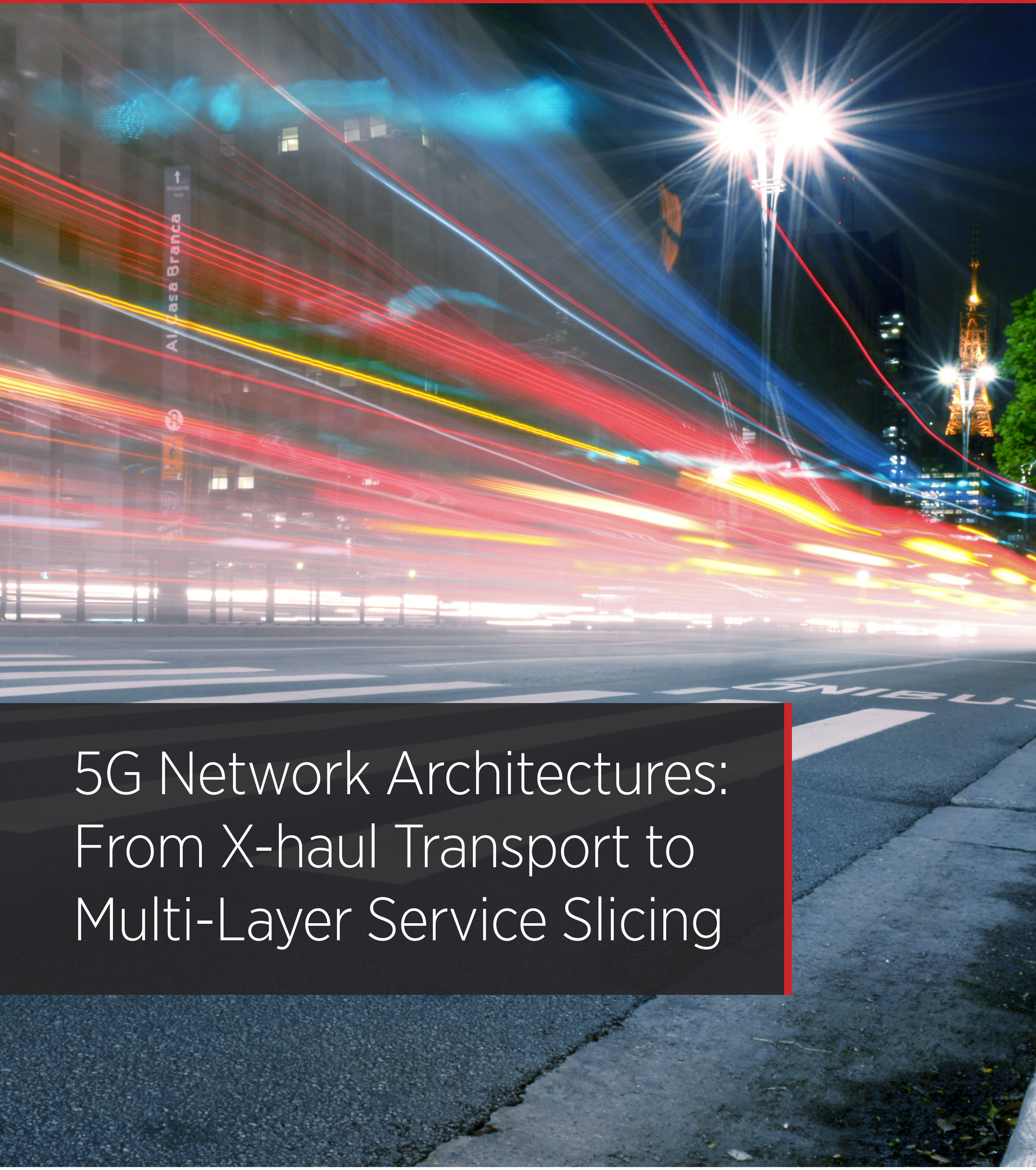
SURVEY REPORT



5G Network Architectures: From X-haul Transport to Multi-Layer Service Slicing

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Executive Summary

5G introduces new network architectures and service requirements that will have major implications for how operators design transport networks. As communication service providers (CSPs) are in the early stages of rolling out 5G, *Mobile World Live* conducted an online survey of mobile and fixed-line network operators and mobile virtual network operators (MVNOs) to understand current strategies for 5G transport networks. The survey revealed that resolving 5G transport issues is a high priority for CSPs and showed that while CSPs are initially concerned with meeting capacity and low latency requirements in the near term, they are also preparing to support advanced 5G features such as X-haul, network slicing and Multi-access Edge Computing (MEC).

Key Findings

Transport is a high priority in 5G network planning. The overwhelming majority of respondents (84%) said transport was critical or important to 5G deployment plans.

CSPs identify a range of challenges, reflecting the complexity of 5G transport. The top challenges included supporting high bandwidth services, low latency applications and distributed data centres; aggregating traffic flows from diverse sources; enabling network slicing; as well as ensuring accurate timing and synchronisation.

CSPs are factoring advanced 5G features into transport network plans. While the initial focus is on increasing bandwidth and delivering low latency, CSPs are also preparing transport networks to support X-haul, MEC and network slicing deployments in the next one to two years.

Survey Methodology

This report is based on responses from an online survey of 49 communication service providers (CSPs) conducted by *Mobile World Live* (MWL) on behalf of Infinera. The respondents were from mobile network operators (69%), fixed-line operators (18%) and MVNOs (12%).

Geographically, the largest groups of respondents were from companies with headquarters in Europe (37%) and Asia (29%), followed by respondents from North America (14%), with the remainder distributed among Africa (6%), the Middle East (8%) and South America (6%).

Introduction

5G service requirements along with the architectural changes introduced in the 5G radio access and core networks will have a major impact on the way CSPs design and deploy transport capacity and services. Some of the targets for 5G network performance include a peak data rate of 20Gbps with the aim of most users experiencing 100Mbps, while network latency ranges from 20 milliseconds down to 1 millisecond. In short, 5G is expected to be significantly faster and more responsive than today's cellular networks, which will enable CSPs to support a wider range of services and applications.

But, as with any major technological change, the rollout of 5G networks and the full new service capabilities will happen gradually. The first 5G services will be quite similar to current 4G services, albeit with faster speeds. Indeed, early commercial deployments that are rolling out this year are focused on enhanced mobile broadband and fixed wireless access services. It's not until 2020 and beyond when more advanced 5G services are expected to be introduced, which potentially include mission-critical applications, industrial automation, remote healthcare services, massive Internet of Things (IoT) connectivity and even autonomous vehicles.

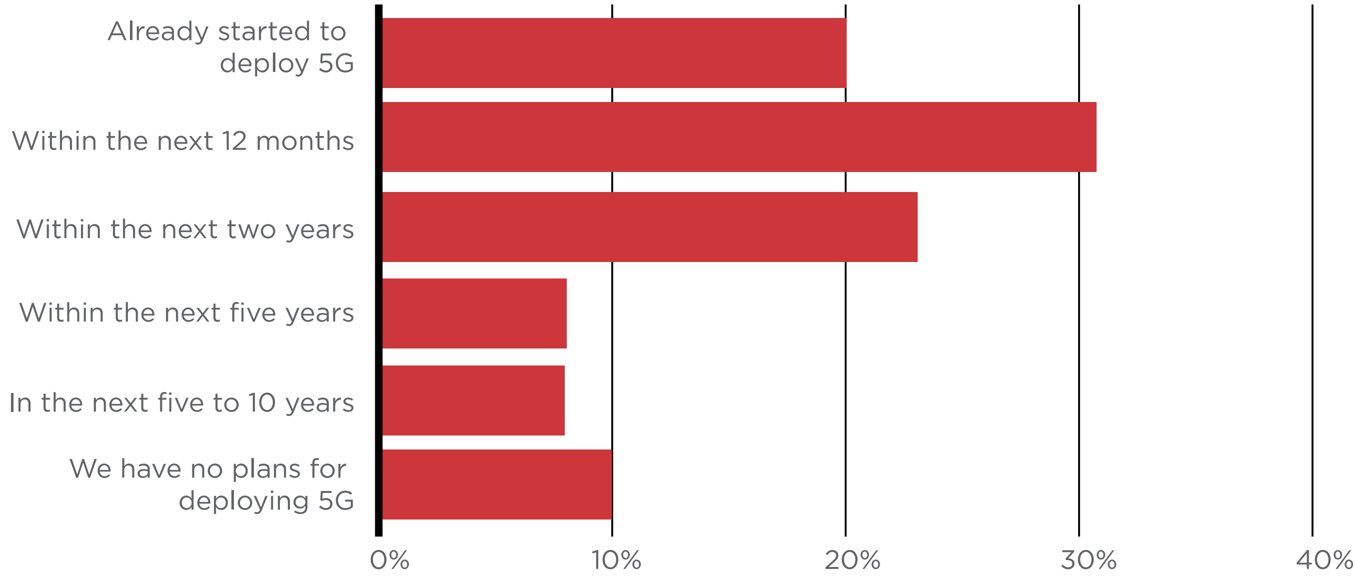
Some of the changes that will most affect the transport network in the 5G era include network slicing, the drive to distribute intelligence and processing closer to users at the edge of the network with Multi-Access Edge Computing (MEC), as well as new radio access architectures that require a unified approach to supporting not only backhaul but also fronthaul and midhaul, which are collectively known as X-haul. In addition to these changes, 5G transport networks will also have to support huge amounts of bandwidth, extremely low latency, different classes of service, all while being energy efficient and cost effective.

Based on the recent MWL online survey results, CSPs are clearly already thinking about how they will evolve their transport networks to support 5G service requirements. This report analyses operator strategies for 5G transport, including timelines for deploying advanced 5G features as well as the complex challenges that CSPs identified.

5G Introduces New Transport Challenges

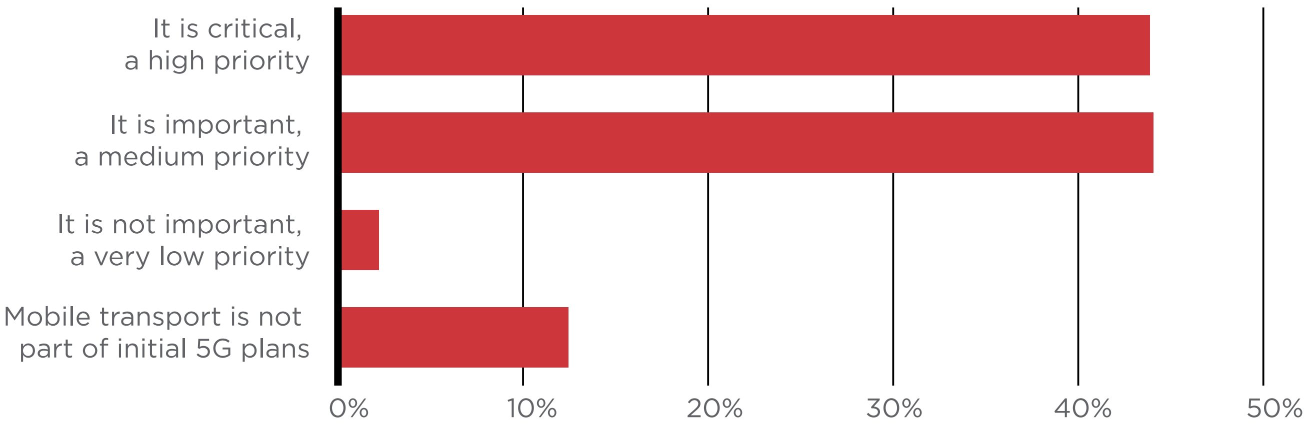
In line with the general industry trend, most respondents said they are in the early stages of rolling out 5G networks. Some respondents (20%) said they had already started deploying 5G, while 30% said they planned to deploy within the next 12 months and 20% said they planned to deploy within the next two years. Only 10% said they currently had no plans for 5G.

Figure 1. When do you plan to start deploying 5G?



CSPs are prioritising the transport network in their 5G deployment strategies. The large majority of respondents (84%) said that mobile transport was either a critical, high priority or an important, medium priority in their overall 5G network considerations. The result suggests that CSPs recognise the strategic importance of the transport network for supporting the requirements of 5G services as well new architectures in the radio access and core networks.

Figure 2. How does mobile transport factor into your 5G network plans?



Respondents were asked to identify and rank the biggest challenges for 5G transport networks, and the results illustrate how 5G architectures will impose new demands on backhaul. The results show that CSPs consider the top challenges to be meeting high capacity requirements and supporting low latency applications. The rankings also reveal a set of secondary concerns, which include how to support distributed data centres, aggregate traffic flows from diverse sources, enable network slicing as well as ensure accurate timing and synchronisation.

5G Transport Network Strategies

The following survey findings convey current operator thinking in the areas of their key requirements for 5G transport, as well as their networking preferences, plans for fibre deployment, and their views on wholesale transport services.

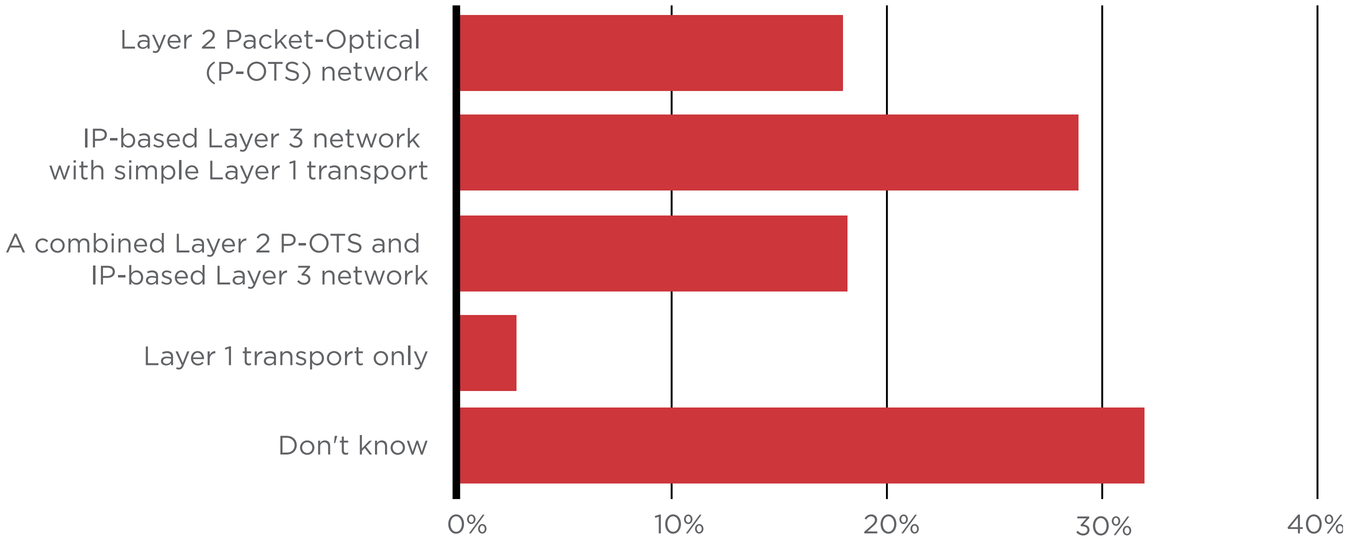
The initial focus of 5G transport network strategies is clearly on ensuring that there is enough capacity available to support higher speed services. This reflects not only that 5G transport is at an early stage of development, but also that the first 5G services will be in the category of enhanced mobile broadband (eMBB), which in some respects will be very similar to today's 4G data services, but faster. When asked to rank their top three requirements for 5G networks from the cell tower to the core, CSPs said the number one requirement was support for 10Gbps to the cell site, followed by support for 25Gbps and support for 100Gbps to cell sites.

In addition to capacity requirements, CSPs also highly ranked other considerations such as synchronisation, network latency and new equipment form factors. The variety of challenges that CSPs highlighted suggests that devising a 5G transport strategy is a more complex, multifaceted undertaking than simply increasing capacity.

More than half of respondents (56%) said that low latency was among their top three requirements for 5G transport, and nearly one third of respondents (29%) said they required highly accurate timing or synchronisation from the transport network for primary or backup synchronisation. Another important requirement for more than a third of respondents (32%) was having hardened IP or DWDM transport equipment for street cabinet deployments, which suggests that CSPs are thinking about how they handle DWDM penetrating deeper into access networks to support the proliferation of cell sites in 5G.

When it comes to choosing the type of networking method for 5G transport, nearly one third of CSPs (29%) said that they prefer to adopt an IP-based Layer 3 network with simple Layer 1 transport, while 17% said that they prefer a Layer 2 Packet-Optical (P-OTS) network and 17% said that they would want a combined Layer 2 P-OTS and IP-based Layer 3 network.

Figure 3. When considering 5G transport from cell tower to core, what is your preferred networking method?

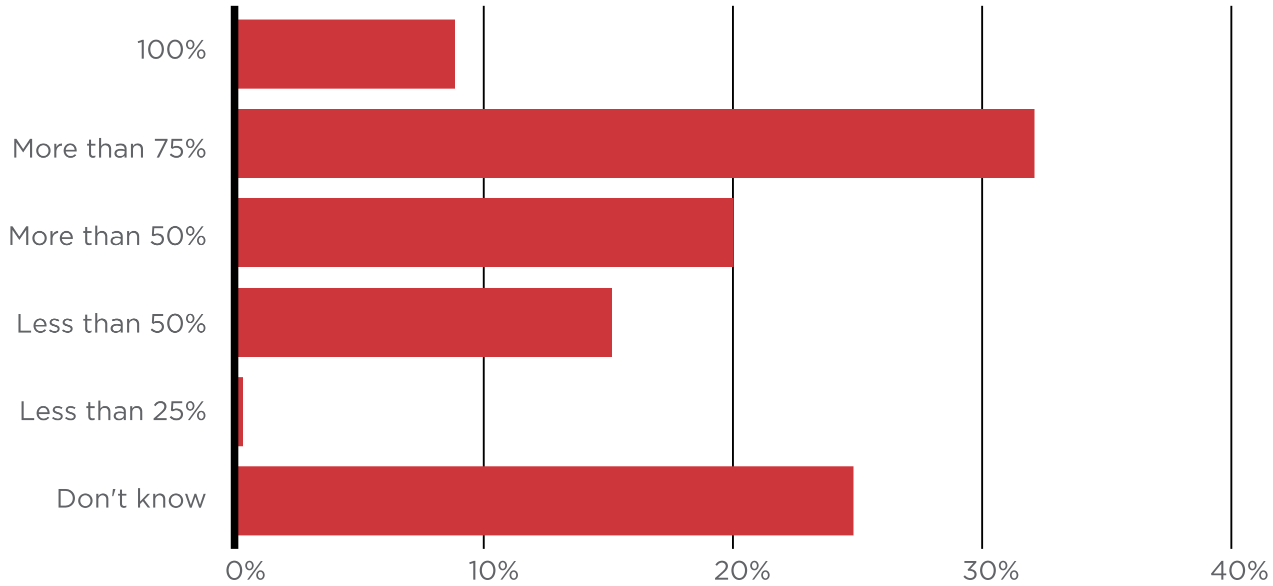


Furthermore, most CSPs said that they plan to build RAN-neutral transport networks with best-of-breed solutions from IP and optical equipment vendors rather than bundling transport equipment with the RAN and core from a single vendor. And nearly half of CSPs said that they plan to support 4G transport (including fronthaul) over new 5G transport networks.

The survey also revealed that CSPs have various amounts of fibre connectivity to cell sites. Currently, 20% of respondents said that more than 75% of their cell sites are connected via fibre, 20% said that more than half are fibre connected and 20% said that less than a quarter of sites were connected. Only 9% of CSPs surveyed said that all their cell sites had fibre connections.

As CSPs consider their 5G strategies, they expect to deploy more fibre to cell sites. For 5G transport, more than one third of respondents (32%) said that they expect to connect more than 75% of their cell sites via fibre.

Figure 4. In your 5G transport network plans, what percentage of cell sites will ultimately be connected via fibre?



For mobile operators that are considering buying wholesale 5G transport services, the key requirements are broadly in line with the results noted earlier. That is, the top requirements for wholesale services are high bandwidth (up to 100Gbps or 25Gbps to cell towers) and low latency. But beyond capacity and latency considerations, CSPs also noted the importance of having reliable synchronisation and network slicing support from their wholesale transport suppliers. More than a third of respondents (35%) ranked network slicing support among their top three requirements for wholesale services. And 29% of respondents said one of their top requirements was accurate timing/synchronisation delivered over wholesale transport services.

Building Support for X-haul, MEC and Network Slicing

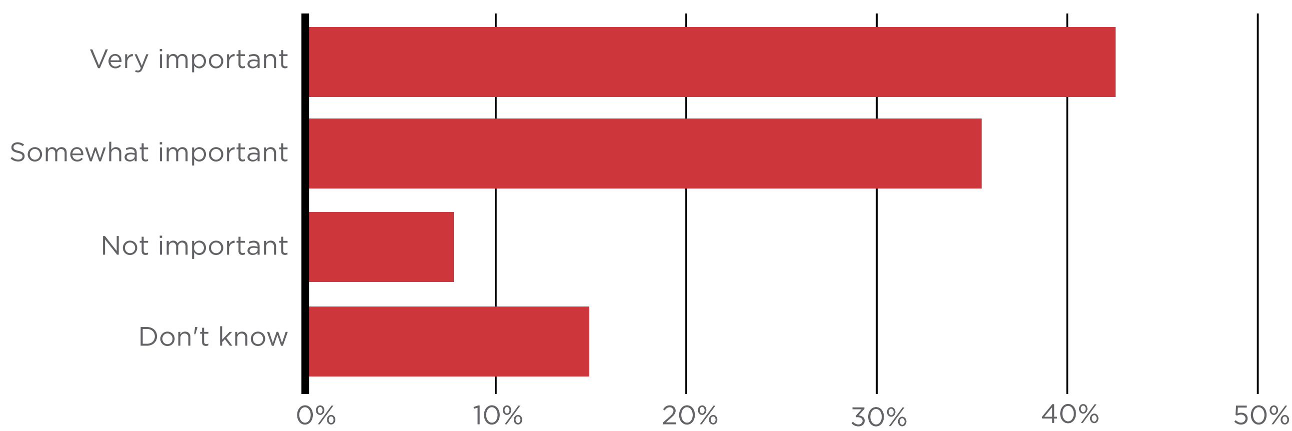
While it's clear that most CSPs are primarily concerned with providing more bandwidth to 5G cell sites to support higher-speed services in the near term, many are also turning their attention to how they will support more advanced 5G features and network architectures in the medium to longer term.

For example, in the 5G radio access network the traditional Baseband Unit (BBU) is broken down into a Distributed Unit (DU) and a Centralized Unit (CU). Depending on how CSPs decide to implement these new elements, along with the Remote Radio Unit (RRU), they will need to support not only backhaul connections to the core network, but also fronthaul and midhaul connections. Together, these fronthaul, midhaul and backhaul connections are referred to as X-haul.

An overwhelming majority of respondents (77%) said that X-haul support is either very important or somewhat important – that is, the ability to support fronthaul, midhaul and backhaul over the same unified Ethernet-based transport network. For the CSPs that are planning to deploy a unified X-haul transport network, most are roughly split between rolling it out within the next 12 months and deploying within the next two years.

Furthermore, the results show that the preferred approach for X-haul deployment scenarios is to ultimately locate the RRH, CU and DU in separate locations to support advanced 5G services.

Figure 5. How important is the ability to support fronthaul, midhaul and backhaul over the same unified Ethernet-based transport network (i.e., X-haul transport)?



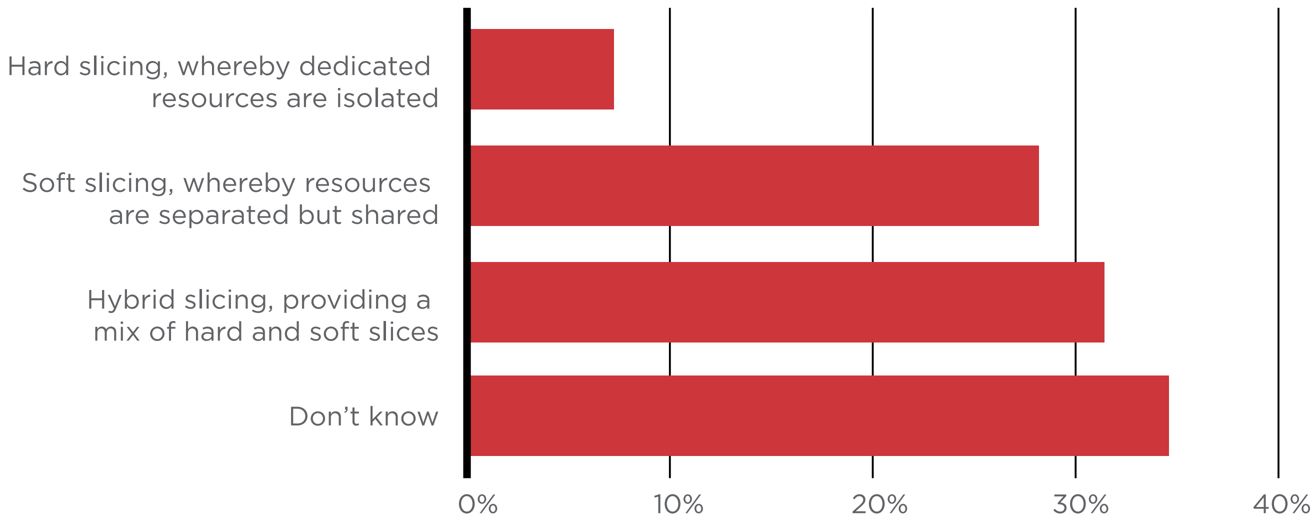
When considering 5G architectural changes in the radio access network and the resulting implications for unified Ethernet-based networks as well as the need to support a wider variety of latency-sensitive applications, it's important to note that most respondents said they were likely to deploy time sensitive Ethernet to support eCPRI-based mobile fronthaul. 66% of CSPs said that they were either definitely, very likely or somewhat likely to deploy time sensitive Ethernet.

MEC is one of the foundational technologies for supporting advanced 5G low-latency applications. Most CSPs (66%) said that they plan to deploy MEC within the next one or two years. To support MEC deployments, the survey results show that the top CSP requirements for transport networks are high bandwidth (up to 100Gbps to the cell site), low latency transport to the cell site, network slicing support and accurate timing and synchronisation from the core network to MEC to cell site.

In addition to MEC, CSPs are also preparing for network slicing and the new service capabilities that it will bring. Most CSPs surveyed said that it was very important to be able to deliver differentiated quality of service or latency for advanced 5G services.

When it comes to how they will support network slicing in their 5G transport networks, the survey results suggest that there is no one-size-fits all approach and that CSPs are looking for flexible options. Just one third (31%) of CSPs said that they plan to adopt a hybrid slicing scenario that provides a mix of hard and soft slices, while 28% said they planned to support soft slicing whereby resources are separated but shared. Only 7% of CSPs said they planned to support hard slicing with dedicated resources that are isolated.

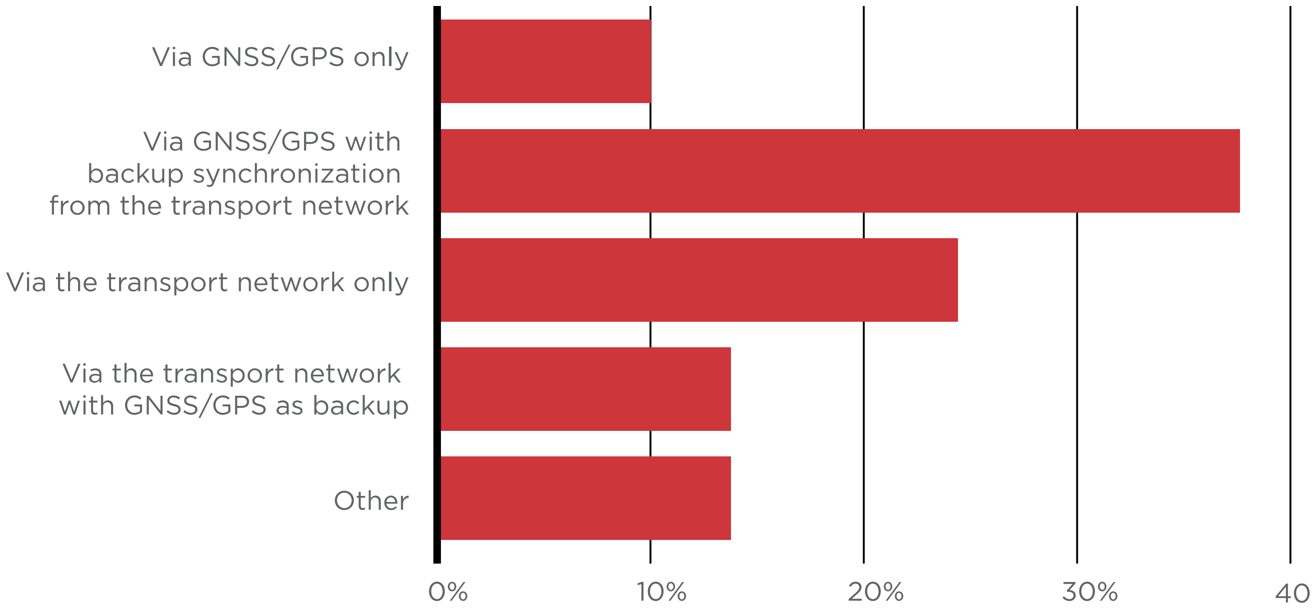
Figure 6. How do you plan to support network slicing in the 5G transport network?



One of the most important issues for mobile transport networks is timing and synchronisation. It is quite a specialist area, but it is essential for ensuring reliable mobile services. Operators have many options for supporting synchronisation, involving various combinations of Global Navigation Satellite System (GNSS), such as the US Global Positioning System (GPS) or the European equivalent Galileo, and techniques within the transport network itself.

Significantly, most CSPs are looking to the 5G transport network to provide primary synchronization or backup sync. While 24% of CSPs said that they would rely solely on the transport network, 38% said that they would use GNSS for sync with backup from the transport network. A further 14% said that they would deliver synch via the transport network and use GNSS/GPS for backup. Only 10% said that they would provide synch only via GNSS/GPS.

Figure 7. How do you plan to deliver synchronisation in the 5G transport network?



Conclusion

As 5G is currently in the early stages of deployment and commercial launches in some markets, CSPs are already thinking about how their transport networks need to evolve to support the new services. The survey results show that operators will migrate gradually to 5G transport, just as 5G networks and services in general will become more sophisticated over time.

To help CSPs in their migration to 5G transport, there are a complex range of challenges that need to be addressed, from timing and synchronisation to aggregating diverse traffic flows. CSPs are looking for solutions that support high-bandwidth applications in the near term and can then evolve in the medium term to support the full range of 5G services with advanced functionality such as network slicing, MEC and X-haul.

The transport network can be viewed as the linchpin for 5G networks and services, and CSPs recognise the strategic role it will play in the next mobile generation.

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