TSG-RAN Working Group 2 meeting #6
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Title: Criteria for Cell Selection/Re-selection Algorithm

Document for: Discussion and Decision

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1. Cell selection

1.1 Cell selection criteria

The cell to camp on can be chosen based on path loss consideration or, in addition, considering other criteria such as, for example:

- available services;
- cell load;
- operator only cell;
- UE speed.

It has to be noted that due to the peculiarities of CDMA, the path loss criterion must always be considered when comparing co-frequency cells (i.e., cells belonging to the same layer). Other criteria such as available services can be taken into account for the choice of the cell to camp on only if the path loss criterion is considered.

Therefore, in order to ensure a reliable cell selection process, it is suggested to stick to the path loss criterion within the appropriate cell layer; other criteria can be considered during the cell re-selection process (see next section).

A proposed algorithm is contained in section 1.3 of Tdoc 462. However, it was commented that the evaluation of the path loss per each cell to be monitored is quite "heavy", for example in terms of battery consumption. Therefore, an alternative (sub-optimum) algorithm, based only on the received power, is proposed in the next section.

1.2 Example of possible algorithm

A possible algorithm could be the following:

1] Recall the last used set of carrier frequencies and codes (if feasible)

2] Per each cell, the PCCPCH pilot strength (PIL_strength) after despreading is measured. If PIL_strength < PIL_strength_TH (where PIL_strength_TH is an appropriate threshold) the current cell is discarded.

3] The UE compiles the list of available cells, sorted according to PIL_strength.

4] When all cells identified by the last used set of carrier frequencies and codes have been considered, if the cardinality of the list of available cells is smaller than its maximum dimension, other cells have to be measured (possibly avoiding the exhaustive search).

5] The UE tries to camp on the cell with the greatest PIL_strength.

6] If the cell selection attempt fails, the UE tries to camp on the subsequent cell in the list of candidate cells.

2. Cell Re-selection

2.1 Cell Re-selection criteria

The UE monitors adjacent cells and updates the relevant list. The monitoring can be performed either continuously or periodically; in the latter case the measurement period can be set based on the UE speed.

When the mobile is in idle state, it selects a new cell if e.g. one of the following has occurred:

- Surrounding cells provide a better link
- The UE Speed has changed.
- The current serving cell is out of action
- The current serving cell is barred from access
- The UE can no longer decode the cell information in the BCCH
- The UE can no longer decode the paging channel

The UE can also select a new cell immediately before the call set up; this in order to access the most suitable cell based on services required by the mobile as well as on the status of the network at call set up. This would happen in case of:

- Failure of random access process
- Service dependent cell re-selection
- The current serving cell is overloaded.

The latter approach may also lead to admission control policies based on the required service and on the current traffic load, as proposed in Tdoc 792.

Cell re-selection may exploit a number of different processes each of which corresponds to a particular criterion listed above. These processes can be configured by the UE manufacturers and network operators.
In any case, the crucial point in a CDMA network is that each access is considered as a source of noise and it is necessary that UE have comprehensive cell information in order to be capable of selecting a suitable cell. A fast and intelligent cell selection technique is required to operate correctly a CDMA network (see [1] and [2]).

As an example, the case in which the current serving cell is overload can be considered. This is a typical situation in which the operator may desire to try to move part of the UEs camped on the overloaded cell to an adjacent cell. This has to be done very carefully in a CDMA network in order to avoid major problems. In fact if a UE is forced to camp on a second choice cell (i.e. not the best server), this will result in high transmitted power at call set up, therefore causing major interference to the best choice cell, thus effectively reducing its capacity. This implies that the choice of the new cell to camp on shall be performed by the UE based on comprehensive information on the current serving cells as well as on adjacent cells; therefore, it is necessary to ensure that each cell broadcasts

information on its current traffic load. The UE, based on the signal strength of the serving and adjacent cells, on the information on their current load, as well as on other criteria such as traffic management or required services, will be capable of correctly selecting the new cell to camp on, if necessary. This implies that it could be possible for the UE to realise that neither the best serving cell, nor any of the adjacent ones are available for the provision of the required service. In this case the mobile will not make any attempt to establish the call (admission control), but it can inform the best serving BS of the situation, so that the best serving BS can take some actions, if appropriate (e.g., trying to free some resources if the new UE requesting service is a VIP). With respect to this possibility, it has to be noted that in a CDMA system it is not possible for the BS to simply move some UEs to an adjacent BS in order to reduce its own carried traffic. However, the BS can re-negotiate services to the UEs currently in communication (i.e., reduce the bit rate provided to them): this would lead to lower interference and therefore lower carried traffic.

2.2 Example of possible algorithm

A possible algorithm for cell re-selection is presented in the following. The proposed algorithm is meant to be used also when a RACH has to be sent (i.e., at call set up), in order to minimise the required transmit power.

1] Per each adjacent cell, the PCCPCH pilot strength (PIL_strength) after despreading is measured.
2] The UE updates the list of available cells, sorted according to the PIL_strength; this implies that some cells previously belonging to the list of available cells can be replaced by better adjacent cells. When all cells to be monitored have being considered:
3a] If no RACH access has to be sent to the network, and if a better cell (i.e., with a greater PIL_strength) replaces the cell the UE is currently camped on, the UE tries to camp on the newly identified best cell.
3b] If a RACH access has to be sent to the network (i.e., at call set up), the cell at the top of the list and all cells (but no more than MAX_CELL, where MAX_CELL is a suitable limit) characterised by PIL_strength within a RE_TH interval (RE_TH being a parameter set by the operator) are considered as candidate cells. Per each of them a UE transmission power factor (UE_TX_factor_SEL/ADJ) is evaluated according to the following equations:

Path_Loss_SEL = (BS_SEL_tx_p - UE_rx_p_SEL)
Path_Loss_ADJ = (BS_ADJ_tx_p - UE_rx_p_ADJ) + cell_reselect_PL_hysteresis

UE_TX_factor_SEL = I_rx_SEL_p + Path_Loss_SEL
UE_TX_factor_ADJ = I_rx_ADJ_p + Path_Loss_ADJ + cell_reselect_TXF_hysteresis

where:

Path_Loss_SEL	path loss to the cell the UE is currently camped on
Path_Loss_ADJ	path loss to adjacent cell

BS_SEL_tx_p	transmitted power of the BS the UE is currently camped on (on the broadcast channel)
BS_ADJ_tx_p	transmitted power of neighboring BS (on the broadcast channel)
UE_rx_p_SEL	UE received power on the broadcast channel of the cell the UE is currently camped on
UE_rx_p_ADJ	UE received power on the broadcast channel of adjacent cell
I_rx_SEL_p	total power currently received by the cell the UE is currently camped on
I_rx_ADJ_p	total power currently received by adjacent cell

The UE updates the list of candidate cells, sorted according to the power margin and if a better cell (i.e., with a lower UE transmission power factor) replaces the cell the UE is currently camped on, the UE tries to camp on the newly identified best cell before attempting the RACH Access.

References

[1] TSGR2#3(99)240, “Idle and dedicated mode performance requirements and procedures”, Source: Vodafone

[2] TSGR4#4(99)182, ”Cell Selection/Re-selection & Handover Requirements”, Source:CSELT, TIM, Vodafone