**Inmarsat response to the ACMA options paper:**

**Future use of the 3.6 GHz band**

**11 August 2017**

In this document, Inmarsat provides comments on the Options Paper: “Future Use of the 3.6 GHz band” and the associated document: “Future use of the 3.6 GHz band: Highest value use assessment—Quantitative analysis”. Although the Options paper also discusses the 5.6 GHz band, our comments are limited to the discussion concerning the 3.6 GHz band (3575-3700 MHz).

**Comments on High Value Use Assessment**

In the context of valuations of the 3.6 GHz band for mobile broadband, it is worth highlighting at the outset the great uncertainty that inevitably exists in making such economically based assessments. There have been a few auctions of spectrum in the 3.6 GHz band around the world, generally fetching much lower prices than the lower frequency bands, which clearly remain more valuable to mobile operators. This seems inevitable considering the higher costs of network deployment at higher frequencies and the difficulty mobile operators are finding in increasing ARPU.

We are not aware of any success cases in the use of the 3.6 GHz band for mobile broadband, while there are many examples of a lack of success, particularly following the short-lived rise and fall of WiMAX about a decade ago. It is possible that the market for mobile broadband is now ready for the 3.6 GHz band, but it is equally possible that mobile operators will remain unable to make a successful business case from the use of these bands.

It is therefore important that the ACMA and other regulators take a pragmatic approach to sharing of the spectrum. Removal of incumbent uses at this time has a high risk of leading to unused spectrum.

Inmarsat does not provide answers to each of the questions in the High Value Use Assessment. However we comment on question 10, in which the ACMA asks: “*Is the cost range for the relocation of all C-band licences from an FSS earth station facility suitable for this analysis?*”. As noted by the ACMA in the document, Inmarsat has already provided to ACMA an estimated cost of relocating the Landsdale facility at $25-30m. We therefore believe that the cost of relocating the entire Landsdale earth station facility, which includes antennas used by other C-band operators, is well in excess of $30m and may exceed the top end of the range suggested by the ACMA, i.e. more than $50m.

As shown in Table 28 of the analysis, the economic analysis favours retaining C-band earth station operations at Perth assuming MBB is limited to small cell deployment and assuming the economic benefit forgone is valued between $0.03 and $0.25 ($/MHz/pop). Even with the higher assumed values of $0.5 and $0.625 ($/MHz/pop), the estimated forgone economic benefit for Perth is $54m and $67m respectively - only just exceeding the ACMA’s estimated relocation costs. Hence, for the small-cell case, the economic case is marginal with respect to the relative merits of relocating the Landsdale earth station. Given the general uncertainty in this analysis, and also the uncertainty regarding the benefits of MBB, it seems wise to err on the side of caution and allow for continued FSS operations at Perth.

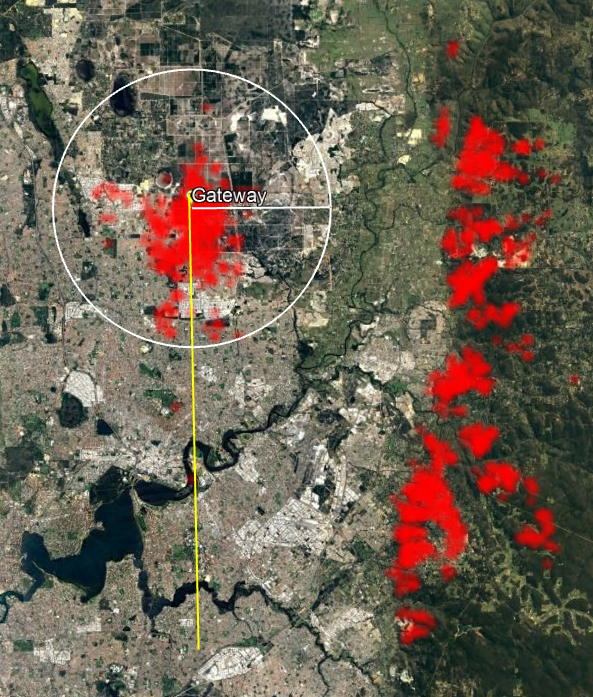
Furthermore, Inmarsat believes that in fact the reduction in benefits to MBB could be significantly lower than the values estimated by the ACMA, since Inmarsat suggests that MBB operations are restricted to small-cell use only in a part of the 3.6 GHz band. In the remaining part of the band, not currently used at Landsdale, there would be minimal constraints on MBB deployment needed (to address only potential adjacent band interference). In this case, the “reduction in re-farming benefits” as presented Table 29 would be diminished, thereby increasing the balance of the analysis still further in favour of retaining FSS earth station operations.

**Comments on the Options Paper**

Inmarsat has a number of earth stations around the world which provide the feeder links for our L-band GSO satellite constellation. It is vital that our earth stations are able to continue to operate without significant inference in the 3.6 GHz band to support our global MSS operations. Inmarsat’s next generation of L-band satellite will continue to use C-band feeder links in the 3.6 GHz band. It is not practicable for Inmarsat to transition to alternative parts of C-band due to the existing use of those frequencies by other satellite networks.

Inmarsat generally agrees with the assumptions used for the FSS parameters in the technical analysis provided in Appendix 4. Our own analysis contained in the Annex to this response, has used the same assumptions as the ACMA for MBB system characteristics. Our analysis has used the actual ES pointing directions for the three earth station antennas used to communicate with Inmarsat satellites but otherwise the earth station parameters are the same as those used by the ACMA. The results show that deployment of MBB macro-cells in Perth on the same frequencies as FSS earth stations seems impracticable, which is consistent with the results obtained by the ACMA. However, as shown in the figure below, operation of MBB small cells in Perth does appear to be feasible, with some constraints on small cells at locations near the earth station and on the hills to the East of Perth.

Figure 1 Interference from small cell base stations -10 dB (red shaded area indicates where either the short-term or long-term interference criteria are exceeded)



The majority of Perth would be unrestricted for deployment of small-cells. These results are based on the assumption that typically at least 10 dB additional loss exists, which is a reasonable assumption considering that small cell base stations are positioned indoors or below roof-top level which would result in additional clutter loss. Furthermore, interference is generally received on the far-side lobes of the earth station antenna, for which the antenna gain could be lower than the -10 dBi figure assumed. A coordination area could be defined around the earth station location, outside of which small-cell base stations could be deployed without any extra coordination requirement with respect to earth station protection. Inside the coordination area, additional assessment would be needed to ensure that harmful interference is not received.

Inmarsat’s earth station at Landsdale, Perth has been in operation since 1990 and will continue to be required for many years to come. Inmarsat believes that the Perth earth station facility should continue to be protected from interference from MBB systems. In order to minimise the constraints to MBB, Inmarsat proposes the sharing be based on the following elements.

1. A part of the 3.6 GHz band would be protected for continued FSS operations. Accounting for future requirements, the protected band could be 3599-3650 MHz. In this band, MBB operations in Perth would be limited to small-cell systems only (i.e. no macro-cell deployment), which would be subject to relatively minor coordination constraints to protect operations at Landsdale.
2. In the remaining 74 MHz (3575-3599 MHz and 3650-3700 MHz), all types of MBB system could be deployed - including macro-cells - and Inmarsat would not seek protection of our earth station operations except regarding potential adjacent band interference issues.
3. We recognize that there are other FSS operators at Perth which might require ongoing protection on other frequencies within the 3.6 GHz band, but we believe that significant spectrum can be found that could be made available for MBB with only minimal restrictions.

However, in the case that ACMA does not ensure the ongoing protection of the Landsdale earth station on the frequencies described above, we request that the earth station is grandfathered for 20 years (commensurate with typical satellite lifetime) and that any requirement to re-locate in a shorter timeframe should receive financial compensation to cover the costs of re-locating.

Answers to the specific questions are below:

1. *Should the 3.6 GHz band be progressed from the preliminary replanning stage to the re-farming stage in the ACMA’s process for considering additional spectrum for MBB services? Why/Why not?*

Inmarsat is content for the 3.6 GHz band to progress to the re-farming stage. However, as described above, we do not believe that the case for re-locating the Perth earth station has been made. On the contrary, the analysis supports the continued protection of the Perth earth station and hence FSS protection issues should be appropriately addressed.

1. *Do the areas identified in this analysis cover the likely areas of high demand for access to the 3.6 GHz band? Would smaller or larger areas be more appropriate? Why?*

Inmarsat does not comment further here on the demand for terrestrial services. In some cases, breaking up areas may be appropriate to define areas where protection of other services is required.

1. *If any part of the 3.6 GHz band is re-allocated for the issue of spectrum licences is seven years a suitable re-allocation period? If not, what period of time would be appropriate?*

As explained above, Inmarsat does not believe that re-allocation for exclusive spectrum licences is justified or necessary. Spectrum licences or wide area apparatus licences could be designed for MBB operations in Perth that would continue to protect the Landsdale earth station. If the AMCA is considering eventually ceasing protection of the Landsdale earth station, we believe that ongoing protection for 20 years is justifiable, considering that 20 years is a typical lifetime of a satellite and future Inmarsat satellites will have C-band feeder links. If the ACMA wishes to shorten the protection period, it would seem justified that compensation is provided to cover the cost of re-locating. If the economic case did support such action, then clearly the benefits from the reduced restrictions on MBB would outweigh the sums paid to earth station operators for re-location costs.

1. *Should different re-allocation periods be considered for different areas? For example, should a longer period be considered for services outside Area 1?*

No comment.

1. *Are these guidelines appropriate? Why?*

With regard to protection of the Landsdale earth station, the geographic areas to be defined are (1) the area within which MBB in certain frequency bands is limited to small-cell base stations and (2) the area close to the Landsdale where small-cell base stations require additional coordination.

1. *Are there any other issues that affect the usability of an area-wide licence that should be taken into account when defining the licence area?*

No comment.

1. *If point-to-point licences are affected by replanning activities in the 3.6 GHz band, are the options identified for point-to-point licences suitable? Are there any alternative options that should be considered?*

No comment.

1. *Is the 5.6 GHz band a viable option for wireless broadband systems?*

No comment.

1. *Under what circumstances should apparatus- and class-licensed arrangements be considered for the 5.6 GHz band?*

No comment.

1. *If apparatus licensing arrangements are developed for wireless broadband systems in the 5.6 GHz band, are the notional arrangements proposed in Appendix 3 suitable?*

No comment.

1. *If point-to-multipoint licences are affected by replanning activities in the 3.6 GHz band, are the alternative options identified suitable? Are there any alternative options that should be considered?*

No comment.

1. *The ACMA seeks comment on the suitability of the current west coast earth station protection zone located near Mingenew, WA, for long-term satellite service use. Are the current regulatory arrangements effective?*

No comment.

1. *In the event FSS earth stations are affected by replanning activities in the 3.6 GHz band, the ACMA seeks comment on:*
2. *Any issues surrounding the development and establishment of an east coast earth station protection zone; particularly on what factors would be necessary to make it an attractive option for earth station operations.*

No comment.

1. *Whether there are any views on potential candidate locations to consider.*

No comment.

1. *Whether there should there be more than one earth station protection zone on the east and west coasts of Australia.*

Inmarsat would support the provision of additional zones on the east and west coasts. However, as stated previously regarding the ACMA consultation on earth station siting, Inmarsat is not in favour of any forced migration of current earth stations to the protection zones.

1. *If the identification of a central Australia earth station zone should be considered.*

No comment.

1. *Are the approaches for amateurs, radiolocation services, class licensed devices and TVRO systems suitable?*

No comment.

1. *Are there any other options for incumbent services, not identified in this paper, which should be considered?*

No comment.

1. *Should any of the sharing arrangements discussed in this section be considered for implementation in the 3.6 GHz band? Why or why not?*

The FCC arrangements place existing FSS earth stations in “Tier 1”, which gives them grandfathered protection from new MBB applications. Inmarsat is proposing a similar approach in Australia for Landsdale.

The ECC “licensed shared access” approach is also based on defining protection for incumbent services, while allowing a newcomer to operate in the same frequency band. A more prescriptive implementation of this approach, specifically for the band 3600-3800 MHz is described in ECC Report 254 could also be considered as a methodology to define FSS earth station protection requirements.

Both the CEPT and FCC framework are based on authorising the C-band spectrum for MBB while protecting incumbent operations, including FSS earth stations. This should be the general approach adopted by the ACMA. Regarding the more detailed aspect of how the protection measures are defined and implemented, Inmarsat considers that the definition of the restricted deployment areas outlined above, provides the right balance of simplicity versus flexibility, but Inmarsat would be happy to develop licence conditions based on the ECC Report 254 approach.

1. *Are there any other sharing arrangements that should be considered?*

No comment.

1. *Are there any other replanning options that should be considered?*

The approach put forward by Inmarsat is similar to Option 4b, except that for the protected frequency sub-bands at Landsdale, those frequencies could be available for spectrum licences, but subject to the described protection requirements for the Landsdale earth station.

1. *Which replanning option should be implemented in the band? Why?*

Any option that allows the incumbent services to continue to operate unaffected is acceptable for Inmarsat, noting that this is possible without substantial impact on the deployment of MBB systems, since exclusion zones will be limited, and will only affect portions of the 3.6 GHz band.

1. *In the event an area-wide licensing option is implemented, in which of the defined areas (that is, Area 1, 2, 3 and Australia-wide as defined in Appendix 6) should these arrangements be implemented? Are the current area definitions appropriate? If not, what area should be defined?*

Areas can be defined with reference to existing FSS Earth station locations to allow these stations to continue to operate.

1. *If Option 4a is implemented, what frequencies and areas should be re-allocated for the issue of spectrum licences? How much spectrum should remain subject to site-based apparatus licensing arrangements? Should different amounts be considered in different areas?*

Inmarsat has described the frequencies for which it seeks protection of earth station operations above and under Option 4a the other sub-band in the 3.6 GHz band would be available for spectrum licences. The frequencies could vary for other locations, where other earth stations have different frequency bands that require protection.

1. *If Option 4b is implemented, what frequencies and areas (that is, incumbent apparatus licence services) should remain subject to site-based apparatus licensing arrangements?*

If Option 4b is pursued, the protected frequencies could remain subject to site-based licensing arrangements. However under the approach put forward by Inmarsat, the protected frequencies could alternatively be subject to spectrum licences, subject to protection of existing FSS Earth station sites.

1. *Comment is sought on the ACMA’s preferred option (Option 3c) for the 3.6 GHz band.*

This option has a disastrous impact on FSS operations. However, this impact can be removed by combining Option 3c with Option 4b to protect existing FSS Earth station sites. This will have limited impact on MBB deployment in the band.

**Concluding comments**

As is indicated in our comments above related to the High Value Use Assessment, we believe that the economic assessment presented by the ACMA is in favour of retaining ongoing protection of the Landsdale earth station based on the conditions outlined above. Option 3c as proposed by the ACMA would require existing users to relocate by the end of the re allocation period, which seems not to be well justified by the ACMA’s own economic analysis. Inmarsat’s proposed approach to sharing tilts the economic analysis further towards protecting the existing earth station.

Irrespective of the economic arguments, Inmarsat believes that the Landsdale earth station and the few other earth stations in Australia which operate in this band should continue to be protected. We have described a method to provide that protection that minimizes the constraints on new MBB applications and we ask that the ACMA give careful consideration to this and similar approaches to protect those earth stations.

**Annex**

# Inmarsat analysis of MBB Interference in the 3.6 GHz band into Inmarsat gateway stations at Landsdale

## Introduction

The ACMA is considering the future use of MBB in the 3 575-3 700 MHz (3.6 GHz band) in Australia. Inmarsat operates three gateway stations in Perth in the identified frequency range that could receive interference from such deployments.

This document analyses the coexistence of MBB base stations and Inmarsat gateways deployed in Perth in the 3.6 GHz band.

## MBB parameters

The parameters indicated in Table 1 were suggested for MBB usage by ACMA and are consequently used for the analysis in this document. Interference from user terminals (indicated in grey in Table 1) is not studied since user terminals generally produce less interference than base stations due to the lower power levels and these scenarios can be considered to be covered by the base station interference analysis results. Assuming MBB systems are using TDMA, aggregate interference from the user terminals and base station on the same frequency would not need to be studied since there would be no simultaneous transmission.

The parameters indicated in blue shaded cells were not used in the studies performed by the ACMA but are considered for this analysis.

Table 1 MBB parameters used in the study

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Parameter | Unit | Macro-BS | Small-cell BS | Mobile UE | Micro-BS/ Fixed UE |
| Antenna height | M | 25 | 6 | 1.5 | 5\* |
| Tx Power | dBW | 13 | –6 | –7 | –4 |
| Bandwidth | MHz | 5 | 5 | 5 | 5 |
| Losses (feeder/body) | dB | 0\*\* | 0 | 4 | - |
| Maximum antenna gain | dBi | 18 | 5 | –4 | 18\*\*\* |
| Antenna downtilt | degrees | 6 | 0 | - | - |
| Antenna pattern | - | F.1336 | F.1336 | - | - |
| Antenna gain towards horizon | dBi | 10.4 | 5 | - | - |
| EIRP | dBW | 23.4 | -1 | –21.99 | 7.01 |

## Inmarsat gateway earth station parameters

Inmarsat gateway parameters used for the analysis are indicated in Table 2 below.

Table 2 Inmarsat gateway parameters used in the study

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Parameter | Unit | APAC  (143.5E) | IOR  (64.5E) | POR  (178E) |
| Location | Latitude  Longitude | -31.80425,  115.88753 | -31.804604,  115.887375 | -31.805121,  115.888276 |
| Antenna height | M | 7.0 | 9.0 | 9.0 |
| Noise temperature | K | 100 | 100 | 100 |
| Bandwidth [[1]](#footnote-1) | MHz | 5 | 5 | 5 |
| Antenna Pattern | - | S.580-6 | S.580-6 | S.580-6 |
| Maximum antenna gain | dBi | 51.9 | 54.8 | 54.8 |
| Elevation (towards satellite) | degrees | 42.45 | 24.09 | 15.02 |
| Gain (towards horizon) | dBi | -11.7 | -5.5 | -0.4 |

Most of the parameters in the table above were calculated based on the information available at the time of the analysis and can be refined for further accuracy.

The interference criterion used for the protection of the gateway stations is shown in Table 3 below. The criteria is the same as used by in the analysis performed by the ACMA.

Table 3 Gateway earth station protection criteria

|  |  |  |
| --- | --- | --- |
| Parameter | Value | I/N |
| Long-term protection criteria (p0=20%) | –130.15 dBm/MHz | -12.2 |
| Short-term protection criteria (p0=0.005%) | –121.48 dBm/MHz | -2.1 |

## Study methodology and results

The study is performed using an “area analysis” methodology, for which interference into any of the Inmarsat gateway stations from a single MBB base station in a specific geographic location is calculated. If the short-term or long-term interference criterion at the gateway earth station receiver is exceeded for that specific MBB base station location, then this MBB base station location is highlighted in red on the map. This analysis is repeated for every “pixel” in the area surrounding Inmarsat gateway earth stations and the results indicate all the locations where there would be risk of interference into any one of the three gateways if an MBB base station would be placed in the highlighted area.

The study also assumes full overlap of the bandwidths of the MBB base station and Inmarsat gateways in a 5 MHz channel.

The level of interference received by the Perth gateways from MBB base station deployments in the surrounding area is modelled using a terrain database (with 30 m accuracy) of the area around Perth and the propagation model defined in ITU-R Recommendation P.452.

The level of propagation loss of the transmitted signal is subject to temporary atmospheric phenomena that can significantly decrease the propagation loss and thereby increase interference. The duration and occurrence of such effects is statistically distributed in time, so that interference will be highest for the lowest duration of time. Consequently, Recommendation P.452 accounts for this by defining a percentage of time, for which the level of propagation loss is expected to remain above a certain value.

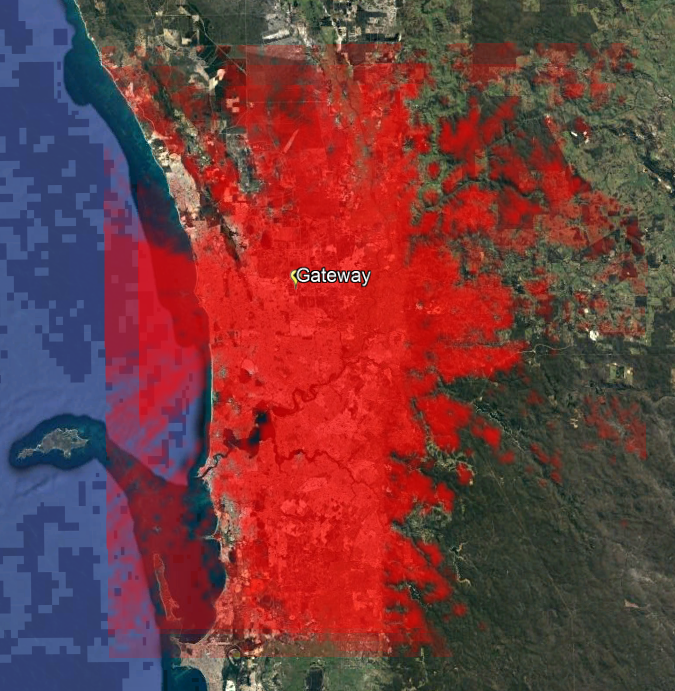
Due to this, studies considering interference between satellite earth stations and terrestrial base stations generally assess interference in two dimensions: long-term and short-term interference. In this study, interference is not expected to be exceeded for 20% of the time for the long term interference criterion and 0.005% of the time for the short term interference criterion as also indicated in Table 3 above. In order to ensure interference free operation, both long-term and short-term interference criteria needs to be met.

### Macro cell interference analysis

This analysis studies the interference into Inmarsat gateway stations from macro base station deployment based on the parameters indicated in Table 1 above. The results of this analysis are shown on Figure 2 below, where red indicates areas where either the long-term or short-term interference criterion (or both) at the gateway locations would be exceeded, if a macro base station would be deployed in the highlighted location.

The results indicate that the Inmarsat gateway stations are potentially interfered with from MBB macro base station deployments throughout the city of Perth and coexistence would not be possible between the two services.

Figure 1 Interference from macro MBB base stations (composite long-term and short-term interference contours)



### Small cell interference analysis results

Three separate area analyses are performed in order to characterise the interference from MBB small cell base stations into the Inmarsat gateway stations.

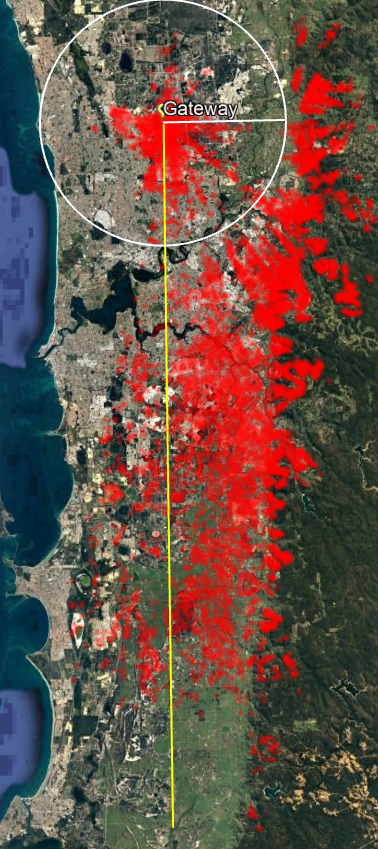
#### Baseline small cell interference analysis

This analysis uses small cell base station parameters as shown in Table 1 above, but does not consider any clutter loss between the gateway and the base stations. This means that the interference contour is driven by the propagation loss due to terrain.

The results of this analysis are shown on Figure 2 below for the composite of short-term and long-term interference contours. It can be seen that interference is concentrated in a 15 km circle around the gateway earth station and also follows the eastern flank of Perth. The latter is due to elevated terrain on the eastern side of the city, which increases the radio horizon of the small cell base stations.

Large portions of the eastern side of Perth consist of farmland and suburban areas, where a small cell deployment is less likely. However, interference can also be experienced by large portions of the city south of the gateway, which stretches for about 70 km from the gateway location, where small cell base stations could be deployed.

Figure 2 Interference from small cell base stations (composite of short-term and long-term interference contours)

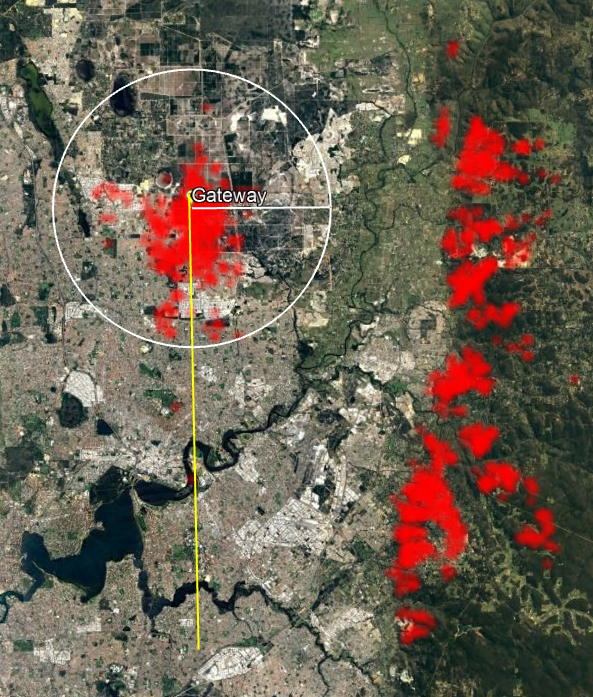


Note: the yellow line is 82 km from the Inmarsat gateways and white circle has a radius of 15 km

#### Baseline small cell interference analysis -10 dB

The same analysis as in Section 4.2.1 is repeated below with the exception that the propagation loss for all analysis points is increased by 10 dB. This is to take into account that small cell base stations with 6 m height are likely to be deployed in urban areas and between buildings, which would result in clutter loss for the interference paths into the Inmarsat gateway stations. In addition, majority of Perth is located on the back-lobe of the gateway antennas. The antenna pattern in Recommendation ITU S.580-6 used for this analysis indicates that the antenna gain towards the back lobe is -10 dB, which in reality is likely to be lower.

The results of this analysis are shown on Figure 3 below for the composite of short-term and long-term interference contours. It can be seen that interference is mainly concentrated in a 9 km circle around the gateway earth stations. Interference could also be caused by stations deployed on the hilly terrain to the east of the gateway, but this overlaps with mainly farmland and suburban areas, where a small cell deployment is less likely. The analysis does indicate however that interference could be received from stations deployed as for as 29 km away from the gateways if placed in any of the locations indicated in red. These are non-built areas, which also seem to be unlikely locations for high demand for MBB applications.

Figure 3 Interference from small cell base stations -10 dB (composite of short-term and long-term interference contours) 

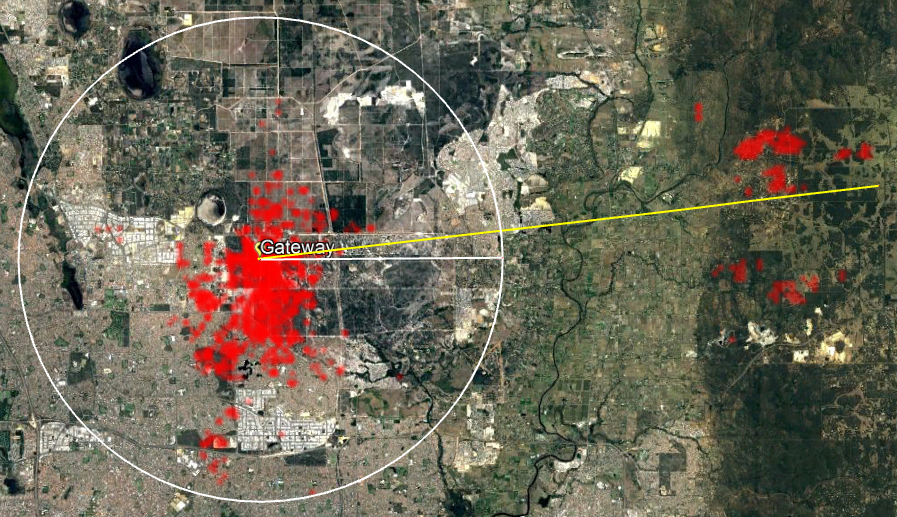
Note: the yellow line is 29 km from the Inmarsat gateways and white circle has a radius of 9 km

#### Baseline small cell interference analysis -20 dB

Similarly to Section 4.2.2 above, the analysis is performed by increasing the propagation loss for all analysis points, but this time interference into the Inmarsat gateways is reduced by 20 dB. This is to take into consideration the maximum effects that could occur due to clutter loss and mismatch between the modelled gateway antenna back-lobe gain and realistic values.

The results of this analysis are shown on Figure 4 below for the composite of short-term and long-term contours. Interference from small cell base stations for this scenario is confined within the 9 km radius around the gateway stations. Interference could also be caused by stations deployed on the hilly terrain to the east of the gateway, but this again overlaps with scarcely populated and suburban areas, where a small cell deployment is unlikely.

Figure 4 Interference from small cell base stations -20 dB (composite of short-term and long-term interference contours)



Note: the yellow line is 23 km from the Inmarsat gateways and white circle has a radius of 9 km

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1. The bandwidth is chosen to match the bandwidth of the interferer. The actual bandwidth used is greater. [↑](#footnote-ref-1)