



**ED GUBBINS**

September 24, 2024

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## Small Cells:

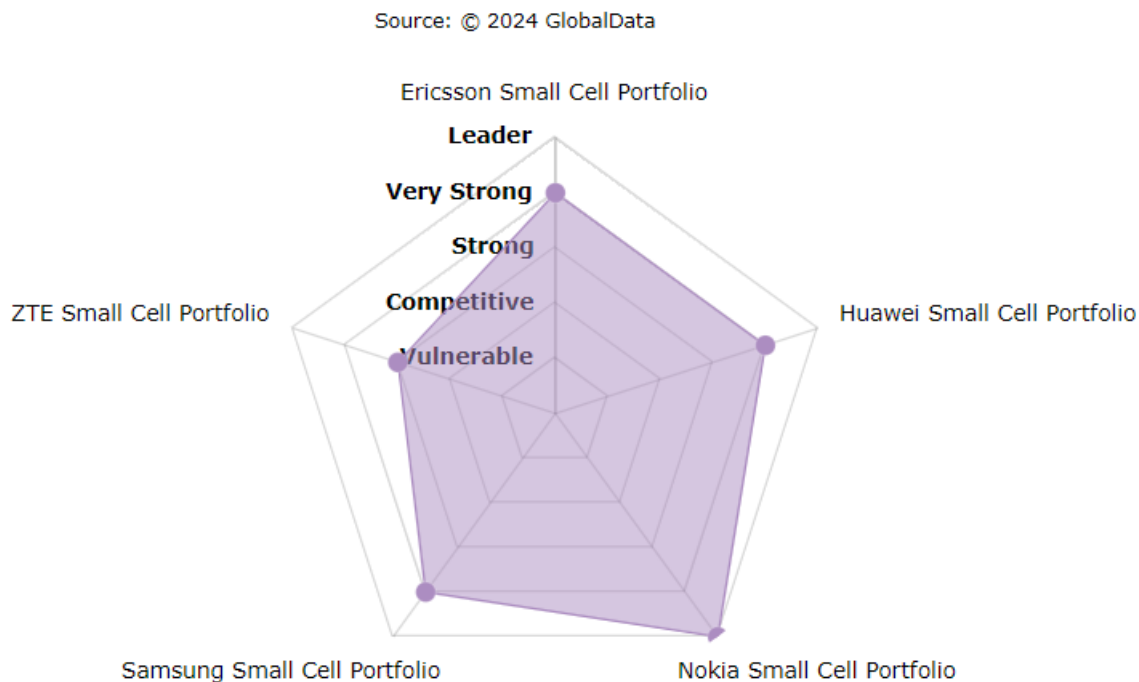
# Competitive Landscape Assessment

# Competitive Landscape Assessment - Small Cells

## Report Summary:

Activity in the small-cell space continues to revolve largely around distributed enterprise solutions, where vendors are adding support for radio access virtualization options. And among outdoor products, a new category is emerging: all-in-one 5G small cells.

## Product Class Scorecard



# Market Overview

Product Class	Small Cells
<b>Market Definition</b>	<p>Small cells are mobile base stations that operate under lower power and with a smaller coverage range than traditional base stations. This category includes what have traditionally been called femtocells and picocells, which improve mobile coverage and capacity inside homes and businesses, respectively. However, it also includes outdoor metrocells, a way to densify existing urban macrocell networks, and solutions with distributed hub-and-spoke architectures aimed at large indoor enterprise venues. As small cells and macrocells are essentially marketing terms, what precisely distinguishes a small cell from a macrocell product can be subjective. This analysis examines products with maximum output power not exceeding 20 watts per transceiver.</p>
<b>Rated Competitors</b>	<ul style="list-style-type: none"> <li>• <a href="#">Ericsson Small Cell Portfolio</a></li> <li>• <a href="#">Huawei Small Cell Portfolio</a></li> <li>• <a href="#">Nokia Small Cell Portfolio</a></li> <li>• <a href="#">Samsung Small Cell Portfolio</a></li> <li>• <a href="#">ZTE Small Cell Portfolio</a></li> </ul>
<b>Additional Competitors</b>	<ul style="list-style-type: none"> <li>• AirSpan Networks</li> <li>• BaiCells</li> <li>• Comba Telecom</li> <li>• CommScope</li> <li>• Corning</li> <li>• Mavenir</li> </ul>
<b>Changes Since Last Update</b>	<ul style="list-style-type: none"> <li>• <b>July 2024:</b> Nokia <a href="#">introduced</a> an all-in-one outdoor 5G small cell and voiced plans to offer a new indoor small cell supporting Citizens Broadband Radio System (CBRS) in early 2025.</li> <li>• <b>July 2024:</b> Ericsson added multiple new products including three new indoor radio units (the hub units in its distributed Radio Dot System) and a Radio Dot end unit. The company also removed some older products from the Radio Dot end unit portfolio.</li> <li>• <b>July 2024:</b> ZTE added multiple new products to its small-cell portfolio, including outdoor radios and radio end units for its distributed indoor QCell solution.</li> <li>• <b>April 2024:</b> Huawei promoted its new Light Site iNCR and Light Site Max solutions, which offer inexpensive deployment for coverage in specialized spaces including elevator shafts and parking garages, respectively.</li> </ul>

# Market Assessment

With many of their macrocell 5G network rollouts now mature, operators may be increasingly focused on densifying their networks with small cells - both outdoors (in both urban and rural areas) and indoors, where they can also hope to add new revenues from enterprises.

Judging by the investments that small-cell equipment vendors have made in their product portfolios, Ericsson, Huawei, and ZTE seem to have prioritized those enterprise opportunities, evolving their distributed indoor solutions to suit a variety of needs. To address network densification needs, these vendors have focused more on micro radio units than on all-in-one small cells, since micro radios can act essentially as extensions of existing baseband units, fortifying their positions as incumbent suppliers.

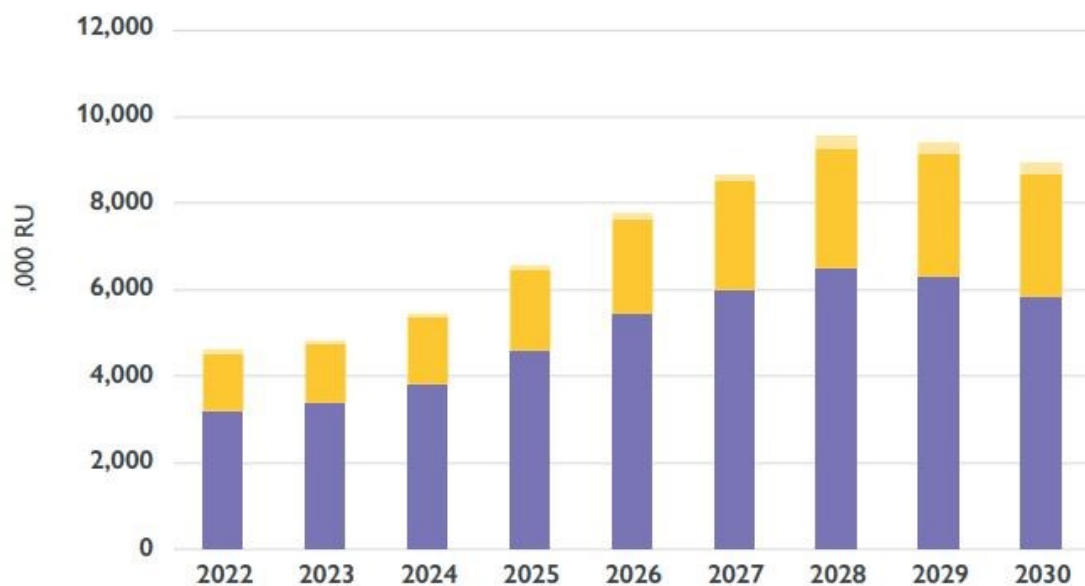
Nokia, meanwhile, was for years more focused on all-in-one outdoor small cells, using them to try to gain market share by penetrating competitors' network footprints, and it has recently distinguished itself in this area by commercializing the global market's first all-in-one outdoor 5G small cell. Nokia was later to the market for distributed indoor solutions and hasn't diversified its offering in that space as much as its three biggest RAN rivals have, but it has had notable success in the market for private (enterprise) wireless networks. And it also serves the market for residential small cells, which most vendors have not emphasized.

Samsung has also focused more on all-in-one small cells and was later than Nokia to join the distributed indoor enterprise solutions space - a space it has acknowledged has proven difficult to penetrate. For a time, Samsung's enterprise small-cell position was distinguished by support for virtual RAN, but more than one rival has followed Samsung by adding vRAN to their indoor small-cell portfolios. Meanwhile, Samsung's outdoor and all-in-one offerings are broader, in line with a strategy to grow market share in the shadow of larger vendors.

The small-cell market also includes multiple participants that compete with the major RAN vendors. U.S.-based Airspan Networks rose to prominence in large part on the strength of its residential small cells before expanding to address a broader focus on open RAN and private wireless opportunities. Another open RAN contender, Mavenir, offers its own small cells (and even acquired small-cell vendor ip.access) - partly to stimulate the open RAN market so that the open RAN ecosystem can grow large enough to allow Mavenir to exit the radio hardware space entirely and become a software-only vendor.

In addition, vendors including BaiCells, Comba Telecom, and others pursue opportunities overlooked by the largest vendors, while the CBRS market in the US and the open RAN movement have attracted new entrants. But, as with the broader RAN market, the global small-cell market is dominated by the five vendors examined in this analysis.

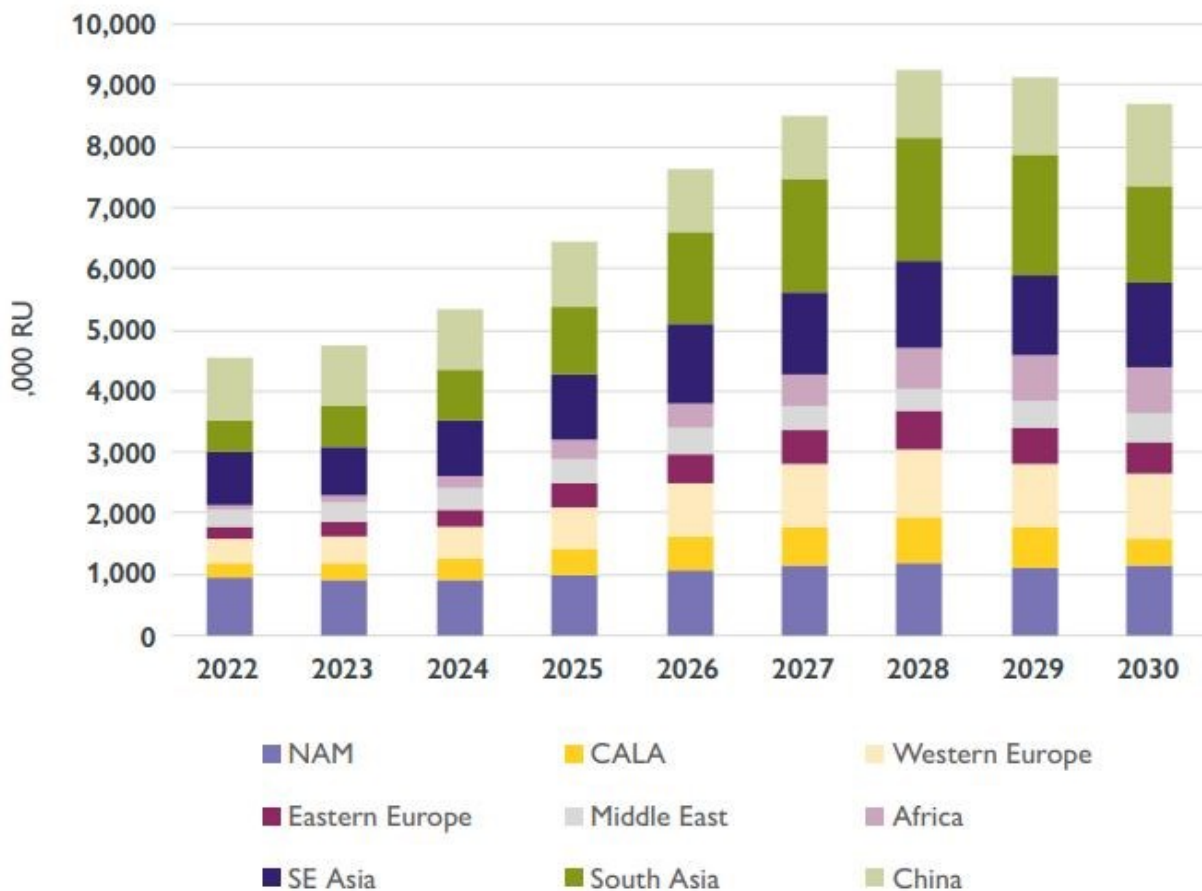
# Market Drivers



	2022	2023	2024	2025	2026	2027	2028	2029	2030
Rural and remote	92	97	109	132	156	173	286	283	269
Urban	1,341	1,357	1,530	1,841	2,178	2,514	2,768	2,826	2,864
Enterprise	3,190	3,392	3,826	4,603	5,446	5,982	6,491	6,311	5,818

Source: Small Cell Forum, July 2024

- Densification:** Small cells are commonly deployed to meet ongoing needs to increase network capacity and coverage in a more precise and less costly way than traditional base stations (i.e., macrocells) can. In addition to consumer mobile broadband, small-cell densification is even more important to deliver faster, more diverse 5G services - both outdoors and indoors (for more information, please see the chart above).
- Enterprise IoT Plus Private Networks:** Small cells are used to address use cases beyond consumer mobile broadband, including a range of enterprise functions. These include factory automation and remote monitoring using networked video surveillance devices and other sensors. In some instances, these use cases are served via private networks using spectrum that is dedicated to the enterprise rather than shared by an operator's broader consumer services. Some countries (e.g., Germany) have allocated spectrum specifically for this purpose.
- Spectrum/Network Sharing:** The opportunity to deploy small cells that use shared spectrum in the US can unlock new revenue streams (e.g., from enterprises wanting better indoor service) and enable new mobile service providers (e.g., neutral host providers, cable MSOs). These opportunities have helped drive acquisitions in the space, including CommScope's purchase of Arris and Airspan's purchase of Mimoso.
- 5G vs. Distributed Antenna Systems (DAS):** DAS, common in large indoor enterprise venues today, face challenges migrating to 5G (e.g., high-frequency spectrum, higher-order MIMO). This encourages vendors of distributed enterprise small-cell solutions to compete more aggressively with DAS for large venues.



Source: Small Cell Forum, July 2024

## Buying Criteria

- Capacity:** Whether in terms of the number of users supported by a single endpoint, the number of 5G layers (or uplink and downlink data connections) or the maximum data throughput it supports, the capacity of small cells is important in meeting ever-increasing data traffic levels.
- Compact Form Factors:** Outdoor small cells that are smaller can be easier (and thus less costly) to install. In addition, small cells indoors and out that are more compact are more visually discreet, which improves their appeal. At the same time, small-cell design often involves trade-offs for capabilities (e.g., multi-band support, higher bandwidth or power output, etc.) that can increase the size and weight of the hardware.
- Spectrum Support:** Small cells with a wide array of supported frequencies are better able to meet diverse market needs and to give operators (or even perhaps enterprises or venue owners) flexibility in deploying them. In addition, multi-band solutions can add capacity in the face of finite spectrum assets and across a range of radio technologies (i.e., 4G, 5G, etc.).

- **Mid-Band and Millimeter-Wave Spectrum:** Small cells using mid-band and millimeter-wave spectrum can utilize the copious bandwidth available in those frequencies to offer high-capacity (and in the case of millimeter wave, limited reach) services that give users a satisfying 5G experience. Although outdoor millimeter wave radios are not included in this analysis (rather, they are treated as a separate product category altogether, addressed in other reports), millimeter-wave support among distributed indoor enterprise solutions is.
- **RAN Sharing:** The ability of RAN infrastructure to support multiple service providers, including those using shared spectrum such as in the CBRS model, can satisfy multi-operator service needs and potentially offer lower investment capital, as it may be shared by multiple operators. The number of operators supported by a given solution could be a selection criterion, for example.
- **IoT Services:** Operators may use small cells to support both communication and IoT services, which will benefit from network slicing capabilities and network management offerings tailored to include IoT.

## Vendor Recommendations

- **Give Enterprise Offerings Vertical Specialization:** Do more to tailor distributed indoor enterprise solutions to specific industry verticals and applications. For example, optimizing solutions for a mix of Internet-of-Things applications - and processing virtual RAN capabilities efficiently on common infrastructure with other applications - could be compelling and differentiating.
- **Promote 5G-Advanced Possibilities:** Educate operators on the opportunities enabled by 5G-Advanced technologies used in combination with standalone 5G to create new enterprise services. Promote these opportunities are potential sources of new revenues to better monetize 5G networks.
- **Don't Neglect Rural 5G:** Although small cells are primarily regarded as an urban densification solution, remember that they can also be effective in rural areas where lower demand makes macrocell deployment less economically justified and where small cells may also unlock IoT opportunities.

## Buyer Recommendations

- **Discern Best Millimeter Wave Mix:** In network densification planning, consider site-by-site where the use of millimeter-wave radios may be preferable to using small cells and existing spectra. For example, millimeter wave is well-suited to boosting network capacity, while small cells can be better for filling coverage holes.
- **Plan to Pursue 5G-Advanced Opportunities:** Engage with vendors to understand how 5G-Advanced features like reduced capability (RedCap) might be used to grow new enterprise revenues. Develop a thorough understanding of the relevant business models surrounding such services.

# Rated Competitors

Product Name	Nokia Small Cell Portfolio
<p><b>Current Perspective</b></p>	<p>Nokia's outdoor small-cell portfolio offers the lightest, smallest 5G products on the market and support for a wider range of spectrum bands than nearly every other vendor. The portfolio is also distinguished by containing the only all-in-one 5G small cell supporting sub-6 GHz spectrum that is not a CBRS product - a product, branded Kolibri, that is also as compact as any outdoor small cell radio on the market. And its Shikra 5G outdoor radios have a flexible modular architecture that allows them to be deployed either as remote radios (connecting to a traditional or virtual baseband) or integrated with compact, outdoor BBUs. The vendor also offers CBRS products for the US market, including strand-mount options (primarily aimed at cable TV providers).</p> <p>For indoor enterprise networks, Nokia touts the 4G/5G integration of its distributed AirScale indoor Radio (ASiR) solution (with 4G and 5G supported in the same hub, unlike some of the competition, and end units supporting each access technology deployable in series). The weight and volume of those end units is unremarkable within the broader landscape of competing products, as is its support for triple-band end units. The solution includes the option to connect end units directly to BBUs (with no hub in between) for smaller deployments. Nokia's indoor portfolio also supports more spectrum bands than nearly any other vendor - but the ASiR does not support millimeter-wave bands, unlike similar solutions from rivals. And unlike some rivals, the solution doesn't include a hardened end unit for outdoor deployment.</p> <p>Each BBU in the ASiR can serve up to 18 hub units (an unremarkable figure, competitively). And each hub can feed 12-24 end units, depending on whether the end units are deployed in series; the former figure falls in the middle of market claims, while the latter surpasses them all, albeit in a way that discourages direct comparisons (e.g., 4G end units cannot be deployed in series unless they are fed by 5G units). ASiR also supports multi-operator and neutral-host capabilities and a CPRI Digital Donor module connecting DAS directly to the AirScale BBU.</p> <p>Nokia also offers a residential small cell: a 4G/5G femtocell that supports two LTE carriers and one 5G carrier. This offering distinguishes Nokia from rivals with much older products in this category (or none at all). It also helps Nokia tap another potential revenue stream.</p>
<p><b>Buying Criteria Rating</b></p>	<p><b>Enterprise</b> Very Strong</p> <p><b>Outdoor</b> Leader</p> <p><b>Residential</b> Leader</p>
<p><b>Product Scores</b></p>	<p><b>Leader</b></p>



<p><b>Strengths</b></p>	<ul style="list-style-type: none"> <li>• <b>All-in-One 5G Options:</b> Nokia is the only vendor in this analysis to offer all-in-one 5G options for both outdoor and residential use cases. It is also the only vendor to offer an all-in-one 5G small cell for the global market (i.e., not a CBRS product). This position differentiates Nokia and allows it to capture opportunities in the residential and small business spaces (including CBRS in the US).</li> <li>• <b>Compact Lightweight Outdoor 5G Radios:</b> Nokia's smallest outdoor 5G radio unit is 4 L, as small as any such product on the market. Its lightest such product is 4 kg - the lightest on the market. Compact designs can be less aesthetically obtrusive and easier (i.e., less costly) to deploy.</li> <li>• <b>Flexible Architecture Options:</b> Nokia's outdoor radios can be deployed remotely or integrated with a compact outdoor baseband unit. Deployed remotely, they can interface with either traditional purpose-built BBUs or virtual BBUs. Its indoor solutions include options with hub units for larger venues and options with direct connections between BBUs and end units (with no hub) for smaller venues. These options help meet a variety of operator preferences and give them more flexibility in deployment.</li> </ul>
<p><b>Limitations</b></p>	<ul style="list-style-type: none"> <li>• <b>Indoor Millimeter-Wave Options:</b> Nokia's indoor enterprise portfolio doesn't support millimeter wave spectrum, unlike all of the other vendors in this analysis. Millimeter-wave spectrum, though complicated by limitations in its ability to penetrate walls, can provide high capacity in some enterprise environments.</li> <li>• <b>Indoor Multi-Band Support:</b> Nokia's AirScale Indoor Radio supports up to three frequency bands simultaneously. However, nearly all of the other vendors in this analysis surpass that claim, supporting at least four bands at once. Multiband support can increase network capacity and maximize utilization of operators' spectrum assets.</li> <li>• <b>Indoor Enterprise Scalability:</b> The ASiR has some capacity limitations. It can support up to 144 4G end nodes per BBU, a number that trails competing figures. And each hub unit needs small Ethernet extension modules to reach end units that are more than 100 m away, whereas competitors claim longer reaches. Greater scalability per BBU and longer cabling spans could allow operators to cover larger venues with a given infrastructure investment.</li> </ul>

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