Multiservice Data Networks

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Data service is the new philosophy in data communication. A working knowledge of communication technologies like Frame Relay and Asynchronous Transfer Mode (ATM) based solutions, present state of technology, available product options and interface and interoperability issues are essential for network managers and operators. It is also important to understand service issues such as network availability, assurance of grade of service, bandwidth management and optimization techniques and applicable standards to achieve seamless interoperability and integrated management of the network resources. This paper introduces multiservice networks, highlights their benefits and discuss their relevance in meeting the communication requirements of Sri Lanka in the next millennium. This paper does not discuss the SMDS (Switched MultiMegabit Data Service), B-ISDN (Broadband ISDN) and FDDI (Fibre Distributed Data Interface)/CDDI (Copper Distributed Data Interface) technologies.

1. Introduction

Today's networks must handle a growing mix of traffic: voice, fax, multiprotocol data, LAN traffic and video. Integration of all these traffic lowers communication costs, simplifies and stream line the network management and reduces maintenance operations for network managers and network service providers. The proliferation of wide area networking services gives the corporate users the freedom to choose the service that best suites their topology requirement, application and budget. On the other hand, multiservice networks enables the network operators to provide a wide range of bearer services and value-added services such as Internet connectivity and Virtual Private Networks (VPN) catering a spectrum of users ranging from home Internet surfers to large corporate customers. The implementations of the data service networks can be broadly categorized into three main classes viz. remote office connectivity, corporate networks and service provider networks.

2. Remote Office Connectivity

This section of the paper address small organizations with a head office and one or more branch offices at remote locations. Typically the main communication requirement between the offices will be voice/fax, Local Area Network (LAN). Legacy system application which require synchronous or asynchronous communication such as between a host computer in the head office and terminals in the branches is also common in today's organizations.

The traditional way of interconnecting these offices will be to provide a tie line trunk between the private branch exchanges (PBX) for voice/fax communication and a leased line wide area link by deploying routers at each office for LAN traffic. A set of dial-up lines could be used for host/terminal communication. In this traditional solution the tie line (voice) and the leased line (LAN) are often under utilized.

Integration Multiplexers or Access Multiplexers are a new bread of products that can provide a cost effective inter-office communication by way of integrating the different types of traffic in to one single link. Figure 1 illustrates the application of a Integration Multiplexer between two offices.

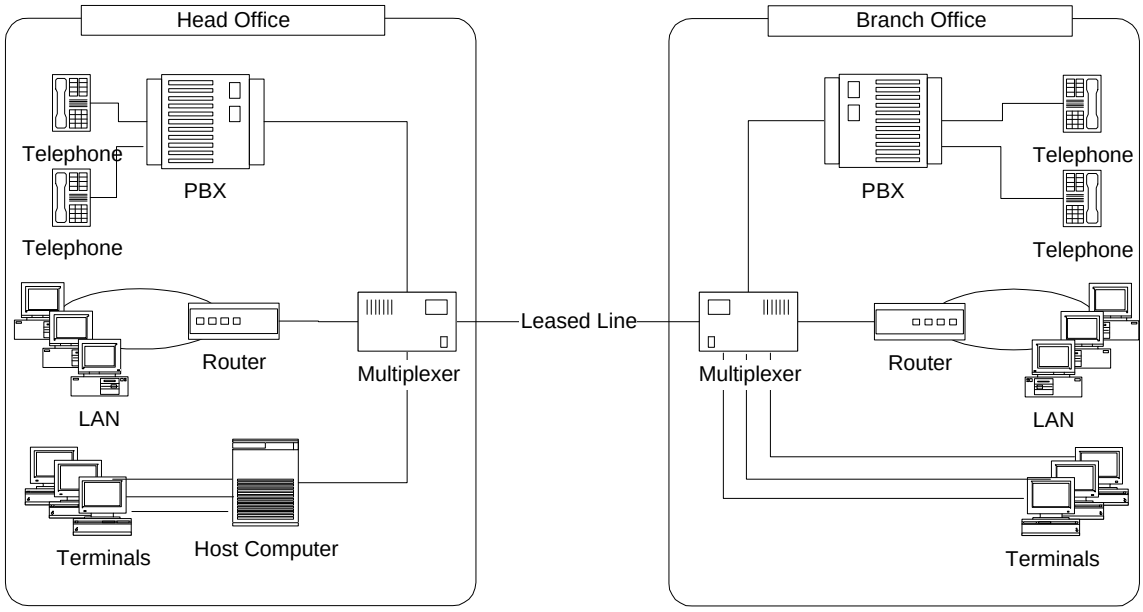

Figure 1: Multiplexer based solution for remote office connectivity.

Multiplexers use various techniques to compress the voice and data so that the available bandwidth in the leased line is utilized efficiently. On average a voice channel utilizes only about 30 - 40% of the bandwidth during a normal conversation. Voice can be compressed by silence suppression technique and coding techniques like Adoptive Differential Pulse Coded Modulation (ADPCM). The ITU standard G.729 compress the 64kbps standard Pulse Coded Modulation (PCM) voice down to 8kbps at the tone quality. Other proprietary coding methods adopted by different can compress voice down to 4kbps; of course, the tradeoff is between voice quality and occupied bandwidth.

LAN traffic is bursty in nature. The bandwidth utilization of a data channel can vary from 0 to 100%. Moreover the packet latency of the data is not as critical as that for voice. Therefore data can travel along with voice channels in a communication link. Data compression algorithms are being in existence for some time and they are heavily used in multiplexers.

Proprietary standard framing and encapsulation types are used by the vendors to achieve best utilization of the channel bandwidth. With today's Integration Multiplexers available in the market it is possible to construct a network with star, ring and mesh topologies. Most multiplexers support Asynchronous Transfer Mode (ATM) and Frame Relay interface to enable them to be deployed over a Public Data Network (PDN). Generally throughput of multiplexers are considerably low than that of dedicated routers or switches. This prevents the use of them in large corporate networks.

3. Corporate Networks

A well planed and deployed enterprise wide corporate network can serve as the communication infrastructure for large organizations. Messaging, work flow automation and video conferencing applications can be implemented over an enterprise network. An enterprise wide network can span across the country or it can even be a global one. The arrival of the Internet and Intranet technologies have made several large, medium and small organization to setup their own corporate networks. The organization who cannot justify the investment have found the way out by riding on PDNs using Virtual Private Network (VPN) technology.

Shown in figure 2 is a medium scale corporate network. The nodes of the network are connected through leased lines or VSATs (Very Small Aperture Terminals) links and routers on each nodes. The reason for referring it as a medium scale network is that the non-integration of voice service. The integration of real time voice and video into a corporate network is the next step in investment and will require high bandwidth on the network. Asynchronous Transfer Mode (ATM) offers the best bandwidth management for data, voice & video applications.

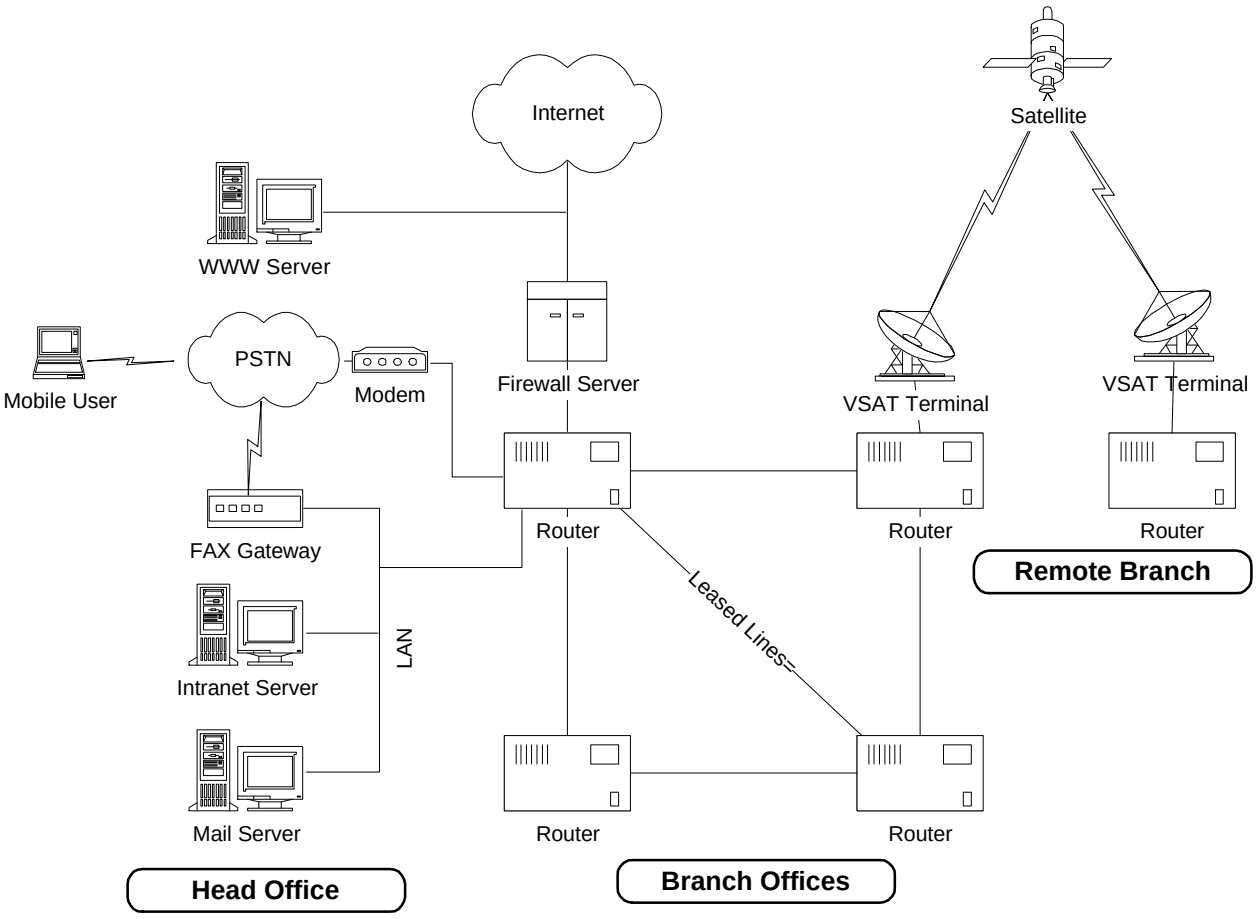

Figure 2: A Multiservice Corporate Network

Document sharing and messaging are two important applications of a corporate network. All the inter-branch communications can be done effectively through electronic mailing system. The Internet connectivity to the whole enterprise is provided through its own network. This extends the corporate mailing system to the global e-mail system. An intranet server at the head office will serve as centralized database for all the corporate information and publications. The information in the database can be anything from plane text to multimedia contents. The type of traffic expected on corporate network determines the bandwidth of the interconnect links and throughput of the nodes. Video and other multimedia applications require high bandwidth. The Network Manager of the organization should scale the network for the anticipated traffic. The node routing/switching capacities and link speeds should of the right size. A high speed link between two low speed routers or vise-versa will be a wastage of network resources.

The common type of links are leased 64kbps running wide area data link protocols like PPP (Point-to-Point Protocol) for LAN traffic and ATM or Frame Relay over E1 link. In the above diagram, a geographically isolated branch is connected via VSAT. VSAT technology provide a cost effective way of connecting two remote sites. But the limited bandwidth (64kbps max) and latency issues impose restrictions in the application of the VSAT links.

The fax gateway server located in the head office provide store & forward fax service over the PSTN (Public Switched Telephone Network) for the entire organization. The home and mobile employees can dial-in via the modem and get access to the Intranet and mail system. A limited access can be given to partner organizations to access the information via Internet and a World Wide Web server can also be deployed for Web presence.

The network is not of a fully meshed topology. The alternate paths between the routers maintains the connectivity in the event of link failures. Dial backup and 'Bandwidth on Demand' links can be configured to protect from multiple link failures and high bandwidth demand during certain time periods.

4. Service Provider Networks

Service provider networks are built and operated by commercial organization to cater for corporate customers. A carefully planned and operated network can provide almost any communication service that is demanded by the end user. The services available from a public network ranges from Internet access, point-to-point '*clear channel*' links, Virtual Private Networks (VPN) services. Multimedia contents and video conferencing activities demand high bandwidth and low network latency. Service providers uses various technologies to provide the bandwidth and assure the quality of service (QoS).

Figure 3 illustrates a typical multiservice network operated by a service provider. The core of the network is a mesh connected ATM switches connected by SDH (Synchronous Digital Hierarchy) or PDH (Plasynchrnous Digital Hierarchy) transmission system.. ATM is a connection oriented cell relay technique that can carry connection and connection less services at both constant bit rate (CBR) and variable bit rate (VBR). ATM uses virtual calls to transmit user information. 155 Mbps ATM remains as the popular choice for inter connecting back bone nodes. Backbone nodes are to render high speed switching at the OSI layer 2 (data link layer). Since ATM uses fixed length frames switching can be done at hardware level resulting in high throughput. ATM operates by defining Switched and Permanent Virtual Circuits (SVC & PVC).

Unlike the circuit switching technologies, ATM makes best use of the available bandwidth. The standards define ATM for E1 (2.048 Mbps) rates as well to provide access connections.

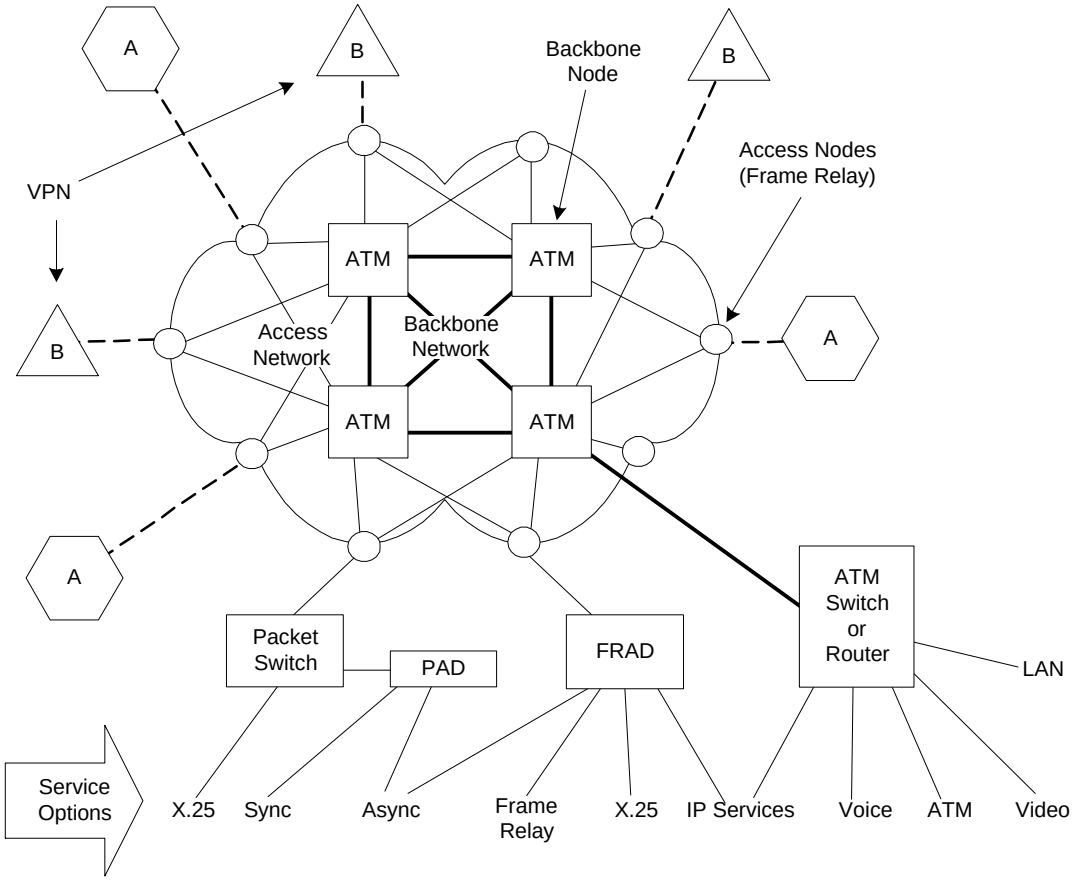

Figure 3: A Multiservice Network & service options

The periphery; i.e. the access network is made up of Frame Relay switches. Frame Relay is being considered as the next generation packet switching technology. Similar to X.25, Frame Relay switching is accomplished through the use of HDLC (High level Data Link Control) based frames. The major difference is that unlike X.25, Frame Relay lacks error detection and correction mechanisms. Error detection is only applied to the frame header and in the presence of error the packet is dropped. The application running over the Frame Relay is expected to take care of lost and out of sequenced frames. Frame Relay will perform best when the underlying transmission medium is reliable.

The Frame Relay technology provides a flexible way of providing several logical connection in one physical connection. Different Data Link Connection Identifiers (DLCI) defined by the user and the network service provider enables multiple service connections over single physical channel. Frame Relay technology defines a Committed Information Rate (CIR) which is the data transfer rate guaranteed by the service provider to each customer. CIR is usually about one third of the link bandwidth. This means the user data can burst above the CIR up to the link speed and if the network has spare capacity the data will flow through. If the network is loaded it will drop the packets. The network provider can also specify a Committed Burst Information Rate (CBIR). CBIR is higher than the CIR and lower than the channel bandwidth. This guaranties

that a short burst of data up to the CBIR also will be delivered to its destination by the network. Such QoS factors enable the Frame Relay service provider to present a flexible tariff structure to his customers based on CIR and CBIR while always allowing them to utilize the excess bandwidth available on the network. Frame Relay is being considered as the most appropriate 'last mile' access connection to the customer premises in a Multiservice network.

Frame Relay Access Device (FRAD) is deployed at the customer end to split the different virtual circuits. Most of the routes available in the market today has a Frame Relay interface to function as a FRAD when the appropriate software is loaded into the router.

Figure 3 also describe the concept of Virtual Private Network (VPN). Organization *A* and *B* has connected their respective branches to the public network physically. But the logical interconnections are defined within the respective organizations, branches only. Both organizations will *'see'* it as if they are connected by their own network. VPN technology drastically reduces the intra-company communication costs since the network's initial and operational costs are shared by several customers.

In addition the network service provider can run value added services like Internet access, Web Hosting, E-Commerce and other On-line services. Voice over IP (Internet Protocol) and voice over Frame Relay are two immerging technologies which the network service providers seriously considering and the telecom (voice) providers are feared of!

Adherence to standards in the communication industry is important to ensure what is called a 'seamless integration and interoperability'. ITU (International Telecommunication Union) and the ISO (International Standards Organization) play key role in defining standards. Industry groups like ATM Forum and Frame Relay Forum leads the standardization process by setting and complying to working (draft) standards.

5. Conclusion

In Sri Lanka there is no fully fledged public Multiservice Networks. Data services are provided in a limited way by the telecom and other data network providers. In the present day communication industry providing digital data links in not only uneconomical, but also does not yield the best out of the network resources. In an age where customer service and quality reign over price, the real winner is the individual or company who provides the widest range of data transport services and quality network services such as good user response, well-planned operations activities, user-friendliness and an entrepreneurial answer to customer needs. The service providers who accomplish this through deployment and operation of integrated service oriented networks will emerge as the true winners.