# Global mobile Suppliers Association

## Response to Australian Communication and Multimedia Authority's consultation on 26 GHz (25.1–27.5 GHz) band spectrum licence technical framework

Created: 21-08-2020

Version: 1.0

The Manager
Spectrum Management Outlook and Strategy Section
Australian Communications and Media Authority
PO Box Q500
Queen Victoria Building NSW 1230
Australia

Email: SpectrumAllocations@acma.gov.au

# GSA[1] response to Australian Communication and Multimedia Authority's consultation on the 26 GHz (25.1–27.5 GHz) band spectrum licence technical framework

The GSA submitted general information related to the deployment of 5G in the 26 (and 28 GHz) bands in its response to the ACMA's consultation on *the Draft Five Year Spectrum Outlook 2020 – 2024*. In this response to the *Draft allocation instruments for the 26 GHz (25.1–27.5 GHz) metropolitan and regional lots auction Consultation paper* (herein referred to as the "26 GHz Allocation Consultation") and the *26 GHz (25.1–27.5 GHz) band spectrum licence technical framework consultation document* (herein referred to as the "26 GHz Technical Consultation") the GSA focusses on technical band planning issues and specific technical conditions applicable to licensed 5G operations in order to maximise the utility of the subject spectrum (and hence provide the greatest economic and social value to Australia), whilst also affording sufficient protection to the operation of other Radiocommunications services. If the ACMA requires any clarification to this response, please do not hesitate to contact:

Alex Orange (aorange@qti.qualcomm.com), GSA AUS/NZ group coordinator.

## Introduction

The GSA is pleased that the ACMA is following up its licensing of low band (< 3 GHz), mid band (< 7 GHz) spectrum suitable for 5G deployment and service delivery with the planned allocation and licensing of high band spectrum in the 26 GHz and 28 GHz bands. This combination of low, mid and high band spectrum will assist the full range of 5G use cases to be realised in Australia.

---

[1] *The GSA (Global mobile Suppliers Association, https://gsacom.com) develops strategies and plans, and contributes studies and technical analysis to international, regional and individual country policymakers and regulators to facilitate the timely availability of spectrum for use by mobile network operators. GSA has a focus group for spectrum topics for technical and regulatory matters of radio spectrum pertaining to the successful evolution of International Mobile Telecommunication (IMT) and associated radiocommunication systems and comprises a team made up of spectrum and regulatory affairs specialists from GSA Executive Member and GSA Member companies. In addition, GSA reports regularly on global spectrum developments.*

The GSA is looking forward to the prospect of licensed spectrum supporting mmWave 5G deployments in late March 2021 as indicated in the 26 GHz Allocation Consultation. GSA applauds the progress made to date and appreciates the ACMA's facilitation of the process to seek a consensus for the technical conditions around spectrum licensing in the 26 GHz via the Technical Licensing Group (TLG) process. Furthermore, GSA appreciates the ACMA publishing the results of the TLG process and subsequently consulting publicly on the technical framework and details.

## Comment

In this submission the GSA provides its views on the ACMA's two public consultations on the 26 GHz bands.

26 GHz Allocation Consultation

The ACMA's publication of this consultation paper is a welcome step towards releasing the spectrum for use in Australia as the 5G NR ecosystem for the 26 GHz and 28 GHz bands is developing rapidly. By end-July 2020, GSA had identified[2]:

- eighteen announced form factors (phones, head-mounted displays, hotspots, indoor CPE, outdoor CPE, laptops/notebooks, modules, snap-on dongles/adapters, industrial grade CPE/routers/gateways/modems, drones, robots, tablets, TVs, cameras, USB modems, a switch, a vehicle OBU and a vending machine).
- ninety-one vendors who had announced available or forthcoming 5G devices.
- three hundred and sixty-four announced devices (including regional variants, and phones that can be upgraded using a separate adapter, but excluding operator-branded devices that are essentially rebadged versions of other phones),
- including 162 that are understood to be commercially available:
  - one hundred and sixty-two phones, (up 27 from June), at least 113 of which are now commercially available (up 18 in a month). Includes three phones that are upgraded to offer 5G using an adapter.
  - ninety-four CPE devices (indoor and outdoor, including two Verizon-spec compliant devices not meeting 3GPP 5G standards, and enterprise grade CPE/routers/gateways).
  - fifty-five modules.
  - twenty-three hotspots (including regional variants).
  - five laptops (notebooks).
  - twenty-five other devices (including drones, head-mounted displays, robots, snap-on dongles/adapters, a switch, tablets, TVs, USB terminals/dongles/modems, cameras, a vehicle OBU and a vending machine).

[2] 5G Devices Member Report August 2020, GSA

GSA has identified some spectrum support information for just over 81% of all announced devices: 75.5% of all announced 5G devices are identified as supporting sub-6 GHz spectrum bands while 22.3% are understood to support mmWave spectrum.

We can expect the device ecosystem to continue to grow quickly and for more information about announced devices to become available as they reach the market. Based on vendors' previous statements and recent rates of device release, we might expect to see the number of commercial devices approaching the 200 mark by the end of Q3 2020.

From an ecosystem development perspective, it is timely for the ACMA to set the date of its auction in March 2021 as this provides a clear signal not only to national mobile network operators and their vendors but also to overseas operators, vendors and other regulators about the importance of high-band spectrum to the overall delivery of 5G.

Indeed, in Europe the EC Italy and Finland have already licensed the 26 GHz band and Germany, Greece, Slovenia, Poland and the UK. To ensure that European Administrations licensing proceeds in a harmonized way the European Communications Office has issues ECC decision (18)06[3] and the European Community has issues implementing Decision (EU) 2018/784[4].

Setting the license duration 15 years provides certainty to operators to achieve a return-on-investment for their large-scale investments in spectrum, infrastructure, equipment and their ongoing operations and consumer's investments in devices. The GSA supports a 15-year license duration.

3GPP has standardized carrier bandwidths for FR2 (mmWave) spectrum at 50, 100, 200, 400 MHz and the ACMA's choice a frequency arrangement of 12 x 200 MHz channels is a sensible compromise between allowing bidders a choice of bandwidths to meet their operational needs whilst also ensuring the utility of mmWave deployments to deliver enhanced mobile broadband (eMBB) services.

Under agenda item 1.13 WRC-19 considered the band 24.25 – 27.5 GHz and globally identified it for IMT. The WRC also reached a compromise decision to protect, using out of band emission limits (OOBE), adjacent band services including the EESS (passive) in the 24 GHz range. The protection of these services is predicated on regulators having knowledge and control over IMT deployments in the band above 24.25 GHz. This knowledge and control are usually achieved by recording deployments and associated parameters, licensing the services and if necessary, compliance and enforcement activities. It is difficult to see how this can be achieved using class licence (similar to that employed for Low Interference Potential Devices or LIPDs), which although may contain conditions and restrictions on the deployment under which use is authorized, does not lend itself to the recording of actual deployments and parameters. Furthermore, if interference into the EESS (passive) is noticed it is likely to be caused by the aggregate out of band power from multiple devices. which further exacerbates tracing the origin(s) of the interference and how and where to take compliance and enforcement action. Taking the latter point to its conclusion once a band has been authorized via a class license and deployments have occurred it is very difficult to undo.

[3] https://www.ecodocdb.dk/download/5e74d0b8-fbab/ECCDec1806.pdf
[4] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019D0784&from=EN

No other Administration has implemented/contemplated class licensing or its alternation license exemption in this spectrum, indeed Finland has chosen to implement localised administrative licenses to ensure closer control of the interference scenario at the lower edge of the 26 GHz band.

For the reasons outlined in two preceding paragraphs above GSA cautions the ACMA about implementing a class licensing regime at the lower edge of the 26 GHz band. It would be prudent to delay consideration of a class license until more information is available on the large-scale deployment of spectrum and apparatus licensed mmWave 5G services in Australia.

<u>26 GHz Technical Consultation</u>

The GSA is pleased to note that the **out-of-band core conditions** [page 9 of the 26 GHz Technical Consultation] are to be aligned with the unwanted emission limits of international equipment standards, this in the GSA's view, refers to the limits contained in 3GPP Release 15 specifications. Furthermore, the GSA welcomes; the ACMA's decision to align fully with the outcome of WRC-19 unwanted emission limits to protect passive earth exploration satellite services (EESS) in the adjacent 23.6 – 24 GHz band, and importantly that higher unwanted emissions are permitted in the frequency range 24.7–29.5 GHz range if agreement can be reached with affected spectrum and apparatus licensees.

The GSA is concerned about the application of complex and restrictive license conditions that may inhibit network planning, deployment and/or operation in practice. However, the GSA believes it is preferable to adapt such conditions instead of being constrained by excessively conservative limits. The GSA also recognizes that this topic has enjoyed considerable debate in Australia and some form of restriction may be required for to satisfy FSS operators that harmful interference to their services does not occur. On the other hand, TRP limits and EIRP masks will have a technical impact on achievable 5G coverage and capacity, and this will have flow on financial implications to network capex and opex which will eventually be passed on to consumers.

The above paragraph notwithstanding in relation to the ACMA's proposed **out-of-area core condition** total radiated power (TRP) limits (see page 10 of the 26 GHz Consultation) the GSA believes that restriction of TRP is unnecessary and will restrict innovation, if other suitable mitigation measures are in place and this is also the outcome of the deliberations of the European Communications Office and European Community [see references in the section above.

Furthermore, in support of the claim that TRP restrictions are not required the preliminary results of a GSA study currently being undertaken shows that TRP restrictions are unnecessary (see summary below). The GSA will provide the finalized study to the ACMA as soon as it is finalized.

> Summary of GSA co-existence study in band 26/28 GHz
>
> The study was conducted based on the simulation methodology in ITU-R Sharing and Compatibility of the FSS and IMT operating in the 24.25-27.5 GHz Frequency Range and 3GPP 37.840: Study of Radio Frequency (RF) and Electromagnetic Compatibility (EMC) requirements for Active Antenna Array System (AAS) base station. The GSA study included the scenario of Interference from 5G station to Space Station in the band between 27.5 to 29.5 GHz.

The methodology used in this study follows guidance of Recommendation ITU-R M.2101.

Please find the GSA Sharing Study in Appendix –A, and the results immediately below.

**Results of this sharing study – calculated protection margins**

| | Perth | | |
|---|---|---|---|
| | **Margin (dB) (for a protection criterion of –6 dB I/N)** | **Margin (dB) (for a protection criterion of –10 dB I/N)** | **Margin (dB) (for a protection criterion of –12.2 dB I/N)** |
| **90 percentile cdf** | **21.4 dB** | **17.4 dB** | **14.8 dB** |
| **Maximum interference** | **13.4 dB** | **9.4 dB** | **7.2 dB** |

**Table 10 : Interference at space station at 5G**

We have conducted a simulation at 49 dBm/200 MHz TRP level with 16x16 antenna array configuration (Maximum EIRP 78 dBm/200 MHz). Simulation has considered practical, yet stringent condition in term of TRP off-axis towards space station, within beam view of Space station and found Maximum 21.4 dB of interference margin. We may consider further studies and practical deployment to further provide additional 7-9 dB of interference margin.

We have seen very high interference margin available as mentioned in table above, such margin can be further improved with practical deployment. We therefore, propose not to have any TRP limit at base station, which would limit the base station operation and will make 5G deployment economically challenged without any benefit to interference at space station. Such limit would result in inefficient use of spectrum.

In conclusion the GSA notes that its study above shows that aggregate interference from 5G deployments is far below the thresholds required to cause harmful interference to FSS (earth-Space) reception in 27.0 – 27.5 GHz, and shows that restrictions on the deployment of 5G in the 26 GHz band can be minimal. Furthermore, as the cases examined above represent the most restrictive scenario outlined in the 26 GHz technical framework consultation, being **27–27.5 GHz inside gateway footprint areas,** even more aggressive relaxations of restrictions on 5G base stations can be contemplated in the scenario **27–27.5 GHz outside gateway footprint areas** and **25.1–27 GHz all areas**.

As the least restrictive conditions that have been decided by international consensus are those that were arrived at during WRC-19 and are contained in ITU-R Resolution 242 (WRC-19) the GSA recommends that these are used for authorizing 5G operations in Australia.

When considering the issue of coordination of services under the auspices of the Radio Regulations, WRC-19 (Doc WRC-19/550), and later confirmed by the CPM23-1, the ITU-R WP5D is the responsible group and the WPs 4A, 4C, 5A, 5C, 7B and 7C are interested groups, to study as a matter of urgency “the applicability of the limit specified in No. 21.5 of the Radio Regulations to IMT stations, that use an antenna that consists of an array of active elements, with a view to recommend ways for its possible replacement or revision for such stations, as well as any necessary updates to Table 21-2 related to terrestrial and space services sharing frequency bands. Furthermore, the ITU-R is invited to study, as a matter of urgency, verification of No. 21.5 regarding the notification of IMT stations that use an antenna that consists of an array of active elements, as appropriate."

This task has been considered in the two WP5D meetings that have been held after the WRC-19 without agreement. Furthermore, further clarification is needed from BR in written form to what type of technical studies/information and objective of the studies from WP 5D.
Therefore, it is the view of GSA that any type of interpretation or use of No 21.5 related to implementation of 5G/IMT-2020 is immature at this stage and should not be considered for a regulatory framework in any way until this work has been agreed and approved in ITU-R WP5D.

On a separate point, as the out-of-area core conditions are not allowed to be varied by mutual agreement between the spectrum licensee and an affected party it means they would remain in place for the 15-year duration of the spectrum license. Considering the uncertainties in predicting future 5G deployments, improvements in antenna technology and operations the ACMA should consider allowing variations by mutual agreement of all affected parties to the conditions.

In relation to the ACMA's proposals in the 26 GHz technical consultation for statutory spectrum license conditions involving the registration of transmitters and devices exempt from registration, the GSA agrees to the ACMA's proposals that:

- Spectrum licensed transmitters are to be registered before they can be operated, unless specifically exempt.
- The following transmitters are exempt from registration:
  - transmitters with a TRP less than or equal to 23 dBm per occupied bandwidth
  - transmitters located indoors
  - fixed transmitters that are not base stations and operate with a TRP greater than 23 dBm and less than or equal to 35 dBm per occupied bandwidth

## Conclusion

The GSA thanks the ACMA for its open, consultative approach towards allocation of 26 GHz spectrum. In this paper the GSA provides justifications for the ACMA to:

- avoid implementing class licensed operations in the band 24.25–25.1 GHz GHz
- adopt the least restrictive licensing conditions for 5G in the 25.1 – 27.5 GHz, specifically to not specify an in-band TRP restriction, and to rely on ITU-R Resolution 242 (WRC-19) for coexistence with satellite services
- allow variations by mutual agreement of certain out-of-area core conditions.

In closing, the GSA urges the ACMA to address the remaining issues associated with the 26 GHz band and to proceed to auction as scheduled at the end of March 2021.

Contact:

Joe Barrett
President of GSA
Email: joe.barrett@gsacom.com

Alex Orange
Chair of GSA AUS/NZL Group coordinator
Email: aorange@qti.qualcomm.com

# Appendix A

## 1 Introduction

In this study, we have assumed earth station is pointing towards space station and evaluated interference originated from 5G stations within beam view of space station.

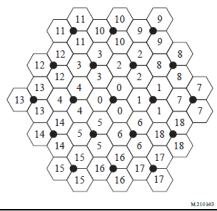
## 2 Technical characteristics

This section provides the specific parameters used in the included study/studies, as provided by the contributing groups to TG 5/1.

### 2.1 Technical and operational characteristics of IMT systems

Technical and operational characteristics of IMT systems operating in the 24.25-27.5 GHz frequency range

| **IMT-2020 parameters used in this sharing study. Parameters have been taken from Attachment 2 to Document 5-1/36 (noting that parameters not relevant to this study set have been omitted).** | **Suburban** | | **Outdoor urban hotspot** | **GSA Study** |
|---|---|---|---|---|
| | **Outdoor suburban open space hotspot[2]** | **Outdoor suburban hotspot** | | |
| **Base station characteristics/Cell structure** | | | | |
| Network topology and characteristics | 1 BS/km$^2$ | 10 BSs/km$^2$ | 30 BSs/km$^2$<br><br>NOTE 1 | 30 BSs/km$^2$ |

| **IMT-2020 parameters used in this sharing study. Parameters have been taken from Attachment 2 to Document 5-1/36 (noting that parameters not relevant to this study set have been omitted).** | **Suburban** | | **Outdoor urban hotspot** | **GSA Study** |
|---|---|---|---|---|
| | **Outdoor suburban open space hotspot[2]** | **Outdoor suburban hotspot** | | |
| Frequency reuse[5] | 1 | 1 | 1 | 1 |
| Antenna height (radiation centre) | 15 m (above ground level) | 6 m (above ground level) | 6 m (above ground level) | 6m (above ground level) |
| Sectorization | Single sector20% | Single sector | Single sector |  |
| Downtilt | 15 degrees | 10 degrees | 10 degrees | 10 degrees |
| Antenna deployment | At the edge of the roof | Below roof top | Below roof top | NA |
| Network loading factor (Average base station activity) | 20% | | 20% | 20% |
| BS TDD activity factor | 80% | | 80% | 80% |
| 1 Antenna characteristics | | | | |
| 1.1 Antenna pattern | Refer to Recommendation ITU-R M.2101 | | | TR.37.842 |
| 1.2 Element gain (dBi) | 5 | | 5 | 5 |
| 1.3 Horizontal/vertical 3 dB beamwidth of single element (degree) | 65° for both H/V | | 65° for both H/V | 65° for both H/V |

[5] Frequency reuse of 1 indicates that the same frequency is used in each sector and each cell.

| IMT-2020 parameters used in this sharing study. Parameters have been taken from Attachment 2 to Document 5-1/36 (noting that parameters not relevant to this study set have been omitted). | | Suburban | | Outdoor urban hotspot | GSA Study |
|---|---|---|---|---|---|
| | | Outdoor suburban open space hotspot[2] | Outdoor suburban hotspot | | |
| 1.4 | Horizontal/vertical front-to-back ratio (dB) | 30 for both H/V | | 30 for both H/V | 30 for both H/V |
| 1.5 | Antenna polarization | Linear ±45° | | Linear ±45° | Linear ±45° |
| 1.6 | Antenna array configuration (Row × Column)<br><br>NOTE 2 | 8×8 elements | | 8×8 elements | 16 x16 |
| 1.7 | Horizontal/Vertical radiating element spacing | 0.5 of wavelength for both H/V | | 0.5 of wavelength for both H/V | 0.5 of wavelength for both H/V |
| 1.8 | Array Ohmic loss (dB) | 3 | | 3 | 3 |
| 1.9 | Conducted power (before Ohmic loss) per antenna element (dBm/200 MHz) | 10 | | 10 | 24.91 |
| | TRP | | | | 49 dBm/200 MHz |
| | Max EIRP | | | | 78 dBm/200 MHz |
| 1.10 | Base station maximum coverage angle in the horizontal plane (degrees) | 120 | | 120 | 65 |
| **User terminal characteristics** | | | | | |
| User equipment density for terminals that are transmitting simultaneously | | 30 UEs/km² | | 100 UEs/km² | 100 UEs/km² |
| Body loss resulting from proximity effects | | 4 dB | | 4 dB | 4 dB |
| UE TDD activity factor | | 20% | | 20% | 20% |
| 1 | Antenna Characteristics | | | | |
| 1.1 | Antenna pattern | Refer to Recommendation ITU-R M.2101 | | | |

| IMT-2020 parameters used in this sharing study. Parameters have been taken from Attachment 2 to Document 5-1/36 (noting that parameters not relevant to this study set have been omitted). | | Suburban | | Outdoor urban hotspot | GSA Study |
|---|---|---|---|---|---|
| | | Outdoor suburban open space hotspot[2] | Outdoor suburban hotspot | | |
| 1.2 | Element gain (dBi) | 5 | | 5 | 5 |
| 1.3 | Horizontal/vertical 3 dB beamwidth of single element (degree) | 90° for both H/V | | 90° for both H/V | 90° for both H/V |
| 1.4 | Horizontal/vertical front-to-back ratio (dB) | 25 for both H/V | | 25 for both H/V | 25 for both H/V |
| 1.5 | Antenna polarization | Linear ±45° | | Linear ±45° | Linear ±45° |
| 1.6 | Antenna array configuration (Row × Column) NOTE 2 | 4×4 elements | | 4×4 elements | 4×4 elements |
| 1.7 | Horizontal/Vertical radiating element spacing | 0.5 of wavelength for both H/V | | 0.5 of wavelength for both H/V | 0.5 of wavelength for both H/V |
| 1.8 | Array Ohmic loss (dB) | 3 | | 3 | 3 |
| | Atmospheric loss (dB) | | | | 3 |
| 1.9 | Conducted power (before Ohmic loss) per antenna element (dBm/200 MHz) | 10 | | 10 | 10 |
| 2 | Transmit power control | | | | |
| 2.1 | Power control model | Refer to Recommendation ITU-R M.2101 | | | M2101 |
| 2.2 | Maximum user terminal output power, $P_{CMAX}$ NOTE 3 | 22 dBm | | 22 dBm | 22 dBm |
| 2.3 | Transmit power (dBm) target | –95 | | –95 | -95 |

| IMT-2020 parameters used in this sharing study. Parameters have been taken from Attachment 2 to Document 5-1/36 (noting that parameters not relevant to this study set have been omitted). | | Suburban | | Outdoor urban hotspot | GSA Study |
|---|---|---|---|---|---|
| | | Outdoor suburban open space hotspot[2] | Outdoor suburban hotspot | | |
| | value per 180 kHz, $P_{0\_PUSCH}$ | | | | |
| 2.4 | Path loss compensation factor, $\alpha$ | 1 | | 1 | 1 |

| | |
|---|---|
| NOTE 1: The BS (sector) density must be translated into the inter-site distance (ISD) according to the network topology for use as input in Recommendation ITU-R M.2101. Dense urban environments are likely to be served by single sector small cells.<br>NOTE 2: The antenna pattern for base station or user equipment depends on the antenna array configuration and the antenna element pattern and gain. For example, the antenna array composed of 8×8 identical antenna elements with 5 dBi gain each produces a maximum 23 dBi main beam antenna gain for base stations and an antenna array composed of 4×4 identical antenna elements with 5 dBi gain each produces a maximum 17 dBi main beam antenna gain for user terminal. Antenna gain in directions other than the main beam is reduced according to the antenna model described in Recommendation ITU-R M.2101.<br>The use of antenna array configurations other than those indicated in the table above should not lead to an increase of interference to other services to which the bands are currently allocated and should not increase the e.i.r.p., by adjusting the other relevant parameters.<br>NOTE 3: Maximum user terminal output power depends on the antenna array configuration and conducted power (before Ohmic loss) per antenna element. For example, the antenna array composed of 4x4 identical antenna elements with conducted power per antenna element 10 dBm produces 22 dBm maximum user terminal output power. The reduction of maximum user terminal output power resulting from power control model is applied to each element within antenna array; i.e. conducted power (before Ohmic loss) per antenna element is reduced to same extent as $P_{PUSCH}$ reduced compared to $P_{CMAX}$. | |
| Path Loss in dB | 3D-Uma (TR 38.803) |
| Standard Deviation | 8 dB |
| Inter site correlation ρ | 0.5 |
| Intra site correlation | 1 |
| Thermal Noise (dBm/Hz) | -174 |

| IMT-2020 parameters used in this sharing study. Parameters have been taken from Attachment 2 to Document 5-1/36 (noting that parameters not relevant to this study set have been omitted). | Suburban | | Outdoor urban hotspot | GSA Study |
|---|---|---|---|---|
| | Outdoor suburban open space hotspot[2] | Outdoor suburban hotspot | | |
| Total Number of UE's | | | | 171 per cluster (57 cells/cluster and 3 active UEs per cell) |
| Thermal Noise (dBm/Hz) | | | | -174 |
| Cell Radius R (m) | | | | 100 m (ISD : R x √3 = 173.2) |
| Antenna Model | | | | AAS (Active antenna system) |

Table 1 : IMT 2020 /5G parameter and deployment used study.

The IMT-2020 density for large areas (Dl) is calculated using the equation below (sourced from Document 5-1/36). The relevant Ra and Rb values are provided in Table-2.

$$Dl = Ds * Ra * Rb$$

**Values for Ra and Rb used to calculate IMT-2020 deployment densities over large areas. Parameters have been taken from Document 5-1/36.**

| | |
|---|---|
| Ra | 7% Urban, |
| Rb | 5% |

Table 2 : Values for Ra and Rb

## 2.2 Technical and operational characteristics of FSS operating in the 24.24-27.5 GHz frequency range

**FSS satellite parameters used in this study**

| Parameter | Value | Comment |
|---|---|---|
| Antenna model | Rec. ITU-R S.672-4. Annex 1 – single feed circular beam | Document 5-1/89 |
| Antenna peak gain | 46.6 dBi | Document 5-1/89 |
| Antenna 3 dB beam width | 0.8° | |
| Noise temperature | 400 K | |
| Satellite system noise[6] | –112.6 dBm/MHz | Calculation: $\mathbf{10\log_{10}(1.38 \times 10^{-23} \times} \boldsymbol{noise\ temperature} \times \mathbf{10^{6}) + 30}$ |
| Protection criteria *I/N* | –6, –10, –12.2 dB | |
| Orbit/slot | GSO, 145°E | Assumed |
| Noise bandwidth (MHz) | 200 | 200 |
| Antenna Diameter | | 2.5 |
| Elevation Angles ( Earth Station at Pert) | | 41 degree |
| Satellite coordinates | | 145°E |
| Beam Footprint Area | | 13400 km2 |
| Max. Distance to satellite Space Station. | | 41000 km |

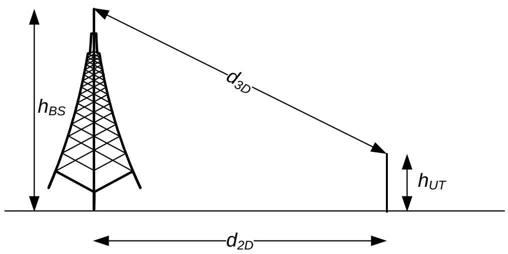
Table 3: FSS satellite parameters used in this study

# 3 Propagation models for sharing and compatibility studies in the 24.25-27.5 GHz frequency range

The following propagation model, from 3GPP document TR 38.803, was used for signal paths between IMT UE and BS:

| | | | |
|---|---|---|---|
| **UMi - Street Canyon LOS** | $PL = 32.4 + 21\log 10(d_{3D}) + 20\log 10(f_c)$ <br> $PL = 32.4 + 40\log 10(d_{3D}) + 20\log 10(f_c) - 9.5\log 10((d'_{BP})^2 + (h_{BS} - h_{UT})^2)$ | $\sigma_{SF}$=4.0 <br> $\sigma_{SF}$=4.0 | 10m < $d_{2D}$ < $d'_{BP}$ 1) <br> $d'_{BP}$ < $d_{2D}$ <5000m <br> 1.5m ≦ $h_{UT}$≦ 22.5m <br> $h_{BS}$ = 10 m |
| **UMi – Street Canyon NLOS** | $PL = \max(PL_{UMi-LOS}(d_{3D}), PL_{UMi-NLOS}(d_{3D}))$ <br> $PL_{UMi\text{-}NLOS} = 35.3\log_{10}(d_{3D}) + 22.4 + 21.3\log_{10}(f_c) - 0.3(h_{UT} - 1.5)$ | $\sigma_{SF}$=7.82 | 10 m < $d_{2D}$ < 5000m <br> 1.5m ≦ $h_{UT}$≦ 22.5m <br> $h_{BS}$ = 10 m <br> Explanations: see note 4 |

Table 4 : Propagation models for sharing and compatibility studies




**Definition of $d_{2D}$ and $d_{3D}$ for outdoor UEs**

| | |
|---|---|
| Scenario | LOS probability (distance is in meters) |
| UMi – Street canyon | Outdoor users: $P_{LOS} = \min(18/d_{2D},1)(1-\exp(-d_{2D}/36)) + \exp(-d_{2D}/36)$ |

Table 5 : LoS probability as per 38.803

# 4 Study methodology

5G Network layout is composed of multiple hexagonal grid as in [7] around the earth stations. At anytime only three UEs are actively transmitting within an active cell. The entire 5G network has assumed time synchronized, i.e. all the cells either do downlink or uplink transmission at any given observed TTI. The study was conducted based on the simulation methodology as suggested in [5] [6][7]. In this study, we have created 1 k.m. Fresnel zone around earth station and deployed 5G base stations in clusters within whole 13400 km2 beam view area of space station and interference originated from all 5G base station has measured at space station. In specific, to study the interference originated form Perth Australia, we have considered interference originated from 6600 km2 area from Perth within beam view of space station.

i) Total number of BS that are actively transmitting : 34 clusters with 218 cells/cluster

ii) All the BS transmits only in the beam pointing towards the active UE. The total transmission bandwidth is shared equally among the three active UE at any Transmit Time Interval.

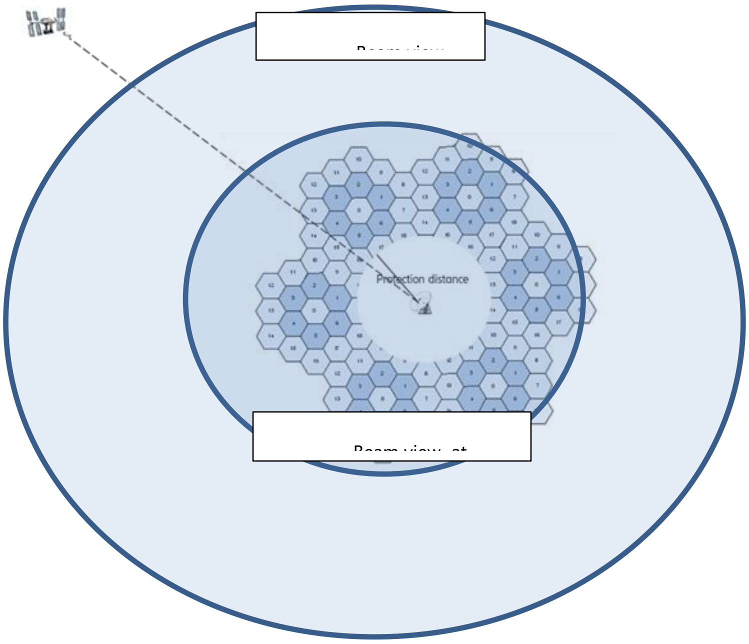
iii) Scheduling of active UE's at the BS is based on the feedback received by BS from UE's after measurements of coupling loss.

iv) Maximum interference from a BS's to earth station is only when the BS's beam is pointing towards the earth station, statistical interference is measured based on off-axis EIRP receiver at the earth station.

v) All the UE stations transmit only in the beam pointing towards the active BS and are also subject to uplink power control and adaptation of radio link. Thus the aggregate interference from UE stations (uplink) are comparatively lower than the aggregate interference from BS stations (downlink)

vi) BS has dropped at once during whole simulation time and UE dropping is randomize at every transmit time interval in each snapshot. In every snapshots, steps from ( ii to V) has repeated .

vii) In the simulation, aggregate interference is average of the total interference over multiple snapshots ( 1000 times ).




## 5 Study results

Table 6 also details the calculated number of simultaneously transmitting IMT-2020 stations from Perth Australia within the visible Earth satellite. The IMT-2020 numbers are calculated using the densities and network loading factors, the Ra/Rb values as in Table 6 and a visible land area of 6600km² ( within 13400 km² of beam view) for a GSO satellite at 145°E.

It is noted that the IMT-2020 numbers in may be excessively large given a large proportion of the visible land area from a GSO satellite will be areas where IMT-2020 will not be deployed (e.g., deserts, forests and other unpopulated areas). Further advice may be needed to ascertain a more accurate method to estimate IMT-2020 station numbers in extremely large areas such as the visible Earth of a GSO satellite. Therefore we have consider 5G deployment in the whole area (6600 km2) of Perth.

**IMT-2020 numbers of stations used in this study**

| | Urban | Comments |
|---|---|---|
| Number of UE (simultaneously transmitting) | 6600 km2 (within beamview of 134000 km2) | $Ds \times Ra \times Area \times Network\ loading\ factor$<br>Land area within visible Earth = 134000 km² |

**Table 6 : IMT-2020 numbers of stations used in this study**

## 6 Consideration of the impact of IMT-2020 stations within the main beam of the satellite antenna

| | Urban | Suburban | Suburban – open area | Comments |
|---|---|---|---|---|
| **Pointing at Perth** (Area of Perth 6600 km²) | | | | City area source: Demographia World Urban Areas |
| Number of UE | 8316 | | | $Ds \times Ra \times Area \times network\ loading\ factor$<br>30 km2 x .07 x 6600 x . 2 |
| Number of BS | 2772 | | | |

**Table 7 : Number of simultaneously transmitting stations in perth**

The aggregate level from IMT stations in the example city is then summed with the aggregate levels from all IMT stations (from Table 7) to calculate the total aggregate interference level. Finally, the combined aggregate level is weighted using the TDD activity factor.

**Calculation of aggregate interference level at the satellite receiver from IMT-2020 stations within the visible Earth plus the aggregate interference of IMT-2020 stations located in the example cities**

| | Satellite pointing location | | Comments |
|---|---|---|---|
| | **Perth (6600 km2)** | **Whole beam view ( 134000 km2)** | |
| IMT-2020 station type | **BS & UE** | **BS & UE** | |
| **Average interference levels at satellite receiver from all IMT-2020 stations in example city (dBm/MHz)** | | | |
| Urban | -200 dBm/Hz (-140 dBm/MHz) | | Average of interference level using the maximum satellite antenna gain (46.6 dBi) |

**Table 8 : Calculation of aggregate interference level at the satellite receiver**

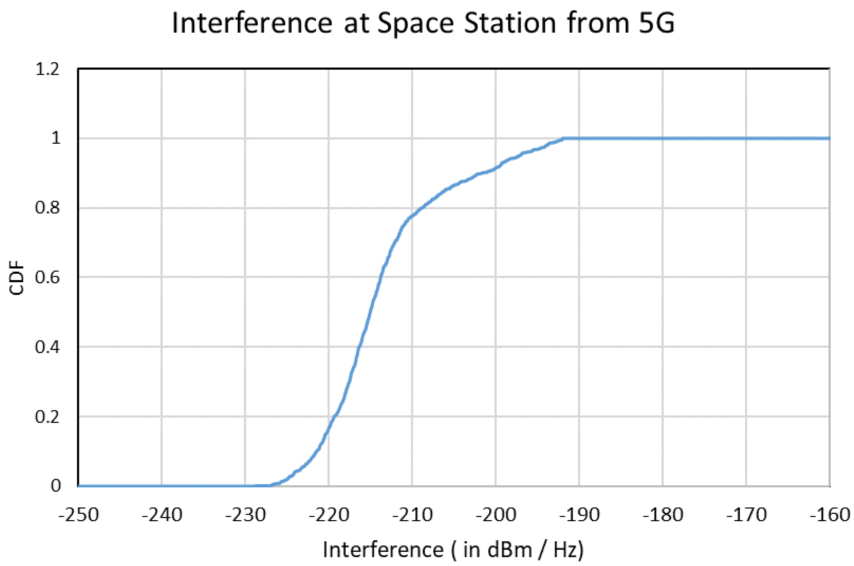



Figure 1: Interference at space station at 5G

As shown in Table 10 , adding the aggregate interference level of IMT-2020 stations from the Perth total interference could be seen -200 dBm/ Hz (-140 dBm/MHz) at 90 percentile and maximum interference is seen as -192 dBm/Hz ( -132 dBm/ Mhz). Considering the interference at space station and noise at the space station -112.6 dBm/MHz , I/N could be derived as -27.4 for 90 percentile and -19.4 as Maximum interference at the space station.

Considering I/N protection level as -10 dBm/MHz, from our simulation results we see 17.4 dBm/MHz interference margin at 90 percentile and 9.4 dBm/MHz at maximum interference level.

# 7 Summary and analysis of the results of study E

Table 9 and Table 10 below provide a summary of the results of this sharing study.

RESULTS OF THIS SHARING STUDY – CALCULATED *I/N* VALUES

| | Perth | | |
|---|---|---|---|
| | **Satellite system noise (dBm/MHz)** | **Aggregated interference level (dBm/MHz)** | ***I/N* (dB)** |
| Base line | –112.6 dBm/MHz | –140 dBm/MHz | –27.4 dB |
| Sensitivity analysis (addition of aggregate interference from IMT-2020 stations in Sydney) | | –132 dBm/MHz | –19.4 dB |

**Table 9 : Interference at space station at 5G**

**Results of this sharing study – calculated protection margins**

| | Perth | | |
|---|---|---|---|
| | **Margin (dB) (for a protection criterion of –6 dB I/N)** | **Margin (dB) (for a protection criterion of –10 dB I/N)** | **Margin (dB) (for a protection criterion of –12.2 dB I/N)** |
| **90 percentile cdf** | **21.4 dB** | **17.4 dB** | **14.8 dB** |
| **Maximum interference** | **13.4 dB** | **9.4 dB** | **7.2 dB** |

**Table 10 : Interference at space station at 5G**

**Observation:** We have conducted simulation at 49 dBm/200 MHz TRP level with 16x16 antenna array configuration (Maximum EIRP 78 dBm/200 MHz). Simulation has considered practical, yet stringent condition in term of TRP off-axis towards space station, within beam view of Space station and found Maximum 21.4 dB of interference margin. We can consider advance studies and practical deployment to further provide additional 7-9 dB of interference margin.

**Proposal:** We have seen very high interference margin available as mentioned in table above, such margin can be further improved with practical deployment. We therefore, propose not to have any TRP limit at base station, which would limit the BS operation and will make 5G deployment economically challenged without any benefit to interference at space station. Such limit would result in inefficient use of spectrum and will derive to leverage full potential of spectrum for socio economic benefit. We fully support guidance provided by WRC-19 to restrict EIRP within off axis towards the space station to protect satellite operation and use 5G station capability to co-exist and operate in non-interfering manner.