Congestion Control and Traffic Management of Asynchronous Transfer Mode

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Abstract:
The bursty nature of traffic in Asynchronous Transfer Mode (ATM) networks can be problematic and thus requires efficient traffic management scheme to improve quality of service (QOS). The aim of controlling traffic is to safeguard the equipment at the receiving end and other elements in the network like routers, switches etc from congestion. Effective traffic management results in a more predictable network, resource utilization and enhancement of quality of service. This paper investigates traffic management in ATM networks for curbing congestion and introduces the traffic simulator model while focusing on CISCO extension to the traffic model for managing virtual ATM connections.

Keywords: ATM, B-ISDN, CISCO, TRAFFIC, CONGESTION CONTROL, QOS.

I. INTRODUCTION

The simplification of user access and optimization of resource utilization is maximized by the synthesis of various services provided by different networks in a specific network. The first approach to such an integration resulted in Narrowband Integrated Service Digital Networks (N-ISDNs) which were not providing the much needed broadband services required and this led to the development of Broadband-Integrated Service Digital Networks (B-ISDNs) to better handle broadband services. Asynchronous Transfer Mode (ATM) was maintained by the International Telecommunication Union; Telecommunication standardization sector (ITU-T) as the choice transfer mode for B-ISDNs [1] [2]. In the view of a broadband network as resources supporting a set of services, the aim of its designer will be to maximize resource usage by ensuring the requested quality of service is delivered to every user and practically this implies sharing of the resources amongst users. We know how this ends subsequently, because in an event where many users require a particular service at the same time, congestion is likely to occur. That state of the network in which it’s not able to meet the QOS of the users is termed congestion. In the event of congestion, traffic management is required to decongest the network and meet the QOS requirements of users. It should be noted that classical traffic control architectures are not well suited to ATM networks [2] [3].

II. B-ISDN CONGESTION CONTROL TECHNIQUE

The congestion control technique of B-ISDN contrasted with that of packet and circuit switching requires more attention, since it is an integration of various networks and contains signals such as images, video, multimedia etc. congestion can adversely affect B-ISDN’s performance as a result of its high transmission speed [5][6]. Expertly managing the network resource to curb congestion by confining traffic flow and introducing some preventive measures was proposed by ITU-T to effectively manage congestion on B-ISDN. The primary notion of the technique shows that by the introduction of preventive measures, constraining traffic flow and expertly managing network resources to curb congestion, or adopt congestion control measures in the event of congestion, the B-ISDN network can be efficient. Congestion control systems can be classified into two main levels, the preventive level also called flow control measures by ITU-T and the reactive level also called congestion control. The flow control measures include Use Parameter Control (UPC), Priority Control (PC), Network Resource Management (NRM), etc. The reactive measures are set to eliminate congestion or reduce them as soon as they occur, like congestion indication mechanisms etc. Congestion control of ATM networks should in cooperate flow control and congestion control mechanisms. congestion control architecture of ATM network is shown:

Figure 1. Congestion control technique of ATM networks
III. TRAFFIC MANAGEMENT OF ATM

Managing ATM traffic is very essential to ensuring QOS delivery, since user node traffic can be excessive during congestion which usually results in overflowing memory buffers of switches, causing loss of data. Efficient congestion control systems are essential for proper functioning of ATM networks. Traffic management of ATM networks comprises of methods for congestion control and prevention and can be subdivided into Traffic Control which has to do with measures taken to prevent the occurrence of congestion by keeping optimal, network resources utilization. Congestion Control measure is used after the occurrence of congestion [6] [7]. Traffic management in ATM networks has two basic components: call admission control and congestion control. The call admission control policy controls new traffic coming into the network while the congestion control policy deals with the existing traffic sources which are already admitted into the network. Two fundamental components of managing traffic in ATM networks are the call admission control (CAC) and congestion control (CC). CAC admits fresh traffic when available bandwidth is enough otherwise it is rejected. CC controls traffic by checking the sources to ensure that excessive traffic is not permitted in the network.

Figure 2. Traffic management functions in an ATM switch

Outlined are some functions for controlling traffic, proposed by the ATM Forum for the sustenance of QOS in ATM networks [8][12].

These functions can be utilized in suitable configurations and compose a scheme which manages and controls traffic congestion in ATM networks. They are as follows:

a) Connection Admission Control (CAC): which involves the actions (including call routing) carried out by the network in the call setup section to ascertain if a virtual channel path call connection request can be allowed or stopped.

b) Usage Parameter Control (UPC): this also has to do with actions carried out by the network to regulate and control ATM traffic in terms of the ATM validity and offered traffic. The UPC’s major aim is to defend the network against unintended malfunction which can jeopardize the QOS of connection already in place.

c) Priority Control: through the use of cell loss priority bit for some categories of services, end-user systems can produce varying priority traffic flows. As much as possible, network cell with high priority are given much preference by network elements which may end up rejecting low priority cells to enhance network performance.

d) Network Resource Management (NRM): the allocation of network resources for dividing the flow of traffic due to their service characteristics is done by provisioning the network. Virtual paths/routes are essential for resource management [8].

e) Traffic Shaping: the systems for traffic shaping can be utilized in providing required enhancement of traffic features.

f) Feedback Controls: the set of activities carried out by the end systems and the network to control the traffic on ATM network connections due to the present condition of network elements are referred to as feedback controls.

IV. TRAFFIC MODEL OF AN ATM NETWORK

The cell production manner of an ATM traffic simulator is described which shows the manner in which an end user/subscriber uses the network. When the user begins making a call, many messages are produced and are divided into ATM cells of fixed length. These messages turn-up as burst’s of cells to an ATM switch after which a silent period which is the interarrival period of the message before another message signal is sent in as a different burst of cells. This process keeps on repeating until call is complete, after which the user goes off for some time before starting another call. Because of the memory less attribute of the inter arrival times between successive bursts, the characteristics of an ongoing call can be depicted as a two-state Markov Process [9][10]. The figure below shows the ATM Traffic simulator model;
The ATM traffic simulator model exemplifies the ON-OFF Markov process phase changing diagram for an ongoing calling time which the end user transits the OFF/ON phase with some kind of probabilities. In the On state, it remains steady with $1-\beta D$ probability while producing cells for the ongoing message. In a situation when it is in the off state, it stays steady in this state with $1-\alpha D$ probability or could turn to the off state with a probability $\alpha D$. The probability $\beta D$ enables the end user switch to the off state. From the described model, the end user starts a burst with $\alpha D$ probability characterized by an exponential distribution and terminates a burst with $\beta D$ which is characterized by a geometric distribution in a specific cell period. Where:

$$D = \text{cell duration in seconds}$$

While average burst duration, $d$ can be calculated with standard geometric series as

$$d = \frac{1}{\alpha D}$$

(1)

The traffic model also describes the characteristic behavior of the end user during call. The generation of the calls is through a Poisson arrival process and the period of inactivity between consecutive calls follows an exponential distribution [8].

V. EXTENSION OF ATM TRAFFIC MODEL TO CISCO

Cisco ATM switch resource management MIB (Management information base) was made to effectively manage switching resources like ATM interfaces, memory cell buffers etc. The diagrammatic structure if Cisco MIB is shown below. Two groups in the MIB are designed to control an LS1010 ATM switch. General resource control configuration information is made available by the switch configuration group, these resource management information includes available bit rate (ABR) closed loop control mechanisms. Furthermore, the primary QOS targets for service categories like constant bit rate (CBR), real time variable bit rate (rt-VBR) and non real time variable bit rate (nrt-VBR) can also be configured in this group. The major targets of QOS include maximum cell transfer delay, peak-to-peak cell delay variation etc. The switch shared memory group was made to control resources for the shared memory algorithm used in LS1010. Four varying delay classes of service are supported by the switch each having dual loss priority classes. Delay can be minimized in the network for guaranteed service of real time traffic if the class-based priority scheduling architecture is utilized [7] [9].

VI. CONCLUSION

Through traffic management and control of ATM network, already negotiated QOS is guaranteed for the subscriber. The CISCO extension of the traffic management and congestion control takes into account virtual connections of the ATM network. We therefore conclude by saying that a single
congestion control mechanism cannot be optimal for serving the needs of all connections in an ATM network, due to the heterogeneous nature of traffic sources and requirements for service in ATM networks.

VII. REFERENCES


