

A man in a white shirt and red tie is holding a large red cable that loops around a globe. The globe is blue and green, representing Earth. The background is a textured, yellowish-brown surface.

Introduction to DSL

Its here, Its Now, It is prime time



Agenda

- ➔ **What is “Broadband”?**
- ➔ **Why is it important?**
- ➔ **What is DSL?**
- ➔ **DSL Technology Overview**
- ➔ **Basic DSL Network Design**
- ➔ **New World Services**
- ➔ **Market Dynamics**

Life Beyond 56K

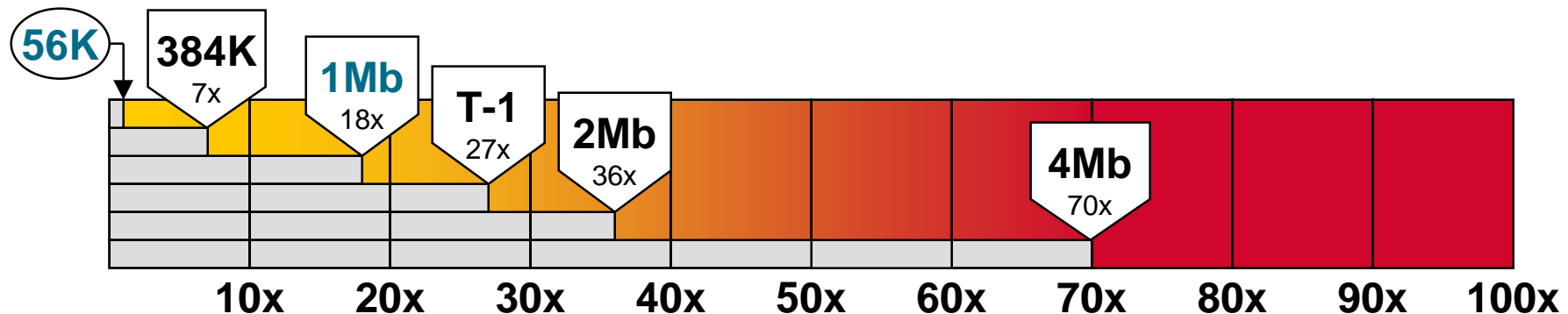
56K is too slow to provide a satisfactory consumer Internet experience

- Our century-old telephone network is designed specifically around the audible frequency range 0-4KHz
- Voice Band Modems use tones in the audible spectrum and communicate via standard voice circuits (you can hear modems & fax machines “talking” to one another)
- 56kbps (“56K”) is the practical limit for voice band modems
- DSL uses inaudible high-frequency signaling to achieve megabit transmission speeds

What is “Broadband”?

“Broadband” = “Megabit” data rates

- Common unit of measure: “T-1” = 1.544Mbps
- “Fractional” T-1’s, starting around 384kbps
- Compare to current maximum voice-band modem speed of 56kbps (“56K”)...



Broadband Access Technologies

- **DSL (Copper)**
- **Cable (Coax)**
- **Wireless**
- **Optical Fiber**

Consumer Access Options

	<i>Transmission Medium</i>	<i>Download Speed</i>	<i>Upload Speed</i>	<i>Requirements & Limitations</i>	<i>Equipment Cost</i>	<i>Installation Cost</i>	<i>Monthly Expense</i>	<i>Target Market</i>
56K analog	Copper (Std phone wire)	56Kbps (typically less)	33.6Kbps (or less)	Slow, but available everywhere	\$0 (typically incl'd w/PC)	\$0 (with existing phone line)	Cost of phone line + \$19 for ISP	Residential
ISDN	Copper (Std phone wire)	64 Kbps or 128 Kbps	64 Kbps or 128 Kbps	Reach extends several miles with repeaters	\$75 terminal adapter to \$500 router	Up to \$300	\$19-\$39 + \$19-\$39 for ISP	Residential and Business
ADSL	Copper (Std phone wire)	144 Kbps to 8 Mbps	144 Kbps to 1.7 Mbps	<18K ft from CO, no DLC	\$200 PC NIC, \$500 SOHO router (unless rented)	Up to \$500	\$39 (min), may include Internet connection	Residential and Business
Cable Modem	Coax	384 Kbps to 4 Mbps	128 Kbps to 4 Mbps	Requires cable TV availability; speed varies noticeably with subscriber load	Up to \$349 for set-top modem, unless rented, plus \$29 (min) for Ethernet NIC	Up to \$175	\$29-\$49 (min), incl. Internet connection; may incl. equip. rental	Residential
Satellite	Wireless (req's phone line return path)	400 Kbps	33.6 Kbps (via 56K analog modem)	Requires "dish" antenna & phone line	\$199 (min)	Up to \$800	Cost of phone line + \$29-\$129, incl. Internet connection	Residential
LMDS (Fixed Wireless)	Wireless	1.5 Mbps to 4 Mbps	1.5 Mbps to 4 Mbps	Requires antenna	Negotiated, depending on service package	Negotiated, depending on service package	Varies widely, depending on service package	Business

Business Access Options

<i>Service</i>	<i>Installation</i>	<i>Monthly</i>
<i>Leased Line T-1 (1.5 Mbps)</i>	\$750-\$1,500	\$1200-\$1600
<i>Frame Relay (384 kbps)</i>	\$700-\$1,200	\$550-\$850
<i>Business ISDN (128 kbps)</i>	\$100-\$350	\$100-\$250
<i>DSL (1.5 Mbps)</i>	\$400-\$1000	\$900
<i>DSL (384 kbps)</i>	\$100-\$350	\$100-\$150

Deregulation and access to “dry copper” has created a market for US CLECs and IXC's to provide lower cost DSL access as an alternative to reselling traditional local loops.

Why is Residential Broadband Important?

RBB enables the full commercial potential of the Internet

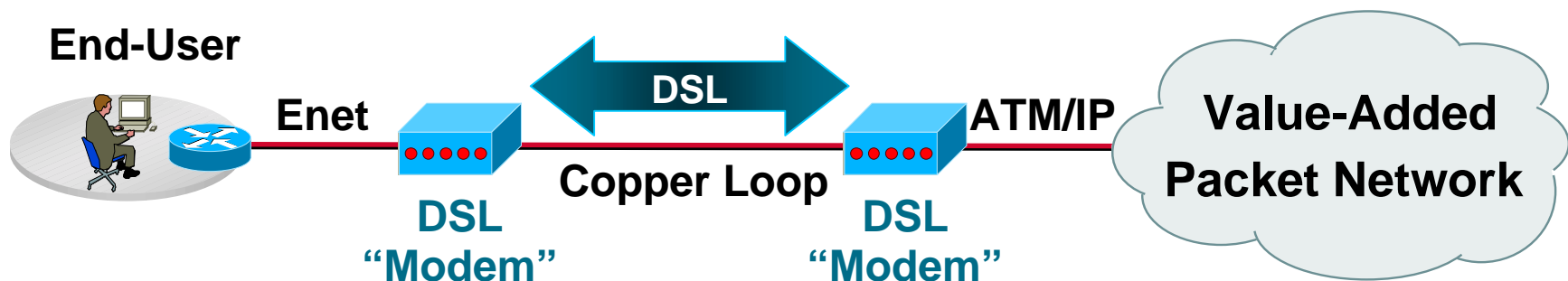
- **Fast downloads of “rich” content**
 - Graphics, animation, audio, video
- **Always-On**
 - Constant interaction with a multitude of network-aware “Internet appliances”
- **Real-time person-to-person interaction**
 - Video conferencing, interactive gaming, multimedia collaboration
- **Integrated Services**
 - Data + Voice + Video
- **New Services**
 - Variable bandwidth, add'l lines on-demand, multimedia conferencing
- **Relieves voice networks overloaded with Internet traffic**
 - Average voice call lasts 3 minutes, compared to 30-60 minutes per internet session

What is “DSL”?

A family of access technologies that utilize high transmission frequencies (up to 1MHz) to convert ordinary phone lines into high-speed data conduits



“DSL 101”



- DSL is a pair of “modems” on either end of a copper wire pair
- DSL converts ordinary phone lines into high-speed data conduits
- Like dial, cable, wireless, and T1, DSL by itself is a **transmission technology**, not a complete end-to-end solution
- End-users don’t “buy” DSL, they “buy” services, such as high-speed Internet access, intranet, leased line, voice, VPN, and video on demand

DSL Modem Technology

DSL Technology	Max. Data Rate Down/Uplink (bps)	Line Coding Technology	Baseband Voice?	Max. Reach feet (km)	Key Attributes
VDSL – Very-High-Bit-Rate DSL	51-55M / 1.6-2.3M 13M / 1.6-2.3M	TBD	Yes	1,000 (0.3) 4,500 (1.5)	Very fast - Short reach No standard yet
ADSL – Asymmetric DSL	8M / 1M 1.5M / 640K	CAP, DMT, G.lite	Yes	18,000 (5.5)	Coexists with POTS Technology of choice for residential
IDSL – ISDN DSL	144K / 144K	2B1Q	No	18,000 (5.5)+ (w/repeaters)	Uses existing ISDN CPE Relatively slow
SDSL – Symmetric DSL	768K / 768K	2B1Q/CAP	No	22,000 (6.9)	Symmetric No standard
HDSL2 – High-Bit-Rate DSL	1.5M-2M / 1.5M-2M (T1-E1 Symmetric)	OPTIS	No	15,000 (4.6)	Standard still under development

- Trade-off is reach vs. bandwidth
- Reach numbers are best-case assuming “Clean Copper”
- Different Layer 1 transmission technologies, need a common upper protocol layer to tie them together

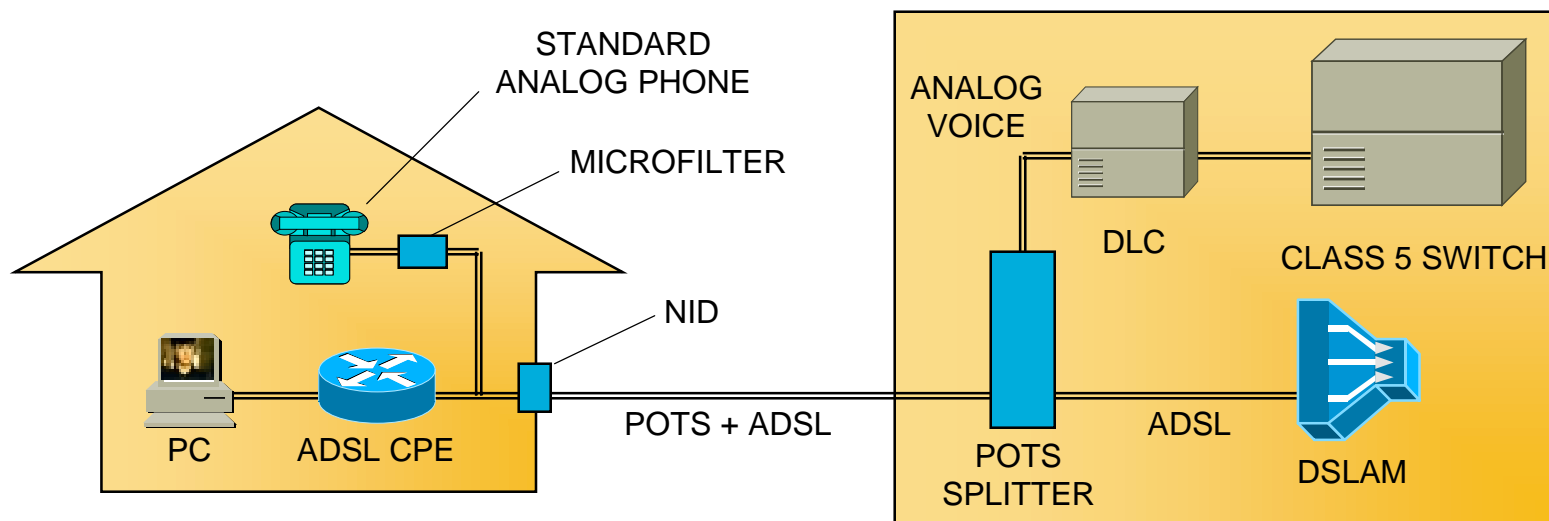
ADSL

“Consumer DSL”

- **Designed to co-exist with POTS, unlike most other DSL types**
- **“Slow” upstream for low-data-rate requests**
- **“Fast” downstream for bursts of rich graphics & multimedia content**
- **Three Basic “Flavors” of ADSL (modulation techniques)**
 - CAP (Carrierless Amplitude Modulation/Phase Modulation)
 - DMT (Discrete MultiTone Modulation)
 - G.lite (Consumer / Mass-Market DMT)

ADSL & POTS

A key feature of ADSL is co-existence with POTS



Customer Premise

Central Office

- Permits transmission of both signals on the same wire pair
- Off-loads data circuit from the voice switch
- “POTS Splitter” at the CO separates analog POTS from data
- “Microfilters” at the customer premise prevent off-hook interference between analog voice signal and ADSL signal

G.lite

“Mass-Market DSL”

- **Simplified DMT encoding scheme**
- **Limited “features” to facilitate broad interoperability & minimize end-user interaction**
- **No embedded management channel**
- **“Splitterless”**
- **Max. downstream data rate = 1.5Mbps**
- **Max. upstream data rate = 640kbps**

ADSL Standards

- **Full-rate DMT**
 - ANSI T1.413 - Issue 2
 - ITU G.992.1 (G.dmt)
 - ITU G.994.1 (G.hs)
- **Consumer DMT**
 - ITU G.992.2 (G.lite)

Interoperability

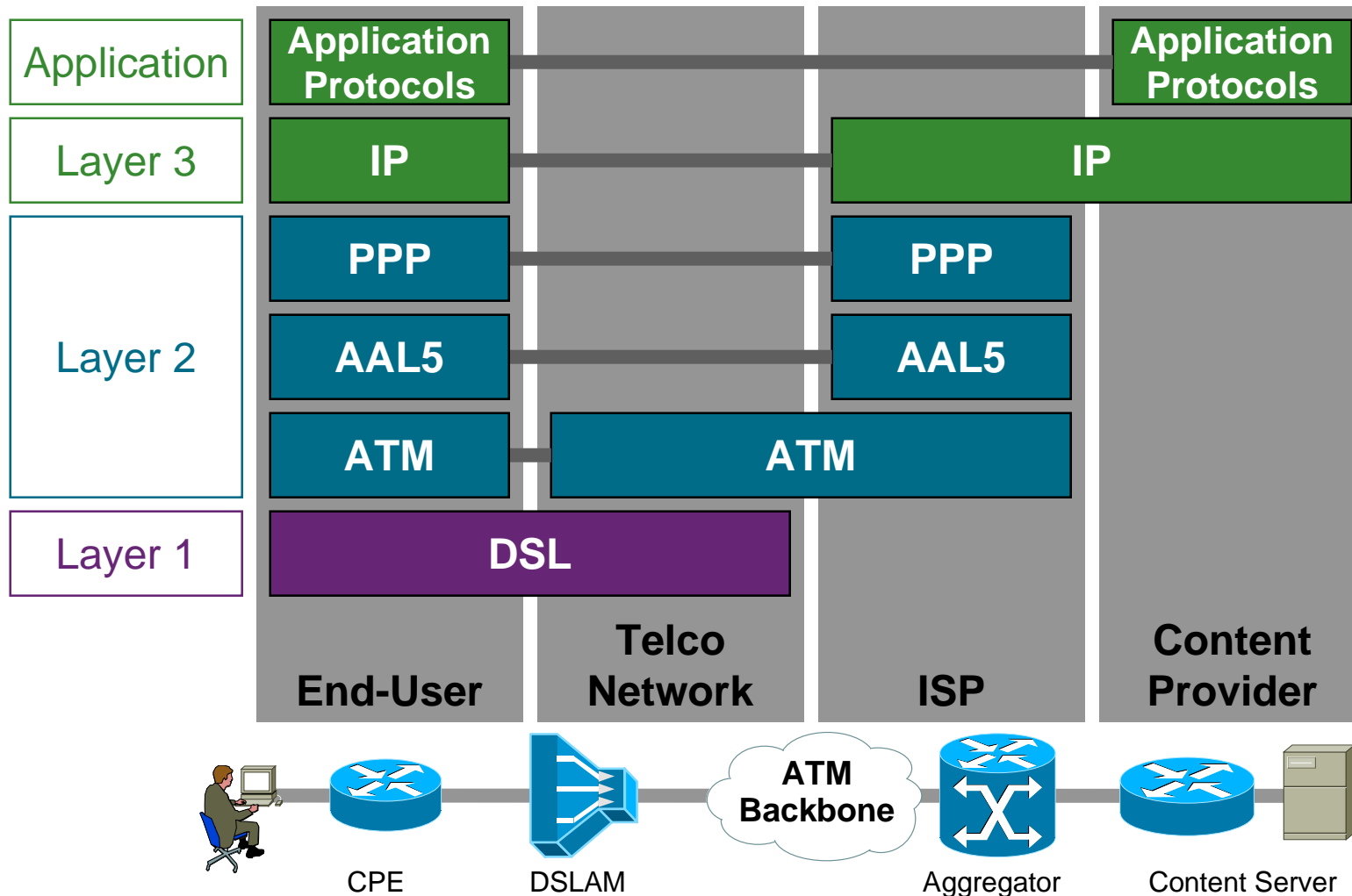
Why it's good...

- Enables competition & lower equipment costs for service providers & end-users
- Lower component costs for equipment manufacturers
- Proliferation of CPE options for end-users
- Retail availability of CPE (consumer mass market)

Why it's difficult...

- Standard must specify physical layer (at all data rates) & framing
- Value-added services require Layer 2/3 implementations
- Standards development takes time

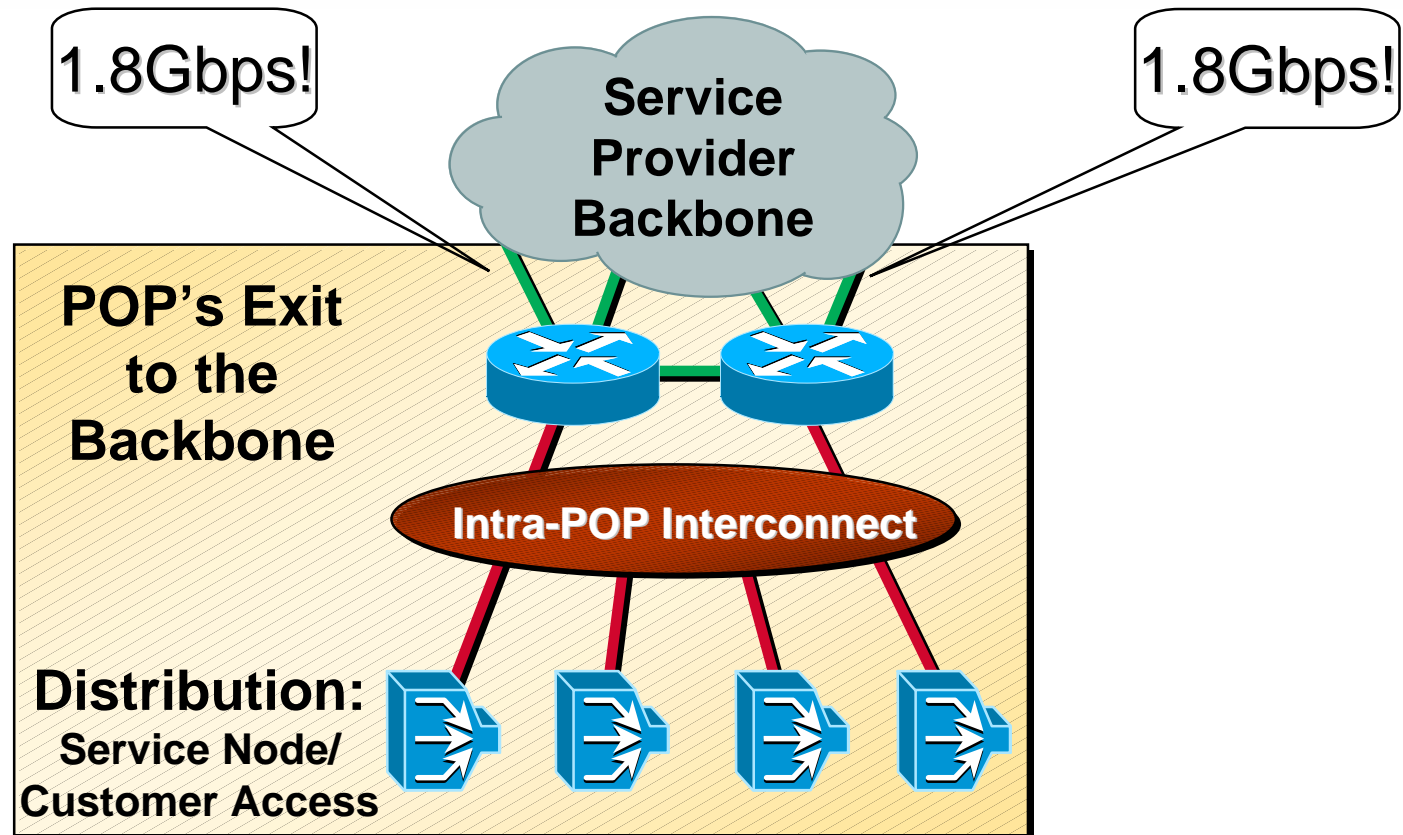
End-To-End DSL Protocol Stack



No one is offering 1.5 Mbps. Why?

- **How do you build a ADSL POP with 5000 lines all sucking 6 Mbps of traffic?**
 - **5000 x 6 Mbps = 30 Gbps!**
(30% utilization = 9 Gbps)
 - **5000 x 1.2 Mbps = 6 Gbps!**
(30% utilization = 1.8 Gbps)
- **Is OC-12 out of a POP enough? What about the backbone? If the POP exits are 622 Mbps, what's the backbone going to look like?**

No one is offering 1.5 Mbps. Why?



1.8Gbps is optimistic. Imagine if your customers like your service and start pulling the maximum capabilities of your ADSL links?

Basic DSL Network Components



DSL CPE

Customer Premise Equipment

PC NICs, Bridge/Routers, Enterprise Routers



DSLAM

DSL Access Multiplexer

Concentrates individual subscriber lines from CPE



Aggregator/Service Selection Gateway

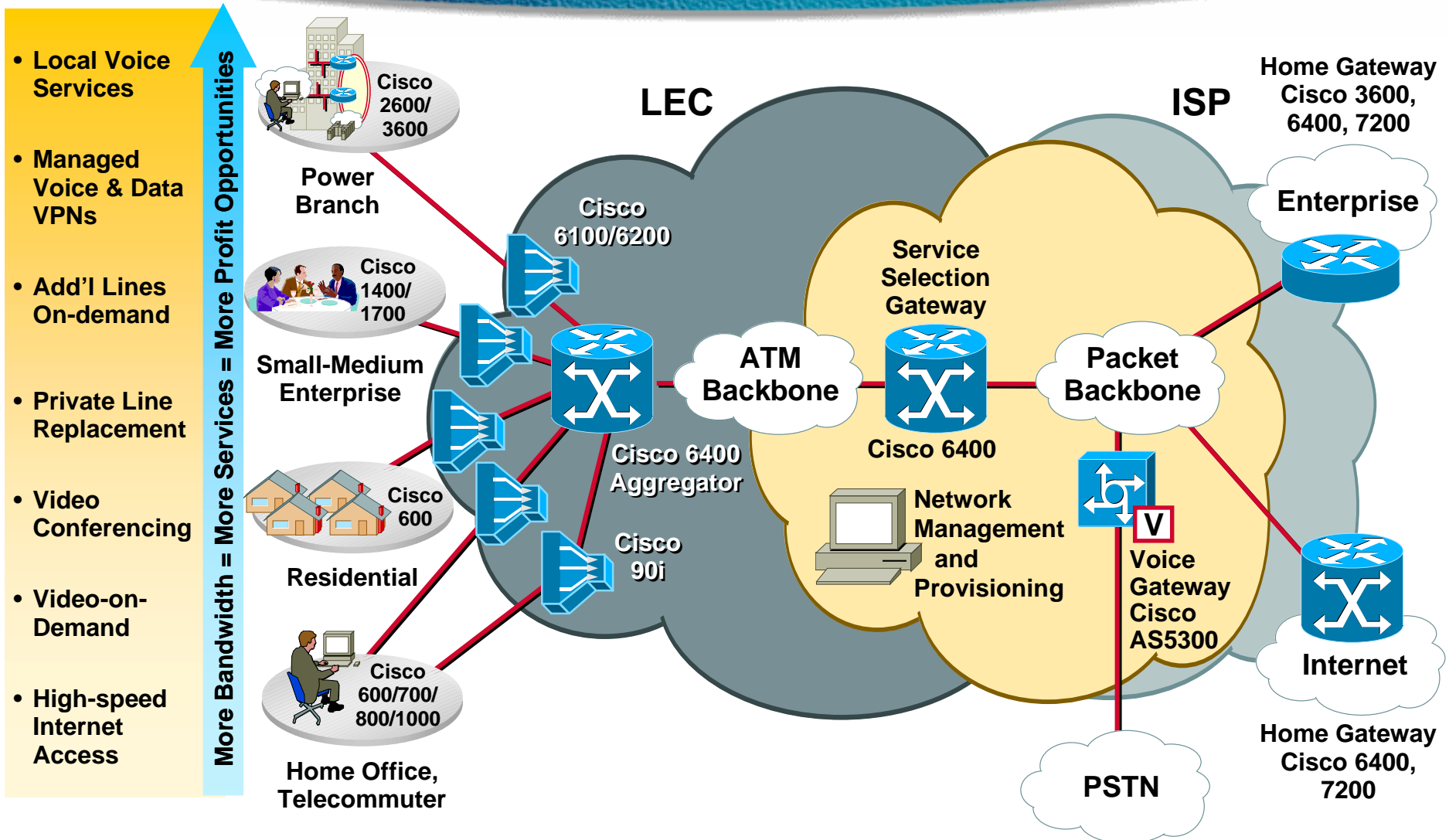
Concentrates ATM feeds (T-1,DS-3,OC-3) from DSLAMs

PPP termination, Layer 2 & 3 service selection

On-Demand, personalized services

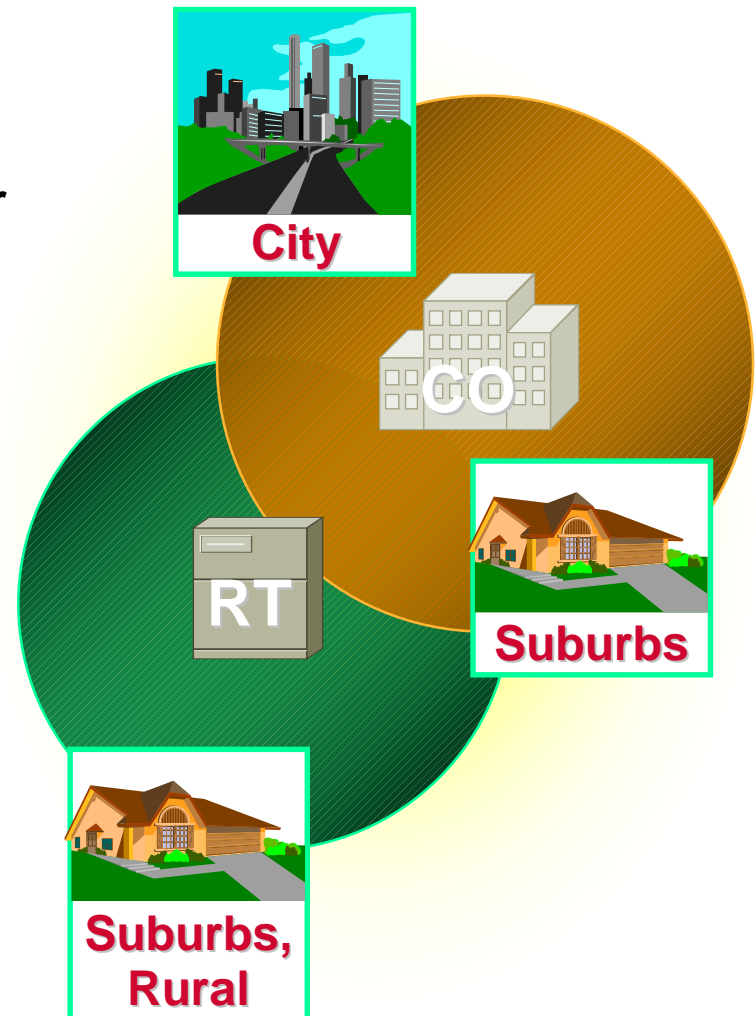
Accounting & Billing

Basic DSL Network Topology



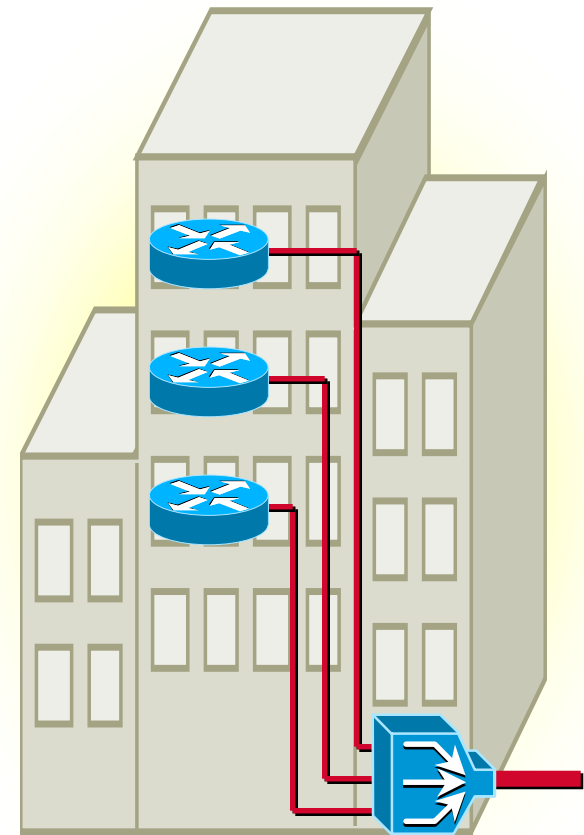
Telephone Company Deployment Options

- **Central office**
 - Locate DSLAM in central offices (COs) for best coverage in cities, dense suburbs
- **Remote terminal**
 - Locate DSLAM in unmanned remote terminals (RTs) for expanded coverage in suburbs and rural areas—very common in new developments
- **Collocation**
 - In some countries, competitive carriers can obtain CO space from incumbent carriers and lease “dry” copper loops to reach customers



Private Copper Deployment Options

- **DSL can be effective wherever there is existing copper**
- **In-building networks**
 - Located in the basement or telco closet of hotels, apartment buildings, or office buildings
- **Campus-style networks**
 - Located centrally to serve multi-building campus networks, such as office parks and apartment complexes



New World Services

400%

\$30  **Basic & Premium**

Today

\$10  **Network Video on Demand**

\$10  **Shopping/Transaction**

\$10  **Targeted Advertising**

\$25  **Communications
Phone/Voice Mail**

\$25  **Information
Web/News**

\$10  **Enhanced-TV**

\$30  **Basic & Premium**

Consumer

Voice over Data 

Video Conferencing 

E Commerce 

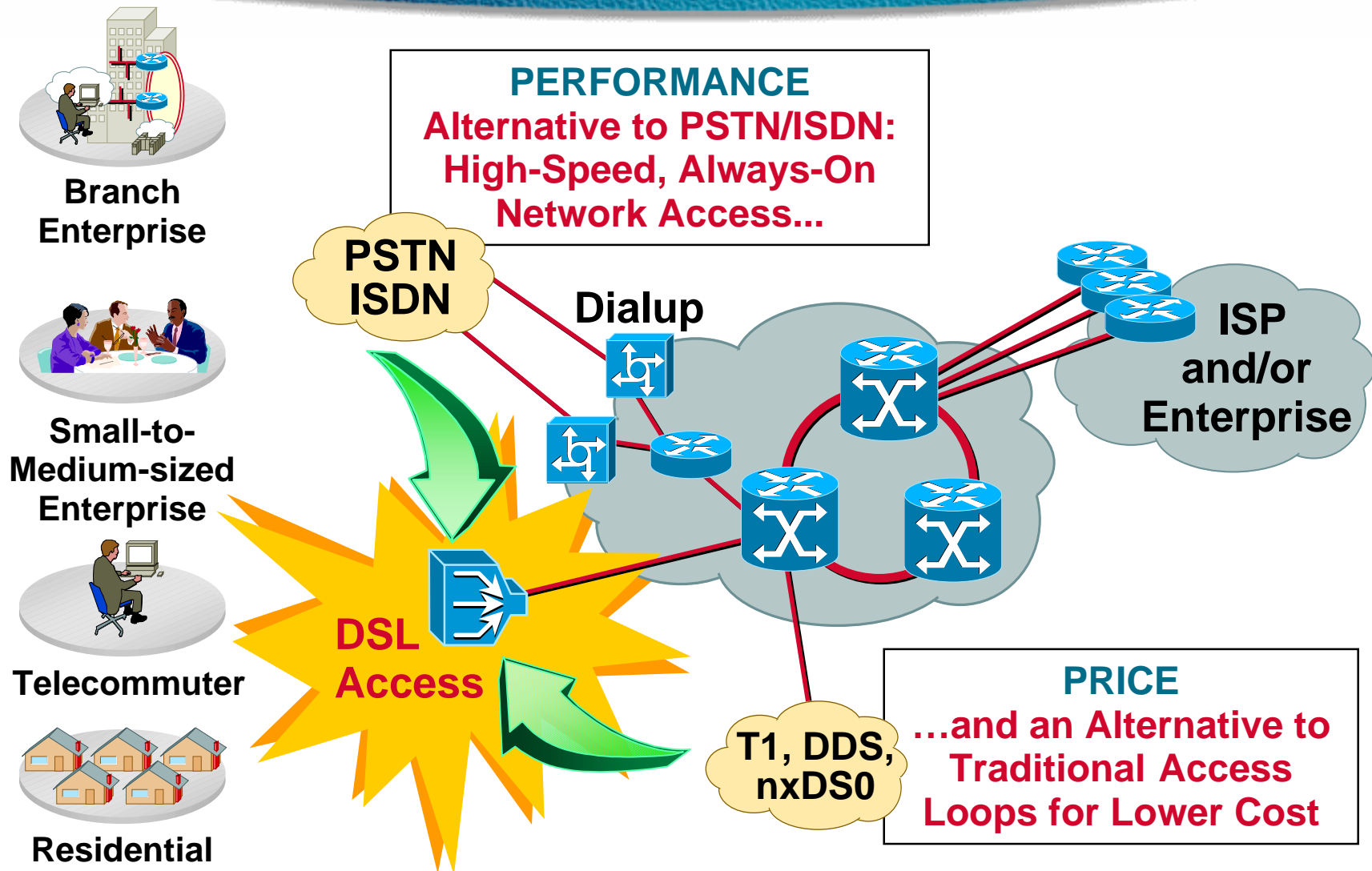
Distance Learning 

Secure VPN 

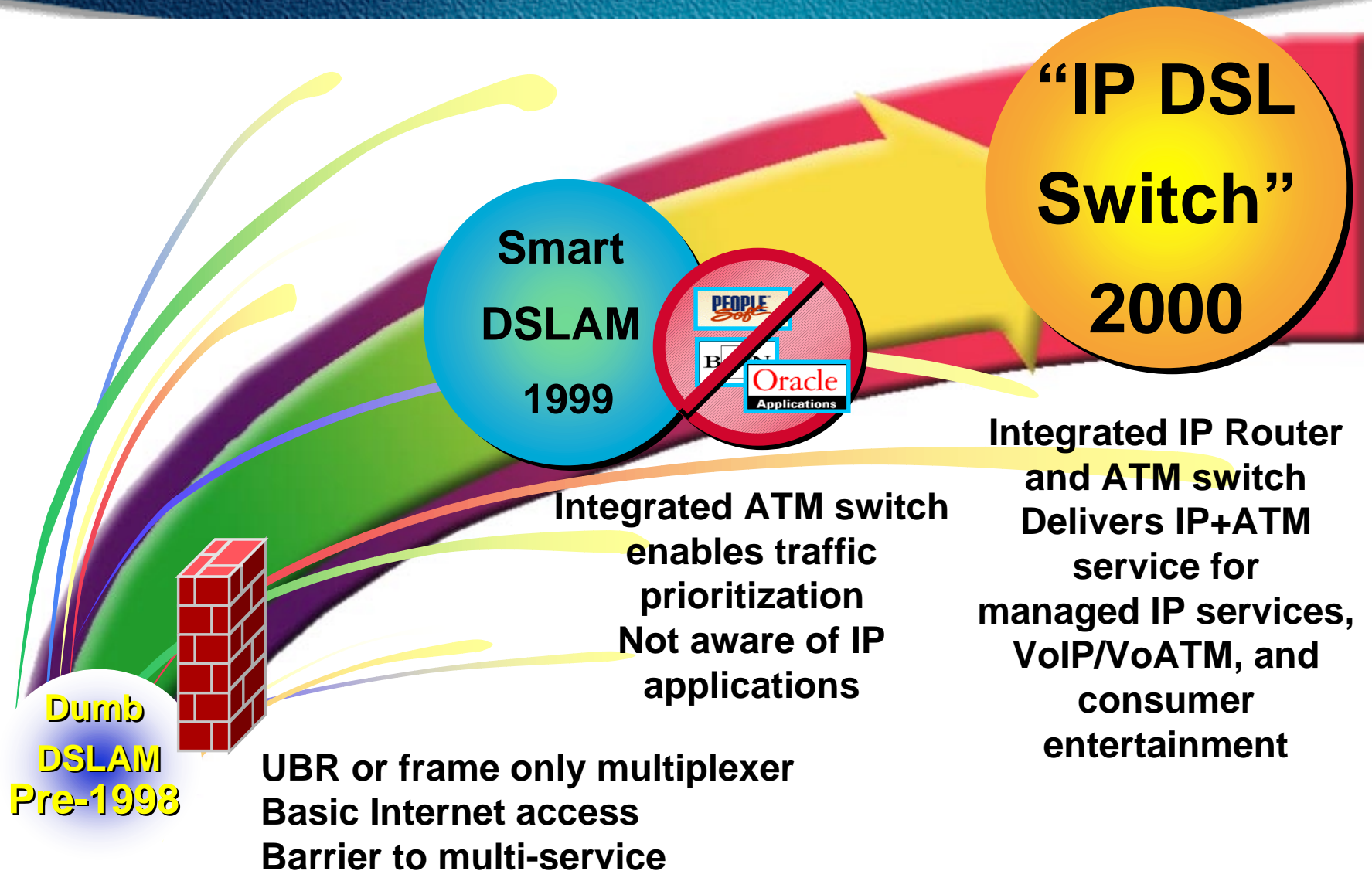
Internet Access 

Business

Exploding DSL Marketplace



DSL Revolution



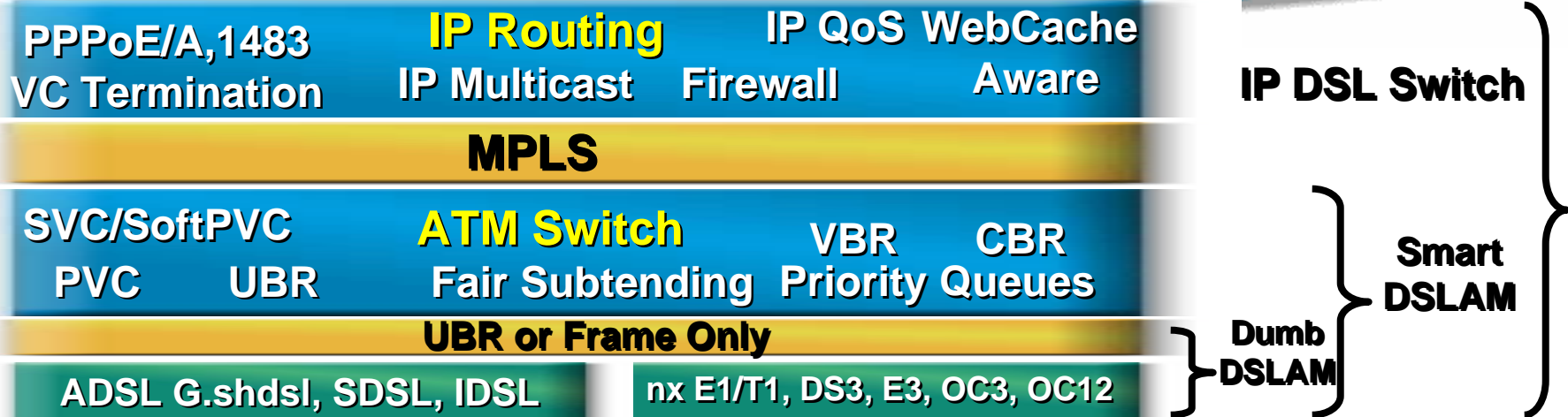
More, Better, Faster, Cheaper

Consumer Proposition

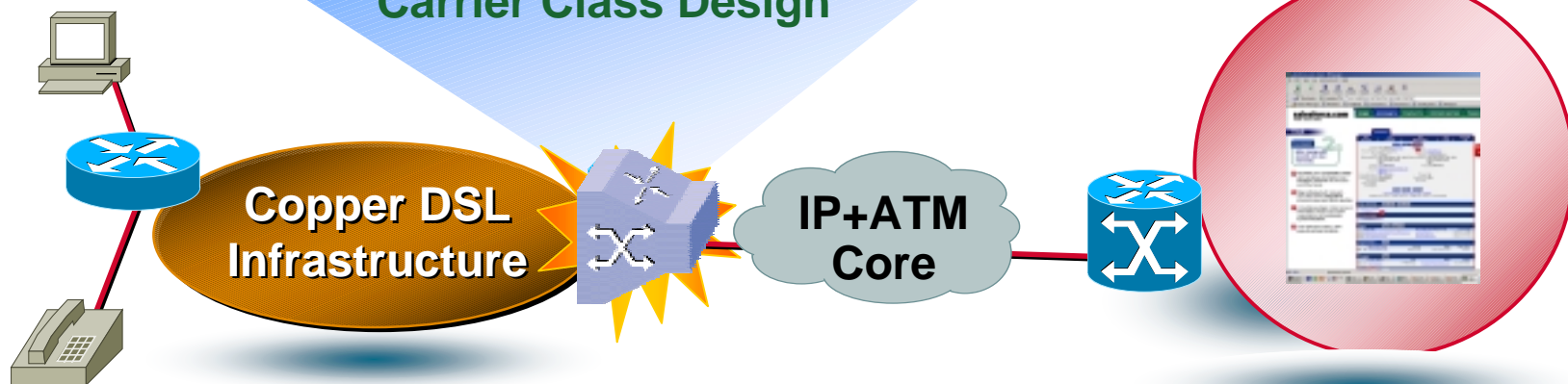
- **It's no longer just about cheaper phone bills...**
- **Now it's about high-speed internet access...**
- **And, “Oh, by the way”, bundled voice lines...**
- **And, value-added voice/data/video services!**

Cisco 6000 IP DSL Switch

Foundation for Cisco GlobalDSL



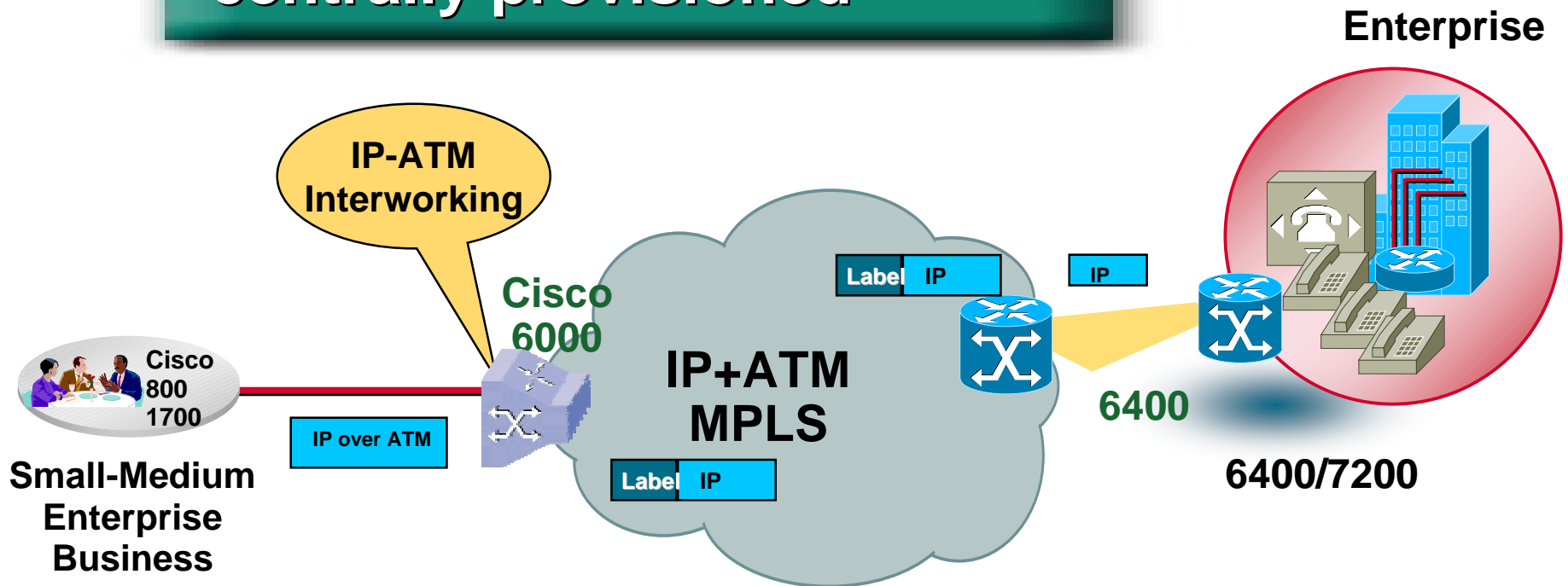
Carrier Class Design



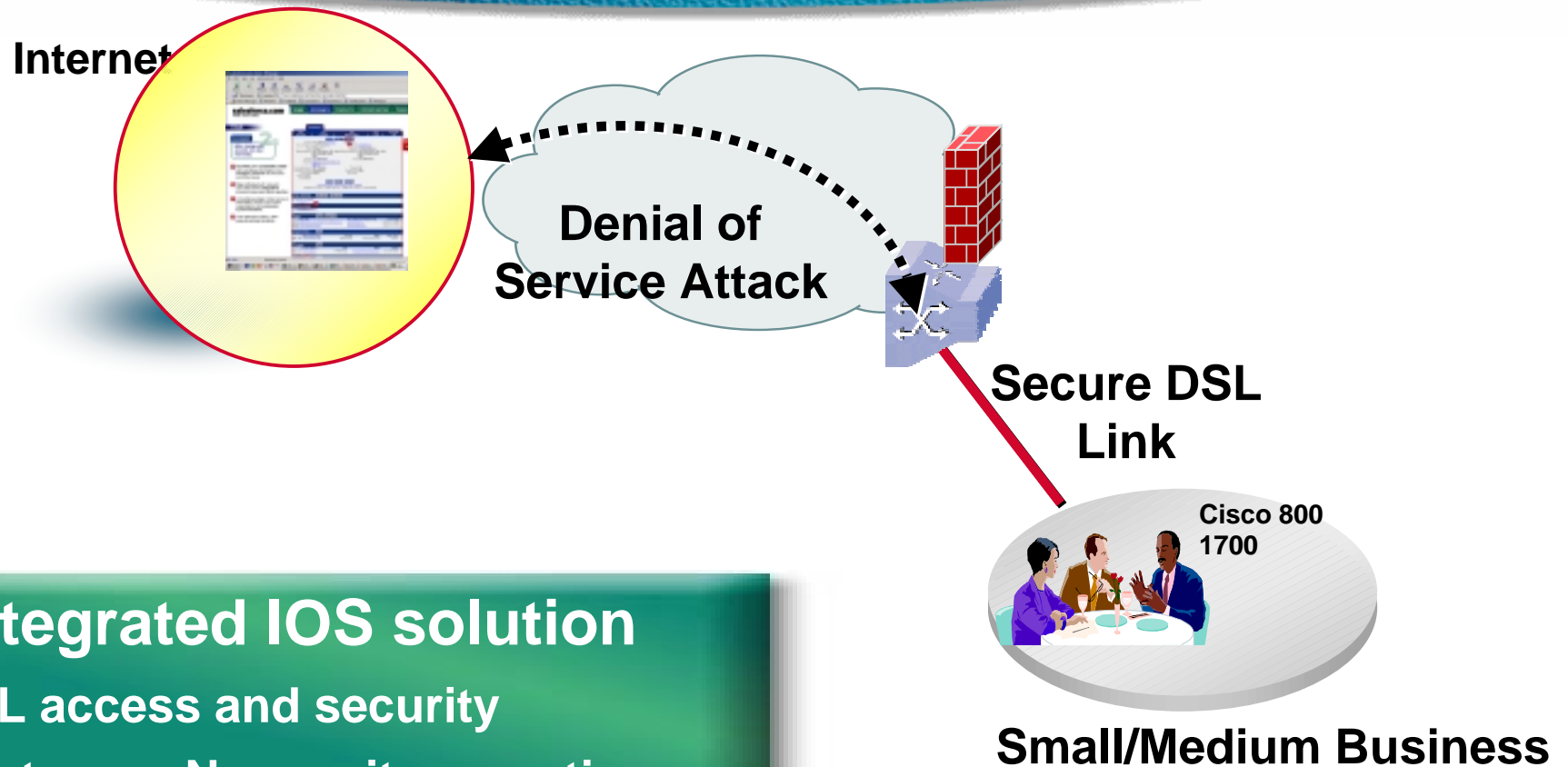
... offers choice of privacy, QoS, flexibility and scalability with IP and/or ATM

Managed Services: MPLS VPN

Tremendous profit potential
in IP virtual private network
(VPN) services to business;
centrally provisioned

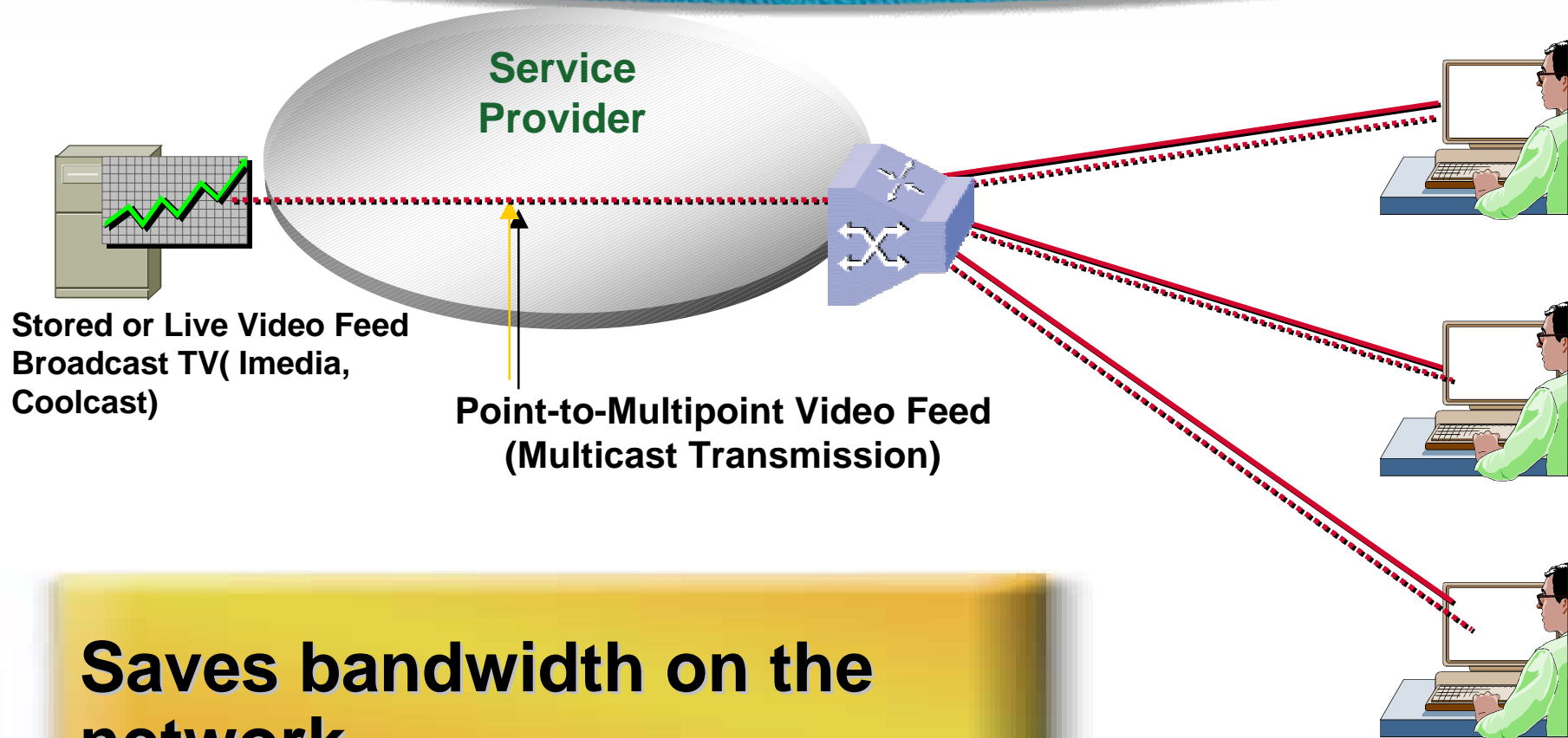


Managed Services: Secure Firewall



Integrated IOS solution
DSL access and security
Customer- No on-site expertise
needed
Provisioned from NOC

Managed Services: Multicast Video

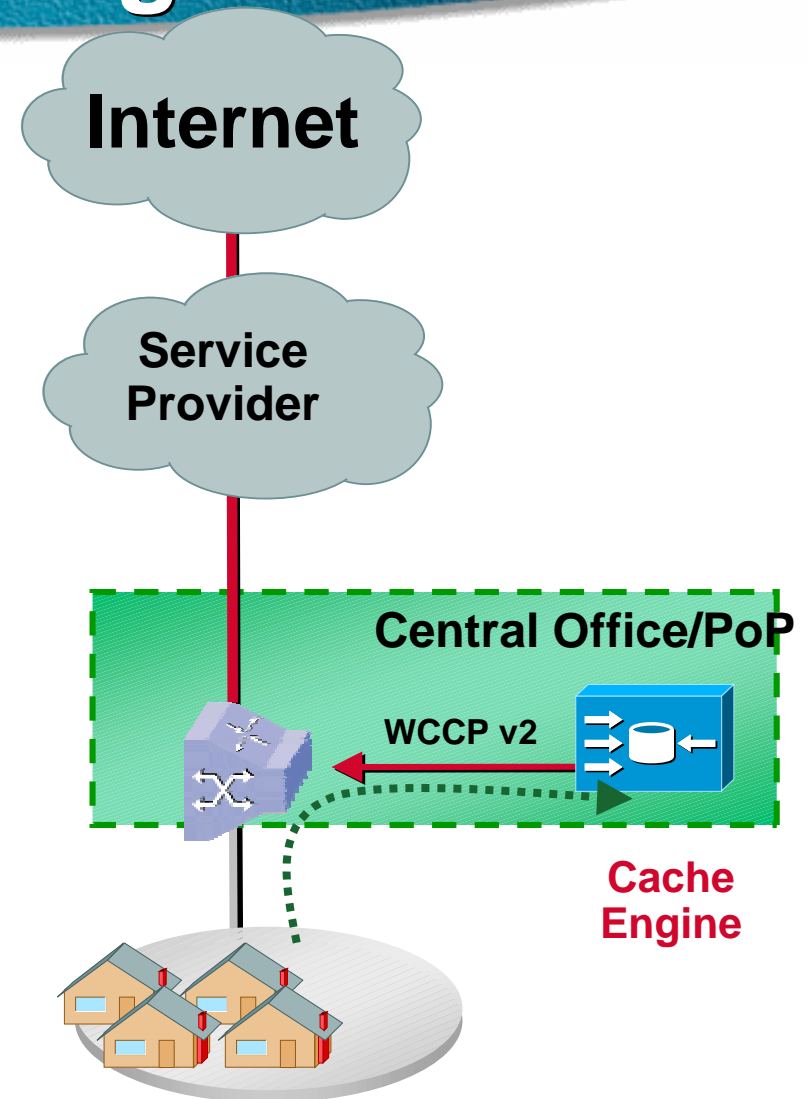


**Saves bandwidth on the
network**
Lesser host/core processing

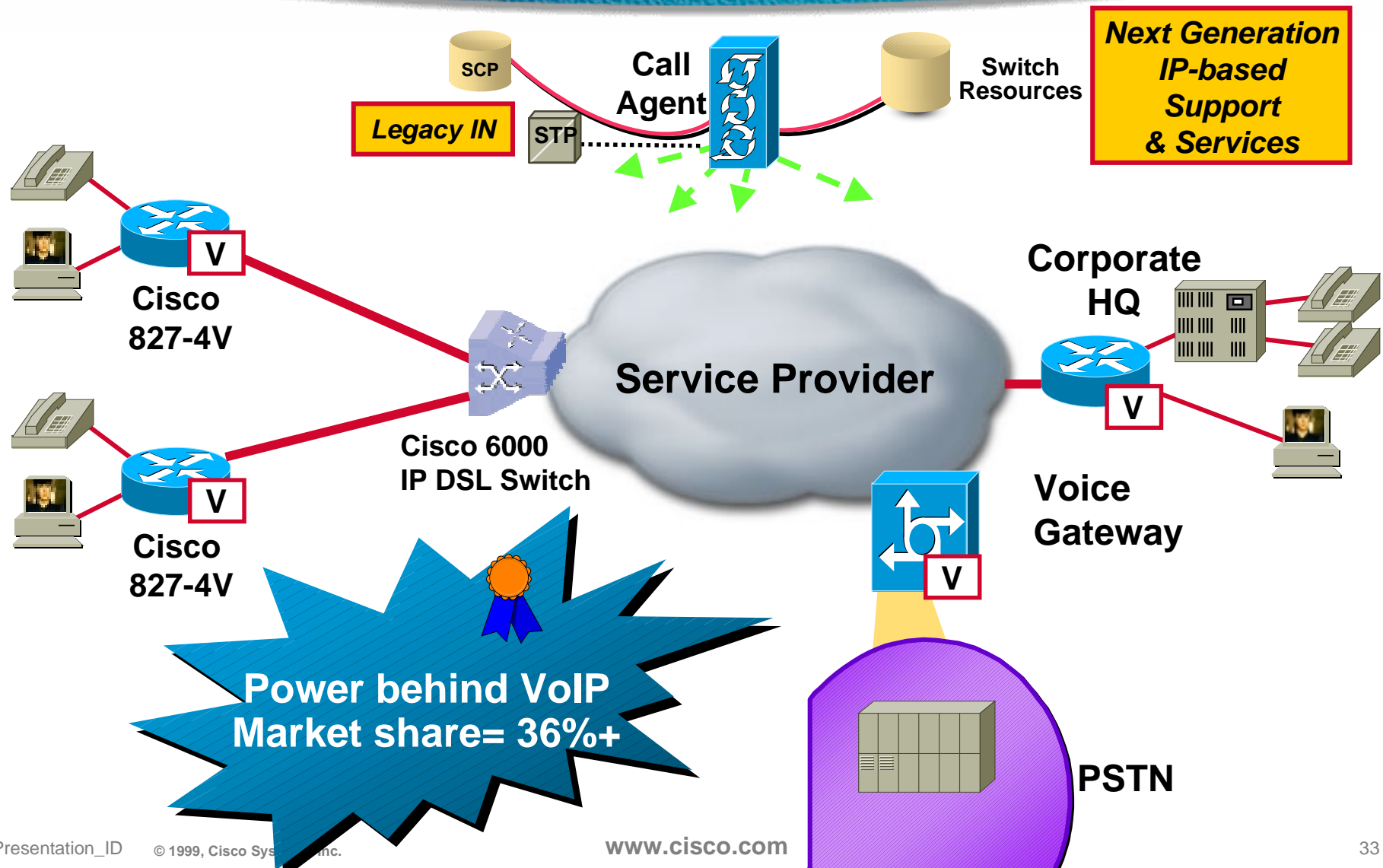
Managed Services: Webcaching

**Localize traffic
patterns at CO/PoPs**
**Accelerated content
delivery**

–WAN bandwidth savings
(25–60%)

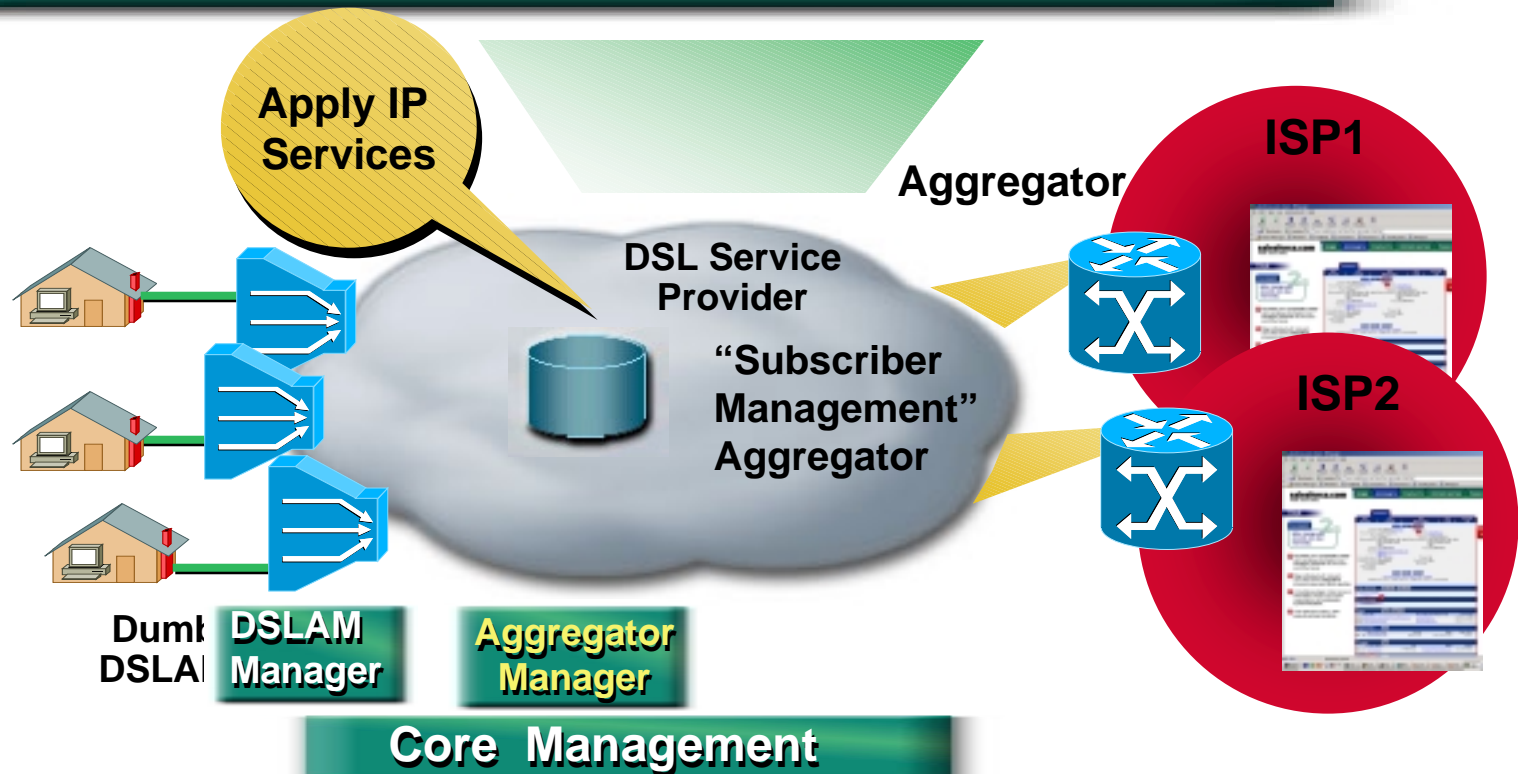


Managed Services: Voice over DSL



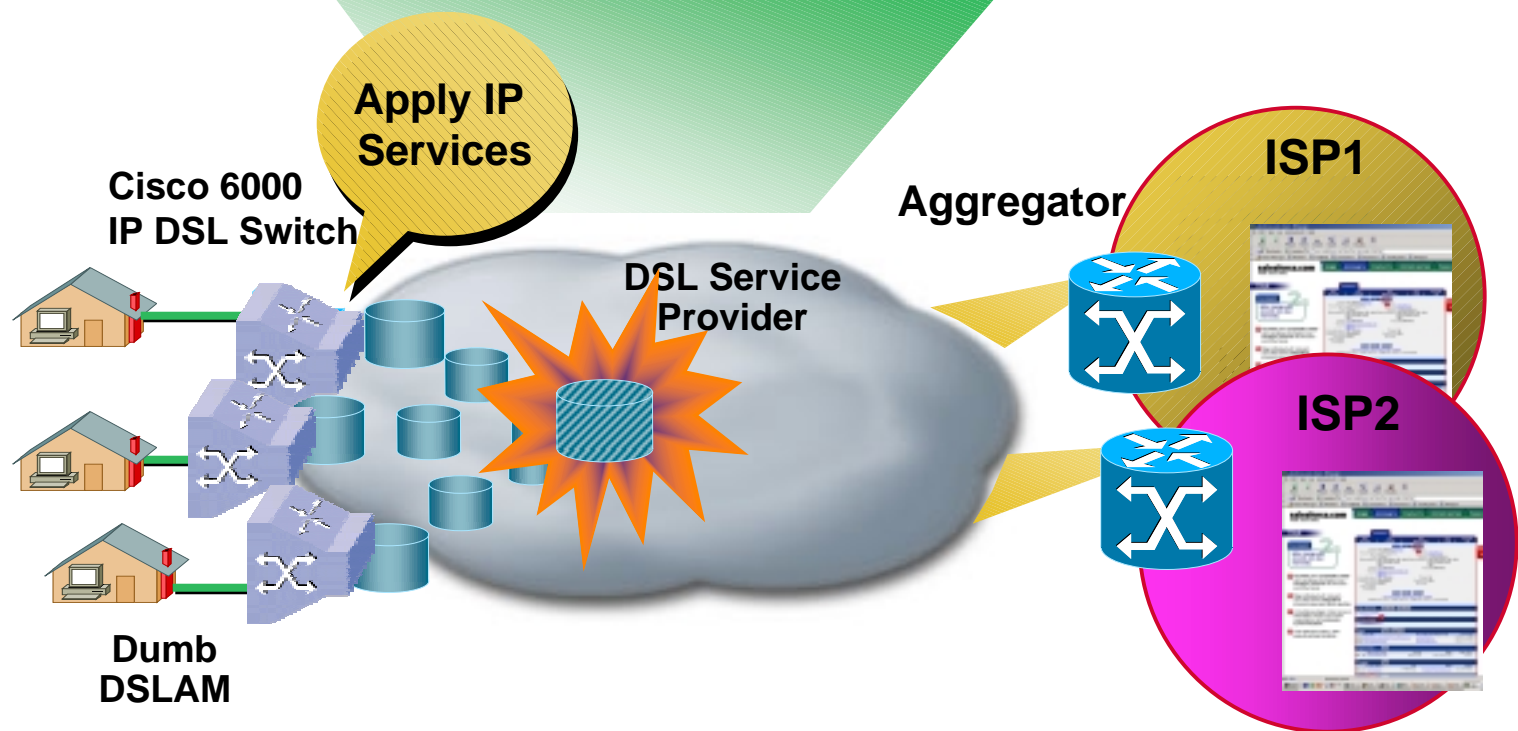
Today's End-to-End DSL Network

**“Subscriber Management” aggregator
addresses DSLAM problem with centralized
ATM to IP mapping
Creates scaling and management challenge**



DSL Network Evolution . . .

**Services Scale—Distributes ATM to IP mapping
to IP DSL Switch
End-to-end centralized service management
No single point of failure**

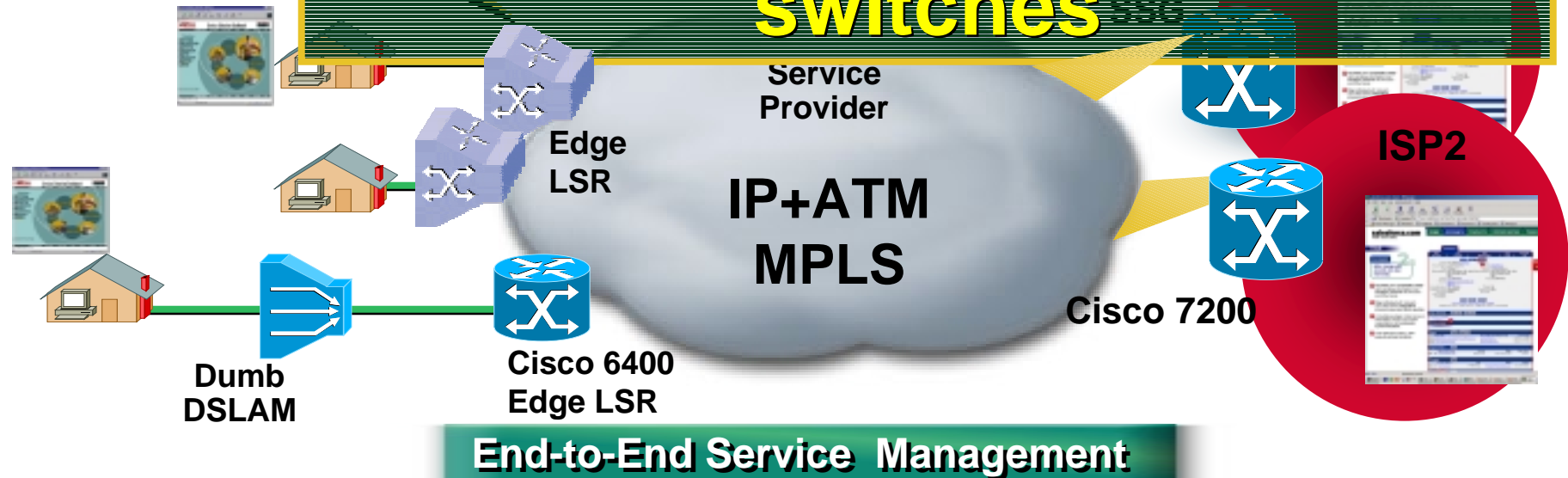


... to Scaleable DSL Service Deployment

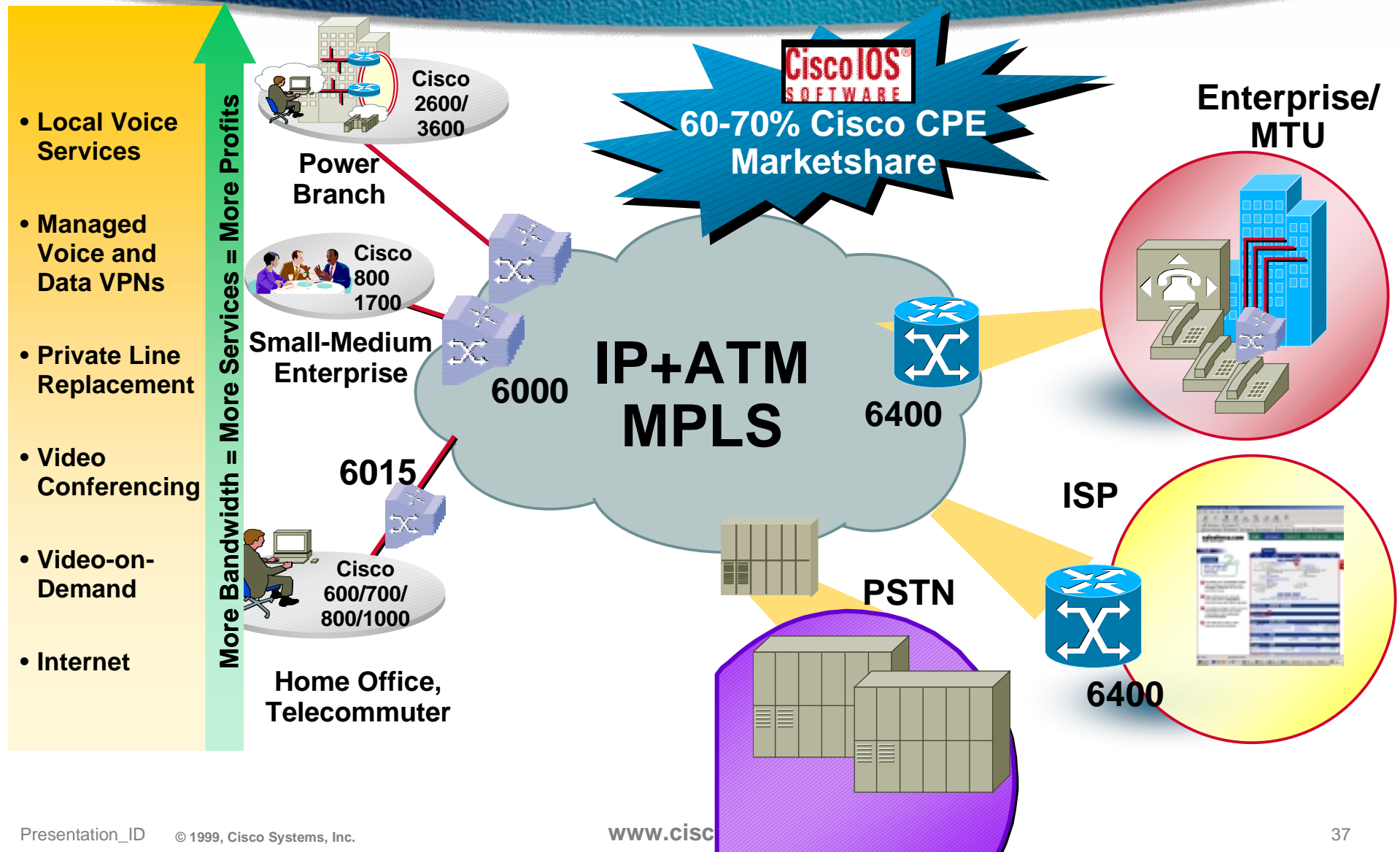


Apply IP
Services
MPLS VPN
Firewall
Webcache
Multicast

Worldwide installed base of
10,000+ Cisco 6000 DSLAMs
are upgradable to IP DSL
switches



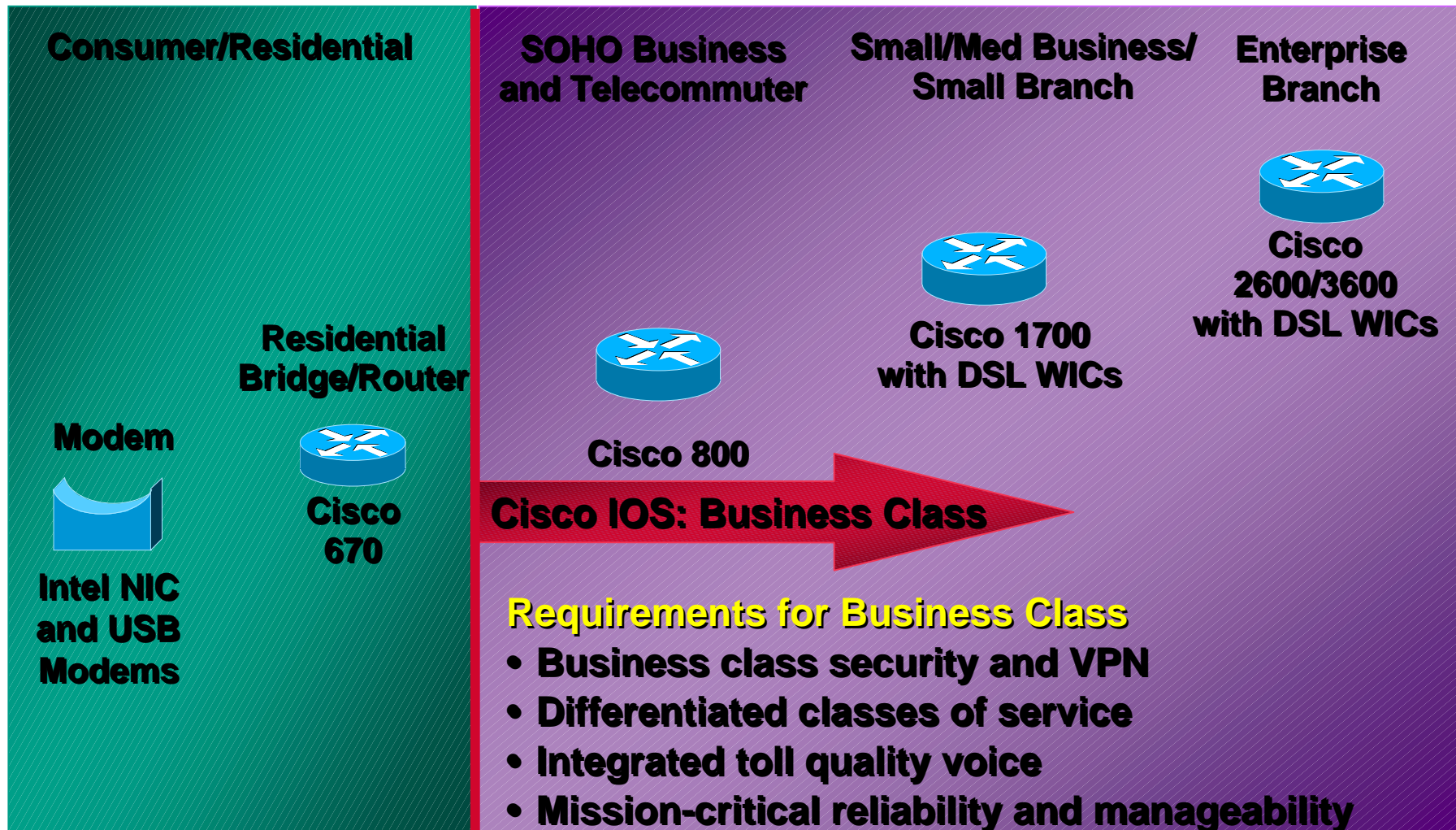
Cisco is Undisputed Leader in Business-Class Solutions



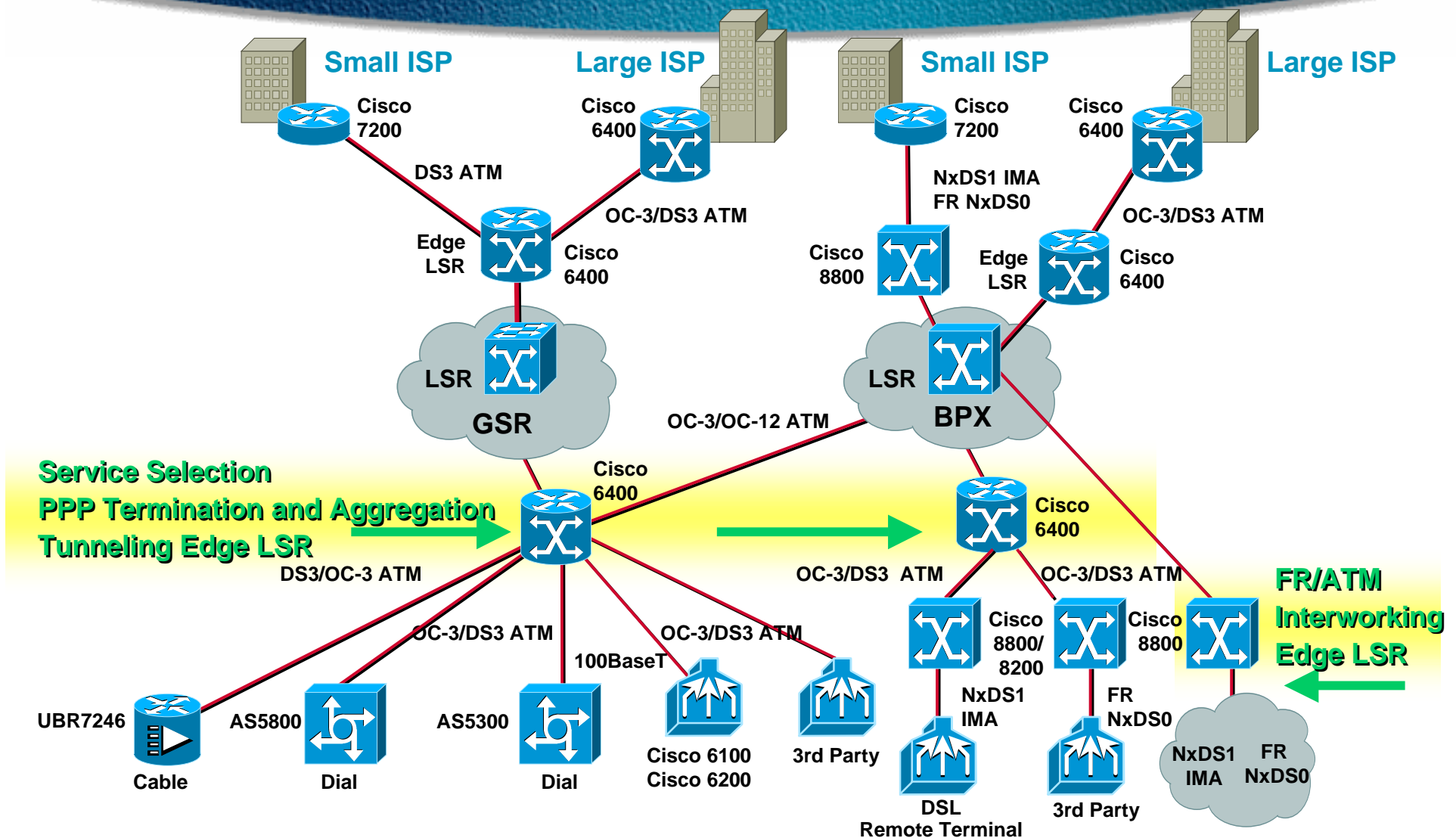
Cisco 6000 IP DSL Switch Product Family

Products	 Cisco 6015	 Cisco 6100 family	 Cisco 6260
Markets	N.A. CO, MTU, DLC	N.A. CO	W.W. CO, N.A. MTU
Applications	<ul style="list-style-type: none"> • Scalable VPN • Managed Firewall Service • Consumer Entertainment • Voice over DSL • Distance Learning 	<ul style="list-style-type: none"> • Scalable VPN • Managed Firewall Service • Consumer Entertainment • Voice over DSL • Distance Learning 	<ul style="list-style-type: none"> • Scalable VPN • Managed Firewall Service • Consumer Entertainment • Voice over DSL • Distance Learning
Certification	ETSI and NEBS	NEBS	ETSI
System Density	24 to 48 Subs	128 to 256 Subs	120 to 240 Subs
Investment Protection	Common IOS IP+ATM, DSL(ADSL, SDSL, G.shdsl, IDSL) and Management		
Platform Availability	Q3 '00	Shipping	Shipping

Industry Leading DSL CPE

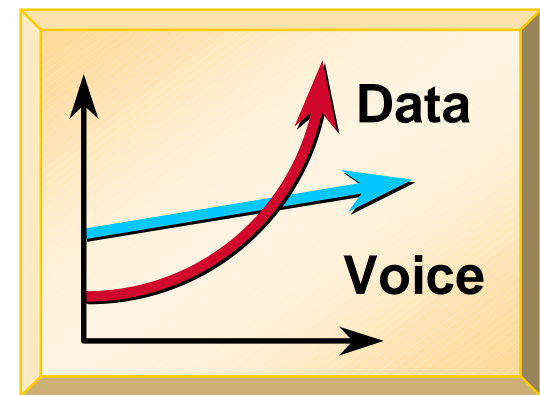


Cisco 6400 Roles

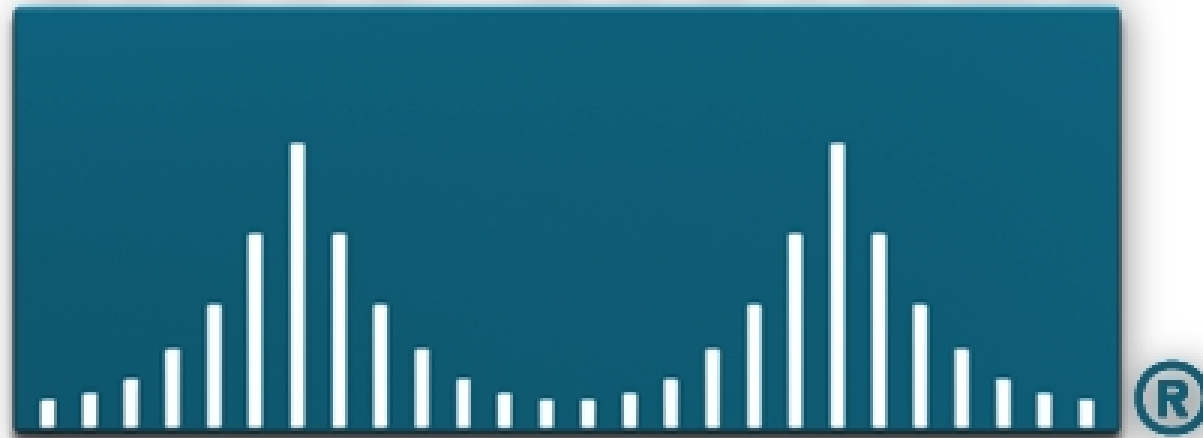


Summary

- **DSL is Prime Time!**
- **Data traffic volumes are eclipsing voice traffic volumes on the public networks**
- **Carriers are deploying DSL and now need to scale for mass deployment**
- **Profits in an era of low cost access will come from New World services**



CISCO SYSTEMS



EMPOWERING THE INTERNET GENERATIONSM