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ETHERNET BASICS : SWITCHES, HUBS, MEDIA CONVERTERS, MANAGED SWITCHES & GIGABIT MEDIA CONVERTERS

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Several Indian Cable Network Owners Have Set Up Independent LAN Networks To Distribute Bandwidth & Provide Broadband Internet Access To Their Clients. This Article Should Serve As A Primer Covering Basic To State-Of-The-Art Devices & Network Components Currently Available In The Indian Market.

BASICS: SWITCHES & HUBS

A HUB

The traditional ethernet hub (concentrator, repeater, etc) is a relatively simple device. It just amplifies the signals received on any of its ports, and broadcasts this signal to all its the other ports.

A SWITCH

A "switch" (or "intelligent" hub, as it is sometimes called) is more of a multiport bridge. It "learns" which MAC addresses (each computer has its own, unique Machine Access Code or "MAC" address, on a network) are on each of its ports and only "repeats" (rebroadcasts) data frames to the appropriate port.

HUBS & NETWORK COLLISIONS

In a traditional hub only one computer on a given network segment can be "talking" at any given time.

The whole network segment is virtually a single wire. Whenever 2 or more systems attempt to send packets at close to the same time there is a "collision." This is called CSMA/CD --- Carrier Sense (listen for quiet), Multiple Access (any card and "speak up"), with Collision Detection.

Whenever a collision occurs the cards involved send a short jamming signal, and then they perform a random "back-off" delay. They then attempt to re-broadcast. Since it is incredibly unlikely that 2 cards will choose the same amount of back-off delay one of them will usually "win" and get to send first.

CSMA/CD works fine with only a few computers on a network. However, as utilization approaches 20% or more, the number of collisions skyrockets and the overall average throughput drags to a crawl.

The traditional answer was to segment the systems, keeping only a few computers on a network.

SWITCHES

Ethernet switches are used to alleviate some of these problems. On a 24 port ethernet switch, it is theoretically possible for 12 computers to be simultaneously exchanging data. This allows for much larger segments (called VLANs or Virtual Local Area Networks).

Ethernet switches are typically much more expensive than Hubs - their more passive cousins. Ethernet switches processors, memory, and firmware.

SWITCH BOTTLENECKS

Also there are degenerate cases. If all of your servers are located on one or two legs of an ethernet switch, it won't help much. All of the clients will be waiting for that one (or those couple of) port(s) to be clear --- a classic bottleneck.

Again the solution is to have lots of smaller servers - segment the network, and replicate the data and services so that they clients tend to use local copies of everything. This is ofcourse expensive and always feasible.

TYPES OF SWITCHES

Switches establish a direct line of communication between 2 ports and maintain multiple simultaneous links between various ports. Switches send information directly from the port and proficiently manage network traffic by reducing un-necessary data transmission to irrelevant ports.

There are 2 types of switching protocols: Cut Through and Store-& Forward.

CUT THROUGH SWITCHING

Cut-through switching starts sending packets as soon as they enter a switch and their destination address is read. The entire frame is not received before a switch begins forwarding it to the destination port. This reduces transmission latency (delay) between ports, but it can propagate bad packets and broadcasts "storms" to the destination ports.

STORE & FORWARD SWITCHING

Store-and-forward switching buffers incoming packets in memory until they are fully received. A cyclic redundancy check (CRC) is run after the full packet is received. The CRC check confirms that the entire packet is received accurately.

However, buffering through a memory adds latency to the processing time, which increases in proportion to the frame size.

Switches enable connection to either a group of computers (workgroup) or a dedicated computer, on each of the ports. Importantly, switches control traffic without modifying any software or hardware already running on the computers.

SMART AND MANAGED SWITCHES

As networks increase in size and complexity, it becomes increasingly important to manage them efficiently. The most important aspect to managing a network, is to ensure that data traffic is routed, through as short a path as possible between the sending and receiving computers.

To do this, switches may be even configured remotely by a network administrator. Such switches are referred to as "Smart Switches" or "Managed Switches".

It may be relevant to take a quick look at the different types of network configurations typically deployed for various applications.

VLAN

Often, a group of computers may intensively exchange data between themselves. These computers may rarely need to communicate outside their "work-group". Such work-groups often also do not

want outside users to eavesdrop on their flow of data. A Virtual Local Area Network (VLAN) provides such a solution.

A Smart or Managed Switch can easily be configured even remotely to isolate the entire work-group quickly creating a VLAN facility for the work-group.

Multiple VLANs can then be set up, allowing VLAN to VLAN communication. Managed Switches permit such a set up without using external routers.

PORT TRUNKING

A Smart / Managed switch can also provide port trunking capability. Port Trunking allows a system administrator to, remotely increase bandwidth where and when required. No additional hardware is needed.

Such a feature can prove invaluable for large LAN networks used to distribute Internet bandwidth. If a corporate customer in your locality is willing to pay for a high speed line (e.g. 256 KBps or higher) this can be configured from the Headend without redeploying additional cable or hardware.

MEDIA CONVERTERS

Indian cable TV networks often deploy a separate (LAN) system for delivering Internet bandwidth to their customers. We have covered this topic in past articles in our magazine. (The articles are included in our "How To..." book reprints as well as available free on our website - www.scatmag.com).

Such LAN distribution networks used Switches for distributing the incoming bandwidth from the control room to various users in the building.

Most switches accept a CAT5 Ethernet cable input. However, there is a limit to CAT5e and Cat 6 cable for long distance data distribution.

To carry the data over long distances (several kilometers), the data is often carried as an optical signal along fibre optic cables. To do this the electrical data signals need to be first converted into optical signals. This function is done by media converters. Media converters accept digital data as electrical signals. These signals are typically in a 10/100 base T format, which are converted, by the media converter to a 100base FX signal. This optical signal can be transmitted, almost lost free, over large distances. The distance over which the optical signal can be transmitted will depend on the loss in the fibre and the optical power output of the media converter. If single mode glass optical fibre (same fibre as used for CATV applications) is used, its loss is a predetermined industry standard (0.35 dB per kilometer @ 1310 nm or 0.25 dB per kilometer @ 1550 nm). In such cases, the media converter directly specifies the total distance of optical transmission e.g. 3 kms, 5 kms or 20 kms.

SINGLE & MULTI MODE MEDIA CONVERTERS

Various types of media converters are available in the market.

Since fibre optic cables are available for either single mode or multi mode propagation, media converters are available for both these modes viz.

* Multi mode media converter
* Single mode media converter.

Media converters may operate in Simples mode, Half Duplex or Full Duplex mode.

Simplex mode implies only Uni-directional (one way) communication.

HALF & FULL DUPLEX

"Duplex" simply means the ability to send and receive data from the same device (e.g. Computer or

telephone).

Half-duplex devices sends & receives, but only one-way at a time. If you've ever used a walkie-talkie, then you know what half-duplex conversations sound like. You have to push the TALK button to send your message. But as long as you are holding the TALK key, you can't hear what anyone else is saying. You must release the button to receive.

FULL DUPLEX

Full Duplex lets each device (PC) send and receive data simultaneously.

BI-DIRECTIONAL DATA

Computer data is necessarily bi-directional. Each computer needs to send out and receive data.

A computer on the Internet receives data from each website. However, to browse, each computer needs to send back information asking for a new web page or URL.

Data is also sent out by Internet users when sending out email.

Hence all media converters must support data in both directions (half/full duplex mode)

To transmit this data in both directions, the media converter may use two separate optical fibre cores.

One strand of optical fibre would be used to send data and another strand to receive data.

It would ofcourse be more economically and elegant for a media converter to send and receive data on the same strand of optical fibre. To do this, a single fibre full duplex media converter users WDM (Wavelength Division Multiplexing) technology. WDM sends data at a particular wavelength and receives data at a different wavelength. This ensures that the received and sent data streams do not interfere with each other.

MULTIPORT SWITCHING MEDIA CONVERTER

Large Ethernet networks not only deploy Smart switches but also could utilise Multiport switching media converters. These devices are essentially a combination of a media converter along with a Smart / Managed switch. Such devices are necessary to route or reroute the data traffic along the trunk. In comparison, a Smart switch will route or reroute traffic along a local distribution path only since the input and output of a smart switch is an electrical signal. The input and output of a Smart Media converter is a combination of optical and electrical signals.

Various configurations of Smart Media Converters are available. These typically could be:
1. One FX port and 4 Tx ports
2. Two FX port and 2/3 ports.

Some very high speed LAN networks utilise optical fibre distribution right upto and into each end users' computer. This topology is referred to as Fibre To The Desktop (FTTD).

In an FTTD network, multiport switching media converters are indispensable to route traffic to individual users.

GIGABIT DEVICES

As networks grow larger and users demand increase in bandwidth, the old 10 Base -T networks have given way to 100 Base T networks, which support data transfer rates of upto 100 MBps. However, even these 100 Base T networks do not offer adequate speeds for large LAN distribution networks.

Gigabit Switches and Media Converters are now available to meet these demands. For Gigabit devices, data is exchanged at speeds upto 1000Mbps.

A Gigabit media converter converts 1000 Base-T electrical signals to 1000 Base-FX optic signals, which are then transmitted on low loss, low interference optical fibre. Gigabit Ethernet is usually deployed along the trunk route of large LAN networks.

OPTICAL NIC

Every computer on a LAN network must have a Network Interface Card (NIC). Each NIC has embedded into it, during manufacture, a unique MAC number. The MAC number uniquely identifies each computer. A LAN administrator can not only identify but also authorise/deauthorise a specific computer.

10 Base T LAN cards (NIC), have now given way to 100 Base T NICs.

As the need for speed increases, the Ethernet based NIC is now giving way to optical network interface cards which directly accept an optical fibre instead of a CAT5 cable.

Optical NICs are essential for FTTD networks. These offer, today, the fastest data speeds with the best noise suppression. Within a few years, these cards will almost certainly see widespread use.

CONCLUSION

The humble Ethernet hub was replaced by an Ethernet switch, which provided faster speeds and better traffic management.

10 Base T networks which supported data transfer speeds of 10 MBps are now obsolete. Infact, even 100 Base T networks are finding it difficult to meet today's demands.

Gigabit devices today promise data transfer speeds of 1000 MBps.

Distribution of data over a LAN network has also undergone a sea of change. Earlier coaxial cables carried signals along the main distribution path but delivered only 10 MBps. A single break anywhere along the distribution line caused the entire system to collapse. The coax trunk in LAN networks has been replaced by optical fibre and optical media converters.

As networks have increased in complexity, Smart media switches have been developed that permit a network administrator located at the control room to reconfigure or redirect signals remotely. These Smart media converters are also now available in India.

We are now rapidly approaching the "Holy Grail" solution where the entire LAN network is based on optical fibers alone. All copper cables are eliminated. The optical fibre snakes all the way upto the computer, terminating into an optical network interface card.

Users and network operators have little to complain about since prices of optical hardware are rapidly falling and available at no more than what was paid for 10 Base T equipment barely 5 years ago. ■

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