White Paper

INNOVATION IN THE MOBILE CELLULAR ANTENNA SECTOR

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One of the key pieces of equipment in a RAN, connecting end-user devices and the communication network, is the base station antenna. The base station antenna is a sophisticated piece of equipment transmitting and receiving thousands of radio signals and data traffic each day. With the launch of 5G, alongside new frequency bands, base station antennas need to cater to additional spectrum and adopt new features to meet data traffic demands. Base station antennas are also subjected to huge amounts of stress due to their exposure to weather and the environment.

Today's base station antennas consist of an extensive list of features, such as multi-band, multi-port, multi-beam, active-passive integration feature, and mMIMO (a.k.a. an active antenna). There are two main types of base station antennas—passive antennas and active antennas.

PASSIVE ANTENNA

Traditionally, almost all of the macro base station antennas mounted on poles or masts are passive in nature. The passive base station antennas contain the antenna array or diploe, the reflector or side walls, and feeding network in its radome. While the history of passive base station antennas goes back to the 1990s, they have seen many innovations breaking into the market.

With each new generation of mobile cellular technology, more frequency bands are made available for CSPs to deploy. Base station antennas need to evolve and cater to these demands by having multi-band/multi-port capabilities. Today, passive base station antennas can have as many as 30 ports. ABI Research posits that a growing number of base station antennas have more than 10 ports and support 5 or more frequency bands.

FDD + TDD hybrid antennas are also one of the innovations that allows CSPs to deploy both FDD and TDD frequency bands with a single antenna, thus saving on space and rental costs. Space constraint is also a key challenge for antennas with more frequency bands; to meet these challenges, innovations like the interleaved antenna dipole design are key. With an interleaved antenna dipole design, both a low band (< 1 GHz) and a high-band (e.g., 1 GHz – 3 GHz) can fit neatly together and meet the space constraints.

Base station antennas need to meet the strict requirement of handling wind load. Wind load is an important parameter for designing base station antennas, as it affects the performance, reliability, and safety of the mobile network infrastructure. Therefore, base station antennas today have incorporated the dimpled golf ball design to create smaller wake and reduce the wind load on the antennas.

The arrival of 5G has introduced new frequency bands, as well as new products, such as the active antenna, which is covered in the next section. To help mitigate the increase in cost of deployment, antenna vendors created the active-passive antenna platform solution, allowing active antennas to be mounted at the back of the passive antennas. The active-passive antenna platform is a cornerstone solution to help CSPs overcome deployment challenges.

ACTIVE ANTENNA

An active antenna is an evolutionary product, which derived from the higher frequencies and the need for higher capacity and performance. Today, active antennas support 32T32R or 64T64R mMIMO.

The key differences between an active antenna and a passive antenna lie in the components encapsulated within the radome. An active antenna is the result of integration between a passive antenna array and the RU. For an in-depth discussion on the differentiation between active antennas and passive antennas, please see ABI Research's Clarifying the Role and Relationships of Passive and Active Antennas and Their Innovation Roadmaps whitepaper.

A key feature of active antennas is the ability to create highly directable narrow beams for each end user. These narrow beams allow active antennas to generate multiple beams, while balancing constructive interfaces between each beam. This enhances the spectral efficiency for CSPs, while improving overall performance of the mobile network, as each user could obtain a dedicated beam.

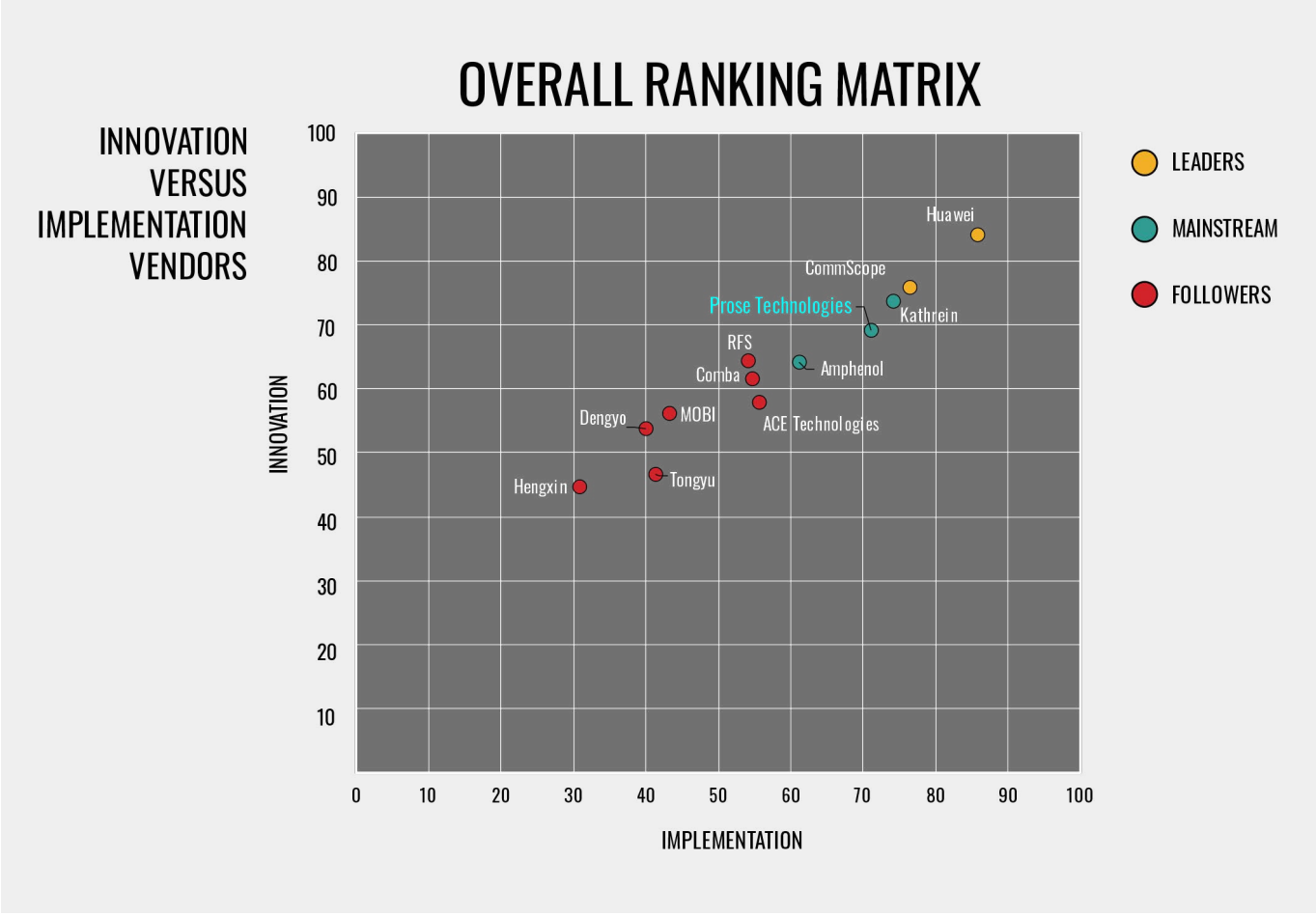
RAN vendors, such as Ericsson and Huawei, have already launched 64T64R mMIMO that weighs approximately 20 Kilograms (kg) or even less. Ericsson launched a 20-kg unit, while Huawei launched one that weighs 19 kg. Aside from weight, the number of antenna arrays, between 192 and 384 antenna elements, and the number of frequency bands have also increased, with the latest supporting triple bands.

COMPETITIVE ASSESSMENT SNAPSHOT

ABI Research conducts a regular competitive assessment study, the "Cellular Base Station Antenna Market" competitive assessment (CA-1326), which was published in June 2021. Prose Technologies, formerly Rosenberger, was assessed as one of the top five vendors in the passive base station antenna market based on ABI Research's annual vendor matrix assessment. The vendor matrix assessment assesses each vendor based on two major categories—innovation and implementation.

Passive Base Station Antenna Vendor Matrix (2020)

(Source: ABI Research)



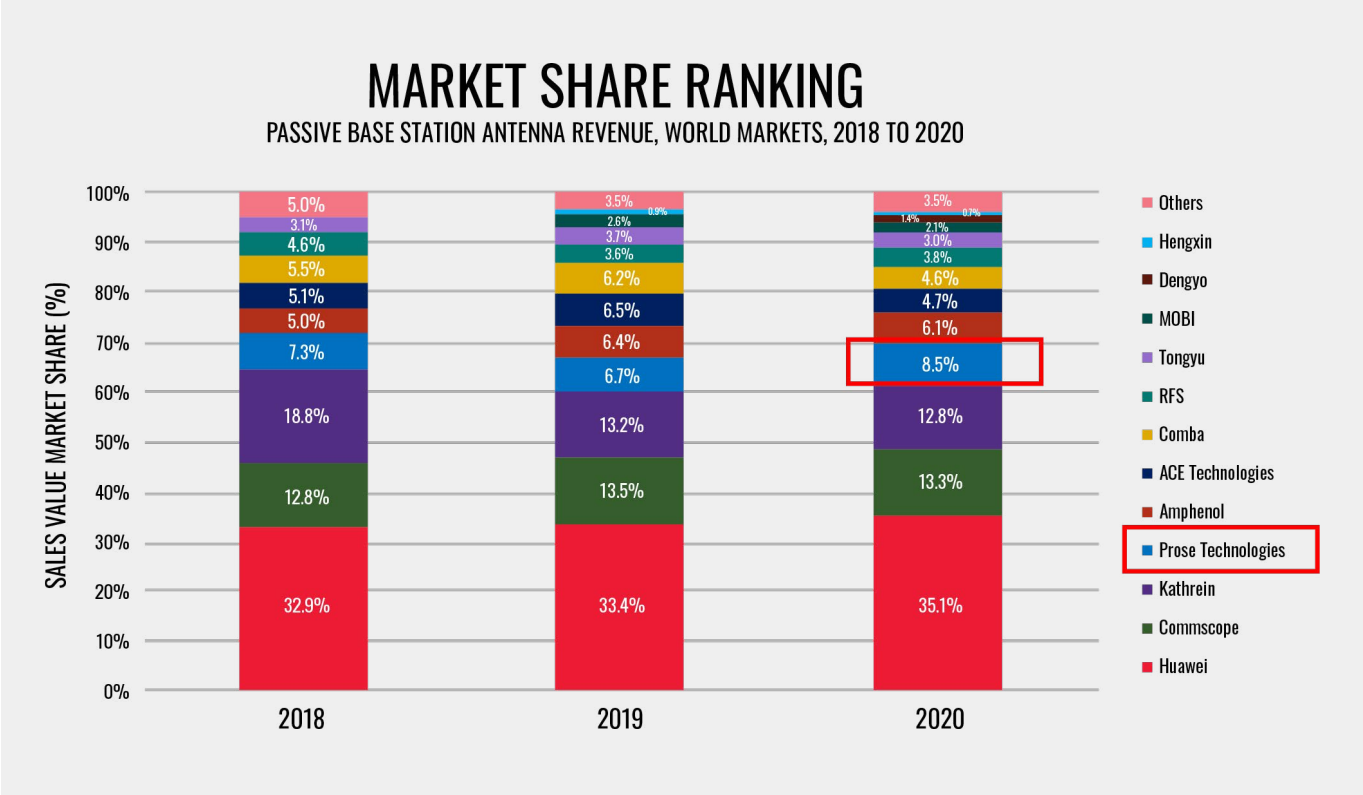
Prose Technologies is a market challenger and has risen up the ranks to become one of the leading base station antenna vendors globally. In ABI Research's latest competitive assessment, Prose Technologies ranked in fourth position, four ranks higher compared to 2016. Over the years, Prose Technologies has continued strengthening its R&D capabilities to ensure its products meet the stringent demands of CSPs in different regions of the world.

MOBILE CELLULAR ANTENNA MARKET SHARE

Based on ABI Research's latest passive base station antenna competitive assessment, the "Cellular Base Station Antenna Market" (CA-1326), almost 70% of the market, based on revenue, was captured by the top four vendors in 2020. These vendors include Huawei, CommScope, Ericsson Antenna System (previously Kathrein Mobile Communications), and Prose Technologies. Prose Technologies is one of the antenna vendors that has emerged over the years, capturing 8.5% of the global market in 2020.

Passive Base Station Antenna Market Share Ranking (2020)

(Source: ABI Research)

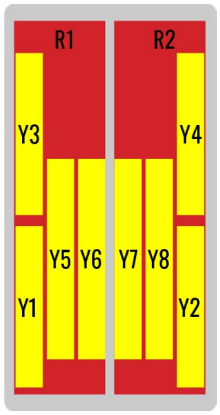


PROSE TECHNOLOGIES SOLUTIONS

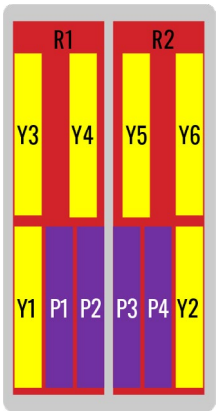
While mMIMO active antennas have been touted as essential for deploying 5G, particularly in the n78 band (3,330 – 3,800 MHz), passive base station antennas remain the foundation for CSPs. Passive base station antennas have seen innovations over the years and there is increasing demand for an optimal solution capable of delivering coverage and capacity. The 8T8R (8 transmitters and 8 receivers), with its beamforming capabilities, is one solution that allows CSPs to scale up network capacity, while balancing cost of deployment, a perfect alternative option to deploying mMIMO.

TDD + FDD Antenna Developments Example

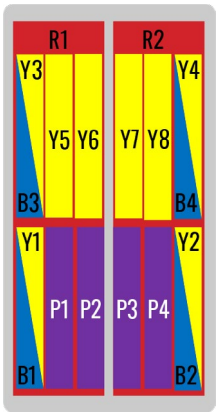
(Source: Prose Technologies)



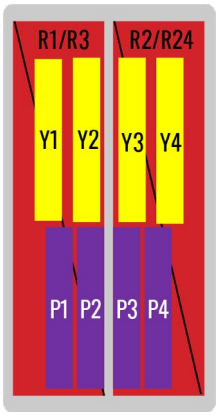
2L4H + 2.6G TDD
498mm width
20 Port - 2.0&2.7m



2L6H + 2.3-3.8 TDD
448mm width
24 Port - 2.0&2.7m



4L4H + 3.5G TDD
498mm width
24 Port - 2.0&2.7m



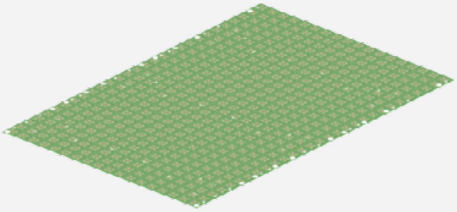
2L8H + 2.6&3.5G TDD
498mm width
36 Port - 2.0&2.7m

Prose Technologies has TDD + FDD antenna solutions to overcome space constraints on masts, while increasing capacity. Figure 9 shows some of Prose Technologies' innovative solutions. For CSPs uncertain about the Return on Investment (ROI) for 5G mMIMO, the TDD + FDD antenna is one of the most cost-effective solutions to introducing 5G and upgrading the network.

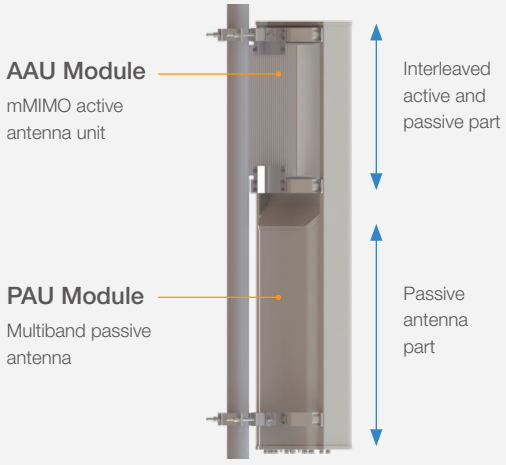
To help CSPs upgrade their network smoothly, Prose Technologies also has its active + passive platform solution. This solution has seen increasing interest among CSPs as they look to deploy mMIMO on cell sites without needing additional construction or poles. To ensure high performance, Prose Technologies' active + passive antennas are equipped with a Frequency Selected Surface (FSS), which allows 5G transmissions to pass through the passive antenna elements with little loss.

Active + Passive Antenna Platform with Frequency Selected Surface

(Source: Prose Technologies)



Frequency selected surface



To further improve the performance of Prose's antenna solutions, a low-loss stripline structure that replaces the traditional RF cables is used in antennas. According to Prose Technologies, this can provide up to about 1.5 Decibels (dB) higher gain compared to antennas using traditional RF cables. The use of a low-loss stripline structure can also help CSPs save up to 30% of the cost of base station sites. Other key innovations from Prose Technologies include an antenna radome design to minimize wind load and materials innovation to reduce the weight of antenna mounting brackets by up to 70%.

BACKHAULING WITH MICROWAVE ANTENNAS

In the RAN infrastructure, the backhaul, also known as the transport network, is an indispensable part. The backhaul connects the access network to the core network, typically via copper or fiber, or through microwaves and satellites. With the increasing amount of mobile data traffic expected to be generated with 5G, CSPs need to upgrade their backhaul infrastructure as much as they are upgrading the core and access networks. There are key developments in the backhaul market, such as Cross Polarization Interference Cancellation (XPIC), the availability of E-band (71 – 76 GHz, and 81 – 86 GHz), and the bonded channels or multiband microwave.

ABI Research forecasts that the total number of macro cell links will increase from around 8.1 million links in 2021 to 11.1 million links in 2027, while the number of small cell backhaul links will increase from 1.6 million links in 2021 to 6.1 million in 2027 at a CAGR of 25.8%.

ROLE OF XPIC

XPIC is a signal processing technique used on carrier-grade microwave links to drive higher capacity and spectral efficiency. XPIC potentially doubles the amount of capacity a microwave link can achieve through enhanced spectral efficiency by propagating two signals horizontally and vertically over the same frequency channel.

IMPACT OF THE E-BAND

The E-band is a frequency band covering 10 GHz of spectrum ranging from 71 – 76 GHz and from 81 – 86 GHz bands. Its full duplex bandwidth capacity can reach up to 25 Gigabits per Second (Gbps) and has a longer range than the V-Band (57 – 70 GHz), as the E-band is not readily absorbed by oxygen.

The beamwidth of the E-band is very narrow, making it highly suitable for Point-to-Point (PTP) Line-of-Sight (LoS) transmission. Due to its narrow beamwidth, and thus less likely chance of interference, multiple E-band radios can be deployed on a single cell site. Additionally, the narrow beamwidth and the need for PTP LoS transmission make it more difficult for a security breach, as it requires the intercepting radio to be placed between the transceivers.

THE VERSATILITY OF BONDED CHANNELS/MULTI-BAND

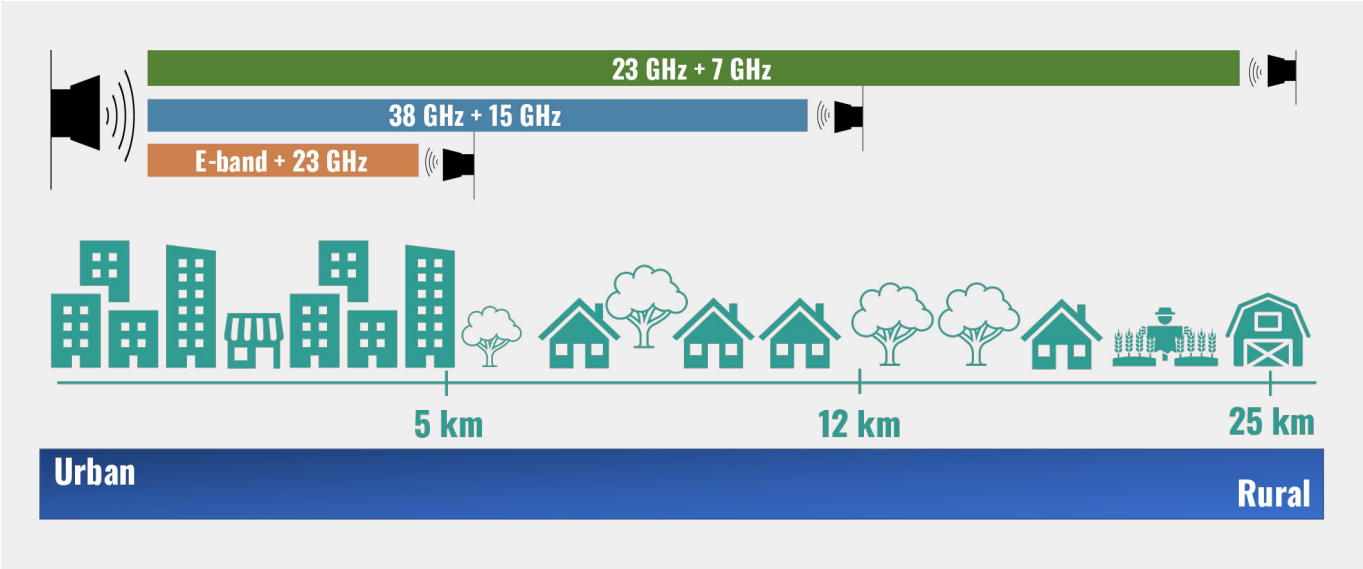
Just as the access network taps into multiple frequency bands to provide superior performance, backhaul can do the same. Bonded channels tap into different frequency bands in order to achieve a good balance between throughput and distance of hops. Traditional microwave frequency bands, such as 7 GHz, perform much better when traveling through longer hops. While the higher frequency bands, such as the E-band, perform much better in delivering the capacity to meet heavy traffic, they suffer from higher attenuation. By leveraging the advantages of different frequency bands, CSPs can benefit from increased flexibility in deployments.

KEY BENEFITS OF BONDED CHANNELS

Traditional microwave bands have much less bandwidth (28 – 56 MHz), as compared to the E-band (500 – 2,000 MHz). This restricts the throughput achievable by the traditional microwave bands. By tapping into different combinations of the E-band and the traditional microwave bands, for example, CSPs can boost the performance of backhaul significantly. Through bonded channels, CSPs can improve throughput and the distance covered between each hop to meet network demands.

Examples of Multi-Band Microwave Backhaul Configurations (not to scale)

(Sources: ABI Research, Ericsson)



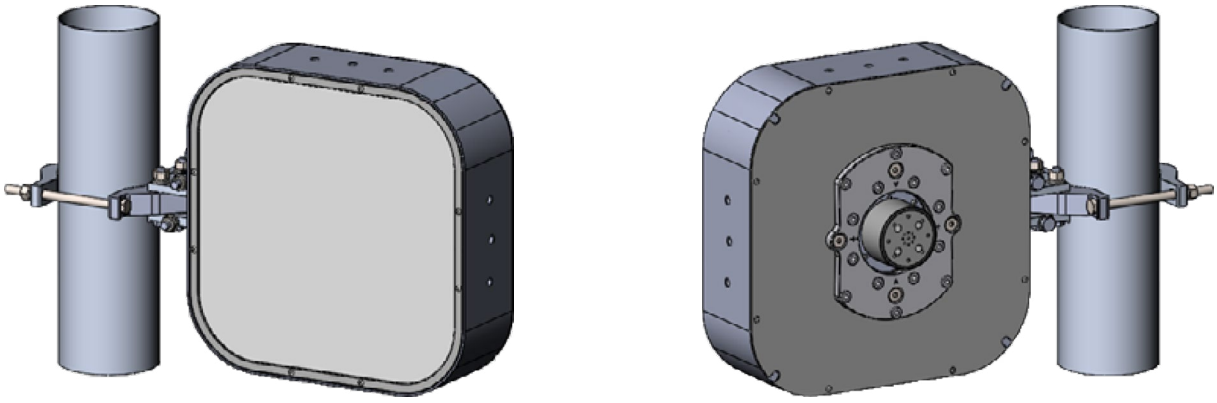
PROSE TECHNOLOGIES SOLUTIONS

Prose Technologies has a suite of microwave antenna solutions that meets the current and future demands of CSPs. Prose's current microwave antennas come in the range of 0.3 meters (m) up to 3.0 m, supporting 6 – 80 GHz bands. These microwave antennas can support single or dual-band for CSPs with either a single or dual polarization capability compliant with ETSI Class 3 or Class 4 Standard.

Given the importance of the E-band, Prose Technologies also offers its E-band Flat Planar Antenna (FPA) with up to 43 Decibel Relative to Isotropic Radiator (dBi) to meet the demand from CSPs. Prose Technologies has completed sample designs for the new upcoming W-band as well.

E-Band Flat Panel Antenna

(Source: Prose Technologies)



Source: ABI Research (2022). *INNOVATION IN THE CELLULAR TECHNOLOGY SECTOR AND THE ROLE OF PROSE TECHNOLOGIES.*