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An eBook from the editors of FierceWireless

5G: A Look at the Business Models

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Introduction

5G is poised to soon become a reality.

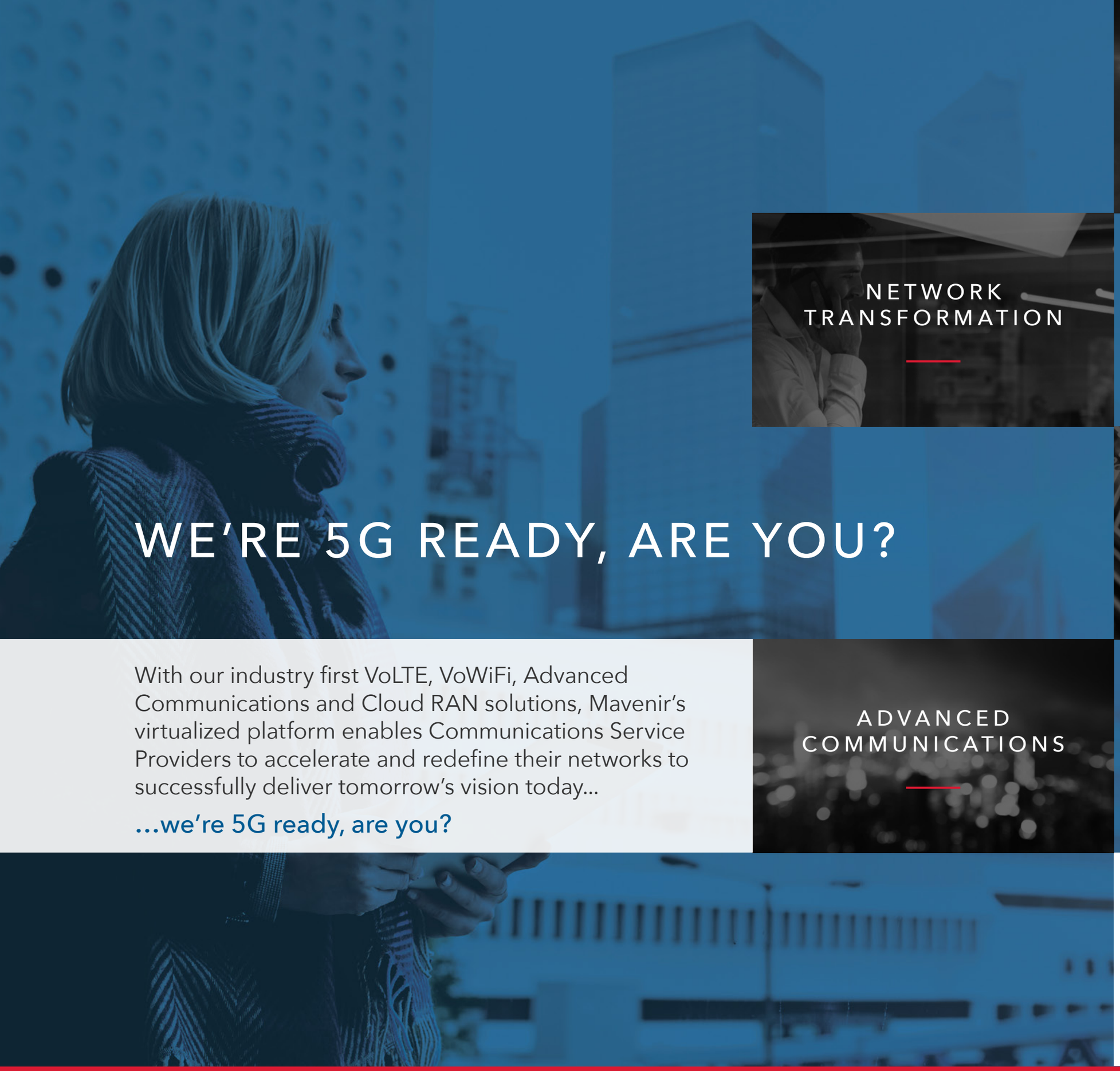
Indeed, top wireless carriers across the globe are already deep into tests of the network technology in order to ascertain exactly what it can do, and exactly what they can do with it. And early tests have shown that 5G can support dramatic increases in wireless speeds alongside new features and services that wireless network operators and others hope will create significant new business opportunities.

Further, the 5G pace is quickening. Operators across the globe, from the United States to Japan, are rushing forward with their 5G plans. An industry that initially expected 5G launches to hit in the 2020 timeframe now expects to see substantial action on the front as early as next year.

This, of course, raises a critical question: How will operators make money from 5G?

It's a question that has enormous ramifications for all the players in the wireless ecosystem, from wireless network operators to equipment vendors to backhaul suppliers to technology providers. And it's a question that remains cloudy at best.

This Fierce eBook will seek to shine some light on this still-evolving market, in four parts.



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5G: Into The Breach

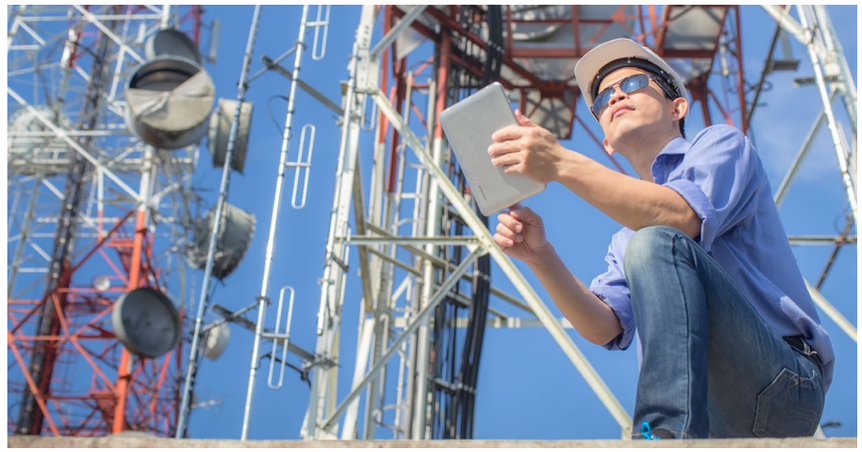
By Tara Seals

The collection of mobile technologies known as 5G has seen a rash of advancement in 2017, with a bevy of notable trials all aimed at testing business cases and determining technology plans. What's emerged from all of that activity are a few lessons learned and some consensus—and plenty of outstanding questions and unknowns.

As the standards process winds its way through the 3GPP, it has become clear that the first 5G use case to see commercial applications will be enhanced mobile broadband, or EMBB, as defined in Release 15 (due in the second half of 2018). With EMBB, operators can offer services ranging from 4K Ultra HD streaming to virtual and augmented reality to 3D modeling, as well as smart home and office applications.

Verizon Wireless took EMBB for a spin at this year's Indy 500, building a pre-standard test network that achieved a staggering 6 Gbps on the downlink. It then outfitted a driver with a virtual reality (VR) headset and mounted a camera on the roof of the car. The camera "saw" the track ahead, transmitting the video over the 5G network to the driver's headset. While zipping around the track, he relied only on the camera link to guide him.

Aside from the stunt action aspect of the trial, Verizon said that it sees a future business case in cameras and



sensors mounted on cars and at the track that enables fans to experience the race from different vantage points.

"Imagine viewing from the pole position as the race is in progress, turning around to see the cars in chase because a 360-degree video is streaming from every car," the company said. "Then imagine you can switch to a track side camera at turn 4, or one at the top of the Pagoda, or to a fan in the Snakepit using a portable camera to stream the party going on there." Presumably, broadcast partnerships would provide the monetization aspect.

Verizon too has been conducting pre-commercial 5G fixed wireless trials in 11 markets, promising to share more details about lessons learned later this year.

AT&T, meanwhile, also has been trialing pre-standard fixed wireless 5G using millimeter-wave spectrum, where the connection becomes an alternative to fiber. The model gives operators access to an entirely new addressable market in the enterprise space, especially.

"The applications that we'll see first are fixed wireless and enterprise services, because these offer the best business model and these subscriptions tend to be a higher revenue affair," said Tom Anderson, senior technology consultant at ATIS, an association focused on communications technology standards. "Operators can offer a 5G millimeter wave small cell in an office park, creating short-range, tight beams that they can steer. The idea will be to have a variety of beams hitting various office areas—and the service will offer a good revenue point as a replacement for fiber."

He added that the residential use case for 5G fixed wireless is a bit trickier, because not only is the network build more expensive, but the competition from existing cable and telco providers adds downward pricing pressure on the market, making for a more difficult return on investment.

"Some operators will try to do residential, but they'll need more small cells and a very dense footprint, which gets expensive, and the geography has to work for that," Anderson said. "There are some questions as to whether it makes sense."

While the applications that EMBB will enable are next-gen and have the coolness factor, not everyone is convinced that it will be enough for operators to build fresh revenue streams.

"The big question is whether or not 5G is going to be more of the same," said Dan Hays, an analyst with consulting firm PwC. "This question of use cases is still lurking in the shadows. There is arguably no killer app for 5G, and there's not a single driver that's creating a pull beyond a desire to continue to increase speeds and capacity and decrease latency."

"The big question is whether or not 5G is going to be more of the same."

– DAN HAYS, ANALYST, PWC

He added that the existing market for mobile broadband has become cutthroat, and there's no indication that will change simply with the advent of bigger, faster networks.

"We believe that the current state of the market is defined by an intense price war, coupled with a move to unlimited data, and that is really going to put significant pressure on operators' will and ability to invest in a major capital program for 5G," Hays said. "They just don't have the dry powder of capital today to start a major program when they're largely all losing money. We think the risk to 5G is that it either gets delayed, or the rollout is significantly elongated and stretches out over more years than it typically would."

While the business models remain unknown for now, operators are hoping to explore them on a commercial basis sooner rather than later, which has led to a movement to fast-track parts of the 3GPP's Release 15 standard.

"We're in the middle of standardization, but to get a

march on things AT&T and other ecosystem members have identified the different specs within Release 15 of the standard that are specifically impacting to hardware," said Dave Wolter, assistant VP of radio technology and architecture at AT&T. "The goal is to attack and complete those by the end of December, so silicon manufacturers can start building and we can get compatible endpoints into the market and ready for our networks."

AT&T intends to have an initial commercial deployment towards the end of 2018, and Wolter said there are many unknowns that are lingering in the roadmap.

"As we come up to that event horizon, we need to determine where to roll this out and how widely—and whether it will still be all fixed, or if it will incorporate some mobility," he said. "It all depends on how the standard and the equipment have matured at that point. We don't have silicon yet so there are plenty of unanswered questions."

Industrial And The IoT

The other two main use cases for 5G, ultra-reliable low latency communications (URLLC) and massive machine type communications (mMTC), are being addressed with Release 16, which is expected by the end of 2019. These two buckets involve sensor networks and the IoT, among other scenarios. It's this arena that will really move operator business cases beyond what we know today—and it's here that the biggest business model questions rear their heads. Few operators are as yet conducting trials in these arenas, though all agree that industrial applications will offer opportunities for innovation.

T-Mobile, for its part, has committed to building a nationwide 5G network by 2020 and will be using its 600 MHz spectrum. While it too will offer EMBB, it also plans to expand the scope of wireless technologies to new verticals with low latency or critical communication capabilities.

"We see 5G enriching the mobile internet experience while at the same time opening up new possibilities, applications and services—not as a technology to bring the same old experiences to homes via fixed wireless displacement," said Karri Kuoppamaki, vice president of network engineering at T-Mobile. "We think nationwide 5G coverage will unleash the potential of the internet of things, not only for consumers, but also for various industries."

"We see 5G enriching the mobile internet experience while at the same time opening up new possibilities, applications and services."

– KARRI KUOPPAMAKI, VICE PRESIDENT OF NETWORK ENGINEERING, T-MOBILE

Verizon is eyeing this space as well. In a trial earlier in the year, the carrier used the Ericsson Distributed Edge Cloud to amplify the power of simple drones to

match or exceed the capabilities of complex drones, which are much more expensive. This proof of concept demonstration showed that as intelligence and processing are moved to the 5G core and the very edge of the network, existing device constraints can be lifted—with big benefits for industrial control and intelligent transport systems.

AT&T's Wolter said that while the carrier is focused on EMBB in its trials so far, "machine-type communications will be a huge use case someday." He added: "We've always had too much latency in the network to support real-time machine communications and artificial intelligence-driven analysis. There could be some very interesting deployments around that."

One caveat: These deployments don't offer the same revenue profile or customer behavior as a traditional mobile subscriber—if a provider is serving a connected sensor, the ARPU might only be 50 cents per month, or less.

"In order to serve the IoT market, operators have to look at the operating models and understand what needs to be different to serve these effectively," PwC's Hays said. "That ARPU changes the dynamic for the supply chain, network coverage, customer care, repair and billing and truck rolls—everything. For instance, you can't take a customer care call—it wipes out all of the revenue let alone profits for years. Operators will need to be very diligent in how those things are going to be structured."

Further raising questions is the movement to allow devices to authenticate to the 5G core that aren't SIM-based.

"That would mean that carriers could natively authenticate different kinds of devices—things you use for Wi-Fi for instance," ATIS' Anderson said. "If we open that up, there will be a much richer set of devices, billions of them, with different authentication mechanisms. It eliminates the need to deploy SIM cards on all devices, but it's an operational change."

Network Changes

Given that 5G theoretically represents the convergence of several next-gen technologies and architectural approaches (including new spectral strategies, densification, virtualization and network slicing, edge computing and more), operator trials are also providing important information about what that network will end up looking like.

In its trials this year, "we've learned that technologies like massive MIMO, beamforming, operating in millimeter-wave frequencies and ultra-low latency are feasible," said T-Mobile's Kuoppamaki.

For example, beam management will be a key technology across low- and high-band spectrum. In a line-of-sight scenario, narrow beams can extend the reach of high-frequency bands, providing greater antenna performance and less radio interference. In the field, it's been shown that a user device can be serviced by multiple beams to boost capacity and ensure coverage.

Verizon and Ericsson set up a millimeter-wave network at Indianapolis Motor Speedway to demonstrate 5G.

In a mobile scenario, beam management will be required so that users can switch from one beam to another as they move, even at high speeds, without a dropped signal. Beam tracking meanwhile monitors the quality of connections available to the device and switches between beams to ensure the best user experience at all times. For use cases like self-driving cars, this will be critical.

The Verizon Indy 500 trial, for instance, took beamforming and beam tracking out for a drive, achieving uninterrupted, high-throughput connectivity at up to 60 miles per hour. The carrier had more than 180 beams tracking to keep the connection strong to the radio in the car.

Operators are also moving toward technologies like edge computing and cloud RAN, where the network's computational processes are pushed closer to the end user, thus providing faster speeds and lower latency. However, these efforts require a significant level of investment in order to rework the network's traditional design and introduce additional computing locations.

Also, operators are well on their way to implementing network function virtualization (NFV) and software-defined networking (SDN) within their existing networks, and are actively employing that architecture in 5G trials. For 5G, these specifically lend themselves to network slicing, in which the network dynamically adapts to support the different types of access traffic that's coming into it by assembling resources into a network slice that supports a specific application. One network view can be optimized for the specific requirements and cost objectives of massive IoT, while another could have the low latency and high bandwidth necessary for connected cars. Rather than having the network be everything to all applications all the time, this allows for a more efficient use of resources, which brings the cost per bit down and helps improve the business case for most applications.

It's clear that carrier trials are actively exploring the many questions that surround 5G today, and are leading to a better-defined state of play for the market as the months march on.

"We expect there to be some tidy and messy conclusions to initial 5G trials," Hays said. "They are refining the technology approach and testing the viability of the business model for 5G services. Whether those will be more of the same or serving a diversity of use cases is still an open question—but they're getting closer to answering it."

Understanding the Network Economics for 5G

By John Baker, SVP Business Development, Mavenir

As the reality of commercially available 5G approaches even more quickly than anticipated, there is little question of the predicted value of the technology. Analysts have estimated as much as $12 trillion in global economic activity[1] in the next ten to fifteen years, a number driven by the relentless expansion of IoT (internet of things) apps, services, and devices in all industry sectors.

"These savings provide the margins required to turn the 5G network into an engine of growth while still leveraging the 4G network."

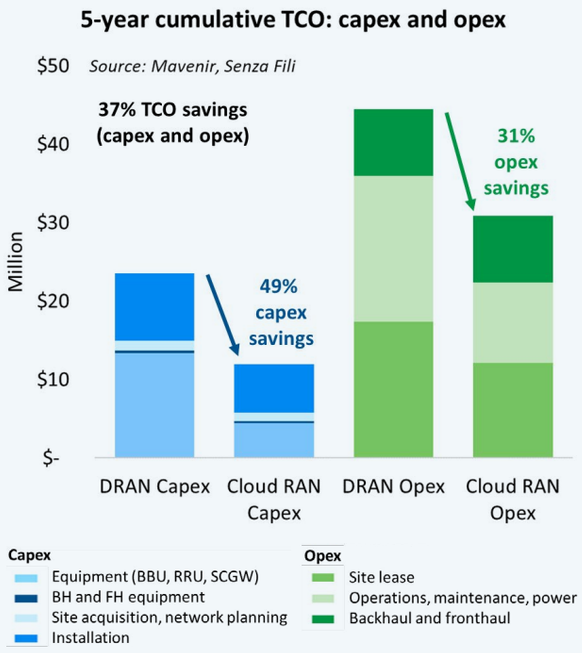
– JOHN BAKER

With many operators around the world still implementing 4G, however, the question is not one of the technology's value, but one of how to build-out and monetize 5G. The problem lies in the fact that global capex is decreasing, as the GSMA points out with their forecast[2] that operators will invest $673 billion between 2017 and 2020 versus $772 billion over the preceding four years. Essentially, carriers are being forced to build out new and vastly different 5G networks with less money while still attempting to fully realize their 4G and LTE investments.

To solve the problem, many are turning away from the traditional vendors of the last generation's proprietary hardware to search for innovative suppliers that can quickly bring something new to the mix with a smaller capital outlay. That's where disruptive players such as Mavenir come into the picture. Already a world leader in software-based network transformation, the company has virtualized core network and RAN functions on open-interface hardware platforms to bring solutions to the market that meet the 5G standard. Not only do these architectures give control of the technology back to the operator, they are much less expensive.

The 5G technical challenge is in squeezing vastly more data into a much faster, more efficient, and less expensive pipe. To answer it, various strategies such as carrier (spectrum) aggregation and densification of the network with small cells are beginning to be deployed. But the requirements of 5G go well beyond that. Essentially, the entire infrastructure should act as a cohesive platform that has a huge variety of different applications; it is fine-tuned to flex with demand and quickly tailored to meet the unique requirements of each new service as it is deployed.

Only a fully programmable, end-to-end framework, like Mavenir's, with software-defined networking (SDN), network functions virtualization (NFV), multi-access edge computing (MEC), network slicing, and cloud-based radio access networks (Cloud RAN) can fully deliver on the 5G requirements while also being deployable at the low total cost of ownership (TCO) required for operators to make money. To that end, Mavenir developed a TCO model that found Cloud RAN architectures will save operators 42%[3] (a 49% capex reduction and a 31% annual opex reduction) in deployment and operational costs over a five year period. These savings provide the margins required to turn the 5G network into an engine of growth while still leveraging the 4G network. To learn more about how our TCO model can help you understand 5G network economics, contact Mavenir, the company poised to turn vision into reality.



1 The 5G Economy: How 5G technology will contribute to the global economy, IHS Economics, January 2017
2 Capex outlook: coverage capacity, and competitive edge, GSMA Intelligence, September 2017
3 Mavenir/SenzaFili TCO model, September 2017

5G Brings New Use Cases for Fixed Wireless

By Kendra Chamberlain

Fixed wireless access (FWA) solutions have been available for years across cellular, LTE and proprietary networks. These solutions are used primarily in reaching communities where it is difficult or expensive to deploy wired broadband services. But the advent of 5G promises to bring new opportunities and use cases for fixed wireless solutions. 5G may give carriers new ways to leverage high-frequency spectrum assets to deliver high-speed and high-capacity wireless broadband services to consumers in more competitive fixed broadband markets.

"There have been a variety of standardized and proprietary solutions for fixed wireless; but a number of things are different about 5G, and as a consequence, fixed wireless is going to change dramatically," said Peter Rysavy, president of Rysavy Research and author of the recent report, "Broadband Disruption: How 5G Will Reshape the Competitive Landscape."

The promises of fixed 5G are, at least at this stage, endlessly optimistic. Both Verizon and AT&T—two top U.S. carriers that have been the most vocal about using

5G for fixed wireless—seem confident that the wireless technology will be able to deliver a robust, high-capacity wireless broadband service that'll compete directly with wireline broadband solutions like DOCSIS 3.1 and fiber. Proponents even argue that 5G could provide an alternative to wireline pay TV connections. But the economics of fixed 5G are, as of yet, still unproven.

While it is still early days for 5G, a number of U.S. carriers have already begun fixed 5G trials. Verizon has been analyzing a fixed wireless trial service in 11 markets; AT&T is conducting trials in at least four markets; and U.S. Cellular, the nation's fifth largest wireless carrier, has announced a successful round of fixed 5G tests. T-Mobile and Sprint, however, have focused their investments in mobile 5G.

Deploying 5G For Fixed Wireless

5G proponents claim the technology offers many advantages to carriers for fixed wireless deployments, both in the millimeter-wave (mmWave) bands—technically speaking, bands at around 28 GHz or higher—and even in the mid to lower bands, such as 2.5 GHz or below.

The biggest hurdle to fixed wireless deployments is getting the network infrastructure in place to support the service. Fixed wireless offerings in mmWave spectrum will require very dense deployments of small cells. "The operators need to go to a level of putting antennas on multiple street lights to make sure they can get coverage," said Joe Madden, principle analyst at the market research firm Mobile Experts. "That gets pretty expensive. And even more than the cost of the equipment, there's a lot of cost involved in bringing fiber into those locations, setting up those small cells, getting technicians out there trenching for fiber. It's a costly process."

The 3GPP 5G standard, due to be completed by 2018, allows for integration with existing 4G networks. That will make the transition go more smoothly for operators, said Monica Paolini, principal analyst at mobile research firm Senza Fili Consulting. "It makes it less expensive and less disruptive to the rest of the network to integrate it," she said. "That's a huge advantage, and that's a difference from the previous millimeter-wave technologies. If you use it as a tool, you can integrate it with whatever else you have."

That detail is proving to be a key enabler for fixed 5G deployments. Take the case of regional operator C Spire, which recently announced it'll be offering FWA at speeds of up to 100 Mbps to customers in eight markets. The initial deployment will use LTE-Advanced, but C Spire President Stephen Bye said the company will upgrade to 5G once the technology becomes commercially available.

"We plan to move forward with 5G as a fixed wireless solution in the future."

–STEPHEN BYE, PRESIDENT, C SPIRE

"We are leveraging our extensive fiber network, our deep spectrum position and the towers which we already have in place," Bye said. "We plan to move forward with 5G as a fixed wireless solution in the future. We have the spectrum depth in our markets—including 600 MHz, 2.5 GHz and 28 GHz—to leverage the emerging 5G technology."

Another important enhancement over other versions of fixed wireless is the advent of massive multi-input multi-output, also known as massive MIMO. Massive MIMO advancements will enable carriers to install very dense antenna arrays at the base station that enable carriers to focus radio energy into very tight beams. "The combination of being able to use mmWave and massive MIMO—those technologies are just now coming to the market in a way that's affordable and scalable," Rysavy said.

Still, there are many considerations that carriers are now weighing for fixed 5G deployments. For instance, mmWave spectrum can't propagate as far as lower-band spectrum like 600 MHz. "Where it works, it's great, but it doesn't work everywhere," Paolini said.

Extending The Fiber Network

The high capacity of 5G networks gives operators like Verizon or AT&T a very useful tool in extending service at the edge of their respective fiber networks. In this type of deployment, fixed 5G acts as a complement to the fiber network, rather than as a standalone service. "This allows you to go to the very edge of the fiber network, and fill in parts where the fiber doesn't reach," Paolini said.

The costs of deploying fixed 5G can be lower than running fiber to the premises; but in some cases, it isn't. Paolini predicts operators with fiber assets will approach deployments in an opportunistic way: "Whatever is cheaper, you'll use it," she said. "You do both wherever they make financial sense."

Depending on the topography of the environment, it may not be feasible to reliably serve every home within a small cell with a wireless solution. Wireless signals in mmWave spectrum are uniquely vulnerable to obstructions: Things like buildings, trees and even Christmas decorations can interrupt the signal, or render some houses unable to receive the service at all.

Those hiccups will factor into carriers' cost-benefit analysis of deploying the service. Carriers will need to strike a delicate balance between link distances and customers reached in mmWave fixed 5G.

"If they can't get the link to go 200 meters, I think it'll be difficult for them to get a financial return on 5G."

–JOE MADDEN, PRINCIPLE ANALYST, MOBILE EXPERTS

Analysis from Mobile Experts estimates carriers using mmWave spectrum will need to reach 25-30 homes with a 200 meter link distance to make a profit. "If they can't get the link to go 200 meters, I think it'll be difficult for them to get a financial return on 5G," Madden said.

Carriers that are deploying fixed 5G as a complement to a fiber service will be in a much better position to benefit from the technology: They'll be able supplement the fixed offering with wireline where needed, and vice versa. "By doing a combination of wireless and wired, you end up investing less in your broadband infrastructure than if you have to run a wire to every single home," Rysavy said.

Competing With Wired Broadband

Carriers are boasting about 5G as though it will provide an infallible alternative to the cablecos' dominance in broadband subscriptions. But there are still plenty of questions about how real world deployments will stack up against wireline options. One of the biggest question marks is around cell densification. Given the constraints of fixed wireless access, operators aren't exactly sure how dense their 5G networks will need to be to deliver reliable connections.

"I don't see any reason why 5G can't be as reliable as a coax."

–PETER RYSAVY, PRESIDENT, RYSAVY RESEARCH

"That's one of the things the industry will be figuring out over the next year or two: What are the exact parameters that need to be addressed to provide reliable connections," Rysavy said, though he indicated that fixed 5G will be able to compete with wireline broadband generally. "I don't see any reason why 5G can't be as reliable as a coax."

The prospect of 5G fixed wireless will position wireless carriers to take advantage of the convergence of trends: the insatiable demand for high-speed data on each and every device with a screen, and consumers' ever-growing appetite for streaming video on mobile devices.

The final piece of the puzzle for carriers to determine is how to handle usage and congestion across the wireless network in today's data-hungry world. Wireless networks are shared among subscribers, while wired broadband networks provide mostly dedicated channels for each subscriber, with data caps has high as 1 terabyte. Most of today's FWA solutions typically provide much smaller data caps and data throttling to protect the network from congestion. But in order for fixed 5G to be competitive with wireline broadband, those data caps will need to more closely resemble wireline caps.

So how is C Spire handling data congestion on its FWA service? The company doesn't plan to impose data throttling initially but will act to protect the network and optimize subscriber experience during periods of congestion, though its trials will certainly inform that policy. "Data usage continues to grow and the usage is only limited by the imagination of our customers," Bye said.

5G's Economic Prospects: Flexibility and Fuzziness

By Rob Pegoraro

5G wireless may be years from commercial deployment, but futuristic hype over its prospects is well established. It will bring self-driving cars, one common 5G prophecy goes. It will bring robot surgery, another assures us. Perhaps someday it will deliver robot surgery in self-driving cars.

Or as FCC Chairman Ajit Pai said in his keynote opening the inaugural Mobile World Congress Americas trade show in San Francisco: 5G will deliver "things that will make the impossible seem possible."

The reality for the first several years of high-bandwidth, low-latency 5G rollout is more nuanced, though, constrained by the need to construct 5G networks out of much more densely-packed cell sites. That doesn't exclude self-driving cars—but they'd better have their own smarts onboard instead of assuming 5G coverage.

Localized Ambitions

Just as LTE wasn't initially deployed at every street corner, 5G will pop up only in certain places in its early years.

But because 5G's highest-bandwidth frequencies cover much less ground and therefore demand more densely-packed sites, its early deployment may be even spottier than LTE's. That fact, more than its advances in bandwidth and latency, should govern much of 5G's early adoption.

"Where 5G really shines is millimeter-wave [spectrum] with massive cell site-splitting," said Roger Entner, founder of research firm Recon Analytics.

"Where 5G really shines is millimeter-wave [spectrum] with massive cell site-splitting."

– ROGER ENTNER, FOUNDER, RECON ANALYTICS

In the context of self-driving cars, that means cities, not the country or even rural highways. To build a business out of 5G, you'll need a density of customers akin to what leads wired telecom firms to decide to invest in fiber.

"Maybe these systems emerge in those exact areas where there's so much congestion and usage, that lends itself to higher revenue opportunity and benefits," suggested Moody's financial analyst Mark Stodden. "The Lincoln Tunnel, maybe: You line up, you go through the toll, you take your hands off the wheel."

Entner pointed to uses of high-definition video in industrial environments and digital cities as promising uses for 5G, allowing companies and municipalities to advance from today's "rinky-dink" cameras to HD or 4K video.

"Having millimeter wave and tens of gigabytes can be handy in that situation," concurred Philippe Guillemette, chief technical officer for wireless component firm Sierra Wireless.

Serving Up Network Slices

To the extent that 5G connects individual humans to content that happens to demand more bandwidth or lower latency than today's fare—for instance, live virtual reality—it need not look much different in terms of functional output than LTE.

But 5G also allows for a different kind of distributed computing. "Network slicing" starts with wireless carriers taking advantage of 5G's flexibility to tune their service to a given customer's needs, but can go much further than that.

"Depending on the priority of your data, you will be charged differently."

– PHILIPPE GUILLEMETTE, CHIEF TECHNICAL OFFICER, SIERRA WIRELESS

"It's basically every base station, every utility box, becomes a small server farm," Entner said. "That gives the telcos basically computing, storage, all of that within less than a mile of almost every American."

"You'll be able to put the data inside the network," said Paul Bradley, 5G strategy and partnerships director for the digital-security firm Gemalto. "All of the decision making and all of the autonomy can happen extremely quickly."

But, he added, this sort of edge computing will come even slower than rural 5G: "By the time the network is built up to be able to meet those use cases, it will probably be 10 years."

Some use cases may fit poorly on a network slice even then. "In a rapid R&D environment, you might not want to work with carriers," Entner cautioned. "For good reason, Silicon Valley looks at companies that depend on carriers' cooperation as a business model as a kiss of death."

New Business Models

Tailored service also means tailored billing. Simply paying for the rough amount of data you use may seem old-fashioned in a few years.

"Depending on the priority of your data, you will be charged differently," Sierra's Guillemette predicted.

Relative latency may also become a bullet point on a price list. "Right now, we're looking at only how big is the data faucet," Enter said. "We're not looking at how quickly does it turn on and off."

There's also the possibility that wireless carriers will adopt the airline strategy of unbundling once-included aspects of their service to allow for cheaper offerings.

At a breakfast hosted by FierceWireless at MWC Americas, Verizon's executive director for core network technology, Rick Hornby, mused that we could see a lower-cost service with a lower advertised level of reliability: "Perhaps, depending on what the customer wants, five 9s [reliability measurement] is not a requirement in all situations."

"Perhaps, depending on what the customer wants, five 9s [reliability measurement] is not a requirement in all situations."

– RICK HORNBY, EXECUTIVE DIRECTOR FOR CORE NETWORK TECHNOLOGY, VERIZON

The Future May Not Need 5G

Guillemette observed that extending the battery life of remote, wireless-linked devices would represent a huge advance—and doesn't demand a new generation of wireless.

"In fact, we have that with 4G LPWA," he said, pointing to low-power, wide-area networks like LTE M that are already deployed.

"There's a lot happening with the internet of things, there's a lot happening with 5G, there's a lot of people who want to think of this as all of one solution," Moody's Stodden said. "But you don't need a super-high performance solution to read your [water] meter."

	Current services	On the road to 5G	5G experiences
Enhanced mobile broadband	Browsing, social media, music, video	Fixed Wireless Access, interactive live concerts and sport events	4K/8K videos, mobile AR/VR gaming, immersive media
Automotive	Wi-Fi hotspots, on-demand GPS map data	Predictive vehicle maintenance, capturing real-time sensor data for different services	Autonomous vehicle control, cooperative collision avoidance, vulnerable road user discovery
Manufacturing	Connected goods, intra-inter enterprise communication	Process automation and flow management, remote supervision and control of machines and materials	Remote control of robots, augmented reality support in training, maintenance, construction, repair
Energy and utilities	Smart metering, dynamic and bidirectional grid	Distributed energy resource management, distribution automation	Control of edge-of-grid generation, virtual power plant, real-time load balancing
Healthcare	Remote patient monitoring, connected ambulance, electronic health records	Telesurgery, augmented reality aiding medical treatment	Precision medicine, remote robotic surgery

In its latest Mobility Report, equipment vendor Ericsson covered some of the potential use cases for 5G.

Measuring The 5G Opportunity

By Kendra Chamberlain

Global consensus from industry players is that 5G will prove to be a transformative technology, delivering a new era of connectivity and innovation. But there are still plenty of unknowns about the future business models and use cases for the technology. This fact has clouded the future for operators that are weighing strategies for moving forward.

It's still very early days for the technology—the first 5G 3GPP standard for nonstandalone 5G NR is slated for release by the end of 2017—but that hasn't stopped some operators from investing in research and development for pre-standard 5G technologies. To date, many of the biggest carriers in the U.S. have announced trials for testing different facets of 5G ranging from fixed wireless to machine-to-machine and vehicle-to-everything scenarios. According to wireless research firm SNS Telecom, pre-standard 5G investments will reach $250 million by the end of 2017.

Analysts have warned that 5G will require significant upfront expenditures for network upgrades, but Chris Pearson, president of industry trade organization 5G Americas, downplayed those concerns. "It's too early to tell what the 5G costs will be, from a capex standpoint," Pearson said, though he doesn't seem worried that costs will deter operators from upgrading their networks. "Mobile wireless operators are always spending capex to improve their networks. Yes, there are upgrade cycles when you go to new technologies, but at the same time, you're not investing as much in the old technologies."

Cost Drivers For 5G

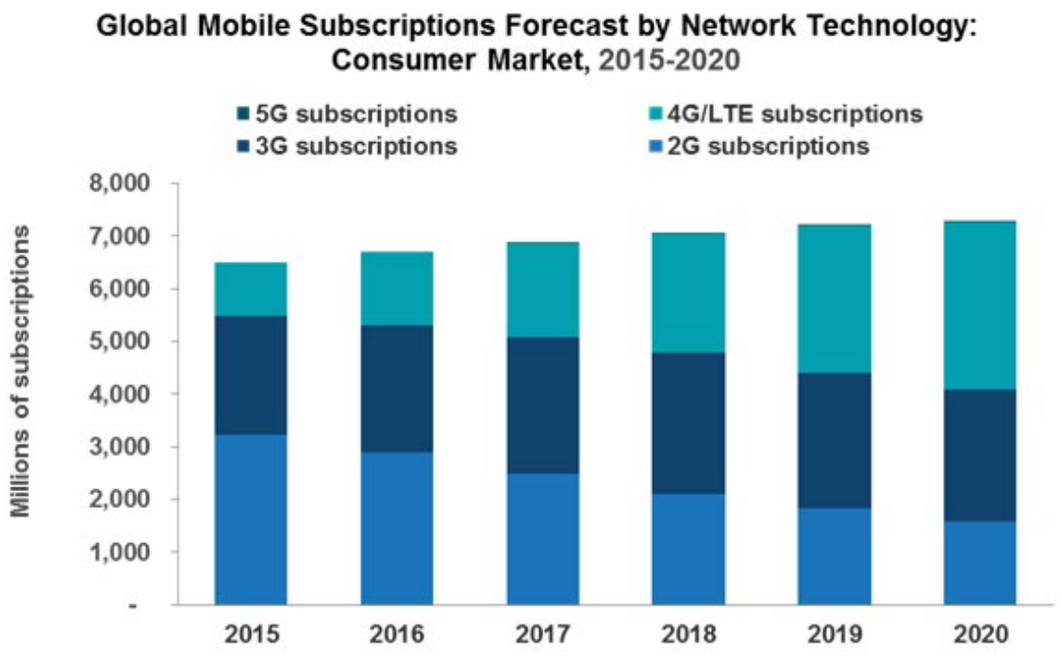
Once the 3GPP 5G standard is released, SNS Research predicts the 5G infrastructure market will grow aggressively over the next few years, as carriers begin upgrading their networks. In a report released in May 2017, SNS forecast 5G investments to account for $28 billion in annual spending by the end of 2025.

"It's too early to tell what the 5G costs will be, from a capex standpoint."

–CHRIS PEARSON, PRESIDENT, 5G AMERICAS

Specific deployments will depend on the specific assets each carrier has. Carriers like AT&T and Verizon, for example, have extensive fiber networks that they will likely rely on for backhaul. And both carriers also have invested in purchasing millimeter-wave (mmWave) spectrum.

Sprint and T-Mobile, on the other hand, don't own fiber and therefore may look for 5G backhaul alternatives. They also have said they plan to deploy 5G in bands including 600 MHz and 2.5 GHz.



In a report, research firm Parks Associates analyzes service providers' wireless service strategies surrounding the development of 5G mobile network technology.

"In the mmWave bands, we're going to have major issues with coverage, because the signals don't travel as far," said Joe Madden, principle analyst at the market research firm Mobile Experts. "The existing grid of towers won't provide very good coverage."

Mobile ARPU Is Tapped Out

There are a number of market considerations that put mobile 5G on uneasy ground. The mobile sector in the U.S. has hit saturation levels and competition among wireless carriers is incredibly fierce at present. At the same time, experts warn that mobile ARPU has hit its ceiling.

"Everyone in the world with money has a smartphone. The operators have a strategic problem: They need to find a new source of revenue, especially if they're going to invest in a 5G network," Madden said. "There has to be some rationale for how they justify that."

It's unlikely that mobile customers will be willing to pay significantly more for wireless service than they already pay, especially if there aren't any significant benefits to the new service that the customer can see beyond speed upgrades.

That means carriers will have to get creative in marketing 5G to customers if they want to squeeze more money out of mobile subscribers. Once again, the promises of 5G will give operators more room to experiment.

"Is there any way, in a mobile fashion, to get more money out of you? Yes, given your willingness to pay more for speed," said William Ho, principal analyst at mobile analysis and consultation firm 556 Ventures. With mobile operators suddenly able to deliver speeds that rival fixed broadband, Ho suggested carriers may be able to introduce pricing tiers based on speeds, just as wireline providers do.

Lucrative Business Cases Hard To Find

But it's clear that mobile broadband and traditional wireless subscribers won't offer the best path to monetization for carriers. Mobile operators are relying on 5G to open up new revenue streams. They'll have to look to new business models to generate a return on their 5G investments, particularly in the business-to-business sector.

There are three main uses cases for 5G, according to 5G Americas' Pearson: enhanced mobile broadband, machine-to-machine communications and low-latency communications. It's up to the operators to leverage these three families of use cases for profit. "As we move to 5G, we're looking at more limitless innovation in wireless. People can start to think, what could we really do if we can provide this type of speed and this type of latency?" Pearson said.

GSMA Intelligence, in a report released in February 2017, predicted operator revenues will grow at a compound annual growth rate of of 2.5% to reach $1.3 trillion in 2025. GSMA estimates that 5G technologies could drive annual growth up to 5% for carriers around the world.

Still, opinions are split over which new opportunities will deliver the most bang for the operator's buck. Some believe sectors such as IoT and smart infrastructure, industrial IoT and autonomous vehicle communications will open up opportunities for carriers to develop new services and acquire new enterprise customers. While revenue opportunities in these sectors could be much smaller than traditional mobile subscriptions, Ho noted that cost of acquisition should be much lower.

"From the carrier's standpoint, the business model is still connectivity," Ho said. "Today they look at connections via a physical subscriber, by ARPU. In the future, talking about massive IoT, and the cost to acquire those units of connectivity—it'll be less."

"From the carrier's standpoint, the business model is still connectivity."

–WILLIAM HO, PRINCIPAL ANALYST, 556 VENTURES

For carriers that have mmWave spectrum, however, the best financial bet may be in 5G fixed wireless. Once carriers are able to deliver up to gigabit speeds with fixed 5G, they will be in a good position to compete head to head with wireline service providers, and particularly the cable companies that have come to dominate the fixed broadband market in the U.S.

"People are spending between $50-$100 per month for Comcast or Charter to provide their home with cable TV," Madden said. "If you can get a 500 Mbps stream to your mobile device, do you really need your cable modem to your house anymore? There's an opportunity to go after that revenue and cannibalize the fixed business. That's probably the biggest revenue opportunity right now for the operators."