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EMERGING TRENDS IN TRIPLE-PLAY ENABLED INTELLIGENT DSLAM

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ABSTRACT

The need for value added and differentiated services such as video-telephony, internet TV .etc in the broad-band access hardware continue to increase rapidly nowadays, so we need to analyze the capabilities of the broad band access network architecture whether it can meet the design challenges for providing triple –play services (e.g. video on demand, voice IP).these services generally consumes very high bandwidth, highly delay sensitive and requires efficient hardware.

Most of the service provider based broad band access network has a DSLAM which is a high end network multiplexer; a DSLAM should be completely analyzed based on the following design challenges such as bandwidth scalability, packet scheduling with less complexity, quality of service (QoS) assurance and a good application support. Because implementing triple service in a network needs an intelligent access hardware which adopts itself to meet the requirements. So the ultimate aim of this paper is to focus on the design challenges and the emerging recent trends in triple-play service deployment and how Intelligent DSLAM facilitates itself to meet the challenges in terms of selecting appropriate network processor and aggregation network migration.

Keywords: *DSLAM- Digital Subscriber Line Access Multiplexer, Triple-Play Service, Quality Of Service, Network Processors, Aggregation Network, Bandwidth Scalability*

1. DESIGN CHALLENGES IN TRIPLE-PLAY SERVICE DEPLOYMENT

Over the past few years service providers have focused on adding triple-play services to their products, which actually gives them challenges in transforming their traditional IP based network infrastructure. In spite of network devices are being capable of providing best –effort services in the non-real time data services like e-mail, they need highly reliable, more scalable and quality of service enabled network architecture. The foundation for a successful triple-play service is to ensure a flawless user experience by satisfying the user with superior quality of expectation.

As most of the service providers are in the early stage of deployment, their major Challenge is to build an optimized network infrastructure for accommodating massive growth of subscribers. Since the resource utilization efficiency plays a vital role in determining the quality of service of the triple-play device, most of the service providers upgrade their existing infrastructure like replacing the existing ADSL line with ADSL+ for higher bandwidth reach in the DSLAM. Like wise most of the service providers are careful in making critical investments in network infrastructure to prepare them for a long term utilization to meet the subscriber demand and minimize the cost.

Triple-play service deployment has considerable specific challenges or requirements for efficient service delivery than the above; some of those services are:

- Bandwidth scaling
- Service control and priority

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- Providing good Quality of Experience
- Congestion avoidance
- Ensuring for smooth migration of legacy services

2. TRIPLE PLAY – REQUIREMENTS AND RECENT TRENDS

2.1 BANDWIDTH

In order to support any kind of triple-play service starting from broadcasting TV, internet video or voice IP. The architecture must be optimized for sustained high bandwidth demand. As shown in the table 1 below, the upstream and downstream bandwidth of some of the triple play applications has been analyzed .which can clarify the bandwidth need of these services and how the network infrastructure should adapt itself for the bandwidth scalability .

Table 1:

Type of service	**Bandwidth**	
	upstream	**downstream**
IP television	50 Kbps	16 Mbps
Internet gaming	256 Kbps	256 Kbps
Voice and video phone(VOIP)	220 Kbps	220 Kbps
High speed internet	512 Kbps	3 Mbps
Total	1 Mbps	20 Mbps

Though this increased downstream bandwidth looks satisfactory, it is quite difficult to deploy the services with higher quality of experience as the video streaming services need constant and deterministic bandwidth. Meanwhile the bandwidth scalability and optimization also depends on the type of the access network or an aggregation network like DSL, ADSL, which should give maximum bandwidth reach b_r . The value of b_r get reduces when the distance of the aggregation line increases. Following graph in fig 1 illustrates the bandwidth limits of ADSL, ADSL2, ADSL2+ and VDSL2 lines; it shows the maximum theoretical bandwidth reach of the each line with respect to the increase in the distance.

By looking into the graph below in fig 1 the suitable aggregation network can be identified with respect to the maximum bandwidth reach. VDSL2 lines have the maximum reach (more than 50 mbps) in the DSL family of networks, VDSL2 is highly scalable to offer the required capacity of bandwidth and minimize the transport cost of video traffic. Can accommodate hundreds of gigabit Ethernet ports per node, thereby it can support hundreds of broadcast channels to support video and voice related triple-play services.

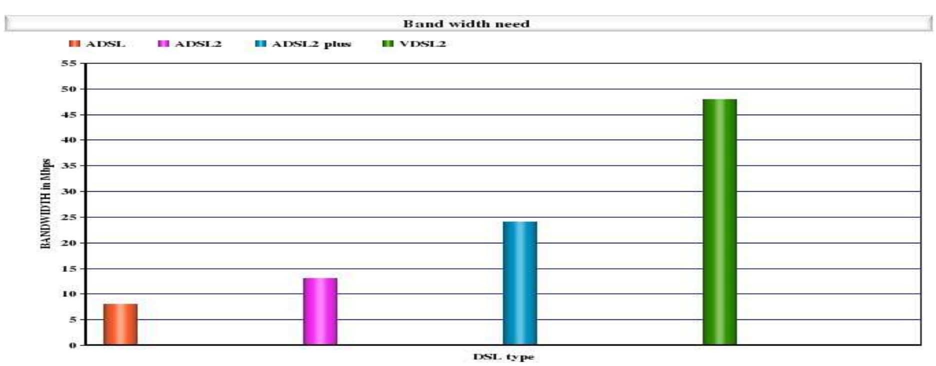

Fig 1: Bandwidth limits for DSL family of networks

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2.2 SERVICE FORWARDING AND SCHEDULING

In order to utilize the available bandwidth for every particular triple-play service, the network resource has to be controlled by a centralized service and a subscriber management system. This ensures the appropriate scheduling of network resources and priorities involved in the service forwarding. Streaming applications such as audio or video are characterized by the time taken for the packet flow rather the time taken between the inter packet flow.

Triple-play services are highly real-time streaming applications, it needs a constant bit rate, and resources need to be reserved in a number of possible time intervals and also a priority based resource allocation. Audio and video are encoded at a low bit rate, in order to assemble a payload of large data and to be sent in a short periodic burst., thereby the burst data transfer needs a priority-based, non-blocking and time frame conservation for executing low priority services.

Among the triple-play services voice based services has the highest priority, then video and followed by the high-speed internet services. The unused bandwidth has to be reserved with a time frame for executing the low priority network services in the queue. In the case of a high priority service is in need of bandwidth, low priority services can be pre-empted for optimizing the resources.

2.3 QUALITY OF SERVICE

The foundation for a successful triple-play service is to ensure a flawless user experience, by ensuring a guarantee in the performance which the user expects. The quality of experience not only lies on the bandwidth scalability or scheduled traffic management in the services. Moreover, it is with the positive experience and customer satisfaction as it comes to video and audio services. For the triple-play services the QoS lies in the quality of expectation QoE, which provides them a complete satisfaction if the following requirements are satisfied.

- Uninterrupted service delivery – which guarantees mechanism for avoiding node failure and assured restoration or recovery of service.
- Multicast functionality support – enables multiple channel based services for multiple users at a faster bit rate.
- Congestion avoidance- preserves service session from quality degradation due to network overload.
- Content security- helps to deliver content securely and protection against piracy or replication
- Trouble shooting and monitoring- manages the usage data through a centralized monitoring and trouble shooting tool.

2.4 FLEXIBILITY TOWARDS APPLICATION SUPPORT

The success with any triple-play deployment is decided by the flexibility and innovative service architecture provided by the hardware associated with that. Architecture should help us to re-architect existing service or new hardware deployment. Features like aggregation network flexibility, subscriber management, protocol based authentication and security policy enforcement can be implemented for efficient service delivery. Most flexible features for better application support are

- A non-disruptive migration of existing data and network services.
- Scalable network infrastructure for optimized transformation

By considering the above design challenges the DSLAMs and aggregation network must have sufficient capacity to grow with the rapid growth of customers, together with the offering of multiple services per customer. DSLAMs also need enough processing power to replicate the video and voice data services. By considering these design challenges service providers started implementing the triple services with Intelligent DSLAM, which has been evolved to meet the design challenges. In the upcoming section we will focus on how it does.

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3. INTELLIGENT DSLAM

Recent years had a drastic growth in the DSL technologies, lead to develop a multiservice and intelligent DSLAM that combines support for multiple DSL transmission type from a single integrated platform. such DSLAMs delivers scalability, redundant architecture for reliability, efficient deployment of broad-band networks with high-speed, supports several application services like ISDN,RADSL,DMT(Discrete Multi tone), quality of service(QoS), optimizes the bandwidth of existing infrastructure, as well as delivers integrated service over a single physical medium that is providing multiple service to the DSLAM from different vendors.

Considering the inherent qualities of the Intelligent DSLAMs it is clear that they are well suited for the triple-play service deployment, we will proceed further to know how the Intelligent DSLAMs are managing the design challenges efficiently, also how it overcomes the constraints like low resource utilization, complexity in bandwidth scaling, less quality of service., with respect to the type of network processor hardware and aggregation network deployed in DSLAM.

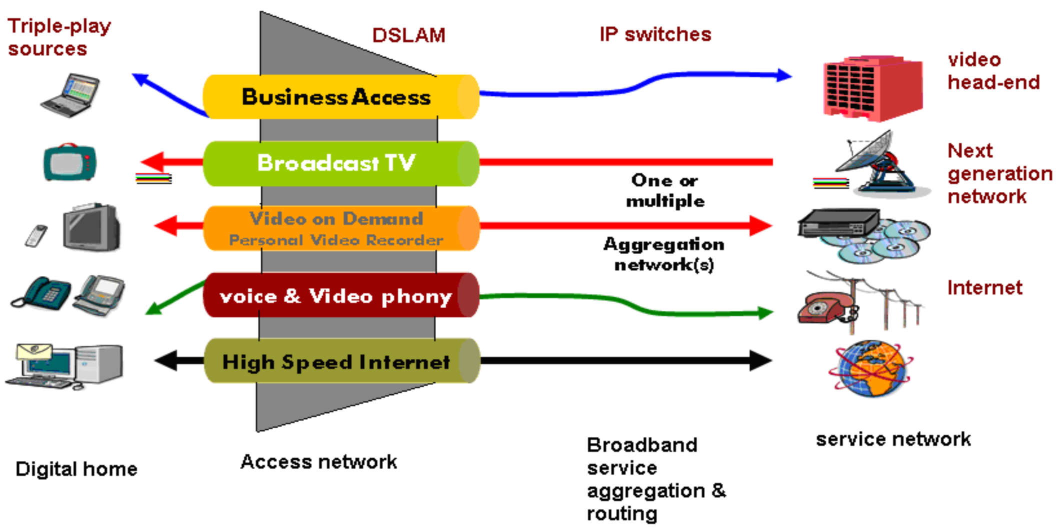

Fig 2: DSLAM as Triple play enabled device

3.1 SIGNIFICANCE OF NETWORK PROCESSOR AND AGGREGATION NETWORK IN INTELLIGENT DSLAM

3.1.1 Network processor

Network processors are inherent for carrying out the tasks which require more processing power, also tasks which is time critical and routed over a critical path inside DSLAM. Their architecture is based on parallel processing with pipelined as well as non-pipelined architecture depending upon the application different types of processors are used in the DSLAM slots. As the intelligent DSLAMs are in growing phase of triple-play deployment, it selects network processor based on ASIC and FPGA design technologies emerged with Intelligent and integrated, multi-core processors.

The processors exhibit lot of flexibility in distributing the processing across the chip. Like, service guarantee for bandwidth-constrained networks, co-processor based traffic scheduling, line sensitive power consumption. Even more processors involved in both low and high processing power consuming tasks

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depending on its architecture. Services like video on demand where multiple processor lines are requires replicating the frames. Where assured multicast of the video service at n number of channels, can be achieved through a non-pipelined architecture. On the other side dedicated service tasks like voice applications, encryption and decryption and other high speed internet services can be processed with a individual co-processor which forwards output to the processing unit. The following table 2 has the comparative study between a pipe-lined and non-pipe lined processor, along with their specific functionalities can be used in determining the suitable processor for Intelligent DSLAM design.

Table 2:

	Cisco	**Mind speed**
Speed	900MHz to 1.2GHz	450MHz,533MHz and 650MHz
Memory Architecture	Four 32-bit RISC core Packet processing equipment PPEs,1 GB on chip memory	ARM based, (64+64)kb data and instruction cache, on-chip 128 kb SRAM
Bandwidth	5 Gbps-100 Gbps	155 Mbps-10 Gbps
Programmability For Feature Additions	Supports instructions based on ANSI C	Supports ARM thumb instructions and java instruction sets
Voice Related Features	Series session border control, Call admission control, firewall based flow control to media	High quality acoustic echo cancellation technology, 3-way conferencing
Video Related Features	Multicasting, Visual quality experience and video call admission control (Cisco ASR 1000)	Video overlay insertion, video image trans- sizing, frame rate modification (COMCERTO M85000)
Different Types Of Data Features	High-end route reflector, voice and data service along with regular IP service, embedded high-speed firewall	Unified threat management applications, IP enabled PBX, high speed WAN router
Security	Deep packet inspection, intrusion detection and prevention	Has security co-processor, supports IPv4,IPv6,tunnel/SSL & also algorithms like DES,SHA1-256,RSA
Specific Feature	Efficient packet scheduler, centralized shared memory and forwarding – path software	Combine efficient DSP processors, acceleration co-processors in a single SOC chip, application specific network processors.
Hardware Architecture	Non-pipelined architecture, packet processing	Eight stage pipelined architecture, single and dual core architecture
Scalability	Highly scalable, can execute 1200 MIPS	Highly scalable, can execute 1600 MIPS
Interface & Co-Processor Support	Supports external interfaces and co-processors, major processing inside the chip by PPE's	Has very high I/O, QoS and co-processor support ,such as Wi-Fi, voice-DSP and video co-processors
Software Compatibility	Has combined hardware and software architecture, scalable multi -processor software	Supports open source tools also backward compatible with lower version processors
Processors	Cisco ASR 1000 series	Comcerto 800,1000 & 5000 series
Power	Less than 400 mW	Less than 1.5 W

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3.1.2 Aggregation network

Aggregation network are the carriers which delivers the service end to end, thereby they are responsible for the quality of service and flexible application support. in order to support a triple play capable device it should be able to manage point to multi point traffic, sustained QoS capabilities, low implementation cost and higher bandwidth capacity.

In the recent years most of the service providers started migrating from ATM based aggregation network to Ethernet and Fiber optic can be seen in the graph illustrated in fig 3 below. Even though ATM has strong QoS capabilities it could not satisfy the challenges of triple-play services. In case of Ethernet based network it supports most recent DSL technologies (like VDSL) with maximum QoS capabilities in terms of bandwidth efficiency with less packet over head, provision for multicast services and also with scalable bandwidth. Moreover fiber optic based network design started emerging in the recent years which has passive optical network technologies (PON), capable of high speed point to point communication, excellent quality of service for video and voice, very high bandwidth (more than 100 Mbps) reach for upstream and downstream network traffic.

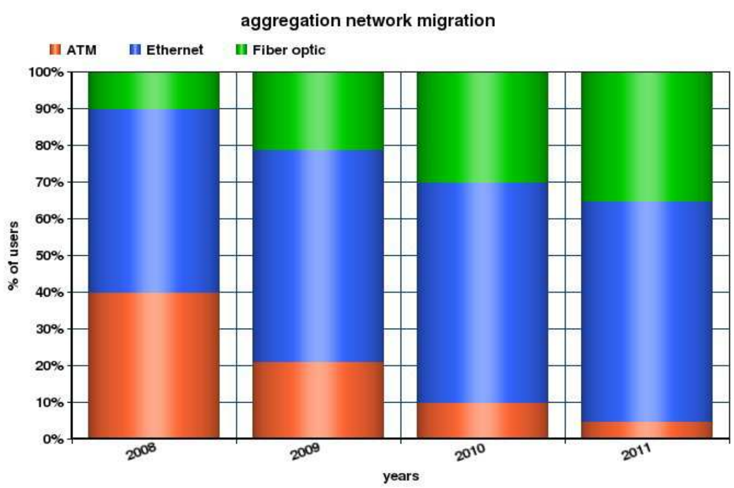

Fig 3 migration towards Ethernet and fiber optic

4. SUMMARY & CONCLUSIONS

Triple-play service deployment has imposed a wide variety of new functional, performance and capacity requirements on the intelligent DSLAM especially. Hence in order to develop a state-of-the art testing tools and methodologies, which allows the customer to ensure their devices to comply with requirement, deliver the desired performance and quality of service. The DSLAM equipment manufacturer or designer need to be updated with the emerging technology over the triple-play enabled DSLAM equipments. This makes him comprehending the architecture, functionality of the DSL network and new testing methodologies.

Intelligent DSLAMs has been developed in the recent times has features like optimizing the bandwidth with existing Infrastructure, providing multiple service in a single hardware platform, customer specific application support and smooth migration from legacy services; is decided by the network processor and type of aggregation network available with the DSLAM, thereby the selection of suitable network processor and aggregation network plays a vital role in the overall efficiency. As the bandwidth scalability and scheduling functionalities are managed by the network processors, other side the type of aggregation network decides the quality of service and the application support flexibility of the deployed service like triple-play service.

Even then the intelligent DSLAMs performance also lies on the implementation of an advanced IP control plane on a commodity operating

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system and also a standard –based API is needed to enable efficient control and data plane communication for developing an intelligent DSLAM based triple-play solution.

It always helps the service providers to keep updated about the rapid requirement changes and trends in the design of the Intelligent DSLAM enabled with the triple –play services, will help them in re defining their own architecture and design policies for a better growth in deployment of new services at low cost and high customer satisfaction, as they are promising technology for the future communication industry.

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