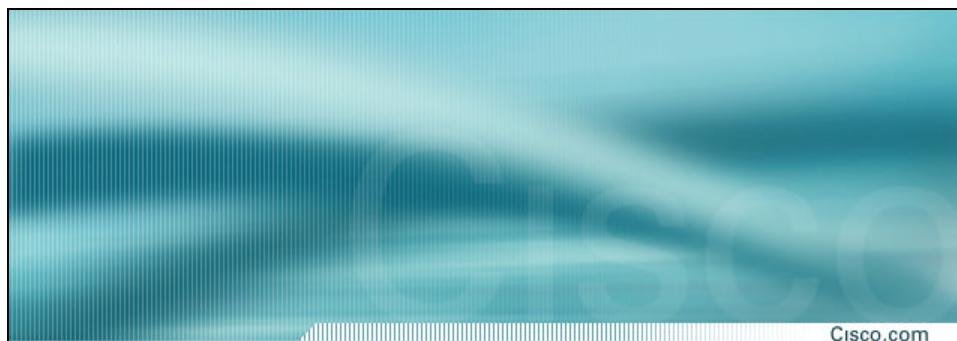# NETWORKERS 2003
THE POWER TO TRANSFORM BUSINESS. now.

CISCO SYSTEMS

Advanced Dial Plan Design for IP Telephony Networks

Session VVT-4010

2

Q³: Quick Quiz Question

- **Please try to answer for yourself the following question**

- **We will immediately give you the answer**

- **And the rest of the presentation contains the information to back up our answer!**

Q³: Quick Quiz Question

- **Let us consider phones A and B; both phones are registered in the same cluster; phone A is configured with extension 1000**
- **Phone B is configured with extension 2000**
- **[Q] Indicate which of the choices below is necessary and sufficient to allow phone A to be able to call phone B AND phone B to be able to call phone A**
    - A. **Both phones are in the same partition**
    - B. **Both phones are assigned the same calling search space**
    - C. **Both (A) and (B)**
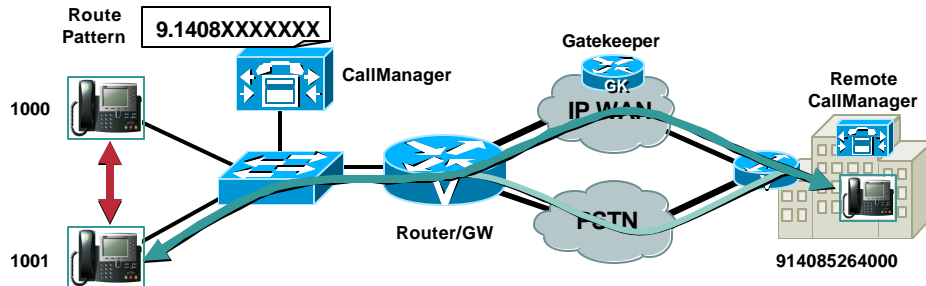   - D. **None of the above**

Dial Plan—
The "IP Routing" of IP Telephony

Route Pattern `9.1408XXXXXXX`

CallManager

Gatekeeper

GK

IP WAN

Remote CallManager

1000

Router/GW

PSTN

1001

914085264000

CallManager Routes Two Basic Call Types:

On-Cluster Calls: Destination Directory Number (DN) is Registered with CallManager

Off-Cluster Calls: External Route Patterns Must Be Configured on CallManager

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Session Scope and Objectives

- **Learn how to build an enterprise IP telephony dial plan**

- **Design based on CallManager 3.2 or higher**

- **Aspects we will cover:**

  Dial plan operation

  Design best practices

  Caveats and recommendations

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Agenda

- **IP Telephony Deployment Models**

- **Cisco CallManager Dial Plan Toolkit**

- **Dial Plan Design Guidelines**

- **Conclusions**

IP Telephony Deployment Models
Single Site

- **Cisco CallManager, Applications and DSP Resources at same physical location**

- **Supports up to 30,000 IP phones per cluster**

- **Multiple clusters can be interconnected via Inter-Cluster trunks**

- **PSTN used for all external calls**

Applications (VMail, IVR, ICD,...)

CallManager Cluster

PSTN

IP Telephony Deployment Models
Distributed Call Processing

Applications (VMail, IVR, ICD,…)

CallManager Cluster

CallManager Cluster

Applications

PSTN

Branch A

Headquarters

IP WAN

GK

Gatekeeper

CallManager Cluster
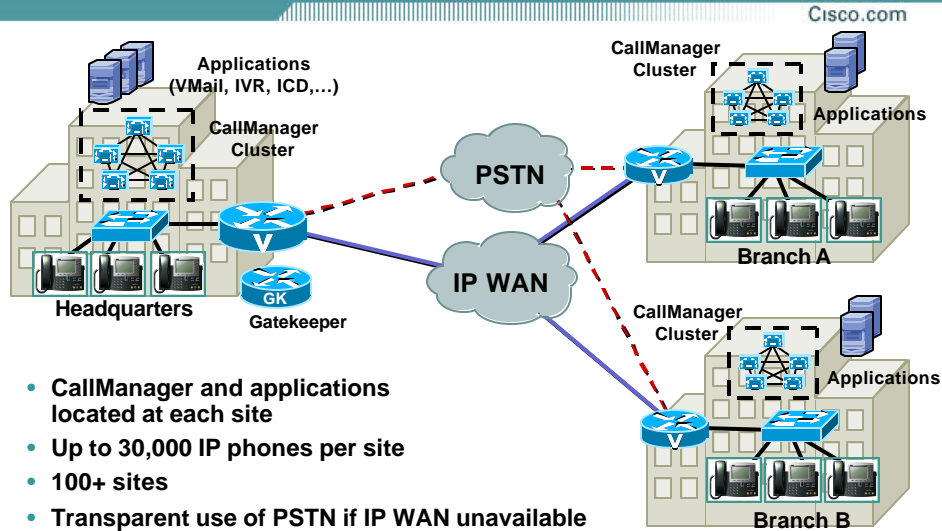
Applications

- CallManager and applications located at each site
- Up to 30,000 IP phones per site
- 100+ sites
- Transparent use of PSTN if IP WAN unavailable

Branch B

IP Telephony Deployment Models
Centralized Call Processing

Applications (VMail, IVR, ICD, ...)

PSTN

SRST-Enabled Router

CallManager Cluster

Branch A

IP WAN

Headquarters
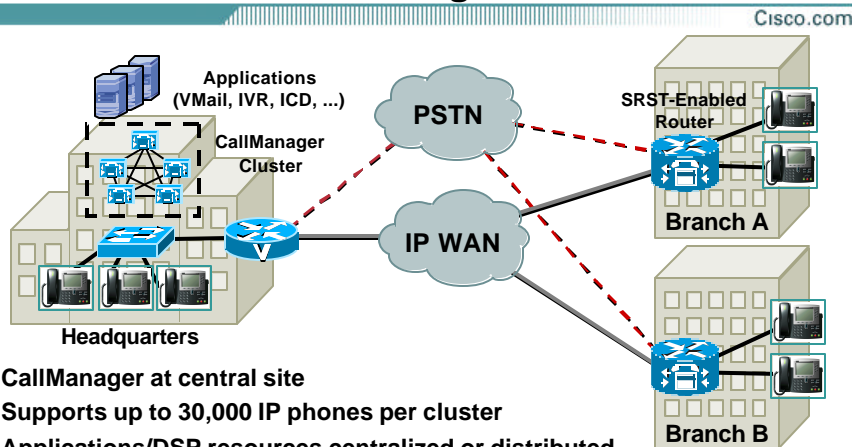
Branch B

- CallManager at central site
- Supports up to 30,000 IP phones per cluster
- Applications/DSP resources centralized or distributed
- Survivable Remote Site Telephony for remote branches
- PSTN access at each remote branch and/or central site
- Transparent use of PSTN if IP WAN unavailable (CCM 3.3)

Agenda

- IP Telephony Deployment Models

- **Cisco CallManager Dial Plan Toolkit**
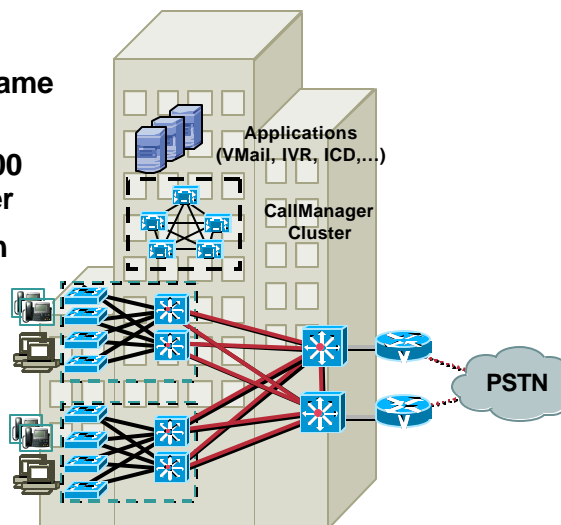
- Dial Plan Design Guidelines

- Conclusions

CallManager Dial Plan Toolkit

- **External route configuration**
  - **Route patterns**
  - **Route lists**
  - **Route groups**
  - **Route group devices**
- **Routing by user class or location**
- **Advanced tools**

External Route Elements in CallManager

Route Pattern
- Matches dialed number for external calls
- Performs digit manipulation (optional)
- Points to a route list for routing

Route Pattern

Route List
- Chooses path for call routing
- Points to prioritized route groups

Route List

1st Choice

Route Group

2nd Choice

Route Group

Route Group
- Performs digit manipulation
- Points to the actual devices

1st Choice

2nd Choice

Devices
- Gateways (H.323, MGCP)
- Gatekeeper
- Inter-cluster trunk (remote CM)

GK

IP WAN

PSTN

Configuration Order

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External Route Example: PHL to SJ

User Calls "526-4000"

Philadelphia

Route Pattern "52.XXXXX"

1 Route Pattern Match
No Digit Manipulation

Route List "SJ"

2 Select Route Group
Based on Priority

3a Discard Access Code "52"
Point to Remote CM via
Inter-Cluster Trunk + GK

1st Choice

Route Group "SJ-IPWAN"

2nd Choice

Route Group "PHL-PSTN"

3b Prepend "1408"
Point to Local
PSTN Gateway

4a "64000" Sent over
IP WAN
to SJ CallManager

IP WAN

GK

PSTN

4b 1 (408) 526-4000
Sent over PSTN
to San Jose

(408) 526-4000 x64000

San Jose

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Route Patterns

User Calls
"526-4000"

Philadelphia

Route Pattern
"52.XXXXX"

1 Route Pattern Match
No Digit Manipulation

Route List
"SJ"

1st Choice

2nd Choice

Route Group
"SJ-IPWAN"

Route Group
"PHL-PSTN"

IP WAN

GK

PSTN

(408) 526-4000
x64000

San Jose

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Route Patterns
Configuration

System Route Plan Service Feature Device User Application Help Logout

Cisco CallManager Administration
For Cisco IP Telephony Solutions

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Route Pattern Configuration

Add a New Route Pattern
Back to Find/List Route Patterns

Route Pattern: New

Status: Ready
Note: Any update to this route pattern automatically resets the associated gateway/route list

Insert

Pattern Definition

Route Pattern*	52.XXXXX
Partition	IPWAN
Description	San Jose off-net
Numbering Plan*	North American Numbering Plan
Route Filter	< None >
Gateway/Route List*	SJ
Route Option	⊙ Route this pattern ○ Block this pattern
☑ Provide Outside Dial Tone	☐ Urgent Priority

Calling Party Transformations

☐ Use Calling Party's External Phone Number Mask

Calling Party Transform Mask	
Prefix Digits (Outgoing Calls)	
Calling Party Presentation	Default

Called Party Transformations

Discard Digits	< None >

Route Pattern
Digits Left of "." Are
the Access Code

Partition
Determines WHO
Can Reach 52.XXXXX

Route List
Defines HOW
to Reach 52.XXXXX

Digit Manipulation
Not Recommended
in Route Pattern

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Route Patterns
Commonly Used Wildcards

Delimiter (Does Not Match any Digits)—Used for Discarding

Range of Digits (between 2 and 9)

Single Digit between 0 and 9, * or #

9 . [2-9] XXXXXX

One or More Occurrences of Digits between 0 and 9

The "#" Digit—Used to Avoid Inter-Digit Timeout

9.011! #

A Macro that Enters the Whole North American
Numbering Plan into CallManager
(Equivalent to 166 Individual Route Patterns)

9. @
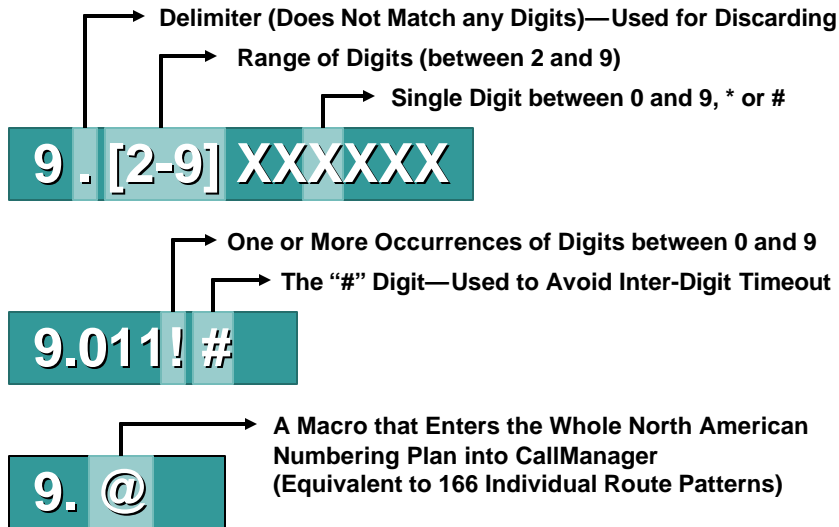
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Route Patterns
CallManager Call Routing Logic

CallManager Call Routing Logic

User Dials "1200"

User Dials "1234"

Route Patterns

1XXX

12XX

Directory Numbers

1234

1234

- **CallManager matches the most specific pattern (longest-match logic)**
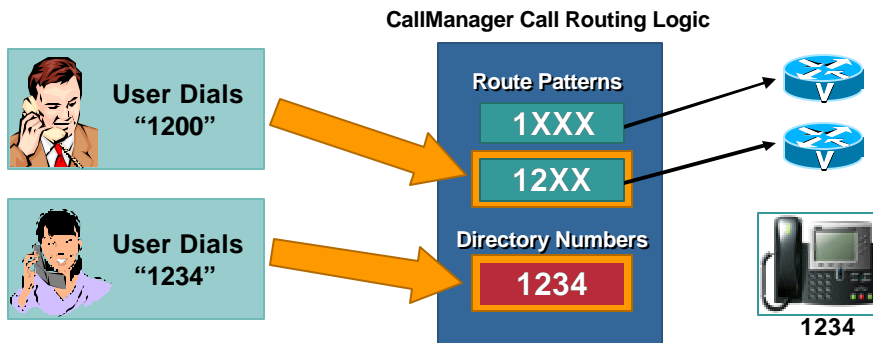- **An IP phone directory number is a special case of route pattern that matches a single number**

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Route Patterns
CallManager Call Routing Logic

Configured Route Patterns

User's Dial String:

_____

CallManager Actions:

1111
1211
1[23]XX
131
1[0-4]XX
13!

Route Patterns
CallManager Call Routing Logic

Configured Route Patterns

User's Dial String:

<Off Hook>

_____

CallManager Actions:

**Provide Dial Tone
Wait**

1111	Might Match
1211	Might Match
1[23]XX	Might Match
131	Might Match
1[0-4]XX	Might Match
13!	Might Match

```
Digit analysis: match(fqcn="9195555644", cn="15644",
    pss="PA:Line1:Cisco:Local:Long Distance:International", dd="")
Digit analysis: potentialMatches=PotentialMatchesExist
```

Route Patterns
CallManager Call Routing Logic

Configured Route Patterns

User's Dial String:

1

1111	Might Match
1211	Might Match
1[23]XX	Might Match
131	Might Match
1[0-4]XX	Might Match
13!	Might Match

CallManager Actions:

Break Dial Tone
Wait

```
Digit analysis: match(fqcn="9195555644", cn="15644",
    pss="PA:Line1:Cisco:Local:Long Distance:International", dd="1")
Digit analysis: potentialMatches=PotentialMatchesExist
```

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Route Patterns
CallManager Call Routing Logic

Configured Route Patterns

User's Dial String:

13

1111	Doesn't Match
1211	Doesn't Match
1[23]XX	Might Match
131	Might Match
1[0-4]XX	Might Match
13!	Might Match

CallManager Actions:

Wait

```
Digit analysis: match(fqcn="9195555644", cn="15644",
    pss="PA:Line1:Cisco:Local:Long Distance:International", dd="13")
Digit analysis: potentialMatches=PotentialMatchesExist
```

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Route Patterns
CallManager Call Routing Logic

Cisco.com

Configured Route Patterns

User's Dial String:

131

1111	Doesn't Match
1211	Doesn't Match
1[23]XX	Might Match
131	Match!
1[0-4]XX	Might Match
13!	Match! and Might Match

CallManager Actions:

Keep Waiting; More Digits Might Cause a Different Pattern to Match

```
Digit analysis: match(fqcn="9195555644", cn="15644",
    pss="PA:Line1:Cisco:Local:Long Distance:International", dd="131")
Digit analysis: potentialMatches=PotentialMatchesExist
```

Route Patterns
CallManager Call Routing Logic

Cisco.com

Configured Route Patterns

User's Dial String:

1311

1111	Doesn't Match
1211	Doesn't Match
1[23]XX	Match!
131	Doesn't Match
1[0-4]XX	Match!
13!	Match! and Might Match

CallManager Actions:

Keep Waiting; More Digits Might Cause a Different Pattern to Match

```
Digit analysis: match(fqcn="9195555644", cn="15644",
    pss="PA:Line1:Cisco:Local:Long Distance:International", dd="1311")
Digit analysis: potentialMatches=PotentialMatchesExist
```

Route Patterns
CallManager Call Routing Logic

Cisco.com

Configured Route Patterns

User's Dial String:

1311<timeout>

1111	Doesn't Match
1211	Doesn't Match
1[23]XX	Match!
131	Doesn't Match
1[0-4]XX	Match!
13!	Match!

CallManager Actions:

Extend Call to the Best Match

Can You Tell which Route Pattern Is the Best Match in This Case?

Hint: We Are Being Crafty to Make Sure You Remember Forever ☺

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Route Patterns
CallManager Call Routing Logic

Cisco.com

Configured Route Patterns

User's Dial String:

1311<Timeout>

1111	Doesn't Match
1211	Doesn't Match
1[23]XX	Match!
131	Doesn't Match
1[0-4]XX	Match!
13!	Match!

Matches 200 Digit Strings ←

Matches 500 Digit Strings ←

Matches ¥ Digit Strings, However for the Purposes of Closest Match Routing in this Case, this Matches 100 Digit Strings because You Only Consider the Number of Potential Strings <u>Given the Number of Digits Dialed</u>

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Route Lists

Cisco.com

User Calls "526-4000"

Philadelphia

Route Pattern "52.XXXXX"

Route List "SJ"

2 Select Route Group Based on Priority

1st Choice

2nd Choice

Route Group "SJ-IPWAN"

Route Group "PHL-PSTN"

GK

IP WAN

PSTN

(408) 526-4000 x64000

San Jose
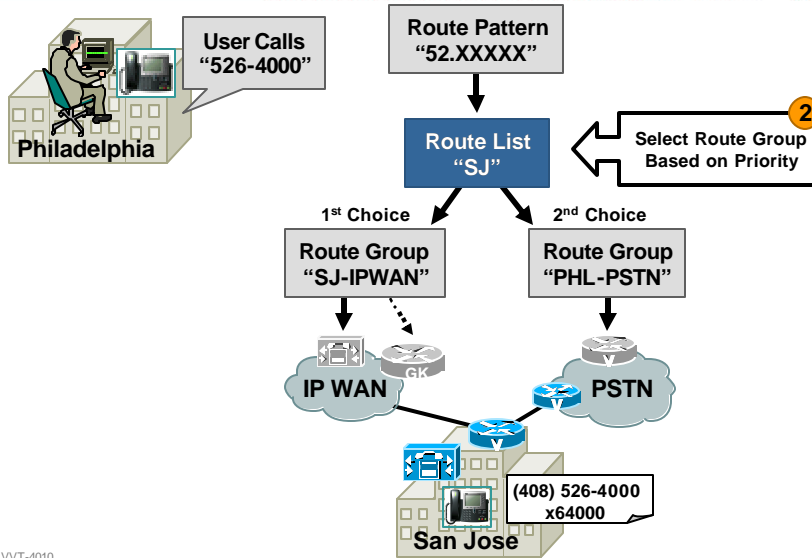
Route Lists Configuration

Cisco.com

System   Route Plan   Service   Feature   Device   User   Application   Help

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For Cisco IP Telephony Solutions

Cisco Systems

Route List Configuration

gearanto-PSTN
✕ Route Details for PHL PSTN
PHL
✕ Route Details for PHL IPWAN
✕ Route Details for PHL PSTN
PIT
✕ Route Details for PIT IPWAN
✕ Route Details for PHL PSTN
SJ
✕ Route Details for SJ IPWAN
✕ Route Details for PHL PSTN

Route List: SJ
Status: Ready

New   Update   Delete   Cancel

Route List Name*   SJ
Description

Add Route Group   Remove Route Group(s)

Route Groups selected ordered by highest priority

SJ IPWAN
PHL PSTN

- Prioritized list of Route Groups
- Route Groups used to reach destination via different paths
- Digit manipulation in Route Group based on "parent" Route List

Route Groups

Route Pattern "52.XXXXX"

User Calls "526-4000"

Philadelphia

Route List "SJ"

1st Choice

2nd Choice

Route Group "SJ-IPWAN"

Route Group "PHL-PSTN"

3b

Prepend "1408" Point to Local PSTN Gateway

IP WAN

GK

PSTN

San Jose

(408) 526-4000 x64000

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Route Groups
Viewed from within the Route List

Cisco CallManager Administration
For Cisco IP Telephony Solutions

Route Details Configuration

geteranto-PSTN
Route Details for PHL PSTN
PHL
Route Details for PHL IPWAN
Route Details for PHL PSTN
PIT
Route Details for PIT IPWAN
Route Details for PHL PSTN
SJ
Route Details for SJ IPWAN
Route Details for PHL PSTN
trusti-ibn
Route Details for MeuhViein IPWAN
Route Details for PHL PSTN

Add Route Group to

Route List: SJ
Route Group: PHL PSTN
Status: Ready

Update   Delete   Cancel

Calling Party Transformations
These settings will override that of Route Pattern Page.
Use Calling Party's External Phone Number Mask*   Default
Calling Party Transformation Mask

Called Party Transformations
These settings will override that of Route Pattern Page.
Discard Digits   < None >
Using North American Numbering Plan
Called Party Transformation Mask
Prefix Digits   1408

Note:
- **Digit manipulations in Route Group cancel and override those defined in Route Pattern**
- **Digit manipulation recommended in Route Group**

Digit Manipulation Prepend "1408"

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Route Groups
Digit Manipulation Notes

Calling Party Transformations

☑ Use Calling Party's External Phone Number Mask

Calling Party Transform Mask

Called Party Transformations

Discard Digits   PreDot 11D->10D

Called Party Transform Mask

Prefix Digits (Outgoing Calls)

If Checked, Uses CLID Configured on IP Phone

Transforms Calling Line ID (CLID)

Transforms Called Number

- **Order used to apply digit manipulations:**

    1. **Discard digits instructions**
    2. **Called party transformation mask**
    3. **Prefix digits**

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Route Groups
Standalone View

System   Route Plan   Service   Feature   Device   User   Application   Help

Cisco CallManager Administration
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Route Group Configuration

PHL IPWAN
   10.1.20.25 on all H.323 ports

PHL PSTN
   10.1.70.1 on all H.323 ports

PIT IPWAN
   10.1.50.1 on all H.323 ports

SJ IPWAN
   10.1.20.1 on all H.323 ports

ttruitt-isdn IPWAN
   10.1.30.25 on all H.323 ports

Route Group Name : SJ IPWAN
Status: Ready

[New] [Update] [Delete] [Cancel]

Route Group Name*   SJ IPWAN

[Add Device]   [Remove Device]

Devices for SJ IPWAN

Device	Port	Order
☐ 10.1.20.1	All	1

* indicates required item

Actual Device(s) Pointed by the Route Group

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Route Group Devices

User Calls "526-4000"

Philadelphia

Route Pattern "52.XXXXX"

Route List "SJ"

1st Choice

2nd Choice

Route Group "SJ-IPWAN"

Route Group "PHL-PSTN"

4a

"64000" Sent over IP WAN to SJ CallManager

GK

IP WAN

PSTN

4b

1 (408) 526-4000 Sent over PSTN to San Jose

(408) 526-4000 x64000

San Jose

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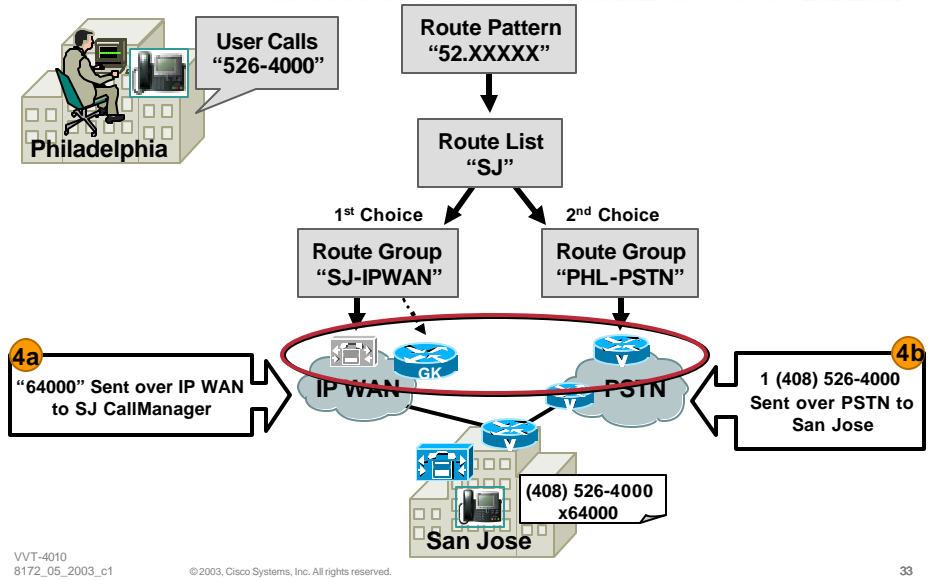
Route Group Devices
Device Types

Route Group

MGCP Gateways	H.323 Gateways (H.225)	H.323 Gateways (Inter-Cluster Trunk)	Anonymous Device/ H.323 Trunk (in 3.3)
• VG-200 • Cat 6K T1/E1 • 26xx-36xx • IAD 2400 ...	• All Cisco IOS gateways	• Other CallMgr clusters	• Cisco IOS Gatekeeper
Dial Plan Config. in CallManager	*Device Protocol = H.225* Dial Plan in Cisco IOS	*Device Protocol = Inter-Cluster Trunk*	Delegates External IP WAN Routing to the Gatekeeper

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Route Group Devices
H.323 Gateway Configuration (CallManager)

Cisco.com

Gateway Configuration

Go to your personal start page | Back to Find/List Gateway

No Port Information

H.323 Gateway: 10.1.20.1
Device Protocol: H.225
Status: Ready

[New] [Update] [Delete] [Reset Gateway] [Cancel]

Device Name*	10.1.20.1
Description	
Device Pool*	Default
Calling Search Space	Incoming_PHL_GW
Location	< None >
Caller ID DN	
Calling Party Selection*	Originator
Presentation Bit*	Allowed
Display IE Delivery	☐
Gatekeeper Name	< None >
Media Termination Point Required	☐
Num Digits*	23
Sig Digits	☐
Prefix DN	9

Device Name
IP Address of H.323 GW

Calling Search Space
Defines Where this Device May Place Inbound Calls

Is Gatekeeper Needed to Call this Device?

To Strip All But Significant Digits for Incoming Calls

To Prefix Incoming Calls

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Route Group Devices
H.323 Gateway Configuration (Cisco IOS)

Cisco.com

```
dial-peer voice 101 voip
 destination-pattern ..........
 session target ipv4:10.1.20.25
 dtmf-relay h245-alphanumeric
 codec g711ulaw
 ip qos dscp af31 signaling
 ip qos dscp ef media
!
dial-peer voice 1 pots
 destination-pattern 1..........
 port 3/1/1     (Long Distance)
 prefix 1
!
dial-peer voice 2 pots
 destination-pattern 911
 port 3/1/1     (Emergency)
 prefix 911
!
dial-peer voice 5 pots
 destination-pattern .......
 port 3/1/1  (Local 7 Digit Dialing)
!
dial-peer voice 6 pots
 destination-pattern 011T
 port 3/1/1
 prefix 011   (International Dialing)
```

CallManager

Cisco IOS-Based
H.323 Gateway

PSTN

Incoming Dial Peer(s)
Point to CallManager Cluster
(CM Redundancy Not Shown)

Outgoing Dial Peer(s)
• Must match outgoing string lengths
• May need to prefix digits for PSTN

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Route Group Devices
"Anonymous Device" Configuration (Pre-3.3)

Gatekeeper Configuration

Gatekeepers
📞 172.26.217.54

Gatekeeper: 172.26.217.54

Status: Ready

| Update | Delete | Reset Gatekeeper | Reset Gatewa~ |

| Cancel Changes |

Gatekeeper Device

Gatekeeper Name*	172.26.217.54
Description	San Jose Gatekeeper
Registration Request Time To Live	60
Registration Retry Timeout	300
Terminal type*	Gateway
Device Pool*	Default
Technology Prefix	1#
Zone	SJC1

Anonymous Calls Device

The following section only applicable when 'Allow Anonymous Calls' is se~

Allow Anonymous Calls	☑
Device Protocol	Inter-Cluster Trunk
Calling Search Space	InboundCS

The "Anonymous Device"
Is Introduced to Use the
Gatekeeper for Dial Plan
Resolution (as Well as
Call Admission Control)

Allow Anonymous Calls
Creates "Anonymous Device"

Device Protocol
In CallManager 3.2, this Is the
DEFAULT Device Protocol
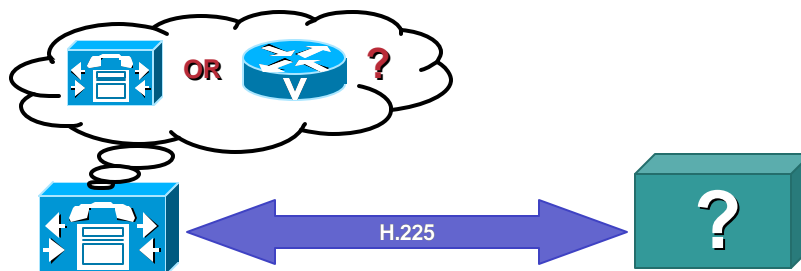
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Route Group Devices
Anonymous Device—Auto-Discovery

- **During H.225 setup, CallManager identifies itself to the remote device**
- **If the remote device identifies itself as another CallManager, supplementary services can be used**
- **Otherwise, the default Device Protocol is used**

OR ?

H.225

?

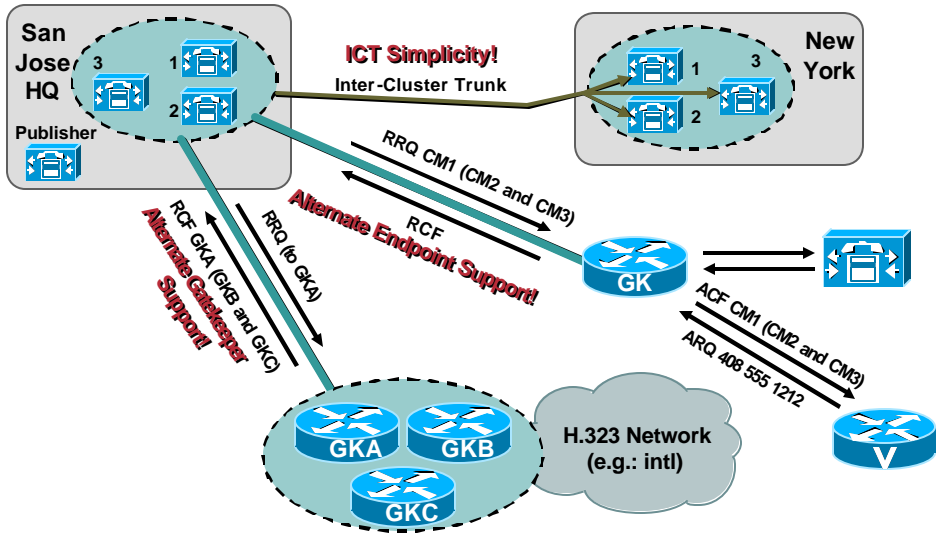**Use H.225 as Default Device Protocol if all CallManagers Are 3.2 or Later**

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Route Group Devices
H.323 Trunks (3.3)—New Simplicity and Possibilities

San Jose HQ
3 1
2
Publisher

ICT Simplicity!
Inter-Cluster Trunk

New York
1 3
2

RRQ CM1 (CM2 and CM3)

RCF GKA (GKB and GKC)
Alternate Gatekeeper Support!

RRQ (to GKA)

Alternate Endpoint Support!

RCF

GK

ACF CM1 (CM2 and CM3)

ARQ 408 555 1212

GKA GKB
GKC

**H.323 Network
(e.g.: intl)**

V

VVT-4010
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Inter-Cluster Trunks—Redundancy

San Jose HQ
Backup 1
2
Publisher
Backup 3
4

1st Inter-Cluster Trunk

2nd Inter-Cluster Trunk

New York
1 Backup
2
Publisher
3 Backup
4
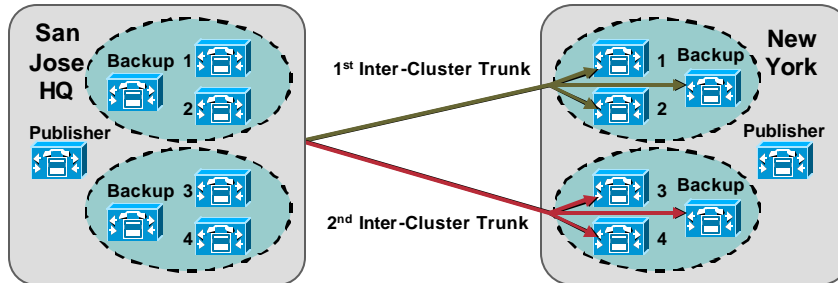
Remote Cisco CallManager Information

Server 1 IP Address/Host Name*	172.16.1.100
Server 2 IP Address/Host Name	172.16.2.100
Server 3 IP Address/Host Name	172.16.3.100

* indicates required item

Back to Find/List Trunk

**As of CallManager
3.3, Redundancy
Is Built into the
Inter-Cluster Trunk**
(2 ICTs instead of 6)

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Configuration—Inter-Cluster Trunk

- **Calls to an inter-cluster trunk without GK-control are load shared in a round robin fashion among the configured peer signaling addresses**

- **For example, the first call is routed to peer transport address 1, next call to peer transport address 2, 3rd call to transport address 3, 4th call to transport address 1, and so forth**

Alternate Endpoint Support

Cisco CallManager Administration
For Cisco IP Telephony Solutions

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Trunk Configuration

Add a New Trunk
Back to Find/List Trunk

Product: H.225 Trunk (GateKeeper Controlled)
Device Protocol: H.225
Status: Ready

| Update | Delete | Reset Trunk |

Device Information

Device Name*	EMEA_Trunk
Description	EMEA_Trunk from SF
Device Pool*	SF
Media Resource Group List	< None >
Location	< None >
AAR Group	San Francisco

☐ Media Termination Point Required

Alternate Endpoint Support
No Extra Config Needed Here; the CallManager Will Advertise All Servers in the CallManager Group of the Trunk (as Associated to the Device Pool) in the RRQ

Alternate GK Support

System Route Plan Service Feature Device User Application Help Logout

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Up to 10 Gatekeepers
Can Be Defined in
CallManager 3.3

Gatekeeper Configuration

Gatekeepers

<Add a New
Gatekeeper>

10.1.2.3

172.21.51.137

Gatekeeper: 10.1.2.3

Status :Insert completed

| Update | Delete | Reset Gatekeeper |

Gatekeeper Information

Host Name/IP Address* 10.1.2.3

Alternate GK Support
No Extra Config Needed Here;
the Alternate GK Addresses
Will Be Returned in the RCF
from this GK

Description   EMEA Gatekeeper

Registration Request   60
Time To Live

Registration Retry   300
Timeout

Enable Device   ☑

* indicates required item

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H.323 Trunk Possibilities

- **Up to 10 Gatekeepers can be defined**
- **Trunks allow multiple path into IP telephony networks: IP IXC, IP LEC, theaters, etc…**
- **When a GK-controlled trunk is configured with more than one CCM in the device pool, CCM will automatically send RRQ with alternate endpoints when backup CCM(s) come up in service**
- **If the given destination call signaling address is unreachable, all of the alternate CCMs in the device pool will be attempted before giving up**
- **No CLI configuration in Cisco IOS GK is needed**
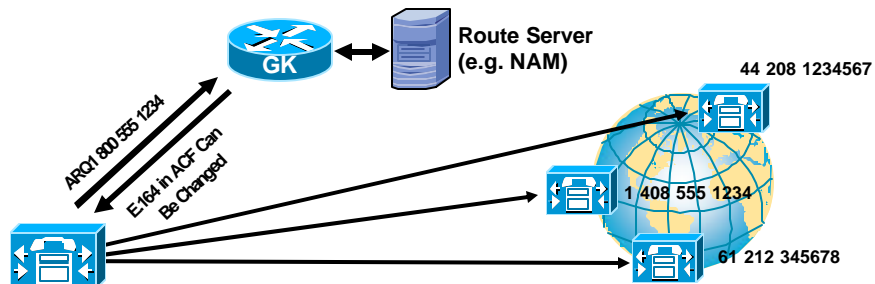- **Alternate endpoint is supported in IOS GK load 12.2T**

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H.323 Enhancements
CanMapAlias

- **Time of day routing (follow the sun)**
- **Follow me service (virtual phone number)**
- **"Number mobility" single point of administration**
- **Hotel "gold customer" 1-800-WhateverHotelRoomThisWeek**

Route Server (e.g. NAM)

GK

ARQ1 800 555 1234

E.164 in ACF Can Be Changed

44 208 1234567

1 408 555 1234

61 212 345678

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CallManager Dial Plan Tool Kit

- **External route configuration**
- **Routing by user class or location**

    Partitions

    Calling search spaces

- **Advanced tools**

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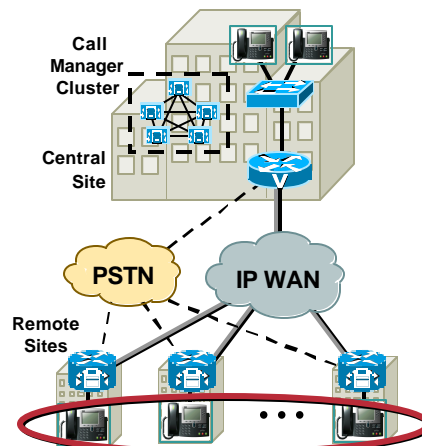46

Routing by User Class or Location

CallManager

Exec Phones

Office Phones

Lobby Phones

International Calls

Local Calls

911
Emergency Calls

Create "Classes of Service" to Define Calling Restrictions

Call Manager Cluster

Central Site

PSTN

IP WAN

Remote Sites

Instruct Remote Phones to Use Their Local Gateway for PSTN Access

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Partitions and Calling Search Spaces
Analogy with Subnets/Access Lists

Access List/ Calling Search Space
- Permit B
- Permit C
- (Implicit) Deny D

Subnet/Partition A

Subnet/Partition B

Subnet/Partition C

Subnet/Partition D
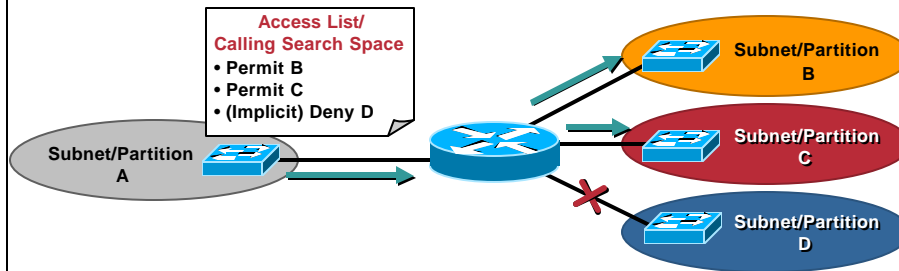
- **Partition—"where you are"**
  - Collects devices with similar "reachability" characteristics
  - Items placed in partitions: Directory Numbers (DN), route patterns, voice mail ports...

- **Calling Search Space— "where you may call"**
  - Set of rules to set call restrictions/permissions
  - Defines which partitions a device may search to reach a dialed number
  - Is assigned to IP phones, GWs

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Partitions and Calling Search Spaces

- **Partitions and Calling Search Spaces cause the majority of call routing configuration errors**

- **Understanding Partitions and Calling Search Spaces is essential to understanding call routing in CallManager**

- **Allow toll bypass from one geographical region to another**

- **Allow different outside calling privileges by class of calling user**

- **Allow multiple tenants with overlapping dial plans to be served by the same CallManager**

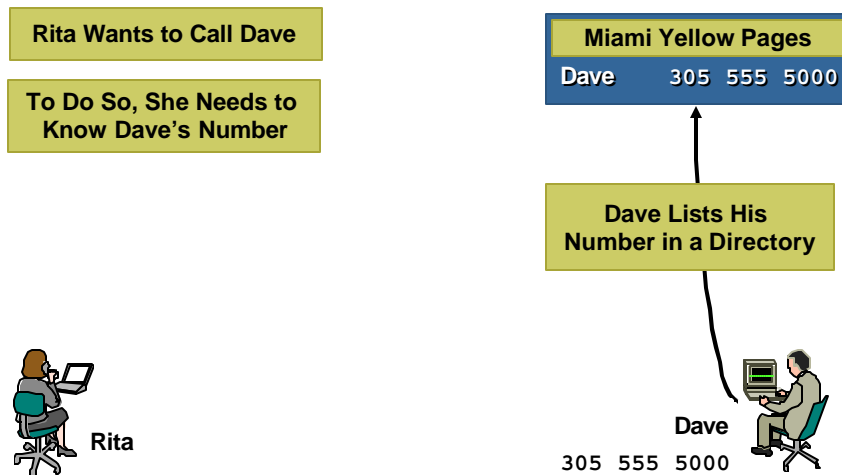# Partitions and Calling Search Spaces
Analogy

Rita Wants to Call Dave

To Do So, She Needs to Know Dave's Number

Miami Yellow Pages

Dave   305 555 5000

Dave Lists His Number in a Directory

Rita

Dave

305 555 5000

Partitions and Calling Search Spaces
Analogy

To Look up Numbers, Rita Looks through the Directories She Owns

If She Doesn't Have the Right Directory…

Miami Yellow Pages

Dave   305 555 5000

Rita's List of Directories

Dallas White Pages

Outlook Address Book

Little Black Book

…She Can't Place the Call

Rita

Dave
305 555 5000

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Partitions and Calling Search Spaces
Analogy

But if She Has the Directory Dave Has Listed His Number in…

Miami Yellow Pages

Dave   305 555 5000

Rita's List of Directories

Dallas White Pages

Miami Yellow Pages

Little Black Book

…the Call Will Go Through

Rita

Dave
305 555 5000

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Partitions and Calling Search Spaces
Analogy

Cisco.com

The Directory in which Dave's Number Is Listed Is His Number's **Partition**

Miami Yellow Pages

Dave   305 555 5000

Rita's List of Directories

Dallas White Pages

Miami Yellow Pages

Little Black Book

The List of Directories in which Rita Looks up Numbers Is Her **Calling Search Space**

Rita

Dave

305 555 5000

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Partitions and Calling Search Spaces
Definition

Cisco.com

- **Partition:** A logical grouping of patterns; all patterns in a partition are equally reachable

- **Calling search space:** An *ordered* list of partitions; digit analysis looks through the caller's list of partitions when searching for the closest match for the caller's dialed number

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Partitions and Calling Search Space Rules

- **Calling entities (phones, lines, gateways, applications) have calling search spaces**

- **Called entities (route patterns, translation patterns, directory numbers, feature codes) have partitions**

Partitions and Calling Search Space Rules

- **Digit analysis looks through every partition in a calling search space and looks for the best match**

- **The order of the partitions listed in the calling search space is used only to break ties when there are equally good matches in two different partitions**

- **Contrary to popular belief, the partition the calling party's line is in has NO effect on where you can call from that line; only the Calling Search Space for that phone/device matters**

Partitions and Calling Search Space Rules

- **If no partition is specified for a pattern, the pattern is listed in the null partition**
- **All callers look in the null partition (as well as any partitions specified in their calling search space) to resolve dialed digits**
- **The null partition is always the last partition in any Calling Search Space**
- **Closest-match routing takes precedence over the partition ordering in a Calling Search Space, so a closer match in the null partition will be used to route a call over a less-explicit match in a partition**

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Partitions and Calling Search Spaces Configuration

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Partitions and Calling Search Spaces
Impact of Partition Order

User Dials "2345"

Device

User Dials "1234"

Calling Search Space

Partition 1
1XXX
23XX

Partition 2
12XX
23XX
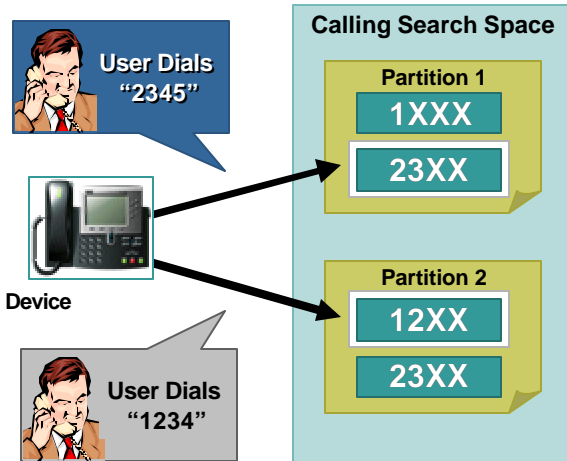
- **Most specific patterns are chosen irrespective of partition order**
- **Partition order is only used as a tie-breaker in case of equal matches**

Partitions and Calling Search Spaces
Device-Line CSS Interaction
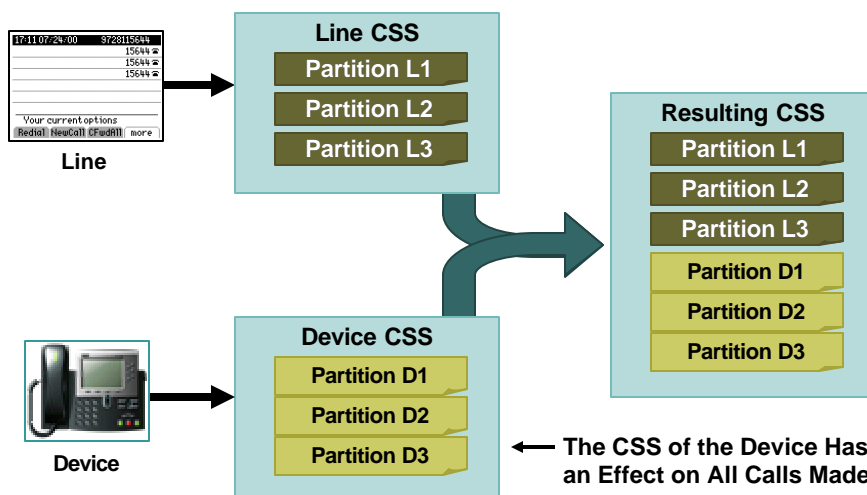
Line

Line CSS
Partition L1
Partition L2
Partition L3

Device

Device CSS
Partition D1
Partition D2
Partition D3

Resulting CSS
Partition L1
Partition L2
Partition L3
Partition D1
Partition D2
Partition D3

The CSS of the Device Has an Effect on All Calls Made from that Phone

Partitions and Calling Search Spaces
How to Build Classes of Service

Calling Search Spaces

Partitions

Calling Search Space Assigned to IP Phone Based on Policy

InternalOnly

LocalOnly

Unrestricted

Default CSS **<None>**

Internal — All IP Phones, Voice Mail, Media Resources, 911 Route Pattern

Local — Local Route Patterns

Long Distance — Long Distance Route Patterns

<None> *Default Partition*

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Partitions and Calling Search Spaces
Determine Class of Service AND Call Path (1/2)

Calling Search Spaces | **Partitions** | **Route Lists** | **Route Groups** | **Devices**

Calling Search Space Assigned to IP Phone Based on Policy

Internal Only

Local

National

International

Internal
All IP Phones
911
9.911

Local
9.[2-9]XXXXXX

National
9.1 [2-9]XX
[2-9]XX XXXX

International
9.011!
9.011!#

Route Patterns

PSTN RL

PSTN RG

SF Gateway — PSTN

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Partitions and Calling Search Spaces
Determine Class of Service AND Call Path (2/2)

Partitions and Calling Search Spaces

- **Previous slides have important implications:**

  The Calling Search Space implements a "class of service" (e.g.: Local, National, etc…).

  AND

  It ultimately chooses the path of the call, including the Gateway

- **For these reasons, if you have N branches, and X classes of service, you need (N times X) Calling Search Spaces**

- **An alternative approach is possible!**

Partitions and Calling Search Spaces
An Alternative Approach

Cisco.com

Line CSS: no_intl

Partition L1
9.1 [2-9]XX
[2-9]XX XXXX
(blocked)

Line

Blocked Pattern Is More Specific
In Case of a Tie, the Line's CSS
Comes First

Resulting CSS

Partition L1
9.1 [2-9]XX
[2-9]XX XXXX
(blocked)

Partition D1
9.1 XXX
[2-9]XX XXXX

Device CSS: SF

Partition D1
9.1 XXX
[2-9]XX XXXX

Device

The CSS of the Device Allows
All Calls, and "Points" the
Calls to the Right Path

Partitions and Calling Search Spaces
An Alternative Approach

Cisco.com

Calling Search Spaces | Partitions — Route Pattern | Route Lists | Route Groups | Devices

Device's CSS.
"All Permitting",
and Locally
Significant

CSS_NY_D

The Effective CSS for a Call Is the
Concatenation of the Line's CSS
Followed by the Device's CSS

NY911
911
9.911

911_NY RL 2nd **CAMA_NY RG**   CAMA   911 LEC

NYLocal
9.[2-9]XXXXXX

NYNational
9.1 XXX
[2-9]XX XXXX

1st

PSTN_NY RL **PSTN_NY RG**   PSTN

NY
Gateways

**All_Phones
Contains All
Phones for the
Entire Enterprise**

Line's CSS; List
of Blocked
Patterns, Globally
Significant

CSS_lcl_Only

No_National
9.1 [2-9]XX
[2-9]XX XXXX
(blocked)

Bogus   **Bogus**   Bogus
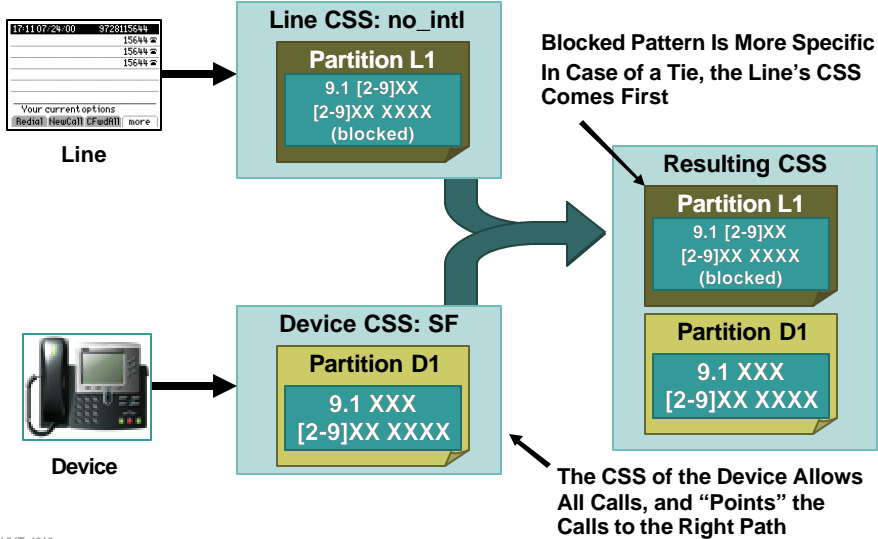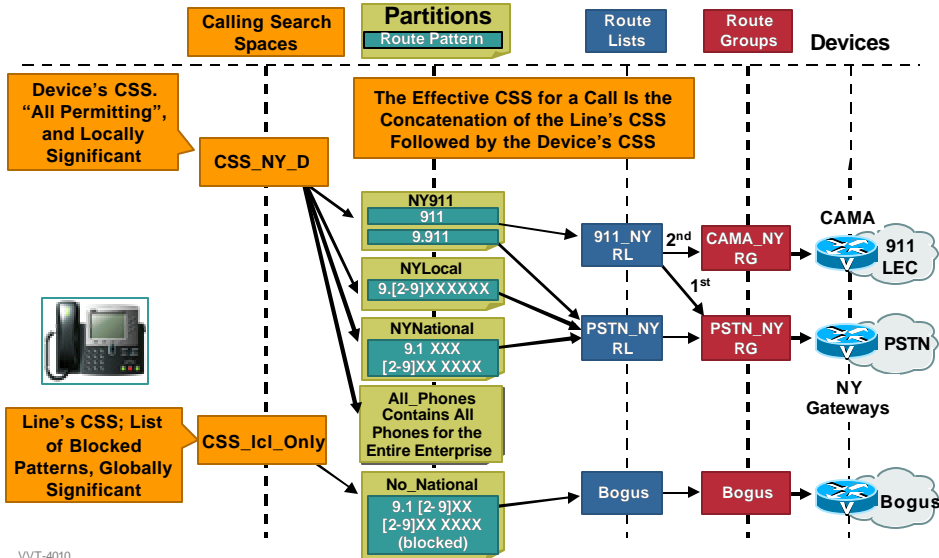
Partitions and Calling Search Spaces
An Alternative Approach (Summary)

- **Create an unrestricted calling search space for each location and assign it to the phone's device calling search space; this calling search space should contain partitions featuring route patterns that route the calls to the appropriate gateway for the phone's location (e.g.: a co-located branch GW for emergency services and local calls, etc…)**

- **Create calling search spaces containing partitions featuring blocked route patterns for those types of calls not part of the user's dialing privileges, and assign them to the user's lines; for instance, if a user has access to all types of calls except international, his line (or lines) should be configured with a calling search space featuring a blocked route pattern for international dialing. Be as specific as possible!!! Make sure that the blocked pattern is a better match.**

Partitions and Calling Search Spaces
An Alternative Approach (Summary)

- **This approaches allows the enterprise with N locations and X classes of service to implement N + X Calling Search Spaces, as opposed to N times X**

- **This approach also allows Extension Mobility to work in a centralized call processing environment**

CallManager Dial Plan Tool Kit

- **External route configuration**

- **Routing by user class or location**

- **Advanced tools**

  Translation patterns

  Route filters

  Automated alternate routing

Translation Patterns
The Basics

Calling Search Spaces   **Partitions**

Translation Pattern Transforms "0" in 2001 and Forces Second Lookup

OperatorCSS → **Translations**

0 [Transform Mask: 2001]

Dials "0" to Reach Operator

Delivers "2001"

InternalCSS → **AllPhones**

All IP Phones
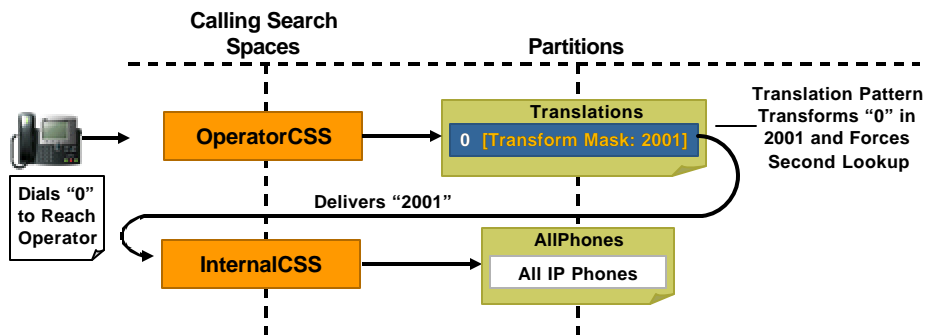
- **Looks like a Route Pattern, allows digit manipulation**

- **Instead of sending calls outside via a route list, forces second lookup in CallManager, using a (possibly different) Calling Search Space**

Translation Patterns
Configuration

Translation Pattern Configuration

1XXX,
Partition=gearanto~isdn users

Translation Pattern: 1XXX
Status: Update completed

[New] [Copy] [Update] [Delete] [Cancel]

Pattern Definition

Translation Pattern	1XXX
Partition	gearanto~isdn users
Numbering Plan*	North American Numbering Plan
Route Filter	< None >
Calling Search Space	Unrestricted
Route Option	⦿ Route this pattern ○ Block this pattern

☐ Provide Outside Dial Tone   ☐ Urgent Priority

Calling Party Transformations

☐ Use Calling Party's External Phone Number Mask

Calling Party Transform Mask

Called Party Transformations

Discard Digits	AccessCode
	< None >
Called Party Transform Mask	4XXX
Prefix Digits (Outgoing Calls)	

Partition where Translation Pattern Resides

Calling Search Space after Translation

Note:
Translation Patterns Are Routed as Urgent; as Soon as It Is the Best Match, it Routes the Call Even if There Are Other Potential Matches

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Translation Patterns
Example—Overlapping Extensions

Inter-Site Access Code = "8"

Calling Search Spaces

Partitions

Delivers 1XXX

Site1_Internal
Site 1 IP Phones

Site1_Internal

Site 1
Loc. Code 1
Ext. 1XXX

On_Cluster
81.1XXX [Discard PreDot]
82.1XXX [Discard PreDot]
83.2XXX [Discard PreDot]

Translation Patterns Force a Second Lookup Using a Different Calling Search Space

Site2_Internal

Site 2
Loc. Code 2
Ext. 1XXX

Site2_Internal
Site 2 IP Phones

Delivers 1XXX

To Site3_Internal

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Route Filters
The Basics—"9.@" Route Pattern

- **The "@" wildcard represents all the routes defined in the national numbering plan**
- **CallManager identifies <u>tags</u> in each number:**
  - INTERNATIONAL-ACCESS
  - AREA-CODE
  - OFFICE-NUMBER…
- **Route filters are logical expressions that operate on these tags**
- **Useful for blocking 900, Caribbean, international…**

Route Pattern "9.@"

North American Numbering Plan:
9.[2-9]11
9.[2-9]XX XXXX
9.1 [2-9]XX [2-9]XX XXXX
9.011 !

Route Filter "Local Only"

"INTERNATIONAL -ACCESS" DOES-NOT-EXIST
AND
"AREA-CODE" DOES-NOT-EXIST

Actual Routes in CallManager:
9.[2-9]11
9.[2-9]XX XXXX
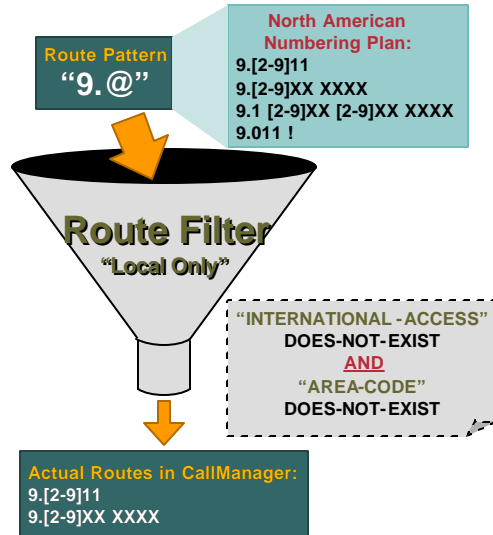
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Route Filters
Configuration

Route Filter Configuration

LIMITATION:
Entire Route Filter Can Contain up to 1024 Characters (Excludes "NOT-SELECTED" Fields)

Choose a Dial Plan* North American Numbering Plan

Route Filter Name: Domestic calls
Clause: (AREA-CODE EXISTS AND INTERNATIONAL-ACCESS DOES-NOT-EXIST)
Status: Ready

Copy | Update | Delete | Reset Devices | Cancel Changes

Route Filter Name* Domestic calls

To add a clause within this route filter, click 'Add Clause'.   Add Clause

Remove Clause

AREA-CODE	EXISTS	AND
COUNTRY-CODE	NOT-SELECTED	AND
END-OF-DIALING	NOT-SELECTED	AND
INTERNATIONAL-ACCESS	DOES-NOT-EXIST	AND
INTERNATIONAL-DIRECT-DIAL	NOT-SELECTED	AND

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AAR—Automated Alternate Routing

- **Allows for calls to DNs to be re-routed through an alternate network (e.g.: PSTN) if there is insufficient bandwidth to reach the destination**

- **Introduced in CCM 3.3**

- **Need to set "Automated Alternate Routing Enable" to True (default is False)**

AAR—Summary

AAR Will Re-Route the Call through the PSTN!

No BW Available Call Denied by CAC

Applications (VMail, IVR, ICD,...)

PSTN

CallManager Cluster

51234

51235

San Francisco

IP WAN

Central Site

55678

New York
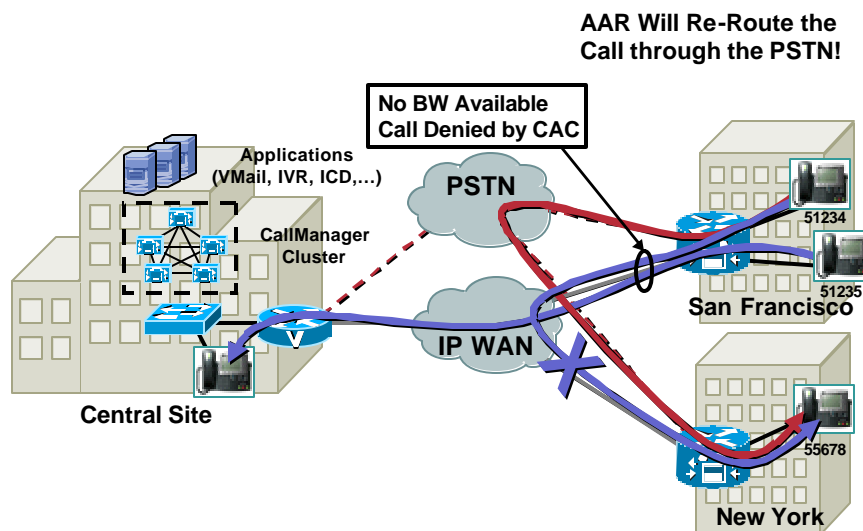
AAR—Required Information

- **51234 dials 55678, and call is denied by CAC**

- **System needs to know how to reach 55678 through the PSTN**

    What is the PSTN-dialable number for extension 55678?

    Called phone's External Phone Number Mask: 212 555 5678!

    How do I reach this number *from* San Francisco?

    Need to pre-pend 9 1;
    9 1 212 555 5678!

    What Gateway do I use from San Francisco to dial this number?

    San Francisco's local GW!

PSTN

51234

San Francisco

External Phone Number Mask: 212 55X XXXX

IP WAN

55678

New York
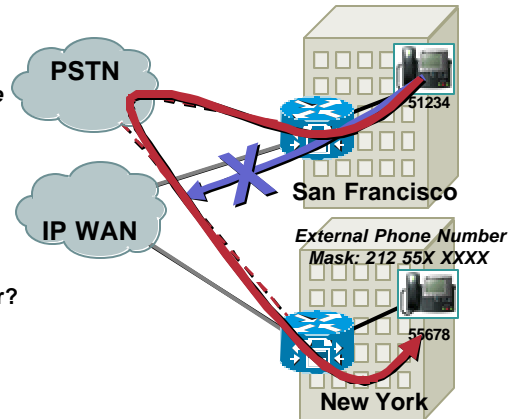
AAR—Configuration

- **AAR calls are assigned their own independent Calling Search Space; gateway selection can thus be segregated to AAR calls (i.e.: central site GW for long distance normally, but local for AAR LD calls)**

- **DNs placed in AAR groups**

- **All AAR groups form a matrix, used to determine what prefixes are required to reach destination**

AAR Group—Any to Any Prefix Rules

- **Full prefix matrix between AAR groups**
- **Can have more than one branch within a region**
  - e.g.: two branches in San Francisco
- **Use "9"only between two San Francisco branches in the same AAR group**

System Route Plan Service Feature Device User Application Help Logout

Cisco CallManager Administration
For Cisco IP Telephony Solutions

CISCO SYSTEMS

Automated Alternate Routing Group Configuration

Add a NewAAR Group
Back to Find/List AAR Groups

AAR Group: San Francisco
Status: Update completed

Update   Delete

AAR Group Name*   San Francisco

Prefix digits within San Francisco
                         Prefix Digits
San Francisco   9

Prefix digits between San Francisco and other AAR groups

	Prefix Digits (From San Francisco)	Prefix Digits (To San Francisco)
Dallas	91972	91415
New York	91212	91415
San Jose	91408	91415

First Previous Next Last   Page 1 of 1

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AAR Group Assigned to DN!

- **DNs are assigned to an AAR group**
- **But, the CSS used for AAR calls is on the device (see next slide)**

System Route Plan Service Feature Device User Application Help Logout

Cisco CallManager Administration
For Cisco IP Telephony Solutions

CISCO SYSTEMS

Directory Number Configuration   Configure Device (SEPABC123ABC123)

Devices using this Directory Number
SEPABC123ABC123 (Line 1)

Directory Number: 55678 (ALL_IPPHONES)
Status: Ready

Update   Delete   Reset Devices

Directory Number

Directory Number*   55678

Partition   ALL_IPPHONES

Directory Number Settings

Voice Mail Profile   < None >
Calling Search Space   < None >
AAR Group   San Francisco
User Hold Audio Source   < None >
Network Hold Audio Source   < None >
Call Waiting   Default
Auto Answer   Auto Answer Off

Call Forward and Pickup Settings
                    Voice

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AAR Calling Search Space Assigned to *Device*

- **Be mindful of this for Extension Mobility**
- **This is how an AAR-specific gateway can be chosen**
- **You could also, since this is a CSS, have a route list that matches the dialed number**
- **This would let you choose any combination of WAN or PSTN paths**

SystemRoute PlanServiceFeatureDeviceUserApplicationHelpLogout

Cisco CallManager Administration
For Cisco IP Telephony Solutions

CISCO SYSTEMS

Add a new phone
Add/Update Speed Dials
Subscribe/Unsubscribe Services
Back to Find/List Phones

Phone Configuration

Directory Numbers	Phone: SEPABC123ABC123 (SF reception)
Base Phone	Registration: Unknown
	IP Address:
Line 1 – 55678 in ALL_IPPHONES	Status: Ready
Line 2 – Add new DN	Copy Update Delete Reset Phone

Phone Configuration (Model = Cisco 7960)
Device Information

MAC Address*	ABC123ABC123
Description	SF reception
Device Pool*	SF ▼ (View details)
Calling Search Space	Local_SF ▼
AAR Calling Search Space	Local_SF ▼
Media Resource Group List	< None > ▼
User Hold Audio Source	< None > ▼
Network Hold Audio Source	< None > ▼

AAR Rules and Caveats

- **Rule 1: The originating IP phone and the outgoing gateway should be at the same CAC location**
- **Rule 2: The terminating IP phone and the terminating gateway should be at the same CAC location**
- **Caveat 1: No AAR support for any call that originates from or terminates to Cisco CTI Route Point**
- **Caveat 2: This MAY not work with Extension Mobility; IF—the originating IP phone is in a separate location than the users 'normal' IP phone; why? the AAR group is on the line and the AAR CSS is on the device; so, the call will use the phone CSS to route out a local gateway but the prefixed digits will be according to the lines AAR group! works if dialing is same from any AAR group**

Agenda

- IP Telephony Deployment Models

- Cisco CallManager Dial Plan Toolkit

- Dial Plan Design Guidelines

- Conclusions

Dial Plan Design Guidelines Agenda

- Single Site Enterprise

- Multi-Site with Distributed Call Processing

- Multi-Site with Centralized Call Processing

- Tail-End Hop-Off (TEHO)

- Overlapping Extensions

- Useful Tidbits

Single Site
Typical Route Patterns

Route Pattern	Route Pattern	Route Pattern	Route Pattern
911 9.911	9.[2-9]XX XXXX	9.1 [2-9]XX [2-9]XX XXXX	9.011! 9.011!#

Route List
"PSTN-RL"

Discard PreDot
Discard Trailing #

Route Group
"PSTN-RG"

Local Area Code
Route Patterns
May Be Added

**PSTN
Gateway(s)**

PSTN

Single Site
View of Partitions/Calling Search Spaces

Calling Search Spaces

Partitions

Calling Search Space Assigned to IP Phone Based on Policy

| InternalOnly |

| Local |

| National |

| International |

| Internal |

All IP Phones, Voice Mail, Media Resources, 911 Route Pattern

| Local |

| National |

| International |

External Route Patterns
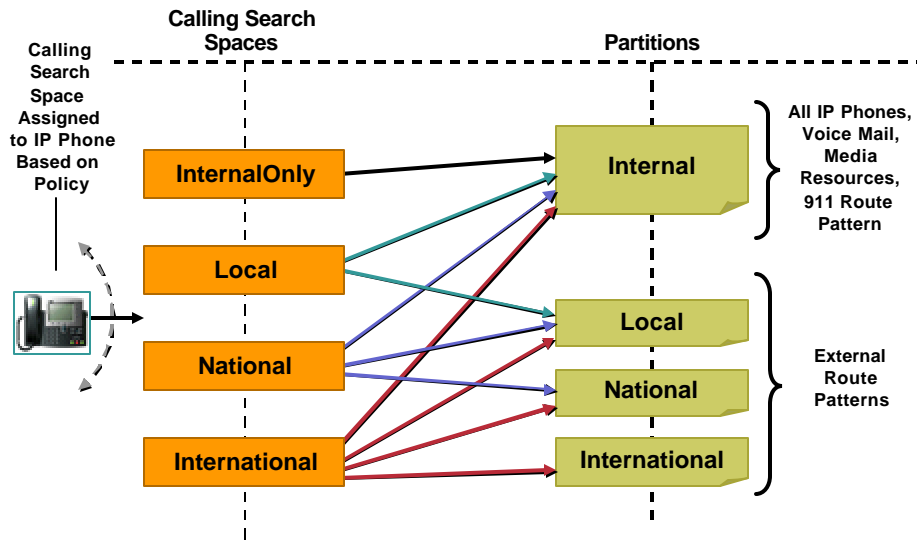
Single Site
Composite Dial Plan View

| Calling Search Spaces | Partitions | Route Lists | Route Groups | Devices |

Calling Search Space Assigned to IP Phone Based on Policy

Internal Only

Local

National

International

Internal
All IP Phones
911
9.911

Route Patterns

Local
9.[2-9]XXXXXX

National
9.1 [2-9]XX [2-9]XX XXXX

International
9.011!
9.011!#

PSTN RL

PSTN RG

PSTN

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Dial Plan Design Guidelines Agenda

- **Single Site Enterprise**
- **Multi-Site with Distributed Call Processing**
- **Multi-Site with Centralized Call Processing**
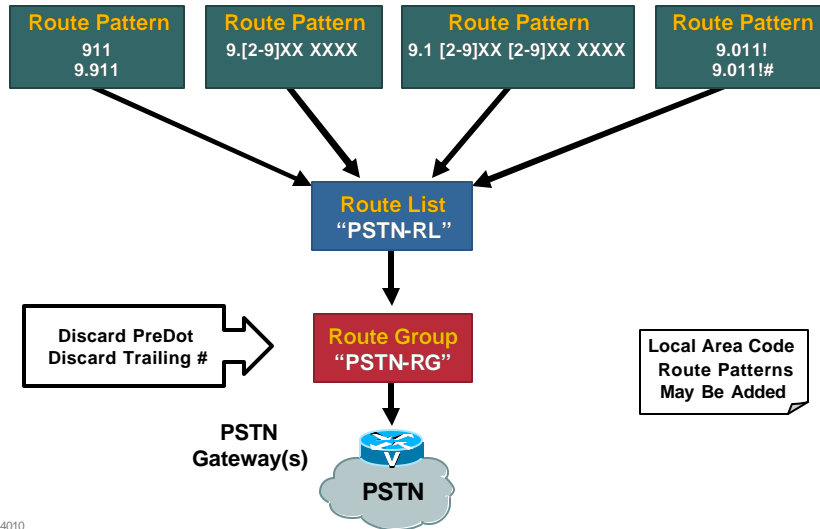- **Tail-End Hop-Off (TEHO)**
- **Overlapping Extensions**
- **Useful Tidbits**

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Multi-Site with Distributed Call Processing
Example of Dial Plan Requirements

5-Digit Dialing within a Site

Full E.164 Dialing for All External Calls

Voice Mail

Gatekeeper

Secondary Voice Path

CallManager Cluster

CallManager Cluster

GK

Voice Mail

PSTN

V

V

IP WAN

(408) 526-XXXX Ext. 6XXXX

San Jose

Primary Voice Path

User Dials 9 1 408 526 4000

w York

(212) 555-XXXX Ext. 5XXXX

Primary Voice Path: IP WAN
- Outgoing (NY cluster): Strip "9" and deliver "14085264000" to Gatekeeper
- Incoming (SJ cluster): Strip all but significant 5 digits

Secondary Voice Path: PSTN
- Outgoing (NY cluster): Strip "9" and deliver "14085264000" to the PSTN
- Incoming (SJ cluster): Strip all but significant 5 digits

Multi-Site with Distributed Call Processing
Gatekeeper for Dial Plan Resolution

San Jose HQ

Backup 1

2

Publisher

GK

Gatekeeper for CAC and Dial Plan Resolution

New York

1 Backup

2

Publisher

Backup 3

4

3 Backup

4
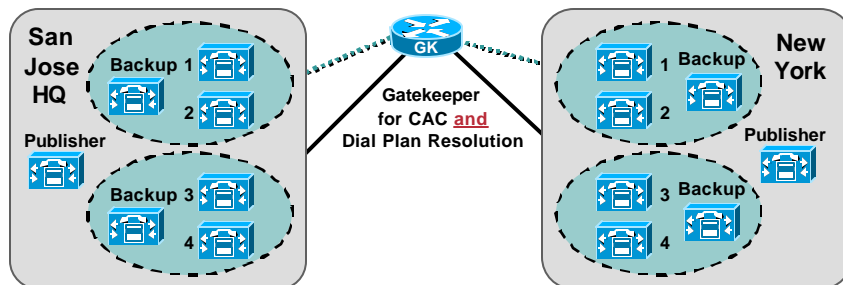
- **Gatekeeper provides Call Admission Control in presence of multiple CallManager clusters (distributed call processing deployments)**
- **CallManager configured with "Anonymous Device"—uses Gatekeeper also to resolve E.164 addresses**
- **Lower dial plan administration, highly scalable distributed model**

Multi-Site with Distributed Call Processing
Automatic Re-Route with Gatekeeper

1st Choice

GK Gatekeeper

ARQ   ACF

SJ   Call Setup   NY

2nd Choice

GK   ARJ Triggers CM to Use the Next Route Group in the Route List (PSTN Gateway)

ARQ   ARJ

SJ   Call Setup   NY

SJ Gateway   PSTN   NY Gateway
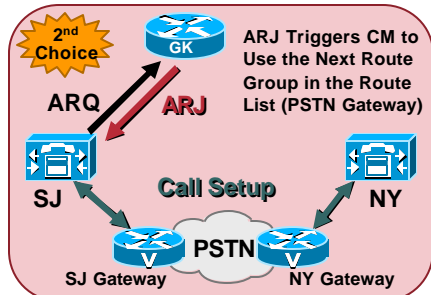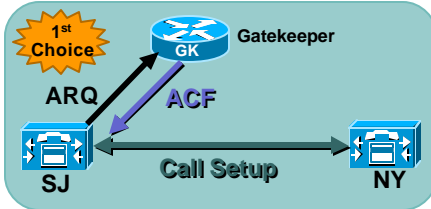
```
gatekeeper
  zone local SJC cisco.com
  zone local NYC cisco.com
  zone prefix SJC 140855534..
  zone prefix SJC 14085557...
  zone prefix SJC 131055598..

  [...]

  zone prefix NYC 16465551...
  zone prefix NYC 131255568..
  zone prefix NYC 120255524..

  [...]

  gw-type-prefix 1#* default-
                 technology
  bandwidth interzone zone SJC 480
```

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Multi-Site with Distributed Call Processing
Typical Route Patterns

Route Pattern
911
9.911

Route Pattern
9.[2-9]XX XXXX

Route Pattern
9.1 [2-9]XX [2-9]XX XXXX

Route Pattern
9.011!
9.011!#

Route List "PSTN-RL"

Route List "IPWAN-RL"

2nd Choice   1st Choice

Route Group "PSTN-RG"

Route Group "IPWAN-RG"

Individual Route Patterns for Remote Corporate Sites May Be Added

PSTN Gateway

PSTN

Anonymous Device

IP WAN
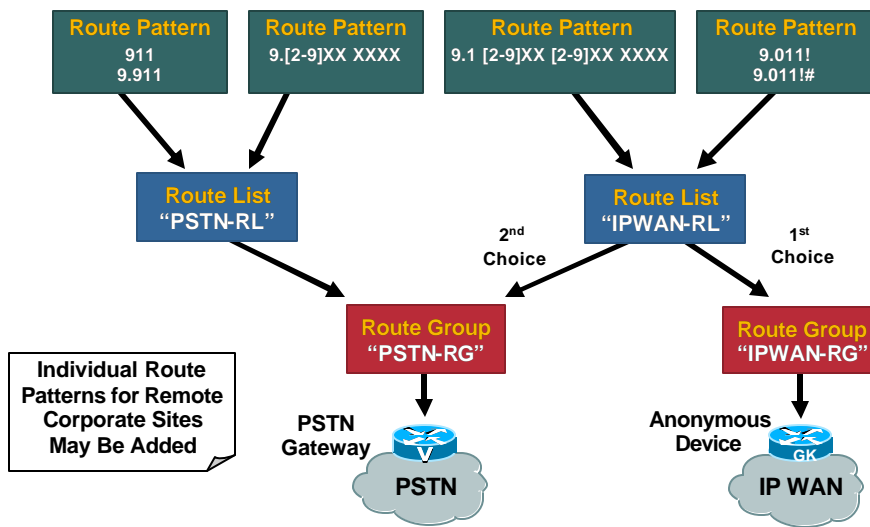
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Multi-Site with Distributed Call Processing
Composite Dial Plan View

| Calling Search Spaces | Partitions | Route Lists | Route Groups | Devices |

Calling Search Space Assigned to IP Phone Based on Policy

Internal
All IP Phones
911
9.911

Internal Only

Local
9.[2-9]XXXXXX

Local

National
9.1 [2-9]XX [2-9]XX XXXX

National

International
9.011!
9.011!#

International

Route Patterns

PSTN RL → PSTN RG → PSTN

2nd Choice

PSTN RL → PSTN RG → IP WAN

1st Choice

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Dial Plan Design Guidelines Agenda

- **Single Site Enterprise**
- **Multi-Site with Distributed Call Processing**
- **Multi-Site with Centralized Call Processing**
- **Tail-End Hop-Off (TEHO)**
- **Overlapping Extensions**
- **Useful Tidbits**

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Multi-Site with Centralized Call Processing
Example of Dial Plan Requirements

Voice Mail

CallManager Cluster

PSTN

IP WAN

SRST-Enabled Router

Philadelphia

San Jose

New York

- **CallManager at central site, up to 10,000 IP phones per cluster**
- **Common PSTN access code ("9")**
- **911 and PSTN calls use each site's local gateway**
- **Non-overlapping extensions** *(overlapping case covered later)*

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Multi-Site with Centralized Call Processing
View of Partitions/Calling Search Spaces

Calling Search Space Assigned to IP Phone Based on Policy and Location

Calling Search Spaces

Partitions

PHLInternal

PHLAllCalls

PHL Phones

PHL911

PHLPSTN

External Route Patterns for PHL

OnCluster

All IP Phones, Voice Mail, Media Resources

NYCInternal

NYCAllCalls

NYC Phones

NYC911

NYCPSTN

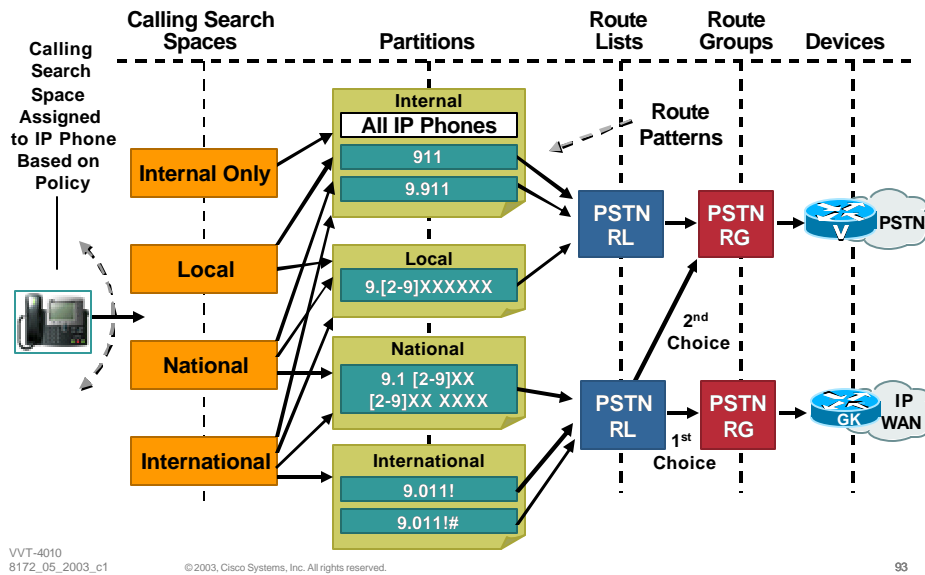**External Route Patterns for NYC**
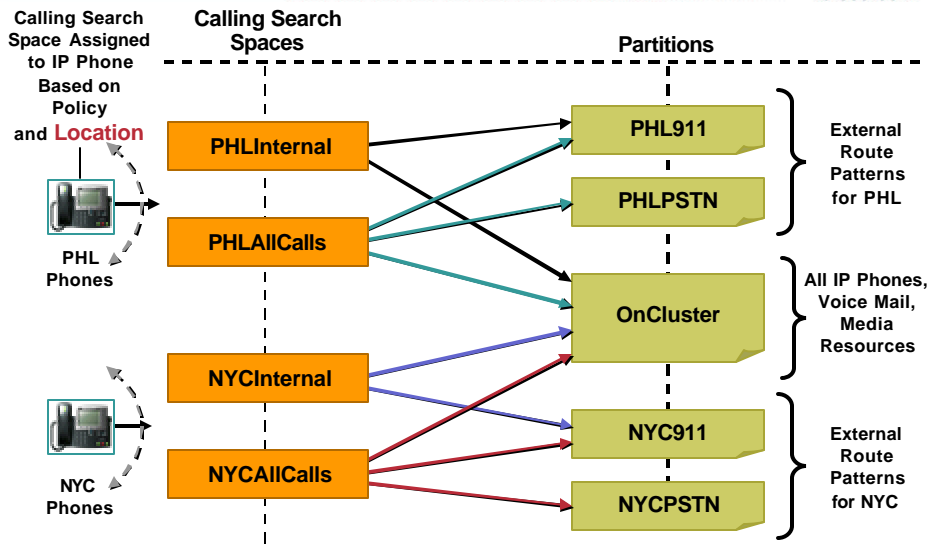
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Multi-Site with Centralized Call Processing
Composite Dial Plan View

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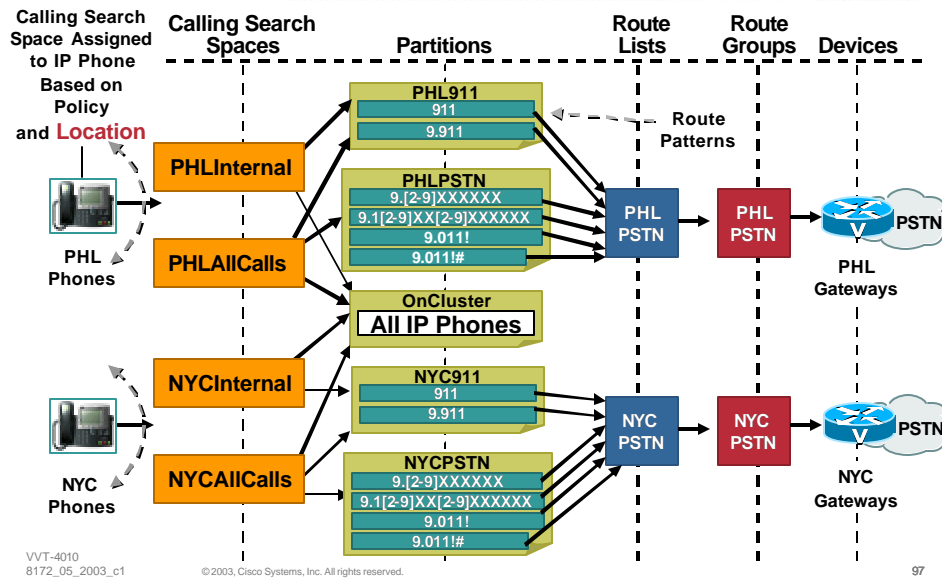
Calling Search Space Assigned to IP Phone Based on Policy and Location

Calling Search Spaces

Partitions

Route Lists

Route Groups

Devices

PHL Phones

NYC Phones

PHLInternal

PHLAllCalls

NYCInternal

NYCAllCalls

PHL911
911
9.911

PHLPSTN
9.[2-9]XXXXXX
9.1[2-9]XX[2-9]XXXXXX
9.011!
9.011!#

OnCluster
All IP Phones

NYC911
911
9.911

NYCPSTN
9.[2-9]XXXXXX
9.1[2-9]XX[2-9]XXXXXX
9.011!
9.011!#

Route Patterns

PHL PSTN

PHL PSTN

PHL Gateways

PSTN

NYC PSTN

NYC PSTN

NYC Gateways

PSTN

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Dial Plan Design Guidelines Agenda

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- **Single Site Enterprise**
- **Multi-Site with Distributed Call Processing**
- **Multi-Site with Centralized Call Processing**
- Tail-End Hop-Off (TEHO)
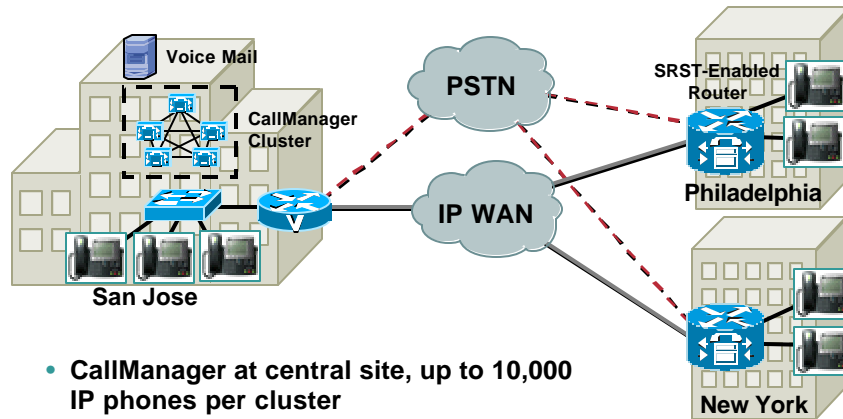- **Overlapping Extensions**
- **Useful Tidbits**

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Presentation_ID.scr

Tail-End Hop-Off (TEHO)
What Is it?

CallManager Cluster 1

(408) 555-1234

Calls
9 1 646
5556789

Gatekeeper
GK

San Jose PSTN

San Jose

Local call

1

IP WAN

CallManager Cluster 2

(646) 555-6789

New York

New York PSTN

Local Call

2

Seattle PSTN

Calls
9 1 408
5551234

Seattle

Calls to a Remote PSTN Number Use the IP WAN and Terminate at the GW Closest to the Destination

1 Within a CallManager Cluster

2 Across CallManager Clusters

99
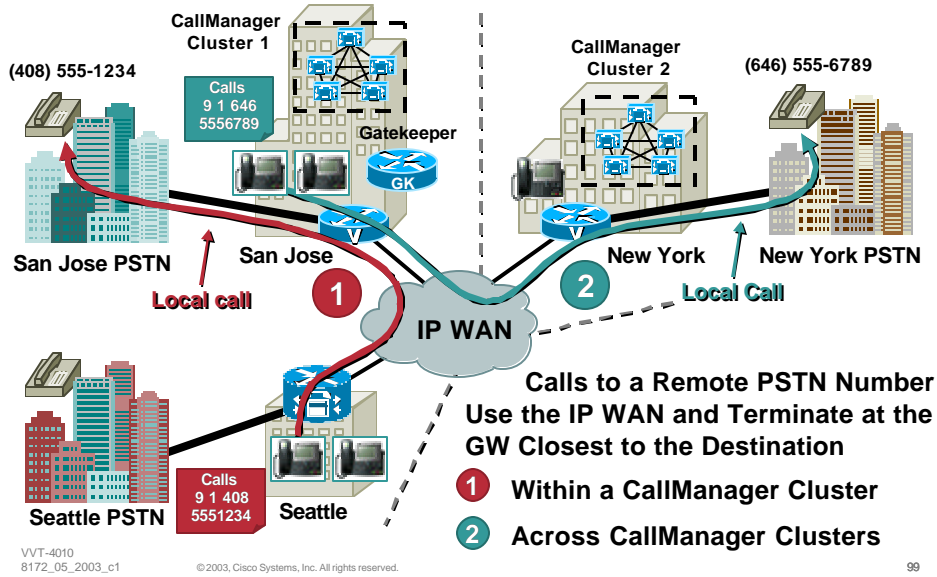
Tail-End Hop-Off (TEHO)
Intra-Cluster—Seattle to San Jose

User Calls 914085551234

Seattle

Route Pattern 91408[2-9]XXXXXX

1 Route Pattern Match
No Digit Manipulation

Route List SE-SJ-RL

2 Select Route Group
Based on Priority

1st Choice

2nd Choice

3a Route Through SJ GW
as a Result Call Is Local
CCM Strips off '9'
CAC May Reject Call

Route Group SJ-RG

Route Group SE-RG

3b Backup Path
Use SE GW
CAC Not Required

4a SJ Gateway Presents
Call to PSTN in SJ

PSTN

4b GW Strips '9'
Then Presents Call
to PSTN in SE

(408) 555 1234
San Jose

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Tail-End Hop-Off (TEHO)
Intra-Cluster—Route Patterns for Seattle

Cisco.com

Route Pattern
9.1 408 [2-9]XX XXXX

Route Patterns
9.011!, 9.011!#
9.1 [2-9]XX [2-9]XX XXXX

Route Patterns
911, 9.911
9.[2-9]XX XXXX

Route List
"SE-SJ-RL"

Route List
"SE-SE-RL"

1st Choice

2nd Choice

Route Group
"SJ-RG"

Route Group
"SE-RG"

San Jose
Gateway

PSTN

Seattle
Gateway

PSTN
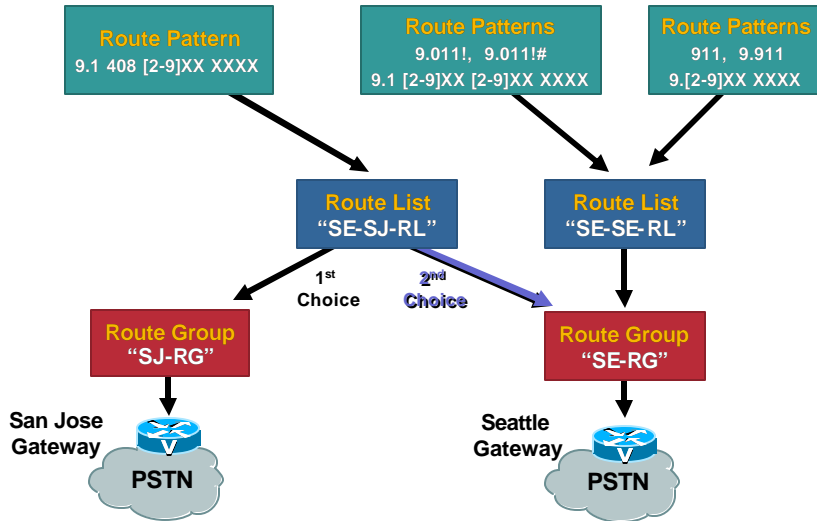
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Tail-End Hop-Off (TEHO)
Intra-Cluster—Composite Dial Plan for Seattle

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Calling Search Space Assigned to IP Phone Based on Policy and **Location**

Calling Search Spaces

Partitions

Route Lists

Route Groups

Devices

Internal
IP Phones, VM

Internal_SE

SE_911
911
9.911

Local_SE

SE_Local
9.[2-9]XXXXXX

SE-SE RL

SE-RG

PSTN

Seattle Gateways

National_SE

SE_National
9.1 [2-9]XX [2-9]XX XXXX
9.1 408 [2-9]XX XXXX

2nd Choice

International_SE

SE_International
9.011!
9.011!#

SE-SJ RL

SJ-RG

PSTN

1st Choice

San Jose Gateways

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Tail-End Hop-Off (TEHO)
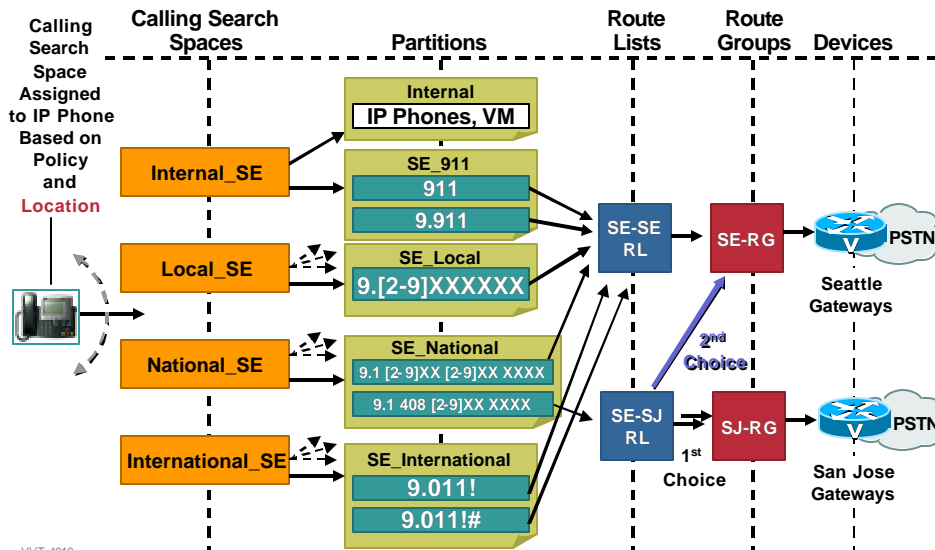Inter-Cluster—San Jose to New York
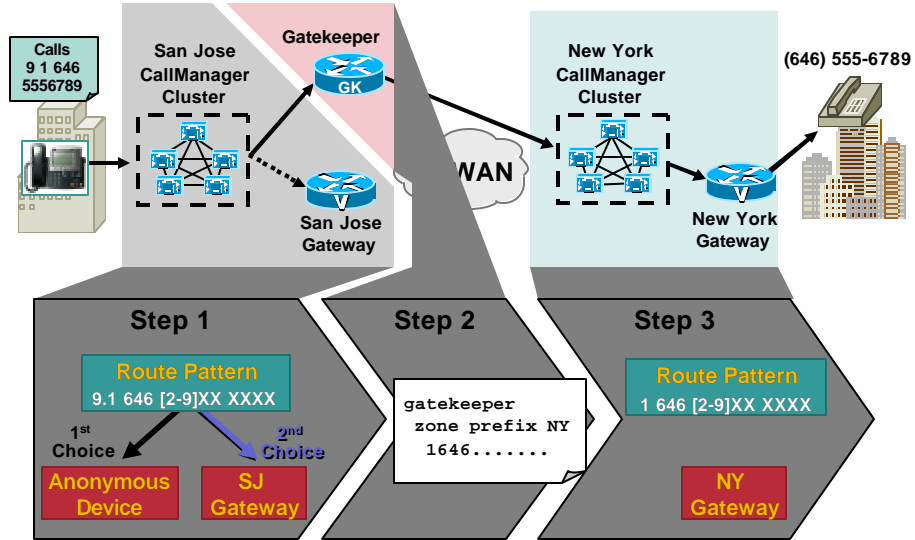
Tail-End Hop-Off (TEHO)
Inter-Cluster—Composite Dial Plan for San Jose
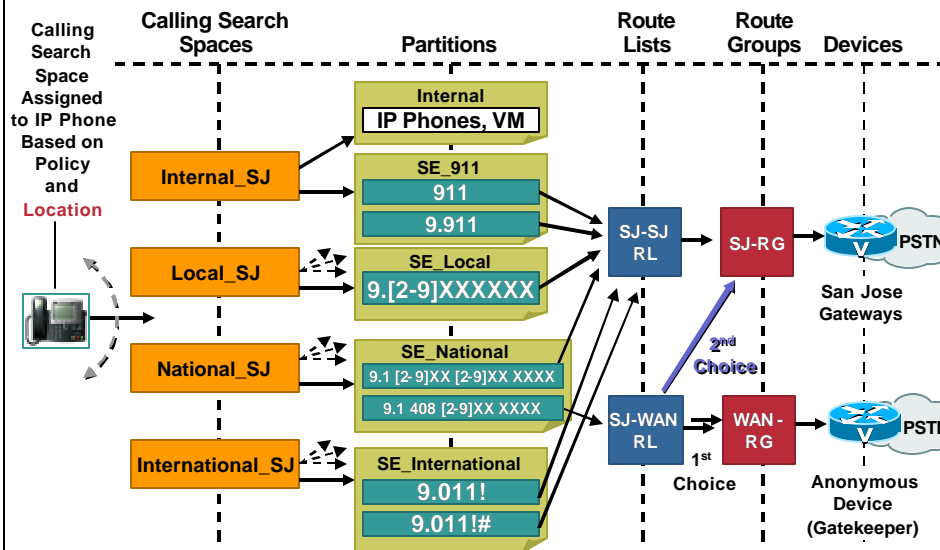
Tail-End Hop-Off (TEHO)
Inter-Cluster—Dial Plan for New York
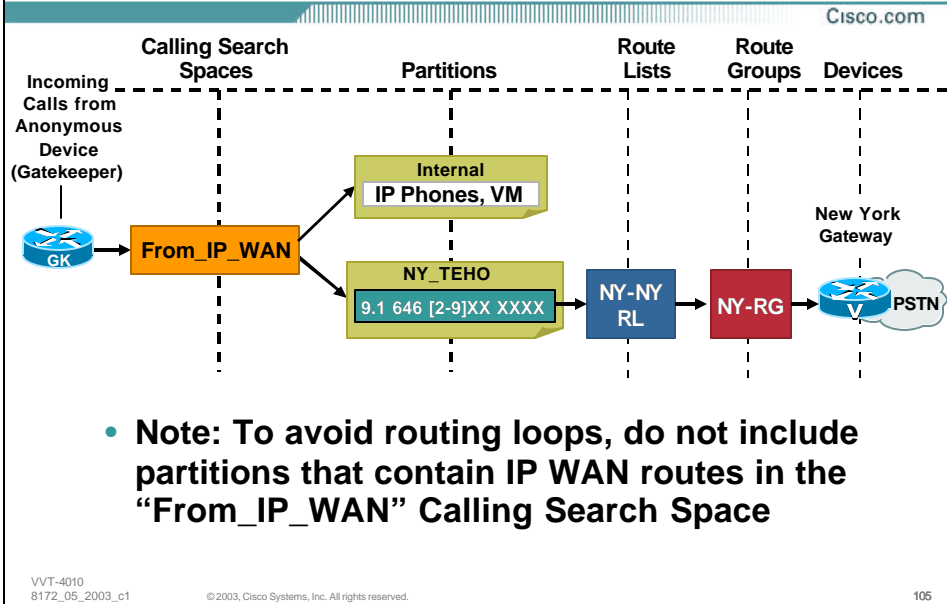
- Note: To avoid routing loops, do not include partitions that contain IP WAN routes in the "From_IP_WAN" Calling Search Space

---

Dial Plan Design Guidelines Agenda

- **Single Site Enterprise**
- **Multi-Site with Distributed Call Processing**
- **Multi-Site with Centralized Call Processing**
- **Tail-End Hop-Off (TEHO)**
- **Overlapping Extensions**
- **Useful Tidbits**

Multi-Site with Overlapping Extensions
Characteristics

- **More complex dial plan**
- **Might be required (acquisitions, preservation of existing DNs,…)**
- **Abbreviated dialing within a site (4 or 5 digits)**
- **Inter-site calls use either full E.164 or "8 + site code + extension"**
- **CallManager cluster and Voice Mail system can be shared**

Voice Mail

CallManager Cluster

Full E.164 Dialing between Sites

IP WAN

Site 1   **Site N**

DN 1000   **DN 1000**

5-Digit Dial within Site
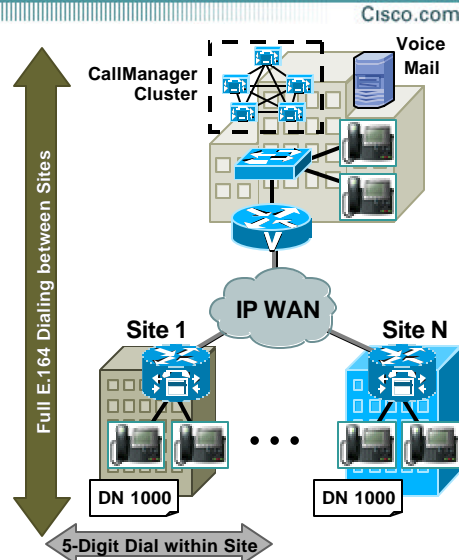
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Multi-Site with Overlapping Extensions
Per-Site Partitions/Calling Search Spaces

- **1 Partition per site (for IP phones DNs)**
- **X Calling Search Spaces per site, depending on number of classes of service (4 in this example)**

Partitions

Site1	Site2	SiteN

Calling Search Spaces

Site1_Internal	Site2_Internal	SiteN_Internal
Site1_Local	Site2_Local	SiteN_Local
Site1_National	Site2_National	SiteN_National
Site1_International	Site2_International	SiteN_International

Site 1   **Site 2**   **Site N**

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Multi-Site with Overlapping Extensions
View of Partitions/Calling Search Spaces

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Calling Search Spaces

Partitions

Calling Search Space Assigned to IP Phone Based on Policy

Site 1

Site1_Internal

Site1_Local

Site1_National

Site1_International

Site1Phones

On_Cluster

Shared

Site1911

Site1Local

Site1National

Site1International

Site 1 IP Phones

On-Cluster Translations

Shared Resources (Voice Mail, Media Resources)

External Route Patterns

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Multi-Site with Overlapping Extensions
Dial Plan Architecture

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Site 1

Site 2

Site N

1. Outgoing Calls

Route Patterns
9.XXXYYYZZZ
9.XXXX
9.YYYYYY

PSTN Route List

PSTN Route Group

PSTN

2. Inter-Site Calls

On_Cluster Translation Patterns
9.XXXYYYZZZ [Discard]
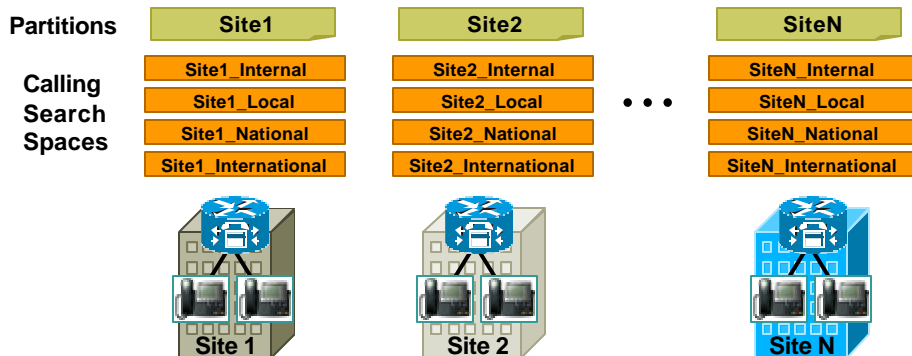9.XYZXYZXXXX [Discard]

Incoming Calling Search Space

3. Incoming Calls

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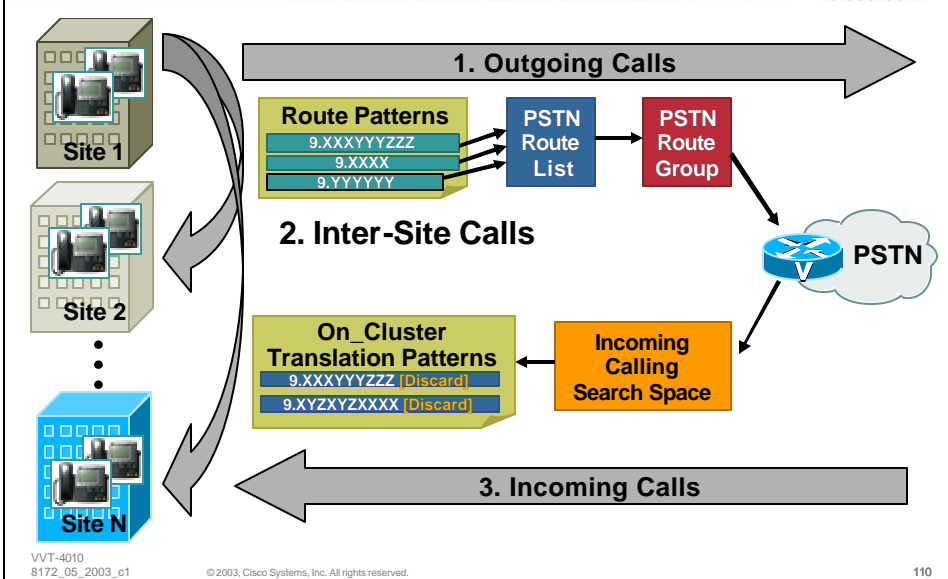
Multi-Site with Overlapping Extensions
Outgoing Calls

Cisco.com

1. Outgoing Calls

Route Patterns
- 9.XXXYYYZZZ
- 9.XXXX
- 9.YYYYYY

PSTN Route List → PSTN Route Group → PSTN

On_Cluster Translation Patterns
- 9.XXXYYYZZZ [Discard]
- 9.XYZXYZXXXX [Discard]

← Incoming Calling Search Space

Site 1
Site 2
Site N
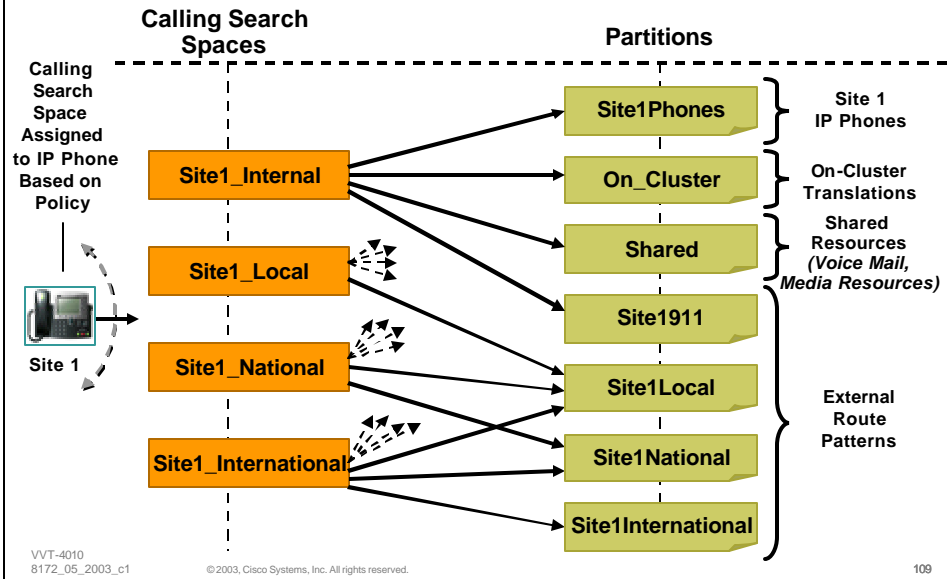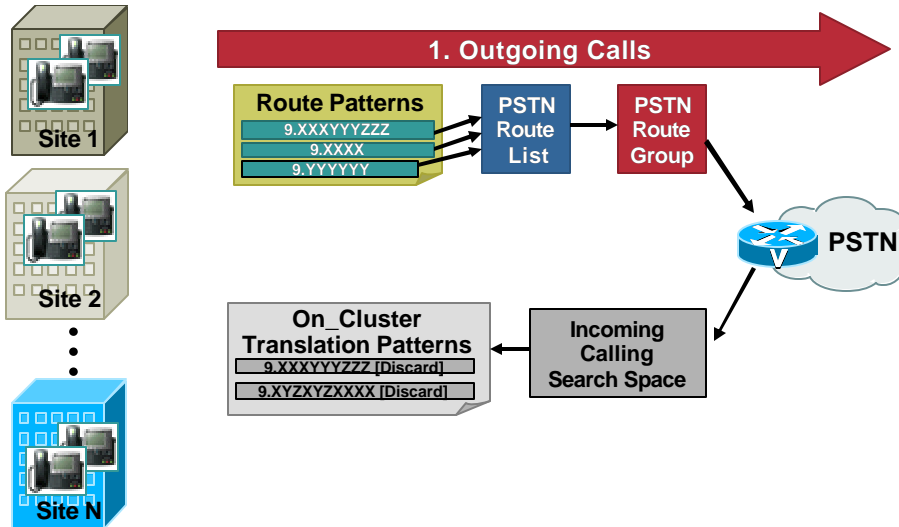
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Multi-Site with Overlapping Extensions
Outgoing Calls—Composite View

Cisco.com

| Partitions | Route Lists | Route Groups | Devices |

Site 1

Site1911
- 911
- 9.911

Site1Local
- 9.[2-9]XXXXXX

Site1National
- 9.1 [2-9]XX [2-9]XX XXXX

Site1International
- 9.011!
- 9.011!#

PSTN1 RL → PSTN1 RG → PSTN

Site 1 Gateways

Site 2

Site2911
- 911
- 9.911

Site2Local
- 9.[2-9]XXXXXX

Site2National
- 9.1 [2-9]XX [2-9]XX XXXX

Site2International
- 9.011!
- 9.011!#

PSTN2 RL → PSTN2 RG → PSTN

Site 2 Gateways

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Multi-Site with Overlapping Extensions
Inter-Site Calls

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Site 1
Site 2
Site N

Route Patterns
9.XXXYYYZZZ
9.XXXX
9.YYYYYY

PSTN Route List
PSTN Route Group

2. Inter-Site Calls

PSTN

On_Cluster Translation Patterns
9.XXXYYYZZZ [Discard]
9.XYZXYZXXXX [Discard]

Incoming Calling Search Space

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Multi-Site with Overlapping Extensions
Inter-Site Calls—Partitions and Translations
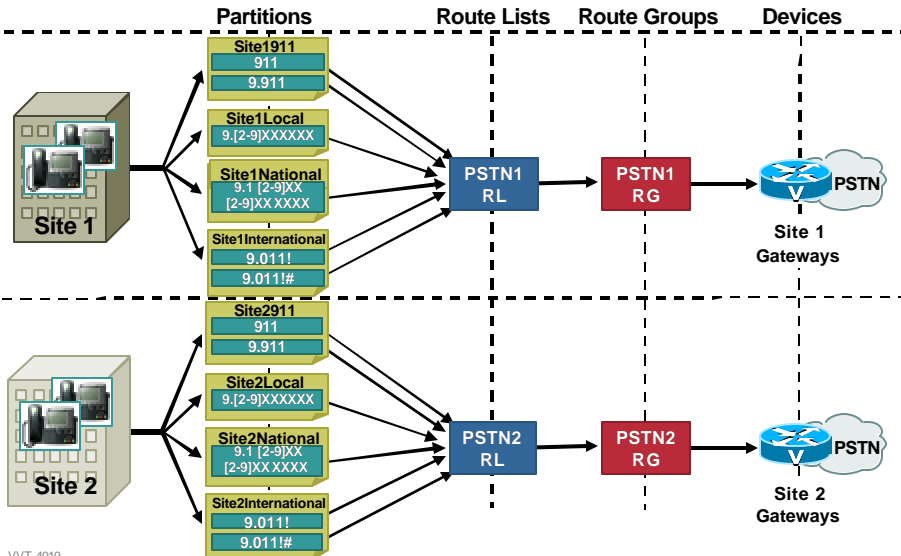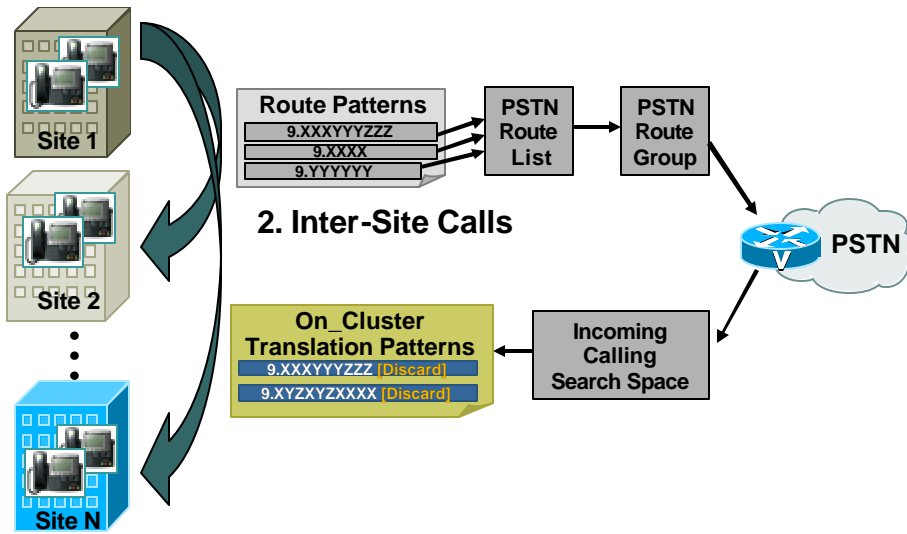
Cisco.com

Calling Search Space Assigned to IP Phone Based on Policy and **Location**

Calling Search Spaces

Partitions

Delivers 1XXX

Site1Phones
Site 1 IP Phones

Site1_Internal

Site 1
(215) 555 1XXX

On_Cluster
91215555.1XXX [Discard PreDot]
91408555.1XXX [Discard PreDot]
9121255.52XXX [Discard PreDot]

1 Translation Pattern per Site's E.164 Address Range

Site2_Internal

Site2Phones
Site 2 IP Phones

Site 2
(408) 555 1XXX

Delivers 1XXX

To Site3_Internal

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Multi-Site with Overlapping Extensions
Inter-Site Calls—Translation Pattern Configuration

Translation Pattern Configuration

91215555.0XXX, Partition=On_Cluster
91215555.1XXX, Partition=On_Cluster
91215555.2XXX, Partition=On_Cluster
91215555.3XXX, Partition=On_Cluster
91215555.4XXX, Partition=On_Cluster
91215555.5XXX, Partition=On_Cluster
91215555.6XXX, Partition=On_Cluster
91215555.7XXX, Partition=On_Cluster
91215555.8XXX, Partition=On_Cluster
91215555.9XXX, Partition=On_Cluster
9215555.0XXX, Partition=On_Cluster
9215555.1XXX, Partition=On_Cluster
9215555.2XXX, Partition=On_Cluster
9215555.3XXX, Partition=On_Cluster
9215555.4XXX, Partition=On_Cluster
9215555.5XXX, Partition=On_Cluster
9215555.6XXX, Partition=On_Cluster

Translation Pattern: 91215555.1XXX
Status: Ready

New   Copy   Update   Delete   Cancel

Pattern Definition
Translation Pattern   91215555.1XXX
Partition   On_Cluster
Numbering Plan*   North American Numbering Plan
Route Filter   < None >
Calling Search Space   Site1_Internal
Route Option   ● Route this pattern   ○ Block this pat
☑ Provide Outside Dial Tone   ☑ Urgent Priority

Calling Party Transformations
☑ Use Calling Party's External Phone Number Mask
Calling Party Transform Mask

Called Party Transformations
Discard Digits   PreDot
Called Party Transform Mask
Prefix Digits (Outgoing Calls)

What Users Dial

Partition where Translation Pattern Resides

Calling Search Space the Call Gets "Sent to" after Translation

Discard Instructions
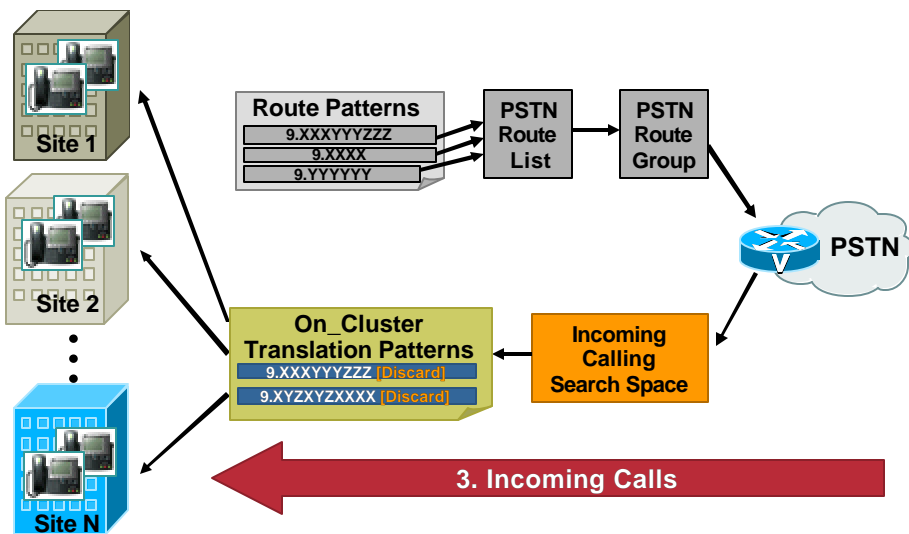
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Multi-Site with Overlapping Extensions
Incoming Calls

Site 1

Site 2

Site N

Route Patterns
9.XXXYYYZZZ
9.XXXX
9.YYYYYY

PSTN Route List

PSTN Route Group

PSTN

On_Cluster Translation Patterns
9.XXXYYYZZZ [Discard]
9.XYZXYZXXXX [Discard]

Incoming Calling Search Space

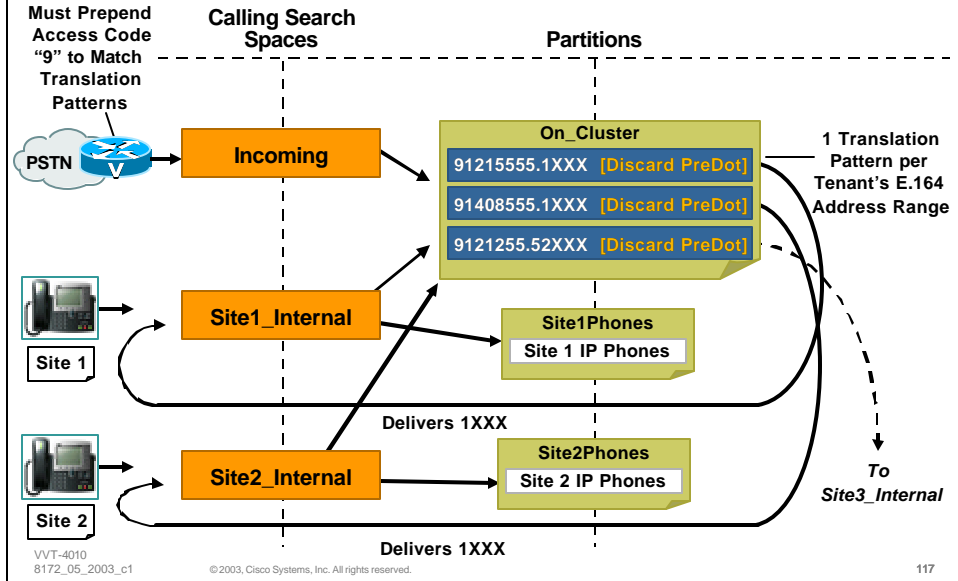**3. Incoming Calls**

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Multi-Site with Overlapping Extensions
Incoming Calls—Translation Patterns

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Must Prepend Access Code "9" to Match Translation Patterns

Calling Search Spaces

Partitions

PSTN

Incoming

On_Cluster
91215555.1XXX [Discard PreDot]
91408555.1XXX [Discard PreDot]
9121255.52XXX [Discard PreDot]

1 Translation Pattern per Tenant's E.164 Address Range

Site 1

Site1_Internal

Site1Phones
Site 1 IP Phones

Delivers 1XXX

Site 2

Site2_Internal

Site2Phones
Site 2 IP Phones

To Site3_Internal

Delivers 1XXX

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Multi-Site with Overlapping Extensions
Putting It All Together—Composite View

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Calling Search Spaces

Partitions

Route Lists

Route Groups

Devices

Prepend "9"

PSTN

Incoming

On_Cluster
91215555.1XXX [Discard PreDot]
91408555.1XXX [Discard PreDot]
9121255.52XXX [Discard PreDot]

Site1_Internal

Site1Phones
Site 1 IP Phones

Shared
All Shared Resources

To Site2_Internal

Assign to CSS Based on Policy

Site1_Local

Site1911
911
9.911

Site 1

Site1_National

Site1Local
9.[2-9]XXXXXX

Site1National
9.1 [2-9]XX
[2-9]XX XXXX

PSTN1 RL

PSTN1 RG

PSTN

Site1_International

Site1Int'l
9.011!
9.011!#

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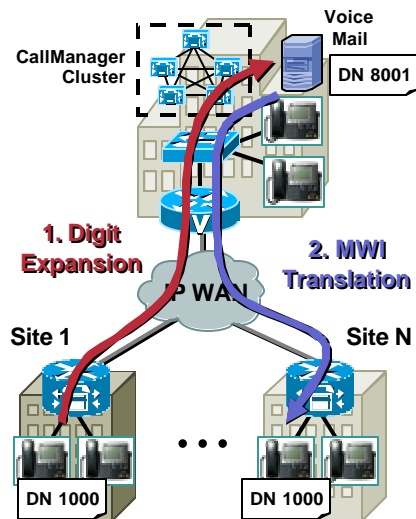
Multi-Site with Overlapping Extensions
Voice Mail Integration

- **Both SCCP - *(Unity)* and SMDI-based voice mail systems can be used**

- **Voice mail boxes need a unique DN**

- **Need to "expand" DNs when accessing VM**

- **MWI messages from VM system need to be "translated" to match appropriate DN/partition**

Voice Mail
DN 8001

CallManager Cluster

1. Digit Expansion

2. MWI Translation

IP WAN

Site 1
Site N

DN 1000
DN 1000

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Multi-Site with Overlapping Extensions
Voice Mail Integration—Digit Expansion

Voice Mail Profile Configuration

Add a New Voice Mail Profile
Back to Find/List Voice Mail Profiles

Voice Mail Profile: Site1-VMProfile
Status: Ready

| Copy | Update | Delete | Restart Devices | Cancel Changes |

Voice Mail Profile Name*   Site1-VMProfile

Description   VM Profile for Site 1 users

Voice Mail Pilot **   8001/VM_Translation ▾ (Choose <None> to use default)

Voice Mail Box Mask   408555XXXX

☐ Make this the default Voice Mail Profile for the system

* indicates required item

** The Voice Mail Pilot is comprised of the Voice Mail Pilot Number and it's corresponding Calling Search Space Name
(<Voice Mail Pilot Number>/<Calling Search Space>).

- **Use the "Voice Mail Box Mask" field in each VM profile to uniquely identify the voice mail boxes (e.g., using the full E.164 number)**
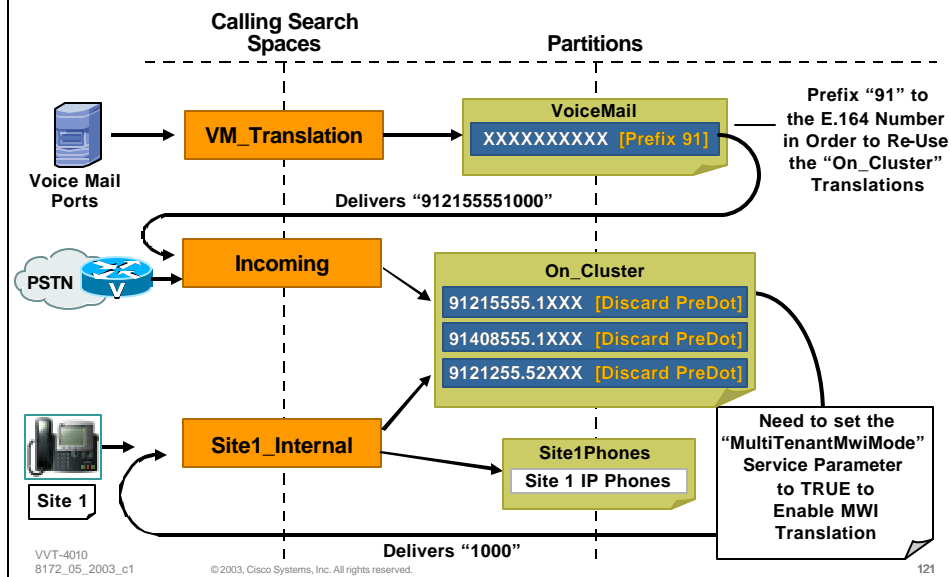
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Multi-Site with Overlapping Extensions
Voice Mail Integration—MWI Translation

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Calling Search Spaces

Partitions

Voice Mail Ports

VM_Translation

VoiceMail
XXXXXXXXXX [Prefix 91]

Prefix "91" to the E.164 Number in Order to Re-Use the "On_Cluster" Translations

Delivers "912155551000"

PSTN

Incoming

On_Cluster
91215555.1XXX [Discard PreDot]
91408555.1XXX [Discard PreDot]
9121255.52XXX [Discard PreDot]

Site 1

Site1_Internal

Site1Phones
Site 1 IP Phones

Need to set the "MultiTenantMwiMode" Service Parameter to TRUE to Enable MWI Translation

Delivers "1000"

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Dial Plan Design Guidelines Agenda

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- **Single Site Enterprise**
- **Multi-Site with Distributed Call Processing**
- **Multi-Site with Centralized Call Processing**
- **Tail-End Hop-Off (TEHO)**
- **Overlapping Extensions**
- **Useful Tidbits**

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Dial Plan Entries Have a Weight!

- **Dial plan complexity is a factor to consider**

- **In essence, each DN, route pattern, translation pattern, etc…has a weight**

- **Each server platform has a maximum capacity (i.e.: can handle a maximum dial plan weight)**

- **This is another metric, separate from the device weights**

Weights per Entry

- **Subscriber dial plan weights**

  IP phone or other dialable device (excluding line appearance) = 5

  Unique line appearance = 5

  Shared line appearance = 4

  Reachability by line appearance = 3

- **Global dial plan weights**

  Route pattern = 2

  Translation pattern = 1

Weight Capacities per Platform

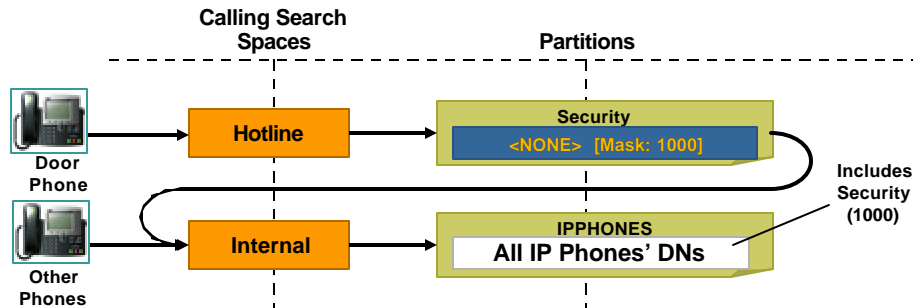| Total Dial Plan Weight Units on Subscriber Server	Server Memory Requirements
Up to 15,000	512 MB of RAM Installed
Up to 35,000	768 MB of RAM Installed
Up to 70,000	1 GB of RAM Installed
Up to 140,000	2 GB of RAM Installed

Useful Tidbits
Configuring a Security Hotline (PLAR)

Calling Search Spaces   Partitions

Door Phone → Hotline → **Security** <NONE> [Mask: 1000]

Other Phones → Internal → **IPPHONES** All IP Phones' DNs

Includes Security (1000)

Create Partition *SECURITY*

Create *HOTLINE* CSS Containing SECURITY Partition

Create Translation Pattern Matching <NONE>, Called Party Transformation Mask Equal to 1000, CSS Set for Internal. (Contains Partition with Security Phone)

Create Door Phone with CSS set to *HOTLINE*

Useful Tidbits
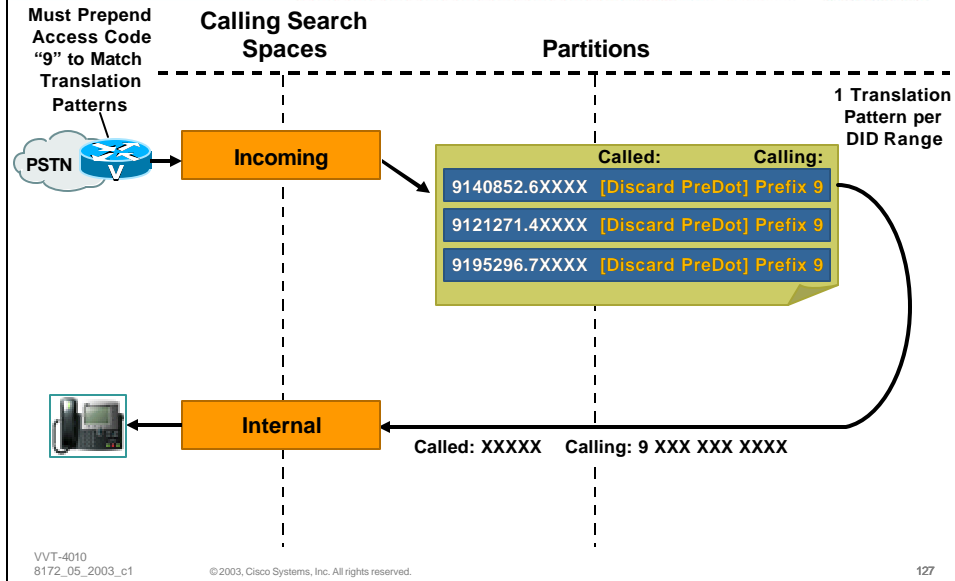**Mapping DID to 5 Digit Extension—Prefix Calling # with 9**

Cisco.com

Must Prepend Access Code "9" to Match Translation Patterns

Calling Search Spaces

Partitions

1 Translation Pattern per DID Range

PSTN → Incoming

Called: Calling:

9140852.6XXXX   [Discard PreDot] Prefix 9
9121271.4XXXX   [Discard PreDot] Prefix 9
9195296.7XXXX   [Discard PreDot] Prefix 9

Internal

Called: XXXXX   Calling: 9 XXX XXX XXXX

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Useful Tidbits
Staff Calls Other Internal Staff Member via DID

Cisco.com
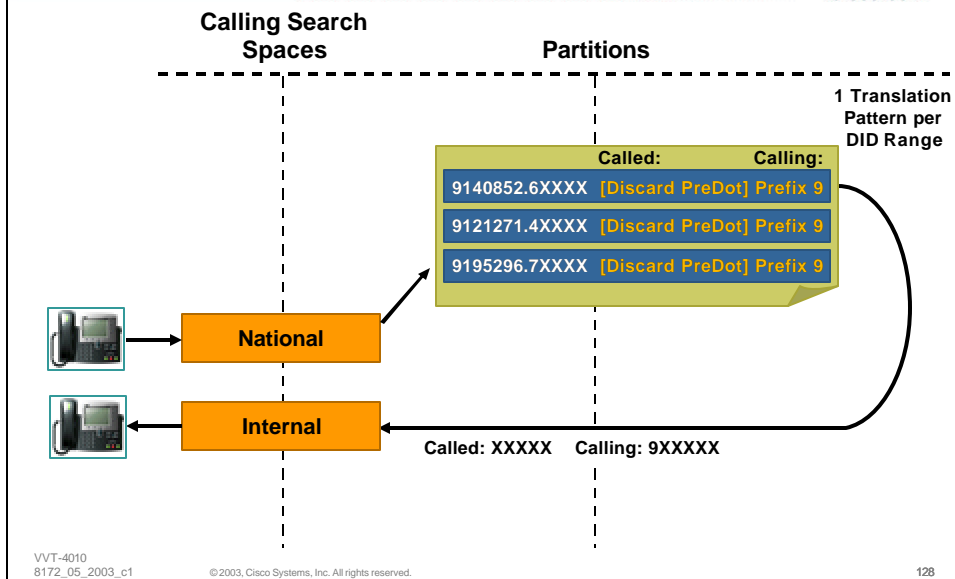
Calling Search Spaces

Partitions

1 Translation Pattern per DID Range

Called: Calling:

9140852.6XXXX   [Discard PreDot] Prefix 9
9121271.4XXXX   [Discard PreDot] Prefix 9
9195296.7XXXX   [Discard PreDot] Prefix 9

National

Internal

Called: XXXXX   Calling: 9XXXXX

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Agenda

- **IP Telephony Deployment Models**

- **Cisco CallManager Dial Plan Toolkit**

- **Dial Plan Design Guidelines**

- **Conclusions**

Conclusions
General Recommendations

- **Keep it simple!**

- **Plan for future growth**

- **Use the Anonymous Device when more than 2 CallManager clusters are present**

- **Normalize DNs to the full E.164 when using Gatekeeper for dial plan resolution**

Conclusions
Summary—What Did We Cover?

- **Enterprise IP Telephony dial plan operation—the tools and how to use them**

- **Design recommendations for the different deployment models:**

  Single Site

  Multi-Site WAN with Distributed Call Processing

  Multi-Site WAN with Centralized Call Processing

For More Information:

http://www.cisco.com/warp/customer/779/largeent/netpro/avvid/srnd.html

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For More Information about Dial Plan and IPT in General, See Latest SRND!

Solution Reference Network Designs - Microsoft Internet Explorer

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Address http://www.cisco.com/warp/public/779/largent/it/ese/srnd.html

SOLUTION REFERENCE NETWORK DESIGNS

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In order to assist enterprise customers in building an efficient, reliable, and scalable network, Cisco has developed a set of documents with detailed design and implementation guidance for various Cisco networking solutions. These Solution Reference Network Design Guides (SRNDs) provide proven best practices to build out a Cisco AVVID network infrastructure. The SRNDs available are listed below. Please visit the site often as new SRNDs are posted periodically.

- Implementing 802.1w and 802.1s in Campus Networks (Implementation Guide) (PDF - 1 MB)
- Identity-Based Network Access Control and Policy Enforcement (Implementation Guide) (PDF - 2 MB)
- IP Multicast (PDF - 2 MB)
- Data Center Networking: Infrastructure Architecture (PDF - 2 MB)
- Data Center Networking: Securing Server Farms (PDF - 2 MB)
- Data Center Networking: Optimizing Server and Application Environments (PDF - 4 MB)
- Data Center Networking: Integrating Security, Load Balancing, and SSL Services using Service Modules (PDF - 2 MB)
- Data Center Networking: Internet Edge Design (PDF - 2 MB)
- Data Center Networking: Distributed Data Centers (PDF - 2 MB)
- IP Telephony for CallManager 3.3 (PDF - 3 MB)
- IP Telephony for CallManager 3.1/3.2 (PDF - MB)
- IP Telephony for CallManager 3.0(5) (PDF - 5 MB)
- IP Videoconferencing (PDF - 2 MB)
- IP Contact Center (PDF - 3 MB)
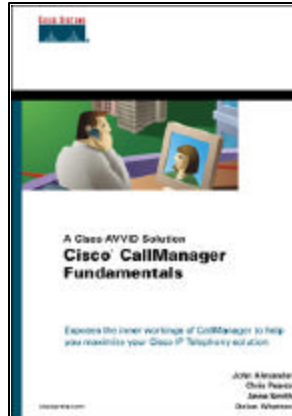- Quality of Service (PDF - 2 MB)

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Recommended Reading

**Cisco CallManager
Fundamentals:
A Cisco AVVID Solution**
ISBN: 1-58705-008-0

Available On-Site at the Cisco Company Store

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