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Multiport Network Ethernet Performance Improvement Techniques

Tanaji Shankar Nalawade
Dhole Patil College of Engineering Pune, Maharashtra
Department of Electronics & Telecommunication Engineering
tanmaynalawade@gmail.com

V. L. Jogdand
Dhole Patil College of Engineering Pune, Maharashtra
Department of Electronics & Telecommunication Engineering
varshajogdand29@gmail.com

Abstract: An Ethernet has its own importance and space in network subsystem. In today's resource-intensive engineering the applications need to deal with the real-time data processing, server virtualization, and high-volume data transactions. The real-time technologies such as video on demand and Voice over IP operations demand the network devices with efficient network data processing as well as better networking bandwidth. The performance is the major issues with the multi-port network devices. It requires the sufficient network bandwidth and CPU processing speed to process the real-time data at the context. And this demand is goes on increasing. The new multi-port hardware technologies can help to improvements in the performance of the virtualized server environments. But, these hardware technologies having their own limitations in terms of CPU utilization levels and power consumption. It also impacts on latency and the overall system cost. This thesis will provide the insights to some of the key configuration decisions at hardware as well as software designs in order to facilitate multi-port network devices performance improvement over the existing infrastructure. This thesis will also discuss the solutions such as Virtual LAN and balanced or symmetric network to reduce the cost and hardware dependency to improve the multi-port network system performance significantly over the currently existing infrastructure. This performance improvement includes CPU utilization and bandwidth in the heavy network loads.

Keywords: Multi-port, Ethernet; Symmetric Network; VLAN; Asymmetric Network; CPU Utilization, Bandwidth.

I. INTRODUCTION

In network wired network i.e. Ethernet is one of the important technology for data exchanges at data centers and businesses. Initially it was designed for simple file transmission between two points, but later on extended to supports the real-time video and voice data. Ethernet is used to transfer the packet data over the Ethernet cables.

Network interface cards (NICs) also called as network interface controllers are evolving to add more features and intelligence to boost network performance, including jumbo frames, offload capabilities, buffer and spacing tweaks. Network interfaces use the data structures available with the Kernel to register with the kernel and processes the packet data to exchange with the external world. Network device drivers are used to initialize the device, configure the device data including the memory assignment, network addresses, and other parameters to maintaining traffic. It is working on interrupt based or polling based mechanism. An interrupt will be generated to the processor for each and every packet received on the interface. In case of the multi-port systems, interfaces will receive lots of packets per second. This data load needs to process in the same context, but due to large packet load, it may cause to drop in overall performance of the system, but it is not the desired mode of network operation. The system should process data packets effectively in any case.

This topic will discuss the Networking throughput measurement techniques, in brief, technical research on efficient network bandwidth utilization, data security and configuration decisions for multi-port systems. Section two will describe the techniques for advanced network performance measurement and related issues. Section three and four contain the main point of the draft i.e. technical research on efficient network bandwidth utilization with Virtual LAN and the symmetric routing of network data in the multi-port system and final are acknowledge and references.

II. MULTIPORT NETWORK ISSUES

This topic will describe the tools and different techniques used to evaluate the network performance. The network performance will depend on the type of applications, system configurations, how the hosts handle for these running applications on networking devices and system design of the network as a complete solution. The hardware, as well as software configuration, are important factors in networking. Even the small change in the software configuration may create a hardware capacity problem. The typical data flow involves a logical OSI layered model. The data flow can be graphically represented as below figure.

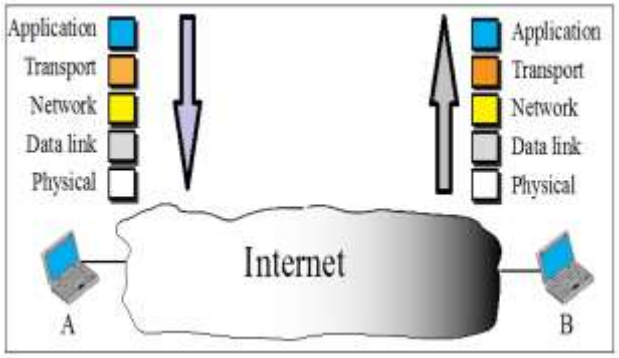

Fig. 1 End-to-end network packet data flow

The network performance can be measured with different techniques such as single point and multi-point traffic-measurement. In single-point traffic-measurement, the information is captured by equipment and displayed in Real-time traffic graphs. It can help to categories based on the location they are used in the network. Host-monitoring is used to measure the traffic coming into or going out for the particular point, this is also called as host system monitoring. The promiscuous mode will allow capturing all the network traffic at the interface. It uses the different parameters as packets passed counter, packet size, packets dropped counter over a predefined time. The single port network traffic-measurement has issues such as:

- The resource with slowest first byte
- The Resources that needs longest load time
- Network request initiation and terminations

Multi-point traffic-measurement technique helps to overcome the above drawbacks. It also helps to add more accuracy and help to draw the spatial differences as it measures the data at different points. It provides the data counts and also the measurements of the data flow dynamics. It helps to isolates issues in both time and space. Its focuses on the outcome and adds excellent diagnostic power for the end customers.

III. VIRTUAL NETWORK

In networking, a layer-2 network may be virtually partitioned to create multiple distinct domains. These are mutually isolated so, the packets can pass through the one or multiple routers. This term is referred as a virtual local area network. VLAN allows multiple bridged networks to share the same physical link without leakage of information over the networks.

The main purpose of formatting the VLAN is to provide the compatible interconnections. It defines the principles of operation with the VLAN aware bridge and also identifies the functions to be performed. It provides an architectural model of the operation of a VLAN in terms of processes and Entities. It specifies the frame format which allows a VLAN Identifier (VID) and carried out the priority information for the user data frames. VLAN can be set up with the rules to govern the addition or removal of VLAN tags and forms user data frames. In the simple form, the devices support only partitioning on a hardware at the port level. It uses the VLAN ID port tag in order to connect the transported data for multiple VLANs across the Network. In a traditional LAN, the workstations are interconnected to each other by the multi-port network switches or hubs. These devices are used to propagate any incoming data to the connected network. The workstations, hubs, and switches together form a LAN segment. This allows the LAN area within which broadcasts or multi-casts are configured. Thus a LAN can consist of one or more LAN segments. The logical view of Virtual LAN is as shown in below Fig. 2. It describes the protocols and procedures that are necessary to support inter-operation between networks.

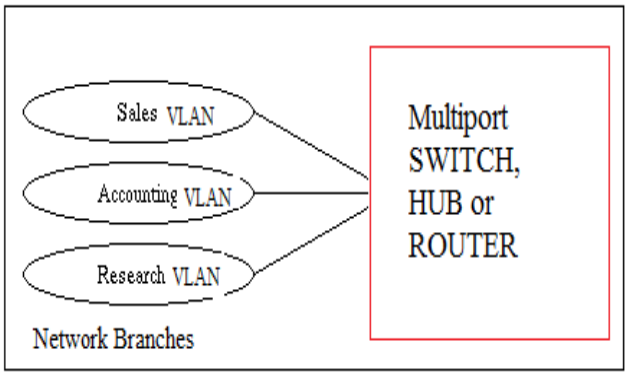

Fig. 2 Physical view of a Virtual LAN

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

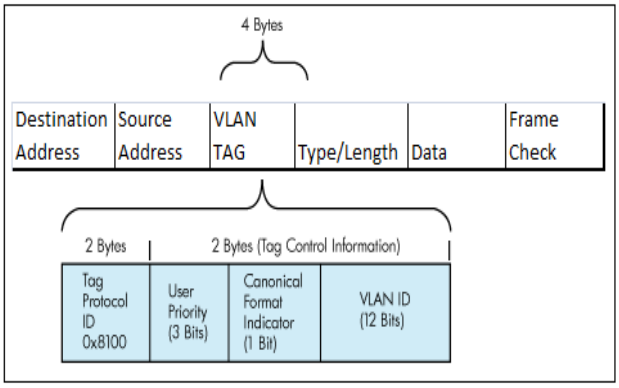

Fig. 3 Virtual LAN Packet Header

IV. SYMMETRIC ROUTING AND BALANCING THE NETWORK

In the networking, data is uploaded to the network as well as downloaded from the network. The up-link data rates and downlink data rates are showing a huge difference. In many cases, data need to be transmitted in both directions simultaneously. In such scenario, the performance may be severely degraded, as low as 22 - 25%. This thesis will discuss an analysis of how window-based method combined with queuing helps to improve the bi-directional network performance across network links. Following scenario illustrate the bi-directional traffic across an asymmetric link with the default sized buffers. If a user is streaming a video with a typical network link, and in the middle of the video, the user decides to download some movie clip from other network sites. During the same period that movie clip is getting downloaded, the quality of the video is degraded even to the point where it is not viewable. The default performance can be observed as shown below.

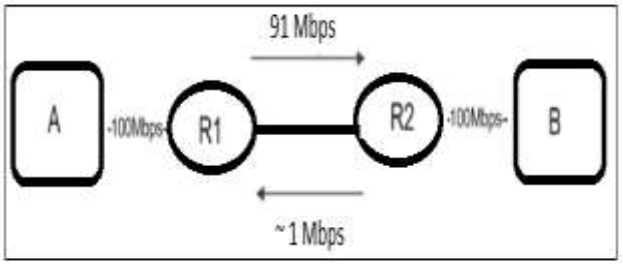

Fig. 4 Network performance with default buffers configurations

If the bi-directional network data traffic is present in the system, the up-link side throughput may be degraded by about 25%. So, it is clear that buffer size plays an important role in determining performance for bi-directional network traffic. With these examples, it is also clear that this problem has real significance in networks.

The network data asymmetry occurs when the data rates in both directions of a path are unequal. This type of configurations is common in access networks. The problem of the performance of bi-directional TCP traffic across network links remains widely unsolved. This gets even worst in case of multi-port scenario. The window-based buffer approach will help in a packet switched systems. It requires buffers to store packets during processing network data. Process time can be comprised of with other things as

security functions, table look-ups, traffic classification and queuing delays. The proper configurations of the buffers play a critical role in order to prevent packet loss. It also helps to maintain efficient throughput for traffic.

In IP based equipment the buffers are typically implemented with full-size IP packets. That is a buffer is broken up into segments of 1500 bytes long. This creates the packets less than or equal to the full size to be stored in the window buffer. The buffers that are managed in 1500 bytes allow more efficient use of the time and space. Variable size packets can be placed in a queue with variable offsets based on packet size. The memory efficiency of the buffer can be increased with this model, therefore a dynamic list of memory pointers need to be maintained.

These buffers contain a couple of main components, the physical memory, and the software to controls the memory. The memory that is allocated to the buffers must be with sufficient speed to match the line rate with the transceivers being used in the network element. In general, high-speed DRAM and SRAM are used as a buffer memory. The system scalability becomes an issue when the line rates begin to exceed memory speeds. Furthermore, as data rates increase, the amounts of virtual memory required is also get increased but doesn't affect the cost as much due to virtual memory.

The sizing of the buffers in the network elements has evolved with capacity and utilization. The improved performance can be observed as shown below.

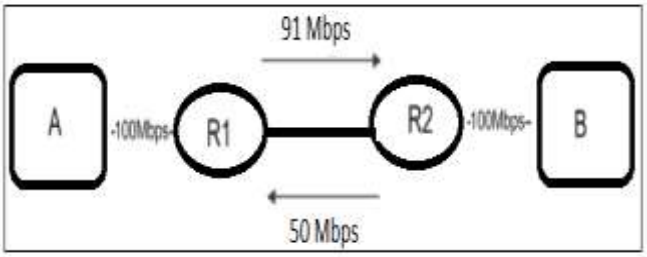

Fig.5 Window based buffered network communication

CONCLUSION

The multi-port network architecture can be optimized to achieve the good performance over the existing infrastructure. There are different theoretical techniques to achieve. Here, below two techniques are considered as the scope of this thesis:

- Port VLAN
- Symmetric port speed for balance network

The software techniques such as Virtual LAN and symmetric network configuration play a vital role for the Network throughput and device performance. The Ethernet performance can be improved approx. 30% in multi-port network systems.

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