FTTn/VDSL2 Broadband Networks
Capabilities and Economics

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Overview of presentation

- What is AT&T’s fiber strategy?
- What is FTTn/VDSL2 network architecture?
- What are its capabilities?
- What are its economics?
- Why is it a good broadband strategy?

The FTTn/VDSL2 technologies, architectures, services and costs described in this presentation are generic – unless explicitly identified to be those of AT&T U-verse.
Competitive NGN environment in the USA

- **Wireline deployments**
  - ADSL2+ (Covad/Embarq)
  - FTTn/VDSL2 (AT&T)
  - FTTH/PON (Verizon/Surewest)
  - FTTH/point-to-point (Utopia)
  - HFC DOCSIS 3.0 (Comcast)
  - BPL (Current/Duke)

- **Wireless (terrestrial)**
  - HSPDA/HSUPA/HSPA+ (AT&T)
  - EV-DO Rev.A/B (Verizon/Sprint)
  - Wi-Fi (Earthlink/T-Mobile)
  - WiMAX (Clearwire/Sprint)
  - LTE (AT&T/Verizon)

- **Satellite** (HughesNet/WildBlue)

These services currently offer throughputs up to 50 Mbps and at prices as low as $15/month
AT&T’s fiber strategy

- Reach more customers in less time
- Invest efficiently
- Deploy quickly to compete sooner in the marketplace
- Deliver a pure IPTV solution
- Build a converged broadband platform for the future

**AT&T U-verse FTTn/VDSL2 platform**

- Pass 30 million living units over 5 years (2006-2010)
  - Cost per home passed in the low-US$300 range
What is FTTn/VDSL2 network architecture?
FTTn/VDSL2 schematic

WWW
ISP Backhaul / Backbone
Central Office

FTTn/PON (Greenfield)

FTTn/VDSL2

VDSL2 fiber node

Copper-pair cable
Fiber cable
**Video distribution technologies**

**Broadcast RF video**

- Network must support **all content simultaneously** from head end to customer
- Content **limited** by total bandwidth

**VDSL2: switched IP video**

- **Switched multicast** IP distribution of content
- Network delivers to home only the customer’s chosen content
- **Shared platform** with VoIP and HSIA
What are FTTn/VDSL2’s capabilities?
## Evolving service capabilities

<table>
<thead>
<tr>
<th>Service Profile</th>
<th>2007</th>
<th>2008</th>
<th>Future?</th>
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</thead>
<tbody>
<tr>
<td>HDTV streams</td>
<td><img src="image" alt="HDTV" /></td>
<td><img src="image" alt="HDTV" /></td>
<td><img src="image" alt="HDTV" /></td>
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<tr>
<td>SDTV streams</td>
<td><img src="image" alt="SDTV" /></td>
<td><img src="image" alt="SDTV" /></td>
<td><img src="image" alt="SDTV" /></td>
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<tr>
<td>Internet</td>
<td><img src="image" alt="HSIA (≤6 Mbps)" /></td>
<td><img src="image" alt="HSIA (≤10 Mbps)" /></td>
<td><img src="image" alt="HSIA (≥10 Mbps)" /></td>
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<tr>
<td>VoIP lines</td>
<td><img src="image" alt="VoIP line" /></td>
<td><img src="image" alt="VoIP line" /></td>
<td><img src="image" alt="VoIP line" /></td>
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<tr>
<td>Target throughput</td>
<td>25 Mbps</td>
<td>25 Mbps</td>
<td>25-37 Mbps</td>
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Service capabilities improve as bandwidth expands and/or video encoding/compression becomes more efficient.
Service requirements

- **Standard definition IPTV (SDTV)**
  - MPEG2 coding: ~3 Mbps
  - MPEG4 AVC/H.264 coding: generally at 1.5-2 Mbps

- **High definition IPTV (HDTV)**
  - MPEG2 coding: ~16 Mbps
  - MPEG4 AVC/H.264 coding
    - Currently: 8-9 Mbps
    - Future: ≤ 6 Mbps

- **High speed Internet access (HSIA)**

- **Voice over Internet Protocol (VoIP)**

Figures are industry approximations and not an indication of AT&T’s actual encoding rates.
### Transmission innovations: capped VBR

<table>
<thead>
<tr>
<th>Constant bit rate</th>
<th>Capped variable bit rate</th>
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<tbody>
<tr>
<td>HSIA</td>
<td>HSIA bursts into video bandwidth</td>
</tr>
<tr>
<td>SDTV</td>
<td>SDTV</td>
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<td>SDTV</td>
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<td>SDTV</td>
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<tr>
<td>HDTV</td>
<td>HDTV</td>
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</tbody>
</table>

- Hybrid between CBR and VBR
  - Variable bit rate video encoding enables HSIA to use bandwidth not being currently used by video streams
  - VDSL2 QoS service segmentation protects quality of VoIP and video while allowing HSIA data to “burst” into video bandwidth

Figures are industry approximations and not an indication of AT&T’s actual encoding rates.
VDSL2 bandwidth capability

VDSL2 Bandwidth vs. Copper Loop Length

Design specification examples:

25 Mbit/sec
- Single pair
- 3000 foot maximum copper distance

37 Mbit/sec
- Single pair - 2000 foot max copper distance
- 2 bonded pair – 2000 to 3000 foot max copper distance

Figures are from ATIS and are illustrative only, they not intended to depict AT&T’s particular experience. Actual throughputs will depend on the specific characteristics of the loop plant and network equipment deployed.
VDSL2 future

- Available bandwidth is increasing
  - Improvements in signal processing/crosstalk reduction
  - Pair bonding
  - Loop-shortening
- Service-specific bandwidth requirements are falling
  - Compression technologies continue to improve
  - Transmission technologies allow increased utilization efficiency
- Future of technical platform is bright
What are FTTn/VDSL2’s economics?
Telecom network cost rules

- The closer equipment is to the customer’s home, the greater its share of total network cost
  - Drops and loops are the most expensive on a per-home basis
  - Shared facilities further back in the network are less expensive on a per-home basis

- The cheapest network equipment is the equipment that is already in place
VDSL2 economics

- Video service-specific infrastructure deployed out to Video Hub Offices
- Fiber extended into neighborhoods until customers are within ~3000 feet (1 km) of a VDSL2 fiber node
- Network linking fiber nodes is made highly resilient
- VDSL2 reuse of embedded copper loops and drops – the most expensive network components
  - Minimal disturbance of neighborhood rights-of-way
  - Does not disturb customers’ lawns and driveways
  - Only required work is on the side of the customer’s house and possibly on the in-home wiring
VDSL2 economics

- Costs of the AT&T U-verse buildout have been reasonable
  - Cost to extend fiber into neighborhoods and install video multicast-capable nodes has been in the low US$300 range
  - Success-based costs (NID, STB, install) in US$600-$700 range

- Customer reaction has been strong
  - Growing market share
  - This response occurs in the face of highly-entrenched facilities-based competition from:
    - Cable television/modem networks (DOCSIS-HFC)
    - Direct broadcast satellite systems (DBS)
Why is FTTn/VDSL2 a good broadband strategy?
FTTn/VDSL2 advantages

- **Absolute cost**
  - Cost per subscriber is about half PON FTTH cost of ~US$2000

- **Cost structure**
  - FTTn/VDSL2 costs are predominantly success-based
  - FTTH costs are more heavily fixed

- **Time to market**
  - Deployment is much faster than FTTH

- **Real options**
  - Capabilities of VDSL2 are expanding
  - Costs of fiber deployments are dropping
  - High real options cost of deploying FTTH immediately
Bandwidth debate:
What is important to the customer?

Arguments for FTTH have focused on position that “more is better”

- Without IPTV, video capacity is limited
- Inability of current “network middle” to accommodate ultrahigh bandwidth access
- Inadequate business case for delivery of ultrahigh bandwidth non-video applications
- Extremely expensive – may not be broadly viable
- Requires very high market share for financial success

But what matters to customers is available content, end-to-end performance and good value

- Limitless carriage of IP video content
- Consistent with evolving “middle of the network” capacities and costs
- Sound business case based on demonstrated large-scale residential demand
- Cheaper and more accessible to larger population
- Accommodates facilities-based competition
Conclusions

- Both FTTH and FTTN/VDSL2 are:
  - Exceptionally capable technologies
  - Able to offer customers vastly expanded services of all types
  - Require very significant capital investments
- It is not obvious that one technology is a better choice than another from either a technical or economic point-of-view
  - It likely will take at least 5-10 years to resolve fully the relative economics and capabilities
- We should be pleased that private companies are undertaking the investments today to deploy both of these advanced broadband networks
Thanks for your attention

http://www.atis.org/standardsdeliver/docs/DSL.pdf