5G TDD Synchronisation Q&A

Recommendations for the Coexistence of TDD Networks in the 3.5 GHz range

3.5 GHz TDD Synchronisation Q&A

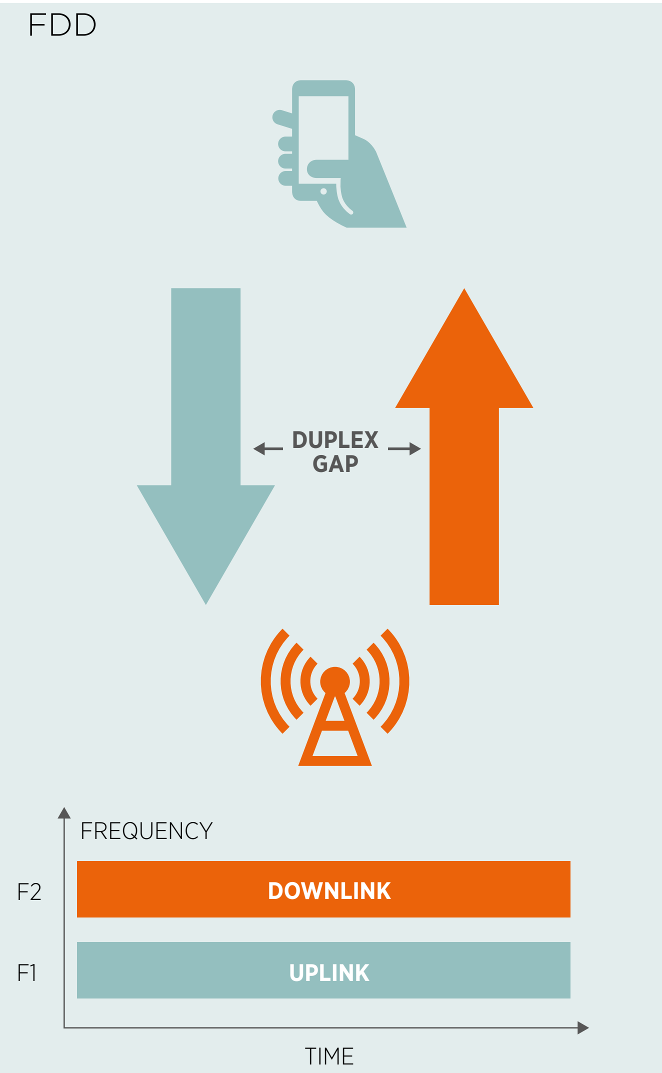
Contents

1. Why is the 3.5 GHz range so important?

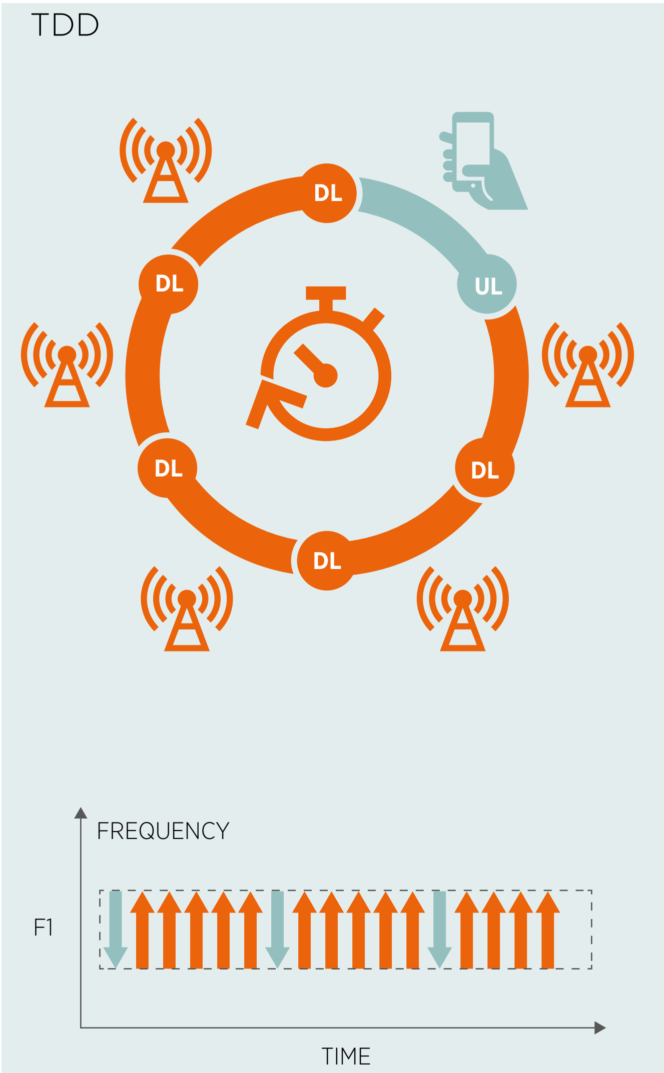
- The 3.5 GHz range (3.3 GHz-4.2 GHz) has quickly become the premier option for commercial 5G deployments worldwide. Its ability to provide coverage and capacity combined with spectrum availability makes it that ideal candidate; and
- This initial focus on one range is also resulting in a quickly developing ecostem, with the launch of increasingly affordable devices.

2. What are the differences between TDD and FDD, and why does that matter for 5G?

- In today's mobile networks, the amount of traffic between the user terminal and the base station (the uplink) and vice versa (the downlink) is often asymmetrical (because users download more than they upload);
- In FDD bands the channel size is the same for both directions. At the same time, more advanced features such as 256QAM modulation and higher order MIMO (4x4) are typically limited to the downlink, thereby supporting the increased download capacity demands;
- A focus on downlink capacity has worked out well so far. However, as traffic patterns are changing, more uplink heavy applications are anticipated (e.g. cloud storage and personal broadcasting) and flexibility with uplink and downlink spectrum usage is desirable; and
- To increase flexibility as well as make spectrum usage more efficient, Time Division Duplex (TDD) is becoming increasingly common and important. TDD uses the same frequency for each duplex direction, with a frame that includes different time periods and slots for uplink or downlink communications. By changing the duration of these, network performance can be tailored to meet different needs and help provide the best possible experience.



Two dedicated frequency bands at the same time



One dedicated frecency band but different time slots

3. What is synchronisation?

- To utilize the spectrum most efficiently, all TDD networks, either LTE or 5G, operating in the same frequency range and within the same area have to be synchronised. Base stations need to transmit at the same fixed time periods and all devices should only transmit in dedicated time periods.

4. Why is synchronisation a must for 5G?

- A key aspect of successful spectrum management is using available frequencies as efficiently as possible. The pay-off is higher speeds and better coverage, which leads to more innovative services and socio-economic benefits; and
- For 3.5 GHz and 5G that means using TDD synchronisation. Failing to do so, comes with a high cost. For example, the separation distance between two unsynchronised macro base stations/ networks is up to 60km for a co-channel configuration and up to 14km for adjacent channel operation, according to ECC report 296.

5. Are there any alternatives?

- Mitigation techniques such as using clutter (where, for example, buildings decrease signal propagation), antenna direction, reduced in-band power or both guard bands and filters between two networks using adjacent channels can also be considered for minimising the impact. Still, it should be noted that use of both guard band and filters is neither spectrally efficient nor commercially viable;
- The use of semi-synchronised networks where part of the frame is synchronised, while the other part of the frame is without coordination, results in possible coexistence issues during the unsynchronised periods; and
- In some countries, it should be noted that use of semi-synchronisation requires the use of restricted emissions and therefore the use of guard band and filters, hence again not providing spectral efficiency or commercial viability.

6. How is synchronisation achieved?

- Synchronisation between TDD mobile networks refer to parameters that make sure adjacent networks send and receive data from mobile devices at the same time, in order to avoid interference; and
- So, for a successful outcome, these parameters need to be agreed upon. They include:
  1. A common phase clock reference
  2. A common frame structure
  3. A timing reference (beginning of the frame
  4. A frame format

7. What frame structures does the GSMA support?

There are currently two main TDD formats considered by the ecosystem in 3.5 GHz range. They are:

- **DDDSU** (5G compatible format)
- The frame structure DDDSU provides best compromise for performance where coexistence between 5G NR systems is required; and
- **DDDDDDDSUU** (compatible with TD-LTE)
- The frame structure DDDDDDDSUU (with 3ms shift), or DDDSUUDDDD provide the best compromise for performance where coexistence with incumbent LTE systems is required.

8. What should countries do when there is LTE/WiMax networks in the 3.5 GHz range?

- The GSMA recommends that these systems, taking potential market distortion issues into account, are upgraded to 5G NR as soon as possible. That is a more efficient use of the spectrum, and can also make way for more innovative services;
- Alternatively, they could possibly be migrated out of the band or switched off, so that the public network performance is optimised to meet the needs of consumers and businesses;
- Considering there are very limited ecosystems for LTE and WiMAX in the 3.5 GHz TDD range, a solution should be possible without a negative impact on existing services; and
- In the meantime, coexistence between LTE and 5G NR networks within a country or a common coverage area can be achieved by selecting a compatible frame structure. However, it should only be considered as a short-term solution because a mandatory configuration prevents the industry to adapt to market demand.

9. What impact does synchronisation have on cross-border coordination?

To solve potential cross-border coordination issues, discussions between operators are encouraged. Where no agreements on the frame structure is found between operators across different borders, the following options to identify practical solutions to coexistence of networks are recommended:

- Localised change of frame structure (i.e. indoor usage);
- Network optimisation (such as base station location, antenna direction, and power limits);
- Protection of 4G systems should take into account their real deployment (i.e. take into account that they are mainly fixed wireless access systems);
- Downlink blanking where operators, on both sides of the border, agree to stop the use of some of their downlink slots when the other operators are using an uplink slot. Although, this will impact performance and may not be built in to all equipment, especially legacy 4G;
- A step-by-step migration based on the regional timings of 5G deployments and 4G migrations;
- Migrate 4G networks to a different band or to 5G technology;
- Commercial agreement between 5G operators and incumbent 4G operators (including acquisitions, re-farming, and reprogramming);
- Reduce capacity near the borders, i.e. by only using a part of allocated spectrum;
- Use alternative bands within the cross border area (including existing bands, mmWaves, additional new/temporary frequencies, or LSA in a different band);
- Avoid co-channel use and aim to have operators only using adjacent channels – temporaryband plan at the border; or
- Use club licences, spectrum and infrastructure sharing along borders.

The GSMA suggests countries also agree on acceptable signal strength levels at borders (on a bilateral, multilateral or regional level). These agreements should aim at allowing the 5G rollout, including in the border areas. Operators should therefore take part in the discussions.

10. How should local synchronisation demands be handled?

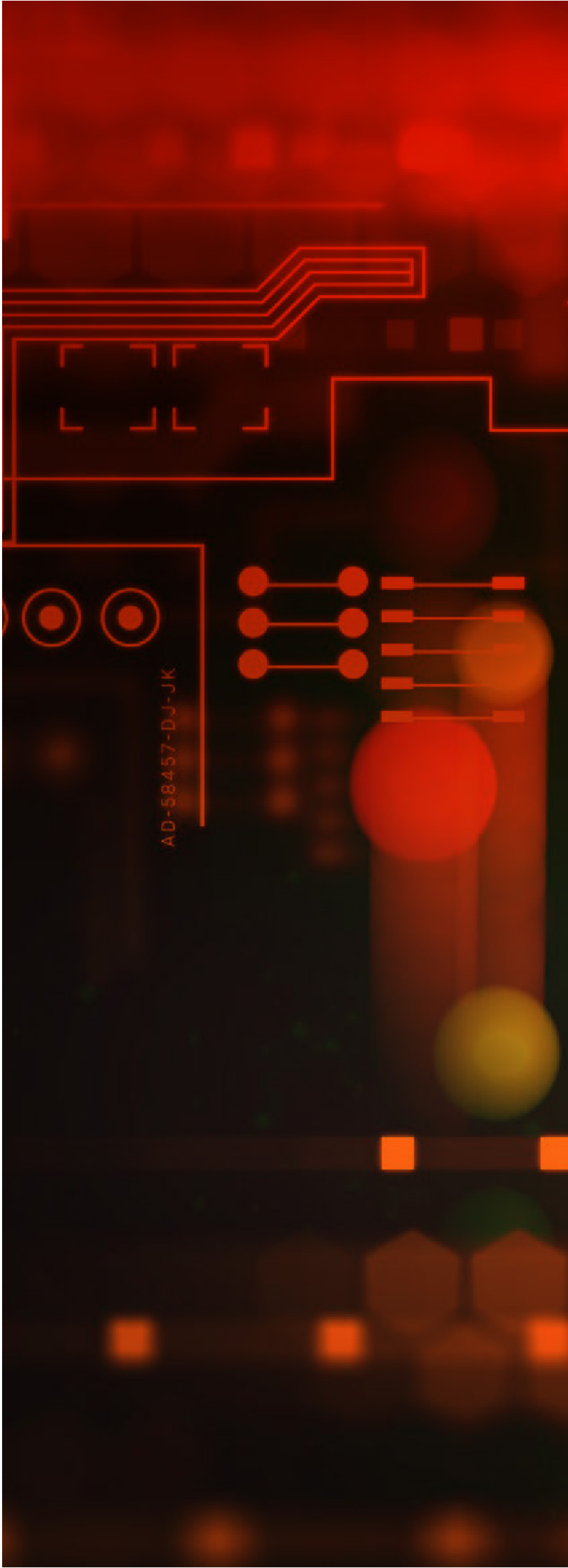
- Network requirements may need to vary locally to address special needs from users such as verticals or events. To meet these requirements, operators should be allowed to propose changes to the frame structure at local level; and
- As part of the process, other operators in the band should be consulted to ensure no additional interference occurs due to the changes. Alternatives to changing the national agreement include:
- Localised change of frame structure;
- Network planning (for example, base station location);
- DL blanking (i.e. not use some of the download slots); and
- Time-limited usage (investigate accelerating the migration of LTE systems or delaying the deployment of 5G NR where the clashes are likely)

11. What impact does synchronisation have on spectrum licensing?

- The initial national TDD synchronisation parameters are defined and made public before awarding the spectrum. Operators need to be able to evaluate the usability of the spectrum when preparing for an award, and synchronisation impacts that; and
- Unless the award conditions are clear, there is a risk that only one operator (by not agreeing or failing to synchronise) can cause severe difficulties for the others.

12. How can governments and regulators future-proof their approach to synchronisation?

- As 5G use cases and network requirements evolve over time, operators should periodically be able to trigger a process to propose changes to the previously agreed TDD synchronisation parameters at national, local, or international level; and
- This process should be defined through engagement between policymakers and mobile operators.



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