Proceedings of the 1995 Winter Simulation Conference
ed. C. Alexopoulos, K. Kang, W. R. Lilegdon, and D. Goldsman

COMNET III: OBJECT-ORIENTED NETWORK PERFORMANCE PREDICTION

Jeffry Jones

CACI Products Company
1600 Wilson Boulevard
Arlington, VA 22209, U.S.A.

ABSTRACT

COMNET III predicts the performance of communication networks using object-oriented simulation analysis. No programming is required to use the standard package. For situations where a developer wishes to customize or fine-tune some aspect of the standard model, a MODSIM-based object-oriented development environment is provided for overriding the behavior of COMNET III objects. Model builders can add parameterized objects or their own customized objects to object libraries. COMNET III provides an integrated, graphical environment for model creation, execution, and analysis that permits interaction with the model while it executes.

In addition to modelling the operation of a network and its protocols in satisfying demands for data transport, COMNET III also models the scheduling of applications on end systems and the use of processing, storage, and transport resources during application execution. A COMNET III model may consist of hierarchically-defined subnetworks.

1 MODEL ELEMENTS

The network topology is defined by Nodes and Links. Nodes and Links can be organized hierarchically into Subnetworks. Nodes perform processing functions and contain Ports for connecting to Links. Ports provide input and/or output buffering and processing. A Link is a physical transmission facility connecting Ports on two or more Nodes.

There are two types of Nodes: Application Nodes and Communication Nodes. Application Nodes run Applications and can contain Storage Devices for Files. An Application issues a sequence of Requests which are performed by the Node where the Application is scheduled for execution. An Application Node accepts Processing, Read, Write, and Transport Requests. Communication Nodes perform switching and/or routing functions and are used when interconnecting Application Nodes and Subnetworks. Both types of Nodes can serve as sources and sinks for Message and Connection Generators. Figure 1 shows a layout of a simple network in COMNET III.

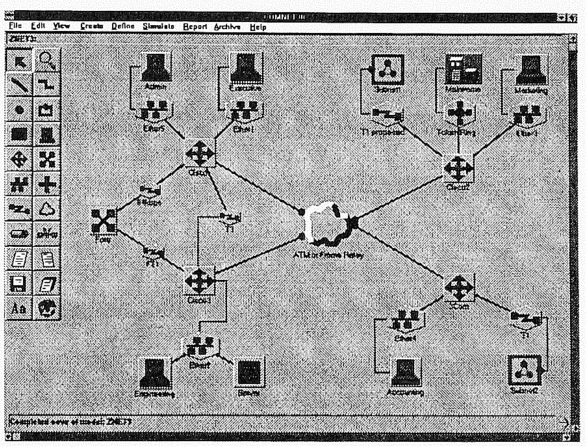

Figure 1: Graphically Select Node, Link, and Generator Objects and Position Them on the Screen with a Mouse

The network workload is produced by Applications running on Application Nodes and by Message and Connection Generators that directly produce demands for data transport. Applications can be scheduled to occur according to an interarrival time distribution or by satisfaction of an incoming Message requirement. Messages originating at a Node are defined by a Message Generator. A Node can have several Message (and Connection) Generators. Each Message Generator has a Message name, a Message size distribution, an optional interarrival time distribution for directly producing messages, and a destination Node list with a probability associated with each destination, a Transport server name, and a Routing Class. A Message from a Message generator not associated with specific source and destination Nodes can inherit its source and destination from the destination and source of a triggering Message.

Messages created by an Application's Transport Request or by a Message Generator are transported from source to destination using Transport, Routing, Data

Link, and Medium Access Control protocols. Transport services are provided by the source and destination Nodes. The Transport service breaks a message into Packets at the source Node and reassembles the Packets into a delivered Message at the destination Node. The Packets are transported by an end-to-end Transport Connection that uses connectionless or connection-oriented routing. A Node selects an outgoing Port for a Packet using a Routing protocol. The Data Link service at the Port creates Frames out of incoming Packets and then uses the Medium Access Controller at the Port to contend for the Link. Physical layer services are provided by Links.

2 INTEGRATED ENVIRONMENT

COMNET III models are created, executed, and analyzed in an integrated graphical environment. A model is created graphically by selecting, from a Palette, icons for Subnetworks, Nodes, Links, and Traffic Generators and positioning them on the display by clicking with a Mouse.

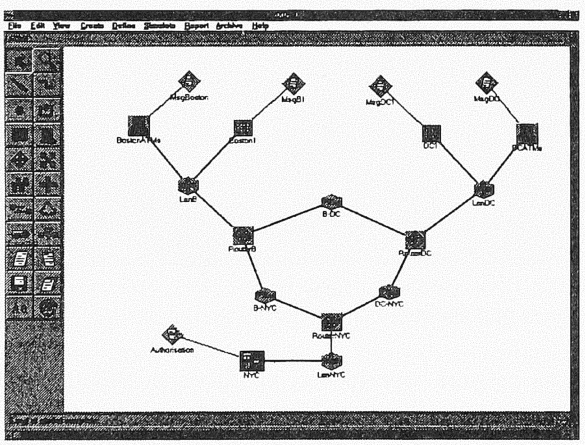

Figure 2: COMNET III Screen Showing Integrated Graphical Environment

Double-clicking on a Subnetwork icon shows the Nodes and Links in the Subnetwork; double-clicking on a Node, Link, or Generator icon brings up a dialog box for editing the details of the selected object. The user can interact with the simulation while it is executing in exactly the same way. By clicking on the icon for an object, the user can get current performance measures for the object.

It is also possible to change selected parameters during simulation execution. While the simulation executes, it is possible to turn on and off an animation of the flow of traffic in the model and to adjust the speed of the animation. When the simulation finishes executing, model results can be analyzed from within the same

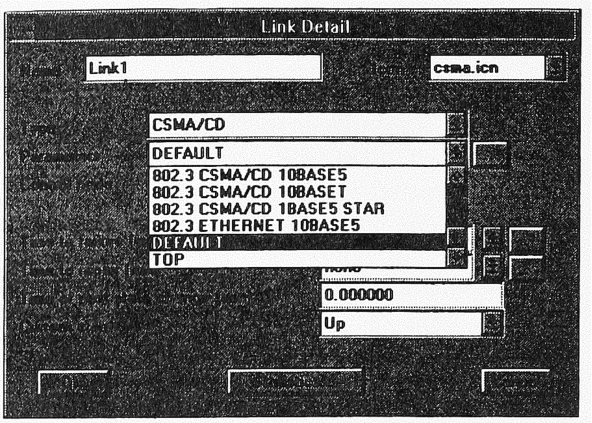

Figure 3: Editing a CSMA/CD Link

graphical environment.

Using CACI's SIMVIDEO technology, included with COMNET III, a complete presentation that supports your recommendation can be built. The presentation, including animated sequences and text, can be distributed on a floppy for replay on a PC. A PostScript file can also be generated for color or black-and-white hard copy output.

3 OBJECT LIBRARIES

An object library facility is provided to allow model builders to add parameterized objects or customized objects. Parameterized objects can be added without recompiling. An instance of an object is assigned specific parameter values and given a name and then added to a saved list of objects (the library). For example, a probability distribution object could be instantiated as a normal distribution with a mean of 500 and a standard deviation of 50 and given the name, E-MAIL. E-MAIL would appear subsequently as one of the distribution choices. Selecting the E-MAIL distribution automatically determines the type of distribution and its parameters. If the parameters of the E-MAIL distribution are changed, the change is effective everywhere. The same facility is provided for the parameters of all object classes in the model.

In situations where simply adjusting object parameters does not produce satisfactory behavior, a facility is provided for customizing objects and registering them in an object library. An object is customized by deriving a new object from an existing object and then overriding the methods or behaviors that require refinement.

Since the new object inherits all of the capabilities of the existing object, this approach minimizes the amount of code required for customization. It also means that after the model builder has customized a model, the integrated graphical environment for the model user is

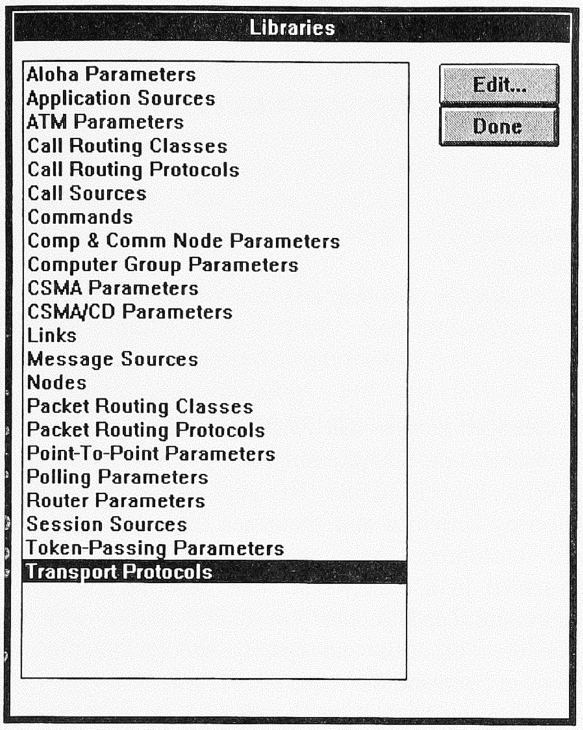

Figure 4: Libraries Available in COMNET III

still retained.

When customizing a model, the model builder manipulates objects graphically and hierarchically using an object-oriented simulation development environment based on MODSIM II. Thus, COMNET III provides a graphical, hierarchical environment for both the model builder and the model user.

From the perspective of the model builder, the notion of hierarchy is embodied in the inheritance structure of the objects in the executable program. From the perspective of the model user, hierarchy corresponds to the subnetworks of the actual network being modeled.

COMNET III is available on UNIX Workstations and PCs running Microsoft Windows or OS/2.

AUTHOR BIOGRAPHY

JEFFRY JONES was educated at the University of Virginia and The Johns Hopkins University where he received Bachelor of Science degrees in Applied Mathematics and Nuclear Engineering and a Master of Science in Electrical Engineering. Over the past 16 years he has built a wide variety of simulation models ranging from analytical studies of University of Virginia reactor fuel elements to theoretical models of satellite communications in a nuclear scintillated environment to discrete event simulation of the Space Station Information System. He is currently an Executive Associate in the Simulation and Modeling Deparment of CACI Products Company.