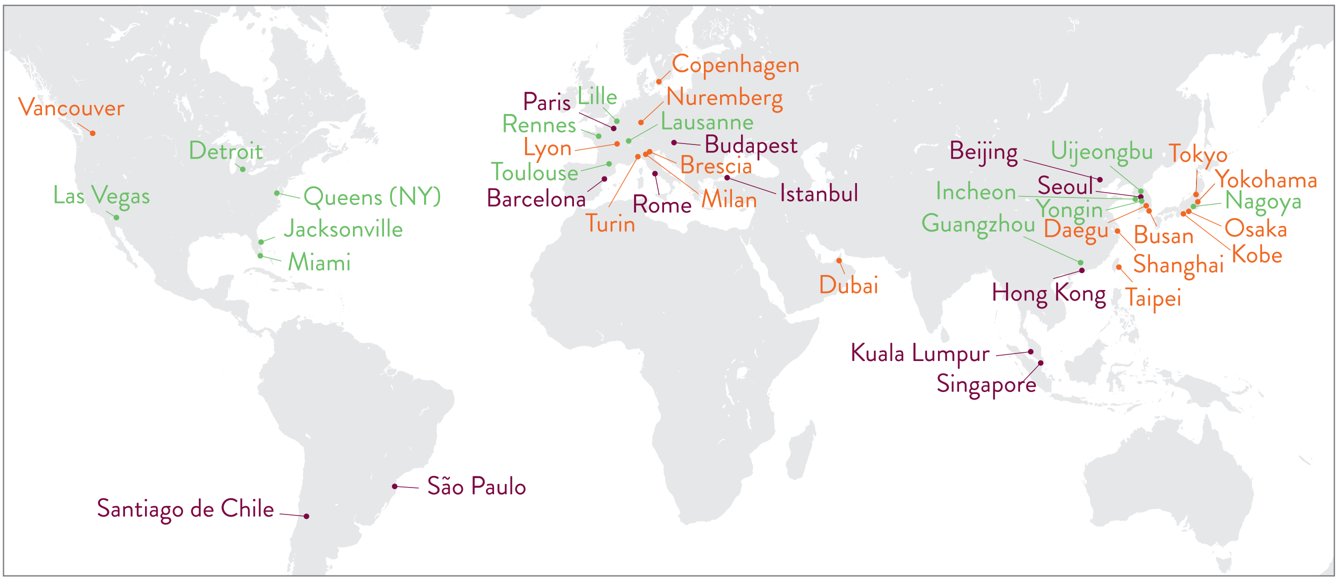
ADVANCING PUBLIC TRANSPORT

STATISTICS BRIEF

WORLD REPORT ON METRO AUTOMATION 2018

INTRODUCTION

In March 2018 automated metros reached the 1,000km milestone with the opening of the Pujiang Line in Shanghai. As of December 2018, nearly a quarter of the world's metro systems have at least one fully automated line in operation. In total, there are 64 fully automated metro lines in 42 cities, operating 1,026km, a 27.7% increase in km over the 2016 World Report figures. The next years will however overshadow this achievement: if confirmed projects advance to plan, by 2023 the number of automated metro km in the world is set to triple, with most of the growth taking place in China. This Statistics Brief offers a general overview of the world metro automation landscape today and its expected future evolution.



High capacity lines: more than 700 passengers per train
Medium capacity lines: 300 to 700 passengers per train
Low capacity lines: under 300 passengers per train

Figure 1: Cities with fully automated metro lines in operation, as of 31 December 2018

INFRASTRUCTURE

The 64 fully automated metro lines in operation in December 2018 provide public transport service to over 1,026km and 1,026 metro stations in 42 cities across the world.

Asia has consolidated its status as the leading world region in metro automation (see Figure 2) with 50% of the km of fully automated metro lines in operation, thanks in particular to the opening of five new lines (in Korea, Malaysia and China) in the last two years. Europe remains second at 30%, with North America and Middle East following at 11% and 8% respectively. Last in the chart, Latin America has however experienced one of the highest relative growth rates, with the opening of Line 6 in Santiago.

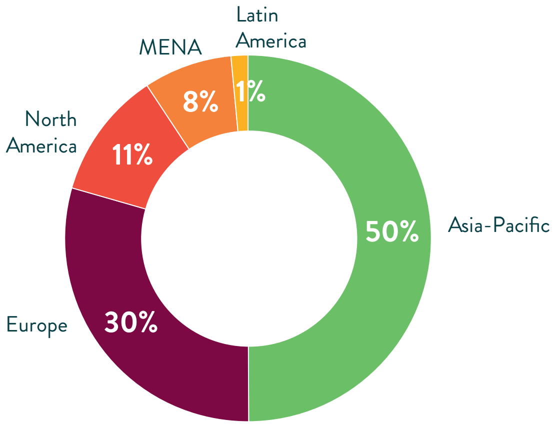


Figure 2 : Automated metros per world region, measured as a % of km in operation

Four countries concentrate half of the world's km of fully automated metro lines: South Korea, France, Singapore and Malaysia (see Figure 3). The same three Asian countries, together with the United Arab Emirates, also lead in growth in the last decade (see Figure 4).

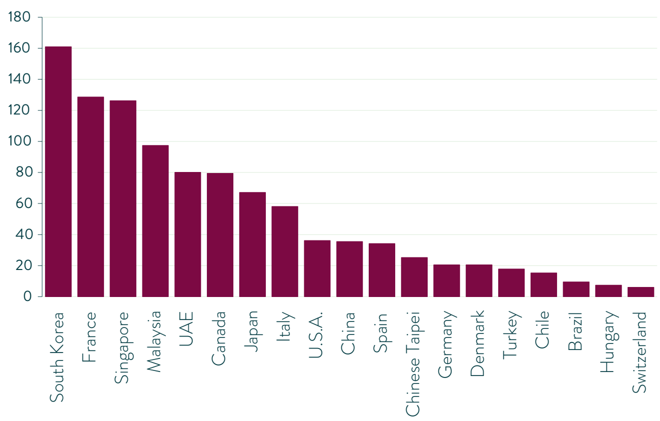


Figure 3 : Fully automated metros per country/territory, measured in km

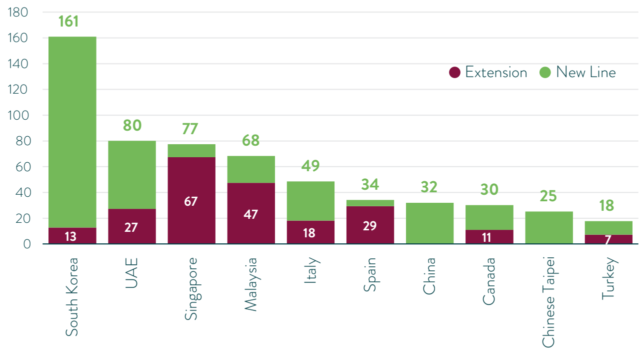


Figure 4: Top 10 countries/territories in building fully automated metros in the last 10 years, measured in km

At city level, Singapore remains the largest automated metro network, with 126km of automated lines (see Figure 5). After Dubai, Singapore has implemented one of the largest network expansions in the last decade (see Figure 6). With the exception of Lille and Paris, today's largest networks have also experienced the highest rates of growth in the last 10 years.

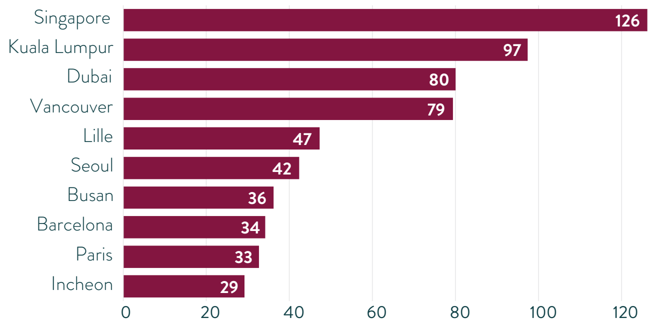


Figure 5: Top 10 cities with fully automated metros in operation, measured in km

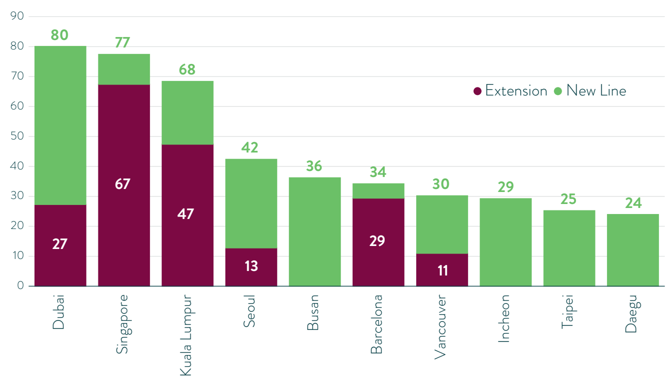


Figure 6: Top 10 Automated metro networks with largest growth in the last 10 years, measured in km

CHARACTERISTICS & TRENDS

CAPACITY

Initially deployed in low capacity lines, currently 75% of the world's automated metro infrastructure operate medium and high capacity trains, a trend that continues to accelerate (see Figure 7). Using train capacity as an indicator, most high capacity systems are deployed in Asia and Europe, and it is significant to note that this is the only typology present in Latin America (see Figure 8).

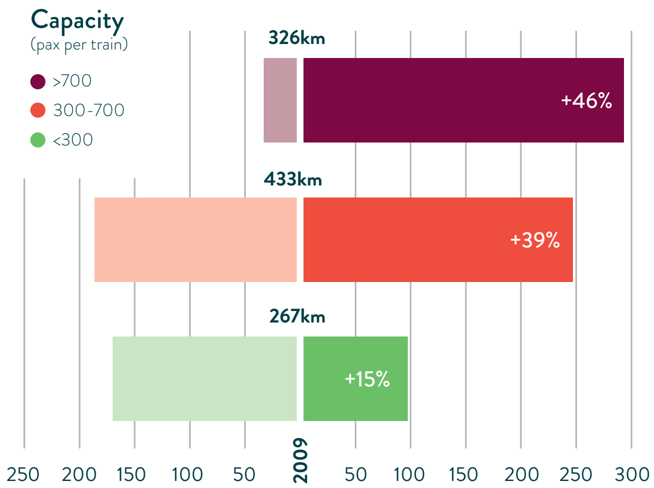


Figure 7: Automated metros per train capacity, measured in km, and inaugurated metros in the last decade, measured as a % of km

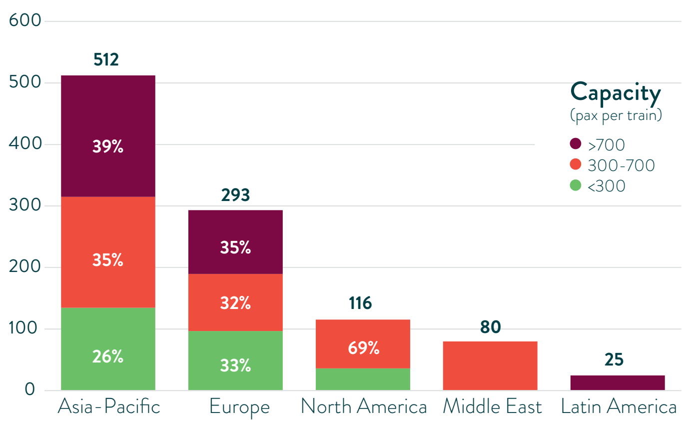


Figure 8: Automated metros per world region and per train capacity, measured as a % of km in operation

SIGNALLING TECHNOLOGY

Communications Based Train Control (CBTC) is the dominant signalling solution for fully automated metro lines: 72% of the world's km of automated metros are operated under CBTC systems (Figure 9). 87% of the fully automated metro infrastructure inaugurated in the last decade was equipped with CBTC.

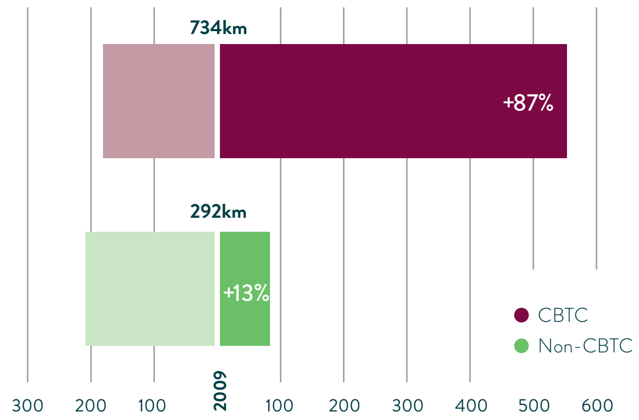


Figure 9: CBTC vs non-CBTC signalling solutions for fully automated metros, measured as km equipped and % of km inaugurated in the last decade

Thales remains the market leader for fully automated lines, with close to 330km of automated metro equipped, in its majority, in mid-capacity lines. Siemens follows with over 250km, of which approximately half corresponds to high capacity lines (see Figure 10).

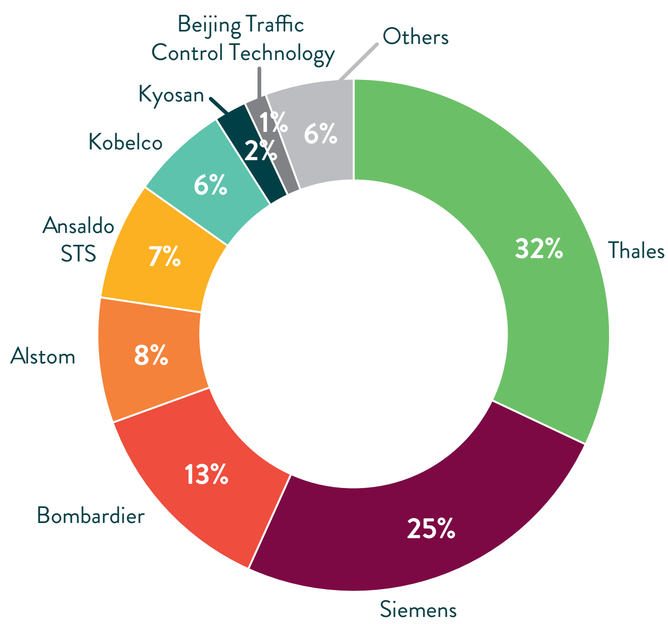


Figure 10: Signalling suppliers of fully automated metro lines, measured as % of km equipped

ROLLING STOCK MARKET

In 2018, 13 rolling stock suppliers share the market for fully automated metro lines. While Bombardier, Siemens and Alstom trains serve over 50% of the km of automated metro in operation (see Figure 11), the last two years also saw three new suppliers entering the market: CAF, CRRC Qingdao Sifang Co Ltd. and Changchun Railway Vehicles Co., Ltd/Norinco.

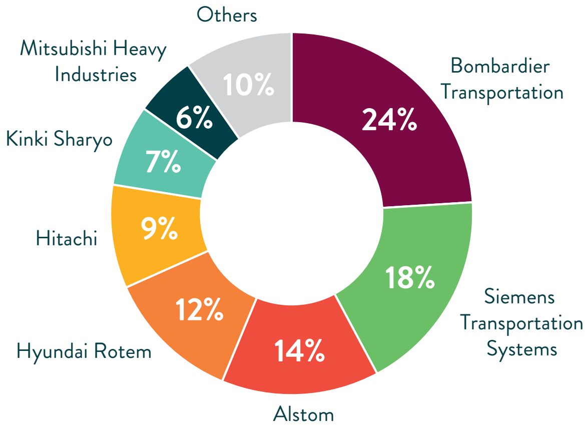


Figure 11: Automated rolling stock suppliers, measured as % of km equipped

CONSTRUCTION MODEL

Unlike conventional metro systems, where underground alignments remain predominant (67% of all stations), automated metro lines underground and elevated stations are almost equally split (see Figure 12). However, 60% of the stations inaugurated in the last decade correspond to underground alignments. When considering the wheel/rail interface system, a majority of lines opt for steel wheels, as opposed to rubber tyres: in the last decade, close to 75% of new automated metro infrastructure corresponded to steel wheel systems.

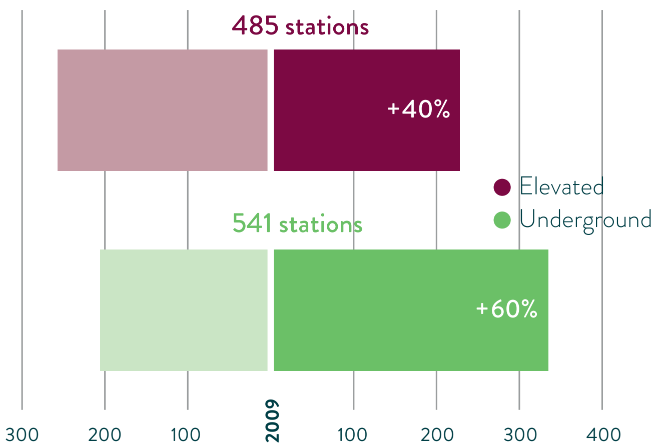


Figure 12: Construction model of automated metro lines (total number of elevated stations vs underground stations, and % of growth in the last decade)

PLATFORM TRACK PROTECTION SYSTEMS

Platform screen doors (PSD) remain the dominant solution over track intrusion detection systems (see Figure 13) to ensure the safety of the platform/track interface in fully automated metro lines. Currently, 77% of stations in automated metro lines in operation are equipped with platform screen doors (and 87% of the stations built in the last decade).

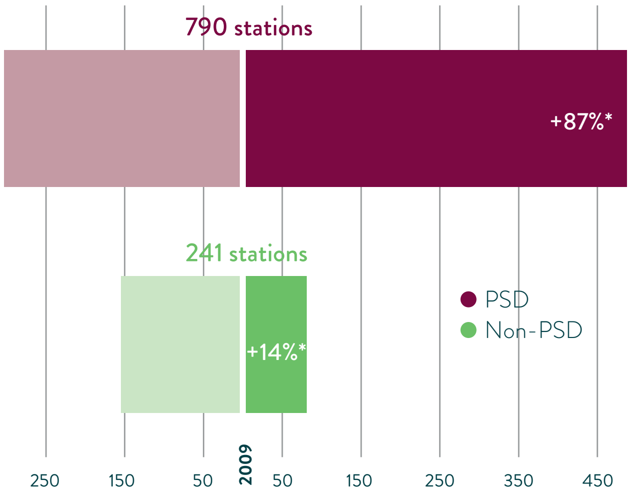


Figure 13: Platform Screen Doors vs. non-PSD (Total stations equipped & % of new stations in the last decade)

GROWTH

Fully automated metro lines represent 7% of the world's metro infrastructure in operation. This comparatively small figure is the outcome of a relatively short time span of exponential growth, especially when considering the 150 years of conventional metro history. In the 37 years since the implementation of the first automated metro line, their growth rate has accelerated with each passing decade, with 2018 marking a significant inflection point. In the next five years, it is expected that full automation will become the mainstream design for greenfield metro lines, increasing from the current share of 10% of km of metro infrastructure in planning and construction, to 48% by 2022.

In the next 5 years, a further 2,000km will be commissioned, tripling what it took 35 years to achieve so far.

* The percentages add up to more than 100% as five lines on Line 1 in Paris are equipped with both PSD and non-PSD systems.

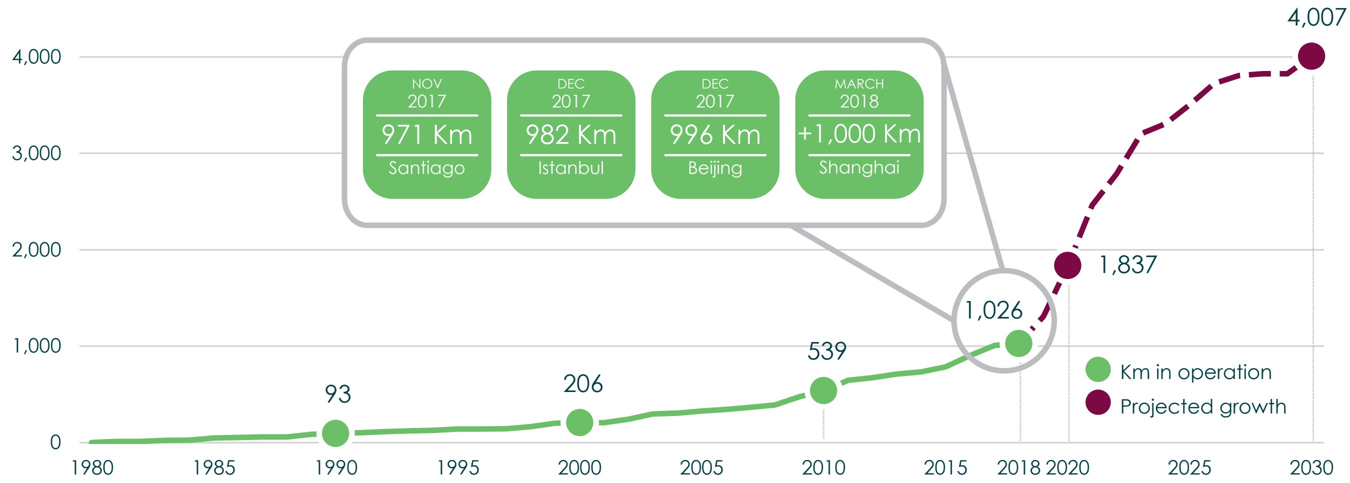


Figure 14: Total growth in Automated metros, measured as km in operation

Forecasts based on confirmed projects indicate that by 2028 there will be over 3,800km of automated metro lines in operation (figure 14). Most of this growth corresponds to the expected opening of 87 new lines, or extensions of existing lines, with conversion projects representing only under 7% of the new infrastructure, all of them in Europe (see box).

CONVERSION PROJECTS

Following the successful conversion projects of Nuremberg (2009) and Paris L1 (2012), seven European cities have confirmed conversion projects in the coming decade:

- Brussels, L1&5
- Glasgow, G. Subway
- London, Docklands
- Lyon, LA & LB
- Marseille, L1 & L2
- Paris, L4
- Vienna, U2/U5

These represent 7% of the projected growth, a relatively low percentage that can be attributed to the complexity of implementing full automation in an existing line while in operation. This difficulty, however, is not unique to full automation: brownfield re-signalling projects are also highly challenging.

With over 140 metro lines inaugurated in the 70s and 80s reaching critical asset replacement needs, the comparative advantages of full automation (see the Automation benefits section) should weigh increasingly in the strategic choices that networks face when considering these modernisation programmes. It is therefore expected that the market for conversions will grow.

The largest share of the growth will be located in Asia, which is set to quadruple the number of km in operation in the next decade and represents, on its own, half of the projected growth. This is mostly thanks to the explosive emergence of automated metro projects in China (see China in Focus section).

At a relative distance follow MENA and Europe (see figure 15). In 2028, Asia is expected to represent 53% of the world's km of automated metro, followed by Europe (21%) and the Middle East (15%).

Figure 15: Current length of automated metro lines and projected growth for the next decade, per world region

CHINA IN FOCUS

Following the inauguration in December 2017 in Beijing of China's first fully automated metro line built with domestic technology, Chinese cities have embraced full automation for their growing networks. A further 37 metro lines are designed for full automated operation are planned to open in the coming five years.

By 2023, it is expected that 19 networks in mainland China will have 40 lines designed for full automation, totalling over 1,200km and 861 stations. In keeping with Asian metro trends, these lines will be relatively long (average of 32.5km, above the Asian metro line average of 26km), with long inter-station distances (1.4km).

This development is supported by a government policy comprising the following elements:

- Mandatory CBTC for metro signalling
- Reservation of exclusive bandwidth 2.4 GHz for metro CBTC applications
- Commissioning a consortium of Chinese universities to prepare interoperable CBTC specifications, fostering a competitive domestic market

As of 2018, five Chinese CBTC suppliers have in their portfolio GoA2 systems, however with the opening of the Yanfang line in December 2017, they have demonstrated their ability to supply the GoA4 market. The appetite is reflected in the above figures, with only a few projects involving global traditional suppliers.

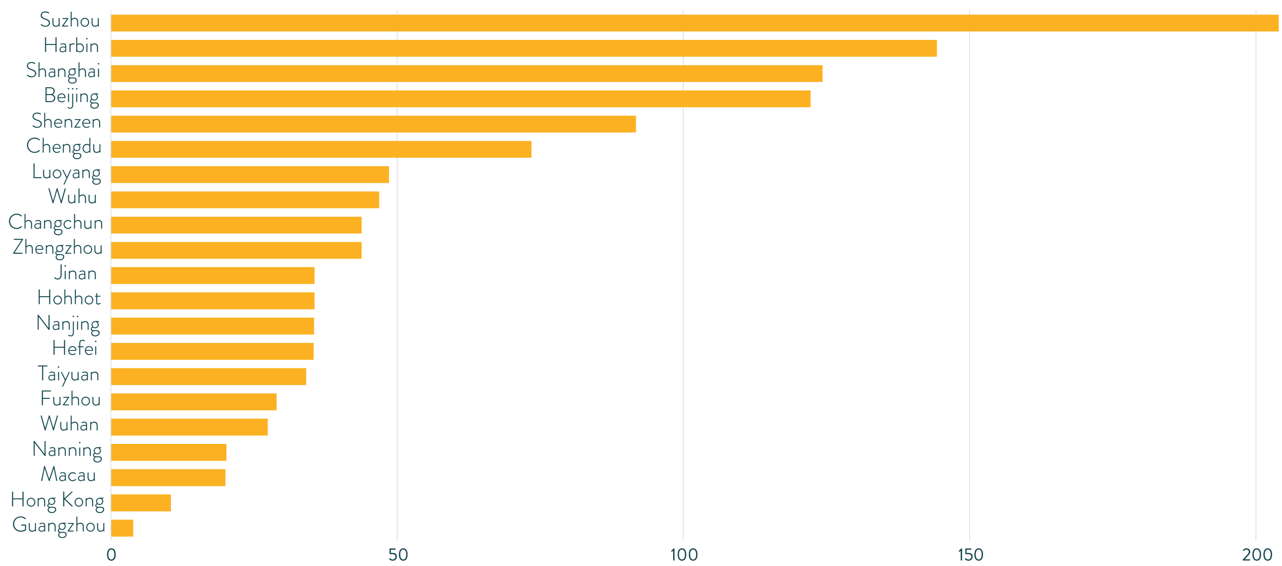


Figure 16: Expected automated metro lines in operation in mainland China by 2023, measured in km

THE CASE FOR AUTOMATION

At the forefront of innovation, automation must however be understood not as a purely technological project, but as a company project. In the wake of the digitalisation wave and the new smart mobility scenario, automation provides companies with a lever to attain strategic goals linked to a more human, customer orientated and flexible service.

According to the analysis of the experienced networks of the UITP Observatory of Automated Metros, full automated operation (FAO) supports these goals facilitating improved performances in five key areas that are essential to any metro network: improve the mobility offer, enhance safety, contribute to the economic balance of the system, reduce its ecological imprint and provide improved customer service while enhancing staff satisfaction.

BENEFITS OF FULLY AUTOMATED METRO OPERATION

*Figure 17: The five key benefits of fully automated operation declined in 10 areas, as identified by the experts of the Observatory of Automated Metros**

DEFINITION AND METHODOLOGY

This Statistics Brief exclusively covers fully automated metro lines, defined as those metro lines designed for operation without staff on board of the trains - a defining characteristic is the absence of a driver's cabin on the train. This type of operation is also known as Unattended Train Operation, or Grade of Automation 4 in standard IEC 62267 (see table below). Moreover, only lines in public transport service have been considered.
Metros are high capacity urban rail systems, running on an exclusive right-of-way. Metro lines included in the above statistics run with trains with a total capacity of at least 100 passengers per train. Systems based on monorail or Maglev technology are included if they meet all other criteria.
Infrastructure growth predictions are based on published information for confirmed projects.
The data in this Statistics Brief is sourced from the database of automated metro lines of the UITP Observatory of Automated Metros. The figures presented are constantly reviewed in light of additional information and as such, some of the historical data presented in this publication may slightly differ from previously published ones. The Observatory gathers the world's leading operators with experience in full automated metro operation. It exchanges best practices in key issues affecting automated metro operation and monitors the global evolution and trends on this field.

For more information on the Observatory work, and further content on metro automation, consult the Observatory website: www.metroautomation.org

Grade of Automation	Type of train operation	Setting train in motion	Stopping train	Door closure	Operation in event of disruption
GoA1	ATP* with driver	Driver	Driver	Driver	Driver
GoA2	ATP and ATO* with driver	Automatic	Automatic	Driver	Driver
GoA3	Driverless	Automatic	Automatic	Train attendant	Train attendant
GoA4	UTO	Automatic	Automatic	Automatic	Automatic

**ATP - Automatic Train Protection; ATO - Automatic Train Operation*

* For a more detailed analysis, refer to the Metro automation benefits Knowledge Brief (planned for release by June 2019).

This is an official Statistics Brief of UITP, the International Association of Public Transport. UITP has more than 1,600 member companies in 99 countries throughout the world and represents the interests of key players in this sector. Its membership includes transport authorities, operators, both private and public, in all modes of collective passenger transport, and the industry. UITP addresses the economic, technical, organisation and management aspects of passenger transport, as well as the development of policy for mobility and public transport worldwide.

This Statistics Brief was prepared by the Observatory of Automated Metros.
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