5G IS COMING:
GET YOUR INFRASTRUCTURE READY

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CONTENTS

5G: PREPARING TO LAUNCH

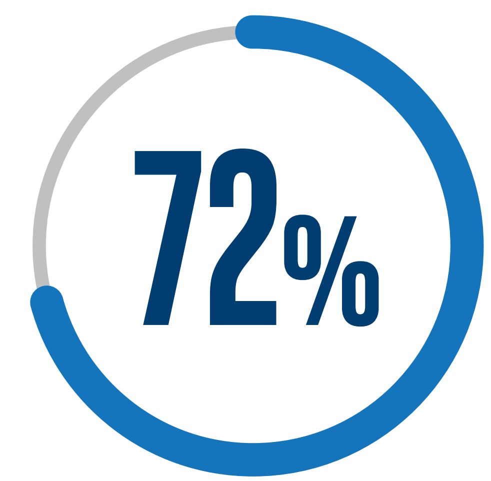
The countdown has begun: 5G services are on their way, and Communications Service Providers (CoSPs) are now preparing to launch. According to Futurum Research, 72 percent of European and North American telcos are planning their first 5G rollouts in the next 12 months[1]. Some will launch even sooner: nearly 29 percent expect to deploy 5G within six months[1]. 42 percent of those surveyed have completely reorganized the company around 5G, and 49 percent of those surveyed have made a start on that process[1].

So, what's driving these investments in 5G? Combining high bandwidth, low latency and mobility enables many new use cases:

- Mobile broadband can support broadcast-like services wherever a device can connect. As well as making live video, augmented reality (AR), and virtual reality more accessible on mobile devices, 5G enables broadband to be provided to rural areas where wired connectivity is sparse. In places where wired internet connectivity is available, 5G is expected to emerge as a new competitor.
- Consumer Internet of Things (IoT) applications can be more easily connected up, such as security systems and smart energy monitors. Wearable technologies can benefit from improved connectivity too, such as lifeline communications for vulnerable adults.
- Industrial IoT applications can more easily gather large amounts of data from factory equipment without the need to use a wired connection.

These three use cases were cited as the top drivers of 5G deployment in Futurum's study, and are also expected to deliver the greatest return on investment. They impose radically different demands on the network, though, which may have to handle an explosion in connected devices making small requests for IoT use cases, and a growth in high-bandwidth content such as video and cloud gaming for mobile broadband use cases.

CoSPs can take several steps today to prepare the infrastructure for the demands of 5G. In this paper, we'll outline five of them.



Of North American and European telcos plan to roll out 5G within 12 months[1]

EVOLVE NFV TOWARDS AGILITY

5G networks will evolve for the next few years with new features and capabilities rolling out over time. To be able to deliver the latest 5G services, CoSPs must ensure the network is easy to upgrade. As new services arrive on 5G, CoSPs will need to be able to move network functions between physical locations, or to add functions to new locations.

Network Functions Virtualization (NFV) brings the required flexibility, and is seen as a central pillar of the 5G network. NFV is also a necessary step in the evolution towards a more cloud-native network.

CoSPs have already begun a journey towards using software in place of the fixed function appliances that traditionally made up the network. Typically, they've started with relatively low-risk use cases and then increased their tolerance for risk as they've gained experience. Functions that many CoSPs have virtualized include Customer Premises Equipment (CPE), IP Multimedia Subsystem (IMS) call servers, the Evolved Packet Core (EPC), and Gi-LAN.

However, the maturity of NFV varies greatly by CoSP. Initial deployments may use vertically integrated solutions from telecommunications equipment manufacturers (TEMs) but the full potential of NFV is only unlocked when hardware resources can be shared across network functions from different vendors, and cloud-like management practices are adopted.

We've identified five maturity levels for NFV, shown in Figure 1.

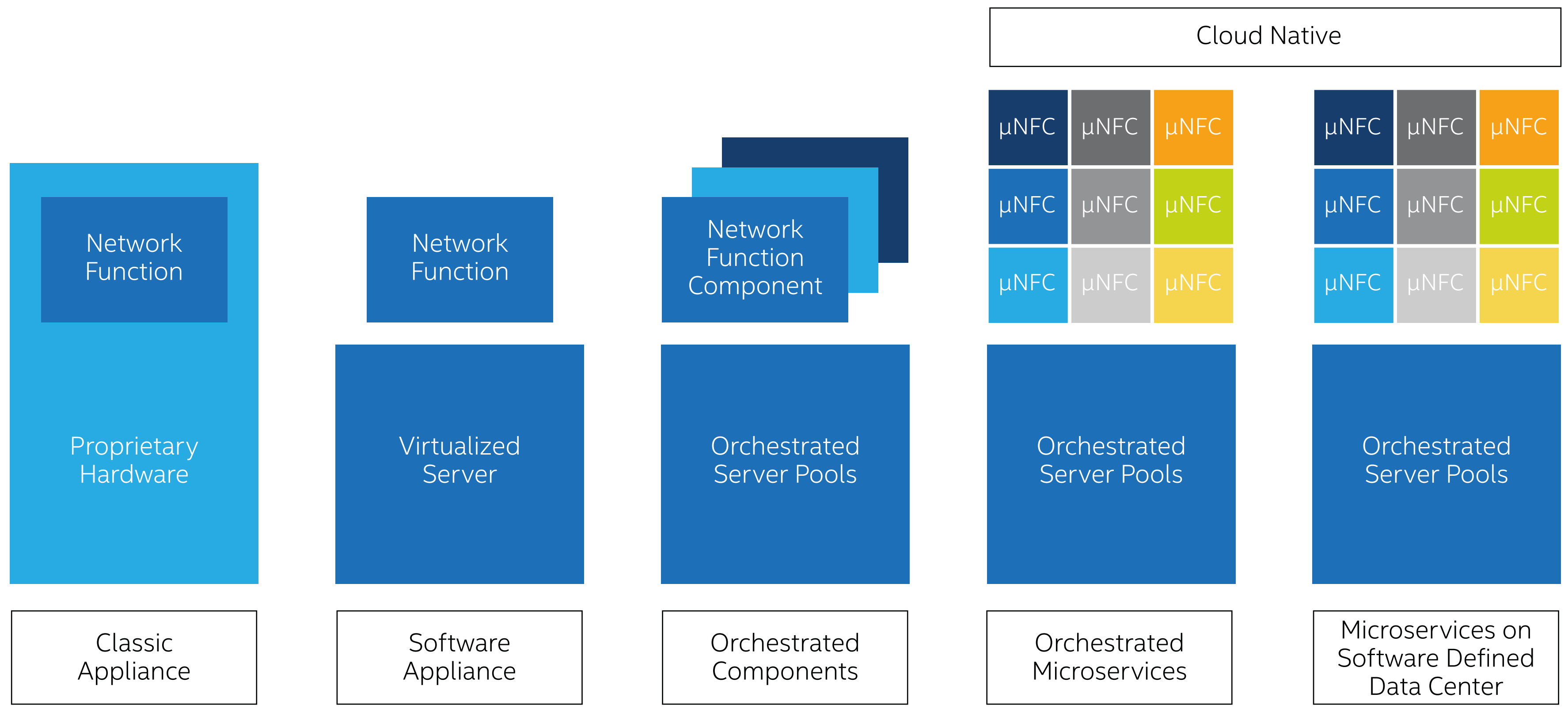


Figure 1. The stages in evolving NFV

AT&T aims to virtualize

Of its network by 2020[3]

The five maturity levels are:

- **Classic appliance:** This was the starting point, before any virtualization. Using fixed function devices makes it hard to respond to growth, because of the long lead-times in procuring hardware. Overprovisioning results from the need to ensure each appliance can handle the peak load.
- **Software appliance:** The first step towards NFV was for equipment vendors to provide software versions of their appliances, which can run on general purpose hardware based on the Intel® Xeon® processor. By using server virtualization, multiple software appliances can share the same hardware. This consolidation helps streamline the management of devices, including enabling backup hardware to be shared.
- **Orchestrated components:** This was the most popular deployment scenario at the end of 2018, although it's worth noting that leading CoSPs may be more mature. Using orchestration enables the hardware and the software appliances to be provisioned in line with traffic, making the network more responsive and reducing the need for overprovisioning. In particular, processing capacity can be reduced during off-peak hours to make significant power savings. IDC expects orchestration to be the fastest growing segment of the market for NFV infrastructure between now and 2022[2].
- **Orchestrated microservices:** Over the next couple of years, the network is expected to evolve by increasingly using microservices. Data plane functions are stateful and require load balancing, which makes them harder to orchestrate than control plane functions. For that reason, some data plane functions are being split into multiple microservices, which are easier to manage in a cloud-like fashion. Using microservices helps to reduce the risk associated with updates and upgrades, potentially even enabling in-service updates when supported by DevOps-style working practices. Tomorrow's CoSP will evolve through small, frequent network updates rather than using lengthy projects to push through big-bang upgrades.
- **Microservices on software defined architecture:** The final step in the evolution is to dissociate the physical servers from their storage and networking devices. Instead, all resources form a pool that can be reallocated to functions as required.

NFV is seen as one of the enabling technologies for 5G. In the past, hardware was provisioned with some headroom to allow for data growth in the future. Because of the diversity of 5G applications, it's hard to predict future hardware requirements now. Decoupling the hardware and software in the network enables them to be upgraded independently, so that additional hardware can be added as required, at lower risk and cost compared to upgrading or replacing fixed function appliances for the peak load.

CoSPs can prepare to launch 5G services now by evolving towards using orchestrated components, so that they have the agility required to deploy new services, and to respond to spikes in traffic without overprovisioning network resources. Not only is NFV an enabler for 5G, it also provides a platform for more easily launching new value-added services sitting on the 5G network, so the CoSP can better compete with over-the-top service providers.

PILOT EDGE COMPUTING

Although 5G is expected to offer unprecedented high bandwidth and low latency, some data-intensive applications might not be viable if they are based in the cloud. It might take too long to transfer data between the user's device and the cloud data center.

For this reason, Intel believes that transformation will occur at the edge of the network, which Intel calls the Next Generation Central Office (NGCO). Multi-Access Edge (MEC) computing is seen as a natural partner to 5G, enabling applications to be hosted in the network, closer to the user, and with lower latency. Suitable applications include AR, computer vision, public safety, and autonomous transportation. IoT applications, including smart city applications, can use edge computing for local analysis, so that alerts can be raised more promptly, and routine sensor data does not need to be transferred continuously across the network.

So far, NFV has largely been limited to network functions hosted in a data center environment. However, the practice can be extended to the network edge, in locations such as central offices, branch offices and traffic aggregation points, or even into the access network. Edge sites will need to host diverse workloads, including virtual network functions and user applications, so the flexibility that NFV brings will be an important enabler for MEC.

Extending NFV into the network may require different server hardware to be used. The data center is a highly controlled environment with dedicated space for servers. By contrast, the hosting environment at network sites may have limited physical space, consumer-level climate control, and limited access. When equipment is located on private property, lease agreements might restrict the number of maintenance visits the CoSP can make, so the reliability of the equipment is critical.

Although different physical form factors may be required across the locations, two guiding principles can help to ensure the infrastructure is best prepared for 5G:

- Ensure the **hardware is consistent with traditional network appliances** as far as possible, to enable easier operational management. For example, it should be able to tolerate transportation (including bumpy roads) and warehouse storage (including temperature and humidity outside of the operational environment).
- Ensure the **software layer is consistent across the network** as far as possible. NFV enables many applications and workloads to be hosted anywhere in the network (subject to the tolerance for latency). Having a consistent software platform in the data center and in network site locations enables resources to be shared across them.

MEC can be deployed now on 4G networks, as a trial in Shanghai has shown. China Unicom, Intel, Nokia, and Tencent Cloud worked together to test HD video streaming to user devices at a concert at the Mercedes-Benz Arena in Shanghai. The MEC solution* from Nokia, powered by the Intel® Xeon® processor family, enables CoSPs to offer 5G-like services using today's 4G infrastructure. The solution delivers low latency video within arenas and other highly populous areas, while avoiding the cost and latency of backhaul across the network. In the trial, live video latency was cut significantly.

CoSPs can prepare their infrastructure and teams for 5G by launching pilot projects for MEC now, in the 4G network.

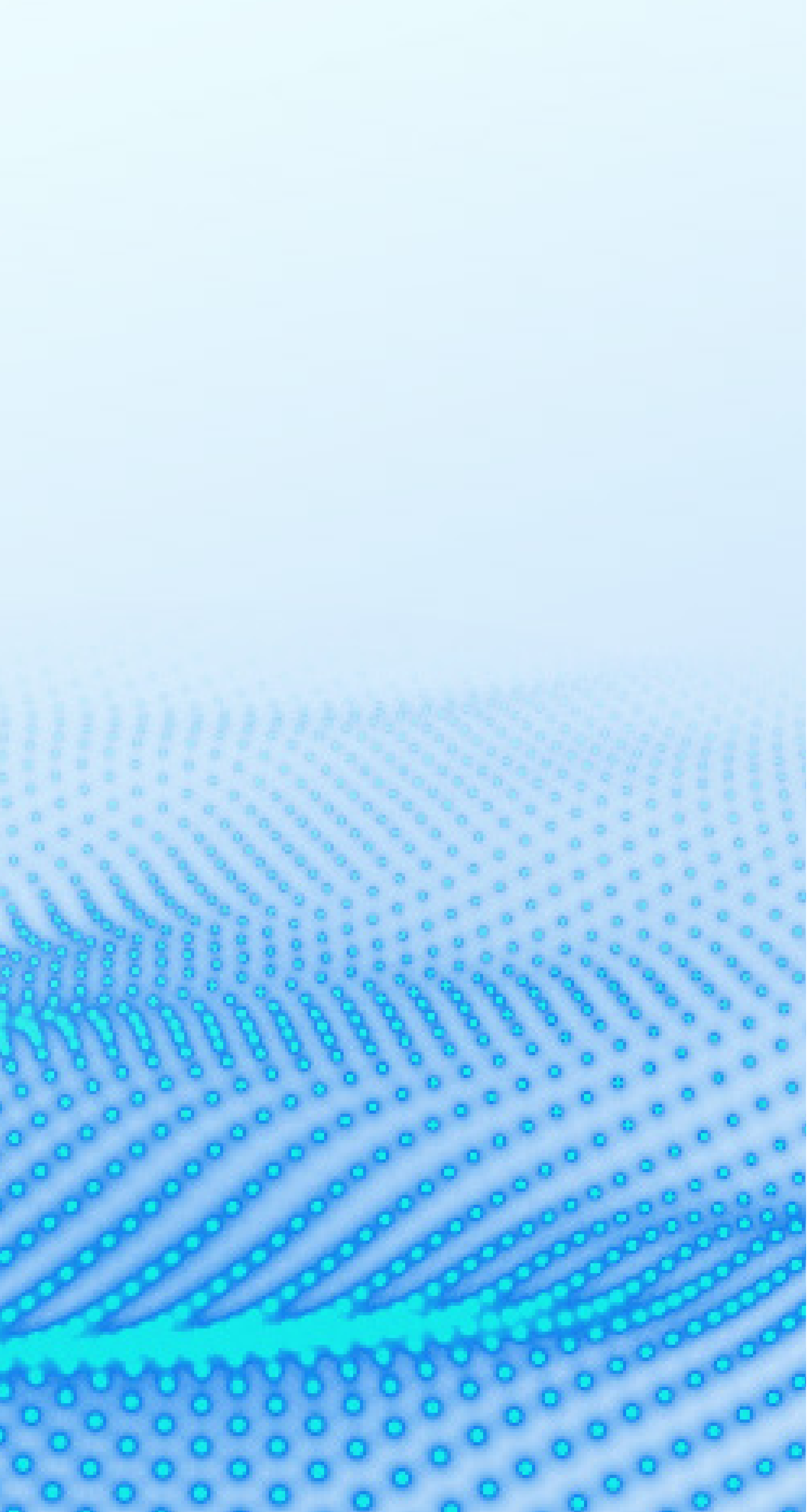
69%

Of CoSPs plan to deploy MEC in the next two years[4]

DEVELOPING FOR THE EDGE

One of the complications of developing edge applications is that the edge spans a broad expanse of the network, with different requirements for accessing the data plane depending on where the application is hosted. OpenNESS provides APIs and libraries that abstract away the complexity, making it easier for applications to be hosted in different edge locations, and potentially accelerating time to market.

Several major companies are working on simplifying software integration too, under the umbrella of an open source project. The Akraino* Edge Stack project, hosted by the Linux Foundation*, aims to create a software stack for edge computing. Participants include Intel, AT&T, Ericsson, Nokia, Huawei and Red Hat, among others.



INTRODUCE NETWORK SLICING

As we've already discussed, services may have radically different requirements of the network with regard to latency and bandwidth, and also with regard to service characteristics such as international roaming. Figure 2 provides a snapshot. Voice calls and AR are highly sensitive to latency, but playing recorded video isn't. Voice and IoT typically wouldn't require high bandwidth, but HD video would. IoT and AR applications tend to be tied to a particular location, but voice and video playback might need support for global roaming. All of these applications, and many more, will need to be supported on the same physical infrastructure.

Network slicing is one of the ways CoSPs can address the diversity of network requirements that services have. This approach, building on NFV, enables virtual networks to be constructed for different services, which can be right-sized for the services they will support. It's more cost effective than building a separate platform for each service, or building a shared platform designed to cope with the most extreme demands of the services it will host. Much of the time, such a platform would be overprovisioned. Network slices can be created for a particular service and/or a particular customer, with the necessary resources to meet the expected service levels.

Network slicing is another technology that is widely seen as playing an important role in the successful commercialization of 5G. Enabling 5G network slicing will require all of the network to be upgraded to 5G. However, it's possible to prepare the infrastructure and team now by using network slicing in today's network to provide services on the existing network. Ericsson and Swisscom have demonstrated end-to-end network slicing[5], and Vodafone and Huawei have carried out a field trial in Ireland applying network slicing to a fixed fiber network[6].

	Latency sensitive?	High bandwidth?	International roaming?
Voice Calls	Yes	No	Yes
Video Playback	No	Yes	Yes
IoT	No	No	No
AR	Yes	Yes	No

Figure 2. Different services may have different service characteristics

EXPLORE RAN VIRTUALIZATION

To serve higher mobile data volumes and a huge increase in the number of devices, CoSPs are looking at using cloud-based Radio Access Networks (RANs). A virtual baseband processing function can be shared across a large number of Remote Radio Heads (RRHs), increasing flexibility and better optimizing costs.

One question is how much intelligence should sit at the RRH, and how much should reside in the cloud. There's no simple answer to that: it depends on the application. 3GPP has identified eight ways to carve up the functions in the RAN, dividing them between the RRH and baseband unit (BBU). Where ultra-low latency is required, or where the connection between the BBU and RRH does not offer the performance required, the processing should take place near the radio. In other cases, virtualization can often be used, with the processing hosted elsewhere in the network.

Several enabling technologies are making RAN virtualization possible:

- To deliver the required communication speed between the RRH and BBU, Intel® Silicon Photonics optical transceivers can be used. They integrate the laser with silicon at the wafer level, enabling high-volume production with significant performance, cost and scale benefits. These transceivers are expected to play an important role in 5G, because they support high bandwidths (up to 100Gbps) and transmission distances of up to 10km. They can also be used in 4G networks where fiber optic connections have replaced copper wire.
- The Data Plane Development Kit (DPDK) accelerates packet processing on general purpose hardware and helps to route data to CPU cores efficiently.
- Intel® Advanced Vector Extensions 512 (Intel® AVX-512), introduced on the Intel® Xeon® Scalable processor, enable more data to be processed simultaneously than on the previous generation processor. This can help accelerate performance for the physical layer signal processing in both 4G and 5G RAN.

To prepare the infrastructure for 5G, CoSPs can start investigating these technologies today.

EMPOWER THE ORGANIZATION TO ACT

To get the best from 5G requires a change in mindset: it's not about huge implementation projects for step-changes in technology. It's about incremental and continuous change. As the network becomes more software-based, the organization needs to become more agile, so it can launch services more spontaneously. A decisive success factor will be how well the CoSP can integrate new software in the network, either working alone or collaborating with others.

The developers and operations teams should come together to share responsibility for the successful creation and launch of software updates and new services, using DevOps practices where appropriate. If network operators are to compete with over-the-top service providers, they need to have the same agility and flexibility when experimenting with new services. Front line staff should be empowered to test new technologies and new approaches, so they can quickly learn about them, and work out how they might be able to serve the network. This knowledge could prove valuable when drawing up the organization's 5G strategy.

Only 14 percent of telcos surveyed by Futurum said that front line staff were involved in guiding their 5G strategy, though. This could be an oversight: organizations where the CEO, senior management and front line staff share responsibility for 5G are less likely to consider themselves behind the competition than organizations where 5G ownership is limited to the CEO and senior managers (see Figure 3).

The experience gained on NFV, edge computing, network slicing, and RAN virtualization projects should inform the 5G strategy, and that's only possible if front line staff play a meaningful role in shaping it.

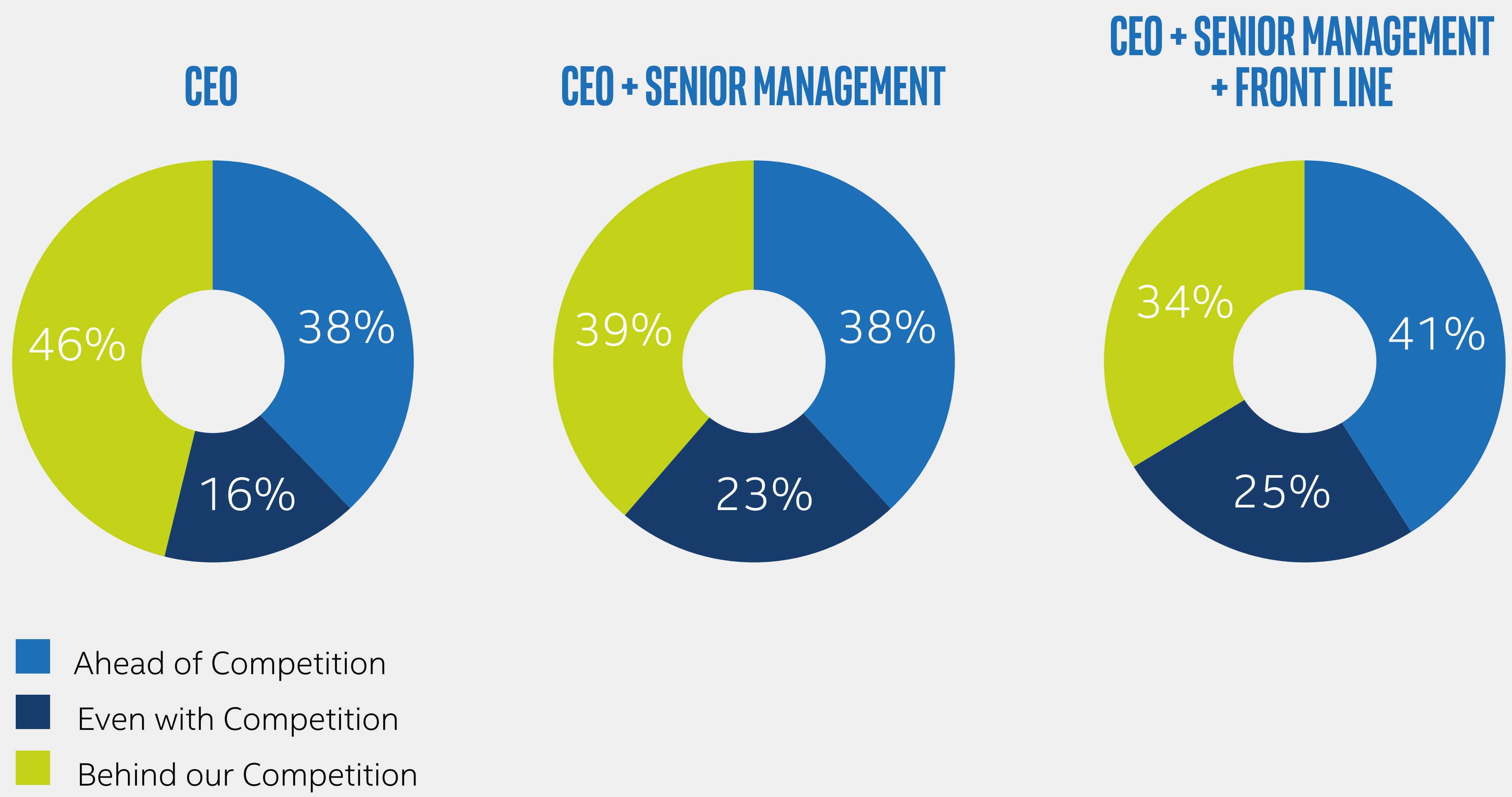


Figure 3. Who is responsible for 5G strategy? Involving front line staff makes the organization more likely to consider itself ahead of the competition, and less likely to consider itself behind the competition. Source: Futurum Research

CONCLUSION

While some CoSPs are planning to launch 5G sooner than others, all of them can start to prepare the infrastructure and the organization today. NFV, based on the Intel Xeon processor, enables organizations to improve agility and flexibility today, as they establish the infrastructure that will be essential for 5G. Edge computing and network slicing will help to fully exploit the technical and business potential of 5G, while keeping a careful eye on costs. These technologies can also be piloted in the 4G network. To handle the anticipated growth in demand for bandwidth and the number of connected devices, CoSPs can investigate RAN virtualization. All these projects and technology initiatives will have limited impact if the frontline staff implementing them don't have a hand in shaping the 5G strategy. The most successful organizations may prove to be those that bring together the CEO, senior managers, and frontline staff to pool their knowledge and talents.

BE READY FOR THE DEMANDS OF 5G

Clouds based on Intel® architecture are the foundation of future-ready digital businesses. The 2nd Generation Intel® Xeon® Scalable platform featuring Intel® Optane™ DC persistent memory provides a solid foundation for CoSPs deploying NFV, edge computing, network slicing, and RAN virtualization.

The 2nd Generation Intel® Xeon® Platinum processor with integrated Intel® QuickAssist Technology can help to boost security and compression performance in the virtual network. For analytics applications, Intel offers a flexible range of processors, from the Intel Xeon Platinum processor in the data center, to the Intel® Xeon® Bronze processor at the edge.

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[1] 5G Readiness and Transformation Index 2019, Futurum Research

[2] IDC Forecasts Network Functions Virtualization Infrastructure (NFVI) Revenues to Reach $5.6 Billion in 2022, August 2018

[3] https://www.intel.com/content/www/us/en/communications/5g-using-edge-computing-whitepaper.html

[4] Heavy Reading: 'Deploying MEC: Drivers, Use Cases, Relationships & Challenges', 2018

[5] https://www.ericsson.com/en/press-releases/2018/2/ericsson-and-swisscom-demonstrate-network-slicing-for-critical-communications

[6] https://www.huawei.com/en/press-events/news/2018/1/Vodafone-and-Huawei-make-Network-Slicing-innovation

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