Critical Assessment of Association Admission Manage Methods in ATM Networks

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Abstract- CAC establishes, modifies and terminates virtual ath/channel connections. More specifically, it is responsible for high-layer signaling protocols ,signaling ATM Adaptation Layer (AAL) functions to interpret or generate signaling cells ,interface with a signaling network ,negotiation of traffic contracts with users requesting new VPCs/VCCs ,renegotiation with users to change established VPCs/VCCs ,allocation of switch resources for VPCs/VCCs, including route selection ,admission/rejection decisions for requested VPCs/VCCs ,generation of UPC/NPC parameters .If the CAC is centralized, a single processing unit would receives signaling cells from the input modules, interpret them, and perform admission decisions and resource allocation decisions for all the connections in the switch. CAC functions may be distributed to blocks of input modules where each CAC has a smaller number of input ports. This is much harder to implement, but solves the connection control processing bottleneck problem for large switch sizes, by dividing this job to be performed by parallel CACs. A lot of information must be communicated and coordinated among the various CACs . In Hitachi's and NEC's ATM switches, input modules - each with its CAC - also contain a small ATM routing fabric. Some of the distributed CAC functions can also be distributed among output modules which can handle encapsulation of high-layer control information into outgoing signaling cells.

Keywords- CAC, Qos, Services

INTRODUCTION

Connection Admission Control is defined as the set of actions taken by the network during the call set-up phase (or during call re-negotiation phase) in order to determine whether a connection request can be accepted or should be rejected (or whether a request for re-allocation can be accommodated).*Admission control*, in the most primitive sense, is the simple practice of discriminating which traffic is admitted into a network in the first place. Admission control can be thought of as controlling what type of traffic is allowed to enter or transit a network. Admission control schemes therefore need to be implemented at the network edges to control the traffic entering the network. An application that wishes to use the network to transport traffic must first request a connection, which involves informing the network about the characteristics of the traffic and the Quality of Service (QOS) required by the application. This information in stored in a traffic contract. The network judges whether it has enough resources available to accept the connection, and then either accepts or rejects the connection request. This is known as Admission Control. Admission Control in ATM networks is known as Connection Admission Control (CAC). CAC can only exist in a connection oriented network.

A connection request for a given call can only be accepted if sufficient network resources are available to establish the end-to-end connection maintaining its required quality of service and not affecting the quality of service of existing connections in the network by this new connection. The role of CAC is to decide whether there are sufficient free resources on the requested link to allow a new connection . A connection can only be accepted if sufficient resources are available to establish the connection end-to-end with its required quality of service. The agreed quality of service of existing connections in the network must not be affected by the new connection .If the network has the required resources, the CAC may allow a connection request to proceed; if not, the CAC will indicate this and notify the originator of the request that the request has been refused .When a connection is requested by an application, the application indicates to the network ,type of service required ,traffic parameters of each data flow in both directions (a set of parameters describing the source traffic characteristics) and quality of service parameters requested in each direction The CAC uses this information to determine the required quality of service of the connection, and determines whether it has sufficient resources to accept the requested connection based on the current network status. The CAC technique can be well understood by the following figure.

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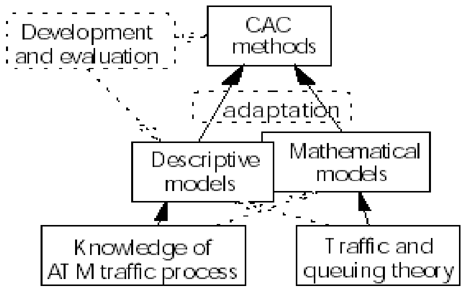

Figure1.

STRATEGY OF CAC FOR DIFFERENT SERVICES

The strategy employed by CAC varies according to the type of service, and in the case of VBR, ABR, and UBR services, becomes a complex issue and is still the subject of intensive research. The policy for each connection type depends on the stochastic nature of the service. The following gives a brief indication of policies for each connection type.

A. CIRCUIT SWITCHED CONNECTION

In this case, the request for a connection, if granted, results in a link connection being allocated to the connection. In principle, a resource manager can be completely non-discriminatory in its allocation of free capacity to connection requests as they will all have the same effect on the state of the resource. There may, however, be some circumstances where CAC may refuse a new connection even when there is sufficient capacity for the connection. For example, circuits could be designated as low priority or high priority, and the CAC may choose to accept a high-priority connection while refusing a lower priority. In refusing the lower priority connection, it is effectively reserving the remaining capacity on the resource for high-priority connections. Prioritization becomes important in service restoration after a failure where the resources become scarce and some connections must be dropped.

B. CBR CONNECTIONS

While the principles of CAC are basically similar to those for circuit-switched connections, CAC is more likely to be discriminatory in CBR connections. As the connections can have different bandwidths, they will have different impacts on the remaining capacity within the link. For example, CAC for CBR connections could employ a strategy of only accepting connections that take less than half of the remaining capacity. With such a strategy, some connections will be refused even if there is capacity available to resource the connection. This makes good commercial sense if several smaller connections are worth more than the single connection of large capacity.

C. VBR CONNECTION

With VBR connections, the CAC is not only making decision about the nature of future connection requests, but is also having to make a decision on the future behaviour of the connections it has already accepted onto the link based on the VBR parameters. This is based on statistical assessment as to whether accepting the new connection will take the likelihood of cell loss for the current traffic beyond acceptable limits.

D. ABR CONNECTION

The role of CAC in ABR services depends on the ABR strategy employed. The use of the resource management protocol allows for the use of CAC; however, it is quite possible to use a policy of accepting all connections and simply regulating the rate of all the connections on the resource to ensure the resource does not become overloaded.

E. UBR CONNECTION

The role of CAC in basic UBR connections is similar to that in VBR connections in that it must decide according to the requested peak cell rate on whether to admit the connection.

RELATED WORK

[3] says that Connection admission control (CAC) is a common traffic management technique used in asynchronous transfer mode (ATM) networks to provide quality of service (QoS) guarantees. We describe the requirements of CAC algorithms, and present an overview of existing CAC models. Then, we introduce a real-time adaptation of the extended Gibbens-Hunt (EGH) CAC method proposed in 1993 and compare its performance against other competing strategies using the Buffet and Duffield (1993) bound as a reference. Our results show that the EGH is a superior CAC technique that guarantees the QoS while offering the highest link utilization possible. The EGH is the CAC algorithm of choice for Nortel Magellan Passport and Concorde ATM switches.

MODEL

Following are the different techniques of CAC:

1. PARAMETER-BASED CAC

The parameter-based admission control uses the user specified flow characteristics in new connection request to decide whether the network has the required resources to accommodate the new connection. The algorithm can be analyzed by formal methods. There are two types of parameter-based admission control algorithms

A. NON-STATISTICAL

This is the simplest form among all CAC algorithms, which is also called Peak Bandwidth Allocation. It uses only the knowledge of the PCR parameter to compare against the network available bandwidth and decide whether to accept the new connection request or not. The algorithm ensures that the sum of requested resources and existing connections is bounded by the physical link capacity. The disadvantage of this type of CAC is that there is no multiplexing gain among the sessions admitted into the network. Because there are no lost data cells and the computation cost is extremely low, this algorithm has been widely implemented by ATM switch and router vendors.

B. STATISTICAL

This is a group of much more complicated form of CAC algorithms. It does not admit new connection requests on the basis of their peak cell rates; rather, the allocated bandwidth is between the peak cell rate and the sustained cell rate. As a result, the sum of all the admitted connections' peak cell rates may be greater than the outgoing link capacity. Statistical allocation makes more economic sense when dealing with bursty traffic. However, because of the potential of network congestion, it is much more difficult to be carried out effectively .Another problem of deciding whether to accept a new connection request is to formulate the problem as a queueing system. The CAC is modeled into that whether QoS will still be maintained if the new connection is admitted, provided that the QoSs of the existing connections are satisfied. This queueing problem is sometimes also known as ATM multiplexer.The measurement-based CAC algorithms use network measurement to estimate current load of existing traffic, instead of computing the traffic characteristics out of the user specified connection's parameters. It has no prior knowledge of the traffic statistics and makes admission decisions based on the current network state only .Because source behavior is not static in general, service commitments made by such measurement-based CAC algorithms can never be absolute, hence can only be used in the context of service models that do not make guaranteed commitments, like those in controlled load service model.

2. BANDWIDTH AND BUFFER CHARACTERIZATION BASED CAC

In the Bandwidth and Buffer Characterization-based CAC, each session connection is defined by (s , r), where s and r represent buffer space and transmission bandwidth allocated for the session at each switching node along the route, respectively. The CAC scheme guarantees the connection QoS that is based on per-session bandwidth and buffer characteristics, and derives a tight probabilistic bound on per-session end-to-end average cell loss rate, which may be caused by either buffer overflow in the route or excessive delay at the destination. This scheme has a great flexibility in connection management because both bandwidth and buffer resources can be adaptively allocated among new and existing sessions according to the availability of present network resources. In such a CAC scheme, reduction of buffer space can be achieved by increasing of transmission bandwidth, and vice versa, as long as the QoS is not violated. A remarkable feature of the bounding solutions is that they are solely determined by the probabilistic characterization of each session itself, independent of the network environment and other connections . The focus of this CAC is on performance mainly measured by end-to-end cell delay and cell loss ratio. It also plays an important role in resolving the so-called network resource fragmentation, i.e., when a new session can not be accepted because of resource fragmentation, the network can selectively re-negotiate the connection parameters of on-going sessions to "create" resources for the new session. With this CAC scheme, one can always trade more buffer resource s for less bandwidth r because the shared buffer space will not be significantly increased by individual s . Such a grouping has the same effect of statistical multiplexing on bandwidth efficiency. Once network resources are allocated to each session according to its characterization one can probabilistically bound per-session and end-to-end loss performance.

3. DYNAMIC CAC

It is of two types:

A. VIRTUAL CIRCUIT LEVEL CAC

A conventional CAC scheme is based on a particular arrival process model, that classifies connection requests into a set of call classes, each of which were pre-calculated using traffic parameters specified by the user and stored in some lookup table. This conventional CAC scheme has difficulties of managing the lookup table, classifying the wide range of traffic characteristics of the ATM network into a reasonable number of class groups, and verifying the fitness of the existing model to other arrival processes'. In addition, there remain problems about policing mechanisms in actual situations, and tight and strict policing in practice is not expected. To overcome the problems mentioned above, new dynamic CAC algorithm, using the measured number of cells arriving during a fixed interval, are independent of the classification of calls, the number of call classes, and the arrival process modeling. The new schemes estimate the distribution of the number of arriving cells with a renewal mechanism called exponential forecasting. The control is effective when the number of call classes is large, since the conventional approach is difficult to implement in such a case. The control also uses traffic parameters specified by users, and the estimated distribution of the number of arriving cells is improved by measurement. Therefore, this control can achieve higher utilization than a control that only uses traffic parameters, and can cope with excessive flow from an individual source. In other words, this control can tolerate loose bandwidth enforcement.

B. VIRTUAL PATH LEVEL CAC

Another dynamic CAC is a virtual path (VP) level bandwidth allocation algorithm based on application of optimal control theory to a fluid flow model of a generic VP. The fluid flow model describes the VP's mean behavior and serves as a state variable model. This scheme is a multilevel optimal control theoretical approach that is used in conjunction with the state model to derive a coordinated decentralized algorithm for virtual path bandwidth allocation. It dynamically shares bandwidth based on feedback of state information, and allocates bandwidth economically while maintaining low loss and delay by allowing a tradeoff between different objectives .Using the flow conservation principle, for a single queue and assuming no losses, the rate of change of the average number of cells queued at the link buffer can be related to the rate of cell arrivals and departures by a differential equation of the form. The size and complexity of the network make dynamic bandwidth allocation difficult to implement, unless a structured approach is adopted which can represent dynamic behavior, and also decompose into smaller sub-problems, with some suitable treatment of localized and global objectives. Using this concept the allocated bandwidth depends on local network state, so the control loop has local autonomy. A solution based on this type of algorithm appears to offer a greater computational advantage as compared with the single level solution. It offers fast local control using feedback from the network queues and slow coordination. This scheme is able to adapt to non-stationary traffic patterns, and hence it is expected to be robust to network malfunctions.

4. POWER SPECTRAL DENESITY (PSD) NEURAL NET CAC

The PSD CAC scheme focuses on the Fourier transform of the auto-correlation function of the input processes. It is an analysis in frequency domain, in stead of in time domain as most CAC schemes are. This CAC function captures the correlation and the burstiness features of the input processes in time domain. It is known that the low-frequency band of input PSD has a dominant impact on queueing performance and the high-frequency band can be neglected to a large extent, because the low frequency component of PSD contains the correlation component. The more the low frequency component is, the burstier the traffic source will be .Meanwhile, neural networks have been also applied in traffic control problems in ATM networks for their self-learning and adapting capabilities. The self-learning feature of neural networks is utilized to characterize the relationship among the user specified traffic characteristics, QoS requirement of connections and the measured network performance. The results showed that the neural network learned a complicated boundary for making call acceptance decisions. According to power-spectrum parameters of the input process, a decision hyperplane of the connection admission control is constructed under the constraint of QoS . The learning and adapting capabilities of the neural networks are further adopted to adjust the optimum location of the boundary between these two decision spaces, which highly improves the network resource utilization while maintaining QoS contract over the conventional equivalent capacity schemes. Unfortunately, the design of the PSD-based neural-net connection admission controller does not consider system performance parameters such as the queue-length, the change rate of queue length and cell ratio.

5. PRIORITY SUPPORT BASED CAC

In this CAC scheme, QoS is specified in terms of delay, delay jitter and cell loss probability. The CAC scheme manages different performance requirements with two levels of cell loss priority within each channel among the shared media channels. The priorities are assigned and enforced by the network locally on a node by node bases at each switch along the connection path, while taking into account the current traffic load at each node. The use of priorities is to increase the utilization of the network by providing the users with different loss probabilities. The delay and delay-jitter guarantees are provided through the use of a modified framing strategy in which the statistical characteristics of the streams are taken into account, and the bandwidth allocation when the channel is active is performed over a continuous range of values . The algorithm makes efficient use of network resources and maps QoS as close as possible to its traffic requirements. The scheme takes advantage that optimal assignment of priorities is a function of not only the characteristics of the channel itself, but also of the state of the system defined by the statistical characteristics and the QoS requirements of the rest of the channels present in the system . At the same time, the priority assignment is dynamically updated to adapt to the current load at each switch, whenever a new connection is admitted or an existing connection is terminated. Also, a dynamic assignment of the percentage of time devoted to servicing each class in response to changes in the traffic load would lead to increased utilization of the system . When a new connection is requested, the channel is mapped to the class that is closer to the service requirements of the channel, and the CAC calculates the anticipated loss probability to each channel to make appropriate decisions. There are some common drawbacks with traditional Priority CAC. All channels that are mapped in the same class will be treated in the same way, although they might have significantly different service requirements. It does not provide jitter control or guarantees, does not take into account the load of each of the switched the traffic traverses, and cannot adapt to changes in the traffic load of the system. Moreover, admission control may be based on pre-computed look-up tables under the assumption of homogeneous channels. Also the assignment of priorities is usually static for the whole duration of a call and does not take into account the local load of the network at every switch.

6. AGGREGATE EFFECTIVE BANDWIDTH ESTIMATION BASED CAC

The central concept of this scheme is adaptive estimation of the aggregate effective bandwidth required by existing connections on each network link. In order to take advantage of all available information, the estimation process takes into account both the traffic source parameter declarations and the connection superposition process measurements. It overcomes the main inconvenience with the effective bandwidth allocation when the QoS can be guaranteed only if the real source parameters conform to the source declarations or if the source declaration parameters can be enforced by a policing mechanism. There is a bandwidth reserved for the estimation error that provides that the source parameter declarations can be more relaxed and that the source policing can be less stringent. The key element of this approach is incorporation of a measurement process that allows to correct the initial bandwidth allocation based on declarations and to adapt to non-stationary changes in the cell process. The estimated effective bandwidth adapts very well to the real effective bandwidth even under very stressful and non-stationary conditions. The estimation algorithm evaluates the aggregate effective bandwidth required of the already admitted connections. The gain from statistical multiplexing of bursty sources is taken into account so that bandwidth allocated to a connection is between the peak rate and the average rate of the connection. There are two drawbacks of this approach. Firstly, since there is no perfect mechanisms which could police statistical parameters, the effective bandwidth based on policing parameters can be significantly higher than the one based on source declarations. Secondly, in many cases the source cannot predict its statistical parameters well so this approach can force source to declare overestimated parameters that will reduce bandwidth utilization Final The central concept of this scheme is adaptive estimation of the aggregate effective bandwidth required by existing connections on each network link. In order to take advantage of all available information, the estimation process takes into account both the traffic source parameter declarations and the connection superposition process measurements. It overcomes the main inconvenience with the effective bandwidth allocation when the QoS can be guaranteed only if the real source parameters conform to the source declarations or if the source declaration parameters can be enforced by a policing mechanism. There is a bandwidth reserved for the estimation error that provides that the source parameter declarations can be more relaxed and that the source policing can be less stringent. The key element of this approach is incorporation of a measurement process that allows to correct the initial bandwidth allocation based on declarations and to adapt to non-stationary changes in the cell process. The estimated effective bandwidth adapts very well to the real effective bandwidth even under very stressful and non-stationary conditions. The estimation algorithm evaluates the aggregate effective bandwidth required of the already admitted connections. The gain from statistical multiplexing of bursty sources is taken into account so that bandwidth allocated to a connection is between the peak rate and the average rate of the connection.There are two drawbacks of this approach. Firstly, since there is no perfect mechanisms which could police statistical parameters, the effective bandwidth based on policing parameters can be significantly higher than the one based on source declarations. Secondly, in many cases the source cannot predict its statistical parameters well so this approach can force source to declare overestimated parameters that will reduce bandwidth utilization Finally, there are two difficulties when implementing the scheme: firstly, the relation between the effective bandwidth and the parameters that can be measured is in general non-linear. Secondly, although one can find in the literature several models for evaluation of the effective bandwidth, these algorithms, there are two difficulties when implementing the scheme: firstly, the relation between the effective bandwidth and the parameters that can be measured is in general non-linear. Secondly, although one can find in the literature several models for evaluation of the effective bandwidth, these algorithms are relatively complex and do not provide solution to most of the problems.

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