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# Unleashing the potential of 5G in Southeast Asia

## Executing a cost-effective migration

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# Contents

# Unleashing the potential of 5G in Southeast Asia

Nearly a decade after the launch of 4G, the deployment of 5G appears to be finally gaining speed and scale. Indeed, hardly a week goes by these days without news of a 5G commercial launch in some part of the world, or a declaration of 5G as critical digital infrastructure amidst the transnational jostle for technology dominance.

At this time of writing, there are at least 118 live commercial 5G networks across the globe[1]. With another 30 more launches scheduled to have taken place by the end of 2022[2], this decade looks set to be a breakthrough one for the telecommunications sector. But even amidst this tectonic shift, we have observed that many communications service providers (CSPs) in Southeast Asia continue to remain cautiously optimistic about the cost-versus-revenue proposition of 5G.

There are, of course, good reasons for this. 5G's speed and coverage capabilities rely heavily on network densification, which requires not only the addition of towers and small cells to the network, but also an evolution in the transport network and transition to a cloud-native core. In addition, 5G standards also provide for less spectral efficiency gains than previous generations of network technology; instead, improved speed and capacity stem from the ability to utilise large blocks of contiguous spectrum and higher frequencies—which, in turn, requires CSPs to add three to 10 times the number of existing sites to their networks[3].

These cost considerations are further compounded by several short-term revenue concerns—in particular, the lack of killer use cases in the enterprise segment, and limited appetite in the consumer segment for the premiums demanded by 5G-enabled devices. Inevitably, the result has been the adoption of more measured, follower approaches by most CSPs towards 5G—with only a few select players daring enough to step up as first-adopters of this ground-breaking technology.

Cognisant that concerns surrounding the fundamental economic viability of 5G—that is, its total cost of ownership—will continue to hold sway on a CSP's strategic choices for the foreseeable future, we will discuss in this report what we believe to be the most cost-effective 5G migration trajectory. Along the way, we will also examine some of the critical considerations that we believe CSPs will need to account for as they embark on their own unique journeys in unleashing the full potential of 5G.

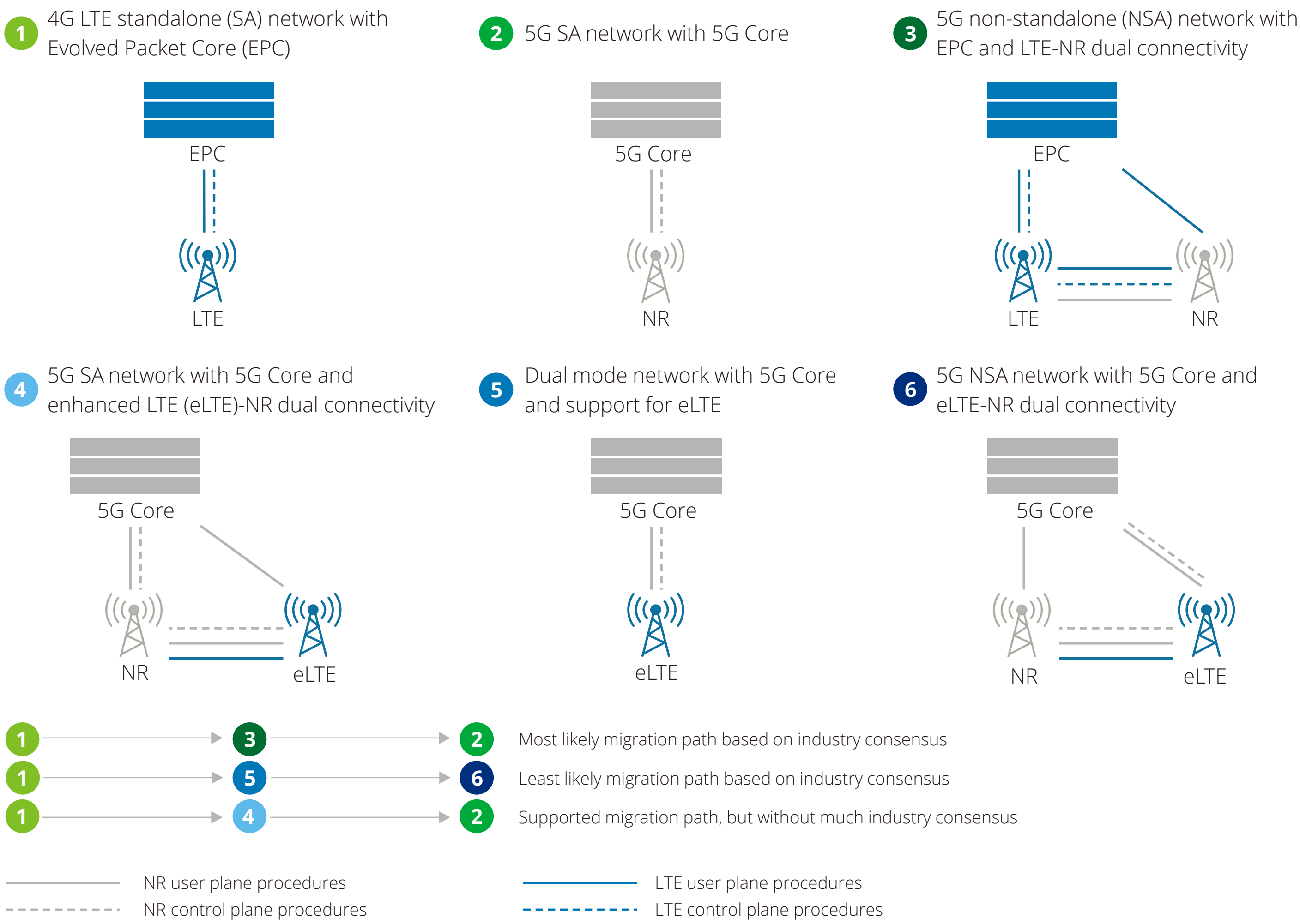
1. "Ericsson Mobility Report: June 2022 report edition". Ericsson. June 2022.
2. "Predictions 2022". Forrester. 2022.
3. "5G: The chance to lead for a decade". Deloitte. 2018.

# Executing a cost-effective migration

## Given that CSPs are at different stages of maturity in their transition to 5G, it is difficult to pinpoint a one-size-fits-all roadmap for deployment. Recognising this challenge, the 3rd Generation Partnership Project (3GPP)—a global organisation uniting seven telecommunications standard development organisations—has developed a series of six different 5G migration options for the industry[4].

Based on the degree of forward and backward compatibility between its 4G Long-Term Evolution (LTE) and 5G New Radio (NR) control plane and user plane procedures—as well as the accompanying support provided by its wider ecosystem of original equipment manufacturers (OEMs), and device and chipset manufacturers—each CSP will likely need to consider a different set of options (see Figure 1).

**Figure 1: Six 5G migration options proposed by 3GPP**




Source: GSMA

4. "5G implementation guidelines". GSMA. July 2019.

### Current industry consensus

It is important to note that while all six proposed migration options will be supported, the 3GPP intends for the industry to align on a single approach to minimise fragmentation of the 5G ecosystem from hardware, software, and interoperability perspectives. Furthermore, adopting a consistent approach could also considerably reduce complexity, lower system integration costs, and lessen the amount of testing that will be required before a system can go to market.

Based on current industry consensus, the most cost-effective and future-proof trajectory is likely to be for CSPs to migrate from Option 1 (4G LTE SA network with EPC) to Option 3 (5G NSA network with EPC and LTE-NR dual connectivity), and then to Option 2 (5G SA network with 5G Core).

There are two main reasons for this. Firstly, this approach would be in line with the pace of development and maturity of 5G use cases in enhanced mobile broadband, ultra-reliable low latency communications (URLLC), and massive Internet of Things (IoT). Secondly, this approach would also maximise the re-use of existing assets, while ensuring a steady, manageable migration process to deliver the full range of benefits from 5G.

### Two key considerations

In this section, we will examine two key considerations for CSPs in Southeast Asia as they embark on their journey of executing a cost-effective 5G migration process according to the abovementioned trajectory:

**1. Leveraging a cross-domain design approach**

For CSPs, the ability to cost-effectively estimate capacity demand and translate it into network capacity is a never-ending challenge—and this conundrum is only going to become even more complex in a 5G world, where there would be a proliferation in the number of use cases (logical networks) that a given physical infrastructure will need to support.

The use of a cross-domain design approach to network planning is, therefore, critical to enabling CSPs to sweep away the inefficiencies of traditional organisational siloes, and make more informed investments in the network upgrades that will ultimately underpin all their service offerings. Indeed, recent research suggests that leading CSPs who have leveraged a cross-domain design approach have benefited from an average 45 percent reduction in time-to-market, 30 percent decrease in total cost of ownership, and 14 percent increase in end-to-end service reliability[5].

To understand how the cross-domain design approach works, it may be instructive to consider its implementation for a specific use case—in this instance, the planning and design of radio sites. Briefly, such an exercise will entail an assessment not only of the radio sites per se, but also the surrounding transport networks and edge data centres.

The two steps in this process are broadly as follows. Firstly, we will conduct a traffic analysis. Using call records, we can create a highly granular 3D map of an urban area illustrating the call volume and data throughput for the different streets and buildings—even down to the specific data for each floor within a building. Secondly, we will conduct an analysis of the site build costs, including those required for power deployment and construction of fibre towers.

The result would then be a radio plan, with a highly detailed cost-benefit analysis of network coverage and cost for each site. This plan could, in turn, serve as the input for a data centre planning tool to be used to identify suitable locations for computing and storage capabilities (or edge data centres) across the network, while taking into consideration requirements for physical space, power, and cooling.

**2. Determining trade-offs in migration priorities**

Without doubt, the 5G NR is expected to account for the lion's share of a CSP's migration effort in terms of capital expenditure, overlay, time, and effort. The 5G NR alone, however, is by no means sufficient for the CSP to realise the full range of benefits that 5G offers. Indeed, the order of priority for CSPs should be to firstly get to the 5G Core; secondly, ensure that their transport network can do the heavy lifting; and only thirdly, focus on the deployment of the 5G NR.

5. "Communications Infrastructure: 2021 Review and 2022 Outlook". MoffettNathanson. December 2021.

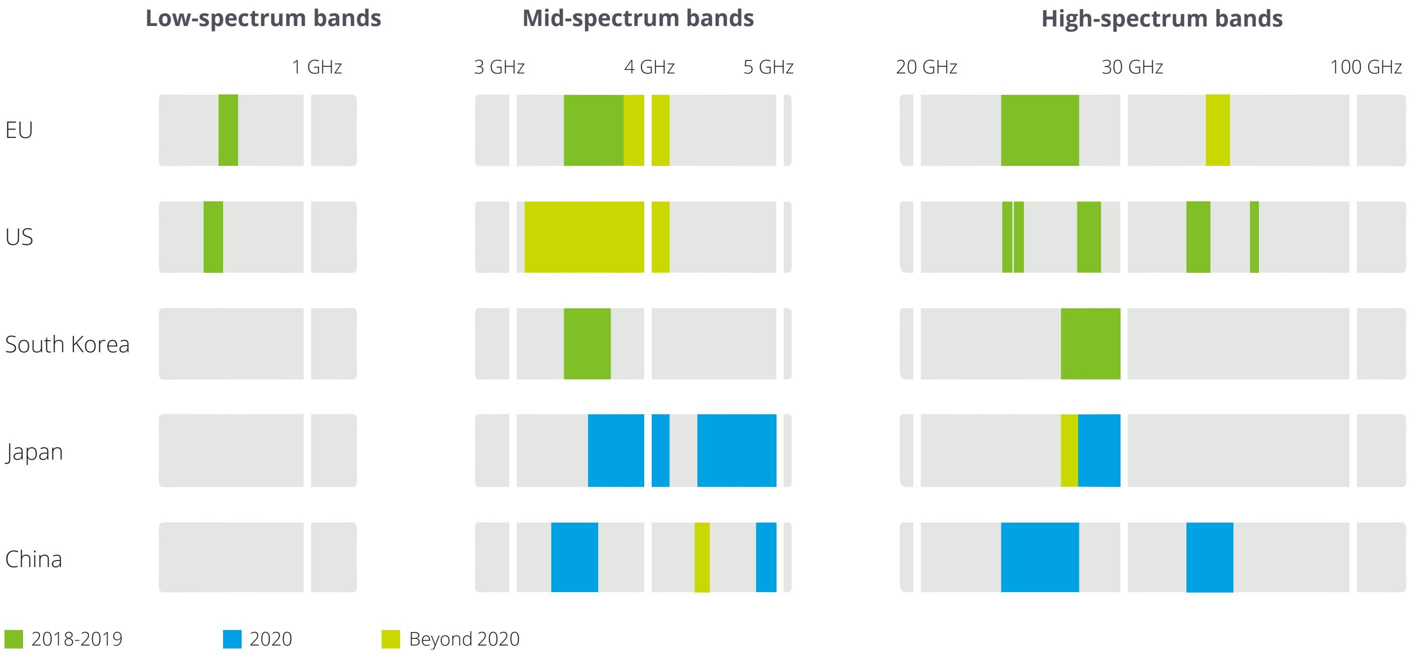
In the migration from 4G LTE to 5G NR, CSPs should also consider re-using existing assets wherever possible, including spectrum, to keep their total cost of ownership under control. Having a solid 4G LTE network, therefore, is an important step to laying the foundation for a seamless migration to 5G NR—especially given that both are expected to co-exist with each other for many years to come. CSPs should also deploy the extensive toolkits that they have at their disposal to expand 5G network coverage and capacity, while balancing these priorities with their legacy investments in 4G LTE.

Furthermore, when CSPs successfully arrive at the Option 2 scenario under our aforementioned trajectory, 2G and 3G networks will have most likely ceased to exist. In addition, we could probably expect a logical split in the 4G and 5G architectures, which will be necessary both to improve the efficiency of 5G systems as well as maximise spectrum utilisation by harmonising the user-plane stack[6]. Indeed, the higher up the user-plane stack this harmonisation can be achieved, the larger the gains for CSPs.

But a word of caution is in order: CSPs must carefully manage the trade-offs between 4G LTE and 5G NR, and determine the optimal level of co-existence that they would like to have between the two. Beyond a certain threshold, it would become counterproductive to forgo potential 5G NR gains in favour of interworking with existing 4G LTE networks.

Currently, most 5G deployments across the globe are taking place in the mid-spectrum bands; the only exception is perhaps the US, where some CSPs have begun deployment in high-spectrum bands[7] (see Figure 2). We expect, however, all bands to eventually be used for 5G, either through dynamic spectrum sharing (DSS) or spectrum re-farming. Ultimately, to ease CSPs' capital expenditure burdens and expedite rollouts, 5G deployments must also be made airwave-agnostic—and in this respect, regulators will have a vital role to play.

**Figure 2: An overview of spectrum availability in key global markets**




Source: Ericsson

6. Level 1: Physical > Level 2: Media Access Control (MAC) > Level 3: Radio Link Control (RLC) > Level 4: Packet Data Convergence Protocol (PDCP) of 5G Air Interface Variants
7. "Ericsson Mobility Report: June 2022 report edition". Ericsson. June 2022.

# Adopting an evolutionary approach

In this section, we will explore some of the issues that CSPs in Southeast Asia should consider as they evolve their radio access network (RAN), transport network, and core in their transition from today's standalone 4G LTE networks to tomorrow's standalone 5G NR networks.

For the purposes of our discussion, we will assume a baseline scenario of a 4G LTE network with three characteristics typically observed in most of today's deployments: inter-site distances (ISD) of 500-700 metres; spectrum bands of 1-3 GHz or sub-1 GHz; and carrier bandwidths of 15-20 MHz.

## Evolving the RAN

Briefly, to evolve the RAN from 4G LTE to fully standalone 5G NR, a CSP will need to implement four key steps (see Figure 3):

**Step 1**: **Introduce 5G NR with dual connectivity**
As a first step, 5G NR is introduced with the use of the standardised 3GPP E-UTRA-NR Dual Connectivity (EN-DC) configuration. Under this configuration, the 5G NR will be anchored onto 4G LTE carriers, with the 4G LTE macro layer continuing to provide blanket coverage.

Limited 5G coverage will be available within cells, typically within a 100-metre radius. A decoupling of uplink and downlink spectrums could also help to improve 5G coverage within a given coverage area: 4G LTE is used for the uplink signalling and data bearers, as well as downlink signalling bearers, while 5G NR is used for the downlink data bearers.

**Step 2**: **Introduce 5G to mid-and low-FDD bands**
Using DSS with 4G LTE and 5G NR carrier aggregation, this step will introduce 5G to the mid- and low-frequency division duplex (FDD) bands. In doing so, 5G coverage will be extended to the point where it nearly overlaps with 4G LTE coverage—that is, a radius of about 300-500 metres.

Prior field deployments have demonstrated clear benefits of carrier aggregation in terms of spectral efficiency. This implies that either a greater number of users can be served with the same spectrum, or existing customers can be served with higher data rates of up to 2 Gbps—which we already know is a commercial reality.

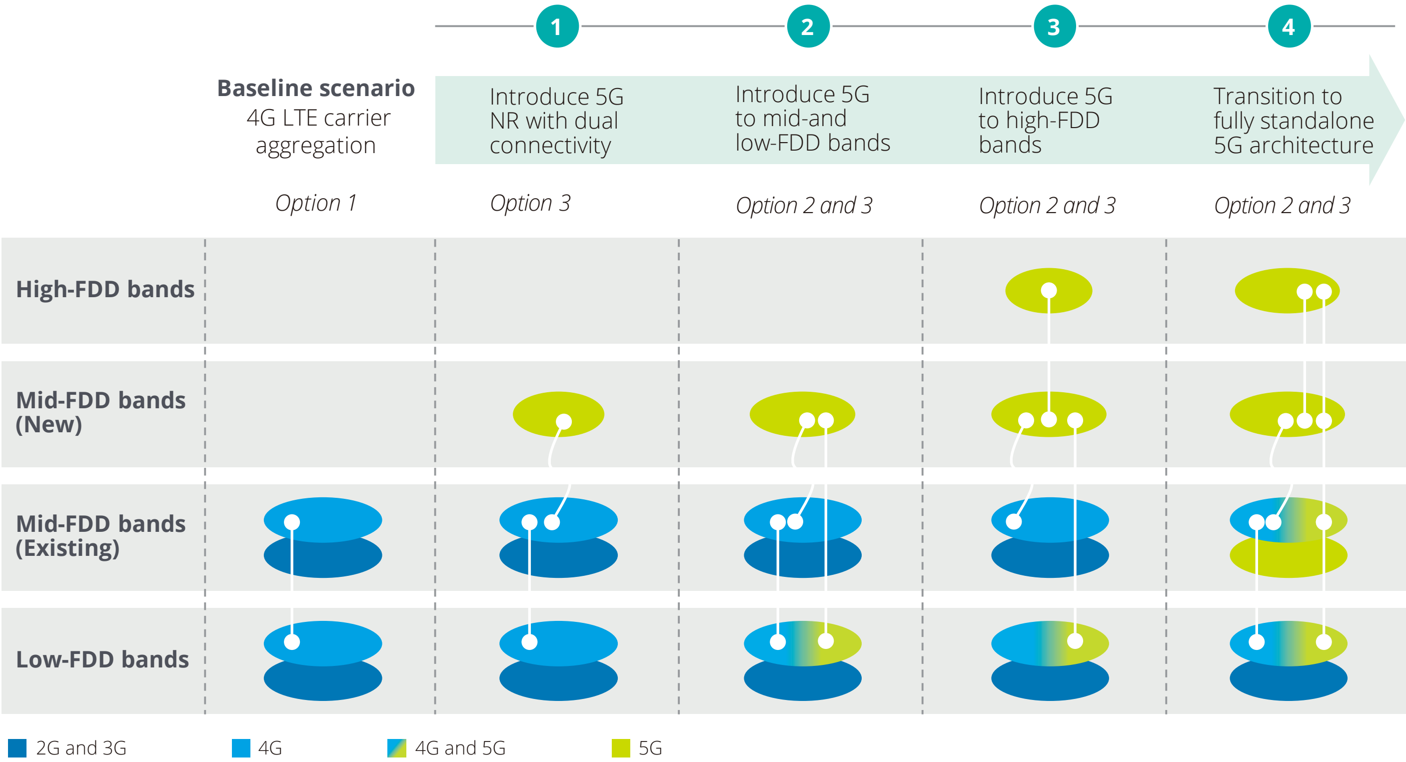
**Step 3**: **Introduce 5G to high-FDD bands**
In this step, the focus is to introduce 5G to the high-FDD bands to boost peak rates to 5-10 Gbps and further reduce latency. 5G NR carrier aggregation is to be deployed between the high-, mid-, and low-FDD bands. On the low-FDD bands, DSS is used to assign more spectrum to the 5G NR instead of traditional spectrum farming, as 4G LTE traffic gradually offloads from the network.

Once complete, robust 5G coverage will almost completely envelop 4G LTE coverage. Extensive use of carrier aggregation will allow CSPs to move 5G NR uplink control channels to 4G LTE to increase 5G NR downlink coverage in the mid- and low-FDD bands.

**Step 4**: **Transition to fully standalone 5G architecture**
In this final step towards a fully standalone 5G architecture, URLLC becomes a reality. 5G NR carrier aggregation between all FDD bands should be pushing peak rates upwards of 10 Gbps.

2G and 3G deployments would cease to exist—at least within the mid-FDD bands—with the freed-up spectrum repurposed for 5G. DSS should also continue to be used extensively, with 4G LTE traffic squeezed into even narrower FDD bands to economically handle dwindling traffic.

**Figure 3: Evolution of the RAN**



## Evolving the transport network

5G RAN performance, both in terms of peak rates and latency, depends in large part on the capacity and topology of the underlying transport networks. While microwave and fibre will continue to form the backbone of the backhaul, they will undergo significant changes along three main dimensions (see Figure 4):

1. **Synchronisation:** Introduction of time and phase synchronisation, in addition to frequency synchronisation used by legacy networks

2. **Capacity:** Introduction of e-band and multi-band solutions for microwave, Internet Protocol (IP) routers with higher switching capacities, and faster interfaces

3. **Routing protocols:** Introduction of IP Multiprotocol Label Switching (MPLS) to support lower latency

Currently, microwave links are capable of handling capacities of up to 100 Gbps with latencies lower than fibre, for distances of up to two kilometres. Given these inherent advantages in speed, point-to-point connectivity, as well as the ease and speed of its deployment—that is, where topography (line of sight) and weather conditions permit—microwave is expected to increasingly replace fibre in last-mile connectivity (within one to two hops).

In addition to microwave, Integrated Access and Backhaul (IAB) will also increasingly be deployed in high-FDD bands—in particular, for the wide-area category, where there is the possibility of leveraging spare radio resources for transport. Furthermore, as the transport network evolves towards a radio-near or integrated transport model—and eventually, convergence between backhaul and access—dense wavelength-division multiplexing (DWDM) and dark fibre could be used as complements to IAB.

The Common Public Radio Interface (CPRI)—the interface between the remote radio head and baseband unit used for fronthauling—will also increasingly give way to the evolved Common Public Radio Interface (e-CPRI) and F1 interfaces (between the central unit and the distributed unit), as the RAN architecture evolves from the present-day distributed model to a centralised model, and then to virtualised model. For the foreseeable future, we expect to see a co-existence of all three architecture models, in view of the risks of operating a centralised and/or virtualised model without sufficiently sophisticated automation.

**Figure 4: Evolution of the transport network**

| | **Baseline scenario** 4G LTE carrier aggregation *Option 1* | 1 Introduce 5G NR with dual connectivity *Option 3* | 2 Introduce 5G to mid-and low-FDD bands *Option 2 and 3* | 3 Introduce 5G to high-FDD bands *Option 2 and 3* | 4 Transition to fully standalone 5G architecture *Option 2 and 3* |
|---|---|---|---|---|---|
| **Capacity** | >200 Mbps | <1.5 Gbps | 1-5 Gbps | 5-20 Gbps | |
| **Interface** | Gigabit Ethernet (GE) | N x GE/10GE | 10GE | 2 x 10GE/25GE | |
| **Synchronisation** | Frequency | Frequency, time, and phase | Frequency, time, and phase | Frequency, time, and phase | |
| **Backhaul** | Microwave/ Fibre | Microwave/ Fibre | Microwave/ Fibre | Microwave/Fibre/Integrated Access and Backhaul (IAB) | |
| **Fronthaul** | CPRI | CPRI | CPRI/Evolved CPRI (e -CPRI) | CPRI/eCPRI | |

### Evolving the core

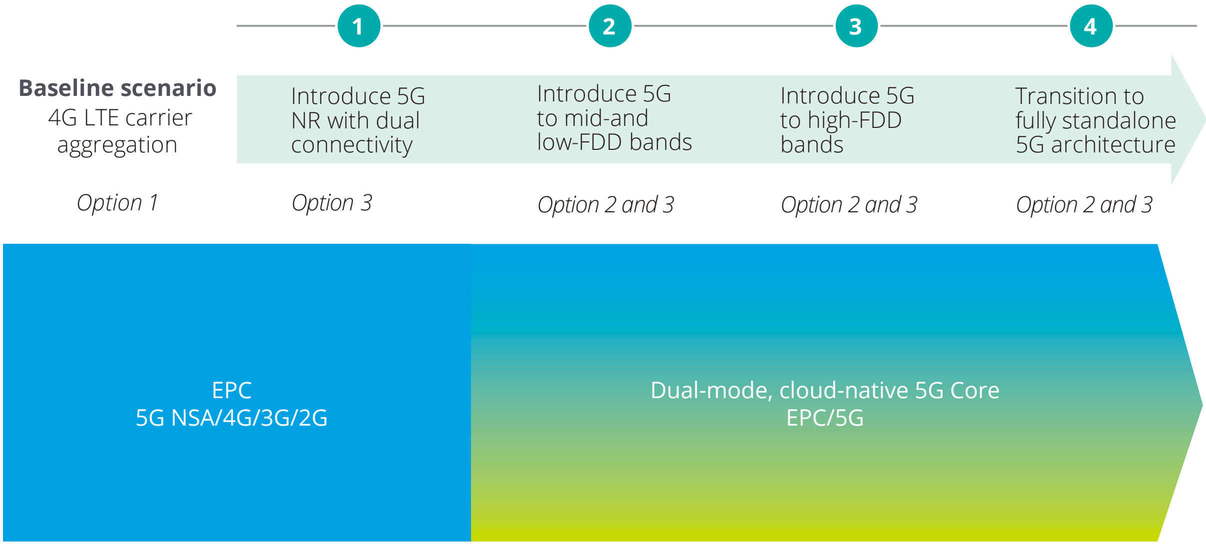
A cloud-native 5G Core is essential for CSPs to reduce the costs and complexity of executing a 5G migration. This, in turn, calls for a gradual but flexible evolutionary approach with the step-by-step introduction of 5G to not only secure traffic during the transformation process, but also protect investments in legacy networks (see Figure 5).

Although commercial EPC networks currently do not support 5G NR control procedures, they are capable of supporting 5G NSA. In such a setup, the 5G base station does not communicate with the mobility management entity; rather, it receives requests to activate or deactivate 5G bearers via the Evolved Node B (eNodeB).

Of note is also the fact that latency is a function of all three domains of the network—RAN, transport network, and core—and not just RAN, as it is often made out to be. Achieving the desired latency, therefore, will require the core to be optimised for the user plane via a network functions virtualisation infrastructure (NFVi)'s computing, storage, and networking functions.

Ultimately, CSPs may also be better off planning for the more ambitious target of sub-1 ms latency, rather than focusing their efforts on reducing latency once it has already been induced as a function of network topology. Making such a strategic choice now will enable CSPs to reap exponential benefits relating to the footprint of their overall network in the long run: the number of sites required to deliver a 2ms latency to a given urban area, for example, may be manifold that of the number required to deliver an 8ms latency to the same area.

**Figure 5: Evolution of the core**



# A closer look at indoor 5G deployment

Much of our discussion thus far has centred around the deployment of 5G by CSPs. In this section, we will adopt a more consumer-centric perspective, and examine how the deployment of 5G could potentially revolutionise the consumer experience—particularly for indoor settings.

Consider the example of a live football match. Any football fan can probably relate to the euphoria of watching a live game and being in the thick of action at a packed stadium. Yet, they would have also at some point experienced just how painful it can be to share these moments with their friends and families—whether it is through video calls, or the sharing of photos and videos through a congested network.

But sports fans may soon have reason to cheer. With the advent of 5G, the in-venue connectivity landscape looks set to evolve. Traditionally, in-venue connectivity has been enabled by legacy distributed antenna systems (DAS), which often provide spotty network coverage during peak traffic. With the implementation of under-the-seat (UTS) capacity densification, however, it becomes possible to achieve a more even and reliable network coverage (see Figure 6).

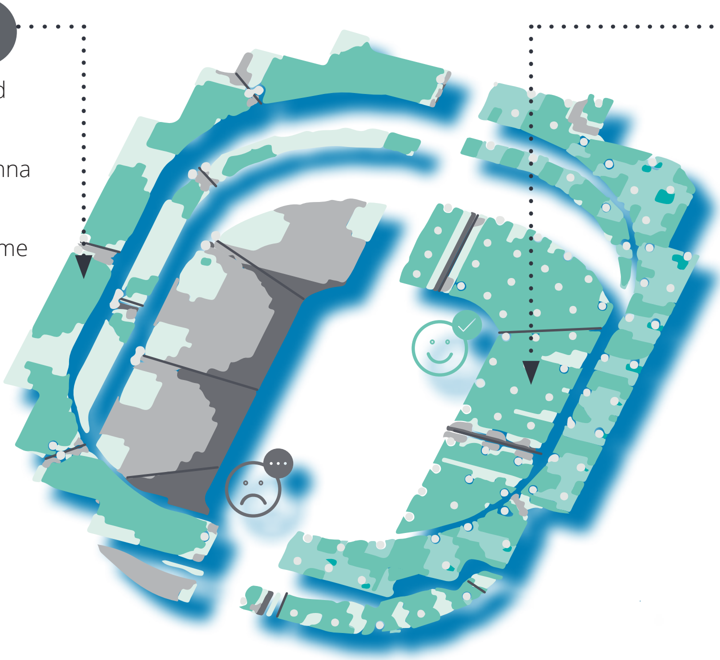
Specifically, UTS capacity densification could be used as a complement to the legacy DAS to not only provide more bandwidth to multi-tasking spectators, but also drastically reduce the amount of interference. This is achieved by leveraging sharply defined cell boundaries and coverage contours that conform to seating sections, which help to ensure that handovers only happen when spectators move up and down the aisles—but not when they move from side to side.

Furthermore, UTS capacity densification could enable venue owners to deploy highly precise location-based services to track spectator movements throughout the stadium, and thereby benefit from a multitude of options to monetise their services. Cells on wheels, otherwise known as mobile base stations, would also no longer be required, except in situations where additional capacity is needed—such as in parking lots, which are typically out of range from 5G UTS deployments that rely on line-of-sight communications.

**Figure 6: How 5G deployment will improve indoor connectivity at a sports stadium**

**Legacy DAS**

- Capacity scaling is limited by interference
- Limited options for antenna locations
- Spotty coverage, with some areas receiving better coverage than others



**UTS capacity densification**

- A complement to the existing legacy DAS
- More effective antenna isolation
- Significantly higher network bandwidth
- An improved and more consistent user experience
- Deployment will enable the rollout of location-based services

Excellent coverage | Good coverage | Poor coverage | No coverage (blind spots)

# The race to 5G leadership continues

CSPs know from experience that many of the players who had been early adopters of prior generations of wireless technology had been rewarded with significant benefits—and that 5G possesses an even greater potential for them to glean a first-mover advantage. Fundamentally, this is because 5G is not merely a new wireless interface protocol offering more capacity and better performance for smartphones.

While it is that, it is also in fact a myriad of technology innovations—such as antenna designs and device communication protocols—capable of standardising both the way in which licensed and unlicensed networks interact, and the way in which network applications collaborate. Given its wide array of capabilities, 5G is set to influence everything we do, with seismic implications on our macro economy.

To harness this potential, however, CSPs must quickly work to coalesce their 5G ecosystems around Option 2 and 3 for deployment. As detailed earlier in this report, such a deployment approach would ensure that all of the investments that they make today are in line with their envisioned, long-term target architecture. This would, in turn, not only enable CSPs to reap the benefits of 5G without incurring unnecessary costs and complexity, but also enable them to reduce the amount of time and cost required for future network upgrades, simplify interoperability between networks and devices, and accelerate the scaling of their 5G ecosystem.

As they do so, CSPs must bear in mind that history has shown that an ecosystem approach almost always trumps isolated solutions in the uptake of new and emerging technologies. They would, therefore, do well to ensure that they and all their ecosystem partners—including but not limited to OEMs, and device and chipset manufacturers—converge on this defined path. Any divergence is only likely to add more complexity to the ecosystem, drive up the total cost of ownership—and ultimately, slow down overall development.

For more insights, please contact

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