



# Discussion document: Technical Arrangements of the 3.5 GHz Band

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and Employment

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## Executive Summary

The Ministry is currently consulting on technical principles for future spectrum users in the range of 3400-3800MHz (3.5GHz band).

We support the Ministry's overarching approach: a common synchronised frame structure will maximise the use of the band and outcomes for end users. The paper further proposes rules that, while affording priority to synchronised systems, leave the possibility open for synchronised and non-synchronised systems to co-exist in the band. In other words, operators may opt out of synchronised operation in the band.

### Co-existence is unlikely to be possible in practice and the focus should be on transition arrangements

Management Rights (**MR**) holders should have flexibility to operate within their MR provided they do not interfere with other rights holders. However, technical interference calculations suggest that co-existence of synchronised and non-synchronised operations in this band won't be possible in practice. Our current rules and techniques for managing interference are further unlikely to be effective when faced with a *planned* incompatibility in the band and complexities associate with interference from unsynchronised transmission.

The broad potential for ongoing interference means that synchronised and non-synchronised systems cannot co-exist in the band – all operators in the band will need to be synchronised. Therefore, we recommend that proposed rules recognise the practical interference concerns and set an expectation that all systems operating in this band must be synchronised, for example:

- To avoid delaying the availability of 5G services to end users, the Ministry should give the proposed 18mth deployment notice to users in the band who do not hold MRs now; and
- As showing interference is likely to be contentious, the Ministry should provide guidance on the criteria, or measures it will accept, that indicate harmful interference which must be remedied. The Ministry should also require all new installations in Crown spectrum parks to be synchronised.

### Other recommendations

The paper addresses several practical issues:

- **Timing verification.** We propose to set up a timing verification lab where all vendors supply their base stations to validate their synchronisation parameters, frame structures, special slot structure etc. The lab would also supply the common timing source to all operators or ensure that all use say the GPS with the GPS receiver part of the baseband unit.
- **Process for agreeing changes to synchronisation parameters.** We believe that national rights holders have incentives to agree efficient changes to synchronisation parameters without arbitration requirements. However, if the band is fragmented, parties are less likely to be aligned on desirable changes. Any arbitration provisions will need to bind the Crown as a MR holder and should include guidance on the criteria for change.

## Introduction

1. Thank you for the opportunity to comment on the Ministry's technical principles paper. The Ministry is considering proposed rules and technical requirements for operating in the 3.5GHz band.
2. We support the Ministry's overarching approach - a common synchronised frame structure will maximise the use of the band and outcomes for end users. The objective should be for all future users of the 3.5 GHz band to synchronise their transmission to a set structure.
3. The 3.5 GHz band is envisioned for use by Time Division Duplex (**TDD**) systems. This frequency range is considered a pioneer band for the deployment of 5G systems internationally. The global trend is to use this band for TDD systems and, in harmony with international trends, we have also decided to use the 3.5 GHz band for similar systems.
4. TDD systems have the inherent problem of causing interference between adjacent operators if transmission and reception are not synchronised. In TDD systems, a base station and a mobile handset take turns, in time, to transmit or receive their signal. If two adjacent operators do not perfectly align the timing of their transmission, there could be occasions when the transmission of one operator coincides with the reception of other operators. Such events will cause harmful interference.
5. There are significant economic benefits to synchronised operation.

## Rules of co-existence and process for change

**Question 1: Do you agree with the proposed rules of co-existence and the process of change?**

**Question 2: Do you have any additional comments about the process?**

6. The Ministry proposes that synchronisation should be the default setting in the band. However, the Ministry further proposes that operators should be able to opt not to synchronise provided they do not cause harmful interference to adjacent spectrum users. In other words, unsynchronised transmissions will only be permitted in the 3.5 GHz band if they are technically compatible and do not cause harmful interference to operators that are already synchronised. The paper sets out a mechanism by which this co-existence can occur.
7. The paper also references existing term harmful interference principles, as harmful interference has a specific meaning in radio regulations. Care should be exercised in using *interference* and *harmful interference* interchangeably.

### Opting out of synchronisation in the band

8. MR holders should, in principle, have the flexibility to operate within their rights provided they do not interfere with other rights holders. However, we believe that opting out of synchronised operation is unlikely to be feasible in practice and as such all operators in this band will need to synchronise. This is the best form of co-existence. Further, the current frameworks for managing interference were not designed to mitigate known cases of interference – i.e. where there is a planned incompatibility - and will not work when one is dealing with synchronisation scenarios.
9. Co-existence must be based on agreed metrics/parameters:
  - a. Timing reference

- b. Frame structure
  - c. Slot structure
  - d. Stability of clocks- clock accuracy requirements
  - e. Frequency synchronisation
  - f. Timing synchronisation
10. Values for the above metrics must be agreed to and defined. This applies to both private and crown managed rights. The arrangement proposed in MBIE's paper appears to imply that co-existence is possible even with unsynchronised transmissions and that regulatory tools will address the complex issues arising from unsynchronised transmission.
11. However, resolving such types of interference will be cumbersome, costly and time consuming, and it remains unclear whether there are tools to do this. If un-synchronised and synchronised systems are to co-exist in the band, then large guard bands and large exclusion zones are needed. A report to this effect has already been provided to MBIE by the technical working group<sup>1</sup>.
12. Further, Spark recently experimented the co- existence of un-synchronised systems in the 5G lab with two radios - one inside and one outside the lab - and observed that even with in-building penetration loss and antenna front to back ratio, i.e. the antennae of two systems not facing each other - there is a significant performance degradation.
13. The current interference management framework is further unlikely to address *planned* incompatibilities within the band. The document also mentions harmful interference, but this type of interference has a special meaning in radio regulations. Unsynchronised transmissions will cause interference that may or may not comply with the regulatory definition of harmful interference.

### Transition arrangements

14. We believe that the notice period arrangements should recognise:
- a. That co-existence is unlikely to be practical in any material way; and
  - b. That national operators plan to deploy synchronised 5G networks widely as soon as spectrum is available.
15. Therefore, any notice arrangements should be applied early, transitional in nature and seek to minimise the impact on planned synchronised deployments.
16. The Ministry has proposed that operators provide 18mths notice of deployments and, if interference is proven, interfering operators must resolve interference within 10 days.

### 18mth notice to unsynchronised licensees

17. The paper proposes that operators in a private management right unable to licence a transmitter because it would cause interference to or suffer harmful interference from an existing licensed

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<sup>1</sup> Technical working group paper to Ministry.

unsynchronised transmission in a Crown management right, must give at least 18 months' notice to the unsynchronised licensee of their intention to install and operate a synchronised transmitter.

18. In principle, impacted operators should be given notice so that they can upgrade or deploy compliant systems or migrate to another band. In this case, however, the Ministry can give notice to all parties now that unsynchronised operation will not be permitted in the band from the earlier of 31 October 2022 or such other time as the existing MRs are relinquished.
19. The proposed approach will require operators rolling out synchronised 5G infrastructure to plan and provide notice well ahead of the roll out, may delay the availability of 5G services and will limit operators' ability to amend planned network deployments in response to new customer demand.
20. Therefore, to minimise the impact on 5G deployments we further recommend that the Ministry:
  - a. Give immediate notice of planned synchronised system deployment to unsynchronised operators in the band who do not hold MRs. In all cases, national operators have signalled that they plan to make 5G services widely available and providing early 18mth notice will facilitate early deployment and availability of 5G services; and
  - b. If you do decide to provide for unsynchronised operation, consider a shorter future notice period following the initial roll out. At this point, we expect expansion to relate to new customer demand (where more flexibility would be desirable) and operators with unsynchronised systems are likely to have the capability to transition more quickly. For example, after a 36mth transition period, the Minister could shorten the period to 6mth's notice.

#### 10 working day period to mitigate interference in Crown MR

21. The paper also proposes that, in Crown management rights, the licensee's unwanted emissions must not cause harmful interference to synchronised users. If such harmful interference is proven and the licensee is unable to remedy the harmful interference within 10 working days, the Crown will retain the right to cancel the unsynchronised licence immediately.
22. We support the proposed approach, there shouldn't be harmful interference and the Ministry should take swift action where Crown spectrum park licensees are causing interference to synchronised users. However, it will likely be difficult to prove interference and trigger the notice period in practice, i.e. significant time will likely be spent detecting and proving an interference issue.
23. Accordingly, we recommend that Ministry consider:
  - a. Providing guidance on the criteria or measures it will accept that indicate harmful interference which must be remedied;
  - b. A requirement to switch off interfering equipment immediately if shown to be interfering with synchronised users; and
  - c. Requiring all new installations in Crown spectrum parks to be synchronised.

## Other proposals

### Timing verification

24. The paper proposes that subsequent deployments should align with existing TDD systems, i.e. a first in rule. This approach can apply for establishing the start of the frame cycle, i.e. symbol on which operators can align (U, D or S for example). However, this rule cannot be applied to ongoing synchronisation of TDD systems.
25. We believe all TDD operators must synchronise, however it is impossible to ensure that the frames of all operators must be perfectly aligned, the start of the TDD frames must be within an allowed +/- 1.5 micro-seconds. This has a nominal impact (around 4.2%) on the cell range when such a timing offset is allowed and is considered reasonable.
26. We propose to set up a timing verification lab where all vendors supply their base stations to validate their synchronisation parameters. Operators will supply their base stations and with necessary tools the lab will verify if the proposed synchronisation parameters are in line with the agreed. This validation could also be done periodically.
27. If all operators use GPS as their timing source, one possible way to conform alignment will be to simultaneously look at the signals of the base stations from individual operator's equipment and validate the timing difference on a multi-channel oscilloscope. The equipment required for this will be simple.
28. The proposed lab could also provide the national master reference clock source for all 5G TDD frames to synchronise with - and in conjunction with – the GPS clock. This is similar to the Chinese market where operators are required to synchronize for TDD operation. The regulatory authority is not involved in the practical operation of the timing source and operators align the timing derived from GPS and the frame structure.
29. We propose to use a high accuracy clock and GPS receiver to provide a clock reference and use IEEE 1588V2 protocol to share the clock reference to different operator by some transportation network.

### Process for agreeing changes to the parameters

30. The paper proposes that band synchronisation parameters may be changed at any time by agreement of all operators in the band or by making a submission to an independent arbitration. We agree, MR holders should be able to agree changes to synchronisation parameters, including the Crown where the Crown is acting as a MR holder.
31. Further, as indicated earlier, we do not believe that mandated arbitration is necessary where the band is allocated to national operators. The band has international support for 5G deployment and, accordingly, it's likely that equipment availability and emerging end user demands will ensure operators have incentives to agree changes to synchronisation parameters. However, agreeing changes to parameters will be more difficult if the band is fragmented – i.e. the Ministry operates a spectrum park in the band - and used by operators with different business models and demands.
32. In which case, arbitration provisions would need to:

- a. Apply to all management rights holders in the band, including the Crown as the MR holder used for the spectrum park users. The Crown should ensure that spectrum park licensees comply with arbitrated changes to parameters;
- b. Set out the criteria for agreeing changes that would, in turn, form the basis for arbitration. For example:
  - i. Agreement to amend parameters cannot be unreasonably withheld; and
  - ii. That the overarching principle for agreeing changes is that the change is in the long-term interests of end users. The considerations of long-term interests could include: the availability of standard compliant and compatible network equipment and end user devices; the adoption of similar parameters in mainstream markets, the costs to implement the change and benefit of new services for end users.

33. The Ministry could consult on detailed considerations for arbitrated changes.

### Proposed arrangements for synchronisation

34. The paper addresses technical parameters relating to frame structure, determining the start of the TDD frame, and synchronisation source and timing alignment.

**Question 3: Do you agree with the proposed frame structure?**

**Question 4: Do you agree with the proposed arrangement for the special slot?**

35. We support the proposed initial frame structure and special slot proposals.

36. We are less certain, however, how parameters will change over time. The technical working group has observed in its submission there may be a need to change to a different frame structure over time. For example, there could be a more ambitious DL/UL signalling slots as compared to allocating all the 14 symbols to DL or UL except for the S slot.

37. Even the subcarrier spacing may need changing at some future date especially if there is a need to support extended CP the special slot structure may need to change.

**Question 5: Do you agree with the process for defining the start of the TDD frame for the first time?**

38. This situation will not arise if operators agree on the metrics given in answer to question 1.

39. There is allowed to be +/-1.5 micro seconds relative time drift /offset between the start of different operator's frames.

### Proposed unwanted emission mask

40. The paper proposes that the unwanted emissions mask for the equipment operating in the 3.5 GHz band be calculated using the 3GPP standard, namely 3GPP 38.104 V15.5.0 (2019-03). The Ministry notes that any equipment which is able to comply with this mask is permitted.

41. We agree with the above but note that TRP must be used instead of EIRP for base stations with active antennas.



**Question 6: Do you agree with the proposed solution for a synchronisation source and timing alignment?**

42. Almost all of our network synchronisation is via GPS and should support

Frequency Sync:  $\pm 0.05\text{ppm}$

Time Sync:  $\pm 1.5\mu\text{s}$

**Question 7: Do you agree with the calculation methodology for the unwanted emission mask, particularly the choice of the nominal antenna gain?**

43. We believe the MBIE should use the TRP method when active antennas are used and EIRP method when passive antennas are used. Furthermore, it is desirable to use the same units as 3GPP.

44. In terms of other technical parameters:

- a. We support adding 9 dB;
- b. In so far as adding 28.03 dB to convert TRP to EIRP it is premature to do that until the WRC agrees on a definition of TRP. Regardless of this, 28.03 dB is dependent on specific antenna parameters, numbers of antennas etc and this will vary from one vendor to another and cannot be assumed as valid for all types of deployments. Furthermore, power is divided amongst users and the calculation methodology needs to address this;
- c. Section 4.2 gives a formula for TRP where EIRP is a function of theta and phi. However, it is unclear what the proposed value of theta and phi is to convert from TRP to EIRP using MBIE's method. Should this be boresight values, should it include any down tilts? Should it be over the sector or over three sectors, what values of antenna losses shall we use?
- d. The methodology to convert TRP to EIRP assumes that users selected are always in the boresight of the antenna beam. The C band equipment has up to 8 beams, a selected user may or may not lie in the bore sight of the selected beam at the serving instant.

**Question 8: Do you agree with the choice of EIRP over the TRP?**

45. It will be premature to agree on this as definitions of TRP and its regulatory impact is the subject of WRC 19. We caution MBIE to change to EIRP in advance of what is agreed at the WRC.

**Question 9: Do you have any other comments regarding the out-of-band emission mask?**

46. Please see answer to question 6 above

## Compatibility with adjacent frequency bands

47. The 3.5 GHz band is adjacent to Amateur Radio and Short Range Devices (SRD) through General User Radio Licences (GURLs), in the frequencies below 3410 MHz, and to the C-band satellite downlink (space-to-Earth direction) in the frequencies above 3800 MHz.

## Lower adjacent below 3410 MHz

### **Question 10: Do you agree with the technical compatibility analysis between the amateur operation in 3300-3410 MHz and 5G (or compatible technology) in the 3.5 GHz band?**

48. We consider a part of this range also suitable to WISPs. If a 5G system operates in 3410 – 3800 MHz then any systems working in 3300 - 3400 MHz could be considered as systems in another band. Emission filters employed in 5G systems will reduce interference to the neighbouring band systems. The technical working group is to provide a separate report to this effect to MBIE.
49. The paper notes that the 3300 to 3410 MHz range is lightly used by amateurs. This is important spectrum that has been designated for 5G use in other markets and, as equipment is available and is standard compliant, is our proposed alternative location for WISPs.
50. The Ministry should consider whether amateurs – given the band is lightly used – require the full 110 MHz of spectrum allocated internationally for mobile use.

## Upper adjacent above 3800 MHz

### **Question 11: Do you agree with the technical compatibility analysis between SRD operation in 2900-3400 MHz and 5G (or compatible technology) in the 3.5 GHz band?**

51. The Ministry has indicated this band is:
  - a. A legacy allocation;
  - b. The current use is more likely to be ultrawideband; and
  - c. regardless there is a peak EIRP limit of -10 dBW, i.e. 100 mW
52. Accordingly, given the peak EIRP limit and the fact this would be adjacent channelled, it's likely that out of band power falling above 3400 MHz would be very low if coming from a SRD device.

### **Question 12: Do you agree with the arrangement for satellite services in the frequency range 3800-3840 MHz?**

53. By granting receive protection for satellite down links 3800- 3840 MHz, in effect MBIE is saying part of the spectrum close to 3800 MHz is un-usable and we even do not know how much. Furthermore, how will be implement receive protection? By forbidding UE's to come within an exclusion zone. This is impractical.

## Summary

### **Question 13: Do you agree that operators should be permitted to choose to not follow these technical principles as long as no harmful interference is caused to their adjacent operators?**

54. See above, we support only synchronised systems being deployed in the band.
55. Nonetheless, if the Ministry intends to permit unsynchronised operation in the band, then we agree this must be on the basis that it does not interfere with synchronised systems. We have recommended several changes to the proposal that minimise the practical implications of the Ministry's proposal.

**Question 14: Do you agree that the same technical principles should be imposed throughout the 3.5 GHz band?**

56. Yes.

**END**