3GPP TSG-RAN Meeting #88 **R1-1702375**
Athens, Greece, 13th-17th February 2017

Source: **Cohere Technologies**
Title: **4-step RACH Procedure**
Agenda item: **8.1.1.4.2**
Document for: **Discussion and Decision**

---

1. Introduction

In the last 3GPP RAN 1 meetings, initial access and its different parts were discussed. A major part of the discussion focused on the 4-step RACH procedure. In the last 3GPP NR Ad Hoc meeting the following agreements were done with regards to 4-step RACH procedure [1].

Agreed Definition:
- For 4-step RACH procedure, a RACH transmission occasion is defined as the time-frequency resource on which a PRACH message 1 is transmitted using the configured PRACH preamble format with a single particular TX beam

Agreement:
For 4-step RACH procedure,
- NR at least supports transmission of a single Msg.1 before the end of a monitored RAR window
- NR 4-step RACH procedure design should not preclude multiple Msg.1 transmissions until the end of RAR window if need arises

Agreement:
For NR RACH Msg. 1 retransmission at least for multi-beam operation:
- NR supports power ramping.
  - If the UE conducts beam switching, working assumption that one of the alternatives below will be selected (configurability between multiple alternatives may be considered if clear benefit is shown):
    - Alt 1: the counter of power ramping is re-set.
    - Alt 2: the counter of power ramping remains unchanged.
    - Alt 3: the counter of power ramping keeps increasing.
    - Other alternatives or combinations of the above are not precluded.
  - If UE doesn't change beam, the counter of power ramping keeps increasing.
  - Note: UE may derive the uplink transmit power using the most recent estimate of path loss.
  - The detail of power ramping step size is FFS.
- Whether UE performs UL Beam switching during retransmissions is up to UE implementation
  - Note: which beam UE switches to is up to UE implementation

In this contribution, the details of the 4-step RACH procedure are discussed.

2. Discussion

In the last 3GPP RAN 1 NR Ad Hoc meeting, the RACH transmission occasion within a 4-step RACH procedure was defined and an agreement on the definition was achieved [1]. In the case of NR, both single and multi-beam operations are considered for NR and therefore RAN 1 should try to design a 4-step RACH procedure for both cases. As discussed within the last RAN 1 meetings, a certain flexibility in the design of the general initial access procedure is required. This implies flexibility in the SS burst configuration as well as in the RA transmission. This flexibility is required in both time and frequency resources of these procedures as well as in the spatial domain ([1], [2]).

So as to capture all of the different options it is proposed that system information – not necessarily PBCH, without this option be excluded – contains all of the necessary information for random access time, frequency and spatial resources to be used for RACH. This method provides information between the DL beam and UL beam correspondence, if this is available.
One open issue in the 4-step RACH procedure is how UEs report the detected DL beam. The choice of a given PRACH format, i.e. RACH sequence set, time and frequency resource indicates to the network the DL beam that the UE has listened.

Proposal 1: The time, frequency, spatial resource as well as the RACH preamble set selected by the UE indicates to the network the detected DL beam.

Another open issue of the 4-step RACH is if the UE should transmit once or several times prior to the RAR window expiration. In most of the cases, the retransmission of MSG 1 prior to the RAR window expiration is unnecessary and it might result in unnecessary load in RACH. In case of single beam transmission from the UE and independently of how many beams are used for downlink transmission, retransmission of MSG 1 prior to RAR window expiration with the same power level is not expected to provide improvement.

In case of multiple beam transmission in both uplink and downlink, after the first MSG 1 transmission, the UE should continue listening to various SS blocks transmissions and should continue to improve the cell ID and system information acquisition, prior to eventually attempt retransmission of MSG 1 before the RAR window expiration. There might be cases, e.g. a case of an UE with URLLC type of traffic and/or if the RACH channel is not loaded, in which the network allows MSG 1 retransmission prior to RAR window expiration. In this case, the network notifies UEs in the system accordingly.

Proposal 2: UEs should not attempt more than 1 MSG transmission prior to the RAR window expiration and without having been allowed by the network.

Another open issue is the behaviour of the UE upon expiration of the RAR window without the UE receiving any RAR. The proposal is that the counter of power ramping increases only if UEs have detected the DL beam and UEs transmit at the appropriate UL beam. This can be achieved only when UEs keep on listening synchronization sequences and system information even after having transmitted MSG 1. This procedure reduces the probability of wrong cell ID detection without increasing considerably the UE power consumption, since initial system synchronization is achieved.
In case the UE has not reached the required accuracy in synchronization and system information acquisition, then, upon RAR window expiration, the counter of power ramping is re-set and the power level is set according to the latest DL path loss estimation.

Proposal 3: Upon RAR window expiration, MSG 1 is retransmitted and the counter of power ramping increases only if UEs detected the proper DL beam and if UEs transmit at the corresponding UL beam.

3. Conclusion

In this contribution, the 4-step RACH procedure is discussed. The following conclusions are drawn:

Proposal 1: The time, frequency, spatial resource as well as the RACH preamble set selected by the UE indicates to the network the detected DL beam.

Proposal 2: UEs should not attempt more than 1 MSG transmission prior to the RAR window expiration and without having been allowed by the network.

Proposal 3: Upon RAR window expiration, MSG 1 is retransmitted and the counter of power ramping increases only if UEs detected the proper DL beam and if UEs transmit at the corresponding UL beam.

4. References

[1]. RAN1# NR Ad-Hoc Meeting, January 2017, Chairman's notes.

[2]. R1-1702375, "SS Burst Composition and SS Time Indication", Cohere Technologies, 3GPP RAN 1 #88 Meeting, February 2017.