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Nationwide Spectrum Sharing of Mobile Network Operators with Indoor Small Cells

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Abstract

In this poster, we propose a novel technique to share licensed spectrums of nationwide mobile network operators (MNOs) with in-building small cells by exploiting the external wall penetration loss of any building and introducing the time-domain eICIC technique. The system architecture and co-channel interference management are discussed and the outperformance of the proposed technique is shown. The proposed spectrum sharing technique can help overcome the scarcity of licensed spectrums of an MNO and boost the indoor data rates and capacity without any additional investment on licensing spectrum for indoor small cells.

Introduction

Existing MNOs suffer from the fact that though their user-base has been increased many times over time, the allocated radio spectrum resources to an MNO is still dedicated and insufficient in amount.

Spectrum sharing among multiple MNOs is considered as one of the most effective solutions to address the scarcity of spectrum availability of an MNO. Though several spectrum sharing techniques have already been proposed in literature, most lack from addressing adequately the user demand particularly when sharing the spectrum B_{op} of one system with the other simultaneously.

This paper addresses this issue by presenting a novel spectrum sharing technique for indoor small cells of MNOs nationwide.

Proposed Technique

- **Figure 1** shows the system architecture for x_m=4 MNOs of a nation. To overcome the problem with assigning B_{co} to x_m MNOs, in this paper, we propose a novel spectrum sharing technique by considering that the dedicated spectrum B_{op} of any MNO is allocated to its outdoor macro UEs.
- However, for indoor small cells, B_{co} is made accessible by each small cell of all MNOs with an equal priority such that technically any indoor small cell can have the access to the maximum spectrum B_{co} as shown in **Fig.2**.
- B_{co} is aggregated to a common pool where a centralized scheduler manages sharing and allocating B_{co} to all operators. Such a common spectrum polling can be provided by either the NRA, or any third party, or operators under certain common sharing and negotiation among them.

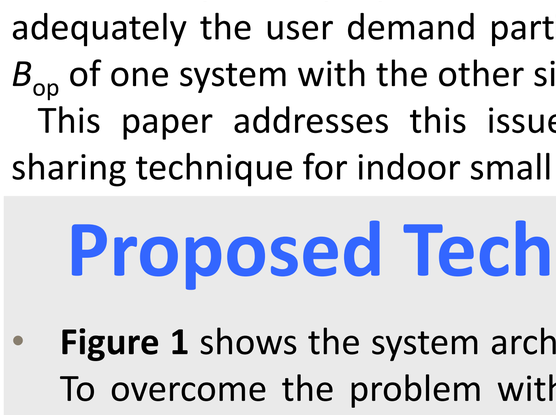

Fig.1. System architecture for x_m=4 MNOs.

Fig.2. An abstract view of the proposed spectrum sharing technique for the maximum number of MNOs x_m=4.

Interference Management

- **Figure 3** shows numerous co-channel interference scenarios with respect to MNO 1 .
- We propose an approach for the interference management that employs the almost blank subframe (ABS) based eICIC technique [3] to share the whole spectrum B_{co} with indoor small cells of all x_m=4 MNOs such that in any TTI of an ABS pattern period (APP), only UEs of at max one MNO can be served (**Fig.4**).

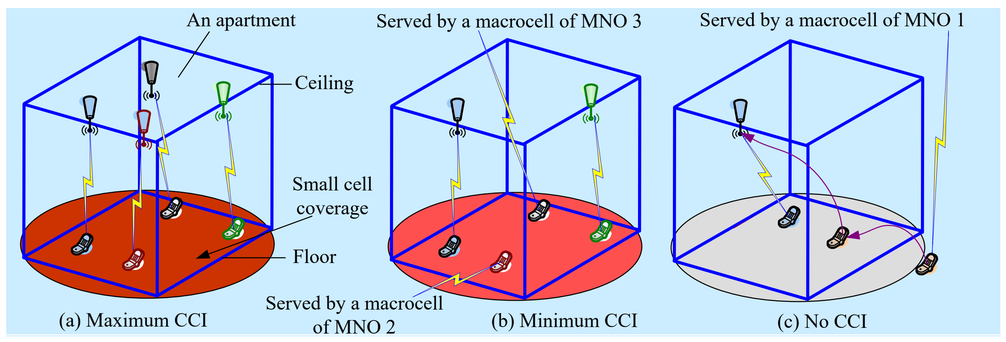

Fig.3. An illustration of co-channel interference strengths when sharing the spectrum of one MNO (MNO 1) with that of others (MNOs 2, 3, and 4).

Fig.4. An example illustration of interference avoidance using the ABS based eICIC technique for small cells of x_m=4 MNOs in Fig.3 in a building.

Performance Evaluation Results

The capacity of small cells of MNO 1 with/without applying the proposed spectrum sharing technique for varying CCI is shown in **Fig.5.**

Table I. Parameters for evaluation.

Parameters	Values
Simulation run time T, B_{op}, B_{co}	8 TTIs, 10 MHz, 40 MHz
Link quality, x_m	3 bps/Hz, 4
Number of indoor small cells per MNO	1
Number of indoor UEs per small cell	1
Number of buildings	1

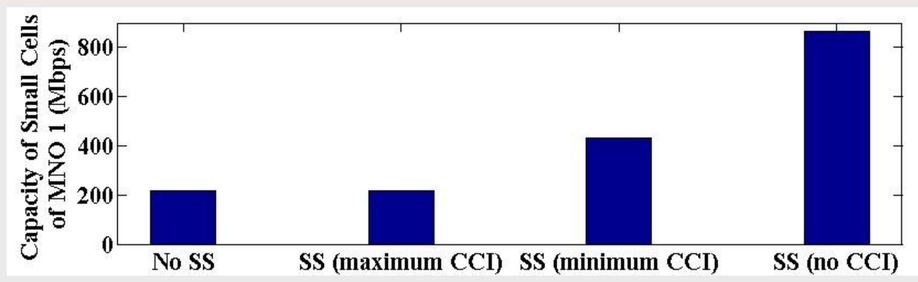

Fig.5. The capacity of small cells of MNO 1 with/without applying the proposed spectrum sharing (SS) technique for varying CCI shown in Fig.3.

Conclusion

- In this poster, we have presented and showed how to share the spectrum of all MNOs nationwide with in-building small cells.
- We have exploited the high external wall penetration loss and employed the eICIC technique for small cell interference avoidance.
- With a simple problem, for a number of small cell deployment scenarios, and hence corresponding interference variations, the outperformance of the proposed technique has been clarified.

References

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[3] R. K. Saha, "A hybrid system and technique for sharing multiple spectrums of satellite plus mobile systems with indoor small cells in 5G and beyond era," in *IEEE Access*, vol. 7, pp. 77569-77596, 2019.