



**Long term view on Fixed Services
in frequency bands below 10 GHz;
Assessment of low frequency bands importance
in delivering ubiquitous network coverage**

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Reference

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ETSI

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Foreword

This Technical Report (TR) has been produced by ETSI Technical Committee Access, Terminals, Transmission and Multiplexing (ATTM).

Modal verbs terminology

In the present document "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

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Executive summary

Wireless Backhaul is and has always been a key asset in building transport networks not only for reaching locations not yet connected by fibre thanks to the high capacity delivered and the fast time to market, but also to provide effective disaster recovery networks and fibre back-up.

Notwithstanding fibre penetration and mobile networks evolution shifted network topology towards short link at in high bands (15 GHz to 80 GHz), infrastructure network in developing countries, rural areas, mountain sites and islands require long reliable MW links.

Moreover, last mile links connecting mobile sites to the first fibre PoP and feeder links and high capacity backbones that aggregate the traffic of multiple sites are deployed also in low bands: hops longer than 15-30 km rely on frequency bands lower than 10 GHz thanks to reduced rain attenuation and favourable propagation conditions.

In the present document different aspects of wireless backhaul have been analysed in order to have a picture of the usage of different bands, in general, and bands lower than 10 GHz in detail.

Clause 4 gives overview on bands available for Fixed Services and relevant application scenarios. Capacity requirements and MW capability to fulfil them are the key point to understand the necessity to have enough spectrum in different frequency bands to grant ubiquitous ultra-broadband connectivity.

Clause 5 collects analysts, vendors and international organizations bands statistics to present actual bands deployments and trends for wireless backhaul. Focusing on bands below 10 GHz regional segmentations have been analysed highlighting huge differences across the world on band usage. The relevance of the discussion on low bands allocation is underlined by the operators' contributions: some global level operators disclosed their network statistics giving an insight of configurations and applications of these bands and confirming their unique value to deliver reliable high-capacity connections.

Clause 6 gives a high-level introduction of microwave planning rules defined by ITU-R and compare the link performances in low bands (6 GHz to 13 GHz). Since propagation losses vary with the frequency band and geographical area, 6 GHz, 7 GHz and 11 GHz have been considered, using different configurations and setting the parameters for designing hypothetical links. The analysis demonstrates that under specific propagation conditions the performances of 11 GHz over medium long links do not meet the KPI usually set in mobile backhaul networks. Link length statistics in Europe, Sub-Saharan Africa and USA have been reported showing a great spread in average and maximum link length deployed mainly due to different application scenarios and wide variations in rainfall across the regions.

The information collected confirm the need of granting enough spectrum to wireless backhaul, including bands below 10 GHz, to build ubiquitous, reliable and ultra-Gbps communication networks.

Introduction

Microwave Radio, Fixed Service as per ITU-R Radio Regulation, represents a key technology for building infrastructure communication networks since early 1950's of last century serving multiple application scenarios, evolving from long haul nationwide backbones to present wireless backhaul links capable to deliver ultra-Gbps capacities required by 5G mobile access.

Mobile backhaul network topology is evolving from tree topology to hub-and-spoke as long as the fibre penetration and mobile network densification increase: not only chains of cascading links are shortening but high frequency bands became predominant in wireless backhaul (ETSI White Paper No.25 [i.1]).

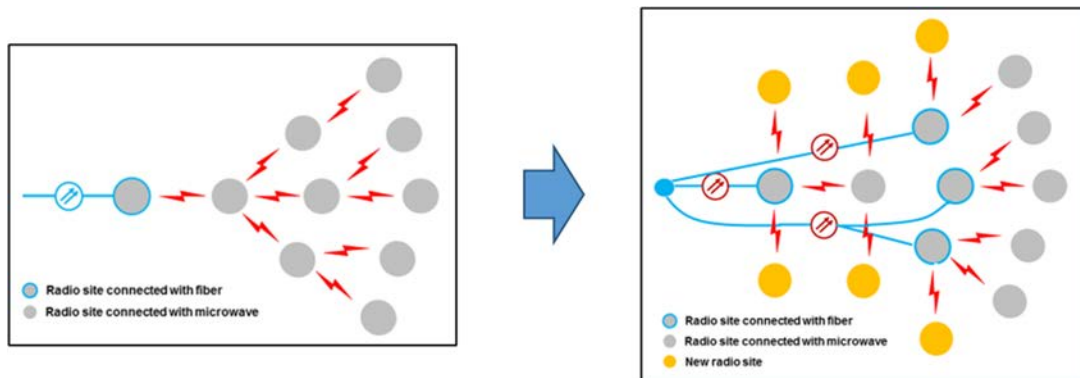


Figure 1: Topology evolution in the macro cell backhaul network

Nevertheless, widespread 4G/5G coverage requires nationwide transport network capable to reach remote locations, small rural/mountain communities or island/offshore sites and microwave technology is a key enabler in delivering ultra-broadband connectivity wherever fibre is not available.

Moreover, even though Mobile Sites Backhaul (MBH) is the main application scenario, wireless transport complements or substitute wirelines in multiple telecom and vertical deployments:

- National Broadband Networks, to deliver fixed broadband connection remote areas like mountains communities or islands.
- Local operators, WISP/ISP infrastructure networks.

- Army/police, utilities and broadcasters' private communication networks and data collection.
- Private line connection to Small and Medium Enterprises, schools, hospitals.
- Disaster recovery communication networks after emergencies like floods, earthquakes, fires.

Microwave Radio delivers fast, flexible and reliable broadband and ultra-broadband connections, the choice of frequency band according to different application scenario, required capacity and link length:

- Short haul radios are available in all MW bands (6 GHz to 80 GHz) and are mainly used in last mile connections: split mount or full outdoor architecture in high bands (≥ 18 GHz) or mm-wave deliver ultra-Gbps connectivity over short distances. Mid/low bands are chosen to collect the traffic from sites far from fibre PoP.
- Long haul radios are available in low bands (≤ 13 GHz) and are mainly used in long feeder links or high capacity backbones, even though they can be selected in the last mile for covering distances higher than 30-40 km to deliver ultra-Gbps connectivity.

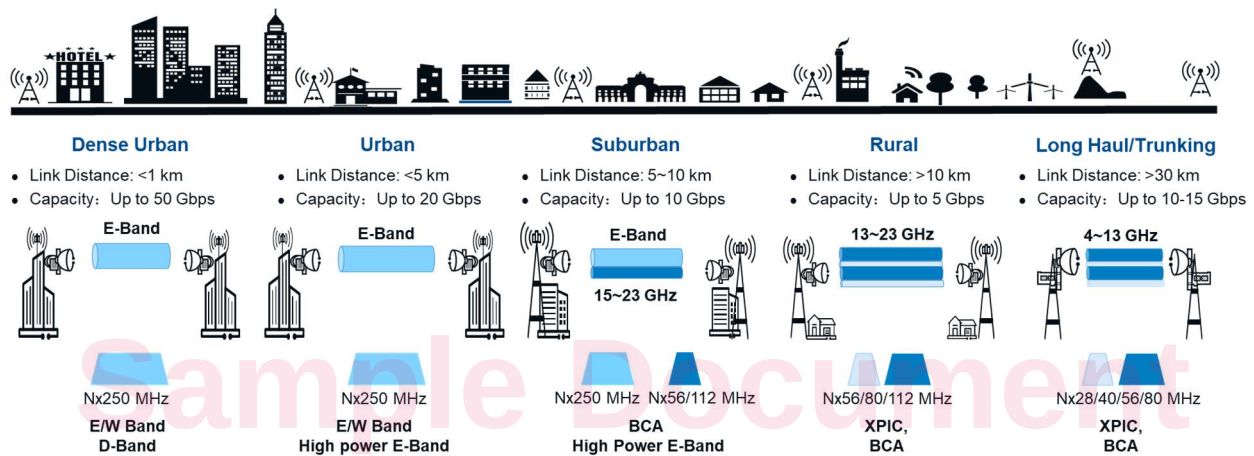


Figure 2: Microwave application scenarios

The availability of enough spectrum in each segment is paramount important to grant broadband connectivity in each network layer: high power E-Band, E-Band and E-Band-traditional bands BCA provide ultra-Gbps capacities with simple configurations over relatively small distances for both access and feeder links, while the lack of very wide channels in lower frequency bands leads necessarily to multi-channels single band or multiple bands configurations to deliver the required capacity over longer distances either as last mile connection or as fibre alternative/complement over long haul backbones.

The present document will report microwave bands usage and application scenarios focusing on low bands assessing the actual deployment inside and outside Europe to map present and future needs to fulfil operators backhauling needs.

1 Scope

The present document assesses the importance of low frequency bands in wireless backhaul networks collecting information on current use by Fixed Services of the bands lower than 10 GHz, expected use on medium term and reporting technical considerations on why bands below 10 GHz are necessary to deploy long haul links, supported by link planning examples and bands performances comparison in different areas.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non-specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents may be useful in implementing an ETSI deliverable or add to the reader's understanding, but are not required for conformance to the present document.

- [i.1] ETSI White Paper No. 25 (February 2018): "Microwave and Millimetre-wave for 5G Transport".
- [i.2] Recommendation ITU-R P.530-17: "Propagation data and prediction methods required for the design of terrestrial line-of-sight systems".
- [i.3] Recommendation ITU-R F.746-11: "Radio-frequency arrangements for fixed service systems".
- [i.4] ETSI GR mWT 012 (V1.1.1): "5G Wireless Backhaul/X-Haul".
- [i.5] Radio Regulation, Edition of 2024: Articles (Vol.1) and WRC-23 Final Acts (Vol.3).
- [i.6] ETSI White Paper No. 58 (July 2023): "Worldwide Analysis and proposals to promote and facilitate the wireless transport networks as the key enabler for fat mobile backhaul network modernization".
- [i.7] GSMA Wireless Backhaul Evolution-Delivering next-generation connectivity (2021).
- [i.8] ECC Report 173: "Fixed Service in Europe Current use and future trends post 2022".
- [i.9] ECC Report 365: "Fixed Links in CEPT; Technical characteristics and statistical review".
- [i.10] Recommendation ITU-R P.530-19: "Propagation data and prediction methods required for the design of terrestrial line-of-sight systems".
- [i.11] Recommendation ITU-R P.837-8: "Characteristics of precipitation for propagation".
- [i.12] Recommendation ITU-R PN.837-1: "Characteristics of precipitation for propagation".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

access link: last mile connection to site (fixed or mobile)

dense urban: location in highly populated areas (malls, business districts, city centres) very close to fibre PoP: distances less than 1 km and very high capacity, up to 50 Gbps

NOTE: Usually, one single hop is enough to connect the base station to fibre PoP.

feeder link: connection aggregating traffic from more than one site

long haul: long distance multichannel connections in frequency bands ≤ 13 GHz.

NOTE: Long haul systems are typically designed for easily deliver multichannel ($N \geq 8$), BCA, space diversity combiner, narrow band filters and could be either all indoor mount or split mount.

n+0: multi-channel link configuration where n channels in one or more than one band are transmitted together

NOTE: In Ethernet era, the channels are aggregated together at Layer-1 level to increase the capacity of the link; this type of configuration is generally addressed also as Band and Carrier Aggregation.

rural: locations like small communities or scarcely populated areas generally far from fibre PoP: distances higher than 10 km and capacity up to 5 Gbps

short haul: split mount systems delivering connectivity in all bands

NOTE: Typical configurations are up to 4 + 0 according to the network layer they are used. Short haul radio in bands ≤ 13 GHz can be used for delivering long haul connections in configuration simpler than long haul systems.

sub-urban: location in less populated areas (like suburbs or small cities) with distances in the range of 5 km to 10 km to fibre PoP and delivering capacity up to 10 Gbps

NOTE: Usually one/two hops are enough to connect the base station to fibre PoP.

trunk / trunking: general terminology including both Long Haul and Short haul radio in multi-channel configuration delivering feeder long distance multichannel connections in frequency bands ≤ 13 GHz

NOTE: Capacity may vary according to type of service backhauled and number of mobile sites aggregated reaching 10 Gbps to 15 Gbps.

urban: location in populated areas close to fibre PoP: distances less than 5 km and relatively high capacity up to 20 Gbps

NOTE: Usually, one single hop is enough to connect the base station to fibre PoP.

6 GHz: 5 925 MHz to 7 110 MHz

L6 GHz: Lower 6 GHz: 5 925 MHz to 6 425 MHz

U6 GHz: Upper 6 GHz: 6 425 MHz to 7 110 MHz

7 GHz: 7,11 GHz to 7,9 GHz

L7 GHz: Lower 7 GHz: 7,125 GHz to 7,425 GHz

U7 GHz: Upper 7 GHz: 7,425 GHz to 7,725 GHz

8 GHz: 7,725 GHz to 8,5 GHz

L8 GHz: Lower 8 GHz: 7,725 GHz to 8,8275 GHz