; operator, 4.1 billion yen]
Project cost per kilometer: Approx. 0.8 billion yen/km [Municipality, 0.2 billion yen; operator, 0.6 billion yen]

Operational cost per kilometer [Financial resources breakdown]
Approx. 95 million yen/km [Operator, 95 million yen]
* Based on FY 2012 financial closing

Some performance data and results

GuideWay Bus System (as of 2012)

Ridership (passengers/day)	Elevated track segment	10,282 passengers/day (Sunday to Saturday)		
	Non-elevated segment	3,772 passengers/day (Sunday to Saturday)		
Headway	Elevated track segment	Peak time (*Notes 1): 15 (buses/hour) Off-peak time: 6 (buses/hour)		
	Non-elevated segment (* Note 2)	Peak time: 8 (buses/hour) Off-peak time: 6 (buses/hour)		
Travel time				
Punctuality and delay status	Elevated track segment	Peak time	Planned required time	13 min.
			Actual required time	As planned
		Off-peak time	Planned required time	13 min.
			Actual required time	As planned

	Elevated track segment (*Note 3)	Peak time (Monday through Friday only)	Planned required time	16 min.
			Actual required time	16 min. 54 sec.
		Off-peak time	Planned required time	13 min.
			Actual required time	14 min. 19 sec.
Commercial operating speed (Scheduled speed)	Elevated track segment	30km/h		
	Non-elevated segment	Peak time	19.1km/h	
		Off-peak time	23.5km/h	
Number of accidents (/100,000 km)	Elevated track segment	0.77 accident		
	Non-elevated segment	1.00 accident		
Balance of payments	Elevated track segment	Sales revenue (Coverage from the government, etc.)	612,815,000 yen (-)	
		Sales expense	642,942,000 yen	
	Elevated track segment	Sales revenue (coverage from the government, etc.)	250,959,000 yen (-)	
		Sales expense	274,835,000 yen	

Notes) 1. The peak time is 7:00 a.m. to 9:59 a.m. on weekdays, and the off-peak time is 10:00 a.m. to 3:59 p.m. on weekdays.
2. For the headway of the non-elevated segment, the value of the segment with the highest operation frequency was presented.
3. While there are three lines for the non-elevated route, it was represented by the line with the highest operation frequency (Departing from/arriving at Nakashidami).
4. The balance of payments shows the operating profit and loss of FY 2012.
At Nagoya GuideWay-Bus Co., Ltd., which manages and operates the elevated track segment, a profit was mostly realized after the implementation of fixed asset impairment (2005); however, they have excessive liabilities.
For the cost of IC ticket introduction and renewal of cars, they receive support (subsidies) from the government and municipalities.

Success factors / strengths

GuideWay Bus System

- As the line operates in the suburb area where a large-scale housing land development is underway, the ridership is on an increasing trend, and demand is expected to increase in the future.
- Until the demand increases to a certain level, it is possible to respond in stages within the possible scope of operator's management, such as increasing the number of buses by utilizing increased fare revenue as the resource.

Barriers / weaknesses /points to monitor

GuideWay Bus System

As the applicable laws and regulations are different for the elevated track segment and the non-elevated segment, car remodeling, etc., is required to satisfy each safety standard; in addition, as the system is not diffused in Japan, renewal of cars, etc., requires high development costs, which makes it difficult for the operator alone to manage in terms of business.

Lessons learnt

GuideWay Bus System

When buses continuously operate in the elevated track segment and the non-elevated road segment, delays in the non-elevated road segment due to congestions, etc., will be passed on to the elevated track segment; if it is not possible to increase the number of buses for the elevated track segment due to the restriction of the number of cars owned or staff, it will impair the punctuality of the elevated track segment.

References and contacts for further details

Some pictures

8. Argentina

8.1 Buenos Aires : development of the BRT program called "Metrobus"

1 - Background / context

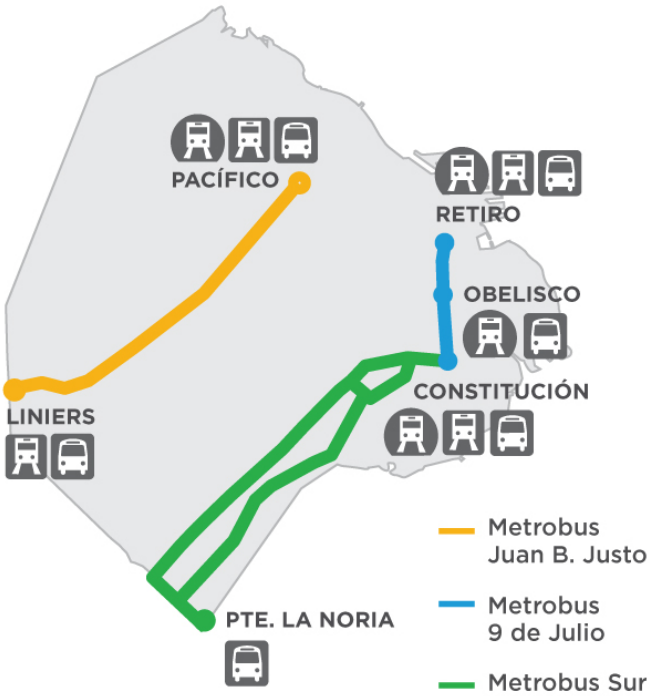
The City of Buenos Aires is facing a historical transformation that is improving the quality of life of millions of people. This transformation is framed within a sustainable mobility plan which has four key objectives. Firstly, public space is being redesigned to give priority to public transport, which it is the most efficient transport mode. Secondly, cycling and walking are being promoted together with a profound change in traffic order and safety. Last but not least, information technology is being incorporated so that people can make decisions on the most efficient way of commuting based on real time information.

Hence, a very large Metrobus program has been decided and launched in Buenos Aires.

In 2011, the first BRT has been implemented in the countryside, called Metrobus, , with an extension of 12km. It immediately achieved very good results and significant users' acceptance. As a first experience, it has demonstrated that it is possible to upgrade our traditional bus service, which transports 70% of public transport commuters per day, to a faster, safer, and more comfortable one which as well is less pollutant.

In 2013, 2 new corridors have been launched, one that has constituted a real challenge because it is located in the 9 de Julio Avenue that goes across the city's central area and represents a landmark of great significance to porteños as well as Argentineans, and because it is home to green spaces and trees that give the avenue part of its identity, bringing colour and life to it. The other corridor connects the central area with the city's south.

In only 2 years, a new passenger transport network "Metrobus" has been developed in Buenos Aires, that, at present, has an extension of 38km (graph herewith).



Metrobus: a network under expansion

Buenos Aires will launch four new corridors in the second semester of 2014 and the first of 2015.

2015 will finalise with 56km of Metrobus connecting the main transport hubs of the city.

1.200.000 people will be benefited. In 2015 it is estimated that the reduction of greenhouse gases' emissions will reach 49,000 CO2-eq tons, which represent 9% of the target set for the City of Buenos Aires.

Obelisco terminal - avenue 9 de julio

Within the framework of the Metrobus 9 de Julio, an underground terminal was created for the operation of combis (for long distance transport, without stops inside the city) that significantly alleviated congestion and benefited all combi users that have now an indoor waiting area with wifi.

- 600 combis or mini buses operating / day.

- 60.000 users benefited / day.

Before this terminal, people used to wait for the Combi were in very bad and unsafe conditions, with no protection from the rain, in high traffic flow streets, without any readability. The Terminal has significantly modified how people wait for the minibus. Now there are seats, roofs, wifi, comprehensible information, CCTV, real time information panels and better lighting.

2 - Description of the Metrobus 9 de Julio

The 9 de Julio Avenue, considered the widest in the world up to 2006 (110 meters between buildings), worked as a highway before the Metrobus: in fact it has 16 central lanes used by cars and 6 lanes at the sides for buses, cars, taxis, loading and unloading, hotels operations, etc..., so that, without any efficiency at all.

Today, there are 4 lanes at the centre of the avenue, dedicated exclusively for 11 bus lines. A public space that was a monument to the car is now a tribute to people. The humanisation of this space is quite striking. Every 10 pedestrians that walk the avenue, 4 do so alongside the centre of the avenue, where the bus stations are, and where the links between these stations have generated a new pedestrian path.

People choose this path not only because of accessibility to public transport, but also because of it is a high quality, illuminated and safe place.

This most emblematic BRT has been opened in 2013, 3,5km long, very well connected with the 5 metro lines arriving in this centre. Its description is as follows:

Description of the main system components :

Infrastructure:

length: 3,5km

Station spacing: approximately every 200 m (17 stations)

Types of road crossings: all at grade without priority at traffic lights (impossible with very high bus frequency).

Buses: standard buses, mini-busses

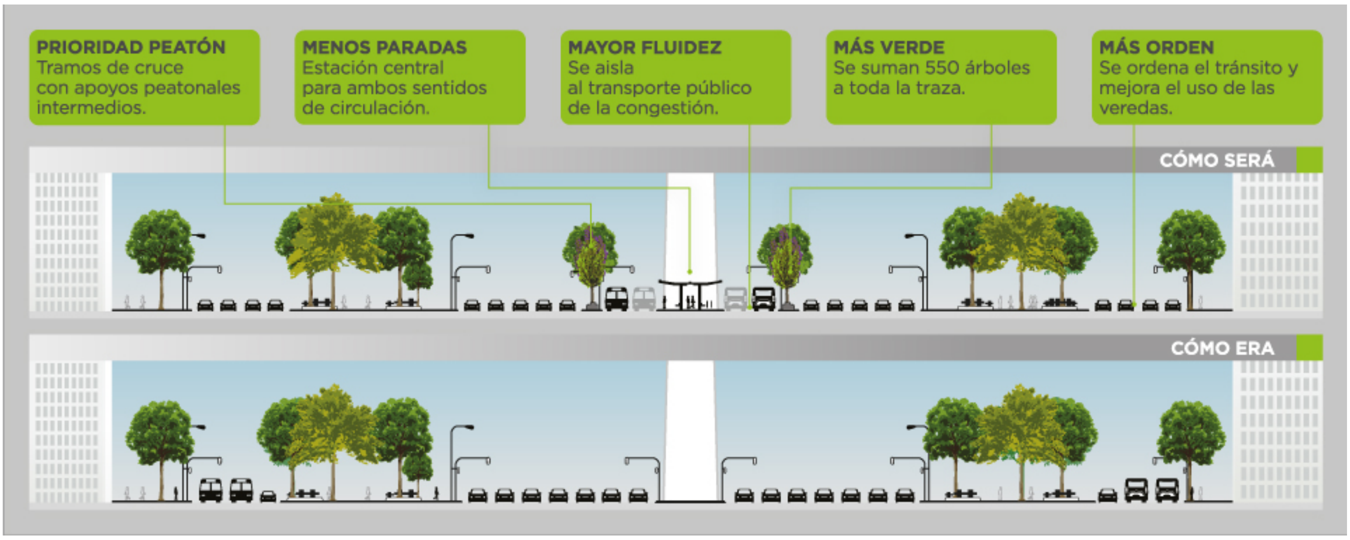
Fare collection system: classic

Priority at traffic lights: not (high frequency of busses)

Identification / branding trend if any: high identification of the infrastructure and all shelters (same specific design, with a high comfort)

The cross section of the avenue 9th of July, before / after the Metrobus project:

before the Metrobus	with the Metrobus
Central Section In each side: 8 lanes of 3,20 / 3,30 meters width Lateral Streets: Bernardo de Yrigoyen/Carlos Pellegrini and Cerrito/Lima Each Street; 3 Lanes of 3,10 to 3,20 width Total: 11 lanes in each direction.	For buses In each side: 2 lanes of .... meters width For cars In each side: 5 lanes of 3,20 meters width Depending of the geometry there are in some places, sections with 6 lanes or 4 lanes (see Photos) Lateral Streets: Bernardo de Yrigoyen/Carlos Pellegrini and Cerrito/Lima Each Street; 3 Lanes of 3,10 meters width and one lane (parking lane) of 2,50 meters. Total for cars: 8 lanes in each direction and 2 lanes for parking..



Cross section after / before - Metrobus "avenue 9 de Julio"

In total, 4 car lanes have been removed from the centre to each side, so that the capacity can be maintained, with a much better efficiency for buses.

Intermodality with the existing mobility network:

This system is connected with 5 metro lines.
Taxis and "collectivos long distance" are not allowed to ride in the central bus dedicated corridor, but are well in the underground connection (Obelisco terminal), into a dedicated location.

Cost and financing sources if available :

Even though the City Government has credit lines available with International Agencies to afford several Infrastructure enhancement projects, the Metrobus 9 de Julio Works were paid with current resources from the City Budget. There is an additional source of funds with the contribution of AUSA, an autonomous State-run Company, which uses the City Highway Toll collection and which has been responsible, in part, for all the made works. According to published data, the Total Work investment, including the Combis (Minibus) Underground Station, has amounted to 19.5 million US dollars. In addition, the cost of the works in progress for the construction of Constitución Hub tunnels is estimated at 12.7 million US dollars.

Some performance data and results :

Capacity of this Metrobus system
200 busses/hour/2direction with 11 different lines, 200 000 passengers / day along this central corridor.
Environmental impact
Metrobus "9 de Julio" reduces emissions of greenhouse gases. It cuts 5,612 metric tons of CO_2 equivalent per year, which represent the emissions of 4,300 cars or 65 buses in a year.
Groups benefited
The 9 de Julio Avenue used to cater for the majority of north-south traffic flow across the city's central area, an area which is a hub for employment and administrative, financial, judicial, commercial and educational activities. The reorganisation of traffic flows across the avenue generated a positive impact for all actors in the avenue.

- Pedestrians: before, the avenue of 20 lanes used to be a barrier for pedestrians. Now, it can be crossed in more steps and there are pedestrian boulevards in-between. In addition, the project has created a new pedestrian path between stations.
- Public transport: travel time was reduced from 55 minutes to less than 20.
- Taxis (cabs): their activity shows an improvement since the lanes next to sidewalks are now free of buses.

- Combis: Combis are like shuttle mini buses, privately operated, that used to share lanes with buses, cars and taxis, and were an obstacle to traffic flow when loading and unloading passengers. Within the framework of the Metrobus, an underground terminal was created for the operation of combis that significantly alleviated congestion and benefited all combis users that have now an indoor waiting area with wifi.
- Private cars: traffic flow also improved, since there is an additional lane at each side of the avenue, cars are separated from buses, combis do not park in the area anymore, and some traffic turns have been eliminated, all of which meant that travel time went down from 40 to 27 minutes.

Success factors / strengths:

- dedicated lane well protected, only buses are authorised
- dedicated lane implemented into the centre of the Avenue: not disturbed by lateral traffic
- Respect of the dedicated lanes
- wide platforms of the passenger waiting space
- connection with all metro lines
- Alternative connection between the two main Retiro and Constitución Railways Stations, which complements the connection of the existing metro line.
- Removal of bus traffic along the central area, now with a priority use for pedestrians in coexisting streets.
- Improved safety in pedestrian roads, particularly in the Avenue crossing with 16 lanes.

Barriers / weaknesses /points to monitor:

- Difficulties to convince the stakeholders by the feasibility of removing of 4 car lanes
- Traffic flow significantly affected, particularly with the removal of left turns from central roads.
- Removal of central traffic islands which were important green spaces with different types of trees.

Lessons learnt:

- Efficient operation in organised bus transport, although traffic direction was changed to the left in exclusive lanes after building central platforms for bus units with right access only.
- By moving trees and planting new species the public space was offset and improved, thus complying with the demands of the current environmental impact laws.
- The total capacity of 9 de Julio Avenue, in terms of traffic direction, was not affected, even though part of the central roads has been used for the Metrobus infrastructure to improve traffic direction flow.

References and contacts for further details:

http://movilidad.buenosaires.gob.ar/metrobus/metrobus-9-de-julio/

Some pictures :

	
Metrobus on avenue 9 de Julio, 3km long	Metrobus on avenue 9 de Julio, 3km long

The avenue 9 de Julio, before the Metrobus

	
The Metrobus "Juan B Justo"	The Metrobus "Sur"

9. Chile

9.1 Santiago

Background / context

Area of the Metropolitan Region of Santiago :

- Inhabitants : 6.771.964 (2012)
- Surface : 15.391 km2 (Santiago city = 1.258 km2)
- density : 439,9 inhab/km2

Modal shift :

- public transportation : 32,9%
- cars : 22,1 %
- bicycles : 39,7 % (with walking mode)

The BRT program has been introduced in 2007. It is a Public Transportation System of Santiago City, which integrates the 100 % of buses of the city in tariffs and geographical coverage of all the city.
The system is managed by private companies, these are divided into business units, which reach the different areas of the whole city and with the underground METRO. The medium of payment for buses and METRO is an electronic card named BIP.

System problems:

The lack of coordination of the urban mobility comes since 1970, when the first METRO line were built. This system was managed by the public operator named MOP, in those years the private Buses Association, was created, and then during the 80´s was consolidated, so that, in those years we observed a mix of private and public entities managing this system.

Actions to have been solved:

In 1980 the public services of passengers were regulated, and it was given to private companies for its management, the colors of buses were white and yellow, and the buses were registered in the SEREMITT transportation service register, increasing the number of environmental and operational requirements.

The small private buses owned by small entrepreneurs disappeared, then a new system which connected buses and underground was implemented METRO+BUS, which offered a discount in the integrated tariff of buses and METRO, this was the first attempt of integrated system.

In 2003, the first foreign companies arrived to the country to operate METRO+BUS system, and began to take shape the basis for bidding Transantiago.

Since 2007, started the structural change of the public transport in the Metropolitan Region of Santiago.

The System remained under the Ministry of Transport (MTT), through the Coordination of the Transantiago, which integrates the 100% of the system physically and its prices, of the companies managed by privates and the Metro of Santiago.

One of the most important changes in the daily lives of the Santiago citizens, was the implementation of the **BIP electronic card.**

In some words the BRT program has structured 3 groups of corridors, as follows:

- Group 1:Corridors of buses , 67 km (several lines, how many, or single route on the corridor, presence of express services)
- Group 2: Mixed corridors with performance measures, 16 km (run by several privates companies, and supervised by MOP)
- Group 3: Corridors with a projected section, 19 km

Main bus Corridors :

a) Alameda , betwen Pajaritos and V. Mackenna

b) Providencia, betwen V. Maclenna and Tobalaba.

c) Lo Marcoleta, betwen Lo Etchevers y Ruta 5 Norte

Description of the main system components :

Infrastructure:

Length: 2.766 km (Road network covered by buses)

Segregated roads : 62 km (2012) increased 67,7 km (2013)
Exclusive roads : 31 km
Bus only lanes :119,3 km

Station spacing: approximately every 500 m

Types of road crossings: all at grade.

Buses: 6.298 (year 2012) - 6.516 (Dec. 2013), Articulated buses number: 1.435 (22%)

Fare collection system: with the **BIP electronic card**

Average transactions of a labor day: 3,2 million

ITS tools implemented (for operator, passengers,…):

- Monitoring cameras: 110 units- 165 units (year 2014)
- BIP electronic card, it has 1.667 distribution centers and load.
    - BIP card no personalized
    - BIP card personalized, with name and identification of the passenger and photo
    - Student card
    - Bank card with the passenger name on it.
- Web page (Google maps, public transport), cellular phones (***moovit*** program), cash machines, banks, etc.
- General maps, maps of companies (pdf, jpg formats) to plan the travel for the passengers.
- It is the instrument that define and rules the conditions and features of the public transportation that the privates companies must follow.
- Code identification and names, detail of routes, transportation capacity, frecuencies, capacities, distances , speed, etc.

Identification / branding trend if any: no "BRT" identification.

During 2012, operating programs suffered various modifications, service were expanded and modified, where some were merged and created new services, resulting in the reduction of transfers and more similar to user´s needs or passenger routes.

Intermodality with the existing mobility network:

Objectives of the Ministry of Housing and Urbanism- MINVU:

- Densification around to Metro
- Approximately of 1.035 ha
- Density of 80 house per ha as maximum
- Less than 600 m of infrastructure of transportation
- Areas of development: Metro of Santiago city, Metro train of Valparaiso city, Train of Concepcion Biotren.
- Net of Metro: Area of 278 ha; 8.640 houses; 18.711 normal houses; Additional houses: 19.182- 33.082 to 46.982.
- Structuring roads: Area of 1.035 ha; 25.429 houses; 71.897 normal houses; Additional houses: 77.625- 129.375 to 181.125.

Cost and financing sources if available :

Average total investment cost per km: 10- 12 US $millions

- Infrastructure: Year 2011-2015: MM$CH 789.264 / MM$US 1.411.315
- Vehicles: Cost is assumed by the 7 privates companies

Some performance data and results :

- Decrease of accidents, declines by 70 % since the implementation in the year 2007.

Year	Number of accidents
2007	6.366
2012	1.903

Source:www.mtt.gob.cl

- Reduction of CO2 emissions from buses by 29% since 2007. Over 90 % of the buses comply with the Euro III standard.

- The implementation of Transantiago decrease emissions of breathable particles (PM10) and nitrogen oxides (NOx). The renewal of the fleet, improved fuel quality, incentive programs of energy efficiency, has made public transport bus stops being the largest source of PM10.

- The system has 6 intermodal stations working.

- Renewal of bus fleet, in 2010, 961 new buses were acquired. (Old buses 2007 51 %, in 2009 32%, today is 4%)
- Improvement of stop zones, in 2007 had 9.397 without minimum infrastructure and efficient lighting. Nowadays there are 11.165 , 9.767 with infrastructure, and 3.246 with solar lightening.
- Decreased financial deficit in 2009 there were $CH 395.251 million, in 2012 to $CH was 340.295.

Success factors / strengths:

- Electronic card BIP, model of payment
- Improvement of the environment
- Agreement with Metro
- Technology innovation
- Contract signed and regulation of the systems
- Increase safety, dismiss crime
- Streamlining buses
- Better working conditions for drivers

Barriers / weaknesses /points to monitor:

- Infrastructure
- Empowered Institutions
- Transfers
- Reliability and forecast travel times
- Evasion, not to pay passengers
- User information

Lessons learnt:

- To build adequate infrastructure: corridors and exclusive lanes
- To set a period of time for test these plans, it could be by sector or in small towns
- To incentive the number of passengers carried in contracts
- To incentive to the passengers to use the public transport
- To detect user needs
- To improved control
- To develop and integrated system with Metro and trains
- Decrease transfers
- To improve the comfort of the users

Projects must be approved by all the stakeholders
Projects must be add value to the city

References and contacts for further details:

<u>Bibliography/ Source/ internet link:</u>

- MINVU (Ministry of Housing and Urbanism)
- (*) www.INE.CL (In review 2012)
- Ingrid Loevel. MTT, loevel@dtpm.gob.cl
- Nelson Arriagada, MTT, nelson.arriagada@dtpm.gob.cl
- Jose Ramon Ugarte, MINVU , rugarte@minvu.cl
- Francisco Baranda, Seremi MINVU: fbaranda@minvu.cl

Some pictures :

Corridor continuity and exclusive lanes Santa Rosa

Corridor continuity and mixed road Departamental

Only bus lane Alameda of Santiago

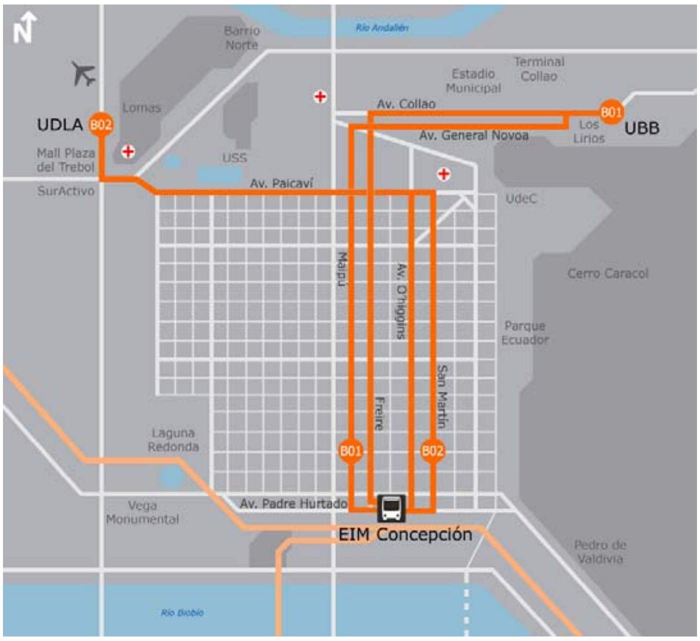
Only bus lane in Santiago downtown

Mixed roads Lo Espejo

9.2 The Biobus in Concepción

The City of Concepción is the entrance gate to Southern Chile and the capital of the Bío-Bío Region. Having a population of almost 370 thousand inhabitants, this city is constituted as one of the most important centers of financial, commercial and tourist services in the country.
It is surrounded by Mount Caracol, the Andalién and Bío Bío Rivers and the Pacific Ocean.

Biobús es una red de buses integradores, que operan en el Gran Concepción. Fue diseñada para optimizar el uso del Biotrén, permitiendo cubrir zonas alejadas de la línea férrea mediante la combinación con buses en las Estaciones de Intercambio Modal (EIM). Éstas son: EIM El Arenal, EIM Concepción y EIM Chiguayante.



The biobus sub-urban network planed in Concepcion

Some photographs regarding this on going BRT projects called "Biobus" :

	
Oneway central dedicated lane. Ticketing system : manual payment at the driver, according to the distance	Bus entrance into the central dedicated corridor

	
Two ways well protected , implemented in the centre	The stop is requested by waiting passengers

Type of mini-bus implemented for the Biobus network

9.3 Bus stations on the "Pan-American" motorway

Some photographs regarding the frequent bus stations along the motorway "Pan-Americana"

The stops on the motorway are generally implemented near a pedestrian bridge

	
A stop with a shelter	A stop without shelter