3GPP TSG RAN WG1 #42 R1-050720
London, U.K., Aug 29 – Sept 2, 2005

Source: **Motorola**
Title: **Frequency Selective Scheduling Resource Block Size for EUTRA Downlink**
Agenda Item: **10.4**
Document for: **Discussion**

1. Introduction

In this contribution, we investigate the resource block size of the frequency selective scheduling for EUTRA downlink. Our simulation results show that optimal resource blocks size may vary with the channel model and the appropriate resource block size is around 200 KHz.

2. Simulation Assumptions

The system simulation assumptions are given in Table 1. Pedestrian B and Typical Urban (TU) channel models are simulated and the corresponding delay profiles are given in Table 2 and Table 3 respectively. The time average of the number of sub-carriers allocated to each user is approximately the same to make sure that the fairness is the same for all the cases for different resource block sizes. This is very important for the selection of the optimal resource block size because without fairness measurement, throughput of one resource block size varies wildly. In addition, with maximum throughput scheduler (no fairness) and full-buffer traffic, frequency selective has only 10 to 20% higher throughput compared to frequency non-selective one. The results presented assume ideal channel information and no overhead of pilot and control channels.

The downlink EUTRA numerology is given in Table 4 as the baseline scheme in [1]. Resource block sizes from 75 KHz to 2250 KHz are simulated for bandwidth of 5, 10 and 20 MHz.

Parameter	Configuration
Layout	19 Node-B, 3 sector wrap-around layout Down Link Site-to-site distance = 1000 m
Channel Model	Pedestrian B Typical Urban (TU)
Traffic Model	Full-buffer
# users per sector	10, 20 and 40
# Antennas	1 at Node-B, 1 or 2 at UE
TTI	0.5 ms
Bandwidth	5, 10 and 20 MHz
Carrier Frequency	2 GHz

Scheduler	Frequency Selective with equal chance.
Channel estimation	Ideal.

Table 1 - Assumptions and Conditions

Relative Delay (ns)	Relative Power (dB)
0	0
200	-0.9
800	-4.9
1200	-8
2300	-7.8
3700	-23.9

Table 2 - Pedestrian B channel model

Relative Delay (ns)	Relative Power (dB)
0	-4
100	-3
300	0
500	-2.6
800	-3
1100	-5
1300	-7
1700	-5
2300	-6.5
3100	-8.6
3200	-11
5000	-10

Table 3 - Typical Urban (TU) channel model[1]

Parameter	5 MHz	10 MHz	20 MHz
TTI	0.5 ms	0.5 ms	0.5 ms
Number of OFDM symbols per TTI	8	8	8
FFT size	512	1024	2048
Useful sub-carriers	301	601	1201
Sub-carrier spacing	15 KHz	15 KHz	15 KHz
Sampling rate	7.68 M	15.36 M	30.72 M
GI (us)	4.69/4.82	4.75/4.82	4.75/4.79
GI (samples)	36/37	73/74	146/147
Resource block size (KHz)	2250, 900, 450, 225, 150, 75		
Resource block size (# sub-carriers)	150, 60, 30, 15, 10, 5		
# resource blocks	2, 5, 10, 20, 30, 60	4, 10, 20, 40, 60, 120	8, 20, 40, 80, 120, 240

Table 4 - Numerology for EUTRA OFDMA downlink

[1] Note that results were also run with the 6-ray TU model given in TR25.814 and no significant differences in results were seen.

3. Simulation Results

Figure 1 to Figure 3 show results with 1 antenna at the receiver for bandwidth of 5, 10 and 20 MHz, respectively. For each bandwidth, sector throughput versus the resource block sizes for load equal to 10, 20 and 40 UEs per sector are given for full-buffer traffic and for Pedestrian B and TU channel model.

As shown in Figure 1 to Figure 3, TU channel is more sensitive to the selection of resource block size. Also, it may be observed that higher frequency selective gain is obtained with TU channel compared to Pedestrian B channel. This is because TU channel has longer delay profile and is naturally more frequency selective. We also noticed that higher load of the system requires relatively smaller resource block size and can take more advantage of the frequency selective scheduling. For Pedestrian B and TU channel, the optimal resource block size is in the range of 225 to 450 KHz and 150-225 KHz respectively.

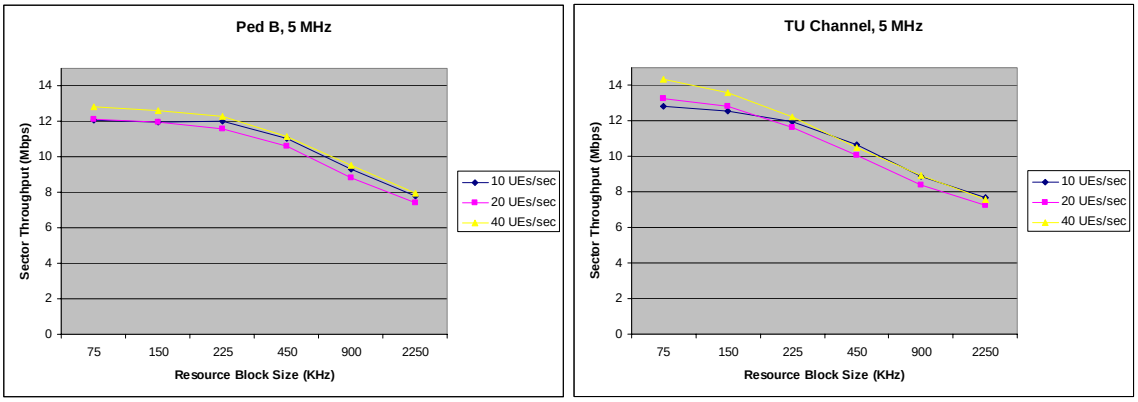

Figure 1 - 5 MHz bandwidth performance for resource block size selection

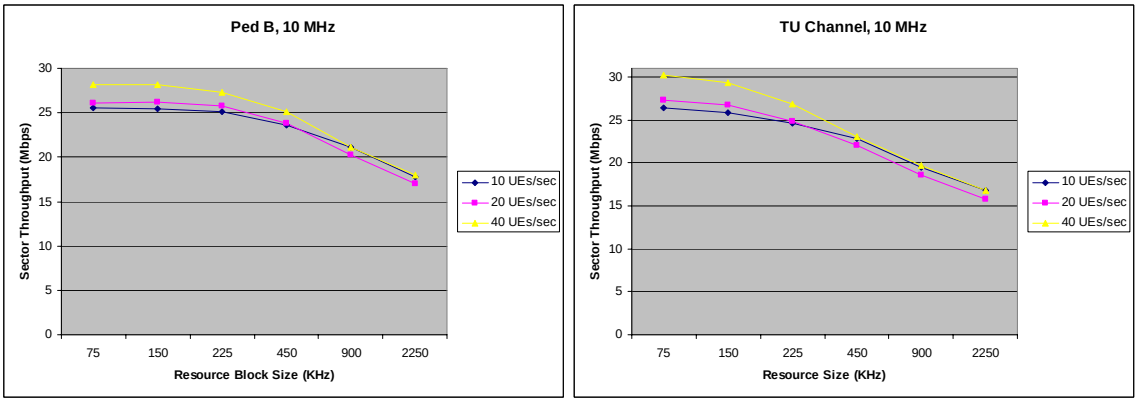

Figure 2 - 10 MHz bandwidth performance for resource block size selection

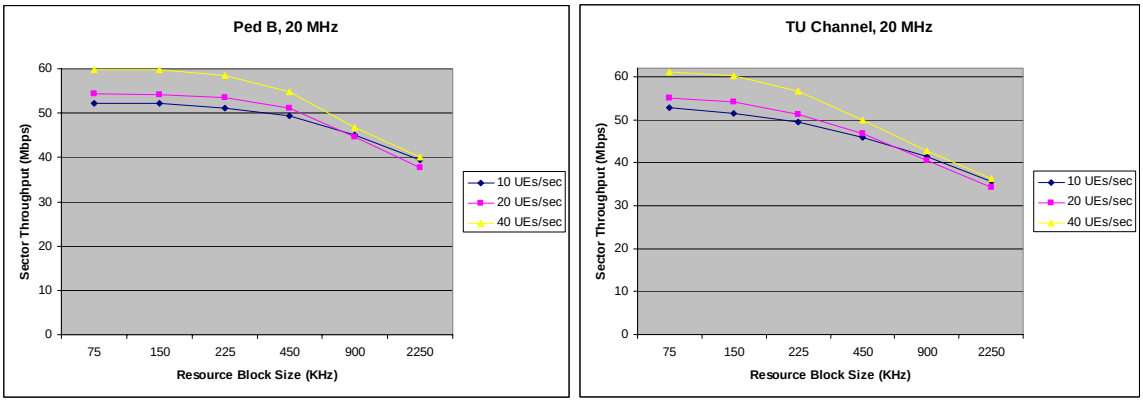

Figure 3 - 20 MHz bandwidth performance for resource block size selection

Figure 4 shows the fairness performance in terms of CDF of the normalized user throughput. The left plot gives results for resource block size fixed to 225 KHz with different bandwidth and number of UEs per sector. The right plot gives results for 20 MHz bandwidth and 40 UEs per sector but different resource block sizes. We can see that approximately the same fairness is achieved for all the cases.

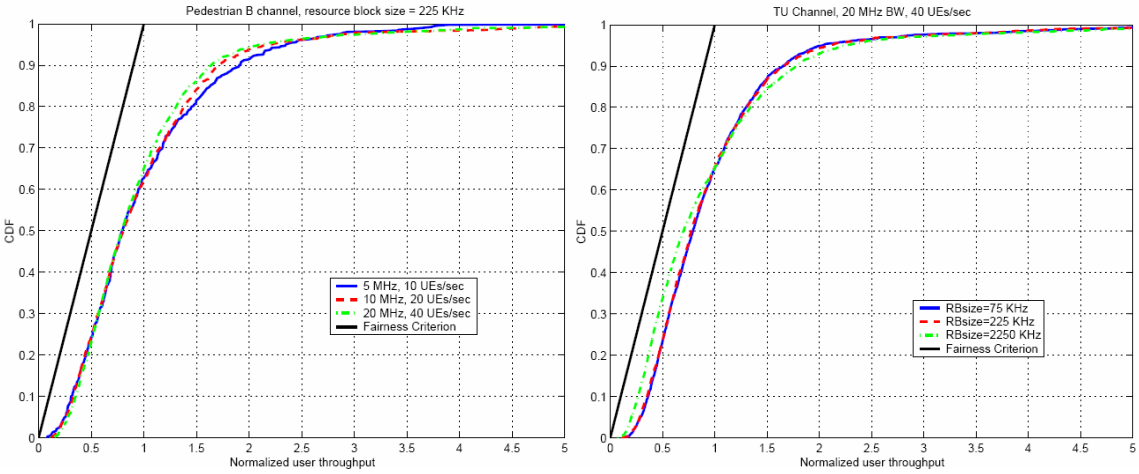

Figure 4 - Fairness alignment illustration

Figure 5 to Figure 7 show results with 2 receiver antennas for bandwidth of 5, 10 and 20 MHz, respectively. Compared to the results with 1 receiver antenna the gain is reduced from 50% to 30%. However, the frequency selective scheduling with receiver diversity is still substantial. Further, the optimal resource block size is still in the range of 225 to 450 KHz.

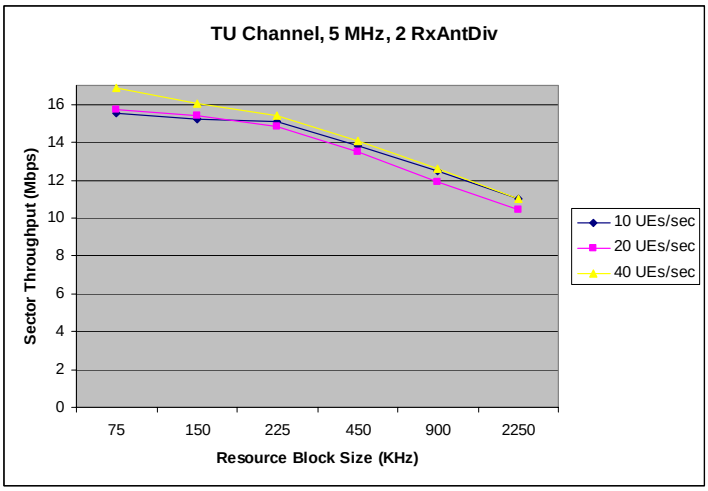

Figure 5 - Resource block size selection: 5 MHz bandwidth, TU channel with 2 receive antennas

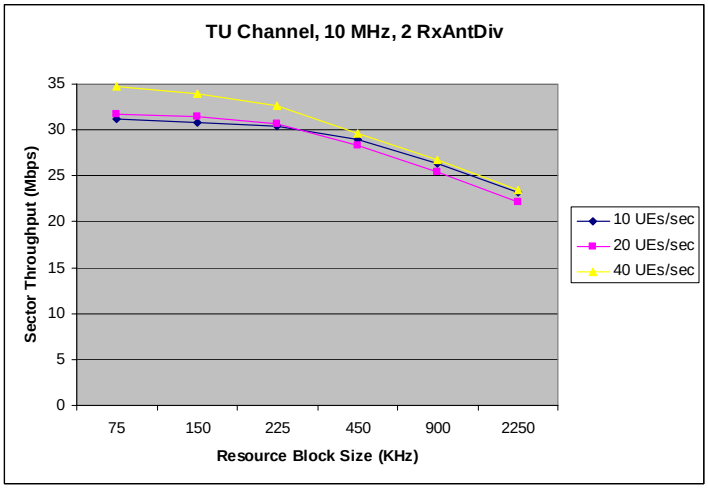

Figure 6 - Resource block size selection: 10 MHz bandwidth, TU channel with 2 receive antennas

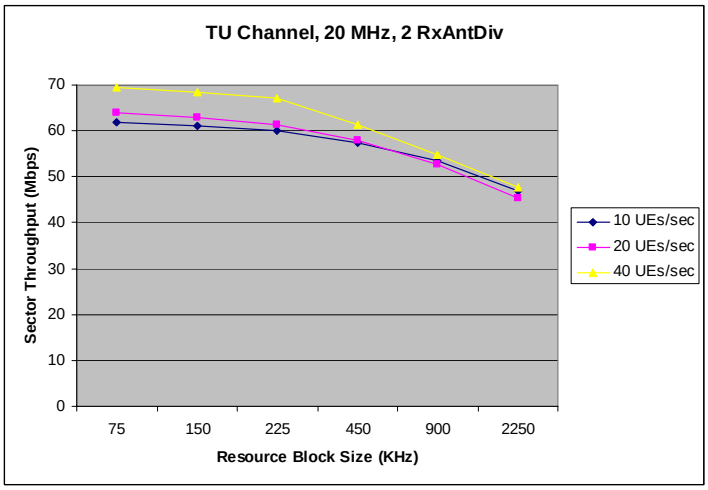

Figure 7 - Resource block size selection: 20 MHz bandwidth, TU channel with 2 receive antennas

4. Conclusions

Based on the simulation results, the following conclusions are drawn:

1. Optimal resource block size depends on the channel model and the load of the system. Harsher frequency selective channel such as TU requires smaller resource block size to take full advantage of frequency selective scheduling. However, the feedback requirement increases with lower resource block size and puts undue burden on the reverse link capacity.
2. With UE RX diversity, the frequency selective gain is reduced significantly. Other impairments such as CQI errors will further reduce the frequency selective gain.
3. UE Rx diversity, certain scheduler designs, and CQI errors indicate a larger resource block size may be acceptable.
4. The optimal resource block size, without CQI errors, falls in the 225-450 KHz (15-30 sub-carriers with sub-carrier spacing of 15 KHz) and it is recommended to choose a size closer to 450KHz to take advantage of frequency selective scheduling while at the same time optimizing the feedback requirement.

References

[1] R1-050682, "3GPP TR 25.814 v 0.1.1 (2005-06)", RAN1 LTE Ad Hoc, Sophia Antipolis, France, June 2005.