RETHINK THE APPROACH TO 5G INDOOR COVERAGE

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Executive summary

With continuing adoption of 5G services, customers are increasingly demanding in their expectations for the speed and availability of connections in all locations, not least in indoor environments. Building owners also consider that unified, predictable, and futureproof in-building digital infrastructure is a key value proposition to their tenants, as well as an enabler for their own digital transformation. It is clear that these expectations will not be met by existing networks, and require instead a new dedicated 5G indoor solution. Neither distributed antenna systems (DAS), nor outside-in coverage from macro sites, nor Wi-Fi 6G can deliver that seamless, reliable, gigabit experience.

Despite the hype, investing in indoor networks is not a straightforward proposition for mobile network operators (MNOs), which are already under considerable financial pressure and face constraints on capital expenditure (capex). A real 5G indoor solution can be expensive for an MNO to deploy alone, typically resulting in higher capex and operational expenditure (opex) per subscriber than macro sites. With the prospect of worsening return on investment (ROI) and the difficult process of finding interested building owners and MNO partners, it is no surprise that indoor coverage has been relegated to a backseat position behind outdoor 5G deployment.

Still, leaving the demand for indoor coverage unaddressed limits the value that MNOs bring to their customers. It opens opportunities for other players that can bring innovative solutions to overcome the cost and process barriers for indoor coverage. One example is the growing numbers of neutral hosts popping up in different markets, like Freshwave in the UK, Proptivity in the Nordics, and Cellnex across Europe, each with its own niche rooted in that operator's distinct background.

Rather than seeing them as a cause for worries, we believe MNOs should embrace these new players as ecosystem partners for indoor coverage. Neutral hosts often bring their own investment to build up the indoor network, removing the capex hurdle from MNOs. With the scope, process and organisational set-up focused on indoor coverage, these neutral hosts can achieve a competitive pricing point for equipment and services, and overcome many challenges faced by MNOs during the sales and implementation process. Furthermore, neutral hosts address a key concern of building owners by facilitating network sharing over a unified infrastructure. With the technology available today, a shared indoor network can save 40–50% of the total cost of operation (TCO) compared with an MNO building it by itself, not to mention energy savings and other sustainability benefits.

The cost to MNOs adopting this approach could be close to zero, as the capex and opex for the radio network are covered by neutral hosts exploring the building owner paid business model. MNOs only need to bring in their spectrum assets to the shared networks. It is a risk-free way for them to unlock new business opportunities for delivering indoor services at predictable gigabit speeds with a high average revenue per user (ARPU) premium. It also opens non-capital-intensive options to differentiate, such as bundled offers of information and communications technology (ICT) services, 5G office devices and 5G subscriptions for small and medium-sized enterprises (SMEs). Furthermore, the 'free' offloading of indoor traffic reduces the need for outside-in coverage and enables MNOs to further optimise their capex for outdoor deployment.

Still, as with all things new, there will be a learning process for both the MNOs and the neutral hosts to work smoothly with each other. The important thing for all parties is not to hold back and to stay ahead of the curve.

2 Demand for 5G services

2.1 The average user perspective

There is a lot of expectation surrounding advanced services in the future 5G world. Self-driving cars, industry automation and remote surgery will be dependent on a high-speed, low-latency network. Augmented reality will enable services and experiences we can hardly imagine today. However, the market that will drive 5G revenue will, at least for the next decade, be based on mobile handsets with some additional revenue for connected laptops, tablets and other internet of things (IoT) devices that already exist.

When assessing where these services will be consumed, it is clear that mobile services need to secure a much stronger and more reliable grip on the indoor environment. Most people spend around 90% of their time[1] indoors and 80% of the traffic[2] is generated indoors already today.

This means that mobile network operators (MNOs) that aspire to maintain and increase their relevance to their customers need to have a very clear indoor agenda. However, indoor coverage has never been high on MNOs' priority lists. It has typically involved negative discussions with customers with limited or poor indoor coverage, and working with indoor coverage has not been a classical career path within any MNO. So, many MNOs stand today with only limited internal capabilities to address the future indoor challenge and opportunity.

2.2 The building owner perspective

In a further complication of the traditional network-to-customer relationship, indoor coverage involves a new stakeholder as well: the building owner. Unlike the mobile oligopoly with 3-4 players in each country, there are hundreds of building owners. While the real-estate sector typically has a low internal knowhow of mobile systems and technologies, a shift is starting to emerge in the real-estate industry as digitalisation also enters into buildings. Tenants are increasingly demanding when it comes to more advanced connectivity capabilities.

[1] Ericsson (2021), *Mobility Report.*

[2] U.S. Environmental Protection Agency (1989), *Report to Congress on indoor air quality: Volume 2.*

In Sweden, several leading building owners formed REDI,[3] an industry group with clear views on how indoor coverage should be approached from a building owner's perspective. In short, Swedish building owners see 5G as a vital and integral part of the future building infrastructure, just like water and electricity.

REDI has created a set of requirements to meet future demand from the real-estate sector including vital future sustainability aspects, as summarised in four main points below:

• **Predictable coverage, capacity and speed** of the service in the whole building.

• **High-performance 4G and 5G** - indoor user experience should be as good as outdoor with the high-speed 5G subscriptions that now are offered in most markets.

• **One network and one party to manage the network.** Building owners would like to avoid having 3-4 networks from different service providers as this would drive up costs, affect the look and feel of the buildings, and increase management overheads for building owners.

• **All or most of the MNOs should have the ability to connect** to the network and provide service.

2.3 The growing gap between outdoor and indoor experiences

As the MNOs upgrade macro networks to 5G, outdoor users can easily achieve over 1Gbit/s throughput thanks to the use of multi-input multi-output (MIMO) technology and the C-band spectrum[4]. Indoors, however, the upgrade offers users only marginal improvement, if any at all. This is because MNOs are still relying on outside-in coverage and legacy indoor networks – mostly passive distributed antenna system (DAS) built in the 3G era. Signals in the C-band are not effective at penetrating walls and windows to reach indoors (especially relevant for buildings in the Nordics with high insulation), nor does legacy DAS support MIMO.

Wi-Fi technology with its latest advancement provides gigabit throughput and high capacity as well. A professionally installed and managed Wi-Fi network can deliver a high quality of service with good availability, to the extent possible with unlicensed spectrum. Yet, typically separate networks will be built for different tenants by various enterprise IT integrators. This goes against building owners' desire for a unified infrastructure and cannot replicate the seamless user experience and the intrinsic end-to-end security that come with 5G services.

In fact, the gap between outdoor and indoor user experiences will only get worse without a dedicated 5G indoor solution. With the existing focus on macro layer and MNOs' lack of interest in providing a building-specific solution (as opposed to providing a floor-specific solution for a customer on e.g. the fourth floor of a building), there is a need to rethink indoor and partnerships for MNOs.

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[3] REDI (2022), *5G inomhus fastighetsägares perspektiv.*

[4] It is possible to achieve 1Gbit/s in 4G with carrier aggregation, but 5G increases the network capacity that allows more users to achieve such throughput simultaneously.

3 Challenges for MNOs to prioritise indoor coverage

Many MNOs are issuing high dividends to maintain share value, limiting the amount of capital available to reinvest into the network.

3.1 MNOs facing capex constraints

Most MNOs around the world have faced a steady decline in revenue and average revenue per user (ARPU) in the past decade. Their share prices are under considerable pressure without a clear revenue upside. Many MNOs, including the Swedish ones, opted for an effective, if not very sustainable, strategy of issuing high dividends to maintain share value. For those MNOs, this has meant paying dividends far above reported earnings as shown in Figure 1 below. This limits the amount of capital available to reinvest into the network, and thus limits the growth potential.

The difficulty this causes to MNOs is further compounded by higher inflation (especially related to the increase in energy costs). Telia Group reported an increase of SEK0.8 billion in energy costs during 2022 compared with 2021, and Telenor reported a NOK0.4 billion negative impact in the third quarter alone. Furthermore, MNOs also face higher interest rates which have caused significant volatility, with a consequent negative impact on the value of outstanding bonds. Telia, Telenor and Tele2 all issued bonds with coupon rates of 0.75–1.12% in 2019 and 2020, which was in line with the overall economical state. Throughout 2022, the yields of those bonds have more than tripled, indicating a significantly lower interest from the market to invest and a higher price tag for MNOs to secure external funds. Without additional capex being invested in the telecoms networks it is unlikely that MNOs can embark on a growth journey with indoor 5G.
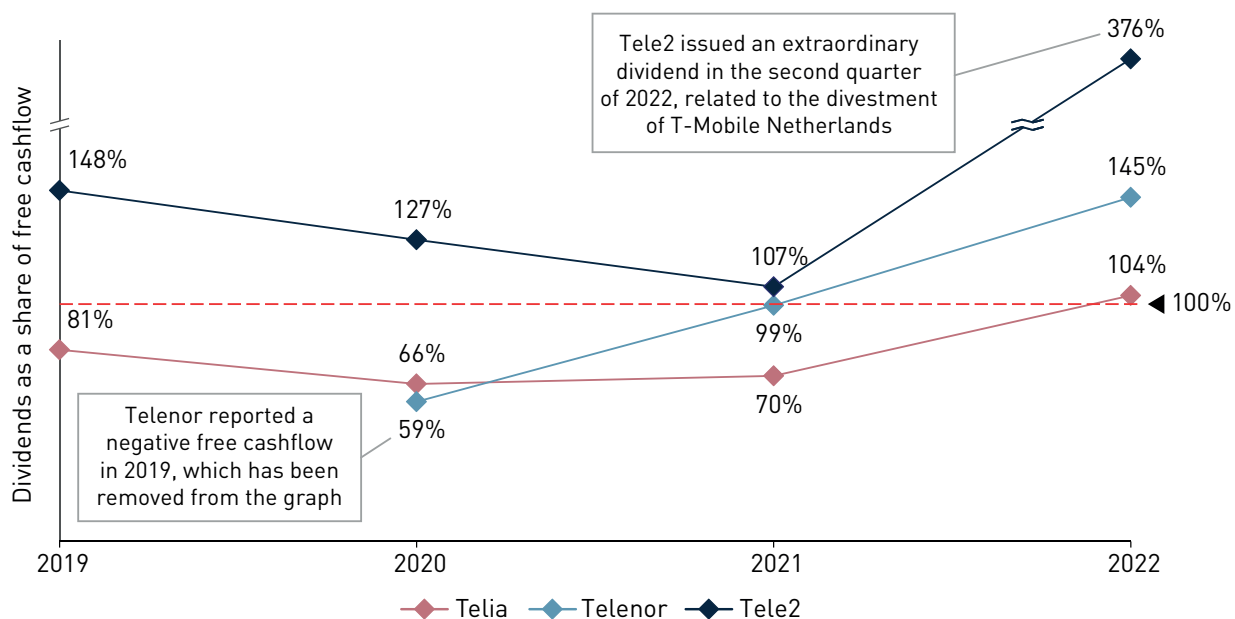
Figure 1: Dividends as a share of free cash flow per year for publicly traded Swedish MNOs (percentage, 2019-2022)[5]

The limited capex must meet competing demands for fibre deployment, 5G mobile networks, spectrum payments and IT transformations. MNOs are forced to prioritise where to spend the capex left for mobile networks. In that priority list, it is not difficult to understand from an MNO's perspective, why indoor coverage often lies at the bottom. A dedicated indoor solution that can deliver real 5G performance can be expensive and slow for MNOs to deploy by themselves, while the ROI it brings is still uncertain.

3.2 An expensive solution for individual deployment

Traditional indoor solutions are reaching their limits both in terms of capacity and uplink performance and will not be sufficient for advanced commercial use cases. Legacy passive DAS are typically single input, single output (SISO) and can hardly utilise C-band spectrum. New indoor small cells or active DAS can support 4x4 MIMO and C-band. Even in the most demanding areas, these advanced solutions can facilitate businesses cases with high requirements.

These new 5G indoor solutions[6] typically come with a higher price tag than legacy solutions. Analysys Mason estimates that a 5G indoor solution based on active DAS or small cells will typically incur costs that are more than double those of a legacy 4G-only indoor solution. When adding in the full C-band and MIMO support, which many building owners will demand as a futureproof solution, the cost can be three times higher. For a large building of 100 000m2 (e.g. Mall of Scandinavia in Stockholm), a dedicated 5G high-performance indoor solution could therefore cost almost EUR1 million in capex. It is over ten times the cost of a typical outdoor macro site, which could easily cover the same area in an outdoor environment.

A 5G indoor solution will typically incur costs that are more than double those of a legacy 4G-only indoor solution.

3.3 A challenging process for MNOs to navigate

MNOs that decide to improve indoor coverage themselves will face several hurdles. The first hurdle is identifying crucial locations where there is sufficient demand for additional indoor coverage. Once a building is identified, the MNO must assess whether there is a sufficiently positive business case to pursue by acknowledging both costs and competition. If the investment then is justified, a relationship with the building owner will need to be established.

Establishing a beneficial relationship with the building owner is the second hurdle. MNOs will need to address the 'pain points' of building owners, whose target is to improve the experience of their tenants and make the building more attractive. Several real-estate companies in Sweden have stated that a unified network (either through a neutral host or a multi-MNO solution) with one contact point is the only relevant option for indoor infrastructure, even if multiple MNOs are interested in the location.[7] Furthermore, building owners will require full building coverage from the network. Thus, it can be a difficult business case for MNOs serving an enterprise customer's office on perhaps one to two floors of a large building.

In a regulated oligopoly market, we can expect competition authorities to be especially watchful of anti-competitive behaviour, for example coordination between MNOs. A separate joint venture (JV) might be required to set up a shared indoor network which brings its own set of governance overhead and cumbersome restrictions. Even if they could navigate through the legal and operational quagmire, the collaborating MNOs may still lack the agility to effectively address the indoor market that is far less predictable than meeting certain outdoor coverage targets. This could even be detrimental to the development of the indoor 5G market and harmful for the national economies, and in particular, the real-estate sector.

Beyond identifying a location and reaching an agreement with the building owner together with partner MNOs, the deployment of the network infrastructure for in-building solutions can be complicated. While outdoor network deployment is an area of expertise for MNOs, indoor deployment is rare and infrequent. The process for indoor radio-frequency (RF) planning, network design and installation is rather distinct from that of a typical outdoor network. MNOs will need to recruit and/or use external specialist with the right toolkit to plan, install, operate and maintain the network, incurring extra opex.

[7] REDI (2022), *5G inomhus fastighetsägares perspektiv.*

3.4 Limited ROI from indoor coverage

Investing in indoor coverage generates improvement in network performance, such as average user data speeds, quality of service, and enablement of new services. These all have some associated willingness to pay from users and commercial benefits for the MNOs as the improvements can lower churn and improve market position. However, there are few cases beyond the more populous geographical areas with high footfall (e.g. stadiums) that the MNOs deem as having high enough return on investment (ROI) after weighing the cost of deployment, lease, power connection, backhaul, etc., against the potential revenue streams.

The higher capex and opex per subscriber required for MNOs to deploy indoor networks by themselves results in a lower ROI than the outdoor network, which typically has an established payback period and tangible competitive benefits/impacts. This has been the case with previous technology generations and the same mindset applies to 5G. Relying on the outdoor network to provide basic indoor connectivity allows MNOs to avoid the more costly option of indoor deployment. Even if there could be tangible benefits by transferring outdoor traffic to indoor networks (such as lower energy costs on outdoor sites, mitigating the need for densification and capacity upgrade in outdoor), the prospect of pushing the overall ROI further downward is not coveted by any MNO.

Given the above, it is understandable that MNOs adopt a defensive approach that prioritises outdoor over indoor networks, especially with increasing energy costs and an unstable global financial situation. Nevertheless, this approach limits the value that MNOs bring to their customers and leaves the demand and opportunities open to be addressed by enterprise IT integrators such as Cisco and Juniper with Wi-Fi solutions, and other players with different ways of overcoming cost and process barriers for deploying 5G indoor solutions.

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4 Emerging players addressing the unmet demand

Different types of neutral hosts are establishing themselves in markets across the globe, including towercos, indoor specialists, wireless network providers and building-specific connection providers.

4.1 Notable emerging players in different markets

Seeing the opportunity of the unmet demand for indoor coverage, a new class of digital infracos is emerging. They are specialised in the provision of high-quality, reliable cellular and Wi-Fi coverage in landmark buildings, private enterprises and public spaces. Many of these players originate from towercos. As part of their growth strategies, towercos increasingly seek to diversify their passive infrastructure management core business by offering active services. This includes provision of neutral-host solutions for indoor coverage both in terms of 5G solutions, DAS and small cells, leveraging their continuously expanding passive infrastructure. Besides towercos, there are other types of neutral hosts establishing themselves in markets across the globe. These include indoor specialists, wireless network providers and building-specific connection providers.

Europe has seen several investments in the indoor coverage space in the last few years. In 2018–19, DigitalBridge acquired four indoor specialist firms and formed UK-based Freshwave. European towercos have also invested in strengthening their indoor presence. Cellnex has subsidiaries in multiple countries specialising in indoor coverage, including CommsCon (Italy, acquired in 2016), Herbert In-Building Wireless (UK, acquired in 2022), and Springbok Mobility (subsidiary since 2019). Wireless Infrastructure Group acquired Arqiva (UK) in 2018. Inwit, a towerco in Italy, has also made it a strategic priority to pursue indoor and small-cell solutions recently. In the Nordic region, Proptivity has emerged as a strong player recently announcing a collaboration with Ericsson to expand in indoor coverage in the Nordic and Baltic regions.

There are also similar examples of neutral-host providers in the North American market, including American Tower, Crown Castle, Extenet (formerly ExteNet Systems) and BAI Communications. Through the spectrum model Citizens Broadband Radio Service (CBRS) initiated in the USA, there is a high availability of spectrum simplifying both private 5G networks and 5G indoor coverage solutions. This has increased the possibilities for enterprises to acquire spectrum and enabled a low-cost option of neutral-host services.

Fewer infrastructure-sharing examples exist in developed Asian markets. Several MNOs rushed to deploy 5G early on. With highly populated urban areas, the MNOs were able to cover many customers without the need for network sharing. For example, Japan and South Korea only have one active network-sharing agreement each, with MNOs collaborating to cover rural remote areas. However, Asian MNOs have been more keen on working with neutral hosts for 5G indoor coverage. One emerging player is Comba Telecom, which has recently partnered with both 3 Hong Kong and China Mobile to deploy 5G indoor coverage solutions in multiple locations.

4.2 Commonly adopted business models

In contrast to outdoor network sharing, the indoor market is at an early stage with both emerging and matured markets exploring business models. Freshwave provides infrastructure as a service through small cells, DAS, private networks and Wi-Fi across the UK. The indoor coverage specialist firm recently partnered with Three UK to improve 4G connectivity in several locations across London with intentions of upgrading to 5G over time. Freshwave has adopted a model which involves charging building owners for indoor mobile coverage, as opposed to charging the MNO which is often expected to support deployment. The Italian towerco Inwit, which offers both small cells and DAS for indoor coverage, has also expressed intentions of adopting a commercial model where building owners partly or fully undertake costs for indoor solutions.

The Nordic player Proptivity has origins outside of the telecoms ecosystem, being owned by real-estate management group Stronghold Invest. With well-established real-estate connections and access to properties through Stronghold, Proptivity is in a good position to both reach agreements with building owners and provide quick deployment processes. Proptivity also utilises a similar model as mentioned above, charging a network fee from the building owner and not the MNO.

Generally, MNOs expect building owners or companies to fund indoor wireless solutions. In France, we have recently seen this type of development where building owners, especially of newer and more sustainable buildings, pay MNOs to set up the equipment and connect their networks. French MNOs now have an obligation to publish conditions and tariffs for indoor solutions, enabling a more transparent market.

The trend seems to be converging towards a model where the neutral host is charging opex and/or capex fees from the building owner, not from the MNOs or the end customers. The business model may evolve in different directions, as players from various backgrounds with different approaches continue to explore this market. But the fundamental characteristics of investing in infrastructure that secures long-term, stable, recurring revenue from multiple customers will likely remain.

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5 Partnership could be the answer to indoor coverage

Partnerships with neutral hosts can unlock new business potential for MNOs at minimal cost and risk, and have a positive effect on MNOs' financial KPIs and customer experience.

5.1 Embracing a broadening ecosystem

It is natural for any incumbent to feel unease at the prospect of disruptions brought by new entrants to the ecosystem. However, the last decade has shown that a broadening telecoms ecosystem can benefit the MNOs and their customers. The much-feared entrance of 'hyperscalers' into the telecoms market has, instead of taking over MNOs' business, brought fresh innovation in technology and services. The establishment of towercos around the world also brought much needed cash injection into the sector.

A walled-garden approach can protect MNOs' share of value and their control over the direction of the ecosystem's development, but it could also limit their growth potential. During the last decade, this has been seen with ICT service revenue growing outside of telecoms due to the inability to innovate and increase relevance for their customers. More MNOs are starting to accept and embrace an ecosystem approach to grow new business in IoT and enterprise ICT services. For example, Deutsche Telekom is partnering with Google to support the digitalisation of European companies and public-sector entities, and with Azure and AWS for private networks and edge compute.[8]

Neutral hosts as ecosystem partners can similarly help MNOs to address indoor coverage demand. Such partnerships can unlock new business potential for MNOs at minimal cost and risk, and have a positive effect on MNOs' financial key performance indicators (KPIs) and customer experience.

[8] Analysys Mason (2022), *Collaborations between MNOs and public cloud providers for IoT: framework and analysis.*

5.2 Reduced costs and streamlined deployment

Depending on the business model selected, a neutral host could charge an opex fee from either the building owners or MNOs for connecting the indoor network. In either case, it removes the significant up-front capex hurdle by bringing in new investments. Furthermore, a neutral host can secure a lower total cost of ownership for the network solution from vendors and system integrators thanks to its focus specifically on indoor solutions in the procurement and operational processes. In contrast, MNOs' price negotiations typically focus on major items for outdoor macro sites such as radios or active antennas, while the indoor solution with its limited volume is often left as a secondary concern and without much senior management attention. This lowered cost base enables the neutral host to price its network-as-a-service (NaaS) offer competitively even against managed Wi-Fi as seen in Figure 2.

Neutral hosts have a dedicated sales force that understands real estate and have extensive connections for identifying, and entering into discussions with, interested building owners.

Figure 2: Comparison of typical annual prices for 5G NaaS and managed Wi-Fi NaaS provided by a neutral host, not including subscription fees for 5G or fixed broadband.[9,10]

Neutral hosts typically have specialised indoor-focused organisations and processes that are set up to overcome the particular challenges MNOs face during the sale and deployment of indoor solutions. They have a dedicated sales force that understands real estate and has extensive connections for identifying, and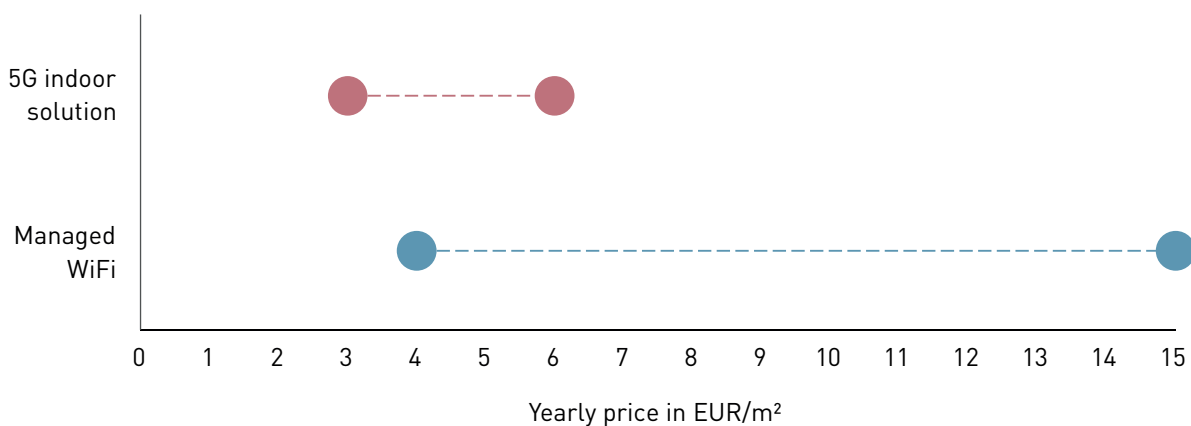 entering into discussions with, interested building owners. The neutral host's sales team can provide a high-level design for a candidate building to sound out interest from MNOs. Given enough interest from MNOs, the neutral host's network design team can then conduct a detailed solution design prior to a go/no-go decision with the MNO partners. Finally, a dedicated roll-out team/partner typically carries out the deployment and integration of the indoor network.

A neutral party will often be well positioned and incentivised to ensure its solution provides as many options as possible for all MNO partners, while meeting the building owner's requirements. For a specialist neutral party, the timeframe for the full process of identifying a candidate building through to

[9] Analysys Mason Research and Proptivity.

[10] It is worth noting that managed Wi-Fi pricing has a much wider range than 5G. Managed Wi-Fi has a broad variation in its scope of the service and the service level agreement (SLA), ranging from broadband for a few users with basic support service to multi-network setup with guest access and proactive monitoring etc. The nascent 5G indoor coverage as a service is by contrast fairly standard, including by default most of the advanced features in managed Wi-Fi (user authentication & security, location services, etc). The 5G solution price does depend on the number of operators onboard the shared network and how much bandwidth each operator will utilise. Lastly, the prices for both solutions scale with the building size and the number of users.

lighting up the network typically takes three to six months (including the lead time for equipment from vendors). After that, the operation and maintenance of the indoor networks will be carried out by the neutral host, removing the opex burden from MNOs which would otherwise need to set up a dedicated team for a potentially subscale operation.

An MNO approaching the same process will tend to focus on the tenants' immediate need and have to negotiate both a subscription contract and a network deployment, typically ending up with a sub-optimal outcome for both the MNO and building owner. This MNO-led approach can take six months to work through initial discussions with building owners (and other MNOs for a potential shared network).

5.3 More savings and better sustainability from shared infrastructure

Building the best network may be a valid (if capital-intensive) approach to achieving differentiation in the outdoor market, but is less viable for indoor scenarios. Few commercial building owners would accept more than one set of networks in their buildings. Historically, shared infrastructure has primarily been deployed with passive DAS, as small-cell architecture offered insufficient bandwidth to support multi-MNO sharing. Since then, small-cell technology has advanced significantly, and small-cell products from several major vendors can now support the full C-band and various legacy bands with sufficient bandwidth for four-MNO sharing.

In a multi-operator RAN (MORAN) or multi-operator core network (MOCN) sharing set-up, the entirety of the indoor network can be shared, from baseband to radio to small-cell access points. Together these account for over 90% of total network cost (versus 20–40% of the total cost when only the radio components are shared in a traditional DAS network).[11] There is still the marginal cost for adding capacity and bandwidth (primarily in licences and software) to accommodate more MNOs to the shared network, but the total cost for the neutral host to provide 5G coverage for one MNO over the shared network is less than half or even one third of the cost for the MNO to build a network by itself.[12]

Network sharing is also a key step towards improving sustainability. Most of the network hardware, from the radio access point to the baseband, has enough bandwidth and capacity to support multiple MNOs. Sharing a single unified network removes the duplication of equipment in the building. A shared infrastructure also reduces the total energy consumption as compared to having a multitude of overlapping networks, as there are proportionally fewer active components in the building.

> The total cost for the neutral host to provide 5G coverage for one MNO over the shared network is less than half or even one third of the cost for the MNO to build a network by itself.

[11] Analysys Mason Research.

[12] Note that current network-sharing technology still lacks 'true' multi-tenancy support. Therefore, it typically requires a third party (either a neutral host or a JV) to operate the shared network, instead of having one MNO as the leading operator, to ensure data integrity amongst the sharing MNOs.

5.4 Reasons to stay ahead of the curve

Despite being focused on indoor coverage, the fresh capital invested by neutral hosts could bring a broader impact on MNOs' capex constraints. While MNOs today mostly stay away from building dedicated indoor networks, they still need to build the outdoor macro sites to provide a minimum level of outside-in 5G coverage. In urban areas, between one and two thirds of the macro traffic is served to indoor users.[13] A 5G indoor network built by a neutral host can offload this traffic and enable MNOs to optimise their capex for outdoor coverage by requiring fewer carriers or sites for outside-in coverage.

More importantly, a high-performance 5G indoor coverage opens new opportunities for MNOs at minimal risk. For example, enterprise ICT services are widely expected to be the next growth engine for MNOs in the coming years. High-performance 5G indoor coverage provided through a neutral host can be the catalyst to unlock new business-to business (B2B) use cases that are dependent on reliable gigabit connections in buildings. It will accelerate the adoption of and revenue growth from enterprise ICT services. Embarking on this journey early will allow MNOs to show their shareholders that they can meet expectations and stay relevant in evolving markets.

While a shared network necessarily reduces opportunities for network-quality differentiation, a MORAN shared network still allows operators to offer differentiated services on the basis of the different spectrum assets brought by each MNO. It also allows distinction relative to any other MNO that is not involved in the shared network or other Wi-Fi service providers. Furthermore the new business opportunities unlocked by indoor coverage open up the prospect of new non-capital-intensive options for differentiation in product innovations and packaging, such as bundling 5G-compatible office devices, ICT services and 5G subscriptions as a packaged offer for SMEs.

As with all things new, there will be a learning process for both the MNOs and the neutral host to work seamlessly together to mutual advantage. MNOs may have to set up new processes and governance structures to monitor and control the indoor service through the shared neutral host infrastructure, and to co-ordinate between their own macro sites and many coverage islands created by the indoor network. It is another reason to start early and stay ahead of the curve.

High-performance 5G indoor coverage provided through a neutral host can be the catalyst to unlock new B2B use cases that are dependent on reliable gigabit connections in buildings.

[13] Ericsson, 2021, *Planning in-building coverage for 5G: from rules of thumb to statistics and AI.*

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