



State of the Art Packet and
Optical Networking



Network Slicing

Cutting a Long Story Short...

The Quick Guide to Network Slicing Technologies for Mobile Network Operators – Which to Use, and When

If 5G achieves its full potential, it will, without doubt, revolutionise numerous sectors and industries. It promises vastly better connectivity, capacity, reliability, and latency, along with a huge range of completely new services vastly superior to anything that's gone before. But with such a leap in technology comes a whole new level of complexity – from Multi-access Edge Computing (MEC) to Xhaul to synchronisation to security – and not least of all, network slicing.

A Slice of the Future

As we've written about before, 5G will allow a raft of new services and applications not possible with 4G. Ones that go far beyond 'best-effort' mobile broadband. Not just for consumers, but businesses, public services and of course, industry. These new services will open up new opportunities for MNOs to broaden their portfolios and create new revenue streams. The big sectors set to make the most of 5G include:



Strategic Industries

5G will be essential for mission-critical infrastructure to evolve, so strategic industries that generate, manage, and distribute energy and other utilities can make the most of smart meters and smart grids, multi-directional power grids and other energy sources like wind and solar.



Media and Entertainment

High quality augmented reality (AR) and virtual reality (VR) services including gaming. Downloading 4k movies will take seconds and there will be new opportunities for broadcasters to enhance the viewing or live experience.



Smart Cities

Hyper-connected urban areas where traffic management systems, transport services, driverless cars, utilities, homes, healthcare and municipal services, cut costs and consumption, improve services, well-being, and quality of life for citizens.



Education and Training

Again, VR and AR will probably feature heavily, as will personalised learning plans, remote classrooms and better special needs services for students.



Self-driving Vehicles

Trials for 5G-enabled autonomous vehicles are underway. 5G connectivity will provide the real-time data from multiple sources to enable collision avoidance technology, in-car travel information, traffic management systems, roadside sensors, weather reports and other services.



Industry 4.0

5G will enable data collection and transfer and continuous monitoring and control for Industry 4.0 – IoT, robotics, analytics and machine intelligence on a grand scale.



Healthcare

5G-enabled devices could help to identify illness, dispense medication and call first responders in medical emergencies. With 5G's ultra-low latency capabilities, remote diagnosis, remote surgery and remote anaesthetic control are moving ever closer, though probably still a decade away.

Many forward-thinking Mobile Network Operators (MNOs) are getting to grips with the reality of the 5G opportunity (and its challenges). In fact, some are already quite advanced with their strategic plans of where they want to play in this new landscape, what new services they want to offer, and which of their current services can they evolve to take advantage of the technology and steal a march on their rivals.

However, there's a lot of complexity involved and where complexity resides, there's often confusion. And two words in the 5G tech mix that seem to cause more perplexity and puzzlement than, for example, 'MEC', 'Xhaul' or 'synchronisation' are... 'network slicing'.

The Size of the Prize

Ericsson and Arthur D Little (2017) estimate the 5G-enabled industry digitalization revenues for ICT players will be US\$1.3 trillion by 2026. Of this, Enterprise is seen as the biggest opportunity (\$300 billion expected revenues by 2025). Source: GSMA, 2016.

What is Network Slicing?

Network slicing is an architectural concept that allows the cutting of one physical infrastructure into multiple virtual networks. Each slice is then customised to meet the specific needs of the applications, services and resources that need to run over it. Up until now, in many cases this meant building different networks for each type of service offered. But in the 5G world, that would be incredibly expensive and commercially inviable. Instead, the idea is to allocate one set of network resources by service type.

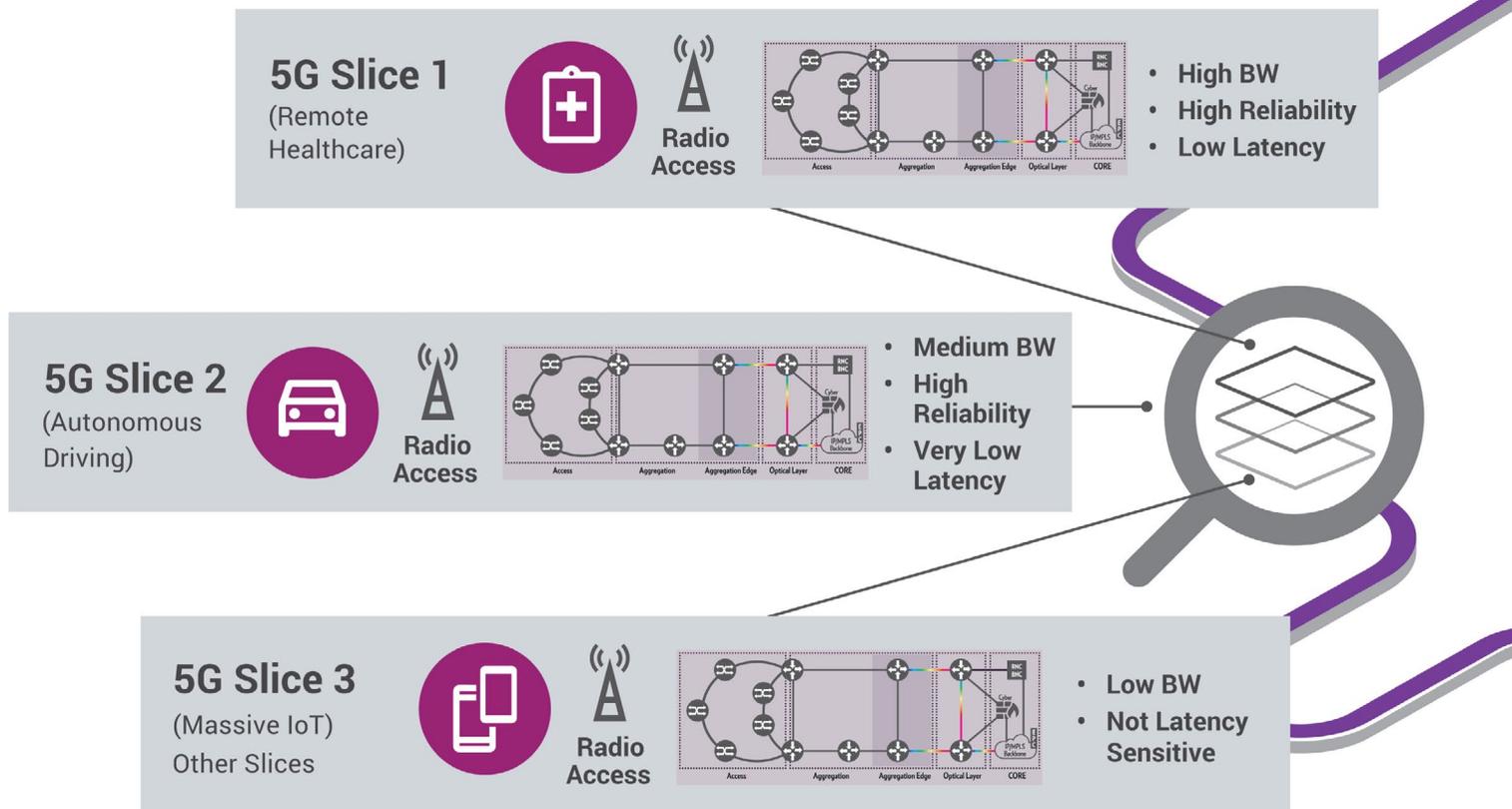
For enhanced broadband, for example, a lot of capacity is needed but not exceptionally low latency. So there would be no need to add compute power at the edge of the network. For ultra-reliable low-latency (URLLC) services however, resources need to be allocated in a way that provides a highly reliable, resilient and secure service. Which usually means needing edge computing to guarantee real-time monitoring and control to the inputs received from sensors.

There is some debate about how many slices would be required, but at least a slice for each high-level service type – enhanced broadband, mass IoT and mission-critical services. And possibly one or two sub-virtual networks (sub-slices) to cope with different types of service within that slice

What Does a Slice Look Like?

The simplest way to describe a network slice is to view a network as a pool of assets made up of physical network functions (PNFs), virtual network functions (VNFs), connectivity, bandwidth and compute. By combining these assets, it's possible to form a network slice with a specific set of operational parameters that fit what's required. All while being dynamic enough to allow extra capacity, processing and VNFs to be spun up and down as service requirements change.

Each slice is isolated from other slices so performance and loading of a slice won't affect the performance and loading of other slices. In other words, the resources and assets assigned to each slice are reserved for services that run over that slice – and cannot be used by other slices. In effect, a private network is created for each service type, much like building a separate network for each service type, but assets may be shared across multiple slices as long as they can be isolated. So for example, the compute asset offered by the network may be used by multiple slices, with one slice running two virtual machines (VMs) and another running three VMs on this asset. Or one slice may require 100G capacity through a node and another may require 200G capacity, as long the capacity is reserved then this is acceptable



Once Slice or Two, or Three, or More?

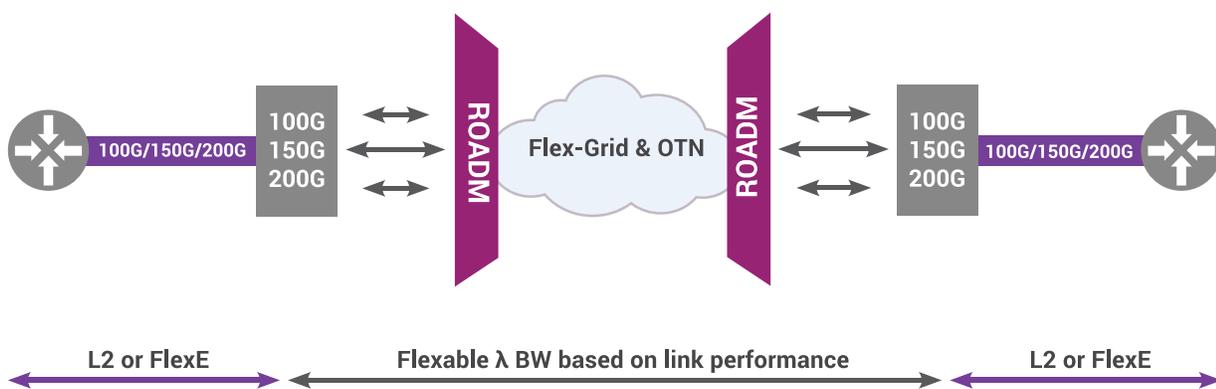
To live up to its billing, 5G has to support services that might require ultra-high capacity, or ultra-high reliability, or ultra-low latency. But to achieve these very different requirements on the same network means cleverly orchestrating an already complex system in such a way that each slice accommodates different operating constraints and policies. In other words, finding the right path across the network for each service type, and using the best (transport) technology.

So what viable slice-enabling technologies are there? At Ribbon, we think there are a few key ones to consider and possibly combine, depending on what the end-goal is:

1

OTN and Wavelength Slicing (Hard Slicing)

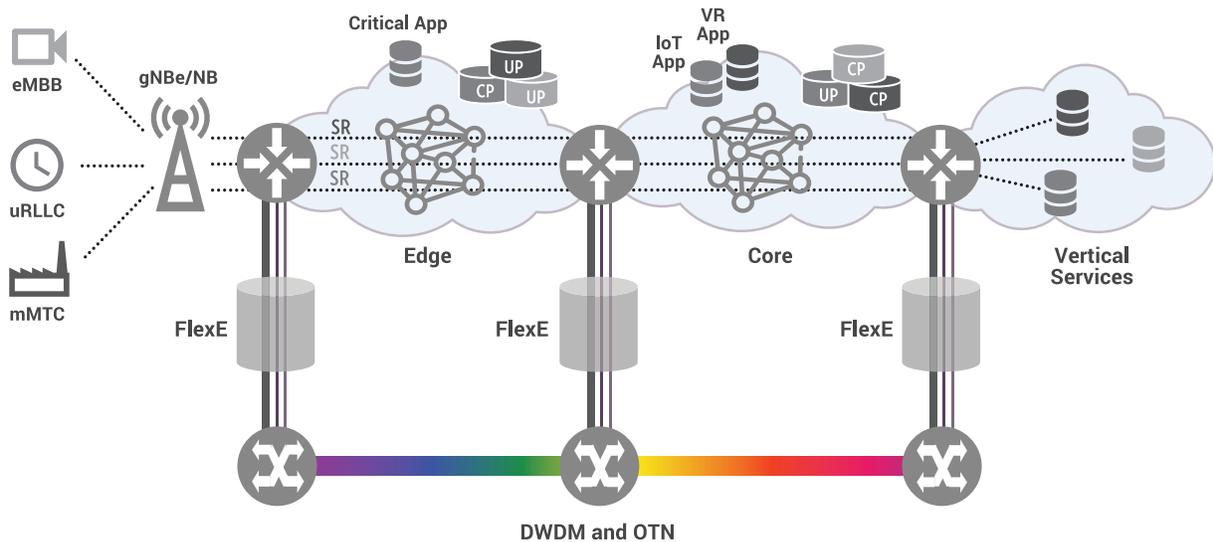
OTN or wavelength slicing can be used to create network slices directly across the optical transport network. Router bypass can then be used for services travelling directly from the edge to the core, to provide the lowest possible latency and free up router ports. OTN is deterministic and rides on wavelengths – the lowest cost per bit mechanism you can find in a network.



2

Flexible Ethernet (FlexE) (Hard Slicing)

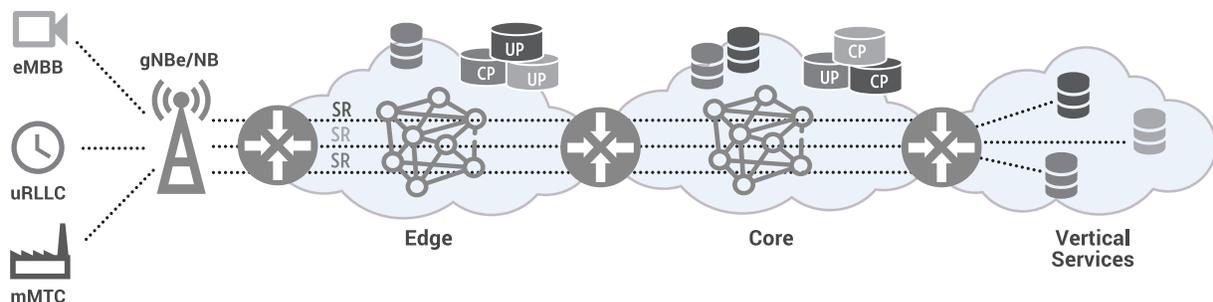
FlexE provides deterministic transport by using TDM (time-division multiplexing) principles to remove flow control when mapping IP packets services onto the optical layer. It essentially acts like a clutch mechanism between the IP slices and the OTN slices. In effect, FlexE adds a TDM frame structure, which allows more efficient dynamic bandwidth capacity than traditional link aggregation – but without the latency associated with flow control. It's the FlexE pipes that create the fixed bandwidth connectivity that links specified network assets for each network slice you need.



3

Service Provisioning (Soft Slicing): Segment Routing (TE) and Enhanced VPN

Segment routing is a key enabler for network slicing and adds determinism to packet networks, which you need to guarantee latency and reliability. It uses source-based routing controlled by a centralized path computation element (PCE) that allows precise, deterministic paths to be created across the network. The control function has full knowledge of the transport resources. With segment routing it's possible to create network slices that meet the specific service demands of the service type being transported. So for example, slices created to meet strict requirements on service reliability and delay variation would follow very different paths to services offering low-cost transport of high-capacity services.



Roll-Out: Three Things to Think About

Here are three things Ribbon recommends you do when it comes to rolling out 5G services:



Plan for Future Services

While enhanced mobile broadband services won't require a slicing to begin with, it makes sense to be ready to add a highly deterministic slice for future new services MNOs might want to offer in order to increase their revenues. In other words, service providers need to make sure the network they put in place can easily evolve to support slicing technologies such as: segment routing, FlexE and OTN.

Don't forget: companies will need to revisit their operations support systems (OSS) strategy to understand how to orchestrate these dynamic new services. These are far from static like the traditional mobile and fixed services.



Gain Some Autonomy

MNOs who see an opportunity to generate income through autonomous vehicles and remote surgery in future, will require ultra-reliable low-latency connectivity (URLLC) slices, along with segment routing.

Don't forget: MNOs need to make sure the air interface (the radio) is paired with the right transport slice, once the transport network is set up for these types of services. If they want low latency, they must optimise the radio for low latency. Again, this should form part of a company's OSS strategy.



Think About the Optics

The optical layer slice will underpin everything. That's because bulk transport is so much more cost-effective on the optical layer. Of course, it might not be used every time, but it needs to be there so it can be used for bulk transport.

Don't forget: orchestration needs to happen between resources an MNO owns and between resources outside of their organization. More than likely, MNOs will need to orchestrate across vendors and networks, each with their own orchestration systems. It sounds complex, because it is, but rest assured the industry is working diligently to find a solution to this issue.

Conclusion

5G promises to change the way we live our lives, with unprecedented services and unparalleled user experience. However to deliver on this promise, service providers need to ensure that their underlying connectivity infrastructure is capable of delivering on demands like massive machine connectivity, ultra-low latency and hyper-flexible bandwidth. Preparing for these changes will require a whole new way of thinking and working for many mobile network operators worldwide.

Up until now, carriers often built different networks for each type of service offered, or offered 2 basic types of services: all-purpose connectivity (like the internet) and dedicated connectivity (i.e. VPN). But in the 5G world, this would be incredibly expensive and commercially inviable. Instead, the idea is to employ network slicing.

Ultimately, 5G's success will depend on its ability to support a diverse set of services with varied requirements for latency, capacity and availability. What's clear is that today's 'good enough' and 'one-size-fits-all' approach is just not viable. Network slicing, working in conjunction with other network assets, provides a way to support a full range of services, by creating multiple virtual networks on a single common network infrastructure, that's simply not possible in traditional mobile networks.

Contact us to learn more about Ribbon's 5G solutions at [rbbn.com](https://www.ribbon.com)

About Ribbon

Ribbon Communications (Nasdaq: RBBN), which recently merged with ECI Telecom Group, delivers global communications software and network solutions to service providers, enterprises and critical infrastructure sectors. We engage deeply with our customers, helping them modernize their networks for improved competitive positioning and business outcomes in today's smart, always-on and data-hungry world. Our innovative, end-to-end solutions portfolio delivers unparalleled scale, performance, and agility, including core to edge IP solutions, UCaaS/ CPaaS cloud offers, leading-edge software security and analytics tools, as well as packet and optical networking leveraging ECI's Elastic Network technology.