PERFORMANCE STUDY OF PROPORTIONAL FAIR SCHEDULING ALGORITHM WITH TRANSMIT DIVERSITY MULTI-ANTENNA TECHNIQUE FOR LTE NETWORK

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Abstract— Long Term Evolution (LTE) access network is based on Orthogonal Frequency Division Multiple Access (OFDMA) which provides multi user diversity gain to enhance the system throughput. However, fading of a radio channel causes inter channel interference and reduces overall system throughput. This deteriorating effect of wireless channel fading is higher for mobile users which can be reduced by channel aware scheduling algorithm and transmit diversity multi-antenna technique. Hence in this paper, an attempt has been made to evaluate the effect of mobility on the performance of Proportional Fair (PF) channel aware scheduling algorithm in conjunction with transmit diversity multi-antenna technique by considering throughput, delay and jitter as performance metrics.

Index Terms—LTE, Proportional Fair Scheduling algorithm, SFBC

I. INTRODUCTION

Telecommunication industry has witnessed an increased demand for multimedia applications such as social media, high-definition video streaming, mobile banking and full-featured web browsing at high vehicular mobility. These applications require higher system throughput and certain Quality of Service (QoS) constraints to be satisfied within the fading wireless channel. In order to reduce the effect of fading for both stationary and mobile users, Long Term Evolution (LTE) has incorporated transmit diversity multi-antenna technique and channel aware scheduling algorithm. Transmit diversity technique uses multiple antennas at the transmitter to enhance system throughput by increasing Signal to Interference plus Noise Ratio (SINR) [1]. Further, channel aware scheduling algorithms (e.g. Proportional Fair) employed at the LTE eNodeB (eNB) exploit multi user diversity in improving overall system throughput while ensuring fairness [2, 3]. Hence in this paper, an attempt has been made to evaluate the performance of Proportional Fair scheduling algorithm with transmit diversity (SFBC) multi-antenna technique for different vehicular speeds using QualNet simulator. The rest of this paper is organized as follows. Proportional Fair channel aware scheduling algorithm is described in section II. Space Frequency Block Coding (SFBC) transmit diversity multi-antenna technique in LTE is described in section III. Section IV gives simulation and results and section V concludes the paper.

II. PROPORTIONAL FAIR CHANNEL AWARE SCHEDULING ALGORITHM

Channel aware scheduling algorithms exploit multi-user diversity by allocating the resources among several users depending on their channel conditions [4].

By scheduling users with good channel conditions, the resources are efficiently used and the system throughput is enhanced [5]. The serving eNB determines the channel quality using Channel Quality Indicator (CQI) feedback from the User Equipments (UEs). Channel aware scheduling algorithm which assigns radio resources to user with highest instantaneous achievable data rate relative to its past average data rate is called Proportional Fair (PF) scheduling algorithm. The PF scheduling algorithm provides a good trade-off between system throughput and fairness by selecting the user with maximum PF metric calculated during each transmission time interval.

III. SPACE FREQUENCY BLOCK CODING (SFBC) TRANSMIT DIVERSITY MULTI-ANTENNA TECHNIQUE

Transmit diversity techniques are used to reduce the effect of fading on system performance for both stationary and mobile UES [6]. Transmit diversity based on Space Frequency Block Coding (SFBC) scheme uses two transmit antennas to improve the signal quality at the receiver. SFBC implies that two consecutive modulation symbols S_i and S_{i+1} are mapped directly to frequency-adjacent resource elements on the first antenna port (Fig. 1).

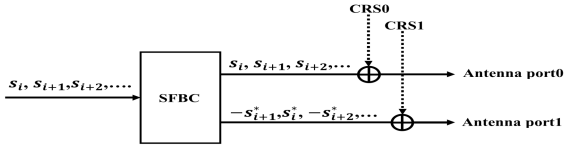

Fig. 1 Transmit diversity for two antenna ports – SFBC

On the second antenna port the frequency-swapped and transformed symbols s_{i+1}^* and s_i^* are mapped to the corresponding resource elements, where $*$ denotes complex conjugate [7].

IV. SIMULATIONS AND RESULTS

The effect of mobility on the performance of Proportional Fair channel aware scheduling algorithm is evaluated with Space Frequency Block Coding multi antenna technique using QualNet 5.2 simulator. A single cell scenario with an eNB and ten pairs of UEs are considered in a simulation area of 5Km x 5Km. In this scenario, Rayleigh fading environment and two ray path loss model with lognormal shadowing are considered for the simulation studies. The remaining simulation parameters are listed in Table 1.

Table 1. Simulation parameters

Property		Value
Simulation-Time		20S
Propagation-Channel-Frequency		2.4GHz
Propagation-Model		Statistical
Shadowing mean		4dB
Channel-Bandwidth		10MHz
Antenna-Model		Omni directional
eNB	MAC- Scheduler-Type	Proportional Fair
	PHY- Num-Tx-Antennas	2
	PHY- Num-Rx-Antennas	2
	PHY-Tx-Power	46dBm
	Antenna-Height	15m
	Antenna-Gain	14dB
	MAC- Transmission-Mode	SFBC
UE	MAC- Scheduler-Type	Simple-Scheduler
	PHY- Tx-Power	23dBm
	PHY--Num-Tx-Antennas	1
	PHY--Num-Rx-Antennas	1
	Antenna-Height	15m
	Antenna-Gain	14.0dB

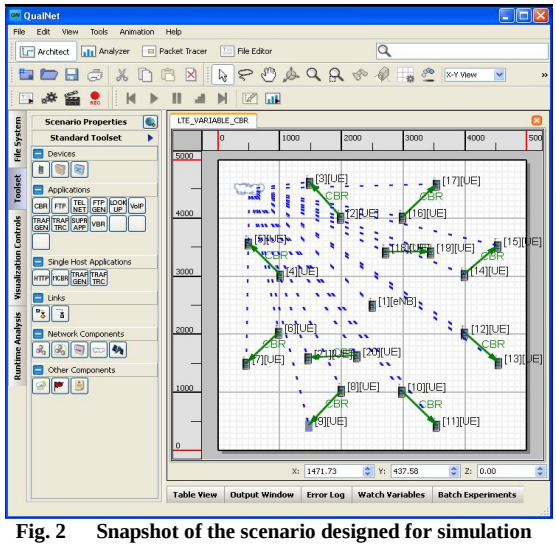

Fig. 2 Snapshot of the scenario designed for simulation studies

The snapshot of the scenario designed for the simulation study using QualNet 5.2 simulator is shown in fig. 2. Simulation has been carried out by establishing a CBR connection with the data rate of 200Kbps between each pair of stationary UEs and performance metrics such as aggregate throughput, average end-to-end delay & average jitter have been recorded. Simulation studies have been repeated by changing the data rate of each CBR connections insteps of 200Kbps up to 2Mbps and further insteps of 1Mbps up to 4Mbps. Further, simulation studies have been repeated by enabling random mobility of 10Kmph, 50Kmph and 100Kmph for all the UEs. Fig.3 illustrates the aggregate throughput performance of PF scheduling algorithm with SFBC transmit diversity technique for stationary and mobile UEs.

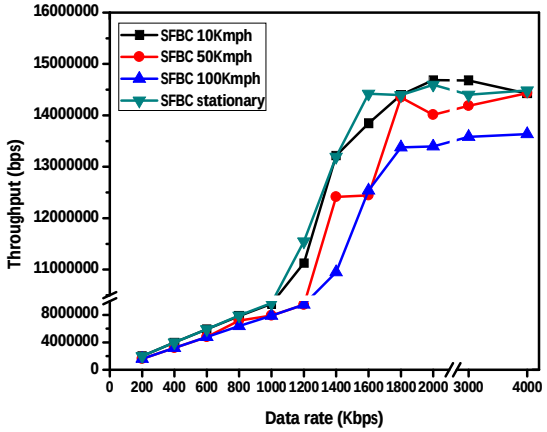

Fig. 3 Aggregate throughput performance of PF scheduling algorithm for stationary and mobile UEs

It is observed from Fig. 3 that the aggregate throughput performance for stationary and mobile UEs saturates at higher data rates as radio resources required by individual users increases with data rate leading to scarcity of resource blocks [8][9]. Further it is observed (Fig. 3) that there is marginal variation in throughput performance of PF scheduling algorithm for stationary UEs and UEs moving at 10Kmph speed. Since PF scheduler is effective in reducing variations in data rates as long as user average SINRs are fairly uniform [10]. Further it is also observed from Fig.3 that the throughput decreases with increasing vehicular speeds. Since higher vehicular speeds causes more variation in SINR [11].

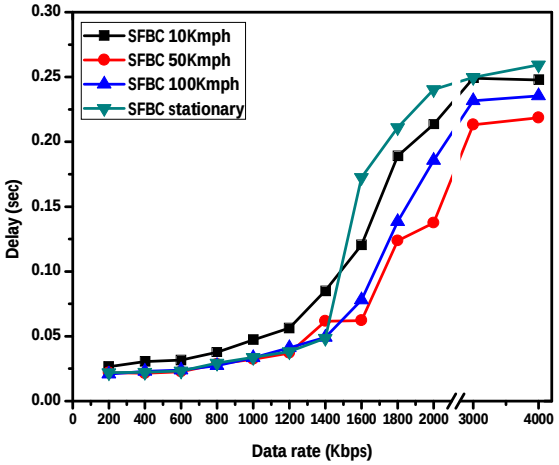

Fig. 4 Average delay performance of PF scheduling algorithm for stationary and mobile UEs

The average delay performance of PF scheduling algorithm for different vehicular speeds with SFBC transmit diversity technique are shown in Fig. 4.

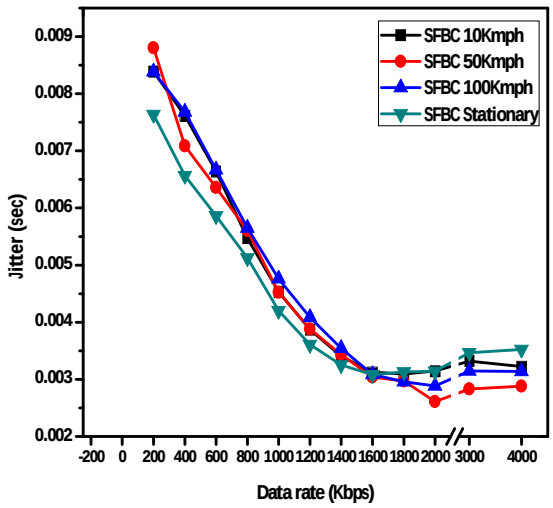

Fig. 5 Average jitter performance of PF scheduling algorithm for stationary and mobile UEs

The average jitter performance of PF scheduling algorithm for different vehicular speeds with SFBC transmit diversity technique are shown in Fig. 5. Average jitter performance of PF scheduling algorithm increases marginally with increase in vehicular speeds, since SINR varies with mobility [11].

CONCLUSION

In this paper, the effect of mobility on the performance of Proportional Fair channel aware scheduling algorithm with SFBC transmit diversity multi-antenna technique is compared through simulation studies considering throughput, delay and jitter as performance metrics. The simulation results show that the performance of PF scheduling algorithm with SFBC transmit diversity multi-antenna technique is better for stationary UEs.

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