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Agenda Item: 7.5.2

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Title: A way Forward to Specify the Requirements for Active Set Size

Document for: Discussion

1. Introduction and Background

Currently it has been specified that the UE shall be capable of supporting at least 6 radio links in soft handover [1]. In RAN4 it has been proposed to limit the E-DCH active set size to 3 as this would reduce UE implementation complexity [2]. On the other hand it has been shown that small E-DCH active set size adversely impacts the system performance [3-5]. As of the last RAN4 meeting (RAN4#35) in Athens, RAN4 has not reached any agreement on this issue. According to the indicative voting in RAN4#35 equal number of companies support E-DCH active set size 3, 4 and 5. In this document we propose a way forward to resolve this issue.

2. Discussion

Since RAN4#34 meeting in Phoenix, RAN4 has been discussing the requirements for the E-DCH active set size. The current requirement in TS 25.133 [1] insures that the UE supports at least 6 radio links in soft handover. The introduction of the Enhanced Uplink would require that the UE is also capable of listening to E-DCH related downlink channels (E-HICH, E-AGCH and E-RGCH) from at least 6 radio links. However, it has been proposed to limit the E-DCH active set size to 3. Hence according to this proposal the UE shall be capable of listening to DPCH and E-DCH related channels from at least 6 and 3 radio links respectively. The main argument for this combination (6 DCH RLs + 3 E-DCH RLs) is cited to be the UE implementation complexity. Table 1 depicts the maximum number OVSF codes the UE has to listen in soft handover [2].

Table 1. Impact of AS size on OVSF code usage.

Active set size		**OVSF codes reception in soft handover**					
		Rel-99	**Rel-5**	**Rel-6**			**Total**
DCH	**E-DCH**	DPCH	HS-PDSCH + HS-SCCH	E-AGCH	E-RGCH	E-HICH	Max OVSF codes
6	3	6	5 + 4	1	3	3	22
	4		5 + 4		4	4	24
	5		5 + 4		5	5	26
	6		5 + 4		6	6	28

But it has also been argued in [2] (based on previous results presented in RAN1) that E-DCH active greater than 3 does not provide any system gain. Although it is important to note that these results were obtained from system simulation that assumes the coverage area comprising of regular hexagonal cells. However, real network may bear much more challenging environment due to varying terrain elevation, buildings, sharp corners etc.

3. System Impact of Smaller Active Set Size

Ericsson has presented a number of contributions showing that smaller active set size degrades the system performce [2-5]. These results and arguments are based on study that mimic the real network environment. The sections below discusses the major system aspects that are affected due to the active set size.

3.1 High Uplink Interference on Neighbouring Cells

One of the major concerns is that smaller E-DCH active set size would cause high uplink interference on those neighbouring cells, which are excluded from sending the relative grants (E-RGCH) but should have otherwise been included in the scheduling process. This is due to the fact that the neighbouring cells can control interference by sending the 'Down' command on E-RGCH.

In [5] a real network deployed in a city, which comprises of hilly terrains, was simulated and results were presented in RAN4#35 meeting. The results clearly showed that in some scenarios up to 25% coverage area is adversely affected due to high interference in case E-DCH active set size is 3.

It is also important to note that such areas, comprising of high-rise buildings, hilly areas and sharp contours, are not unique rather quite common in reality. Furthermore network planning in such areas is also very challenging.

3.2 Impact on Frequency of Replacement

In case E-DCH active set size is smaller than DCH active set size, more frequent replacements of the E-DCH soft handover legs would be needed to insure that E-DCH best cell matches with that of DCH. It has been shown [4] that replacement frequency increases with the decrease in the active set size from 4 to 3. Frequency of replacement has an impact on the signaling load. The signaling channel (SRB) bears limited capacity. Therefore, high replacement frequency will increase the call drop rate deteriorating the grade of service.

3.3 Impact of Different DCH and E-DCH AS on Ecat Requirements

The network should have an option of setting the same active set size for both E-DCH and DCH as this configuration has an impact on the requirements for the reporting criteria (Ecat) specified in table 8.10 of section 8.3 in TS 25.133 [1]. Using the same AS set size for DCH and E-DCH would reduce the number of measurements required by the UE compared to the case, where different AS set size are used for DCH and E-DCH. Given the specified Ecat for different measurement categories in TS 25.133 [1] and considering a scenario, where several services are active (EUL, HSDPA, video and speech) in loaded traffic situation, it might be necessary to use the same AS size for E-DCH and DCH. But this option is not possible if the max E-DCH active size is limited to any value other than currently specified [1].

3.4 Impact of Different DCH and E-DCH AS on E-DCH Transmission Power

Having different active sets for DCH and E-DCH could result in UL power being primarily controlled by non-E-DCH cells. Non E-DCH cell may have better uplink quality due to lower load than the E-DCH UL and thus would result in non E-DCH cell sending down TPC commands more frequently. Note UE decreases it's transmit power if any of the TPC commands is down. This will lead to E-DCH transmission at wrong power levels.

3.5 Impact of Different DCH and E-DCH AS on Protocol Complexity

Having different DCH and E-DCH active sets for one UE increases the complexity, compared to having the same active sets. The signalling protocols (over Iub, Iur, Uu) need more complexity, in

terms of number of information elements (IE) and amount of procedure text, for old use cases that are re-used, and for new use cases. An example is the radio link re-configuration on Iur/Iub that is needed to add/remove E-DCH from RLs carrying DCH. Both increase in IE and RL reconfiguration increases complexity in node B and RNC, in terms of successfully used-cases and in handling errors in the information provided in the signalling. It should be noted this complexity would not be due to any implementation reasons rather due to the inherent complexity of such a protocol, which would set different active sets for E-DCH and DCH.

4. Proposed Way Forward

We propose to specify the same number of active set size = 4 for DCH and E-DCH channels, when E-DCH is enabled. This means release 6 UE when not using E-DCH would still be capable of supporting at least 6 radio links as currently specified in TS 25.133. This provides a reasonable trade-off between the UE complexity and the system impact. As shown in table 2 that active set size 4 would require UE to listen up to 22 OVSF codes (assuming 5-code HS-DSCH). In terms of UE complexity this is equivalent to the proposed combination (6 DCH RLs + 3 E-DCH RLs) [2].

Table 2. Impact of DCH and E-DCH AS size= 4 on OVSF code usage.

Active set size		**OVSF codes reception in soft handover**					
		Rel-99	**Rel-5**	**Rel-6**			**Total**
DCH	**E-DCH**	DPCH	HS-PDSCH + HS-SCCH	E-AGCH	E-RGCH	E-HICH	Max OVSF codes
4	4	4	5 + 4	1	4	4	22

5. Conclusion

RAN4 has not been able to agree so far on the requirements for E-DCH active set size. According to indicative voting in RAN4#35 meeting, equal number of companies are supporting active set size 3, 4 and 5. In real network environment hilly areas, sharp corner, locations with difficult network planning etc are not uncommon. Therefore based on our analysis we believe that active set size 3 will cause serious system degradation in real network operation.

Secondly, we have believe that in order to reduce Iub/Iur protocol complexity and insure correct E-DCH transmission power, it is important that the E-DCH and DCH active set sizes are kept the same. We have already shown that system performance in real network improves by increasing the DCH active set size from 3 to 4 [4].

In order to find a suitable compromise between the UE hardware complexity and the system performance we propose to specify the same active set size (4) for all transport channels, i.e. DCH and E-DCH, when E-DCH is active. When E-DCH is not used the UE will support the currently specified active set size, i.e. 6 radio links.

6. References

[1] 3GPP TS 25.133, ‘Requirements for support of radio resource management (FDD)’.

[2] R4-050336, ‘UE and UTRAN/Node B E-DCH Active set size,’ Motorola.

[3] TELCO-17_03_2005-Ericsson-Tdoc#8, ‘Requirements for E-DCH Maximum Active Set Size’.

[4] R4AH-05015, ‘Impact of Active Set Size on Network Performance’, Ericsson.

[5] R4-050299, ‘Impact of Active Set Size on Enhanced UL System Performance, Ericsson.