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PARALLEL EVENT PROCESSING FOR CIRCUIT-SWITCHED TELECOMMUNICATION NETWORK SIMULATION

Haruhisa Hasegawa
Akiya Inoue

Network Traffic Laboratory
Telecommunication Networks Laboratories
Nippon Telegraph and Telephone Corporation
3-9-11, Midori-cho, Musashino-shi, Tokyo 180, JAPAN

ABSTRACT

This paper describes parallel event processing for accelerating circuit-switched telecommunications network simulation. This technique processes a specific number of serial events in parallel and reprocesses some events based on information about data-dependencies between events. It does not require mathematical approximations to run the simulation in parallel. It guarantees to give the same result as the conventional sequential simulation algorithm because causality errors are avoided by checking data-dependencies among events.

1. INTRODUCTION

A high-speed simulator for NTT's public circuit-switched network is strongly required to help network operators comprehend the traffic flow and to manage the network (Hasegawa and Inoue 1992). A fast network simulator should be possible using parallel processing techniques. This paper describes parallel event processing algorithms for network simulation on MIMD multiprocessors with tightly coupled memory.

The network simulation is a call-by-call traffic simulation, so the major events are call origination and call termination. When a call origination event occurs, the network tries to connect with available trunks. If it is connected, the trunk is occupied during its holding time and then it is released.

The network to be simulated is NTT's circuit-switched network for public long-distance telephone service. This network has about 60 nodes, and about 4000 calls originate every second on average. It uses a dynamic routing algorithm called STR (State- and Time-dependent Routing) (Inoue et al., 1991), which has a hybrid control architecture of centralized and isolated control methods. A set of possible alternate routes for each origin-destination node pair is first determined by a centralized control method once a week for each time period of the day. In each telephone exchange, a near-optimum alternate route is determined using only the network information obtained through the call-connection processes.

2. PARALLEL NETWORK SIMULATION

In this algorithm, a specific number of serial events are taken from the event-list and are processed in parallel. The number (N) of events is called the degree of parallelism. N event-tasks to process events are prepared and can run in parallel. A set of N events processed by the N tasks is called one frame. The simulation has common data to express the network status.

First, the earliest N events are taken from the event-list. Their processing is started using the currently available common data (see Fig. 1). Each event-task decides how to modify the data, and then all tasks except the one for the earliest event are suspended. Only the earliest event has the right to update common data. If the earliest event does not affect the results of later events, the right is handed to the second event and the process is resumed. The first frame is completed when the N-th event has finished updating common data. Then the next frame, for processing the next N events, is started.

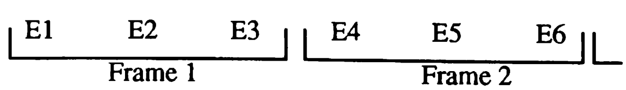

Fig. 1: Basic algorithm

If an event affects the result of later events, however, the later events must be processed again in order to recover from causality errors. There are two kinds of situations in which events must be reprocessed. One occurs when an event modifies the common data and the modification may affect the results of the later events (see Fig.

2). In this situation, the later events must be reprocessed with the common data updated by the earlier event. The other situation (see Fig. 3) occurs when an event creates new events before the N-th event. Then the later events and new events should be rescheduled and processed with the data updated by the earlier event.

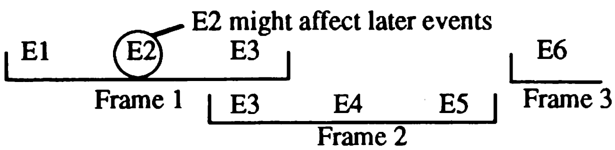

Fig. 2: Reprocessing E3 because E2 might affect later events

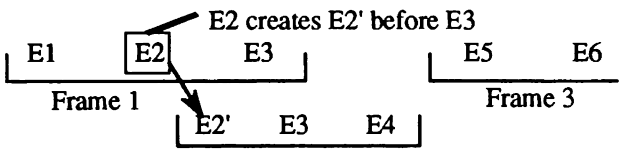

Fig. 3: Reprocessing E3 because E2 creates a new event E2' before E3

The major events in network simulations are call origination and call termination. As long as events do not affect later events, there are no problems in processing N calls in parallel. But for application to network simulation, the data dependencies among N events must be analyzed.

In a circuit-switched network, there are no differences between two calls that are to utilize the same route if the route has two or more available trunks: both calls can be connected through the route. If there is only one available trunk, however, the later call cannot be connected through the route and tries to be connected through an alternative route. If the call is blocked at the alternative route, the alternative route for the later calls is changed. This routing procedure means that a call origination event affects the later events if the call occupies the last trunk in a route or if the call is blocked. The later events should therefore be reprocessed, as described above. Similarly, when a call termination event releases a trunk and the number of available trunks is increased from zero to one, a later call origination event can be connected through that route. This is also a situation in which the later events should be reprocessed.

A call origination event creates the new origination and termination events. If the occurrence times of these new events are earlier than any later events processed in parallel at that time, the later events and new events should be rescheduled and processed with the common data updated by the earlier event.

Table 1 shows that the number of frames decreases as the number of events processed in parallel increases. According to this figure, the degree of parallelism should be chosen to be five or six.

Table 1: Number of frames/number of events

N	Ideal	End-to-end traffic load		
		5 erl	7.5 erl	10 erl
1	1.00	1.00	1.00	1.00
3	0.33	0.35	0.38	0.43
4	0.25	0.27	0.31	0.37
5	0.20	0.23	0.27	0.34
6	0.17	0.20	0.25	0.32
10	0.1	0.16	0.21	0.30

N:Degree of parallelism

3. SUMMARY

This paper describes an algorithm for parallel simulation of a circuit-switched telecommunications network. This algorithm can provide fast simulation, because it can process multiple events in parallel. The number of events processed in parallel is determined before the simulation starts. The algorithm has two mechanisms for reprocessing events. One is designed to avoid causality errors among events processed in parallel. This mechanism functions when an event may affect the later events processed in the same frame by modifying common data. The other is designed to recover from scheduling errors.

This algorithm is suitable for simulating a circuit-switched network. And it guarantees the same simulation result as the conventional sequential simulation algorithm.

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AUTHOR BIOGRAPHIES

HARUHISA HASEGAWA has been engaged in research on the evaluation of telecommunications traffic control at the Network Traffic Laboratory, NTT Telecommunication Networks Laboratories, since 1990. He received the B.E. and M.E. degree in electrical engineering from Waseda University, Tokyo, Japan, in 1988 and 1990, respectively.

AKIYA INOUE is a senior research engineer in the Network Traffic Laboratory, NTT Telecommunication Networks Laboratories. He received the B.E. and M.E. degrees in electrical engineering from Nihon University, Tokyo, Japan, in 1979 and 1981, respectively.