LightReading

5G PHASE II: BEYOND eMBB

SPONSORED BY

ECI THE ELASTIC NETWORK

CONTENTS

ABOUT THE AUTHORS

Ray Le Maistre, *Editor-in-Chief*
Light Reading

Ray joined Light Reading in 2002, having previously held senior editorial roles at Total Telecom, Communications Week International, Communications International and Computer Weekly. He was appointed Editor-in-Chief of Light Reading in March 2013. Ray has written extensively about the broadband technology and services sector for the past 15 years, and has tracked the evolution of fixed and wireless networks from ISDN/DSL and GSM to FTTx, 4G/5G and Carrier WiFi. He has also been at the forefront of Light Reading's coverage of the service provider IT sector, which in recent years has heralded the emergence of SDN and NFV into the market's vocabulary and which is now embracing open source developments and software-defined, automated processes.

Iain Morris, *International Editor*
Light Reading

Iain Morris joined Light Reading as News Editor at the start of 2015 -- and we mean, right at the start. His friends and family were still singing Auld Lang Syne as Iain started sourcing New Year's Eve UK mobile network congestion statistics. He is now International Editor, with responsibility for Light Reading's coverage of EMEA and Asia/Pacific (so, most of the world, really...) as well as leading our coverage of the super-hot topic of automation.

Gabriel Brown, *Principal Analyst – Mobile Networks & 5G*
Heavy Reading

Gabriel leads mobile network research for Heavy Reading. Starting from a system architecture perspective, his coverage area includes RAN, core, and service-layer platforms. Key research topics include 5G, LTE Advanced, virtual RAN, software-based mobile core, and the application of cloud technologies to mobile networking. Gabriel has more than 15 years' experience as a mobile network analyst. Prior to joining Heavy Reading, he was Chief Analyst for Light Reading's Insider research service; before that, he was editor of IP Wireline and Wireless Week at London's Euromoney Institutional Investor.

ABOUT THE AUTHORS CONTINUED

Mike Dano, *Editorial Director, 5G & Mobile Strategies*
Light Reading

Mike is responsible for leading Light Reading's 5G editorial strategy and coverage, including its news analysis, executive interviews, editorial content for live events, on-camera video interviews and more. Based in Denver, Mike comes to Light Reading from FierceMarkets Telecom Group. He was Editor-in-Chief of the publication group for two years, spent five years as the group's Executive Editor and two years as one of its Managing Editors. Prior to his time at FierceMarkets, Dano spent nine years in various editorial roles at RCR Wireless News.

Sue Marek, *Contributing Editor*

Sue is a long-time and much respected technology journalist, editor and analyst with expertise writing about 4G, 5G, Internet of Things, software-defined networking, cloud computing, and more.

INTRODUCTION

5G IS UP AND RUNNING BUT THIS IS A MARATHON, NOT A SPRINT

Initial 5G services have been launched in multiple markets across Asia, Europe, the Middle East and North America, but these represent only the first very small steps on what will be a very long, challenging and hopefully rewarding journey.

Ahead of the original schedule of 2020, the first commercial 5G services are up and running in multiple markets across Asia, EMEA and North America. Many eyes are on South Korea right now, where all three major mobile operators launched 5G services simultaneously in early April this year and are delivering Gigabit-plus mobile broadband services that allow users to try out cloud gaming and augmented reality applications on their new devices. Between them, South Korea's trio of mobile operators already have about 3 million 5G customers and are expected to have signed up about 5 million by the end of the year.

That could be viewed as a success for the communications networking and services sector: Technology development and delivery, even official specifications from the 3GPP, were fast-tracked in a collaborative effort that has brought enhanced mobile broadband (eMBB) and 5G-based fixed wireless access (FWA) connectivity to paying customers.

But any celebrations should be tempered – getting to a milestone early is something to cheer, for sure, but this is little more than the first step of a very long journey (though it's a relief to see the industry is at least heading in the right direction).

The promises made for 5G, as 'sold' to smartphone users, enterprises, industrial bodies and governments, were bold – 5G would be like no mobile generation before it, with the ability to transform lives, companies, vertical sectors and economies. What wasn't made quite so clear to the excited masses was that delivering on those promises would involve a quite dramatic transformation of the communications networking and services sector that would take many years, even decades.

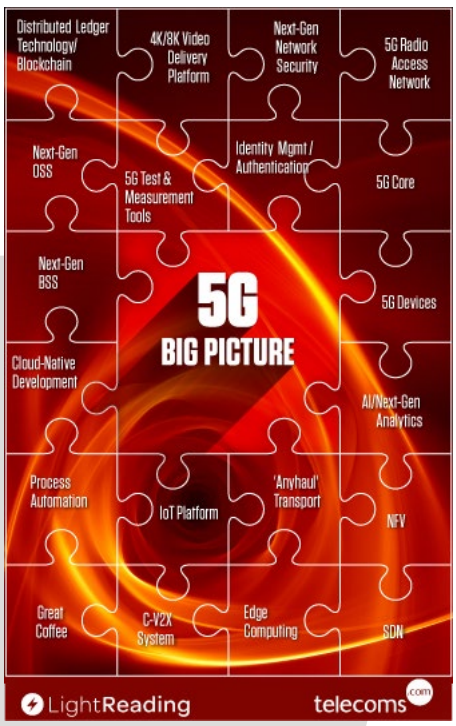
That's because delivering on the full promises of 5G – enabling not only eMBB services but also Ultra Reliable Low Latency Communications (URLLC), such as industrial robot automation, and massive Machine Type Communications (mMTC), to cope with billions of connected 'things' – requires network operators to address, in one way or another, a very broad range of technologies and processes, all of which will play a critical role in enabling them to capitalize on the full potential that a 5G deployment will offer.

Light Reading identified the key technologies and processes in its Big 5G Picture puzzle, which you can see here. Our view is that all of these pieces need to be addressed not just individually but also in terms of their relationships: Miss, or dismiss, any of the 20 elements, many of which are interdependent, and the picture will be incomplete and opportunities lost. Deploy them together and the grand 5G vision might just be realized.

INTRODUCTION CONTINUED

Delivering eMBB services requires only a subset of these elements: Network upgrades in the radio access network (RAN), including the supporting 'anyhaul' transport infrastructure, and the availability of 5G-ready smartphones ad other devices are a minimum, but that's as much as is needed. Launching eMBB services doesn't require next-gen OSS or BSS, edge computing, process automation, AI/next-gen analytics, cloud-native development… it doesn't even require a 5G core. All of these would help a network operator to do more than just deliver faster mobile broadband speeds and a few enhanced applications, of course, but they're not needed.

And that's where we are just now, with only a few of the puzzle pieces in place, deployed by a subset of the world's mobile operators and in just a few locations. The first step has been taken, but the road ahead is long: Now vital decisions and actions need to be taken about how precious capex dollars are spent and with what goals in mind. Indications from the networking infrastructure market suggest that the next few years will witness further strategic investments in fiber plant and transport network systems in the access, metro, long-haul and data center interconnect (DCI) portions of major networks, while 5G core platforms are poised for deployment.



At the same time, significant efforts are underway to figure out how edge computing resources might be deployed and used – quite how that part of the market will play out is less clear, though.

Further, and vitally important, specifications are yet to be finalized and rubber-stamped by the 3GPP, after which the potential game-changer that is 'network slicing' should become a reality.

All of that, of course, is related to technology – in addition, operators are facing strategic and cultural challenges: Many network operators admit that, to adapt to the new communications services landscape, a shift in 'mindset,' corporate structure and day-to-day business operations is also needed, and that transformation is an even bigger challenge than anything on the technology side.

The build up to, and start of, the race is always compelling and many companies want to be seen as 5G leaders and boast about being 'first' with one thing or another. But the most interesting developments are yet to come, particularly in the enterprise services market, where a combination of network slicing, edge computing, cloud-native functionality, AI and process automation in addition to the low latency and high capacity of a 5G RAN, for example, could lead to a new era of industrial development across pretty much every vertical sector.

In the meantime, South Korea is, arguably, leading the way and it's already interesting to hear about the impact that the first few months of 5G are having on the business and operations of key network operators such as SK Telecom and KT: Average data usage is up considerably compared with 4G usage and average revenue per users numbers are stabilizing instead of declining, which is positive, even if not exactly the answer to the return on investment (ROI) questions that still hang over 5G.

But this is why the era beyond eMBB is so important. Enormous investments will be required, of that there's no doubt, but the ROI timescale needs to be realistic – this is, after all, a marathon, not a sprint…

The articles in this report highlight many of the challenges, and doubts, that operators are facing in the early days of 5G deployments but also points to opportunities and the roles that will be played by others in fulfilling the promise of this new communications era.

Ray Le Maistre, *Editor-in-Chief*
Light Reading

EUROPE'S LONG WALK TO 5G

Europe's path to 5G is littered with regulatory and financial obstacles. But falling far behind China and the US in the 5G race could have dire consequences.

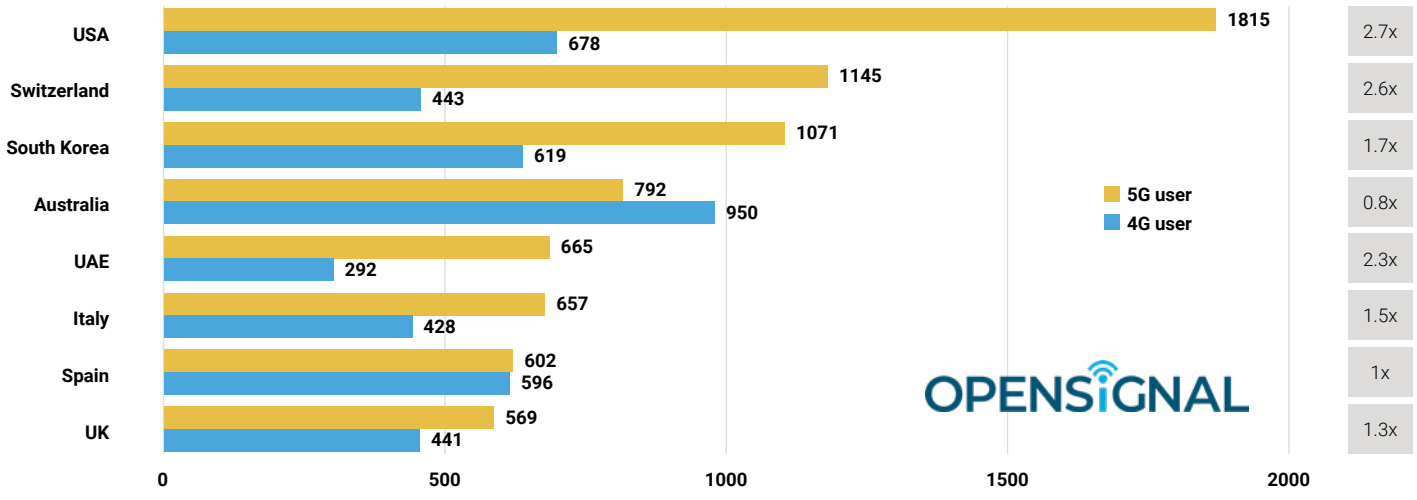
Visitors to the UK, lapping up cheap beer and pub grub while its currency plummets, can also witness some of the slowest 5G connections in the world. For anyone cash-rich enough to buy an early 5G smartphone, and station themselves near one of the few mobile sites providing 5G coverage, speeds max out at 569 Mbit/s, according to data from OpenSignal.

That might sound impressive, but it's less than 5G customers can expect in the US, Switzerland, South Korea, Australia, the UAE, Italy and Spain. It is, at least, some 128 Mbit/s faster than maximum 4G speeds -- unlike in Australia, where the top 5G speed is 158 Mbit/s slower than the zippiest 4G connection. But when the "old" tech can deliver as much as 950 Mbit/s, who needs 5G anyway? (At least for faster mobile broadband...)

Discounting Switzerland (so often Europe's outlier), European countries fare poorly in OpenSignal's comparison of 5G speeds. But speed is only a part of the story. While US and Asian operators work on extending their 5G reach, many European countries have yet to introduce a commercial service. And in some that have rushed 5G to market, rollout could be a long and painful business. Operators spend years deploying any new network technology. The worry is that 5G rollout will take even longer than usual.

This matters for two reasons. The first is that 5G could turn out to be far more economically important than it might currently appear. If those, ahem, lightning-fast connections give rise to new services, developers will probably flock to the countries with the best 5G infrastructure.

5G users already experience dramatically higher real-world max download speeds than 4G users in most countries



Data collection period: April 1 - June 30, 2019

One might turn out to be the next Google, and Europe could do with a digital giant of its own. New services might also boost industrial productivity (factory automation is a focus area). Should Europe lag the US and China, its companies might struggle to compete on a global stage.

The second reason is that a long walk to nationwide 5G could exacerbate the "digital divide" -- the gulf between the digital haves and have-nots -- in individual countries. For governments trying to reinvigorate deprived areas and stop rural communities sliding into economic irrelevance, this long walk looks awkward. It also comes amid a surge in populism, fueled by a growing wealth gap between rich and poor and a sense that established elites have ignored the concerns of ordinary people. Operators that have chosen to focus their early 5G efforts on places like London's Canary Wharf, where Oxbridge-educated lawyers sip grande soy caramel frappuccinos opposite pinstriped bankers, could provoke further discontent.

THE SPECTRUM SQUEEZE

But why is Europe struggling to get its 5G act together? In countries yet to launch 5G, it is often because new spectrum has still not been made available by government authorities. Most countries in eastern Europe fall into this category, but France does, too. In markets such as the UK, meanwhile, operators are being spoon-fed new 5G spectrum in successive auctions, as if the government is worried about the dangers of an overdose.

The effect is twofold: fragmentation -- a kind of digital divide across the European region -- as different countries fall out of sync; and higher costs. By restricting the amount of spectrum sold at any one time, authorities have driven up prices, say critics, as operators fight over scraps. Toss a thin slice of meat into a pit of hungry predators and see what happens.

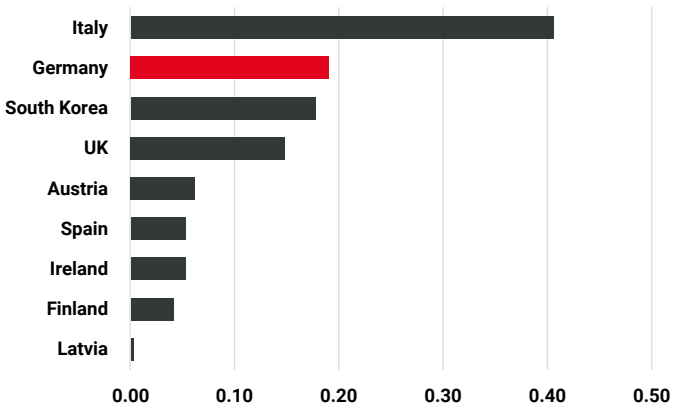
Operators that have fought hard for their 5G concessions are now mewling in pain. After spending nearly €2.2 billion ($2.5 billion) on new 5G spectrum, Deutsche Telekom said the money could have been used to build approximately 50,000 mobile sites instead. It soft-launched a 5G service in Berlin and Bonn to gain its 5G club badge, but does not expect to have more than 300 5G antennas in operation by the end of the year. Across Germany, Deutsche Telekom currently maintains about 28,000 mobile sites.

Opponents are unsympathetic. Operators always bleat about regulatory unfairness, and yet competition forces them to invest, they say. Another argument is that operators would simply pocket the money, if spectrum were given away, and not use it for network rollout. Many shareholders with an eye on short-term dividend payments would undoubtedly approve. France's Orange, one of Europe's biggest operators, is understood to have encountered shareholder resistance to its splurge on all-fiber networks in recent years.

Regulators have an alternative, though. In the "beauty contests" favored by the likes of Ericsson, a Swedish mobile network equipment maker hoping to profit from 5G network spending, authorities have substituted stringent coverage obligations for high spectrum fees. Fail to meet these and you could lose your license, is the ultimate threat.

Germany, however, plumped for both high fees and stringent obligations. Its auction design was clearly intended to maximize returns, according to Ericsson. "There were about 450 rounds and after 100 rounds, with the price at €2 billion [$2.3 billion], the allocation of spectrum didn't change," says Gabriel Solomon, Ericsson's head of European government affairs. The eventual proceeds were roughly €6.5 billion ($7.3 billion). At the same time, license winners are supposed to hit a 98% coverage target by 2022. Outraged operators took legal action against those rules and were rebuffed by the Cologne Administrative Court in March. That seems unlikely to be the end of the dispute.

Price per MHz Pop ($) for 3.4-3.8GHz Spectrum



Source: Regulators, operators, Light Reading.

Capital Intensity in Europe (€B)

	2013	2014	2015	2016	2017	2018
DT non-US capex	5.9	6.2	6.6	6.8	7.5	7.8
DT non-US revenues	41.6	40.3	40.3	39.4	39.2	39.1
DT non-US capital intensity	14%	16%	16%	17%	19%	20%
Orange capex	5.6	5.6	6.5	7.0	7.2	7.4
Orange revenues	41.0	39.4	40.2	40.9	41.1	41.4
Orange capital intensity	14%	14%	16%	17%	17%	18%
Telecom Italia (domestic) capex	3.0	2.8	3.9	3.7	4.6	5.6
Telecom Italia (domestic) revenues	16.4	15.3	15.0	15.0	15.4	15.2
Telecom Italia (domestic) capital intensity	18%	18%	26%	25%	30%	37%

Source: Operators

Elsewhere, authorities seem to have prioritized a short-term windfall over long-term 5G benefits. In Italy, the other European country whose 5G auction proceeds well exceeded forecasts, the coverage obligations attached to the critical "midband" spectrum do not seem very onerous. According to a presentation given last year by Mauro Martino, the head of the spectrum office for Italian regulator Agcom, operators are required to cover a relatively small percentage of Italian municipalities, and some rules do not apply to licensees with less than 80MHz of spectrum. That would seem to excuse Wind Tre and Iliad, but not Telecom Italia and Vodafone.

In any case, Telecom Italia aims to provide a 5G service to just 22% of the population by 2021. Operators in other countries have been far cagier about rollout targets, preferring to identify cities where 5G will show up. "We've said 25 cities by the end of 2019, but there is not necessarily blanket coverage -- it is a presence," says Mike Eales, the head of network services strategy and architecture for Three, the smallest of the UK's four mobile network operators.

A few other details have slipped out, though. BT, the UK's biggest operator, wants 5G at 2,000 of its 19,000 mobile sites by May next year. Deutsche Telekom, before its costly spectrum outlay, said it would cover 99% of Germany's population by the end of 2025. Swisscom, remarkably, is targeting 90% coverage by the end of this year, even though a government requirement is for only 50% of people by 2024. Its hope, perhaps, is that authorities will relax legislation on radiation limits -- which could hinder 5G services -- if it shows it is a good citizen.

BALANCING THE BOOKS

But something will have to give. Excluding its large US business, Deutsche Telekom's capital intensity (capital expenditure as a percentage of revenues) has soared from 14% in 2013 to about 20% last year. Orange's has risen from 14% to 18% over the same period. Telecom Italia's domestic business has seen the most dramatic increase, with capital intensity rocketing from 18% in 2013 to a possibly record-breaking 37% in 2018, including fees for spectrum licenses. Those figures cannot rise interminably.

What makes them harder to stomach is the lack of any immediate sales opportunity for telcos building 5G networks. If mobile telecom history is a reliable guide, customers are unlikely to pay more for a 5G service than they do for a 4G one. And there is little scope for pricing innovation. The UK's Vodafone hopes charging for different connection speeds and unlimited usage will draw consumers away from plans based on monthly data caps. But if its move proves popular, rivals will eventually respond. Its competitive, SIM-only rates have already sparked concern about a "race to the bottom," says James Crawshaw, a senior analyst with Heavy Reading.

Trying to justify the move to reporters at its 5G launch, Vodafone executives said profits would accrue partly from the "spectral efficiency" of 5G compared with 4G. The basic argument is that sending one data bit over a 5G network is much cheaper than transporting it on 4G. But the difference is a point of contention. 5G costs four to five times less, said Scott Petty, Vodafone UK's chief technology officer (CTO), during the 5G press conference. At the end of 2017, Johan Wibergh, Vodafone Group's CTO, reckoned it would be ten times cheaper.

Caption:
DEUTSCHE TELEKOM'S TIMOTHEUS HÖTTGES SAYS HIS COMPANY'S BALANCE SHEET GIVES IT LITTLE "WIGGLE ROOM."

Skepticism that spectral efficiency will boost earnings seems warranted. Operating costs are unlikely to budge significantly without staff reductions or other measures to cut overheads, such as the sale of real estate. The 4G standard was similarly touted as a more cost-efficient technology than its 3G predecessor, and yet the margin for earnings (before interest, tax, depreciation and amortization) at Vodafone Group has risen just two percentage points in the 4G era, from 29.9% in the fiscal year before Vodafone UK's 4G launch to 31.9% in the most recent one. Spectrally efficient technology seems like a mechanism for coping with a spike in data traffic rather than a route to bigger profits.

"5G doesn't change the overall cost structure for an operator to run the network," says Bengt Nordström, the CEO of Northstream, a consulting company that is now part of Accenture. "It significantly reduces the cost of introducing higher data speeds and adding more capacity. But if operators want to increase profitability it is going to be through their digital transformation programs."

The debt profile of some large European operators makes all this a bigger worry for investors. Telecom Italia's net debt last year was equal to about 3.3 times its earnings, a high level by comparison with most peers. With a ratio of 2.65, Deutsche Telekom is skirting a comfort-zone limit of 2.75. "Our numbers don't indicate that we're going to leave the corridor … but there is going to be very little wiggle room," said Timotheus Höttges, the German operator's CEO, during an earnings call earlier this year.

ALL TOGETHER NOW

What Europe desperately needs is more consolidation, according to some analysts. The US, a market of 330 million people, has four big mobile operators, and that number could fall to three if T-Mobile eventually merges with Sprint. In China, three operators serve a population of 1.4 billion. With about 510 million people, the European Union (EU) is home to several big telco groups -- including Deutsche Telekom, Orange, Vodafone and Spain's Telefónica -- as well as numerous sub-scale operators that compete alongside the giants.

Many of the small players struggle, says Ericsson's Solomon. "The fixed cost base is similar to an operator with larger market share and it is much harder to sustain and generate returns," he says.

In this worldview, everyone is worse off as incumbents settle for a smaller market share and competition drives down prices. Solomon thinks an operator needs an EBITDA margin of 38% to achieve "optimal levels of investment" and says the European average is much lower. Vodafone's adjusted EBITDA margin was 31.6% across its European markets last year. Deutsche Telekom's was 30.8% after adjustment for special factors.

Unfortunately, for the investor community, European regulators have continued to oppose merger activity, arguing it would lead to price inflation and hurt consumers. In the less competitive US market, customers have tended to pay much higher rates for telecom services, note fans of the European approach.

Yet this means European operators face spending constraints, according to Nordström. "The biggest challenge for Europe compared with the US is that our revenues per user are much lower, and so our starting point is that we have less money to spend if you break it down to investment per user," he says. "That is fueled by resistance to consolidate markets in Europe."

When regulators did allow Hutchison and Orange to merge their Austrian operations in 2012, the deal led to a 20-30% improvement in network coverage and higher connection speeds, according to analysis carried out by the GSM Association, a lobby group for the mobile industry.

As the EU selects new leaders -- to the annoyance of critics who see it as an undemocratic and byzantine institution -- the telecom industry is waiting to see if a more investor-friendly regime will emerge. But a more relaxed attitude toward in-country takeover activity would not solve the problem of European fragmentation or aid the development of a cross-border market for telecom services. Even Deutsche Telekom's efforts to build a single network across multiple European countries have been somewhat frustrated by national regulators' demands for local data facilities -- to prevent information from being stored in another European jurisdiction.

Those objections will not easily be addressed in today's political climate. For populists throughout the region, the EU is an unaccountable, Kafkaesque monster that has stripped nation states of their rightful sovereignty. UK voters chose to leave the EU during a referendum in 2016 (triggering the currency devaluation that explains why beer and food are now relatively cheap for European visitors). With or without a deal, that "Brexit" is due to happen in late October. And it could spur demands for referendums in other member states.

The arguments for and against more European integration will rumble on. But as China and the US flex their 5G muscles, it is hard to find anyone in the industry who doubts the need for a new approach. "Thinking about connectivity as the bedrock for a new industrial strategy is vital, and I don't see the EU doing that right now," says Solomon. "If we remain fragmented, other superpowers will accelerate forward into the digital domain."

Iain Morris, *International Editor*
Light Reading

PRIVATE 5G MOBILE NETWORKS FOR INDUSTRIAL IOT

Dedicated 5G campus networks, designed to meet the coverage, performance and security requirements of industrial users, are one of the most exciting – and tangible – advanced 5G use-cases under development.

Dedicated 5G campus networks, designed to meet the coverage, performance and security requirements of industrial users, are one of the most exciting -- and tangible -- advanced 5G use-cases under development.

Part of the reason for this is that the private mobile network market in general is taking-off. These networks enable enterprises to optimize and redefine business processes in ways that are not possible, or are impractical, within the limitations of wired and WiFi networks, and also cannot be reliably served by wide-area cellular. Right now, this means using LTE technology. Backed by a robust ecosystem of suppliers and integrators, private LTE is a growth market, with deployment activity across diverse industry sectors in all global regions.

Looking one step farther out, however, to scenarios where users have more demanding performance requirements -- for example, the cyber-physical systems that characterize Industry 4.0. -- and 5G technology comes into the picture, offering an investment path that can support these new-wave applications at scale. Building on the existing LTE ecosystem, private 5G campus networks are emerging to address the performance requirements of production-critical processes in sectors such as smart factories, logistics/warehouses, container ports, oil & gas production, chemical plants, energy generation and distribution and more.

In a recent white paper, "Private 5G Networks for Industrial IoT," I discuss how 5G technology meets the performance requirements of industrial users and why it will integrate with the next generation of Operational Technologies (OT) used in these markets. The paper discusses how private 5G can be deployed across licensed, shared-licensed and unlicensed spectrum bands, and investigates key 5G radio innovations. Specifically, it addresses the use of time synchronization in shared spectrum to ensure predictable performance.

Among the key findings in the paper are:

- The strategic importance of private networks is reflected in 5G R&D. Whereas in previous generations, private networking was an add-on capability to public cellular; in 5G these requirements are addressed directly in the initial specification phase.

- The first 5G standards release (3GPP Release 15) contains many of the critical features that will underpin the performance needed in the industrial IoT segment. In addition, to support the advanced capabilities needed for cyber-physical industrial communication networks, an enormous amount of work is underway in Release 16, scheduled for functional freeze in March 2020 and ASN.1 freeze (i.e. protocols stable) in June 2020.

- 5G offers the opportunity to consolidate industrial networking complexity onto a common network platform. An example is the cross-industry effort to transition diverse fieldbuses to the Time Sensitive Networking (TSN) Ethernet standard, and the mapping of TSN requirements to the 5G system specifications, such that a 5G campus network can transport TSN within the required latency, jitter and timing bounds.

- There are a range of spectrum options that will accelerate private network adoption. In some markets, regulators are investigating, or already allocating, dedicated spectrum to enterprises to run private networks; these allocations are often targeted at industrial verticals.

- Unlicensed spectrum is also attractive, with new radio techniques emerging to increase reliability in shared bands. Time synchronized sharing in unlicensed spectrum, in combination with other advanced 5G radio capabilities, can deliver highly predictable performance.

- Heavy Reading believes spectrum will, in many cases, be de-coupled from the decision about which party designs, operates and maintains private networks. There is evidence that operators themselves see opportunities in dedicated enterprise spectrum and are preparing to offer manged private networks in these bands. Other active parties include systems integrators and specialist OT companies.

- In the radio domain, multiple techniques are under development to will enable 5G to meet extreme industrial IoT performance requirements. These include flexible numerology, ultra-reliable low-latency communications (URLLC), spatial diversity, Coordinated MultiPoint (CoMP), cm-accurate positioning, QoS, spectrum flexibility (including NR-Unlicensed), etc.

- At the system level, capabilities such as network slicing, improved security, new authentication methods, edge-cloud deployment, TSN support (with synchronization) and API exposure make 5G suitable for the private industrial IoT market

The investment the global 3GPP community -- which includes leading technology vendors, research organizations and network operators -- is making in industrial IoT is very significant. This multi-year commitment draws deeply on R&D capabilities at these organizations and creates confidence in the technology and roadmap.

Gabriel Brown, *Principal Analyst, Mobile Networks & 5G*
Heavy Reading

(This blog, first published on Light Reading, was supported by Qualcomm.)

SPONSOR CONTENT

MUCH ADO ABOUT SLICING WHO NEEDS NETWORK SLICING AND WHY?

IVAN BYKOV, 5G SOLUTION PLM, **ECI**

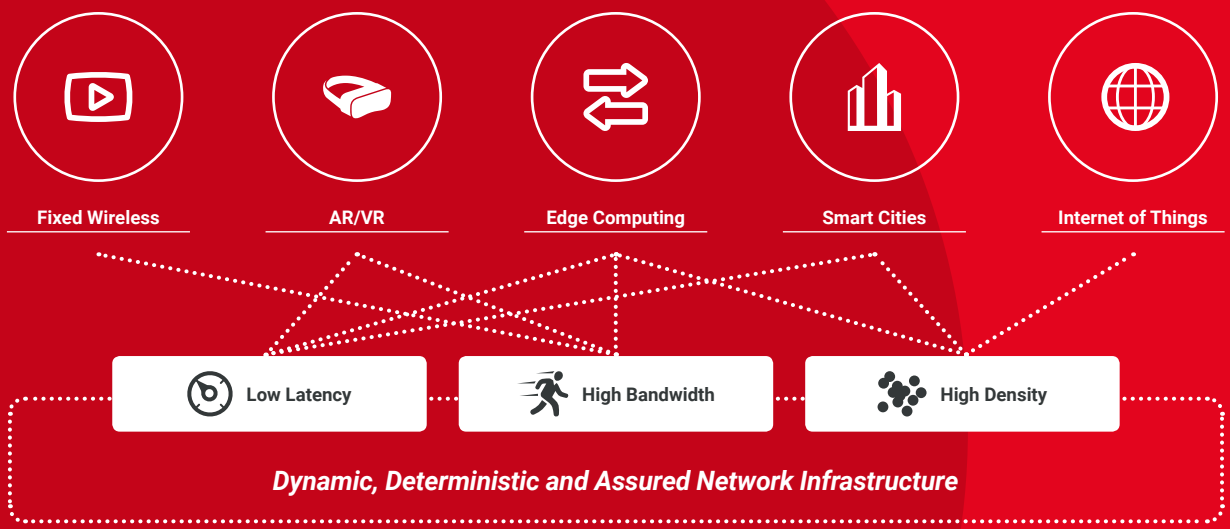
To say much has been said and discussed about the 5G business case is an understatement. In fact, it seems that the one thing the industry agrees upon is the fact that the 5G business case is questionable, at best. There is no doubt that early adopters may be willing to pay more for 5G, but the vast majority agree that consumers will pay only 5% more for 5G, than they currently pay for 4G package. Moreover, most agree it will take operators years to break even on their 5G investments. So where is the money?

The first, obvious answer is that the money is in entering new/additional markets. Some mobile operators talk about entering the cable/video streaming market. Others about improving coverage via Fixed Wireless Access in some rural areas where they currently have little business. And, indeed, these first 5G services will cover some of the costs incurred.

The second, perhaps more future-thinking line of thought, suggests that carriers will be able to launch a wide range of new services with 5G, services that will offer customers unique value. We are talking about services with unique requirements, SLAs and profiles. Services which do not exist today. These tiered services will be priced differently and therefore offer a new source of revenue. And yet achieving these new, tiered services with guaranteed SLAs will require a change in the way networks are architected. Or will they?

Of course those of us, who are not that sure about the launch of these 'brand new' services - which may or may not be realized – prefer to continue to work with the network as it is today. I mean why fix that which is not broken? When 5G drives more traffic, it's best just to 'throw more bandwidth' at it and things will work themselves out. No?

The answer is yes and no.



SPONSOR CONTENT

Yes the network does a pretty good job today, but let's face it massive overprovisioning and 'good old college try' approach to guaranteed SLAs, has already been proven as severely limiting. As we've discussed before, most networks do not have the measurement and telemetry systems in place to proactively guarantee SLAs.

IN COMES SLICING

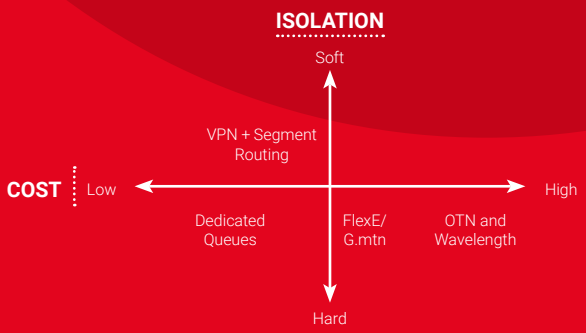
Many years ago carriers built different networks for the different services they offered. A voice network, a data network, a synch or OT network and so forth. But decreasing margins and the need for reducing CAPEX have forced them to rethink their network architecture. In the 5G world, building separate networks for each type of service is just not viable. So network architects and organizations (IETF, ITP, and others) have come up with a solution in the form of network slicing.

Network slicing is an architectural concept that allows the cutting of one physical infrastructure into multiple virtual networks. Each slice is then customized to meet the specific needs of the applications, services and resources that need to run over it. In this sliced world, carriers will build a super high capacity network, and then allocate resources to optimize and prioritize the traffic which runs over it. Some of my colleagues have suggested that network slicing is only an evolution of today's networking technologies spiced up with some of the newer capabilities the industry has been discussing for years.

And while it may be true, slicing is more complex. The industry is differentiating between 'hard slicing' and 'soft slicing'. To simplify, 'hard slicing' refers to the provisioning of resources in such a way that they are dedicated to a specific service or slice. Whereas 'soft slicing' will adjust the VPN path in case of congestion (PCE based on performance monitoring). This, of course, suggests that soft slicing cannot absolutely guarantee the availability of resources nor the SLA. The difference between enhance VPNs, Segment Routing and Hierarchical QoS, is the methodology which defines the slicing structure.

The only way to 'absolutely, positively' assure that a slice receives 'X' network resources is to hard slice it.

The fact is that today we have a variety of technologies with which to slice the network. And industry experts agree that a combination of these technologies is the best way to move forward. These technologies differ in their level of isolation as well as their cost-efficiency. Obviously dedicating resource is more expensive/less cost efficient than sharing resources. The following chart helps visualize:



WHO NEEDS HARD SLICING ANYWAYS?

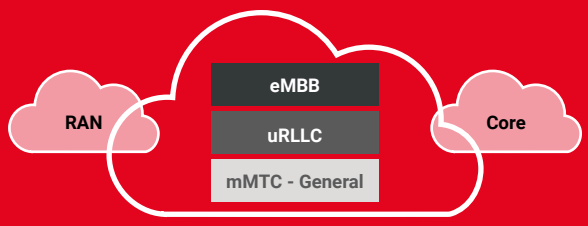
I admit, that I have heard from customers that the benefits of network slicing do not outweigh the complexities (and cost) of re-architecting the network. And while that may be true, our engagements have demonstrated 3 distinct use cases where 'hard slicing/isolation' is being asked for:

HARD SLICE PER SERVICE CLASS (SST= EMBB, URLLC, MMTC ETC.) AS PER RELEASE 15

The industry defines at least three distinct classes of service brought on by 5G. Each of these classes, on a high level, is different than the others in the type of resources it requires and the accompanying SLAs. Enhanced broadband, for example, requires a lot of capacity but not exceptionally low latency. Whereas, for ultra-reliable low-latency (uRLLC) services, resources need to be allocated in a way that provides a highly reliable and resilient service with stricter SLAs.

SPONSOR CONTENT

Use Case 1: *Slice per service class*



Transport Envionment

HARD ISOLATION PER CARRIER OR MNO

It seems that the industry has been talking for years about shared network resources. However, 5G may be the turning point. The higher 5G spectrum frequencies travel much shorter distances than their 3G/4G predecessors. This means that cell-sites or antennas need to be installed much more closely together, especially in city-centers. If in the past, network sharing could reduce TCO by 30%, it is believed that in the 5G era TCO can be reduced even more. In the case of network sharing, the only way to absolutely, positively assure that one carrier is not discriminated against by various soft slicing measures is to implement hard slicing which dedicates resources to each carrier.

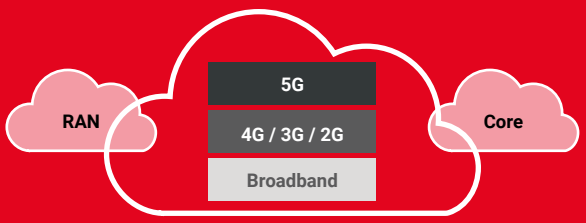
Use Case 2: *Slice per carrier/MNO*

Transport Envionment

HARD ISOLATION FOR RAN AND NGN CO-EXISTENCE

One last, and perhaps less obvious need, is to provide better or different SLAs to services with different ARPUs. In the case where the MNO intends to provide both 5G internet and broadband internet over the same network, they are likely to prioritize the 5G traffic over the general broadband traffic. By allocating the resources for the different types of traffic, these operators will be able to guarantee SLAs, and of course prioritize their more profitable 5G services over less profitable previous generations.

Use Case 3: *Slice per ARPU*



Transport Envionment

IN SUMMARY

To be honest, we do not see one single killer application or use case for slicing. We often see a combination of the three use cases described above. Granted, as one of the few vendors in the world who offer a wide variety of both hard and soft slicing and isolation technologies, it might be said that we are biased as to the need for network slicing.

Of course, I can't decide for you whether you do or don't implement slicing in your network. What I can say 'absolutely, positively' is that chances are you don't know what you will need in the future. With that in mind, as you upgrade your network (and network upgrades are a day by day phenomenon), shouldn't you look for solutions which will give you the freedom of choice? If you don't, then it's more likely than not that your next network upgrade will come faster than you hope.

About Ivan Bykov

Ivan Bykov is a technical evangelist with over 15 years of experience in telecommunications. At ECI, Ivan leads the company's 5G solutions strategy. Prior to joining ECI, Ivan led the network architecture division of the largest mobile operator in Russia. Ivan is currently working on PhD in Technics, and has and MBA in Chemical Technology from Mendelyev University. He also several technical patents to his name.

POWER BROKERS: UTILITIES EXPLORE THEIR ROLE IN 4G & 5G

Utility companies like Duke and Xcel are already major players in the telecom market. Now they're looking at how they might participate in 4G and 5G.

5G is certainly all the rage right now, so it's no surprise that some of the nation's biggest utility companies are working to figure out whether they have a role to play in the space. However, it's unclear whether that role will position utilities as 5G operators, customers or both.

One trend is growing increasingly clear though: Utilities are very interested in launching their own private wireless networks using 4G LTE technology.

Utilities are in the very early stages of exploring 5G, too. For example, the Utilities Technology Council (UTC) recently commissioned a white paper that outlines how utilities might play in a 5G world. The white paper represents an important part of the conversation because the UTC is a major mouthpiece for utility companies in the US; the association was founded in 1948 to advocate for spectrum for utilities, and now it represents a who's who of electric, gas and water utilities, as well as natural gas pipeline providers, critical infrastructure companies and others in the industry.

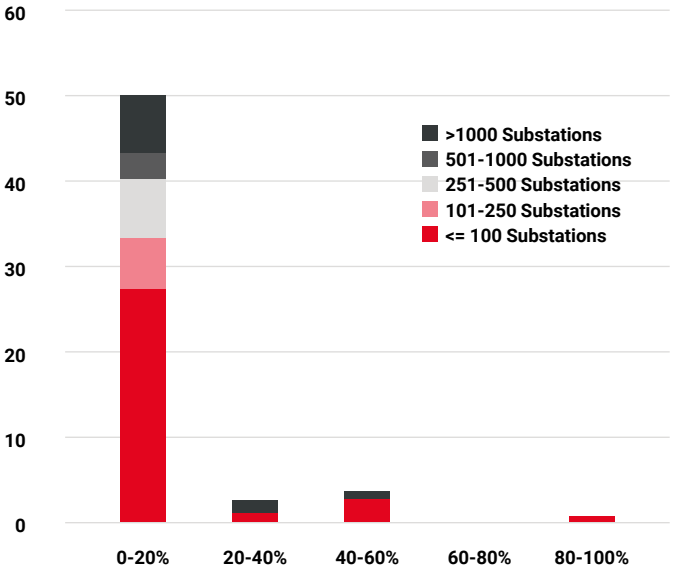
According to the group's 5G white paper, utilities could potentially help wireless network operators deploy 5G by providing locations for small cells and base stations or, potentially, fiber for backhaul. Already Xcel Energy -- the eighth-largest electricity utility in the US based on market value -- confirmed that it is working to provide unnamed wireless network operators access to the 180,000 street lights it owns throughout Colorado and elsewhere. The utility said it had received roughly 1,000 small cell installation requests so far.

Utilities could become 5G customers or even 5G network operators. The white paper speculates that utilities could purchase 5G connections, or network slices, from commercial wireless network operators like Verizon and AT&T for applications like remote drone inspection of power lines, or VR headsets for technicians so they can better see how to repair things. Indeed, Verizon recently announced it would provide 4G connections for thousands of Peninsula Light Company (PenLight) electricity meters.

But, according to the UTC, utilities probably won't want to buy 5G connections when they could build their own. "Utilities will also wish to participate in the 5G world by acquiring spectrum in order to have the option to construct their own private 5G networks and integrate them into a 5G world," the association wrote, noting utilities could use their own private 5G networks for things like greater security, low-latency services, and coverage in areas not served by commercial operators.

The UTC's position on 5G network ownership doesn't come as much of a surprise. Most utilities already own extensive private telecommunications operations -- from fiber to copper to wireless microwave networks -- in part because commercial providers don't provide services in some areas. Also, utilities don't want to be at the mercy of commercial providers in emergencies. The UTC said that in its latest survey of US utilities conducted earlier this year, three-fourths of respondents said they own 80% or more of their networks. The group said that only one small public power utility reported less than 40% ownership of its network.

Third-part network ownership, by number of substations



Source: Utilities Technology Council

TEEING UP 4G FOR UTILITIES

Although the UTC is investigating what 5G might mean for utilities, it's clear that the technology isn't really on the front burner. "5G [for utilities] is probably a little premature," said Alan McIntyre, engineering director for Southern Linc, a wireless company that's owned by the nation's fourth-largest electric utility. "It's often a challenge for utilities even to get to 4G LTE."

Southern Linc, it turns out, is a bit of an outlier in the utility industry. Its parent company, Southern Company, manages power and gas services in several Southern states like Alabama and Georgia, but also operates an extensive, commercial LTE network under the Southern Linc brand throughout the Southeastern US, selling wireless phones and services to people who live there. Thus, the company's LTE network plays a dual role in terms of providing commercial services while also helping to monitor the company's power and gas operations.

McIntyre said he believes Southern Linc is the only major utility with its own LTE network. But it's certainly not the only one interested in building one.

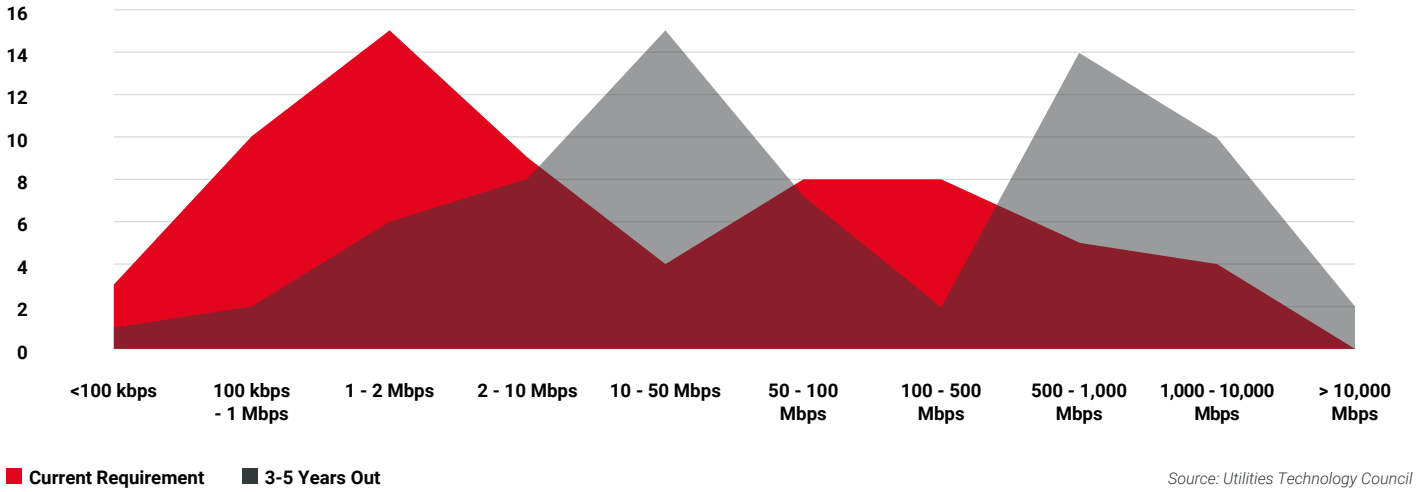
"Duke Energy is currently evaluating the potential for establishing its own private broadband LTE system that could provide the enhanced network systems and services necessary to support its current and future mission-critical communications network needs," the company wrote in a recent FCC filing.

Duke is the second-largest utility in the US by market value, providing electricity and gas service to 7.5 million customers over 95,000 square miles across seven US states. Like most utilities, Duke operates an extensive telecom network that stretches across both wireless and wireline technologies. And like most utilities, the company is working to keep pace with technology. "The recent dramatic growth in the number of communicating intelligent devices is anticipated to continue to grow at an ever-expanding rate for the foreseeable future, which, in turn, drives the ever-expanding need for enhanced broadband wireless communications networks to provide reliable and secure networking capabilities between them," the company wrote.

"Broadband is needed more and more and more," Southern Linc's McIntyre acknowledged.

The UTC agrees: "Grid modernization and streaming video drive … growth in bandwidth consumption."

Current and future bandwidth required



Source: Utilities Technology Council

That's part of the reason why McIntyre's Southern Linc joined the new Utility Broadband Alliance (UBBA), which is specifically designed to help educate utilities on what their options are when it comes to LTE-powered private wireless networks. Such networks promise to meet the needs of utilities in terms of coverage and cost, considering wireless networks are easier and cheaper to build than wired networks.

"A private LTE system owned, operated and maintained by energy utilities for their exclusive use would improve both capacity and connectivity, and would provide such utilities with a wireless network that is inherently more reliable, more secure, and less susceptible to disruptions or other malicious activity than are the commercial services and other private network systems currently available," Duke argued.

UBBA members include utilities like Ameren, Evergy, National Grid and Xcel, as well as vendors like Ericsson, Cisco and Motorola Solutions.

It's worth pointing out that a wide range of LTE vendors are salivating at the prospect of private wireless LTE networks; Nokia's CTO recently predicted the private wireless opportunity could be twice the size of the commercial LTE opportunity. Already companies like Facebook and Charter are testing private wireless LTE networks.

FINDING SPECTRUM FOR UTILITIES

Now, here's where things get a bit complicated. Utility companies like Duke do own some spectrum, but often not enough to build a full-blown LTE network. That's not really a surprise considering operators like AT&T and T-Mobile have paid billions of dollars for LTE spectrum in recent FCC auctions. The UTC has been urging the FCC for years now to carve out spectrum specifically for the nation's utility companies, but the FCC is mostly busy working on releasing more low-, mid- and high-band spectrum for commercial 5G services. Driving the FCC are arguments that commercial 5G is a national priority now given the Trump administration's ongoing trade war with China.

Into this spectrum gap are stepping several companies -- such as Access Spectrum, Select Spectrum and Anterix -- with spectrum holdings they want to sell or lease to utilities. In fact, Anterix was instrumental in forming the UBBA in part to groom potential customers for its 900MHz spectrum holdings.

Anterix, previously called pdvWireless, acquired some 900MHz spectrum licenses from Sprint in 2014 and used that spectrum to offer enterprise push-to-talk networks in seven major US cities under the TeamConnect and pdvConnect brands. But last year the company embarked on a corporate restructuring that involved selling its push-to-talk operations to two companies called Beep and Goosetown, and rebranding from pdvWireless to Anterix.

Morgan O'Brien also took over as the company's CEO. O'Brien is among the luminaries of the wireless industry, having co-founded Nextel (subsequently acquired by Sprint) and, later, Cyren Call Communications, which was involved in the market for wireless public-safety communications.

Now Anterix is urging the FCC to modify the 900MHz spectrum band to allow wireless broadband operations there, including LTE. Those modifications would raise the value of the company's spectrum holdings, making them capable of handling LTE traffic. And, in an indication of Anterix's ambitions, Christopher Guttman-McCabe has been representing Anterix at the FCC. Guttman-McCabe is currently the CEO of CGM Advisors but for more than a decade was a top executive at CTIA, the wireless industry's main trade association.

So far, Anterix appears to be making headway in its efforts. The company is already testing private wireless LTE networks in 900MHz with utilities Southern Linc and Ameren and with the Department of Energy's (DOE) National Renewable Energy Laboratory (NREL) as part of the agency's energy grid modernization initiative.

However, Anterix is facing serious opposition to its efforts to get the FCC to modify the 900MHz spectrum band. Utilities like the City of Los Angeles Department of Water and Power (LADWP), delivery companies like UPS and casino operators like Caesars Entertainment already operate slow-speed communications services in that spectrum, and they don't want the FCC to move things around in the band to allow broadband operations there. They're worried that any changes to the band will cause interference with their existing operations. For example, Caesars told the FCC it operates thousands of 900MHz radios in its Las Vegas casinos for employee communications, and that changes in the band would disrupt those communications. At the very least, Caesars wrote, "incumbents should not be responsible for relocation costs caused by a 900MHz band reconfiguration."

Indeed, Anterix is facing opposition to its plan from the nation's largest utility company, NextEra. "NextEra strongly opposes any rule changes," the utility wrote to the FCC, adding that "the massive broadband reconfiguration process is championed by pdvWireless [now Anterix], a startup company with essentially no customers, no track record, and an unproven technology."

NextEra added that its operations in Florida have already invested a total of $140 million in 900MHz operations there. And the utility said it currently uses the spectrum for, among other things, voice communications for nuclear power plant security operations.

WHAT'S NEXT

What this all means is that US utility companies are already major players in the telecommunications market, either as customers of commercial operators or -- more commonly -- as operators of their own private networks, including both wired and wireless networks. Further, utility companies could well look to build private LTE networks -- and potentially private 5G networks in the future -- to address their growing bandwidth needs. As long as they can find suitable spectrum to do so.

Mike Dano, *Editorial Director, 5G & Mobile Strategies*
Light Reading

5G CUSTOMERS USE MORE DATA THAN 4G CUSTOMERS

What effect might 5G services have on networks? Data out of South Korea certainly indicates that 5G customers, at least initially, will use more data than 4G customers.

As 5G networks light up in cities around the world, a big question for operators is exactly how customers might use them.

Based on recent figures from South Korea, it seems that customers will use them a lot.

Research firm Strategy Analytics, citing data from the country's telecommunications ministry, reported that average customer data usage on 5G was 24GB in June, which was 2.6x higher than the 4G average of 9.1GB and 3.2x higher than the overall market average of 7.4GB.

And when comparing customers on unlimited plans specifically, the firm found that 5G users still consumed more data: 27GB per month on 5G versus 23GB on 4G.

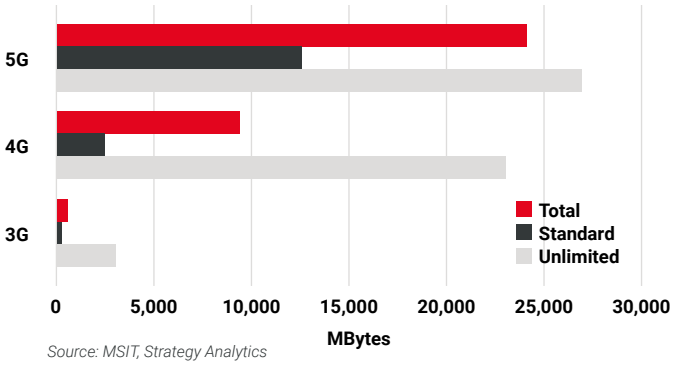
Strategy Analytics also reported that the number of 5G subscriptions at the end of June totalled 1.34 million, or roughly 2% of the total market. However, those 2% of subscriptions on 5G accounted for 6.4% of all of the country's data traffic in June.

The firm also noted that SK Telecom was, at that point, leading the South Korean 5G sector with 40% market share.

WHAT THIS MEANS

An oft-repeated maxim in the telecommunications industry is that, if you give people faster speeds they'll find ways to use them. That certainly seems to be the case in 5G in South Korea, where 5G speeds are 1.7x faster than 4G speeds, according to recent numbers from OpenSignal.

Average data use by plan type South Korea, Q2 2019



Source: MSIT, Strategy Analytics

However, it's unclear how this trend might play out in the broader industry, and over an extended period of time. For example, South Korean operators first launched 5G just a few months ago, so the customers who used 5G in June are probably early adopters who revel in the latest and greatest technology. Meaning, they might be the kind of customers who use more data anyway.

Further, South Korea is unique in that the country's telecommunications minister tracks usage data. That kind of data is extremely hard to come by in other countries, including in the US, where operators often carefully guard such information. Thus, it will be difficult to track such trends globally.

That said, it's reasonable to assume that 5G users, in the long term, will figure out ways to consume more data than 4G users before them.

Mike Dano, *Editorial Director, 5G & Mobile Strategies*
Light Reading

OPERATORS MAY MOVE TO STANDALONE 5G FASTER THAN ANTICIPATED

Operators continue to test their initial 5G networks, and are finding a number of surprises that could hasten changes like a move from non-standalone 5G to standalone 5G.

The companies that sell equipment to test wireless networks are typically down in the trenches during wireless network buildouts. And that means they are privy to the unexpected challenges that might occur when operators deploy a new technology.

5G is no exception. From measuring 5G to 4G handovers to testing signal distortion, executives from several top network-testing firms say that 5G is so dramatically different from LTE that operators are spending a lot more time testing their networks than in previous network upgrades.

Interestingly, test equipment makers say that operators launching the non-standalone (NSA) version of 5G in millimeter-wave spectrum such as 28GHz and 39GHz are now considering moving to the standalone (SA) 5G version more quickly because of the complexity of non-standalone 5G. In the US, Verizon, T-Mobile and AT&T are all using millimeter wave (mmWave) spectrum and NSA for their initial 5G deployments.

"In the short-term, NSA gets you up and running faster," said Paul Denisowski, product management engineer at Rohde and Schwarz North America, one of the industry's biggest vendors for testing and measurement equipment. "But then it becomes a crazy, convoluted thing to support."

That sentiment was echoed by Sameh Yamany, CTO of test and monitoring firm Viavi. "We are seeing an acceleration in standalone," he said.

One of the big problems with NSA is the handoff from 4G to 5G because it introduces latency to the network.

"A lot of carriers are realizing that in urban areas with high density, they will have handoff issues," Yamany said. The reason for the latency is that 5G networks that use mmWave spectrum have trouble maintaining a stable signal. If the network can't find a stable 5G signal, it will push that connection to 4G, and that introduces latency.

Indeed, those difficulties were recently highlighted by a report on 5G in South Korea by IHS' RootMetrics, which found that "upswitching" from 4G to 5G was adding significant latency to some users' connections.

And while the handoff issue with NSA may be fixable, Denisowski said that manufacturers are not sure how much time to spend working on NSA if operators are going to migrate quickly to standalone 5G. "As an engineer, NSA offends me because it is overly complicated," he said. "The other part is that people would like to get to standalone 5G because it is pure 5G."

Already T-Mobile has signaled it plans to launch standalone 5G as early as next year, and Verizon could launch SA 5G in a similar time frame. Such a move would pave the way for them to eventually shut off LTE networks; NSA 5G requires an LTE network to provide things like authentication, while standalone 5G does not require a supporting LTE network.

SIGNAL INSTABILITY

Another big issue with 5G are the spectrum bands that carriers are initially using for it. 3G and 4G wireless networks were always deployed in low-band spectrum, so wireless network operators don't have as much experience working with spectrum in the mmWave bands where today's 5G sits. That may be causing some of the handoff and latency issues.

Russel Lindsay, senior product manager at Anritsu, another testing and measurement company, said that wireless networks deployed in millimeter wave tend to have intermodulation issues. For example, simple things like nails or unused wires can create signal distortion. Lindsay added that because of these intermodulation issues, operators need to figure out new modulation schemes for their 5G networks. "We try to work with them to give them as much information as possible about their signal," Lindsay said.

He added that different tools are required for 5G testing because 5G networks have very different requirements. For example, LTE networks could be tested more easily because an LTE radio sends its signal in a wide arc. With 5G, though, the signal can behave differently in different directions because it can use beam-forming technology, which directs connections to specific targets. "I could be 10 yards from the radio and not be able to measure it," Lindsay said.

This difference in how the 5G signal radiates also means that drive testing -- the decades-old method of testing the signal strength of a network in a neighborhood or city by driving around in a car -- may not be as important of a tool as it was in the past. Instead, network testing will likely be done by technicians wearing backpacks filled with test gear. "We home-brewed a backpack solution," Lindsay explained.

That situation is also due to the propagation characteristics of transmissions in mmWave spectrum. Such signals only travel a few thousand feet, unlike signals in low-band spectrum that can often travel several miles.

Another possibility is using drones to do network testing. Yamany said drones can be used to test signal penetration in high buildings that can't be tested on the ground. "Testing the network in higher bands becomes more complicated," he acknowledged.

Sue Marek, *special to* **Light Reading**

ECI RESOURCES

VIDEO

MORE INFORMATION

The 5G connectivity challenge

5G promises unprecedented services and unparalleled user experience. To provide this new experience, mobile network operators need to build an underlying connectivity infrastructure that is capable of delivering on changing demands.

WHITEPAPER

MORE INFORMATION

5G – A fork in the road for network transport

Today's networks provide one predominant service: all-purpose IP connectivity; however, 5G has the potential to change this picture dramatically. So how will carriers be able to support the range of 5G services? We see three distinct SP strategies emerging.

BLOG

MORE INFORMATION

The 5G Business Case Revisited

Carriers around the world are slowly, but surely, rolling out 5G networks. However, between the promises of brand new services and blazing speeds, there remains a question: Just how will carriers recoup their 5G investments?

For more information on ECI
please visit https://www.ecitele.com

ECI RESOURCES CONTINUED

BLOG

MORE INFORMATION

Taking the Blinders Off 5G Networks

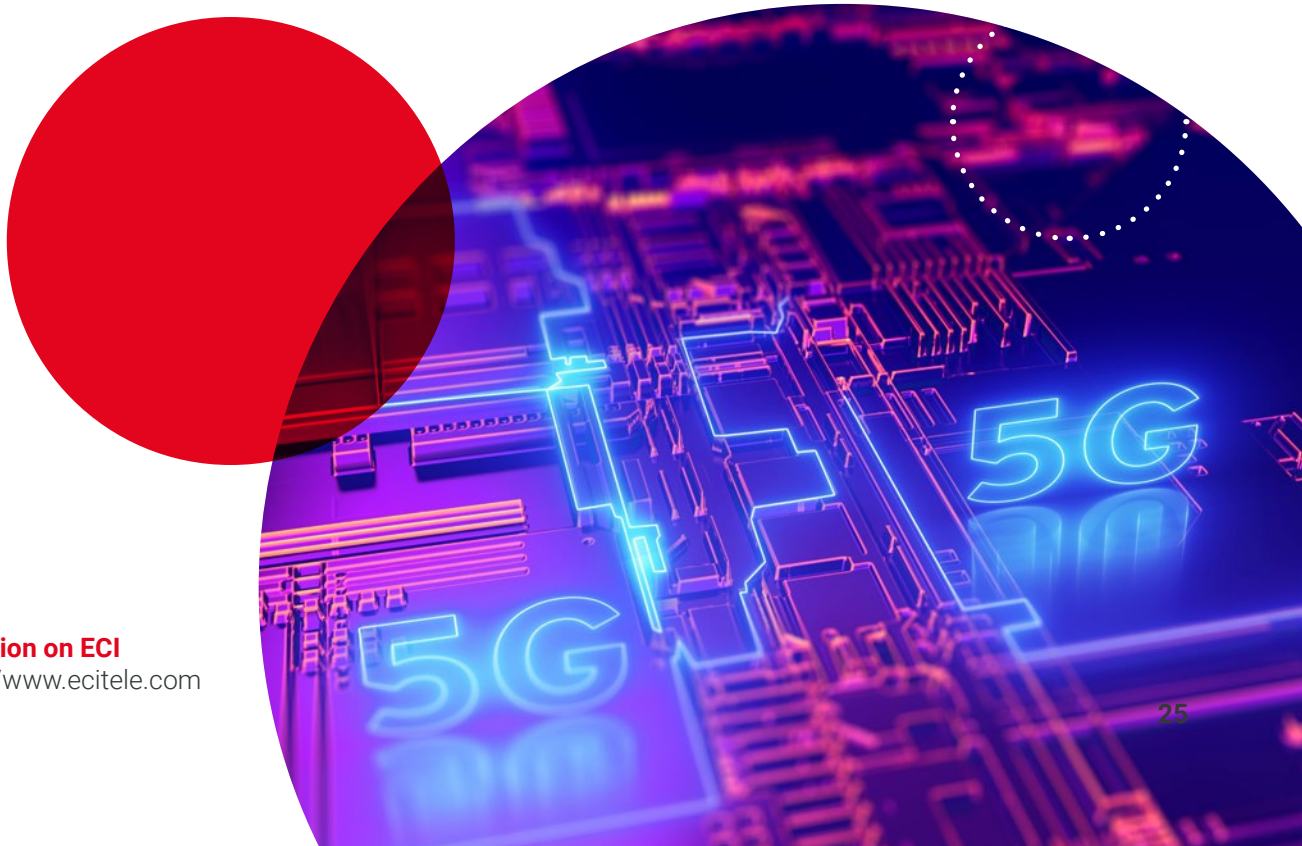
Today's service-blind networks will need a big change to manage the demands of a 5G world where more users, more data and more services are just the beginning. Just what needs to change to assure that 5G is like no other G before it?

RESEARCH SURVEY

MORE INFORMATION

ACG Research Survey: Trends, Opportunities and Challenges in 5G Transport Networks

Service providers need to evaluate the best 5G transport deployment strategy. A strategy that focuses on rapid time-to-market may not be optimal in the medium to long term.



For more information on ECI
please visit https://www.ecitele.com

5G NETWORK SLICING: CAN YOU CUT IT?

It's hard to find any unused superlatives to describe the leap in connectivity, capacity, reliability, latency, and the sheer diversity of services that 5G will bring. Let's all agree on 'monstrously better'. But there is a catch: 5G is also monstrously complex. The one area that seems to cause more perplexity than any other is network slicing.

Put simply, network slicing will allow you to cut or slice one physical infrastructure into a variety of virtual networks, which can be customized to meet the specific needs of the applications, services and resources. Each slice will combine a variety of network assets – whether PNFs (Physical Network Functions), VNFs (Virtual Network Functions), connectivity, bandwidth and compute. In addition, each slice will be dynamic enough to allow you to dial up or down those resources as service requirements change. Each slice will support a separate control plane and user plane. As you can imagine, all this requires clever orchestration of an already complex system.

So what slice-enabling technologies are there to support services with wildly different requirements on the same network?

Download our white paper:
Network Slicing, Cut a Long Story Short...
Or visit: www.ecitele.com/5g