A Modeling and Analysis Methodology for DiffServ QoS Model on IBM NP architecture

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Abstract: Modeling and Simulation methodology permits analytic and mathematic performance estimation. Recent switched router systems have been more complicated and functional, and so performance estimation is more difficult. This paper shows the application capability about a Modeling and Simulation methodology to that problem.

Key-Words: QoS, DiffServ, OPNET, Modeling, Simulation, FSM, CLS-40.

1 Introduction

Flexibility about functional extension of switched router systems is obtained by NP (Network Processor) appearance; moderate type between general purpose processors and ASIC. Not only simple packet transmission, but also detailed and complicated traffic engineering according to parent’s policy can be really implemented. But, a difficult problem exists about prediction of performance degrading as growing appended extra functions, because of structural effectiveness based on processor clustering concept.

The other side, in modeling and simulation area supporting analytical and mathematical performance estimation method, many research results has been completed through virtual prototype development.

In this paper, A methodology is suggested about QoS performance estimation of switched router systems based on NP architecture, IBM NP4G3. Section 2 explains CLS-40 system, real original system of the virtual prototyping, and DiffServ QoS Architecture. In section 3, NP is modeled as OPNET node model, and constructs virtual test network, and then finally, section 5 concludes.

2 Background

2.1 CLS-40 (Converged LAN System-40)

CLS-40, network backbone system in companies or buildings, can be used for edge network systems adapting to faraway company network or direct terminals. In order to support new network service rapidly, distinctive high-quality service and effectiveness of network equipments composition, this system includes several functions; open programmable switch management, sensitive traffic engineering and QoS support. Also, the system supports VoIP Gateway to connect external existing PSTN networks and Converged LAN Call Coordinator for real-time multimedia call service.

Figure 1. CLS-40 Hardware System

CLS-40 has 40Gbps programmable LAN switching capability and 10/100/1000 Mbps Ethernet, STM-1/4 ATM, E1/T1, Frame Relay adaptation. Through such above adaptation, other CLS-40s,
existing/future networks, and terminals/servers can connect this system. As Figure 1, CLS-40 consists of MPRU (Main Processing & Routing Unit), CLSU (Converged LAN system Switching Unit), and line interface part. MPRU executes routing protocol process and system management, CLSU transmits from ingress packets to egress line interface. Line interfaces have path finding function for different kind of transmission types. Dual redundancy concept for MPRU and CLSU is applied to this system.

2.2 DiffServ Architecture (Differentiated Services Architecture) [1]

The DiffServ is based on a simple model where traffic entering a network is classified and possibly conditioned at the boundaries of the network, and assigned to different behavior aggregates. Each behavior aggregate is identified by a single DS (DiffServ) code-point. Within the core of the network, packets are forwarded according to the per-hop behavior associated with the DS code-point.

Traffic meters measure the temporal properties of the stream of packets selected by a classifier against a traffic profile specified in a TCA. A meter passes state information to other conditioning functions to trigger a particular action for each packet which is either in- or out-of-profile (to some extent). Packet classifiers select packets in a traffic stream based on the content of some portion of the packet header. We define two types of classifiers. The BA (Behavior Aggregate) Classifier classifies packets based on the DS code-point only. The MF (Multi-Field) classifier selects packets based on the value of a combination of one or more header fields, such as source address, destination address, DS field, protocol ID, source port and destination port numbers, and other information such as incoming interface. Packet markers set the DS field of a packet to a particular code-point, adding the marked packet to a particular DS behavior aggregate. The marker may be configured to mark all packets which are steered to it to a single code-point, or may be configured to mark a packet to one of a set of code-points used to select a PHB in a PHB group, according to the state of a meter. When the marker changes the code-point in a packet it is said to have "re-marked" the packet. Droppers discard some or all of the packets in a traffic stream in order to bring the stream into compliance with a traffic profile. This process is known as "policing" the stream. Note that a dropper can be implemented as a special case of a shaper by setting the shaper buffer size to zero (or a few) packets.

2.3 IBM NP4GS3 [2]

The IBM PowerNP™ NP4GS3 network processor enables network hardware designers to create fast, powerful, and scalable systems. The NP4GS3 contains an Embedded Processor Complex (EPC) in which processors and coprocessors work with hardware accelerators to increase processing speed and power. Additional features, such as integrated search engines, variable packet length schedulers, and support for QoS functions, support the needs of customers who require high function, high capacity, media-rate switching. The NP4GS3 is also highly scalable, capable of supporting systems with up to 1024 ports. The EPC is the heart of the NP4GS3, evaluating, defining, and processing data. It maximizes the speed and processing power of the device and provides it with functionality above that of an independent switching...
device. Within the EPC, eight dyadic protocol processor units (DPPUs) combine pico-code processors, coprocessors, and hardware accelerators to support functions such as high-speed pattern search, data manipulation, internal chip management, frame parsing, and data pre-fetching. The NP4GS3 provides fast switching by integrating switching engine, search engine, and security functions on one device. It supports Layer 2 and 3 Ethernet frame switching, and includes three switch priority levels for port mirroring, high priority user frames, and low priority frames.

3 Behavior Modeling of DiffServ Components on OPNET Environments

3.1 Proposed Methodology

Figure 4 shows OPNET environments. OPNET has three modeling concept depth: process, node, and project. Smallest components, process, describes one functional block to FSM (Finite State Machine) model, for example a protocol stack, TCP. These processes compose a node, network device, with connections through packet exchange or variable change interrupt. Several nodes build up one virtual network, project with link model connection.

In Figure 5, there is a result node model about IBM NP4GS3 on OPNET environment. NP4GS3 consists of memory buffer area storing data and DPPU (Dyadic Protocol Processor Units) processing static pico-codes. To describe memory buffers, we can use queue modules as interrupt driven types or non-interrupt type. Because of processor cluster type, DPPU is described as FSM model composed of states and transition between them. Next section explains a modeling example, DiffServ components based on above process.

3.2 Composition Components

Figure 5. Modeling DiffServ Model on NP4GS3 [2]
There is classifiers FSM model designed from IBM NP4GS3, in Figure 6. IBM NP4GS3 has classifying steps from layer 2 to layer 4, and each step relates to different fields, for example, layer 2 classifies with MAC header while layer 4 also concerns IP addresses and port data.

IBMNP4GS3 supports 2047 QCBs (Queue Control Blocks) and they have traffic character such as peak rate, transmission sequence, and so on. Figure 10 shows Shaper/Scheduler block diagram. Shaper/Scheduler controls each flow to overflow into the egress link, and to guarantee flow specifications.

4 Conclusion
In this paper, a methodology is proposed to estimate performance of DiffServ QoS Architecture. Through such methodology, queue models can be considered NP’s memory buffer and process models express complicated extra functions.
OPNET environments support many flexible statistics gathering functions. That proof remains as future work.

References:

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