5G deployments: A window of opportunity for tower companies?

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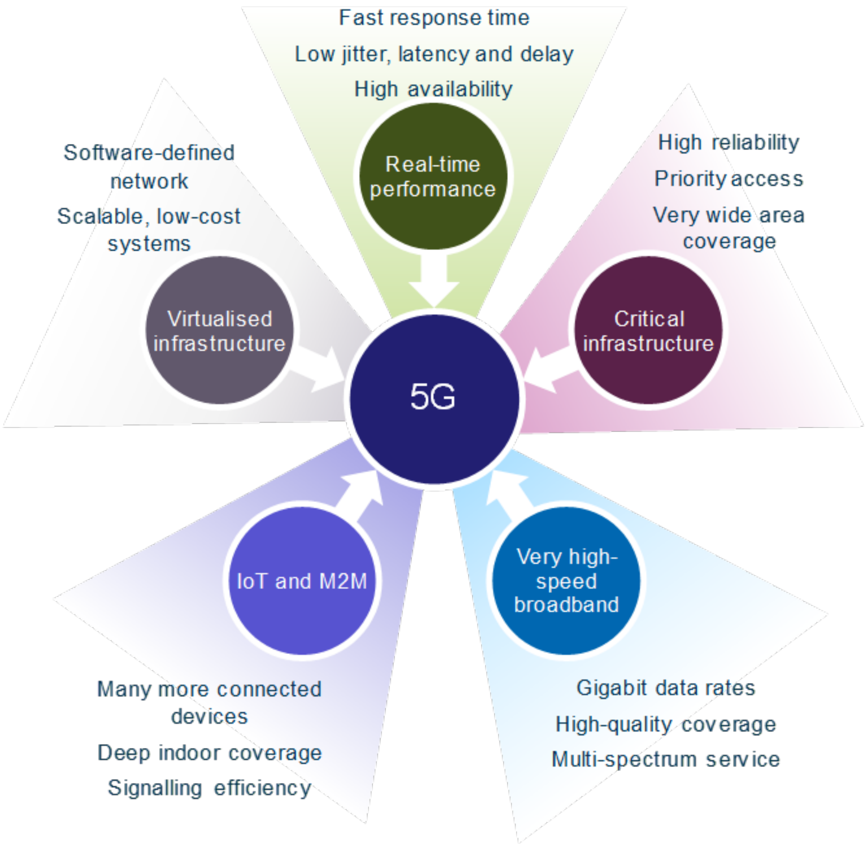
"Use of macrocells and increasing use of small cells will drive the need for further mobile network infrastructure"

5G is currently a major topic but there still appears to be confusion around what 5G actually means. For instance, Vodafone's CTO Johan Wibergh was recently quoted as stating that "You already feel that 5G is going to solve world hunger".[1] In this article, we look at potential 5G technology developments and provide our view on the impact they may have on mobile networks and tower companies.

5G is driven by a vision, or a wish list, which appears more revolutionary than the move from 3G to 4G and that is supposed to open new revenue streams for mobile network operators (MNOs), while at the same time reducing costs and increasing efficiency. The figure below summarises the 5G requirements.

Figure 1: Key drivers and requirements for 5G [Source: Analysys Mason, 2016]



[1] FierceWireless, Vodafone CTO Johan Wiberg warns industry not to over-hype 5G, 12 October 2016

Several use cases are being used as the commercial justification for 5G

Analysys Mason has for several years identified three use cases, which should serve as the commercial justification for 5G:

- **Enhanced mobile broadband** – an evolution beyond 4G to provide even higher broadband capacity and bandwidth. It is difficult to see enhanced broadband translating into massive new revenue streams for MNOs but it will help them to keep up with end-user demand. There appears to be particular interest in Japan and South Korea for this use case.
- **Massive connections (IoT)** – the management of millions/billions of connected devices. 5G will compete for this use case with other technologies that are already being deployed (Sigfox, LoRa and the NB-IoT protocol within 4G). Several European MNOs (e.g. Vodafone, Deutsche Telekom) appear very interested in this use case as a way to find new revenue streams.
- **Ultra-reliable networks** – specific low-latency, high-availability services or applications such as remote surgery. This is the use case that leverages the 5G vision the most. The monetisation potential could be substantial, but this is also the most uncertain and least developed use case.

A fourth use case has recently emerged: **fixed-wireless access (FWA)**, driven by interest in the USA. Verizon has announced intentions to use 5G small cells instead of fibre final drop and in-building wiring. AT&T has also announced that it is developing a proprietary fixed-wireless technology, AirGig, using mm-Wave signals along power lines. FWA solutions using WiMAX, LTE or other technologies are already used in rural areas in many countries, but 5G has the potential to bring performance closer to that provided by fixed networks. The main drivers for FWA solutions are cost savings and avoiding operational difficulties related to connecting homes with fibre. FWA is therefore likely to be the first use case to be implemented.

5G networks are likely to be based on different technologies/solutions and use a wide range of spectrum

5G networks are not expected to be based on a single specific radio-access technology but rather to be a mixture (or a portfolio) of different technologies and solutions. New and flexible 5G air interfaces that will incorporate the high-bandwidth, low-latency and high-reliability requirements are under development. Such air interfaces are likely to be initially deployed as small cells using newly licensed or unlicensed spectrum bands, typically >6GHz. LTE-A is, however, likely to continue to be used for macrocells for several years following 5G introduction. LTE-A may gradually be replaced by 5G air interfaces or be incorporated into and integrated with 5G and then evolve to converge with 5G.

Mobile networks traditionally use spectrum in the frequency range 700MHz–2.6GHz (with regional differences). The spectrum that can be used for mobile services in these bands is less than 1GHz. This translates into a potential total capacity (shared between multiple MNOs) of tens of Gbit/s per km^2. For 5G it is likely that higher frequency bands will be used. These include (again with some regional differences) 3.5GHz and 5GHz, which are relatively similar to the current mobile bands, but also cm-Wave bands (e.g. 24.5–27.5GHz or 31GHz) and mm-Wave bands (e.g. 70–80GHz). The cm-Wave and mm-Wave bands are characterised by a high availability of spectrum, multiple 10s of GHz. Therefore, it would be possible to provide multiple Tbit/s per km^2 using the cm-Wave and mm-Wave bands. The main drawback of these higher frequency bands is propagation. Theoretical cell radii for the traditional mobile network bands can be up to tens of kilometres in rural areas (but substantially lower in urban areas). The cm-Wave band will have cell radii in the hundreds of metres whereas for the mm-Wave band it will likely be in the tens of metres (and may require line-of-sight). The different propagation characteristics mean that cm-Wave and mm-Wave can realistically only be used for small-cell deployments. Macro-sites using <6GHz spectrum remain the only real realistic solution for wide-area coverage outside the densest areas.

New technologies will be incorporated into 5G to maximise network capacity

5G will incorporate a number of technological developments (some already used in LTE-A) that are intended to maximise the network capacity but also to provide more efficiency and flexibility. Some examples are:

- Multiple input, multiple output (MIMO)[2], which is likely to be used with beamforming in order to allow the generation of narrow beams, especially useful for high-frequency bands in order to mitigate path loss and reduce interference. The principle of beamforming is illustrated below. This however requires large antenna arrays.
- Cloud or Virtual RAN (C-/V-RAN), where centralised shared server pools replace base station (BTS) equipment or at least the baseband units (BBUs) with remote radio heads (RRUs) on the towers. On the other hand, there may be a need to deploy mobile edge computing[3] to reduce latency for ultra-reliable networks applications.
- Dynamic cell allocation (facilitated by C-/V-RAN) that allows the network to dynamically and in real time associate each device with one (or more) access point instead of assigning a specific geographical area (a cell) to an access point.
- Software-defined networking, network functions virtualisation and network slicing[4]
- Self-backhauling where backhauling and access are provided using the same spectrum and radio interfaces. Such developments will, together with general improvements on point-to-point radio backhaul, mean that fibre backhaul and fronthaul will not be required to all sites. (Although we expect fibre usage to continue to increase.)

Figure 2: Illustration of beamforming [Source: Analysys Mason, 2016]

How 5G networks will be implemented in reality is still unclear

Above we have described different potential technology developments. The actual network deployments and configurations that MNOs will use will however also depend on the commercial success of new use cases and therefore remain uncertain. Below we outline a likely evolution. There will be some regional differences to this evolution: we expect East Asia to be the front-runner for 5G (driven by the 2018 and 2020 Olympic Games in

[2] MIMO allows the use of multiple parallel transmit streams to a single device.

[3] Servers deployed at the edges of networks, close to the end users, which e.g. cache content.

[4] These technologies allow a more flexible and efficient use of network capacity while at the same time being able to ensure specific QoS for different services.

South Korea and Tokyo), followed by the USA (especially if FWA deployments take off). Europe is expected to see limited 5G development before 2022.

- Until 2020:
  - 4G will continue to be the main technology deployed
  - Macro-layer densification will continue, driven by capacity and quality-of-service requirements (cell-edge data rates)
  - Small cells will continue to be deployed in the USA and East Asia and will start to be deployed in Europe as an additional capacity layer in dense-urban areas
  - FWA deployments may begin in some countries (e.g. the USA).
- 2020–2025:
  - 5G will co-exist with 4G
  - Macro-layer densification will subside in dense-urban and urban areas, small-cell densification will continue
  - Macro-layer densification may continue in more rural areas.

Depending on how the use cases mentioned at the beginning of this article develop, we may also start to see “amorphous” or focused coverage (e.g. along roads if connected cars become a big driver, along residential buildings if FWA becomes important, or in hospitals for remote surgery). Such coverage is likely to use small cells rather than macrocells.

Beyond 2025, it is possible that 4G and 5G will merge.

We believe that 5G will continue to require extensive use of macrocells, which will remain important in rural areas but likely also in urban areas. The traditional tower business model will therefore be valid also in the 5G world. Small cells will become increasingly important but they will be deployed in addition to existing macro-sites rather than as a substitute for them. It is important to note that there are significant practical and cost issues associated with small cells (first and foremost access to locations at a low cost) that new 5G technologies do not necessarily solve on their own. In any case, we expect mobile networks to require more and more infrastructure, which should open a window of opportunity for infrastructure providers.