Agenda Item : **10.4.1.6.6**

Source : **LG Electronics Inc.**

Title : **Remaining issues on on-demand SI request procedure**

Document for : **Discussion and Decision**

Introduction

In RAN2 NR AH#2, RAN2 made the following agreements:

Agreements for Msg1 based SI request method:
1: RAPID is included in Msg2.
2: Fields Timing Alignment Information, UL grant and Temporary C-RNTI are not included in Msg2.
3: RACH procedure for SI requests is considered successful when Msg2 containing a RAPID corresponding to the transmitted preamble is received.
4: Msg2 reception uses RA-RNTI that corresponds to the Msg1 transmitted by the UE (details of RA-RNTI selection left to UP discussion)
5: UE retransmits RACH preamble according to NR RACH power ramping
6: Msg1 for SI request re-transmission is continued until reaching max preamble transmissions. Thereafter, a Random Access problem to upper layers is indicated. (depending on the NR RACH procedure design)
FFS: Upper layer actions when MAC reports Random Access problem. To be discussed in CP session.
7: Back off is applicable for Msg1 based SI requests but no special Back off subheader/ procedure is required.

Agreements for Msg3 based SI request method:
1: UE determines successful Msg3 based on reception of Msg4
FFS Details of the Msg4 content used to confirm successful Msg3. To be discussed initially CP.
2: Preamble(s) for SI request using Msg3 based Method are not reserved.
3: RRC signalling is used for SI request in Msg3.
FFS: RRC signalling how to indicate the requested SI/SIB details left to ASN.1 work.
5: Temporary C-RNTI received in Msg2 is used for Msg4 reception

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In this document, we further discuss on-demand SI delivery procedure.

General aspects for SI request

RAN2 agreed in RAN2#98 that on-demand SI request will maximise commonality with the RACH procedure. Assuming that RACH procedure is a function of the NR MAC, we think that on-demand SI request should be a function of the NR MAC. Meanwhile, as captured in TR38.804, broadcast of system information is a function of RRC layer. Thus, we assume that NR RRC perform system information acquisition procedure. Then, it should be NR RRC that triggers SI request because NR RRC would monitor system information and should determine whether on-demand SI request is needed or not.

Considering RAN2 agreements and conventional modelling of RRC/MAC, we propose that when NR RRC triggers RACH procedure for SI request to NR MAC, NR MAC performs RACH procedure for SI request. We propose to define the RRC SI Request procedure which triggers MAC RACH procedure.

Proposal 1: When the RRC SI Request procedure is initiated, NR RRC triggers RACH procedure to NR MAC. If triggered, NR MAC performs RACH procedure for the RRC SI Request procedure.

In our view, it is not necessary that NR RRC suspends monitoring system information while NR MAC performs RACH procedure for any purpose, i.e. regardless of whether RACH procedure is triggered for SI request or not. Even while UE MAC performs RACH procedure for SI request, UE RRC may check if the requested SI message begins to be scheduled or not.

If RACH procedure for SI request cannot end quickly e.g. due to power ramping or collision, it may happen that during ongoing RACH procedure for SI request, UE RRC receives the SI message that may be also requested by another UE. If it is the case, it is desirable that UE stops RACH procedure for SI request if the requested SI message is to be scheduled or already received. However, it is not required that UE MAC checks if the requested SI message is to be scheduled or already received before re-transmitting RACH preamble for SI request.

Proposal 2: UE is not required to check if the requested SI message is to be scheduled or even already received before re-transmitting RACH preamble for SI request. Nevertheless, UE stops ongoing RACH procedure for SI request if UE RRC recognizes that the requested SI message is to be scheduled or already received.

RACH failure for SI request

RAN2 agreed that Msg1 for SI request re-transmission is continued until reaching max preamble transmissions. Thereafter, a Random Access problem to upper layers is indicated. RAN2 should further discuss upper layer actions when MAC reports Random Access problem. We assume that upon receiving the indication(s) of the RACH problem, UE RRC declares failure of the RRC SI Request procedure. Then, it should be further discussed how UE RRC finally handles this RACH failure for SI request.

Proposal 3: Upon receiving the indication(s) of RACH problem, UE declares failure of the RRC SI Request procedure.

One alternative is to treat the cell as barred. We think that if essential SIBs are missing at a cell, UE shall consider the cell as barred. However, we wonder if Other SI is really essential. Assuming that Other SI is not essential, it is not likely that UE considers the cell as barred due to no acquisition of Other SI. There seems no reason that UE considers the cell as barred even though minimum SI has been received for the cell. If UE sees only that cell where the requested SI is not received, it seems not desirable that UE considers that cell as barred.

Proposal 4: If minimum SI has been received for a cell, UE does not considers the cell as barred regardless of whether Other SI is received or not.

In case of RRC Connection Establishment procedure in LTE, if T300 has expired a consecutive *connEstFailCount* times on the same cell, UE shall use *connEstFailOffset* for the parameter *Qoffsettemp* for the concerned cell when performing cell selection and reselection for a period as indicated by *connEstFailOffsetValidity*.

From our perspective, applying such offset based approach is useful, so that UE may reselect to another cell from the cell where the requested SI is not received. This approach does not lead to cell barring while allowing nomadic/stationary UEs to camp on other cells where UEs may receive requested SIs. Thus, UE may increase possibility of leaving the cell where the requested SI is not received. Nevertheless, UE could possibly camp on the cell in which UE may establish a RRC connection without acquisition of the Other SI. Such case is undesirable, but it would rarely happen.

Proposal 5: If the RRC SI Request procedure fails and the requested SI has been not received at a cell, UE applies minus offset for the concerned cell when cell selection and reselection.

Meanwhile, UE may continue to camp on the same cell after RACH procedure for SI request is unsuccessfully completed. It seems undesirable that UE insistently camping on the same cell cannot acquire Other SI any more, after one RACH procedure for SI request was unsuccessfully completed. Rather, UE should be allowed to insistently request SI delivery to the same cell multiple times unless the cell finally broadcasts the requested SI or RACH is not overloaded. The number of SI request at the same cell could be limited to a certain number. gNB could configure the number of SI request per cell e.g. depending on RACH resources.

In addition, gNB should control RACH overload due to SI request. Thus, a prohibit timer for SI request could be introduced and configured by gNB. In our view, upon receiving the indication of RACH problem from UE MAC at a cell, NR RRC starts a prohibit timer. While the timer is running, UE RRC shall not request SI delivery to the cell. After the timer is expired, UE RRC sends SI request to the cell again, up to the configured number.

Proposal 6: Upon receiving the indication of RACH problem from UE MAC at a cell, UE RRC starts a prohibit timer. While the timer is running, UE RRC shall not trigger RACH procedure for SI request at the cell. After the timer is expired, if SI is still requested, UE RRC re-triggers RACH procedure for SI request at the cell.

Proposal 7: UE RRC is allowed to trigger RACH procedure at the cell up to N times. N is configured by the cell.

We should avoid the case that UE performs RACH procedure(s) for SI request endlessly. Thus, if UE RRC triggered RACH procedure for SI request N times at a cell, UE RRC shall not trigger RACH procedure for SI request at the cell. As proposed above, UE may apply minus offset for the concerned cell when cell selection and reselection, then.

Proposal 8: After UE RRC has triggered RACH procedures N times at a cell for the RRC SI Request procedure, UE RRC stops the RRC SI Request procedure. Then, UE RRC shall not re-initiate the RRC SI Request procedure and re-trigger RACH procedure for SI request at the cell, while keeping camping on the same cell.

Furthermore, UE MAC shall not re-transmit RACH preamble if maximum number of preamble transmissions is reached. Thus, UE does not perform RACH procedure(s) for SI request endlessly.

Proposal 9: UE MAC shall not re-transmit RACH preamble if maximum number of preamble transmissions is reached.

Delayed state transition caused by SI request

RAN2 agreed that RRC signalling is used for SI request in Msg3. We assume that on-demand SI request will be used at least by UEs in IDLE and UEs in INACTIVE. UE in IDLE or INACTIVE may request or activate a RRC connection by sending a RRC message such as a RRC Connection Request or RRC Connection Resume message.

There may be the case that UE RRC triggers RACH procedure for SI request and then UE NAS triggers RRC Connection Establishment before completing the RACH procedure for SI request. For example, if the SI request is a RRC message over CCCH, the RRC Connection Request message over CCCH can be transmitted only after the SI request is successfully transmitted and then UL resource is granted for the second RRC message. Thus, the RACH procedure for SI request would delay state transition from IDLE to CONNECTED or from INACTIVE to CONNECTED sometimes.

Observation 1: Since SI request is a RRC message, when NAS triggers RRC Connection Request/Resume right after RRC triggers SI request, RACH procedure for SI request would delay state transition from IDLE to CONNECTED or from INACTIVE to CONNECTED.

We think that there are two options to avoid this problem:

- **Option 1: If RRC triggers state transition procedure such as RRC Connection Establishment or RRC Connection Resume, UE stops ongoing RACH procedure for SI request.**

- **Option 2: RRC Connection Request/Resume message and SI request message use different SRBs. The SRB carrying SI request message has a lower priority than the SRB carrying the RRC Connection Request/Resume message**

In Option 1, if RRC triggers state transition procedure such as RRC Connection Establishment or RRC Connection Resume, but if RACH procedure for SI request is ongoing, UE stops ongoing RACH procedure for SI request and then triggers new RACH procedure for state transition.

In Option 2, RRC Connection Request/Resume message and SI request message use different SRBs. The SRB carrying SI request message has a lower priority than the SRB carrying the RRC Connection Request/Resume message. If RRC triggers state transition procedure such as RRC Connection Establishment or RRC Connection Resume, but if RACH procedure for SI request is ongoing, UE continues to perform RACH procedure. If UE receives UL grant from Msg2, UE constructs MAC PDU based on Logical Channel Prioritization. Thus, RRC Connection Request/Resume message with a higher priority will be included in the MAC PDU before SI request message with a lower priority.

Accordingly, we propose one of the options above to avoid the problem.

Proposal 10: We propose to consider one of the following options to avoid delayed state transition caused by SI request transmission:

- **Option 1: If RRC triggers state transition procedure such as RRC Connection Establishment or RRC Connection Resume, UE stops ongoing RACH procedure for SI request.**

- **Option 2: RRC Connection Request/Resume message and SI request message use different SRBs. The SRB carrying SI request message has a lower priority than the SRB carrying the RRC Connection Request/Resume message**

Conclusion

In conclusion, we propose the followings for SI request:

Proposal 1: When the RRC SI Request procedure is initiated, NR RRC triggers RACH procedure to NR MAC. If triggered, NR MAC performs RACH procedure for the RRC SI Request procedure.

Proposal 2: UE is not required to check if the requested SI message is to be scheduled or even already received before re-transmitting RACH preamble for SI request. Nevertheless, UE stops ongoing RACH procedure for SI request if UE RRC recognizes that the requested SI message is to be scheduled or already received.

Proposal 3: Upon receiving the indication(s) of RACH problem, UE declares failure of the RRC SI Request procedure.

Proposal 4: If minimum SI has been received for a cell, UE does not considers the cell as barred regardless of whether Other SI is received or not.

Proposal 5: If the RRC SI Request procedure fails and the requested SI has been not received at a cell, UE applies minus offset for the concerned cell when cell selection and reselection.

Proposal 6: Upon receiving the indication of RACH problem from UE MAC at a cell, UE RRC starts a prohibit timer. While the timer is running, UE RRC shall not trigger RACH procedure for SI request at the cell. After the timer is expired, if SI is still requested, UE RRC re-triggers RACH procedure for SI request at the cell.

Proposal 7: UE RRC is allowed to trigger RACH procedure at the cell up to N times. N is configured by the cell.

Proposal 8: After UE RRC has triggered RACH procedures N times at a cell for the RRC SI Request procedure, UE RRC stops the RRC SI Request procedure. Then, UE RRC shall not re-initiate the RRC SI Request procedure and re-trigger RACH procedure for SI request at the cell, while keeping camping on the same cell.

Proposal 9: UE MAC shall not re-transmit RACH preamble if maximum number of preamble transmissions is reached.

Observation 1: Since SI request is a RRC message, when NAS triggers RRC Connection Request/Resume right after RRC triggers SI request, RACH procedure for SI request would delay state transition from IDLE to CONNECTED or from INACTIVE to CONNECTED.

Proposal 10: We propose to consider one of the following options to avoid delayed state transition caused by SI request transmission:

- **Option 1: If RRC triggers state transition procedure such as RRC Connection Establishment or RRC Connection Resume, UE stops ongoing RACH procedure for SI request.**

- **Option 2: RRC Connection Request/Resume message and SI request message use different SRBs. The SRB carrying SI request message has a lower priority than the SRB carrying the RRC Connection Request/Resume message**