

Agenda item: 7
Source: Ericsson
Title: Physical-layer aspects of Fast Cell Selection for HSDPA
Document for: Discussion

1 Introduction

Fast Cell Selection (FCS) has been proposed for HSDPA [1]. Fast cell selection implies that HSDPA data to a specific UE is transmitted from only the instantaneously “best” cell in the active set, as measured by the UE. Thus fast cell selection is conceptually very similar to current SSDT.

This paper discusses the physical-layer impact of FCS. It is pointed out that FCS can inherit many of its physical-layer functionality from SSDT, implying that FCS for HSDPA can be implemented with little impact on e.g. UE complexity. The only identified aspect that needs special attention is if physical-layer signalling is to be used to transfer transmission-state information over-the-air in case of fast inter-Node-B cell selection, see further Section 2.3 below.

2 Physical-layer requirements for FCS

Fast Cell Selection implies that the UE should decide on the “best” cell for HSDPA transmission and signal this to the network. To support fast cell selection, the physical-layer

- may have to provide physical-layer measurements at the UE to support the selection of the “best” cell from the cells in the active set
- may have to provide uplink physical-layer signalling to support signalling of the selected cell to the Node B in the active set
- may have to, in case of fast inter-Node-B cell selection, provide uplink physical-layer signalling to support over-the-air transferring of the transmission state of the old Node B via the UE to the new Node B, see also Section 2.3.

2.1 Physical-layer measurements for cell selection

In case of SSDT, the “best” cell (the so-called “primary cell”) is selected based on measurements of CPICH RSCP for the cells in the active set. The same measurements can be used as a basis for fast cell selection. It should be noted that other factors than measured CPICH RSCP might also affect the fast cell selection. As an example, it has been pointed out in [2] that the transmit-power offset between HS-DSCH and CPICH may be different for different cells in the active set and that knowledge of this offset may be useful in the cell selection. Similarly, knowledge of the relative load of different cells may effect the cell selection. However, these are not Layer 1 issues, neither will they have a significant impact on e.g. UE complexity.

2.2 Physical-layer signalling for cell selection

In case of SSDT, the best cell is reported to the network using Layer 1 (DPCCH) signalling with a maximum rate 500 Hz. Basically identical signalling could be used for fast cell selection.

It remains to be decided if there may be requirements that a UE may have to support simultaneous independent signalling for SSDT and FCS (there may be a situation where a UE should receive HS-DSCH and dedicated transport channels on DPCH simultaneously). If this is the case there is a need for new uplink DPCCH slot formats to allow for simultaneous SSDT and FCS signalling. If this is not the case, FCS can reuse the DPCCH SSDT-signalling field and no new UL DPCCH slot formats are needed.

SSDT signalling is robust in the sense that downlink transmission from a cell is “turned-off” if and only if the SSDT signalling indicates, with sufficiently high reliability, that the cell has not been selected as primary cell. In a similar way, the FCS signalling should be robust in the sense that a cell would schedule HS-DSCH data to a UE only if the FCS signalling indicates, with sufficiently high reliability, that the cell has been selected.

2.3 Fast inter-Node B cell selection

If scheduling for HSDPA and termination of fast Hybrid ARQ is done at Node B there must be explicit means to ensure synchronisation of the scheduling and fast Hybrid ARQ states of the two Node B in case of fast inter-Node-B cell selection.

There are different alternatives by which such “transmission-state” synchronisation can be achieved:

- over the RNC by means of network signalling
- over the air by means of higher-layer signalling
- over the air by means of Layer 1 (uplink DPCCH) signalling

Of these alternatives, Layer 1 signalling over-the-air seems to be the only viable candidate if true *fast* inter-Node-B selection is to be supported (selection periods of the order 10 ms or shorter).

However, if the fast cell selection can select an arbitrary Node B in the active set, it requires that this uplink Layer 1 signalling can be reliably detected by an arbitrary Node B in the active set. This is in contradiction with normal uplink power-control strategy that ensures that uplink transmission can be reliably detected by at least one Node B in the active set but does not guarantee that uplink transmission can be reliably detected by an arbitrary Node B in the active set

At least two possible solutions can be identified:

- Use a modified uplink power-control strategy, where the UE transmit power is increased if *any* Node B in the active set requests an increase in the UE transmit power
- Use the normal uplink power-control strategy, but add a sufficiently large energy offset to the UE power to ensure that the transmission-state information is correctly detected with sufficiently high probability by the new Node B.

Taking into account the vast experience in the current power-control strategy and the importance of a well-performing power control in CDMA systems, the first alternative is clearly not attractive and would, as a minimum, require extensive studies to evaluate the impact on system performance. Thus the second solution is preferred. However, it remains to be studied what power offsets is needed and what would be the impact on the overall system performance.

A third alternative is to support only fast intra-Node-B cell selection for HSDPA. This could be achieved by a more general definition of a sub-set of the active set (“a more active set”) where fast cell selection is only allowed between cells of the “more active set”. It should be noted that this possibility must, most likely, anyway be supported, as there may be situations where only some of the cells in the active set support HSDPA. In this case, fast cell selection can obviously only select between those cells in the active set that support HSDPA, i.e. a sub-set of the active set.

Thus, the potential performance benefits with fast inter-Node-B cell selection need to be further evaluated together with the evaluation of the means by which the physical layer can support the necessary signalling.

3 Conclusions

It is proposed that the text above are included as part of the RAN WG1 technical report on Physical Layer Aspects of UTRA High Speed Downlink Packet Access.

4 References

- [1] TSGR1#12(00) 0556, "Feasibility study of Advanced techniques for High Speed Downlink Packet Access", Motorola.
- [2] TSGR1#16(00)1185, “Signalling of CPICH and DSCH power ratio for FCSS”, Panasonic