Congestion Control in Machine Type Communication

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Outline

Problem in Machine Type Communicatio

- More and more applications such as smart grid, real-time health services, etc are growing vigorously
- It's can be predicted that the number of M2M devices will expand to billion in 2020
- Great amount of MTC device could make the radio access network be very clogged

Problem in Machine Type Communicatio

- Different service like real-time health service can not tolerance with the environment with high access delay and failure of access
- **Alleviate the Radio Access Network overload**
  - ellvate the access success probability
  - reduce access delay

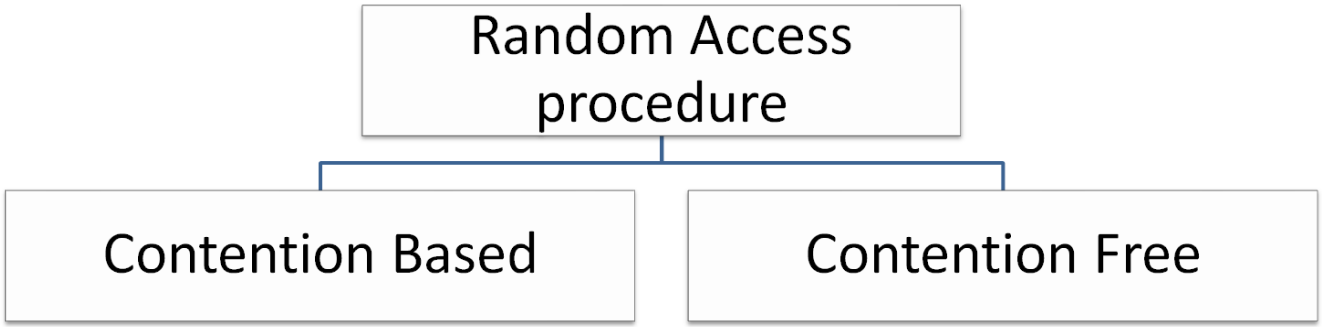
Random Access Procedure - intro

- Random Access Procedure is triggered when
  - Initial access from RRC_IDLE
  - Handover
  - DL data arrival during RRC_CONNECTED requiring random access procedure

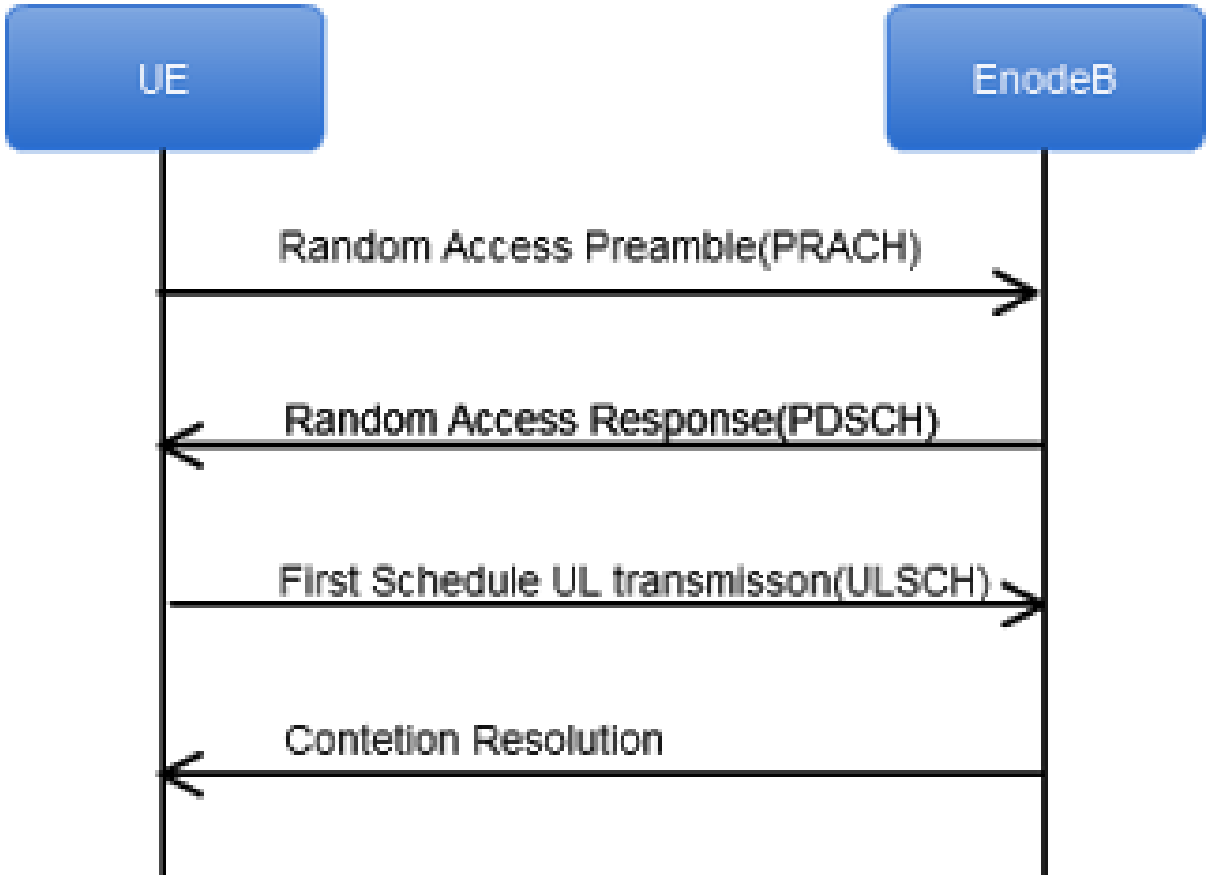
Terms

- RACH - Random Access Channel
  - time-frequency resource blocks repeats in the system periodically
- Preamble
  - A set of codes called preambles, which shared by all users in their random access

Random Access Procedure - two type



Random Access Procedure - illustration



Congestion of Random Access Procedur

- Lets assume two UEs send same RACH preamble at same time in step 1
- Same message will be received by two UEs in step 2
- In step 3 eNodeB may be able to receive Msg3 from only one UE or none of them due to interference
- In step 4 the UE which does not receive Msg4 from eNodeB will back-off after expiration of RACH specific timers. Possibility is also that none of them receive Msg4

ACB - Access Class Barring

- eNB broadcast an access probability p and a limit time τ
- UE will generate a random value q, if $q \leq p$, UE can start the Random Access Procedure
- if not, UE have to wait for τ to retry

MTC backoff

- When there is collision in Random Access Procedure, UE will wait for a backoff time to retry
- Use the backoff time to release loading on Random Access Channel

Random Access Procedure - flow chart

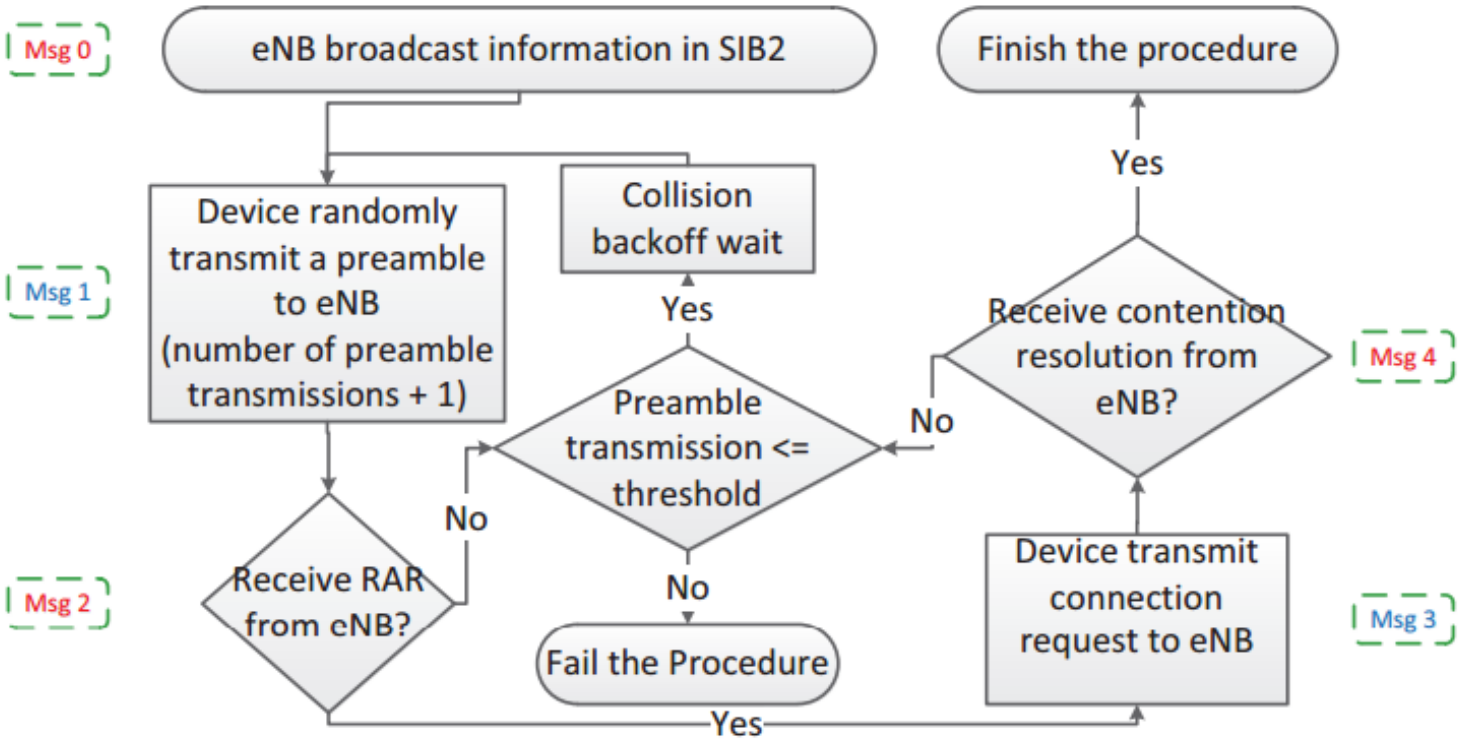


Figure 3.3: Random access flow chart

Papers

- Retransmission-based Access Class Barring for RAN overload control in Machine Type Communications[1]
- Efficient LTE Access with Collision Resolution for Massive M2M Communications [2]
- Adaptive RACH Congestion Management to Support M2M Communication in 4G LTE Networks [3]
- D-ACB: Adaptive Congestion Control Algorithm for Bursty M2M Traffic in LTE Networks [4]

Solution from these papers

- Retransmission-based Access Class Barring for RAN overload control in Machine Type Communications[1]
  - Classify into several groups by the number of retransmission. Each group were assigned a weight which means the proportion of RACH resource they get.
  - The way to control the proportion of RACH resource is dynamic change their ACB factor

Solution from these papers

- Efficient LTE Access with Collision Resolution for Massive M2M Communications
  - Proposed a collision resolution algorithm. The algorithm use q-ary tree spliting to split the set of avaliable preable
  - Revise MSG4 to make UE next contention attempt use the sub-set of available preamble on dedicate RAO(random access oppo rtunity)

Solution from these papers

- Adaptive RACH Congestion Management to Support M2M Communication in 4G LTE Networks
  - With several known algorithm for congestion control, and seperate congestion situation in three level.
  - Propose an algorithm “ARC”, to apply the best congestion control algo to correspond congestion level.

Solution from these papers

- D-ACB: Adaptive Congestion Control Algorithm for Bursty M2M Traffic in LTE Networks
  - Proposed a “D-ACB” algorithm to adaptively update the ACB factor
  - Use available information (e.g. number of success preamble transmissions, number of available preambles...) to derive $E[C_{M,p}]$: average number of preambles experiencing collisions in the RACH
  - and use $E[C_{M,p}]$ can derive the improved ACB factor

Difference between this papers

- The work in [1] and [4] both discuss with how to adjust ACB factor
  - These two paper are using the same parameter “ACB” to alleviate the Radio Access Network
  - but [1] is more focused on the access success probability, so it’s hard to integrate to gain better result
- [2] and [4] both concern in how to decrease access delay
  - Combine the perspective between these two, might gain better result

References

[1] J. W. Chiou and S. Cheng, “Retransmission-based access class barring for ran overload control in machine type communications.”

[2] G. C. Madueo, . Stefanovi, and P. Popovski, “Efficient lte access with collision resolution for massive m2m communications,” in *2014 IEEE Globecom Workshops (GC Wkshps)*, Dec 2014, pp. 1433–1438.

[3] M. K. Giluka, A. Prasannakumar, N. Rajoria, and B. R. Tamma, “Adaptive rach congestion management to support m2m communication in 4g lte networks,” in *2013 IEEE International Conference on Advanced Networks and Telecommunications Systems (ANTS)*, Dec 2013, pp. 1–6.

[4] S. Duan, V. Shah-Mansouri, Z. Wang, and V. W. S. Wong, “D-acb: Adaptive congestion control algorithm for bursty m2m traffic in lte networks,” *IEEE Transactions on Vehicular Technology*, vol. 65, no. 12, pp. 9847–9861, Dec 2016.

Thanks for Your Attentions