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ECOCC: A Hybrid Approach to Control Congestion in High Performance Computing

V.SIVAKUMAR,
PG Scholar,
Department of Computer Science and Engineering,
Arunai Engineering College, Tiruvannamalai,

M.VIJAYALAKSHMI,
Assistant Professor,
Department of Computer Science and Engineering,
Arunai Engineering College, Tiruvannamalai,

***Abstract*- High performance computing, significantly refine and optimize the hybrid CC approach to take advantage of features in current state-of-the-art HPC switch architectures. The result is a novel CC technique that is even more efficient and resource friendly. Specifically, CCFIT was designed to prevent both low- and high-order HoL-blocking. Modern commercial HPC switches, however, "naturally" disallow low-order HoL-blocking, as the de facto standard is to have several read ports to connect each switch input buffer separately to all the output buffers of the switch. As a consequence, any CC technique suitable for modern commercial switches can focus on preventing only high-order HoL-blocking, thereby leveraging the resources and mechanisms devoted to deal with congestion. The new Efficient and cost-effective Congestion- Control technique (ECoCC) propose in this paper has been designed according to this key idea, so that the available resources are used more efficiently to isolate hot flows, congestion is detected more accurately, and implementation complexity is reduced.**

***Key terms*—High performance computer, HoL-blocking, Congestion- Control, and ECoCC.**

I. INTRODUCTION

High-performance computing (HPC) is use to run the applications in parallel processing system more efficiently, reliably and quickly. The systems that function above a teraflop or 10^{12} floating-point operations per second will be called as high performance computers. The supercomputing system has significance of the high performance computing, although technically now a day's supercomputer system performs at or near the currently highest operational rate for computers. Many supercomputers can work at the rate of petaflop or 10^{15} floating-point operations per second. High Performance Computing most generally refers to the collection or cluster of computing power in a way that delivers much higher performance that makes the user to get out of a typical desktop computer or workstation in order to solve larger problems in science, engineering, or business. Each individual computer in a commonly configured small cluster having one and four processors, and today's processors typically has from two to four cores. An individual computer in a cluster of high performance computing is referring to nodes. In point of having HPC is to solve the larger problem by the individual processer working together. As like people each individual nodes as to communicate with each other in order to perform the work meaningfully. Probably, all the nodes communicate over a network (interconnect). There is variety of networks for transmitting the data. Meanwhile, there may under provision with respect to the number of cores or concurrent communication between the nodes in high performance computers. The performance degradation happens during the situation of congestion. Congestion originates when several packets flows request simultaneously access the same output port in the switch, or if a destination node is not able to transmit the packets at the rate they arrive. Efficient and cost-effective Congestion-Control technique (ECoCC) propose in this paper has been designed according to this key idea, so that the available resources are used more efficiently to isolate hot flows, congestion is detected more

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accurately, and implementation complexity is reduced.

II RELATED WORKS

JesusEscudero-Sahuquillo et al [1] proposed a straightforward congestion-management method suitable for fat-tree topologies built from InfiniBand components. Their proposal is based on a service-level traffic-flow mapping is to prevent the maximum usage of available resources in current InfiniBand components (basically Virtual Lanes) to control the negative impact of the HPC which is caused by the congestion is: head-of-line blocking and buffer-hogging. To evaluate the efficiency of proposed work is by providing a mathematical approach and this consists of some set of analytical metrics. The ideal performance gain that could be achieved by preventing the HoL-blocking and buffer-hogging is upto 68%.

XinYuan Mahapatra et al [3] proposed a new performance metric, that classifying the throughput performance of interconnect design is called as LANL-FSU Throughput Indices (LFTI). LFTI combines the simplicity of topological parameters and the accuracy of simulation. LFTI can be obtain from interconnect specification as like topological parameter. At the same time; it directly indicates the performance of application level communication. Moreover, main role of the proposed system is to provide an efficient communication along the interconnect network, Throughput of the interconnect network can be evaluated theoretically. LFTI for interconnect network can be computed efficiently. These features probably allow LFTI for rapid use, comprehensive evaluation and comparison of extreme-scale interconnects designs. We exhibit the effectiveness of LFTI by evaluating and exploring it in large-scale interconnect designs.

Juan A. Villar Pedro et al [4] proposed efficient switch architecture is suitable for implementing deterministic source-based routing at any interconnect technology. This switch architecture uses the same network resources, which produce two issues and that can be control and network performance can be improved by: Congestion Management and QoS support. They also provided results to compare the effectiveness of this architecture by comparing it with other proposals typically used to prevent these issues in this context. These results have been secure the synthetic traffic and for tracing parallel benchmarks and also for video frames. From the results, we can decide that in any traffic scenario, this proposed system is effective than the previous ones, while requiring small number of resources and it is cost-effective.

III MOTIVATION AND OBJECTIVE

Interconnection networks are one of the key factors in high-performance computing (HPC) systems, the performance of interconnect design is having a strong impact on the overall system of HPC. Although, at high load, congestion and its negative effects (e.g., Head-of-line blocking, buffer-hogging) endanger the performance of the network, even the entire system. Congestion control (CC) is critical to make certain an efficient utilization of the interconnection network during congestion conditions. Mostly, congestion consists in a number of internal network paths as vigorous traffic clogging, as a result; it slows down the traffic flows. Congestion may occur at hotspots, network burstiness, re-routing around faulty regions, and also to save power by lowering the link speed.

The main objective of this proposed system is to use the available resources in efficient way, to isolate the hot flows and to detect and control the congestion. The proposed technique ECOCC combines the injection throttling and congested-flow isolation to decrease their individual drawbacks and increases the overall system performance. This new strategy is suitable for switch architectures used now a day, where it could be implemented without obtaining any significant complexity. Experimental results, provided using simulations under synthetic and real trace-based traffic patterns, show that this technique improves the performance up to 55 percent when compare to other congestion control techniques.

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IV SYSTEM ARCHITECTURE

The propose system will be implemented by using the following modules:

A. Network Configuration

B. Congestion Detection

C. Hot Packet Identification and Isolation

D. Flow Control

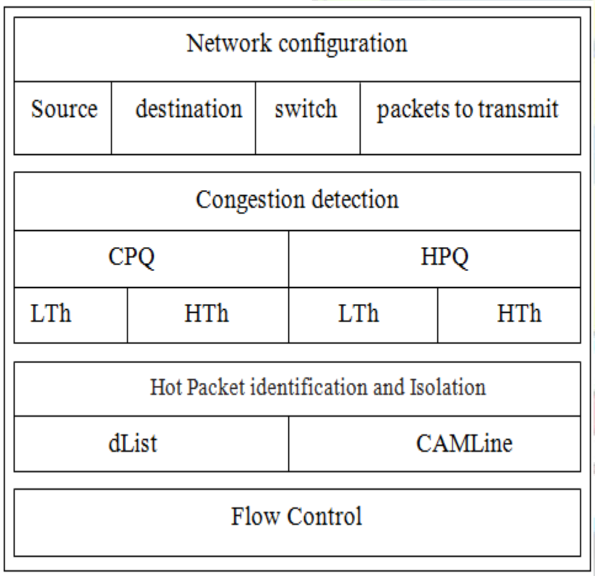

Fig1: System Architecture

A. Network Configuration

In our project, we have configured five nodes as the source nodes, nine nodes are configured as switches and three nodes are configured as destination nodes. All the source and destination nodes are interconnected by using switches. The nodes are connected by using duplex-link. The type of the queue maintained in each link is Drop Tail. The queue is continuously monitored to detect the congestion in the network. The Maximum number of packets can be stored in the queue is 50 packets. The communication protocol UDP and TCP is used for congestion. The packet traffic flow is created by using the agent CBR (Constant Bit Rate). The rate of traffic is 1Mb.

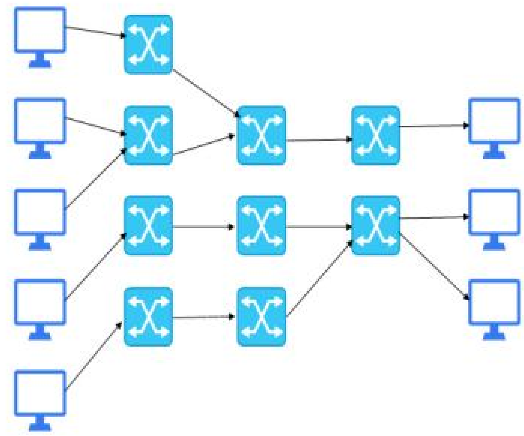

Fig2: Network Configuration

B. Congestion Detection

Each CPQ has two congestion-detection thresholds, one lower (LTh) and one higher (HTh). When a CPQ fills over the HTh threshold, congestion is detected and the corresponding output port is considered to be congested as long as the occupancy level of the CPQ remains above the LTh. The use of two thresholds is important for the assurance of fairness among hot flows. In contrast with CCFIT that mixes in the same CPQ packets headed for different output ports, the detection of congestion in EcoCC is exact, as all the packets stored in a specific CPQ which has exceeded the HTh threshold, request the same output port. Thus, this port is for sure a congestion root (i.e., all the packets in a CPQ detecting congestion are for sure hot packets).

C. Hot Packet identification and Isolation

All the packets reaching an input port are initially stored in the CPQ corresponding to their requested output port. Christo Ananth et al. [8] discussed about a system, In this proposal, a neural network approach is proposed for energy conservation routing in a wireless sensor network. Our designed neural network system has been successfully applied to our scheme of energy conservation. Neural network is applied to predict Most Significant Node and selecting the Group Head amongst the association of

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sensor nodes in the network. After having a precise prediction about Most Significant Node, we would like to expand our approach in future to different WSN power management techniques and observe the results. In this proposal, we used arbitrary data for our experiment purpose; it is also expected to generate a real time data for the experiment in future and also by using adhoc networks the energy level of the node can be maximized. The selection of Group Head is proposed using neural network with feed forward learning method. And the neural network found able to select a node amongst competing nodes as Group Head. Thus, all hot packets contributing to a specific congestion tree (i.e., "matching" a given CAM line) are isolated in the same HPQ, and high-order HoL-blocking at CPQs is prevented.

D. Flow Control

To avoid oversubscription of HPQs, a Stop & Go flow-control is implemented between consecutive HPQs, also based on the LTh and HTh thresholds. Stop notifications are sent each time the HTh threshold is reached (except for the first time), and a Go notification is sent when the LTh threshold is reached. The LTh threshold is also used to deactivate the marking of packets (i.e., the injection-throttling part of EcoCC). Note that EcoCC uses only two thresholds, LTh and HTh, for congestion detection, congestion propagation and flow-control. This is a further optimization of EcoCC over CCFIT. In CCFIT five different thresholds are needed to keep track of congestion detection for the injection throttling and HFDI parts of the technique, as well as for managing the flow-control between consecutive HPQs.

V. RESULT ANALYSIS

The performance of the proposed technique is estimated by calculating the throughput value. The throughput is the quantity of packets transmitted at unit rate of time. The performance of the proposed technique is compared with the existing techniques HFDI and VoQnet. The throughput for various traffic flows has been measured to evaluate the proposed method.

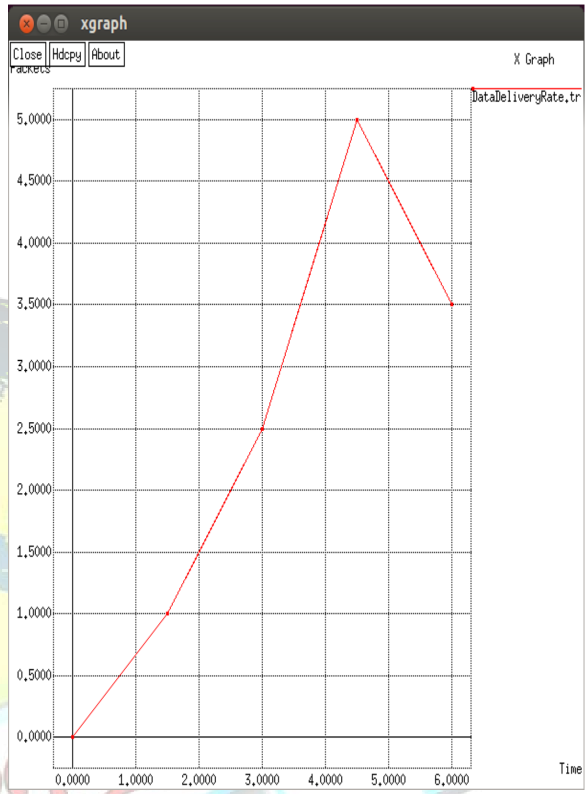

Fig3: Data delivery rate

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Fig4: Packet loss

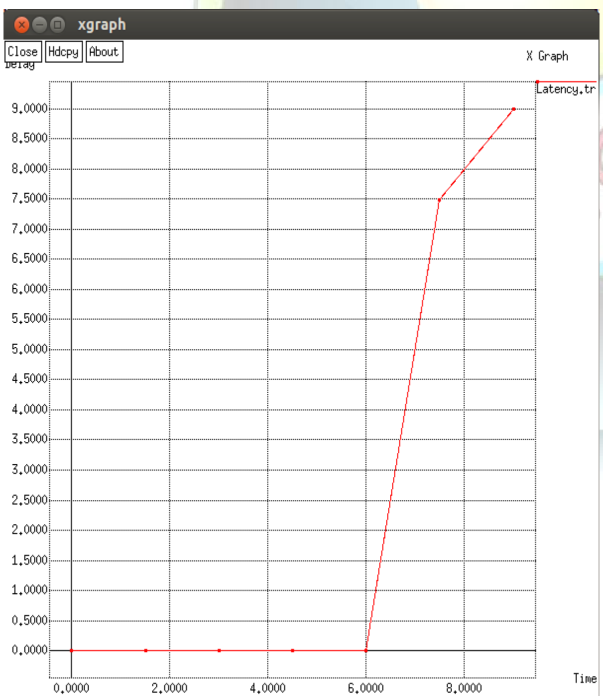

Fig5: Latency

VI. CONCLUSION

Interconnection networks are essential elements for HPC systems. Network designers are focused on fulfilling requirements such as low power consumption, cost-effectiveness and scalability. In this context, new network designs are prone to suffer from congestion and the corresponding negative effects (e.g., the Head-of-Line blocking), since the network has to operate close to its saturation point. Thus, a highly efficient congestion control mechanism is required. Our new hybrid technique, called Efficient and cost efficient Congestion Control, has been designed to take advantage of switch architectures that, like those of current commercial switches, have several buffer sections per input port, each one with its own read port into the switch crossbar. This improvement allows EcoCC to more accurately locate congestion roots and to more efficiently use resources to isolate and throttle hot flows, compared to our precedent hybrid CC technique CCFIT.

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