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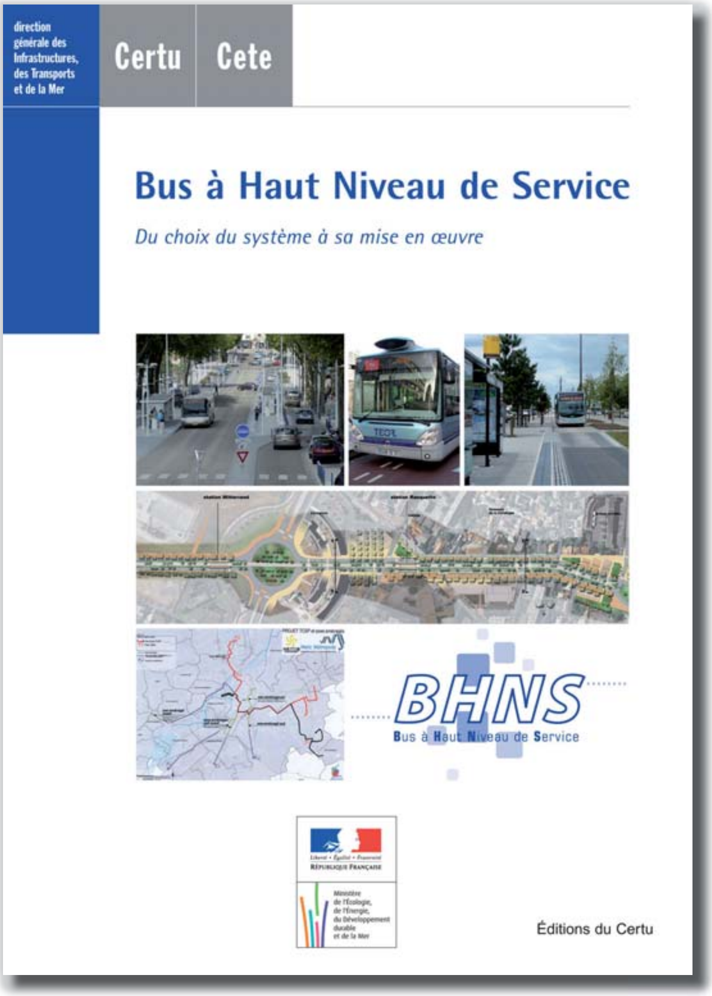
English version

Buses with a High Level of Services

Choosing and implementing the right system



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Ministère de l'Écologie, de l'Énergie, du Développement durable et de la Mer

DGITM – CERTU - CETE

BUSES WITH A HIGH LEVEL OF SERVICE (BHLS), THE FRENCH BUS RAPID TRANSIT (BRT) CONCEPT

CHOOSING AND IMPLEMENTING THE RIGHT SYSTEM

May 2010

Centre for the Study of Urban Planning, Transport and Public Facilities

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Ministère de l'Écologie, de l'Énergie, du Développement durable et de la Mer

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Translation

This report is the English version of the original work “Bus à Haut Niveau de Service (BHNS) : du choix du système à sa mise en ouvre”, published by Certu in 2009. The translation was made by Linguarama in October 2009.

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Certu could not be held responsible of any misunderstanding or translation mistakes and is very interested in any comments and suggestions.

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The text was written by Sébastien Rabuel, who is in charge of public transport projects at Certu, with the support and participation of a **working group** including:

- Christian Babilotte, Dominique Bertrand, Thierry Gouin, Marie-Noelle Mille, Sébastien Rabuel and François Rambaud from Certu
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- Christian Bourget from the CGEDD (*Conseil Général de l'Environnement et du Développement Durable* – General Council for the Environment and Sustainable Development)
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- Sophie Hasiak from CETE Nord–Picardie
- Bertrand Hervier and Marie Vilette from the DGITM
- Odile Heddebaut from the Inrets (*Institut National de Recherche sur les Transports et leur Sécurité* – French National Institute for Transport and Safety Research), who is the co-author of Appendix 1: "From American BRT to European BHLS"
- Stéphanie Lopez d'Azevedo and Anne Meyer from the UTP (*Union des Transports Publics et Ferroviaires* – French Public Transport Union)
- Stéphane Patouillard from CETE Méditerranée
- Michel Pouchard from CETE Sud-Ouest
- Mathieu Rabaud from CETE Normandie–Centre
- Jean Robert from CETE Lyon

The discussions of the working group were stimulated and inspired by research studies produced by the CETEs, which will be gradually made available at the following website: www.bhns.fr

Seven meetings were organised in different parts of France in order to find out more about urban transport authorities' opinions and expectations with respect to BHLS:

- 19–20 March 2007 in Lyon, with the participation of the following urban areas: Clermont-Ferrand, Annecy and Lyon;
- 12–13 June 2007 in Rennes, with the participation of the following urban areas: Saint-Brieuc, Lorient, Brest, Nantes and Rennes;

[1] The CETE (Centres d'études techniques de l'équipement) are technical local services of the Ministry for Ecology, Energy, Sustainable Development and the Sea (MEEDDM). They are linked to the CERTU which manages national studies carried out by the CETE.

- 10–11 September 2007 in Rouen, with the participation of the following urban areas: Orléans, Le Havre and Rouen (special theme on choosing a tramway/BHLS system);
- 19–20 November 2007 in Lille/Douai, with the participation of the following urban areas: Douai and Lille;
- 17–19 March 2008 in Toulouse, with the participation of the Toulouse urban area;
- 19–20 June 2007 in Lyon, with the participation of the RATP (Paris city transport operator) and the Annecy urban area;
- 19–20 January 2008 in Lille/Maubeuge, with the participation of the Maubeuge urban area.

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- Anne Bellamy (Communauté d'Agglomération d'Orléans–Val-de-Loire)
- Claire Blanchard (RATP)
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- Claudine Chtitah (Syndicat Mixte Val-de-Sambre–Maubeuge)
- Elsa Delabaere and Jean Rince (Communauté de l'Agglomération Rouennaise)
- Pascal Delisle (Communauté d'Agglomération du Pays de Montbéliard)
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- Claire Vilard and Benoît Pavageau (Tisséo SMTC – Toulouse)
- Didier Waelkens (Semitib – Maubeuge)

The group's work also took inspiration from:

- feedback from abroad and exchanges from **European COST group TU0603, "Buses with a high level of service",** led by the Certu and Nantes Métropole (website: www.bhls.eu);
- presentations and exchanges from **ENPC's[2] continuing education division *Ponts Formation*** (website: http://pfe.enpc.fr/ in the section entitled *Déplacements, mobilité, transports*.

Discussions were also held with Jean-François Guédec and Nicolas Giorgi from Keolis Conseil & Projets and Pierre Tavernier from TransÉtude, who participated in the writing of sections 5.2, "Organisation and technical coordination of projects", and 5.3, "Involving transport operators and drivers in projects".

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- Laurent Chevereau from CETE Sud-Ouest,
- Claude Soulas from Inrets,
- Valéry Cervantes from Irisbus,
- Richard Darbéra from LATTS for Appendix 5.

[2] ENPC: *École Nationale des Ponts et Chaussées*, a prestigious French engineering school

Foreword

Daniel Bursaux, Director-General for Infrastructure, Transport and the Sea (at DGITM) within the French Ministry for Ecology, Energy, Sustainable Development and the Sea (MEEDDM).

The French State has contributed extensively to the development of urban public transport networks in France outside of the Paris/Ile de France region: first, by helping to finance the construction of the first metro lines in the largest urban areas; and subsequently by encouraging the development of new transport systems that are better adapted to smaller urban areas. Notably, it has supported the renaissance of tramway systems and helped pave the way for a new generation of rolling stock, deployed for the first time in Nantes in January 1985.

Since then, tramway systems have generated considerable interest among provincial urban transport authorities, as well as STIF (the Île-de-France passenger transport authority) in the Paris region, with dozens of tramway lines inaugurated in the intervening years. Today, there are around twenty urban areas in France that are served by one or more tramway lines.

Trams are now recognised as a high-quality transport mode that offers performance that is overwhelmingly appreciated by users and which actively contributes to making public transport more attractive. Indeed, trams have become much more than a simple means of transport: the creation of a new line is often accompanied by the redefinition of public spaces, new developments, urban renewal operations, and new neighbourhoods, all along the line, thus making it possible to structure the development of the urban area and improve the quality of city life.

Today, the development of urban and peri-urban public transport networks is prominent in the conclusion of the *Grenelle de l'Environnement* (the French government's environmental round table). This is a priority for the government, which is set to participate in the development of 1,500 kilometres of new dedicated lanes and corridors for public transport by providing up to €2.5 billion of support and assistance for new projects, through calls for projects, by 2020.

The results of the first call for urban public transport projects, launched on 22 October 2008 in response to the conclusions of the *Grenelle de l'Environnement*, were made public by Jean-Louis Borloo, the *Ministre d'État* [cabinet minister], and Dominique Bussereau, *Secrétaire d'État* [junior minister] for Transport, on 30 April 2009. They confirmed not only the importance of trams as a mode of transport, with half of the selected projects involving the creation or extension of tramway lines, but also the benefits for urban public transport authorities of creating BHLS lines (buses with a high level of service). Of the 50 or so projects selected, around 20 involved BHLS lines.

Trams are not the only solution to encourage and develop the use of public transport. The cost of investing in tramways remains high, and such systems are relevant only where demand and ridership levels are high. Depending on the needs to be addressed and the characteristics of the urban area concerned, BHLS is one possible strategy, in particular given the quality of service it enables.

The aim of BHLS is to offer users a transport service with a level of quality comparable to that of tramways, but using road-based vehicles, typically buses, which often operate in preferential conditions (dedicated lanes, priority at traffic lights, etc.).

Four years ago, Certu published its first study on this subject, entitled "*Bus à Haut niveau de service : concept et recommandations*" ("Buses with a high level of service: concept and recommendations"). Since then, the BHLS concept has been put into practice, with a number of projects that are now operational.

It is important to support the development of this new type of transport service using not only primary data obtained from the very first operational projects, but also examples from other countries. The DGITM has therefore commissioned Certu to produce a publication that will provide urban transport authorities and their operating companies with technical information on various topics (integrating BHLS services, choosing the right system, defining the level of service, etc.) that relate to the development and implementation of their projects.

This is the subject of this study, "Buses with a high level of surface: choosing and implementing the right system", which is the fruit of collaborations of the scientific and technical network of the ministry, together with GART, the UTP and various urban transport authorities, all of whom I would like to thank for their contributions.

The publication of this study comes at a particularly opportune time, between the announcement of the successful submissions from the first call for urban public transport projects and the launch of the second call for projects in 2010.

I hope that it will contribute to the further development of BHLS.

Le directeur général des infrastructures,
des transports et de la mer

Daniel BURSAUX

Chantal Duchène, director-general of GART (Groupement des Autorités Responsables de Transport – French Association of Public Transport Authorities)

For many years now, GART has been promoting the concept of buses with a high level of service (BHLS), initially by focusing on little-known French systems, such as the one in Évry (near Paris), and schemes in use abroad. Gradually, following various conferences and round-tables on the subject, and in particular sessions held at the *Congrès du GART*, the concept has become more established and transport authorities have begun to show considerable interest in BHLS: the first projects in France, notably in Rouen (*TEOR*), Lorient (*Triskell*) and Nantes (*BusWay*®), have shown the potential of this type of service and have ultimately proved popular with users. Today, these examples are themselves references for other countries. BHLS has not only transformed the image of bus travel, but has also shown that is possible to develop a high-performance dedicated-lane public transport (TCSP)[3] system at a reasonable cost, both in terms of infrastructure investment and day-to-day operation.

Subsequently, the first working group on this subject brought together the key players in the field of public transport, centred on Certu, GART and the UTP. In 2005, this group produced a report entitled "*Bus à haut niveau de service : concept et recommandations*" ["Buses with a high level of service: concept and recommendations"], which sought to legitimise the concept, and show how it could be developed as a transport system in its own right, with its own particular scope of application. The aim here was not to compete with other types of TCSP systems, such as trams, but rather to demonstrate that urban transport networks could also be developed using different techniques. Since then, Line 4 in Nantes, implemented according to the "*BusWay*®" concept developed in parallel by Transdev, has shown that a BHLS system can enjoy the same performance levels and the same degree of integration within the city as a tramway. Recently, this concept was also successfully implemented in Maubeuge.

One of the main advantages of BHLS is being able to offer both a system-based approach and a high degree of flexibility in terms of the concept and its operation. Even when BHLS is considered as a fully-fledged form of TCSP, including the homogeneous and coherent treatment of the basic system components (running way, stations, traffic priority at junctions, passenger information, and even the design and integration of rolling stock), just like a tramway, the contracting authority still has considerable room for manoeuvre in terms of adapting the system to the local context: it might choose to create dedicated lanes from end to end, or just for certain sections (e.g. in congested central areas, or alternatively in outlying areas where space is at less of a premium). Different examples can be found in Lorient, Rennes, Lille or Toulouse. Another choice could be to develop several key lines from the outset, in order to favour a balanced, more uniform network that is no longer focused on a single, heavily used – and therefore fragile – key route. This is the philosophy behind the projects currently in progress in Metz and Nîmes.

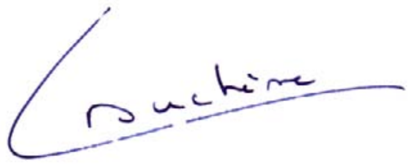
[3] The term “Transport collectif en site propre” (TCSP) – literally *Dedicated lane public transport* – refers to a mean of public transport system that mainly uses a right-of-way that has been specifically designated to public transport operations. It operates with rolling stock ranging from buses to metros. As it is a French concept adapted to the national history and culture, the acronym TCSP will be used throughout this report.

Just as a tramway cannot purport to be a surface metro, so a BHLS system cannot purport to be a substitute for a tramway system. Tramways continue to be the system of choice for many local authorities because of their image and the opportunity they provide to undertake large-scale urban enhancement projects. Although BHLS may offer a more modest solution to public transport needs, it can also pave the way for "building-to-building" enhancements. Today, the context has changed, and many elected representatives are now more concerned with budgetary issues, specifically system set-up costs and, above all, operating costs. As has been pointed out by many elected representatives within GART, as well as the association's new president, Roland Ries, the era of expensive TCSP systems and budget overruns is over. Elected representatives are now turning their attention to "optimised tramways", as well as to the issues of TCSP operating modes and ownership costs, making the BHLS approach all the more relevant.

This trend was reflected in the results of the call for projects that resulted from the *Grenelle de l'Environnement*. Naturally, the projects selected included many tramway projects, but a number of major BHLS projects were also selected. More than ever, it appears that a process is now in motion: each BHLS project that is successfully completed will lead to more and more similar projects, especially since they are easier to implement than "heavier" TCSP modes (metros, tramways). All the evidence suggests that the current supply of public transport is approaching saturation, and new solutions must therefore be developed – and it will not be possible to meet the vast array of differing needs with trams alone. The flexibility of the BHLS concept, together with its modular aspect and economic relevance, means that it is set to become an effective and attractive reponse to user needs and expectations. It also offers considerable potential for innovation and development, particularly in terms of energy consumtpion. And what if all bus lines were to one day benefit from the sort of service quality offered by BHLS – who would complain about taking the bus then?

Chantal Duchène

Director-General of GART



*Bruno Gazeau, delegate-general of the UTP (*Union des Transports Publics et Ferroviaires – *French Public Transport Union)*

The success of BHLS (buses with a high level of service) systems implemented in recent years has helped break down the myths and preconceptions associated with the bus. A number of urban areas, large and small, have now integrated this mode in development projects for their urban transport networks, to the point where 23 projects have been accepted following the call for dedicated-lane public transport (TCSP) projects launched by the French president in autumn 2008. In total, this represents 242 kilometres of BHLS lines that, with the government's help, are to be opened within the next five years.

As a direct result of the *Grenelle de l'Environnement*, this call for projects expresses the desire to reduce greenhouse-gas emissions in urban areas through a modal shift from private vehicles to public transport, which would be made possible by increasing the range and attractiveness of public transport provided. The stakes here are high, as the 2008 *Observatoire UTP de la Mobilité* (UTP mobility observatory) illustrates[4]: 70% of French respondents said they would be prepared to use public transport if services were more frequent, while 62% cited improved punctuality as a decisive factor.

However, in order for this modal shift to actually occur, and for regular passengers to benefit from a qualitative and quantitative increase in the public transport being provided to them, adequate funding needs to be allocated to BHLS systems.

This would mean that public transport would not need to make concessions with respect to the way roadspace is divided up in built-up areas. Similarly, priority at traffic lights, though not essential in all situations, remains a decisive factor in ensuring reliability and frequency.

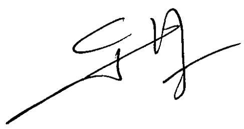
This is why, during the *Grenelle de l'Environnement* consultation process, the UTP proposed that the responsibilities of public transport authorities should be extended to include highways and parking as well, so that TCSP projects would have the best possible chance of meeting their objectives.

Furthermore, the current period of uninterrupted growth in ridership (for over three years now) means that systems capable of coping with this rapidly rising demand must be put in place.

Hopefully, the "toolbox" formed by this study, and the BHLS success stories it relates, will further contribute to this trend.

Bruno Gazeau

Delegate-General of the UTP



[4] *Observatoire de la Mobilité*: telephone survey carried out by BVA from 12 to 18 November 2008 using a sample of 1,001 people aged 18 and over; the sample selected is representative of the population of urban areas of more than 50,000 inhabitants.

Introduction

As transport habits and mentalities gradually change, public transport plays an increasingly vital role in the way our urban areas function. Formerly restricted to a captive ridership, public transport is little by little proving to be a real, viable alternative solution to private vehicles in the context of comprehensive transport policies. From the late 1970s onwards, congestion in city centres led France's largest provincial cities to launch projects for rapid, high-capacity metro systems. In 1982, the law known as LOTI (*Loi d'Orientation sur les Transports Intérieurs* – framework law on inland transport) marked a turning point by strengthening the role of urban transport authorities and devolving responsibility for transport-related issues to local government. Furthermore, in the mid- to late 1980s, new concerns began to emerge: the environment and quality of life. In 1985, for example, Nantes heralded the return of trams in city centres by appropriating part of the roadspace previously used by motor vehicles. At a time when the infrastructure stakes were becoming increasingly high, the new tramway networks constructed in Grenoble (in 1987) and Strasbourg (in 1994) once and for all established the concept of "French-style tramways", the performance and efficiency of which have long since been proven (in terms of speed, frequency, reliability, comfort, accessibility, and image). Up until then, only Lille and Saint-Étienne had retained part of their pre-war tramway systems[5]; now, tramways grace the streets of 17 urban areas in France, representing over 400 kilometres of infrastructure in total. Between now and 2013, around 350 additional kilometres of tramway lines are planned, 80 kilometres of which will be in six urban areas currently without tramway systems.

Buses, on the other hand, generally suffer from a negative image associated with congestion, unreliability, a lack of comfort and vehicle designs that have changed little over the years. The difference in service levels compared with modern trams remains considerable, despite the creation of a certain number of bus lanes. And yet tramway systems are not always best placed to meet the transport needs – and financial capacity – of urban areas. Growing awareness of environmental issues and the new economic climate (increased oil prices and reduced spending power) has put public transport in a paradoxical situation: the potential for modal shift has never been higher, but the financial capacity have never been more constrained. The necessary development of surface public transport must therefore also include seeking greater economic efficiency for the systems implemented. In this context, buses can offer a fresh outlook.

In addition to the special case of Évry, a new town in the 1970s, a few urban areas have explored the potential offered by new bus concepts in the late 1990s. The first sections of the *Axe Est–Ouest* (East–West Cross Route) for buses in Rennes, the shared lanes in Annecy town centre, the *Trans-Val-de-Marne (TVM)* in the Paris region and the east–west line in Clermont-Ferrand were the precursors of more recent, more comprehensive bus-based TCSP" projects, where innovation plays a key role:

- Rouen, in 2001, with optical guidance at stations and alternating dedicated lanes;
- Nancy and Caen, in 2002, with guidance by a central rail;

[5] In Marseille, the No. 68 tram remained in service until the decision was made to create a new tram network, the first part of which opened in 2007.

- Nantes, in 2006, with a design and operating conditions that closely mirrored those of the city's trams;
- Lyon, in 2007, with a new generation of trolleybuses;
- Lorient, in 2007, with new ideas for infrastructure and layout (e.g. urban integration, junctions);
- and, very soon, Nîmes, with vehicles that will resemble trams even more closely in terms of design and comfort levels.

On the basis of these experiences, Certu played a significant role by defining the BHLS concept in 2005, in partnership with the GART, the UTP and Inrets[6]. This work was inspired by the concept of bus rapid transit (BRT) developed in the United States in the 1990s. However, it has been adapted to the urban context and culture in France (narrow streets, roadspace shared with sustainable transport modes, etc.). Since then, other urban areas have developed their own projects (inauguration of BHLS systems in Maubeuge and Toulouse in 2008, with other projects in development in Douai, Metz, Montbéliard, etc.).

The time is now right to gather feedback on the different ways the BHLS concept has been adapted and the various projects that have been, or are currently being, realised. There is much demand for this information from urban transport authorities – indeed, it is primarily for this reason that this report has been produced. In its pages, you will find details and clarifications concerning the concept, its scope and potential, and its limitations. With its "*Tour de France*" of BHLS systems in operation, as well as examples from further afield, this study takes a look at the future of public transport.

[6] Certu, *Bus à Haut Niveau de Service : concept et recommandations* ["Buses with a high level of service: concept and recommendations"], Lyon, Certu, 2005, 111 p.

Important note on terminology

The term **“Transport collectif en site propre” (TCSP)** – literally *Dedicated lane public transport* – refers to a mean of public transport system that mainly uses a right-of-way that has been specifically designated for public transport operation. It operates with rolling stock ranging from buses to metros. As it is a French concept adapted to the national history and culture, the acronym TCSP will be used throughout this report.

The acronym **BHLS** refers to the adaptation of the concept of **Bus Rapid Transit** (**BRT)** to the French context, where the mass transit function is already delivered by metros and tramways and that includes narrow streets, at-grade urbanism, a focus more on reliability than on speed, etc.). For these reasons, the French have thus developed a specific term. See part 1.5 : “From the American BRT to the European BHLS”.

Throughout this report, the following terms are used to refer to specific concepts:

- "large urban areas" are *unités urbaines* ("urban units")[7] with more than 300,000 inhabitants;
- "medium-sized urban areas" are *unités urbaines* with 100,000 to 300,000 inhabitants;
- "small urban areas" are *unités urbaines* with fewer than 100,000 inhabitants.

[7] "The notion of the *unité urbaine* ("urban unit") is based on continuity of housing: a *unité urbaine* is considered to exist when one or more municipalities form a continuous built-up area (with no more than 200 metres between any two buildings) with at least 2,000 inhabitants. For a municipality to be considered part of the *unité urbaine*, at least half of its population must live in this continuously built-up area." (Definition used by INSEE, the French statistical office)
Informally, the term *agglomération* ("urban area") is sometimes used in French to designate an *unité urbaine*.

Summary

1. What is a bus with a high level of service (BHLS) ?

The 2005 working group[8] deliberately did not seek to formalise a national "BHLS" quality label. As local contexts often differ greatly, the objective was to encourage the emergence of suitable configurations for each context, based on the broadly defined BHLS concept.

However, time and again, discussions with urban transport authorities have underlined a need for the concept to be articulated more clearly. This is the aim of the first chapter of this report.

1.1 Some precisions regarding bus terminology

What is a bus? This question may seem trivial. And yet confusion and imprecisions abound with the emergence of new systems formerly described as "intermediary" solutions (e.g. the *TVR*[9] by Bombardier or *Translohr* by Lohr Industrie).

In France, the length of a bus is limited to 24.5 m by the Code de la Route (highway code)

The characteristics of a bus are defined in France by the regulation of 2 July 1982 relating to public passenger transport, modified by the regulation of 18 May 2009 and the *Code de la Route*[10]. This road vehicle, which must contain at least 9 seats (including the driver's seat) is **limited in length to 13.50 m for standard buses, 18.75 m for articulated buses, and 24.50 m for bi-articulated buses. Furthermore, its width is limited to 2.55 m, excluding side mirrors**. These definitions have a direct impact on vehicle capacity.

Unlike buses, tramways are not limited in terms of length. Although the width of trams in France varies relatively little (between 2.17 m and 2.65 m), tram lengths can exceed 40 m, as in Bordeaux. In certain German cities, trams can be up to 70 m long. Moreover, like Line T2 in the Paris region, two trams can be coupled together in order to increase capacity.

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[8] Working group coordinated by Certu which developed the BHLS concept presented in the report *Bus à Haut Niveau de Service, Concept et recommandations* ["Buses with a high level of service: concept and recommendations"], Lyon, Certu, 2005

[9] The *TVR (Transport sur Voie Réservée)*, also known as GLT (Guided Light Transit) in English, is the name given by Bombardier to its BHLS vehicle, a rubber tyred vehicle with central guidance rail

[10] Articles R. 311-1, R. 312-10 and R. 312-11 of the *Code de la Route*

Table 1: unitary capacity of different types of rolling stock (source: Certu)

System	Capacity of rolling stock in terms of number of maximum passengers[11] (based on 4 persons/m² as standard)	Capacity of the system in terms of maximum number of passengers per hour per direction (headways of 3 min)
Standard bus (12 m)	80	1,600
Articulated bus (18.5 m)	120	2,400
Tram (23 m long and 2.30 m wide)	130	2,600
Bi-articulated bus (24.5 m)	150	3,000
Translohr STE 4 rubber-tyred tram (32 m long and 2.20 m wide)	170	3,400
Tram (33 m long and 2.30 m wide)	210	4,200
Tram (43 m long and 2.30 m wide)	280	5,600

Buses can be powered using various energy sources. Currently, three energy categories can be identified:

- diesel and similar fuels (e.g. buses in Rouen, including the city's BHLS service, *TEOR*[12]);
- natural gas (CNG, LNG, biogas) (e.g. buses in Nantes, including the city's BHNS service, *BusWay®;* most of the *Liane 1* bus fleet in Lille[13]),
- electrical energy supplied via trolley poles which make contact with overhead lines: in this case, the vehicles are called **trolleybuses** (e.g. the *Cristalis* lines in Lyon). In the case of Caen's BHLS vehicle (the *TVR*), – the return current passes via the central guide rail.

New systems using thermal energy and electricity are also being developed.

Two categories can be identified:

- With **hybrid rolling stock**, the "raw material" is still diesel energy, which is then transformed into electrical energy. This can then be used to drive electric motors (e.g. Douai's future BHLS system, known as *Évéole*[14]).
- With **"dual-mode" rolling stock**, which can switch between using electrical energy from overhead lines and using thermal

[11] In practice, actual crush vehicle conditions (6 persons/m² or more!) mean that higher capacities can be obtained, but with an unacceptable level of comfort for passengers.

[12] TEOR (Transport Est–Ouest Rouennais – Rouen east–west transport) is the name that the intercommunality has given to its BHLS service, which incorporates optical guidance at stations

[13] Buses in Lille's *Liane 1* fleet emblazoned with the phrase *Je roule avec vos déchets* ("I run on your rubbish") operate on biogas produced by the local organic waste management centre.

[14] *Évéole* is the commercial name of the future BHLS line

energy from the combustion of fuel. No rolling stock of this type currently operates in France, except in degraded mode.

	Health					Greenhouse gases from from well to wheel	Economic aspects				Public perception	
	CO	*HC*	*NO*$_X$	*Part*	*Non-Reg.*		*Energy diversity*	*Invest.*	*Operat. costs*	*Reliability*	*Noise Odours Fumes*	*Image*
Emulsion										*To be validated*		
Biofuel										*Specific maintenance*		
Particle filter						*If biofuel*	*If biofuel*					
EEV diesel						*If biofuel*	*If biofuel*					
Natural gas						*If biogas*	*If biogas*					
LPG												
Hybrid (potential)										*To be quantified*		
Ethanol (diesel)										*Specific maintenance*		
Electric												

Not as good as diesel			Euro 4			Better than diesel

Table 2: summary of performance offered by different energy sources for buses (source: ADEME)

Finally, certain buses can be guided. A variety of configurations exists, which can be grouped according to:

- **the type of guidance**: using curb guide wheels (e.g. Essen in Germany, Leeds in the UK); using cameras and visual recognition (e.g. *TEOR* in Rouen); using a central guide rail (e.g. *the TVR* in Nancy and Caen); or using magnetic sensors for electronic steering (e.g. the *Évéole* project in Douai, which will use the *Phileas* guided bus built by APTS[15]);
- **the guidance operating mode**: ranging from guidance at stations only (e.g. *TEOR*), to full guidance along the whole route (envisaged for Douai).[16]

In all the cases presented here, vehicles have the technical ability to switch into unguided mode. Vehicles must therefore comply with the *Code de la route* (the highway code).

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[15] APTS: Advanced Public Transport Systems

[16] For further details regarding operation in guided mode, please see Appendix 2: *BHLS in the Certu classification of urban TCSP systems.*

Photo 1: the Irisbus Civis in Castellón in Spain: an optically guided trolleybus (source: Certu)

1.2 What are the objectives of a "high level of service"?

The term "level of service" covers a host of factors, expressed in terms of objectives regarding frequency, service span, reliability, journey time, comfort, accessibility, image and ease of use.

The word "high" here refers to high performance; this contrast, of course, is somewhat subjective and will depend on local contexts, objectives and customer's expectations, but in all cases this means performance levels that are higher than those of conventional buses.

Achieving this "high" level of service requires the implementation of a certain number of measures.

The objectives behind the implementation of a TCSP system primarily concern the politics, organisation and management of transport:

- limiting the use of private vehicles by encouraging a modal shift to alternative forms of transport;
- increasing satisfaction among existing public transport (PT) users.

These objectives are also compatible with the three pillars of sustainable development:

Transport with a high level of service helps create sustainable towns and cities

- *environmental objectives*: reducing pollution (air, noise) and energy consumption;
- *social objectives*: opening up deprived neighbourhoods, improving accessibility (to jobs, services, facilities, etc.), improving the living environment and improving journey safety;

- *economic objectives*: contributing to the development of the urban area (commercial activity, attractiveness, etc.), ensuring the profitability of transport systems.

The socioeconomic benefits of TCSP systems are evaluated by comparing the different gains with the costs incurred by the system.[17]

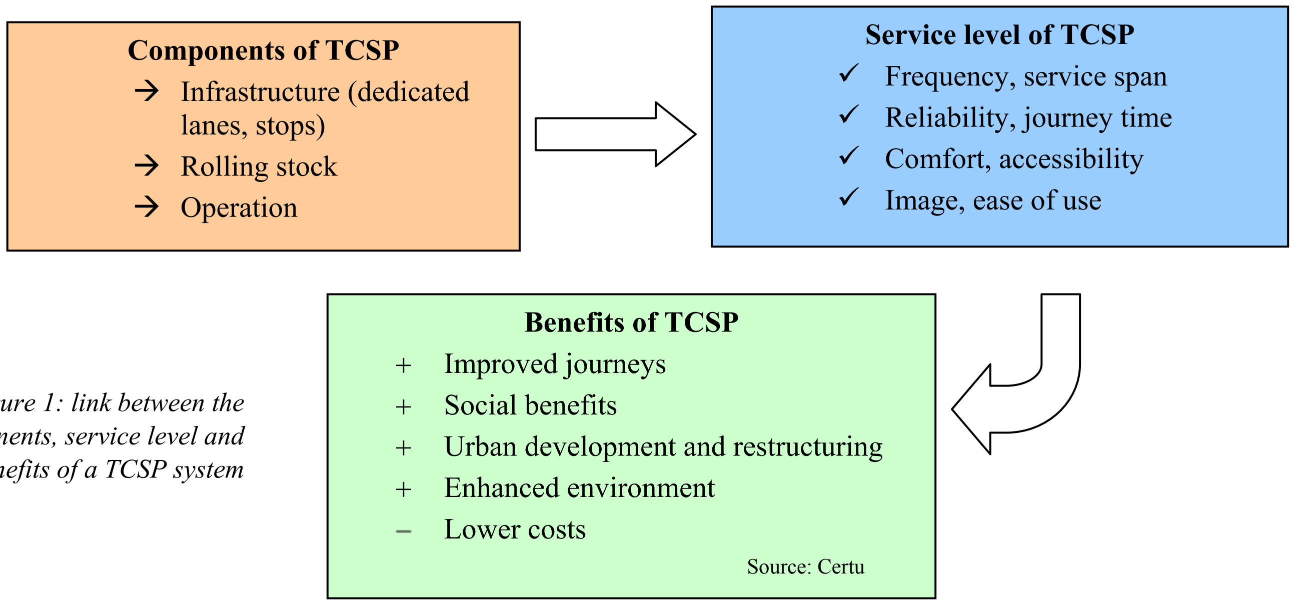

Figure 1: link between the components, service level and benefits of a TCSP system

1.3 What are the characteristics of a high level of service?

The modal shift from cars to public transport can only happen if credible alternatives, such as TCSP systems, are developed

In addition to the social role played by public transport, new issues – linked to congestion in cities, atmospheric and noise pollution, the living environment and purchasing power – have emerged. These issues call for public bodies to take measures to persuade SOV drivers[18] to limit their car use, or even abandon their cars completely, in favour of public transport in particular. However, these drivers benefit from a degree of freedom, comfort and even speed that is difficult to compete with. In order to win them over, robust policies restricting car use in city centres and demanding objectives for public transport services are necessary. TCSP is one possible response.

The table below aims to provide a list of factors, for each service component of surface public transport, which can be used to determine together whether a service level is high. These have been defined on the basis of feedback in the field from working-group members and urban transport authorities.

In Chapter 6, "*Tour de France* of BHLS systems and evaluations", the service level of different BHLS schemes in operation is detailed.

[17] For more information on TCSP evaluation methods, please refer to the *Note méthodologique pour l'élaboration des bilans LOTI de TCSP* ("Methodology for producing LOTI assessments of TCSP systems"), Certu, 2003.
[18] SOV: single-occupant vehicle, i.e. a vehicle containing only a driver.

Frequency	▪ Headways of 8 [19] to 10 minutes maximum at peak times, depending on the size of the urban area[20] ▪ Headways of 15 to 20 minutes maximum off peak, depending on the size of the urban area ▪ No distinction made between term-time and school holiday periods
Service span	▪ Service more or less between the hours of 5 a.m. and midnight, with simple timetables[21]
Reliability/Punctuality	▪ BHLS vehicles should be evenly spaced along the route and arrive punctually at stations ▪ Journey times should vary as little as possible
Journey time	▪ Door-to-door journey time must be the same, if not shorter, than the equivalent journey made by car ▪ Uniform speed along the whole route throughout the day
Comfort[22]	Should offer a similar degree of comfort to trams: ▪ Limited vehicle movement (i.e. a smooth ride) ▪ Comfortable seats and standing facilities; ease of movement within the vehicle ▪ High-quality interior (lighting, ambiance) ▪ Provision of real-time passenger information (waiting time, next station, delays) both on board and at stations ▪ For headways of more than 10 minutes, display of wait times is essential for passengers
Accessibility	This is a legal obligation[23]. However, BHLS services must be exemplary in this regard: ▪ All BHLS lines in a given transport network should benefit from even greater accessibility than conventional bus lines ▪ The accessibility approach adopted should be related to the local "transport chain" (pedestrian routes, boarding/alighting, park and ride, cycling, etc.)
Image/ease of use	▪ Users must be able to identify the line on maps and within the town or city, and associate it with a high level of service ▪ Services should benefit from a modern, "high-performance" image in order to attract users ▪ The creation of BHLS lines should be accompanied to a greater or lesser degree by enhancement to the urban fabric

Figure 2: characteristics of a high level of service (source: Certu)

[19] This headway value corresponds to the frequency below which users generally need to check the timetable.

[20] Studies show that transport needs tend to be spread across the day. Off-peak frequencies should not, therefore, differ too greatly from peak-time frequencies.

[21] In small and medium-sized urban areas where evening activities and nightlife are limited, a service up until 11 p.m. or an evening service consisting of one or two buses per hour may suffice, providing that alternative solutions exist (taxis, demand-responsive transport, car-sharing, etc.).

[22] The need for air conditioning in vehicles will depend on the local climate; this is therefore an issue for individual urban areas to decide upon.

[23] French law no. 2005-102 of 11 February 2005 for equal rights and opportunities, involvement and citizenship of people with disabilities

A public transport line cannot be considered as offering a "high level of service" unless this high level of service is maintained **continuously** throughout the day and along the entire line.

In Annecy, the dedicated lanes in the town centre are a perfect example of the measures that could be achieved in the late 1990s. However, the term "buses with a high level of service" cannot be applied to the lines operating in this space: as the breakdown of operating time for Line 4 shows, speeds vary considerably according to the time and place. In the part of the town centre with dedicated lanes (Zone 3), the ratio between free-moving time and the total operating time is high except during the morning rush hour. However, this ratio is lower on the edge of the town centre (Zone 4) where there are no dedicated lanes and no priority at junctions. This ratio is particularly low during the evening rush hour.

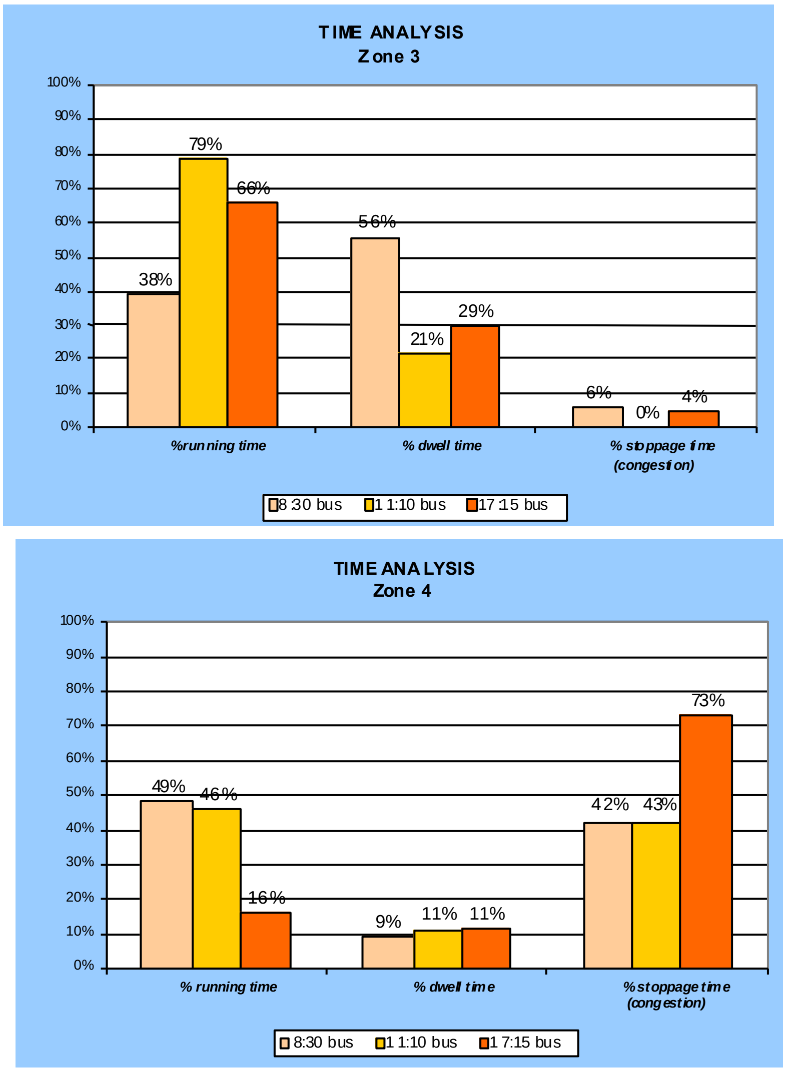

Figure 3: breakdown of operating time for buses on Line 4 in Annecy (source: Communauté de l'Agglomération d'Annecy)

1.4 The BHLS "system approach"

In France, tramways are naturally associated with highly favourable infrastructure and operating conditions. Buses, on the other hand, are only considered as rolling stock. The BHLS concept therefore aims to integrate buses into a TCSP system that also includes a specific approach to infrastructure and mode of operation.

TCSP systems

The "system approach" to TCSP is based on 3 components and the way they interact:

- infrastructure (dedicated lanes, stops, etc.),
- rolling stock,
- operating conditions (priority at junctions, passenger information in real time, etc.).

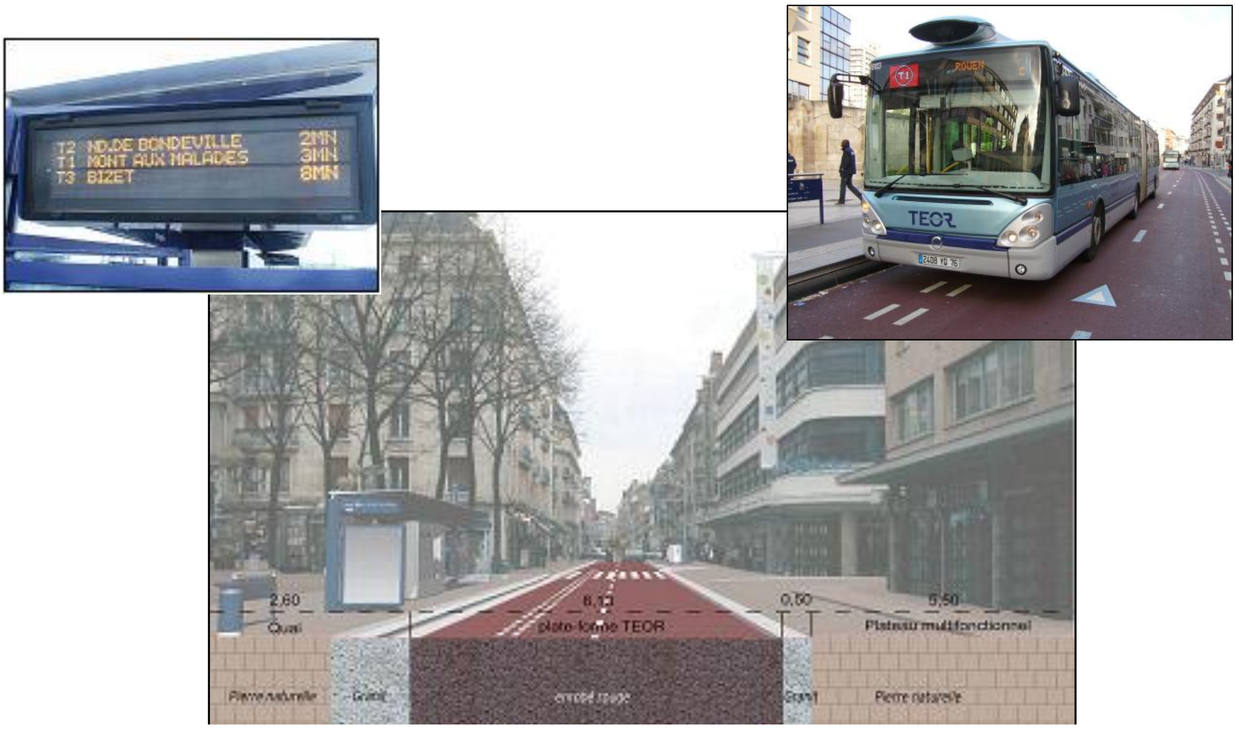

Photo 2: example of the system approach as implemented for TEOR, the BHLS system in Rouen (sources: Communauté de l'Agglomération Rouennaise and Certu)

The choice of components is made according to local constraints and objectives. This may vary for different sections of the same route. This is the case in particular with respect to the design of infrastructure, which can switch between a mixed flow lane and a dedicated lane (e.g. the *TEOR* in Rouen).

Each project therefore has its own "signature" in terms of TCSP system components.

1.5 From the American BRT to the European BHLS (by Odile Heddebaut, Inrets and Sebastien Rabuel, Certu)[24]

1.5.1 The American BRT concept

"Bus Rapid Transit" (BRT) has been used since the 1970s as the means to improve bus services in numerous cities in the United States, Canada, Australia and South America. In the United States, BRT first emerged in the form of bus lanes on freeways known as "busways" (Los Angeles in 1973 and 1979, Houston in 1979). However, these were progressively transformed into carpool lanes for high-occupancy vehicles (HOV), a tool developed by the Americans in response to the oil crises of the 1970s which had negatively impacted bus circulation.

Until the end of the 1990s, BRT was defined as "a rapid mode of transportation that can combine the quality of rail transit and the flexibility of buses". As the range and number of successful implementations grew in North and South America, the many new projects launched by the Americans allowed for a more nuanced BRT concept. This introduced a very wide scale of implementation, from the “BRT-Lite” to the “Full-BRT”[25]. The characterization of the BRT spectrum was made possible by studies defining the various elements that can (or must) be present in any given BRT project. These studies present the different levels of BRT-system components, divided into various classes, such as running ways, stations, vehicles, fare collection, intelligent transportation systems (ITS), service and operating plans, and branding elements.

BRT-Lite constitutes the first step in the improvement of a bus line and represents the "lower limit" of the BRT concept. A BRT-Lite line is, as a minimum, faster than a regular bus line. It relies for the most part on greater stop-spacing, the implementation of some right-of-ways at junctions, and an improvement in headways and spans. While passenger information is often rather limited for regular bus lines, BRT-Lite typically provides better information. In addition, a BRT-Lite service is often given its own identity by the use of a brand name, logo and specific colors (for the buses and stations). BRT-Lite is the most common form of BRT in North America (the Vancouver B-line in 1996, Chicago since 1998, the MetroRapid Bus in Los Angeles since 2000, etc.).

At the other end of the spectrum, Full-BRT targets the same qualities as the metro: fully grade-separated transitways, pre-board fare collection, frequent and rapid services, modern and clean vehicles, and marketing and identity. Bogotá, Brisbane and Ottawa are the three Full-BRT examples most often cited by the Americans. While Full-BRT does not yet really exist in the United States, the model is greatly admired and provides the „ideal’ reference point. In addition to operational performance, the system's flexibility and capacity to redevelop a peri-urban area interest the Americans. Some professionals are pushing for the implementation of "quickways", true Full-BRT systems integrated into an environment to be made

[24] Based on Finn, B., Heddebaut, O., Rabuel, S., *Bus with a high level of service (BHLS): the European BRT concept*. AP050 Bus Transit Systems Committee, Transportation Research Board, 2010.

[25] Gray, G., Kelley, N., Larwin, T., *Bus Rapid Transit: A Handbook for Partners*, Mineta Transportation Institute Report 06-02, San Jose State University, 66 p., 2006.

denser and based on a network-system operating plan: local, express and semi-express lines, as well as combined line-haul/feeder services. This flexibility of use, well suited to America's urban and peri-urban environment, is often cited by advocates of Full-BRT, who criticize Light Rail Transit (LRT) since it often forces additional transfers for users.

Finally, the emergence of the intermediary BRT-Heavy concept represents the recognition of on-street dedicated right-of-way as the best means to cut time and ensure regular service. However, the concept of taking space away from cars to make room for increased public transportation is not yet well established in the American culture. Indeed, this can engender impassioned responses on the part of residents, as was seen with the Honolulu project. And yet, carried along by a few flagship projects (Boston's Silver Line starting in 2002, the Max project in Las Vegas in 2004, and the Los Angeles Orange Line in 2005), dedicated right-of-way is on a roll: 63% of American BRT projects scheduled for completion by 2017 include this as an integral component.

1.5.2 Differing conceptions of urban transportation systems, influenced by urban-planning culture

In most European cities, the needs for high capacity transit are already satisfied by metros, tramways and suburban trains. The metros, characterized by exclusive grade-separated right-of-ways, are rather similar to American HRT and LRT, depending on vehicle size. Tramways, however, are more specific to Europe. In general, tramways are light systems operating mostly via exclusive on-street right-of-ways and are integrated into the city (at grade junctions, accessible platforms). Capacity is limited by intersection management, with a maximum of 6,000 trips/hour/direction for a tram that is 45 meters (148 feet) long, and a headway of 3 minutes. Tramways differ from LRT, light suburban railways which circulate off-street and are usually physically separated from their environment (via gates, walls, grade crossings). The tramway is therefore similar to a modern, high-performance streetcar having a strong impact on its city.

The organisation and history of transportation in European cities differs further from those of the United States. Unlike American development based on an extremely dense CBD and greatly spread out residential areas, the European model consists of relatively dense cities, often with narrow streets, and which concentrate most activities and residences. The result is a different form of organisation of public transportation. In the United States, public transportation essentially answers the needs of commuters headed downtown, from extremely scattered and often distant origins. In Europe, public transportation systems take advantage of concentrated transport flows and are becoming increasingly popular for reasons other than commuting.

1.5.3 A shared philosophy: do it better and cheaper

Initially, the development of rapid transit systems in Europe naturally concentrated on the most important axes of demand. Metros and tramways already offer mass transit. However, buses generally suffer from a negative image linked to congestion, unreliability, a lack of comfort and largely outdated designs. Despite the implementation of bus lanes, a significant gap in the level of service remains between modern tramways and buses. Thoroughfares not served by metros or tramways present a relatively low user-potential (less than 3,000 trips/hour/direction), which does not justify the higher capacity offered by a tramway for a higher cost (€15-30 million per km, or $30-70 million per mile). The emergence of the Bus with a High Level of Service (BHLS) concept in Europe can therefore be explained by answering the following question: how to fill the gap between the regular bus and the tramway in terms of performance, cost and capacity?

Just as for the North American BRT, the BHLS approach has the same objective of taking greatest advantage of an economical, bus-based system, by using the "ingredients" of heavier systems whose performance is well known (tramways in Europe, LRT in the United States, and even subways for Full-BRT projects such as that of Bogotá). BHLS has also been largely inspired by American BRT with regard to methodology and design, favoring a transportation system in which the vehicle is merely one of various system components. Just like BRT, BHLS remains generic and can be integrated into any type of infrastructure configuration.

In 2005, a French workgroup headed by CERTU, set out to define its own concept of BRT based on early local experiences (the "new town" of Évry in the 1970s, the Trans-Val-de-Marne system in the Ile-de-France region (Paris) starting in 1993, TEOR in Rouen in 2001) and by adapting BRT to the French urban environment and "transportation culture".

1.5.4 French BHLS: a different choice of components compared to the Americans models

The French context necessarily excludes very high-capacity configurations using grade-separated transitways, which are difficult to implement (due to the lack of available space) and, in general, create undesirable urban divides. In the United States, insertions of this type are, in fact, few in number (Pittsburgh since 1977, the bus tunnel under Seattle's CBD) and often dismissed for financial reasons.

In France, the on-street exclusive lane constitutes the fundamental component allowing for the greatest gains in speed and reliability, as well as a redistribution of space in favor of alternative transportation modes (walking and cycling, in addition to public transportation). In the case of BHLS, its use can be limited to congested zones, such as city centers (for instance, Rouen's TEOR). In addition, the French concept of BHLS allows for a certain flexibility of the exclusive lane, an important factor for the effective management of a limited but heavily used roadway (taxis, cyclists, deliveries).

In comparison, while avenues are more numerous, wider and often less congested in the United States, the use of on-street exclusive lanes remains limited. Bi-directional insertions in the center of urban thoroughfares are rare. BRT systems generally make do, in the best of cases, with discontinuous and not well-marked bus-only lanes that are sometimes limited to rush hours. Outside the CBDs - besides the use of a few, often dated freeway busways - BRT circulation via reserved lanes is often restricted to taking advantage of unique opportunities: the re-use of unused railroads (Miami's South Dade Busway in 1997, the Pittsburgh Busway in 2000, the Los Angeles Orange Line in 2005, the Hartford Busways planned for 2009, and the Max project in Fort Collins) or the use of freeway shoulders. Nevertheless, attitudes are progressively evolving. With the implementation of the EmX Green Line in Eugene in 2007 and the Healthline in Cleveland in 2008, the USA now has two projects using on-street exclusive lanes integrated into the urban environment (use of grass-planted lanes in Eugene, building-to-building regeneration on Euclide Street in Cleveland).

The French BHLS concept more or less corresponds to America's only BRT-Heavy. This form of BRT, common in France is also present in the Netherlands (Amsterdam in 2001, Eindhoven in 2005), England (Leeds in 1998, Cambridge in 2009), Sweden (Gothenburg in 2003), and is being developed in Spain (Castellón in 2008) and Italy (projects for Messina and Bologna). While Full-BRT is not present in Europe, as it has not been chosen to fulfil the mass transit function, numerous systems could be classified as BRT-Lite. Among the most well-known are the blue buses of Stockholm (Sweden) since 1999, the Lianes of Dijon (France) since 2004, and the Linea Alta Mobilita in Italy (Prato, Brescia, Pisa). All of these projects rely on a hierarchical organisation of the bus network.

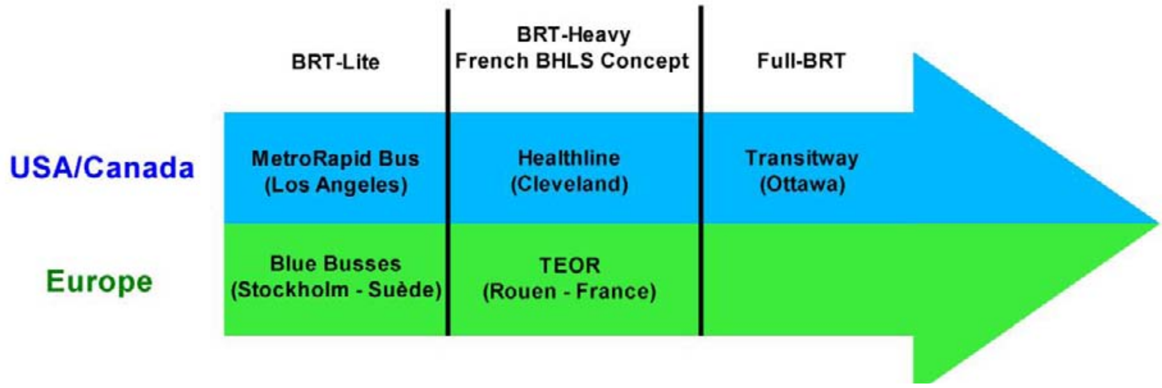

Figure 4: Comparison of the BRT/BHLS concepts based on a few illustrative examples, by S. Rabuel and O. Heddebaut based on American (Wright et al.,; Kantor et al., and European studies; 2009).

The components outlined by the FTA in its *Characteristics of Bus Rapid Transit for Decision-Making* reveals other differences between the United States and Europe, in addition to their approach to interpreting exclusive right-of-way. Increases in stop-spacing (used by 89% of future American projects planned for 2017 or earlier, according to Kantor *et al.*), off-board payments (54%), and branding remain largely undeveloped in Europe. Increasing stop-spacing is blocked by the resistance of users - in particular, disabled persons - and by the difficulty of separating the functions of speed and accessibility within transport networks. Concerning off-board payment, raising public awareness of this measure's effectiveness should allow for its development, despite its high cost. Branding is being increasingly integrated into projects (TEOR in Rouen in 2001, Jokeri-line in Helsinki in 2003, etc.). While long commute times encourage Americans to retain a high number of seats in their vehicles, capacity needs and attempts to reduce costs lead to less seats in European vehicles. This results in a higher proportion of standing passengers whose comfort could especially be ensured by special modifications of the bus interior platform, albeit at additional costs.

1 – What is a BHLS system? Points to remember…

- → By adopting an overarching "TCSP system" approach (infrastructure, rolling stock, operating conditions), BHLS provides a service level that is higher than that of conventional bus lines (in terms of frequency, journey time, reliability, comfort and accessibility) and which is similar to that of the best-performing tramway systems.
- → The choice of components is made according to local constraints and objectives. The BHLS concept therefore adapts to the local socioeconomic and urban contexts.
- → BHLS is characterised by rolling stock which complies with the rules of the French highway code (*Code de la Route*). This means vehicles cannot exceed 24.5 m in length. Therefore, for a minimum headway of 3 minutes, the capacity of a BHLS service is limited to around 3,000 passengers/hour/direction (2,400 pass./hr/dir. for an 18 m articulated bus).
- → BHLS vehicles can be guided (by physical or non-physical means).
- → BHLS vehicles can use all sources of energy available and imaginable (thermal, electrical, hybrid, etc.).
- → Contrary to received thinking, trolleybuses do not automatically imply BHLS. The term "trolleybus" refers to a particular means of propulsion. While trolleybuses with a high level of service are possible, conventional trolleybuses also exist (e.g. in Limoges, Saint-Étienne, Lyon).
- → The Bombardier *TVR* (GLT) used in Caen and Nancy is subject to the *Code de la Route* and, as such, should be considered as a BHLS vehicle.

2. Integrating BHLS services into networks: a multifaceted tool

2.1 BHLS: a tool adapted to different urban contexts

BHLS has broadened the range of TCSP systems available (see Appendix 2: *BHLS in the Certu classification of urban TCSP systems*).

It can be adapted to different urban configurations with an aim to structure the public transport network.

2.1.1 BHLS on an equal footing with trams in certain large urban areas

Nantes

After three tramway lines, Nantes has opted for BHLS for its fourth TCSP line. This fourth line, known as the *BusWay*®, is put on an equal footing with the tramway lines, and as such is subject to the same objectives. **For tramway and *BusWay*® alike, the aim is to ensure and promote a high level of service throughout the network.** There is therefore no hierarchy between the two modes.

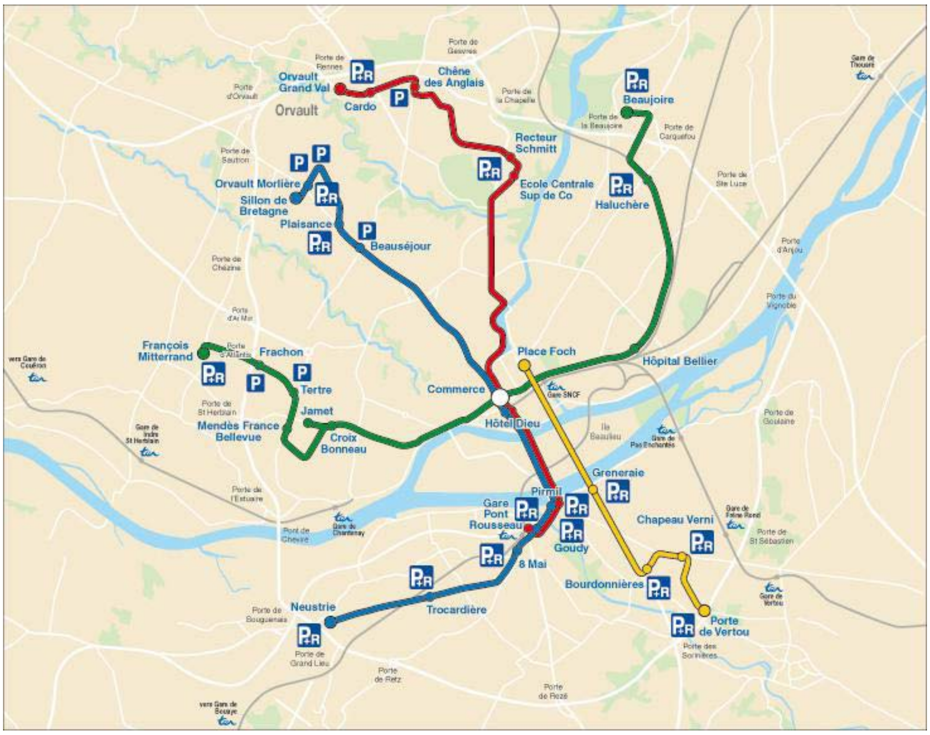

Figure 5: the BusWay® line (in yellow) is integrated into the TCSP network as "line 4" alongside existing tram lines 1 to 3 (source: Nantes Métropole – Semitan)

Rouen

The situation in Rouen is very similar. In parallel with the opening of the city's first tramway line in 1994, the then District de l'Agglomération Rouennaise (predecessor of the current Communauté de l'Agglomération Rouennaise) initiated studies for the creation of a second TCSP line. The aim was to link the university plateau, the city centre and the northern plateau (40,000 inhabitants within 400 m of the proposed line). An initial, unsuccessful call for tenders highlighted a mismatch between the cost of the systems proposed (Bombardier *TVR* (GLT), Siemens tramway, Alsthom tramway and Pomagalski cable-driven transport) and actual transport needs. Furthermore, the route did not respond to the needs of the eastern and western plateaux or the Cailly valley (50,000 inhabitants within 400 m of a potential TCSP line). The District therefore finally opted for a BHLS system, adding three branches to the initial project in order to **extend the high level of service across a wider area**.

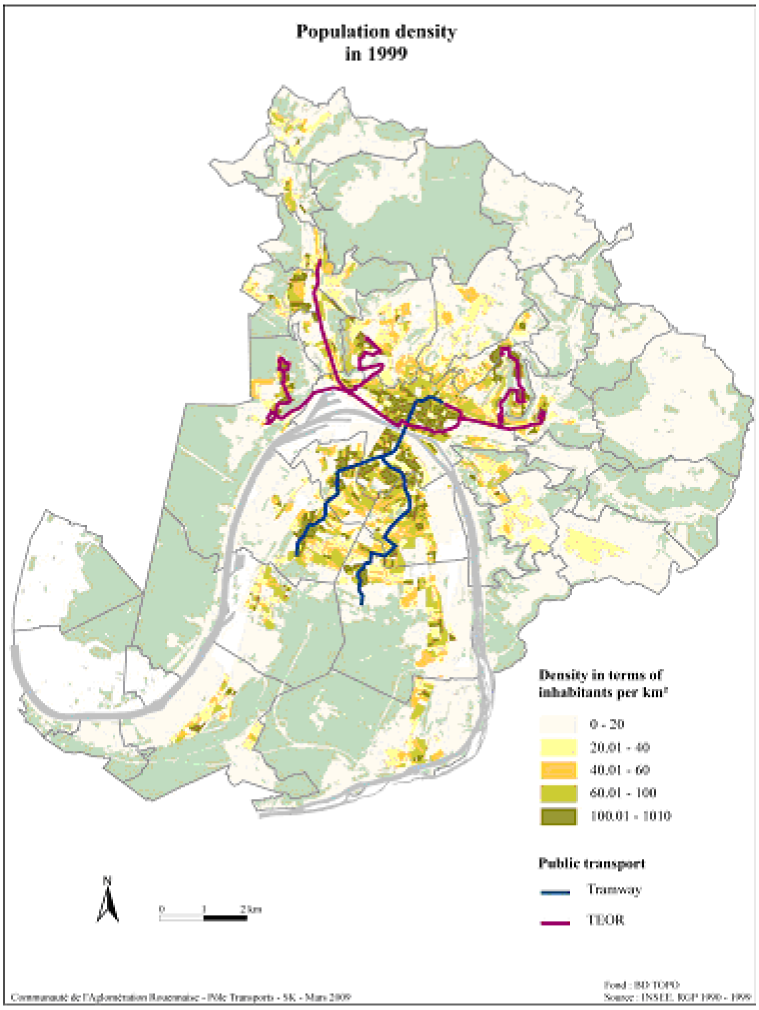

Figure 6: the most densely populated parts of the Rouen urban area benefit from a high level of service (tram/BHLS) (source: Communauté de l'Agglomération Rouennaise)

In these cases, where BHLS systems are put on an equal footing with tramways, the aim must be to offer a service level that is equivalent to that offered by tramway systems. To achieve this, the system components must take inspiration from tramways.

2.1.2 BHLS as an intermediate urban network

Urban areas which already have metro and/or tramway systems can use BHLS as an intermediate system, offering service levels between those offered by the metro/tramway system and conventional buses. The aim here is to create a hierarchy within the bus network, and indeed the urban transport network as a whole. The level of service sought for BHLS lines in these cases may therefore be slightly lower than that of "heavy TCSP" systems (metros, tramways); however, in order to make the contrast, service levels must be significantly higher than those of conventional bus lines.

Lyon

The approach adopted in Lyon (*Cristalis*[26] lines) is based on this principle, but is not yet complete. Work on BHLS lines C1 and C2 is still in progress. Line C3, on the other hand, cannot currently be considered to be a BHLS line (variable running-way quality, unreliability due to the lack of dedicated lanes and/or priority at traffic lights in places, parked cars in certain bus lanes).

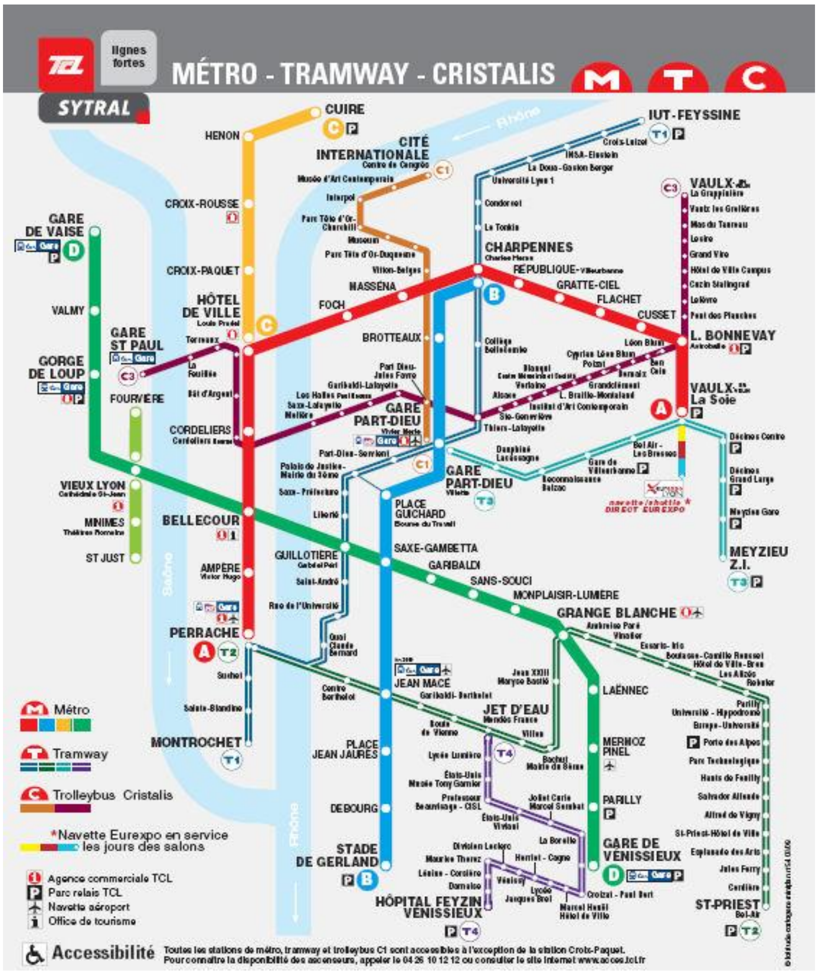

Figure 7: hierarchical organisation of Lyon's TCSP network, according to the level of service on offer (source: TCL)

26 The *Cristalis* lines are named after the rolling stock that operates on them.

2.1.3 BHLS as a feeder system for "heavy TCSP"

Toulouse

Toulouse, an urban area of almost 800,000 inhabitants, has chosen to develop a BHLS network that feeds the city's two metro lines.

Public transport infrastructures in the Toulouse urban area

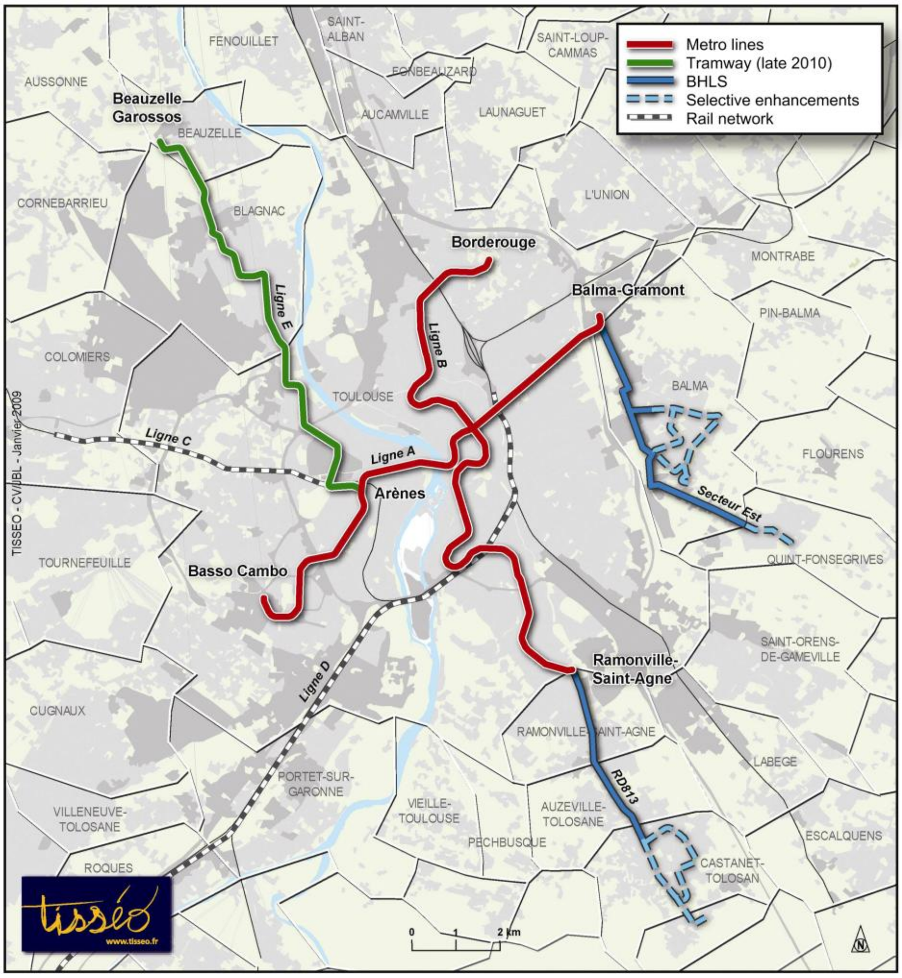

Figure 8: BHNS routes (in blue) act as feeders for the city's metro lines (in red) (source: Tisséo – SMTC)

To date, two corridors[27] have been created: one in the east of the city and one that follows the D813 road (former N113[28]), totalling 11 km. Two BHLS lines operate on each of these corridor.

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[27] In the rest of the document, the terms "corridor" or "trunk" will be used when several lines are able to operate on the same route.

Park-and-ride schemes (with 50- and 100-space car parks) have been created at the ends of the bus lines, but they are little used. The number of transfers[29] necessary for a journey (at least two for a journey into the city centre) is proving to be a disincentive to users. This example raises a number of questions on how best to encourage public transport use among inhabitants in outlying areas:

- How can priority be given to other feeder solutions (cycling, walking)?
- What is the real impact of transfers on users' behaviour?
- Should priority be given to BHLS lines that feed "heavy" transport modes (metro and tramway lines) as in Toulouse, or is it better to use BHLS lines to serve town and city centres directly with a denser and more "meshed" network (cf. the concept of "optional transfers" implemented in Rennes)?
- How best to deal with competition between park-and-ride schemes directly serving the metro and BHLS feeder lines be managed?
- What role is there for high-performance road-based systems that complement TER (regional rail) services?

There are no standard answers to any of these questions. In the end, it all depends on the combination of time, comfort and price that users are offered.

2.1.4 BHLS systems as structural elements in medium-sized urban areas

BHLS offers new prospects for medium-sized urban areas

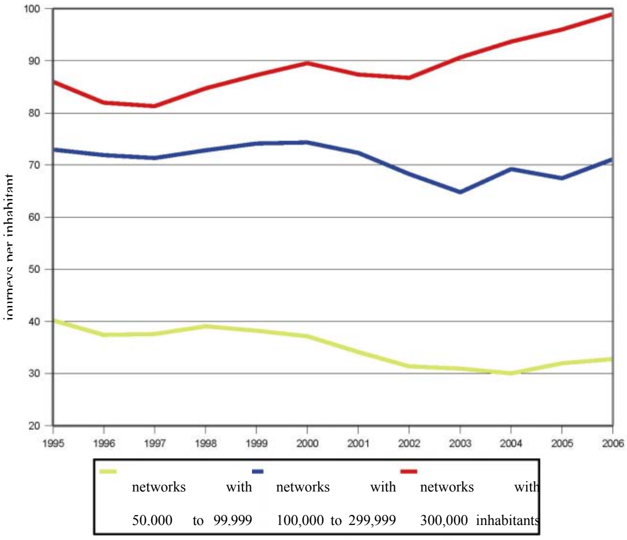
In many medium-sized urban areas (i.e. *unités urbaines* with approximately 100,000 to 300,000 inhabitants), the financial resources and development potential for public transport available in the medium term mean that the creation of a tramway system often cannot be justified. While their larger counterparts were busy building high-performance metros and tramways, medium-sized urban areas had few options open to them to give their transport systems a new lease of life. In large urban areas, the noticeable increase in the number of journeys made by public transport is in part due to the "TCSP effect"[30]. In medium-sized urban areas, on the other hand, the general trend over the last decade has been one of stagnation, even decline.

[28] Responsibility for the former N113 was transferred to the Haute-Garonne *Conseil Général* in accordance with the latest decentralisation laws.

[29] The term "forced transfers" can also be used.

[30] Other factors may also explain growth in public transport use: significant population growth, policies restricting car use, development of the rest of the (non-TCSP) transport network, changes in the economic situation of households, etc.

Figure 9: changes in public transport use between 1995 and 2006 by size of urban area (excluding the Paris region) (source: annual Certu-DGMT-GART-UTP urban public transport surveys, 1995–2006)



BHLS therefore offers new prospects – notably, the possibility of creating a "TCSP effect" – for medium-sized urban areas.

As of December 2008, Lorient, Maubeuge and Nancy[31] are the only medium-sized urban areas in France with BHLS systems[32]. These towns and cities are considering extensions to their networks (e.g. the third branch of *Triskell* in Lorient, a second BHLS line in Nancy). However, many medium-sized urban areas have projects that could be fast-tracked thanks to government subsidies:

- Nîmes and Douai from 2009/10,
- Metz, Montbéliard, Pau, Cannes, Perpignan, Antibes, etc., in the longer term.

BHLS projects adapt to the individual contexts of urban areas

Although in the same category, **different BHLS schemes may act as structural elements to a greater or lesser extent and may have different objectives in terms of service levels, depending on the individual context of the urban area concerned**. The projects for Nîmes and Metz, which incorporate stringent service-level requirements, take inspiration from the best-performing BHLS systems currently in operation (namely the *BusWay*® in Nantes and *TEOR* in Rouen). In Maubeuge, the service levels sought are lower, particularly in terms of frequency (headways of 10 minutes at peak times) and service span (5 a.m.–10 p.m.), as a result of a compromise between the needs of different users (dedicated lanes shared with small numbers of bicycles, taxis and interurban coaches), potential ridership (5,000 passengers per day) and costs (€68 m).

[31] As mentioned earlier, Nancy's *TVR* (GLT) system falls into the BHLS category, as the vehicles can operate in non-guided mode (and are therefore subject to the rules of the *Code de la Route*)

[32] Here, "medium-sized urban area" means *unités urbaines* with 100,000 to 300,000 inhabitants, as defined by INSEE (the French statistical office)

2.2 From dedicated key routes to trunk sections: different BHLS configurations

The flexibility of BHLS means that different types of configuration can be envisaged. These configurations are characterised by the **"degree of dependency" of BHLS lines on dedicated infrastructures and the "degree of openness" of dedicated lanes to conventional bus lines.**

2.2.1 The "busway" configuration: an infrastructure designed exclusively for BHLS

The "**busway"** approach, sometimes called a "closed system", takes its inspiration from Line 4 in Nantes. This configuration is relatively close to that of a typical French tramway:

- the dedicated lanes are for the exclusive use of BHLS lines in order to guarantee a higher level of service[33];
- two or three BHLS lines can operate on certain trunk sections (the number of lines is limited by service frequency[34]);
- transfers with other bus lines are organised around stations.

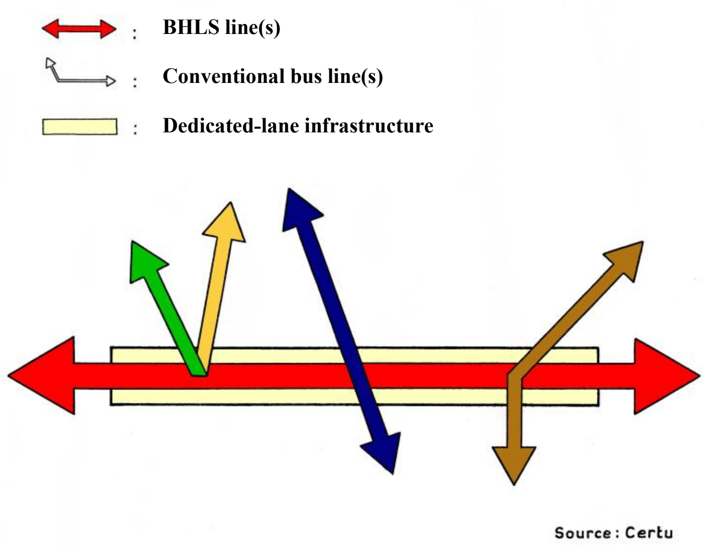
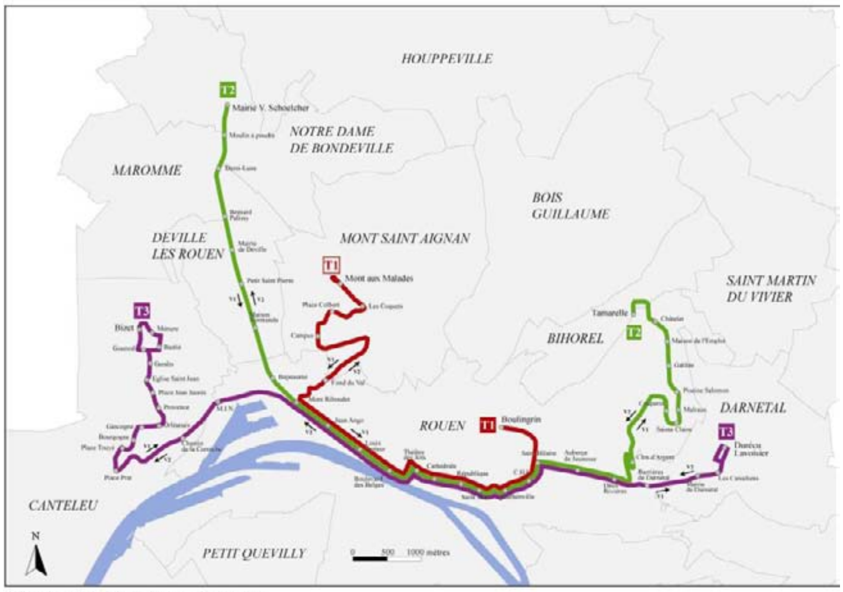


Figure 10: diagram showing the operation of a "busway"-type BHLS system (source: Certu)

[33] Very occasionally, these dedicated lanes may be shared with other bus traffic – as is the case with certain sections of tramway – in order to ensure the continuity of a particular bus route.
[34] For headways of less than three minutes in each direction, priority at traffic lights cannot be guaranteed at every junction (observed).

This "busway" configuration can be found in Nantes, Rouen, Caen and Nancy. In Rouen, all three BHLS lines use a trunk section over a distance of 5 km, depending on the line. In Caen, the city's *TVR (GLT)* services also operate in a 5.6 km trunk section.

Tracé TEOR



Agglomération de Rouen. Pôle des Transports - SK - Mars 2009

Figure 11: "busway"-type configuration in Rouen with a three-line BHLS trunk section (source: Communauté de l'Agglomération Rouennaise)

Conventional bus lines should be organised around "busways" with great care, so as not to excessively increase the number of transfers

The implementation of a "busway"-type BHLS system means that **other bus lines will have to be reconfigured**. The aim of such an exercise should always be to noticeably improve journey conditions for as many users as possible. In order to justify a TCSP system vis-à-vis the population, there is sometimes a political temptation to encourage excessive trunk-and-feeder arrangements in order to encourage transfers at the ends of TCSP lines. While such practices boost ridership on TCSP lines – and increase the total number of trips made across the network – the impact on the total number of journeys made by public transport may be limited because of the increased number of forced transfers[35].

Where changes are absolutely necessary, the inconvenience to the user should be kept to a strict minimum:

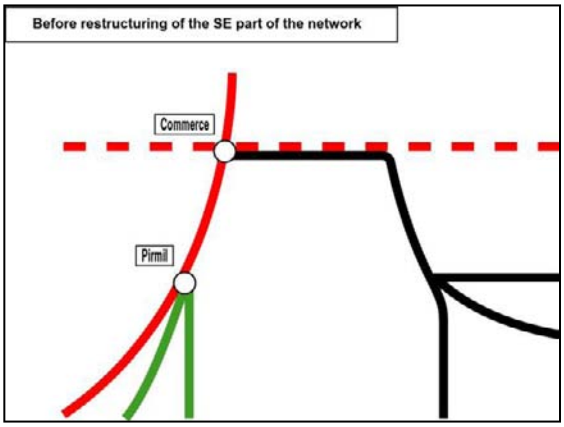
- pedestrian routes between lines should be as short as possible, clearly indicated and safe;
- timetables should be coordinated so as to keep waiting times to a minimum;
- the wait for passengers should be a comfortable one (with shelters, facilities, etc.);
- passengers should be provided with information (both on the bus[36] and at stations).

[35] Please see the glossary for the distinction between a *journey* and a *journey step.*

[36] In Nantes, *BusWay®* vehicles are equipped with LCD screens showing waiting times for transfers to other bus lines at the next station, in real time.

In Nantes, the creation of the *BusWay*® (Line 4) necessitated a reorganisation of exisiting bus lines (shown in black and green on the diagram opposite) that used streets now reserved for Line 4. A new link known as the "*tapis roulant*" ("conveyor belt")[37] was created in order to safeguard transfers between conventional bus lines and Line 2 of the tramway (shown in red on the left-hand side of the diagram). The "conveyor belt" operates with a headway of 2 min 20 s in the morning rush hour for a trip of approximately 3 to 4 minutes between Pirmil and Gréneraie.

Furthermore, the *BusWay*® helps relieve Commerce station – where all three tramway lines intersect – and represents a first step towards creating a truly "meshed" network in the city centre.



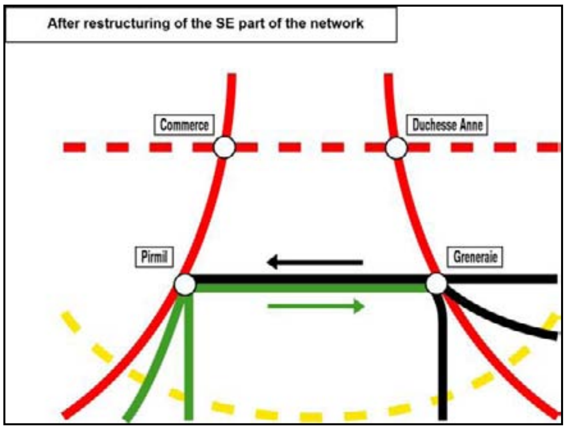


Figure 12: diagram showing the reorganisation of conventional bus lines (in black and green) following the launch of the BusWay® (in red on the right-hand side) (source: Nantes Métropole)

Busway and BusWay®: using the right terminology

The term "busway" originated in the United States. In the 1970s, it was used to designate lanes on motorways that were reserved for buses (with the first being implemented in Los Angeles in 1973)[38]. In urban areas, the term "bus lane" is now generally used, on both sides of the Atlantic.

When Line 4 was inaugurated in Nantes in 2006, transport operator Transdev registered *BusWay*® as a trademark.In France, the term "busway" is today mostly restricted to technical circles, although it is occasionally used by some elected representatives for their local projects (e.g. in Metz). With reference to the Nantes project, it designates a form of BHLS that resembles a typical French tramway, with an infrastructure intended for use by BHLS lines only.

[37] This term refers to the short distance covered and the high frequency in place thanks to the numerous bus lines that serve it

[38] See Appendix 1. "From American BRT to European BHLS"

2.2.2 The "trunk section with a high level of service" configuration: dedicated lanes shared by different lines

Depending on the context, a **trunk**-based approach, also known as an "open system" may be preferred. The trunk section is used by conventional bus lines, which then split off to serve the rest of the network. The high level of service is ensured by the way the trunk section is laid out (dedicated lanes, priority at junctions, etc.). Outside the trunk section, where traffic is free-flowing, mixed flow lanes are predominant. However, in order to guarantee a continuous high level of service, localised improvements (stations, bus lanes, priority at junctions, etc.) may be envisaged.

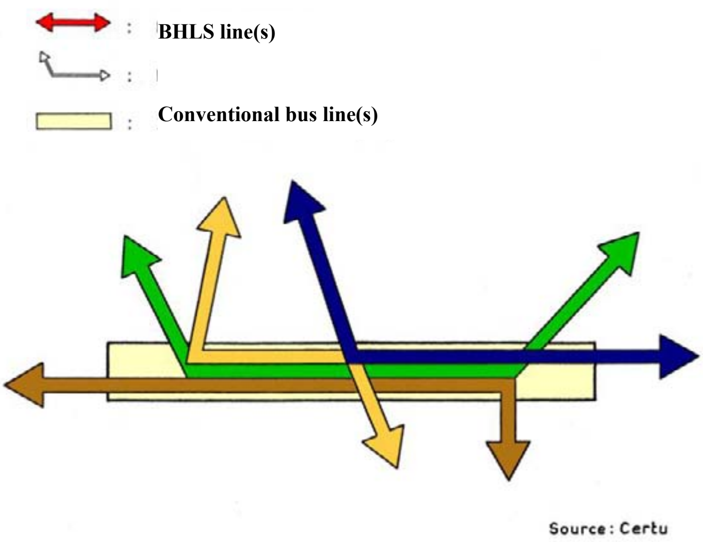


Figure 13: diagram showing the operation of a BHLS system of the type "trunk section with a high level of service" (source: Certu)

Rennes

This was the choice made in Rennes for the city's trunk section, known as the *"Axe Est–Ouest"* ("East–West Corridor"). In 2000, the first 4 km section (2 km in dedicated lanes, 2 km in shared lanes) was opened. This trunk section is used by 7 bus lines.

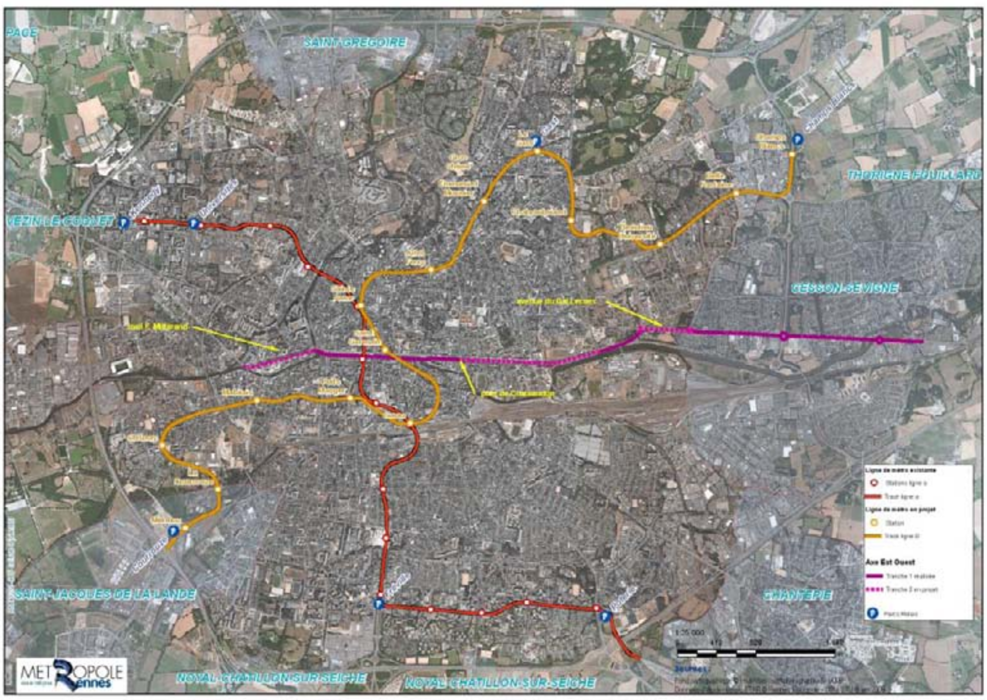


Figure 14: long-term projection for Rennes' TCSP network (source: Rennes Métropole)

The stated objective of the urban transport authority is to improve the flow of buses without creating a hierarchy within the bus network. The trunk section achieves this by **extending a high level of service across the whole network**. However, the high frequency (30 to 40 buses per hour in each direction at peak times) means that the sorts of speeds and reliability levels obtained by "busway"-type configurations cannot be guaranteed here, even though certain improvements do mean that buses have priority at junctions. In the long term, the trunk section will be 6.5 km long with a consistently high level of service.

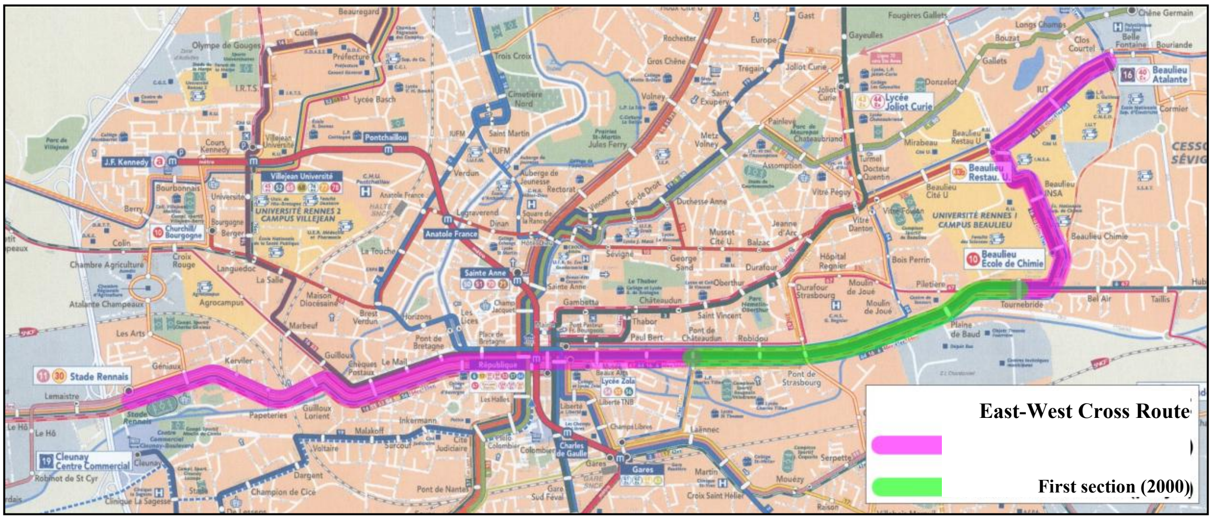


Figure 15: overview of bus lines running east-west in Rennes
(source: CETE Ouest, based on data and cartography from STAR [the city's public transport operator])

Lorient

In Lorient, the PDU (Urban Transport Plan), revised in 2001, approved the creation of a TCSP system in order to revitalise the city's public transport network. Originally, the idea was to implement a rubber-tyred tramway or a "busway"-type BHLS system. However, the project rapidly took on a "trunk section" configuration with a high level of service that would be better suited to the shape and size of the urban area (120,000 inhabitants, of which only 60,000 live in the core town of Lorient):

- The polycentric nature of both the urban area itself and its transport needs means that no single key route could be identified.
- **Transfers** created by other lines feeding into a single TCSP route would have penalized users, given the **short distances of most journeys.**
- The trunk section means that the **benefits for users may be better distributed** across an urban area that is relatively dispersed.

"Trunk section" configurations are particularly suitable for smaller, less dense urban areas

The infrastructure and improvements implemented will be compatible with any future conversion to a guided system on tyres or rails, although such a project is unlikely[39].

[39] However, there may be some isolated problems regarding curve radii if the system were to be converted to a tramway on rails.

The first phase of the *Triskell* trunk section is 5 km long. It incorporates a new bridge over the River Scorff, used by lines arriving from the north-east. Two extensions could extend the trunk section by around 10 km.

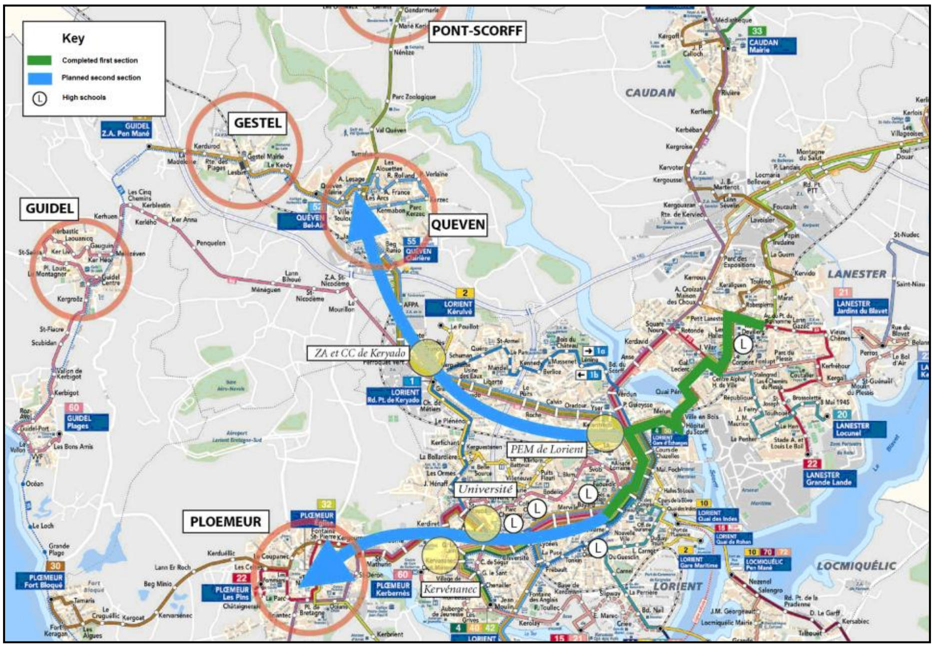


Figure 16: route of the Triskell on the Lorient public transport network map (Source: Cap Lorient)

12 bus lines operate on the busiest part of the trunk section, with a theoretical headway as high as one bus every 30 seconds at peak times. Ponctuality, speed and comfortable driving conditions are ensured by:

- priority at junctions ("give way" in most cases) and the creation of cut-through perforating roundabouts;
- low levels of traffic on roads intersecting with the *Triskell* route, with few red lights run in general.
- Usage of bus lanes and queue jumpers

In both cases (Lorient and Rennes), no separate identity or branding has been given to rolling stock operating on the trunk sections.

2.2.3 The "mixed" configuration:

The "mixed" approach makes it easier to optimise performance and make the best possible use of the available space

In order to make the most of the available space and/or optimise the performance of a public transport network, certain urban transport authorities opt for a "mixed" configuration, which consists of:

- one or more clearly identified BHLS routes;
- allowing conventional bus lines to use certain sections of the BHLS dedicated lanes (in both urban and interurban areas).

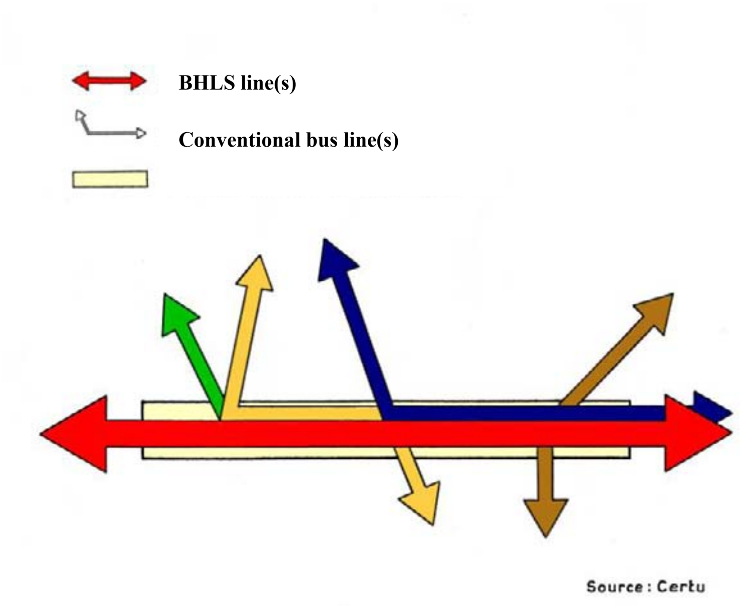
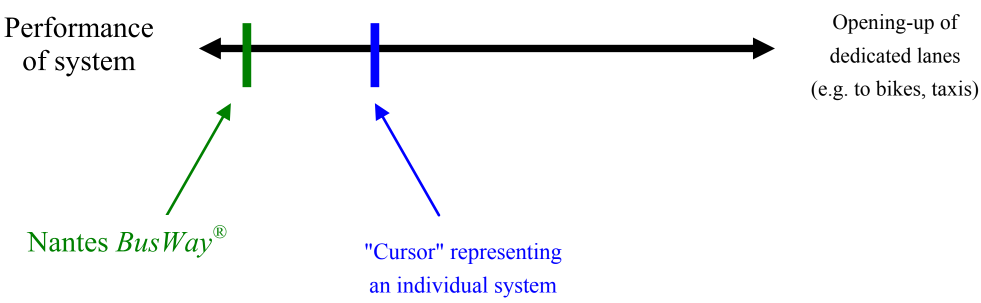


Figure 17: diagram showing the operation of a "mixed" BHLS system (source: Certu)

In this case, the difficulty lies in finding the right balance between performance objectives for the system and making best use of the reserved space. This balance must be established as early as possible in the planning process and must be maintained during the study phase – the flexibility of BHLS means that it is easier to make concessions to performance objectives during the implementation phase.



Saint-Brieuc

The Saint-Brieuc urban area has recently opted for a "mixed" configuration.

Saint-Brieuc is a town of 50,000 inhabitants at the centre of an urban area with a population of 90,000. Against a backdrop of discussions on the PDU approved in September 2006, the *communauté d'agglomération* of Saint-Brieuc (formerly known as Cabri) decided to create a TCSP service. 5 potential routes were identified, including the existing Lines 3 and 5, which represent 45% of network ridership with 10,000 passengers per day.

Following further studies, the project is to be based on:

- a clearly identified 8 km BHLS line running east–west with headways of 8 minutes at peak times;

- dedicated lanes that are open to other (conventional) bus lines in order to recoup the infrastructure costs.

As in Lorient, feeder transfers will be kept to a minimum, as they would be heavily penalising to users. However, unlike in Lorient, a key structural route will be created.

The "mixed" approach enables networks to create the dynamism of a TCSP system while also improving the performance of conventional bus and/or coach lines. This is a particularly good choice for medium-sized urban areas that wish to develop a key structural route, but where very high frequencies are not necessary.

2.2.4 Types of BHLS system and the overall organisation of public transport networks: potentially delicate choices

The choices of BHLS system in Nantes and Lorient were relatively straightforward:

- In Nantes, the service and identity objectives led to the creation of a "busway"-type system. This choice was all the more obvious given that the reorganisation of conventional bus lines presented few constraints.
- In Lorient, the size and configuration of the urban area meant that a trunk section was the obvious solution.

In other urban areas, the definition of BHLS characteristics and the integration of such a system into the existing public transport network are more delicate matters. This is the case notably for Montbéliard and Metz.

Montbéliard

The Montbéliard urban area shares certain characteristics with Lorient:

- the population of the *unité urbaine* is approximately 115,000;
- the urban area has two key centres (only 30,000 inhabitants live in Montbéliard proper; 15,000 live in Audincourt).

The BHLS route drafted in the 2006 feasibility studies sought to link the two main parts of the urban area.

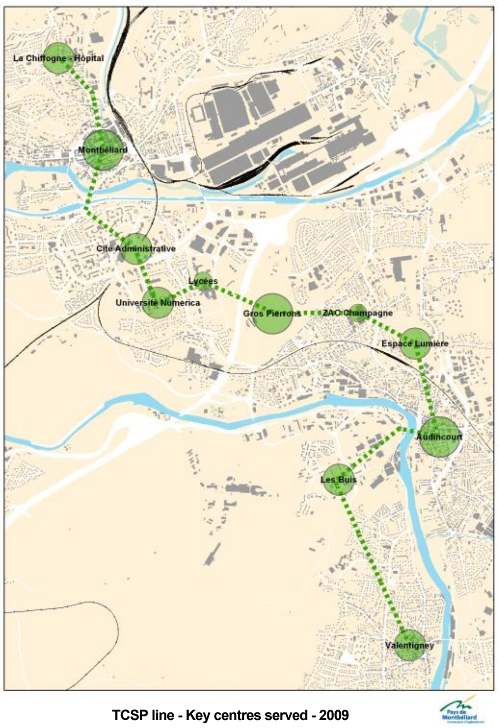


Figure 18: projected BHLS route (source: Communauté d'Agglomération du Pays de Montbéliard)

This choice of route immediately gave rise to a number of questions:

- Should there be one BHLS line with transfers to other bus lines organised around Acropole and Temple stations?
- Should there be two or three "busway"-type lines with a trunk section and branches to the north and south (rather like *TEOR* in Rouen), which would avoid highly inconvenient transfers?
- Should existing conventional bus lines be reorganised using a trunk configuration, like the *Triskell* scheme in Lorient?

Metz

In Metz, a city of 130,000 inhabitants at the centre of a considerably larger urban area, studies carried out in the 1990s resulted in the definition of a key TCSP route that was included in the PDU approved in 2000. The route is largely dictated by major urban constraints (numerous waterways to be crossed, very narrow streets, extensive pedestrian area). After initially considering a trunk-based BHLS set-up, a two-line BHLS system was finally selected (shown in red and black on the map below) for the project, known as "Mettis".

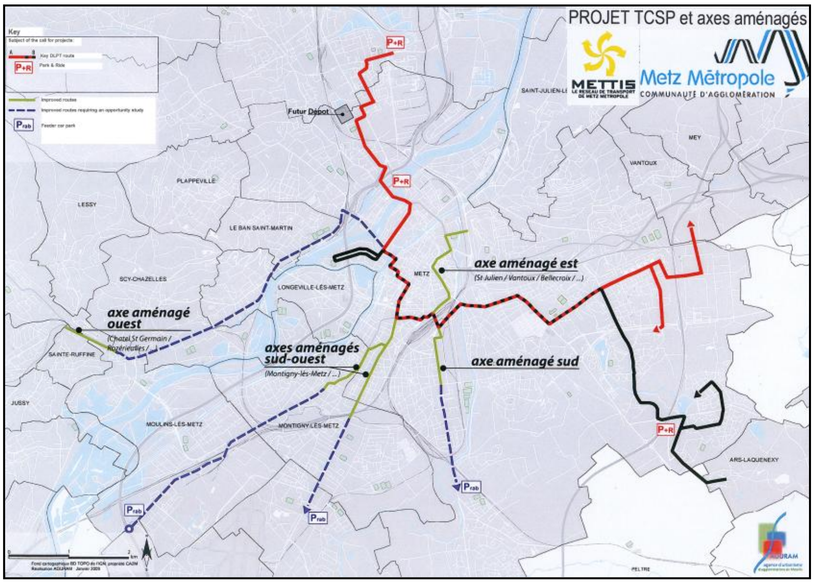


Figure 19: the Metz BHLS project includes two "busway"-type lines, which form the backbone of the public transport network (source: CA2M – AGURAM)

Network reorganisation studies carried out in 2007 and 2008, on the basis of Origin/Destination surveys and microsimulations, openly sought to eliminate the inconvenience caused by the four bus lines that run through the city's pedestrianised shopping area. These buses currently go through the city centre at very low speeds and represent a source of pollution and potential danger for pedestrians. As in Dijon, the aim is therefore to separate the performance and accessibility functions of public transport. The reorganised bus lines, which will now only skirt the pedestrian city centre, will benefit from higher operating speeds, bringing a more attractive image among users and savings in terms of operating costs. In order to ensure ample accessibility to the pedestrian zone (essentially a 400 × 800 m rectangle), the route of the city-centre shuttle bus will be redrawn. In particular, this will provide persons with reduced mobility (PRMs) with easy access to shops and services. Furthermore, one conventional bus line will continue to cross the pedestrian zone.

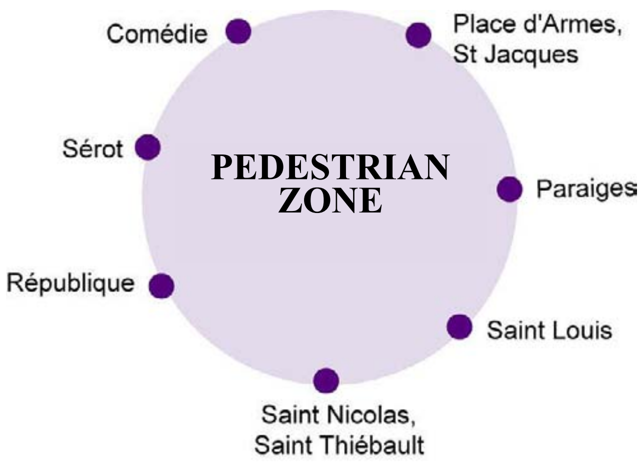


Figure 20: bus stops in Metz city centre (source: CA2M – AGURAM)

The various street-related constraints in the city centre mean that options for linking the two BHLS lines with the rest of the network are limited:

- conventional lines could feed the BHLS lines at points where many lines converge (e.g. Saulcy to the north and Metz railway station to the south), relatively close to the central business district (less than 1.5 km away);
- open up the BHLS dedicated lanes to other bus lines.

Modelling the first scenario highlighted two problems:

- passengers would be forced to transfer to another bus, even though very close to their final destination;
- there would be far too many transfers overall, which, in the long term, would lead to capacity problems at interchange points and on BHLS lines at peak times.[40]

In order to counter these difficulties, technical teams suggested opening up the BHLS dedicated lanes to two other lines. Studies are currently in progress with the aim of defining ways in which these lines could be incorporated into the trunk section at peak times so as not to disrupt BHLS flows (one BHLS vehicle every 3 minutes). One of the hypotheses proposed involves voluntarily creating convoys of buses (BHLS + conventional line), together with stations around 40 m in length capable of accommodating two articulated buses.

In conclusion, the type of BHLS system chosen often plays a key role in determining the overall attractiveness of a transport network. Detailed studies must therefore be carried out beforehand in order to **take account of objectives in terms of service levels, configurations and other development projects within the urban area**. If we were to draw an analogy with high-speed rail, the "busway" approach would be similar to the Shinkansen system in Japan (a single infrastructure dedicated to high speed), whereas the trunk-based approach would be more like the French TGV system (where certain conventional rail lines are used by high-speed rolling stock).

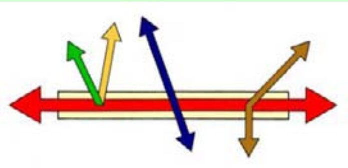
[40] For example, the study carried out by AGURAM estimated (on the basis of current public transport usage) that, at the height of the rush hour, around 50 users could be forced to transfer to or from a BHLS line.

Buses with a high level of service (BHLS)

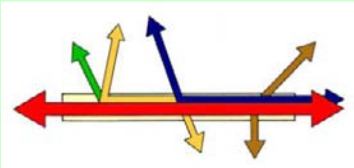
Type of TCSP

Type of BHLS system

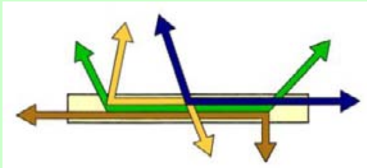
Dedicated route



Mixed approach



Trunk based



Source: Certu

Example: the *BusWay®* in Nantes

- A very high level of service is sought
- High frequencies (peak-time headways of 4 min when operation began)
- Simple reorganisation of other bus lines: alternative routes, limited transfers
- Strong identity and important role as a catalyst for urban development

Example: the BHLS project in Saint-Brieuc

- Transport needs focused on a small number of lines
- Desire to create a key structural route for the network and the urban area
- Limited frequency on the key bus line (headways of 8 min at peak times)
- Dedicated lanes used to improve services on other lines and thus recoup costs
- Many signal-controlled junctions

Example: the *Triskell* in Lorient

- Aim: less ambitious but widespread service levels
- Reorganisation of buses is difficult: few alternatives, major transfer constraints
- Junctions can be managed in order to enable very high frequencies (cut-through roundabouts, very few traffic lights, low traffic levels)
- A strong identity is not essential
- Transport needs are relatively dispersed

Characteristics of urban areas and corresponding service-level objectives

Figure 21: chart summarising the different types of BHLS system (source: Certu)

Integrating BHLS services into networks: points to remember…

→ BHLS is a multifaceted tool that can adapt to the city surrounding and respond to the needs of both large urban areas (as a complement to "heavy" TCSP networks, as an intermediate system between "heavy" TCSP and conventional buses, or as part of a trunk-and-feeder system) and medium-sized urban areas (constituting many cities' first TCSP lines, forming a structure for the rest of the network).

→ BHLS systems can take different forms:

- the "**busway**" model is preferable where service-level objectives (including frequency) are high and where there are few local constraints (in terms of bus network reorganisation, junction management, etc.);
- the "**trunk based**" model, without any identification of BHLS lines and where dedicated lanes are open to a number of conventional bus lines, should be restricted to urban areas with dispersed transport needs and few traffic constraints (low levels of private-vehicle traffic, junction management, etc.);
- the "**mixed**" approach (identification of a BHLS line, the infrastructure of which is shared with certain conventional bus lines) is particularly suited to situations where service-level objectives (frequency, speed, reliability) are lower than for a single "busway"-type line, or where an extensive reorganisation of the bus network would prove too difficult.

→ In all cases, the restructuring of the public transport network as a whole must form an integral part of the BHLS project, and as such must be studied as far upstream as possible – ideally from the feasibility-study stage onwards – as reorganisation constraints can be a decisive factor in the choice of system.

3. When is BHLS an appropriate choice?

The BHLS concept fills a gap between conventional buses and tramways in terms of both performance and image. **It is not, therefore, directly comparable with a tramway. Rather, it is a new, separate system with its own specific field of application**, which we will discuss in detail in this chapter.

Of course, this field of application sometimes overlaps with that of tramway systems, which means that, in certain urban areas, the choice of surface TCSP system is not always immediately obvious.

3.1 Choosing a surface TCSP system: stages and criteria

This is a choice that must be made in a number of stages, according to a range of criteria which are not always mutually compatible. Moreover, it is also a choice that may change during studies. The text box below outlines the criteria that determine this choice at each stage of opportunity and feasibility studies.

Key factors determining the choice of TCSP system

Stage 1: long-term vision for the urban area and TCSP objectives

- Definition of long-term urban planning objectives
- Analysis of current and future transport needs within the urban area
- Long-term network plan (identification of TCSP routes, principles for the reorganisation of buses, etc.)
- Identification of potential improvements and urban redevelopment projects
- Definition of service-level objectives

Stage 2: capacity and cost of TCSP

- Analysis of demand along the TCSP route and the capacity necessary to cope with passenger flows
- Estimate of costs and financial resources

Stage 3: technological precautions and local impacts of TCSP

- Evaluation of local impacts (economic activity, noise, pollution, etc.)
- Analysis of technological and supply sector risks for different systems
- Evaluation of potential for interconnections and compatibility of rolling stock

Stage 4: integration and realisation of a TCSP system

- Conditions for urban integration
- Organisation of construction work

Figure 22: criteria for choosing a TCSP system and schedule for opportunity/feasibility studies (source: Certu)

The discussions and exchanges which lead to the choice of TCSP system may be **iterative**, and depend on many technical elements, which may have a significant impact on the future of the public transport network. This phase of consultation and discussion with technical teams and elected representatives takes time and must be undertaken in a transparent manner, without star assumptions or preconceptions.

3.2 Stage 1: long-term vision for the urban area and TCSP objectives

The decision to opt for a BHLS system (or not) will very much depend on the long-term vision for both the urban area and the public transport network.

3.2.1 Changing urban form

Long-term strategies regarding the location of housing, employment, services and leisure, together with changing expectations and behaviours, can **modify the balance of transport needs and transport provision** within an urban area. The creation of TCSP networks must therefore anticipate these developments as far as possible.

In areas where there is considerable population growth, TCSP systems can act as a **tool for urbanisation**. The organisation and densification of urban development around TCSP routes means that, in theory, it is possible to control urban sprawl and encourage the use of public transport. In this case, the capacity of the system must take account of demand, which can change considerably over time. This is the case, for example, with tramway line T3 in Lyon, which runs on a former rail line serving the city's eastern suburbs. It transports almost 20,000 passengers per day with headways of 7½ minutes at peak times. The potential for urban development around this line are considerable, and ridership is likely to increase rapidly.

Even in areas with lower levels of population growth, urban form may undergo major changes. In Montbéliard, for instance, where the population is stable, the demand for housing remains high, if only because the number of households is increasing. Urban redevelopment should serve to make the urban area more attractive. Furthermore, economic changes (switching from manufacturing to the service sector) and the construction of new amenities (such as a TGV station on the new Rhine–Rhône high-speed line) are all elements which modify the way the urban area functions and offer new opportunities.

3.2.2 Developing a long-term vision for public transport networks

The technical characteristics of TCSP systems mean that they are relatively inflexible and not always mutually compatible. Moreover, their integration into urban areas is often subject to many constraints, and typically causes considerable disturbance (long and disruptive construction works).
Local authorities must therefore have a clear vision for the future of their public

transport network, so that the choices made today do not adversely affect those of tomorrow.

Finally, lessons can be learnt from other cities with tramway systems with regard to the long-term development of a public transport network.

"Meshed" networks and balancing traffic at key interchanges

The iconic TCSP networks in Nantes and Strasbourg have two points in common: **a central interchange hub and congested trunk sections**. When these systems were built, the prevailing view was that public transport networks should be concentrated around a strong intermodal hub. In Nantes, this hub is Commerce station, where the city's three tramway lines intersect; in Strasbourg, four lines meet at Homme de Fer station. Aside from the operational difficulties that this creates, these configurations also give rise to pedestrian flows that are difficult to manage in what have quickly become confined and unsafe spaces. The result is delays, increased dwelling times, and reduced operating speeds, neither of which benefit passengers. In order to attenuate these problems, the networks in question have tried to respond to transport needs more precisely, while relieving pressure on their respective central hubs[41]:

- by creating new hubs as part of the construction of new lines (as is the case with the Nantes *BusWay*®, which actively avoids Commerce station – see Figure 23 below);
- by creating peripheral lines (as is the case with Line E in Strasbourg).

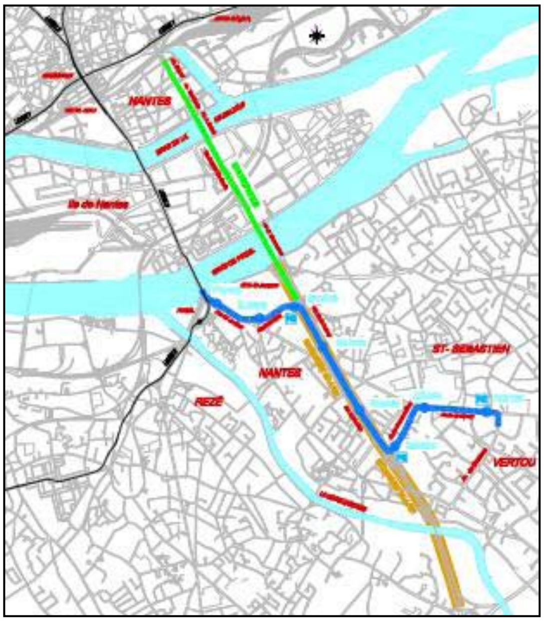


Figure 23: by choosing the busway project (in green) over the tramway extension project (in blue), Nantes took a step towards creating a "meshed" public transport network while reducing congestion on trunk sections and around the central hub
(source: Nantes Métropole)

[41] The same problem exists, albeit on a much larger scale, on the transport network in the Paris region.

Reorganising the public transport network while keeping transfers to a minimum

The creation of TCSP lines provides new opportunities for trunk-and-feeder arrangements which may improve journey times in return for one or more transfers. However, this sort of arrangement must not be implemented systematically. No matter how many measures and precautions are taken (high-quality spaces, simple platform-to-platform transfers ("cross-overs"), passenger information, minimal waiting times, etc.), passengers still regard transfers as a significant inconvenience, especially those used to travelling by car. In the Lyon urban area, Origin/Destination (O/D) surveys and household travel surveys (HTSs) show that the modal share of public transport is inversely proportional to the number of transfers to or from conventional bus lines[42].

Making service choices without jeopardising the future

When a city constructs its first TCSP line, elected representatives are sometimes under enormous pressure to serve many different areas. However, it is often difficult to serve railway stations, outlying neighbourhoods, streets in need of redevelopment, public amenities, and key housing and employment areas, all with one high-performance line! Therefore, in order to ensure a high level of service (which means avoiding twists and turns!), choices need to be made with a view to improving transport provision in the long term. Ultimately, the aim is to **obtain a high level of service across as wide a space and time period as possible**. This requires a long-term approach.

Cracking the conundrum of transport provision in historic city centres

In certain urban areas, narrow streets in central areas make high-quality transport provision (in terms of speed and reliability) difficult. Although surface TCSP lines mean improved accessibility for businesses, they can also bring problems of their own (e.g. noise from tramways negotiating curves, coexistence with pedestrians, disruption to traffic caused by convoys of trams or buses). The issue of transport provision in historic city centres must therefore be studied with care, as part of a long-term strategy for the public transport network as a whole. A new trend is to route TCSP lines around the edges of historic centres so as to conserve high service levels on these lines. In order to compensate the reduced service levels in the historic core, pedestrian routes are typically improved and shuttle services set up to meet the needs of PRMs. However, it would seem that this type of configuration is only possible in cities where the historic core is relatively compact (no more than 1 km in diameter) and surrounded by broad avenues. In Besançon, for example, it was decided that the TCSP line should run through the historic core, which is surrounded not by broad avenues, but a meander of the River Doubs!

[42] Page 45 of the Certu publication, *Évaluation des transports en commun en site propre, recommandations pour l'évaluation socio-économique des projets de TCSP* ["Evaluating dedicated-lane public transport systems: recommendations for the socioeconomic evaluation of TCSP projects"], 2002.

An example of long-term vision: the future network of the Dijon urban area

Dijon is a particularly good case study. Studies carried out by Egis Rail have led to the definition of a TCSP network that takes account of all the elements presented above.

Today, Dijon's public transport network is structured around 7 *Liane* lines:[43] high-frequency radial bus services which transport almost 110,000 passengers per day (80% of trips across the network). These *Liane* services benefit from some localised bus lanes, but cannot be considered as BHLS lines (largely due to their relatively low operating speeds and reliability levels).

Most of the network's bus lines cross the very dense and very constricted historic centre. In particular, almost 1,000 buses travel along Rue de la Liberté every day. This street includes a 200 m single-lane section that is just 9 m wide (building to building). This situation is highly inconvenient for the many pedestrians that use this major shopping street: bus traffic is noisy, polluting, potentially dangerous and makes crossing the road difficult. It is also a less-than-ideal situation for the buses (very low speeds).

Photo 3: a short single-lane section of Rue de la Liberté, Dijon, frequented by almost 1,000 buses per day before the implementation of the tram project (source: CETE Lyon)

The motivation for creating a TCSP network in Dijon is to obtain a noticeable improvement in service levels, particularly in terms of speed, reliability and comfort. The TCSP system must also bring with it urban redevelopment projects (as a catalyst for urbanisation, pedestrianisation of the city centre, etc.).

The local intercommunality, Grand Dijon, has therefore opted for a TCSP network that is built around the existing *Liane* lines. The urban area's three main transport

[43] See the definition of the *Liane(s)* concept given by Keolis in section 8.2: "Revitalising bus lines"

corridors will be the basis for two tramway lines. The other corridors will continue to be served by *Liane* services, which could be converted to BHLS or even tramway lines in the long term.

The tramway and the *Liane* network will bypass the historic core via the boulevards that surround it, with the aim of redistributing space in central Dijon (from buses to pedestrians in the historic centre, and from private vehicles to public transport on the boulevards). As the northern boulevards will be reserved for the tramway, the southern boulevards could be specially adapted to bus traffic (e.g. a BHLS trunk section similar to that implemented for the *TEOR* in Rouen). The selected routes will enable many interconnections, particularly around three key interchange points (the railway station, Place de la République, and Place Wilson). Trunk-and-feeder strategies will be used for conventional bus lines only.
The route of tramway line B takes in the neighbourhood of Les Grésilles (an urban renewal area with ANRU funding) rather than the Porte-Neuve district, which has a TER station (800 passengers per day) and which is likely to be the location for a future TGV station in the longer term. However, the tramway routes selected will be compatible with a future public transport/TGV connection.

According to modelling studies carried out[44], journey times will either be reduced or maintained, depending on the area, with 50% of users benefiting from journey time reductions of more than 5 minutes. The transfer rate (i.e. the ratio of trips to journeys) is likely to increase from 1.10 to 1.25, but this remains acceptable.

The reorganisation strategy for interurban coaches is yet to be defined, particularly with regard to school-bus services.

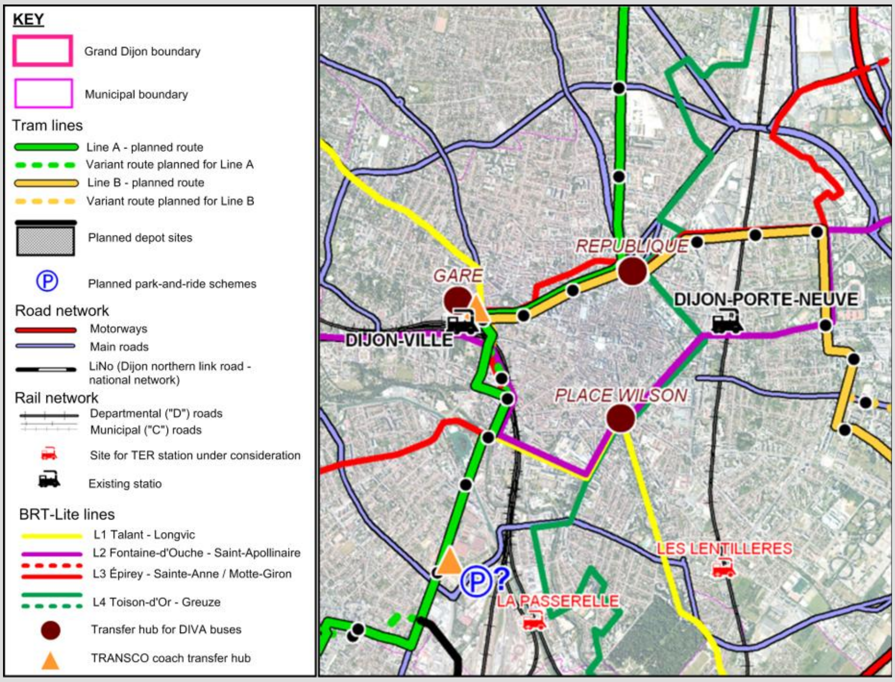


Figure 24: proposed route layout as part of the project to create two tram lines in Dijon (source: Grand Dijon – produced by: DRE Bourgogne)

[44] Egis Rail, Alfred Peter, *Premières lignes de TCSP de l'agglomération dijonnaise, dossier de prise en considération* ["The Dijon urban area's first TCSP lines: dossier of considerations"], 2008

3.2.3 BHLS and tramways: tools for urban development

Tramways and BHLS can both form a basis for urban development

The idea that only a tramway system is capable of structuring the city and triggering urban development is still widespread This vision sometimes even leads to the "transport" dimension of tramways being relegated to the sidelines. This can lead to choices that are not always pertinent (choice of transport system and routes, general organisation of the public transport network, etc.).

The first BHLS systems in service show that this system also has considerable potential as a tool for urban development. BHLS can contribute to the way in which an urban area is structured.

Nantes

In Nantes, the *BusWay*® is at the heart of the GPV (*Grand Projet de Ville* – major urban project) for the Île de Nantes. The *BusWay*® crosses the island along a north–south route that is parallel to the trunk section of tramway lines 2 and 3. Consequently, the area around the BusWay® is set to become home to a host of new constructions, including collective housing and administrative buildings, which will gradually bring the neighbourhood to life. The Beaulieu shopping centre was extended and completely reorganised (13,000 m² of net floor space) in 2008, while the Tripode neighbourhood encompasses a project launched in 2008 that is set to include a business hub (20,000 m² of offices and 7,000 m² of hotels), housing (10,000 m²) and retail space (8,000 m²).

Photo 4: BusWay® on the Île de Nantes (source: Certu)

The future Line 5 could ultimately cross the island from east to west. Whatever system is selected (tramway or busway), TCSP should be at the heart of the structure of this "new territory".

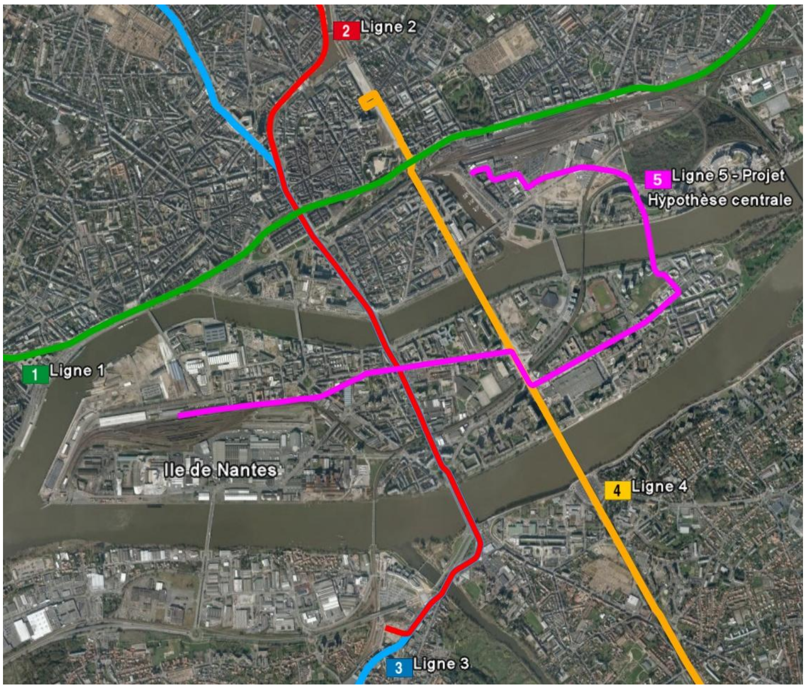


Figure 25: Île de Nantes, the new heart of the city's TCSP network (source: CETE Ouest; background map from Google Earth)

Finally, the PLUs (local urban development plans) of the municipalities served have been revised to enable **densification** around the *BusWay*®.

Rennes

In Rennes, the route of the second phase of the *Axe Est–Ouest* (East–West Cross Route) is integrated into a changing urban fabric (*ZAC* [mixed development zone] with a population of 8,000 habitants, creation of a new streetscape). One of the aims of TCSP here is to **act as a binder for the urban project as a whole** (e.g. integration into the surrounding landscaping, pedestrian access to buses).

Île-de-France (Paris Region)

In Île-de-France, one of the aims of the *Trans-Val-de-Marne (TVM)* was to build urban landmarks in outlying areas where such features are few and far between. In particular, new interchange hubs should help **create new urban centres**.

Lorient

Finally, in Lorient, *Triskell* plays **a structural role in projects across the urban area**. For example, the location of the new maternity hospital was modified as a result of *Triskell*. Originally, it was to be sited on the outskirts of the town, in an area poorly served by public transport; now, it is located within easy reach of the segregated trunk section.

The "*corridor contract*": a tool for encouraging urban development around TCSP systems

The "*corridor contract*" is a tool for structuring urban development around TCSP (tramway or BHLS) projects. This approach, trialled in Grenoble and Toulouse, aims to put the principles laid down in the PDUs and SCOTs (Regional Integrated Development Plans) into practice in the context of a TCSP project:

- control and development of land with variable land use;
- densification around the TCSP route;
- reduction in the number of car parking spaces (on-street parking and in terms of building standards);
- infrastructure for pedestrians and cyclists (including bicycle parking);
- organisation of feeder routes around TCSP routes;
- urban redevelopment;
- diversification of urban functions;
- encouragement of social mix;
- HQE® (high environmental quality) constructions;
- awareness-raising and communication with residents;

This contract enables each municipality served by TCSP to become involved in the TCSP project and make known local expectations (routes, stops), in exchange for urban development obligations.

The contract also clarifies the breakdown of the financial burden according to the different responsibilities involved (transport system for the urban transport authority, other enhancements shared between the municipalities and intercommunalities). This contract is therefore particularly important when the urban transport authority is a syndicate, as in the case in Grenoble and Toulouse.

The corridor contract would appear to be even more relevant for a BHLS project, as the regular discussions involved would be useful opportunities to explain the concept and its advantages from an urban planning viewpoint. The corridor contract enables urban transport authorities to convince local councils of the potential boost that could be provided by BHLS. It is also an educational tool.

For further details, please see the Certu study report entitled *Le contrat d'axe : un outil de cohérence entre urbanisme et TCSP* ("The corridor contract: a tool to ensure consistency between urban planning and TCSP"), to be published in 2009.

3.2.4 Defining the high level of service desired

The choice of system may be linked to objectives set by the urban transport authority in terms of service levels for TCSP systems.

Tramways and BHLS have the same potential in terms of **speed** and **reliability**. These service-level characteristics are essentially due to the importance given to the segregated aspect (running in dedicated or shared lanes) and operating conditions (priority at junctions). Depending on the configuration of the urban area, surface TCSP lines can achieve operating speeds of 15 to 20 km/h or more. Where there are signal-controlled junctions, the maximum headway possible observed at peak times without causing major disruption to other traffic remains 3 minutes.

BHLS and tramways can provide the same performance in terms of speed, reliability, frequency and service span

The service span in place is not linked to the system: they are decided by the local authority.

The theoretical **frequency** that can be obtained with a BHLS system is the same as that for tramways. However, this is not the case if frequency is determined by **passenger traffic** at peak times. For example, in order to transport 3,000 passengers per hour in each direction, there would need to be a 200-spaces tramway every 4 minutes or a 100-spaces BHLS every 2 minutes. In this example, choosing the BHLS option would generate additional operating costs, as well as disruption at light-controlled junctions. These disruptions would in turn have an impact on the speed and reliability of the buses, and therefore on the system's overall capacity.

BHLS services can provide levels of comfort and accessibility close to those offered by tramways

As far as **comfort** and **accessibility** are concerned, "new-generation" tramways have amply demonstrated their benefits. These tramways enjoy a positive **image** not only because of how they perform, but also because of their ability to help "develop the city". On all of these points, BHLS has considerable potential which must be realised when projects are implemented. Indeed, BHLS systems are changing in order to provide greater comfort and accessibility, by looking towards tramways for inspiration. BHLS systems also need to be able to create an outlook and image to match their performance.

3.2.5 BHLS and tramways: tools for restructuring urban spaces

BHLS can contribute to the redevelopment of public spaces

The opportunity for redeveloping public spaces such as streets and squares exists as soon as the question of shared public spaces arises. Whether with cobbles, granite or grass, rail-based tramways have already amply demonstrated their ability to smarten up the city. While these developments could, of course, also be envisaged without a supporting transport element, tramways do appear to act as a catalyst for this type of action.

But what about BHLS? As a road-based system, BHLS requires a smooth surface to travel along, whether the bus is guided or not. This means that the design options for the righ-of-way are more limited for BHLS than for rail-based tramways (where, for example, grass can be laid across the whole running way; this would not be possible for BHLS). For the rest (street furniture, vegetation, design of stations, structuring of uses, etc.), BHLS has the same potential as a tramway system.

The *TVR (GLT)* systems installed in Nancy and Caen in 2001 and the *Translohr* system installed in Clermont-Ferrand in 2006 have demonstrated the potential of tyre-based systems in terms of urban redevelopment.

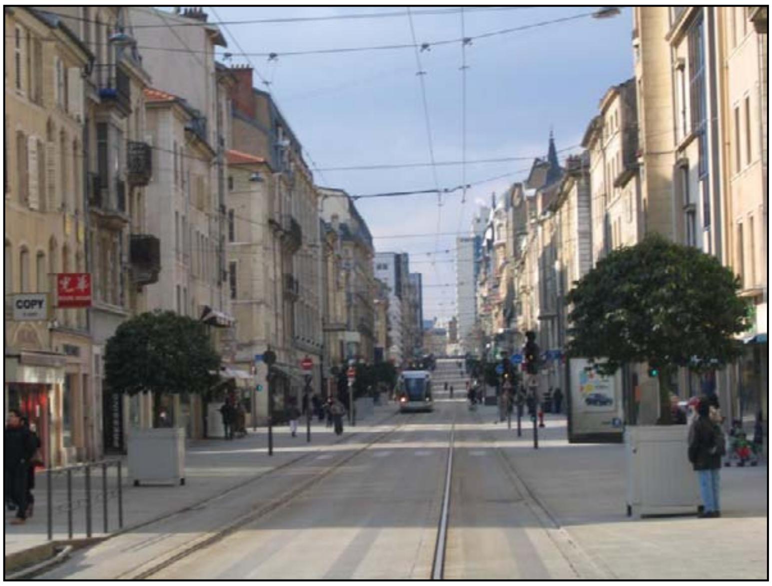


Photo 5: the shopping streets of Rue Saint-Jean and Rue Saint-Georges in Nancy today offer a high-quality environment reserved for BHLS and pedestrians (source: CETE Est)

In 2007, the second phase of *TEOR* in Rouen brought BHLS into the heart of the city, following an initial phase further west. By choosing a route that passes right through the city centre's shopping streets, the project provided an opportunity to redistribute the available space in favour of public transport and pedestrians, therefore also providing a boost to local shops.

BEFORE **AFTER**

Photos 6 and 7: Avenue Alsace-Lorraine in Rouen before and after the introduction of TEOR (source: Communauté de l'Agglomération Rouennaise)

Similarly, in Lorient, *Triskell* was an ideal opportunity to smarten up the town. The restructuring of Avenue Anatole France is a perfect example. The space was redistributed in favour of buses and sustainable transport modes (with the number of lanes for motor vehicles reduced from four to two). The result has been improvements in terms of safety and the surrounding environment.

Figure 26: artist's impression of the restructuring of Avenue Anatole France in Lorient (source: Cap Lorient and Arka Ouest)

In Douai, the restructuring of spaces has been particularly radical. The project to redevelop the square in front of the station aims to create a new public space. Although there is an underpass for through traffic, it has been possible to optimise the connection between the BHLS and the station, thanks to the large amount of space available.

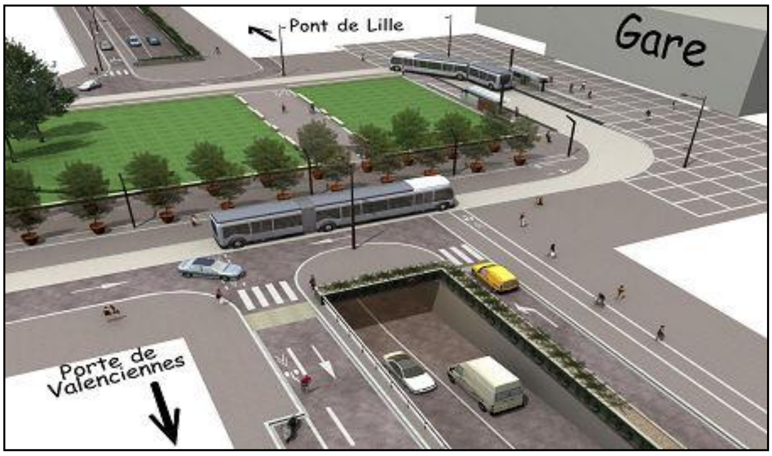


Figure 27: new layout of the square in front of Douai railway station (source: SMTD)

Along the rest of the BHLS route, enhancements have been more conventional. The surrounding environment has been improved through simple, economical measures. This reflects a particular political choice.

Photo 8: example road layout on Avenue du Maréchal Leclerc in Douai (source: CETE Nord–Picardie)

As with tramway systems, architects play an increasingly important role in BHLS projects. This is a sign that mentalities are changing: **with BHLS, the bus has become a tool for enhancing public spaces**. BHLS can go hand in hand with building-to-building enhancements.

3.3 Stage 2: capacity and cost

Once the long-term vision has been defined, the criteria of capacity and cost sometimes have a strong influence on the choice of system.

3.3.1 Matching capacity with demand

The capacity of BHLS systems depends on the **frequency** of service and the **unitary capacity of the rolling stock**. The unitary capacity of the vehicle is calculated on the basis of a comfort standard of 4 persons per square metre and an optimum headway of vehicle every 3 minutes in each direction.

The values in the table below are given as a guide only, as rolling-stock capacity can vary from one model to another (vehicle interior lay-out, proportion seating, etc.).

Rolling stock	Capacity of rolling stock in terms of number of maximum passengers[45] (based on 4 persons/m² as standard)	Capacity of the system in terms of number of maximum passengers per hour per direction (based on a frequency of 3 min)
Standard bus (12 m)	80	1,600
Articulated bus (18.5 m)	120	2,400
Tram (23 m long and 2.30 m wide)	130	2,600
Bi-articulated bus (24.5 m)	150	3,000
Translohr STE 4 rubber-tyred tram (32 m long and 2.20 m wide)	170	3,400
Tram (33 m long and 2.30 m wide)	210	4,200
Tram (43 m long and 2.30 m wide)	280	5,600

Table 3: capacities of different types of rolling stock (source: Certu)

Tramways are modular systems. Capacities can vary considerably, depending on constructors and models, ranging from 2,600 to 5,600 passengers per hour in each direction. Tramways can also be coupled together, as is the case with Line T2 in the Paris region. In such cases, capacity can therefore exceed 10,000 passengers per hour in each direction.

Currently, apart from the Bombardier *TVR (GLT)* in Caen and Nancy, only standard or articulated BHLS vehicles operate in France. However, a number of urban areas abroad operate bi-articulated, non-guided buses. Constructors working

[45] In practice, actual vehicle filling conditions may mean that these values cannot always be attained (depending on how easy it is to move in the aisle, etc.).

in this field are expected to propose new rolling stock in the next few years. However, the market for bi-articulated buses in France will remain limited. This beeing said, the urban areas of Nantes (looking to increase *BusWay*® capacity) and Nîmes (project for a second BHLS line) are interested by this type of vehicle.

Photo 9: a bi-articulated bus in Utrecht (source: Certu)

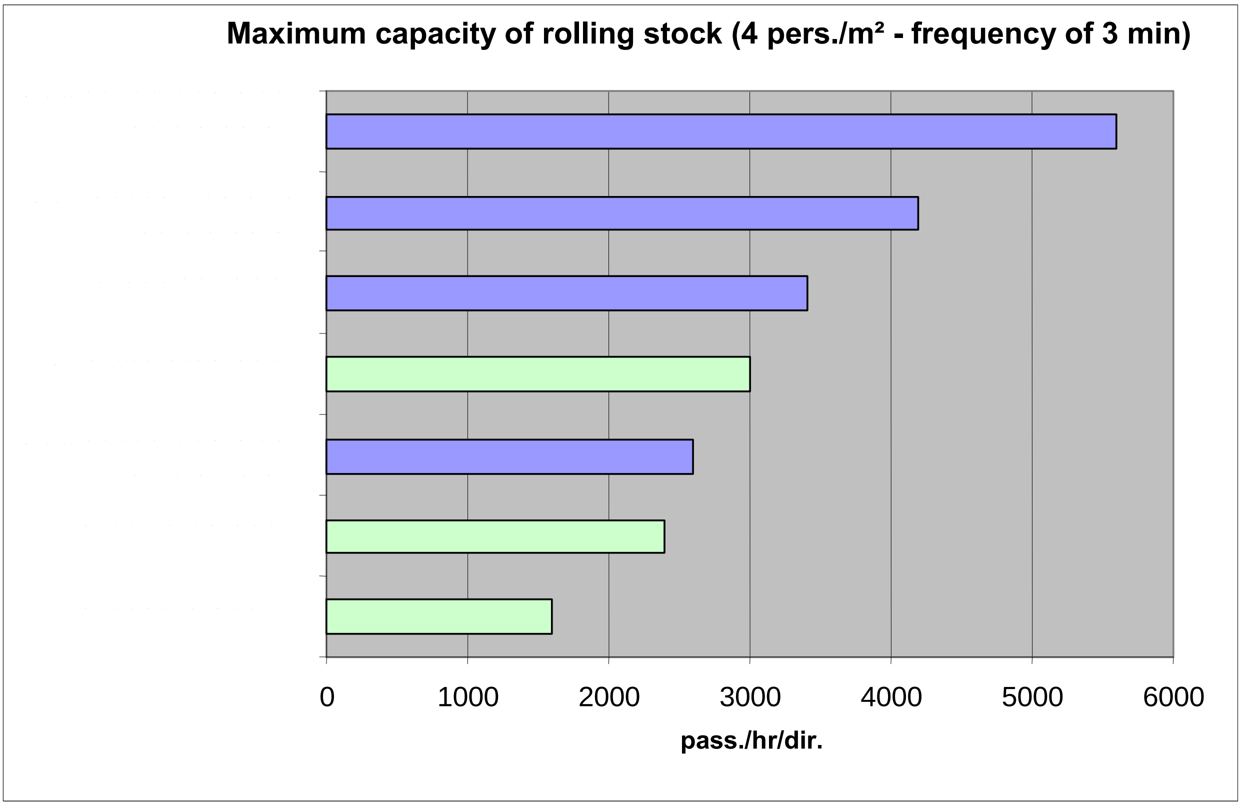


Figure 28: capacities of different types of rolling stock (source: Certu)

In general, the capacity offered by public transport is one of its principal assets, as it helps reduce congestion in urban areas and make them more pleasant places by redistributing the available space. As far as cars are concerned, the capacity of an urban thoroughfare is limited to around 800 vehicles/hour/direction, or

1,040 passengers/hour/direction using the occupancy rate generally observed for car journeys in urban areas (1.3 persons per car[46]).

Photo 10 : advertising to promote alternative modes of transport in Dijon (source : Grand Dijon)

Until certain threshold of demands, performance of BHLS and tramway systems are quite similar; however. There is an overlap, however, above 3,000 passengers/hour/direction, only tramways are capable of effectively meeting demand.

Ridership on TCSP lines: what comparisons can be made?

Comparing ridership figures for TCSP lines in different urban areas is a delicate matter, and mistakes can easily be made if sufficient care is not taken. The configuration of these lines can differ greatly from one city to another, particularly in terms of line length and the distribution of passengers at different stations (concentration or dispersion). For example, the *TVM* in the Paris region has a ridership of 65,000 passengers/day spread over a distance of 22 km, whereas Line B of the Grenoble tramway network boasts 50,000 passengers/day over just 9 km (2007 data).

As a minimum, ridership must therefore be expressed in terms of passengers per kilometre of line. In 2005, **the vast majority of tramway lines had riderships exceeding 4,000 passengers per kilometre**[47]. With just 2,500 passengers per kilometre of line, Orléans is something of an exception; however, this is largely because a long section of line passes through a non-built-up area between the neighbourhood of Les Sources and the city centre.

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[46] Source: *Enquêtes Ménages Déplacements* [Household Travel Surveys] (Certu)

[47] Source: Certu, CETE Lyon, *Panorama des villes à transports publics guidés (hors Île-de-France): situation 2005* ["Overview of cities (outside the Paris region) with guided public transport systems: the situation in 2005"], Lyon, Certu, 53 p., 2007 (available for download from the Certu website).

As far as matching capacity to demand is concerned, the difficulty lies in making accurate predictions for the future, even when using the most powerful modelling tools. The lifetime of vehicles is high (around 30 years for a tramway, and 15 to 20 years for a BHLS vehicle, depending on how it is powered), and changing external factors are difficult to control: changes in mentality and behaviour (including greater environmental awareness), a changing economic context (notably oil prices), development of the urban area, etc. Provision must therefore be made for reserves in order to be able to increase system capacity when necessary.

The issue of capacity must be examined throughout the system's lifetime

However, in reality, it is often the key ridership figures that determine the choice of system. This is the case, for example, in Dijon, where estimates after three years of operation show maximum riderships of 1,600 to 2,000 passengers per hour and in each direction for each line. a total of 3,800 passengers per hour and per direction should therefore be expected on the trunk section between the railway station and Place de la République.

3.3.2 System costs

Costs can vary considerably from one project to another. In particular, the number of bridges and tunnels, the construction of depots and park-and-ride, and the choices made in terms of urban improvements not directly connected to the running way can have a major impact on the final cost. Furthermore, the comparative analysis of the different solutions envisaged must take account of investment costs over an equivalent time period and operating costs, which are often poorly known by transport authorities.

Investment costs (including rolling stock, building-to-building improvements and park-and-ride facilities)

All-inclusive costs for recent tramway systems have been in the order of €22m/km (excluding tax). However, depending on the context, the variations can be enormous. In Nice, for example, the first tramway line (opened in 2007) cost €38m/km. This high cost can be explained in part by geological constraints and the architectural design of the depot. Civil engineering structures such as bridges, tunnels and park-and-ride facilities increase the cost of systems, as do high-quality urban redevelopment projects (e.g. Place Masséna in Nice). Indeed, complementary works (i.e. not directly connected to the running way) can sometimes represent up to 40% of the total cost of a tramway system.

Costs also depend on the areas served. In peripheral areas, where landscaping is less important, the use of rails laid on ballast can reduce costs. In Lyon, for instance, this method was used for many parts of tramway line T3 – which reuses a former railway between Part-Dieu station and Meyzieu in the eastern suburbs – and cost less than €15m/km to build.

With regard to rolling stock, tramways cost around €2m (excluding tax) on minimum in France. The choice of frequency can therefore have a considerable impact on overall costs.

The variation in costs can be just as pronounced for BHLS systems, depending on the type of layout and enhancements selected. For example, the overall cost of the Nantes

BusWay® was €8.5m$_{2006}$/km before tax (16% of which was not directly connected to the TCSP system), while the future *Évéole* scheme in Douai is estimated at €10m$_{2007}$/km before tax (23% of which is not directly connected to the TCSP system).

The cost of buses is linked to the order size, type of propulsion, technological innovations, market conditions, vehicle length, degree of customisation and level of equipments (air conditioning, plasma screens, IT). The "adaptation" of Mercedes-Benz *Citaro* vehicles for the Nantes *BusWay®* meant that articulated buses could be obtained for less than €500,000 (exc. tax). The additional cost incurred for electric-powered trolleybuses is generally estimated at 30%, but the articulated *Cristalis* buses in Lyon cost almost €900,000 (exc. tax) each, while the APTS *Phileas* to be used in Douai is set to cost more than €1.3m (exc. tax) for a standard-length bus (18 m). This high cost can be explained by the innovative guidance technology used, the inclusion of doors on both sides of the bus[48] and its hybrid propulsion system. According to the manufacturer, this last factor means that operational savings can be made, with a theoretical consumption level[49] 30% lower than a conventional diesel bus that meets Euro 4 emissions standards.

The over-costs for hybrids are observed in a range 50%-100%.

System	BHLS[(1)]	Tramway[(2)]
Cost of a vehicle (exc. tax)[(3)]	€0.4–1.3m	€1.5–3m
Overall total cost of system (exc. tax)[(4)]	€4–10m/km	€15–30m/km
Lifetime of rolling stock	15–30 years[(5)]	30-40 years

(1) The Bombardier *TVR* (GLT) is no longer manufactured, and therefore is not accounted for here

(2) Including the rubber-tyred *Translohr* tramway in Clermont-Ferrand

(3) For BHLS vehicles, the cost is based on rolling stock that is of a higher quality than conventional buses (e.g. the Mercedes *Citaro* used for the Nantes *BusWay®*, the APTS *Phileas*, or the Irisbus *Crealis* and *Cristalis*)

(4) This depends on the service level and context (civil engineering works, associated structures, depots, archaeological excavations, etc.)

(5) The lifetime of a bus that runs on thermal energy is estimated to be 15 years; for a trolleybus, 20 years

Table 4: order of magnitude of investment costs required for TCSP systems in 2008 (source: Certu)

Enhancements not directly connected to the transport system can prove costly

Regardless of the type of TCSP implemented, the cost of the system (infrastructure + rolling stock + stations) often represents less than 80% of the total cost[50]. Building-to-building renovations and specific neighbourhood improvements therefore represent a significant cost.

In Rouen, the intercommunality (a *communauté d'agglomération*) funded basic enhancement work, but individual municipalities served by *TEOR* could finance certain "customisation" measures or additional facilities and features. These "municipal" investments amounted to €4 million out of a total budget of €165 million.

By drawing up corridor contracts, the urban transport authorities in Grenoble and Toulouse sought to clarify the funding arrangements for TCSP projects with regard

48 Having doors on both sides of the bus enables greater flexibility for the system (e.g. stations can use central platforms 4 m wide instead of two side platforms 2.5 m wide each)

49 Consumption data remains theoretical, as the system is not yet operational.

50 See *Appendix 3* for a breakdown as per the "19 Certu items" for the example of the *Triskell* in Lorient

to different authorities' responsibilities. In this context of negotiation, urban transport authorities tend to concentrate on funding the "TCSP system" part of the project.

Operating costs (excluding depreciation)

It is becoming more and more difficult to obtain data concerning operating costs. Such data is at the heart of transport groups' strategies and is not only highly complex, but also varies from one urban area to another. Characteristics such as topography, congestion, or the presence of tunnels or viaducts can influence unit costs. Furthermore, in addition to personnel and energy, which represent more than two thirds of costs, maintenance costs need to be identified, especially for tramway systems (fixed installations, rail grinding, etc.).

Costs are also linked to the size of the network and how modern it is. Economies of scale are possible, particularly with tramway systems. For example, Nantes declared tramway operating costs of €4 (exc. tax) per kilometre travelled in 2005, whereas the Rouen tramway cost €6 (exc. tax) per kilometre travelled due to the presence of a tunnel and two stations located underground. In Bordeaux, tramway operating costs for 2013, when a number of extensions are due to open, are estimated at more than €8/km (exc. tax), but this is because parts of the Bordeaux tramway use a ground-level power supply (Alstom APS[51] system), which tends to make the system more complex.

For BHLS, feedback is still somewhat limited. We shall exclude the Bombardier *TVR (GLT)* here, the costs of which are difficult to interpret because of problems encountered when these systems were put into operation. In Nantes, operating costs for the *BusWay*® amount to €3.60/km (exc. tax). The cost of operating *TEOR* in Rouen, on the other hand, is approximately €4.20/km (exc. tax), while Lyon's trolleybuses cost around €3.60/km (exc. tax). In all cases, the improved operating speeds obtained through the creation of a BHLS system help reduce operating costs. For example, per-kilometre energy costs have been reduced by 6% on the Trans-Val-de-Marne following its western extension.

Switching from conventional buses to a BHLS systems means savings can be made in terms of operating costs

System	Conventional bus line	BHLS(1)	Tramway(2)
Average operating costs (exc. tax) per kilometre travelled (2007) for a city's first TCSP line	€3–4/km	€3.5–5/km	€5–7/km

(1) The Bombardier *TVR (GLT)* is no longer manufactured, and therefore is not accounted for here

(2) Including the rubber-tyred *Translohr* tramway in Clermont-Ferrand

Table 5: operating costs of TCSP systems (source: Certu)

51 APS : Alimentation Par le Sol

System renewal costs

Investment costs correspond, for the most part, to the construction of a TCSP system. However, a number of occasional – and sometimes costly – investments will also be necessary throughout the lifetime of a system (major maintenance, mid-life vehicle upgrades, replacement of rails, corrective treatment for ruts in roads, etc.). These are often difficult to predict and estimate. This is especially true given that feedback on the lifetime of TCSP systems is still insufficient, and given the speed with which the technology is developing. Furthermore, each subsystem has its own lifetime, often different from that of others.

For BHLS systems:

- the surface of the running way has an expected lifetime of only around 7 years in general, due to rutting problems[52];
- vehicles have a lifetime of 12–15 years (a little more for trolleybuses)[53].

For tramway systems, the following points have been observed:

- 20 years after becoming operational, those sections of track that suffer the most wear will need to be replaced (e.g. curves and points in Grenoble).
- Vehicles require mid-life modernisation, i.e. after 15 to 20 years' service[54]. Nantes, for example, invested €2m in the renovation of 46 first-generation trams acquired in the 1980s. The lifetime of these trams could be as high as 40 years rather than 30.
- Platforms need to be upgraded to ensure they are compatible with new low-floor vehicles (e.g. Grenoble) which offer improved accessibility without the need for ramps.

The notions of costs and capacity must therefore be considered as part of a long-term vision that takes into account the lifetime of systems, all operating costs (including upgrades of running ways, etc.) and potential changes to the network (increases in vehicle capacity, transfer of rolling stock between lines, etc.).

For a given project, a comprehensive economic approach from the feasibility stage onwards should make it possible to assess the different possible systems and the various "network" and "service level" scenarios associated with these systems. In particular, **choices regarding frequency will have an impact on operating costs and the overall balance sheet**.

3.3.3 Raising awareness of the economic relevance of BHLS and tramway systems with regard to their capacity

Frequency is defined primarily in terms of a desired service level. However, it also plays a vital role in terms of system capacity. In order to deal with congestion

[52] Rutting is especially pronounced on guided systems

[53] The tax instruction of 21 January 1985 gives maximum acceptable depreciation times for wear and tear of 15 years for conventional buses and 20 years for trolleybuses

[54] The tax instruction of 21 January 1985 gives a depreciation time due to wear and tear of 30 years for trams, trains, railways, etc.

situations on a public transport line, particular efforts are made to improve and optimise frequencies according to demand.

Operating costs for tramway systems per unit capacity can appear lower than those of BHLS systems. This can be explained by the fact that these costs are largely dependent on the number of drivers required, which in turn is directly linked to the number of vehicles necessary, and therefore the headway.

While tramways require higher investment costs than BHLS systems, overall costs per passenger place in the long term could well be lower for tramway systems.

Appendix 5 includes a number of simple calculations that help us to understand this phenomenon. They underline the fact that **choosing a BHLS system to cope with given passenger levels may prove to be unsuitable in the long term, <u>if the following conditions are all met</u>:**

- demand at peak times in the 15–20 years following the launch of the service is close to the maximum capacity offered by the fleet of articulated BHLS vehicles (2,100–2,400 pass./hr/dir.);
- bi-articulated buses are not an option (integration problems, desired rolling stock not available on the market, etc.);
- local opinion is that the advantages of a tramway system (image, comfort, integration, etc.) would compensate for lower frequencies (e.g. 6 min for tramways compared with 3 min for BHLS).

On Line 4 in Nantes, demand has been so high that the headway of the *BusWay*® has had to be increased to one bus every 3½ min at peak times. It would seem that its economic success will very much depend on whether it will be possible to operate bi-articulated buses in the long term. From the viewpoint of urban integration, this change would present no major problems: the route is mostly straight, with no narrow streets to negotiate. Furthermore, the 24 m platforms could easily accommodate longer vehicles. Any switch to bi-articulated buses would therefore depend primarily on the ability of manufacturers to respond to local needs. However, the market for this type of vehicle remains limited.

The key to making the right choices is carrying out detailed studies upstream

When different TCSP options are on the horizon, the **urban transport authority must carry out precise economic and financial analyses** in order to assess the relevance of these options in terms of capacity. The scenario whereby a **BHLS system is converted to a tramway** must also be examined, as it means that investments can be more evenly distributed and adapted to changing demand. In this case, earmarking space for dedicated lanes and constructing an appropriate running way from the outset will make any conversion work at a later stage considerably easier.

3.4 Stage 3: technological precautions and local impacts of TCSP

3.4.1 Choice of technological innovation

France has a long history of pioneering innovation in the field of transport (e.g. the TGV, driverless metros or the Airbus A380 to cite only the most recent examples), particularly when it comes to urban transport. And innovation means experimentation zones: Lille with the *VAL metro,* Lyon with the Maggaly system[55], Nancy with the *TVR (GLT)*, Clermont-Ferrand with the *Translohr*, and Bordeaux with APS (*alimentation par le sol* – ground-level power supply). As the difficulties experienced with the *TVR (GLT)* in Nancy illustrate, innovation also has its risks.

In addition to technological problems, urban transport authorities must also be aware of the **supply sector risks** that could arise from a particular choice of system. For example, **"conventional" trams and buses are products that are today sold in large quantities around the world**. Indeed, they are the subject of intense competition, with a number of manufacturers vying for contracts across the globe. The same cannot be said for certain other vehicles developed recently.
The **Bombardier *TVR (GLT)***, for example, has only been adopted in Caen and Nancy. For these two cities, the threat of manufacturing being dicontinued puts any future network development strategies (using the same system, thus enabling economies of scale) in jeopardy. Maintenance costs and spare-parts prices are uncertain and conditions are not guaranteed.

While Nancy is considering using a different system for its second BHLS line, Caen is faced with a dilemma. The urban area would like to acquire new vehicles in order to increase the capacity of – and extend – its existing line (12 additional vehicles would be necessary). In view of this, Bombardier has declared that it would be prepared to start manufacturing the *TVR (GLT)* again, but only for a minimum order of 20 vehicles. This could mean that Caen chooses the *TVR (GLT)* for its second BHLS line, currently on the drawing board.[56]

The ***Translohr* by Lohr Industrie** was first exported to Italy, notably because of its ability to integrate seemlessly into historic city centres (e.g. Padua and soon Venice). Lohr is now trying to invest in Asia (China, Japan) and the Paris region! Although the system exports well, it does have the disadvantage of being the exclusive product of a single manufacturer. This is also the case with the **APTS *Phileas***, planned for Douai, which as of mid-2009 had still not been approved for use in France, whereas the infrastructure work was completed in early 2008.

However, innovation-related risks also exist for **rail-based tramways** (APS system in Bordeaux, on-board batteries in Nice, etc.).

It would therefore seem preferable to anticipate problems by integrating the risk associated with technological innovation into the project (schedule, back-up solutions in the event of malfunction, etc.).

[55] The first large-profile driverless metro system in France

[56] Source: ENVER F., *Caen : le TVR n'a peut-être pas dit son dernier mot* ["Caen: we've perhaps not heard the last of the TVR"], in Ville & Transports, 28 November 2007

3.4.2 Systems are not always mutually compatible

Interconnected tram-trains: relatively limited potential

The potential for developing tram-train systems that interconnect with urban transport networks still needs to be studied

The possibility of interconnection with the conventional rail network is often cited as an argument in favour of tramways. This argument is perfectly valid as long as such interconnections are relevant in the long term from a socioeconomic viewpoint. This is the case in Mulhouse, for example, which expects almost 12,000 passengers per day on the peri-urban section of its tram-train. The Nantes–Châteaubriant tram-train project has less potential, but can nonetheless be considered as a true urban development tool in an area where the population is growing at a phenomenal rate. However, this project does not offer any sort of interconnection with the urban network in Nantes, for technical and financial reasons. Indeed, the issues surrounding the compatibility of tram-train and urban tramway networks are highly complex: the type and gauge of rails, curves, minimum clearance outlines (dynamic envelope + safety margin), etc., must all be taken into consideration. Today, only Mulhouse's urban network is capable of accommodating tram-trains, mainly because it was specifically designed with this in mind. **The development prospects of interconnected networks (urban–national rail) must therefore be studied as far upstream of any project as possible.**

Tram-trains are also suitable for peri-urban rail transport

The low population density in suburban areas of large French cities, together with urban sprawl, means that the profitability of interconnected tram-train projects is limited. Ultimately, the potential today depends above all on the performance of tram-train rolling stock (acceleration and braking abilities), enabling a more precise, targeted service within an area. The conventional use of tram-train rolling stock for conventional TER (regional rail) services was begun with tramway line T4 between Aulnay-sous-Bois and Bondy in the Paris region, which uses Siemens *Avanto* vehicles. In 2007, the *conseils régionaux* (regional councils) of Pays de la Loire and Rhône-Alpes ordered 31 *Citadis Dualis* vehicles from Alstom (7 for the Nantes–Châteaubriant route and 24 for the TER network in Lyon's western suburbs). The cost of each vehicle is estimated to be €3m for the confirmed part of the contract and slightly more than €3.5m for the optional parts, which also includes an order for the Paris region. While the vehicles in Mulhouse are 2.65 m wide, Alstom is proposing a version of the *Dualis* that is 2.40 m wide in order to respond to the constraints of urban integration.

Changing trams

Different types of tram are not always compatible either! The historic metric-gauge systems remain confined to Lille and Saint-Étienne, for example. The tramway systems installed since the 1980s have undergone numerous changes, some of which mean that different makes and models of tram are incompatible.

First of all, there have been many changes in terms of accessibility, ranging from the high-floor trams of Nantes to the 100% low-floor vehicles in Lyon via the intermediate partial low-floor layout found in Grenoble's trams; platform–vehicle interfaces are therefore different.

Above all, however, it is the variety in vehicle width that causes incompatibilities. Vehicle manufacturers, especially Alstom, have developed modular systems that can adapt to a range of urban area configurations. When trams were reintroduced in France the 1980s, the TFS (*Tramway Français Standard* – Standard French Tram) was launched with a width of 2.30 m; however, since then, other widths have also appeared on the market. For example, the three tramway systems launched in 2000 and 2001 that used the Alstom *Citadis* each had different widths (2.32 m in Orléans, 2.40 m in Lyon and 2.65 m in Montpellier). In Orléans, the choice of width was due to the narrowness of certain streets along the tramway route. Today, Alstom has revised its catalogue, with a tendency towards greater standardisation and thus less choices for sizes. Now, only widths of 2.40 m or 2.65 m are offered. This means that the second tramway line in Orléans will no doubt be equipped with trams that cannot be used on the first line. This creates additional operating constraints (different maintenance standards, second depot) and limits the options for creating a "meshed" network in the long term.

Finally, changes in regulations (particularly with regard to safety) can also lead to incompatibilities between trams.

The international bus market

Conventional buses essentially use the same, simple techniques the world over, thus ensuring greater compatibility between lines. However, certain choices of guidance system could lead to the same sort of problems encountered with trams.

Nonetheless, the relative simplicity of bus systems means that an international second-hand market could be envisaged, which is not necessarily the case for tramway systems[57].

System compatibility as part of an overall vision for public transport networks

BHLS may be seen as an intermediate step towards a future tramway system[58]. A tramway, on the other hand, is seen as a much more permanent, long-term choice requiring more extensive construction and modification works. It is therefore important to have a clear long-term vision in order to ensure that successive choices and decisions are compatible.

3.4.3 What are the impacts on the environment and on economic activities?

Impacts on noise and vibrations

Disturbances associated with motor noise can vary from one vehicle to another. It depends above all on the type of propulsion (electrical or thermal) and the type of wheels (tyres or iron).

For diesel buses, the noise levels recorded at a distance of 7.5 m from the source are generally higher than 80 dBA, regardless of speed. For electric vehicles, on the other hand, noise levels increase with speed: at 10 km/h, the noise level recorded is around 65 dBA for trolleybuses and 70 dBA for tramways. As speeds increase, the difference between the trolleybus and the tramways becomes less pronounced. At 50 km/h, noise levels are close to 80 dBA for both systems. However, it should be mentioned that diesel-powered buses are slightly quieter (by 2–3 dBA) than buses that run on natural gas.

Clearly, electrical traction has certain advantages, particularly at low speeds. However, it should be noted that noise levels also vary much depend on the quality of the roadway for rubber-tyred vehicules (type of surface, evenness, etc.), and on the number of gradients and curves along the route. Noise levels will also be higher around stations, particularly when vehicles are full. However, screeching caused by

[57] In recent years, however, rapidly changing emissions and accessibility standards mean that the market potential for reselling buses is more limited.

[58] Albeit with the inconvenience of modifications or system downtime during infrastructure upgrade works

trams negotiating tight curves remains the biggest source of noise – and of complaints from the local population[59].

As far as vibrations are concerned, potential disturbances of this nature mainly involve rail-based systems. Following a number of teething problems with the first tramway systems implemented, this problem is today controlled through the use of in-situ soil analyses and by taking account of the protection levels to be realised. The technical solutions implemented are highly effective (e.g. tramways in Montpellier run alongside the Corum opera house and conference centre).

The impacts on CO_2 emissions

A summary of the latest CO_2 emissions data from ADEME is given below[60]:

CO_2 emissions (use + production of energy) for urban trips in gCO_2/veh.·km	
Car	230
Standard bus powered by thermal energy	1,400
Articulated bus powered by thermal energy	1,800
Tram; trolleybus	200

They highlight the advantage of electrical propulsion over thermal propulsion.

The impacts on economic activities (by Marie-Noëlle Mille from Certu)

The creation of a surface TCSP system disrupts and transforms public spaces, and necessarily has an impact on the way these spaces are used and on nearby activities, particularly commercial activities.

Owing to the recent nature of the first BHLS lines in France, it has not yet been possible to analyse and disseminate feedback concerning the impact on businesses. However, this information should soon be available for Rouen.

In the meantime, we can use data from a number of other urban areas that have had tramways for several decades now. Indeed, Certu has carried out a number of studies on the economic impacts of tramway systems[61].

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[59] Presentations by Joël Lelong from Inrets and Bernard Miège from CETE Lyon during the day-long event jointly organised by Inrets and Certu on 27–28 November 2008: *Tramway : un mode de transport durable pour la ville ?* ["Tramways: a sustainable transport mode for cities?"]

[60] Deloitte, *Efficacité énergétique, émissions de CO_2 et autres émissions gazeuses spécifiques des modes de transports* ["Energy efficiency, CO_2 emissions and other specific gaseous emissions from transport modes"], ADEME, 150 p., 2008

[61] Certu, Armacande, *Déplacements et commerces, Impacts du tramway sur le commerce dans différentes agglomérations françaises* ["Transport and trade: the impact of tram systems on commerce in different urban areas in France"], Lyon, Certu, 2005, 48 p.

The analysis of studies carried out by certain local authorities highlights a number of constants and enables lessons to be learnt; however, generalisations are avoided, as each surface TCSP line and each neighbourhood served is different, even within the same urban area.

One of these constants is that any modification to a public space that affects its layout, its use or the way it functions will provoke concern and even fear among the local population, particularly among shopkeepers, who are almost always the first to complain.

Once the construction phase – which can undeniably be inconvenient, even traumatic – and the reappropriation and readjustment phases are over, shops' normal business typically resumes, or even improves, especially in central areas. The situation is most difficult for certain shops in "transition" zones and/or in the centres of outlying towns and villages.

However, it is very difficult to isolate the effect of the TCSP line from the local, national and sometimes international contexts that affect trade, the economy and lifestyles – especially as most TCSP projects are not just transport schemes, but also form part of a wider plan for the whole urban area, which in many cases involves substantial urban development operations.

The table below gives a summary of the results observed according to different indicators:

Indicator	Effect observed
Number of shops	In the TCSP corridor, the number of business increases, but sometimes at a slower rate than in neighbouring areas. A reduction in the number of shops does not necessarily mean a reduction in retail space: some businesses expand to take over neighbouring retail units.
Vacant units	TCSP lines are the cause of vacant retail units only in exceptional cases. It is more frequently the national economic climate or local neighbourhood problems that are responsible for this phenomenon; moreover, the situation often tends to improve with the arrival of a TCSP line and the enhancements it brings.
Termination and creation of businesses	More businesses are created than closed down. These changes occur in city-centre streets regardless of the presence or absence of a tramway. Grenoble CCI[62] observed that "changes in the retail sector vary greatly, depending on the sections of street concerned".
Turnover; business activities	The data collected suffers from a lack of reliability and is not sufficiently representative. Nevertheless, we can note that the effect on customer numbers varies according to location (city centre, "transition" zones, outskirts). Shops in "transition" zones that were already fragile before the arrival of a tramway have greater difficulty keeping their business going, especially if they are heavily reliant on passing trade and have not been able to "ride the wave" of new development brought by the TCSP line.

Certu, *Déplacements et commerces, Évaluation de l'évolution des impacts du tramway de Lyon sur le commerce* ["Transport and trade: evaluating the changing impact of the Lyon tramway on commerce"], Lyon, Certu, 2005, 89 p.

Certu, ADEUS, *Déplacements et commerces, Impacts du tramway sur le commerce dans l'agglomération strasbourgeoise* ["Transport and trade: impact of the tramway on commerce in the Strasbourg urban area"], Lyon, Certu, 2004, 136 p.

Certu, *Déplacements et commerces : Enquête auprès des commerçants de la rue de Marseille et du cours de la liberté à Lyon ["Transport and trade: survey of shopkeepers in Rue de Marseille and Cours de la Liberté in Lyon"],* Lyon, Certu, 2001, 52 p.

[62] Chambre de commerce et d'industrie

Changes in business activities	The arrival of a TCSP line provides shopkeepers with an opportunity to redefine their business; other considerations must also be taken into account. The most commonly observed trend is the development of banks, restaurants and other service-sector activities. The city centre generally attracts more pleasure/leisure purchases, while outlying areas cater to more "useful" purchases.
Chain stores	It is not the "tramway effect" so much as the flow of new customers that encourages national and international chains to set up in attractive areas; however, the arrival of chain stores can be at the expense of the originality and diversity of shops in the area. This is generally seen by local authorities as a sign of the growing attractiveness of their urban area. It should be noted that when a TCSP project includes the creation of a pedestrian zone, all city-centre retailers benefit from the increased pedestrian traffic this brings.
Value of retail units	Although not all sectors of a city will benefit equally from the arrival of major chains, these chains are nonetheless signs of increased retail value, and therefore herald increases in rents and the value of business assets; this benefits outgoing businesses, but penalises independent newcomers.
Patronage; purchases	Grenoble urban planning agency has found that the tramway helps "redistribute" shoppers, either because of the increased mobility it brings, or because it has completely changed the way people access the city: the development of the tramway was combined with a wholesale reorganisation of the city's transport system.
Transport modes used by shoppers	In the Lyon urban area, a shopping habits survey carried out by the CCI showed a stabilisation in car use for shopping journeys in recent years: 73% in 1996, compared with 70% in 2006. Walking, although in decline, remains the preferred mode for local shopping journeys. Public transport use is low, at 5–10%. However, this proportion is gradually increasing, thanks to TCSP. Finally, an increasing number of shopping journeys are made using two-wheelers.

The enhancement of public spaces and reorganisation of traffic flows that often accompany the development of a tramway have significant repercussions on shops. Building-to-building improvements, observed in most streets used by tramways, bring a new image to the public spaces concerned and a new identity for the urban area as a whole, which in turn leads to an increase in the attractiveness of its shopping districts.

On the other hand, new traffic systems can aggravate an already difficult situation for shops that are essentially reliant on passing trade, especially if they have not adapted their business to the new retail climate.

Finally, customer parking and deliveries are always two of the most controversial aspects of any TCSP project. Experience has shown that these two factors must be integrated into the project from the very start. Delivery needs, in terms of space and time, must be fully analysed upstream of the project, so that appropriate solutions can be proposed and implemented at the construction stage. Longer-term adaptations should also be made, in order to take account of potential changes in the types of shops present in a given area.

In conclusion, although changes in the retail sector undoubtedly occur following the development of a TCSP system, it is impossible to isolate the "TCSP effect" from other societal, economic and urban changes. TCSP systems often amplify or accelerate pre-existing trends and processes already in motion, but are never the root cause of them. Taking the time to listen, recognise and understand the habits, needs and processes of local actors; adopting a meticulous approach with regard to the use of public spaces (e.g. parking and deliveries); and explaining, supporting and following up projects constitute the keys to success for any TCSP scheme.

3.5 Stage 4: integration and realisation

3.5.1 The urban integration of TCSP

The narrow streets present in most French cities can make integrating public transport difficult. The long-term vision for an urban area and its public transport network can sometimes lead to choices of systems and routes that are incompatible with the integration options available.

Turning conditions of TCSP systems

Tyre-based systems (BHLS or rubber-tyred trams) have the advantage of being able to negotiate turns with greater ease, especially when they are guided and follow a single path. The minimum outer turning radius is less than 12 m for these vehicles (except for *TEOR* when it is operating in optical guidance mode[63]), while for tramways on rails it is 25–30 m. Tramway curve radii that are too tight are a source of noise pollution, cause rapid wear and tear on tracks, and restrict travel speeds.

However, with the same radius, tramways on rails require less space on curved sections than tyre-based systems,

Of course, if high performance is being sought (particularly in terms of comfort and speed), TCSP systems should generally avoid overly tortuous routes in any case.

Integrating TCSP into straight sections of street

Tramways (whether on rails or rubber-tyred) can be integrated into straight sections of street more easily, as rolling stock is not excessively wide (2.40 m for standard conventional trams, 2.20 m for the *Translohr*). Buses, on the other hand, tend to be between 2.50 m and 2.55 m wide, not including wing mirrors (an extra 0.25 m on each side)[64]. By having doors on both sides of vehicles (this is the case for all trams in France, as well as for the APTS *Phileas* bus), it is also possible to reduce the space taken up by stations (e.g. using central platform 4 m wide instead of lateral platforms 2.5 m wide each).

What are the benefits of guided systems?

The use of guided systems is often motivated in technical terms by integration problems. However, the reality is far more complex. While physical guidance systems, such as the central rail of the *TVR* (GLT), do indeed help reduce the space required by the vehicle, the same cannot always be said for vehicles that use non-physical guidance systems. Regulations on guided public transport[65] impose safety margins which, in straight sections, can cancel out the gains obtained by guidance (this is the case for the APTS *Phileas* system in Douai, for example) or even increase the amount of space required (e.g. *TEOR* in Rouen). Although the space required (including the safety margin) on curves is reduced, guidance measures are not always suitable for tight bends (this is the case for the optical guidance system Rouen, for instance).

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[63] In this case, the minimum radius necessary for the system to operate correctly is 25 m

[64] Wing mirrors can cause major problems if there is not sufficient space between buses (wing mirrors can become "entangled"). They also represent a potential danger for users during docking at stations.

[65] French decree no. 2003-425 relating to the safety of public transport

Finally, given the various problems encountered with physical guidance systems (higher costs than expected, operational difficulties) and the limits of non-physical systems when it comes to integration, guidance systems now seem to interest local authorities largely because of the improved accessibility they provide at stations (this is the case with projects in Metz, Nîmes and Nancy) but also because of the innovative aspect on itself, to create enthousiasm and push the modern image of public transport.

System	**Rail-based tram 2.40 m**	**Translohr**	**TVR**	**Phileas (1)**	**TEOR**	**Conventional bus (2)**
Type of guidance	2 load-bearing rails	central rail	central rail	computerised with correction using magnetic sensors	optical	no guidance
Single-path	yes	yes	yes	yes	no	no
Width of running way on straight sections (double lane)	5.6 to 5.8 m	5.4 m	6.2 m	6.5 to 7 m	6.7 to 7.3 m	6.5 to 7 m
Minimum acceptable radius	25 m	10.5 m (on rail)	12 m (on rail) (3)	12 m	12 m (non-guided) 25 m (guided)	11 to 12 m
Width of running way on curves	7 to 7.5 m	6.7 to 7 m	7 to 7.6 m	8.2 to 8.5 m	9 to 11 m	10 to 12 m

(1) as of 1 June 2009, the Phileas system had not yet been approved in France; running-way measurements may therefore be subject to modifications
(2) with no cyclists
(3) feedback from Nancy and Caen shows that it is preferable not to descend below 15 m

Table 6: space consumption for different TCSP systems (source: Certu and CETE Méditerranée)

TCSP and gradients

With few exceptions, tramways today are designed to be able to cope with gradients of 6% or 7% at most. With motors on each axle, slopes of 10% could be envisaged; however, this would involve significant modifications to vehicles which could considerably increase rolling-stock costs. Rubber-tyred systems are better equipped to negotiate slopes, with a limit of 13% often set in order to ensure user comfort. Finally, it should be noted that electrically powered systems have greater accelerating capacity on slopes.

3.5.2 Impacts during construction work

Work takes longer for tramway lines

Construction work for surface TCSP lines causes major disruption and inconvenience, regardless of the type of system concerned: access for residents and businesses – as well as delivery access – is affected, safe pedestrian routes have to be established, vehicular traffic has to be reorganised, etc. The only major difference is how long this disruption lasts: whereas work on a BHLS line takes 2 years on average, almost 3 years are necessary to build a 10 km tramway line. Naturally, the work involved in building a tramway is more substantial, not least because its lifespan and rigidity ensures a degree of permanence for the neighbourhoods it serves.

Solutions to minimise disruption

Lessons learned from existing tramway systems (from the 1980s onwards) today mean that surface TCSP work can be organised more effectively.

With regard to traffic management, one option involves cutting the roadspace into strips. This was the method used for the tramway in Mulhouse and the BHLS system in Douai, for example. In Douai, the BHLS route was divided into 34 independent sections, each 150 m to 400 m long, taking account of the types of activities present in different areas[66]. This approach to construction minimises the impact of delays and reduces disruption. The first three sections were used as "testing grounds".

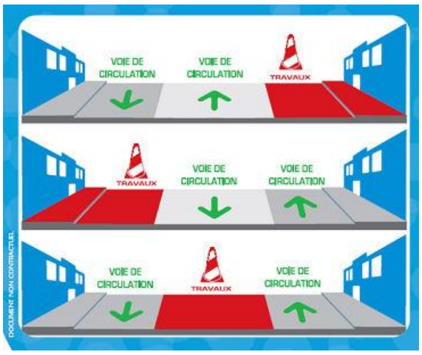


Figure 29 organisation of construction work for the BHLS in Douai (source: SMTD)

In order to facilitate deliveries in shopping streets during work on *TEOR* in Rouen, the city council and the local CCI set up local delivery areas (known as *ELPs* or *espaces de livraison de proximité* in French). Each "*ELP*" comprised a prefabricated building and parking space for two lorries with specialist equipment available (on loan) to make deliveries to shops.

3.6 The need for successive iterations: the example of the city of Besançon (by Yann Chauvin from Grand Besançon)

Since 1974, Besançon – population 120,000 and the core city of an urban area of 180,000 inhabitants – has been cultivating a voluntary policy of developing alternative transport modes to the car. Besançon was the first urban area in France to implement a Transport Plan, 35 years ago, leading to the pedestrianisation of its city centre through the creation of "traffic cells". Since then, the city has always sought high-performance solutions, despite its relatively small size: in 1974, its transport network was the first in France to be equipped with an automatic vehicle location (AVL) system; in 2001, it implemented a multimodal information hub (a joint project between Grand Besançon, Franche-Comté Regional Council, Doubs *Conseil Général*, and SNCF); in 2002, it rolled out an intermodal fare scheme in conjunction with the regional and *département*-based networks; it introduced dynamic real-time information at bus stops (in 2001) and via mobile phones (in

[66] The TCSP line is 12 km long in total

2004); and in 2002 it created interchange hubs at city gateways, to name but a few measures.

In September 2002, Grand Besançon, the local intercommunality created in 2001, launched Ginko, the new intercommunal public transport network, comprising 50 regular bus and coach lines (18 urban and 32 peri-urban) plus a number of demand-responsive transport services. Between 2002 and 2004, ridership increased by 14% and use of the network (around 90,000 trips per day) is similar to levels achieved in certain larger urban areas.

However, the Ginko has an inherent structural weakness resulting from the fact that the city's urbanisation has been quite gradual: only 6 km of bus lanes, and buses have priority at only 50 junctions. Since 1997, the network's limits in terms of capacity have become apparent: congested lines because of increased car traffic, a slow but sure drop in operating speeds, and finally stagnation and even a slight drop in ridership since 2005. The need to take performance to a new level has therefore become an objective. In 2000, as part of the PDU, a tramway was suggested as a possible solution, but this option was the source of concerns: as the bus network already performed very well, and as the cost of a tramway would be very high, it was felt that the expense could not be justified by the potential gain in performance (and therefore ridership), which could be quite low in proportional terms.

To try to gain a better understanding of the issues at stake and the feasibility of such a project, no less than 29 studies into TCSP schemes were made between 1997 and 2008, covering everything from preliminary steps to operational phases and ranging from the very general to the highly specific. In December 2005, the master plan for a TCSP scheme was finally approved.

Based on a comprehensive opportunity/feasibility study, this plan envisaged the creation of a network comprising two radial lines running in dedicated lanes over a distance of 18 km from east to west (capable of handling 15,000 and 25,000 trips per day respectively), dedicated bus lanes over a further 14 km, and the reopening of a 10 km rail line in the north of the urban area, with the three new stations. This initial project was developed in response to quite a simple observation: what the Ginko network needed above all was dedicated-lane infrastructure; the precise choice of system was secondary. With regard to financing, a deliberately pragmatic approach was taken: how much could the urban area afford to invest simply by raising the VT (transport payment) rate from 1.05% to 1.80%? The expected gain was around €12m per year extra. This meant that the whole project would have to cost no more than €155–175m before tax (2004 estimates). In 2005, the decision was therefore taken to opt for a BHLS system.

However, in 2006 and 2007, the launch of operational and urban integration studies (and expert evaluations of rolling stock) for the east–west line would change these plans to some extent. The problem lay in the historic centre of the urban area, which has many narrow streets while generating 46% of ridership for the whole Ginko network. The historic core therefore became a major focus point within the project in terms of capacity, integration and the environment. The choice of system – and, by extension, the choice of rolling stock – was therefore of the greatest importance, in order to ensure the best combination of route and system. It is here that the limitations of buses, and therefore BHLS systems, become apparent:

- they are difficult or even impossible to integrate into certain narrow streets (9–12 m wide);
- the length of vehicles, and therefore vehicle capacity, would be limited;
- thermal energy would be undesirable, but electrical energy sources would be difficult to implement in the historic centre, which is a UNESCO world heritage site (overhead lines would be an eyesore, no non-thermal autonomous systems that offer sufficiently high performance are available, etc.).

Furthermore, with a view to implementing rail-based operation, the two lines running in dedicated lanes 18 km long would be transformed into a single 14 km line with a branch in the direction of the railway station and a 200 m single-track in a pedestrian street. Traffic modelling gave an expected ridership for this line of 45,000 trips per day, which would be enough to justify building a tramway[67].

In 2008, a final decision had to be made. Although a tramway was the right choice of system, the financial approach was now different: how much would such a project cost, and how would Grand Besançon be able to finance it? A financial working group was therefore set up. This group, composed of elected representatives and technical experts, concluded that the project was financially viable, but with strict limits given that Besançon is a medium-sized urban area, even though public transport usage levels are as high as in certain larger cities. The tramway project was initially estimated to cost €255m before tax. However, the final budget allowance was fixed at €200m before tax (2008 estimate), give or take €20m (exc. tax), for the construction of the TCSP line. Other funding was found for the rail infrastructure in the north of the urban area (€11m before tax; 2007 estimate).

During this time, routing options for the TCSP line were fine-tuned by the technical departments, and integration issues were analysed in even greater detail. However, there was considerable opposition regarding both the choice of system and the choice of route in the city centre, as well as concerns about the impact on urbanisation and network ridership levels. There were essentially two conflicting visions: BHNS was presented as being "reasonable" (too short-term a vision?) while the tramway was presented as "ambitious" (too ambitious?).

This iterative approach over a period of years culminated in the public presentation of the project with two possible routes, notably in the city centre, and two possible systems. This dual project was submitted for public consultation in autumn 2008.

On 18 December 2008, after presenting the results of the consultation exercise, Grand Besançon validated its reference project in a session of the *Conseil Communautaire* (intercommunal council). This project now comprised a 14 km "optimised" east–west tramway line, costing €210m before tax (2008 estimate).

In 2009, the emphasis has been on designing this optimised scheme, and mobilising project managers, business and construction firms in order to ensure the success of

[67] In 2005, all tramway lines in operation in France had ridership levels of at least 3,000 passengers per kilometre of line, except in Orléans (source: Certu, *Panorama des villes à transports publics guidés (hors Île-de-France) : situation 2005* ["Overview of cities (outside the Paris region) with guided public transport systems: the situation in 2005"]

this essentially quite innovative project. For Grand Besançon, if the scheme is a success, this innovation will lie in showing that tramways *can* be necessary in medium-sized urban areas, that this choice *is* sometimes legitimate (with regard to capacity and urban integration), as studies have shown to be the case, but also that tramway systems *must* be adapted to the specificities of these urban areas (in terms of size, ground coverage and capacity), as well as their financial means. By the end of 2009, if the invitations to tender are conclusive, Grand Besançon will know whether its gamble will pay off for a final delivery in 2014.

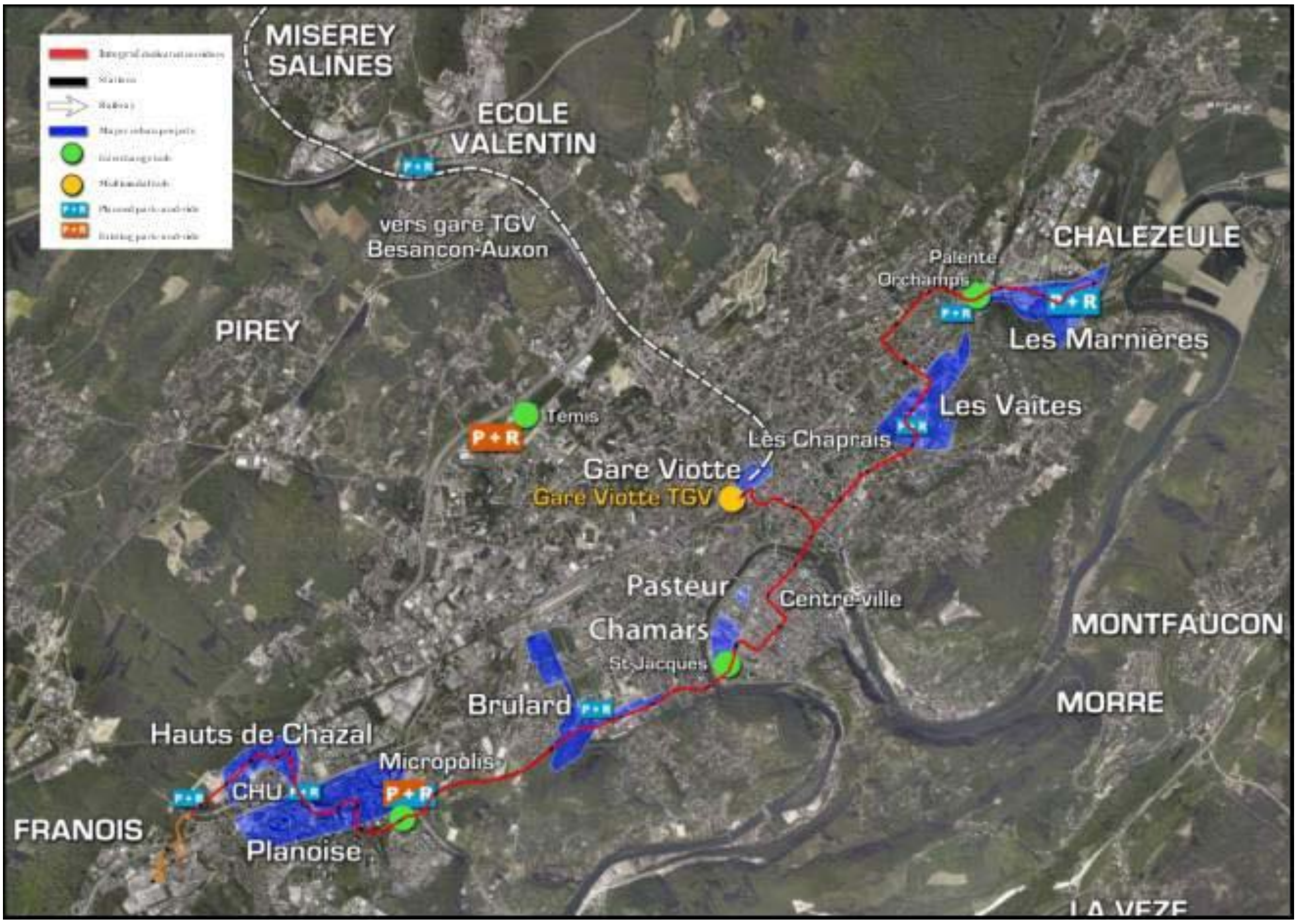


Figure 30: route of the TCSP project approved in late 2008 (source: Grand Besançon)

3.7 Summary of the scopes of application for surface TCSP systems

Figure 31: summary of the scopes of application of different TCSP systems (source: Certu)

3 - When is BHLS an appropriate choice? Points to remember…

→ Before even discussing a TCSP system, a development plan for the urban area must be established, taking account of the key principles behind any potential changes to the public transport system.

→ The process that eventually leads to a TCSP system being chosen is necessarily a long and often iterative one. At the heart of this process lies a programme of studies that serves to identify the determining factors for the choice of system for the urban area. The project schedule must incorporate this preliminary phase.

→ BHLS occupies a position between conventional buses and tramways, in terms of both capacity and cost. It can act as a vector for urban development and enhancements, just like a tramway.

→ Depending on its characteristics (e.g. guidance, single-path vehicles), BHLS offers a number of solutions in terms of integration, but remains a system that is governed by the *Code de la Route* (limited to 24.5 m in length and 2.55 m in width, excluding wing mirrors).

→ The analysis of system costs (investment, operation and regeneration) must be as detailed as possible for each of the scenarios studied, and in particular must take account of expected system lifespans.

→ The issues of serving historic city centres and reorganising bus networks must be examined very closely, as far upstream as possible.

4. How can a high level of service be achieved with buses?

4.1 Optimising every element of a BHLS system

4.1.1 Dedicated lanes: the building blocks of BHLS systems

Regulations governing shared thoroughfares make a distinction between three types of configuration:

- **Mixed flow lanes**, open to all categories of vehicle;
- **shared lanes**, reserved for a number of clearly identified vehicle categories;
- **dedicated lanes (or reserved lanes)**, for the exclusive use of one particular category of vehicle.

For a BHLS line, operation in dedicated lanes along most (or, ideally, all) of its route is a necessary but insufficient condition for high performance, and thus for achieving the high level of service desired for the system. Indeed, as long as they are respected, dedicated lanes constitute an essential factor in improving operating speed and service reliability, by enabling public transport vehicles to sidestep problems such as traffic congestion.

Opening these lanes to other categories of vehicle (e.g. bicycles, taxis, conventional bus lines) is an option that may be envisaged, particularly where the frequency of the BHLS line allows it and where the impact on BHLS safety and service levels (i.e. reliability, speed) is low. This arrangement is known as a **shared lane**. This contrasts with the very first BHLS approaches adopted, which were concerned with large urban areas or first-ever TCSP lines in medium-sized urban areas[68]. The emphasis at this time was on dedicated lanes being for the exclusive use of public transport, in order to meet very high performance objectives similar to those in place for tramways in France.

For both dedicated and shared lanes, a number of road layouts are possible. These configurations have a decisive impact on the way the system operates[69] and must be discussed as far upstream as possible in connection with service-level objectives.

[68] Certu, *Bus à Haut Niveau de Service : concept et recommandations* ["Buses with a high level of service: concept and recommendations"], Lyon, Certu, 2005, 111 p.

[69] See the Certu publication, *Guide d'aménagement de voirie pour les transports collectifs* ["Guide to road layouts for public transport"], Lyon, Certu, 2000, 268 p.

	Advantages	Disadvantages
Bilateral lanes	- pavements can be encroached upon to make room for stations - easier and safer for cyclists using these lanes on the approach to junctions - improved passenger safety at stations	- potential conflicts with the surrounding environment (parking, deliveries, adjacent general traffic lanes, residential access) - potential conflicts caused by turning traffic needing to cross the dedicated lane - dedicated lanes are less obvious
Two-way medial lanes	- easier access for services (refuse collection, deliveries, parking) in direct contact with businesses and housing - conflicts with residents limited - dedicated lanes respected - easier to negotiate junctions - in practice, possible to obtain higher speeds on the approach to junctions (less risk of side collisions)	- takes up more space, especially around stations - pedestrians have to cross the road to access stations
Two-way lanes on the same side	- useful in cases of urban asymmetry (residential access, junctions, businesses) - cars run in the opposite direction to the nearest buses (improved safety, dedicated lanes respected)	- operational problems at signal-controlled junctions (3 phases necessary) - less safe for cyclists using these lanes - potential problems associated with traffic turning at junctions and residential access

Table 7: three most common layouts for dedicated lanes served in France : advantages and disadvantages (source: Certu)

As with tramways, choices regarding protection levels depend on the urban context and on the risk of dedicated lanes being breached. To be effective, dedicated lanes must above all **be respected** by other road users!

Photo 11: the installation of axial dedicated lanes in Rennes limits the effects of external disruption and makes the roadspace easier to understand as a whole (source: Certu)

Photo 12: on Line C1 in Lyon, the decision to install unprotected side lanes can be a source of disruption for bus traffic (double-parked cars, delays or disruption due to kerbside parking, etc.) (source:Certu)

4.1.2 How can dedicated lanes be used to best advantage, and what can be done when space is limited?

b) Dedicated lanes can take different forms in different areas

"100% dedicated lanes" is not always essential

In developing the infrastructure for *TEOR* [70], Rouen used three different road layouts:

- **two-way dedicated lanes** in the city centre, where congestion and urban redevelopment stakes were highest;
- **spatially alternating dedicated lanes** in areas where space is limited and where no alternative route is possible;
- **mixed-flow lanes** at the ends of lines, where congestion is absent and public-transport demand is lower.

[70] See Appendix 1: definitions of infrastructures for buses

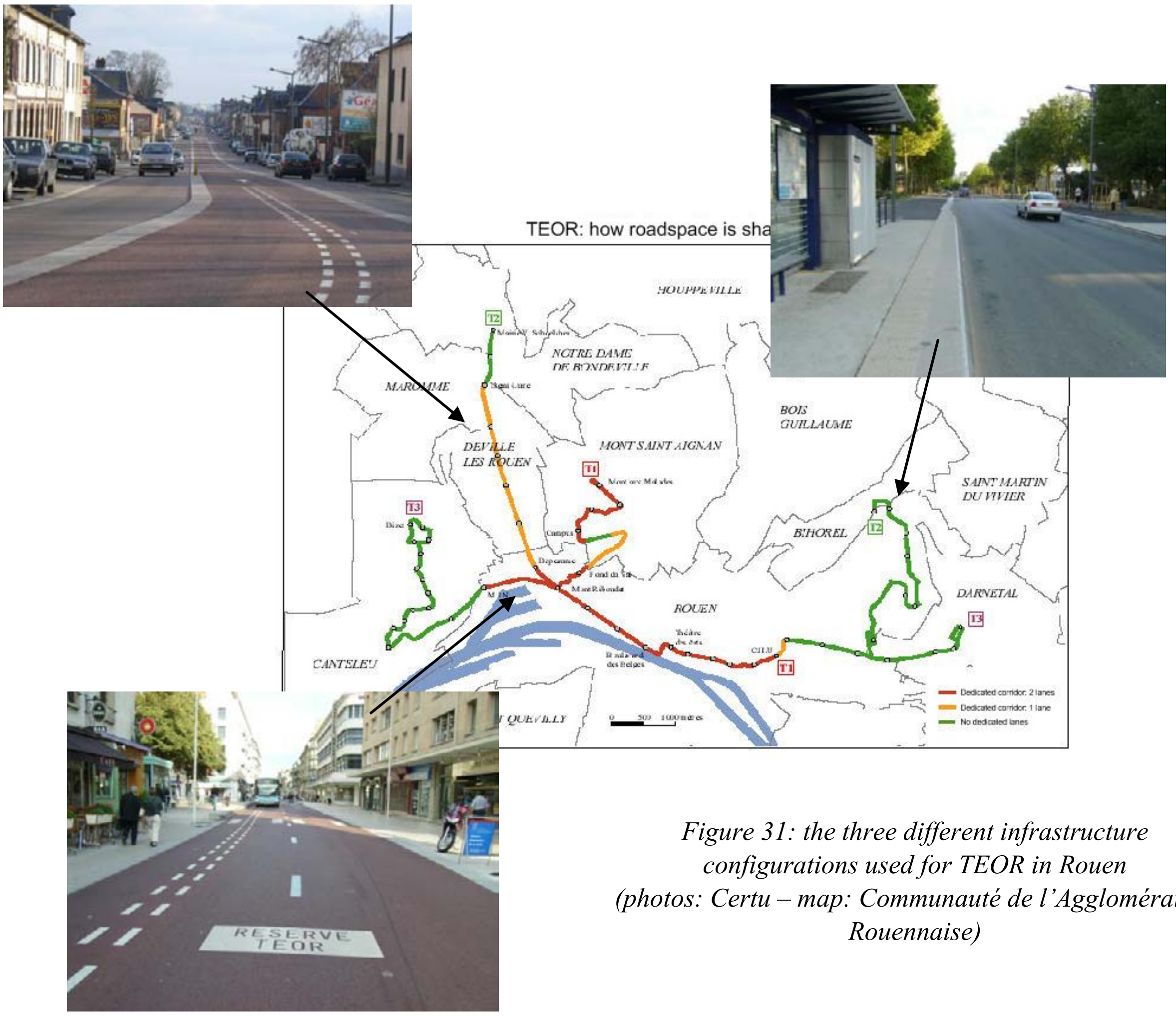


Figure 31: the three different infrastructure configurations used for TEOR in Rouen (photos: Certu – map: Communauté de l'Agglomération Rouennaise)

In Nantes, the *BusWay*® runs in two-way axial dedicated lanes for the majority of its route, in order to achieve a particularly challenging political and technical goal: to be as good as the city's tramway! This choice of layout means that high levels of service (in terms of speed, reliability and image) are practically guaranteed. However, because of space restrictions, one section uses spatially alternating dedicated lanes, as in Rouen. The main disadvantage of this arrangement is the number of lateral movements required to change lane, which can lead to lower comfort levels compared with the rest of the line.

Photo 13: spatially alternating dedicated lane for the BusWay®, Nantes' BHLS system (source: CETE Ouest)

Similar enhancements have been implemented for the *Triskell*, Lorient's BHLS system, in order to facilitate its integration at junctions.

At roundabouts, the dedicated lanes in each direction separate, thus reducing the amount of space required at the junction. In addition, buses have priority over cars at all times, ensuring they are always at the front of the line of traffic in non-reserved sections. This arrangement is sometimes referred to as "intermittent dedicated lanes".

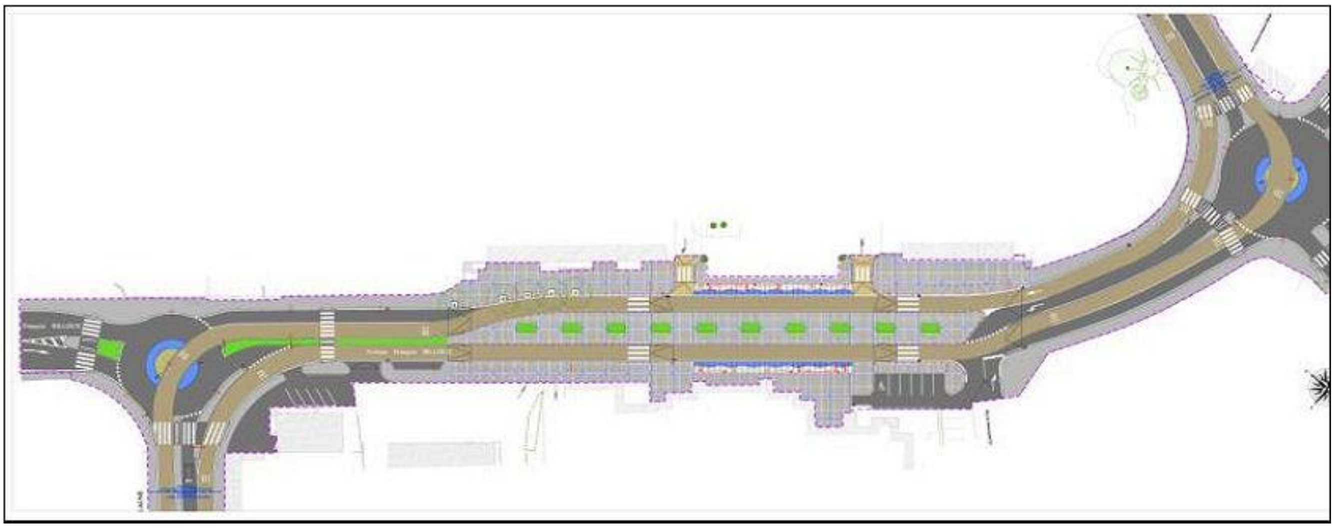


Figure 32: example of road layouts on a section of the Triskell network in Lorient (source: Cap Lorient)

In the three cases presented above, priority at junctions enables buses to **merge back into mixed flow lanes ahead of all other vehicles**. This type of priority is managed using traffic lights in Rouen and Nantes and "give way" markings in Lorient.

These few examples highlight the **flexibility of BHLS systems and their ability to adapt to different urban contexts**. These choices also mean that **investments can be optimised** by adapting them to needs more closely.

b) <u>Whatever the type of surface TCSP system chosen</u>, integration issues form part of the route selection criteria

In the centre of Douai, the urban transport authority decided to separate the two directions of the BHLS route via two narrow, parallel streets. This has the advantage of maintaining speed, reliability and comfort, as it means that dedicated lanes can be built. However, there are also some drawbacks: the separation of stations means that the same areas are not served in each direction, and could lead to confusion among users. This solution is therefore recommended only if the two streets concerned are close together and suitable measures are put in place to facilitate connections between the two sections (and comprehension of the system), as is the case in Douai.

Photo 14: separate running in each direction for Douai's BHLS system, Évéole (source: Certu)

4.1.3 Moving towards "tramway-style" stations

As with tramways in France, the creation of a BHLS system can be an opportunity to envisage stations with the following characteristics:

- locations and street furniture that ensure high visibility and ease of use; also, stations on opposite sides of the street should ideally be facing one another;
- easy and safe access for pedestrians from surrounding areas;

- comfortable waiting conditions: adequate space, shelters, seats, real-time information;
- a platform height that ensures easy vehicle access (for example: 23 cm on the *Trans-Val-de-Marne*, 27 cm on the *BusWay*®, 29 cm on the second phase of *TEOR* as a result of guidance);
- alignment with the bus's trajectory.

It should be noted that the choice of street furniture can have a significant impact on the management and cost of stations. For example, Maubeuge opted for advanced designer shelters made in Italy at a cost of €20,000, compared with €5,000 for a standard shelter.

In Nantes, the nature of the route (many straight sections) and the use of bevelled kerbstones enables high-performance docking at stations with no need for guidance.

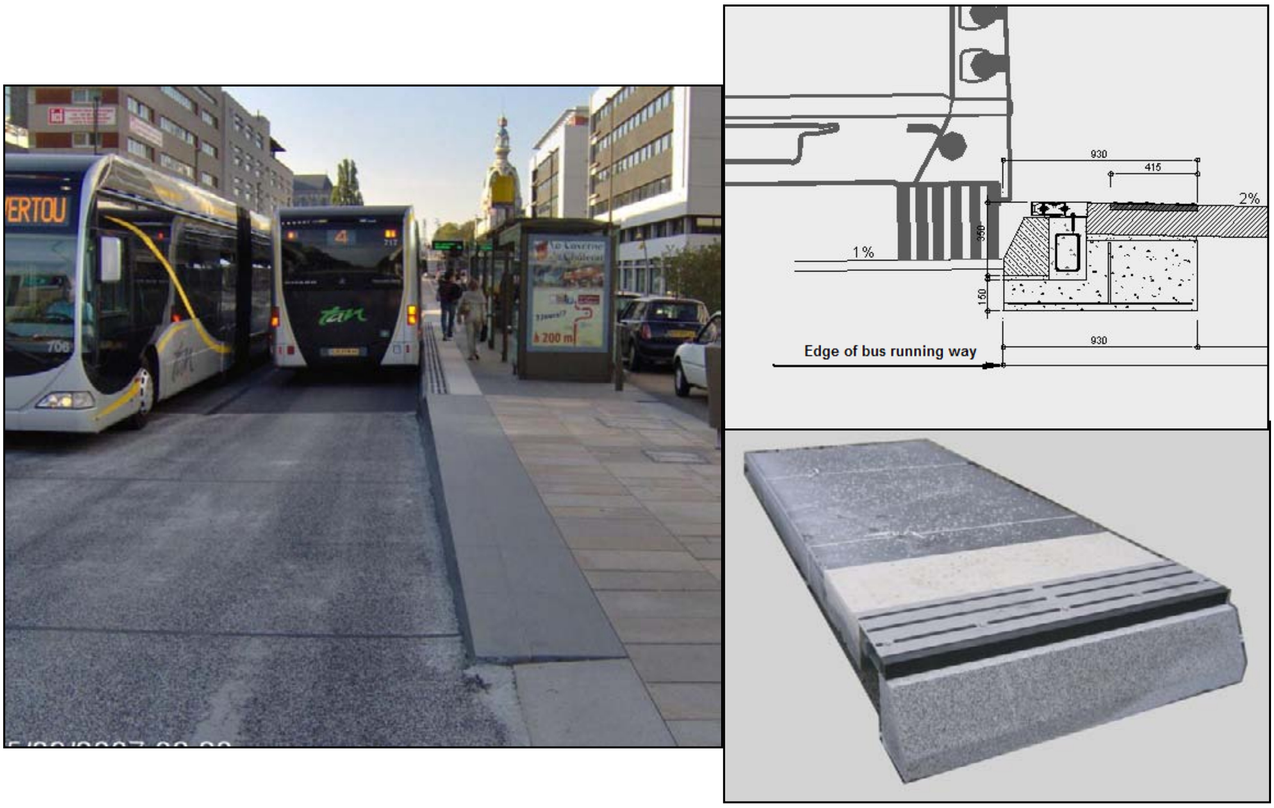


Photo 15: bevelled kerbstones and docking on the BusWay® site in Nantes (source: Nantes Métropole)

Stations can help identify the high level of service offered by a BHLS system in the same way as vehicles or dedicated lanes.

Photo 16: in Lorient, the architect-designed stations identify the Triskell service (source: CETE Ouest)

4.1.4 Appropriate station spacing to ensure high speeds

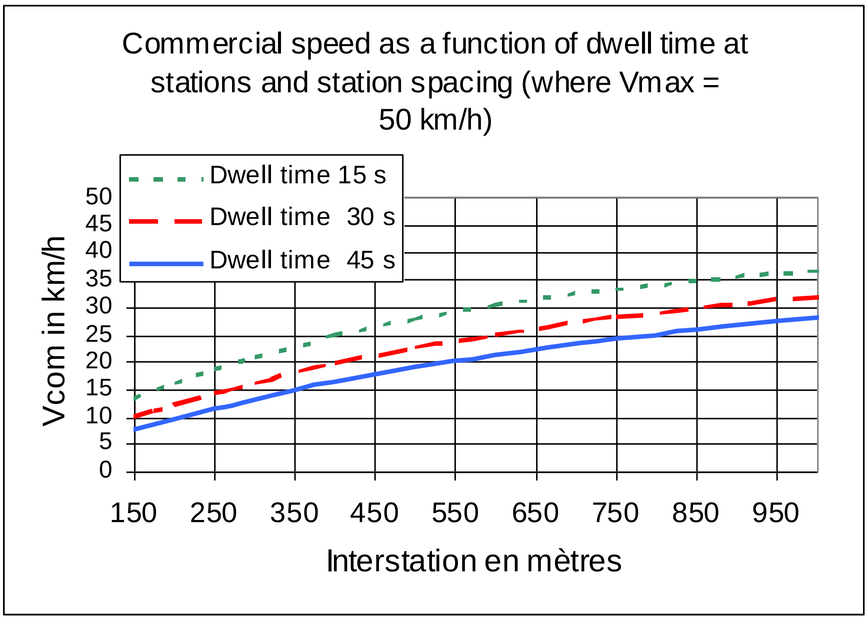
Public transport networks must often respond to objectives that are not mutually compatible:

- they must serve as many people and areas as possible; and
- they must offer high performance levels in order to encourage modal shift.

For a long time, surface bus lines have tried to combine these two roles. Today, however, there is a trend to separate these functions to some extent, in order to obtain better results. For BHLS, it is undoubtedly the "performance" aspect that is more important.

Therefore, when deciding on the location of BHLS stations, networks tend to favour greater distances between stations (around 400 m to 500 m on average)[71] to ensure higher operating speeds while still serving businesses and housing areas effectively.

[71] In 2005, the average station spacing on French tramways was approximately 480 m (source: Certu, CETE Lyon, *Panorama des villes à transports publics guidés (hors Île-de-France): situation 2005* ["Overview of cities (outside the Paris region) with guided public transport systems: the situation in 2005"], Lyon, Certu, 53 p., 2007 (available for download from the Certu website).



4.1.5 Operating conditions that encourage bus growth

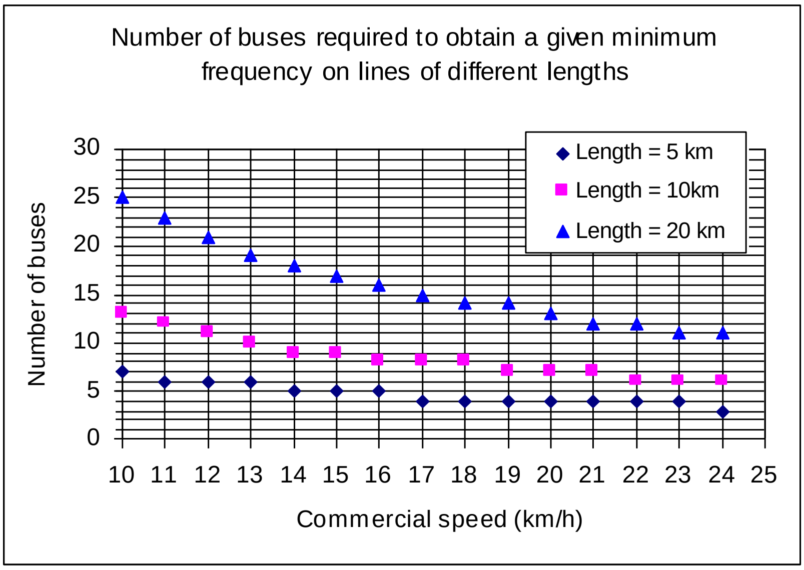
Speed and reliability ensure attractiveness, capacity and operational savings (in terms of both energy and personnel costs)

Congestion in built-up areas is increasing, and public transport is suffering as a consequence. In Besançon, the reduction in average speeds across the network has forced the city to increase its fleet (172 buses in 2008, compared with 155 in 2001) in order to keep frequencies and service spans at the same level.

BHLS operating conditions must ensure reliability and speed, in order to offer a high-performance service and make operational savings.

For example, on a 10 km line with headways of 10 minutes, increasing the average speed from 12 km/h to 17 km/h will free up 3 buses (and 3 drivers) that can be used to increase frequency elsewhere. It will also reduce the energy consumption and greenhouse-gas emissions of every bus in operation. Following the opening of the western extension of the *Trans-Val-de-Marne (TVM),* energy consumption was reduced by around 6% as a result of fewer stops at traffic lights and increased speeds.

Reliability ensures that the network runs at optimum capacity and facilitates the smooth running of automatic vehicle location and real-time passenger information (AVL–RTPI) systems.



Like the majority of tramways, BHLS systems must have priority at junctions

With dedicated lanes, **priority at junctions** is an element that ensures a high level of service, particularly in congested areas. Politically, this is sometimes a delicate measure to implement. It can also be a source of conflict between the local government departments responsible for public transport and traffic management. It is therefore important to carefully select priority junctions beforehand, in order to avoid the need for modifications at a later date.

This sort of priority is particularly effective, as vehicle detection systems installed ahead of the junction mean that stops at traffic lights, however brief, can be avoided, thus affording greater comfort for users.

In Maubeuge, service-level objectives have been adapted to the size of the urban area. As the BHLS line has a headway of one bus every ten minutes in peak time, the line is operated according to a timetable[72], without any headway management measures. In order to ensure punctuality, a system for **traffic-light priority** has been put in place with the aim of meeting reliability targets for the BHLS line. With this system, traffic lights should automatically turn to green for all buses that are on time or behind schedule. Buses are fitted with an on-board transmitter with detector boxes in traffic-light control cabinets.

BHLS dedicated lanes must be kept as free as possible from obstructions

The choice of **design for dedicated lanes** plays a decisive role[73]. In order to achieve a high level of service, these lanes should ideally not be shared with cyclists, taxis, conventional bus lines or interurban coaches when BHLS frequencies are high. Occasionally, a shared arrangement may be envisaged to ensure the continuity of other bus or cycle routes or maintain access to specific public facilities, provided that vehicle speeds are compatible. However, other solutions should be explored first to meet the needs of particular users such as: opening up new and existing conventional bus lines to these users, creating cycle lanes, paths and contraflows, etc.

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[72] We can distingish two manners of “time management” in a bus system. For a high frequency (e.g. under 10 minutes), we speak about **headway management** as the goal is to keep intervals regula **(reliability).** For a bus with a low frequency, it’s important not to miss the bus ! Here we speak of **timetable** management (poncutality).

[73] See Appendix 1: definitions of infrastructures for buses

When BHLS frequencies are lower, shared arrangements may be envisaged in order to optimise the available space, provided that additional traffic does not adversely affect desired service levels. For example, with a BHLS headway of 8–10 minutes at peak times, it may be possible to envisage sharing lanes with other bus lines and cyclists. However, this configuration must be carefully examined over time: any significant increase in the numbers of bicycles and conventional buses could adversely affect BHLS service levels – and, unfortunately, this is the sort of choice that, politically, cannot be easily undone!

These strategies for the sharing (or non-sharing) of lanes and priorities must be clearly identified within the context of an overarching planning approach, such as the PDU (Urban Transport Plan).

Frequencies must be adapted not only to the desired level of attractiveness, but also to the level of demand. In Nantes, for example, a few months after the launch of the *BusWay*®, headways were reduced from 4 minutes to 3½ minutes at peak times in order to increase system capacity. However, as with tramways, it becomes more difficult to ensure the reliability of buses with headways of less than 3 minutes. This situation is particularly delicate for trunk-based configurations, where entry to and exit from the trunk section must also be managed. In smaller urban areas, where transport needs are generally lower, headways may be higher (10 minutes in Maubeuge and 10 minutes in Douai, for example).

Photo 17: on the trunk section of TEOR in Rouen, the theoretical frequency is roughly one bus every two minutes in each direction (source: CETE Sud-Ouest)

Intelligent technologies (or ITS[74]) also contribute to performance and comfort levels:

- Smart ticketing is not unique to TCSP systems. It has been gradually introduced across many networks. It provides transport operators with more detailed information about journeys made[75], encourages intermodality, and conveys a modern image of public transport.
- Electronic ticketing on platforms means that boarding times can be reduced, thus ensuring improved speeds and reliability. This arrangement is highly recommended for busy stations.

[74] ITS: intelligent transportation systems

[75] Provided that users validate their tickets or travelcards and complementary surveys are carried out to correct results (taking account of fare evasion, accidental non-validation, etc.)

- On TCSP systems, passenger information is particularly useful in the event of disruption or delays. While precise waiting-time information is less vital on lines with high frequencies, it can be beneficial for less frequent services. On-board real-time information (e.g. next station announcement, perhaps journey time and/or indicators showing progress along the line and departure times for other lines on transfer stations), on the other hand, is essential.
- Certain networks have been developing CCTV security surveillance, so that drivers can concentrate on driving.

Finally, operating conditions are also always pre-conditionned by **traffic conditions** around the BHLS line. High traffic levels and significant flows of traffic perpendicular to the BHLS route can cause disruption. A number of measures to help reduce such disruption may be implemented, depending on the urban context, including:

- preventing traffic cutting across BHLS lanes, by prohibiting perpendicular traffic from continuing straight on and prohibiting parallel traffic from making left turns [in countries which drive on the right]; this would be compensated by the creation of roundabouts (as is the case on Avenue de l'Europe in Maubeuge);
- limiting through traffic, particularly on mixed-flow lanes, by alternating traffic flows.

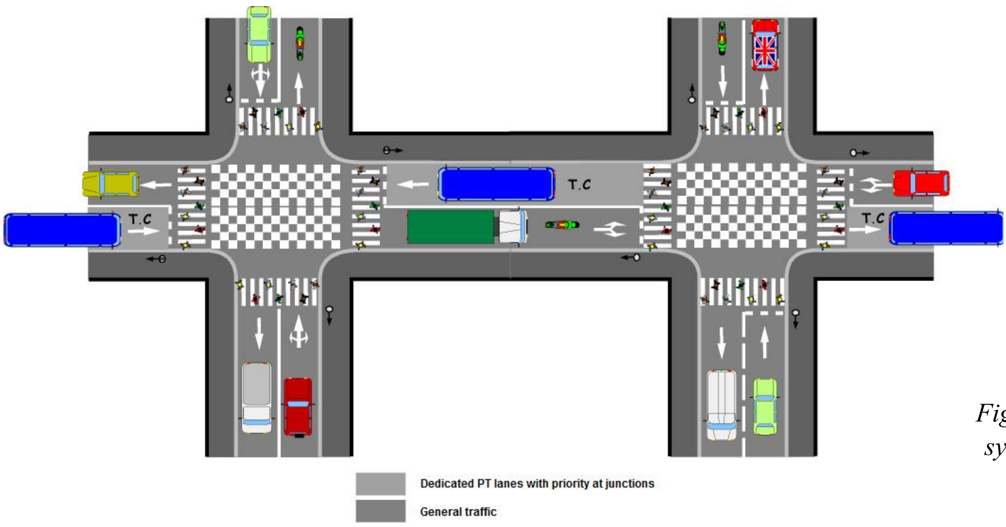

Figure 33: example of a traffic system with alternating flows (source: CETE Est)

4.1.6 Fostering a positive image for buses and improving comfort and accessibility

Currently, buses still suffer from a rather unglamorous image; however, rolling stock can play a key role in boosting the attractiveness of BHLS services as being one of the most visible components of the system in the city image.

- **Comfort** is one area where noticeable improvements have been achieved in recent years: quality of seats, internal layout, lighting, engine noise, braking, suspension, etc.

Photo 18: interior of the Irisbus Crealis with woo and transparancy, which will operate on the first BHLS line in Nîmes from 2011 (source: Nîmes Métropole)

- The increasing importance accorded to **accessibility** has led to significant advances, such as low-floor buses and spaces for PRMs[76]. The 2005 law[77] governing this issue in France means that disabilities should be taken into account to an even greater extent in the future, notably with developments in the field of audio and visual information.
  Depending on the objectives set, the use of **docking guidance at stations** may prove beneficial; this does, of course, incur an extra cost that varies according to the system selected: optical, magnetic, with rail central, kerb-mounted wheels, etc. For example, the extra cost of the guidance system for the BHLS project in Nîmes is estimated to be €90,000 per vehicle[78].
  Even without guidance systems, there is a number of measures that can be implemented to improve accessibility. Maubeuge has opted for bevelled kerbs, as well as road markings to act as visual aids for drivers. A green line on the running way indicates the path to be taken by the bus, while markings at stations enable the driver to align the front of the vehicle so that the wider doors for PRM access are positioned correctly with the platform.

[76] PRM: person with reduced mobility
[77] French law no. 2005-102 of 11 February 2005 for equal rights and opportunities, involvement and citizenship of people with disabilities
[78] This cost includes project design and management, the on-board and external elements of the system, and testing

Photo 19: road markings at BHLS stations in Maubeuge help facilitate docking (source: Certu)

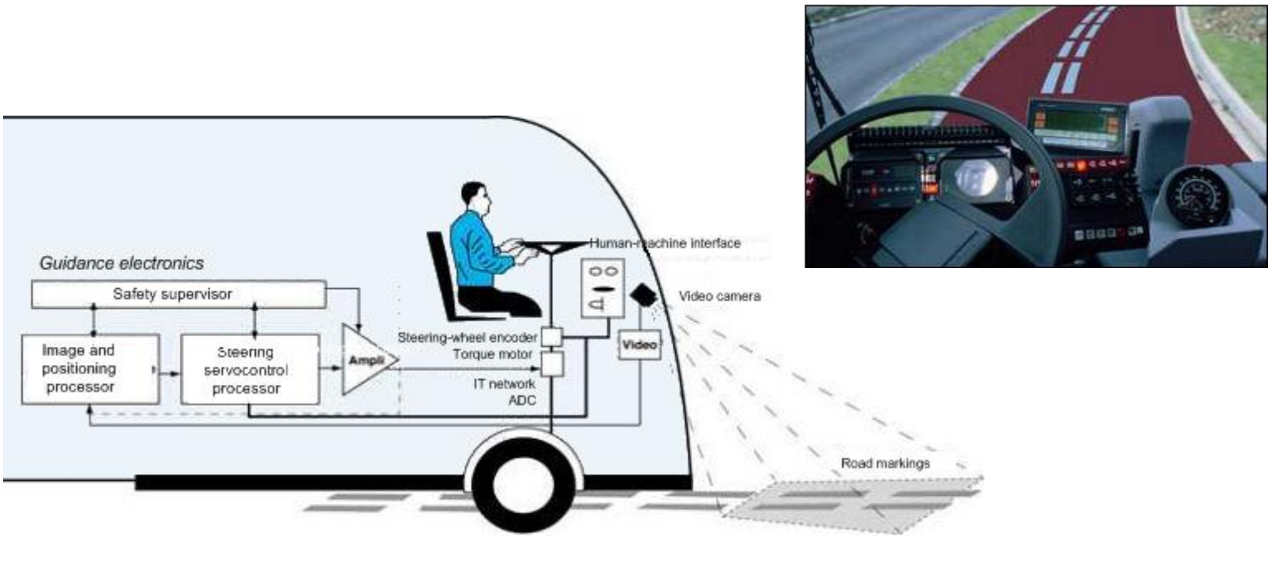

Figure 34: Rouen chose a Siemens optical guidance system designed for Irisbus Agora and subsequently Irisbus Citelis buses, adding around 5–10% to the overall cost of the BHLS system (sources: Communauté de l’Agglomération Rouennaise and Siemens)

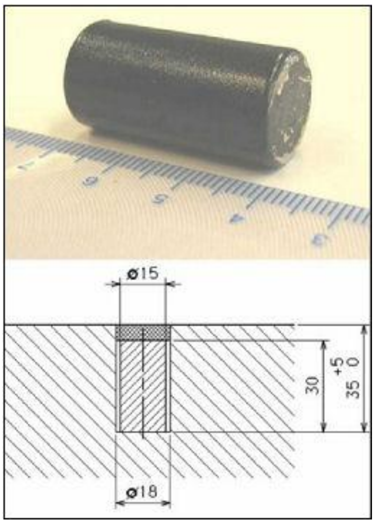

Figure 35: in Douai, magnetic sensors are inserted in the roadway at 2-metre intervals in order to correct bus trajectories and provide immaterial guidance along the entire route of the BHLS line (source: SMTD)

What are the benefits of guided systems?

+ Today, improved accessibility at stations is the main benefit emphasised in guided BHLS projects. This improved accessibility makes bus use easier for PRMs, thus reducing dwell time at stations (thanks to optimised boarding/alighting conditions), resulting in improved speed and reliability across the line.
+ Depending on the system selected, guidance may make it easier to integrate a BHLS line into restricted spaces (see section 3.5).
+ Guidance also provides greater comfort on curves and increases the visibility of the BHLS system to a certain extent (additional features required for guidance mean that dedicated lanes are more distinctive in some cases).
+ It can support and vehiculate modern image of public transport

- Finally, the rolling stock conveys the **image** of the BHLS system and the performance it is set to bring. With BHLS, the aim is to combine modern vehicles and facilities with high performance.

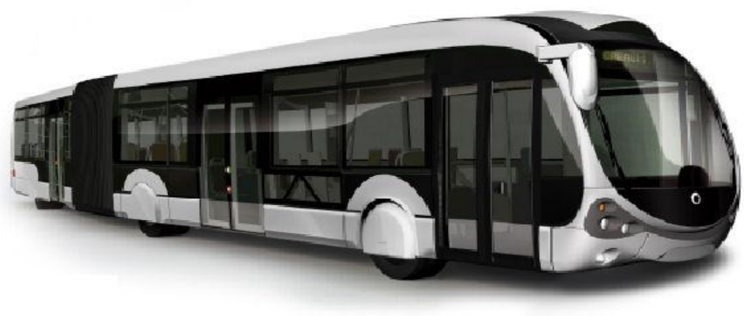

Photo 20: the design of the future BHLS vehicle for Nîmes, with a customised front section (source: Irisbus)

Manufacturers have rapidly come to grips with the requirements of BHLS systems. With new vehicles that are modern and comfortable, a new type of customer is being targeted: users that would happily hop aboard a tram, but would avoid conventional buses at all costs!

Following the "BHLS-isation" of the Mercedes-Benz *Citaro* for the Nantes *BusWay®*, rival manufacturer Irisbus has now unveiled the *Crealis*. This vehicle has been specially designed for use on BHLS lines. Nîmes, Maubeuge and the RATP in Paris have already placed orders. The RATP plans to have 120 *Crealis* buses in operation by 2011, notably for the *Trans-Val-de-Marne* line and its future eastern extension. The vehicles will benefit from translucent "accordion" sections, sliding doors and a "high-end" level of comfort. The RATP estimates that these "super buses" cost around 20–30% more than standard buses.

Of course, the use of more accessible, more comfortable and more modern buses is only effective and justifiable if system performance is of a similarly high standard. Inversely, design image (“service promise”) without improvement in level of performance is counter productive.

4.1.7 Buses of the future

Specific needs in terms of capacity and propulsion

Nîmes (Line 2), Nantes (Line 4) and a number of other local authorities in Europe are interested in the possibility of using **bi-articulated buses** 24 metres long in order to meet capacity needs. This type of rolling stock is relatively undeveloped in Europe (notable cities that use such vehicles include Zürich, Geneva, Utrecht and Hamburg[79]) with few manufacturers on the market.

There is also increased interest in **electric vehicles**, and not just from those cities that already have trolleybuses (e.g. Lyon, Limoges). This type of rolling stock is currently envisaged for BHLS projects in Nancy, Lyon (Lines C1 and C2), Nîmes (Line 2), Valenciennes, Montbéliard and others. Hybrid systems also generate considerable interest, but they are not yet used in France; by contrast, the market for hybrid buses in the USA is highly developed.

Indeed, for cities looking for vehicles that combine high capacity with electric or hybrid propulsion, the options available in Europe are quite limited:

- Hess has a 24 m vehicle that can run in trolleybus or hybrid mode (used in Zürich). Design studies are in progress to respond to changing needs in terms of image. Furthermore, Hess is working on a device for steerable rear wheels which would reduce overhangs on curves and provide bi-articulated buses with curve integration conditions close to those of articulated buses.
- The APTS *Phileas* is also available in a 24-metre version with hybrid propulsion, but has encountered some difficulties (e.g. in Eindhoven, Douai, Istanbul) and, to date, has only been partially approved in France (operation without guidance).

For its Line 2 BHLS project, the Nîmes urban area is set to purchase bi-articulated trolleybuses with additional specifications: **guidance** at stations (as for Line 1) and **no overhead lines** in the vicinity of the Roman amphitheatre.

Regarding guidance, the fact that Siemens' video-camera device is no longer exclusively linked with Irisbus opens up new perspectives for other manufacturers.

[79] In Utrecht and Hamburg, the Van Hool AGG300 is used. This is only available in a diesel version. In Zürich and Geneva, Hess Trolleybuses are used.

Moreover, certain manufacturers, such as Mercedes-Benz, may envisage proposing their own optical guidance system.

For operation without overhead lines, the solutions are relatively limited at present. However, it should be noted that the manufacturer Solaris produces a trolleybus capable of operating with its poles "disconnected" over a distance of 3 km, such can be seen in Rome. A 24-metre version of this vehicle could be envisaged.

Longer-term research projects

The prospect of a "bus revival" and the enthusiasm for BHLS systems will hopefully pave the way for plenty of innovations in the years and decades to come.

Towards "wireless buses"?

Certain manufacturers are involved in research programmes. Their primary concern is energy. Following the development of fuels such as compressed natural gas for vehicles, the first *hybrid* technologies are now arriving on the market (e.g. the APTS *Phileas* in Douai in 2010). From 2009 onwards, APTS will also be testing fuel cells in two *Phileas* vehicles in Amsterdam and two others in Düsseldorf. Manufacturers and elected representatives alike are now entertaining the dream of using electric buses without overhead wires or seeing the development of *dual-mode*[80] vehicles. It is a dream that could perhaps soon become a reality. Two avenues are currently being explored:

- the use of **on-board batteries**, as is the case with the Nice tramway;
- the use of **central rails providing a ground-level power supply**, as is the case with the Bordeaux tramway,
- the use **fast charging at stations**.

Irisbus presented the **Hynovis** research project, financed by Predit[81], at the 2008 European public transport exhibition. This experimental 12-metre bus, produced in conjunction with the RATP and Inrets, boasts a number of innovations:

Increased capacity and reduced consumption with the Hynovis concept by Irisbus

- a "stop-and-start" engine that can be shut down and restarted in 0.3 seconds during short stops;
- a new kind of engine architecture based on a hydraulic hybrid system;
- a regenerative braking system;
- a new steel structure that is around a tonne lighter than conventional 12-metre buses;
- an internal aisle that is 1.20 m wide, compared with 90 cm for conventional buses, thus improving wheelchair access and general ease of movement and fluidity within the bus in order to reduce dwell time (meaning gains in terms of speed and reliability);
- windows that have been lowered by 20 cm to allow more natural light into the bus and a “sceneric” experience for the customer;
- increased capacity as a result of space savings in the engine compartment;
- doors that can be easily fitted on the left-hand or right-hand side, thanks to a long platform with no protruding wheel housings.

[80] Please see the glossary for the distinction between "dual-mode" and "hybrid"

[81] Predit: *Programme de Recherche et d'Innovation dans les Transports Terrestres* (French National Land Transport Research and Innovation Programme)

The Hynovis bus is claimed to consume 30% less fuel compared with a modern standard bus.

Other research or prospective projects concern the link between the bus and its environment. As part of its long-term planning work, the RATP has launched a "think tank" approach on the subject of BHLS.

A number of innovative ideas have come to the fore, including:

- The concept of **double-sided interactive stations**: this is a new way of designing stations in order to create true living spaces that are landmarks within the city. As they face both the city streets and the TCSP line, they must act as a link between the two.
- **Heads-up display** that provides all the necessary information to the driver.

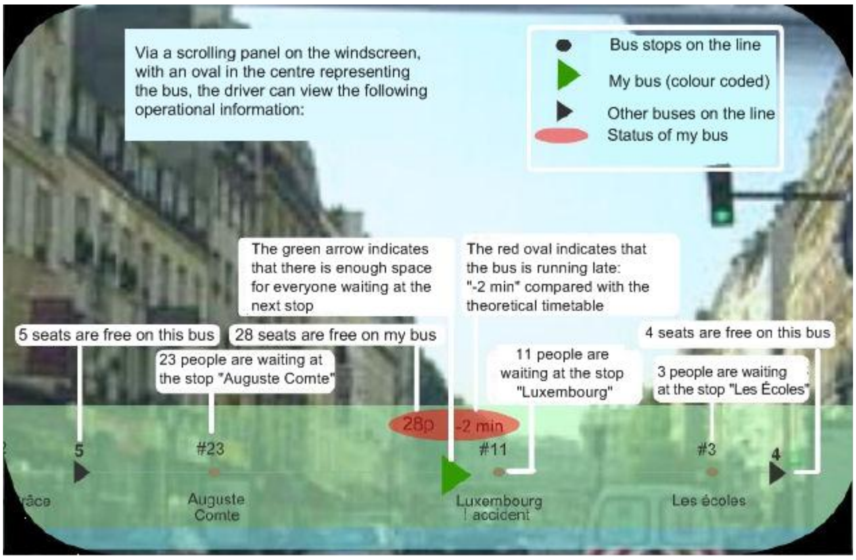

Figure 35: an example of a driver assistance panel (source: RATP)

Bus projects of the future: moving towards EU-approved BHLS products?

Finally, at EU level, the **EBSF (European Bus System of the Future) project** coordinated by the UITP (International Association of Public Transport) seeks to bring European manufacturers together with the aim of performing better on the international market. The objective here is also to innovate and develop new concepts based on buses.

This project shall lead to the design of a number of prototypes and concept buses, which will then be tested in different partner cities (Paris and Rouen in France). The research themes for this project include:

- optical guidance and steering strategies,
- improving door access,
- optimising seat layout,
- the driver's cab,
- on-board information,
- priority at traffic lights,
- the organisation of maintenance (diagnostics and telemaintenance),
- the organisation of depots.

4.2 Handling the interfaces between system components

To attain a high level of service, particular importance must be given to the interfaces between the three "families" of system components.

The **bus–running way** interface must be dealt with in such a way as to ensure a high level of comfort. By contrast, in Line C3 in Lyon, the running way has not been resurfaced along the whole of its route. Certain sections are still paved with tessellating blocks, which do not provide a smooth, flat running surface. This illustrates perfectly that implementing modern and comfortable trolleybuses is not sufficient alone to ensure a high level of comfort.

A high-quality **station–bus** interface ensures improved accessibility, in compliance with legal obligations[82]. It also helps keep bus dwell times to a minimum, which in turn has a major impact on reliability and operating speed. To optimise boarding/alighting flows, the following measures can be taken:

- aim to keep the gaps between the platform and the bus to a minimum, e.g. using **guidance systems;**
- encourage off-board fare collection, at least at the busiest stations and remove ticket sales from the bus;
- increase the number of doors providing access to the bus; boarding by the front door only is not an appropriate option for BHLS lines.
- Widening of the doors

Photo 21: TEOR's guidance systems ensures that horizontal and vertical gaps between the platform and the bus are less than 5 cm for the main doors (source: Certu)

[82] French law no. 2005-102 of 11 February 2005 for equal rights and opportunities, involvement and citizenship of people with disabilities

Photo 22: a station on the TVM line with ticket vending machines (source: Certu)

4.3 Summary of the BHLS "system approach"[83]

4.3.1 "Choose buses but think in terms of tramways"

As we have seen, a number of BHLS system components can take inspiration from "French-style tramways". The *BusWay®* in Nantes is the most accomplished example of this approach.

Photo 23: a cut-through roundabout used by the BusWay® in Nantes; it is controlled by R17 and R24 signals, just like the city's three tramway lines (source: Certu)

[83] See also Appendix 6: "cross-referencing BHLS system components with the level-of-service characteristics"

Figure 36: the Mercedes Citaro, adapted to incorporate typical tram-style components (source: Nantes Métropole)

4.3.2 Adapting the "system approach" to local contexts and local-authority objectives

Each component of a BHLS system can be dealt with at a number of different levels, depending on the objectives set, the local context and the resources available. Ideally, each local authority will take inspiration from the concept, and then adapt it to local needs.

For example, Lorient opted for:

- a 5 km trunk section in dedicated or shared lanes, with mixed-traffic lanes at the ends of lines;
- visible and comfortable stations along the majority of the route, including those not on the trunk section;
- conventional but modern buses, with no distinction made between the different lines on the network;
- passenger information, but no smart ticketing as yet (for financial reasons);

- guaranteed priority at junctions, despite the high frequency on the trunk section shared by the 7 *Triskell* lines (more than 600 buses per day – and one every 30 seconds at peak times); priority is ensured by the redesign of junctions, involving mostly cut-through roundabouts, with "give way" road markings.

These elements can be grouped together in a table, using a model inspired by American BRT specialists[84].

Components of the Triskell system in Lorient	1	2	3	4	5
Infrastructures*	Lateral bus lanes	Protected two-way reserved lanes that can be accessed and shared with bicycles, taxis and other buses	As for 2, but with dedicated lanes for BHLS only	As for 3, but with dedicated lanes that cannot be accessed	Fully dedicated lanes with grade-separated junctions
Stations	Bus stops on pavements	Bus stops on enhanced pavements (accessibility)	Stations aligned and enhanced with conventional street furniture	Modern stations identified with special street furniture	Grade-separated stations
Vehicles	Traditional diesel buses	Traditional buses with alternative fuels (LPG, natural gas, etc.)	Buses or trolleybuses with alternative fuels and which offer a higher comfort level and better image than conventional buses	As for 3, but with guidance	As for 4, but with bi-articulated rolling stock
ITS	None	Computer ticketing	Computer ticketing** + passenger information	Computer ticketing + passenger information + off-board fare collection	As for 4, but with a closed system
Operation	No priority at traffic lights	Occasional priority at traffic lights with bus queue jumping	Priority at traffic lights for most junctions	Priority at traffic lights for all junctions	No traffic lights (grade-separated junctions)

* outside trunk sections, buses run in general traffic lanes
** computer ticketing is to be rolled out across the whole network at a later stage

Table 8: example of a component classification and scaling system for the Triskell project in Lorient. The coloured cells indicate descriptions that apply to the components of the system in question (source: Certu)

Photo 24: a bus, dedicated lanes and stations on the Triskell network in Lorient (source: Certu)

[84] Gray, Kelley and Larwin, *Bus Rapid Transit: A Handbook for Partners*, p. 8, 2006

4 - How can a high level of service be achieved with buses? Points to remember…

→ An overarching "system approach" is at the heart of the BHLS process. It is inspired by the approaches used for "heavy" TCSP systems (e.g. metros, tramways).

→ Depending on service-level and operational objectives, the urban transport authority must adapt this approach by taking appropriate action for each system component (infrastructure, rolling stock, operation) with a view to optimising investments.

→ Dedicated lanes that are respected by other traffic form the basis of BHLS systems in congested areas; however, dedicated lanes are not necessarily required along the entire route. A range of solutions for the integration and operation of BHLS services can be implemented in order to ensure a consistently high level of service in congested streets, however narrow or broad.

→ To ensure that dedicated or shared lanes are respected, other users must be taken into consideration and adequately catered for.

→ Bus priority and traffic control at junctions are fundamental elements for ensuring speed, reliability, comfort and operational savings.

→ Stations can be dealt with in a number of ways. As the interface between the BHLS system and the surrounding environment, they play an essential role in terms of visibility and accessibility. Additionally, stop spacing should be sufficiently large to ensure high operating speeds.

→ Comfort and a positive image are the focus of bus manufacturers' latest projects. Other research projects are in progress with regard to propulsion, with a view to reducing fuel consumption and responding to local authorities' needs as closely as possible.

→ The use of guidance systems is optional. A precise cost–benefit analysis must be carried out beforehand. Its principal application is ensuring improved accessibility at stations. Guidance can also be useful for integrating BHLS lines on curves, especially if the system uses single-path vehicles. 20% of BHLS projects submitted in response to the call for urban public transport projects resulting from the *Grenelle de l'Environnement* plan to incorporate optical guidance systems.

→ The way interfaces between components are managed is vitally important. User comfort depends as much on the rolling stock as the infrastructure. In particular, the station–bus interface plays a key role in terms of accessibility and reliability.

→ The identification of the system through its stations, buses or infrastructure enables users to associate a high level of service with a particular bus line. This is a double-edged sword, however: if you advertise a high level of service, users must be able to expect this high level of service at all times!

5. Implementing BHLS as a TCSP system

The BHLS concept can take different forms. Technical experts and elected representatives need time to adapt the concept to the local context and ensure that, when implemented, the quality of service obtained will match the service levels sought and advertised[85].

In order to meet this requirement, the BHLS scheme must be conceived as a true TCSP project, including in terms of the way it is managed and steered. In addition to appropriate organisation, the definition and implementation of a BHLS system requires the approval of all players involved, as well as strong political backing, in the same way that a tramway does.

5.1 Organisation of institutional responsibilities and political backing

Unlike a tramway, BHLS is not an obvious choice for urban areas and their key players

In certain cases, the separation of responsibilities (overall transport policy, public transport, urban planning, roads and traffic, parking, police, bus shelters, etc.) is not conducive to a coherent project. In France, tramway projects receive sufficient political backing to ensure that these responsibilities are all brought together around a common aim. Unfortunately, this is not always the case for BHLS projects, which may be the subject of difficult negotiations between various institutions or departments (regarding the management of junctions, dedicated lanes, etc.).

In Lille, for instance, *Liane* line 1 serves eight municipalities, three of which are on the urban part of its route (namely Ronchin, Lille and Wambrechies). These three municipalities did not share the same vision for the project (which was led by the intercommunality, Lille Métropole), particularly with regard to the planned enhancement work. For example, while there is a 5.5 km section of dedicated lanes in Ronchin, the part of the line in Lille has seen no such improvements, despite the fact that it is this section that suffers from the most congestion. This lack of homogeneity means that a high level of service cannot be guaranteed along the whole line.

[85] The distinction between "service level" and "service quality" is discussed on page 20 of the Certu publication, *Bus à Haut Niveau de Service, Concept et recommandations* ["Buses with a high level of service: concept and recommendations"], Lyon, Certu, 2005.

Photo 25: the absence of dedicated lanes for the Liane service in this part of Lille means that a high level of service cannot be guaranteed across the entire line (source: Odile Heddebaut, Inrets)

In Nantes, on the other hand, the *BusWay®* project was made easier by the **integration of certain responsibilities (transport, roads and urban planning)** within the intercommunality (Nantes Métropole) and **backing from local politicians**, which played a vital role in transforming the previous tramway extension project into a more appropriate BHLS project.

With certain projects (e.g. Nîmes, Metz), political backing and the definition of a more ambitious project in terms of performance emerged only after elected representatives had visited systems already in operation.[86]

Regarding the split between transport-related aspects and aspects related to urban enhancements, a number of different options may be envisaged. Although overall control of the project by the urban transport authority ensures greater coherence and makes implementation easier, it would nonetheless seem important to **clearly separate the two components of the project**, particularly with regard to funding. This also means that individual municipalities can envisage specific improvements within their boundaries.

5.2 Organisation and technical coordination of projects (by Transétude/Keolis Conseil & Projets)

The technical approach for a tramway project is to a certain extent dictated by standards, products and dimensions with proven track records in terms of adaptability and compatibility. However, there are still choices and innovations to be made in terms of vehicle widths, types of propulsion and guidance, means of capting or storing electrical energy, and human–machine interfaces. The subsystems that make up these projects are available "off-the-shelf", while the various skills and expertise required can be found within specialised organisations.

[86] Elected representatives from Nîmes visited Nantes and Rennes in late 2007, while their counterparts from Metz observed the operation of the *BusWay®* and *TEOR* in 2008

The "system approach" to BHLS is by definition complex, as the enhancements, structures, facilities and vehicles that are designed or required all contribute to the coherence, identity and performance of the BHLS system, despite the fact that, in isolation, these components are not always predisposed to work together. Individual techniques are tried and tested; however, the expertise required to implement them all may not be present in one place.

At the start of the project, it is therefore necessary to clearly formalise the ambitions and objectives of the BHLS concept locally and determine what these goals mean in qualitative and quantitative terms, particularly with regard to service. There is no point tackling the technical aspects of the project before performance levels, comfort, overall attractiveness of services, and urban redevelopment have all been taken into account.

The next stage aims to create and assemble the various elements of the project, rather like a jigsaw puzzle. This requires the same type of approach – and therefore the same degree of rigour – as a tramway-type project. An additional dimension also emerges here: BHLS services can be phased in gradually, offering greater operational flexibility. Whereas tramways cannot run until the whole line has been finished from end to end, BHLS corridors and lines can be created and opened in stages, without jeopardising the aims and performance of the scheme as a whole. However, although the solutions to be implemented here are more varied, a number of permanent facilities and structures must be in place if the dedicated lanes are to be clearly identified, and therefore effective. The programmes and specifications drawn up to define these elements must be tackled in an order that enables their interfaces to be managed, together with the targets allocated to their designers.

The different teams and experts called upon must be united in pursuit of a common aim, even if their respective backgrounds sometimes mean that they apply knowledge and techniques relating to the management of "rival" transport modes. This apparent difficulty can be an advantage: when correctly managed, diversity and even confrontation in terms of expertise and knowledge can lead to innovative, high-performance solutions. These in turn enable the right balance to be struck between providing the BHLS line with the performance level necessary for public transport use without necessarily creating wide dedicated lanes from end to end, which, although beneficial for buses, cannot always be achieved.

With BHLS projects, the quest for innovative solutions is very real, as feedback on current solutions for developing interfaces or complementary functions is far less widespread than for tramway systems. For example, there is a real need to bring together the most appropriate solutions for managing the capacity, accessibility, design, layout and energy efficiency of vehicles all at once. This highlights the necessity for technological watch in all fields, as well as the option of using market procedures that enable and structure dialogue with manufacturers.

In general terms, the definition of the constituent elements of the BHLS system can be dealt with by the engineering teams present within the relevant urban transport authorities or local authorities, in conjunction with the operator's engineers. The relevant central government departments are also used to contributing to this type of project, thanks in particular to their ability to identify and analyse solutions, and recommend particular improvements and systems which have proved useful in specific contexts in the past. These departments should also be contacted to validate projects where there is a safety case.

In order to unite these teams, ensure that their skills and contributions are mobilised at all times, and legitimise the project as a whole, it is important that groups such as panels and steering committees – and, of course, the institutional structures of the urban area – approve proposed courses of action, research into solutions, decisions, and the people putting these decisions into practice, on an ongoing basis. The "general-purpose" departments of local authorities, such as those involved in accounting, finance, managing invitations to tender and procurement procedures, public relations, managing regulatory procedures (Declarations of Public Utility, consultation, etc.), are obviously also involved. For these groups, bodies, technical teams and experts to function together successfully, an overarching management structure must be put in place at a level recognised by the institution. In addition, elected representatives must be available, particularly those who have responsibilities in the fields of urban planning, transport, trade, economy and finance.

5.3 Involving transport operators and drivers in projects (with the assistance of Transétude/Keolis Conseil)

Obtaining high-performance services is one of the primary objectives of BHLS projects. Passengers expect this, as does the urban transport authority. Developing an overall vision for a network, establishing the hierarchy of its lines, encouraging growth in ridership and ensuring economic performance all require the experience and knowledge – and sometimes commitment – of transport operators. These projects are best managed when sufficient resources and skills are made available in pursuit of the desired results.

By virtue of their responsibilities, transport operators are able to highlight factors for productivity and target issues that need to be dealt with as a matter of priority. Analyses of data from automatic vehicle location and real-time passenger information (AVL–RTPI) systems, occasional surveys (e.g. origin/destination surveys) and other observations quantify the gains to be expected from the implementation of suggested practical solutions: junction access improvements, dedicated lanes, priority at traffic lights, station layout, etc. The expected gains are quantifiable both in terms of operating and investment costs, as well as from an environmental standpoint.

Although carrying out a BHLS project uses the skills and expertise (notably in terms of engineering) present in the urban transport authority's departments, it also requires the support of the operator in all its activities, above and beyond its involvement in the engineering tasks mentioned above. In particular, operators are ideally placed to make suggestions or offer expert opinions on issues relating to operation, regulation, methods and maintenance and the viability of solutions in this regard. This involvement helps foster support for the management of changes in general, which can be potentially disrupting when customary operating practices are modified. These changes may even involve wholesale reorganisation of operations. The advance knowledge – and therefore gradual appropriation – of the content of BHLS projects therefore facilitates the internal drafting of procedures and regulations, and their dissemination through training and accreditation where necessary, particularly in cases where new roles or responsibilities are created.

Case study: a TCSP network operated by a *SEM*

In Nantes, Semitan (*Société d'Économie Mixte des Transports en Commun de l'Agglomération Nantaise*, a type of public–private partnership) was created in 1977 to operate the urban public transport network, the public service contract for which is regularly put out to tender. Semitan – 65% of which is owned by the intercommunality, Nantes Métropole – is also in charge of developing the network via a *mandat de maîtrise d'ouvrage déléguée* (mandate for contract oversight), obtained after the tendering process, in compliance with current laws[87]. This delegation occurs after opportunity and feasibility studies have been carried out. This arrangement has enabled Semitan to develop considerable expertise in the field of TCSP since Nantes' first tramway line was created, and to ensure that the interests of the operator are taken into account in projects, along with effective budget management (e.g. by taking an economical approach to maintenance). This same arrangement was selected for Line 4 (*BusWay®*). In particular, it enabled considerable responsiveness when a late decision was taken to change the line's northern terminus (to Foch station instead of Commerce) in order to create the beginnings of a "meshed" network in the city centre and avoid congestion around the central hub (Commerce).

5.4 Citizens at the heart of BHLS projects

Upstream of the project

At a time when the BHLS concept is still poorly understood by the general public, consultation plays a key role. The consultation processes included **as part of the PDU** can be a good opportunity to raise awareness of the different technologies available, and BHLS systems in particular.

The consultation procedures that are subsequently imposed by law are common to all TCSP projects costing more than €1.9m. The *Code de l'Urbanisme* (French Urban Planning Code)[88] imposes a **preliminary consultation**. Although the contracting authority is free to organise this consultation in any way it sees fit, it often makes most sense to carry out this exercise at the end of the feasibility studies. It is at this moment that the choice of system and type of BHLS (if this mode is selected) needs to be discussed. Finally, the *Code de l'Environnement* (French Environmental Code)[89] – and occasionally compulsory acquisition needs – requires a public inquiry, during which the pre-project studies are generally presented. Ideally, related projects (reorganisation of the bus network, revision of traffic and parking schemes, etc) should also be adressed here.

In addition to these legal requirements, it would also seem important to **communicate regularly** and define appropriate strategies.

For example, if a BHLS system is selected, choosing an inspiring name that reflects local buy-in of the concept could be advantageous. Initially dubbed the "*tram-bus*" during feasibility studies, the *BusWay®* brand rapidly became

[87] French law no. 85-704 of 12 July 1985 relating to public project contracting and its relationship to private project management (known as the "*Loi MOP*") and the *Code des Marchés Publics* (Public Procurement Code)

[88] Articles L. 300-1 to L. 300-6 and R. 300-1 to R. 300-3 of the *Code de l'Urbanisme*

[89] Articles L. 123-1 to L. 123-16 fo the *Code de l'Environnement*

established in Nantes – so much so that the name has now begun to be used in other towns and cities (e.g. Metz, Toulon, Maubeuge) to designate this particular form of BHLS. Elsewhere, simple "TCSP projects" have become *Évéole* in Douai, *Viavil* in Maubeuge, *Triskell* in Lorient, *TVM (Trans-Val-de-Marne)* in the Paris region, and *TEOR (Transport Est-Ouest Rouennais)* in Rouen. All the tools used for communications concerning tramway projects can be used for BHLS (brochures, newsletters, logos, dedicated websites, forums, meetings, field trips to other cities with public delegations, sketches and artists' impressions, participation in choices of name or colours, etc.).

During the construction phase

Communication exercises carried out during the construction phase must be independent from the rest of the system. In Douai, for example, "*cafés tram*[90]" were set up to encourage dialogue with residents inconvenienced by the construction of the BHLS system. These informal meetings, which also included site personnel, took place throughout the construction phase in 15 partner cafés spread across 4 municipalities. These cafés were identified by posters and stickers bearing the project logo in their windows.

"Discovery visits" before the system comes into operation and inauguration events also enable the public to find out about, and take ownership of, the system.

[90] The Douai project is described using the term "tramway". In reality, it is a guided BHLS system.

5 - Implementing a BHLS system: points to remember…

- → The BHLS concept requires time and effort if local politicians and citizens are to take ownership of such a system.
- → The relative flexibility of BHLS becomes a disadvantage at the implementation stage, as the concept is not an obvious solution for cities in the same way that tramways are, and because the image of BHLS does not yet reflect its full potential.
- → Strong organisation, communication and political backing are therefore essential for the smooth running of the project and the attainment of targets for high levels of service.
- → The involvement of all parties (transport operators, drivers, citizens, construction firms, etc.) must be sustained throughout in order for the project to mature and become accepted.