THE WORLD OF METRO RAIL IN PICTURES

"Dragon Boat Architecture" at Jiantan Metro Station, Taipei, Taiwan

By Dr. F.A. Wingler, Germany, July 2020

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21st Century Global Metro Rail in Pictures

This is Part II of a Gallery with Pictures of 21st Century Global Metro Rail, with exception of Indian Metro Rail (Part I), elaborated for a book project of the authors M.M. Agarwal, S. Chandra and K.K. Miglani on *METRO RAIL IN INDIA* .

Metros across the World have been in operation since the late 1800s and transport millions of commuters across cities every day. There are now more than 190 Metro Installations globally with an average of about 190 million daily passengers.

The first Metro Rail, that went underground, had been in London, England, and opened as an underground steam train for the public on 10st January 1863:

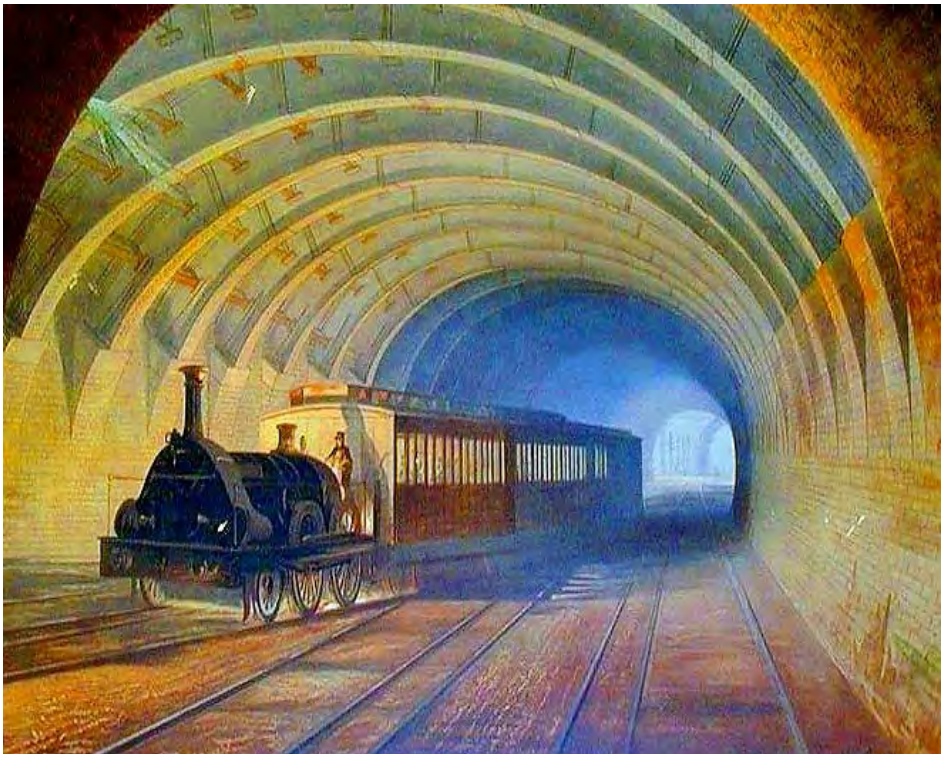


Illustration of a Train at Praed Street Junction near Paddington, 1863;
from: History Today, Volume 63, Issue 1, January, 2013

Vintage London Underground Steam Train; Source "Made up in Britain"

The world over, the 21st Century observed the opening of many new Metro Lines, the extension of existing Metro Systems and the acquisition of modern Rolling Stocks, mostly in Asian Countries.

In the last decades Urban Rail Transits in China developed fastest in the world. Urban Rail Transit in the People's Republic of China encompasses a broad range of urban and suburban electric passenger rail mass transit systems including subway, light rail, tram and maglev. Some classifications also include non-rail bus rapid transport. By the end of 2016, there were 30 metro systems in Mainland China with a total combined length of 3,586 km (2,228 mi). Today China boasts the world's longest, second-longest and third-longest metro systems. Eight of the world's 15 longest metro systems are in China. Although the Shanghai Metro only started operating in 1993, it is now the world's longest subway system. Half of the top ten busiest metro systems in the world are in China. As of January 2016, 39 cities have metro systems approved according to the National Development and Reform Commission. China plans to spend 4.7 trillion Yuan ($ 706 billion) on transport infrastructure in the three years following 2016. As of early 2017, China has 5,636.5 km (3,502.4 mi) of under-construction rail transit lines. By the end of 2018, Mainland China has opened 35 metro installations with 185 metro lines. The country's urban rail expansion programme continues unabated. December 2019 saw the opening of metro and tram extensions in seven Chinese cities.

Map of Cities in Mainland China, the SARs, and Taiwan with Rapid Transit, Commuter Rail and Light Rail. The two higher-Resolution Maps to the left show the Yangtze River Delta (YRD) and Pearl River Delta (PRD) Regions. Black: Operational; Red: Under-Construction

Source: Wikipedia, the free Encyclopedia

The fastest growing new Metro Rail Networks are in Asian Countries. China is leading. Next comes India with since 2004 with 14 new lines now in operation with a total length of 692.65 km, with 19 Metro Rail under construction and a total length of 968.52 km and 10 uppproved Metro Rail expansions with a total length of 968.52 km.

In Africa there are only 3 cities with Metro Rail Subways. Several emerging cities have decided to go instead of Metro Rail for other more cost effective public transport technologies, that could be better integrated with existing on-demand para transit.

Sydney, New South Wales, in Australia got the first Metro Rail. Europe, North and South America have a long tradition from the 20st century in Metro Rail Installations and Subways.

In Germany, in most of the larger towns, Subway Metro Rail (Underground Urban Rail) have evolved from City Tramways, that have been laid underground by dig and cover technology in the city centers. They can run intermodal as Subway, City Street Tram, Tram on reserved routes and regional on Governmental Main Railway Lines as Tram-Train:

Cologne-Bonn intermodal Tram-Train-Subway

The Russian Metro Stations are renowned for their Art-Beauty:

Yekaterinburg Metro Subway Station

The international operating suppliers of Metro Rail Rolling Stocks have designed futuristic concepts:

Futuristic Design Impression for London Underground; *INSPIRO* by Siemens Mobility

One of the most beautiful vintage and reconditioned Metro Underground Car runs in Glasgow, Scotland, UK:

Anniversary Coach of Glasgow Underground; Source: Heritage Railway

I. Metro Rail in Asia: China

Left: **Bejing**; Design-Picture by Zhahojiong

The Beijing Subway is the rapid transit installation of Beijing Municipality, that consists of 23 lines including 19 rapid transit lines. By route length in operation, the Beijing Subway is the world's longest metro rail. With 3.8484 billion trips delivered in 2018, the Beijing Subway is the world's busiest metro.

Right: **Bejing** Driver-less Yanfang Line opened 2017.

The Beijing Subway opened in 1969 and is the oldest metro in mainland China. Before the system underwent rapid expansion since 2002, the subway had only two lines. Beijing Subway's extensive expansion plans call for 998.5 km of lines serving a projected 18.5 million trips every day by 2021. The most recent expansion came into effect on December 28th, 2019, with the extensions of Line 7 and the Batong Line.

Left: **Changzhou** Metro Line 1, Animation

The Changzhou Metro is a rapid transit in Changzhou, Jiangsu Province, China. The system started operation on 21th September 2019, with the opening of its first Line 1.

Left: **Changzhou** Line 1

Line 1 started operation on 21th September 2019. Construction for Line 1 began on 28th October 2014. The first phase runs from Forest Park in the north to Nanxiashu in the south. It is 34.24 km in length with 29 stations, including 27 underground and 2 elevated. The line will eventually be extended to 42 km.

Right: **Chengdu** 140 kmph Express Metro

Chengdu Metro is the rapid transit of Chengdu, the capital of Sichuan Province, China. The system has seven lines in operation. Line 1 was opened on 27th September 2010. Line 2 began operations in September 2012 and Line 4 opened December 2015, while Line 3 opened in July 2016. By 2020 the Metro will reach 521 km.

Left: **Fuzhou** Metro Train Configutation, ful Alominium Body supplied by CNR Tangshan.

The Metro opened 2016. Till May 2019, Fuzhou Metro had 55.52 km of route. Construction of additional 111 km of network has started and is expected to open by 2022.

The Model-B trains of Line consist of 6 cars with 256 seats and have a capacity of around 1,500 passengers. There are 28 trains ordered for Line 1, the first few of which were produced by CNR Tangshan Railway Vehicle Co.,Ltd. in April 2015.

Left: **Guiyang** Metro Train-Set supplied by CRRC Nanjing Puzhem.

Guiyang Metro is branded as ***Guiyang Urban Rail Transit (GYURT)***. A short northern section of Line 1 opened on 28th December 2017, with the full line entering operation on 1st December 2018. Line 2 is due to open at the end of 2020 and Line 3 in 2022 or 2023.

Right: **Nanjing** Metro Line 2; Train-Set supplied by a Consortium of Alstom and CSR Puzhem.

The Nanjing Metro is a rapid transitnserving the urban and suburban districts of Nanjing, the capital city of Jiangsu Province and began operation in September 2005. With 394 km total length of it ranks fourth in China, after Shanghai, Beijing and Guangzhou

Left: **Shenzhen,** Driver-less Metro Car Line 9 supplied by CRRC Chagchou.

The Metro System opened on 28th December 2004. The network underwent major expansion prior to the 2011 Summer Universiade and with three new lines in 2016. The extension opened on 8th December 2019 putting the network at 303.4 km operating on 8 lines with 215 stations.

Left: **Ürümqi** Metro

The Ürümqi Metro or Ürümqi Subway is in operation in Ürümqi, capital of the Xinjiang Autonomous Region in China. Line 1 has been under construction since March 2014. It has a total length of 27.615 km with 21 stations It is fully underground.
The northern section of the line was opened on 25th October 2018. The southern section of the line was opened on 28th June 2019.

Right: Design Study for **Xiamen** Metro

Planning for the Xiamen Metro began in the early 2000s in the meantime the mostly elevated Xiamen BRT opened in 2008.The approved phase I of system development includes three lines (1, 2, 3) with 62 stations, 75.3 km. Line 1 uses six car CRRC Tangshan rolling stocks.

Left: **Zhengzhou** Metro; Trainset supplied by CRRC Zhuzhou, Type B 6-car-set.

Zhengzhou Metro serves the urban and suburban districts of Zhengzhou, the capital city of Henan province. It is operated by the state owned. As of September 2019, the network has 5 operational lines, with a network length of 151.8 km and 98 stations. Opened on 28th December 2013, it is the first and currently the only operational metro system in Henan, in mainland China.

II. Metro Rail in Asia; exept China

Left: Animation by ALSTOM for proposed **Baghdad** Metro; **Iraq**

In February 2011, an agreement was signed with Alstom, for the construction of a 25 km line from central Baghdad to the northern suburbs of Adhamiya, Al-Hurriya, Kadhimiya, and Sha'ab.[

Right: **Bangkok , Thailand,** Blue Line; Metro Car supplied by Siemens Mobility.

The Bangkok Metro begun operating in 2004. From mid 2011, construction began to extend the MRT Blue Line.When fully completed by April 2020, the Blue Line will become a fake loop line around the centre of Bangkok. The first section of the MRT Blue Line extension from Hua Lamphong via Tha Phra to Lak Song opened for full operation on 29th September 2019.

Left: Animation of Aluminium Body **Dhaka** Metro Train, **Bangladesh.**

The Dhaka Metro is an approved metro rail system under construction in Dhaka, the capital of Bangladesh. Together with a separate BRT (Bus Rapid Transit) it has been long called for to ease the extreme traffic jams and congestion, that occur throughout the entire city on a daily basis, one of the heaviest in the world. It is a part of the 20-year long Strategic Transport Plan (STP) outlined by the Dhaka Transport Coordination Authority (DTCA), a governmental agency.

Left: Animation of **Doha** Metro, **Qatar**

The Doha Metro is a rapid transit in Doha, Qatar's capital city, which became operational on 8th May 2019. It has three lines with an approximate overall length of 76 km. Capable of reaching 100 kmph, the Doha Metro will be one of the fastest driverless trains in the world.T he 75 three-car driverless trainsets will be supplied jointly by Japanese companies Mitsubishi Corporation and Kinki Sharyo. The first four sets were delivered in August 2017.

Right: **Dubai Metro, United Emirates**

The Red Line and Green Line are operational since September 2009, with one more line being constructed. These first two lines (75 km) run underground in the city center and on elevated viaducts elsewhere. All trains are fully automated and driverless. Architecture firm Aedas designed the metro's 45 stations, two depots and operational control centers. The Al Ghurair Investment group were the metro's builders.

Left: Cat Linh-Ha Dong Line, **Hanoi, Vietnam,** Trainset by CRRC, China

The first phase of the system is composed of two sections: Line 2A from Cat Linh to Ha Dong (Cát Linh Line) and Line 3 from Nhon to Hanoi Station (Văn Miếu Line). Trials runss of Line 2A begun October 2019. Planned are 8 Lines with 318 km. Rolling Stocks will be supplied by CRRC and Siemens.

Left: **Kobe** Municipal Subway 3000 trainset (Seishin-Yamate Line), **Japan.**

Construction of the first Seishin Line, began on November 1971. The line opened on March 13th, 1977, running for 5.7. The Yamate Line, opened on June 17th, 1983, running for 4.3 km. In June 1985, the Yamate Line was extended to Shin-Kobe and the Seishin Line was extended to Gakuen-toshi. On July 7th, 2001, the 7.9 km Kaigan Line opened between Sannomiya-Hanadokeimae and Shin-Nagata.

Right: **Kuala Lumpur Metro,**
Malaysia; SIEMENS *INSPIRO* Train-Set.

Kuala Lumpur has a modern, complex, and very well interconnected transport system. The subway, known as KTM Komuter, was opened in 1995. It has 2 lines: Seremban and Port Klang, complemented by other 3 lines of light trains, and a monorail. The Sangai Buloh Kajang driverless Line 9 with 51 km was opened December 2016.

Left: **Lahore** Orange Line, **Pakistan**

Lahore Metro is an automated rapid transit system under construction in Lahore, Punjab, Pakistan. Three metro lines have been proposed, of which the Orange Line is under construction, when completed it will become Pakistan's first metro line. Test runs started December 2019. The headway will be 2 Min.; max Speed: 80 kmph. The CRRC sets willrun driverless.

Left: **Mashad** Urban Rail Line 1**; Iran,** Vehicles by CRRC**.**

The 19.5 km, 22 station Line 1 was the first line to be built; it opened for service on 24th April 2011 Line 1 runs between Nakhrisi in the east and Vakilabad in the southwest, with travel time of 41 minutes. Approximately half the route is in tunnels; the rest is at ground level.

Right: **Seoul** Metropolitan Subway; **South Korea;** Line 2

The first Line opened 1974. Between 1980 and 2014 8 lines had been added. Seoul metropolitan Subay is touted with as one of the world`s best maintained Metro Rail Subway with a length of 332 km. Providers for the train-sets are Daewoo, Hyundai Rotem and Hanjin.

Left: **Taipei** Metro, **Taiwan**; "Dragon Boat Architecture" of Jiantan on Tamsui Xinyi Line; Pict. by Yula.

The Metro opened first 1996 and operates now with 6 lines on 153 km. The top speed is 90 kmph and the headway 2-7 Minutes. It runs with CBTC provided by Bombardier, Anasaldo and Alstom. Hitchi Rail in Italy provided January 2020 driverless trainsets for the Circular Line.

III. Metro Rail in Africa

Left: **Algiers** Metro Car Trainset from CAF, **Algeria.**

Algiers Metro opened to passengers on 1st November 2011, making Algiers only the second city in Africa (after Cairo) to have a metro.
The first phase of Line 1, which spanned 9.2 km and 10 stations, opened for public service on 1st November 2011. A 4 km extension opened for commercial service on 4th July 2015 after test runs in June.

Right: **Cairo** Metro, **Egypt; T**rainset by Hyundai Rotem

The metro was opened in 1987 as Line 1 with a length of 29 km. Line 2 had been completed in 2000. As of December 2019, the Cairo Metro has 65 stations (mostly at-grade), of which 3 are transfer stations, with a total length of 77.9 km. The metro consists of three operational lines numbered from 1 to 3. As of 2013, the metro carried nearly 4 million passengers per day.

Left: CRRC Dalian Rolling Stock for **Lagos** Metro, **Nigeria.**

Lagos Metro is under construction and suposed to open in 2021 with 27 km length.
The system is build by China Civil Construction Company. The first section of the network, Phase I of the Blue Line, was originally planned to be completed in 2011. After many delays caused by funding shortfalls, the opening date was pushed forward to 2021.

IV. Metro Rail in Australia

Left: ALSTOM **METROPOLIS TS** Car build in India in the Sri City ALSTOM plant ready to be exported to **Australia** for first **Sydney** Metro Rail in New South Wales, NSW.

The metro opened in May 2018 with a length of 36 km with extensions planned. It runns driverless fully automated with ALSTOM Urbalis 400 CBTC system.

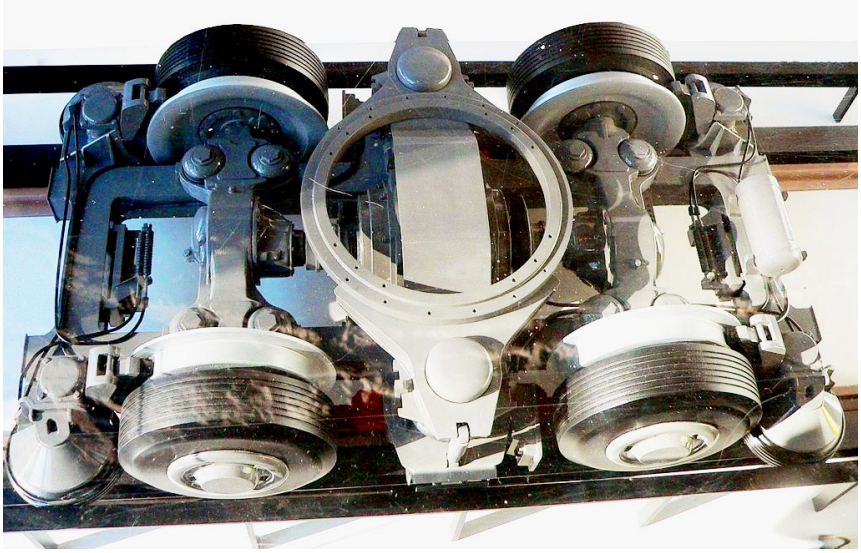
V. Metro Rail in Europe

Right: New Stadler build Metro Train-Set for **Berlin** Metro Subway "U-Bahn", **Germany.** Pict.: Credit: Bahnsteigkante / WikiCommon.

The U-Bahn in Berlin, Germany, began operating in 1902 and has since expanded across ten lines with more than 151 km of track. Approximately 80% of the lines run underground.

Left: Metro **Lausanne**, **Switzerland**

Lausanne Metro evolved by extending a short city underground funicular and converting it to a metro. It is now a fully automated, rubber-tyred metro line based on the technology of the Paris Métro and opened on 27th October 2008. This makes Lausanne the first and only city in Switzerland to have a full metro system. A third line (Line M3) is now planned, based on the same rubber-tyred metro technology as Line M2.



Left: Bogie of Rubber Tyred Metro **Lausanne,Switzerland**

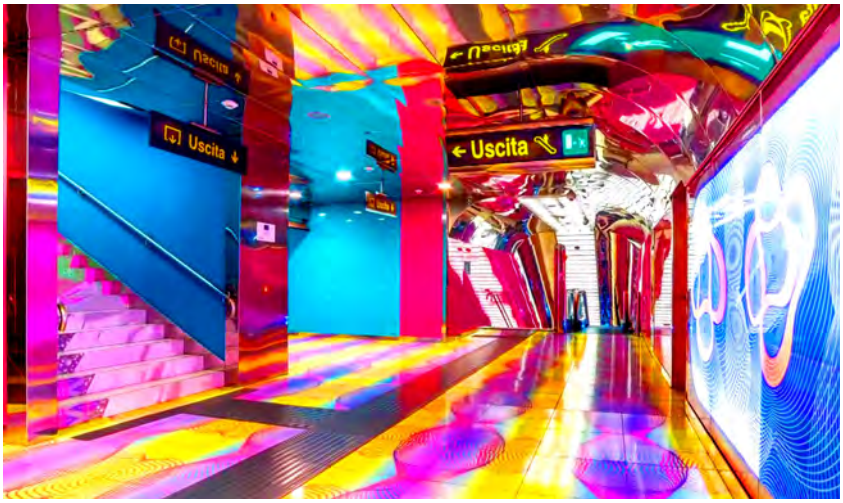
The variant of Paris Metro uses for better adhesion in addition to the Steel-Wheels in flange guided bogies inflated Rubber Tyres. This allows higher acceleration and deceleration and to negotiate steeper ruling gradients. This technology had been adopted by several other Metro Rail around the globe.

Right: New Siemens Trainset for **Munich** Underground (U) Metro; **Germany.**

The Munich U-Bahn is an electric rail rapid transit network , tha begun operation in 1971. The network is integrated into the Munich Transport and Tariff Association and interconnected with the Munich S-Bahn. The U-Bahn currently comprises eight lines, serving 96 stations encompassing 103.1 km. Since May 2020 new trainsets from Siemens Mobility are in service.

Left: CAF *INNEO* Metro Car for **Naples**, **Italy**

Nables Metro started operation March 1993 and had been extended between 2001 and 2015 with now 3 lines. Line 1 has been renamed 'Il Metrò dell'Arte' (The Art Metro) reflecting the fact that eight stations have been upgraded to exhibit works of art.



Left: **Naples** Metro Art Station, **Italy**

The Art Stations, distributed along the lines 1 and 6 of the Metro network, include more than 180 pieces of art created by 90 international authors and by some young local architects. The Toledo station was elected as the most beautiful of Europe.

Right: New SIEMENS *INSPIRO* Trainset for **Sofia** Metro, **Bulgaria,** displayed at Innotrans 2018, Berlin

Sofia Metro began operation on 28th January 1998. As of July 2016, the Sofia Metro consists of two interconnected lines, serving 35 stations, with a total route length of 40.0 km.

Left: New Metro Train-Set for **Yekaterinburg** Metro, **Russia**, build at Transmeshholding Plant in Mylishi.

The Metro opened on 26th April 1991, and with 12.7 km serves 9 stations. The Yekaterinburg Metro is the 13th and last metro to open in the USSR. By 2012, the average daily ridership had increased to 130,000.

VI. Metro Rail in North America

Left: **Washington DC** Dullas Airport Silver Line; **USA.**

The Silver Line began service on July 26, 2014. The 18.8 km portion of the Silver Line between its split from the Orange Line and Wiehle–Reston East station is in Fairfax County, Virginia and was constructed as Phase 1 of the Dulles Corridor Metrorail Project. Phase 2 expands the line another 11.5 18.5 km to Ashburn in Loudoun County, via Washington Dulles International Airport.

Right: The trainset on trial run is build by Hitachi Rail Italy for **Honolulu** Metro, **Hawaii -USA.**

The Honolulu High-Capacity Transit Corridor Project) is an urban rail rapid transit system under construction in Honolulu County, Oahu, Hawaii, U.S. The mostly-elevated system features design elements from both heavy rail systems and light metros, with a commuter rail-like design incorporated into trains and suburban stations.

VII. Metro in South America

Left: 80 kmph fast CAF Train-Set for Metro **Caracas, Venezuela.**

Metro Caras started operating January 1983 and expanded in the periode from 1987 to 2010. It operates with 4 Lines over a 54 km network as for 2010.

Left: Metro de **Santiago de Chile**, **Chile.**
The subway network in the Chilean capital Santiago de Chile is the largest in South America and the third oldest after Buenos Aires and São Paulo and opens up large parts of the capital region. It currently has 136 subway stations on 140 km of network. 225 trains are available for use on the six lines. They were supplied by Alstom, Concarril and CAF; as of autumn 2018.

Right: ALSTOM **METROPOLIS 9000** Metro-Set for **Santiago Domingo, Democratic Republic Caribbean,**

The current length of the Metro, with the sections of the two lines open as of August 2013, is 27.35 km. Four more lines are planned to be constructed in the near future, for a total of six.

Left: CAF Metro Set for new Metro **Quito, Ecuador.**

The Quito Metro is an underground rail mass transit system consisting of a single line under construction in Quito, the capital of Ecuador. The metro is projected to be operational in August 2020

ANNEXURE

World's oldest Metros

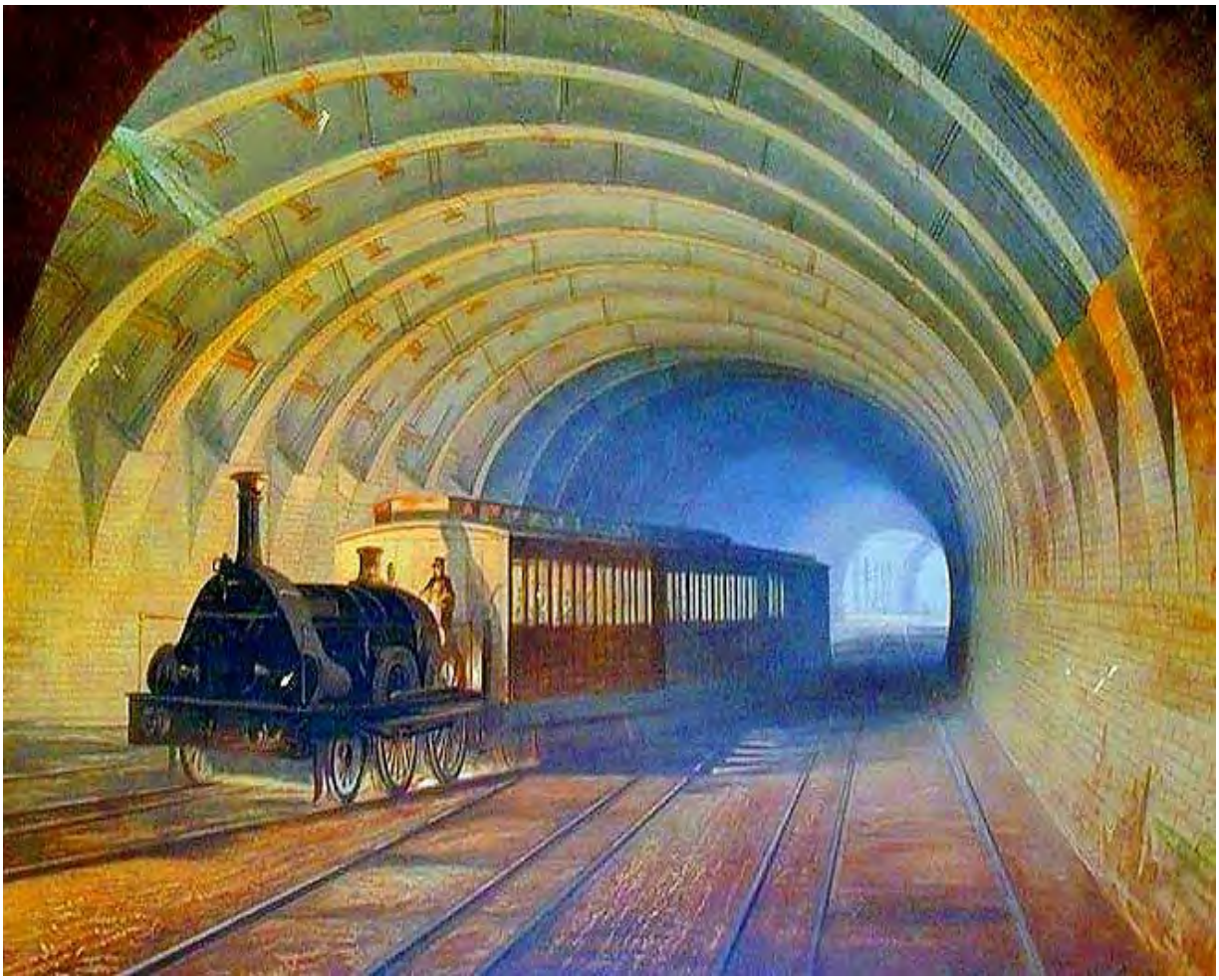


Illustration of a Train at Praed Street Junction near Paddington, 1863;
from: History Today, Volume 63, Issue 1, January, 2013

By F.A. Wingler
June 2019

I. First Day of London Tube; January 1863; UK

The capital went underground on 10th January 1863.

Source: **Richard Cavendish** | Published in History Today, Volume 63, Issue 1 January, 2013

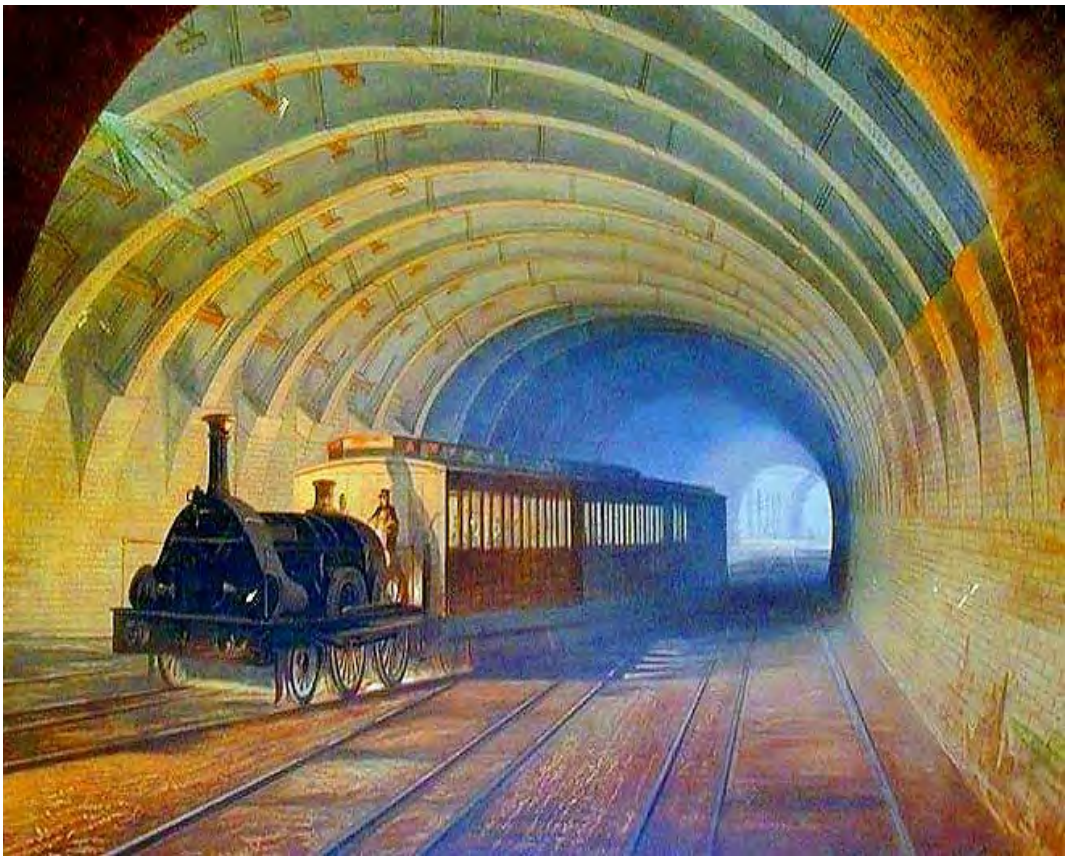


Illustration of a Train at Praed Street Junction near Paddington, 1863

Work on the world's first underground railway started in 1860 when the Metropolitan Railway began building a tunnel more than three miles long from Paddington to Farringdon Street. It was largely financed by the City of London, which was suffering badly from horse-drawn traffic congestion that was having a damaging effect on business. The idea of an underground system had originated with the City solicitor, Charles Pearson, who had pressed for it for years. It was he who persuaded the City Corporation to put up money and he was probably the most important single figure in the underground's creation. He died in 1862, only a few months before his brainchild came to life.

The first section linked the City with the railway stations at Paddington, Euston and King's Cross, which had been built in the previous 30 years. The chief engineer was John Fowler, the leading railway engineer of the day, who would go on to create the Forth Bridge in Scotland. He did not come cheap and his Metropolitan Railway salary of £137,700 would be worth about £10 million today.

A deep trench was excavated by the 'cut and cover' method along what are now the Marylebone Road and the Euston Road and turning south-east beside Farringdon Road. Brick walls were built along the sides, the railway tracks were laid at the bottom and then the trench was roofed over with brick arches and the roads were put back on top, though the last stretch to Farringdon was left in an open, brick-lined cutting. Stations lit by gas were created at Paddington, Edgware Road, Baker Street, Great Portland Street, Euston

Road and King's Cross on the way to Farringdon, which was at ground level and was built, not entirely inappropriately as things turned out, on the former site of the City cattle market. W.E. Gladstone, who was Chancellor of the Exchequer at the time, and his wife Catherine were passengers on a trial trip in May 1862.

Built round the clock by shifts of navvies, the line had to avoid numerous water and gas pipes, drains and sewers. There was a problem when the noxious Fleet Ditch sewer flooded the works in Farringdon Road, but that was dealt with and on January 9th, 1863 the line's completion was celebrated at a gathering of railway executives, Members of Parliament and City grandees including the lord mayor. The Prime Minister, Lord Palmerston, had declined his invitation, saying that at 79 he wanted to stay above ground as long as he could. Starting from Paddington, some 600 guests were carried in two trains along the line to Farringdon Street station, where a banquet was held, speeches made and due tribute paid to the memory of Charles Pearson. Music was provided by the Metropolitan Police band.

The line was opened to the public on the following day, a Saturday, and people flocked to try it out. More than 30,000 passengers crowded the stations and pushed their way into packed trains. The underground had been mocked in the music halls and derisively nicknamed 'the Drain'. There were predictions that the tunnel's roof would give way and people would fall into it, while passengers would be asphyxiated by the fumes, and an evangelical minister had denounced the railway company for trying to break into Hell.

In fact the railway was a tremendous success and *The Times* hailed it as 'the great engineering triumph of the day'. In its first year it carried more than nine million passengers in gas-lit first-class, second-class and third-class carriages, drawn by steam locomotives that belched out choking quantities of smoke. The fact that the passengers were at first forbidden to smoke in the carriages was not much help.

Over the next two years the line was extended further east into the City to Moorgate and, in the other direction, to Hammersmith. Other lines were soon added to the growing network, deeper underground tunnelling was introduced and the steam trains were replaced by electric trains. The first underground electric railway, the City and South London, which ran from near the Bank of England under the Thames to the South Bank, opened in 1890. It was the first line to be called 'the tube' and the windowless carriages with their heavily upholstered interiors were popularly known as 'padded cells'.

As far as the City was concerned, the corporation was able to sell its shares in the Metropolitan Railway at a profit and the underground did ease congestion for a time. A more lasting consequence was to make commuting far easier and so cause London to sprawl out even more from its centre, while the number of people actually living in the City itself declined sharply.

II. World`s oldest Metros in Brief

Source: **Magdalena Dugdale**
28 May 2019
Analysis; railwaytechnology.com

Metros across the World have been in operation since the late 1800s and transport millions of commuters across cities every day. There are now more than 178 Metro Installations globally with an average of 168 million daily passengers. We take a look at the world's ten oldest metros.

London Underground in England

The UK's London Underground was originally opened in 1863 for locomotive trains. In 1890, it became the world's first metro system, when electric trains began operating on one of its deep-level tube lines.

It is the world's third longest metro system, spanning 402 km with 270 stations across its 11 lines. Only 45% of the network actually runs underground, mainly in the city centre, with lines in the suburbs mostly running overground.

The network handles approximately five million passengers a day, with as many as 540 trains operating throughout the network at peak times. With increased usage, the network has undergone a number of extensions and upgrades since it was first opened but overcrowding is a common problem across the network.

London Underground has been owned and operated by Transport for London subsidiary London Underground Limited since 2007. Originally, tube lines were owned by various private companies until 1933, when the London Passenger Transport Board was introduced. Ownership of the London Underground was then passed to London Regional Transport in 1984.

Vintage London Underground Steam Train; Source "Made up in Britain"

Budapest Metro in Hungary

Budapest Metro in Hungary first became operational with the opening of Line 1 in May 1896. In 2002, the line was listed as a World Heritage Site by Unesco.

The network comprises four lines. A fifth line to connect the suburban rail system has been proposed but construction has not yet been planned. Lines M1 and M2 were extended in 1973 to their current respective lengths of 4.4 km and 10.3 km.

Line M3 was opened in 1976, which marked the start of the three lines being colour-coded yellow for M1, red for M2 and blue for M3.

The system features the first automated metro route in Eastern Europe on the M4 line, which opened in March 2014. It was estimated that the line would save passengers 14 million hours of travel time each year, as well as lowering the amount of road traffic. While initial planning for the line began in the 1970s, construction did not begin until 2006.

Europe's oldest Subway: M1, Budapest; Hungary

Glasgow Subway in Scotland

Glasgow Subway in Scotland is the world's third oldest metro opening in December 1896. The metro runs along an underground 10.5 km loop in the city and is one of the only metros in the world not to have been expanded beyond its original route.

"A number of upgrade works are being undertaken across the subway as part of its largest project in 30 years."

The system carries approximately 13 million passengers every year. It features an outer and inner circle, with services operating the same route in separate tunnels clockwise in the outer circle and anti-clockwise in the inner circle.

Towards the end of the first day of service, an accidental carriage collision caused four injuries and forced the network to close. It reopened on 19 January 1897.

A number of upgrade works are being undertaken across the subway as part of its largest project in 30 years. It includes modernisation of all stations, 17 new trains from Swiss train manufacturer Stadler, and replacement of the ramps and turnouts that allow trains to access the upgraded depot overground.

Anniversary Coach of Glasgow Underground; Source: Heritage Railway

Chicago ‘L’ in USA

The Chicago elevated ‘L’ Metro in Illinois, US, began operating as an electrified system in 1897. With 230.2 million passengers in 2017, it is the second busiest metro in the US. There is a 24-hour service available on two lines of the network, which is only featured on four other rapid transit systems in the country.

The network is approximately 165 km long with eight lines, which includes a loop in the city centre, that services run through or circle to return to their starting point. Tower 18 junction located at the intersection of Lake and Wells in the ‘Loop’ is one of the world’s busiest railway junctions with six of the system’s lines running through it.

Stations in the Loop have undergone a number of changes, with the most recent being the closure of Randolph / Wabash and Madison / Wabash stations, which were replaced with the Washington / Wabash station in August 2017.

In June, the Boring Company secured a contract to expand the network with a high-speed Chicago Express Loop link to O’Hare International Airport.

Paris Métro in France

Paris Métro in France was opened on 19 July 1900. It was one of the first to use the term ‘metro’, which was abbreviated from its original operating company’s name, ‘Compagnie du chemin de fer métropolitain de Paris’. In 2016, Paris Métro had approximately 1.52 billion passengers.

There are 16 lines with 302 stops on the 214 km-long network. The average distance between them is 548 m and stops are often located within a short walking distance of each other in the city centre. A total of 197 km of the network runs underground.

Paris Métro stations are known for their Art Nouveau style, and 83 of the original entrances are still in place. Most station interiors were renovated after the Second World War with various redecorations following.

Construction of the metro began in 1898 with a cut-and-cover method, that allowed for the track to be built underground. The lines did not extend to Paris' inner suburbs until the 1930s with Line 9 terminating at Boulogne-Billancourt in 1934. Planned expansions were put on hold during the Second World War, which resulted in a number of stations being closed.

Paris Métro Stations are known for their Art Nouveau Style; Credit: Moonik / WikiCommon

MBTA Subway in Boston Massachusetts, USA

Massachusetts Bay Transportation Authority (MBTA) operates passenger bus, light and heavy rail services in Boston, Massachusetts, US. Its subway has three main lines, and the first electrified rapid transit line, now the Orange Line, was opened in 1901.

Boston Elevated Railway was the original Orange Line before its elevated sections started being demolished in the 1920s. The line was renamed after Metropolitan Transit Authority, later MBTA, took over operations in 1964 and introduced the colour coded system.

The 9.7 km Blue Line is the second metro line, which opened in 1904, and it is the shortest of the three routes. Plans to extend the line to the city of Lynn have been proposed multiple times since the 1940s but the work has never begun.

The first service was the Green Line, which is a light rail underground, that was opened in 1987 running through the Tremont Street Subway.

MBTA Red Line, Boston, USA; Credit: Pi 1415926535 /WikiCommon

Berlin U-Bahn in Germnany

The U-Bahn in Berlin, Germany, began operating in 1902 and has since expanded across ten lines with more than 151 km of track. Approximately 80% of the lines run underground.

“During the First World War, expansion of the network was stopped, and when it restarted, progress on the U-Bahn was affected by lack of funding.”

It is estimated that every year trains on U-Bahn travel a total of 132 million kilometres and carry more than 553 million passengers.

Berlin’s U-Bahn was built as a solution to increasing amounts of traffic around the city and began as an elevated transport link between Stralauer Tor and Zoologischer Garten. The underground network opened in 1910, linking Wilmersdorf with the capital city.

During the First World War, expansion of the network stopped, and when it restarted, progress on the U-Bahn was affected by lack of funding. Passenger numbers increased during the Second World War as car use decreased. Some parts of the system suffered from damage caused by bombs, and the whole network was shut down in April 1945 following the failure of a power supply system.

Stations in East Berlin were closed following the construction of the Berlin Wall, and those on the north-south lines became ‘ghost stations’ as trains were prohibited from stopping at them.

New Stadler build IK Trainset for Berlin U Bahn, Germany;Credit: Bahnsteigkante / WikiCommon

Athens Metro in Greece

Athens Metro in Greece operates within Greater Athens and East Attica, where it terminates at Athens Airport. The line began operating as an electrified rapid transport system in September 1904, when it was converted from the former Athens-Piraeus Electric Railways, which was opened in 1869.

The system comprises Line 1, which was the original network until Line 2 and Line 3 opened in 2000. The 25.6 km-long Line 1 runs mostly over ground and was operated separately to the rest of the city’s transport network until 2011, when the Greek Government created the Athens Mass Transit System to merge services.

Construction on the 17.9 km-long Line 2 and 18.1 km-long Line 3 began in 1992, aiming to offer alternative transport to car users in an effort to lower pollution levels.

A fourth line has been planned since 2005 and is expected to open in 2026. It will add 33 km to the network with 30 new stops. Trains on Line 4 would operate automatically without a driver present.

Athens Airport Metro

New York City Subway

The New York City Subway in the US opened in October 1904 with the Interborough Rapid Transit Company (IRT) division, which is now known as the A division, and the Brooklyn-Manhattan Transit Corporation (BMT). When it first opened, a single fare cost $ 0.05.

It is the largest system in the world by the number of stations, totalling more than 420 stops across 380 km. It handles more than 1.72 billion passengers a year, making it the busiest out of the metros in this list and eighth busiest in the world.

There are 36 different lines with 27 services operating on them. Due to the subway operating all day and night, the lines operate across different service patterns and can change while maintenance takes place. The subway has suffered from a backlog of maintenance work since the 1970s when ridership fell as crime and vandalism increased.

One part of the subway being modernised is the signalling system. Originally, vehicles operated using block signalling, which can limit operations due to its lack of precision. Some lines have incorporated communications-based train control (CBTC) signalling, which optimises line usage and allows trains to operate through the blocks at the same time.

New York City Subway

SEPTA in Philadelphia, USA

Southeastern Pennsylvania Transportation Authority (SEPTA) in Philadelphia, US, operates two rapid transit lines along with four other major public transport services in the city, similar to the MBTA's operation.

Market-Frankford Line (MFL) is the oldest, having opened in 1907, while Broad Street Line was opened in 1928. Broad Street Line (BSL) operates completely underground apart from the terminus Fern Rock station, while MFL has underground and elevated stations.

The original MFL track split and looped around the foundations of Philadelphia City Hall at the end of the line, but in 1908 the track was extended and redirected underneath the city hall. BSL originally operated from the city hall to Olney Avenue. Since then, it has been expanded to Fern Rock in the north and to the sports and entertainment complex in the south, offering access to the city's main stadiums and arenas.

The two lines have a combined weekday ridership of more than 310,000 passengers a day and are both approximately 20 km long. MFL is the busier line, with more than 185,000 passengers a day.

Elevated Section of MFL Line of SEPTA Philadelphia; USA

Buenos Aires Underground “Subte”, Argentinia

The **Buenos Aires** Subterraneos de Buenos Aires, Subte, was the first underground **Metro** (**Subway**) in Latin America (line A opened in 1913), and it's often the quickest way to get around the city, especially when travelling to and from the downtown area. ... Lines A, B, C, D and E converge in the centre of the city.

Buenos Aires Underground **Cars,** Series 300**,** at Parque Patricos Workshop