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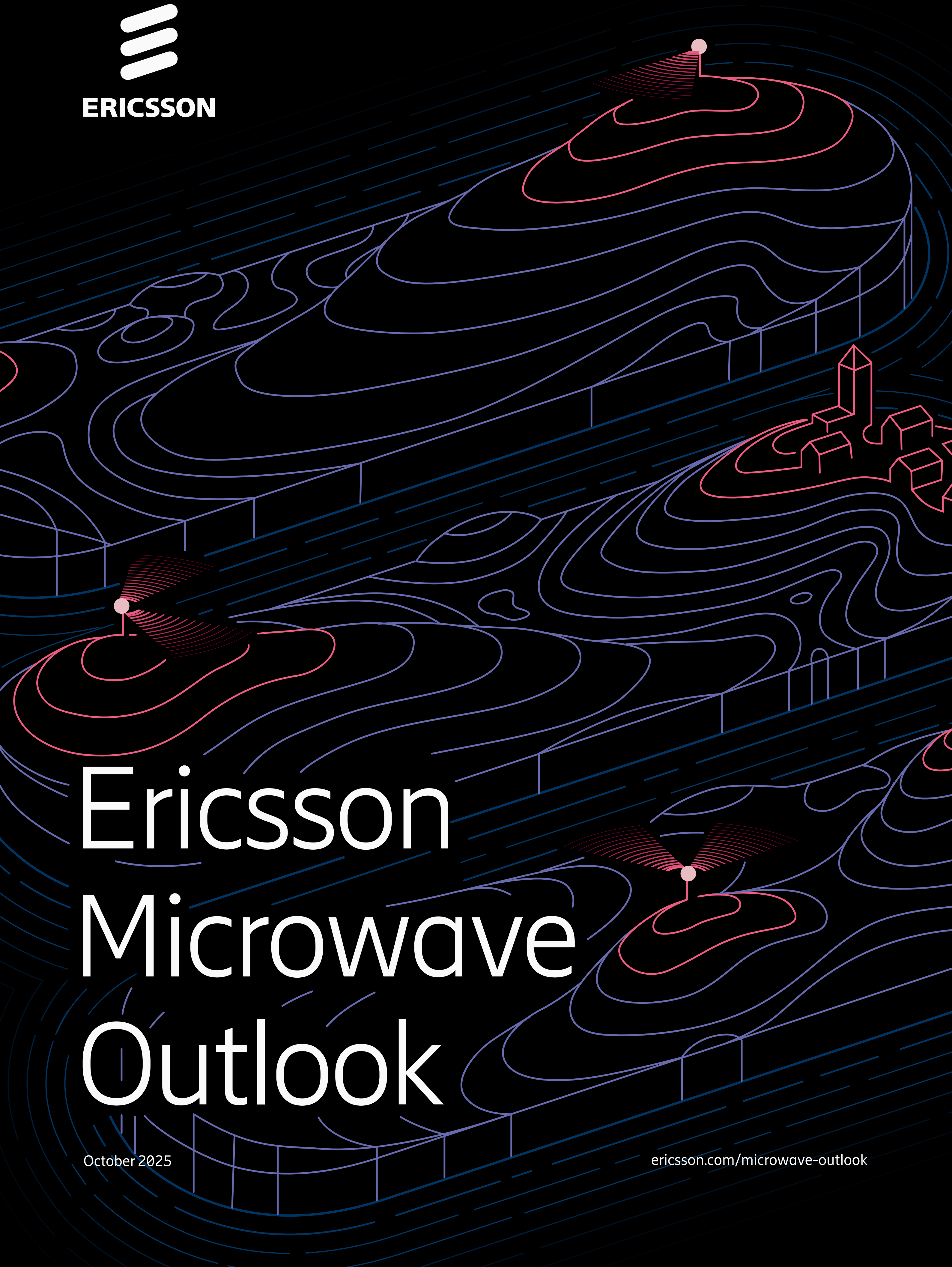

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Exploring ways to double mmWave capacity

Innovations in millimeter-wave (mmWave) technology and network simulations reveal the most effective strategies to double backhaul capacity. So which solutions lead the way in capacity evolution?

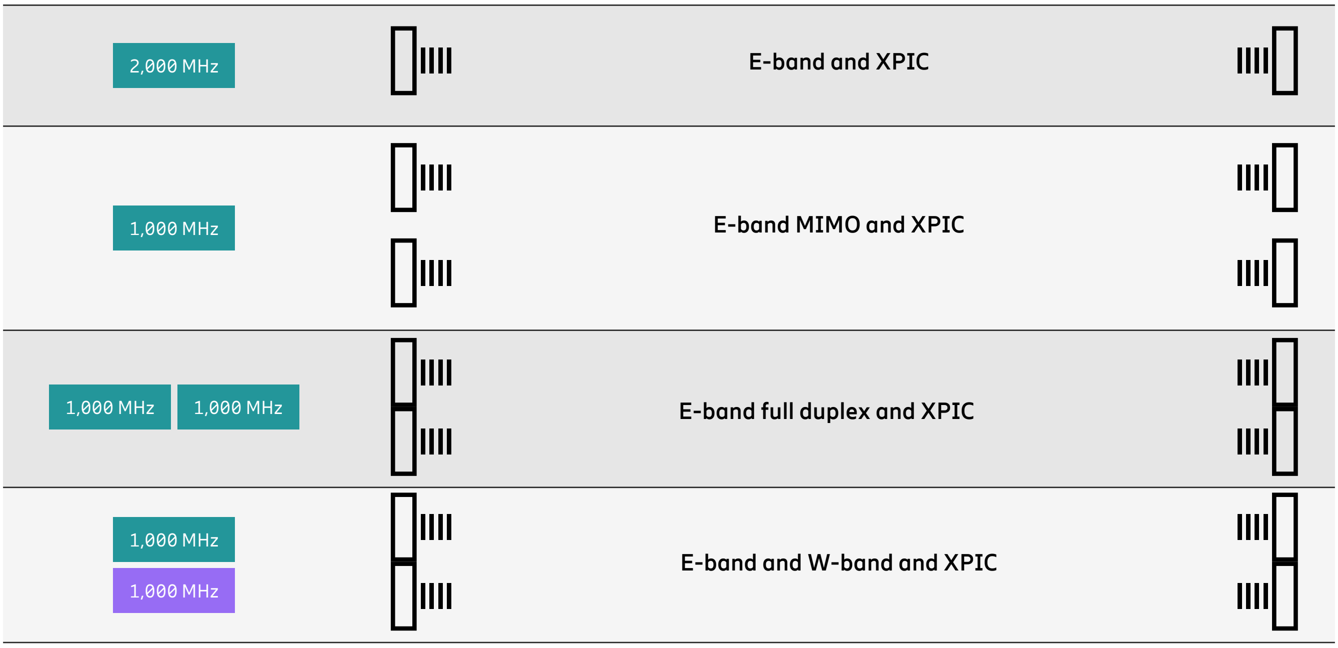
The large amount of spectrum provided by mmWave technology enables it to deliver high capacity. By mmWave, we typically refer to E-band (70/80 GHz), W-band (92–114 GHz) and D-band (130–174.5 GHz). E-band provides 10 GHz of spectrum, while the W-band provides almost twice this amount.

The different mmWave bands have different maturity levels. E-band technology is mature and commercially deployed worldwide, while W-band technology is currently only used in pre-commercial trials. W-band technology shares many commonalities with E-band and can therefore be seen as an extension of E-band. Meanwhile, D-band technology is based on separate radio technology, and it will take many years of research and development (R&D) before we see commercial deployments.

Technologies doubling mmWave capacity
Moving to higher frequencies and more spectrum is not the only way to achieve higher capacities. There are features that can be used to increase capacity in existing bands. For example, the use of CCDP/XPIC with dual-polarized antennas can double the capacity over the same frequency channel. Another related antenna technology called multiple-input, multiple-output (MIMO) uses multiple, spatially separated antennas to increase capacity. These types of antenna technologies are well-proven and commercially used in a variety of wireless communication systems. Another possibility to explore is the use of full-duplex (FD) radios in microwave links where the same frequency channel is used both in transmit and receive mode at the same time. Theoretically, this can achieve twice the capacity of a classical frequency division duplex (FDD) radio, where the available band is divided in half between a transmitter and a receiver. The obvious challenge with FD radios is potential interference between transmitters and receivers, which requires more sophisticated interference mitigation techniques and network planning compared to conventional FDD radios. FD radio technology needs further investments in R&D and standardization before it can be deployed in commercial networks.

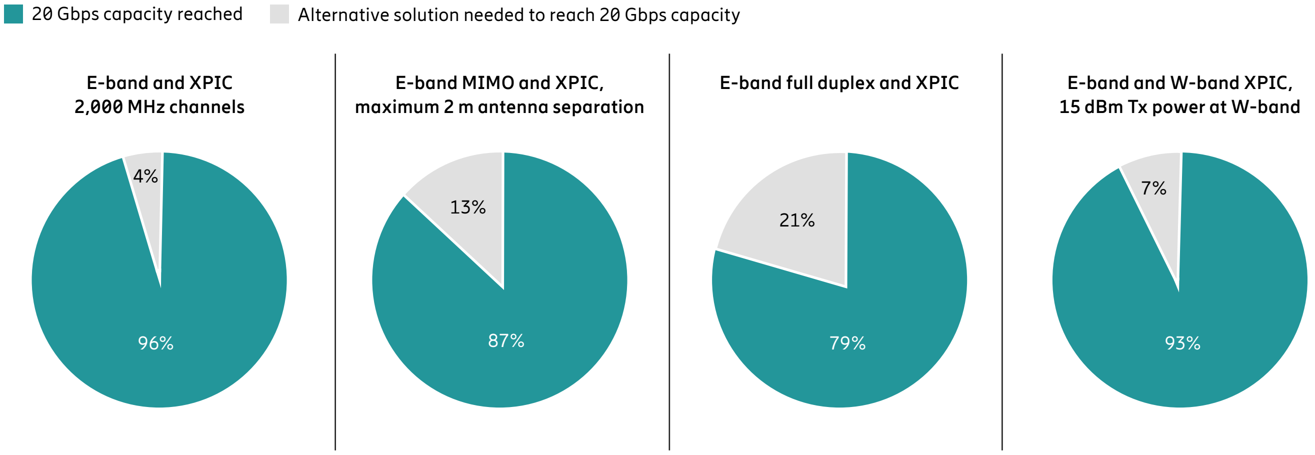
Technology comparison through network simulations
We carried out extensive simulations of very dense network deployments from three different European cities to evaluate how different mmWave technology options can be utilized to support a doubling

Figure 8: Different options to reach 20 Gbps capacity



Source: Ericsson (2025).

Figure 9: Simulation outcome showing the potential to reach 20 Gbps capacity using different options



Source: Ericsson (2025).

of the capacity of every single link in the network. The total number of links over the three cities was 1,619.

The baseline configuration was that each link used a dual-polarized (XPIC) antenna over a 1,000 MHz channel with 128 QAM (99.9 percent availability). This baseline configuration achieved 10 Gbps capacity and the goal was to double that capacity to 20 Gbps. Given the aforementioned technologies, there are several options to achieve this goal, as illustrated in Figure 8.

Doubling E-band channel

The first, and most straightforward cost-effective option, is to double the channel bandwidth from 1,000 MHz to 2,000 MHz in E-band and continue using XPIC and conventional FDD. This is assuming that all E-band spectrum is made available by the national spectrum regulator, such as 5 GHz of paired E-band spectrum. Thus, two 2,000 MHz channels and one 1,000 MHz channel are available in this scenario. A potential problem with doubling the channel size is that not all links can acquire 2,000 MHz, since the number of 2,000 MHz channels is limited to two. When having only two 2,000 MHz channels, network planning might not allow all links to use a 2,000 MHz channel due to possible interference between links, which means that some links could potentially only use a 1,000 MHz channel. However, our network simulations showed that 96 percent of all links could, in fact, use a 2,000 MHz channel and achieve the goal of 20 Gbps (see Figure 9). This really demonstrates the strength of using wider E-band channels, even in very dense network deployments, since only 4 percent, or 66 out of 1,619 links, could only use a 1,000 MHz channel.

MIMO

Instead of doubling the channel size, we also investigated how MIMO and XPIC over a 1,000 MHz channel can be used to achieve the goal of 20 Gbps. We know from a previous Microwave Outlook report[1] that the optimal antenna separation in a MIMO deployment depends on frequency and hop length. The optimal antenna separation can sometimes become impractical if it becomes too large for long hop lengths. Therefore, suboptimal antenna separations, say 80 percent of optimal, may sometimes be used without causing too large a performance penalty. We found that, if the maximum permitted antenna separation is 2 m, 87 percent of the links could achieve 20 Gbps by using MIMO and XPIC. The remaining 13 percent were too long.

Full duplex

We also studied FD E-band radios and found that 79 percent of the links could use FD to achieve 20 Gbps with proper network planning that fulfilled conventional interference criteria. The remaining 21 percent of the links could not use FD due to too much interference between links, which is caused by the fact that FD radios use both the low and high bands for transmitting and receiving in both directions, which reduces the available degrees of freedom in network planning. Meanwhile, conventional FDD radios can utilize the extra degree of freedom provided by having separate channels for each direction and therefore do not suffer from this kind of interference.

Complement with W-band

Finally, we also studied how W-band could be used to complement E-band to achieve the goal of 20 Gbps links. W-band radios have a shorter range compared to E-band equivalents, which can also be seen in Figure 7 in the Spectrum article. This is a result of W-band being an immature technology that cannot achieve the same maximum output power as today's E-band radios. However, if we carried out multi-band operations with E-band and W-band over 1,000 MHz channels, then we found that 93 percent of the links could achieve 20 Gbps. This assumed a maximum output power of 15 dBm at W-band, which limited the maximum hop length. With continued R&D, W-band radios will be able to support similar capacities and hop lengths as E-band radios of today, which means that 100 percent of the links could achieve 20 Gbps or more in the future.

Conclusion

The approach that is clearly most cost-effective (assuming spectrum fees are not overly costly) is to double the capacity for the vast majority (96 percent) of the existing links in this simulation by utilizing a 2,000 MHz channel together with XPIC, as there is no need to invest in new hardware. The other three alternatives require, besides added spectrum cost, various investments including radios, antennas and site installations (including on-site labor).

Overall, the simulation shows that all four technologies would offer a good range of possibilities for a capacity upgrade, as even the least usable one would still make it possible to expand 79 percent of the sites. However, a mix of two, or more, technologies would likely be needed to upgrade all links from 10 to 20 Gbps, and the choice of technology would be guided by regulatory requirements as well as network topology and financial possibilities to invest in new hardware.

Use of 2,000 MHz E-band channels is the most cost-efficient way of doubling capacity for 96 percent of links.

96%

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[1] Ericsson Microwave Outlook (October 2019)

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