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Survey on Flow Control Mechanism with QoS Conciliation for Next

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ABSTRACT

Next generation Wireless network communications will offer a wide range of services available to users anywhere at any time. Wireless users access those services depends on the current users location, characteristics of the available networks, application requirements, user preferences, and terminal capabilities. The NGN will leads to flexibility in the handling, mobility, reduced installation time, comparatively lower initial cost and nil maintenance cost on the user perception. This will increase the problem of network traffic which becomes major critical issue. This paper is meant for study of network traffic flow analysis based flow control management with QoS conciliation and it reviews the key aspects of end-to-end and network feedback based approaches and pure end-to-end congestion control schemes such as High Speed TCP (HSTCP) for large congestion window. Several objectives like achieving high end user utility for video services, considering the unicast as well as multicast proprieties to meet interclass fairness, and trying to achieve the high QoS requirement by adaptively adjusting the thresholds based on the traffic situations are reviewed.

Keywords: Wireless communication, Cellular network, Next Generation Network, Network Congestion

1. INTRODUCTION

Today we have various wireless and mobile technologies, such as 3G mobile networks (UMTS, cdma, 2000), LTE (Long Term Evolution), WiFi (IEEE 802.11 wireless networks), WiMAX (IEEE 802.16 Advanced wireless Broadband network), as well as accompanying networks, such as personal area networks (e.g., Bluetooth, ZigBee) or sensor networks, which are mass deployed. By replacing traditional circuit switched Mobile terminals, today we are going towards into all-IP based wireless and mobile networks, meaning all data and signalling will be transferred via IP (Internet Protocol) on network layer (Floyd, 2003; Gazis et al. 2005). So, we are having different Radio Access Technologies (RATs) today and new more RATs in the near future (e.g., LTE Advanced), but the common "thing" for all of them is IP, which is unifying technology. NGN is about the evolution of networks towards IP transmission instead of circuit switched TDM networks and the entire network is based on the Internet Protocol (IP).

Future generation of mobile and wireless networks will certainly need to fit within the NGN, since it is based on wireless and wired access possibilities by using all-IP concept to include all services. However, the main principle for NGN is to make a complete separation between the transport part in the access and in the core networks from the service provisioning. Since, the 4G is already in the communication world, the expected next generation of mobile and wireless networks will be labelled as 5G. We believe that the 5G approach will be user-centric approach, since the mobile terminals are becoming highly computationally capable devices which can support more complex functionalities for performing Complex computations, as well as bigger memory space and longer battery life in years will provide enough storage capability for control information (ITU-T Recommendation1, 2001; ITU-T Recommendation2, 2001). In IP world, the main principle is to keep simple network nodes and having smart end devices (e.g., computers) and this is completely different from the Public Old Telephone Systems (POTS). However, we need smart nodes in the All-IP network for providing necessary Quality of Service, authorization, authentication, accounting and security functionalities.

1.1. Migration Of 4G to 5G - NGN

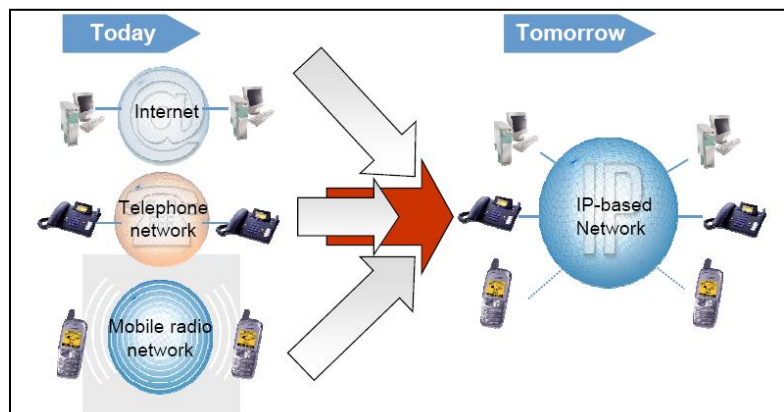In the essence, an NGN is a packet-based network able to provide telecommunication services and able to make use of

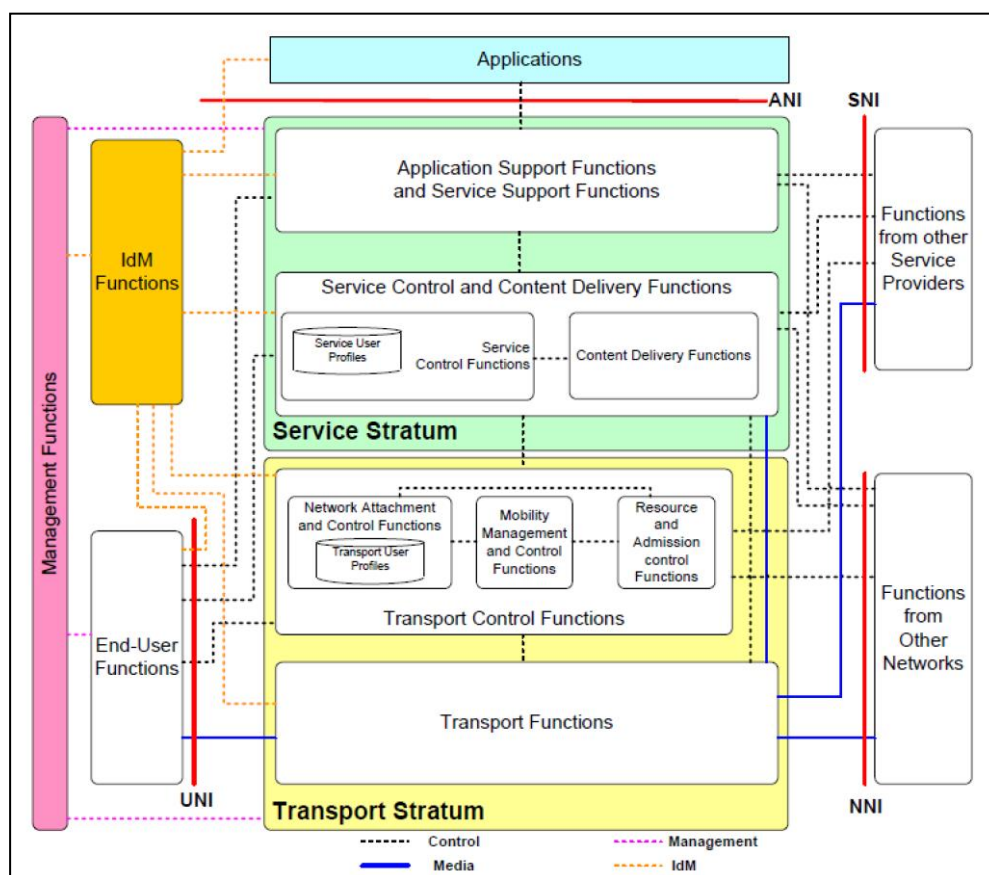**Figure 1**
Migration of 4G to 5G - NGN
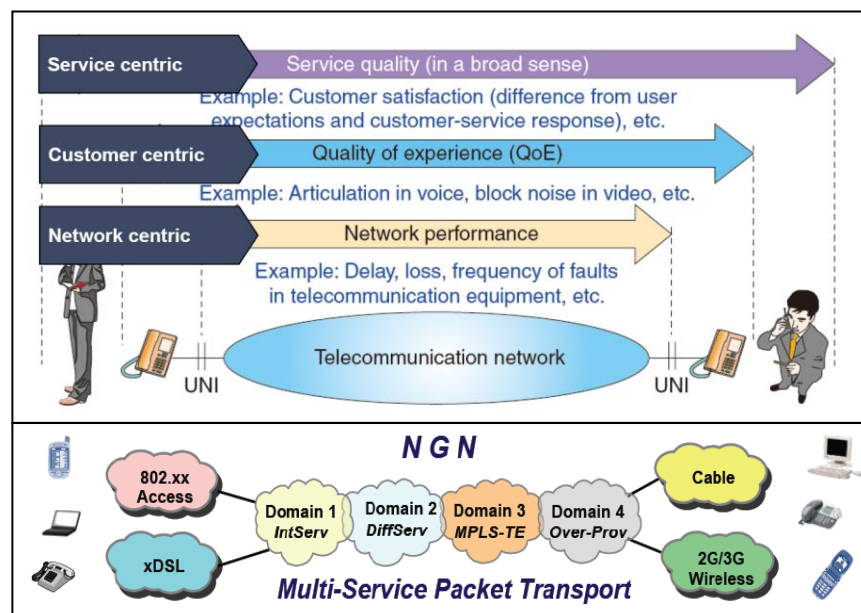
Figure 2
NGN Interconnection architectures

Figure 3
QoS Parameters defined for NGN

multiple QoS-enabled broadband technologies and in which service-related functions are independent from underlying transport-related technologies. It enables agile access for users to networks and to competing service providers and/or services of their choice. It supports more generalized mobility which will allow consistent and ubiquitous provision of services to users. Migration from legacy Circuit based networks to more efficient All-IP based Next Generation Networks (Fig.1) requires

- Switches and MSC should be replaced by IP-Routers
- In All-IP-networks network concept, alll applications and services must be implemented in one IP-network
- A New network architectures to support All- IP and for Interconnection.
- New signaling and interfaces need to defined within and between the networks
- New network structures to provide more centralized networks functions
- To define new and more differentiated management of quality of service for differentiated services

In NGN network, most relevant areas which requires for NGN implementation are

1. *Interconnection*: In order to implement NGN for internetwork traffic, the interconnection needs to be migrated to NGN. In NGN, the Coordination of the implementation of interconnection required (1) Definition of interfaces and architectures for interconnection, (2) Interconnection structure (PoI) (3) Development of interconnection offers for NGN and (4) Adapt the charging regime

2. *Quality of service regulation:* All-IP networks with multiple services sharing one network has implications on quality of service issues Coordination within the industry needed to guarantee end-to-end quality of service. The issue of quality of service is relevant for Retail services and Interconnection

3. *Licensing issues*: Licensing regime established for current ecosystem might have to be adapted to NGN. The issuing of service specific or access specific licenses vs. one network for multiple services Need for unified licenses Modification of ISP licenses required, e.g. with regard to internet telephony restrictions.

1.2. Interconnection Architectures

The User Network Interface (UNI) connects terminal equipment, user networks and corporate networks to the NGN (Fig.2). The Network Network Interface (NNI) is used to provide connectivity to other NGN, other IP-based networks and PSTN/ISDN. The NNI supports both a control level type of interaction and a media level type of interaction. Transport interconnection: The border gateways of two NGN networks are interconnected. Control interconnection: This interface interconnects the service control functions of both networks. The Application Network Interface (ANI) is an interface which provides a channel for interactions and exchanges between an NGN and exchanges between an NGN and other service providers (such as a content provider). The SNI supports both a control plane level type of interaction and a media level (or data plane) type of interaction.

1.3. Routing and roaming in NGN

Routing is nothing but the process of collecting and distributing topology-related information, calculating the routes, establishing and maintaining the routing table in the network. Routing in the IP-based networks is determined by information

in the individual routers. In routing between networks, routing information is advertised with the border gateway protocol (BGP). In traditional networks, routing is performed within a network. If it is determined, that a specific address is not within the network the connection is routed to an appropriate point of interconnection. Routing might also involve overflow or traffic management mechanisms that take care of outages or congestion in the network. According to GSM specifications calls towards a roaming subscriber are routed via the home network. Home network only will determine the charge for the roaming leg. Calls by a subscriber are routed directly to the destination without using the home network; the visited operator records the CDR and sends them to the home network via the so called transferred account procedure (TAP), which is specified by the GSMA. Mobile internet usage by roaming subscribers is routed to the home network in all cases and the home network controls the access to the internet. Routing and roaming in next generation networks will use IP mechanisms. It is expected that operators will maintain their influence on roaming traffic and will be included in the call path to roaming subscribers. The solution for the routing and exchange of this information is included in the IMS specifications. In an NGN routing of the media stream is decoupled from the routing of control information. Control information is processed by the MGC and can be centralized.

1.4. Quality of Service

Contrary to PSTN, there is no standardized QoS in NGN networks; but End-to-End requirements for QoS exist. Usually QoS for the Internet is "Best Effort" (BE) and only if it necessary, Network upgrade will be done to improve the QoS and this decision will be taken only by the operators. Network always uses traffic thresholds, e.g. if busy-hour, network traffic average reaches 80% of network capacity and there will be Strong variation of service quality. In this no end-to-end QoS is archived and it is acceptable only for data services, but not for other services. If all services are to be migrated to NGN (i.e. IP), networks must be upgraded to support the End-to-End QoS (Fig.3). Some of the Options for network upgrades are:

- Keeping BE, NGN need to Provide sufficient transmission capacities which are more expensive (over-engineering)
- Implementation QoS for NGN requires common standards
- Include legacy networks (MPLS) Quality of Service will be a major concern for NGN.

Quality of Service will be a major concern for NGN since it is very complex to define QoS for user application with diverse performance needs. Effective management of resource contention is an important aspect of NGN's QoS support. The Resource and Admission Control Functions (RACF) is the NGN Subsystem, which is responsible for elements of admission control, policy control and resource reservation. In addition, it also supports core Border Gateway Services (BGS) including Network Address Translator (NAT) mechanisms. The Resource and Admission Control Service RACS provides policy based transport control services to applications. This enables the request and reservation of transport resources from access and core transport networks within its coverage include points of interconnection between them in order to support e2e QoS.

1. *Admission Control*: RACS implements Admission Control to the access and aggregation segment of the network.
2. *Resource reservation*: RACS implements a resource reservation mechanism that permits applications to request bearer resources in the aggregation, access and core networks.
3. *Policy Control*: RACS uses service based local policies to determine how to support requests from applications for transport resources.

Different QoS Parameters defined for the NGN will be classified into i) Network Centric Parameters, ii) Customer Centric Parameters and iii) Service Centric Parameters. Bandwidth, Delay, Jitter and Packet loss will be considered for Network Centric Parameters and Customer satisfaction, Provision of service and Network availability will be considered for Customer Centric Parameters. For Service Centric Parameters, PoI congestion, Grade of Service, and Focus on the delivered quality of specific services are considered.

1.5. Standardization of Service Classes (ITU)

ITU Y.1541 defines the QoS classes that quantify user application needs in terms of IP network performance. It describes the traffic control and congestion control procedures for IP-based networks and also enables support services with quality of service (QoS), where the QoS is negotiated between a user and the network. ITU Y.1221, which defines "traffic contracts" that complement the QoS classes by describing flow characteristics/limits. The traffic contract defines conditions under which specified QoS levels can be met and it includes IP transfer capability (dedicated bandwidth, statistical bandwidth or best effort) and traffic descriptor (maximum packet size and token bucket). These two recommendations include the basic parameters required for signalling between networks in order to achieve end-to-end QoS. Service specific QoS parameters safeguard the quality of TDM networks, and can be used for implementation of these services in NGN networks. Table 1 summarizes the QoS service classes defined for NGN by ITU.

Table 1 Standardization of Service Classes (ITU)

QoS class	Applications (examples)	Node mechanisms	Network techniques
0	Real-time, jitter sensitive, high interaction (VoIP, VTC)	Separate queue with preferential servicing, traffic grooming	Constrained routing and distances
1	Real time jitter sensitive interactive (VoIP, VTC).		Less constrained routing and distances
2	Transaction data, highly interactive (Signalling)	Separate queue, drop priority	Constrained routing and distance
3	Transaction data, interactive		Less constrained routing and distances
4	Low loss only (short transactions, bulk data, video streaming)	Long queue, drop priority	Any route/path
5	Traditional applications of default IP networks	Any route/path Separate queue (lowest priority)	Separate queue (lowest priority) Any route/path

2. SURVEY ON NETWORK TRAFFIC IN NGN

The Internet is growing rapidly and its growth has been steady and successful in the wired networks over the past several years. Hence, the traffic in computer network become unavoidable problem. The problems of network traffic become major critical issue for the past few decades. In October 1986, network had a series of congestion collapses, the data throughput from Lawrence Berkley Lab to University of California, sites separated by only two intermediate hops, dropped from 32 kbps to 40 bps, i.e., 99.88% packet drop (Jacobson, 1995). Due to this incident, the traffic management in computer network becomes a critical problem in data communication. Several research efforts have proposed different approaches for traffic management problems, each one has its own strengths and limitations but optimality not yet achieved. The above particular network is a wired network, but the present network era is integrated with wired; wireless – both infrastructure and adhoc; sensory network; and in some time with wireless sensor network. This type of complicated heterogeneous network provides user satisfaction in many ways such that the improved type of services, applicability even in emergency environment but the reliability due to network traffic is still in question mark. Table 2 shows the average response time and the average packet

Table 2 Continent wise Average Response Time and Average Packet Loss (Network Traffic)

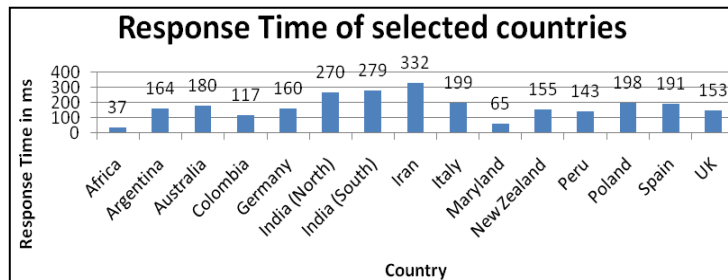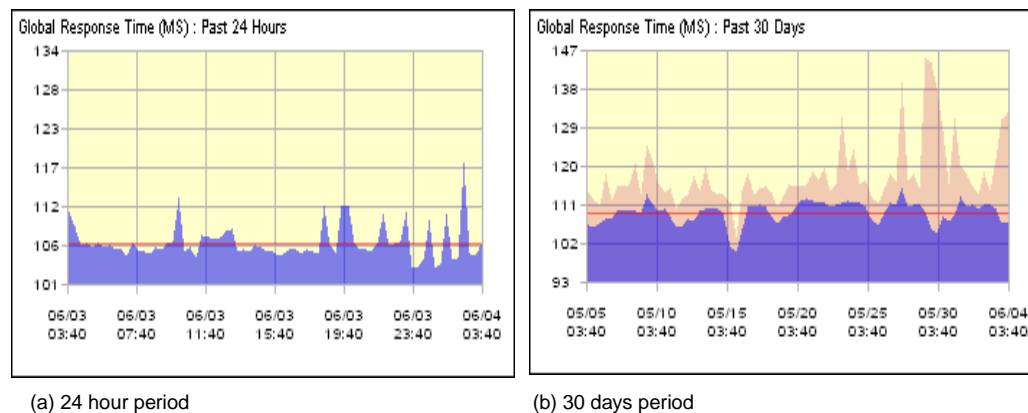| Continent	04-06-2011 at 04.10PM	
	Average Response Time (in ms)	Average Packet Loss (%)
Asia	475	33%
Australia	158	0%
Europe	180	5%
North America	204	18%
South America	138	0%

Figure 4
Country Wise Average Response Time

loss of each continent recorded on 27th January of 2008 at 8:00PM and 4th June 2011 at 03.40AM (Network Traffic), (Fig.4). It is obvious from these experimental results that the average packet loss reaches up to 33%. When considered to response time, less than 150ms is an appreciate value for data communication, but most of the continents have more than 150ms, especially in Australia, even though the packet loss is 0% the response time is above 150ms.

Figs. 5 and 6, show the in depth study on the average response time and average packet loss recorded in 4th June 2011 at 04.10 AM. In which Fig. 5 displays the response time of some of selected countries. From Fig. 5, in most of the countries, the response time is above 150ms. The appreciable value of response time for an effective data communication is 150ms and for effective voice and video communication is 100ms. For a more

(a) 24 hour period

(b) 30 days period

Figure 5
Global Response Time

(a) 24 hour period

(b) 30 days period

Figure 6
Global Packet Losses

detailed study on response time and packet loss, the data on 24 hour period and 30 days period also recorded which is shown in Figs. 5 and 6. Figs 5 and 6 show the global response time and global packet losses. Fig. 5(a) and 6(a) show the global response time and the global packet losses respectively in the 24 hours period starts from 03-06-2011 03.40PM to 04-06-2011 03.40PM. Figure 5(b) and 6(b), show the global response time and the global packet losses respectively in the 30 day period starting from 05-05-2011 03.40PM to 04-06-2011 03.40PM. From these figures, the average global response time, which is shown in red, is an apt value for data communication and an inappropriate value for media communication. And the global packet losses are also inappropriate value which is always above 15%. In the detailed report, the maximum data is shown in red and average data is shown in burble.
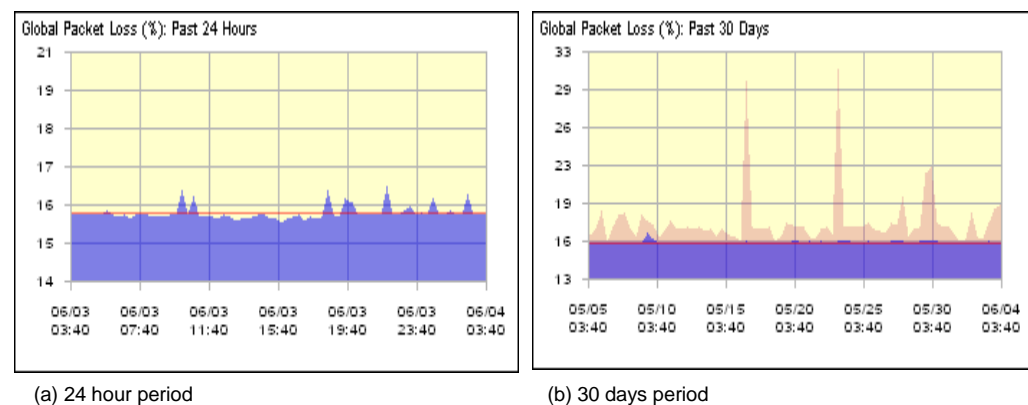
3. FLOW CONTROL MECHANISM FOR NGN

Wireless communication has many segments such as Infra-structure based Wireless communication, Adhoc Wireless communication; Satellite based Wireless communication, and Wireless Local Area Network (Gazis et al. 2005; Surachai et al. 2010). Adhoc Network is applied wide spread across the world in many different applications, which include all major engineering systems. The cellular communication which is a part of wireless communication following infra-structure based networking.   The cellular has introduced the packet switching in addition to circuit switching in the Second Generation (2G) and it extends the features such as MMS in the 2.5G, Video Conferencing in 3G and IP networking in the 4G. It is in progress to extend its capability through the 5G, it is also termed as Next Generation Network (NGN). Now the Internet access through the cellular communication has increased rapidly over the last few years. It is because the flexibility in the handling, mobility, reduced installation time, comparatively lower initial cost and nil maintenance cost on the user perception. International Telecommunication Union - Telecommunication Standardization Sector Study Group 13 defines an NGN in Recommendation Y.2001 (ITU-T Recommendation1 – 4; Lee and Knight, 2005) as "A packet-based network able to provide telecommunication services and able to make use of multiple broadband, Quality of Service (QoS) enabled transport technologies, and in which service-related functions are independent from underlying transport-related technologies. It enables unfettered access for

users to networks and to competing service providers and/or services of their choice. It supports generalized mobility which will allow consistent and ubiquitous provision of services to users".

In essence, the proposed work paying attention to provide reliable communication for NGN by opting transmission control protocol. Additive-Increase-Multiplicative-Decrease (AIMD) congestion control algorithm employed by TCP is known to be ill-suited for cellular networks. With rapid advances in the deployment of very high bandwidth links in the Internet, the need for a viable replacement of TCP in such environments has become increasingly important. Several research efforts have proposed different approaches for this problem, each with their own strengths and limitations. These can be broadly classified into two categories: end-to-end and network feedback based approaches. Pure end-to-end congestion control schemes such as High Speed TCP (HSTCP) for large congestion window (Floyd, 2003), TCP-RENO with fast recovery algorithm, FAST TCP (Jin et al, 2004). The end-to-end protocols are attractive short-term solutions as they has a lesser deployment barrier whereas which not be suitable for the long term deployment. There are many pitfalls in end-to-end category in the view of congestion control purpose, for ex., the end-to-end schemes artificially introduce packet loss or queuing delay at bottleneck routers. This should be avoided, otherwise, it incurs undesirable effects such as periodical increase in end-to-end delay, which makes real-time applications like VoIP and video conferencing very hard to work well in the Internet. To address the limitations of end-to-end congestion control schemes, many researchers have proposed the use of *explicit* network feedback. However, while traditional *congestion notification* schemes such as Active Queue Management (AQM) and Explicit Congestion Notification (ECN) proposals are successful in reducing the loss rate and the queue size in the network, they still fall short in achieving high utilization in high bandwidth networks.

4. CONCLUSION

Several standardization bodies introduced QoS control architectures and flow control mechanism for NGN, including RACF by ITU-T, RACS by ETSI/ TISPAN, and the IP transport plane of IMS by 3GPP. These QoS control standards are mainly employed in the transport stratum of NGN for resource control and admission. In this paper, these standards were surveyed and compared in terms of QoS coverage and the number of required signalling messages. We also surveyed several recent papers which aim at strengthening present QoS control standards for adaptive QoS modification with respect to users' QoS change and QoS continuity for mobile users and the flow control mechanisms in the NGN. Despite exiting standards and recently published papers, the QoS control and the flow control mechanisms in NGN still requires further improvements. Examples presented in this paper illustrate trends in migration of traditional network to NGN. Now, many carriers in the world build or upgrade their networks to meet requirements imposed by new broadband multimedia and VoIP services. In This paper, network traffic flow analysis based flow control management with QoS conciliation is studied and it reviews the key aspects of end-to-end and network feedback based approaches and pure end-to-end congestion control schemes such as High Speed TCP (HSTCP) for large congestion window. Several objectives like achieving high end user utility for video services, considering the unicast as well as multicast proprieties to meet interclass fairness, and trying to achieve the high QoS requirement by adaptively adjusting the thresholds based on the traffic situations are reviewed.

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