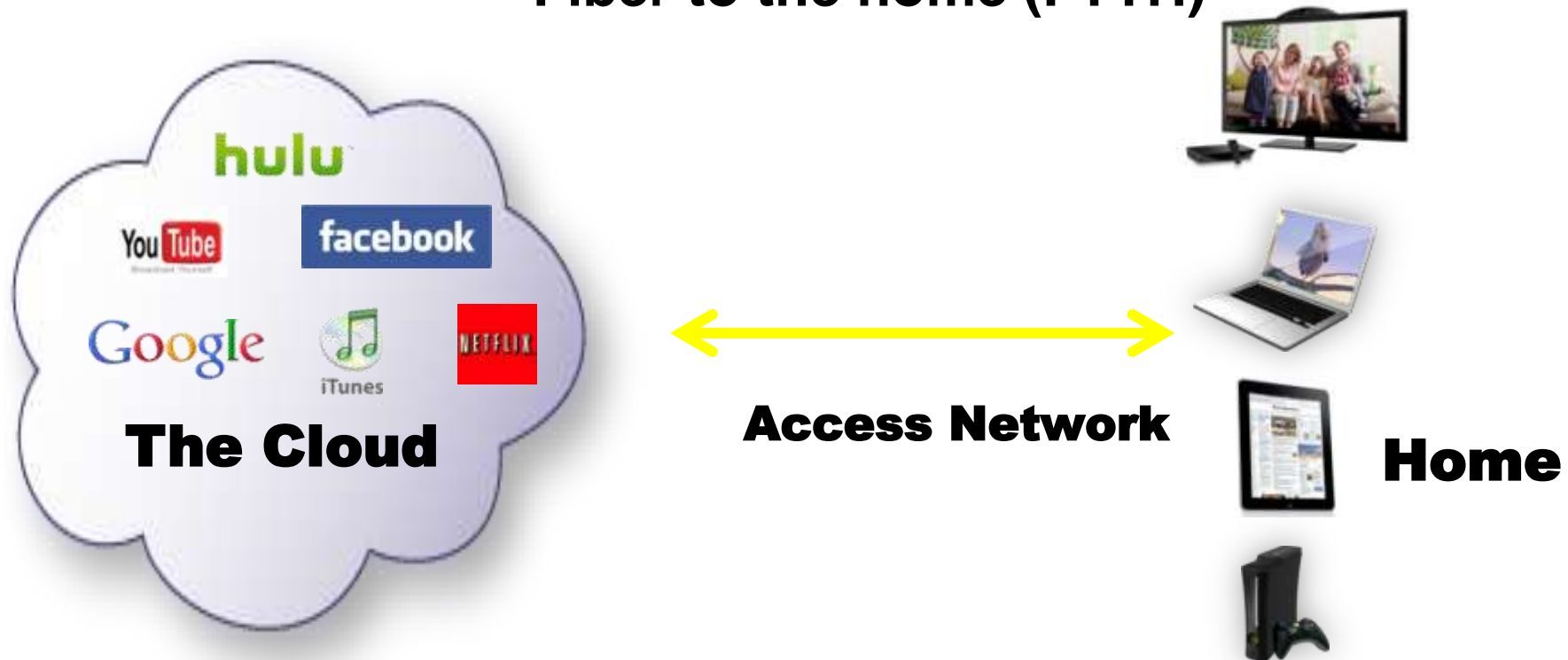




Wireline Access Technologies

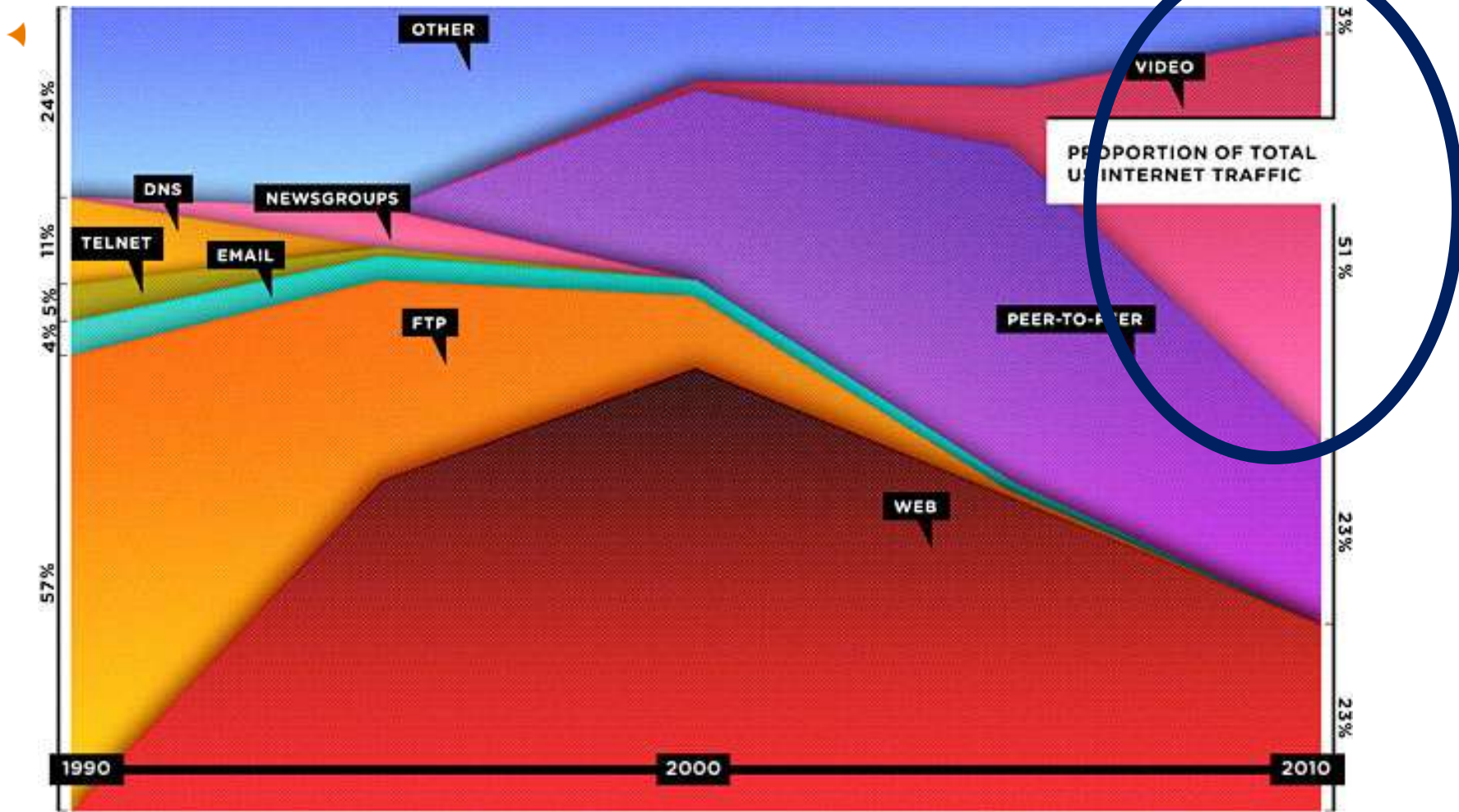
The information contained in this presentation is not a commitment, promise, or legal obligation to deliver any material, code, or functionality. The development, release, and timing of any features or functionality described for our products remain at our sole discretion.

- Access network connects subscribers to services
- Wireline Media: Hybrid fiber coax (Cable Modem)
Fiber to the node (VDSL2)
Fiber to the home (FTTH)



IP Video is Driving Bandwidth

Online video community ~ 1 billion users currently



Statistics Source: Cisco IVN
Graph Source: Wired Sept. 2010

Cable operators have lots of bandwidth-downstream

- ▶ Greater than 95% of the bandwidth is downstream
- ▶ Downstream bandwidth is divided between analog video, digital video and DOCSIS.
- ▶ Voice and data services ride on top of the DOCSIS
- ▶ Bandwidth in the downstream is equivalent to 2-3 Gbps shared over 100+ customers
- ▶ Cable operators will have to reconfigure or rebuild parts of their systems to increase upstream capacity

Incumbent DSL operators should be deploying VDSL2 by now

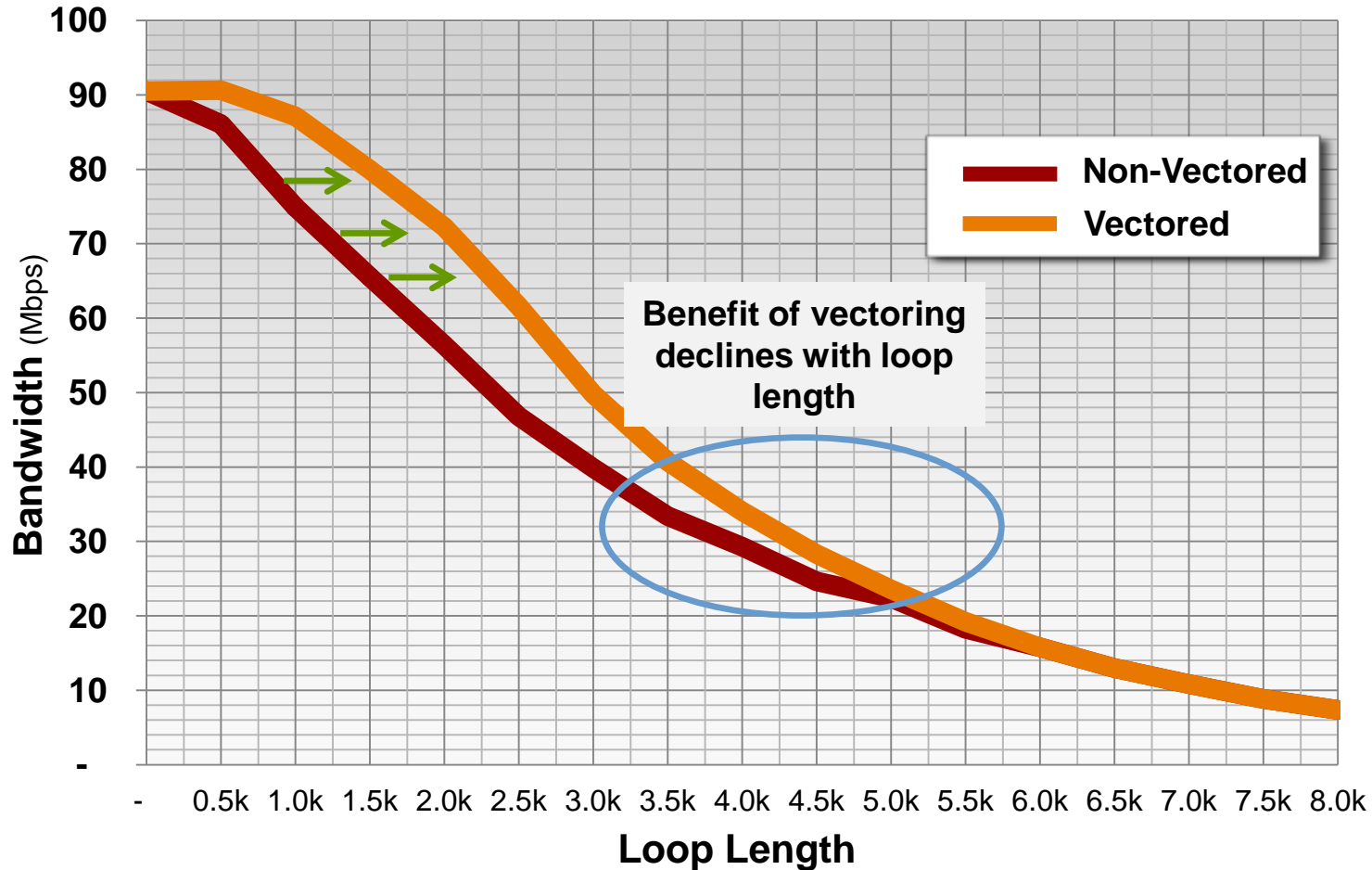
- ▶ VDSL2 is the newest version of DSL technology
- ▶ VDSL2 increases bandwidths to consumers on short loops-fiber to the cabinet or node
- ▶ VDSL2 is designed to fall back to ADSL2+ on longer loops

Vectoring or “DSM Level 3” is a technology that eliminates cross talk in a VDSL2 binder group

- ▶ Elimination of cross talk leads to higher throughput

Vectored VDSL2 yields the greatest results in shorter loops

- ▶ Benefits seen on loop lengths less than 5,000 feet
- ▶ Downstream bandwidth up to 90 Mbps on short loop lengths
- ▶ Upstream bandwidth limited to 16 Mbps



- Fiber network can be point-to-point or the light can be split using a passive optical network (PON)
- PONs: 32 subscribers share 2.5 Gbps downstream
- Point-to-Point: No sharing. 100 Mps symmetrical now shifting to 1 Gbps symmetrical

PON



Point-to-Point



Serving Office

Fiber Network






Home

Technology	Down-Shared Bandwidth	Up-Shared Bandwidth	Homes Sharing Bandwidth	Down-Max per Sub Data Bandwidth	Up-Max per Sub Data Bandwidth
HFC: Cable*	2+ Gbps	120 Mbps	100+	160 Mbps	120 Mbps
VDSL2: Twisted Pair	N/A	N/A	N/A	50 Mbps	16 Mbps
FTTH: PON	2.5 Gbps	1.2 Gbps	32	250 Mbps	75 Mbps
FTTH: Point-to-Point	N/A	N/A	N/A	1 Gbps	1 Gbps

*Includes RFOG (DOCSIS over fiber)

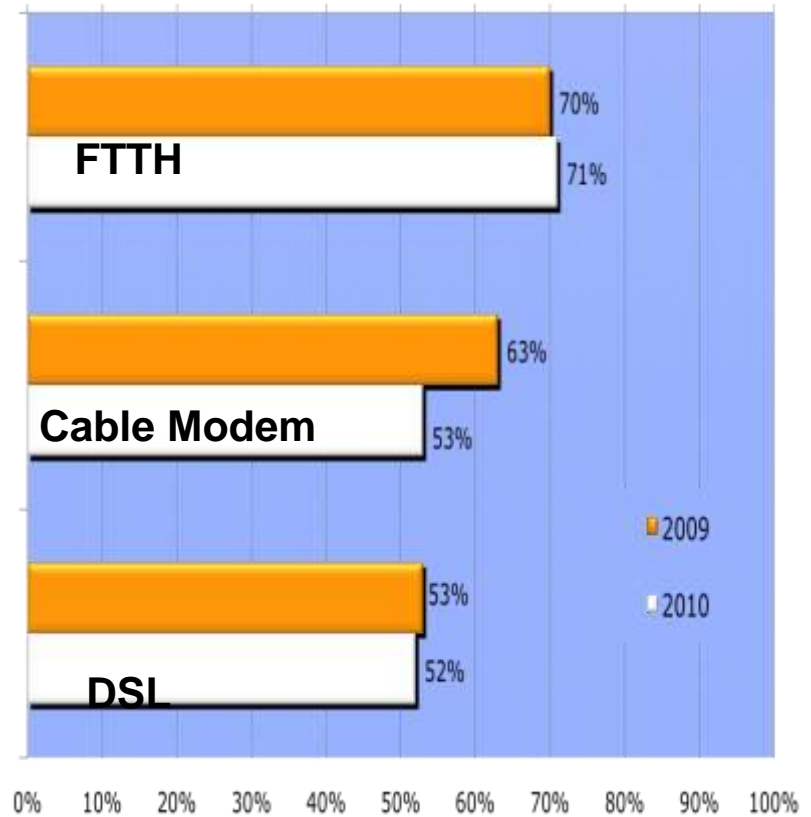
Internet video is the key driver of the new game

- Bandwidth requirements range from burdensome to instantaneous

		Wireless	ADSL2+	DOCSIS 3.0 / VDSL2	GPON / Pt-to-Pt
	Size	3 Mbps	10 Mbps	50 Mbps	1 Gbps
	Photo – 7 Megapixel	4 Mb	48 s	3.6 s	.7 s
	Music – Download	4 Mb	48 s	3.6 s	.7 s
	Podcast – News	114 Mb	20 m 20 s	1 m 31 s	18 s
	TV Show – 40 min	200 Mb	36 m	3 m	35 s
	Movie – iTunes	1.5 Gb	4h 38m	21 m	5 m
	Movie – Best Quality	2.5 Gb	7h 42m	36 m	8 m

History of broadband has shown **SPEED SELLS**

- Download speed currently valued by customers
- Upstream, latency more important in future



Source: RVA LLC

Technology	Down-Shared Bandwidth	Up-Shared Bandwidth	Homes Sharing Bandwidth	Down-Max per Sub Data Bandwidth	Up-Max per Sub Data Bandwidth
HFC: Cable*	6 Gbps	120 Mbps	100+	320+ Mbps	120+ Mbps
VDSL2: Twisted Pair	N/A	N/A	N/A	90 Mbps	16 Mbps
FTTH: PON	40 Gbps	10 Gbps	32+	1 Gbps	250 Mbps
FTTH: Point-to-Point	N/A	N/A	N/A	1 Gbps	1 Gbps

*Includes RFOG (DOCSIS over fiber)



Calix

ACCESS INNOVATION