TRAM ATLAS BRITAIN & IRELAND (1st edition, 2015) by Robert Schwandl

Introduction

Like France and Spain, Britain also abandoned virtually all of its first-generation tram systems rather early. The last urban networks had been closed by the late 1950s or early 1960s, namely in Liverpool in 1957, Aberdeen in 1958, Leeds in 1959, Sheffield in 1960, and finally in Glasgow in 1962. Ireland was already almost completely tram-free by 1949, with just the 'Hill of Howth Tramway' northeast of Dublin surviving until 1959 — in fact, outside Greater Dublin, Cork was the only city in the Republic of Ireland that had an electric tramway, which operated from 1898 until 1931. Some of the once numerous British trolleybus companies survived a little longer, e.g. in Cardiff and Walsall until 1970, in Middlesbrough (Teeside) until 1971, and in Bradford until 1972. While trolleybuses also operated in Belfast, Northern Ireland, until 1968, this form of transport was never able to establish itself in the Republic of Ireland. Other than some heritage lines, the only surviving tram operation in the British Isles was the one in the seaside resort of Blackpool, as its route was largely separated from road traffic and its potential as part of the city's tourist attractions was realised in time.

By the mid-1980s, France had opened the first modern tramways (in Nantes and Grenoble), which led to Britain also rediscovering this form of urban transport. The first system to open was the high-floor light rail network in Manchester in 1992, which incorporated some old railway lines, but as low-floor technology had in the meantime become available, all the subsequent systems were brought into service using low-floor cars: in 1994 in Sheffield, in 1999 from Birmingham to Wolverhampton, in 2000 in the London Borough of Croydon, and finally in 2004 in Nottingham and the Irish capital Dublin. A nationwide reintroduction of tramways like in France, however, was not achieved, mostly due to a lack of will on the part of the national government in London. In particular, the well-advanced projects in Leeds and Liverpool were unable to be implemented. With Scotland now largely governed autonomously, Edinburgh opened its new tramway in 2014, albeit with some delay. Today, there is hardly any talk of entirely new systems (e.g. a new tramway has been proposed for Oxford), and even extensions to the existing networks seem difficult to push through, which makes the achievements in this regard in Manchester and Nottingham in recent years all the more admirable.

Leeds, with some 770,000 inhabitants one of the largest cities in England, is currently planning a trolleybus route branded 'New Generation Transport' (NGT), a 15 km long line from the northwest (Holt Park) to the southeast (Stourton), passing through the city centre and running mostly on a dedicated road.
[More information at www.ngtmetro.com]

Besides the trolleybus in Leeds, the next edition of this atlas may already contain the 'tram-train' from Sheffield to Rotherham, which is currently being implemented with the support of the Department of Transport as a pilot project. Should the results be satisfactory, this form of transport might also be chosen for other metropolitan

areas. In the medium term, a regional light rail system similar to that in Greater Manchester is planned for the Cardiff area.
[More information at metroconsortium.co.uk]

As far as the existing tram networks go, minor extensions can be expected in Birmingham, Manchester, Blackpool and hopefully also in Edinburgh. There are some ambitious projects, however, in Dublin, but their implementation is still foiled by the slowly ebbing financial crisis.

In the field of metros/Underground, little has happened in recent decades. Since the important extension of the Jubilee Line in the year 2000, the London Tube network has only been expanded once, when a 2 km Piccadilly Line branch to Heathrow Airport's Terminal 5 was opened in 2008. In the near future, a 3 km Northern Line branch to Battersea Park is to be built, as well as a roughly 3 km link for the Metropolitan Line in the outskirts to connect it to the hub at Watford Junction. The large network of the Docklands Light Railway was last extended in 2011 in preparation for the Olympic Games, adding 4.5 km. Among the most important milestones for urban rail in London in recent years was the creation of the London Overground network, which certainly has many features of an S-Bahn or RER system, as well as the start of the long-planned Crossrail project, which in a few years will enable suburban trains to pass under central London in an east-west direction, similar to the Paris RER.

The second underground metro in the British Isles, the Glasgow Subway, as well as the two metro-like suburban railways in Newcastle (Tyne-and-Wear Metro) and Liverpool (Merseyrail), have been modernised in recent years, but not expanded.

BIRMINGHAM

Birmingham is the centre of the metropolitan area known as the West Midlands, which also contains Wolverhampton, Walsall, Dudley, Sandwell, Solihull and Coventry, the latter located some distance from Birmingham. Besides the single light rail line, the so-called 'Midland Metro', the area is also served by several suburban rail lines with dense headways. Although no combined tickets are available for single rides, there is a wide range of day tickets for the entire 'Network West Midlands', combining different modes of transport: Daytripper for Metro+Bus+Rail after 09:30 - £6.40, full day - £8.10; Metro+Bus £6.20; single fares for the Metro range from £2.20 to £3.70, while a Metro Daytripper valid after 09:30 is £5.40.

The ***Metro****, as it is commonly referred to, is a modern light rail system. It is operated by 'West Midlands Travel Ltd', which trades as 'Midland Metro' and is part of the National Express Group. The planning authority is 'Centro', the West Midlands Passenger Transport Executive.*

Although the original line runs segregated from other traffic along 90% of its length and has only one level crossing, which lies south of Black Lake, passengers have to cross the tracks at most stops to get to the opposite platform or the exit. The tracks are only embedded in the roadway on the westernmost section, from right after Priestfield to the St. George's terminus in Wolverhampton.

The first of a number of routes proposed in 1984, most of which radiated from the

Birmingham city centre, was to have been built to the eastern suburbs of Hodge Hill and Chelmsley Wood, which would have required the demolition of many homes. Due to strong opposition in those areas, the least controversial route was chosen instead. The line from Birmingham to Wolverhampton via the Black Country would run mostly along a former railway alignment, so no private property would be affected.

The original railway line from Snow Hill to Wolverhampton (Low Level) was opened in 1854 by the Great Western Railway, and during its heyday it was used by long-distance trains from London Paddington to Birkenhead. Passenger service was eventually withdrawn in 1972 as the line paralleled the route from New Street Station. In 1995, a rail service was reintroduced between Snow Hill and a new station at The Hawthorns (Jewellery Line project), and from there on to Kidderminster, creating a new cross-city service.

Unlike in Manchester or Newcastle, the Midland Metro does not preserve anything of the former railway line, except for the Hill Top Tunnel. New track was laid along the entire route, and simple uniform stops with 35 cm high platforms were established.

With the first line in service, several attempts have been made to add more routes. For a long time, the 11.7 km extension from Wednesbury to Dudley and Brierley Hill seemed to be a priority. This line would mostly have been built along the abandoned South Staffordshire Line, with some street-running sections in the Dudley town centre. The only new section, however, is a mere 800 m city centre extension from Snow Hill to Birmingham's main railway station, New Street, scheduled to open by the end of 2015. This extension requires the original terminus to be abandoned as the trams will use a ramp on the eastern side of the railway station to reach street level before running down on Corporation Street to terminate on Stephenson Street, right in front of the new northern entrance to Birmingham New Street railway station. Funding for a further 700 m stretch to Centenary Square via Victoria Square (Town Hall) has been secured. In a later stage, the trams may continue along Broad Street to reach Five Ways.

In Wolverhampton, a loop around the city centre was once on the drawing board, but currently, a short 550 m extension to the railway station is more likely.

In conjunction with the future arrival of high-speed trains at the planned Curzon Street station in the mid-2020s, a branch for the tram is being designed. The so-called 'Eastside Extension' will allow trams to continue from the new railway station along New Canal Street to Digbeth Coach Station, and on to an initial terminus on Adderley Street.

The Midland Metro service was launched in 1999 with a fleet of 16 trams, all built by Ansaldo of Italy. These T69 vehicles were 60% low-floor, while the end sections were 85 cm above the rails. As their performance was never very satisfactory, by August 2015 they had all been withdrawn from service and replaced with new rolling stock, a total of 21 100% low-floor Urbos trams from Spanish manufacturer CAF. Some of the T69s still received a new livery in pink and silver before being retired from service.

BLACKPOOL

The seaside resort of Blackpool in Lancashire is the only city in Britain where a first-generation tram system has survived. Like the city buses, the tram line, which was completely upgraded in 2012, is operated by Blackpool Transport Services Ltd, while the tram infrastructure and vehicles are owned by Blackpool Council. Single tickets for the modern tramway cost between £1.00 for 1 stop and £2.50 for 16 stops or more. "Blackpool1 Tickets" allow unlimited travel on the modern tram and buses for £5.00 a day, and £11.00 or £14.00 for three and seven days, respectively.

The country's first electric tramway system opened along the Promenade between North and South Piers on 29 September 1885. Initially powered via a current rail fitted into an underground conduit between the rails, the power supply system was changed to conventional overhead wire in 1899. In 1898, the Blackpool and Fleetwood Tramroad Company had opened a separate line between Gynn Square and Fleetwood Ferry. The two lines were only connected and operated jointly after the Blackpool Corporation had taken over the Fleetwood line in 1920. Besides this north-south line, Blackpool had several other routes in those days, like those to Layton and Marton or the one along Central Drive.

The surviving, approximately 18 km north-south line was operated with heritage tram vehicles for many decades until eventually the Department for Transport granted funds in 2008 to upgrade the line to modern light rail standard, including the purchase of new vehicles. While low-level platforms approximately 30 m long were built for the future trams, almost half the stops were eliminated, resulting in an average station distance of some 500 m. The tracks were replaced and the tension of the overhead power supply was increased from 550 to 600 V DC. Regular service with the new Flexity fleet was launched on 4 April 2012.

The trams run mostly on a dedicated right-of-way, first on a paved reservation along the Promenade between Starr Gate in the south and Cabin (approximately 7 km), before moving to a railway-style ballast trackbed and heading north to Fisherman's Walk, with some interurban stretches between Rossall Beach and Broadwater. A mere 1.2 km through the Fleetwood town centre has the tracks embedded in the roadway, including the loop at the ferry terminal. The former on-street section between North Pier and Pleasant Street in the centre of Blackpool was separated from road traffic by curb stones during the route upgrade. A branch approximately 600 m long to Blackpool's main railway station is planned, with the necessary points already in place.

Besides the modern trams, the route is busy from April until October with a number of heritage tram vehicles. They run every weekend, but also during the week in high season, when they serve certain sections of the route. The heritage fleet includes a large number of different cars, most of which date back to the 1930s, like the nine "widened balloon cars" which were adapted to serve the new low-level platforms (nos. 700...724). The fleet also comprises many open cars, both single-deck ("boat cars") and double-deck.

DUBLIN

The Irish capital Dublin (Baile Átha Cliath in Gaelic) lies on both sides of the River Liffey shortly before it flows into the Irish Sea. Since 2004, the city has once again had a tram system (Luas), while an electric S-Bahn-style suburban railway (DART) was already established in 1984.

The Greater Dublin area does not have a unified fare system, and instead, each operator has its own zonal system and different fares. The tram network is divided into 9 zones, with single tickets costing from €1.80 to €3.00; the two parts of the split network can be explored using a 1-Day Flexi Ticket for €6.80. Single fares are cheaper when paid with the Leap Card, a rechargeable contactless smartcard. As long as you just ride on the tram, the daily fare is capped at €6.40, and if urban buses, DART and other suburban trains are used, too, a maximum of €10.00 will be charged. For the Leap Card itself, however, a deposit of €5.00 is payable.

LUAS

Dublin's modern tramway was named after the Gaelic word for 'speed'. The Irish language is also visible on station signs, occupying the first place, even though most other information is only given in English. Until at least 2019, Luas will be run by Transdev, while the expansion of the network is now the responsibility of 'Transport Infrastructure Ireland' (TII).

For now, the Dublin tram network consists of just two separate lines, with no physical connection between them. Transferring passengers need to take a 15-minute walk or hop on a bus. Fortunately, this situation will change in 2017, when the construction of 'Luas Cross City' is set to be completed.

*The **Red Line**, which connects the southwestern districts to the city centre, actually consists of two overlapping lines, Tallaght — The Point and Saggart — Connolly; however, during off-peak hours, the Saggart — Belgard section is operated as a shuttle, and Connolly Station, which is located just 130 m from the Busáras Bus Station, is not served. Between Belgard and Busáras, trams run every 4-5 minutes during daytime hours.*

Through the city centre, this east-west line resembles a classic tramway, with partly marked-off tracks. A dedicated right-of-way is only available from James's stop; from Fatima, the route first follows a filled-in side canal before continuing parallel to the Grand Canal to Blackhorse. Subsequently, the route runs in the median strip of Naas Road. The intersection with the roundabout above the M50 motorway, shortly before the Red Cow depot, was rebuilt in 2008, and is now completely grade-separated. The stop at Belgard, some 500 m from the actual junction where the two western branches split, was expanded to three tracks in 2011 to enable a convenient shuttle service on the new Saggart branch at certain times. On the Red Line, only the older Citadis vehicles are in service; 14 of the long type, which had originally been delivered for the Green Line, were transferred to the Red Line, while the initially just 30 m long vehicles on that line were extended with two additional sections only a few years after the

opening of the system.

*The alignment of the **Green Line** is rather different from that of the Red Line, as on long sections it uses the railway formation of the Harcourt Street Line, which had been abandoned since 1958. However, unlike the old railway, the tramway runs some 650 m further into the city centre before terminating at St. Stephen's Green. The old railway route starts north of Charlemont station and extends all the way to the original terminus in Sandyford, where the depot for the Green Line is located. Nonetheless, this section also required some bridges to be rebuilt, the most spectacular being a cable-stayed bridge north of Dundrum station. There are also several level crossings, mostly located directly at tram stops. For the extension to Brides Glen, which was completed in 2010, the tram route diverges from the old railway corridor to serve the Central Park business area as well as the districts of Glencairn and Leopardstown. To do so, the Green Line crosses the M50 motorway twice. After passing through a sparsely built-up area, the trams finally reach the terminus at Brides Glen in Cherrywood, where large areas have been awaiting development for years. South of Carrickmines, the tram route again runs partly on the old route of the Harcourt Road Line. Between Carrickmines and Laughanstown, provisions were made for another station, and immediately to its south, a 150 m tunnel was even dug into the open countryside. On the southern section, trams run every 10-13 minutes during daytime off-peak hours, but every 5-7 minutes as far as Sandyford.*

*Following the success of the first lines, Dublin developed an ambitious expansion program: **Metro North** has been designed as a mostly underground light rail line from the city centre via the airport to Swords. Like the tangential **Metro West**, it should run on a grade-separated route throughout, but it should be operated with vehicles similar to those in service on Luas, just longer. In the long term, the well-aligned Green Line could be directly linked to Metro North. The route to Lucan, however, is planned to be built in the style of the Red Line. Despite having reached an advanced stage of planning, these projects were all postponed indefinitely in 2011 as a result of the financial crisis. After a decision taken in September 2015, Metro North will be realised in a reduced version, with construction now set to start in 2021 (16.5 km, with 8.5 km underground).*

*The only project under construction since 2013 is the essential link between the two Luas lines. Labelled '**Luas Cross City**', this nearly 6 km northern extension of the Green Line will be completed by the end of 2017. Through the city centre this will be a classic tramway, running partly through parallel streets — northbound trams will cross the Liffey River on the traditional O'Connell Bridge, while southbound they will use the Rosie Hackett Bridge, which was only opened in 2014 for the exclusive use of public transport. From Broadstone-DIT to the terminus at Broombridge, an old railway corridor in a cutting out of use since 1961 is available.*

EDINBURGH

In 2014, the Scottish capital became the latest, and for the foreseeable future, also the last new member of the club of British tramway cities.

Along with the opening of the city's first tram line, Transport for Edinburgh was founded, thus creating a joint fare system with Lothian Buses, a publicly owned transport company which operates buses both within the City of Edinburgh as well as in the surrounding areas in Midlothian and East Lothian. The tramway company Edinburgh Trams is owned by the City of Edinburgh.

All tram stops are equipped with automatic ticket vending machines. Single tickets are only valid on the tram and cost £1.50 for most of the route (City Zone), but £5.00 all the way to the airport (Airport Zone; round trip £8.00). Day tickets include the Lothian Buses network and are available for £4.00 (or £9.00 incl. the airport). Weekly and monthly tickets are issued in the form of a contactless smartcard (Ridacard). The local trains operated by ScotRail (Abellio) are not integrated into this fare system.

Edinburgh has only one tram line so far, which is 14 km long and connects the city centre to the airport in the west of the city. The city-side terminus at York Place is temporary and therefore has just a single track; in the case of an extension, this stop would be moved further east. At St. Andrew Square, interchange is provided to the city's major bus station and, though requiring a longer walk, Edinburgh's main railway station, Waverley. The trams then travel west along Princes Street, the city's main shopping street, providing great views of Edinburgh Castle on the left looking over Princes Street Gardens. The urban, almost 2.6 km long section runs mostly on marked-off lanes, which are, however, also partly used by buses. This section ends at the Haymarket stop, which lies next to the city's second most important railway station.

The alignment of the remaining 12.4 km resembles a typical American light rail line, with its own dedicated right-of-way making partial use of railway corridors. The trams therefore cross the railway line to Glasgow twice, and for that purpose a 300 m long viaduct was built to the west of Edinburgh Park station. The most substantial station can be found at Murrayfield Stadium. Between Saughton and Bankhead (1.5 km), the former West Edinburgh Busway was reused to form the trackbed. Established in December 2004 and featuring a bus guidance system similar to that in Essen (Germany), its integration into the new line enabled two road intersections to be avoided.

The tram depot is located just north of the crossing under national road A8; at this point, an interchange is currently under construction to allow transfer to and from trains towards Perth, Dundee and Aberdeen. Travelling through largely undeveloped areas, though still with some rather tight curves, the trams then pass the park-and-ride facility at Ingliston before reaching the airport. A trip from St. Andrew Square to the airport takes 40 minutes.

The tram route which opened on 31 May 2014 represents just about a half of what the Scottish Parliament approved in 2006, and that had already been trimmed down from the original proposal. In addition to the logical extension towards the port area of Leith (4.5 km), a northern branch from Haymarket towards Granton was to be built in

the following phase, with the two northern branches originally meant to become a circular route of sorts. After construction had begun in the summer of 2008, there were repeated delays, cost overruns and problems with the contractors. At times, the entire project was in danger of being scrapped, and it was only rescued by truncating the initial stretch. At the opening of the present route, the Scottish government declared their unwillingness to continue their investment in the tramway. The City Council, however, is in favour of an extension to Leith. Time will tell whether the Scottish capital's tram network is one day expanded or not.

With such optimistic plans, Edinburgh placed an order in November 2007 for a total of 27 100% low-floor Urbos trams from the Spanish manufacturer CAF, of which just 17 are now required for normal operation. The first test runs began in 2011, three years before commissioning. The vehicles are generously equipped with luggage racks. The burgundy-and-white livery as well as the vehicle numbering system are a continuation of the tradition of Edinburgh's first-generation tramway, which was abandoned in 1956.

GLASGOW

The largest city in Scotland has boasted a metro line for the past 120 years, but since its opening in 1896, it has never been expanded. The system known as the 'Subway' is complemented by an extensive electric S-Bahn-style suburban rail network which covers the whole of Greater Glasgow.

The Subway is operated directly by SPT ('Strathclyde Partnership for Transport', until 2006 'Strathclyde Passenger Transport Executive'). As a regional transport authority, SPT is responsible for the coordination of buses and trains, but in comparison with other British metropolitan areas, fare integration is still rather inadequate.

A single ticket just for the Subway costs £1.60, two trips are £3.00, while a day pass also exclusively for the Subway is priced at £4.00. The fares are cheaper when using a Subway smartcard, but this is available just for registered users. For those who also want to use other means of transport, a Roundabout Ticket for the Subway and suburban trains in Greater Glasgow is on offer for £6.50 (after 09:00), while a Daytripper Ticket worth £20.30 is valid throughout the Strathclyde region after 09:00, and can also be used on most buses and some ferries.

While the Subway operates from 06:30 to 23:30 on weekdays, on Sundays it only opens at 10:00 and already closes at 18:00! A full round trip on the circular line takes 24 minutes. The Subway is not accessible for disabled people.

*When it opened in as early as 1896, the **Glasgow Subway** became the third urban underground railway in the world, after London (1863, electric from 1890) and Budapest (also 1896).*

The first proposals for an underground line to link the city centre to the West End were made in 1887. A year later, the project became more ambitious with two river crossings and a route on the south bank of the River Clyde to form a full circle line with 15 stations. Two single-track tunnels were excavated through numerous different strata, ranging from various types of clay and sandstone to solid rock. The tunnels have

a diameter of only 3.35 m, and are thus slightly narrower than the London tube tunnels. About a third of all the tunnels was lined with cast-iron rings, the rest being secured with brickwork. Two short sections on the south bank were built by the cut-and-cover method. Every station had a 3 m wide island platform, with exits at only one end. At 12 m below street level, Buchanan Street is the deepest station. The original subway trains were hauled by a cable running between the rails, and the trains had to grip onto it except when stopping at stations, much like the Cable Cars in San Francisco still do today. The track gauge was (and still is) 1219 mm (4 ft); there was no link between the two circular tracks, and neither were there any sidings.

In 1923, the Subway was handed over to the Municipal Corporation, which also ran an extensive tramway network. The need to modernise the Subway had become obvious, and eventually in 1935, an electrification scheme (600 V dc, third rail) was completed. At the same time, the Subway was officially renamed the 'Underground' to give it a more modern image, although no new rolling stock had been acquired; instead, the existing cars were retrofitted with current collector shoes and the bogies were motorised. Journey times were thus reduced from 39 to 28 minutes for a full circuit.

Once the Greater Glasgow Passenger Transport Executive had been founded in 1973, a wide-ranging modernisation plan was approved. In 1975, the Subway was transferred to the new Strathclyde Regional Council. Modernisation began in earnest in 1977, when the entire system was closed for almost three years. New tracks were laid on a concrete bed and all the stations were upgraded, although only the busiest were enlarged. New rolling stock was ordered from Metro-Cammell in Birmingham, with electrical equipment being supplied by GEC Traction (now Alstom). Major construction work was carried out at Govan, where a direct track link to the depot was built, the cars having been lifted from the tunnels by a crane for the previous 80 years.

A 3-car train is 38 m long and just 2.65 m high; the floor height is 695 mm above the top of the rail, allowing level access. The trains are operated automatically in ATO mode, with the drivers merely required to close the doors and put the trains in motion. The trains are fed via a third-rail power supply system.

In 2003, the 'Underground' returned to its original name 'Subway', a designation it had never lost among the local population. In recent years, many stations have been refurbished and new signage has been implemented. The trains, now 35 years old, have received a new livery, with orange remaining the dominant colour. The Subway route is signposted as an 'Outer Circle' (clockwise — orange signage) and an 'Inner Circle' (anti-clockwise — grey signage).

LIVERPOOL

The port city of Liverpool is the centre of the (former) metropolitan county of Merseyside, which extends on both sides of the River Mersey in the northwest of England. Merseyside includes the boroughs of Liverpool, Wirral (Birkenhead), Sefton, St. Helens and Knowsley, and on its eastern side adjoins the metropolitan area of Greater Manchester. Liverpool lies some 55 km west of Manchester, the two cities being

linked by three railway routes.

Other than the heritage tramway in Birkenhead (see p. 153), Liverpool has neither a tram system nor a classical metro — the 3-line 'Merseytram' project was well-advanced when it was refused financial support from the British government in 2005, before eventually being completely shelved in 2013 — but nonetheless the city deserves to be included in this atlas for its special suburban railway called 'Merseyrail'.

Merseyrail is part of the Merseytravel transport system. Merseytravel is the regional transport authority, which is under the control of the Liverpool City Region Combined Authority, created in 2014. A Day Saver ticket allows unlimited rides on the Merseyrail system (Northern and Wirral Lines) for £4.90, while a Saveaway Dayticket for £5.10 includes buses and ferries, too. Single fares are charged according to the zones travelled through (£1.75-4.90).

***Merseyrail** is not a conventional underground or light rail network, but is similar to the S-Bahn systems in Berlin and Hamburg. Almost entirely segregated from other rail traffic, it has a third-rail power supply (750 V DC), offers a frequent service throughout the day, and there are even several exclusive underground stations in the city centre. These special characteristics also explain why Merseyrail was the only former British Rail franchise to be awarded by the Merseyside Passenger Transport Executive (now Merseytravel) rather than the now abolished Strategic Rail Authority. Since 2003, Merseyrail has been operated by Merseyrail Electrics, a 50/50 joint venture between Serco and Abellio.*

Merseyrail comprises two line groups, the Wirral Line and the Northern Line. Other local rail services, most of which are diesel-operated, depart from Lime Street station and are referred to as the City Line. For a long time, the only electrified railway route in the Liverpool region besides Merseyrail was the main line to London via Runcorn, which is a branch off the West Coast Main Line (25 kV 50 Hz AC overhead line). Starting in spring 2015, 'Northern Electrics' now links Liverpool to Wigan and Manchester.

*Apart from the present Merseyrail system, Liverpool once had a proper 'metro', the '**Liverpool Overhead Railway**' (LOR). This electrified elevated line opened in 1893 and ran along the riverside for 11.5 km, linking many of the once important docks. The southern terminus Dingle, opened in 1896, lay underground and was located further inland. At its northern end, the LOR was linked to the rail lines to Southport and Aintree, which were electrified from the early 20th century. Due to a lack of funds for modernisation, the LOR was closed down in 1956 and demolished a year later.*

*The **Wirral Line** is one of the oldest electric underground lines in the world. Similar to the PATH routes that link New York to New Jersey under the Hudson River, it was initially built to link the Liverpool city centre to Birkenhead on the Wirral peninsula on the other side of the River Mersey. The 2.7 km tunnel, of which approx. 1.6 km runs under the river, was opened in 1886 to connect Green Lane to James Street. In 1888, a branch to Birkenhead Park was added, and in 1891 and 1892, two short extensions to Rock Ferry and Liverpool Central completed the original 'Mersey Railway'. As with the first underground routes in London, steam operation through the tunnels was rather dissatisfactory, so in 1903 the 'Mersey Railway' was electrified. Up to then, cross-river*

trains had continued their journey on the 'Wirral Railway' to West Kirby and New Brighton. For the following 35 years, however, the electrified 'Mersey Railway' remained an isolated network, and passengers had to change trains at Birkenhead Park and Rock Ferry. Whereas the West Kirby and New Brighton lines were electrified in 1938, the southern leg of the present Wirral Line was only equipped with a power rail in various stages during the 1980s and 1990s. During daytime hours on weekdays, the Wirral Line offers a train every 15 minutes to West Kirby and New Brighton, and four trains per hour to Chester and two to Ellesmere Port. The Wirral Line has a total length of 52.8 km, of which approximately 8 km runs underground in Liverpool and Birkenhead.

Today's ***Northern Line*** *was created in 1977, when the northern branches, which up to then had terminated at Exchange Station, were connected underground to a single line in the south. Until its closure in 1972, this line used to have its terminus at Liverpool Central surface station. The initially planned integration of the eastern lines to St. Helens via a tunnel curve up to Edge Hill did not materialise. While the Southport and Ormskirk branches had been electrified in the early 20th century, the present Kirkby line remained diesel-operated until the central tunnel was completed in 1977. The Northern Line provides trains every 15 minutes on all branches during daytime hours on weekdays. The southern leg is linked to the Southport branch, with the Ormskirk and Kirkby services terminating at Liverpool Central. The Northern Line has a total length of 65.6 km, with approximately 5 km in tunnel.*

*The centrepiece of the present Merseyrail network is the so-called '****Loop and Link****', built in the 1970s. This scheme included a 3.2 km single-track loop at a depth of 17-38 m for the Wirral Line, and a 2.6 km double-track link for the north-south lines. Most parts of the central underground sections were excavated with roadheaders instead of tunnel-boring machines. The tube-shaped tunnels were lined with precast concrete elements. An underground track link exists between the two tunnel routes.*

Merseyrail service is provided by a fleet of 59 three-car trains of class 507 (001...033) and 508 (101...143), built by British Rail Engineering Ltd. in York in 1978-80. Thoroughly refurbished during the early 2000s, the units are currently undergoing a further interior facelift, their exteriors having recently received a 'new look' featuring six different designs. During busy hours, double units can also be seen in service.

LONDON

Croydon (340,000 inh.) is the southernmost borough of Greater London, lying about 15 km south of Charing Cross. The borough is served by several rail lines from Victoria and Charing Cross/London Bridge, as well as by Thameslink, which allows through journeys via the City of London to the northern boroughs. Since 2010, the London Overground has also provided direct connections between the boroughs north and south of the River Thames via the East London Line. The London Underground, however, has never been extended that far south, although there were plans in the 1950s for the new Victoria Line to serve Croydon town centre.

In 1996, 'Tramtrack Croydon Limited' (TCL) won a contract to design, build, operate

and maintain the Croydon tram system. The TCL consortium included FirstGroup and Bombardier. Although the contract was for a 99-year period, Transport for London (TfL) purchased TCL in 2008 and rebranded it from Croydon Tramlink to London Tramlink, in view of more tram and light rail lines to be built across London. The change in ownership was accompanied by a change in corporate design, from the former red to a lime-green livery, a colour already previously used for signage. The trams are currently operated as a concession by Tram Operations Limited, which is part of FirstGroup. Tramlink is fully integrated into the TfL fare system, and a travelcard including zone 3 is good for all tram routes.

*The **London Tramlink** is a typical modern light rail system, making use of former mainline railway routes, combined with some street-running sections in central Croydon and a new alignment to New Addington. The network is currently operated with four routes, all running around a single-track loop in a clockwise direction in the Croydon town centre. Lines 1 and 4 operate every 15 minutes, line 2 every 10, and line 3 every 7-8 minutes. While the other lines are in service from 05:00 until approx. 01:30, line 4 finishes at 19:00.*

The western leg, most of which runs through the neighbouring boroughs, makes use of the former 'Wimbledon to West Croydon Railway' (1855). Along this branch, there are several single-track sections as well as the Wimbledon terminus, where only platform 10 is available. With the single-track section west of Mitcham Junction reduced to a minimum (Carshalton Road) in 2012, the section east of the bridge across the Thameslink tracks up to Beddington Lane is to be doubled by 2016. The Wimbledon terminus is currently being rebuilt to accommodate two trams at the same time. Just west of the Mitcham stop, there is a short section of interlaced track that passes under the A217 London Road. The railway was closed for conversion in May 1997. Among the major infrastructure works carried out on this branch are the viaducts across the mainline at both Mitcham Junction and West Croydon.

From East Croydon, the trams leave the town centre on a street alignment up to Sandilands, where the route splits, continuing in either direction along a disused railway which had once linked Elmers End to Sanderstead. The northern route to Arena is now served by three lines and features several level crossings. At Arena, the route splits once again, with the eastern leg becoming single-track and terminating at the north side of Elmers End station on the Hayes — Charing Cross line. Line 2 continues on a new alignment through the western side of the South Norwood Country Park before joining the Crystal Palace — Beckenham railway line at Birkbeck. The Birkbeck — Beckenham Junction section was reduced to single-track, and the former westbound track was converted for the Tramlink. Whereas Birkbeck and Beckenham Road have just a single platform face for both directions, there is a passing loop with two side platforms at Avenue Road. Line 2 terminates at the south side of Beckenham Junction station, with two tracks lying outside the original station compound.

After branching off at Sandilands, line 3 runs 1 km south along the former railway to Sanderstead, including a stretch through a 500 m long tunnel. The route from the stop at Lloyd Park to the terminus at New Addington was purpose-built for the

Tramlink, and runs mostly alongside roads on reserved track with several level crossings.

Despite the success of the Tramlink system in Croydon and several ambitious expansion projects, the network has not been extended since it first opened in 2000. A branch from Harrington Road to Crystal Palace is still an option. It would be achieved by taking over the second track between Beckenham Junction and Birkbeck, and adding a new alignment at the Crystal Palace end. Other tram schemes had reached an advanced stage of planning before being shelved: the 'West London Tram', linking Shepherd's Bush to Uxbridge along Uxbridge Road (A4020) through Acton and Ealing; and in central London, the 'Cross River Tram' linking Euston to Waterloo, with several branches at both ends. The only project currently being pursued is a second loop in Croydon to open in 2019, allowing trams from the eastern branches to turn around without using the Croydon town centre loop.

Tramlink was launched with a fleet of 24 FLEXITY Swift CR4000 trams (2530-2553). Built by Bombardier in Vienna, they are based on the K4000 tram designed for the Cologne low-floor network. The strange number assigned to the first tram delivered (2530) is a continuation of the traditional numbering system, the last trams having disappeared from London's streets in 1952. To improve frequencies, six Variotrams were delivered by Stadler in 2011, vehicles which had initially been intended for the new light rail system in Bergen (Norway). Another four of the same type were added in 2015. Both types of tram are only allowed to operate as single units.

The ***Docklands Light Railway*** *(DLR) is a fully segregated, driverless automatic system which is better classified as a 'light metro'. It is monitored from the Control Centre at Poplar. The signalling system is based on Alcatel's SelTrac system, which uses the 'moving block' technology. All trains are staffed, however, with Passenger Service Agents, who are responsible for closing doors and inspecting tickets, which is necessary as the system has not been equipped with access barriers. The DLR was the first fully accessible railway in the UK. 'KeolisAmey Docklands' is currently in charge of operation and maintenance.*

The DLR operates six basic off-peak routes (each with trains every 10 minutes, though Stratford — Canary Wharf every 5 minutes), with additional trains during peak hours. The different services are not numbered or distinguished by different colours.

The Docklands Light Railway was conceived in 1982 as a low-capacity rail link from the City to the regeneration area in the former port area on the Isle of Dogs peninsula. Construction started in 1984 on an initial network from Tower Gateway to Island Gardens with a branch to Stratford (12 km), which opened in 1987. Long sections of these routes were built on abandoned railway alignments. Soon after services started, work began on a 1.6 km underground extension to Bank as well as on lengthening the platforms, which used to be just 30 m long as they had been designed for single units. This would allow operation with 2-car trainsets to start from 1991.
The first proposals for a rail link to the Docklands had included 'proper' light rail with some street-running to Mile End Underground station. The final decision, however, went in favour of a completely grade-separated system.

The success of the DLR soon led to the construction of several new branches, the first in 1994 from Poplar via Canning Town (then with connections to the North London Line) to Beckton (8.4 km) providing service to the convention centre ExCel, various other attractions as well as access to the second depot. A few years later, the first crossing under the River Thames was completed, for which the original elevated station at Island Gardens had to be demolished and replaced by an underground station. In Greenwich and Lewisham, interchange is provided with many suburban lines serving the south of London. Another branch was added in two stages in the first decade of the new millennium, the first part to King George V, with a station right at the London City Airport, followed by a second Thames crossing in a tube tunnel to Woolwich.

As part of the successful bid to host the 2012 Olympic Games, a new route from Canning Town to Stratford International, a new mainline station for regional services on the Channel Tunnel Rail Link, was built. It replaced the former North London Line service between Stratford and Canning Town, while the remaining section to North Woolwich was abandoned (part of it is now being used for the Crossrail alignment to Abbey Wood).

In recent years, most platforms have been extended for 3-car operation, which required the strengthening of certain viaducts and bridges. A 'selective door close' system is used at the shorter platforms when 3-car trains are in operation. In addition, the junction north of West India Quay station was disentangled in 2009, with the result that trains from Bank to Lewisham no longer stop at this station during normal service. The last major modification to the DLR system happened on 28 April 2014, when the new Pudding Mill Lane station opened on a new elevated route roughly 500 m long, moved slightly to the south to allow for the construction of a tunnel ramp for Crossrail.

Yet another planned branch, this time from Gallions Reach on the Beckton branch to Dagenham Dock with four intermediate stations, is no longer being pursued, as the redevelopment area now known as Barking Riverside will be linked by a London Overground extension.

The DLR fleet comprises 149 vehicles belonging to two generations. The original P86 and P89 stock can now be seen in service in Essen (Germany). The older cars (classes B90, B92 and B2K) were all refurbished in the mid-2000s and like the newer B2007 and B2009 vehicles, now boast a predominantly red livery. With a floor height of 1025 mm above the top of the rail, the high-floor articulated vehicles provide stepfree access. The trains are made up of two or three cars. The DLR is powered by 750 V DC via an aluminium third rail, with current being taken from the underside of the rail. The track gauge is the standard 1435 mm.

MANCHESTER

With roughly half a million inhabitants in an area of 115 km^2, the City of Manchester is just a small part of the metropolitan area known as Greater Manchester, which also includes Salford, Trafford, Tameside, Stockport, Bury, Oldham, Rochdale, Bolton and, at some distance, Wigan. To the west, it borders with Merseyside, the conurbation around Liverpool.

Public transport in Greater Manchester is coordinated and planned by 'Transport for Greater Manchester' (TfGM). Besides the light rail system Metrolink, which has seen some significant expansion in recent years, the region is criss-crossed by numerous local railway routes, some of which are non-electrified.

A large selection of day tickets is available for Greater Manchester. These include exclusive tickets for Metrolink or buses, as well as combined tickets for tram+bus, tram+train+bus, etc. For visitors, the easiest ticket to use is probably the 'System One DaySaver', valid for all three types of transport and priced at £8.60, and for those who want to travel further afield, e.g. to Warrington or the Peak District, a Wayfarer for £12.00 is available. A Metrolink-only Adult Day Travelcard valid from 09:30 is sold for £5.00, while single fares for Metrolink range from £1.20 to £4.70.

The Manchester light rail system is known as ***Metrolink****. It is owned by TfGM (Transport for Greater Manchester) and currently operated by RATP Dev. When it opened in 1992, Metrolink was Britain's first new-generation tramway system, and it is still the only system that uses high-floor vehicles on street-running sections. The system has rapidly expanded in recent years, and now serves all of Greater Manchester except Bolton and Wigan. At the same time, the entire rolling stock has been replaced, accompanied by a complete restyling of the system from its former turquoise to the current yellow colour scheme.*

In the early 1970s, an underground scheme referred to as 'Picc-Vic' was proposed to link the city's major railway stations, Piccadilly and Victoria. The project was similar to the Liverpool city centre loop and included underground stations at Whitworth/Princess Street, St. Peter's Square, and at Royal Exchange for the central shopping area, as well as under the respective railway terminals. In 1977, however, the project was abandoned due to a lack of funding.

Today's system comprises seven colour-coded lines (line letters A-G were introduced in August 2015), each operating a basic 12-minute headway. The Altrincham and Bury routes are thus served every 6 minutes. The MediaCityUK spur is mostly served by the Eccles Line. Due to capacity constraints on the existing city centre route, trains from the airport currently terminate at Cornbrook, and will do so until the second city centre crossing becomes available in 2017.

For the initial Metrolink north-south route opened in 1992, two former British Rail lines were directly taken over and linked via a city centre route, thus creating a kind of 'tram-train', though without any mixed traffic with other trains.

The ***Bury Line****, opened in 1879, had already been electrified at 1200 V DC via a third rail by as early as 1916. As this system had since become obsolete, conversion to light rail was considered the best option for this route.*

The ***Altrincham Line****, opened in 1849, was electrified in 1931 using overhead wires and 1500 V DC, and converted to 25 kV AC in 1971. For light rail operation, the tension on this line had to be switched to 750 V DC, whereas on the Bury line, totally new overhead line equipment had to be installed. All the stations along both lines were made accessible for the mobility-impaired by means of ramps or lifts.*

The choice of high-floor vehicles was based on the existence of high platforms at every station along the two railway lines. At Victoria, the Bury Line was linked to the city centre section via an opening cut into the station's southern wall. The Altrincham Line was connected via a ramp next to the Exhibition Centre, which is housed in the former Central Station. At Piccadilly, the Metrolink station was built in the 'undercroft' of the railway station, between the arches supporting the mainline tracks.

*The next route to open was the **Eccles Line** in 1999/2000. This route diverges from the Altrincham Line at Cornbrook, runs on a viaduct across the Manchester Ship Canal, and then at grade through the redeveloped areas of Salford Quays. Cornbrook, initially just an isolated transfer station, only became accessible from street level in 2005. The western section to Eccles runs mostly on-street, partly marked-off and partly mixed with road traffic.*

*Following a ten-year break, Metrolink's 'big bang' started in 2011: an expansion program previously unthinkable in England almost tripled the system in size within just a few years. The **South Manchester Line** to East Didsbury (7.1 km), which diverts from the Altrincham Line in a grade-separated junction, takes advantage of a railway corridor disused since 1967. A further extension to Stockport would also be possible. The branch known as the **Airport Line** (14.5 km) via Wythenshawe, however, was built on a completely new route, and therefore features anything from an independent right-of-way across the Mersey Valley to on-street sections in Wythenshawe. A ride from the airport to the city centre by tram takes approximately 50 minutes and requires a change of trams at Cornbrook, while frequent regional trains cover the same distance in only 15 minutes.*

*The **East Manchester Line** starts at Piccadilly, the city's main railway station. On its way through the eastern parts of the city, it boasts two underpasses beneath major roads. Instead of Piccadilly, some trams now terminate at the FC Manchester City stadium, currently sponsored by an Arab airline. The following route runs mostly on-street along Manchester Road through the district of Droylsden in Tameside. A dedicated right-of-way is only available from Audenshaw to the terminus in Ashton-under-Lyne.*

*The **Oldham and Rochdale Line** resembles the older Metrolink routes to Bury and Altrincham. Unlike those, however, the railway line purchased from Network Rail was completely upgraded, including a new trackbed, which is why the former Oldham Loop Line was decommissioned in October 2009. Between June 2012 and January 2014, when the partly on-street route through Oldham town centre came into service, Metrolink used the old railway route between Freehold and Derker via the former railway station Oldham Mumps (200 m south of the present Metrolink stop). In Rochdale, a single-track bridge was built over the railway to Leeds, followed by a ramp that takes the trams to the station square. From there, they run partly in mixed traffic and with a short single-track section down into the Rochdale town centre, where the line ends at the bus station.*

*From 2017, a **second city centre route** will connect Victoria railway station with the central stop at St. Peter's Square. For this purpose, the stop at Victoria station was*

expanded to three tracks in 2014, while at St. Peter's Square, a four-track station with two island platforms is being built. Inbound trams now also benefit from an expanded two-track platform at Deansgate-Castlefield.

In the medium term, a new line will be built to the Trafford Centre shopping mall, and perhaps later on to Port Salford. In about 2020, the so-called ***Trafford Park Line*** *will diverge from the Eccles Line on the elevated structure just west of Pomona station, and operate as a modern light railway along wide roads through a redevelopment area and industrial zone. The Manchester United stadium will be accessible from the tram stop at Wharfside.*

If the pilot project in Sheffield proves successful, Greater Manchester may also see the implementation of tram-trains on several lines, especially in the eastern part of the region.

The original 32 Metrolink vehicles (nos. 1001-1026 and 2001-2006), manufactured by FIREMA (now Ansaldobreda) of Italy, were all withdrawn between 2012 and 2014 after just 20 years of service. They were replaced with new M5000 vehicles from Bombardier, which are based on the K5000 in service in Cologne and Bonn and are part of the Flexity Swift family. The initial order placed in 2007 was for just eight cars, but this was increased in various stages to the current 120 cars to be delivered by 2017. They mostly operate as single units, but can also be seen as two-car sets during peak hours.

NEWCASTLE

With less than 300,000 inhabitants, Newcastle would not normally be considered eligible for a metro system. The city is, however, the heart of the conurbation known as Tyne and Wear, which includes the metropolitan boroughs of Newcastle, Gateshead, North Tyneside, South Tyneside and Sunderland, and is home to over a million people.

Although often referred to as 'light rail', the ***Tyne and Wear Metro*** *does not have much in common with other light rail systems, as this term is nowadays mostly used for modern tramway systems. The Tyne and Wear Metro system could be described as a hybrid between a suburban railway and a proper metro. It runs entirely on its own right-of-way, totally segregated from road traffic, but with a few level crossings on the outer branches. The Metro is owned by Nexus, the 'Passenger Transport Executive for Tyne and Wear', and is currently operated by 'DB Regio Tyne & Wear Ltd'. Transport and infrastructure planning is now in the hands of the North East Combined Authority, which besides the Tyne and Wear region, includes County Durham and Northumberland.*

Fares for single journeys on the Metro are payable according to the number of zones (max. 3 zones) travelled through, costing £1.80/2.70/3.40, respectively. Accordingly, a DaySaver ticket is sold for £2.70/3.70/4.60, and is also valid on Northern Rail trains between Newcastle and Sunderland as well as on the ferry between North Shields and South Shields. For those who wish to use buses too, a Day Rover ticket for £7.00 is on offer.

The Metro system comprises two colour-coded lines. A full journey on the Green Line between Airport and South Hylton in Sunderland takes 67 minutes. The Yellow Line is made up of the North Tyneside loop and the South Shields branch through South

Tyneside, with trains running twice through Monument station, which lies in the centre of Newcastle. A trip around the loop takes 54 minutes, and the entire journey to South Shields, 82 minutes. With each line operating every 12 minutes during normal daytime service, there is a train every 6 minutes on the shared section between South Gosforth and Pelaw. The Metro is in service from about 05:30 until midnight.

The Tyne and Wear Metro was conceived in the late 1960s when the once busy suburban railway lines had reached a desolate state and some kind of action was needed. While several branches were closed, the remaining routes, i.e. the coast loop and the South Shields line, were upgraded and linked by underground routes through the Newcastle and Gateshead city centres.

The coast loop was originally built between 1839 and 1882, although the northern leg terminated in Newcastle at New Bridge Street until 1909, when a short link to Manors station opened, enabling trains to depart and arrive at Central Station (opened in 1850). In 1879, the loop was complemented by the Riverside Branch, which served the neighbourhoods and shipyards along the River Tyne between Manors and Percy Main until 1973. These routes were electrified with a third rail at 600 V DC in as early as 1904. In 1967, the ageing EMUs were replaced with diesel trains.

The present Airport branch follows an alignment opened to Ponteland in 1905. This single-track line, however, only carried passengers until 1929. With several rather simple stops located adjacent to level crossings (two having staggered platforms), this branch most resembles a typical German 'Stadtbahn' of the Frankfurt type.

The routes now used by the Metro on the south side of the River Tyne were opened between 1835 and 1872. The line to South Shields was electrified in 1938, but the electric trains were replaced by diesel units in 1963. Between the junction at Pelaw and Jarrow, this branch features three single-track sections as the second track is still used by freight trains.

Approved in 1973, the Metro scheme took 11 years to be completed. The project included electrification at 1500 V DC using overhead line equipment, the upgrading or relocation of existing stations, and the construction of approximately 10 km of new routes. Some 6.4 km of these lies in tunnels, the rest being elevated or at grade, including the 350 m Queen Elizabeth II Bridge across the River Tyne and the 820 m Byker Viaduct across the Ouseburn Valley between Byker and Manors. Using mining techniques, the tunnels through Newcastle and Gateshead were excavated as single-track tubes with a diameter of 4.75 m. The former route between Jesmond and Manors was connected to the east-west tunnel and now functions as a non-revenue track link between the two routes.

The initial network having been completed in 1984, the northwestern branch was extended from Bank Foot to the airport in 1991, still following the former railway to Ponteland.

For the Sunderland extension, the existing railway line was not taken over, but instead the route was upgraded to allow mixed service. The three stations along the route, Brockley Whins, East Boldon and Seaburn, were rebuilt, and three new stations were added. Within Sunderland, the existing railway formation of the former

Sunderland to Durham freight line, abandoned in 1984, was used to build a new route. Finally, the opening of the 18.5 km route from Pelaw to South Hylton in 2002 completed the present network. Between Sunderland and Newcastle, the metro service, with trains every 12 minutes, is complemented by hourly regional Northern Rail trains which only stop at Heworth. Although Northern also operates other regional services in the Northeast, a dense local service is only provided between Central Station and MetroCentre (four trains per hour).

For the opening of the Metro, a total of 88 2-section vehicles (4003-4090) with a Jacobs bogie in the middle were delivered, two prototypes (4001+4002) having previously undergone a lengthy period of testing. The vehicles are usually operated in pairs, and both trains and stations are all fully accessible. Due to a lack of funds necessary for new rolling stock, most of the existing cars, already 35 years old, were refurbished between 2010 and 2015, and now boast a black and yellow livery.

NOTTINGHAM

Located some 200 km north of London, Nottingham is one of the larger cities in the East Midlands region, along with Derby and Leicester, and the centre of Greater Nottingham.

For Greater Nottingham, 'Kangaroo Day Tickets' are available for tram, bus and train for £4.50, a day ticket just for the tram costs £4.00, and a single ticket £2.20. Discounts for the tram are granted when one uses a rechargeable MANGO SmartCard, sold for £3.00.

While the tram network in Sheffield has not been extended at all since its opening, and the one in Birmingham only very modestly, Nottingham's tram system more than doubled in size in August 2015, 11 years after the original line had been brought into service. Suburban rail traffic plays a minor role in the region; the northern route, which runs parallel to the tramway, has a half-hourly service operated by East Midlands Trains to Hucknall and beyond, but the trains only stop once an hour at Bulwell, and while Attenborough is also just served once an hour, three trains per hour call at Beeston.

*The Nottingham tram system is officially called '**Nottingham Express Transit**' (NET). It is now run by Keolis, a member of the 'Tramlink Nottingham' consortium, which was set up to develop and operate the system. The current network consists of two unnumbered lines which share an approximately 7 km section through the city centre, resulting in a tram every 5 minutes during daytime off-peak hours.*

The first 13.5 km route opened in March 2004, with about 10 km running on a segregated right-of-way, mainly parallel to the Robin Hood Line, a long out-of-use railway line reopened in stages between 1993 and 1998 from Nottingham to Worksop. In contrast, the central section between the depot at Wilkinson Street and the railway station resembles a classic tramway, with on-street running though on a partly marked-off lane. The platforms are mostly integrated into the pavement.

The two southern branches, which opened in 2015, also feature lengthy on-street sections. The most important structure built for both branches is a steel bridge

inserted over the railway station. For the 7.5 km long Clifton line, on the south bank of the River Trent an old railway corridor of the Great Central Railway was available, including an underpass under the ring road A52. After that, the trams run across an open field, then on-street through Clifton along Southchurch Drive and then Farnborough Road before reaching the terminus at the edge of the built-up area, where a park-and-ride facility was established.

The roughly 10 km Beeston line first serves the industrial and business area 'ng²' before crossing the railway line to London on a purpose-built bridge. While the following section is embedded in the roadway, a 650 m elevated structure was built through the area of the Queens Medical Centre and also spanning the A52 ring road. On University Boulevard, a dedicated trackbed runs parallel along the southern side of the road, whereas through Beeston, the tracks are again embedded in the roadway. At Central College, however, the trams leave the public roads and run on a green strip through quiet residential areas to the terminus at Toton Lane, where a park-and-ride facility has been set up next to the access road for the M1 motorway. An extension to the planned high-speed rail station is an option for the late 2020s, although its location has not yet been decided.

The original Incentro vehicles, built by Bombardier in nearby Derby, all carry the name of a Nottingham-related personality, among them Lord Byron (#205), D.H. Lawrence (#202) and, of course, Robin Hood (#211). The trams were all refurbished between 2013 and 2015, and now boast a new livery, dominated by silver, though maintaining the share of dark teal they had before. The new Citadis trams were delivered in a similar livery, and the naming convention has been continued, e.g. with Alan Sillitoe (#219).

SHEFFIELD

Sheffield lies at the southernmost tip of historical Yorkshire and is now part of the metropolitan county of South Yorkshire (incl. Doncaster, Rotherham and Barnsley; 1.4 million inh.). The city is known for its hilly cityscape, with the city centre in the valley and the residential areas spread out over seven hills.

Sheffield boasts a tram network made up of three colour-coded lines, which, like some urban buses, are operated by Stagecoach. The infrastructure is owned by the South Yorkshire Passenger Transport Executive (SYPTE). The Blue Line (Malin Bridge — Halfway) and the Yellow Line (Middlewood — Meadowhall) run every 10 minutes during daytime service, and the Purple Line (Cathedral — Herdings Park) every 30 minutes. Between 09:00 and 14:30, Purple Line trams continue to Meadowhall displaying a yellow route sign. In the evenings and on Sundays, all three lines operate a 20-minute headway.

Sheffield's range of tickets is rather diverse, with a single trip on the tram costing £1.50 or £2.20, depending on the distance travelled. Tickets can be bought from the conductor on the trams. A 'Dayrider' pass for the tram and Stagecoach buses in Sheffield is sold for £3.90, while a 'Travelmaster Gold' offers unlimited travel in the entire South Yorkshire region, including all buses and local trains (£7.50).

Other than Blackpool, England's last first-generation urban tramway closed in Sheffield in 1960. The Sheffield ***Supertram*** *was the first low-floor system in Britain when it opened in 1994, only two years after the high-floor Manchester Metrolink system. As the Sheffield tram does not use any former British Rail passenger lines, however, the choice of low-floor technology was obvious. The system is a mix of conventional street-running tramway and segregated light rail. The share of reserved track is about 50%, with only the 7 km Meadowhall branch, which runs mostly alongside a freight railway, being totally segregated from road traffic, although with several level crossings. The most significant structures built for the system are an underpass to avoid the roundabout at University Square on the western side of the city centre, three bridges at the track triangle above the roundabout at Park Square on the eastern side of the city centre, as well as an approximately 300 m long viaduct between Granville Road and a stop called Park Grange Croft, which was only added in 2001. All the off-road sections feature railway-type Vignol tracks.*

The Sheffield tram system is operated with a fleet of 25 vehicles, all built by Siemens-Duewag in Düsseldorf. The end sections of these 3-section trams are partially low-floor in the door area (42 cm), whereas the rest is higher and accessible via steps. Power is supplied via an overhead wire at 750 V DC.

The tram stops are 26.5 m long and provide level access into the vehicles from 37.5 cm high platforms. The platform edges are fitted with tactile markings for the blind. The stops all have a standard design with shelters, and have recently been equipped with next-tram indicators. The original ticket machines were withdrawn in as early as 1996, and tickets are now inspected and sold on the tram by conductors.

The entire system as we know it today was opened in stages, but within a period of only 18 months (1994/95). Apart from changes in the trams' livery, with the last repainting done in 2006, there have not been any significant modifications in the last 20 years. In 1997, South Yorkshire Supertram Ltd was acquired by Stagecoach Holdings PLC, which now operates the system as Stagecoach Supertram. After some initial difficulties due to parallel bus routes following the deregulation of the bus service, the Supertram has now become a very popular means of transport. Having priority at traffic lights guarantees a fast and reliable service despite the high percentage of on-street running.

Initially, there were several projects for network expansion, but none of them have come to fruition. Eventually in May 2012, after several years of discussion, Sheffield was chosen by the Department for Transport (DfT) for the realisation of a two-year ***tram-train*** *pilot project. From approximately 2017, new Citylink vehicles will run from the city centre on Yellow Line tracks to Meadowhall South/Tinsley, where they will diverge onto the 150 m so-called Tinsley Chord to reach an existing freight line. Just before arriving at Rotherham Central, the tram-trains will join the Sheffield — Rotherham — Doncaster passenger line and terminate some 2 km further north at the Parkgate Shopping Centre. Approximately 5.5 km of tracks will be electrified at 750 V DC. Even though the rail network around Sheffield has not been electrified, the new trains are ready for dual-voltage operation on both tram routes and Network Rail tracks*

(25 kV 50 Hz AC).

In the long-term future, the Meadowhall hub may be rebuilt in the early 2030s as it has been chosen as the site of the future high-speed rail station on the line to be built from London/Birmingham to Leeds/York.