

3GPP TSG RAN WG1#104b-e

R1-2104032

e-Meeting, April 12th – 20th, 2021

Agenda item: 6.2.1

Source: Moderator (Qualcomm Incorporated)

Title: [104b-e-LTE-eMTC5-01] Reply LS on timing of neighbor cell RSS-based measurements

Document for: Discussion and Decision

1 Background

In R1-2102299, RAN4 sent an LS to RAN1 regarding the timing of neighbor cell RSS-based measurements.

In RAN1#104b, the following contributions were submitted:

Table 1:

R1-2102853 (ZTE)	Proposed response to <u>Question a</u> : The UE is able to calculate the frame offset of the start of RSS transmission on neighbor cells from RRC signalling (periodicity in ce-RSS-Config-r15 and timeOffsetGranularity in RSS-ConfigCarrierInfo-r16) and PCID in the serving cell. The RSS Time Offset of a neighbor cell is relative to the serving cell SFN. Proposed response to <u>Question b</u> : From RAN1 perspective, for the purpose of performing RSS-based measurements, the UE is not expected to acquire SFN on the neighbour cells. Proposed response to <u>Question c</u> : There is no SFN synchronization requirement defined solely for the purpose of performing RSS-based measurements.
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R1-2103065 (Qualcomm)	<p><u>Proposal 1:</u> The UE is not required to acquire neighbor cell SFN for the sole purpose of RSS-based measurements.</p> <p><u>Proposal 2:</u> For the purpose of neighbor cell RSS measurements, the UE can assume that the network is sync (i.e., SFN is sync within ± 5ms).</p> <p><u>Proposal 3:</u> The condition on synchronization of SFN is not captured in RAN1 specifications. RAN1 recommends RAN4 captures this condition on their specifications.</p>
R1-2103760 (Huawei, HiSi)	<p>The UE is able to infer or calculate the frame offset of the start of RSS transmission on neighbor cells from RRC signaling in the serving cell. The frame offset of the start of RSS transmission on neighbor cells is relative to the serving cell SFN.</p> <p>UE is not expected to acquire SFN on the neighbor cells solely for the purpose of performing RSS-based measurements.</p> <p>There is no need to have SFN synchronization solely for the purpose of neighbor cell RSS-based measurements. The frame after offset relative to serving cell SFN is misaligned with the frame containing the RSS on neighbor cell by no more than 5 subframes. If they are aligned with 5 subframes, the frame containing the RSS on neighbor cell is 5 subframes later than the frame after offset relative to serving cell SFN.</p>

R1-2103714 (Ericsson)	<p>Proposal 1 Include in a reply LS to RAN4 that: The UE is capable to derive the frame offset of the start of a neighbor cell RSS transmission from serving cell RRC signaling, and, The neighbor cell RSS frame offset, as provided by a serving cell's RRC signaling, is related to the neighbor cell SFN.</p> <p>Proposal 2 Include in a reply LS to RAN4 that: a. The UE is required to determine the neighbor cell SFN once in order to utilize RSS for neighbor cell measurements. b. SFN misalignment may be tracked while performing measurements on RSS.</p> <p>Proposal 3 Include in a reply LS to RAN4 that: a. RAN1 does not pose any synchronization requirements between neighbor cells and the serving cell to enable RSS-based measurements. b. RAN1 would like to make RAN4 aware that even in a fully synchronized network, only a subset of the RSS configurations for RSS-based measurements specified by RAN1 will result in an RSS alignment among neighbor cells within ± 5 ms.</p>
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2 Discussion

Q1. Is the UE required to acquire SFN of the neighbor cells for the purpose of performing RSS measurements?

Feedback Form 1: Q1. Is the UE required to acquire SFN of the neighbor cells for the purpose of performing RSS measurements?

Item	Company	Comments
1	Qualcomm Incorporated	No, the UE should not be required to acquire SFN of the neighbor cell (i.e., read MIB) before performing RSS measurements.
2	ZTE Corporation	No

Item	Company	Comments
3	Ericsson Limited	<p>In general, yes.</p> <p>First, the UE will not know of the cell if it not in the neighbor cell list. For cells not in the NCL, the neighbor cell first needs to be detected via traditional detection of PSS->SSS->PBCH.</p> <p>Second, for an unsynchronized network (that already is up and running), it may not be possible to provide accurate relative timing for two different unsynchronized serving cells.</p> <p>However, if RAN1 assumes that networks are synchronized, there is no need for the UE to acquiring neighbor cell SFN. Without such assumption, we think that the UE is initially required to acquire SFN once.</p>
4	Nokia UK	No, if the network is synchronized.
5	HUAWEI TECHNOLOGIES Co. Ltd.	No, in both cases of synchronized or non-synchronized networks, the UE doesn't need to require SFN of neighbor cells.
6	Qualcomm Incorporated	<p>To reply to Ericsson:</p> <p><i>For cells not in the NCL, the neighbor cell first needs to be detected via traditional detection of PSS->SSS->PBCH.</i></p> <p>We do not agree with this statement. For detecting a neighbor cell, the UE does not need to decode PBCH. PSS/SSS are enough. The UE can perform neighbor cell measurements over CRS without decoding PBCH. We think this behavior should be kept for RSS-based measurements.</p>

Q2. Can the UE assume any synchronization between serving and neighbor cells? If so, what is this value?

Feedback Form 2: Q2. Can the UE assume any synchronization between serving and neighbor cells? If so, what is this value?

Item	Company	Comments
1	Qualcomm Incorporated	The UE can assume that there are up to +/- 5ms difference between serving cell and neighbor cell timing.
2	ZTE Corporation	<p>The UE can acquire the start of RSS transmission of a neighboring cell relative to the SFN of serving cell.</p> <p>If RSS-based measurement feature is enabled, the network should guarantee the RSS transmission of a neighboring cell in the right time location by implementation.</p>

Item	Company	Comments
3	Ericsson Limited	If RAN1 assumes synchronized networks it is reasonable to assume a +/- 5 ms maximum misalignment between cells.
4	Nokia UK	If network is synchronized, then +/- 5ms is reasonable.
5	HUAWEI TECHNOLOGIES Co. Ltd.	The RSS time offset is relative to serving cell, so UE doesn't need to assume any synchronization between cells.

Q3. Can the UE infer / calculate the frame offset of the start of RSS transmission based on RRC signaling from the serving cell? If so, what is the mechanisms?

Feedback Form 3: Q3. Can the UE infer / calculate the frame offset of the start of RSS transmission based on RRC signaling from the serving cell? If so, what is the mechanisms?

Item	Company	Comments
1	Qualcomm Incorporated	Yes, the UE can calculate the start of the RSS based on serving cell signaling. What the UE does is to search for the neighbor cell RSS in a window of 10ms centered around "Serving cell SFN + SFN offset".
2	ZTE Corporation	Yes. According to RAN1's agreements and TS 36.331, the UE is able to calculate the frame offset of the start of RSS transmission on neighbor cells from RRC signalling (<i>periodicity</i> in <i>ce-RSS-Config-r15</i> and <i>timeOffsetGranularity</i> in <i>RSS-ConfigCarrierInfo-r16</i>) and PCID in the serving cell.
3	Ericsson Limited	In general no, but for synchronized networks yes. For synchronized networks , we share QC's view that serving cell SFN can be used as a starting point for detecting neighbor cell SFN. For unsynchronized networks , the UE will first need to determine the timing misalignment between the serving cell and the neighbor cell. Having done that, it can use the $SFN_SC + T_misalignment + SFN_Offset$ to determine the neighbor cell RSS location. Due to minimal drift between cells, the required search window would likely be substantially less than 10 ms over a long period of time.
4	Nokia UK	For synchronized networks - YES For unsynchronized networks - NO for the reasons stated by Ericsson

Item	Company	Comments
5	HUAWEI TECHNOLOGIES Co. Ltd.	Yes, UE can infer / calculate the frame offset of the start of RSS transmission based on RRC signaling from the serving cell. Without acquiring SFN of neighbor cells, UE still knows the frame boundary of neighbor cells. Then based on serving cell SFN + RSS time offset, the frame of serving cell can be inferred. Then with the information frame boundary of neighbor cells, the frame carrying RSS on neighbor cells can be inferred by UE.

Q4. Any other issues?

Feedback Form 4: Q4. Any other issues?

Item	Company	Comments
1	Ericsson Limited	We think that this boils down to what networks RSS for measurements are beneficial and hence should support. We think there will be benefits with both, albeit the benefits are more substantial in a synchronized network. It is highly likely that a Rel-16 LTE network is synchronized, but it cannot be guaranteed why we cannot support an unconditional assumption of networks being synchronized. Hence, the question is if RSS for neighbor cell measurements is restricted to synchronized networks or should be applicable for general LTE networks. This should somehow be included in the response to RAN4.

3 Summary of input of first round

In the first round, five companies provided feedback. The summary is as follows:

Q1. Is the UE required to acquire SFN of the neighbor cells for the purpose of performing RSS measurements?

Summary: 4 out of 5 companies state that the UE is not required to acquire SFN. One of the 4 companies state that this is the case for sync networks. One company states that the UE is, in general, required to acquire SFN of the neighbor cell.

Q2. Can the UE assume any synchronization between serving and neighbor cells? If so, what is this value?

Summary: There are a variety of answers to this question. The common understanding is that, if the network is synchronized, +/- 5ms is reasonable.

Q3. Can the UE infer / calculate the frame offset of the start of RSS transmission based on RRC signaling from the serving cell? If so, what is the mechanism?

Summary: If the network is synchronized, the UE can infer the neighbor cell RSS transmission based on RRC signalling from the serving cell.

Q4. Any other issues?

Summary: We should include assumptions on network synchronization in the LS to RAN4

Given the input above, the moderator proposes the following as a conclusion:

Proposed conclusion:

- RAN1 concluded that neighbor cell RSS measurements are only feasible in networks *that are sufficiently synchronized with some degree of synchronization*.
- A UE is not required to acquire neighbor cell SFN for the purposes of neighbor cell RSS measurements.
- A UE can calculate the frame offset of the start of RSS transmission from RRC signaling in the serving cell. The frame offset is relative to the serving cell SFN.
- A UE can assume that the start of RSS transmission is within a window of +/- 5ms around the calculated frame offset. RAN1 specifications do not capture this synchronization requirement.

Feedback Form 5: Do you agree with the proposed conclusion? If no, please provide details

Item	Company	Comments
1	Ericsson Limited	We can agree to the conclusion although, technically, we think that it is not a matter of <i>feasibility</i> but instead <i>usability</i> that prevents a more general use for RSS for measurements. However, under current circumstances is a trade off between achieving a larger gain in synchronized networks or a smaller gain in general networks and then this seems to be the preferred outcome. Furthermore, the term <i>some degree of synchronization</i> could possibly be reformulated to <i>networks that are sufficiently synchronized</i> .
2	Qualcomm Incorporated	[As moderator] Made change as suggested from Ericsson: "networks that are sufficiently synchronized"
3	HUAWEI TECHNOLOGIES Co. Ltd.	We don't think SFN synchronization between cells would be needed for neighbor cell RSS based measurement. This would have large interruption to network operation when network want to enable neighbor cell RSS based measurement. As the timing offset of RSS is relative to serving cell, then UE can derive the RSS timing location solely by serving cell SFN, no SFN synchronization is needed.
4	Qualcomm Incorporated	[To Huawei] We think the proposed conclusion is aligned with what you said. Do you have any proposed change?

Item	Company	Comments
5	ZTE Corporation	<p>We have concern on the first bullet.</p> <p>Existing spec supports RSS measurement for neighbour cells not in the Neighbour Cell List.</p> <p>Since RSS of neighbour cells not in the Neighbour Cell List may be used for measurements(e.g. indicated by <i>rss-MeasNonNCL</i> parameter), it is impossible to keep the neighbor cells not in the Neighbour Cell List synchronized with the serving cell. According to the first bullet, does it mean RSS measurement for neighbour cells not in the Neighbour Cell List can not be supported?</p>
6	Qualcomm Incorporated	<p>[To ZTE] Our understanding is that if the two cells have no sync at all between them, then neighbor cell RSS measurements cannot be supported (regardless of whether the cells are in the neighbor cell list or not). The assumption in RAN1 for measurement was that the UE should know roughly where the RSS is - that is why we introduced all these offsets that are known by the UE.</p>
7	Ericsson Limited	<p>To QC: Isn't it so that you don't <i>want</i> to support them because you think it would require too much power for the UE to sync to another cell? As ZTE correctly points out, there was never an alternative to PSS/SSS/PBCH for cells not in the NCL since the UE will hardly perform blind RSS detection over 504 cell ids. These operations are no different from what needs to be performed using CRSs for measurements.</p>
8	Qualcomm Incorporated	<p>To Ericsson / ZTE: Today, the UE is not required to read the neighbor cell MIB for measurements. So "there was never an alternative to PSS/SSS/PBCH" is not true. The UE would find the cell using PSS/SSS, but will not read PBCH. For CRS-based measurements the UE does not need to know SFN, since the CRS sequence is repeated every 10ms.</p> <p>If the cells are synchronized to +/- 5ms, the UE would do as follows:</p> <ol style="list-style-type: none"> 1) Find the cell using PSS/SSS. Get cell ID and 10ms boundary from here. 2) Apply the SFN offset with respect to serving cell SFN for that particular cell ID. Search for RSS in the 10ms window around "serving cell SFN + offset" <p>If the cells are not synchronized at all, the UE has to perform a full blown RSS search in step 2 (the RSS periodicity is up to >1s), which does not make sense. If the UE is going to be searching for RSS during 1s, it may as well perform CRS-based measurements during this time.</p>
9	ZTE Corporation	<p>Can the first bullet be changed to "RAN1 concluded that sufficient synchronization is beneficial for neighbor cell RSS measurements"?</p>

Item	Company	Comments
10	HUAWEI TECHNOLOGIES Co. Ltd.	<p>[To Qualcomm] We don't think the synchronization as below is needed. As the timing offset is relative to the serving cell, no SFN synchronization is needed. eNB just make sure the RSS of neighboring cells is in the proper position by implementation.</p> <p><i>Q3. Can the UE infer / calculate the frame offset of the start of RSS transmission based on RRC signaling from the serving cell? If so, what is the mechanism?</i></p> <p><i>Summary: If the network is synchronized, the UE can infer the neighbor cell RSS transmission based on RRC signalling from the serving cell.</i></p> <p><i>Q4. Any other issues?</i></p> <p><i>Summary: We should include assumptions on network synchronization in the LS to RAN4</i></p> <ul style="list-style-type: none"> - RAN1 concluded that neighbor cell RSS measurements are only feasible in networks that are sufficiently synchronized with some d - A UE can assume that the start of RSS transmission is within a window of +/- 5ms around the calculated frame offset. RAN1 specifications do not capture this synchronization requirement.
11	HUAWEI TECHNOLOGIES Co. Ltd.	<p>[To Qualcomm] thanks for elaboration of steps as below, my understanding is that in step 2), as UE just searches for the timing position of neighbor cell using serving cell SFN, there's no need that the cells are synchronized. The network would make sure the RSS of serving cells and neighbor cells are in the right place by implementation, but SFN doesn't need to be synchronized.</p> <p>If the cells are synchronized to +/- 5ms, the UE would do as follows:</p> <ol style="list-style-type: none"> 1) Find the cell using PSS/SSS. Get cell ID and 10ms boundary from here. 2) Apply the SFN offset with respect to serving cell SFN for that particular cell ID. Search for RSS in the 10ms window around "serving cell SFN + offset"
12	Qualcomm Incorporated	<p>OK, I think we are converging.</p> <p>Yubo, what I meant by "sufficiently synchronized" is not that the network is sync, but that the serving cell knows the offset of the neighbor cell, and thus can calculate the offset to signal. This is the same as "eNB just make sure the RSS of neighboring cells is in the proper position by implementation."</p> <p>Maybe we do not need to include the assumption on sync / no sync. Would the following conclusion be acceptable? It just captures what the UE can assume, it is up to the network to make sure these conditions are met.</p> <p>Proposed conclusion:</p> <ul style="list-style-type: none"> - A UE is not required to acquire neighbor cell SFN for the purposes of neighbor cell RSS measurements. - A UE can calculate the frame offset of the start of RSS transmission from RRC signaling in the serving cell. The frame offset is relative to the serving cell SFN. - A UE can assume that the start of RSS transmission is within a window of +/- 5ms around the calculated frame offset. RAN1 specifications do not capture this synchronization requirement.

Item	Company	Comments
13	Ericsson Limited	<p>We think we need to include the synchronization requirement. There are unsynchronized LTE networks out there and the above discussed procedure will not work in these. Please note that there is no provisioning of RSS-specific timing alignment between cells so such behavior cannot be assumed. Furthermore, if the network is too unsynchronized the above procedure will not work since it assumes synchronized cells. A neighbor cell will only have a single RSS location, related to the SFN of that cell. From the perspective of different serving cells (serving different UEs), regardless of any potential cell misalignment between the neighbor cell and the different serving cells, they must all point to that single RSS location. If the UE should determine the neighbor cell RSS location based on serving cell SFN, the network must be synchronized because otherwise different serving cells will point to RSS locations outside the search window, resulting in an RSS misdetection. Hence, the only way this can work is if the network is loosely synchronized to at least the same level as the search window. In that case, we think it is better to restrict the use of RSS for measurement to synchronized networks than leaving it to network implementation since the implementation will assume functionality that was specifically out of the scope for the WI.</p>
14	Qualcomm Incorporated	<p>OK, let me try something in between, hopefully this will address both Huawei's concern (not mention directly that the network is synchronized) but also Ericsson's (mention something about the synchronization requirement). Let me know if this is OK. The new part is underlined in the last subbullet.</p> <p><u>Proposed conclusion:</u></p> <ul style="list-style-type: none"> - A UE is not required to acquire neighbor cell SFN for the purposes of neighbor cell RSS measurements. - A UE can calculate the frame offset of the start of RSS transmission from RRC signaling in the serving cell. The frame offset is relative to the serving cell SFN. - A UE can assume that the start of RSS transmission is within a window of +/- 5ms around the calculated frame offset. <u>RAN1 specifications do not capture this synchronization requirement. RAN1 assumes that RSS measurements are only feasible for the case where the network can guarantee that the neighbor cell RSS is within this time window.</u>

Item	Company	Comments
15	Qualcomm Incorporated	<p><i>(Sorry for the repeated messages, minor correction)</i></p> <p>OK, let me try something in between, hopefully this will address both Huawei's concern (not mention directly that the network is synchronized) but also Ericsson's (mention something about the synchronization requirement). Let me know if this is OK. The new part is underlined in the last subbullet.</p> <p>Proposed conclusion:</p> <ul style="list-style-type: none"> - A UE is not required to acquire neighbor cell SFN for the purposes of neighbor cell RSS measurements. - A UE can calculate the frame offset of the start of RSS transmission from RRC signaling in the serving cell. The frame offset is relative to the serving cell SFN. - A UE can assume that the start of RSS transmission is within a window of +/- 5ms around the calculated frame offset. <u>RAN1 specifications do not capture this synchronization requirement. RAN1 assumes that RSS measurements are only feasible for the case where the network can guarantee that the start of the neighbor cell RSS is within this time window.</u>
16	HUAWEI TECHNOLOGIES Co. Ltd.	<p>[To Ericsson] I don't really follow that the point on synchronization regarding the following. UE obtains the timing offset for neighbor cell RSS from serving cell RRC parameters. As the timing offset is relative to serving cell SFN, UE could get the timing position using the serving cell SFN. Then the frame carrying the RSS in neighbor cell is the frame overlapping with the calculated timing position. The SFN of neighbor cell doesn't need to be the same as the serving cell. The information UE needs to know about the neighbor cell is just the frame number, obtained from PSS/SSS.</p> <p><i>Furthermore, if the network is too unsynchronized the above procedure will not work since it assumes synchronized cells.</i></p>
17	Ericsson Limited	We can agree to that.
18	Ericsson Limited	To Huawei: Correct me if I'm wrong, but isn't SFN derived from PBCH and not from PSS/SSS? Hence, if the UE is operating in an unsynchronized network, the neighbor cell sync achieved by PSS/SSS is insufficient to determine SFN of the neighbor cell. I think we all agree that the RSS of a cell will start according to the SFN of that cell. In such a situation, the only way a serving cell's SFN can be used to reliably obtain the SFN of the neighbor cell is if the cells are synchronized such that their SFNs coincide.
19	ZTE Corporation	<p>For the new added part in the last subbullet, we suggest a small modification (adding for neighbor cell).</p> <p>RAN1 assumes that RSS measurements <u>for neighbor cell</u> are only feasible for the case where the network can guarantee that the start of the neighbor cell RSS is within this time window.</p>

4 Potential conclusion

Given the discussion above, the moderator makes the following proposal:

Proposed conclusion:

- A UE is not required to acquire neighbor cell SFN for the purposes of neighbor cell RSS measurements.
- A UE can calculate the frame offset of the start of RSS transmission from RRC signaling in the serving cell. The frame offset is relative to the serving cell SFN.
- A UE can assume that the start of RSS transmission is within a window of +/- 5ms around the calculated frame offset. RAN1 specifications do not capture this synchronization requirement. RAN1 assumes that RSS measurements for neighbor cell are only feasible for the case where the network can guarantee that the start of the neighbor cell RSS is within this time window.

Feedback Form 6: Comments on proposed conclusion

Item	Company	Comments
1	Ericsson Limited	We support the conclusion. Possibly, the last sentence could be changed into: RAN1 <u>considers</u> that RSS measurements for neighbor cell are only feasible for the case where the network can guarantee that the start of the neighbor cell RSS is within this time window.
2	Qualcomm Incorporated	Thanks, I will change "assumes" -> "considers" in the final version.
3	HUAWEI TECHNOLOGIES Co. Ltd.	One typo in our previous comment #16: <i>The information UE needs to know about the neighbor cell is just the frame numberframe boundary, obtained from PSS/SSS.</i> We are fine with the proposed conclusion. To be clearer, perhaps the following could be added: - A UE can calculate the frame offset of the start of neighbor cell RSS transmission from RRC signaling in the serving cell. The frame offset is relative to the serving cell SFN. - A UE can assume that the start of neighbor cell RSS transmission is within a window of +/- 5ms around the calculated frame offset. RAN1 specifications do not capture this synchronization requirement. RAN1 assumes that RSS measurements for neighbor cell are only feasible for the case where the network can guarantee that the start of the neighbor cell RSS is within this time window.
4	ZTE Corporation	We agree with Huawei to add 'neighbor cell' in the last two bullets, but using "the start of RSS transmission <u>on neighbor cells</u> " instead.

5 Conclusion

Given the comments above, the following is concluded:

- A UE is not required to acquire neighbor cell SFN for the purpose of neighbor cell RSS measurements.

- A UE can calculate the frame offset of the start of RSS transmission on neighbor cells from RRC signaling in the serving cell. The frame offset is relative to the serving cell SFN.
- A UE can assume that the start of RSS transmission on neighbor cells is within a window of +/- 5ms around the calculated frame offset. RAN1 specifications do not capture this synchronization requirement. RAN1 considers that RSS measurements for neighbor cell are only feasible for the case where the network can guarantee that the start of the neighbor cell RSS is within this time window.