ISSN: 2278 – 7798
International Journal of Science, Engineering and Technology Research (IJSETR)
Volume 2, Issue 1, January 2013

Link Aggregation Models and Services

Chithra Balakrishnan, M.Manikandan

Abstract— Link Aggregation is a concept to combine number of physical links into one logical link. In this case high volume data should be transferred by using 1GB Ethernet cards. The aggregation process should be done between two network interface cards. 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. Both node connected to an 802.3ad aggregated link and comprise the appropriate number of active link with respect to the traffic load. The present link aggregation exists increases the bandwidth only in the case of multiple data streams. In other wards the bandwidth increase can be seen only while using multiple TCP or UDP streams. The performance characteristics are measured by the experimental test bed including LAN and MAN. The main goal of this project is to increase the data in the single path of the data transfer.

Index Terms— *Gigabit Ethernet cards, Link Aggregation, multiple data stream,Physical and logical links*

I. INTRODUCTION

Link Aggregation means that multiple connections between two network instances are treated like a multiple connection of higher bandwidth. It is implemented according to the IEEE802.3ad standard. It will increase the bandwidth (assuming the system has enough resources to process additional data) and fault tolerance of the connection. Link Aggregation offers an efficient and low-cost solution to increase bandwidth between server and switch. Another advantage it provides is that if a connection fails completely the remaining links can take over the traffic and thus replace the broken line. The Link Aggregation driver helps to increase the network performance by distributing the network traffic among the network adapters belonging to the same group (load balancing). As soon as the server is contacted the driver assigns links to the diverse applications according to the network load. This way, bandwidth can be extended proportionally to the network adapters. All ports that are configured for Link Aggregation (two or more) can be used to transmit and/or receive frames, depending on their configuration. If one connection fails the aggregated connection will lose bandwidth but remain stable as long as at least one connection of the group is working.

II. EXISTING LINK AGGREGATION MODEL

Link aggregation channel has been developed in variety of transmission channels, including ADSL, ISDN, ATM, SHDSL etc. Current link aggregation model can be classified into bonding models, frame-based models, and packet based models.

Bonding models needs identical link rates, and perform link aggregation at the physical layer. It will use bits or bytes of data for operation. Dual duplex High-bit-Rate Digital Subscriber Line (HDSL) combines two 784kbps circuits into a single 1.544Mbps circuits.

Digital Channel Aggregation (DCA) bonds multiple 56MBPS or 64 Mbps circuits into a single logical connection. Four-wire mode Single-pair High-speed Digital Subscriber Line(SHDSL)bonds two identical rate circuits into a single channel, with a total bandwidth ranging from 384KBPS to 4.624Mbps.

Frame-based models implemented in data link layer and use transport protocol for transmission. Inverse Multiplexing for Asynchronous Transfer Mode (IMA) and multilink Frame Relay are examples. Both models require identical link rates, and are subject to all the protocol overhead associated with the transport protocols.

The packet-based models perform aggregation at the network layer. Packet from a single data flow may be transported over a single link and multiple data flow may be transported over a multiple link. The links may have different characteristics in some cases, and individual character may be fragmented to improve performance. PPP Multilink and 802.3ad Ethernet link aggregation are two examples of packet-based models

III. APPLICATION OF LINK AGGREGATION

Each of the link aggregation models has some limitations. Bonding is usually implemented in hardware and which need some identical link rates. Bonding model with ADSL would require disabling the features like link rates, worst-case minimum.

Frame-based model support transport protocol such as ATM to perform framing and synchronization which introducing significant overhead. ATM virtual circuit requires more than 10% overhead for cell headers alone. Most frame-based models are also requires identical link rates.

Packet-based model operate at the network layer, using an end to end protocol such as PPP(Point-to-Point Protocol)to encapsulate each packet. Physical layer characteristics of the ADSL circuit decoupled from the aggregation model so that it is difficult to improve the performance. If the data packet contains mixed packet sizes,

an additional fragmentation and reassembly protocol may be required to improve performance. Packet-based aggregation models cannot guarantee good performance when used with ADSL circuits.

IV. LINK AGGREGATION AND ITS APPLICATION

Aggregation technologies are used to improve the performance and management of a workgroup network in a number of ways. This section presents some scenarios for setup of link aggregation in a network backbone.

A. switch-to-switch

In this scenarios multiple workstations are linked together in an aggregation group between the switches S1 and S2.By aggregating multiple links, higher speed connections can be achieved without any failure occurred in the hardware.

In the Fig 1 depicts the two switches are connected using four GE links. If one link fails between the two switches, that link responsibilities take over another link and connection is maintained, the traffic between the two workgroups are distributed over the 4GE links. This configuration reduces the number of ports of the switch available for the connection.

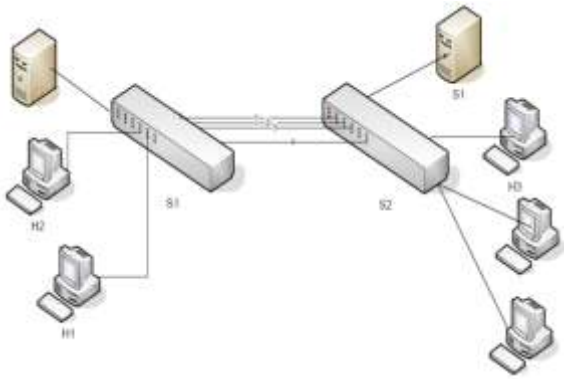

Fig 1 A Sample Model of switch-to-switch connection

B. switch-to-server

Many of the applications available today in a single in a single 100Mb/s link. Link capacity is the limiting factor for overall system performance. Aggregating links is to improve the access to applications and system performance. This diagram shows the connection between server and switch, and Fig 2 shows a trunk with physical links. Switch is connected to nine clients and two Ethernet hubs.

One server is connected to a switch using four 100Mb/s links. In this application, link aggregation is used to improve the performance of the link-constrained server. By aggregating multiple links better performance is achieved without require any hardware upgrade.

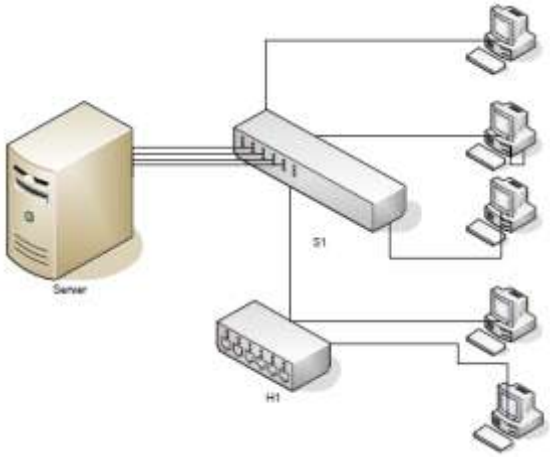

Fig 2 A Sample Model of switch-to-server connection

C. Server-to-server

Application such as data warehousing and data distribution movements are done by using this link aggregation method. This aggregation connections are useful for multiprocessing and or server redundancy applications. This application (eg:-Fig 3)shows how link aggregation group can be employed between 3 servers.

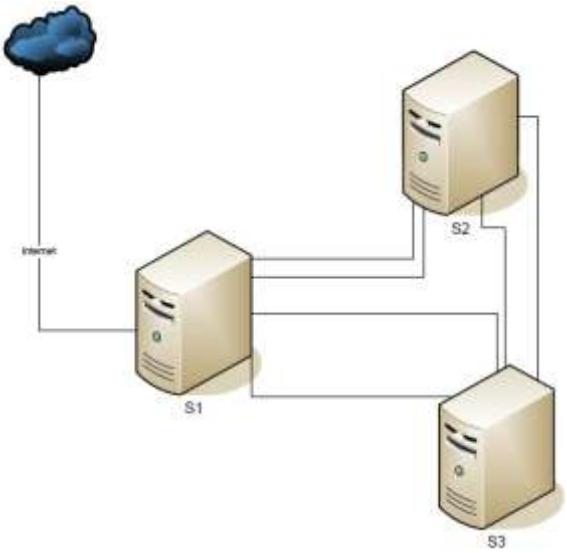

Fig 3 A Sample Model of Server-to-Server

V. LINK AGGREGATION WITH HIGH AVAILABILITY BONDING

The link aggregation mechanism should be take place by using high availability bonding. The driver is used, which allows the kernel to present single logical interface for two physical links.

To guard against layer two (switch)layer one(cable)failure, a machine can be configured with multiple physical connections to separate switch devices while presenting a single logical interface. Bonding support under Linux is part of a high availability solution. This bonding technique can be used to reduce the single point of failure.

Aggregating the bandwidth of multiple physical links is a common approach used to increase network performance. However it will follow splitting a flow over multiple paths with different characteristics can result in transport control problems, which reduce the performance of that particular flow. In this paper briefly explained how link aggregation should performed in Wi-Fi links.

It is used to aggregate multiple Wi-Fi links. The figure shows the two Linux computers each attaches with multiple cards were setup to achieve aggregated wireless links. This technique is used to bond multiple wireless LAN interface into one logical interface. Bonding process requires two P.C terminals. Modes for the Linux bonding driver are supplied as parameters to the kernel bonding module at load time. The behavior of the single logical bonded interface depends upon its specified bonding driver mode. There are seven different bonding modes available in standard Linux distributions. In this study we use the round-robin mode, which allocates one packet in turn to each bonded interface, achieving an even load among all interfaces. The other different modes are,

A. Round Robin:-

Transmit network packets in sequential order form the first available network interface slave through the last. This mode provides load balancing and fault tolerance.

B. Active Backup:-

Only one network interface slave in the bond is active. A different slave becomes active if and only if the active slave fails. The single logical bonded interfaces MAC address is externally visible on only one port to avoid distortion in the network switch. This mode provides fault tolerance.

C. XOR:-

Transmit network packets based on modulo network interface. This selects the same network interface slave for each destination MAC address. The mode provides load balancing and fault tolerance.

D. Broadcast:-

Transmit network packets on all slave network interfaces. This mode provides fault tolerance.

E.Adaptive transmit load balancing:-

Linux bonding driver node that does not require any special network switch support. The outgoing network packet traffic is distributed according to the current load on each network interface slave.

F.IEEE 802.3ad Dynamic link aggregation:-

Creates aggregation groups that share the same speed and duplex settings, utilizes all slave network interfaces in the active aggregator group according to the IEEE802.3ad specification.

G. Adaptive load balancing:-

The bonding driver intercepts the replies sent by the local system on their way out and overwrites the source hardware address with the unique hardware address of one of the network interface slaves in the single logical bonded interface such that different network peers use different MAC address for their network packet traffic.

VI. EXPERIMENTAL SETUP

It is implemented according to the IEEE802.3ad standard. It will increase the bandwidth (assuming the system has enough resources to process additional data) and fault tolerance of the connection. Link Aggregation offers an efficient and low-cost solution to increase bandwidth between server and switch. Another advantage it provides is that if a connection fails completely the remaining links can take over the traffic and thus replace the broken line. The Link Aggregation driver helps to increase the network performance by distributing the network traffic among the network adapters belonging to the same group (load balancing). As soon as the server is contacted the driver assigns links to the diverse applications according to the network load. This way, bandwidth can be extended proportionally to the network adapters. All ports that are configured for Link Aggregation (two or more) can be used to transmit and/or receive frames, depending on their configuration. If one connection fails the aggregated connection will lose bandwidth but remain stable as long as at least one connection of the group is working.

The protocol is able to automatically detect the presence and capabilities of other aggregation capable devices, beyond the features required for Link Aggregation in the IEEE 802.3ad standard, the drivers support an additional failover feature, Redundant Switch Failover (RSF). At the moment this feature is only implemented in the driver for Windows 2000, but will be available for other operating systems in the future.

The concept behind this implementation is to establish two or more TCP connections which are on two or more separate network interface cards [en0, en1, en2 and en3]. This can be achieved by configuring en0, en1, en2 and en3 in four different subnets. The data to be send will be partitioned into different segments which are simultaneously send over the four interfaces and reassembled at the receiving side. In short, for this solution we are required to develop our own protocol. As per our preliminary experiments, we hope to get maximum throughput using this solution.

Theoretically the bandwidth shall increase based on the number of Ethernet links available. However, the real performance of the aggregation with more than two links can be verified only after the implementation.

The system (Fig 4) consists of a read module, message queue implementation and threads for reading operation in the sending side. In the receiving side also, threads for reading data, message queues and a write module will be

implemented. In the sending side, file read operation will be carried out by a single main thread. File will be read as a chunk of 'N' bytes and a header will be added to this chunk of file content. The protocol header will contain the sequence number. After adding the header, the data will be written to a message queue.

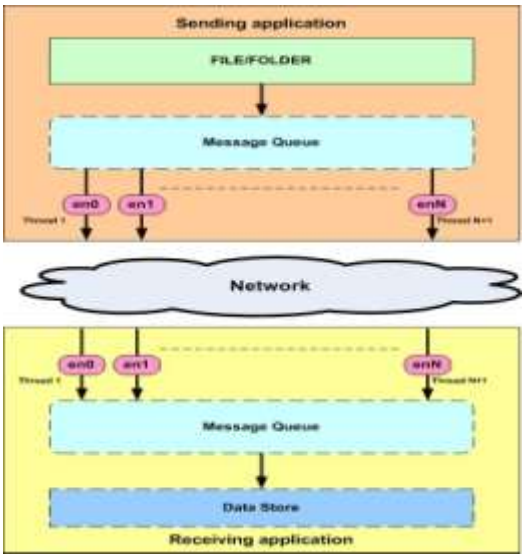

Fig 4 System Architecture

The data from the message queue will be sent to remote application through TCP/IP stack. The data sending operation will be carried out in multiple threads. Number of simultaneous threads will be equal to number of physical Network interfaces [en0, en1…en [N-1]].

At the receiver end data will be read from the TCP/IP stack using multiple threads. The received data will be stored in a message queue. The file will be recreated based on the 'N' bytes chunk containing sequence number as header information. File recreation operation will be carried out in a single thread.

CONCLUSION

. 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. The bandwidth increase can be seen only while using multiple TCP or UDP streams (i.e. multiple conversations). This means that, all the present link aggregation implementation is insufficient to achieve a higher data transfer speed in case of a single file transfer or a single TCP/UDP stream. This is primarily because, all the data packets which are part of single TCP streams are sent through a single port. The objective of this project is to design custom algorithms to uniquely overcome this limitation and also increase the bandwidth of a single TCP or UDP stream. The file transfer speed of a single file can be increased by using multiple links. The experiments will be done first for two ports and then for four ports.

ACKNOWLEDGEMENT

I express my humble thanks to the Almighty for having showered his blessings and divine light to raise me to the height of presenting this beneficial report and to complete my project successfully.

The authors would like to thank members of Ministry of Internal Affairs and Communications,Japan.

REFERENCES

[1] Aust.S,Davis P,Yamaguchi A,Obana S,"Interface Status Monitoring for Wireless Link Aggregation in Cognitive Networks" Global Telecommunications Conference, 2007. GLOBECOM '07.IEEE Digital Object Identifier: pp: 4873 – 4877

[2] Chi-Yuan Chang1, Tin-Yu Wu1, Chin-Cheng Huang1, Allen Jong-Woei Whang2, Han-Chieh Chao3 Department of Electrical Engineering, National Dong Hwa Unviersity," Robust Header Compression with Load Balance and Dynamic Bandwidth Aggregation Capabilities in WLAN"www.google.in

[3] Chih-wen Hsueh, Hsin-hung Lin and Guo-Chiuan Huang"Channel Bonding in Linux Ethernet Environment using Regular Switching Hub", Department of Computer Science and Engineering University of Minnesota,www.google.in

[4] Daniel J.Edeen and David H.C.Du "Implementation and Performance Evaluation of a New ADSL Link Aggregation Model", Department of Computer Science and Information Engineering National Chung Cheng University,www.google.in

[5] Hideaki Imaizumi1, Tomohiro Nagata2, Goro Kunito2, Kenichi Yamazaki2,"Power Saving Mechanism based on Simple Moving Average for 802.3ad Link Aggregation". Research Center for Advanced Science, The University of Tokyo, Tokyo, Japan Research Laboratories, NTT DoCoMo, Inc., Japan.

[6] HOWARD FRAZIER Cisco Systems Inc and Signal Consulting Inc. HOWARD JOHNSON ,"GIGABIT ETHERNET: From 100 to 1,000Mbps". http://computer.org/internet/,Feb 1990,IEEE Internet Computing

[7]http://www.asante.com/downloads/adverts/Link_Aggregation_and_its_applications_R2.pdf

[8] Jayasuriya A, Aust, S, Davis. P, Yamaguchi A, Obana. S, "Aggregation of Wi-Fi Links:

[9] When Does it Work? "2007 ICON 2007,IEEE15th International Conference on Networks, pp 1-5.

[10] Josep M. Blanquer, Josep M. Blanquer,"Fair Queuing for Aggregated Multiple Links", Department of Computer Science University of California Santa Barbara,www.google.in

[11] Klaus Dolzer, Wolfgang Payer," ON AGGREGATION STRATEGIES FOR MULTIMEDIA TRAFFIC", Proceedings of the First Polish-German Teletraffic Symposium (PGTS2000),Dresden, Septempber 2000,Elsviewer.

[12] Kondalarao.Punati1, G. Subramanya Sarma2, Naresh Kumar Reddy.Beechu3"Impact Aggregation of Ethernet Frames For Higher Throughput", @ http://www.ijesat.org [IJESAT] INTERNATIONAL JOURNAL OF ENGINEERING SCIENCE & ADVANCED TECHNOLOGY,Feb 2012,pp 111-116
[13] Martin A. Brown "Link Aggregation and High Availability with Bonding" ,<martin@linux-ip.net
[14] Tiziana Ferrari," End-To-End performance analysis with Traffic Aggregation", Italian National Institute for Nuclear Physics (INFN-CNAF).

Biography

I am Chithra Balakrishnan received my B.E degree in Computer Science Engineering in Viswajyothi College of Engineering from Mahatma Gandhi University in 2011 and now doing M.E in Adhiyamman Collage of Engineering under Anna University Chennai.

M.Manikandan received his B.E degree in Computer Science Engineering from Vel Multimedia Engineering College in 2005 and M.E degree in Computer Science Engineering from Arunai Engineering College in 2007 and currently working as Assistant Professor in Adhiyamaan College of Engineering.