May 10, 2014

John Glover
The Office of Communications (Ofcom)

Subject: Comments on "PSSR: Technical coexistence issues for the 2.3 and 3.4 GHz award"

Dear Mr. Glover,

The Global TD-LTE Initiative (GTI) is pleased to be able to respond to Ofcom's consultation "PSSR: Technical coexistence issues for the 2.3 and 3.4 GHz award". This response has been prepared by the Spectrum Working Group of GTI[1].

GTI (Global TD-LTE Initiative) is an open platform in 2011, advocating cooperation among global operators and vendors to energize the creation of a world-class and a growth-focused business environment. GTI aims to build a robust ecosystem of converged LTE TDD/FDD, and speed up its commercialization. With 3 years' development, GTI has become one of the most important cooperation platforms with 106 operator members and 84 vendors.

Accordingly we welcome the initiative by the Ofcom to open 190 MHz of the 2.3GHz and 3.4 GHz band in a way that is consistent with an unpaired (TDD-compatible) band plan only, which aligns with our interest. We believe such an action of Ofcom will be a strong impetus to the global mobile market and TD-LTE ecosystem.

General view on the 2.3 and 3.4GHz bands award

We think it is very wise for Ofcom to consider the two bands mainly for high power 4G mobile system deployment, which is the most attractive area of

[1] Individual members of GTI may respond separately and their views may be different to those in this document. We note that Vodafone did not endorse this contribution and their view will be given in their response.

wireless and mobile operators. As the latest advanced mobile network technology, Long-Term Evolution (LTE) will contribute to maximize the social and economic value of spectrum, especially in the case of wide area deployment.

In general, we agree with Ofcom's studies that the high power LTE on 2.3GHz and 3.4GHz bands could coexist with most of the existing systems on adjacent bands. Even some systems, such as Wi-Fi and radar, may encounter the interference from LTE, mitigation techniques and coordination procedure respectively could be used to reduce the interference to an acceptable level. In the case of Wi-Fi, the legacy equipments with interference risk may meet difficulties to apply the mitigation techniques in some scenarios. It is also expected the natural technical evolution will help to upgrade the Wi-Fi systems with improved filtering, which depends on the Wi-Fi Alliance (WFA) to enhance the Wi-Fi requirement in coming years. Thus, the available guard band will also affect the probability of interference occurring.

Considering the commercial rollout will begin in 2016 at the earliest, the mobile wideband access will be a common requirement of subscribers using 2.3 GHz and 3.4GHz bands, and LTE-Advanced technology aggregating multiple carriers will be widely deployed by operators to meet the demand of user rate. Therefore, GTI suggests considering the spectrum requirement of LTE-Advanced technology to facilitate operator providing higher data rate for end users, and licensing the spectrum in large blocks, such as 20MHz for 2.3GHz and no less than 40MHz for 3.4GHz.

In addition, GTI suggests licensing with a clear decision on full synchronization or un-synchronization and the relevant technical conditions, in order to remove the uncertainty of delaying on utilization of the spectrum via reducing the BS and UE implement variances. Due to the spectrum utilization and especially the equipment cost consideration, GTI recommends a full synchronization approach. For the 2.3GHz band with only 40MHz, it is in greater need to adopt full synchronization to avoid the spectrum waste of a guard band.

Feedback for the consultation questions

With regards to the consultation questions of the technical issues for the 2.3GHz and 3.4GHz award, we would like to explain the views and comments on several aspects as below.

1. TDD synchronization & un-synchronization technical licence conditions

Question 13.1: Do you agree with our preference not to have a transitional region between blocks for licences in the 2.3 GHz band?
Question 13.2: Do you agree with our preference not to have a transitional region between blocks for licences in the 3.4 GHz band?

Question 13.3: Do you agree with our preference to not require synchronisation between different networks in the frequency band?
Question 13.4: Do you agree with our preference to include both the permissive (unsynchronised) and restrictive (synchronised) masks within the TLCs in the 2.3 GHz band?
Question 13.5: Do you agree with our preference to include both the permissive (unsynchronised) and restrictive (synchronised) masks within the TLCs in the 3.4 GHz band?
Question 13.6: Do you agree with our preference to not require synchronisation between different networks in the frequency band?

When several TDD networks are overlaid on the same geographic areas in the same band with adjacent channels, the severe interferences of DL to UL or UL to DL may happen if the networks are uncoordinated. As for the 2.3GHz and 3.4GHz bands, the usable spectrum is abundant thus it is quite possible to be shared by different operators in adjacent channels.

Specific considerations are needed for the synchronization or un-synchronization deployments.

The synchronization networks assume the following technical conditions to ensure that "no simultaneous uplink and downlink occur" as discussed in GTI whitepaper[2]:

- Starting the frame in the same time;
- Configuring compatible frame structures (Uplink Downlink configuration and Special subframe configuration) so that all transmitter stop before any receiver starts;
- The normal case is requiring identical UL/DL configuration and compatible special subframe configuration (e.g. no conflicting UL/DL OFDM symbols) between networks.

With the network synchronization, no interference will occur between DL and UL. However the above technical conditions for synchronization need to be coordinated among multiple operators. If more than 2 operators are using the same band then a bilateral agreement may not be enough, in that case agreement among all relevant operators is needed. With network synchronization, the BEM could follow the preferred BEM demonstrated as Figure 13.1 (i.e. option 3 in Figure 13.6), where the Transition region = 0 MHz, and there will be no need for an internal guard band. The benefits and cost are clearly described in the Ofcom PSSR. As mentioned, if licensees are synchronized or agreed to use the more permissive mask, it is easier for a licensee to meet the required out of block emissions without the need for a stringent limitation on RF filtering.

[2] GTI, "GTI White Paper on TDD Synchronization", http://www.lte-tdd.org/Resources/rep/2013-11-11/1409.html.

For un-synchronized networks, the transition region, restricted block or internal guard band need to be considered together with the restrictive mask. It may introduce additional requirements on the equipments or additional limitations on spectrum usage. The actual cost for fulfilling the restrictive mask highly depends on the frequency offset between the operating spectrums of operators. Especially for a small cell radio, the low cost technology can only provide some rejection at large frequency offset. It is difficult to implement a size & cost effective small cell BS with e.g. only 5MHz guard band.

The Ofcom preferred block edge masks in Figure 13.1 does not limit network operation in terms of synchronization or unsynchronization. However, it has the benefits of higher spectrum efficiency and allowing higher output power in synchronization case.

GTI has the view that it is better for the regulator to decide on full synchronization or un-synchronization when licensing, in order to remove the uncertainty or delay in spectrum utilization and reduce the BS and UE implement variances. The relevant technical conditions are also desirable to be decided as license conditions when licensing.

- The un-synchronization case will be more complicated than the synchronization case, with regards to the bandwidth of guard band(internal or intranet)/transition region/restricted blocks where the exact offset may be different for the restrictive mask according to bilateral discussion.
- For the synchronized case, the effort beforehand prior to the licensing is needed to coordinate the operators for synchronization parameters. GTI has the view it is good to clearly indicate the synchronization configuration as technical license conditions, e.g. UL/DL configuration and special subframe configuration to be used by multiple operators.

And due to the spectrum utilization and especially the equipment cost consideration, GTI slightly prefers the option 4 “Permissive mask only” in Figure 13.6, where only a permissive mask would be required for co-operation between licensees. It should be mentioned that regulatory effort is needed to facilitate the operator coordination to ensure the interference free deployment and better spectrum utilization as mentioned above. Although the licensees may acquire spectrum for different business models that require different traffic profiles due to deployment demand, it is still possible for the licensees to select a sub-optimized common configuration among each other. For example as the performance shown in figure 13.5, it is possible that the sub-optimized TDD configuration may still achieve higher system performance than the un-synchronization case.

In China, both 2.6GHz and 2.3GHz band have been allocated for multiple operators, e.g. 2.6GHz band for CMCC, CUC and CTC, and 2.3GHz band for CMCC and CUC with adjacent channels. Full Synchronization is mandatory between multiple operators within the same band and no guard band is reserved.

It is agreed under the RRB (Radio Regulatory Bureau) coordination that the exact synchronization configurations should be applied among operators, including coordination on frame starting time, UL/DL configuration and special subframe configuration. Moreover, it also set a rule to coordinate the unsynchronized interference caused by out of sync. Those could be reference information for Ofcom.

2. Coexistence issues between LTE and Wi-Fi

Question 6.1: Do you have evidence to challenge our methodology and assumptions, which show the number of Wi-Fi routers likely to be affected by LTE interference is low?
Question 6.2: Do you have evidence to challenge our methodology and assumptions, which show the number of Wi-Fi client devices affected by LTE interference is low?
Question 6.3: Do you agree with our assessment of the available options for mitigation of interference to home networks?
Question 6.4: Do you agree with our assessment of the available options for mitigation of interference to public networks (both indoor and outdoor)?
Question 6.5: Do you agree with our assessment of the available options for mitigation of interference to Enterprise Networks?
Question 6.6: Do you agree with our conclusion that the impact to Wi-Fi is not of a significant nature and therefore no regulatory intervention is necessary? If not, can you provide evidence?

GTI agree with Ofcom that the impact from LTE on 2.3GHz band to Wi-Fi on 2.4GHz band is not expected to be a major problem for many devices, especially newer ones which may incorporate better filtering. However, legacy Wi-Fi devices will have a range of different receiver filtering characteristics and some may be more vulnerable to interference than others.

According to the Wi-Fi device usage in UK, only a proportion of the Wi-Fi devices have the risk to suffer the interference from LTE system, which may cause a speed drop on the Wi-Fi link. However, it will be severe in some cases. From our field test[3], LTE and Wi-Fi devices considered in that study, in which LTE operated below 2370MHz, can coexistence in most cases. Wi-Fi AP receiving performance (uplink) will decrease by 64% when there's a LTE eNB within 1 meter isolation. Wi-Fi client device receiving performance (downlink) will decrease by 41% when there's a LTE UE within 0.5 meter isolation. The Ofcom proposal is to extend the LTE band up to 2390MHz. In general the larger the guard band the more effective will be filtering in reducing interference risks.

Although interference could be avoided or mitigated in most circumstances, there remains a coexistence risk between LTE and WI-FI. As Ofcom plans to commence an auction process of 2.3GHz and 3.5GHz bands in the second half of 2015, and the new LTE services will be deployed from 2016 at the earliest, the natural evolution of the market and regular network/device upgrade over the next

[3] GTI, "GTI TDD Spectrum White Paper", http://www.lte-tdd.org/Resources/rep/2013-11-11/1407.html .

few years will help to reduce the issue in the long term if effective filtering is built into new Wi-Fi devices and sufficient guard band is correspondingly allowed for.

Some Wi-Fi devices are sensitive to the interference on the adjacent channel(s), which is mainly due to its poor receiver blocking performance. It is derived from no receiver blocking specification in the Wi-Fi standard which was developed many years ago. Currently, the Wi-Fi Alliance (WFA) has recognized the problem and optional filtering for carrier grade systems may be proposed. Furthermore, devices from many leading manufacturers, such as Huawei, ZTE and H3C already meet this new requirement.

Therefore, we believe that Ofcom's decision on 2.3GHz band spectrum award should be used to urge the WFA to release the new Wi-Fi specification. GTI could like to cooperate with Ofcom to promote the WFA and industry to improve the performance of Wi-Fi devices.

3. Coexistence issues between LTE and ATC

Question 11.1: Do you agree with our proposal to require coordination procedures for the 3.4 GHz band - in order to protect of air traffic control radar - in line with those applied to the 2.6 GHz band?

We fully agree to ensure satisfactory on-going ATC/ATM (Air Traffic Control and Air Traffic Management) service operation when taking into account deploying new communication system on the 3.4 GHz award band. There is a possibility that high power communications networks operating in the 3.4 GHz band may cause interference to ATC/ATM services in the 2700 to 3100 MHz band. However, just what the radar manufacturers said, according to a number of completed studies, the risk of harmful interference to ATC/ATM from communications transmissions operating at 3.4 GHz was less than the risk of interference from similar systems at 2.6 GHz. The main reason is due to over 300 MHz distance existing between the 3.4 GHz band and air traffic control radar, totally different from the 2.6 GHz scenario. Under this wide distance, RF filter operating in 3.4 GHz band could provide much better OOB interference suppression capability (at least dozens of dB) than its in 2.6 GHz band. Although the additional bandwidth of 3.4GHz release band introduces up to 2 dB more aggregate signal, the interference on the radar from 3.4GHz band, which has been suppressed by the RF filter, will be much lower than that from 2.6GHz band.

To conclude, in order to protect air traffic control radar, a certain power flux density (pfd) level is a must for 3.5 GHz band but no need to completely apply the same pfd across the band in the 3.4 GHz band as the 2.6 GHz band. Considering a more reasonable pfd level on 3.5 GHz award band is a necessity.

If you have a question, comment or suggestions regarding our submission, please send your feedback to my attention.

Yours truly,

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