Feature

Urban Transport in France

Georges Dobias

Since the mid 1970s, France has developed a significant programme of urban transport networks and systems for the major metropolitan areas.

There are three main reasons explaining the renewal of public transport in France:

- the idea that public transport is necessary and that a system based on the car cannot fulfil the challenge of growing mobility
- the availability of new funding dedicated to public urban transport investments and operations
- the creation of new metropolitan authorities in charge of organization of urban public transport.

It is not necessary to explain the first point in detail, because it is not unique to France. The first attempt to define an urban transport policy was debated at a congress on mass transit held in Tours in 1971. Since then, a specific policy in favour of investment in urban public transport has been promoted by all local governments in France.

In the same year, a new transport tax was created in the Paris region and it was extended in 1973 to all cities with more than 20,000 inhabitants. This tax is levied on companies with more than 9 workers. The tax rate varies locally from 1% to 2.5% of the payroll. The revenue is used to fund investment in and operation of urban public transport. In 1993, the transport tax revenue for France totalled more than FFr17 billion, divided into FFr9.4 billion in the Paris region and FFr7.6 billion for the other 147 cities. The economic justification for the tax is the important role that public transport plays in the employment market, especially because employers will have more possibilities if there is an efficient public transport network.

At the same time, organizing authorities (OAs) were created by the local boroughs, and they have responsibility for urban public transport in the cities. The OAs were ratified by legislation in 1981, and receive the transport tax revenue and spend it based on the following responsibilities:

- Organization of public transport in cities
- Creation and management of transport infrastructures
- Regulation of transport services (volume, fares)
- Development of information systems

The 150 OAs now in existence have important funding and operations at their disposal, and have boosted the development of many public transport networks.

New Public Transport Networks

In 1971, only Paris had a metro network consisting of 13 lines (the first opened in 1900), and the first section of the first regional (RER) line. No other French city had a metro; only three tram lines remained in Lille, Marseille and St. Etienne; all other public transport networks used buses or, in some cases, trolleybuses.

The situation in 1998 is significantly different both for metro and light rail networks. Six OA areas are served by a metro: Paris, Marseille, Lyon, Lille, Toulouse, and soon Rennes. Eight have developed a light rail transit (LRT) network: Nantes, Grenoble, Paris, Lille, Rouen, Strasbourg and soon Orleans and Montpellier. Caen has decided to build a rubber-tyred system. The different plans are outlined in this article.

New metro systems

- In the Paris region, metro Line 14, which is to be fully automated and unmanned, will be opened in September 1998, extending the network towards the suburbs. At the same time, four RERs have been completed, linking the centre of Paris with five new satellite towns. A fifth line is due to open in 1999. Three of the lines and half of one other are operated by French National Railways (SNCF); the other one and half of one line is operated by the Paris Transport Authority (RATP).
- Marseille has a two-line conventional metro network (18 km, with 25 stations).
- Lyon is served by four metro lines (two conventional, one rack-and-pinion, one fully automated, totalling 29.5 km with 44 stations). It is the second largest metro network after Paris. The fourth line, Line D, is a fully automated, unmanned, computer-controlled system.
- Lille has a metro network of two VAL (le Véhicule Automatique léger) lines (25 km, with 30 stations). It is the first implementation of the fully-automatic unmanned guideway or VAL system.
- Toulouse has only one VAL metro line in operation (10 km, with 15 stations) but the OA decided in March 1998 to build a second line.
- Rennes is building a VAL metro, due to enter operation in 2001.

New LRT systems

The new LRT systems are as follows:

- Nantes was the first city to adopt a new LRT system with two lines (18 km, with 53 stations) serving the metropolitan area. Currently, a tram-train project, using SNCF tracks on part of the line is under discussion (Fig. 1).
- Grenoble is served by two LRT lines (21 km, with 46 stations) and a new tram-train project is under discussion (Fig. 2).
- In the Paris region, two suburban LRT lines (Saint-Denis, Issy/La Défense) are operated by RATP (21 km, with 33 stations). Many projects are being studied, especially a suburban loop.
- Rouen and Strasbourg have a single LRT line each (Rouen: 16 km with 31 stations; Strasbourg: 10 km with 18 stations). Severe competition between VAL and LRT caused a politically difficult decision in Strasbourg, but the LRT was chosen as a method to remove the car from the city centre (pedestrian

zones and streets). The city has also decided to build a second LRT line.
- Three more cities have already decided to build LRT lines: Orleans, Bordeaux, and Montpellier, the latter using a new type of LRT system called CITADIS (18 km, with 28 stations).
- Lastly, Caen has decided to choose a new LRT (15 km) using a rubber-tyred wheeled vehicle called TVR. The rubber-tyred wheel is a specific French innovation already used in the Paris conventional and VAL metros, because it causes less vibration and noise, resulting in higher passenger comfort, and lower infrastructure costs.

Different Operators in France

In addition to SNCF, there are four main companies in charge of metros and LRT networks in France:
- RATP, a national company, operates the entire metro network in the Paris region, part of the RER network (along with SNCF), the two LRT lines, and most of the bus network.
- VIA-GTI in Lille, Lyon and Caen
- CGEA in Rouen
- Transdev in Toulouse, Grenoble and Strasbourg

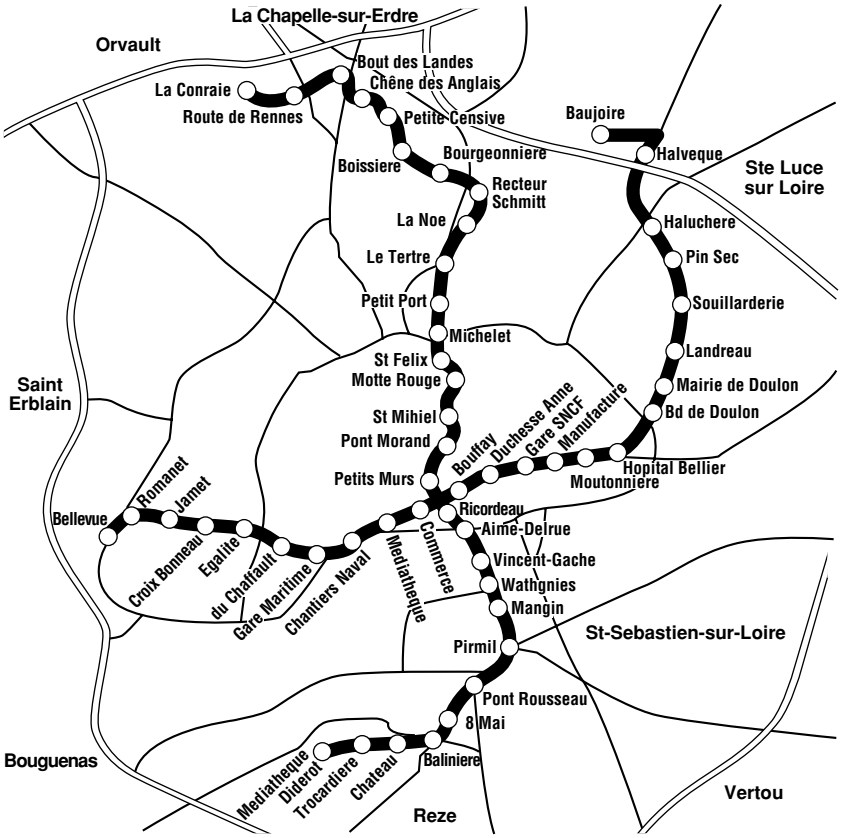
A small local company runs the Marseille network (metro and buses).

After a call for tenders, each OA contracts a concession with the selected company to operate the services for a specified time period. This organization ensures that the selected company can offer good expertise in metro, LRT, or bus operations.

New Technologies

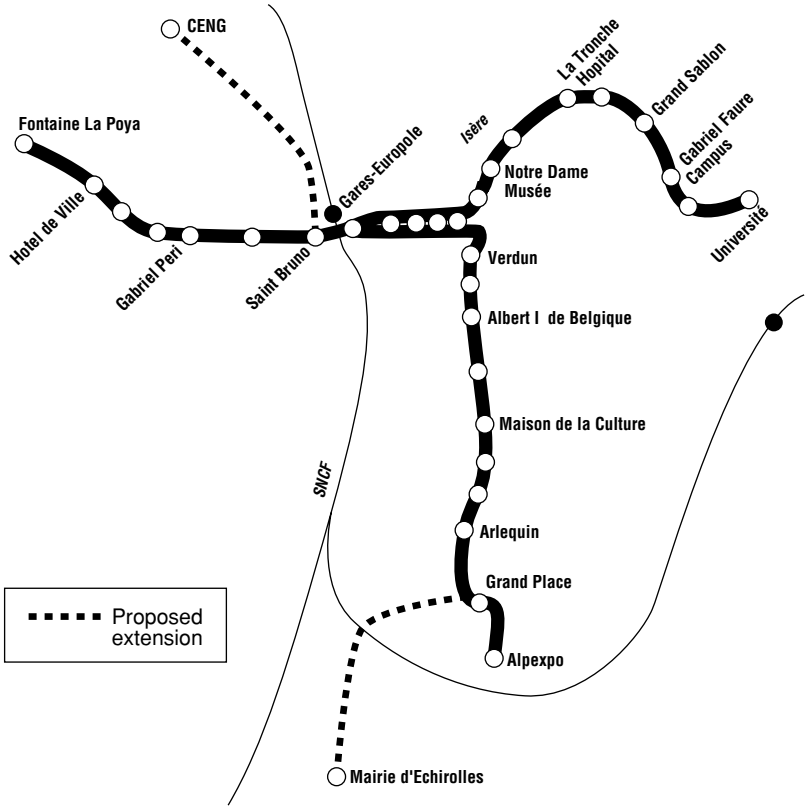
The growing market for mass transit systems in France coupled with the typically French behaviour of each local OA choosing a different system from its neighbour, has increased the technical variety of new

Figure 1 Nantes LRT System



CITADIS guided LRT system *(GEC-ALSTHOM)*

Figure 2 Grenoble LRT System



systems.

To clarify the differences, I will describe the specifications of the train control systems, and the new urban transport systems.

Train control systems

Since 1974, the following different automatic train control systems have been introduced:

- PA135 Autopilot
  This system is used to control 13 lines on the Paris metro. It monitors the presence and speed profile of trains in specified track blocks.
- SACEM
  In this train control system, the track equipment collects data on the presence of trains in blocks and the status of traffic movement. This information is transmitted continuously to the cab along with a route profile and safety envelope, and controls the train speed and power. It has been in operation since 1989 on the first RER line (Line A) in the Paris region. The safety relies on a single processor with specific data coding and processing, rather than on redundancy.
- Fully automated computer-controlled system
  This is based on fixed track blocks, or on moving blocks for Line D in Lyon, in which the train calculates the headway between its own position and the position of the ahead train and compares the headway with the braking distance based on the rolling stock characteristics. This permits better use of the infrastructure capacity, because the headway between the trains is always optimized.

New Urban Transport Systems

All new systems aim to improve the efficiency of the service offered to passengers and to reduce total costs (infrastructure and rolling stock investment cost, and operation costs). The main technical innovations have been applied to the conventional and VAL metro systems, and the new LRT systems.

VAL

VAL is a fully-automated unmanned transit system with rubber-tyred wheels, developed by Matra Transport International. Most of the platforms have access doors in addition to the car doors themselves. All information concerning the stations, trains, maintenance and storage depots is monitored from a central control room, so the controllers can react instantly to any incident. Passengers can speak with controllers over an intercom. It has been in use since 1983 on the Lille network, and was subsequently introduced on a line to Orly Airport near Paris, and on one line in Toulouse. Toulouse and Rennes have recently each decided to build a new line using VAL.

VAL is very safe and flexible—since 1983, there have been no injuries or fatalities and, for example, during the Lille September Festival, it operated for 44 hours nonstop.

One drawback is that its small gauge restricts its size (2.08-m wide and 3.28-m high). Although lowering infrastructure costs, the small gauge also limits capacity.

Fully automated conventional metro

This limitation of VAL is partly overcome by using longer trains, which were first used on Line D in Lyon, and which has two main innovations. The signalling system uses moving blocks instead of fixed blocks, and the platform doors have been replaced by an infra-red protection system, issuing an alarm if a passenger falls on the rails. It has been running since 1993 without an accident.

A second fully automated conventional metro is under construction by RATP in Paris. The first section of 7 km with 7 stations (METEOR Line) will open in September 1998. It is a fully automatic metro, with platform doors, using rubber-tyred 6-car trains. The 708 passengers can circulate freely between the different carriages.

Line D underground metro in Lyon *(SYTRAL)*

Light rail

In 1975, the French government decided to hold a competition to define a new standard French tramway system for smaller cities of less than 500,000 inhabitants.

In 1981, Nantes became the first to decide on construction of a new tramway line, partly re-using old railway infrastructure. The first section was opened in 1985 and has been a great success.

The early rolling stock, constructed by GEC-ALSTHOM, consists of 2.3-m wide articulated carriages consisting of two light chassis on three bogies. It can carry 168 passengers with 60 seated. The later 29.4-m long articulated carriages have low floors (340 mm over the rail) and a higher capacity (174 with 58 seated).

This first example was followed by Grenoble—its first line entered service in 1988, and the second line in 1990.

Different rolling stock

Paris (Saint-Denis North, Issy/La Défense), Lille, and Strasbourg soon followed suite. The Strasbourg rolling stock has very large windows and a panoramic driver's cab located at both ends. It is an articulated train, 33.3-m long, 2.40-m wide on four bogies, of which three are powered, carrying 230 with 66 seats. The floor is a single-level flat floor, 340 mm over the rail. This rolling stock is very popular.

However, building tramway lines has become more-and-more expensive, both due to the very small numbers of rolling stock and to the high cost of incorporating the system in the urban infrastructure (special pavements, landscaping, street remodelling, etc.,). The Strasbourg system (10 km) cost FFr194 million per km, including rolling stock (20 vehicles).

Tramway in Strasbourg *(CTS-Strasbourg)*

New R&D Programmes

In an attempt to lower the cost of an LRT line to FFr70 million per km (including rolling stock but excluding the cost of special urban incorporation), a number of R&D programmes (Table 1) have been developed within the framework of a government programme called Research and Development Program for Ground Transportation (PREDIT).

CITADIS

GEC-ALSTHOM has developed a new LRT system called CITADIS based on two main innovations: lighter bogies requiring shallower track beds, and a modular concept for carriages allowing more choices (number of cars and doors, types of windows).

TVR, Translohr, and CIVIS

Another programme consists of the so-called France Intermediate Transit System, an intermediate system between a bus and a guided LRT. All three types under development consist of articulated carriages on tyred axles with electric motors on wheels, but are guided in different ways. They are being tested on a 1.4-km track south of Paris, which is part of a bus route with curves and gradients. Each system will be tested in commercial service for 6 months along the whole bus route (12 km). This test will provide a first evaluation of the system in full operation with passengers.

The first system prototype known as TVR (Bombardier, ANF, SPIE Enertrans) is already being tested on this track. The guidance system clings mechanically to a central rail.

The second system to be tested will be the Translohr developed by Lohr Industries. The carriages, guided mechanically along a central rail, are available in different widths from 2.10 to 2.50 m, and different lengths (18 to 38.5 m) due to a modular concept with 3 or 5 axles. The floor is completely flat (340 mm over the rail) with a capacity ranging from 114 to 196.

The third system, named CIVIS, has been developed by Renault VI and Matra. The guidance is based on an image processing system following two painted lines on the road. Very wide tyres from Michelin spread the load on the road. Axle electric motors, developed by GEC-ALSTHOM, permit a wider corridor over the rear or intermediate drive train. The length can be from 12 to 24 m offering a

LRT on tyres (TVR), running on RATP network near Paris *(RATP-Audiovisuel)*

Translohr car *(LOHR Industrie)*

CIVIS system *(Matra Transport International)*

capacity of 70 to 150. All systems have a flat floor, for easy access.

Another system, in operation since late 1997 between Sarreguemines in France and Saarbrücken in Germany, is a tram-train using normal railway tracks and specific tramway rails. Other different projects are under consideration in Nantes, Grenoble and the Paris region.

Conclusion

The French transport industry is successfully developing a large range of different urban transport systems taking into account the different demands. These various systems:

- Offer better services for citizens with better accessibility, more room and comfort, less noise, and more information
- More friendly integration into metropolitan areas
- Reduced investment costs both for construction of infrastructure and for operation during the total life cycle.

The French and world markets will choose between the different systems based on the urban environment and transport policy.

The challenge is immense, but I am sure that French industry will succeed in developing its share of this global market. ■

Tram-train between Sarreguemines and Saarbrücken *(ANF-Industrie, Bombardier Eurorail)*

Table 1 Specifications of New Systems

	TVR	Translohr	CIVIS		CITADIS (TGA 202)	Tram-Train
Power	Electric	Electric	Electric	GNV	Electric	Electric
Length	24.50 m (3 cars)	24.50 m (3 cars)	19.50 m	18 m	22 m	37 m (3 cars)
Width	2.5 m	21 to 2.5 m	2.55 m		2.20 to 2.60 m	2.65 m
Height	3.22 m	2.6 to 3.1 m	3.22 m		3.20 m	3.5 m
Capacity (4 passengers/m^2)						
Total	150	96 to 146	140	115	137	240
Seated	50	36 to 46	35	32	50	108
Empty weight	25 te	17.7 to 22.3 te	19 te	18.4 te		53.8 te
Guidance	4 rubber tyred axles each axle	4 rubber tyred axles each axle	4 rubber tyred axles		Tram bogies	4 railway bogies
Max. speed	70 km/h	70 to 75 km/h	70 km/h			100 km/h
Gradient	13%	13%	13%			8%
Min. curve	12 m	12.5 m	12 m		15 m	25 m
Rail	Sunk into road	Sunk into road	No rail, image processing		Two tram rails	Normal rail
Track thickness	0.55 m	0.55 m				—
Underground utilities	No effect	No effect	No effect			—

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