

THE INTERNATIONAL LIGHT RAIL MAGAZINE

TRAMWAYS & URBAN TRANSIT



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OCTOBER 2018 No. 970

FLORENCE CONTINUES ITS TRAMWAY RENAISSANCE



InnoTrans 2018: Looking into light rail's future



LRT automation

How much can and should we aim for?



Bydgoszcz

Growth in Poland's tram-building capital

- › Brussels, Suzhou and Aarhus openings
- › Gmunden line linked to Traunseebahn
- › Funding agreed for Vancouver projects



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Maintenance is just as important as expansion



For politicians, the public and the media it's always sexy to look at shiny new kit, or extensions that open up new travel opportunities. Yet it is vital that we remember that for every new piece of line, stop or depot we open, decades of everyday wear and tear will come with a maintenance bill.

It's a commitment not only in the original capital cost, but in many cases of significant further funds for decades into the future.

Much of the world's light rail and metro infrastructure – particularly on surviving first-generation systems – is getting on in years. Even many of the 'new' systems in places such as the US, France, Spain or the UK have now been around for 20 years or more.

In the US, the Department for Transportation produced a report in 2015 that put a 'State of Good Repair' backlog for public transport at nearly USD90bn – and climbing. Likewise, the American Society of Civil Engineers' 2017 Infrastructure Report Card rates public transport infrastructure as a 'D-', the lowest grade the ASCE gave to any category.

Such debates are not new – it was partly the cost of renewals that led to the waves of tramway closures around the world after World War Two. Yet it is still a very valid one.

Fortunately, technology has some of the answers. As you'll read in this issue's preview of the InnoTrans rail exhibition that as we write is about to take place in Berlin, automation, digitisation and robotics are increasingly offering answers to the cost-effective and predictive monitoring and analysis of infrastructure and vehicles. In this edition we also have an examination of tramway automation, increasingly moving from the metro sphere into other aspects of rail-borne transport.

Yet this can only ever be part of the answer. Building things brings commitments. While we rightly celebrate the 'new', we should never let that overshadow how we look after the legacy of what has come before.

Simon Johnston, Editor



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Cover images: Alessandro Fantechi, Siemens Mobility, Neil Pulling

Shanghai's new tramway to open on 25 December

Chinese megacity to add modern low-floor network to its metro offering on Christmas Day

The Shanghai Alstom joint venture has completed delivery of 30 double-ended 33m five-section *Citadis* 100% low-floor trams (with a contract value of EUR72m) for the city's first modern tramway. The two lines in the Songjiang district are expected to open on 25 December.

This year's opening will be of an initial 13.9km (8.6 miles); a further 16.9km (10.5 miles) is under construction for completion in 2019.

The five-year operations and maintenance contract for the full system has been awarded to a joint venture of Shanghai

Shentong Metro Group and Keolis, which will operate a ten-minute service 05.00-23.00 on east-west line T1 from Xinqiao to Chenta Rd. The network, with 46 stops, is expected to carry 170 000 passengers per day.

This is Keolis' first tram contract in China, although the international operator already operates the Pujiang rubber-tyred metro line in the southern suburbs, and the automated airport peplemover.

Shanghai's first-generation tramway operated from 1908 to 1975. A rubber-tyred rail-guided bus (Translohr system) has operated in the Pudong district since 2010.



▲ One of the first batch of Alstom *Citadis* trams for Shanghai stands at the Songjiang South interchange terminus between the new tramway and metro line 9. Keolis

▶ With construction of the southern extension of metro line 5 nearing completion, the opening for this 19.5km (12.1-mile) line is expected at the end of the year. With 7.7km (4.8 miles) underground, the latest extension (branching from Dongchuan Lu station to a new terminus at Fengxian Xincheng)

is also the first of the city's metro lines to cross the Huangpu River on an elevated alignment.

To handle the increased passenger volumes from the extension, the line will use six-unit trains (currently four cars) with stations on the existing 16.6km (10.3-mile) line renovated to match.

WMATA begins search for the 8000-series

Washington's Metropolitan Area Transportation Authority (US) has issued a Request for Proposals for the design and construction of its next-generation rolling stock, to be delivered from 2024.

Plans foresee the acquisition of at least 256 cars, designated the *8000-series*, to allow for retirement of the *2000-series* and *3000-series*. Options would allow purchase of up to 800 cars, giving the flexibility to support scenarios including expanding all trains to eight cars, more frequent trains, and retiring the *6000-series* fleet.

The *8000-series* will follow the Kawasaki *7000-series*. The 748th and final car of this roster is expected in 2019.

Features of the *8000-series* design will include new digital advertising screens; support for remote PA announcements from the Operations Control Centre; dynamic digital system maps; 110v power outlets; additional hand holds; and improvements to lighting, floor markings and signage for ADA space.

Proposals are due in January 2019, with expected contract placement late next year.



Aarhus Letbane adds interurban service

Test running on the Aarhus light rail extensions to Odder (29km/18 miles) and Lisbjergskolen (3km/1.9 miles) began on 16 July and Midtrafik carried its first passengers from 25 August. It is hoped to extend the line north over the rail line to Grenaa by the end of the year. In use are Stadler *Variobahn* (14 80km/h cars) and *Tango* (12 100km/h cars).

The lines to Odder and Grenaa had their conventional rail service suspended two years ago, and management was pleased that passengers returned in large numbers in the first days, when standing loads were recorded at peak periods and 40-50% loads off-peak. Letbane Director Michael Borre said: "Customers have taken great pleasure in



▲ ABOVE: The former heavy rail line to Odder takes a Stadler *Tango* LRV through rural scenery. Aarhus Letbane

◀ LEFT: The first Letbane departure from Odde collects passengers on 25 August. A. Christiansen/Aarhus Letbane

using our new service. From the start we have seen full trains at peak periods, but still many in the middle of the day. We see this as an expression that rail service has been missed, and that fulfils an important role for public transport in the area".

Citizens are now being consulted on stage two of the

Letbane project, a link from Braband in the western suburbs to join the existing line near Aarhus-H, and then branch off to the redeveloping docklands area at Aarhus-Ø.

▶ For a detailed description of the Aarhus Letbane project, see TAUT 963.

Royal ceremony for Brussels' latest tramline

Jette extension formally opened in September

Belgian monarch HM King Philippe inaugurated Brussels' new tramline 9 on 1 September, driving specially-liveried Bombardier Flexity 3111 out of Simonis station. The 3.3km (two miles) of new double-track links Simonis and UZ Brussel (Dikke Beuk/Arbre Ballon) in Jette. Regular services began on 2 September.

Apart from the subway interchange at Simonis, which uses the modified pre-metro subway built for line 19, the line is all on surface reserved track. Of that, 900m is shared with line 19.

There is a three-level underground park-and-ride

facility for 199 vehicles at Place Reine Astrid (Miroir), allowing the square there to be pedestrianised. Although 181 trees had to be felled for tramway construction, 240 new ones were planted as replacements.

The new 4.2km (2.6-mile) line 9 and the extension of line 94 (8) to Roodebeek represent an investment of EUR76.4m in Brussels' tramway in 2018, although the new line was first proposed in 1981.

Work will start next year on a 1.5km (0.9-mile) extension of line 9 to Heizel (Stade Koning Boudewijn metro station, lines 51 and 93). Some politicians would like the line to eventually reach Zaventem international airport.



▲ HM King Philippe driving Brussels Flexity 3111, with its royal headboard, along Avenue de Jette from Simonis to Miroir on 1 September. Quentin Jo

Although the decision to provide a fast link between Simonis metro station and the University Hospital was taken in 2003, finance was not agreed until March 2012, and tracklaying for the new line did not begin until mid-September 2015. The first tram to be placed on the tracks was PCC 7749, fitted out as an information

office for the project. Full-scale test running started at the end of June 2018.

Nine 3000-series Bombardier Flexity low-floor trams, running every six minutes at peaks and every ten minutes off-peak, now work line 9. At evenings and weekends there is a 15-minute service. The new tram replaces bus line 15.

Portland plans to order up to 66 new LRVs – and to refurbish 79 more

TriMet (Portland, OR) has issued a Request for Proposals for LRVs to replace 26 high-floor Bombardier cars, its Type 1 car, which date from 1983-86. There is an option for eight more for the planned extension of Red line service to Fair Complex/Hillsboro Airport, and a further 32 for the Tulatin line, if approved. Unlike TriMet's last two orders, the new Type 6 cars will be double-ended.

The last original car to emerge from the agency's in-house Body

Overhaul programme, 112, returned to service in April, and for the first time since the start of that programme in 2003 all 26 Type 1 cars are now in service. Three cars (102/3/16) will not be overhauled.

Seven of the Bombardier cars have two pantographs, one of which is for ice cutting and has a heating element, but does not draw power from the overhead. These ice-cutter pantographs were added to 107-12 in 2006, but the

seventh-and-last such fitment took place in early 2018, with 113 being fitted due to car 112 (out of service for the Body Overhaul work since 2015).

The overhaul programme proceeded more slowly than anticipated, with 23 cars dealt with in a span of 15 years, due to a TriMet staff shortage that frequently caused work to be suspended. In its latest union contract, TriMet successfully negotiated for the right to hire an outside contractor to perform such work in future, and this method will be employed for a 'Mid-Life Overhaul' of Type 2 and Type 3 cars (Siemens SD660).

A Request for Proposals for this work was issued on 20 August. Covering all 79 cars, the work will be more extensive than the overhaul programme of the Type 1 cars, encompassing nearly all mechanical components as well as the bodies.

The work is to include repainting into the agency's current livery; to date, only two vehicles (203/35) of the 79 SD660 LRVs have received the livery, which was adopted in 2002.

Suzhou opens tramline 2

Free travel on new tramline 2 took place in Suzhou, China, for six days from 25 August, with regular service starting on 31 August.

From an interchange with line 1 at Longkang Rd, the line runs 17.2km (10.7-mile) to Suzhou New District railway station, with a 1.3km (0.8-mile) branch from Hogfu Road to Wenchang Rd. Services run 06.30-21.30, with ten-minute peak headways and a commercial speed of 27.5km/h (17mph).

A fleet of 18 five-section trams was delivered by CRRC Nanjing Puzhen, using Škoda Kingway electrical equipment.

Line T3 (due to open in 2019) will link Suzhou New District station with the terminus of line T1 and metro line 1 interchange Amusement Land, requiring a further six trams. Three more lines are proposed.

Meanwhile, four new metro lines have had CNY95bn (EUR12bn) in funding approved; construction of lines 6, 7, 8 and S1 should start in 2019. They will add 137km (85 miles) to the existing three-line 105km (65-mile) network.



▲ Portland Type 1 LRV 119, coupled to Siemens car 318, seen inbound on the Tilikum Crossing Bridge. This is one of 23 given a body overhaul and the new livery. S.J. Morgan

Two new Vancouver light rail projects gain funding approval

Federal and provincial money agreed for Surrey LRT and SkyTrain extension

On 4 September, Canadian Prime Minister Justin Trudeau and British Columbia Premier John Horgan confirmed more than CAD3bn (EUR1.95bn) in federal and provincial funding for the Surrey – Newton – Guildford LRT project and the Broadway Subway extension of TransLink's Millennium SkyTrain line.

The 10.5km (6.5-mile) Surrey – Newton – Guildford route would be the province's first light rail line, running between 152nd Street in Guildford and Newton with 11 stops and

using segregated lanes along 104th Avenue and King George Boulevard. Offering five-minute service during the peaks, opening is planned for 2024.

The CAD1.65bn (EUR1.1bn) scheme will be delivered by regional authority TransLink, with contributions from federal and City of Surrey sources.

The Broadway Subway would extend the existing Millennium light metro for 5.7km (3.5 miles) to the west in-tunnel from VCC-Clark station to Arbutus Street, adding six stations. Work is expected to begin in 2020 for an opening in 2025.



▲ An image of what the future LRT may look like, running on Surrey's King George Boulevard at 76 Avenue. Translink

This CAD2.83bn project is to be funded and delivered by the province, with contributions from the Federal Government

and the City of Vancouver. Both projects are part of Translink's ten-year plan to enhance transit options.

Edinburgh's vigilance device challenge

An innovation challenge has been launched by Edinburgh Trams and the City of Edinburgh Council (UK) for a device to detect when a tram driver might be about to lose consciousness or focus due to illness or fatigue, and notify the control centre. Funding of GBP168 000 (EUR188 000) is to come from Scottish Enterprise's Can Do Innovation Fund. The project is also supported by UKTram.

A consultation process took place in September with businesses on the proposed GBP165m (EUR185m) Newhaven tramway extension. Prospective contractors will be asked to make provision for measures to help sustain local business during construction. These are estimated to cost in the region of GBP500 000 (EUR560 000) and will include local hubs for parking, deliveries and goods storage as well as additional signage and pedestrian crossings.

The project's Final Business Case and route layout is expected to be decided by councillors in December.

➤ Edinburgh Trams celebrated its busiest ever Festival during August with over 600 000 customer journeys made – up more than 7% on last year.

Preferred alignment chosen for New York's Brooklyn Queens Connector

After two years of preliminary studies, on 29 August New York Mayor Bill de Blasio announced a revised plan for the proposed Brooklyn Queens Connector (or BQX) light rail line.

The plan now calls for a 17.7km (11-mile) line with 26 stops from Gowanus, passing through central Brooklyn to Astoria. The route is planned to move away from the waterfront to better serve downtown Brooklyn and to give greater connectivity to the city's subway and bus routes.

The study determined that the revised project scope would cost USD250m/mile (USD155m/km), up from the original projected USD150m/mile (USD93m/km) estimate, largely because of the complexity and condition of underground utilities.

Overall the new plan comes with a revised cost estimate of USD2.73bn (up from the previous

USD2.5bn), with passenger service beginning in 2029 and not 2024 as initially projected. Environmental impact studies will begin this winter.

Originally the new line – also linking Red Hook, Williamsburg, Greenpoint, Long Island City – was expected to pay for its own construction through property taxation along its route, but a 2016 city policy now earmarks this funding for other purposes, such as affordable housing.

New York City's Deputy Mayor for Housing and Economic Development Alicia Glen said the city anticipates that the public-private partnership contracted to build the line would contribute up to 10% of the total cost, leaving a USD1bn funding gap to come from Federal Government sources.

Former Metropolitan Transportation Authority

Chairs Richard Ravitch, Tom Prendergast and Jay Walder and former MTA CEO Elliot Sander have offered their support to the project in a written statement published by the support group Friends of BQX: "There are few, if any, projects that match the potential of the BQX to expand opportunity in an equitable way for a wide range of New Yorkers. And we know that light rail, with dedicated right-of-way and high ridership capacity, is by far the best mode of transit to accomplish that."

Following the 29 August announcement, Mayor de Blasio said in a statement: "It is time for our transit system to catch up..."

"The BQX is one of the biggest, most ambitious projects in a generation. It will be a challenge, but New York City is taking it on."

CAF completes takeover of Polish bus and tram builder Solaris

CAF finalised its acquisition of Polish bus, coach and tram builder Solaris on 4 September. The Spanish rail equipment supplier has also entered into an agreement for the PFR Polish Development Fund to acquire a 35% stake in Solaris.

Solaris currently holds contracts for the supply of its *Tramino* low-floor tram to the Polish city of Kraków and the German cities of Braunschweig and Leipzig. The company is also a global bus supplier; it has plants in Sroda and Bolechowo.

Announcing the deal, CAF President & CEO Andrés Arizkorreta said in a statement: "Together with Solaris, we will create a leader in urban mobility solutions beyond rolling stock, particularly in the e-mobility segment."

Spårväg scheme now complete

Line 7 route into the city centre forms key link and connects to metro services

The 560m double-track extension of tramline 7 in Stockholm (Sweden) opened on 3 September; car 461 was the first tram to negotiate the route from Kungsträdgården to T-Centralen.

The key extension promises an uplift in passenger numbers by drastically improving the tramway's utility in the Swedish capital: the new section of line offers connections to Stockholm C station as well as metro lines.

This completes the first phase of the Spårväg City project that began in 2010 with the expansion of the existing museum operation that took place between Norrmalmstorg and Waldemarsudde. It became the first modern tramway to run in the Swedish capital since the change from driving on the left to driving on the right in 1967.

Services are run by Stockholms Spårvägar, a company owned by the Swedish Tramway Society, on behalf of Stockholm County.

The results of investigations into an extension from Djurgårdsbron to Frihamnen are due to be presented in 2019.

Line 7's new end-point at Klarabergsgatan is a stub, meaning that only double-ended trams can be used. Museum trams on line 7N normally turn on the loop at Norrmalmstorg.



▲ The formal ribbon-cutting of Stockholm's tramline 7 extension at the new T-Centralen terminus on 3 September. Thomas Johansson

Hamburg plans for S-Bahn automation

Deutsche Bahn, Siemens and the German city of Hamburg have signed an agreement that should see the first automated S-Bahn commuter rail line in operation by 2021. The 23km (14-mile) section of S21 between Berliner Tor, Bergedorf and Aumühle will be equipped for automatic train operation, with four S-Bahn sets fitted with the technology. This is the first example of metro-style automation being applied to a commuter rail network.

The EUR60m cost will be shared between the partners. The future European Automatic Train Operation (ATO) will be used, with radio-based ETCS Level 2. A driver will be retained on each train in the short to medium-term to manage any disturbances or irregularities. However, in a further extension of the principle, trains will operate between Bergedorf stabling sidings and station platforms without staff on board.

If everything proves successful, the principle will be extended to the whole Hamburg S-Bahn network.

Hamburg S-Bahn is currently taking delivery of 60 new ET490 three-car trains built by Bombardier in Hennigsdorf.

NTA – Metropolitan Mass Transit System Ltd, Israel



Tender No. 097/2018

Invitation for Pre-Qualification to Participate in Tenders for the Tel Aviv Metropolitan LRT Network – the “Green Line” and the “Purple Line”

1. NTA, in accordance with its obligations under the Israeli Mandatory Tenders Law, 5752-1992, the Mandatory Tenders Regulations, 5753-1993 (the “Regulations”) and further implementing regulations promulgated thereunder, hereby invites entities and consortia from the private sector in Israel and abroad, to participate in a pre-qualification process for tenders for PPP projects for the design, finance, construction and maintenance of light rail train lines (the “Green Line” and the “Purple Line”) in the Tel Aviv metropolitan area, all as further described in the Invitation for Pre-Qualification (the “Projects”).
2. Pre-Qualification Requirements – The participants or other entities participating in the applicable consortia shall be required to demonstrate compliance with the Professional Pre-Qualification Requirements, Financial Pre-Qualification Requirements and all other requirements, all as detailed in the Invitation for Pre-Qualification.
3. The Invitation for Pre-Qualification and any updates thereto shall be available for online review, at the following website: <https://www.nta.co.il/ppptender>, for no charge.
4. Any questions or requests for clarifications shall be addressed in writing only to Tender's Mailbox: ntatender@nta.co.il by no later than October 15, 2018.
5. Submission Date – the date for the submission of the Pre-Qualification Submissions is December 13, 2018, by no later than 14:00 (Israel standard time).
6. This notice contains general and preliminary information only. Participants are required to comply with all the provisions of the Invitation for Pre-Qualification in their entirety.



Bolzano trams in the 2019 State budget

At a meeting between Bolzano Mayor Renzo Caramaschi and South Tyrol Regional Governor Arno Kompatscher on 2 August it was agreed that plans for a 7km (four-mile) tramline for the Italian city should be put forward for State funding in 2019.

The line would link the rail station and the Sigmundskron transit interchange in the south-western suburbs, using 40m trams. Design and construction would be overseen by Struture Trasporto Alto Adige, which is 100% owned by the province.

The city had first-generation trams from 1909 to 1948.

New rail proposals for Heathrow Airport

Spelthorne Borough Council (UK) is promoting a GBP375m (EUR420m) light rail link from Staines-upon-Thames to Heathrow Airport. The scheme would be privately financed and largely run alongside the M25 motorway corridor, on 'brownfield' land.

The proposal is in competition with schemes for heavy rail lines submitted by Windsor Link Railway and Heathrow Southern Rail. Spelthorne Borough Council leader Ian Harvey said the LRT proposal would both reduce road congestion and bring an economic boost, saying that for the council the scheme was a "no brainer".

Metrotenerife selected for Cuenca consultancy

Consultancy Metrotenerife has been chosen by the city of Cuenca, Ecuador, to assist with operation of the new tramway due to open in 2019. The 9.9km (six-mile) line is to be the first in the South American country. Expected daily ridership is 45 000, on a route that will cross Cuenca's historic centre, and combine single and double track.

Metrotenerife's contract, worth approximately USD3.5m, covers 43 months and covers various aspects including preparation for operation, supervision, and implementation of quality controls. > For more on the Cuenca project, see TAUT 969.

Sorocaba light rail studies

The city of Sorocaba, Brazil (population 660 000) has issued a request for proposals to conduct feasibility studies for a 24.1km (14.9-mile) light rail line linking Brigadier Tobias and George Oetterer on the alignment of the existing east-west railway.

The studies will look at project structure and possible concession models. The 13km (eight-mile) first phase is scheduled to begin operation in late 2020.

For a preview of the highlights at Berlin's InnoTrans exhibition see page 370

Gmunden tramway joins StadtRegioTram network

Connection of metre-gauge Austrian lines marked with free rides

One of the world's smallest tramways, operating in the lakeside

Austrian town of Gmunden, was subsumed into the *StadtRegioTram* operation from 1 September, running through over the Gmunden-Vorchdorf light railway (Traunseebahn).

The metre-gauge 2.3km (1.4-mile) line, with its 10% gradient, was built by engineers Stern & Hafferl in 1893-94 to link the 1877 railway station above the town with Rathausplatz.

The tramway was cut back from Rathausplatz to Franz-Josef-Platz in 1975 to ease traffic congestion in the narrow town centre street. However pandering to the motorist is no longer on the town's agenda, partly thanks to the pressure group Pro Gmündner Strassenbahn (founded in 1989, when the existence of the tramway was threatened); in February 2013, after several years of study, the decision was taken to link the two lines by building new tracks, back to Rathausplatz, then through the city walls at Trauentor and across the rebuilt Traunbrücke river bridge to Klosterplatz, terminus of the Traunseebahn since 2014, and Seebahnhof.

A total of 650m of new double-track route has been laid, with the EUR30m project cost divided between the *Land* of Upper Austria and the town in the ratio 80/20, though the latter received various grants and donations that reduced its effective cost to EUR1.5m.

During the Gmunden tramway's existence it has been served by 13 trams, including what was until recently Stern & Hafferl's last new tram, bogie car 8, delivered by Lohner in 1961. There are a further two bogie trams, 9 and 10, purchased in the 1970s from the closed Vestische tramway in Germany, which originally bought them from Düwag in 1952. Historic trams 5 (Graz 1911) and ex-Linz Pöstlingbergbahn open-sided cross-bench tram 100 (Graz 1898) complete the traditional fleet.

The double-ended trams, which carried 318 000 passengers/year and ran every 30 minutes, were unusual in

The *StadtRegioTram* Gmunden with the new section highlighted in red.



▲ A wet 25 August with the farewell parade of historic trams 100, 5, 8 and 9 at Franz-Josef-Platz; car 10 in blue advertising livery is drawing up at the rear. A.Varga

featuring doors on one side only, since all the platforms were built on the same side of the line.

The 14.9km (9.3-mile) Traunseebahn electric interurban linking the east side of Gmunden with the agricultural town of Vorchdorf-Eggenberg, also built and operated by Stern & Hafferl, dates from 1912. The timetable listed 20 trains/day, and second-hand stock has been a feature of the line, including some from Swiss light railways. The line is noted for its heavy scholar traffic, with extra trains to cope with the number of young people needing transport.

Stern & Hafferl has purchased 11 five-section 32m *Tramlink* LRVs from Vossloh-Kiepe, of which three are allocated to the *Attergaubahn* from Vöcklamarkt to Attersee, and the remainder to the new *StadtRegioTram* service.

The new timetable features four departures per hour, of

which two run as far as Engelhof, the historic station on the outskirts of Gmunden where a new park-and-ride facility has been built. The other two reach Vorchdorf-Eggenberg in 38 minutes. The first test LRV ran across the Traunbrücke on the evening of 6 August. *Tramlink* cars 129/31 took over operation of the Gmunden tramway from 17.30 on 10 August.

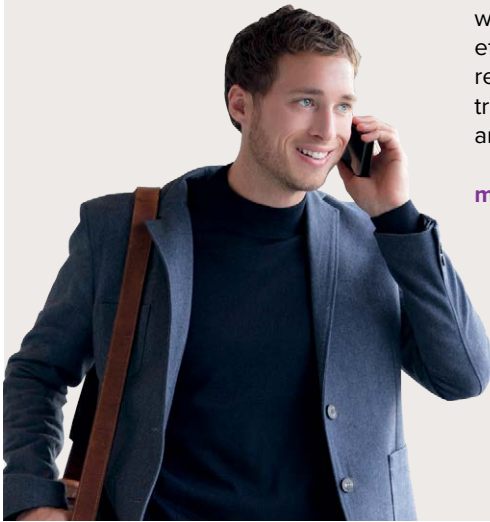
The old trams were given a suitable send-off on 25 August, after which the 57-year-old car 8 joined the historic fleet and 9/10 were earmarked for German museums. The opening of the new service on 1 September was marked by a series of events from 09.00-22.00, with a ceremonial ride by Federal Transport Minister Norbert Hofer at 11.00.

Regular service started the following day, with free travel offered for two weeks.

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NEXT STOP: BERLIN

Geoff Butler previews some of the exciting technologies on display at the world's biggest railway trade fair, September's InnoTrans.



Siemens will be demonstrating what it claims to be a world first in autonomous tram operation in partnership with Potsdam operator ViP during the InnoTrans exhibition. Siemens

With around 3000 exhibitors from over 60 countries, this year's InnoTrans exhibition in Berlin (18-21 September) is once again set to showcase the latest developments at the rail industry's biggest international trade exhibition. This biennial event is a great opportunity to see next-generation innovations and concepts up close, as well as to explore the latest products and services from global suppliers.

Showing continual growth since it moved to Berlin in 1996, InnoTrans will host a total of 140 vehicles on display on Messe Berlin's 3.5km (2.2 miles) of outdoor tracks between 18-21 September. That is in addition to the 41 halls, covering over 200 000m² of indoor space.

New vehicles on display

Although debuted at PK Transportnye Systemy's plant at Tver on 20 July, InnoTrans sees the first overseas display for the new *Lion* and *Lionet* 100% low-floor models from this rapidly expanding Russian concern.

The single-section 100% low-floor *Lionet*, designated 71-911M, is a development of the *City Star* platform supplied to Rostov Na-Donu with the capability for catenary-free operation as well as design modifications and a new driver's cab. The 16.5m double-ended version will be displayed in Berlin before it embarks on longer-term operational trials in Perm. The 37.4m *Lion* is a three-section version.

Both will be standard gauge versions, demonstrating the firm's export ambitions.

Siemens will again have one of the largest exhibitions in Berlin, including a display of one of the 12 *Avenio-M* low-floor trams destined for the German city of Ulm that includes the company's 'Tram Assistant' collision warning system. In nearby Potsdam (27km/17 miles to the south-west), the company is partnering with undertaking ViP to demonstrate autonomous tram operation to the world's media with a modified *Combino* tram on a 6km (3.7-mile) section of that city's network. For a more detailed analysis on the latest developments in tram automation, see page 374.

The company will also be displaying an *Inspiro* automated metro car destined for the Bulgarian capital of Sofia and the first of 25 *Cityval* automated peplemovers on order for Rennes' Line B (France), due to open in 2020.

Stadler will display the first 1220mm-gauge driverless trainset that it is supplying as part of a GBP200m (EUR222m) joint venture with Ansaldo STS to the Scottish city of Glasgow. These 39.24m walk-through trains feature the latest in digital passenger information, entertainment and security features and will be running under Unattended Train Operation on the city's Subway from 2021. Further displays include next-generation *S-Bahn* cars for Berlin, to be delivered as part of a framework contract with Siemens for up to 1380 cars for delivery from 2021.

"A total of 140 vehicles will be on display... in addition to the 41 halls that cover over 200 000m² of indoor space."

Chinese manufacturers are set for a strong showing again in 2018, with CRRC displaying its innovative composite-bodied 'New Generation Metro' concept. Promising a 13% weight saving over traditional steel-bodied metro trains, as well as energy efficiency improvements of 15%, the NGM also uses advanced traction technologies using silicon carbide permanent magnet motors and fully active suspension systems and is designed for either manual or automatic operation at speeds of up to 140km/h (87mph).

Another interesting concept – jointly developed by Xinzhu, Southwest Jiaotong University and Voith – is the 100% low-floor *XZD-100* that will also make its international debut. With a modular design, common platform and hybrid technologies, it offers lower lifecycle costs as well as the potential

for long-distance catenary-free operation. With a passenger capacity of 353 and a turning radius of 25m due to an advanced bogie design, the consortium behind its development claims that it is the most advanced tram design on the Chinese market and is up to the very best on offer from the established western manufacturers.

Meanwhile, as part of the UNIFE Shift2Rail initiative, CAF will be presenting the world first view of its virtual coupling mechanism for light rail vehicles. Entitled 'Connected Trams', this is the first deployment of CAF's TCMS wireless backbone, which controls functions such as propulsion, braking, doors, lights and passenger information. Combining sensor data and vehicle-to-vehicle communications, the system is able to control the distance between vehicles.

A variety of interactive presentations will be displayed on the Bombardier stand, including virtual reality suites offering 360° views of one of the latest *Flexity* LRVs for Zurich and a *Movia* metro train in Stockholm, while Alstom will be exhibiting its SRS ground-based charging solution for tramways, as installed in the recently-opened Cadam-Magnan section of Nice's new line 2. The company's established APS technology is also now available for road vehicles and this will also be shown in Berlin.

Digitisation and automation

Automation across all fields is a key focus of this year's event, with German company Vollert, for example, presenting its new road-rail robot. The battery-operated (and therefore emission-free) model is designed for use in depots and stabling yards, with one-man operation and a towing capability of up to 300 tons. Individually controlled wheel hub motors promise agility and economy – the first units are already proving themselves with German tramway operators such as Stuttgarter Straßenbahnen (SSB).

Asset management is going through its own quiet revolution with robots, sensors and algorithms replacing manual inspection



and testing. I-Moss will demonstrate how robots can be used for rail head measurement and the detection of rolling contact fatigue and rail roughness with its autonomous trolley. Using a brushless DC motor with energy recuperation and a GPS-based 'engine' to execute pre-programmed inspection routes, safety is ensured by real-time camera supervision and ultrasonic object detection.

Infrastructure specialist Vossloh will be exhibiting its 'intelligent infrastructure' concept, with technologies for both stationary and mobile condition-monitoring that also include integrated microprocessors for real-time data processing and analysis. Using its Easyswitch MIM-H point machine as an example, the company will be showcasing its use of 'digital twins' to create virtual replicas of physical components or systems to investigate performance and functionality. This digital approach will also feed into future research and product development.

Similarly, Strukton Rail is using InnoTrans to unveil new automatic video recognition technology which can identify potential track defects before they occur using contactless real-time measurement. Combining the company's track expertise with Siemens' Railigent data analytics

technology, laser scanners are mounted in the track area and calibrated to a common baseline. As a vehicle passes, the diameter, profile and distance between the wheels are measured and corresponding tolerances are given. The sensors are self-cleaning and virtually maintenance-free, reducing labour costs of manual inspection.

Meanwhile, 3D printing specialist Stratasys will demonstrate the value of additive manufacturing for the rail industry and how this game-changing technology is reinventing the supply chain. The US-based company's new Fortus 450mc 3D Printer offers the capability for rapid tooling and final part production to give operators the opportunity to cost-effectively print replacement parts on-demand.

Of course, the move to digital and connected technologies brings with it cyber security challenges and Spanish technology firm Revenga Smart Solutions will be premiering CiberTrack, its network cyber-attack protection system. Certified to the highest international standards, this innovative new encryption solution is fully adapted to the needs of railway operators and using the IPsec protocol makes it compatible with other off-the-shelf solutions.

Infrastructure innovation

With all the world's biggest players at InnoTrans, one of the very biggest, Pandrol, is to showcase its four specialisms in Berlin: rail fastenings, aluminothermic welding, electrification and control systems. It will also be hosting 'ask the expert' sessions, with seminars on topical issues such as smart monitoring systems, floating slab track solutions for urban environments and pre-assembly efficiencies through robotics.

Mechan, the British-based depot equipment specialist, will be using its largest stand to date to further raise its global profile following its recent takeover by France's CIM Group. This includes a fully-working version of its flagship lifting jacks used by rail operators around the world that allow one-man operation to avoid the decoupling of articulated units as well as its new range of lightweight jacks designed specifically for the tram and light rail market.

Further depot innovation will be on display from SEG in the form of its new mini underfloor wheel lathe (UFWL), created to allow smaller operators to reprofile their wheels at reduced cost. Less than half the size of a traditional UFWL, this piece of

equipment is easily moveable and removes the need for major construction work while also promoting sharing between operators.

Kraiburg Purasys will present its new sub-ballast mat SBM PN 22-0.02 (25mm including fleece lamination) made of closed-cell material with low dynamic stiffness to reduce vibration and shock emissions. Tested to the highest European standards, this new matting system is designed for rail systems of all shapes and sizes with axle loads up to 16t and speeds up to 120km/h (75mph). Using a 'hook-and-loop' system simplifies laying and the bonding of two mats.

Sustainability in the maintenance lifecycle is of increasing significance to rail operators and Netherlands-based Lankhorst will be using InnoTrans to demonstrate its range of cost-effective, durable and environmentally-friendly KLP sleepers. Not just a substitute for traditional timber or concrete sleepers, this hybrid polymer sleeper has its own unique features that mean a range of improvements over an expected 50-year life. Approved by the German Federal Railway Authority for operational testing, options are available for urban, regional or industrial railways.

Additional damping properties and optimum stiffness are found due to the ductility of the polymer in combination with the strength of the steel reinforcement bars. Users of the KLP sleeper have found reductions in noise levels of 3-5dB on bridges as well as a decrease in transmitted vibration. The sleepers have a high chemical resistance to moisture, acids and salts, compensate for the reduction in elasticity of the ballast in case of ballast contamination and have high lateral resistance which makes them ideal for the sharp curves often found in tramway and light rail systems. For these reasons, the city of Amsterdam chose polymer sleepers when replacing sections of its light rail infrastructure in 2015.

As well as unveiling improvements to its existing product range, level crossing and noise and vibration mitigation specialist STRAIL will use InnoTrans to demonstrate its new STRAILastic_MSW sound dampening walls and the STRAILastic_IP Infill Panels, a series of noise protection measures for railings and bridges. These can be fitted to existing structures to reduce the impact of passing rail vehicles by absorbing and reflecting the sound back at the track.

A new 'cycle-safe' system will be displayed by Datwyler, created to help prevent accidents caused by cycle wheels falling into



◀ **LEFT:** Stadler is due to reveal the first completed metrocar for the Glasgow Subway; we hope to bring you a picture of the real thing next month! Stadler/SPT

▶ **RIGHT:** Lankhorst's KLP hybrid polymer sleepers installed on GVB tramway infrastructure. Lankhorst



grooved rails in city streets. A safety profile screws into the rail groove and a guiding plate restricts the sine curve of the wheel, increasing the lifetime of the rubber profile. The design promises easy removal for rail maintenance and has a drainage channel to avoid dust and dirt build-up.

UK-based Rosehill Rail will be using this year's event to showcase its easy to install and high quality rubber rail crossing systems, along with the latest version of its Anti-Trespass panels. Visitors to the stand will be able to see for themselves how quickly and easily it can be installed and removed for maintenance.

Although mentioned earlier, more 'analogue' innovations from Vossloh include new, longer-lasting and more environmentally-friendly materials for both S&C and sleeper construction and a new compact milling machine designed for light rail. Despite its low 16t weight, the new Multi-Purpose Milling (MPM) machine achieves metal removal of up to 2mm per pass due to its counter-rotating milling process, in which the milling unit rotates against the direction of feed. Contactless laser scanning of the rail surface also supports enhanced condition-based turnout maintenance.

On the outside tracks, Linsinger will exhibit two rail milling machines for the light rail and metro markets: the MG11 can re-profile rails on lines with limited clearance and tight curvature, while the SF02T-FS has been designed for use on metros and narrow-gauge railways, and can negotiate 50m-radius curves.



Amongst the many electrification displays, Powerlines Group will present its new GRP catenary masts that weigh just 800kg. Following testing on Belgium's Kusttram, these 11m masts are now being trialled with Baden-Württemberg operator Albtal Transport (AVG) on a turning loop in Ettlingen, with installation of the test infrastructure due to be completed by the time InnoTrans begins. A variety of cantilevers, carrying the contact wires, will be mounted on the GRP masts, for evaluation.

Safe and accessible environments

Some of the most promising developments can be found in the areas of passenger-focused technologies. For example, Heidelberg-based Aristech will be demonstrating its multilingual announcement generator

(MAG) that can produce and translate perfect message output by text-to-speech voices. Standard phrases are included in the system, but an individual vocabulary can be added in seconds using the system's powerful AI-based machine translation, both for repeating standard information, or up-to-date announcements in a realistic human voice – and in any language.

A fascinating smart technology for passengers with disabilities is the 'Guide-Me' video assistance system. Passengers can request audio or video help from a control centre or a family member at the touch of a button using their smartphone. If a passenger is in distress, their current location is transmitted via GPS, along with additional important information, if necessary, such as their address, medicines, or relatives to call. As a 'smart help point', this travel companion can deliver support on a point-by-point basis, in real-time and without any additional infrastructure.

From the relatively simple to the very sophisticated, South Korean national rail operator Korail will be showing its automated safety management system that recognises and predicts hazardous situations at stations and stops in real-time. CCTV image analysis and 3D calibration technology detects incidents such as passenger falls, escalator accidents and fires, and deep-learning tracking technology can even detect distracted passengers and prevent their accidents. Incidents detected by the system are displayed in real-time images and in 3D map location to an alert app on the smartphone of operational staff, allowing them to pinpoint and react to incidents quickly and more easily.

One innovative new technology that has great potential for passenger information systems is e-paper. Polish company Dysten will be displaying its latest displays that are a cost-effective and environmentally-friendly alternative to traditional paper-based timetables or LED and LCD displays.

With very low power consumption, which is consumed only during changing the content, these tablet-like e-paper devices are updated via the 3G network from an operator's central operations centre and can be changed in seconds. Energy can be derived from renewable energy sources, such as small solar panels or wind turbines.

Their thin and lightweight yet durable construction means they can be mounted almost anywhere, reducing the need for additional components, and their durability makes them scratch and vandal-resistant.

With so much to see, TAUT will present a detailed InnoTrans review next issue... **TAUT**

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▲ **ABOVE:** Powerlines' lightweight and high-strength GRP masts have been tested in the harsh coastal climate seen on Belgium's coastal tramway. Powerlines Group

▼ **BELOW:** E-paper technology allows rapid updates to low-power screens that can be used for either static or dynamic information with either monochrome or colour displays. Dysten



NEW SOLUTIONS FOR ONE-OFF PARTS

Faced with the challenge of meeting increased customer demand for one-off customised parts, Siemens Mobility required an alternative manufacturing solution to overcome the time and cost barriers associated with traditional low-volume production.

This was particularly exemplified during a recent project for German operator, Stadtwerke Ulm/Neu-Ulm Verkehr (SWU). With the integration of a Stratasys Fortus 900mc 3D printer into its production process, Siemens Mobility was able to address these challenges by printing customised parts on-demand, rapidly and cost-effectively and reducing inventory costs for itself and its customers.

Simplifying production with FDM 3D

Creating an armrest for an Ulm tram driver's seat does not sound too complex at first, but the conventional manufacturing process is not that simple.



If the part is not in stock, Siemens Mobility needs to purchase the machinery or tools to manufacture it, incurring large costs for a one-off part. Outsourced, the component is typically made from glassfibre plastics, using traditional processes such as injection moulding, welding and milling.

Shipped to Siemens Mobility, the part is tailored and treated to the customer's exact specifications, who receives the final component several weeks later. This is not only

a lengthy process, but from a cost-perspective would limit the company to only taking orders above ten parts, with lower volumes unable to justify the production cost.

Servicing customer needs with repeatability and precision

Bringing 3D printing in-house was a game-changer, enabling Siemens Mobility to improve production flexibility and responsiveness to customer demands.

Enjoying the ability to print larger production parts on the Fortus 900mc, Siemens Mobility particularly values the performance of Stratasys' flame, smoke and toxicity-compliant thermoplastic material to align with necessary fire protection requirements.

After testing and finishing them, this enables the company to supply the 3D printed components – which serve as lightweight and durable transport parts – direct for installation onto the trams in Ulm.

CREATING ADDITIONAL BENEFITS AND ADDING VALUE

- Successful integration of FDM 3D printing into its processes has seen the Siemens Mobility team overcome the limitations of traditional manufacturing methods for low-volume production
- A significant reduction in lead times for customised final production parts has been created, with turnaround times decreasing from weeks to days
- Having a Stratasys Fortus 900mc 3D printer in-house improves Siemens Mobility's production flexibility and responsiveness to customer demands, reducing unnecessary inventory costs in the process
- Advances in part repeatability, customisation and availability sees an increase in customer satisfaction within Siemens Mobility's customer base.

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SIEMENS MOBILITY CUSTOMIZES PRODUCTION

STRATASYS FDM 3D PRINTING ENABLES EXTENDED CUSTOMER SERVICE OFFERING AND STREAMLINED SUPPLY CHAIN

“Customizing low volume production parts using FDM 3D printing has been transformational for our customer service offering, as well as our supply chain. Not only are we taking orders on-demand, 3D printing has also given us the flexibility to meet customer requirements faster with no obsolete parts created in the process.”

– Michael Kuczmik, Siemens Mobility, Head of Additive Manufacturing –



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AUTONOMOUS TRAMS: WHY? WHEN? HOW?

Drawing on current thinking from across the industry, *TAUT* looks at the increasing role and complexity of driver assistance systems and how they are leading to greater automation of tram and LRV operation.



Dubai's tramway is currently the most 'automated' LRT system, using adapted CBTC technology. Jay Tornaquia

In recent years, systems designed to assist or 'automate' many of the most common functions of tram and LRV operation have gained prominence, using technology influenced by the automotive 'arms race' that is striving for increased driver assistance and even, at some point in the future, full automation.

Greater autonomy for cars and goods vehicles are made possible by the continued emergence of technologies such as machine learning, image analysis, and Lidar. Advances in mobile and cloud computing and sensor technology have enabled the progress of these intelligent systems to the point where driver assistance systems that allow high levels of automation in highway conditions are now commonplace. While complete autonomy could be achieved by 2030, updates to infrastructure and the regulatory environment will certainly take longer.

So, will the proliferation of new automotive developments, allied to established metro technology, offer the fundamental enablers for future fully autonomous tram operation? Is this technology practical and how far will it go? And what are the barriers to progress?

A few basic definitions

There are many things that computers, sensors and servos can undoubtedly do better than a human being and they are generally more accurate and more consistent.

What is far more complex is the anticipation of situations such as changing weather conditions and wheel/rail adhesion, or perhaps the courtesy of holding the doors for an extra few seconds to cater for a less mobile passenger, knowing that time can be made up elsewhere through sensible, safe judgement.

Artificial intelligence and machine learning are evolving rapidly, but there is currently still an essential role for human judgement in what is a customer-focused industry. Therefore any transition period with mixed human and machine traffic in urban environments must be rigorously analysed and carefully managed.

Automation of urban rail networks is far from new and figures from UITP show that 36% of the new metro lines opened in 2017 were fully automated. But in segregated environments an automated metro only has to make decisions in relation to what is in front of it. Computers and controllers can comfortably assume a clear alignment with track access prohibited by tunnels, barriers, bridges or screen doors.

In contrast, trams and LRVs circulate in primarily open environments, mixing with other city traffic and pedestrians. With far more variables at play, drivers therefore have to make a wide range of decisions about their surroundings that are related to an almost endless amount of external factors – that can change quickly.

A certain level of computer assistance is already here. Most of the major rolling stock manufacturers – and a growing number of aftermarket suppliers – offer 'driver assistance systems' (DAS) that promise everything from obstacle detection, speed warnings and real-time component monitoring at the basic level, up to speed and platform door control at the higher end. These range from simple and cost-effective retrofit solutions that repurpose existing technology, to more bespoke equipment that is specified as part of a system's procurement (see panel).

Dubai's tramway, opened in November 2014, marked a world-first in the application of CBTC technology. With long segregated sections and a desire for higher commercial speeds, this solution was adapted from an existing Alstom product although, crucially, a driver remains in the cab.

Yet the opportunities for autonomy go far beyond the automotive industry as we see public transport operators increasingly positioning themselves as 'mobility providers' and the boundaries between mass and private transport become increasingly blurred.

The differences between 'autonomy' and 'automation' are a source of much debate and in a recently-published white paper SYSTRA identified the following useful definitions: **Automatic system:** One that performs tasks based on pre-defined rules; the information needed to comprehend its environment is

provided to it to enable decision-making. It can be with or without a driver.

Autonomous system: Capable of making its own decisions without human-defined instructions. It must therefore manage the functions of comprehension, environment analysis, and decision-making; responsibilities currently reserved primarily for human beings.

To be truly autonomous, a tram must therefore be able to capture, perceive, analyse, plan, make decisions and act without human intervention. All this must be carried out in real-time.

Tramways' unique issues

The key challenges of any moves towards increased automation will be of a technical, security, regulatory, social or societal nature.

Yet autonomous vehicles of all kinds have common needs, whether they be a car or public transport: collision avoidance; high level communication integrity; self-monitoring of vehicle condition; management of degraded modes; situational management; and a minimum onboard intelligence to cover loss of communication.

Technology will face the need for certification, standardisation, and will have to be justly insurable. The current legal void and lack of safety references on these types of solutions leads to many questions.

Although amendments to the Vienna Convention on Road Traffic are under consideration, the current regulations state that a driver remains ultimately responsible for his or her vehicle. While there are reasonable arguments for rewriting parts of this important document to reflect advances in technology, it is likely that the fundamental point will remain for the time being. It will also be interesting to see how vehicle manufacturers draw that line of liability as greater levels of automation are made possible.

Nevertheless, these common challenges offer a real opportunity for sharing resources and the creation of inter-nodal technological bridges. These include:

No reference/security standard: Before allowing the circulation of autonomous vehicles on roads or granting operating authorisation in real conditions, validation and security will be necessary. For example, will any system that replaces a driver have to be the highest Safety Integrity Level, SIL4?



▲ Metrotenerife Citadis 26 taking the curve below Conservatorio stop heading to Santa Cruz; its SIMOVE system was developed in response to over-speeding incidents on curves on a variety of networks. Mike Russell

In the event that the system has not been approved or certified at a safety integrity level by a manufacturer, the project itself must incorporate the implementation of the generic safety case.

Evolution of regulation: This will allow the necessary testing to develop reliability and provide authorisation for service. It will be impossible to have a universal rule for all forms of autonomous vehicles in mixed traffic and the highway code and public transport regulations in each country will require consultation.

Who holds liability? Likewise, liability in the event of an accident must be determined – is it the manufacturer, the software programmer, the operator, or the mobility authority? What will be the level of risk acceptance? Who will qualify it?

The fight against cybercrime: Any service requiring a high level of computerised intervention comes with the associated risks of cybercrime. As soon as there is communication between the vehicle and its environment, the vehicle must be ready to

DEFINING LRT AUTOMATION

SYSTRA's white paper prescribes two logical preferred areas of development in the short to medium term. The first is within the depot – from simple automatic storage to a perimeter that encompasses other functions: washing; preparation and taking vehicles out of service.

The second is giving assistance; as with the autonomous car, this encompasses a gradual increase in electronic aids that address the concerns of operators (avoidance of collisions, over-speed protection, driving in low visibility, problems of training or turnover of staff etc).

Both of these are linked to greater connectivity between the vehicle and its infrastructure to allow for more detailed analysis of real-time characteristics to improve safety and efficiency and reduce downtime.

Defining a new framework could therefore look something like this:

LoA0: No automation

LoA0+: The system controls the speed (with gentle and progressive sanctions)

LoA1: The system assists the driver (speed set points, passive driving aids)

LoA2: The driver assists the system (speed control by the system, initiated either by the driver or the system)

LoA3: The driver becomes an attendant and intervenes only when necessary

LoA4: The tram drives itself, without the presence of any onboard agent



▲ ABOVE: Parisian operator RATP carried out a pilot with 'driverless' tram stabling in conjunction with Alstom in 2017. A retrofitted Citadis manoeuvred itself around the T7 depot in Vitry-sur-Seine, following staff members around at safe distances and stopping at designated stabling positions. RATP/Alstom

▼ BELOW: A Basel Tango trialling DSA technology in early 2018. Note the driver's hand on the controller and the warning light on the dash that indicates that controlled braking is taking place to avoid a collision. BLT



make a decision when it sees something, or by remote control if operated this way. In a more global environment, new digital threats generated by increased online connectivity may have an impact on operational safety.

The important period of cohabitation:

During this period of transition, questions will arise in terms of 'driving practices' and shared responsibilities. Machine learning will have to develop response-driven strategies that adapt driving.

Return on investment: Cost must integrate investment, operation, maintenance and upgrades over a complete lifecycle. Any value analysis must be carried out case-by-case, and according to context as well as individual operators' needs.

Degraded modes: Trams and cars must manage 'degraded modes'; these may be caused by the failure of any element that contributes to service provision. Such failures may require human intervention at source or even removal of the degraded mode. These situations, currently managed by the driver, must be listed and identified.

Anticipating danger: Any scenario that involves emergency braking can directly affect the safety of passengers, as well as the availability of the transport system.

Emergency manoeuvres must therefore remain exceptional. Onboard intelligence will require the capacity to anticipate potential dangers, equivalent at least to that of a human driver.

Passenger movements: Service departures near pedestrians must be managed. It is also important to think about evolution of stop layouts, for example to discourage passengers from crossing in front of vehicles. This may result in new warning systems.

Practical operational matters: For tramlines in urban areas, general challenges include the location of vehicles (based on headway rather than timetable), balancing passenger density, and guaranteeing optimal dwell times. With these in mind, instructions are passed to drivers who adapt their movements with respect to other trams or LRVs on the line. This level of line



▲ ABOVE: Frankfurt's decision to implement an 'electronic guardian angel' for its tram drivers has seen both R and S type trams fitted with DAS enhancements in recent years.

◀ LEFT: DAS equipment is visible on the front of VGF 035 (seen on Stresemannallee in August 2017). The radar sensor is below the windshield on the right hand side, with the video camera mounted in the cab just above it. Both: Neil Pulling

management must therefore be integral to the 'automation' system, as it will have to oversee optimum running speeds while also dealing with obstacle detection in real-time. Trade-offs between traction power, energy consumption and risk management may therefore arise.

Human factors: Close co-operation with those employed in operational functions is crucial as we consider the impact on the labour market. In the immediate term, questions exist such as how can we ensure

that automation supports the person in the system, and what happens when it fails? Trust is also a major concern. In the early years, operators, passengers and other road users will face an adjustment period to place their full trust in the technology and this handover period needs to be carefully managed. **TAUT**

► For further detail on SYSTRA's recommendations: www.systra.com/IMG/pdf/systra_-_automated_and_autonomous_public_transport.pdf

WHAT ARE OPERATORS DOING NOW?

The consequences of even minor collisions can be significant and undertakings around the world are already implementing DAS and the first steps towards tram automation.

A study from Hannover operator üstra revealed the cost of such incidents over a ten-year period amounted to a staggering EUR6m; this doesn't include the disruption of removing damaged vehicles from service.

Some of the first work on so-called 'driver vigilance systems' began with a partnership between üstra and Frankfurt-am-Main operator VGF in 2013. A joint pilot project evaluated the capabilities of two systems: the first from Bosch Engineering, trialled by both VGF and üstra, and the second from Bombardier, which VGF tested. Both could be considered the first steps towards LoA1.

The Bosch system combines data from a video camera and a radar sensor to monitor objects in the rail area and measure their distance to the tram. Software in the DAS control unit evaluates whether a collision is likely, and if it is, triggers visual and audio warnings to alert the driver who then has two seconds to either override the warnings or take action. If an intervention doesn't take place then a safety braking sequence is initiated.

Bombardier's stereo camera system relies on cameras alone to scan for obstacles of more than 40cm in size in a 15-60m area in front of the tram; three cameras underneath the destination display offer a three-dimensional view. Again, software evaluates the chances of a collision before triggering a warning to the driver; automatic braking can be configured as the next step.

Impressed with the trials, VGF has now installed the Bombardier system on 74 S type trams, using the Bosch system for its older R type Düwag cars.

Baselland Transport (Switzerland) is evaluating a similar collision warning system, working with rolling stock manufacturer Stadler and Bosch. If the trials are deemed successful, the DAS will be rolled out across the BLT's fleet of metre-gauge Tango LRVs.

Metrotenereife took the path of developing its own SIMOVE DAS that uses GPS to continuously monitor the speed of its Alstom trams in relation to appropriate set line speeds. If excess speed is detected, the driver is first given an audible warning and if no intervention is seen the system can apply the brakes. Using readily available technologies, SIMOVE also features a web application for full event logging and driving analysis tools that can be used for further driver training.

Given the high annual costs of collisions on larger systems, it has been suggested that investments in DAS could be paid back in as little as two years.

In France, tests within a controlled environment have also shown that LoA3 and LoA4 are possible, such as the trials undertaken at RATP's T7 depot in Vitry-sur-Seine, Paris. A combination of technologies have proven that a Citadis tram can start and stop by itself, recognise obstacles and follow pre-determined routes supplied by the Easymile start-up (in which tram manufacturer Alstom has a stake). The trials are now in their next phase.

Most recently, in September Siemens announced a 'world first' in its own research to be carried out during the InnoTrans trade exhibition in Berlin. Working in partnership with Potsdam operator ViP, a Combino tram fitted with Lidar, radar and cameras was to operate over a 6km (3.7-mile) section of the network in real traffic, although without passengers.

Artificial intelligence is said to allow the tram to respond to signals, stop locations and to hazards such as crossing pedestrians and other vehicles.

The company stressed that while the technology is not currently available for commercial use, it is in discussions with ViP to continue development of the system beyond the InnoTrans trial period.

SIMOVE: A UNIQUE SAFETY AND EFFICIENCY TOOL

Light urban railways and tramways have become one of the most popular and in-demand forms of mobility for cities around the world facing rising populations and intensified urbanisation.

But with these significant increases in demand, railway operators face greater challenges in relation to safety and supervision of the operation.

MetroTenerife, the operator of the tram network on the island of Tenerife, offers a novel driving aid for light railways and trams as well as conventional trains – SIMOVE. This sophisticated tool continuously supervises operations and, at the same time, helps to prevent accidents caused by excessive speed.

During its development, the current needs of railway operators were carefully considered as well as potential improvements in the sector, resulting in a novel product which is unique in the market. Cost savings, greater efficiency in incident management, a reduction in action times and an increase in safety are just some of the immediate benefits of this tool. It also has a reliability rate of 99.985%.

Based on the compilation of real-time data using GPS and odometer, making it possible to monitor how vehicles are driven on each section of a route, the system takes samples up to ten times a second. The resulting records are stored on a centralised database, with the capability to generate rapid and reliable reports which make it possible to exercise exhaustive control of the operation at all times.

In terms of safety, SIMOVE generates audible and visual warnings and is capable of activating a vehicle's emergency brake if its speed rises beyond that indicated for a route section and there is an imminent risk of an accident. The system also generates maps of event hotspots, facilitating the identification



“The success of SIMOVE has captured the interest of railway operators around the world.”

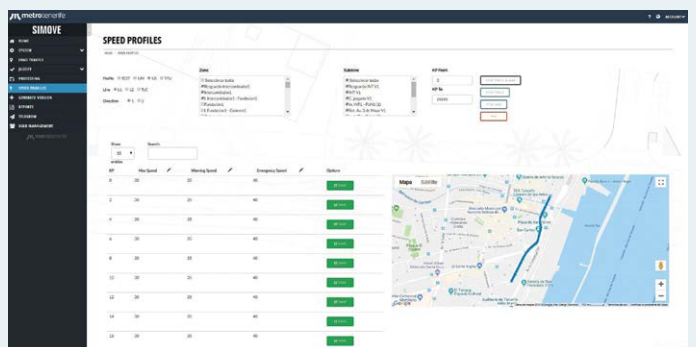
of ‘black zones’. If an event arises, SIMOVE can also issue alerts in real-time to a supervisor’s smartphone or tablet. Apart from the obvious benefits of these basic functions, SIMOVE is a very useful tool for vehicle maintenance, featuring a characteristic for detecting wear and tear on wheels, thus avoiding unnecessary maintenance costs.

Since its installation in 2016, this technology has demonstrated excellent results at Tranvía de Tenerife. In the first instance, improvements in driving behaviour have been observed and there has been a significant reduction in emergency braking – both of these factors have led to an increase in passenger comfort. Furthermore, it is now possible to detect excesses in speed which had previously gone unrecorded and put

corrective policies into place to prevent future situations of risk.

Additionally, Tranvía de Tenerife has seen notable improvements in key indicators such as the punctuality and regularity of its service. As SIMOVE compiles data about dwell times at stops and termini, this valuable information is used for effective optimisation and planning of the network to increase the overall quality of the service provided.

This success of SIMOVE has captured the interest of railway operators around the world seeking to incorporate this technology into their own operations. For example, SIMOVE has been installed on Madrid’s Metro Ligero Oeste tramway and MetroTenerife is currently in discussions with other operators – within Spain and internationally. **TAUT**



FIND OUT MORE

For details - and a video demonstration - visit:
www.metrotenerife.com/services-and-consultancy/
contact@metrotenerife.com +34 922 024 810



A ABOVE AND RIGHT: Simple graphical interfaces give valuable real-time information of all vehicles in current operation. This data helps enhance safety and efficiency while improving training regimes and reducing cost. MetroTenerife

'THIS IS NOT AN INDUSTRY WHERE SIZE MATTERS'

From its first order for metro cars – for the Canadian city of Montréal – in 1974, Bombardier Transportation has become one of the world's biggest suppliers of rail equipment, with a presence in every major market.

Building a global presence initially through mergers and acquisitions, the company now offers design, manufacture, maintenance and refurbishment of all forms of rolling stock, as well as offering solutions for operations, signalling, propulsion and control equipment and control systems.

With a current order book for over 700 trams and LRVs across its *Flexity* platforms, Bombardier's future looks healthy.

Tramways & Urban Transit caught up with Benoît Brossoit, the company's President of the Americas Region, to discuss the recent challenges with its major LRV replacement programme for the city of Toronto – one of the world's biggest streetcar operators – and what the future holds in a disrupted and increasingly consolidated global marketplace.

Q North America is currently a very strong urban transit market, with a number of significant players. Is this competition for orders a good or bad thing?

A We are focused on delivering state-of-the-art mobility solutions adapted to the specific needs of each market. Mobility is growing exponentially in North America with over CAD20bn (EUR13bn) of projects to be awarded in the next five years. I am extremely confident in our ability to win our share of these contracts.

For instance, nine of the ten busiest airports in the United States have chosen Bombardier for their automated transit systems. We have one of the largest footprints in North America, which is a testimony of our commitment to this market.

Q The delays to the LRV order for the TTC have been covered extensively in both the national and international media - what effect do you think this has had, if any, on Bombardier's reputation?

A From the time I joined Bombardier Transportation two years ago as President of the Americas Region, solving the delivery issues in Toronto has been on top of my priority list. Since then – with a new leadership team – we have launched our turnaround plan and made a CAD20m (EUR13m) investment to add a second assembly line in Ontario, along with additional major structure manufacturing in Quebec, to deliver on our commitment to Torontonians.

The results are compelling: we multiplied our delivery capacity by four. We delivered



27 cars in the first six months of this year, an increase of 250% from last year, and 38 more car deliveries are planned for 2018. We are fully committed to our goal of delivering 204 cars by the end of 2019.

We have a long-standing relationship with the TTC and appreciate the continued co-operation. Toronto riders appreciate their streetcars and we are committed to manufacture high performance products that will meet their mobility challenges.

Another example that confirms Bombardier's true nature of delivering high-quality products that are safe, reliable and on-time is the recent delivery in July of our first LRV in Edmonton.

We are building trust one delivery at a time with a great team and great products to meet our commitment to our customers.

Q Although the LRVs you are supplying for other Canadian systems are badged as part of the Flexity range, what detail differences do they have with vehicles that you are supplying for European or Australasian cities?

A The vehicles are very similar as they are based on the *Flexity* platform that has proven itself over the last 20 years. At present, over 4000 *Flexity* LRVs are moving millions of people around the world every year.

This proven design was adapted to respond to specific weather conditions of the Canadian market, with the major difference being the type of steel used in the carbody structure, which is a duplex type stainless steel compared to a more conventional black steel carbody.

The HVAC and electrical systems were also modified to be more effective in extreme temperature variations.

▲ ABOVE: TTC Flexity 4435 leads a pair of new LRVs on the stand at Gunns Loop in May 2018.

Vic Simons

➤ RIGHT: Benoît Brossoit – President, Bombardier Transportation, Americas Region. Bombardier



Q We continue to see a great deal of mergers and acquisition activity within the global rolling stock sector. Where do you see Bombardier's future and what is its key differentiator in an increasingly consolidated supply sector?

A While some of our competitors are focused on merging, we remain focused and agile. Over the past two-and-a-half years, Bombardier Transportation has been successful in executing its transformation plan. We have improved our cost structure and our profitability, while continuing to win new orders.

This is not an industry where size matters. I am proud of the breadth of mobility solutions Bombardier Transportation can provide to its customers including rolling stock, signalling and operation and maintenance. Our customer base and footprint span over 60 sites globally and we are present in all relevant rail markets. **TAUT**

◀◀◀ Bombardier will be taking part in this year's InnoTrans exhibition See page 370

FIRENZE'S TRAMWAY RENAISSANCE

▼ Italy's first electrified tramline, the Firenze - Fiesole line, seen near San Domenico, 1890.

Alessandro Fantechi and Giovanni Mantovani explore the reintroduction of the tramway in this magnificent Italian city - and its continuing success and expansion.

The city of Florence (Firenze) is famous as the birthplace of the renaissance, and has many outstanding museums and cultural sights, also counting both food and fashion as major tourist attractions. With a population of over 380 000, the capital of the region of Tuscany is also one of Italy's most prosperous.

The first tramway was inaugurated on 5 April 1879; horse-drawn, it linked the city centre to Peretola. Horse-drawn tramlines soon expanded to cover the city, while steam-hauled interurbans were also being opened, starting with the one to the town of Prato (around 25km/15.5 miles to the north-west) in October of the same year.

Steam locomotives were not conveniently capable of attacking the steep slopes of the route to Fiesole however so, after consideration of conversion to electric traction throughout the 1880s, on 19 September 1890 the first electric tramway line in Italy - linking Firenze with Fiesole - began revenue service. Technically an interurban line, since it was

linking two different *comuni*, this was the nucleus of an urban electrified network that had replaced the horse-drawn tramways by 1899. By the middle years of the 1920s, the system comprised 26 urban electric lines and five interurban steam-powered lines, running on around 200km (125 miles) of mostly single-track routes.

From 1938 the network had already been reduced by trolleybus replacement, particularly on the lines to the northern hills (Fiesole, Trespiano, Settignano), followed by some lines to new areas of residential and industrial expansion to the flatlands of the east and the west, and later by the first diesel buses.

Mostly operated with two-axle trams, aided by trailers on the extra-urban lines, the network saw experiments and planning in the 1940s to replace the fleet with modern bogie cars; a programme of reconstruction of some cars with modern bodies and automatic doors was undertaken as an intermediate step. World War Two

brought widespread destruction of the bridges over the river Arno, as well as many areas close to sensitive objectives, and overhead line was even stolen by the retiring German Army, stopping those plans. A rapid reconstruction of the network and some rebuilding of two-axle cars ensured the continuation of the tramway for another decade.

As in many other Western European cities, the advance of the diesel bus easily won over an ageing street-running, often single-track,

▼ *Sirio* 1003 rounds the tight curve in Piazza Dalmazia, heading towards Viale Morgagni on the T1 extension, 22 July 2018. A. Fantechi





▲ TOP: Track construction in Viale Talenti, May 2008. G. Mantovani

▲ ABOVE: The Sirio fleet lines up at the new depot in Scandicci, ready for the beginning of tramway service on 13 February 2010. G. Mantovani

► RIGHT: An example of the grassed reservation used on the first T1 section, close to the main Scandicci stop in November 2013. G. Mantovani



network served by obsolete vehicles. At 01.15 on 20 January 1958, the last tram of the only surviving line returned to the depot to join a dormant fleet that would be scrapped in the coming months, leaving no examples for preservation purposes.

The 'tram sferraglianti' (metal-rattling tramways) were soon forgotten in favour of modern-looking diesel buses at a time when air pollution was not an issue on the mainstream agenda. Yet they were not forgotten in the common language – even today, many Florentines use the term "prendo il tram" when boarding an urban bus.

The remaining trolleybus network, together with the replacement bus services, was in full operation by that time by municipal operator ATAF (Azienda Trasporti dell'Area Fiorentina – founded on 1 January 1946), with rails already removed from the streets of the historic city centre in 1958, and covered by asphalt during the years to follow elsewhere. The only eye-catching novelty would have been the fleet of nearly 50 double-decker buses in the early 1960s that served the most crowded routes through the narrow central roads.

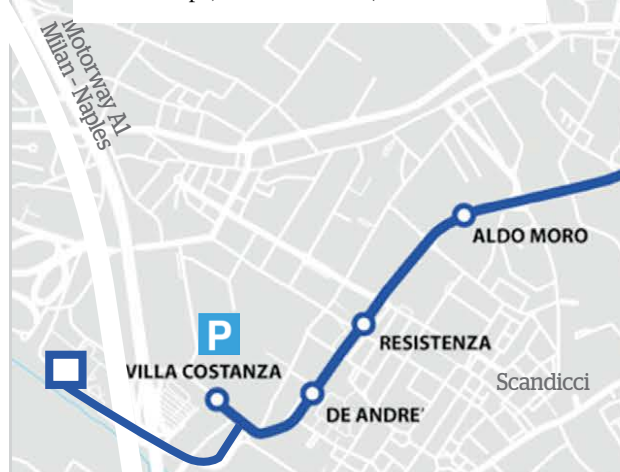
The trolleybus network closed in the early 1970s, with several vehicles sent to the Greek city of Athens, leaving a bus-only network that later operated 100 articulated vehicles on the longest and most crowded lines to the peripheral urban centres, from the mid-1980s.

Developing T1

The growing awareness of urban mobility problems led the municipality to consider the possibility of realising a modern mass transit system in the 1980s. As in other European cities, two opposing solutions were considered: light metro (to be built underground) and a modern tramway.

In 1996 a solution based on a fast tram system – or light rail transit as we might call it now – prevailed, and was confirmed in the town plan revision of 1998. This tramway programme could also benefit from an agreement with the Italian State Railways (Ferrovie dello Stato – FS) which entailed economic contributions and engineering services as compensation to the city because of the disruption associated with construction of the high-speed railway line.

A mobility plan defining the network was approved in 1999, consisting of three lines: two diametral (west to east, Scandicci – Rovezzano, and north to east, Careggi – Viale Europa) and one radial (north-west



to downtown, from the city's international airport to Piazza Beccaria).

Construction began on the radial western stretch of the first line, from the Scandicci terminus to the main railway station, Santa Maria Novella, with EUR250m in financing obtained from the State, the Municipalities of Florence and Scandicci, and in smaller proportion, the European Union and State Railways. A limited batch of works started in 2001, with the bulk beginning in 2004, including the creation of a depot and workshop appropriately sized for the future extension of the network.

Various difficulties were encountered during the works, which consequently lasted longer than expected. The project underwent numerous changes, due to new requirements of local administrations and the intended operator, which caused delays

and partial redesigns. Grooved rails with concrete embedded bi-block sleepers were laid to standard gauge, using elastomeric support pads in areas sensitive to noise and vibration. A variety of surface finishes are seen depending on location: porphyry setts in the historic city centre; sedum mats on peripheral avenues of the Scandicci stretch; synthetic resin-bonded grit to imitate park paths on the section around Cascine Park features; with the remainder and road crossings featuring an asphalt top layer.

The line, and subsequent extensions, are electrified at 750V dc via overhead power supply.

Construction was further hindered (common in street-running tramway and light rail projects) by the diversion of unexpected utilities and significant archaeological discoveries: the remains of an Etruscan house, an 18th Century river

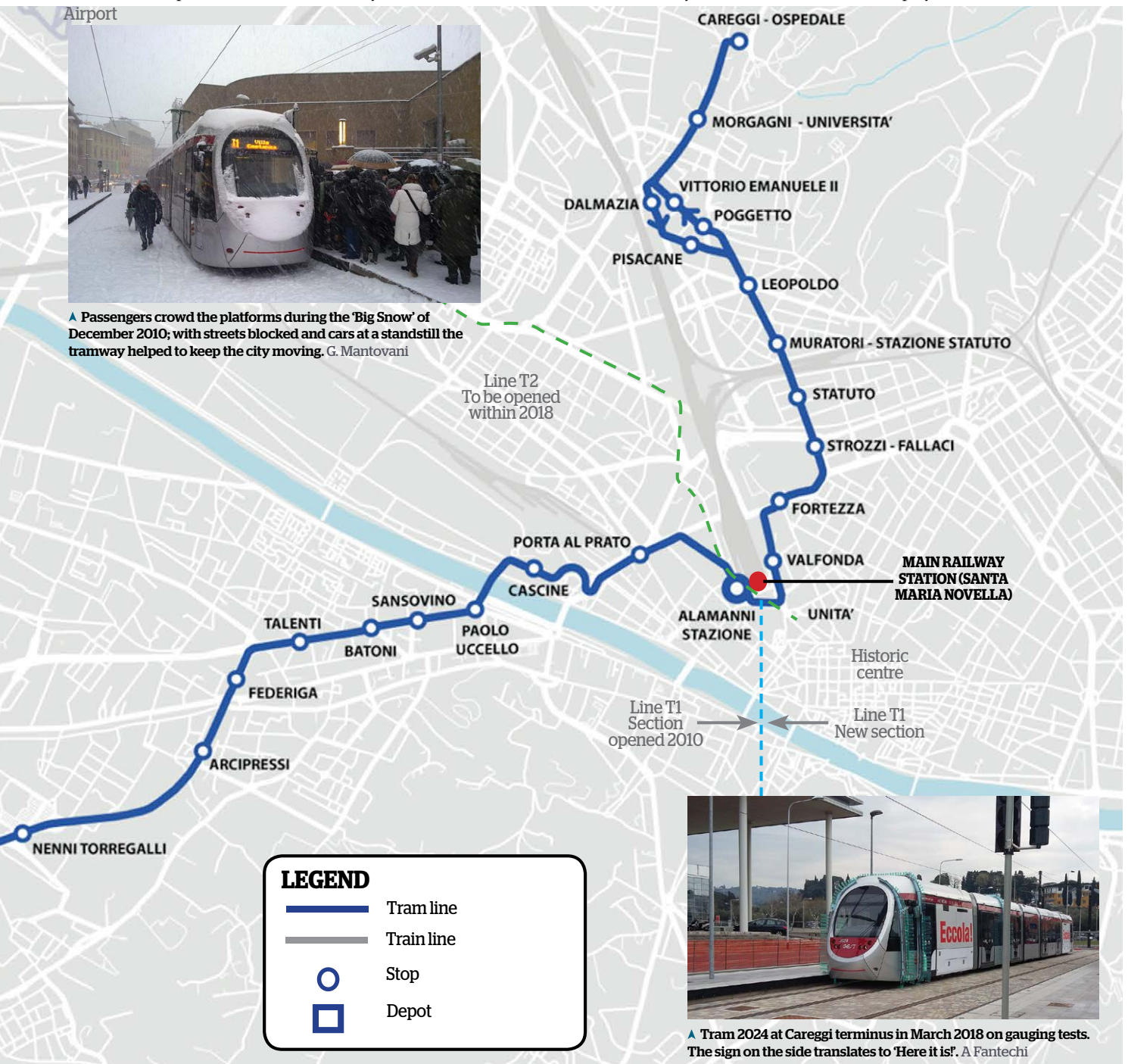
port quay, as well as walls of as yet unknown origin have been found and required investigation and preservation. Another source of delay and cost increase came from difficulties in disposal of contaminated soil discovered during the excavations. Short interruptions were also undertaken at the request of shopkeepers keen to not impede customers' access during periods of greater commercial activity.

The first 7.7km (4.8-mile) section was inaugurated on 14 February 2010 as line T1, with an additional 600m branch to the depot, near the Villa Costanza terminus in Scandicci. Between the two termini there were 12 stops, with distances between 312m and 1023m, according to the density of residences and other urban functions. All stops feature waiting shelters, digital information displays, CCTV and ticket

Airport



▲ Passengers crowd the platforms during the 'Big Snow' of December 2010; with streets blocked and cars at a standstill the tramway helped to keep the city moving. G. Mantovani



▲ Tram 2024 at Careggi terminus in March 2018 on gauging tests. The sign on the side translates to 'Here it is!'. A Fantechi

vending machines, and are laid to either island or side platform layouts depending on the road configuration.

The original Alamanni terminus, now a stop, was located by a side entrance of the main railway station, allowing easy interchange with rail services. The Scandicci terminus, near the A1 (Milan – Naples) motorway, was subsequently completed with a large car and bus interchange parking facility.

Along the line, five important structures have been created: a bridge across the Arno river (124m long and reserved for trams, pedestrians and bicycles), the widening of a pre-existing bridge across the Greve river and, to eliminate critical and complex crossings, two subways and a viaduct. The first section is basically level, with significant slopes (up to 7%) only on some short ramps.

A decision was taken to preclude other vehicles from the tram lanes (with the exception of emergency vehicles and only on paved stretches) and to provide all crossings, vehicular and pedestrian, with traffic lights controlled by a centralised tram priority system based on arrival forecast. Thus, safety is ensured, together with good commercial speed (19.5km/h) and regular headways.

The tramway is operated and maintained by GEST, an RATP Dev company (initially a joint venture of ATAF and RATP Dev), under a



▲ **Sirio 2036 in advertising livery coasting the Fortezza da Basso on 1 August.** G. Mantovani

30-year concession from the opening of new lines. The first section met with great success, with patronage reaching 44 000 weekday passengers within a few years, against a forecast of about 30 000. It is interesting to note that the load diagram during the day is almost flat, an important goal for public transport and seldom achieved. This shows how T1 has attracted many non-systematic users, usually the most difficult to attract to public transport. A significant modal shift

was also achieved, confirmed by a 2012 study with 24% of passengers declaring that they were car or motorcycle users before the tramway opened.

T1 - The second phase

In 2005, with works on the first line underway, the City signed a concession with Tram di Firenze S.p.A. (a consortium constituted of RATP, ATAF – subsequently substituted by an investor – civil engineers and the rolling stock manufacturer) for the design, construction and operation of the two new lines towards the Careggi hospital and the Airport, as well as operation of the expanded network.

The actual start of the works for the T1 extension from Santa Maria Novella to Careggi hospital (for a long time known as line 3) and for the T2 line, from the Airport to Piazza dell'Unità close to the city's historic centre, dates back to 2007. That was when utility relocation was carried out in two main streets where the two lines should have been built. From the beginning protests against the necessary removal of several trees in Viale Morgagni fuelled anti-tram sentiment, and the works did not progress further for years, plagued by delays, political fighting and cashflow problems.

The stretch of line 2 due to serve the historical centre, passing by the 15th Century Duomo, was cancelled by the new city council in 2009 when the area surrounding the Duomo – a UNESCO World Heritage site – was pedestrianised and closed to all motor vehicle traffic. This cutback did not help as the economic structure supporting the development of the tramway lines was in part based upon the revenue foreseen from the important tourist traffic for the area.

Eventually construction resumed and (slowly) proceeded, and the first *Sirio* tram reached Careggi to start testing on the evening of 9 February 2018, placed on the tracks from the back of a truck since the rails connecting the new section to the existing line and the depot were not yet ready.

The extension opened to the public on Monday 16 July, with free rides offered on this section for two weeks.

The extension is on reserved right of way for its full length, but features more intersections with car traffic than the existing section of T1 as it runs in a denser



▲ **TOP: Via Tavanti, showing the coming together of the two tracks after running in parallel streets.** A. Fantechi

▲ **ABOVE: A central island platform in Via Guasti: the yellow sign tells the driver to open the left-hand side doors.** G. Mantovani

Eastbound and westbound services pass on the impressive bridge of the River Arno, created for the tramway project - on 19 March 2013. G. Mantovani



ROLLING STOCK

Produced by AnsaldoBreda (Hitachi Rail Italy since November 2015), the *Sirio* has been used by the Florentine tramway since the beginning. It is a family of modular, multi-articulated, 100% low-floor vehicles (entrance height at 350mm above the top of the rail) which serves four other Italian cities (Milano, Bergamo, Napoli and Sassari) as well as systems in Greece, Turkey and China. The latter are built under licence by CRCC Dalian.

Here it is a double-ended 32m version with five sections, the second and fourth suspended from the adjacent bodies; motor bogies are located under the first and fifth sections with a trailing bogie under the middle section. The traction system is equipped with two IGBT inverters for each motor bogie, rated at 106kW.

At 2.4m wide, each vehicle has a capacity for 210 passengers, 42 seated plus eight folding seats, at the acceptable density of four passengers/m². Four wheelchair places are also provided. Like all *Sirio* variants, these have air conditioning, with separate equipment for cabs and saloons.

The first 17 are numbered 1001-17 and to cover the needs of the T1 extension and line T2, a further 29 trams of the same type (2018-46), have been added (22 plus 7).

It is worth noting that lessons learned from the first line have resulted in the development of an improved wheel profile for T2 and the extension of T1, eliminating the raised groove in the switch frogs and to improve the quality of wheel-rail contact. The tyre width was also modified from 84mm to 105mm and the radius of the tyre-flange transition has been adjusted.

Tyres on trams from the initial delivery have been changed to match and the track of the first stretch has been checked to avoid contacts of the tyre out of the rail.

urban environment, with narrower roads. For this reason, in order to allow access for emergency vehicles, a paved surface has been preferred over the grassed reservation used for large sections of the Scandicci - Alamanni stretch. Operating speeds are also lower here for the same reason; around 14km/h (9mph).

The new tracks join those already laid behind the church of Santa Maria Novella in front of the main train station and - after a delta junction that will be used by the T2 line to reach its Piazza dell'Unità terminus - the trams reach another stop on the other side of the station, opposite the already operating Alamanni stop, and serving the Palazzo Congressi as well.

The new line then passes the Fortezza da Basso, a 14th Century fortification that now hosts the main exposition and trade centre of Florence, with two nearby stops located over two road underpasses. The first was built 15 years ago with the aim of giving easier access to the Fortezza without crossing the heavy traffic of the previous boulevard; the other was an integral part of the tramway construction, and its surface hosts a new garden surrounding the tramstop.

Next it proceeds along the long straight road named in its first stretch via dello Statuto, cutting under the Firenze - Roma railway and the regional train stop Statuto, with a tramstop nearby.

This road, with its central line of trees from the 1930s, was completely renewed as part of the tramway project which runs in central reservation, with a new line of trees to replace the ones that had to be removed.

At the upper end of this road, with its steep slope, the route diverges using Via Vittorio Emanuele towards Careggi and via Pisacane in the opposite direction, joining again in Piazza Dalmazia, the commercial heart of the Rifredi district. The last straight run follows Viale Morgagni, where a stop serves the student houses and University premises before arriving outside the newly-built entrance of the Careggi Hospital, the largest such facility in Tuscany.

Given the size of the hospital, it was decided to continue laying tracks to directly serve its northern part, which includes the important Meyer children's hospital. But these plans did not materialise and, in the opinion of the authors, this was a missed opportunity as the tram service could have been designed to better penetrate the hospital campus, already partly pedestrianised, to provide a far better and more convenient service.

Given the key passenger generators along the line as listed above, the opportunities for significantly growing patronage on T1 are obvious. The first weeks of service have shown positive results.

Overall, T1 now runs for 11.5km (7.1 miles), with 22 stops between the two termini in each direction (two stops are in the section of the line where the two directions run in separate streets, hence are doubled). **TAUT**

➤ *A continuation of this article, covering the opening of T2 and the city's plans for future tramway development, will appear in a future issue of TAUT.*



▲ Trams of the first and second generation at the new northern T1 terminus with the new entrance to the Careggi Hospital in the background; this hospital is one of the largest in the country. A. Fantechi

SYSTEMS FACTFILE

No. 132 Bydgoszcz,
Poland

System closures are exceeded by post-1945 extensions and a major 2016 addition in what is now Poland's main tram building centre.



Bydgoszcz is Poland's eighth-biggest city, located around 225km (141 miles) north-west of the capital, Warsaw. It has a population of 354 000 and shares the capital role for Kuyavian-Pomeranian Voivodeship (province) with the smaller city of Toruń. A military incursion in 1760 foreshadowed long periods of Prussian/German control, with Bydgoszcz becoming Bromberg – the name under which the city saw the introduction of trams. Not the first restoration of the Polish identity, it has been Bydgoszcz since 1945.

Public transport and the area's roads are controlled by a municipal authority, ZDMIKP. The transport operator is Miejskie Zakłady Komunikacyjne w Bydgoszczy (MZK), constituted as a

limited company under city ownership since 1998. There is a common if complex fare structure for trams and buses; wholly separate ticketing applies to local heavy rail services.

Founded in 1346, Bydgoszcz extends along both banks of the Brde river which overall runs east-west on a course modified for navigation. It is near where the Brde joins the Wisla/Vistula, Poland's longest river. Waterways helped to establish the settlement as a trading centre and the position of bridges has influenced the tramway's current configuration.

Bydgoszcz is on the Gdansk – Poznań railway line, one of several routes running through the main station, Bydgoszcz Główna. This is overlooked on the northern side by the railway works, previously used

▲ Representative of the system - old and new at Bydgoszcz Wschód station. This elevated stop and interchange opened as part of the Fordon extension in January 2016.

mainly for repair and overhaul. In the 21st Century this vast site has become better known for manufacturing the heavy and light rail vehicles of Pesa Bydgoszcz SA. Although Pesa products have attracted many customers both in the domestic market and increasingly overseas, disruption of income led to state intervention in 2018 to support long-term operation. Amongst Pesa's clients is the home city system which, at its closest point to the works, passes the Bydgoszcz Główna entrance on the railway's south side.

The station's location well to the north-west of the city centre created the demand leading to the first tramway. Initially horse-drawn, this connection which opened in May 1888 remains in today's metre-gauge system, albeit partly using a new

Words and pictures by Neil Pulling.

THE FLEET

The most numerous type in the all-domestic, uni-directional fleet remains the Konstal *105Na*, with over 100 examples (numbered from 201). They are from a wide spread of the 1979-92 production run in Chorzów, Silesia, and operate singly or as pairs.

Stock renewal only became substantial upon infrastructure extension and modernisation. Pesa's *Tramicus 121N* was tested in Bydgoszcz, although the only six of this type in service are on the Elbląg system around 180km (110 miles) to the north.

The first MZK low-floor trams in normal service were two of the longer *122N* version, 364-365, from 2008. It was not until 2016 and under the Fordon project that more new trams, by then from Pesa's *Swing* range, joined the fleet. These 100% low-floor, air-conditioned trams are 12 five-section, 30.1m *122NaB* (111-122) and six three-section, 19.35m *121NaB* cars (170-175) dating from 2017. The three more recent of the *121NaB* were the first deliveries from a 2017 contract that includes 15 more of the longer version.

Blue, red and white feature in the tram livery, albeit in very different proportions on the Pesa and Konstal vehicles; some of the latter have all-over advertising.



▲ Prompting the initial tramway, the main railway station was without trams for many years. Bydgoszcz Główna rejoined the system in 2012.



▲ ABOVE: An early Pesa venture in the tram market, this 2003 Konstal *805Na* remodelling created the only examples of type *805Nm*, allocated numbers 362 and 363.

◀ LEFT: A single Konstal *805Na* moves through the spaciouly laid out junction near Szarych Szeregów.

▶ RIGHT: A Konstal pair leaving Most Władysława Jagiełły, the bridge created for the new line giving access to the station.





▲ ABOVE: Tramicus 365 and the recently in-service 121NaB 174 at Toruńska depot storage sidings.

▼ BELOW: Having turned in the compound of the new depot, 344+345 are on non-revenue track approaching Łoskoń terminus.



route. By 1896 electric trams were introduced, becoming a 12km (7.5-mile) operation a decade later.

During the inter-war Polish Republic, Bydgoszcz took the system into municipal ownership in 1928. A short-lived trolleybus installation was amongst the transport changes brought under German occupation in World War Two. Communist direction up to 1989 saw the tramway extended to meet the demand brought by a growing population and spreading urban area. This is exemplified by lines extending from a delta junction near Szarych Szeregów stop, installed to serve a spread of housing estates around the city's southern edge.

The rationale for the long south-eastern reach is less apparent today, but it was influenced by the presence of industrial sites. Not all of these survive and generally far fewer people are employed in such districts. There is now the slight feel of a heritage operation here, having undulating track and with vegetation brushing the tram side in summer.

The loop at Łęgnowo terminus edges open countryside. This and the wooded surroundings of the northerly Las Gdański terminus are very different from those lines ending amongst housing estates or by major roads. Contrasting with some tightly-positioned city sections that originated in the early tramway, the system features several

spacious junctions within major road intersections. The following of such roads and the naming convention for stops explains the recurrence of certain names like Toruńska and Akademicka, coupled with the intersecting road name.

The city's historic centre around the main square (Stary Rynek) is just south of the river, in what local tourist information designates in English as the Old Town. A short section of rails in a renewed bridge ramp represent the former presence of trams on both sides of the Brde. Diminishing Old Town tram coverage led to complete closure here when access from the river's south bank was cut in 1973. The remaining connections between operations north and south of the Brde are both appreciably east of the city centre. This creates the potential for some rather indirect tram journeys.

North of the river around Plac Teatralny is the tramway's main east-west axis. Tagged for tourism as Downtown, this area with some of Bydgoszcz's finest tram buildings has the most intensive tram coverage. It also accounts for the approximately 20% of the system in shared road-space. At the southern end of tracks along Ulica (Ul. / street) Gdańska, this early part of the system previously included access for the original station line. Fears about a gas pipeline's safety led to ending public tram operations at the city end of that line.

◀ LEFT: 1988-built 348 + 349 Konstal 805Na on the Fordon extension at Bajka.



NETWORK FACTS

- > **Opened:** 1888 (electric 1896)
- > **Lines:** 10
- > **Depots:** 2
- > **Length:** 40.8km (25.5 miles)
- > **Approx. weekday hours:** 05.00-23.00
- > **Main frequencies:** 10 or 20 minutes
- > **Gauge:** 1000mm
- > **Power:** 600V dc, overhead supply
- > **Fleet:** Approx. 130
- > **City network/operator:** MZK
w Bydgoszczy - www.mzk.bydgoszcz.pl
- > **Service information:**
www.zdmikp.bydgoszcz.pl
- > **Civic information:** www.bydgoszcz.pl
- > **Tourist information:**
www.visitbydgoszcz.pl

Empty stock movements continued for some time due to continuing use of Zygmunta Augusta depot (now closed), sited west of the main station. It was not until 2012 that the station rejoined the system via a longer route than previously used. New track diverged from Ul. Dworcowa (Station Street) at the southern end onto a new alignment which included a new Brde crossing, Most Władysława Jagiełły. This cable-stayed 83m bridge is also available to cyclists and pedestrians.



▲ A Konstal pair at Rondo Toruńskie between two staples of Polish retailing, a kiosk and a hypermarket. The latter format has influenced the tramway's modern development.

Near where the original station route entered the city, Konstal 805Na 300 + 301 head south on Gdańska.



“Bydgoszcz appears set to continue its light rail coverage, with potential extensions identified to the south-west as well as a third river crossing.”



▲ ABOVE: Inside 1985-built Konstal 805Na 311. The Pesa works are to the right, on the opposite side of the railway tracks.

◀ LEFT: Then Bydgoszcz's newest tram, Pesa 121NaB 175 near Focha / Opera on 6 June 2018.

ESSENTIAL FACTS

Local travel: Modern ticket machines can be found at prominent locations, including the main station. There are many agency outlets, but these may not have the full fares range in stock. Single journey tickets from PLN3 (EUR0.7); one-hour passes at PLN4.20 (EUR1); 24 hours at PLN12 (EUR2.80). All tickets require validation upon boarding.

What is there to see?

Tourist information is at Stary Rynek, the reconstructed Old Town Square that is likely to attract most visitors, as does the adjoining riverside/canal area. There is also a 'Water Tram' boat service along the more picturesque stretches, April-September, with separate fares. There is a great deal of public art in the Old Town and Downtown areas.

For heritage/tourist tram and bus services visit www.zdmikp.bydgoszcz.pl - using the Rozkład Jazdy (timetable) tab.

The city of Toruń also features a tramway, and lies 40km (25 miles) and 50 minutes away by train from Bydgoszcz.



▲ ABOVE: Pesa's *Tramicus* was the first low-floor type to join the Bydgoszcz fleet; 364 leaves the Bielawy branch at Gdańska Chodkiewicza.

◀ LEFT: Some of Bydgoszcz's oldest trams, 1981-built 271+272 pass Toruńska depot.



▲ ABOVE: Two pairs at semi-rural Łęgnowo, due to problems with 346+347. The service was terminated at the stop before the depot.



The line west of the junction created for the new station contains the system's only single-track section, about 500m approaching Wilczak terminus.

A new 9.5km (5.9-mile) line serving the Fordon district, north-east of Bydgoszcz, joined the system in January 2016. Now with around 75 000 residents and growing, Fordon became part of Bydgoszcz in 1973. Plans for a tram connection between the two long predated their union. The new 13-stop line extended from existing route around Bydgoszcz Wschód (East) station which was rebuilt to create an interchange on the elevated tram crossing of the railway. The curved viaduct can be used by tram replacement buses if required.

Around 2.6km (1.6 miles) separates Bydgoszcz Wschód and the next stop to the east, Akademicka / Rejewskiego. This gives the extension a strong interurban nature, heightened by sparse development and the tracks being segregated from the nearby busy road. Services are split between two eastern termini, Niepodległości and Łoskoń. For the latter, trams run beyond the stop to turn inside the compound of the new depot which

includes storage sidings and inspection facilities. Marking a substantial change in motive power, 12 Pesa *Swing* trams were included in the project which was delivered by special-purpose company, Tramwaj Fordon Spółka. Trackside signs and tram vinyls mark the substantial funding contribution from the European Union.

The system's main maintenance and storage facility remains Toruńska, next to the Stomil-Łęgnowo line. It opened in 1959 and has had upgrades.

There are ten regular lines (1-10), with most passing through the Downtown area; the majority have a 20-minute interval. Line 9 is restricted to peak-time reinforcing services south of the river. The longest service is line 3 at 18.3km (11.4 miles) and taking 44 minutes between Łoskoń and Wilczak. At Focha/Opera stop, the location gets appropriate audio on the *Swing* trams with a burst of Rossini's *William Tell Overture*.

Subject to permissions and finance, Bydgoszcz appears set to continue light rail coverage. Potential extensions have been identified that include new lines in the south-west and a third river crossing. **TAUT**

◀ LEFT: Plac Teatralny, where track near the buildings in the background used to reach into the Old Town.

▶ RIGHT: A Pesa 122NaB *Swing* between services at Rycerska. Giving a more spacious turning area, this extension was added with the new station route.



EXPERTS IN NOISE AND VIBRATION ATTENUATION IN RAIL TRACK



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- Noise and vibration evaluation.
- Transition zones for bridges and turnouts.

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EN15085

Worldwide Review

AUSTRALIA

ADELAIDE. Driver training on the city tramway extensions resumed on 6 August, and it was hoped to start passenger service on 19 August. However this was not achieved and has been delayed to an unknown date while efforts continued to resolve technical problems with the tram/traffic light interface. *I. Hammond*

MELBOURNE. The 8km (five-mile) suburban rail extension from South Merang to Mernda was opened on 26 August; this AUD588m (EUR364m) project is part of the level crossing elimination programme.

On 28 August the Victoria Government unveiled plans for an underground suburban rail loop from Werribee to Cheltenham via Fawkner and Box Hill that could be built from 2022. If the current government wins the November election, AUD300m (EUR185.7m) will be invested in a feasibility study. *RGI*

NEWCASTLE. The first of six 33m CAF Urbos 100 trams were shipped from Spain in early August to be delivered in September.

Sydney Morning Herald

PERTH. Three bidders have been shortlisted for the AUD1.6bn (EUR990.5m) contract to deliver and maintain 41 six-car 1067mm-gauge EMUs: Alstom, CAF/UGL and Bombardier/ED1 Rail. Assembly will be at a new factory in Bellevue. Delivery should start in 2021. *IRJ*

AUSTRIA

INNSBRUCK. The opening of new tramlines 2 and 5 has been postponed to early 2019 due to delayed delivery of new Bombardier Flexity trams. *BS*

LINZ. Wednesday 4 July saw the ground-breaking ceremony for the new Donau bridge that will carry tram-trains from autumn 2020. *TR*

ST PÖLTEN - MARIAZELL. On 26 June the narrow-gauge train of Himmelstreppe sets ET5 and 6 derailed at 55km/h (35mph) on a 35km/h (22mph) curve near Pielachbrücke, destroying the former and severely damaging the latter. Of the 80 people on board, 30 were injured.

On the same day the Mayor of Waidhof and his deputy and driver were injured when a VT12 service collided with their car on a level crossing. Service resumed on 3 July, but some journeys are bus operated due to the rolling stock shortage. *EB*

WIEN (Vienna). Tracklaying started in June for the 900m extension of line D from Alfred-Adler-Strasse to

Aspergasse, due for completion in September 2019. *EB*

BELGIUM

ANTWERPEN. Route 12 was cut back to operate Astridplein - Halenstraat (Schijnpoort) from 1 September, and operated by six double-ended ex-Gent PCCs. Tramline 70 (Eilandje - P+R Luchtbal) was due to start carrying passengers from 15 September. *T2000*

BRUXELLES/BRUSSEL. Planning permission has been given for the rebuild of Albert pre-metro station to become (in 2023) a full metro station, with interchange to tram lines 4 and 51. On 29 September tramline 94 will be renumbered 8, and extended from Woluwe (Tram Museum) to Roodebeek (metro line 1 interchange).

OOSTENDE. The hot weather during July and August saw a record 3.7m passengers use the coastal tramway during these months. In 2017 the total patronage for the year was 4.2m.

The next phase of the construction of a new four-track undercover tram station at Oostende took place on 17 September with temporary single-line working to permit the new tracks to be connected to the existing lines.

The Trammelant festival at De Haan saw ex-Gent PCC 26 carrying passengers on the coastal tramway for the first time. *T2000*

BULGARIA

SOFIA. Czech manufacturer CZ Loko has delivered two MUV 74 M-S track maintenance vehicles for the city's metro. One has a work platform for overhead line maintenance, while the other features a snowplough for surface sections of the network. *RGI*

CANADA

MONTRÉAL. The private transit company has secured a CAD1.28bn (EUR838m) loan from Canada Infrastructure Bank to build the REM light metro system. *D. Drum*

TORONTO. Flash flooding from heavy rain on the night of 7-8 August caused part of subway line 1 to be shut down, while tram 4471 was caught in a flooded underpass on King St West. It had to be towed in and dried out. Nine of the new Flexity trams were also damaged by water entering their interiors. Some will be sent away for repair.

New LRVs up to 4497 had been delivered by the end of August, with 4500 expected in the second week of September. From 7 October



▲ With new tram tenders soon to be issued, the German city of Nürnberg has been testing a München Siemens Avenio alongside one of its refurbished Bombardier NGT9 trams. *VAG*

the 504 King and 514 Cherry lines were to be revised to provide two overlapping services: 504A Dundas West Station - Distillery Loop; 504B, Broadview Station - Dufferin loop. All workings should be in the hands of Flexity trams. *D. Drum, S. Munro*

CHINA

CHANGCHUN. The 22.8km (14.2-mile) east-west underground metro line 2 from Dongfang Square to Shuangfeng opened on 30 August. The line is operated with 1500V dc overhead. *urbanrailnet*

COLOMBIA

BOGOTÁ. Metro de Bogotá has invited prequalification bids and expects to award a Design, Finance, Build, Operate and Maintain contract in 2019, with opening planned for 2024. The USD4.4bn project involves the construction of a 24km (15-mile) elevated line, will require 23 trains and is underpinned by funding agreements with three international groups (the World Bank, European Investment Bank and Inter-American Development Bank). *RGI*

CZECH REPUBLIC

OSTRAVA. The first two of 30 new Stadler Tango (nOVA) 24.9m LRVs entered passenger service on 13 August on line 4. *traminfo.pl*

PRAHA. Tenders have been invited for 124 air-conditioning units to re-equip the first batch of Škoda 15T trams that were delivered without this equipment.

During civic rehabilitation work around the National Museum at the top of Václavské nám, a new section of tram track will be laid in preparation for the future return of trams to the square (and closer to the railway station). The new track is unlikely to be connected to any other track for many months *traminfo.pl, A. Prescott*

DENMARK

ODENSE. Tracklaying for the new tramline started by the Spanish company COMSA on 30 July. *SHS*

DOMINICAN REPUBLIC

SANTO DOMINGO. Alstom has delivered six more three-car metro trains for the extension of line 2 from Eduardo Brito to Carrera Mella. This 3.6km (2.2-mile) extension was opened on 8 August by President Danilo Medina. *RGI*

EGYPT

EL QAHIRA (Cairo). Loan funding of EUR605m, including EUR205m from the European Bank for Reconstruction and Development, was announced on 1 August to provide urgent rehabilitation work on the 42.5km (26.5-mile) metro line 1 and increase its capacity by 40%. *IRJ*

FINLAND

HELSINKI. The first of the prototype Artic trams sold to Schöneiche in Germany left Helsinki by road on 19 August. *DS*

FRANCE

BORDEAUX. Five more 44m Alstom Citadis trams have been ordered for delivery immediately after the 25 currently under construction. This will bring the fleet of Citadis to 130 trams. *RHB*

NANTES. After two months of closure, tramline 1 re-opened on 27 August with 900m of new track and rebuilt stops at Gare and Duchesse-Anne. Tenders have been invited for 46 trams up to 48m long (with two options, each for 15 more trams). Bids were to close on 20 September. *lineoznet*

PARIS. The first test run on the EUR211m, 4.3km (2.7-mile), extension of tramline T3 ran on 18 August between Porte de la Chapelle and Porte d'Asnières. An eight-minute passenger service will start on 24 November.

A further 3.2km (two miles) to Porte Dauphine should be ready in 2023.

Le Parisien

SAINTE-MARIE - SAINT-DENIS. After rejecting a more expensive 40km (25-mile) tram-train project three years ago, the Réunion region has now published details of a planned 9.1km (5.7-mile) east-west tramway from Bertin to Duparc, expected to cost EUR300m, with the aim of carrying passengers in 2024. The Ecotram project is described by some sources as a monorail, but visuals show a conventional tramway. Patronage is estimated at 30 000 passengers/day.

A EUR5m feasibility study is underway.

Région Réunion

ST ÉTIENNE. Trams did not operate between Hôpital Nord and Place du Peuple from 2 July-26 August to permit the junction to be installed for new line 3, and various other works taking advantage of the temporary closure.

Y. Allain

GERMANY

BERLIN. Wednesday 8 August saw a farewell tour for *KT4D* party tram 4592 (ex-6014), delivered by ČKD Tatra in 1982.

H. Tschirner

DÜSSELDORF. Lines U71 and 701 started using the new terminus at S-Bhf Rath from 4 August.

DS

FRANKFURT-AM-MAIN.

An order for 22 25m centre-sections has been ordered from Bombardier to lengthen *US-50* LRVs.

DS

HAMBURG. A planning application has been submitted for the 2.6km (1.6-mile) *U-Bahn* extension from Horner Rennbahn to Dannerallee. The EUR465m project should break ground by the end of 2019.

IRJ

KASSEL. City centre routings returned to normal from 9 September after completion of relaying of the Grand Union at Am Stern and Königsstrasse.

Low-floor tram 672 was sent to Bombardier at Bautzen on 28 August to have its accident-damaged A-section replaced.

DS

KÖLN (Cologne). The first test run on the EUR12m 600m extension of line 3 to Görlinger-Zentrum took place on 21 August using *Stadtbahn-B* cars 2035+2310. Passenger service started on 27 August after an official inauguration on 25 August.

DS

OBERHAUSEN. Route 112 was cut back from Sterkrade to Mülheim-West from 14 September to 29 November for replacement of the Thyssenbrücke.

DS

MÜNCHEN (Munich). The delivery of the current batch of

22 Siemens *Avenio* trams was completed on 3 August with the arrival of 2709 and 2759. Despite this the type *P* four-axle sets can still be seen on two line 15 workings on Monday-Friday 06.30-20.00, since none of the new *Avenio* have been cleared to enter service.

F. Buchleitner

NÜRNBERG (Nuremberg). München *Avenio* 2801 (Siemens) and Krakow *Flexity* 818 (Bombardier) arrived for demonstration on 25 August, when both were displayed alongside refurbished Nürnberg *NGT8* 1011 at St Peter depot. The *Avenio* carried passengers the following day and until 2 September on a special route incorporating parts of lines 4, 6 and 8. The *Flexity* was not cleared to carry passengers as it is 2.4m wide compared with the Nürnberg standard of 2.3m. VAG is planning to order 12 (option 73) trams for delivery by 2024.

DS

WUPPERTAL. New Schwebbahn cars 12 and 13 entered service on 16 August (over a year after delivery), but were not permitted to exceed 30km/h (19mph), increasing the 31-minute journey time to 37 minutes. The restriction was lifted on 28 August.

DS

INDIA

DELHI. Monday 6 August saw the opening of the 8.1km (five-mile) Pink line 7 metro extension from Durgabai Deshmukh South Campus to Lajpat Nagar, including interchanges with lines 2 and 6.

IRJ

MUMBAI. A tender for 63 six-car metro sets for lines 2A and 7 attracted bids from seven countries. A decision is due in October.

RGI

INDONESIA

JAKARTA. The automated light metro line from Kelapa Gading to Velodrome (5.8km/3.6 miles) opened on 10 August, just in time for the Asian Games (18 August-2 September). Hyundai Rotem has supplied two-car trains. The line is planned to extend to 26.1km (16.2 miles).

Service had to be suspended on 12 August however and passengers evacuated due to malfunctions in the power and control systems, and the problems could not be resolved in time to provide service during the Games. A December opening is now planned.

E. B. Havens

PALEMBANG. The new light metro line was inaugurated by President Widodo on 13 July, and started carrying passengers free of charge in a limited way from 14.00 on 23 July, using eight



▲ The latest design of new tram from Japanese builder Alna Koki has entered service in the city of Sapporo. *H. Usui*

three-car trains. Fares were payable from 1 August.

During the Asian Games priority was given to athletes and officials. There were several breakdowns during the initial period, and service was suspended from 3 September to an unknown date in October.

Detikfinance

IRELAND

DUBLIN. The visit of Pope Francis over the 25-26 August weekend saw free travel on all forms of public transport for those travelling to Phoenix Park with tickets for the event. With many city centre roads closed to road traffic, Luas services were operated in sections on both days, depending when events were scheduled.

ISLE OF MAN

DOUGLAS. Former horse car 34, one of the cars sold off at auction by Douglas Borough Council in 2016, has been converted into a road vehicle by mounting the body onto a rubber-tyred chassis. It is now based at the Isle of Man Motor Museum at Jurby. The museum says the tram can be converted back into a railed vehicle in the future, as all running gear has been kept by the owner who has loaned the vehicle to the museum.

MANX ELECTRIC RAILWAY. In preparation for the September 125th Anniversary events, 1898 ratchet-braked tram 14 has been restored at Derby Castle and ran to Ramsey on test in August. Royal Saloon trailer 59 has received a repaint in its original blue livery after work to the bodywork and trucks.

Two stations on the Island's steam railway are to be listed on the protected buildings register: Port St Mary station and Port Erin.

ITALY

CATANIA. A fleet of 27 two-car metro trains is to be ordered,

financed by a mixture of local, state and EU funding.

RGI

FIRENZE. The city has been allocated EUR47m in state funding for the construction of tramline T4 (12km/7.5 miles Campi Bisenzio - Porta al Prato FS). Line T2, 5.3km/3.3 miles Piazza dell'Unità d'Italia-Aeroporto Peretola) is now expected to open in mid-November.

RGI

GENOVA. State funding of EUR137.8m has been allocated to provide 11 more metro trainsets, and build one-station extensions at each end of the line.

RGI

GENOVA - CASELLA (FGC). Summer 2018 saw the regular operation of restored electric railcar A2 (Carminati e Toselli, 1929) between Genova and Casella Paese on Saturdays.

TR

MILANO. A further EUR90m has been allocated towards the purchase of 50 new double-ended trams, bringing total state aid to EUR150m.

RGI

SASSARI. EUR36m has been made available for the 1.9km (1.2-mile) tramway extension from Santa Maria di Pisa to Marginesu.

TR

TORINO. The Italian Ministry of Infrastructure and Transport has allocated EUR75m to the city to help finance the purchase of new trams.

RGI

JAPAN

SAPPORO. New bogie tram 1101 was unveiled at the depot on 30 August. The 13m 70% low-floor car was built by Alna Koki and carries 24 seated passengers (60 in total). The first of two trams on order, 1101 should enter service in October.

H. Usui

NETHERLANDS

DENHAAG. New ticket machines are being fitted to *GTL* trams 3101-47 that offer one-hour and day tickets with payment by chip card or cash. Later in the year ticket sales by the driver will be withdrawn. The three tramlines



▲ The Stadler LRV that is entering service on the new through service across St Gallen from Trogen to Appenzell in Switzerland. AB

6, 12 and 16 that cannot take 2.55m-wide *Avenio* trams are not likely to be rebuilt for wider stock for several years. OR

ROTTERDAM. From 13 August to 8 December line 8 trams are diverted away from Zaagmolenstraat and Benthuizerstraat due to infrastructure work, using Noordsingel instead. The same applies to Linker Rottekade, with line 7 and 10 trams diverted to Goudsesingel/Boezemweg. OR

NORTH KOREA

PYONGYANG. At the beginning of August the Chairman of the Workers' Party of North Korea, Kim Jong Un, visited the capital's Bus Repair Factory to inspect a new trolleybus and a heavily-rebuilt tram. The three-section tram is the first of 35 1990 Tatra *KT8D5K* cars that have been given a new body and new traction system using ac motors. Test running is in progress from Mangyongdae depot. DS

PANAMA

PANAMA CITY. Metro line 3, a monorail, will be equipped by a joint venture of Hitachi, Mitsubishi Corp and Ansaldo STS. The 26.7km (16.6-mile) line will be financed by a JPY29.5bn (EUR228.2m) Japanese loan and use 28 six-car trains. RGI

POLAND

ELBLĄG. The number of *Moderus Beta* on order has been increased from three to four. *traminfo.pl*

ŁÓDŹ. The overhead on the Lutomięrski line was stolen on 3 August, resulting in the need to start a bus replacement service. A major scheme to rebuild 11km (6.8 miles) of track started on 19 August, featuring new viaducts in Ul Łaczcza, and new tram tracks at ground level. The work will take two years. EU funding has been announced for a 7km (4.4-mile) cross-city rail tunnel

to link Fabryczna, Kalisk and Zabieniec by 2022. *traminfo.pl*

POZNÁN. Turkish civil engineering contractor Gulermak has been awarded a PLN380m (EUR87.9m) contract to build a new tramline from Plela Wilczak to Naramowice by the end of 2021. *traminfo.pl*

PORTUGAL

LISBOA. To mark European Mobility Week and 117 years of tramway operation, a parade of historic trams was operated twice on 16 September; CCFL cars involved were 283, 330, 444, 508, 535 and 802. *P.R. Costa*

RUSSIA

KAZAN. The new metro station Dubravnaya (interchange with tramline 4) was opened on 30 August, extending the line to 11 stations. *transphotoru*

MOSKVA. The western part of metro line 8 (temporarily 8A) from Ramenki – Rasskazovka (14.2km/8.8 miles) opened on 30 August, with a new depot at Solntsevo. Work continues on an extension to Vnukovo airport, due to open in 2023. *urbanrail.net*

SAMARA. Tram operation along Ulitsa Frunze ceased for a year from 29 August to permit highway reconstruction. Service is diverted via Ulitsa Pionerskaya and Ulitsa Chapaevskaya. *transphotoru*

SANKT PETERBURG. With the prototype *Metelitsa* tram now under test on the main network (and the expanding 'private' network taking delivery of this type), Stadler has proposed to the city council that it build a tram assembly plant in the city, in return for orders for more trams of this type. *RGI*

ULYANOVSK. The first second-hand 71-153 (*LM-2008*) tram, Moskva 4916, has become 1281 in the Ulyanovsk fleet. *transphotoru*

YAROSLAVL. Ex-Moskva *KTM-19* trams 5356 and 5361 arrived on 4 September. *transphotoru*



▲ A rainbow of trams in Göteborg (Gothenburg), Sweden, ready for Pride. GS

SOUTH KOREA

SEOUL. Hyundai Rotem is to supply 50 two-car automated metro sets for the 13.4km (8.3-mile) underground line from Seongdong-gu to Nowon-gu. The contract value is KRW365.1bn (EUR280.9m) and includes signalling and electrification. Completion is due in 2024. *RGI*

SPAIN

CÁDIZ. The latest official opening date given for the Bahía de Cádiz tram-train operation is October 2018, with service expected between Cadiz and Chiclana. Other local media sources are more pessimistic, claiming the opening date will not be until 31 March 2019. *TR*

SWEDEN

GÖTEBORG. *M29* trams 806/9/17/27/41/59 were given all-over artistic liveries over rainbow base colours to mark EuropaPride on 18-19 August. *MjSS*

SWITZERLAND

BASEL. New Bombardier *Flexity* low-floor tram 5034 was seriously damaged when it was hit by a van in St Louis on 21 August, derailed and hit a traction standard.

Be4/8 204/6/21/2/3/52 have been sold to the German city of Gotha, and were dispatched by road in August. *DS*

BERN (RBS). The first of 14 60m low-floor LRVs destined for lines S7 and S9 (*Be4/10* 10 01, named *Worbla*) was delivered by Stadler on 7 August. Each has 102 seats and space for 380 standing. They should start entering passenger service in December to permit a 7.5-minute headway between Bern and Worb via Bolligen.

LAUSANNE. Work on the new tramline to Renens will finally start in December, having been delayed by a legal challenge to the planned demolition of two buildings. *tram*

GOSSAU – WASSERAUEN (AB).

The first of the new Stadler *Walzer* three-section trains entered service on 6 August.

ST GALLEN – APPENZELL (AB). The first of 11 *AB8/12* Stadler *Tango* 52.6m 59% low-floor LRVs entered service between Teufen and Appenzell on 15 August. *IRJ*

TAIWAN

KAOHSIUNG. The first of 15 Alstom *Citadis X05* trams was shipped from Antwerpen on 3 August and should have been delivered by now. The five-section double-ended cars are fitted with Alstom's *Citadis Ecopack* for on-board energy supply during catenary-free operation.

Stage 2 of the 13.4km (8.3-mile) circle line was 38% complete at the end of July, with testing expected to start in September.

Tropical storms saw severe flooding across large parts of the city beginning on 24 August, with many transport arteries closed as rainwaters rose. Kaohsiung Rapid Transit Corporation continued tram operations, despite minor track flooding. *IRJ, Taiwan News*

UKRAINE

DONETSK. What is claimed as the first new tram in the 'Donetsk People's Republic' was rolled out at the Donetsk Electrotechnical Plant on 21 August, christened *DT-1* 'I am from Donetsk'. The tram is in fact a heavy rebuild of 1980 Tatra *T3* 4119, withdrawn last December. It is now being used on line 1; 4111 is now being rebuilt similarly. *transphotoru*

ZAPOROZHYE. The first of 12 ex-Berlin Tatra *KT4D* trams were delivered on 28 July. *transphotoru*

UNITED KINGDOM

BLACKPOOL. The LRTA is supporting a 'Trams to Lytham' campaign to connect the towns of Lytham and St Anne's to the tramway, currently being extended to Blackpool North.

Tram 642 has been returned to heritage service use while *Coronation* 663 has left storage at Rigby Road for restoration by a specialist company in Heywood.

BRISTOL. An underground metro would be transformational for the city, according to the draft Bristol Transport Strategy document. Such a system could cut journey times between Aztec West, Emerson's Green and Bristol Airport into the city to below 25 minutes. However, it also reports that costs would be significant at around GBP3.4bn (EUR3.3-4.4bn) for three lines, and that most schemes take around 20 years to deliver.

GREATER MANCHESTER. Manchester and Salford City Councils, supported by Transport for Greater Manchester, have launched a ten-week consultation to find out what people think of the current transport offering and what improvements they would like to see delivered. These are likely to include alterations to Piccadilly station and a possible Metrolink tunnel under the city centre. Visit www.tfgm.com/your-city-centre before 17 October to take part.

Approval has been given to introduce a simpler fares system on Metrolink. A four-zone system will be introduced next year alongside the planned fares increase. Despite the proposed increase, 78.5% of fares will be lower under the zonal system than they would have been under the current arrangements; 10% remain the same and 11.5% will be higher.

The Greater Manchester Combined Authority is aiming to draw down the full GBP100m (EUR111m) loan from the European Investment Bank towards the GBP350m (EUR390m) Trafford Park Line extension before Brexit, local authority online news service *Room 151* has reported. Brexit is to take place in March 2019.

KENT. Regional media have reported that local bus provider Arriva would be supportive of local light rail. The comments came in an interview with the company's Managing Director for Kent and Surrey. A scheme, dubbed KenEx, has been proposed to link Kent and the neighbouring county of Essex via a tunnel under the River Thames.

NOTTINGHAM. The section between Wilkinson Street and The Forest was closed 23 August-2 September to allow reconstruction of the track on the one-way sections of road through Hyson Green. Replacement buses linked the two sections of tramway

but did not precisely serve all intermediate stops. A temporary timetable was in place on the other sections of tramway.

STOURBRIDGE. The operation of *Class 139* railcars on the Stourbridge Town shuttle by Pre-Metro Operations on behalf of West Midlands Trains reached a milestone of five million passengers in August. The shuttle began full operation in 2009 and currently carries around 10 500 passengers on 1300 individual journeys per week.

SOUTH YORKSHIRE. Rail replacement continued in August and September with no tram service expected between Gleadless Townend and Herdings Park or Halfway 25 August-9 September. During this period Purple Route trams operated between Meadowhall/Cathedral and Gleadless Townend on Sundays only, while a normal service operated on the Yellow route. Replacement buses ran on the closed sections of tramway. From 10-21 September track reconstruction was scheduled to only affect the Donetsk Way to Halfway section. Dates can be flexible depending on weather conditions and progress.

The Rail Accident Investigation Branch is to publish a 'safety digest' after a passenger was thrown across a tram and part of a door mechanism was broken, causing it to come open. The passenger was injured in the 19 July incident, which took place near Middlewood Road; the RAIB reports that the tram was travelling at around 37km/h (23mph), some 21km/h (13mph) over the speed limit.

TYNE & WEAR. Plans have been submitted for a temporary Metro depot in Howdon to accommodate ten train sets overnight plus maintenance facilities. This is needed to allow the main depot at Gosforth to be redeveloped ready for the proposed new fleet of trains. The land has been purchased from North Tyneside Council for GBP1m (EUR1.1m). It is expected that the main use of the depot will be to commission the new trains as they are delivered from 2021.

WEST MIDLANDS. The West Midlands Combined Authority has said the projected cost of the planned 11km (seven-mile) Wednesbury - Brierley Hill line is GBP343m (EUR381.5m), GBP33m (EUR36.7m) more than initially planned and mostly due to the increased cost of acquiring land. The projected cost of the proposed Birmingham - North Solihull line has increased from GBP675m (EUR750m) to



▲ The first rebuilt Tatra tram in the breakaway Donetsk People's Republic, Donetsk, Ukraine. City of Donetsk

GBP735m (EUR817m). Efforts are currently being made to bring the projects back under the initial budgets.

The Brierley Hill line is expected to open in two phases, from Wednesbury to Dudley in 2022, and to Brierley Hill in 2023. Work has started to remove vegetation and structural surveys are being carried out on bridges, while drainage is being repaired. The project is to be funded with GBP207m (EUR230m) from the UK Department for Transport, GBP103m (EUR115m) from the Combined Authority, and GBP400 000 (EUR445 000) from the Local Growth Fund. GBP8.8m (EUR9.8m) has been spent so far.

Transport for West Midlands has waived the GBP10 fee for a photocard for 16-18-year olds, meaning they can now gain half-price travel without a fee.

Pipers Row reopened to traffic on 2 September, following work over the summer in preparation for the extension of the tramway in Wolverhampton.

USA

BALTIMORE, MD. Light rail service south of Patapsco resumed on 17 August after repairs to storm damage were completed. *R.Barrows*

BOSTON, MA. The second CAF-built *Type 9* LRV, 3901, was delivered to MBTA at Riverside on 28 June. *Rollsign*

DURHAM, NC. The Durham County Board of Commissioners approved a letter from its Chair to the GoTriangle Board of Trustees, agreeing to fund the USD57.6m gap for the Durham-Orange light rail project, created after the N.C. General Assembly changed the funding plan this summer. *R.Barrows*

ELPASO, TX. Daytime motorman training using four renovated PCC trams began on 13 August on the downtown loop. This was extended to the Uptown loop a week later. *P.Ehrlich*

INDUSTRY. Hyundai Rotem has announced the closure of its railcar assembly facility in south Philadelphia. The ten-year-old factory once employed 300, but has been short of orders since the SEPTA and Denver contracts for *Silverliner V* commuter rail trains. SEPTA's subsequent order went to Chinese conglomerate CRRC. *phillynews.com*

KANSAS CITY, MO. The KC Streetcar carried 262 593 passengers in July, a new record. Average Monday-Friday patronage is 7909 compared with a pre-opening forecast of 2700. *E.B.Havens*

LOS ANGELES, CA. The 28-year-old Blue light rail line linking Los Angeles and Long Beach will close for four months at its south end (January-May 2019) and north end (May-September 2019) to permit complete infrastructure rehabilitation (track and overhead) and a new depot train control system. Bus replacement shuttles will serve affected passengers. *J.Vigrass*

MANITOU, CO. After suspension of service for 2018, the decision has been taken to invest USD100m in the 16km (ten-mile) Pikes Peak rack railway, including new rolling stock and rehabilitated infrastructure. Work on the latter started in August. *EA*

MILWAUKEE, WI. *Liberty* tram 04 from Brookville Equipment Corporation was delivered on 13 August and 05 was expected on 6 September. The first daylight test on the 3.4km (two-mile) route between the Intermodal Terminal and Burns Commons was on 22 August. *P.Ehrlich, E.B.Havens*

NEWARK, NJ. The USD3.8bn budget for 2019 comprises USD2.3bn for revenue and USD1.5bn for capital costs, including USD39m towards network expansion, particularly the HBLR Northern Branch.

PITTSBURGH, PA. Station Square light rail station had to



▲ The Texan city of El Paso is testing its rebuilt PCCs ready for the inauguration of city loop service later this year. P. Ehrlich

be closed from 13.00 on 5 August when a Norfolk Southern freight train derailed and fell on to the light rail tracks. A bus bridge was set up and ran until 12 August. *E. B. Havens*

PORTLAND, OR. The Southwest Corridor Steering Committee has selected the preferred route for the 19km (11.8-mile) light rail line to Tigard and Tualatin. It will branch off the existing MAX line between PSU South and Lincoln St running south-west along Barbur Blvd, 70th Ave, Elmhurst St and private right-of-way to Hall Blvd. It will then follow the existing commuter rail line to Bridgeport Village shopping centre. The USD2.86bn project could be ready by the end of 2027, subject to federal funding being confirmed in 2022. *S. J. Morgan*

ST LOUIS, MN. The first new MetroLink light rail station to be built for more than a decade, Cortex, opened on 31 July (25 years to the day from the opening of the line). The new station serves the Cortex Innovation Community and the new Chateau Greenway, a track for pedestrians and cyclists. *R. Barrows*

SAN FRANCISCO, CA (Muni). Two months of rehabilitation work

on the Twin Peaks tram tunnel were completed on 24 August, with the network returning to normal the following day.

By late August new Siemens S200SF LRVs up to 2037 had been delivered.

On the night of 15-16 June, the fleet of historic trams used for regular service on lines E and F were moved back to Cameron Beach Yard (formerly Geneva Car Barn), at San Jose Avenue and Geneva Avenue, after four years of being at Muni Metro East, just east of the T (Third Street) line at 25th Street & Illinois Street. They had been temporarily displaced in June 2014, for a major project to replace all of the track at the light rail depot located across the street, which necessitated the move of many LRVs from that facility to the Cameron Beach Yard.

During the four-year displacement, all trams running into or out of service on lines E and F ran along line T tracks, and PCCs or Peter Witts on training or testing runs could also be seen on the section of line T between 25th Street and just south of Market Street.

From the start of service, all E and F line trams have resumed using the J line tracks when

entering or leaving service. Trams will serve all regular J line stops.

PCC 1050, now wearing red-and-cream St Louis Public Service Company livery, had returned to service on the F line by the first week of June. Brooklyn-deriered PCC 1053 returned to service in mid-August. *S. J. Morgan*

SAN JOSE, CA. VTA will cease its six peak-period express workings on the Alum Rock - Santa Teresa line from 8 October to reduce operating costs. They have been running since 2000. *E. B. Havens*

SANTA ANA, CA. The OCTA contract for eight Siemens S70 trams was signed in August. *E. B. Havens*

TEMPE, AZ. The FTA gave its approval for the start of construction on the 4.8km (three-mile) modern tramway project on 21 August. The line is expected to be ready to open in 2020. *E. B. Havens*

MUSEUM NEWS

CRICH (UK). The London County Council Tramways Trust has agreed that its next project will be the 'restoration' of a North Metropolitan Tramways horse car (184) also using parts from a similar car rescued from Wales. It is intended to create a double-deck horse tram from the kit of parts with a start date in the Crich workshops, expected provisionally in 2021.

FERNY GROVE (AU). The 66-year-old Mercury Arc Rectifier that has provided power for the Brisbane Transport Museum for 37 years was replaced by a substation with transformer at the end of June. *TA*

PORTLAND, OR (US). With newly refurbished motors, Brill replica tram 513 entered service on the Willamette Shore Trolley line at the beginning of the 2018 season, on 26 May, replacing car 514 for the time being. This was its first time carrying passengers since 2005, when Vintage Trolley service on the Portland Streetcar

line ended. A second generator has been acquired, to allow concurrent operation of both cars, which should be possible for this year's Christmas-season runs. *S. J. Morgan*

THUIN (BE). The ASVi museum group celebrated the return of 1888 steam tram HL303 on 4 August with a special train from Thuin to Biesmes-sous-Thuin. *T2000*

WEHMINGEN (DE). Den Haag PCCs 1308+2104 arrived at the Hannover Tramway Museum in the third week of August. *Haagse Tramnieuws*

WHITEMAN PARK (AU). The Perth Electric Tramway Society has modified Melbourne W7 1023 as a works car, including overhead inspection tower. *TA*

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MEETINGS & EVENTS

Compiled by the LRTA. For a full list of the year's events and meeting places please visit www.lrta.org

SEPTEMBER 2018

- ▶ **Thursday 27.** Manchester 19.00. Robert Pritchard: Tramways of the Czech Republic and Slovakia - Part 2.
- ▶ **Saturday 29.** Garstang 14.00. Tony Young: Worldwide tramway developments. (TLRS)

OCTOBER 2018

- ▶ **Tuesday 2.** Southampton 19.30.

- Paul Coles: Preserved trams in the British Isles. (LRTA/SEG)
- ▶ **Saturday 06.** Birmingham 14.00. Mike Ballinger: The Gulf and India. (LRTA/TLRS/ERS; TMS invited)
- ▶ **Monday 8.** Thames Valley 19.30. Results of the Gerald Warner legacy kits distribution, plus 'How it is done' by Adrian Batt. (TLRS)
- ▶ **Wednesday 10.** Brighton 19.45. Paul Snelling: Three countries in a day by tram. (TLRS)

- ▶ **Monday 15.** Liverpool 19.45. Martin Jenkins: More Merseyside memories from OTA. (TLRS Merseyside)
- ▶ **Monday 15.** Wickham 19.30. David Lusby: Baltic experience. (TLRS Solent)
- ▶ **Tuesday 16.** Leeds 19.00. Vic Simons: American trams.
- ▶ **Tuesday 16.** London 19.00. Tim Kendall: Tram-Train
- ▶ **Saturday 20.** Oxford & Chilterns 14.00. Northampton - 01865 370634 for further details. (TLRS)

- ▶ **Saturday 20.** Taunton 14.00. John Prentice: East London. (TLRS)
- ▶ **Thursday 25.** Manchester 19.00. Andy Barclay: Tram Slides from the Peter Fox Collection - Part 2.
- ▶ **Friday 26.** John Hampton. Quaker Meeting House, Edinburgh. Tramways of Graz.
- ▶ **Saturday 27.** Beeston 14.00. Modelling: Bring your project. (TLRS)
- ▶ **Sat 27.** Garstang 14.00. Members: What I did on my holidays... (TLRS)

MAILBOX

Get your views into print



simon@mainspring.co.uk



Letters submitted by post should be clearly typed and preferably not handwritten. We reserve the right to shorten contributions for publication.

When will the Government take action on air quality?

Recent weeks have seen a great deal of media coverage surrounding the 2013 death of nine-year-old Ella Kissi-Debrah, with suggestions of a link between her fatal asthma attack and the levels of air pollution in her London neighbourhood that breached EU legal limits.

We have long been campaigning for the UK Government to address this most serious issue and investigate the links between transport-related pollution and public health. It is sad that it now appears that we have a death that can be directly ascribed to excessively high concentrations of air pollution.

An inquest in 2014 concluded that Ella died due to a severe asthma attack followed by a seizure, possibly caused by an allergic reaction to something in the air. Following recent research, Ella's mother has called for a new inquest to establish the cause once and for all of her daughter's premature death.

A report by one of the country's leading experts on asthma and air pollution, Professor Stephen Holgate, says that there was a "striking association" between Ella's hospital admissions and recorded spikes in nitrogen dioxide and micro-particulates in the area. He added that there was a "real prospect that without unlawful levels of air pollution, Ella would not have died".

If readers wish to support Mrs Kissi-Debrah's campaign,

they can view the details at www.change.org/p/grant-an-inquest-to-find-if-air-pollution-caused-my-daughter-s-death/

At the time of writing, this online petition had garnered over 130 000 signatures, proving that there is a strong desire from the people to see the Government take action on illegally high levels of air pollution in many of our towns and cities.

We support this action as we believe it only strengthens the argument for an urgent need for local and national policies that support the greater adoption of tramway and light rail solutions. These environmentally-friendly modes generate zero pollution at point of use and are proven the world over in their effectiveness in getting motorists out of their cars.

The Government recognises the risks of poor air quality; indeed it has been classified as the largest environmental risk to public health with a belief that over 40 000 premature deaths in the UK are linked each year. The World Health Organisation says this figure could be as high as 70 million globally.

Levels of nitrogen dioxide have been illegally high since 2010 in the vast majority of our urban areas, yet the authorities are still failing to act. We need to force the hand of politicians, both local and national, to take up this cause.

Jim Harkins, Chair, TramForward

Heavy-duty token working in Prague!

These days, most single-line working is by signal control. Batons (tokens) were traditional, but are not widely used today and there is always a risk one would be accidentally (or purposely) pocketed.



Yet in Praha they are using token working for the line 30 temporary shuttle using the biggest token I have ever seen (see left)!

Mike Russell, by e-mail

How do we break the deadlock?

I was struck by your cover sub-headline on issue 969, "Industry debates why UK is behind the light rail curve". As far as I can see there is not the slightest doubt why - look around, the UK is behind in almost everything.

The reason is clearly the Westminster Government, in particular the Treasury. This seems to stultify almost every development, in light rail but also on the railways - think electrification. Note a different policy obtains in Scotland.

This stultification has resulted in no new tramways in either Leeds or Liverpool - we all

remember the cancellation of these schemes and also the one in the Portsmouth area. Both northern cities are larger than Sheffield, which has had new trams since the 1990s.

However this slowness also applies to local politics. Everything in the UK, south of the border anyway, seems to take forever to make any headway. Endless committees, referrals back and forth and rethinks: every development is like struggling through a plate of particularly glutinous porridge.

John Gilbert, by e-mail

Credit where credit is due

In *Köln: Private funding for public transport (TAUT 969)*, the map on page 342 was created by G. Storbeck from Bonn University while images on page 343 are courtesy of S. Anemüller and U. Kissmann.

Obituary: Frits van der Gragt

We regret to report the death in Hilversum on 24 August of Frits van der Gragt, Knight of the Order of Oranje Nassau. He was 88 years of age.

Frits was born in Amsterdam on 21 September 1930, and was an early student of tramways, particularly in his beloved home city, where he was a regular passenger for many years. He also became an expert on the Belgian *Vicinal*, prompted by a bicycle tour in 1947.

Frits was a committee member of the LRTA-affiliated society, NVBS, eventually becoming its Chairman. He led work on

three jubilee celebrations (1981, 1991 and 2006) and was Editor-in-Chief of its magazine *Op de Rails* 1986-2007.

A prolific author, Frits specialised in rolling stock and systems in Eastern Europe at a time when travel there was not easy. He authored the seminal works, *Europe's Greatest Tramway Network* (covering the Rhein-Ruhr area) and *Moderne Trams*, which analysed tram designs around the world since the 1930s; in recent years he had been engaged in updating this, unfortunately a project that will have to be completed by others.

Professionally, Frits was a sales manager for France's largest manufacturer of tyres

to Dutch bus companies (which gave him many useful public transport contacts), and after retirement he became a steam tram driver on the Hoorn - Medemblik preservation line and was Chairman of its management organisation from 1993 to 2011. He also drove historic (and occasionally modern) trams in Amsterdam.

An LRTA member of many years, Frits was always a good friend of British tramway fans, and a participant in some of the famous Jack Wyse tours. He was also a tour leader for NVBS trips to five continents. We offer our condolences to his children, Erik, Marjan and Linda, and grandchildren. **RNHJ and MRT**

THE GROWING BRUS COLLECTION

PART
TWO



Mike Russell continues his review of the varied and growing fleet of tramcars assembled in the museum collection at the former Brus depot in Łódź.

Three two-axle motor cars from the inter-war period have been restored by Miejskie Przedsiębiorstwo Komunikacyjne w Łodzi (MPK) and remain in its ownership but are regularly seen at Brus. Car 48 is a *Lilpop II*; the Łódź tramways obtained three separate series of cars from the Warszawa firm Lilpop, Rau i Loewenstein during these years, and this is one of the second batch.

With a distinctive narrow body, they were strong, serviceable cars that gave years of good service. After withdrawal in 1973 this example served as a works car until 1988. The third batch of Lilpop cars was built in 1939, comprising 24 motor cars and ten trailers. Only 23 ever reached their intended destination though, the remainder being lost in air raids and a factory fire. All were withdrawn in 1973, and 153 and 158 became works cars 2015 and 2017. The latter was renovated to passenger condition by MPK in 1981; 153 is extant but not currently restored.

The third car is a product of the Sanok works in 1928-29. Car 17 (a fantasy fleet number) was originally trailer 461, built as one of a series of 17 motor and 23 trailer cars fitted with all-metal bodies. All the motor cars were transferred to other Polish systems in the 1950s. Car 461 lasted in service until 1973 and subsequently found further use as a house verandah until acquired privately for preservation in 1999. Restoration work completed in 2010 included motorisation. Its survival owes much to the initiative of Tomasz Adamkiewicz, who has saved and owns not only this car but several works cars, all of which are exhibited at the Brus project.

Three post-war articulated cars are in the collection. Pride of place goes to TP car 2, the last *803N* operated by the company and the last of the type in regular passenger service in Poland. Built in 1973, it was originally MPK 947 before several re-numberings and eventual transfer to TP, and after withdrawal was bought by KMST in September 2012. Cars of this type were last in service with MPK in 1994, and were internally reconstructed with fully-separated driving cabins in the late 1980s. Car 2 is kept in full working order and used for excursions and private hire by KMST.

Lines hived off

When the interurban lines were hived off from the city network in 1993, the two northern lines to Zgierz (45) and Ozorków (46) passed into the ownership of Miedzynmianna Komunikacja Tramwajowa (MKT). This undertaking invested in upgrading and modernising its fleet, and the first move was to reconstruct transferred

803N cars with new, angular metal bodies built in Helenówek depot. These distinctive, if somewhat ungainly, cars formed the nucleus of service requirements for some years until it was realised that the cost of the work exceeded that of acquiring secondhand cars from Germany and Austria. As a result, rolling stock from places such as Freiburg-im-Breisgau, Bochum-Gelsenkirchen, Innsbruck, Ludwigshafen and Mannheim joined the fleet. Of the rebuilt *803N* cars, 37, dating from 1974, was one of the last in MKT service and bought by KMST in 2013. It appears in the MKT 'oranges and lemons' livery.

The third modern articulated car is 1042, one of the eight Düwag *GT6* vehicles acquired from Bielefeld in 1990 by MPK, in whose fleet it became 4042. Built in 1957, it passed to TP as its 42 in 1994. The car remains in MPK ownership, but has been on long-term loan to KMST since September 2015 intended for future restoration.

Mention should be made of the set of *N-type* cars owned by MPK and operated on special summer tourist services since 2003, staffed by KMST volunteers. These are Konstal-built *5N* motor car 337 of 1961 and Swidnice-built *5ND* trailer 644 of 1960, both of which are normally housed at Chocianowice depot. Out of a total *N-type* passenger fleet of 378 motor and 386 trailer cars, Łódź had some 210 motor and 376 trailer cars of types *5N* and *5ND*, the last remaining in service until 1991. Both examples retained double-ended layout with manually-operated doors, being withdrawn in 1983 along with all others that had not been rebuilt to single-ended configuration. They were renovated in 1989-90 and at time of writing were in course of a heavy overhaul, with the intention of returning to service.

The KMST has its own two *N-type* motor cars. Car 1234 is a rare example of the type *2N1* built in 1950 at Stocznia Gdanska (the Gdansk shipyard); it was 193 in the city fleet and modernised to single-ended layout in 1975. Latterly it served as a training vehicle until 1996. It is in active use at Brus and awaiting restoration. Car 4092, a Konstal-built *5N*, also has an interesting history. Built in 1961, it originally served on the Bielsko-Biała tramway (closed 1971) as that organisation's 35, before transfer to Łódź, where it was rebuilt to single-ended configuration. It was the last of the type in service in the city, withdrawn in October 1991, and then became the Telefontyczna depot shunter (12092). Restored in 2006, it passed into KMST ownership in 2017. The intention is that it should be used on tourist services.

Works cars

Works cars have been a familiar sight on the Łódź tramways for many years, with examples of cut-down former *N-type* passenger vehicles conveying bogies to and from Tramwajowa works each day for attention. Several, mainly in their distinctive two-tone green livery, have been assembled at Brus after years of outside storage at Helenówek, used to store museum candidates before Brus became available.

In numerical order, they are 101, a 1954 Konstal *2N2* that in 1979 was converted to a snow-clearance car with rotary brushes and later served with TP; 103, a Konstal *5N1* car of 1961 that was converted into a general transportation car in 1980, of which several examples are still in use by MPK; and KEL, the diminutive Ulm trailer 36 built by Busch of Hamburg which came to Łódź under wartime conditions in 1942 and was subsequently rebuilt as a goods wagon for sand transport. All the foregoing remain in MPK ownership.

KMST owns 38, a Gregg bogie flat-wagon built in the 1920s that came to Łódź in 1943 and was later used for rail transport; 109, a type *5N1* car built by Konstal in 1959, in 1975 rebuilt as an overhead line inspection and maintenance car and latterly operated by MKT; and 92031, a *2N2* Konstal product of 1956 that was later rebuilt as a more advanced rotary snowplough and used by MKT. Finally, there is 108, a 1951 *2N1* car built by Stocznia Gdanska and operated as 218, which was latterly rebuilt as a more orthodox type of snowplough. It is privately owned by Jerzy Wojtowicz and intended to be rebuilt as a mobile exhibition and party tram.

The Brus museum hosts open days on several weekends each season. Admission is free but donations are welcome given the extensive programme of restoration work that the club has to finance in future years. Members are extremely enthusiastic and have already achieved a great deal in negotiating occupation of the historic Brus depot to house their cars; they deserve the support of all tramway students visiting this city.

The depot can be reached by tram route 43 from the city centre. Those who take the opportunity to continue their journey westwards towards Konstanyńów Łódzki and Lutomiersk will observe a static monument at plac Kosciuszki in Konstanyńów, where *2N2* car 282 is proudly exhibited on a short length of track as a reminder of the cars that steadfastly provided daily services conveying local inhabitants to work, school or recreation during the hard years of the second half of the 20th Century. **TAUT**



2

1. *Lilpop II* car 48 is about to set off for a trip around the external depot track circuit with a group of visitors on one of the depot open days.

2. Driver training car 1234 is a rare 2N1 example of the standard design of two-axle tramcar produced in large numbers in early post-war years to help devastated Polish tramways get back on their feet. This was one of 45 such motor cars built for Łódź by the Gdansk shipyard in 1950-51.

3. Car 158 is the serviceable example of two surviving cars from the third batch of trams delivered to the city by the Warszawa-based firm of Lilpop, Rau I Loewenstein. *Lilpop III* 158 of 1939 is seen here in Kopernika on 13 May 2018 during a brief stop during a private tour of the system.

4. Representing the rolling stock that was the mainstay of the Lutomiersk interurban line, which passes Brus depot, from 1991-2012 is a Konstal-built 803N articulated car, latterly number 2 in the TP fleet and originally MPK 947.



3



4

5. A survivor of the eight Düwag C76 cars acquired by MPK from Bielefeld in 1990 is 1042, the fleet number it has carried since rejoining the MPK fleet in April 2012 following almost 18 years' service with the independent TP interurban tramway company.



5



6

6. Variety on the track fan of Brus depot, with general transportation works car 103 nearest the camera and in the background Herbrand *GE-58* motor car 71 of 1910, currently the oldest working heritage tramcar, still in MPK ownership.

7. Another member of the 2N1 class built for Łódź by the Gdansk shipyard was car 218, now rebuilt as 108, a conventional snowplough. The intention is ultimately to rebuild this car for use as a mobile exhibition.



7



8

8. Two different forms of snow-clearance vehicle stand in the summer sun on the external stabling tracks at Brus. Nearest the camera is 92031, a 2N2 car rebuilt as an advanced type of rotary snowplough, whilst in the rear is 108, a 2N1 car rebuilt as a conventional snowplough.

Except where otherwise stated, all photography by Mike Russell.

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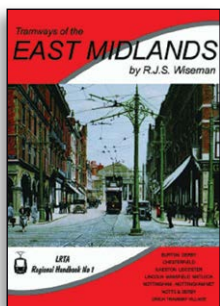
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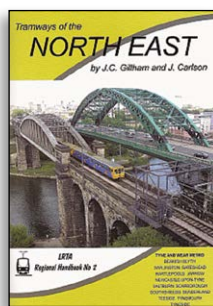
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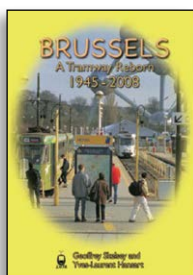
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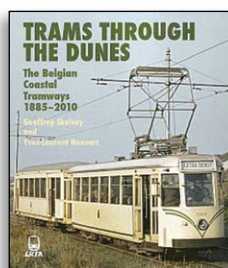
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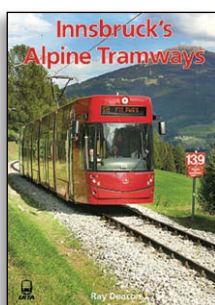


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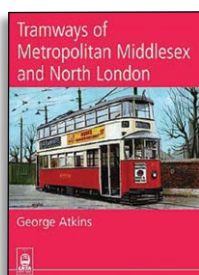


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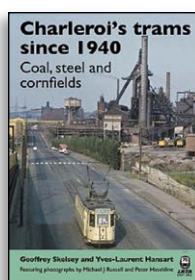
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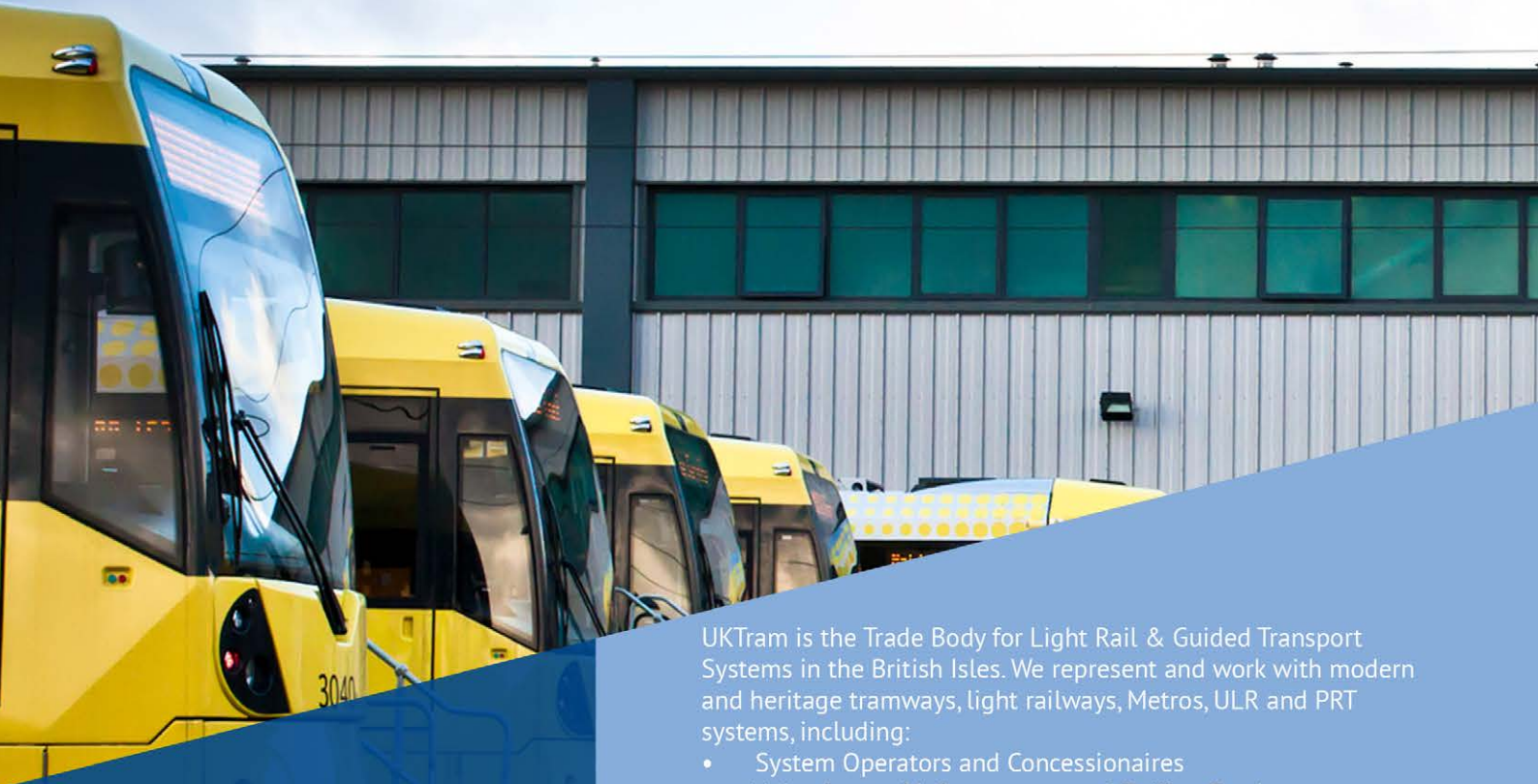
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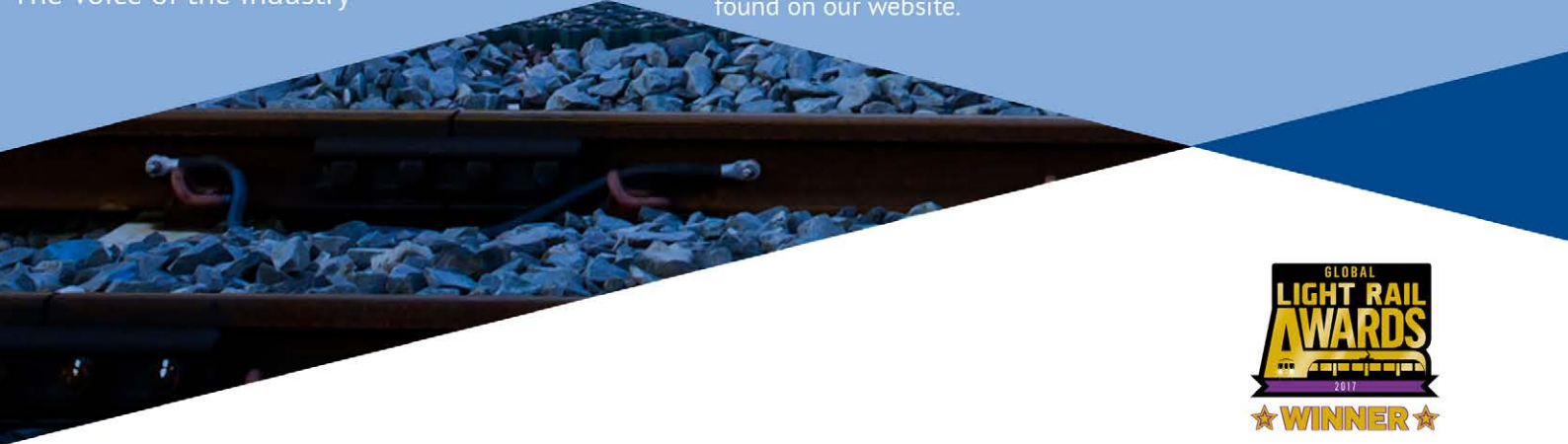
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