IPTV Technologies and Deployment Challenges

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Outline

What is IPTV?

Market Drivers

Triple Play/IPTV – A Quick Introduction

Technology Enablers

Network Transport Architectures

Challenges

Competitive Threat

IPTV Vendors and Service Provider Strategies

Conclusion

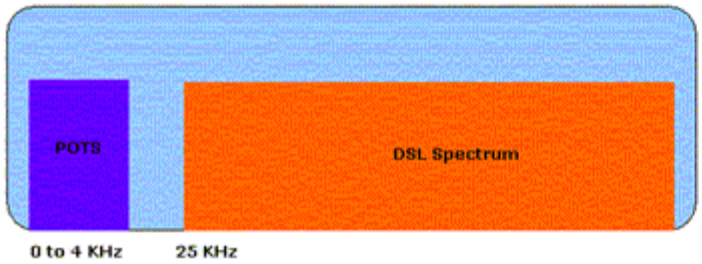
Technology Enablers

Digital Subscriber Line (DSL) Standard

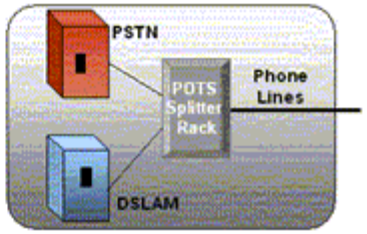
Enables bi-directional communication on the copper pair

- Existing copper plant can be leveraged without spending billions in fiber
- Designed to co-exist with the *plain old telephone service* (POTS)

Family of standards (*ADSL, ADSL2, ADSL2+, VDSL* etc.) with various rate and reach characteristics



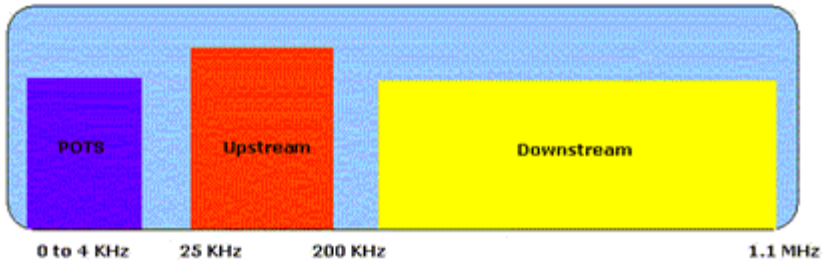
DSL Spectrum Space



Asymmetric DSL

First version of the standard

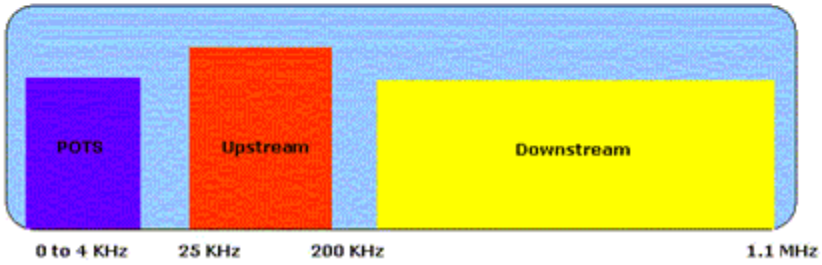
- DMT based modulation. Divides spectrum into small 4KHz (32 QAM) channels
- Peak data rate *10Mbps* downstream, *640Kbps* upstream
- Reach upto *18K* feet



ADSL2

Improves the rate and reach of ADSL on longer lines

- Improves rate by *50Kbps* downstream and reach by *600+ft*.
- Achieves higher coding gains, reduced frame-overhead (*programmable*), advance signal processing algorithms
- Rate adaptive. Power management support. Interoperable.
- *Deployment friendly!* Diagnostic capability built-in to support troubleshooting and in-service performance monitoring



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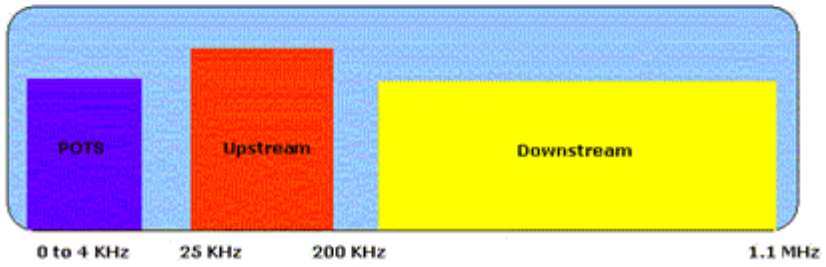

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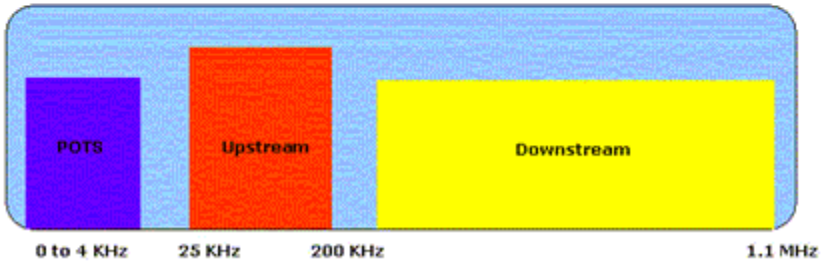
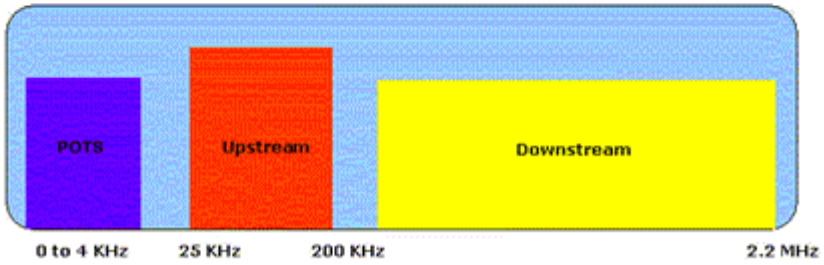


ADSL2+

Doubles the Downstream bandwidth for loops *< 9Kft*

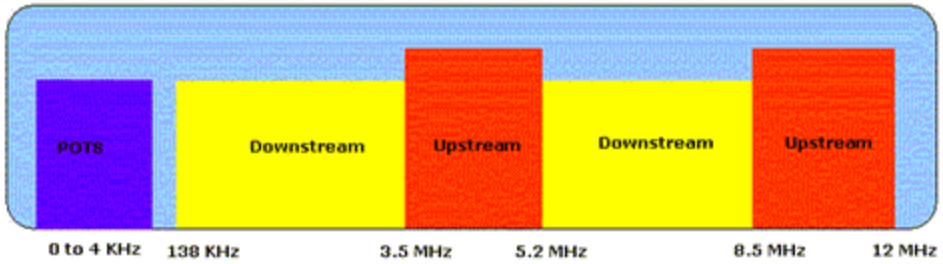
- Peak data rate *25+Mbps* downstream
- Supports masking of frequencies below *1.1MHz* to reduce crosstalk between CO and Remote Terminal *(RT)* based ADSL services



VDSL

Standard Finalized in late 2004

- Supports both DMT and QAM modulation schemes
- Peak data rate *52Mbps* downstream, *3Mbps* upstream for distances upto *2Kft*
- Supports symmetric mode



VDSL2

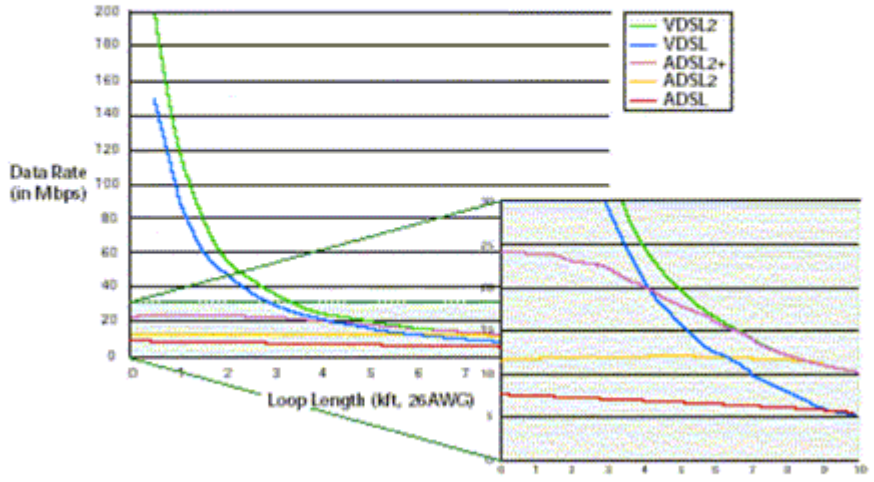
Still in the standards but chipsets in the market

- Extends the spectrum usage to *30MHz.* Supports single DMT based linecode
- Interoperable with VDSL
- Supports symmetric data rate *100Mbps*
- Works for very short distances. Useful for the FTTC deployments

DSL Rate Reach Comparison

DSL Performance Matrix

Source: Texas Instruments, Aware Inc. and the Yankee Group, 2004



Video Compression Technologies

High compression of video content is an important element in IPTV environment

- Last mile DSL bandwidth is limited
- Lowers bandwidth requirement in transport network
- Better compression means lower storage requirements for VoD servers and Personal Video Recording (PVR) devices

MPEG-2 is the most popular standard

- Developed in 1995. Can achieve compression ratio of 50:1
- Widely used in the Set-top boxes, DVDs
- Most of the content today is encoded in MPEG-2

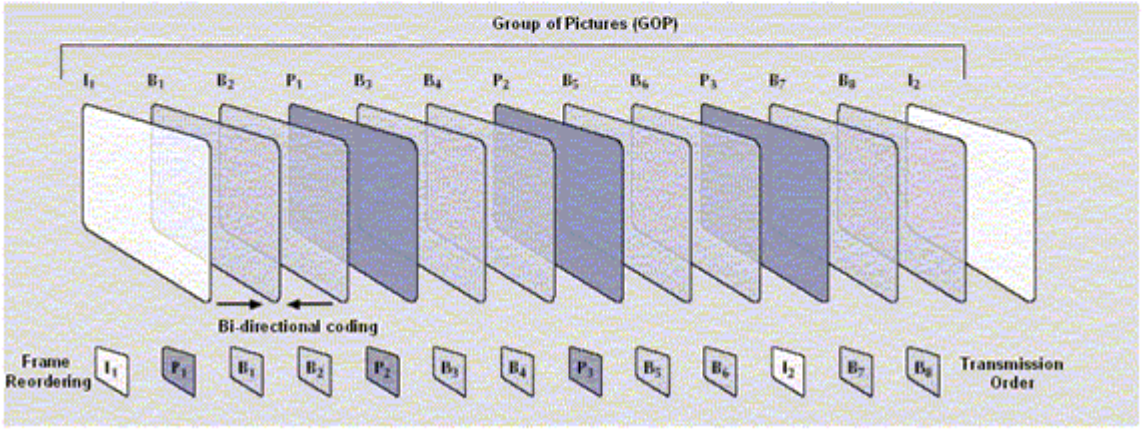
Advances in video compression significant in last decade

- Advances in algorithms
- Moore's law

MPEG Frames – Generation, Transmission, Reordering

All MPEG standards use identical I(Intra-coded), P(Forward predicted), B(Bi-directional predicted) frame structure

- Transmission order of frames different from display order



MPEG2 Compression

DTV Standard	Pixel Resolution	Data Rate
Standard Definition (SDTV or DVD Quality	640 x 480	4 Mbps
EDTV	704 x 480	7 Mbps
HDTV	1280 x 720	7 Mbps
HDTV	1920 x 1080	15 Mbps

HDTV sales in US low but expected to grow

- FCC forcing broadcasters to migrate to digital television

MPEG4-H.264

Recently standardized by ITU-T

- Also known as *MPEG-4 Part 10* or *MPEG4-AVC*

Most advanced codec in MPEG-4 standard.

- Substantially improves over MPEG-2 performance

DTV Standard	Data Rate
SDTV	< 2 Mbps
HDTV	6-8 Mbps

Utilizes object level structures to achieve better compression

Can achieve even better compression ratio for VoD content

- Ability to make multiple passes over data improves the performance

MPEG-4 standard "future-proofs" itself by providing a mechanism for incorporating new codecs as technology improves.

Windows Media 9 Series

Microsoft proprietary compression format

- Compression performance comparable to MPEG4-H.264 *(Microsoft claim!)*

End to end digital media solution

- Media server, player, codecs, encoder, Digital Rights Management, SDK

Offering better licensing terms (encoder/decoder) than MPEG-4

- Allowing developers to create software running on non-windows systems

Video Head End

Content acquisition from various satellite, over the air broadcast and terrestrial sources

- Demultiplex the Multi Program Transport Stream (MPTS)

Advertisement insertion

- Commercials inserted into video stream using various Digital Program Insertion (DPI) techniques

Grooms the signals for the downstream network

- Encoding/transcoding / Rate Shaping / Encapsulation
  - The three functions may be done by one device
  - Encapsulator packetizes the video stream into UDP/IP packets and maps to Multicast addresses

Feeds the transport network, house VoD servers, Middleware Servers, EPG servers, etc.

Middleware

Heart and soul of the end user experience

- Defines electronic program guide (EPG)
- Content management. Defines available VoD title etc.
- Service management platform allows operators to define, configure, and maintain services
- Defines channel packaging and pricing

Packaging

- Subscriber management
- Conditional access controls allow unique services to be defined to unique subscribers
- Transaction and billing management for PPV and VoD
- Digital rights Management, program rating and parental control
- Automated provisioning and remote management of STBs

Interfaces with other network elements and Service Provider's OSS infrastructure

Sample Program Guide

Source: www.sbc.com/lightspeed

IPTV CPE

DSL modem to terminate DSL signal

Set Top Box (STB)

- Not optional (unlike cable TV).
- Can run a middleware client software to render the EPG data or, a browser to obtain program guide data from server (thick vs. thin client)
- Support for MPEG2, MPEG4 decoding, DRM
- High-end box can run an operating system (Win CE) and off-loads some middleware tasks from Middleware Server
- DSL Modem may be integrated in STB. Obviates the need of an additional box
- Support for 802.11 becoming popular. Simplifying the home networking

Video Encoders

Performs various tasks like encoding of analog and digital baseband signals, transcoding, transrating

Satellite content typically delivered as Variable bit rate

- VBR peaks pose a challenge. May occur in one or more frames where bandwidth is abnormally high
- May overrun the STB buffer
- Cause congestion in the transport network or, exceed the bandwidth of the DSL pipe

Bit rate management is key to deliver superior quality video

- Primary goal *bit-rate reduction* (rate-shaping or, transrating)
- Convert VBR content to constant bit rate (CBR)
- Must preserve the quality of the incoming video
- Make optimum use of the access network resources
  - Scheme should be aware of available DSL bandwidth

Bit Rate Management Schemes

Decode and re-encode: Decode the incoming VBR signal and re-encode at desired CBR rate

- Requires expensive hardware and may result in perceptible loss of quality if advance encoding methods are not used

Non-adaptive re-quantization: Drop data from frames which exhibit peak bandwidth

- Reduces the viewable video quality as peak frames are invariably associated with high on-screen motion

Sign-on rate manipulation: Simply pass through the VBR signal

- Attempt to reduce the number of simultaneous program channels at the DSL end

Video on Demand (VoD) servers

Consists of streaming engines (video pumps), switches, disks

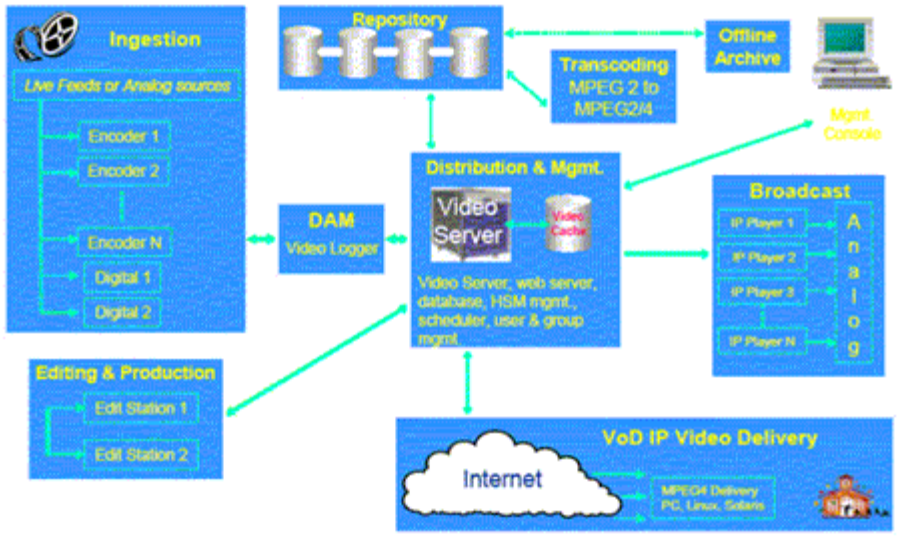
- Components may be packaged separately or integrated into single box
- Cost-effective scalability of the system to support increasing demand is key
  - Both centralized and distributed systems are available today

Storage requirements huge. Small content library not attractive to consumers

- Requirement to house 10000+ hrs of programming

VoD Servers are coupled with Asset Management Systems for automatic acquisition, storage, management of content

VoD end-to-end Architecture



Source: Callisto Media Systems

VoD Servers (Contd.)

- Supporting VoD places stringent requirement on the network transport infrastructure
  - Unlike broadcast content, each stream is unicast
  - Streaming engine Implements RTP, RTSP stack. Supports trick-play modes to enable pause, rewind, fast-forward features on stream
- GigE based transport on VoD server may not be sufficient in future
  - Can only deliver ~*200 (1000/5)* simultaneous streams
- Streaming requirements growing faster than the content storage requirement
  - Popular video titles may generate substantial traffic

Advertisement Insertion

Commercial insertion is important element of the overall operations

- National and local commercials inserted into video content

Ad insertion can happen in the local or regional headend

- Tradeoff of cost vs. advertisement relevance

Ad revenue is significant and can offset part of the programming costs

- Over 30% of 2003 Cable revenue is from Commercials

Nearly all video providers leverage commercial insertion opportunities

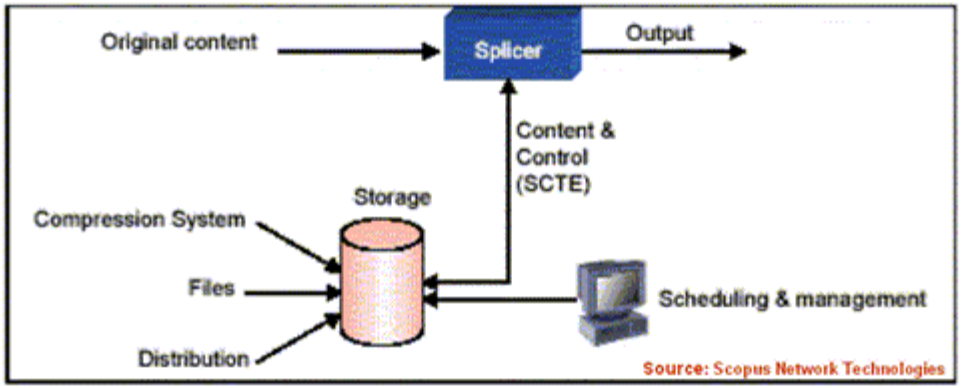
Advertisement Insertion

Three popular techniques – Differ in the mechanism used for insertion of the ad markers

Analog insertion: used in the uncompressed domain

Hybrid (Analog and Digital): used in the compressed digital domain, with analog tools

Digital insertion: used in the compressed digital domain



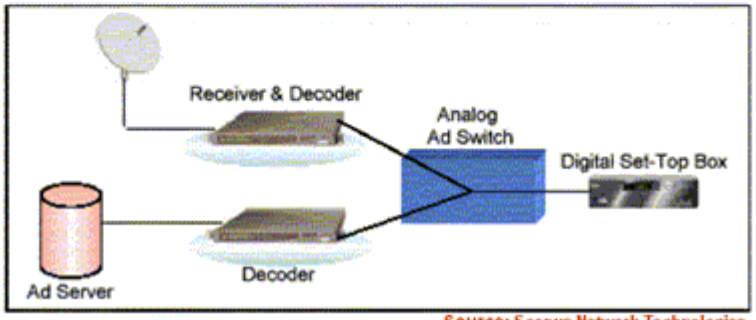
Generalized Architecture for Ad Insertion System

Analog Ad Insertion

Performed in uncompressed domain. Most widely used today

- Decodes the MPEG-2 program to baseband level, inserts commercial and re-encodes

Two encoding/decoding passes degrade the overall quality of video



Source: Scopus Network Technologies

Generalized Architecture for Ad Insertion System

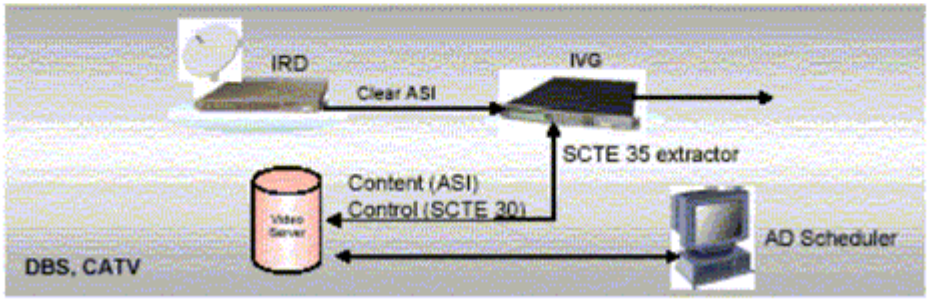
Digital Ad Insertion

Requires ad insertion markers in the transport stream, as *SI tables* (SCTE 35 standard)

Special encoders enable creation of the Ad insertion markers in the transport stream during the contribution process.

At headend, splicer detects the insertion markers and triggers video server to insert relevant ads.

- Communication between the Splicer and the video server is based on the SCTE 30 protocol.



Source: Scopus Network Technologies

Personalizing TV Advertising

- "Addressable Advertising" holy grail for Ad world
  - Unique ads tailored to user groups (or, individual)
- Personalized Ads bring in more revenue
  - Avg cost per viewer for Superbowl 2005 ads: ~2c
    - Most expensive TV ad in the year
  - Avg cost per ad click on Google (2004): ~54c
- Cable companies starting to offer limited solutions
  - Comcast Spotlight: Adtag/Adcopy
    - Different commercials to different Zip codes
- How to leverage in-built addressability of IP to deliver personalized Ads via IPTV?