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Ethernet Performance Improvement in Multi-port Network System

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ABSTRACT : Ethernet network devices have their own space and importance in the network age. The real time operations demand the network devices with greater networking bandwidth as well as efficient network data processing. The major concern with the multiport network devices is the performance. Today's resource-intensive engineering and technology applications deals with the server virtualization, consolidation, high-volume data transactions and real-time technologies such as VoIP and video on demand. The operations requires the sufficient network bandwidth and CPU processing speed to process the data at a real time and this demand is continue to grow. The newer multiport hardware technologies provide performance improvements in virtualized server environments. But, hardware technologies having their own limitations in terms of power consumption, CPU utilization levels, latency and more importantly cost. This thesis will discuss some of the key software designs as well as configuration decisions, to facilitate multiport network devices to improve the performance over the existing infrastructure. This will provides the solutions such as symmetric network and Virtual LAN to overcome the hardware dependency and cost required to significantly improve the multiport network system performance over the current infrastructure. This improved performance includes bandwidth and CPU utilization under the heavy network loads.

KEYWORDS –Bandwidth, Ethernet, Multi-port, Network, Symmetric, Virtual LAN, Symmetric.

I. INTRODUCTION

Ethernet is the predominant network technology for data centers and businesses. It supports the real time voice and video data in parallel with workloads such as storage data. Ethernet is aimed to transfer the packetized data over the cable. Even with vastly expanded bandwidth, Ethernet can be inefficient for time-sensitive traffic that causes packet loss.

Network interface cards (NICs), sometimes called network interface controllers, are evolving to include more features and intelligence that will boost network performance, including jumbo frames and offload capabilities, buffer and spacing tweaks, and more. Network interfaces uses the kernel data structures to register with the kernel and processes the packet exchange with the external world. Network device drivers are configures the network addresses, and other parameters to maintaining traffic. It is working on either interrupt based or polling based. It generates the interrupt to the processor for every packet that received on the interface. The multiport systems interfaces can receive thousands of packets per second. This may cause to drop in overall performance of the system, but it is the desired mode in network operation.

This topic will discuss the Networking throughput measurement, technical research on efficient network bandwidth utilization, data security and configurations for multiport systems.Section II briefly describes the advance network performance measurement techniques and related issues. Section III contains main point of the draft i.e. technical research on efficient network bandwidth utilization with Virtual LAN. Section IV takes a look at the problem of bi-directional link and asymmetric routing experiment. Section 5 is conclusions.

II. MULTIPORT NETWORK ISSUES

This chapter will describe the tools and different techniques that are used to evaluate the network performance. Network performance will depend on many things such as on the applications, configurations, how the hosts running these applications on the networking devices and design of the network as a whole system. The hardware capacity as well as software configuration plays an important role in networking. The small change in the software configuration may cause a hardware capacity problem. The typical data flow involves a logical layered model. The end-to-end data flow can be graphically showed as fig. 1.

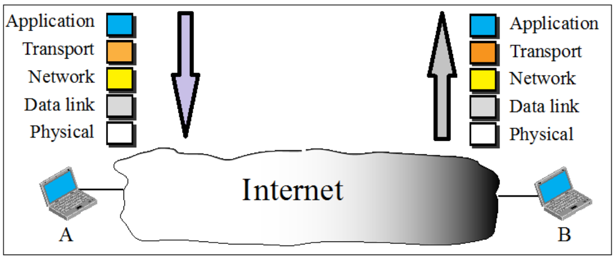

Fig. 1 End-to-end network data flow

Performance can be measured with advanced techniques such as Single-point traffic-measurement and Multi-point traffic-measurement.Single-point traffic-measurement technique is the typical information captured by equipment. It can be categories based on where they are used within a network. If traffic coming into or going out is captured on a particular machine, it is called as host-monitoring. If an interface is in promiscuous mode, it will allow capturing all the traffic at an interface, this method is called point-monitoring. It uses the counters (e.g. packets passed, packet sizes, packets dropped) over a predefined time period. The multiport network traffic-measurement has issues such as:

- Which resource had the slowest time to first byte?
- Which resources took the longest time to load?
- Who initiated a particular network request?
- How much time was spent in the various network phases for a particular resource?

Multipoint traffic-measurement technique helps to overcome the above drawbacks. It measures a value between different points. It is not just counting things but also measuring the dynamics of the flow and isolates issues in both space and time. It has excellent diagnostic power which leads to a focus on schedulability and trading, it focuses on the outcomes for the customer.

III. VIRTUAL NETWORK

In computer networking, a single layer-2 network may be partitioned to create multiple distinct domains, which are mutually isolated, so that packets can only pass through the one or more routers. It is referred as a virtual local area network or VLAN. It allows multiple bridged networks to share the same physical link without leakage of information between networks.

The VLANs across devices requires running Ethernet cabling. In a simple form, devices only support partitioning on a hardware port level. It uses the port tagging in order to interconnect the transported data for multiple VLANs across the multiple ports.

In a traditional LAN, workstations are connected to each other by means of a multiport network switch or hub or a repeater. These devices propagate any incoming data throughout the network. Collision may occur if multiple people attempt to communicate the information at the same time and it may cause to loss the transmitted data. The collision will continue to be propagated throughout the network by hubs, switches and repeaters. Collision need to be resolve and resent the original information thereby incurring a significant wastage of time and resources. In order to prevent top collisions travelling through all the workstations, a switch or a bridge can be used. It will not forward collisions, but will allow unicast (to directive user in the network) and multicasts (to a pre-defined group of users) to pass through. The workstations, hubs, and repeaters together form a LAN segment. The area within which broadcasts and multicasts are confined is called LAN. Thus a LAN can consist of one or more LAN segments. Defining broadcast and collision domains in a LAN depends on workstations, switches, hubs, and routers physical configurations. A Virtual LAN may be used to prevent broadcasts and multicasts from travelling through the network.

The logical view of Virtual LAN is as shown in below fig. 2.

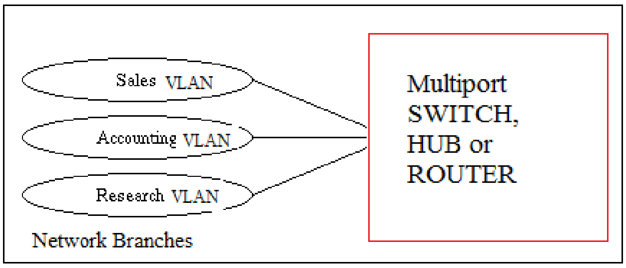

Fig. 2 Logical view of a VLAN

It can have many different IP subnets as VLANs are not based on IP's and does not actually encapsulate the original frame. VLAN adds a 32-bit field between the source MAC address and the Ether Type/Length fields of the original frame. Fig. 3 shows a Virtual LAN 32-bit field.

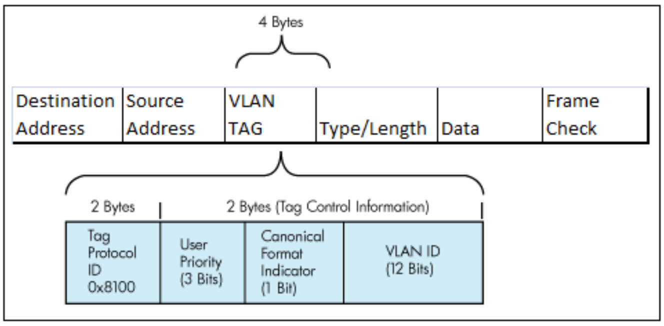

Fig.3 Virtual LAN Packet Header

IV. ASYMMETRIC ROUTING AND BALANCING

Asymmetric uplink and downlink rates are common in many broadband networks. In some cases TCP connections can send data in both directions simultaneously. The performance can be severely degraded, as low as 25%. This thesis presents an analysis of how window-based buffers combined with queuing affect bi-directional TCP performance across asymmetric network links. This window-based buffer sizing strategy provides 40% performance improvement across the asymmetric links. Consider the following scenario to illustrate the bi-directional traffic across an asymmetric link with poorly sized buffers. A user is streaming a video across a typical network link. In the middle of the video, the user decides to download a movie clip from another network site. During the period where the movie clip is downloaded, the quality of the video is degraded to the point where it is not viewable.

Below fig. 4 shows this scenario.

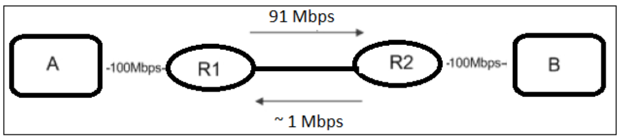

Fig. 4 Windowed buffer for Network Communication

Once the bi-directional data traffic is present in the system, one side throughput is degraded by about 40%.It is clear that buffer size plays a dominant role in determining performance for bi-directional TCP traffic. Through these examples, it is clear that this problem has real significance in networks.

The network asymmetry occurs in a network when the data rates in each direction of a path are unequal. This type of configuration is common in access networks. The problem of maximizing performance of bi-directional TCP traffic across asymmetric links still remains widely unsolved. This thesis suggests the window-based buffer approach. Packet switched systems require buffers to store packets during periods of processing and congestion within the network element. Process time can be comprised of among other things, table look-ups, traffic classification, security functions, and queuing delays. Congestion occurs as data arrives into a network element faster than it can leave. Buffers play a critical role in preventing packet loss and maintaining efficient throughput for traffic that transits the element.

In IP based equipment, buffers are typically implemented in full size IP packets. That is, a buffer is broken up into segments that are 1500B long. This permits packets less than or equal to full size to be stored in the window buffer. Buffers that are managed in bytes allow for more efficient use of the space. Variable sized packets are placed in queue at variable offsets based on packet size. While the memory efficiency of the buffer is increased under this model, therefore a dynamic list of memory pointers must be maintained.

Buffers have two main components, physical memory and the software that controls the memory. The memory that is allocated to the buffers must be of sufficient speed to match the line rate of the transceivers being used in the network element. Generally, high speed SRAM and DRAM is used as buffer memory. System scalability becomes an issue when line rates begin to exceed memory speeds. Furthermore, as data rates increase, the amounts of memory can be required is also increased and it lead to increased cost.

The sizing of buffers in TCP/IP based network elements has evolved with capacity and utilization. The improved performance can be observed as fig. 5.

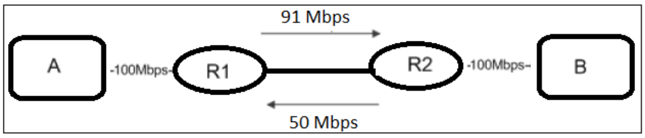

Fig.5 Buffered Data Network Communication

V. CONCLUSIONS

This thesis majorly focused on performance improvement techniques for multiport Ethernet system. The Network data speed and efficient processing are the most important criteria for networking subsystem. This explains the technologies such as Virtual LAN and symmetric network links to improve the data speed and processing over the existing network infrastructure. This thesis also discusses the effect bi-directional networks connections over asymmetric links. It suggests a new approach that helps to solve asymmetric link problem by appropriately sizing the windowed-based buffers. Experiments were performed on a real network where the windowed-based buffer sizes were varied from 1 KB to 128 KB in increments of ten.

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