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White paper

Operators can use SuperDSS to fast track their 5G network deployments

October 2020

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RESEARCH

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1. Executive summary

The persistent growth in mobile data traffic during the last 10 years has incentivised mobile network operators (MNOs) to continuously innovate and improve their network coverage and capacity by investing in new sites and spectrum. However, both are scarce resources. MNOs must invest in new 5G mobile technology to increase spectrum efficiency and avoid a drop in customer satisfaction due to network congestion. Tools such as super dynamic spectrum sharing (SuperDSS) will facilitate the early introduction of 5G networks by enabling spectrum sharing and will futureproof network designs by simplifying the operations and maintenance (O&M) of legacy 2G, 3G and 4G networks. Analysys Mason forecasts that mobile data traffic worldwide will grow at a CAGR of 30% in the 7 years to 2024 to reach 1632EB.[1] We also forecast that mobile data traffic will grow at a CAGR of 31% in China and 25% in Western Europe during the same time period.

However, there are challenges to MNOs' 5G business cases, despite the benefits outlined above, because mobile ARPU has been flat or declining in the last 5 years in many countries. In fact, mobile ARPU fell by 20% worldwide between 2015 and 2020,[1] which puts pressure on MNOs' abilities to invest in new networks. Operators will deploy 5G networks to not only offset declining revenue, but also to ensure that new revenue-generating services from consumer- and industry-based use cases (such as gaming and smart factories, respectively) can be realised.

The availability of 5G spectrum is critical; without it, MNOs cannot deploy new networks. Spectrum in the sub-1GHz, 3.5GHz (known as mid-band) and millimetre-wave (mmWave; above 26GHz) bands has been designated for 5G use. However, national regulatory authorities (NRAs) must either auction or allocate spectrum blocks in these bands to MNOs because it can be used. On occasion, existing incumbents (such as satellite service providers) may already be using spectrum in these bands. In these cases, different spectrum will have to be allocated in order to free up resources for mobile services. This process can be arduous, bureaucratic and may require lengthy negotiations, which can delay MNOs' 5G deployment plans.

MNOs can use SuperDSS technology to launch 5G networks using their existing spectrum assets in countries where NRAs' spectrum auction plans have been delayed (due to COVID-19 in some cases). SuperDSS is an innovative technology that goes one step beyond 3GPP-defined DSS. Traditional DSS only considers the dynamic sharing of 4G and 5G, while SuperDSS, an industry first, supports triple-RAT sharing (that is, either 2G, 4G and 5G dynamic sharing, or 3G, 4G and 5G dynamic sharing). As such, MNOs can use SuperDSS to maintain a competitive advantage in the market, fast track their 5G deployments using existing spectrum assets and continue to deliver legacy services.

Even those MNOs with advanced 4G networks may still depend on 2G and 3G networks for legacy services, such as circuit-switched voice and other machine-to-machine (M2M) or internet of things (IoT) services. There may be several reasons why next-generation voice-over-LTE (VoLTE) services have not been launched on a nationwide basis. For example, M2M devices for smart meters and point-of-sales (POS) devices can still have several years of life left and are costly to replace. As such, MNOs must continue to deliver legacy networks services as they plan their 5G service launches.

SuperDSS will simplify the O&M complexities that are associated with a live network. MNOs can use SuperDSS to ensure that parameter change requirements are kept to a minimum. For example, if the 4G central

1 For more information, see the Analysys Mason DataHub.

frequencies are set correctly as SuperDSS is rolled out, there will be no further requirement to readjust them as 3G traffic patterns change over time and the technology is phased out. Ongoing parameter changes lead to other operational costs, such as those due to the need to carry out new drive tests to certify whether the altered parameters have affected the overall network performance.

2. Customer demands and network economics are driving operators to upgrade

The relentless rise in mobile data usage, the demand for ever-faster download speeds and market competition all put pressure on MNOs to continuously upgrade their networks and improve their capacity in order to meet customer demands and avoid churn. An MNO's ability to deliver increased network capacity is contingent on three main factors: the number of sites in the network, the spectral efficiency and the available spectrum. However, an MNO's capacity to effectively improve each of these three variables is limited, and requires investment.

- **New sites.** Increasing the number of sites, especially in a dense urban environment, is both capex intensive and bureaucratic because MNOs must obtain the necessary permission (for example, from building owners).
- **Spectral efficiency.** This can only be improved by migrating to a new mobile technology (for example, from 4G to 5G) or by increasing the number of antenna elements. Both scenarios are capex intensive.
- **Spectrum.** MNOs in most countries can only acquire spectrum during an auction process held by the NRA.

MNOs have made improvements in each of the areas listed above during the last decade. However, more sites and spectrum are required to keep up with demand as mobile data consumption on handheld devices continues to grow. Analysys Mason forecasts that mobile data traffic worldwide will grow at a CAGR of 30% in the 7 years to 2024 to reach 1632EB.[2] We also forecast that mobile data will grow at a CAGR of 31% in China and 25% in Western Europe during the same time period.

Network coverage and data speeds are almost as important as price in terms of driving customer satisfaction. Indeed, price and network coverage were the most commonly cited reasons for churning by customers in Europe and the USA in 2019, according to Analysys Mason's *Connected Consumer Survey* (an annual multi-region survey). Mobile data speed was the third most commonly cited reason, and was a particular issue in Turkey and the USA. A high proportion of customers of Sprint (53%), T-Mobile Germany (41%), AT&T (41%) and Vodafone Turkey (40%) cited insufficient data speeds as a reason for churning.

These examples indicate how critical network capacity, coverage and quality of experience (QoE) are to MNOs' most fundamental KPIs. MNOs must therefore continue to invest in their networks and plan for 5G to avoid network congestion, reduce churn and remain competitive.

2 For more information, see the Analysys Mason DataHub.

2.1 MNOs in a variety of countries have launched 5G in the hope of securing some immediate benefits

101 operators in 44 countries have launched commercial 5G as of mid-September 2020.[3] The three MNOs in South Korea (KT, LGU+ and SK Telekom (SKT)) were some of the early movers; they simultaneously launched 5G networks on 3 April 2019. MNOs in other countries such as Rain in South Africa, Sunrise in Switzerland, Telstra in Australia and Verizon in the USA quickly followed suit.

Early movers can secure the following benefits if they are in a position to move quickly.

- **Improved efficiency.** 5G RAN provides improved spectral efficiency compared to even the most advanced versions of 4G, such as LTE-Pro. The first 5G deployments used the non-standalone (NSA) architecture, where 5G new radio (NR) technology was connected to the 4G packet core. The main advantages of this approach are the fast time-to-market for 5G use cases and the commercial benefits to MNOs.

- **Improved QoE.** Enhanced-mobile broadband (eMBB) and fixed-wireless access (FWA) are the main use cases that MNOs deliver using 5G NSA architecture. These allow operators to continue to improve QoE compared to that of 4G networks (thereby driving overall customer satisfaction) and address new revenue sources. For example, FWA will allow MNOs to enter the broadband market and compete with fixed network providers. 4G FWA has been available in some countries, but its success has been limited. 5G FWA will allow MNOs to compete with fibre-to-the-home (FTTH) providers for the first time.

- **Increased smartphone sales.** MNOs' finances have been negatively affected by flat or declining smartphone sales because consumers have been keeping their phones for longer due to higher device prices. The onset of 5G has given MNOs an opportunity to revamp the smartphone upgrade cycle.

- **New revenue streams** (see Section 3)**.**

3. MNOs must launch 5G services in a timely manner

There are nonetheless challenges for early adopters too, and these will drive those wanting to deploy 5G early on to seek even greater spectral and cost efficiencies. A few operators have been able to increase their prices following a 5G launch, at least until they were no longer the sole 5G provider in the country (such as EE in the UK). However, there has been no 5G premium in most cases, and KPI improvements have come from higher data usage and increased take-up of high-value packages that include video streaming services, AR/VR services and gaming (as was the case in China and South Korea).

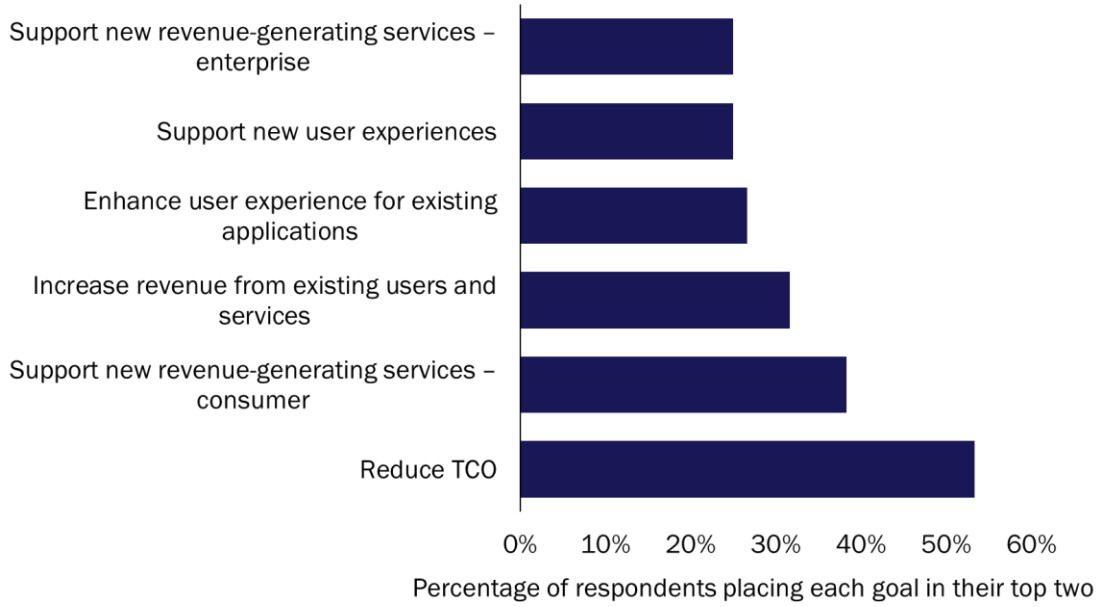
SK Telecom in South Korea said that its ARPU rose by 1.7% in the first three quarters following its 5G launch. However, it also reported that its operating profits were down by 50% year-on-year in 2019, largely because of the costs of 5G build-out and marketing.

[3] GSA (2020), *5G Market Status September 2020-1 – Snapshot*. Available at: https://gsacom.com/paper/5g-market-status-september-2020-snapshot/.

Mobile ARPU has been flat or declining in many countries during the last 5 years. In fact, mobile ARPU fell by 20% worldwide between 2015 and 2020,[4] which puts pressure on MNOs' ability to invest in new networks. Operators will launch 5G networks to not only offset declining revenue, but also to ensure that new revenue-generating services can be rolled out.

Analysys Mason carried out a survey of 60 Tier-1 and 2 mobile and converged operators and asked them about the business goals for their next-generation network deployments. Figure 3.1 shows that the key top-level commercial objective that will shape MNOs' decisions is a reduction in the total cost of ownership (TCO); more than half of the respondents said that this is one of their top-two objectives. Other important drivers are generating new revenue from new or existing user bases and improving the user experience across many applications.

Figure 3.1: MNOs' most important high-level commercial goals for next-generation network deployments, 2019



Source: Analysys Mason, 2020

MNOs have a focus on new revenue sources because the revenue/margin growth that is available from established mobile broadband applications is limited. Traditional operators are relying on new use cases to increase their revenue and carve out new markets. These use cases may be new user experiences for mobile broadband consumers (such as virtual reality gaming) or services targeted at the enterprise, industrial and IoT sectors to enable players in these verticals to support their own digital transformation programmes. In either case, MNOs will need to build their 5G networks differently than those for previous generations.

4 For more information, see the Analysys Mason DataHub.

3.1 Operators must continuously re-evaluate their network economics and use the most efficient products

The efficiency of RAN technology and spectrum usage is more critical than ever to support these new use cases while keeping costs low.

In the past, operators migrated to new RAN technologies by adding new base station hardware at each site. This required additional capex, not just to cover the cost of the hardware and software, but also to pay for the new spectrum required. Operators also incurred opex costs with every additional RAN generation due to the need to lease extra floor and tower space for new equipment and antennas and the requirement for higher-capacity fibre to support the rising consumption of mobile data. MNOs also has to pay for increased power consumption. Our research shows that MNOs' opex is typically three times their capex each year.

MNOs have demanded increased efficiencies from their vendors' products because they cannot continue to build next-generation networks in the same way without sacrificing profitability. Vendors' response has been to create smaller and more-efficient radio units that fit on the towers near the antennas and support spectrum used in previous network generations, as well as that for 5G.

3.2 Operators cannot launch new services in a timely manner without access to 5G spectrum

Timely access to spectrum is one of the most critical success factors for the launch of a new network. It allows an MNO to decide on a launch date that meets its commercial objectives, and sometimes enables it to improve services or QoE more quickly than its competitors. For instance, during the migration from 3G to 4G, some operators, such as EE in UK, were able to launch 4G services several months ahead of their competitors. As a first mover, EE had 9 months to capture market share before its competitors launched services. It gained this lead by refarming some of its 1800MHz spectrum that was previously used for 2G services. However, refarming spectrum can be arduous and bureaucratic because it requires the NRA's permission. As such, this is not an option for every MNO in the build-up to 5G.

The 5G specifications target new spectrum bands, mainly the sub-1GHz band, the C-band (around 3.5GHz in most markets) and the mmWave band (26GHz and higher). Each band has different characteristics and will enable different benefits; for example, the sub-1GHz band will deliver wide-area network coverage, while the C-band will deliver the best combination of coverage and QoE, and mmWave spectrum will support applications that require very high, localised capacity. Operators must have access to one or more of these bands in order to deploy the revenue-generating use cases that 5G networks can deliver.

MNOs' ability to deploy 5G networks will be limited unless NRAs plan and execute 5G spectrum auctions in a timely manner or MNOs are allowed to refarm existing spectrum. MNOs that are permitted to refarm existing spectrum can roll out 5G on legacy frequency division duplex (FDD) bands, such as the 900MHz, 1800MHz or 2100MHz bands. However, refarming will prevent these bands from being used for other legacy radio access technologies (RATs).

Most MNOs already use these bands to carry 4G traffic, and MNOs in countries with existing 2G and 3G RATs may also depend on these bands to carry legacy traffic. For this reason, MNOs will need to use spectrum sharing technologies to simultaneously utilise the same spectrum band for two or more RATs. However, when creating hybrid networks, MNOs must ensure that the unbalanced distribution of 2G or 3G traffic in the network does not negatively affect the O&M of the network.

4. SuperDSS will enable MNOs to use their existing spectrum bands and accelerate their 5G roll-outs

4.1 DSS was the first iteration of 5G spectrum sharing technology

As discussed previously, every mobile generation required its own spectrum band (acquired through an NRA auction) until dynamic spectrum sharing (DSS) became a commercial reality in 2018. DSS enables operators to deploy two RAN technologies, such as 4G and 5G, on the same spectrum band, thereby increasing its utilisation.

Operators in many countries have acquired spectrum in the sub-3GHz range for 4G and 3G services (typically the 2600MHz and 2100MHz bands, respectively). However, spectrum in the 2600MHz band is not always fully utilised for 4G, and a large percentage of operators continue to use it instead for 3G. However, as 3G becomes less relevant, this results in poor utilisation of a valuable asset.

In such situations, MNOs can use DSS to launch 5G services using spectrum in both the 2600MHz and 2100MHz bands, provided that the incumbent RAT in use is 4G. They cannot use the 2100MHz band for 5G if it is already being used for 3G.

4.2 SuperDSS will make it easier for MNOs to launch 5G while still serving legacy use cases

SuperDSS is an innovative technology that goes one step beyond 3GPP-defined DSS. The latter only considers the dynamic sharing of spectrum for 4G and 5G, but SuperDSS, an industry first, supports triple-RAT sharing (that is, either 2G, 4G and 5G dynamic sharing, or 3G, 4G and 5G dynamic sharing). In both cases, SuperDSS will help MNOs to continue to innovate and create network efficiencies, maintain a competitive advantage in the market, fast track their 5G deployments using existing spectrum assets and maintain legacy services.

Operators in a number of countries, including several in Europe, have been unable to launch 5G or have done so on a limited scale due to spectrum auction delays, some of which were caused by COVID-19. For example, the NRAs in Austria, Brazil, France, the Netherlands, Portugal and Spain postponed 5G auctions that were set for early 2020. The NRA in the Netherlands carried out a spectrum auction in late June 2020, but the only 5G spectrum released was that in the 700MHz band. The Dutch NRA does not plan to hold a C-band auction until 2022. The NRAs in France, Portugal and Spain plan to delay their auctions for the 700MHz band. The NRA in Spain auctioned off a small amount of C-band spectrum in 2018; there are plans to release more, but no firm date has been announced.

MNOs may need to use existing investments, such as legacy circuit-switched networks for voice services, even in countries where 4G networks have been launched. This is the case when the IP multimedia subsystem (IMS) that is needed for voice-over-LTE (VoLTE) is absent, for example. Analysys Mason conducted a survey of 72 mobile operators (including Tier-1 and 2 MNOs) in 2Q 2020 and found that 17% had not deployed any kind of IMS. It will therefore be impossible for these operators to turn off 2G or 3G networks completely in the near term.

Operators must also continue to support legacy networks when there are M2M and IoT devices that rely on 2G or 3G networks. These devices are usually used as POS solutions, smart meters and vending machines, and a substantial number of such devices are still in operation in many countries. These devices have a significantly longer lifetime (about 7–10 years) than feature phones and smartphones (2–5 years in most markets) and cannot

be migrated to 4G or even 5G cost-effectively, so legacy networks will continue to play an important role for a number of years. Analysys Mason research shows that there were 277 million IoT devices that used 2G worldwide in 2019, the majority of which were in emerging Asia–Pacific (186 million).[5] We forecast that the number of these devices worldwide will decrease at a CAGR of –5% to 201 million in 2025 (105 million in emerging Asia–Pacific, at a CAGR of –9%). This means that there will still be significant demand for legacy networks, even in 2025.

A substantial number of 2G and 3G handsets are still in active use. 2G and 3G handsets accounted for 18.5% and 25.3%, respectively, of all handsets worldwide in 2019. The majority of these handsets were in the Middle East and North Africa (MENA) and Sub-Saharan Africa (SSA) (35.6% and 47.6%, respectively, for 2G and 38.3% and 43.6%, respectively, for 3G).

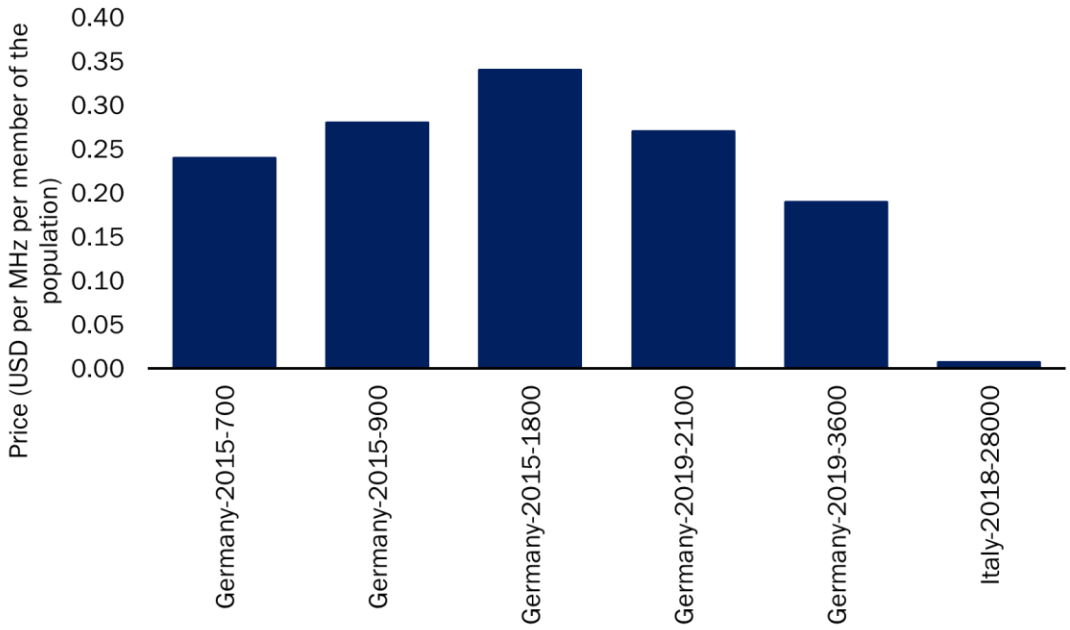
To summarise, operators can use SuperDSS technology to go ahead with early 5G service launches in countries where there are auction delays or requirements to meet commercial obligations related to legacy network services.

4.3 SuperDSS will enable operators to improve their 5G coverage, but it can also lead to spectrum cost savings

Spectrum cost (measured as price per megahertz (MHz) per member of the population (pop)) represents significant capex for operators. The bands are valued according to both their coverage and capacity. Figure 4.1 shows the average price per MHz per member of the population for spectrum in the sub-1GHz and mid-bands in recent auctions in Germany. The prices for mmWave spectrum are usually significantly lower than those for spectrum in other bands. This is shown in Figure 4.1 by the price paid in the 2018 auction in Italy because the German NRA did not auction spectrum in the mmWave band in its latest round of spectrum auctions in 2019.

5 For more information, see the Analysys Mason DataHub.

Figure 4.1: Prices paid for spectrum in the 700MHz, 900MHz, 1800MHz, 2100MHz, 3600MHz and 28 000MHz bands, 2015–2019



Source: Analysys Mason, 2020

The spectrum in Figure 4.1 was auctioned for different RATs and in different years, but it is the market conditions that determine the value placed on each band. For example, spectrum in both the 700MHz and 900MHz bands was available in the German auction in 2015. The downward pressure on the price for these may have been less pronounced if spectrum in only one band had been available.

Spectrum in the sub-1GHz bands has significantly better coverage than that in the higher bands, and is very desirable for wide-area coverage and indoor penetration, unlike that in both the C-band and the mmWave bands. However, sub-1GHz spectrum does not deliver the same level of customer experience in terms of speed due to the limited bandwidth available. Also, massive-MIMO (mMIMO) antennas are not feasible when using the sub-1GHz bands because they would have to be very large. As such, the high spectral efficiency gained from mMIMOs is not accessible when using spectrum in the sub-1GHz bands. Nevertheless, the sub-1GHz bands are usually viewed as some of the most valuable during auctions because the capex required to deploy a wide-area network using spectrum in these bands is far lower than that for the higher bands, and the supply sub-1GHz spectrum is far more constrained.

The price per MHz per member of the population for mmWave spectrum is the lowest of all the bands. A significant amount of bandwidth (in the order of 1000MHz per channel) is available, but the signal range is the most restrictive, meaning that this band is mainly only useful for point-to-point connectivity. The sub-3GHz bands, such as the 2100MHz and 1800MHz bands used for 3G and 4G technologies, respectively, deliver a good mix of both coverage and bandwidth (similar to the C-band). In addition, MNOs in many countries (especially those in Asia–Pacific, Europe and the Middle East) have acquired a substantial portfolio of spectrum in these bands over the years.

One way to assess the value of SuperDSS is to calculate the cost of buying the additional spectrum that would be required if the technology were not implemented (such as that in the 700MHz band). Prices paid in auctions for sub-1GHz spectrum vary considerably depending on factors such as the threat of entry by new players, the

overall amount of spectrum auctioned and the number of existing operators in the market. The use of SuperDSS could therefore lead to considerable cost savings for operators in countries where the price of spectrum in the 700MHz band is high.

Furthermore, the use of SuperDSS in the 900MHz band can reduce the demand for additional spectrum in the sub-1GHz band (such as that in the 700MHz band). SuperDSS can therefore deliver a further benefit to operators because it may reduce the demand for 700MHz spectrum during auctions, which could lead to lower prices.

4.4 Operators will use SuperDSS to ensure that sites are aligned and to reduce O&M complexities

Operators must make adjustments to network parameters when using spectrum in bands previously used by legacy RATs for 5G. There may be different network configurations and numbers of RATs in each network segment, such as urban and suburban. For example, 4G and 5G may be present in urban areas, while only 3G and 4G are present in suburban areas. Co-ordination between the 4G central frequencies assigned to the two sites next to each other (one carrying 3G and 4G and the other carrying 4G and 5G) plays a vital role in reducing network interference.

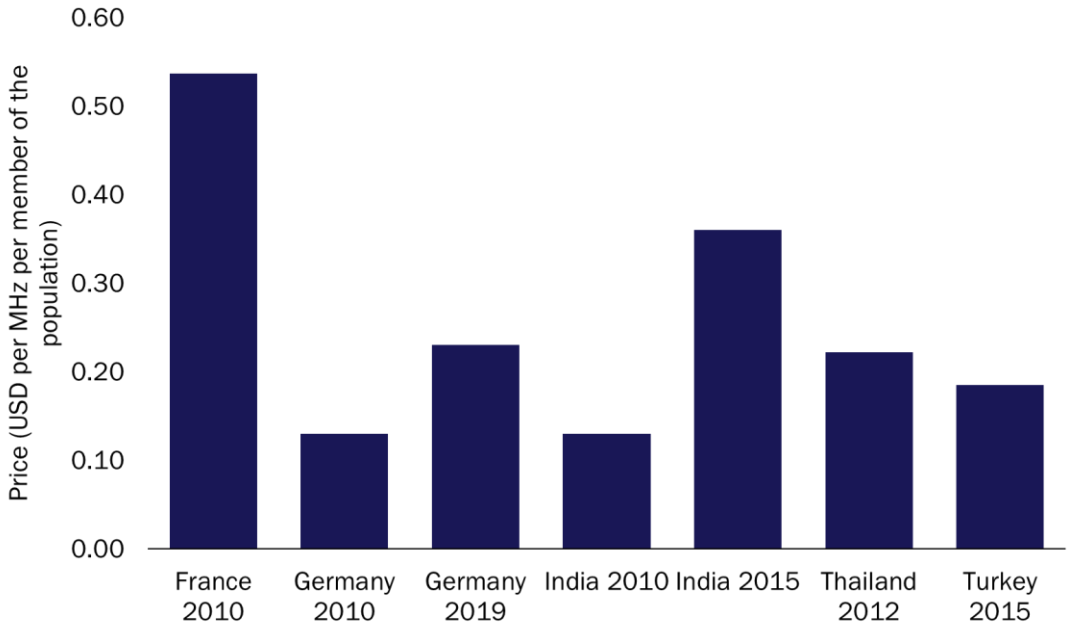
MNOs must ensure that parameters are altered as infrequently as possible. In the scenario described above, the 4G central frequencies for the sites in suburban and urban areas must therefore be set correctly initially, so that there is no need to make readjustments as 3G traffic patterns change and the technology is gradually phased out. Ongoing parameter changes can lead to other operational costs, such as those required to carry out new drive tests to certify whether the altered parameters have affected the overall network performance.

5. There are three key scenarios that demonstrate the benefits of SuperDSS to operators

5.1 Operators can shorten the lead time for launching 5G and avoid waiting for new spectrum allocations

Analysys Mason's *Spectrum Auction Tracker* shows that operators acquired between 2×5MHz and 2×20MHz of spectrum in the 2100MHz band in the early 2000s to launch their 3G services. Many operators in countries such as France, Germany, India, Thailand and Turkey later expanded their spectrum portfolios between 2010 and 2015 by acquiring additional spectrum in this band to supplement their mobile broadband services. Figure 5.1 shows the average price paid per MHz per member of the population for spectrum in the 2100MHz band.

Figure 5.1: Prices paid for spectrum in the 2100MHz band, selected countries, 2010–2015



Source: Analysys Mason, 2020

Some operators continue to use the 2100MHz band for 3G services, but mobile data traffic is now delivered using 4G technology in most countries, and a small portion of the 2100MHz band (usually one carrier (2×5MHz)) is reserved for 3G voice services. The band is statically configured between 3G and 4G in countries where SuperDSS is not deployed, but elsewhere, SuperDSS allows the network to dynamically adjust the amount of spectrum available for each technology according to traffic requirements.

Regulators in several countries, including those in Brazil, India, the Netherlands and Poland, decided to postpone their auctions for spectrum in the 3.5GHz band by at least a year. In these cases, operators can use SuperDSS to launch their 5G services using spectrum in the 2100MHz band, while maintaining their existing 3G and 4G services.

Spectrum in the 2100MHz band will not deliver the same download speeds as that in the C-band, but operators that launch 5G using the former spectrum will have a 6–18-month first-mover advantage, which will help them to gain a substantial market share. For example, EE (in the UK) had a 9-month first-mover advantage for 4G in 2013 and gained almost 1 million 4G subscribers. Vodafone Ziggo (in the Netherlands) has already launched 5G services using the 2100MHz band and spectrum sharing.

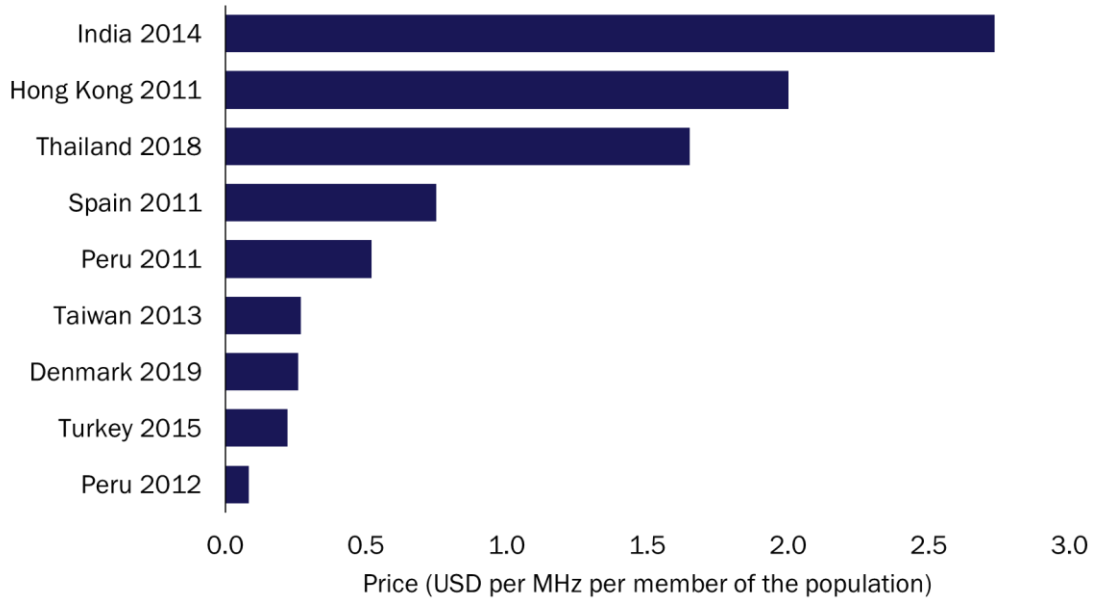
5.2 Operators can use their existing 900MHz investments to deliver nationwide 5G control-plane signalling

The 5G NSA mode delivers control-plane signalling on a different band to that used for the traffic plane. It is possible to use the 1800MHz and 2100MHz bands to deliver such control-plane signalling, but the sub-1GHz band provides the best coverage.

Operators acquired up to 2×10MHz of spectrum in the 900MHz band to deliver 2G services in most countries. This band is still used for voice, IoT and M2M services, and operators extended their spectrum licences for a

further 15–20 years between 2010 and 2019. Figure 5.2 shows the prices paid for spectrum in the 900MHz band in auctions in selected countries between 2011 and 2019.

Figure 5.2: Prices paid for spectrum in the 900MHz band, selected countries, 2011–2019



Source: Analysys Mason, 2020

The NRAs in several countries in Europe (including Czech Republic, Norway, Portugal, Romania and Spain) have postponed their 5G 700MHz spectrum auctions due to COVID-19, and no revised dates have been announced. Operators in these countries would benefit from using spectrum in the 900MHz band and SuperDSS to maintain their 2G services (such as voice and IoT), while also dynamically allocating a small portion to support 5G signalling. MNOs that have sufficient spectrum in the 900MHz band can choose to either postpone acquiring spectrum in the 700MHz band or avoid it completely, thereby reducing their network TCO.

5.3 SuperDSS will enable operators to use existing infrastructure and delay additional investments

Most operators have launched 4G services, but some may not have an IMS platform and hence will continue to depend on their legacy 2G/3G networks to deliver voice and other circuit-switched services, such as M2M. SuperDSS will facilitate the introduction of 5G services using spectrum currently used for legacy networks, without affecting the underlying services or requiring additional investments.

Analysys Mason's 2020 survey of 72 mobile operators (including Tier-1 and 2 MNOs) revealed that there are four main operator groups according to their IMS deployment stage: leaders, agile operators, conservatives and laggards. Leaders have a fully virtualised IMS, agile operators have a hybrid of physical and virtualised IMS platforms, conservatives have only a physical IMS and laggards have no IMS deployments.

Operators in the conservative category accounted for 39% of all MNOs surveyed. These MNOs have limited physical IMS infrastructure, and this infrastructure may also lack the capacity required to deliver a full nationwide VoLTE service. Their decision to invest in further IMS capacity upgrades or migrate to virtualised

IMS platforms may depend on the need to wait until the end of the life of their current solutions. However, without additional investments, they would depend extensively on their legacy network infrastructure for voice services.

Laggard operators accounted for 17% of all MNOs surveyed. Operators in both the conservative and laggard categories could use SuperDSS to both deliver 5G and create network efficiencies through dynamic spectrum allocations between 2G, 4G and 5G, 2G and 4G or 3G and 4G. This would allow these operators to continue to use existing infrastructure and postpone new IMS investments.

6. Example vendor solution: ZTE Magic Radio Pro

ZTE Magic Radio Pro is a comprehensive multi-RAT DSS solution that supports up to seven scenarios with five radio technologies (GSM, UMTS, LTE, NB-IoT and NR). ZTE is exploring additional spectrum sharing possibilities in the 5G era using SuperDSS.

ZTE implemented SuperDSS in a commercial deployment with China Unicom in September 2020; this enabled a fast 5G deployment without affecting legacy network performance. SuperDSS is used with spectrum in the 2100MHz band and 20MHz of bandwidth is reserved for 3G/4G/5G dynamic sharing. The bandwidth used for 3G is adjusted on demand; this guarantees the 3G voice experience, while providing more spectrum resources for 4G and 5G users, thereby improving the QoE. When the UMTS traffic load is high, the UMTS bandwidth decreases and the number of available LTE and NR resources increases, and vice versa. The SuperDSS solution improves 4G throughput by up to 35% compared with the 15MHz DSS solution, while the UMTS MOS remains stable without any impact on voice service experience.

7. Conclusion: operators can use SuperDSS to launch 5G and maintain legacy services

Operators in many countries plan to deploy 5G networks to offset ARPU declines and take advantage of new revenue opportunities from consumers and enterprises. However, MNOs will not be able to use the designated 5G bands and launch these services unless the NRAs plan and hold spectrum auctions in a timely manner.

This paper has shown that, as of mid-September 2020, customer demand and mobile economics have driven over 101 operators in 44 countries to launch 5G services and add a new layer of network capacity using the more efficient 5GNR technology (compared to even the most advanced 4G networks). These operators will benefit in multiple ways, not just from delivering improved QoE. New 5G use cases, such as FWA, will enable MNOs to compete with FTTH service providers and deliver comparable download speeds, but more importantly, MNOs in countries where there is a lack of fixed broadband competition or where FTTH deployments are costly can deploy FWA to deliver high-speed broadband services to homes and enterprises. Other advantages of launching 5G services include re-energising the stagnant smartphone market.

MNOs in countries where spectrum auctions have been delayed can use SuperDSS technology to launch 5G using spectrum that is currently used to serve 4G or legacy RATs. Contrary to DSS (the first iteration of spectrum sharing technology), SuperDSS will enable MNOs to support triple-RAT spectrum sharing and deploy 5GNR using a band that is currently in use for either 4G and 2G or 4G and 3G. There will be two key benefits of this for operators: to deploy 5G and become a first-mover and to ensure that the existing legacy services (that is, those that require either 2G or 3G networks) remain unaffected. Voice is the most important example of such a legacy service, especially in countries where the VoLTE service provision is limited or non-existent. Other legacy use cases include smart meters, POS devices and vending machines.

SuperDSS is a 5G-oriented solution that will facilitate a lean, multi-mode, multi-service network by allowing operators to use one unified configuration for the whole network and reducing the need for repeated O&M configuration changes. Configuring the spectrum bands in a co-ordinated manner will also ensure that ongoing network planning activities are kept to a minimum, no matter how 3G traffic patterns change. This will lead to further operator cost savings.

Finally, technologies such as SuperDSS are good examples of how 5G can be further developed to offer more options and flexibility to operators as they roll out new networks to meet market requirements, deliver benefits for the whole industry and spark new innovation ideas.

8. Recommendations

- **Operators that plan to launch 5G ahead of spectrum auctions should do so using SuperDSS and gain a first-mover advantage.** NRAs in many countries have delayed 5G spectrum auctions for various reasons. SuperDSS is an innovative technology that goes one step beyond 3GPP-defined DSS and will enable operators to launch 5G services using their existing spectrum portfolio (that currently serves a combination of 4G and 3G or 4G and 2G), without needing to wait for 5G-specific spectrum auctions or refarm existing bands.
- **Operators should use SuperDSS to ensure that legacy network services are not disrupted and to continue to utilise existing investments as they migrate to next-generation networks.** 56% of operators surveyed have limited or no physical IMS platforms, despite them being a critical network component for delivering VoLTE services. MNOs can use SuperDSS technology to deliver legacy services (such as circuit-switched voice, M2M or IoT connectivity) so that they can continue to meet their commercial commitments and delay new investments, even as they deploy 5G services.
- **Operators should use SuperDSS to co-ordinate each RAT's central frequency on a network-wide basis and ensure O&M parameter changes are kept to a minimum.** Operators can use SuperDSS to deploy spectrum in a co-ordinated manner and align each RAT's central frequency on a network-wide basis to reduce interference. This will limit the future requirements to update O&M parameters as legacy networks are phased out, thereby improving network performance and reducing ongoing network costs.

9. About the authors

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Published by Analysys Mason Limited • Bush House • North West Wing • Aldwych • London • WC2B 4PJ • UK
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