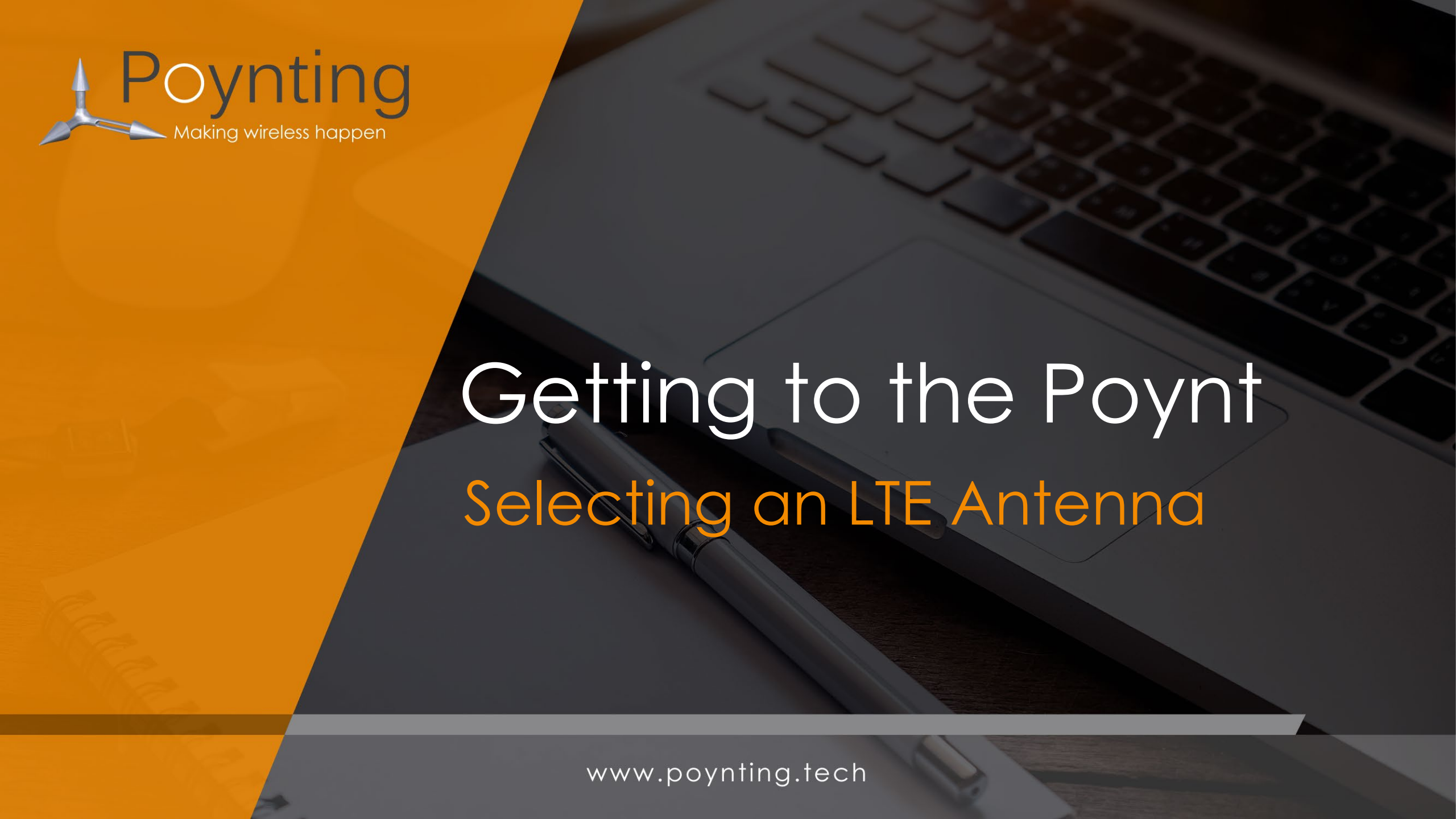
Poynting

Making wireless happen



Getting to the Poynt

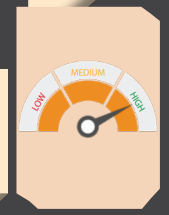
Selecting an LTE Antenna

www.poynting.tech

Agenda

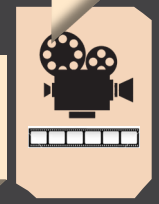
What is an antenna?

How does an external antenna improve LTE Performance



General concepts when selecting your LTE Antenna

Choosing the correct antenna



What does this increase mean in practice?

List of cheat sheets/links on our website

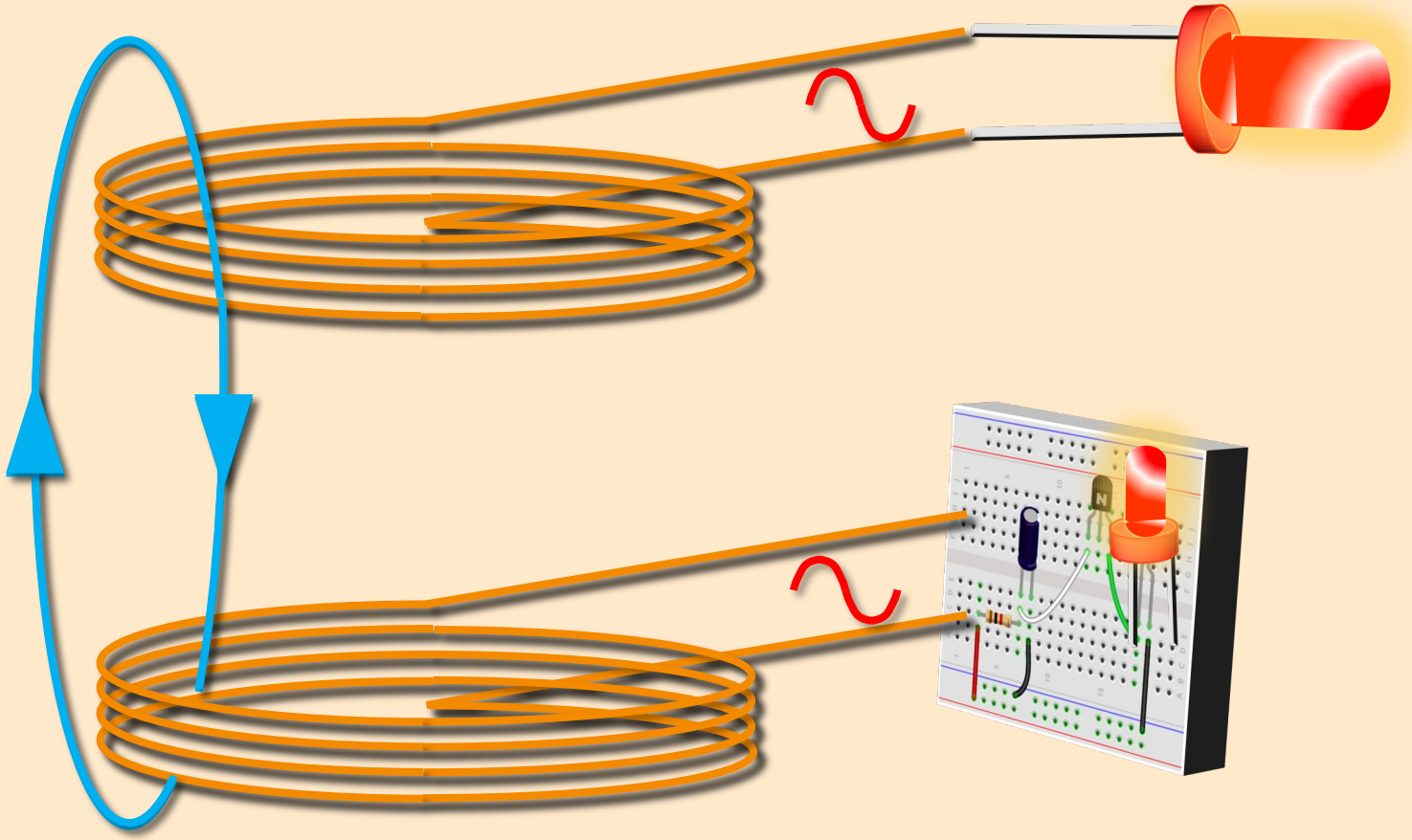
Poynting

Making wireless happen

What is an Antenna?

www.poynting.tech

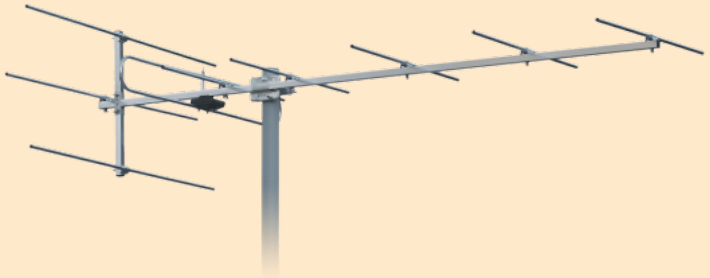
Practical Demonstration of an Antenna



Types of Antennas

Car antenna

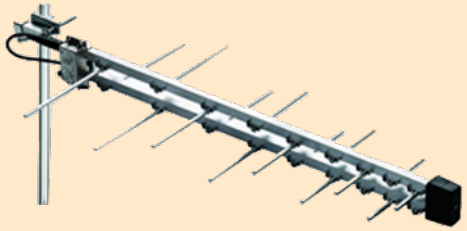
TV antenna



"Bunny Ears" antenna

PCB antenna

Log Periodic antenna



Horn antenna

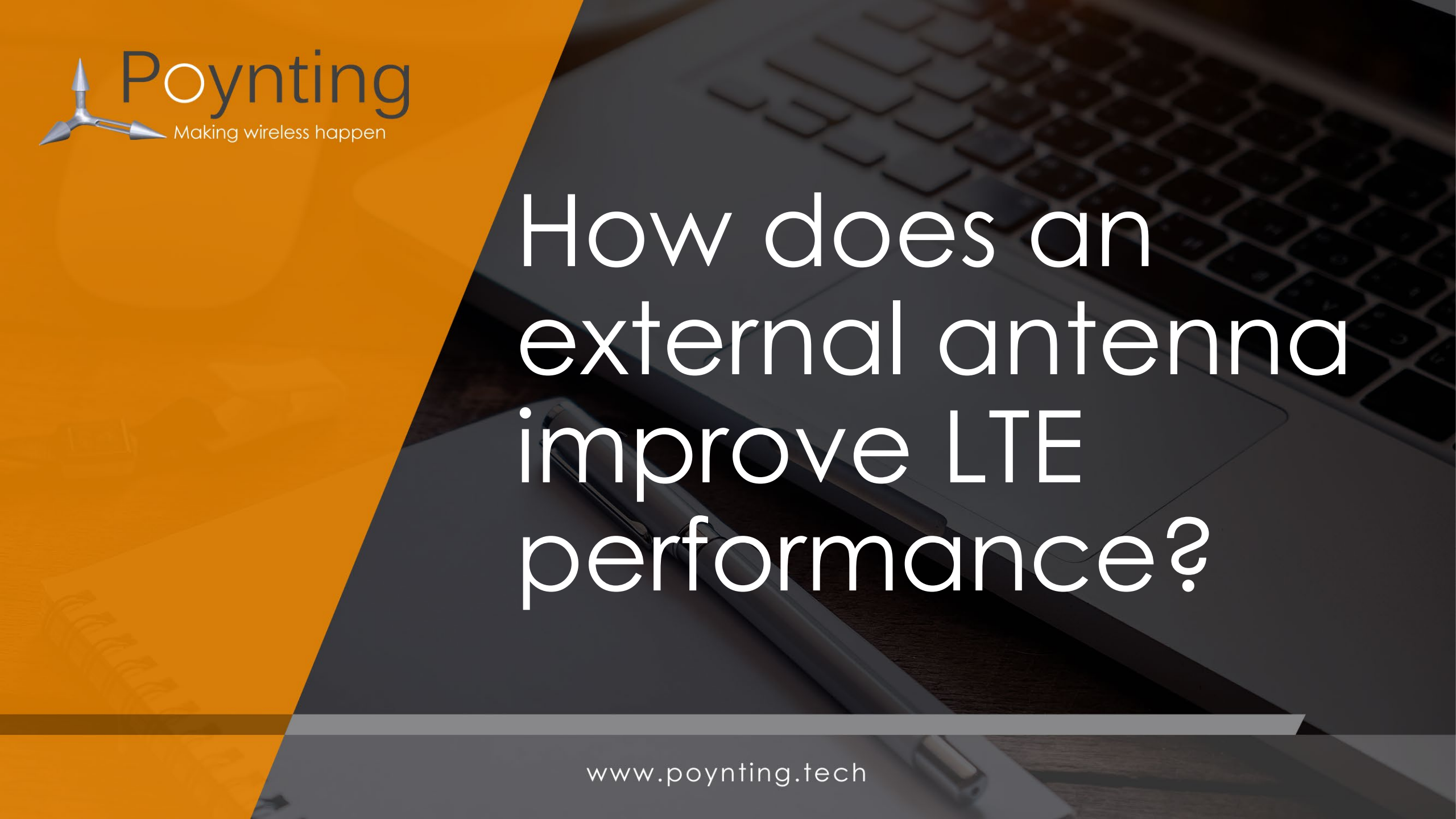
Dish antenna

Poynting XPOL antenna

Poynting

Making wireless happen

How does an external antenna improve LTE performance?



www.poynting.tech

Indoor vs Outdoor Signal

- ✓ Signal Indoor 20dB lower because: have to penetrate walls/windows etc.
- ✓ Massive multipath fading indoors is the biggest reason for the 20dB difference.
- ✓ Both outdoor AND indoor noise affect indoor signal

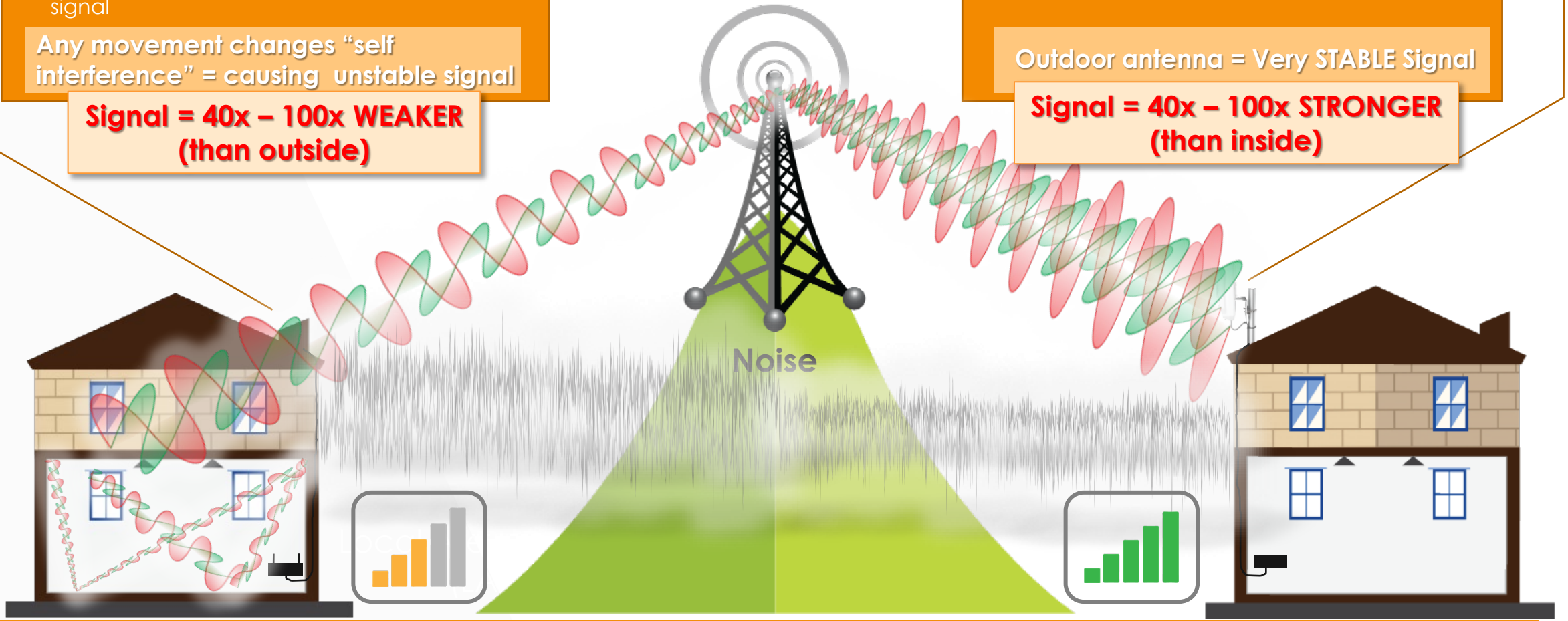
Any movement changes "self interference" = causing unstable signal

Signal = 40x – 100x WEAKER (than outside)

- ✓ Outdoor signal is 16dB to 20dB higher than indoor.
- ✓ Antenna gain adds to this.
- ✓ Directional antenna reduces noise from other directions.

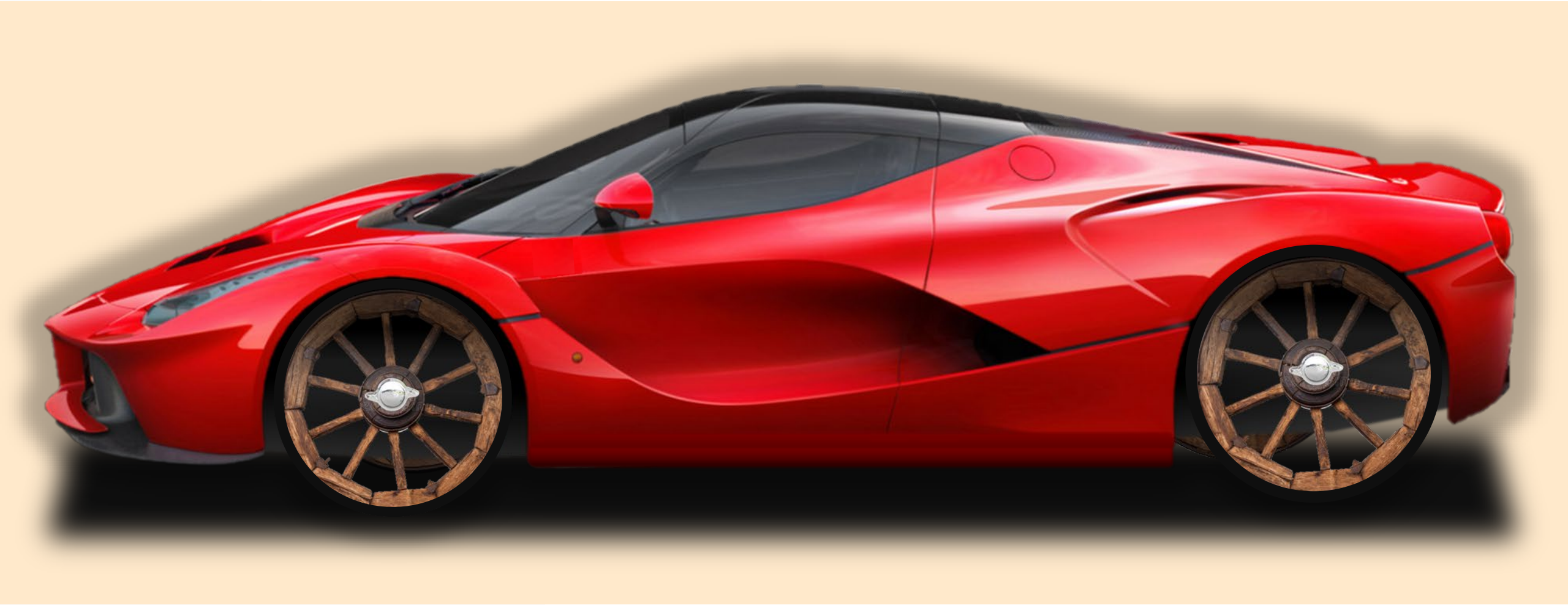
Outdoor antenna = Very STABLE Signal

Signal = 40x – 100x STRONGER (than inside)



How does a bad Antenna impact LTE performance?

How does a bad Antenna impact LTE performance?



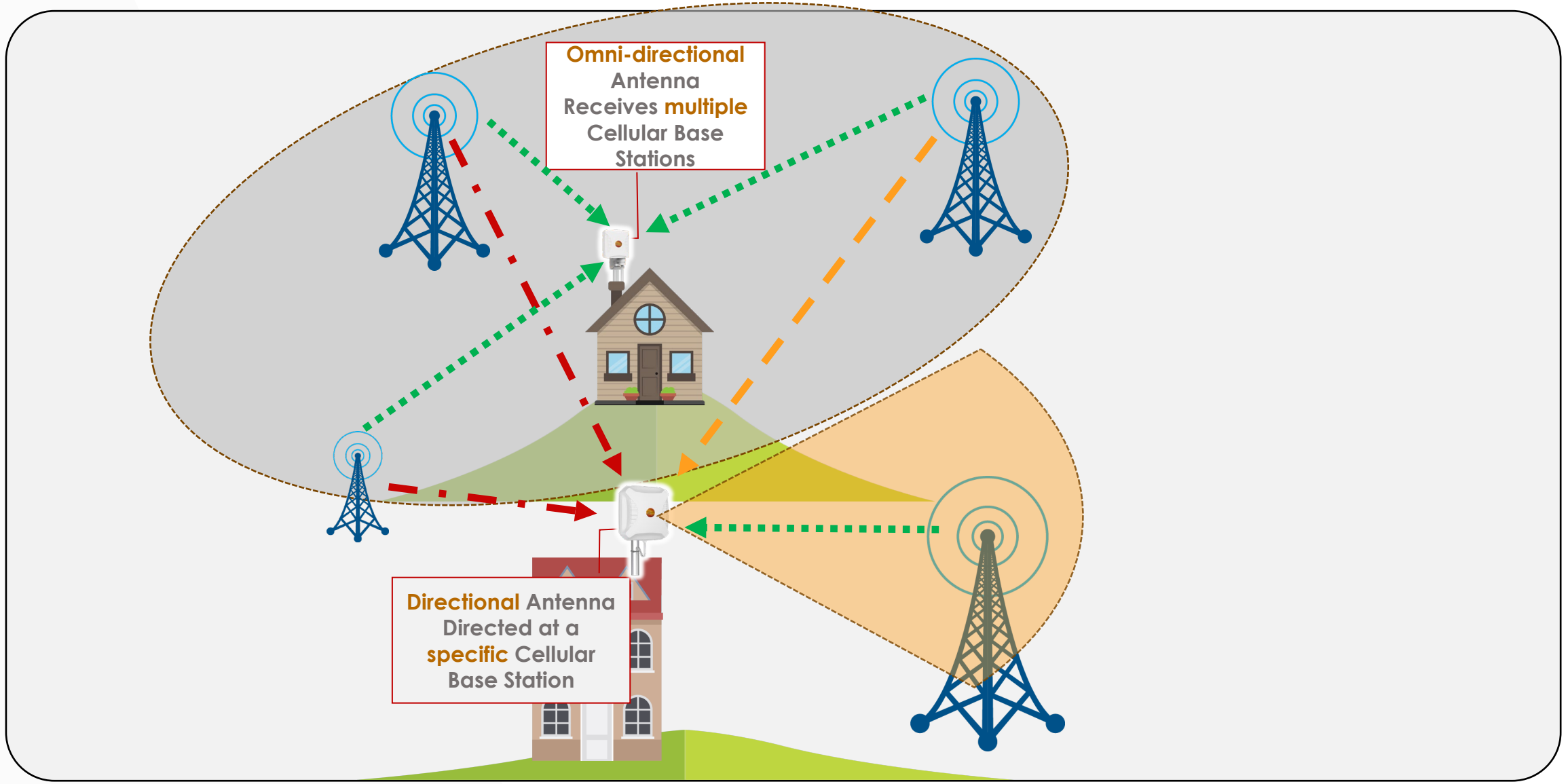
Poynting

Making wireless happen

General concepts when selecting your LTE Antenna

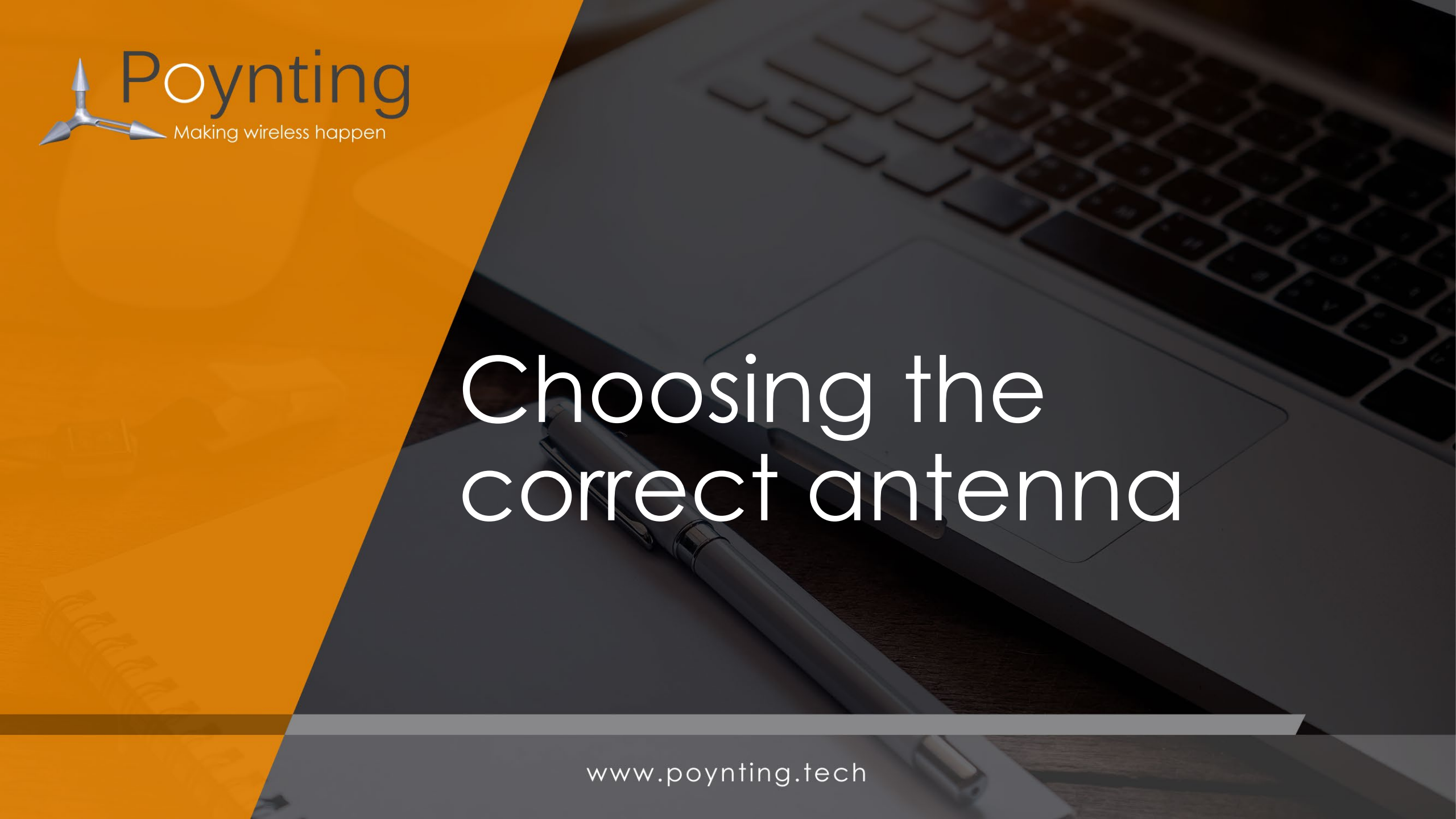
www.poynting.tech

LOCATION? OMNI- or DIRECTIONAL Antenna?



Poynting

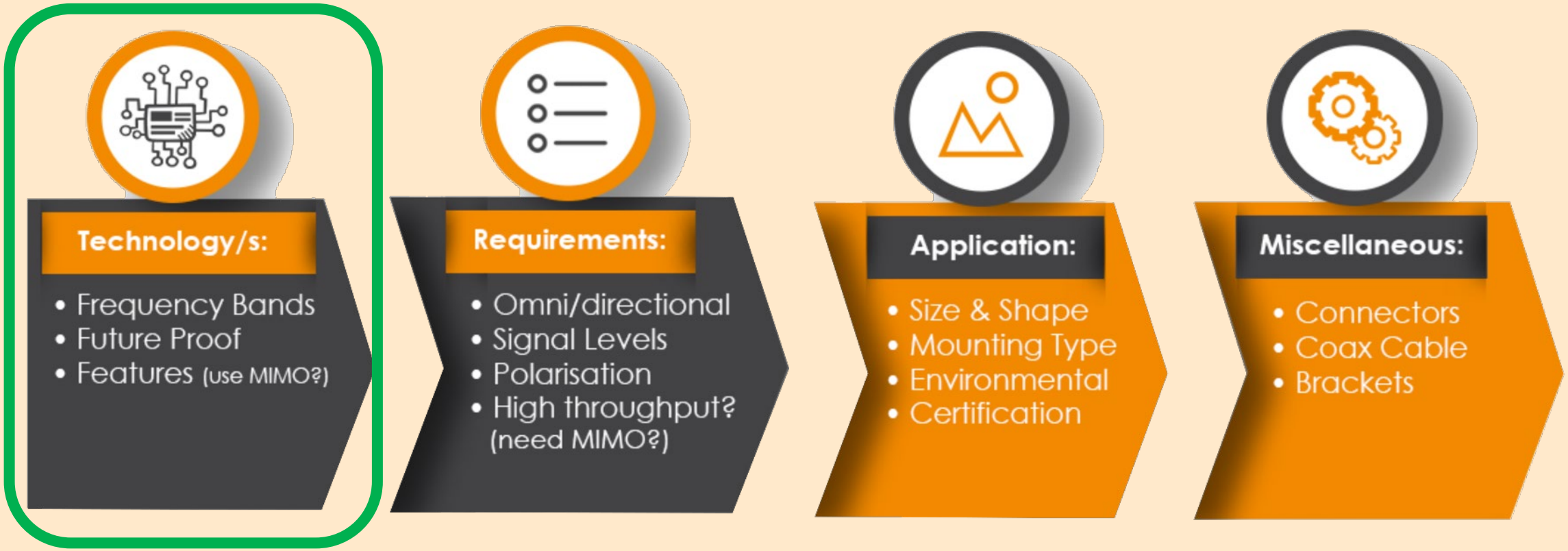
Making wireless happen



Choosing the correct antenna

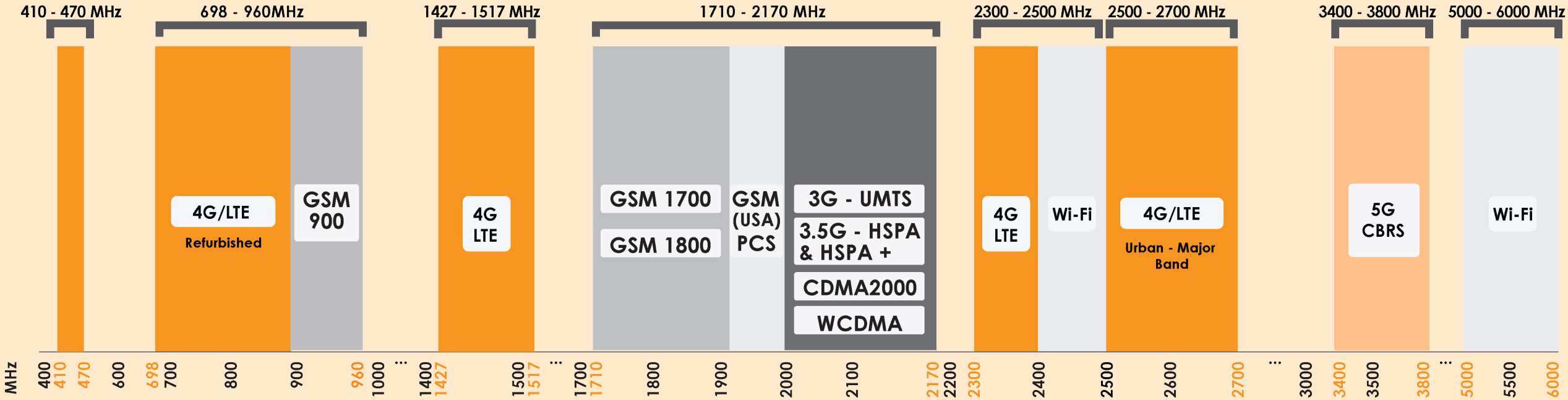
www.poynting.tech

Initial Considerations



Radio Frequency Spectrum: Wireless Communication

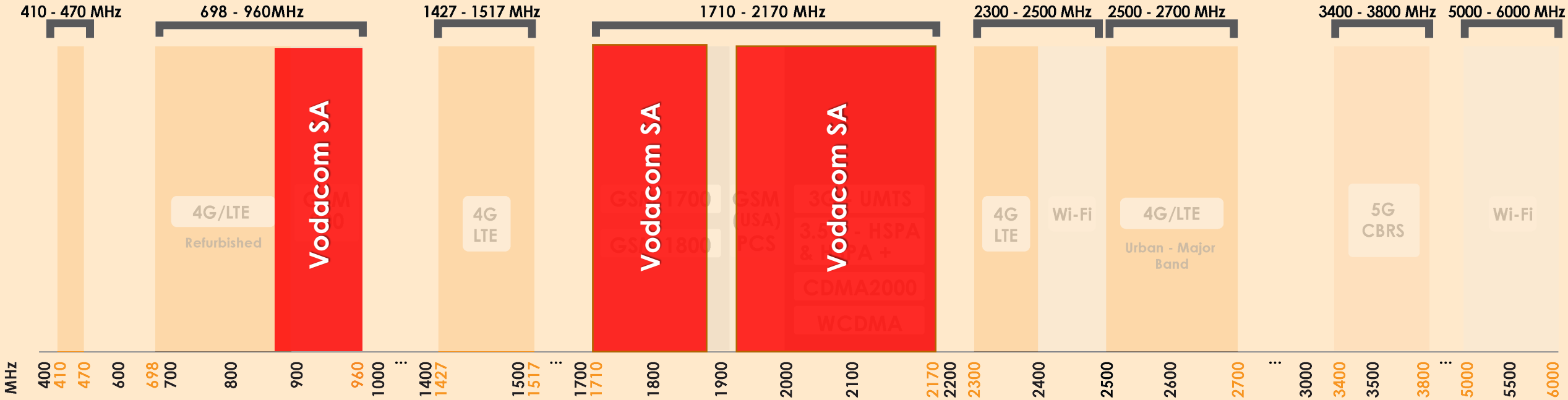
Overview of the more common Cellular & Wi-Fi Bands:



Country specific frequency bands not differentiated in the above overview

LTE Antennas we will use as examples

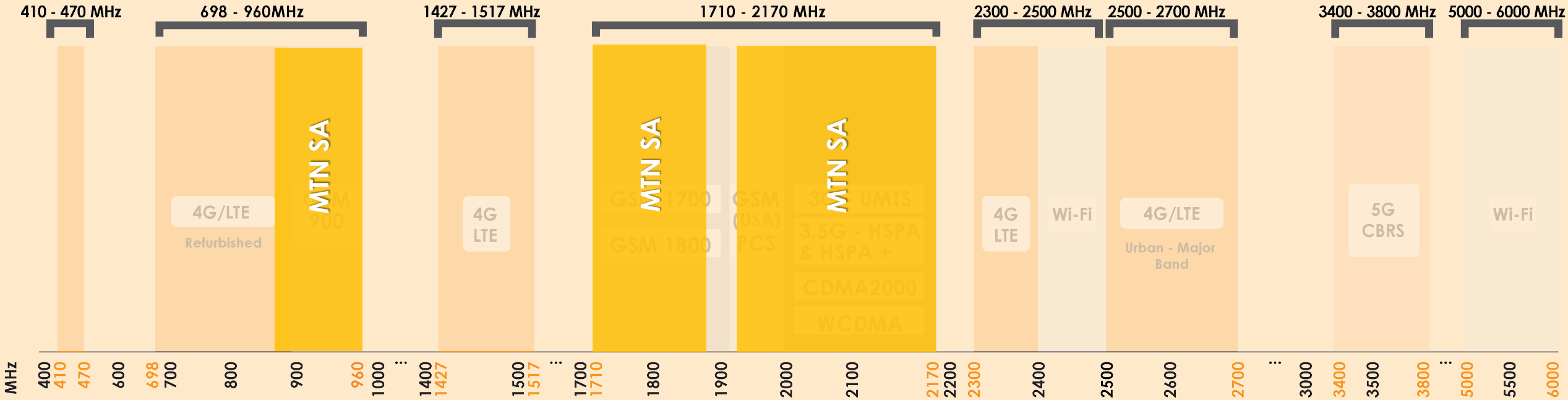
Overview of the more common Cellular & Wi-Fi Bands:



According to Frequencycheck.com

LTE Antennas we will use as examples

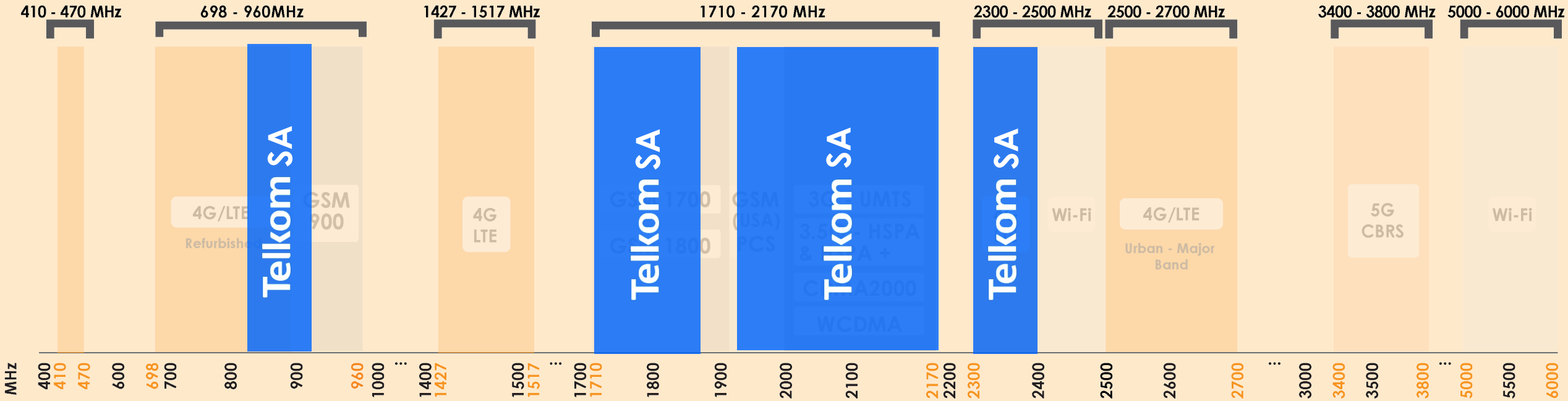
Overview of the more common Cellular & Wi-Fi Bands:



According to Frequencycheck.com

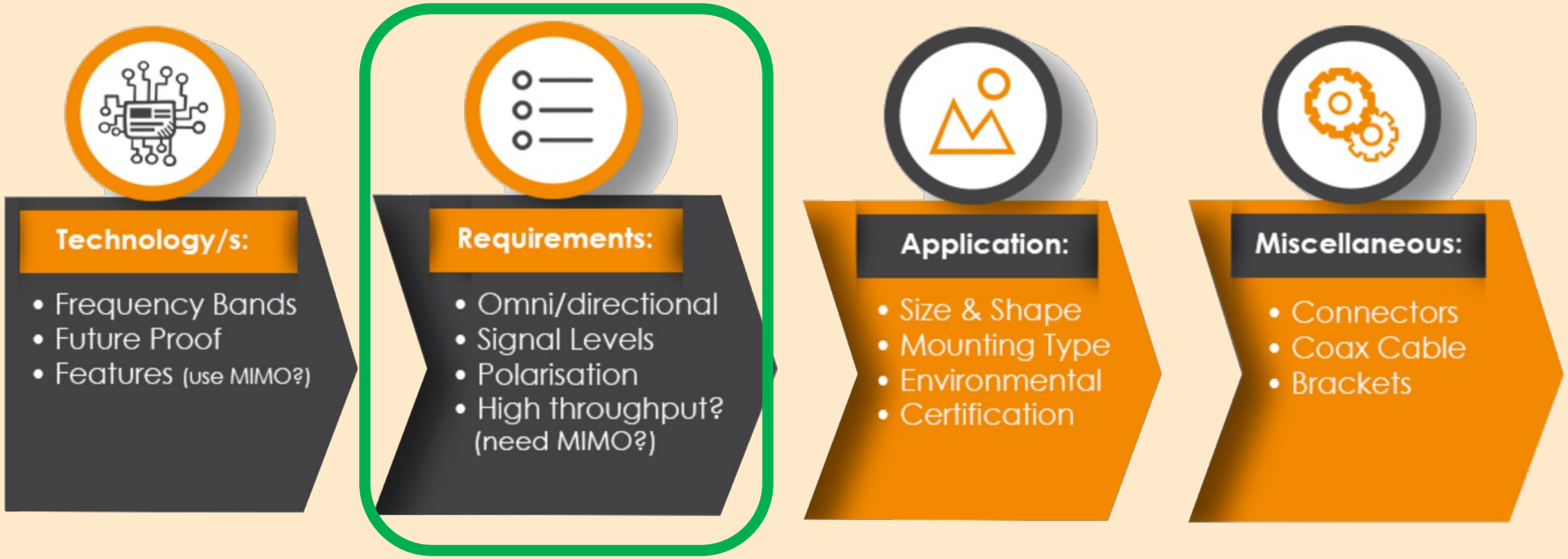
LTE Antennas we will use as examples

Overview of the more common Cellular & Wi-Fi Bands:

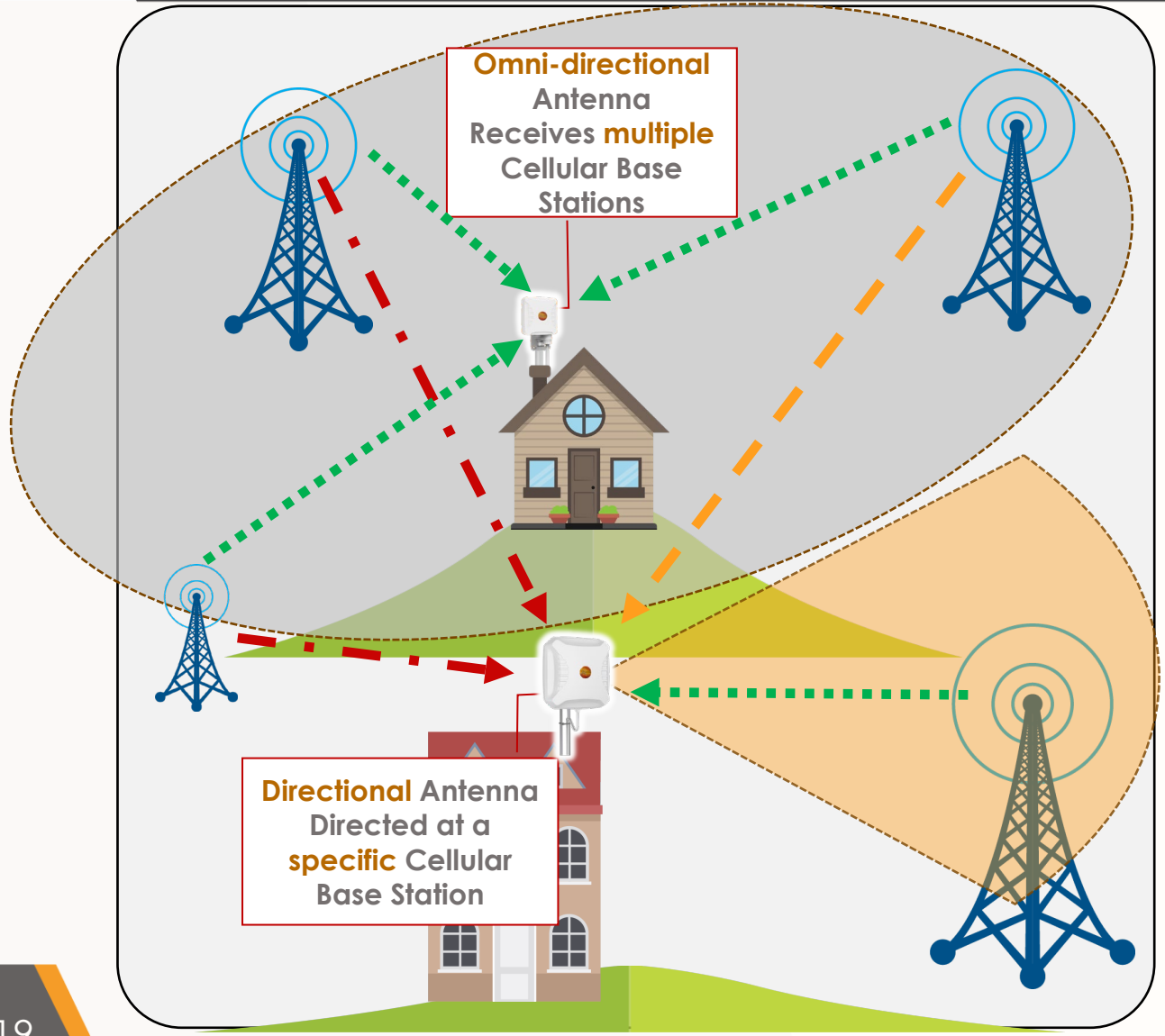


According to Frequencycheck.com

Initial Considerations



LOCATION? OMNI- or DIRECTIONAL Antenna?



Customer Premises Equipment Perspective

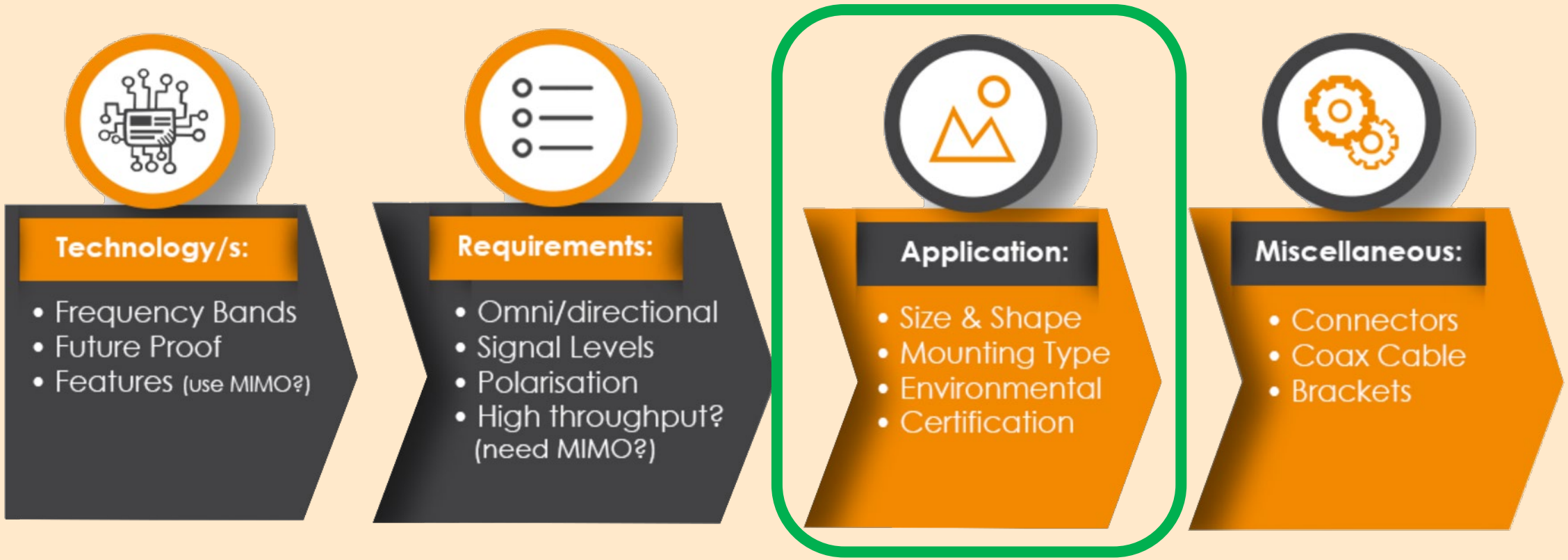
Omni-directional antenna:

- Allows router to 'roam' amongst various cells (incl. newly built cells)
- Ease of installation
- Lower gain, but more redundancy (from other base stations)

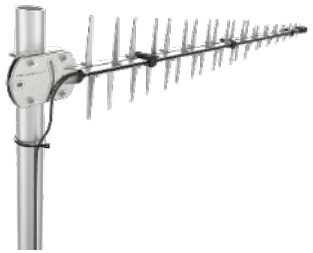
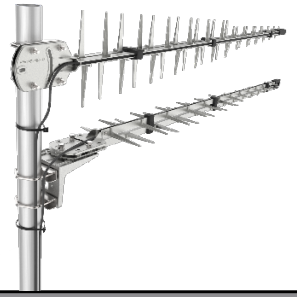
Directional Antenna:

- Reduces interference from other directions
- Higher throughput, but limited to specific base station capacity
- Dependant to cellular tower availability

Initial Considerations



Choosing between LPDA-92 & XPOL-2 Panel Antenna

				
Type	LPDA-92 (SISO)	LPDA-92 (2x for MIMO)	XPOL-2-5G Panel	
Visually (Aesthetics)	Array of elements with different lengths	Array of elements with different lengths	Rectangular, flat & unobtrusive	←
Bandwidth	Widest Frequency Band	Widest Frequency Band	Frequency Band depends on design	
Reliability	Ultra High	Ultra High	High	←
Gain	High, best at lower bands	High, best at lower bands	High, best at higher bands	←
MIMO	Upgradable with Second Antenna for MIMO	Requires 2x Antennas for MIMO	Integrated 2x2, 4x4, etc.	
Best suited for:	Rural, Farming, Industrial, Oil & Gas	Rural, Farming, Industrial, Oil & Gas	Residential, Commercial	←

Choosing between OMNI Antennas

			
Type	Omni (e.g. OMNI-600)	XPOL-1	
Visually	Longer Antenna	Low height, wide antenna	
Bandwidth	Wide Frequency Band	Wide Frequency Band	
Gain (Extent of coverage)	Medium / High	Low / Medium	←
Elevation beamwidth	Lower Beamwidth	Larger Beamwidth	←
MIMO	Yes, vertically separated	Yes, cross polarised	←
Best suited for:	Low to Hight Clutter Areas, e.g. Rural, Urban, Suburbs	High Clutter Areas, e.g. High Rise areas, CBD	←

Initial Considerations

WHICH ROUTER? Router Types / Examples

Front

Back

Cradlepoint IBR600C

Huawei 5G CPE Pro

Front

Back

Teltonika RUT950

Peplink Pepwave UBR-LTE

Front

Back

Sierra Wireless Airlink MP70

Advantech Smartflex

WHICH CONNECTOR? Examples

SMA

Often used for Cellular Antenna connection to Modems/Repeaters

Often used in lower frequency bands

N-Type

TS-9 Patch leads are used between HDF-195 cable from XPOL-1-5G or XPOL-2-5G; provides for 'strain relief' between cable and Router

RP-SMA

Often used for Wi-Fi Antenna connection to Routers/APs

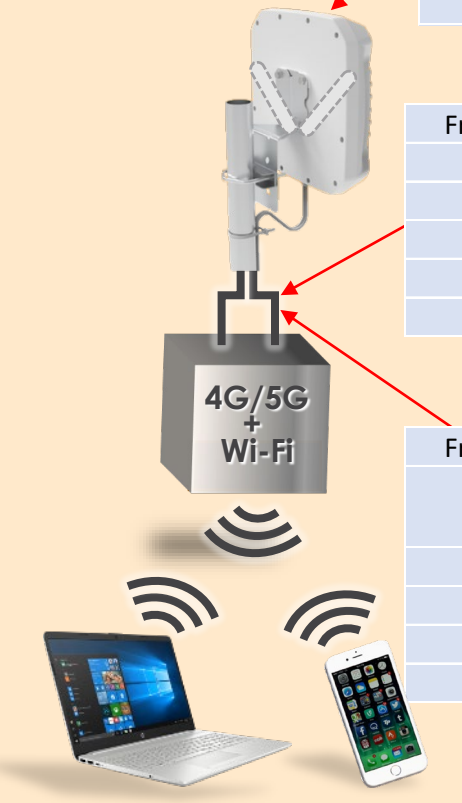
SMA to TS-9 Patch leads

Beware of fitting own connectors – Whole cable assembly MUST be measured with network analyser

CABLE LENGTH: HDF-195 VS LMR-400

Antenna Gain

Frequency	Antenna Gain
900 MHz	9 dB
1800 MHz	10 dB
2400 MHz	10 dB
3000 MHz	11 dB



Cable Losses HDF-195

Frequency	Cable Loss/m	Cable Length	Cable Loss
	HDF-195		
900 MHz	0,362 dB/m	15 m	5,430 dB
1800 MHz	0,514 dB/m	15 m	7,710 dB
2400 MHz	0,533 dB/m	15 m	7,995 dB
3000 MHz	0,603 dB/m	15 m	9,045 dB

System Gain 15m HDF-195

Frequency	Cable Loss/m	Cable Length	Cable Loss	Antenna Gain	Net Gain
	HDF-195				
900 MHz	0,362 dB/m	15 m	5,430 dB	9 dB	3,570 dB
1800 MHz	0,514 dB/m	15 m	7,710 dB	10 dB	2,290 dB
2400 MHz	0,533 dB/m	15 m	7,995 dB	10 dB	2,005 dB
3000 MHz	0,603 dB/m	15 m	9,045 dB	11 dB	1,955 dB

Cable Losses LMR-400

Frequency	Cable Loss/m	Cable Length	Cable Loss
	LMR-400		
900 MHz	0,1274 dB/m	15 m	1,911 dB
1800 MHz	0,1855 dB/m	15 m	2,783 dB
2400 MHz	0,2175 dB/m	15 m	3,263 dB
3000 MHz	0,2464 dB/m	15 m	3,696 dB

System Gain 15m LMR-400

Frequency	Cable Loss/m	Cable Length	Cable Loss	Antenna Gain	Net Gain	Difference
	LMR-400					LMR-400 vs HDF-195
900 MHz	0,1274 dB/m	15 m	1,911 dB	9 dB	7,089 dB	3,519 dB
1800 MHz	0,1855 dB/m	15 m	2,783 dB	10 dB	7,218 dB	4,928 dB
2400 MHz	0,2175 dB/m	15 m	3,263 dB	10 dB	6,738 dB	4,733 dB
3000 MHz	0,2464 dB/m	15 m	3,696 dB	11 dB	7,304 dB	5,349 dB

Poynting

Making wireless happen

Poynting Antennas Use Cases

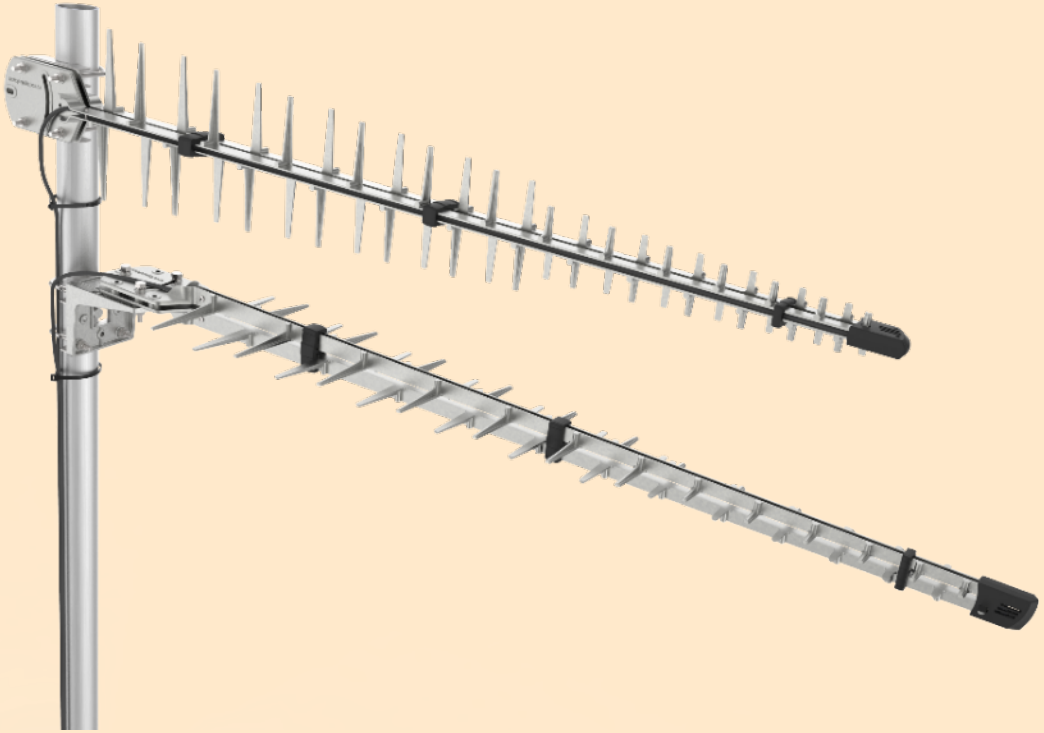
www.poynting.tech

Introduction: How do I choose an LTE antenna?

XPOL-1-5G

OMNI-600

XPOL-2-5G



LPDA-92

Scenario1: Why do you need an antenna?

How can I help?

Please help me choose an Antenna

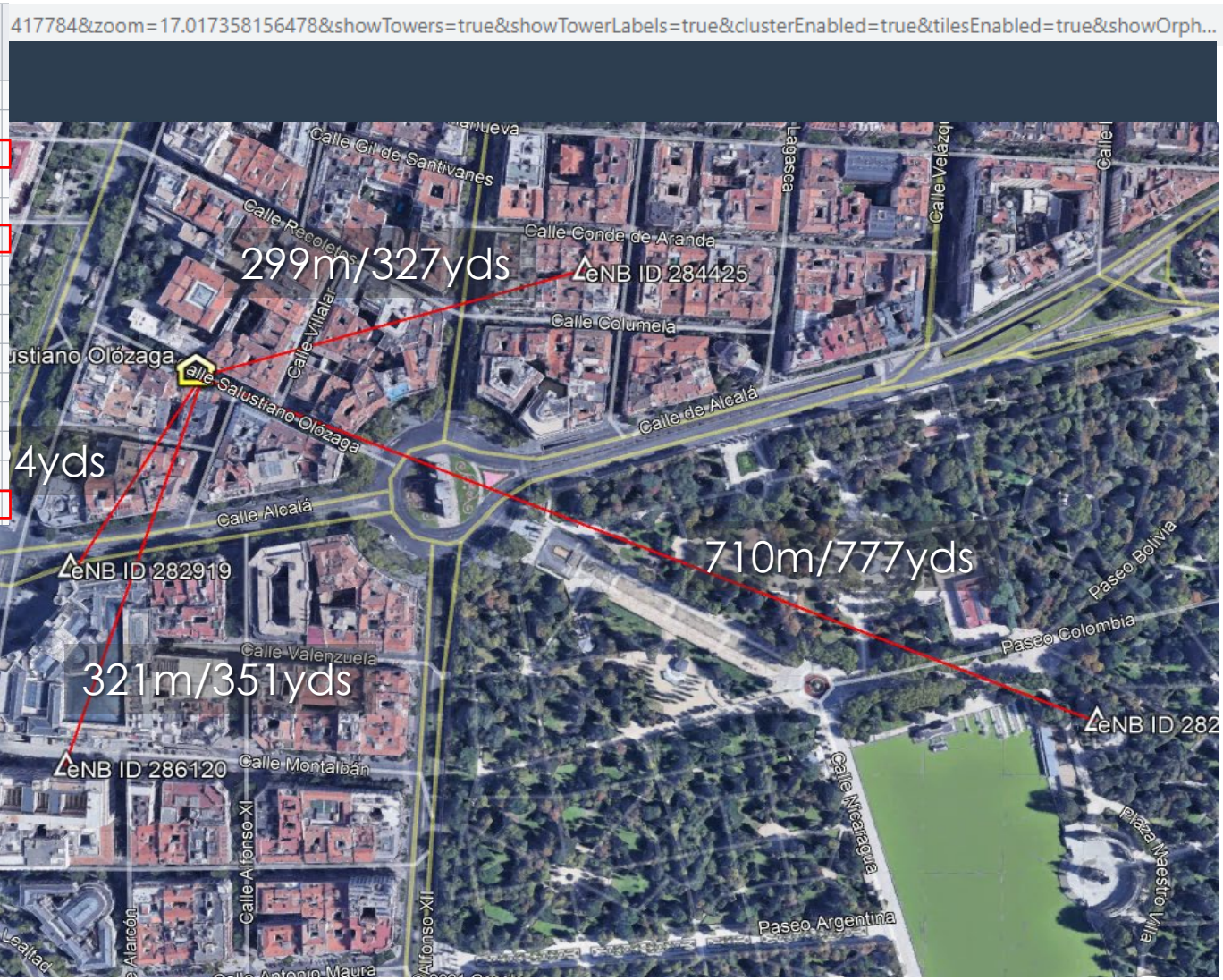
Scenario1: Why do you need an antenna?

Where do you live?
and
Which operator do you use?

Calle du Salustiano, Madrid
And
I use Vodafone ES

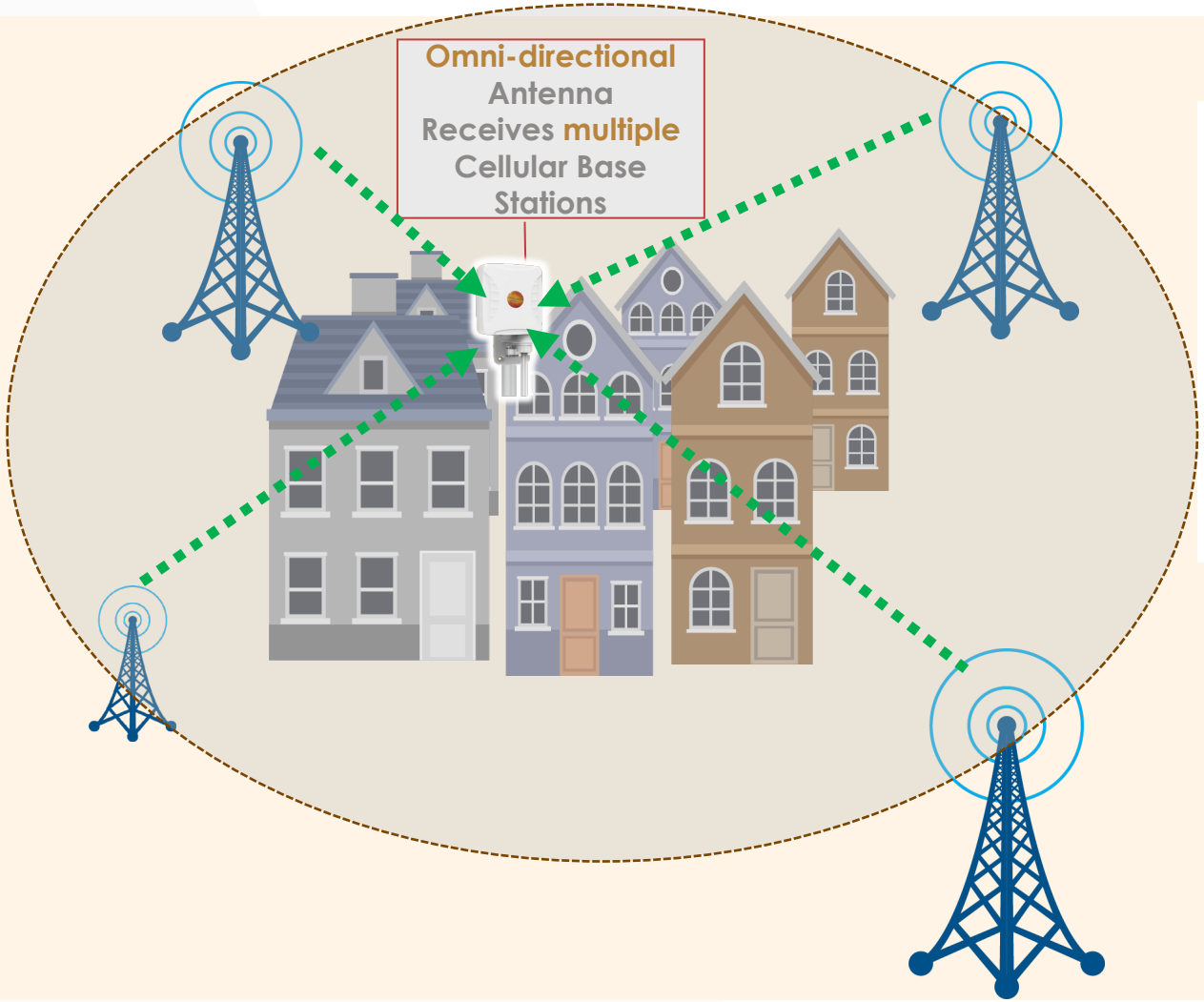
Scenario 1: Urban - High Density [Vodafone ES – 2141]

Band	Duplex mode[A 1]	f (MHz)	Common name	Subset of band	Uplink[A 2] (MHz)	Downlink[A 3] (MHz)	Duplex spacing (MHz)	Channel bandwidths (MHz)
1	FDD	2100	IMT	65	1920 – 1980	2110 – 2170	190	5, 10, 15, 20
2	FDD	1900	PCS	25	1850 – 1910	1930 – 1990	80	1.4, 3, 5, 10, 15, 20
3	FDD	1800	DCS		1710 – 1785	1805 – 1880	95	1.4, 3, 5, 10, 15, 20
4	FDD	1700	AWS-1	66	1710 – 1755	2110 – 2155	400	1.4, 3, 5, 10, 15, 20
5	FDD	850	Cellular (CLR)	26	824 – 849	869 – 894	45	1.4, 3, 5, 10
7	FDD	2600	IMT-E		2500 – 2570	2620 – 2690	120	5, 10, 15, 20
8	FDD	900	Extended GSM		880 – 915	925 – 960	45	1.4, 3, 5, 10
11	FDD	1500	Lower PDC	74	1427.9 – 1447.9	1475.9 – 1495.9	48	5, 10
12	FDD	700	Lower SMH	85	699 – 716	729 – 746	30	1.4, 3, 5, 10
13	FDD	700	Upper SMH		777 – 787	746 – 756	−31	5, 10
14	FDD	700	Upper SMH		788 – 798	758 – 768	−30	5, 10
17	FDD	700	Lower SMH	12, 85	704 – 716	734 – 746	30	5, 10
18	FDD	850	Lower 800 (Japan)	26	815 – 830	860 – 875	45	5, 10, 15
19	FDD	850	Upper 800 (Japan)	26	830 – 845	875 – 890	45	5, 10, 15
20	FDD	800	Digital Dividend (EU)		832 – 862	791 – 821	−41	5, 10, 15, 20



NB! This is a simulation, NOT an actual coverage plan

Scenario 1 - Urban Environment-

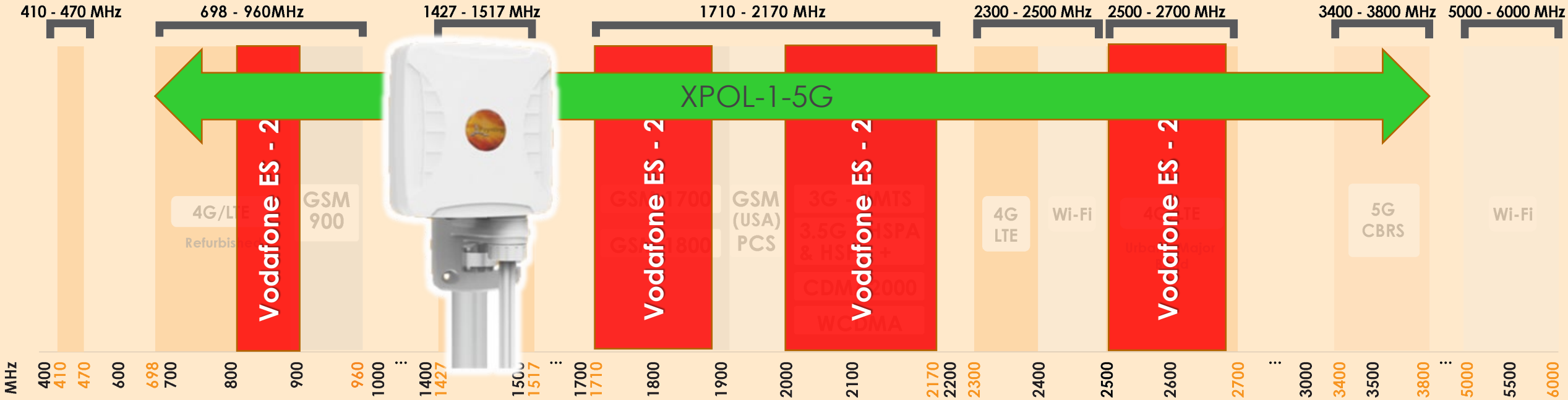


Omni-directional antenna:

- Allows router to 'roam' amongst various cells (incl. newly built cells)
- Ease of installation
- Lower gain, but more redundancy (from other base stations)

XPOL-1-5G

LTE Frequencies – Vodafone Madrid Frequencies



XPOL-1-5G MOUNTING OPTIONS

Suckers on Window

Wall mount

Pole mount

Scenario 2: Urban Low Towers

How can I help?

Please help me choose an Antenna

Scenario 2: Urban Low Towers

Where do you live?
and
Which operator do you use?

I stay in Sharonlea, Johannesburg, South Africa;
I use Rain Internet as a Service Provider

Sharonlea, Johannesburg, South Africa

Band	Duplex mode[A 1]	f (MHz)	Common name	Subset of band	Uplink[A 2] (MHz)	Downlink[A 3] (MHz)	Duplex spacing (MHz)	Channel bandwidths (MHz)
1	FDD	2100	IMT	65	1920 – 1980	2110 – 2170	190	5, 10, 15, 20
2	FDD	1900	PCS	25	1850 – 1910	1930 – 1990	80	1.4, 3, 5, 10, 15, 20
3	FDD	1800	DCS		1710 – 1785	1805 – 1880	95	1.4, 3, 5, 10, 15, 20
4	FDD	1700	AWS-1	66	1710 – 1755	2110 – 2155	400	1.4, 3, 5, 10, 15, 20
5	FDD	850	Cellular (CLR)	26	824 – 849	869 – 894	45	1.4, 3, 5, 10
7	FDD				2500 – 2570	2620 – 2690	120	5, 10, 15, 20
8	FDD				880 – 915	925 – 960	45	1.4, 3, 5, 10
11	FDD				427.9 – 1447.9	1475.9 – 1495.9	48	5, 10
12	FDD				699 – 716	729 – 746	30	1.4, 3, 5, 10
13	FDD				777 – 787	746 – 756	−31	5, 10
14	FDD				788 – 798	758 – 768	−30	5, 10
17	FDD				704 – 716	734 – 746	30	5, 10
18	FDD				815 – 830	860 – 875	45	5, 10, 15
19	FDD				830 – 845	875 – 890	45	5, 10, 15
20	FDD				832 – 862	791 – 821	−41	5, 10, 15, 20

eNB ID 100618 - LTE

MCC / MNC / Region	655 / 38 / 20009
Bands	3
First Seen	Sun, 28 Apr 2019
Last Seen	Wed, 08 Jul 2020

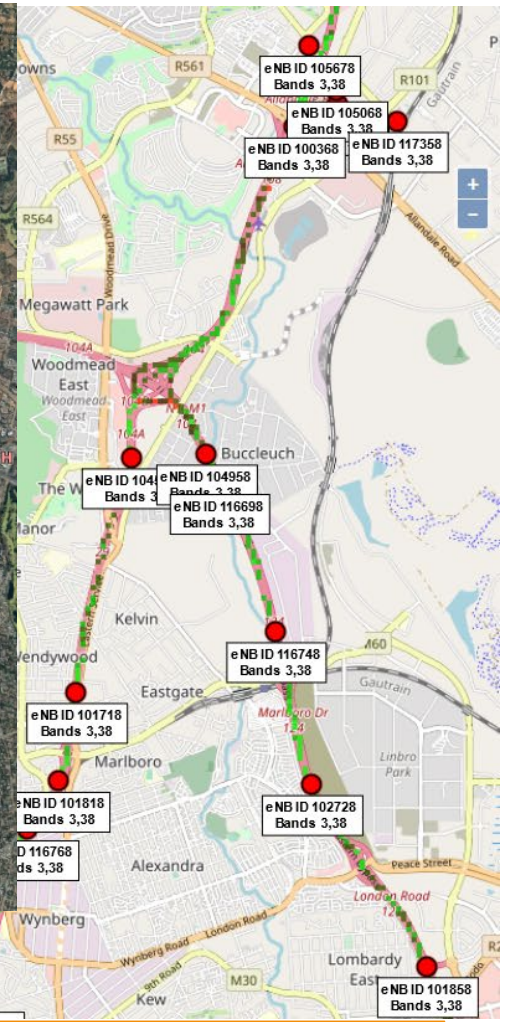
Edit Site Data

Extra Data

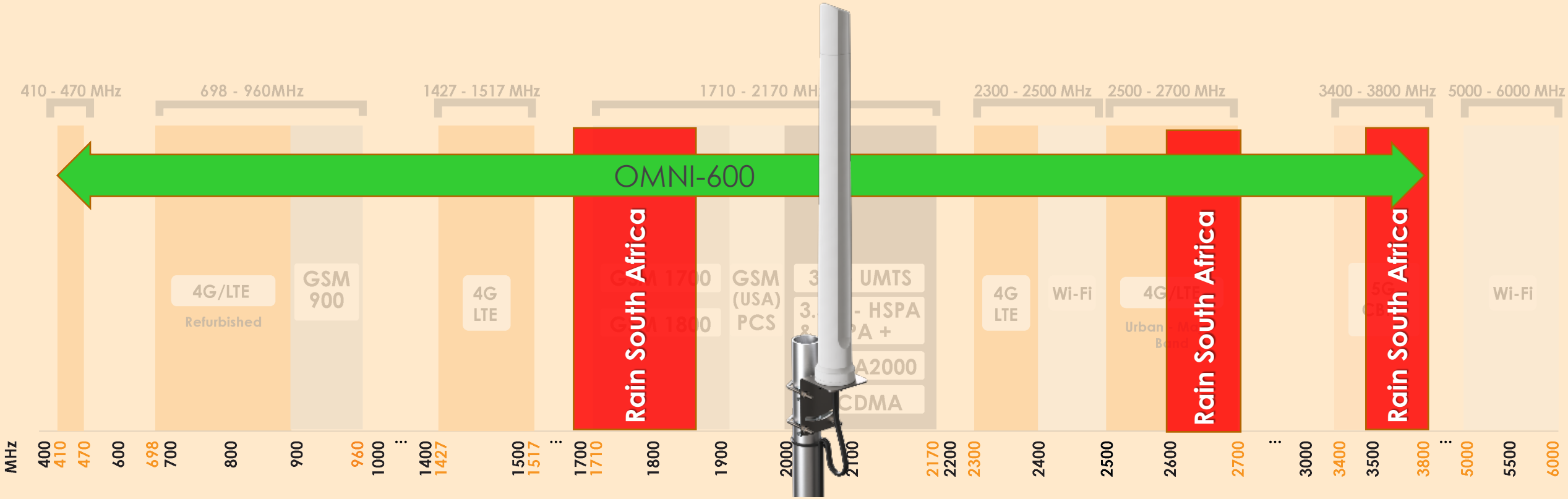
Cell 1

Cell Identifier	25758209
System Subtype	LTE
PCI	471 (157/0)
EARFCN	1877
Maximum Signal (RSRP)	-74 dBm
Direction	N (12°)
First Seen	Sun, 28 Apr 2019
Last Seen	Wed, 08 Jul 2020
Uplink Frequency	1777.7 MHz
Downlink Frequency	1872.7 MHz
Frequency Band	DCS (B3 FDD)

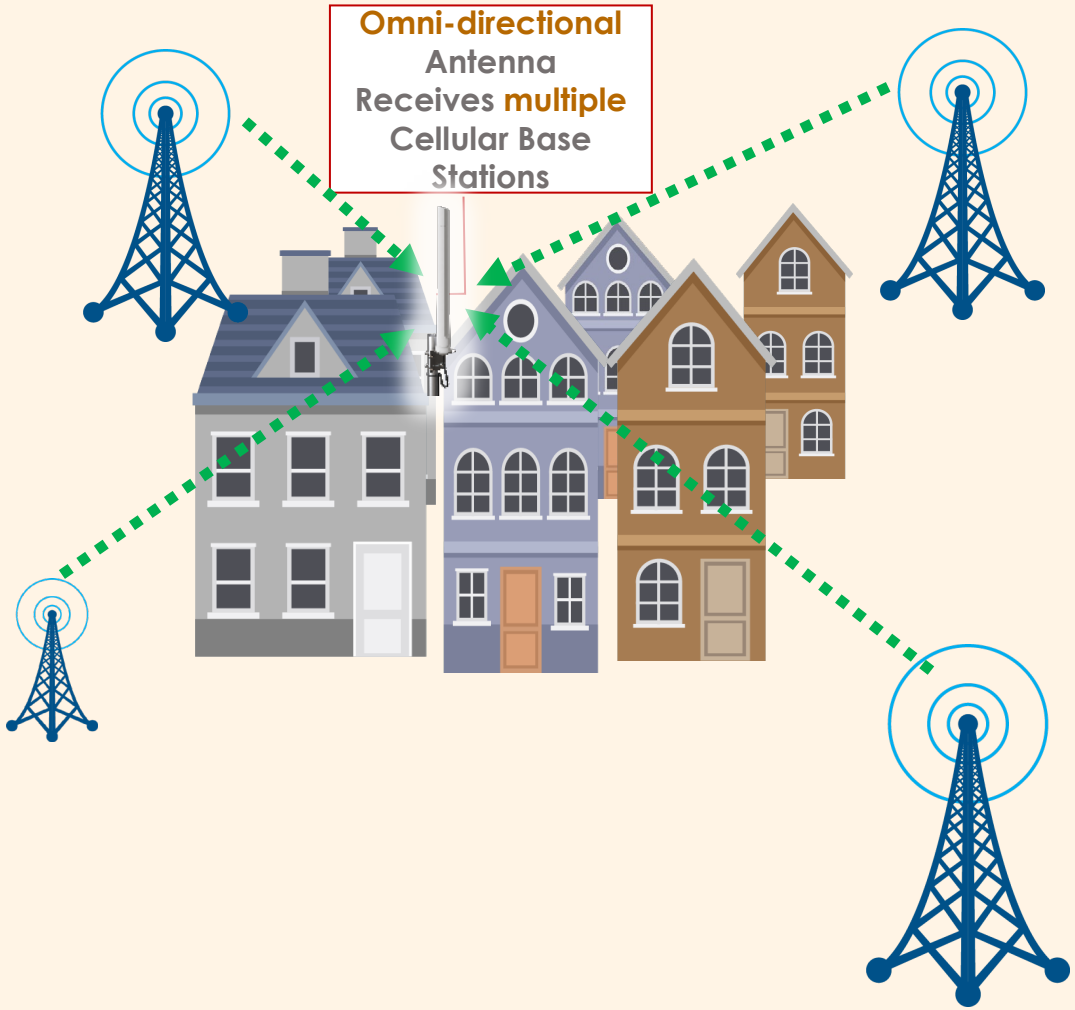
NB! This is a simulation, NOT an actual coverage plan



LTE Frequencies – Rain, South Africa

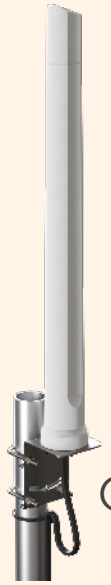


Scenario 2 - Urban Environment-



Omni-directional antenna:

- Allows router to 'roam' amongst various cells (incl. newly built cells)
- Relative ease of installation, pole/wall mount
- Medium gain, greater distance, but more redundancy (from other base stations)

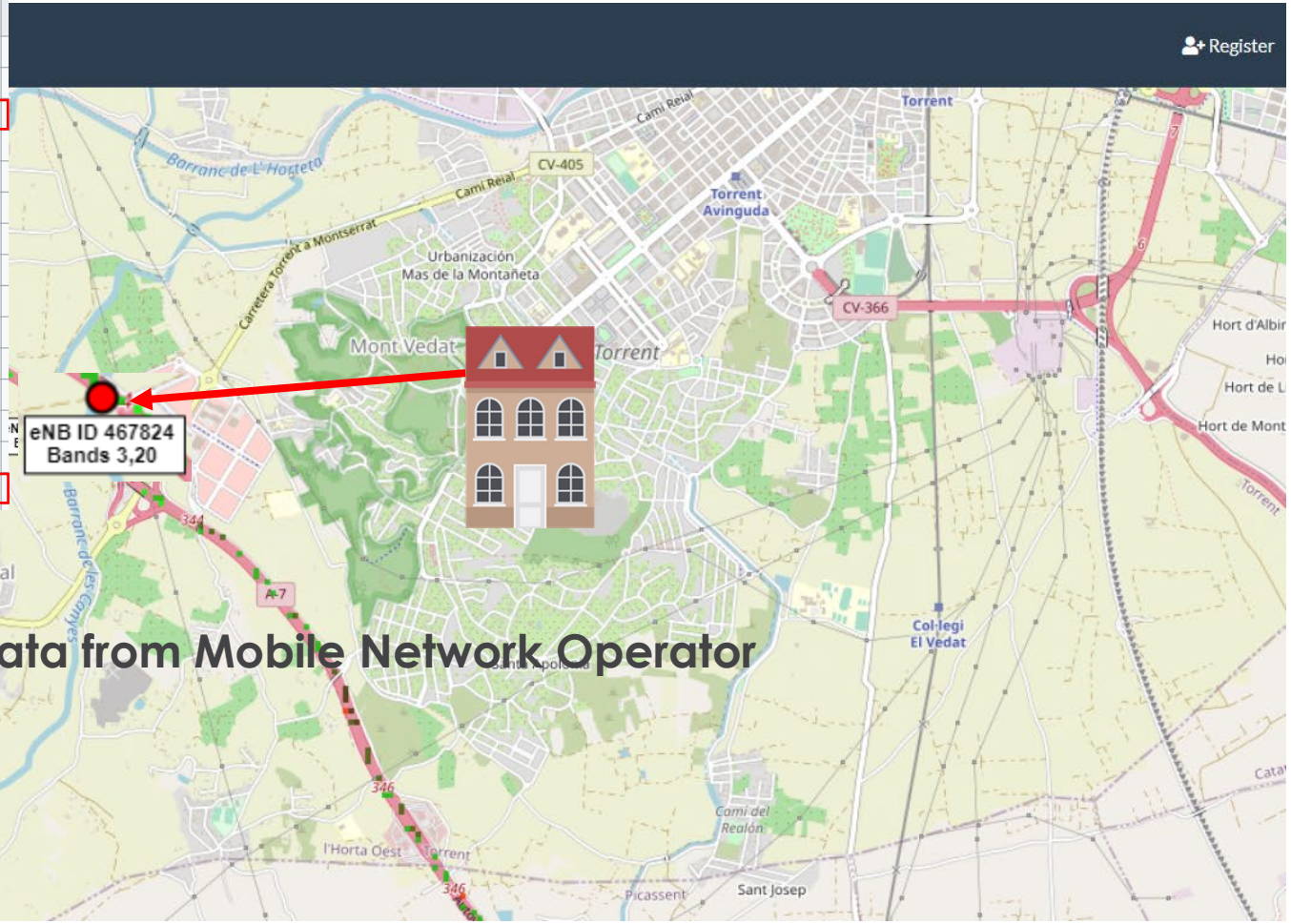


OMNI-600

Scenario 3 – Suburban; Single Tower Identified

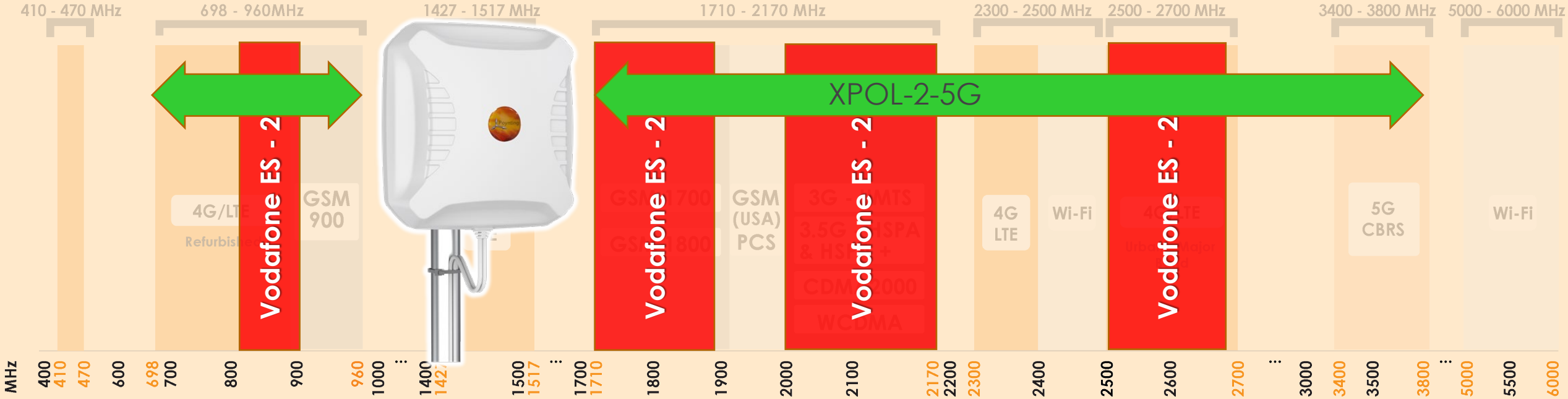
Scenario 3: Suburban Spain

Band	Duplex mode[A 1]	*f* (MHz)	Common name	Subset of band	Uplink[A 2] (MHz)	Downlink[A 3] (MHz)	Duplex spacing (MHz)	Channel bandwidths (MHz)
1	FDD	2100	IMT	65	1920 – 1980	2110 – 2170	190	5, 10, 15, 20
2	FDD	1900	PCS	25	1850 – 1910	1930 – 1990	80	1.4, 3, 5, 10, 15, 20
3	FDD	1800	DCS		1710 – 1785	1805 – 1880	95	1.4, 3, 5, 10, 15, 20
4	FDD	1700	AWS-1	66	1710 – 1755	2110 – 2155	400	1.4, 3, 5, 10, 15, 20
5	FDD	850	Cellular (CLR)	26	824 – 849	869 – 894	45	1.4, 3, 5, 10
7	FDD	2600	IMT-E		2500 – 2570	2620 – 2690	120	5, 10, 15, 20
8	FDD	900	Extended GSM		880 – 915	925 – 960	45	1.4, 3, 5, 10
11	FDD	1500	Lower PDC	74	1427.9 – 1447.9	1475.9 – 1495.9	48	5, 10
12	FDD	700	Lower SMH	85	699 – 716	729 – 746	30	1.4, 3, 5, 10
13	FDD	700	Upper SMH		777 – 787	746 – 756	−31	5, 10
14	FDD	700	Upper SMH		788 – 798	758 – 768	−30	5, 10
17	FDD	700	Lower SMH	12, 85	704 – 716	734 – 746	30	5, 10
18	FDD	850	Lower 800 (Japan)	26	815 – 830	860 – 875	45	5, 10, 15
19	FDD	850	Upper 800 (Japan)	26	830 – 845	875 – 890	45	5, 10, 15
20	FDD	800	Digital Dividend (EU)		832 – 862	791 – 821	−41	5, 10, 15, 20

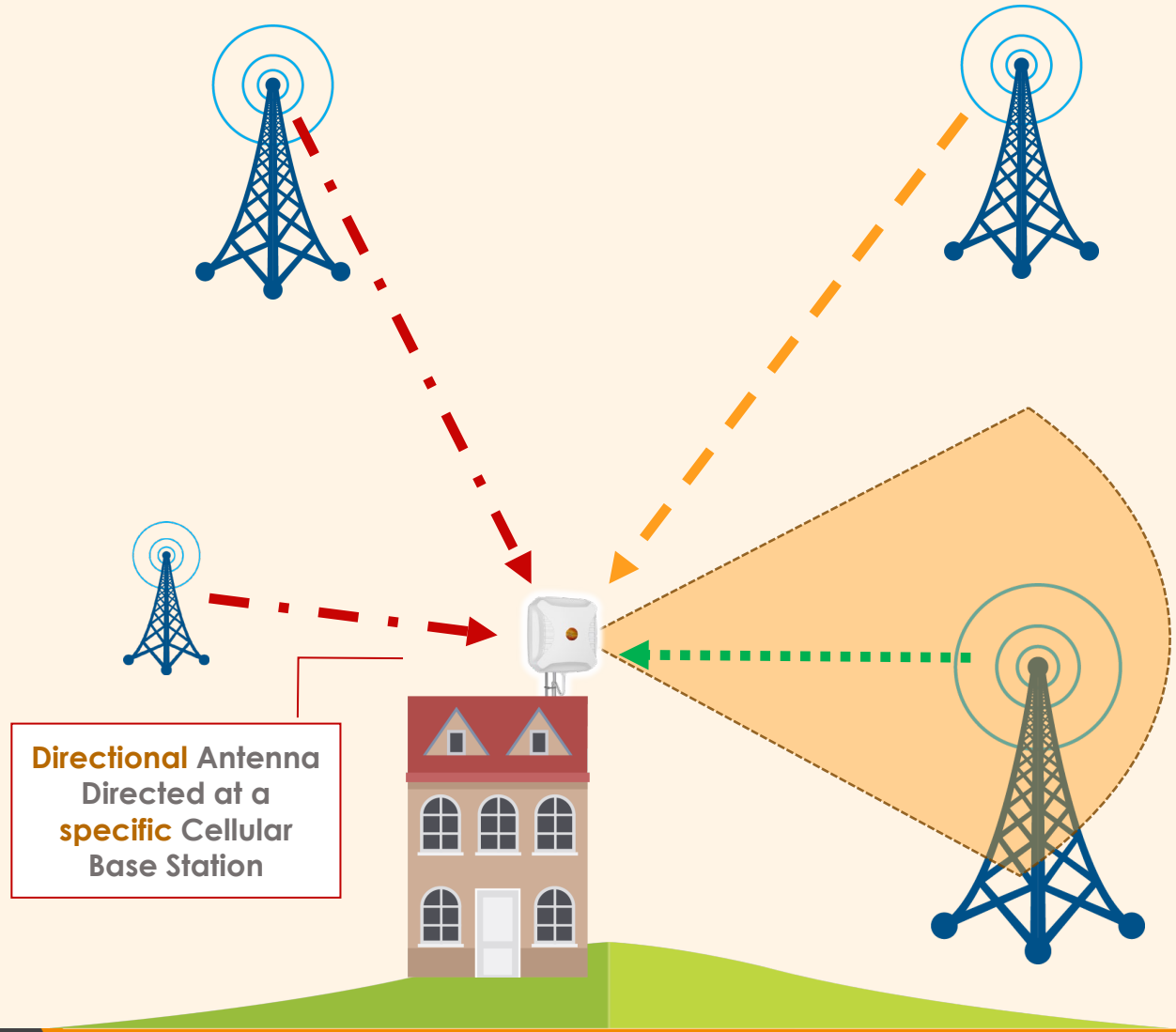


NB! This is a simulation, NOT an actual coverage plan

Scenario 3: Vodafone Valencia Frequencies



Scenario 3: Family in a Suburb - Sub-Urban Scenario



Directional Antenna:

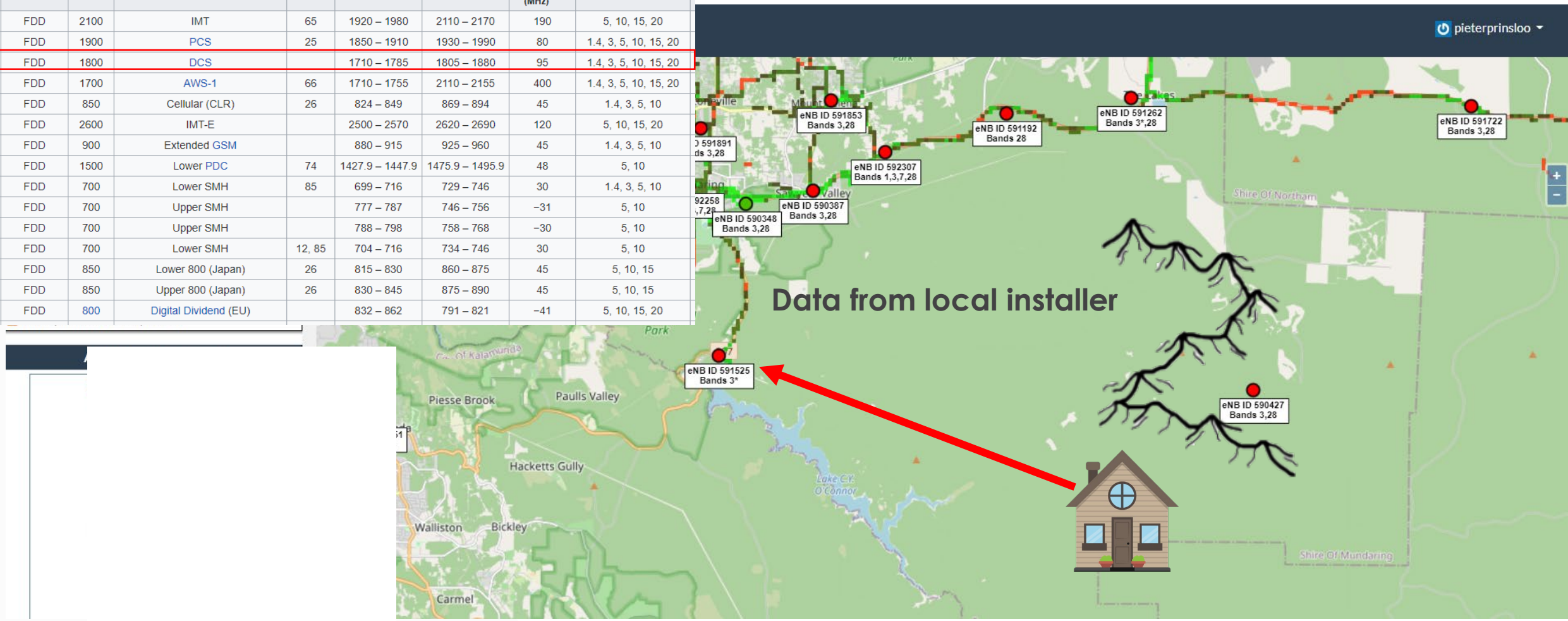
- Reduces interference from other directions
- Higher throughput, but limited to specific base station capacity
- Dependant to cellular tower availability

XPOL-2-5G

Scenario 4: Rural Australia, Telstra

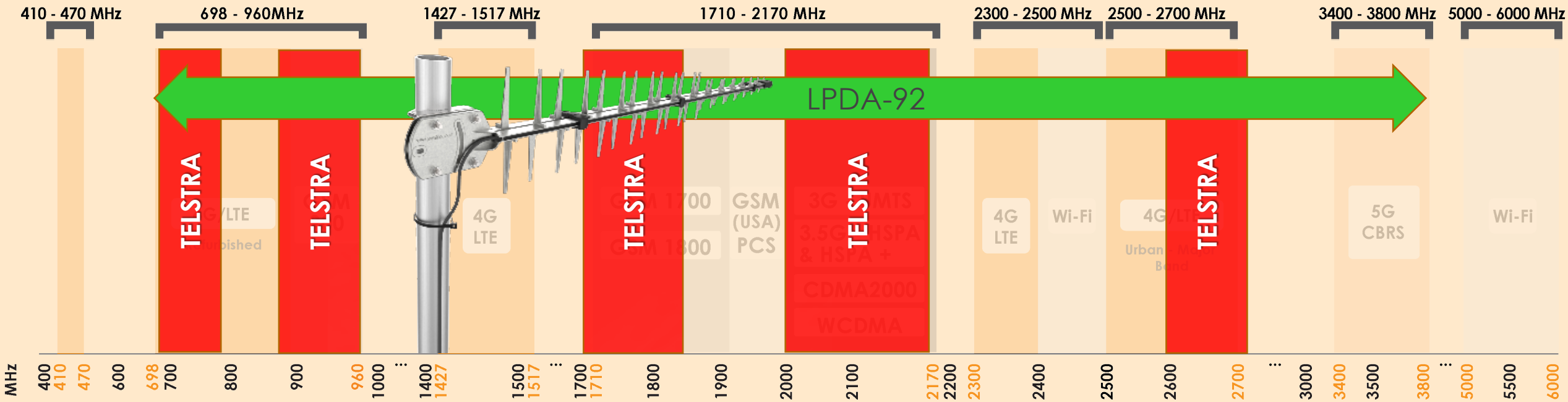
Scenario 4: Rural Australia, Perth Rural - Telstra

Band	Duplex mode[A 1]	*f* (MHz)	Common name	Subset of band	Uplink[A 2] (MHz)	Downlink[A 3] (MHz)	Duplex spacing (MHz)	Channel bandwidths (MHz)
1	FDD	2100	IMT	65	1920 – 1980	2110 – 2170	190	5, 10, 15, 20
2	FDD	1900	PCS	25	1850 – 1910	1930 – 1990	80	1.4, 3, 5, 10, 15, 20
3	FDD	1800	DCS		1710 – 1785	1805 – 1880	95	1.4, 3, 5, 10, 15, 20
4	FDD	1700	AWS-1	66	1710 – 1755	2110 – 2155	400	1.4, 3, 5, 10, 15, 20
5	FDD	850	Cellular (CLR)	26	824 – 849	869 – 894	45	1.4, 3, 5, 10
7	FDD	2600	IMT-E		2500 – 2570	2620 – 2690	120	5, 10, 15, 20
8	FDD	900	Extended GSM		880 – 915	925 – 960	45	1.4, 3, 5, 10
11	FDD	1500	Lower PDC	74	1427.9 – 1447.9	1475.9 – 1495.9	48	5, 10
12	FDD	700	Lower SMH	85	699 – 716	729 – 746	30	1.4, 3, 5, 10
13	FDD	700	Upper SMH		777 – 787	746 – 756	−31	5, 10
14	FDD	700	Upper SMH		788 – 798	758 – 768	−30	5, 10
17	FDD	700	Lower SMH	12, 85	704 – 716	734 – 746	30	5, 10
18	FDD	850	Lower 800 (Japan)	26	815 – 830	860 – 875	45	5, 10, 15
19	FDD	850	Upper 800 (Japan)	26	830 – 845	875 – 890	45	5, 10, 15
20	FDD	800	Digital Dividend (EU)		832 – 862	791 – 821	−41	5, 10, 15, 20

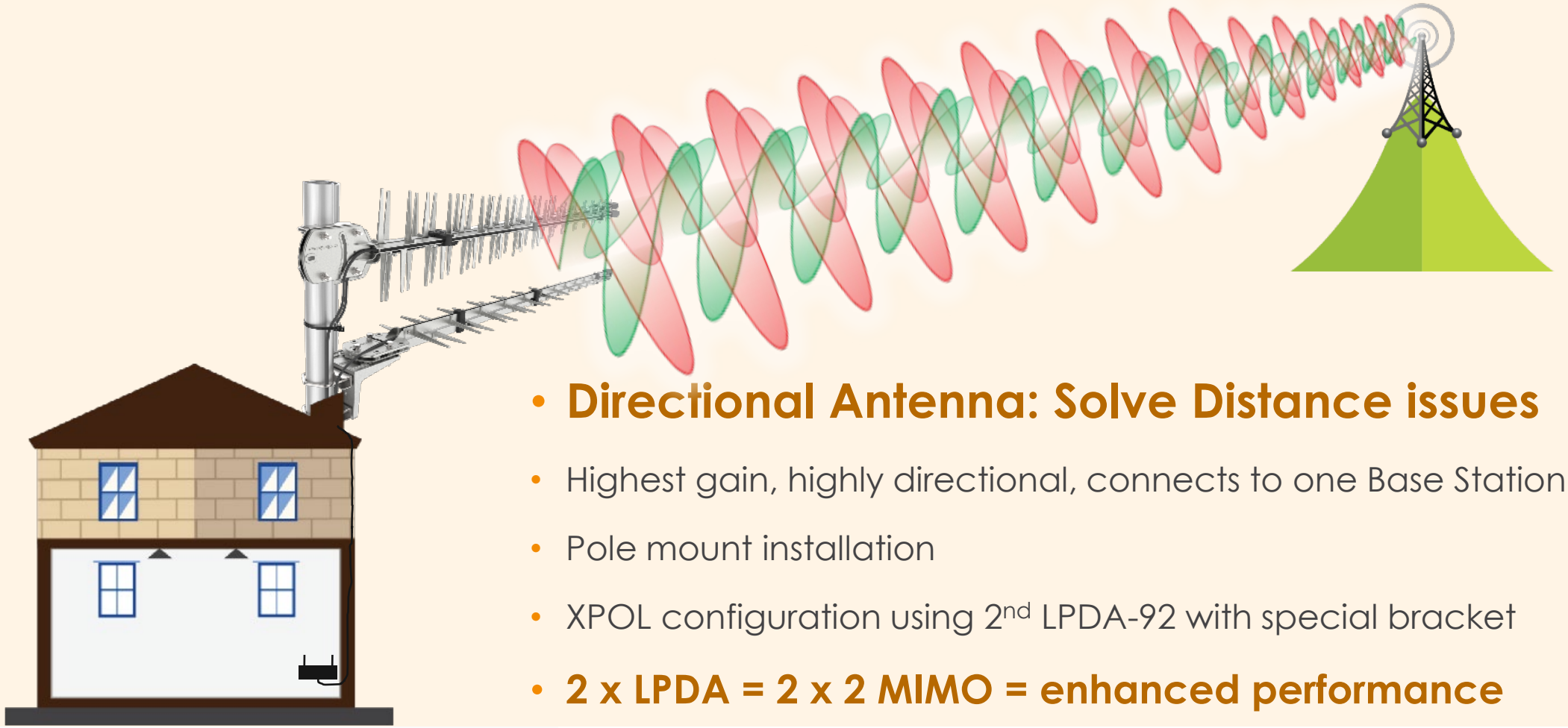


NB! This is a simulation, NOT an actual coverage plan

Scenario 4: LTE Frequencies – Telstra Australia



Scenario 4: Farmer or Country Estate – Rural Scenario



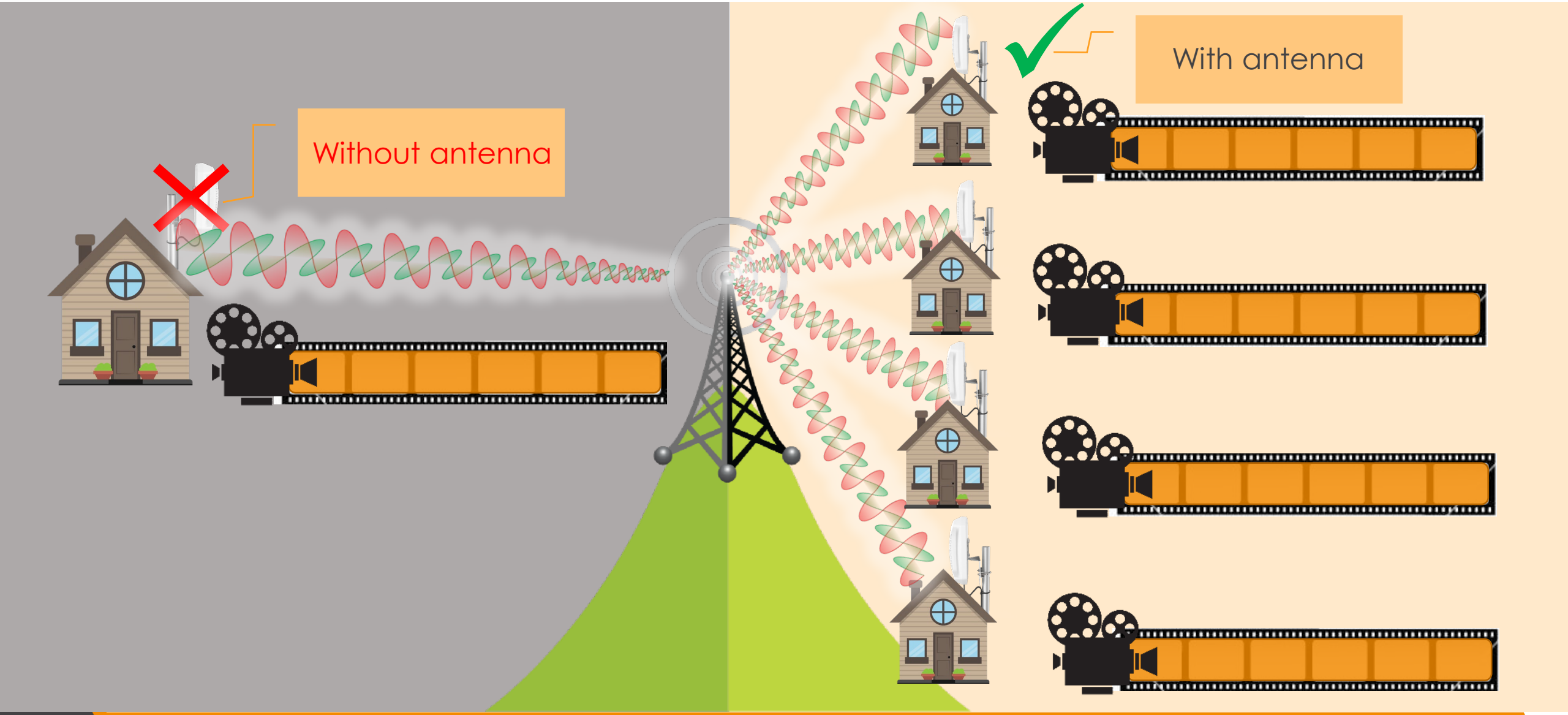
- **Directional Antenna: Solve Distance issues**
- Highest gain, highly directional, connects to one Base Station only
- Pole mount installation
- XPOL configuration using 2nd LPDA-92 with special bracket
- **2 x LPDA = 2 x 2 MIMO = enhanced performance**

Poynting

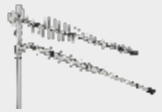
Making wireless happen

What does this increase mean in practice?

Comparing Equal Bandwidth (symbol/sec) to Download Movies?



Built Environment & RF Clutter Types

		Rural	Suburban	Urban	Dense Urban
		Agricultural/farming, open fields, grass lands, small villages, etc.	Sparse residential, Freestanding Houses, etc.	Dense housing, 2 to 3 storeys	City Centres (CBD), High-rise buildings, etc.
OMNI DIRECTIONAL	XPOL-1-5G 	✗	✓	✓ ✓	✓ ✓ ✓
	OMNI-600 	✓ ✓	✓ ✓ ✓	✓ ✓ ✓	✓ ✓
DIRECTIONAL	XPOL-2-5G 	✓ ✓	✓ ✓ ✓	✓ ✓ ✓	✓
	LPDA-92 	✓ ✓ ✓	✓ ✓ ✓	✓	✗

List of cheat sheets/links on our website

- Which antenna short list:

https://poynting.tech/articles/which-lte-antenna-do-i-use/

- The long version: https://poynting.tech/how-to-choose-an-antenna/
- Popular LTE Frequencies:

https://poynting.tech/articles/common-cellular-and-wi-fi-frequency-cheat-sheet/

- Cellular tower and coverage mapping service:

https://www.cellmapper.net/map

- Frequency Bands: https://en.wikipedia.org/wiki/LTE_frequency_bands
- Signal Strength Cheat Sheet: https://poynting.tech/articles/signal-strength-measure-rsrp-rsrq-and-sinr-reference-for-lte-cheat-sheet/
- Cable Loss Cheat Sheet: https://poynting.tech/articles/cable-loss-cheat-sheet/

Note! Some coax data displayed beyond their tested abilities – shown only for indicative purposes

Poynting

Making wireless happen

Thank you!

Any questions?

info@poynting.tech

www.poynting.tech

Subscribe to our YouTube Channel