Internet connectivity in underground rail systems

Author(s): Veronika RUDNENKO, Laurent DAUBY

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CONTENT

1. INTRODUCTION

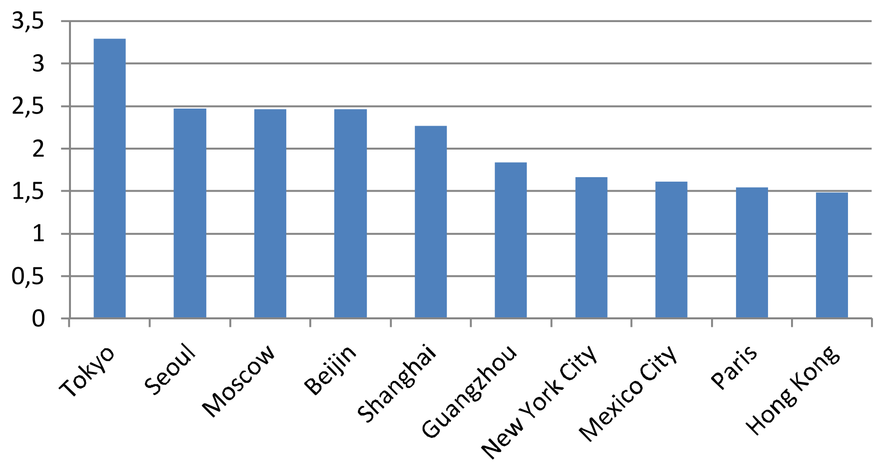
The number of metro networks in the world continues to grow. Since the beginning of new millennium, more than 45 new systems have started service. Rapid development, together with a high level of service and convenience, makes it a very popular and effective urban transport mode.

Today, 148 cities have a metro, for a total of over 9,000 stations and 540 lines and 11,000 kilometers of lines. More than 150 million passengers travel on metros every day, i.e. 45 billion trips per year.

The major part of the world's metro networks is located in Asia and Europe (50 and 45 networks respectively), followed by other regions: 16 in Eurasia, 16 in Latin America, 15 in North America and 6 in the Middle East and North Africa (MENA) region.

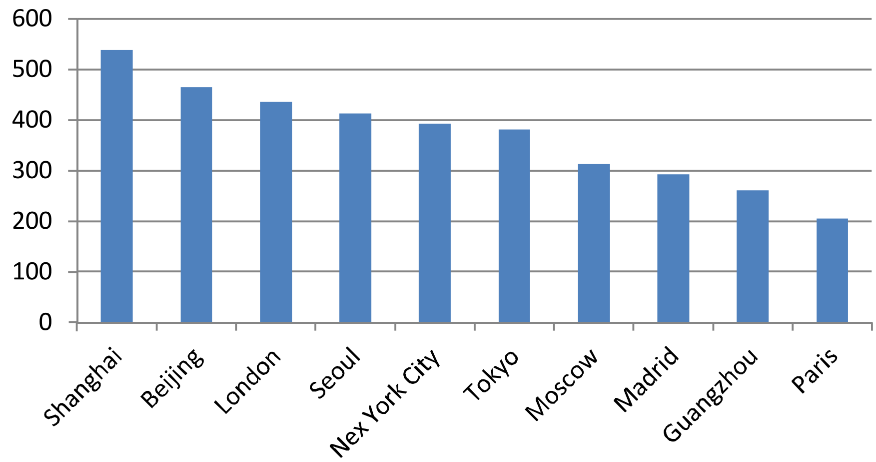
6 out of the 10 busiest networks worldwide belong to the Asian region (Tokyo, Seoul, Beijing, Shanghai, Guangzhou and Hong Kong). The other 4 systems are evenly distributed between Eurasia (Moscow), North America (New York City), Latin America (Mexico City) and Europe (Paris) (Figure 1).

Figure 1: Top 10 busiest networks in the world (million passengers per year)



Unsurprisingly, half of top 10 cities with longest networks belong to Asia (Shanghai, Beijing, Seoul, Tokyo, and Guangzhou). The complete top 10 is shown on Figure 2.

Figure 2: Top 10 cities in networks length in the world (kilometers)



2. METROS AND CONNECTIVITY : OBJECTIVES OF THE STUDY

Together with the expansion of metro systems, the level of service offered is growing as well. Service providers are constantly developing new options to improve the comfort and convenience of passengers and attract more users to the networks. Travelers' expectations today are getting ever more demanding: urbanites are a mobile and hyper-connected community. They do expect a seamless surfing experience when they are travelling. As a consequence, Internet connectivity in the underground transport infrastructure is becoming a subject of paramount importance.

In the last decade, mobile phone communication platforms and signal in metros have experienced rapid growth. With the evolution from conventional mobile phones to smart devices (phone, tablets etc) people expect uninterrupted and fast broad-band connection for their multiple devices at any location, including underground metro stations and trains.

The rapid development of this service and absence of comprehensive research triggered this study, in partnership with New Cities Foundation. The main purpose is to give a general overview of internet access in metros in order to "map" current practices and to depict evolution of future trends in this fast evolving subject.

The study makes a distinction between stations and trains. The reason is that the technicalities and operating conditions to deploy broad-band services are different: stations are confined (by definition stationary) environment while trains are mobile assets, "covered" by ground-based equipment (terminals, antennas, leaky cables etc) installed along the tunnels. And in fact, the study shows that not all metro networks provide connectivity service for their whole system. A number of metros offer Internet connectivity either in stations, or on trains.

This research is based upon a questionnaire distributed to all metro operators worldwide as well as upon additional information originating from telephone follow-up one-to-one discussions.

The collected data is presented in an aggregated way by group of countries. There are six regions:

- Asia-Pacific
- Eurasia
- Europe
- Latin America
- MENA
- North America

3. SURVEY RESPONSE

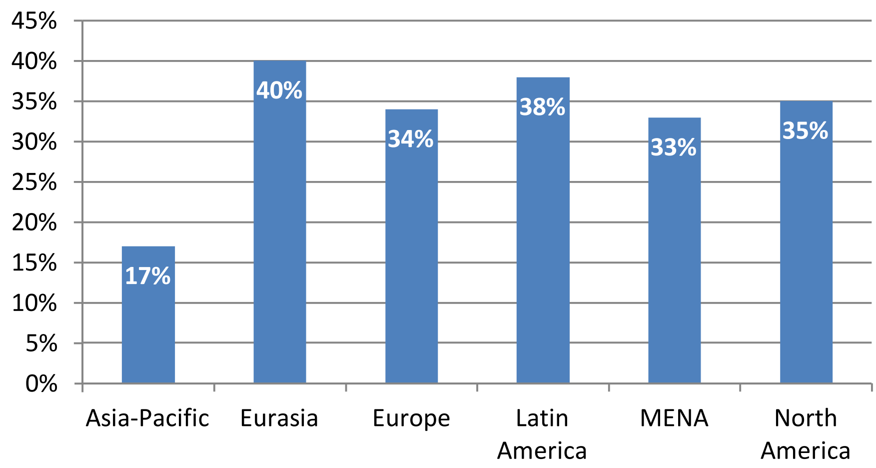
A total of 48 metro systems from 28 countries took part in this research (see Table 1). They are distributed between 6 geographical regions in the following way:

- Asia-Pacific – 11 systems
- Eurasia – 6 systems
- Europe – 17 systems
- Latin America – 6 systems
- MENA – 2 systems
- North America – 6 systems

Table 1: Participating countries per region

Region	Participating countries
Asia-Pacific	China, India, Japan, Korea, Singapore, Taiwan, Thailand
Eurasia	Kazakhstan, Russian Federation, Ukraine
Europe	Belgium, Czech Republic, Denmark, France, Germany, Greece, Italy, Netherlands, Spain, United Kingdom
Latin America	Argentina, Brazil, Chile, Mexico
MENA	Iran, United Arab Emirates
North America	Canada, USA

Figure 3: Participating metro systems per region (%age from total in region)



These percentages reflect the response rate from each region. The survey results cover 32% of all metro networks in the world. However, it does include the largest systems in terms of patronage, line length and total number of stations (see Table 2), and therefore the study can be said to reflect the reality of more than half of world metros. It allows to assess the current situation of the most progressive metro systems and to draw an outline of future development. Indeed, these larger companies are generally more advanced and are often acting as "trend-setters/leaders" in their respective regions or even internationally.

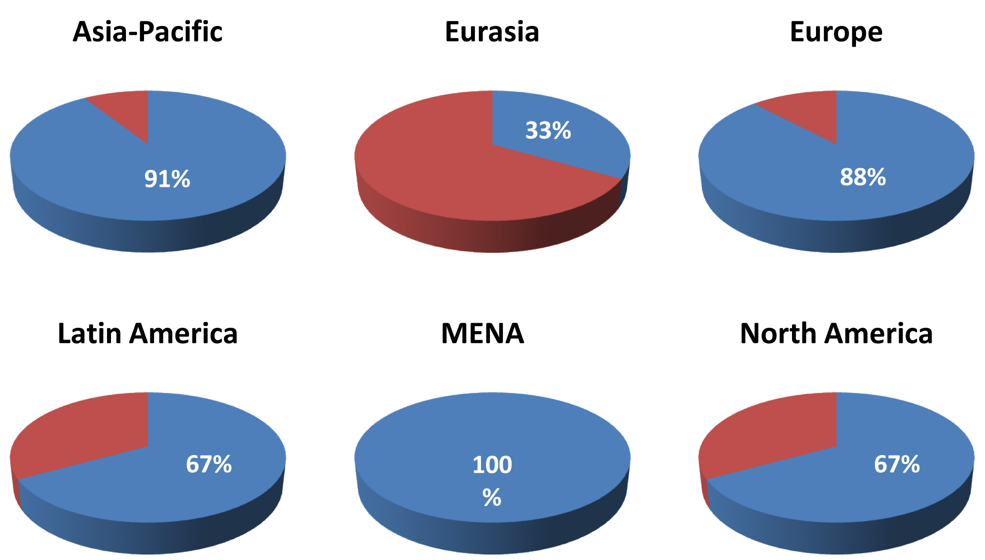
Table 2: Qualification of survey feedbacks

	Responses / total metros	Passengers ratio (% of the total patronage)	Line length ratio (% of the total network length)	Station numbers (% of the total station numbers)
Asia-Pacific	17%	56%	40%	40%
Eurasia	40%	67%	59%	57%
Europe	34%	67%	56%	63%
Latin America	38%	59%	63%	68%
MENA	33%	33%	57%	48%
North America	35%	97%	50%	61%
Total	**32%**	**62%**	**49%**	**53%**

4. SURVEY RESULTS

77% of metro systems surveyed provide some level of Internet access in their underground installations (37 systems). This can be full or partial coverage. It can also be through mobile network and/or Wi-Fi. Figure 4 shows the distribution among the 6 regions.

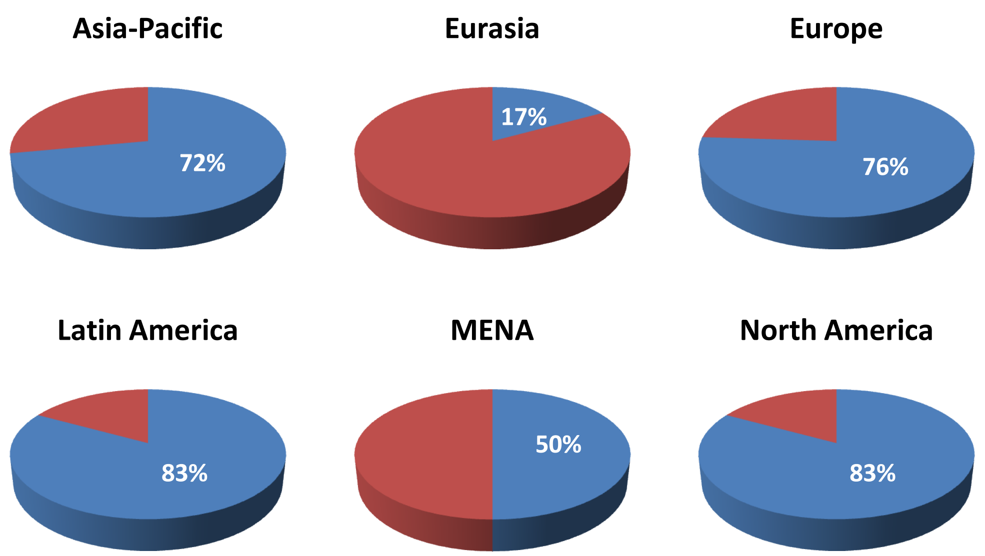
Figure 4: Metro operators offering Internet connection per region (in blue, systems with internet connection)



Results for MENA and Asia may be influenced by the lower number of systems in the sample, but above all, it reflects their more recent construction, as opposed to older networks in Europe or North America where the systems were predominantly built before 1980 (56 systems) or even before World War II (18 systems).

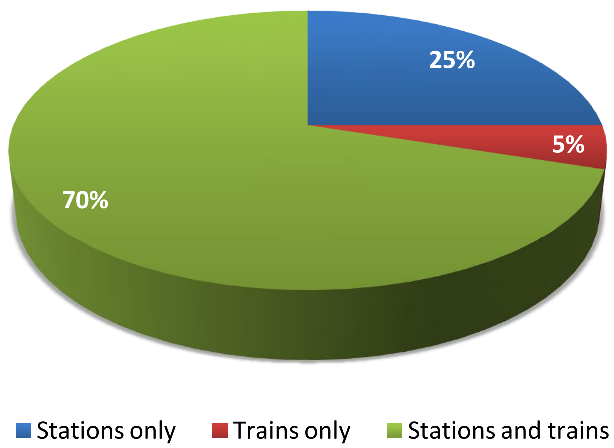
Among metros offering no or only partial internet access, 69% of the operators surveyed plan to provide or expand broadband connectivity in the next 1-3 years. Figure 5 shows the distribution among the 6 regions.

Figure 5: Metro operators planning to offer/expand Internet connection per region (in blue, the percentage of systems planning to offer internet connection)



The deployment strategy of broad-band connectivity is not the same for all metros: some provide it in stations, on trains, or both (see Figure 6).

Figure 6: Global distribution of broad-band connectivity coverage

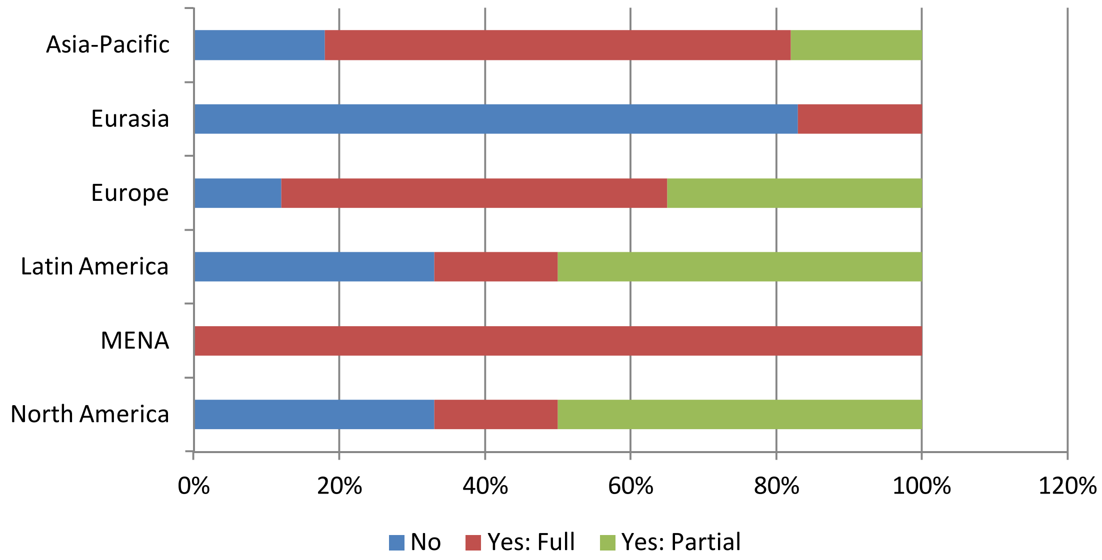


4.1 CONNECTIVITY IN STATIONS

A specific analysis of broad-band availability in metro stations shows that 73% of metros offer Internet connectivity to their passengers in underground stations. 60% (21 systems) offer broad-band connectivity in all stations and 40% (14 systems) only in selected stations.

4.1.1 Current situation

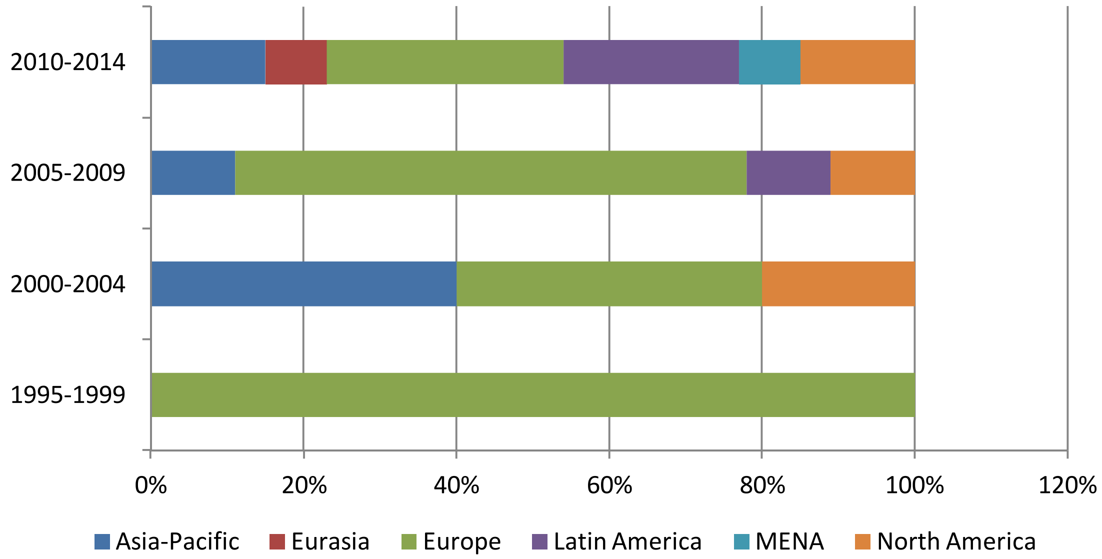
Figure 7: Number of networks offering Internet connectivity in underground stations



MENA, Europe and Asia-Pacific are the most advanced regions, with a maximum of 15% not offering connectivity. In the Americas, this proportion doubles to 30% while in Eurasia, a large majority of systems do not offer any coverage (yet). Trends from Figure 7 do not seem to point towards a rapid change.

Among metros offering connectivity, it is possible to observe an evolution of the technologies deployed over time by comparing the initial and the current situation.

Figure 8: Regional breakdown of connectivity launch over time (number of systems in regions per 5-year period)



Europe and Asia were the first regions to decide to deploy mobile and/or Wi-Fi connectivity in their underground assets as early as the mid-90s or early days of 2000's. The Americas followed in the middle of the last decade, while Eurasia and MENA just recently begun.

Figure 9: Type or level of connectivity provided initially (both full and partial coverage)

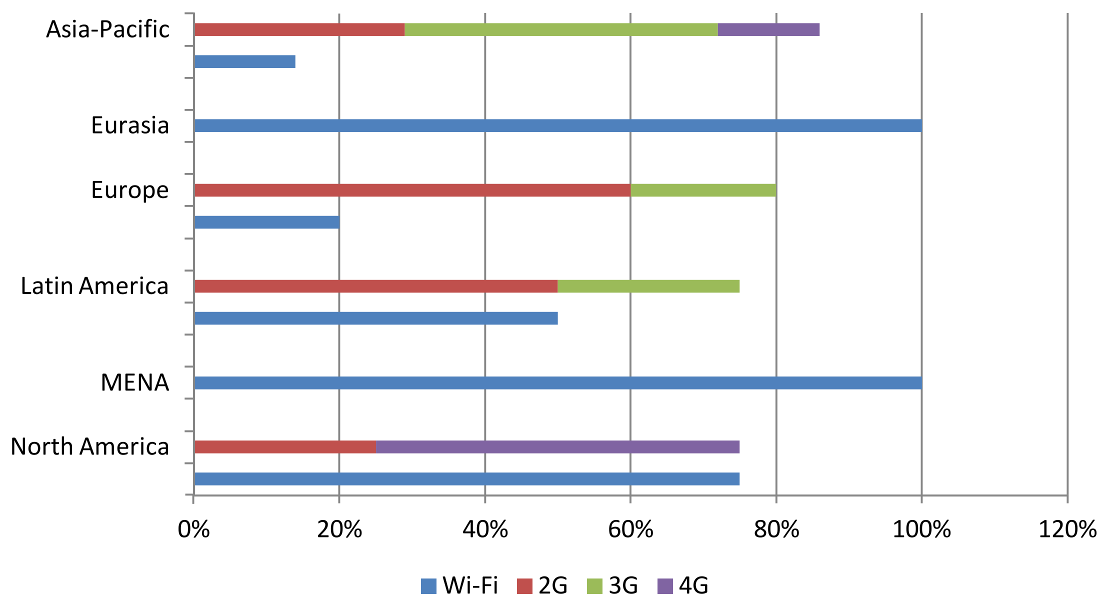
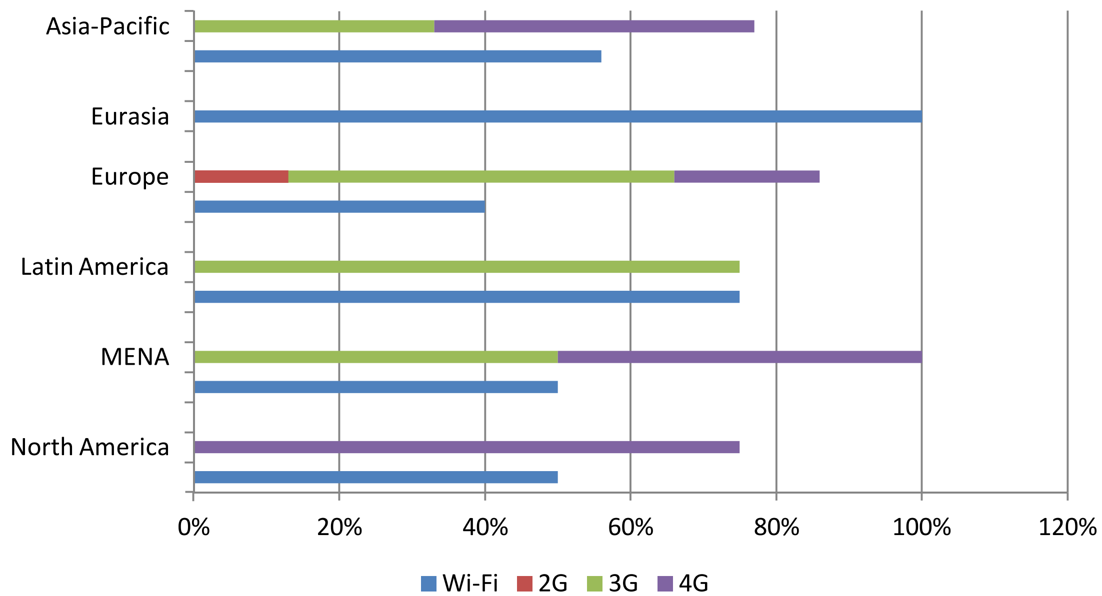


Figure 10: Type or level of connectivity provided currently (both full and partial coverage)



As European and Asian metros were the first to equip (see Figure 8 above), it is not surprising that they feature a higher proportion of older generation technologies. The Americas, which started later, had an opportunity to start with the latest mobile generation.

In 2014, 3G and 4G mobile communication have unsurprisingly established themselves everywhere.

40% of metros offer connectivity only in selected stations. They were clustered in four groups reflecting low, medium-low, medium-high or high connectivity coverage as of today.

Table 3: Partial Internet connectivity coverage in stations

%age of total stations with connectivity	Cities
<25%	Marseille, Athens, Rotterdam, Rio de Janeiro, Vancouver, New York City
25-50%	London
50-75%	-
>75%	Buenos Aires, Sao Paolo, Philadelphia

Full coverage (100% of stations) is provided by 60% of metros.

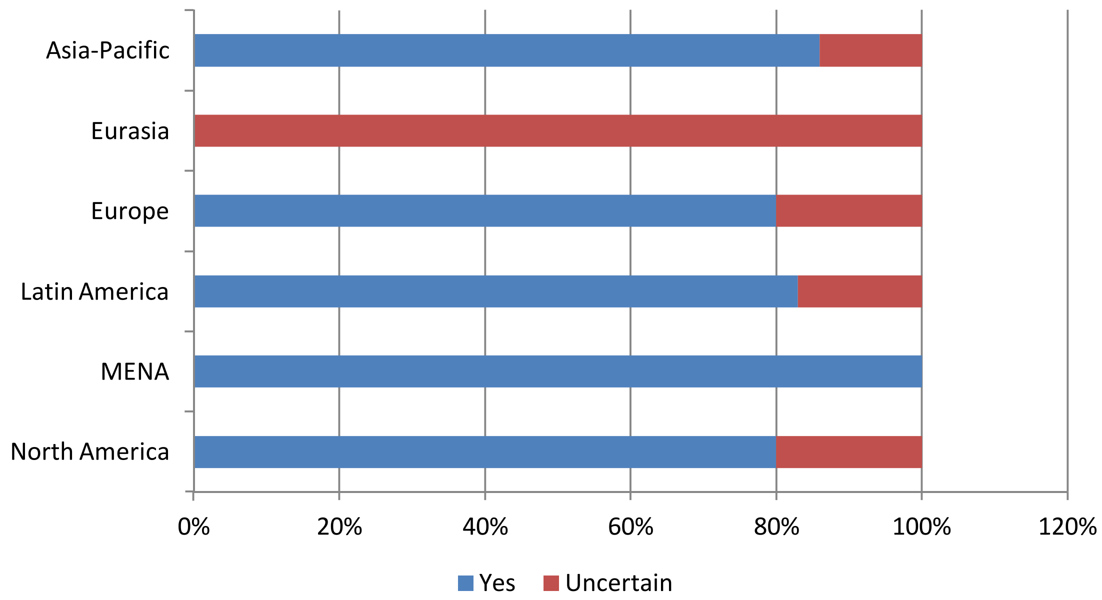
The analysis of the evolution of connectivity type over time shows that Wi-Fi is still gaining in popularity. As far as mobile communication is concerned, the newer mobile communication generations are logically gaining ground to the detriment of the older ones.

Table 4: Change in tendency of different connectivity types provision in stations

Type/level of connectivity	Wi-Fi	2G	3G	4G
Provided initially	36%	42%	21%	9%
Provided currently	51%	6%	43%	31%
%age change	+41%	-86%	+104%	+244%

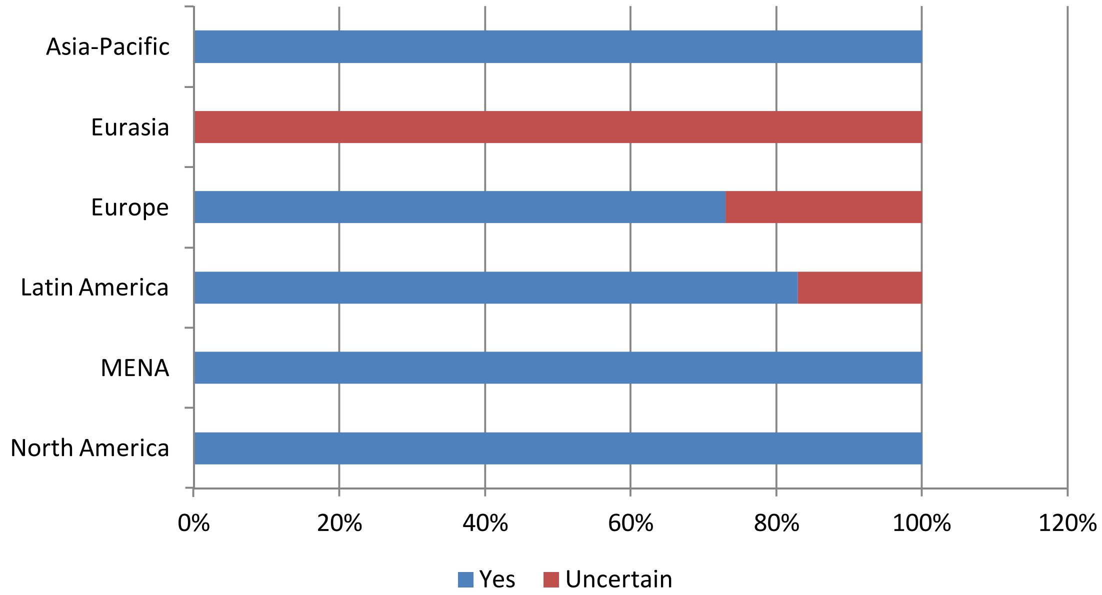
4.1.2 Perspectives for the future

Figure 11: Number of metro operators planning to install Internet connectivity equipment in their existing underground stations (next 1-3 years) per region



With the exception of Eurasian operators, a very strong majority of metros plan to increase their efforts to expand broad-band connectivity in existing stations in the coming 1-3 years.

Figure 12: Number of networks planning to design new underground stations with Internet connectivity equipment (next 1-3 years) per region



In the future, most new metros stations will be designed from scratch as "digital stations", with the exception of Eurasia, where the uncertainty level is very high.

4.2 CONNECTIVITY IN TRAINS

58% of metros offer Internet access to their passengers during their ride on metro trains. Among these, 71% (20 systems) offer broad-band connectivity on all their lines, while 29% (8 systems) offer it only on some lines. These are lower levels than for stations, due to technical complexity and higher installation costs.

4.2.1 Current situation

Asia and MENA are the most advanced regions in provision of on-board connectivity. Europe and the Americas follow, but it should be noted that the level of connectivity on trains is significantly lower than in stations. In Eurasia, on-board connectivity is at similarly low level as for stations.

Figure 13: %age of networks offering Internet connectivity in trains per region

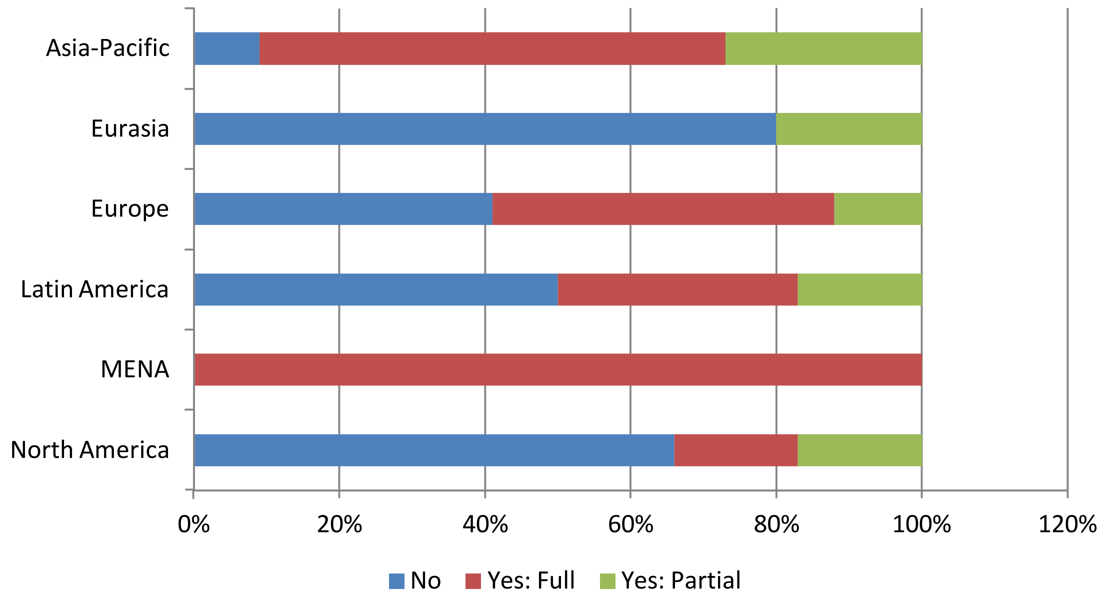
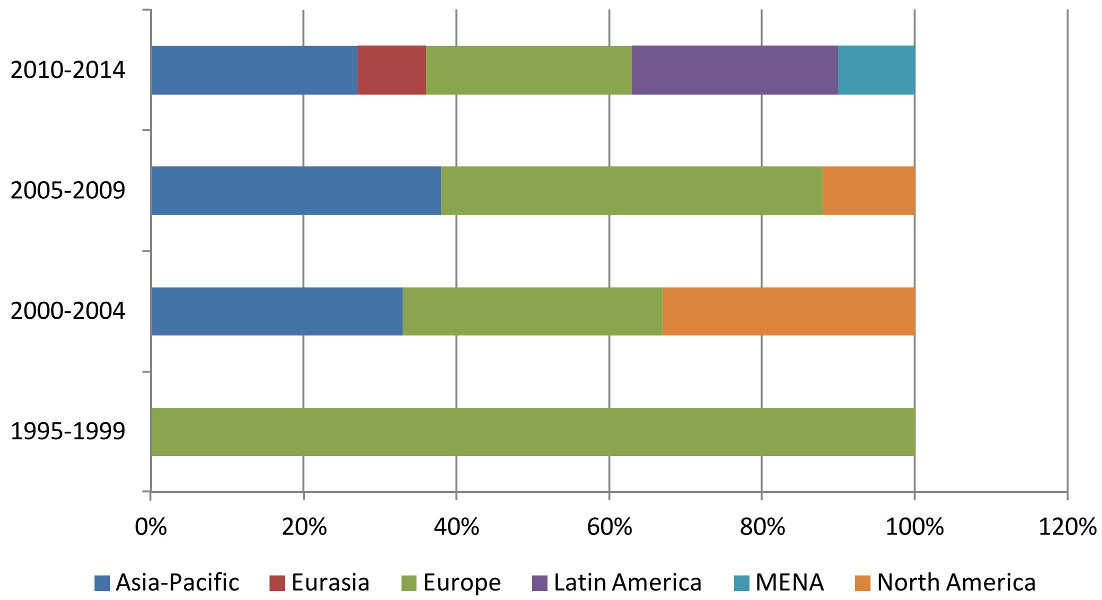
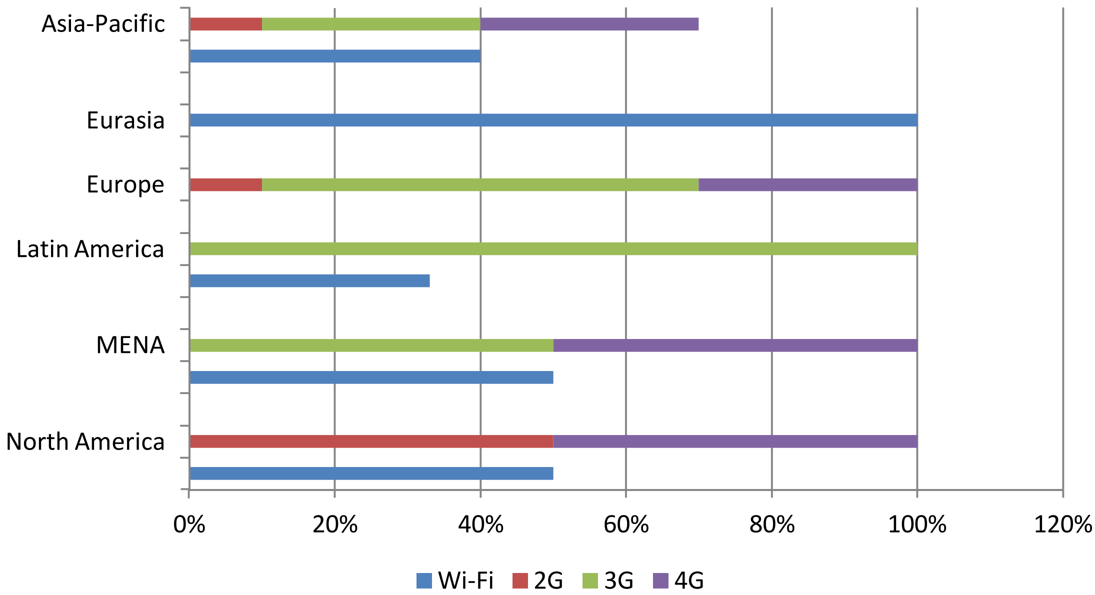


Figure 14: Regional breakdown of connectivity launch over time (number of systems in regions per 5-year period)



With regard to stations, Europe and Asia were also the first regions to provide on-board connectivity as early as the mid-90's or early 2000's. They were followed by North America in the middle of the last decade while MENA, Latin America and Eurasia have just recently started.

Figure 15: Type or level of connectivity (both full and partial coverage)



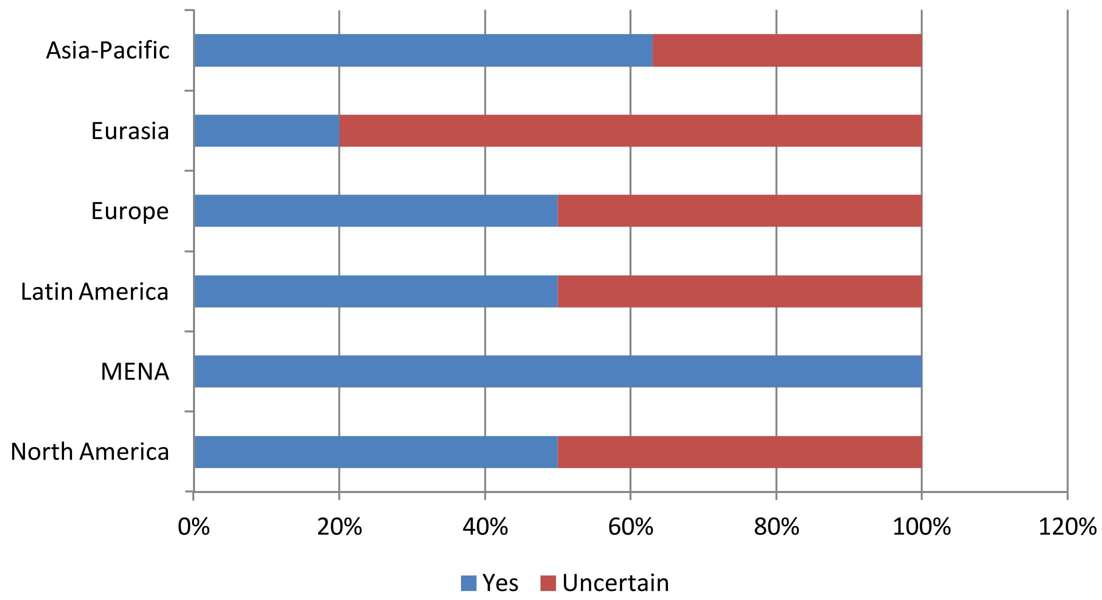
29% of metros offer on-board connectivity only in part of their tunnels. As can be expected, this is the case for some of the longest metros. They are clustered in four groups reflecting current levels of low, medium-low, medium-high or high connectivity coverage.

Table 5: Partial Internet connectivity coverage in trains

%age of total lines with connectivity	Cities
<25%	-
25-50%	Moscow, Vancouver
50-75%	Barcelona
>75%	Beijing, Buenos Aires
Unspecified	Bangalore, Rotterdam, Tokyo

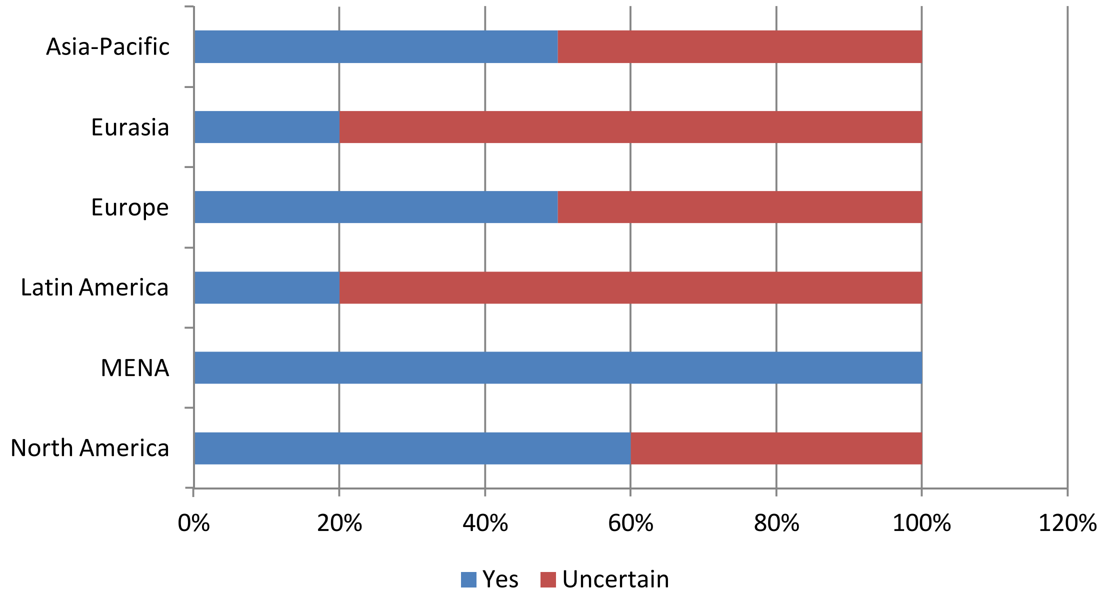
4.2.2 Perspectives for the future

Figure 16: Number of networks planning to install Internet connectivity equipment in existing underground lines (next 1-3 years) per region



With the exception of Eurasia, a slight majority of metros plan to increase their efforts to expand broad-band connectivity in tunnels in the coming 1-3 years, but the level of certainty is lower than for stations. Strangely, the level of uncertainty for the design of new lines or line extensions features an equally high level of uncertainty, except for Latin America (less certain).

Figure 17: Number of networks planning to design new underground lines with Internet connectivity equipment (next 1-3 years) per region



4.3 WI-FI CONNECTION

Wi-Fi broad-band supply has been quite popular over the past years, as it can provide free-of-charge complimentary access to internet for users in a given geographic space.

Wi-Fi is easy and fast to install in stations. It is more challenging to install on trains because of the relatively low power signal derived from leaky cables that requires base stations to be installed at intervals of 300-500 m to support uninterrupted connectivity.

In addition, quality of Wi-Fi connection is affected by the number of users logging on the system. With the multiplication of MB/s-hungry applications and internet use, Wi-Fi restrictions may turn out to be a necessary step for metro operators to take.

In addition to strictly technical reasons, it was also mentioned that providing too comfortable internet access in metro stations could encourage travelers to loiter in stations, which can hamper rapid passenger boarding and the fluidity of crowd movement required, especially in rush hours.

60% of metros currently have Wi-Fi restrictions in place and a slight increase is expected in the coming years. One of the possible reasons is the rapid development of mobile technology. Increased use of smartphones and "bandwidth hungry applications" has led to rapid growth in mobile data traffic volumes (e.g. video streaming). People watching videos and listening to music via their phones use higher amounts of mobile data than other users.

Different types of Wi-FI restrictions are aimed at controlling the amount of data consumed by a user. The types of restrictions and tendency of their application in the future is shown on the Figure 18.

Figure 18: Application of Wi-FI restrictions. Current situation and future perspective

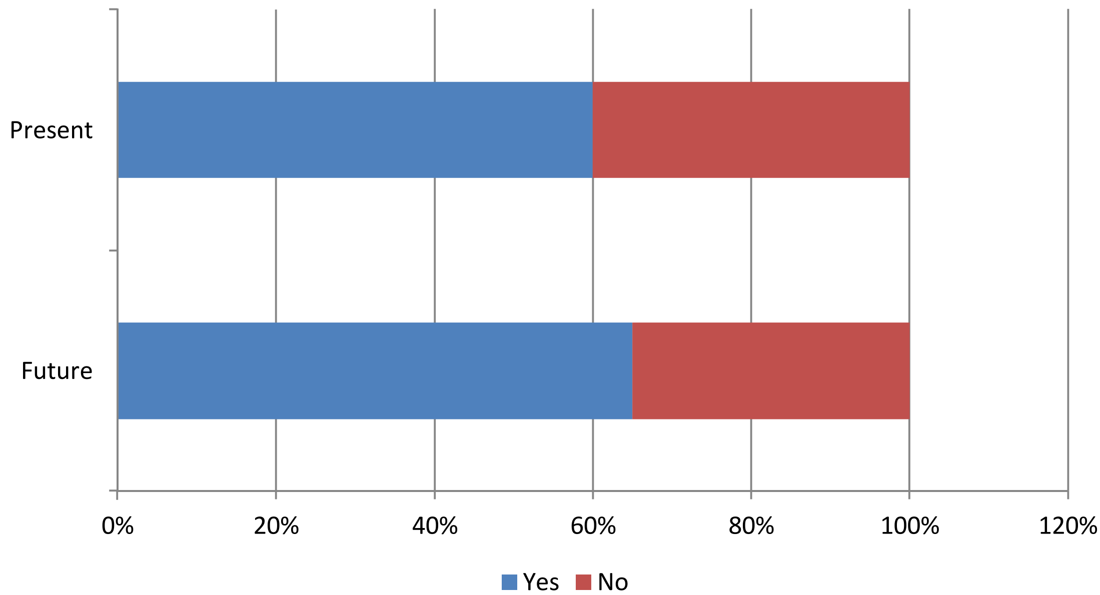
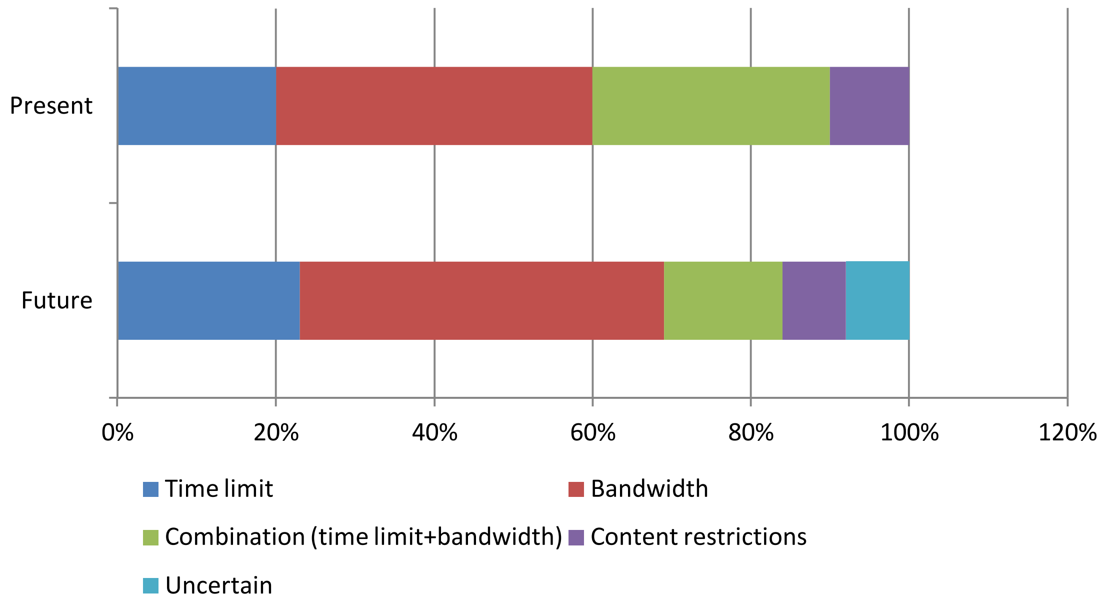


Figure 19: Types of restriction in use. Current situation and future perspective

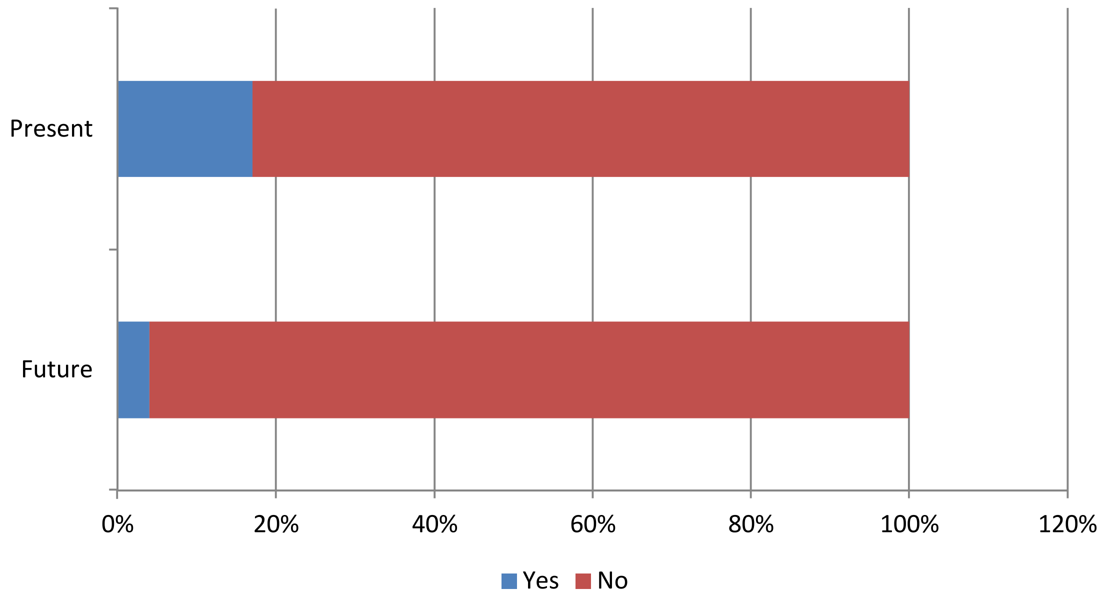


Bandwidth restriction ranges between 512 kbps and 1Mbps. Time restriction ranges between 15 and 60 minutes per day. DLR is London has a tight policy on the content of visited sites[1].

Today 90% of metros with Wi-Fi facilities are offering the service free-of-charge, and this trend is expected to be confirmed in future.

[1] access is filtered at the ISP level so that following types of sites are blocked: Suicide, Self-harm, Pro-Anorexia and Eating disorders Discriminatory language Encouragement of Drug Use Repeated / aggressive use of *** words, Pornography, Violence and Gore restriction).

Figure 20: Wi-Fi usage fee. Current situation and future perspective

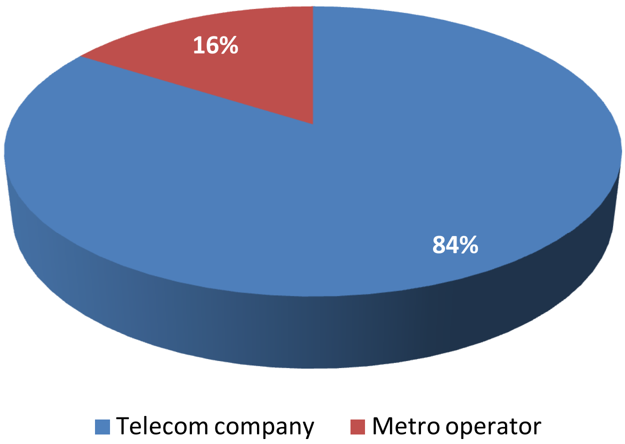


4.4 BUSINESS MODEL AND TELECOM PROVIDERS

The dominant model for investment and installation of the broad-band connectivity in metro infrastructure is the telecom investors, at least for mobile communication coverage. The model is expected to remain stable in the next few years.

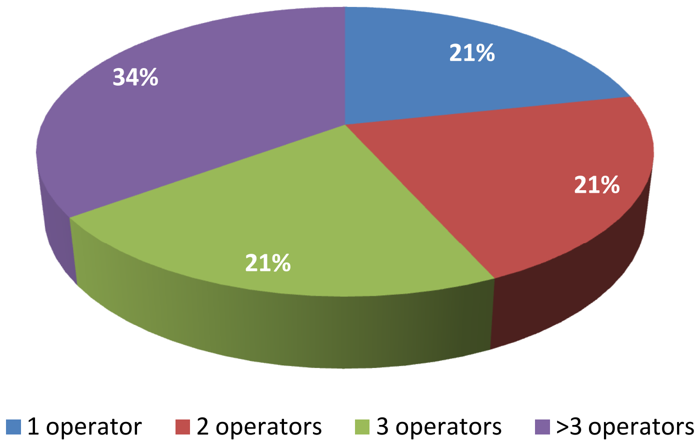
When specific arrangement was mentioned for Wi-Fi, the model tends to be implemented by a more "local" stakeholder such as the metro company itself or the city government.

Figure 21: Suppliers of infrastructure and services



Where mobile communication is available, 78% of metros offer multiple-operator access. Only 22% of metros are in a "monopoly" relationship with a single telecom provider (Figure 22).

Figure 22: Number of mobile operators offering connectivity in the system



5. CONCLUSIONS

Urbanites are a mobile and hyper-connected community. Today, the expectations of travelers are increasing. Passengers expect a seamless surfing experience when travelling. As a consequence, Internet connectivity in the underground transport infrastructure is becoming a subject of paramount importance.

According to the results of the research, 77% of the metro systems surveyed provide some level of Internet access in their underground installations, either in stations (73%) or on board metro trains (58%).

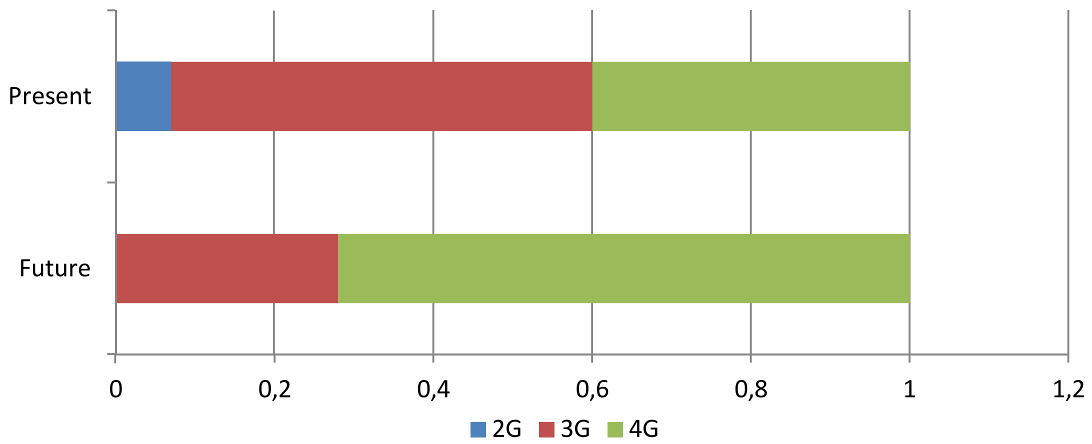
In the future, 68% of metros definitively plan on increasing their efforts to expand broad-band connectivity over their existing stations in the coming 1-3 years, while only 5% do not.

Over the past years, Wi-Fi broad-band has been quite popular as a channel for connectivity in 51% metros (and will continue to grow up to 72%), as it can provide free-of-charge complimentary access to internet for users in a given geographic space. Now, only 17% of metros charge their passengers for the use of Wi-Fi, and in the next 1-3 years this number should decrease to 4%.

60% of metros apply Wi-Fi restrictions today and a slight increase is expected in the coming years. The dominant business model for investment and installation of the broad-band connectivity in metro infrastructure is the telecom investors, at least for mobile communication coverage. The model is expected to remain stable in the next few years.

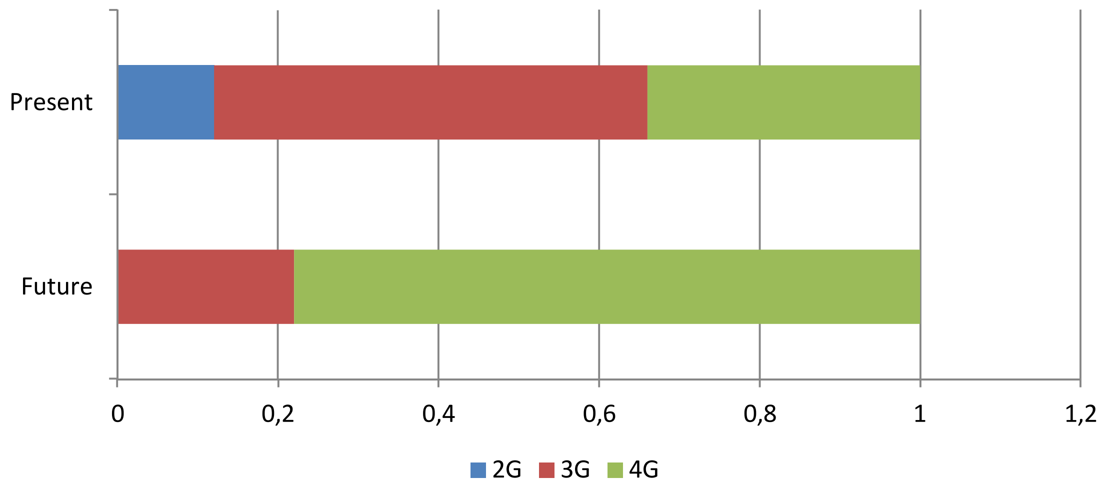
5.1 STATIONS

Figure 23: level of mobile Internet connectivity in underground stations. Current situation and future perspective



5.2 TRAINS

Figure 24: level of mobile Internet connectivity in underground train lines. Current situation and future perspective



For both stations and trains, the trend is evident for the increased provision of 4G level of mobile connection, paralleled by a drop of 2G and 3G technologies. For stations, the increase in connection is 4G is 85%. For trains, the value is 129%.