



Executive Briefing

5G: 'JUST ANOTHER G' – YET A CATALYST OF CHANGE

Our predictions for 5G, based on our assessment of the opportunities and barriers it faces, including how and when it will impact different markets. Combined with other technologies and industry trends, 5G will change the shape of the industry, but not in the way that many expect. The era of identikit, standalone, national mobile operators may be nearing its end.



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Executive Summary

In ten years' time, 5G networks will be widespread.

Few would view that as a controversial statement. Neither is the assertion that we will see some commercial launches from late 2018 to early 2020, especially in South Korea and the US, plus China and Japan. From mid-2020 to late 2021 we should see Europe and other key markets join the fray, although many deployments will be confined to certain cities, rather than nationwide.

Yet behind those soundbites is a lot of complexity, and a huge range of possible pathways from 2018 onwards. More-disputed issues and questions concern timelines, use cases, technology, obstacles, value chains, regulation, stakeholders, vendor and SP profitability, national interests and regulatory policy.

But above all, there is a spectre waiting in the 5G shadows. While the assumption is that the technology will lead to radical shifts in other industries such as manufacturing or transport, that may turn out to be the wrong focus. Those sectors are changing rapidly already, without 5G, through various manifestations of artificial intelligence (AI), Internet of Things (IoT), mobile devices, robotics and more. 5G will certainly help, but that is a correlation not causation.

5G may well prove to be more transformative **for the mobile industry itself**, than for other end-user sectors, at least in the medium term.

Key action points

Every operator and market starts from a different point for 5G – they have varying size, scale, maturity and profitability – as well as regulatory divergence and differences in consumer purchasing-power and behaviour. However, key pointers for all involved include:

- Ignore the media frenzy around a supposed 'race' to 5G. Except in markets where individual operators can gain competitive advantage over peers (for example, the US), there is little benefit to a given country, beyond bragging rights.
- Focus on the realistic near-term uses for 5G, especially mobile broadband for dense urban areas. Look at what increased capacity-density can enable in terms of flat-rate or more innovative data plans, multiple devices on one account, mobile backup for fixed connections, enterprise solutions for employees and so forth. All of these are tolerant of patchy use of 5G, and can work across hybrid 4G/5G networks effectively.
- Think through *all* prerequisites for 5G well in advance – technical, regulatory, operational and commercial. Full deployment of 5G doesn't just depend on obvious things like spectrum, but also others like fibre availability and SDN/NFV, both of which will take huge investments of time and resources in their own right.

- Keep an eye on long-term visions of a '5G society' but recognise that initial years will mostly be 'more of the same', as 5G will be rolled out in specific locations. Expect any use cases that rely on 'ubiquity' will be waiting a long time.
- Don't underestimate the value and speed of other wireless technologies – 4G, Wi-Fi, satellite networks, LoRa, Bluetooth, ZigBee and others will all be much larger contributors to economic growth and social welfare for at least the next five years, and in Wi-Fi's case, for decades to come. Don't let lobbying asymmetry of the mobile industry hype the notion that everything will be 5G. It won't.
- Expect – and indeed encourage – new entrants building cellular networks. Private networks, government involvement, hybrid MNO/MVNOs and many other types of operator will emerge, and both regulators and vendors should recognise their contribution to the overall picture. Even current operators, worried understandably about cannibalisation, should recognise they can't do everything and look for roles providing supporting capabilities or wholesale capacity to these players, where feasible.
- Vertical markets are going to be important for 5G, but will tend to consume connectivity as part of much broader solutions. In some cases, they can feed requirements into the main 5G specifications, but the industry should also expect – and prepare for – extensive customisation and systems integration efforts. In particular, any industries with safety-critical systems or particularly strong requirements for ownership / 'sovereignty' of systems and data may not fit well with today's telco paradigms.
- Do not overlook the indoor penetration issues for 5G, especially for mid-band (>3GHz) and mmWave (>20GHz) spectrum. These will require careful planning, and potentially new business models and capex plans for dedicated in-building systems. It may not be possible to upgrade existing indoor wireless antennas nor easily get coverage from multiple operators. The timelines for installation (and training the required personnel) may be protracted.
- Think carefully about pitching evolved 4G solutions as 'fake 5G'. While it may be tempting to masquerade as the newer technology, there are reputational and maybe even legal risks for this subterfuge, particularly if funding is involved.

Standby for a strategic realignment of the mobile industry

The real impact of 5G might be less about transforming 'verticals', and more about transforming the mobile and telecoms industry itself, internally. The massive investments needed will likely drive more network sharing and consolidation – that scale requirement is part of the reason for Sprint and T-Mobile US's renewed drive for a merger. The technical complexity of 5G is likely to give significant advantage to operators that are further down the curves for adopting software-defined networking (SDN), network functions virtualisation (NFV) and AI for their own operations. The massive requirements for fibre, to connect 5G cell sites and antennas, will further entrench converged operators able to own and operate both.

The embedding of 5G connectivity within broader solutions – consumer or enterprise verticals – will mean deeper specialisation and integration skills will be needed. No operator will be able to service every 5G customer segment fully; they will have to pick their battles (and partners) more strategically. The specialised requirements – and the challenges of in-building coverage – will mean that other non-telco players will want to deploy and control their own 5G networks, perhaps in shared or localised spectrum allocations. While some of these needs may be serviced by network-slicing techniques, that will not be enough for some. Expect to see industrial mobile operators, indoor 'neutral hosts' and new MVNO/MNO hybrids emerge, exploiting both regulatory shifts in attitude and the same commoditised, simpler equipment and software that telcos are themselves demanding from vendors.

There is no real 'race to 5G'

Despite the breathless headlines – and rousing speeches by some politicians – there is no real race for 5G deployments, especially between countries. While the US, China, Japan and South Korea are leading the way, that was also largely true for 4G, except for China. While certain vendors will benefit from their national markets' scale, they all export anyway, notwithstanding a possible trade war. Samsung seems to be benefiting as much from its relationship with Verizon as with SKT. It is not possible to read across from earlier deployment of 5G, to strategic benefits to countries' economies, national security or industrial productivity.

It **is** possible for the market, vendor and regulatory environments to be tilted one way or another, either to hasten or slow 5G deployments or to affect the beneficiaries. In 2018, it is in almost everyone's interest to 'talk up' 5G, even to the extent of over-hype and unattainable promises. In a way, the current 5G market is less about technology and more about perception and influence. A 'race' is a good narrative to drive interest and investment, even if at base it is more about bragging rights and headlines.

But that rose-tinted view can only be temporary, and if there are subsequent disappointments then those who made unrealistic promises may (and should) be held to account, by shareholders if not governments and customers. That said, some of the worst 5G 'hype merchants' seem to be **in** government, positioning the technology as a panacea for everything from GDP and productivity to enhancing national security.

It is notable that a number of operators and vendors have toned down the 5G rhetoric in recent months. Huawei appears to be acknowledging that 5G will get deployed in patches but the main action is still around improving 4G. Telenor, BT, Vodafone and others appear to be taking a wait-and-see approach. By contrast, operators in China and the US seem to be fitting in with their nations' aggressive posturing in trade or geopolitics, and viewing the technology more as a 'race' – although the US operators probably would have done that anyway, given their history with 4G. Arguably, 5G has been the catalyst for the newly announced Sprint/T-Mobile merger.

In STL Partners' view, it is probably fair to say that 5G really is 'just another G', despite widespread pronouncements to the contrary. It's very important, and will ultimately continue the immense work the mobile industry has already done for people, businesses and society, but its emergence will be

patchy and often slow. Its huge ambitions mean that many moving parts need to fit together smoothly, from access to rooftops for antennas, down to AI algorithms that automate fault management.

Many of the suggested IoT and vertical use cases look fragile and as yet unconvincingly fleshed out, but the need for ever-more capacity for smartphone data might act as a counterbalance if verticals disappoint in the short term. The oft-stated need for 5G-integrated edge computing and complex network slicing are probably real, but only up to a point.

One of the greatest paradoxes is that many of the most demanding 5G users (say, utilities or manufacturing) will also be the most willing and able to build their **own** networks rather than use telcos'. More mid-term opportunity should come from sectors such as entertainment/sports or smart cities. This may well need ultra-low latencies or dense networks of sensors, but without the safety-critical risks and liabilities of overhyped 5G autonomous car or surgical-robot concepts.

Figure 1: 5G predicted timeline, 2018–2026

Source:STL Partners

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Introduction

This briefing document is being published in June 2018. This report does not re-hash the familiar background story to 5G – the original specifications, the much-ballyhooed early thoughts on use cases, nor the breathless rhetoric about how it is going to change the world (or in the risible words of one hyperbolic tech CEO, “be more important than electricity”). Neither is it a hatchet job decrying the whole exercise as worthless. Instead, it looks at the factors acting as brakes and accelerants for 5G, and how they may affect the overall ecosystem’s evolution.

What *is* needed, however, is a way to cut through the spin – especially where it is aimed at policymakers and investors, who often latch on to simple but unrealistic stories. Some of the most absurd ‘5G-wash’ hyperbole emanates from Brussels and Washington DC, and in the run up to the next World Radio Congress in 2019 (where spectrum allocations are debated) it is critical that rationality and critical thought prevails over glossy lobbying. It is harmful to us all if 5G hype means it ends up overshadowing worthy parallel developments in satellite communications, private wireless and other technologies that also deserve attention, spectrum or subsidised research projects.

It is understandable that many in the industry ‘talk up their own book’, especially given consolidation and profitability concerns in the vendor space. The 2018 market for telecoms infrastructure is expected to decline, and there are huge hopes at Ericsson, Nokia and Huawei that 5G can help turn it around in 2019–20. But that is not an adequate excuse to exaggerate. Neither is it an excuse to mislabel and market diverse other technologies (advanced versions of 4G, Wi-Fi and so on) as ‘5G’ – although such egregious duplicity is one of the few certainties here. It is probably enhancements and capacity additions for 4G that will prove the biggest moneyspinners over the next 12–24 months.

In theory, the next 24 months should be when it all happens for 5G. Early demonstrations and trials have been well publicised, including various global cities’ testbeds and the South Korean Winter Olympics in Pyeongchang. Almost every week yields new press releases, lauding everything from medical diagnosis (NTT DoCoMo) to self-driving snowploughs (Telenor). It is unclear how much any of these shiny announcements actually accelerate real, commercial deployments – or real business models.

This period is also a critical juncture for standards, starting with the formalisation of the first phase of standards at the June 3GPP meeting (Release 15), leading up to the full ratification of 5G as the official IMT2020 technology by the International Telecoms Union (ITU) in 2020.

Much of the technology media is trying to pitch the development and deployment of 5G as a race, either between countries or individual operators. The first fixed-wireless deployments are under way, while the earliest mobile devices are expected by the year end (probably portable 5G/Wi-Fi hotspot modems). 2019 should see a flurry of early launches and the first 5G-capable smartphones becoming available.

Yet those forms of 5G broadband – fixed or 'enhanced mobile' – are hardly novelties, despite the gigabit speeds and low latencies promised. In many ways, they risk being overshadowed by continued evolution of 4G networks, which is occurring in parallel.

There are also plenty of IoT-type demonstrations, whether for delivery drones, autonomous vehicles or automated industrial machinery. Yet these seem much less real for now – the value-chains are far from clear, and often they will need networks to be built in new locations, rather than reusing existing towers and backhaul. It also isn't obvious that large enterprises are willing to pay much for such connectivity, and whether they'll be happy with 'slices' of MNO-controlled networks or if they want to own them outright.

There remain many hard-to-answer questions about 5G's emergence:

- Will global consumers switch to 5G phones en masse in 2021–22 or more from 2023–24?
- Will today's mobile operators consolidate further or will there be an explosion of new niche providers targetting verticals or specific uses?
- Is there a 'race' between countries to deploy 5G, and if so, why? Do arguments about 5G 'leadership' really translate to economic benefit and jobs, and if so, for whom?
- Will the US, Japan, South Korea and maybe China take a significant lead on 5G, or is it more about geopolitical grandstanding in the Trump/Xi age, and helping national-champion vendors and operators gain a reputational boost?
- Will 5G, NFV, SDN and edge computing work in true synergy, or will delays or limitations in one area have knock-on impacts on the others?
- What are the unexpected practical 'gotchas' for 5G that might add friction, cost or delay to deployment, or complexity to operations? Is fibre availability for backhaul a critical prerequisite?
- Does 5G pose an opportunity for new niche suppliers of technology – for example in small cells – or will thinning margins and price pressure from operators and open source force many aspirant vendors out of the market?
- Will 'verticals' and IoT really matter for 5G, and if so will telcos view enterprises more as customers, partners or even suppliers and competitors? Which industries are realistic opportunities for 5G's new capabilities for low latency or 'massive IoT'?
- Who, if anyone, will make a profit from 5G-enabled networks, devices, services and embedded capabilities?

The truth is that many of these questions cannot be definitively answered today, despite the emphatic nature of a lot of industry comment. Here, we present some scenarios and especially look at the idea of pre-requisites: what needs to be done first, for 5G to be successfully deployed or monetised? There are potential bottlenecks ahead, as well as opportunities.

Hopefully, we have plotted the roadmap, even if the industry cannot 'drive autonomously' yet.

The rest of this report is structured into the following sections:

- 5G positive signals – standards, trials and enthusiasm
- 5G cautions – prerequisites, questions and complexities
- Verticals – huge opportunity or more market fragmentation and competition?
- Timelines and practicalities

Think of this report as a weather forecast. 5G will be much like the UK climate: patchy clouds, with rays of sunshine and the occasional storm. The summer will be late but warm, but you'd best pack a 4G or Wi-Fi umbrella just in case.

And just as with weather, trying to do long-range forecasts is very risky. There's a good chance that circumstances will prove you wrong. But despite that, we have some qualitative predictions stretching out to 2026, at which point we expect to be bombarded with 6G hype, alongside 5G reality.

NB We have also just published "[5G: Why Verizon thinks differently – and what to do about it](#)", which looks in detail at why the US operator is an enthusiastic proponent and strong early backer of 5G, and what other telcos should do about it.

5G positive indicators: reasons to be happy!

In many ways, the development of 5G is going remarkably well, especially compared to some of the partisan inter- and intra-technology standards warfare of the past.

In the recent past we have seen:

- Approval by 3GPP of the first New Radio (NR) specifications in December 2017, for Non-Standalone mode, which means that 5G NR can be deployed using the existing 4G core networks.
- Early engagement by the cellular industry with various industries' representatives, notably automotive, manufacturing and healthcare. A number of joint bodies have been set up, with the objective of defining 'vertical' and especially IoT-centric requirements and testbeds.
- A timeline for silicon and device availability that aligns much better with that for networks than was the case with 3G or 4G.
- A whole range of cool demonstrations in Pyeongchang at the South Korean Winter Olympics in early 2018.
- Research labs for 5G set up around the world.
- High awareness of 5G among governments, businesses and media, even if it is often over-hyped, as that is hardly unusual for new technologies.
- An ongoing procession of spectrum auctions for frequencies suitable for 5G, and ready availability of test licences.
- Good (albeit uneven) progress in adjacent mobile areas such as NFV, SDN, edge computing, cloud RAN, network slicing, automation of processes, AI and so forth.
- Continued growth of 4G usage, and likelihood of capacity constraints driving the need for future upgrades.
- Commendable work by both large and small vendors in creating early equipment, and approaching target speeds and latencies more closely than many observers (including the author) thought were probable.
- Some good early results from trials, especially of high-frequency mmWave networks, which show decent propagation properties and even indoor penetration – albeit through glass, not solid walls – exceeding the (admittedly low) expectations. For instance, AT&T has tested for weather resistance of its mmWave 5G trials – important as some have expected rain or snow to have an impact on propagation.

- The effectiveness of MIMO (multiple-in, multiple-out) antennas appears to negate some of the poor notional radio properties of midband spectrum in the 3–4GHz range as well. Essentially beam-forming and beam-steering allows radio 'spikes' to concentrate power towards actual users' positions (including indoors), rather than radiating uniformly and thus wastefully.
- No major fights (yet) over IPR and costly patent licences.
- Encouraging forecasts from some analysts (not published by us, so we won't quote them) and trade associations about 5G subscriptions and related services.

Early trial results and deployment plans

While many operators and international laboratories and organisations are testing 5G, a few of the experiments stand out.

Probably the most high profile have been the various South Korean initiatives that took place during the Pyeongchang Winter Olympics, and Verizon's work on fixed-wireless access in the US. KT and SKT showed various approaches to 5G-connected cars, novel camera footage from 5G-connected drones, real-world usage of mmWave radios and numerous other showcases. Korea is expecting to see launches of commercial 5G services around March 2019.

Verizon announced at the end of 2017 that it was aiming to light up a handful of cities – Sacramento, California most notably – by the end of this year. More details have become clearer recently: initially it will launch fixed 5G for mostly residential users, with mobile variants following around six months afterwards. Samsung has had its 28GHz-band routers approved for both indoor and outdoor use in the US, and these are expected to feature in Verizon's early offerings. (STL Partners is writing a separate briefing report digging more deeply into Verizon's 5G strategy, which includes an estimate of its huge investment into fibre for back/fronthaul).

(Mobile launches usually lag fixed-wireless services, as they need more coverage, more testing and a lot more complexity around cell-to-cell handoffs. And within mobile uses, it is usually easier to provide simple devices such as modems or cellular/Wi-Fi hotspots, as phones and voice access require even more work.)

AT&T is being aggressive with its 'proper' 5G rollout, as well as its controversial "fake" branding of advanced 4G as '5G Evolution'. It is intending to launch standards-based 5G, capable of supporting mobile devices (initially mobile Wi-Fi hotspot 'pucks') in at least 12 cities by the end of 2018.

AT&T started demonstrating and testing pre-5G technology in late 2016, including an enterprise trial in mmWave bands, together with Intel. In June 2017, it extended the trials to residential users in Austin, Texas, doing video streaming over fixed-wireless access. This was followed by a small-business fixed-wireless trial in Waco, Texas, which generated good results including 1.2Gbps throughput speeds and

9–12 millisecond latencies. That said, it seems less enthusiastic than Verizon about the general fixed-wireless opportunity¹, especially given the backhaul fibre investment needed.

The other operators that are well advanced on 5G plans include:

- **Japanese operators:** NTT DoCoMo, KDDI and SoftBank have all been running multiple trials, for a wide variety of use cases and deployment scenarios. All are expected to have networks up and running in time for the 2020 Summer Olympics. NTT in particular has been very visible, signing contracts with vendors including Nokia and NEC.
- **Chinese operators:** Spurred on by its government and Huawei as national champion vendor, all three telcos are deploying significant test networks, in a total of 16 cities across the country. Importantly, the regulator has shown commitment to issuing 5G spectrum in large tranches, and also seems to be encouraging infrastructure both between the operators and also China's electricity grid operator. Chinese operators have also been quite aggressive on other key technical enablers such as AI/automation and network slicing.
- **Sprint and T-Mobile US:** Both operators had previously been talking up 5G, but this has taken on a new perspective since the announcement of their potential merger. T-Mobile's plan to use 600MHz spectrum for 5G is fairly unique and points to a possible nationwide network much earlier than its peers. Sprint's hoard of 2.5GHz frequency is also extensive and could be a key differentiator given that the US has been slower to release 3.5–4.5GHz 'midband' spectrum than other markets. If their merger goes ahead (possibly a big if, given previous regulatory reluctance) the new T-Mobile may try to do for 5G what Verizon did for 4G – use it as a competitive differentiator to gain market share. It may face challenges getting devices supporting its unique 600MHz band, though – a similar problem that plagued it with the early days of 4G.
- **Deutsche Telekom:** Aligning with its US arm, the domestic German arm of DTAG is perhaps the most vocal early enthusiast for 5G in Europe, deploying a growing test network in Berlin in particular. It is also getting its backhaul house in order, deploying tens of thousands more fibre kilometres annually.
- **Telstra:** In Australia, local operator Telstra has launched a number of trials, including 5G for fixed-access backhaul to some publicly available Wi-Fi hotspots on the Gold Coast.
- **Spark:** In New Zealand, local operator Spark has signalled an intent to deploy 5G (probably for fixed wireless) as early as possible, if it can get spectrum.
- **MTN:** One of the few notable developing market 5G trials is that by MTN in South Africa, with Huawei.
- **India:** The Indian government has signalled that it expects to announce its overall 5G strategy in June 2018. Although some are talking of 2020, it seems unlikely to gain a broad deployment fast,

¹ <http://www.telecompetitor.com/att-the-business-case-for-fixed-5g-is-ugly-verizon-seems-to-beg-to-differ/>

given economic limitations, especially driven by the 4G rollout and subsequent price war and consolidation between operators.

There are some notable absentees from this list. The UK has various government and MNO-sponsored trials, but little commitment by the telcos to move towards commercial launches yet. The Scandinavian operators, early on 3G and 4G, also seem more diffident this time. So too are the smaller countries in developed Asia; Singapore and Taiwan are also (comparatively) lagging the timelines that might be expected, again reflecting caution over business case. In the Middle East, Ooredoo, Etisalat and STC have all been keen to be early to market with demo networks, but it's unclear whether that will translate to broader, rapid deployments.

Figure 2: Who are the 5G bulls and bears?

Organisation type	Generally enthusiastic	On the fence	Generally sceptical
Major vendors	Ericsson Qualcomm Nokia	Huawei Cisco	(Some Wi-Fi and LPWA vendors)
Operators	Verizon SKT KT China Mobile and China Unicom NTT T-Mobile US Ooredoo Etisalat	SoftBank Deutsche Telekom AT&T Telstra Orange	Vodafone BT/EE Telenor Telefonica

Source: STL Partners

Spectrum

As always with new mobile networks, one of the input requirements is suitable radio spectrum. Generally, 5G seems to be doing fairly well in this regard. Many countries have started initial awards or have them planned for the next year or so.

Various European countries are releasing 3.5GHz 'mid-band' spectrum, while the US has earmarked both 600MHz (which T-Mobile has large amounts of) and 28GHz as priorities. Japan's early focus is on 4.5GHz. In addition, there is a strategy by many operators to progressively switch off old 2G and 3G networks, and 'refarm' the bands for 5G.

The general expectation is that 5G will require a combination of three broad sets of frequencies:

- Low-band, mostly below 2GHz, for wide-area coverage and good indoor penetration
- Mid-band between 3GHz and 6GHz, for densified, mostly urban networks, probably with complex MIMO antennas

- High-band above 6GHz, and probably mostly from 20–40GHz, although some are speaking of 90GHz or even higher for local usage.

Notably, many markets are not waiting for the official seal of approval from ITU and its World Radio Congress at the end of 2019, which was supposed to define the first set of 'harmonised' 5G frequencies (more accurately, IMT2020). A second set is expected, based on ITU's ridiculously leisurely process, to be ratified only in 2023. Instead of this timeline, many regulators are either pre-guessing the outcomes (fairly uncontroversial for the 3.5GHz band) or just ignoring them (such as 28GHz in the US and South Korea). We wrote about 5G spectrum in early 2017, discussing this in more depth.

Summary – the good news!

In other words, 5G is becoming 'real', it's getting a lot of interest and investment, and the basic technology enablers seem to work, at least in the lab and limited field trials. There are plenty of suggested use cases, and even if some of them prove far away or unrealistic, there should be some that make it through the funnel, plus others that are unanticipated.

That said, there is a cliché that states that any parts of a sentence or speech before the 'but' should probably be ignored.

The rest of this paper looks at the obstacles, how verticals will evolve, and draws detailed conclusions.

End of Extract