QoS Enhanced Scheduling Framework for IoT Using LTE-A

Aiswariya Milan K, Shilpa Ramesh

Abstract— Internet of things (IoT) allows different devices to connect with each other and exchange data, which can be controlled remotely. Long Term Evolution-advanced (LTE-A) is mobile communication standard used for transferring data in cellular networks. It is the most suitable technology for IoT because of its high speed, high performance and low latency. Quality Of Service (QoS) ensures high quality services for higher priority applications. It allows to segregate traffic based upon the type of services. In this paper, a scheduling architecture is proposed to enhance quality of service in internet of things. The proposed architecture uses Priority Scheduling Algorithm (PSA) to allocate resources to devices which needs urgent servicing. Key idea of our scheme is to show that how to intelligently allocate resources to devices in case many devices are requesting at same time .Simulation results guarantee less response time and packet loss rate for higher priority devices.

***Index Terms*—Internet Of Things (IoT), Long Term Evolution-Advanced (LTE-advanced), Priority Scheduling algorithm(PSA), Quality Of Service(QoS)**

I. INTRODUCTION

Internet of Things(IoT) provides an environment where numerous devices can connect with internet and transfer data without using human interaction. For IoT applications like Smart meter, baby monitor and video surveillance devices should be given importance than other devices like thermostat; smart electric dryer and their status messages has to be reported as early as possible to user equipment. Several wireless technologies such as LTE, Zigbee can be used to capture and transport data in IoT. But for this 3GPP LTE- advanced (LTE-A) can be used because of its high speed and flexibility. Quality Of Service provides preferential treatment for some traffic based upon their requirements by ensuring less response time and reduced data loss. IoT devices has to continuously report status messages to user equipment's. Different devices has different needs and according to that some devices requests should be serviced in a short period of time . In case of network congestion, higher priority devices requests should be considered carefully and they should not be dropped.

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In this paper a scheduling framework is designed, to ensure QoS in IoT**.** The main objective is to reduce response time and packet loss rate for higher priority devices. For this, priority scheduling algorithm is designed which will Intelligently allocate resources to the devices based upon priority. In this paper, a mechanism is provided to categorize status messages from different devices and service them. It also discusses how to handle the requests from devices which needs extra care, and also provides a way to reduce packet loss rate based upon the devices. Priority scheduling algorithm is introduced which enables to allocate resources for the devices whom should be serviced first. Simulation results show that proposed architecture provides less response time and packet loss rate.

The rest of the paper comprises of following. Related work is discussed in section II. Proposed packet scheduling architecture is given in section III. Section IV presents performance evaluation. Conclusions are drawn in section V.

II. Related Work

Jia-Ming Liang [1] proposes an Energy efficient sleep scheduling algorithm and a DRX aware scheduling which will do scheduling based on active and sleep state of devices .The main objective is to maximize the sleep period and also satisfy their QoS requirements. But in this paper they have not considered how to handle requests from devices whose status should be reported urgently. B.Hung [2] proposes a DRX aware scheduling scheme for delay sensitive traffic, in which resources are allocated to UE whose inactivity timer is going to expire first. Thus packet loss rate can be reduced. In [3] R.Kausar proposes an intelligent scheduling architecture to enhance the QoS in LTE-Advanced downlink transmission, where different traffic types are considered. But in this prioritization is only based upon the packet drop rate. For this, hebbian learning and k-mean clustering algorithms are integrated in time domain of scheduling architecture. In [4] rehana.k discusses about packet scheduling algorithms such as Maximum carrier to interference(MAX C/I)and proportional fairness(PF) algorithms.MAX C/I algorithm allocates resources to the users with good channel quality and PF algorithm allocates resources based on their throughput. However, these algorithms do not consider the QoS requirements. Shimin Yang [5] proposes, convergence architecture for internet of things and 3GPP LTE-A, it discusses about an enhanced IMS architecture for IoT using LTE-A. But this architecture does not provide any guarantee for QoS. In [6] M. Sajid Mushtaq

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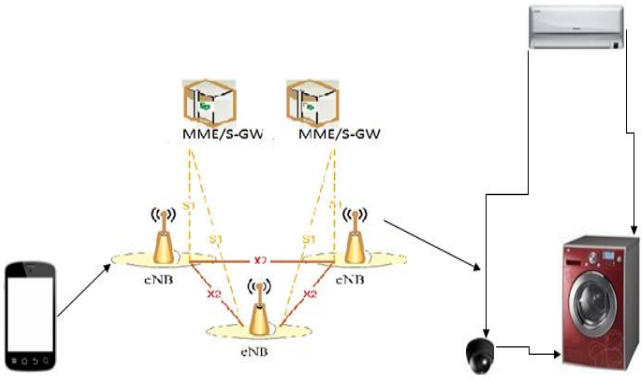
discusses about some QoS parameters which are considered during scheduling with fair resource allocation. Packet delay and packet loss is minimized even in power saving environment. But in this, scheduling is done such a way that priority is assigned to UE who has oldest packet in eNB buffer .In [7] Yue chen proposes a packet scheduling framework for LTE –advanced downlink transmission. Its main aim to achieve better QoS for different traffic types. But it comprises only throughput and fairness. In this paper, an Adaptative time domain scheduling is proposed along with sleep scheduling algorithm which will enhance the QoS in IoT and also allow the devices to sleep and wake up periodically. And also it allows multiple devices to communicate with a UE.

III.PROPOSED PACKET SCHEDULING ARCHITECTURE

In this section, we discuss about our proposed scheme in which IoT devices are assigned with different priorities. Priority scheduling algorithm decides how to allocate resources efficiently and intelligently in case some higher priority devices needs to be serviced. Scheduling is done to group devices and they are placed in different queues. Queue management and scheduling is done in eNodeB(eNB).



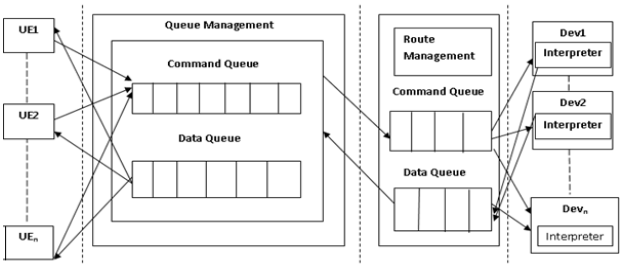
Priority Scheduling Algorithm

When User Equipment (UE) sends commands to particular device through user plane .This commands are routed to particular device through several stages. Device interpreter interprets and sends the commands to particular device which replays with the status messages. eNB receives packets from different devices, and in case of a congestion lower priority packets requests are removed and requests from higher priority are considered and by using priority scheduling algorithm highest priority devices requests are serviced first. Priority scheduling algorithm checks the priority of each request and according to that requests are considered. Proposed packet scheduling architecture is given below.

Proposed Packet Scheduling Architecture

UE's eNB IoT Device

UE's



Queue Management

Queue management is a part of packet classification and QoS schemes, in which packets are identified and placed in queues. Thus higher priority packets are serviced first and when congestion occurs packets with low priority queue are dropped first. Command Queue contains all commands send to device and data queue contains the status messages of the devices. Based upon priority scheduling algorithm messages are inserted into data queue, which is delivered to appropriate UE's.

UE's sends different commands to devices and which will be first forwarded to eNB and from there it is directed to device interpreter which interprets the commands and based upon that status messages are send. These messages are directed to eNB where scheduling is done based upon the priority of packets and it is forwarded to particular UE. During this process, Response Time and Packet loss rate of higher priority packets are monitored and it is calculated.

Performance Evaluation

In this section, we present our simulation results to verify the effectiveness of the proposed scheme. We used LTE-A simulator which creates a LTE environment where signaling happens. We developed Device modules and scheduling part in eNB and integrated with LTE-A simulator. In this,two types of scenario's are considered ie, Normal and Enhanced modes. In normal mode, scheduling is done in such that the requests will be coming and according to the order it comes they are serviced .In enhanced mode, priority will be assigned based upon the services requesting by the devices and scheduling is done based upon the priority of the devices. Comparison of the two schemes is done and results are evaluated.

Response Time

In enhanced mode, the response time of higher priority devices are less compared to normal mode. Because the devices which need urgent servicing are given higher priority and they are serviced first. Based upon the traffic flow, replays from different devices are scheduled. In that way QoS is improved in enhanced mode. But in

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case of normal mode, replays are serviced as the way it comes. So even though if some devices need urgent servicing then also it has to wait.

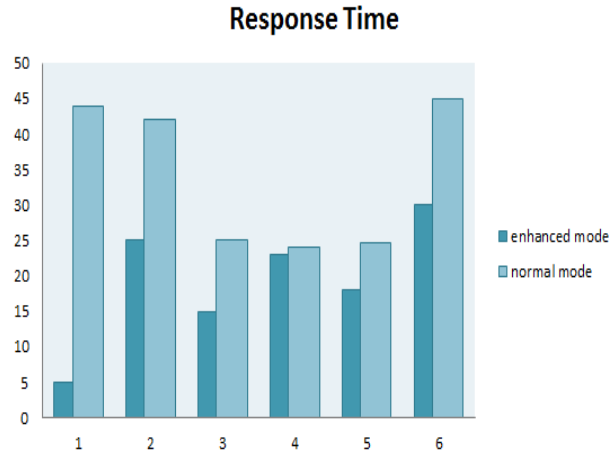
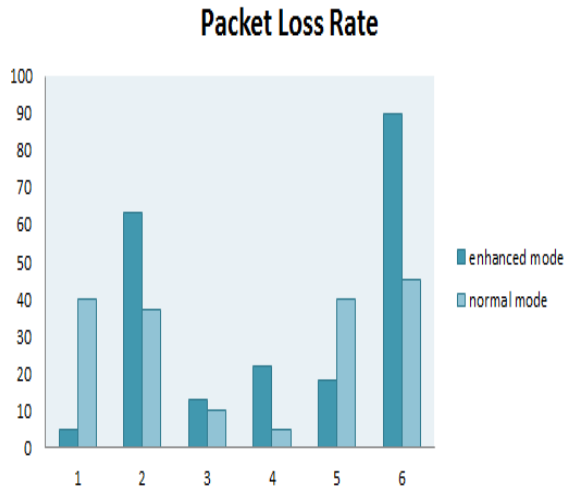


Figure (a) shows that higher priority devices have less response time than the lower priority devices. Here x-axis indicates devices and device 1 has highest priority so its response time is less. But in normal mode since no priority is considered device 1 takes more time to respond. Y-axis indicate average response time

Packet Loss Rate

In enhanced mode packet loss rate for higher priority devices are less compared to normal mode. Because before dropping the packets, priority of packets are checked, and lowest priority packets are dropped. But in the Normal mode, since they are not checking priority any packets can be lost. In that case, the devices which needs to be scheduled first may be lost and its effects quality of service. Thus in enhanced mode, higher priority device will not have much packet loss.



Figure(b) shows that packet loss rate for higher priority devices are less than lower priority devices. Y-axis indicates packet loss rate. Device 1 has highest priority so packet loss rate is less for them. But in normal mode, whenever there is congestion any packet can be lost.

IV Conclusion

In this paper, we proposed a scheduling framework which will enhance the QoS of IoT applications in LTE-A networks. For this, a priority scheduling algorithm is proposed. This algorithm makes a LTE broadcasting scheme that would allow the network to prevent all low-priority devices from accessing the network when higher priority devices are requesting. Thus in this project, Packet loss rate and Response Time have been evaluated and it has shown that this scheme guarantees QoS in terms of packet loss rate and response time.

In this, to guarantee QoS for higher priority devices sometimes lower priority devices are compromised. So in future work, if lower priority devices are losing packets for long period of time there fairness can be increased by slowly increasing priority of such devices.

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