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Design and Implementation of LACP Protocol in L3 (Layer3) Switch

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ABSTRACT: There are number of reasons affected in the transmission of high capacity communication like network load, link failure, switch failure, and connection problems. In this case we can apply this method for reducing the transmission time and increasing the throughput. Link aggregation is a mechanism or a method to combine the number of physical link into a single logical link or combining the number of tasks into a single task. We can able to increase the bandwidth between the devices by providing high speed Ethernet cards, Gigabit Ethernet cards etc. The main aim of the project is to increases the transmission speed of the single data files. High Data volume data transfer face problems of low speeds for large file/video transfers over the network, especially in digital/HD video editing, where popular applications require high speed video streaming. It is one of the provisioning approaches for flexible, reliable and high capacity communication. In this mechanism aggregating multiple Ethernet links and achieves a higher data transfer for a single file across networks. Most recently used Gigabit Ethernet cards are provided between the devices which scales up two orders of magnitude to 1000 Mbps, while maintaining the compatibility with systems.

Keywords: Gigabit Ethernet, Power Over Ethernet, Multi Chassis LAG, Switched Port Analyzer.

I. INTRODUCTION

IP is the networking technology of choice for all Defence & other communication networks. Any Communication Network system consists of various network elements like Routers, Switches, Exchanges, and Servers etc are connect together and provide various services to the users. Network will be connected in tandem and users will be connected to the Network by different means. Switch will be an integral part of the network and will provide a versatile interface facility to achieve remote connectivity between various elements of the system. It will provide interface to enable Data Terminals and Graphic Workstation to work off Computing Units located at remote locations on line, Radio Relay and Radio's. It will have appropriate interface to use the existing, planned and projected communication systems of the Defence networks. It will enable networking on dedicated, circuit switched, packet switched networks with varying data rates. The system will be able to work under both LAN/WAN configurations. It will be able to facilitate integration of other component systems of the Tactical C3I System like ACCCS, EW systems, MRASM, NCS etc. The main objective of the project to design and development of a PoE Enabled Gigabit Switch to connect various network elements like Servers, VoIP subscribers, Layer2 switches to the various Communication Networks. This L3 switch design will be planned for 24-ports GbE interfaces with Electrical and Optical SFP port support, 2-10 GbE Optical ports for LAN/WAN connectivity along with other user interfaces. This Switch design is targeted to meet the various requirements of above mentioned networks and to provide high-speed IP packet switching at Layer3 and also to support various other networking protocols with add-on security features support.

II. RELATED WORK

The feature of Link aggregation or Trunking exists in many of the Ethernet switches these days. It is a method of combining similar physical links into one logical link or 'fat pipe' with increased bandwidth and reliability.

Link Aggregation also provides load balancing where network traffic across the logical link is distributed over the physical link members so there is less possibility that a single link is oversubscribed. Link Aggregation has the important benefits below: Better connection availability in case of single link failure. Better utilization of physical links to their capacity due to load balancing. Upgrade to higher performance links can be unnecessary since the 'fat pipe' functions as a high performance link itself. Feature descriptions Link Aggregation or Trunking is a feature on an Ethernet switch to group multiple physical links into a trunk or 'fat pipe'. The number of physical links that can be in a trunk is usually limited[1]. The common number is 8. One requirement is that each link in the same trunk must have the same physical characteristics. They must be either all Gigabit(GE) or Fast Ethernet(FE) links and they should be operating in full duplex mode. Each trunk of a switch can be connected to a trunk of another switch. Connecting 2 trunks means connecting a link member of one trunk to a link member of the other trunk. It is not necessary to connect all trunk members to all trunk members of the other trunk. Therefore it is not necessary for the 2 trunks to have the same number of link members. However in practice, two connecting trunks will have the same number of link members. It is necessary that link members of both trunks to have the same link characteristics (GE or FE) and configuration(auto-negotiation and other link setup) 3 PC's, one server and 2 switches are in the network. Switch S1 and S2 have Trunks(Link Aggregation Groups) configured, with each trunk having 4 link members. When a frame is received in S1 and determined to be forwarded to S2, one of the links (1,2,3,and 4) is selected to carry the frame to S2. The selection is based on a configured hash algorithm in S1. Normally, the hash is calculated based on Ethernet source and destination addresses. Hash can also be derived based on IP addresses or TCP/UDP ports on some high-end switches. Frames receive by S2 that are to be forwarded to S1 will go through the same process. Since links in the trunk must carry traffic in both directions at the same time, it is required that they operate in full duplex mode.

To configure a member link, one must know the configuration of the ports of the LAG of the other switch or server. The port configuration of the port members of the LAGs must be the same. This will insure that the operating speed and duplex will be the same once the ports of the LAGs are connected. Therefore ports of each LAGs must be either configured to be auto-negotiate enabled or disabled. If disabled, the port speed must be configured to be the same and duplex must be configured to be FULL. Power over Ethernet (PoE) allows the switch to deliver power to a device over the existing Ethernet cabling. As you can see in the figure, this feature can be used by IP phones and some wireless access points. PoE allows you more flexibility when installing wireless access points and IP phones because you can install them anywhere you can run an Ethernet cable [2]. You do not need to consider how to run ordinary power to the device. You should only select a switch that supports PoE if you are actually going to take advantage of the feature, because it adds considerable cost to the switch.

III. PROPOSED ALGORITHM

The L3 switch main card consists of two Altera's Cyclone 4 series CE/GX FPGA's, which are connected on distributed architecture. These FPGA's having many built modules like memories, high speed LVDS transceivers, Gigabit Ethernet interfaces, CPCI interface etc along in-built NIOS processor (soft core). Physical Layer functions, Data link layer functions, IP/Ethernet packet processing, other miscellaneous functionalities such as KB/Mouse/USB, VGA, RS232/RS422 interfaces will be implemented in FPGA. External interfaces like Ethernet, parallel Flash, Serial Flash, SDRAM, SBSRAM, ADC, SD card, interfaces are connected to FPGA I/O pins. FPGA is having inbuilt NIOS processor, all the external interface devices are configured and controlled by Nios processor[3]. These devices are interfaced (invoked) to

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Nios processor by SOPC builder tool provided by Altera Quartus Tool. Nios System Software is in C/C++ and many in-built library functions can be used. This processor can be used for device configuration/controlling and testing purpose. Each FPGA is having 12 high-speed transceiver (Rapid I/O 2.5 Gbps) blocks. Internal High-Speed DPRAM blocks are being used for fast processing of data from Trans path (TIFMEM – Transmit Interface Memory block) to Receive path (RIFMEM- Receive Interface Memory block). External SBSRAM also being used for temporary storing and processing of data, Nios processor will handle this. This gives us high-performance and through put.

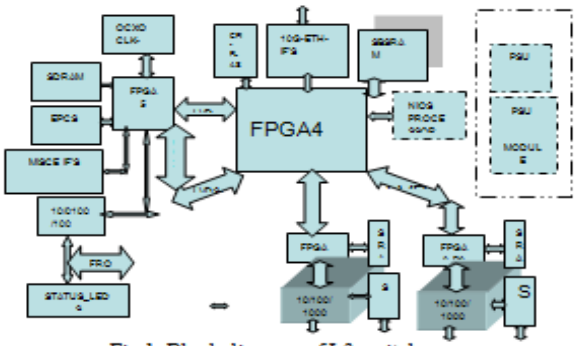

Fig 1: Block diagram of L3 switch

IV. PERFORMANCE EVALUATION

The main goal is to increase bandwidth and provide graceful degradation as failure occurs and also to increase availability. Link aggregation provides network redundancy by load balancing traffic across all available links. Link aggregation is a technique used in a high speed back bone network to enable the fast and inexpensive transmission of bulk data. Best feature is its ability to enhance or increase the network capacity while maintaining a fast transmission speed and high link availability with higher accessibility [4]. A typical LAG deployment includes aggregate trunk links between an access switch and a distribution switch or customer edge device.

Configuration of LAG:

Configuring EtherChannel on Layer2 and Layer3 ports on switches provides fault-tolerant high-speed links between switches, routers, and servers It is used to increase the bandwidth between the wiring closets and the data centre. EtherChannel provides automatic recovery for the loss of a link by redistributing the load across the remaining links. If a link fails, EtherChannel redirects traffic from the failed link to the remaining links in the channel without intervention [5]. The LACP enables Cisco switches to manage Ethernet channels between switches that conform to the LACP protocol. LACP facilitates the automatic creation of EtherChannels by exchanging LACP packets between Ethernet ports. By using LACP, the switch learns to identify partners capable of supporting LACP and the capabilities of each port.

It then dynamically groups similarly configured ports into a single logical link

Creating LAG interfaces

Configuration of EtherChannels is done by assigning ports to a channel group with the channel-group interface configuration command. This command automatically creates the port-channel logical interface.

```
Switch#config terminal
Enter configuration commands, one per line.  End with CNTL/Z.
Switch(config)#interface gigabitE
Switch(config)#interface gigabitEthernet 0/9
Switch(config-if)#channel-group 10 mode active
Creating a port-channel interface Port-channel 10

Switch(config-if)#exit
Switch(config)#interface gigabit
Switch(config)#interface gigabitEthernet 0/11
Switch(config-if)#channel-g
Switch(config-if)#channel-group 10 mode active
Switch(config-if)#exit
Switch(config)#interface gi
Switch(config)#interface gigabitEthernet 0/21
Switch(config-if)#channel
Switch(config-if)#channel-group 11 mode active
Creating a port-channel interface Port-channel 11

Switch(config-if)#exit
Switch(config)#interface g
Switch(config)#interface gig
Switch(config)#interface gigabitEthernet 0/23
Switch(config-if)#channel-group 11 mode active
Switch(config-if)#exit
Switch(config)#interface port-channel 10
```

Fig 2: Configuration of LAG

Configuring port mirroring:

Port mirroring also know as SPAN (Switched Port Analyzer) is a method of monitoring network traffic. With port mirroring enabled, the switch sends a copy of all network packets seen on one port to another port, where

the packet can be analyzed. We use port mirroring to check whether load balancing is happening or not.

```
monitor session 1 source interface Gi0/14 , Gi0/21
monitor session 1 destination interface Gi0/13 , Gi0/24
monitor session 2 source interface Gi0/23
monitor session 2 destination interface Gi0/15
end
```

Fig 3: Configuration of port mirroring

Load balancing

Load balancing distributes workloads across multiple computing resources. Load balancing aims to optimize resource use, maximize throughput , minimize response time and avoid overload of any single resource [6]. Using multiple components with load balancing instead of a single component may increase reliability and redundancy. Using source addresses or IP addresses might result in better load balancing

Configuration of load balancing

Different load-balancing methods have different advantages, and the choice of a particular load-balancing method should be based on the position of the switch in the network and the kind of traffic that needs to be load-distributed

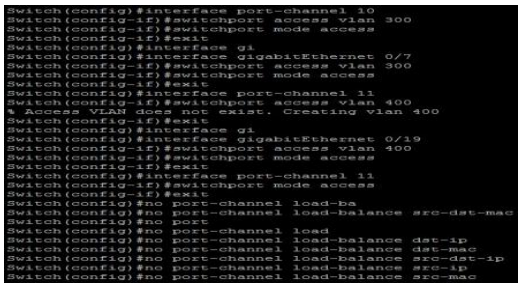

Fig 4: Configuration of load balancing.

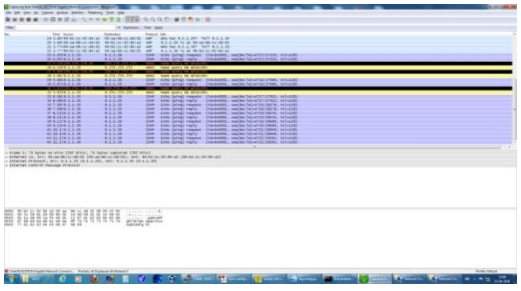

Fig 5: Captures of result on wireshark

V. CONCLUSION

Link aggregation offers two main features which are essential for every network administrator as it provides increased capacity and a failsafe system. By employing Link Aggregation the costs for upgrading the performance and the resiliency of a system can be kept reasonable because both benefits can be attained using the designed hardware. By using automatic configuration protocol LACP we can provide redundancy with automatic switching to the standby link in the case of active link fails. Higher throughput by aggregating multiple links is possible with the designed hardware. No additional network adapters have to be purchased. The benefits of Link Aggregation can be reached with this concept and design and demanding applications running in high performance environments like servers in enterprises, web servers and intranet server gain particularly from the high bandwidth and duplex capabilities of Link Aggregation.

Another important use from this concept is in the MC-LAG (Multi Chassis-Link Aggregation Group).MC-LAG helps organizations build resilient and high performance network architectures allows them to transition smoothly to the world in which information and applications can reside anywhere. The resulting network architectures are fast and reliable and can scale to meet the needs of customers or applications.

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