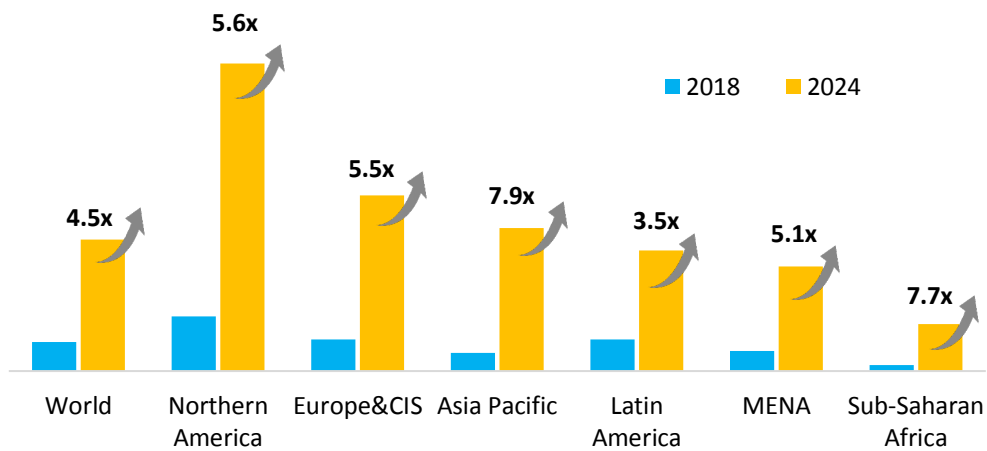


4T4R 6-Sector, the Next Leap in LTE Capacity Expansion

LTE Capacity Expansion Solution

5G is already coming, but LTE is still long-term capacity foundation of wireless network. New smart devices are gaining strong momentum of broader adoption, requiring a tremendous amount of capacity from wireless networks. The capacity demand for wireless network is projected to exponentially grow in the next coming years as figure 1 shown, which will drive LTE to keep evolution. LTE capacity expansion is already inevitable for global operators.



Source: *The Mobile Economy 2019 (GSMA)*

Figure 1 Mobile DOU (GB) growth forecast

Typically, operators expand capacity of wireless network by resorting to the following options:

- ◆ Adding spectrum to existing network. This is the most direct, effective option to increase capacity. However, as all we know, spectrum is limited and quite expensive in many countries. Besides, this option requires a lengthy period for deployment.
- ◆ Adding new sites on existing network. This option faces a number of serious challenges in terms of site acquisition, deployment costs, and project duration, particularly in urban areas. It is already not feasible for a majority proportion of operators.
- ◆ Improving spectrum efficiency. Two approaches are available for this option. One is upgrading xTxR, such as 4T4R, or swap to Massive MIMO. Considering its high investment, LTE Massive MIMO is not a good choice for scaled deployment. The other is multi-sector solution, which allows for a high capacity gain and is cost-efficient and easier to deploy.

The LTE 4T4R 6-sector solution has been gradually accepted by operators in many countries, making its way to be a mainstream expansion solution to LTE networks. Thailand is a typical adopter of multi-

sector solutions. Facing limited spectrum but high capacity demand, all operators in this country have successfully completed multi-sector deployment and achieved a 70% increase in capacity without increasing spectrum and sites.

4T4R 6-Sector Capacity Expansion Solution

Network congestion occurs when capacity is insufficient just like traffic gets jammed on a highway without having sufficient lanes. Compared with 3-sector solution, the six-sector solution works like increasing 3 lanes to 6 lanes as figure 2 shown. Therefore, capacity-caused congestion on mobile networks can be effectively addressed.

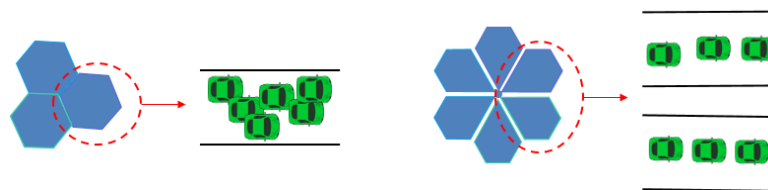


Figure 2 Changing 3-sector deployment to 6-sector deployment

The 4T4R 6-sector solution supports cell splitting and 4x4 MIMO to improve spectral efficiency and significantly boost capacity. The following table provides 4T4R 6-sector improvements over 4x2 MIMO (2R terminals) and 4x4 MIMO (4R terminals).

Solution		Capacity Gain
Baseline	3-sector 2T2R	1X
4x2 MIMO	3-sector 4T4R	1.1–1.3X
	6-sector 4T4R	1.7–2X
4x4 MIMO	3-sector 4T4R	1.5–1.9X
	6-sector 4T4R	2.3–2.8X

Table 1 Capacity gain comparison among solutions

4T4R multi-beam antennas are commonly used in the 4T4R 6-sector solution. This practice requires only antennas to be replaced on existing poles, eliminating the need of new poles. The reconstruction with 4T4R multi-beam antennas to the 4T4R 6-sector solution includes:

- ◆ 3-sector to 6-sector reconstruction on a single band as figure 3 shown
- ◆ Single-band 3-sector to multi-band 6-sector reconstruction (using wideband RRUs) as figure 4 shown
- ◆ Two single-band RRUs with external combiners to 6-sector reconstruction as figure 5 shown

In addition, using 4T4R multi-beam antennas to support 2T2R 6-sector first and then changing to

4T4R 6 sectors is another option for special scenarios.

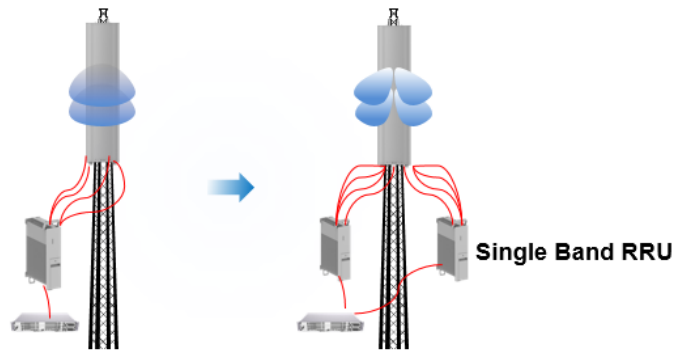


Figure 3 3-sector to 6-sector reconstruction on a single band

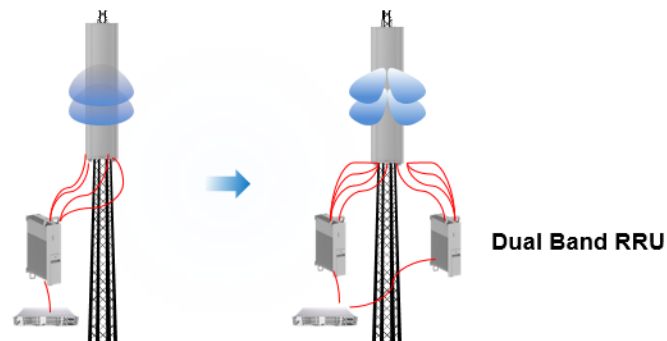


Figure 4 Single-band 3-sector to dual-band 6-sector reconstruction (wideband RRUs)

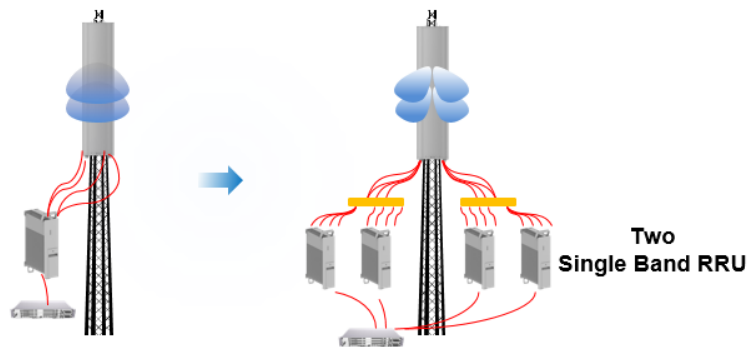


Figure 5 Single-band 3-sector to dual-band 6-sector reconstruction

Nowadays, the complete industry chain is mature for 4T4R 6-sector deployment to support E2E capacity expansion and user experience improvement. High-performance multi-beam antennas and wideband RRUs are released, which can simplify 4T4R 6-sector deployment. Huawei's 6-sector solution also supports interference suppression features to significantly mitigate interference from neighboring cells and Smart site tools based on optimization algorithms allow operators to locate sector-level sites for 4T4R 6-sector deployment.

4T4R Multi-Beam Antenna: Perfect Partner for 4T4R 6-sector Solution

A multi-beam antenna splits one 65° beam into two 33° beams. With multi-beam antennas, the front-to-rear ratio, side lobe, and other specifications have obvious improvements over those when two 33° antennas are used to provide multi beams. This makes them the first choice for 4T6S deployment.

With multi-beam antenna patterns, some negative impacts are likely to occur. For example, interference control and missing coverage between two beams affect cell capacity and user experience. Huawei's multi-beam antenna patterns use the "Snake" array architecture and self-adaptive feeding network technology to optimize the antenna pattern. This allows Huawei's 6-sector solutions to deliver maximal capacity while ensuring optimal experience.

Multi-beam antennas are categorized as high-band multi-beam antennas and hybrid multi-beam antennas. The high-band multi-beam antennas support multi beams only of high frequency band from 1800MHz to 2600MHz. The hybrid multi-beam antennas support multi beams of high frequency bands as well as 65° beams of other frequency bands.

- ◆ The following figure shows a high-band multi-beam antenna. It is small and lightweight and is ideal for deployments that use existing site resources. The aforementioned networking modes can be used, adding significant flexibility to deployments. High-band multi-beam antennas are already commercially available on global markets.



Figure 6 High-band multi-beam antenna with 8 ports

- ◆ Hybrid multi-beam antennas allow other antennas to be incorporated while LTE capacity is increased. This 'all-in-one' deployment reduces antenna installation space and is suitable for '1+1' deployment. The following figure shows a 2UL + 4T4R multi-beam hybrid antenna and a 2UL + 2UH 4T4R multi-beam hybrid antenna (2UL: 2x690-2690MHz; 2UH:2x1695-2690MHz).

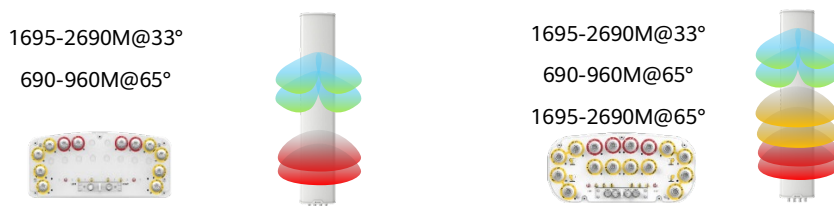


Figure 7 Hybrid multi-beam antennas



Figure 8 "1+1" simplified site