

# Rail Transport in The World's Major Cities

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Many of the world's large cities grew in conjunction with railways, and today, large cities cannot depend only on motor vehicles for transportation. With worries over global environmental issues, public transportation systems are increasingly seen as an important way to expand and revitalize large cities, while consuming less energy and other resources.

This article looks at public transportation systems in some major cities of the world and identifies similarities and differences in areas such as history of development, railway networks, and method of operation. Our aim is to explore the future relationship between urban and transport

development, particularly with regard to the following:

- The correlation between railways and urban growth
- The location of terminals for intercity and intra-city transport
- Examination of various public transit systems, including non-infrastructure
- Strategic planning of rail networks based on urban development trends and future models

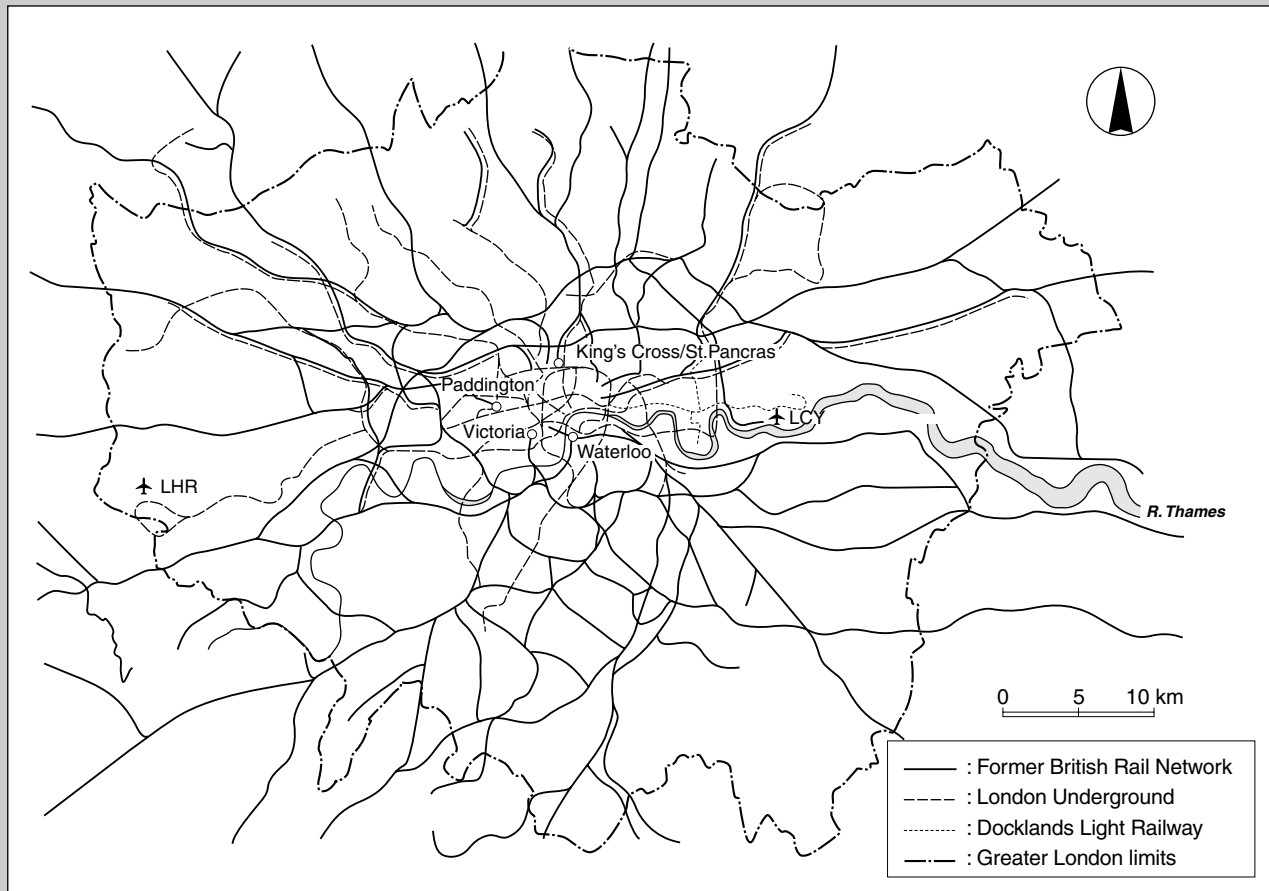
The cities selected for this comparative study are: London as the first city to adapt rail technology to public transport; Paris, Berlin and Moscow as three major European cities; New York as a North-

American city; and Hong Kong, Seoul and Tokyo representing Asian cities.

## London

Located in southeast England near the mouth of the River Thames, London expanded during the Industrial Revolution (1760–1850) and secured its dominance as the heart of the British Empire during the Victorian era (1837–1901). Its population grew from about 500,000 in the 17th century to 4.5 million by the end of the 19th century. The modern metropolis of Greater London consists of

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the central city and suburbs. This conurbation is surrounded by a 'green belt.' Greater London covers a total area of 1578 km<sup>2</sup> and has a population of 6.85 million. The industrial structure is shifting steadily from a traditional reliance on manufacturing and trade, toward sectors such as finance and tourism.

London was the world's first city to build a public transport system, starting with intercity rail links in the mid-19th century, but railway construction within the built-up city was banned in 1859, so terminals were located on the city outskirts. Many entrepreneurs had a keen interest in railways, and their railway construction efforts eventually led to the city being encircled by more than ten terminals at the city edge. This configuration remains even today although the city has spread further out past the terminals.

Britain's trunk railway network was nationalized in the 1940s and then privatized in 1996 in a bid to improve operating efficiency and services. The ownership of infrastructure has been separated from railway operations, with 25 different operating companies responsible for running the various passenger lines.

The network in London consists of former British Rail suburban lines, and 12 subway lines (tubes), with a total length of 391 km, and also extensive bus services. The ridership breakdown in 1997 was: buses 53%; subways 34%; and railways 12%. London's subway—the first in the world—began as a privately-operated, horse-drawn service in 1863, and steadily expanded with more lines and electrification. Most lines in the centre were completed by the early 20th century. The fact that the original facilities have changed little to this day is testimony to the foresight of the original planners.

The operations of London's transport system have undergone many changes. One entity (London Passenger Transport Board) was given responsibility for

managing and operating subways, buses, and trams in 1933, and the entire system was nationalized during WWII. Control was transferred to the City of London (Greater London Council or GLC) in 1970 and then back to the national government in 1984, when the bus component was subsequently privatized. The present zone-based fare structure was introduced in 1981.

Total passenger-km have been rising gradually since the introduction of the zone-based fare system, although this is thought to be due more to chronic road congestion and the resulting disillusionment with cars, as well as to new demand accompanying redevelopment of the centre core area. Recent projects include the Jubilee Line extension (opened in 1999) and the Docklands Light Railway, designed to serve the redeveloped docklands. The government provides funds for construction of new lines like these, and for maintenance and improvement of existing lines, but funding levels vary according to the government's budget. Operating expenses are not subsidized. Recent years have seen increasing concern about aging subway lines and stations, and deteriorating services. In fiscal 1998, the reliability indicator for subways (the percentage of subway trains in service) was 94%, meaning that one in every 16 trains was cancelled. This poor showing is believed to be the result of excessive emphasis on profits, and has become a focus of concern for the subway system, particularly in light of the need to fund upgrade programmes, and the question of privatization.

A new Greater London Authority (GLA) was established in May 2000 around the time Ken Livingstone was elected the first Mayor of London. He has control over London's transport and his policies are awaited with interest.

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## Paris

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Paris has a metropolitan population of 11 million while 2.17 million people live within the central city area of 105 km<sup>2</sup>. Paris is a truly cosmopolitan city, hosting some 20 million tourists and business travellers every year, half of whom are international visitors. The city layout, with many roads radiating out from a central hub, was designed by Baron Haussmann in the mid-19th century during the reign of Napoleon III (1852–70).

In France, the ratio of passenger car use to public transport use is a high 2:1 and mass transit systems are rarely profitable. This is true even in Greater Paris. To ensure viability, Syndicat des Transports Parisiens (STP, a body under direct control of the national government) was established to coordinate operations, fares and subsidies between the various public transport operators. STP brokers agreements on the extent to which each transport provider operates on tracks owned by the national railway, Société Nationale des Chemins de Fer Français (SNCF) and the subway operator Régie Autonome des Transports Parisiens (RATP).

The Paris subway (Metro) was opened in 1900 and currently has 14 lines totalling 209 km with 297 stations. The Réseau Express Régional (RER) composed of five additional subway lines is run jointly by SNCF and RATP. Paris has six intercity terminals (including some for the high-speed TGV) that connect to the Metro for travel in the city centre.

The line configuration has changed in accordance with the growth patterns. Five new satellite towns built on the outskirts of the city grew considerably between 1990 and 1996 and boosted demand for transport into the city centre. New RER lines crisscrossing the city were built to serve this demand and it is said that their layout was partially modelled on Tokyo's through operations between subways and

suburban railways (*JRTR* 23, pp. 36–41). In addition, STP monitors investment plans and determines the amount of subsidies for unprofitable lines and discount fare programmes. The national and local governments split their contributions 7:3. Investment in rail transport is generally 80% publicly funded with the remainder being financed by the private operator.

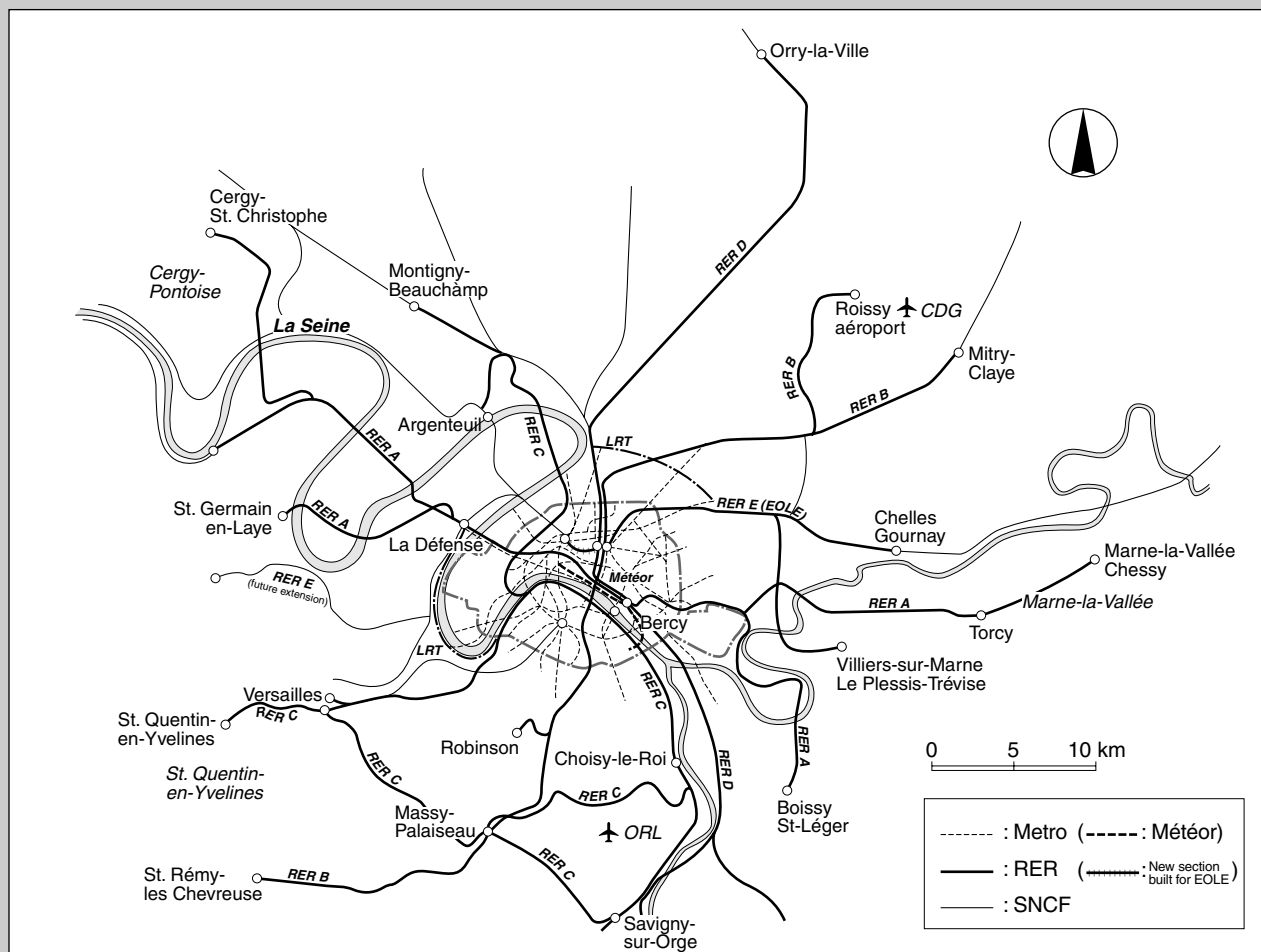
Fares within Greater Paris use a zone system while the Metro uses a flat rate fare. Intercity fares use a taper system. Paris, like other large cities in France, levies a

transportation tax on companies (based on the number of employees) to keep both types of fares low. STP distributes revenues from the transportation tax between SNCF, RATP, RER and private bus companies according to a set ratio. Although originally introduced to cover revenue shortfalls caused by discounted commuter tickets, the transportation tax now also represents a valuable source of funds for capital investment. Weekly and monthly *Carte Orange* cards are sold at discounts of up to 50% that are valid on all public transport within the city.

The national government's 1994 amended urban development plan for Greater Paris specifically limits the size of the metropolitan area and places increased emphasis on environmental protection. The plan estimated the total population of Greater Paris at 11.8 million, including 5.8 million workers, but made no provision for new transport lines except for two previously planned lines—the *Météor* (No. 14 subway line) opened in 1998, and the EOLE (RER-E) opened in 1999.

Today, the streets of Paris remain largely

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Unmanned trains at station on Paris Metro Line No. 14 Météor

(EJRCE)

as they were laid out by Baron Haussmann with little new development other than some major projects on the Left Bank, on land formerly used by SNCF, and in the Bercy district. There are also plans to improve transport access by extending subway lines and adding RER facilities, and to relocate important institutions like the Ministry of Finance and the Bibliothèque nationale (National Library) in a bid to revitalize local areas.

RATP has recently introduced light rail transit (LRT) systems providing a convenient mode of transport (LRT) that links up with subway stations in Saint Denis and La Défense. (Paris abandoned its original tramways in 1937 because they caused traffic congestion.)

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## Berlin

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Berlin began developing as the capital of the Deutsche Reich (German Empire 1871–1918) in the second half of the 19th century. The city was divided in 1945 following defeat in WWII and the east and west halves of the city were completely

separated by the Berlin Wall from 1961. German reunification in 1990 saw East and West Berlin rejoined as a city state within the Federal Republic of Germany. Berlin finally became the capital both in name and fact with the 1999 relocation of the President's office and various branches of government from Bonn.

A number of places around the city are being redeveloped to create a more uniform urban structure. They include Potsdam Platz, other areas near the former Berlin Wall, and land formerly owned by the military. Central Berlin has a population of 3.47 million in an area of 890 km<sup>2</sup>, while the greater metropolitan area has a population of 4.30 million in an area of 7340 km<sup>2</sup>.

Berlin's railway system was developed quite early and a modern network of some 300 km was already in place by the 1930s. However, the network was extensively damaged during WWII and then cut in half by the Berlin Wall (see article by Thomas Fabian in this issue of *JRTR*). After the fall of the Wall, the former connections have been restored and the network is being rapidly upgraded.

Public transport in Berlin is supplied by four operators: the S-Bahn railway, a subsidiary of German Railways (DBAG), linking the city centre and suburbs; the U-Bahn subway network in built-up parts of the city; trams mainly in the former East Berlin; and buses. About 2.4 million people use Berlin's railway network each day (including medium-distance passengers). The public transport system is rated quite highly by users, because it covers most parts of the city, transport information services are well integrated, the fare structure is simple, and the trains are clean and not crowded.

In Berlin (and other major German cities), the S-Bahn, U-Bahn, trams and buses are all members of the Verkehrsverbund (transit union) serving the specific metropolitan region. This body administers a common fare pricing system, and shortfalls are made up from funds provided by the federal and state governments. New railway construction in urban areas is funded almost entirely from the public purse mainly using federal subsidies financed by a fuel tax, and state government subsidies.

Berlin's S-Bahn consists of 15 lines totalling 324 km with 163 stations. It carries over 770,000 passengers each day. The main S-Bahn lines form a so-called 'Dog's Nose' loop (Ringbahn) and an elevated section (Stadtbahn) cuts east-west through the city centre.

The U-Bahn carries a large proportion (1.1 million passengers each day) of Berlin's traffic on 9 lines totalling 143 km with 169 stations. Important future additions to the network include the U7 line extension to Berlin's new international airport, and the U5 line extension to Lehrter, to meet new demand as government functions are transferred from Bonn to Berlin.

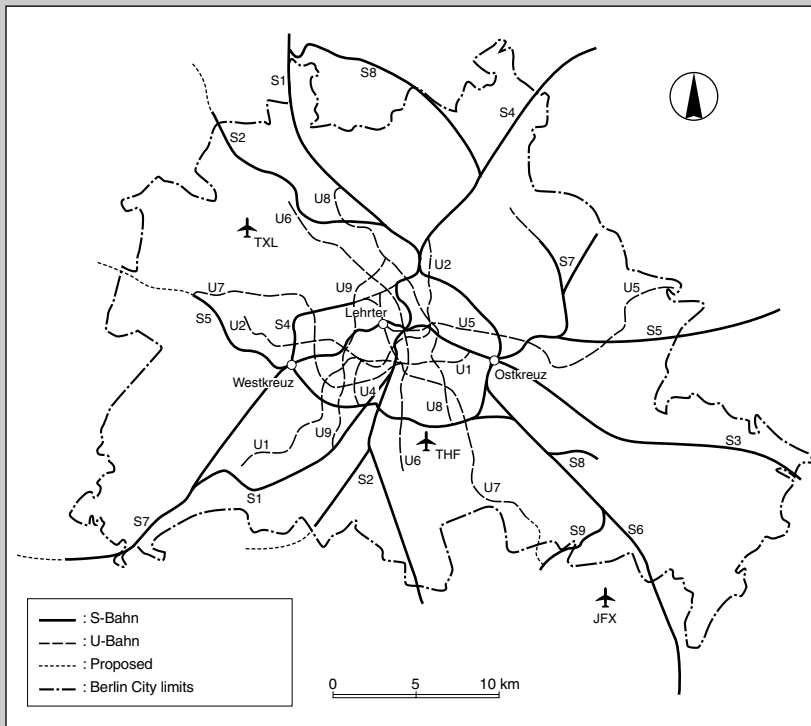
Before WWII, Berlin had eight terminals serving the nation's trunk railway network. The completion of an elevated line through the city in 1882 linked these



Berlin S-Bahn's Ostkreuz Station where Ringbahn loop crosses over east-west Stadtbahn. (EJR/CF)

stations to provide through services to a central station in the heart of the city. (This unusual approach for a European city is said to have served as a model for Japanese railway engineers when they constructed an elevated line to link Shimbashi to Ueno via Tokyo Station.) The re-establishment of Berlin as the German capital has prompted a flurry of railway development intended to provide better high-speed access from different parts of the country. A new north-south underground line is under construction and the existing east-west line is being upgraded. Berlin's new central station is being built at the intersection (Lehrter Bahnhof) of the two lines. The current Berlin master plan is designed to produce a compact rather than sprawling city, through 'decentralized concentration' with the neighbouring state of Brandenburg. This compact metropolis will have a number of core areas centred on nodes serving a radial transport network extending to the suburbs.

**The Berlin Railway Network**



**Moscow**

Situated in the centre of the Russian Plain, Moscow has an area of 1059 km<sup>2</sup> and a population of 8.37 million. Although St. Petersburg was the capital during part of the Czarist era, Moscow has always been a dynamic city and it is now the hub of nation's political and economic activity where industry and a skilled labour force are concentrated. Given the very low rate of private vehicle ownership compared to other industrialized nations and the almost total absence of well-maintained expressways between major cities, the public transport system fulfills an important role in transporting people within cities and to suburbs. Moscow has nine terminals for railway services to suburbs and distant cities. Most are located on the subway loop line. There are no direct railway services into the city

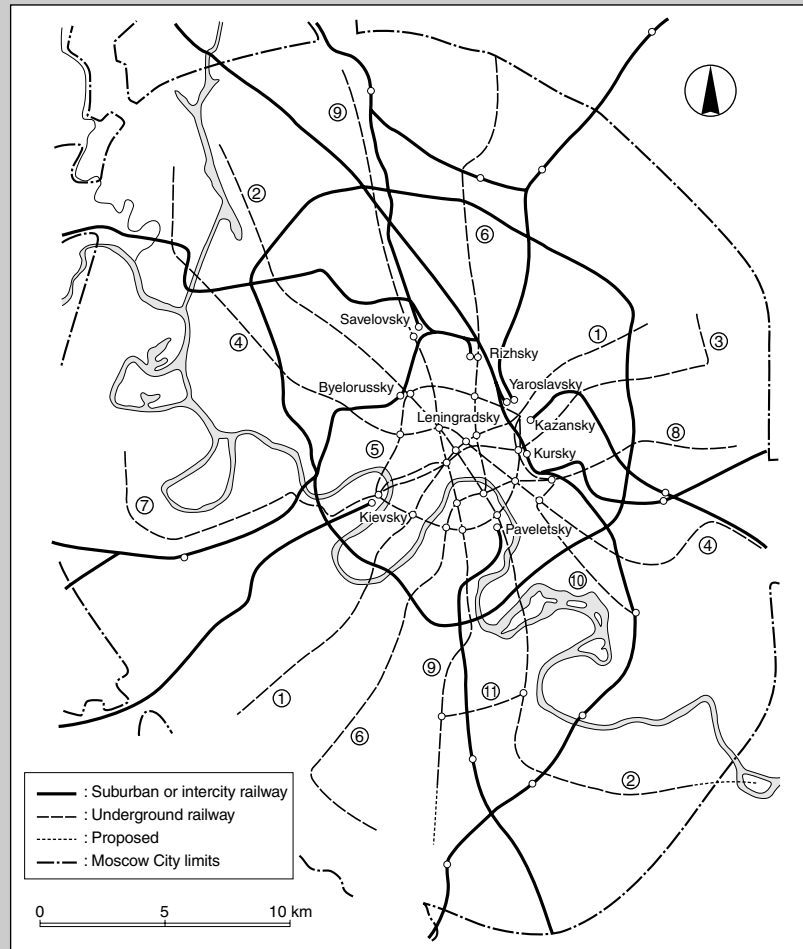
centre, so passengers must change to the subway or take another form of transport. Moscow's main public transport modes are subways, trolley buses, ordinary buses, and trams. The first subway line was opened in 1935 and was quickly followed by a succession of new routes and branch lines. The Stalinist regime saw the subway system as a symbol of prestige, so subway stations (or 'palaces') were designed with considerable grandeur. Subway construction continued during WWII when the stations were used as air-raid shelters; further expansion took place in the postwar period. The present subway network consists of 11 lines totalling 262 km with 160 stations and carries 8.88 million passengers each day.

Part of the subway network is a loop line with a radius of about 2 to 3 km from the city centre. Radial lines crisscross the area enclosed by a loop road encircling the city at a radius of about 15 km. The subway fare is fixed irrespective of distance travelled or number of changes. Entry is by *jetton* (coin) or card.

Intercity and suburban train services in Russia are operated by the Ministry of Railways at the federal level through 19 regional railway bureaus. The federal government covers all deficits in intercity services—fares contribute only around 40% of revenue and the remaining 60% shortfall is received as subsidies from the national government. In the case of suburban rail services, 17% of operating expenses are provided by the regional railway bureaus with the remaining 83% subsidized by regional governments.

The Moscow subway system is operated by the municipal government and fares are kept low to make transport affordable to all. As a result, fare revenues only cover 30% of operating costs (1995 figures), and the government subsidizes the shortfall. The federal government provides the municipal government with subsidies for development projects such as new line construction, station construction and

### The Moscow Railway Network



refurbishment, and introduction of operation control systems.

Construction of 45 km of new subway lines was planned at one stage; extension of Line 10 was completed in 1997, and the Line 2 extension is presently under construction. However, construction of new Line 12 has been abandoned.

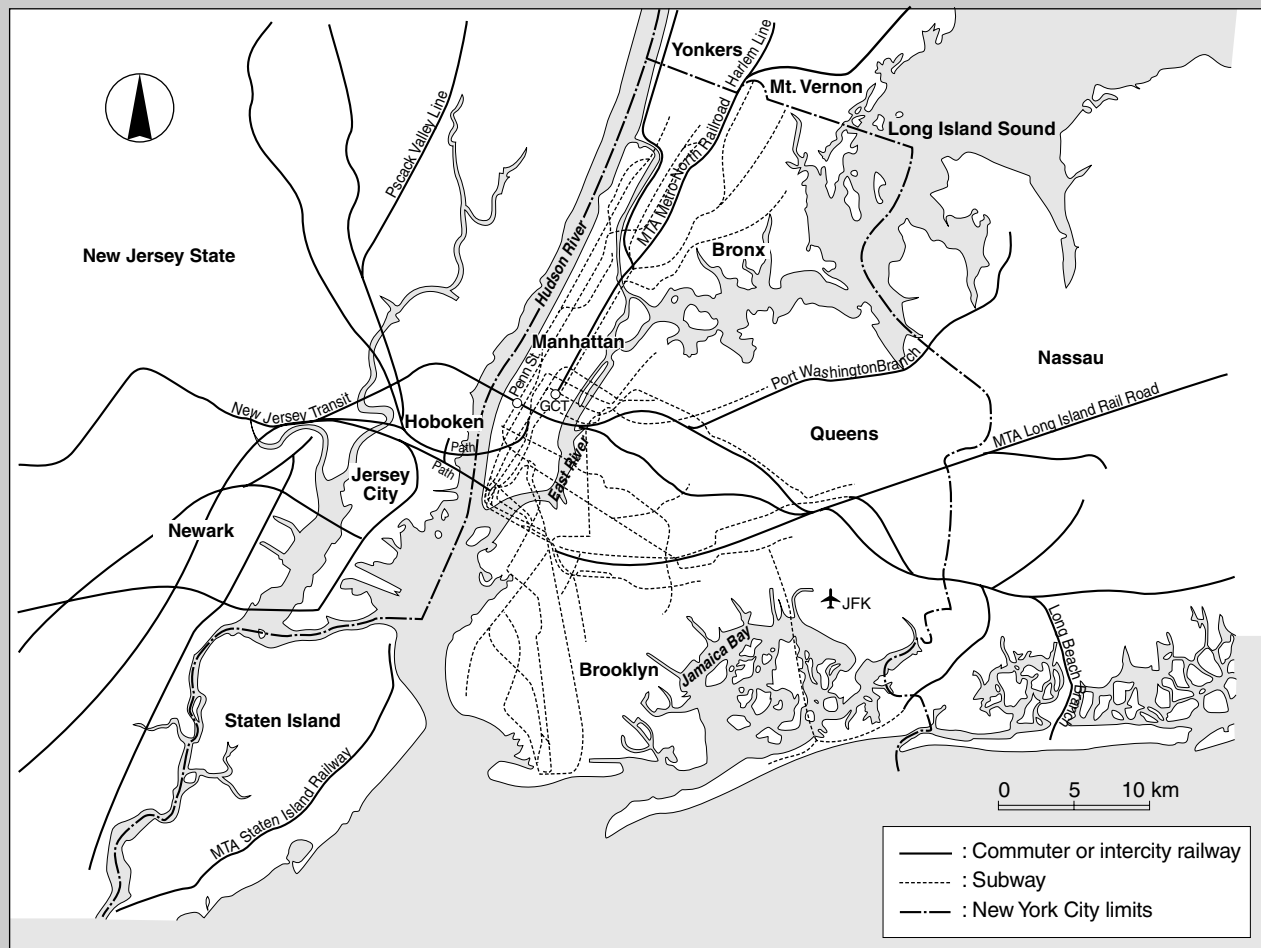
### New York

New York has a population of 7.34 million in an area of 833 km<sup>2</sup>. The city is divided into five districts, and is centred around Manhattan. Greater New York covers a much larger area, including the northern part of neighbouring New Jersey, and Long Island.

Until the early 19th century, New York consisted of a mixed residential and business district in south Manhattan. As the area became more business-oriented from the mid-19th century, people moved their homes toward the north of the island or to Brooklyn, the Bronx, and Queens. Public transport played a prominent role in New York's development, first by horse-drawn cart, then by horse-drawn railways, then elevated railway lines, and then subways.

Most public transport in New York is controlled and operated by the Metropolitan Transportation Authority (MTA), a body of the state government. The MTA is responsible for New York City Transit, which operates public transport

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within the city, and Long Island Rail Road (LIRR) and Metro-North Rail Road, which operate commuter rail services to the suburbs. The MTA operates alongside other bodies such as the Port Authority Trans Hudson and New Jersey Transit. New York's first subway opened in 1904. Originally built and run by a private operator, the Interborough Rapid Transit Company (IRT), it ran into financial difficulties and was purchased by the City of New York in 1940. Since then, all subways have been run by the municipal government. The city's population grew from about 4.8 million to 7.5 million between 1910 and 1940. Most of the new residents lived in 'subway suburbs' located 6.5 to 19 km from the city centre and developed as a result of new subway line

construction. A number of new commuter railways serving areas beyond the city were developed around this time. Penn Station (opened in 1910) and Grand Central Terminal (GCT, opened in 1913) provide direct connections for commuters from the suburbs to the city centre. New York's subway network can be broadly divided into three groups linking Manhattan with the Bronx, the downtown area with Brooklyn, and mid-town with Queens. Nearly all the subway lines pass in a dense formation through the city's central district (south of Central Park). Many stations serve multiple lines—42nd Street, for example, even has a shuttle service from GCT in the east to Times Square in the west, and functions as a giant interchange node. At present, the

subway system consists of 25 lines stretching 389 km with 468 stations. The daily ridership is 3.1 million. Commuter rail fares are tapered, while the subways and buses charge a flat rate of \$1.50. The relatively recent pre-paid Metro Card enables passengers to switch between subways and buses much more easily than before. Notable features of the New York subway system include 24-hour operations and quadrupling of some lines. Since 1940, New York's population has remained relatively stable at under 8 million, but the surrounding areas have grown. Many of the new population centres do not have good access by public transport into the city centre. The MTA is attempting to address this problem by extending the LIRR to Grand Central

Terminal, and by driving a new tunnel under the Hudson River.

New York is more reliant on public transport than any other city in the USA, and continuing high levels of investment are required each year to provide good services. Operating revenues cover 65% of funding requirements and the shortfall is obtained as federal and state government subsidies. However, funding for future network expansion and operation of existing lines is a major problem for the MTA.

## Hong Kong

After a long period as a British colony, Hong Kong was returned to the People's Republic of China in July 1997 and now enjoys a high degree of autonomy as the Hong Kong Special Administrative Region. Hong Kong covers a total area of 1080 km<sup>2</sup> and has a population of 6.5 million. Hong Kong Island is home to 3.5 million people and another 1.9 million live in Kowloon and the New Territories. The older districts facing Victoria Harbour house some 4 million residents on just 20% of Hong Kong's total land space. This represents a population density of about 250 people per hectare, one of the highest in the world. Large 'new towns' are being built in the New Territories in the northern part of the Kowloon Peninsula.

Hong Kong has a very high concentration of commercial activities and the rapid railway network plays a vital role in facilitating movement within the old district, and from the new towns to the city centre. Rapid rail accounts for 62% of all journeys between Kowloon Peninsula and Hong Kong Island.

Rail services are provided by the Mass Transit Railway (MTR), the Airport Express (built in conjunction with the new Hong Kong International Airport and run by MTR), and the Kowloon–Canton Railway (KCR). These three networks carry 2.2

million people each day on trains that are often very crowded. The northwest part of the New Territories also has a 23-km Light Rail Transit (LRT) service, while a 16-km network of double-decker trams dating from 1904 on Hong Kong Island is useful for short trips around the island.

The subway system consists of two lines from Kowloon Peninsula under Victoria Harbour, and one line running east–west across Hong Kong Island. The three lines are operated by the Mass Transit Railway Corporation (MTRC) subway authority, which also runs the Airport Express and is involved in real estate development along railway routes. There is talk of privatizing the MTRC at some stage.

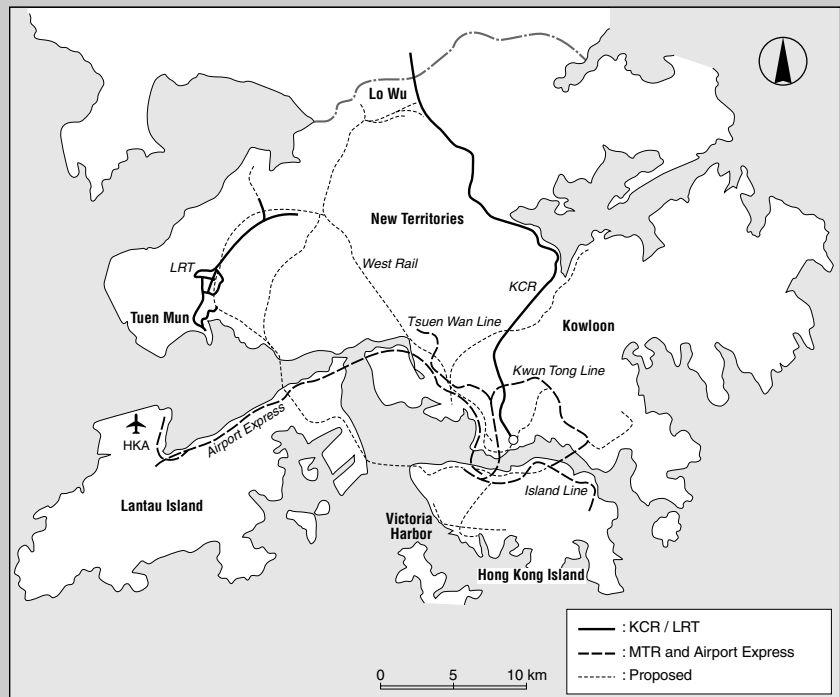
The Kowloon–Canton Railway was originally built in 1910 to provide trunk services between Kowloon and Canton. In 1983, the route was double-tracked and electrified as far as Lo Wu, to provide an intra-city commuter service for residents

of new towns along the route. Originally owned by the Hong Kong government and now run by the Kowloon–Canton Railway Corporation (KCRC), the 34-km line carries 740,000 passengers each day.

The Hong Kong administration provides funding for line works, although the amount varies annually. The individual railway operators have different fares structures, as in Japan, but the fares are lower. Services on all lines are frequent and operate from the early hours until late at night. Public transport in Hong Kong provides a fairly high level of service, although rush-hour overcrowding is a problem in some sections.

Under the latest revisions to its broad strategic land usage programme called the Territorial Development Strategy (TDS), the Hong Kong administration plans to finish construction of a new airport (already partially completed), a new container terminal, and other port facilities

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by 2011. The TDS also proposes reclaiming land from the western side of Kowloon Peninsula, pursuing another landfill and development project around the former Kai Tak airport site, developing new towns in the New Territories, and constructing a border crossing transport axis on both sides of the Pearl River. The administration is presently considering a Second Railway Development Strategy, and two priority rail projects are being built as part of the TDS. The first is the West Rail route, currently under construction by KCRC and due for completion in 2003. This line will head north from Kowloon beyond the west bank of the Kowloon Peninsula to the northwest region of the New Territories. The other line, which MTRC is about to begin building, is a branch extension to the subway following the eastern edge of the Kowloon Peninsula.

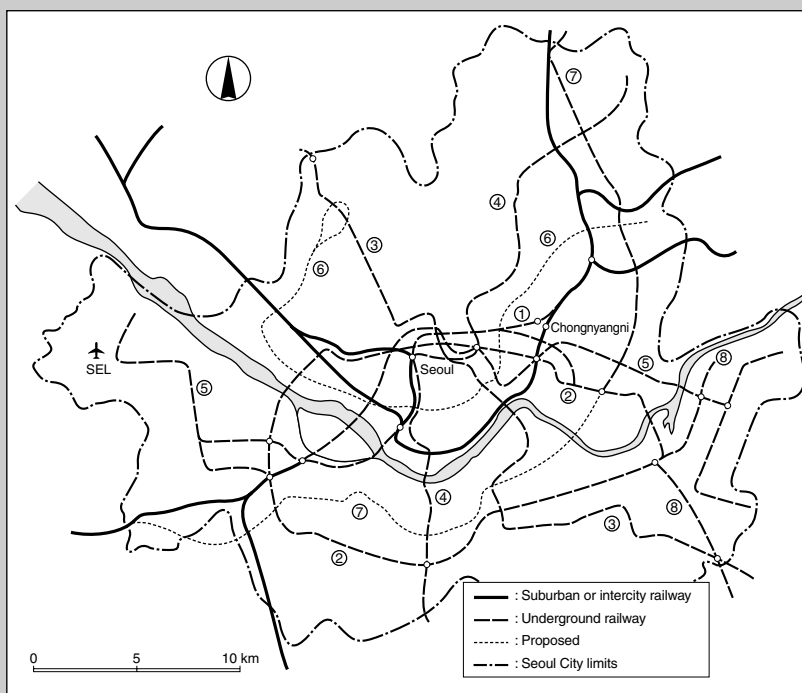
### Seoul

Situated in the middle of the Korean Peninsula and bisected by the Hangang River, Seoul has a population of 10.23 million (about 25% of the national total) in an area of 605 km<sup>2</sup>. The city and its neighbouring areas are the economic engine of South Korea and contribute about 25% of the nation's GDP. The city suffered enormously during the Korean War (1950–53) but subsequently rebounded in a period of rapid economic growth. The 1988 Korean Olympics boosted the economy further and provided an impetus for expansion of the subway system and construction of many high-rise buildings, completing the transformation of Seoul into a modern city. South Korea's first railway was the Kyongin Railroad between Incheon and Seoul, which opened in 1899. With the partitioning of the Korean Peninsula into North and South after the Korean War, the line was cut in two and the southern

section joined the Korean National Railroad (KNR) network, which was under the jurisdiction of the National Railroad Administration. Seoul has two terminals for intercity rail services, Seoul Station and Chongnyangni Station. Seoul Station is the largest due to the greater number of lines terminating there. Chongnyangni is the terminus for several lines to the southeast and northeast. Seoul Station is served by subway lines 1 and 4, and Chongnyangni Station by subway Line 1. The main modes of public transport in Seoul are buses and the subway (37% and 30% of total capacity, respectively, in 1995). Work began on the subway Line 1 in 1971, 3 years after the tram system was closed and services began in 1974. The subway network now has 7 lines totalling 217 km with 197 stations. Lines 1 to 5 cover the city while lines 7 and 8 serve the suburbs. Trains on Line 2, a loop line, take about 80 minutes to circle the

city. Line 5 runs from Kimpo Airport to the city centre. Line 6 and part of Line 7 are still under construction. Subway construction and operations are divided between two public bodies: the Seoul Metropolitan Subway Corporation, which manages lines 1 to 4, and the Seoul Metropolitan Rapid Transit Corporation, which manages lines 5 to 8. The Seoul Metropolitan Rapid Transit Corporation operates each of its Automatic Train Operation device (ATO) equipped trains with only one driver and no conductors to improve cost effectiveness. It has also promoted construction of small-cross-section tunnels to cut construction costs. The subway network receives subsidies from a transportation tax system funded mainly by a fuel tax but operating losses are reported each year. The municipal government is obliged to inject additional funds and issue subway bonds to make up the shortfall. The subway system is

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exempt from taxes on real estate acquisition and registration, and does not pay corporate income, town planning or business taxes.

A single fare structure applies to the 7 subway lines and the Korean National Railroad (KNR) services in the metropolitan area and the same ticket can be used for travel on both. The city is divided into 7 zones, with fares set at 500 Won within one zone and 600 Won when crossing to another zone. The minimum fare covers travel from the city centre to most of the main stations in the city.

The average overcrowding rate for all 7 subway lines is 207% with the most

crowded being Line 2 at 237%. Trains on lines 1 to 5 in the city centre run every 2.5 to 3 minutes during rush hours (except the Line 2 branch line).

Seoul's rapidly increasing population has caused a range of problems in housing, employment, the environment, and road congestion. In 1996, the city authorities produced a comprehensive transportation strategy calling for reduced car usage, increased use of public transport, and elimination of some factors that tend to impede traffic. Strategies designed to boost subway ridership include discount fares during off-peak periods, events in stations, new bicycle parking, and

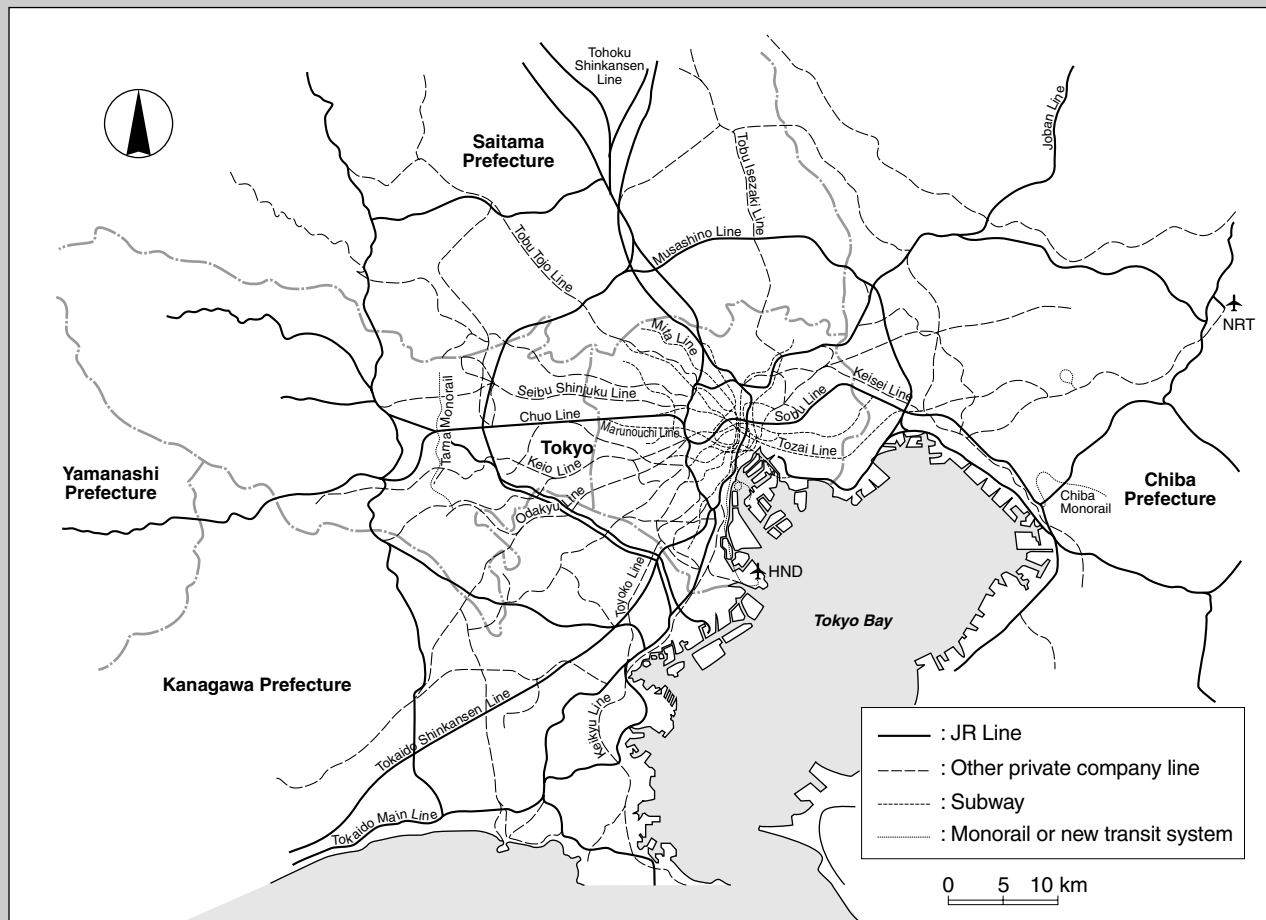
construction of new lines.

In addition to new lines already under construction, the authorities plan to build another four lines (lines 9 to 12), and to extend Line 3. When completed in 2005, this new construction will add 120 km to the subway network, boosting the capacity by 50%, and helping to alleviate traffic congestion.

## Tokyo

Tokyo and its surrounding metropolitan area is located on the Kanto Plain in the centre of the Pacific coast of Honshu, the

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main Japanese island. Originally known as Edo, the city saw substantial development from the early 17th century as the seat of government of the Tokugawa Shogunate (1603–1867) which excavated canals, dug moats, and reclaimed land. Edo soon became the political, economic and cultural centre of Japan with a population of around 1.1 million. The Meiji Restoration in 1868 marked the beginning of the modernization of Tokyo. Tokyo's population rose steadily as it developed into a modern city and reached 7.35 million in 1940. The effects of WWII brought a temporary drop to around 5 million in 1947 but the population soared to 11.41 million by 1970. The population of Tokyo's 23 wards has remained fairly stable since 1970 but the population of surrounding prefectures has exploded.

The first railway line in Japan between Shimbashi and Yokohama opened in 1872 and was soon followed by massive expansion of government and private railways as described in *A History of Japanese Railways 1872–1999* published by EJRCF.

Electric tramways were introduced to Tokyo in 1903 when the first service ran between Shimbashi and Shinagawa on rails previously used by a horse-drawn tramway. The tram network expanded steadily to a total length of 193 km and served as an important form of city transport. However, trams caused road congestion when motor cars appeared in greater numbers in the 1960s and the tram network was almost completely dismantled by the late 1960s, leaving the single 12-km Arakawa Line running on a reserved right-of-way.

The first 2-km subway (now part of the Ginza Line) was opened in 1927 between Ueno and Asakusa, and the Teito Rapid Transit Authority (TRTA) built and now operates a 172-km network of 8 subway lines. As Japan entered the rapid economic growth period in the 1960s, other bodies were encouraged to build

and operate subway lines. The Tokyo Metropolitan Government (TMG) began subway operations in 1958, and eventually completed four lines totalling 80 km, including the Asakusa and Mita lines. New sections including the Oedo Line will bring the total length of lines operated by the Tokyo Metropolitan Government to 109 km.

More through operations linking subways, JNR lines (before privatization), JR East lines (after JNR privatization), and private railways have been established since the 1960s in order to minimize the inconvenience for commuters changing trains and to reduce station congestion. The resulting improvements have encouraged further outward expansion of residential housing into more remote urban areas.

Recent developments include new monorails, rail-airport links, and light rail services to newly developed urban areas as described in previous issues of *JRTR*. Long-distance intercity services provided by the Tokaido, Hokuriku, Tohoku, and Joetsu shinkansen lines all terminate at Tokyo Station.

Tokyo's railway operators, including JR East and various private companies each have different fare structures, making for an unwieldy ticket system and higher costs. Subway travellers are similarly inconvenienced by the fact that the two subway operators (TRTA and TMG) have exclusive fare systems, although there are some discount tickets. Morning and evening rush hour services on all lines still remain heavily congested.

Tokyo's public transport system is still in need of more new lines and an integrated fare structure in order to improve convenience and help relieve congestion. Around 50% of subway construction costs are subsidized by roughly equal contributions from the national and local governments, which have recently introduced low-interest and interest-free loan schemes. The national and local

governments also equally share part of the interest charges above 5% on new-construction loans taken out by private railway companies.

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### Comparison of Transit Systems

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Of the 8 cities described above, Tokyo's population of roughly 8 million in its 23 wards (central Tokyo) is third after Seoul and Moscow. However Greater Tokyo including Yokohama, Kawasaki and other neighbouring cities has a population of about 33 million, far more than any other city. According to our estimate, Greater New York has only 60% of Greater Tokyo's population, Paris around 30%, and the other cities even less.

Both Tokyo and New York have separate business and residential districts that are dependent on rapid suburban rail services. By contrast, the other cities have interlocking business and residential districts, with public transport networks primarily serving the built-up urban area (notwithstanding the presence of some lines extending into suburbs). Berlin is currently in the process of developing a high-density rail network for both the city and surroundings, but at the moment, the public transport network mainly serves the city area.

In cities such as London, Paris, Moscow and Berlin, where intercity rail services were established early, the major terminals are located at what was the city's edge at the time of construction. (London actually banned railway construction within the central city in 1846.) Although some cities subsequently either allowed trains through the centre or built radial lines linked by loop lines serving the suburbs, the 'bicycle wheel' configuration is still found in most major cities today. There are exceptions—Berlin built lines

traversing the city, and Tokyo, although late in embracing railways, was quick to appreciate the need for lines traversing the city in different directions and later brought the shinkansen (Bullet Train) services right to the city centre. Berlin is currently extending its intercity lines to the city centre and beyond as part of the process of relocating government functions to the new capital.

The geographical location of a city generally affects the development of its rail network—generally a radial pattern is favoured. Exceptions are New York and Hong Kong, which have peninsular shapes. New York has two intercity services and the east–west service is a

through route passing under water. Similarly, Hong Kong has an intercity line to the city at the tip of the land, providing integrated land and sea transport.

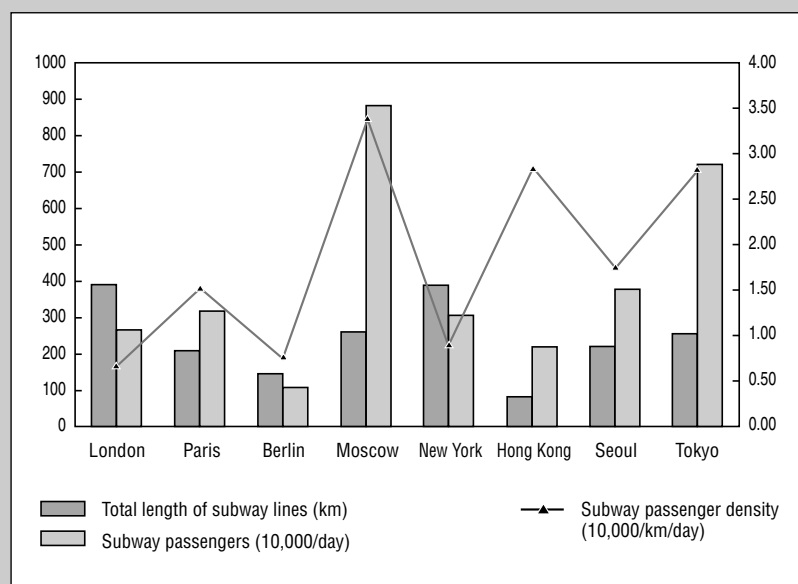
Although trams were once an integral part of inner city transport they became impractical when conflicts arose with road traffic patterns and also had limited capacity. This prompted construction of urban subway systems, starting with London in 1863, Paris in 1900, and Moscow in 1935. In many cities, the subway networks expanded as the cities grew, extending outward into the suburbs. Almost all the cities described here have extensive subway networks—New York has 25 lines, Paris 14, London

and Tokyo 12, and Moscow 11. London, Moscow, and Seoul also have subway loop lines, with Tokyo due to follow suit in 2000. Notwithstanding some differences in coverage, subways play a very important role in inner-city transport. Meanwhile, cities such as London, Paris, Berlin, and Hong Kong are developing new and improved light-rail systems similar to trams, providing inner-city services that appeal to local residents. In Tokyo, postwar development of the subway network included through operations with existing private and national suburban lines, permitting direct connections to the city centre from up to 50 km away. Meanwhile,

### Rail Transport in Eight Major Cities of World

	London	Paris	Berlin	Moscow	New York	Hong Kong	Seoul	Tokyo
Metropolitan Zone	Greater London	Ile de France	Berlin and Brandenburg		Greater New York incl. north New Jersey and Long Island			Tokyo and 3 neighbouring prefecture
Area (km <sup>2</sup> )	1578	12000	7340	-	26329	-	-	13494
Population (1000)	6850	11000	4300	-	19880	-	-	32570
Inner City	13 central boroughs	City of Paris	City of Berlin		New York City			23 wards
Area (km <sup>2</sup> )	311	105	890	1059	833	1080	605	621
Population (1000)	2500	2170	3470	8370	7340	6500	10230	7970
Subway system		RATP Métro	U-Bahn			including Airport Express		TRTA and TMG
Began operation (Year)	1863	1900	1902	1935	1904	1979	1974	1927
Number of lines	12	14	9	11	25	4	7	12
Total length (km)	391	209	143	262	389	77	217	252
Number of stations	272	297	169	160	468	51	197	237
Passengers (1000/day)	2500	3200	1100	8880	3100	2200	3800	7240
Passenger density (1000/km/day)	6.4	15.4	7.7	33.9	8.0	28.6	17.5	28.7
Fare system	Zone based	Flat rate	Zone based	Flat rate	Flat rate	Distance based	Zone based	Distance based
Other urban railways	Former British Rail network run by private operators	SNCF's suburban services and Regional Express Network (RER) run by SNCF and RATP	S-Bahn services run on German Railway (DBAG) suburban network	Russian State Railway suburban services	Commuter railways linking Manhattan and suburbs	Kowloon-Canton Railway's commuter services	Korean National Railroad's suburban services	JR East, eight major and some smaller private railways, Yokohama municipal subway
Intercity railways	13 terminals; not centrally located	6 terminals; not centrally located	3 terminals; axial configuration	9 terminals; not centrally located	2 terminals	1 terminal	2 terminals	7 terminals incl. those of private interurban lines; axial and non-centralized
Data year	1998	1999	Population, 1995; ridership, 1998	Population, 1995; ridership, 1996	1997	1998	Population, 1995; ridership, 1993	Population, 1995; ridership, 1997; line length, 2000

Subway Systems in Eight Major Cities



some national lines into the centre were quadrupled to boost carrying capacity. These improvements encouraged further development in the city centre, and generated new demand.

In Berlin, the resurrection of the former pre-Cold War network and construction of several new lines will boost direct services on both the U-Bahn and S-Bahn from all sides into the city centre. In Paris, six subway lines are linked to SNCF lines to provide direct express subway services to the city centre. Seoul, meanwhile, has created direct services from the suburbs to the centre in much the same way as Tokyo by connecting some subway lines to suburban KNR lines.

All subway systems described in this article are operated either by government or public bodies established and funded by government. The London and Paris subways are run by public corporations; the Moscow subway by the city authorities; the Berlin subway by the government Transport Bureau; New York

by the Metropolitan Transport Authority; Hong Kong by the government Mass Transit Railway Corporation; Seoul by two government bodies; and Tokyo by the Teito Rapid Transit Authority and the Tokyo Metropolitan Government. National railways (or their successors or affiliated bodies) also play important roles in providing transport in London, Paris, Berlin, Seoul, Hong Kong and Tokyo.

Underground railway construction is very expensive and new lines must often be built deeper underground at even greater cost. However, to attract passengers, fares for new lines must be kept at a reasonable level or on a par with fares for previously constructed lines, bus services and other transport modes. Consequently, it is virtually impossible to recover the full cost of inner-city railway construction from fare revenues alone.

Funding the tremendous construction costs is therefore a major issue. One solution that has become increasingly popular is vertical separation in which

subway construction is clearly separated from subway operations by funding the construction costs largely (or wholly) from the public purse. This approach is based on the notion that urban railways, like roads, are an important part of a city's infrastructure and that their construction is therefore a government responsibility. Railways also represent a more environmentally-friendly mode of transport and are likely to gain favour.

In Paris, 80% of public transport investment is publicly funded primarily from the transportation tax levied on employers. In Berlin, urban railway development is almost totally publicly funded with contributions from both the federal government (through a fuel tax) and local government. The operating revenue shortfall is also subsidized by both government levels.

Investment in Tokyo's public transport receives different types of assistance, reflecting the variety of different operators and conditions. Assistance includes subway construction subsidies, low-interest and interest-free government loans to transport operators, subsidization of interest payments by private railways, and subsidies for new transport systems funded by fuel taxes.

Tokyo and Hong Kong are the only cities where fares are based on distance. All the other cities have zone-based fare structures, with fare revenues divided between the different operators. However, many cities use distance-based fares for travel to the suburbs.

In terms of both transport volume and density, Tokyo is reliant on its railways. It is also the only city where transport operators essentially function independently of government assistance (except for construction subsidies). The subsidies for operating costs in Western countries do not encourage transport providers to make

operations more efficient and profitable. There are fears that such subsidies can cause national and local government expenditures to balloon out of control and the Tokyo approach—expecting railway operators to manage their own operating finances—certainly has advantages. The experiences of Paris, Berlin, Hong Kong, and Tokyo clearly indicate the importance of linking expansion of the urban rail network to strategic development planning for the city as a whole. Urban railways encourage intensive development around stations, and are very important as a tool to reduce dependency on cars and protect the urban environment.

One should also consider the manner in which intra-city and intercity transport networks mesh within the context of the overall transport system. Many European cities are developing flexible connections between their subway network and their major rail terminals (which lead to different destinations from the old city boundaries). On the other hand, Berlin, Tokyo and New York have integrated their services by linking intercity and intra-city lines. The latter approach is more convenient for travellers, but imposes a greater burden on the city centre, requiring development of sub-terminals and other solutions. On another front, most cities have recently integrated

intercity and intra-city networks to include rail-air links as well.

Ultimately, urban transport systems must function in a manner that attracts passengers. This year will see the completion of Tokyo's first subway loop and other lines now under construction will improve services further within a few years. But there is still work to be done, particularly in areas, such as relieving congestion, linking lines to provide through services, providing services commensurate with fare levels, and embracing barrier-free design principles. ■

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