Market Insight: Accelerate 5G Adoption Through In-Depth Indoor Coverage

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Responsible for over 80% of data consumption, in-depth indoor coverage is crucial for the success of 5G adoption and related digital services. To gain competitive advantage in 5G, product managers need to reinvent existing indoor solutions to be 5G-ready and improve digital capabilities.

Key Findings

- Indoor cellular connectivity remains inferior to outdoor network coverage in many areas due to a combination of challenges, including technology, cost, energy, site acquisition and ROI. 5G, which is expected to be deployed using higher frequency bands, will bring its own complications to the indoor coverage challenge.

- Enterprises are looking for secure and reliable indoor solutions to maximize their productivity in the 5G era, presenting a huge opportunity for TSPs.

- The opportunity from indoor 5G coverage is high, but the cycle time to complete an agreement between stakeholders is too long.

Recommendations

Product managers in the telecom industry responsible for strategy execution should:

- Anticipate indoor coverage opportunities in the 5G era by investing in and developing a 5G-ready indoor solution strategy. Create competitive advantage through enhanced digital capabilities on top of connectivity.

- Create usage scenarios by mapping 5G capabilities to enterprise indoor requirements. Demonstrate value by highlighting the business value that 5G and its associated capabilities (edge computing and location) enable or better support.

- Accelerate 5G indoor adoption by building and demonstrating use cases with property owners, regulators, IT service providers and local governments while creating innovative business models.
Strategic Planning Assumption

Less than 45% of CSPs globally will have launched a commercial 5G network by 2025.

Analysis

Communications service providers (CSPs) are struggling to provide adequate indoor cellular services due to many technology challenges, including how to handle signal propagation, subscriber density and cell border interference. Other than technology issues, CSPs and vendors...
face challenges such as site acquisition, associated planning approvals, regulations, deployment costs and business justification.

As CSPs begin deploying 5G, they will most likely start by creating outdoor hot spots in dense, urban areas.

Network-based CSPs in North America, Greater China and Japan will launch projects to complete 90% of nationwide 5G population coverage by 2023. CSPs in Western Europe will achieve similar coverage by 2026, while other regions will not achieve the same coverage until after 2026.

Like with previous generations of cellular, the in-building space is at risk of remaining an underserved market. The approach of waiting a few years to have broad availability of fully functioning public 5G — putting some digital business plans at risk — will need to be revised and recalibrated. Early 5G indoor coverage that is able to address specific digital service needs from both enterprise and consumer use cases is a potential way to monetize 5G earlier.

However, 5G, which is expected to be deployed using higher frequency bands, will bring its own complications to the indoor coverage challenge:

- Firstly, the traditional “outside-in” approach, which leverages macrocells to provide indoor coverage, faces technology challenges in the 5G era. 5G is expected to be deployed in higher frequency bands such as at C-band or mmWave. These frequencies penetrate buildings poorly compared to lower frequency bands used in 4G today. Advanced technologies such as massive multiple input/multiple output (MIMO) and beamforming can be leveraged for indoor coverage. However, deployments can be expensive and take time to be ready, and the improvements may be limited.

- Secondly, traditional indoor hardware is not able to support 5G and needs to be reinvented. Distributed antenna solutions (DAS) have difficulties supporting bands of 3.5GHz or higher frequencies found in 5G because the high-frequency, band-specific components have higher signal loss over cables. It is also complex or prohibitively expensive to support higher antenna arrays. Traditional small cell solutions do not support multiple operators and bands as effectively as DAS.

- Finally, the diversified digital services that 5G promises to support (such as 4K/8K video, smart manufacturing, smart buildings, augmented and virtual reality [AR/VR], and the Internet of Things [IoT]) require high-quality indoor coverage. Hence, CSPs must deliver on indoor network quality.

As new services (video, IoT and artificial intelligence [AI]/machine learning [ML]) emerge for indoor environments, property owners and enterprises are starting to view the quality of their indoor
network as a fundamental amenity. Applying 5G technology to indoors is a new trend and emerging as an increasingly vital issue for rapid 5G network rollout.

The benefits of a 5G indoor network are multifold:

- It allows CSPs to unleash suppressed traffic indoors to increase revenue without waiting for widespread 5G deployment and coverage.
- Next-generation indoor networks allow infrastructure sharing, fast deployment and intelligent operation, which can help CSPs reduce their installation costs and operating expenditures (opex). This will mean savings in manual labor and resources.
- New digital capabilities such as accurate positioning are crucial for CSPs to expand service boundaries and explore new services and business models.

Indoor 5G presents a broad set of opportunities for technology and service providers (TSPs). However, product managers must capture the nuances detailed in this research and use them to differentiate their offerings appropriately. Hence, product managers need to follow a disruptive approach like the one shown in Figure 1.
Gartner believes that a 5G-oriented indoor strategy in the early stage of 5G deployment is crucial to accelerate 5G adoption and achieve early 5G monetization.

Therefore, as part of our ongoing research for 5G, this research aims to answer several questions about 5G and how a 5G-oriented indoor solution can help:

- What is the best indoor coverage product roadmap that enables seamless 5G migration?
- Which market segments present the best 5G opportunities, and what is their relation to the indoor environment?
Will existing approaches to indoor environments be adequate for TSPs to exploit the 5G opportunity?

Which other stakeholders of technology, services and business models do TSPs need to partner with to advance the potential of 5G?

**Background and Context**

Service provider usage of indoor solutions is driven by changing user traffic patterns. The vast majority (70% to 90%, depending on the geography) of subscribers’ data traffic arises when subscribers are indoors (see “Magic Quadrant for Small Cell Equipment”).

With the continued proliferation of wireless devices, explosion of new mobile applications under the IoT umbrella and forthcoming 5G evolution, traffic originating from indoors is positioned to grow further, as a percentage of all traffic and in absolute terms. The traditional approach of “outdoor coverage for indoor areas” will face increasing challenges as high-frequency bands are put into use. Hence, a dedicated 5G-oriented indoor solution will be necessary for the imminent 5G era.

Deploying a 5G-oriented indoor solution has had its difficulties in terms of time to activate and cost. While CSPs aim to provide low-cost products at optimum locations, getting planning permission and access to street furniture, power and broadband backhaul can prove to be costly and time-consuming.

Meanwhile, city governments get frustrated by rarely coordinated, multiple planning applications from multiple CSPs. Also, the proposed small cells are often considered ugly and out of character with the location. Procedures and product appearance are improving in an increasing number of cases, and the inclusion of neutral host infrastructure companies can ease the process.

**The Impact**

**Create Competitive Advantage for 5G by Investing in and Developing a 5G-Oriented Indoor Digital Solution Strategy**

Ensuring omnipresent service consistency in indoor and outdoor environments is becoming a basic network requirement. CSPs must ensure their cellular network infrastructure supports flexible capacity expansions and that leading 5G-oriented indoor networks can be built while addressing constantly growing capacity demands.

Today, various solutions address indoor coverage and capacity requirements; however, most solutions have challenges evolving to support 5G (see Table 1). Therefore, a novel and scalable in-building solution for 5G becomes critical as CSPs plan their 5G access solutions to meet ever-increasing capacity requirements.
Table 1. Current Indoor Coverage Solutions

<table>
<thead>
<tr>
<th>Name</th>
<th>Description</th>
<th>5G Challenges</th>
</tr>
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<tbody>
<tr>
<td><strong>Macrocell</strong> (outdoor-to-indoor)</td>
<td>Deployed outdoors. Leveraging outdoor macrocells and signal boosters to provide indoor coverage.</td>
<td>■ 5G will make greater use of high-frequency spectrum that doesn’t penetrate walls. This results in poor user experience at the cell edge.</td>
</tr>
</tbody>
</table>
| **DAS**                     | Deployed indoors. Mainly used for large venues such as airports, urban centers, business parks and stadiums. | ■ High frequencies: DAS (passive DAS in particular, which uses components without active electronics) has more difficulty supporting 5G at a higher frequency (C-band and mmWave).  
■ MIMO: Even active DAS faces hurdles because migrating to 5G will require higher antenna arrays, for example, 4T4R, which could be difficult or prohibitively expensive for DAS.  
■ Digital services: DAS, especially passive DAS, is not designed to handle the digital services that 5G enables, from IoT to analytics to location services. |
| **Small cells** (femtocells, picocells) | Deployed indoors. Mainly used for small and midsize venues such as high-rise office buildings, hospitals and retail stores. | ■ Small cell solutions may not be cost-effective for large venues.  
■ Not be as effective as DAS at supporting multiple operators (some small cell solutions simply don’t). |
| **Wi-Fi**                   | A wireless extension of a wired LAN that connects devices via a wireless access point. | ■ Wi-Fi does not operate on licensed spectrum.  
■ This option will not be discussed in this note. |

Source: Gartner (June 2019)

In current indoor deployments, competition is fierce between DAS and small cell vendors. DAS is suited to high-profile, multiband, multioperator environments. Therefore, DAS has been used extensively in large stadiums, airports and other public buildings such as convention centers and shopping malls. Small cells, on the other hand, have typically been used in small and midsize office buildings and other commercial venues. However, all face pressures to reinvent when migrating to 5G (see Table 1).

To fulfill 5G performance requirements and provide a superior user experience indoors, recent developments show that new indoor solution concepts merge the best of DAS and small cells, and have six key capabilities (see Figure 2).
Figure 2. Key Capabilities for a 5G-Oriented Indoor System

Key Capabilities for a 5G-Oriented Indoor System

- Transmission over Ethernet cable or optical fiber
- Enhanced digital service enablement, e.g., location services
- Virtualized and intelligent network management and operations
- Full spectrum support, e.g., C-band, mmWave, CBRS
- Simplified architecture, cost-effective upgrading process to meet future requirements
- Support multivendor, multivendor and neutral hosting

CBRS = Citizens Broadband Radio Service
Source: Gartner (June 2019)
ID: 383862
5G-oriented indoor digital solution architecture with three fundamental layers (see Figure 3) has emerged and been selected by major indoor solution vendors. In this setup, the baseband function is centralized like a DAS, but the radio function is distributed. Different vendors may have additional components on top of this, such as a new composition point to support a multioperator environment.

This architecture is able to support a range of technologies with high data rates, including multicarrier aggregation and distributed MIMO. Most importantly, this architecture is backward compatible with 4G, which enables CSPs to reuse existing hardware, such as network and fiber optic cables, during 5G upgrades.

**Figure 3. Reference Architecture for Next-Generation Indoor Solutions**

Traditional macro-network vendors have made changes to their small cell portfolios with new architecture that supports more aggressive competition with DAS.

- Huawei introduced its 5G Digital Indoor System (DIS), which uses active antenna, networks and fiber optic cables to transmit data, which are advantageous in visualized operations and management (O&M) and diversified services.
Ericsson introduced the 5G Radio Dot, a small cell radio designed to satisfy the advanced indoor mobile broadband performance requirements demanded by 5G.

Nokia introduced its 5G-ready AirScale Indoor Radio (ASiR) system, which is an enhanced indoor solution with centralized architecture, including multiband ASiR-pRRH, ASiR-sHUB and AirScale BBU.

ZTE released 4G and 5G multimode Qcell products that can be easily and quickly installed in indoor high-density and deep coverage scenarios.

Other vendors that offer small-cell-based indoor solutions include Cisco and Baicells.

Meanwhile, traditional indoor distributed network (DAS) vendors are shifting to digital solutions using active digital devices. For example, Comba Telecom launched the new iCell solution and CommScope launched the ION-E solution.

Other technology trends related to small cells are the development of OpenRAN and, particularly, white-box small cell solutions. For new entrants, a small cell white box built to a standard reference design lowers the barrier of creating a new baseband unit from scratch. The lower transmission power radio frequency (RF) and white-box baseband create a combination that will allow new entrants into the market in the coming 5G era. As mobile networks will be increasingly densified, CSPs will see strong demand for cost-effective small cell solutions.

However, OpenRAN is still in its early stages. It is facing a lot of challenges, especially in 5G, such as deployment options; proprietary interfaces, such as Common Public Radio Interface (CPRI) and enhanced CPRI (eCPRI); complexities from multivendor integrations; and resistance from incumbent vendors. OpenRAN still needs three to five years to be widely accepted and proofed.

**Recommendations for product managers:**

Do not wait for widespread 5G deployment, which needs three to five years to reach proper coverage:

- Start defining and investing in your 5G-oriented indoor solution strategy and roadmap. 5G needs an indoor-ready solution in the beginning to accelerate adoption and achieve early monetization.

- Refine your small cell products and make sure they have a simplified architecture, elastic expansion, cost-effective upgrading process, and simple and automated management tools.

- Work closely with ecosystem partners to develop a set of generic, solution-neutral design guidelines focused on cheaper, faster and more reliable deployments of indoor solutions. Being more open will reduce barriers to entry and accelerate innovation.

- Develop a compelling value proposition to deal with substitution challenges from alternative technologies such as Wi-Fi 6.
Create Usage Scenarios by Mapping 5G Capabilities to Enterprise Indoor Requirements

5G promises to deliver enhanced consumer services such as AR/VR/mixed reality (MR), ultra-high-definition (UHD) video and superior gaming experiences. 5G is also intended for specific vertical-market use cases, such as manufacturing, utilities, transportation, retail and healthcare. These areas focus on the enterprise market to enable new monetization models and new sources of revenue, which also mean new opportunities in the telecom ecosystem.

We don’t believe 5G will achieve nationwide coverage in three to five years. But we think that indoor coverage can be a potential opportunity to achieve early 5G monetization (see Figure 4).

**Figure 4. Monetize 5G Indoor Opportunities**

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**Monetize 5G Indoor Opportunities**

**5G Indoor**

- Over 80% of traffic is consumed under an indoor environment.
- Most of the 5G target use cases require a quality indoor network.
- Most of the enterprise customers that 5G targets are interested in ensuring their indoor areas have adequate wireless coverage.

Source: Gartner (June 2019)
ID: 363892

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**Most Traffic Initiates From Indoors**

Gartner research shows that 80% of data consumption and services (such as 4K/8K video and AR/VR) are more data-hungry and require impeccable indoor coverage and capacity. This means CSPs cannot compromise indoor network quality. A 5G-oriented indoor network should provide huge capacity and fast, flexible capacity expansion. An optimal method will allow operators to unleash suppressed traffic in indoor hot spots to increase revenue without waiting for widespread 5G coverage.
5G Target Use Cases

Many 5G target use cases, such as industrial automation, remote surgery and “smart building” applications, will be deployed inside buildings. To fulfill the 5G vision, operators need to deliver exceptional 5G performance — ultra-high data rates with high reliability and low latency — indoors. These types of networks support capability openness and accurate positioning, which are features crucial to expanding service boundaries and discovering new services and business models. This invariably leads to the advantage of adding new proposed sources of revenue.

Digital Rise of the Enterprise Market Is a Key Driver for 5G

High-rise office and residential buildings, schools, universities, healthcare facilities, and buildings between 100,000 and 500,000 square feet are being referred to as the midsize market. Building owners and landlords alike are becoming increasingly interested in ensuring their buildings have adequate wireless coverage to satisfy the needs of residents, employees and visitors and their own internal digital service needs (such as smart operations, e-healthcare and IoT).

Addressing this market with an indoor solution opens new opportunities for CSPs and TSPs to effectively monetize 5G in a faster and more economical way (see Table 2).
Table 2. Key Verticals With a Clear Value Proposition for 5G Indoor Coverage

<table>
<thead>
<tr>
<th>Key Verticals</th>
<th>Indoor Services</th>
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| Retailing              | As retailers continue to digitally transform and shopper demographics continue to shift toward younger generations, it is crucial for businesses to understand their customers and provide a superior shopping experience. The addition of 5G technology can help power new technologies many retailers are starting to utilize such as:  
  ■ Real-time collection of customer data for in-store analytics  
  ■ AR/VR, high-definition video and interactive mobile apps  
  ■ Video and pattern recognition of shoppers  
  ■ Online and offline shopping experience and mobile payment  
  ■ In-store navigation                                                                 |
| Tourism and hospitality| The smart hotel concept is gaining a lot interest and robots are starting to be deployed. For these reasons, many hotels are looking to deploy 5G networks to deliver a better, more innovative customer experience.  
  ■ In a smart room, customers can adjust the temperature, window shades and light with the touch of a button on their mobile devices.  
  ■ Cloud-based gaming and entertainment, such as UHD video, will be enabled.  
  ■ Robotic service support will be possible.                                                                 |
| Smart manufacturing    | Within industrial manufacturing, increasing digital transformation and automation demand a highly reliable and low-latency network to support use cases such as:  
  ■ Augmented remote services assistance  
  ■ Digital twins with real-time and historical data to support predictive maintenance  
  ■ Robotic control and defect services                                                                 |
| Smart building/ smart office | Integrating 5G, cloud and IoT technology, enterprises are able to create a hassle-free, cableless and data-driven workplace to support smart working. Examples include:  
  ■ Enabling cloud-based digital working spaces  
  ■ Supporting real-time collaboration through AR/VR and UHD video technology  
  ■ Allowing biological identification, such as facial recognition, to be deployed in the working environment to enhance security |

Source: Gartner (June 2019)

Recommendations for product managers:

- Look beyond connectivity. Create usage scenarios by mapping 5G capabilities to enterprise indoor requirements. Demonstrate value by highlighting the business moments that 5G’s associated capabilities (edge computing and location) enable or better support.
Engage with customers to address their real issues and needs. Make your solution easy for enterprise decision makers to move forward with by lowering procurement barriers and reducing deployment complexities.

Expand the Market Beyond CSPs by Building Partnerships

In previous generations, the biggest obstacle slowing down the adoption of mobile networks indoors has been the lack of robust and scalable business models. The main reason is that traditional solutions — DAS and small cells — are too expensive for many enterprises to justify deployment.

In addition, enterprises are not satisfied with the prevalence of models in which the operator owns, operates and controls the infrastructure. As a result, wireless access within a venue is frequently split between the enterprise-owned Wi-Fi (for data service) and the operator-owned mobile network (for voice and messaging service), which is delivered through either outdoor macrocells or small cells.

However, both enterprises and CSPs are unsatisfied with this arrangement. On the one hand, the enterprise does not get the mobile coverage and lacks network control. On the other hand, although CSPs want to quickly monetize 5G business with enterprise services, in-building solutions in small venues have been difficult to justify financially and complex to manage. Further, it is a missed opportunity for neutral hosts and third parties.

The issue will become more critical in 5G era. CSPs will lose the flexibility of offering outdoor-to-indoor coverage due to the poor penetration caused by higher frequencies. However, enterprises are looking for deep 5G coverage, higher capacity and lower-latency wireless connectivity to support their digital services including video, mission-critical priorities and the IoT. Therefore, business model innovation is required when talking about 5G indoor systems.

5G gives operators the opportunity to rethink their indoor network business models for the enterprise and start introducing the same sophistication in terms of private networking, network colocation and SLAs as is the case for fixed network services. There are basically three models, though responsibility for specific components and services may be available in many different combinations:

- **Funded by the enterprise** — In this model, the enterprise may choose to create, pay for and operate a private network. Sometimes, it may outsource the maintenance and monitoring. The operator maintains responsibility for the RF signal source unless the enterprise is deploying a small cell, in which case the radio is part of the infrastructure and may be funded by either the enterprise or operator.

  With this setup, the enterprise may allow CSPs to lease access to its private network on a wholesale basis to service the operator’s subscribers within the venue without financing the network deployment directly. This allows CSPs to share the infrastructure without having to share the spectrum or their own network infrastructure, and thus keeps costs down.

- **Offered by a neutral host company** — Many enterprises don’t have the resources to own and operate the wireless network directly or may prefer to avoid managing one. This raised a new
opportunity, which we call “neutral host.” Neutral-host companies are third-party providers of DAS and small cell solutions that support multiple operators and bill those operators for access to their deployments. For these partners, significant ROI is required in order to deploy in an enterprise environment, a requirement usually reflected in their contracts. For the enterprise, very little cost is involved, assuming the enterprise offers a profitable enough location.

- **Funded by CSPs** — Currently, wireless operators typically only offer in-building wireless (IBW) solutions to very large (and profitable) venues such as stadiums. This is because these venues provide fast, significant ROI for the operator, even where they carry different operators’ traffic in addition to their own.

However, CSPs sometimes negotiate to provide single-operator IBW solutions for smaller, less lucrative enterprise spaces in exchange for exclusivity. Innovation in the business offering is important, especially when talking about the smaller enterprise space. Some CSPs sell access to enterprises on a coverage-as-a-service model, or build-your-own-coverage model, which T-Mobile promoted.

These new sharing ownership and operational models will accelerate indoor coverage deployments and enable early 5G monetization without waiting years for a widespread 5G coverage.

**Recommendations for product managers:**

- Look beyond CSPs. 5G indoor coverage is no longer a CSP solo game, your customer can be a neutral host or an enterprise. Make sure your indoor solutions have the flexibility to adopt a different business model.
- Build partnerships with property owners, regulators, IT service providers and local governments to accelerate 5G indoor adoption and maximize opportunities.

**Conclusion**

As new services continue to emerge in indoor environments, applying 5G technology to indoor networks is becoming a new trend. Ensuring omnipresent service consistency in indoor and outdoor environments is evolving into a basic network requirement.

CSPs, building owners and TSPs are facing challenges to successful 5G indoor coverage. These challenges stem from both technology and commercial sides. New technologies and new business models need to adapt to make sure they address new digital services needs for both coverage and capacity. A proper 5G-oriented indoor strategy can help TSPs build their competitive advantage in 5G rollouts and achieve early monetization.

**Gartner Recommended Reading**

*Some documents may not be available as part of your current Gartner subscription.*
“Brooklyn 5G Summit Provides 5G Update”

“Ask These Four Questions About Enterprise 5G”

“3 Requirements to Successfully Offer Commercial 5G Services”

“Critical Capabilities for Small Cell Equipment”

“Include 5G and Next-Generation Wireless in Roadmaps to Elevate In-Store Retail Customer Experience”

“Market Insight: Roadmap for Bluetooth 5 and Wi-Fi 6 in Smart Workspaces — When to Invest”