New challenges of managing ICNIRP compliance with 5G and possible solutions

20th June 2019

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Introduction

- All operators committed to ensure compliance to ICNIRP public reference levels for all of their sites following the Stewart report.

- Control of electromagnetic fields at work act 2016 also mandates compliance to occupational reference levels.

- IEC62232:2017 provides methodologies for calculation and measurement of compliance distances against ICNIRP reference levels
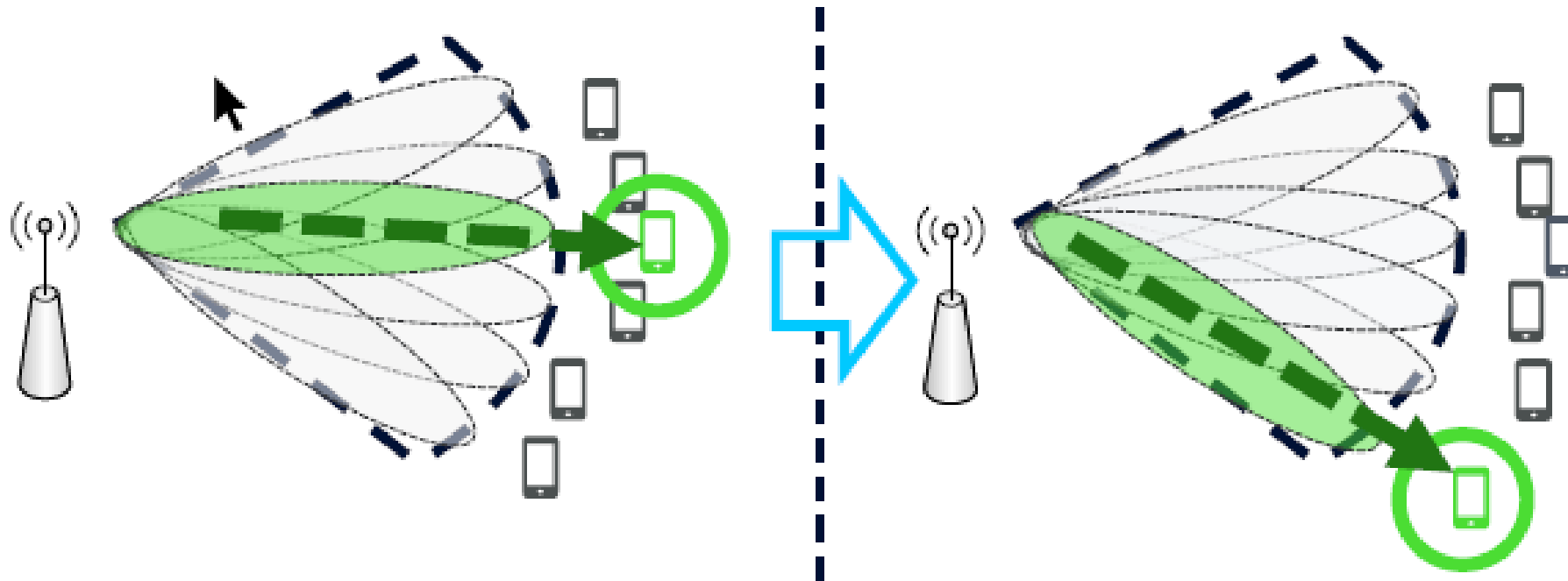
Introduction

- Calculation is typically preferred to measurement due to ease of implementation, and provides the most conservative compliance distances.

- 5G initial rollout requires the addition of more carriers onto existing EE sites

- 5G also introduces the use of TDD and beamforming antennas are being deployed which add additional complexity to calculation

What is TDD?

- Previous generations of cellular have mainly used different frequency channels for uplink and downlink transmission, known as FDD (Frequency Division Duplex)

- 5G will predominantly use uplink and downlink transmission separated in time but using the same frequency, TDD (Time Division Duplex)

- This can be taken into account in ICNIRP calculation due to the 6minute time averaging window within the guidelines, since the frame structure and consequently the amount of time where downlink transmission occurs is mandated by Ofcom

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What is TDD?

SCS	Numerology	Radio Frame	Subframe length	Slot length	Switching periodicity													
						Slot:	0	1	2	3	4	5	6	7	8	9	
NR 15 kHZ SCS	0	10ms	1ms	1ms	5ms		D	S	U	D	D	D	S	U	D	D	
								9:3:2					9:3:2				
						Slot:	0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19										
NR30 kHz SCS	1	10ms	1ms	0.5ms	5ms		D D D S U U D D D D D D D S U U D D D D										
								4:6:4					4:6:4				
Frame structure:	38.211 - slot format:						0 0 0 ? 1 1 0 0 0 0 0 0 0 ? 1 1 0 0 0 0										

- Timeslots are split between Downlink (D), Uplink (U) and Special (S). Special frame consist of both uplink and downlink subframes

- We can calculate that 72.9% of time is the maximum that may be spent in downlink transmission

What is beamforming?

- Power is not distributed in a constant pattern but will be targeted at different times to active users, depending on their position in the cell

- These focused "service beams" typically have significantly higher gain than a traditional passive antenna's broader coverage, but are not transmitting continuously.
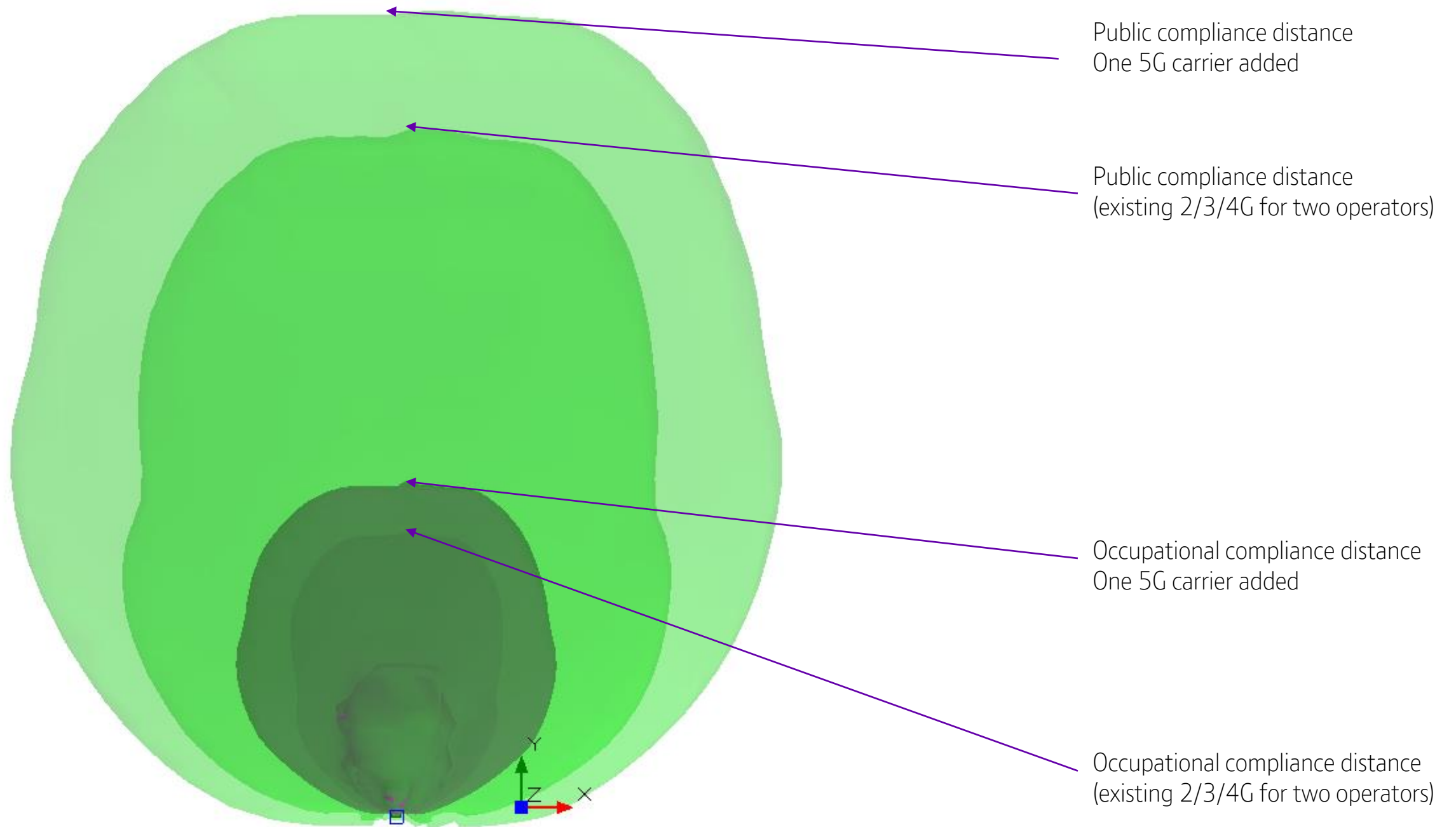
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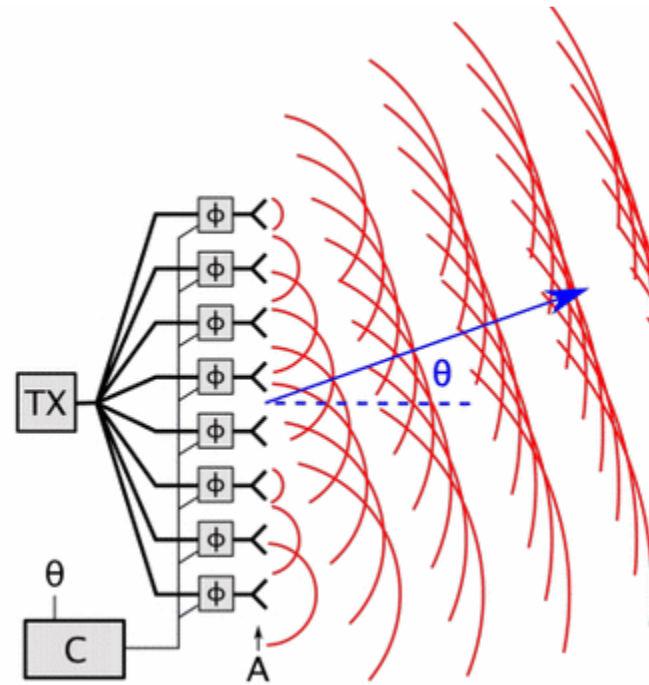
- This is achieved by the additive/destructive effects of waves transmitted from multiple individual antenna elements controlled in phase and amplitude

Managing beamforming antennas in calculations

- Distribution of power on any site in the network on 5G will vary over time in an indeterminate manner, depending on distribution of users within the coverage area who are active at any particular time.

- Conservative approach is to consider an "envelope" antenna pattern which encompasses all of the individual beams which may be formed at any particular time

- This is a worst-case and has the most significant impact to compliance distances, but provides absolute certainty of compliance

Increase in compliance using worst case scenario

Public compliance distance
One 5G carrier added

Public compliance distance
(existing 2/3/4G for two operators)

Occupational compliance distance
One 5G carrier added

Occupational compliance distance
(existing 2/3/4G for two operators)

Single 5G carrier increases public compliance by ~20% in typical MBNL scenario

What are the implications?

- Some sites in urban areas become increasingly difficult to provide required capacity while maintaining compliance using standard designs

- Significant time and cost can be associated with works necessary to ensure compliance – new planning permissions, physical structures, new site acquisition etc

- As 5G is deployed further, particularly as additional spectrum is auctioned in 700MHz and 3.6-3.8GHz bands these problems will be exacerbated

How can we reduce this impact?

- IEC62232 includes standards for statistical modelling of actual power output

- IEC62669 technical report includes some case studies using these methods

- However, this methodology is based on a known number of users with an assumed regular distribution within the cell coverage area

How can we reduce this impact?

- In reality, users will migrate to 5G over time, and they are often clustered within localities rather than being distributed over the whole cell

- There is a need to gather data from the EE network before confirming what level of back-off can be achieved through statistical means

- This should be accompanied by rigorous control within base station software to ensure required maximum powers are not exceeded if and when network conditions change (vendors are developing the necessary features, expected in 2020)

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