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5G NETWORK & SERVICE STRATEGIES

2020 OPERATOR SURVEY

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Introduction

The Heavy Reading **2020 5G Network & Service Strategies Operator Survey** is designed to provide insight into how operators will scale 5G networks and identify the service strategies operators believe will drive investment and customer value. Developed in association with the report sponsors, the survey questionnaire was fielded to respondents in the Light Reading service provider database in January 2020. It was open only to employees of communications service providers (CSPs).

This report analyzes the results of the survey in the following thematic sections:

- 5G Deployment Timelines & Services
- 5G Radio Access Network (RAN) Evolution
- 5G Core Network
- 5G Edge Cloud
- 5G Monetization & Network Slicing
- 5G Enterprise Services
- 5G Security Stance
- 5G Transport Networks

The survey garnered a total of 164 respondents who self-identified as working for CSPs. Rogue, and obviously non-operator responses were removed. Respondent demographics are shown below. Technical, engineering, and network operations personnel from large operators in advanced markets accounted for the majority of the responses. The U.S. was the dominant region, with as many responses as the rest of the world combined; however, all major global regions were represented.

At places in this analysis, Heavy Reading compares responses from different demographic groups. In particular, at several points in this report, we compare U.S. and Rest of World (RoW) responses. Where this is the case, it is noted in the text. ■

REPORT AUTHORS

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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.

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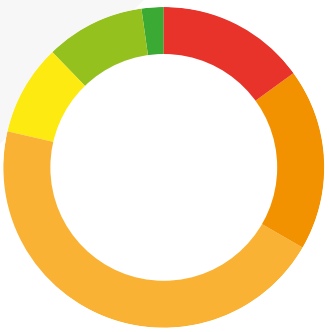
5G Network & Service Strategies Survey Demographics

Fig 1. In what region is your organization headquartered? (N=164)

- US 57%
- Canada 6%
- Central/South America 6%
- Western Europe 9%
- Central/Eastern Europe 6%
- Asia Pacific (including Australia) 10%
- Middle East 4%
- Africa 2%

Fig 2. What is your primary job function? (N=164)

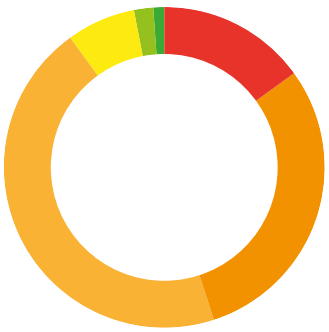


- Corporate management 15%
- R&D or technical strategy 18%
- Network planning, engineering, operations 45%
- IT, data center & cloud domain 9%
- Product management, sales & marketing 10%
- Other 2%

Fig 3. What are your company's approximate annual revenues? (N=164)

- Less the $50 million 17%
- $50 million to $200 million 9%
- $201 million to $500 million 9%
- $501 million to $1 billion 15%
- $1 billion to $5 billion 12%
- More than $5 billion 38%

Fig 4. What type of communications service provider (CSP) do you work for? (N=164)



- Fixed network CSP 15%
- Mobile network CSP 30%
- Converged Network CSP (fixed & mobile) 45%
- Cable or satellite CSP 7%
- Other CSP 2%
- I don't work for a CSP 1%

Source: Heavy Reading's 5G Network & Service Strategies Operator Survey, February 2020

5G Deployment Timelines & Services

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

The commercial drivers for 5G, how fast it becomes a mass-market service, and how operator service portfolios may evolve to take advantage of the technology are of great interest to all parts of the mobile industry value chain.

The key findings for this section are as follows:

- On a 2-year view, 41% of respondents said "faster end user speeds" is the primary driver for 5G, up from 33% in Heavy Reading's 2019 survey. Over a 5-year view, the ability to "address new markets & services" climbs to first place in the ranking, with 42%. Operators appear to see 5G technology investment as focused on evolving their current service strategies in the near term and becoming more ambitious in the medium term.
- Heavy Reading asked when operators think more than 25% of their subscriber base will have a 5G device. 50% of respondents expect this to be the case by the end of 2022, up slightly from 45% in our 2019 survey. This looks like a bullish view at first glance, but it is in line with Omdia's independent estimate of 28% 5G penetration in the U.S. during the same timeframe.
- Over a 3-year view, operators expect some differences between their 4G and 5G service portfolios, but not major ones. 43% said their company will offer a "very similar services portfolio" while a comparable 45% believe their portfolio will offer "mostly common services, with some 5G-only services." Only 8% expect to offer "many 5G-only services."

As was the case in our 2019 survey, Heavy Reading asked respondents to identify the primary drivers for 5G deployment over 2- and 5-year time horizons **(Fig 5)**.

On a 2-year view, the large st group (41%) said "faster end user speeds" is the primary driver for 5G, up from 33% in 2019. "Addressing new markets and services" comes second with 28%. "System capacity and efficiency" (16%) and "competitive reasons" (16%) bring up the rear, both with reduced support relative to our 2019 survey. These results fit with how operators tended to market 5G in 2019 – namely, on downlink speed and gigabit performance claims.

Over a 5-year view, the ability to "address new markets & services" climbs to first place in the ranking at 42%, significantly above all other scores. Operators clearly see 5G investment as focused on how advanced technology capabilities can be translated into compelling services over the medium term.

Fig 5.
What will be your company's primary driver in deploying 5G networks, in 2 years and in 5 years? (N=155-157)

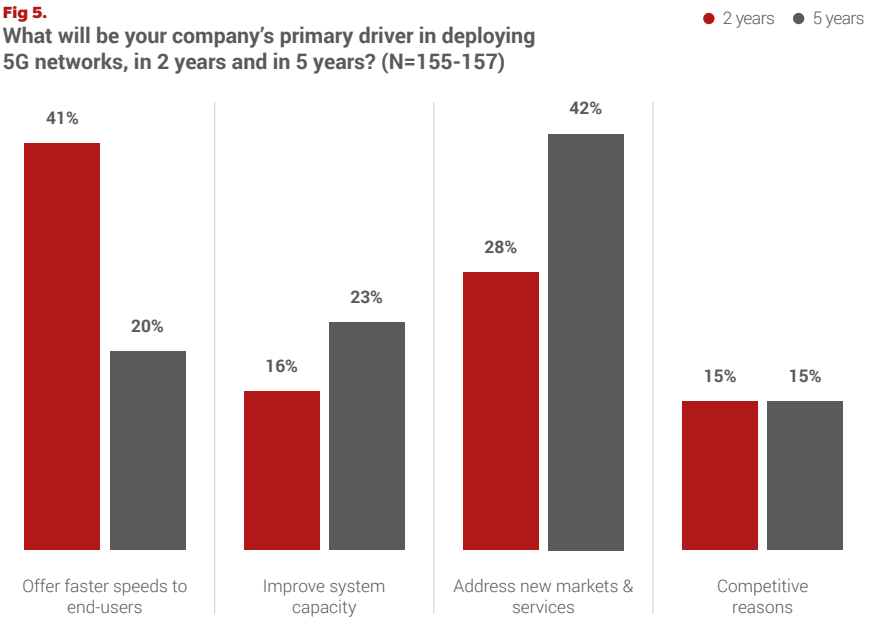
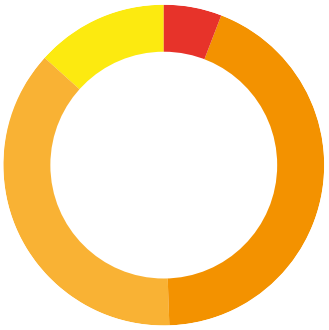
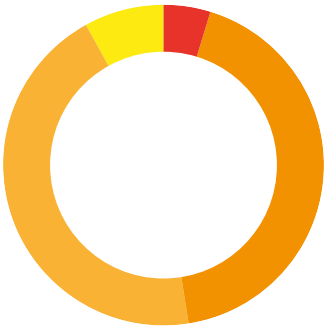


Fig 6. By what year do you estimate more than 25% of your subscriber base will have a 5G compatible device? (N=158)



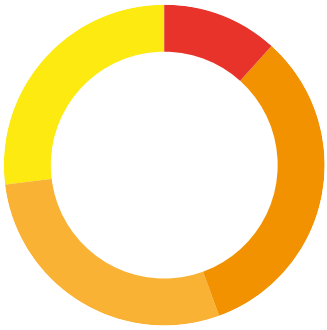
- 2020 ..... 6%
- 2021 to 2022 ..... 43%
- 2023 to 2024 ..... 37%
- 2025 or later 13%

Fig 7. How much commonality do you expect between your 4G and 5G service portfolio over the next three years? (N=157)



- Identical service portfolio 5%
- Very similar services portfolio 43%
- Mostly common services, but with some 5G-only 45%
- Many 5G-only services 8%

Fig 8. When do you expect your company to start offering URLLC (ultra-reliable, low-latency communication) services? (N=157)



- In 12 months 12%
- In 12 -24 months 33%
- After 24 months 29%
- Don't know / no plans at present 27%

In terms of 5G devices, 50% of respondents expect 25% or more of their subscriber base to have a 5G-compatible handset by the end of 2022 **(Fig 6)**. At first glance, this looks like a bullish view, and it is up slightly from Heavy Reading's 2019 survey. This positive view on 5G adoption perhaps reflects better knowledge of, and greater confidence in, 5G device and chipset development timelines. It also possibly echoes analyst upgrades to 5G device estimates made by research firms across the board in 2019 and widely reported in the media. For example, the result is in line with Omdia's independently produced estimate of 28% 5G penetration in the U.S. during the same timeframe.

A critical factor is handset replacement cycles for smartphones, which have lengthened in most developed markets in the past few years. In some markets – for example, China and South Korea – there is evidence that 5G can drive an acceleration in handset upgrades. But this is not a universal phenomenon; for instance, there is not yet good evidence of this in Europe and the U.S. This may be because first-generation devices tend to come with compromises (e.g., on power consumption, cost, and bugs). Looking into 2020 and 2021, newer handset models at high- and mid-tier prices will become available in volume. For example, a 5G iPhone – rumored for late 2020 – will be important, particularly in the U.S., where iPhone market share is high.

As established earlier, over a 5-year view, operators see 5G addressing new markets and driving advanced services **(Fig 7)**. sought insight into the differences between 5G and 4G service portfolios over a 3-year view. A fair summary would be that operators expect some differences, but not major ones. A large 43% said their company will offer a "very similar services portfolio" for 4G and 5G users, while a comparable 45% believe their portfolio will offer "mostly common services, with some 5G-only services." Only 8% expect to offer "many 5G-only services."

In part, this result may reflect that 5G deployed in non-standalone (NSA) mode makes existing 4G services faster rather than fundamentally different. As discussed later, it may be that a transition to standalone (SA) is a prerequisite for service innovation.

"ULTRA-RELIABLE LOW LATENCY COMMUNICATION (URLLC) SERVICES ARE ONE OF THE DEFINING FEATURES OF 5G. URLLC REQUIREMENTS WERE INFLUENTIAL IN THE DESIGN OF THE 5G SYSTEM AND AIR INTERFACE."

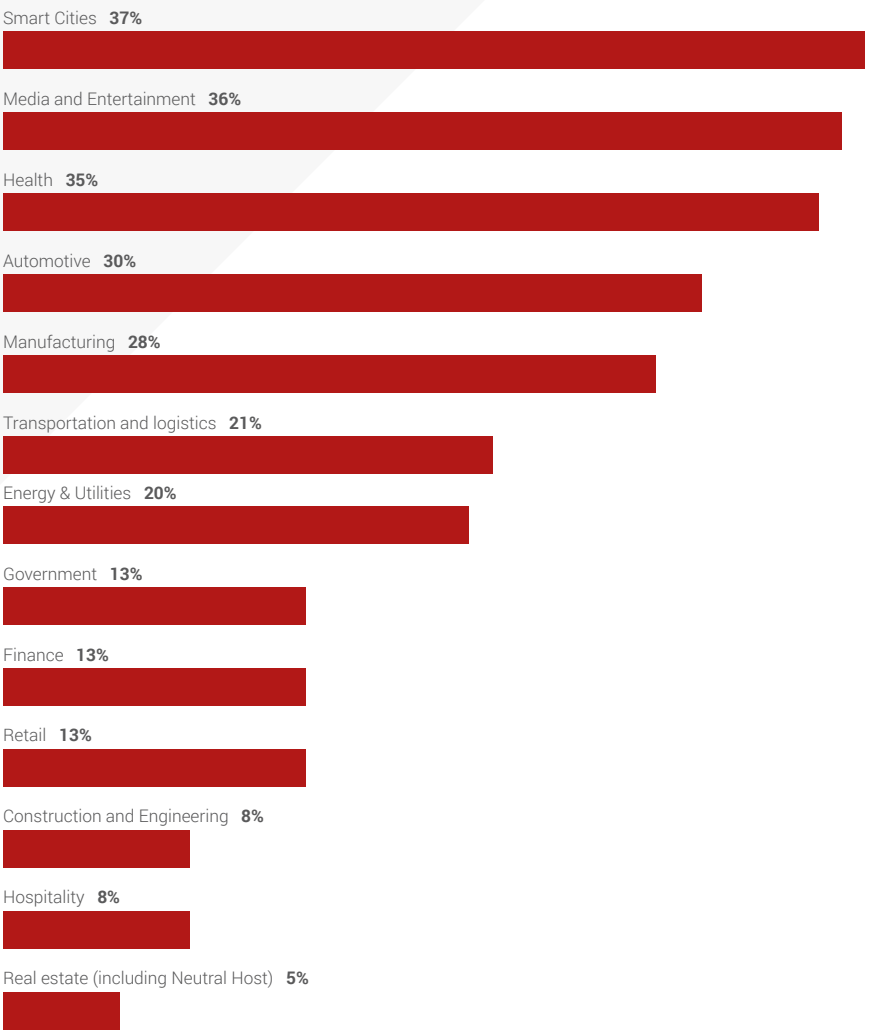
Ultra-reliable low latency communication (URLLC) services are one of the defining features of 5G. URLLC requirements were influential in the design of the 5G system and air interface. As a result, the industry is heavily committed to this category of services, particularly where 5G can be used in cyber-physical systems. These service types cannot be supported on 4G and therefore represent new business opportunities.

The next question **(Fig 8)** asked when operators will start to offer URLLC – note the emphasis on the start of services rather than offering at scale – and it drew quite a diverse response. A minority (12%) think URLLC could happen within 12 months and 32% within 2 years (i.e., by the start of 2022). This 2-year timeframe aligns with the expected availability of products that incorporate Release 16 capabilities, which are important for many URLLC use cases for industrial customers. The R16 standards will be finalized in June 2020; it will take a year or so for the functionality to be incorporated into products and then deployed into networks.

And clearly not everyone is bullish. Over half of respondents think it will be more than 2 years before URLLC will be introduced (29%) or they do not know or said their company does not have plans at present (27%). This accords with a view that URLLC is still some time from being ready for broad-based marketing to customers.

Another important objective of the 5G technical specification process was to create a system capable of supporting the diverse needs of different industries and sectors. Accordingly, there is interest in understanding which vertical sectors may adopt 5G first and at scale. Heavy Reading asked operators **(Fig 9)** about the verticals they think will be most attractive in the near term (12-18 months). Smart cities (37%), media and entertainment (36%), health (35%), automotive (30%), and manufacturing (28%) lead the pack. Of the top two, smart cities always perform well in Heavy Reading surveys. One reason for that may be that this category incorporates many types of use cases and thus appeals to everyone. We tend to think that media and entertainment, in second, is the safest bet because 5G services often already bundle video, music, and gaming with customer plans. ■

Fig 9. What are the top enterprise verticals for 5G over the next 12 to 18 months for additional B2B revenue streams? (select up to three) (N=157)



2020: Benefits and Challenges of 5G Deployment

*By **Chris Pearson,** President, **5G Americas***

With the first year of live commercial 5G networks under our belts, we look ahead at a bright and promising 2020 for wireless. There are very few times when a new generation of wireless networks comes around, perhaps once every 10 years or so, so it's especially interesting to see how 5G is both evolutionary as well as revolutionary for the world.

By now, many enterprises and consumers understand some of the basic reasons why 5G is important. As a radio access technology, it provides much higher data rates of 1 Gbit/s-20 Gbit/s, enabling customers to upload or download content much more quickly. Ultra-reliable low latency (URLLC) improvements in 3GPP's Release 15 allow for much less network lag and delay when requesting data from the network – a latency imperceptible to most humans.

These realizations have driven the market for 5G early adopters, even as LTE continues to serve as the global workhorse of wireless communications – gaining 250 million global connections in 3Q 2019, according to data from Ovum. By the end of 2019, global 5G connections reached 5 million subscribers. There are 52 5G commercial networks now live, based on numbers by TeleGeography. With 1.3 billion 5G connections projected by the end of 2023, it's clear that 5G's rapid ascent is in the cards for the next decade.

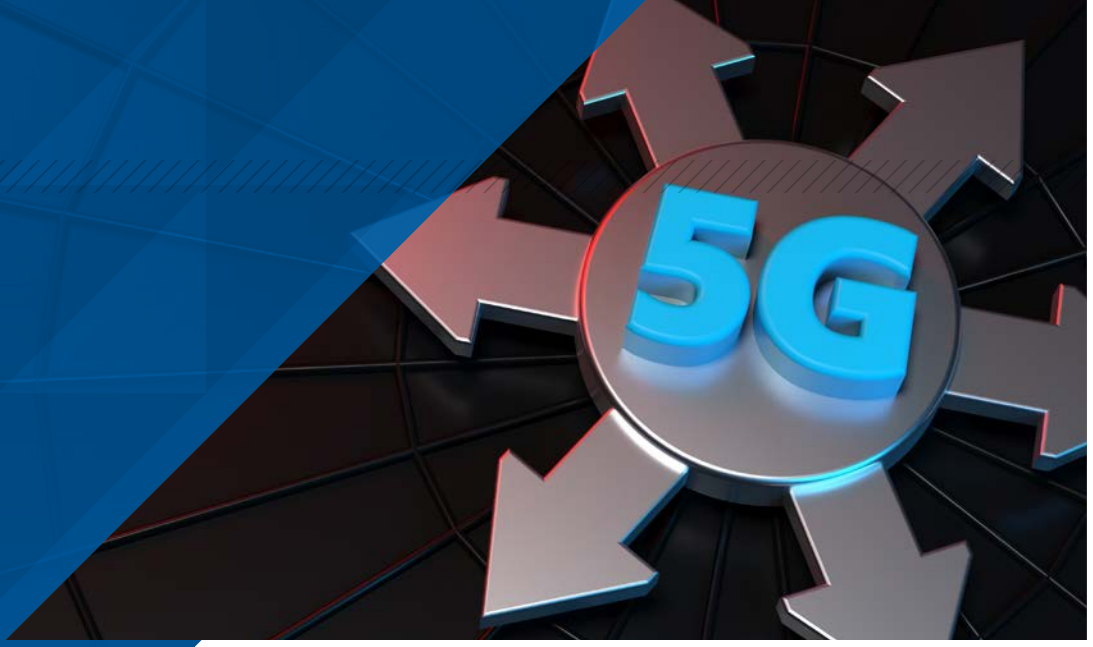
So a major story for 2020 will be the proliferation of consumer and enterprise devices. At CES 2020, the "Year of 5G" was touted as a major theme by many technology companies. Dozens upon dozens of new 5G mobile devices will emerge this year as early adopters begin to test out what 5G can do. As the market pivots around new devices and capabilities, questions remain about whether network operators will be able to ramp up capacity and coverage quickly enough to match the insatiable demand for data.

Here, 3GPP offers great hope with an affirmative. While 5G end-user capabilities are widely known, less well understood (but just as important) are some of the other capabilities that 5G is offering network operators that will greatly increase the progress of network deployments.

For instance, through dynamic spectrum sharing (DSS), network operators will see a much faster, more flexible capability to increase the capacity of their networks without needing to "re-farm" existing spectrum for modern 5G devices. Advanced 5G antenna technologies like massive multiple input/multiple output (MIMO) and beamforming will greatly expand the number of devices that a cell site can communicate with simultaneously – up to 1 million devices per square kilometer. Energy efficiency improves with narrowband Internet of Things (IoT) and Cat M1 devices, even while new licensed and unlicensed spectrum bands become available for 5G.

Beyond the radio air interface, modern wireless networks will also be seeing tremendous improvements to network architecture and compute capabilities. The latest 3GPP releases offer amazing frameworks in which to build networks using service-based architecture and support for radio access network (RAN) self-organizing networks. They will support a wide variety of vertical applications for automotive, health, manufacturing, critical communications for first responders, and entertainment industries with New Radio (NR) broadcast and multicast. Beyond these improvements, artificial intelligence can now help carriers in their management and orchestration of network operations – as well as being tested for usage in the challenge of small cell siting.

With the technical specifications and studies for 5G well underway in 3GPP Releases 15-17, the wireless industry seems poised to explode into the roaring 2020s. However, stiff headwinds continue to blow.



Across the industry, several significant challenges could slow down the progress of change. These factors generally revolve around two key issues: spectrum and cell siting.

From a spectrum standpoint, the demand for data continues to accelerate, so the need for more internationally harmonized license spectrum is significant. In general, the industry needs more spectrum across a mix of low, mid, and high bands across every region. Specifically, the U.S. has led in the identification and allocation of high band millimeter wave (mmWave) spectrum but needs to continue to address low- and mid-band spectrum allocations. Regulatory agencies throughout the Americas should also be looking to configure spectrum licenses with wider bandwidths so that there is less overhead in network management for technologies such as carrier aggregation.

Moreover, additional internationally harmonized exclusive-use licenses are needed before shared use options are pursued by governments. From a pure spectral efficiency perspective, having spectrum uses managed by privately owned network operators will reduce signal attenuation and "cross-talk" and provide more spectrum capacity in the aggregate. Also, having operators looking after spectrum ensures that valuable natural resources are appropriately managed, new technologies are developed, and usage is maximized.

Finally, spectrum harmonization and interoperability are significant issues across borders for roaming and economies of scale. We must ensure that devices will be able to communicate with each other, whether one is in Los Angeles or São Paulo. This means pursuing interoperability among equipment, chipsets, antenna, devices and other network elements. It also means that each regulatory agency should establish a cooperative spectrum plan and transparent spectrum policy that aligns the allocation of spectrum.

Cell siting challenges continue to be an obstacle for the industry. Streamlined cell siting policies by cities, states, and municipalities are critical to a country's leadership in 5G. Thus, cities, states, and municipalities must work with the wireless industry to realize the benefits of 5G for their communities, which will result in greater economic opportunities, better access to critical public safety services, and improved ability for their citizens and residents to bridge the digital divide and connect to the internet.

At the same time, a balance must be struck with infrastructure providers, such as cell tower owners, utilities, and other owners and managers of public right of way. In many respects, 5G is not just about a competitive business, it's also about the creation of public goods, services, and technological progress that impact international competitiveness and national security. It is important to realize the costs borne by wireless operators will not just be passed along to their consumers, but also impact a nation's entire vital communications network.

With such high stakes, this is an exciting time for the industry. 5G is just getting started. We will continue to have many more conversations about deployments, benefits, uses, and challenges in the future. For now, 2020 offers a bright road ahead. We should work together so we do not squander its promise. ■

The State of 5G Standards Work for North America

Tom Anderson *and* ***Iain Sharp,*** *Principal Technologists,* ***ATIS***

Industry-driven specifications are the foundation for the mobile networks that revolutionized communications in the first decade of the 21st century and will continue to transform lifestyles and business operations. These specifications help networks deliver services that span countries and continents and support a competitive, interoperable market for mobile devices and network equipment.

Based in Washington, DC, ATIS has been at the heart of creating mobile specifications for the North American marketplace. ATIS' membership includes network operators and mobile equipment vendors. Increasingly, we also collaborate with vertical industries and government agencies that utilize mobile technology. As the North American partner in 3GPP, ATIS is responsible for ensuring that 3GPP developments meet market and regulatory requirements in the region. This role includes publishing regional standards that encapsulate 3GPP specifications.

ATIS is addressing key concerns of companies introducing 5G in the highly competitive North American marketplace. These concerns include Internet of Things (IoT) performance requirements, the use of shared 5G infrastructure, network security, and enabling smart cities and vertical industries to make the best use of 5G.

3GPP Releases 16 and 17 Are Deep in Development

3GPP specifications are the basis for creating interoperable 5G systems. The 5G system is a complete mobile communications platform that delivers three key 5G service categories:

- Enhanced Mobile Broadband (eMBB)
- Massive Machine-Type Communications (mMTC)
- Ultra-Reliable Low Latency Communications (URLLC)

The 5G system's New Radio (NR) specifications deliver a high performance and highly configurable radio that operators and vendors can adapt to meet a wide range of current and future application requirements. In the standalone (SA) configuration, the NR is linked to a 5G core network that supports cloud-like deployment of functions and network slicing to separate user groups on to different virtual resources.

Additionally, the 5G system can be deployed to support all the capabilities of LTE networks, though with limitations on the level of integration with legacy 2G (GERAN) and 3G (UTRAN) radios. It's important to note that the pure 5G system doesn't support circuit-switched fallback, thus creating an impetus to support the IP Multimedia Subsystem (IMS).

The ambitious goals of 5G and the potential applications of the 3GPP platform represent a large body of work that will play out over several specification releases. 3GPP Release 15 is the first full set of 5G specifications. After initial delivery of non-standalone (NSA) NR specifications in late 2017, 3GPP spent the next two years focused on completing 3GPP Release 15, as well as the 3GPP submission for International Mobile Telecommunications for 2020 and beyond (IMT-2020).

With Release 15 stabilizing, 3GPP turned its focus to developing Release 16, which addresses 5G operational enhancements and lays the groundwork for vertical industry requirements.

> "5G WILL DOMINATE THE COMMERCIAL MARKET FOR MANY YEARS. NOW IS THE TIME FOR EARLY PREPARATION FOR 6G TECHNOLOGY."

This includes creating enablers for 5G use in industrial automation and vehicle-to-everything (V2X) applications. The target scope for Release 17 was approved in December 2019. It includes work to support public safety users in 5G and integrate satellite and other types of non-terrestrial (NTN) networks. ATIS has also taken a lead industry role in the NTN/5G integration.

Releases 15 and 16 Submitted to ITU IMT-2020

The International Telecommunication Union (ITU) Radiocommunication Sector (ITU-R) plays a role in setting performance objectives and endorsing technical specifications to define mobile network generations, as in 2G, 3G, 4G, and 5G.

ITU's vision for 5G was completed in September 2015 and is the basis for IMT-2020. The organization is now in the process of formally reviewing and endorsing candidate specifications to implement IMT-2020. Candidates must successfully complete a nine-step evaluation process to be referred to as an ITU 5G technology. ATIS is one of the 13 registered Independent Evaluation Groups worldwide and the only North American organization engaged in this process, which is expected to be complete by November 2020.

3GPP made two submissions based on work in Releases 15 and 16:

1. NR RIT (New Radio – Radio Interface Technology), which is a pure 5G network.

2. NR+LTE SRIT (set of RITs), which includes the NR specifications, along with an LTE component covering specific areas such as IoT/MTC (eMTC and narrowband IoT [NB-IoT] specifications).

It is fully expected that the 3GPP specifications will be recommended by the ITU-R as a 5G technology.

ITU projects run on long timescales. The organization already has a focus group on networks in 2030. Though 5G will dominate the commercial market for many years, now is the time for early preparation for 6G technology.

North American Priorities

North America has unique regional needs and priorities based on market dynamics and regulatory requirements. Of specific interest are 3GPP specifications that enable the region's operators to comply with existing and future anticipated regulatory requirements. Priorities in this category are:

- Enhanced 5G support for select vertical domains that intersect with emerging regulatory interest, including V2X enhancements, that are applicable to public safety applications and unmanned aerial system identification.
- 5G multicast, broadcast, and proximity services in support of mission-critical situations applicable to FirstNet and other public safety applications.
- Multimedia Priority Service, which helps ensure that national security/emergency preparedness users can make important calls/sessions even when public networks are congested.

In addition, important work in the 5G system to meet market requirements includes:

- Enhanced 5G support for vertical markets such as agriculture and industrial automation.
- Network automation enhancements to support the application of 5G data analytics for improved network operations.
- Enhancements to network slicing.
- Radio performance enhancements, such as for multiple input, multiple output (MIMO), control channel, and LTE/NR co-existence and coverage.
- Efficient usage of operator-licensed bandwidth when available spectrum does not align with existing standard 5G channel bandwidth options.

As we enter a new decade, the evolution of mobile specifications will continue at a fierce pace to accommodate the ever-increasing demands of new technology. ATIS is poised to continue delivering the standards and solutions it takes to advance our industry's transformation. ■

5G RAN EVOLUTION

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

The RAN is the most expensive part of a 5G network and requires constant investment in new coverage, equipment, and optimization. 5G coverage is critical to virtually every player in the ecosystem and every prospective customer.

KEY TAKEAWAYS:

Almost half (49%) of respondents indicated they think between 25% and 50% of their RAN footprint will support 5G by the end of 2021. This is a bullish outlook, but it is not an outlandish expectation, given the opportunity to use low band frequencies and the increasing maturity of operator deployment capabilities.

The survey shows strong, but not unequivocal, support for open RAN, with 18% saying it is a "critical strategic priority" and 44% "important." Perceptions of the challenges around open RAN are fairly evenly divided, which indicates the solutions will be found at the system level.

About a third (31%) of respondents said 5G RAN field testing is "significantly more challenging" and over half (54%) said "somewhat more challenging." Inter-technology handover between LTE and 5G is considered the greatest challenge according to 57% of respondents, ahead of validation of low latency URLLC applications at 39%.

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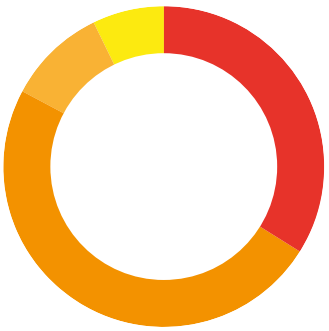
5G RAN Evolution

Expectations for 5G coverage are critical to every player in the ecosystem and every prospective customer. As expected, coverage in the first year of commercial launch (2019) was severely limited in all markets except South Korea, where it was merely limited. With this question, Heavy Reading wanted to get a feel for coverage expansion in the next 2 years **(Fig 10)** – i.e., by the end of 2021. We also posed this question in 2019, when we asked for a 3-year view, so both surveys land on expectations for 2021.

In the 2020 survey, 49% indicated they think between 25% and 50% of their RAN footprint will support 5G, versus 43% in 2019. This suggests operators anticipate 5G coverage will increase significantly in the next 2 years and that they are slightly more confident on coverage than last year. This is a bullish position, but it is not an outlandish expectation in advanced markets, given the interest in low band frequencies (and dynamic spectrum sharing) and the increasing maturity of 5G RAN solutions and operator deployment capabilities. It is worth keeping in perspective, however, that a not insignificant 34% think less than 25% of their RAN footprint will support 5G access in that timeframe.

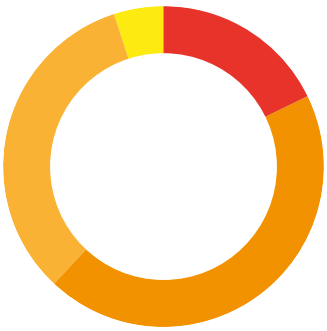
The prospects for open RAN solutions was one of the major discussion points in the RAN market in 2019. Initiatives such as the Telecom Infra Project (TIP) OpenRAN Project Group and the O-RAN Alliance have helped to generate and marshal support for this approach to mobile access networks. The survey shows strong, but not unequivocal, support for open RAN, with 18% saying it is a "critical strategic priority." The 44% of respondents **(Fig 11)** who said it is "important" are significant, but this falls short of whole-hearted endorsement. The combined 38% that said open RAN is only "somewhat important" (33%) or "not important at all" (5%) shows that there remain a decent number of people still to be convinced.

Fig 10. How much of your RAN footprint will be running 5G access, within the next two years? (N=154)



- Less than 25% **34%**
- 25 - 50% **49%**
- 51 - 75% **10%**
- More than 75% **7%**

Fig 11. How important will "Open RAN" and "white box radio" be to your network within the next two years? (N=154)



- Critical – it's a strategic priority **18%**
- Important **44%**
- Somewhat important – but it's not a priority **33%**
- Not important at all **5%**

"INITIATIVES SUCH AS THE TELECOM INFRA PROJECT (TIP) OPENRAN PROJECT GROUP AND THE O-RAN ALLIANCE HAVE HELPED TO GENERATE AND MARSHAL SUPPORT FOR THIS APPROACH TO MOBILE ACCESS NETWORKS."

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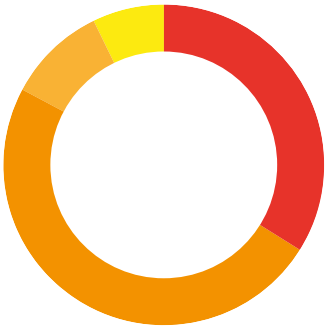
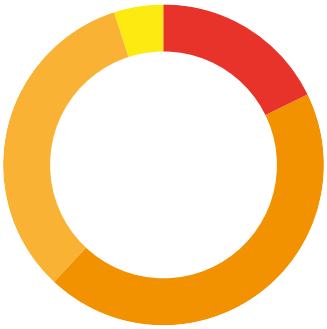
Fig 12. For multi-vendor Open RAN deployments, which of the following do you see as the biggest challenge? (N=153)



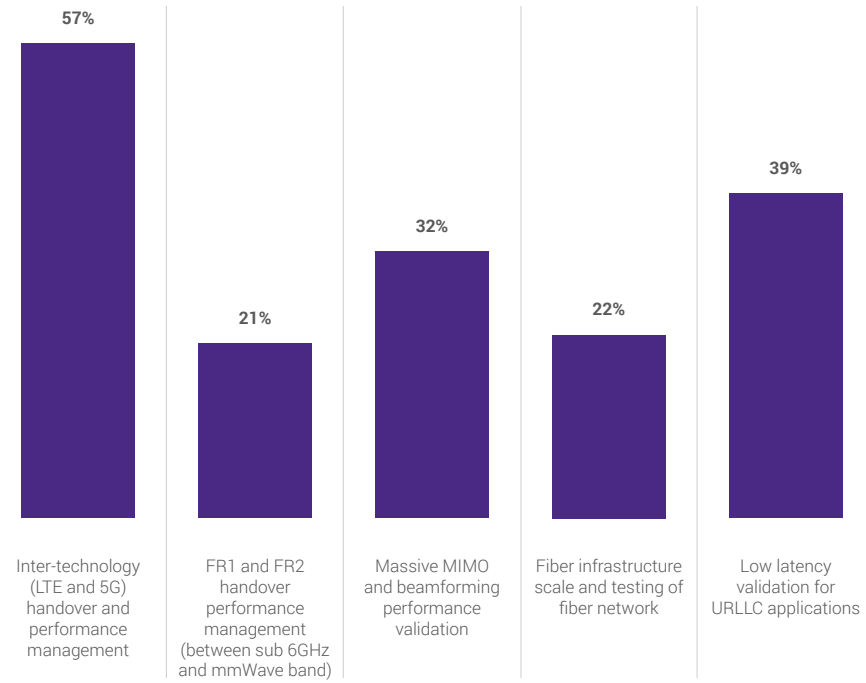
- Functional and protocol compliance **35%**
- Systems performance and robustness **39%**
- Maintenance and daily operations **26%**
- Other **1%**

Fig 13. From a 5G RAN perspective, do you see field testing as a bigger challenge than LTE technology? (N=153)



- Yes, 5G RAN field testing is significantly more challenging than LTE **31%**
- Yes, 5G RAN field testing is somewhat more challenging than LTE **54%**
- No, it's about the same **14%**
- No, 5G RAN field testing is less challenging than LTE **1%**

Fig 14. What aspects of 5G field testing are your greatest concerns? (select up to two) (N=153)



"EXPECTATIONS FOR 5G COVERAGE ARE CRITICAL TO EVERY PLAYER IN THE ECOSYSTEM AND EVERY PROSPECTIVE CUSTOMER."

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Perceptions of challenges around open RAN are addressed in **(Fig 12)**. Most notable is that responses are fairly evenly divided, with "system performance" (39%) just ahead of "functional compliance" (35%) and third placed "daily operations" (26%) not a million miles behind. This indicates the challenges are holistic in nature; therefore, the solutions will likely be found at the system level.

Turning to RAN field testing, the survey asked if 5G RAN testing is a bigger challenge than LTE **(Fig 13)**. A reasonable assumption, given 5G introduces another RAN layer, with significant flexibility in how it is configured and deployed, would be that it increases complexity and field test challenges. The survey results bear out this view. About a third (31%) said 5G RAN is "significantly more challenging" and over half (54%) said "somewhat more challenging." This indicates that 5G RAN testing is considered a stiff challenge, but not an insurmountable problem.

Looking more deeply into 5G RAN field testing shows that "inter-technology handover between LTE and 5G" is considered the greatest challenge by 57% of respondents **(Fig 14)**, ahead of "validation of low latency URLLC applications" at 39%. This is consistent with early experiences of network operation where 5G is deployed in NSA mode, with the control plane anchored on LTE and the user plane split between the LTE and 5G bearers on the downlink (and sometimes uplink). Inter-technology operation is inherent to NSA, and there are many examples of it being challenging to implement, monitor, and optimize. In time, as operators become more familiar with inter-technology operations, and as operators move to SA mode, this challenge may moderate and other challenges will come to the fore. Massive multiple input, multiple output (MIMO)/beamforming and URLLC testing are likely to rise up the list of concerns as these technologies are introduced more widely and scaled for the mass market. ■

VIAVI Solutions

As standards continue to evolve and 5G is deployed in more and more cities across the world, it is clear that the new 5G radio access network (RAN) – whether it is deployed non-standalone (NSA) or standalone (SA) – is the fundamental piece of the 5G puzzle. If we look back at traditional 3G/4G networks, there is clear delineation between RAN and core. The eNodeB in the RAN in 4G, for example, connects with a service gateway in a centralized core. With 5G, however, there is a need for a more flexible, liquid, and virtual open RAN architecture – and one that is more adaptive and intelligent.

New interfaces are created that offer access points to data intelligence as we move to a disaggregated 5G RAN architecture. Protocol layers are split across the various network elements to satisfy cost and flexibility. With mobile edge computing (MEC), you may now find that the application service is much closer to the edge (for low latency applications, for example). The user plane function that you typically would have access to at the core will now be accessed in the RAN. In addition, previous RAN technologies have always been cell-centric – that model starts to disappear with 5G as we move to a 3D beam-centric model with both coverage and users beams. Dynamic spectrum sharing (DSS) is also being used by service providers to find a balance between coverage and throughput. So, with 5G, the RAN truly has become the new core.

5G CORE NETWORK

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

The core network controls user sessions, authentication, policy, and mobility. It also connects to external networks such as the internet, to cloud providers, and into enterprises. It is therefore critical to the 5G system architecture and the 5G service offer. The major story in 5G core is the introduction of SA mode alongside NSA. NSA uses a 4G core with a combination 4G/5G access and is in all commercial networks launched to date. SA uses a 5G core and is not yet commercial. Deployment and scaling of SA is a multi-year process that affects devices, RAN, transport, and telco cloud strategies.

KEY TAKEAWAYS:

Almost one-third of respondents (30%) said they "strongly agree" with the view that a 5G core is necessary to capture the full benefits of 5G, up from 14% in Heavy Reading's 2019 survey. By far the largest respondent group, however, is the 59% that "agree" with the statement, but not "strongly."

A lead cohort (16%) expect to start 5G SA operations before the end of 2020. By the end of 2021, over half of respondents expect their employer to have deployed 5G core and introduced SA mode.

Most operators will use "two or three vendors" in their 5G core. With a score of 47%, this is the favored option by some distance relative to "multiple best-of-breed vendors" (26%) and "likely to use a single vendor" (11%).

A combined 82% said they will deploy 5G core in virtual machines (VMs), either as virtual network functions (VNFs; 40%) or as containerized applications in VMs (42%). This is probably because operators now have stable telco cloud platforms based on virtualized infrastructure. A minority (18%) indicated their company will go direct to a cloud-native model with containerized applications on bare metal.

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5G Core Network

To test the importance of SA mode and 5G core, Heavy Reading asked respondents to what extent they agreed or disagreed with the following statement:

"It will be difficult to offer the full range of 5G services in NSA mode using a 4G core; we need a 5G core to capture the full benefits of 5G."

Almost a third (30%) said they "strongly agree" with this view **(Fig 15)**. This is a high number but lower than Heavy Reading's expectations. It is, however, up from the 14% that agreed with the statement in the 2019 survey. Note also that the RoW region is more likely to "strongly agree" (40%) than U.S. respondents (24%). By far the largest response is the 59% that "agree" with the statement, but not "strongly." There are a number of plausible reasons for this "agree but not strongly" view. In particular, some operators will likely converge the 4G and 5G core to the extent that new functionality is introduced but an entirely new core is not necessarily deployed.

The timeframe in which operators deploy 5G core and can support SA operation is important to understand the rate at which certain types of advanced services can be introduced. The survey **(Fig 16)** shows a lead cohort (16%) expect to start SA operations before the end of 2020. This aligns with public comments from large U.S. operators and one or two elsewhere, notably China, South Korea, and the Middle East. In Heavy Reading's view, it is likely that these 2020 deployments will be small-scale pilots, deployed as preparation for mass-market services over 5G core from 2021 onwards.

The largest respondent group (40%) expects 5G core to be a 2021 event. The take-away is that within 2 years,

Fig 15. **To what extent do you agree or disagree with the following statement: It will be difficult to offer the full range of 5G services in NSA mode using a 4G core; we need a 5G core to capture the full benefits of 5G. (N=151)**

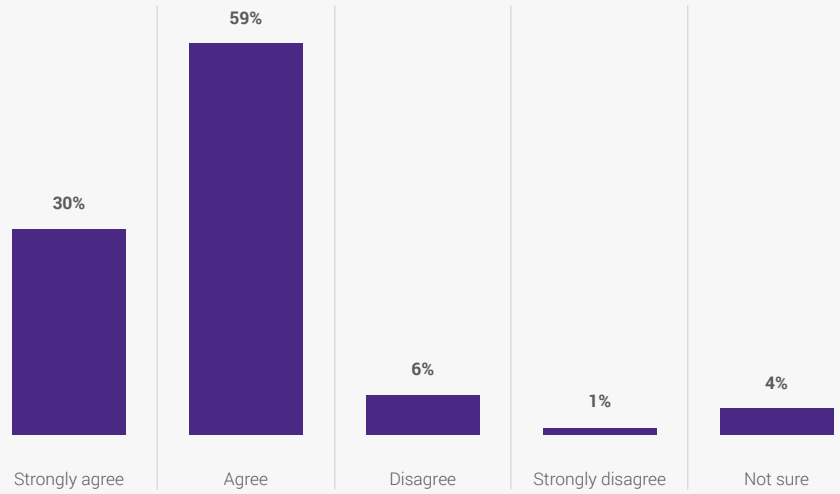
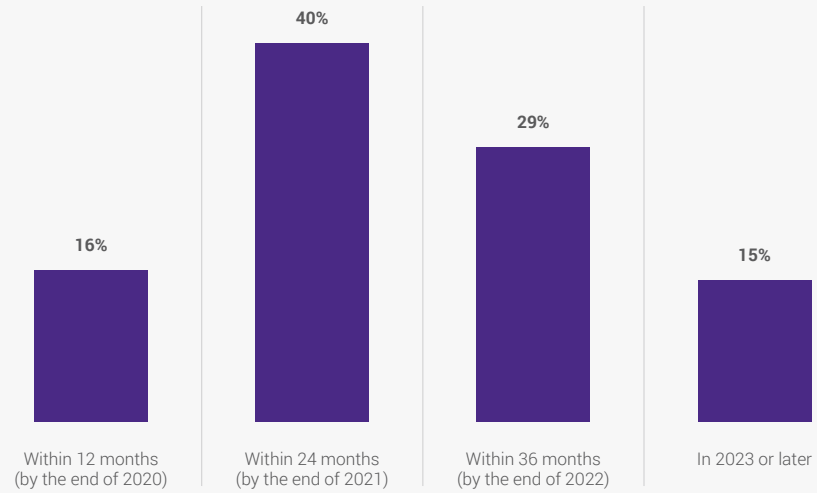


Fig 16. **When do you expect to deploy 5G core and standalone 5G? (N=152)**



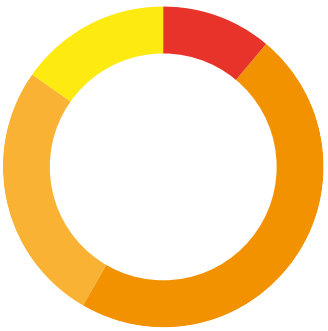
over half of respondents expect their employer to have deployed 5G core. However, the respondent demographics are concentrated on larger operators in advanced economies; 2021 should not be read as a worldwide industry timeline. Even in Europe, 2021 may be a little too aggressive.

Most operators will use "two or three vendors" in their 5G core, according to the survey **(Fig 17)**. With a score of 47%, this is the favored option by some distance against "multiple best-of-breed vendors" (26%) and "likely to use a single vendor" (11%). Depending on definitions, the mobile core comprises half a dozen to a dozen different network functions. Selecting two or three vendors, each providing a few closely coupled functions, is common in 4G. It makes sense the same model would prevail in 5G core.

Only 11% selecting "single vendor" is low relative to what is common today, on a global basis, in 4G core. This could reflect the fact that the survey was primarily taken by larger operators in advanced markets that have the wherewithal and incentive to manage multi-vendor cores. There is also an interesting disparity between U.S. and RoW: just 3% of U.S. respondents selected single vendor versus 23% for RoW.

There is an expectation that the 5G core will be cloud native. Although "cloud native" is not formally defined, it typically means containerized applications (workloads) composed of microservices. These are sometimes called cloud-native network functions (CNFs), as opposed to VNFs. The challenge is that the mobile core has extremely high uptime requirements and must be very stable before an operator will risk large-scale commercial deployment. Failures in the core are the major cause of mobile network outages. Some believe that cloud-native platforms and applications are not yet mature or stable enough for commercial 5G core, even where vendors are ready to offer them. This question **(Fig 18)** tested that supposition.

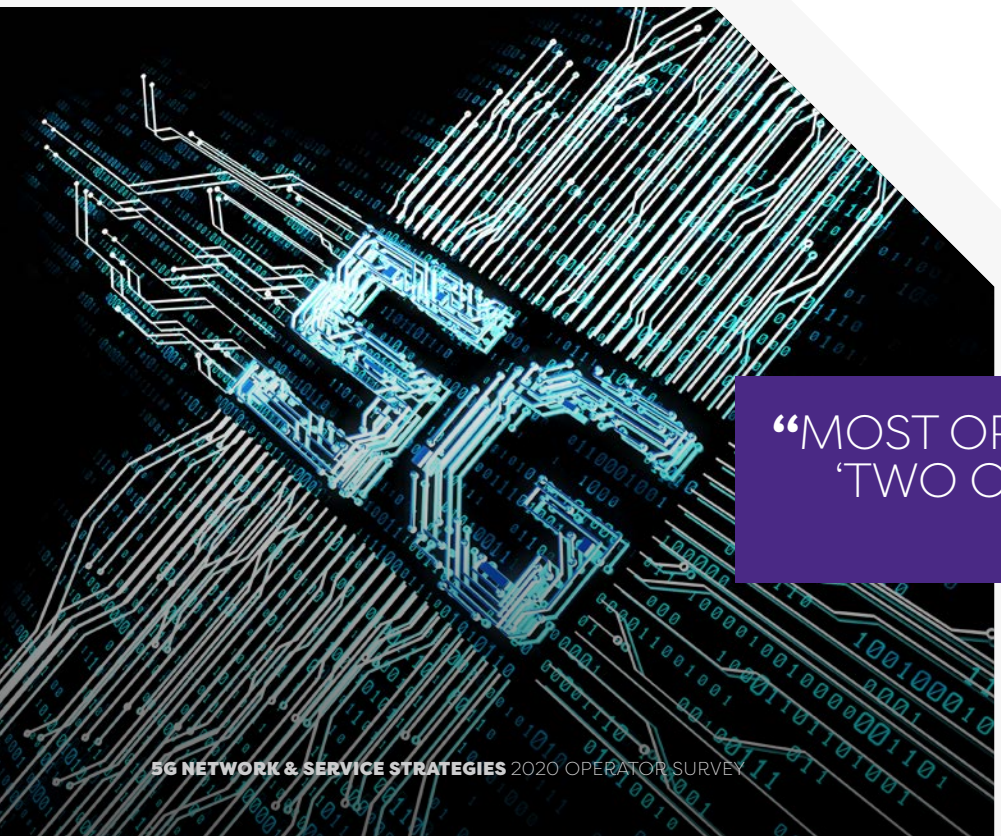
Fig 17. Thinking about your 5G core network, do you plan to assemble the functions that make up the service-based architecture (SBA) 5G core from multiple vendors or from a single vendor? (N=150)



- Likely to use single-vendor **11%**
- Likely to use two or three vendors to assemble a 5G core **47%**
- Likely to use multiple vendors to create a best-of-breed 5G core **26%**
- Don't know / too early to say **15%**

Fig 18. On what technology platform do you expect to deploy your initial 5G core? (N=150)

- As VNFs in VMs **40%**
- As containerized applications in VMs **42%**
- Containerized applications direct to bare-metal with cloud native orchestrator (e.g. Kubernetes) **18%**



"MOST OPERATORS WILL USE 'TWO OR THREE VENDORS' IN THEIR 5G CORE"

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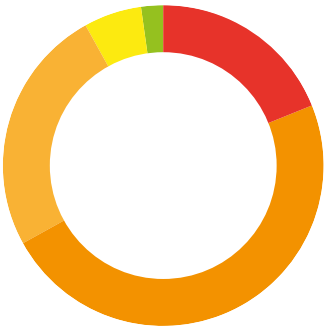
When asked on what technology platform they expect to deploy their initial 5G core, a minority (18%) of respondents indicated their company would go direct to a cloud-native model with CNFs deployed on bare metal.By far the larger group was the combined 82% that said they would deploy 5G core in VMs, either as VNFs (40%) or as containerized applications in VMs (42%). This preference is probably because operators now have stable, scalable telco cloud platforms based on virtualized infrastructure that will allow them to deploy 5G core faster, and at lower risk, than going direct to containers and bare metal.

One of the defining features of 5G, and one that that depends on having a 5G core, is network slicing. Heavy Reading asked **(Fig 19)** how attractive network slicing is as a commercial proposition, with the added qualifier of the business case. This qualifier is important because a lot of people like the idea of network slicing but may not be convinced that it can be implemented, marketed, and sold effectively.

19% said their company views networks slicing as "very attractive with a strong business case," while 48% said it is "attractive and we think there's a good business case, but are not certain." Heavy Reading interprets this to mean the majority want network slicing to work and be commercially successful and are reasonably optimistic it will be but have some doubts. It is also revealing that only 8% said it is "not attractive." ■

Fig 19. How attractive is Network Slicing as a commercial proposition for your company? (N=151)



- Very attractive – there's a strong business case...**19%**
- Attractive – we think there's a good business case, but are not certain **48%**
- Quite attractive – but we're not sure of the business case **25%**
- Not attractive – there is limited commercial opportunity **6%**
- Not attractive at all **2%**

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The 4G Evolved Packet Core (EPC) is significantly different from the 5G core, with the 5G core leveraging virtualization and cloud-native software design at unprecedented levels. The new 5G core, as defined by 3GPP, utilizes cloud-aligned, service-based architecture (SBA) that spans across all 5G functions and interactions, including authentication, security, session management, and aggregation of traffic from end devices. The 5G core further emphasizes network function virtualization as an integral design concept with virtualized software functions capable of being deployed using the multi-access edge computing infrastructure that is central to 5G architectural principles.

Test tools are required that support the development of virtualized functions in mobile edge architecture; offer an end-to-end testing solution from RAN through the edge to the mobile core; and stress test the impact of RAN traffic on the core network. Service providers need to prepare their networks for the demands of a massive number of connections through the Internet of Things (IoT) while also coping with bandwidth-hungry, delay-sensitive edge applications such as augmented reality.

5G EDGE CLOUD

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

To deliver consistent performance in 5G networks, and low latency ultra-reliable services in particular, it is widely expected that operators will need edge cloud infrastructure. Hosting applications and content closer to the "user" should improve the service experience and enable high performance applications that are impractical, inconsistent, or not possible using only large, centralized cloud infrastructure.

KEY TAKEAWAYS:

There is no single motivation to deploy edge cloud infrastructure that stands out, but rather, several reasons – each with solid support. **To illustrate, "ensuring application performance" scores highest in terms of the primary motivation with 32%,** ahead of "differentiated communications services," which scores lowest at 19%.

Operators are making progress on their edge cloud deployments. "Developing" scores highest, followed by "early stages" in respondents' self-assessment of their progress. Less than 20% said they have "not started," and in all but one case, fewer than 20% claim their deployment as "mature." This indicates the rollout of edge cloud infrastructure is well underway in advanced operators but far from finished.

At the edge, operators expect to support both containers and VMs now and in the medium term. Consistent with the prior finding on 5G core, **the conclusion is that edge cloud infrastructure must support multi-mode workloads.**

A majority (71%) expect to support less than 100 edge cloud locations in 2020. Looking ahead to end-2023 – i.e., 4 years from now – the picture changes. At this stage, a majority of operators expect to support more than 100 edge cloud locations, but less than 1,000. U.S. respondents selected higher numbers of locations than their peers in RoW, both now and in 2023.

5G Edge Cloud

In an attempt to identify respondents' primary motivation for edge cloud deployment in 5G networks, the first question in this section **(Fig 20)** allowed only one answer. The result shows there are several reasons, each with solid support and no clear winner. "Ensuring application performance" scores highest at 32%, followed by "vertical industry services" at 28%. These two options in combination account for 60%. The percentage of respondents that are more focused on operators' internal priorities (21% "reduced transport cost" and 19% "differentiated communications services") is lower at 40%, but not by a huge amount.

Fig 20. What is your PRIMARY motivation to move workloads to the edge? (N=143)

- Reduce bandwidth use/cost **21%**
- Offer differentiated communications services (vs competitors) **19%**
- Offer vertical industry services (e.g. in-vehicle scanning for ambulances, advanced real-time analytics for investment banking) **28%**
- Ensure application performance **32%**

Given the evenness of response, the conclusion is that the investment case for 5G edge cloud will require operators to pursue multiple motivations simultaneously.

The next question **(Fig 21)** asked about the stage of development of operators' edge cloud deployments. In all cases, "developing" scores highest, followed by "early stages"; less than 20% have "not started." In all but one case (network virtualization), less than 20% claim their deployment as "mature." The clustering of response around the middle options indicates the rollout of edge cloud is well underway in advanced operators, but far from finished.

U.S. respondents were slightly more likely to select "mature" than their RoW counterparts. However, only in the categories of "containerized network functions" and "containerized workloads" was this significant – to the tune of a 10% higher score. This may indicate U.S. operators are a little more advanced than peers elsewhere.

Asked about the risks of running different types of workloads at the edge **(Fig 22)**, most respondents view edge cloud as "moderately risky" for nearly all workloads, with security at the edge considered more severe. A third (35%) believe edge security presents "extreme risk." Quality control and cost control are considered somewhat less risky aspects of edge cloud deployment, perhaps because respondents feel these are issues operators are already familiar with when designing and deploying new infrastructure.

One might argue that the inclusion of the word "risk" in the question led respondents to express greater concern about security than they might have otherwise. However, security is highlighted elsewhere in the survey as a primary concern. For example, "security" was identified as the biggest risk of working with external cloud providers to provide enterprise 5G services.

The transition to virtualized and cloud-native telecom networks must consider the infrastructure on which workloads will run. This question **(Fig 23)** asked specifically about the edge and the mix between containers and VMs in 2020 and 2023. The straightforward analysis of the response is that operators expect to support both VMs and containers now and in the medium term, which leads to the conclusion that edge cloud

Fig 21. Where is your organization in its rollout of edge cloud capabilities? (N=140-144)

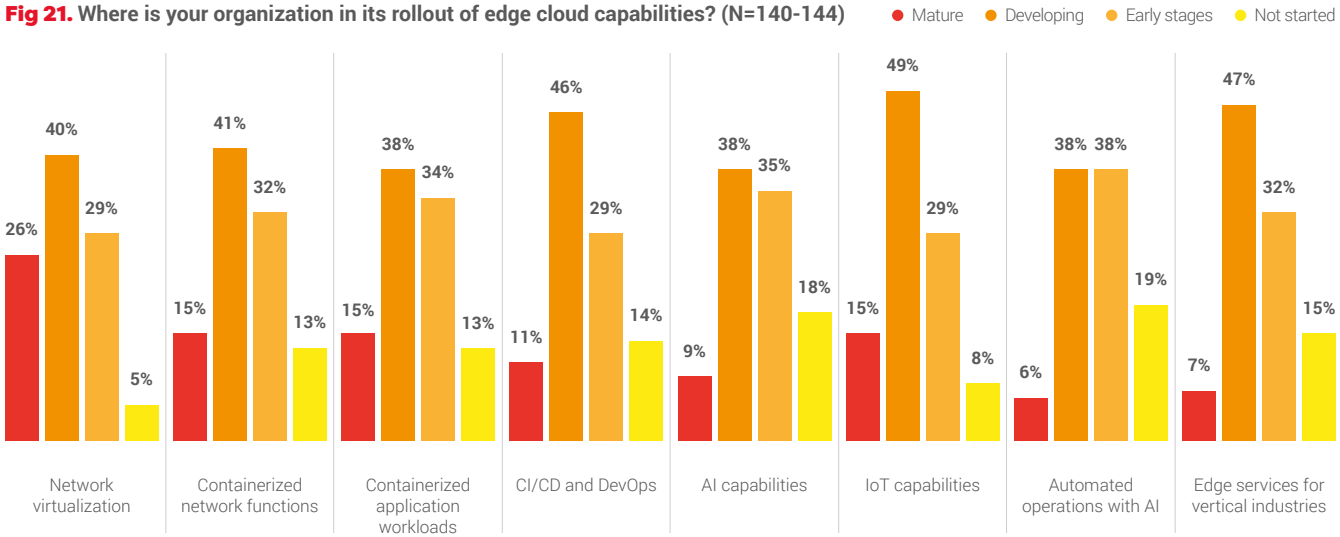


Fig 22. How much risk is involved in running more of the following workload at the edge? (N=143-144)

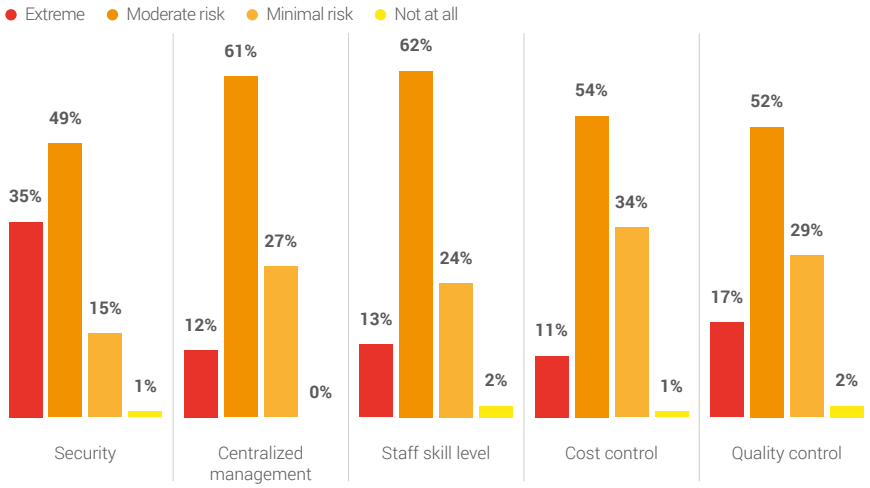
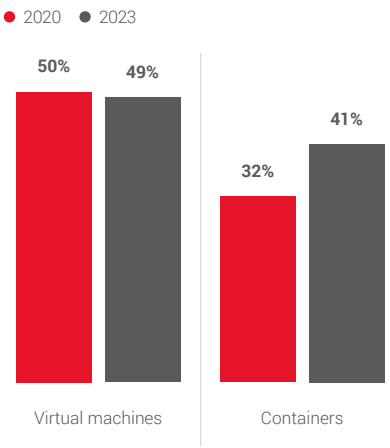


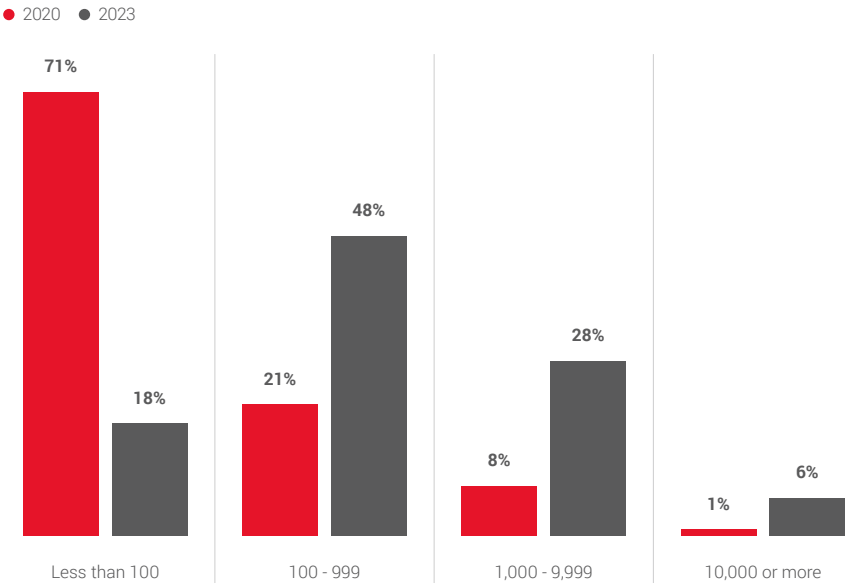
Fig 23. What percentage of your edge workloads will you run in virtual machines or containers? (N=137-144)



infrastructure platforms will be multi-mode. This finding is consistent with the response to the 5G core variation of this question in the section above, where it was established that a majority of operators (82%) would deploy 5G core using both VNFs and CNFs.

One of the most common discussion points in telco edge cloud in the past few years has been: How many locations will operators deploy? Heavy Reading asked respondents **(Fig 24)** for their views in 2020, and then in 2023. The first finding is clear: a majority (71%) expect to support less than 100 edge cloud locations this year, which indicates larger facilities serving larger numbers of users will prevail in the near term.

Fig 24. How many network edge cloud locations do you support now, and will support in 2023? (N=141-143)



Looking ahead to 2023 – 4 years from now – the picture changes. At this stage, a majority of operators expect to support more than 100 edge cloud locations, with 48% saying between 100 and 999 locations, and 34% more than 1,000. However, this also means a majority expect to have less than 1,000 locations in 2023, given 18% will still have less than 100 locations. Thus, operators likely expect to take an assertive, but also phased and measured, approach to edge cloud deployment in the medium term.

The basic pattern is the same for U.S. and RoW respondents. Note, however, that U.S. respondents selected higher numbers of locations than RoW in both time periods. For example, 35% of U.S. and 18% of RoW respondents expect to have between 1,000 and 9,999 locations in 2023. ■

ORACLE

5G MONETIZATION & NETWORK SLICING

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

Monetization of network assets via services is one of the primary goals of mobile operators. This section focuses on 5G monetization, with reference to network slicing, enterprise services, and public cloud partnerships. These topics inevitably raise questions about the role of operators in the value chain, where value accrues, and how investment in network infrastructure is rewarded.

KEY TAKEAWAYS:

Operators continue to see themselves at the top of the value chain for network services (selected by 52% of respondents). Perhaps more interesting is that almost as many (50%) selected "value-added channel for partner products." In other words, operators are now self-identifying as distribution platforms. This shows operators are becoming more inventive in terms of how they contribute value to customers and the wider ecosystem in the 5G era.

The 38% that want to be a "partner to specialized systems integrators" also represents new thinking by operators about their role in the ecosystem. It suggests that in 5G, they believe they can help generate greater overall value by taking a secondary role in the customer engagement in some circumstances.

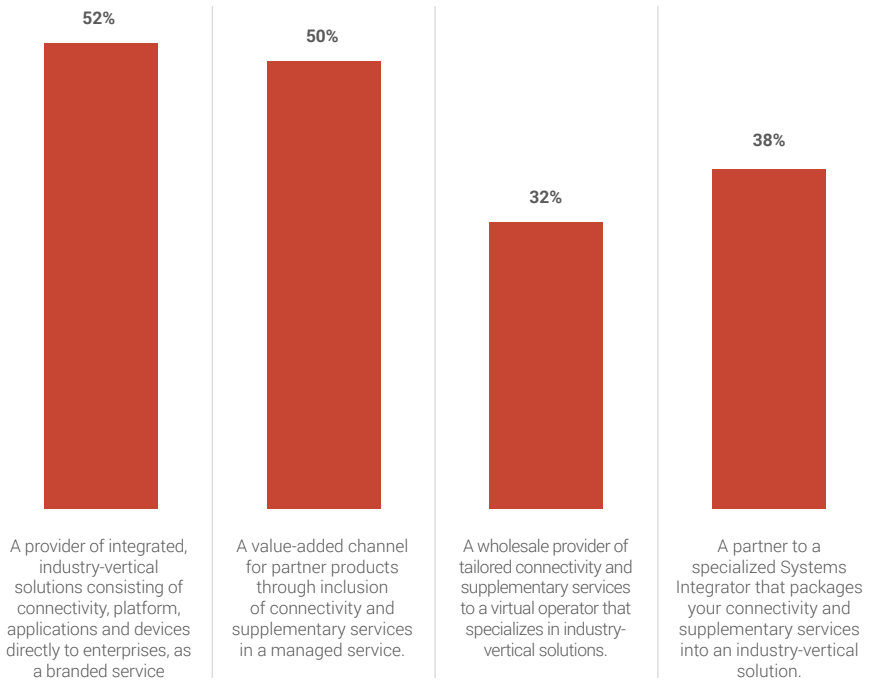
A majority of operator respondents think it likely they will integrate public cloud software as a service (SaaS) offerings into their enterprise 5G services. **A lead cohort of 18% said they have a "plan to do this" or are "already doing it" and 40% said they will "probably pursue this in the medium term."** This positive stance to working with cloud providers is also seen in recent publicly announced partnerships.

ORACLE

5G Monetization & Network Slicing

Heavy Reading asked how operators see their role in the wider communications ecosystem **(Fig 25)**. This was a "select all that apply" question (that generated 244 responses from 142 respondents for an average of 1.7 responses per survey taker) to reflect that operators do not have to choose one single role but can pursue diverse strategies. The lead option, with 52%, is the operator as a "value-added provider of vertical industry solutions." This is the operator self-identifying as the creator of services – and associated value – and is representative of how operators have classically seen their roles at the top of the value chain. In this sense, respondents expect to evolve, and advance, a similar business model in the 5G era.

Fig 25. What role(s) do you expect your company to play in the communications ecosystem within the next 12 to 18 months? (select all that apply) (N=142)



Perhaps more interesting is that almost as many respondents (50%) selected the "value-added channel for partner products" option. In other words, they think the operator will become a value-added distribution platform. This signals a significant change in operator self-perception and shows operators are becoming more inventive in the 5G era in terms of how they contribute value to customers and the wider ecosystem. Distribution is an undoubted strength of telecom operators, and one can argue that recent partnerships with consumer video and gaming companies and among enterprise cloud providers show this is already taking root.

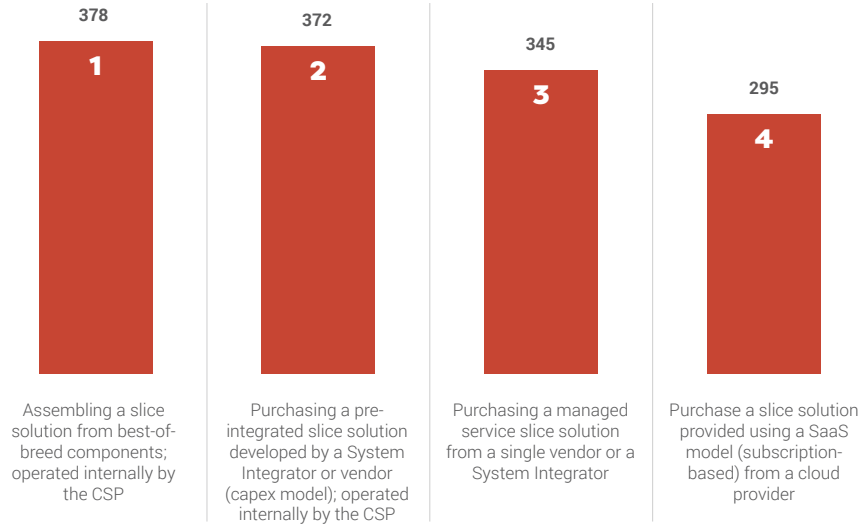
The 38% that want to be a "partner to specialized system integrators" also represents new thinking by operators on their role in the ecosystem. It suggests operators believe they can generate greater overall value for their customers, and themselves, by taking a secondary role in the customer engagement. Heavy Reading believes working with specialist integrators, with experience of different industrial sectors, will be important for operators to extend 5G into new markets. On this premise, the operator calculation may be that taking a lesser role in more opportunities will result in an overall larger addressable market. Heavy Reading tends to think this will play out more fully beyond the 18 months asked about in this question.

A prior question established that operators are reasonably optimistic about network slicing. In the next question **(Fig 26)**, Heavy Reading sought to determine which procurement models operators might use to create the platforms on which they can offer slice-based enterprise services.

The lead response is "assembling a slice solution from best-of-breed components" with a weighted average score of 378. Purchasing a "pre-integrated slice solution developed by a systems integrator or vendor" scores surprisingly highly in second, perhaps indicating that operators will select large parts of the slice solution from a single vendor. Given the complexity of network slicing, this has obvious appeal.

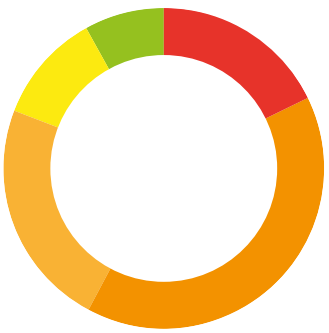
Operators appear less keen to move to an opex model where they connect to a managed service offered by a systems integrator. They seem even less keen to connect to a SaaS-based network slice solution offered by a cloud provider. The relatively lower weightings for the opex-based models can be explained by the fact that operator accounting, in general, prefers capex to opex.

Fig 26. What procurement models do you see as most important in achieving your business objectives for offering a slice-based enterprise solution? Please rank in order of importance (1 = Most important and 4 = Least important). (N=139)



Ranking Score (The score is calculated by assigning a weight to each rating where the highest priority rating holds the highest weight.)

Fig 27. Do you expect to integrate public cloud SaaS offerings into your 5G enterprise network services offer? (N=141)



- Yes, we have a plan to do this / already doing this **18%**
- Probably – this is likely in the medium term **40%**
- Probably – in the longer term **23%**
- Not likely – no plans at present **11%**
- Don't know **8%**

The fact that solutions provided by cloud providers scores lowest is expected in the sense that some operators, particularly in the U.S., see brand name hyperscalers as competitive and may not want to move core network functions (in this case, the slice platform) to these third parties. This is, however, an area where Heavy Reading believes operators may reconsider their approach as the attractions of SaaS-based core networks and network slicing solutions become better known for certain service types – for example, private networks. An opex-centric model may work to their advantage for specialist, advanced enterprise services because it will broaden their reach without a large upfront investment.

Moving away from network slicing platforms, but staying with public cloud partnerships, a majority of respondents think it likely they will integrate public cloud SaaS offerings into their enterprise 5G services **(Fig 27)**. A lead cohort of 18% said they have a "plan to do this or are already doing it" and a larger 40% said they will "probably pursue this in the medium term." This generally positive stance to working with cloud providers to offer enterprise 5G is consistent with Heavy Reading's finding above that operators are keen to become value-added distribution platforms and ecosystem managers. This model has also been seen in real-world business activity, with a number of such partnerships already publicly announced. We expect partnerships between operators and cloud providers to be a major industry theme in 2020.

Concerns around working with cloud providers center on security.

Fig 28. **What are your primary concerns around consuming public cloud SaaS offerings (e.g., Core Network-as-a-service hosted in a public cloud)? Please rank in order of concern (1 = Most concern and 5 = Least concern). (N=141)**

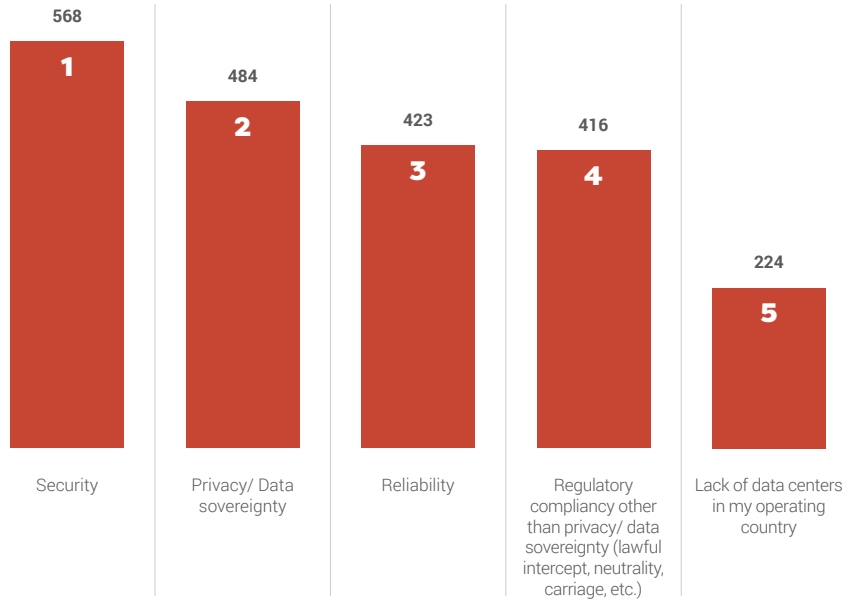
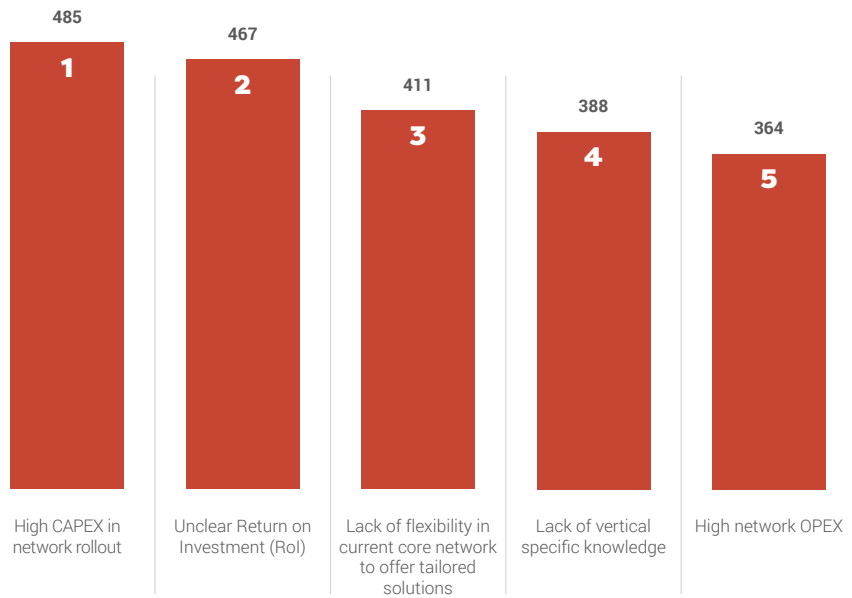


Fig 29. **What are the main obstacles to expanding B2B vertical offerings, including both 4G and 5G use cases? Please rank in order from most to least challenging (1 = Most challenging and 5 = Least challenging). (N=141)**



Ranking Score (The score is calculated by assigning a weight to each rating where the highest priority rating holds the highest weight.)

Asked about consuming public cloud services **(Fig 28)**, "security" received the highest number of "most concerned" responses by some distance (a weighted average score of 568), followed by "privacy and data sovereignty." These related, but not identical, concerns center on the control and integrity of user and application data hosted on the public cloud. This result is unsurprising in the sense that operators are typically cautious about security. It also underlines that some aspects of partnering with cloud providers to create integrated 5G service offers will be challenging.

Consistent with the preference for capex over opex identified above, when asked about the obstacles to expanding enterprise vertical offerings **(Fig 29)**, respondents identify "capex related to network rollout" as the major challenge and "network opex" the least challenging of the obstacles they were presented with. "Unclear return on investment" scores as the second biggest obstacle not far behind capex itself, indicating that it is not only the amount and availability of funding needed to build a 5G network that is of concern, but also the ability earn back investment and make a profit.

Operators seem relatively unconcerned about their "lack of vertical specific knowledge." Perhaps they feel this skill set can be developed as market demand becomes more concrete. There may also be a view that industry knowledge can be acquired or addressed via partnerships. This would be consistent with the finding that operators are seeking more, and deeper, partnerships to address the enterprise 5G market. ■

> “HEAVY READING BELIEVES WORKING WITH SPECIALIST INTEGRATORS, WITH EXPERIENCE OF DIFFERENT INDUSTRIAL SECTORS, WILL BE IMPORTANT FOR OPERATORS TO EXTEND 5G INTO NEW MARKETS. ”

ORACLE

While 5G can unlock new value for service providers, there needs to be a serious rethink about how to move beyond connectivity with app-specific networks or “slices” that can help enterprises capitalize on Internet of Things (IoT), artificial intelligence (AI), blockchain, robotics, and other transformational technologies. Service providers can be enablers to connected, secure, and smart end-to-end ecosystems by building dedicated solutions tailored to industry-specific use cases.

No doubt this is a daunting task for service providers. Some of them will have to reinvent themselves to stay relevant to the emerging trends, regulations, and business models of the respective industries they are serving.

They can only do that with agile IT practices like cloud native and DevOps, which will help them embrace the multi-cloud environments so critical in the digital era of smart end-to end ecosystems. In addition, network as a service (NaaS), cybersecurity, and data integrity will be needed to cost-effectively optimize resource utilization and ensure protections from ever expanding threats.

Oracle’s heritage in IT, core networks, business apps, data privacy, and security can help service providers play a more significant role. Oracle is elevating security to new heights with autonomous systems and self-driving, self-securing, and self-repairing core attributes. Oracle also is helping service providers unlock business value by developing core network slices, IoT cloud services, and enterprise software as a service (SaaS) applications that leverage highly secure customer data, AI-driven connected intelligence, and IoT-driven use cases.

With Oracle as an ecosystem partner, service providers will move up the stack and deliver the value enterprises need in today’s digital marketplaces.

Radisys

5G ENTERPRISE SERVICES

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

One of the big ideas that informed the specification of the 5G system is that it would enable operators, and vendors, help their customers optimize business processes and introduce new ones. In this way, 5G becomes integral to production and operating processes in adjacent industries and greater value is generated.

KEY TAKEAWAYS:

A majority of respondents expect enterprise to increase in importance to some degree. **11% expect "a strong swing to enterprise in the short term"; however, a majority 57% expect a "strong swing to enterprise in the longer term."** A further 20% expect a "small swing to enterprise."

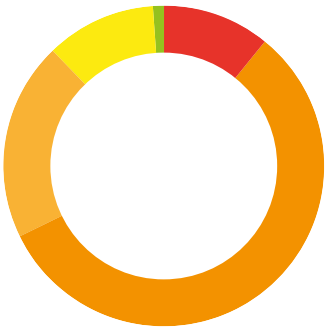
The majority (66%) agree with the statement that "monetizing 5G deployments will be very difficult over the next 5 years." Of these, 15% "strongly agree" and 51% "agree." In other words, operators believe they have a big challenge ahead of them. To put a positive spin on this, the result at least shows operators are realists, not fantasists.

A solid 37% expect to introduce network slicing to their wide-area 5G networks in the next 2 years. U.S. respondents appear more likely than RoW respondents to launch services, with scores of 42% to 31%, respectively. However, close to half of respondents (55%) do not expect to launch network slicing within that

5G Enterprise Services

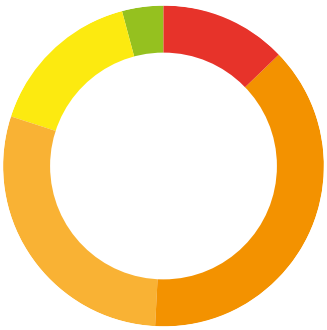
Heavy Reading sought to gauge the extent to which operators think that the enterprise market will grow in importance in 5G relative to the consumer market. Overall, the picture is that a majority expect enterprise to increase in importance to some degree **(Fig 30)**. A small 11% expect a "strong swing to enterprise in the short term"; however, a majority 57% expect a "strong swing to enterprise in the longer term." A further 20% expect only a "small swing to enterprise."

Fig 30. **Do you think 5G will increase the focus on the enterprise sector at your company? (N=141)**



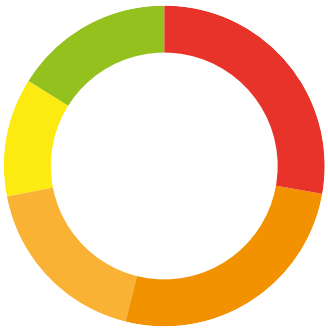
- Strong swing to enterprise – in the short-term... **11%**
- Strong swing to enterprise – in the longer-term. **57%**
- Small swing to enterprise..... **20%**
- Enterprise & consumer will remain the same..... **11%**
- Enterprise will decline in importance..... **1%**

Fig 31. **How likely are you to deploy '5G for Enterprise' use cases over the next 2 years? (N=141)**



- Already deploying..... **13%**
- Yes, will start to deploy..... **38%**
- Yes, probably..... **29%**
- Not sure, still considering deployment options... **16%**
- No, not likely..... **4%**

Fig 32. **What is the primary business problem(s) 5G will solve for your enterprise customers in 2020? (N=141)**



- Increase network capacity enabling high-bandwidth applications **28%**
- Enable higher speeds to end users/end points... **26%**
- Enable lower latency enterprise applications..... **18%**
- Increase business process automation..... **12%**
- Reduce operational business costs..... **16%**

This strong preference for enterprise is somewhat surprising to Heavy Reading because, to date, the consumer sector is making the running in 5G. Media, entertainment, and gaming have a more direct path to market and monetization and a faster ramp-up in product volume. Enterprise services are generally a more complex propositions with lengthier implementation cycles; this may be why respondents, while positive on enterprise, emphasized the longer-term outlook.

Consistent with that positive view, a majority (51%) of operators expect to launch 5G enterprise services over the next 2 years **(Fig 31)**, made up of 13% who said their company is "already deploying" and 38% who said they will "start to deploy" in that timeframe. Two years is not far in the future; this finding indicates developing a 5G enterprise offer is already a priority, if not yet urgent.

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"ONE OF THE BIG IDEAS THAT INFORMED THE SPECIFICATION OF THE 5G SYSTEM IS THAT IT WOULD ENABLE OPERATORS, AND VENDORS, HELP THEIR CUSTOMERS OPTIMIZE BUSINESS PROCESSES AND INTRODUCE NEW ONES."

In terms of what problems 5G will solve for enterprise customers in 2020 – i.e., in the very short term – the results are consistent with Heavy Reading's findings in the introduction that it will be about capacity and speeds. For example, the ability to support high bandwidth applications leads with 28% of the response **(Fig 32)**. Examples of this type of service might include connected video cameras or fixed wireless access to branch offices. It would be interesting to track sentiment toward this question in next year's survey to see if operators start to place more emphasis on, for example, process automation enabled by 5G.

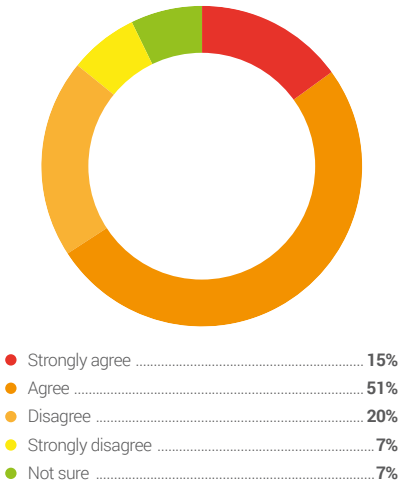
In the previous section on monetization, Heavy Reading investigated the value chain and the roles operators play in the ecosystem. This question **(Fig 33)** is more direct and asked respondents to what extent they agreed with the following statement:

"Monetizing 5G deployments will be very difficult over the next 5 years."

A laudable 27% disagree with the view monetization will be difficult, of which 7% "disagree strongly" and a larger 20% merely "disagree." The majority (66%), however, agree with the statement – 15% "strongly" and 51% "agree" – which shows operators believe they have a big challenge ahead of them. There were no significant regional differences in the response, suggesting it is a broad-based view. To put a positive spin on this, the result at least shows operators are realists and not fantasists.

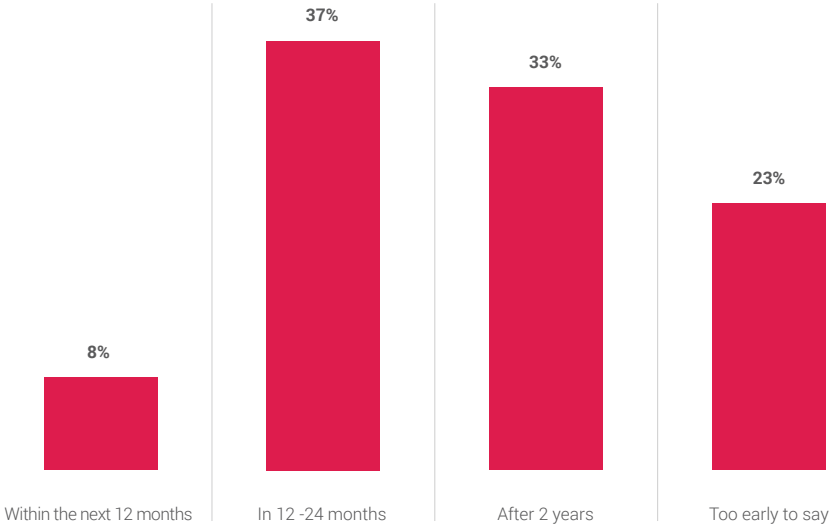
Heavy Reading previously asked about sentiment toward network slicing and how operators might build slicing service platforms. The next question **(Fig 34)** asked more directly: When will you introduce services commercially? It specified network slicing in the public wide-area network to distinguish from deployments where slicing is used in local-area or campus-area networks, which would be less challenging. Over half of respondents (55%) do not think they will launch slicing within 2 years, with 23% indicating "too early to say" and 33% "after 2 years." However, a solid 37% do expect to introduce network slicing in 12-24 months. U.S. respondents are slightly more positive and more likely to select 12-24 months than RoW, with scores of 42% and 31%, respectively. The take-away is that network slicing will take some time to be commercially introduced, but it is not something that can be relegated to the far distance. ■

Fig 33. To what extent do you agree with the following statement – "Monetizing 5G deployments will be very difficult over the next 5 years." (N=141)



- Strongly agree 15%
- Agree 51%
- Disagree 20%
- Strongly disagree 7%
- Not sure 7%

Fig 34. When do you expect to introduce network slicing services in your wide-area public network? (N=141)



By Neeraj Patel, Senior Vice President and General Manager, Software & Solutions, Radisys

If you turn on the TV, you'll see a lot of advertising campaigns from communications service providers promoting their 5G networks for consumers – detailing their coverage areas and speeds. However, today's mobile subscribers are unlikely to pay more for faster 5G service. The kinds of use cases that will demand the full performance and ultra-low latency capabilities of 5G that are high value opportunities lie in industrial and enterprise settings – those that are connecting machine to machine rather than just person to person. Enterprises represent a whole new customer base with infinite growth potential.

We see tremendous opportunities in the mid-band spectrum bands to architect the 5G network with macro coverage and small cells for densification. Initial deployments will layer 5G into existing LTE networks. Private 5G networks will also play a critical role in delivering high performance in dense environments with massive Internet of Things (IoT) connectivity demands such as a factory floor or shipping port. These private networks open up new business models and revenue-generation streams for service providers.

5G is here. What we do with it will shape our world for generations to come. 5G for enterprise will ultimately define the potential and the reality of the power of 5G.

5G SECURITY STANCE

Author: ***Jim Hodges,*** *Chief Analyst,* ***Heavy Reading***

Without question, CSPs must turn up their security game in 5G. To accomplish this will require not only stepping up monitoring and general vigilance, but also new strategies to mitigate the distributed threat landscape that 5G will introduce.

KEY TAKEAWAYS:

"Encrypting live data" (56%) and "aggressive policy scanning" (55%) are identified as the top two components of an effective 5G security strategy. However, "encryption of stored inactive at-rest data" (48%), "consistent infrastructure provisioning," and "conducting vulnerability tests on platforms" (both 47%) are also key considerations. "Automation" is not far behind (42%).

Many operators are still in the development or pre-implementation phase in terms of executing governance, risk, and compliance management strategies, according to survey responses. **While 28% have mature, implementable compliance strategies, many more have yet to start to implement** (23%) or are still developing plans, either with external partners (21%) or without external partners (11%). Perhaps even more telling is that only 9% of respondents have 5G security strategies in production.

Survey respondents ranked having "trust in the physical hardware" (51%) as the most important security focus area. This was followed by "identity and access management" (40%), "isolation and policy enforcement" (38%), and "visibility into trust status and operations" (35%).

Although many survey respondents believe that secure zero-trust deployment and provisioning are of critical importance, more than half (51%) currently either have "limited familiarity" (37%) or "no familiarity" (14%) with zero-trust concepts. Perhaps even more telling is that as it stands, only 7% of respondents said their company is currently "implementing a zero-trust based security strategy" in commercial deployments.

5G Security Stance

One reason why 5G will necessitate new security strategies is because it will introduce an unparalleled level of data processing, storage, and encryption at the edge to meet extremely tight end-to-end service latency budgets. As a result, respondents **(Fig 35)** expect to adopt a multifaceted strategy that includes focusing on "encrypting live data" (56%), "aggressive policy scanning" (55%), and the "encryption of stored inactive at-rest data" (48%).

In addition, CSPs will continue to focus on the hardware resources of both "physical and virtual platforms" (47%) to ensure adequate resources are available to meet policy enforcement requirements. They also plan to maintain a strong focus on "patching and conducting vulnerability tests" (47%).

Although "automation" ranked sixth (42%), the gap between third and sixth placed priorities is not that significant. In Heavy Reading's view, this confirms that automation is already considered a key component of an effective 5G security strategy.

5G security hinges not only on a strong strategy, but also on flawless execution. Many survey respondents are still in the development or pre-development implementation phase in terms of governance, risk, and compliance management.

This is concerning since Heavy Reading believes 5G is less well suited to a "build first and secure second" strategy that CSPs have used in previous generations of mobile technology. The next question **(Fig 36)**, for example, shows that while 28% have mature compliance that can be implemented, many more have yet to start to implement (23%) or are still developing plans with external partners (21%) or without external partners (11%).

The remaining 18% represent opposite extremes of the spectrum, with 9% having in-production security and 9% without any plans or development activity. In fairness, many service providers have yet to roll out 5G, so they have time to complete development plans and implement. However, Heavy Reading interprets these data points as being less progressive than the pace of 5G deployments will necessitate.

Fig 35. As 5G emerges, with more edge activity and smart devices, how do you plan to evolve your security strategy? (select all that apply) (N=141)

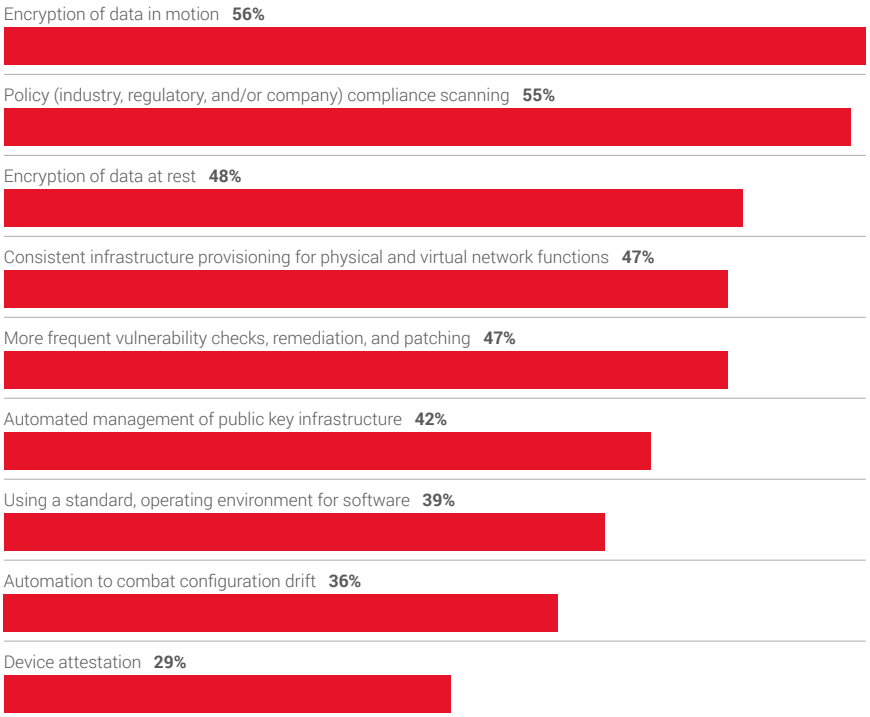
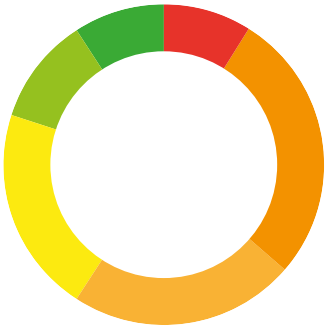


Fig 36.
How mature are your plans for governance, risk, and compliance management within your overall 5G security strategy? (N=141)



- Our 5G security strategy is mature, scalable and in production 9%
- Implementation is underway 28%
- Plans are in place, but implementation has not yet started 23%
- Plans are being developed by/ with external partners 21%
- Plans are being developed without external resources 11%
- No plans in place or in development yet 9%

In addition to governance and compliance, effective 5G security strategies must also consider the infrastructure capabilities on which these policies will run. Essentially, 5G infrastructure must be multi-modal to ensure holistic security coverage.

Based on the "critical" responses, a number of infrastructure areas stand out **(Fig 37)**. Of these, having "trust in the physical hardware" (51%) was considered the greatest concern. This was followed by "identity and access management" (40%), "isolation and policy enforcement" (38%), and "visibility into trust status and operations" (35%). The close rankings of these three areas was not unexpected since 5G networks, particularly the 5G core, are policy-driven and place great emphasis on identity management (both human and non-human) as well as creating specific trust areas to execute sliced-based services.

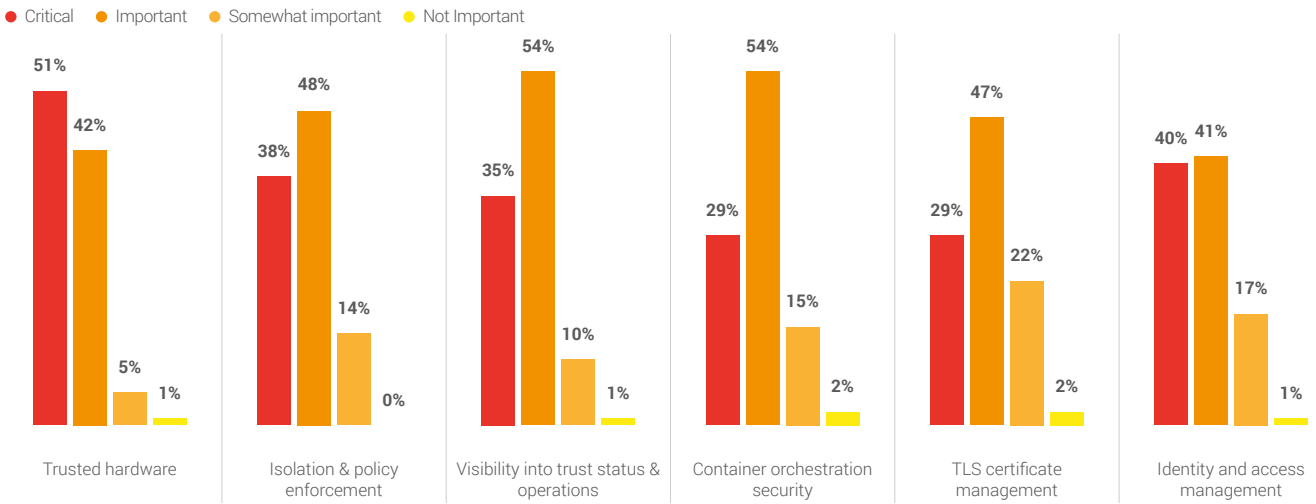
The 5G infrastructure requirements documented above apply to both centralized and edge clouds. However, the edge cloud **(Fig 38)** has unique security requirements related to pushing compliance and risk management to remote devices before they can unleash threat vectors.

Yet, the survey respondents view the technical fundamentals as still very similar in that the foundational focus area continues to be utilizing "trusted hardware" (54%) to ensure policy deployed at the edge is consistent with the "global security posture" (50%).

However, the third- and fourth-ranked attributes – "root of trust for remote devices" (41%) and "integrating edge security best practices with existing security incident procedures" (40%) – do capture that some aspect of the security postures are different at the edge relative to centralized infrastructure.

In order to adequately address edge security requirements, there must also be a strong focus on the management of edge devices. **(Fig 39)** As with security

Fig 37. **For your 5G infrastructure, how important are the following security areas? (N=138-140)**



"WITHOUT QUESTION, CSPS MUST TURN UP THEIR SECURITY GAME IN 5G. TO ACCOMPLISH THIS WILL REQUIRE NOT ONLY STEPPING UP MONITORING AND GENERAL VIGILANCE, BUT ALSO NEW STRATEGIES TO MITIGATE THE DISTRIBUTED THREAT LANDSCAPE THAT 5G WILL INTRODUCE."

Fig 38. How important are the following security capabilities for securing the edge? (N=139-140)

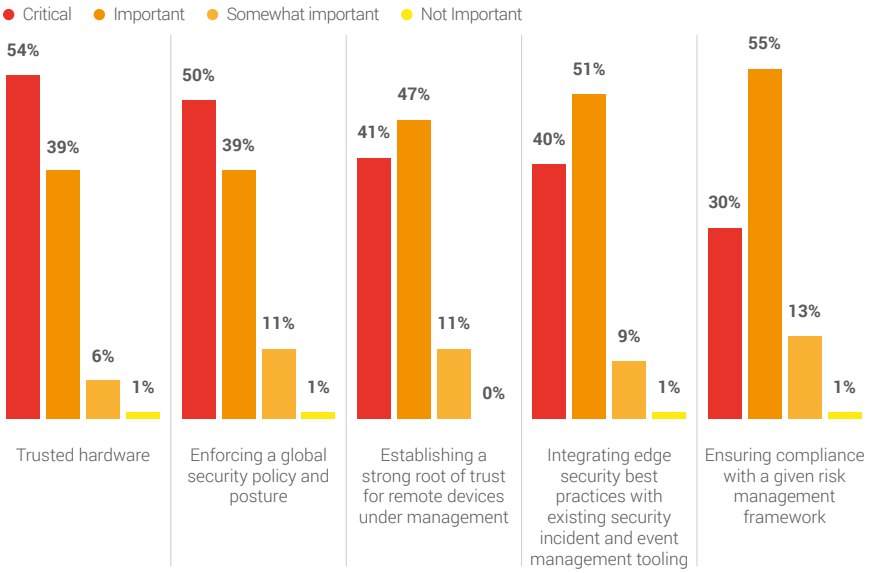
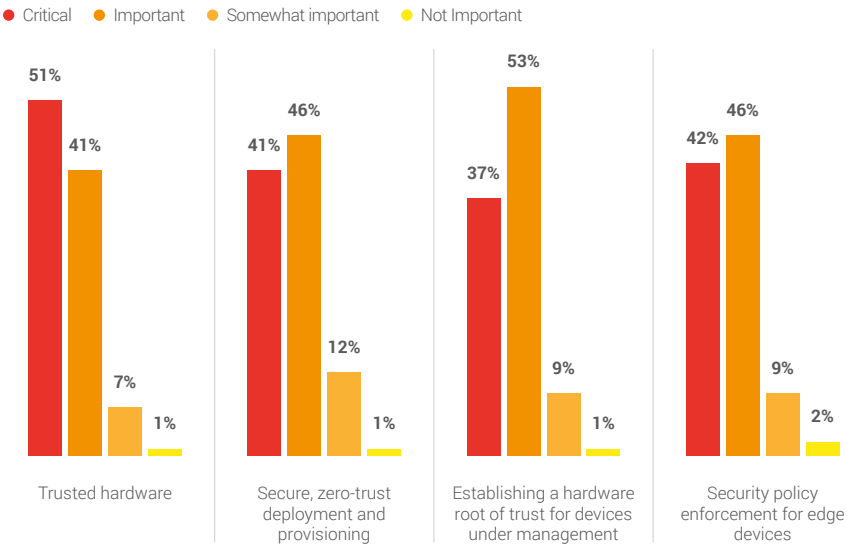


Fig 39. Please rate the importance of the following security capabilities of edge devices. (N=137-140)



infrastructure, the survey respondents indicated they believe the leading consideration based on "critical" response levels is that the devices must be deployed on "trusted hardware" (51%).

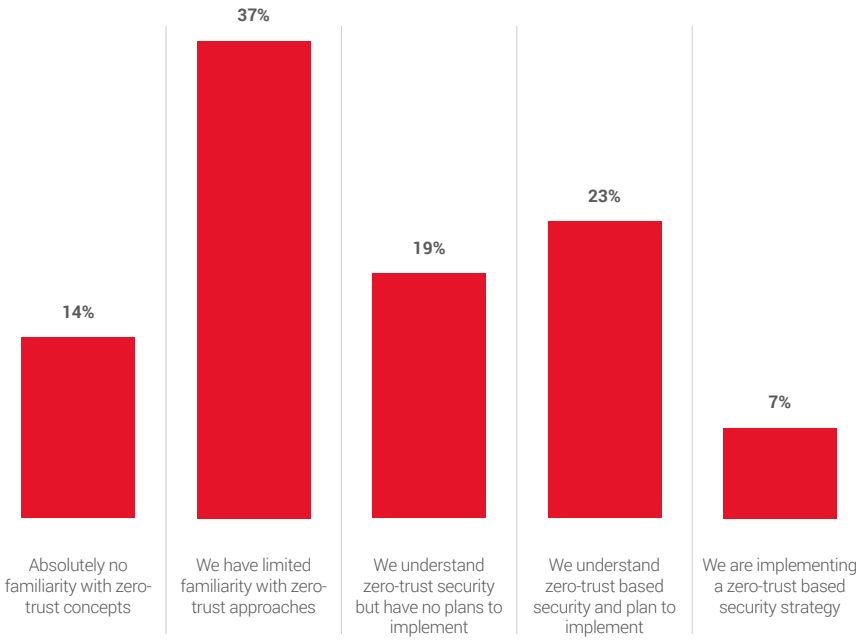
However, a number of other considerations are critical as well. Of these closely ranked capabilities, the ability to support "policy enforcement for edge devices" (42%) ranked second. Not far behind were "secure zero-trust provisioning" (41%) and "establishing a hardware root of trust for devices under management" (37%).

Heavy Reading interprets these findings as confirming that CSPs will initially focus on hardware platforms both for infrastructure and devices. Yet, in the device realm, they are implementing advanced security policy enforcement capabilities that apply zero-trust principles to edge devices.

Support of zero-trust was one area where the U.S and RoW respondents had notable deviation in their security question responses. In this case, while 46% of U.S. respondents felt a "trust no one, authenticate everything" zero-trust provisioning approach was critical, only 34% of RoW respondents felt this way.

As noted above, roughly 4 out of 10 (41%) survey respondents believe that "secure zero-trust deployment and provisioning" is of critical importance. Yet, half (51%) either have "limited familiarity" (37%) or "no familiarity" (14%) with zero-trust concepts **(Fig 40)**.

Fig 40. To what extent do you plan to employ zero trust security concepts for commercial deployments? (N=139)



It can be argued that the majority of CSP employees do not need to understand zero-trust concepts because they rely on their security colleagues, which typically represent a very small percentage (usually less than 8%) of the employee base. However, in the 5G era, Heavy Reading believes all employees will need to have a greater understanding of advanced security fundamentals, including zero-trust.

Interestingly, even though U.S. respondents place a higher value on zero-trust, when looking at the familiarity level of zero-trust concepts, the splits are very similar (36% U.S. vs. 38% RoW), which confirms that limited knowledge in this area is a global concern. This is perhaps a reason why only 7% of respondents (9% U.S. and 5% RoW) are currently implementing a zero-trust strategy in commercial deployments. ■

5G TRANSPORT NETWORKS

Author: ***Sterling Perrin,*** *Principal Analyst, Optical Networks & Transport,* ***Heavy Reading***

5G transport networks include the fronthaul, midhaul, and backhaul segments that connect cells sites to the mobile core. Transport is now well understood to be critical to the success of advanced, mass-market 5G services that are only a few years out, and there is much work to be done to upgrade networks to meet the unique performance demands of 5G. This section addresses 5G transport technologies and challenges, including fiber as well as wireless connectivity.

KEY TAKEAWAYS:

5G transport network upgrades have begun. **At 38%, a plurality of respondents reported that 5G transport network upgrades are "already taking place"** and an additional 18% reported they plan to begin their upgrades this year. All told, transport upgrades will have begun for more than half of respondents (56%) by the end of 2020.

For nearly half of operators surveyed (45%), expectations for the role of wireless transport in 5G are about the same as those for 4G. For nearly a third of respondents (27%), expectations for the role of wireless transport are actually greater than for 4G. The findings are significant because 5G transport is generally understood to be a "fiber-led" initiative due to the 10-100x capacity increases anticipated by 5G devices. The survey shows operators expect wireless transport technologies to play an important role.

When building microwave transport networks for 5G, two challenges top the list: "improving the reliability of microwave links" (30%) and "addressing the wireless bandwidth bottleneck by upgrading to 10 Gbit/s" (26%). The results are not surprising given that reliability and capacity are the two most common knocks against wireless access cited by those who prefer fiber connectivity. Operators (and their suppliers) must address these challenges for wireless transport to be an effective backhaul technology option.

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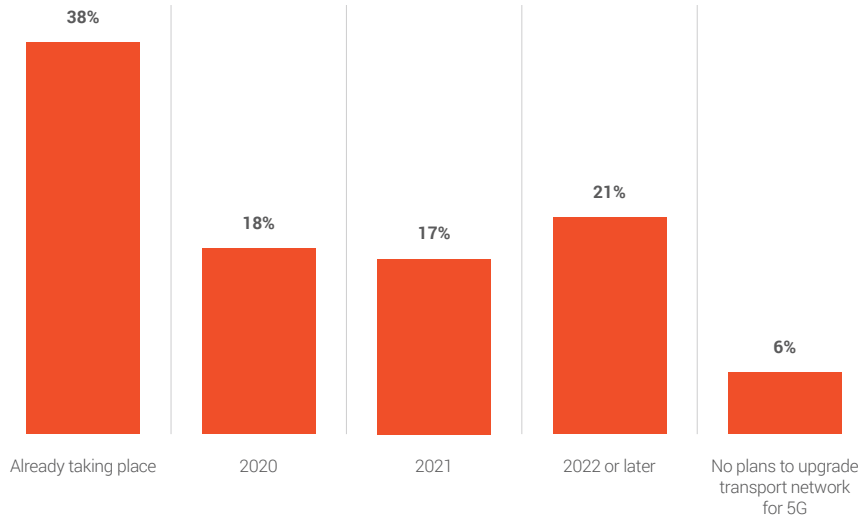
5G Transport Networks

The operator survey results indicate that upgrades for transport networks have begun **(Fig 41)**. At 38%, a plurality of respondents reported that 5G transport network upgrades are "already taking place" and an additional 18% reported they plan to begin their upgrades this year. All told, transport upgrades will have begun for more than half of respondents (56%) by the end of this year. Just 6% reported "no plans to upgrade their transport networks for 5G," which is consistent with Heavy Reading's general understanding that existing backhaul networks will not meet the bandwidth and performance demands of 5G.

When planning 5G transport networks, operators have several existing and new technology tools at their disposal, and results show that a number of these options have strong appeal. At the top of the list **(Fig 42)**, Ethernet virtual private networks (VPNs), network synchronization protocols, 50 Gbit/s Ethernet, evolved Common Public Radio Interface (eCPRI), and 25 Gbit/s Ethernet were each selected as critical by 25% of respondents or more.

Fig 41. When will your organization begin upgrading its transport network to support 5G?



Heavy Reading thinks the broad appeal of multiple technologies reflects two 5G market realities:

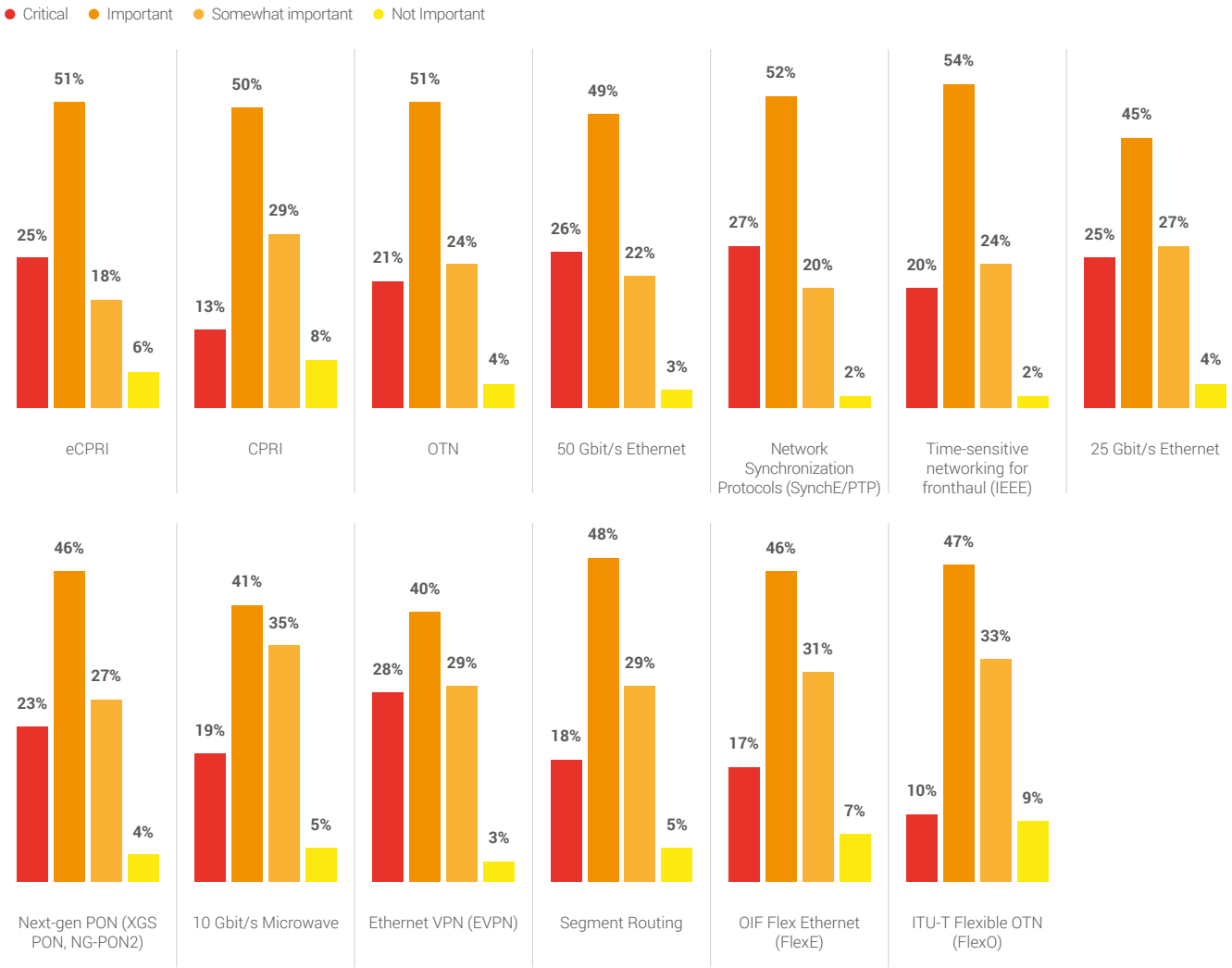
1) Transport networks are at an early stage and a technology option shakeout has not yet occurred.

2) 5G transport requirements are more demanding and diverse compared to previous mobile generations and multiple options will be required.

10 Gbit/s microwave scores in the middle of the pack of options – viewed as critical by 19% of respondents. At the low end of the preference scale, legacy CPRI was selected as critical by 13% of the group, and the ITU-T's Flexible OTN (FlexO) standard was selected as critical by just 10%.

The next set of survey questions focused on wireless transport options for 5G, a topic of growing interest to operators globally, based on Heavy Reading's discussions. First, we asked about the role operators expect wireless transport to play as they move to 5G, including microwave, free-space optics, and satellite technologies **(Fig 43)**. For nearly half of operator respondents (45%), expectations for the role of wireless

Fig 42. How important are the following technologies & protocols for your 5G transport network? (N=133-138)



transport in 5G are about the same as those for 4G. For nearly a third of respondents (28%), expectations for the role of wireless transport are actually greater than for 4G.

The findings are significant because 5G transport is generally understood to be a "fiber-led" initiative due to the 10-100x capacity increases anticipated by 5G. However, Heavy Reading operator survey data – including the findings in this study – consistently show that wireless transport will play an important adjunct role alongside fiber. Just 19% of operators surveyed anticipate a diminished role for wireless transport as they move to 5G.

Link distances are a critical metric in planning wireless transport networks. Heavy Reading asked operators **(Fig 44)** about the mix of distances expected in their high capacity transport links, including short links (less than 2 km), medium links (2-5 km), and long links (5-10 km). On average, short links are expected to dominate (accounting for 44% of the link mix), followed by medium links (31%) and long links (25%).

Fig 43. What role do you expect wireless transport (e.g. microwave, free-space optics, satellite) to play in your 5G transport network? (N=138)

- A larger role for wireless transport **28%**
- The importance of wireless transport will stay about the same..... **45%**
- A smaller role for wireless transport..... **19%**
- Not sure / don't know **9%**

Fig 44. For high-capacity 5G wireless transport links, what will be the mix of distances in your network? (Total should equal 100%) (N=139)

- Short links (<2km)..... **44%**
- Medium links (2-5km)..... **31%**
- Long links (5-10km) **25%**

Fig 45. What is the biggest challenge to microwave transport network for 5G? (N=140)

- Addressing bandwidth bottleneck by upgrading to 10 Gbit/s **26%**
- Simplifying network topology and decreasing link latency **19%**
- Saving spectrum cost by maximizing spectrum efficiency **12%**
- Improving reliability of microwave links..... **30%**
- Improving OAM function by enabling SDN and routing technology..... **13%**

In the 2019 version of this survey, Heavy Reading asked the same question, and the results for both years are largely consistent, with similar average percentages for each of the link distance choices. While the survey respondents were different each year, the comparisons are still telling, particularly since the responses are so consistent.

Heavy Reading also asked operators about their biggest challenges in building microwave transport networks for 5G **(Fig 45)**. Two challenges top the list: "improving the reliability of microwave links" (30%) and "addressing the wireless bandwidth bottleneck by upgrading to 10 Gbit/s" (26%). The results are not surprising, since reliability and capacity are the two most common knocks against wireless access cited by those who prefer fiber connectivity.

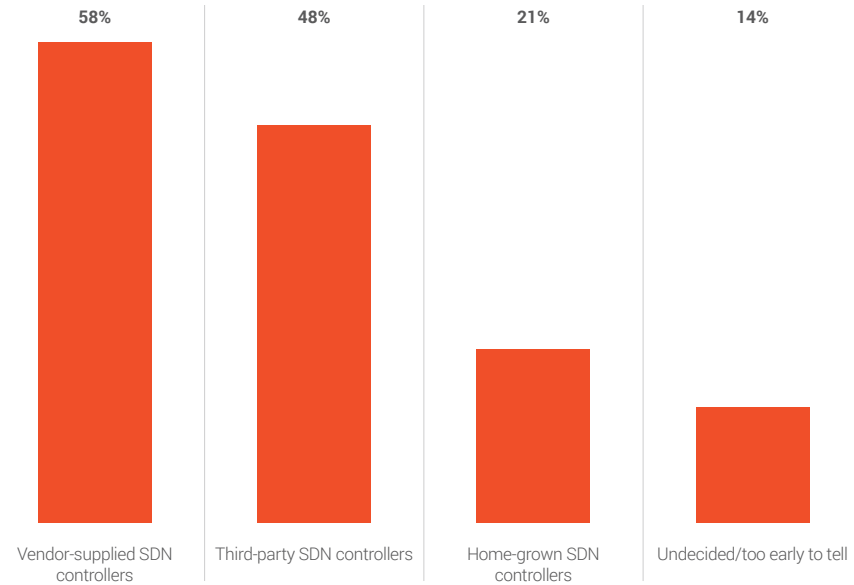
However, some differences in the results emerge when slicing the data by geographic region. For U.S. respondents, "improving reliability" topped the list by a large margin (33%), with "addressing the bandwidth bottleneck" a distant second (19%). For non-U.S. (RoW) operators, however, the 10 Gbit/s bottleneck stood out as the biggest challenge (36%), followed by reliability as a distant second challenge (26%).

Differences in microwave backhaul use in existing networks is a reasonable explanation for the difference. Microwave backhaul is far more common outside the U.S. For these operators, upgrading existing links to the 10 Gbit/s data rates required by 5G will be a major challenge. Within the U.S., many deployments will be greenfield and based on the newest generation 10 Gbit/s equipment available. Thus, ensuring reliability for microwave connectivity will be the paramount concern for U.S. operators.

Heavy Reading's final transport question **(Fig 46)** focused on the role

of software-defined networking (SDN). Specifically, we asked operators how they plan to manage the integration of their 5G transport infrastructure with SDN control. In the early days of SDN, there was quite a debate on the "build it or buy it" controller issue, but it seems this debate has largely been resolved. At 58%, the majority of operators intend to rely on "vendor-supplied controllers" and, at 48%, nearly half will use "third-party controllers" (from independent software companies or vendors that are not their hardware suppliers). It is clear that the appetite and need for homegrown controllers is limited. Just 21% expect to build their own. Significantly, these results are largely consistent with the results from Heavy Reading's 2019 survey in which we asked the same question. ■

Fig 46. How will your organization manage integration of 5G transport infrastructure and SDN control? (select all that apply) (N=139)



Unlike previous 3GPP systems that attempted to provide a "one-size-fits-all" system, the 5G system provides optimized support for a variety of different verticals, services, traffic loads, and end user communities. 3GPP industry participants expect the 5G system to support multiple combinations of reliability, latency, throughput, positioning, and availability. For the transport component, 5G releases address latency reduction, integrated access backhaul, unlicensed spectrum, and specifications specific to Internet of Things (IoT) and industrial automation.

5G network requirements go beyond capacity and latency, encompassing the provision and management of end-to-end traffic services delivery via the access networks and through the transport networks to the core. In practice, the design of networks to support new 5G radio access technologies must also support evolved LTE, legacy technologies and their systems, non-3GPP radio access technologies, and legacy transport networks.

Transport network technologies – algorithms, telemetries, software, and hardware – are evolving to support greater capacity, flexibility, and diverse data transport needs. Industry standards organization are working on advanced packet networking functionality to meet these new networking requirements.

Bridges are being built between industry organizations focused on the access and core sides and on the signaling and transport, switching, routing, and securing sides. Non-mobile network operator (MNO) network builders are joining MNOs, extending cellular/Wi-Fi networks in the digitization of industrial and food production, healthcare, and education.

In this section, Heavy Reading delves into operator plans and expectations for transport networks supporting 5G, including upgrade timelines, architecture preferences, and top inhibitors that must be addressed for the deployment of new 5G-based services.

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