Introduce the FWA in the Band 3300-3400 MHz

Lway F. Abdulrazak, Zaid A. Shamsan, Ali K. Aswad, and Tharek Abd. Rahman

***Abstract*—**This paper gives a study about forging solution to deploy the fixed wireless access (FWA) in the band 3300-3400MHz instead of 3400-3600MHz to eschew the harmful interference between from the FWA towards fixed satellite services receiver presented in this band. The impact of FWA services toward the FSS and the boundaries of spectrum emission mask had been considered to calculate the possible Guard band required in this case. In addition, supplementary separation distance added to improve the coexistence between the two adjacent bands. Simulation had been done using Matlab software base on ITU models reliance on the most popular specification used for the tropical weather countries. Review the current problem of interference between two systems and some mitigation techniques which adopted in Malaysia as a case study is a part of this research.

***Keywords*—**Coexistence, FSS, FWA, mask.

I. Introduction

LICENSES for Fixed Wireless Access (FWA) in the 3400 – 3600 MHz band, among preferential bands for Fixed Wireless Access (FWA), identified by ITU-R and CEPT/ERC REC, cover operation in a single paired frequency block [1]. Licenses were awarded for geographical regions throughout the tropical countries as a primary served for FSS [2]. This requires certain procedures to place, in order to assist co-existence and co-ordination. In that band, CEPT/ERC REC14-03 recommends channel arrangements that, for Point-to-Multipoint (PMP) systems, are primarily based on multiple slots of 0.25 MHz with possible duplex spacing of 50 and 100 MHz, but also other rasters (multiple of 1.75 MHz) are provided in the recommendation [3]. However, none of the above mentioned recommendations gives any further guidance on the assignment rules among different operators, or different service types, in either co-ordinated or uncoordinated deployment in the band 3300-3400 MHz, leaving to administrations to decide on any further limitations (e.g. in term of EIRP limitation, guard-bands, co-ordination distance, etc.). Also no guidance is given within the referenced documents on how sharing should be managed between PMP FWS that use spectrum adjacent to non-MP services [1].

L. F. Abdulrazak is with Wireless Communication Center, Faculty of Electrical Engineering, Universiti Teknologi Malaysia, 81310 Skudai Johor, Malaysia (phone: +60-177384690; e-mail: audayt@yahoo.com).

Z. A. Shamsan is with the Wireless Communication Center, Electrical Engineering Faculty, Universiti Teknologi Malaysia, 81310 UTM Skudai, Johor Bahru, Malaysia (phone: 0060-177687427; e-mail: shamsan22@yahoo.com).

A. K. Aswad is with Wireless Communication Center, Faculty of Electrical Engineering, Universiti Teknologi Malaysia, 81310 Skudai Johor, Malaysia (phone: +60-0176434135; e-mail: ali_altmimi@yahoo.com).

T. A. Rahman is director of Wireless Communication Center, Faculty of Electrical Engineering, Universiti Teknologi Malaysia, 81310 Skudai Johor, Malaysia (e-mail: tharek@fke.utm.my).

Those bands, even if being of limited size, are valuable because they provide for quite wide cell coverage when Line-of-Sight (LOS) rural conventional deployment is considered, as well as connections with partially obstructed (Non-LOS, NLOS) paths and even with simple self-deployable indoor terminals, which is important feature for deployments where simple and cost-effective radio-access connections are desirable. Therefore the bands around 3500 MHz are potentially interesting for a quick growth of domestic/small business access connectivity of moderate capacity, typically for ensuring the policy goals of proliferation of broadband Internet (IP) connections (e.g. in accordance with EU e-Europe action plan).Nowadays different system capacities, modulation formats (e.g. 4 or 16 states using Single Carrier or OFDM) access methods (e.g. TDMA, FDMA, CDMA and OFDM/OFDMA), system architectures (PMP and MP-MP), duplex arrangements (TDD and FDD) and asymmetry (different up-stream/down-stream traffic as typically needed for IP-based access) are exist in the market, but the main focus of this paper is to cover the simplest mixed TDD and FDD systems as a most used technology. We have to mention that each technology offers to operators specific benefits for specific market segments/characteristics; some of these technologies would enlarge the field of possible applications, for instance to nomadic applications for indoor terminals [3]. We will take the same region – block edge mask, typical ETSI mask positioning, flow diagram for the co-ordination process as a considered parameters.

The remainder of this paper is organized as follows. In section II, the current problem of interference and interference scenarios had been discussed in conciseness. Section III is devoted to describing the system parameters. Section IV discussed the adjacent band division. In section V we concluded the mask idea and we illaburated in the case study in section V. Finally, conclusions are presented in Section VII.

II. Current Problem

Tropical weather countries are facing serious problems regarding the interference between the Fixed Satellite Services and the Fixed Wireless access [4]. Depending on the C-Band for these countries is vital issue because of rain attenuation effect for the high frequencies. On the other hand we have a Fixed Wireless Access have being deployed to work on a part of C-band from 3400-3600MHz, as clarify in Malaysian spectrum plane Fig. 1.

Fig. 1 Malaysian spectrum plane for 3400-4200MHz

Some countries gave the priority of using C-band to the FSS services, and regulation made to keep a separation distance between the both services according to the ITU-R studies, beside the clutter loss consideration we may not be able to deploy both FSS and FWA services in the same area because of the interference [4], as elaborated in Fig. 2.

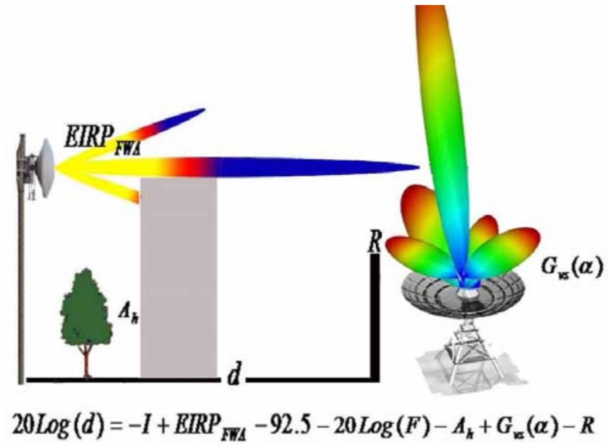

Fig. 2 Separation distance formula within the clutter loss effect when A_k is a factor related to the territories, D is distance, R is the shielding loss, EIRP: is the radiated power from the FWA transmitter, F is the frequency and G_{vs} is related to the typical receiving FSS antenna gain

This separation distance will be come a very huge distance which is impossible we rely on because of the high sensitivity of FSS receiver, since the FSS signal is very week for the Geostationary satellite station which is 36000 kilometers faraway from the earth, figure below (Fig. 3) shows the maximum acceptable in-band interference between the two services.

A way for enabling the coexistence of both systems would be to introduce a large geographical offset between two systems if we didn't deem the guard band and improve adjacent channel leakage ratio (ACLR) and adjacent channel system (ACS) of equipment [5].

Co-located and non co-located base stations will require additional filtering and site engineering to facilitate coexistence between the two systems [5].

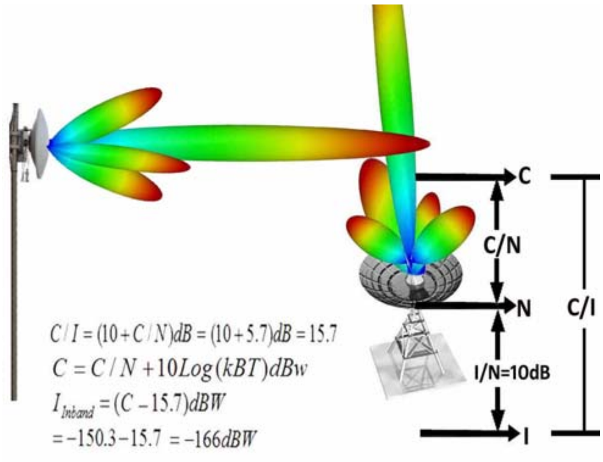

Fig. 3 Maximum acceptable in-band interference between FSS and FWA, when I: is the interference level, C is the carrier signal, N is the receiver noise level

III. Specifications

A. FSS specifications

For Malaysia as a case study the fixed satellite service is allowed to work within 3.4 to 4.2GHz, and the frequency bandwidth is varying from 4 KHz to 72MHz, base on different use. Following table is describe the typical FSS earth station already in use by Petronas station (fuel stations).

TABLE I
FIXED SATELLITE SERVICES SPECIFICATIONS

Specifications	Satellite terminal
Antenna diameter (m)	2.4
Gain (dBi)	38
Antenna diagram	ITU RS.465
Noise temperature	114.8oK
Elevation angle	75.95
Azimuth	263.7
I/N	-10dB
I	-166dB
Fc	3436MHz
Receiver bandwidth (MHz)	72

B. Fixed Wireless Access Specifications

In Malaysia the frequency range (3.4-3.6) GHz is allocated for FWA systems, It is divided into sub-bands for duplex use (non duplex systems can still be used in this band), 3400–3500 MHz paired with 3500–3600 MHz. However, Countries have various frequency channel spacing within the 3.5 GHz bands 1.25, 1.75, 3.5, 7, 8.75, 10, 14, and 28 MHz can be used according to capacity needs. Currently, this services had been stopped because of there impact on the FSS receivers. Alternatively, if we change the parameters defiantly we will gate a grate change in the interference upshot. So, we will be focused on the parameters listed in Table I and we had considered that the FWA working band is 3300-3400MHz [6].

TABLE II
FIXED WIRELESS ACCESS SPECIFICATIONS

Specification	FWA(TS)
Tx Peak output power (dBm)	36
Channel bandwidth (MHz)	3.5
Peak BS antenna gain (dBi)	15
Antenna gain pattern	ITU-R F.1336
Base station antenna height (m)	30
Noise figure (dB)	7
Interference Limit Power (dBm)	-109

IV. FINDING THE ADJACENT BAND

To use the FWAP2MP in the band (3300-3400), interference will appear according to the out of band emission of FWA which will have the impact on the FSS receiver. This study has covered the minimum possibility of interference by proposing 3.5MHz bandwidth for each sector in the FWA Base station, so the band described in Fig. 4.

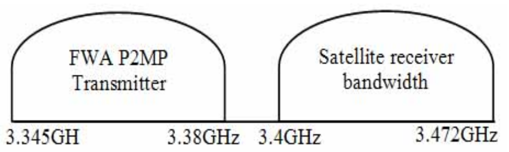

Fig. 4 Proposed scenario

This scenario is covered the possibilities of deployment two FWA operators in the band 3.3-3.4 and the impact on the FSS receiver, the FSS receiver bandwidth is exactly in the adjacent channel within 72MHz band width. 20MHz as Guard band between two services (FSS and FWA), as clarified in Fig. 5.

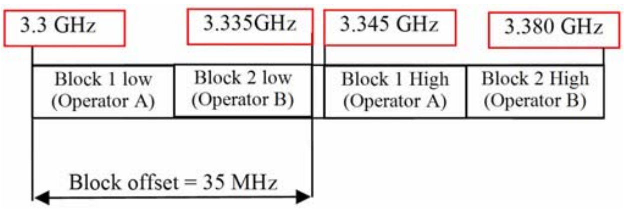

Fig. 5 Guard band between two operators

For the examples of P2MP FWA applications, it appears that most of them are designed for a cell coverage methodology of "reuse four", using four frequency channels with separation of typically 3.5 MHz.

The channel size of system is in practice constant at 14 MHz (3.5X4), the recommended assignment methodology provides for blocks composed by 14 MHz channels, keeping, for mixed TDD and FDD licensing, one further channel as guard band (total is 17.5MHz).

Therefore, for contiguously adjacent, technology neutral blocks that may need to contain also suitable guard bands inside those blocks, this would require block sizes that would exceed the 4 x ChS by an amount of one additional channel. Therefore in such cases of contiguously assigned blocks, typically required block sizes might be in the order of:
System channel raster 3.5 MHz: Block size B=~17.5MHz

But, if an external guard bands are employed between the assigned blocks, then the suitable size of assigned blocks should be equivalent just to the sum of 2 reference channel bandwidths.

V. FWA MASK

The Fig. 6 below explained how much Guard and we need to reduce the interference to Zero, However the signal received from of FSS receiver shouldn't exceed the interference level -166 dB [2].

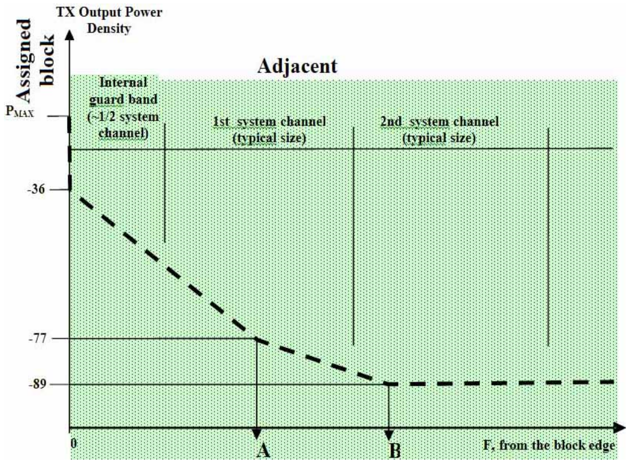

Fig. 6 Suppression mask of 3.5MHz bandwidth for FWA

We can conclude the result of the mask simulation into a table as described in Table III.

TABLE III
FREQUENCY MASK BOUNDARIES

Frequency offset break points for the mask	Definition (% of the size of the assigned block)
A (-77dB)	20%
B (-89dB)	35%
C (-123dB)	75%
D (-166dB)	113%

Theoretically, Since 1.75 of the system channel typical size equal to 35% of the size of the assigned block. So, 113% of the size of the assigned block equal to 5.65 of the system channel typical size.

Thus; Minimum Guard band required is: 5.65 x 3.5=19.775MHz

VI. CASE STUDY: BLOCK EDGE SPECTRAL DENSITY MASK OF FWA ETSI- EN301021

The spectrum emission mask is a graphical representation of a set of rules that apply to the spectral emissions of radio transmitters. Such rules are set forward by regulatory bodies such as FCC and ETSI. It is defined as the spectral power density mask, within ±250 % of the relevant channel separation (ChS), which is not exceeded under any combination of service types and any loading [7]. The masks vary with the type of radio equipment, their frequency band of operation and the channel spacing for which they are to be authorized. The transmit spectrum mask is considered in this study because it may be used to generate a “worst case” power spectral density for worst case interference analysis purposes, where the coexistence study can be applied by spectrum emission mask as an essential parameter for adjacent frequency sharing analysis to evaluate the attenuation of interference signal power in the band of the victim receiver. Fig. 6 is a generated spectrum mask in Matlab.

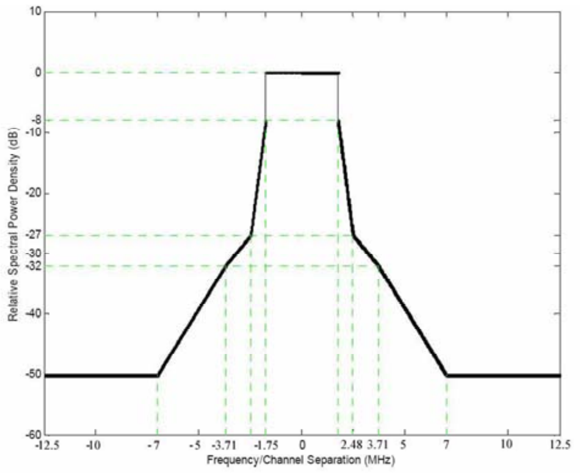

Fig. 6 Generated spectrum mask

From FWA base station (BS) systems into FSS receiver as a victim, if we don’t want to consider the separation distance with minimum I/N ratio of -6 dB are analyzed according to the selected bandwidth of FWA channels in the dense urban area (clutter loss (Ah)=18.5) .

It can be observed that within 20 MHz as a Guard band the minimum separation distance between the two base stations is 20m as in Fig. 7.

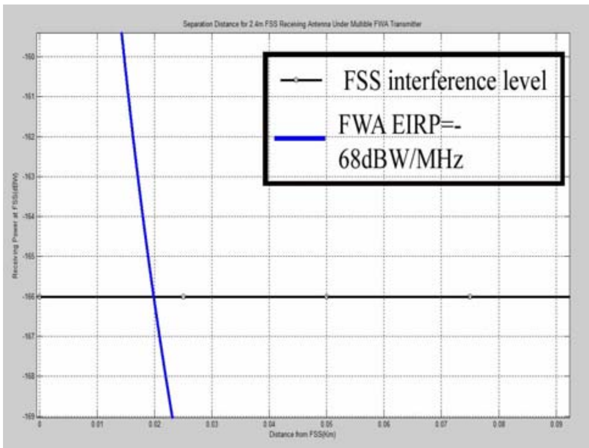

Fig. 7 Separation distance from FSS to improve the coexistence

VII. Conclusion

Different brands of FWA can have different Mask shape, radiated power and deferent assumption; generally 20MHz Guard band is quite good for the proposed scenario. If we want to use more bandwidth for the FWA like 7MHz we will be able to deploy only one operator and 10MHz bandwidth is not applicable. Theoretical justification is required before practical implementation. However, link budget, MultiPoint site deployment details and FWA versus FSS adjacent region (or country) / same frequency block, will be considered in the future work.

Acknowledgment

The authors would like to thank the Malaysia Communication and multimedia commission (MCMC) for the financial support.

References

[1] Zaid A. Shamasn, Lway Faisal and Tharek Abd. Rahman “On Coexistence and Spectrum Sharing between IMT-Advanced and Existing Fixed Systems” *International Journal Publication in WSEAS Transactions on Communications*, ISSN: 1109-2742, Issue 5, Volume 7, May 2008, pp505-515.

[2] Lway Faisal Abdulrazak, Zaid A. Shamsan and Tharek Abd. Rahman “Potential Penalty Distance between FSS Receiver and FWA for Malaysia” *International Journal Publication in WSEAS Transactions on Communications*, ISSN: 1109-2742, Issue 6, Volume 7, June 2008,pp637-646.

[3] Zaid A. Shamasn, Lway Faisal, S. K. Syed-Yusof, Tharek Abd. Rahman,” Spectrum Emission Mask for Coexistence between Future WiMAX and Existing Fixed Wireless Access Systems” *International Journal Publication in WSEAS Transactions on COMMUNICATIONS*, ISSN: 1109-2742, Issue 6, Volume 7, June 2008, PP627-636.

[4] Lway Faisal Abdulrazak and Thaek Abd. Rahman, “Potentiality of Interference Correction between FSS and FWA for Malaysia”' WSEAS Transactions. Mathematics and Computers in Science and Engineering, Selected Papers from the WSEAS Conferences in Istanbul, Turkey, May 27-30, 2008.

[5] Zaid A. Shamasn, Lway Faisal and Tharek Abd. Rahman, “Transmit Spectrum Mask for Coexistence between Future WiMAX and Existing FWA Systems” WSEAS Transactions. Mathematics and Computers in Science and Engineering, Selected Papers from the WSEAS Conferences in Istanbul, Turkey, May 27-30, 2008.

[6] Lway Faisal Abdulrazak, Tharek Abd Rahman, “Review Ongoing Research of Several Countries on the Interference between FSS and BWA”, International Conference on Communication Systems and Applications (ICCSA'08), 2008 Hong Kong China.

[7] Zaid A. Shamasn, Lway Faisal and Tharek Abd. Rahman, “Co-sited and Non Co-sited Coexistence Analysis between IMT-Advanced and FWA Systems in Adjacent Frequency Band” WSEAS Transactions. 7th WSEAS Int. Conf. on Telecommunications and Informatics (TELE-INFO '08), Istanbul, Turkey, May 27-30, 2008.