COMPETITION REDUCTION FOR CHANNELS MM2M- COMMUNICATION OVER LTE/LTE-A NETWORKS

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Abstract

The study aimed to investigate the possibility of the use current an approach to resource allocation in access LTE network for mM2M communication in order to support a large number of sensors and actuators to facilitate data among. The techniques to improve the performance of RACH for M2M, random access procedure and it fail reasons for a large amount of channel contention are analysis. Describes mathematical model optimal resource allocation by BS and to maximize the number of connections, techniques of grouping in M2M communication. Methods for improving massive M2M random access in LTE/LTE-A networks with methods for clustering massive machine communications are analyzed and was proposed use K-means methodto cluster the mM2M group with coordinator selection of the MTDs in LTE-based mMTC deployments.

Depending on the major demands and the specific application, M2M communications can be considered massive machine type communication (mMTC) , which are key use cases of coming 5G network. The mMTC devices are always numerous with low complexity and constrained power. Exists mMTC devices have critical requirements in terms of latency and reliability. To achieve a ubiquitous connectivity for mMTC devices, the cellular network, like LTE and LTE-A network has become one of the most promising solutions for support of M2M communications due to its wide coverage, easy installation and flexible resource management methods. Different of the characteristics of M2M traffic are always massive access attempts, infrequent short payload transmission, power constrained.

If the existing cellular infrastructures are used to support the M2M applications, it would have been to suffer heavy congestion and overload both in the radio access network (RAN) and core network.

Before data transmission in LTE/LTE-A networks, unconnected M2M devices need to execute the random access procedure (RAP) for connection establishments with the evolved-Node B (eNodeB). Compared to the large amount of access requests, the finite available radio access resources are not sufficient.

Consequently, massive simultaneous access attempts lead to heavy congestion and even make the network collapse, posing a giant impact on H2H communications. Collisions also bring about the ceaseless back-off process and retransmission, prolonging the access delay, wasting finite resources and increasing the power consumption of power-constrained M2M devices. Therefore, proper congestion control mechanisms are urgently required to handle the massive IoT access attempts. 3GPP six possible remedies have been identified to combat the PRACH overload problem: the backoff scheme, slotted access scheme, access-class barring scheme, pull based scheme, PRACH resource separation scheme, and dynamic PRACH resource allocation scheme [1]. Owing to the traffic load dynamics on the PRACH, these schemes alone cannot fully alleviate the overload problem. Group or cluster-based multistep access mechanisms have proven to be effective in further reducing signaling overhead by sacrificing access delay. A group-based access mechanism delegates the random access procedure of the devices to an access group controlled by a designated device, this device is referred to as the group head MTC devices construct a group based on their location or subscription features. However, the number of MTC devices in a group is fixed are analyzed to establish a reasonable group size.

According to the way MTC traffic is generated, current RAN-overload control schemes can be :

1) access procedures are initiated by devices and request messages are pushed by devices to the eNodeB. Typical solutions are Access Class Barring (ACB), Extended Access Barring (EAB), Resource Separation Scheme (RSS), back-off scheme, slotted access scheme, etc. The key idea of the solutions is to scatter the massive simultaneous access attempts into a longer time period to decrease the chance of collisions.

2) In the pull, based solutions, the access procedures are initiated by the eNodeB and she informs specific M2M devices for network connection and data transmission. One of the most typical pull-based solutions is paging.

When dividing of groups mM2M nodes into clusters MTCDs are grouped based on characteristics such as quality of service, energy efficiency, services, geographic location, co-grouping, signal-to-interference ratio (SIR) or shared services/requirements with one MTCD selected as the head (coordinator) of the cluster. It is responsible for collecting data from surrounding MTCDs and transmitting them to the BS. The number of access requests to the BS is limited by the number of coordinators, M2M clustering reduces the load on the random-access channel.

Typically, the signal transmitted by low-power MTCDs has difficulty reaching its destination due to long propagation path or shadowing.

Data communication between sensor devices and eNodeB can be divided into two stages - inner-cluster data collection stage and header-based data transmission stage.

1) At the stage of intra-cluster data collection the header of clusters aggregates data from devices for its high access capacity, low cost, flexible deployment, and high technical. Once devices learn that their groups have been in the message, header devices would begin the data collection process and others within clusters would be in formed by the clusters and prepare for the inner-cluster data transmission. The access capacity of header devices is extremely important for massive devices within the clusters.

2)At the stage of header-based data transmission stage data aggregated within the clusters would be sent to the LTE/LTE-A cellular networks for subsequent applications. All the paged header devices would perform the random-access channel (RACH) procedure for connection establishment. One base station (BS) is located at the center of the cell and mMTC UEs and N cellular UEs are uniformly distributed within the cell. We adopt a contention-free manner of allocating the preambles, whereby all UEs initiate the connection to the BS by allocating of preamble before data transmission.

The main tasks of group communication in the LTE/LTE-A network were identified, which are as follows.

•Data aggregation: - when multiple MTCDs transmit small packets and delay-tolerant co-related data then the data packets from different MTCDs can be aggregated at an intermediary node and sends together to save bandwidth and to reduce frequent scheduling.

• Connectivity support: - gateways, which have the dual connectivity facility, can provide connectivity support to non-LTE devices.

• Reduced network traffic: - unnecessary data transmission can be avoided through preprocessing of data at gateway to reduce the network traffic, for example

• Reduced energy consumption: - energy consumption can be optimized by limiting the frequency of packet transmission and reducing transmission-time.

• QoS support for MTCDs: - gateway-based communication can provide QoS support to MTCDs through preprocessing and intelligent decision approach.

• QoS requirements of devices - the MTCDs having same QoS requirements can be grouped together to support a QoS-aware scheduling decision.

The grouping of devices is generally based on the characteristics and requirements of devices, which can be classified as the following criteria.

• Communication protocol - MTCDs can be grouped together which have same communication protocols such as WiFi, BLE, ZigBee, etc. to support ease of connectivity with the gateway.

• Data generation and traffic pattern - MTCDs which have same data generation pattern and same traffic characteristics can be grouped to avoid the frequent scheduling task.

• Payload size - to support data aggregation approach MTCDs can be grouped based on the payload size.

• Physical layer parameter - MTCDs can be grouped based on the physical layer properties to support better resource utilization.

• Locality of device - MTCDs can be grouped based on the distance from different gateways. This approach can improve the energy efficiency through sort-range communication.

The choice of group coordinator is iterative algorithm that first groups M2Ms into groups and then selects a coordinator for each group. The algorithm starts from a random selection of the coordinators.

Then, each terminal joins the group whose coordinator has minimum energy cost for delivering the packet from the M2M to eNodeB. Successively, a new coordinator is selected among all nodes in the same cluster in order to minimize the group average energy cost. The procedure is iterated until the composition of the groups and the set of coordinators remain unchanged.

We propose to implement algorithm for clustering mM2M group with coordinator selection using the k-means method.

There are an initial set of k means (Aa coordinators) μ1…, μk in clusters S1, S2…, Sk. Gg nodes are selected randomly as coordinators.

1 We to select the initial centers of clusters so that we can bind each device to the center of the cluster, the distance from the center to the device determines who each device will be given to.

2. The distance from each center to each device is calculated as the Euclidean distance between points in space and onwards determine the distance between devices, we use the K-means clustering method to further cluster the devices, the remaining MTDs join the cluster according to the conditions of their channel to the corresponding coordinator.

3. We count the distances from the first device to each center and determine the smallest value, for the center, we recalculate this distance value, after we distribute the devices into clusters.

4. For each group, a new coordinator is selected in accordance with the coordinator selection rule that minimizes the energy consumption within each of the groups returned by the K-means algorithm. The remaining MTDs are again grouped by non-coordinators. Everything starts again as long as the devices remain in the same clusters. The entire procedure is repeated until the coordinators stop changing between successive cycles.

K-means clustering method implementation was done by using PyCaret , a library that supports many the tasks such as regression, classification, clustering, and anomaly detection, PyCaret is a low-code library that is easy to use [2]. The code work on all major operating systems, Microsoft Windows, Linux and Apple macOS. Is suggest use Anaconda, data science toolkit that includes many useful libraries and software packages. Alternatively, can use a cloud service like Google Colab to run your Python code. The PyCaret library can be installed locally by running the according command in the Anaconda terminal or the same command can be run on Google Colab or a similar service to install the library on a remote server.

Conclusion

Massive machine type communication (mMTC) is focused on optimizing the use of network resources to support a large number of stable connections per unit of area. We are analyzed the most common approaches proposed to enable the coexistence of conventional and M2M services, comparative analysis of current solutions for massive access. A critical issue handled by MTC is support for massive numbers of connections, which is a growing problem that will become increasingly challenging as MTC share spectrum resources with cellular communication. Are detailed MTCD-related transmission analysis is done, mainly to increase LTE capacity for massive MTC devices. For massive machine type communications is selected method using clustering and group data transmission from terminals mM2M for clustering mM2M groups with coordinator selection using the K-means method in accordance with the coordinator selection rule that minimizes energy consumption within each of the groups .

References

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