Performance of Alternative Fast Power Control Schemes

1. INTRODUCTION

This document presents a simulation study on the effect of different power control signalling intervals to the network level capacity in a typical macro cellular network.

It has been shown that ECSD Fast Power Control (FPC) can provide considerable capacity benefit at least in certain environments [1]. The ECSD FPC is 24 times faster than normal SACCH-based PC (20 ms vs. 480 ms). It has been proposed to adopt similar kind of scheme for 8PSK speech [2] . A proposal of 120 ms FPC signalling period has also been made [3], which has the benefit that it is applicable to both GMSK and 8PSK modes.

A simulation study [4] has been made which suggests that normal PC is enough for low mobility (3 km/h) users and that 120 ms PC period can provide some gain for fast moving mobiles (50 km/h).

Earlier version of this document [5] showed that some additional gain can be achieved with 20 ms FPC signalling period. That document considered only non-hopping case and error-free FPC signalling conditions.

In this new version, power control command and measurement report errors are now taken into account and the results are shown for the RF hopping case using DTX. Both MS speeds of 3 km/h and 50 km/h are still considered.

2. SIMULATION MODELLING AND SCENARIOS

Simulations were run in a typical macro cellular environment with 3-sector sites. Both uplink and downlink directions were taken into account. Simulated speech service was AMR 7.4 with ETCH-FS channel – no link or codec mode adaptation was applied.

Main simulation parameters are listed in Annex A.

2.1 Signal Quality Reporting

An RXQUAL sample is collected from bursts over 20, 120 or 480 ms measurement period. A running average filter of the collected samples are fed to the PC algorithm with the frequency as which match to the quality reporting. For 120 ms and 480 ms case, the newest sample is not taken into account, for 20 ms period two newest samples are not taken into account – these model the delays between the measurement and the PC command.

Measurement reporting error is modelled due to SACCH burst errors in 120 ms case and due to SACCH frame errors in 480 ms case.

During DTX no measurement reports or PC commands are sent. The performance of FPC mechanism during DTX presented in [2] will be studied later.

2.2 Power control algorithm

In order to have fair comparison between different PC intervals, same simple quality-based based PC algorithm was used. The algorithm adjust the transmission power according to the deviation of the target RXQUAL, see equation below

$$PCCommand_dB = 2.0 * (Avg(RXQUAL) - RxqualTarget)$$

Final transmission power was naturally limited between maximum and minimum power levels. An RxqualTarget value of 2 was used in simulations.

2.3 Error Modelling

When 20ms PC interval is used on full rate channels, an error free signalling can be assumed. However when SACCH based PC is used, the errors have to be taken into account. The assumptions are :

- 8 power levels & 120 ms rate
- 12 bits used for PC signaling (10 bits punctured on every SACCH burst)
- 1.1dB loss on SACCH (see Annex B)
- 1% WER for PC signalling at 11dB of C/Ico [4]

Errors on SACCH are taken into account only in PC signalling. The additional 1.1 dB loss in SACCH performance in the 120ms scheme would slightly degrade the capacity due to additional losses especially in handover signalling.

3. RESULTS

In this section, the simulations results are shown. Network capacity (load) is plotted as a function of network quality (satisfied user ratio[1]) for all the three studied FPC signalling schemes.

Figure 1 shows the results for MS speed of 3 km/h. It can be seen that there is not any significant difference in the curves with different PC signalling periods.

The signalling error rates were between 1.4-4.0% and 0.2-1.5% for the 120ms and 480ms cases, respectively.

[1] Defined as *1- (NrOfBlockedCalls+NrOfDroppedCalls+ NrOfBadQualityCalls / AllCalls*)

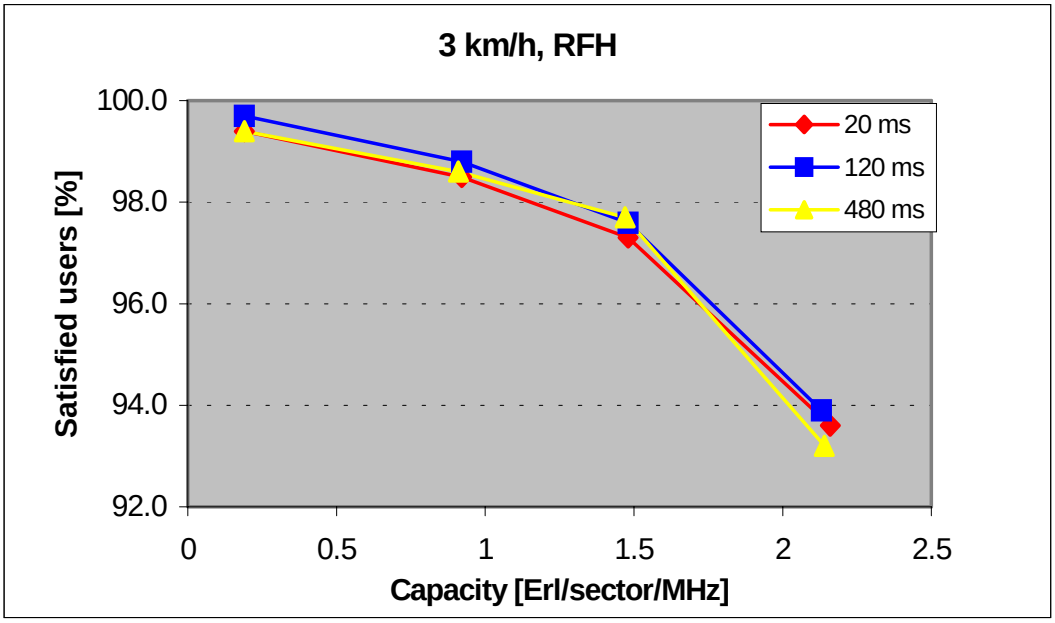


Figure 1. Network quality versus capacity with different PC intervals. 3 km/h MS speed, DTX On, FH On.

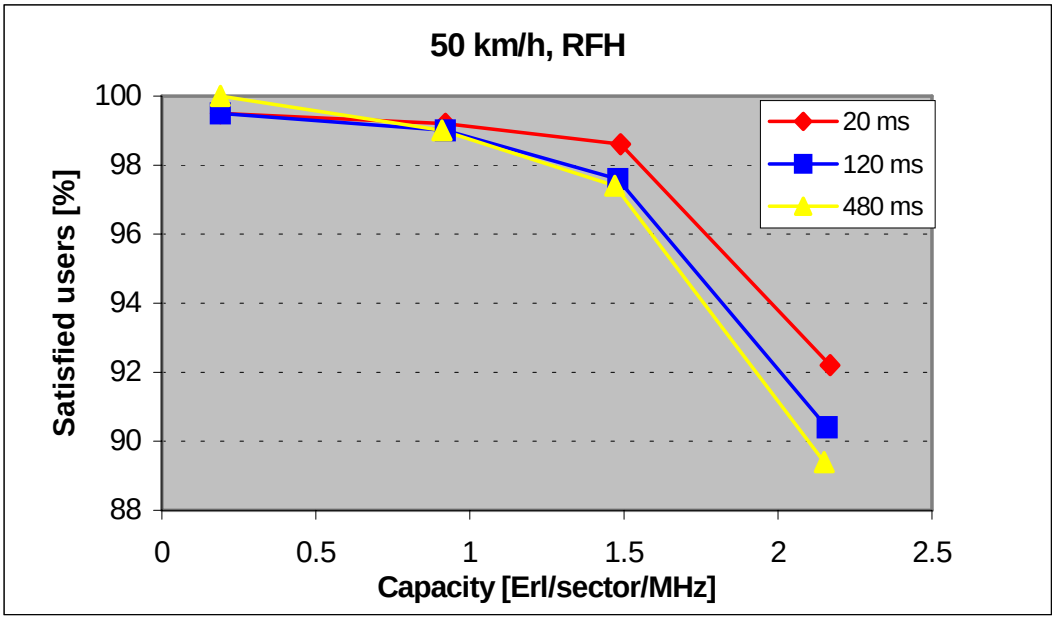


Figure 2. Network quality versus capacity with different PC intervals. 50 km/h MS speed, DTX On, FH On.

From the above figure above (50 km/h case), it can be seen that some moderate gain can be achieved with both 120ms and 20s signalling period. However, on the contrary to references [4-5], in this case most of the gain is coming from the 20 ms period. The total gain is quite moderate, 15-20%. The signalling error rates were between 1.5-5.0% and 0.2-2.7% for the 120ms and 480ms cases, respectively.

4. CONCLUSION

This document presents network simulations results on the effect of different PC measurement reporting and PC command interval. Three different cases are considered: 20ms, 120 ms and 480 ms PC cycles. These simulation results show that gain can be achieved also with FH for fast moving mobiles when going down to 20 ms PC interval, although it seems like most of the gain is already achieved by reducing the interval to 120 ms.

Shorter PC interval could give more gain for example in a network with bursty packet data and/or in an environment with more aggressive interference behaviour, like in indoor or micro cell scenario. These items are left for further study.

5. REFERENCES

[1] Tdoc SMG2-2e99-331:"Fast measurement reporting and power control for ECSD" (Source: Nokia). ETSI SMG2 Working Session on EDGE, 24th-27th August 1999, Versailles, France.

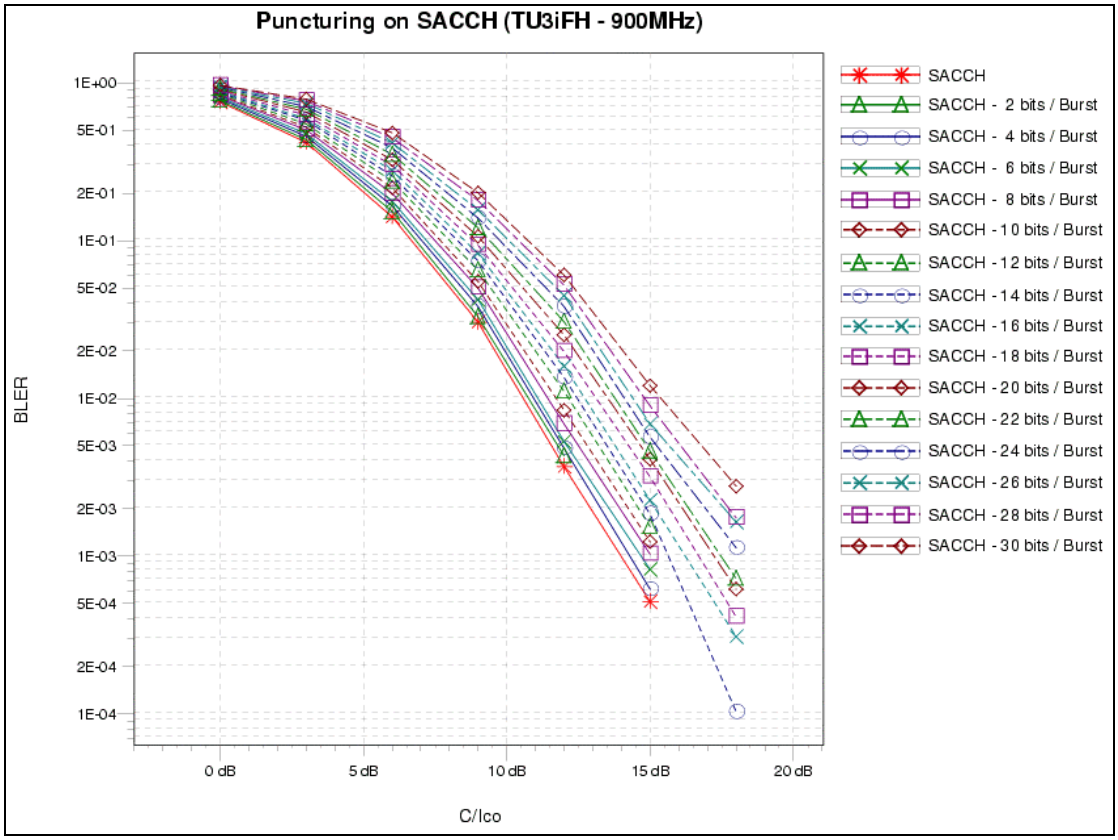
[2] 3GPP TSG GERAN Adhoc #2, Tdoc GAHW000064, Fast Adaptation Mechanisms for 8PSK Speech Bearer, Nokia, 9th-13th October 2000, Munich, Germany

[3] Tdoc GERAN Adhoc 052/00: "SACCH Stealing Bits for 120ms EGPRS Voice Power Control (source AT&T)".)". 3GPP TSG GERAN Adhoc #1, 7th-11th August 2000, Helsinki, Finland.

[4] 3GPP TSG GERAN #2, Tdoc GAHW000603, Fast Power Control for Speech in GERAN, Ericsson, 6th-10th November 2000, Norrtälje, Sweden

[5] Tdoc TSGG#02(00)0885 : "Performance of Alternative Fast Power Control Schemes" (Source: Nokia)". 3GPP TSG GERAN Meeting #2, 6th-11th November 2000, Norrtälje, Sweden.

ANNEX A – Main simulation parameters

Parameter	Value	Unit	Comment
Frequency band	900	MHz	
Bandwidth	5.4	MHz	Incl. BCCH
Reuse and number of TRXs	TCH 2/6, BCCH 5/15, 3TRXs per cell		
Frequency hopping	• Not used. • Random RF (synthesized) hopping		
Cell radius	500	m	
BTS power	20	W	
MS power	2	W	
Noise floor	- 114	dBm	
Path loss exponent	3.67		
Slow fading standard dev.	6	dB	
ACP value	18	dB	1st adj. taken into account
Simulation time step	4.615	ms	1 TDMA frame
Simulation length	200000	TDMA frame	~15.5 minutes
Call arrival rate	0.001389	1 / h	5 calls / hour / user (Poisson process)
Avg. call length	120	sec.	
Handover margin	6	dB	
Handover check interval	4	SACCH multiframe	
Required FER for speech	3	%	
Voice activity	66	%	

ANNEX B – SACCH link level performance