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Study of Interference Between LTE-FDD and LTE-TDD System in UHF Band

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Abstract: With the rapid development of mobile communication, the interference between different mobile communication systems is more and more complex. The interference between LTE-FDD and LTE-TDD system in coarea and cosite scenarios is studied. The interference scenarios between LTE-FDD and LTE-TDD system is given, the models, simulation results, related analysis and finally the solution to resolve the interference is given which can be used as reference to deploy the LTE-FDD and LTE-TDD systems.

Key words: System interference, LTE-FDD, LTE-TDD, throughput loss

INTRODUCTION

Mobile communication is developing from the third generation to the fourth generation and the requirement of spectrum is increasing greatly. More and more spectrums will be needed, causing greater co-channel and adjacent channel interference between wireless networks. Long Term Evolution (LTE) is a specification of 3rd Generation Partnership Project (3GPP) which is the evolution of 3G system. LTE systems consist of TDD and FDD mode. LTE-FDD and LTE-TDD system will be deployed in adjacent frequency band, so it is necessary to study the interference between LTE-FDD and LTE-TDD system (ITU, 2010; ECC, 2009).

This study deals with interference between LTE-FDD system and LTE-TDD system, macro networks and with urban, suburban and rural, including Basestation (BS) to User Equipment (UE), UE to BS, UE-to-UE case.

SCENARIO OF INTERFERENCE

The topology of the LTE-FDD and LTE-TDD systems is in Fig. 1, it is assumed that both LTE systems are composed of 19 base stations (each has 3 sectors), where the base stations are placed in the middle of 3 sectors. Figure 1 gives the topology of LTE-FDD and LTE-TDD systems, each system consist of 19 BS which has 3 sectors, respectively and the BS is in the middle of three sectors. Wrap-around is used to eliminate edge influence.

Figure 2 depicts the topology of the hotspot interference scenario, including the cosite and coarea situation. As LTE-FDD and LTE-TDD system have some system parameters, the interference of TDD system to FDD system can be used as the interference of FDD system to TDD system.

Table 1 is the LTE system parameters which are used in the interference studies (3GPP TR 36.942, 2012) (3GPP TR 25.942, 2012).

The propagation model of BS to UE is vehicle mode in ECC (2009). When the distance is small than 100 m, free space model is applied; else the following model is used:

$$L_{BS\text{-}UE} = (40(1-4\times10^{-3}\Delta h_b))\bullet\log(d)-18\bullet\log(\Delta h_b)+21\bullet\log(f)+80 \quad (1)$$

where, f is carrier frequency, Δh_b is the height between BTS and average buildings, equals 15 m, d is distance.

The UE-UE propagation models is as follows:

$$L(d)=\begin{cases} L_{FS}(d) & \text{dB} \quad d<d_{BP} \\ L_{FS}(d_{BP})+35\log\dfrac{d}{d_{BP}} & \text{dB} \quad d\geq d_{BP} \end{cases} \quad (2)$$

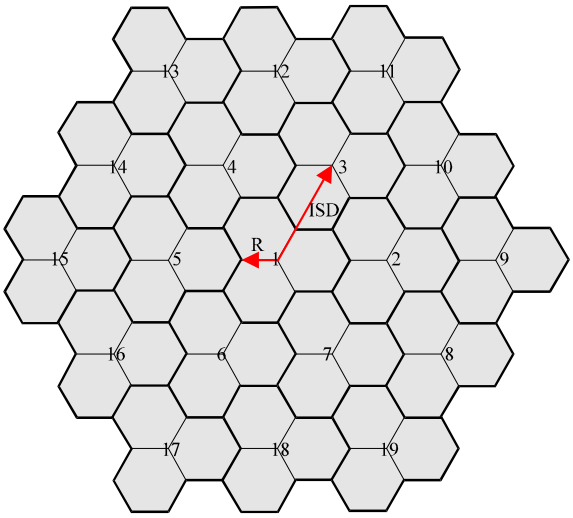

Fig. 1: Topology of LTE-FDD and LTE-TDD systems

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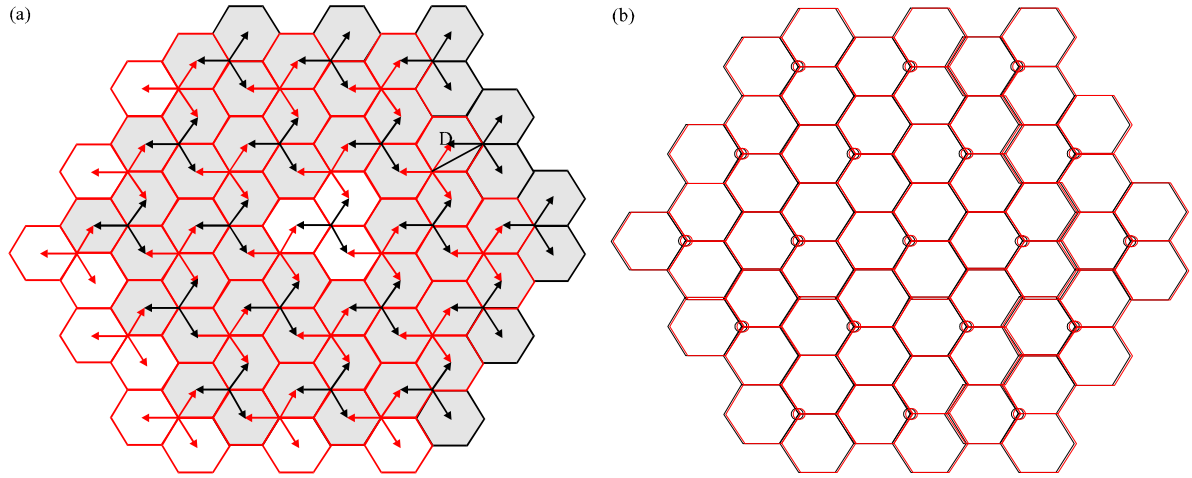

Fig. 2(a-b): (a) Coarea scenario of LTE-FDD and LTE-TDD systems and (b) Cosited scenario of LTE-FDD and LTE-TDD systems

Table 1: System parameters of LTE system

System parameter	BS	UE
Simulation type	Snapshot	
Bandwidth (MHZ)	10	
Transmitting antenna type	3 sectors	
Coverage radius (m)	Urban: 500	
	Suburban: 2000	
	Rural: 8000	
Number of user per cell	5	
Number of snapshot	(>=1000)	
Antenna model	Aperture in the horizontal plane at 3 dB: 65	
	Aperture in the vertical plane at 3 dB: 15	Omnidirection
Antenna gain (dBi)	15	0
Fader loss (dB)	3	0
Polar gain (dBi)	3	0
Total Antenna gain (dBi)	15	0
Smart antenna	Off	Off
Maximum transmitter e.i.r.p. (dBm)	43	23
Minimum transmitter e.i.r.p. (dBm)	-	-40
Noise figure (dB)	5	9
Pass loss	Free space, hata model	Free space, hata model
MCL (dB)	MS-BS 70	
Antenna height (m)	30	1.5
Power control	Off	PC Set1: 1/115
Link level performance model	36.942	

where, d is the distance between transmitter and receiver, if the distance is small than 5 m, an additional shadow fading with 3 dB standard deviation is used, else 4 dB is used, f is center frequency, dBP equals 5 m.

SIMULATION RESULTS AND ANALYSIS

Due to the relative fixed position of basestation, the ACIR needed between LTE-FDD and LTE-TDD BS is 77.5 dB in cosite case and 40.5 dB in coarea case by deterministic calculation.

The simulation results of cosite scenario, BS interfere UE is in Fig. 3.

From Fig. 3, to assure the TP Loss of interfered system less than 5%, the ACIR of urban, suburb and rural is 23.6, 20 and 19.9 dB separately. Similarly, to assure the edge user TP loss less than 5%, the ACIR of urban, suburb and rural is 30, 29.5 and 28 dB separately.

The simulation results of coarea scenario are shown in Fig. 4.

As in Fig. 4, when the system distance is R m, to assure the TP Loss of interfered system less than 5%, the ACIR of urban, suburb and rural is 22.5, 21.2 and 21.2 dB separately. Similarly, to assure the edge user TP loss less than 5%, the ACIR of urban, suburb and rural is 28.5, 29.5 and 30 dB separately.

The simulation results of UE interfere BS is shown in Fig. 5.

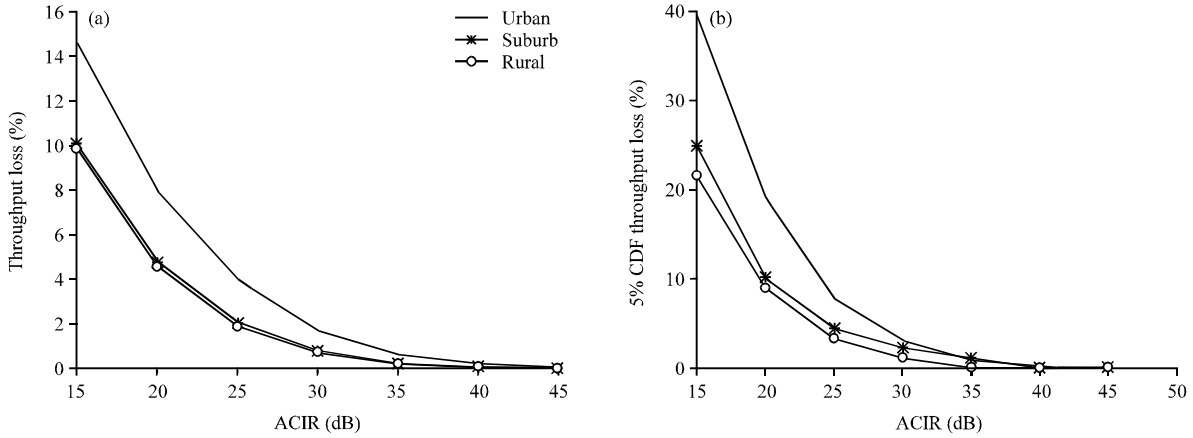

Fig. 3(a-b): (a) Throughput loss of downlink interfere downlink, cosite and (b) Cumulative distribution function (CDF) throughput loss of downlink interfere downlink, cosite

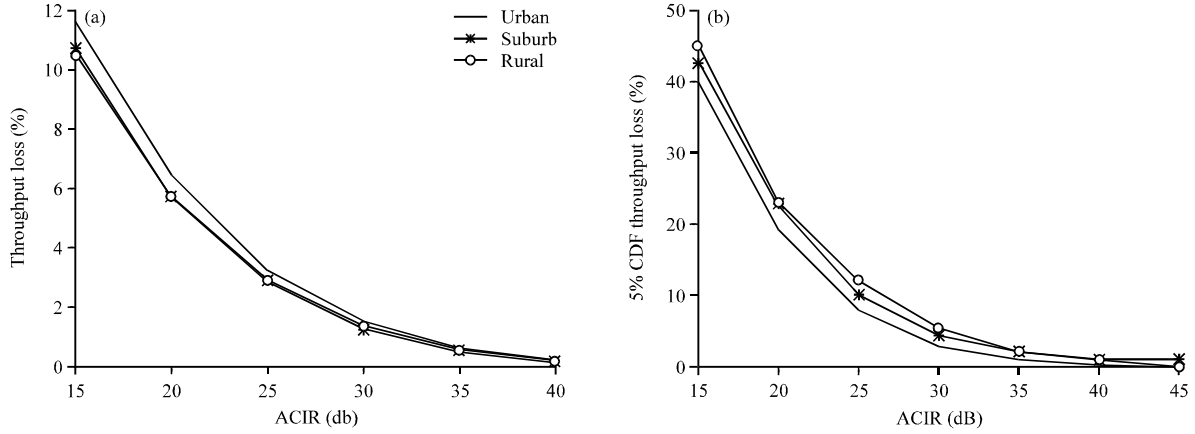

Fig. 4(a-b): (a) Throughput loss of downlink interfere downlink, coarea and (b) CDF throughput Loss of downlink interfere downlink, coarea

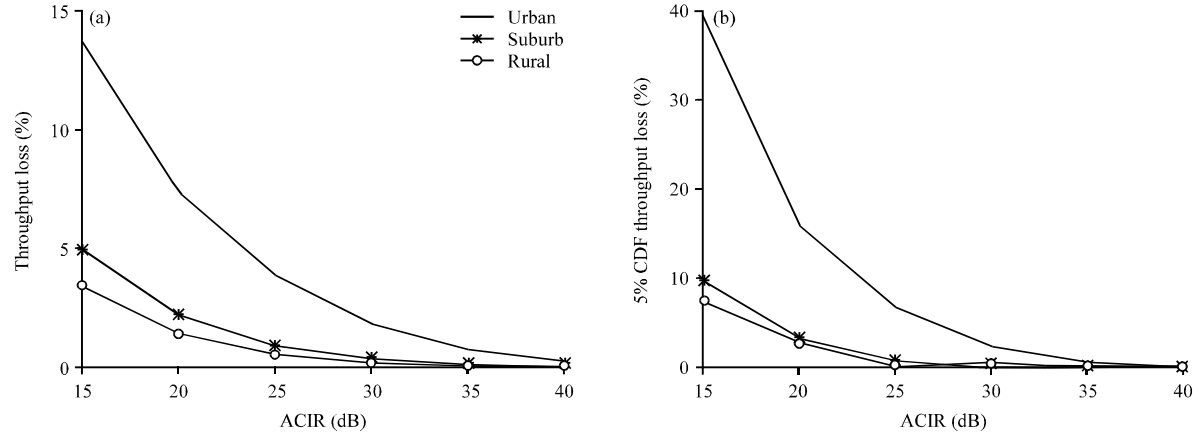

Fig. 5(a-b): (a) Throughput loss of uplink interfere uplink, cosite and (b) CDF TP Loss of uplink interfere uplink, cosite

As shown in Fig. 5, when the system distance is zero, to assure the TP Loss of interfered system less than 5%, the ACIR of urban, suburb and rural is 23.5, 15 and 14 dB separately. Similarly, to assure the

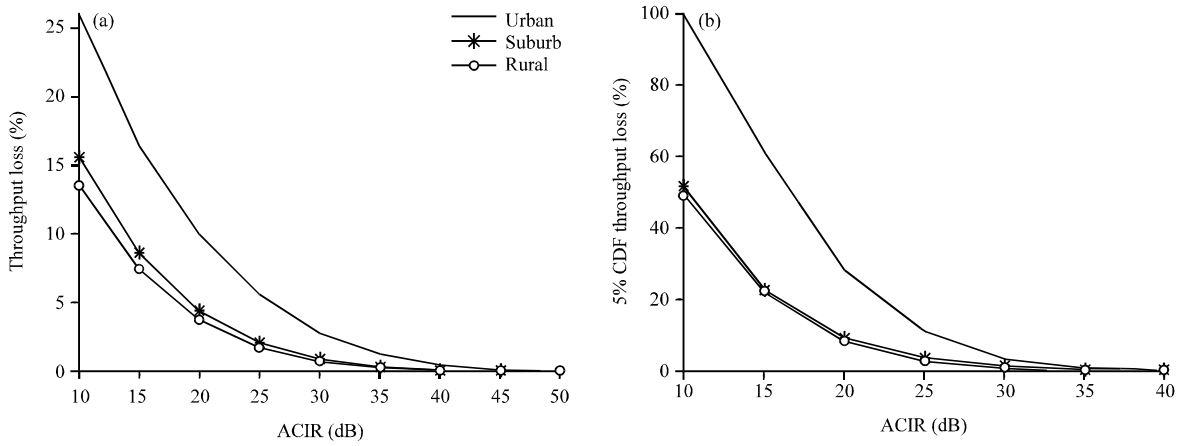

Fig. 6(a-b): (a) Throughput loss of uplink interfere uplink, coarea and (b) CDF throughput loss of uplink interfere uplink, coarea

edge user TP loss less than 5%, the ACIR of urban, suburb and rural is 27, 18.5 and 17.5 dB separately.

The simulation results of UE interfere BS is shown in Fig. 6.

As shown in Fig. 6, when the system distance is R m, to assure the TP Loss of interfered system less than 5%, the ACIR of urban, suburb and rural is 26.7, 19.5 and 18 dB separately. Similarly, to assure the edge user TP loss less than 5%, the ACIR of urban, suburb and rural is 28.8, 24.2 and 23.2 dB separately.

Finally, the UE interfere UE is also studied, with the increase of ACIR, the TP Loss decrease and the results shows that the throughput loss is less than 1.4%, that is the interference is negligible in macro scenario.

CONCLUSION

According to the simulation results and analysis, LTE-FDD and TDD systems can coexist successfully in adjacent bands with a appropriate isolation and the BS to BS interference is the main source, 77.5 dB in cosite case and 40.5 dB in coarea case and need some method to avoid the interference. Such as guard band, antenna isolation, with appropriate RF filters and some additional mitigation methods in the engineering field in the 698-806 MHZ band. Based on review of the foregoing study results, the following common mitigation methods are proposed.

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