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ETSI
INDUSTRY SPECIFICATION GROUP (ISG) ON MILLIMETRE WAVE TRANSMISSION (mWT)

PROPOSALS FOR SPECTRUM LICENSING FOR WIRELESS BACKHAUL FACILITATING FUTURE MOBILE NETWORK

15/02/2023

5G Impacts on Economy

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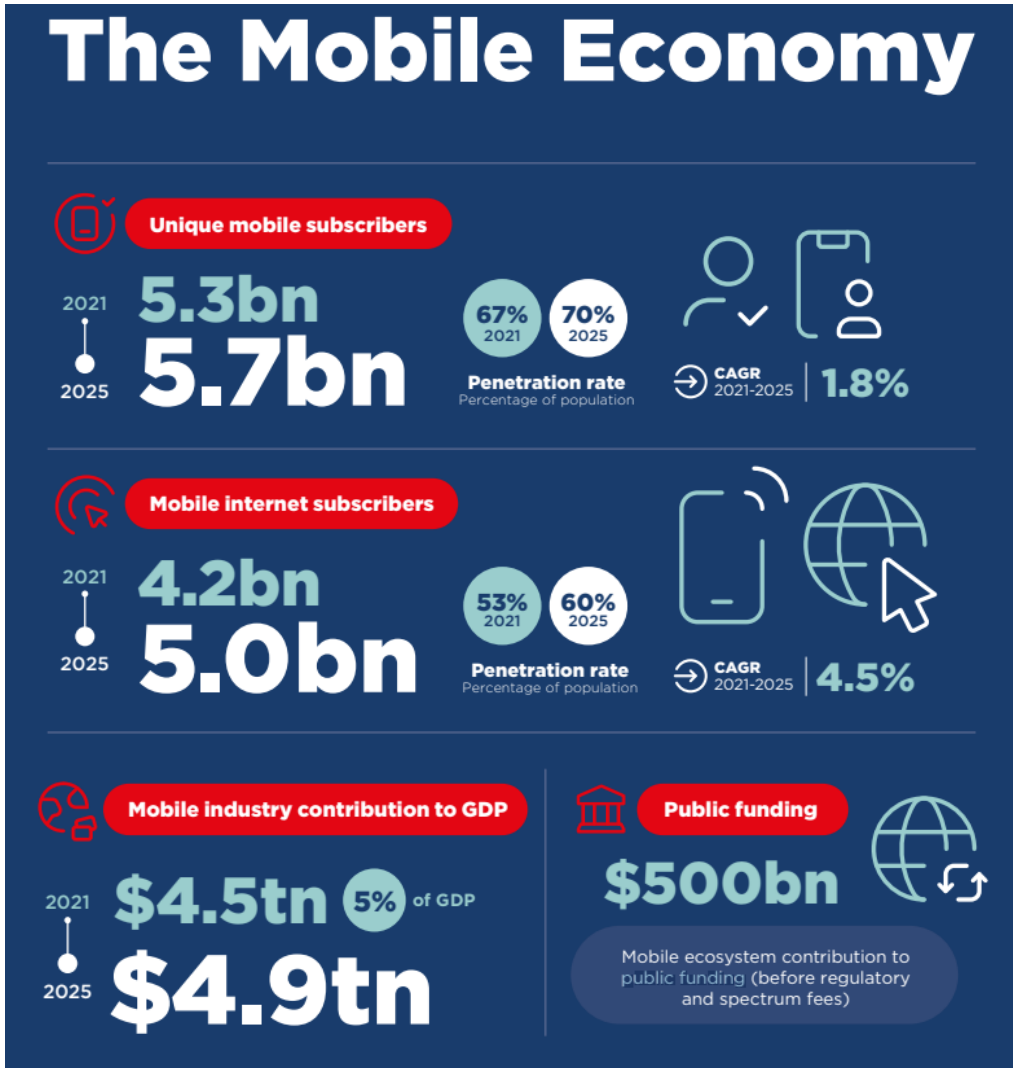

- 5G is a pillar of digital transformation impacting communities and economies
- In 2021, as 5G delivers transformational services, it generated 5% of global GDP, a contribution of $4.5Trillion of economic added value
- The mobile ecosystem supported ~ 26 million jobs (directly and indirectly) enabling a contribution to the funding of the public sector, with almost $500bn through taxes (excluding spectrum fees)
- This can only happen, however if sufficient spectrum resources are made available for enabling the Backhaul/Fronthaul network modernization.

Ref: GSMA- The Mobile Economy 2022

5G Impacts on Economy

Regions, Sectors, Use cases and Penetration

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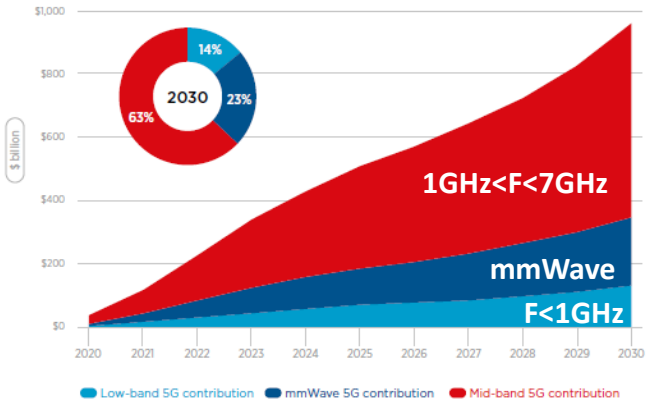
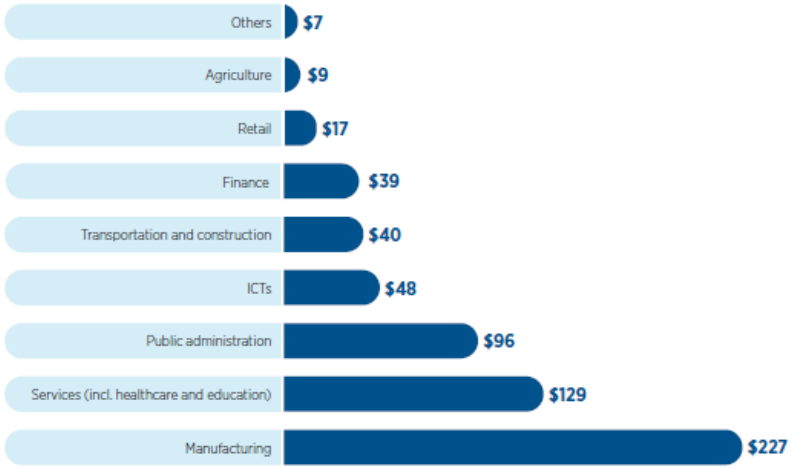
Annual impact of 5G on GDP, by band, 2020-2030



Estimated global contribution of mid-band 5G spectrum to GDP by sector, 2030

($ Billion)



Regional overview in 2030: GDP contribution generated by mid-band 5G

North America
GDP $122bn
Percentage of GDP 0.36%

Latin America and the Caribbean
GDP $41bn
Percentage of GDP 0.50%

Asia Pacific
GDP $285bn
Percentage of GDP 0.51%

East Asia and the Pacific
Sub-group of the Asia Pacific region
GDP $218bn
Percentage of GDP 0.52%

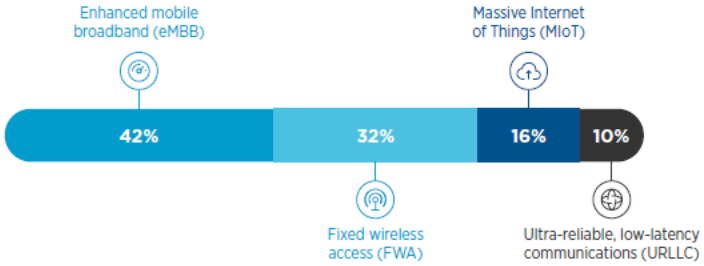
Europe
GDP $121bn
Percentage of GDP 0.38%

RCC*
GDP $14bn
Percentage of GDP 0.51%

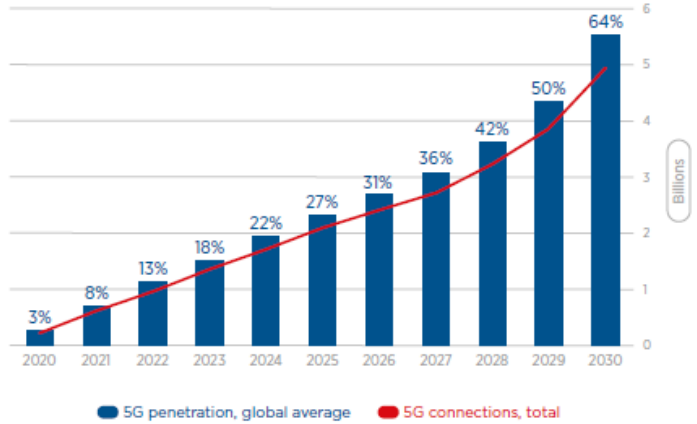
Middle East and North Africa
GDP $16bn
Percentage of GDP 0.35%

Sub-Saharan Africa
GDP $13bn
Percentage of GDP 0.37%

Projected global contribution of mid-band 5G spectrum to GDP, by use case



Global 5G connections and market penetration, 2020–2030



5G benefits will depend by the rate of penetration.

Ref: GSMA - The Socio-Economic Benefits of Mid-Band 5G Services – Feb.2022

Wireless Backhaul Evolution → Why WBH is so important

GSMA view – Transport Network and WBH role

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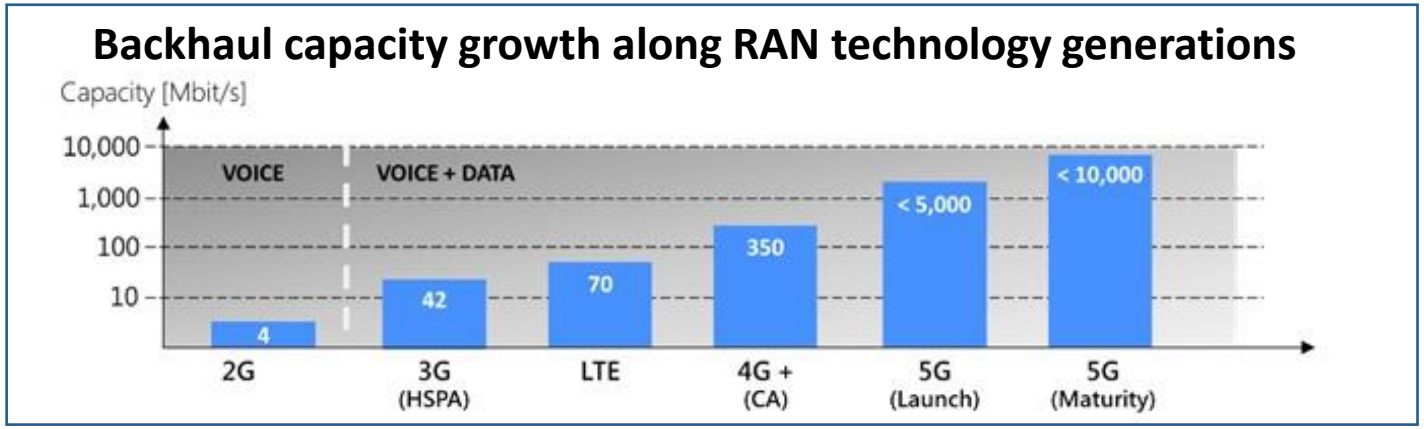
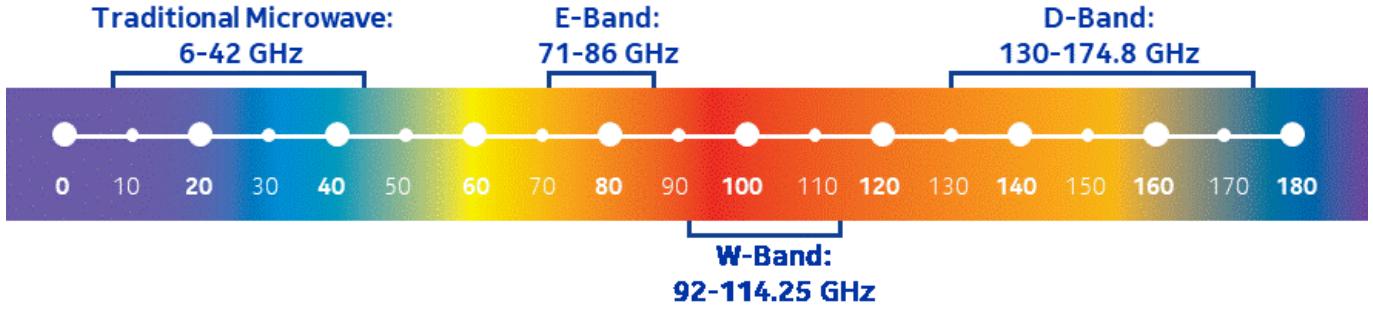
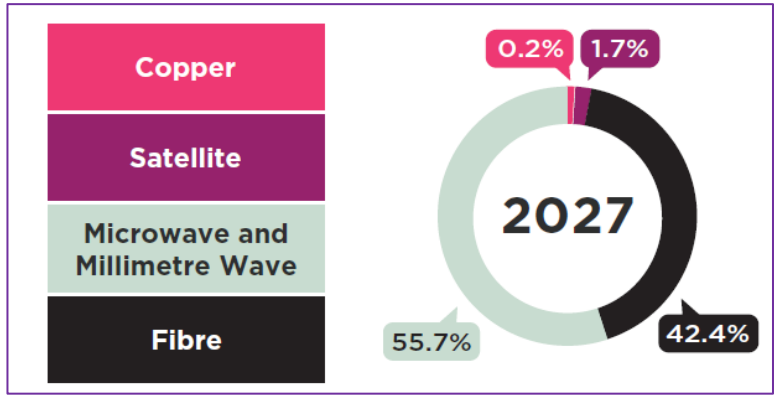
Evolving 4G and 5G networks require significant additional, affordable backhaul spectrum.

Wireless backhaul – using new and refarmed spectrum bands – will be vital as fibre will not be available or affordable in many areas. This will only be possible with the right regulatory decisions.







Microwave and millimetre wave backhaul will continue to be used by a majority of global macro and small cell backhaul links from 2021 to 2027. Followed by fibre as the second most popular option.

KEY FACTORS FOR WBH

→ BAND AVAILABILITY AND CHANNEL SIZES

- Traditional bands with larger channels, 56-224MHz are needed
- E-band spectrum is needed today
- W-band and D-band are expected to be needed in near future
- The E-band and W-band are expected to support channel sizes of up to 2 GHz and D-band even wider channel

Ref: GSMA and ABI Research "Wireless Backhaul Evolution"

Wireless Backhaul

What is wireless backhaul (WBH)

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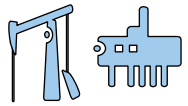
Point-to-point links

Different frequencies depending:

- Distance
- Throughput/Latency
- Country regulation
- Rain zone

What WBH connects

RAN
Mobile and Private Wireless Backhaul

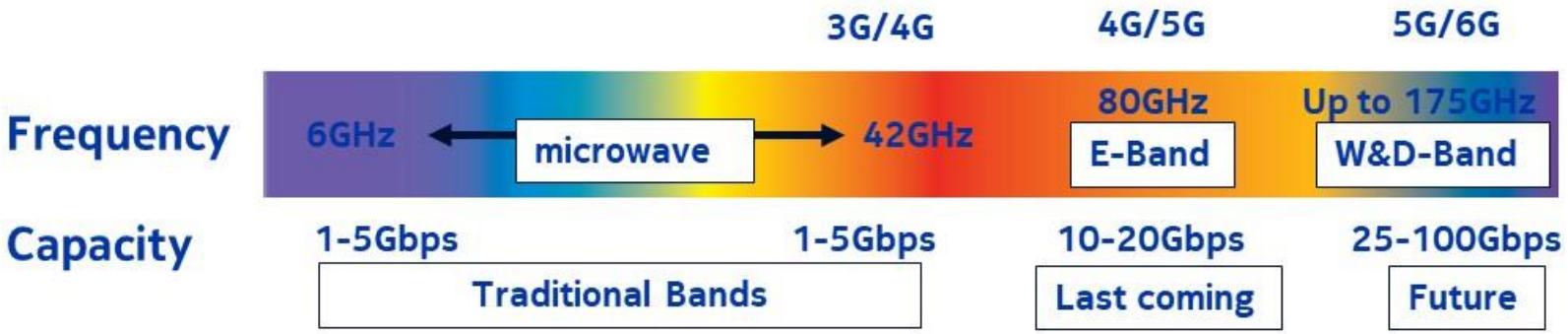


Enterprise
Mission critical Networks, Government, Transport, Mining

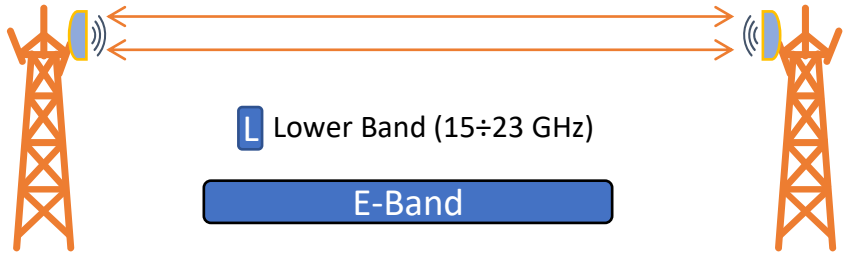
Long distance
High-Capacity Backbones
Rural sites
Difficult fiber accessibility

Technology

Towards higher frequencies, for larger bandwidth and more capacity, reduced form-factor



Bands and Carriers Aggregation (BCA)
Mixing bands & Single antenna



Overview of current wireless backhaul capabilities vs 4G & 5G.

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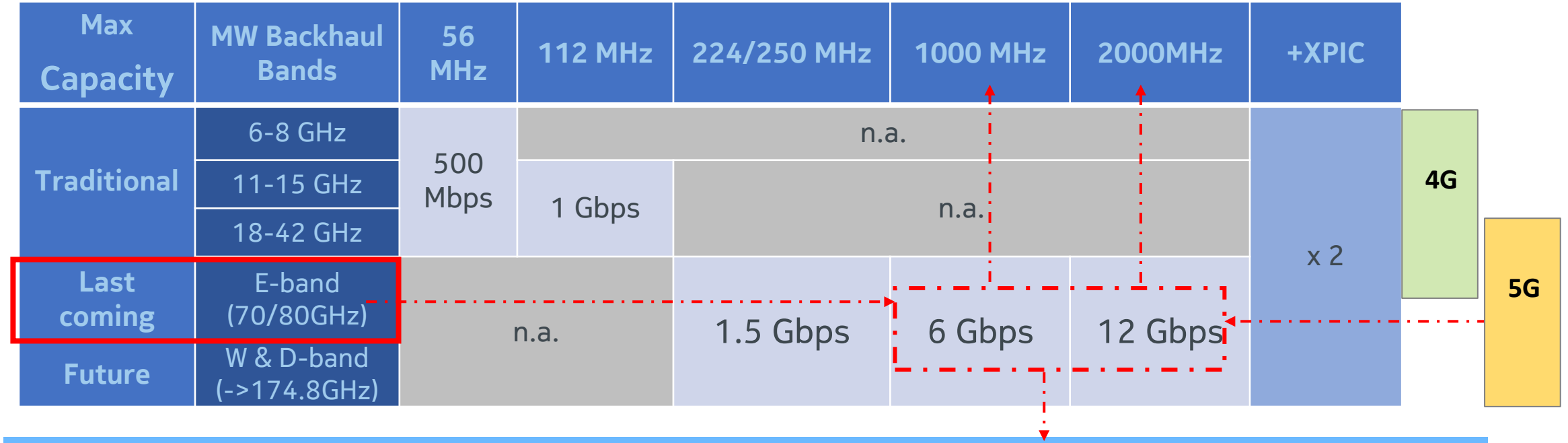
Why E-Band and wider channels are mandatory to have

- Evolution to enhance capacity → larger channels and XPIC (Frequency Reuse)
- **E-Band** is the **key band** and the **baseline for any backhaul network** post 4G because having wide channels makes it possible to transport capacities in the order of Gbps
- Bands and Carrier Aggregation (**BCA**) → **E-Band** combined with one traditional band (same antenna) mainly, for large distances
- Reuse of the same channel with XPIC and LoS MIMO is doubling the capacity (spectral efficiency)



5G capacity requires today a wireless backhaul solutions based on E-band and larger channels

xG Market Penetration vs Normalised Fees Traditional Bands

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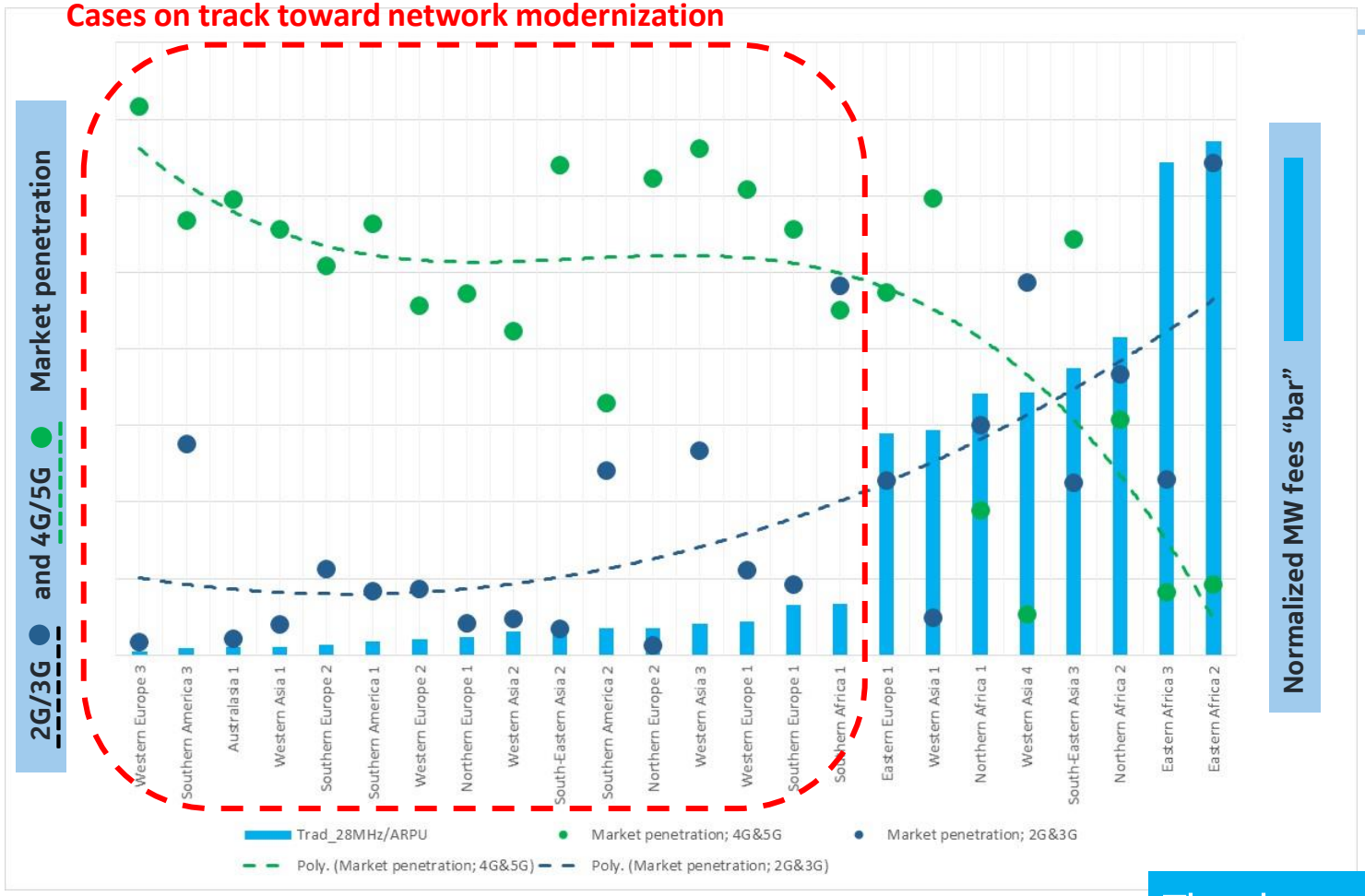


- The annually fee level for 18GHz 28MHz, was considered as a representative case for the purpose of comparison.
- Fees were normalised (NF) divided it by country monthly ARPU(*).
- Countries were sorted by increasing normalised traditional bands fees
- Dots indicate the level of 2G & 3G (blue) and 4G & 5G (green) penetration, as a percentage share of the total market population (*)
- The two dashed lines represent the two cases interpolated with a polynomial.

2G & 3G importance and usage has today waned and then 2G & 3G should be switched off for the faster and more efficient 4G and 5G networks

The degree of network modernisation is given by two KPIs:

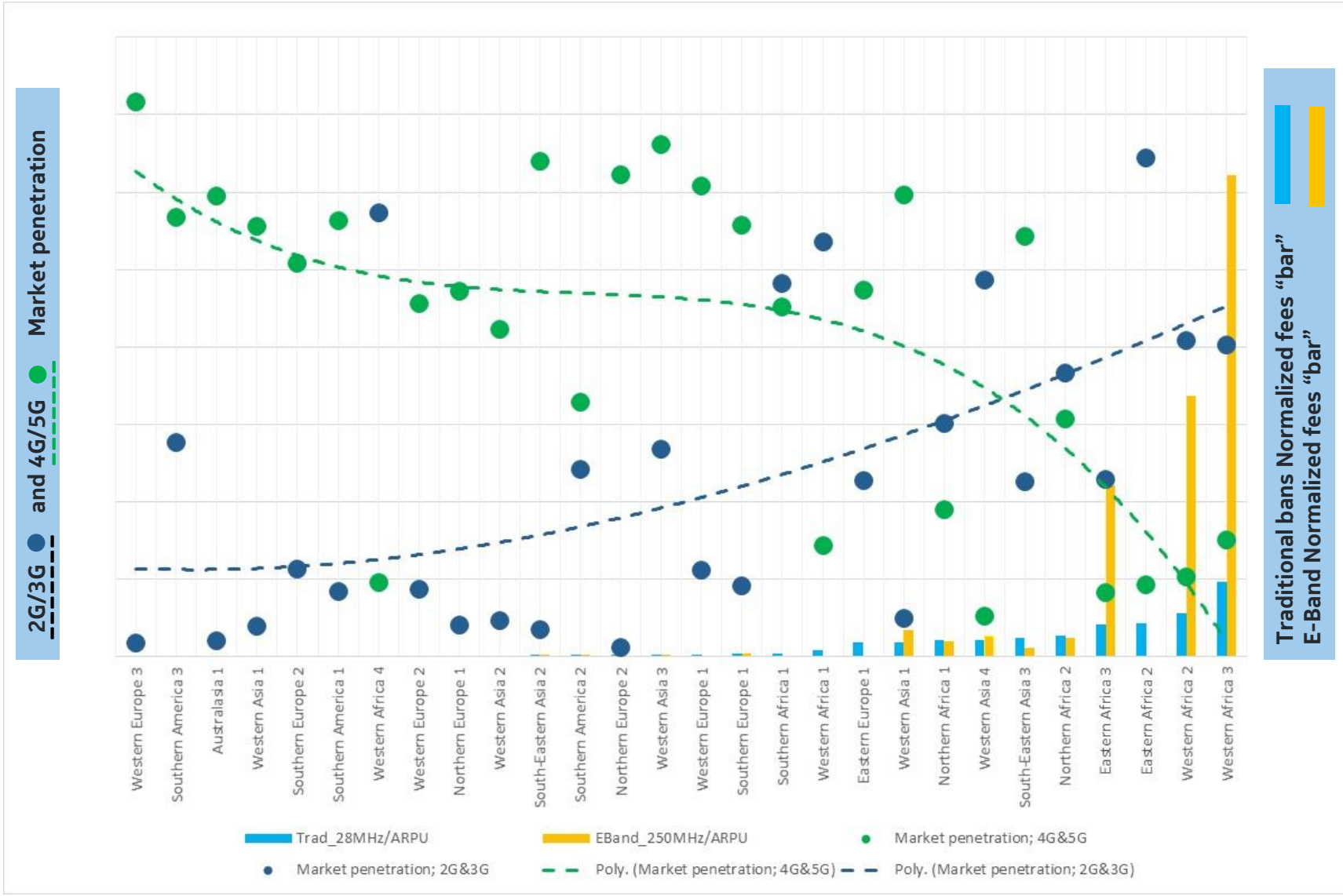
- Level of 4/5G penetration – Green line
- 2/3G switch-off level – Blue line

(*) Reference:

- Monthly ARPU and penetration data from GSMA
- Fees data from public websites

xG Market Penetration vs Normalised Fees E-Bands & Traditional Bands

ISG mWT



- E-Band normalised fees for the 250MHz channel, are reported as well (yellow bar).
- Excluding rare cases, the rank based on traditional bands Fees level remain substantially unchanged when considering E-Band cases.

xG Market Penetration vs Normalised Fees E-Bands & Traditional Bands

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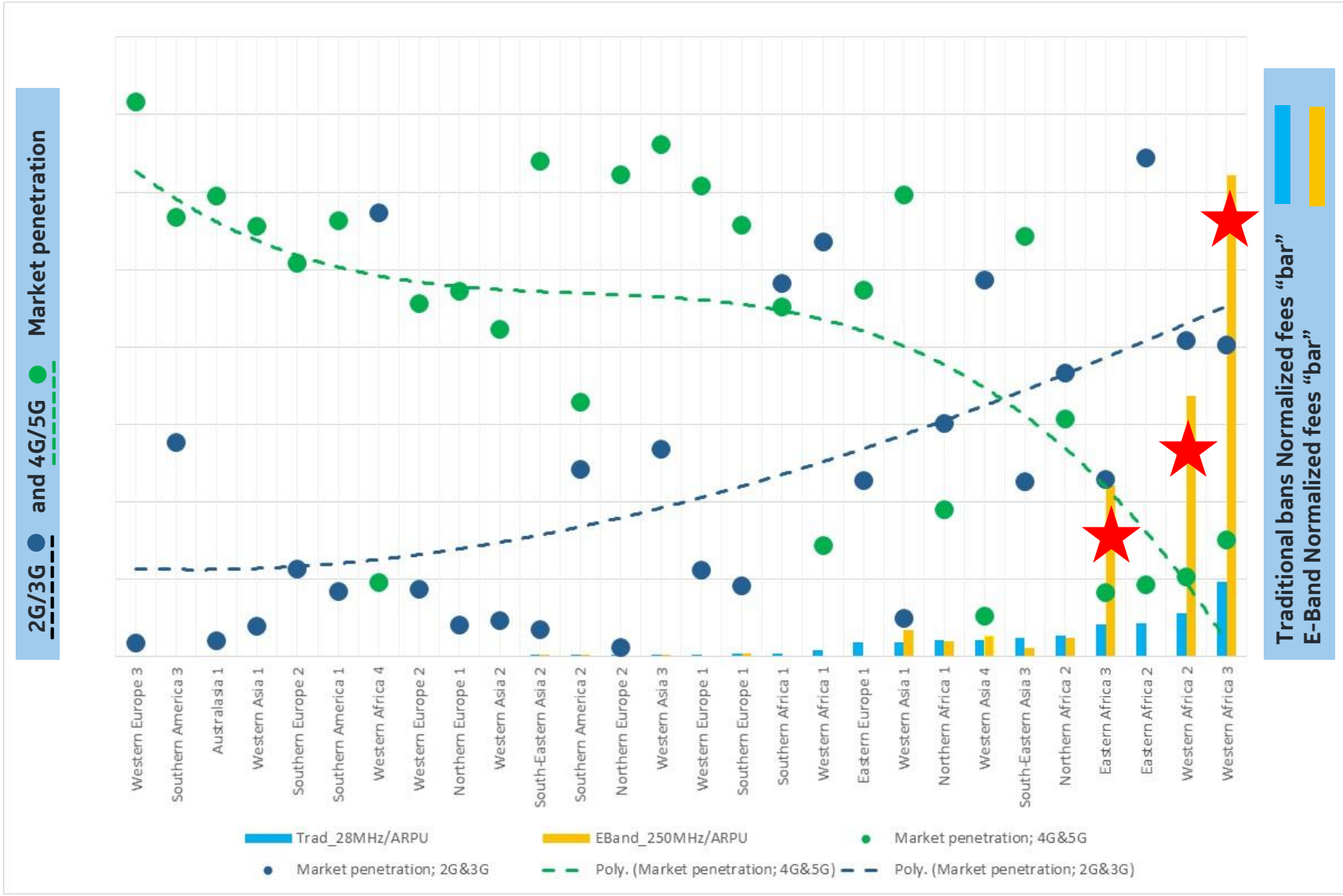

- E-Band normalised fees for the 250MHz channel, are reported as well (yellow bar).
- Excluding rare cases, the rank based on traditional bands Fees level remain substantially unchanged when considering E-Band cases.
- Let's remove these ★ three extreme E-Band Fees cases for having a better view

xG Market Penetration vs Normalised Fees E-Bands & Traditional Bands

Cases on track toward network modernization

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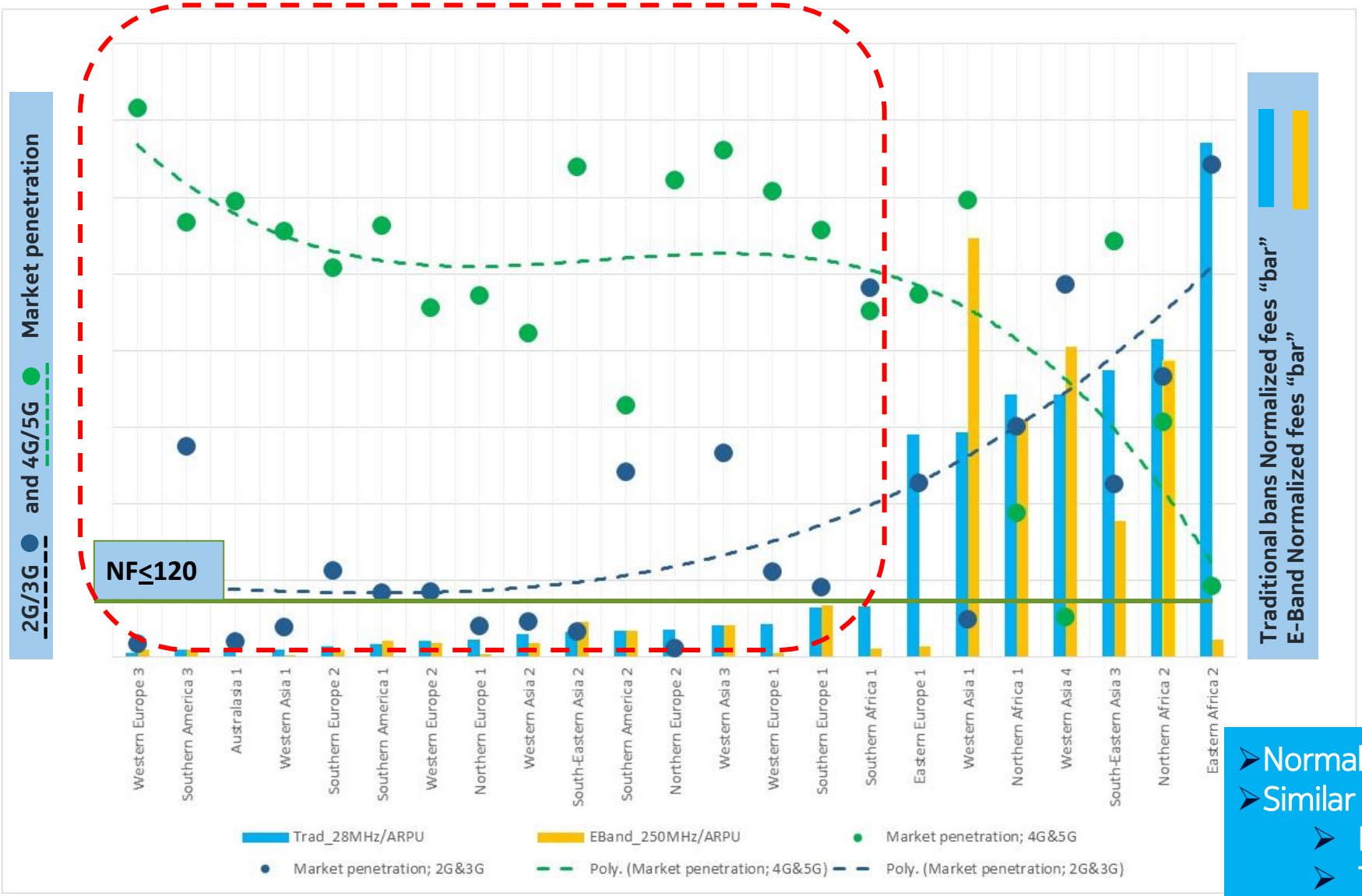

- E-Band normalised fees for the 250MHz channel, are reported as well (yellow bar).
- Excluding rare cases, the rank based on traditional bands Fees level remain substantially unchanged when considering E-Band cases.
- Let's remove these ★ three extreme E-Band Fees cases for having a better view
- We can note a good tendency in many of the cases already <u>on track to modernise the network</u>, to apply the following rules:

- Normalised Fees levels below 120 (NF<120)
- Similar fee level for the two reference cases:
  - E-Band/250MHz
  - Traditional bands/28MHz.

xG Market Penetration vs Normalised Fees

Same data ordered differently

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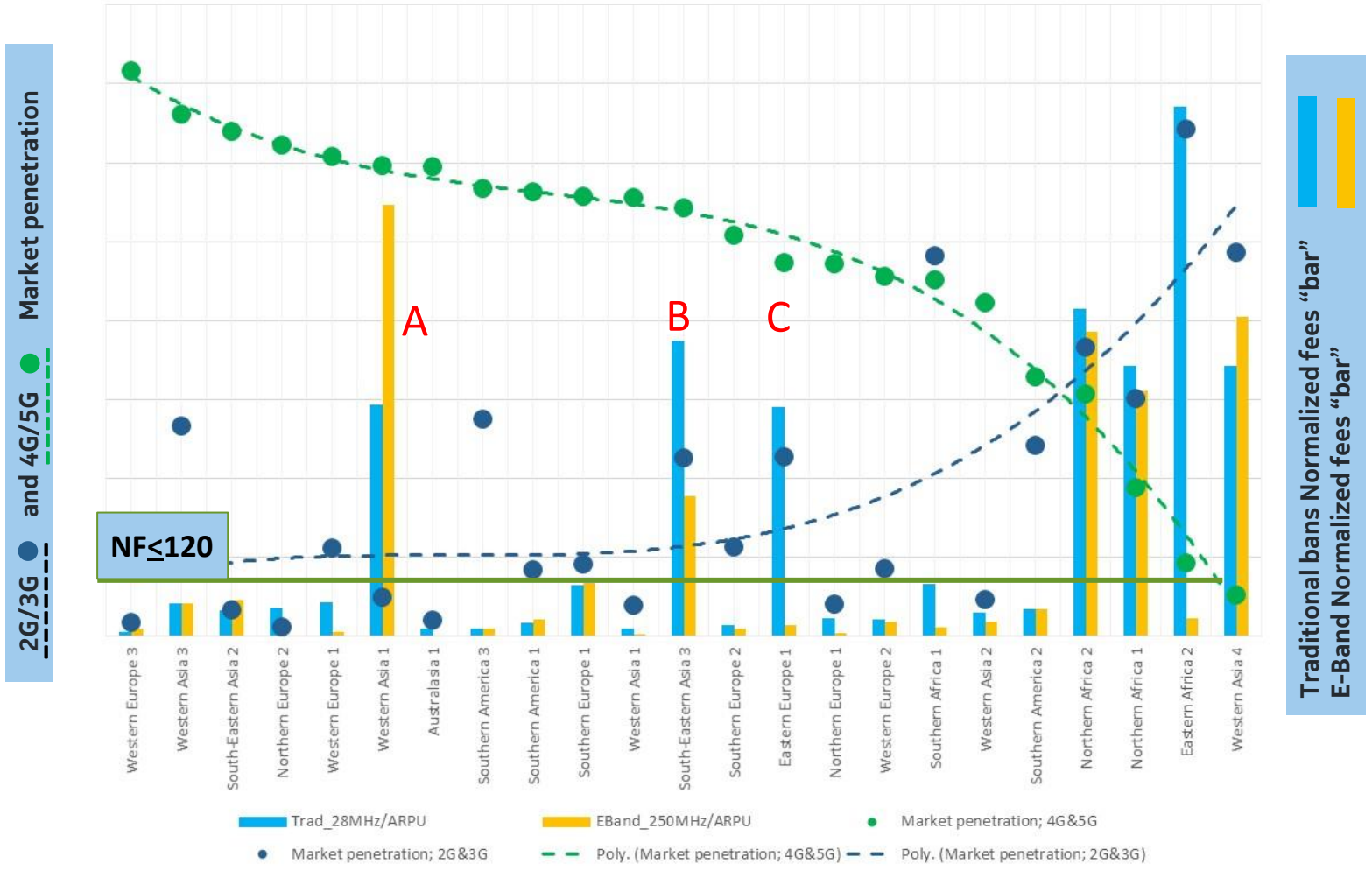

The same data presented before but ordered, differently, by decreasing values of 4/5G penetration.

With three exceptions, A-B-C, this picture confirms the strong correlation between fair/low normalised Fees and high level of 4/5G penetration.

Case A: Government's heavy investment in favouring fibre. Difficult and onerous to complete the 4/5G penetration

Case B-C: Despite the governments' heavy investment in favouring fibre, 4/5G penetration is not excellent and 2/3G is holding out.

Majority of the cases on the left, with an high degree of 4/5G penetration, are applying fair/low spectrum fees level

Best Practice

- Two best practices are here provided as possible guidance
- These two cases recently changed the fees policy in such a way to encourage, enabling and favouring the use of the WBH and opening to a fast and sustainable transport network modernization
- They represent a good example for managing the spectrum for WBH, to adapt it to the new challenges due to 5G introduction (allowing wider channel and E-Band) and incentivizing the spectral efficiency as well (e.g.: incentivizing the XPIC)

→ More info can be found here: ETSI_ISG_mWT

Best Practice #1a
KSA - E-Band opening incentivized 5G Roll-out

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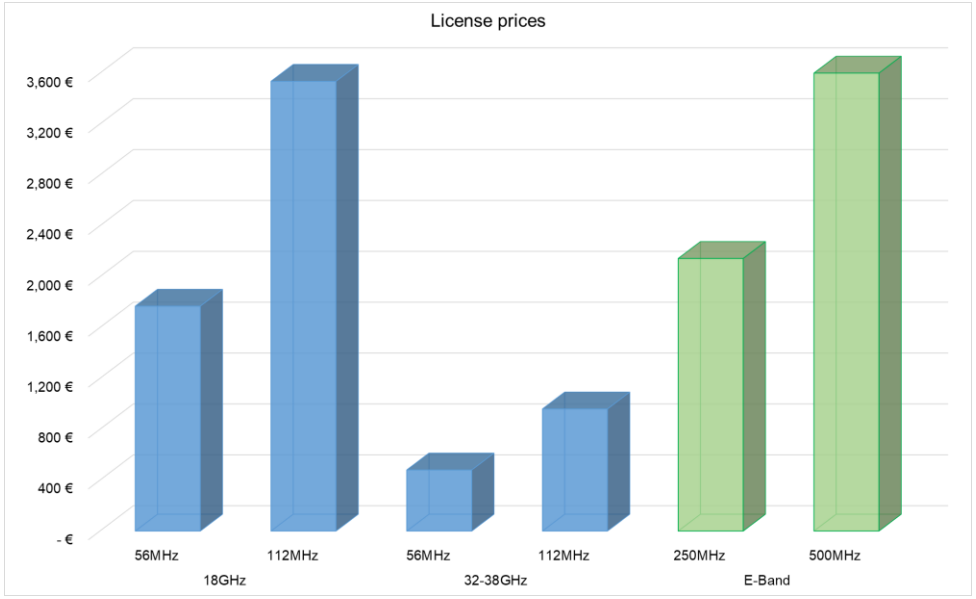
Spectrum Fee= 0.1xB x H x M x P x W x L x G Saudi Riyals

Parameter	*Definition*
B	The bandwidth factor
H	The antenna height factor
M	The mobile or non-directional antenna factor
P	The power factor
W	Spectrum demand density factor
L	The high-usage-cities factor
G	Geographical coverage factor

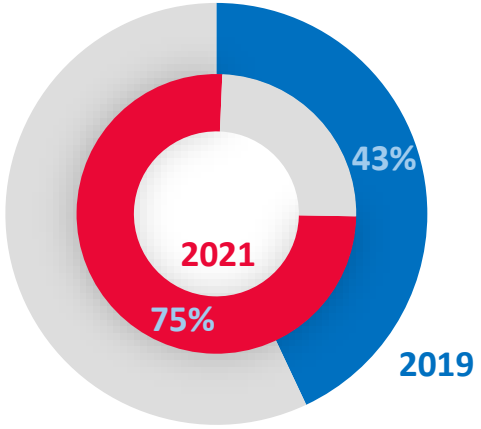


1SAR=0.25€

Old Formula

- Same spectrum demand density factor for all bands >30GHz
- Frequency reuse x2
- Price per Mbps per MHz makes E-Band better choice compared to Traditional bands
- **Massive E-Band and BCA deployment in 2019-2021 granted to improve 5G coverage by 74%**

5G Coverage as percentage of total KSA Population



Source: GSMA Intelligence

Best Practice #1b
KSA - - New license scheme released to incentivize wireless backhaul

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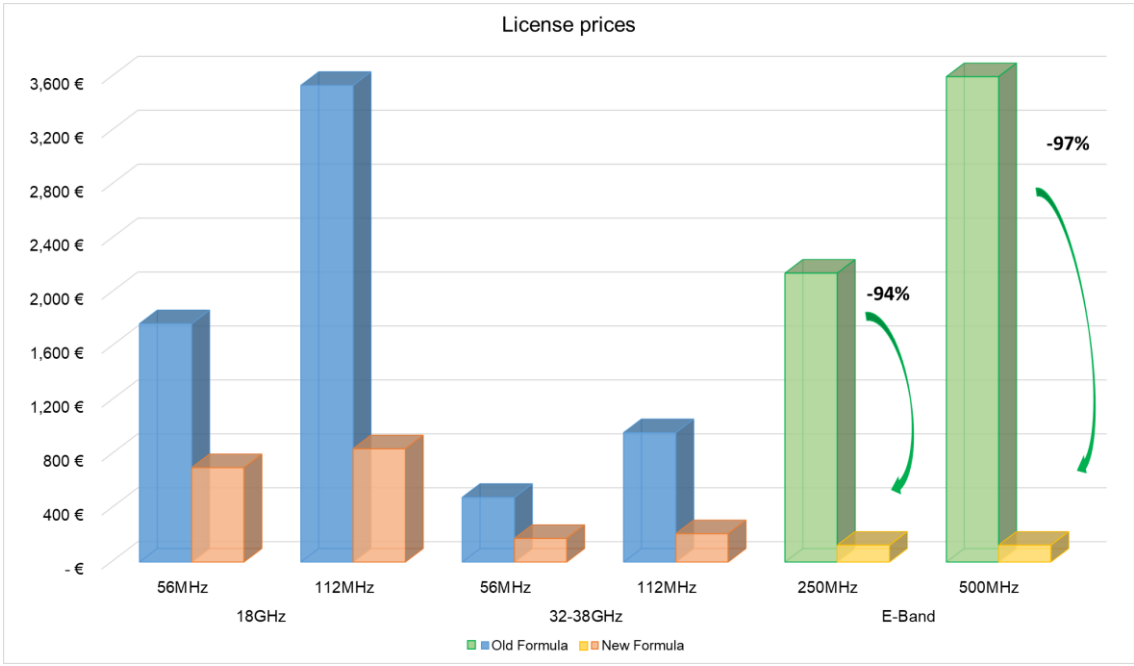
NEW Formula

Spectrum Fee= C x B x F x S x E Saudi Riyals

- (C): A fixed value that represents the minimum costs of frequency spectrum management and is equal to (200).
- (B): The bandwidth factor; the value of this factor is equal to the sum of the transmitter frequency bandwidth in MHz.
- (F): The frequency band factor.
- (S): The Frequency spectrum service factor.
- (E): The Frequency spectrum efficiency factor; the value of this factor in normal cases is (1). CITC has the right to set other values for this factor in some cases according to what CITC perceives to be encouraging for the optimal use of the frequency spectrum.

- Band Factor F decreasing when Frequency band Increase
- Frequency reuse x2
- About 60% decrease for 56MHz CS and >75% for 112MHz CS
- More than 90% cost reduction on E-Band



1SAR=0.25€

Best Practice #2
Italy – New License Scheme Incentivize Frequency reuse

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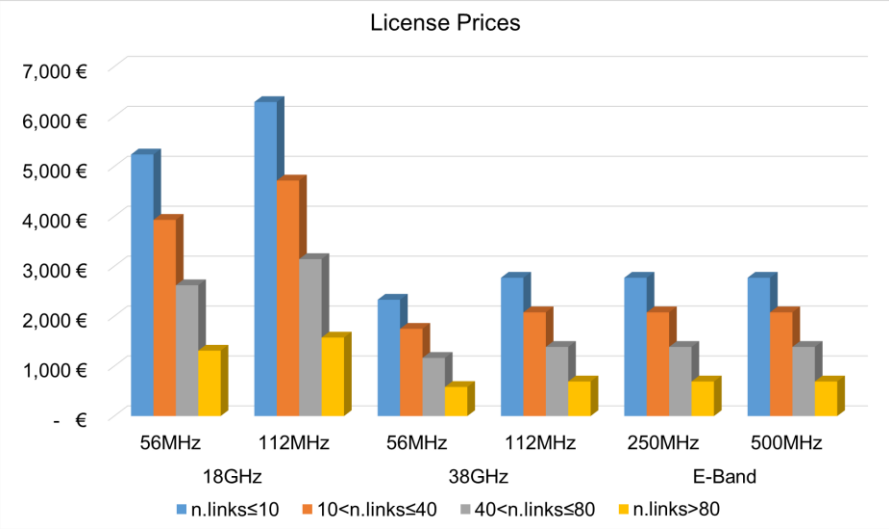
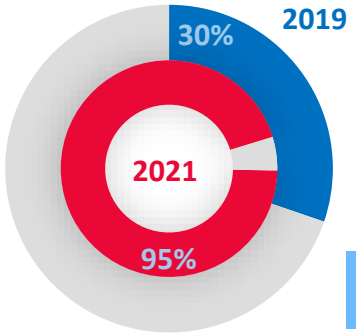
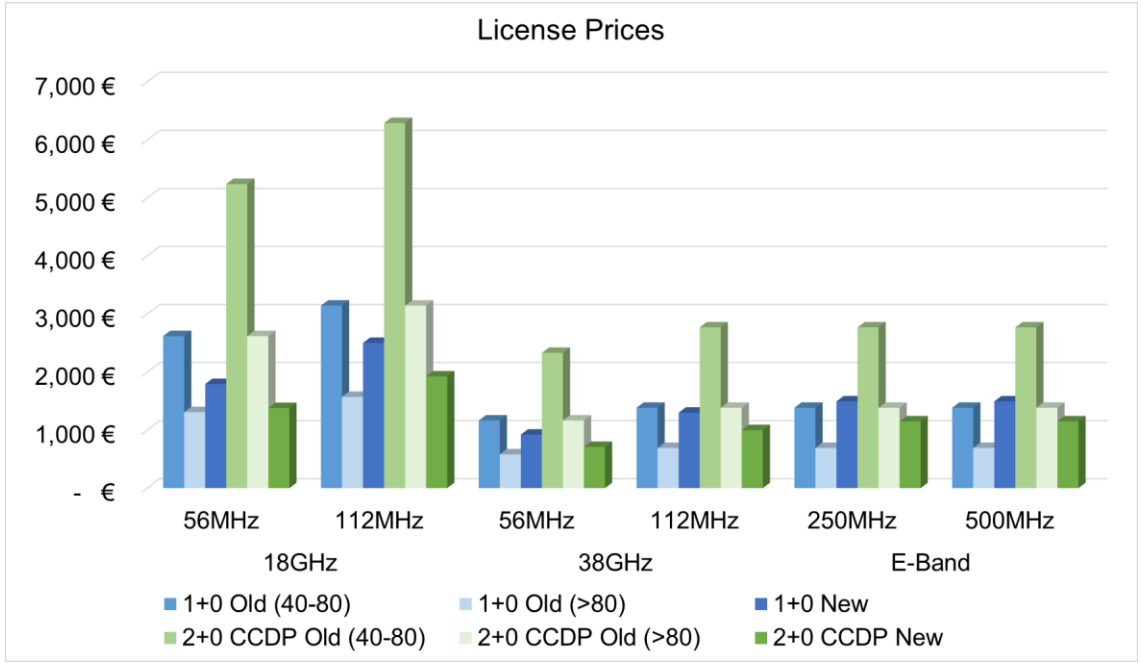


Old Prices
- Discount on link deployment basis
- Frequency reuse x2
- Same price above 30GHz/56MHz
- E-Band/BCA deployment for 5G sites connection



Source: GSMA Intelligence

New Prices
- Price fixed for 2+0 CCDP, 1+0 links price increased 30%
- Price independent from link deployment
- E-Band cost savings in 2+0CCDP configuration (-17% worst case)
- Traditional bands: cost saving for 2+0 CCDP (-28% worst case) and for 1+0 (≤80 links) reducing costs for small local operators/WISP
- 1+0 not competitive on large scale (+37%~+88% for traditional bands, 2x for E-Band)



To be noted that fees are not scaled linearly with channel size. E.g.: Fees for 112MHz vs 56MHz are +22%

Conclusion/Takes aways

→ Quickly modernizing the transport network, aims to 5G deployment and preparing the future 6G, brings substantial socio-economic benefits to the whole population.

→ One of the key element that allows this to happen is the effective availability of the WBH solution for complementing fibre infrastructure.

→ The studies here presented shows that the effective availability of WBH solution is strictly correlated to the availability of the suited frequency spectrum and to the fair level of the fees to be paid for it.

→ In the end, it is proposed a reference level for the ARPU normalised fees to be considered for the cases of 28MHz channel in traditional bands and 250MHz channel in E-Band. For different channel sizes, fees should be based on connectivity and then not linearly scaled with channel size.

Thank you