TOTAL RADIATION SOLUTIONS

RF EME SURVEY REPORT
5G SMART APARTMENT

MERITON SUITES
SOUTHPORT QLD 4215

December 2020

RF EME SURVEY REPORT

For
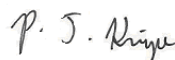
Telstra Corporation Limited
242 Exhibition Street
Melbourne VIC 3000

At

MERITON SUITES - SOUTHPORT
2 Como Crescent
Southport QLD 4215

Measurement Dates: 6th to 9th and 16th March 2020

Reference No: 4692-7452

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Total Radiation Solutions

Contents

1. Introduction

Modern wireless telecommunication networks encompass the connection of many complex network and wireless devices.

The introduction of the 5G network along with an increasing number of wireless devices that can be connected over 5G has raised some concerns regarding the level of radiofrequency (RF) electromagnetic energy (EME) exposure within modern 5G connected homes.

In response to these concerns, a measurement program was developed to specifically look at RF EME levels in smart homes and apartments called the 'Smart Home Measurement Program'.

This report presents results of EME measurements in a large modern apartment containing a multitude of wireless devices that provide wireless connectivity to 5G connected Wi-Fi mobile hotspots, and 4G and 5G mobile networks.

This report is based on measurements taken during the survey.

2. Scope

To measure and document RF EME levels within a modern 5G connected smart apartment with respect to the Australian regulatory exposure standard, and to compare the RF EME levels with and without connected devices inside the apartment.

The apartment selected is in a modern high-rise complex in close proximity to mobile base stations with a variety of telecommunications carriers and mobile technologies including Telstra's 5G network. The apartment complex included a 2.4 and 5GHz Wi-Fi network. For the smart apartment EME testing the Wi-Fi network inside the smart apartment was deactivated and replaced by a 5G connected Wi-Fi.

A wide variety of wireless devices were installed operating over 5G and 5G connected Wi-Fi to replicate a modern smart apartment configuration.

3. Regulatory Exposure Limits

The Australian Radiation Protection and Nuclear Safety Agency (ARPANSA), an agency of the Commonwealth Department of Health has established a Radiation Protection Standard (RPS3) specifying limits for continuous exposure to RF EME transmissions (Table 1). Further information can be gained from the ARPANSA web site at http://www.arpansa.gov.au .

The Australian Communications and Media Authority (ACMA) mandates exposure limits for continuous exposure of the general public to RF EME. Further information can be found at the ACMA website at http://www.acma.gov.au.

Table 1   Reference Levels for Time Averaged Exposure to RMS Electric and Magnetic Fields (Unperturbed Fields) (ARPANSA)

Exposure Category	Frequency Range	E-Field Strength (V/m rms)	H-Field Strength (A/m rms)	Power Flux Density (W/m²)
Occupational (RF Worker)	100 kHz – 1 MHz	614	$1.63/f$	N/A
	1 MHz – 10 MHz	$614/f$	$1.63/f$	$1000/f^2$
	10MHz – 400 MHz	61.4	0.163	10
	400 MHz – 2 GHz	$3.07 \times f^{0.5}$	$0.00814 \times f^{0.5}$	$f/40$
	2 GHz – 300 GHz	137	0.364	50
Non-Occupational (General Public)	100 kHz – 150 kHz	86.8	4.86	N/A
	150 kHz – 1 MHz	86.8	$0.729/f$	N/A
	1 MHz – 10 MHz	$86.8/f^{0.5}$	$0.729/f$	N/A
	10MHz – 400 MHz	27.4	0.0729	2
	400 MHz – 2 GHz	$1.37 \times f^{0.5}$	$0.00364 \times f^{0.5}$	$f/200$
	2 GHz – 300 GHz	61.4	0.163	10

NOTES:
1. f is frequency in MHz.
2. For frequencies between 100 kHz and 10 GHz, S_{eq}, E^2, and H^2, must be averaged over any six-minute period.
3. There are also applicable limits for exposure to instantaneous RMS electric and magnetic fields (unperturbed fields). These limits are less restrictive than the limits specified in Table 1 and as a result are not referenced in this measurement report.

4.   Measurement Location

Apartment 2807 at the Meriton Suites in Southport, Queensland was the selected for this survey.

The total area of the apartment is approximately 88m² (22m x 4m), including living, dining, kitchen, media, 2 bedrooms, 2 bathrooms and 2 balconies.

Figure 1 illustrates the location of 8 Telstra 5G macro base stations in close proximity to the Meriton Suites according to their Radio Frequency National Site Archive (RFNSA) site number.

Apartment 2807 is located on the east side of the building and the front balcony and living areas face directly towards Site No. 4217025 which is located approximately 1km east of the building.

It is noted that Site No. 4215026 is located on the north side of the building. However, it is not visible from Apartment 2807.

Figure 1   Measurement Site Location

This photo shows the Meriton Suites Apartment location and nearby Telstra 5G base stations

5.   Measurement Methodology

Measurements in the apartment were conducted from 6th to the 9th March 2020 for the time periods listed in Table 2. Individual device measurements were conducted on the 16th of March.

Using the NARDA SRM-3006 Selective Radiation Meters with an E-Field (27 MHz to 3 GHz) probe, E-Field (420 MHz to 6 GHz) probe and 5m RF-Cable (9 kHz – 6 GHz) the following were measured:

1. Background EME levels for the 27MHz – 6GHz band inside and outside the apartment with no devices inside the apartment connected.

2. RF EME levels for the 27MHz – 6GHz band in a family occupied apartment over an extended period.

3. RF EME levels due to individual devices.

The measurements were based on the ACEBR EME in Homes Survey Protocol 2019 (Appendix C).

The one-minute average value and maximum value for the selected frequency bands as a percentage of the RPS3 general public limit were measured.

ARPANSA RPS3 Table 7 specifies the reference levels for time averaged exposure to ambient electric and magnetic fields, where the RMS field strength for frequencies between 100kHz to 10GHz must be averaged over any six-minute period.

The averaging time for these measurements was one minute and through post processing, six-minute average values were calculated for the 5G, 4G, and Wi-Fi EME levels inside the apartment. The six-minute average values are presented in this report consistent with the ARPANSA RPS3 requirements.

The one-minute average recordings are an average of all the spectrum 'sweeps' measured within that minute.   A spectrum sweep includes measurement of all signals within the frequency band. The one-minute average measurement has approximately 40 sweeps at 1.5 seconds per sweep.

Wi-Fi 5GHz signals from the apartment complex were consistently greater than all other mobile technologies by a factor of approximately 6 times (> 0.006% of GP limit). To avoid the influence of complex interactions generated by 5GHz Wi-Fi signals on the EME testing program, all devices within the smart apartment were set to only use the 2.4GHz Wi-Fi band.

5.1   Background RF EME Measurements

Measurements were conducted on the front balcony, rear balcony and living room (Figure 2 - ML1).

Due to the frequency band limit of the probes 27MHz – 3GHz for one and 420MHz to 6GHz for the other, measurements for frequencies below 3GHz were recorded during a different one-minute time period to that above 3GHz (i.e. NR3500 and Wi-Fi 5GHz).

The following services were included in the background measurements.
- Telstra – LTE700 / WCDMA850 / LTE900 / LTE1800 / LTE2100 / LTE2600 / NR3500
- Optus – LTE700 / LTE900 / LTE1800 / LTE2100 / UMTS2100 / LTE2300 / LTE2600
- Vodafone - LTE700 / LTE900 / LTE1800 / LTE2100
- Wi-Fi – 2.4GHz / 5GHz
- FM Radio
- VHF / UHF TV and Radio

5.2   Family Occupied Apartment RF EME Measurements

These measurements were conducted during three time periods (Table 2) across the dates 6/03/2020 to 9/03/2020.

Three individual meters were utilised for these measurements. Two were located in the living Room (ML 1) and Media Room (ML2) to measure activity over extended periods (12 - 24hrs) and another for recording only the 5G level at various locations for various time intervals.

The floor plan (Figure 2) illustrates where the extended period measurement Locations ML1 and ML2 were positioned.

Figure 2   Floor Plan and Device Layout
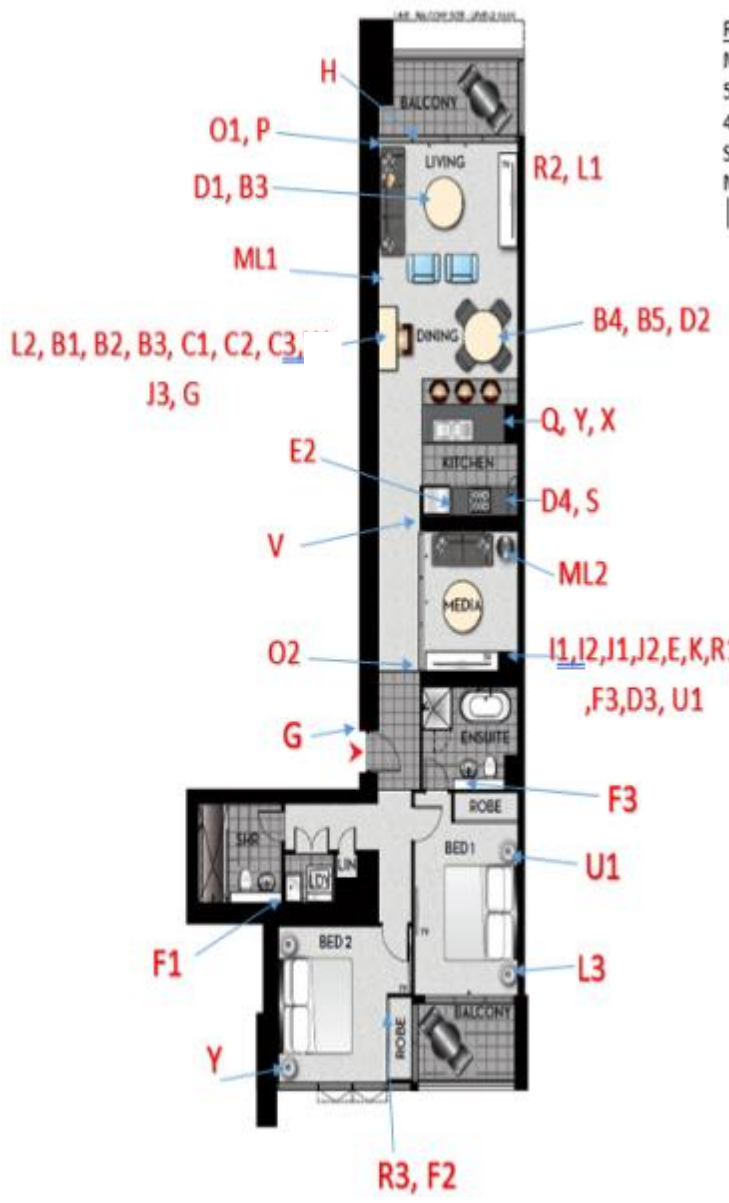
Roaming devices
Mobile phones (13 devices):
5G A1 - A4
4G A5 - A13
Smart watch N1, N2, N3
ML3

Device	Quantity	Identifier
Mobile phone	4	A
Mobile phone	9	A
Laptop	6	B
Wireless keyboard and mouse	3	C
Ipad	4	D
Google home	1	E
Google nest hub	1	E2
Google mini	3	F
Doorbell	1	G
Camera	1	H
Gaming console	1	I1
Gaming controller	1	I2
Wireless headset	3	J
Apple TV	1	K
WiFi router – HTC hubs	3	L
Smart watches	3	N
Smart lights	2	O
Smart plug	1	P
Kasa Smart Wi-Fi Power Strip	1	Q
Vitamix Perfect Bake smart scales	1	S
Airpods	1	T
Chromecast	3	R
Speaker	2	U
WiFi extender	1	V
	57	

A total of 57 wireless and 5G devices were setup throughout the apartment. A list of all devices is in Appendix B.

Sixteen devices were connected directly to the Telstra mobile network. Seven devices (4 mobile phones plus 3 Wi-Fi routers) were connected to the 5G network and 9 mobile phones were connected to the 4G network.

Table 2   Measurement Periods

Period	Time Period	Duration (Hours)
1	6.15pm Friday to 9.14am Saturday	15
2	2.15pm Saturday to 12.05pm Sunday	22
3	2.10pm Sunday to 12pm Monday	22

A third meter in spectrum analysis mode was used to measure the one-minute average and corresponding maximum peak level across the 700MHz to 4GHz bands for varous locations in the living, dining and kitchen areas.

This mode incorporates an integration function which calculates the measured level for all signals within the frequency band.

This determines the broadband cumulative value for the one-minute average and/or maximum over the set time duration, for a specific frequency band.

The integration frequency span can be adjusted to capture any frequency range within the measured bands (e.g. for NR3500 min freq is 3.5GHz and max freq is 3.65GHz).

5.3   Individual Devices RF EME Measurements

To provide information about the EME exposure from the smart devices, the one-minute average and maximum RF EME level for a number of individual devices was also measured following the ACEBR EME in Homes Survey Protocol – 2019 (refer Annex C).

These measurements were conducted with the probe located at 20cm from the device under utilisation.

These measurements were conducted separate from the apartment in a low background noise environment.

The devices tested are listed in Table 6, along with the measurement results.

6. Measurement Equipment

- NARDA SRM-3006 Selective Radiation Meter
  Frequency Range 100 kHz – 6 GHz
  Model Number 3006/01

- NARDA 3-Axis Antenna
  Frequency Range 27 MHz – 3 GHz
  Model Number 3501/03

- NARDA 3-Axis Antenna
  Frequency Range 420 MHz – 6 GHz
  Model Number 3502/01

- NARDA RF-Cable SRM, Length 5m, 50 Ohms
  Frequency Range 9 kHz – 6 GHz
  Model Number 3602/02

7.   Measurement Results

7.1   Background RF EME Levels

The measured one-minute average background levels for the carrier technologies, Wi-Fi, FM radio, VHF / UHF TV and radio at locations ML1, ML2 and ML3 are shown in Figures 3 and 4.

These include the individual carrier technology levels, and a combined cumulative total of all carrier (Telstra/Optus/Vodafone) mobile technology levels shown as 'Total all Carriers' in Table 3.
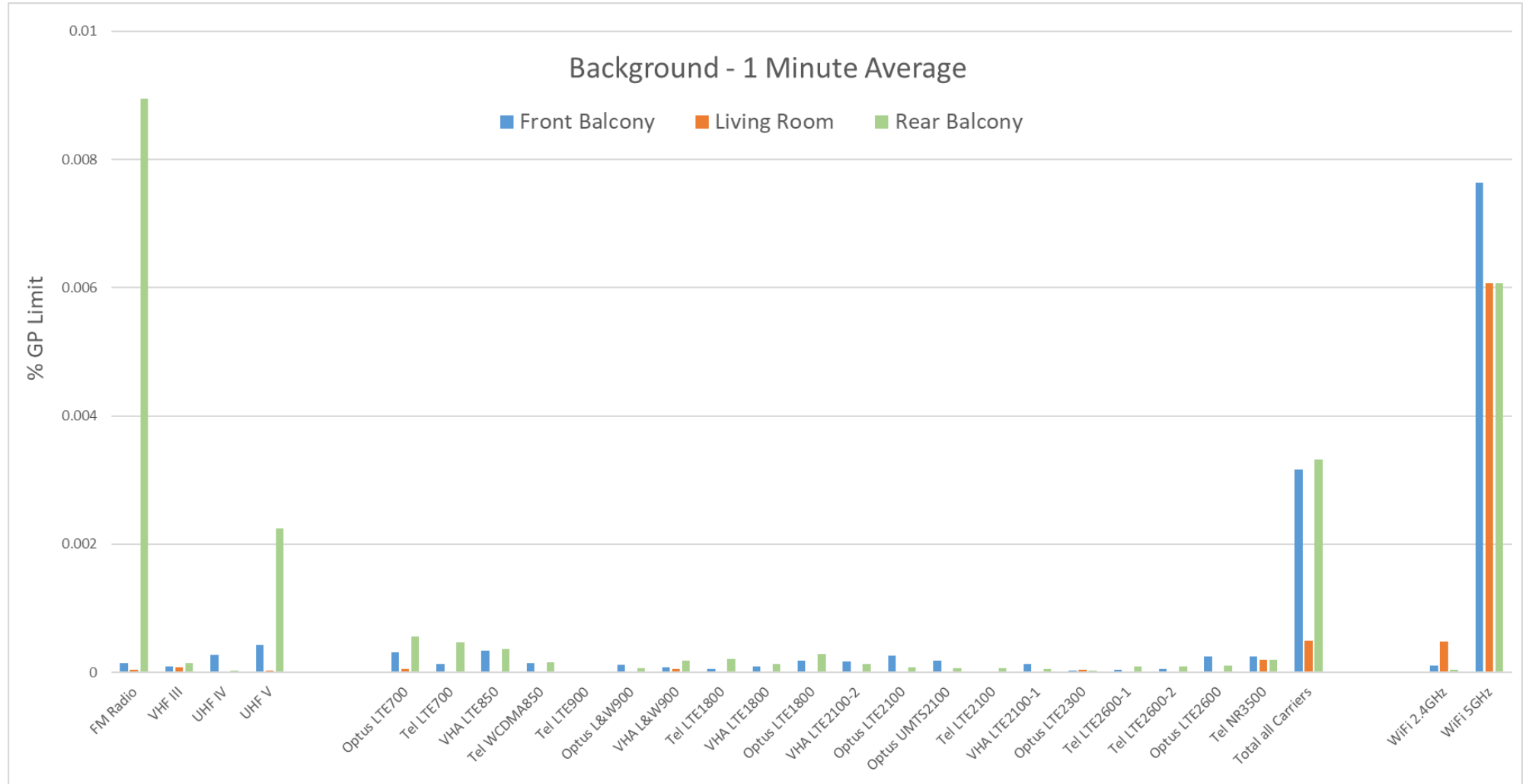
Table 3   Measured Background RF EME Level - % ARPANS RPS3 GP Limit

| Technology	Front Balcony		Rear Balcony		Living Room	
	1 Min Ave	Peak	1 Min Ave	Peak	1 Min Ave	Peak
Total All Carriers	0.0032	0.0083	0.0033	0.0077	0.0004	0.0008
Wi-Fi 2.4GHz	0.0001	0.0008	0.00004	0.0002	0.0003	0.0033
Wi-Fi 5GHz	0.0076^6	0.0076^6	0.0061^6	0.0061^6	0.0061^6	0.0061^6
TV and Radio	0.0009	0.0011	0.0113	0.0172	0.00015	0.00022

Notes:

1. The recorded measurements were taken from the SRM-3006 for the 27 MHz – 6 GHz band.
2. The measurements were taken as per Australian Standard AS/NZS 2772.2:2016 Radiofrequency fields Part 2: Principles and methods of measurement and computation– 3 kHz to 300 GHz.
3. The measurements conducted with the SRM-3006 instrument with/without a tripod mounted probe and 5m cable have an expanded uncertainty of + 3 dB. See uncertainty excel spreadsheets in the specific job folder for the calculations.
4. The coverage factor (k) value used to give an upper one-sided expanded uncertainty with a 95% confidence interval was 1.64.
5. The recorded measurements taken from the SRM-3006 were percentage of RPS3 general public limit, power density and frequency.
6. The measured levels of Wi-Fi 5GHz and Telstra NR3500 were within 3dB of the noise floor.
7. % RPS3 GP Limit – Percentage of the Australian Regulatory General Public Exposure Limit.
8. The SRM probes were mounted vertically on a wooden tripod and centered at 1.5m above standing level (ASL).
9. TRS permanently stores all measurement equipment calibration details, site maps and recorded measurement scans.
10. The assessment methodologies in AS/NZS 2772.2:2016 are consistent with international best practices such as IEC 62232.

Figure. 3   Measured Background One-Minute Average

Figure. 4   Measured Background One-Minute Average – Telstra/Optus/Vodafone Only
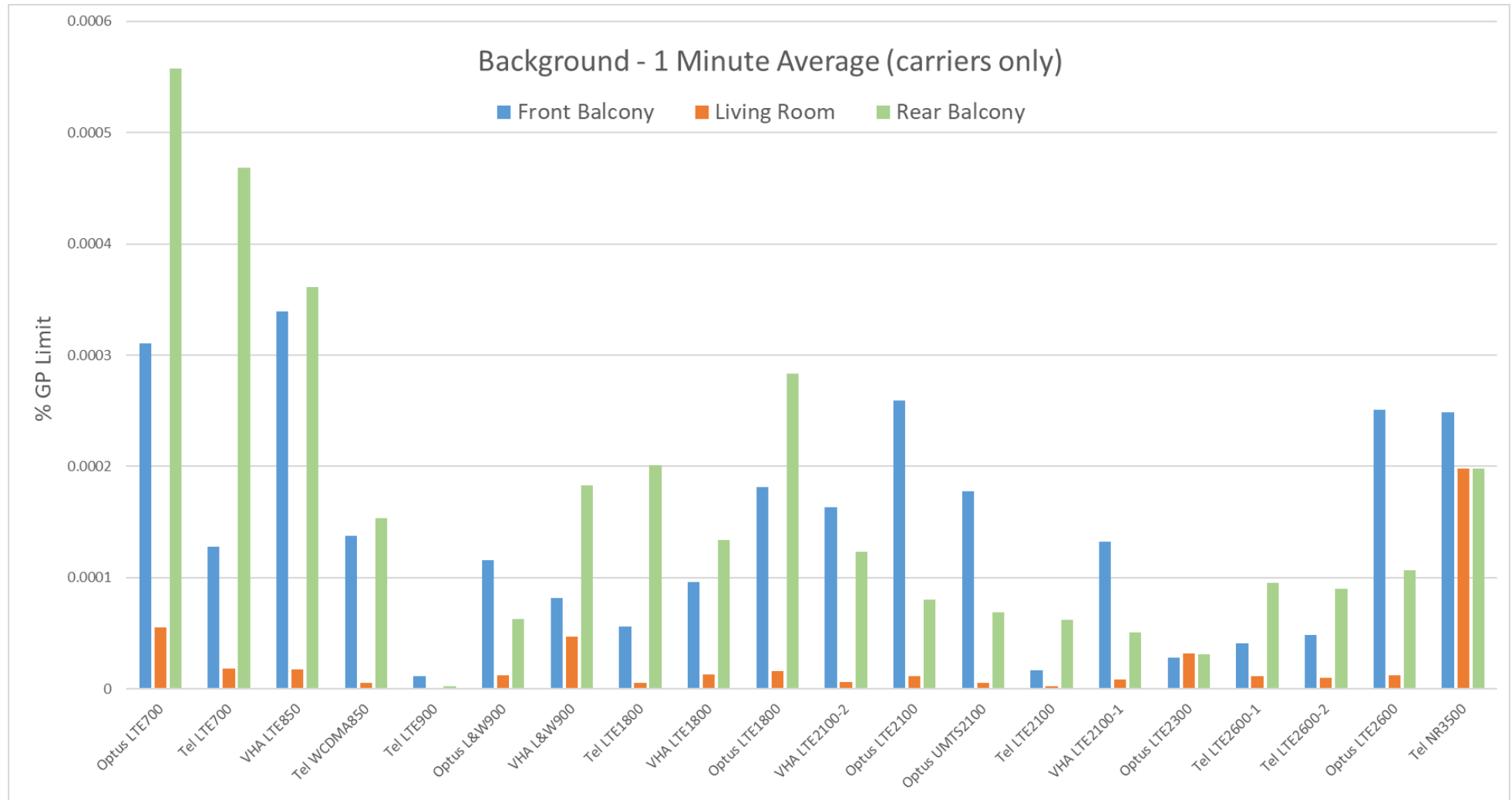
7.2   Family Occupied Apartment RF EME Measurements

The most significant contributors to the measured RF EME levels in the apartment living and media rooms over the duration of the measurements were Telstra 5G NR3500 and Wi-Fi 2.4GHz in the living room. The Telstra 5G NR3500, 4G and 3G EME levels in the media room were all lower than the living room and below the noise floor settings of the instrument.

The media room is in the middle of the apartment with no external windows and well shielded from mobile signals from outside the apartment.

These measurement results are presented in Table 4 and Graphs 1- 6.

Table 4   RF EME Levels inside apartment - % ARPANS RPS3 GP Limit
(highest 6-minute average level)

Technology	Friday/Saturday		Saturday/Sunday		Sunday/Monday	
	Living Room	Media Room	Living Room	Media Room	Living Room	Media Room
Wi-Fi (2.4GHz)	0.006	0.0005	0.006	0.002	0.006	0.0006
5G (NR3500)	0.0007	n/a	0.00149	n/a	0.0007	n/a
4G	0.0002	n/a	0.0003	n/a	0.0003	n/a
3G	0.0001	n/a	0.0002	n/a	0.0002	n/a
TV	0.00009	n/a	0.00009	n/a	0.00009	n/a

First Time Period - 6.15pm Friday to 9.14am Saturday – Graph 1 & 2

The first 3 hours saw minimal activity occur until the family arrived at the apartment around 9:30pm.   After their arrival there was an increase in Wi-Fi activity and corresponding 5G levels.

The 6-minute average for Wi-Fi in the living room on the Friday evening was 0.004% at 9:53pm and 0.006% was measured at 08:21am on Saturday morning.

The 6-minute average for 5G in the living room on the Friday evening was just below 0.0005% and 0.0007% was measured at 07:41am on Saturday morning.

Second Time Period - 2.15pm Saturday to 12.05pm Sunday – Graph 3 & 4

During the second time period, consistently high activity occurred from 5:30 to 7:00pm when the family hosted a dinner party with 5 mature network users and 4 teenage gamers.

Devices used during the dinner party included 4 x 5G connected phones, 3 x 5G connected HTC Wi-Fi routers, 6 x Wi-Fi connected laptops, 4 x Wi-Fi connected iPads, and 3 x gaming devices.

During this period of activity devices simultaneously streamed 4K video, on-line gaming and 5G network data speed tests. The 5G network was also activated using the Perfect Bake Pro smart scales to prepare a dish using instructions via an internet sourced recipe (Guacamole).

The highest 6-minute average for Wi-Fi in the living room on the Saturday evening was 0.006% at 6.20pm.

The highest 6-minute average for 5G in the living room on the Saturday evening was 0.00149% at 7:28pm.

Third Time Period - 2.10pm Sunday to 12.00pm Monday – Graph 3

The highest 6-minute average Wi-Fi during this period occurred at 6.10pm when the levels reached 0.004%. The corresponding 5G level was 0.00056%

The highest 6-minute average Wi-Fi on the Monday morning was 0.006% at 7.50am and the highest 6-minute average 5G level was 0.0007% at 11.50am.

Testing the maximum 5G network loading and EME levels – Monday afternoon

Measurements in the apartment living room using a 5G network loading tool called iPerf were performed on Monday afternoon to determine the EME levels possible under high network utilisation.

The iPerf tool connects to a server in the Telstra network and streams a continuous data rate over the 5G network to a 5G device. The data rate achieved during these tests ranged from 500-560Mbs and the corresponding highest six-minute average EME level was 0.00143%.

This is consistent with the highest six-minute 5G EME level of 0.00149% measured on Saturday night at the family dinner party where the objective was to generate a very high level of activity.

This comparison confirms that the 5G network loading during the dinner party on the Saturday night was achieving a very high level of utilisation.

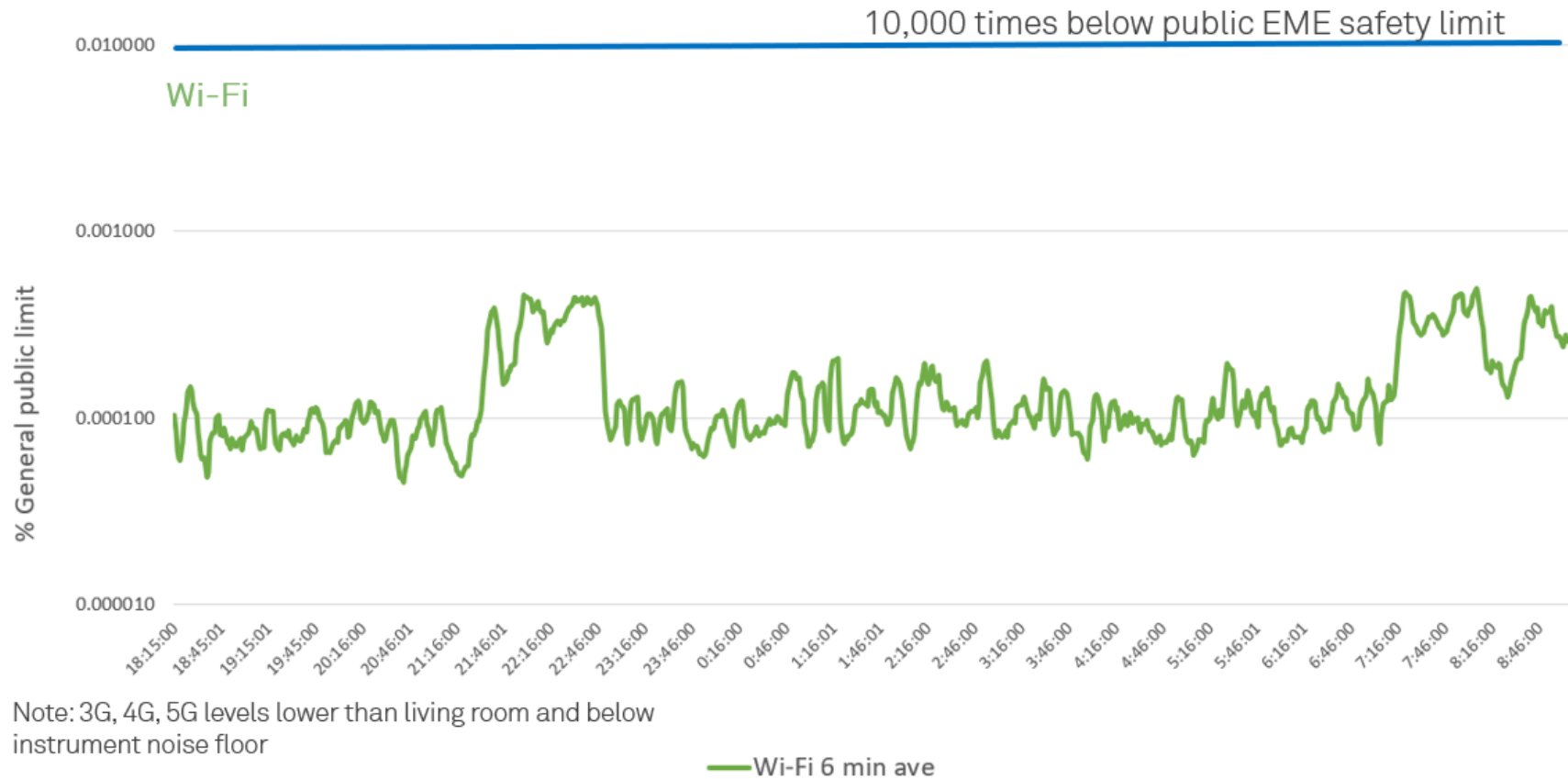**Graph 1 – 6-minute average EME levels Living Room (Friday/Saturday)**
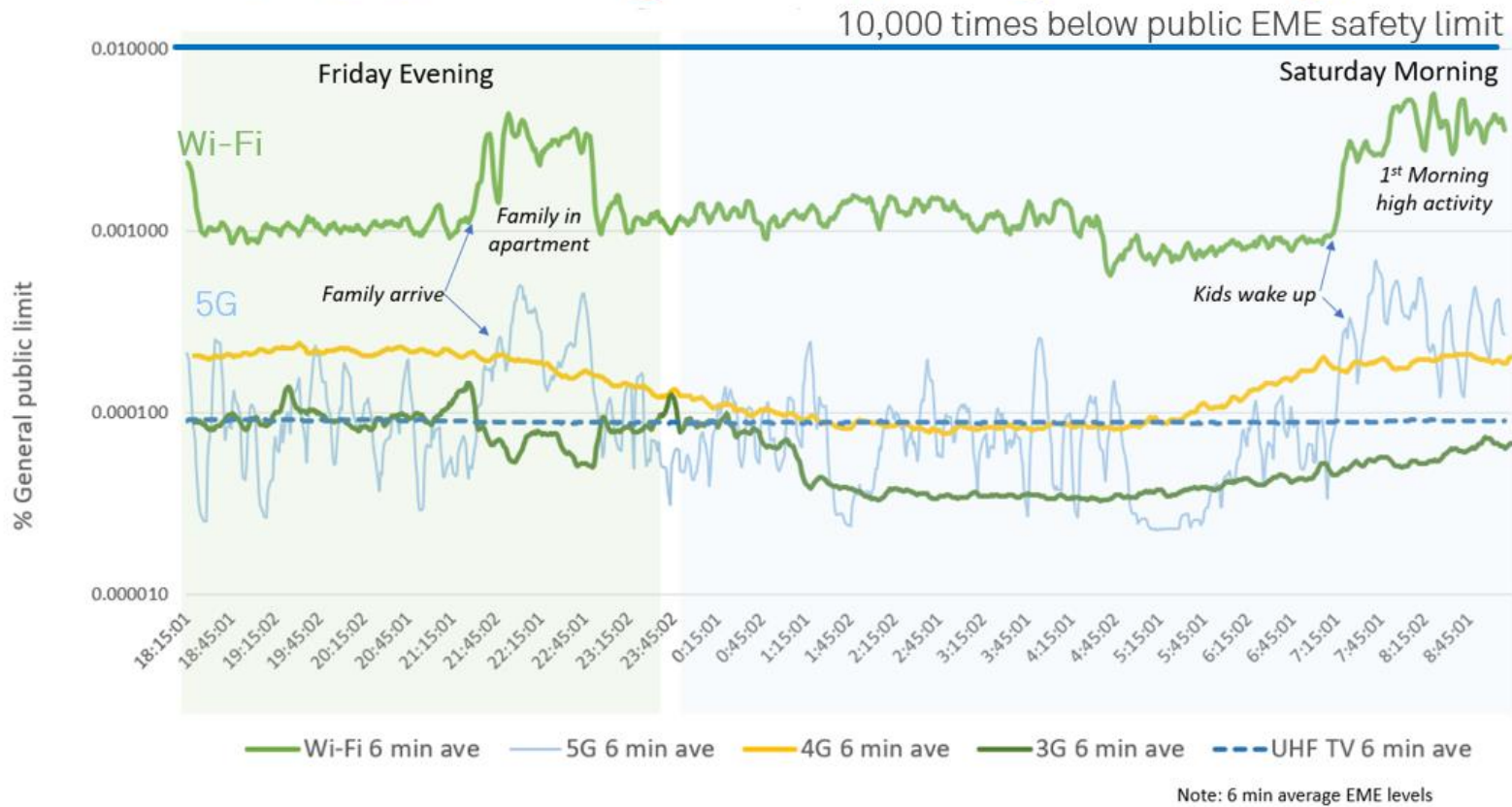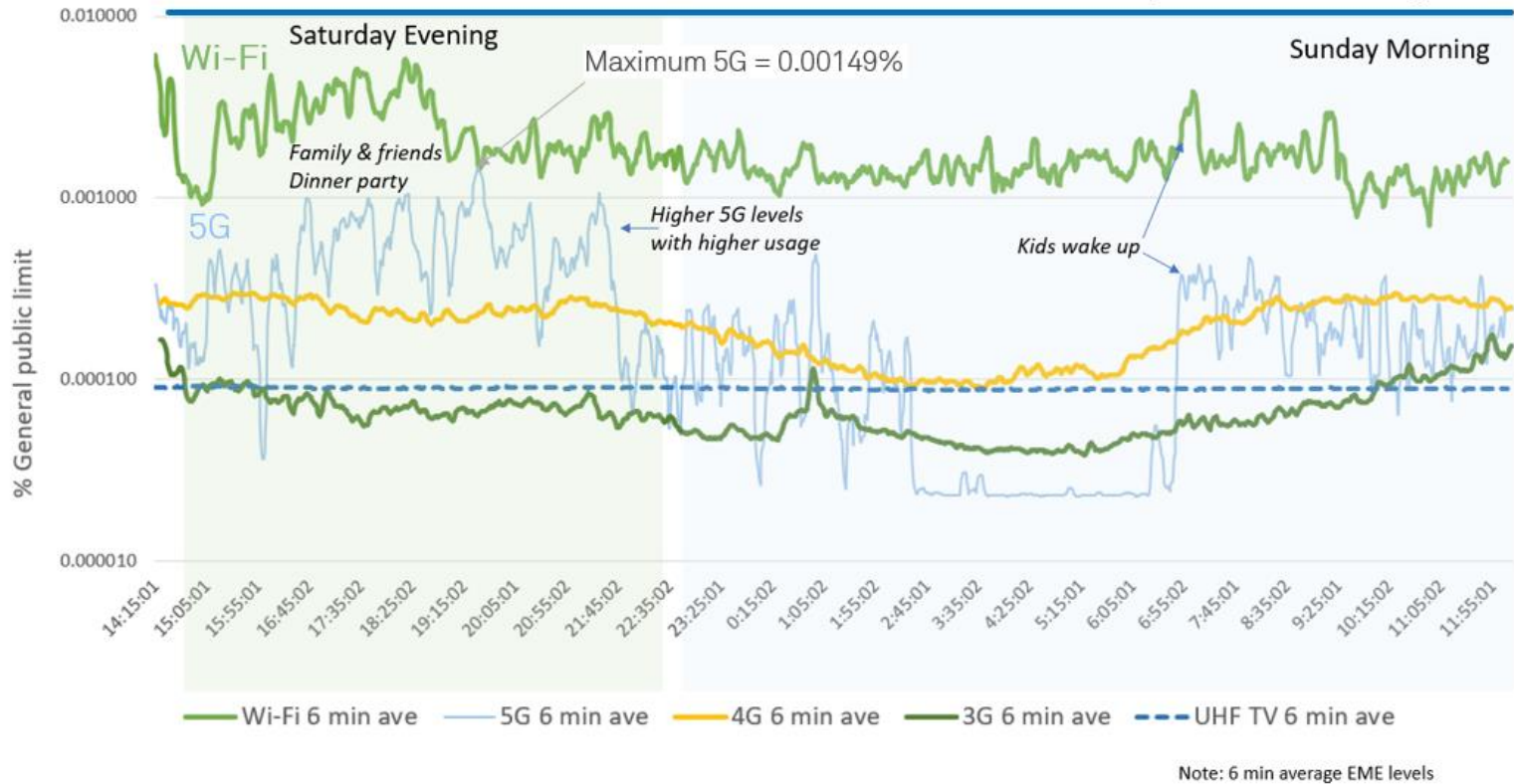
Graph 2 – 6-minute average EME levels Media Room (Friday/Saturday)

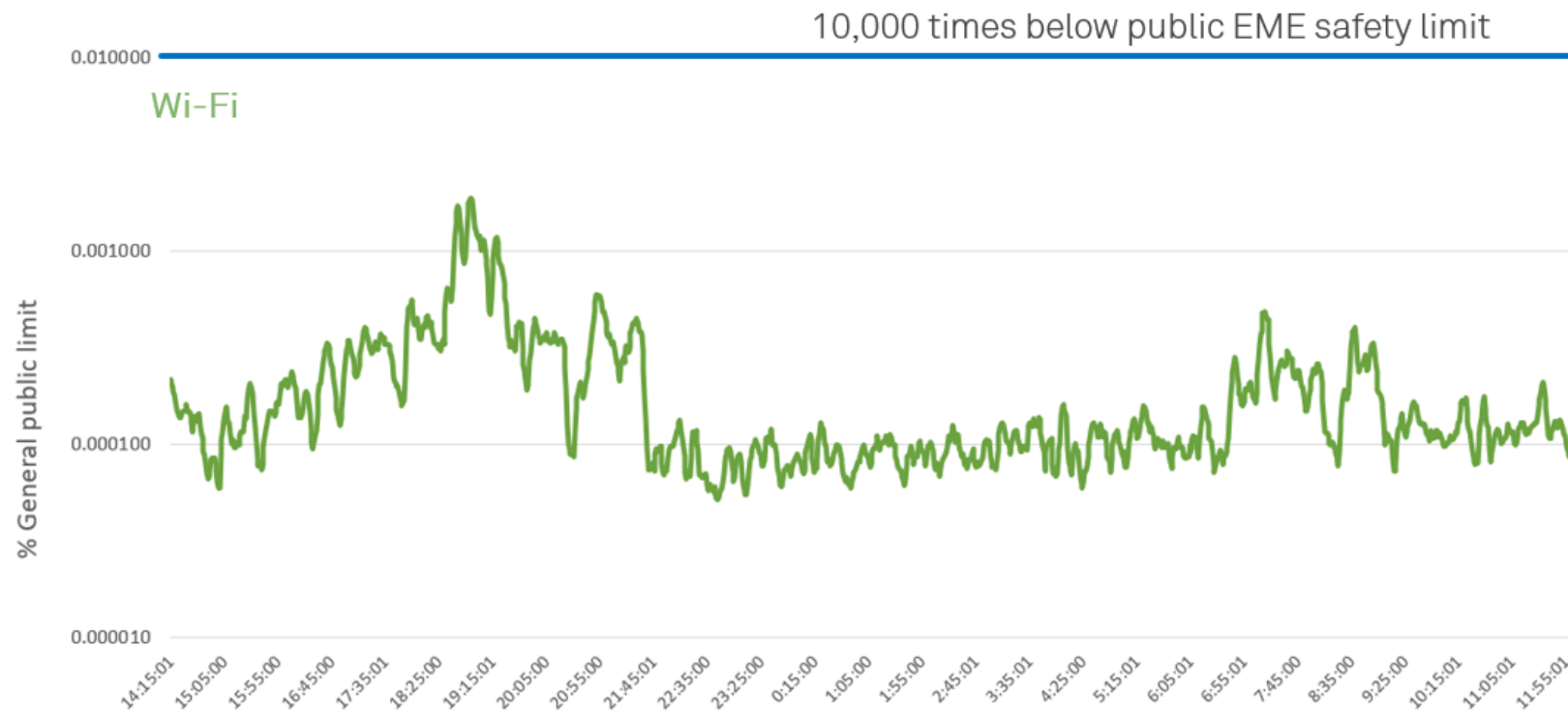**Graph 3 – 6-minute average EME levels Living Room (Saturday/Sunday)**

EME Levels – Living Room (Saturday/Sunday)
10,000 times below public EME safety limit

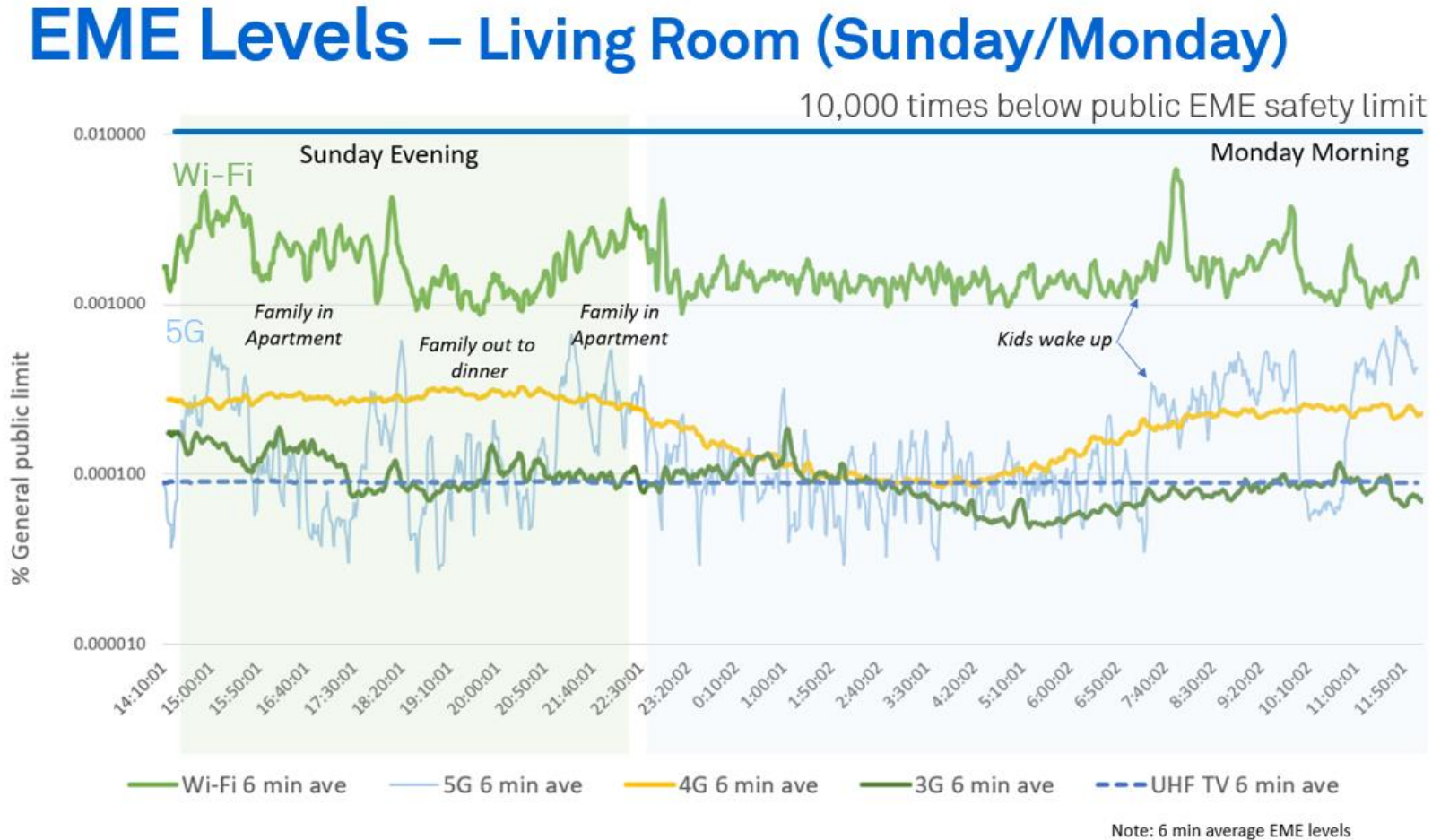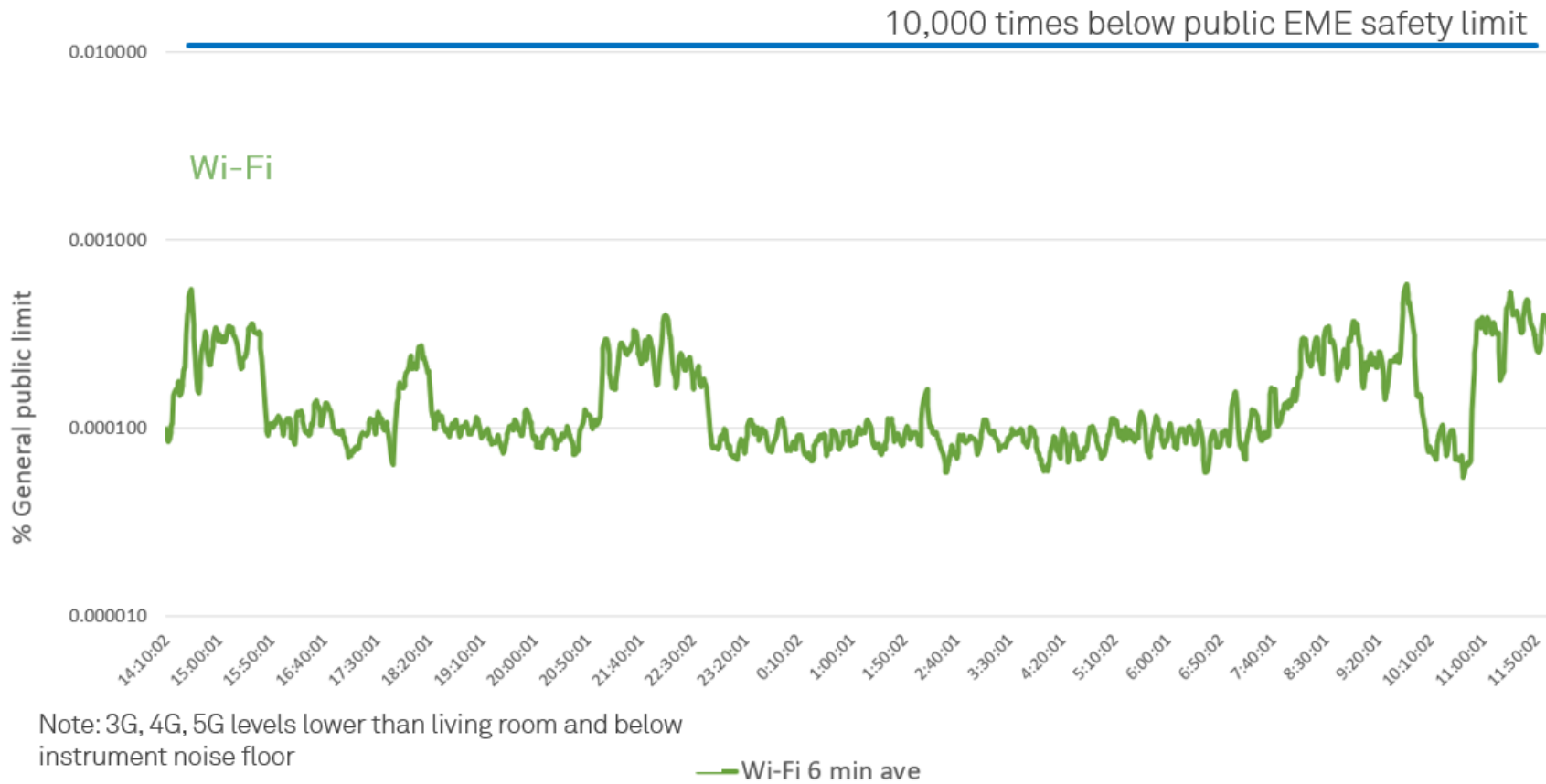**Graph 4 – 6-minute average EME levels Media Room (Saturday/Sunday)**

Graph 5 – 6-minute average EME levels Living Room (Sunday/Monday)

Graph 6 – 6-minute average EME levels Media Room (Sunday/Monday)

EME Levels – Media Room (Sunday/Monday)

7.3   Individual Device RF EME Measurements

In addition to the measurements in the main living areas from mobile technologies and Wi-Fi, individual device measurements were also conducted in close proximity (20cm) to the devices in accordance with the ACEBR EME in Homes Survey Protocol – 2019 (refer Annex C). The results are presented in Table 6 below showing the average and the maximum value.

The device with the highest average EME level was 0.813% for the baby monitor camera.

The device with the lowest average EME level was 0.000009% for a smart light.

Table 6   **Measured RF EME Levels - Individual Devices**

Device Measured	% RPS3 GP Limit	
	Average (one-minute)	Maximum
HTC Wi-Fi 2.4GHz	0.00379	0.222
Chromecast	0.00452	0.858
Smart Plug	0.00014	0.022
Google Home	0.00142	0.322
Google Home - Nest	0.00094	0.178
Google Mini	0.00111	0.353
Smart Power Board	0.00008	0.00763
Smart Light	0.000009	0.0015
Wi-Fi Extender	0.00698	0.382
Camera Doorbell	0.00273	0.541
Security Camera	0.000061	0.0174
Baby Monitor - Camera	0.813	49.09
Baby Monitor - Screen	0.055	8.97

8. Summary

This report presents results of RF EME measurements in a large modern smart apartment containing over 50 wireless devices that provide connectivity over 5G connected Wi-Fi, and 5G and 4G mobile networks. EME testing was conducted while a family of 4 people was staying in the apartment over a 4-day period including a dinner party where the family and guests (including 4 teenagers) specifically utilised the devices in very high activity modes.

The highest 5G EME levels inside the apartment were recorded during the dinner party and were 0.00149% of the ARPANSA EME general public exposure limits.

The highest Wi-Fi EME levels also occurred during the dinner party and were 0.006 % of the ARPANSA EME general public exposure limits.

The measured levels of RF EME at all the selected locations inside the apartment, were over 10,000 times below the general public exposure limits (Table 1) specified by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) Radiation Protection Standard – Maximum Exposure Levels to Radiofrequency Fields – 3 kHz to 300 GHz (RPS 3). See graph 7 summary of results.

8.1 Background RF EME Levels

Measurements were conducted inside the apartment living room and on the apartment front and rear balconies to determine the background EME levels that are present before the smart apartment was active.

The background EME levels recorded on the front balcony from the environmental 3G, 4G and 5G mobile services was 0.0032% averaged over 1 minute and a peak EME level of 0.0083%.

The front balcony measurements for the combined Optus and Vodafone EME levels are approximately 65% of the all carriers one-minute average total and 82% of the all carriers peak total. This was due to the close proximity of the adjacent Optus and Vodafone base stations.

Background levels recorded inside the apartment were approximately 10 times lower than levels outside on the balconies.

The highest background recorded level was FM radio on the rear balcony. The one-minute average level was 0.0089% and the peak over the same minute was 0.014% of the GP limit. A frequency spectrum measurement was not recorded for this FM transmission, so the precise frequency and radio station was not identified.

The front balcony recorded FM levels of 0.00013% for one-minute average and 0.00023% for peak, approximately 60 times lower than the rear balcony. See graph 7 summary of results.

8.3 Individual Device Measurements

In addition to the EME measurements in the main living areas from mobile technologies and Wi-Fi, individual device measurements were also conducted in close proximity to the devices.

The one-minute average and maximum RF EME level for a number of individual devices was measured following the ACEBR EME in Homes Survey Protocol – 2019 (refer Annex C).

The device with the highest measured average EME level was 0.813% for the baby monitor camera.

The device with the lowest measured average EME level was 0.000009% for a smart light.

The measured levels of RF EME for the selected devices, were below the general public exposure limits (Table 1) specified by the Australian Radiation Protection and Nuclear Safety Agency (ARPANSA) Radiation Protection Standard – Maximum Exposure Levels to Radiofrequency Fields – 3 kHz to 300 GHz (RPS 3).
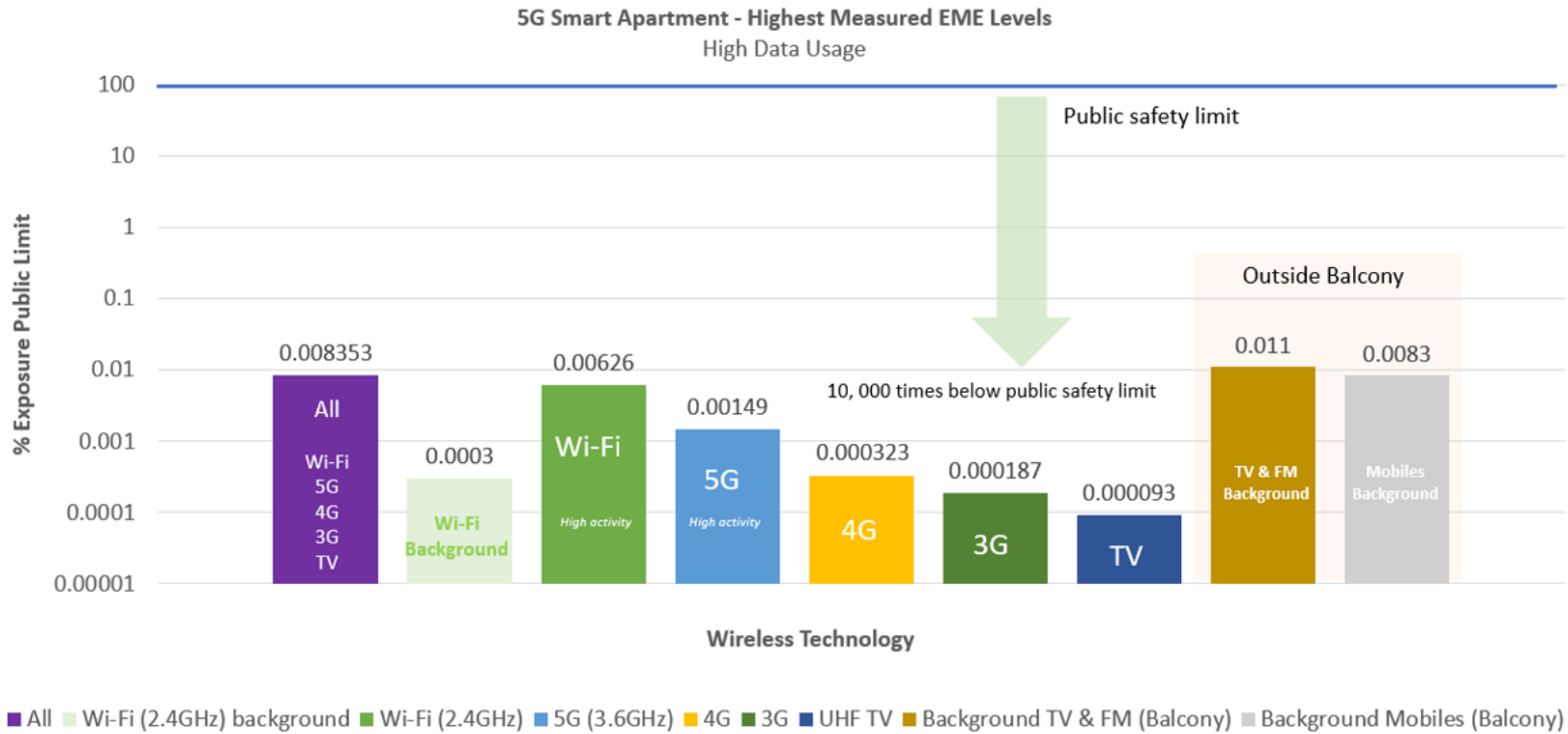
Graph 7 – Summary of Results

APPENDIX A - Glossary and Abbreviations

ARPANSA RPS3 General Public Limit	Current Australian Radiation Protection Standard limits (reference levels) for continuous exposure of the general public to radio frequency transmissions.
Broadcast	Public transmission services such as radio and TV.
LTE	Long Term Evolution
Power Density	The amount of electromagnetic energy flowing through a given area.
P-CPICH	Primary Common Pilot Channel
Radio Frequency Electromagnetic Energy (RF EME)	RF EME is the radio waves generated by transmitting devices such as antennas.
RS	Reference Signal
WCDMA	Wideband Code Division Multiple Access
NR	New Radio
RFNSA	Radio Frequency National Site Archive www.rfnsa.com.au

APPENDIX B - Devices

Device	Quantity	Identifier	Wi-Fi	Bluetooth	Technology
Mobile phone	4	A			5G
Mobile phone	9	A			4G
Laptop	6	B	Y		
Wireless keyboard and mouse	3	C		Y	
iPad	4	D	Y		
Google home	1	E	Y		
Google nest hub	1	E2	Y		
Google mini	3	F	Y		
Doorbell	1	G	Y		
Camera	1	H	Y		
Gaming console	1	I1	Y		
Gaming controller	1	I2		Y	
Wireless headset	3	J		Y	
Apple TV	1	K	Y		
Wi-Fi router – HTC 5G Hub	3	L			5G
Smart watches	3	N			
Smart lights	2	O	Y		
Smart plug	1	P	Y		
Kasa Smart Wi-Fi Power Strip	1	Q	Y		
Vitamix Perfect Bake smart scales	1	S	Y		
Airpods	1	T		Y	
Chromecast	3	R	Y		
Speaker	2	U		Y	
Wi-Fi extender	1	V	Y		
	57				

Additional devices

Microwave	1	X	Fixed in apartment
Baby monitor with video	1	Y	
Smart Fridge	1		At 5GIC

APPENDIX C - ACEBR Measurement Protocol

ACEBR EME in Homes Survey Protocol - 2019

Introduction

The following section outlines the general research protocol that should be followed by personnel in conducting a survey of wireless devices in a 20 home sample of Australian homes in accordance with the agreement between the consultant and the Australian Centre for Electromagnetic Bioeffects Research (ACEBR). Adherence to this protocol should ensure that sufficient and accurate data is recorded at each site so that ACEBR can complete an analysis of the data and produce findings which contribute to a better understanding of the exposure experienced by members of the general public from the radiofrequency devices in their own homes. The methodology below provides a general guide to the sequence of steps that should be undertaken for each survey, although minor adjustments to this order of proceedings may be made to suite the particular requirements at each site. Any significant departure from this methodology must be recorded in comments included in the reporting tool, providing details of what was done and why.

Methodology

- Use the measurement reporting tool to record all relevant household details including:
    - Number of occupants
    - Type of structure – i.e. brick, roof type, window coverings etc
    - Orientation of structure
    - An audit of the RF emitting devices and their location in the home
    - Proximity to RF transmitting infrastructure (i.e. mobile base stations)
    - Details of all RF measurements taken in the home

- For each RF measurement taken, two measurement values should be recorded:
    - An averaged value (over 1 minute) to allow integration over the signal band
    - The peak RMS value(s) over the band

- Undertake individual measurements for each and every RF device identified above.
    - Measurements will be taken at 0.20 m in a direct line from the device, with other mobile devices, such as mobile phones, switched off, or if this is not possible, being away from the measurement point (> 2 m)
    - Orientation of devices should be noted

- Undertake a measurement for a few devices operating simultaneously in a 'typical working desk' condition
    - RF should be measured at 1.2m (estimated sitting head height) at the normal location of the desk occupant
    - The distances from the devices to the measurement point should be noted

- Undertake a full background measurement (full spectrum, at least 27 MHz – 3 GHz) at a reference location in the home (e.g. lounge room or living room, with the intention to use the same reference location at all sites)
    - The background measurement should be conducted with all devices switched off, or where this is not possible, mobile devices removed from the room, or at least 2 m from the measurement point
    - The background measurement should then be repeated with all devices that have typical duty cycles which are not short compared to the measurement time (i.e. do not include transiently transmitting devices such as remote controls), in operation either at their normal location (where this is fixed) or in the room but > 2 m from the measurement point

- Undertake a full background measurement (full spectrum, at least 27 MHz – 3 GHz) at a reference location outside the home (e.g. backyard, with the intention to use the same reference location at all sites)
  - The background measurement should be conducted with all devices switched off, or where this is not possible, mobile devices at least 2 m from the measurement point
  - The background measurement should then be repeated with all devices that have typical duty cycles which are not short compared to the measurement time (i.e. do not include transiently transmitting devices such as remote controls), in operation either at their normal location (where this is fixed) or in a location inside the home which is > 2 m from the measurement point

- External source (background) measurements will be recorded as measured at the time of the survey and not time averaged (except for as noted above). Integration over a band of signals will be performed

- All devices will be measured whilst at normal operating levels (e.g. *upload* video using Wi-Fi, microwave oven at full power with a glass of water, mobile phone *transmitting* voice)

- Devices may have various modes of transmitting (e.g. mobile phones may transmit in both voice and data modes), Measurements with the device in each possible mode will be performed

- Provide tabulated scans/plots of all survey results taken

- Provide a report with data break-up in Excel

RF emitting devices at home	
Remote control for garage door	Cordless headset
Mobile Phone (on speaker mode, speaking to it; and in different data modes where applicable)	Microwave Oven (Full Power: with a glass of water in it when measured)
Router for wireless internet	Baby Monitor
Laptops with Wi-Fi	Air-conditioning/Heating Remote
Cordless Phone	Wireless Doorbells
Wireless Security System	TV re-broadcaster
Cordless Keyboard/Mouse (Bluetooth)	Cordless game device (NOT infra-red)
Others	Car remote control

APPENDIX D - Photos - Background Measurements

Photo 1 – Front Balcony

Photo 2 – Rear Balcony

Photo 3 – Living Room

APPENDIX E - Photos – Apartment Devices

Smart Plug

TP-Link Kasa Smart Wi-Fi Power Strip HS300

Perfect Bake Pro Smart Scales

Smart Lights x 2

Perfect Bake Pro Smart Scales

Google Home

Google Nest Hub Max

Google Mini x 3

Doorbell

Camera

Wi-Fi Extender

Smart Watches x 3

Mobile Phones, Laptops, Keyboard, Mouse

Wi-Fi Router (HTC) x 3

Speakers x 2

Gaming Console, Controller and Headset

Gaming Console, Controller and Headset