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A concept of potential future-gen radio spectrum administration seeking easy access spectrum paradigm figured on signal to interference noise ratio and interference thresholds

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Abstract

The obscurity of growing demand for the future generation (Future-Gen) spectrum is a concerned issue to resolve the perplexities and to seek for a more proficient manner in accessing the on hand radio spectrum bands and technologies. Frequency, space and time are the three dimensions of the radio spectrum where interference should not be happened if any one of these diverges between transmitters. Nowadays developing attention of the spectrum sharing technology and different strategies are being cultivated to permit more operators to exchange the spectrum in an opportunistic approach and simultaneously grow elevated to proficiency. The authors intentions aiming at this paper the entirely dispensation of the estimated radio spectrum resources among more interfering apparatuses that function in the similar space area are to make equal with the proposed paradigm from the idea of water filling. To alleviate the troublesome, using the application of the easy access spectrum (EAS) algorithm can easily be accomplished with the reciprocal intervention. Efficient use of the achieved spectrum and equal-smoothed allocation by redispensation in view of their particular QoS requisites are agile by this EAS paradigm. It is really allowed to identify the unused spectrum, which was primarily licensed, and to release it if is needed again.

Keywords: ULL; HLL; EAS; SINR; HeNB

Introduction

The core focus of radio spectrum management is to alleviate interference between different users, mitigate blocking possibilities and access time for any radio appliances. Dynamic spectrum allocation (DAS), spectrum sharing (SpS), cognitive radio (CR), spectrum traffic-load countervailing (STC) iterative algorithm, and easy access spectrum (EAS) algorithm based on signal to interference noise ratio (SINR) and interference thresholds are techniques to manage various spectrum but EAS algorithm is more suitable than the other techniques because two distinguished matter can thrive through reservation for the actual frame that is located at the beginning and the devices use the EAS paradigm and broadcast their reservation successfully, and without reservation based on observation of the past frame simultaneously at the commencement/ending (Berlmann *et al.* 2005).

Perplexities of radio spectrum management

A significant objective of radio spectrum management is to make easy sharing of spectrum between different users and/or applications, without matter too much interference to one another. The national regulatory agencies disperse rights to use tangible frequencies within the diverse allocations to particular users or usage. This conventional spectrum management system, figured on the evasion of interference and with an importance on technological masterful use of band, leads to a number of limitations (i) noteworthy parts of the spectrum are scarcely used, and (ii) the system is sluggish in responding to modify in markets and technologies.

The maiden point is authenticated through diverse measurements which have at particular geographical locations colossal portions of the spectrum are barely used or not used at all. Notwithstanding, the qualification when frequency band is not used is arguable, the measurements

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undoubtedly show that there is abundant room for more proficient use of the radio spectrum. The second point replicates the fact that the existing spectrum management regime gives preference to the present services, wherewith new technologies have to get used to the old technologies. In the function of economic logic, there appears to be an inconsistency. The rights to the sufficient vacant radio spectrum are fully assigned, but major part of radio spectrum remains idle in practice when taken into account on a time or geographical perspective. Under the present centralized control radio spectrum management replica is very cumbersome to make this unemployed spectrum available.

Theoretical views of the network

It is taken into account to setup a service in an office ambience, whereas the corridor is not essentially the edge of the cell, office walls are conceived as lights walls and the Home eNode B (HeNB) has a restricted coverage field. In exacting only two HeNB are considered in which the cells will have 10×2 rooms and every cell may have 5 to 10 users (UEs) shown in Fig. 1.

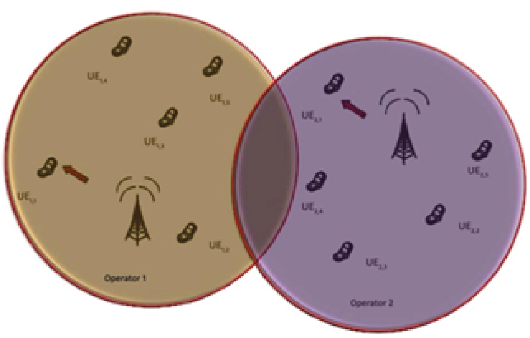


Fig. 1. Theoritical topograhy of HeNB

Practical views of the network

As shown in Fig. 2, the situation of the blueprint characterizes is lithesome to make sure the quantity and the location of walls, HeNB and UEs can be changed. HeNBs and UEs will be located and the path loss (PL) and the shadow fading correlation (SFC) will be calculated, once the fundamental layout is created. Within the cell coverage the UEs will be randomly found and their location will be changed after the number of frames that was selected, at the same time the HeNB can be generated at any pre-defined positions or any arbitrary locations. Having considered the characteristic of the HeNBs the power transmission will be in between of 27 dBm to 30dBm and omnidirectional antenna gain to be 3 dBi. As well as taking into account of the UEs distinctive are between 30dBm and 24 dBm power transmission and omnidirectional antenna gain to be zero (0) dBi (Kabir and Sobhan, 2015).

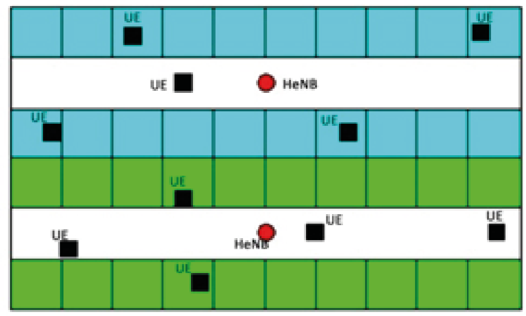


Fig. 2. Official topography of two operators

Node mobility path loss (PL) of the network

Having considered both line of sight (LOS) corridor to corridor and non line of sight (NLOS) corridor to room the users' path-loss calculation is done locating HeNB in a room and contiguous corridor, while for the users, that are placed in the further room and also considered the wall penetration losses (Musil, 2009), where the PL denoted as

$$LOS: PL = 18.7\log_{10}(d[m]) + 46.8 + 20\log_{10}(f_c[GHz]/5)$$

$$NLOS: PL = 36.8\log_{10}(d[m]) + 43.8 + 20\log_{10}(f_c[GHz]/5)$$

NLOS with path penetration factor:

$$PL = 20\log_{10}(d[m]) + 46.4 + 20\log_{10}(f_c[GHz]/5) + n_w \times L_w$$

Shadow fading correlation (SFC) of the network

In probability theory, a log-normal distribution is a continuous probability distribution of a random variable whose logarithm is normally distributed. Thus, if the random variable X is log-normally distributed, then Y= In (X) has a normal distribution. Likewise, if Y has a normal distribution, then X= exp (Y) has a log-normal distribution. SFC (Salo *et al.,* 2005) depending on the number of walls among users and HeNB is applied a log-normal model (probability theory) with standard deviation of 3 for LOS case and 4/6 for NLOS case.

So, for this work the following parameters are considered:
- Scenario: indoor office
- Number of operators: 2

- Rooms per cell: 10x2
- Cell coverage: 100m x 25m
- Number of users per cell: the lowest number is 5 while the highest number is 10; in this work the number of the users per cell considered is equivalent to 5 for both HeNBs.
- Frequency reuse factor: 1, all cells utilize the similar frequency band.
- Synchronization: perfect
- Traffic load: fractional
- Signal Bandwidth: 21.97265 MHz ÷ 15kHz =1500 subcarrier (SC)
- Frequency: 3.5 GHz
- PRB= SC÷12 symbols= 125
- Access scheme- OFDMA, Duplexing scheme- TDD
- Layout: 40 for EAS paradigm based on SINR and interference thresholds while 20 for spectrum traffic-load countervailing (STC) algorithm.
- Selects: This parameter indicates how many times the number and the location of UEs changes; its duration is equivalent to the number of frames. Threshold 20 for EAS algorithm as well as STC algorithm, in this work it is considered equal to 40.
- Frames: 20.

Order formulation and equation of the operational EAS frame structure

The coloring order formulation of EAS is a rencounter free revealed the smoothed traffic-load (data and voice) to redistribute the dispensations and attain an equalized on the whole utilization of the time slots in Figs. 3 and 4.

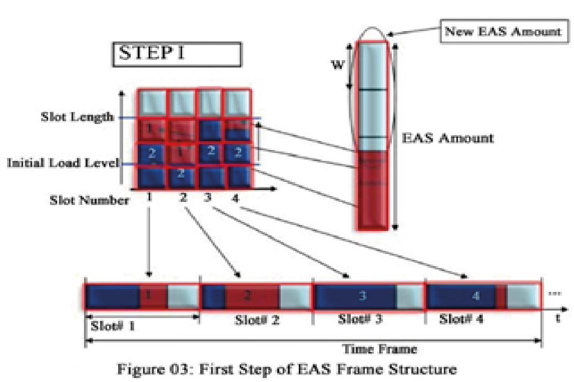


Fig. 3. First step of EAS frame structure

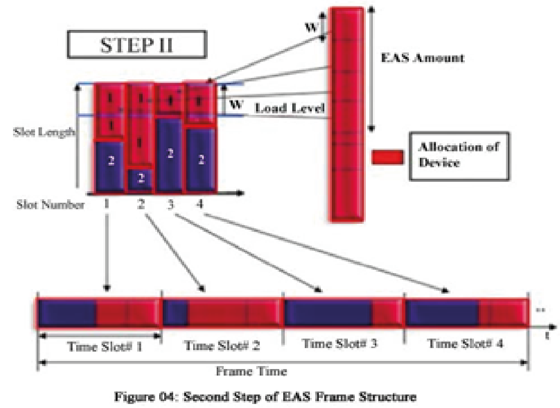


Fig. 4. Second step of EAS frama structure step of EAS frame structure

In this method, a fixed frame structure and fixed single frequency are envisaged and EAS is done by one device per frame. Forming a frame by four slots with the same length and interval the multiple accesses are done. Having shared a set of channels all devices can apply in EAS (Akyildiz *et al.,* 2006). The transmission of current, legacy or non-EAS using apparatuses is seen as fixed allocations and the EAS appliances allocate, if achievable, their distribution around them. In this situation considering secondary devices as interferer (i.e device 2) the EAS amount is computed as the total transmission times per slot that is accessible.

Therefore as the sum of the differences among the Highest Load Level (HLL) and the occupancy of each slot C_i:

$$EAS = \sum_{i=1}^{4} (HLL - C_i)$$

Where the HLL is the threshold of the highest slot practice and it is capable of identical to slot length when this is totally used. In the first step, the slot less consumed is considered and the preliminary load level (PLL) of the device 1 goes up of the step size:

$$W = \frac{EAS\_Amount}{Number\_of\_Slots}$$

Therefore the value of EAS Amount is updated and we get the value:

$$EAS = EAS - W$$

If the updated load level (ULL) is over the occupancy of the supplementary slots, so the parts, that remain blank, are filled with the allotment of device 1. For this reason, these allocations are deducted from the quantity, which is still to be distributed. The innovative value of EAS amount is this case will be:

$$EAS = EAS_{old} - \sum_{i=1}^{4} (ULL - C_i^{New})$$

Where, EAS_{old} is the non-updated value of EAS;

C_i^{New} is the new tenancy vector after the allocation of the step size.

Thus as a result of successive iteration, EAS amount and step size reduced until the HLL is achieved. Thus the HLL is used as the value that provides the condition for closing stages of this iterative paradigm (Berlmann *et al.,* 2005).

Proposed EAS algorithm

The frames of the EAS algorithm that primarily were considered of 4 slots, are transformed and each frame considered is constructed by 4 frames, that will be signified similar to sub-frames. In this way the duration of one frame is equal to 20ms. The frequency frame can be drawn as follows which is shown in Fig. 5:

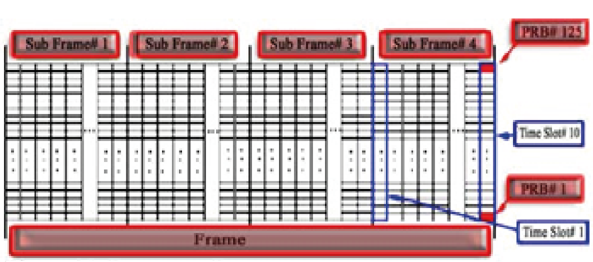
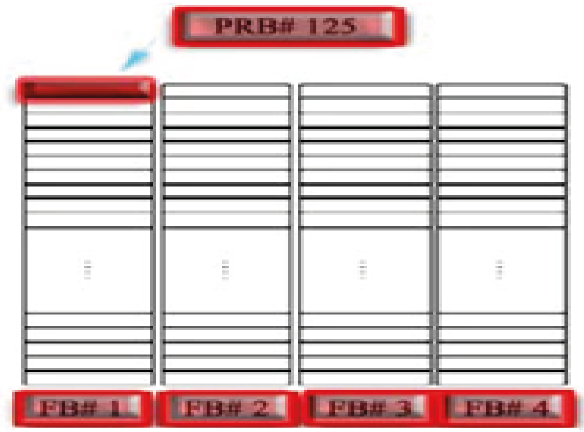


Fig. 5. Frequency frame

In this way the allocations of many users in every time slot are predetermined; consequently the frame structure can be made straight forward as shown in Fig. 6:



FB: Frequency block
Fig. 6. Simplified frequency frame

To obtain a fair shared spectrum in this algorithm, thresholds are determined with the target to select the appropriate physical resource blocks (PRBs=number of subcarriers/PRBs size) by each operator. The first threshold that is considered, concerns the SINR. One will be selected all PRBs that have the SINR greater than the SINR threshold and these PRBs will be candidate for the allocation of the operators, these are called PRB_{good}. The lower threshold will be the higher the number of PRBs that will be allocated. But considering only SINR-threshold leads to a problem, as in the simulator the calculus of SINR in downlink is measured at UE on the scheduled PRBs to the UE, hence if the selection of PRBs, that are candidate for the allocation, is based only on the SINR, step by step the PRBs will be decreased drastically until the point when there will not be more PRBs for the allocation. To avoid the problem another threshold is considered and concerns the interference. The interference is associated to each PRB and depends on the position of the users with respect to interferer operator.

In this case the higher the threshold, the higher the number of PRBs allocated. The PRBs that will have the interference value lower than the threshold, will be chosen as suitable PRBs for the allocation because their interference is not harmful; they are called PRB_{free}. The PRB_{free} selected for each cell will be shared among the operators, but before there is the check to verify how operator is less favourite. Hence the number of PRB_{good} of each cell is matched, and if an operator has a number of PRB_{good} lower than the other operator it will be less favourite for this reason after the calculus of the mean of PRB_{free} for each operator a bigger number of PRB_{free} will be assigned to the less favourite operator. If both operators have the same number of PRB_{good}, so each operator will allocate its own PRB_{free}. In this manner a fair and balanced allocation should be obtained among the operators (Kooper, 2006).

Optimization results

A key role is assumed by the choice of the threshold of interference, from these choice depends the allocation of more or less PRBs. In this case a threshold equal to 10e-15 is selected as shown in Fig. 7 (Grace *et al.,* 1997 and Kumar *et al.,* 2009). After the selection of the threshold the result was compared with the reference case (Case 0) and the case of the EAS algorithm based on SINR (Case 1), in which all HeNB run the algorithm simultaneously to select PRBs based on specified EAS target SINR threshold and the PRBs above the threshold are candidate for share selection, while out of the all candidate PRBs the HeNB will only select the required number of PRBs. The SINR threshold is the same for both cases and it is equal to 10dB. The proposed algorithm (Case 5) is higher than the reference case (Case 0) but it is worst than the EAS algorithm based on SINR case (Case 1) as whown in Fig. 8 (Casey *et al.,* 2008, and Aalborg University). This happens because introducing also the interference threshold the PRBs selected for the allocation will be more respect to the case in which only the signal to interference noise ratio (SINR) threshold is considered.

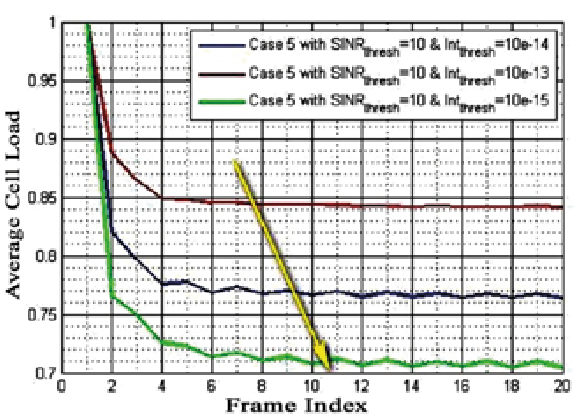


Fig. 7. Interference threshold

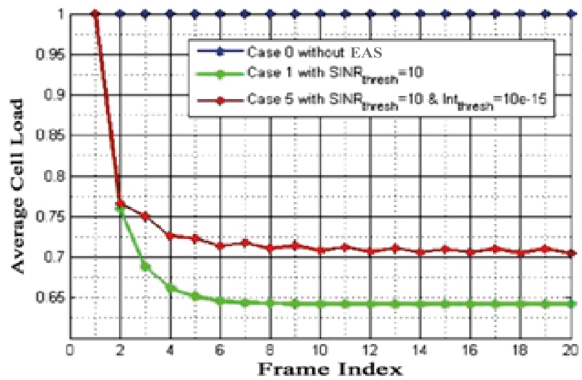


Fig. 8. Average cell phone comparison among reference case, EAS based SINR Case and EAS based on SINR and interference case

Conclusion

In this paper the EAS Paradigm applied in the two operators collaborate among them, consequently every operator identify the number of PRBs previously occupied by the other HeNB in this advance the orthogonality is conserved and the probable clash as well as the reduced spectrum utilization are kept away from. From the evaluation of the results for the EAS paradigm with the reference case, in which all spectrums are allocated, a development for the outage throughput is obtained. From the EAS paradigm based on SINR that the beginning of a latest threshold and interference allow assigning more spectrum respect to the EAS paradigm, but it leads to a fair allocation (Tiwana *et al.,* 2009). In this paper for the EAS paradigm between the two operators are judged to the equal, indeed the similar threshold are measured, but as an growth it would be striking to study what occurs by establishing different thresholds for the dissimilar operators, thus moving from an horizontal to a vertical spectrum sharing paradigm.

References

Akyildiz IF, Lee WY, Vuran MC and Mohanty S (2006), Next generation/dynamic spectrum access/ cognitive radio wireless networks: A survey. Computer Networks.

AALBORG UNIVERSITY, Institute of Electronic Systems, DET DIGITALE PROJEKTBIBLIOTEK, www.projekter.aau.dk/projekter/, accessed on February 2015.

Berlmann L, Hiertz G and Walke B (2005), Reservation-based Spectrum Load Smoothing as Cognitive Medium Access for Spectrum Sharing Wireless Network, EW 2005, *Nicosia*, Cyprus, April 2005.

Casey T, Veselinovic N and Jantti R (2008), Base Station Controlled Load Balancing with Handovers in Mobile WiMAX; PIMRC.

Grace D, Burr AG and Tozer TC (1997), The Effects of Interference Threshold and SNR Hysteresis on Distributed Channel Assignment Algorithms for UFDMA, *International Conference on Universal Personal Communications* (ICUPC).

Kabir MU and Sobhan MA (2015), An idea of future dynamic radio spectrum management (spectrum commons) following fraffic-load countervailing iterative algorithm, *Journal of Bangladesh Academy of Sciences,* (in press)

Kumar S, Palma V, Borgat E, Marchetti N and Mogensen P E (2009), Light Cognitive Radio Enabled Flexible Spectrum Usage in Local Area Development, Aalborg University.

Kabir MU (2015), A Study on Designing a Framework and Pricing Issues in Radio Spectrum Management in Bangladesh, Ph. D Thesis, School of Engineering and Computer Science, American World University, USA.

Kooper M (2006), Achieving dynamic spectrum allocation: Governance rules for a mixed private-commons regime, Stantford university Law School.

Musil BCT (2009), Policy Based Flexible Spectrum Usages for Next Generation Mobile Communication, M. Sc Thesis, Brno University of Technology.

Salo J, Vuokko L, and Vainikainen P., (2005), Why is Shadow Fading Lognormal?, International Symposium on wireless Personal Multimedia Communications, pp 522-526, Aalborg, Denmark.

Tiwana M I, Sayrac B and Altman Z (2009), Statistical learning for automated RRM: Application to eUTRAN mobility ICC.

Zhao Y, Li M and Shi F (2010), Indoor Radio Propagation Model Based on Dominant Path, Int. *J. Communications, Network and System Sciences*. **3**: 330-337.

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