#### Electromagnetic Energy (EME) Exposure assessment of Telstra's 5G trial retwork on the Gold Coast, Australia

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#### Background

- In preparation for Telstra's 5G mobile network, measurements were performed at Telstra's trial millimetre wave (mmwave) 27 GHz 5G base station site located on the Gold Coast, Australia
- The purpose of the measurements was to ascert in the electromagnetic field (EMF) or electromagnetic energy (EME) levels associated with this new technology

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#### Objectives

EMF measurements were performed at Telstra's Southport Exchange located on the Gold Coast to:

Compare actual measured EMF levels with theoretical predictions of EMF levels from a 5G antenna to assess confidence in the computation of exclusion zong

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- Assess environmental EMF levels from 5G and other radio sources at both indoor and outdoor areas in the vicinity of the base station
- Assess suitability of test equipment for mmy ave measurements
  Assess suitability of test equipment for mmy ave measurements



### Operational radio systems located on Southport Exchange tower

| System        | ACMA description   |
|---------------|--|
| LTE 700 MHz   | Mobile   |
| LTE 1800 MHz  | Mobile   |
| LTE 2600 MHz  | Mobile   |
| WCDMA 850 MHz | Mobile   |
| 400 MHz       | Land mobile (e.s. two way service), fixed (point-to-point and point-to-motion), amateur services |

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#### Indoor measurements



#### 5G base station antenna

- Single User Multiple Input Multiple Output (SU-MIMO)
- 27 GHz phased antenna arrays
- Time Division Duplex (TDD) shared frequency channel where downlink and uplink are separated in time by the allocation of different time slots



Information

- Twoseams per array: H and V polarised
  - Refer to the second sec
- Sector coverage: azimuth ( $\pm$  60°) and elevation ( $\pm$  15°,  $\pm$  7.5°)
- 🖕 Up to 800 MHz bandwidth (400 MHz for current trial)
- The ratio of downlink to uplink time slots can be altered



#### 5G base station antenna (continued)

Beam width =  $12^{\circ}$  and maximum gain  $G_{max}$ =21 dBi (boresight)

- Non-boresight beams have lower gain
- 48 different beam positions
- Radiated power (EIRP<sup>#</sup>): 42 dBmW (15.8 W) per beam, 45 dBmW (31.5 W) per array and 48 dBmW (63 W) total @ 800 MHz bandwidth

https://www.ericsson.com/en/5

esight beam, maximum gain G<sub>max</sub>

Time-t<sub>o</sub>

and dynamic steering



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#### EMF measurements from 5G base station antenna

#### Line of sight along the boresight beam

- Indoor: single antenna array under program control: single constant or resight beam, single polarisation, 800 MHz, 42 dBmW (15.8 W) EIRP
- Outdoor: base station antenna 2x2 MIMO, 400 MHz, 45 dBrow (31.5 W) EIRP, vehicle mounted user equipment (UE) antenna connected to base station to 'attract' the brown
- Broadband probe (< 1m from antenna), spectrum  $a_{1}$  spectrum and horn antenna ( $\geq$  1m)
- TDD downlink/uplink ratio 23:1, high downlink Kammy) traffic generating 1-2 Gbps



Indoor







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### EMF measurements along boresignt beam





#### Notes

- Measurements scaled to 63 W total EIRP
- Uncertainties: precise measurement location with respect to boresight, field scattering, calibration.



## Environmental EMF levels - Configurations

#### **Indoors and outdoors**

- Measurements representing exposure at time and place from 5G and other radio sources 'snapshot' of the RF environment
- **G** 5G system configuration and measurement:
  - **Q** 2x2 MIMO, 400 MHz, indoor TDD ratio 1:1, Sutdoor TDD ratio 23:1
  - High downlink traffic, combining user traffic and dummy traffic to generate 1-2 Gbps
  - Measurement of channel power usion spectrum analyser and horn antenna
- Indoor In-Building Coverage (IBC) sestem in 1800/2600 bands
- EMF levels in mobile bands be 3 GHz based on summation of uplink/downlink contributions
- Other radio sources measured over 27 MHz 3 GHz (1 min average)
- 'Isotropic' measurements



## Environmental EMF – indoor/outdoor locations



Indoor gaming demonstration over trial 5G network



Baby monitor (1897 MHz)









400 MHz Walkie Talkie & 4G laptop (1800 MHz)



#### Environmental EMF - indoor spectrum





5G - 27 GHz

Channel power measurement with spectrum analyser and horn antenna





#### Environmental EMF levels - outdoor OUTDOOR



oum of car mounted 5G JE + BS @ 0.3 m from car, carpak

Sum of car mounted 5G UE + BS @ 1.5 m from car, carpak

owards BS, carpark

owards BS, pizza shop







| Highest exposure          |        |  |
|---------------------------|--------|--|
| Cumulative: 27MHz to 3GHz | 0.19%  |  |
| 5G                        | 0.025% |  |



#### Comparing radiated powers

|  | Transmitter power, antenna gain      | Radiated power*             |  |  |
|--|--------------------------------------|-----------------------------|--|--|
| Typical mobile system<br>below 3 GHz   | 50 - 100 W, ~17 dBi                  | 64 - 67 dBmW (~2500-5000 W) |  |  |
| Trial mmwave 5G system   | 0.5 W, 21 dBi                        | 48 dBmW (63 W)              |  |  |
| <ul> <li>4 mobile systems operating at Southport Exchange</li> <li>Trial 5G system contributes less than 1 % total EIRP</li> <li>Comparable to mobile small cell (i. priRP)</li> <li>Expect commercial 5G macro systems to have similar EIRP to existing mobile systems</li> </ul> |                                      |                             |  |  |
| 201  | * Effective Isotropic Radiated Power |                             |  |  |

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#### Findings

- Good alignment between predicted levels and measured levels binder test conditions
- Measurement instruments found to be suitable for the trigo
- Measurements show 5G signals comparable to other signals in the environment and significantly lower than the ARPANSA public limit.
- Indoor measurements with a multitude of radio technologies were well below the ARPANSA public limit
- MIMO systems increase measurement mplexity in a live network environment (e.g. dynamic beam steering). IEC working on methods massessing MIMO systems
- Requires a good understanding measurement practices and the mobile technology



## Example 1: Dynamic beam steering in action

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#### Example 2:5G test car (video)





#### Team effort

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