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Meeting the needs of all users in the 6 GHz band

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A detailed report on the 6 GHz band is available

If you would like to receive free of charge the report with the methodology and analysis to assess the impact of an IMT identification of 6GHz spectrum, please send me an email.

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Agenda

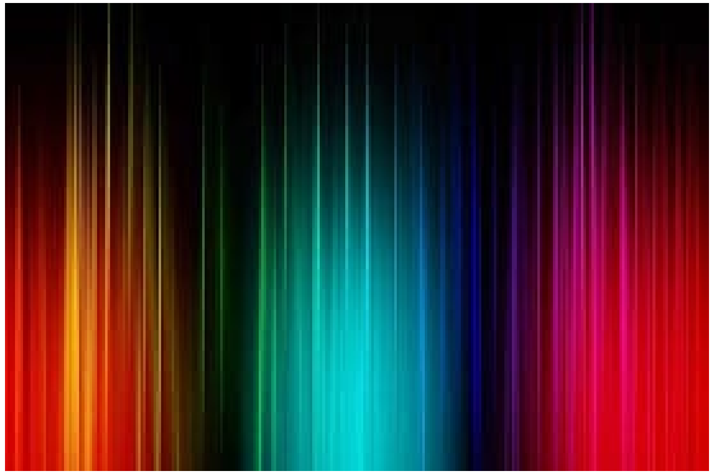
1. Examining the need for IMT spectrum to realise the 5G vision
2. Modelling demand for area traffic density
3. Modelling area traffic capacity
4. Demand for area traffic density and supply of area traffic capacity in five cities
5. The role of the 6 GHz band outside cities
6. IMT (5G mobile) vs. unlicensed (Wi-Fi) use of the 6 GHz band
7. Sharing with incumbents
8. Summary of key findings

Examining the need for IMT spectrum to realise the 5G vision

- The deployment of 5G will bring large benefits to mobile services and users over the coming years.

- We examine whether there is a need for more spectrum for IMT to achieve the 5G vision in developed and developing markets.

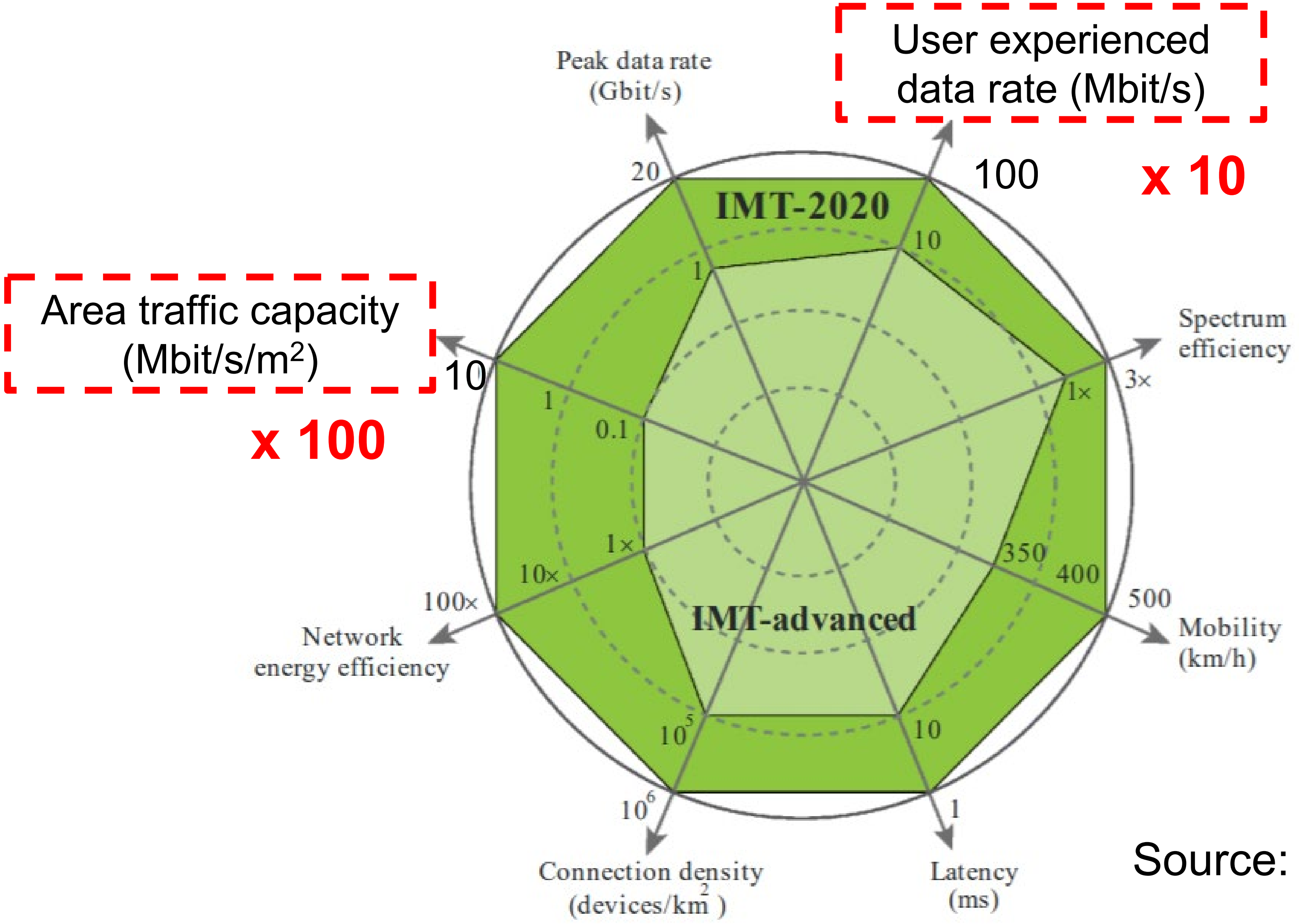
- **Specifically we examine the 6 GHz mid-band spectrum (5925-7125 MHz) as a candidate band for this purpose.**



IMT 2020 requirements drive the need for spectrum

While several of 5G capabilities are inherent in 5G technology, to ensure a consistently high **user experienced data rate** and a high **area traffic capacity** more spectrum is required.

Enhancement of key capabilities from IMT-Advanced to IMT-2020



Source: ITU

5G is not simply a continuation of the mobile business as we know it

Extremely high data rates, very high traffic volumes, high traffic density, rapid mobility, city wide coverage

Enhanced Mobile Broadband
Smartphone, 8k 250fps video, AR/VR, cloud based gaming, venues, body cams

Fibre like data rates, extremely high traffic volumes

Fixed Wireless Access
Home, business, retail, nomadic, cameras

Very large number of devices, very low device cost, low energy, high density, country wide coverage

Massive Machine Type Communications
Sensors, meters, tracking, fleet management

Very low latency, very high availability and reliability

Critical Machine Type Communications
Self-driving car, industrial applications, manufacturing

The 5G vision is for a ubiquitous fibre-like user experience and connectivity for a wide range of new uses coupled with new features, such as:

- an expectation of a near guaranteed data rate, seamless,
- low latency communication,
- smart city and other IoT,
- self-driving vehicles,
- network slicing

New spectrum in the upper-mid band and high band is required to deliver 5G

New "5G" bands are needed to deliver the IMT-2020 requirements

Legacy bands - 780 MHz

Sub-1GHz bands - 220 MHz

700MHz 2x45 MHz
800MHz 2x30 MHz
900MHz 2x35 MHz

Lower mid-bands - 560 MHz

1800MHz 2x75 MHz
2100MHz 2x60 MHz
2300MHz 100 MHz TDD
2600MHz 2x70 MHz *
2600MHz 50MHz TDD *

New "5G" bands - 6500 MHz

Upper mid-bands – 1500 MHz

3.5GHz 200-400 MHz
6GHz 1200 MHz

User experienced data rate 100 Mbit/s

High-bands – 5000 MHz

26, 28, 40, 66GHz
5000MHz TDD

Area traffic capacity of 10 Mbit/s/m^2

Based on typical situation in Sub-Saharan in 2025-2030 timeframe

* Or 2600MHz 190MHz TDD

Spectrum need is driven by the bandwidth required to deliver a near guaranteed fibre like experience rather than traffic volume – Mbit/s rather than Gbytes

Sub-1GHz band 700-900 MHz
deep indoor and rural coverage layer, legacy technologies and 5G

Lower mid-band 1.8 – 2.6 GHz
basic capacity layer, legacy technologies and 5G

Upper mid-band 3.5GHz. 4.5GHz, 6GHz
city-wide speed coverage layer, 5G only

High-band 26GHz & other mmWave, Super high capacity hot-spots, 5G only

IMT 2020 Requirements

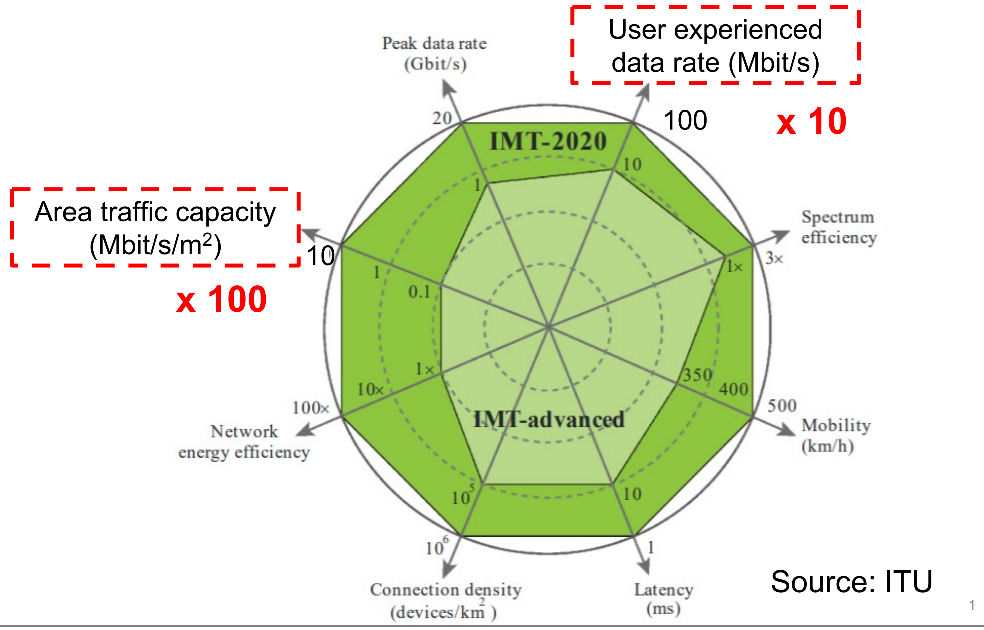
User experienced data rate 100 Mbit/s

Area traffic capacity of 10 Mbit/s/m^2

Dense Urban **Urban** **Suburban** **Rural**

The need for spectrum is driven by traffic density

Enhancement of key capabilities from IMT-Advanced to IMT-2020



To examine future spectrum needs for IMT, we need to analyse traffic demand in areas with high population densities, i.e. cities.

Data volume driven spectrum demand modelling approach

- “Traditional usage” models employ individual user consumption figures coupled with various factors to derive overall capacity needed.
- Assumption is piled on assumption and each assumption is subject to debate.

ITU 2020 requirement driven spectrum demand modelling approach

- Coleago’s model examines the capacity needed over a wide area in an urban environment consistent with the ITU 5G capacity focused requirements, notably the requirement to deliver a user experienced data rate of 100 Mbit/s in the downlink.
- Coleago’s model is concise and easily verifiable.

5G should provide the 100 Mbit/s user experienced data rate any time, anywhere, while "on the move"

ITU Requirement
User experienced data rate 100 Mbit/s

Lte

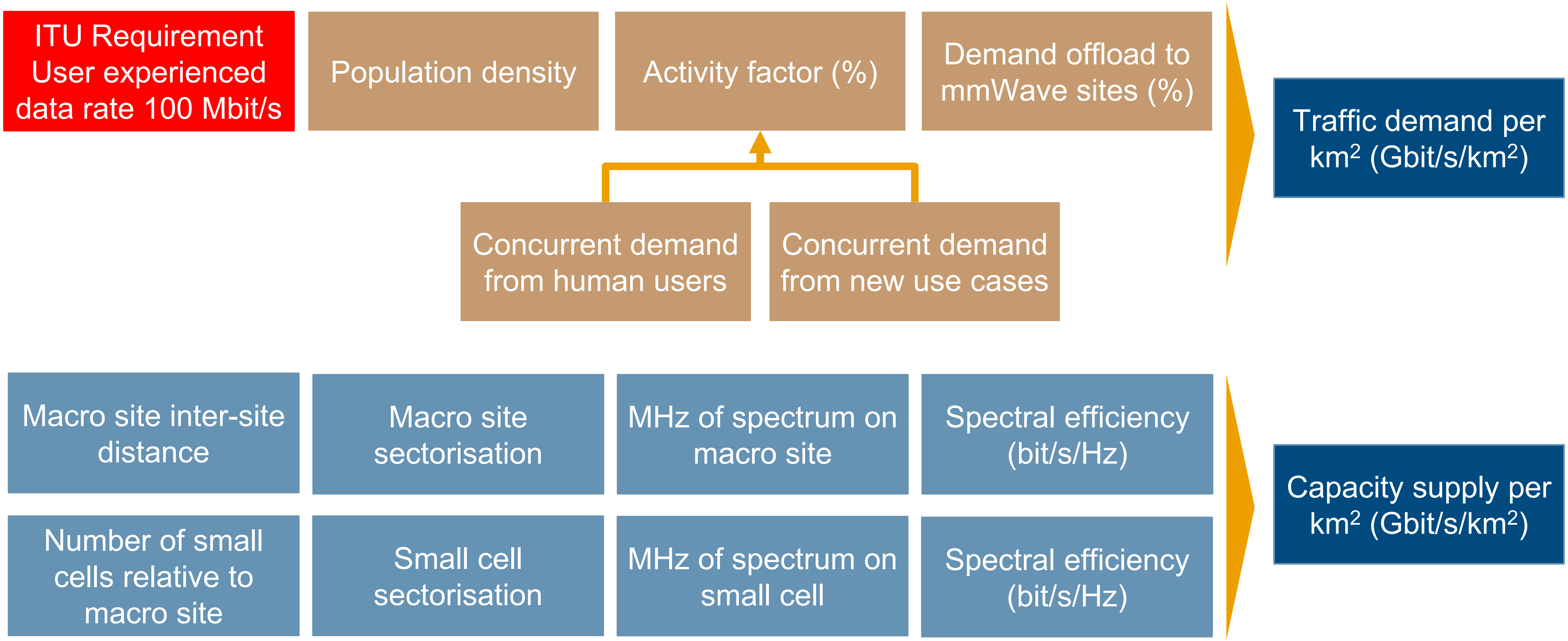
- The data volume based methodology was driven by traffic volume which was a reasonable approach because LTE is essentially used for "best effort" smartphone connectivity.

5G

- *With 5G a key factor in driving the demand for capacity is the vision that 5G should provide the 100 Mbit/s user experienced data rate any time, anywhere, while "on the move".*
- While fundamentally in a mobile network a particular speed cannot be guaranteed, there is a quasi guarantee which translates into a high probability of experiencing this data rate.
- This means networks will be designed to deliver a data rate (Mbit/s) rather than data volume (Gbytes / month).
- As a result, as we transition to 5G, the need for capacity will grow faster than traffic volume.

Agenda

The required 100 Mbit/s user experienced data rate is the key driver to assess the need for 6 GHz spectrum



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Using population density as proxy for area traffic demand

The population density approach

- We use population density in cities as a proxy for traffic density to estimate the minimum or floor capacity requirement.
- This is conservative, since traffic generated by connected vehicles and video based sensors could be a multiple of traffic generated by human users.
- Hence tying traffic demand per capita to the 100 Mbit/s requirement generates a conservative estimate for future spectrum needs.

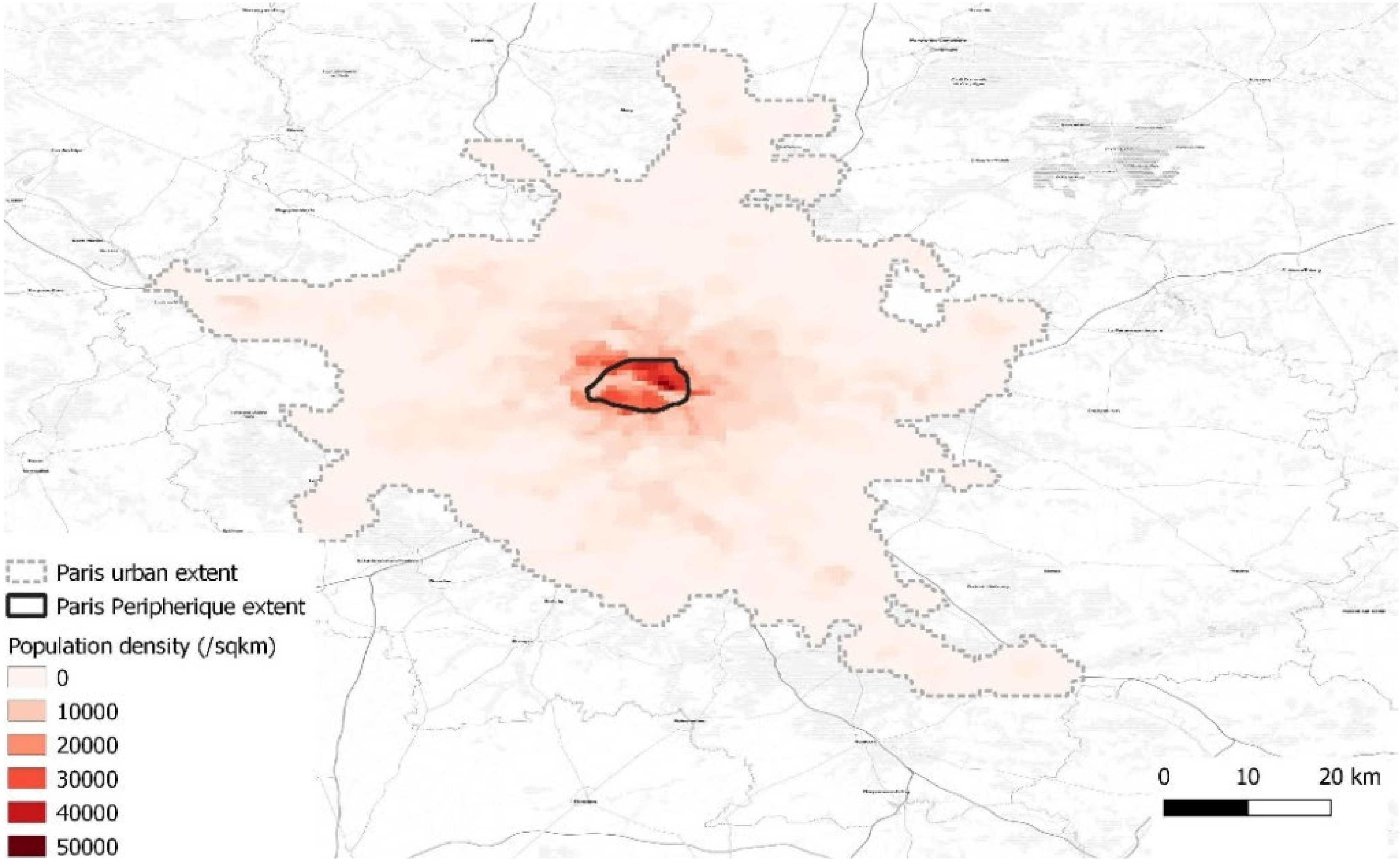
Focus on high population density areas

- From a network dimensioning perspective administrative city boundaries are irrelevant. What matters are areas with a high population density.
- Population density should be looked at over a reasonably large urban area which may or may not be within the administrative boundaries of a city or encompass the whole city.

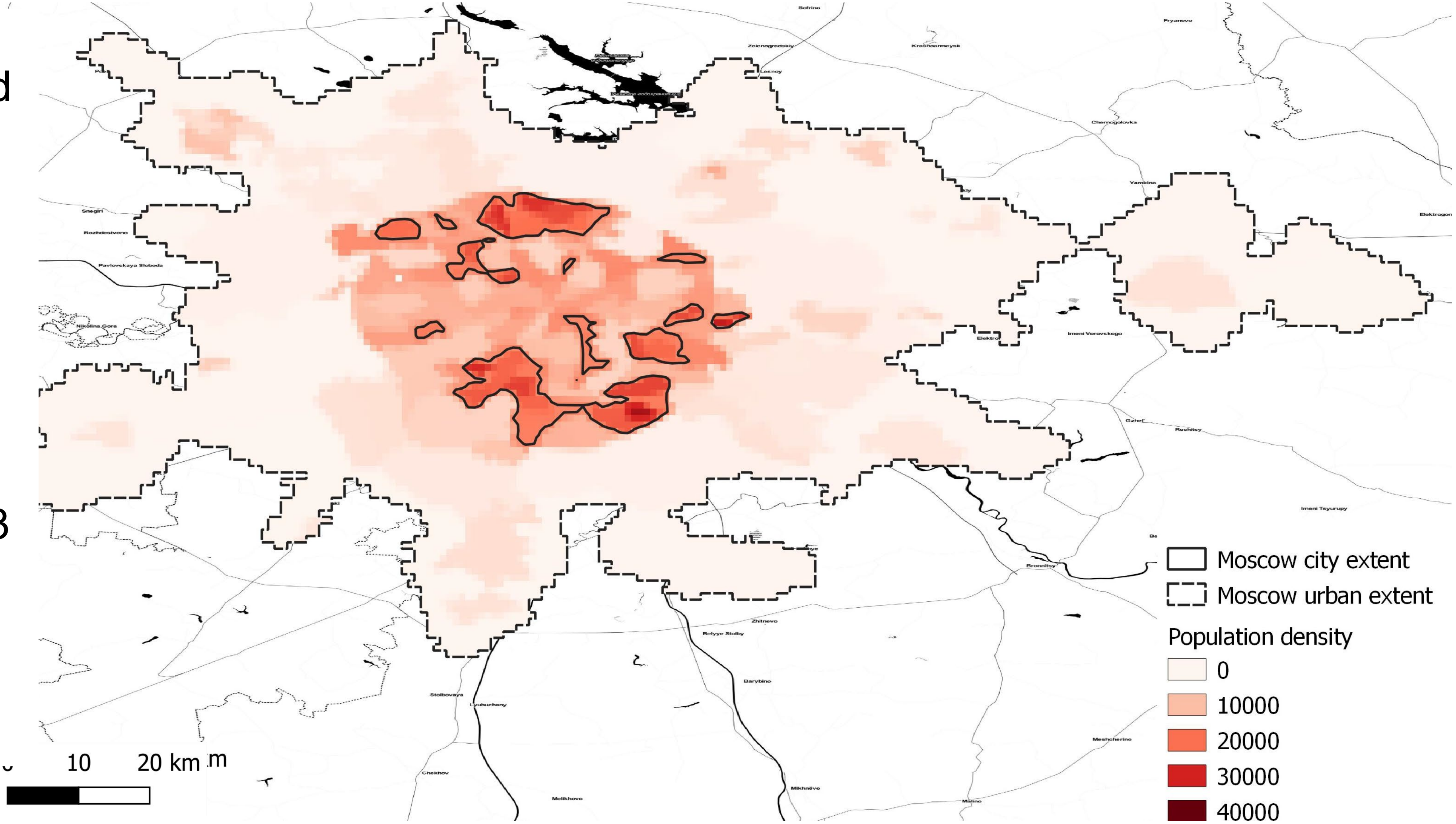
Identifying the high density area, example Paris

Population density

- A contour of 17,500 people/km^2 has been used to identify the central region.
- The central region, which corresponds to the area inside the Boulevard Périphérique. represent an area of 85.3 km^2 with an average population density of 25,018 people/km^2, i.e. a population of 2.1 million in the identified areas.



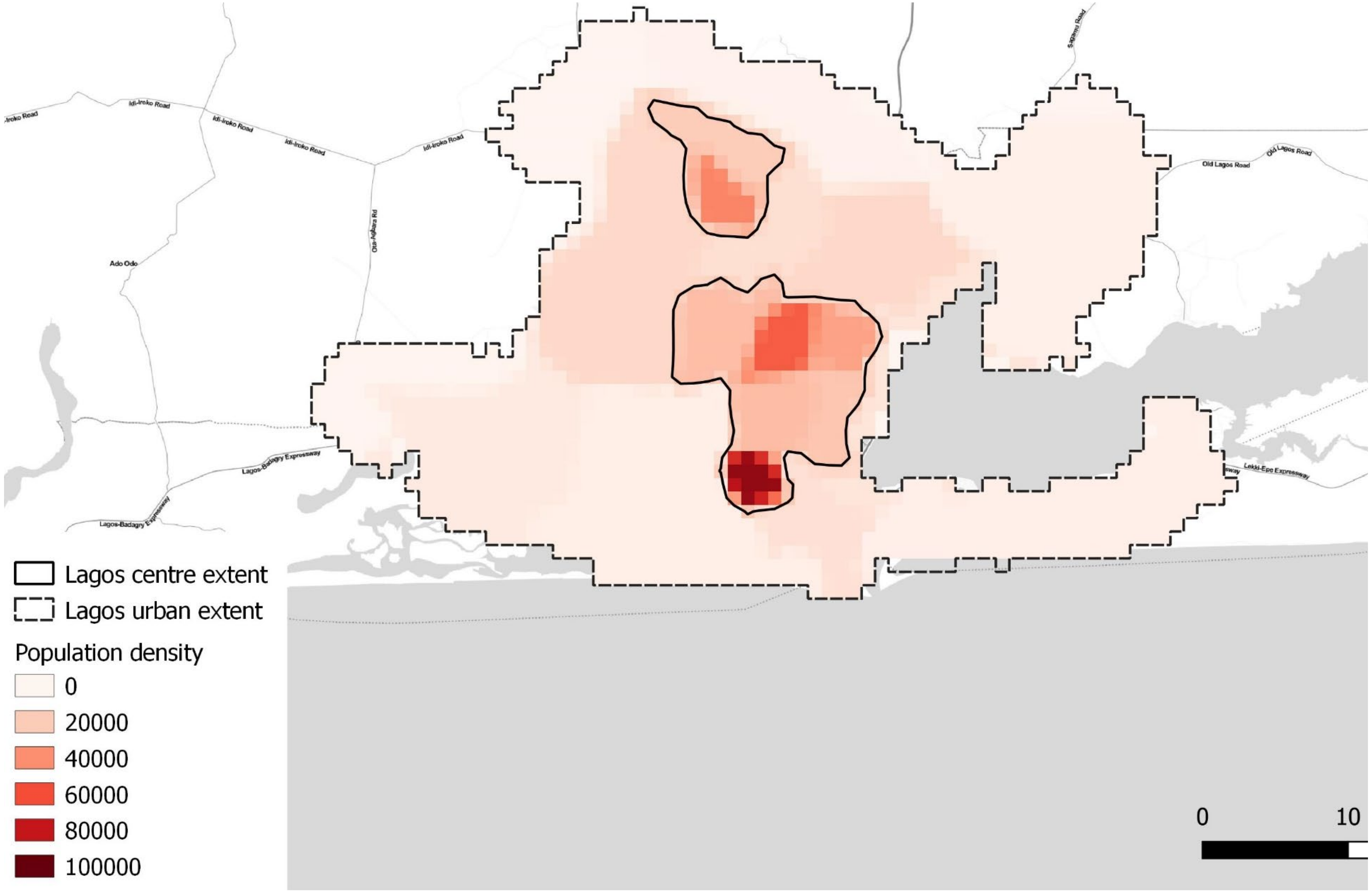
- A contour of 17,500 people/km^2 has been used to identify the central regions.
- The urban extent of Moscow is also shown for reference which extends beyond the map area.
- The central regions represent an area of 204.3 km^2 with an average population density of 20,975 people/km^2, i.e. a population of 4.3 million in the identified areas.



Identifying the high density area, example Lagos

Population density

- A contour of 17,500 people/km^2 has been used to identify the central regions.
- The urban extent of Lagos is also shown for reference which extends beyond the map area.
- The central regions represent an area of 192.7 km^2 with an average population density of 28,356 people/km^2, i.e. a population of 5.5 million in the identified areas.



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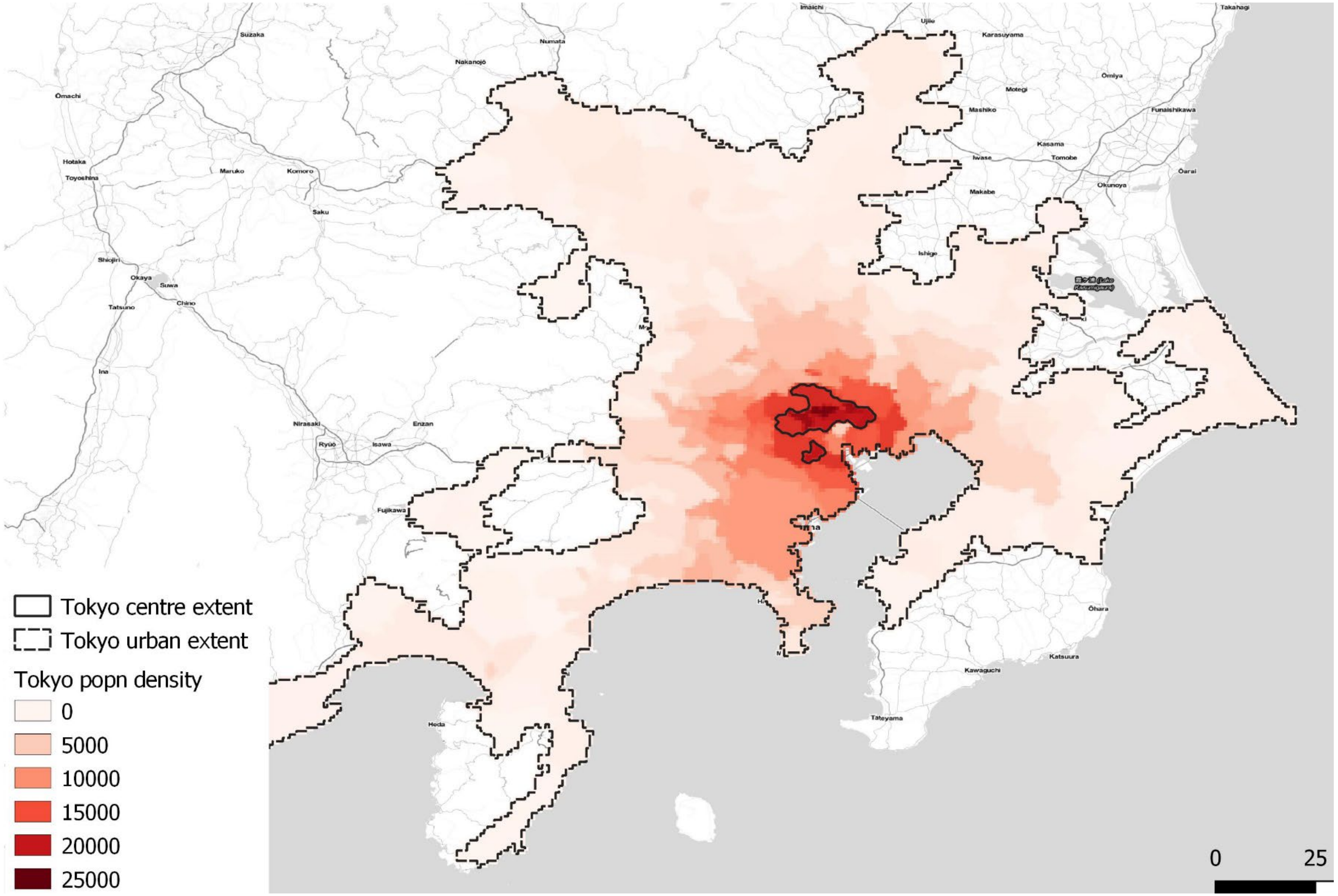
Identifying the high density area, example Tokyo

Population density

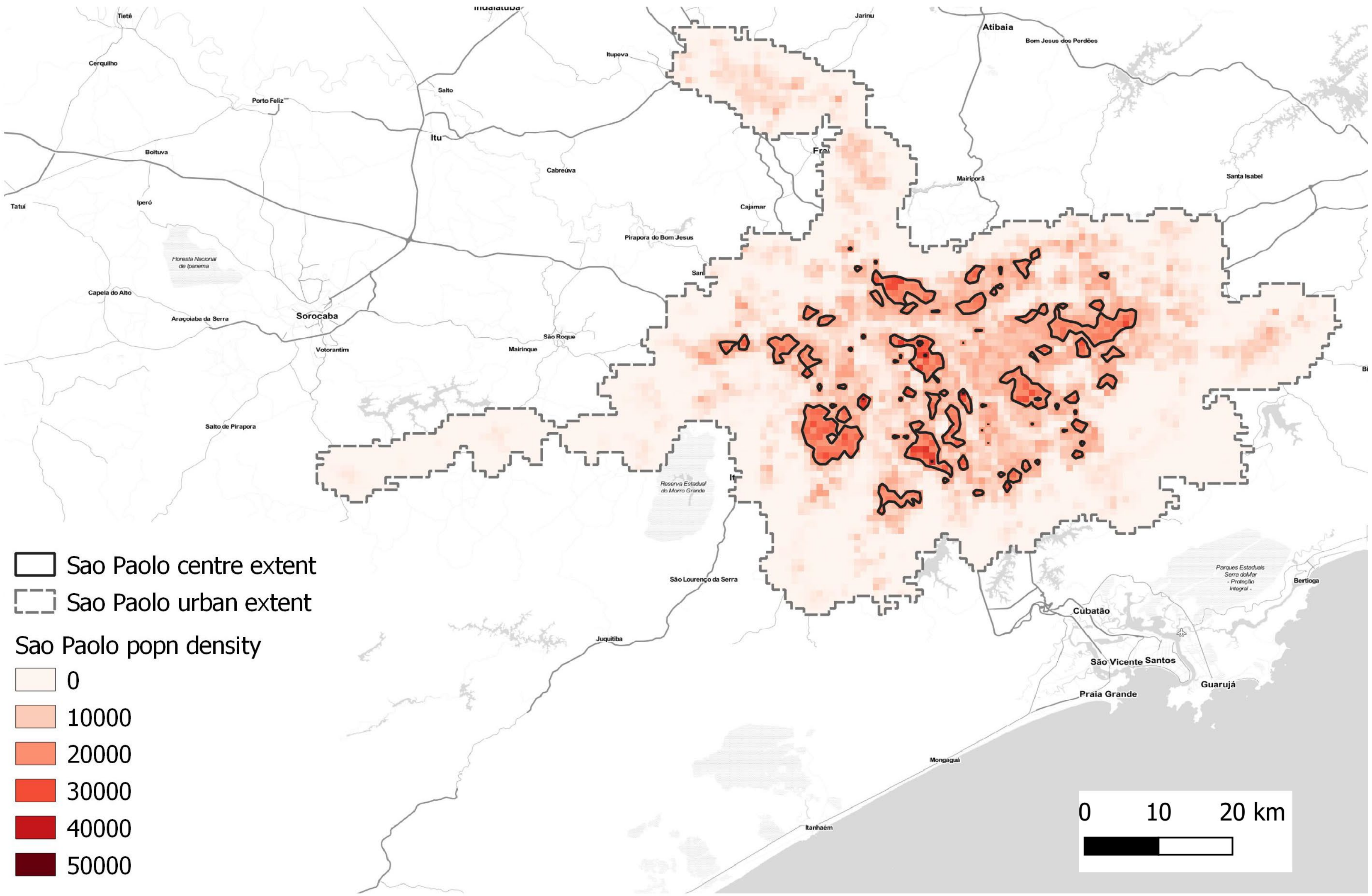
- A contour of 17,500 people/km^2 has been used to identify the central regions.
- The urban extent of Tokyo is also shown for reference which extends beyond the map area.
- The central regions represent an area of 173.6 km^2 with an average population density of 19,440 people/km^2, i.e. a population of 3.3 million in the identified areas.



Identifying the high density area, example Sao Paulo

Population density

- A contour of 17,500 people/km^2 has been used to identify the central regions.
- The urban extent of Sao Paulo is also shown for reference which extends beyond the map area.
- The central regions represent an area of 266.4 km^2 with an average population density of 21,542 people/km^2, i.e. a population of 5.7 million in the identified areas.



The activity factor represents concurrent demand in a cell by human users and new uses

Concurrent demand for 100 Mbit/s

- Not all users would require 100 Mbit/s at the same time. We need an assumption with regards to the concurrent or simultaneous demand for capacity during the busy period.
- In our model this is captured in the form of an "activity factor" to represent concurrent use in a cell
  - from human users with smartphones and
  - other devices, and new use cases such as connected cars, sensors, and cameras.

Using population density as a proxy

- It is reasonable to use population density as a proxy for demand from human users with smartphones and other devices as well as new use cases because many new use cases occur where people are.
- Traffic from new use cases occurs in additional to traffic generated by human users. In other words it adds to the human activity factor.

The activity factor will increase: As usage increases, so will concurrent use

Smartphone usage is heading towards fixed usage

- In 2019, the average usage per smartphone was 7.0 Gbytes / month.
- In Finland average usage is already nearly five times higher.
- Looking specifically at 5G users in South Korea, monthly data usage is already higher than average usage in Finland.
  - This is driven by the fact that the majority of 5G plans offer unlimited data usage and do not throttle speed above a certain limit.

Increased use means people are using more data for longer periods

- The higher the usage, the more concurrent use there will be. This is evident from FTTH, xDSL, and cable broadband which have a busy period lasting several hours rather than the peaky traffic pattern associated with today's mobile use.
- Unlimited data plans are becoming common for 5G mobile.
  - This translates into a higher activity factor for human users, i.e. more people use their devices in the same period in the same cell.
- The activity factor for human users is anticipated to reach 20%.

Some traffic will be carried by High Bands (mmWave) sites deployed in traffic hotspots

Demand offload to mmWave sites (%)

The role of high bands (mmWave)

- In traffic hotspots, high bands will be used to deliver the required area traffic capacity of 10Mbit/s/m2.
- In those hotspots, high bands sites will carry some of the traffic.
- High bands will only cover a small percentage of a city, i.e. only indoor and outdoor locations with an extremely high traffic density.

While the number of high bands sites will vary substantially from city to city, coverage and hence traffic capture will be limited.

- *"Millimetre wave (mmWave) spectrum has great potential in terms of speed and capacity, but it doesn't travel far from the cell site and doesn't penetrate materials at all. It will never materially scale beyond small pockets of 5G hotspots in dense urban environments."* Source: Blogpost by Neville Ray, CTO of T-Mobile USA, April 22, 2019
- We have assumed that as much as 20% of the total traffic in a dense urban area may be carried by high bands sites.

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Variables in the area traffic capacity (supply) side calculation of the model

Macro site inter-site distance	Macro site sectorisation	MHz of spectrum on macro site	Spectral efficiency (bit/s/Hz)	Capacity supply per km^2 (Gbit/s/m^2)
Number of small cells relative to macro site	Small cell sectorisation	MHz of spectrum on small cell	Spectral efficiency (bit/s/Hz)	

Area traffic capacity model value

Band	Category	Average Inter-Site Distance (m)	Number of sectors	Av. DL spectral efficiency (bit/s/Hz)	Amount of available spectrum (MHz)
<1.6 GHz	Macro site; Low bands	400	3	4	Typically 190 to 220
1.6-2.6 GHz	Macro site; Lower mid-bands	400	3	8	Typically 460
3.5 GHz / 4.5 GHz	Macro site; Upper mid-bands	400	3	8	200 to 400
6 GHz	Macro site; Upper mid-bands	400	3	8	Zero or 700 or 1200
3.5 GHz / 4.5 GHz	Small Cell; Upper mid-bands	n/a *	1	8	200 to 400
6 GHz	Small Cell; Upper mid-bands	n/a *	1	8	Zero or 700 or 1200

* For small cells this does not assume contiguous coverage because small cells are deployed to fill in speed coverage holes rather than providing contiguous coverage. Hence the inter-site distance is irrelevant.

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Demand for area traffic density and supply of area traffic capacity in five cities

To illustrate the output, we have applied the model to Lagos, Moscow, Paris, Sao Paulo and Tokyo

- We a look a situation in the 2030 time frame when 5G will be mature and 6 GHz spectrum may be available for mobile.
- We assume all the available spectrum is used across all available sites.
  - This removes issues around differences in numbers of mobile operators, co-location, and the amount of spectrum held by individual operators.

Traffic demand per km^2 (Gbit/s/km^2)

Capacity supply per km^2 (Gbit/s/km^2)

Population density in the sample cities

City	Population million (1), (2)	Size of urban area (km^2) (1), (2)	Avg. pop density in the urban area	Size of city centre area (km^2) (3)	Avg. pop density in the city centre (pop/km^2) (3)
Lagos	17.0	1,171.28	14,514	193	28,356
Moscow	13.2	2,511	5,257	204	21,000
Paris	2.1	105	20,382	85	25,018
Sao Paulo	12.3	1,521	8,055	266	21,542
Tokyo	13.5	2,191	6,169	174	19,440

- A contour of 17,500 people/km^2 has been used to identify the centre area region.

Sources: (1) For Moscow, Paris, Sao Paulo, Tokyo, https://en.wikipedia.org/wiki/List_of_largest_cities
(2) For Lagos: https://worldpopulationreview.com/world-cities/lagos-population/
(3) Coleago GIS analysis based on data from, https://sedac.ciesin.columbia.edu/data/set/grump-v1-urban-extents

Between 700 and 1,200 MHz of additional mid-bands spectrum could be made available for IMT in the 6 GHz band

The WRC-23 offers an opportunity for the global or regional harmonisation of the 6 GHz band

- In accordance with Resolution 245 (WRC-19) WRC-23 agenda item 1.2 will consider, among others, the identification for IMT of the frequency bands
  - 6425-7025 MHz in EMEA (ITU Region 1) - 600 MHz
  - 7025-7125 MHz globally – 100 MHz

CIS and CEE countries can support the IMT identification in the 6GHz band

- During WRC-23, countries outside EMEA will also have the opportunity to join in the IMT identification of the 6425-7125 MHz band.
- Depending on the Region and country, outside the WRC process it may be possible to also use the 5925-6425 MHz for 5G and its future evolution, i.e. an additional 500 MHz.

6GHz spectrum scenarios for five cities

We examine three scenarios:

- Scenario1: 6 GHz spectrum not available for IMT mobile
- Scenario 2: 700 MHz of 6 GHz spectrum available for IMT mobile.
- Scenario 3: 1200 MHz of 6 GHz spectrum available for IMT

Spectrum available for IMT by 2030 (MHz)

City	Low & lower mid bands MHz	3.3-4.2 GHz / 4.4-4.99 GHz	6 GHz scenarios
Lagos	650	400	0, 700, 1200
Moscow	650	200	0, 700, 1200
Paris	650	600	0, 700, 1200
Sao Paulo	650	400	0, 700, 1200
Tokyo	650	800	0, 700, 1200

Note: Moscow in 4.4-4.99 GHz, Sao Paulo 200 MHz in

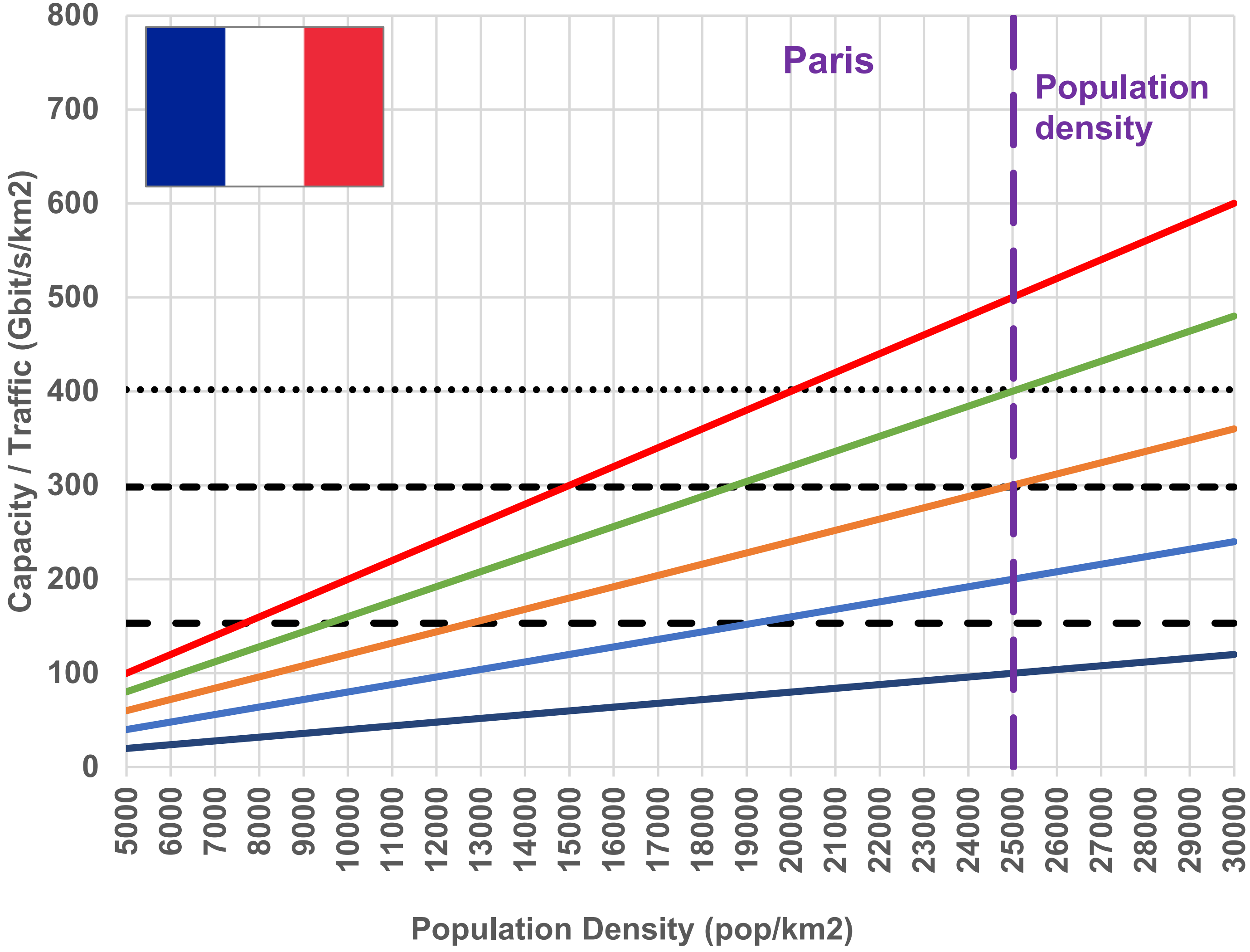
Paris: 600 MHz available at 3.5 GHz, with an activity factor of 15%, 700MHz of 6 GHz spectrum is needed for the 100 Mbit/s user experienced data rate

Capacity supply depending on amount of 6GHz spectrum

- Capacity supply scenario 1: No 6GHz
- Capacity supply scenario 2: 700MHz @ 6GHz
- Capacity supply cenario 3: 1.2GHz @ 6GHz

Traffic demand with varying activity factors

- Traffic demand 5% activity factor
- Traffic demand 10% activity factor
- Traffic demand 15% activity factor
- Traffic demand 20% activity factor
- Traffic demand 25% activity factor



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Moscow: 400 MHz available at 4.5 GHz, with an activity factor of 15%, more than 700MHz of 6 GHz spectrum is needed for the 100 Mbit/s user experienced data rate

Capacity supply depending on amount of 6GHz spectrum

- Capacity supply scenario 1: No 6GHz
- Capacity supply scenario 2: 700MHz @ 6GHz
- Capacity supply cenario 3: 1.2GHz @ 6GHz

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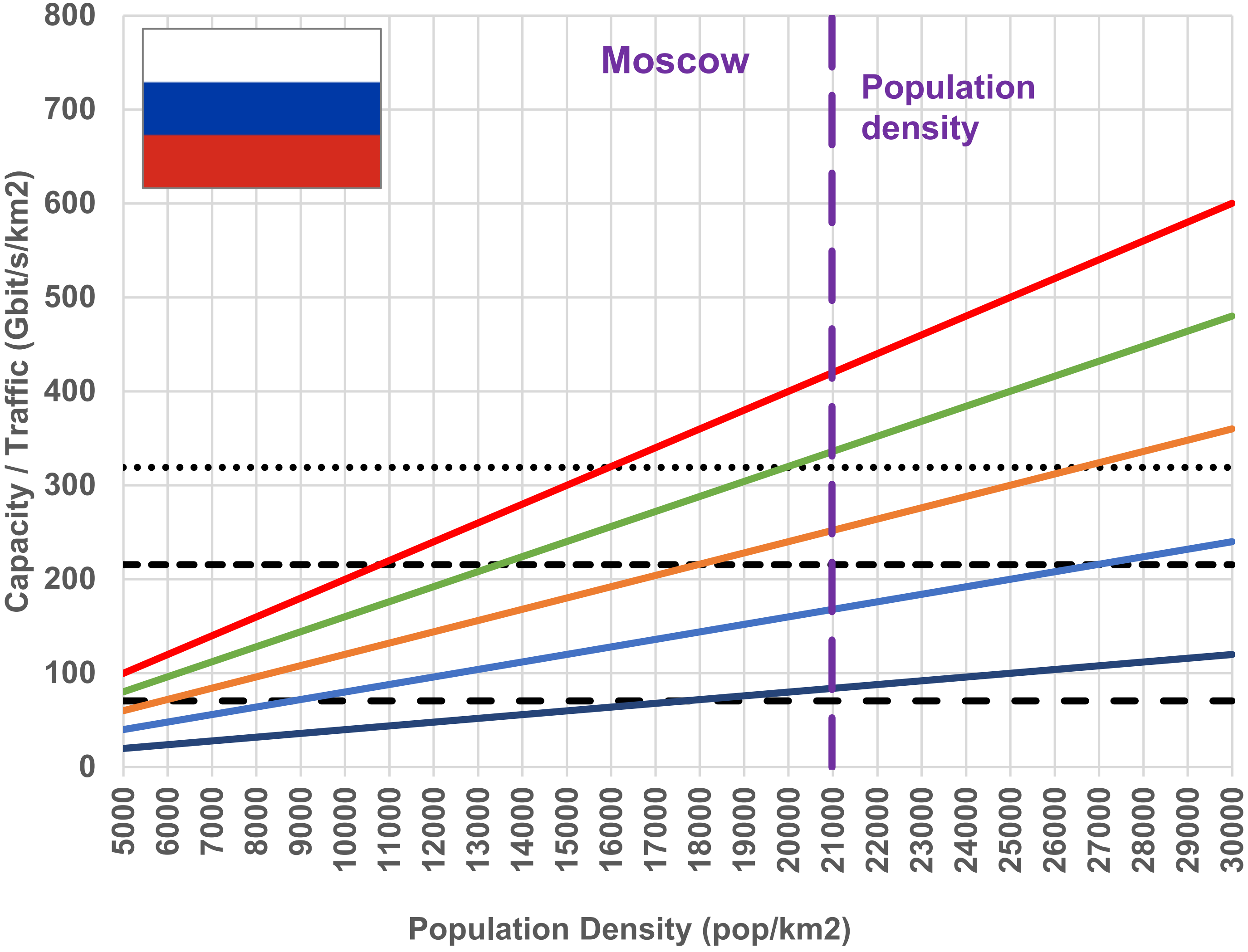

Lagos: 400 MHz available at 3.5/4.5 GHz, with an activity factor of 15% some 1200 MHz of 6 GHz spectrum is required to deliver the 100 Mbit/s user experienced data rate

Capacity supply depending on amount of 6GHz spectrum

- Capacity supply scenario 1: No 6GHz
- Capacity supply scenario 2: 700MHz @ 6GHz
- Capacity supply cenario 3: 1.2GHz @ 6GHz

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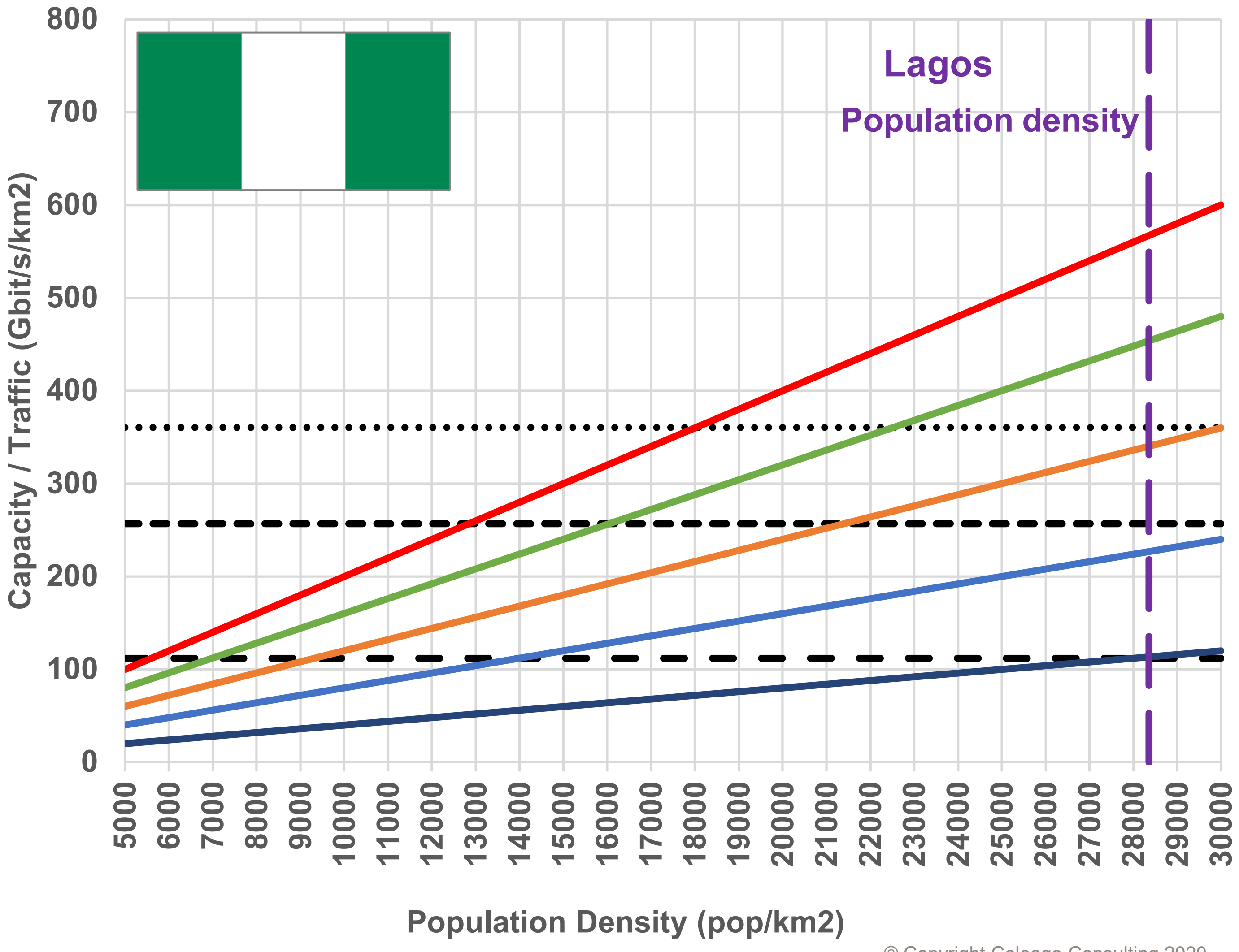

Tokyo: 800 MHz available at 3.5/4.5 GHz, with an activity factor of 15% at least some 6 GHz spectrum is required to deliver the 100 Mbit/s user experienced data rate

Capacity supply depending on amount of 6GHz spectrum

- Capacity supply scenario 1: No 6GHz
- Capacity supply scenario 2: 700MHz @ 6GHz
- Capacity supply cenario 3: 1.2GHz @ 6GHz

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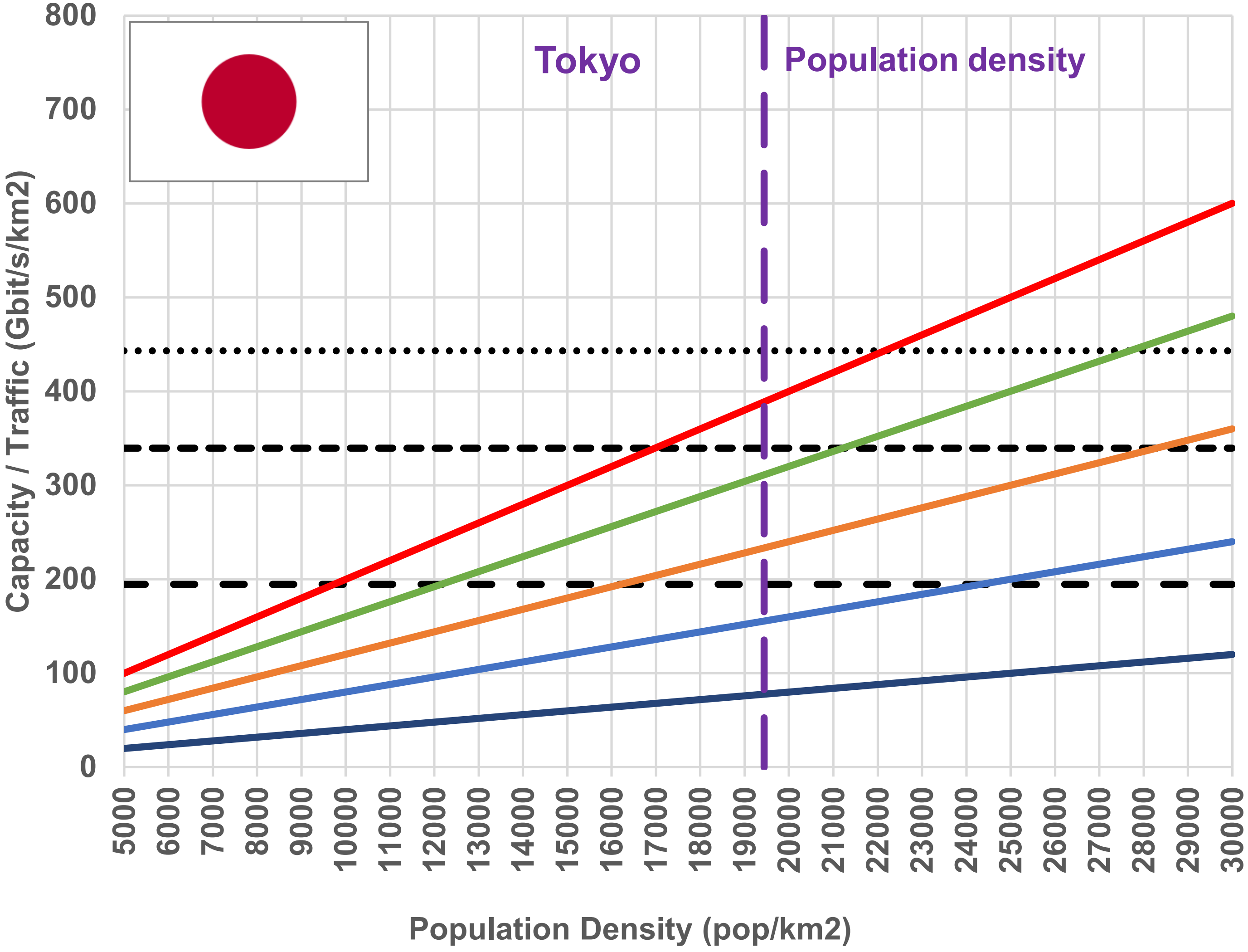

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Sao Paulo: 400 MHz available at 3.5/4.5 GHz, with an activity factor of 15%, 700 MHz of 6 GHz spectrum needed for the 100 Mbit/s user experienced data rate

Capacity supply depending on amount of 6GHz spectrum

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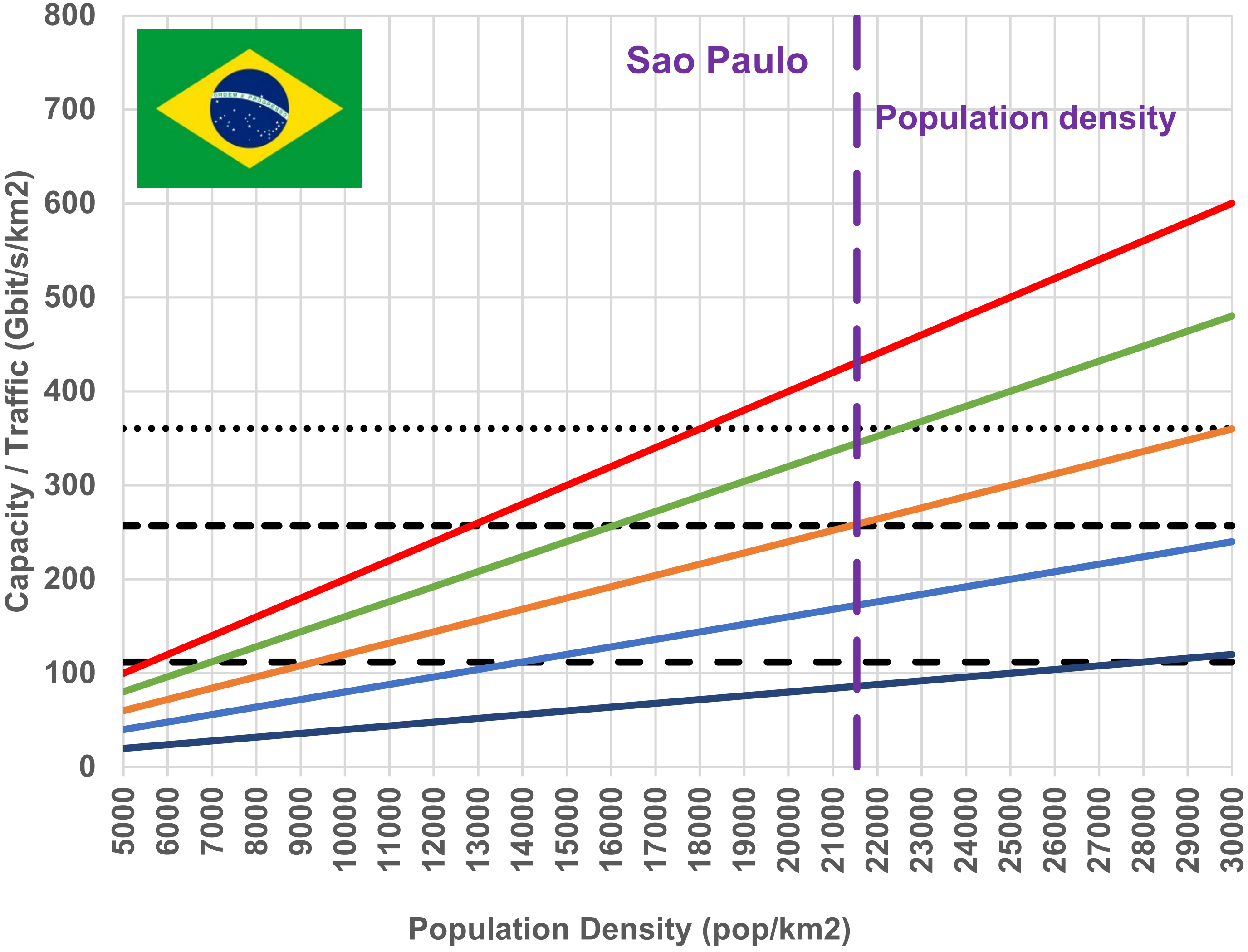


Agenda

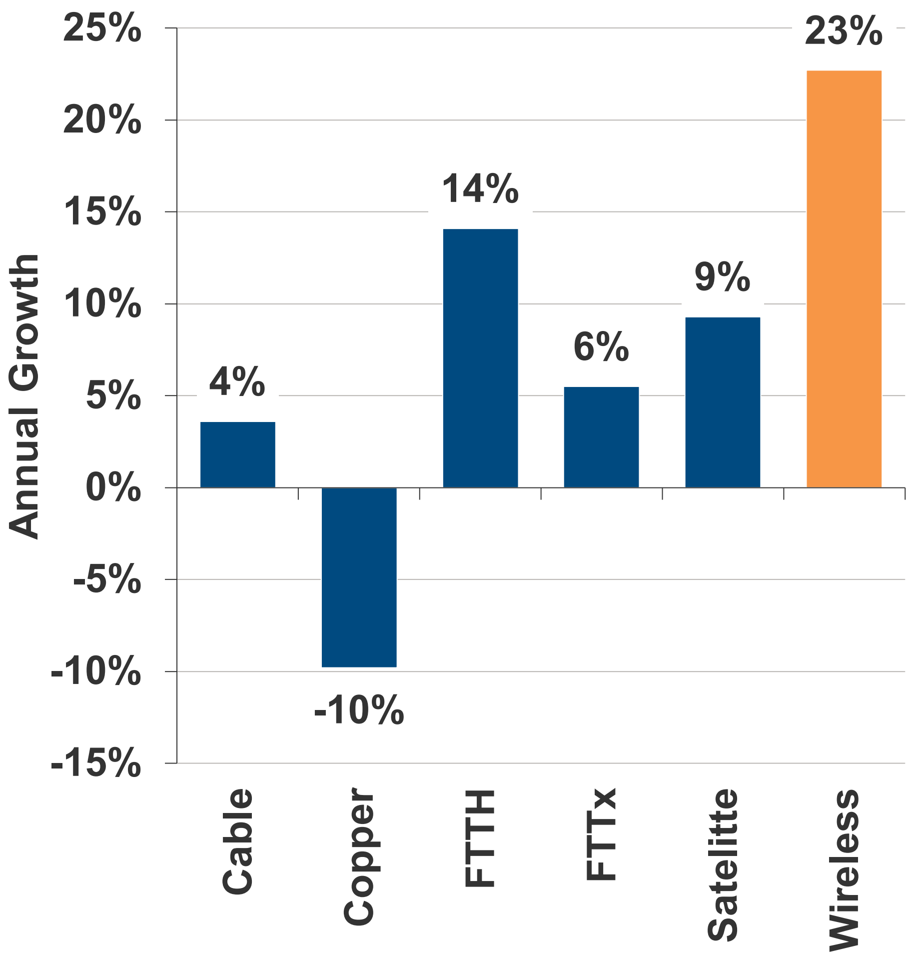
Fixed Wireless Access (FWA) is one of the 5G use cases

As a result of the performance improvement of LTE-A and now 5G-NR, FWA is experiencing rapid growth world-wide

- 401 operators in 164 countries offer FWA services based on LTE.
- 75 operators that have announced 5G launches worldwide, 38 operators that have announced the launch of either home or business 5G broadband using routers.
- Of these 38, operators selling 5G-based FWA services.

Source: Fixed Wireless Access, General Report, Global mobile Suppliers Association, 19 May 2020

Growth of fixed broadband subscribers by technology in 2019



Source: Point Topic, World Fixed Broadband Statistics – Q4 2019

With 5G FWA, fixed wireless growth is likely to accelerate further to become the dominant form of fixed broadband connectivity in developing countries

- 5G FWA is relevant in developed markets with a high fibre availability as well as in countries where fibre and older copper broadband connect only a small percentage of homes and businesses.
- While some countries, such as South Korea and UAE, have near universal fibre access in many developed countries there is a lack of rural broadband availability.
- In most developing countries, notably in Africa, emerging Asia, Eastern Europe and Latin America copper or fibre network access is almost an irrelevance.

"We estimate there were 51 million FWA connections by the end of 2019. This number is forecast to grow threefold through 2025, reaching close to 160 million. FWA data traffic is estimated to have represented around 15% of global mobile network data traffic by the end of 2019. This is projected to grow by a factor of around 8 to reach 53EB in 2025, accounting for 25% of total mobile network data traffic globally."

Source: Ericsson Mobility Report, June 2020

5G FWA is used to close the urban-rural digital divide in developed markets

The end of copper

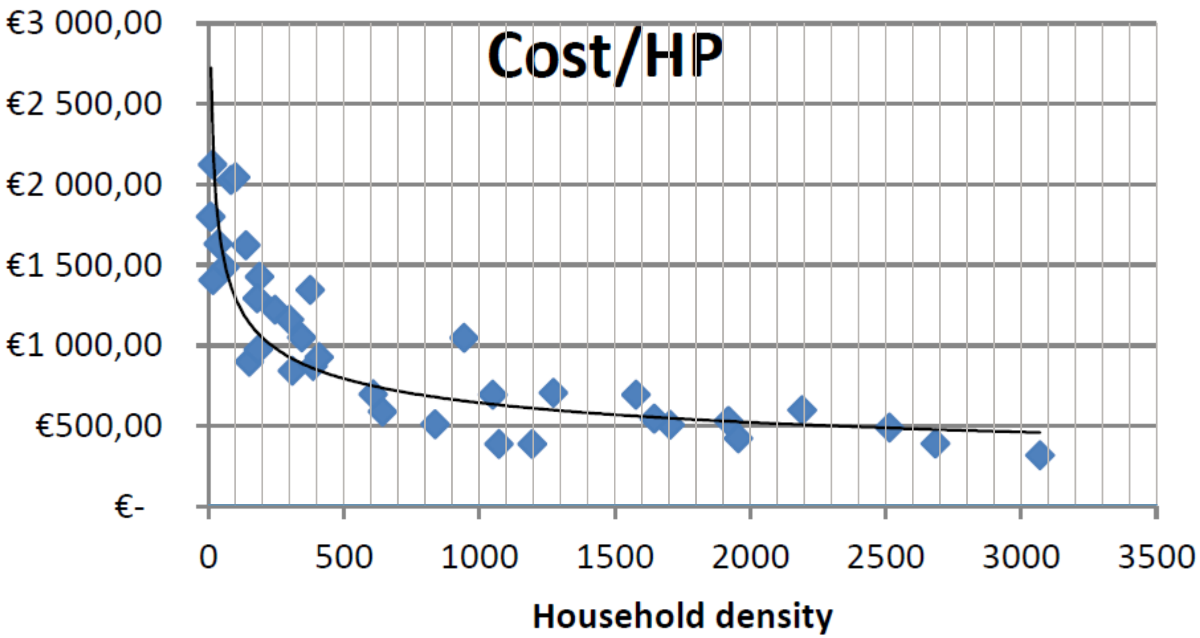
- In many advanced economies bringing 100 Mbit/s broadband to rural users is a problem and copper based access is nearing the end of its useful life.
- Copper networks, even with the latest upgrades, cannot provide 100 Mbit/s or more.

Rural fibre requires subsidies

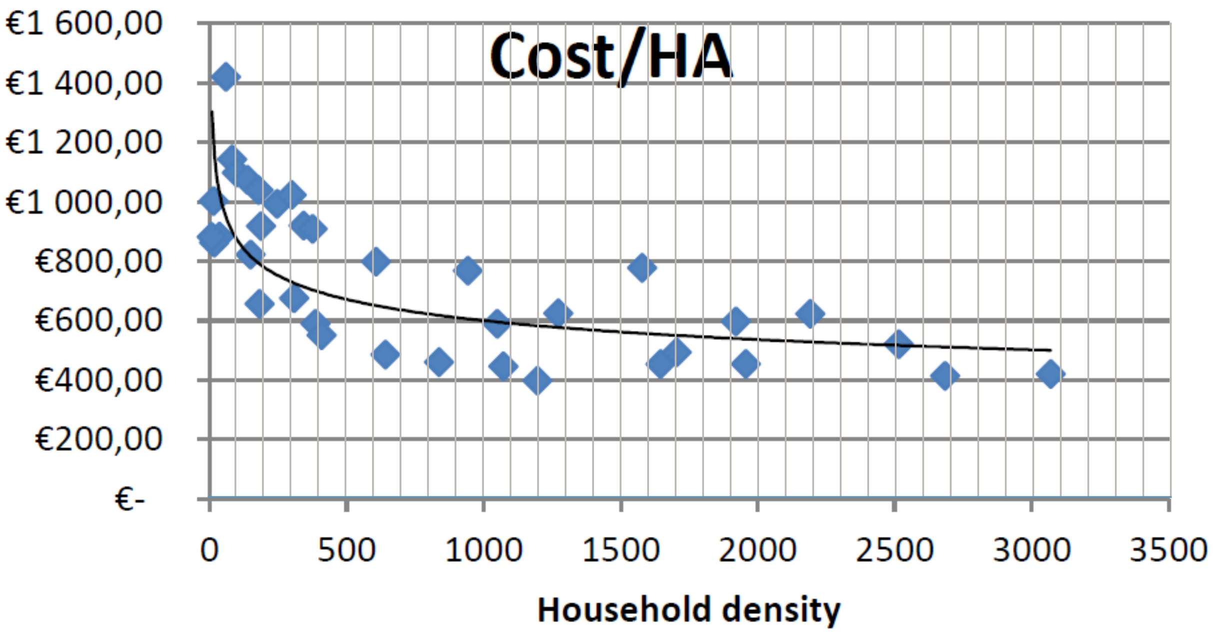
- The investment required to connect all premises to fibre would be extremely high
- Deploying FTTH to rural premises will require substantial subsidies.
- Depending on the local situation, connecting a building with 5G FWA in rural areas is in the order of 50%-80% lower in cost compared to fibre.
- Hence rural broadband connectivity subsidy schemes leave it up to the provider to build rural broadband access with either fibre or FWA

The lack of rural broadband access is due to the poor economics of connecting homes and business premises in areas with a low population density

Fibre cost per home passed



Fibre activation cost per home



Source: The Cost of Meeting Europe's Future Network Needs, FTTH Council Europe, 3/2017

- The average cost of connecting a rural household with FTTH amounts to circa €2,000.

The more spectrum is available for rural FWA, greater the savings of using FWA instead of fibre to reach the European 2025 connectivity target

- If FWA is used to provide broadband connectivity to households, the cost per household connected is highly dependent on the number of connections that can be supported per cell tower.
- In turn, this is a function of the data rate that must be delivered and, crucially, the amount of spectrum used at a cell tower.

Required data rate per FWA connection	Concurrent use (activity factor)	Amount of spectrum deployed on cell tower	Supported number of connections per cell tower
100 Mbit/s 150 Mbit/s 300 Mbit/s 1 Gbit/s	50%	Base line + 1,000 MHz + 2,000 MHz	

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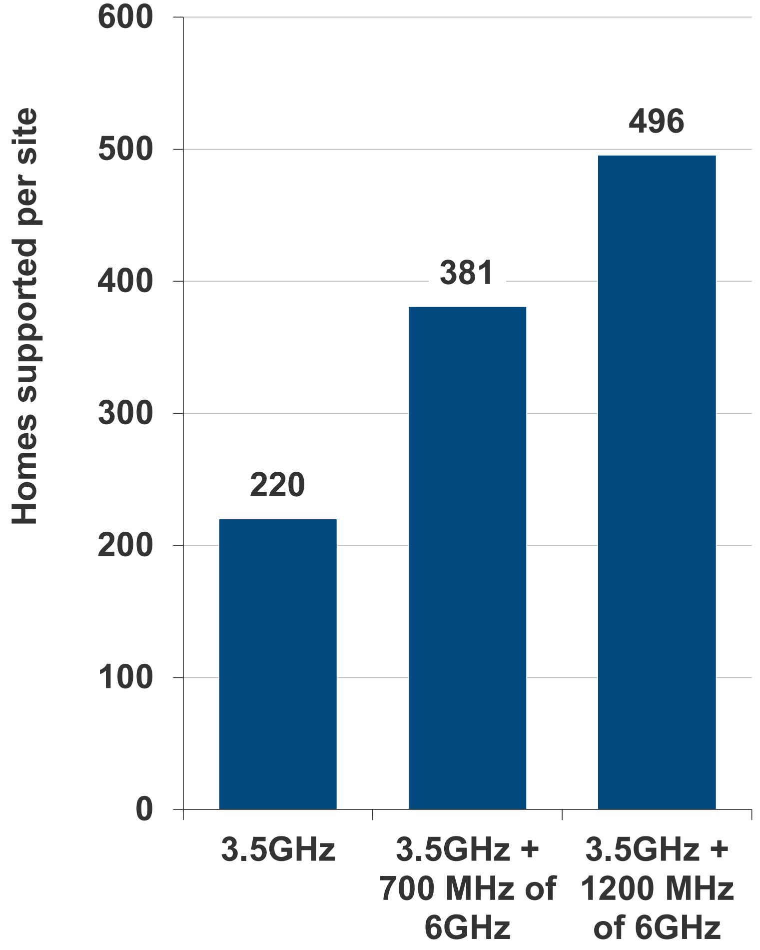
The more spectrum is available the better the business case for rural 5G FWA

- We compared three scenarios examining 5G FWA delivering a household experienced data rate of 100 Mbit/s:
  - Scenario 1, 600 MHz at 3.5 GHz is available;
  - Scenario 2, 600 MHz at 3.5 GHz plus an additional 700 MHz at 6 GHz; and
  - Scenario 3, 1200 MHz is available at 6 GHz.
- In the short term the 3.5 GHz spectrum will be sufficient for a viable FWA business case that delivers 100 Mbit/s to rural premises.
- Within 5 years the 3.5 GHz band will be insufficient to serve an economically viable number of premises with 100 Mbit/s FWA.
- Using 700 or 1200 MHz of 6 GHz spectrum for 5G FWA may eliminate the need for rural broadband subsidies

Number of premises supported per 5G FWA site



Using 6 GHz for FWA in addition to other mid bands future proofs FWA to deliver speeds beyond 100 Mbit/s

- The definition of broadband keeps increasing. 100 Mbit/s may be considered sufficient now, but we are moving to what is now defined as ultra-fast broadband.
- Ofcom, the telecoms regulator of the United Kingdom, defines ultrafast broadband as broadband with download speeds of greater than 300 Mbit/s.
- Using 6 GHz for FWA, in addition to other IMT bands, improves the economics of FWA and means that FWA can be a long-term solution for rural broadband connectivity.

In developing countries the case for an IMT identification for 6 GHz is not simply a technical issue but also an economic one

In developing countries internet access is synonymous with wireless access.

- In theory, fibre can be built to all locations and thus provide “unlimited” access network capacity. However, this is not economically feasible even in advanced economies let alone in developing countries where affordability is a key issue.
- In most countries broadband will be wireless, including in mega cities such as Lagos, Cairo, and Dhaka. 6 GHz spectrum has a key role to play and is required to provide fibre like access at a cost that makes it affordable even for lower income groups.

The broadband access deficit in developing countries

- There are around 2 to 2.4 billion households world-wide.
- At the end of Q4 2019, the number of global fixed broadband connections stood at 1.11 billion to 1.2 billion (excluding mobile).
- Approximately 0.9 to 1.2 billion households have a broadband connection in the form of DSL, fibre, cable, or FWA.
- This leaves 1.1. to 1.2 billion households without broadband access and the vast majority of these are in developing countries.

Using 6 GHz in addition to other mid-bands for 5G FWA will make broadband more affordable in developing countries

SUSTAINABLE DEVELOPMENT GOALS

- Broadband connectivity in developing countries goes hand in hand with affordability.
- The Broadband Commission for Sustainable Development 2025 Targets make this explicit:

  "By 2025, entry-level broadband services should be made affordable in developing countries, at less than 2% of monthly gross national income per capita."

  Source: Broadband Commission for Sustainable Development 2025 Targets: "Connecting the Other Half", 2018

10th ANNIVERSARY BROADBAND COMMISSION FOR SUSTAINABLE DEVELOPMENT ITU UNESCO 2025 TARGETS

- IMT spectrum is an essential element to attain the Sustainable Development Goals and the Broadband Commission 2025 targets in the context of affordability:
  - using more spectrum means fewer cell towers need to be built, thus lowering costs;
  - the ability to deploy radios with 100 MHz wide bands or more per operator reduces the cost of capacity, i.e. lower the cost per bit; and
  - identifying the 6 GHz band for IMT would make a significant contribution to delivering affordable broadband.

Agenda

IMT (5G mobile) vs. unlicensed (Wi-Fi) use of the 6 GHz band

- It is important to assess whether the 5925-7125 MHz band should be
  - licensed to operators (for 5G networks) or
  - if it should be made available on a license exempt basis (for RLAN equipment such as Wi-Fi or 3GPP NR-U).

Wi-Fi only provides the last hop between devices and the broadband access network

Wi-Fi is an important connectivity tool

- With billions of Wi-Fi enabled devices, Wi-Fi is a critical element providing device connectivity in homes, business premises, venues, and other indoor uses.
- There is also limited outdoor use of Wi-Fi. Wi-Fi uses unlicensed spectrum to provide the radio channel between Wi-Fi enabled devices and a Wi-Fi access point over a range of around 30 metres and perhaps up to 100 metres outdoors with Wi-Fi 6.
- All smartphones and many other devices such as tablets, laptops, TVs, appliances, controllers and sensors are Wi-Fi enabled.

Wi-Fi only provides the last hop between devices and the broadband access network

- In developed countries which have a well developed broadband access network using copper, fibre, or cable, Wi-Fi is present in virtually every home, commercial and public premises.
- The usefulness of Wi-Fi depends on the availability of a broadband access network.

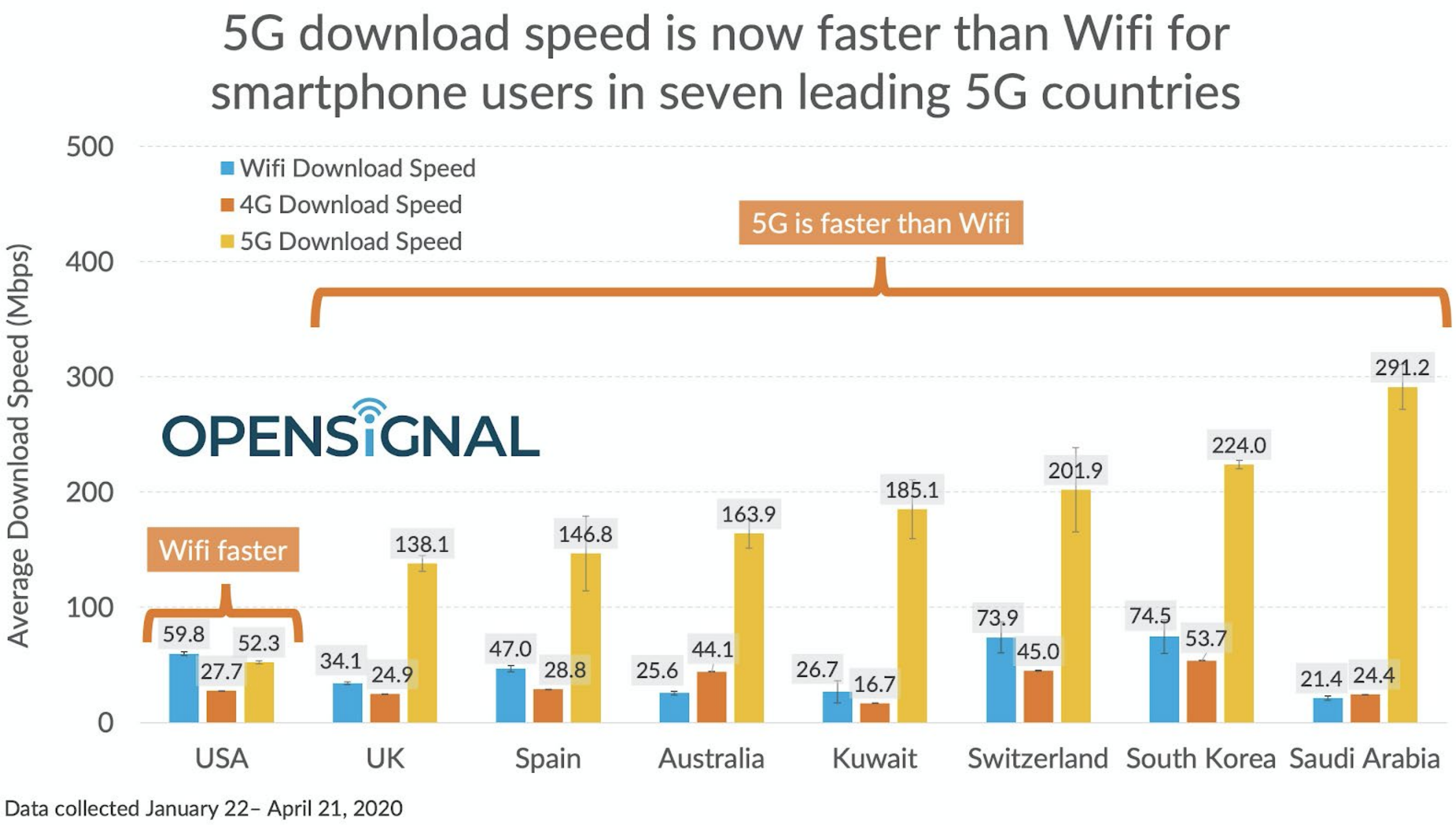
In CIS and CEE countries the unlicensed use of the 6 GHz band does not solve the connectivity problem

- In many CIS countries the access network is essentially provided by mobile operators using 4G and now 5G.
- The notion of using 6 GHz Wi-Fi to distribute traffic around buildings is pointless because the connectivity bottleneck is the connection to the network.
- The 6 GHz spectrum should be used to overcome this bottleneck, i.e. have an IMT identification.
- The use of the 6 GHz band for 5G mobile will make a significant contribution to overcoming the connectivity problem.

"In CIS and CEE countries the IMT identification for the 6 GHz would produce socio-economic benefits which would not be the case if the 6 GHz band is used for unlicensed (Wi-Fi or other) access."

5G download speed is now faster than Wi-Fi for smartphone users in seven leading 5G countries

5G mobile offers a fibre-like user experienced data rate while most Wi-Fi connections are not connected to FTTH and hence offer a lower speed. This is borne out by real world measurements from OpenSignal.



Wi-Fi offload vs. Wi-Fi onload

Wi-Fi offload is declining

- Where the capacity and speed of mobile networks is low and / or prices for mobile data are high, smartphone users often log onto a Wi-Fi network rather than using the mobile network.
- This is referred to as “Wi-Fi offload”. This is the traditional way in which people look at the complementarity of mobile (IMT) and Wi-Fi.
- The key factors in the trend away from Wi-Fi-offload are the better 4G and 5G mobile user experience in terms of speed, the proliferation of unlimited data plans, and user convenience.

Wi-Fi onload is growing

- Wi-Fi offload can only work where there is fibre, cable, or good DSL access to which Wi-Fi access points can be connected. This is not the case in most places in the world.
- In reality we are seeing a phenomenon which we refer to as *“Wi-Fi onload”.* Wi-Fi enabled devices are connected to the router and the traffic is loaded onto the mobile network.
- Driven by lower mobile broadband prices and higher data speeds, shipments of 4G and now 5G enabled Wi-Fi access points are increasing much faster than fibre or other wired broadband connections.

Key take-aways IMT (5G mobile) vs. unlicensed (Wi-Fi) use of the 6 GHz band

For most of the world's countries and most of the world's population, an IMT identification of the 6 GHz band will deliver better socio-economic benefits compared to the unlicensed (Wi-Fi) use of the 6 GHz band.

- For consumers, the advantage of using the 6 GHz band for IMT (5G mobile and FWA) are:
  - Spectrum is not the bottleneck of user experience now and in the future for home broadband access; and
  - Wi-Fi 6E only meets the high speed demand from FTTH users, which only consist of a small proportion of the total home broadband users. For the other users, the 5 GHz band is more than enough (what they need is a faster fixed home broadband access) so they will not benefit from Wi-Fi 6E, but 5G can provide the ultra fast speed experience to whoever needs it.

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Key take-aways IMT (5G mobile) vs. unlicensed (Wi-Fi) use of the 6 GHz band

- For enterprise, the advantages are:
  - Reliability: Wi-Fi can not guarantee high level reliability while 5G-NR can provide 99.999% reliability;
  - Capacity: Wi-Fi can only meet the capacity needs from fewer users, not competent for large scale wide-area deployment scenarios;
  - Latency: Wi-Fi can not guarantee certain latency i.e. it is unsuitable for the increasing number of applications that require ultra-low latency; and
  - Mobility: Compared to 5G mobile, even Wi-Fi 6 has high latency in handover with a high risk of packet loss

IMT high radiation power macro site deployment will be a more effective way of providing broadband access to people than that of low-power Wi-Fi. In other words, if a band coexistence condition is allowed, IMT deployment is the first priority.

Agenda

1. Examining the need for IMT spectrum to realise the 5G vision
2. Modelling demand for area traffic density
3. Modelling area traffic capacity
4. Demand for area traffic density and supply of area traffic capacity in five cities
5. The role of the 6 GHz band outside cities
6. IMT (5G mobile) vs. unlicensed (Wi-Fi) use of the 6 GHz band
7. Sharing with incumbents
8. Summary of key findings

Sharing with incumbents

Work on coexistence is under way…

- Work in ITU-R is currently focused on defining the technical and operational parameters of both the incumbent users and 5G at 6 GHz.
- The relevant ITU-R technical groups are expected to provide a stable set of incumbents' parameters for sharing studies by June 2021.
- Similarly, 3GPP will develop the characteristics of 5G covering the 6 GHz range, and communicate these to the ITU-R in the same timeframe.

… and the initial results are encouraging

- Some initial sharing studies between 5G and incumbents at 6 GHz, based on typical parameter values, which are currently being carried out by the IMT industry indicate that coexistence is likely to be achieved – particularly in the 10 year timeframe for 5G at 6 GHz considered in our 6 GHz study.
- It is in particular believed that certain technology developments and suitable regulatory frameworks could facilitate the co-existence

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Summary of key findings

Benefit of using 6 GHz spectrum for IMT	Developed countries with good wired broadband	Developing countries with poor wired broadband
Economic delivery of a consistent 100 Mbit/s user experienced data rate, citywide, urban and suburban	✓	✓
Ensures that FWA broadband is a long-term solution	✓	✓
Lower cost for urban FWA overcomes lack of fibre or xDSL broadband access		✓
Improves rural FWA broadband economics to bridge the digital divide	✓	✓
Helps to deliver United Nations Sustainable Development Goals		✓
Economic delivery of a consistent 100 Mbit/s user experienced data rate on busy highways	✓	✓
Contributes to reaching the ITU and UNESCO Broadband Commission 2025 targets		✓

A detailed report on the 6 GHz band is available

If you would like to receive free of charge the report with the methodology and analysis to assess the impact of an IMT identification of 6GHz spectrum, please send me an email.

stefan.zehle@coleago.com

About Coleago Consulting

Since 2001, Coleago has provided a wide range of advisory services to the telecom industry world-wide

Spectrum Valuations and Auctions

- Spectrum strategy
- Spectrum valuation for auctions
- Spectrum auction bid strategy and execution
- Beauty contest bid books

Telecoms regulation & interconnect

- Accounting separation & price control
- Interconnect cost modelling, RIO
- Competition (merger) assessment
- Moving to a unified licencing framework

Spectrum policy and licencing

- Prepare and executing spectrum auction for regulator
- Spectrum policy and spectrum roadmap
- Spectrum related regulatory advocacy
- Spectrum pricing

Strategy & Business Planning

- 5G strategy
- Strategy development, marketing strategy
- MVNO and multi-brand wholesale strategy
- Business planning and business modelling

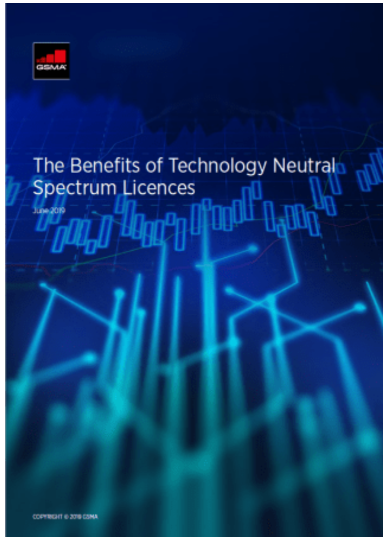
Mobile Network Sharing

- Mobile network sharing
- Managed services and outsourcing
- Tower due diligence
- Network audit

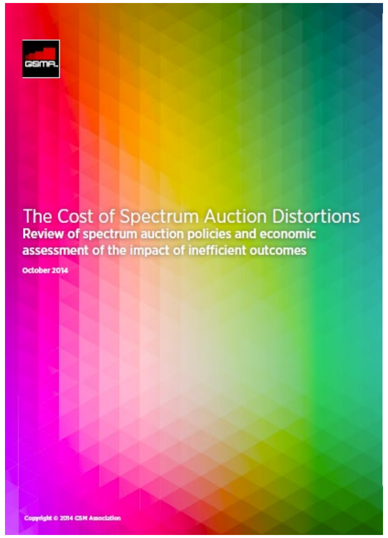
Transaction Services

- Commercial due diligence
- Tower due Diligence
- Preparation of Information Memorandum

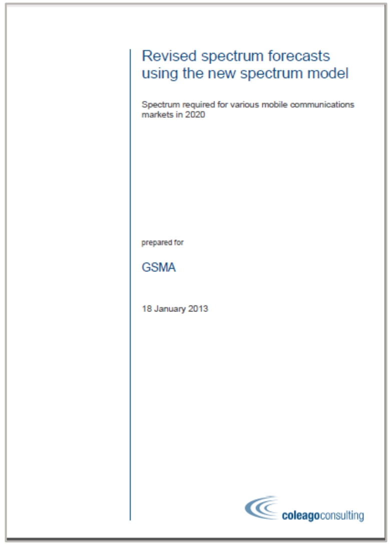
A sample of Coleago reports and conference papers in the public domain



The benefits of technology neutral spectrum licences, a Coleago report for the GSMA showing clear evidence that technology neural spectrum licences produce benefits for mobile services development and efficient use of spectrum.



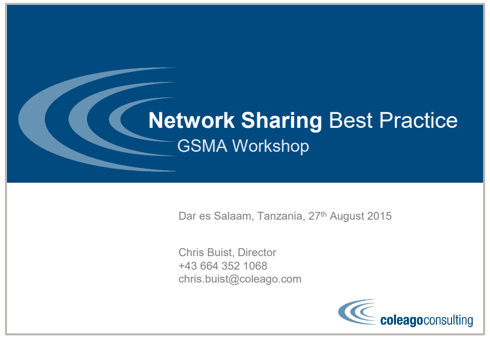
The cost of spectrum auction distortions, a Coleago report for the GSMA to highlight how flawed spectrum auction rules result in inefficient outcomes and adverse consequences for a country's economy



Report on Coleago spectrum demand model for the GSMA to estimate future spectrum demand for mobile broadband as an input to the WRC-15.

Spectrum Auctions: Best Practice Workshop, New Delhi, 24th of Sept. 2014 for the Department of Telecommunications & TRAI, sponsored by GSMA

Assessment of spectrum award procedures, a 2 day training course for the European Commission developed and delivered by Coleago



Workshop for the GSMA on best practice network and spectrum sharing, for operators in Tanzania

Coleago has carried out over 120 spectrum consultation, valuation, auction, spectrum licence regulatory, and beauty contest licence projects

Completed in 2018

- Denmark – 700 and 3500MHz
- Ukraine – 1800, 2600MHz
- Paraguay – 700MHz
- Malaysia – 700MHz
- Ireland – 3.5GHz
- Canada – 600MHz
- South Africa – 800, 2600MHz
- Botswana – Frequency Plan
- Nigeria – 900, 1800MHz
- Guatemala - multiple
- Angola – multiple
- Peru – multi-band
- Bahrain – 800, 2600MHz
- Oman – Multi-band renewal
- Belgium - Multiple

Completed in 2019

- Slovenia - 700 and 3500MHz
- Slovakia - 700 and 3500MHz
- Malaysia – 700, 2300, 2600MHz
- Bahrain – 800 and 2600MHz
- Afghanistan – multi-band
- Georgia – multi-band
- Iraq – licence renewal
- Colombia – 850MHz renewal
- Colombia – spectrum policy
- Chile – 3.5GHz regulatory issues
- Nigeria – multi-band
- South-Africa – 700, 800, 2600, 3.5
- Global – spectrum pricing
- Global – technology neutrality

Projects in 2020

- Canada – 3.5/3.8GHz
- Iraq – 3.5GHz FWA
- Ghana – Multiple
- South Africa – 3.5GHz
- Europe – spectrum pricing
- Uganda – 700MHz
- Greece – Multi-band
- Southern Africa – spectrum policy framework
- Global – IMT identification of 6GHz