APPENDIX

I. COEXISTENCE AND COLLOCATION

Coexistence of two or more wireless systems in adjacent frequency bands in the same and/or adjacent geographical areas is an issue that is not limited to the case of TDD-FDD interaction or the circumstances surrounding the 1910-1930 MHz band. Coexistence of competing carriers has always required coordination procedures and rules. These may seem to impose an additional burden on the carriers but the long-term benefits of enabling competing carriers and technologies to coexist outweighs the short-term impediments.

Collocation occurs when two or more wireless systems operating in adjacent bands are deployed at the same site; e.g., rooftop, tower, etc. This is a potential problem for every wireless communication system because of a shortage of suitable sites especially in urban areas. For instance, cellular and PCS operators have always needed to solve collocation problems among each other through careful site engineering practices. Such practices include antenna placements, antenna orientations, and customized shielding. This problem will continue to exist irrespective of the underlying technologies and air interfaces as long as adjacent channels are being used at the same site.

Discussions of coexistence and collocation often mix the two concepts, as is the case in some of the documents cited by Motorola. Coexistence does not necessarily include collocation. It is essential to understand each and distinguish between the two. Each requires its own solution.

II. REVIEW OF THE DOCUMENTS CITED BY MOTOROLA

In its filings with the Commission in this proceeding, Motorola referred to certain papers presented to international regulatory and standards bodies to support its opposition to TDD spectrum allocations.[1] These papers (mostly presented to ITU-R Working Party 8F) are summarized below. It should be noted here that these documents are merely contributions from participating parties that reflect the views of the presenters and are not final recommendation or approved texts produced by the ITU.

A. ITU-R 8F/335: Compatibility Analysis of IMT-2000 (UMTS 1800) Downlink and GSM 1900 Uplink in Adjacent Frequency Bands, Contribution from Motorola S.A. to ITU-R, Working Party 8F

The above-referenced document presents the results of a statistical analysis aimed at finding the likelihood of interference between two FDD systems in adjacent bands but opposite duplex directions with various guard band values. The analysis is applied to UMTS FDD and GSM 1900. Despite Motorola's reference to this document[2] in this proceeding, the study in 8F/335 concludes that Minimum Coupling Loss (MCL) of 50-60 dB is required between the two systems' base stations antennas to bring the interference down to acceptable levels.[3]

B. ITU-R 8F/242: Potential Guard Band Requirements Between 1800 MHz and 1850 MHz, Contribution from Canada to ITU-R, Working Party 8F

This document deals with the same FDD-FDD problem as discussed above; i.e., collocation

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1 Comments of Motorola, Inc., pp. 15-18.

2 Ibid, p. 17.

3 ITU-R 8F/335, Compatibility analysis of IMT-2000 (UMTS 1800) downlink and GSM 1900 uplink in adjacent frequency bands, contribution from Motorola, Section 4, Conclusion, p. 6.

of FDD 3G and 2G PCS and the guard band required. It concludes that 5 MHz of guard band as well as coordination between the FDD systems is essential in most cases, given current specifications. The analyses are performed for absolute worst-case scenarios "which is unlikely in many situations."[4] Motorola cites this document to conclude that "mobile terminals would have to be separated by relatively large distances in order to reduce interference levels below acceptable levels."[5] This conclusion is misleading, however, since a look at the cited ITU document reveals that immediately after stating the problem, the authors add "In most scenarios, handsets will be operating well below the regulatory maximum, path loss will be much higher than free-space loss and interference will be limited and not impact service."[6]

C. ITU-R 8F/375, Attachment 8.6: Report of the Fifth 8F Meeting in Stockholm, 27 June – 3 July 2001.

This document is a collection of several papers contributed by various parties. Parts of this collection present conflicting assumptions and results. *As a whole, the document is a work in progress that was numbered as Document 8F/TEMP/183-E after the 6th 8F meeting in Tokyo in October 2001.* Since this is a TEMP document, it is premature to draw conclusions on the material discussed. Some of the conflicting arguments include the treatment of antenna gains and Minimum Coupling Loss (MCL) for collocation and coexistence studies.

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[4] ITU-R 8F/242, Potential guard band requirements between 1800 MHz and 1850 MHz, Contribution from Canada, Section 3.3, Analysis Results, p. 4.

[5] Comments of Motorola, Inc., p. 16.

[6] ITU-R 8F/242, Potential guard band requirements between 1800 MHz and 1850 MHz, Contribution from Canada, Section 3.3, Analysis Results, p. 4.

D. ITU-R 8F/410: Interaction of TDD and FDD Systems: Interference Related to Cell Collocation of Adjacent-Band TDD and FDD Systems, Contribution from United States of America to ITU-R WP 8F

A portion of this contribution is included in the document 8F/TEMP/183-E discussed above. The document, in its original form, concludes that 5 MHz of guard band is not enough for collocation. The conclusions are based on an MCL of 30 dB.

E. R4-011277 to 3GPP TSG-RAN Meeting #19, Edinburgh, Scotland, Sept. 3-7, 2001

While Motorola cites the above-referenced document as an ITU document that indicates the minimum necessary guard band,[7] it is actually a change request document that suggests additional text to 3GPP specifications Release 99 on minimum blocking requirements for collocation cases involving UTRA TDD systems. The actual additional text is quoted below.

> The current state-of-the-art technology does not allow a single generic solution for co-location with UTRA-TDD on adjacent frequencies for the same 30dB BS-BS minimum coupling loss used to calculate the requirements in 7.5.1 and 7.5.2. However, there are certain site-engineering solutions that can be used. These techniques are addressed in TR [TBD].[8]

There are two important points in the above quoted text: assumption of the 30 dB MCL, and site engineering solutions, both indicating that the collocation issue does not have a generic solution.

III. DISCUSSION OF THE FOREGOING DOCUMENTS

In many places in the above documents, reference has been made to the early versions of 3GPP document TR 25.942 as the basis for the assumption of 30 dB of MCL for collocation studies. This assumption is clearly unrealistic given site engineering practices and the reality of

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[7] Comments of Motorola, Inc., p. 16.

[8] TSG-RAN, R4-011277, Section 7.5.3 Minimum Requirements – Co-location with UTRA TDD.

antenna installations on rooftops or towers. Based on an independent study done by Allgon,[9] the results of which have been presented to TSG-RAN WG4 (Radio), even 60 dB of isolation is easily achievable with separation distances of less than a meter. This is 30 dB less than the assumption in the documents discussed above and directly leads to 30 dB less interference from one collocating system into another. In many cases, this alleviates the collocation problem and makes it quite easy to achieve.

Coexistence, however, is a different problem to solve. Coexisting systems may or may not collocate. In order to make coexistence possible, one needs to look at realistic, potential deployment scenarios including license areas of operation, antenna locations, cell architecture and reuse patterns, amount of spectrum, etc. These factors obviously vary from case to case. Therefore, while deterministic calculations are appropriate for collocation analysis, statistical approach is a necessity for modeling coexistence. As with any other analysis, statistical analyses also require realistic input. For instance, the analysis of coexistence of two systems in adjacent bands in a dense urban area must not use a free space propagation model as the basis for calculating path loss. The document referenced by Motorola, however, assumes unrealistic parameters in regard to antenna height, gain, and downtilt.[10] Specifically, all base station antennas are assumed to be directing their maximum energy towards each other at all times. This assumption results in excessive interference power, which directly affects the presumed safe coexistence distance. While this scenario may happen, a statistical analysis can reveal the

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[9] Antenna-to-antenna isolation measurements, TSG-RAN WG 4 (Radio) Meeting #8, Sophia Antipolis, France, 26-29 October 1999.

[10] ITU-R 8F/375, 5th meeting report, ITU-R WP 8F, Meeting Report of Working Group Spectrum, Appendix 8.6, section 2.5.4 Resulting Antenna Gain.

likelihood of such interference and its effect on the coverage and capacity of each of the systems involved. A much more realistic approach with regard to antenna assumptions has been presented in ITU-R WP 8F/422. This more realistic approach is now included in the 8F/TEMP/183 document which will be finalized in the next 8F meeting in February 2002. Based on the analyses in this document, the coexistence of various TDD and FDD 3G systems is manageable with minimal guard band requirements and with minimal effect on system performance.

IV. CONCLUSION

Inefficient use of the spectrum and/or suppressing innovative new technologies is not the solution to coexistence problems. Essentially, guard bands are an inefficient use of spectrum, particularly given the current bandwidth shortage and the availability of new techniques allowing the more efficient use of spectrum. Coexistence scenarios need to be categorized, analyzed, and suitable coordination and harmonization procedures and rules should be laid out for each scenario. Coexistence is a multi-variable optimization problem. There are several factors that affect the final numbers including guard bands, filter specifications, and interference mitigation techniques. Trying to find the solution by optimizing only one variable, i.e., spectrum, produces only a sub-optimal solution.

According to document ITU-R 8F/242, mentioned earlier, almost all spurious and out-of-band emission specifications out of 3GPP are flat beyond a 5 MHz offset, thus, a larger guard band will not change the situation. On the other hand, current filter technology is able to provide additional isolation needed to help coexistence at reasonable cost. Also, interference mitigation techniques, including spatial processing of wanted signals utilizing adaptive antennas, have

proven their capabilities in reducing the overall interference floor as well as suppressing specific interfering signals and, therefore, helping coexistence.

Last but not least, site engineering can potentially eliminate many coexistence problems. Guard bands and/or filters no matter how reasonable and practical, do not obviate the need for prudent site engineering practices. Contrary to the inference that can be drawn from the comments of Motorola, guard bands are not the sole path solution to coexistence. Guard bands are one of several techniques, which taken together, can often manage interference and achieve acceptable coexistence.