IP Video
Industry Overview Review
May 2010
What is IPTV?

- “Pure” IPTV is the delivery of video services over a managed network via Internet Protocol to a TV/screen through a broadband access network:
  - HFC (via DOCSIS)
  - xDSL (e.g. ADSL2+, VDSL2)
  - FTTx (e.g. GPON, MetroE, RFoG)
  - Wireless (e.g. 4G, WiMax)

- Screens include:
  - Personal Computers in the Home
  - Hand-Held Devices (cell phones & PDAs) in the Home
  - TVs with IP STBs in the home

- Services typically include:
  - SD and HD video services
  - Digital Video Recorder services
  - Video-on-Demand services
  - Electronic Program Guide
  - Interactive TV applications
  - Targeted and Personalized Advertising
  - Blending of internet and video services - widgets
Examples of IP Video Services
MSO IP Video
Over-The-Top (OTT) vs. MSO-Managed IP Video

- IPTV typically describes the Telco’s competitive offer to MSO video services

- IP Video is the transport of MPEG video in the payload of an IP packet... there are 2 types:
  - Over-The-Top (OTT) IP Video
  - MSO-Managed IP Video

- OTT IP Video = Delivery of Video from an Internet-based server to a PC-based client (such as Hulu or YouTube, Boxee, Netflix, CinemaNow)

- MSO-Managed IP Video = Delivery of High-Quality Video Services over Internet Protocol from an MSO-Managed Server to any one of the following 3 Screens:
  - Personal Computers in the Home
  - Hand-Held Devices (cell phones & PDAs) in the Home
  - TVs with IP STBs in the Home

- MSO-Managed IP Video might include one or both of the following:
  - **On-Net Transmission**: over the HFC Plant
  - **Off-Net Transmission**: over the Internet in or out of the home
Telco IPTV status

Source: Kagan March 2010

- IPTV video service revenues will grow at a 27% compound annual growth rate from $8.7 billion in 2009 to $22.6 billion, or 9.8% of the global pay-TV revenues, by 2013.
- U.S. will remain the most lucrative IPTV market, accounting for 51.9% of global IPTV video service revenues through 2013.
- The top five operators accounting for nearly 44% of the global IPTV subscriber base at year-end 2009.
  - The U.S. telcos AT&T and Verizon, France’s Iliad and France Telecom, and China’s Shanghai Media are among the largest IPTV providers, each with at least 1.9 million TV
- Latin America and Eastern Europe will see subscriber increases at 119.5% and 31.1% compound annual growth rates, respectively, through 2013.
  - At year-end 2009, Telefónica reported 840,600 IPTV subscribers in Europe, translating into a 15.6% YoY increase since 2008, and since 2007, it has launched several IPTV trials in Latin America, including Argentina, Brazil and Chile.

Convergence Enabled.
# Top 20 WW IPTV Service Providers

Source: Kagan March 2010

<table>
<thead>
<tr>
<th>Rank</th>
<th>Operators</th>
<th>Subscribers (2009 YE)</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Iliad</td>
<td>3,564,800</td>
<td>France</td>
</tr>
<tr>
<td>2</td>
<td>Verizon</td>
<td>2,861,000</td>
<td>US</td>
</tr>
<tr>
<td>3</td>
<td>China Shanghai Media Group (BesTV)</td>
<td>2,623,000</td>
<td>China</td>
</tr>
<tr>
<td>4</td>
<td>AT&amp;T</td>
<td>2,065,000</td>
<td>US</td>
</tr>
<tr>
<td>5</td>
<td>France Telecom</td>
<td>1,923,000</td>
<td>France</td>
</tr>
<tr>
<td>6</td>
<td>Neuf Cegetel</td>
<td>1,899,999</td>
<td>France</td>
</tr>
<tr>
<td>7</td>
<td>Deutsche Telekom</td>
<td>1,054,000</td>
<td>Germany</td>
</tr>
<tr>
<td>8</td>
<td>NTT</td>
<td>1,040,000</td>
<td>Japan</td>
</tr>
<tr>
<td>9</td>
<td>KT Corporation</td>
<td>1,007,000</td>
<td>South Korea</td>
</tr>
<tr>
<td>10</td>
<td>PCCW</td>
<td>710,700</td>
<td>Hong Kong</td>
</tr>
<tr>
<td>11</td>
<td>Telefónica España</td>
<td>703,000</td>
<td>Spain</td>
</tr>
<tr>
<td>12</td>
<td>Chunghwa Telecom</td>
<td>667,892</td>
<td>Taiwan</td>
</tr>
<tr>
<td>13</td>
<td>SK Broadband</td>
<td>402,501</td>
<td>South Korea</td>
</tr>
<tr>
<td>14</td>
<td>Telus</td>
<td>148,000</td>
<td>Canada</td>
</tr>
<tr>
<td>15</td>
<td>Telefónica O2</td>
<td>137,600</td>
<td>Czech Republic</td>
</tr>
<tr>
<td>16</td>
<td>Comstar</td>
<td>128,000</td>
<td>Russia</td>
</tr>
<tr>
<td>17</td>
<td>TPSA</td>
<td>109,000</td>
<td>Poland</td>
</tr>
<tr>
<td>18</td>
<td>Elion 100,000</td>
<td>100,000</td>
<td>Estonia</td>
</tr>
<tr>
<td>19</td>
<td>Manitoba Telecom Service</td>
<td>86,520</td>
<td>Canada</td>
</tr>
<tr>
<td>20</td>
<td>SaskTel 78,893</td>
<td>78,893</td>
<td>Canada</td>
</tr>
</tbody>
</table>
## Telco IPTV Deployments

Source: Kagan March 2010

### IPTV Subscribers:

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>2009</th>
<th>2013</th>
<th>CAGR ‘09-'13</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>France</td>
<td>7,297</td>
<td>8,178</td>
<td>2.9%</td>
</tr>
<tr>
<td>2</td>
<td>U.S.</td>
<td>5,664</td>
<td>12,239</td>
<td>21.2%</td>
</tr>
<tr>
<td>3</td>
<td>China</td>
<td>4,300</td>
<td>10,764</td>
<td>25.8%</td>
</tr>
<tr>
<td>4</td>
<td>South Korea</td>
<td>1,740</td>
<td>4,350</td>
<td>25.7%</td>
</tr>
<tr>
<td>5</td>
<td>Germany</td>
<td>1,095</td>
<td>3,614</td>
<td>34.8%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>20,096</strong></td>
<td><strong>39,145</strong></td>
<td><strong>18.1%</strong></td>
</tr>
<tr>
<td><strong>Global Total</strong></td>
<td></td>
<td><strong>29,888</strong></td>
<td><strong>59,600</strong></td>
<td><strong>18.8%</strong></td>
</tr>
</tbody>
</table>

### Top 5 Countries by Share of Total Global IPTV Market

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>2009</th>
<th>2013</th>
<th>CAGR ‘09-'13</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>France</td>
<td>24.4%</td>
<td>13.7%</td>
<td>-13.4%</td>
</tr>
<tr>
<td>2</td>
<td>U.S.</td>
<td>19.0%</td>
<td>20.5%</td>
<td>2.0%</td>
</tr>
<tr>
<td>3</td>
<td>China</td>
<td>14.4%</td>
<td>18.1%</td>
<td>5.9%</td>
</tr>
<tr>
<td>4</td>
<td>South Korea</td>
<td>5.8%</td>
<td>7.3%</td>
<td>5.8%</td>
</tr>
<tr>
<td>5</td>
<td>Germany</td>
<td>3.7%</td>
<td>6.1%</td>
<td>13.4%</td>
</tr>
<tr>
<td><strong>Total Top 5</strong></td>
<td></td>
<td><strong>67.2%</strong></td>
<td><strong>65.7%</strong></td>
<td><strong>-0.6%</strong></td>
</tr>
</tbody>
</table>

### IPTV Video Service Revenues:

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>2009</th>
<th>2013</th>
<th>CAGR ‘09-'13</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>U.S.</td>
<td>4,009,176</td>
<td>11,733,709</td>
<td>30.8%</td>
</tr>
<tr>
<td>2</td>
<td>France</td>
<td>1,715,216</td>
<td>2,436,484</td>
<td>9.2%</td>
</tr>
<tr>
<td>3</td>
<td>Japan</td>
<td>343,320</td>
<td>1,003,827</td>
<td>30.8%</td>
</tr>
<tr>
<td>4</td>
<td>Hong Kong</td>
<td>259,112</td>
<td>246,800</td>
<td>-1.2%</td>
</tr>
<tr>
<td>5</td>
<td>China</td>
<td>258,387</td>
<td>909,796</td>
<td>37.0%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>6,585,212</strong></td>
<td><strong>16,330,616</strong></td>
<td><strong>25.5%</strong></td>
</tr>
<tr>
<td><strong>Global Total</strong></td>
<td></td>
<td><strong>8,688,920</strong></td>
<td><strong>22,619,352</strong></td>
<td><strong>27.0%</strong></td>
</tr>
</tbody>
</table>

### Top 5 by IPTV Share of Multichannel Households

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>2009</th>
<th>2013</th>
<th>CAGR ‘09-'13</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Hong Kong</td>
<td>44.1%</td>
<td>37.0%</td>
<td>-4.3%</td>
</tr>
<tr>
<td>2</td>
<td>France</td>
<td>42.8%</td>
<td>43.3%</td>
<td>2.9%</td>
</tr>
<tr>
<td>3</td>
<td>Greece</td>
<td>25.7%</td>
<td>51.1%</td>
<td>18.7%</td>
</tr>
<tr>
<td>4</td>
<td>Estonia</td>
<td>25.3%</td>
<td>29.8%</td>
<td>4.2%</td>
</tr>
<tr>
<td>5</td>
<td>Singapore</td>
<td>23.0%</td>
<td>28.3%</td>
<td>5.3%</td>
</tr>
</tbody>
</table>

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Online Video Drives Bandwidth Growth…

83% of the total U.S. Internet audience viewed online video

Source: comScore Video Matrix

* Based on video content sites: excludes video server networks. Online Video includes both streaming and progressive download video, total U.S.-Home/Work/University Locations
OTT Notable Findings

- 83% of the total U.S. Internet audience viewed online video
- 132M viewers watched 11.9B videos on YouTube
  - 89.5 videos per viewer
- Avg. Hulu viewer watched 23 videos
  - Totaling 2.4 hours of video per viewer
- The duration of the average online video was 4.3 minutes
- The top video ad networks in terms of their actual reach delivered were:
  - Joost Video Network (by Adconion Media Group) with 38.3% penetration
  - BBE with 18.3% penetration
  - BrightRoll Video Network with 18.1% penetration
Cable IP Video Deployments

- Future Deployments by Cable MSOs
  - Guangzhou Digital Media Group
    - Public Announcement of ITPV Service
    - Launch Name is Zhujian Digital
    - Microsoft Mediaroom IPTV over DOCSIS
    - 2.5 M Analog Customer to Transition to IPTV
    - China Mandate to transition TV to all Digital
  - Other MSOs are Analyzing – No Announcements …
## Competitive Comparison

<table>
<thead>
<tr>
<th></th>
<th>Multi-room DVR</th>
<th>Personal Media Share</th>
<th>Advanced OTT</th>
</tr>
</thead>
<tbody>
<tr>
<td><a href="http://www.att.com">AT&amp;T</a> Universal DVR</td>
<td>5 TV’s + PC</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><a href="http://www.verizon.com">Verizon FiOS TV</a></td>
<td>4 TV’s + PC</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><a href="http://www.dish.com">Dish Network</a></td>
<td>2 TV’s + PC</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><a href="http://www.directv.com">DIRECTV</a></td>
<td>PC ONLY</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><a href="http://www.comcast.com">Comcast</a></td>
<td>✓</td>
<td>✓</td>
<td></td>
</tr>
</tbody>
</table>

*Convergence Enabled.*
Rogers Curve
– aka Subscriber Adoption Curve

IP Video is ~ here

Convergence Enabled.
Typical Technology Lifecycle

Technology Status Summary

- Telco’s
  - Deploying integration intensive solutions
  - Developing standards via IPTV Forum & ATIS IIF
- Over The Top
  - deployments are significantly proprietary
    - player and streaming specific to provider
- Cable
  - Evaluating architecture options
  - Developing standards

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The NCTA's proposed consumer principles are:

1. Consumers should have the option to **purchase video devices at retail** that can access their multichannel provider's video services without a set-top box supplied by that provider.

2. Consumers should also have the option to purchase video devices at retail that **can access any multichannel provider's video services** through an interface solution offered by that provider.

3. Consumers should have the option to **access video content from the Internet** through their multichannel provider's video devices and retail video devices.

4. Consumers should have the option to purchase video devices at retail that can **search** for video **content across multiple content sources**, including content from their multichannel provider, the Internet, or other sources.

5. Consumers should have the option to easily and securely **move video content between and among devices** in their homes.

6. Consumers should be assured the benefits of **continuous innovation** and variety in video products, devices and services provided by multichannel providers and at retail.

7. To maximize consumer benefits and to ensure **competitive neutrality** in a highly dynamic marketplace, these principles should be embraced by all video providers, implemented **flexibly** to accommodate **different network architectures and diverse equipment options**, and, to the maximum extent possible, serve as the basis for private sector solutions, not government technology mandates.

**Convergence Enabled.**
Implementation by Cable Operators

- Recognize the subscriber experience and content availability are what is in demand and not technology
- Comcast launched Xfinity OTT service
- Comcast & Time Warner partnering on TV Everywhere
- MSOs can reuse current investments & migrate toward IPTV
  - DOCSIS CMTS, provisioning systems
  - Encoding, VoD
  - Access and Transport
  - training, etc
- MSOs adopting open standards & web tools to develop applications
  - OpenCable, Tru2way, etc
- DOCSIS 3.0 offers:
  - Bonded RF channels (4 today going to 8 and beyond), IPv6, Multicast QoS, High Asymmetry
  - A future-proof platform that will cost effectively support IPTV
IP Convergence at the Edge, in the Distribution Network and in the Home

- Premium Linear Content
- Premium VoD Content
- Managed Operator Network
- Content Delivery Network Storage Library
- Edge Streaming VoD / Start Over
- Distribution Network HFC / DOCSIS
- Internet Content
- Mobile Network
- Operator Portal

PC’s / Laptops

Residential Gateway

TV

Mobile Devices

PC
Mobile Device
Subscriber Control

Convergence Enabled.
Cable’s NEW Offering!

<table>
<thead>
<tr>
<th>Multi-room DVR</th>
<th>Personal Media Share</th>
<th>Advanced OTT</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Multi-room DVR" /></td>
<td><img src="image2.png" alt="Personal Media Share" /></td>
<td><img src="image3.png" alt="Advanced OTT" /></td>
</tr>
</tbody>
</table>

- **6 TV’s + PC**
- **Seamless Integrated User Experience**
- **Convergence Enabled.**
What Other Reasons Do MSOs Have For Supporting IP Video?

- It provides access to a broader audience through all 3 screens in the home (TV, PC, Handheld)

- It provides a direct conduit to 15-30 year-old demographic (through their Handheld devices)

- It creates a means of further monetizing their high-quality video content partnerships

- Eliminate the high costs demanded by the current STB duopoly

- Provides a means to meet the increase in bandwidth and content options without breaking the bank

- It creates a means to further enhance the subscriber experience thru service mash ups and reach mass market

Convergence Enabled.
Conclusions

- The Cable Industry is entering a decade of rapid change in services offerings & bandwidth trends

- Most of these changes are occurring because of the "New Kid On The Block"... IP Video

- MSOs & vendors must work together to ensure that the capacity and flexibility required by subscribers in the next decade will be available
The MSO Video Value Chain Under Attack

Market Analysis & Business Case impact

May 2010
Introduction

- The Cable Industry is entering a decade of rapid change in services offerings & bandwidth trends

- Most of these changes are occurring because of the "New Kid On The Block"... IP Video

- MSOs & vendors must work together to ensure that the capacity and flexibility required by subscribers in the next decade will be available
Why Are MSOs Interested In IP Video?

- The threat from Over-The-Top content providers is growing...
  - 84.4% - the % of U.S. Internet users who viewed online video in one month
  - 10.8 hours - the average time each online video viewer watched content during one month
  - 125.3 million viewers - the number of viewers who watched YouTube in one month
  - 10.4 billion videos - the number videos viewed on YouTube in one month
  - Nearly 37% of broadband households in North America are extremely or very interested in viewing Over-the-Top video content on the home TV, according to market research firm, In-Stat

- MSOs realize they must change to remain the content distributor of choice
  - The market demand and distribution challenges for OTT parallel those experienced by the introduction of DVR services.
  - The cable industry can make this easy to deploy and an affordable experience, repeat the DVR success and ultimately own the consumer experience for OTT

Source: comScore, INstat
Traditional Video Distribution Value Chain

Producers and Rights Holders → Cable TV Networks → Broadcast TV Networks & Stations → Retail Distributors (cable TV, satellite, telco)

Advertisers → Consumers

Source: Broadband Directions LLC

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6 Key Market Triggers to Watch

Trigger #1
Rising adoption of broadband video

Trigger #2
New “over-the-top” service providers offer substitutes

Trigger #3
Cost of delivery declining/user experience improving

Trigger #4
Content providers adopting broadband medium

Trigger #5
Broadband experience moving to living room

Trigger #6
Rise of online video advertising model

Convergence Enabled.
Convergence – In the User Experience

Any Media, Anywhere, Any Time

Uniform User Interface

Any content
Any device

Personal Media Sharing

Any Media, Anywhere, Any Time

Convergence Enabled.
By virtue of increased competition and increasingly diverse forms of video delivery, video is becoming ubiquitous.

Connected Televisions will push video over the top

TV Everywhere: for a fee, cable operators will give subscribers multi-platform access to whatever is on the cable

Mass consumption of video will transcend beyond media and entertainment into other markets, such as enterprise, education, healthcare and government

Convergence Enabled.
Transition to IP Video Has Begun - Driving Increases in IP Traffic

U.S. Online Video Viewed on Major Video Properties*
2009 – An Inflection Year

Source: comScore Video Matrix, January 2010

Jan. 2010: Average Hulu Viewer Watched 23.5 Videos
(Comscore)

Convergence Enabled.
Current Value Chain participants want to maintain their share
New entrants see a GIANT opportunity

Sources: 1, 2 – SNL Kagan, 3, 4 - NCTA, 5, 6 – Television Bureau of Advertising, 7 – DirectTV and DISH Financial Statements, 8 – AT&T and Verizon Financial Statements
Over the top Service Providers
Reconstitute Value Chain

Producers and Rights Holders

New Video Providers
(startups, incumbent non-video media or marketers)

Cable TV Networks

Broadcast TV Networks & Stations

Over-the-Top Service Providers

Retail Distributors (cable TV, satellite, telco)

Advertisers

Consumers

Source: Broadband Directions LLC

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Revenue models matter

- Just ask newspapers
  - Bankruptcies
    - 2008: 35
    - 2009: 96
    - 2010 to date: 3
  - Source: McClatchy Watch Blog

- Just as music industry
  - 1999 $14.6B
    - Peak revenue year
    - CD albums at ~$14.99
  - 2008 $8.4B
    - Peak unit year
    - MP3 singles at ~ $0.99
  - Source: Recording Industry Association of America
If OTT video indeed starts a small migration away from Cable TV, what would this mean for NA Cable Operators?

Source: Broadband Directions analysis

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Convergence Enabled.
NA MSO Revenue impact due to Over-the-Top Video

Phase 1: Young demo, students, YouTube, Facebook generation, PC experience

Phase 2: Hulu, Netflix, YouTube provides compelling OTT TV/movie alternatives to TV viewing. Many IP connected Video devices available

Phase 3: OTT replicates TV experience in HD and offers more content, interactivity and social networking for less than Cable with lots of free content

~ $13B potential revenue loss over the next 7 years

NA MSO Revenue Impact due to OTT

Source: DIGIT, Kagan, Company Financial Reports, Broadband Directions and ARRIS Estimates

Revised Video Revenue | Lost Revenue due to Cord Cutting | % Lost to OTT based alternative

$25 $30 $35 $40 $45 $50 $55 $60


0.2% 0.3% 0.5% 0.7% 1.1% 1.6% 2.4% 3.5% 5.4% 7.7%

Convergence Enabled.

“Cable is now under threat from two sides: Telco and Over-the-top”

IDC, Consumer Predictions 2009
Conclusions

- Viewer behavior changes will drive operators to introduce new service models embracing IP Video
- Increases in network capacity and new architectures will be required to deliver these new services
- These new architectures will require long transition periods where traditional and IP delivery systems co-exist
- Long term the network must be consolidated into one converged IP transport and delivery architecture
- ARRIS is emerging as a clear leader in some of the fundamental building blocks required
  - Converged IP and MPEG video storage and streaming
  - Converged HFC and PON distribution architectures
  - Converged DOCSIS and MPEG delivery systems
  - Converged CPE
  - Converged Management & Monitoring Systems
MSOs can remain the content provider of choice

Service Provider
- Broadcast Video
- Narrowcast Video
- Video on Demand
- Voice over IP
- Video over IP

MOXI Portal/SDP
- 3rd Party Content
- Subs self mgmt
- Usage & diagnostic data collection

• Improved Subscriber Experience
• Lower Costs
• Simplified Integration

• Bandwidth Efficiencies
• Cross-platform Features

Convergence Enabled.
IP Video...
An Evolution
Into the Next Decade

May, 2010
Service Provider Objectives

- 4 ‘Anys’
  - Any content
  - Any device
  - Any time
  - Any place
- Simpler, easier for subscribers
- High quality
- More services, faster
- Cost effective
- Focus on New over Legacy

Convergence Enabled.
Drivers for IP Video Adoption

▪ Consumer
  - Any content, Anywhere, Anytime
  - Content sharing across multiple devices
  - Personalized and integrated services – one provider
  - Exponential growth of internet video usage

▪ Cable Operator
  - Competition on user experience and variety of services
  - Additional revenue streams such as targeted advertising
  - Competition on price – new CAS architectures to reduce set-top box (STB) costs
  - Improved network efficiency – bandwidth

▪ Technology
  - DOCSIS® 3.0 (IPv6, Multicast, High Asymmetry, M-CMTS)
  - Emergence of systems on chip for home devices that are capable of “blending” traditional TV with IP video content
  - Network support for higher security and end-to-end QoS
  - Advancements in processing and memory – Moore’s Law

Convergence Enabled.
MSO Transition to IP Video

- Settop installed base will be replaced by IP-Cable STB & gateways
  - Hybrid devices (MPEG2 and IP) provide for smooth transition and CAPEX/OPEX efficiencies
- IP-Only Gateways will eventually dominate
  - complemented by IP STBs and IP-enabled display devices in the home
The Vision….

IP Convergence at the Edge, in the Distribution Network and in the Home

Premium Linear Content

Premium VoD Content

Managed Operator Network

Content Delivery Network Storage Library

Edge Streaming VoD / Start Over

Distribution Network HFC / DOCSIS

Internet Content

Internet

Mobile Network

Operator Portal

PC’s / Laptops

Mobile Devices

Residential Gateway

TV

PC

Mobile Device

Subscriber Control

Convergence Enabled.
MSO Delivery of IP Video to their Subscribers

- IP Video delivery requires careful design of many network "hops":
  - Hop 0: Ingest to Server (ex: encode and file prep ↔ CDN)
  - Hop 1: Server to HFC Edge device (ex: Server ↔ CMTS or E-QAM)
  - Hop 2: HFC Edge device to HFC CPE device (ex: CM or STB)
  - Hop 3: HFC CPE device to client (ex: PC, handheld and IP-STB)
IP Video... An Architecture in Transition

May, 2010
IP Video Architectures

- MPEG core & IP Encapsulation in the home
- Hybrid IP Encapsulation & IP Video Over DOCSIS
- IP Video over DOCSIS

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IP Video Architectures – IP Encap

- **IP Encapsulation in the Home**
  - **Network Overview**
    - **Current Elements**
      - Video Network
      - Data Network
    - **New Elements**
      - Gateway: Termination device in the home
        - Voice, Video, Data
      - IP Set Top
      - Video Player (software client)
      - Video Security for in home distribution: Digital Rights management
      - User Interface (Middleware)
      - Subscriber Portal (Back Office Data & Control)
  - **Features Delivered**
    - New User Interface
    - Internet Information (Widgets)
    - Over the Top Video subscriptions
    - Visual Call Log
    - Home Network (Whole Home DVR)
    - Others ….
  - **Network Benefits**
    - Little or No change to existing infrastructure
    - Consolidate Network Monitoring via DOCSIS CPE
Accelerated Evolution – “RF to IP”

E-MTA to Home Gateway

- High Speed Data
- Voice

HD DVR

E-MTA
- Voice
- High Speed Data

Cable Modem
- High Speed Data

Home Gateway
- Multi-screen Video
- Voice
- High Speed Data
- Home Networking

User Friendly Interface

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Convergence in the Home

Service Provider
• Broadcast Video
• Narrowcast Video
• Video on Demand
• Video over IP
• Voice over IP

Internet OTT
• 3rd Party Content
• Subs self mgmt
• Complementary Service Offerings

Seamless Integration of Traditional Video and OTT Services to ALL Screens
Increased ARPU, Customer Satisfaction, Advertising, etc..

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User Friendly Interface

- Enhanced TV Viewing Experience – More Control over When, Where and How Subscribers Consume Content
  - Enriched Interactive Program Guide and DVR user interface with video navigation, mosaics
  - On any TV in the Home – Pause, Record, and Replay with trick modes
  - Pause recorded or live content on one TV, resume on another TV
  - View live TV or recorded assets on the PC
  - Schedule recordings and manage assets on any TV – or remotely over the internet
  - Increased personalization and control of content
  - Blending of broadcast, on-demand, and internet content into menus and searches

- Share digital photos, music, and home movies to TVs, PCs and players in any room within the home
- Listen to music collection or internet radio simultaneously in multiple rooms
- Seamless integration of Internet Premium Services - Flickr™, CinemaNow, and Rhapsody®
  - Future services include Netflix®, Pandora®, Facebook, etc..
- Easy access to Internet content - news, sports scores, entertainment, financial information, and weather
- Caller ID on TV
- Home Automation and Security
The IP Back Office Engine

Network Management & Diagnostics

MSO’s Web Portal

Subscriber Provisioning & A/C Mgmt

Firmware version & Download Management

EPG Data Acquisition

Other 3rd Party Content Acquisition

Secure Web Svcs APIs

Various 3rd Party APIs

Secure Web Services Platform

SNMP v2c/3

Data Warehouse

Head-End Based SNMP Proxy Service

Head-End Based Caching Service

Multimedia Gateway

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IP Video Architectures - Hybrid

- IP Encapsulation in the Home & MPEG over DOCSIS
  - Network Overview
    - Current elements
      - Video Network
      - Data network
    - New Elements
      - Gateway: Termination device in the home
        - Voice, Video, Data
      - IP Set Top
      - Video Player (software client)
      - IP Session Manager
      - Video Security for in home distribution: Digital Rights management
      - User Interface (Middleware)
      - Subscriber Portal (Back Office Data & Control)
  - Other Possible Network Updates
    - Encoding / packaging format
    - Video/Streaming server format
    - Multicast Servers / Control
- Features Delivered
  - New User Interface
  - New/Additional linear channels
  - New/Additional On Demand streams
  - Internet Information (Widgets)
  - Over the Top Video subscriptions
  - Visual Call Log
  - Home Network ( Whole Home DVR )
  - Others ….
- Network Benefits
  - Bandwidth efficiency gains
  - First step to a single network for all services
Benefits Of IP Video Over DOCSIS

- Fully converged architecture for Voice, HSD, and Video → Lowers Capex & Opex in future
- Based on a proven (& trusted) architecture
- Channel-bonding → Stat-Mux gains → more than 30% extra programs (see next slide)
- Load-balancing can be easily managed between Video and HSD tiers
- Advanced QoS is available for Video Content from Internet Partners
- High availability is intrinsic in many CMTSs
- DOCSIS naturally offers all the shared resource benefits of Switched Digital Video
- CMTS schedulers are naturally good at the optimized combining of Unicast VoD streams (with large jitter buffers at the client) and Multicast Linear streams (with very short jitter buffers at the client)
- CMTS Price/DS is dropping quickly due to Moore's Law, Multicore chips, DRFI Channel Multiplexing (the "Car-Pooling Effect"), and IPTV packet size

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IP Video Delivery Proposals

1) CMTS-Offload

Potential Issues:
- Doesn't have proc. power to support HSD
- Excludes advanced QoS needed to work with un-trusted 3rd-party content providers
- May not offer stat-mux gains of bonding
- Creates 3rd delivery structure to manage
- Proprietary solutions w/ no standard
- May require CM & CMTS customization
- Precludes the Capex/Opex benefits of a single converged network for HSD/Video
- Must simulcast MPEG video on DOCSIS

Some MSOs should/will use this as an interim solution

Convergence Enabled.

A few MSOs will use this

2) Hybrid MPEG/IP

Potential Issues:
- Doesn't have proc. power to support HSD
- Excludes advanced QoS needed to work with un-trusted 3rd-party content providers
- No stat-mux gains of bonding
- Requires new CPE devices
- Costly Cable card required for most CAS-oriented content
- Precludes the Capex/Opex benefits of a single converged network for HSD/Video

Some MSOs should/will use this as an interim solution

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3) DOCSIS

Potential Issues:
- Must simulcast MPEG video on DOCSIS
- Higher per-downstream pricing for another year or so (which is prior to most major deployments)

Most MSOs should/will use this as a final solution
Stat-Mux Gains for CBR & VBR Streams in Non-Bonded and DOCSIS Bonded Channels

21 MPEG4 CBR streams peaking at ~ 20 Mbps each require 11 Non-Bonded Channels

63% of spectrum vs. Non-Bonded CBR

21 VBR Streams combined into Non-Bonded Channels require 7 channels

57% of spectrum vs. Non-Bonded VBR

21 VBR Streams combined into Bonded Channels require only 4 channels

Note: Captures are not on the same scale

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Potential Bandwidth Profile
Hybrid IP Transition

Scattered Deployment of Demarcation GW - Bandwidth Estimates

- IP Multicast channels - AVC demand
- DOCSIS DS needed per SG average data rate
- IP Unicast VoD Channels - AVC demand
- VoD Channels - MPEG 2 demand/SG
- SDV channels - MPEG 2 demand
- Broadcast channels - MPEG 2 - non-encrypted
- Broadcast channels - MPEG 2 - encrypted

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## Video Access Multicast Control Plane: IGMP vs. PCMM

<table>
<thead>
<tr>
<th>Capability</th>
<th>IGMP¹</th>
<th>PCMM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamic Creation of Multicast Flows</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Attribute-based Resource Selection</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>QoS (Traffic Priority, Token Bucket Rate Shaping/Limiting, Guaranteed Data Rate, Latency and Jitter Guarantees)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Service-Class Name QoS Specification</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Request-defined (customized) QoS Specification (also provides ability to not provision Multicast QoS per CMTS)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Modification of Dynamically-created Multicast Flows</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Control Plane Acknowledgements</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

**NOTES**

1. Group Management Protocol refers to either IGMPv3 or MLDv2 – depending on the version of IP protocol.
Universal Transcoding

VIPr

Quality Metrics

MPEG-4 AVC HD
MPEG-4 AVC SD
MPEG-2 HD
MPEG-2 SD

MPEG-2 HD
MPEG-2 SD
MPEG-4 AVC HD
MPEG-4 AVC SD
MPEG-4 AVC PC Res
MPEG-4 AVC Mobile
MPEG-4 MVC 3D

Linear & SDV
Linear & IP-Video
Over-The-Top 3-Screen
Mobile

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Other Encapsulations Required?

- Fragmented MPEG4
- Multiple bitrate output for adaptive streaming
- Support for SVC (Scalable Video Coding) and MVC (multi-view Coding for 3D)
Conditioning Video Streams for IP Video

- Static pre-conditioning CBR/VBR video streams compliant to BW profiles for DOCSIS CAC
- CMTS feedback based dynamic VBR transcoding
IP Video Architectures

- IP Encapsulation in the Home & MPEG over DOCSIS
  - Network Overview
    - Current elements
    - New Elements
  - Features Delivered
    - New User Interface
    - Complete Video line up
    - Internet Information (Widgets)
    - Over the Top Video subscriptions
    - Visual Call Log
    - Home Network (Whole Home DVR)
    - Others ….
  - Network Benefits
    - Significant Bandwidth efficiency gains
    - Single network for all services
    - Flexible IP service creation environment
A Taxonomy of Video Types

General Video Type
- Analog Video
- MPEG-TS Digital Video
- IP Video

Network Path (If Applicable)
- NTSC or PAL
- ATSC or DVB (MPEG-TS)
- Hybrid (MPEG-TS & IP Encap)
- DOCSIS (IP)
- By-Pass (IP)
- Ethernet (IP)

Last-Mile Transport Protocol
- Off-Net

Specific Video Type
- Linear
- VoD
- Linear
- VoD

Last-Mile Transmission
- BCast
- SDV
- BCast
- SDV
- Static IP Mcast
- Switched IP Mcast
- Static IP Mcast
- Switched IP Mcast

In-Home Transmission
- BCast
- UCast
- IP UCast
- IP UCast
- IP UCast
- IP UCast
- IP UCast
- IP UCast

Convergence Enabled.
Dataflow
(“On-Net” Linear Multicast IP Video)

Back-Office Server Components
- Metadata & Content Mgmt
- Entitlement, DRM, & Rights Mgmt
- Application Server
- Device/Client/Service provisioning
- Geolocation
- Billing/SMS mediation
- Authentication
- Advertising System

ServAssure

SM interacts with Content Resolution Service, Entitlement Resolution Service, and Geolocation Service

Content Router

Ad Decision System

DRM

Streaming Server

DOCSIS/IP/UDP/MPEG Multicast

SM

Gateway

IP/TCP/MPEG Unicast

CMTS

Client

IP/UDP/MPEG Multicast

IP/UDP/MPEG Multicast

IP/UDP/MPEG Multicast

Convergence Enabled.
Dataflow
(“On-Net” VoD Unicast IP Video)

Back-Office Server Components
- Metadata & Content Mgmt
- Entitlement, DRM, & Rights Mgmt
- Application Server
- Device/Client/Service provisioning
- Geolocation
- Billing/SMS mediation
- Authentication
- Advertising System

ServAssure

Ad Decision System

SM interacts with Content Resolution Service, Entitlement Resolution Service, and Geolocation Service

Content Router

IP/TCP/MPEG Unicast

DRM

Streaming Server

Content Processing
E.g. transcoding transrating, ad-splicing

SM

Gateway

Client

CMTS

SM interacts with Content Resolution Service, Entitlement Resolution Service, and Geolocation Service

Convergence Enabled.
Dataflow
(“Off-Net” Unicast IP Video)
Potential Bandwidth Profile
E2E IP Transition

Node by Node Deployment of Demarcation GW - Bandwidth Estimates

- IP Multicast channels - AVC demand
- DOCSIS DS needed per SG average data rate
- IP Unicast VoD Channels - AVC demand
- VoD Channels - MPEG 2 demand/SG
- SDV channels - MPEG 2 demand
- Broadcast channels - MPEG 2 - non-encrypted
- Broadcast channels - MPEG 2 - encrypted

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The Vision....

One Source, One Protocol between the Client and Network regardless of location

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Summary
Benefits of E2E IP Video?

- Subscriber access to a broader audience through all 3 screens in the home (TV, PC, Handheld)
- Subscriber Access to a broader audience through On and Off-Net connection
- Provides a direct conduit to 15-30 year-old demographic (through their Handheld devices)
- Provides access to the growing "Internet advertising market" through directed advertising in IP-based videos
- Allows MSO to become the "organizers" of all IP Video content (MSO-based and Web-based)
- It could eliminate the high costs demanded by the current STB duopoly
- Provides reduction in training, spares, failure points, support systems, etc associated with todays separate networks
- Leverages the world wide pool of IP development for new technology and services
Thank You