Cindy: June 18, 2010

This is further to my e-mail when I said I wished to file documents showing that both main line and light rail trains can share, and are, sharing rail tracks. This should negate comments we hear frequently to the effect that we do not know if LRT trains could share tracks with Orlando trains extended westward from Tampa over a reconstructed Howard Frankland Bridge. The European phrase equivalent to our LRT is "Tram", and trams intended to share main line tracks are called "Tram-trains". Attached are copies of four documents:

- Light Rail: an American alternative: describes current operation in the US, (California), of light rail trains sharing tracks with freight trains, and where passenger trains have previously been withdrawn.

- Tram-trains: are they worth it?: describes existing and planned sharing of rail tracks in Europe.

- Next-generation tram-train is ready to roll: describes tram-trains constructed for French National Railways designed to share tracks and operate equally well under the 25kv contact wire of French high speed lines as under 750v wires in city streets.

- Bangkok: multi-level urban transit: describes light rail trains serving the airport in Bangkok with non-stop trains averaging 69.6mph and similar trains making six stops to average 38.6mph.

I have myself held operating responsibilities in four different locations where main line passenger trains operated on a scheduled basis sharing tracks with light rail services under the 750v contact wires (Quebec, Montreal, Cornwall, St Catherines).

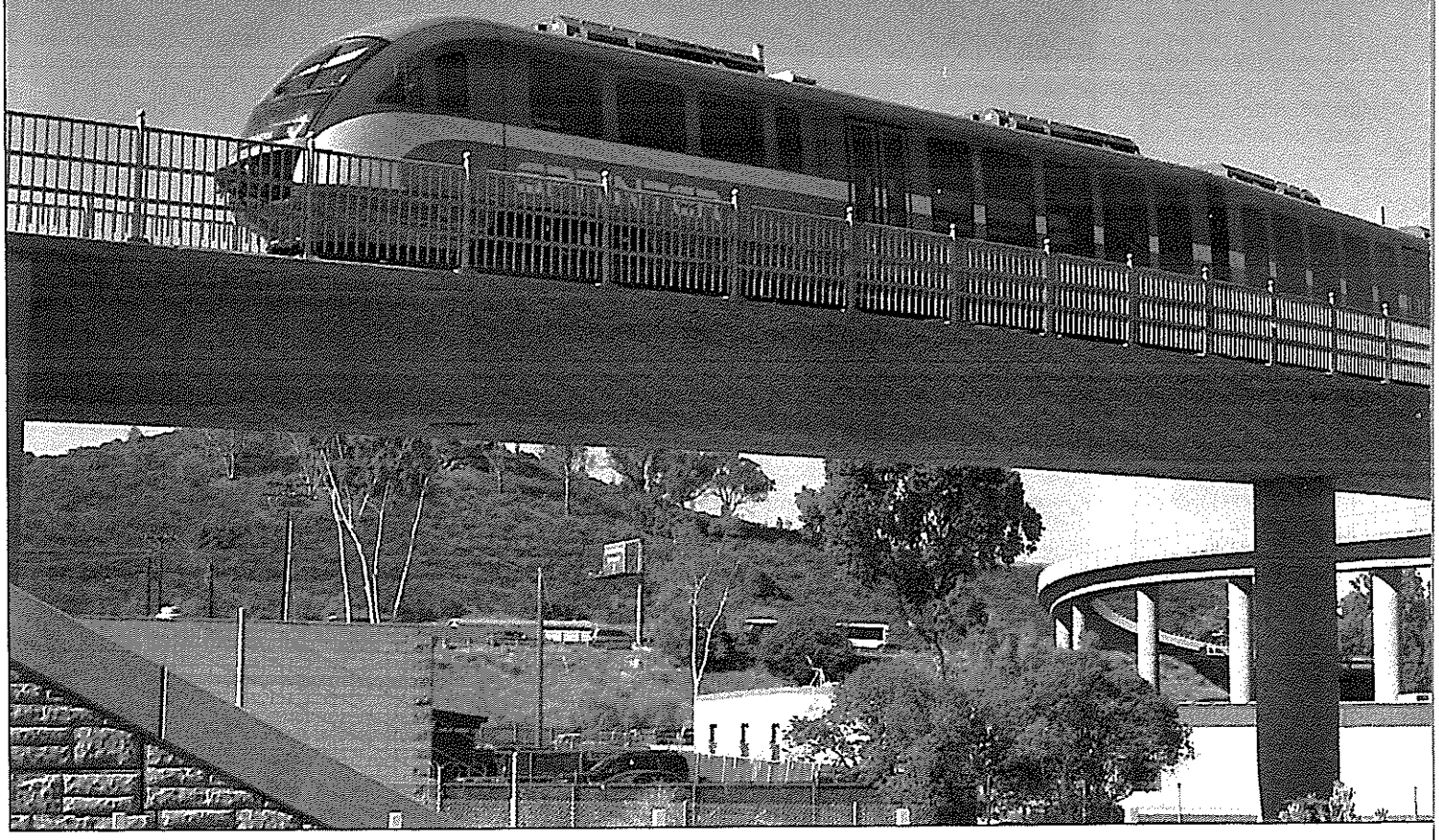
In summary: it is demonstrated from practice that it is technically feasible to design rail tracks for inclusion in the redesign of the Howard Frankland Bridge suitable to be shared and traversed both by light rail trains operating between Pinellas County and Hillsborough County and by long-distance trains from Orlando and beyond.

I would be happy to speak in relation to these possibilities.

Wilfred Sergeant

Light rail: an American alternative

Vic Simons and **Simon Johnston** report on the difficult birth of Southern California's diesel 'light rail' system between Oceanside and Escondido, plus how the 22-mile Sprinter line now shows massive potential for growth.



Another fine example of the growing acceptance and adoption of light rail as a transport mode for urban centres in North America is the new Sprinter diesel light rail system connecting Oceanside and Escondido in Southern California. Although perhaps not light rail in the way many Europeans recognise it – the Siemens *Desiro* diesel-powered rolling stock is more commonly considered heavy rail in its European applications – in US terms where double-deck commuter rail vehicles are the norm, this is very much light rail.

Having gone through an extended, and often difficult, construction and testing process (with many lessons learnt along the way) the standard gauge line in the attractive residential area of Southern California has just completed its first year of operation with many favourable comments from local officials and contented customers.

Three decades of planning

As early as the mid-1970s, plans were mooted by the North County Transit District for a commuter rail line utilising existing freight tracks between Oceanside and Escondido.

Detailed plans were drawn up and routes debated and in 1987 the project was included in TransNet – a countywide 0.5% sales tax for transportation projects. In 1990 more concrete plans were passed by the NCTD board of directors.

Initial cost projections put the scheme at USD60m, to begin revenue-generating operation in 1999. However route revisions in 1991 saw the addition of another 1.7 miles of double-track alignment to California State University San Marcos; this is the only all-new alignment on the system, the other 20.3 miles being on existing line purchased in 1992.

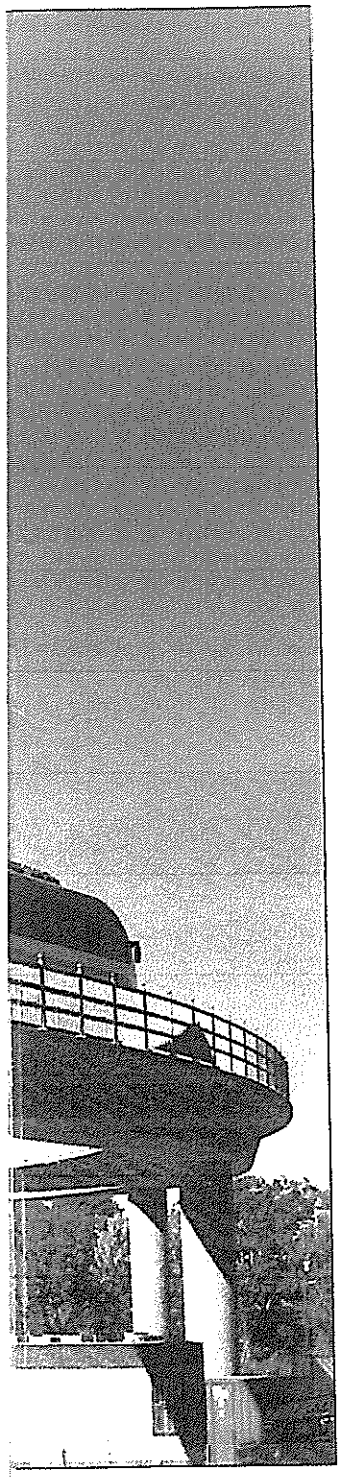
In 2003, the Federal Transit Administration (FTA) approved USD152m in funding; by then the projected budget had spiralled to USD351m and the operational date had moved to late 2005, in part because of the revisions in system design.

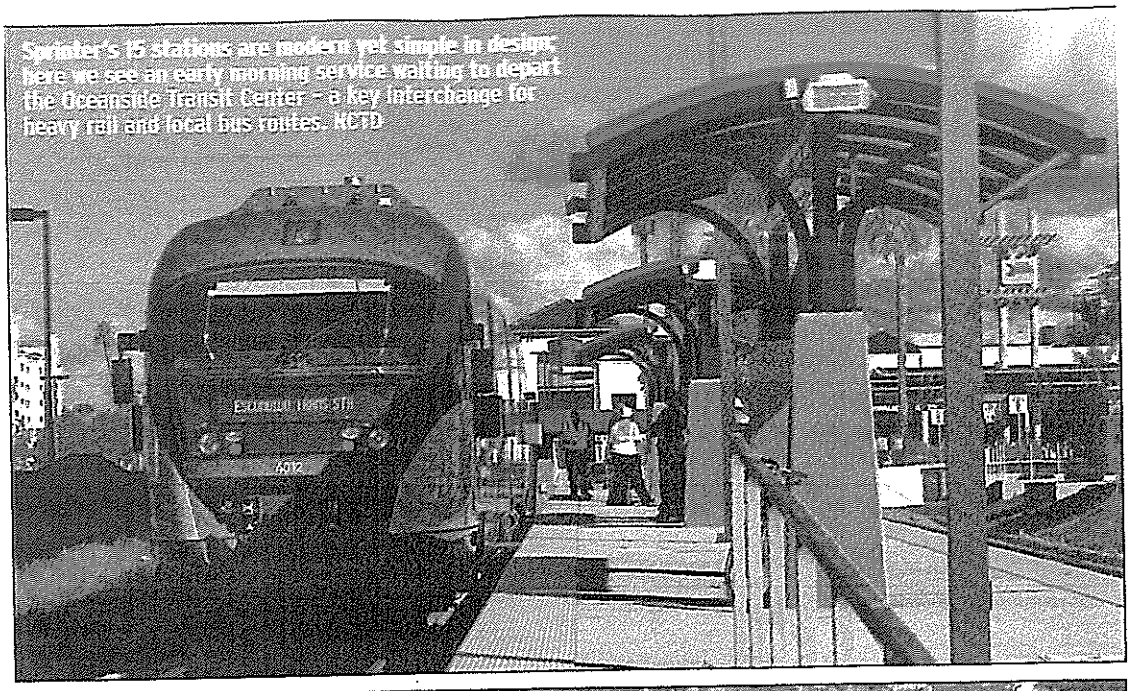
Sprinter, as it was designated, eventually opened to the public on 9 March 2008, with unexpected delays, operating issues and higher than expected inflation pushing final capital expenditure to USD484.2m.

22 miles @ 22.00 m/mile

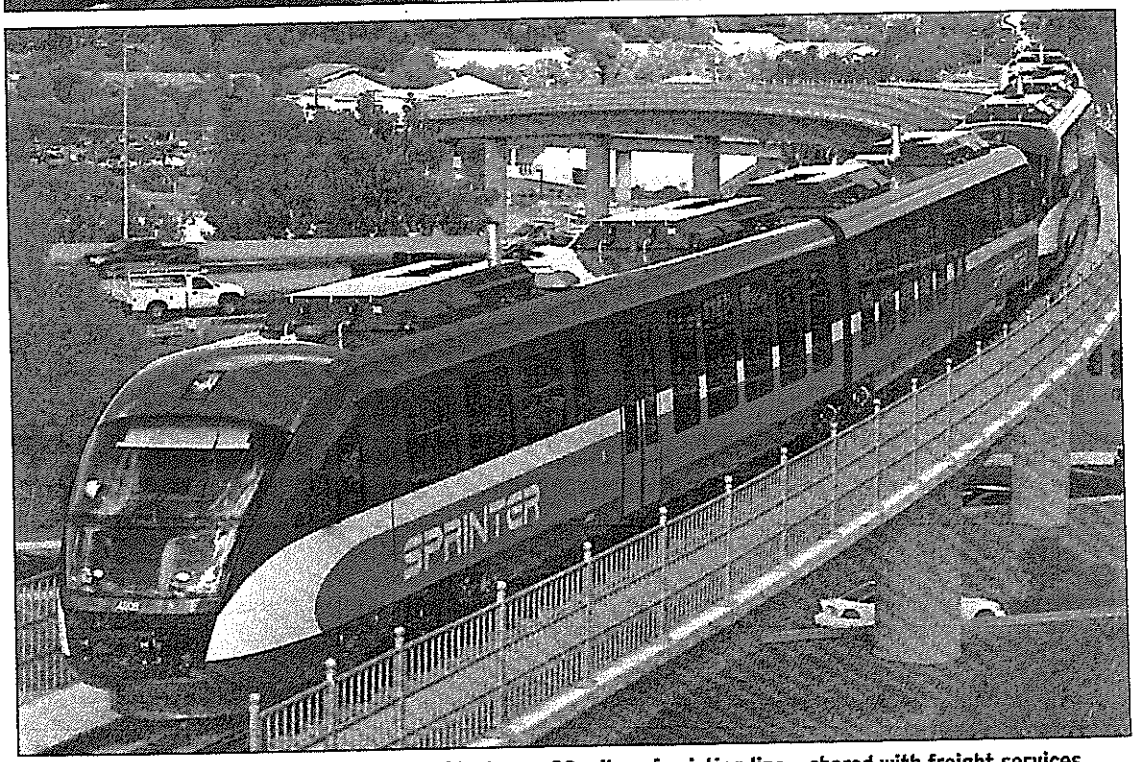
Construction issues

Establishing the route for Sprinter required removing the 120-year-old single-track alignment used exclusively by freight trains





Sprinter's 15 stations are modern yet simple in design; here we see an early morning service waiting to depart the Oceanside Transit Center – a key interchange for heavy rail and local bus routes. NCTD



The Sprinter's 22-mile route is comprised of just over 20 miles of existing line – shared with freight services after 21.00 – and 1.7 miles of new alignment to California State University San Marcos. NCTD

since 1946 when the Santa Fe Railroad discontinued passenger services on the route – Escondido station is the only remaining feature from that era. Preparing the alignment for its new role entailed extensive rebuilding of the trackbed and replacement of the ties (sleepers) and rails to enable safe and smooth passenger journeys. The entire 22-mile line has eight miles of passing loops, much of which is at stations.

Final construction was scheduled for completion in early 2007, with the first trial runs later that month and passenger services beginning on January 13 2008. However multiple safety-related issues prevented opening in early January as hoped and it was postponed until later that month.

One of the main issues surrounded the operation of the safety gates at level crossings. The unreliability of service of the safety gates was attributed to poor rail conditions and the lightweight nature of the *Desiro* rolling stock not being recognised by the system's road crossing electronics.

Another issue was that the California Public Utilities Commission did not certify the rail line or new rolling stock until 7 March 2009. Part of the problem involved the eastbound platforms at Escondido Avenue Station in the respect that train doors did not line-up with the platform's retractable gangways that are folded up at night to allow freight trains to pass as they have a wider loading gauge. The design problem was found during car testing and it was decided to bypass the stop until extensions to the gangways could be put in place.

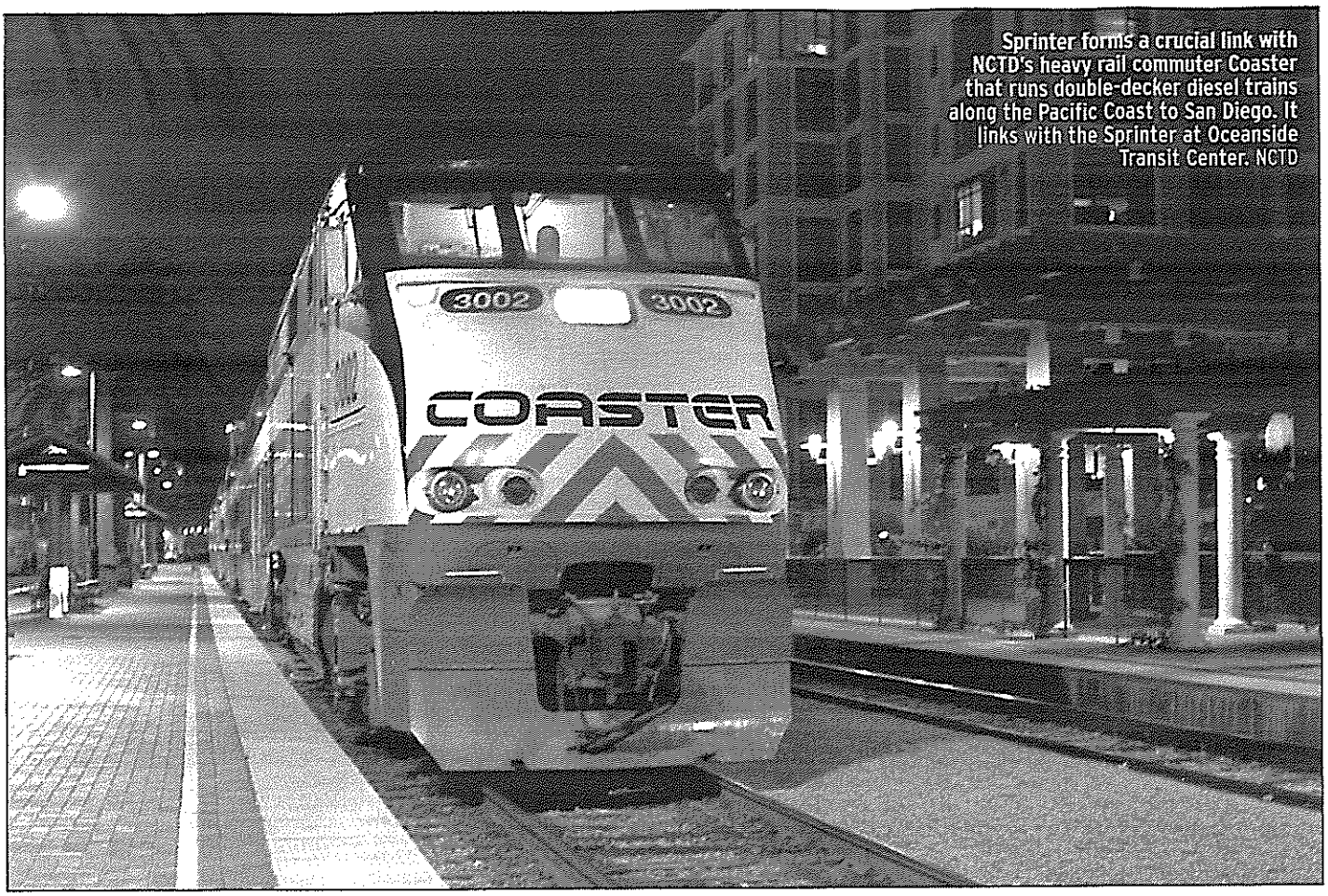
After the required modifications Escondido Avenue Station opened fully on 15 September 2008, a full seven months after the first *Desiros* ran on the network.

The full route and operation

Passenger services run seven days a week, with weekday services operating at 30-minute headways on the line from 04.00-21.00. Weekend services run every hour in both directions. After Sprinter services finish in the evenings, freight vehicles use the line two or three nights a week.

With maximum running speeds of 55mph, Sprinter offers a viable alternative to the automobile, despite the parallel route 78 freeway; it is estimated that the new light rail line reduces road journeys in the region by 5 000 a day. With an average journey time of three to five minutes between stations, a journey over the entire 22-mile length of the system takes just 53 minutes. The operational speeds compare favourably with electric traction. There are 64 trips daily.

The *Desiro* cars can accommodate a



Sprinter forms a crucial link with NCTD's heavy rail commuter Coaster that runs double-decker diesel trains along the Pacific Coast to San Diego. It links with the Sprinter at Oceanside Transit Center. NCTD

maximum of 266 passengers (136 seated and 90 standing) for single trains and over 450 for two-car trains, such as are run at weekends.

Veolia Transportation operates the Sprinter and has worked with NCTD to integrate the new system with the extensive existing express bus system (named Breeze), with interchangeable fares, through-ticketing and integrated operations.

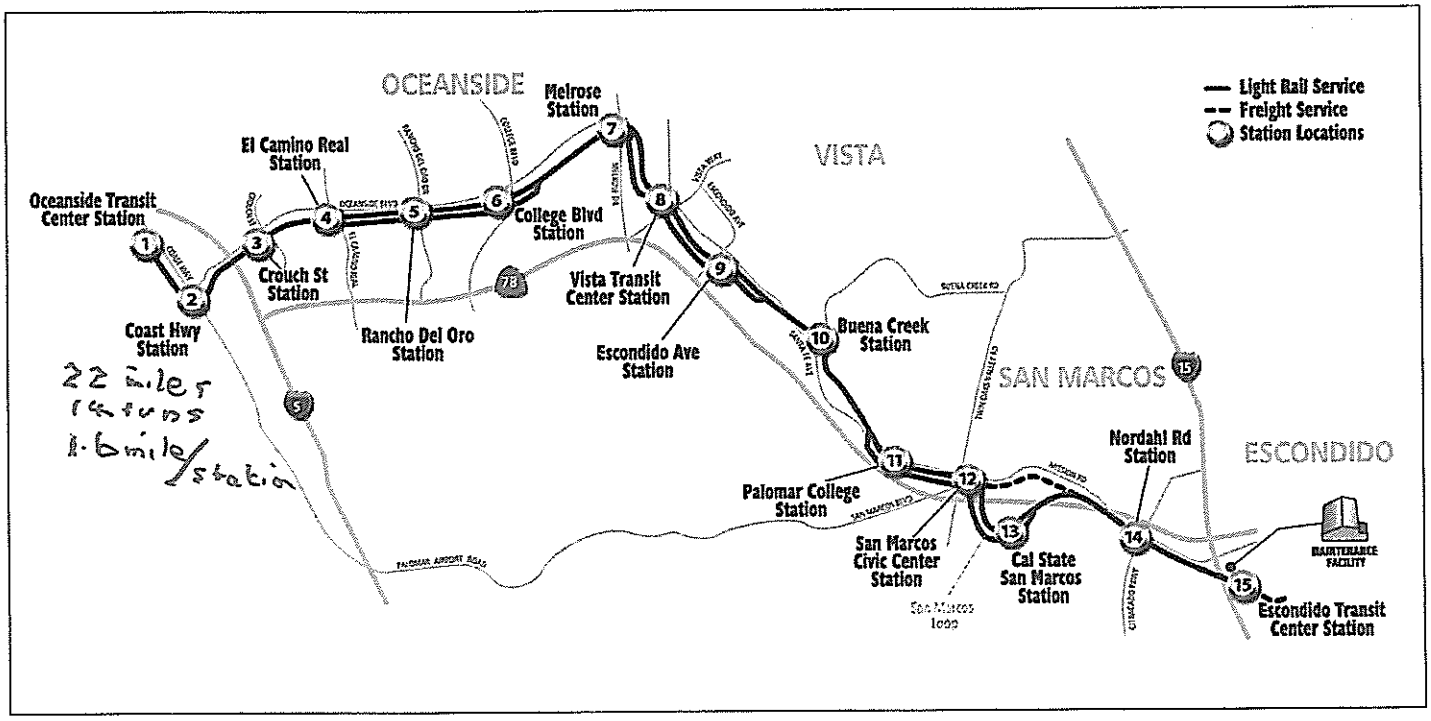
The line starts at the Oceanside Transit Center. This is a key transportation hub with interchange to the San Diego Coaster (the San Diego commuter rail service), the Los Angeles Metrolink and Amtrak's San Diego - Los Angeles service, as well as the many local Breeze bus routes – also operated by NCTD. There are 15 stations on the Sprinter, most of which have interchange with buses.

As well as the end-to-end traffic objectives of Oceanside and Escondido, the line serves the communities of Vista and San Marcos. In addition, there is a station serving the campus of California State University at San Marcos. All stations are well equipped with shelters, seating, and ticket machines. As in most of North America, an 'honour system' backed up by random checks and penalty fares is used.

Free car parks are available at all Sprinter stations except the California State San Marcos and the San Marcos Civic Center stations.

Rolling stock and ridership

The Sprinter system uses 12 Siemens' VT642 *Desiro* Diesel Multiple Units – used in either single or two-car trains – and took delivery of



its first cars in August 2006 in an order worth USD52.2m. Built at Siemens' facility in Krefeld, Germany, each aluminium-bodied car is powered by two 420bhp six-cylinder turbocharged diesel engines and weighs 67 tons unladen. Each car also uses three different braking systems: pneumatic wheel brakes; engine retarders and electromagnetic track brakes in the powered bogies.

The units are quiet, comfortable and feature air-conditioning in both the passenger compartments and the driver's cabs. Large low-floor sections and wide aisles make the *Desiros* accessible for disabled passengers and the operators make a point of encouraging cyclists and parents with young children as there are multi-purpose areas for the stowage of carriages, cycles, surfboards and so on.

The attractive new vehicles have attracted impressive passenger figures over the system's first year of operation. On the inaugural day, operator Veolia counted 12 921 passengers on 37 trains, including over 100 passengers on the first train of the day from Escondido at 04.33. From there ridership figures peaked in late 2008 at nearly 8 500 passengers per day but had fallen as low as the mid-6 000s during May 2008, with average journeys lasting ten miles.

The mid-year fall in figures can be attributed to US academic term times as it is estimated that more than 20% of Sprinter passengers use the system to reach educational institutions. With services to MiraCosta College in Oceanside, Palomar College in San Marcos and California State University San Marcos, more than 48 000 college students in the corridor now have access to public transit in getting to school. Students also benefit from discounted monthly passes sold on campuses and with campus parking at some institutions reaching USD300 per semester, suddenly the Sprinter becomes an attractive option for the school commute.

So although initial projections of 11 000 passengers a day may have been ambitious, there is no doubting that, with well over two million patrons in its first year, Sprinter is successfully reducing car use along the route. Encitas Mayor Jerome Stocks, who represents his city on the NCTD board, commented: "Each rider represents another car not adding to our traffic congestion situation."

Other local authority figures are impressed with the service that Sprinter gives to their communities: "Our community is very pleased to see the Sprinter bringing visitors to our downtown area and the job-oriented connections it offers," says Escondido councilman and NCTD board member Sam Abed. "We look forward to the growth of mixed use redevelopment projects around the station and the impact they will have on growing ridership."

Averaging out at more than 7 300 passenger trips each weekday – four times the figure that used the express bus service the new DMUs replaced – the congestion-busting and linked environmental benefits are self-evident.

On the system's first anniversary, NCTD board chairman Bob Campbell stated: "The Sprinter provides critical east/west connections that take cars off the road and reduce congestion along Highway 78. Additionally, the Sprinter will help transform our region by supporting development opportunities that spur economic growth and support increased revenues for cities along the corridor."

Diesel vs electric

Overall, Sprinter can and should be seen as a success and the decision to use DMUs instead of the more prevalent electric rolling stock seen in Europe and other US locations appears to have paid dividends.

In this respect Sprinter compares favourably with the two other diesel light rail operations in North America (the larger New Jersey Transit River line, running from Camden to Trenton, and the Bombardier-supplied five-mile Ottawa O-Train). Both these systems have successfully operated for some years and have shown that there is an alternative to catenary-supplied light rail traffic, especially where utilising existing capacity on freight lies is an option.

Capital Metro in Austin, Texas, is also close to running services for its 32-mile DMU commuter line and another is planned to connect the city of Denton to the Dallas LRT system. Already operating, as of early February, is a 13-mile DMU-operated line in the suburbs of Portland, so maybe for North American light rail, diesel is the future. *TAUT*

Network facts

Route distance: 22 miles
Stops/stations: 15
Operator: Veolia Transportation
Gauge: 1435mm
Vehicles: 12 Siemens *Desiro* VT642 DMUs
Capacity: 136 seated plus a further 90 standing
Information: *www.gonctd.com*

Tram-trains: are they worth it?

Clarifying the position and description of tram-trains, Robert Davidson weighs up the pros and cons of a concept being increasingly discussed in the light rail arena.

In the Netherlands, the 54 single-voltage *RegioCitadis* on RandstadRail have already covered 11.4m km. A new order for 18 additional vehicles was placed in November 2008; they will be built at Alstom's Reichshoffen plant in France. Alstom

There seems to be some misunderstanding in the UK as to what a tram-train IS and what it can DO.

A tram-train is not a simple way of replacing the UK's fleet of clapped-out diesel railcars, nor is it a way to reduce operating costs and improve services on lightly used lines. These objectives can be met by the innovative work being undertaken by the Department for Transport and Hertfordshire County Council (ably supported by Network Rail and consultants; here it is proposed that an already-electrified line should have the infrastructure upgraded following tramway precepts and recycled tramcars from the European mainland should be used for the service. If Network Rail looks at cost-effective ways of electrifying similar lines elsewhere, coupled with time separation to provide slots for freight, then we could see the emergence of some light rail lines in the UK similar to those seen in Switzerland. However, this is not tram-train.

A tram-train (see also *TAUT* 865) is a light rail public transport system where urban trams are able to run over railway tracks to access outlying commuter areas, offering seamless penetration directly into the heart of urban centres and the ability to serve traffic objectives remote from existing rail lines – without reducing the heavy rail network flexibility and routing options. It also offers a cost-effective solution to capacity constraints on key parts of the heavy rail network, by allowing local services to 'break out' into the street before reaching congested terminal stations.

Established concepts

The idea of tram-trains isn't new; some of the great American interurban systems did this before the Great War. The concept fell out of use and increasing safety worries about mixing comparatively light weight tramcar and interurbans with heavy railway trains militated against the concept.

Saarbrücken pioneered the rebirth of the idea – operating LRT tramcars both on urban streets and sharing infrastructure with 'heavy' railway trains. As this concept proved successful, it was applied to operations in Karlsruhe and elsewhere. Karlsruhe upgraded and integrated a *Kleinbahn* (narrow guage railway) into the network in 1961, they moved on to operation over a short length of lightly-used freight railway in 1979 and in 1989 this shared-use was extended over 4.4km (2.75 miles) of federal railway track to Hochstetten.

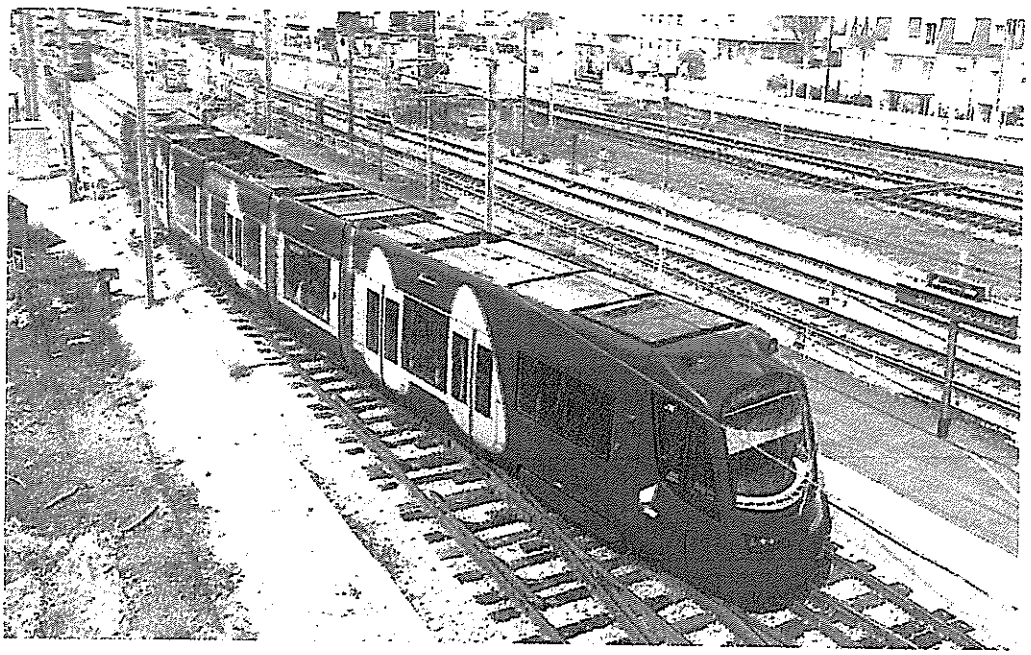
The line demonstrates all the features that make tram-train a success. It links major residential areas with the city centre and provides seamless access to important destinations; offices, shops, leisure facilities and the university. On the outer ends of the route, cars operate as a suburban train, running at relative high speed and with larger distances between stops. In the city centre they become conventional trams, running at a slower speed and with shorter distances between the stops. There are even some sections of mixed running with other road vehicles.

Of course tram-trains with improved performance offer a number of other advantages. Services can be speeded

FURTHER UK TRAM-TRAIN OPPORTUNITIES

- Linking the inner end of the proposed Borders Railway with the Edinburgh south suburban line, the new tram could provide a direct link from new commuter housing, Park-and-ride site and the west Edinburgh business area, without going through congested central Edinburgh.
- A simple link from Starr Gate to Squires Gate would allow the modernised Blackpool tramway to serve St Annes and Lytham.
- A link at Meadowhall onto the line to Rotherham would extend Sheffield Supertram services.

It is pleasing to see that having abandoned the Penistone trials the DfT and NR are now pursuing the Rotherham option listed above. It is a great pity that more of the others are not being actively developed at the same time.



up, getting greater productivity out of machinery and manpower while improving the competitiveness of rail. Alternatively, additional request stops can be added along the line, improving service to the community – without compromising overall journey time. Analysis in Germany has also shown that tram-trains, with their greatly improved braking performance, can reduce the number and severity of level crossing collisions on secondary lines. Tram-trains can thus offer lower operating costs, improved passenger convenience, better commercial performance and improved safety. At the same time, the lines will continue to be available to heavy rail trains, whether diverted main line trains, specials or freight trains.

Conversions require careful planning

Simply converting an unpopular heavy rail line to tram operation will not result in overnight success. The 'Manchester/Croydon miracle' only happens when the line serves places people actually want to go. It requires careful and thoughtful planning to find the potential winners.

What tram-trains are NOT is cheap. The difficult procurement of a small number of diesel electric cars for the proposed Penistone trial showed that; tram-trains only offer high value when certain conditions are met. The advantage over separate trams and trains is that passengers travelling from outside a city need not change from train to other transport at a central station, though some passengers are displeased by replacement of regular trains with tram-trains, which usually lack amenities such as on-board lavatories.

The concept needs:

1) Early masterplanning to identify areas that will benefit from direct services into the urban centre, to produce the overall system layout, to allocate the roles of different transport modes and to identify the consequences for urban planning.
2) Serious understanding of any compromises, especially if integrating an existing urban tramway. Being more complicated in its project structure, it is highly dependent on supportive political and regulatory structures.
3) Close management. Combining two existing infrastructures and regulatory concepts will not be easy and can result in cost escalation if not carefully managed. Main cost factors are possibly regional electrification, increased tramcar crashworthiness requirements, signalling and detection installations, physical railway and tramway infrastructure links, creating tramway infrastructure from scratch or necessary adaptations of the existing networks.

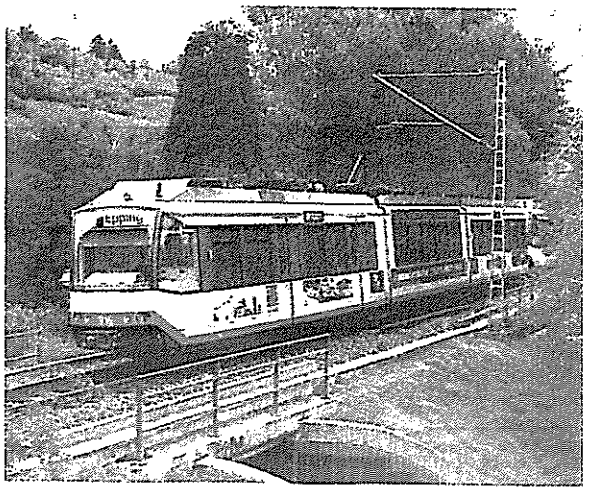
Some of these issues are not as onerous as is imagined. Cost contained electrification is possible – as are stored energy options. Some railways have adopted the concept of a 'mobile power house', coupled to an electric train at the end of the electrified section to allow the train to continue.

Increased crashworthiness adds weight and complication to a tramcar. It is far better to ask how many times collisions occur and finding methods of prevention than on increasing the likelihood of driver and passenger surviving them. This will lead to the introduction of improved signalling with active train stops, adding cost but increasing value if serious accidents can be prevented.

Adapting networks is not just a matter of enabling tramways to accept tram-trains, for although tramcars are narrower than trains their 'boxy' shape can give loading gauge problems under arched bridges. A further advantage is that they can relieve congestion on the railway network by getting local services out of busy main line stations. Thus converting the Marple and Glossop lines in the north of England to tram-train and routing them at Ashburys over Metrolink into the city centre could release up to four platforms at Manchester Piccadilly.

The opportunity value of this would probably pay for the whole tram-train conversion. Similar routing of many of the former 'Blue Train' routes onto the street in central Glasgow would relieve Central and Queen Street Low Level. Similar arguments could apply in Birmingham, Bristol, Edinburgh and Leeds.

So, tram-trains are NOT CHEAP and they are NOT SIMPLE. They require careful planning and consistent political support. But they can offer excellent value for money in improved public transport – both on lines served and in the terminal stations relieved of congestion. TAUT



Left: On the Eastern edge of Karlsruhe, KVV 916 is pictured at Grötzingen Oberausstrasse on 17 July 2009. Neil Pulling

Paris has also adopted the TramTrain concept, here an Alstom *RegioCitadis* unit is seen at Aulnay Sous Bois on the Paris T4 tramway line in April 2008. Neil Pulling

• Robert Davidson is the *nom de plume* of a leading international light rail consultant with over 30 years experience in planning and delivering public transport systems.

Tram-Train 25kv/750v

Next-generation tram-train is ready to roll

FRANCE The first of 39 Citadis-Dualis tram-train cars ordered by SNCF for routes around Nantes and Lyon has started test running in Pays-de-la-Loire, reports Dr Harry Hondius.

Photos: Alstom

The four-door 'périurbain' Dualis (top) was demonstrated in Nantes on February 6 (inset). The four-axle section 2 has a central door, whilst on sections 1, 3 and 4 the doors are located as far as possible from the powered bogies.

At a small ceremony in Nantes on February 6, Alstom Transport officially presented to local officials the first of 15 dual-system tram-train cars being supplied for use on modified railway routes in Pays-de-la-Loire. This marks the start of deliveries for the 39 Citadis-Dualis cars currently on order for two French cities within a framework contract for up to 200 vehicles placed by SNCF three years ago (RG 7.07 p420).

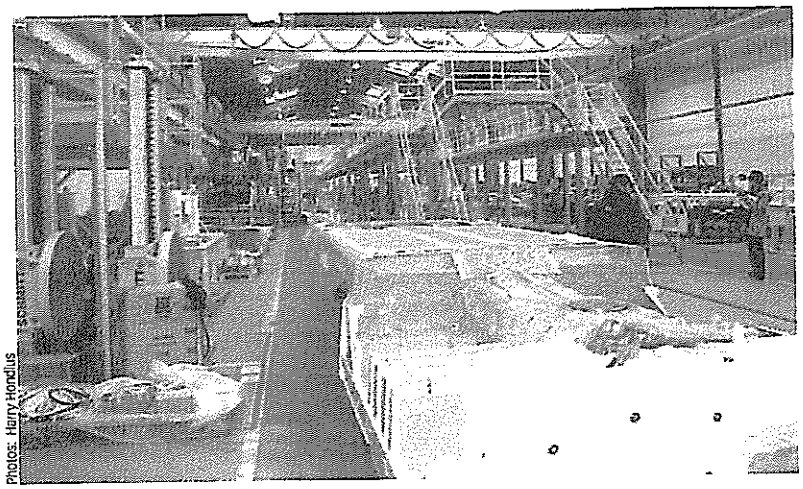
Although SNCF describes them cars will run solely on dedicated ex-railway routes, as happens on T4 in Paris and Bellegarde – Genève, and not work through onto conventional tram tracks. So it would be better to describe them as train-trams. The first real tram-train operation in France will be the Mulhouse – Kruth line which opens in December this year; this will be worked by 12 Siemens Avanto cars running on both the SITRAM tram network and the conventional railway to Kruth.

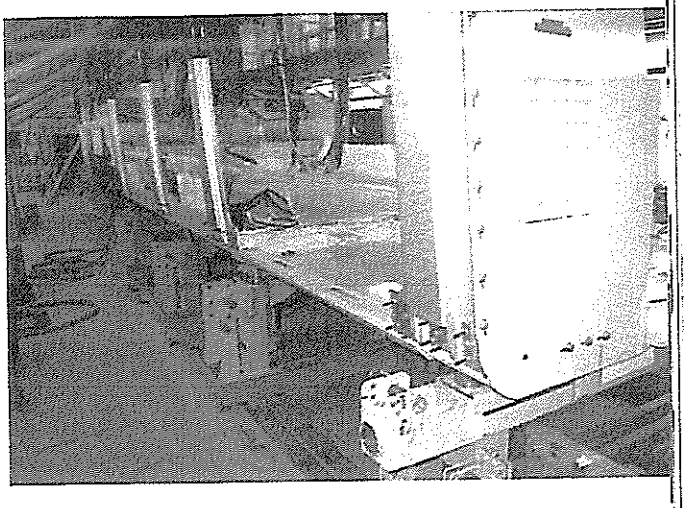
To undertake the development, production and testing of the Citadis-Dualis, Alstom established a dedicated team at its Petit-Fôret works in Valenciennes, designated *Tram Train Nouvelle Génération*. Production is now running at one car a month, but the company suggests that the plant could ultimately produce up to 2½ Dualis vehicles per month.

Two versions of Citadis-Dualis 25 kV 50 Hz/750 V DC model for Pays-de-la-Loire and a 1·5 kV/750 V DC model for Rhône-Alpes. The latest batch of eight 25 kV cars ordered in 2009 cost €3·49m each or 31 400 €/m²; this is quite a reasonable price by current standards for modern trams and LRVs.

More train than tram

Citadis-Dualis is essentially a 42 m long, 2 650 mm wide suburban train-set, with a buffing load of 600 kN and satisfying the EN 15227 crash-worthiness requirements. The dual-system 25 kV/750 V version weighs 65 tonnes, or 584 kg/m², but as this is spread over five bogies the maximum axleload is limited to 12 tonnes. With six permanent-magnet traction motors of 150 kW, the power-to-weight ratio of an empty car is 13·8 kW/tonne, comparable to a Transilien Z50 000 EMU.





Photos: Harry Hondius

correspond well with those of Alstom's Coradia Continental EMU now in operation on various regional lines in Bayern. The main differences are the smaller width of the Dualis cars, the higher deceleration rates available with electro-magnetic track brakes, and the ability to tackle 6·5% gradients and 25 m curves, which would make it possible to use the vehicles on tram tracks in towns. Each car has around 98 seats and space for 153 standing passengers.

The bodyshell assembly is similar to the Citadis tram family, but using structural steel for the side walls. It is a cold-formed construction with the parts bolted and Huckbolt riveted together; the roof is an aluminium sandwich. The welded-steel bottom parts are supplied from Katowice, bogies from Le Creusot, the motors from Ornans, the inverters from Tarbes and the electronic controls from Villeurbanne.

Offset articulation

The 42 m long four-section car has a Bo' 2' 2' Bo' Bo' axle arrangement, with three powered bogies. The two unpowered bogies are located under section 2, from which the remaining three sections are supported via the articulations. Section 3 is accessible for people with reduced mobility, and on the Nantes version this includes an accessible toilet — another first for a tram-train vehicle. The lower articulation supports use ball-and-socket joints, while the upper ones permit a degree of movement in all three planes; there are also two longitudinal dampers at each articulation. Hübner double-articulation modules provide a 1150 mm wide gangway between the sections.

on the roof. Section 2 carries the pantograph and the Areva transformer which weighs 2·8 tonnes. On the 1·5 kV version the transformer is replaced by a 1·5 kV/750 V down-chopper, which will reduce the weight by around 2 tonnes. A separate inverter is provided for each motor, and these are mounted above the powered bogies. The cars are air-conditioned, with two Thermoking units fed from a 60 kVA auxiliary inverter supplied by AB Turgi. All of the electrical equipment is air-cooled.

Without any doubt, the iXège bogies for Citadis-Dualis are very innovative, bringing the first use of permanent-magnet motors in a tram-like vehicle. The bogies have a 1850 mm wheelbase and 740 mm diameter V60 resilient wheels from GHH. The axle is split in two parts, a rotating sleeve driving the wheels and a fixed axle to carry the vertical forces. The traction motors are mounted longitudinally outside the bogie frame, and drive the axle sleeves via a cardan shaft and a conical gear. The non-driven bogies have a similar structure.

According to Alstom, the riding qualities at up to 120 km/h are excellent. Unfortunately, the author has not yet had the opportunity to sample the iXège bogies.

Floor height above the bogies is 530 mm above rail, with an 8% ramp leading down into the central parts of the saloon where the floors are at 405 mm; the entrance height at the doors is just 370 mm. The seats are 460 mm wide, arranged as 2+2 to leave a gangway width of 560 mm. Seat spacing between the face-to-back seats is 620 mm.

Above right: **The upper articulation between sections 1 and 2, showing the longitudinal dampers.**

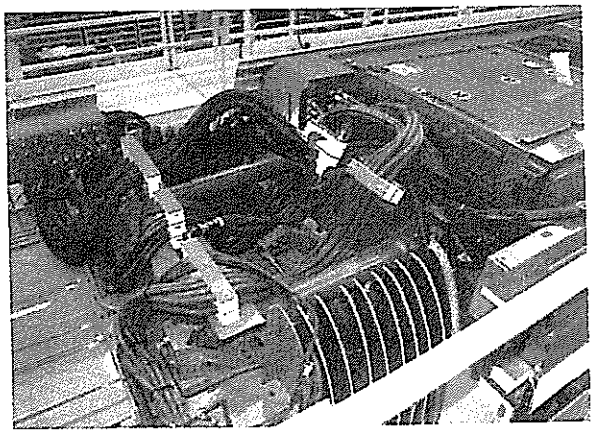
Right: **The lower articulation uses a ball-and-socket joint to transfer the weight of one section onto the offset**

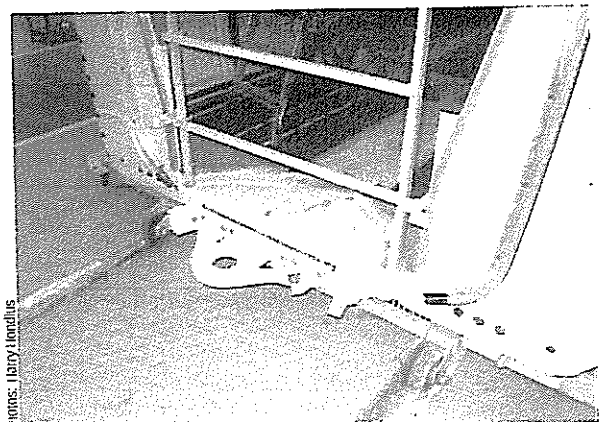
Testing and approval

Before delivery to Nantes, the first car was thoroughly tested at Wildenrath, at Valenciennes and on the Plouaret – Ploumérin section of the St-Brieuc – Brest line in Bretagne, which is electrified at 25 kV. Alstom's first priority is to obtain approval from EPSF for general use on RFF

Left: An inverted floor section, showing the recess for the bogie to turn. In the background is the Dualis assembly line.

Above: Bolted and riveted sides for an intermediate section.





Photos: Harry Hondius

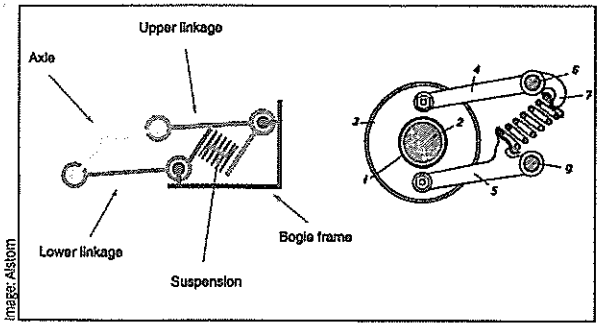


Image: Alstom

Fig 1. The primary suspension on the iXege bogie works on the parallelogram principle. The axle is supported from the bogie frame by upper and lower linkages which are separated by rubber/metal springs.

lines. It estimates that this process might cost up to €10m.

If the Dualis cars are to be integrated into a town tram network, they would also have to be approved by the appropriate authority STRMTG. However, as the tram networks in both Nantes and Lyon are designed for 2 400 mm wide cars and the Dualis cars have a width of 2 650 mm, it seems difficult to envisage any form of inter-running at this stage.

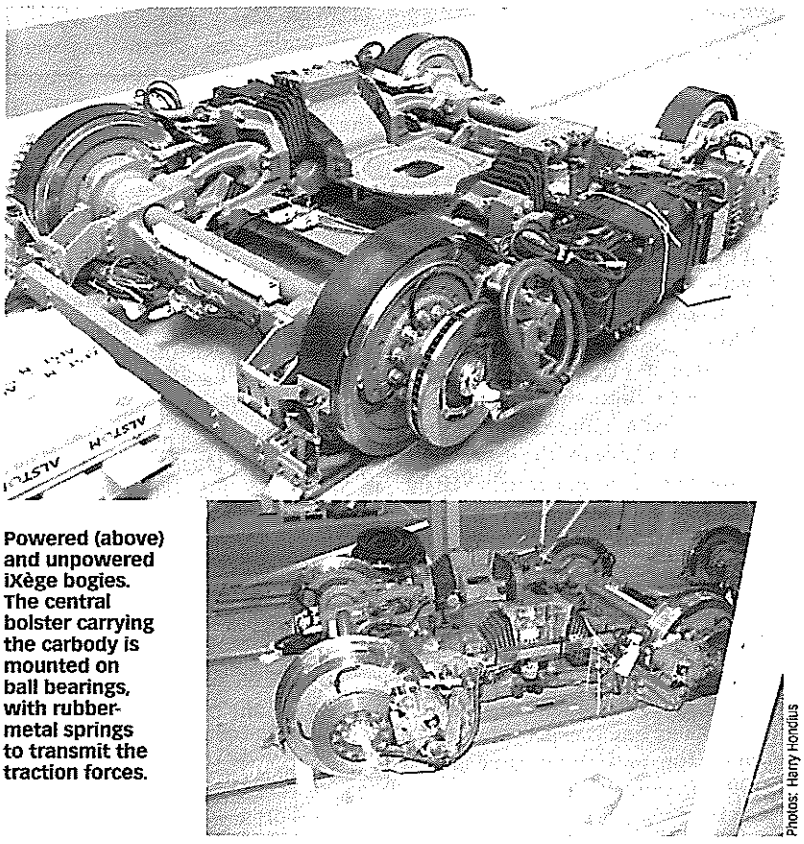
FRA 3.0

Two applications

Of the 39 cars ordered so far, 15 are destined for Pays-de-la-Loire. Of these, seven are due to start running later this year on the 31 km route between Nantes and Clisson, part of the Nantes – La-Roche-sur-Yon line which was electrified at 25 kV 50 Hz in 2008.

Photos: Alstom

Interior view, showing the 8% ramp descending from the higher floor over the bogie to the saloon level at 405 mm above rail.



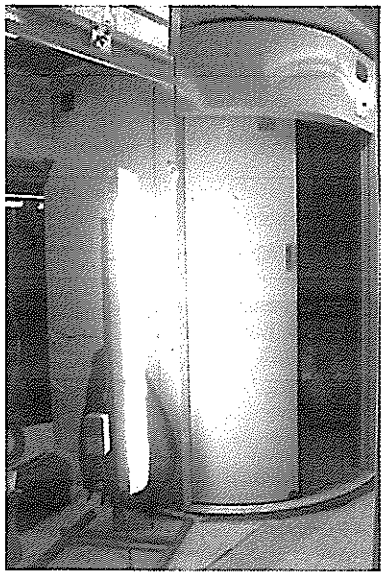
Photos: Harry Hondius

Powered (above) and unpowered iXège bogies. The central bolster carrying the carbody is mounted on ball bearings, with rubber-metal springs to transmit the traction forces.

The other eight will arrive in time for the reopening of the disused single-track line between Nantes and Châteaubriant. The first 26 km section as far as Nort-sur-Erdre is due to open in 2011, and the whole 61 km route to Châteaubriant is expected to be ready by the end of 2012. Most of this line is being electrified at 25 kV, but there will be a short section around the eastern side of Nantes wired at 750 V DC because of a flat crossing between the railway and the existing Nantes tram Line 1. All of these cars are to be based at a small depot which has been built at Doulon near Nantes.

The remaining 24 cars are destined for Rhône-Alpes, which will use them on the lines radiating from Lyon Saint-Paul; these are currently operated by diesel railcars. First route to be converted will be the 25 km Saint-Paul – Tassin – Charbonnières-les-Bain – Sain-Bel line which will switch to train-tram operation in 2011. This includes the 9 km section from Saint-Paul to Charbonniers which was electrified at 1·5 kV DC in 1954. Following the construction of a new curve at Tassin, the Saint-Paul – Tassin – Brignais route will be launched in 2012. A third route linking Tassin, Dardolly and Lozanne could follow in 2015.

The lines are being extensively rebuilt as part of the project, which was costed at €300m in 2008. Parts of the routes will be double-tracked, and the lines will all be electrified at 1·5 kV DC, although the cars are designed to operate on both 1·5 kV and 750 V DC. A new maintenance depot will be built at Arbresle. Current projections envisage around 13 000 passengers/day using the services in 2012.



The first train-tram in the world with a toilet.

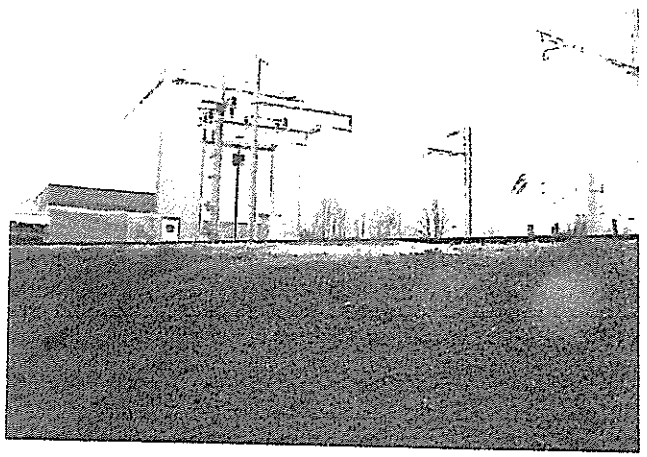
Where next?

With both Mulhouse and Nantes – Clisson starting in 2010 and Lyon next year, what will be the next tram-train application in France? The most likely the project is the 28 km Tangentielle Nord route being built around the northern suburbs of Paris. Linking Sartrouville on RER Line A with Noisy-le-Sec on Line E and T1, this double-track route will have 14 stops.

The line is being built alongside the Grande Ceinture freight ring, but the restricted alignment means that the width available for the new tracks is limited to 8·5 m, compared to 10 m for a conventional railway. Tangentielle Nord is ultimately expected to require a fleet of 83 Dualis cars, but only 11 will be ordered for the first phase linking Epinay-sur-Seine on RER Line C with Le Bourget on Line B. This section is already under construction at a cost of €300m. The complete line is expected to cost around €1bn, and would carry up to 150 000 passengers per day when it opens in 2017.

Another possible tram-train project in Ile-de-France is a route between Massy and Evry which is now under discussion. This would share RER Line C tracks between Massy and Epinay-sur-Orge, where the tram-trains would diverge onto a new tramline to Evry-Couronnes.

Another true tram-train project is envisaged in Alsace, linking Strasbourg, Entzheim, Molsheim/Barr or Weisswiller. This would be achieved by connecting the new Strasbourg tram Line F, which is due to open this year, with existing SNCF tracks, which would be shared with TER services. To allow through running, Alstom envisages a 2 400 mm wide version of the Dualis, but extended to 52 m long with another suspended module. However, the number of powered bogies would remain at three. No target date has been set for this scheme, but 2014 would seem possible.



Photos: Harry Hondius

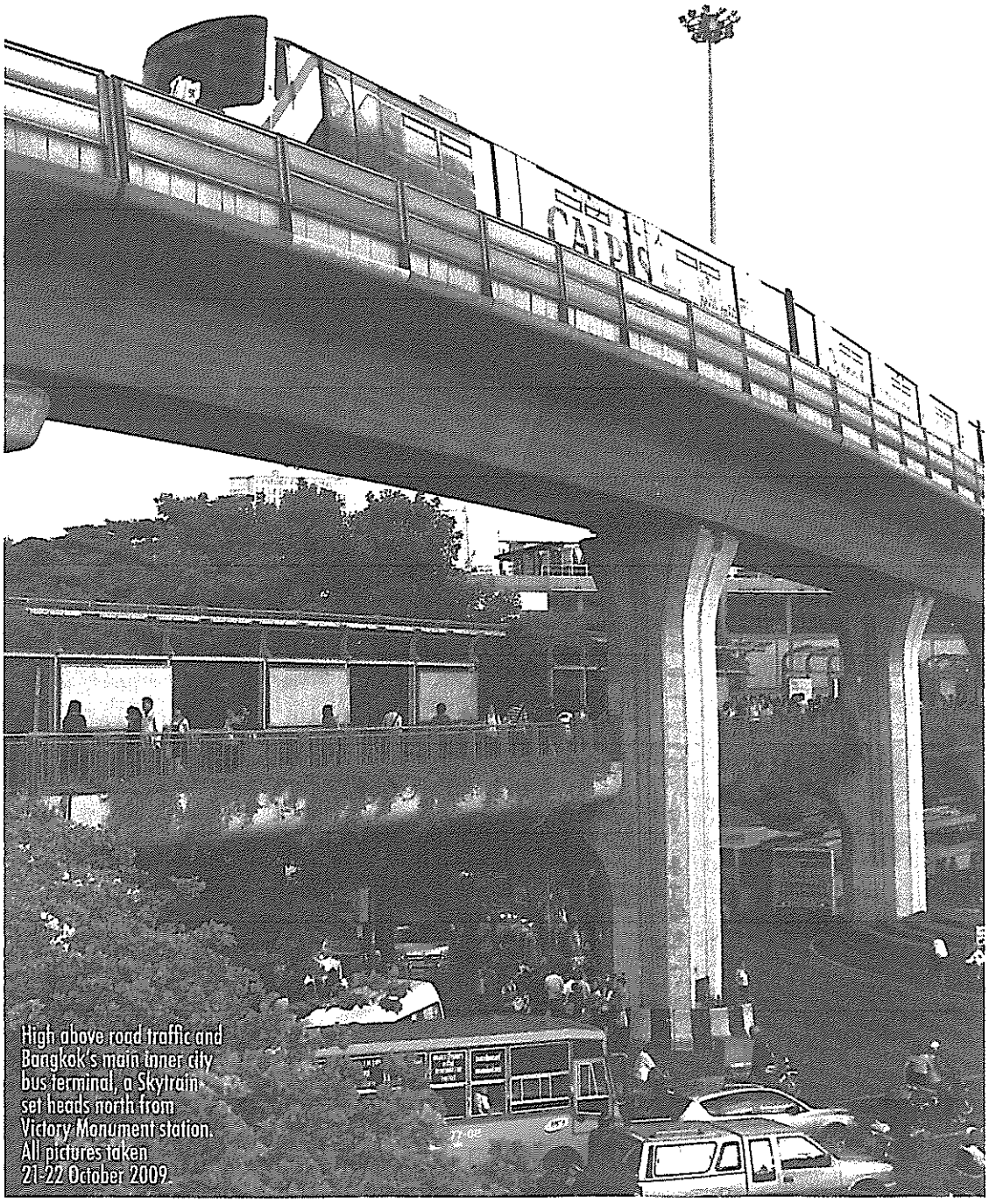
Above right: The Citadis-Dualis cars for Pays-de-la-Loire will be maintained at a new depot at Doulon on the outskirts of Nantes.

Right: A short section of the Nantes – Châteaubriant line is to be wired at 750 V DC because of the flat crossing with tram Line 1 at Haluchère.

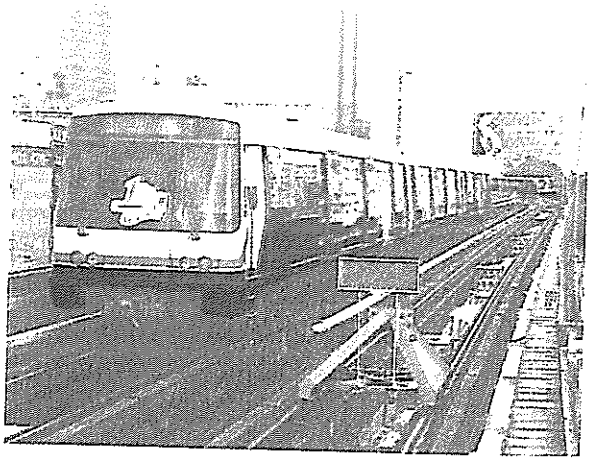
BANGKOK:
Multi-level urban transit

Ten years after the opening of the Skytrain elevated metro, *Tramways & Urban Transit* reflects upon the introduction of urban rapid transit in Bangkok, the present operations and some ambitious expansion plans.

REPORT AND PHOTOGRAPHY BY NEIL PULLING



High above road traffic and Bangkok's main inner city bus terminal, a Skytrain set heads north from Victory Monument station. All pictures taken 21-22 October 2009.



Left: No longer a Silom Line terminus, Saphan Taksin station's single platform creates a bottleneck to services now crossing the Chao Phraya river.

Right: Delivered from late 2007, City line and Airport Express *Desiros* are based at Khlong Tan depot in readiness for the Airport Rail Link opening.

follow a 20km (12.5-mile) route with 18 stations, broadly in the same commercial area of central Bangkok as Skytrain with which it has three interchanges. Operating with a normal 3.3-minute headway, the Metro has an average daily ridership of 170 000. Like Skytrain, trains have air conditioning, a particular attraction in Bangkok's climate. On the Metro this extends to stations, where platform screen doors are fitted throughout.

Although separate physically and as businesses, the two systems use near-identical 80km/h (50mph) three-car Siemens trains built in Vienna: 19 for Metro and 35 for Skytrain. An operational quirk is that stock maintenance for the underground Metro is at a spacious garden-surrounded ground level facility, whereas the counterpart serving the two Skytrain lines is in a cramped basement chamber of a development originally intended for retailing.

An end to Siemens' status as sole vehicle supplier to Bangkok's urban railways came in 2007 with a contract awarded by BTS to China's Changchun Railway Vehicles Co (CRC). Propulsion and control equipment for 12 four-car trains to handle growing Skytrain demand is being supplied by CRC partner Bombardier, which has also been contracted by BTS to provide a signalling upgrade. The CRC stock was expected to be delivered from China in late 2009.

The Siemens units for Skytrain and Metro (pictured) are very similar inside and out.

The Airport Rail Link

The Airport Rail Link is Bangkok's third modern rail project. Construction began in January 2005 with anticipated completion by November 2007, but with contractors unable to gain access to sites, delays began to accumulate.

With settled operational arrangements between Deutsche Bahn International and owners SRT, normal services could begin by April 2010. The 28km (17.4-mile) 25kV ac dual-track line runs from deep beneath the Suvarnabhumi Airport terminal to central Bangkok. Most of the route, which has 94% of the line on elevated concrete gantries, follows the SRT surface alignment. The infrastructure supports two services, Airport Express and City Line, both operated by 160km/h (100mph) Siemens *Desiro* units based on the UK platform as used for the Heathrow Connect Class 360. Four-car Airport Express trains including one car for containerised baggage will operate the point-to-point service taking 15 minutes between Suvarnabhumi and the Makkasahn city air terminal. Multiples of three-car units with high-density interiors will convey City line passengers using segregated platforms at these stations and with stops at six others. Open to airline passengers opting for a less expensive trip, the 27-minute end-to-end journey is expected to generate business from airport workers and commuters, with the city terminal at Phaya Thai giving interchange with the Skytrain Sukhumvit line. In a microcosm of the problems for getting the projects operational, a planned short bridge for level access between the two rail systems has not been installed, pending further agreements and separate contracts. The Airport Rail Link would be extended to serve a future second Suvarnabhumi terminal, but its greatest potential lies as the launch pad for a network of much-needed high capacity suburban lines.

Master Plan

With business activity stalled in Thailand as elsewhere, public expenditure is the main hope for bringing back economic growth and furthering Bangkok's regional aspirations. In November 2009 government approval was given to seek the equivalent of USD1.35m of foreign loans for rail projects including the 23km (14 mile) Metro Purple line and Skytrain extensions.

The Bangkok Mass Transit Development Plan for 2010-19 projects 372km (231 miles) of lines being added - a combination of extensions and wholly new routes – with an addition of 326km (203 miles) to the present combined Skytrain and Metro. Although small by comparison, a further 114km (71 miles) is envisaged for 2020-29.

Even with only part of these ambitions realised, the scale of contracts would be such that suppliers would be likely - or required - to set up factories in Thailand. As with the short Skytrain extension of 2009, any growth should make existing lines far busier due to the enabling of wholly rail-based journeys, perhaps the greatest current obstruction to increasing passenger numbers.

Before such expansion is underway, the lack of co-ordination between the systems needs to be addressed for increasing the network's appeal to anyone whose regular journey is not neatly confined to a single system. Contrary to the increasingly established international norm for travel in major cities, Bangkok's Metro, Skytrain and Airport lines each use different ticketing systems and there are no cross-mode passes. Such is traffic congestion across the city that a continuing problem for Skytrain and Metro is the ability of would-be passengers to reach their nearest station.

Similar problems prompted India's Delhi Metro Rail Corporation to involve itself in feeder bus operations to improve train loadings. However in spite of light rail's apparent suitability in the feeder role for Bangkok's heavy rail systems, the mode had not figured in transport planning here due in part to capacity limitations. However, such perceptions seemed to have been laid aside with an announcement in late November 2009 by the Bangkok Metropolitan Administration that a monorail or light rail could be the latest mode to join the transport mix. For the three initially identified lines, it was claimed that these could be installed within three years and at one-third the cost of equivalent Skytrain coverage. If this proves to be the case, in spite of the 'horses for courses' wisdom for future feeder routes, this would need to avoid replicating the inhibiting lack of integration that history ha given us in Bangkok's present urban transit system. TAUT

17.4 miles
15 mins = 69 bmph
2.5 miles/stop
38.6 mph