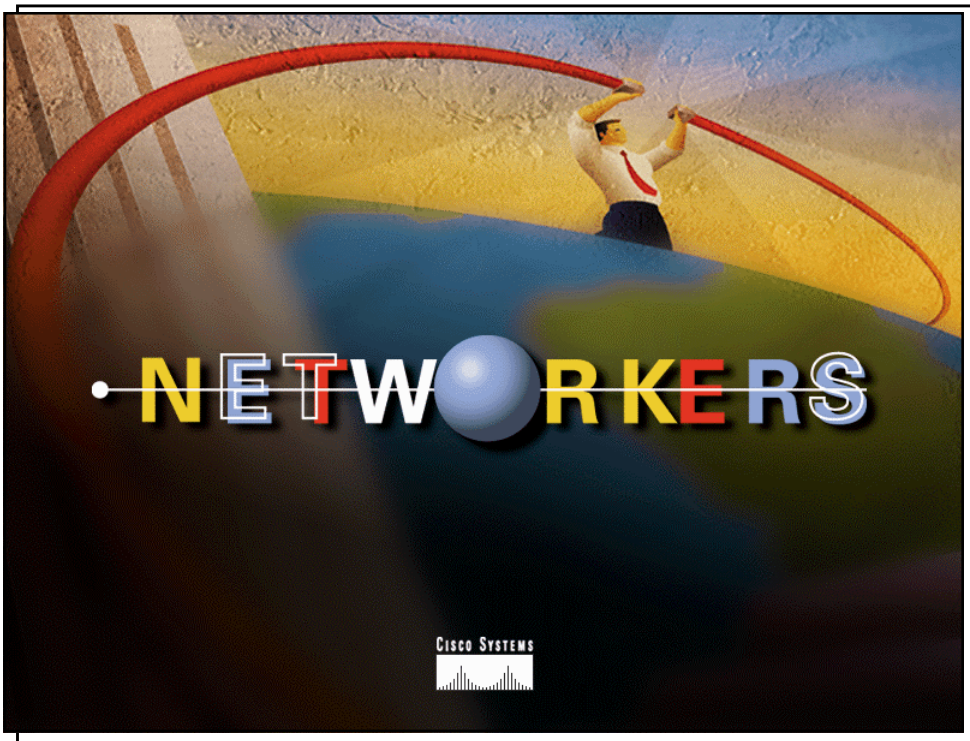


# Abstract

## Deploying DSL


- Digital Subscriber Line (DSL) technology unlocks the potential of conventional twisted pair telephone wire to deliver high-data-rate (“broadband”) digital services. Over the past two years, Cisco has partnered with several Service Providers to roll-out DSL based services in mass. Learn how the Cisco end-to-end DSL solution can be utilized to meet your DSL deployment needs. This session includes a review of DSL service models and options, DSL transmission choices and subscriber qualification, provisioning methods, and tools for customer care.




# Agenda

- DSL Technology Overview
- Real World DSL
- DSL Network Architectures
- Subscriber Provisioning
- Cisco DSL Equipment Overview
- Conclusion
- Questions

# 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


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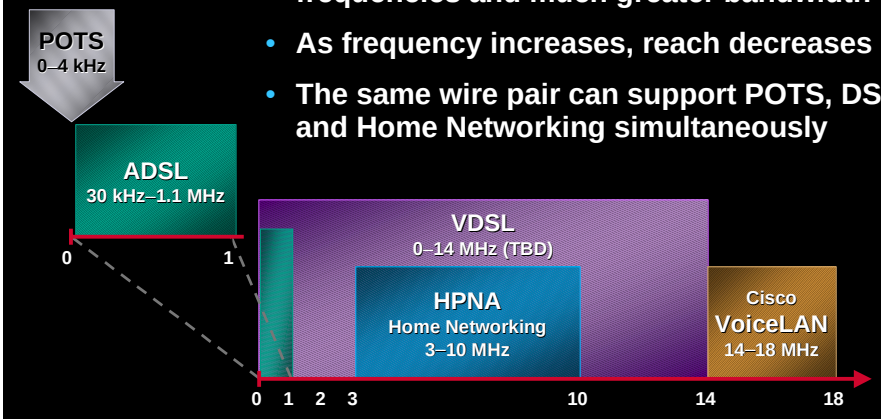
# Turbo-Charging Twisted Pair Copper

- Twisted pair copper can carry much higher frequencies and much greater bandwidth
- As frequency increases, reach decreases
- The same wire pair can support POTS, DSL and Home Networking simultaneously

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# DSL Terminology

- Symmetric (SDSL)
  - Same speed in both directions
- Asymmetric (ADSL)
  - "Slow" upstream for low-data-rate requests
  - "Fast" downstream for bursts of "rich" content and streaming audio/video
- ADSL variants
  - CAP (Carrierless Amplitude/Phase Modulation)
  - DMT (Discrete Multitone Modulation)
  - G.lite (Consumer/Mass-Market DMT)
- Industry Standards
  - ANSI T1.413 Issue 2— "DMT Issue 2"
  - ITU G.992.1 (G.dmt)—"full rate"
  - ITU G.992.2 (G.lite)—"consumer"

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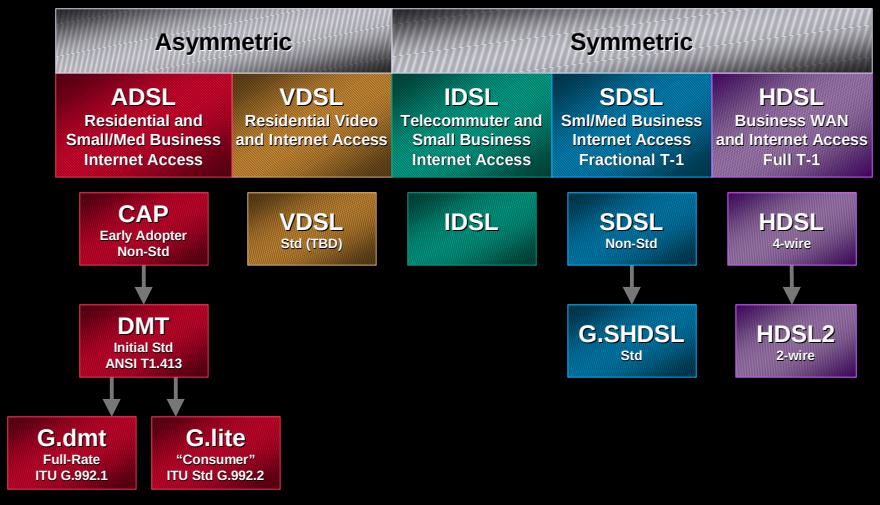
# DSL Family Tree

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# DSL Comparison Chart

| DSL Technology | Max Data Rate Down/Uplink (bps) | Max Reach feet (km) | Key Attributes | Primary Applications |
|---|---|---|---|---|
| **ADSL** Asymmetric DSL | Full Rate: 8M/1M<br>G.Lite: 1.5M/640K | 18,000 (5.5) | Coexists with POTS technology of choice for residential/telecommuter | Consumer high-speed Internet access |
| **IDSL** ISDN DSL | 144K Symmetric | 18,000 (5.5) x2 (with repeaters) | Uses existing ISDN CPE long range, but relatively slow | Telecommuter long reach fast Internet access |
| **SDSL** Symmetric DSL | Up to 1 Mbps Symmetric | 22,000 (6.9) | Symmetric non-standard | Small/med business data and voice over IP fractional T1 |
| **HDSL** 4-Wire High-Bit-Rate DSL | 1.5M-2M (T1-E1) Symmetric | 15,000 (4.6) | Current technology for T-1 deployment Requires 2 pair (4 wires) | Business WAN Full T1 |
| **HDSL2** 2-Wire High-Bit-Rate DSL | 1.5M-2M (T1-E1) Symmetric | 15,000 (4.6) | Optimized for full-rate Replaces 4-wire HDSL Std under development | Business WAN Full T1 |
| **G.SHDSL** High-Bit-Rate DSL | Up to 2M Symmetric | 26,000 (8.2) | Optimized for fractional rates and long reach Std under development | Small/med business long reach fractional T1 |
| **VDSL** Very-High-Bit-Rate DSL | 55M/1.6-2.3M<br>13M/1.6-2.3M | 1,000 (0.3)<br>4,500 (1.5) | Very fast, short reach Co-exists with POTS No standard yet | Residential video and Internet access |

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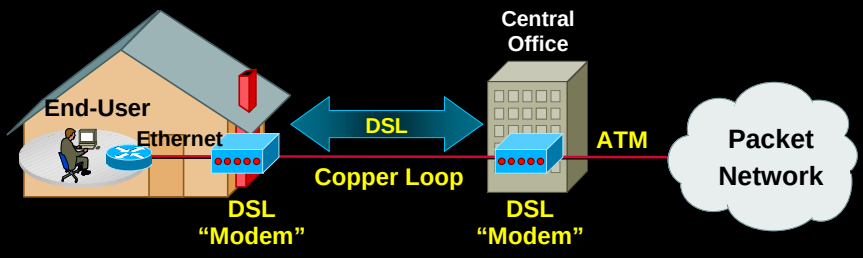
# DSL 101




- 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, secure intranet access, packet voice, video-on-demand, etc.

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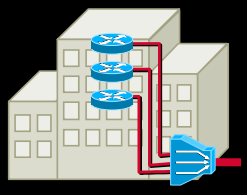
# DSL Applications

- Residential and business service from central office
- Multibuilding campus networks
  - High-speed links over existing phone lines between buildings
- Multitenant buildings
  - Hotels, apartment buildings, and office buildings



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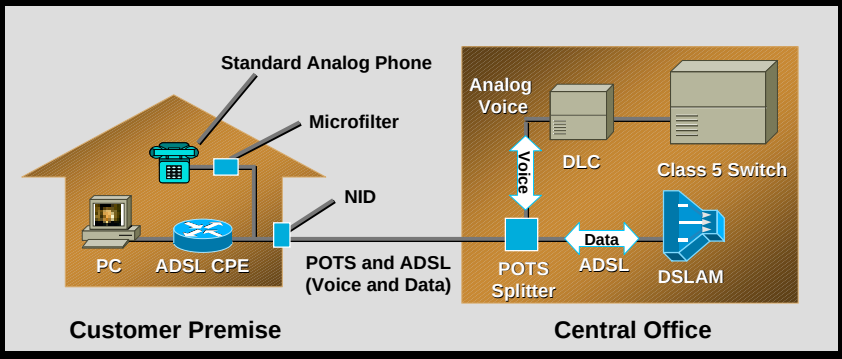
# ADSL and POTS (or ISDN)

## A Key Feature of ADSL Is Co-Existence with POTS




Permits transmission of both signals on the same wire pair

"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

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# Real World Considerations

- Loop quality
  - Actual performance (speed/reach/stability) degraded by corrosion, splices, load coils, mixed wire gauges, and interaction with other signals in same “binder group”
- Loop length
  - Actual loop length is typically much longer than point-to-point distance
- Current network topology
  - CPE must connect directly to DSLAM in central office or DLC remote terminal equipped with DSL
  - Repeaters disrupt DSL transmission (except IDSL)
- Interoperability
  - Industry-wide effort to assure acceptable loop performance between different DSL chipsets

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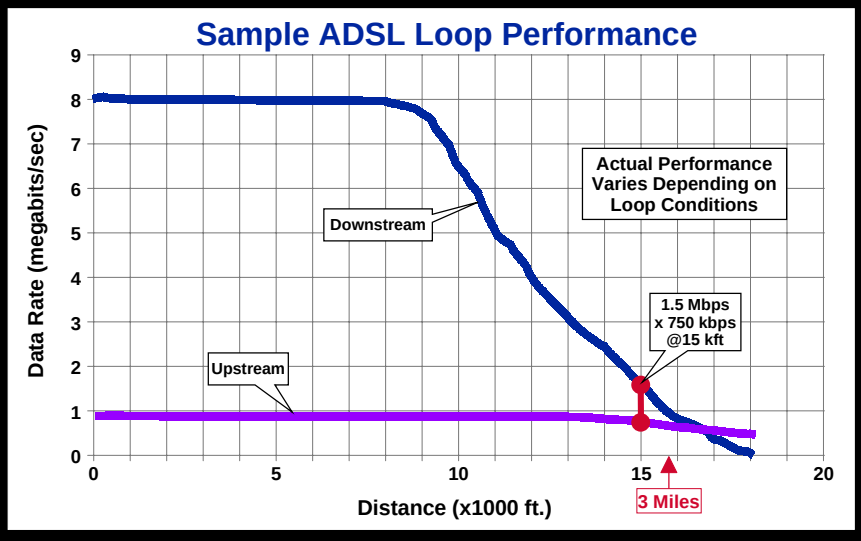
# Speed vs. Reach

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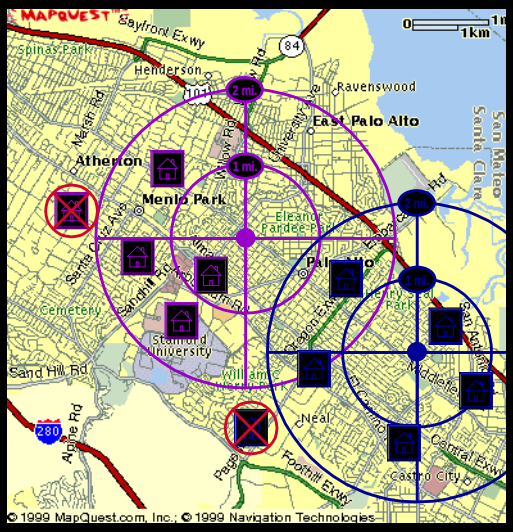
# Reach and Coverage

- With 16,000 feet reach, a service provider might capture 60% of the subscriber base
- With 20,000 feet of reach, the coverage can increase to 80% or more
- In one instance, relaxing the ADSL disturber model by 1 db or adding 1k feet of reach yields 100k new loops






# Other Highlights

- DSL reduces loads on expensive analog voice switches
  - The switched voice network relies on over-subscription of expensive Class 5 switches based on short conversations
  - Increasing demand for long-duration data connections violates traditional over-subscription models
  - DSL off-loads data connections to the data network
- DSL dramatically changes the traditional T-1 economic model
  - Leased Line T-1 (1.5 Mbps) cost more than $1000 per month
  - Symmetric business-class DSL runs as low as $200 per month
  - Residential broadband runs as low as $20 to $50 per month
- DSL and deregulation have energized the CLEC marketplace
  - High speed data and low cost voice is a powerful new bundle
  - Multiple competitive local exchange carriers vying for your $$$
- DSL paves the way for voice and data convergence
  - Cheaper to build new data networks than build or lease analog voice networks

# Basic DSL Network Components

- CPE
  - Customer premise equipment
  - Subscriber-side interface and DSL interface
  - PC NICs, bridge/routers, enterprise routers
- DSLAM
  - DSL Access Multiplexer
  - Concentrates individual subscriber lines from CPE
- Aggregator/Service Selection Gateway
  - Concentrates ATM feeds from DSLAMs
  - PPP termination, Layer 2 and 3 service selection
  - Provisions on-demand, personalized services
  - Accounting and billing

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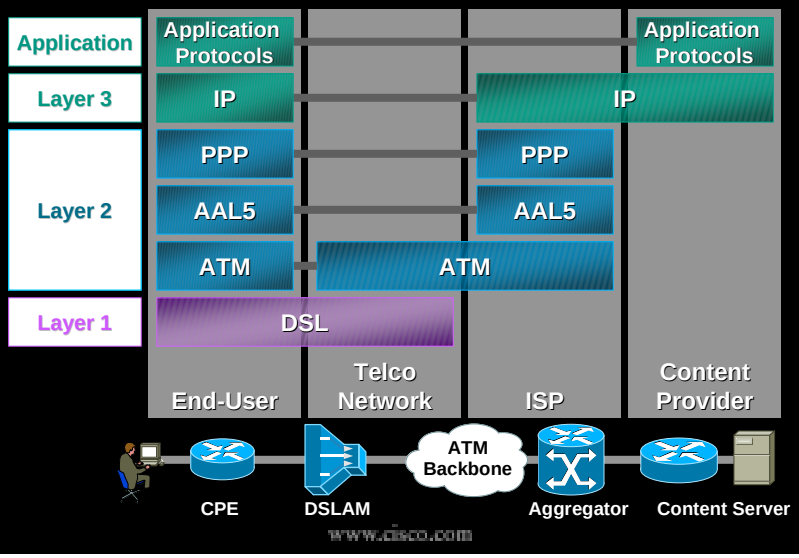
# End-To-End DSL Protocol Stack

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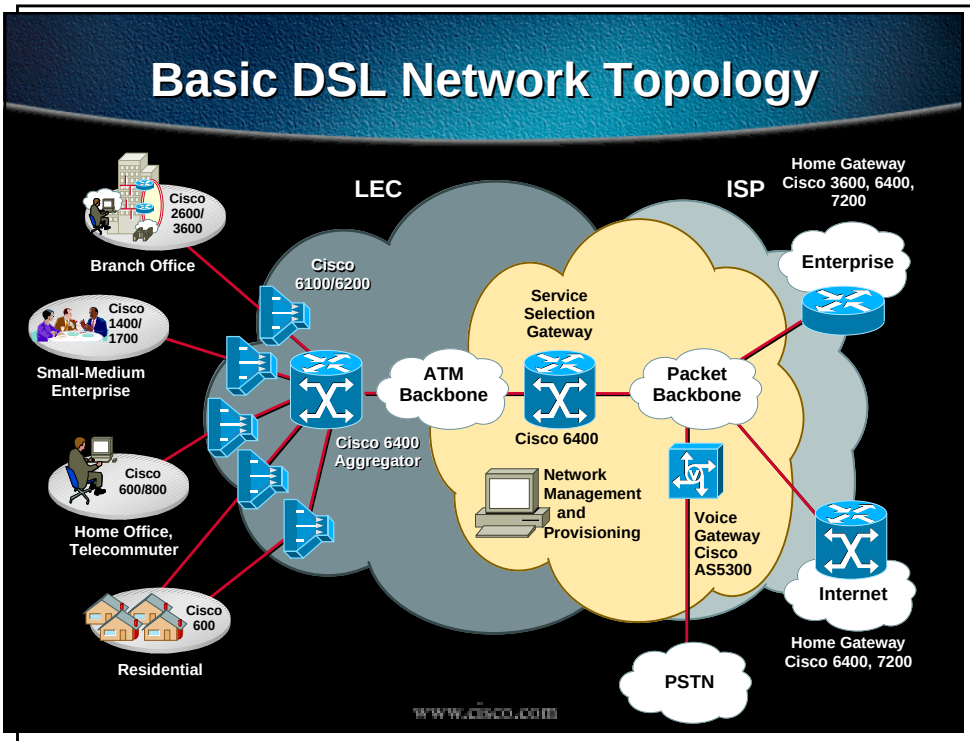
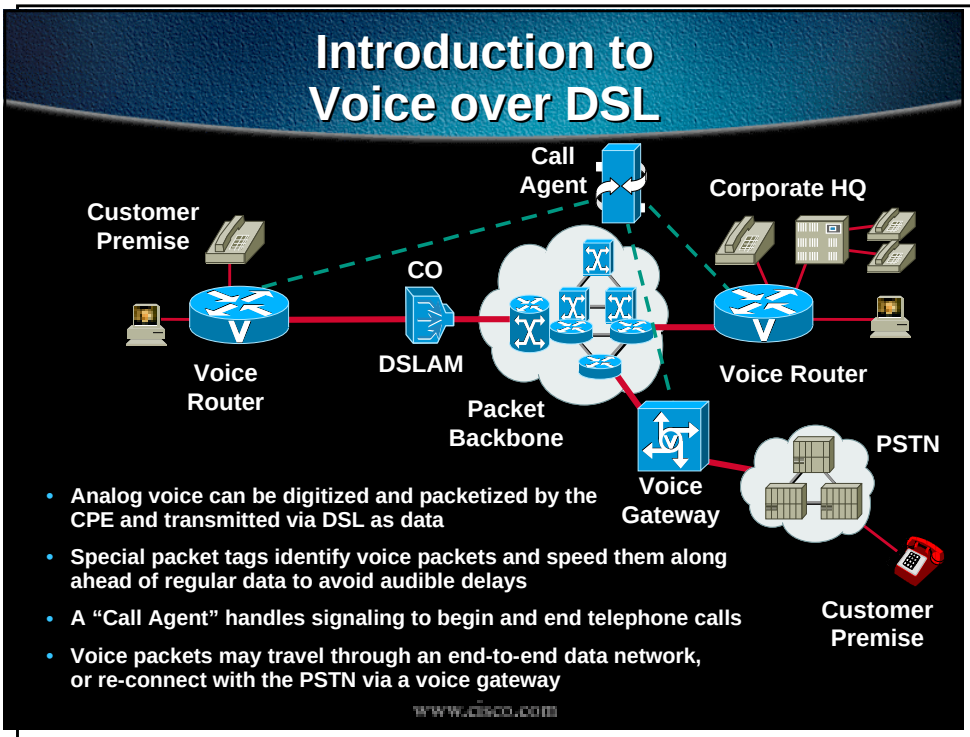
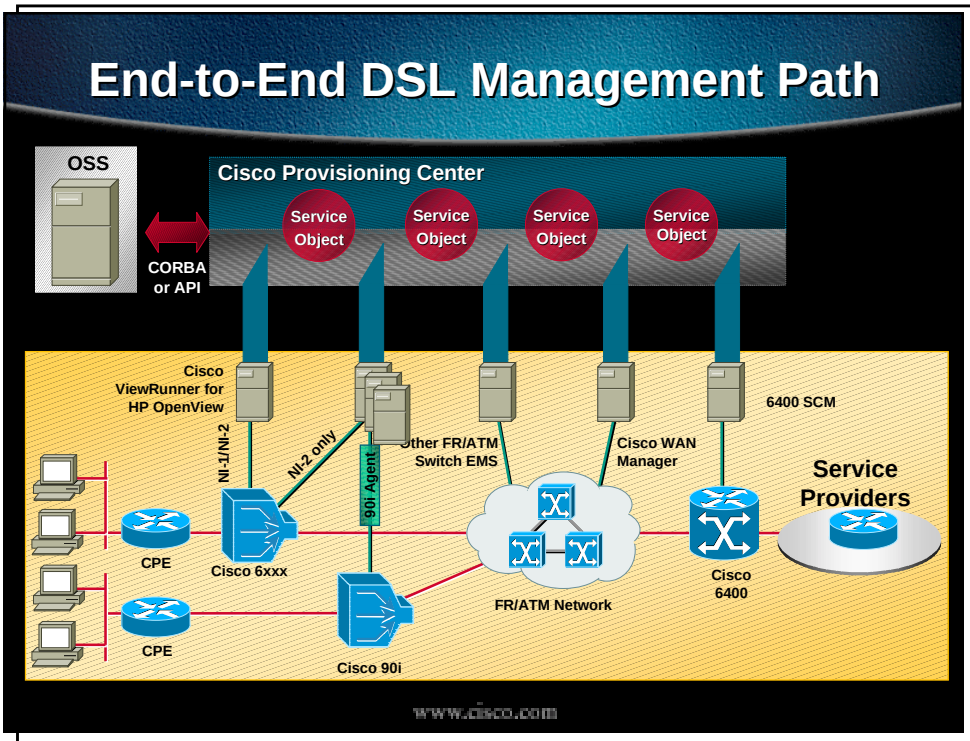
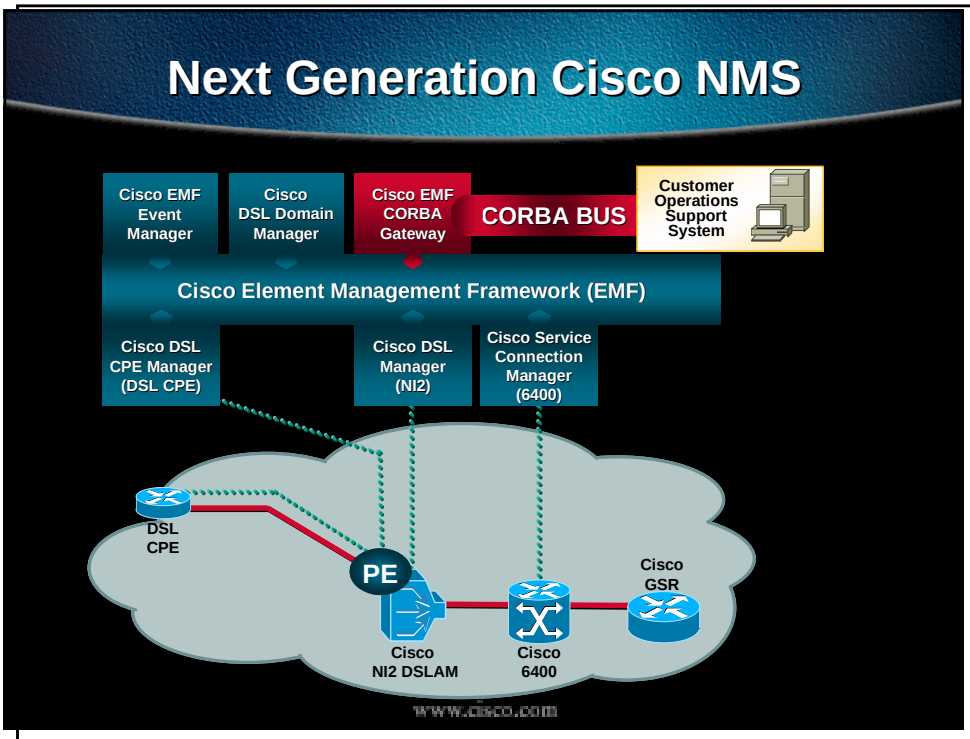


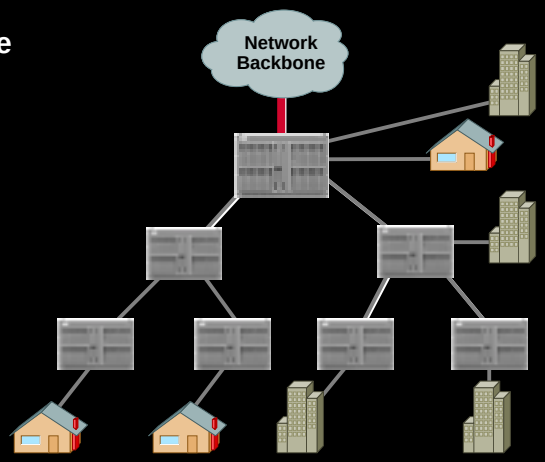





# Cisco DSLAM Subtending

- Subtends up to (12) chassis from a single Cisco 6260
- Scales up to 1664 users per ATM WAN connection
- Fewer ATM switch ports required
- Reduces $/user for ATM network connection
- Fairness is critical!

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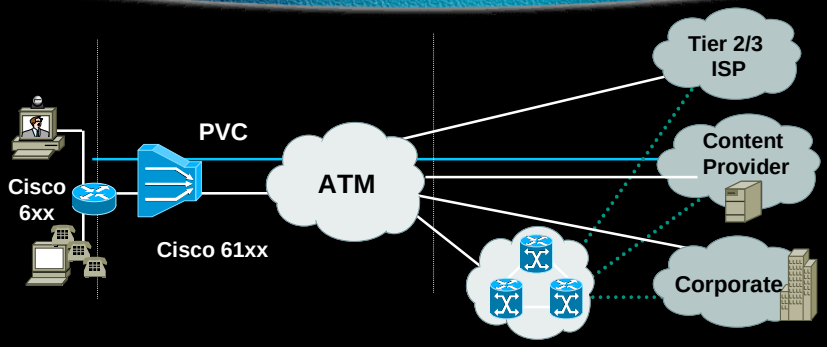
# Single Destination PVC Architecture




PVC per end point
Destination owns end point and terminates PVC (PPP option)
Protocol transparency

IP address independence
CPE in bridge or routed mode with config options

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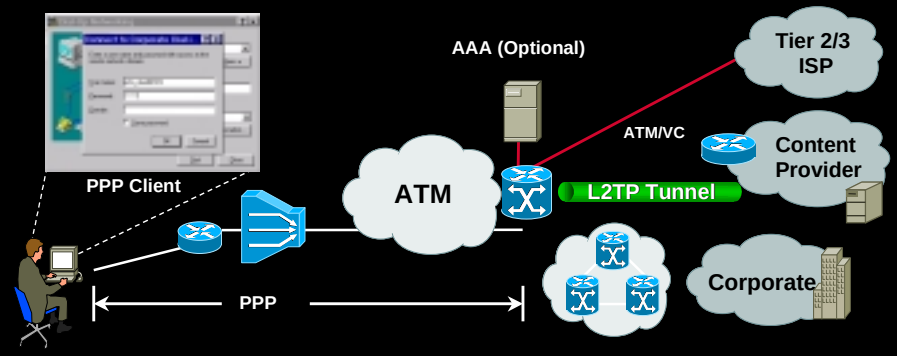
## Single Destination PVC Architecture Challenges

- PVC nailed up to a single destination
- Ability to scale core
- Coordination with end point on PVC
- PPPoE client software issues



## Layer 2 Service Selection




PPP forwarded via tunnels or
PPP termination/aggregation
L2TP/L2F tunnel options
Protocol transparency

IP address independence
PPP troubleshooting
Radius accounting

# Layer 3 Service Selection via Enhanced Web

**Customer Benefits**

- Turn services on/off instantly
- Access multiple services simultaneously
- Access personalized service portfolio
- Select varying services security and quality options

**Service Provider Benefits**

- Advertise services available
- Offer on-demand services
- Keeps users “on-net”
- Accounting and billing on usage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# Multiservice Selection

**Dashboard**


**User Profiles**

jdoe Password = letmein
Service = Internet
Service = cisco.com
Service = Games

dsmith Password = wombat
Service = Internet
Service = coke.com
Service = Games

**Service Profiles**

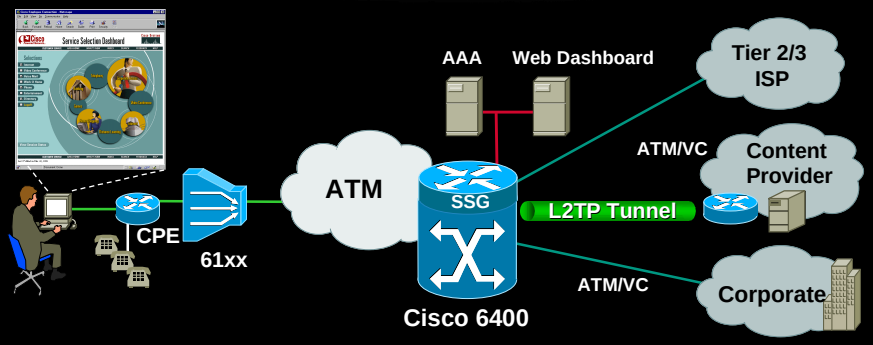
cisco.com Password = cisco
vpdn:tunnel-id=cisco-gw
vpdn:ip-addresses=1.1.1.2
vpdn:nas-password=12000
vpdn:gw-password=GSR

Games Password = cisco
vpdn:tunnel-id=games-gw
vpdn:ip-addresses=3.1.3.1
vpdn:nas-password=Space
vpdn:gw-password=Invader

**Radius Server**

VoIP Password = cisco
vpdn:tunnel-id=voip-gw
vpdn:ip-addresses=3.3.2.1
vpdn:nas-password=pin
vpdn:gw-password=drop

# Layer 3 Service Selection with Web Dashboard and SSG




Account Logon Connects PPP or bridge to SSG

As long as the account is logged on, the Web Interface is always available to connect and disconnect services

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# Managed Business Service Architecture Challenges

- **Multiple market segments: LAN telephony, PBX extension/call center, toll bypass, etc**
- **Multiple end-to-end QoS levels: CBR, VBRnrt, VBRrt, UBR and ABR**
- **Multiple call control options: xGCP, H.323, GR303, v5.2, etc.**

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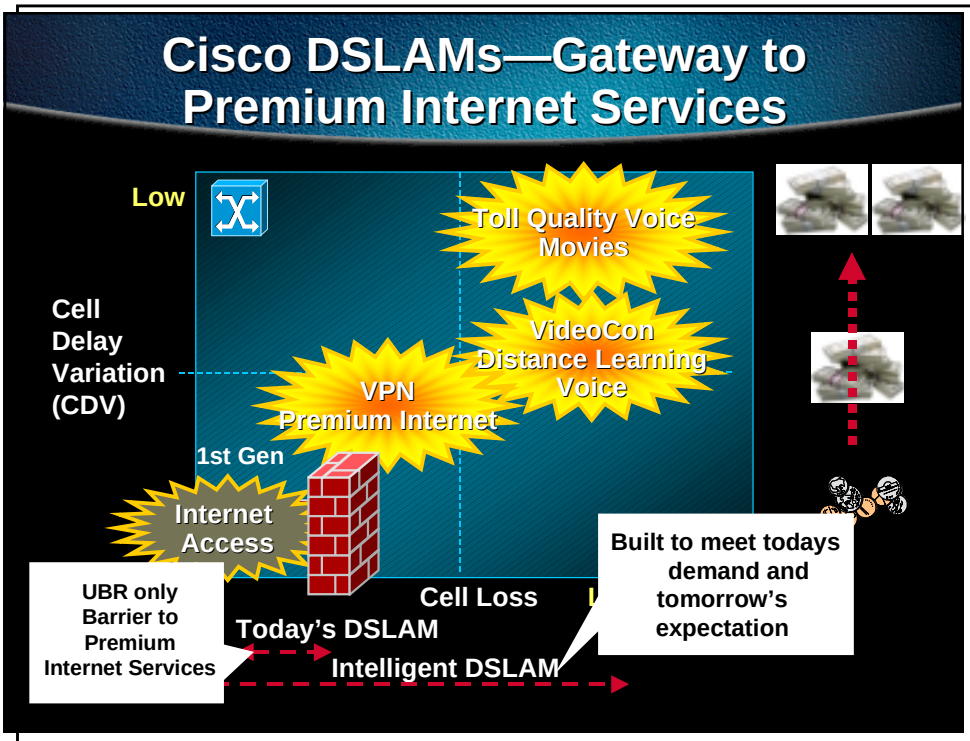
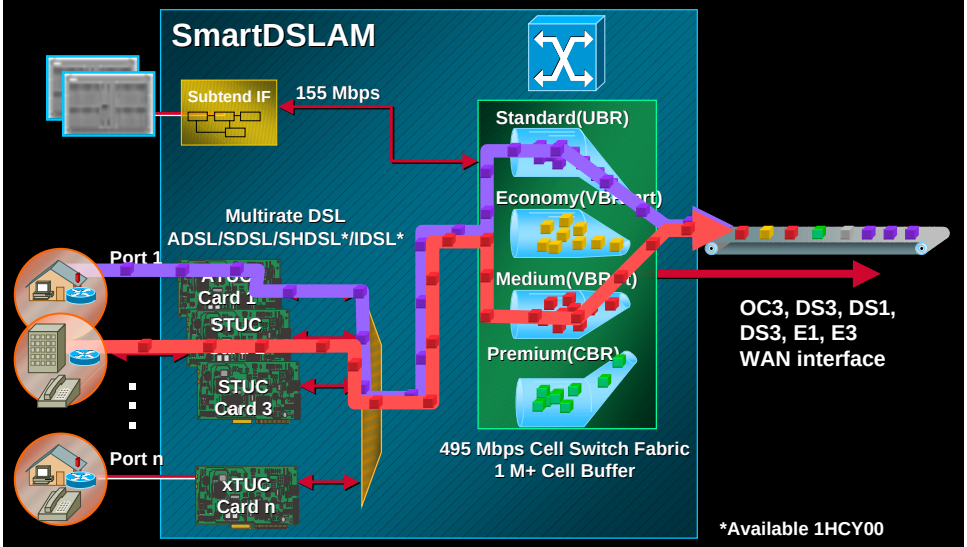
# Cisco DSLAMs—Gateway to Premium Internet Services




# ATM Traffic Classes

- Four priority queues available
- Programmable QoS support in CPE and DSLAM
  - CBR (Constant Bit Rate) for rate-limited services requiring guaranteed bandwidth and bounded delay
  - VBR-rt (Variable Bit Rate—Real-Time) for delay-sensitive voice and video services
  - VBR-nrt (Variable Bit Rate—Non-Real-Time) for high-priority data services
  - UBR (Unspecified Bit Rate) for low-priority data services
  - EFCI marking for ABR (Available Bit Rate) service support
  - Guaranteed minimum-frame-rate service (NI-2)

# Cisco 6000 *smart*DSLAM Architecture




# Cisco Smart DSLAM Requirements

- The DSLAM is the gatekeeper…where services meet the customer
- Enable individual SLA to each subscriber
- Guarantee cost effective bandwidth on demand
- Offer value-based service offerings to drive multiple revenues streams
- Reduce operations and management costs
- Enable mass-market scale services deployment

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# The DSL Market Today

- Relatively small rollouts
  - 100,000–150,000 lines maximum
- Individual element managers for each network component
  - Point-to-point setup of PVCs
  - Limited flow-through capability
- CPE configuration
  - Choose one:
    - High touch Installation
    - Limited functionality
      - Typically one PVC per subscriber

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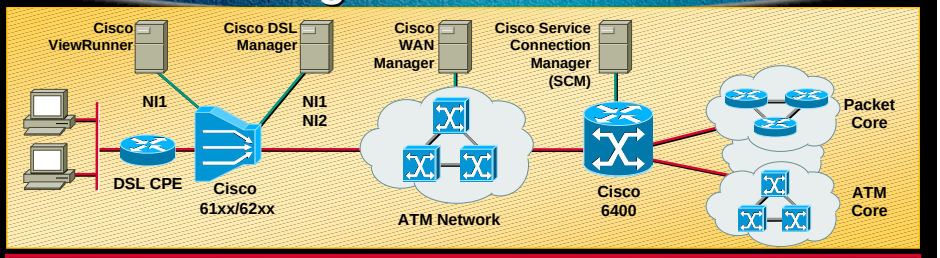
# Current Cisco DSL Management Solutions




| Network Element | Element Management System |
|---|---|
| Cisco NI1-Based 6100/6130 DSL Access Concentrators | Cisco DSL Manager (Q1 CY 00)<br>Cisco ViewRunner for HP OpenView |
| Cisco NI2-Based 61xx/6260 DSL Access Concentrators | Cisco DSL Manager |
| Cisco 6400 UAC | Cisco Service Connection Manager |
| Cisco ATM Switches | Cisco WAN Manager |
| Cisco DSL CPE | SNMP or Command Line Only |

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## Barriers to Mass Market Deployment

- Operator interaction with multiple element management systems
  - No end-to-end view
  - Limited flow-through provisioning
- Multiple truck rolls
  - Loop qualification
  - CPE configuration and installation
  - Manual connection of customer lines to DSLAMs
- Extensive help-line interaction for end-user installs
- Scheduling and coordination of manual processes
- No automated life cycle management processes



## Current Provisioning Process

- On receipt of customer call
  - Determine service viability (qualify loop, etc.)
  - Determine desired type and level of service
  - Connect loop from MDF to DSLAM
  - Configure CPE and install at customer site
  - Configure Layer 1 parameters on DSLAM
  - Configure Layer 2 connection from CPE to Layer 3 endpoint
  - Configure Layer 3 services

## Enabling the Mass Market

- Mass market DSL deployment for network access providers
  - Defined: 1,000,000 customers per year
- Mass market characterized
  - No truck roll for installation or turn-up
  - Retail sales of CPE
  - User registration and selection of services
  - Management of the life cycle
  - Reliable turn-up of services
- What does 1,000,000 customers per year mean?
  - Install two DSLAMs every hour
  - Install one or two DSL aggregators every week
  - Completely provision a new subscriber every three seconds



## Streamlinig the Process

- Use mapping systems and facility databases to estimate service availability
- Pre-qualify all loops in a service area
  - Reduces service turnup time
  - Costly in low take-rate areas
- Statically provision Layer 2 network
  - Limits amount of operator interaction required to turn up service
  - Simple in existing networks (1 PVC per subscriber)
- Configuration scripts for CPE turnup
  - Shortens time technician is on site

# Mass Market Enablers

- Automation everywhere
  - CPE auto configuration
  - End-to-end provisioning
    - Must integrate with existing operations support systems
  - Smart DSLAM
    - Supports flow-through provisioning of CPE
  - Automated cross connect and loop qualification
- Life cycle management—moves, adds, changes and deletions of:
  - Subscribers
  - Connections
  - Services
  - Technologies

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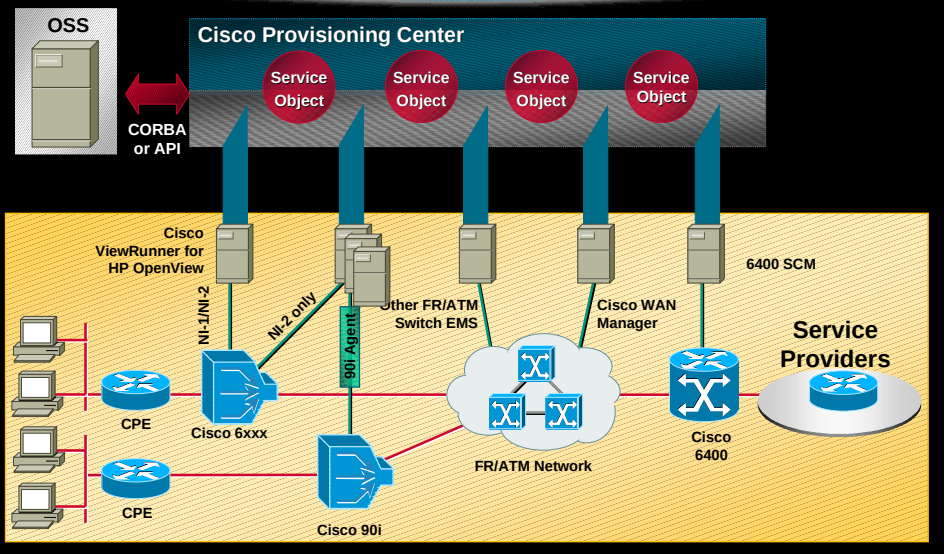
# End-to-End DSL Management Path

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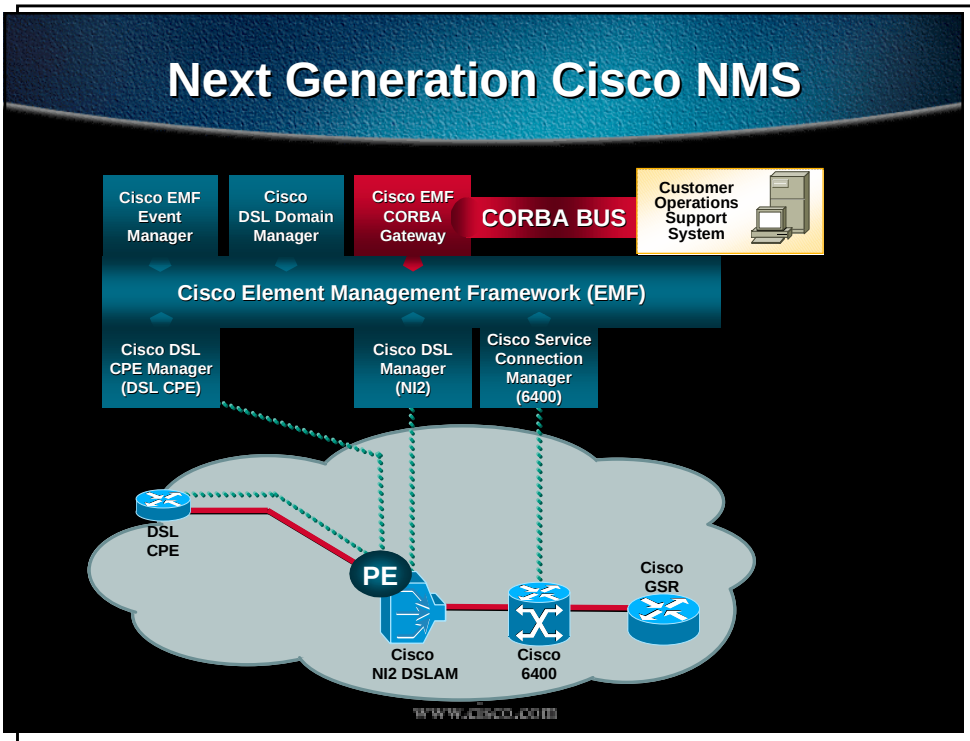
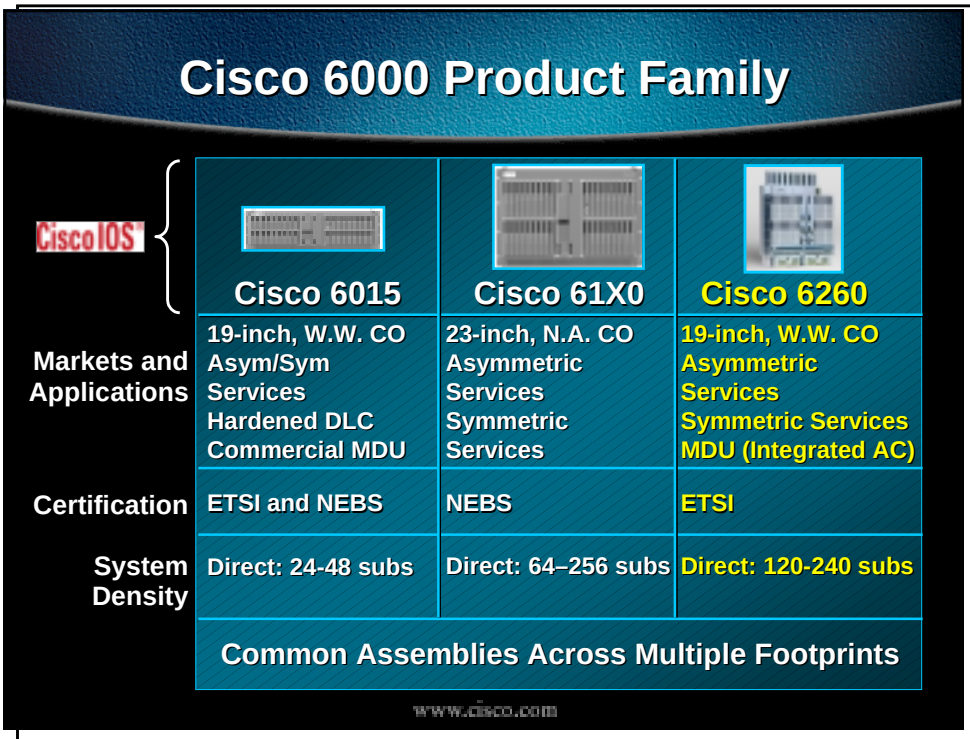
# Next Generation Cisco NMS

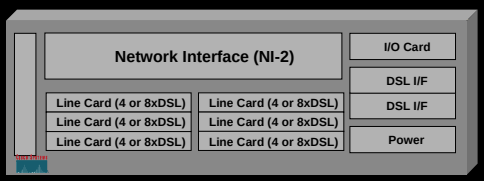



# Cisco 6000 Product Family



# Cisco 6015 Product Overview

- Worldwide small CO, MDU & DLC
- 24–48 subscriber density
- Scalable, high-performance ATM architecture
  - DS1 IMA, OC-3, DS3 uplinks
  - Full CoS/QoS
  - ATM signaling support (SVCs, SPVCs)
- Carrier-class design and compliance
  - NEBS Level 3, OSP, and ETSI-300
- ADSL (CAP and DMT), SDSL (planned), G.SHDSL (planned), IDSL (planned)
- Cisco IOS® and Cisco DSL Manager
- Available 3Q00

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# Cisco 6260 Product Overview

- Worldwide PTTs, CLECs, ILEC, N.A. MDU
- 120–240 subscriber density
- Scalable, high-performance ATM architecture
  - STM-1/OC-3, E3/DS3 uplinks
  - Full CoS/QoS
  - Fairness-based subtending for up to 3,120 subscribers
  - ATM signaling support (SVCs, SPVCs)
- Carrier-class design and compliance
  - ETSI compliant
- DMT, SDSL/G.SHDSL (planned)
- Cisco IOS® and Cisco DSL Manager


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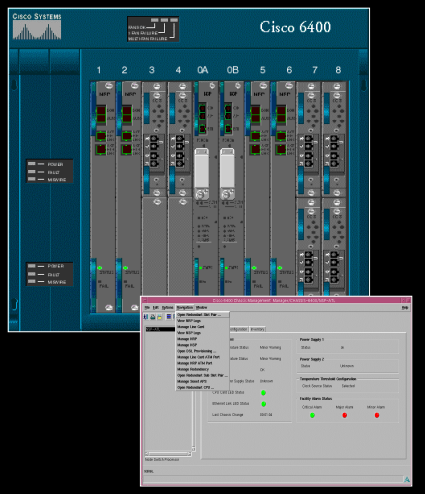
# Cisco 6400 Product Overview

- Scalable element management system for Cisco 6400 Universal Access Concentrator
  - GUI based app running on Sun Solaris
- Builds on the Cisco Element Management Framework (CEMF)
  - Installs as add-on to CEMF
- Provides end-end management of Cisco 6400 UAC including
  - Preprovisioning
  - Autodiscovery
  - Service and subscriber configuration
  - Capacity planning
  - Performance analysis

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# Residential ADSL CPE

Cisco 677
ADSL Router

Intel PRO/DSL 2100
ADSL NIC

Best of Show
Award
CES2000

Cisco IHG2000
Internet Home Gateway

Intel PRO/DSL 3100
USB Modem

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## Business Class DSL CPE

Cisco 2500/2600 Series with DSL WIC

Cisco 1700 with DSL WIC

Cisco 3600 Series with DSL WIC

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## Cisco Is the New World Leader

- Technology you can deploy today for immediate revenue generation
- Scalability to support evolution to mass-market customer deployments
- Leading the way to enable new billable services for new revenue opportunities and increased profitability
- Providing investment protection with a smooth migration to even more advanced New World architectures

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## Learn More

Cisco has a fully staffed DSL solutions lab available to support your network architecture and services development. We welcome the opportunity to partner with you in making DSL a key component of your business success

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