||Certu

Bus with a High Level of Service

Concept and recommendations

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**Centre for studies on urban planning, transportation,
and public facilities**

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CERTU could not be responsible for any misunderstanding or translation mistakes and will be very interested for any comment or suggestion..

Thanks

This report was ordered from Certu by the Sea and Transportation Department of the Ministry of Equipment, Transportation, Housing, Tourism and the Sea.

It was drawn up by a working group led by François Rambaud and Christian Babilotte (Certu). The partners involved in the project included GART, UTP, INRETS, the CETE of Lyon, Metz, Nantes and Aix, the RATP and the metropolitan areas of Rouen, Nantes, Lyon, Grenoble, Nîmes, Lorient and Evry (organising authorities and/or transportation operators). The list of the group's members is included in appendix.

The whole group took part in the reviewing of the document, especially Odile Heddebaut and Claude Soulas of Inrets, as well as Maryvonne Dejeammes of Certu.

Foreword

More than thirty years ago, the Government became very actively involved in the development of services and the use of urban transportation systems and their renewal by taking part in defining new transportation systems adapted to the differing needs of urban areas and their population sizes. The "new" urban tram, originally designed for urban areas with less than one million inhabitants, made its first appearance in the Nantes urban area in January 1985.

Until 2003, the Government made major contributions to the development of most of the urban public transportation networks with a particular focus on RLPT (reserved lane public transportation: metros, trams, reserved-lane buses, etc.) and favouring those that led to a better sharing of the road system, with financial aid in proportion with the socio-economic importance of the projects involved.

The Government was particularly attentive to identifying the lessons to be learned from the implementation of these transportation systems, with a focus on follow-up studies and also to the development of exchanges and thinking on their impact and effects. The Committee for the Development of Reserved Lane Public Transportation (RLPT - TCSP) was established for this purpose.

The reintroduction of the tram in French cities was a response to real needs in satisfactory economic conditions. It is not just a form of transportation that is highly appreciated and efficient, it is now also recognised as being one of the best vectors for urban transformation.

French urban areas of all sizes are now becoming more and more interested in reserved-lane public transportation projects, while the constraints affecting public resources suggest the need for a finer tailoring of supply to demand, while meeting the service quality needs of users of public transportation.

In targeting this quality objective, which is an essential factor in the choice of public transportation as a means of travel, the tram on standard rails is no longer the only option available to transportation authorities. New reserved-lane systems in between classic buses and trams on rails are starting to appear.

The main issue is then, "How can we, with buses, get closer to the service quality levels of rail transportation systems?" In the past, with surface road and rail reserved-lane transportation projects eligible for Government subsidies, the first answers to this question appeared with the projects of Nantes, Clermont-Ferrand, Montpellier, Rouen, Lorient, etc. While some were the precursors of tram lines, others remained reserved-lane road systems.

The lesson learned from these experiences was that, beyond the choice of the mode of transportation, it is the quality of the transportation service that is essential. Bus transportation services can reach this service quality level if this is the priority objective for the project.

While the French Government no longer contributes financially to investment in urban public transportation, it continues to pay special attention to this sector because of the national importance for sustainable development and for meeting the mobility needs of citizens in economic conditions that are satisfactory for the areas involved. For this reason, CERTU was assigned the mission of specifying the elements involved in defining bus services offering very good service quality and the development of the methodological principles for their implementation.

This document is the fruit of many exchanges between the various actors of the transportation sector (GART, UTP, INRETS, AOTU, Operators, etc.) within a working group led by CERTU.

Patrick LABIA

Assistant-Director for rail and public transportation services

GART has been working on the High Level Bus Service concept for several years now, giving elected officials examples of foreign systems, particularly that of Curitiba, in Brazil. In September 2003, GART organised a day of talks on this subject with foreign participants who had come from London, Dublin, Bologna, and Switzerland, and also the organising authorities of Dijon, Lorient, Lyon, Rouen, who, in France, are pioneers in this field.

The idea progressively gained favour and more and more actors took an interest in this reserved-lane system involving efficient bus operation and involving investments and operating costs per kilometre that are lower that those for trams, but offering the same "structuring" qualities for networks.

The High Level Bus Service concept is based firstly on service quality, which users of public transportation evaluate based on regularity, frequency, and rapidity, all essential elements in the efficiency of transportation systems. For us, the BHLS is not a tram substitute: it is a type of reserved-lane public transportation that is appropriate in its own way.

The Ile-de-France led the way with the Evry reserved-lane system, reserved lanes for the 183 bus, then the Trans Val-de-Marne. More recently, the Mobilien network of the Urban Transportation Plan revamped this concept, focusing more on service quality than on infrastructure.

Beyond the Ile-de-France, Dijon has been a pioneering city in this regard. More recently, Rouen opted for optical guidance, allowing for accurate and systematic docking: it was developed initially for the CIVIS, but was easily transposed to normal buses. The urban integration of this RLPT was done with particular care. The example of Rouen is very well-known, even abroad, and has become a model. The system was very well received by the population, and the process demonstrated that the public's expectation was less an issue of infrastructure and type of equipment and more one of supply and coherence of the transport system. Lorient, a city often cited as a pioneer in transportation management, also undertook an ambitious urbanisation project based on an efficient reserved-lane bus network.

The stopping of Government subsidies to organising authorities for the development of their RLPT stimulated interest in the BHLS, as local authorities sought efficient solutions that were less expensive than a tram, or which could foreshadow the building of a tram line with larger capacity at a later stage.

We should be happy about the emergence of a French-style BHLS, if only because it marks the return of an idea that was born in our country and went on – as is often the case – to enjoy great success elsewhere before being adopted here. It shows that RLPT is part of a whole range, metro, tram, BHLS, and that the image of buses or trolleybuses can be revamped with developments to make them efficient, with real reserved lanes. This type of RLPT could also be of interest to the smallest urban areas.

The task of the working group brought together by CERTU with initial support from GART, revealed that, beyond mere fashions, there is a real need to establish transportation systems that are efficient as a whole. Thus the BHLS is less an issue of vehicle type than one of the organisation and designing of a transportation system, following the example of a tram, with the different sub-sets forming a homogeneous whole. The approach in terms of the arrangements to provide accessibility, safety of reserved lanes, efficiency of exchange poles, passenger information, and the validity of inter-modal tickets, must be identical, whether for trams, buses or other new types of equipment, and should enhance the efficiency and coherence of the transportation system.

In a context of financing difficulties, what is needed are public transportation solutions that offer flexibility - in terms of time and in the event of incidents - and performance. The fight against the greenhouse effect and the concerns about sustainable development require that we seek innovative solutions adapted to the diversity of the contexts involved: the BHLS is one of these and it will certainly see many developments.

Chantal DUCHENE
General Director of GART

The bus is a strong symbol of cities and the emblematic vehicle of public transportation. Since the time of its appearance and then its development in the 1950's, it has evolved considerably, adapting to the changes in cities and in mobility practices. In order to better meet the various needs, it has been diversified. It has made substantial progress in terms of accessibility, especially for people with reduced mobility, and more generally in terms of comfort and passenger information. There has also been progress for the environmental quality of vehicles. Despite these changes, buses have lost their attractiveness. They are the victims of worsening driving conditions in city centres and a bad image.

In the 1990's, in an attempt to improve the performances and the image of buses, substantial work on diversification of services and their hierarchy was carried out in many networks. Main lines appeared, associated with secondary lines, and also city centre shuttles and express lines for "periphery – city centre" links with, in some cases, the use of special bus lanes and reserved areas.

Today, with the "hyper-capacity" lines developed in Latin America in cities such as Curitiba and Bogotá and with those developed in North America for the "Bus Rapid Transit" (BRT) concept, new possibilities for buses are opening up. The quality of the infrastructure (reserved lanes, priority at traffic lights, stations, etc.) allows for a significant improvement of the performance level of the bus service (accessibility, speed, capacity, flow, etc.).

In Europe, public transportation operators are also very interested in these new style bus lines. Such projects are underway or in planning in several urban areas in France (Rouen, Lyon, Nantes, etc.). As the results of a recent UTP study indicate, the development potential is high: 22 urban areas offer services that could evolve towards "high service level" lines.

These first experiences should help guide the thinking that is going on today. The return of buses to the forefront of urban transportation modes will require consideration of the system as a whole. It is therefore important to go beyond the habitual distinctions in terms of infrastructure, rolling stock, information systems, marketing, and accessibility, etc.

The work done by Certu and its partners (Organising Authorities, urban transportation operators and government services) is very encouraging in this regard. It promotes a French "BHLS" concept inspired by BRT but taking into account the specificities of European urban areas. It highlights the fundamental points of "BHLS", which have a significant effect on the quality and the level of service offered to public transportation customers (reserved lanes, traffic priority at crossings, station spacing, etc.). The thinking carried out benefited substantially from the experience of urban insertion and the renewal of the image of public transportation inherited from the return of the tram to France in the 1990's.

The diversity of French urban areas and their needs in terms of mass transportation calls for very different approaches. That is why, beyond the general concept of

"BHLS", local actors could develop and label their own projects adapted to their situation (population, density, geography, spatial organisation, etc.), thereby offering a renewed transportation service capable of satisfying the ever-growing mobility needs of city dwellers in a context of increasing constraints on automobile travel.

Thierry Soupault
General Delegate of the UTP

Introduction

Unlike heavier modes of public transportation, trams in particular, the image of buses has not changed much. Buses also offer potential advantages, of which flexibility is often mentioned. However, it is very often this flexibility which is used against it and which dilutes its efficiency. Bus manufacturers have been constantly innovating in terms of equipment and operating and information facilities thanks to the progress with computers and communications, but all these developments are not sufficient to ensure the desired effects unless they are part of a comprehensive bus system approach including infrastructure, urban insertion, etc. The image of buses is still too often negative with decision-makers, even though some projects have enhanced their image.

Responding to a request from the field, Certu, under the auspices of DGMT, brought together a working group with the objective of developing this High Level Bus Service (BHLS) concept, a methodological and teaching tool that also seeks to highlight the key points or minimal requirements for the success of an efficient and structuring bus project. "Bus" in this case means a means of road transport to be considered in its broadest conception, guided or not, thermal or trolleybuses, vehicles of classes I, II or III. On the other hand, modes of transport that must permanently follow a trajectory determined by a physical rail or rails and which use the roadway[1], are not taken into account in this approach.

This idea of developing a national concept gradually came into being with various needs studies and regulatory changes for the urban insertion of tram projects (chiefly with the networks of Nantes, Grenoble, Lyon, Bordeaux, etc.). The twenty-year period of the tram's revival, closely linked to its infrastructure, has established a new dynamic. Its first success quickly brought it a very good image and many of the projects that followed went on to innovate further in terms of urban integration, crossings at intersections and sharing of the roadway. Physically separated sites are no longer the only option. When guided systems with tyres arrived, the issue of their regulatory integration had to be addressed, along with the choice of the type of signing to be applied to them. To simplify and facilitate the requirements in the event of sections used jointly by several types of vehicles, the idea was then to abandon the strategy by type of rolling stock and to seek signing by the type of site. Buses, guided or not, could then be integrated like trams and thereby offer a High Level of Service; the BHLS concept then emerged. And couldn't the "BHLS" vehicle also have priority like the tram? And why not allow tram projects to integrate the BHLS systems that will be developed? Shouldn't we speak of high quality surface public transportation, following the example which is being developed in certain cities in Germany?

The growing demand and the strong mobilisation that we are seeing to revive buses shows that the tram is no longer the only option for structuring and developing networks. Observation of what is happening abroad, on the American continent (Curitiba, and then the BRT approach that was largely inspired by it - Bus Rapid Transit – in the United States and Canada), and also in Europe (Stockholm, Dublin, Geneva, Rome, etc.) is certainly a factor in this new enthusiasm, without forgetting that foreign experiences cannot always be directly transposed to the French context, and also that several recent French initiatives significantly enhanced this thinking.

[1] Definition of guided modes for which car traffic regulations do not apply (article R 110-3, modified by the decree of 9 May 2003 on public guided transportation systems).

Our BHLS approach is based on technical and functional considerations and is not connected with the recent constraints on public financing. The building of TEOR in Rouen and other thinking such as for line 4 in Nantes occurred before the arrival of these new constraints. We can certainly say that, theoretically, the BHLS should be less expensive than rail trams, but the latter involves different solutions with generally greater capacity. The working lives of the vehicles are also quite different.

This publication will help people working in this sector to get a better understanding of this abstract idea. When applying this concept on a local level, it is important to follow what we call the "system" approach[1]; this was favoured for the development of this concept, and it allowed us to assemble the messages that were considered to optimise the clarity and the efficiency of the projects, especially the taking into account of infrastructure and the physical links with the urban environment.

The process involved two approaches, one theoretical, involving a presentation of the essential characteristics of a high level of service for buses, the other, more operational, which drew on the results of French and foreign experiences and which is cited in section 9 of this document and in a more detailed manner on the site "www.BHNS.fr" which is now under construction.

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The logo of the future site[2]

BHNS
Bus à Haut Niveau de Service

[1] In reference to the approach described in the document "Modes of urban public transportation, *Elements of choice through a comprehensive systems approach"*

[2] In colour in section 9.17

Warning

High Level Bus Service should not be compared with the tram mode. These two modes should be seen as technically different solutions that are sometimes complementary (They do not have the same potentials).

The High Level Bus Service concept is just another tool made available to urban public transportation planners. According to the situation, it can be added to another structuring mode or it can be the sole structuring mode of a network.

The BHLS concept is not a rigidly set concept. It will evolve and be enriched by new experiences. We hope that the thinking carried out for the BHLS will also lead to evolutions for the tram approach and lead to a "High Service Level Public Transportation" concept.

Contents

1. Definitions and objectives of the BHLS concept

1.1 Definitions

A concept is a construction of the mind to make explicit a stable set of common characters designated by a verbal sign, in our case “BHLS.” The BHLS concept thus remains an idea or abstract image, made concrete by a set of common characters describing a High Level of Service.

A label is a distinctive brand created by a union of producers or an official organisation, which is put on a product “on the shelf” to guarantee its origin, the manufacturing conditions, qualities, etc.

Our objective was limited to the development of a concept, without seeking to formalise one or several “BHLS” labels on the national level. The local contexts are so different that it seems more coherent to leave room for the emergence of varied configurations. It is on the local level that the best strategies should be sought with inspiration from the recommendations of this concept.

Definition of the BHLS concept:

BHLS is a public road transportation concept for the structuring services of the network that meet a set of efficiency and performance criteria, coherently integrating stations, vehicles, circulation lanes, line identifications, and operating plans in an on-going manner.

“Bus” in this case means a mode of road transportation to be considered in the broadest conception:

- A vehicle that does not have to permanently follow a path determined by a physical rail or rails and that uses the roadway,
- A standard, articulated or semi-articulated bus (class I, according to Geneva regulation n°36 of 20-03-1958)
- A thermal, electrical (trolleybus type for example), or hybrid motorisation
- A bus or coach (Class II and III).

The BHLS seeks to come close to the comfort of rail transportation with bus type infrastructure. Its layout design (right of way, lanes, crossings, stations) does not exclude the possibility of future construction of a tram on the same site.

In appendix, readers will find the many definitions of the BRT (Bus Rapid Transit) expressed in a pragmatic and open approach developed in North America, in the United States and Canada.

We certainly drew on this BRT approach in building our BHLS concept. In particular, it likewise seemed wise to choose a flexible and less framed approach to allow for the development of road transport potentialities as a function of the contexts encountered. We sought to promote the search for the best BHLS strategies and configurations, without forgetting the necessary coherence with those observed for the tram modes.

We are not forgetting our differences. The American urban context is often very different from ours: many wide highways and urban development with more space.

The idea of the concept and its logo seeks to stimulate communication between all of the actors involved in such an approach.

1.2 The objectives of the “BHLS” concept

1.2.1 The general objectives

The objectives targeted in developing the BHLS concept on the national level are as follows:

A comprehensive approach to the system is not so simple when the idea is to make it a real design principle

- Promoting a “system” approach, rarely implemented for bus-based services.
- Responding to the need to enhance the image of bus networks. Even though the projects that emerge have varied configurations, they usually involve “structuring” bus lines, which generally have the highest capacities.
- Supplying a methodological and pedagogical tool to decision-makers and to the many partners involved. A comprehensive approach to the bus system will allow for the building of a coherent and efficient set of arguments, opening the way to constructive developments through consultation.

The BHLS should be considered as a surface RLPT in its own right.

- Allowing the organising authorities to adapt this concept on the local level in order to establish a long-term “Bus” and “coach” policy in urban planning studies.
- And lastly to make credible the existing and future innovations of the vehicle on an economic level.

1.2.2 The strategies

With reference to the knowledge acquired in the tram projects implemented recently, the following strategies were identified for the development of this BHLS concept:

Transposing the good practices of insertion signing from the tram to the BHLS.

The "identification" dimension should be integrated into the comprehensive system approach

- Capitalising on the major efficiency principles observed in the tram projects, particularly infrastructure integration principles.
- Promoting exchanges of practices and experiences between the various actors, and taking an analytical look at what is going on abroad.
- Modifying regulations and signing for surface reserved lane systems; promoting signing by type of site, and not by type of rolling stock: in particular, the BHLS could perhaps also benefit from the crossing signing used for trams, or from having priority with respect to all of the other modes. Integrating the problematic of coaches from outside of the urban area. They also serve urban centres and can be involved in the use of reserved lane systems, rapid urban lanes, or through the integration of dedicated roads within a new road project.
- Integrating the problematic of reserved-lane projects shared by several lines, without establishing a hierarchy of service levels between them. This measure does not exclude the possibility of creating a hierarchy of the system at a later time.
- Not seeking competition between trams and BHLS but rather stressing their differences and their complementarity, even if there is some overlap. The idea is to broaden the line of "transportation" products to better meet the needs of urban complexity and the variety of the contexts involved.
- On the local level, promoting a strong personalised identification of the "BHLS" service.

1.2.3 The finalising of the concept on the local level

The "BHLS" concept remains a theoretical and pedagogical approach. It includes the recommendations of many specialists in the field. It should be kept flexible, allowing for local variations based on the contexts of the projects to be carried out.

On the local level, different terminology must be found and adapted to the configuration to identify the particular BHLS project and to communicate regarding the new service offered to users.

The identification of the service is a crucial factor. It is the role of the local authorities to define its modalities, for which we offer some orientations in this document.

1.3 The actors of the BHLS project

As for any surface transportation project in an urban environment, the BHLS projects will involve many actors. The discussion involved becomes more difficult and time-consuming when the stakes involved in the new sharing of the roadway are high in the area involved. The discussion can be more difficult than for a tram because of the vehicle's capacity to circulate outside of the BHLS reserved-lane system.

For non-guided BHLS

We can cite the following actors, although these may vary as a function of the institutional or partnership context:

- The organising authority for urban transportation, the initiator and principal in the process. Depending on whether it is a municipality, a SIVU, a SIVOM, a community of towns, a metropolitan or urban area, or a mixed union, of SRU-type or not, and depending on its powers, it may or may not have the capacity to alter the road system, traffic and parking;
- The operator, the specialist partner leading the way on a practical level, will be in charge of the future operation as well as the marketing for the new network. He may also act as a project coordinator for the organising authority;
- The local authorities (municipalities, communities of towns, urban communities or the department) and their services or agencies in charge of urbanisation, development and management of roadways;
- The Government and its services for the management of national roads, the approval of road vehicles or as a regulatory authority or technical advisor (particularly in the case of regulatory changes);
- Operators of urban express roads or motorways, if applicable;
- Economic or professional private transportation actors involved in changes in traffic plans;
- Users' representatives, environmentally-friendly modes, local residents, etc.;
- Emergency services affected in the new traffic plans.

The experience of many tram projects has helped build a solid body of knowledge for carrying out surface projects in which the infrastructure modifies the sharing of public areas. BHLS projects will be able to take full advantage of this. A new challenge is to be expected however, that of informing the actors involved of the fundamental features of this concept and providing training.

Contrary to some trends for trams, where in French cities the design of the equipment or the renovation of the new neighbourhood is primordial in communications, the transportation service level could be highlighted for the BHLS (as could also be the case for tram projects).

For BHLS with guidance integration

In addition to the actors mentioned above, there are those introduced by the decree of 9 May 2003 on the safety of guided public transportation, such as approved organisations or experts, Government technical services, etc.

"Immaterial" guidance (the case of vehicles that do not always have to follow a path determined by one or several physical rails and which use the roadway) or "disconnectable" mechanical guidance introduces the obligation of simultaneously meeting 2 regulations (road regulations and the decree concerning the safety of guided transports). Compared with a tram project which is always guided, the technical and regulatory constraints are different: there is a need to manage interfaces and to seek a synthesis of the standpoints of both regulations. The experiences of the cities involved (Caen, Nancy, Rouen, Clermont Ferrand) allowed for the testing of this new regulation and the organisations established were found to be satisfactory.

With reference to the decree concerning the safety of guided transport, the intervention of Government safety services for immaterial guidance will be limited to the guidance system; it will not involve the system as a whole.

2. Considerations on the level and the quality of Service

In order to help readers appreciate these two notions of service quality and level, which are sometimes hard to distinguish, we can give the following comparison as an example:

> A bus line with a frequency of 20 min offers a level of service which is poorer than a bus line with a frequency of 3 min, although it might offer much better service quality if its regularity is much better. In fact, irregularity can lead to the bunching of buses. The number of buses is then the same, but they are very poorly divided in space and time. Then the service quality has deteriorated.

Below, the first two sections present what we mean when we speak of service level and service quality.

The third section synthesises the many expectations of passengers. They apply to the whole transportation system.

The last section is a reminder of the value of integrating the monitoring of service level and quality objectives within the operating contract.

2.1 Notion of service level

The level of service refers to the quantity of services offered. Frequency, vehicle capacity, and vehicle commercial speed are all important factors in the service offered, but they are by no means the only ones. There are also:

- The service span (or schedule amplitude),
- Comfort, safety,
- Accessibility,
- Connection to the rest of the transportation network and other modes,
- Related services, etc.
- …

The High Service Level of the BHLS thus refers to the highest capacity bus mode services, which are also called structuring services for the network involved. But of course it is inconceivable to avoid consideration of service quality when planning to increase the service level (the quantity of service).

We will also use the term BHLS, or CHNS (high level coach service) for pole-to-pole or inter-urban links. Their high service level is relative and should be considered in relation to services of the same type, i.e. generally with lesser frequencies.

2.2 Notion of service quality

Providing a high service level is inconceivable without aiming for high service quality. Some of the service quality norm criteria will thus be preponderant for the BHLS.

Service quality involves service fulfilment. The notion of service quality is used to describe and qualify the differences between the scheduled service and the service as it is perceived by the client. Service quality describes the factors that influence passengers' perception of the quality of their journeys and provides quantitative methods for the evaluation of these factors.

This notion of "service quality" encompasses the point of view of passengers, with respect to an "objective" reference level.

Since June 2002, the European norm,

NF EN13816 "Public transportation of passengers – service quality"

defines this notion of service quality applied to passenger transportation. This norm identifies numerous criteria, and it constitutes a reference tool for measuring the quality of the service with respect to a reference situation; its principles are summarised in appendix 13.3.

The French law of 11 February 2005 concerning equal rights and opportunities, the participation of and rights of handicapped persons, stipulates that the transportation system, which includes infrastructure, roadways, arrangement of public spaces, transportation systems and their intermodality, should be organised so as to offer total accessibility to handicapped people.

To meet this objective, the law specifies that, over the course of a ten-year period, public transportation services must be made accessible to handicapped people or people of limited mobility (all types of handicap).

Improving accessibility to public transportation networks is also a crucial factor in providing excellent service quality for all users.

2.3 Passenger expectations

When we speak of service level and quality, this means "service to passengers," so we always seek to put ourselves in the passenger's place rather than starting from technical criteria.

Some of the main concerns of public transportation users are mentioned below, although these naturally depend on the context of the network in question. The "service quality" norm recommends carrying out a survey with users in order to identify their "service quality and level" expectations within the context of the line being studied.

These concerns sometimes go beyond the framework of the line project involved. A "network" approach is often necessary, especially for information and ticketing.

Proximity of stations: for a journey origin and destination, the proximity of a station is modulated by the acceptance of an on-foot walking distance that differs depending on the individual and on the context. While the origin can sometimes be P+R, for a passenger coming from outside of the urban areas, this cannot be the destination. The passenger must be able to get closer to his destination by public transportation at an acceptable distance.
Intermodal transfers: Journeys may be made using several lines. The number of transfers is a factor that can sharply reduce the service quality. This factor also depends on the way in which transfers are handled.
Ease of identifying stations is a decisive factor for occasional users: they shouldn't have to spend a long time looking for the place to go to take public transportation.
Ease of access to the station is linked to the clarity of the path and the ease in getting there. The width and quality of the pavement, the absence of significant sloping, easy and safe crossing of the general traffic and all important elements in the quality of the access itinerary. Accessibility for people with reduced mobility[1] is required.
The quality of the waiting area is judged by the reserved area and its equipment: surfacing, shelters, benches, etc. Its size and capacity should be based on rush hour needs.
The waiting time is an important factor related essentially to the frequency and (or) observance of the schedule. When the time between vehicles is low enough, users no longer worry about the schedule, because they are certain that they will never wait more than x minutes (less than 5 / 8 min[2]). Delays will not be appreciated if they occur too often, (too often might mean 1 time out of 10). This timing facilitates memorisation of the schedule, which users will appreciate for planning their journeys.
Ease of boarding is linked to the possibility of boarding the transport without difficulties at times and in places where there are many passengers (Both boarding configurations, by all of the doors or by the front doors, can be justified). It is also related to the height and the distance between the door and the platform, mostly for people with reduced mobility.
The space available on board, or rather the capacity of the public transportation with respect to the number of passengers, will quickly become a factor for rejection if it is insufficient on a regular basis.
Comfort in traffic is a function of the available space, the number of seats for the longest journeys and the holding points for passengers who are standing up. The route and the insertion of the infrastructure will be fundamental: the curves - reverse curves, paved areas, level differences (steps, edges), traffic circles not crossed, etc. can make the journey chaotic, as can poor upkeep of the paving.
The total journey time: this duration could include several modes and could thus depend on several operators.
Guaranteed journey time: any unplanned stopping and any abnormal waiting becomes crippling if it goes on too long or occurs regularly. Passengers are concerned about guaranteed journey times.
The regularity regardless of the period can be seen in two ways: observance of the schedule or absence of a cluster of buses (for operation by interval). The service provided must respect the forecasts within ranges to be set and announced to the passengers.
The interior atmosphere including cleanliness is a significant comfort component for passengers.
Internal safety without forgetting the feeling of insecurity. This feeling must be provided by the quality of the project environment, with surveillance systems if necessary, and with the presence of staff.
Information before the journey, at the station and during the journey is more and more in demand (announcement of stations, reminder of last stop, announcement of travel times, waiting time). The announcement of problems and alternative solutions if any becomes the challenge of a high service level; this area is to be handled on the level of the network however, or even of the whole urban area.

[1] People with reduced mobility, with the definition of this term summarised in European directive 2001/85: all people who have difficulties, such as handicapped people (including people who have sensorial or intellectual handicaps, people with physical incapacities and people in wheelchairs), small people, people with cumbersome bags, elderly people, pregnant women, people with shopping carts, and people with young children (including children in pushchairs).
[2] The higher value will vary depending on the passenger, the context, the type of service, etc.; some operators will take into account a higher value, below 8 to 10 min.

Ease of acquisition and validation of tickets: this aspect is handled on the scale of the line (location of ticket machines and validators) but also on the scale of the network: we must not forget the value of intermodal strategies. This area is also connected with ease of boarding.

2.4 Contractualisation with the operator

The contracts and agreements signed between the transport operating authorities and the companies that operate their transport networks now most often integrate systems for monitoring these service level and quality objectives.

Operation aid systems now include tools for the localisation of vehicles that are more and more reliable and available thanks to the development of GPS and, in the near future, Galileo. These tools can help with the regular monitoring of service level and quality criteria, particularly those that involve regularity/punctuality.

The contract specifies bonus/penalty clauses based on well-defined thresholds of criteria judged to be most important.

This integration in the contract must be operative when the BHLS service starts.

It should also be stressed that in some contexts the service level and service quality obligations also require commitments from local authorities in order to guarantee that some elements of the service will be maintained over time (station spacing, quality of maintenance of the pavement, efficiency of priority at traffic lights, respecting of reserved lanes, etc.).

3. The BHLS, a promising niche for transportation and development policies

3.1 The BHLS, to develop the public transportation network

Depending on the size of the urban area, the BHLS can be either a main axis of the public transportation network or a secondary axis.

Developing a BHLS concept on a local level is an important step in the building of a public transportation network. Implementing such a programme will not be neutral for transportation policies, it could even lead to a major break with past practices. The designing of a BHLS line should lead to a complete rethinking of the organisation of the network around a larger number of structuring lines, to increasing the interweaving of high level services, with capacities designed to fit the potential. If these network restructurings are accompanied by a significant feeder service policy, the effects on the increase in the rate of transfers may be compensated for in the long-term by a more dense interweaving of structuring lines.

The BHLS is a strong axis for the public transportation system of an urban area:

It can supplement the structuring services of a city that already has tram and/or metro lines. For smaller cities, it can be the backbone of the public transportation system and policies. Depending on the quality of the infrastructure built, it can be developed into a tram when its capacity becomes insufficient.

Defining the BHLS concept for a transportation policy means detailed consideration of the following issues:

- What should be its place in the public transportation network (basic structuring network, intermediary network for a city that already has systems of greater capacity?, What restructuring should there be around local bus services? etc.)
- Should there be several configurations, several BHLS identifications? Should there be several service levels? What solutions for what types of lines? For suburb to suburb connections? For beltway lines?
- What architecture or what interweaving should be developed in the long-term for the urban area with BHLS and CHNS tools?
- What strategy should be adopted for inter-urban coach networks?

We know the problems that can arise with an increase in intermodal transfers when a higher capacity axis is established, creating a strong hierarchy in the network. How can we handle these problems for BHLS?

Adding an additional tool that is not compatible with the others can block progress in interconnections. The tram has the virtue of being able to evolve towards a tram-train service[1]. The experience of Karlsruhe shows us the value of limiting intermodal transfers.

Even if our thinking must be as for a tram, the BHLS remains a more flexible tool as an investment, which can be both an advantage and a disadvantage.

Another drawback of adding an additional tool is that it can lead to a more complex operation (BHLS vehicles assigned to a line for example).

On the other hand

- A BHLS can potentially be transformed into a tram. The line 4 “Busway” of Nantes will supplement the network of 3 tram lines, with equivalent service

[1] Under certain conditions, particularly with regard to the availability of rail right of way.

quality. It could later be developed into a tram and would then connect with the existing system.

- The BHLS infrastructure can also include express or inter-urban coach services; an efficient peri-urban network with tyre vehicles can then be developed, as in the case of Ottawa's network (Canada).

Another advantage that is often mentioned for BHLS is the possibility of designing a primary network of several lines to better distribute the financing in the area, whereas a single axis using a heavier mode might attract all investments, to the detriment of the remainder of the network. This argument should be used with caution however, because the situations may vary as a function of the context and the financing needs for the building of efficient BHLS networks (with urban integration, real stations, etc.) which must not be underestimated, even if the initial investments appear to be lower. We present the following two projects in this context:

A juxtaposition of simple bus lanes cannot create a BHLS, which is a structuring RLPT.

- The Dijon urban area has identified a network of seven major bus lines (Lianes) for which the service was first reinforced (in frequency and schedule amplitude). A study was done for the feasibility and investment priority for reserved lanes to progressively reach a high service level. The tram mode was not ruled out for lines with sufficient potential.
- Nîmes, a smaller urban area, identified the primary bus network, well connected to the rail and inter-urban network, and planned a first "BHLS" line with service equivalent to that of a tram.

The issue of financing for the network will lead to the issue of resources and especially an increase in the transportation contribution for the implementing of a BHLS. It can be considered that as long as a BHLS project meets the conditions set in the finance act of 30 December 2003, the transportation organising authority can increase its contribution if necessary[1].

3.2 Including BHLS in transportation planning

As structuring elements for a public transportation network and in transportation policies, the BHLS or a network of high service level lines should be more broadly included in transportation planning, such as urban development plans (obligatory for urban areas with more than 100,000 inhabitants) or comprehensive transportation policies (for average-sized cities). The BHLS must be coherent tools with objectives that match those of the planning documents, including in particular:

[1] Since the elimination of investment subsidies from the State for regional public transportation, the finance law of 30 December 2003 for 2004 introduced in its article 132 the possibility of increasing the rate of this contribution to the ceiling rate of 1.75 % for Transportation Organising Authorities with populations of more than 100,000 inhabitants and who have decided to build a "public transportation infrastructure with a road or guided mode." This rate can be as high as 1.80 % for communities of towns, metropolitan area communities, for urban communities and for urban transportation organising authorities when there is participation from an urban community, a metropolitan area community or a community of towns. This increase is not subject to a prior taking into consideration of a RLPT project by the Government that disappeared with the ceasing of Government subsidies. If the corresponding work has not begun within a period of five years as of the date of the increase in the transportation contribution rate, the applicable rate as of the sixth year is decreased to 1% (or to 1.05%) at most.

- Objectives set in terms of the modal share of public transportation and/or volume of public transportation journeys;
- Sharing of roadways, to the benefit of alternatives to cars;
- Arranging of spaces for environmentally-friendly modes;
- Service to priority neighbourhoods based on urban policies;
- Intermodality, etc.

The implementation of this type of transportation system on a roadway, as for a tram, requires reconsideration of the place of the other modes of transportation, pedestrian traffic, environmentally-friendly modes and individual cars, and the place of delivery vehicles.

Integrating the BHLS identification process as soon as the mobility master plan stage starts.

Nevertheless, as with the development of a public transportation network, this is not the only tool nor the only way to readjust the shares between individual cars and other modes. Its implementation provides an opportunity to rethink parking policies and development policies (city enhancement, installation of structuring equipment, densification of the axis in question, etc.)

BHLS projects need their own identification, which is more difficult to achieve than for a tram (see section 4.4): this thinking should be included very early on in planning studies and urbanisation documents.

3.3 The BHLS, an opportunity for city development

Like the tram, the BHLS is a structuring axis for transport. It should also be seen as an opportunity to comprehensively reconsider the city, through voluntary accompanying measures for example (renovation of public spaces from façade to façade, priority urbanisation along the route, opening nearby of major generators of travel such as hospitals, schools and cultural and sports facilities, urban renewal projects, synergies with policies in favour of non-motorised modes). Also, the local urbanisation plan should specify the priority principles for urban development around this strong axis.

On this level, it would be wise that the actors in charge of the transport project establish discussions with those in charge of urban development to think about the possible scope of the project: should they move towards what has been done for trams? Should they choose a project for renovation of roadways or the neighbourhood, significant improvement of transportation, or both at once? In most cases, tram projects have linked urban development and public transportation elements. The success of the BHLS will also lie in its ability to sufficiently mobilise all actors and to involve the local residents in such a project.

4. The BHLS concept, through a comprehensive system approach

This section explores the generic concept for a standard urban line operated from one end stop to the other. The following sections will deal with particular configurations that we have identified, such as management of a section common to several lines and inter-urban or periurban service.

The characteristics chosen to describe this concept are limited to those that will identify or characterise a BHLS lines with respect to other bus lines of the network.

The comprehensive approach must entail consistent choices between all the concept sub-systems.

We will therefore not put emphasis on characteristics that are common to all transportation systems, even if these are sometimes important, as with accessibility for all, which is an obligatory objective[1], or propulsion that is environmentally-friendly. For this characteristic, we should stress that the high service level concept, with standard propulsion, already offers potential environmental progress: better productivity associated with a transfer of the most polluting mode.

We once again draw readers' attention to the need for a comprehensive approach, which must entail consistent choices insofar as concerns all the concept sub-systems. It is because the bus is not technically linked to its infrastructure that this approach is relevant, if we want to achieve a high service level, as the tram can offer. Building a thriving and respected service requires attention to detail in making choices.

4.1 Area of relevance of the BHLS

Hourly capacity rate

Given that the length of "bus" or "guided bus" rolling stock remains limited by the road regulations (18 m in two sections, 24.50 m in three sections), a structuring line is one with a high passenger rate, which for a BHLS can reach values of around 2500 to 3000 people per hour in each direction during rush hours. The table below defines this area of relevance with respect to other modes. These values correspond to urban contexts and infrastructure configurations generally found in France and Europe.

The "Transitway" line of Ottawa in Canada[2], which began service in 1983, has much higher passenger rates, reaching 9000 to 10,000 people per hour in each direction on some common segments where express and local services run together. The vehicles are of lower capacity (fewer seats), but they come very frequently. Such capacities would be difficult to transpose to French cities because they involve a whole set of constraints that are in contradiction with our urban development culture: high needs for space for infrastructure (common sections, platforms, passages on different levels), passing lanes at stations or stops, pedestrian crossings on different levels, etc.

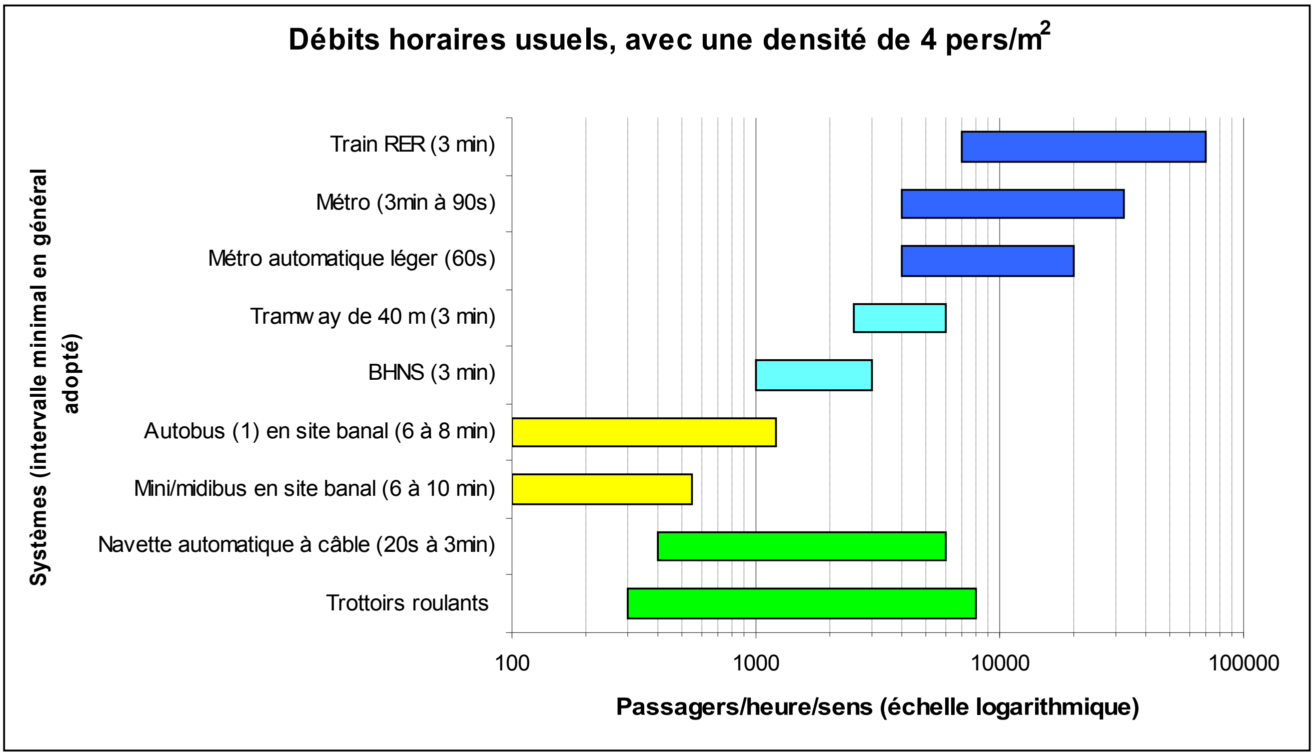
Consequently, it doesn't seem necessary or useful to specify capacity rates that would characterise the BHLS concept. These would depend firstly on the context, the inter-

[1] Objective reinforced by the new law on equal opportunity for handicapped people enacted on 11 February 2005.

[2] Reference "Bus Rapid Transit: A Canadian Industry Perspective" published by the "Canadian Urban Transit Association." Other projects in South America have had similar or even higher results, from 14,000 to 25,000 people per hour and per direction with different comfort levels.

sections to cross, the available road space and also the constraints of the desired urban development. This concept can also include long distance services, which often have small capacities.

The average occupancy rate of the vehicles will be one of the valuable indicators for the proper dimensioning of the project and for its economic factors.



Furthermore, the evolution from a bus line to a BHLS project, thanks to the advantage of its high service level, will allow for improvement of the spatial coverage and the demographic coverage. These two criteria are summarised below.

Spatial coverage (area served)[1]:

This figure is the proportion of the urbanised area served by the public transportation network; the distance values are a function of the service level offered by the mode of transportation:

$$\frac{\text{Area less than 300, 400, 600 metres from a stop}^{2}}{\text{Urbanised area}}$$

Demographic coverage (population served) [1]:

This figure is the proportion of the population served by the public transportation network. The distance values are the same as for the spatial coverage:

$$\frac{\text{population at less than 300, 400, 600 metres from a stop}^{2}}{\text{population served}}$$

All of these values for distances to the stop are for people walking. These values would be greater for the "bicycle" mode, as long as bicycle parking is properly integrated at the stops. Some users may be willing to walk further if the public transportation service is attractive and if the pedestrian routes are well-designed (and not too disturbed by car nuisances).

4.2 The service offered to passengers

With respect to a standard bus service, we think that the BHLS project must represent a real step forward in terms of quantity and quality. It is this combination, along with a strong identity, that will allow the concept to succeed.

Regularity/punctuality will be the most important "quality" criterion for the BHLS, and one of the essential factors

Service regularity/punctuality

These are essential factors for BHLS, ensuring service and travel time reliability regardless of traffic conditions. The means to reach this objective lie firstly in the design of the infrastructure, but also in the sphere of operations. Regularity refers to operation in terms of intervals, and punctuality to operation based on a schedule. There must be an effort to achieve the same performance over the entire service period.

Frequency and schedule span are the fundamental factors for BHLS services

Service frequency

[1] In reference to the efficiency indicators for a public transportation network summarised in section 1.2 of the Certu document "Modes of urban public transportation, *Elements of choice through a comprehensive system approach."*

[2] We generally use 300 metres for the secondary network, 400 metres for trams and road reserved lane system, 600 m for metros (using walking distances if possible).

The frequency will have an impact on the waiting time and thus on the user's journey time, especially when there is a transfer.

If it is under 5 to 8 minutes[1], the frequency is high and specified schedules are no longer essential: it is replaced by headway-based control, in other words the operator regulates headways (or in "frequency mode" based on the language used); users don't feel that they need to know the schedule, but rather the waiting time, which can create the need for dynamic information at stops. The time of the first vehicle and the last vehicle is still essential information however.

Above this threshold level, the regulation is schedules-based controlled (based on a specified schedule), which does not however eliminate the need for dynamic information for passengers. We can also sometimes find both the "schedule" and "frequency" modes for the same service.

Time phasing, when it is economically possible, makes the service clearer for users

In some contexts, it can be valuable for the operator to establish time phasing for the services: in this case the interval should be a whole fraction of an hour; this practice is frequent in Germany and Switzerland. Users can then easily memorise the schedule.

Generalised phasing over a large schedule amplitude can lead to high and unproductive costs. This may mean adding additional vehicles to cover all of the needs: this factor should be weighed against the increased ridership to be gained through time phasing coupled with other measures.

For a BHLS, as for any structuring line, the reduction in service during off peak periods (week-end, vacation period, evening, middle of the day) should not be too great.

Service span

The service spans for structuring lines should be in correspondence between them.

Schedule span will be a fundamental characteristic for a BHLS project, it will naturally depend on the size of the urban area and the types of lines that already structure the network.

The BHLS service, as a structuring line, must be maintained at a sufficient level during off peak periods, in the evenings, as well as on weekends and holidays.

The most attractive networks in Europe offer services running all night for a certain number of structuring lines, in Prague for example (two services once an hour between midnight and 5 AM)

As an example, the BRT network of Ottawa (725,000 inhabitants) runs 22 hours/day and covers 70% of trips (200,000 trips per day). The Mobilien lines in the Île-de-France are based on the schedule of the metro 5:30-24:30.

Running time and guarantee

Passengers expect guaranteed journey times for their trip.

The running time is the most important factor for passengers, especially the time for the total "door to door" journey. While the running time performance is an important criterion, its guarantee is just as important at all times (during rush hours, at off peak times).

A significant increase in commercial speed is necessary to bring credibility to any BHLS approach

The savings in running time thanks to the BHLS project (often associated with greater frequency and better regularity) will be one of the determining factors for its attractiveness and for modal transfer[2]: evaluations done in North America on BRT start-ups

[1] The upper value will be variable depending on the passenger, the context, the type of service, etc. Some operators will use a higher value, but below 8 to 10 minutes.

[2] The modal transfer can of course be favoured by other factors such as the congestion of automobile traffic, a stricter parking policy, an urban toll, etc.

have shown varied results, with running time savings of 23 to 47%, contributing to increases in customer base of 20 to 80% but without a proportional relationship between these values; however, these evaluations indicate that an overall saving of 5 minutes for passengers appears to be necessary for there to be a beginning of a modal transfer[1]. In Grenoble, increasing the speed on Line 1 had a particularly strong impact: for a running time saving of 20%, there was a 40% increase in the number of passengers[2].

The commercial speed between the end points is of lesser importance for passengers, it is more the concern of technicians: it allows for a comparison of the overall economic efficiency of lines of the same nature. It has an impact on operating costs because, with constant means, an increase in speed makes it possible to increase the service offered.

The commercial speed is influenced mostly by the design of the reserved lanes and the distances between stations, without forgetting the commercial times, stops at intersections, winding sections, road traffic and bus-bus interference.

The stops, their number and their duration, winding sections and disturbances from road traffic can all sharply reduce the commercial speed

As for most of our tram projects in urban areas, the commercial speed of a BHLS going through dense urban areas most be able to reach 18 to 20 km/h and the overall variability, without forgetting that the variation between peak and off-peak periods, must be as low as possible. Less urban configurations could of course make it easy to reach much higher speeds, particularly for express services for which the distance between stations is greater. In other, much more difficult configurations, it will not be possible to reach the speed of 18 km/h. In this case the increase in speed with respect to the preceding situation will be the criterion for evaluation.

A maximum speed greater than 50 km/h is only of value if there are many inter-station distances greater than 500/600 m. A local lowering of the maximum speed has almost no impact on the commercial speed, except in areas with mixed pedestrian traffic, or if this is repetitive.

Bus manufacturers are seeing more and more that the cost of innovation (guidance, motorisation, comfort, design, etc.) is not attractive or economically justified without a “BHLS” approach with an ambitious productivity objective.

Norm NF EN13816 “service quality” certification

While it is not obligatory, it is strongly recommended for a BHLS line and the lowest degree of variability must be sought for all services (between peak and off-peak times). The most important criterion to take into account for a BHLS is of course regularity/punctuality, but we must not underestimate other criteria, such as:

- Guaranteed connections;
- Comfort criteria, such as a maximum load rate of 4 pers/m2.

Experience shows that a certification approach is not of particular direct interest to passengers. It is more a tool of interest to the operator and the organising authority in their steps to make improvements.

Services related to the journey

With regard to the constant progress with communication and localisation systems, public transportation seeks to respond to the potential demand of its users. As for any

[1] Reference to TCRP report 90 “Bus Rapid Transit.” The modal transfer from cars remains varied and dependent on the context (especially congestion). As an example, for the Los Angeles BRT, the savings in running time is 30% and of the 30% additional users, 1/3 are new public transportation users, 1/3 come from other lines, and 1/3 are existing users who are travelling more. In Vancouver, 20% came from automobiles, and 75% from other bus lines.

[2] There was also an increase in the service level of about 20%.

structuring line, the BHLS must be able to integrate new services and information, such as:

- localisation and guidance to the final destination;
- information about the city;

Here are some of the ideas of the "DILIDAM" project led by the RATP, within the framework of the Mobilien programme:

DILIDAM is a service for information to passengers on board vehicles, provided on screens that can receive and display targeted real-time information based on the areas that the vehicle goes through. This could be transportation information for the line in question (next stop, map of the neighbourhood, service, running time) or for the connecting lines (times or problems), or information regarding the area, or entertainment (documentaries, news) or advertising. The transport/city information for the project aims to:

- allow passengers to verify the proper completion of their journey compared with what was scheduled (operational objective)
- facilitate intermodal mobility by announcing to passengers the times and problems for connecting lines (operational navigation objective)
- keep passengers in contact with the city they are travelling through (objective of reassurance and mobility, particularly for underground rail networks)
- through the modernity of the system, to highlight the operational qualities of the line. This can be a means of identification and promotion (with respect to passengers and the organising authority) of a network such as Mobilien (RATP promotion objective)

An experiment on Mobilien line 38 (the whole fleet: 33 vehicles equipped with two screens) is to begin in autumn 2005.

The data transfer technology is based on a "mobile router" which selects the best suited transmission system, particularly from among GPRS or wi-fi terminals installed along the route.

4.3 Intermodality

4.3.1 Connections with other modes

The BHLS network is intended to be structuring, i.e. to be part of a structuring network or to supplement one, on its level based on the type of urban area (with or without metro, with or without tram). For cities that do not have other RLPT, the BHLS network will be the backbone of the public transportation system. For urban areas that already have RLPT (metros, tram, etc.), it is an "intermediate" network, equivalent to a tram. The interworking of all of these services must be clear and efficient.

Intermodality reflects relationships between BHLS lines, the remainder of the public transportation network, and the other modes of transportation (walking, bicycles, automobiles, train, etc.).

Excellent quality and efficiency of transfers between modes is of course a primordial objective. This does not just apply to the BHLS, but we will limit ourselves here to a few comments regarding the technical specificities of the BHLS.

Special numbering of lines

This subject is connected with the necessary identification of all BHLS services. The numbering must be coherent with the overall identification choice of the line.

This identification could involve a new numbering of the BHLS lines, using a particular letter, for example T for TEOR in Rouen, C for the Cristalis lines in Lyon, and L for the Lianes in Dijon. In Nantes, the choice was to continue the numbering from the tram lines.

Organisation of exchange poles and management of connections between public transportation modes

This is indeed a crucial factor. For a BHLS mode, the problematic will be similar to that of a tram mode, although the differences between the two modes can lead to incompatibility and thus different technical approaches:

- Trams can be reversible, buses are not, which means that they need additional space for turning;
- Trams are usually configured with left and right side doors, allowing for flexible arrangement of platforms, and better boarding/alighting productivity; there are not yet any buses with doors on both sides (a project was reported in the USA, but it is not yet in service);
- When there are multiple and assigned platforms, the bus mode requires steps to make docking “accessible”;
- The platform heights are different between these two modes when the bus is not guided (the case of Nantes is an exception, but guidance is included if the docking is not sufficiently regular); the platform heights are similar when the buses are guided;
- Non-guided buses require right alignment before the platform to allow for quality docking;
- The width of the tram mode is much more variable, but this does not rule out compatibility of spaces if a common bus and tram section seems valuable;
- The bus mode can appear to be more flexible for the use of passing lanes at stops (in the case of a common section used by both express and local services), but it requires more space than a small-gauge tram.

Park and ride lots

The BHLS can be accompanied by park-and-ride lots, as is the case for other types of structuring lines. This solution is now often promoted in France, and if it is done as part of a comprehensive and coherent approach to parking on the level of the urban area, it can have positive effects in that it encourages drivers to leave their vehicles at the ends of BHLS lines, rather than going into city centres.

It is important however to stress the necessity of carefully choosing the locations and the sizes of the lots, taking into account their possible undesirable effects: decreased use of feeder buses, impact on urban development around the stations, nuisances for environmentally-friendly feeder modes.

Bicycle parking lots

In general, bicycle/public transportation complementarity is poorly developed in France. As for the tram, the BHLS can provide two ways to implement this:

- chiefly by creating possibilities for parking in the immediate proximity of the stations or stops (covered bicycle parking if possible, bicycle racks, etc).
- to the extent possible, by allowing people to take bicycles on vehicles at certain times. Compared with a tram however, taking bicycles on a bus is generally not as easy. It is not always compatible with the objectives of high service level for busy lines. In the United States, the placing of two bicycles on a rack on the outer front side of the vehicle is allowed, a measure sometimes used by the BRT lines (particularly the Rapid Bus of Los Angeles).

Drop off points (Kiss and ride)

This raises issues found for other structuring lines. They are useful, and often forgotten. This system is less space consuming than park-and-ride lots and can be implemented at a larger number of stops. Some development work must be done for drop-off and pick-up points however.

4.3.2 The design of services, of various configurations

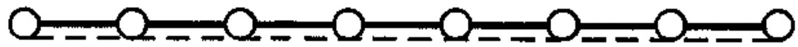
In this section, we will consider the possibility of implementing varied configurations of services within a given transportation network in order to meet the needs of the major mobility flows.

Infrastructure will play a fundamental role and must be adapted according to the configuration(s) chosen. The necessary optimisation of transfers between services should not be forgotten.

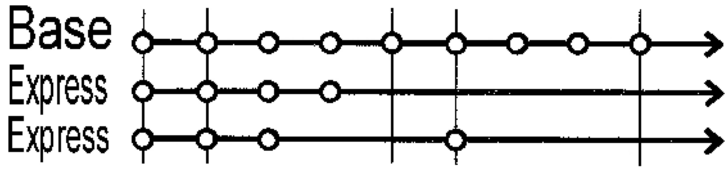
Although this list is not exhaustive, and without describing the consequences in terms of infrastructure, some examples of the configurations that are found are presented below.

A BHLS service alone on its site with obligatory or non-obligatory stops:

A BHLS service that does not stop at all stations and a local service on the same line:

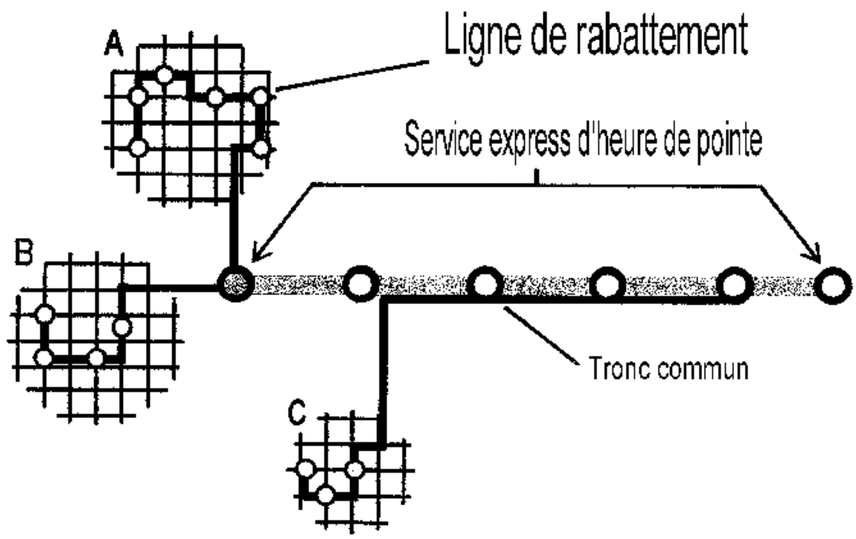


The integration of an express service and a regular service at all stations; these express services may be available during limited time periods[1]:



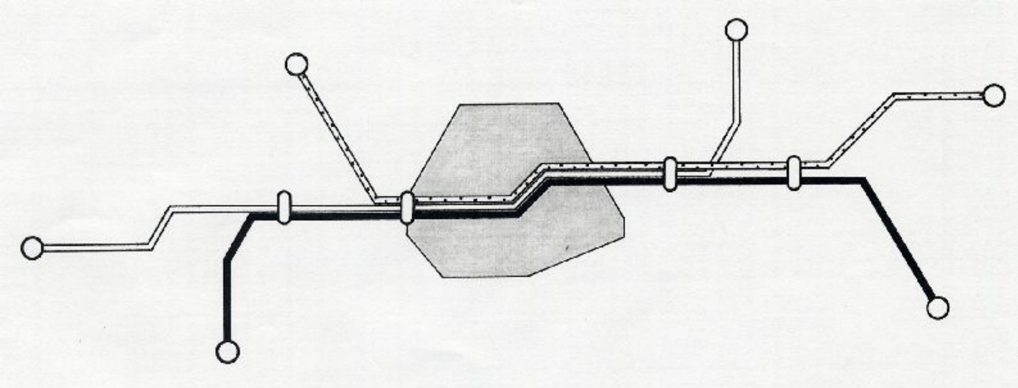
The integration of various feeder services on a common section with an express service:

Legends: feeder line, rush hour express service, common section

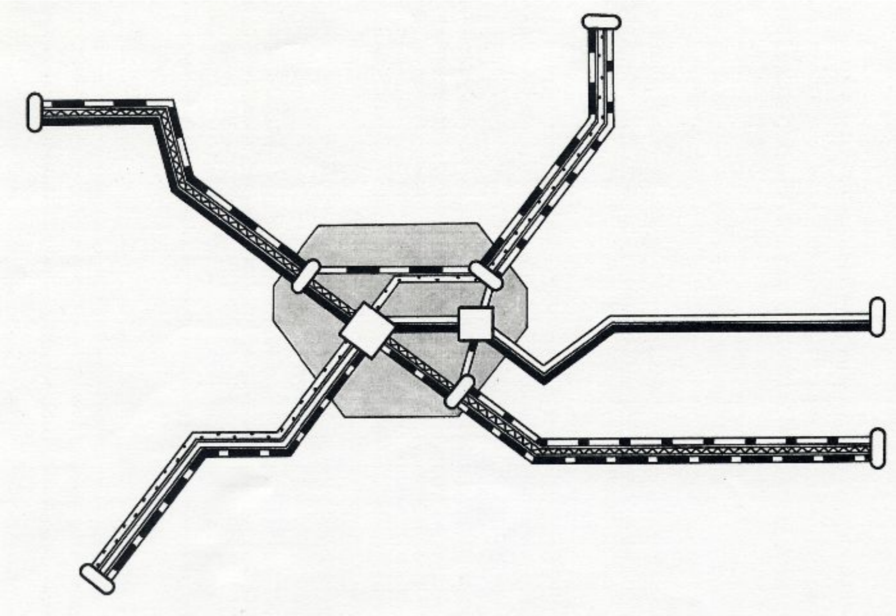


[1] Frequent North American examples (Miami, Ottawa, Pittsburgh) – Source TCRP report 90 *Bus Rapid transit*

A radiating star pattern with a common central section, like the TEOR lines of Rouen:



The integration of various destinations starting from the extremities of the network, configurations often found in densely enmeshed tram systems, in Germany or in Prague for example:



4.4 Brand identification of the system

4.4.1 Coherent brand identification of all of the sub-systems

Establishing the conditions so that the BHLS service offered develops a good image should be a major objective for the principal.

Offering on-going high level service is of course a prerequisite for building this image.

The BHLS service needs to be identified (branded), this is an essential part of the concept

The difficulty lies in the fact that this high service level is not defined in a simple way, and may not necessarily be unique within the network, or from one urban area to another (the Marseille metro does not have the same schedule span as the Paris metro; it cannot offer the same service).

This identification cannot be reduced to the type of rolling stock alone, or to the particular design of the vehicle.

In order to facilitate communications regarding this high service level, it should be easy for users, area residents, users of all other modes, and visitors to identify and distinguish it. The BHLS must have its own identification as a structuring line and thereby create a complementarity effect with respect to the other bus lines.

One of the points of controversy often mentioned is the following:

- For some people, without a particular design of the bus itself or of the urban furniture of the stations, the identification of the service will not be sufficiently strong to establish the image of the BHLS. Buses do not have a good image and are much less attractive than trams.
- Other people, on the contrary, stress that it is absolutely unnecessary to have a special bus design or architecture to efficiently identify a BHLS line. They further stress that in France the tram projects did not need to do so much in terms of design, and that in consequence less expensive projects are possible.

It is worth raising this issue, even if we don’t need to give an answer. A BHLS project, like a tram project, is mostly on the surface and thus involves the organisation of the neighbourhoods it goes through.

The choice of a special design or architecture is a comprehensive issue that goes beyond the transport function and its marketing. This choice should not obscure the main objective of identifying the high service level offered in coherence with the network’s services.

Based on North American and European examples, including the approach chosen in Rouen, which is exemplary in terms of identification of the line and the service, here are some of the issues to be coherently identified:

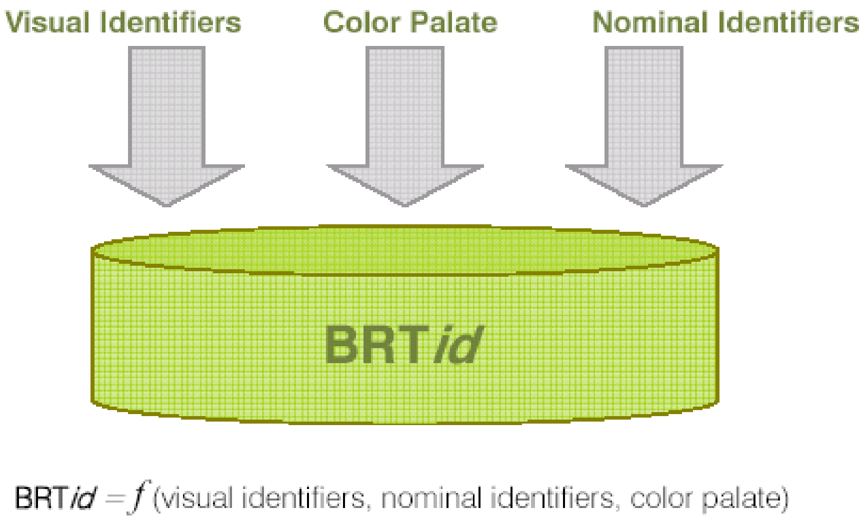
- **A specific fleet of vehicles**: a special fleet is recommended for BHLS line vehicles. This recommendation implies that the vehicles are used exclusively for the line in question, which removes some of the operational flexibility for the overall management of the bus lines. Analyses of the BRT in the United States show that advertising on vehicles diminishes the impact of the identifiers.
- **Infrastructure specifications:** ease in identifying the route and the BHLS stops when the bus is not visible; the strategy will involve the following elements for the whole line:
    - The contrast, colour of the paving of the reserved lanes or its marking for normal lanes; reserved lanes are naturally a great help in identifying the line.
    - Identification and design of stops;
    - Urban furniture for the line;
    - Night time lighting of the station;
    - The marking of stations for pedestrians.

- **Special name and numbering for the BHLS line:** to totally differentiate its numbering from that of the other bus lines of the network. This difference will exist for the vehicle, but also for the stops and all of the markings and passenger information, maps and schedules**.** This will facilitate communication actions; the BHLS lines must be easy to identify[1].

The creation of a logo associating the name of the BHLS line is an additional identification tool. This approach is widely used in North America: some examples of logos are shown in the references section in appendix.

An approach for the identification[2] of a BHLS line will involve choosing:

- A set of colours
- Visual identifiers used for the whole line
- Specific terminology (name, sign, logo…)



4.4.2 The positive impact on marketing

The choice of the BHLS "service" brand identification will be the vector for the clarity and efficiency of all marketing operations. As indicated in the preceding chapter, a logo can be chosen for communications, as for many manufacturers of product brands.

In Rouen, the name "TEOR" for the three lines T1, T2, T3 is the support for the whole commercial operation. This name turned out to be much clearer and more efficient than a reference to the guidance technology, despite the fact that it was very innovative[3]. TEOR refers to a service and a geographical link; the innovation of camera guidance is not very visible for passengers and does not contribute to the service level oth-

[1] As already indicated in the intermodality section: T for the TEOR lines in Rouen, C for the Cristalis lines in Lyon, L for the Lianes in Dijon. In Nantes, the numbering of the tram lines will be continued.

[2] Source: session "Bus Rapid Transit Identity" of Daniel Baldwin Hess, State University of New York, Buffalo – TRB 2005

er than through other specifications, particularly the reserved lanes and the stations that offer regular intervals close to those of trams.

In order to enhance the coherence of the entire system, it is helpful if these identification choices are made early on, within the framework of a comprehensive "marketing" policy for all of the various service levels that are planned for the network. It is also important to choose a coherent strategy when several BHLS lines are used for the same network.

4.5 The sustainability of the system

As indicated in the definition of the BHLS, ways must be found to make sure that the BHLS service is on-going and to guarantee its service level and quality. This objective is not simple for a surface system and still less if the system is not guided.

Guaranteeing a sustained high service level is an essential factor for the BHLS.

Thanks to its rails, the tram takes its place firmly in the environment and encourages people to respect its reserved tracks and operating objectives; for example, for work for the renovation of a neighbourhood it goes through, and in a context of low density, a modification of the tram line cannot be easily decided: if it is possible, its cost will be high and the deterioration of the service will be all the harder to accept if the line is very busy. For a bus, if it is not a trolleybus (or if it is a bi-mode trolleybus), and even if it has a high service level, there will be a strong temptation to suggest temporary diversions.

Knowing that many daily deteriorations can be managed by the operating regulations, in this chapter we would like to suggest the establishment of guidelines that set rules or provisions to be respected for foreseeable major events that could lead to deterioration of the BHLS service. These events could be the following:

- requests for additional stops;
- road work projects within a certain radius of the BHLS;
- modifications of intersection management or of traffic plans;
- requests for road use permission for moving or maintenance work;
- requests for use of the reserved lanes for special events (bad weather, festive events, official journey, strike, etc.).

[3] The TEOR recently obtained a very good score in the passenger satisfaction survey on the Rouen network. Its rating was slightly higher than for the tram.

5. The design of a BHLS line

5.1 The infrastructure, the backbone of the system

The high service level bus BHLS constitutes a specific system with its three main components: rolling stock, operation and infrastructure, which is the real backbone.

5.1.1 Comprehensive conception of development

This infrastructure must constitute a coherent whole including stations, the standard sections and the intersections, along with the signals that go with them.

With regard to infrastructure, the quality of its insertion must be one of the main concerns of the BHLS project

Each element of this system must be studied in relation with the others: a station and a contiguous intersection must be considered as a whole, a reserved lane coming out into an intersection without a priority system is nonsensical, etc.

As for the tram, much more than the maximum speed, it is the distance between stations, the stopping time at stations, the conditions for the crossing of intersections, the optimised route, etc. that create the conditions for a good commercial speed for the transportation system, as long as the bus is not affected by the random factors of the general traffic.

In the same way, much more than the arrangement of the standard sections, it is the arrangement of the stations and intersections that allow for high speeds, all the more so when the two are contiguous.

5.1.1.1 The Lay-out of the route

Systems with tyres, guided or not, allow technically for routes with low radii.

It is important to avoid the traps of a winding route through attempts to serve a maximum number of poles to generate traffic, or through ease of insertion:

- overall, it is a source of detours that increases the point to point running time for the user;
- in the winding areas, it is a factor that reduces the commercial speed and increases the running time;
- locally, it is a factor that decreases comfort for passengers, it can potentially lead to unsafe situations in terms of urban insertion and can also lead to premature wear of vehicles and infrastructure.

5.1.1.2 Station locations and design

5.1.1.2.1 The station spacing

In line with the objective of a high service level, the station spacing must be greater than for an ordinary bus line, and closer to that of urban tram lines (generally on the order of 300 to 500 metres). While it is not the only factor, this station spacing helps in obtaining a good commercial speed. The TEOR project, like that of line 4 in Nantes, adopted a tram-style station spacing of 500 m. The average station spacing is 600 m on the Trans Val de Marne.

As for the tram, it is also important to have shorter inter-station distances for areas in the centre or where there is heavy traffic, and given the available space for the opening of stations (see below). This should not become the rule however.

5.1.1.2.2 Typology and localisation of stops

Stops conceived of as real stations.

The stops are located as near as possible to traffic poles, being sure to avoid curves that hinder operations.

To the extent possible, the stops will be designed as real stations, like those of trams, within the limits of acceptable costs. Platforms should be built facing each other if possible for this reason.

If platforms not facing each other are necessary, stations immediately before or after intersections each offer advantages and drawbacks; neither solution should be ruled out.

For the largest stations, located on sections common to several busy lines, special measures to allow for very high passenger rates should be considered: two or several platforms for the same traffic direction, allowing buses to pass each other, etc.

As for trams, the layout and functioning of the station - intersection system must be studied as a whole.

Likewise, particular care should be taken for the access points to the stations in terms of safety.

5.1.1.2.3 Dimensioning of stops

The length of the stations will be a function of:

- the length of the vehicles used;
- the maximum frequency at rush hours and the probability of having to simultaneously receive two vehicles;
- the existence of sections shared with other lines;
- foreseeable short- and medium-term upgrading of the system (longer vehicles, higher frequencies, heavier mode.

Saturation of platforms is detrimental to safety and to commercial speed.

For most stations, the width of the platforms will be determined from specifications relating to accessibility (width at shelters and ticket machines, or switch boxes). a width of 2.50 m seems like an absolute minimum, and 3.00 m is preferable. The latter dimension is an absolute minimum for platform-sidewalks.

For the busiest stations, it is important to verify the capacity of the platforms to handle the largest crowds. This verification could be done on the following bases:

- capacity of 2 people / m^2 of usable space;
- interval between overtaken buses, to take possible disturbances into account.

If this capacity is not available, we must seek other solutions, by reducing the station spacing in very dense areas, for example.

5.1.1.2.4 Docking quality and comfort of waiting areas

The geometric conception must absolutely meet the obligation of accessibility for all[1].

In particular, it should make the driver's job easier, especially when the vehicle is not guided: it is up to the "stop to come to the bus route," and not the other way round. The docking must be straight, taking the vehicle's length into account. The docking concept of line 1 in Grenoble takes this into account. The same is true for the Nantes project, which will have platforms similar to those in Rouen, but with no guidance during an initial phase.

Providing accessibility to handicapped people helps all passengers and optimises productivity.

For all of these buses, guided or not, the rear-view mirror is a problem for docking, especially if the objective of accessibility means trying to come as close to the platform as possible: the risk of hurting people on the platform is real; rear viewing with cameras is not authorised alone, there must also be standard rear-view mirrors. The solutions include:

- a platform that is sufficiently wide, coherent with the number of passengers;
- platform kerbs of different widths, to encourage people to move away;
- communication to passengers.

The platform heights will differ depending on whether or not the buses are guided; they are indicated in section 5.2.2; a slanted shape seems best suited.

While it is not necessary to offer the same service at all stops, the comfort must be on the level of the structuring lines for the most important stops, especially for ticketing and passenger information.

5.1.1.2.5 Identification and marking of stops

These are essential elements of the BHLS. They must be coherent with the choice of identification of the line and the BHLS service (see section 4.4).

5.1.1.3 Insertion in the standard section

5.1.1.3.1 Terminology of infrastructure dedicated to public transportation

The term "reserved lanes" is often used to cover all types of protection, without precisely defining their nature, nor their proportion on the line: the term RLPT, Reserved Lane Public Transportation, can refer to buses with reserved lanes or to a tram on a protected site or even a metro with its own completely separate area, even if, in recent years, the term RLPT has mostly been used for surface transportation.

Several notions overlap:

- the regulatory nature of the site: what users are authorised to use it?

[1] The law of 11 February 2005 concerning equal rights and opportunities, the participation and civic rights of handicapped people, stipulates that the transportation chain, which includes the buildings, roads, layout of public spaces, the transportation systems and their intermodality, must be organised to allow for total accessibility to handicapped people. In order to reach this goal, the law requires that, within ten years, public transportation services must be accessible to handicapped people and people with reduced mobility.

- its degree of protection or separation with respect to the environment: is the site physically, easily accessible or not accessible to vehicles? Is it accessible to pedestrians?

There are regulatory distinctions between three types of sites:

- **reserved lanes:** exclusively reserved for certain public transportation vehicles; the only exception is for emergency vehicles;
- **shared site** with one or several categories of well-defined users. e.g. taxis, bicycles or non-urban bus lines;
- **mixed-flow sites**, which can be used by all types of vehicles.

Based on the degree of physical protection, we can distinguish, for reserved or shared lanes:

- sites that are closed to all users, including pedestrians, such as a metro, which we can refer to as **completely separate sites**;
- sites that are considered to be inaccessible to vehicles because of physical separators, but which are physically accessible to pedestrians;
- sites that are considered to be accessible, with separators which allow for crossing, for example short kerbs, slanted or not;
- the extreme case is when the separation is only with regulatory markings, or even a simple difference of colour, material or texture.

By combining these two notions, many configurations are possible. We generally find them successively within a given system.

5.1.1.3.2 The value of reserved lanes and the alternative solutions

As long as there are means to make sure that it is respected, reserved lanes are an essential factor for improvement of the commercial speed, and especially the regular progression of public transportation vehicles, eliminating traffic uncertainties.

In general reserved lanes are efficient tools for improving the service level offered to passengers.

In general, they facilitate priority crossing of intersections with traffic lights or roundabouts crossed in the ring[1], leading to additional improvements in commercial speed and regularity, along with the gains from the effect of the reserved lanes themselves.

But reserved lanes are also a tool for the reassignment of public space to support modal readjustment policies and a way to make public transportation clearer and more visible. This is all the more important for the BHLS, which unlike the tram, does not have "natural" markings in the form of rails and overhead lines (except for trolleybuses or electric systems with tyres).

By reducing braking and other variations in speed due to traffic fluctuations, it improves one of the components of comfort and reduces buses' energy consumption and emissions.

In appearance, reserved lanes can be seen as space-consuming, and experience shows that the creation of reserved lanes for BHLS (more than for trams) can lead to jealousy, particularly from cyclists or motorcyclists, taxis, emergency vehicles, specialised

[1] For roundabouts crossed in the traditional manner, in addition to the discomfort for passengers, the bus loses its priority. It would be better not to have a reserved lane entering this type of roundabout which, in any case, should be avoided for a BHLS line.

upon-request services for handicapped people, tourist buses, armoured cars for transport of funds, and still others.

Reserved lanes must be justified by sufficient occupation.

Reserved lanes must therefore be justified by a sufficient occupancy rate, which is generally the case for structuring lines, but it is also important to take into account the fact that individual automobile transportation is a much bigger consumer of urban space if we consider both the space for driving and the space for parking.

When the installation of a permanent reserved lane system in both directions doesn't appear to be possible, an ordinary lane system can be used, and could even be recommended, as long as the buses can make adequate progress:

In cases where the creation of reserved lanes is not possible, mixed-flow lane or other flexible solutions could be very efficient.

- with no special provisions if the traffic conditions at peak times allow for it;
- making approach corridors at intersections;
- use of a priority system with lights, allowing buses to go before other vehicles;
- arrangements to allow buses to "stay ahead", for example stops on the line with no possibility of passing, stops before roundabouts, etc.

Other solutions, such as the switching to single lanes (alternating) or flexible assignment of the lanes in the direction of the rush hour traffic can also be considered in some contexts[1]. We should also remember the advantages that a modification of the traffic plan can bring.

5.1.1.3.3 Sharing of sites with other categories of users

The opening of BHLS sites to other categories of users raises many issues and thus requires a certain number of precautions and above all consultation, well before the studies are done. It also seems preferable, whenever possible, to optimise the use of the reserved lanes by several BHLS lines, and, if necessary, by the other vehicles of the urban operator, under certain conditions:

- the frequencies of the various lines, BHLS and other, must allow for functioning of the site compatible with the planned service level, particularly with regard to the operation of the stations and the crossing of intersections;
- the stations must be designed accordingly (see above), and the ticketing (mode of issuing of tickets) and the mode of operation (self-service or front door entry) must be compatible in order to avoid penalising the BHLS;
- for the crossing of intersections with traffic lights, all of the vehicles must be equipped with an identification system similar to the one that the BHLS vehicles use;
- the drivers of the lines in question must have received specific training.

The vehicles of other public transportation operators (periurban, inter-urban) must meet the same conditions, which would seem more difficult to implement. The fact that these vehicles pass through stations without stopping can lead to safety problems which cannot be easily resolved.

Taxis clearly cannot meet these conditions. Furthermore, there would be no question of giving these vehicles any form of priority for going through intersections. Their going through the stations would only detract from safety.

[1] See the CERTU document on the variable assignment of public spaces and roads – Jacques Nouvier – March 2004.

Cyclists and drivers of two-wheeled motorised vehicles should likewise not be authorised to use the lanes if there is a system for priority crossing at intersections, particularly for a central site. While their presence in normal bus lanes seems perfectly possible, at least for bicycles, it would seem very difficult to accept them for a BHLS, just as it would for a tram.

Vehicles that have priority in application of article R. 415-12 of the traffic regulations (national or municipal police, gendarmes, fire brigade, paramedic vehicles), when they use their sirens, are authorised to use the reserved lanes in application of articles R. 412.7 and R. 432.1.

5.1.1.3.4 The geometry of the standard section

Allowing for easy circulation at a speed suited to the area.

The width of the lanes should allow for easy circulation of buses at speeds suitable for the area they go through. Initially, and as long as the other elements of the horizontal alignment are correctly dimensioned, the following values can be used in right alignment (to be increased at curves to take vehicle turning into account):

	1 lane	2 lanes	
30 km/h	3.25 m	6.00 m	2.75 m/lane + 0.50 m
50 km/h or more	3.50 m	6.50 m	3.00 m/lane + 0.50 m

The circulation of buses in pedestrian lanes must remain exceptional. Their speed is limited by regulations to 10 km/h. The area of this change must be marked, if only by the use of a different material that creates a visual contrast. The required width is basically as follows:

1 lane	2 lanes	
3.00 m	5.50 m	2.50 m/lane + 0.50 m

Radii greater than 20 m are the rule.

The geometry of the lane for the buses is an essential component of the comfort for passengers, and is also part of obtaining an attractive commercial speed.

This applies to the horizontal alignment and the longitudinal section, as well as to the superelevation. The tyre system allows for radii on the order of 12 metres, but at the price of a greater loss of comfort and speed. For the BHLS, radii greater than 20 m are recommended.

5.1.1.3.5 Position of the reserved lanes

Traditionally, unidirectional bus corridors were installed on the sides of roads, which created difficulties, particularly for local residents (access, parking, deliveries, etc.), with all of the negative effects that inevitably hinder bus traffic.

Installation in the middle of the road offers many advantages

For this reason, the bilateral installation of such lanes, in some configurations, can be prohibitive.

On the other hand, this measure simplifies the installation of stops, most often limited to simple bus shelters.

The installation of real bi-directional reserved lanes in the middle of the road, as is done for trams, seems greatly preferable overall, even if it requires special precautions for users' access to the stations, as well as specific measures for station exits at intersections with traffic lights. This excludes all sharing of the site with other categories of users (cyclists, taxis, etc.), other than priority vehicles for emergency services.

This measure also has the advantage of reinforcing the presence of the reserved lanes.

Bi-directional reserved lanes systems can also sometimes be installed laterally, with identical or worse difficulties for services for local residents with respect to simple lateral corridors.

Other less conventional provisions, such as, for example, a unidirectional site or axial alternating site or even lateral on the left, when the general traffic is one-way, could be considered, taking into account the particular context as well as the constraints that these measures can lead to[1].

5.1.1.3.6 Marking of dynamic clearance, colouring or contrast of dedicated sites

Colouring or a good contrast for the reserved lanes are advantages for identifying the BHLS, but also for making sure that the reserved lanes are respected.

For trams or for any guided system on wheels, this marking refers to the obstacle clearance limit. It is not regulated. It can also be materialised at a normal site. It is very useful for the driver.

A recent survey of practices for materialising the obstacle clearance limit of guided systems revealed the value of using a surface contrast, compared with a solution limited to treatment of the lateral limits of the site.

For the BHLS, guided or unguided, like trams, the use of differentiated surfacing is recommended at roundabouts (sometimes even for intersections with traffic lights), which constitute interruptions of the reserved lanes. Nantes is moving towards a similar system for its tram lines and its first BHLS line (line 4, Busway).

For buses with camera guidance, this marking must include the rear-view mirrors, which can lead to markings on the sidewalk that are not very comprehensible before the docking of the bus.

5.1.1.3.7 Lane separators

The various types of separators are defined in the CERTU guide Road Development for Public Transportation – January 2000.

A slight raising of the reserved lanes allows for flexibility in use which is essential in some contexts.

For buses, the design of the separators should of course take into account the fact that the vehicles are not guided: it is impossible to make raised sites without special precautions in terms of separators.

The experience acquired from tram projects with regard to accessible sites, i.e. with separators that can be crossed, could benefit the BHLS: this option allows for flexibility in arrangement which is indispensable in some highly urbanised areas where the residual pavement has only one traffic lane in each direction and where services for local residents is primordial.

For BHLS, the need to design separators so that they can include signs, particularly to forbid access to unauthorised vehicles, is greater, because of the differences in the regulations that apply to them compared with those for trams (see 5.1.1.5 below).

5.1.1.4 The crossing of intersections

5.1.1.4.1 Priority crossing at intersections

The crossing of intersections, including roundabouts, intersections with traffic lights and those with priority systems, is one of the main causes of the loss of time and comfort. The crossing of intersections should of course be done with care, but also with minimal slowing down. This implies:

[1] For further information see the CERTU publication, *Guide for road organisation for public transportation*, January 2000.

- for intersections with no traffic lights, giving priority to the axis on which the buses circulate;
- for intersections with traffic lights, and also for roundabouts that buses go through, to give these vehicles priority so that they have a high probability of going through intersections with slowing down, but without stopping;
- for other roundabouts, we make sure that the entry of buses into the ring can be done without difficulty; otherwise, flow control signals should be installed at the entrance(s) that can hinder bus movements (this type of uncrossed roundabout should be avoided on BHLS lines to the extent possible).

Priority crossing of all intersections is a major objective for the BHLS.

The taking into account of priority at lights, most often in conjunction with the making of reserved lanes that are respected, represents one of the most important challenges for the success of the BHLS concept because of its impact on improving commercial speed and regularity.

Difficulties of various natures must be resolved to reach the objective:

- as for trams, the addition of extra phases at intersections; for proper functioning and good credibility, these phases must be optimised, so that they are either masked (passage of public transportation compatible with one or several traffic currents), or as short and as few in number as possible;
- the taking into account of numerous passages that are often more random than for trams, particularly for common sections; there is a limit beyond which priority assignment becomes very awkward or unbearable for the other users;
- the taking into account of priorities at lights for two public transportation lines (BHLS or other) in conflict;
- the need for a real political will to ensure real priority at traffic lights and to make the system on-going. This could be more difficult to achieve and to maintain over time than in the case of trams.

In technical terms, giving priority to BHLS at intersections is little or no different than the solutions used for tram lines, except in the case of common sections (more frequent and more random passages, conflicts of public transportation vehicles and handling of turning movements).

5.1.1.4.2 The crossing of roundabouts

A succession of roundabouts adds to the discomfort for passengers, as the crossing of each of these means three curves and reverse curves, with frequent slowing down and acceleration, as well as variations in superelevation.

A BHLS should cross a roundabout like a tram for reasons of efficiency and passenger comfort

One solution could be to have a lane reserved for buses go through the roundabouts or, for turning movements, to have them avoid the roundabout with a direct lane. Specially adapted measures, particularly in terms of signing, can then be used as for trams.

With certain precautions, the use of mini-roundabouts which can be completely crossed could also be considered.

5.1.1.5 Road rules and signing as applied to the BHLS

Analysis of existing regulations shows that there is a certain level of priority along with rules of caution that apply to trams.

It would be worthwhile to give BHLS with reserved lanes the same road and signing rules as for trams.

In terms of regulations, such priority is non-existent for buses, even with reserved lanes. Buses, regardless of how they are used, are still considered automobiles, and must therefore conform to the general rules of the traffic regulations.

For the moment then, it is the rules of the traffic regulations that will apply to it, although studies are underway towards establishing equality between all surface public transportation modes that exclusively use reserved lanes: trams on roads, guided systems with tyres, buses, even non-guided.

With regard to signing for these surface public transportation modes, various developments are planned:

- a certain number of "non-tram" sites (the TVR of Nancy and Caen, the guided bus only at stops in Rouen) are already equipped with light signals that are usually used only for trams: R 17 intersection signals and driving assistance signals (effective taking into account, and announcement of change of state); other cities use driving assistance signals along with standard three-colour signals for buses; in light of the excellent results obtained (observed, but not formalised), there should be no opposition to using the light signals used for trams for all surface reserved lane public transportation systems. One of the advantages of this signing is that it avoids confusing users of other modes of travel who are used to standard green, orange and red lights;
- it should be possible to use the R 24 stop signal, intended for other users for (among other things) the crossing of tram platforms, in similar conditions for the crossing of platforms exclusively reserved for buses; an experiment for this is to be implemented;
- these evolutions suppose that the static signing intended for the other vehicles evolves in the same direction; for the moment, buses do not benefit from any specific priority rules, and this should be taken into account for signing at intersections, particularly those without lights;
- for pedestrians, as the common priority rules apply to pedestrian crossings of bus lanes, the common regulatory signing remains in effect.

5.1.1.6 The structural design of the pavement

The purpose of the pavement is to allow for vehicle circulation in appropriate comfort and safety conditions.

In addition to the needs of vehicle traffic, the pavement must meet requirements in terms of aesthetics, slipperiness, water runoff and easy recognition of the high service level road, particularly if there are no reserved lanes. The materials must be chosen so as to ensure that these qualities are present through the planned working life of the pavement or so as to reduce maintenance.

The quality of the pavement is very important for passenger comfort and the image of the service.

Also, the pavement materials must be chosen and their thicknesses designed with the same goal of maintaining their functional qualities and limiting maintenance.

In the interest of obtaining the qualities sought for this concept, we can successively examine the requirements for BHLS lanes based on the following 4 points:

- preparatory work,
- the choice of surface materials,
- the choice of the type of structure and the pavement design,
- the special case of stations.

5.1.1.6.1 Preparatory work

First, it is important to make sure that exterior factors such as trenches do not disturb the functioning of the line and its high service level or reduce the working life of the pavement.

In order to do this, we do a complete survey of all utilities running under the pavement, distinguishing parallel and perpendicular lines, transportation and distribution sheaths and connections. As for tram platforms, a complete rerouting of parallel networks is recommended, with limitation and/or renovation of the crossing lines. For more discussion of this point see section 5.1.1.7.

For other reasons, it is important to make sure that the surface water evacuation system is of good quality. In the event of rain, any flaw in this regard will greatly detract from the users' comfort, particularly at the stops.

5.1.1.6.2The choice of surface materials

The materials must be able to withstand the loads of buses. These loads are concentrated by the limitation of the wearing areas, especially on the reserved lanes, which is always the case for the BHLS. This concentration is all the greater for guided sites and stops, where the materials are subjected to particular horizontal stresses at the places where braking occurs.

This is a major and recurring problem which is responsible for most of the deterioration of reserved lanes, especially at stops (Grenoble, Caen, Nancy, Rouen, etc.).

In order to withstand rutting, the asphalt surfacing must be carefully chosen based on the traffic expected. Certain mixes should be avoided when there is heavy traffic.

Percolated asphalt mixes[1] can be particularly good choices.

Rigid materials such as concrete are highly suitable, as is thin, bonded cement concrete).

Modular materials, made to the state-of-the-art and on adapted structures, are perfectly capable of withstanding rutting. They are often ruled out however due to comfort, noise and upkeep constraints.

For safety and comfort, the materials chosen must be able to maintain their skid resistance and noise reducing qualities. The use of special materials that are visually distinguishable from ordinary roads is valuable.

Economic criteria must be given careful consideration. For a BHLS project, the best materials should be used, possibly the most expensive, in order to ensure good quality over time. This can lead to long-term savings on the upkeep of pavements and rolling stock.

5.1.1.6.3 The choice of the type of structure

The pavement structure chosen must be compatible as a support for the wearing course and must be able to handle the expected stresses, which could be very high.

Flexible structures ("as dug" gravel) should be avoided because of the risk of permanent deformation, as should semi-rigid structures (materials treated with hydraulic binders) in order to avoid problems of reflective cracking and its treatment. The other types are all well-suited, heavy duty composite pavement, rigid (concrete), or mixed.

The pavement design must take into account particular factors inherent to buses. The following parameters must be known or, failing that, estimated: the intensity of the

[1] They are composed of a very open-graded asphalt mix, the voids of which are filled with a grout that is usually cement-based.

traffic, its aggressiveness, the width of the lanes, the service duration chosen, the calculation risk, etc.

We can consult specialised documents for help in choosing the materials and in the pavement design for these roads.

5.1.1.6.4 The special case of stations

Stations are the points on the line where the difficulties are most numerous:

We must aim for a total absence of rutting at stations, which can require special treatment of these areas.

- these are the places where the traffic is most focused (for guided and non-guided buses), which is what is sought for docking to offer a very good level of accessibility;
- there are special constraints at stations due to the stresses of braking, acceleration and contact with the sides of the platforms, and all in the same places (corresponding to the markings for accessibility for wheelchairs or because the vehicle length corresponds to the length of the platform);
- the materials of the structure must withstand these constraints for longer periods than the standard sections, and this increases the fatigue and creates the risk of permanent deformations of viscoelastic materials such as asphalt mixes;
- any flaws can have serious consequences that immediately affect comfort and the quality of the docking, and possibly also for the flow of surface water;
- the handling of repairs in these places will be more difficult and disrupting that those done elsewhere.

The materials must be chosen with particular care in order to maintain the system over time, and especially to withstand rutting. It is possible and even recommended to change materials at stations to reinforce the visibility of the facilities and the importance they are given. There should however be a good connection between the structures (provide for a transition zone), and surface waterproofing for runoff water.

5.1.1.7 The value of diverting buried utilities

The diverting of buried utilities can be a heavy budget item for RLPT projects.

For trams, the presence of the rails creates an additional difficulty for the upkeep of utilities; this is an additional argument to justify moving them, with the corresponding costs, but it is not the only one of course.

For a BHLS project, this budget can reach the same level as for a tram; the following various advantages should be evaluated, from functional and economic standpoints, without forgetting the validated objectives of the high service level:

- Absence of any disruption of service during surveillance and maintenance work. This means that no diversions of BHLS lines could be accepted, especially in the event of emergencies.
- The maintaining of the quality of the pavement structures made, work involving digging trenches would not be acceptable.
- An opportunity for renovating utilities, increasing capacities, adding other utilities, etc. In this case, moving them would be easier to justify.
- The possible changing of the schedule span may reduce or may even remove any possibility of intervention outside of service times.

For all of these reasons, complete diversion is desirable. While some utilities are difficult to move, because of their size for example, we can have appraisals carried out and decide whether the risk taken in leaving them in place is compatible with the objectives of the BHLS line, particularly in terms of service duration.

5.1.2 Possibility of evolution towards a tram mode

A BHLS can be upgraded to a tram when:

- it was established to connect with rail systems and the increase in demand justifies the extension of the rail part;
- it was built as the first stage before the arrival of a tram;
- it coexists with other "tram" corridors and there is a wish to facilitate interconnections;
- it is saturated at peak times, and the service must be increased.

Total compatibility should thus be sought. Initially, some of the most difficult points or those which are difficult to eliminate might not be made compatible.

For example, these could be special points for which land acquisitions would only be necessary in the event the decision was made to build a tram. In some contexts a tram is easier to insert than buses however.

In terms of geometry, while the constraints in terms of horizontal alignment and longitudinal profile are greater for trams than for buses, the constraints for cross-section are greater for buses (non-guided vehicles). The upgrading from bus lanes can be done to a tram with a 2.65 metre gauge[1], which is easily compatible with the tram train. The station lengths must take into account the lengths of the planned “tram” vehicles.

The evolution of the platform-vehicle interface could require that the kerb have a different shape and height.

In terms of signing and the functioning of intersections, the transition from bus to tram should not involve any particular difficulties, especially if the planned modifications in regulations are taken into account.

5.1.3 The “safety inspection” mission for urban insertion and its usefulness

The "Urban Insertion" safety inspection mission is obligatory for guided transportation systems[2]. This service can be very worthwhile and useful, even if no guidance is planned in the short or medium-term in the BHLS project.

This service can be justified according to the context and scope of the modifications resulting from the new sharing of the roadway. It is strongly recommended if the BHLS project is to evolve towards guided equipment or a tram.

An inspection is especially useful for the safety of operations for the new sharing of the roadway.

As with a guided project, the advantages of this mission are the following:

- taking into account of the safety of passengers and third parties, as of the preliminary studies for the project;
- taking into account of accessibility for all;

[1] This is what was done in Montpellier in the Train Station – Antigone sector.

[2] This mission must be carried out by a qualified and approved expert or organisation, in reference to Decree 2003-425 of 9 May 2003 concerning the safety of guided public transportation)

- assistance for the choice of systems and signing, in observance of regulations, particularly at intersections;
- supervision and control of work.

5.1.4 The quality of urban insertion, necessary reflection

The urban insertion of a structuring transportation system leads to reconsideration of the sharing of modes, particularly in dense urban areas. In fact, it is a good opportunity for resolving the malfunctions of the traffic plan for the area.

A broader diagnostic is needed

The urban insertion of a high service level bus line must take into account a broader area beyond the actual bus route. Its obvious impact on the transportation system as a whole (public transportation, environmentally-friendly modes, motorised modes, parking, deliveries, etc.) requires a detailed urban analysis and appraisal to generate objectives for the conceptualisation of the high service level bus project.

Qualitative integration that is often seen as more difficult than for the tram

The tram mode theoretically gives the designer and the architect greater ease and freedom: grass planting or varied paving of the platform, freer design for a larger vehicle, presence of rails that also mark the ordinary site and the crossing of intersections, etc. For the BHLS, identification solutions will be harder to find for mixed-flow lane.

The urban insertion of a BHLS line could be done in very different ways in terms of architecture and urbanisation. It could be an opportunity for urban requalification (with or without constructions) to renovate the façade to façade space, to stimulate urban construction, to combine certain functions (stores, services, offices, etc.), to correct the malfunctions encountered, and to improve the quality of the urban environment, etc. The making of certain types of trams has been exemplary in this respect, but they should not always be taken as models with regard to costs, especially for lines with less traffic.

The urban insertion could also be discreet. It could be limited to the start of a process of urban reorganisation to be continued and extended later. It is important however to find the means to identify it in the areas it will go through and where it is expected.

Potential for mixed use that should not be neglected

The functional part must respect the environment, take into account all of the related uses, avoid intruding into the neighbourhood and maintain a certain transparency.

Choosing to conquer a space to the detriment of invasion by automobiles also means reserving a space to be dedicated to a function. Exclusive allotment of spaces can make the use and clarity of developments more complicated. It is worthwhile to seek greater clarification and to optimise the management of urban space when it is rare, and thus very valuable.

Then it is essential that the terms for the use of these new spaces be well defined in order to justify the technical principles for the separation and the transparency to be adopted.

This functional and urban economy approach can justify the choice of the type of BHLS site: reserved lanes whenever possible, but sometimes also shared lanes, mixed-flow lane or alternative solutions. These alternative solutions are very varied and there could also be flexible forms of use in time and space.

Analysis of the insertions of the tram lines in Nantes shows a clear evolution: for the first line, a sharp separation of uses was chosen. For the following lines, there was more transparency and much more flexible use of the platform, as well as mixed-flow lane with an adapted traffic plan and with acceptable productivity. In Rouen, the alternating, central slightly raised lanes are being crossed at very reduced speeds and their red colour contributes to the respecting of the use of the lanes.

5.2 Rolling stock

5.2.1 The type of vehicle, interaction with other concepts

In terms of rolling stock, it is important to first explain how the BHLS concept strongly interacts with the following three concepts, which are themselves all interconnected:

- trolleybus,
- guided systems on tyres,
- high capacity buses, articulated or bi-articulated.

A BHLS will most often be used for busy lines or even the busiest lines of the network (within limits compatible with the passenger rates of public road transportation). These are lines on which we could consider installing one of the three types of equipment mentioned above. A BHLS could very well work with standard articulated buses (18 m) or even standard buses (12 m) but conversely it would be hard to image that these three types of systems would not meet our criteria for the BHLS concept.

In general (except for special cases such as sites on slopes), the trolleybus can only be used for busy lines because of the investment cost for the overhead power lines. The busiest routes would seem to be the logical choices for priority deployment of equipment to reduce atmospheric and noise pollution nuisances beyond the trends seen with the most recent thermal equipment.

Guided systems with tyres represent a rather broad concept which has been much studied in recent years and which is now becoming less homogeneous because of the spreading of three different types of equipment: the bi-mode TVR, the guided Translohr (tram on tyres) and lastly the so-called “immaterial” guidance systems which, up to a certain point, overlap with the BHLS concept. A fourth type of equipment could be added: buses or trolleybuses guided with the help of a mechanical system, but this solution, developed some twenty years ago in Essen (Germany), didn’t develop as much as hoped. Only a very few lines were built in Europe and none in France. We will thus focus on the so-called “immaterial” guidance systems: optical guidance with CIVIS or the guided AGORA and electronic guidance with readjustment with Dutch PHILEAS transponders. The impact of the addition of immaterial guidance on the structure of the rolling stock can occur on different levels:

- For the guided Agora (particularly TEOR in Rouen), the rolling stock is identical to that used for classic buses, except for the addition of the camera and the associated on-board equipment.
- For the CIVIS the structure of the rolling stock is modified, with the making of a central control centre (as for a tram), which means relieving the drivers of their ticketing duties. But in its current version the base of the CIVIS rolling stock is very similar to that of a standard articulated bus (see comment on wheel motors in the accessibility category).

- The PHILEAS rolling stock is unconventional in various ways however, particularly with the orientation of all of the wheels, which tends to make it a single-track vehicle.

Three-section high-capacity buses (24 metres) have not developed in France beyond the experience in Bordeaux.

Projects have been carried out in South America but they are not necessarily applicable in France because of the very different conditions, particularly with regard to roadways. We would thus prefer to pay more attention to the very recent attempts made in Europe to introduce high capacity vehicles, on the order of 24 m. We can distinguish three types of situations:

a) 24 m vehicles with immaterial guidance which take us back to the preceding section on intermediary systems, although there is currently only one concrete example: the PHILEAS, but for only one of the vehicles made. All of the vehicles made for the Eindhoven project (only application of PHILEAS so far) are 18 metres except for one which is 24 metres.
b) 24-metre non-guided vehicles with thermal motorisation. Recent equipment was developed in Europe: the Van Hool (AGG300) high capacity bus. This bus is now in service in a small number of European cities. Of these, for the moment only the City of Utrecht has a significant fleet. There have been very interesting experiments with a vehicle of this type in some cities in Germany, particularly Hamburg, which placed an initial order for 10 vehicles. The Utrecht project could have very easily ended as for the MEGABUS in Bordeaux, i.e. a single project with no continuation, but the interest of the Germans in the technical, regulatory and “scientific” aspects (with the assistance of the University of Wuppertal) opened up new possibilities[1].
c) 24-metre trolleybus vehicles. An example is the project in Geneva.

Consequently, the BHLS concept can be realised with very different types of vehicles, as we have seen in particular in terms of capacity and possible guidance. The solutions can vary greatly in terms of energy supply, motorisation, interior design, etc.

5.2.2 Particular characteristics of the vehicle

Dynamic performance

This criterion can be important depending on the topology, while for flat sites its impact on the commercial speed is secondary after the impact of priority at lights and the making of well-protected reserved lanes. For sloping sites strong motorisation is necessary, and the use of electrical traction (trolleybus) is favourable in this regard.

Environmental performance

This does not specifically characterise the BHLS with respect to other bus lines. European norms apply to all new vehicles. The innovative aspect of BHLS lines tends to lead to the use of high quality environmentally-friendly vehicles however. This enhances the image of the service. Furthermore, the economic efficiency of a BHLS approach more easily justifies the innovation and the additional costs (within reasonable limits).

[1] Article in the review “Der Nahverkehr” check spelling cosigned VDV University of Wuppertal.

Vehicle seat capacity

This is a particularly important element of comfort. It will depend on the length of the journeys, on the quality of the driving and, as its corollary, the infrastructure (quality must be required for a BHLS).

Accessibility

As a reminder, the objective of accessibility for all was reinforced by the law of 11 February 2005 concerning equal rights and opportunities, the participation and civil rights of handicapped people. One of its provisions is that, within a period of 10 years, public transportation services must be accessible to handicapped people and people with reduced mobility.

For the BHLS, we can consider two levels of accessibility.

- **The first "standard"[1] level** is the one seen on all buses now in use: the making of low floors (70 or 80%) and a threshold 32 cm or 34 cm from the ground with a pallet for people in wheelchairs (with lowering mechanism if necessary); the recommended sidewalk height would then be 21 cm maximum. A 100% low floor at all doors is also possible; the use of "wheel motors" facilitates this type of installation but it has higher costs and is not necessary.

Bus guidance becomes more worthwhile when the platforms are of a suitable height.

- **A superior level of accessibility** is possible, either with an "immaterial" guidance system (like TEOR in Rouen or the Phileas project in Eindhoven), or through a system that is more rustic, less elaborate and less expensive, using mechanical kerbs that meet the tyres of the buses. In Germany there are the "Kassel kerbs" which have been used in several cities and also the "Dresden kerbs" which can be used for platforms to provide bus/tram compatibility.

  With reference to the first projects, this superior level of accessibility can offer regularity of docking as well as a "platform to platform" platform/bus interface of a quality close to that of a tram. The platform heights are between 27 and 30 cm. This higher investment can be justified by higher user demand or by a local context.

Comfort inside vehicles

The notion of comfort covers several topics. The quality that is experienced depends not only on the outfitting of the vehicle itself, but also on the infrastructure and the driving quality. Air conditioning or cooling is another factor that is not cited, and which should be considered as a function of the local context, just as for demisting.

Performance of passenger entry/exit flows

Beyond a well-designed waiting area, the number and the width of the doors with respect to the m^2 of usable floor space are very important criteria for busy urban lines; the interior design at doors is likewise a factor that should not be neglected.

Some countries (Canada/USA) are thinking about the value of having doors on both the right and the left, allowing for more flexible positioning of stops, but there has not yet been any development in this regard. In Curitiba (Brazil), the express lines have

[1] Accessibility equipment is obligatory for class I buses, in reference to European directive 2001/85/CE: the pallet must have a width of 800 mm and a slope of 12% on a platform of 150 mm. Kneeling becomes obligatory for long 800 mm pallets.

With regard to making accessible platforms for buses, see Certu's publication, *Buses and stops accessible to all*, methodological guide, August 2001.

doors on the left for direct connection at transfer stations with urban lines that have doors on the right.

The location of the ticket selling machines and validators on buses or on platforms can also affect the entry/exit flow performance (see section 5.3.1).

When there are many busy stops, ways to limit the time at the stops should be evaluated, for example with a bell that announces the closing of the doors as is the case for some trams and heavier modes.

In general, bus lines should not stop at every stop, passengers must request the stops. This measure could be valuable if there are very few stops however.

The "passenger" survey done by the RATP on the Trans Val de Marne and the T1 and T2 tram lines shows that "*the simple fact of having to request stops breaks the feeling of continuity and fluidity which is particularly strong on the two tram lines.*" "*The TVM is however seen as being particularly efficient and it maintains the human dimension of buses. The passengers are much more communicative on the TVM than on the two tram lines.*"

Vehicle design

Special attention must be paid to vehicle design and to vehicle identification in the field, which logically leads to specific assignment of vehicles to BHLS lines (like the TEOR lines of Rouen, the "trunk network" of Stockholm, the line 4 project of Nantes, the Nîmes project, etc.).

The image effect for the buses themselves is very attractive for elected officials and decision-makers, but this area should be handled as part of a comprehensive and coherent approach to the identification of the entire system and service offered – see section 4.4. For users, the design is not a fundamental factor influencing the quality of the service although, all other things being equal (if the fundamental needs of regularity and frequency, etc. are met), it can be a plus.

5.3 Modalities for operation and information

5.3.1 Applications of Intelligent Transportation Systems (ITS)

Operating aid system

This is not necessarily a characteristic of BHLS, although the features chosen can characterise a structuring surface line.

Reliable and constantly-available localisation, with DGPS for example, has become the standard for any new operating aid system. For the bus mode, which is flexible, it can facilitate regulation, especially management of downgraded procedures.

Downgraded procedures must integrate the constraint of assignment of BHLS vehicles on their lines (as in Rouen for its TEOR lines for example).

When various operators are authorised to use BHLS reserved lanes, their vehicles can affect the quality of the BHLS service. The condition of the authorisations on the following factors should then be considered:

- condition of use of commercial stops
- being localised and integrated at the control centre
- having phone link with the control centre
- activating priority at traffic lights

- be integrated in the BHLS downgraded procedures

Priority at intersections

This function is covered in the section on infrastructure. The operating aid system could handle the following tasks however:

- telemonitoring of proper technical functioning (availability);
- relaying of data for evaluation of system efficiency;
- monitoring of management of dynamic traffic light plans, for certain intersections;

Driving aid signing

These are signs that tell the driver the time for the taking into account of priority at traffic lights. The current regulations only explicitly authorise this equipment for trams. It is being tested at guided bus sites, and *as long as the regulations concerning signing are changed*, it could be authorised for BHLS. In general, these systems are appreciated and contribute to more flexible management.

Passenger information

This is not specifically a feature of the BHLS, because it is handled on the level of the transportation network, and the trend is of course towards multi-modal systems for transportation system areas.

There are generally particular specifications for structuring lines (especially dynamic information at stops and in the vehicles to take into account the need to provide information about problems). This will apply to all BHLS projects as part of the high service quality level defined for them.

Ticketing

Ticketing should not affect the running time on the BHLS line .

If high capacities are expected, particularly during rush hours, the ticket payment and validation procedures can substantially affect the efficiency and regularity of the BHLS.

The objective will be to minimise all of the negative effects on the boarding and alighting time, if this is involved with validation when exiting.

The new ticketing techniques can provide good solutions to save time and to provide the convenience that passengers seek, particularly for multi-modal, or inter-modal journeys.

There are many organisational choices to be made, and these will depend on the expected capacity level. It is important to analyse the impact of the combination of these choices on the time spent in stations (with many and fewer passengers), for all of the following functions:

<u>Sale of tickets:</u>

- on board by the driver: maintaining the driver's role in selling and checking tickets can affect the running time. This is not recommended for BHLS status;
- on board by an automatic machine: this is often the practice in Germany and in other countries (new Lisbon tram in Portugal). This practice seems to be highly appreciated.
- outside: sales on platforms are frequent at tram stations. This could be used at first at major transfer points.

<u>Validation or checking of tickets:</u>

- on board: practice used on buses and sometimes on trams, but this risks increasing the stopping time at stations;
- outside in the waiting area (for boarding or alighting): this system applies to trams; validation on platforms seems to be more efficient; the closing of the waiting area is effective in preventing fare dodging, but it involves many constraints; it could initially be used for major transfer points.

<u>Boarding of vehicles:</u>

- front door, with alighting at other doors: this is rather frequent for standard and articulated buses, and the first argument given for it is to combat fare dodging; this solution is often seen as one that can increase the time at stops. This view is not shared by all however. This approach is used in Toulouse on busy lines and very often in England, even on double-decker buses. It is thought that the productivity is not affected or is even improved: the flows are not contrary. However, people in wheelchairs and people with pushchairs are often allowed to board by the middle door (door equipped with a ramp).
- By all doors, as for alighting (especially for articulated vehicles and trams): this approach theoretically optimises the stopping time, particularly during very busy periods, and limits some constraints of long journeys in the vehicle. The layout of the buses also plays a role in the efficiency of the flows of boarding and alighting passengers.

Automatic counting of passengers

This tool is being more widely used and is becoming reliable. It can offer the following advantages:

- evaluation in real time for regulation decisions;
- better understanding of demand in order to optimise service scheduling;
- monitoring of quality indicators as a function of the number of passengers involved (service quality norm).

Safety systems for people and property

This is not specific to BHLS, it involves the entire network. The systems required for structuring lines may be different, particularly with regard to maintaining service in the event of problems.

In a BHLS vehicle, the isolation of the driver will not be required. If he is in direct contact with the users, he thus remains exposed to all forms of aggression. This vulnerability must be taken into account as much as for the rest of the bus network.

5.3.2 Operational considerations

Accreditation of drivers

While flexibility in assignment to all modes should be sought, a specific BHLS qualification for drivers seems essential and it should take the following points into account:

- the specificities of the vehicle used,
- the specific objectives of line regulation,
- docking and management of commercial time objectives,
- the objectives of careful driving, user relations.

A "driver" accreditation is recommended for a BHLS, although this doesn't rule out flexibility

As for the TVR lines of Nancy and Caen, drivers must have a TEOR accreditation because of the guidance. This is also planned for line 4 in Nantes, particularly for the quality of the docking.

User relations

This criterion is the fundamental basis of the good image of the bus mode: the driver is generally not isolated and is very available for all types of information and sometimes for the sale and checking of tickets. This mode brings the drivers closest to users, who greatly appreciate this presence.

This presence contributes to the feeling of safety and can be a big help for certain handicapped people (particularly for blind people or people with very poor eyesight) or elderly people (waiting until the person is seated to start driving for example).

In the countries of northern Europe, this "quality of user relations" criterion is frequently measured, and can lead to a bonus or decrease in remuneration based on the operating contract.

For a BHLS, we naturally seek to avoid all negative consequences for the running time. The conception of the bus driver's job should be adapted to the objectives in this area. For very high capacity bus lines, it might be best to adopt a tram configuration.

The users should be informed of the reasons for the type of relations applied, with adequate responses to particular requests.

Respecting of reserved lanes

This is an essential factor for the regularity and credibility of reserved lane investments. The same level of requirements will be expected for all structuring lines.

As with Germany and Switzerland, it would be particularly worthwhile to reinforce civic spirit and the monitoring of public areas in order to reduce the systematic use of anti-parking posts or automatic posts for control of access to the lanes reserved for public transportation. These posts make life difficult for pedestrians, and especially handicapped people (people in wheelchairs, blind or people with poor eyesight, elderly people).

The operator must have the authority to penalise any offences in the BHLS sites.

As in Rouen and other urban areas, it seems efficient to give the operator the authority to penalise illegal parking. These urban areas even considered that it was necessary to extend this authority to all infractions involving the use of these reserved or shared lanes.

The need for operating rules

Operating rules are obligatory for the start-up of a tram. They formalise all of the operating instructions and procedures to be applied with reference to safety and productivity objectives in the context of the line. An annual safety appraisal is also requested.

As with the tram, it is recommended that such rules be used for BHLS lines, adapted to the particular project context. These rules set the speed levels based on the environment and contribute to peaceful driving.

The availability of the services must be very good so that the users recognise the High Service Level. Intervention measures must be rapid and effective.

Monitoring of service quality

The service quality and level objectives and the systems for monitoring them are now very often present in urban public transportation operating contracts (Sections 2.4 and 4.2 on norm NF EN13816 certification). This must be taken into account for BHLS lines in order to give these lines a strong identity and image within the network.

6. The case of a section common to several lines

The approach of Lorient (urban transportation perimeter of 180,000 inhabitants) with its “Triskel” project inspired this section: this project involves building, in the centre of an urban area, a well-identified “common section” reserved lane system, through which most of the bus lines of the network pass. The idea, in this configuration, is not to create a hierarchy or to structure the existing network, but to reinforce its overall productivity by making a reserved lane system that is essentially limited to dense urban areas (where a large number of lines are concentrated). The project will also include a qualitative façade to façade renovation of the areas in question as well as a new sharing of the modes in favour of pedestrians, bicycles and public transportation.

This configuration seems suited to medium-sized urban areas.

6.1 Infrastructure

Where it is dealt with, its insertion will be that of a BHLS line as described in section 5. The handling of intersections and the signing will be equivalent.

On the common sections, tram type insertion and signing may also be implemented.

The stations must take into account the potential irregularity of the passages from the various destinations. The lengthening of the platforms, with no precise assignment of stops, is often the solution chosen. passing lane at stops on the reserved lanes are another solution, especially if some lines don’t stop.

The functioning of intersections with traffic lights should take into account the random arrivals of buses of the different lines. Their passage could be in groups of two or more if necessary, with waiting times that would be limited, but not zero. The same would be the case for roundabouts crossed by the bus reserved lanes. Nevertheless, average intervals of less than 2 minutes would alter the performances of the system, with this alteration becoming crippling as soon as the average interval falls below one minute over a length greater than several hundred metres.

The immediate proximity of the stations and the intersections with traffic lights naturally increases the difficulties mentioned above. There must be a possibility for sufficient storage of buses between the front of the station and the line where the lights take effect.

As in general the lines are not entirely treated, some irregularities could occur and be concentrated in the functioning of the reserved lanes.

The sharing of the reserved lanes with other modes, such as taxis and bicycles, would not be compatible for the same reasons mentioned in section 5.1.1.3.3.

6.2 Vehicles

These will not theoretically be differentiated between the lines of the network. Only the infrastructure will provide the visibility of the High Service Level, given to all the lines that use it.

In this configuration, the guidance of a line would be hard to justify. It would be more complicated to integrate different platform heights, with stop management requiring passing lane at platforms.

6.3 Operation and information systems

Several lines are involved in this configuration, so it would be difficult to graphically represent[1] a theoretical regularity of the passages in the common section, which would very likely be variable depending on the time of day.

Ticketing, depending on the system used, could downgrade the functioning of the reserved lane system, especially if the drivers are in charge of ticket sales.

An accreditation process for drivers is not justified, but training in docking is particularly recommended to optimise the entry/exit flow, particularly at very busy stops that will be located on the common section.

Special operating rules for reserved lanes should be implemented for the same reasons mentioned for the BHLS concept, section 5.3. All authorised operators involved must observe these (for inter-urban lines for example).

6.4 Identification of services

In this "common section" configuration, no line is theoretically identified as "High Service Level" by a particular mark or label, even if some differences between them exist in terms of capacity, frequency and comfort.

There are no major differences in terms of schedule span and this type of project does not lead to the creation of feeder services between lines, thus contributing to increasing the number of transfers involved in the journeys.

The reserved lanes become the only identifying element, showing the priority areas for public transportation.

6.5 Evolution potential of network

This common section strategy can reach its limits if traffic increases.

One possible evolution would then be to establish a strong hierarchy within the network by choosing the services to favour and by decreasing the number of lines on the common section. A strategy of BHLS structuring lines could then follow.

In Dijon for example, the central reserved lane system operated partly as a single lane was one of the operations that most improved the productivity of the network. This system is now almost saturated with 1300 buses per day. A hierarchy for the network was established in September 2004 (7 lines called Lianes) and it reduced this rate to 970 buses.

[1] Establishing service operation charts (in schedule or frequency mode)

7. The case of peri-urban or inter-urban services

7.1 The problematic

Beyond the areas managed by urban transport authorities[1], three convergent objectives reveal the need to promote rapid inter-urban links of about one hundred kilometres or so-called peri-urban links (30 to 50 km around an urban pole for example):

1. the desire to decrease automobile traffic;
2. priority and “rapid” service for less dense zones by public transportation;
3. efficient inter-modality with the urban public transportation network.

These services currently differ from the urban bus mode by the following characteristics: in general, the journeys go further and are longer, the inter-station distances are greater, the capacity and frequency are lower, fewer exchanges at stops, and accessibility for people with reduced mobility is harder to implement for high floors.

Two types of public transportation are appropriate for these links, with characteristics that differ from those of urban buses:

- Coaches (in which all passengers must be seated – class III vehicles) most often with the General Council as the organising authority.
- Rail transportation with various techniques (TER, tram-train) with the Region as the organising authority. This document does not cover this area.

There is increasing demand for the development of rapid and paced regular coach lines as a complement to rail transportation. Coaches are subject to unpredictable traffic conditions however, including the increasing and recurring congestion on the main access roads to these cities.

For example:

- the Voiron ⇔ Crolles Express line via Grenoble is greatly slowed down at the two motorway entrances North/West (A48) and North/East (A41)
- the Aix en Provence ⇔ Marseille line exceeded 2 million users in 2004 (10,000 per working day), making it one of the busiest lines in France. Its potential for increasing this seems limited by the non-existence of specific structures on the motorway and at its edges, and given the heavy traffic on the A7 and A51 motorways.

[1] i.e. outside of the Urban Transportation Perimeter defined in the LOTI law

7.2 The current proposals

There are several ways to give greater priority to coaches. We can distinguish the following two cases:

The case of non-motorway roads

The problematic here is similar to that for buses, the bus' construction environment is either non-existent, or not very dense and far from the road, or compact for the crossing of towns.

Beyond the initial and indispensable approach of optimisation of the existing operation, especially for intersections and stops, the developers can create reserved or separated lanes for all or part of the itinerary. At intersections with traffic lights for example, coaches could have the possibility of overtaking lines and passing with a specific green phase.

An interesting experiment is now in progress on the RN 4 between Wasselonne and Strasbourg (Bas-Rhin Department). A reserved lane was first created on a particularly congested "transition" section: it has a length of 1,100 m, is upstream and in the West ⇒ East direction, from the Furdenheim entrance (in the middle of the itinerary). The results have been very positive in terms of running time regularity, which makes it easier to follow the schedule. The experiment will now be extended to the whole itinerary.

The case of motorways:

On these axes, it is strongly recommended to give priority to examination of the possibilities for improvement of the overall operation of the motorway system based on the following orientations:

- control of speeds, particularly before congestion in order to maintain fluid service
- video-monitoring and automatic detection of incidents
- regulation of access during peak periods:
  - entrance: adapting demand to the capacity supply and giving priority to Coaches
  - exit: controlling the intersection extremity to avoid lines backing up on the motorway and giving priority to Coaches
- closing of certain access points (entrances and/or exits) at peak periods
- access authorisation (entrances and/or exits) reserved for coaches

After having exhausted all of these possibilities, we can then consider heavier infrastructure solutions. With reference to the state-of-the-art in Europe, we see two main systems that have been used to give priority to public transportation systems:

1. Creation of axial or lateral reserved lanes that cannot be crossed (uni- or bi-directional lanes).

   This option is being considered for a lateral reserved lane for the Crolles ⇒ Grenoble direction on the A 41 (Chambéry ⇔ Grenoble)

We note that this option is in fact the creation of a heavy RLPT.

2. Creation of a lateral reserved lane.

This option is being studied in the Saint-Égrève ⇒ Grenoble direction on the standard section.

We note that this option should first be applied in sections that are congested on a recurring basis.

What right of way to use for the reserved lane on motorways?

This is a major issue.

It was quickly agreed that the expression "free circulation of coaches in the emergency lane" was inappropriate.

The emergency lane has a special status (see traffic regulations, article R412-8) and driving is forbidden there except for emergency, police and maintenance vehicles. Furthermore, its width is less than that of a standard traffic lane.

There is no obligation to create an emergency lane. This is the case for many sections of motorways, particularly when they are on viaducts or in tunnels. It is only forbidden to stop in traffic lanes, so the principal must reserve specific spaces for emergency stopping outside of these lanes. An emergency lane is generally built for this purpose, but simple safety zones that are spread out in an appropriate way can be sufficient. Also, an emergency lane is not recommended at access points (entrance, exit and weaving). It is replaced by a cleared right-side strip.

It was this regulatory opening that allowed for experimentation with the reserved lane on the exit ramp in Grenoble.

On the standard section, on the existing right of way of a motorway, it is often possible to create an additional lane by reorganising the traffic lanes: decreasing the widths of the traffic lanes and replacing the emergency lane with a 3.50 m reserved lane after levelling of the pavement structure if necessary. Safety zones are installed about every 500 m. The great difficulty is making this reserved lane at interchanges and on access roads, not just because of the geometric conception but also to provide the maximum level of safety, particularly at exit ramps. One essential condition: the maximum speed on the motorway must not exceed 90 km/hour. The absolute differential of speeds between the normal traffic and the Coaches must not exceed 20 km/hour with a maximum recommended speed for coaches in the reserved lane of 70 km/h.

Beyond the design of this lane in the standard sections and/or at interchanges, there is the issue of the specific status of the reserved lane. There is also the issue of signing for it, both vertical instructions and horizontal markings.

The last difficulty, and not the least, is to promote continuity on the non-motorway network of the High Service Level that the Coach lines achieve on motorways. The intersections of interchange access roads must give priority to these coaches. These Coaches must then be able to circulate in full complementarity on the urban network and particularly in the BHLS infrastructure.

The General Council of Bridges and Roads brought together a working group and should submit a summary report on the knowledge acquired in France and abroad and on the progress with the experiments in this area. This report is currently entitled

"Analysis of possibilities and conditions for the use of emergency lanes on express roads for coach traffic." It will offer development recommendations.

7.3 Outlook for development

With reference to the experiments and difficulties encountered by the organising authorities, we can see here how appropriate it is to think about the development of a "High Service Level Coach" concept to be included within a structuring "High Service Level Public Transportation" network on the scale of a whole urban area. This service must be designed to fully complement the existing services, particularly rail services.

This High Service Level Coach technique, which can be integrated with the BHLS, can, in many cases, allow for a better distribution, on the scale of an urban area, of the investments for the whole structuring public transportation network without having to suddenly invest heavily in a single line (metro, tram-train, express regional tram, etc,).

Lastly, but a very important advantage, if the creation of this type of service on infrastructure with motorway characteristics can avoid the creation of an additional traffic lane or – though this is much more difficult – lead to the elimination of a motorway lane, then its value is obvious.

This development outlook will require changes in the following areas:

Infrastructure

In order to offer an efficient service, the line should have a schedule and journey times that are respected. Reserved lanes take on their full importance during the times when congestion hampers the services.

Also, in order to bring credibility to any reserved lane system, the frequency must be sufficiently high. There could be integration of several lines or other modes, such as car pooling, ride sharing or taxis.

Rolling stock

Without limiting the innovation to the design, there is research and development for vehicles that are better suited to the needs of these high service level coach lines. The goal is to improve comfort and to offer on-board services, but also and above all to optimise accessibility for all[1]: the final report of action COST 349 "Accessibility of coaches for people with reduced mobility" is expected at the end of 2005.

Ticketing

As for urban buses, ticketing can increase the boarding time, because in most cases the driver handles almost all ticket sales and checking. An inter-modal service with the urban network would certainly be an important step forward.

Interoperability with the urban BHLS network

[1] As for urban buses, the inter-urban lines are affected by the new law of February 2005 concerning equal opportunity for handicapped people.

The rapid Coach lines are to connect with the structuring urban network, and thus with the possible BHLS lines so that passengers benefit from service level continuity.

With the need to use the same infrastructure, the difficulty will be in obtaining technical compatibility between the two systems, both in terms of docking (different threshold heights) and for issues of operations and passenger information (supervision by the same control station, coordination of passages, priority at traffic lights, management of problems, integration with the same signing and regulation of reserved lanes).

Coach services generally have larger inter-station distances, even in urban areas, which could require passing lane at stops for example. We can also imagine transposing the "tram train" approach to these services to provide good service in the urban setting.

Identification of the lines

As for the BHLS, the transportation service must be identified. The vehicles are assigned to the line and already have very visible messages or markings indicating the service, which contributes to this identification. What is not so easy however is that it there be better adaptation to stops and the infrastructure for the High Service Level.

8. Research and evaluation needs

The innovation can come from national or European research and development programmes, as well as from local initiatives or the analysis of foreign experiences. In this area, as some observers have noted[1], we must not merely seek to transpose what works well elsewhere. Cities are not all the same, they differ in their geography, mobility practices, constraints, and their economic conditions (for example the hourly cost of drivers if we consider cities of other continents). It is preferable to seek to understand the concepts implemented as a whole (infrastructure, vehicle, operation and use) and also in their context, to then draw on the technical and organisational strategies which are at the heart of performance.

The research and evaluation needs are very diverse, they are on different levels (technological, organisational, urbanisation, social, etc.) and it is not always easy to distinguish the specific BHLS needs from the other more general needs for urban public transportation networks. Here we seek to identify the needs that more particularly apply to the BHLS, without necessarily being exclusive regarding this mode.

Furthermore, this concept work for the BHLS has shown that it is useful to develop synergies and coherent strategies between the RLPT surface modes, buses and trams, when we are aiming for a High Service Level.

The ideas below, organised around several topics, present some of the evaluation and research needs that were identified:

8.1 For the Vehicle

- **For accessibility**: need for complementary evaluations concerning the performances on the horizontal and vertical gaps for the various manual, assisted or automatic docking solutions: the development of "telemetry" type equipment allowing for automatic processing by laboratory buses (planned on TEOR by Siemens, and on the line 4 Busway of Nantes).
- **For results from experiences with optical guidance:** in light of the experiences of Clermont Ferrand and Rouen, it seems useful to capitalise on the optimal conditions, or the areas of use that are most valuable for this type of guidance (type of line, minimal capacity, type of stop, etc.).
- **For the evolution of immaterial guidance:** progress is still to be made for immaterial guidance. In the short-term, the "Lateral and Longitudinal Guidance System for Reserved Lane Buses" project was launched by PREDIT in order to improve optical guidance (CIVIS and guided AGORA type) and longitudinal positioning. In the medium-term: investigations of other types of guidance (magnetic, etc.) will be considered. Initially, guidance represents one of the aspects among others of the accessibility category addressed above in a general manner, and it can also have an impact on lateral guidance. Thereafter, another objective could be the reduction of the area used at the site, although this point is more sensitive and it is not certain that it could be

[1] In particular Gorges Amar in his work "Urban mobility, in praise of diversity and the need for inventiveness."

achieved without the installation of mechanical kerbs, which would make the infrastructure more complex.

- **For retractable rear-view mirrors or rear-view camera**: the sweeping of the rear-view mirrors at the stops requires that passengers move back if good docking is desired. The problem is greater in the case of guided buses. These practices are well-known for the tram mode and have been fully satisfactory (moving back 20 years for retractable rear-view mirrors in Nantes, and rear-viewing by cameras on the new trams).
- **For the development of bi-articulated buses:** special attention should be paid to possibilities for increasing capacity, because on some lines this is a limiting factor for the BHLS. With regard to bi-articulated vehicles, contacts have been made with the University of Wuppertal which is taking part in an evaluation of Van Hool bi-articulated vehicles, for which the first applications are appearing: see § 5.2.1.
- **For trolleybuses and their bimodality:** the development of the BHLS concept could be an opportunity to return to these electrified bus solutions, but in full awareness that much work was done in France and Europe in the 1980’s, with few results. The new possibilities should thus be well targeted and could come, as for hybridisation, from the use of new storage components (super condensers and new batteries) used with different specifications to achieve bimodality.
- **For on-board auxiliary systems:** this point is of particular importance because of the increased needs on the most modern buses (air conditioning, for example) and thus the increase in energy consumption, sometimes with low yields. Starting from a common base, work can be done with a few particular specificities and optimisations depending on the characteristics of the vehicles and their motorisation (thermal, electric, hybrid).
- **For taking bicycles into account:** we see requests for authorisation to take bicycles on board vehicles (as for TEOR in Rouen). Configurations were authorised with certain precautions (as in Annecy for a special mountain bike site). It would be useful to do a survey of the state-of-the-art, including things that are happening abroad, and to formalise the most interesting developments.
- **For standardisation** of equipment in order to lower costs.

8.2 For the “clean bus” aspect

In general, work on clean buses is not specific to the BHLS, but it is of course the BHLS lines, or at least some BHLS lines, that can be expected to go beyond the general trend. Special attention has thus been paid to hybrid buses for example. Various projects have already been carried out, particularly for the parallel electric hybrid solution with batteries. To go further, it will be necessary to work on other solutions: new parallel hybrid architectures or parallel series, the use of new energy storage systems: supercondensers, new batteries (the use of inertia wheels in buses seems theoretically less promising but tests have been carried out in Holland). Hydraulic hybridisation with oleopneumatic accumulators seems to have been abandoned in recent years, but it could perhaps be of interest to researchers in the years to come.

8.3 For infrastructure

- **For pavements:** within the framework of Group 10 of the PREDIT (Vehicles and infrastructure, integrated developments) and following a tender offer a project was launched for surface public transportation platforms: the DEVIN project. Beyond this, other projects could be carried out to optimise bus platforms.
- **For the evolution of the signing of reserved lanes:** as indicated in the corresponding section, strategies were implemented to have a common approach to signing between BHLS and trams. There should also be further thinking on regulatory changes (priorities granted to the BHLS in comparison with trams).
- **For road safety for reserved lanes:** it is important to measure the impact of the creation of reserved lanes on the safety of the project surroundings. An evaluation analysis on several large sites such as the Trans Val de Marne could improve our knowledge on this subject. An accidentology observatory was established for tram lines and could be extended to BHLS.
- **Research for better coexistence of pedestrians** and BHLS on the platforms could be undertaken (sound, tactile perceptions – warning of approaching buses as for trams, etc…)
- **Broadening of research on the possible cohabitation between BHLS and other modes, particularly cyclists and taxis**, taking into account specific configurations (given that the sharing of BHLS lanes should generally be avoided). Research and evaluations can also focus on the juxtaposition of infrastructures, for example bicycle paths with a BHLS reserved lane system, with taking into account of special points such as bicycle paths at BHLS stops.
- **Capitalisation and distribution of technical information** for the many “infrastructure” insertion tools that are developed, especially for trams – evaluation of certain references.

8.4 For the economic analysis for the BHLS

This is a sensitive subject that requires many precautions, because the local context has such a big influence. It concerns all the actors.

- Analysis of the socio-economic appraisal of BHLS projects
- Monitoring of investment costs according to the “DGMT” breakdown of the old projects taken into account;
- Follow-up/evaluation of operating costs by line or type of line. New criteria could be introduced. These evaluations must take into account the associated performance criteria as well as the major constraints of the context.
- Follow-up/evaluation of maintenance costs, particularly those concerning certain recently introduced components (such as pallets, etc.) or technical innovations such as guidance and its associated components.

8.5 For the identification of a BHLS service

- **State-of-the-art** of the strategies adopted (in Europe in particular);
- **Evaluation of the impacts on passengers**, consequences on marketing strategies, lessons;
- **Research on ways to "highlight"** to identify a BHLS, particularly when the vehicle is not visible. A comprehensive system approach should be sought with development of a methodology that takes into account the first study phases of a project.

8.6 For the acceptance of the BHLS reserved lane system and the modalities for consultation

- **Research and capitalisation on consultation methods**, and explanation and decision-making methods for BHLS projects; research on situations involving blocking by the public (particularly local residents and merchants);
- **State-of-the-art for experiences of installation of reserved lane systems**, their successes, failures (resolution of problems through inter-municipal arrangements, axis committees, transversal policies, analysis of failures in order to learn lessons, etc.)
- **Research on the carrying out of public debates** and the participation of the public (consultation, public enquiry): what information needs for the public? In what way?

8.7 For ergonomic efficiency for passengers

- **For the platform/bus interface and improvement of knowledge of efficiency factors for passenger flows and their interactions:** the number and width of the doors, the waiting area, the interior configuration of the bus, the occupancy rate in the bus and on the platform, the quality and regularity of the gaps, the ticketing procedures, the various strategies for validation without contact, boarding by the front door or by all of the doors.
- **For the needs of complementary services** for users to include in the BHLS (announcement of points of commercial, tourist, or cultural interest, interactivity) in the continuity of projects already carried out, particularly at INRETS LEOST.
- **For passenger information** taking into account the specificity of the BHLS concept, concerning multimodal information, information in real time and paper documents made available to users (maps, schedules, etc.) to properly distinguish the hierarchy of the network including the BHLS. This work could overlap with that planned for the Marne la Vallée Polytechnicum competitiveness pole for example, with INRETS and the operators.
- **For the clarity of the schedule** (rhythm).

9. References abroad and in France

9.1 Brazil, the integrated network of Curitiba[1]

Curitiba is the capital of the State of Paraná. It includes an attractive city centre surrounded by several urban poles. Like all large cities in Brazil, its expansion has been very rapid (annual average of 5% from 1950 to 1980) and it now has about 2.5 million inhabitants. Curitiba has become a reference in the public transportation milieu, partly because of the integration of urban planning and transportation, and also in terms of the organisation of a bus network with a hierarchy. The urban planning/transport integration began in the middle of the 1960's, with a very specific master plan. The principle of hierarchy was applied to the design of the road network and the public transportation network, which is structured exclusively around buses.

As of the 1970's, the main lines were gradually brought into the reserved lane system and equipped with "tube stations," a concept that made Curitiba known throughout the world. In 1974, the first structuring line came into service, with "bus alimentador" connections, i.e. feeder lines. In 1977 and then in 1980, two other structuring and diametral "omnibus expresso" lines were opened. Then peripheral "interbairos" links were created, allowing for non-diametral connections. It was at that time that large sections were arranged in reserved lane systems with the establishment of the "tube station" concept reserved for structuring lines (mix between bus and metro). It offers a particularly reliable "platform-bus" interface with ticketing integrated before waiting for the vehicles (tickets are paid for just before entering the waiting area from a ticket seller present at each tube station).

In 1991, the direct line concept was created, with station spacing of more than one kilometre. The particular technical feature is the doors on the left of the vehicle that are compatible with the "tube station," which allows for very good connections with the structuring "expresso" lines.

In 1992 the first bi-articulated buses appeared on the "expresso" lines in order to meet the ever-growing demand on these routes. This bi-articulated bus, built by Volvo, is like the Mégabus developed in Bordeaux (24.50 m long and 2.50 m wide) with an extra double door.

This line hierarchy is particularly visible for the user as a specific colour is adopted for each type of line. The "standard" buses are yellow, the "alimentador" buses are orange, the "expresso" buses are red, the "interbairos" buses are green, and the direct line buses are grey.

On the busiest line, there are on the order of 15,000 passengers per hour and per direction at peak times, with an interval on the order of one minute, or even less. The system has reached its capacity limits and regularity is hard to maintain in these conditions. Priority at lights is no longer possible. The commercial speed is declining and is now at about 20/21km/hour at peak times.

[1] Source: article ATEC No.165 Alain Meyère and François Rambaud – June 2001

The efficient interface between the 24.5m bi-articulated bus and the tube station, platform height of about 70 cm
Source Certu.

Integratoin of an express line near the centre
Source Certu

Integration of an express line in the centre
Source Certu

9.2 United States, the BRT concept

Inspired by Curitiba's example, the FTA (Federal Transport Administration) approved a project to formalise a "BRT" Bus Rapid Transit concept that would be flexible and adapted to the many requests for financing of the development of public transportation, especially tram projects. In a urban context that differs from ours, with more roadway space and numerous and wide urban motorways, it was important not to rule out "bus" solutions and to integrate all of the "ITS" tools that were being developed: localisation by GPS, priority at lights, dynamic information, ticketing, safety, guidance assistance, immaterial coupling between vehicles, anti-collision systems, etc.

To launch this movement and to support it, the US government appointed the "WestStart-CALSTART" association, which is in charge of developing new industrial technologies with the following objectives: improving air quality, promoting efficient use of energy resources, and creating highly qualified jobs.

Over more than a dozen years, 30 cities have carried out recognised projects and some of them have been evaluated. Many documents and reports have been published, including technical guides for making BRT. These guides are cited in the bibliography (On the TCRP 90 report, a photo of TEOR in Rouen was chosen for the cover page); some of these documents can be downloaded free of charge at their site "http://www.calstart.org/" and a newsletter is sent out regularly (subscription at site).

The BRT concept is a flexible concept, with a teaching objective for the method. A comprehensive approach is favoured. This concept integrates all of the configurations that can be found with buses: very urban or inter-urban configurations using reserved lanes on motorways, and possibilities for bus guidance.

The World Bank has taken a particular interest in this BRT concept and now supports it in many poor and developing countries (Colombia, Indonesia, South Africa, China, etc,). High capacity and clean bus technology is not complicated or difficult to implement and develop. The Transmillenio of Bogotá is very often cited as an example. The improvements in terms of running time, passengers, the decrease in accidents, and the decrease in pollution have been impressive. The operating costs are in equilibrium with the receipts. But these buses use high floors, a strategy that we have abandoned.

Source: University of New York, Buffalo – TRB 2005, example of particularly successful BRT identification in Los Angeles (USA): the Rapid Bus; this colour and logo are also included on the bus shelters

9.3 Canada, the BRT concept and some major examples[1]

Within the framework of a congress, the Canadian urban transportation association published an "SRB" concept (Service Rapide de Bus, a literal translation of BRT from the United States) adapted to Canada in April 2004 with, in appendix, the detailed descriptions of many references. It draws inspiration from the approach used in the USA, but also from the long experience with several well-known projects in Canada: Ottawa, the oldest (started in 1983), Montreal, Vancouver, and Quebec City. The movement is well underway; twelve other projects are being built or are in planning. The infrastructure is fundamental in this concept because the objective is to carry out projects with high capacities by integrating local and express services within the same infrastructure. Canada does not have an automobile industry, as it is too close to the USA, which is particularly dynamic in this sector. It does however have a bus and coach industry, which has understood the value of supporting the "BRT" approach, which economically justifies the investments in terms of research and development as well as the additional costs for innovation.

There is a strong tendency to use brand logos to identify the service and the BRT line, and thus to clearly differentiate it from the other services.

Logo of the B line in Vancouver

Logo of the BRT of Ottawa

Some information about the B line in Vancouver:

The Vancouver urban area has 2.1 million inhabitants and its centre offers 16% of the jobs (130,000), 46% of which involve the use of public transportation every day. The public transportation network is composed of heavy rail modes and the main bus lines that come into the centre are designed according to the specifications of the "B line" label, the BRT concept of Vancouver. Two lines are in service, a third one will be starting soon. Below are the main characteristics and appraisal elements for these 3 lines[2]:

[1] Source: Canadian Urban Transit Association – Bus Rapid Transit, a Canadian industry perspective - April 2004.

[2] Source TCRP report 90 "Bus rapid Transit" - 2003; volume 1: case studies in BRT.

Performance of the "B-Line" buses			
	#99 B-Line Broadway-Lougheed	#98 B-Line Richmond-Vancouver	Projected #97 B-Line Coquitiam-Lougheed
Start of service	Sept 1996	August 2001	
Length	27 kms	16 kms	10 kms
Average station spacing	1.9 kms	900 metres	550 metres
Running time (peak hours)	70 minutes	44 minutes	30 minutes
Commercial speed	23 km/h	22 km/h	20 km/h
Number of identified articulated buses "B line"	28	28	9
Frequency	From 4 to 15 min	From 4 to 15 min	From 10 to 15 min
Annual trips	7,200,000	4,200,000	1,800,000
Trips per day	26,000	14,000	6,000
Hours of service per year	91,000	71,000	49,000
Annual cost	$7.5 million	$5.8 million	$4 million
Annual receipts	$7.2 million	$5.2 million	$2.2 million
Cost per passenger	$1.04	$1.38	$2.22
Passengers per bus and per hour	79	59	37
Rate of cost coverage	96%	90%	56%

Source: Leicester, Glen. Bus Rapid Transit Development in Vancouver, B.C. Compendium of Technical Papers, 2002 Annual Meeting, Institute of Transportation Engineers Philadelphia, PA, August 4-7, 2002.

Vancouver, the 98 b line with reserved lanes
Source CUTA

Some details about the Transitway of Ottawa:

The Transitway network, the largest in North America, is located in the administrative and political capital of Canada (700,000 inhabitants). The Transitway was started in 1983 and is connected to heavy rail modes. It offers a highly efficient 60-km long BRT network. It can reach very high rates, 200 buses per hour and per direction and 10,000 passengers/h per direction, thanks to common sections that also integrate secondary lines. The main characteristics of these three lines are given below[1]:

- Length: separate site for 26 km; reserved lane for 16.1 km; ordinary site for 18.1 km; total: 60.2 km.
- Number of stations: 28; platforms: 6 m wide and 55 m long.
- Lane width: main axis of 13 m (2 lanes, 8 m with 2.5 m of shoulder for snow clearing operations); at stations: 17 m (2 lanes for docking and 2 for passing)
- Capacities of the parking lots: 2140 places (4 parking lots)
- Attractiveness: 200,000 passengers per day; peak of 9,000 to 10,000 passengers; 70% pass holders.
- Bus services: 700 buses; number of BRT lines: the 95 and the 97; number of buses at peak times per direction in the city centre: 180 at morning and evening rush hours.
- Rate of coverage of operating costs: about 60% .

Ottawa, the central station of Tunney's Pasture on the Transitway
Source CUTA

Ottawa, a station in a peripheral area on the Transitway
Source CUTA

[1] Source TCRP report 90 "Bus rapid Transit" - 2003; volume 1: case studies in BRT.

9.4 Japan, the Key Route Bus System of the City of Nagoya[1]

Located between Tokyo and Osaka, Nagoya is the fourth largest city in Japan (2.2 million inhabitants). It recently hosted the universal exhibition "Love and Earth" (March 2005). The public transportation network includes 89 km of metros, with high capacity service and very good frequencies. It also includes 732 km of bus lines, with attractiveness that has been steadily falling since 1964. Despite the strong growth in metro journeys, the market share of public transportation has remained stable, as that of cars has increased at the expense of walking, an observation that is often true for France as well. The response to this appraisal was to promote a "Key Route Bus System" (KRBS) starting in 1980: this is a network of 8 lines (81.4 km) to complement the rail network and the metro with the following main principles:

- aiming for a speed of 20 km/h,
- an increase in visible reserved lane infrastructures (yellow);
- very comfortable stations and inter-station distances of 600 to 1000 metres;
- service from 6 AM to 12 AM and a frequency of 2 to 3 minutes at peak times (10 at off-peak times);
- accessible, air-conditioned vehicles with wide doors, and the integration of ITS (priority at traffic lights, etc.);
- The development in some sectors of different level bridges dedicated to buses, equipped with simple axle guidance (principles of the O-Bahn of Essen, of the Superbus of Leeds) – adopted in 2001; the guidance here allows for limiting the width of the right of way, the rollers are retractable.

Two projects are now operational (since 1982 and 1985). They were carried out with standard buses and low infrastructure costs (€2 million per km on average). Some projects are experiencing delays due to difficulties of insertion and cost effectiveness.

The evaluation of the second line (Shindekimachi KRBR) indicates:

- growth in passenger use of 27%;
- a reduction in running time of 15 min with much better regularity (the stops were decreased from 23 to 17, which made it possible to cut the commercial stop time in half);
- a reduction of the average speeds of individual cars of 1.2 km/h on average over the course of the day;
- a rather low modal transfer from individual cars, about 4%;
- reactions from local residents that are mostly negative. First, the nuisance of the increased congestion (40%), the best positive evaluation is the greater ease of reaching the city centre or other sectors (20%); the negative opinion about the stops being further away with the need for more walking, a narrower sidewalk does not reach 10%.

[1] Source: City of Nagoya, "Street planning Division" - presentation and evaluation report of 1986.

Nagoya, integration of reserved lane system in centre, “center lane Key Route Bus”
Source City of Nagoya, ”Street planning Division”

9.5 Sweden, the “Trunk network” of Stockholm[1]

The City of Stockholm has 760,000 inhabitants and adding in the suburbs there are about 1,700,000 inhabitants. The public transportation network is extensive (50% modal share in the city) and includes 410 bus lines, 3 metro lines, one tram line, 3 local railroad lines, 4 regional railroad lines and two ferry companies.

In order to maintain the advantage of public transportation, the city decided to improve the bus network, establishing a hierarchy for it through the creation of the “trunk network,” five major High Level Bus Service lines (79 km in all) with a very distinct design and clearly announced efficiency objectives:

- A commercial speed of 18 km/h, for an increase in running time of 35%;
- Blue articulated vehicles, distinct from the red buses of the other lines;
- Extending of the inter-station distances: from 200/300 m to 400/500 m); reserved lanes, priority at traffic lights;
- Stops identified with a specific colour code;
- Spacious shelters and dynamic passenger information giving the waiting time;
- Special numbering of these lines (from 1 to 5);
- Better interconnection with heavy modes.

An overall cost of €44 million was estimated for the infrastructure (€0.6M/km).

Following the implementation of the first services, very encouraging results and certain difficulties were observed:

- Increase in ridership of about 50 %, although the running time objectives were not yet met
- Creation of deferred reserved lanes (delays with diversions of peripheral roads that did not lead to the decrease in road traffic that was hoped for)
- Good comprehension and clarity of the new network, although the idea of a blue line painted on the pavement was refused by the city architects

The project requested having boarding by all of the doors to save time at commercial stops. This was refused, even though articulated buses were used. The drivers were in charge of checking tickets and this principle was maintained. People with pushchairs and wheelchairs have the right to board by the central doors. Better docking and the new low-floor buses made it possible to maintain the stopping time.

[1] Source article ATEC n°164 Yves Robin-Prévallée April 2001 and Sten Sedin evaluation report, AB Storstockholms Lokaltrafik.

Stockholm, one of the lines of the "Trunk network"

Source Sten Sedin, AB Storstockholms Lokaltrafik.

9.6 The MOBILIEN concept in the Île de France region

A concept called "Mobilien" was created and implemented by the DREIF and the STIF (Syndicat des Transports de la région Île de France). Justified by the urban transportation plan, a potential 150 major bus lines were chosen to be "Mobilien line" eligible. In order to meet the objectives of this concept, financing was reserved and the work projects must follow a very precise methodology. The first projects are now in service, such as lines 38 and 91 in particular, located in the heart of Paris. Faced with a dense and particularly difficult urban context, the results in terms of productivity remain limited (a 20% improvement in running time was sought, when a speed of 18 km/h cannot be reached) but still encouraging: an increase in the number of passengers is beginning to be observed.
A strong identification programme for all of these Mobilien lines was not included in the concept, which makes any communications operations more difficult.
In parallel, the RATP has been thinking about a "BRT French touch" concept within a group called "ASTUS" (The Future of Urban Surface Transportation Systems). A report was published in September 2004 and was used in our thinking.
The financing for these Mobilien projects ranges from €1 to 2 million per km on average, for infrastructure alone.

In the Île de France the bus lines can have very different configurations, and some projects are very ambitious. The Trans Val de Marne is clearly in the BHLS category. The TVM (12.5 km), built in 1993, is a reserved lane urban transportation system that uses articulated buses and that runs between St-Maur-Créteil and the Rungis Market (south of Paris). Thanks to its infrastructure which is 93% protected lanes, the service is efficient, rapid and regular:

- 12.5 km between end points,
- 600 metre station spacing,
- daily traffic of 23,000 journeys when service began, more than 35,000 today,
- a commercial speed of about 23 km/h.

Its extension to Croix-de-Berny – RER B will bring service to another four towns. This extension, to be put in service in 2007, will have the following characteristics:

- an additional 7.2 km,
- creation of 9 new stations,
- a bus every 4 minutes during the rush hours,

- easier connections with the metro line 8 and the RER A, B and C lines.
- A cost of €45.19 M (based on the preliminary scheme), or €6.3 million/km. This is an overall urban development cost that includes: client's and project coordinator's expenses, land acquisition, work, and also acquisition of vehicles.

In addition to this extension to the West, consideration is being given to an extension towards the East to connect the St-Maur-Créteil terminal station to the Boullereaux RER E station (4km).

Line 91
axial, bi-directional arrangement

Source RATP - Paris

Line 38
lateral protected corridor
Source RATP - Paris

Trans Val de Marne, axial arrangement

Source RATP – Île de France

9.7 Evry, a RLPT network designed in keeping with the new city[1]

The Evry urban area (about 110,000 inhabitants), a new city of the Île de France region decided on in 1965, was designed in the 1970's according to the principle of the separation of urban functions, housing, activities, leisure and spaces devoted to transportation according to the various modes (pedestrians, two-wheel vehicles, individual cars, public transportation).

The issue of public transportation was addressed from the outset of the project with regard to travel to Paris and also with an emphasis on local service within the new urban area, which was originally intended to welcome more than 450,000 inhabitants.

This Evry site, still too little known, is quite remarkable because of this integration of public transportation, the best example of this in France. The means chosen in Evry to achieve the objective of efficiency of public transportation was to establish reserved lanes or corridors for part of the network. This makes it possible to offer quality service and an alternative to automobile use. The choice was made for a transportation system that could successively use reserved lanes and normal lanes. The development of such a system can then be progressive, a very important advantage for a new city. In 1969, when the project began, the infrastructure of the network had to consist of a real reserved lane system that would not allow any level crossing over most of its route. At the time it was thought that the infrastructure could first be made for buses and then later adapted to a new guided, electrified transportation system and even, in the longer term, automated on completely reserved sections. However, the uncertainty regarding the date at which such a system would be technologically available and reliable, its cost, and the resulting difficulty for insertion, led to a revision of this strategy. With the projects for new neighbourhoods, there was a move towards a more flexible conception of the reserved lane system, accepting level crossings with secondary and tertiary lanes, and with the stations located on ground level in pedestrian areas. Non-conditional priority at intersections was included however in some areas and with pavement loops. The stations of the Evry reserved lane system were made with rather comfortable functional and geometric characteristics with respect to installation in an existing dense milieu. To the extent possible, they were installed in straight sections, or at least in curves with radii greater than 200m. Three types of stations

[1] Source Evry urban area community, Centre Essonne, TICE and CETUR report of 1977

were defined according to the density of the traffic and as a function of the traffic expected in the future:

- Dense traffic (>50 vehicles/h/direction): multiple platforms for 3 or 4 buses and passing lane in each direction separated by a median (made for the exchange station with the Evry Courcouronnes railroad station);
- Not very dense traffic (<50 vehicles/h/direction): multiple platforms for 2 buses with no assigned platforms and no passing lane;
- Low traffic: single platform with no passing lane;

On the central common section, the frequency, on the order of 200 buses/h/direction over time, led to plans for doubling the reserved lanes over the entire length involved (we can see in the field the spaces still reserved for this). The stations were also to be doubled. For the moment, the second infrastructure is only in service at the “Les Miroirs” station (below an area of dense housing). Each pavement is two-way. This type of station had been designed with guidance in mind as well as future automation. The principle of chain electricity supply for the stations was chosen for the great ease of management that it brings, and also because of the difficulty of connecting to the network. Electrical sub-stations were installed but were never used because the transportation system was never electrified. They were removed at the end of the 1990’s due to wear.

Thus, 30 years ago, an overall length of 40 km of reserved lanes were set aside. These were not all used and some of them were abandoned. The infrastructure, currently using reserved lanes, is more than 17 kilometres long and is used by the buses of the TICE network and by departmental express lines.

Today, the common section that goes through the business centre and which is connected to the central station of Evry Courcouronnes (SNCF and RER link to Paris), has more than 12,000 movements per day in both directions. At peak times, more than 40 buses use the central section in each direction. The passenger traffic is 36,000/day.

The commercial speed on the reserved lane part is 27 km/h, which allows the TICE network to reach a commercial speed of 19 km/h on average on the network at peak times.

The inter-station distances are 400 metres on average and all of the intersections of the reserved lanes are equipped with detection loops that give priority to the buses.

An energy and transmission network (fibre optics) is being deployed, and all of the stops are being outfitted with passenger information terminals and video-monitoring. These investments were made possible, at a lower cost, because of the availability of the infrastructure (multi-tubular) built more than thirty years ago.

The current characteristics of line 402, the busiest line for which there has been a rapid transit study:

- 27 km including 7.1 km of reserved lanes in the centre of Evry with priority at intersections;
- Frequency: 7mins at peak times and 12mn at off-peak times;
- span during the week: from about 4:40 to 23:30;
- 21 vehicles including 18 that are articulated;
- Constant increase in use since 2000 of 4.5 %: 25,000 passengers / day during the week at present;
- A commercial speed that is declining from year to year, of 17.6 km/h (peak times) and 21.7 km/h (off-peak times).

View of the exchange station with the Evry Courcouronnes railroad station (RER B) located below – very good example of a very good connection with station in 2x2 lanes

Source TICE.

View of central reserved lanes on viaduct, in an inhabited area

Source TICE.

9.8 Rouen, the TEOR project[1]

At the end of 1997, the Rouen Urban Area Community (37 municipalities – 400,000 inhabitants), the organising authority, decided to create three new reserved lane public transportation lines called TEOR (Transport Est-Ouest Rouennais), to supplement the main network armature installed in 1994 with the metro. The objective was to provide a reserved lane public transportation mode on the East-West axis of the Rouen urban area, offering good performances in terms of commercial speed, frequency, with regularity and passenger comfort equivalent to that of a tram line and which would correspond as well as possible to the financial means at its disposal and to the travel needs in the area.

These three lines, located on the right bank of the Seine, serve the densely populated valleys and plateaus to the East and West of Rouen (steep slopes) and they use a protected reserved lane system common section when they go through the centre of this city:

- Line T1: Mont-Saint-Aignan – Les Hauts de Rouen/Bihorel (length: 16 km, 26 stations),
- Line T2: Notre Dame de Bondeville – Darnétal (length: 12 km, 25 stations),
- Line T3: Canteleu – Franqueville-Saint Pierre (length: 20 km, 41 stations).

The common section used by the TEOR lines in the centre of Rouen, between the Mont Riboudet and CHRU stations, has a length of close to 4 km (10 stations). The stations are about 500 m from each other.

The TEOR lines are designed to handle the journeys of several tens of thousands of passengers each day, thanks to new infrastructure designed to provide a high commercial speed, with efficient vehicles and excellent quality in-station equipment.

The first phase now in service has a length of 28 km (40 km by 2007). The percentage of reserved lanes is about 65 %. The vehicles are Agora-type articulated buses, guided by cameras at all stops to ensure regular docking and accessibility to all (platform height: 27 cm).

The first results are very encouraging (a very sharp increase in the number of passengers in one year, from 30 to 35,000 journeys per day with no making of the second phase infrastructure) and

[1] Source Organising and operating authority of the Rouen network

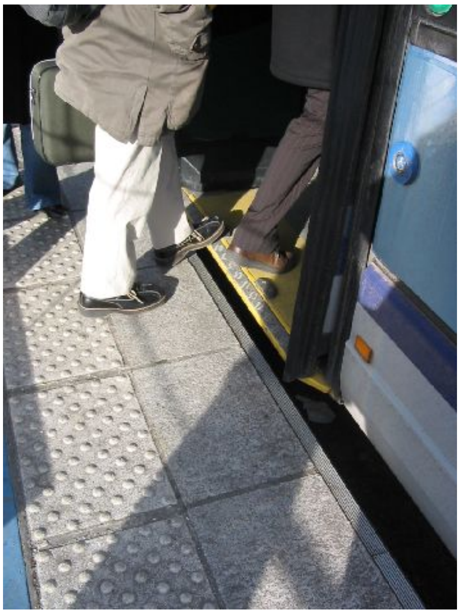
show the value of a comprehensive approach to a system that includes a strong identification in the field (vehicles of a specific colour, red-coloured reserved lanes, tram-type stations soon to have ticket vending machines on the platforms, special numbering of lines, regularity and high frequency). The users have identified the High Service Level, and recently gave it an extra satisfaction point compared with the tram.

The guidance has become very reliable (less than 4 incidents for 10,000 dockings) and is well accepted by the drivers. It offers regular accessibility without pallets (from the experience of the first phase, improvements were undertaken and should allow, in the second phase, for horizontal gaps that are all of less than 50 mm at the second door). The passengers have gotten used to moving back to avoid the sweeping of the rear-view mirror.

The average investment cost (studies, infrastructure and vehicles) per km is about €5.5 million (before tax), a ratio that includes three civil engineering structures (the Mont Riboudet exchange pole and parking lot, a three-lane, wide-gauge tunnel approach to take the traffic under a complex intersection, and a rail bridge to take the reserved lanes under the Paris-Rouen-Le Havre rail line) and the rolling stock. The cost of the guidance represents about 5% of the total cost (about 15% for the vehicle).

TEOR on the two-way reserved lanes, common section, Mont Riboudet station
Source Certu

TEOR, the entrances to the alternating reserved lanes
Source Certu



TEOR, level access and regular tram-type gaps thanks to guidance
Source Certu

9.9 Lyon, type C trolleybus lines[1]

Justified by the urban transportation plan that has just been revised, the Sytral developed a concept of busy Cx intermediary lines between the bus network and tram lines (T1 and T1) that were recently put in service. Three services were identified and organised (C1, C2, and C3). The vehicles for this concept are “trolleybus” type (Cristalis type, with a solid low floor and a design to distinguish them from buses). Service quality (frequency and schedule span) and running time efficiency criteria were defined. The infrastructure projects must take this in account.

This concept also provides for special identification of stations, for which the quality level will be close to that for the tram lines (accessible platforms, information about waiting time, ticket machines)

On the location of line C1, a reversible central reserved lane system was recently installed on the *Montée des Soldats*, a major access point to the northern sector of Lyon. The configuration of this reserved lane system is as follows:

- Length: 1.4 km
- Slope greater than 5 %
- Central reserved lane system: a 3.50 m lane protected by a right kerb; the site is controlled by an automatic barrier and lights that function with the request of the arriving bus detected by the loop; at the lights, the taking into account of the request is indicated to the driver.
- An intermediate stop in each direction; it is doubled in each direction: one on the reserved lane and one on the ordinary lane. Real-time information is provided to passengers.
- Reversible functioning of the reserved lanes: in the morning until noon, the site is used for descending buses; the site is unoccupied between 12:00 and 13:00; the reserved site is used for buses going up as of 13:00.
- There are currently 20 buses per hour at peak times, i.e. one bus every 3 minutes.

[1] Source SLTC, operator of the Lyon network

- Taxis are not authorised to use the reserved lane, and the barriers ensure that the site is respected and operating safety maintained – no problems observed, good clarity, no need for innovation in signing.

Before the reserved lane system, the *Montée des Soldats* was in 2X2 lanes with public transportation over more than 1 km; its configuration was not very urban with a speed limit of 50 km/h and 19,000 passengers/day per direction.

Lyon, exit from reversible reserved lane of the future C1 line, here authorised in the descending direction

Source Certu.

9.10 Grenoble, improving service on line 1[1]

Line 1 of the urban network is a North-South service of 8.9 km, with a rather direct route and mostly on a major infrastructure of the urban area (2x2 lanes with median). It is the number one line of the Grenoble bus network, which has been improved with an objective of accessibility for all:

- 70% reserved lane coverage (reserved corridor on pavement),
- accessible stations (platform at 21 cm) and on-line docking,
- organisation of intersections and priority at lights,
- new air-conditioned vehicles.

This “system” approach brought very good results: the commercial speed increased by about 20% to now reach 18 km/h. By maintaining the fleet, the service increased, as did the number of passengers (by about + 40%). The use of this line by people in wheelchairs has increased sharply (about 20 per day on average). The operator has obtained a dispensation for two spaces for wheelchairs on the articulated buses.

The station spacing has remained relatively low: 350 m. The accessibility concept is applicable to all of the lines and no hierarchy of the bus network is currently planned.

The investment has focused mostly on the stops. The total amount was about 50 million francs not including VAT 1998 (or 5.6 MF/km): 20 % for traffic light regulation, 28 % for reorganisation of intersections and securing of pedestrian crossings, 40 % for accessibility of stations and improving waiting comfort, 12 % for development of bus corridors. The acquisition of the 16 new air-conditioned and accessible buses required a budget of 42 MF.

[1] Source: Semitag and evaluation report written for Predit - 2000

Interior view of articulated Agora on Line 1 in Grenoble
Source Certu

View of the reserved lane and an accessible stop of line 1
Source Certu

9.11 Nantes, line 4 "Busway"

The High Level Bus Service project (called "Busway") constitutes the 4th line of the main public transportation network of Nantes, the first three being the tram lines. Line 4 links the city centre with the towns of the southeast of the urban area, Vertou and St Sébastien. It is composed of a 6-km reserved lane system, with the exception of two 400-metre sections operated as an ordinary lane in one direction. The reserved lanes are mostly axial with 15 stations (platform height 27 cm with slanting kerbs).

The bus platform is as strongly identified as the former tram lines, but without the rails and the catenary system. With few exceptions, the intersections are roundabouts crossed by a corridor or mini-roundabouts that can be crossed. An authorisation application is in progress to use the same luminous signing as for the tram (R17, R24, SAC).

Bus guidance (20 articulated buses using natural gas – 150 passengers) was not initially planned, but all of the station entrances are straight and should allow for satisfactory docking.

In March 2005, alongside Nantes Métropole and Semitan, TRANSDEV signed the first BusWay commitments charter: in September 2006, this new bus transportation system on reserved lanes will link Nantes with the Porte de Vertou in about twenty minutes. The BusWay label (trademark registered by Transdev) which applies to the future Line 4 will offer the users of Nantes Métropole public transportation a bus with the same service quality as the tram: regular and rapid service with a frequency of less than 10 minutes (4 min at rush hours), priority at lights, handicapped access, development of urban spaces and stations, information on the network and comfort.

The average investment cost (studies and infrastructure, not including rolling stock) is about €7 million not including VAT / km.

Typical cross section of the line 4 “Busway” of Nantes – Source Semitan

9.12 Lorient, the Triskell project

Lorient is an average-sized urban area, like Nîmes (Urban transport perimeter of 180,000 inhabitants). The goal of the Triskell project is not to create a hierarchy for the current bus network but rather to reinforce its efficiency, particularly in the city centre, where there is a section shared by several lines.

The main travel flows in the urban area are organised around 3 axes going out from the exchange station:

- to the northeast: towards Hennebont via the centre of Lanester,
- to the northwest: towards Quéven via Keryado,
- to the southwest: towards Plœmeur via the University and Kervénanec.

In time, the RLPT will use the Triskell qualified scheme.

The first phase connects the Merville market in Lorient to the Kesler Devillers neighbourhood in Lanester and will allow for:

- development of the most widely used section of the network (close to 800 buses per day), rue Anatole France and Cours de Chazelles
- improvement of the services in the northeast sector of the urban area with a more direct route thanks to a new crossing of Scorff, and adapted roads in areas where there are traffic problems;
- optimising circulation on Line B (Plœmeur – Lanester) which already has 30% of the passengers of the network.

In this phase, a new "urban" road bridge is planned (length 260 metres, width 14 metres), shortening the service to Lanester. The buses, which will have priority at the entrances, will then be in a "Nantes style"[1] ordinary site on the bridge. Bicycle lanes are also planned.

Some elements of the project:

- length of the route: 4.6 kilometres;
- 15 stations (including 4 new ones);
- Overall cost for infrastructure with the structure: €31 million (before tax), or €6.7 million per km (including €11 million for the bridge);
- Time saving of 2 to 7 minutes for the lines involved;
- Increase in regularity on these lines: reduction of difference from 9 to 4 minutes between peak and off-peak times;
- The colour of the pavement will be contrasted and differentiated over the whole reserved lane bus route.
- the stations symbolize the project as for the tram stations.

9.13 Nîmes, project for a structuring network with buses[2]

The population of the urban transport perimeter of Nîmes is now about 216,000 inhabitants, a size not easily compatible with "tram" capacities. The idea of structuring the network with a BHLS concept has grown on people with the thinking for the urban transportation plan and elected officials are now fully behind it. The "network" approach takes fully into account the future rail potential of the Nîmes region (TGV station, existing rail star, etc.).

The BHLS projects will form the structuring network of the urban system according to the following objectives:

- Creating a transportation concept based on a road mode that can evolve;
- But in an urban environment to match the specific historic context;
- Bringing passengers conviviality and modernism thanks to intermodality;
- Recreating around this RLPT an environment and a spirit equivalent to that of a tram or metro line. Specific and very comfortable vehicles will be allocated to these lines and they will be visible indicators of the high service level.

The Nîmes Métropole RLPT was designed as a comprehensive system of public transportation with a coherent whole based around 2 axes forming a total length of 13.5 km, a north-south service of 3.5 km in the short-term and an East-West service of 10 km. The entire network will thus be connected to these two main axes via transfer points with means adapted to the specific traffic of each line.

In the towns of the Nîmes Métropole, several possibilities are planned to reinforce this service, first by improving service at rush hours, and also by establishing park and ride lots in conjunction with the RLPT. The reserved lane system will be used first and foremost in the dense areas

(zone of restricted circulation, zone justifying a very dense public transportation service).

The BHLS approach is also interesting because it allows for the carrying out of successive phases of restructuring of the network, without waiting for the complete development. The work can also be carried out more quickly.

[1] Portion of the ordinary site managed by entry lights and giving priority to public transportation.

[2] Source: Nîmes Métropole, urban community

The provisional investment cost is between about €7 and 8 million per kilometre.

Nîmes, principle of non contractual insertion of the RLPT

Source Nîmes Métropole, urban community

9.14 Dijon, the "Lianes" structuring lines[1]

The Dijon urban area now has about 250,000 inhabitants and has one of the most efficient public transportation networks in France. The active policy implemented in 1978 in favour of public transportation bore fruit until 1994. The system became less attractive and more costly, despite the improvement in the frequencies and services. The network has lost about 1% of its passengers per year since 1996. For that reason, on October 25, 2004, the Dijon urban area established its new public transportation network called Divia.

The modernisation of this public transportation system was based on the creation of a hierarchy of the network including 7 main lines: the LIANES (High Service Level Lines). They are supplemented by "secondary" feeder lines. The city centre is at the heart of a star composed of the 7 LIANES in which the "Rue de la Liberté" is the obligatory focal point that they all pass through.

Rue de la Liberté:

- It is a street of about 500 m between the Porte Guillaume and the Palais des Ducs de Bourgogne. On 170 m between the places Rude and Libération its right of way is reduced to 9 m between the façades. It is located in the commercial and historic neighbourhood of the city centre, at the heart of the pedestrian precinct.
- It is a street reserved mostly for public transportation. Emergency vehicles and taxis are authorised, delivery vehicles are allowed there within strict time slots while two-wheel vehicles are forbidden. 50,000 boardings/ alightings are recorded per day in this sector.
- 9 regular lines before the restructuring of the network. Today, 5 LIANES use the lane and two others go across it. 1270 buses per year before the restructuring of the network. Today, 970 buses per day use this reserved lane. In its narrow section, the directions of the traffic are managed in alternation by traffic lights on a single lane.

These LIANES, a real backbone of the network, serve the main facilities and the most dense neighbourhoods. They have been assigned higher frequencies (5, 8 or 10 minutes), without any substantial investment for the roads. The journey times will therefore not change much. Studies were carried out to identify an infrastructure programme on these various corridors. The tram mode could be chosen as a function of the passenger levels anticipated.

[1] Source: report of the CETE of Lyon - Alain De Mayer and Jean Robert –March 2005

Dijon, single lane operation,
rue de la Liberté

Source Certu

9.15 Grenoble, an experiment on the emergency lane of the A48

Experiment with a lane reserved for coaches of the Voiron ⇔ Crolles Express line via Grenoble on the A48 (Saint-Égrève ⇒ Grenoble direction). This experiment involves two phases. The first phase of the experiment is very short and already operational: an additional lane on the emergency lane, allowing for coach traffic, was juxtaposed with a lane from the exit from an interchange (Wilson bridge). In order to give them priority on the single access lane to the roundabout intersection at the end of the exit ramp, a system of controlled and coordinated lights was implemented, both on the access ramp and on the roundabout. This experiment gave good results: with respect to the initial situation, at peak times, the time saving for the Coaches is about 40 seconds whereas individual cars lose about 8 seconds. The overall result in terms of collective time is very positive. Furthermore, no negative effects were observed with regard to accidents. However, the waiting line of individual cars, which initially remained on the ramp, now comes on to the right lane of the A 48. This could potentially lower the level of safety.

The second phase involves the examination of the extension of these reserved lanes on the A48. It is being studied and will be carried out in 2005/2006 as long as the Road Department approves it.

Grenoble, A48, view of lane reserved for coaches

Source Certu

9.16 Madrid, example of a “high occupancy” lane on a motorway[1]

A reference very often cited: on a motorway axis, a lane reserved for vehicles with a high occupancy rate and buses was created. This is a separate roadway with two traffic lanes for buses and high occupancy vehicles. There are 2 sections: the first has two lanes over 12.3 km for both modes and another has 3.8 km with one lane for buses alone. This is a reversible lane depending on the time of the day (toward the city centre in the morning and toward the outskirts in the evening). There are 3 access and exit ramps.

The results are interesting: the percentage of vehicles with at least 2 occupants increased from 30% to 39.5% after one year. Public transportation did not suffer however, on the contrary (increase in the number of passengers). The vehicle occupancy rate in the “HOV lane” of Madrid increased from 1.3 to 1.5 and even 1.8 at rush hours. The buses run better and are more frequent.

The logo of the future BHLS site

BHNS

Bus à Haut Niveau de Service

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[1] Source: TFE of Anthony Le Rousic “Variable assignment of lanes” July 2002.

10. Conclusion

The work on the High Level Bus Service concept confirmed the indispensable nature of a "system" approach in order to sustainably promote the Bus mode, whether guided or not. Buses benefit from many technological innovations and the corresponding investments are not justified without a coherent and comprehensive approach to the system (infrastructure, vehicle, operating conditions).

The infrastructure and all of the urbanisation work represents the fundamental sub-system and is the most complex to implement. However, these are just one of the ways to achieve service efficiency and sustainability. Reserved lane systems are an essential means for better management of urban spaces, but they are not the only solution.

Through tram projects, in France and abroad, we have learned much about urban insertion techniques. There now seems to be a need for synergy between the tram and bus modes, guided or not, particularly with regard to signing and traffic rules. It is important today to capitalise on the many insertion tools, with their advantages and drawbacks, without forgetting the main recommendations for their use.

The identification of a BHLS line seems to be a particularly useful challenge. But since buses are not inherently linked to their infrastructure, this identification, which must be clearly defined with a long-term view, will be more difficult to formalise and render sustainable in practice. For a BHLS project, special attention must be given to this identification as of the first phases of the study and with a comprehensive system approach.

The potential market for the BHLS now looks promising. A recent survey of the UTP[1] with its members shows a great diversity of bus lines declared as structuring for the network and also a particularly large number of projects in the study phase: this would lead to a doubling of the number of structuring lines. As urban areas are facing very different realities, the BHLS concept must remain flexible and evolving. It will also be important to adapt it to local contexts as part of the development of the whole transportation network.

[1] Source UTP report, structuring bus lines or high service level.

11. List of acronyms used

AO: Autorité Organisatrice (Organising Authority of public transportation)

BHLS: Bus with a High level of service, or High Level Bus Service

BRT: Bus Rapid Transit

CERTU: Centre d'Études sur les Réseaux, les Transports, l'Urbanisme et les Constructions Publiques (Centre for Studies on Urban Planning, Transportation and Public Facilities)

CETE: Centre d'Études Techniques de l'Équipement (Regional Public Works Engineering Offices)

DGMT: Direction Générale de la Mer et des Transports (Directorate-General for Sea and Transport)

EOQA: Expert ou Organisme Qualifié et Agréé (qualified, certified surveyor or body)

GART: Groupement des Autorités Responsables du Transport (French association of public transport authorities)

INRETS: Institut National de Recherche sur les Transports et leur Sécurité (French National Institute for Transport and Safety Research)

MR: Matériel Roulant (rolling stock)

PDU: Plan de Déplacements Urbains (Urban mobility master plan)

PMR: Personnes à Mobilité Réduite (people with reduced mobility)

PREDIT: Programme National de Recherche et d'Innovation dans les Transports Publics (French programme of research, experimentation and innovation in land transport)

PTU: Périmètre de Transport Urbain (périmètre de transports urbains)

RATP: Régie Autonome des Transports Parisiens (Paris transport company)

RER: Réseau Express Régional (regional express network)

RLPT : Reserved Lane Public Transportation (encompass or cover all means of urban PT with reserved lanes)

SAE: System d'Aide à l'Exploitation (operating aid system or fleet management system)

SAEIV: System d'Aide à l'Exploitation et à l'Information aux Voyageurs (fleet and passenger information management system)

STRMTG: Service Technique des Remontées Mécaniques et Transport Guidés (the Technical Agency of Ropeways and Guided Transportation under the French Ministry of Transport, Infrastructure, Tourism and the Sea (http://www.strmtg.equipement.gouv.fr)

TC: Transport Collectif (Public Transportation : PT)

TCU: Transport Collectif Urbain (public transport in urban areas)

TCSP: Transport Collectif sur Site Propre (RLPT, Reserved Lane Public Transportation)

UTP: Union des Transports Publics (Association of public transportation companies)

VP: Voiture Particulière (private cars)

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13. Appendices

13.1 Definitions of the BRT concept

As a reminder, here are some of the definitions for "Bus Rapid Transit" used in North America[1]:

Definitions of BRT	Source
"The BRT is a visionary approach" in which planning and new technologies come together to allow buses to offer the "rapidity, reliability and efficiency of light rail vehicles at a fraction of the cost."	Former administrator of the Federal Transit Administration
The BRT is an express network of vehicles on tyres with traffic lanes, stations and all of the other characteristics normally associated with rapid rail networks.	ACTU workshop, 9 November 2003 – Outlook of the Canadian Industry
The BRT is a concept that aims to offer a superior public transportation service with buses that integrates technology, an operational plan (or service concept) and interaction with the ridership.	Innovative Service Design Among Bus Rapid Transit Systems in the Americas, R.B. Diaz, D.C. Schneck
The BRT combines the quality of rail transport and the flexibility of bus transport. It can use reserved lanes, lanes for vehicles with a high occupancy rate, rapid lanes or ordinary streets. A BRT combines the technology of intelligent transportation systems, the priority of public transportation, more quiet and cleaner vehicles, a system of perception of the right of passage that is rapid and convenient and integration with territorial development policies.	Federal Transit Administration
The BRT is a rapid mode of transportation with tyres that includes stations, vehicles, services, traffic lanes and ITS elements in an integrated and flexible system, with a strong positive identity and projecting a distinctive image. The BRT is designed as a function of the market it serves and the physical environment and can be implemented progressively in diverse milieus. In short, the BRT constitutes an integrated network of facilities and services which improves the rapidity, reliability and identity of the bus transport network.	Transit Cooperative Research Program Report 90, Bus Rapid Transit
BRT systems meet the needs of urban mobility by offering a low-cost service focusing on the user, aiming for quality, rapidity and comfort.	Bus Systems for the Future – Achieving Sustainable Transport Worldwide, International Energy Agency, 2002

A definition specific to the Canadian situation and which covers all of these characteristics was written as follows:

"BRT systems are services of express public transportation vehicles on tyres, which combine stations, vehicles, lanes, technology and a flexible functional plan and integrate them into a high quality service, focused on the client, offering rapidity, frequency, reliability, comfort and cost effectiveness."

[1] Source: Canadian Urban Transit Association – Bus Rapid Transit, a Canadian industry perspective - April 2004.

13.2 Result of the survey on key words linked to the BHLS

Within the working group, a survey was carried out to identify the key words that could characterise the BHLS concept; the result of this survey is summarised here as a reminder.

The survey initially involved giving the members of the working group a list of key words, with no order or hierarchy, relating to public transportation in general, and more specifically to a notion of service level. The responses received allowed us to put alongside each word one or several expressions to qualify this word in the idea of the BHLS.

The participants were then asked to propose a hierarchy of these key words in their most significant expression. The goal was to identify the essential, secondary and marginal notions in the High Level Bus Service concept.

The task was then to add up the ratings for each line. The overall rating obtained was used to classify the key words into 3 categories: the notions that are indispensable for the concept, important notions, and then the notions considered secondary.

The results below helped organise the debate. The priorities that were finally adopted to draw up this concept changed significantly and other characteristics were added, such as intermodality and the quality of connections to the network.

A- The essential notions

- Priority at intersections
- Commercial speed / High frequency / Schedule span
- All or maximum reserved lanes / Traffic police priority
- Ticketing and passenger information
- Special qualification for drivers
- User comfort – Not shaken up, not compressed

B- The basic BHLS notions

- Quality of stations
- Quality of service
- Quality of infrastructure
- Identification of the line

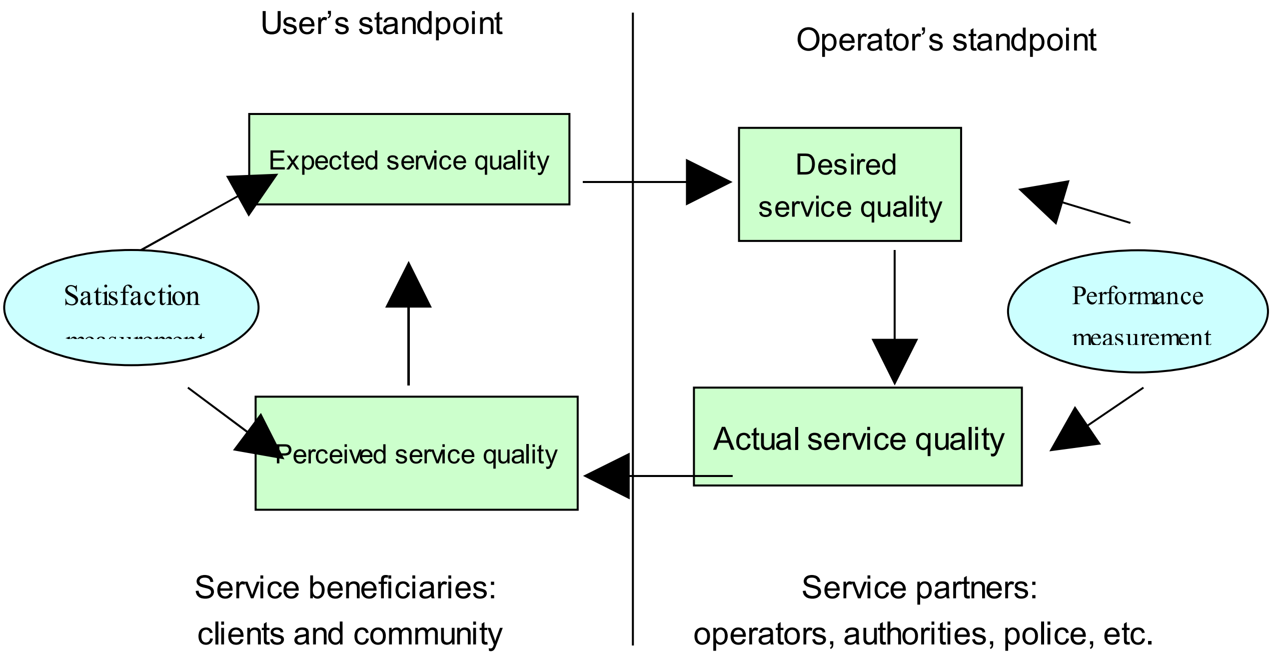
C- Other notions to take into account depending on the context

- Guidance outside of stations
- Power supply mode
- Doors on the left
- Transport 2R
- Flexibility of drivers
- Maximum number of seats
- Tram-type stations
- Safety control for the project is necessary (by approved specialists)
- Tram-type light signals
- A new pictogram to indicate the reserved lanes
- Marking of door locations on platform
- All doors are used for boarding

- Anti-parking posts

13.3 The European "service quality" standard

European standard NF EN13816 "Public transportation of passengers – service quality" defines a management and quality measurement method with reference to the quality cycle concept:



The quality cycle concept

The fundamental principle is that all measures are "client" oriented. They must take into account the number of passengers involved by a required quality level.

This norm defines the obligatory and optional quality criteria. These are established by a certain number of possible indicators measuring the difference with the reference service.

As an example:

Quality criterion	***Reference service***	***Requirement level***
Information at stops		
Information on buses		
Information on service		
Driver's attitude		
Regularity/punctuality	Measurement of advances / lateness at stops, for example for schedule regulation: Bus passing between H and H+5min Bus passing between H and H+3min …	 90% of passengers 80% of passengers
Availability of on-board equipment		
Bus reliability	Technical problem on line immobilising passengers more than …min.	99% of passengers
Cleanliness of the bus		
Load factor	No more than 4 passengers/m2 in the bus	80% of passengers are transported with the reference service
Driving comfort		

Excerpt from the obligatory criteria of norm NF EN13816.

Each indicator must be supplemented by:

- A threshold of non-acceptability or of service not provided: special measure to take concerning passengers (compensation, substitution, etc.);
- the way of managing the unacceptable situation: reestablishment of service, substitution/replacement, management of passenger annoyance, etc.

As a reminder, the "MOBILIEN" concept includes the obligation to obtain certification of this standard, indicating certain values.

This standard does not however give any details on the criteria for accessibility to people with reduced mobility.

13.4 Group Members

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AUTOBÚS DE ALTO NIVEL DE SERVICIO
Concepto y recomendaciones

Las numerosas innovaciones realizadas en los autobuses no pueden producir todos los efectos previstos si no se enfoca de manera global el sistema de autobuses, enfoque que incluye la infraestructura, inserción urbana y modalidades de explotación. Para los líderes de la toma de decisión, la imagen del autobús sigue siendo demasiado a menudo negativa respecto al tranvía, aunque algunos proyectos consiguieron valorizarlo.

Al inspirarse de la gestión "Bus Rapid Transit" instaurada al otro lado del Atlántico, un Grupo de Trabajo, reunido por el Certu bajo los auspicios de la DGMT, ha elaborado este concepto de Autobús de Alto Nivel de Servicio (BHLS), herramienta metodológica y pedagógica que pone la mira en subrayar los puntos clave para llevar a bien un proyecto de autobús eficaz y estructurante. El autobús es aquí un modo de transporte por carreteras que debe considerarse en su concepción más amplia, guiado o no, térmico o trolleybus, autobús o autocar.

Este grupo ha reunido a la DGMT, el GART, el UTP, el INRETS, cuatro CETE, la RATP y las autoridades organizadoras y/o los operadores de las aglomeraciones de Rouen, Nantes, Lyon, Grenoble, Nimes, Lorient, así como la nueva ciudad de Evry.

El lector encontrará recomendaciones a nivel técnico y organizativo, un balance sobre las evoluciones reglamentarias que se desarrollan en sinergia con el tranvía, deseos en materia de investigación y evaluación, así como referencias de realizaciones o proyectos.

BUS WITH A HIGH LEVEL OF SERVICE
Concept and recommendations

Obtaining satisfaction from the many innovations made to bus services requires a global approach that embraces infrastructure, urban integration and operating procedures. Decision-makers feel that bus services are too frequently considered as second rate in comparison with tram networks, despite the fact that certain projects have succeeded in upgrading their image.

By drawing from the example of the Bus Rapid Transit system in operation on the other side of the Atlantic, CERTU, acting under the aegis of DGMT, has brought together a work group to formulate the concept of Bus with a high level of service (BHLS), a methodological and pedagogical tool aimed at highlighting key points for ensuring a successful, efficient and structuring bus service. It takes the widest possible view of the bus as a means of road transport, whether guided or non-guided, powered electrically or by combustion engine, or bus or coach.

This group brought together DGMT, GART, UTP, INRETS, four CETE units, RATP and the transport organising authorities and/or operators of the cities and towns of Rouen, Nantes, Lyon, Grenoble, Nîmes, Lorient and the new town of Evry.

The reader will find recommendations on technical and organisational plans, an inventory of the regulatory changes that have occurred in synergy with tram networks, preferences for paths of research and evaluation, and the references of implementations and projects.

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