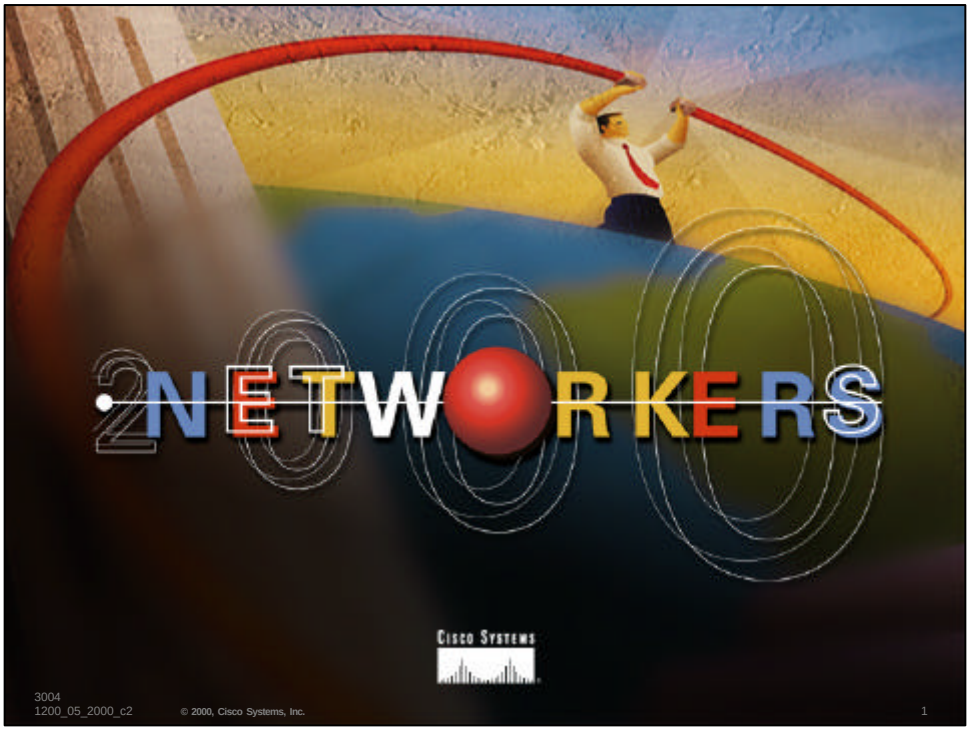

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Design Principles for Very Large Wholesale Dial Services

Session 3004

Cisco Systems

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Agenda

- Wholesale Dial Market
- Architecture Overview
- Design Issues
  - SS7 Integration
  - Port Policy Management
  - IP Addressing and Routing
  - Preventing Spam and DoS attacks
  - RADIUS Integration
- Summary

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Market Trends

- "Free" Internet services changing business models for ISPs (especially in Europe)
- Evolution of service provider from transport supplier to enabling enterprise e-commerce through "virtual ISPs"
- Emergence of application service providers (ASPs) offering unified messaging, Find Me-Follow Me, and fax services
- Wholesale representing greatest market opportunity for service providers

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What Is Wholesale Dial?

- Wholesale ISP provides “virtual dial ports” to retail ISPs
- Subscribers get Internet access (i.e. not a VPN service)
- Retail ISP owns relationship with user base

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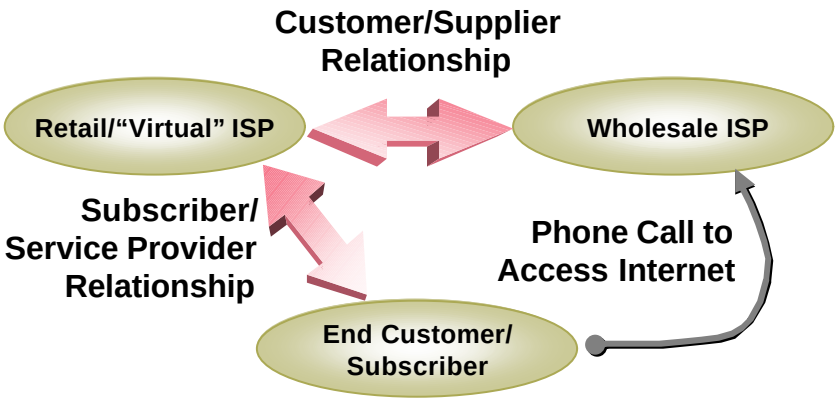
The Wholesale Dial Relationship Triangle



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Who Is Buying Wholesale Dial?

- **Enterprises**

  Dial access as channel to customers

- **Virtual ISPs/“dot coms”**

  Add dial access to service bundle

- **Other dial service providers**

  Extend range/reach

  Accelerate time to market

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Buyer: Enterprise Private Label Internet

- **Example: Kmart (US), Dixons (UK), JB Oxford (US), Deutsche Bank (Germany)**
- **Free Internet as a channel for reaching customers**
- **NOT providing access for company employees to corporate network**
- **Control access = control customer**
- **Cost of providing access comparable to or less than cost of TV/news/radio advertising**

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The Role of Intermediaries in Private Label Internet Access

	Advertiser Supported		Subsidized
	Consumer Free Internet Services	Enterprise Private Label Internet Services	Employee Internet Services
Brand	altavista, LYCOS, NETZERO	DELL net, E*TRADE, BLUE LIGHT, JBOxford & COMPANY	Ford Motor Company, intel, AmericanAirlines
Internet Service Enablers	1stUp.com free the web, spinway.com, freei		peoplepc
	Cisco Powered Network		

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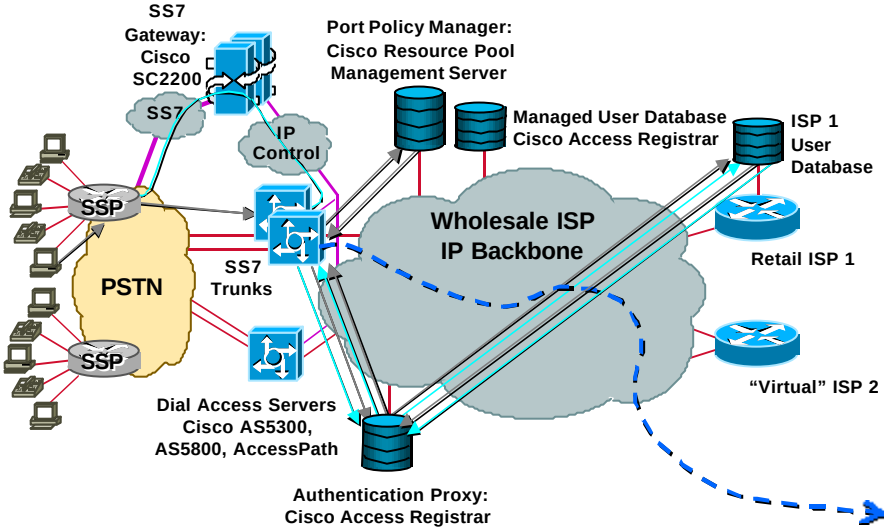
A Day in the Life of a Wholesale Dial Call



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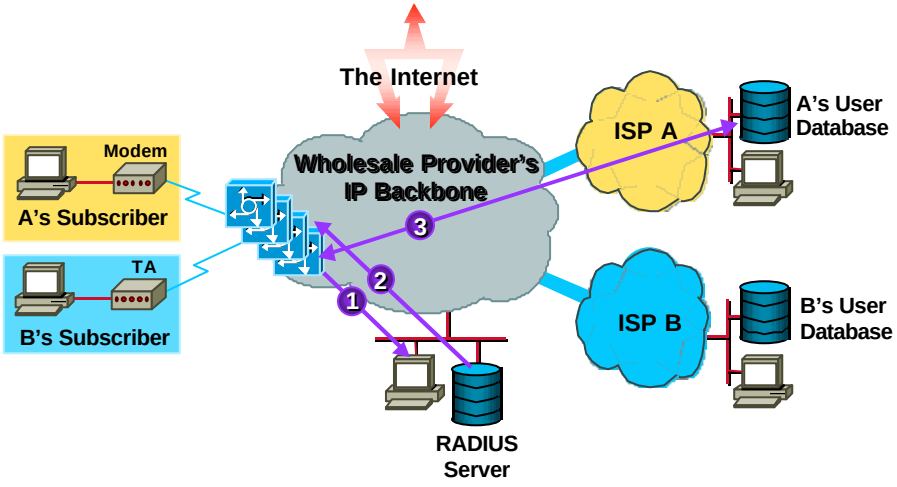
RADIUS-Only Wholesale Dial



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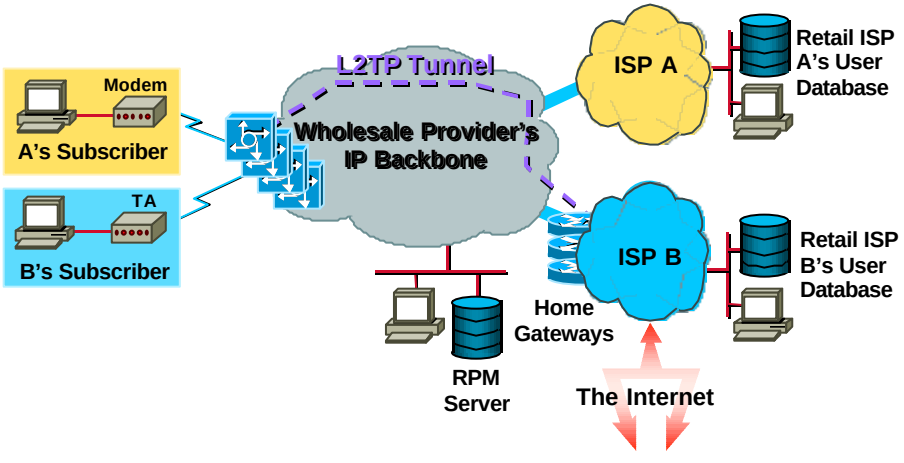
Wholesale Dial with Tunnels



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Design Considerations

- SS7 integration
- Port policy management
- IP addressing and routing
- RADIUS integration

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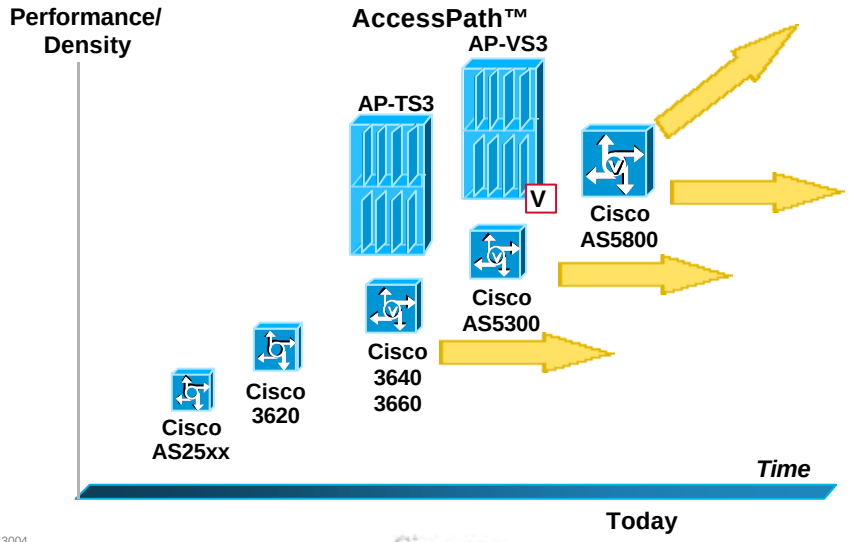
Dial Access Server Products



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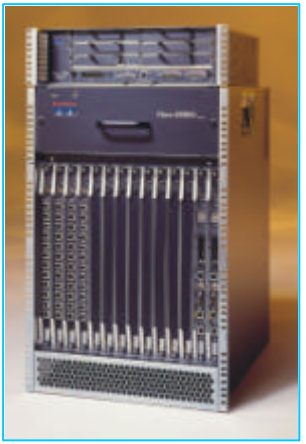
AS5800 Platform Description

- Carrier-class remote access concentrator
  - Hot swap on all cards
  - Redundant power, modems, line cards, controllers
  - Up to 1440 calls (up to 48 T1/E1 ports or 2xCT3)
- Power and flexibility is key to services
  - High performance for multimedia/voice applications
  - QoS features: NetFlow, RSVP, IP precedence, WFQ
  - Dial VPN features: L2F, L2TP, IPSec, GRE, tag
  - Universal backhaul: FE, Serial, HSSI, ATM
  - SS7 integration for large scale
- Integrates with existing access servers
  - Cisco IOS stacking software enables true scalability and investment protection
  - Cisco stacking technology: MMP, SGBP, L2F
  - Same user interface and management as AS5200/AS5300



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Dial Shelf

- 14 slots with hot-swap on all cards
- Front-to-back airflow
- Redundant fan modules
- Load balancing, redundant DC or AC power supplies

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Router Shelf

- Router shelf is a Cisco 7206 (VXR)
- Performs packet forwarding and routing functions
- Houses backhaul port adapters
- Houses service adapters
- Hot swap on all PAs and SAs

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AccessPath-VS3 and -TS3 System Overview

- **Completely integrated solution**
  - Dial, switching, backhaul routing, system controller
  - Configurator—quick deployment, user-friendly configuration
- **Scalability**
  - CT1/PRI data port capacity: 192 to 4032 (6*T3)
  - CE1/PRI data port capacity: 240 to 5040
  - CT1/PRI VoIP port capacity: 96 to 1008
  - CE1/PRI VoIP port capacity: 120 to 1260
  - Integrated gatekeeper (optional)
- **High availability**
  - Feature shelves: hot swap and RPS
  - Gatekeepers: HSRP
  - DASA: no single point of failure
- **NEBS compliant**

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Cisco AS5300

- Dial/voice access server
- Data 196/240 ports (T1/E1)
- Voice 48/60 ports (T1/E1)
- Cisco IOS software
- Two RU height
- Redundant power
- NEBS/ETSI compliant

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Cisco 3600 Series

- RISC-based architecture
- 50–70-kpps fast switching
- 3–4-kpps process switching
- Four network module slots
- Up to 128-MB DRAM

Versatility
Integration
Performance

- RISC-based architecture
- 20–40-kpps fast switching
- 1.5–2.0-kpps process switching
- Two network module slots
- Up to 64-MB DRAM

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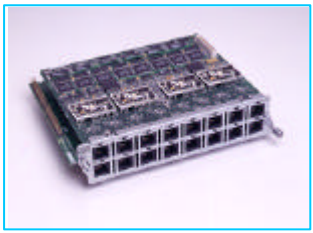
Cisco 3600/2600 Analog Dial Interfaces

- 8 or 16 V.34 analog modems; up to 48 modems in a Cisco 3640
- Up to 16 modems in a Cisco 2600
- Integrated dial-and-routing solution for small and medium businesses, workgroups, and small ISPs

Cisco 3600/2600 Series



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SS7/C7 for Dial Access

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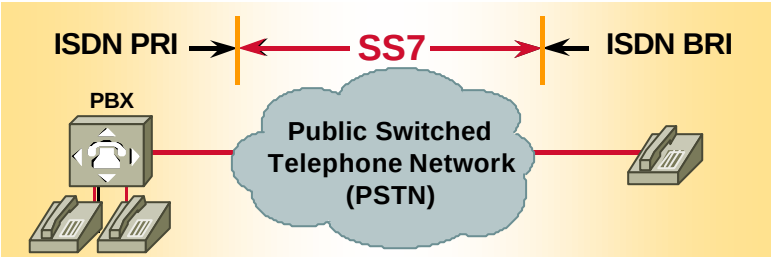
What Is SS7/C7?



- Chosen PSTN signaling protocol—used worldwide
- Provides look ahead and circuit reservation
- Sets up calls and tracks call status
- Accesses databases (800, local number portability) and intelligent network services (e.g. voice VPN)
- Highly scalable—designed for telephony scale

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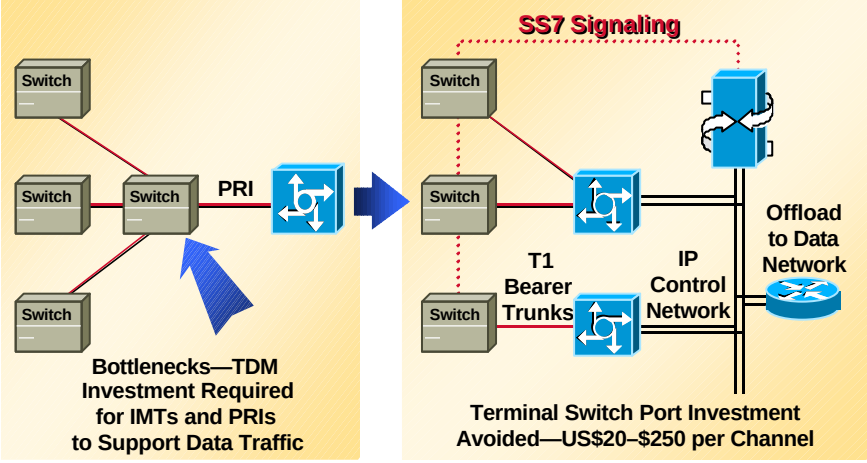
Cisco SC2200 Reduces Telco Switch Congestion



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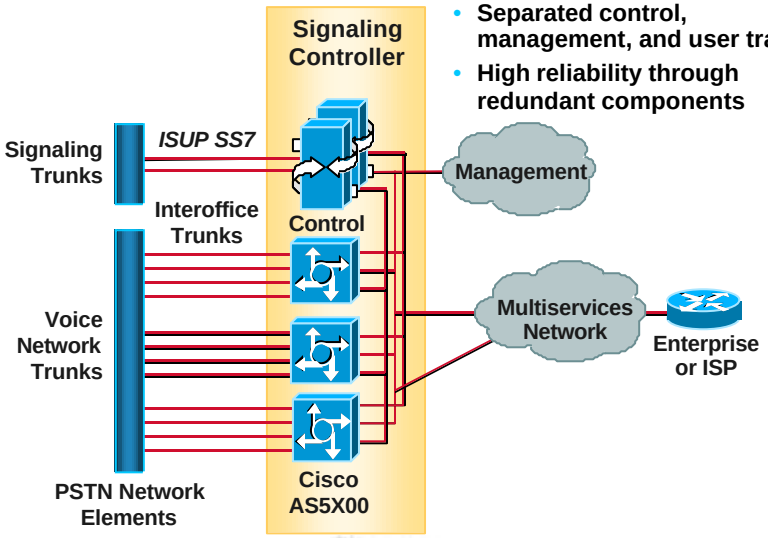
Cisco SC2200 Signaling Controller Architecture

- Separated control, management, and user traffic
- High reliability through redundant components



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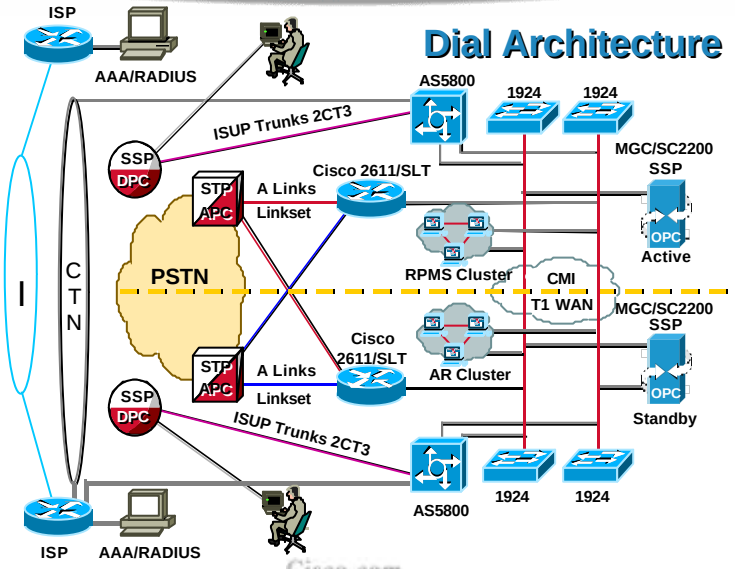
Detailed SS7 Architecture



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SC2200 Benefits the ISP

- "Reciprocal compensation" available in some countries
- ISPs getting much better PSTN charges with SS7 (10–75% lower)
  - Carriers benefit because they relieve congestion and free up PRIs
  - Regulations may dictate lower SS7 interconnect rates
- Potential for fewer busy signals

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Resource Pooling Capabilities

- Call filtering (before call is answered)

- Port availability guarantees

- Data over Speech Bearer Service (DOSBS)

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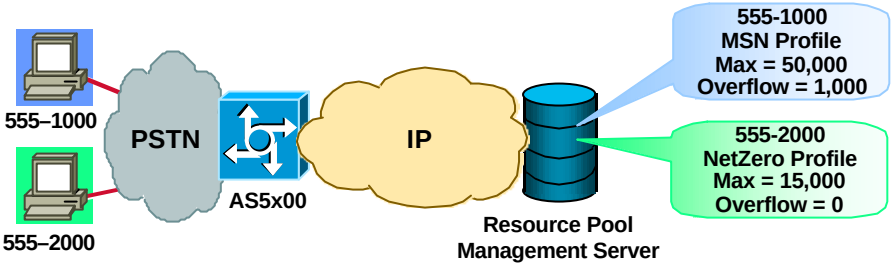
Cisco Resource Pool Management



- Port policy management for wholesale dial providers
- Enables service level agreements
  - Maximum number of active ports
  - Overflow capacity
  - Call detail records with overflow flagging
  - Flexible Web-based reporting for retail ISPs

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Fault Tolerance and Resiliency

- No RPMS, no calls answered
- Database replication
  - Synchronizes back-end database records
- Multiple RPMS servers (primary/secondary)
  - Distributed Session Management Protocol
  - Synchronizes state of primary and secondary RPM servers
- Call context reconstruction
  - NAS retains enough information to reconstruct correct counters on secondary after failure

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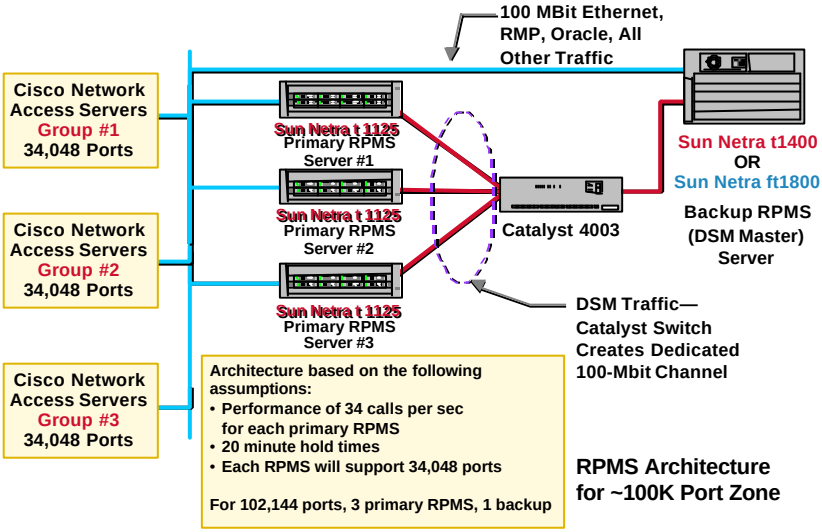
Detailed RPMS Redundancy Architecture



RPMS Architecture for ~100K Port Zone

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How Dial IP Routing Works in Cisco IOS

- PPP assigns IP address to end user
  - Part of IPCP negotiation
- Host route on NAS for every dial user
  - Relatively large number of /32 routes
  - Frequent NAS route table changes
- IP addresses assignment alternatives:
  - Server-defined IP address pool
  - RADIUS-defined IP address pool
  - Per user according to AAA profile

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Dial IP Routing Guidelines

- Summarize and advertise routing prefix to backbone
  - Minimize backbone route recalculations
- Use classless routing protocol
  - For example: OSPF, EIGRP, IS-IS
  - Minimizes advertised routing prefixes
- Don't propagate /32s to backbone unless *absolutely necessary*

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Wholesale Dial IP Addressing and Routing

- Wholesale dial provider owns address space
  - Follow dial IP routing guidelines
- Retail ISPs provide address space
  - Use L2TP tunneling
- Mostly own, some retail ISP-provided
  - Address pools (with care), L2TP

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Retailer-Provided IP Address Space

- Must aggregate addresses into larger blocks for routing sanity
- Don't know where users are going to "land" on the network
- Can't aggregate with per-user IP addressing
- Use L2TP to tunnel users to retailers network

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Stopping E-Mail Spammers

- ACL configured on the access server blocks non-local SMTP

```
ip access-list extended NoSPAM
   permit tcp any 192.168.55.0 0.0.0.255 eq smtp
   deny   tcp any any eq smtp log
   permit ip any any
```

- Enabled in the RADIUS "user" file

```
spamford Password = ”wallace"
        Service-Type = Framed,
        Filter-Id = "NoSPAM.in",
        Framed-Protocol = PPP,
        Framed-MTU = 1500
```


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Disconnect Problem Users with "Packet of Death"

- Enables remote disconnect of problem users
- Send NAS a RADIUS packet on port 1700
- Uses IDs from RADIUS accounting file

```
Sun Apr 11 11:53:39 1999
        NAS-IP-Address = 10.65.106.167
        NAS-Port = 49
        ...
        Acct-Session-Id = "1010013BE"
        Framed-Protocol = PPP
        POD-Session-Key = "DD62C63D"
        Acct-Delay-Time = 0
```

Accounting session ID

Packet Of Death key ID

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"Packet of Death" (Cont.)

- Enable on NAS with command

  aaa pod server key *<key>*

- RADIUS packet must contain:

  User ID

  POD key

  MD5 hash (computed using RADIUS shared secret key)

- Optionally contains

  Accounting session ID

  IP address

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Denial of Service Prevention: Stopping IP Address Spoofing

- Problem:

  Hackers launching attacks forge source IP

  Smurf attack can use low bandwidth link

- Solution:

  Reverse path filtering (part of CEF)

  Drops packets with forged IP source addresses

  CEF on AS5800/5300 in IOS 12.0T

```
*Nov  4 111043.439 CEF-Receive Packet for
172.21.13.110 -- receive
*Nov  4 111043.439 CEF-Drop Packet from 10.1.1.10 via
Serial1/1/023 -- unicast rpf check
*Nov  4 111045.423 CEF-Receive Packet for
172.21.13.110 -- receive
*Nov  4 111045.423 CEF-Drop Packet from 10.1.1.10 via
Serial1/1/023 -- unicast rpf check
```


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RADIUS Authentication and Accounting

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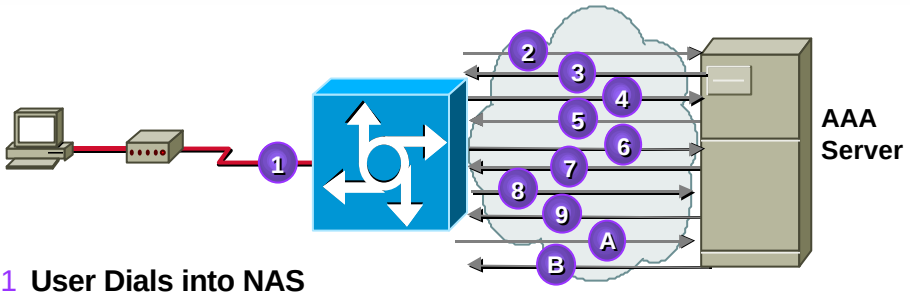
NAS and RADIUS Interaction



1 User Dials into NAS
2 Pre-Authentication Request
3 Pre-Authentication Accept
4 Authentication Request
5 Authentication Accept
6 Accounting Request (START)
7 Accounting Request Accept
8 Accounting Request (INTERMEDIATE)
9 Accounting Request Accept
A Accounting Request (STOP)
B Accounting Request Accept

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RADIUS Requests in Wholesale Dial

- **Pre-authentication**

  Wholesaler decides whether to take call

- **Authentication**

  Retailer decides whether to accept user

- **Accounting**

  Start, intermediate, stop accounting

  For both retailer and wholesaler

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Preauthentication

- **Introduced in Cisco IOS 11.3(10)AA, finalized in Cisco IOS 12.0(7)T**
- **Authenticates calls using DNIS**

```
aaa preauth
   dnis password Cisco-DNIS
```

```
1015551234 Password = "Cisco-DNIS", Service-Type = Outbound
        Service-Type = Outbound, Class = "ISP01",
        Cisco:Ascend-Require-Auth=Require-Auth
```


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Preauthentication RADIUS Packet Trace

```
15:32:05.644549 nas07.radius > tusk.radius: Access-Request ID: 102 PLen: 117
    NAS-IP-Address [4]              Len:6     10.65.106.167
    NAS-Port [5]                    Len:6     54
    VSA:Cisco:Cisco-NAS-Port [26,9,2]         Len:19/13 "Serial1:22*"
    NAS-Port-Type [61]              Len:6     ISDN-Sync [2]
    User-Name [1]                   Len:12    "1016719406"
    Called-Station-Id [30]          Len:12    "1016719406"
    Calling-Station-Id [31]         Len:12    "1017770875"
    User-Password [2]               Len:18    73 34 c0 ec 57 62 0a 70 96 2f 21 c4 64 c5 f8 45
    Service-Type [6]                Len:6     Outbound [5]
    Acct-Session-Id[44]             Len:10    "0A001782"

  15:32:05.690623 tusk.radius > nas07.radius:  Access-Accept  ID: 102 PLen: 33
    Class [25]                      Len:7     "ISP01"
    Service-Type [6]                Len:6     Outbound [5]
```


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Multivendor RADIUS Support

- Critical to integrate with retailers with existing dial ports
- Configuration

  radius-server host non-standard

  radius-server vsa send

  radius-server attribute nas-port format c

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Wholesale/Retail Correlated Accounting Records

- **Logging the IP address in the accounting START record**

  aaa accounting delay-start

- **Consistent port reporting across pre-authentication and accounting records**

  radius-server attribute nas-port format c

  radius-server attribute 44 on-for-access-req

```
 1             0
5 4 3 2 1 0 9 8 7 6 5 4 3 2 1 0
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
F F S S S S L L L L L C C C C C
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+

FF    = shelf (0-3)
SSSS  = slot (0-15)
LLLLL = line (0-31)   <-- the DS1#, even within a CT3
CCCCC = channel (0-31)
```


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Troubleshooting Essentials

- Four commands to run on any dial access server:

```
no logging console
service timestamps debug datetime msec
service timestamps log datetime msec
modem call-record terse
```

- Ensures debugging is nonservice affecting
- Enhances value of debug information
- Allows establishment of call failure patterns (Cisco IOS 11.3AA and 12.0T only)

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Conditional Debug

- *Essential* for larger access servers
- Allows debug to be turned on and off based upon:
  - Username
  - Calling number/called number
  - Interface

```
debug condition {username username | called
                                  dial-string | caller dial-string}
debug condition interface "interface"
```


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Debugs Affected by Conditions

debug aaa {accounting | authorization | authentication}

debug dialer {events | packets}

debug isdn {q921 | q931}

debug modem {oob | trace}

debug ppp {all | authentication | chap | error | negotiation | multilink events | packet}

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Active User Information

Show caller ({ interface *name* [full] | username *name* [detailed] | line *range* [full] | ip })

```
5300# show caller username mary
User: mary, line Vi1, service PPP Bundle, active 00:00:18
  PPP: LCP Open, multilink Open, IPCP
  Dialer: Connected 00:00:25 to 60222, inbound
        Idle timer 120 secs, idle 19 secs
        Type is IN-BAND SYNC, group Dialer0
  IP: Local 1.0.0.3/8, remote 10.1.1.1
  Bundle: First link of mary, 1 link, last input 00:00:19
  Counts: 3 packets input, 36 bytes, 0 no buffer
        0 input errors, 0 CRC, 0 frame, 0 overrun
        3 packets output, 36 bytes, 0 underruns
        0 output errors, 0 collisions, 0 interface resets
```


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Modem Troubleshooting

- Factor out Layer 3/PPP issues
- Verify connectivity from Layer 1 upwards

  Check the T1/E1 before assuming modem problems
- Fix individual client modem problems through upgrades

  http://www.56k.com/

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SS7 SLT Troubleshooting

debug ip udp	Verify connectivity with SC2200
debug ss7 mtp2 backhaul 0	Verify interactions between SLT and SC2200
debug ss7 mtp2 iac 0	Verify alignment *during SS7 link bringup*

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SS7 SLT Point-Code Debugging

```
slt-pop1# debug ss7 mtp2 pac 0
    *Mar 6 18:37:50.650: ---- Incoming Rudp msg (35 bytes) ----
    SM_msg_type 0x00008000
    protocol_type 0x0001
    msg_ID 0x0000
    msg_type 0x0010
    channel_ID 0x0000
    bearer_ID 0x0000
    length 0x0013
    data 0xB2020202 0x01010100 0x11905472 0x616E7350
    0x61746800
```

Originating Point Code 2.2.2

Destination Point Code 1.1.1

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Verifying NAS↔SC2200 Connectivity

```
nas1-5300# deb rlm group 0

RLM Group debugging is on

nas1-5300 #
Feb 17 15:11:51.093: rlm 0: [State_Down, rx OPEN_WAIT_TIMEOUT
Feb 17 15:11:51.093: rlm 0: link [16.1.1.1(Ethernet0), 16.1.1.20] tx
ECHO_REQ(tid=6254)
Feb 17 15:12:06.093: rlm 0: link [16.1.1.1(Ethernet0), 16.1.1.20] tx
ECHO_REQ(tid=6259)
Feb 17 15:12:06.093: rlm 0: link [16.1.1.1(Ethernet0), 16.1.1.20] rx
ECHO_ACK(tid=6259)
Feb 17 15:12:06.093: rlm 0: [State_Down, rx LINK_OPENED] over link
[16.1.1.1(Ethernet0),16.1.1.20]
Feb 17 15:12:07.093: rlm 0: link [16.1.1.1(Ethernet0), 16.1.1.20] tx
ECHO_REQ(tid=6260)
Feb 17 15:12:07.093: rlm 0: link [16.1.1.1(Ethernet0), 16.1.1.20] rx
ECHO_ACK(tid=6260)
```


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Verifying SS7 Connectivity (Cont.)

```
Feb 17 15:12:09.093: rlm 0: link [16.1.1.1(Ethernet0), 16.1.1.20] tx
START_REQ(tid=0)
Feb 17 15:12:09.093: rlm 0: link [16.1.1.1(Ethernet0), 16.1.1.20]
requests activation
Feb 17 15:12:09.093: rlm 0: link [16.1.1.1(Ethernet0), 16.1.1.20] tx
ECHO_REQ(tid=6262)
Feb 17 15:12:09.093: rlm 0: link [16.1.1.1(Ethernet0), 16.1.1.20] rx
START_ACK(tid=0)
Feb 17 15:12:09.093: rlm 0: [State_Down, rx START_ACK] over link
[16.1.1.1(Ethernet0),16.1.1.20]
Feb 17 15:12:09.093: rlm 0: link [16.1.1.1(Ethernet0), 16.1.1.20] is
activated
Feb 17 15:12:09.097: rlm 0: link [16.1.1.1(Ethernet0), 16.1.1.20] rx
ECHO_ACK(tid=6262)
Feb 17 15:12:09.097: %ISDN-6-LAYER2UP: Layer 2 for Interface
Se0:23 SC, TEI 0 changed to up
```


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Performance Optimization for Dial Access Servers

- For best performance
  - Don't log to console
  - At least 10 AAA processes on AS5800
  - Enable CEF (FIB) switching
  - Use virtual profile precloning
  - Switch off VJ header compression
  - Always use conditional debug
  - Minimize dynamic routing
  - Minimize use of ACLs

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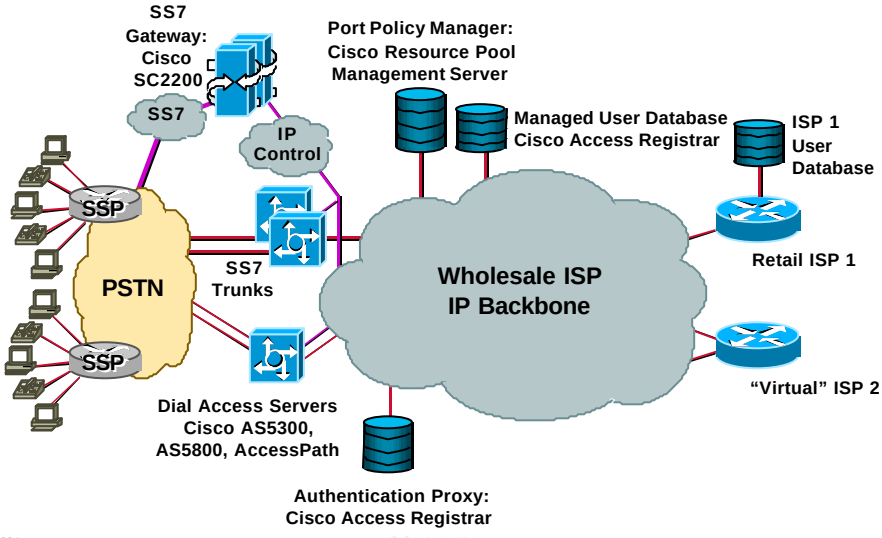
Summary



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Summary

- **SS7 integration**
  - Reduce costs, improve scale
- **Port policy management**
  - Guarantee port availability
- **IP addressing and routing**
  - Minimize operational complexity
- **Prevent denial of service and spam**
  - Maximize service availability
- **RADIUS integration**
  - Key for network extension

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Contacts

- **http://www.cisco.com/**

  Everything that's official

- **Cisco-NAS@datasys.net**

  Not an official Cisco mailing list, but many technical Cisco staff read and respond daily

- **comp.dcom.sys.cisco**

  The oldest and still the most active list

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Design Principles for Very Large Wholesale Dial Services

Session 3004

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