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METRO SOLUTION

Video Service Solutions: Delivering Video over DSL

Abstract

Telecommunications operators around the world are struggling with problems of increasing the average revenue-per-user (ARPU) in a highly-competitive market. Revenues from traditional local and long-distance telephone services are declining, and competition for customers is increasing. Many are searching for the Holy Grail of service provision – the killer application. One application, which is gaining a lot of interest, is the delivery of digital TV channels and video streams over the existing telephone network. This Metro Solution discusses the potential for this market, the building blocks for delivering this as a revenue-generating solution, and, finally, gives an example of such a video service delivery deployment.

The Market Landscape

Once upon a time, everything was a lot simpler. Telephone companies delivered telephone services to a market in which they were the only players. Protected from the competition by government regulations, telephone companies enjoyed a steady stream of revenues from their telephony service offering. But deregulation in the 1990s and the resulting growth in competition has changed the competitive landscape forever. We now see many new players such as cable TV companies, utility companies, and alternative carriers offering voice and data services to both residential and business users. The exponential growth of Internet usage in the second half of the last decade has placed extra demands and requirements on the service providers. Although there is ample bandwidth available in the metro and core network, the so-called "last-mile" bottleneck in the access network remains a challenge. Furthermore, recently the huge growth in the use of the World Wide Web and email as both business and leisure tools has focused much attention on the infamous last-mile bottleneck. The two leading solutions for providing better broadband access to residential subscribers are:

- Digital Subscriber Line (DSL) technologies, which use the existing telephone wire connection to deliver both voice and data at speeds up to 8 Mbps or even higher depending on distance for the telephone exchange and condition of the copper cabling. DSL technology is maturing and reaching price points suitable for delivering Video-over-DSL. Asymmetric Digital Subscriber Line (ADSL), the simplest and inexpensive DSL technology, is ideally suited for broadband access to the residential customer base. It is a fairly mature standard leading to cost-efficient ADSL implementation. ADSL offers data rates of roughly 8 Mbps downstream to the customer and 650 Kbps upstream. It is ideally suited for residential broadband access, especially a combined package of voice, video, and data service.
- Cable TV systems, which, although originally designed for one-way TV broadcast, have now been upgraded to allow two-way traffic with the addition of cable modems for attachment of home PCs. Cable companies are also starting to offer or experiment with delivery of local telephone services.

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The stage is therefore set for the battle for subscribers. Winning customers is key. Cable TV companies feel they have a major advantage with their so-called triple play of TV, data, and voice services on the same cable. They have the potential for packaging different combinations of all three services to create attractive monthly tariffs and a single bill at the end of the month. Cable TV companies see this as the main weapon to compete with the incumbent telephone and direct satellite broadcast operators.

So how should incumbent telephone companies respond? They have seen their margins from fixed-line telephone services plummet over the last few years due to the deregulation and commoditization of the voice market and the growth in the use of mobile telephony. Deregulation has forced many to rent their twisted copper pairs to competitive local carriers to provide broadband DSL access. But these new players have found it increasingly difficult to implement a viable business plan and many are in financial difficulties or have ceased trading altogether. This has left the stage clear for the incumbent telephone operators to compete head-on with cable TV companies using their most important asset – the local copper loop.

If there is one thing that the incumbent telephone operators can and should learn from the experience of the competitive local carriers offering DSL services over the local loop, it is that basic connectivity services are not enough. There will always be someone offering such a service cheaper or faster. What is crucial to customer acquisition and retention is the delivery of value-added services, which provide high margin incremental revenue while utilizing the existing infrastructure. The most promising service to deliver is video streaming. Not only are these services popular and forecast to increase in adoption as broadcast technologies move from analog to digital transmission, but they are also the missing service to compete effectively with the cable operator's triple-play strategy.

Sample Business Case

Alliant Telecom of Canada decided in the early '90s to transform themselves from a traditional telephone company into a multimedia service company. They could see that revenues from fixed-line telephone and other narrowband services were falling under the dual pressures of commoditization and competition from other carriers and mobile operators. Alliant launched its first new service offering in 1996: high-speed Internet access utilizing its all-digital, all-fiber network. Then in 2000, Alliant was the first company in North America to launch a commercial interactive digital TV service over the same telephone connection as the Internet and voice service. Introduction of high-margin digital TV service incrementally doubled average revenue per subscriber as shown in Figure 1.

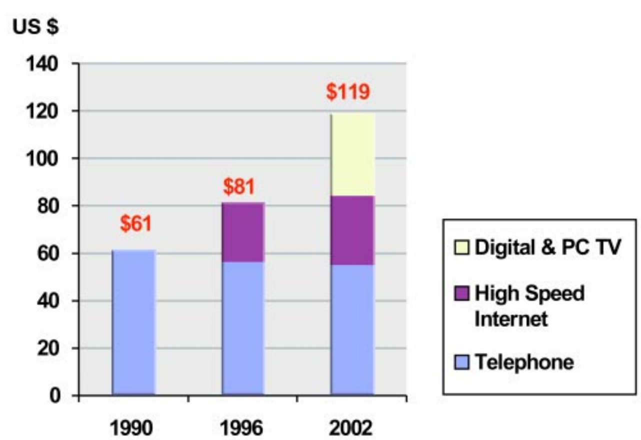

Figure 1. Incremental Subscriber Revenue Example ($/month)
(Source: Cahners In-Stat Group)

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Types of Video Services Available

The cable TV and the direct satellite broadcast companies have seeded the market for all types of new services not currently available on terrestrial analog broadcast networks. Features such as channel bundling, home shopping, premium channels, and pay-per-view sports events have increased the revenue per subscriber from a basic package averaging $30 per month to premium packages of nearly $100 per month. For telephone companies that are seeing their average monthly revenue subscriber falling below $25 per month, these are ideal services to offer. And when combined with the existing voice and high-speed Internet access, the package provides the counter-punch to the cable TV triple-play strategy.

Digital TV

Digital TV is the basic building block and enabler of all these services. Digital TV (DTV) derives from earlier work with High Definition TV (HDTV). HDTV uses a screen ratio of 16:9 instead of the traditional 4:3 (or 12:9) ratio employed by existing TV screens. This format is much better for broadcasting movies, which on a traditional screen either have to be specially formatted or broadcast in "letter-box" format wasting the top and bottom areas of the screen. HDTV also uses nearly twice the number of scanning lines compared to NTSC or PAL systems to give a brighter and clearer picture. Due to the higher resolution and screen size, it takes the equivalent of five analog TV channels to transmit one HDTV channel. However, by digitizing the HDTV format and using MPEG compression techniques, it is possible to fit six digitally compressed channels or one digital HDTV channel in an equivalent analog channel.

Video-on-Demand or Pay-per-View

Video-on-Demand (VOD) offers consumers control over what they view and when they view it – a recently released popular movie or a chance to catch up on an old movie classic. In addition, the huge growth in pay-per-view sports events such as boxing and soccer can provide a useful additional revenue stream above the basic TV subscription service. Other advanced programming features can also be offered to provide the equivalent of full VCR features such as pause, playback, rewind, and fast-forward, as well as full digital viewing quality.

Interactive DTV

Once the provider has a two-way communication channel with its customers, all sorts of interesting revenue-generating services are possible. For instance, in the screening of a sports event, many camera angles are possible. Replays from another vantage point can be called up instantaneously. Video-over-DSL uses a single two-way connection; this offers a huge advantage over cable and satellite competitors in terms of a complete interactive experience. Commands can be sent and received in-band rather than out-of-band over a separate telephone connection as with CATV and DBS systems. This results in much faster channel changes and new picture angles. Other popular interactive services include e-commerce services such as home shopping, networked video gaming, and Internet access through the TV.

Key Technologies for Service Delivery

One of the most convincing business arguments for implementing Video-over-DSL services is that it is enabled over existing deployed assets. The most widely deployed asset is the copper loop. Using Digital Subscriber Line (DSL) technologies, telephone companies can deploy Video-over-DSL services without disrupting existing telephone services. In this section we briefly describe these technologies and then show how they can be used together to provide a video service delivery architecture.

ADSL & VDSL

Digital Subscriber Line (DSL) technologies are familiar to most people as a way of providing high-speed broadband Internet access over the local phone loop. What is not as well known is that these technologies were originally developed in the early 1990s to experiment with delivering video services over the plain old telephone system. For various reasons including regulatory restrictions, services were not deployed. Instead, DSL was utilized as a way of delivering higher speed broadband services to satisfy the huge demand for Internet access in the late 1990s.

Since DSL services use the same copper telephone loop used for voice services, there are built-in speed and distance limitations that have given rise to different variants of DSL depending on the distance from the exchange and the quality of the copper. Most types of DSL are asymmetric rather than symmetric and deliver more bandwidth **downstream** towards the customer's premise than they do **upstream** to the central exchange. The two major variants considered suitable for video delivery are:

- **Asymmetric DSL** (ADSL) – this can operate at up to 5 km from the exchange and provides downstream bandwidth up to 1.5 Mbps and upstream bandwidth of 348 Kbps. Within 1 km of the exchange, these bit rates can increase to 8 Mbps downstream and 640 Kbps upstream.
- **Very-high-bit-rate DSL** (VDSL) – VDSL can operate in either symmetric or asymmetric modes at bit rates up to 52 Mbps downstream and 6.4 Mbps upstream within 300 meters of the exchange or 13 Mbps downstream/1.6 Mbps upstream within 1,500 meters of the exchange.

A recent report by Gartner Dataquest[1] has shown that in Western Europe, nearly three-quarters of customers are within 3 km of the local exchange. In fact, in Italy about 90% of subscribers are within 3 km of an exchange.

MPEG Streaming

Video content to be broadcast can come from a number of sources. It may be an analog feed from local or satellite broadcasters. In some instances, broadcast companies do the digital encoding prior to distribution, or the digitized source can be taken from ad insertion servers or Video-on-Demand servers. The digital encoding normally used is known as MPEG-2. The bit-rate required to broadcast MPEG-encoded video depends on the video content. For example, a typical "talking head" stream such as a newsreader or chat show requires a bit rate of 2 to 2.5 Mbps. Whereas an action movie or sporting event requires a variable bit rate averaging 4 Mbps with peaks of 10 Mbps. From the DSL bit rates given above, it can be seen that ADSL can cope with normal TV or movie streams as long as the consumer is within 3 km of the exchange, whereas VDSL would be needed for handling multiple video streams required for interactive TV applications such as multiple-view sports events. However, there are new encoding standards on the horizon, such as MPEG-4, which will halve the amount of encoded data for both compression rates. Also, further advances in DSL technology indicates that achievable bit rates will improve dramatically over the next few years.

IGMP Multicast

Once a video stream has been encoded digitally, it can be put in an IP packet and then broadcast over the provider's network to all subscribers. Since a lot of subscribers will be watching the basic broadcast channels, only one copy of the video stream needs to be sent out and replicated or multicast at the edges of the broadcast network. In order to identify which subscribers should receive that video stream, a unique channel identifier is assigned to the packet. This is analogous to a normal TV channel. Internet Group Management Protocol (IGMP) multicast is simply the technical term used in the IP world for how subscribers

[1] *Western European Operators' Plans for Video-over-DSL, Gartner Inc., December 2001*

are added or removed from different channel groups. Subscribers sign up for one or more channels; a database of different IGMP multicast groups (channels) is maintained by the IGMP-enabled Riverstone multicast routers. The multicast routers around the edges of the transmission network will then broadcast to individual subscribers who are members of the multicast groups. When subscribers change channels, the IGMP database is updated with fast "Joins" and "Leaves;" this is equivalent to switching from, for example, channel 5 to channel 6. Once an IGMP fast "Join" and "Leave" has taken place, the new video streams are directed to the subscriber.

Video Service Delivery Architecture

Putting these technologies together results in the video service delivery architecture shown in Figure 2.

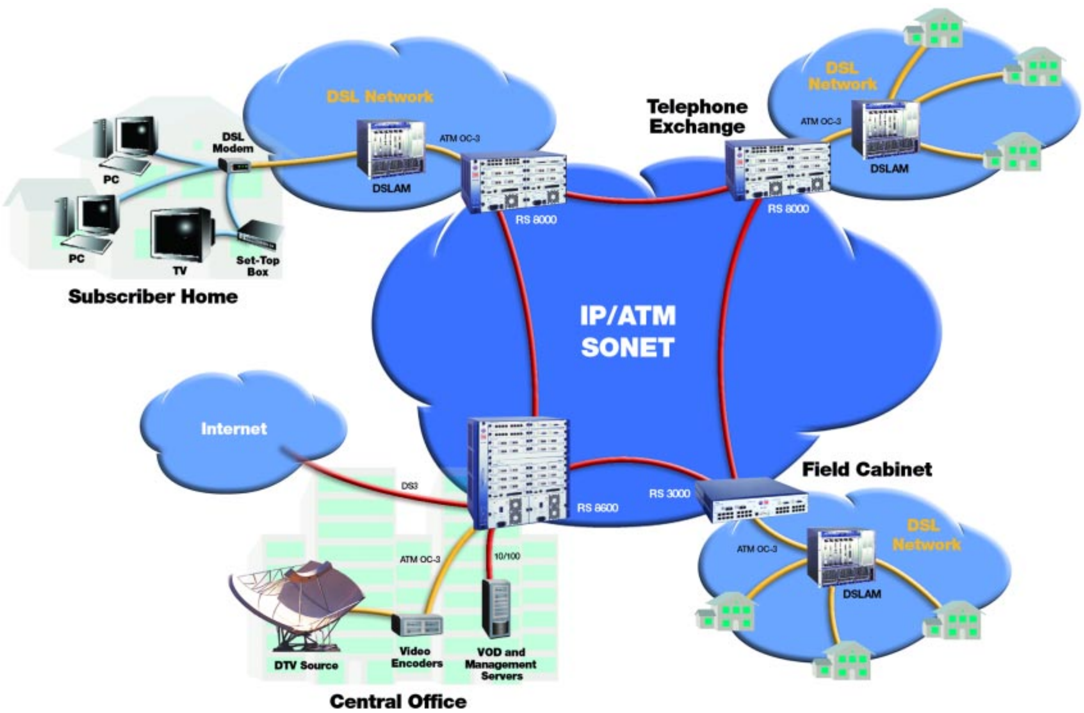

Figure 2. Video Service Delivery Architecture

The Video Headend

The video headend is the source for all video content. It includes the broadcast feeds either from Digital Broadcast Systems, local broadcast studios, local advertisement insertion, Video-on-Demand servers, etc. Once the content has been encoded in MPEG packets, it can also be properly shaped for the constant bit rate used over the ADSL links. The content is then assigned a channel identifier and passed as an IP packet to the IGMP multicast router for broadcast to the channel groups subscribing to each video stream. Each channel group is mapped to an ATM Virtual Circuit (VC) and passed to the ATM switch for forwarding over the backbone network to the appropriate local exchanges.

The ATM Backbone Network

Asynchronous Transfer Mode (ATM) is the preferred backbone infrastructure that incumbent telecommunications operators use to deliver voice and data services. It is also used to provide DSL services to subscribers. Since it runs over the top of the existing SONET/SDH network along with voice and data traffic, it means operators can use a single network for a packaged service delivery – voice, video, and data. ATM was designed for delivery of voice, video, and data streams and has built-in class and quality-of-service mechanisms for transferring both variable and constant bit rate data dependably. It is therefore a natural fit for providing the constant bit rate circuits needed for video transmission. The video streams travel as IP packets across the ATM backbone, to the exchange's local, then to subscribers.

The Last-Mile Delivery

When the IP packets reach the local telephone exchange, they are forwarded to the Digital Subscriber Link Access Multiplexor (DSLAM), which terminates the local subscriber lines. Each virtual channel terminates at an ADSL, which is part of the customer premise equipment. The ADSL modem splits the voice data for the telephone, the video data (MPEG over IP) for the set-top box, and the data stream for the home PC. The set-top box accepts IP packets, unwraps the packets, and decodes the payload back into MPEG cell for video display.

Subscriber Management

One of the main advantages of the Video-over-DSL solution is that it provides a unified single interface to the subscriber. There is one wire going into the house, one TV or PC-based interface for the subscriber to call up and customize services, and, most importantly, one bill at the end of the month. The customer user interface can be controlled through the subscriber's remote control or through a special remote control keyboard provided by the operator. This interface allows the subscriber to:

- Select and customize channels to be viewed
- Change channels
- Select video or pay-per-view extra services
- Set up local preferences and controls e.g. for protecting children from accessing inappropriate material or chargeable services
- View their current bill

The Middleware software package is used for end-to-end subscriber management such as service activation, billing, service termination, etc.

Example: Customer Deployment

Riverstone Networks is partnering with other Video-over-DSL solution component providers to provide a completely tested, end-to-end solution for video service delivery.

Along with Minerva Networks (video headends), AFC, (ATM switches and DSL infrastructure), and Myrio (subscriber management systems), Riverstone is delivering the IP multicast routers to leading companies such as Livingston Telephone of Texas for Video-over-DSL deployment.

Livingston Telephone is a small local telephone company with around 15,000 subscribers in rural Texas. Using Riverstone's Video-over-DSL solution, Livingston is now able to offer digital TV using the existing telephone infrastructure in areas where there is no cable company presence. This means that they are able to reach customers not addressable by the competing cable TV companies. Livingston offers the following services to their subscribers:

- Digital TV with customizable channel line-up, fast channel change, and parental control settings
- Movies-on-demand with support for searchable movie listings, customizable content categories, movie previews, parental control, and virtual VCR for "storing" rental movies
- Web access using either the TV or PC including a walled garden feature for security and parental control

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Summary

Cahners In-Stat Group[2] predicts that by 2005, video broadcasting using the telephone network will be available to 55 million homes worldwide. In the U.S., nearly 30 local telephone companies are already deploying services or are conducting field trials. In Europe, British Telecom and Kingston Communications in the UK, and Telenor in Norway have deployed limited services to test the concept and drive business over their DSL networks. Gartner Dataquest has also predicted that over 60% of incumbent carriers are planning to launch Video-over-DSL services.

Incumbent telephone companies are always looking for ways to increase revenue per subscriber without major expenditure in building out new network infrastructure. Advances in technologies for video compression and digital subscriber line are opening up a brand new market for companies with access to the last-mile local loop. Consumers are looking for a single supplier that can deliver their home entertainment and communication needs. Video-over-DSL offers incumbent operators a powerful competitive weapon to compete with the new players and generate much-needed revenue from their existing asset base.

Glossary of Acronyms

ADSL	Asymmetric Digital Subscriber Line
ATM	Asynchronous Transfer Mode
ARPU	Average Revenue Per User
CATV	Cable Television
DBS	Direct Broadcast Satellite
DSL	Digital Subscriber Line
DSLAM	Digital Subscriber Line Access Multiplexor
DTV	Digital TV
HDTV	High Definition TV
IDTV	Interactive Digital TV
IGMP	Internet Group Management Protocol
Kbps	Kilobits per second (1 Kilobit = 1,024 binary digits)
Mbps	Megabits per second (1 Megabit = 1,048,756 binary digits)
MPEG	Moving Picture Experts Group
SDH	Synchronous Data Hierarchy
SONET	Synchronous Optical Network
VDSL	Very-high-bit-rate Digital Subscriber Line
VOD	Video-on-Demand

[2] *A Telcos Guide to Video Stream Processing Solutions, Cahners In-Stat Group, 2001*

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