IP TV
Network Infrastructure

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IPTV Overview

- **What is IPTV?**
  - Deployed over copper, fiber, wireless, and HFC networks to deliver digital TV services over IP Networks, including real-time broadcast TV services.
  - Leverages IP technologies to deliver an enhanced TV experience in the context of Triple Play (video, voice, data) services.
    - Whatever (diversity of content, customization of experience)
    - Wherever (TV, mobility, iPod)
    - Whenever (VoD, PVR)
  - Blended services such as Caller-ID on TV, Online messaging on TV, customized / interactive Advertisement
    - Personalized and customized camera angles during sport event
    - Intelligent channel control and customized channel selection

- **Service Provider IPTV is delivered over managed network**
  - This includes the FTTx (e.g. G/EPON), xDSL (e.g. VDSL2, ADSL2+), wireless (e.g WiMax, 4G), or HFC (DOCSIS Cable Modem)

- **Market expenditure, revenue, and subscribers growth**
  - Global market IPTV revenue is forecasted to $4.5 billion by end of December 2008 and $19 Billion by 2012
  - IPTV revenue in North America is forecast to reach $2 billion in 2008, and grow to $8 billion by 2012*
  - Worldwide subscriptions to IPTV services to reach 19.6 million at the end of year 2008 *

- **Service providers**
  - Verizon, AT&T, PCCW, China Telecom, France Telecom, Telefonica, Belgacom, KPN, Softbank, France Telecom, Telefonica, Iliad (Free, France),…

*Forecasted by Gartner, October 2008
Major Services Supported by IPTV

- Switched Digital Broadcast Channels (SDB)
- Video-on-Demand (VOD)
- Digital Video Recorder (DVR, PVR)
  - Network based Personal Video Recorder (nPVR)
- Interactive TV applications (iTV)
- Electronic Program Guide (EPG)
- Targeted or Advanced Advertising
- High Speed Internet and VoIP
- Etc.
IPTV Drivers

• More choices and control by subscribers
  – Connect to network – at home, work and on the road
  – Bundled, blended, interactive video, and integrated services

• Video and multimedia applications are major drivers for next generation Service Providers network design
  – QoS requirements for video services
  – More scalability, resiliency, capability, and capacity with in the network.

• More competition among Service Providers
  – Traditional voice and long distance market changed. Voice call almost free
  – Applications are major driver for Cable and Telecom carriers network upgrade

• Technology improvement for CPE, servers, codec, access
  – FTTx, VDSL2, ADSL2+, DOCSIS 3.0, Wireless are access enablers
  – MPEG-4 AVC (H.264) codec improvements
  – Server processing and memory advancements
IPTV Network Elements Major Functions

- **Headend**
  - Processing and aggregation of video content
  - Video Servers capable of MPEG-2 and H.264 encoding
  - Back office billing of video services
  - Architecture: Central or Distributed Headends / encoders
  - New IPTV Network Software Systems and Servers
    - IPTV Middleware
    - Content security & Digital Right Management
    - Ad Insertion systems
    - IPTV Client Management

- **Metro / Transport network**
  - Multimedia distribution over optical transport to the access network

- **Access network**
  - Last mile delivery from central office to home
  - Key attributes
    - Cost-effective, scalable, field-proven solutions
    - Central office and remote DSL for IP multimedia
    - Integrated Fiber-to-the-Premises / Curb (FTTP/C), wireless, and Coax media for delivery of triple/quadruple play services
  - Leverage installed equipment and infrastructure

- **Home network**
  - Residential Gateway & Set Top Box supporting MPEG-2 and MPEG-4 for SD & HD video
  - Distribution of analog / digital video content and Internet
  - IP video content over coax, Cat-5, HPNA, Wireless, etc…
Headend Video Elements and Operations

Headend collects video content from different sources and prepares it for delivery over the video network.

- Video Acquisition
  - Video reception from Satellite and off-air
  - Video Receivers
  - Signal Conversion

- Encoding
  - High and Standard Definition
  - Audio encoding
  - MPEG-2, MPEG-4

- Video Processing
  - Ad-Insertion
  - Multiplexing

- Video Management
  - Digital Right Management (DRM)
  - VOD Servers
  - Video Applications
  - Remote Operations
IPTV Network Architecture

Digital Home

Local VSO

Regional VHO

National SHE

Access Networks

Metro Networks

National Backbone Network

VOD Servers

Library

Local Ad Insertion

Local Content

Regional Content

1-2 SHE, 10-100 VHO, 100-1000 VSO
End-to-End Delivery Components

Content Headend
- Digital Broadcast Network
- VoD Network
- VoD Server
- Router
- IP and Service Management Infrastructure
- Element and Network Management
- Provider Billing System Interface
- Broadcast Sources
- VoD Sources
- Internet

Core Network
- VoD Sources
- Edge Ethernet Switch
- Optical Core
- IP/MPLS
- IP/MPLS, VPLS
- Local Content VoD Servers
- CMTS
- BTS
- RG
- Cable Modem / RG

IP Edge/Aggregation
- Edge Multiplexer (xDSL, PON)
- Ethernet
- IP Services
- Multicast routing
- Digital TV
- Per service QoS
- Aggregation
- Enforce QoS
- Security
- Access Net.
- System Mgt.
- Policy Control
- Device Mgt
- Gateway Mgt
- Interoperability
- Activation

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Digital Home Network
- • Subscriber Mgt
  • Billing Mgt
  • Video Control
  • Video sources
- • Aggregation
  • Enforce QoS
  • Security
  • Access Net.
  • System Mgt.
  • Policy Control
  • Device Mgt
  • Gateway Mgt
  • Interoperability
  • Activation
Content Distribution Network (CDN)

- **Central**
  - Overall management of network elements & content distribution for Live TV and VOD
  - Single point of contact to integrated systems
  - Distribute the content to Branch
  - Consolidated reports & logs

- **Agent or Branch**
  - Manages in-cluster distribution
  - Distribute to client based on request
  - In-cluster server monitoring and reporting
Impact to Access/Metro/Core Network

- **Impact to existing Access Network**
  - Connecting to CPE/STB/GW
  - Multiple services (Broadcast, PVR, VoD, VoIP, SD & HD Signals, Gaming, Internet download, surveillance/monitoring, P2P traffic, …)
  - Application demands for extra capacity (multiple HD channel, VoD,…)
  - Monitoring, security (Subscriber’s Server), and Management
  - Quality of Service and Bandwidth Management

- **Impact to existing Metro/Core Network**
  - High Availability is critical for video
  - Scalability is important for all Network Elements
  - More Capacity requirements
  - Carriers investment to Metro/Core network
  - Optical equipment market getting a boost
IGMP Multicast, QoS, Security, Connectivity Model, Digital Home
Access Node: Key functions

- **Security**
  - 802.1X authentication
  - DHCP option 82 insertion

- Intelligent cross connect and Orchestrate Interaction among Home Gateways and Aggregation Network
  - 802.1X state aware
  - IGMP control message extraction/insertion
  - Multicast stream insertion, and maintain multicast table

- Multicast
  - 802.1p support
    - Tag the traffic generated by the Access Node
IP Multicast

- **Multicast Routing Protocol**
  - Distribute broadcast channels across the network
- **IGMP Snooping**
  - Intermediate nodes (DSLAM, Ethernet switch,…) learn on who has requested joining each multicast group
- **Multicast Group Membership Discovery (MGMD)**
  - Used by a device to request to join or leave a multicast group
  - IPv4 uses IGMP, IPv6 used Multicast Listener Discovery (MLD)
  - IGMPv2 / IGMPv3 / MLDv1 are commonly used
- **Multicast Benefits**
  - **Efficiency**
    - Multicast efficiently transport media streams to unlimited number of customers.
  - **Scalability**
    - When media streams are unicast to tens of thousands of consumers, a serious scalability issues arise with network capacity.
  - **Quality**
    - Enable service providers to support very high quality video and audio delivery.
QoS Model Scalability

- **Multiple types of traffic going through the network**
  - VoIP, multicast, ICC, Internet, management and control traffic

- **Queuing on a per-service-per-subscriber level is essential**
  - Enforce subscriber's access rate for High Speed Internet service
  - Prioritize traffic types and applications

- **Per-subscriber QoS scales better by moving it closer to the subscriber**
  - QoS in the aggregation puts QoS control where it is accurate
  - Works across multiple services and multiple edges

- **QoS enforced on aggregated traffic**

Example:

- **Subscriber VLAN**
  - PIR = 20 Mbps
  - VoIP (priority1) PIR = 3 Mbps, CIR = 200Kbps
  - Video (priority2)
  - Data (shaped+priority3)
  - GE

- **PIR = 3 Mbps**
  - CIR = 200Kbps
Access Node: Security

• **802.1X Support**
  - Provide port based 802.1X per access port (xDSL/PON/…)
  - Local or EAP over RADIUS authentication

• **DHCP**
  - Insertion of option 82 field circuit, slot, shelf, node identification
  - Option to unicast message on network interface
Last Mile Connectivity Model

Categorized User Traffic:

- All services for a subscriber on common link (e.g. VLAN Ethernet)
- Port to VLAN mapping for unicast data at Access Node
- Multicast replication for BTV at Access Node
- VLAN-ID per subscriber at Access Node includes the Port-ID
- There will be a BTV VLAN that carries those channels requires by access node
- Aggregation node may provide VLAN aggregation based on VPLS
- The DHCP traffic, VoD and VoIP may aggregated per node and transported to Core network.
Leveraging the Advantages of IP Video by Cable MSOs

- Cable operator had initiated the Next Generation Network Architecture (NGNA) in 2004
- Large scale metro IP Networks deployed for supporting the cable VOD services
- Extended to a National IP core networks for support of video content distribution
- Improved the network elements for support of IP video (DOCSIS 3.0 modem, Modular Cable Modem Termination System (M-CMTS), Tru2way, ..)
- Next Generation Cable STBs will support IP video integrated DOCSIS modems
Home Networking

Home Networking Options:
- Wireless
- Wireline
Routed Residential Gateways

- Network assigns gateway address
- Gateway assigns in-home address
- Single IP address per home
  - Puts Video, VoIP, HSI all in one public IP address space

Routing Residential Gateway:
- Reduces MACs seen by network
  - Can be single IP or multiple IP addresses
- Requires NAT/ALG for Video and VoIP (RTSP, SIP..)
  - Support of unsolicited messaging to multiple STBs
- Must be managed (TR-069)
  - Configure of service separation, marking, QoS, subnetting, etc.
- Must be high performance
  - Video/VoIP require wirespeed throughput w/NAT
- Must support IGMP Proxy
  - Reduces IGMP upstream load to Access Node
- Must support IP Multicast
  - Replicate IP Multicast BTV frames
More Demands on Robust Home Networking Infrastructure:

**Near-term Opportunities:**
- Advanced DVR functionality
- Network/IPTV management
- Home networking as infrastructure and service
- Fixed-and-mobile blended communications services
- More capable and useful search and navigation
- Access to some PC content
- Traffic/weather applications

**Mid-term Opportunities**
- More Internet-like content
- Fixed-to-mobile content handoffs
- Remote access/content services
- Enhanced advertising
- Blending of social media features
- Growth of federated devices (storage, advanced phones)

**Longer-term Opportunities**
- Video-based communications
- Blended entertainment and communications functionality
- Home, life, and health management features
- Community-based television and communications services
IPTV Services Evolves

Extended TV Viewing
- Record and watch Live TV and Video On Demand

Blended and Interactivity
- Access Blended Services and communication from the TV screen (Web, music, photo, ...)

Personalized Contents
- Access to personalized content and services from mobile, PC, and TV seamlessly

Flexibility on media viewing
- You can access your media and communication services over any devices, anytime, anywhere

Evolving IPTV Services
Consumers are Demanding More…

More Value…
More Content…
More Control…
More Personalization..
More Integration
More Simplicity…
…more of everything
Challenges

- Network and System Scalability, Performance, Quality
  - Can Network and System support the bandwidth, quality, transactions, content required
- Multi-vendor, multi-technology, multi-layer, end-to-end system integration
- Enable services and set up customer devices or plug and play devices, access configuration
- Enable service delivery with follow-through provisioning
- Auto configuration system, remote management
  - Loop, home, customer service, access network management
- Home Networking
- Policy and subscriber management, enforce QoS levels
Last Mile Bandwidth and Video Compression

- Need to offer multiple Standard Definition (SD) and High-Definition (HD) streams
- Most commonly recommended video compression methods:
  - MPEG-2
  - MPEG-4-AVC/H.264
- Rate required for high-motion near-real-time content is:

<table>
<thead>
<tr>
<th>Required Date Rate per Channel</th>
<th>MPEG-2</th>
<th>MPEG-4-AVC/H.264</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard Definition</td>
<td>3.2 Mbps</td>
<td>1.5 - 2 Mbps</td>
</tr>
<tr>
<td>High Definition</td>
<td>15 Mbps</td>
<td>8 - 9 Mbps</td>
</tr>
</tbody>
</table>
Advanced IPTV Features

- **Advanced Advertisements:**
  - Targeted Advertising
    - Based on profile and preferences select a specific Ad
    - Even for VOD, Ad spot before and after the video contents, even during the video
    - Ad for local audiences or regional based Ad
  - Interactive Advertising
    - Solicit customer input
    - Bill Ad-Providers based on customer interactions
    - Ask customers input for types of Ad they prefer to view
  - Emerging Personalized Video Services
    - Any-time, anywhere, any content

The IPTV network will be evolve to an application-aware, intelligent, Full control infrastructure for seamless blended, high bandwidth demand, and personalized multimedia services.
IPTV and IMS

• In the Marketplace, there are two strategies for blending IMS/IPTV services:
  – Integrating IPTV into IMS into one platform using SIP for all services
  – Service-Interworking between IPTV and IMS, since there are elements that can be shared between IPTV and IMS:
    • Network
      – Shared IP infrastructure
    • Common Functions and Shared Environment
      – Resources/Transport Control
      – Service enablers for blended services
      – Subscribers and operations management
High Level Functional Architecture for IMS-based IPTV

- **User Equipment**
  - User Profiles
  - Transport Control Functions
    - Transport Processing Functions
  - Transport Functions
  - Core IMS
    - Application Functions & IPTV Service Control Functions
      - IPTV Media Delivery, Distribution & IPTV Media Control Function
  - Management Functions
  - Content Provider Functions
Shared IMS and IPTV Areas

Profile Functions
- User profile, user authentication, parental control, user policy, unified directory

Communication Functions
- Service discovery, Click for Messaging, Buddy Conversation

Service Functions
- Program Guide, Client Applications Environment, Emergency Notification

BSS/OSS Functions
- Configuration, Activation, Device mangt., Billing, order management, Service creation, Billing, Subscriber self-care

Transport Functions
- IP Infrastructure, Admission Control, Resource Control, Network attachment

Maintenance Functions
- Logging, security

Interworking IPTV & IMS
IPTV Standards Activities

• **ITU-T (Focus Group IPTV)**
  - Collaborating and incorporating input from ATIS IIF, IETF, Broadband Forum, Home Gateway Initiative (HGI), and ETSI into IPTV-related drafts.
  - IPTV service requirements, Architecture, QoS/QoE, security, Control Protocol, Signaling, STB, Middleware, and applications.
  - Non_NGN-based, NGN-based with Non-IMS, and NGN-based with IMS architectures

• **ATIS - IIF**
  - IPTV Interoperability, Architecture, QoS, Remote MNS, EAS, Security, Media protocols, DRM interoperability, EPG, etc.

• **Broadband Forum**

• **ETSI**
  - 3GPP, DVB (Audio-video coding, Mobile TV, STB, Head-ends, Security, PVR, ..)

• **IETF**
  - Protocol: SIP, SDP, IGMP, RTSP, RTP, ..

Global IPTV Standards Facilitate the Interoperability
Conclusions

- Competition and declining voice revenues are driving wireline carriers to triple / quadruple play service bundles
- Large scale access infrastructure investments has been ramped up since 2005
- Video is the most demanding service component from network infrastructure point of view
  - Broadband access, Middleware, Network Elements need to be primarily dimensioned for the needs of the video services
- The IPTV service will be more interactive and personalized while enhancing the end-user QoE
- Simplified operations, blended services, subscribers management, and IMS convergence are critical
- The several dominant broadband access architectures are FTTN, FTTC, FTTP, DSL. But the Broadband wireless will be the next step for IPTV delivery
- Distribute Multicast along with IGMP snooping and proxy within the network
- High Availability – Redundancy and resiliency mechanisms needed for all layers
- QoS per subscriber/application/service basis
- Distributed intelligence to ensure multi-dimensional scalability for network growth
Thank You

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