

Zwickau Riverline Seetalbahn

Three countries, three approaches – but so much in common

Last December, Independent Consultant **Axel Kuehn** wrote about tram-trains. Now he takes us a stage further – with train-trams!

While the term tram-train is now well-established, few people understand the reversed expression train-tram. It is very important however. Tram-train schemes see the operation of light rail rolling stock on heavy rail infrastructure.

However, the difference has to be seen in the fact that in train-tram schemes, heavy rail rolling stock penetrates into the city centre on tramway infrastructure or in a tramway-like manner, while in the case of

the tram-train, the tram leaves the city and enters heavy rail infrastructure.

Readers might argue that train-tram is nothing completely new and pictures from Switzerland, for instance showing Rhätische Bahn in Chur with real trains and locomotives in urban streets, come to mind. It must be said that those few historic examples are not directly comparable – those from Switzerland are anyway very specific as from the author's knowledge only there heavy rail regulations allow a street-running tramway-like operation

without losing railway status for urban sections of the network. US interurbans are seen in a similar historical light.

Completely independent from each other, and with very different starting conditions, two state-of-the-art train-tram cases have been developed in recent years in the German city of Zwickau (Vogtlandbahn) and the US city of Camden (Riverline), while at the same time Swiss Seetalbahn showed another unique solution. All three show perfectly how near heavy rail can come to light rail today.

Zwickau

The city of Zwickau is situated in the western part of Saxony and forms more or less a joint economic region with the neighbouring city of Chemnitz (formerly Karl-Marx-Stadt). Zwickau has a population of 100 000 and is one of a number of smaller East-German cities which kept their historical tramway (opened in 1894) during the communist time.

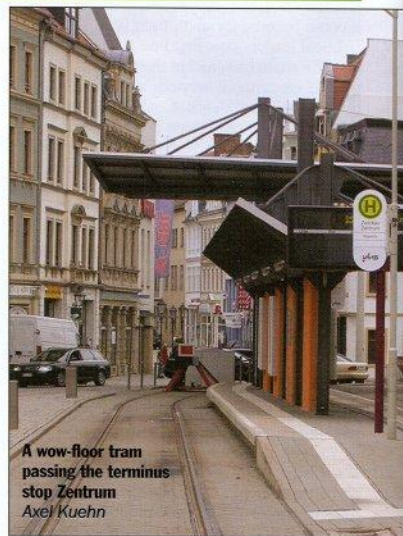
One can assume that a city of this size in West Germany (or elsewhere in Western Europe) would have run buses only since the 1950s or 1960s. However, the tramway survival in Zwickau was not completely safe even in the DDR, as in 1975 the whole southern part of the network including the link to the main railway station was closed and only one tangential tramway line of 8 km remained operational north of the city centre.

Around 1980, the tramway transported just 46 000 passengers/day against 70 000 on the bus network and a complete conversion to bus was under discussion. Import problems for trolley buses and the non-availability of construction capacity for the trolley bus overhead power supply system (VEB Oberleitungsbau) was engaged in the

electrification programme of the railway) contributed to the survival.

After these years of struggling, the winds were changing and 1983/84 saw the first network growth for many years, when the tramway link to the main railway station was re-established. Construction for the first new route to Eckersbach, where a large new housing area had been established, started in the mid-1980s and was completed in 1992. Around this time, the planning process started for the extension to Schedewitz and Neu-Planitz, the latter another big new socialist style housing area created since the early 1970s. With this project the tramway network would grow again through the city centre to the south and close the gap that did exist since 1975.

This project was widened in 1996, and received its train-tram feature. It was decided to adapt the planned tramway alignment with a three-rail track section from the Schedewitz turning loop to the southern edge of the city centre to allow Regiosprinter DMUs of the Vogtlandbahn (now part of the Arriva group) to operate on the new tramway route into the



A low-floor tram passing the terminus stop Zentrum
Axel Kuehn

Regiosprinter at the terminus stop Zentrum Axel Kuehn



city centre. Zwickau did receive proper political support for this pilot project, which is expressed also in the fact that the public funding for the dual-gauge track section was 100%, while the usual funding rate in Saxony was 75%. The total costs for the first section of the tramway project (Neumarkt-Schedewitz) were estimated to be DEM 46 million, Zwickau received DEM 34.5 million in public funding; for the Vogtlandbahn integration a further DEM 35.6 million was received.

The mixed section, which was built with



three-rail track, has a length of about 1100 m. The distances between the track centres of the metre gauge tramway are 3.9 m, for the standard gauge railway tracks it is 3.47 m. Trams are 2.3 m wide, the Regiosprinter 2.97 m. It is still possible to use the tracks with replacement buses or emergency vehicles.

The first line of the Vogtlandbahn network extended to Zwickau city centre was the 73 km one from Kraslice in the Czech Republic via Klingenthal and Falkenstein. The total travel time is about 110 minutes and services run hourly, but with slightly differing departure times in Zwickau centre. The cross-border operation is an interesting feature, even more as the Regiosprinter DMUs are taken over at Klingenthal-Grenze by drivers of a private Czech Railway, Viamont, for the short trip further to Kraslice (4 km – 12 minutes).

One might wonder why it is not possible for the German staff to go on, but still it is a much better solution for the passengers compared to being forced to interchange. A few trains per day are also operated by Viamont to Karlovy Vary via Sokolov. Since 2004, the line from Plauen is also extended to the city centre, but only with a few trains per day.

A general remark is to be made on the arrival and departure times of the trains to/from Zwickau centre at the main station. It is unfortunate that they are not compatible to the departure/arrival times of DB regional trains to and from Chemnitz and Dresden. If passengers wish to take the Regiosprinter from the centre to the main station as a connecting train it is not a worthwhile experience – the train to Chemnitz having left just five minutes before! Those benefiting from the through operation are mainly the Vogtlandbahn passengers travelling on those lines into the region or

coming from there, but the Vogtlandbahn link is not really an alternative link to get to the main station as such.

The 18 Regiosprinters in use by Vogtlandbahn were built in 1996/97 by Siemens-Duewag and represent a 'light' DMU vehicle with 600 kN crashworthiness, thus a vehicle that is having real light rail features. The homologation of this vehicle type on heavy rail infrastructure follows the same regulations as applied e.g. for the Karlsruhe tram-train rolling stock (the so-called LNT-Richtlinien).

The Regiosprinter was a product of fresh thinking in the mid-1990s. At that time one saw a market for state-of-the-art, light and cheap DMUs for rural operation – certainly influenced by German regionalisation and Karlsruhe's tram-train developments. However, the industry recognised very soon that most contracts and the large numbers would still come from the state railways, which required fully UIC-compatible rolling stock and thus Regiosprinter production came to an end in 1998. Besides Vogtlandbahn, only Dürener Kreisbahn (now Rurtalbahn) in Germany and the Danish private railway Naerumbanen use these DMUs. The first 16 were sold in 1996 for a unit price of just DM 1.58 million (EUR 800 000) to Dürener Kreisbahn, which clearly proves the low-cost approach behind this type of vehicle.

The years 1996 and 1997 even saw test operation of one Regiosprinter in Canada (Calgary) and the US (California, Florida), but the vehicle was ruled out as non-FRA compatible for upcoming projects like Riverline described below, the Oceanside Sprinter in California (Desiro) or Ottawa O-Train pilot scheme (Talent).

The Regiosprinter is a medium-floor vehicle with an entrance height of 530 mm that uses 450 mm platforms in the urban part. Therefore, the Zwickau train-tram scheme had to solve a common problem of this kind of mixed operation and find a platform layout able to cope with the low-floor trams using 200 mm platforms and the differing Regiosprinter needs. This was accomplished by separate platforms on those two stops that are served by both rolling stock types. One picture shows the layout at the Zentrum stop with the DMU height on the left and the tram height on the right side of the island platform. The tramway serves two more stops in the mixed section that are passed by the DMUs.

To operate on the mixed-gauge track section, which has to follow German tramway regulations (BOStrab), the DMUs have been equipped with a tramway braking system (emergency deceleration of 2.73 m/s/s), blinkers, and a bell – and they operate with a 40 km/h speed limit. Almost all the complete section is segregated from other traffic, mostly by green fences, but the cross section design is not really different from other locations with similar street width with segregation on pure light rail routes (e.g. Karlsruhe and Kassel).

One might wonder whether train-tram operation in Zwickau is bound to the use of light Regiosprinters and what happens when they need to be replaced? No, train-tram in Zwickau is not endangered. Others, for example the US example of the Riverline described below or Aachen's plans to operate 'heavy' Talents in urban streets with additional BOStrab equipment, prove that train-tram is not dependent *per se* on light rolling stock.

Riverline

Riverline links Camden and Trenton in the US state of New Jersey, said to be the third oldest railway in the US. Trenton, capital of New Jersey, has a population of 85 000, and Camden 80 000. The latter is opposite Philadelphia on the other side of the Delaware River, hence the name of the line. The corridor served by the 57 km railway has a total population of around 265 000.

Riverline is linked in Trenton to the Philadelphia-New York main line, while Camden is linked to Philadelphia via the PATCO *S-Bahn* service. The re-start of passenger services on this former freight-only railway on 14 March 2004 therefore offers also some network-building features.

In Camden, the existing rail alignment was extended through the city centre towards the waterfront, serving a number of important centres including Rutgers University, the New Jersey Aquarium, and museum battleship. Plans for a street-running extension in Trenton are on ice.

Similar to some other US light rail schemes, Riverline is operated in what we might call time-sharing instead of European-style track-sharing. This means that passenger services have the right to operate from 06.00 to midnight except Sundays, while Conrail's freight operation takes the night slot, and on Sunday from 12.00. The schedule offered is a 30-minute frequency, stepped up to 15 minutes in the peak.

Riverline is run with 20 31.2 m GTW 2/6 DMUs (Stadler 2002/03). With its buffer load of 1350 kN, it is seen as 'light' according to US-standards (heavy rail standard is 4000 kN!) but for European standards with 1500 kN UIC requirement it is in principle a 'heavy' vehicle. Like the *Regiosprinter* in Zwickau, it is a medium-floor vehicle with a 580 mm floor height, and platforms are the same height. Different to the non-articulated *Regiosprinter*, the concept of the GTW-family was always based on single (GTW 2/6) or double articulation (GTW 2/8) that has allowed Riverline to deliver a vehicle able to cope with 40 m curves – thus a real light rail feature. With this background, it is understandable that Riverline is seen as the only diesel light rail line in the US.

Capital Metro in Texas has ordered six GTW 2/6 vehicles for the Leander-Austin railway, using existing freight infrastructure

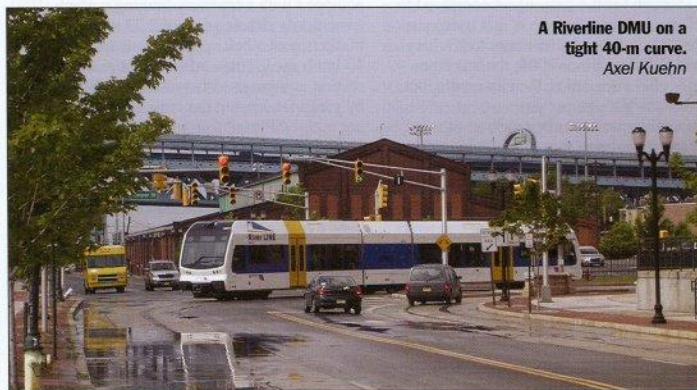
to reach the eastern edge of the CBD. However, it seems this scheme will not show all Riverline's street-running features.

Riverline rolling stock costs are not clear, as the project was procured as a DBOM scheme. However, reliable national sources speak of USD 3.6 million per vehicle (EUR 3 million) which with a passenger capacity of 184 (90 seats, 94 standees) results in a rough ratio of EUR 16 300/passenger. NJ Transit agreed a deal with Southern New Jersey Light Rail Group in June 1999.

With total scheme costs having reached USD 1 billion (EUR 850 million), it is a controversial discussion whether it is a success or complete waste of money. When the scheme was first promoted in 1996, it was a USD 314 million project with 11 200 daily trips. The DBOM contract three years later was worth USD 604 million. Part of the original criticism was because the scheme reached the traffic forecasts, yes - but reduced further from 9000 to 6000 passengers per day in the planning process. Praise for reaching targets with about 5700 passengers per day left a bad taste. To evaluate it is not easy, but one should take into account many bridges which needed to be refurbished on the 57-km line, 20 new stops, about 50 level crossings and a new 2 km city-centre alignment. Generally, unit costs of US light rail schemes are known to be higher than in Europe which also explains at least partly the high project costs.

Riverline remains a success story. It has contributed to and initiated positive changes in an area dominated by a population on low incomes and higher unemployment rates. We read now of increasing land values, establishing new industries and shops, tourism effects (weekend traffic), and higher tax revenues.

The technical solution of introducing state-of-the-art regional rail services into urban areas, as in Camden, remains highly interesting for transport planners. From a European perspective it is worthy of imitation, as it may well offer opportunities for some level of urban rail service, directly linked with the region, where an urban tramway might just stay a dream or where converting heavy rail to light rail is too difficult to achieve. Camden shows that train-tram is feasible – as Zwickau does.



A Riverline DMU on a tight 40-m curve.
Axel Kuehn

Seetalbahn

The Seetalbahn is a standard-gauge, electrified railway route in Switzerland connecting Luzern to Lenzburg, and opened in 1883. Almost the whole alignment is single track, following the parallel road almost throughout and inside the villages, separating houses from the road.

An unbelievable number of level crossings, more than 300 for a 47-km railway, made it responsible for around half of all accidents at crossings within the whole SBB-network, and between 1987-92 nine people were killed. The major target for Seetalbahn – long before delivering more attractive public transport – was therefore to increase safety.

The easy solution would have been wholesale realignment, more or less a new railway route outside the built-up areas. Besides very high cost, it would have also meant losing the attractiveness of public transport through the centre of villages (something Karlsruhe had to achieve anew with central light rail routes in comparable village situations such as Linkenheim, Rheinstetten and Blankenloch). Such change would have been counter-productive (population in the corridor is just about 140 000, Lenzburg and Hochdorf are the biggest towns with 7500 and 7800 residents, Luzern itself having just 57 000).

Understandably conversion to light rail (or tram-train) was discussed as an option and a Saarbruecken vehicle visited Seetalbahn for tests in 1998.

The decision that was finally taken meant staying in the heavy rail world with full UIC-compatibility, but to order low-floor EMUs with a maximum width of 2.7 m. This permitted the creation of more space between parallel road lanes and the railway and also at level crossings. Within the villages a speed limit of 40km/h and tramway-like on-sight operation was

Heavy and light

What are these three exemplary cases telling us? It is about being creative both with infrastructure and rolling stock, and that there are heavy rail vehicles today that look much lighter than their light rail brothers and sisters.

Planners should be aware of the options involved when merging the features of these three cases. Imagine another product of the GTW family which combines the parameters of the Riverline DMU and Seetalbahn EMU in one vehicle, being low-floor, 2.65 m wide, 30-37 m long, able to deal with 40 m curves and having tramway braking equipment. The differences compared to many of today's light rail vehicles would be rather small.

What one would perhaps need to accept in urban streets is a diesel rail vehicle as seen in Zwickau and Camden. We acknowledge it everywhere for buses, lorries and private cars, and we are certainly not speaking about pedestrianised areas being polluted by three-minute metro-like train frequencies. It is more about ordinary streets and roads and headways, which may result in just six trains per hour in



A Seetalbahn EMU in Lucerne main station. Axel Kuehn

introduced, while on other parts the maximum speed allowed was increased to 80km/h. Beyond this the Seetalbahn measure package also included more passing loops, additional stops, a new central control centre in Lenzburg, certainly removal of as many level crossings and improving the safety of others. The total investment was EUR 130 million.

The rolling stock ordered for the Seetalbahn is another child of the GTW-family of Stadler; this time a double articulated GTW 2/8 EMU vehicle, which from the front design is very much comparable to many of today's state-of-the-art light rail vehicles. It is designed for a 1500 kN buffer load which allows full flexibility within the SBB-network — this is one major reason for the rolling stock decision. The minimum curve radius for

these vehicles is 100 m in normal service, 70 m in depot areas.

A pro-tramway decision in Luzern might have been able to influence and possibly change such thinking, but the very central location of the main station meant that tram-train discussions did not go any further some years ago.

The Seetalbahn is operated an hourly service between Luzern and Lenzburg (half hourly in the peak), and half hourly to Hochdorf and Luzern. The 17 GTW 2/8 EMU-vehicles of 53.5 m length were contracted in 2000 for a total cost of SFR 101 million (EUR 65 million), a unit cost of around EUR 3.8 million. With a passenger capacity of 318 passengers (139 seats and 179 standee) this results in a ratio of EUR 12 000/passenger, which shows that

longer DMUs/EMUs are generally more effective.

Compared with Zwickau and Riverline, the light rail features on Seetalbahn are very much concentrated on the appearance and parameters of the rolling stock and less on the infrastructure — it does not really involve street-running features and urban integration.

However, the case perfectly demonstrates that it is feasible today to buy a fully compliant heavy rail vehicle with light rail width and low-floor technology. If not proven before, this vehicle shows the Karlsruhe decision for medium floor tram-trains has at least not been reasoned by the needs of operating on heavy rail infrastructure. Fortunately, all other tram-train cases seem to have learnt this lesson and are now going for low-floor technology.

rail... it's often very difficult to tell the difference

both directions to satisfy the regional demand towards a city centre. The advantage one can see is a vehicle not requiring nasty and complicated approval procedures to get a tram on train territory, and which does not need expensive dual mode technology to be taken around everywhere in a network.

Without doubt there will still be a need for 'real' tram-train-vehicles for certain projects, especially on electrified networks which may require dual-mode or hybrid technology. But to go for tram-train nowadays, if we look at what rolling stock costs have reached lately, one needs a really strong case now.

The barrier of EUR 3 million per vehicle has recently been passed, and also by the Karlsruhe dual-mode vehicle, which however requires electrified infrastructure everywhere. This specific Karlsruhe type, outside of the *Avanto* or *Regio-Citadis* platform concepts, went through its railway inspectorate approval process some years ago. The Kassel *Regio-Citadis* contract was in about the same cost range. A contract for tram-train vehicles was signed a few weeks ago

by Mulhouse and Siemens, and this *Avanto*-type vehicle costs EUR 4.4 million per vehicle! The fact that Siemens won for this price should mean that Alstom was at least not considerably cheaper. With 242 passengers capacity (86 seated) we see a ratio of EUR 18 200 per passenger.

It is rumoured that it was the first tram-train vehicle for which the rolling stock industry has been calculating the costs for the approval process seriously — having learned from earlier bids such as Aulnay-Bondy or Kassel. Approval costs certainly are not only a tram-train feature, but it seems that it is a much more easy way for 'normal' heavy rail rolling stock.

If one looks at the railway line foreseen in Mulhouse for the tram-train, the Thur valley railway to Thann and Kruth, it shows many similarities to Seetalbahn: single track, even un-electrified, running through smaller villages and towns. All the features of the regional tram-train conversion regarding additional stops are no more dependent today on having a light rail vehicle and electric operation — one must

realise that state-of-the-art heavy rail rolling stock (DMUs/EMUs) have made terrific progress in the last ten years. This is something the *Regiosprinter* (or the idea behind it) co-initiated. It is not automatic anymore that conversion to light rail or tram-train results in the same quantum jump of quality improvement compared to the 'normal' railway as it was.

When the Mulhouse tram-train project decision for was taken ten years ago, the railway scene was somewhat different. The more challenging task is to get other tram-train schemes moving today, reflecting progress in the neighbouring world of heavy rail.

This article follows an earlier one by the same author in the December issue entitled Tram-trains: Euphoria or Depression? The author is active in the field of state-of-the-art regional passenger rail — see www.hitrans.org, www.lightrail.nl/Tram-train, www.lightrail.nl/RegioRail or also the 2006 workshops being offered under www.lightrail.nl/Tram-train/workshops2006/workshops.htm

