

# RCR Wireless News

INTELLIGENCE ON ALL THINGS WIRELESS

APRIL 2022

## The global status of 5G

By Catherine Sbeglia Nin

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**Introduction: The 'next wave' of progress**

According to the Global Mobile Suppliers Association (GSA), there have been 209 commercially available 5G networks – in 83 countries – launched as of March 2022. Further, there are at least 958 commercially available 5G devices, up more than 137% from 404 last year. While these numbers are impressive and represent a notable improvement from the 92 reported in August 2020, 5G's progress is getting to the point where simply counting up the number of networks doesn't paint the full picture of how the industry is truly progressing. That's because in the past year, 5G seems to have entered a new phase of development. The first steps, like achieving (mostly) nationwide coverage and establishing a broad smartphone ecosystem, are done for the majority of developed countries.

"We have successfully launched and deployed the networks, we have successfully launched devices into the market, so that phase is definitely over," claimed Reiner Stuhlfauth, technology marketing manager at Rohde & Schwarz, adding that 5G is now "evolving."

"For example, we see that in the move from Non-Standalone [NSA] to Standalone [SA]. We see it also

in respect to the frequency usage, which is the additional spectrum. 5G is going to enhance. We have done the first step – the next wave is coming," he said.

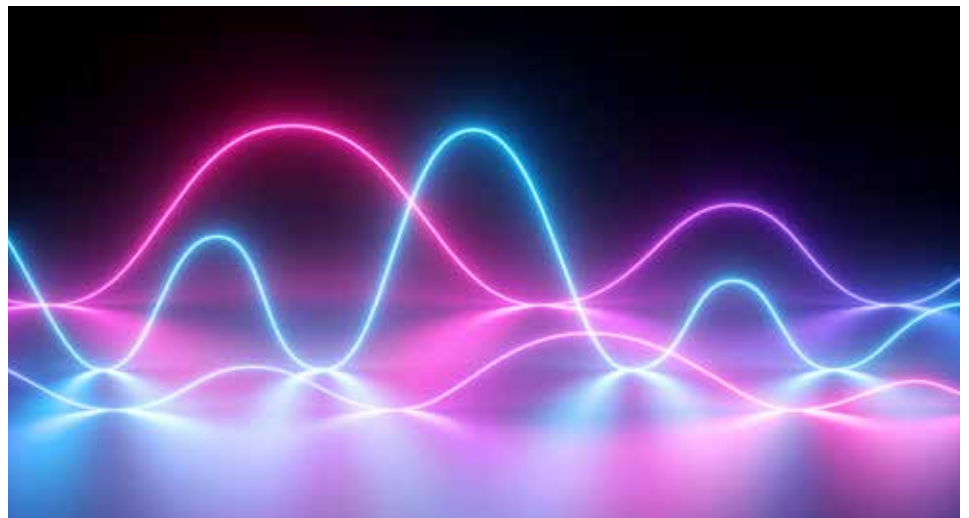
This report explores that next wave, looking at the transition to Standalone, where we go from an architecture linking an LTE core to new radios supporting 5G frequency bands to a cloud-native 5G core, and to more open architectures by disaggregating the radio access network (RAN), and also asking serious questions around how best to monetize the new applications and services that 5G enables.

**In the US, mid-band deployments are changing the 5G game**

At the end of last year, an Ookla report positioned the U.S. as the

world leader for 5G availability, but when compared to other early 5G adopting countries, it fell short in the category of 5G speed, ranking dead last.

However, something big has happened in the U.S. since December that changed the 5G game: C-Band. C-Band is mid-band spectrum between 3.7 and 4 GHz, and when further considered alongside CBRS, which is mid-band spectrum from 3.5 GHz to 3.7 GHz that was authorized for wireless service provider commercialization in 2020, the overall 5G spectrum landscape in the U.S. is rapidly evolving. And because the lack of available mid-band spectrum for 5G in the U.S. is the likely culprit behind the country's poor speed performance, this year's speed rankings might look different than last year's.



Midband has been described as “the goldilocks of spectrum” because while you can only get the speed with the high band and only coverage with the low band, the midband is almost like a combination of the two. In other words, you get much better coverage than possible with millimeter wave (mmWave,) but also enough allocated spectrum to achieve some of the speeds promised by 5G.

“While Europe and Asia were focusing on midband, the U.S. was focused on mmWave and doing the best they could with that spectrum, but now with C-band and CBRS, the game has changed completely,” said Sebastien Prieur, the group manager of 5G transport and RF at EXFO. “In the end, everyone will mix high band, midband and low band because each band is complementary to each other.”

Explaining the global spectrum climate further, Stuhlfauth commented: “In the first years when 5G started, mmWave was only in Korea and the U.S. But now the mmWave range is expanding, spreading into other countries. The opposite trend, the big hype in the U.S. with the C-Band. In Europe, we don’t care, because this was our primary band for 5G.”

#### AT&T and Verizon deploy C-Band

On January 19th 2022, Verizon and AT&T activated their C-Band 5G networks, and in doing so, finally shook up the dynamic in which T-Mobile US was the only U.S. carrier using large swaths of mid-band spectrum for 5G in the form of the 2.5 GHz spectrum that it got its hands on following the April 2020 acquisition of Sprint.

It became clear just how important mid-band spectrum would be for nationwide coverage when the U.S. C-Band auction raised a gross total of \$81.17 billion, far surpassing the previous auction record of \$44 billion raised in the AWS-3 auction that ran in 2014-2015.

Verizon, alone, spent more on C-Band spectrum than the AWS-3 auction raised from all bidders – \$52.9 billion. That amount of money got Verizon 3,511 licenses in all the 406 geographic Partial Economic Areas (PEA) that make up the United States. Other top bidders, in terms of dollar amounts, include AT&T, which spent \$23.4 billion for 1,621 licenses in 406 PEAs; T-Mobile US, which spent \$9.3 billion for 142 licenses in 72 PEAs; and US Cellular, which spent \$1.3 billion for 252 licenses in 99 PEAs.

AT&T secured 80 megahertz



**“While Europe and Asia were focusing on midband, the U.S. was focused on mmWave... but now with C-Band and CBRS, the game has changed completely.”**

*Sebastien Prieur, Group Manager of 5G Transport and RF, EXFO*

of spectrum and a 29% share of the available licenses during the C-Band auctions, and the carrier said it plans to deploy this mid-band spectrum starting at the end of 2021.

At the end of March 2022, Opensignal released a report that explored the 5G speeds seen on each carrier’s mid-band 5G networks, concluding that the carriers are using their C-Band spectrum in “very different ways.” T-Mobile US had a two-year head start using the previously mentioned 2.5 GHz



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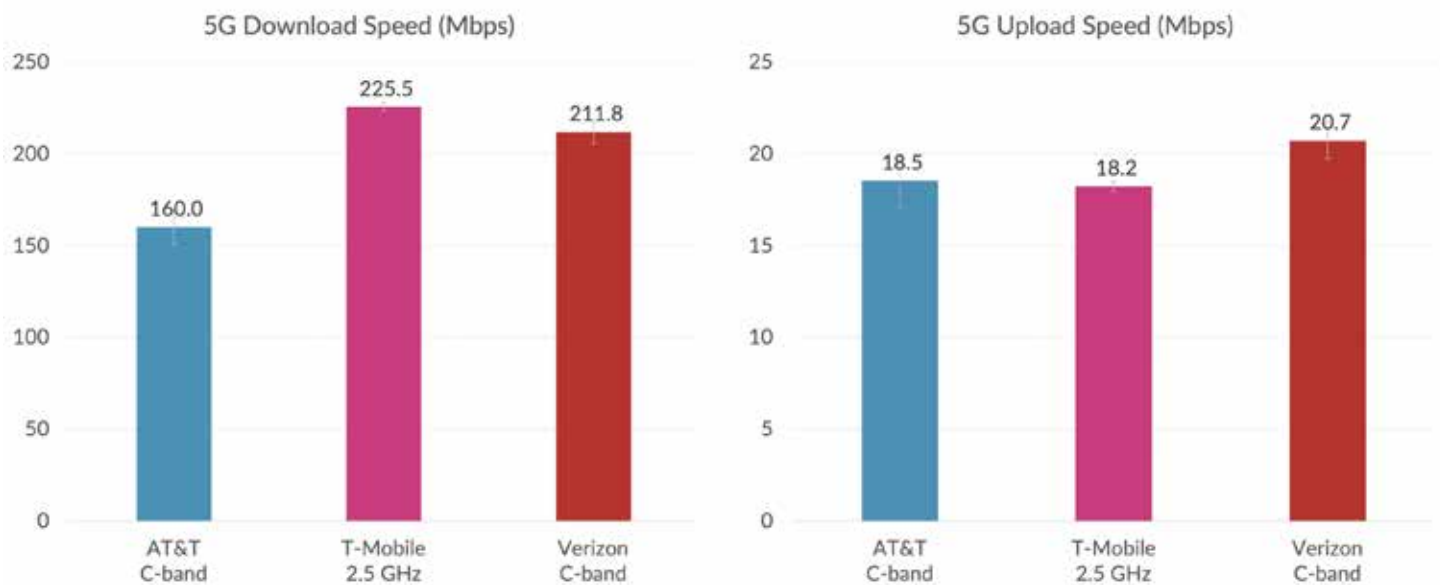


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## Analyzing mid-band 5G speeds in the US



Note: AT&T's initial C-band launch was limited to parts of eight metro areas across the U.S. Data collection period: January 19 – March 19, 2022 | © Opensignal Limited



spectrum, but now, Opensignal said it observed “widespread” C-Band use by Verizon users, resulting in a visible improvement to 5G download speeds. AT&T’s users, however, appear to connect to mid-band 5G very rarely.

This difference in approach is consistent with the firm’s previous findings related to Verizon’s and AT&T strategy, as well as with RCR Wireless News’ reporting. In January 2022, for instance, Verizon CEO Hans Vestberg said its C-Band coverage will initially reach more than

90 million potential customers and boost its ability to bring Fixed Wireless Access broadband to another 9 million households. AT&T, meanwhile, said at the time that it is kicking off its C-Band deployments on a smaller scale, with operations beginning in parts of only eight cities.

Opensignal’s Verizon users observed a significant increase in the 5G download speed experienced on the network following the activation of C-Band spectrum but did not see the same in the carrier’s 5G upload speed. AT&T users did not

experience a statistical change in either average 5G download and upload speeds.

By activating C-Band, Verizon achieved an upward shift in its national 5G download speed score by about 15 Mbps (26.7%), rising from an average of 55.7 Mbps seen in the six weeks before, to an average of 70.6 Mbps afterwards. Again, no such shift was detected on AT&T’s 5G network.

“We are off to a fast start with C-Band and we are seeing better than expected performance,”

Verizon SVP and Chief Engineer Lynn Cox told RCR Wireless News. “Right now, on sites where we have deployed C-Band, we are seeing more than 30 percent of overall traffic leveraging this spectrum—even more than we expected. This is not only giving our customers a great experience on C-Band, but our LTE bands are freed up and we are seeing better performance on those bands as a result. The massive capacity of C-Band leads to more opportunity across the board.”

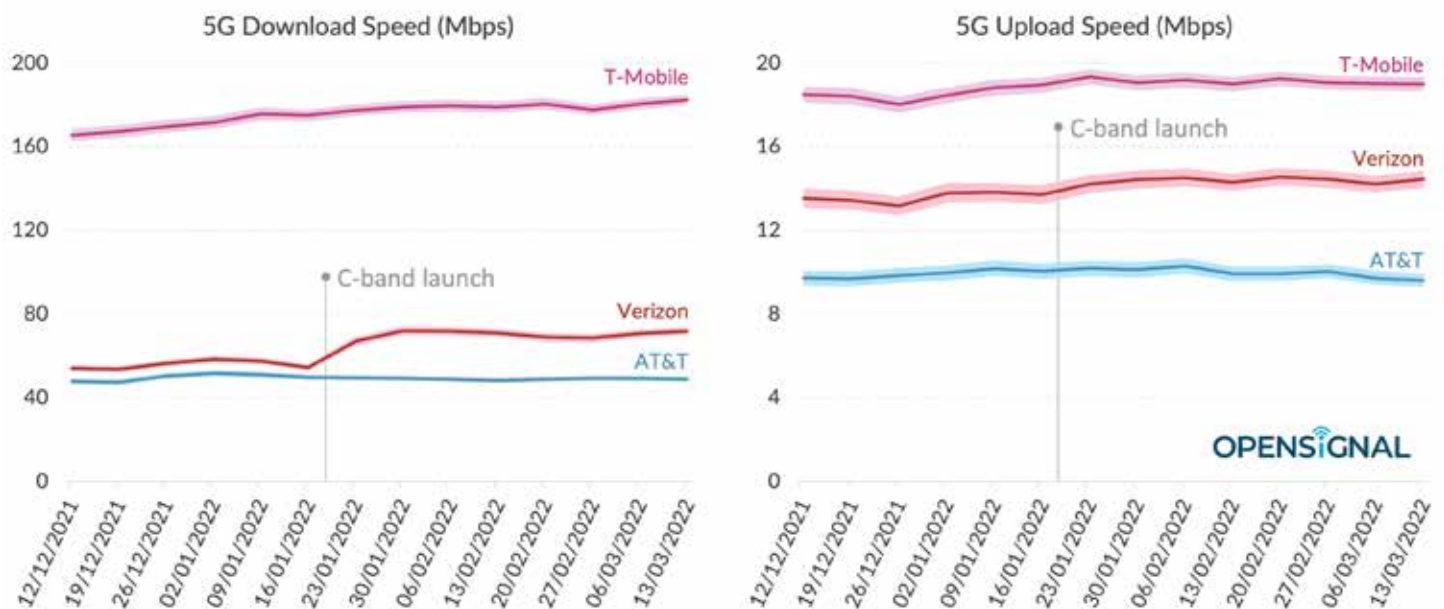
Cox added that Verizon currently

has 60 megahertz of C-Band spectrum deployed, with plans to average 161 megahertz per market. “This is more than double our sub-6 spectrum holdings before the C-Band auction,” she said.

While Opensignal’s reporting has consistently shown that T-Mobile US users have the fastest overall 5G download speeds, that story starts to change slightly when comparing only the mid-band 5G speeds for each carrier. That’s because the bottom line is that mobile users on all three of the carriers’

networks—although in limited markets in the case of AT&T—enjoy much faster 5G speeds when connected to mid-band 5G, Opensignal found. On T-Mobile’s mid band spectrum, users experienced average 5G download speeds of 225.5 Mbps, while Verizon users saw an average speed of 211.8 Mbps and AT&T users an average of 160 Mbps. On the other hand, Verizon’s 5G upload speed on mid-band 5G was 20.7 Mbps, while AT&T and T-Mobile’s scores were statistically similar at 18.5 Mbps and 18.2 Mbps, respectively.

## 5G Download Speed on Verizon improved after its C-band launch



Data collection period: 7 day periods ending on the date shown. Shaded areas represent confidence intervals | © Opensignal Limited



**Highlights from other parts of the world**

*South Korea has the fastest 5G in the world, according to Ookla*

South Korea was the first country to launch commercial 5G networks in April 2019 and currently has 5G coverage across its 85 cities, and now Ookla says it has the fastest median 5G download speeds during Q3 2021 when compared to other early-adopting countries. Combined, Korean mobile operators have deployed a total of 202,903 5G base stations as of the end of February, according to the country’s Ministry of Science and ICT. The number of domestic 5G subscribers reached 21.57 million at the end of last month, roughly equivalent to

half of the number of LTE subscribers. Below is a breakdown of those numbers by operator.

**SK Telecom:** In April 2019, SK Telecom rolled out its nation-wide 5G networks on 3.5 GHz mid-band in data-traffic-concentrated areas, focusing on major cities and highly populated areas like universities, high-speed trains, highways and metropolitan subways with plans to expand that coverage to nationwide subways, national parks and festival sites as 2019 concludes. The initial launch included a total of 34,000 5G base stations in 85 cities.

Much more recently, SK Telecom said in an earnings statement that ended 2021 with a total of 9.87

million subscribers in the 5G segment, after a net addition of 4.4 million customers during the year. In the last quarter of 2021, the carrier added 1.22 million 5G subscribers. SK Telecom also noted that its 5G customer base accounted for 41.6% of total mobile subscribers, up from 36.2% at the end of the previous quarter and 22.8% at the end of 2020.

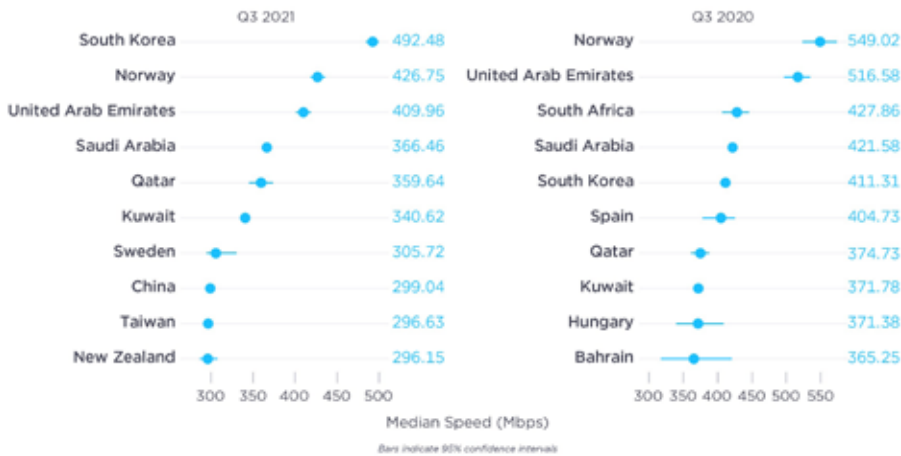
**KT:** KT also launched 5G in April 2019, touting its extensive 5G network as a key differentiator among rivals. The initial launch focused on covering key transportation routes, including two major highways, six airports and the ground section of high-speed railways, as well as throughout 85 major cities, 70 large shopping malls and 464 college campuses across South Korea.

In a recent earnings call, KT said it ended 2021 with 6.37 million 5G subscribers, which makes up 45% of all its handset subscribers.

Also of note, the carrier last July announced what it claimed to be the first 5G SA in South Korea using Samsung’s end-to-end 5G network solutions from Radio Access Network (RAN) to core.

**LG Uplus:** In August 2019, LG Uplus reported 540,000 5G subscribers on its 5G network, which includes

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around 50,000 5G base stations in Seoul and surrounding areas, as well as some metropolitan cities. At the end of 2021, though, the carrier was claiming 4 million 5G subscribers, which accounts for 25.7% of the telco's overall mobile base, up from 16.5% at the end of 2020.

*Spanish operators continue to accelerate 5G deployments*

All Spanish operators accelerated 5G deployments in 2021 and most of the country's main urban areas, as well as in medium-sized cities, have 5G coverage. Below is an update on the current state of next-generation deployments by Telefonica, Orange, Vodafone and Masmovil as of January 2022.

**Telefónica:** Spain's largest operator, Telefónica offers 5G coverage to more than 80% of the Spanish population and in more than 1,250 municipalities across the country. During the first half of 2021, the deployment of 5G has focused on completing coverage in the cities deployed last year and reaching cities with more than 20,000 inhabitants.

The network currently combines the deployment of 5G NSA and DSS (Dynamic Spectrum Sharing), but in July of 2021, the carrier officially announced its decision to award vendors Ericsson and Nokia with

5G Standalone contracts, confirming that the first SA deployments will occur sometime this year and will be carried out on the 3.5 GHz and 700 MHz bands.

**Vodafone:** Vodafone launched Spain's first commercial 5G network in Madrid, Barcelona, Valencia, Seville, Malaga, Zaragoza, Bilbao, Vitoria, San Sebastian, La Coruna, Vigo, Gijon, Pamplona, Logrono and Santander in June 2019. The carrier had previously said that it was working with Huawei and Ericsson in the deployment of the 5G network.

As of this past January, the carrier's 5G network reaches 25 cities across the country and uses spectrum in the 3.5 GHz band and NSA architecture. Vodafone launched a pre-commercial 5G Standalone network in Spain in June 2021.

**Orange:** Orange is already offering 5G services in 787 towns and cities in 38 provinces across the country. According to the European operator, its 5G network infrastructure already reaches 52% of the Spanish population. Orange had said it expects its 5G network to reach 90% of the Spanish population by the end of 2022.

**Masmovil:** Masmovil is currently offering 5G service in 686 towns

and cities in 40 provinces across Spain for the customers of its Yoigo brand. According to the telco, 54% of the country's population is already covered with its 5G network infrastructure. The carrier's 5G service is being offered via a combination of its own infrastructure and an agreement with rival operator Orange. Masmovil currently has 80 megahertz of spectrum in the 3.5 GHz band for the provision of 5G. Since September 2021, the telco has expanded its 5G infrastructure in 133 cities across Spain.

In October 2019, Masmovil signed an agreement with Orange Spain covering mobile, fiber and broadband technologies. The deal gives Masmovil access to Orange Spain's entire 5G network thanks to a "virtual active sharing mode" agreement, enabling it to deploy 5G in 4,500 locations that cover 35% of the Spanish population in 40 main cities.

**5G Standalone is a priority, but 'there's a lot of priorities'**

As of March 2022, the GSA reported that 119 operators worldwide are investing in public 5G Standalone (SA) networks in the form of trials, planned or actual deployments and that 20 operators in 16 countries/territories have launched public 5G

### Countries/territories with operators identified as investing in public 5G SA networks



Image courtesy of the GSA

SA networks.

An additional five operators have deployed 5G SA technology but not yet launched services or have only soft-launched them, another 25 or so have announced 5G SA pilots for public networks and 22 more are reportedly involved in evaluations/tests/trials.

Another way to track progress is to look at the device ecosystem. The GSA reported 663 announced devices with claimed support for 5G SA, up 138% from 278 at the end 2020. Of these devices, 461 are commercially available. 5G SA devices accounted for 35.6% of 5G devices in Dec 2019, 49.7% in Dec 2020 and 54.6% in Dec 2021.

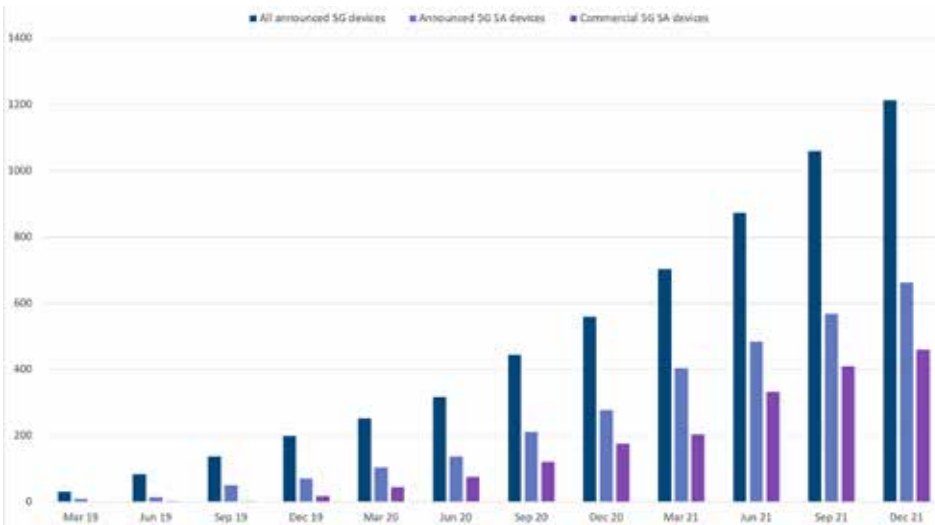
When broken down by form factor, phones accounted for just over half (50.3%) of announced 5G devices with SA support, with fixed

wireless access consumer premises equipment (FWA CPE) and modules tying for second place, each accounting for 20% of devices.

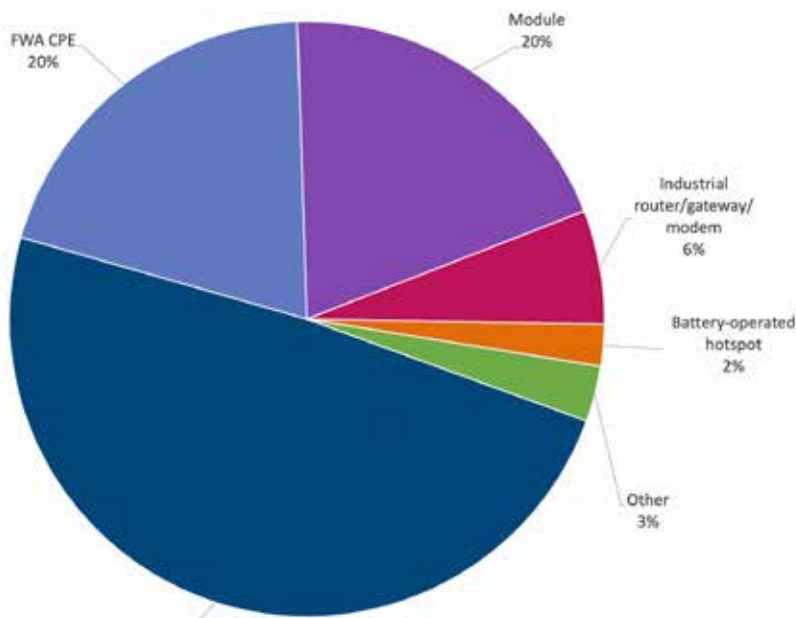
#### Operators that have launched a 5G Standalone network:

- |                                 |                             |
|---------------------------------|-----------------------------|
| 1. China Mobile (China)         | 11. KT (South Korea)        |
| 2. China Telecom (China)        | 12. STC (Saudi Arabia)      |
| 3. China Unicom (China)         | 13. M1(Singapore)           |
| 4. Mobile Hong Kong (Hong Kong) | 14. Smart (Philippines)     |
| 5. T-Mobile US (USA)            | 15. SoftBank (Japan)        |
| 6. RAIN (South Africa)          | 16. Rogers (Canada)         |
| 7. Vodafone (Germany)           | 17. Taiwan Mobile (Taiwan)  |
| 8. Vodafone (U.K.)              | 18. Telia (Sweden)          |
| 9. Telefónica O2 (Germany)      | 19. TPG Telecom (Australia) |
| 10. SingTel (Singapore)         | 20. DIRECTV (Colombia)      |

### Announced and commercially available 5G devices with stated 5G SA support



### Announced 5G devices with stated 5G SA support, by form factor



Images courtesy of the GSA

T-Mobile US was the first carrier in the world to activate an SA network in August 2020. According to Verizon’s Cox, the carrier, though in “the early days of implementing Standalone capabilities,” will begin deployment of its SA 5G core later this year. But for Oracle Communications Group Vice President of Technology Andrew De La Torre, Dish Network is the 5G SA standout.

“Having the benefit of building a greenfield 5G network has liberated them from a lot of the legacy constraints other carriers face, and they have taken full advantage,” he explained. “Their decision to deploy their network in the public cloud, and place an unrelenting focus on the cloud native capabilities of their 5G solutions – as much as the actual 5G features themselves – has demonstrated a visionary approach to building a communications network. Oracle has been fortunate enough to be a major provider to Dish on their journey so far, which I believe will prove to be the future template for how to build carrier networks.”

Despite the progress being made in the U.S. and De La Torre’s comments, Chinese telcos have actually been the biggest champions of this brand of 5G, and according to LitePoint’s Chen, it’s a strategy



somewhat unique to the country. “China is pretty gung-ho about Standalone, not so much in North America,” he explained. “In the U.S., you have 300 million-plus people, and other than a few big cities, we all live kind of far from one another. In China, you have more than four times the population compared with the U.S. and a really high density of people, and if you’re covering those big cities, you’re covering a massive part of the population. So, if you’re China Mobile or China Unicom, if you deploy 5G cellular in Beijing, you can easily achieve scale with 10, 20, 30 million people or more.”

In the U.S., by contrast, there aren’t as many locations – other than maybe New York City and Los Angeles – where there is such a high population density. In this way, the ROI might be a bit fuzzier in the U.S. than in China. “And let’s be honest,” Chen continued. “China has more FRI spectrum deployments than the U.S., so that will make 5G SA more attractive.”

No matter how you look at it, many consider global SA progress to be surprisingly slow. “I thought that by now, SA would be more widely adopted,” said Prieur. “We

are barely starting to see it in terms of operators turning it on. Tier-1 operators in the U.S., for example, are focusing much more on building out the edge.” He added that other priorities like densifying the network and rolling out C-band are taking up a lot of operator energy and resources.

“This will be true for the next few months,” Prieur said. But he assured that SA is coming and that once adequate 5G coverage is achieved in the U.S., with the help of C-Band, operators can move onto the next phase, which he is sure will be transitioning to SA.

Fritz provided additional insight, commenting that SA is certainly a priority, but “there’s a lot of priorities” that are “all competing for attention.”

While De La Torre revealed that he cannot confidently say he expected SA progress to be further along than it is, he did acknowledge some disappointment that the industry hasn’t moved faster, mostly because for him, the 5G standalone core network was “always the main act in this show.”

“The Standalone core network is the real service engine of 5G and has always been the key component

of what realizes the full potential of 5G technology,” he continued. “What our industry failed to anticipate is that, just like the device ecosystem needed radio – for coverage – investment to stimulate it, the services ecosystem needed Standalone deployments for the very same reason.”

He added that by phasing the investment focus in this way, the industry has artificially delayed innovation in the services space. “And, without these new services, 5G will never make that jump from a technology that is just about consumer voice and broadband to one that includes the enterprise market,” he said.

Looking ahead, De La Torre said Oracle expects the next two to five years to be the point “where 5G Standalone deployments finally reach global critical mass” based on observations from customer engagements. He continued that when that happens, two critical things will follow.

“First, the sheer diversity and scale of the 5G opportunity for industrial applications will start to become apparent and carriers will shift their focus from simply deploying 5G as a technology to

transforming their entire businesses and operating models,” he said. “Second, there will be an increasing realization that the future of 5G will lie in this technology being an underlying enabler for vertical industrial applications. Carriers will need to embrace new partner ecosystems with vertical application providers like Oracle and deploy new technology and commercial models that can embed their network capabilities into these integrated offerings.”

**With 5G largely here, the industry turns to questions of monetization**

While expanding 5G coverage is still a priority for operators, the

conversation around how to best monetize the latest generation of cellular, as well as the capabilities it enables, is beginning to take center stage.

Unlike previous generations of cellular technology, which have been highly consumer focused, 5G, with its promise of lower latency and higher throughput, is being used to address enterprise, Industry 4.0 and autonomous vehicle needs, opening up new monetization opportunities for communications service providers (CSPs), as long as they carefully pair technology investments to desired business outcomes.

“The next big step in 5G is creating new applications and services,”



**“The next big step in 5G is creating new applications and services [and] expanding into new verticals.”**

*Reiner Stuhlfauth, Technology Marketing Manager, Rohde & Schwarz*



said Stuhlfauth. “5G is expanding into new verticals. As a smartphone user, you may be wondering ‘why the hell would I use 5G?’ But what is not seen by the standard user is the applications in the industrial network industry. It’s not just coverage.”

*A million private networks by the end of the decade? Vodafone thinks so*

Private cellular networks, for instance, are seen by many as a major opportunity to set up bespoke networks in support of industrial internet of things projects and in

### Countries/territories with organizations cataloged as investing in private mobile networks (pilot projects, deployments and launches)



*Image courtesy of the GSA*

service of applications where data sovereignty is paramount. Operators, therefore, are looking for ways to stake their claim in this emerging market.

However, with the GSA having counted hyperscalers among the more than 50 equipment vendors and more than 70 telecom network operators involved with private mobile network projects, operators still run the risk of missing out and becoming simply data pipeline providers just as they did in the 4G era.

“Streaming, ride sharing, those things took off because of 4G

capabilities, but carriers didn’t capture as much of the upside as the application ecosystem,” said Jack Fritz, principal in Deloitte Consulting LLP’s Technology, Media and Telecommunications. “But I think in 5G, you are seeing carriers take different approaches around how they are making themselves available in the enterprise and government segment... And with private networks and networks as a service, there’s opportunity for carriers to monetize.”

In addition to the above insight, the GSA identified the manufacturing sector as a strong adopter

of private mobile networks, with 111 identified companies involved in known pilots or deployments, up from 51 at the start of 2021, followed by mining companies with 63 deployments. The education sector and utility companies tied at 58, while seaports or maritime companies had 41 deployments.

“We are also seeing increasing traction in other sectors, including healthcare, in which the current pandemic has accelerated adoption of smart and remote healthcare applications needing private mobile connectivity, as well as municipal



government, and transportation and logistics,” said the GSA.

As of February 2022, 58 countries and territories have been identified by the GSA to have private network deployments based on LTE or 5G, as well as several private mobile network installations in offshore locations serving ships and the oil and gas industries. Of these deployments, 61% use only LTE, 21% use only 5G and 17% make use of both.

LTE’s continued dominance in private networks is also supported by data from another February report, this one published by the Dell’Oro Group. However, the Dell’Oro Group posited that 5G NR will surpass LTE in private network deployments by 2026.

“Risks are broadly balanced,” commented the Dell’Oro Group. “On the upside, the 5G enterprise puzzle has still not been solved. The successful launch of private 5G services by suppliers with strong enterprise channels could accelerate the private 5G market at a faster pace than expected. On the downside, 5G awareness is improving but it will take some time for enterprises to fully understand the value of private LTE/5G.”

From one carrier’s perspective,

private networks are due for an explosion. At a January event organized by Athonet, Marc Sauter, head of mobile private networks for Vodafone’s business division, suggested that private LTE and 5G for industry appears to be rolling faster than anyone expected.

“A million private networks by the end of the decade? At Vodafone, we believe it is possible,” he said. “In Europe alone, we have about a million companies that could benefit from private mobile networks – with most in manufacturing, along with logistics and warehousing, utilities, oil and gas, and increasingly in healthcare.”

Sauter’s comments came a few months before the U.K.-based carrier teamed up with Nokia to deploy a private LTE and 5G network to

underpin “the world’s first marine-focused 5G testbed” in the U.K. port city of Plymouth, on the Devon coast. The new installation will be used to connect various IoT sensors, marine vessels (including autonomous vehicles) and research equipment to drive innovation in the maritime and marine sectors.

The Vodafone network features five mobile sites along Plymouth Sound, the inlet in the English Channel around which the city of Plymouth has developed; these include a radio mast on a fort from the Revolutionary Wars with France in the 1800s. The network will be available for free to businesses, academics and government organizations to use for testing and research on and under the waters of Plymouth Sound.



Plymouth Sound – with Drakes Island in the foreground.

Image courtesy of Lewis Huddy

Across the pond, AT&T recently struck a deal to provide a private 5G network and multi-access edge computing (MEC) capabilities to the Ford factory where the car manufacturer's first-ever electric pickup truck, the F-150 Lightning, is being built.

According to AT&T, 5G connectivity at the facility will support multiple types of wireless connections, from tablets and phones used by employees on the production line to over-the-air software updates for the vehicles themselves.

During *RCR Wireless News'* 5G Monetization Forum, AT&T's Vice President of Manufacturing Solutions Ande Hazard shared that Ford will tap into 5G's ultra-fast speed and low latency to enable things like vision systems, automation, robotics and even faster wireless vehicle updates.

*The cost savings of Open RAN might be so huge that 'there's no stopping it'*

For LitePoint's Chen, private networks aren't as compelling as other 5G-related topics, like Open RAN (O-RAN), when it comes to ways for operators to increase revenue. "The thing about private networks is the use case needs to be clearly outlined and defined from the



Image courtesy of Ford Motors

beginning," he argued.

In other words, the case has to be made for private networks over say, Wi-Fi 6 or a private slice of a public network, making it more of a niche approach to monetization. Further, it's hard for a single use case or application to make it worth building and deploying an entire private network. "Whereas with O-RAN, you, for one thing, have this rip-and-replace initiative, so there is an O-RAN push on the government side to open the playing field and not use Huawei equipment," Chen continued.

For many vendors, operators, politicians and other ecosystem

stakeholders, Open RAN, despite not being a new concept, is key to the 5G future. While virtualized RAN decouples hardware and software, allowing network functions typically run on a proprietary technology stack to exist as software workloads using commodity or custom hardware, Open RAN considers the same but adds in modularity wherein hardware and software from multiple vendors can interoperate. In doing so, O-RAN promises to end vendor lock-in and lower OPEX for CSPs, and in that way, increase their revenue.

"Open RAN creates the opportunity for more vendors to participate



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and it's an open system. It's good for consumers and for operational costs for operators," said Chen, adding that this fact, in and of itself, is a compelling reason as to why O-RAN is getting more traction than private networks when it comes to questions of monetization.

EXFO's Prieur agreed, revealing that O-RAN's progress, particularly when compared to progress made by advanced 5G use cases and private networks, has surprised him: "This is happening faster than I was anticipating, while the rest is happening slower than expected."

In fact, the potential cost savings and revenue gain of Open RAN are so significant for carriers that Fritz

sees "no stop to it," explaining that while talk of Open RAN was present in LTE, those system architectures are more closed, and so, the industry wasn't really ready for it until now. "5G seems like the big chance... because it's a more open and modular architecture," he said.

But, O-RAN comes with challenges, particularly for test & measurement companies like EXFO, who are focused on ensuring that testing equipment is suitable for end-to-end interference detection and other services across all of a network's disaggregated parts.

"While the Open RAN concept is very good, the situation now is that we are moving from vendor-specific

equipment implementation to operator-specific implementation," said Prieur. What he means by that is that as vendor choice increases, the operator begins to function almost as an integrator, putting different network elements together as they see fit, making integration very different from one operator to the next.

"For now, it is something that we need to follow very carefully. We are still very early in the game, but we can see that this integrator role for the operator is emerging," he added.

However, the industry continues to march on towards network disaggregation, believing that the benefits largely outweigh such challenges. The U.K, for example, has announced a goal of having 35% of its telecom networks operating with O-RAN by 2030. More broadly, the GSMA last July reported that 73 operators from 38 markets have either deployed or committed to Open RAN deployments.

Some of the biggest Open RAN advocates on the telco side that have been at the top of the watch list are Rakuten Mobile, which launched 4G and 5G commercial services based on open RAN architecture in Japan, and Dish Network in the

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U.S., which continues work on its cloud-native, Open RAN technology-based 5G broadband network.

Key vendors for Rakuten include Altiostar, Cisco, Nokia, Intel, IBM Red Hat, OKI, Fujitsu, Ciena, NEC/Netcracker, Qualcomm, Mavenir, Quanta Cloud Technology, Sercomm, Tech Mahindra, Allot, Innoeye, Viavi, Robin.io, Radcom and Airspan. Key vendors for Dish include Altiostar, Mavenir, Fujitsu, Intel, Qualcomm, Nokia, VMware, Ciena Blue Planet, Matrixx, Hansen Technologies, DigitalRoute, and MTL. DISH will also use AWS Outposts and AWS Local Zones to build its 5G Open RAN network in the cloud.

*There will be 110 million 5G FWA connections globally by 2027, says Ericsson*

Mobile operators are in a consumer bind when it comes to offering new 5G services. Characterizing

this challenge, Fritz commented: “Consumers only have so much that they’re willing to pay and there has been no killer app that’s been identified. There isn’t really one [consumer] thing that the industry can organize around.”

As a result, emphasis has been placed on what 5G can do for the enterprise and to further business initiatives like Industry 4.0 and digitalization, as outlined above. However, there are indeed opportunities for 5G in the consumer market that are more than worth exploring, including fixed wireless access (FWA) for broadband connectivity, as well as more nascent markets like cloud and mobile gaming.

Particularly in the U.S., operators are looking to fixed wireless access and home internet services as a viable monetization strategy, going head-to-head with cable

companies. “There is the emergence of 5G for not just smartphones, but also for CPE [customer premises equipment], like FWA products for consumer homes, which is a “plug and play” solution as opposed to pre-installation with Wi-Fi,” Chen explained, adding that LitePoint is seeing considerable momentum around this particular 5G application, a claim supported by Polaris Market Research, which estimates that the global 5G FWA market size will reach \$88.5 billion by 2027. For reference, the market was valued at 389.05 million in 2019.

By that same year, Ericsson estimated in its November 2021 Mobility Report that there will be 110 million 5G FWA connections globally by 2027, representing almost half of total FWA connections. The vendor also reported that between June 2021 and November 2021, the number of service providers offering 5G FWA services increased from 46 to 57, representing a growth of near 25%, with particularly strong 5G FWA momentum in the Middle East and Africa, which accounts for 60% of the launches in this time frame. The region with the highest percentage of 5G FWA offerings, representing almost 40%





**“There is the emergence of 5G for not just smartphones, but also for CPE, like FWA products, which can be used instead of W-Fi.”**

*Rex Chen, Director of Business Development, LitePoint*

of global offerings, is Western Europe, where nearly every service provider has an FWA offering, whether 4G or 5G (98%).

The fact that T-Mobile US reached the milestone of 1 million FWA customers in early April 2022 just a year after the initial launch of the service supports Ericsson’s claim that this market is seeing significant growth, and quickly. T-Mobile said that the fourth quarter of 2021 was particularly active. During that period, the carrier added

more broadband customers, it said, than any other U.S. provider added during the same timeframe. T-Mobile anticipates that it will have seven to eight million home internet customers by 2025. As analyst Jim Patterson has written for RCR Wireless News, about half of those customers are expected to come from rural markets, with most of the remainder expected to come from poorly covered suburban locations.

T-Mobile US also said that it has expanded its 5G network to make another 10 million households eligible for the home broadband service, bringing its total eligible households to more than 40 million.

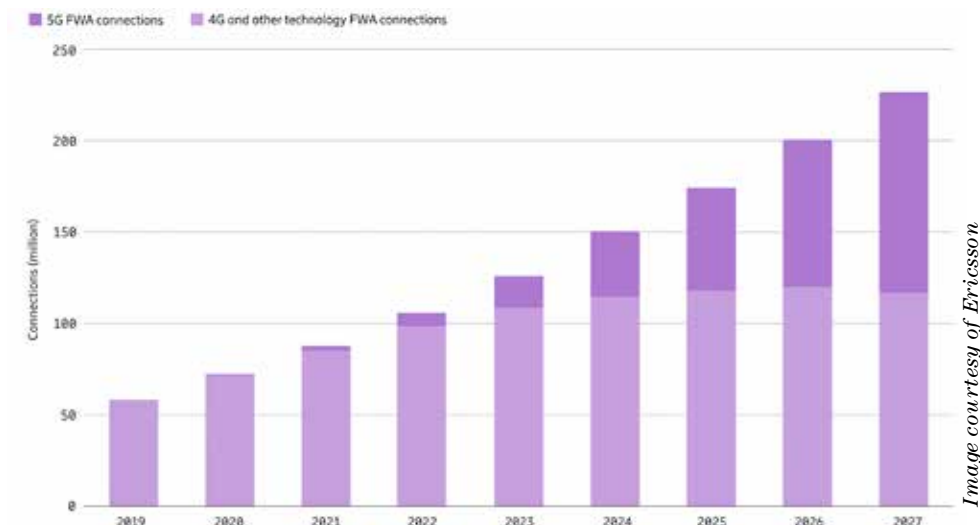
Prior to its FWA launch, T-Mobile CEO Mike Sievert, on a 2020 earnings call, characterized FWA as “a

big piece of the profit pool,” saying the company is “serious about home broadband. It’s going to be an important way that we grow this business and make money.”

*Is mmWave the key to FWA success?*

Millimeter wave is being positioned as a good option for FWA due to the spectrum’s massive bandwidth. However, because the high-frequency spectrum also has poor propagation and penetration, finding the right deployment strategy has proven to be challenging for some CSPs.

To alleviate some of the hesitancy around mmWave, Qualcomm and Movandi have teamed up to provide a more economical way to deploy mmWave. The pair are combining capabilities of mmWave small cells





powered by Qualcomm FSM 5G RAN Platforms and Movandi-powered 5G smart repeaters. Their goal is to lower the cost of mmWave deployment costs for carriers. The new partnership aims to prove, once and for all, that mmWave's well-documented challenges are, in the right hands, opportunities.

"The penetration issue, the line-of-sight issue, these could actually be advantages in some cases because you can actually control the signal better," said Movandi CEO Maryam Rofougaran,

For those CSPs willing to tap into the revenue potential for mmWave by deploying the technology strategically, there is much to gain, according to research conducted by Bell Labs Consulting. "We could see that most operators... would be able to achieve an 8% growth in their top line. That's massive," said Stephen Rose, executive partner at Bell Labs Consulting. "That would be a hard statistic to sniff at."

Verizon is one carrier that has committed to mmWave-backed FWA having unveiled plans to cover 50 million households and 14 million businesses and have 4 million to 5 million FWA subscribers by the end of 2025. The long goal is

becoming a nationwide broadband provider and making FWA the second largest contributor to revenue growth behind mobility. In terms of near-term monetization, Verizon sees fixed wireless access being its second biggest line of business behind mobility.

Verizon's Cox commented that the carrier's FWA services, which now cover more than 20 million households and more than 2 million businesses across 900 cities, are "quickly becoming ubiquitous."

"We used 28 GHz mmWave equipment in our initial 5G Home markets and since those early days additional infrastructure has been actively deployed in 28 and 39 GHz based on the 5G 3GPP NR specification," she continued. "Most recently, we have drastically extended our accessibility with the incorporation of C-Band spectrum, and we have a long roadway of 5G expansion in both midband and highband ahead."

Interestingly, Neil Shah, vice president and co-founder of CounterPoint Research, suggested at *RCR Wireless News*' 5G Monetization Forum that FWA's potential has been somewhat snuffed out as a result of ongoing supply-chain constraints.

According to him, when it comes to 5G monetization, FWA would have been "a clear application" if only there was no pandemic. "We would have seen more FWA roll out... everywhere globally, but that was not the case because of [...] supply constraint," he argued.

*79% of gamers would replace home broadband, mobile connectivity with 5G if it meant better gaming*

While it's true that CSPs will be hard-pressed to find many cellular subscribers willing to pay for premium-tier 5G services, there is one group of consumers willing to pay more, possibly much more, for a better experience: Gamers.

A 2020 study commissioned by Ribbon Communications found that 58% of gamers already pay a premium to their provider to enjoy



the best gaming experience possible and a staggering 95% would pay more for this improved experience.

As Ribbon's Chief Marketing Officer and EVP of Business Development Patrick Joggerst put in a press release, gamers present a "highly addressable audience for carriers," a sentiment echoed in a conversation that RCR Wireless News had with the company's CEO and President Bruce McClelland.

"There is a realization about just how passionate [gamers] are around it and anything that improves [the gaming] experience is something they're willing to pay for," McClelland said. "If that connection to a gamer was mobile and over a 5G infrastructure, there is a willingness to pay more for the quality of that experience."

Gamers are very engaged connectivity customers in the sense that they are aware of the connectivity speeds they're clocking, and they know how to check up on them and even how to improve upon them. And of course, switching providers or technologies is the best way to improve those speeds, giving operators an opportunity to offer a premium-priced gaming tier if they can prove to have the best network.

Gamers' willingness to pay for the improved latency and higher data speeds is precisely what makes cloud gaming powered by 5G such a promising and lucrative opportunity for operators. On average, gamers spend about \$84 a month on their current gaming experience, but 60% of respondents are willing to pay up to 50% more for a better experience.

Further, 79% of gamers would consider replacing their home broadband and mobile connectivity with 5G for a better gaming experience, and 58% would switch connectivity provider as soon as they could if a competitor offered a high-quality gaming service with a new 5G subscription.

"Carriers that invest in and build standalone 5G networks will be the first to offer advanced connectivity and will find themselves well-positioned to form new partnerships with gaming content providers and dominate the 5G cloud gaming sector accordingly," Joggerst said.

Because of this fact, Deloitte is seeing a lot of telcos partnering with gaming companies – a trend the firm expects to continue – and looking at offering dedicated performance for gamers using 5G and network slicing. Such partnerships




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**"[Operators] are going to have to continue to look at ways [...] to really develop an ecosystem of relationships that they are able to sometimes be the lead for, and other times, be part of the broad solution."**

*Jack Fritz, principal, Technology, Media, and Telecommunications, Deloitte Consulting*

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include Singtel and SK Telecom's work with game streaming provider GameGrid. The companies deployed GameGrid on the Singtel edge computing platform to test the cloud gaming experience on a smartphone connected Singtel's 5G Standalone network.

For Fritz, it doesn't matter if you're talking about enterprise or consumer opportunities; either way,

the way operators monetize cellular connectivity is going to look different than before. “I don’t think offerings are going to be solely pure bundling like it’s often been in the past. [Operators] are going to have to continue to look at ways – whether for the enterprise or consumer segment – to really develop an ecosystem of relationships that they are able to sometimes be the lead for, and other times, be part of the broad solution. They have to [develop] more comfort in adapting their role based on where the market is. I think there are opportunities but what those business models look like are still taking shape,” he said.

**Conclusion: Looking ahead to 5G Advanced and beyond**

Despite the headlines, most think it’s too early to be talking about 6G; however, that doesn’t mean 5G isn’t still evolving, and doing so in a big way. 5G Advanced, which refers to a series of innovations outlined in 3GPP Release 18, will evolve the 5G system to its fullest capabilities. This next phase of 5G is expected to provide improved speed, coverage, mobility and power efficiency while delivering features like advanced downlink/uplink MIMO, enhanced dynamic spectrum sharing



(DSS), multi-SIM, in-device coexistence and carrier aggregation just to name a few.

Additionally, 5G’s next iteration involves the expansion of artificial intelligence (AI) and machine learning (ML) data-driven designs, which Chen believes will lead to a new level of innovation. “5G and AI are synergistic and fuel future innovations. As AI plays an expanding role in 5G, we’ll see things like better spectrum utilization and [...] the minimization of battery life for 5G-enabled products such as smartphones, small cells and IoT devices in the future,” he said.

Rohde & Schwarz’s Stuhlfauth described this evolution further: “With LTE, we achieved link efficiency. With 5G, we worked on the system

efficiency – viewing the entire network as one system. And to give you an outlook on 6G, it will be a kind of system of systems, or network of networks, in which there are multiple networks and then, depending on QoS or the use cases, I can select the most appropriate one.”

With some eager to bring the discussion around to the next generation, it feels, in many ways, as if we are nearing the end of 5G’s journey – rollouts are far along, devices have hit the market – but, it’s actually just the beginning. Rel-17 is expected to be completed soon, and once that happens, work will begin on developing a whole new set of tools for the 5G arsenal, which will ultimately – but not just yet – pave the way to 6G. (☞)



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