

Gigabit communications using license exempt mmWave (57-71 GHz)

Mark Barrett : Founder and Chief Commercial Officer

Tech UK, UK Spectrum Policy Forum
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Gigabit Communications & Shannon's Law



Claude Shannon, Bell Labs, 1948:
Upper limit on Information rate in
a noise limited wireless channel

Assuming 50% efficiency for 2 Gbps:

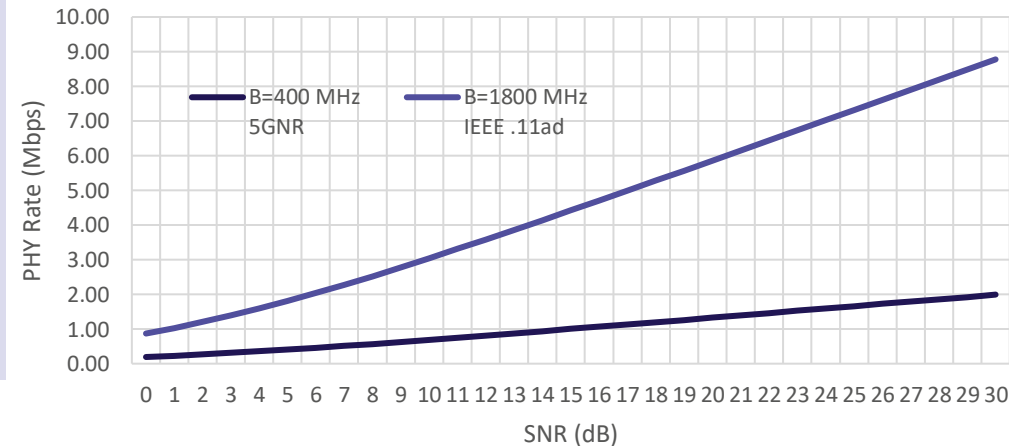
1800 MHz channel : +6 dB SNR (.11ad)

400 MHz channel : +30 dB SNR (5G NR)

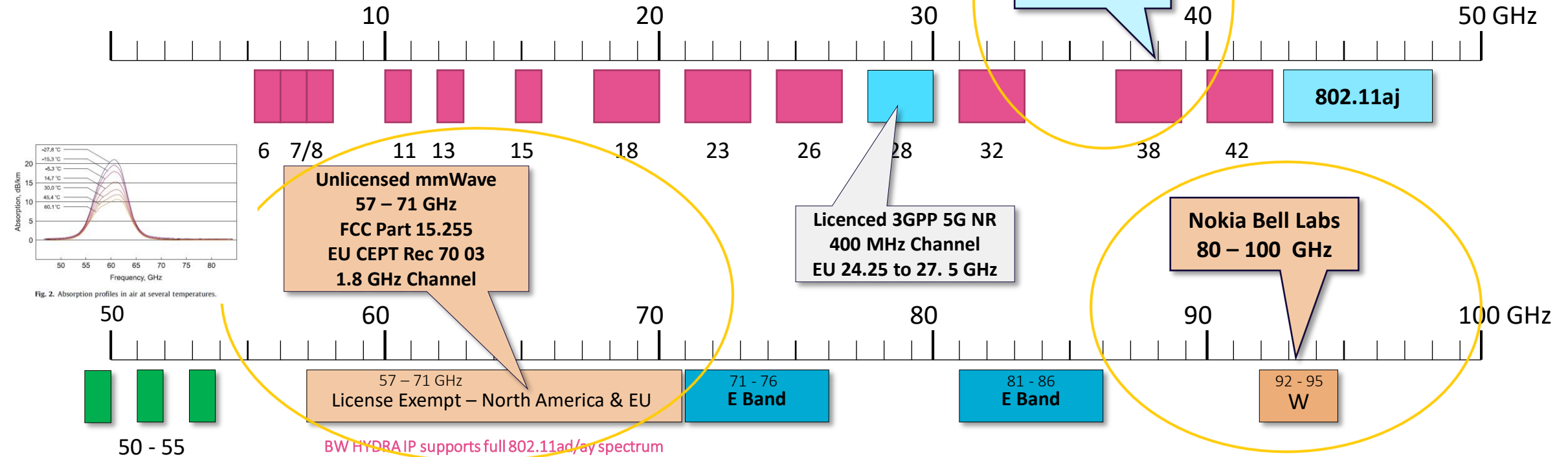
➔ **+24 dB Shannon Advantage**

$$C = B * \text{Log}_2\left(1 + \frac{S}{N}\right)$$

Shannon Limit (50% efficiency)



mmWave Spectrum - Overview



- 57-71 GHz license exempt spectrum is largest block of spectrum available from DC-100 GHz
- Allows 6x2 GHz channels up to +40dBm EIRP with mmWave Phased Array/RF & BWT technology
- BWT solution is spectrum agnostic -> operation at multiple mmWave spectrum bands

US and EU Regulations

Band (GHz)	Channelisation	US EIRP Limit	EU EIRP Limit	Comment
27.5 – 28.35	2 x 450 MHz	<u>Basestation</u> +75 dBmi/100 MHz <u>Mobile</u> +43 dBmi <u>Transportable</u> +55 dBmi		Licensed
37 – 37.6	600 MHz			Shared Federal / Non Federal users
37.6 – 38.6	5 x 200 MHz			Licensed
38.6 - 40	7 x 200 MHz			Licensed
57 – 71	6 x 1.8 GHz Notional – flexible as required	+40 dBmi or $82 - 2 \cdot (51 - G_a)$ Max +82 dBmi for $G_a > +30 \text{ dB}$	+40 dBmi ($G_a \leq +30 \text{ dB}$) +55 dBmi ($G_a > +30 \text{ dB}$)	Radio regulations agonistic on air interface and channelisation

Source : US : FCC Part 15.255 and EU : CEPT 70 03

CEPT 70 03 : 57-71 GHz Wideband Data Transmission



c1	57-71 GHz	40 dBm e.i.r.p., 23 dBm/MHz e.i.r.p. density	Adequate spectrum sharing mechanism shall be implemented	Not specified		Fixed outdoor installations are not allowed.
c2	57-71 GHz	40 dBm e.i.r.p., 23 dBm/MHz e.i.r.p. density and maximum transmit power of 27 dBm at the antenna port or ports	Adequate spectrum sharing mechanism shall be implemented	Not specified	ECC Report 288	
c3	57-71 GHz	55 dBm e.i.r.p., 38 dBm/MHz e.i.r.p. density and transmit antenna gain ≥ 30 dBi	Adequate spectrum sharing mechanism shall be implemented	Not specified	ECC Report 288	Applies only to fixed outdoor installations

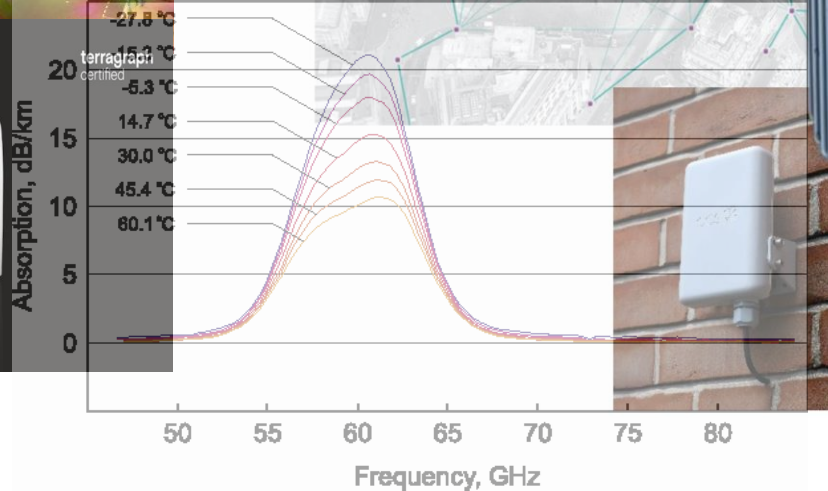
Source : CEPT ERC Recommendation 70 03, February 2021 : P15
<https://docdb.cept.org/download/25c41779-cd6e/Rec7003e.pdf>

Mandated for EU Adoption under 2019/1345 August 2019
Adopted in UK by OFCOM under IR2030 'Short Range Devices'

License Exempt Gigabit mmW Products



Short - Medium range (200m)



59-64 GHz: Fixed Telecom

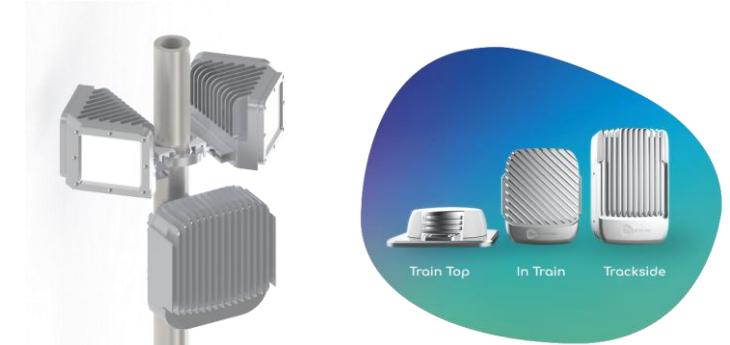
Medium – Long range (400m)



Adtran

59-71 GHz: Fixed Telecom

Long range (1k - 4km)



59-71 GHz: Mobile & SON Mesh

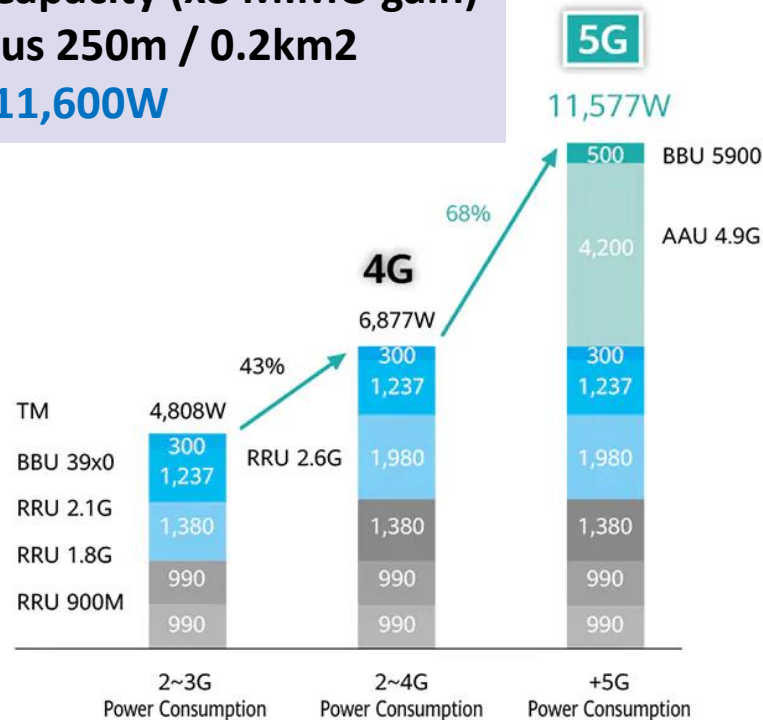
Gigabit Broadband: Licensed vs License Exempt?

5G NR Licensed Basestation

10Gbps Capacity (x8 MIMO gain)

Cell Radius 250m / 0.2km²

Power : 11,600W



Typical maximum power consumption of a single 5G base station

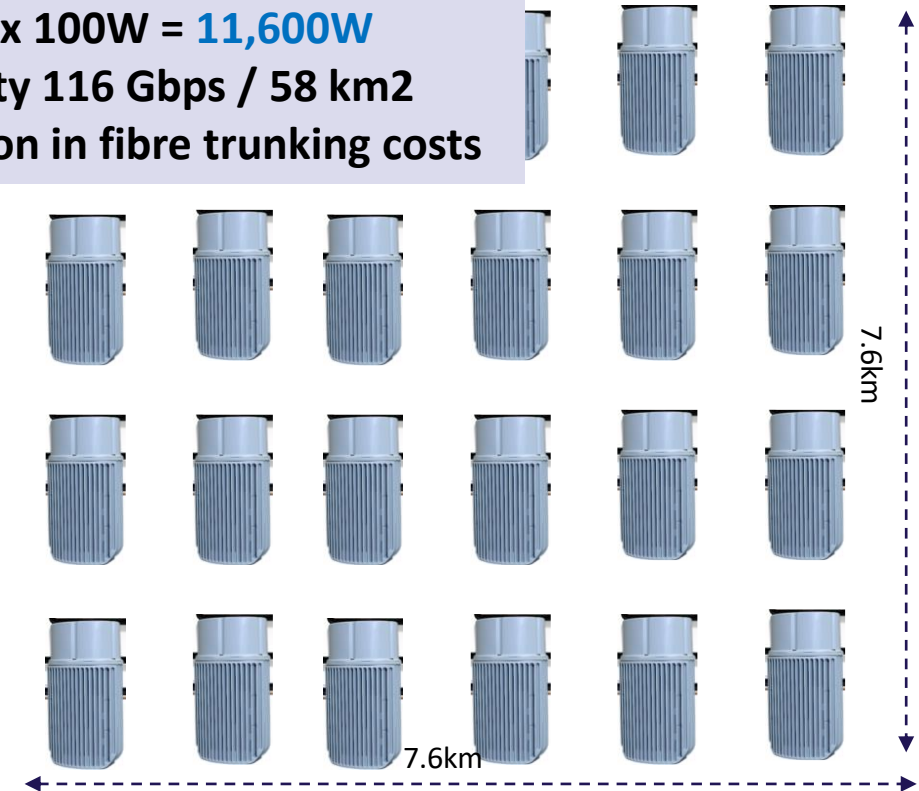
Licensed Exempt mmWave Mesh

1Gbps Cell Radius 400m / 0.5km²

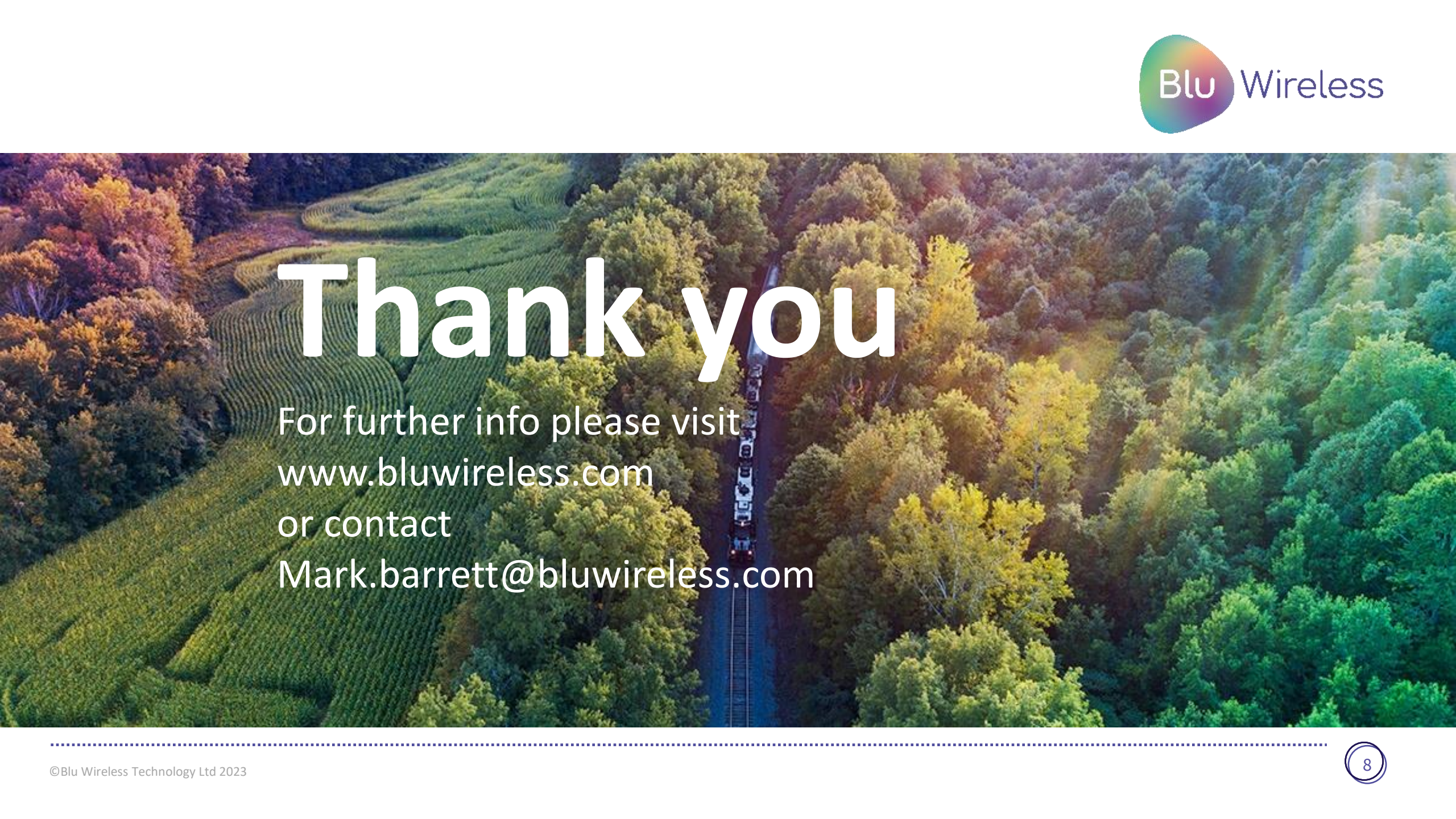
Power : 116 x 100W = 11,600W

Total Capacity 116 Gbps / 58 km²

90% reduction in fibre trunking costs



License Exempt mmWave delivers >10x capacity over 300x coverage area for same power as a 5G NR Basestation



Thank you

For further info please visit
www.bluwireless.com
or contact
Mark.barrett@bluwireless.com