Network Congestion Control in 4G Communication Networks

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Abstract— Wireless technology has continuously evolved adapting to the ever increasing demand of the users to access the internet. After 3G we now have 4G, which has evolved only because of the need for faster internet access, uninterrupted data services i.e. the need to always remain connected. 4G technology has many advantages ranging from high download and upload speeds, high data transmission rates, improved quality of transmission of data and voice. But the users and their demand is ever increasing and this ever increasing number of users is bound to create network traffic and congestion. Congestion is a phenomenon which occurs when the network demand increases its capacity. Congestion is an unavoidable phenomenon which degrades the transmission efficiency of the system and the overall quality of the system. Congestion can be greatly reduced if we apply efficient techniques and algorithms. This paper discusses the software based algorithms to monitor the network traffic and reduce congestion phenomenon.

Key words: Network Congestion Control, 4G Communication Networks

I. INTRODUCTION

Wireless access has seen exponential growth in past decade, and different wireless technologies have been emerging. Internet is the real demand of today world. We can't imagine about life without internet. As internet is emerging the demand of the internet user is also rise up. Every person are using internet as much as possible in his daily life. Recent trends indicate that future network infrastructures will consist of heterogeneous wired and wireless networks. In a fourth generation (4G) environment, a mobile node is equipped with multiple interfaces and it will be able to handover seamlessly between heterogeneous networks to guarantee the continuity of an ongoing application session. In order to make seamless handover possible, future network devices should be capable to roam freely across various access technologies such as wireless local area networks (WLANs), WiMAX networks, cellular systems, etc. Moreover, 4G unifies cellular and wireless local area networks, and introduces new routing techniques. It provides efficient solutions for sharing dedicated frequency bands, increased mobility and bandwidth capacities. The 4G has been developing with the aim of providing transmission rates up to 20 Mbps while simultaneously accommodating Quality of Service (QoS) features. The goal of 4G will be to replace the entire core of cellular networks with a single worldwide cellular network completely standardized based on the IP for video, packet data utilizing Voice over IP (VoIP) and multimedia services. The newly standardized networks would provide uniform video, voice, and data services to the cellular handset or handheld Internet appliance, based entirely on IP. 4G systems will be deployed with software defined radios, allowing the equipment to be upgraded to new protocols and services via software upgrades. It is not a system designed from scratch nor it offers completely new technical solutions. 4G is more a concept whose major goals are integration and convergence. The integration should offer seamless interoperability of different types of wireless networks with the wireline backbone.

II. CHALLENGES AND ISSUES REGARDING 4G

In the 4G - Networks, different types of wireless networks are interconnected to support handoff from one technology to another. These wireless systems were designed independently and targeting different service types, data rates, and users, and thus require an intelligent interworking approach. Effective, secure and efficient operations and management are the major challenge for the development of 4G. In such environment, both the mobile user and the interconnected wireless networks together play an important role in determining how service continuity and service quality can be served in a handover and helps in providing best service to the user. There are number of research challenges which need to be solved in order to achieve 4G network goals. These challenges are listed below.

A. Network Discovery:

4G – Network devices will be multi-mode, multi-access and reconfigurable. Which means each terminal can be using more than one type of network and possibly can access multiple networks simultaneously for different applications. In such an environment, a terminal must be able to discover what networks are available for use. As a solution to this issue currently a technique namely Software defined radio is proposed. In this technique components that have been implemented in hardware are instead implemented using software on a personal computer or other embedded computing devices.

B. Access Technologies:

4G-network is a heterogeneous wireless environment consists of number of radio technologies and may have overlapped radio coverage. A mobile user needs to switch between access networks to maintain service continuity and optimise service quality. Dealing with heterogeneous access technologies is a challenge to the design of 4G – Network. More over selecting the network that will satisfy the QoS requirements of the current service and that will be the most economical.

C. Network Architectures:

4G is an integration of heterogeneous wireless networks. Moreover these networks rely on different network architectures and protocols for transport, routing, mobility management and so forth. The interconnection of these networks in an integral manner to facilitate the cooperation between them is another research challenge.

D. Network Conditions:

Network conditions such as bandwidth, delay, jitter and so forth may vary across wireless networks, and result in different service quality to be provided. How does a mobile user deal with the variation in network conditions, and maintain service quality when crossing heterogeneous wireless networks is needs to be addressed.

E. Charging and Billing:

In the 4G network environment multiple service providers will be involved during a session, if the users roam from one service provider network to one or more other service provider networks. Thus, a single session may consist of number of charges. Moreover, different charging schemes maybe used for different types of services. One challenge is to keep track of charges per use per segment of a session that used their network, service or content. There will need to be more charging agreements between the service providers in order to allow roaming during a session in order to get a continued service as far as a customer is concerned.

F. Large Number of Operators:

A large number of network operators are expected to co-exist and collaborate in the 4G - Networks. In such circumstances, mobile users who are responsible for handover decision will require increased levels of control over how services can be secured in handover. This will be complicated by versatile trust relationships between network operators.

G. Security:

The level of security provided in different networks is different. More interconnectivity and interworking will make the vulnerability even greater. Monitoring, detecting, analysing and preventing worms and viruses on wired networks is very difficult but the same tasks on wired, wireless, and mobile networks combined would be even more difficult and challenging.

H. Congestion Control:

Congestion control is another critical issue in 4G - networks. Avoidance or prevention of the congestion and detection and recovery after congestion are two basic approaches taken towards the congestion control. The avoidance scheme will require the network to suitably implement the admission control and scheduling techniques. The detection and recovery would require flow control and feedback traffic management.

The term 'congestion' in this document applies to a situation where the problems of congestion continue to persist even after all the congestion management mechanisms are applied upon – for example traffic shaping, policing, preferential treatment etc. In such a scenario, there is only option to decline new session request at the front door, as long as congestion persists. The idea is to provide good quality of service to smaller percentage of customer instead of degraded quality to all.

Following are the Figures indicating the overall system performance without congestion control mechanism and also with congestion control mechanism:

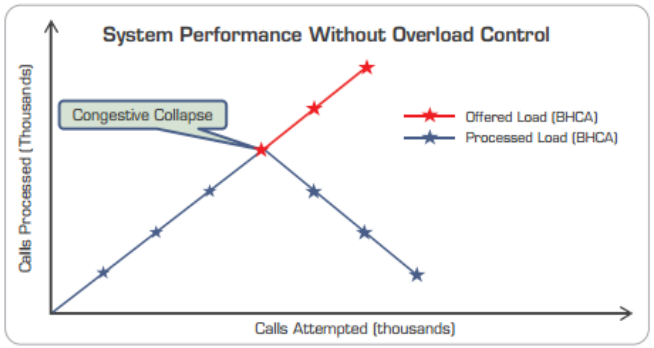

Fig. 1: System Performance without Congestion Control

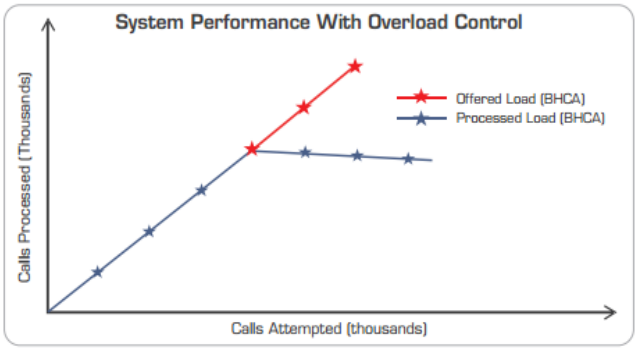

Fig. 2: System Performance with Congestion Control

III. REQUIREMENTS AND SOLUTIONS FOR MOBILITY MANAGEMENT FOR 4G

Besides the basic functions that implement the goal of mobility management, there are many other requirements on performance and scalability that should be carefully taken into account when trying to design or select a mobility management scheme. These includes following:

A. Seamless Handoff:

The handoff operations should be quick enough so that handoff latency is very less in order to reduce the packet drop as much as possible.

B. Signaling Traffic Overhead:

The number of signalling packets or the number of accesses to the related databases should be minimized to avoid the load on the network.

C. Routing Efficiency:

The routing paths between the communication nodes to the mobile nodes should be optimized to exclude redundant transfer or bypass path.

D. Quality of Service (QoS):

The mobility management scheme should support the establishment of new QoS reservation in order to deliver a variety of traffic, while minimizing the disruptive effect during the establishment.

E. Fast security:

The mobility scheme should support different levels of security requirements such as data encryption and user authentication, while limiting the traffic and time of security process e.g. key exchange.

F. Bandwidth:

Higher offered bandwidth ensures lower call dropping and call blocking probabilities. Hence bandwidth handling should be an integral part of the handoff technique.

G. Handoff Latency:

Handoff Latencies affect the service quality of many applications of mobile users. Therefore a good handoff decision model should consider Handoff latency factor and the handoff latency should be minimized.

H. Power Consumption:

In 4G networks, we need to find ways to improve energy efficiency. During handoff, frequent interface activation can cause considerable battery drainage. The issue of power saving also arises in network discovery because unnecessary interface activation can increase power consumption. It is also important to incorporate power consumption factor during handoff decision. I. Network Cost: A multi criteria algorithm for handoff should also consider the network cost factor. The cost is to be minimized during VHO in wireless networks.

I. User Preferences:

The user preferences could be preferred networks, user application requirements (real time, non-real time), service types (Voice, data, video), Quality of service (It is a set of technologies for managing network traffic in a cost effective manner to enhance user experiences for wireless environments) etc.

J. Network Load Balancing:

Network load is to be considered during effective handoff. It is important to balance the network load to avoid deterioration in quality of services.

IV. ADVANTAGES AND DISADVANTAGES

A. Advantages of 4G:

1) Pure Data Network:

4G-network is a “All-IP" based data network. A completely data based network will allow for more bandwidth which means more data can be passed through the network.

2) More Devices and Applications:

4G network devices can take advantage of the higher bandwidth and speeds to deliver more robust and data applications.

3) Speed:

Theoretical speed of 4g has been suggested that data rates up to 100 Mbps for high mobility and 1Gbps for low mobility should be the target value.

4) Hand Off:

The improved 4G network standards will allow for smooth hand off from one coverage area to another without interruption to any on going data transfers. This will result in smooth streaming data for the user.

5) Faster response time:

One benefit of 4G technology is faster response time or lower latency. 4G technology reduces latency to 1/100th of a second (about 10ms).

B. Disadvantages:

In spite of all the above mentioned advantages, there are still limitations that must be addressed. One major limitation is operating area. Rural areas and many buildings in metropolitan areas are not being served well by existing wireless networks.

This limitation of today's networks will carry over into future generations of wireless systems. Moreover new frequencies means new components in cell towers are required. Some other limitations are such as battery usage is more, it is hard to implement, and it need complicated hardware. Another disadvantage is consumer is forced to buy a new device to support the 4G since it is impossible to make current equipment compatible with the 4G network.

V. PROPOSED WORK RELATED TO CONGESTION CONTROL

When a client sends his data to any client then this data will be travelled in network in form of packets. All Packets will be arranged in a queue. These packets will be analysed by Packet Analysis Module. EPA has four parameters:

- MTT (Maximum Travelled Time)
- NTT (Network travelled time)
- ETT (Estimate Total Time)
- MTU (Maximum Transfer Unit).

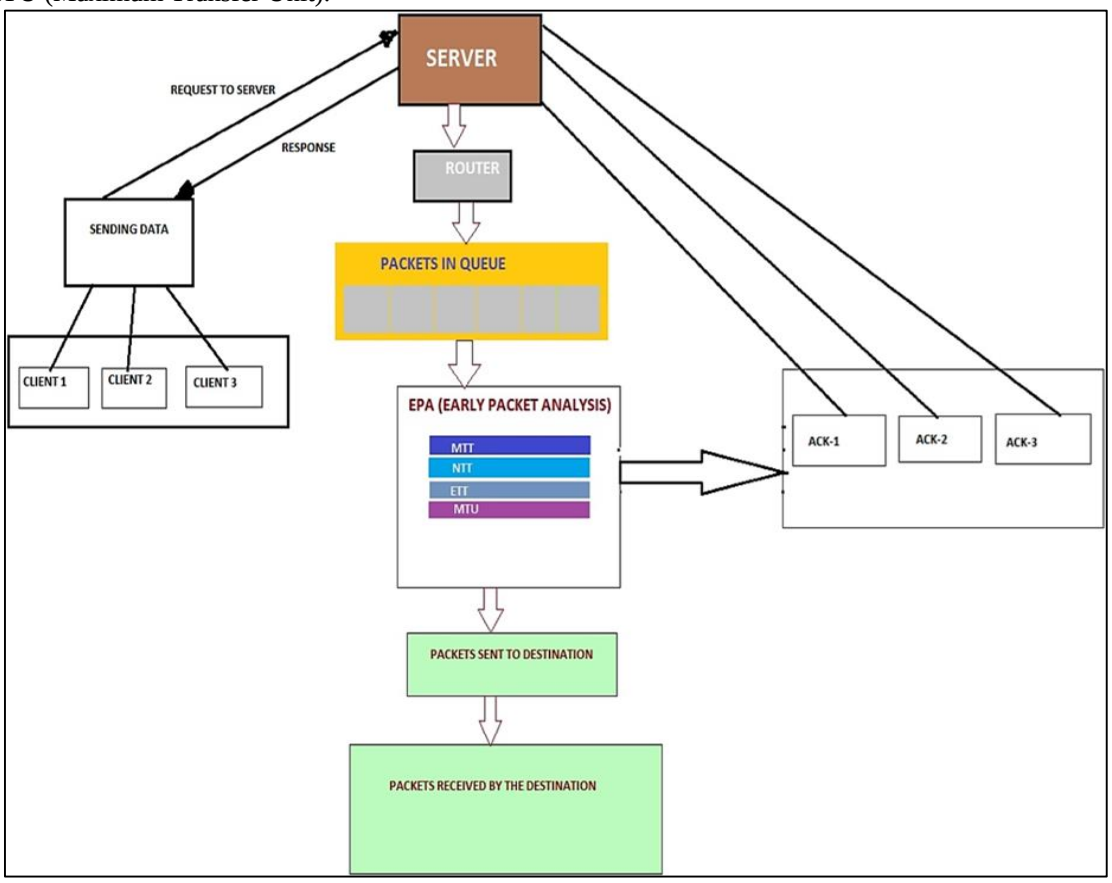

Fig. 3: Proposed Model to Improve the Packet Time in Network Traffic

If the packets fully fill all these condition then EPA will validate and will send packet to the transport protocol (TCP/UDP), which send packets to the receiver otherwise suspend the packets transmission.

Where Pi denotes to the number of packets and PA is available packets. PMTT denote to maximum travelled Time of packets and PNTT is a network travelled time of packets. PETT is estimate total time of a packet and TA defined to the allocation time.

VI. ALGORITHM

A. Algorithm of the Sending Packets:

- Step1: client send request to the server port
- Step2: Server send acknowledge to the server port
- Step3: packet sends from one client to another client
- Step4:

  Implement queue
  PA[n]
  For (Pi=1, Pi ≤ PA, Pi ++)
- Step5:

  Allocate to EPA
  IF (PMTT = = TA)
  Send packets to protocol
  ELSE IF (PNTT= = TA)

Then send "packets will be in pending Status"
ELSE IF (PETT = = TA)
Then send acknowledge to user for failure
ELSE (Pi > MTU)
Then send "your packet is suspend"
Exit ( );

- Step6: Packet received by user
- Step7: END

VII. CONCLUSION

As the wireless communications technologies evolve dramatically, the recent research focus has shifted to the development of fourth-generation (4G) mobile systems. Instead of developing a new uniform standard for all wireless communications systems, 4G communication networks strive to seamlessly integrate various existing wireless communication technologies.

In this paper, we analysed the characteristics of network congestion. We also proposed a model, which will improve the delay time of a packet while travelling in network traffic. In this model, we apply a EPA Module for improving the packet delay time which has four parameter, if the packets follow the rule of these parameters then packets delivered to the another user otherwise packets are suspended.

VIII. FUTURE-SCOPE

Mobile communication is exciting technology in today time for communication and Internet access. As the mobile technology will grow exponentially in future, the user will be totally depending on the mobile. So due to this, we require such kind of technology that a user can easily use it as much as possible. The problem raised in today time of network congestion when accessing the Internet. So, our future work will be implementing to mitigate the congestion control mechanism so that user can easily accessing high speed of the Internet via mobile and there will not be any congestion situation arises while accessing data from Internet.

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