Study of interference and frequency reuse in cellular / micro-cellular communication and in LMCS / LMDS access systems

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Abstract: The modeling of the interference between indoor and outdoor is a domain for which very little data is available. This modeling requires attenuation measurements as a function of the various materials, and adequate quantification of the openings, the effects of frequencies changes, the propagation bandwidth available for acceptable data rates and the bit error rates in function of mixed delays spreads. A model suitable to account correctly for these parameters is essential.

Résumé: La modlisation de l'interference entre les canaux extérieur et intérieur est un domaine peu connu. Ceci requiert des mesures d'atténuation en fonction des divers paramètres, la quantification adéquat de l'effet des ouvertures et des différences entre différentes bandes de fréquence, en tenant compte de la largeu de bande de propagation disponible pour des débits acceptables et des taux d'erreurs par bit en fonction de l'étalement de délai. Un modèle approprié, pour tenir compte correctement de ces paramètres est essentiel.

Introduction

1) Frequency Reuse and interference between indoor and outdoor:

Due to radio frequency (RF) signal attenuation inside buildings it is possible to have self-controlled indoor cellular systems which use the same frequencies as cellular systems outside the building (as shown in Fig. 1) [1]. Such secondary cellular systems are somewhat electromagnetically isolated from the outdoor cellular systems by the building, and use low-power base stations and "sniffer" (receivers that can scan all cellular channels) to determine which forward channels have external signals that are at a low enough level to be reused for indoor communications. These types of indoor cellular systems are called "parasitic" because they benefit from local spectrum holes in the external cellular system. The huge potentially installed base and relatively inexpensive infrastructure cost of parasitic cellular may make it an effective way for cellular carriers to compete with PCS when providing indoor PCS when providing indoor cordless communications in densely populated areas such as office buildings, apartment buildings, and busy market places. Obviously, the frequency reuse plan and growth of the outdoor cellular system as it reaches maturity are major factors in the future reliability and performance capabilities of an indoor parasitic system [2].

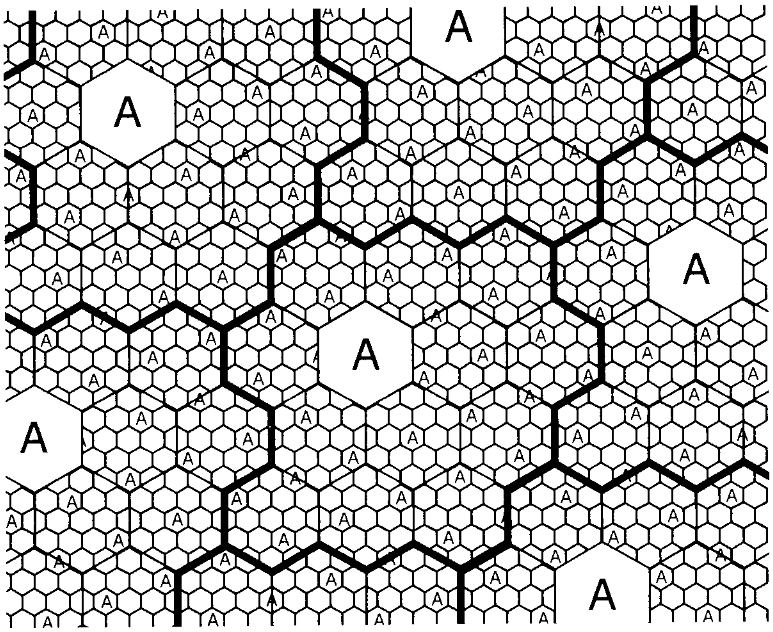

Fig. 1: A typical frequency double reuse system. The large “A” show the macrocells where the frequency A is used. The small “A” show the microcells where the frequency A is reused with low power for the indoor cellular system.

The basic design criterion for frequency double reuse (DR) systems is that signal to interference ratios (SIR) of the urban and indoor cellular systems that use the same frequency are the same. In mathematical terms this condition can be written as:

$$\frac{S_1}{I_1 + J_{21}} = \frac{S_2}{I_2 + J_{12}}$$

where S_1 and S_2 are the signal powers at the macrocell and microcell edges, respectively, I_1 and I_2 are the selfcochannel interferences for the urban (macrocell) and indoor (microcell) systems, J_{21} is the mutual cochannel interference that the indoor system causes on the urban system and vice versa for J_{12}. This condition means that the service quality is the same for both systems[2]. For evaluating the effective parameters in J_{12} and J_{21}, it is important to know the characteristics and the influencing factors of the channel between indoor and outdoor systems.

2) LMDS and LMCS systems

Millimeter wave communication systems in the 27.5 to 29.5 GHz band are being developed in the United States and Canada for use in a local multipoint distribution systems. It is envisioned that these systems could broadcast voice, video, and data and would allow for interactive communications in small cells. Local multipoint communication systems are broadband wireless telecommunications common carrier services in the 28 GHz range that will be capable of carrying basic and advanced communications services, such as “wireless” cable TV, internet access, video tele-conferencing, and various other multimedia services[3]. For designing these systems we require a fundamental knowledge of the interference between indoor and outdoor systems.

Conclusion

This research appears to us very much in line with present trends and present developments. There is a great need for measurements and modeling in the area identified above: the interference between indoor and outdoor and in LMDS / LMCS access systems. Finally, to all extent possible, existing data shall be used for modeling, but systematic measurements and evaluations of performance will also be required.

References

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