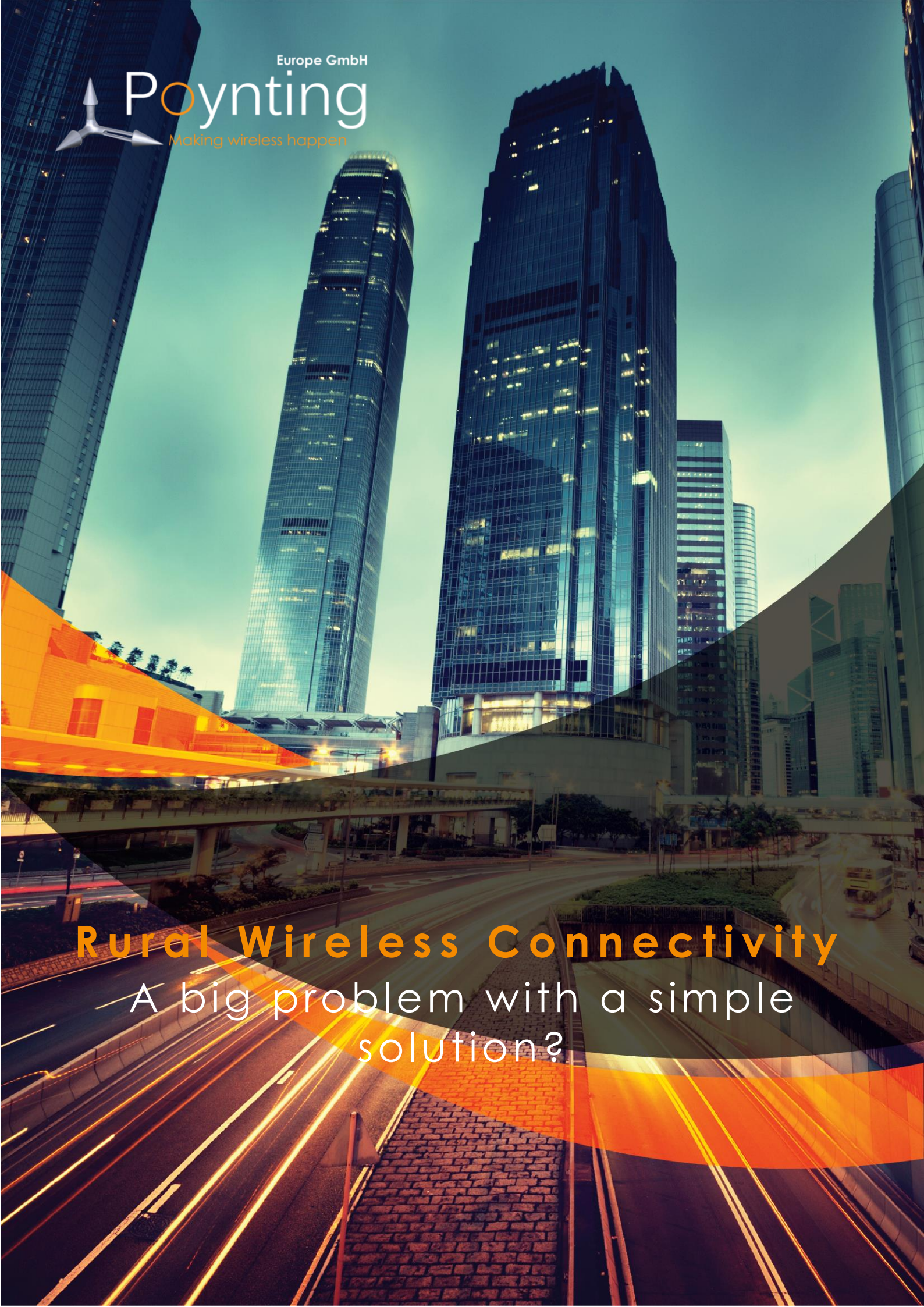

Europe GmbH
Poynting
Making wireless happen
Rural Wireless Connectivity
A big problem with a simple solution?

Rural Concerns

According to a recent OFCOM report, over 1 million people living in the UK do not have access to download speeds of 10Mbps, and where the average download speed at the end of 2018 was 17Mbps - this in an age where consumers and businesses rely on high speed connectivity to operate, whether this is to FaceTime in an important meeting or to make a financial transfer. The UK is not alone, also mainland European mobile network operators in amongst others Germany, France, Italy and Denmark all encounter the same or similar connectivity challenges.

Mobile network operators are starting to wake up to the fact that rural communities, or in some cases 'extra rural communities', require expansion investment to improve the service levels of mobile broadband. And in some European countries it is known that local operators are in fact guaranteeing minimum service levels in rural areas where consumers or businesses sign up to their service. The recent OFCOM report found that rural businesses could receive an overall revenue boost of up to £141m driven by the implementation of 4G, representing a potential £45m boost to the UK economy and boost to underlying employment growth of 31%.

Increasingly, both mobile network operators and SME businesses are becoming aware that advances in antenna technology can significantly improve mobile connectivity performance quickly and at a relatively lost-cost.

Improving download speeds in literally minutes by changing the antenna.

The Antenna - 132 Years in The Making

The first well-known satisfactory antenna experiment was completed by the German physicist Mr Heinrich Rudolf Hertz in 1887.

Figure 1. Mr Heinrich Rudolf Hertz

Although the fundamentals of how an antenna works and the definition of an antenna has not changed - an antenna defined as a device which can radiate and receive electromagnetic energy in an efficient and desired manner - advances in radio communication technology has meant that the design of antennas is a fast and exciting area of study.

How Is the Antenna Important?

One of the main misconceptions that is often repeated in the world of telecommunications, is that the antenna will not make much difference to the performance of a radio system, and choosing an antenna is a quick and easy choice.

So, let's look at one of the main reasons why the antenna, and the technical

performance of the antenna is important to a 3G, or an LTE system, ***the need for speed…***

The antenna can improve the available RF link budget of a radio communication system by focusing the available energy in a given direction, this is commonly known as a directional antenna. The directionality of an antenna can increase the RF link budget across a transmission path by as much as 9-10dB. When the available RF link budget is increased, this can have a significant effect on the quality of the signal that is received, this quality change can increase the data speeds across the transmission path.

LTE Coverage	RSRP (dBm)	RSRQ (dB)	SINR (dB)
Excellent Coverage	>=-80	>=-10	>=20
Good Coverage	-80 to -90	-10 to -15	13 to 20
Semi-Rural Coverage	-90 to -100	-15 to -20	0 to 13
Rural Coverage	<=-100	<-20	<=0

Figure 2. LTE Coverage Vs LTE KPI Measurements

Figure 2 represents classification of RF conditions Vs LTE key performance indicators in relation to cell site coverage, ranging from 'Excellent Coverage' down to 'Rural Coverage'

- RSRP = The average power (dB) received from a single reference point. The higher the value, the better the received power. Typical values can range from -130dBm up to -45dBm.
- RSRQ = Indicates quality of the received signal, and its range is typically -20.0dB to -3dB. Again, the higher this value is, the higher the quality of the received signal.
- SINR = The signal to noise ratio of the given signal. The higher the SINR value, the better/cleaner the signal is that is being received.

If we look at an existing LTE installation at the coverage edge of a cell site, say for example our LTE router is receiving an RSRP signal of -105dBm. With a MIMO (multiple in/multiple out) directional antenna installed outside a building, we would expect to see a 20-25dB improvement in relation to a SISO omni-directional antenna installed inside the building. The improvement in signal strength and quality of the signal would increase the data speed up to 20 times when combining increased signal with de-correlated MIMO antennas. Signal strength only increase with single antenna or two antennas without much de-correlation can improve the speed up to 10 times.

Parameter	Before Antenna Change	After Antenna Change
RSSI (dBm)	-87dBm	-67dBm
RSRP (dBm)	-107dBm	-87dBm
SINR (dB)	12dB	26dB
Download Speed (Mb)	15.29Mbps	54.78Mbps
Upload Speed (Mb)	1.05Mbps	18.33Mbps

Figure 3. Upgrade Results of Outdoor XPOL-2

Figure 3 shows real life results from an LTE router installation in a semi-rural area of

France, with results before and after an antenna change.

This customer was complaining about slow data speeds and intermittent connectivity, resulting in frustration and poor productivity for his SME business.

A local technician was deployed to change the antenna on the LTE router from a SISO (single in/single out) antenna to a Poynting XPOL-2 directional MIMO antenna. No additional changes were made to the customer setup. As this data shows, both the RSSI and RSRP measurements were improved by 20dB, these signal improvements resulted in the SINR measurement improvement of 14dB, which is significant. The customer is now benefitting from much higher data speeds, both download and upload. Furthermore, the customer also reported that the connectivity performance is now much more stable.

Figure 4. Poynting XPOL-2 Installation

Choosing the correct antenna

So how do we choose the best type of antenna?

Choosing the right antenna is not as simple as picking any high gain antenna and expecting it to work. In simple terms the performance of the antenna is as crucial to the success of a wireless system, as quality tyres are critical to the road handling of a car. If the true specification of the antenna is sub-standard, then this will severely impact wireless performance and reduce data speeds. Using the correct type of antenna from a reliable manufacturer is an effective way to help preserve wireless performance. We recommend **four** main considerations when choosing an antenna, these are….

i) Wideband Antenna

Globally, the mobile network frequency spectrum varies greatly, ranging from 450MHz right up to 3.8GHz, with network operators in countries offering many different frequency bands. For example, an operator in a country could well be transmitting LTE data on more than one frequency band. It is a good idea to check the antenna specifications to make sure that it covers a wide band, for the following reasons: -

- The antenna will not need to be changed if the network operator changes their operating frequencies. With more and more spectrum allocation changes, this is happening frequently.

- This will give you the freedom to change your network operator without changing your antenna.

- As new technology emerges, for example 5G, you will not be required to change your antenna.

ii) Antenna Directionality

Many people assume that the highest gain directional antenna is always the best antenna, but different antennas are designed for different situations. Below are some scenarios where a user may require either a directional or omni-directional antenna.

- If a user requires coverage with more than one base station, it might be best to choose to an omni-directional antenna. There can be many reasons why it is best to have coverage from more than one base station, one reason might be that the line of sight to one base station could change over time.

- When a user is in a built-up area, there could be a lot of signal reflection and you have access to more than one tower with LTE. In this case you might want to choose a directional antenna.

- If a user is a located in a rural or semi-rural are and can only communicate to one base station, it could be best to choose a directional antenna with high gain, this would improve the RF link budget.

- It might be best for a user to communicate only with a certain tower. E.g. the tower closest to you is congested and you want to communicate with one that is further away with less users, again it might be best to choose a directional antenna.

iii) MIMO Antennas

LTE is a multi-stream radio, MIMO (multiple in/multiple out) service. The majority of LTE dongles and routers currently being supplied by the providers have 2 antenna ports. If a router has two antenna ports, it is best that a MIMO capable antenna (2 antennas in one enclosure that are cross polarised) or 2 separate antennas is fitted. Some of the benefits of MIMO antennas are as follows: -

- Multiple antennas and spacial multiplexing enable higher data rates on both the downlink and the uplink of a radio system.

- MIMO helps in reducing the Bit Error Rate (BER) due to advanced signal processing on the receiver.

- MIMO based systems minimise fading effects seen by data that is transmitted. This is due to various diversity techniques, such as time, frequency, and space.

- MIMO (2x2) can double data rate if the two antennas are completely decorrelated. In 2x2 scenario this can be achieved using cross polarization (polarity of the two antennas 90 degrees apart).

Figure 5. XPOL-1 Omni-Directional MIMO Antenna

iv) Technical Data

Many antenna manufacturers publish a technical data sheet for each antenna product, each data sheet will contain performance data on important parameters, such as VSWR, gain, radiation patterns, cable type/loss, connector type. With a Wideband antenna that covers many different frequency bands, it is important that each parameter is understood across the full operating band of the antenna. Some antenna manufacturers only issue limited technical data, usually only the best case, Poynting is one of the few manufacturers that publishes the test data for the whole antenna frequency range. This technical data will have an impact on the antenna performance in the real world.

5G Connectivity

5G technology and future generations of wireless connectivity, when deployed future years, will provide much higher bandwidth and lower latency connectivity than current 4G technology. 5G will enable bandwidth in excess of 100 of Mb/s with latency of less than 1ms. New industries and applications will be enabled to transform the way we work, the way we live, and the way we engage with the environment around us.

In Europe, the 1GHz-6GHZ frequency band, also known as the 'coverage and capacity layer' utilises spectrum between 3.4GHz-3.8GHz and plan to make it suitable for 5G deployments. This will be the main frequency band for the launch of 5G services in Europe.

As networks move from 4G frequency bands operating at a maximum of 2.7GHz, to the new 5G 3.5GHz frequency bands, one of the challenges of deploying 5G networks across Europe will be the number of small cells required, and the physical RF coverage these cells with provide. More antennas will be required, and additionally more technically advanced antennas can help with small cell designs.

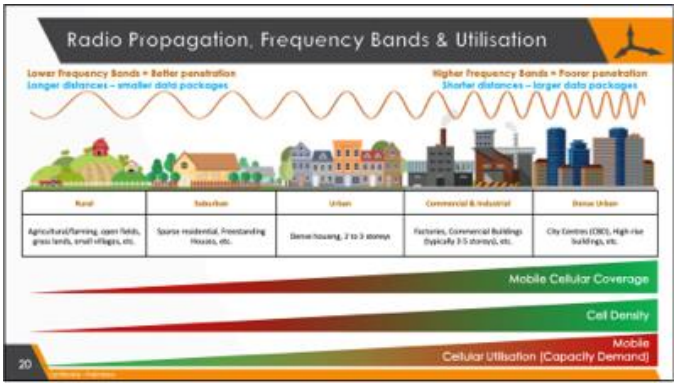


Figure 6. Radio Propagation against cell density

For more than 20 years Poynting has specialised in wideband and multi frequency antennas. Many of the core Poynting antenna products already cover the new European 5G frequency band, this provides peace of mind to our customers who are still deploying 4G systems, that the antenna will be futureproof for upgrade to 5G when required

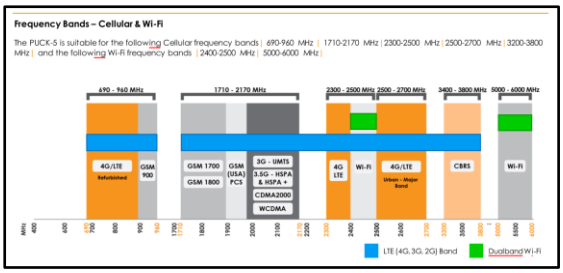
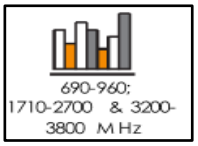


Figure 7. Poynting Puck-5 Frequency Band Chart

Article Summary

Not all antennas are the same. Antenna designs vary considerably between manufacture. Consider a manufacturer that publishes all their test data, this will help any rural connectivity issues.



When choosing an antenna for wireless connectivity, check which frequency bands you will require. Information on network operator frequencies is widely available.

MIMO antennas are here to stay, MIMO antennas can improve antenna performance considerably with regards to quality of signal and data speeds.

5G is coming, 2019 is will be a big year for 5G trials across Europe. Why potentially install an antenna that is not 5G capable and then change within 18 months?

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About Poynting Antennas

Poynting innovates, designs and manufactures integrated antennas solutions primarily for wireless high-speed data applications such as 4G LTE residential as well as B2B, antenna solutions for GSM, M2M, DTV (digital TV) and other CPE applications within the telecommunication, broadcast, and consumer market.

Based in Samrand, South Africa, Poynting is the proud holder of more than 50 patents widely used in its unique antenna solutions for enhanced wireless communications for LTE, 3G, Wi-Fi, RF and other applications. Poynting was founded on the deep knowledge and understanding of the principles of electromagnetics, RF propagation, antenna design, and development. Poynting employees include graduate as well as professionally registered engineers with doctorate level expert knowledge of the technology and the industry.

Poynting has a legacy of innovative design and delivery with customers and partners worldwide. The approach has resulted in extensive Intellectual Property (IP) with over 50 patents and registered trademarks.

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