# CHAPTER 7: EUROPEAN JOINT USE EXPERIENCE

## 7.1 OVERVIEW

While North America pioneered joint rail use by a variety of carriers as described earlier (Chapter 1 - "historical precedents"), the newest and most innovative forms of joint use are found overseas. European and Pacific Rim joint track use practices are specialized and different enough to warrant separate research and treatment in this research. Emphasis has been placed in understanding fully the nature and detail of selected joint use operations. All known contemporary western European joint use situations are inventoried, but only three European case studies (Karlsruhe, Saarbrücken, and Luxembourg) are described in detail and another eighteen are briefly profiled. In the Pacific Rim, 170 rail operators were inventoried. Six case studies were selected and surveyed for description. Other notable joint use examples in the Orient are briefly profiled.

In both Europe and the Orient, joint use is accompanied by major reforms in the organization of railroad institutions and public transportation systems. These major changes permeate every sector, mode and jurisdiction of these transport enterprises. Understanding these reforms is essential to comprehending how joint use is achieved *and applied* in a variety of operating environments.

## 7.2 EUROPEAN JOINT USE EXPERIENCE

Three European joint use rail transit case studies (Karlsruhe, Saarbrücken and Luxembourg) are highlighted because each is unique, though each also imparts similar lessons in shared track experience. These three joint use operations also represent three basic stages in the evolution of a shared track arrangement. These stages are currently:

1. **Planning/preparation** (overcoming obstacles and reaching agreement) - *Luxembourg*
2. **Beginning joint use** (initial shared track operations) - *Saarbrücken*
3. **Expanding/Refining Matured shared operations** (Full integration, expansion, and diverse operations) - *Karlsruhe*

The purpose in presenting overseas joint use experience on two continents is not to dwell on their operating and physical characteristics. These have been described in the trade press, in the case of Karlsruhe, very extensively. Far less is known about Pacific Rim experience, therefore more detail has been allocated to the Oriental System case studies. To the extent that physical plant and operations reveal the nature of joint use, they are described here. What is less known about these three highlighted case studies is the way they confronted planning, institutional, and regulatory obstacles to joint use. *These issues in Europe and the Pacific Rim are the very same types as those being cited in North America as preventing joint use of tracks by railroads and rail transit.*

Joint use literature research focused on the *Karlsruhe,* Germany and *Saarbrücken,* Germany (with short segment in France). A number of a Study Team participated in the planning and design of both of these operations to assist the two transit operators in developing joint use facilities and services. The literature search also investigated German Railway Ministry and Railway Association documents on shared tracks. Additionally, the team contacted the Consul General of Luxembourg to obtain information on the newest proposed joint use operation, to be centered in the metropolitan area around the City of *Luxembourg.*

Lesser-known, smaller-scale but important examples of joint use in France, the Benelux, Switzerland, and Germany are included where they demonstrate additional diversity in the nature and variety of joint use facilities and practices. Eighteen of these *"Other Examples"* are presented at the conclusion of this chapter. These profiles are organized as short, one-paragraph descriptions, in the event that independent researchers wish to focus on joint use in particular geographical areas.

Finally, planning is advancing in 21 additional metropolitan areas for "regionalization" of rail passenger operations. The regionalization process confronts issues of shared facilities, joint use of tracks, and reciprocal running practices accompanied by institutional reform. These 21 areas planning joint use are listed without detailed information. In this manner, all current western Europe and Pacific Rim shared track operations are at least inventoried.

The three European joint use case studies, Karlsruhe, Saarbrücken, and Luxembourg are uniformly structured with "Overview," "System Evolution" and "System Description." Lessons learned from these are treated largely in Chapter 9, Findings and Conclusions. The three case studies exemplify how urban areas achieve new or expanded rail transit using shared track concepts.

Before addressing case studies, a general overview is presented from translated document research.

#### 7.2.1 Joint Use Beginnings in Germany

In Germany, to make public rail transport more attractive, methods were explored to expand coverage, preserve and improve service, and reduce costs. Joint operation systems have arisen as a new strategy on the basis of these objectives. Some joint use operations on small scales pre-existed. Joint use, dual-gauge track, and dualvoltage equipment (18.8kv AC, $25H_3$/650Vac and 550 Vdc) date back almost 90 years at Karlsruhe! Early efforts to achieve larger-scale joint use were based on electrification of railroad branch lines with a light rail system line voltage. (The LRT routes and vehicles were correspondingly adapted to railroad infrastructure in the cities of Cologne and Karlsruhe). Later, dual voltage railcars were designed that could operate both on the electrified routes at the German Rail line (DBAG) high voltage and on transit low voltage light rail routes. The Karlsruhe experience is instructive. Being the earliest joint use application, it demonstrates the most complete and varied evolution of joint use practice. Meanwhile, the town of Zwickau has planned to operate light-weight short-distance diesel railcars (Category 2 DMUs) into the towns on LRT tracks. Düren is the most notable pioneer in using these light rail derivative DMUs in joint operation on shared track.

The infrastructure of the joint use dual mode system is subject to separate (from railroad) BOStrab regulations, and if necessary with corresponding waivers and exceptional regulations. Moreover, the dual system vehicles must fulfill the regulations of both railroad (EBO) and rail transit (BOStrab) systems, if necessary with "exceptional permissions" (waivers), and they shall be accepted by both railroad and rail transit operators.

#### 7.2.2 Shared Track Legal Bases

In principle, two different legal bases apply to the construction and operation of rail transport systems in Germany: *the German Federal Regulations governing the Construction and Operation of Railways (EBO) for the railroads and the German Federal Regulations on the Construction and Operation of Light Rail Transit Systems (BOStrab) for the tramways–which also include the metros and the light rail systems, but not railroad derivative regional rail transit systems ("S-Bahn").*

Several organizations figure prominently with the means of dealing with shared track issues. Regulations are promulgated by the German Federal Ministry of Transport. UITP (International Union of Public Transport) covers research and operating issues. VDV (Association of German Transport Undertakings), is a transit trade group, roughly comparable to APTA in North America).

As the regulations on two major vehicle types are very different, special regulations were established for the joint operation, the so-called Regulations on Light-Weight Short-Distance Railcars. This covers rail buses, or "Schienenbusse;" light DMUs; and LRVs in dual mode service.

#### 7.2.3 Evolution of German Railway Research and Regulations for Joint Use

What is referred to as the "*The Basic Study*" is the pioneering Study of the Use of Light Railway Vehicles (LRV) in Mixed Service with Vehicles [Complying with Regulations for Railway Vehicles by German Ministry of Railways] published in November, 1993. This landmark study built on the early progress made in Karlsruhe with the Albtalbahn and Hardtbahn railroad and light rail systems integration, the early Pforzheim demonstration of prototype dual voltage LRVs, and the shared track Bretten service initiative in 1992. All of these initiatives were in the Karlsruhe area. It laid the foundation for subsequent LRT joint use applications in Karlsruhe and Cologne, and ushered in the first LRT derivative DMU joint use on the Dürener Kreisbahn using RegioSprinters in 1995-96.

Because not enough data on accident occurrences on specific routes was available, the Basic Study used "typical" cases (or general accident data). In researching available accident data, the research study team found a similar dearth of data in the U.S. as explained in Chapter 6. This condition in Germany caused the Ministry of Railways to contract for a detailed Risk Analysis Study, which was completed in February of 1995. This pioneering analysis was called Expert Opinion on the Use of Light-Weight, Short-Distance Rail Cars in Joint Operation with EBO [Standard Railway] Vehicles on Public Transport Railway Lines, 2/95, German Ministry of Railways. This is referred to by its short title as the "*Supplementary Report.*" Note the initial use of "expert opinion" as a surrogate for extensive accident data, which had improved in quality since 1993 but was still considered insufficient. It was intended at that time that a nationwide risk study would avoid having to do "expensive individual studies." The study later acknowledged that the (national standard) safety measures are not fully justified in every individual case, and "there was a possibility of deviating from the national requirements which could be narrowly linked to the specific individual investigations." Localized risk analysis *is* therefore, important, though potentially costly to perform. It is important to note that Germany, in addressing joint use through risk analysis, refined its database and established a national risk assessment using specific case studies, but applied its findings to develop national policy for regulating joint use. This nationally based policy framework may be used *in* *combination* with locally performed risk assessments.

These are near direct quotes from these translated documents, and show an increasing government and operator acceptance of joint use and means for dealing with risk. Accompanying the analysis and production of these two landmark studies was a constant outreach to the experts in the railroad, rail transit, and regulatory sectors. This parallels FRA's approach in developing a cooperative process with AAR and APTA in drafting proposed rule making.

Most encouraging is the fact that the German approach to risk analysis used relatively conventional methodology, and does not depart from the basic techniques used in the FRA-sponsored FOX and NEC risk analyses!

In this research there has been an attempt to combine the German "Basic Study" and the expert opinion risk analysis or "Supplementary Report" into a single research summary, plus some additional background. This was extremely ambitious, starting as this research did from a common point in time, equivalent to 1988 (AVB integration in Karlsruhe). Additional research and detailing is required following the more recent German precedents in operating experience and risk analysis, and a more rigorous domestic peer panel review of the full range of German documents used in evolving their policy on joint use. What follows in Chapter 7 is the most comprehensive and, of necessity, the briefest summary of the material collected for this research. It still does not fully represent the mass of untranslated and unpublished documentation that has not received exposure outside of Germany.

Appendix M contains a summary of conditions and exceptions for operating LRVs with standard railroad vehicles. Accompanying tables (Appendix N) summarize the German Risk Analysis method and results.

The six risk tables in Appendix N are offered to demonstrate methodology in German Ministry of Railway's Risk Analysis. The data and results, while interesting, are unlikely to be directly transferable to North American practice. The approach, however (using North America's data), can be applied. These tables are drawn from the "Basic Study" and "Supplementary Report," which are the foundations of German policy on mixed use and dictate the conditions under which shared track between rail transit and railroads is allowed.

#### 7.2.4 Shared Track Train Protection Systems and Communication Technology

German regulations specify that rail vehicles shall be provided with the train protection systems required for all joint use routes. In Germany separation and intermittent train protection (INDUSI: automatic train stopping device) is usually applied to railroads. Continuous monitoring on high-speed routes is achieved with the continuous inductive ATC system. At present, however, no (LRT) vehicles for joint operation are equipped with this latter monitoring system.

Most often, systems derived from INDUSI, e.g., wayside signal control, are applied in the BOStrab networks if they have track separated from other (road) traffic. If the tramways mix in the traffic, then wayside control is not prescribed and sight distance rules prevail.

The German Ministry further requires that train protection systems be compatible with the brake technology of the vehicles, i.e., the distances between the signals and the braking distances shall be compatible. Air whistles, licensed operators, and centralized dispatching tram control are additional EBO requirements applied to joint use LRVs.

Note especially that the train protection system gains special importance with joint use operation due to the Regulations on Light-Weight Short-Distance Railcars, which prescribe train protection on routes with joint operation. *The degree of protection depends on the maximum speeds, as well as the characteristics, consist, performance, and number of trains.*

#### 7.2.5 Physical Construction Restrictions

As BOStrab (tram) rail systems are usually designed for operation within close-clearance areas, radii below 25 m (82') can very well occur. Apart from a few sidings which cannot be negotiated by all vehicles, EBO (railroad) revenue routes are aligned for minimum radii of at least 140 m (460'). While not a problem for LRVs transitioning from light rail to railroad track, street trackage geometry is a problem for DMU (Category 2) transitioning from railroad to streetcar environments.

Because of the narrower vehicle width (clearance gauge) according to BOStrab, EBO (railroad) vehicles would have considerable difficulty operating on infrastructure constructed in accordance with BOStrab. On the other hand, the clearance gauge of BOStrab vehicles guarantee that these vehicles would not foul fixed wayside obstacles in the EBO System. A first-generation dual voltage Karlsruhe LRV toured Swiss and German cities' branch line railroads, demonstrating the ability of LRV's to adapt to a variety of larger-dimension railroad environments. It is claimed that the first test LRV was delivered from Dusseldorf to Karlsruhe on its own wheels, towed by a DBAG locomotive!

Due to the different clearance requirements of the vehicles, the design of the platforms requires careful attention. Special solutions are applied. Level boarding access is typically sought in order also to guarantee wheelchair users and people with "prams" easy access. However, this is not always possible. (ADA German style is to make an earnest effort at level boarding combined with operator/staff assistance.)

The platform heights in the railway section create additional problems because of the tendency to design the floor heights in the new light rail vehicles much lower than the floor heights of older vehicles in order to be able to realize level boarding and alighting from street and curb surfaces.

The following alternatives have been applied to avoid the problems with the different clearances:

- Setting of the tramway tracks (gauntlets) as in Kassel (Appendix J)
- Use of particularly low platforms as in Kassel (Appendix J)
- Use of folding or sliding steps that bridge the gap between the vehicle and the platform according to EBO, as in Karlsruhe and Saarbrücken
- Use of vehicles with EBO (railroad) profile in the inner city street tracks as planned in Zwickau (disadvantage: larger track and car dimensions in the inner city, requires exceptional permission)

#### 7.2.6 Joint Use Considerations for Workshops/Maintenance

Maintenance facility design depends strongly on the requirements of the vehicles it services. Principally, vehicles constructed in accordance with EBO and vehicles constructed in accordance with BOStrab can use the same workshop, subject to some dimensional and labor limitations. Railroad equipment is primarily located beneath or within the carbody. Streetcar equipment location, on the other hand, varies. Low floor cars place equipment on the roof or within a power module. High floor LRV/DMU tend to have equipment placed predominantly below the carbody. In order to be able to take advantage of one facility for railroad and LRV cars, a determination is needed of the types of maintenance work to be performed, and where. Allowances must be made for the different temporal and physical vehicle maintenance cycles.

#### 7.2.7 Vehicle

The vehicles have very different designs, depending on their EBO or BOStrab derivation. Table 7-1 summarizes the performance and dimensional contrasts between German railroad (EBO) and LRT (BOStrab) rolling stock, as overseen by the Railway Ministry.

A higher degree of risk is assumed for (light) railway vehicles because they might collide with relatively heavy locomotives during joint operations. Locomotive braking deceleration and response time characteristics require a relatively long braking distance. Therefore, a higher static frame test force must be sustained by DMUs and LRVs in joint service.

Most commonly, light rail vehicles in accordance with BOStrab only share track with vehicles of the same kind. Because of the mix with urban vehicular and pedestrian traffic, these vehicles are equipped with high braking deceleration and multiple/redundant braking systems. BOStrab vehicles are also much lighter (and consists are smaller), which means that collision energies remain low.

**Table 7-1**
**German Railroad and Light Rail Vehicle Requirements**

| EBO (RR) | BOStrab (LRT) |
|---|---|
| 1500 kN (337,000 lbs.) static frame rigidity for railcars according to EN 12633 | 600 kN (135,000 lbs.) dynamic rigidity |
| Width according to EBO Appendix 8; Varies depending on the vehicle length - but considerably wider | 2.65 m. (8.7′) maximum vehicle width |
| Braking distance maximum 400 m. (1,312′) for secondary railways | Braking distance from 70 km/h: (43 mph) 69 m. (226′) |
| Maximum speed for secondary railways; 100 km/h (62 mph) | Maximum speed is determined by the supervisory authority, but is usually ≤100 km/h (62 mph) |
| Tread profile according to EBO | Tread profile not prescribed, but usually narrower than EBO; The wheel flange is narrower and relief - turned due to a narrower flange groove in the paved track |

**Wheel Tread Profile:**

In Germany, if use is made of existing railroad lines by rail transit, the design of the crossings and the switches as well as the width of the flange groove or flangeway are decisive for the selection of the wheel tread profile. In the case of *new* construction, as in Saarbrücken, the Association of German Transport Undertakings - VDV (Public Transport and Railways) recommends application of the EBO profile. The disadvantage of these wider flangeways is in street trackage where they cause pedestrians to "stumble and create bicycle wheel traps." Accordingly, the wider grooves are often not commonly accepted by the town or city citizens and officials. Luxembourg, therefore, is going to use narrow flange grooves despite a new network. Saarbahn, though, picked EBO rail profiles.

The problem is one of different wheel tread geometry, according to EBO and BOStrab specifications. In the street sections of BOStrab routes, use is made of tram grooved or girder rails with a flangeway groove which is narrower than that for EBO railways in order to reduce the hindrance to cyclists and pedestrians. This is similar to wheel tread profile differences between railroad rail and tram rail in North America. DBAG and rail transit technicians developed compromise tread profiles. Different designs were also chosen for diamond crossings and switches. At crossings and switches of the BOStrab rail systems, the wheels run on the wheel flange surface in the crossing area to reduce pounding on the diamonds. These are known domestically as "flange beam wheels." This requires relatively shallow flangeways at diamonds. At the switches of EBO railways, the wheels are guided to the opposite side by guard rails. Therefore, the design of the back of these wheel flanges is very aggressive. The BOStrab vehicles would derail in EBO crossings due to the usual relief-turnings of the wheel flange and the flat guard rails. See wheel profile diagrams - Figure 7-1.

Tread profile contrasts between railroad and streetcar exist in the U.S. Some joint use systems select railroad tread profiles. Others select streetcar profiles for reasons stated above. Calgary and Edmonton, for example, do not interchange with railroads, yet one uses streetcar wheels and the other uses railroad wheels, thereby prohibiting easy exchange of otherwise identical LRVs for purposes of testing special equipment (such as AC motors).

Solutions for existing and planned routes for joint operation on five separate metropolitan areas summarize how cooperative local judgments are made to accomplish joint use, on just one issue - wheel tread and flange profile. The remedies vary because of local decision-making responding to a variety of circumstances. All of these decisions are made within the common framework of federal EBO and BOStrab regulations.

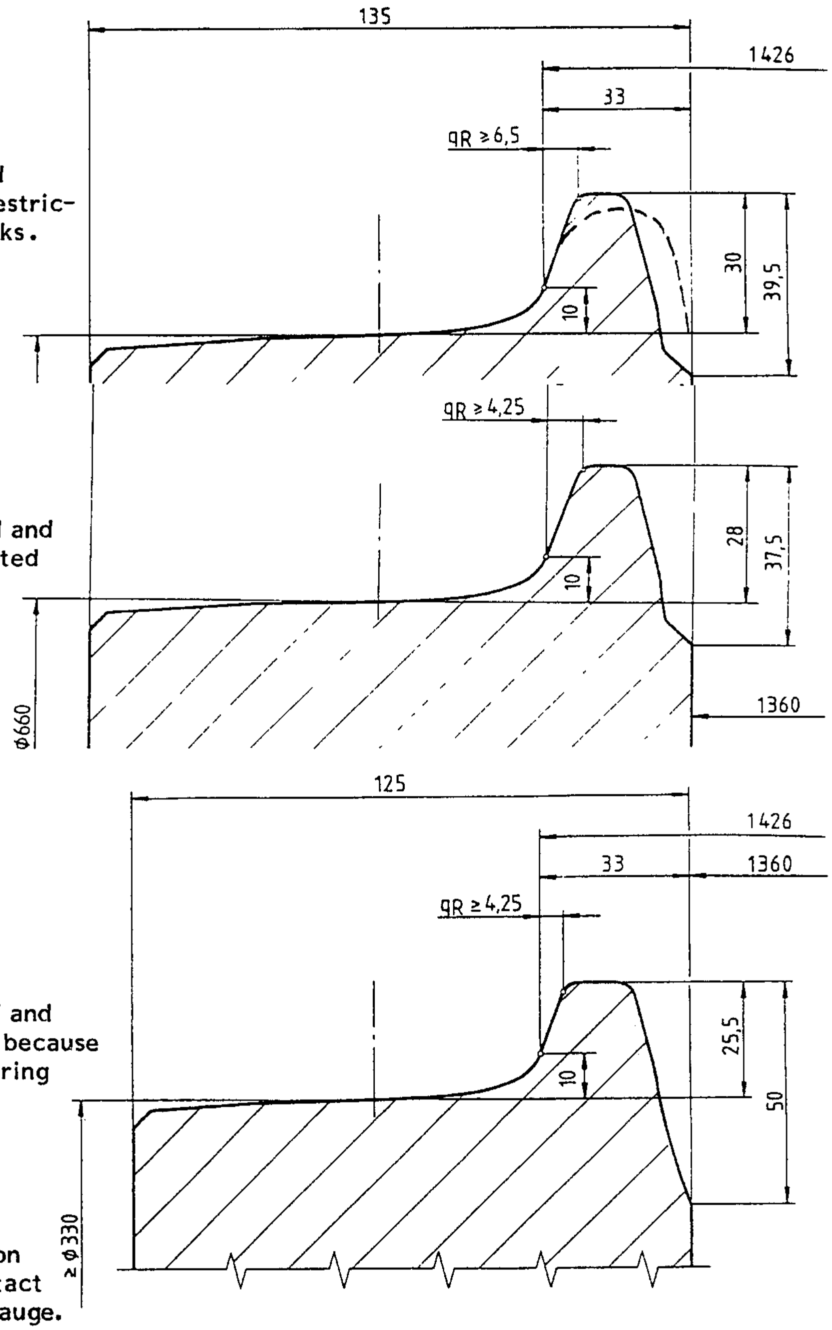
- Karlsruhe: Dual mode light rail vehicles with special compromise wheel tread profile were designed. The vehicles can only operate on the EBO network conditionally, as high guard rails are required.

- Saarbrücken: Dual mode light rail vehicles are equipped with EBO (railroad) tread profile. In principle, these vehicles can operate on the complete EBO network. In the inner city there are special grooves - at locations where the tracks have facing point switches.

- Cologne: Light rail vehicles operate on EBO routes using light rail tread profile. All the switches of the EBO routes are provided with movable crossing points suited for driving on shorter railway sections. The vehicles may not leave the sections equipped with movable crossing points and therefore they cannot freely operate in the universal EBO railroad network. A risk analysis was performed for this limited joint use system.

- Kassel: Light rail vehicles are operated on EBO (railroad) routes and use gauntlets at some stations (Appendix J). The routes have been specially equipped, and freight train densities are modest.

# Wheel Tread and Flange Profiles - Figure 7-1




Compromise wheel tread profile for LRVs for unrestricted use of railroad networks.

Compromise wheel tread and flange profile for restricted use of railroad networks by LRVs.

Compromise wheel tread and flange for restricted use because of raised guard rail requiring reduced cross section.

Note: 1426 mm. dimension is between points of contact in 1435 mm. (standard) gauge. 1360 mm. dimension is between the inside wheel surfaces across the gauge. Dotted line denotes approximate flange profile for conventional railroad wheels.

- Zwickau (planned): Diesel railcars, which (according to the Regulations on Light-Weight Short-Distance Railcars) are really only designed for EBO operation (width 2,970 mm; tread profile according to EBO), are being additionally equipped with bell and direction indicators so that they can also operate into the CBD on tram tracks in streets. The vehicles can operate freely in the EBO network. The only other unique problems with existing BOStrab networks contemplating DMUs is the large width of those vehicles. Zwickau is pioneering in the use of DMUs on in-street tram track and infrastructure. Like Düren and Cologne, risk analysis was performed on the DMU proposal for Zwickau.

**Frame Rigidity:**

The UIC Regulations (the European EU standards correspond to the UIC Regulations) require static tests of the frame rigidity at a test force of 1,500 kN (kips neutons) (337,000 lbs.) for railcars (see also the draft standard EN 12633). Only 200 kN (45,000 lbs.) are required for trams and 600 kN (135,000 lbs.) for light rail vehicles. Recent research has shown that the test forces can be reduced and the same degree of safety maintained if use is made of energy absorbing elements such as crush zones. Note that kN are converted to kips or thousands of pounds by multiplying kN by a factor of .2248 (see Table 7-1 and Figure 9-1).

**Power Supply:**

If electrical vehicles are to be operated on railroad and LRT traction voltages, the cars are provided with the equipment to operate on the dual line voltages encountered. As this dual voltage equipment usually weighs more, costs more, and takes up more space on board, the application of several line voltages should be avoided for new systems to be built, if at all possible. This is a condition unlikely to exist in North America, where de-electrification of rural and suburban railroads (with a few exceptions) permits less costly single voltage LRVs, but more costly electrification of railroad track - unless dual power (diesel-electric) DMUs are used.

#### 7.2.8 Joint Operation

The operating staff are required to fulfill all the requirements made by all the network operators to the joint operation. The staff are required to be trained and qualified for all routes (and under BOStrab and ECO requirements).

Joint use on the regional railways (the first being Düren) using DMU (Category 2 such as RegioSprinters) was subjected to a risk analysis by the German Railway Ministry prior to approval ("The Supplemental Report"). This analysis disclosed a low level of risk for the three lines (two in Cheminitz and one in Düren) and determined what mitigation measures would be applied to further diminish risk. These findings are discussed in Chapter 6 (Risk Assessment) and form one of the bases for applying risk analysis methodology to similar circumstances in North America.

As a rule, basic interval timetables have been prepared for routes with joint operation. The staff and vehicle services are to be optimized by the planning of the timetable. Note that operating discipline is treated as a quality control issue!

A test of LRV equipment was performed on a selected railroad branch (Karlsruhe to Pforzheim) and in revenue passenger service, prior to permanent service. Three major advantages emerged: DBAG was able to increase service by 30% with lower operating cost, passengers embraced the LRT service in preference to predecessor buses and trains, and VKB was able to test and refine vehicle design prior to starting revenue service on the first dual service route to Bretten. The test experience also overcame railroad officials' suspicions and concerns over shared track.

#### 7.2.9 Development of the Passenger Demand Resulting from Joint Use Services

Increases in passenger loads have consistently been demonstrated with establishing of joint operation and related increasing of rail transit in Germany. Research in the development of the demand for the shared track systems introduced in Germany reveal these patronage increases. Karlsruhe has increased ridership on the shared track routes by a factor of four over prior railroad operated regional bahn service. Forty percent of S bahn joint use riders came from autos. Nineteen percent of tram riders came from autos. Only three percent of bus riders switched from auto (Ludwig). *This demonstrates the dramatic effect joint use rail transit had on diversion from autos, in comparison with other rail passenger and transit modes.*

The three system-detailed joint use profiles follow:

## 7.3 KARLSRUHE "VERKEHRSBETRIEBE KARLSRUHE" (VBK)

Because Karlsruhe joint use is already known to rail transit practitioners, this investigation will not dwell in detail on its joint use operation. Because it is changing rapidly, VBK's most recent progress (last 5-7 years) is emphasized. Karlsruhe is highlighted for four important reasons:

- Karlsruhe is a pioneer in overcoming all the institutional and regulatory barriers to various types of joint use. Its experience provides useful lessons for potential application in North America, not so much in the specifics of how it was done, but more in the spirit of the achievement.

- Contrary to popular notion, Karlsruhe is not an instant success story. Earliest joint use existed prior to 1900. Its current joint use experience evolved over 25 years of effort to deal with technical skepticism, suspicion, mistrust, and other obstacles to shared track use by various rail carriers and jurisdictions. Having the most lengthy experience puts Karlsruhe ahead of other joint use practitioners in a variety of joint use applications. An average of one new route annually over the last decade has been added to the LRT system (most, however, overlay and expand declining railroad services).

- Karlsruhe represents several different methods of integrating light rail transit and railroads, all in the same metropolitan region. Each of its joint use services are unique and uniquely created. Several types of joint use LRVs have therefore evolved, building on the favorable experience of predecessor joint use routes.

- Being the first of contemporary joint use applications, Karlsruhe demonstrates joint use in evolution and the benefits and pitfalls of joint use policies.

These four reasons form the structure of the analysis of Karlsruhe.

#### 7.3.1 Karlsruhe Overview

Karlsruhe is an industrial and government city in south central Germany. It is a city of 275,000, a population comparable in size to Norfolk, VA (which has been in quest of light rail to Virginia Beach for over a decade). Its metropolitan area served by transit has a population of over 550,000. As a major manufacturing center, Karlsruhe was heavily damaged during World War II and rebuilt retaining its baroque diagonal/radial street pattern, which causes vexing traffic conditions and capacity constraints on downtown streets for the S Bahn routes that traverse them.

Growth in Karlsruhe's suburbs was accompanied by loss of population in the city center. VBK (Stadtwerke Karlsruhe Verkehrsbetriebe) is the local tram, regional LRT, interurban, and bus operator. It also operates freight trains in joint services on a former interurban line that it absorbed. The shift in population outward motivated LRT extensions by VBK, first on city streets and later on railroad tracks.

#### 7.3.2 VBK System Evolution

The Karlsruhe's current dual mode rail system evolved over 25 years. In its first stage of growth, VBK employed the conventional technique of expanding the tram system outward by conventional tram new construction. Rapid growth and new development surrounding Karlsruhe outstripped the ability and finances of VBK to continue to build new tram or stadtbahn (city/regional rail transit) lines into the outer suburbs. Other less costly and more rapidly implementable alternatives, such as joint use, were explored. This set in motion a strategy which may not have been entirely apparent at its beginning, even to its originators. This strategy evolved into eight fairly distinct phases [note system map, Figures 7-2 and 7-3, for examples] as follows:

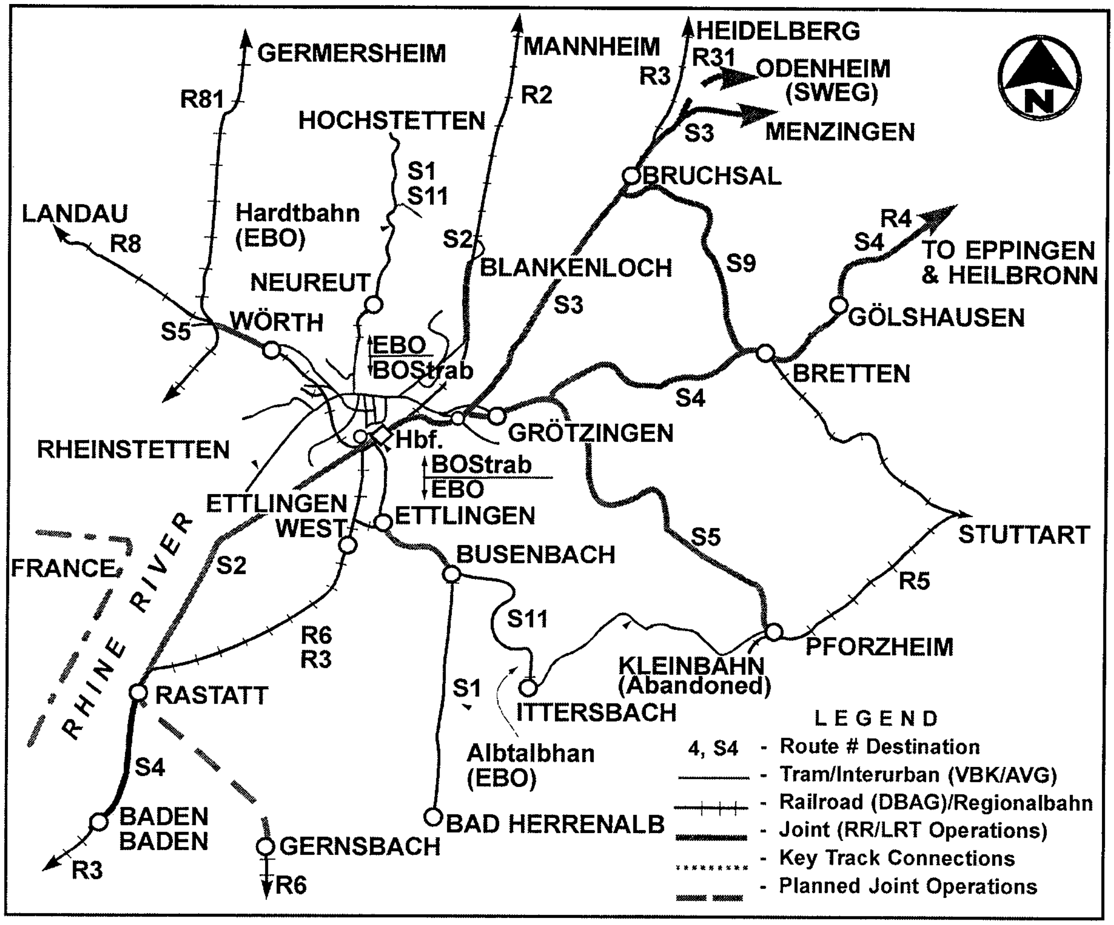
1. **Modernize and expand** existing VBG tram system by conventional new track construction into new areas consistent with Karlsruhe's metropolitan growth plan, population shifts, and BOStrab (federal streetcar regulations). [Example: Tram Line #2]

2. **Absorb and upgrade (to standard gauge) existing rail transit** radial electric interurban lines that terminated inside the CBD (Albtalbahn AVG) in 1957. The takeover included AVG's modest freight operation, which had a tradition of practicing joint use. This change was accomplished under BOStrab and later with DB's Hardtbahn, EBO (federal rail regulations). [Example: Interurban Line S-1, formerly Line A to Bad Hernalb]

3. **Integrate** modernized and regauged rail transit interurban AVG and streetcar (VBG) holdings properties within a single operating entity - VBG, providing a one-seat ride between suburbs and within the CBD. (AVG remains corporately distinct, but is operationally and physically integrated). AVG trains and motormen operate under BOStrab (tram) regulations on train track and under EBO regulations on the suburban-interurban tracks. [Example: Interurban, now Stadtbahn Lines S-1, S-11 extended beyond Albtalbahnhof station to CBD]

4. **Initiate limited (2km) rail transit/railroad co-mingled** LRT operation on a low density DBAG freight service only (Hardtbahn) branch line by purchasing and developing operating agreements with railroad management to improve and electrify a freight branch (1979-1989). DBAG continues modest freight service mixed with LRVs service integrated with AVG interurban. [Example: Extension to Hochstetten, Stadtbahn Lines S-1, S-11]

# Karlsruhe Regional (1998) - Figure 7-2




## KARLSRUHE REGIONAL (1998)

NOT TO SCALE

### KARLSRUHE STADTBAHN REGIONAL LRT SYSTEM

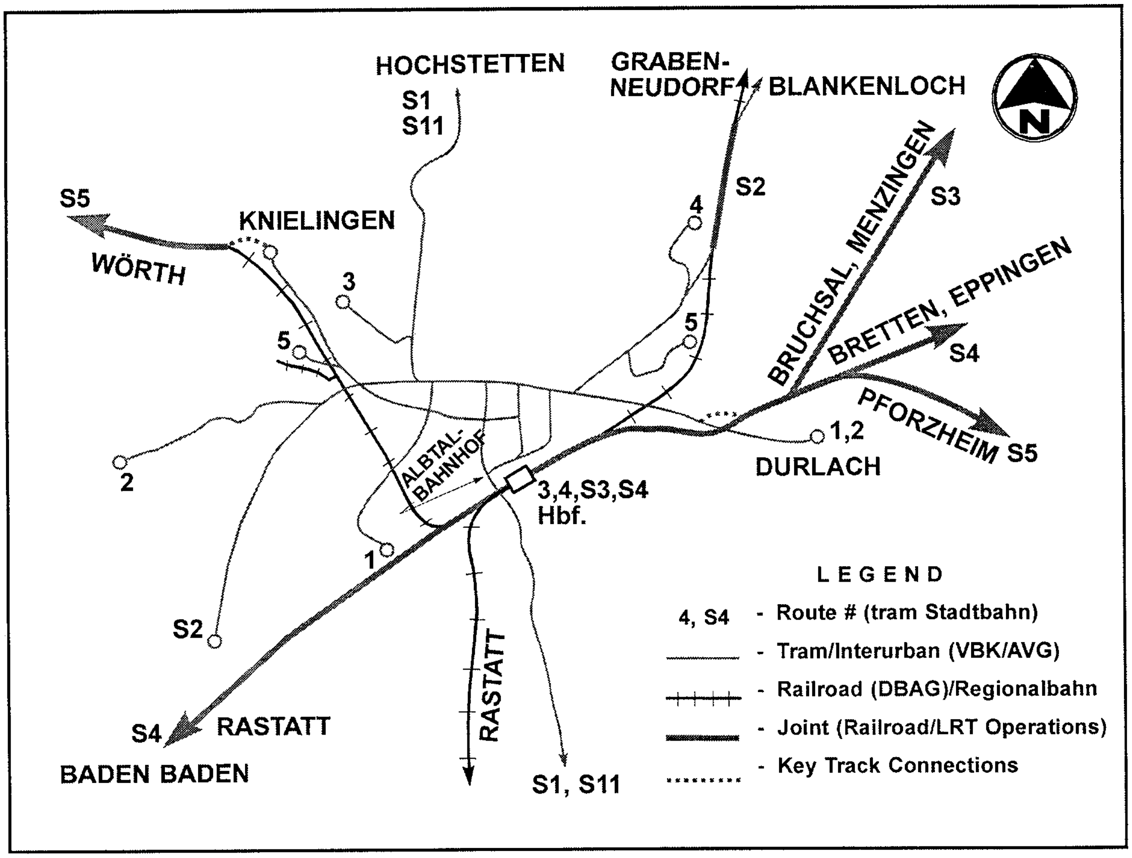
| RT.# | (OPERATOR) | DATE | TERMINAL | OUTER TERMINAL |
|---|---|---|---|---|
| S-1/A | (AVG) | '57-'61 | Hochstetten | Bad Herrenalb |
| S-11/A | (AVG) | '75-'89 | Hochstetten | Ittersbach |
| *S-2 | - | '97 | Rheinstetten | Blankenloch |
| *S-3 | - | '94'97' | Hbf. | Bruchsal/Menzingen |
| *S-4/B | (DBAG)) | '92/'97 | Hbf. | Bretten/Eppingen |
| *S-4 | (DBAG) | '94 | CBD | Baden Baden |
| *S-5 | (VBK) | '94-'96 | CBD | Pforzheim |
| *S-5 | (VBK) | '94-'96 | CBD | Wörth |
| *S-9 | (VBK) | '94 | Bruchsal | Gölshausen |

* = Joint Use Railroad/LRT

NOTES:

- Tram Routes VBK 1,2,3,4,5 shown on local detail.
- Stadtbahn (VKB/AVG) LRT Routes S1, S2, S5 and S11 use VBK tram track through the CBD. Routes S3 and S4, use DBAG railroad tracks through the main station (Hbf.) (1998)
- Regionalbathn DMU Routes - designated "R" are 11 DBAG routes that extend beyond and overlàp the Stadtbahn routes.
- Intercity, DBAG routes not designated but overlay this system.
- Expansion to Heilbronn, Odenheim, Graben-Neudorf and Zennsbach.
- Through routing and rerouting are proposed.

## Karlsruhe Local Detail (1998) - Figure 7-3




# KARLSRUHE REGIONAL (1998)

**NOT TO SCALE**

**KARLSRUHE STADTBAHN REGIONAL LRT SYSTEM**

| RT.# | (OPERATOR) | DATE | TERMINAL | OUTER TERMINAL |
|---|---|---|---|---|
| S-1/A | (AVG) | '57-'61 | Hochstetten | Bad Herrenalb |
| S-11/A | (AVG) | '75-'89 | Hochstetten | Ittersbach |
| *S-2 | - | '97 | Rheinstetten | Blankenloch |
| *S-3 | - | '94'97' | Hbf. | Bruchsal/Menzingen |
| *S-4/B | (DBAG)) | '92/'97 | Hbf. | Bretten/Eppingen |
| *S-4 | (DBAG) | '94 | CBD | Baden Baden |
| *S-5 | (VBK) | '94-'96 | CBD | Pforzheim |
| *S-5 | (VBK) | '94-'96 | CBD | Wörth |
| *S-9 | (VBK) | '94 | Bruchsal | Gölshausen |

* = Joint Use Railroad/LRT

**NOTES:**

- Tram Routes VBK 1,2,3,4,5 shown on local detail.
- Stadtbahn (VKB/AVG) LRT Routes S1, S2, S5 and S11 use VBK tram track through the CBD. Routes S3 and S4, use DBAG railroad tracks through the main station (Hbf.) (1998)
- Regionalbathn DMU Routes - designated "R" are 11 DBAG routes that extend beyond and overlàp the Stadtbahn routes.
- Intercity, DBAG routes not designated but overlay this system.
- Expansion to Heilbronn, Odenheim, Graben-Neudorf and Zennsbach.
- Through routing and rerouting are proposed.

5. **Test concept, then expand co-mingled operation to higher density radial freight and passenger railroad lines**. Research, design and build a dual voltage LRV. Test dual voltage and battery equipment on railroad passenger line (R5 to Pforzheim). Determine public acceptance. Develop operating agreement with German Federal Rys (DBAG). Reconcile and satisfy regulatory and safety (EBO/ BOStrab) requirements for joint use. Build light rail transit/railroad connections and acquire dual voltage cars (1988-1992) for joint operation. [Example: Stadtbahn Line S-5 to Pforzheim]

6. **Integrate railroad passenger and LRT operating schedule** into a single dual mode passenger service. Railroad purchases LRVs to operate its scheduled runs of joint service as an economy measure. [Example: S-3 to Bruchsal, S-4 to Bretten]

7. **Concurrent exploitation of under-used, remote, or circumferential national (DBAG) and private (SWEG South-West German Rys. or Sudwestdeutsche Eisenbahn AG) railroad freight lines and long distance main lines.** Acquisition of second generation low-floor LRV dual voltage rolling stock for longer distance travel and demands for higher amenity (1994-1996). [Example: Lines S-9 Bruchsal-Bretten, S-3 Extension to Menzingen]

8. **Refinement of system by through routing of S bahn routes (1997-1998)**, further conversion of DBAG Regionalbahn routes to S bahn, and developing remedies for downtown congestion on Kaiserstrasse with parallel routes or CBD tunnel. [Example: S-5 Wörth to Pforzheim via Karlsruhe CBD]

Each phase represents a successively higher order of railroad - rail transit integration and intensity of joint use of track. The first decade represented the background work and reorganization. The result is the addition of almost 130 miles of track to the rail transit system within the second decade.

As summarized earlier, in addition to local codes and regulations, three sets of railroad and rail transit *physical and operating* requirements had to be met by Karlsruhe and all German joint use operators:

- BOStrab "Bau- und Betriebsordnung fur Strassenbahnen" Tramway Regulations (German Federal uniform urban streetcar standards and rules on construction and operation). In Karlsruhe, BOStrab applies to the tram network.

- EBO "Eisenbahn-Bau-und Betriebsordnung" Metropolitan Railway Regulations (German Federal uniform urban railway regulations on construction and operation). In Karlsruhe, this applies to the interurbans and railroads.

- DBAG (federal railroad) Regulations (rules and standards imposed by the host railroad, which in most cases is DBAG).

Note that there are regulations dealing with joint use which govern by exception. These are "Regulations on Light-Weight, Short Distance Railcars," full name being "Special Conditions for the use of Light-Weight Short-Distance Railcars in joint operation with Standard Railway Vehicles for Public Transport." A fourth item is legislation applying to financing metropolitan and city rail transport:

- GVFG Gemeinderverkhers-finanzierungsgesetz (local finance transport law). This sets forth the federal, Länder, Kriese, and local funding statutes for rail transit and joint railway use transport. As operating and decision-making authority has shifted to more local jurisdiction, so has funding responsibility.

All of this activity is conducted under the specter of European Union (EU) requirements for change, a "Regionalization" policy in Germany where responsibility for operating *and financing* public transport has been shifted through the Länder (states), to the Kreise (counties) and local jurisdictions, and federal railroad (East and West Germany) merger, reorganization, and privatization. In aggregate, BOStrab, EBO, and DBAG cover track and vehicle standards, station design, operating practices, and signaling and communications equipment. By VGB in Karlsruhe being first and selecting standards applied elsewhere or off-the-shelf designs, and selectively applying and trading off elements of *both LRT and railroad* standards, much of the potential regulatory controversy was deflected. Since Karlsruhe S-bahn is an extension of the existing tram system, those already approved standards were applied to in-street trackage. Note maps which describe the service, alignments, and institutional mixes of joint use.

#### 7.3.3 VBK Joint Use System Description

As of January 1998, the VBK system consisted of five local tram routes and seven Stadtbahn (S-bahn) lines (actually twelve single routes radiating from the CBD and 14 regional bahn (R-bahn) routes operated by DBAG. See Figures 7-2 and 7-3. Conversion and adaptation of railroad routes continues, but is now limited by the capacity of the major traffic and shipping tram thoroughfare - Kaiser Strasse. A referendum to fund a DM 390M tunnel has been defeated twice, but will be tried again in year 1999. Two S-Bahn lines are routed through the CBD and through the main railroad station, which is remote from the CBD, because of CBD congestion and lack of capacity along Kaiser Strasse. The tunnel may represent the next evolutionary stage in the joint use chronology cited earlier.

VBK continues to operate its own freight service, including a garbage train (for DBAG) and its own fleet of trucks. VBK pays DBAG a rate of DM8/km for existing LRV schedule and DM5/km for additional LRVs to use DBAG railroad tracks.

Like the S-bahn routes and schedules, rolling stock has evolved from adaptations of standard LRV designs to purpose-designed cars. Four types of contemporary cars were built for Karlsruhe's S-bahn and tram system; one tram type, one single voltage LRV type, and two dual voltage LRV types - noted Table 7-2.

## 7.4 SAARBRÜCKEN "SAARBAHN" (SBS)

In the case of Saarbrücken, successful designs from other sites were adopted. The Cologne Stadtbahn model "B" LRV was used to determine the track design parameters and limits. Minimum radius was set at 25 meters (82 feet) and 8% gradient, dictated by the in-street alignment within Saarbrücken.

Saarbrücken is unique for two reasons. First, it is the first of the light rail joint use operations that cross an international boundary (into Saareguemines, France). The second unusual feature of the Saarbahn is its start from scratch physically and institutionally. It is the first all-new German LRT system in over 50 years (G. Bottoms, "Light Rail Transit Developments in Western Europe," 7th International TRB Conference Proceedings, Vol. 2, November, 1995). Unlike Karlsruhe, Saarbrücken did

**Table 7-2**
**Karlsruhe LRV Types**

| Model | GT6-70D/N | GT8-80C/573 | GT8-100D/S2 | GT8-100D/25M |
|---|---|---|---|---|
| Type | tram | Stadtbahn 1 | Stadtbahn 2 | Stadtbahn 3 |
| Year | 1996 | 1987 | 1991-1995 | 1997 |
| Width | 2650mm | 2650mm | 2650mm | 2650mm |
| Length | 29,511mm | 36,570mm | 37,610mm | 36,572mm |
| Voltage | 750 DC | 750 DC | 750 DC/15k Vac | 750 DC/15k Vac |
| Wheel Arrangement | Bo2Bo | B22B | B22B | Bo(2)(2)Bo |
| M. Radius | 23m | 23m | 23m | 23m |
| Seats | 90 | 100 | 100 | 100 |
| Standees | 85 | 115 | 115 | 129 |
| Top Speed | 80km/m | 90km/hr | 90km/hr | 100km/hr |

Sources: Stadtverkehr Technik Nahverkehrs Praxis not have an active light rail or tram system on which to base its joint use plan.

Its tram system was dismantled in 1965, thus both light rail tracks and joint LRT/railroad are all new. The advantages of new start is avoiding the old infrastructure or having to conform to obsolete standards of the predecessor tram system. Saarbahn will, as a new system, adhere to the standards of the Association of German Transport "Verband Deutscher Verkehrsun-ternehmen" (VDV) operators (roughly comparable to APTA in North America). Another novel aspect of the Saarbahn is its use of both French and German national railroad systems, SNCF and DBAG, for portions of its light rail routes. It also uses railroad profile rail in downtown streets. Saarbahn is the first joint use LRT in France and has attracted the attention of eight towns (Grenoble, Lyon, Marseille, Orleans, Rouen, Strasbourg, Mulhouse and Nantes) most of which have LRT, but want to expand their systems with joint use as an option.

#### 7.4.1 Saarbrücken Overview

A city of 200,000 population, Saarbrucken is the center of an area historically disputed and shifted back and forth between Germany and France. It is roughly comparable to Dayton, Ohio in population. Located on the French/German border, Europe's second contemporary joint use operation between railroads and light rail transit opened on October 24, 1997 in Saarbrücken. The initial line is a 19 km link starting on the street at the Hauptbahnhof (main train station) downtown and ending at Saareguemines, France. The entire initial operating segment opens to Lebach, on the opposite side of the city from Sarraguemines, thereafter. The resulting system configuration begins at a German suburb on the German national railroad, passes through the middle of the city on its own tram tracks and ends on the French national railroad in a French suburb.

Within approximately a 15-mile radius of the city center, a dense 180 km (112 mi.) network of railroad lines (of which almost 90 percent are electrified) provides ample opportunities for planners and designers to apply joint use. At least eight corridors radiating from Saarbrücken City are candidates for some degree of shared track between the Saarbahn and DBAG/SNCF.

Saarbrücken's traditional city tram system was abandoned and dismantled in 1965. Transit riding is currently high, with about a 25% transit mode split with 60,000 total daily commuter trips. Neuenkirchen, a nearby city in its own right, had a small but modern tram and interurban system which was also abandoned. Saarbahn plans to link these two cities.

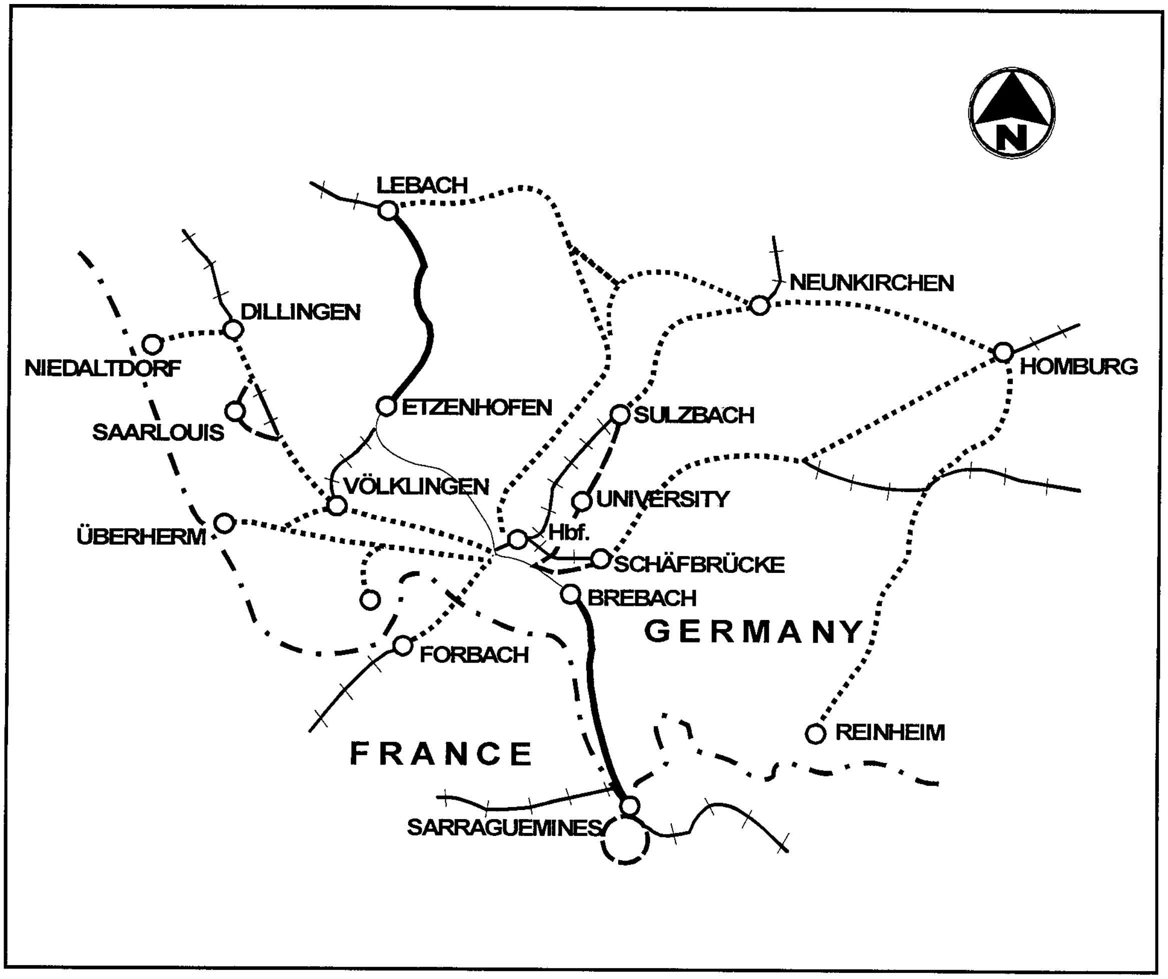
#### 7.4.2 SBS System Evolution

Unlike the twenty-plus year gestation of the shared track Karlsruhe system, Saarbrücken started from scratch and opened the first route within six years. Since some of the same professionals worked on both Karlsruhe and Saarbrücken systems, the institutional experience gained in Karlsruhe migrated west to the Saarbahn. Several years of favorable and safe experience at Karlsruhe, combined with institutional changes within the national railway system, influenced DBAG to cooperate in the Saar.

In December 1991, a special board studying restoring regional LRT service in the Saar region recommended building a new regional-based LRT system. Within a month, the Saarbrücken City governing body approved funds to plan and design the system. Study advanced through 1992 conducted by the Saarland (state). At the same time, the Stadtbahn Saar GmbH (SBS) was formed for the purpose of designing, constructing, and operating the LRT

**Saarbrücken - "Saarbahn" Regional "LRT" System Existing and Planned**

**Figure 7-4**



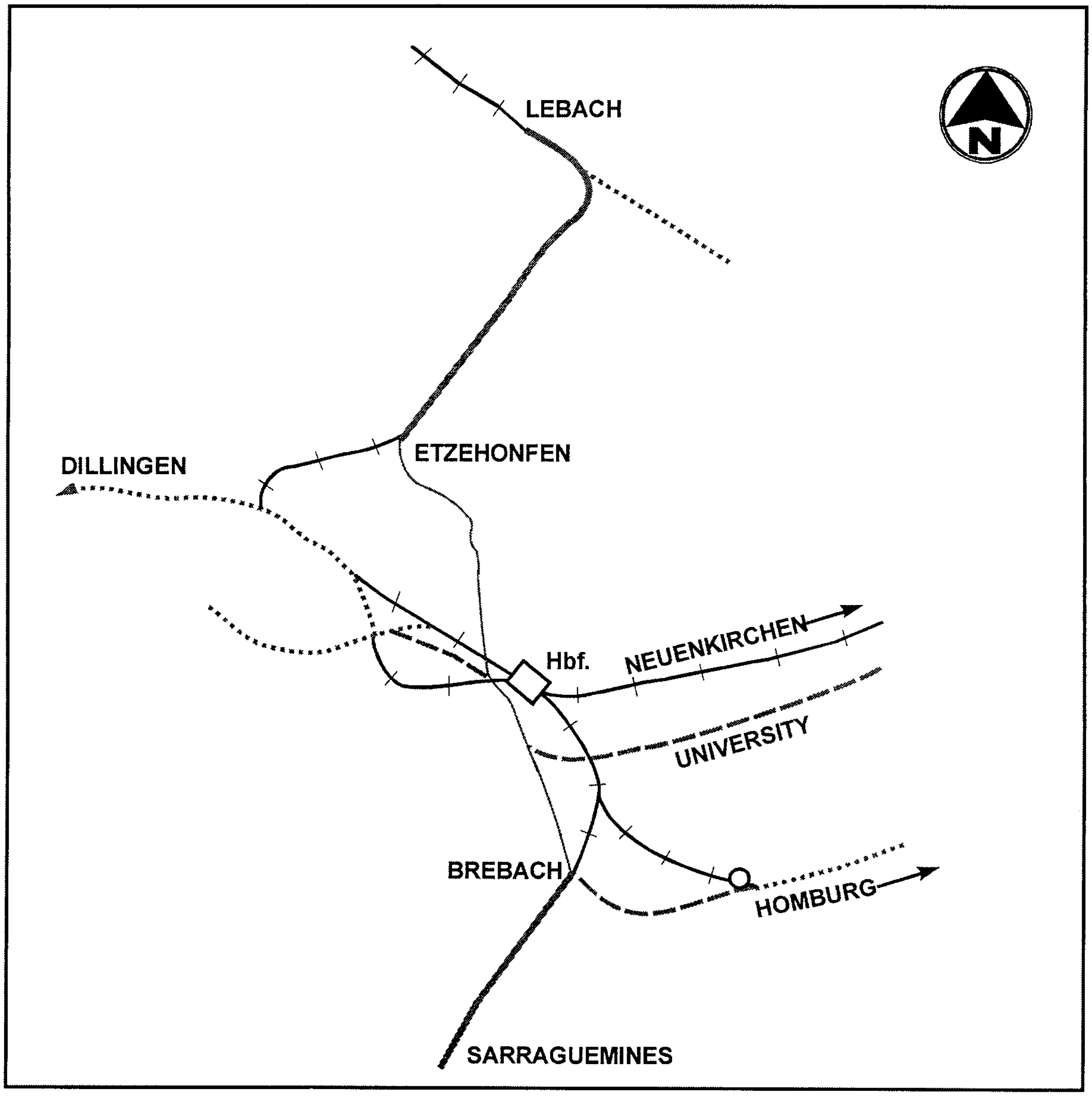

**SAARBRÜCKEN - "SAARBAHN"
REGIONAL "LRT" SYSTEM
EXISTING & PLANNED**

NOT TO SCALE
(derived from RGI and IRJ)

LEGEND

- Tram/LRT (SBS) in Street [BOStrab]
- Railroad (DBAG, SNCF) [EBO]
- Joint (Railroad/LRT)
- Planned Tram
- Planned Joint Use (Railroad/LRT)
- Border

## Saarbrücken Detail "Tram" System Existing and Planned - Figure 7-5




**SAARBRÜCKEN**
**DETAIL "TRAM" SYSTEM**
**EXISTING & PLANNED**
NOT TO SCALE
(derived from RGI and IRJ)

LEGEND

- Tram (SBS) in Street
- Railroad (DBAG SNCF)
- Joint
- Planned Tram
- Planned Joint Use

system. As an instrument of the regional "Lande" and city, the SBS, and all of the municipal jurisdictions, became part of the process and helped share the expense. A grant application (under the transport finance law "Gemeinderverkhers-finanzierungsgesetz" (GVFG), the same law as applied in Karlsruhe earlier, was prepared and submitted by mid 1993. A requirement to meet the German equivalent of the FTA cost effectiveness index was met by the Saarland application and the federal government agreed to supply DM214m by the end of 1994. Work started in early 1995, with service opening on October 24, 1997.

This initial service fell one month short of *a 6-year implementation period from the decision to begin detailed study.* This is nearly the equivalent period of a U.S. style MIS with EIS.

Local (Kreise) match for the Lande/Federal grant consisted of 20 percent of the first phase DM540m ($300.3m) Saarbahn price tag. This is a typical federal/local match. The total costs amounted to DM12.9m per km. or $11.6m per mile, for the 42 km (26 mi.) initial phase (Lebach to Sarreguemines).

#### 7.4.3 SBS Joint Use System Description

A 72 km system is envisioned ultimately. The initial segment to Saargemund (Saaraguemines) includes adaptation of several types of infrastructure; use of AC voltage railroad, laying track in paved city thoroughfares, and use and electrification of a railroad freight branch line to 750 vDC. See Figures 7-4 and 7-5.

The LRV design selected by SBS represents the state of the art in the evolution of cars used in joint use railroad/LRT service. These are Bombardier-built low floor tram derivatives, but are a more robust design and have greater performance (100 km./hr. top speed and 1.1m./sec. acceleration rate) and higher amenity than common trams. Though unquestionably of light rail evolution, these cars and those selected for future joint use operations are developing into somewhat unique designs.

The new SBS cars meet German EBO certification authority requirements with a car body buffing strength exceeding 60 metric tons or 54 U.S. short tons at a height of one meter above the 40 cm. entrance height. The large curved one-piece windshield can withstand penetration of a 1-kg object at 260km/hr. Unlike Karlsruhe, which has to account for existing tram standards, Saarbahn is all new and adopted a railroad wheel tread profile and track.

The Saarbahn LRVs are eight-axle (Bo-Bo-Bo-Bo or four, two-axle trucks with all axles powered), three-section articulated cars with a high floor center section and optional "bistro" level of amenity. These cars are similar in physical configuration to the newest cars for Karlsruhe. The presence of DBAG 15kV, 16⅔ Hz AC traction current and the conventional 750 kV DC for street running portions requires a dual voltage car. Each dual voltage car in the 28-unit order costs DM4.6m ($2.6m) (See Appendix H-14).

## 7.5 LUXEMBOURG (LUXEMBURG) "BUS TRAM BUNN 2002"

Luxembourg is the latest to adopt joint use as a strategic policy for initiating and expanding light rail over rail lines. Like Saarbrücken but unlike Karlsruhe, Luxembourg is building an all new light rail system, rather than expanding an existing city tram network.

The Luxembourg Consulate and BTB provided information on their joint use proposal which is still in the planning and design stages.

This information provided insights into the way a joint use operation is organized and financed in an institutionally complex environment. Consider how, as the text reveals, the joint use proposal became a centerpiece for a reform and overhaul of transport institutions, processes, and attitudes in Luxembourg city and state. This information has not been readily available in the North American trade press.

Luxembourg has dedicated a Project *Bus-Tram-Bunn 2002 (BTB)* organization to plan and execute an LRT/Railroad joint use system within the Luxembourg metropolitan area.

#### 7.5.1 Luxembourg BTB 2002 Overview

Luxembourg City, population 79,000, has a transit service area covers a metropolitan population of 100,000. Transit services consist of local bus (Service des Transportes en Commun, STC) and Luxembourg Railways (CFL). CFL operates a regional rail system and regional buses coordinated with the trains A new light rail system is proposed to be built on city streets and extend outward via CFL. One of CFL's five lines (with branches) radiating from Luxembourg City is operated by Belgian National Railways (SNCB) using two-car EMUs. This line runs to the Belgian border at Kleinbettingen (19 km.) and is electrified at 3 kvDC. The other four CFL rail lines are electrified at 25kvAC, 50Hz. Electrification of the system was completed in 1993, as was scheduling clock headways for regional rail service. Joint LRT/ Railroad service is regarded as the next step in integrating and expanding transit services.

#### 7.5.2 BTB 2002 Joint Use Plan Description

One of BTB's dilemma is three traction voltages, 750 vDC for the proposed LRT, 25kvAC for four CSL lines, and 3kvDC for the CSL/SNBC line to Kleinbettingen. Three voltage LRV's are possible, but initial joint use phases will be confined to high voltage AC and low voltage DC - see Figures 7-6 and 7-7.

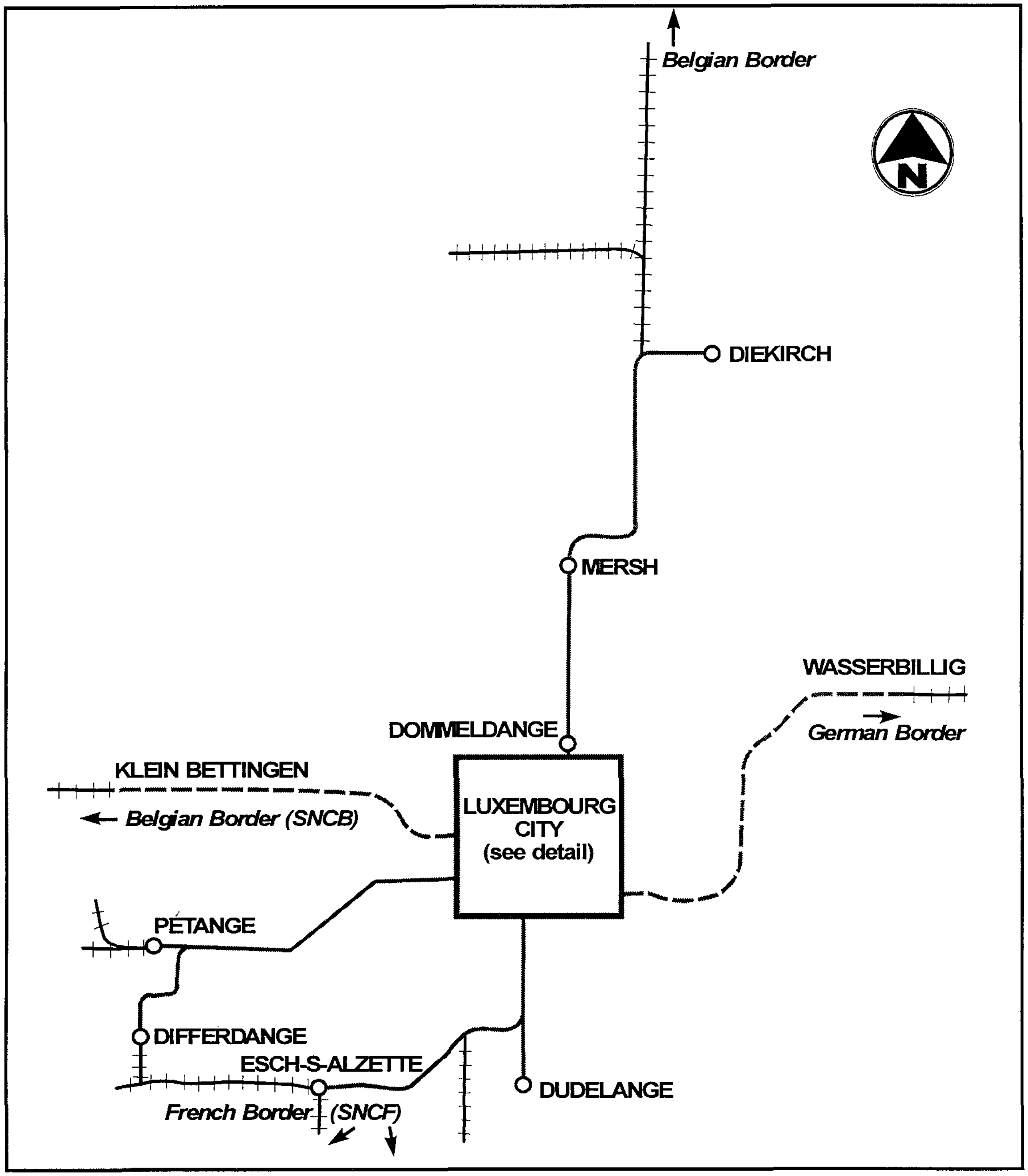
#### 7.5.3 The Bus/Tram/Bunn (Railway) - 2002 Project and its History

The origin of the BTB project was the LUXTRAFFIC consortium's study during 1993/94. Experts from Germany and Switzerland carried out an extensive analyses of local public transportation in Luxembourg and compared several possibilities for an improved system with one another. The recommendation was clearly in favor of a regional urban railway or hybrid "Stadtbahn" railway. ["Stadtbahn" can refer to a light rail system with characteristics superior to those of a street railway system, or to a suburban commuter train system which is operated by a main line railroad over its regular tracks or additional tracks laid solely for the passenger service, or in this case, a combination]. *The LUXTRAFFIC study did not restrict itself to being a technical treatise. Rather, it contained a series of proposals regarding transportation policy, management, and organization, and the economics of public transportation in the Grand Duchy.*

#### 7.5.4 The Political Decisions

The LUXTRAFFIC study was the subject of a parliamentary hearing in March, 1996. At the request of the transportation committee, the statement of possibilities was given to the political and economic promoters. The public and legislative response was mainly positive. In the Chamber of Representatives that same year, speakers from all factions expressed their support of the proposal.

**BTB - 2002 Luxembourg Regional "Tram" - Figure 7-6**




**BTB - 2002**
**LUXEMBOURG REGIONAL "TRAM"**

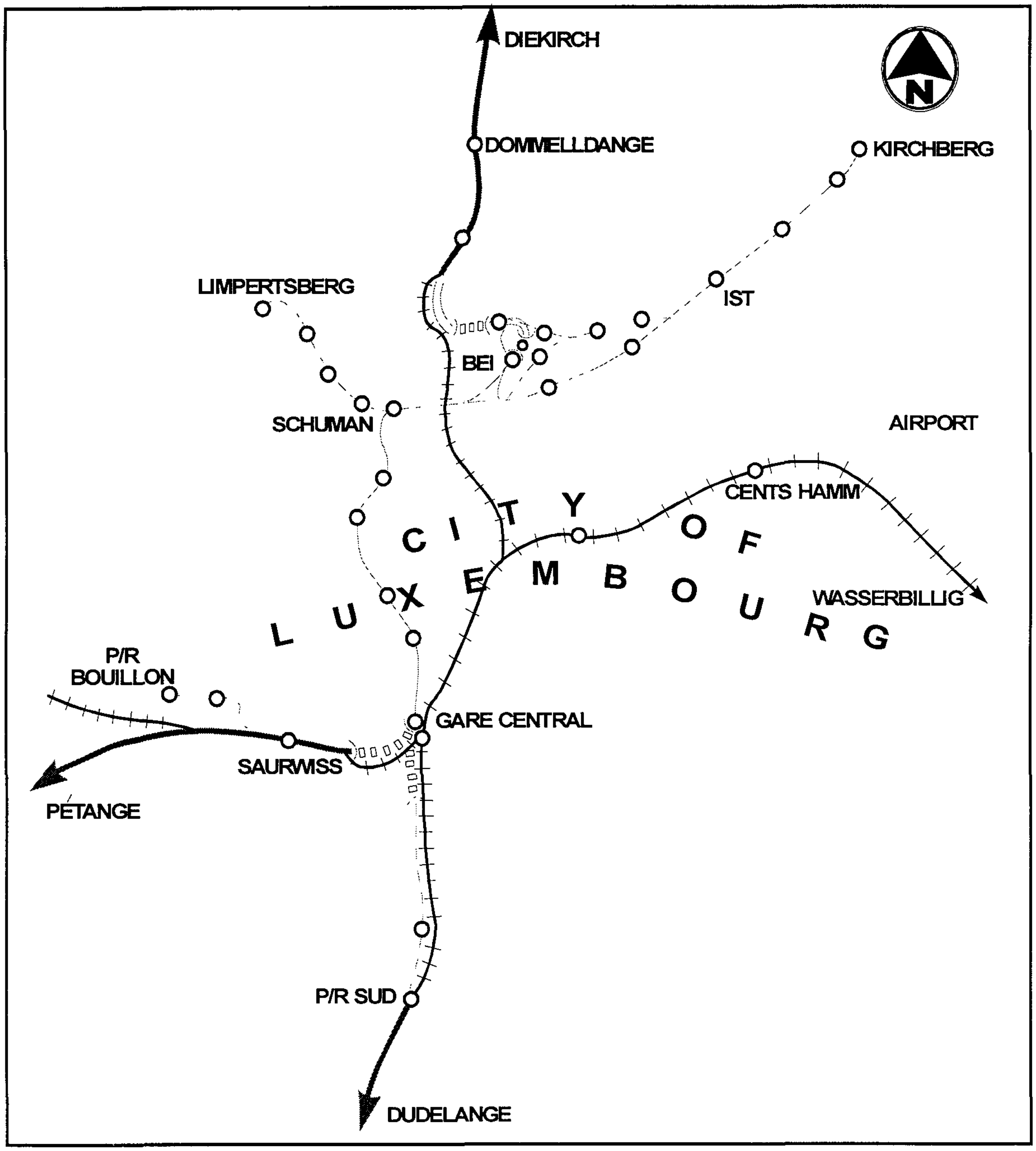
**LEGEND**

- Phase I (Shared Track)

- Phase II (Shared Track)

All RR Track Electrified @ 25KV, 50Hz AC except SNCB @ 3KV DC to be converted

- Railroad (CFL)




## BTB - 2002
## LUXEMBOURG REGIONAL "TRAM" - DETAIL (PHASE I)

LEGEND

- New Line on "Protected" R.O.W. (Non-grade separated lane or reservation along Thoroughfare)
- Variant/Option
- New Line on "Separate" R.O.W. (Grade separated from Throughfare)
- Tunnel (portal to portal)
- Existing Railroad (CFL)
- Joint Railroad/LRT Use (Phase I Shared Track)

The Chamber of Representatives then adopted a motion . . . to push the project forward on the following schedule.

**Feb. 1993:**
After a European-wide invitation for tenders, the City of Luxembourg and the Ministry of Transportation give a contract for a study of public transportation. The contractor is the German-Swiss consortium LUXTRAFFIC.

**Dec. 1994:**
Publication of the LUXTRAFFIC study.

**Feb. 1995:**
Decision by the government in principle for the implementation of the LUXTRAFFIC study recommendations.

**Oct. 1995:**
Creation of the BTB division in the Ministry of Transportation.

**Mar. 1996:** Parliamentary hearing.

The government has set up a separate division in the Ministry of Transportation and, together with the affected partners, created three working groups described below.

The BTB project is being driven forward on several levels at present. The three working groups–PIR, OF, and PTP–are controlled by a pilot group or Coordinating Committee. It is responsible for the political and socioeconomic guiding of the project. The BTB division of the Ministry of Transportation is the location for day-to-day business. It coordinates the entire project.

The lesson here is that operating in railroad and highway environments requires extensive outreach and complex project structure involving many interests.

The Coordinating Committee unites the decision makers who are directly or indirectly concerned with Project BTB 2002. A total of forty delegates are invited to its meetings: government civil servants, representatives of the community, unions and employers, business associations, and interested groups whose activities have to do with transportation. The three working groups inform them about current intentions and ask their opinion about the goals to be attained. The coordination committee is thus able to become a forum for discussions on the future of public transportation.

- **The "Planning and Construction Working Group" (PIR)** develops proposals for the future public transportation network, its supply, and technical means of production (vehicles and physical facilities). Transport Ministry, the CFL, AVL, and the TICE are represented in this group. "CFL" = "Chemin de Fer Luxembourg" (Luxembourg Railways), "AVL" = "Autobus Ville Luxembourg" or service des Transports en commun de la ville de Luxembourg (City of Luxembourg Bus System). TICE = Provincial bus syndicate.
- **The Organization and Financing Working Group (OF)** is entrusted with questions about the future organizational structure of public transportation. They are also working out a solution for financing the infrastructure and day-to-day operations. The Grand Duchy (Ministries of Transportation, Budget, and Interior) and the City of Luxembourg are represented in this group.
- **The "Promotion of Public Transportation" Working Group (PTP)** is developing strategies for outreach. The Ministry of Transportation also participates in this group, along with the public operating authorities (CFL, AVL, TICE), the Confederation of

Commerce, and the "Actioun Public Transportation" as spokesmen for the customers.

#### 7.5.5 The Luxembourg Project

The central piece of the Luxemburg LRT (Sbahn type) will be the north-south axis, the northern route of which will leave Dommeldange, run via Côte d'Eich or Limpertsberg to the city center, and connect with the railroad network at the main railroad station. LRT trains will be able to run into the capital city's center from the north (Mersch, Diekirch) and south (Esch/Alzette, Differdange, Dudelange, Pétange) with about ten kilometers of brand new lines. A line to Kirchberg will branch off from the north-south axis, and a connecting line to Hollerich (Bouillon park and ride, Geessekneppchen Campus) will be investigated. The present thoughts about the first stage of construction are of five principal lines (See Figure 7-6). They will run on a 30-minute basic headway, but Lines S3 and S6 will run hourly. The lines will expand to a more frequent headway within the capital city in order to meet the greater demand. The tramway will therefore connect the railway lines with the highest traffic destination areas within the capital city. In a second phase, regional tramway lines are planned in the direction of Airport-Wasserbillig and Kleinbettingen-Steinfort/Arlon. Up to that point, the regional railroad service will retain an important supplementary role in the rail network (see Figures 7-6 and 7-7).

#### 7.5.6 Optimization of the Bus Network

The new spinal rail network will make the optimization of the city and regional bus networks possible. The parallel routing of numerous (17 plus) bus lines between the main rail station and the upper part of the city can be eliminated.

#### 7.5.7 From Standard Streetcar to High-Tech Low-Floor Vehicle "Half Railroad, Half Tram"

In considering joint use, Luxembourg regards its proposed LRVs in a new way. The development of LRT/tramway vehicles has enabled hybrid vehicles, modern design, stepless entrances, electronic drive technology, and computer controlled information systems. Joint use dictates that the rolling stock and service configuration meet the needs of each of the areas it serves. Joint use LRVs or DMUs must adapt to line haul express (on the railroad) and local functions (on the street).

- **The Joint Use "Urban Railway" [LRT] <u>as Railroad</u>**

  The ideal regional tram for Luxembourg has some specifications of a railroad train: [a] generous supply of seats, comfort and amenable interior furnishings belong in it as much as the electrical equipment (25 kv AC), a sufficient maximum speed, and the capability of forming long trains. These requirements are expressed as passenger amenities for suburban users.

- **The Joint Use "Urban Railway" [LRT] <u>as Street Railway</u>**

  In the city portion of the route, other demands predominate. Numerous wide doors will reduce dwell time. High performance LRVs will allow frequent stops and reduce the walk to the stopping points. Generous platforms will allow the parking of baby carriages and baggage. Vehicle width, length, and shape will be suited to basic urban conditions for urban residents.

- **The Saar Railway as a Model for Luxembourg**

  The requirements only appear to be contradictory at first glance. Existing vehicle concepts show - as those in Saarbrücken and Karlsruhe - that the joint use railway has adapted to the urban and suburban environments it encounters in joint use service.

These vehicles will be three-section articulated cars with operating controls at both ends ("bi-directional cars"). The end sections will form the "city area." Doors, platforms, and nearly all of the technical equipment will be located here. The center section will house the "interurban area" (Bistro) with the most seats and all of the electrical equipment which will be necessary on the railway network. With a length of 37 m and a width of 2.65 m, the railway [vehicles] will be able to traverse the narrower city streets. The vehicle bodies will allow step-free entries from the platforms of the railway stopping points.

#### 7.5.8 Tram [LRV] Luxembourg: Technical Data

**Length:** 30-38 m
**Width:** 2.65 m
**Number of Wheel Sets [Axles]:** six to eight, all powered (Bo Bo Bo)
**Car Floor Height:** 40 cm, reducible to about 30 cm in the city
**Voltage:** 750 v DC and 25 kv, 50 cycle AC
**Minimum Curve Radius:** about 20 m
**Maximum Gradient:** 7-8%
**Maximum Speed:** 100 km/hr [62.5 mph]

The tramway infrastructure and its vehicles will represent a technically costly and valuable capital investment. The tracks will be laid basically on separate rights of way, in order to make possible an unimpeded operation. LRVs will enjoy priority at crossings: an intelligent traffic light control system is being designed to allow the tram trains to pass through intersections quickly. Where necessary, the tram in pavement routes will be jointly used by buses, extra [tripper] vehicles and taxis.

Several key segments and transit points are critical to the success of the BTB proposal:

- **At the Main Railway Station**

  *The key element of the regional tramway system will be its integration with the existing [CFR] railroad network.* The railroad tracks from Bettenbourg and Pétange (via Dippach) must be connected with the tramway tracks at the main railway station. The railroad lines themselves will be correspondingly extended further.

- **From the Main Railway Station to the [City] Center**

  There are no alternatives other than the backbone route of the urban railway network between the main railroad station and Oberstadt ["uptown"]. The present main axis of the bus network runs to Royal Boulevard via Avenue de la Liberté and Adolphe Bridge. The LRT tracks will also follow this route, particularly since there are numerous lanes available for dedicated LRT and bus transit use.

  The Luxembourg main LRT route within the city will not operate in mixed traffic. Non-grade-separated transit lanes for LRVs and selected bus services will constitute priority treatment in the densest areas. This represents another joint use evolution to avoid the Karlsruhe dilemma of too many rail services funneling into and through the main thoroughfare in the CBD.

- **From the Center Outward**

  Two variations for the extension of the northern route are being discussed [shown in Figure 7-7]. The development of the Kirchberg Plateau is expected in the form of a branch line from the city center outward. The Europa quarter and banking quarter are in such a rapid rate of change that the road network will be massively overloaded in the near future. Several variations in the routing are being considered.

#### 7.5.9 Sequence of Planning

In March, 1997, the government agreed to the selection of four engineering firms for route planning in the areas of the main railroad station, city center, to the north, and Kirchberg. The PIR working group had already finished a detailed technical volume of tasks in 1996 and expanded the description of the investigative task in the meantime.

- **The Planning Phase**

  Thus far, one-half of the costs of the external advisory group are being paid from the national budget and one-half from the funds of the City of Luxemburg. The costs of the public work in 1997 will be borne 40% each by the Ministry of Transportation and the CFL [the railroad] and 10% each by the City of Luxemburg and the TICE (provincial bus) syndicate.

- **The Construction Phase**

  In accordance with the ruling of May 10, 1995 by the administration, the pure construction costs of the all-new lines are to be financed by the state. However, the project organization during the construction phase and the financing of the [stations] have still not been decided.

- **The Operating Phase**

  The identity of the operator of the regional urban railway [LRT] is likewise unclear. This system will have a great significance to present CFL employees - after all, about half of the railroad's present passenger traffic will be taken by the tramway network. But whether the railroad company as such will be the operator is not yet certain.

  The Organization and Financing (OF) working group has developed the following model for the future financing of operating costs. A basic rate will be fixed for all transportation carriers (bus, tramway, railroad). The amount which results from this basis, as well as the fare income, will be divided by the state and the municipalities. The share of each municipality will be dependent on its size and the amount (volume) of its public transportation service. The amount for the state will correspond to the present performance. The additional costs of public transportation will be borne by the owners.

  It is essential, therefore, to [convey representation rights] and a share of the financial responsibility to the municipalities by way of the financing and transportation association. This is consistent with the sense of the regionalism as practiced in Germany.

  Finally, an amount for the financing of public transportation could be demanded from the producers of the need for transportation (employers, but also supermarkets, large leisure time establishments, etc.) in the same manner as the French transportation payments ("versement transport").

#### 7.5.10 Regulation by "the Authority" (Transportation Association)

Today, the jurisdiction for the regulation in public transportation is divided among different offices. A new jurisdiction, the Transportation Association, is expected to take over this responsibility. Following the objective of the existing contracts between the state and the CFL, the political responsibility for ordering and financing the service will be clearly separated from the economic responsibility for operating the service with a maximum of efficiency and of success.

- **The Role of the Coordinating Committee**

  The coordinating committee and the authorities and organizations assembled in it have an important role as the broker for information about the importance of public transportation. Reports in their respective publications and the organization of study tours are some of the representative instances which have contributed to explaining the usefulness of the BTB project. Also, the activities of the coordinating committee *have led to a revival of interest in public transportation and the novelty of the joint use/hybrid system concept.*

- **Public Opinion**

  Sixty-five percent of all Luxemburgers see the regional tramway (LRT) project and the BTB project as very positive measures. Only 10% think of them rather negatively. All the same, 54% of them believe the realization of the tramway project to be rather probable to very probable. Seventy-three percent of those asked would rather invest in building up the public transportation system, pedestrian pathways, and bicycle paths, than in road construction.

- **Solutions to the Vicious Circle**

  Many regions of Europe have recognized that the way out of the urban congestion dilemma is to commit to innovative transportation policies. Whether the policy is in the form of road tolls and pricing, as in Bergen, tramway lines as in Strasburg, car sharing as in Bremen, bicycle pathways as in Copenhagen, or joint use, as in Düren or Karlsruhe, future solutions for mobility have become a quest, with diverse conclusions.

## 7.6 BRIEF PROFILES OF OTHER EUROPEAN JOINT USE PRACTICES AND PRACTITIONERS

Joint use of tracks by light weight and railroad equipment is more widespread than the three examples profiled above. One of the by-products of this research is an inventory of major joint use applications in Western Europe and the Pacific Rim. A summary listing below still does not reveal the entire scope and diversity of shared track arrangements found on the European continent. All of the principal operations and proposals are covered as of this writing. There are commonalities in these joint use operations: Most of the examples summarized are privately-owned companies. Most have some business or operating arrangement with local government or other connecting carriers. Several operate separate railway holdings of various types, under a single ownership. Switzerland is particularly rich in these types of arrangements, though complicated by various track gauges, international crossings, language differences, and the prevalence of rack (cog) sections.

Among this inventory of railways routinely practicing joint use are:

#### 7.6.1 Austria

- Stern & Hafferl Light Rys. standard and meter gauge. Nine routes, separated into four operations featuring small freight and light rail equipment are operated jointly under a single management, attempting to maximize yield from single local holdings. This network is a small-scale joint use equivalent of a short line syndicate in the U.S., such as Railtex.

- Vienna (Wien)-Baden Lokalbahnen (WLB) standard gauge, operates interuban articulated LRVs on tracks shared with freight service, also operated by the Lokalbahn Management. On the inner end of this route, joint service is provided with the Vienna (Wiener Stadtverke) tram system over the latter's tracks. Freight service is provided in its mid-section.

#### 7.6.2 Germany

- Cologne - Bonn Interurban Ry. (KVB) Standard gauge Line 18 opened in 1986 and hosts about 40,000 LRV and 15,000 freight movements annually. Cars used on this line were models for the Saarbrücken design.

- Kassel-Naumburger Ry. (KNE) Shared track exists on 4 km of freight railway between "freight trains and Kassel tram operator's low floor LRVs. Gauntlet tracks are used in low platform stations, with LRVs making the diverging move to get in close proximity to platforms. A 1.5 km track connection and service introduced in May 1995 linked city center and ICE Train station. Patronage increases range between 40% and 100%, depending on day of the week (Note: Appendix J).

- Rhein Ruhr (VRR) A comprehensive hierarchy of 24 local authorities and 19 municipal transport undertakings forming a network including DBAG, and a "citybahn" supplementing the regional metro ("Stadtbahn"). VRR's citybahn operates LRVs on tracks shared with freight trains.

- Oberreinishe Eisenbahn (OEG) standard gauge. A 61-km (40-mile) 750 vDC interuban between Mannheim and Heidelberg, Heddesheim, and Weinheim, operating articulated LRVs in mixed traffic with freight service.

- Dürener Kreisebahn (District Ry.) (DKB) standard gauge. As the pioneering light DMU initiative, Düren requires additional attention. A former (up to 1960) operator of trams and freight services jointly, this Kreise-owned company operated a regional bus network in the interim. DBAG actively sought to replace branch line passenger service with buses. After a failed earlier attempt to take over the branch lines, DKB in May 1993, took over operations of two DBAG branch lines, Düren to Heimbach and Düren to Linnich. Dürener Kreisebahn thereby relieved DBAG from obligation for 70 km (44 miles) of branch line passenger operation. The transfer agreement between DKB and DBAG specified that the railroad would make a one-time payment to compensate for deferred maintenance on the branch lines and finance infrastructure restoration, transfer life-expired rail buses (until DKB could order new DMUs) and provide an initial multi-year subsidy (to compensate DKB for being relieved of the deficit branch line operation).

Accompanying the transfer was the development of regionalization of DBAG railroad lines in each of the federal states (Lande). North Rhine-Westfalia was the first to enact "regionalization law" which determines how responsibility for rail passenger transport will be regulated. and transferring responsibility for public transport to municipal and district jurisdictions. Other Länder are developing their own approaches, which in most cases are variations on the North Rhine-Westfalia theme.

This is considered the first successful example of the new-age regionalized railroads using LRV-derived DMUs. Siemens' first order for RegioSprinters replaced former DBAG rail buses "Schienenbusse" in 1995. *DKB was also the first noteworthy ruling by the transport ministry of the principle of selective substituting active safety measures (crash avoidance) for passive safety (crashworthiness) applied to LRT-derived DMU.* A risk analysis methodology was applied prior to approval (explained further in Chapters 6 and 9).

It is regarded in the same pioneering spirit as Karlsruhe, except without electrification. DKB therefore presents a model closer to the North American situation.

A possible DKB extension to Cologne could result in use of city tram tracks to the central core, as in Karlsruhe, but it is doubtful that the RegioSprinters could negotiate the city tram tracks. DKB receives a subsidy from the North Rhine-Westfalen state government. Other routine operating costs and all maintenance costs are absorbed by the Kreise. It is believed that the track charges for using the DBAG tracks are the same as those assessed by DBAG track for DBAG Operations cost centers. DKB runs daily freight and is seeking to develop through running freight over its line and those of DBAG directly to Cologne.

#### 7.6.3 Benelux Countries

- Amsterdam A new ring hybrid route (light rail and rapid transit joint use) connecting new commercial development with the city center, "SnellTram" Route 51 operates in metro subway, on 750 vDC third rail grade-separated right-of-way, and on a 600vDC overhead collector tram route. Rolling stock is considered light rail and blends with metro/rapid transit rolling stock on metro portions. Tram routes 5 and 9 share tracks over metro/light rail Amstlveen Line and operate in the street for portions of their routes.

- Hague/Rotterdam/Utrecht Six routes are planned for LRVs to operate in mixed traffic with railroad (NS) equipment in and between these metropolitan areas. A pilot project is planned for the year 2000. Railned (Railway capacity management [national] Organization) is considering all aspects of design and finance to establish a template for local agencies to achieve portions of this extra-metropolitan, integrated system. This is the Dutch equivalent of Ruhr Valley regional rail system planning. Rotterdam also uses LRT standards to extend its metro (rapid transit) system outward.

#### 7.6.4 France

Aside from a branch of the Saarbrücken system, no significant joint operations are currently in service. At least 10 are proposed - see "Other Initiatives" at the conclusion of this chapter.

**7.6.5 Switzerland** (all listed in Janes _World Railways_, not in Janes _Urban Transport Systems_):

- Biere-Apples-Morges Ry. (BAM) meter gauge low-floor light EMUs operate with bulk freight trains.

- Fribourg Rys. (GFL) standard and meter gauge low-floor EMUs/LRVs operate in street trackage, and with locomotive-hauled freight trains. Some run jointly with meter-gauge transporters carrying standard gauge rolling stock on board.

- Jura Railways (CJ) standard and meter gauge Light passenger EMU interurban stock operated jointly with freight trains.

- Mittel-Thurgau Ry. (MThB) standard & meter gauge Interurban electric EMUs and light DMUs (GTW 2/6) operate on DBAG and SBB branches and thru run on secondary lines in mixed traffic. Because of the regionalization of secondary rail lines and legislation creating DBAG by merging the east and west German railroad systems, local authorities accepting operating responsibility were no longer compelled to contract for services with the federal railroad. This line is located primarily in Germany, but is operated by a Swiss private railway company.

  MThB won the contract with the German Lande of Baden-Württenburg to perform the cross border service since September, 1996. Following the success of this service another disused SBB branch within Switzerland Singen to Ezwilen will be reopened using an additional order of GTW 2/6 cars.

  Other passenger services are being transferred to MThB from SBB, with SBB retaining freight operating rights on the same tracks.

- Nyon-St. Cergue-Morex Ry. (CFNSM) meter gauge. LRVs operate in street and mixed with their own freight trains under common management).

- Rhaetian Ry.(RhB) Meter gauge, four traction voltages. RhB operates light EMU passenger stock with locomotive-hauled passenger and freight trains. It reportedly operated three diesel electric/electric dual power MU cars (One Category 3 DMU).

- Solothurn-Zollikofen-Berne Ry (SZB)/Berne Worb Rys (VBW). Mixed meter and standard gauge. SZB was connected to the Berne tram network before 1960. The two systems share freight rolling stock, including 50 meter gauge transporters for carrying standard gauge cars.

- Montreneux-Oberland Bernois (Vevey Electric Ry Division) (MOB). Meter gauge electric versions of GTW-2/6 (LRV derivative) operate on electrified railroad branch lines. The company operates a variety of light weight equipment and locomotive-hauled freight in joint service.

- Geneva Rhone Express Regional (RER). Standard gauge. Five LRV train sets similar to those in Karlsruhe operate on 1.5 kV DC only (another 31 sets on order @ $3m). Unlike Karlsruhe, this service does not blend with the meter gauge city tram lines in Geneva, since the main railway station is downtown and serves as a major transfer point for local tram routes. *The LRT rolling stock was selected by RER because it is more cost effective to operate over* *the SBB (Swiss Federal Railroad) than railroad stock.* This joint-use service is the latest in a Canton initiative to reach the city center by any point in the Geneva Canton within 30 minutes or less. The Canton contracts ($1.6m annually) with SBB for use of the track by the RER. Track is also shared by seven TGV and twelve international passenger trains daily, in addition to a mix of other railroad rolling stock.

#### 7.6.6 Other Regionalization Transport Initiatives in Europe

The majority of the 18 systems above are single management based, that is, they operate under an individual management developed prior to national regionalization policies. The following metropolitan areas and regions listed below are being developed under the national regional initiatives. Each are considering forming or have already formed regional metros or rail systems which share facilities and expenses. Some cities, such as those in the Ruhr Region, have already joined to form regional rail metros as listed above. Others that are in relatively close proximity are in the process of developing joint agreements.

These regional metros can take the forms of LRT, S Bahn (Stadtbahn), intermediate capacity electric rail, or railbus/DMU-based branch line consolidation. Four electric powered systems, Karlsruhe, Saarbrücken, Heilbronn (anticipated as part of Karlsruhe based system) and Kassel, are in operation, while another 30 in Europe are in the process of planning such systems.

These include Olso in Norway (new city on former airport site); Norrkoping in Sweden; Leeds, Newcastle, Nottingham, Cardiff, and Kent in Great Britain; Vienna, Graz, St. Pölten, and Salzburg in Austria; Paris, Dunkirk, Roúen, Mulhouse, Nantes, Lyon, Orleans, Marseille, Grenoble, and Strasbourg in France; Maastricht in Belgium; Geneva in Switzerland; Ljubljana in Yugoslavia (Slovenia); Kiel, Osnabruck, Paderborn, Dresden, Zwickau, Chemnitz, and Aachen in Germany; and Luxembourg City in Luxembourg.