

Congestion Control in Machine Type Communication

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Outline

Introduction

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Problem in Machine Type Communication

- ▶ 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 Communication

- ▶ 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

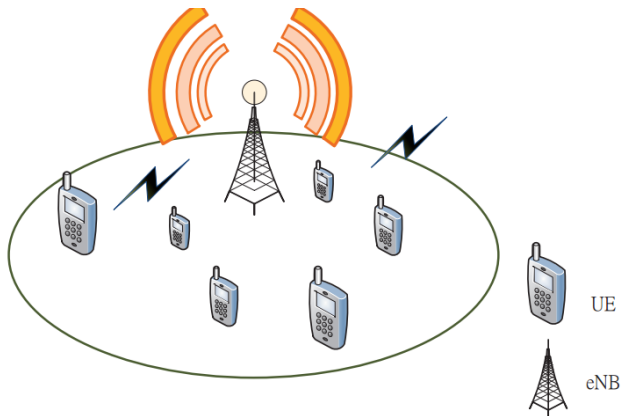


Figure 3.4: Information of random access broadcasted by eNB

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

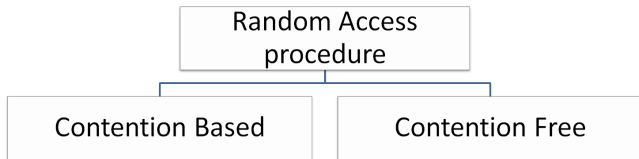


Terms

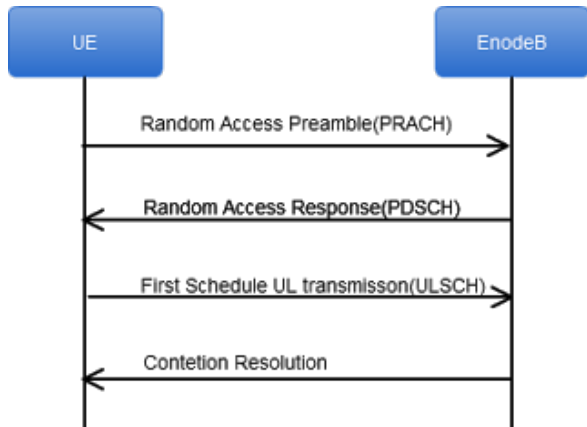
- ▶ RACH - Random Access Channel
 - time-frequency resource blocks repeats in the system periodically
- ▶ Preamble
 - A set of codes called preambles, which shared by all users in their random access



Random Access Procedure - two type



Random Access Procedure - illustration



Congestion of Random Access Procedure

- ▶ 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

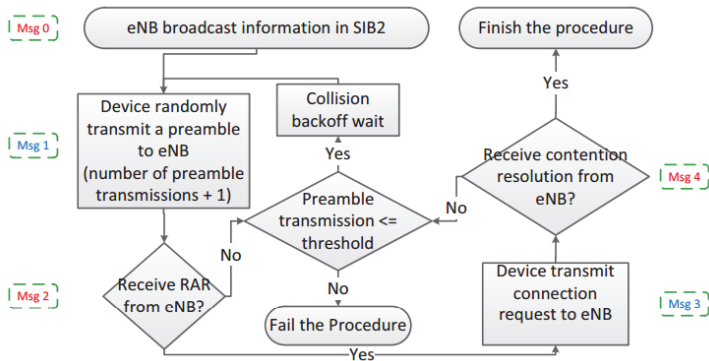


Figure 3.3: Random access flow chart

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

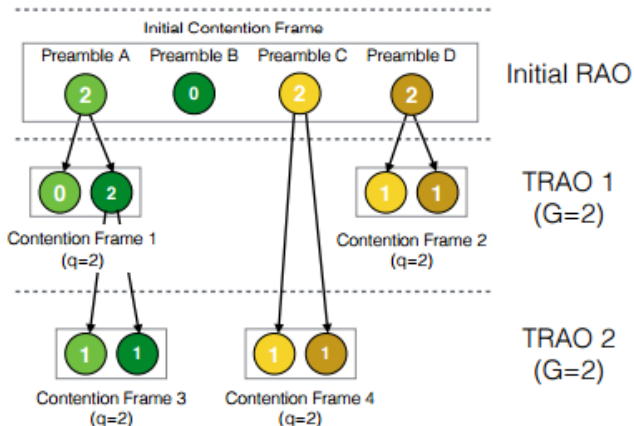


Solution from these papers

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



Solution from these papers



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

