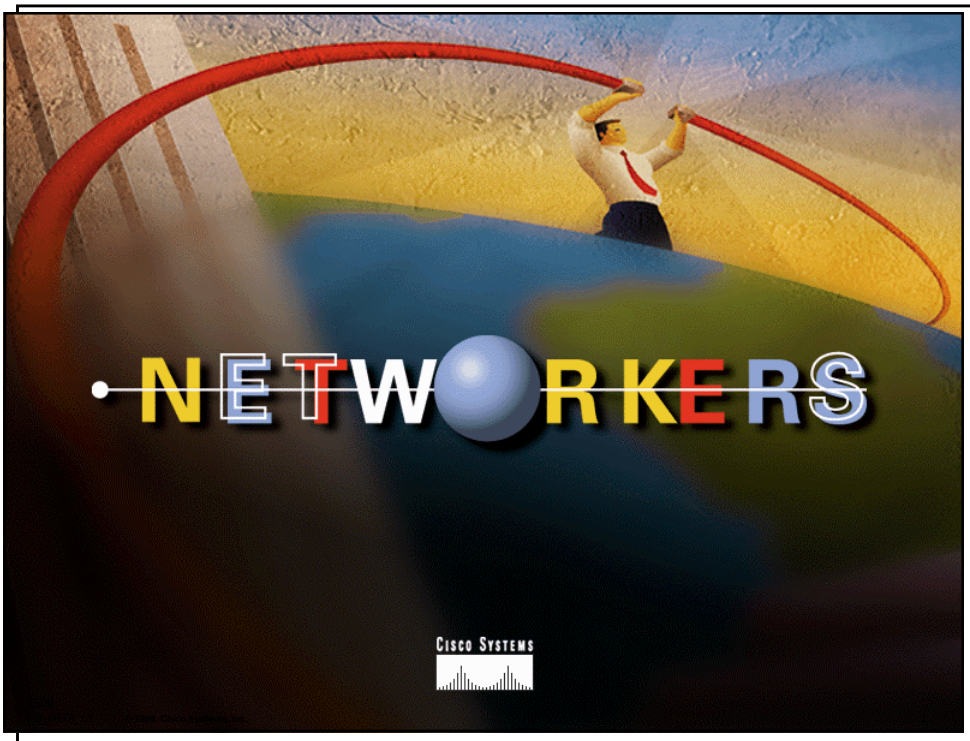

Agenda

- **Market Developments**
  - **Drivers for Voice Over Packet Networks**
- **PSTN Elements**
- **Technology Developments**
  - **Open Packet Telephony Architecture**
- **Architecture Choices**
- **Architecture and Products**

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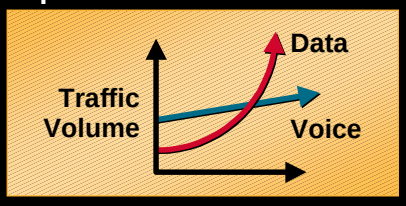
Market Developments

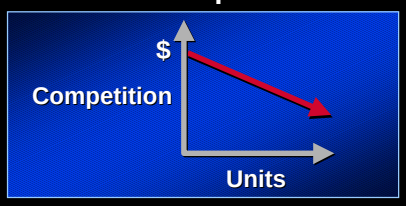
Explosive Growth



Market Expansion

Rapid Change

Increased Competition



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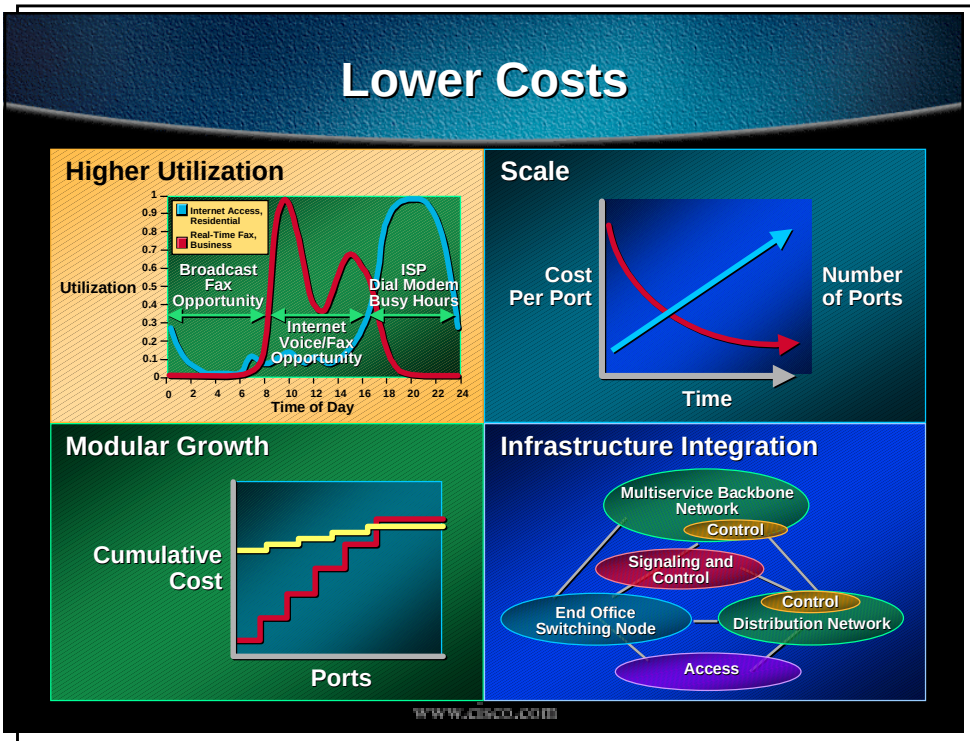

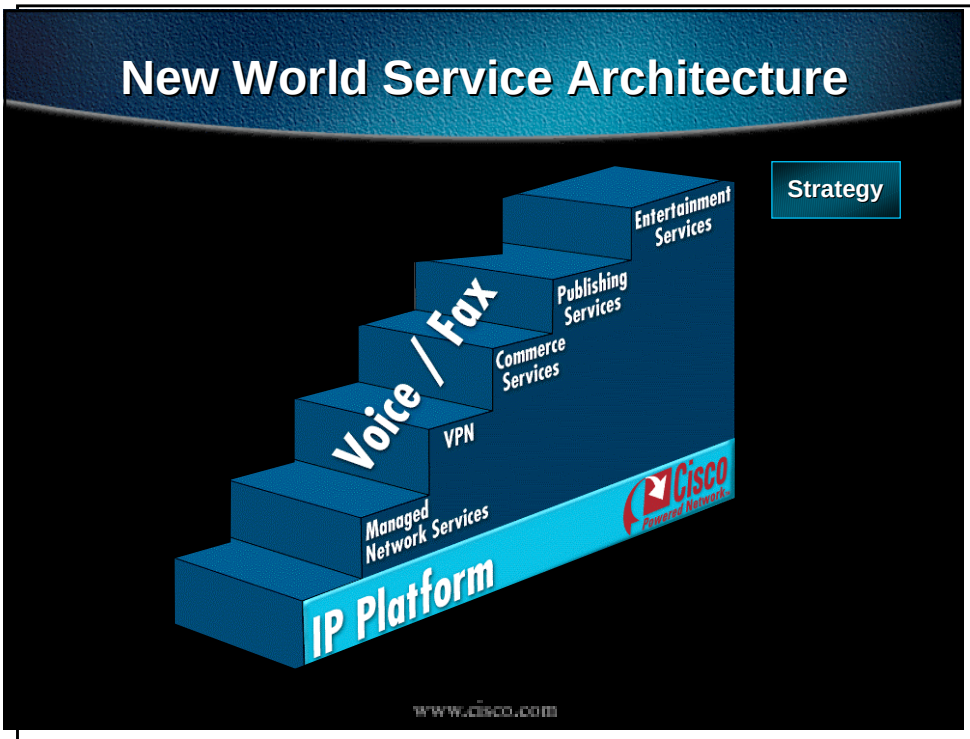

Agenda

- Market Developments
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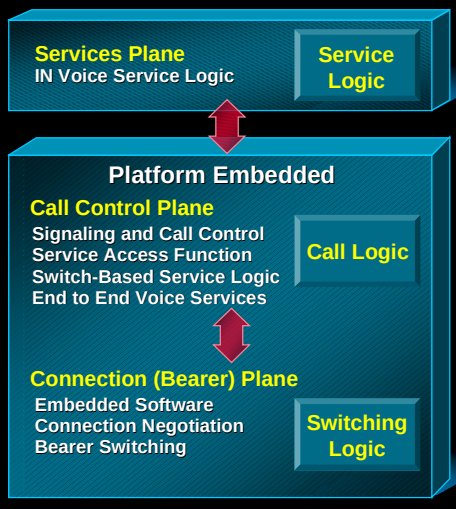
Traditional Switch Architecture

- Legacy TDM closed architecture
- Limited scalability, bottlenecks
- Complex, inflexible
- Tied to physical infrastructure
- Lack of open, standard interfaces



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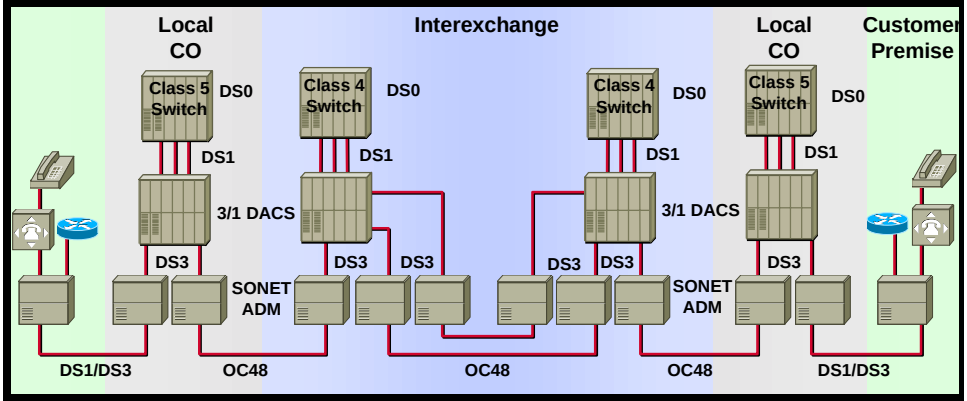
The Limitations of TDM

- Rigid hierarchy yields high cost per bit
- Lower-margin services disfavor new investment
- Inflexible architecture increases time to market



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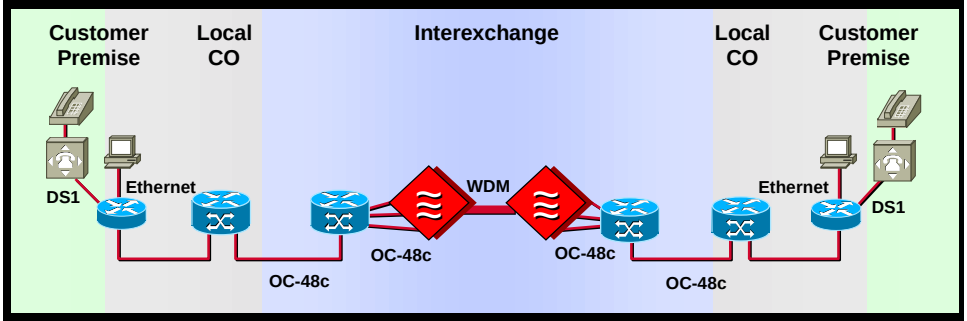
Advantages of Packet Switching

- Optimized infrastructure for data services
- Statistical muxing over largest available pipe
- “Flattened” network reduces costs



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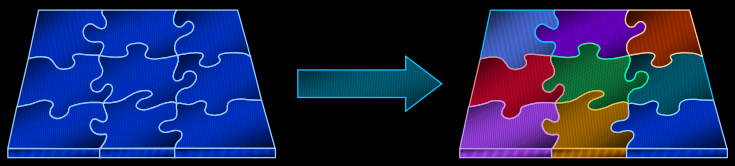
Open Standards Change the Model



Traditional Telephony	Packet Telephony
• Proprietary	• Public standards
• Closed	• Open systems
• Inflexible	• Flexible
• Monolithic	• Teams and partners
• Extremely expensive	• Inexpensive
• Old world speed	• Internet time

Market Transition = Opportunity

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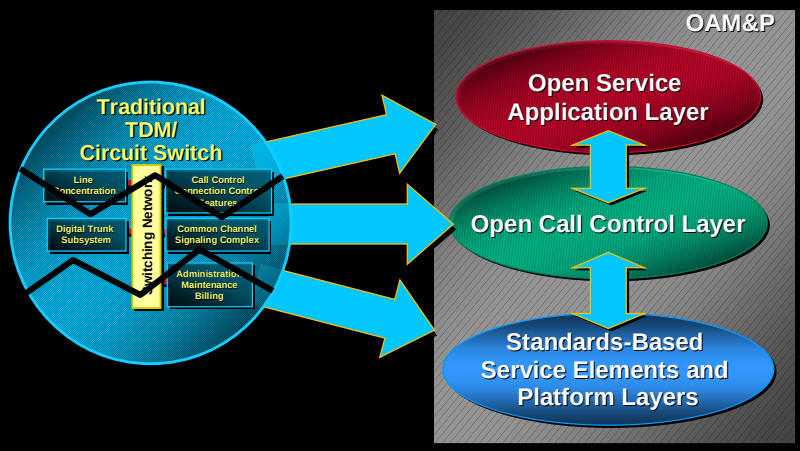
Open Packet Telephony Model



Open and Standardize the Telephony Infrastructure

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Goals for an Open Architecture

- Voice services over heterogeneous networks
- Independence from underlying network transport infrastructure
- Open framework to control voice services
- Access to intelligence at the edges of the network
- Interoperability to legacy networks and services
- Support rapid network and service provisioning

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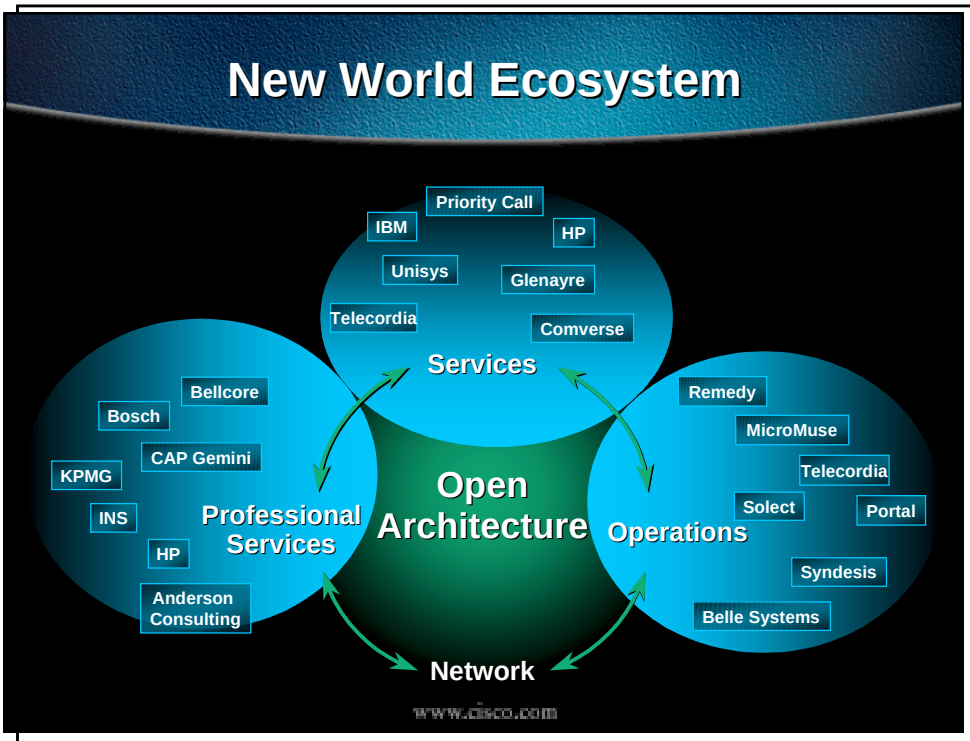

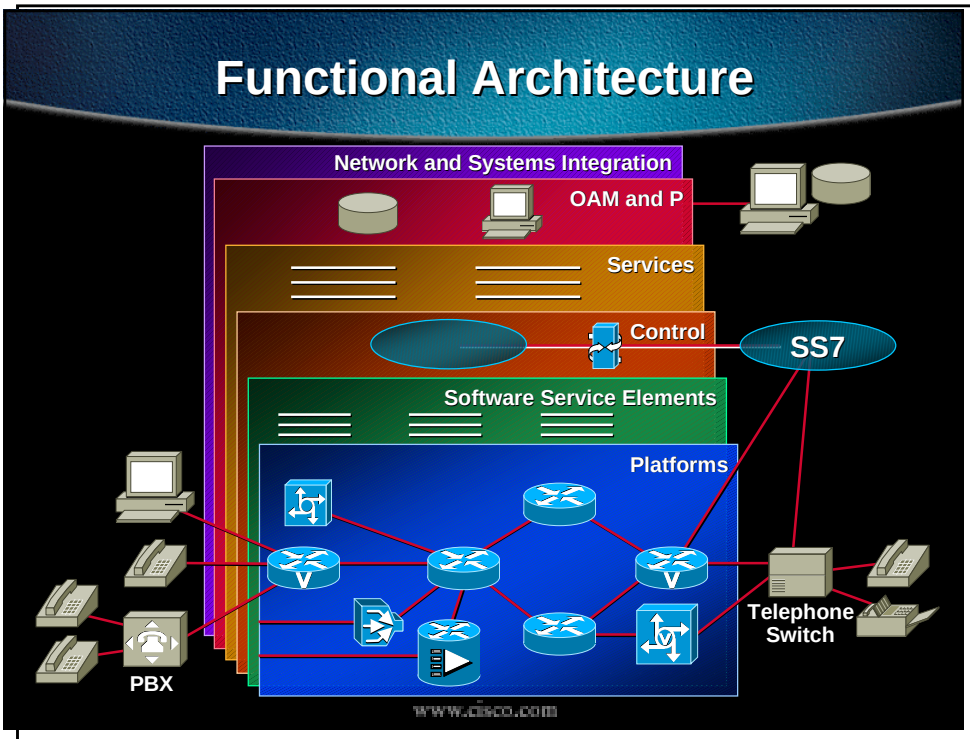

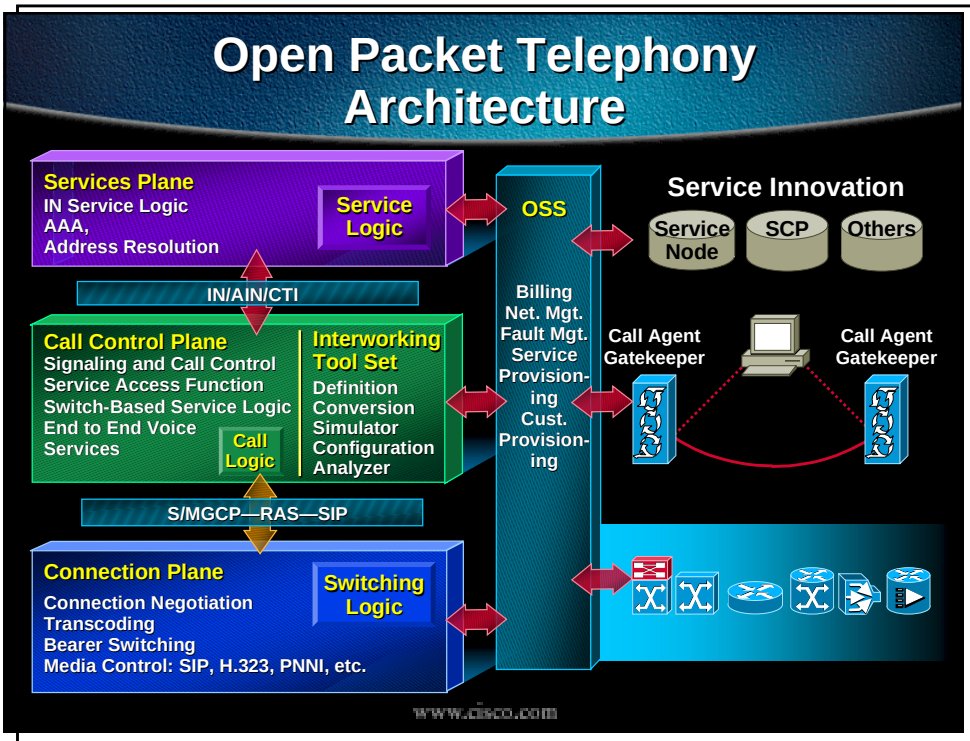

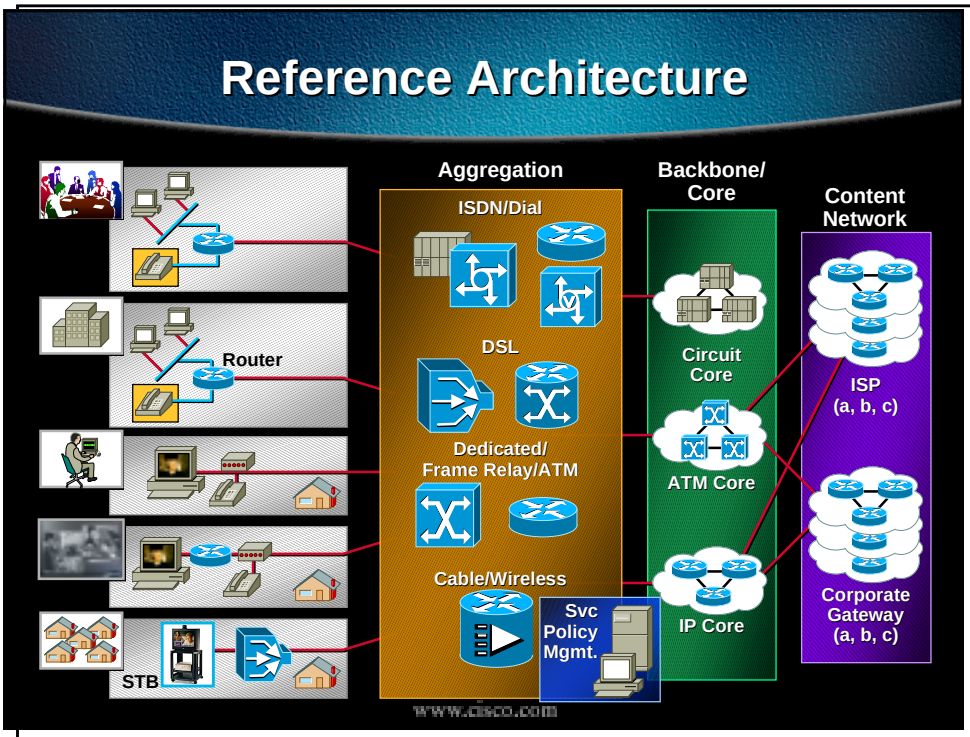

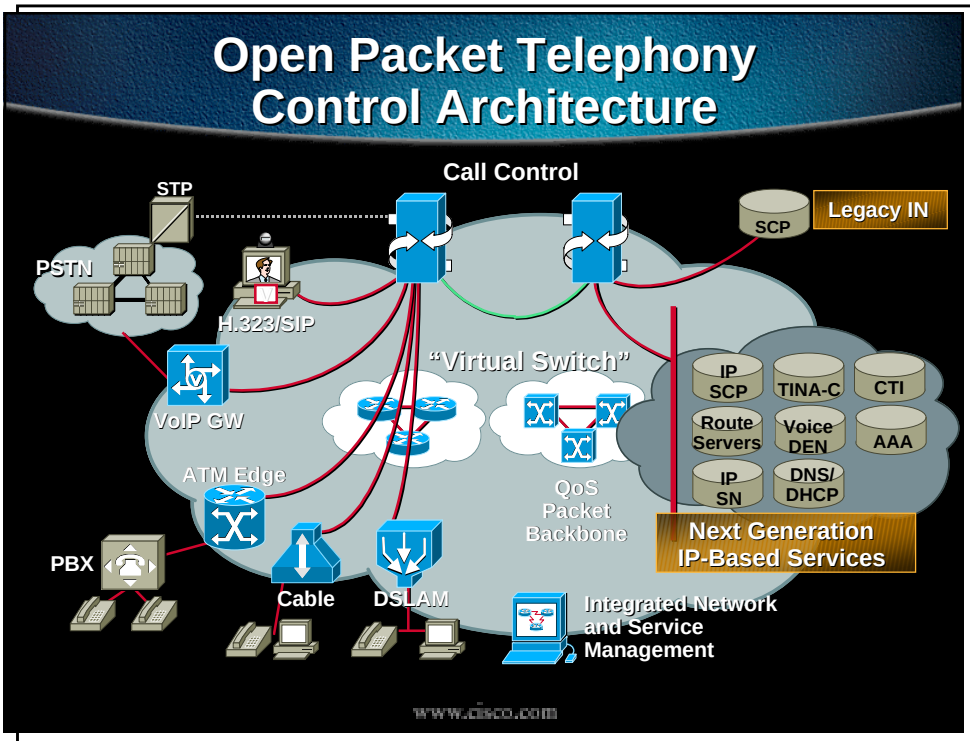

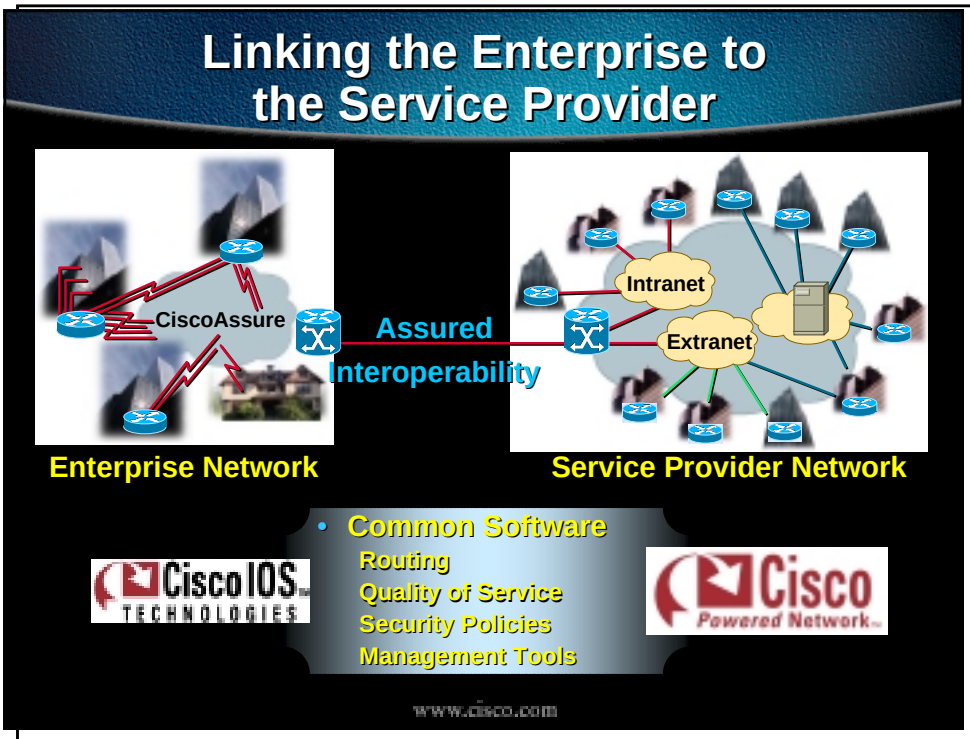

VoIP Applications

- Toll Bypass
- AVVID
- Internet Call Waiting
- Click to Call
- Universal Number Reach
- Web Provisioning
- Call Screening
- Unified Messaging
- Call Centers
- Tandem Replacement
- Fax Store and Forward (Never busy, Personal Fax)
- Voice VPNs

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Agenda

- Market Developments
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Packet Telephony Architecture Choices

- Intelligent Network/Simple Endpoints
- Simple Network/Intelligent Endpoints
- Hybrid—Intelligent Network and Endpoints
- Layer 2 Access Network Voice Carriage

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Packet Telephony Architecture Choices

- Intelligent Network/Simple Endpoints
  SS7, Gateway Control Protocol (SGCP/MGCP)
- Simple Network/Intelligent Endpoints
  Session Initiation Protocol (SIP)
- Hybrid—Intelligent Network and Endpoints
  H.323
- Layer 2 Access Networks Voice Carriage
  VoFR (FRF11), VoATM

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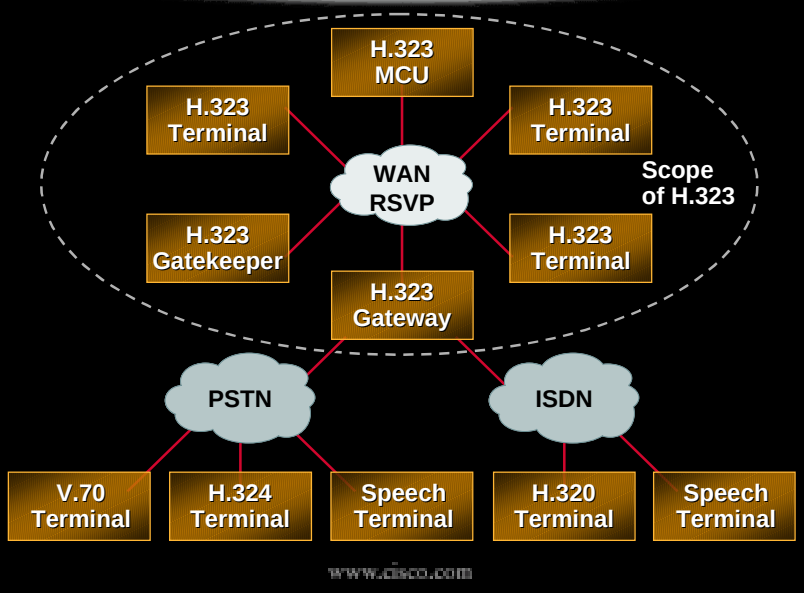
H.323—Multimedia Standard for IP Networks

- The H.323 standard provides a foundation for audio, video, and data communications across IP-based networks, including the Internet
- Original standard approved in 1996 and H.323 V2 was approved January 1998
- H.323 is an umbrella recommendation from the International Telecommunications Union (ITU) that sets standards for multimedia communications over Local Area Networks (LANs) that do not provide a guaranteed Quality of Service (QoS)
- H.323 is H.320 Recast for IP LAN

H.323—System Components

- H.323 defines four major components for a network-based communications system
  - Terminals
  - Gateways
  - Gatekeepers
  - Multipoint Control Units

H.323—System Components



Gatekeeper Functions

- Mandatory services:
  - Address translation
  - Admissions control
  - Bandwidth control
  - Zone management
- Optional services:
  - Call control signaling
  - Call authorization
  - Bandwidth management and reservation
  - Call management
  - Gatekeeper management information data structure
  - Directory services

H.323 RAS

- Gatekeeper functions

  xRQ/xCF/xRJ

- Gatekeeper verbs

  Admit, bandwidth change, disconnect, gatekeeper, information, locate, register, unregister

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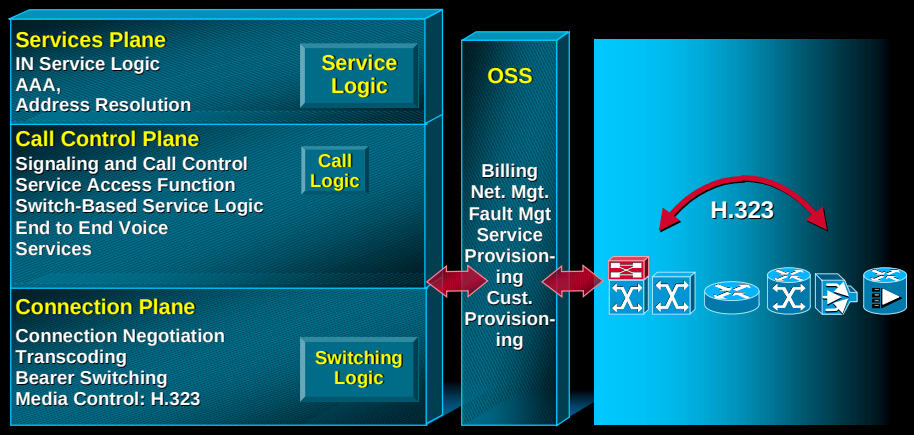
H.323—H.323 Direct Call Model



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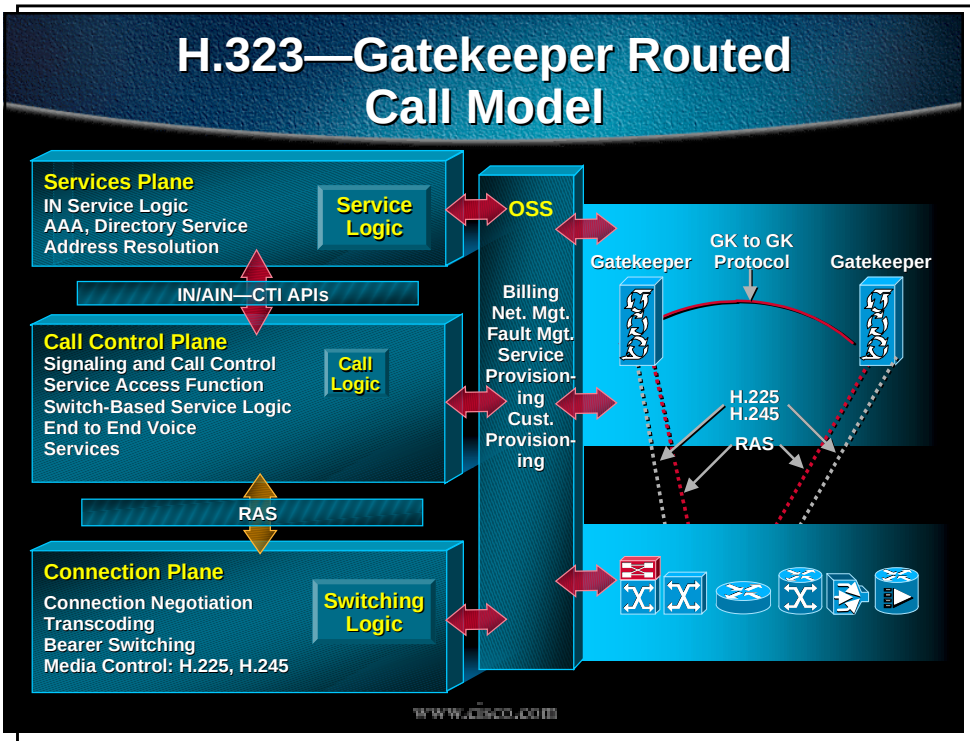
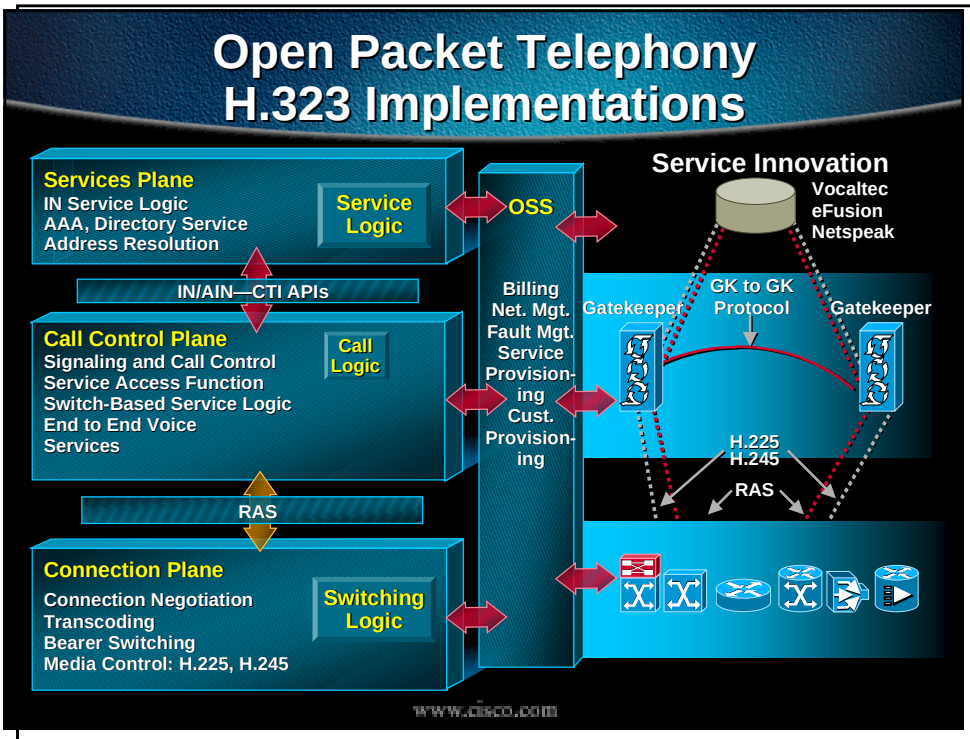
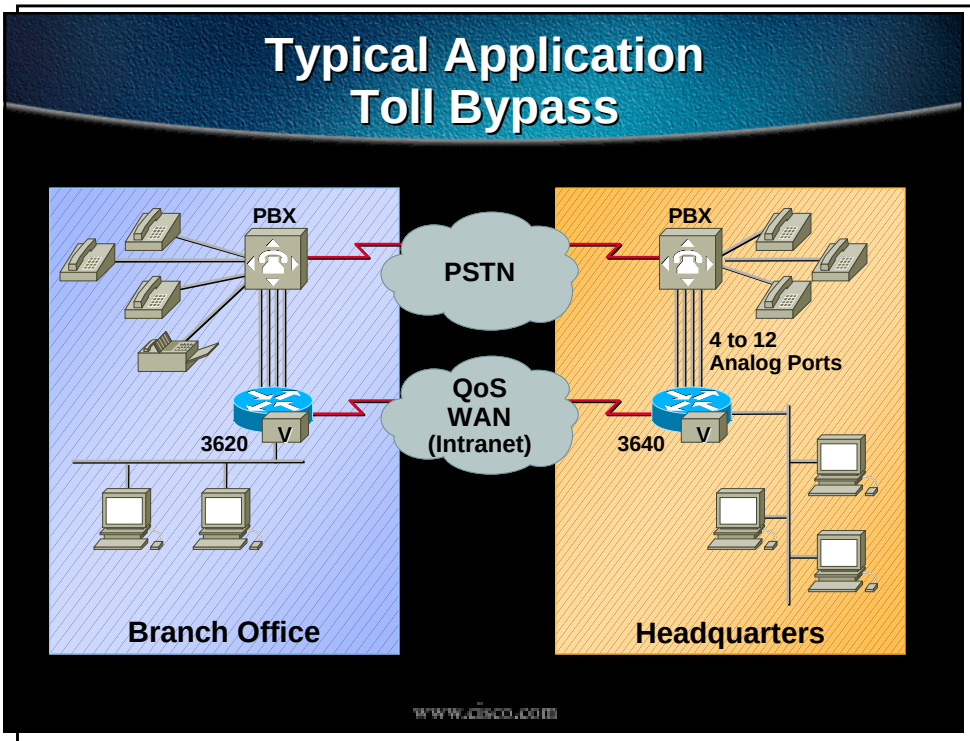
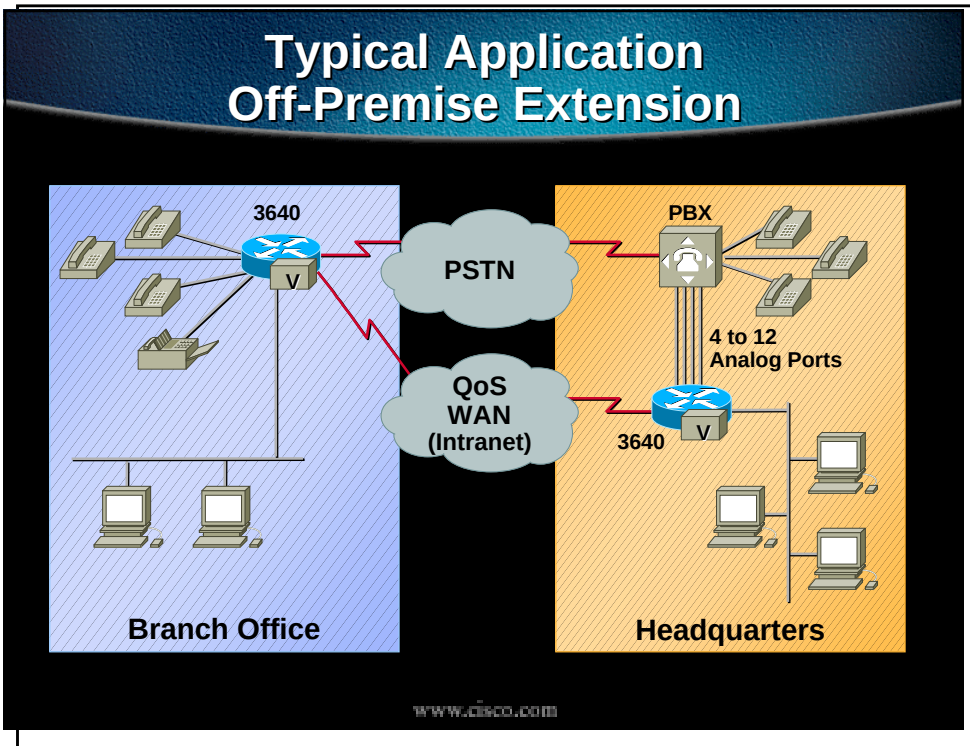
H.323—Gatekeeper Routed Call Model



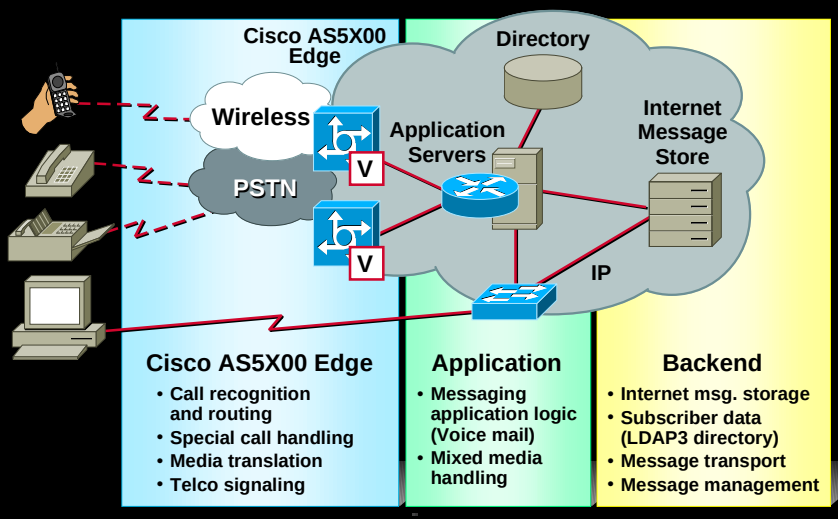
Open Packet Telephony H.323 Implementations







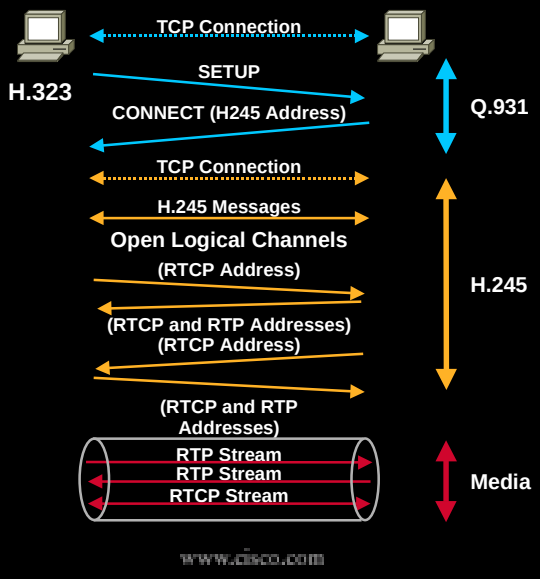
Unified Communications Network Components



H.323 Applications

- NetSpeak
  - Card Services
    - Pre and Post Paid
  - Gatekeeper
- NetCentric
  - Fax Store and Forward
- eFusion
  - Internet Call Waiting
  - Click-to-Talk
- InfoInteractive
  - Internet Call Waiting
- VocalTec
  - Card Services
    - Post Paid
- Other applications 2nd half CY '99
- Cisco uOne
  - Single Number Reach
  - IP Voice Mail
  - Unified Communications
- GRIC and TransNexus
  - Clearinghouse Services

H.323 Generic Call Flow



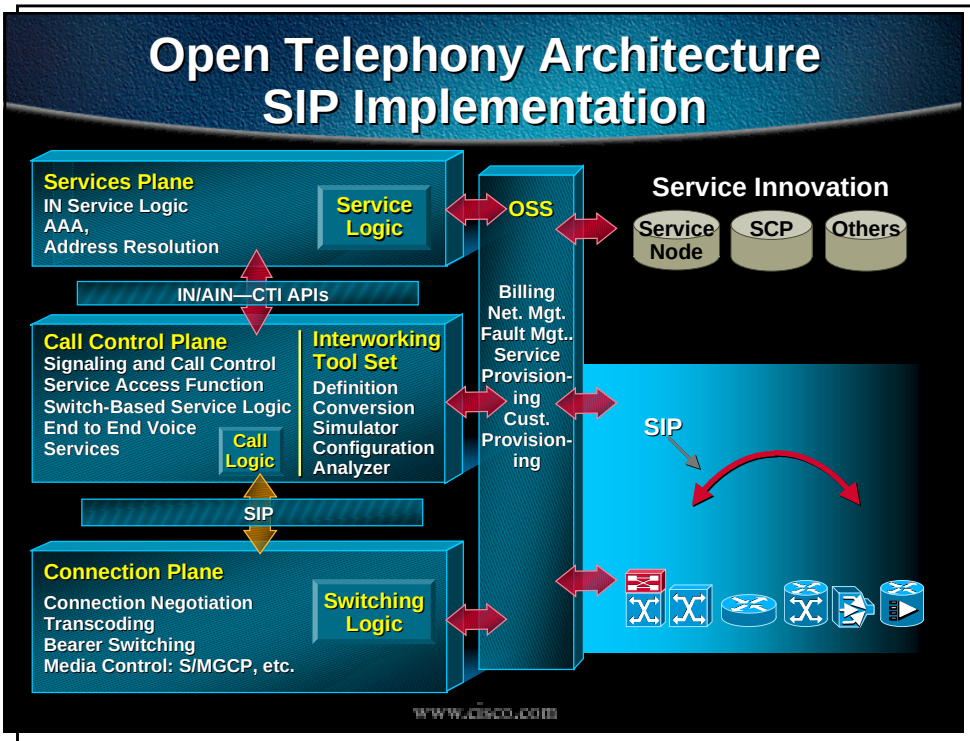
H.323 Resources

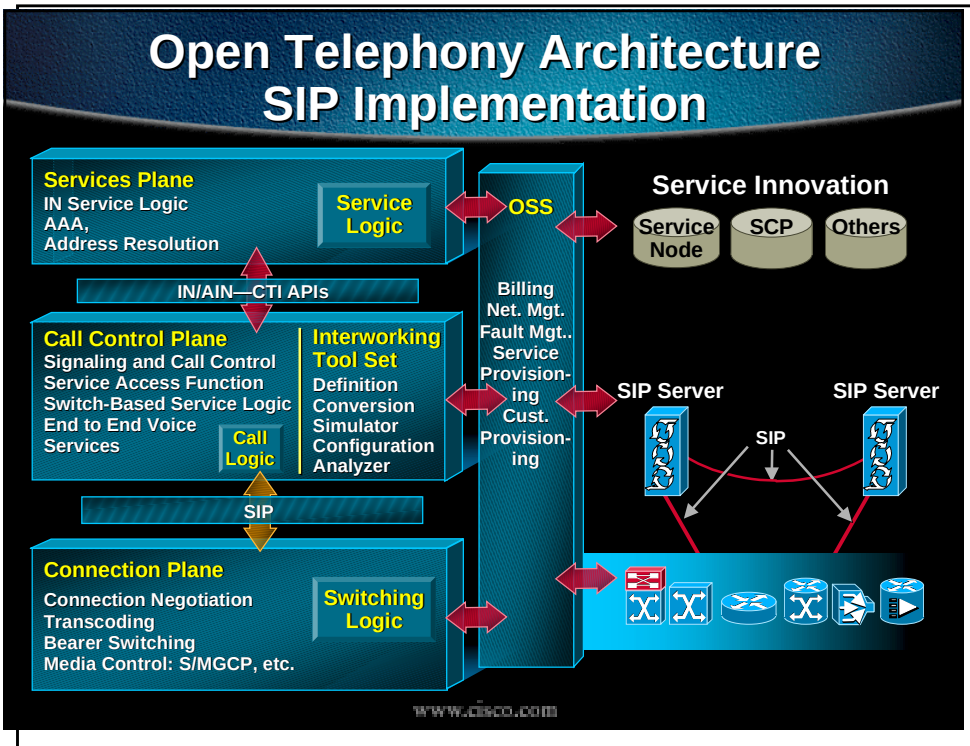
- VoIP Forum

  ftp://ftp.imtc-files.org/imtc-site/VoIP-AG/incoming

- General Information

  http://www.pulver.com





Intelligent Endpoints—SIP

SIP Goals

- To supports some or all of five facets of establishing and terminating multimedia communications:
  - User location
  - User capabilities
  - User availability
  - Call setup
  - Call handling

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SIP Architectural Elements

- Clients
- Servers
  - Proxy
  - Redirect
  - User agent

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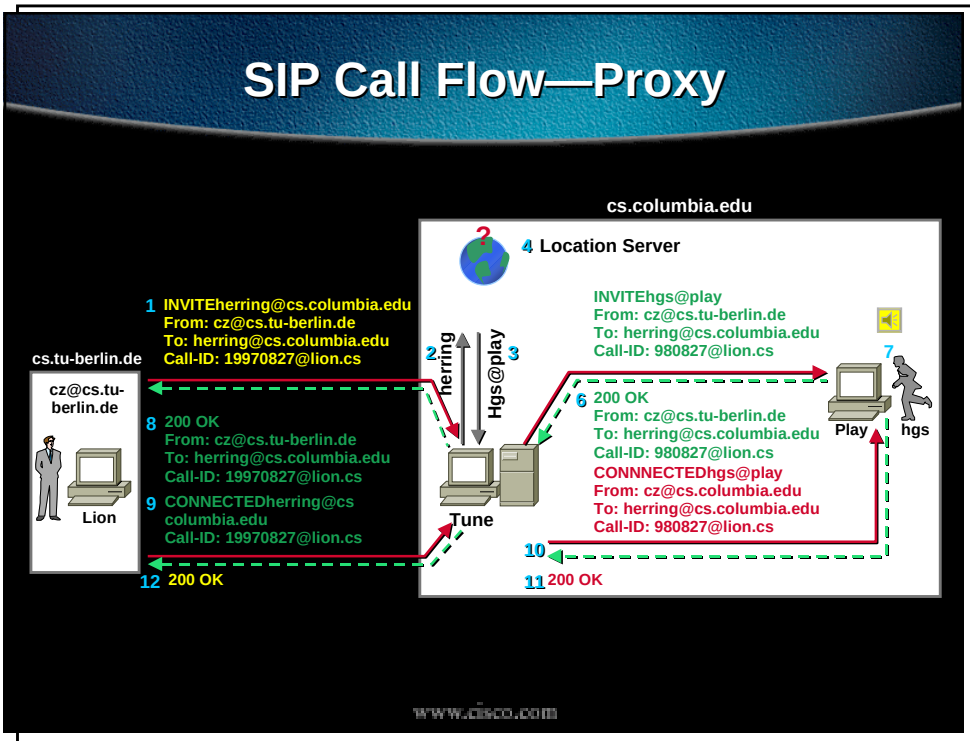
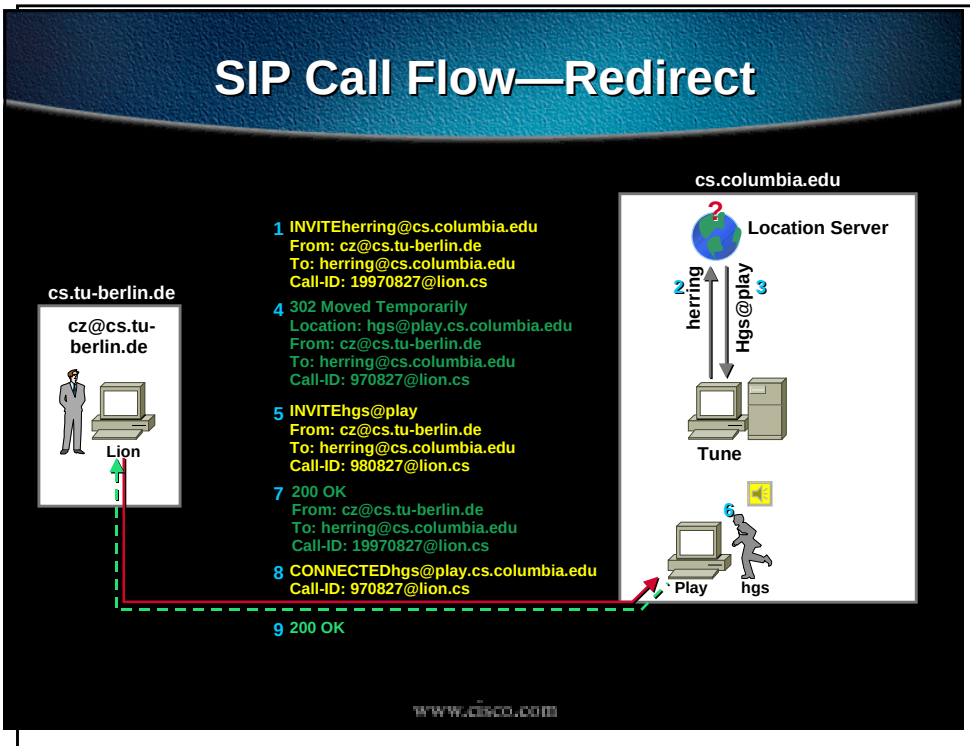


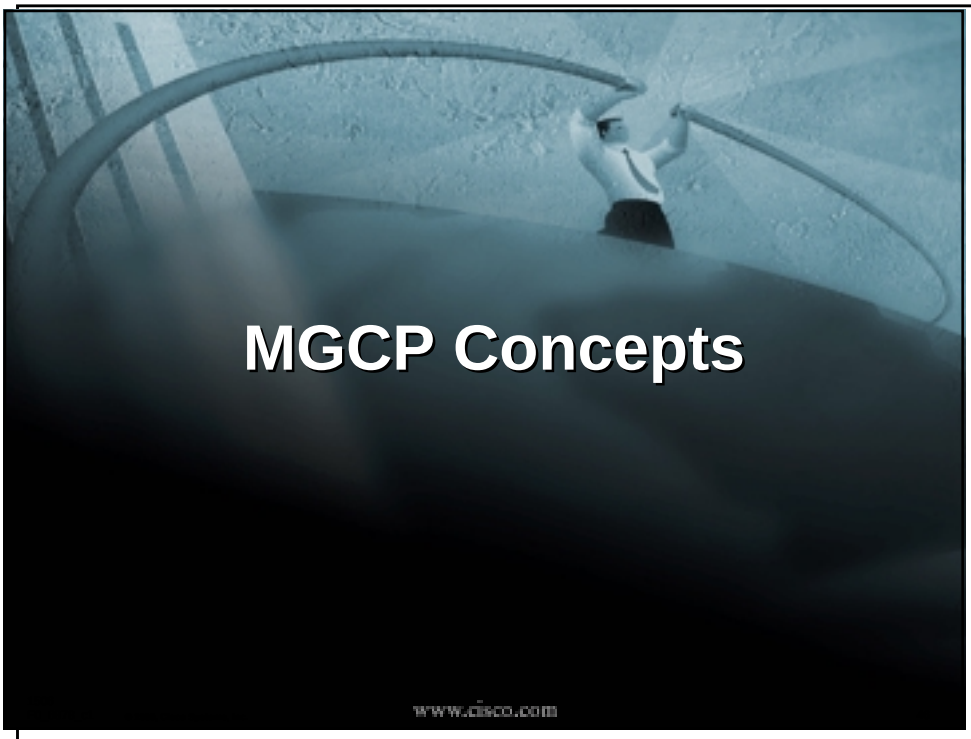


SIP Resources

- SIP standard RFC 2543

  ftp://ftp.isi.edu/in-notes/rfc2543.txt
- General SIP information

  http://www.cs.columbia.edu/~hgs/sip/



Gateway Types

Trunking Gateway: A gateway that terminates a trunk connected to a PSTN switch (e.g., Class 5, Class 4, etc.).

Residential Gateway: A gateway that terminates an analog POTS connection to a phone, key system, PBX, etc.

H.323 Gateway: A MG/MGC pair that emulates the operation of a H.323 Gateway.

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MGCP Endpoints

- Endpoints reside in a Media Gateway or Service Node (IVR, Announcement Server, etc.)
- Endpoints are sources or sinks of data
- Endpoints can be physical or virtual.
- Endpoints execute a small set of simple transactions as instructed by MGC
- No change of endpoint when introducing new service
- Simple Endpoint operations

  Hook transition, DTMF input, play tones, etc.

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Endpoint Types

- Physical
  - Digital channel (DS0)
  - Analog line
  - Packet relay
  - Wiretap
  - ATM "trunk side" interface
- Virtual
  - Announcement Server
  - Interactive Voice Response
  - Conference bridge

Connections

- Bearer Networks
  - Audio using RTP and UDP over IP
  - Audio using AAL1 or AAL2 over ATM
  - Transmission of packets over an internal connection, e.g., TDM bus.
- Connections
  - Modes: Send; Receive; Send/receive; Inactive; Loopback; Continuity Test

MGCP Digit Maps

- Digit Maps
  - A grammar sent by the MGC to the MG
  - Instructing the MG how to accumulate DTMF input
  - Digit map can be tailored centrally and on a per-user basis
  - Example:
    - User A subscribes to basic telephony, User B subscribes to supplementary services as well
    - When User A places a call, the MGC sends a basic digit map to the gateway
    - When User B places a call, the MGC sends a digit map recognizing supplementary service invocation as well

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Session Description Protocol

- A session description protocol for multimedia connections
- Developed by IETF mmusic WG
- RFC 2327
- Simple/Flexible
  - Text based
  - Extensible

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Gateway Control Operations

- NotificationRequest: Instructs the Gateway to Watch for Specific Events
- Notify: Inform CA When Requested Events Occur.
- CreateConnection: Create a Connection to an "Endpoint" Inside the Gateway.
- ModifyConnection: Change the Parameters Associated With an Established Connection.
- DeleteConnection: Delete an Existing Connection - Ack Returns Call Statistics

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Notification Operations

- **NotificationRequest**

  From MGC to MG

- **Notify**

  From MG to MGC

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NotificationRequest—Signals, Events

- **Signals:**

  Ringing; Distinctive ringing (0 .. 7); Ring back tone; Dial tone; Intercept tone; Network Congestion tone; Busy tone; Confirm tone; Answer tone; Call waiting tone; Off hook warning tone; Preemption tone; Continuity tone; Continuity test; DTMF tones; ASDI display

- **Events:**

  fax tones, modem tones; continuity tone; continuity detection (as a result of a continuity test), on-hook transition; off-hook transition; flash hook; DTMF digits

Notify Examples

- **Example 1: POTS line is on-hook,**

  MGC requests to be notified about off-hook events

- **Example 2: POTS line is off-hook,**

  MGC requests to be notified about on-hook, and flash-hook events.

  MGC provides MG with a digit map interpreting NANP numbers and *69.

  MGC requests MG to provide dial-tone.

- **Example 3: POTS line is off-hook, user has not paid his bill**

  MGC requests to be notified about on-hook events.

  MGC provides MG with a digit-map recognizing E911 calls and tells MG to provide dial-tone.

NotificationRequest—Events/Actions

- **Event-Action Table**
  - Action associated with each Event
  - Notify the event immediately, together with the accumulated list of observed events,; Swap audio; Accumulate according to Digit Map; Ignore the event.
- **Digit Map**
  - egrep Pattern
  - Limits Endpoint Telemetry Traffic

Connection Control

- **Used for Trunking Gateways and Access Gateways**
  - CreateConnection
  - ModifyConnection
  - DeleteConnection

Resource Control

- EndpointConfiguration
- AuditEndpoint
- RestartinProgress (RSIP)

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UDP vs. TCP

- TCP requires in-sequence delivery to destination application.
- TCP is a stream-based as opposed to block-based protocol
- Many implementations are limited as to how many TCP sessions can be active (same problem with H.323)
- UDP provides transparent transport for MGCP

MGCP Transport

- MGCP provides own transport features over UDP
- Failover Mechanism—State replication
- Each message has Transaction ID and is acked
- Each message to different endpoints are acked and retransmitted independently.
- Acks acknowledge receipt of operation and possible error code

DNS Usage

- Media Gateways and endpoint are identified by name, not IP address
- DNS used to resolve name to IP address
- Multiple IP Addresses for a Name—Retry
- Substitute Backup Nodes for Failed Nodes

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Simple

- Low CPU/memory Requirement for Endpoint
- Powerful Enough to Support:
  - Basic Telephony Services.
  - Enhanced Telephony Services, E.G. Call Waiting, Call Transfer, Conferencing, Etc.
- Flexible Enough to Support Future IP Telephony Services.
- Text based messages easy to debug

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MGCP Resources

- MGCP IETF Draft
  - http://www.cs.columbia.edu/~hgs/sip/drafts/draft-huitema-MGCP-v0r1-01.txt
  - http://www.ietf.org/internet-drafts/draft-huitema-mgcp-test1-00.txt

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MGCP vs. H.323 Comparison

- Scope
  - MGCP—Device control protocol
  - H.323—Full-featured video conferencing
- Status
  - MGCP—IETF/ITU working together to standardize
  - H.323—V3 in ITU approval cycle
- Interoperability
  - MGCP—Multiple vendors already interoperable
  - H.323—Demonstrated, but problematic

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MGCP vs. H.323 Comparison

- Call setup overhead
  - MGCP—as little as two round trips
  - H.323—7 or 8 round-trips (2 in V2)
- Call control functions
  - MGCP—Device connection control
  - H.323—Based on GK routed call functions
- Control transport
  - MGCP—UDP (multicast, firewalls)
  - H.323—TCP

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SIP vs. H.323 Comparison

- Scope
  - SIP—Full-featured multimedia protocol
  - H.323—Full-featured video conferencing
- Status
  - SIP—Basic SIP ready for proposed standard
  - H.323—V3 in ITU approval cycle
- Interoperability
  - SIP—Initial bake-off, some interoperability achieved
  - H.323—Demonstrated, but problematic

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SIP vs. H.323 Comparison

- Call setup overhead
  - SIP—as little as one round trip
  - H.323—7 or 8 round-trips (2 in V2)
- Call control functions
  - SIP—Relies on existing protocols
  - H.323—Based on GK functions
- Control transport
  - SIP—UDP (multicast, firewalls)
  - H.323—TCP

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MGCP vs. SIP Comparison

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  - SIP—Full feature multimedia protocol
  - MGCP—Device control protocol
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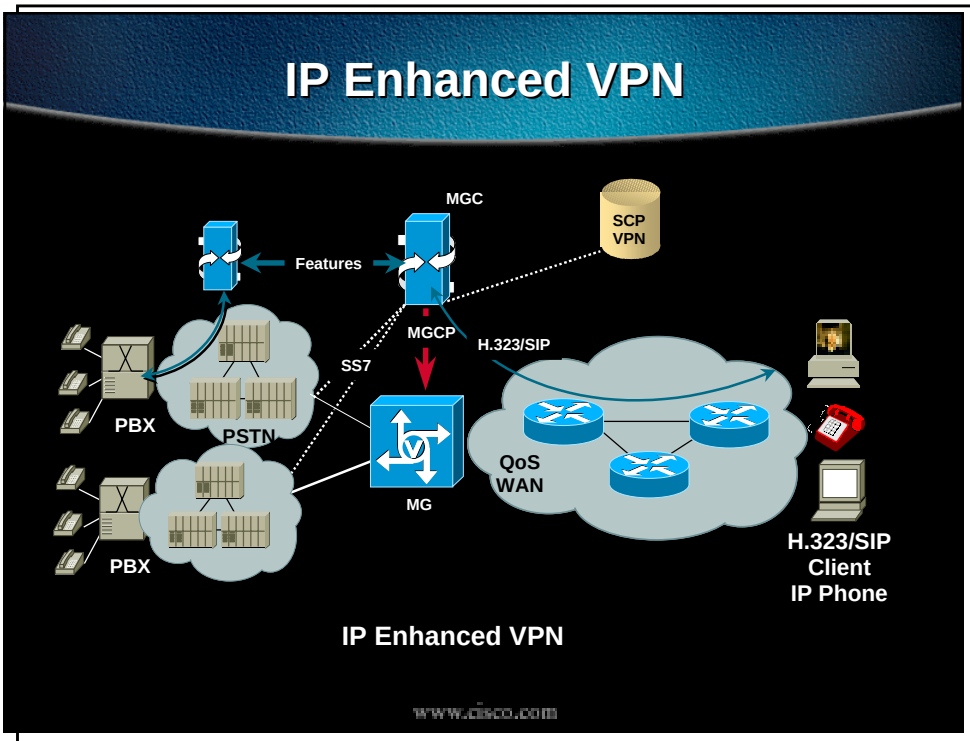
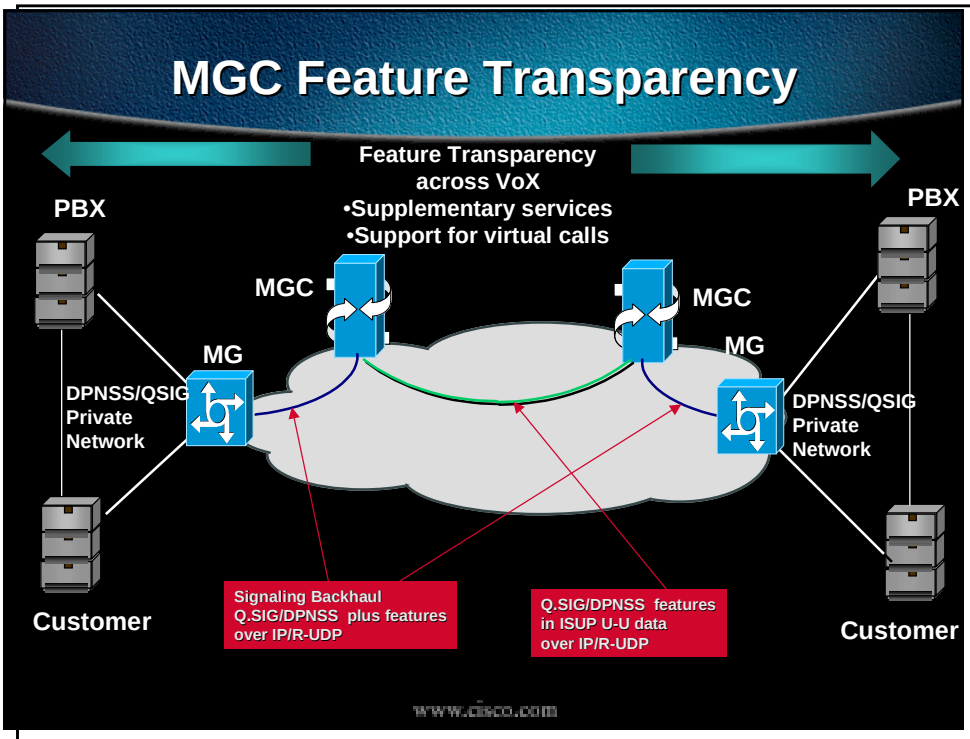
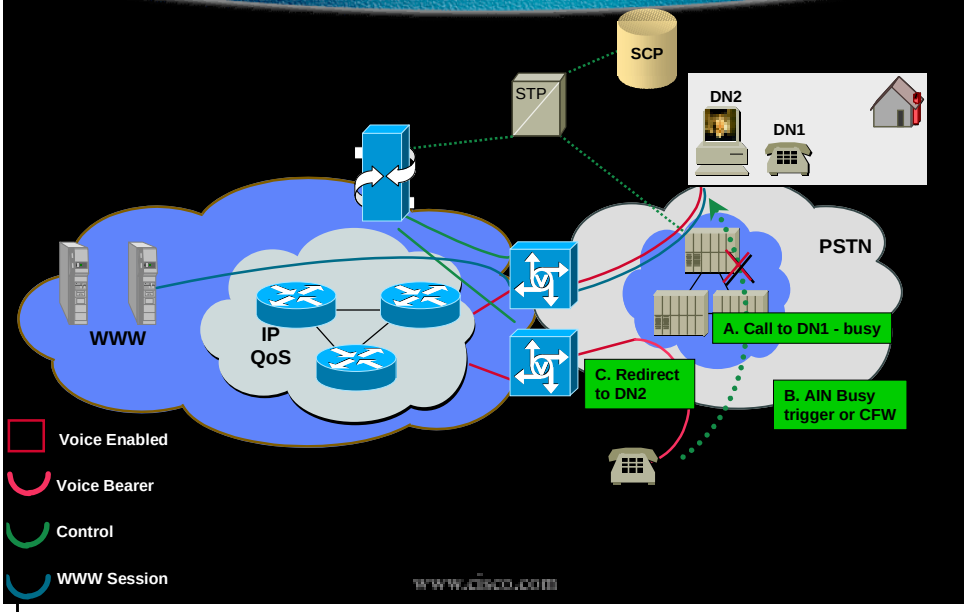




Virtual 2nd Line



FRF.11 Overview

- Access devices
  - End system devices
  - Transparent multiplexing devices
  - Switching system devices
- Payloads
  - Encoded voice and data
  - Inband indications
    - Dialed digits/signalling information/FAX or data

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Voice Over FR

- Efficient user of bandwidth
- Supports multiservice solutions
- Uses simple concepts of virtual circuits
- Gateways are inexpensive
- Large number of virtual circuits in large networks
- Multimedia applications being developed to IP

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Which Packet Telephony Protocol? What's the Right Answer?

- No single VoIP protocol will emerge as clearly dominant; all three will be in use
- Therefore, service providers will be required to support all of them
- What is needed is protocol interworking

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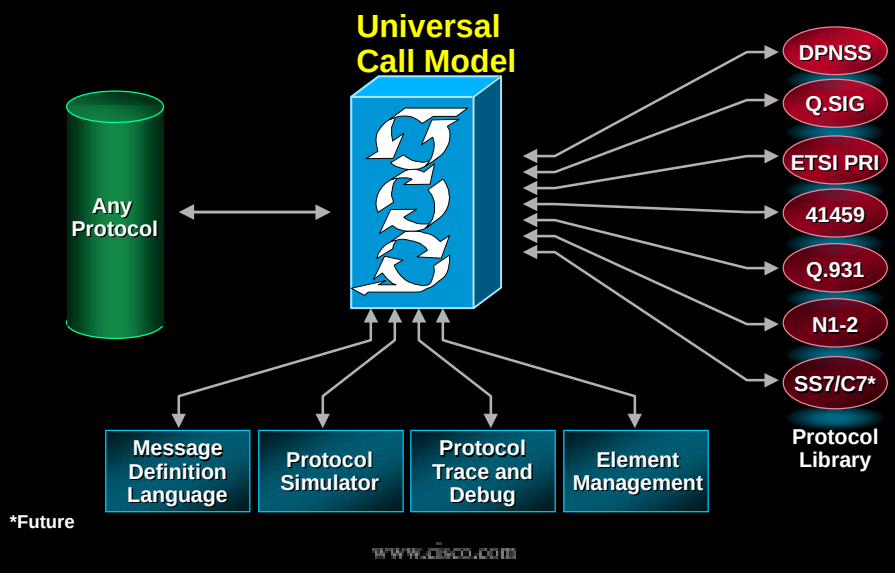
Virtual Switch Controller (VSC) Call Control Protocol Interworking



Agenda

- Market Developments
- PSTN Elements
- Technology Developments
  - Open Packet Telephony Architecture
- Architecture Choices
- Products

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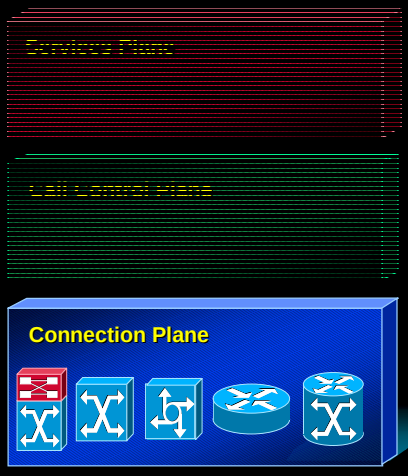
Connection Plane

- Broad portfolio breadth
  - Expands service provider's market reach
  - Match expenses to revenue
  - IP, ATM or FR
- Deliver carrier-class voice quality
- Service providers can leverage Cisco's success in the enterprise



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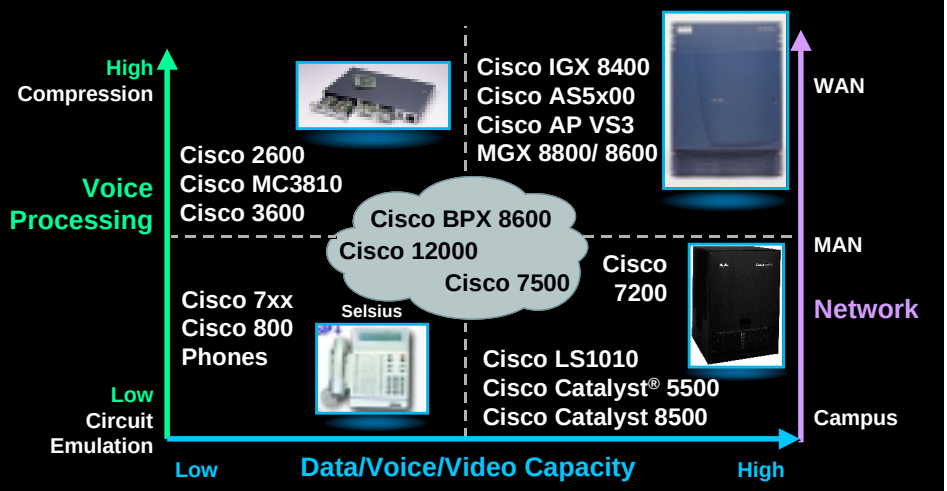
Connection Plane Product Portfolio



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Solution Components—Cisco AS5300

Independent Test Rated
Cisco No. 1 in VoIP

- **Key Applications**
  - VoIP
  - Toll Bypass
  - Fax relay
  - Modem / ISDN Internet access
- **Performance**
  - Embedded, high-performance, low-latency architecture

- **Carrier Class**
  - Highly scalable
  - Supports 96/120 calls (4 T1/E1/PRI) per 2 RU
  - 10MB & 10/100MB Ethernet
- **VoIP protocol support**
  - H.323, RTP, RTCP, NTP, CRTP

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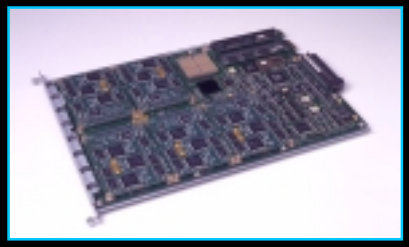
Cisco AS5300 Voice/Fax Feature Card

- **High Performance Voice Processing**
  - Specifically designed for real-time, high quality voice processing
  - Industry standard CODECS including: G.729, G.723.1, G.711
  - Full Featured Voice Processing including: echo cancellation, VAD/Silence Suppression, programmable frame size
- **Group III FAX relay**
- **Distributed IP Processing**
  - QoS packet designation on-card



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Solution Components—AccessPath-VS4

- Highly scalable
  - CT1/PRI VoIP port capacity: 192 to 2018
  - CE1/PRI VoIP port capacity: 240 to 2520
  - Integrated gatekeeper & programmable VCO/4K switch (optional)
- High Availability
  - VoIP feature shelves: hot swap and RPS
  - Gatekeepers: failover w/ HSRP
  - DASA: No single point of failure
  - NEBS Level 3 compliant
- Completely integrated solution
  - Dial, switching, backhaul routing, system controller
  - Configurator—quick deployment, user-friendly configuration

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Modular Access Router Family

- 50–70 kpps fast switching
- 3–4 kpps process switching
- Four network module slots

- 25–40 kpps fast switching
- 1.5–2 kpps process switching
- Two network module slots

- 12–25 kpps fast switching
- LAN interfaces integrated
- One network module slot

Versatility
Integration
Performance

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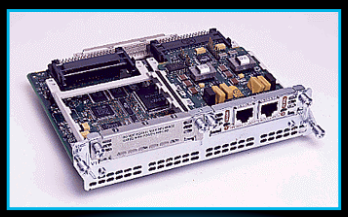
Network Modules—Voice/Fax

- Flexible Voice Interfaces (VICs)
  - FXS
    2-, 4-wire E&M types I, II, III, V
  - FXO
  - BRI VIC—Up to 4 voice channels
- Diverse signaling
  - Delay, immediate, and wink start
  - Loop and ground start



- DSP architecture—TI542
  - G.729 CS-ACELP—8K
  - G.711 PCM
  - Group III fax relay
- Voice transport support
  - Voice over IP—H.323
  - Voice over frame—VoFR, FRF.11, and FRF.12
    - Future support for: VoATM
- Two versions
  - NM-1V (1 VIC slot)
  - NM-2V (2 VIC slots)

Editors' choice:
Computer Telephony
March 1998

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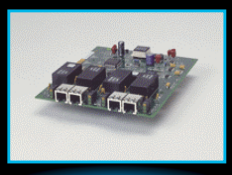
MC3810 Multiservice Access Concentrator

Voice over Frame Relay or ATM

G.729, G.729a, G.726, G.711

Group III Fax Relay

- Analog Voice Module (pictured here)
  - FXS, FXO or E&M up to six interfaces in any combination
- Digital Voice Module—T1 or E1
  - Up to 30 channels—24 compressed
  - Q.SIG PRI CAS and CCS transparent signaling
- BRI Voice Module
  - 4B+2D Q.SIG
- Video
  - MCM H.323 gatekeeper and proxy
  - AAL1 ATM stream



MultiFlex Trunk

- T1/E1 Uplink
- BRI Back-up Option
- Built-in CSU/DSU
- Drop and Insert

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Catalyst 8500 Family

Cisco IOS Multiservice ATM Switch Router

Smooth Integration and Investment Protection

Integrated Wirespeed IP, IPX and IP Multicast Routing

Rich ATM and Layer 3 QoS Capabilities

LightStream® 1010	Catalyst 8510	Catalyst 8540
Chassis	**Performance**	**Line Modules**
NonBlocking Fabric	5, 10 Gbps to 40 Gbps	OC3, OC12, OC-48
Hot Swappable Cards	Multiservice ATM Switch	ATM and Future PoS
Full Redundancy	Wire Speed (6–24 Mpps) throughput	10/100 , GE, FE/GE Channel

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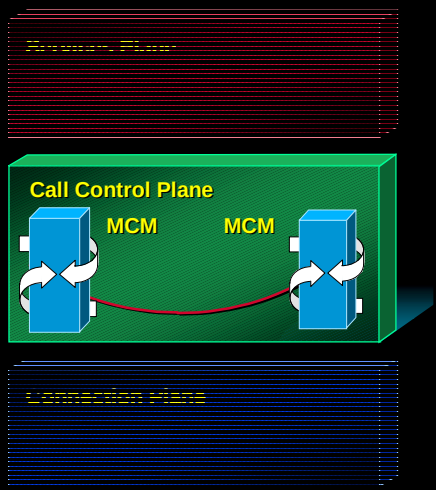
Call Control Plane— Cisco MCM H.323 Gatekeeper

- Scalable address resolution
- Proxy for secure access to enterprises
- Bandwidth management
- Radius support for authentication/ accounting (CDR)
- Provides QoS for intra zone calls
- H.323 traffic segregation



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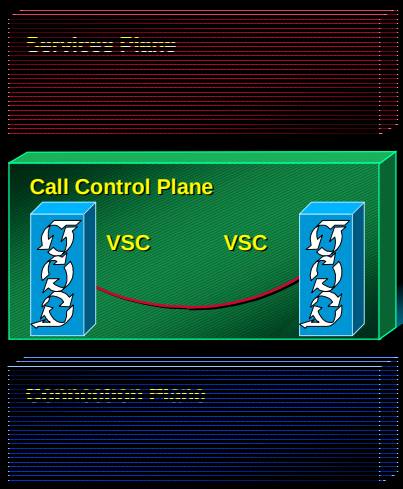
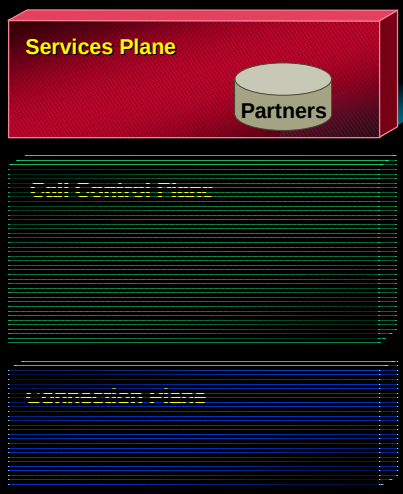
Call Control Plane—Virtual Switch Controller

- Powerful call control engine for service providers
- Cost effective alternative to traditional TDM solutions
- Telco class, NEBS compliant solution
- Scalable
- Comprehensive call accounting detail
- Broad signaling support



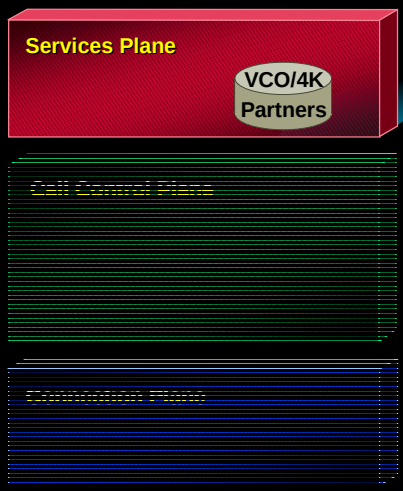
Services Plane—H.323

- NetCentric
  - Fax Store and Forward
- GRIC
  - Clearinghouse svcs
- NetSpeak
  - Calling card svcs
- eFusion
  - Internet Call Waiting
  - Click-to-Talk
- InfoInteractive
  - Internet Call Waiting
- TransNexus
  - Clearinghouse svcs
- VocalTec
  - Calling card svcs
- Cisco uOne
  - Single Number Reach
  - IP Voice mail
  - Unified Communications



Services Plane—Service Node VCO/4K Partners

- Voice Messaging—Unisys, Priority Call
- Calling Card—Comverse, Vicorp, Simplified
- Debit Card—Comverse, Glenayre, Synapsys
- International Callback—Compro, ITL
- Operator Services—MD Telecom
- Predictive Dialing—Castel
- Directory Assistance—Voicetek/Aspect
- Voice Dialing—Intellivoice
- Lawful Intercept—ADC
- Single Number—Priority Call, Compaq/DEC
- Web-Enabled Services—Timeshift



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