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Document for: Discussion and decision

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1 Introduction

Currently, the access process and the UE id have been presented in the RAN2 meeting. In this document the access procedure is analyzed under different application scenes and the information carried on RACH is discussed.

2 Discussion

2.1 Access Procedure

The access procedure performed in the uplink is not synchronised in most scenes. It is usually a contention-based random procedure. Firstly, UE listens to system broadcast, reads the system information, from which the UE can get necessary information for random access.

To reduce the collision probability and detect possible collisions fast, a number of sequences, namely signatures are needed. By correlating with different signatures, the eNB can detect one particular UE or collisions. The UE is assumed to identify itself in a random access procedure autonomously by choosing a signature randomly from a set of signatures. The randomly selected signature by UE's physical layer is referred to as Signature ID. In one cell of 1.25 MHz, the number of signatures may be more than ten (e.g. 4bits). During the random access procedure, UE selects a signature (preamble) randomly, estimates the transmission timing advance due to the non-synchronization of uplink and transmits it. Then the UE listens to the preamble response.

If UE doesn't receive the preamble response within the pre-defined period, it will select a new signature randomly and transmit it again after a random time until the UE has received a expected response or the maximal number of retransmit has been reached.

When eNodeB received the preamble signal, its physical layer deals with the signal by correlation, gets the uplink timing advance and uplink transmit power precisely, reads the signature id of UE, and report to MAC. The MAC of eNodeB allocates a C-RNTI, selects a response channel of preamble and transfers the C-RNTI to physical layer. The physical layer transmits the C-RNTI, timing and power information to the UE on response channel of preamble corresponding to the Signature ID. When two or more UEs transmit preamble signal at the same time with different signature ID, eNodeB should have the capability to distinguish different UE's preamble, and gives different UE different C-RNTI and other information on different preamble response channels.

When two or more UEs transmit preamble signal at the same time with same signature ID, the collision will happen. In this case, eNodeB may detect collision, and doesn't give the response of preamble. If eNodeB doesn't detect the collision(namely only one signature is obtained), it thinks only one UE sent the access request. Then eNodeB provides one C-RNTI and other information on the preamble response channel. The undetected collision

will happen since multiple UEs will get and utilise the same response information. Of course, the probability of such collision is usually very low and it can be found during the following operation, as described below.

After UE received the C-RNTI together with timing and power information, it can transmit the L2 control message on the physical random access channel (e.g. PRACH) corresponding to preamble response channel. The relationship of PRACH with preamble response channel is broadcasted in the system information. To reduce the delay of access request, the data on RACH will be limited. The data should be transmitted within a sub-frame (FDD) or timeslot(TDD). The RACH may include Random ID, C-RNTI, access cause etc. The Random ID is selected randomly by UE. Due to the RACH includes a Random ID that can be designed long enough (e.g. 8bits), the residual possible collisions can be resolved in this step.

UE listens to a downlink share control channel (DL-SCCH) corresponding to preamble response channel or PRACH. The relationship of the DL-SCCH with preamble response channel or PRACH is broadcasted in the system information. Scheduling information for the access UE (signed by the C-RNTI) is carried on the DL-SCCH.

The system can predefine some types of radio resource configurations for access causes. When eNodeB received the UE's RACH data, it will check the random ID to see if two or more UEs using same C-RNTI. If yes, the eNodeB will not schedule this C-RNTI. If these UEs do not find the scheduling information on the related DL-SCCH after a period of time, they will consider that the access procedure is failure and reinitiate the access requests according to their requirements respectively. If eNodeB receives RACH successfully, it will select a type of configuration of radio resource on UL-SCH according to the access cause, and notify the UE on the DL-SCCH. The Random ID can be transferred to UE on DL-SCCH or a RACH response channel or a L3 message. Which channel transfers the Random ID to UE is FFS. Using the Random ID, the UE can know the schedule information for the C-RNTI is for which UE within collision UEs in first access step.

Then, the UE can communicate with NW on UL-SCH/DL-SCH normally. It will transfer IMSI or TMSI in the L3 message on UL-SCH to setup RRC connection and other message. The random access procedure can be seen as in figure 1.

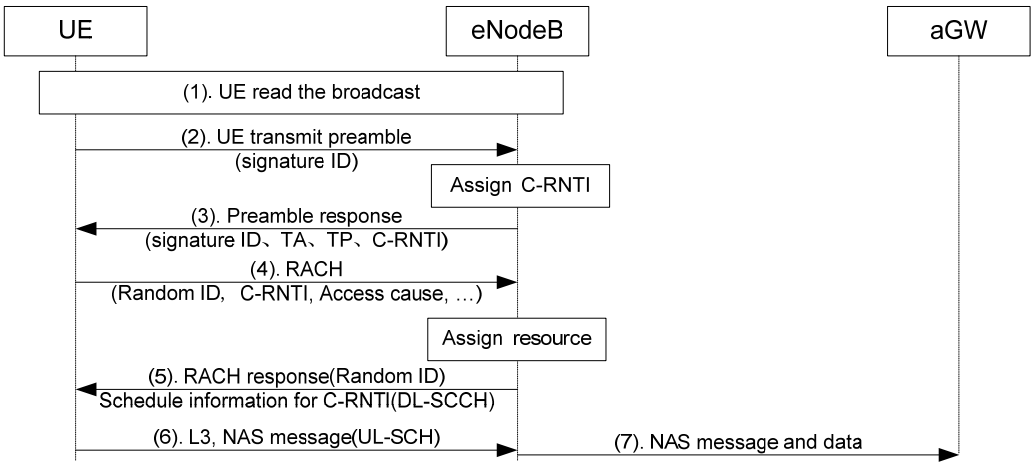

Figure 1: The general random access procedure

2.2 Access scenarios and UE ID

The initial access is used in the fellow scenes:

1) When UE in power on, the UE would access NW to take registration;
2) The UE moves to a new trace area, it will access NW to update location;
3) The UE requires the NW to provide service, it will access NW;

4) After UE is paged by NW, it will access NW;
5) The UE has connected with eNodeB, but uplink is non-synchronized and UE having data to transmit;
6) During handover, but the uplink is non-synchronized, UE will random access in new cell or in old cell.
7) The UE has connected with eNodeB, in the DRX state, the uplink is synchronized, but it needs radio resource immediately;

In scene 1), the NW hasn't any information about the UE. The UE has static ID of IMSI or IMEI only. The access procedure is same as figure1 in the step 1 to step 5. But in the step 6, the L3 message will carry the IMSI to eNodeB. Then the NW will setup RRC connection and do authentication and encrypt, give the UE a TMSI, and encrypt key. After the UE has registered on the NW, the RRC connection will be released together with C-RNTI. The UE will enter the LTE-IDLE state.

In scene 2), 3), 4), the UE has the temporary identity (TMSI) and the last encrypt key. The NW has the UE's capability information, encrypt information and so on. The access procedure is same as figure1 in the step 1 to step 5. But in the step 6, the L3 message will carry the TMSI to eNodeB. The eNodeB transfers the information to aGW. The aGW gets information above, it can give the UE new encrypt key. In addition, in scene 4), the necessary information should be carried on the PCH when the NW paging UE to speed up access procedure.

In scene 5), 6), the NW has all information about the UE, and UE can initiate access on RACH with its C-RNTI after preamble and ignores allocated new C-RNTI. Then UE transmits user data on the UL-SCH/DL-SCH according to the scheduling information on the DL-SCCH corresponding to PRACH. The eNodeB could know that the UE has a RRC connection already via the C-RNTI, it will ignore the random ID. After a period of time, eNodeB doesn't receive the PRACH of new allocated C-RNTI, it will see that access is failure, and frees the C-RNTI. The random access procedure can be seen as in figure 2.

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Figure 2: The random access procedure in case 5) and 6)

In scene 7), the NW has all information about the UE, and UE is synchronized in uplink. The UE can initiate access on RACH with C-RNTI directly. The eNodeB could know that the UE has a RRC connection already via the C-RNTI, it will ignore the random ID. Then UE transmits user data on the UL-SCH/DL-SCH according to the scheduling information on the DL-SCCH corresponding to PRACH. The random access procedure can be seen as in figure 3.

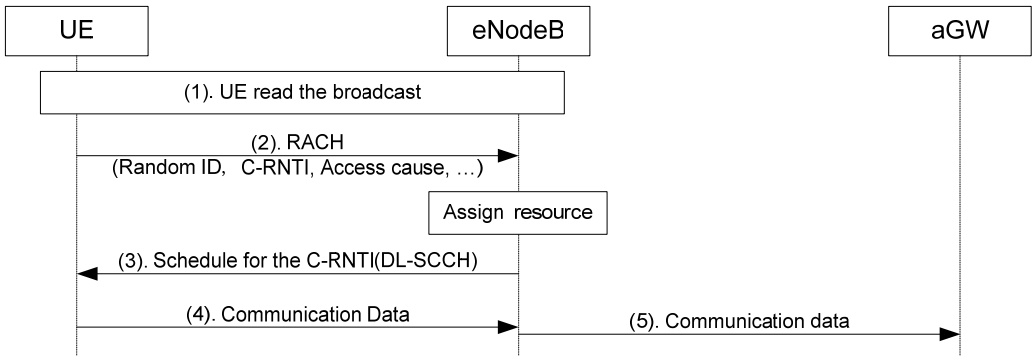

Figure 3: The random access procedure in case 7)

Sum up the above depicted, the data on the RACH should be include following types:

Random ID(e.g.8bits)	C-RNTI (xbits)	Access Cause(xbits)	Resource Indicator(xbits)

The resource indicator is used for UE to request radio resource or report the buffer information.

3 Conclusion

In this document we have discussed the random access procedure and the use of RACH in every scene. The access procedure is put forward that firstly UE transmits a preamble to synchronize with eNodeB, reduce the probability of collision, and fast detection in eNodeB; and then transmits RACH with Random ID, C-RNTI, access cause and Resource Indicator. Since active UE is synchronized in uplink, it can initiate access procedure using C-RNTI directly.

4 References

[1] TR25.813 “Radio interface protocol aspects”, 2005.

[2] TR25.814 “Physical Layer Aspects for Evolved UTRA”, 2005.

[3] R1-060520, EUTRA TDD Random Access Procedure, CATT, RITT, TD-Tech