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Optimisation Criteria for Network Design

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Abstract: This paper is based on research of optimisation criteria for network design. Studied in the general section of the research were the problems of design of optimal network topology. The ATM network was used as a network example. COMNET3 simulation program is used for modelling of described research. Practical application of ATM theory will be used for optimising the ATM network topology. New criteria were defined for this optimisation – bit rate standpoint - network reliability standpoint - date delay transmission standpoint - fluctuation of delay standpoint.

Key-Words: - Optimisation, COMNET, ATM, Delay, Bit rate, Reliability, Fluctuation of delay

1 Introduction

We are going to simulate a virtual ATM network and we will use COMNET3 simulation program for this purpose. The simulation consists of different approaches first of them is the optimum design, second is collecting of the most important traffic results, the connection consists of different types of local area networks like Ethernet 10Mbps, Fast Ethernet 100Mbps, Token Passing, ATM PCs , PDH frames E1 through ATM switches, and public ATM network which means a wide area network, and the whole are connected through ATM switches. The simulation will inform us how the traffic exchanging between these networks will looks like, and how the delay looks like when end terminals are exchanging data.

2 Simulation program overview

Simulation program COMNET3 is a comprehensive performance analysis tool for computer and communication networks. Based on a description of a network, its control algorithms and workload, COMNET3 simulates the operation of the network and provides measures of network performance. Network descriptions are created graphically through a highly intuitive interface that speeds model formulation and experimentation.

COMNET3 is integrated into a single windowed package which performs all functions of model design, model execution and presentation of results.

2.1 Simulation program applicability

Simulation program COMNET3 can be used to model both Wide Area Networks and Local Area Networks. Its models may contain both types of facilities in one integrated model. COMNET3 can also provide detailed modeling of network node logic. A node's computers, their I/O subsystems, their databases and the applications, which run on the computers, can all be modeled. By using discrete event simulation

methodology, COMNET3 provides realistic and accurate results.

The network modeling approach used in COMNET3 is designed to accommodate a wide variety of network topologies and routing algorithms. These include:

LAN, WAN and Internetworking systems

a) Circuit, message and packet switching networks

b) Connection oriented and connectionless traffic

c) ISDN

2.2 Simulation program and networks

The goal of COMNET3 is to provide the capability to include any network equipment type in the simulation. The user interface provides flexible interconnection of different devices so that you can describe your network to the system. COMNET3 does not provide a list of every possible device ever built and used in a network, as this would be an impossible task. Rather, it uses generic building blocks, which can be parameterized to represent the devices you want to model.

A telecommunication network is generally a bearer system like a backbone network or a public service network such as an X.25 system. A major concern in the design of inter network systems is the adequacy of data transmission rates offered by the telecommunication network. Computer to computer traffic normally expects to see a high speed LAN.

Voice networks can also be modeled with COMNET3. ISDN can be modeled with COMNET3 and can carry all types of traffic across the bearer network.

2.3 Simulation program system componets

In general a communication node is a point which the network consists from and a collection of nodes makes the term network to be used, in this node processes are started to do some job and this job depending on what the node will provide and what is the purpose of this node, this node can be used to present computers on which applications can be start, or router or ATM node.

The “generic” node used to represent end systems, packet switches, pads, and general network components. The C&C node may originate all types of traffic, route both data and circuit-switched calls, and execute applications. Applications are used to represent a program or subroutine running on the modeled device. A specific application requests the node to execute a user-defined sequence of read, write, processing, transport, session or answer commands. The C&C node is represented in the model as having:

a) An input buffer for each link transmitting packets to it.

b) A process to execute commands, create packets or switch packets.

c) An input buffer for each link to which it can route packets.

d) Local disk storage capacity for modeling local read/write commands.

e) A command list, which details how particular commands, are executed.

f) A pending application list of currently scheduled applications.

g) A prototype application list of available applications at the node.

h) A received message list for saving received messages until they are used.

It is a common requirement to want to model a population of users connected to a network. Rather than

making a node to represent each of them, and then expecting the details of each node to be edited, COMNET3 provides a Computer Group Node, which only has to be defined once to represent a number of end systems.

In many respects, this node is the same as a C&C node. It has largely the same parameters and performance characteristics.

ATM node is aimed at modelling a device, which operates in an asynchronous transfer mode environment. The basic premise is that for an ATM node the internal architecture of the switch is designed to be non-blocking, and that the performance of the switch can be effectively captured via its input and output buffering characteristics. ATM has input and output ports, which has associated buffer sizes and buffer switching times, but no other internal architecture of the node, is modelled.

To model cell transfer systems, where message generators create packets the packet which is created should be made equivalent to a cell.

A router node is aimed at modeling router-based networks in packet-switched environments. The basic premise is that for a router node the performance can be effectively captured via its input and output buffering characteristics and internal switching rate. Performance characteristics arising from internal design architecture, software release numbers, etc., can be aggregated into the switching speed parameters.

Router node has input and output ports which have associated buffer sizes and buffer switching times, and an internal bus for moving packets from port to port.

Those are the commands, which can present at the computer and communication nodes; these commands can be executed in due to message receiving to the application source, which is connected to that node.

An answer message command is used within an application source to send a reply back to the origin of the message, which caused the application to execute. Received message scheduling for an answer message command to return a reply back to the received messages origin must have started the application.

If the application has several message requirements then the reply is sent to the origin of the first message in the requirement list. If the message requirement is a wildcard the reply is sent to whichever node sent the message, which satisfied the message requirement.

A processing command is used within an application to model some processing task on a node. This would be used to represent some major subroutine or software task that has to run on the node. The loading is effectively defined in time duration terms as the node has a cycle time and the processing load is described as the number of cycles to execute.

A setup session command is used within an application to establish a session between the node and some other node in the network. This is useful for modeling switched or permanent virtual circuits, which arise from within applications.

When a setup session command is executed a session setup packet is created and routed to the destination. A session connect packet is then returned to the origin via the same route (assuming connection oriented routing is specified). Messages are then created on an inter arrival pattern, each of which results in packets being transmitted to the destination over the session route. When all of the packets for all of the messages in the session have been received the session is complete.

Responses may be triggered at the destination by the session messages. In this case the response packets will follow the session route back to the origin (assuming connection oriented routing). The session will not be complete until all the message responses have completed.

A transport command is used within an application to send a message between the node and some other node in the network. The inherent routing is on a data-gram basis where each packet is individually routed to the destination. However, it may be that the routing protocols in force mean that each packet in the message is routed over the same path.

A write file command is used within an application to model the time delay associate with writing to a local disk. The disk access times are specified on the node, and the amount of information to written is specified in the Write File command. The time delay to execute the Write can then be computed.

The parameter set of the node is an option for defining different parameters associated with each node type, that means for each node type (C&C, router, computer group node, ATM node) a different parameters can be set due to the purpose of the node. The fields of the parameter set are (application processing, packet processing, port processing, circuit switching, disk storage, file list).

3 Optimisation criteria for network design

For optimisation were designed four criteria

- Bit rate standpoint
- Network reliability standpoint
- Date delay transmission standpoint
- Fluctuation of delay

3.1 Bit rate standpoint

The optimization can be done by the design of permanent virtual channels. On share with Ethernet segments it can be done by reduction of connecting workstations. There is available bandwidth distribution among their users. This optimisation is possible only by bandwidth distribution by existing requirements. Important is also reducing of LAN applications. Higher bandwidth for existing applications can be realised by next LAN router.

3.2 Network reliability standpoint

The architecture of network topology and powerful network management with optimal network elements dislocation a connection are very important. Physical transmission paths must be duplicated for redundant connection. Duplicated paths are more important for higher hierarchy levels than for lower ones. It is necessary to find compromise between transmission devices utilization and transmission bandwidth reserve.

3.3 Date delay transmission standpoint

Maximal time of packet delay in the simulation network for time sensitive applications is down to 1ms. It is very good value. The problem of LAN emulation exists in the simulation environment COMNETIII. For LANE variation when in ATM network is the TSP packet transmitted with maximal size of TCP protocol (1460+40=1500 bytes) is the delay higher than for ATM cells transmission. This difference is accumulated in concentrators, where small ATM cells are blocked in lines.

3.4 Fluctuation of delay

Delay fluctuation standpoint is known as jitter. The packet fluctuation is given by accumulation of date

transmission. Multimedia applications generate continual data stream, which is by packet network transmission converted to bursts clashes. It is given by packet multiplexing in switches or routers from different input connections to one output connection and also by packet waiting in lines. Packet accumulation can make partial limiting of fluctuation influence. This is on the other side paid by packet delay increasing. ATM can take the fluctuation in defined limits by QoS.

We can summarize results of partial simulations and declare, that simulate network is optimized for the multimedia applications. Response of data accumulations representing approximately using to link full capacity was time increasing of packet network transmission with quiet higher packets fluctuation. Limits warrant provide for safe multimedia services.

4 Conclusion

In our problem of simulation the different types of traffic over the ATM network, we first design the topology which is needed, then some parameters must be defined to support the behaviour of the traffic over the network.

After running the simulation we see that the traffic will flow over the network, and the basic characteristics of optimisation are displayed.

For Ethernet the optimisation must be done cause of that the session delay is higher than other types and increasing due to time and with increasing of traffic, the traffic here is bursty and models a virtual connections. For Fast Ethernet the session delay looks better and it is constant during the session's interval, the delay is approximately 2,5 ms, in this type of connection the optimisation is not needed because the results is good and suitable for fast transmission. For sessions with ATM card connected directly to an ATM switch, the delay is very small and constant it is about 5 ms, and high traffic rate was transmitted over it, so no need to optimisation, generally the traffic with ATM end systems are always suitable for high traffic because of the high bandwidth and fast switching. For Token ring it seems better than Ethernet with lower delay about 10 ms.

For optimisation were designed four criteria: Bit rate standpoint, Network reliability standpoint, Date delay transmission standpoint and Fluctuation of delay standpoint.

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