FTTn / VDSL2 Broadband Networks

Capabilities and Economics

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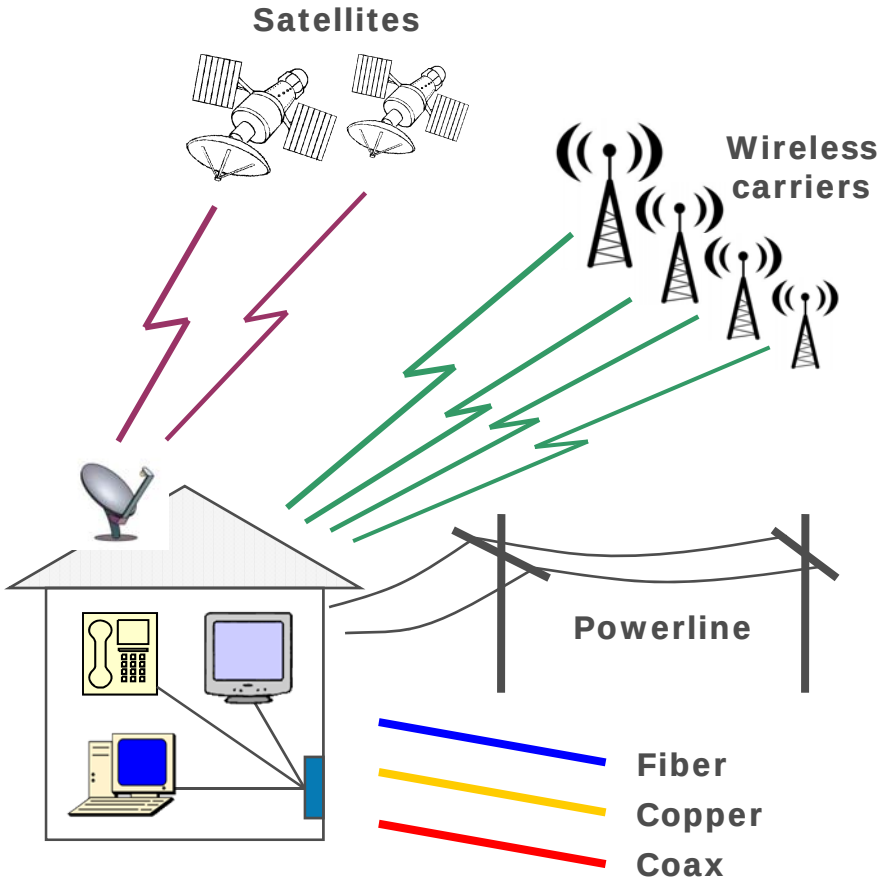
Overview of presentation

- 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

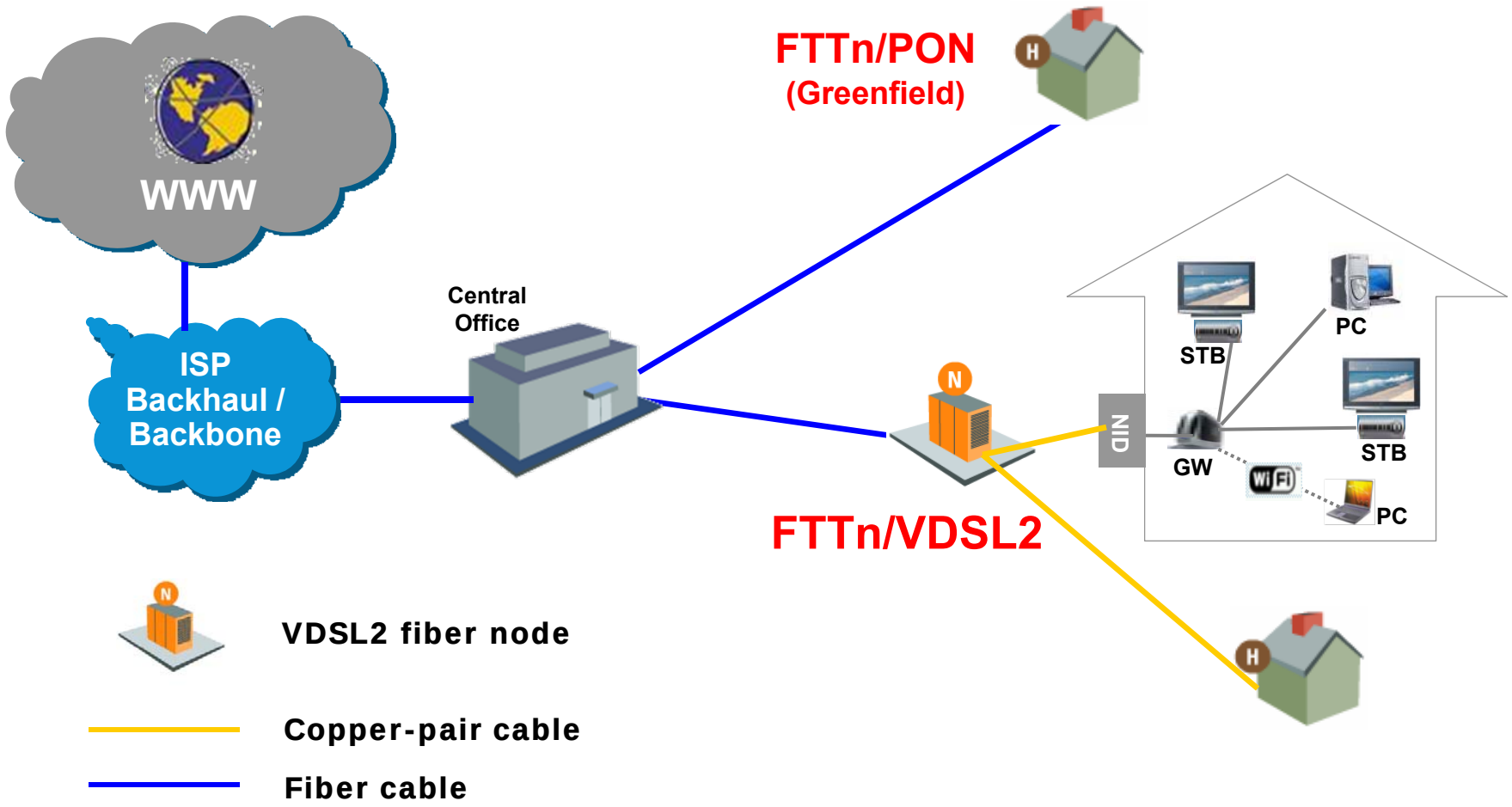
- Reach more customers in less time
- Invest efficiently
- Deploy quickly to compete sooner in the marketplace
- Deliver a pure IPTV solution
- Build a converged broadband platform for the future

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

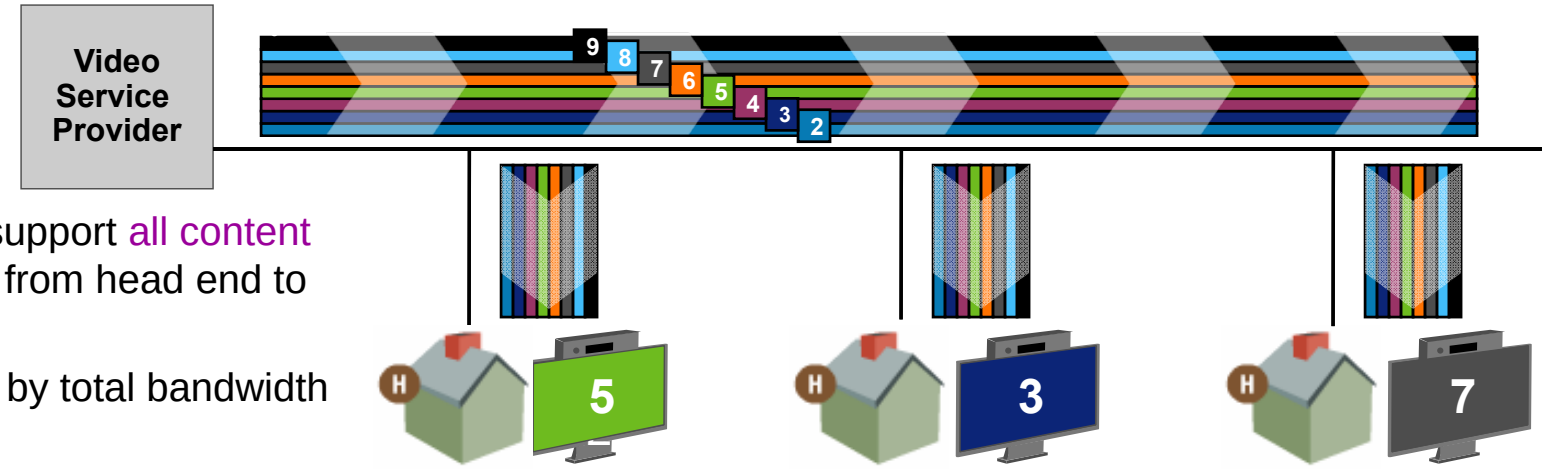
What is FTTn / VDSL2 network architecture?

FTTn / VDSL2 schematic



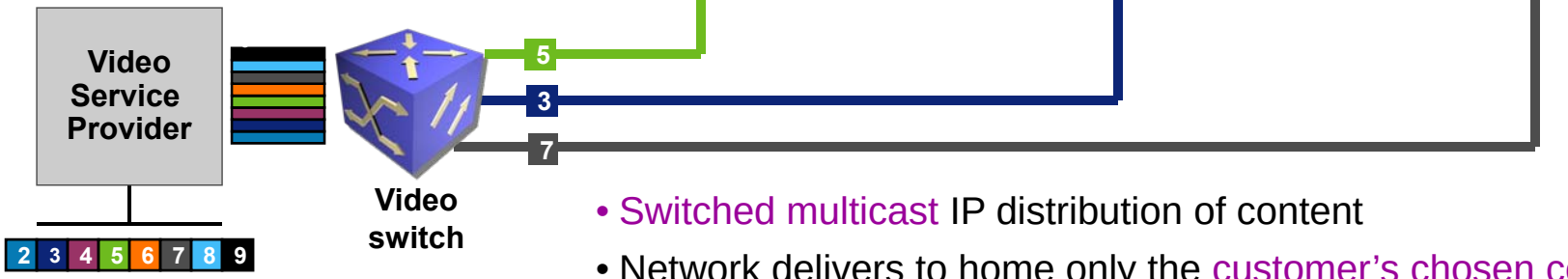
Video distribution technologies

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

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What are FTTn / VDSL2's capabilities?

Evolving service capabilities

Service Profile	2007	2008	Future?
HDTV streams	HDTV	HDTV HDTV	HDTV HDTV HDTV
SDTV streams	SDTV SDTV SDTV	SDTV SDTV	SDTV
Internet	HSIA (≤6 Mbps)	HSIA (≤10 Mbps)	HSIA (≥10 Mbps)
VoIP lines	VoIP line VoIP line	VoIP line VoIP line	VoIP line VoIP line
Target throughput	25 Mbps	25 Mbps	25-37 Mbps

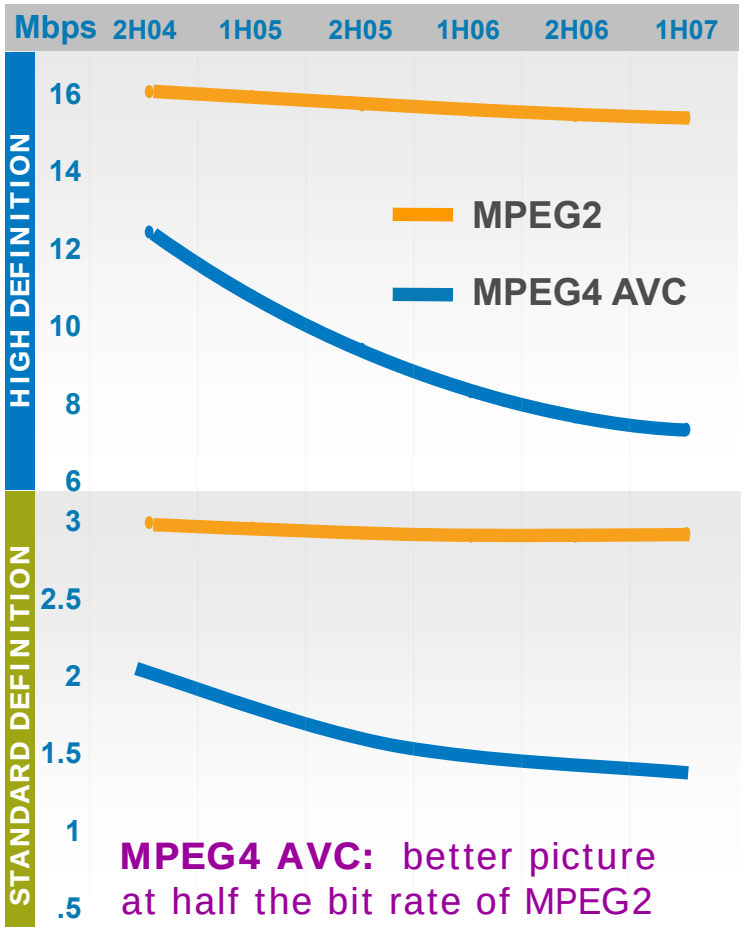
Service capabilities improve as bandwidth expands and/or video encoding/compression becomes more efficient

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

Compression industry estimates



MPEG4 AVC: better picture at half the bit rate of MPEG2

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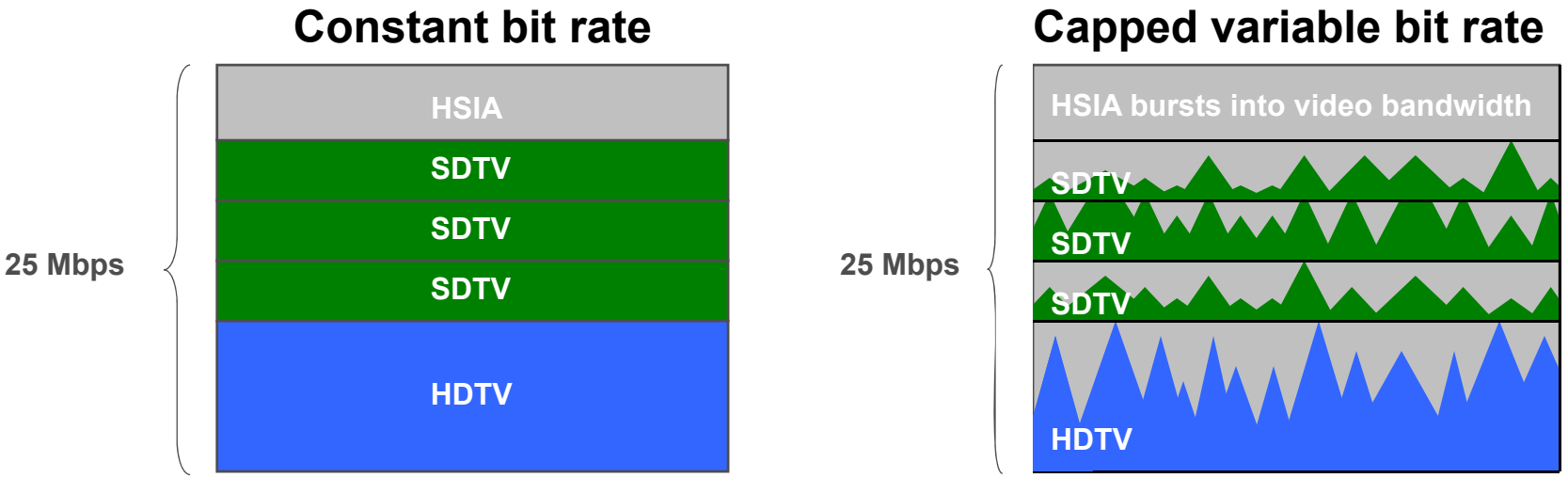
Transmission innovations: capped VBR



- 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

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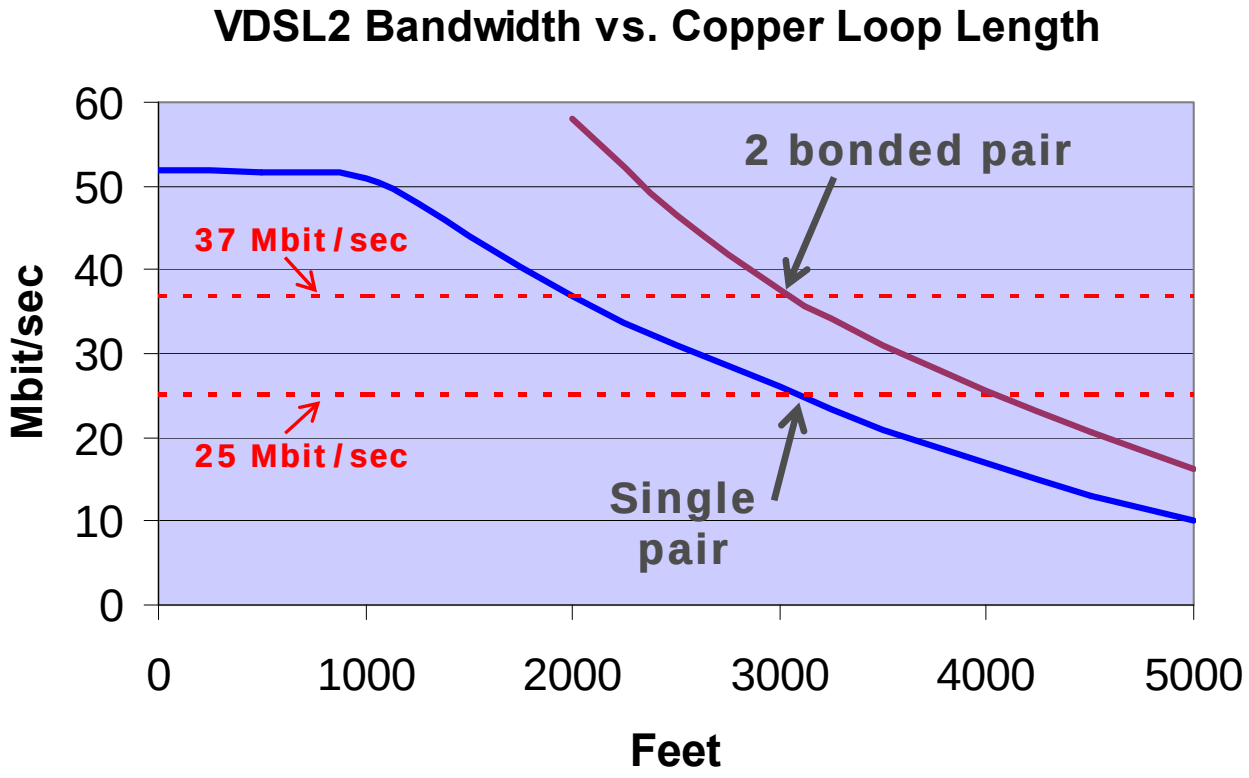
VDSL2 bandwidth capability



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.

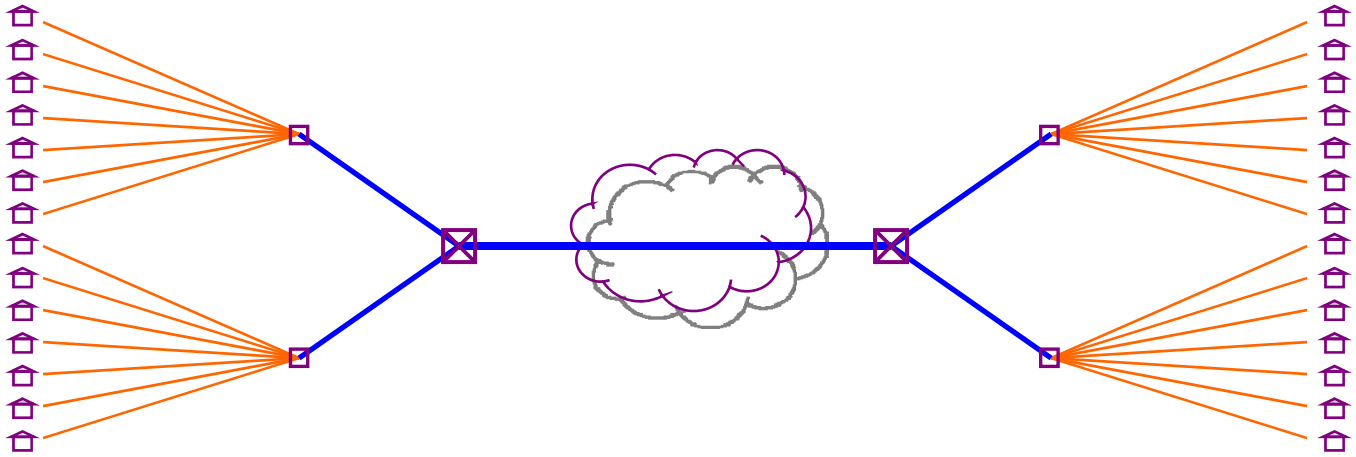
VDSL2 future

- 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

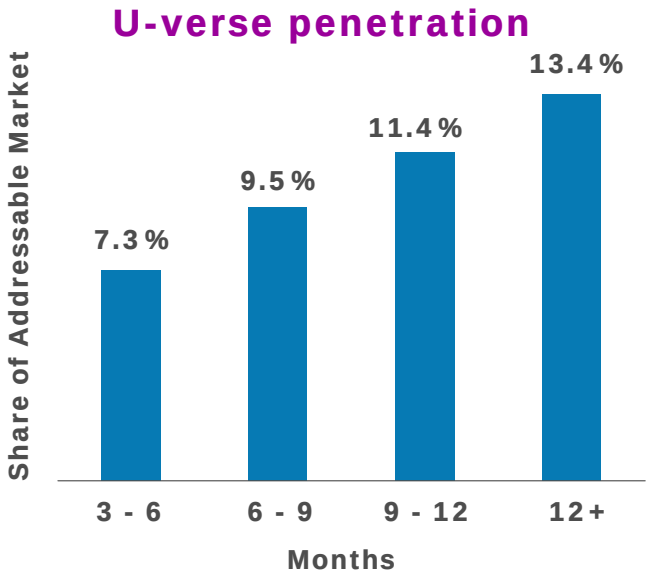


VDSL2 economics

- 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

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