

Cellular Deployment Guide: Antenna & Deployment Best Practices

Picking the correct router or gateway for a 5G and LTE solution is just the first step in successful networking. Ensuring that the solution is deployed in the right manner, with the right antenna, is equally important.

This guide provides step-by-step best practice deployment advice that will ensure your solution is optimised.



Antenna Know-How



Antenna quality can be measured in multiple ways and it's a good idea to be familiar with these:

Gain

Gain is one of the most important parameters in describing an antenna's performance; it describes an antenna's focusing ability which determines the maximum range it can reach. Generally, the bigger the antenna is, the higher the gain. A high quality antenna should have a well behaved gain pattern in all directions without too many nulls (points of no power), and an even signal distribution.

Efficiency

Antenna efficiency is the ratio of the power radiated by the antenna to the power received at its input. A high-efficiency antenna radiates most of the power it receives. Efficiency is connected to the antenna's gain; a well-designed antenna should have both high efficiency and good gain.

Antenna Selection

When selecting an antenna the following considerations need to be made:

- | **Where will the antenna need to be situated?** If outside, then the antenna will need the appropriate IP rating to ensure it is protected against dust and water. If inside, then it will need to be of a suitable size.
- | **What application is the antenna being used for?** Different applications require different types of antennas, for example WiFi and GPS will require their own antennas in addition to cellular antennas.
- | **What environment is the antenna being placed in?** For example, vehicular or industrial locations will require an antenna that is suitably ruggedised with the appropriate fixtures.
- | **What is the quality of the signal in the intended location?** If the signal quality is poor then a high gain external antenna may suit it best.
- | **What frequency band are you using?** Most high quality antennas cover a wide range of frequencies, but some cheaper antennas are only suitable for one type of connectivity, e.g. 5G and LTE.
- | **How visible will the antenna be?** If it is highly visible in a prominent location then it may be important that it is aesthetically suitable.
- | **Where and how does the antenna need to be fixed?** Different locations require for the antenna to be attached in different places, for example on a window, wall or ceiling, and will therefore require different types of fixtures, for example screw-on, stick-on or magnetic.
- | **What options are available to support multiple cellular modems?** The demand for managing solutions with multiple cellular modems is rising, leading to increased complexity. It's common to see modems requiring 4x connections, known as 4x4 setups.

Best Practice Recommendations

After these questions have been addressed, the process of selecting the correct antenna can begin. The following best practice approaches can be used to narrow the selection to the most suitable antenna product/s, but Westbase.io are always on hand to help as well:

Omnidirectional vs Directional

A directional antenna only sends and receives in one specific direction, whereas omnidirectional antennas can send and receive in all directions around it. As such:

- | **A directional antenna** should be used in areas where signal quality is low and the maximum signal needs to be achieved by pointing the antenna in the direction of the nearest base station. Using a directional antenna in an environment where a strong signal is available, could actually have a detrimental effect on reception and performance as it may not be able to benefit from the strongest signal.
- | **An omnidirectional antenna** should be used in areas where there is a good signal quality as it is easier to install and it doesn't need to be aligned with the closest base station, instead connecting to the nearest tower.

High gain vs standard dipole antennas

A high gain antenna is essential for locations which have poor coverage. A standard dipole, which doesn't offer the same gain or efficiency but is easier to install, can be used in locations with high signal quality.

Combined vs individual antennas

Some applications require multiple types of antenna; for example cellular, GPS, and WiFi could all be necessary. A combined antenna provides a single solution with multiple antenna elements built into one casing and is most suitable where the reach of the application is contained to a certain area, for example a vehicle. Individual antennas are preferable when the application is more spread out, for example in a building where the cellular antenna needs to be outside, but the WiFi provision is inside.

Antenna Selection (cont.)

Cross-polarisation antennas; MIMO and diversity support for 5G and LTE

A cross-polarised antenna supports multiple-input multiple-output (MIMO) 5G and LTE wireless systems, and is essential to achieving the high data speeds enabled by cellular. A cross-polarised antenna essentially contains two cellular antenna elements within one housing, one for the primary connection and one for diversity. This improves the efficiency of the antenna so that it can deliver the highest quality and most reliable 5G or LTE connection. If deploying a 5G or LTE gateway or router, a cross-polarisation antenna is recommended. Where this isn't possible, two individual antennas should be used instead.

Mobility application antennas

Typically, a mobility application is best suited to a screw mount, puck-shaped antenna which can be fixed to the roof of the vehicle – enabling it to achieve the best possible signal as it moves through different areas. It should feature IP66 ratings to ensure it is protected against intrusion of objects, water, dust or accidental contact, as well as a ruggedised casing so that it can cope with the vibrations and temperatures associated with the environment.

If providing passenger WiFi then two antennas may be preferable – one which affixes to the roof to gain the best possible cellular signal, and one which fixes inside the vehicle to deliver a strong WiFi signal for passengers. Internal vehicular antennas should still offer some ruggedness, but glass-mount options can be preferable over screw-mount as it avoids having to change the interior.



What is an IP rating?

An IP rating is an international standard used to rate the degree of protection, or sealing effectiveness, in an electrical enclosure against intrusion of objects, water, dust or accidental contact.

Cable Selection



Selecting a low loss cable is very important in maximising the signal delivered to the cellular device. Even with the most suitable antenna, the wrong cable could see loss of signal between it and the device – which could ultimately undermine the solution and handicap its performance.

As with antennas there are a lot of cheaper cable options which can often promise performances which aren't achievable in reality, so ensure that a high quality cable is selected to minimise the risk of signal loss.

Westbase.io recommends either an LMR400 or RG400 (or equivalent) cable where the length exceeds 5 metres, and a maximum length of 10 metres, for an optimised performance.

Cable termination

Westbase.io recommends using pre-terminated cable interconnects or having cable termination done by a qualified installer. Incorrect cable terminations can cause signal loss, impacting the performance of the gateway or router.

Site Installation

By following the below steps, installation can be performed efficiently and effectively.

Before you go to site

1. **Desktop survey:** use the chosen network's website to check coverage at the location where the cellular solution is going to be installed. If a network provider hasn't already been selected for the solution then check several networks to find out which offers the best coverage.
2. **Antennas and extension cables:** Select a range of antennas and extension cables most suitable to the applications based on the above parameters and the results of the desktop survey. This means that the best option is ready to deploy when on site for first time success; saving on costly truck rolls.
3. **Signal analyser:** All installation engineers should be equipped with a signal analyser to determine the best possible location for the cellular device, and the most suitable antenna and cabling for the particular site. While the desktop survey noted above provides a rough idea of signal expectations, it only shows signals at a street level so cannot take into account buildings or the location of the device within the building. A signal analyser is particularly essential to ensuring an optimised deployment where a directional antenna is being used.

On site - device location

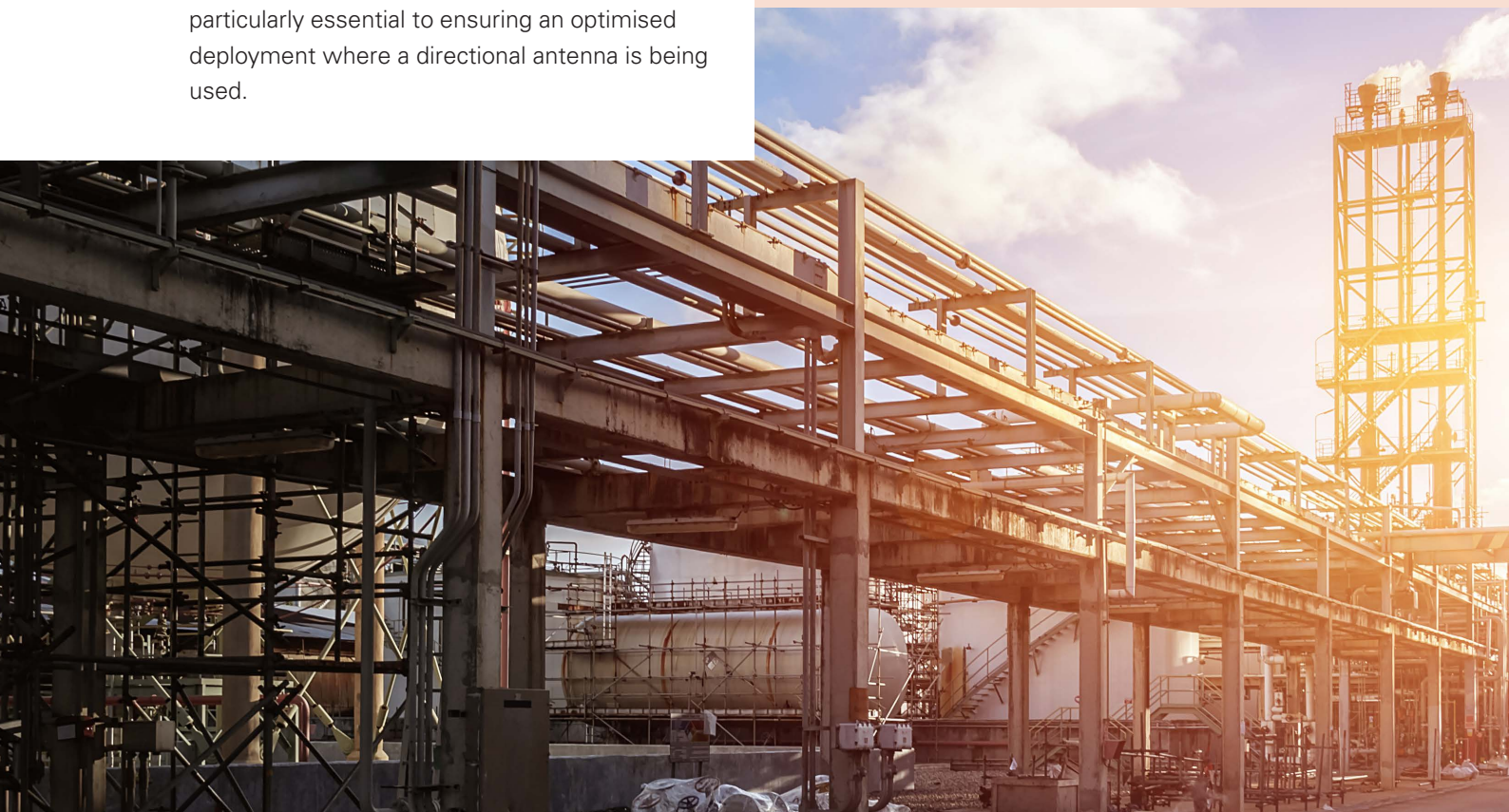
Before beginning to identify where the antenna should be located, it is important that the location of the cellular device is also optimised. The longer the cable between the antenna and the device, the more signal loss that will occur – even with a low loss cable.

Using a signal analyser, test the signal strength in different areas of the location to identify where the strongest signal can be achieved, then use this to help inform the device's location. Generally it is advisable to place the device as close as possible to the external walls as the signal quality will be highest here. If a selection of operators is possible then select the one with the best signal.



Still unsure or need additional support?

Westbase.io partner services include field engineering resources to help with site surveys, antenna installations, and cabling. Whether you want to add these as new services for your customers or scale up your current resources for a project, our team of experts is ready to help globally.



Site Installation (cont.)

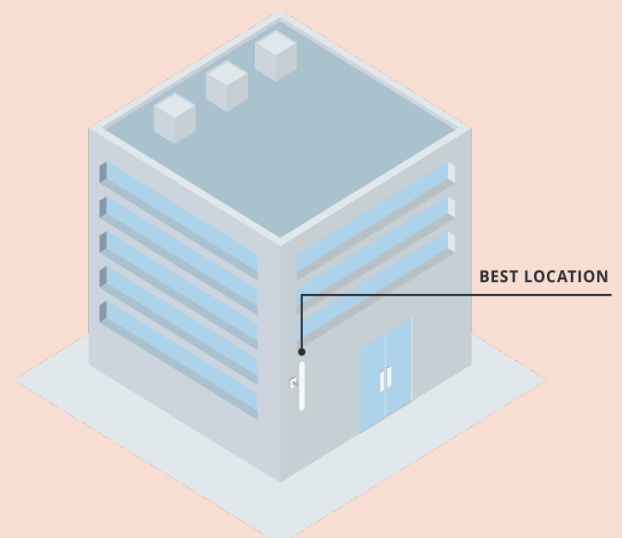
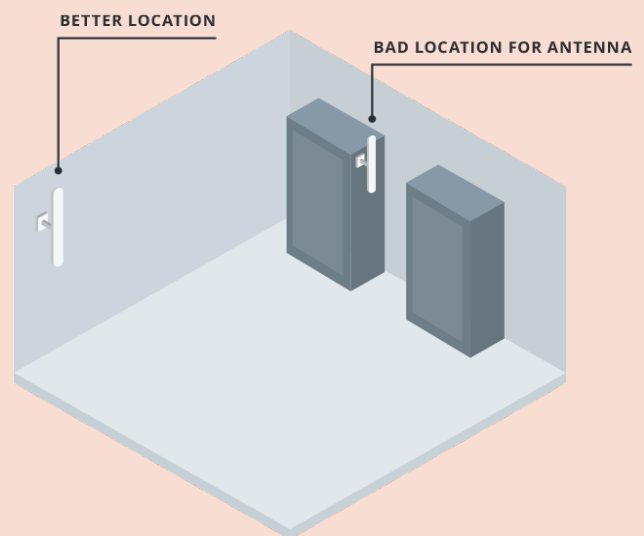
On site - antenna location

Antenna location

Once the antenna has been selected, the mounting options for this then need to be considered. In cases where coverage is good a standard dipole connected directly to the cellular device may be the most suitable option. In many cases however a wall mounted, high gain antenna will provide the best results. Select the best location for wall mounted antennas using the following guidance:

- Modern steel-framed buildings and internal metal obstructions can block signal so try to mount the antenna as high as possible, and away from any obstructions – checking the signal analyser again to determine where the strongest signal can be obtained.
- Mounting the antenna externally will provide the best results so if the antenna selected is suitable for outdoor use, and it is possible to do so, this should always be the first choice of location. If it cannot be mounted outside then try to get it as close to a window as possible instead.
- If the router is located in an enclosure then the antenna should always be mounted externally where possible.
- If using a directional antenna then it is essential that it is mounted externally and as high as possible, without excessively increasing cable length. It must be pointed in the direction of the nearest base station and with the best possible line of sight to avoid buildings blocking the signal. Using the signal analyser to test the outcome, turn the antenna in 10° increments at a time until the direction of the strongest signal has been identified.
- Do not increase the cable length unnecessarily in order to minimise signal loss; as a rule of thumb, when using an omnidirectional antenna the cable should not exceed 5 metres in length, while a directional antenna cable extension should not

exceed 10 metres in length (assuming high quality cabling is used). After these lengths, the signal quality gained by selecting the right high quality antenna will be lost – it's a balancing act between optimum location and distance from the cellular device.



Site Installation (cont.)

Check Connectivity

Once the device and antenna are both installed, power it up and verify the connectivity. Connect a laptop to the device and then browse to the router/gateway user interface to check the received signal strength indicator (RSSI), that it's connected to the network, and that it has its IP address. If using any cloud-based applications which work with the router/gateway, then log in to this to verify the router/gateway is checking in. The following scale indicates what an acceptable signal strength is:

		SINR (DB)	RSRQ (dB)	RSRP (dBm)	EC/Io (dB)
Technology		5G/LTE	5G/LTE	5G/LTE	HSPA+ and EVDO
Excellent		> 12.5	> -5	> -84	> -2
Signal Quality	Good	10 to 12.5	-9 to -5	-85 to -102	-2 to -5
	Fair	7 to 10	-12 to -9	-103 to -111	-5 to -1-
	Poor	< 7	< -12	< -11	< -10

		RSSI
Technology		LTE and 3G
Excellent		> -65
Signal Quality	Good	-65 to -75
	Fair	-75 to -85
	Poor	< -85



Determining Signal Values

Numerous factors affect signal strength and quality, including but not limited to:

- | Proximity to a cellular tower
- | Tower load
- | Physical barriers, such as mountains, buildings, or trains
- | Competing signals
- | Weather
- | Signal going through a cellular repeater

Signal strength and quality numbers do not incorporate all of the relevant factors. It is important to remember that measurements at a specific moment do not indicate the stability of a connection as conditions can change, causing variation.

Interpreting signal values

There is no specific answer to what defines a successful connection. Disconnecting with high signal values or connecting with low values can occur due to various reasons, including:

- | **Modems may vary:** Not all modems have the same acceptable value ranges, which impacts connectivity.
- | **Both signal strength and quality matter:** Excellent RSSI may not guarantee a stable connection if the signal quality is poor, and vice versa.
- | **Signal strength and signal quality values do not hold constant:** Signal variance significantly influences connection success. Readings in one moment can vary considerably over time, requiring consistency for stability.
- | **Environmental factors can affect all of the above:** Factors like network hardware, machinery, and weather affect RSSI, SINR, Ec/Io, RSRP and RSQR.



Westbase.io Partner Services

Westbase.io offer a selection of pick and mix partner services to provide the support you need, where you need it. Our service catalogue includes options through from product, install and manage, to maintenance, resource and disposal.

Take advantage of our hardware pre-sales consultancy and supply services to ensure you select the right antenna. We provide a wide range of antennas from leading manufacturers to ensure that our cellular solutions are fully optimised and can benefit from the best possible signal in each location.

Meanwhile our site survey, installation, cabling, and working at height install services can ensure your antenna and cellular deployments run smoothly.

Find out more about our full range of partner services by [following this link to our dedicated partner web page.](#)

To find out more about Westbase.io, our selection of antennas and related services, or anything else contained in this help guide, please contact us:

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