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# Substance behind the Hype

**5G Smartphones Primed and Ready for Fast Rollout**

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**Wayne Lam**
Director and Principal Analyst

Technology | **White Paper**

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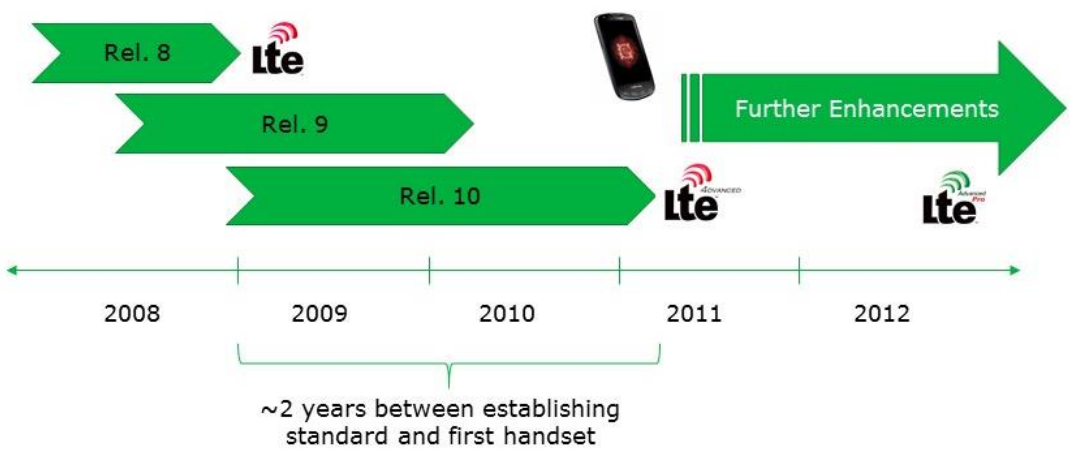
## 5G Smartphones Primed and Ready for Fast Rollout

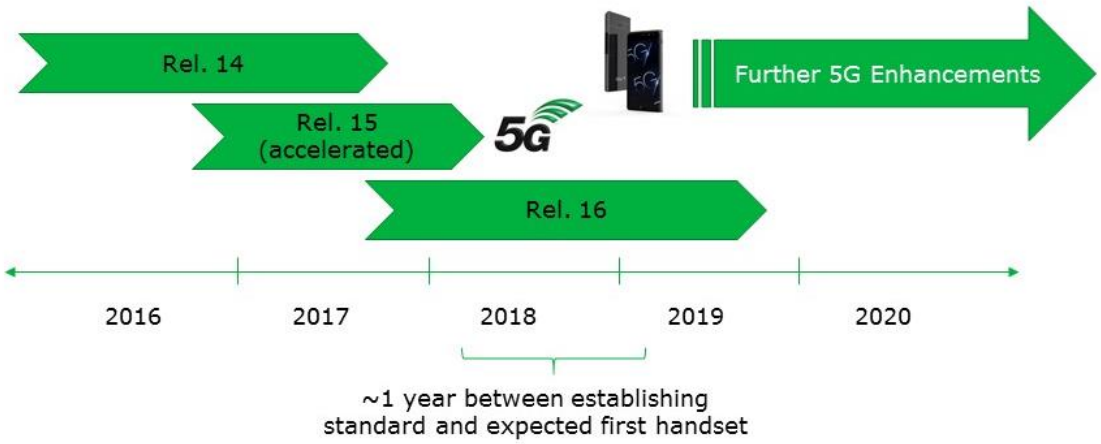
**Wayne Lam,** Director and Principal Analyst

**Executive summary:**

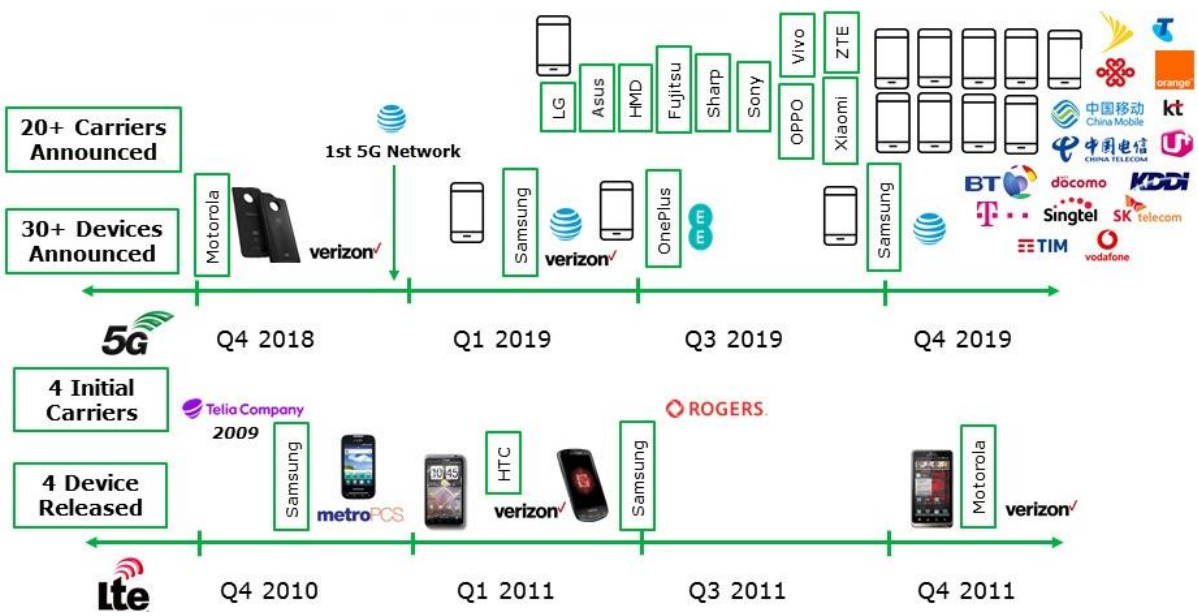
- The global 5G transition is poised to take place at a faster pace than any previously wireless generation transition.
- The industry has been moving in lock-step as a common technology standard drives carrier adoption and capital investment in 5G network technology
- Parallel to global carrier investment in the 5G transition, governments such as China and the US are increasingly viewing 5G technology as critical to their respective global technological and economic prospects and are incentivized to drive for and claim 5G leadership.
- Supply chain readiness, especially those of the modem and RF front end, providing momentum for 5G handset designs and availability.
- Lessons from 4G LTE demonstrate that wireless technology serves as the platform for which new advancements, business models and services will flourish. 5G will be no different as it promises improvements in multiple aspects of network capability.

In the early months of 2017, a small group of mobile industry leaders agreed to submit an audacious proposal to accelerate the development of the 5G standard via the 3GPP - the main industry organization that develops mobile technology specifications. Recognizing that there was critical momentum behind the single 5G standard, this group placed a bet that hastening the 4G to 5G transition would yield tremendous benefits for everyone in the mobile ecosystem. Led by a handful of global carriers as well as a collection of OEMs and component vendors, the proposal would catapult 5G networks deployments with devices to as early as late 2018; nearly a full year ahead of plan. This move is a stark contrast to the 3G to 4G transition where a gun-shy industry with memories of the complicated 2G/3G transition moved deliberately and cautiously in deploying WiMax or LTE networks. Now, almost a decade later, 4G LTE has become the most successful global wireless standard to date, where the use cases for mobile broadband are clearly understood and carrier business models are proven in markets all around the world. With this backdrop, the conditions are ripe for the next step function in wireless technology advancement as the industry gains the confidence to leap into a transformative 5G future.






It is easy to paint the current momentum behind 5G as usual pre-launch hype drummed up by vested stakeholders, but the industry is fundamentally better prepared and more aligned with a common standard than it was for any previous technology transition. Whereas past wireless technology upgrades had competing standards vying for industry attention, there is no doubt around which air interface standard will be used for 5G. Industry uncertainty adds friction to development and discourages firms from making big bets when the outcome is less than certain. Early on in 4G, the competing technologies being considered included both IEEE 802.16m (WiMax) as well as a preliminary version of LTE. While WiMax was first to market, the industry eventually coalesced around the LTE flavor of the new OFDMA air interface for flexibility in spectral utilization, wider coverage and cellular network compatibility. Early players such as Sprint and Intel who bet on WiMax eventually fell behind had to change their technology roadmaps and work to catch-up as the rest of the industry lined up behind LTE.




The serendipitous growth and popularity of smartphones also added demand for the burgeoning LTE ecosystem. The faster data speeds LTE offered coupled with intuitive interactions and excellent apps-based user experiences created an enormous demand for mobile broadband. New services previously not recognized as potential use cases would surface as LTE became the foundational technology in our increasingly mobile world. Applications such as Uber and Lyft were mere abstract ideas at the start of 4G LTE. In similar fashion, the potential "killer app" for 5G has yet to be realized. There is always an argument at each wireless generation transition that

revolves around the known-unknowns, and the lack of concrete use cases. However, history has shown that the mobile industry rewards those who are willing to spearhead development of these new standards. As we exit the 4G era and begin the 5G journey, the industry finds itself in an unfamiliar position with a clear path forward borne out of the successes of LTE and the anticipated exponential improvements 5G can deliver. In other words, the mobile industry finds itself a full step ahead in this upgrade cycle.

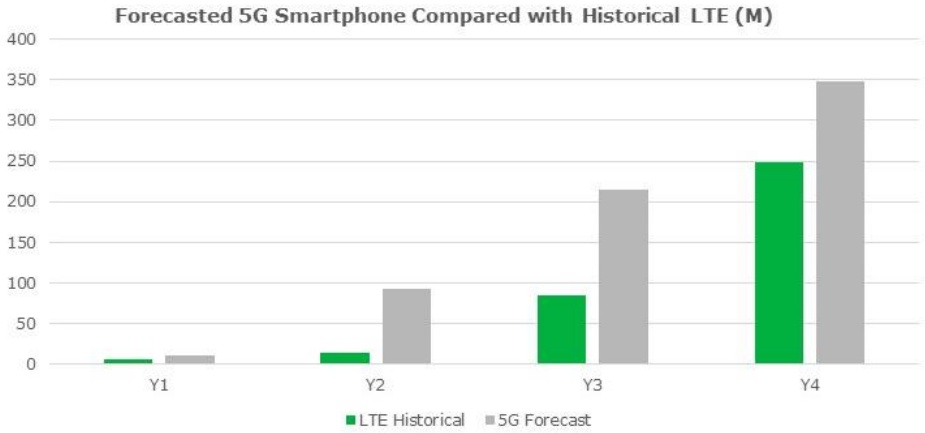
**Mobile Electronics Ecosystem**

One reliable measure of new generations of wireless technology has always been the availability of devices. Moving into 5G, the smartphone will clearly be the most recognizable device and the device category most immediately impacted by the transition to 5G. The previous 4G transition not only sowed confusion as to which air interface standard to back but also fragmented the mobile chipset market forcing OEMs and chipset vendors to spend precious R&D efforts on their modem solution to compete for 4G standards. However, with the 5G transition, the value of the merchant mobile chipset vendor is well understood and, led by companies like Qualcomm, have created complete solutions to address not only the modem needs but also the increasingly complex RF Front End (RFFE). The RFFE is often an overlooked technology enabler but is critical for OEMs to adopt the new standards quickly. Qualcomm's complete modem to antenna solution means that an OEM can go to market faster with a device focusing on differentiate feature sets outside of the radio system.

Early 4G phone designs were varied and leveraged multiple chipset vendors from the likes of Samsung, GCT, Sequans and, of course, Qualcomm. Consumer experience was often a mixed bag, with battery life as the main pain-point. Eventually the OEMs converged on 3rd generation LTE chipsets which resolved many of the power drain issues with features such as envelope tracking ICs as well as integration with applications processor. In hindsight, the supply chain missteps of the first generation of 4G smartphones contributed to the slow initial uptake of 4G in the early stages of its development. Once the LTE electronic ecosystem became more mature and began leveraging silicon and design enhancements, the industry began to see mass adoption of 4G as prices come down and OEMs could focus on other compelling features aside from the LTE radio. LTE smartphones were initially exclusive to the highest tier of smartphones but eventual chipset updates [to a new more efficient design] improved performance and drove economies of scale as costs came down. Ultimately, the modem and RFFE supply chain made it possible for OEMs to enable LTE on a broader range of affordable smartphone designs, eventually reaching the ultra-low cost segment of "smart" featurephones[1] by 2017.

In contrast, 5G electronic ecosystem is significantly more mature at this point compared to the same time during the 3G/LTE transition. Key 5G chipsets have been tested, proven and designed into devices by OEMs with the industry poised to deliver their first 5G smartphone in early 2019. Preparation began as early as February 2018 when Qualcomm announced a group of 18 OEMs had committed to building 5G devices based on their X50 5G modem. These include Asus, Fujitsu, HMD, HTC, inseego, LG, NetComm, Netgear, OPPO, Sharp, Sierra Wireless, Sony, Telit, Vivo, WNC, Wingtec, Xiaomi and ZTE. Of these 16 OEMs, 11 were smartphone brands and 4 of those were top Chinese OEMs. Later in that same year, Qualcomm demonstrated millimeter wave RFFE capabilities with modularized antenna to transceiver designs essentially creating a complete modem to antenna design. More recently, at the Qualcomm Snapdragon Technology Summit in December of 2018, further industry support of Qualcomm's 5G platform was announced as carriers such as AT&T, China Mobile, EE and Verizon as well as additional brands such as Samsung and OnePlus promised to deliver the first 5G smartphones based on the Snapdragon 855 platform and X50 modem in early 2019. In total, by January of 2019, over 30 commercial 5G mobile devices have been scheduled for debut in the new year according to the latest press release by Qualcomm.

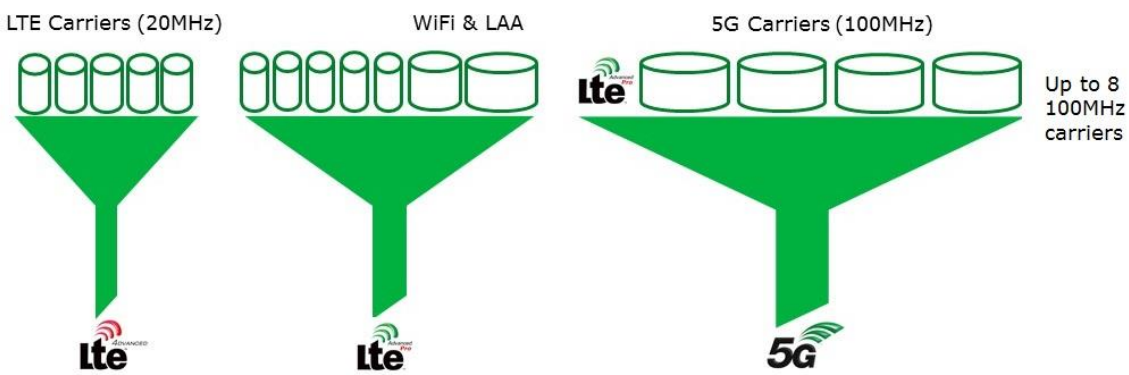
[1] Smart featurephones are essentially mobile phones with a very light [but open] OS (operating system) packed in a traditional hard key industrial design. Examples include the Reliance Jio's LTE-only Jio Phone.




With the industry aligned and momentum clearly behind 5G smartphone introductions in 2019, the leadup to the 5G transition is shaping up to be much more coherent than it was for the LTE transition. It is forecasted that the adoption of 5G smartphones in the second year of introduction (2020) will reach six times the volume of LTE smartphone (2011) during the same timeframe. The critical success criteria in this case would be the single industry standard for 5G, established electronic supply chain and network availability. These robust projections are even more significant since the smartphone industry has now entered a stage of slow growth where the demand for new devices has essentially tapered off.

**Operators Motivated to Deploy 5G**

For carriers 5G presents an opportunity to scale their business and deploy new services by tapping into significant amounts of previously unused spectrum. By opening frequencies in millimeter wave segment of the radio spectrum, operators can now tap into much larger swaths of contiguous spectrum (up to 8x100MHz). In comparison to LTE, which is deployed in sub-6GHz range, each 5G carrier can be up to five times wider than the widest LTE carrier available today (100MHz vs. 20MHz). While it is true that the OFDM air interface [which both LTE and 5G are based on] is the most advanced air interface the industry has today (nearing the Shannon Limit), the sheer size of each 5G carrier along with advanced MIMO and coding techniques allows for more efficient utilization of spectrum than that of the limited bandwidth carriers in LTE. In other words, with a larger carrier bandwidth, the signaling overhead budget is proportionally less than that of smaller bandwidths in 4G, which ultimately yields higher bits-per-second-per-Hertz performance. This spectral efficiency advantage and multi-gigabit per second speeds of 5G will ultimately allow for new and exciting applications in mobile AR/VR, high definition videos, multiplayer gaming and more. Additionally, the higher network capacity and ultra-low latency of 5G technology should allow mobile operators ample opportunities to monetize the services that will be introduced on the new networks.



Combined with the ability to network slice, operators can leverage the same 5G networks to address new commercial and industrial market verticals with services focused on massive IoT and critical communications by customizing service levels to each customer. For carriers, 5G isn't just a bigger and faster LTE network but one that can be a transformative business platform to create value for the industry and recognize ROI (return on investment). The 5G migration will also provide carriers with opportunities to harvest existing spectrum which are currently used for legacy services like 2G. Converting these 2G (and eventually 3G) networks to a more efficient 5G network is economically favorable for carriers to realize higher network capacity and efficiency. Clearly, at the carrier end of the equation, the vested parties are very much incentivized to plow forward with the 5G transition.

**China Market Influence**

One cannot talk about wireless networks without broaching the topic of China. With its enormous subscriber base and government regulated domestic competition between three wireless carriers, China occupies a unique and increasingly important position of global influence. Thus far, China Mobile is a leading advocate for 3GPP Release 15 which would codify the 5G standard for Stand-Alone (SA) networks the operator intends to deploy. China Mobile's commitment to deploying a nationwide 5G network that works without an LTE base layer will enable the entire industry to expand benefiting network equipment vendors and device makers alike. Recently, the Chinese authorities granted all three major carriers 5G spectrums for network testing in 2019. Both China Unicom and China Telecom received 100MHz swathes in the C-Band (3.4-3.6GHz) while China Mobile was granted spectrum in both 2.6 and 4.8GHz totaling 260MHz in bandwidth. 5G services are expected to be rolled out in 2020 with early pre-deployment along with smartphones in late 2019.

To meet that deployment target, the world's largest wireless carrier China Mobile and its domestic rivals China Unicom and China Telecom will deploy a pre-commercial 5G launch as early as the second half of 2019. For carriers with this type of tremendous scale, the pre-commercial launches will essentially rival those of full deployments in other markets. Also, their ambitious SA 5G network will create new demands for mobile electronics and handset OEMs to drive out cost in current 5G designs to meet the needs of a Stand-Alone 5G network. It is useful to note that while North American carriers will begin service with NSA 5G, they have a technology roadmap that will evolve into SA networks as 5G matures. China's out-sized influence carried global LTE adoption forward significantly in 2014 and they are again expected to be another market-mover for 5G. Whereas the Chinese market was more of a follower with 4G LTE deployment, the intention this time is for the largest smartphone market in the world to lead with 5G, which will in turn enable enormous scale for the industry as a whole.

The reason for this aggressive push is because China recognizes the transformative power of 5G to upgrade their digital infrastructure and drive economic growth. Likewise, many other countries such as the US are equally keen to reap the benefits of 5G. It is forecasted that, when fully realized, 5G will enable $12.3 trillion of global economic output[2] by 2035. It is this imperative that developed nations like China and the US are driving for a rapid transition to the 5G future, further hastening the upcoming 5G transition.

Early movers in 5G include China, the US, Japan, S. Korea, Australia and the UK. These six regions represent the first wave of global 5G deployment. The motivation for China and the US was described earlier whereas the impetus for Japan and S. Korea are to accelerate their respective 5G debuts with the upcoming Olympic games. Australia recently secured 5G spectrum after government regulators successfully auctioned the 3.6GHz band. EE Limited (Everything Everywhere) in the UK has stated their intent to build out a 5G network in 2019 with handset partners like OnePlus. Other European operators such as Swisscom, TIM and Vodafone have also stated plans to

[2] "The 5G Economy", IHS Economics and Technology, whitepaper, 2017

deploy 5G in the near term. It is expected that additional European and Asia-Pacific nations will begin rolling out their respective 5G networks in 2019 and then expanding in 2020. As spectrum allocations and 5G deployments are established for the larger wave of adopting markets, the industry will find that the smartphone vendors and supply chain is fully prepared to meet their growing needs.

**Conclusion**

As the industry enters the start of another wireless generation transition, it is doing so with a robust and coordinated ecosystem of carriers, handset OEMs, component suppliers and government support. A "perfect storm" of 5G capabilities and interested parties are coming together to shape the impending technology transition. A common air interface standard has been adopted, carriers are eager to deploy, network equipment vendors poised to help them, the mobile electronic supply chain is ready to deliver the first devices into subscriber's hands and nations are eager to lead the 5G race. By and large, the industry is finding itself in an unprecedented opportunity to execute a wireless transition in the best position possible.

# Contacts

AMERICAS
**T** +1 844 301 7334
**E** technology_us@ihsmarkit.com

EMEA
**T** +44 (0) 13 44 32 81 55
**E** technology_emea@ihsmarkit.com

**APAC**
**T** +60 042913763
**E** technology_apac@ihsmarkit.com

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