Agenda item:	**AdHoc #24 HSDPA**
Source:	**Motorola**
Title:	**Text proposal on system perf. w/wo FCS (faded but no motion, 0047)**
Document for:	**TR**

7.3.1 FCS

7.3.1.1 Summary for FCS benefit:

The effect of Fast Cell Selection (FCS) on throughput with and without Hybrid ARQ (chase combining) is studied using a dynamic system simulation tool. The system simulator tool models Rayleigh and Rician fading, time evolution with discrete steps (0.667ms e.g.), adaptive modulation and coding (AMC), fast Hybrid ARQ, fast cell selection FCS, and open loop transmit diversity (STTD). The simulator also models Lognormal shadowing, delay spread, and fractional recovered power (per ray). The system simulation assumptions used are described in sections 12.3.2 to 12.3.7 and in Tdoc# R1-01-0047. Each UE experienced 3kph rayleigh fading with fractional recovered power of 0.98.

7.3.1.2 Conclusion for FCS benefit:

Fast Cell Selection (FCS) improves throughput and residual FER for UEs in multi-coverage regions (**see Tables 1 thru 4** and **Figures 1 thru 3**). This is because a UE in a multi-coverage region typically has a weaker channel to any single serving cell compared to UEs closer to their serving cell. With FCS the multi-coverage UE has more opportunities to select a better link to one of the serving cells and be scheduled. The overall system benefit due to FCS is more significant with fair (in term of scheduling oppurtunities) schedulers (such as Round Robin) compared to maximum C/I scheduler since the users with weak links are scheduled more often. With a maximum C/I scheduler the larger the load the less impact FCS has on performance. Without FCS it takes longer for UEs with weak links to finish a packet call and hence longer to release the dedicated control channel which results in further overhead and reduced system capacity. Similar conclusions, i.e.FCS is primarily beneficial for Round-robin type scheduling and for users at the cell border, were drawn in Tdoc# R1-01-0036. Open issues include how much larger the FCS benefit is with motion and allowing for MCS changes between re-transmissions.

7.3.1.3 FCS function description

Fast Cell Selection (FCS) allows a UE to rapidly choose any one cell in its active set (i.e. set of potential serving cells) for down link transmission. The potential benefit is that for each frame interval the active set cell with the best faded link can be chosen for frame transmission to the UE. The UE chooses the best cell by comparing each active set cell's estimated CPICH Ec/Io and transmits a cell indicator to be detected by the desired cell on a uplink dedicated control channel. <u>Frame retransmissions can therefore take place by any active set cell if chosen and the resulting received signal energy from each frame is accumulated to model a Chase combining process</u>. Note that the active set evolves with time as a UEs position changes. In this simulation the UEs experience fast (Rayleigh) fading but did not move from the initial location for a given Monte Carlo drop.

As part of the adaptive modulation and coding (AMC) schemes proposed for HSDPA, the UE also estimates CPICH Ec/Nt (C/I) for each cell in its pilot active set for the current slot. The pilot Ec/Nt information for the selected cell is then also fed back on an uplink dedicated control channel. The Node B then uses the C/I estimate to determine the modulation and coding level for that users subsequent frame and possibly also for setting scheduling priorities. The simulation results presented below compare throughput and residual FER statistics with and without FCS enabled. The cell selection update rate is once every 3.33ms. The FCS and CPICH measurement delay, as shown in Figure 0 below, is about 10ms.

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Measure CPICH   Transmit          Sched Decision      Frame
Select cell     C/I and           MCS selection       Transmission
                Cell indicator    (C/I and/or PC info)                      ✍ Simulation Approach
|----------------------|----------------------|-------------------- ---|----------------------|------------------------|
✍ ---3.33ms ----✍ ✍ --- 3.33ms -- ✍ ✍ --- 3.33ms --- ✍
```

Figure 0 Time diagram of FCS and CPICH measurement delay

TABLE 1 FCS Disabled with Max C/I Scheduler

Single Rayleigh Ray, 3kph, FRP=0.98 Block Size=336 bytes Max C/I, Mod. ETSI 30% Overhead AMC, HARQ, no FCS

#Users per sector, Max ovsf codes	Average Throughput Statistics Entire System OTA	Service	Packet call	Percent Utilization	Offered Load	User Packet Call Throughput CDF <32k/64k/128k/384k/1M	%UEs with Residual FER >10-2 / >10-4
	(bps)	(bps)	(bps)	(%)	(bps)	(%)	(%)
012ue/sect, 20size32	2,338,440	387,204	1,568,007	16.5	399,220	00/00/00/01/23	0.0 / 0.2
037ue/sect, 20size32	2,035,561	1,140,388	1,277,785	55.2	1,172,408	00/00/01/11/43	0.0 / 0.4
056ue/sect, 20size32	2,120,471	1,679,382	1,131,307	77.4	1,720,800	00/01/05/23/53	0.0 / 0.4
075ue/sect, 20size32	2,391,955	2,155,493	1,057,189	87.5	2,201,708	02/05/12/32/58	0.0 / 0.5
100ue/sect, 20size32	2,798,980	2,670,794	1,011,444	91.9	2,716,026	07/13/21/40/62	0.0 / 0.4

TABLE 2 FCS Enabled with Max C/I Scheduler

Single Rayleigh Ray, 3kph, FRP=0.98 Block Size=336 bytes Max C/I, Mod. ETSI 30% Overhead AMC, HARQ, FCS

#Users per sector, Max ovsf codes	Average Throughput Statistics Entire System OTA	Service	Packet call	Percent Utilization	Offered Load	User Packet Call Throughput CDF <32k/64k/128k/384k/1M	%UEs with Residual FER >10-2 / >10-4
	(bps)	(bps)	(bps)	(%)	(bps)	(%)	(%)
012ue/sect, 20size32	2,420,614	393,447	1,588,520	16.2	405,329	00/00/00/00/21	0.0 / 0.0
037ue/sect, 20size32	1,997,291	1,148,252	1,274,242	56.4	1,181,163	00/00/00/08/43	0.0 / 0.0
056ue/sect, 20size32	2,049,253	1,699,108	1,109,216	80.7	1,742,468	00/01/04/22/53	0.0 / 0.0
075ue/sect, 20size32	2,345,164	2,171,345	1,041,938	89.6	2,213,770	02/05/12/32/58	0.0 / 0.0
100ue/sect, 20size32	2,766,521	2,692,171	996,139	93.5	2,739,260	07/13/21/40/63	0.0 / 0.0

From **Tables 3** and **4** for the Round Robin scheduler see somewhat larger throughput improvements with FCS on compared to the Maximum C/I scheduler. **Figure 1** illustrates FCS benefits by showing the %User Packet Cell throughput CDF with and without FCS at different loading. **Figure 2** shows the increase in the average number of dedicated channels required to support the users that are not in the dormant state (waiting for all the packets of a packet call). **Figures 3** and **4** compare throughput performance and fairness for Round Robin and Maximum C/I schedulers.

TABLE 3 FCS Disabled with Round Robin Scheduler

Single Rayleigh Ray, 3kph, FRP=0.98 Block Size=336 bytes RRobin, Mod. ETSI 30% Overhead AMC, HARQ, no FCS

#Users per sector, Max ovsf codes	Average Throughput Statistics Entire System OTA	Service	Packet call	Percent Utilization	Offered Load	User Packet Call Throughput CDF <32k/64k/128k/384k/1M	%UEs with Residual FER >10-2 / >10-4
	(bps)	(bps)	(bps)	(%)	(bps)	(%)	(%)
012ue/sect, 20size32	2,157,079	389,284	1,507,379	17.9	401,654	00 / 00 / 00 / 01 / 23	0.0 / 0.1
037ue/sect, 20size32	1,497,979	1,111,120	904,903	72.8	1,136,996	00 / 00 / 02 / 21 / 64	0.0 / 0.6
056ue/sect, 20size32	1,328,442	1,470,168	446,527	100.0	1,476,561	02 / 11 / 30 / 65 / 91	0.0 / 1.6
075ue/sect, 20size32	1,308,320	1,630,910	254,732	100.0	1,598,901	17 / 40 / 60 / 88 / 96	0.0 / 1.3

TABLE 4 FCS Enabled with Round Robin Scheduler

Single Rayleigh Ray, 3kph, FRP=0.98 Block Size=336 bytes RRobin, Mod. ETSI 30% Overhead AMC, HARQ, FCS

#Users per sector, Max ovsf codes	Average Throughput Statistics Entire System OTA	Service	Packet call	Percent Utilization	Offered Load	User Packet Call Throughput CDF <32k/64k/128k/384k/1M	%UEs with Residual FER >10-2 / >10-4
	(bps)	(bps)	(bps)	(%)	(bps)	(%)	(%)
012ue/sect, 20size32	2,282,522	391,198	1,547,580	17.0	397,347	00 / 00 / 00 / 00 / 19	0.0 / 0.0
037ue/sect, 20size32	1,548,366	1,133,420	957,866	71.8	1,161,699	00 / 00 / 00 / 13 / 60	0.0 / 0.1
056ue/sect, 20size32	1,326,962	1,524,255	426,340	100.0	1,532,878	00 / 05 / 26 / 64 / 93	0.0 / 0.2
075ue/sect, 20size32	1,299,941	1,690,414	230,325	100.0	1,665,984	11 / 36 / 58 / 89 / 97	0.0 / 0.2

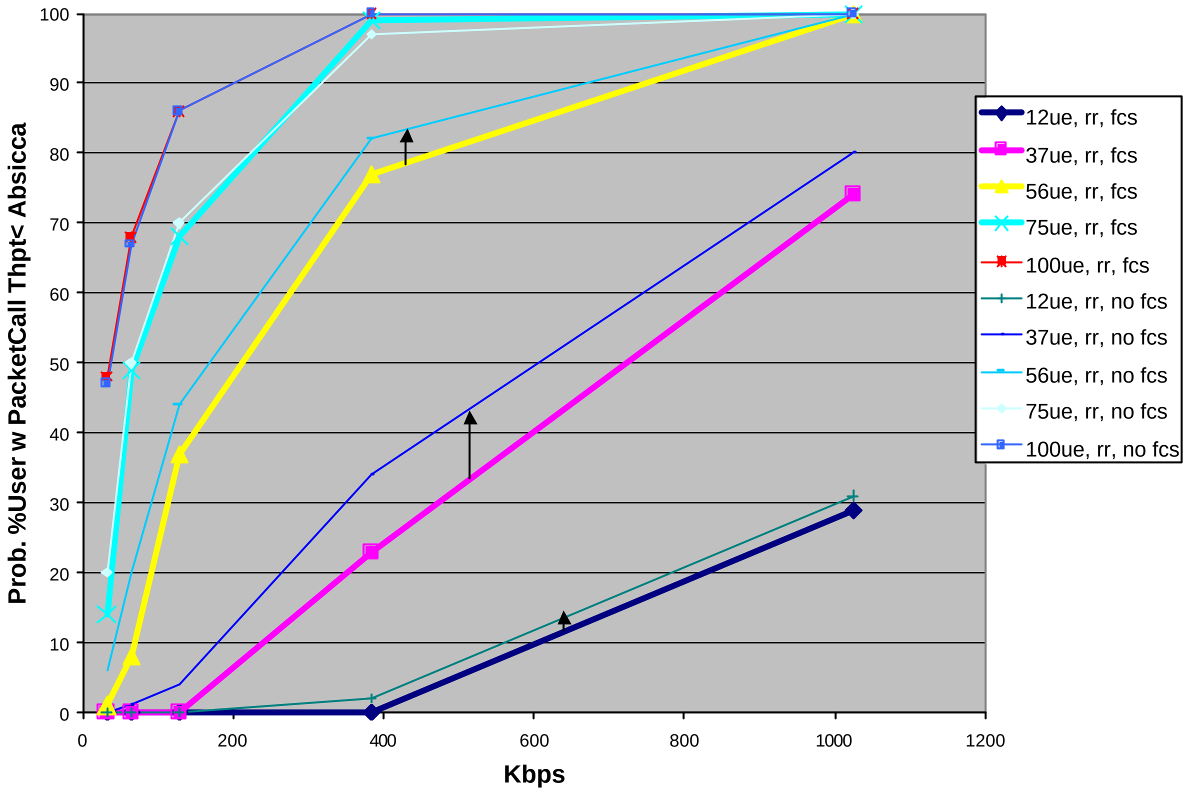

Figure 1. %User Packet Call Throughput CDF w/wo FCS for Round Robin

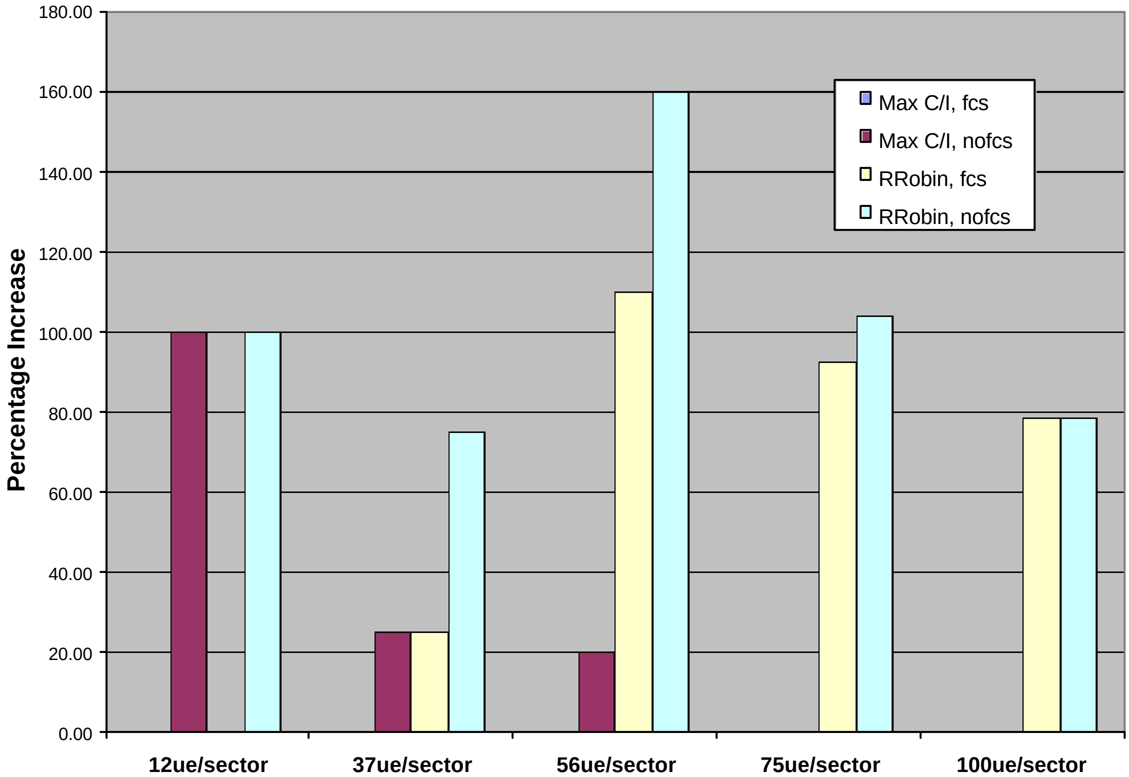

Figure 2. %Increase in required dedicated channels w/wo FCS

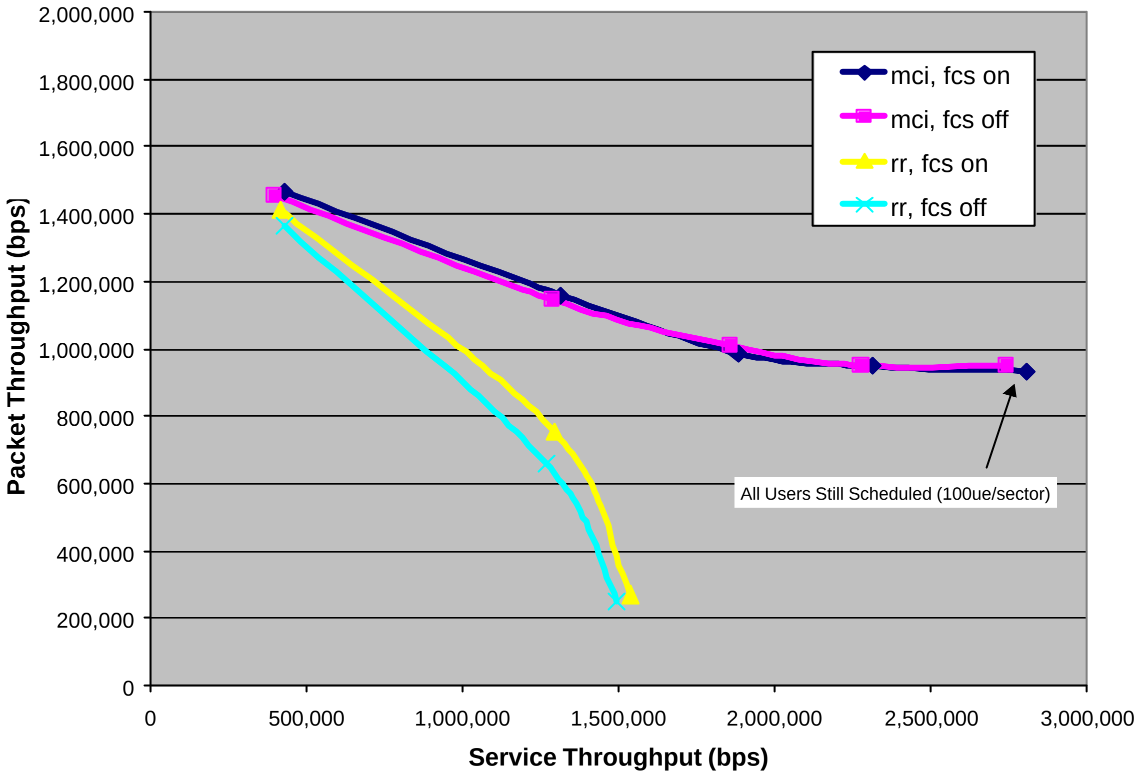

Figure 3. Packet Throughput vs Service Throughput for Max C/I and Round Robin

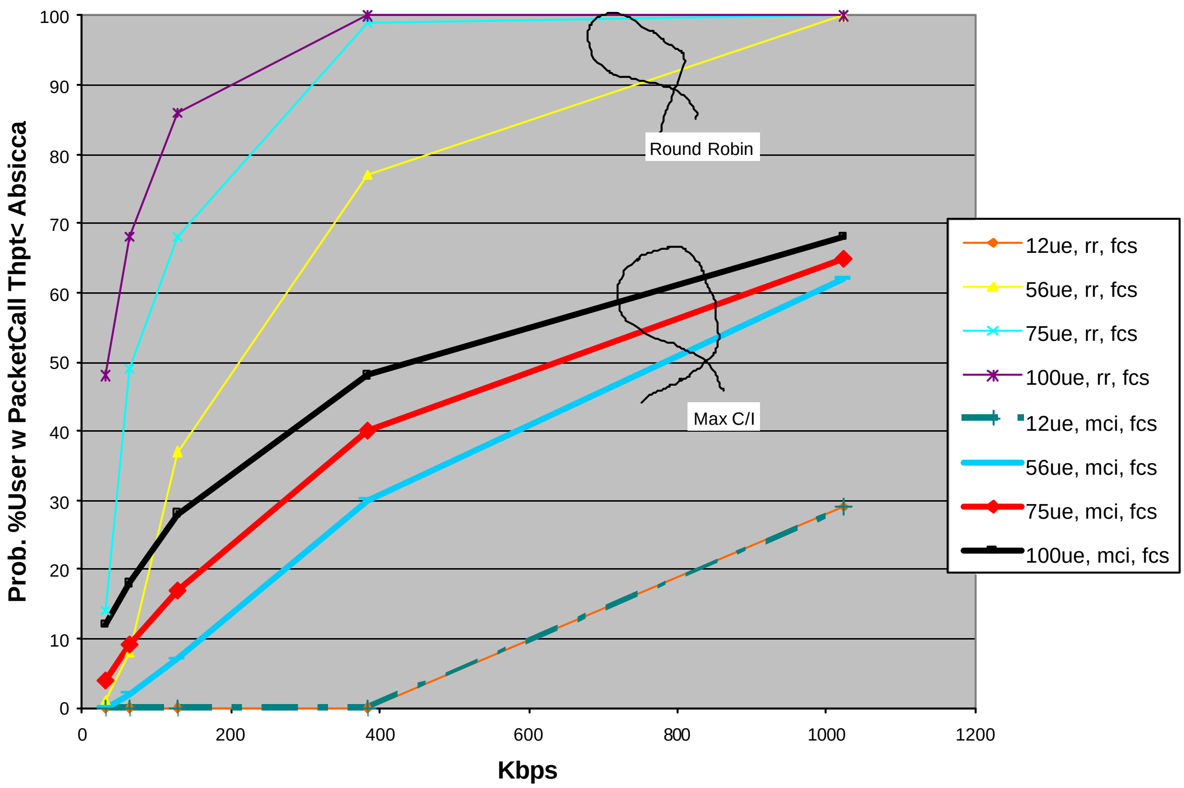

Figure 4. Fairness: %User Packet Call Throughput CDF comparing Maximum C/I with Round Robin Schedulers at 3kph.