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Title: Handling Mobility of UEs in MBSFN mode

Document for: Discussion and Decision

1 Introduction

For MBMS service using MBSFN, an SFA established at one point in time may not be appropriate later due to mobility of UEs and change in the UEs receiving the MBMS service. Below we consider techniques to handle this dynamic aspect of SFAs.

2 Discussion

An SFA established at a particular time might not meet the needs of MBMS subscribers at a different time. This may be because (a) new UEs wish to join the MBMS service and are located in cells where there is inadequate coverage, (b) UEs receiving MBMS have moved to cells where there is inadequate coverage. These situations require the addition of new cells to the SFA.

Additionally an SFA established at a particular time might be "wasteful" at a later time because some of the cells may no longer have UEs receiving the MBMS service (either due to mobility to other cells or due to stopping reception of the service). In order to avoid unnecessarily transmitting the MBMS traffic in cells where no UEs are receiving it, such cells need to be removed from the SFA.

Here we consider various methods to enable the network to add cells or remove cells from the SFA while maintaining SFN coverage for all UEs interested in the MBMS service. Clearly in order for the network to recognize a situation that requires a change in the SFA, some type of reporting by the UE is needed. The information in the report is an input to the algorithm in the MCE that determines which cells to add or remove from the SFA.

In the discussion below a 'report' could contain:

A. Indication of UE's presence in a cell

B. MBSFN SINR of the SFA measured by the UE (or equivalently the MCS that the UE can support)

C. MBSFN SINR of the SFA measured by the UE and unicast SINR of candidate cells for addition to SFA

If report of type 'A' *above is used*, network (MCE) learns which cells have UEs interested in the MBMS service. Based on this the MCE can add cells to the SFA conservatively. For example, network can ensure that at least one "ring" of cells around each cell that has UEs is in the SFA (even if there are no UEs in the cells in the ring).

If report of type 'B' *above is used*, the network learns the additional SINR needed to serve the UE. This may allow the network to estimate more accurately the cells that need to be added to the SFA. For example if the difference between the UEs measured MBSFN SINR and the threshold is small, the MCE might add a single cell to the SFA.

If report of type 'C' above is used, the network learns the additional SINR needed to serve the UE and also the cells in the best position to provide the additional SINR. This allows the network to determine the best cells that can be added to the SFA to serve the UE. For example, the MCE can determine that addition to the SFA of two specific cells is adequate.

It should be noted that the three types of reports discussed here result in increasing complexity from the point of view of the UE and possibly decreasing complexity from the point of view of the network. Detailed comparisons of spectral efficiency and benefits of these are provided in [1], which suggest that for reasonably high UE densities, the incremental benefits of having report C over having report type A do not outweigh the complexity associated with report type C. Therefore, our view is that unless specific scenarios can be identified that require type B or type C reports, type A reports are adequate.

2.1 Strategies for Reporting

2.1.1 Conditional reporting by UEs

In this procedure a UE autonomously sends a report (to the current serving cell) whenever a certain condition is met. Examples of conditions are: (a) MBSFN SINR drops below a threshold, (b) UE performs a test against a probability threshold and succeeds. The conditional reporting can ensure that very few UEs exit DRX mode to send a report at any given time (minimal impact to UE battery life and to UL resource usage).

It should be noted that when UEs are no longer present in a cell, this reporting scheme does not give enough information to the network to enable removal of cells from the SFA.

Additionally, in certain scenarios it is possible that UE observes poor MBMS SINR signal quality, while not being in the SFA boundary region. In this situation, to further save on UE battery life and UL resources, it would be beneficial to prevent UEs from sending conditional reports. This can be achieved ensuring that the UE transmits conditional reports only when the network indicates that it should.

2.1.2 Polling by Network

The MCE polls (i.e. sends a polling request) and UEs send a report in response. The polling request is sent in the current SFA. This procedure enables the MCE to learn when there are no longer any UEs in a cell that is in the SFA.

However, polling does not enable the network to recognize when there is a need to grow the SFA. Since the polling request is sent in the current SFA, a UE that has moved to a cell that is not a member of the SFA may not receive the polling request and does not send a report. One approach to use polling could be to send the polling request in an area larger than the SFA. However, this would then require the network operator to maintain and manage two different areas: SFAs and polling request areas, and ensure that the latter grows correspondingly when the SFA grows.

Another significant problem with polling is that all UEs respond to the polling request. This could be a significant drawback to UE battery life and to the UL resource usage if the polling needs to be done with reasonable frequency. Therefore, we assume that if polling is used, the UE is provided a probability which it uses to perform a test and determine whether to send a report.

2.1.3 Polling with Conditional reporting

Another reporting strategy is to perform a simple combination of the polling and the conditional reporting strategies. *That is, UE sends a report if it receives a polling request OR if the condition is met.*

This strategy overcomes the problem with the polling-only strategy. That is, if a UE is in a cell that is not in the SFA (and does not receive the polling request) and is not adequately served, it sends a report. If there is a

need to distinguish between a report that is in response to a poll and a conditional report, the report can include an indictor to convey this.

3 Conclusion

Polling mechanisms have been used for MBMS counting (for example [2]). A counting procedure generally tries to count the UEs that are interested in a particular service and are in the service area; the UEs that are outside the service area are not counted.

As indicated above we propose extending the polling/counting mechanism to enable the addition of cells to SFAs due to UE mobility, by allowing UEs to send a report in the absence of a polling request, when a condition is met. If the network needs to obtain the number of UEs that are interested in a particular service and are in the coverage area, it needs to consider only the reports that are responses to the polling request.

We propose that RAN2 agree on the following working assumptions:

- Report shall indicate to the MCE the presence of the UE in a particular cell (type A report).
- Polling and autonomous UE reporting shall be supported. Polling can be performed over the entire SFA or a subset of the SFA. Autonomous UE reporting can be restricted to occur at the boundary of an SFA.
- UE shall send a report if it receives a polling request or if a signal quality threshold is met.

4 References

[1] R2-073526, Considerations on Cell Addition Mechanisms for Dynamic SFN, Motorola.

[2] 3GPP TS 25.346