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BUILDING A METRO ETHERNET NETWORK TO DELIVER HIGH BANDWIDTH INTERNET PROTOCOL TELEVISION AND INTERNET ACCESS

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***Abstract*— "If you and I were to exchange an apple Neither would have two But if we were to exchange ideas Each would have two ideas" Internet protocol television (IPTV) is a system through which internet television services are delivered using the architecture and networking methods of the internet protocol suite over a packet switched network infrastructure, e.g. internet and the broadband internet access network, instead of being delivered through traditional radio frequency broadcast, satellite signal and cable television (CATV) formats. The available method for delivering IPTV is the ADSL broadband. ADSL broadband has a download bandwidth of 24Mbps.The main limitation of ADSL broadband is that the bandwidth depends upon distance. The ADSL broadband bandwidth varies between 1.5 Mbps to 24Mbps.The ADSL is a proven technology when it comes to delivering shared low speed internet connectivity solutions of bandwidth ranging from 128Kbps to 1Mbps per line. But in the case of services like IPTV it would be a constant streaming of multicast traffic of high bandwidth and this leads to electromagnetic interference. The latest development enables the users to upload programs onto the servers and let the users to assign rights as to who can view the content. This further increases the requirement of bandwidth. An ideal path is to carry muliti-play converged application traffic over optimized path and to extend everywhere with simple switches.**

***Keywords*— Bandwidth, IPTV, Fiber, Internet access, Manageability**

I. INTRODUCTION

Internet Protocol television (IPTV) is a system through which television services are delivered using the architecture and networking methods of the Internet Protocol Suite over a packet-switched network infrastructure.

The IPTV offers triple play services. Triple play service offers high speed internet access, television services and telephone service over a single connection. The IPTV is an interactive service where the user can upload his videos in addition to the service provided by the service provider. The existing method for delivering television which includes cable television and direct to home service cannot offer such value added services.

Video on Demand (VOD) are systems which allow users to select and watch to video content on demand. IPTV technology is often used to bring video on demand to televisions. VOD systems either stream content through a set-top box, allows downloading it to a device such as a set-top box.

Time shifting is the recording of programming to a storage medium to be viewed at a time more convenient to the consumer. The program usually is recorded in the set-top box. In addition to the services provided by the service provider user can be a part of the service providing process by uploading his private videos for sharing with friends and relatives.

II. SPANNING TREE PROTOCOL

The spanning tree protocol is network protocol that ensures a loop free technology for any Ethernet local area network. The spanning tree protocol permits the usage of active and redundant links in a network. The redundant link takes over the function of the active link if any fault occurs in the latter. The main function of the spanning tree protocol is to create a spanning tree of the switches which are connected together in a network and then to disable the link that are not part of the spanning tree. Thus spanning tree protocol ensures that there is only a single path to reach every destination in a network. To break loops in the LAN while maintaining access to all LAN segments, the bridges collectively compute a spanning tree. The spanning tree is not necessarily a minimum cost spanning tree.

A. Operation

1) Selection of root bridge

The root bridge of a spanning tree protocol is the bridge with the smallest bridge ID. The bridge ID comprises of two parameters. One is the MAC address of the bridge and the other parameter is priority. The priority is usually specified by the user. Otherwise the bridges have a default priority value of 32768. This is because in the bridge ID 2 Bytes is allocated for the priority. Therefore the value can range from 1 to 65536, the middle value being the default value. If two bridges have the same priority then the bridge with least MAC address is selected as the root bridge.

2) Determining the least cost path

The computed spanning tree has the property that messages from any connected device to the root bridge traverse a least cost path, i.e., a path from the device to the root that has minimum cost among all paths from the device to the root. This is done with the help of two rules

Least cost path from each bridge: Each bridge in the network determines the cost of each possible path from itself to the root. Then it selects the path with the smallest cost. The port associated with the path is termed as the **Root Port (RP).**

Least cost path from each network segment**:** The bridges on a network segment determines which bridge has the least cost path to the root bridge. This port is termed as the **Designated Port (DP).**

3) Disable all other root paths

Any active port that is not a root port or a designated port is a **Blocked Port (BP).**

III. MULTICAST

Multicast is the method of delivering Internet Protocol Datagrams to a group of interested users in a single transmission. The source sends the packets only once but the network component such as switches or routers duplicates the packets according to the requirements. Multicast is a technique for one- to -many or many- to-many real time communication over a IP architecture. The Multicast is used by the source and the receiver to send and receive data. The source uses this group address as the destination address and the host uses this multicast group address to join the multicast group. The protocol typically used by the receivers to join a group is Internet Group Management Protocol. In the multicast operation the source does not care about the number of receivers. The multicast receiver tree is generated by the nodes which are close to the receivers. The multicast router must only consider about the downstream receivers associated with it.

IV. VIRTUAL AREA NETWORK

The virtual local area network is used to create multiple broadcast domains in the same physical LAN. All the ports in the switch represent a VLAN. The benefits of VLANs are

1. VLANs help to control traffic.
2. VLANs provide security.

V. ASYMMETRIC DIGITAL SUBSCRIBER LINE

The Asymmetric digital subscriber line is a data communication technology that enables a faster data transmission over the copper telephone line. It can transmit data at higher rate by utilising the frequencies that are not used by the voice telephone calls. A single telephone line is used to provide both voice and data communication with the help of a splitter at the customer side. The copper telephone line from the customer terminates at the IP Digital Subscriber Line Access Multiplexer where the voice and data transmission is separated. Then the data from the DSL line is taken to the internet service provider through Optical fiber cable. As the name suggest this technology provides a faster data transmission towards the customer and slower data transmission in the reverse direction. The ADSL communication is Full- Duplex. The Full duplex communication is achieved in a pair of wire by using Frequency division duplex. The FDD uses two frequency bands known as upstream bands and downstream bands. Each band is divided into smaller frequency channels known as the bins.

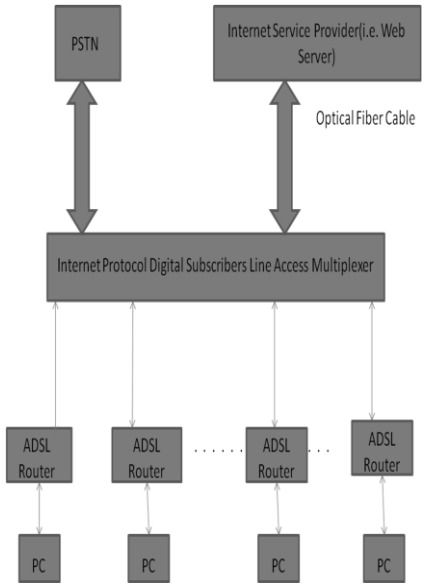

Fig 1.ADSL architecture

B. Digital Subscriber Line Access Multiplexer

The digital subscriber line access multiplexer is a network device, located in the telephone exchange of the internet service provider. The main purpose of using DSLAM is to combine multiple customer digital subscriber lines to the internet backbone of the internet service provider. When the line from the customer terminates at the DSLAM it aggregates the traffic on each ports and send it to the servicing area interface. In servicing area interface the voice and the data traffic are separated from one another. The voice signals are provided to the telephone exchange while the data traffic which is in the form analog signal is changed according to the type of DSLAM which include Asynchronous Transfer Mode, Frame Relay and Internet protocol.

The DSLAM is used only between ISP devices and end-user connection points. The DSLAM traffic is switched to a Broadband Remote Access Server where the end user

traffic is then routed across the ISP network to the Internet. The ADSL2+ provides a downlink bandwidth of 24Mbps and an uplink bandwidth of 8Mbps

C. Limitations:

1. The ADSL provide asymmetric Bandwidth.
2. The uplink and downlink bandwidth provided by the ADSL technology depends on the distance between the DSLAM and the subscriber premises.

VI. Solution For IPTV Delivery

IPTV service also offers high speed internet access and telephone services. The existing technology for providing television does not offer such additional features. Therefore the cable television operators must live with the limited revenue. Therefore the cable television operators must move on to IP based platform. DTH provides Video On demand Movies but cannot provide a wide range of movies due to the usage of satellite for transmission and reception.

In IP based platform the most successful method at present to deliver IPTV is ADSL. The ADSL2+ offer a maximum downlink bandwidth of 24Mbps and a maximum uplink bandwidth is 8Mbps. The IPTV is an interactive service. In IPTV the user is also a part of service providing process by uploading their private videos. Due to the asymmetric bandwidth it does not support such a high demand of uplink bandwidth. Further, the bandwidth offered by ADSL technology is dependent on the distance between digital subscriber line access multiplexer and the subscriber. Each DSLAM can support upto 300 users, therefore if we want to connect more number of customers in the same locality we need additional number of digital subscriber line access multiplexer and which further increases the number of fiber that connects the digital subscriber line access multiplexer and the internet service provider.

An ideal method to deliver IPTV services is to offer multicast traffic over an optimized network path with reliable bandwidth. The services from the central office are taken to the subscriber with the help of the switches and router. The major problem in delivering the service using switches and the router is the last mile delivery. At the last mile we need to provide power to the switches and the last mile delivery is usually restricted to a distance of 100m.

These issues are overcome with the help of power over Ethernet switches. These switches do not require power from any external source and it receives power from the servicing area interface (area node). Due to the usage of the power over Ethernet switches we can extend the last mile delivery up to a distance of 500m.

The core switch (Layer 3) is capable of handling Gigabit ports. The switch has redundancies for switch fabric and power supply. Gigabit ports from the core switch which includes the redundancies is provided to the Optical Multiplexer switch which multiplexes the 8 channel using Passive multiplexer. The multiplexed signal is taken over a fiber with redundancy to the area node. This minimizes the requirement of fiber.

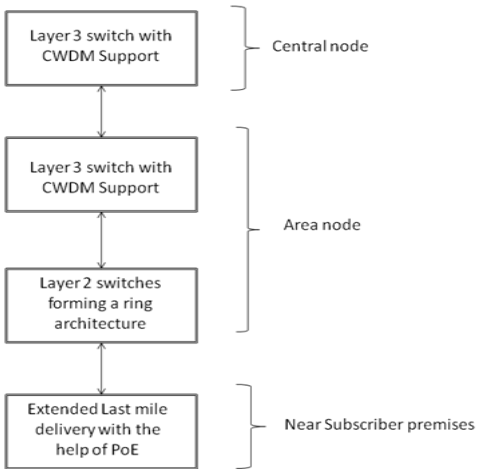

Fig 2.Network Architecture

The multiplexed signal is taken to the local area from the central office. The multiplexed signal is provided to the Optical Demultiplexer switch. At the local area Layer 2 switches are used. The Layer 2 switches consist of gigabit ports with fiber module and 10/100 Mbps Ethernet ports. Eight Layer 2 switches are used to form a ring. This ring architecture is formed using the gigabit ports with fiber module. To each 10/100 Mbps Ethernet port four Layer 2 switch with Power over Ethernet support are connected.

The Layer 2 switches with Power over Ethernet which supports power over Ethernet are used for subscriber connection. The distance between each Layer 2 switch with Power over Ethernet unit is 100m. Thus the last mile distribution can be extended up to 500m. The Layer 2 switch with Power over Ethernet does not require any power supply because it receives its power from the local area where the Layer 2 switches are placed.

Separate ports are used for TV connectivity and internet connectivity. Layer 2 switch constitutes a ring. The Layer 2 switches support the STP protocol. Due to the STP protocol, ring protection feature is enabled. Therefore the port at the extreme Layer 2 switch is disabled automatically.

Even in the worst case condition (i.e. out of the two one gigabit link one is damaged). Then all the customers are on a one gigabit link. At such condition the customers are provided with the same class television service with compromised internet service.

The entire solution is managed end to end with a common NMS for all the products. The setup lets you to manage till the set top boxes. The advantage here is that we can continue to deploy the services with the same set of semi skilled manpower used in the analog cable TV roll out. The Management lets you control each and every point right from controlling the power to the individual Layer 2 switch with Power over Ethernet, to enable or disable the user ports in the Layer 2 switch with Power over Ethernet,

to rate limit on the Layer 2 copper ports to provide pictorial representation of the fiber link status of the Optical Multiplexer. Further the NMS is also equipped with auto provisioning feature wherein any device added in the network gets provisioned automatically in the NMS making management part simpler.

VI. CONCLUSION

Today the setup supports only video, voice and data i.e. triple play services, but tomorrow their might a need for more number of services that has to be delivered to the customer. This needs additional bandwidth that can support the future services and therefore does not pose any problem as the available bandwidth per user apart from the IPTV delivery is enough to deliver other services that might come up in the future. The architecture used is such that it provides services to additional number of users, if in future the population of the same area has increased to a higher level. This is done as the solution offered can be daisy-chained further for extending any/all requirements to evolve from time to time. The solution offered avoids technology and protocol conversion and offers any-time, any technology adaptation in the future, enabling quick roll-out of services. With all these advantages the IPTV is certainly going to be in the top as no other service at present is flexible enough to adapt to the changes that might evolve with time. Due to the above mentioned reasons, these services are in great demand and most of the newly constructed apartments in and around Bangalore are using this technology. It will soon spread to all parts of the city and country where everyone will have IPTV connection, and will be watching movies of their choice or watching a cricket match which they might have missed during the original telecasting time.

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