



ADVANCED DIAL PLAN DESIGN FOR IP TELEPHONY NETWORKS

SESSION VVT-4001

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Session Scope and Objectives

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- To explore the various architectural challenges of planning an IP-based telephony network

Because it can do more than a traditional telephony system, because it breaks all the common boundaries (*few, if any, PBX's have hundreds of sites*)

- To explore the design and implementation possibilities of Cisco's IP telephony system

Design based on CallManager 3.3 and 4.0

Aspects we will cover:

Dial Plan Elements
(*Call Routing Logic, Partitions and Calling Search Spaces...*)

Design Guidelines
(*Classes of Service, Multi-site Deployments, Extension Mobility...*)

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Overall Agenda

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- **Planning Considerations**



- **Dial Plan Elements**



- **Design Guidelines**



- **Conclusions**

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PLANNING CONSIDERATIONS



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Planning Considerations The Fundamentals

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- **A few things we all like in a good dial plan:**
 - Not re-printing business cards (i.e.: not changing numbers because we change phone systems)**
 - Having abbreviated dialing within a site (e.g.: 5 digit dialing)**
 - Having a simple, direct correspondence between someone's DID number (i.e.: business card) and their internal extension**
 - Keeping it simple, where even the new guy can use the phone system (i.e.: dial "9" for an outside line, or 5 digits to reach colleagues)**

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Planning Considerations The Fundamentals (Cont.)

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- **A few things we all like in a good dial plan:**
 - Keeping it simple, where even the new system administrator can maintain the phone system (an area code split would not destroy the plan)**
 - Future proofing, such that when the new office opens, we do not have to re-do it all**
 - Have a good user experience (e.g.: not having to wait for inter-digit timeout when calling the guy in the next cube over)**
- **Remember: the best tool to start with is this:**



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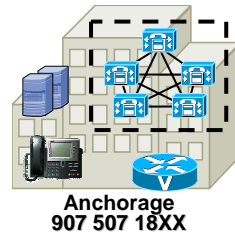
Planning Considerations Uniform Dial Plans Are Simple

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Q: Could this system use a *uniform* 3 digit dial plan?
A: No! Chicago and Dallas' DID ranges overlap in the last 3 digits.

Q: Ok, how about 4 digit uniform dial plan?
A: No! overlaps again!
Because each time you call extensions 9110 through 9119 in Chicago, you get the police department (by calling 911)

AND: Because the system cannot off-hand tell the difference between calling Al Capone at 9141, and calling long distance to a Toronto number (e.g.: 9 1 416 555 1234) you will have to wait for inter-digit timeout, even when calling from Anchorage!



New York
212 555 75XX



Chicago
708 552 91XX



Birmingham
205 937 54XX



Dallas
972 553 11XX

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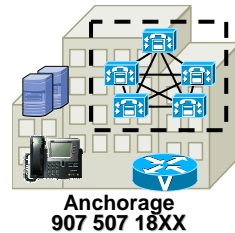
Planning Considerations Uniform Dial Plans Are Simple (2)

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Q: Fine! How about a 5 digit uniform dial plan?
A: Currently, yes! No overlap in the current ranges of DID numbers assigned.

Q: Great! How about that new office we want to get in Hawaii? Room for it in our dial plan?

A: Sure. Well, maybe: it cannot use a DID range where the third digit of the office code is 9 or 0, and cannot overlap with 575XX, 291XX, 754XX, 311XX, or 718XX...



New York
212 555 75XX



Chicago
708 552 91XX



Birmingham
205 937 54XX



Dallas
972 553 11XX



Hawaii
808 ??? ????

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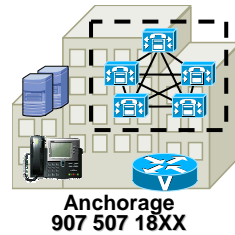
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Planning Considerations Uniform Dial Plans Are Simple (3)

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Q: If all I could get from Hawaii's Telco is a DID range of 808 557 54XX, could I not dial 6 digits to reach a Hawaii phone, and 5 digits anywhere else? That way, I avoid the overlap between Hawaii and Birmingham.
A: No! Because calls to New York (e.g.: 57540) will sometimes overlap with calls to Hawaii's phones (e.g.: 575403), forcing the inter-digit timeout to occur before the call is routed.



Q: What do I do now? Go to 6 digits?
A: No: Anchorage's second NXX digit is 0. Overlaps with the operator code...

Q: 7 digits?
A: No: Birmingham starts with a 9!



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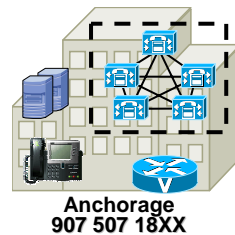
Planning Considerations Uniform Dial Plans Are Simple (or so we hoped)

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Q: 8 digits?
A: ok for now: but you'll never open an office in Raleigh (area code 919)

Q: 9 digits? Oops. Forget about it! That 0 again (4 cases, no less)

Q: 10 digits?
A: Great idea! The North American Dial Plan will make sure that it never overlaps. You can even give up the outside access code. It is not really abbreviated dialing anymore though...



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Planning Considerations

How About an On-net, Inter-site Access Code?

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Q: What about 0 for operator, 9 for outside line, and 8 for inter-site calls?

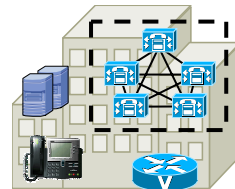
A: Great idea.

Q: How many digits for intra-site calls, though?

A: not 3 (4XX and 1XX overlap).

Not 4 either (911!)

5 would work!



Anchorage
907 507 18XX



New York
212 555 75XX



Chicago
708 552 91XX



Birmingham
205 937 54XX



Dallas
972 553 11XX



Hawaii
808 557 54XX

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Planning Considerations

How About an On-net, Inter-site Access Code?

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Q: ok: now I have it:

0 = operator

8 + 5 digits: inter-site on-net

9 + 7 digits, 9 + 10 digits, 9 + 1 + 10 digits, 9 + 011...

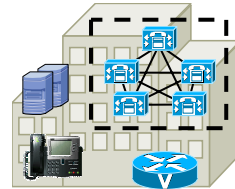
: all off-net patterns

And then any 5 digits that begin with 1 though 7 is an on-net, intra-site call

Am I good to go?

A: Yes

... for now.



Anchorage
907 507 18XX



New York
212 555 75XX



Chicago
708 552 91XX



Birmingham
205 937 54XX



Dallas
972 553 11XX



Hawaii
808 557 54XX

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Planning Considerations

What if I have many, many more sites? More users?

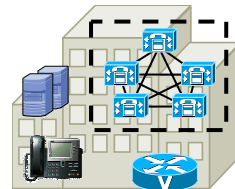
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Q: I have 250 branches, with over 90 with 100+ users, and a dozen with more than 1000 users, and a headquarter with 12000 users. Can I still use 8 + 5 digits for on-net, inter-site calls?

A: No!

You essentially have the following to play with:
1XXXX, 2XXXX, 3XXXX, 4XXXX, 5XXXX, 6XXXX, 7XXXX

250 phone companies' DID ranges, the need for more than a whole 5 digit range for a single site, and dividing the rest into 250 un-equal parts. Future planning, area code splits, new office codes, etc...



San Jose
408 526 XXXX
408 853 XXXX
Site codes 123
and 124



Baltimore
240 555 XXXX
Site code 012



Oakland
510 555 51XX
Site code 345



New Orleans
504 555 5XXX
Site code 256



Philadelphia
267 555 1XXX
Site code 390



Hawaii
808 557 54XX
Site code 822

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Planning Considerations

What if I have many, many more sites? More users? (2)

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Q: What to do?

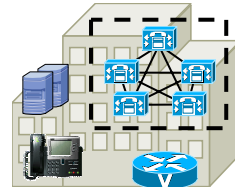
A: Site codes are a good idea.

0 = operator

9 = outside line, all combinations

8 + site code (3 digits would work up to 1000 sites),
followed by a 4 digit extension

[1-7]XXX: on-net, intra-site dialing



San Jose
408 526 XXXX
408 853 XXXX
Site codes 123
and 124



Baltimore
240 555 XXXX
Site code 012



Oakland
510 555 51XX
Site code 345



New Orleans
504 555 5XXX
Site code 256



Philadelphia
267 555 1XXX
Site code 390



Hawaii
808 557 54XX
Site code 822

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DIAL PLAN ELEMENTS



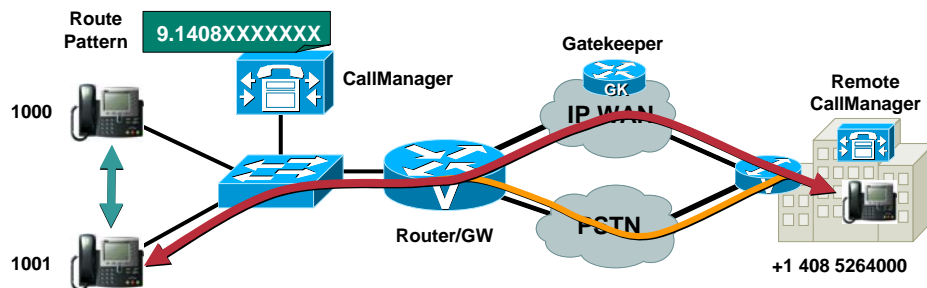
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Dial Plan— The “IP Routing” of IP Telephony

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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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Dial Plan Elements Agenda

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- **CallManager Call Routing Logic**
- External Routes in CallManager
- Partitions and Calling Search Spaces
- Automated Alternate Routing
- Other Tools

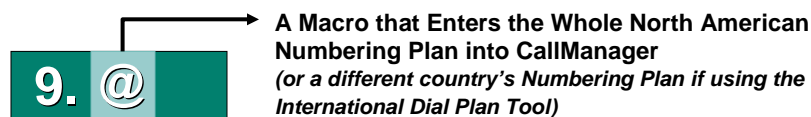
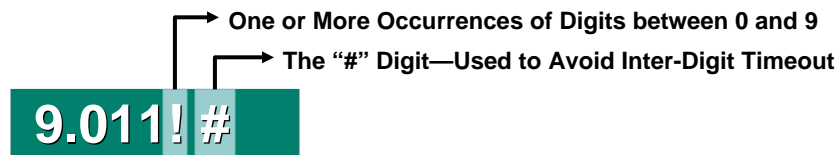
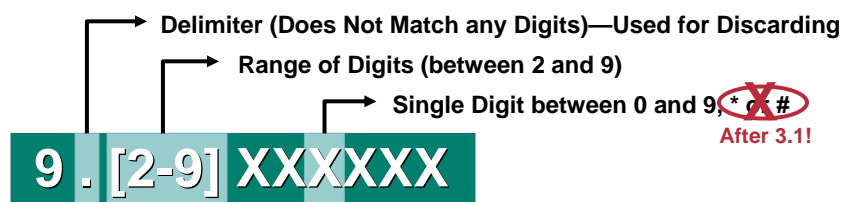
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CallManager Call Routing Logic Commonly Used Wildcards

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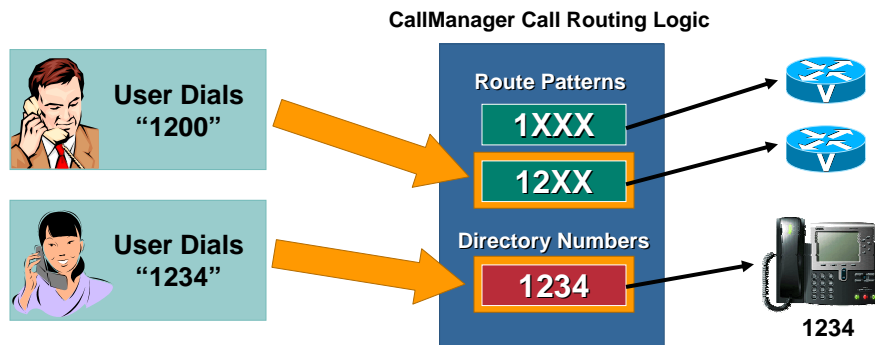
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CallManager Call Routing Logic Basic Principle

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- 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

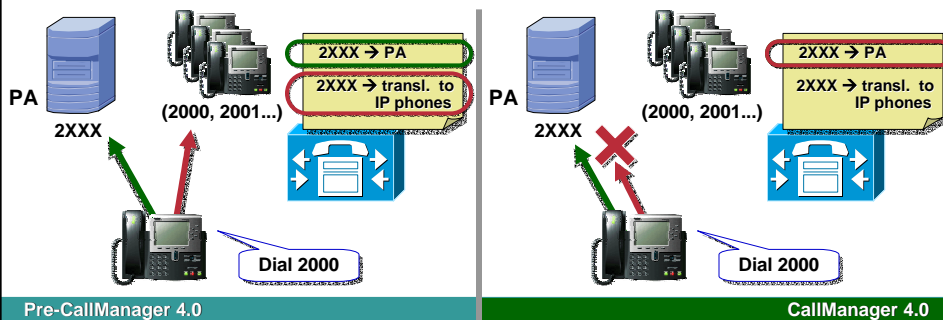
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CallManager Call Routing Logic Changes in CallManager 4.0

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- Patterns are no longer removed from CallManager call routing engine when devices unregister
- "Failover" patterns no longer get hit (used today by some applications, such as PA)
- Use CallFwd on primary pattern instead (CallFwd fields now accept mask, as well as CSS)

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Dial Plan Elements Agenda

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- CallManager Call Routing Logic
- **External Routes in CallManager**
- Partitions and Calling Search Spaces
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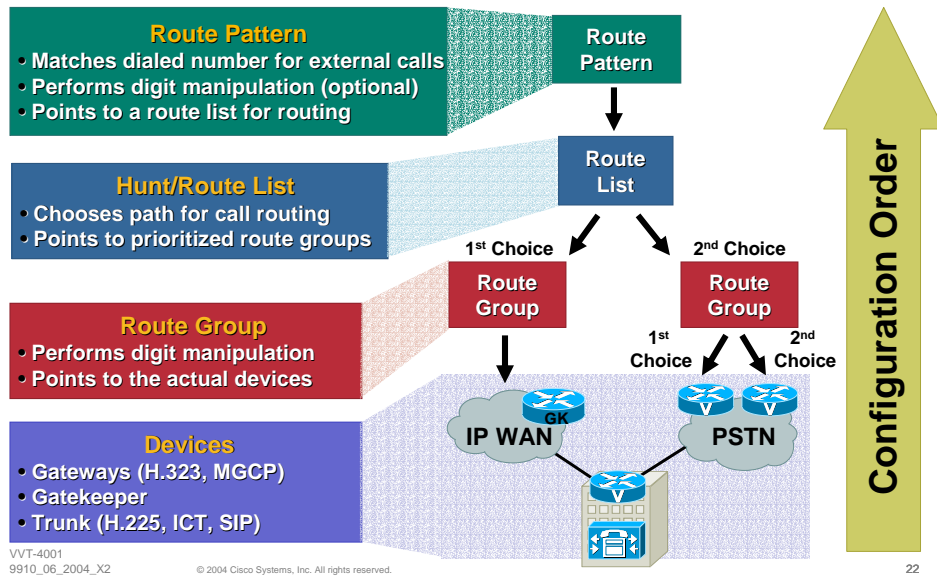
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External Routes in CallManager Overall Structure

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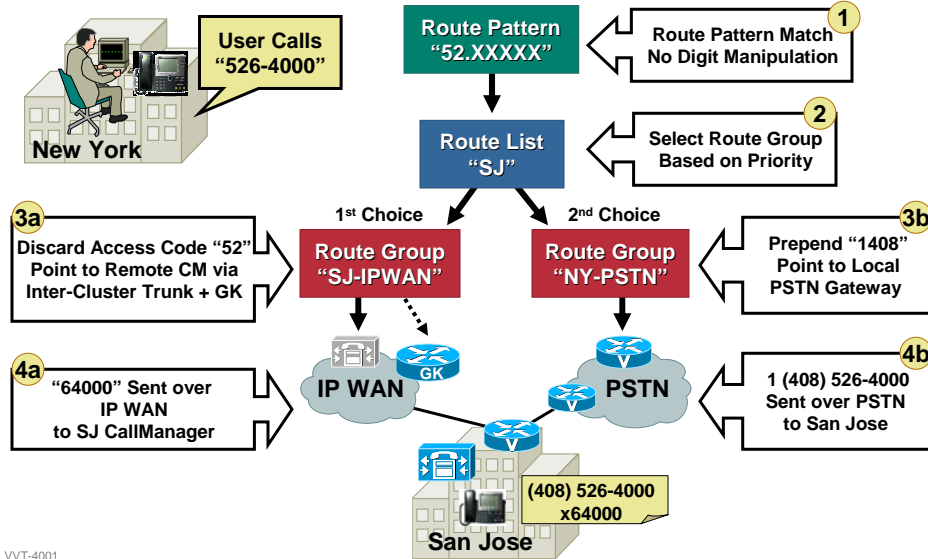
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External Routes in CallManager Example: New York to San Jose

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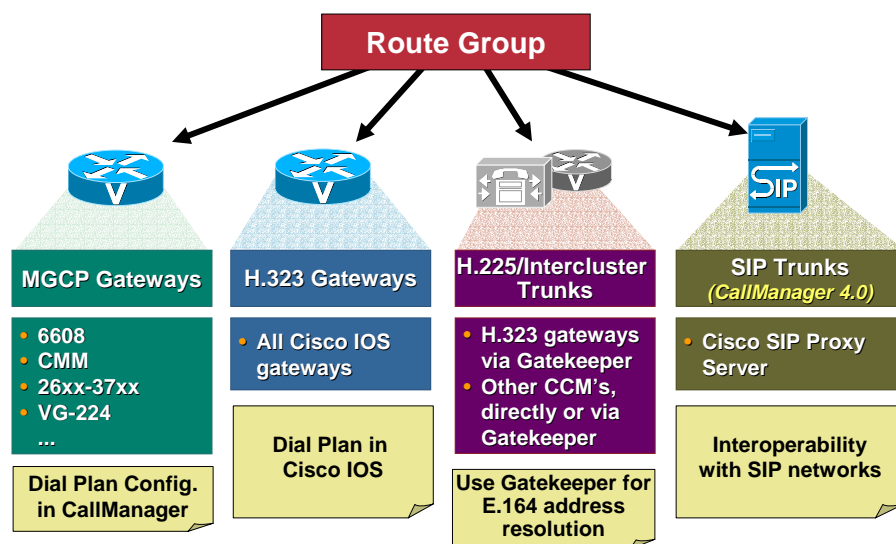
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External Routes in CallManager Route Group Devices

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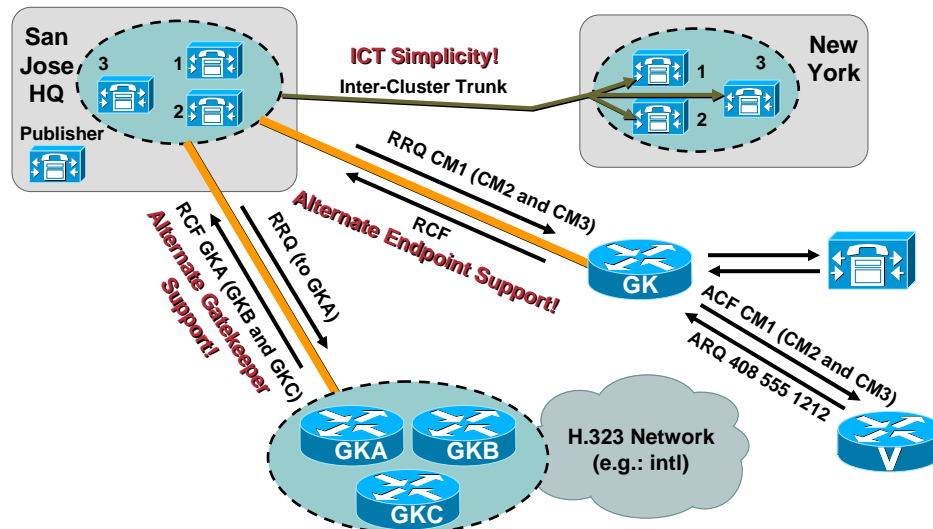
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External Routes in CallManager H.225/Inter-cluster Trunks – Possibilities

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External Routes in CallManager GK-controlled Trunks – Auto-Discovery

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- 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



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

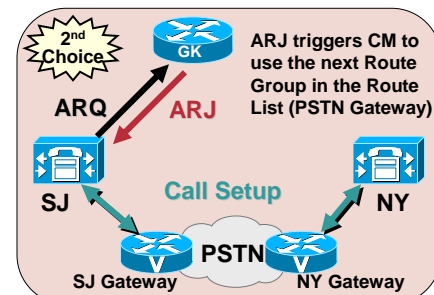
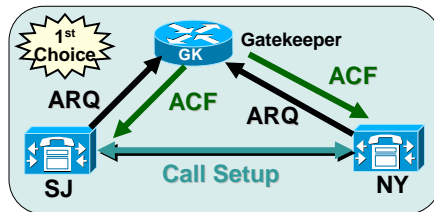
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External Routes in CallManager GK-controlled Trunks – Automatic Re-Route

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```
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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External Routes in CallManager GK-controlled Trunks – Features

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- 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 (for alternate endpoint support)
- Alternate endpoint is supported in IOS GK load 12.2T

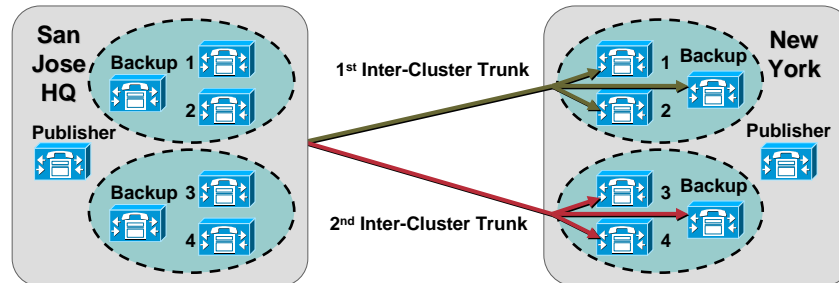
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External Routes in CallManager Non GK-controlled Inter-Cluster Trunks (1)

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Remote Cisco CallManager Information	
Server 1 IP Address/Host Name*	<input type="text" value="172.16.1.100"/>
Server 2 IP Address/Host Name	<input type="text" value="172.16.2.100"/>
Server 3 IP Address/Host Name	<input type="text" value="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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External Routes in CallManager Non GK-controlled Inter-Cluster Trunks (2)

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- 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

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External Routes in CallManager SIP Trunks

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- Provides Voice Connectivity to SIP from H.323, SCCP, CTI/QBE and MGCP voice devices
- Must use an MTP (for DTMF relay)
- No video support yet
- DTMF is relayed using RFC2833
- SIP Trunk does not register with Proxy/Registrar
- Subset of SIP messages supported

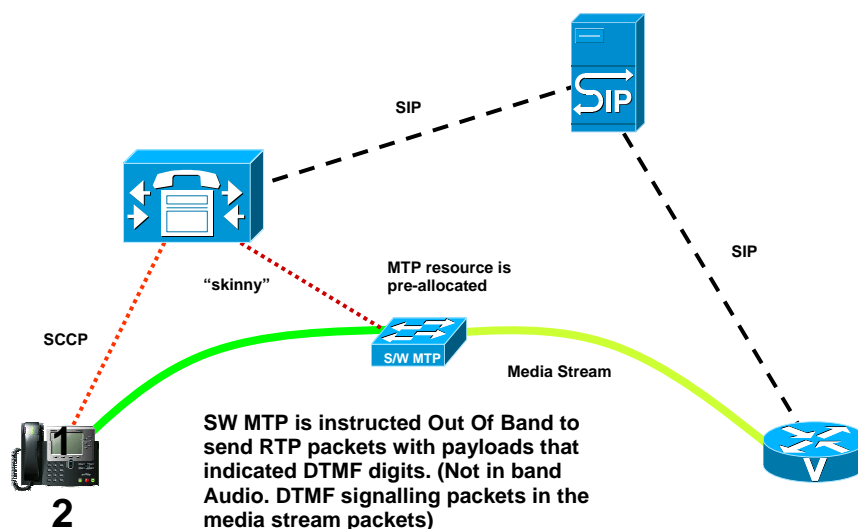
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External Routes in CallManager SIP Trunks – RFC 2833 DTMF Relay

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Dial Plan Elements Agenda

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- CallManager Call Routing Logic
- External Routes in CallManager
- **Partitions and Calling Search Spaces**
- Automated Alternate Routing
- Other Tools

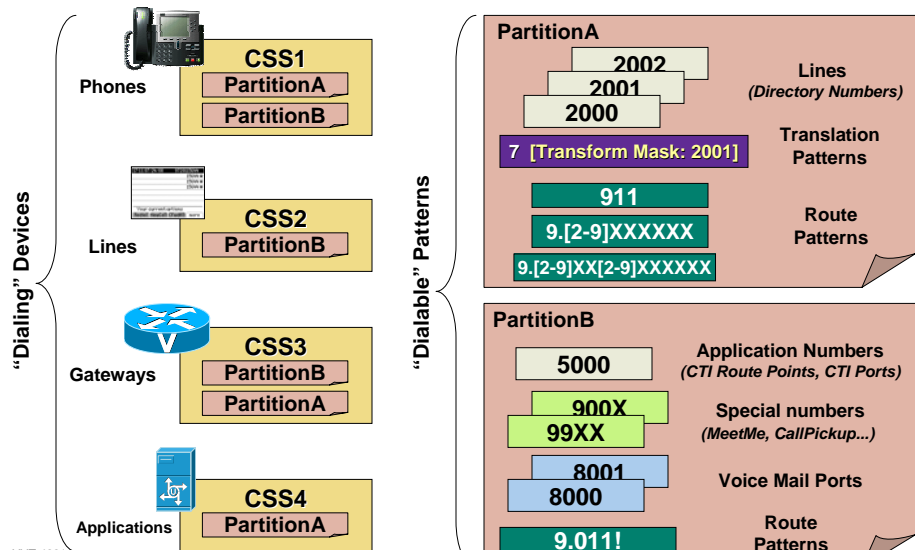
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Partitions and Calling Search Spaces Concepts

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Partitions and Calling Search Spaces

Q³: Quick Quiz Question

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What is needed for Phone A to be able to call Phone B and viceversa?



Line 1000 and Line 2000 must be in the same Partition:

☐ TRUE ☒ FALSE

Phone A and Phone B must have the same Calling Search Space: ☐ TRUE ☒ FALSE

Phone A's Calling Search Space must contain Line 2000's Partition, and Phone B's Calling Search Space must contain Line 1000's Partition: ☒ TRUE ☐ FALSE

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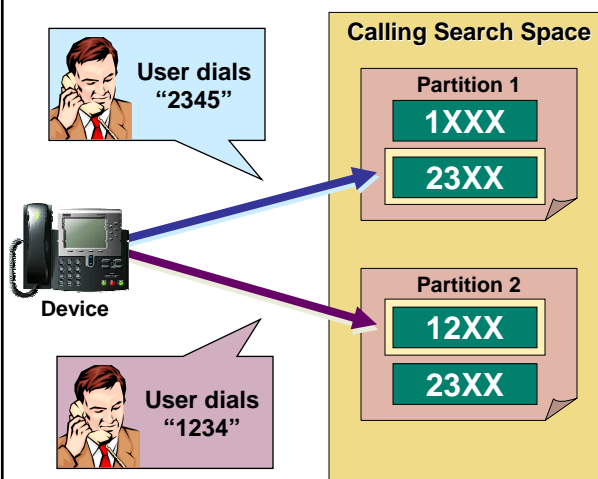
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Partitions and Calling Search Spaces

Impact of Partition Order in a CSS

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

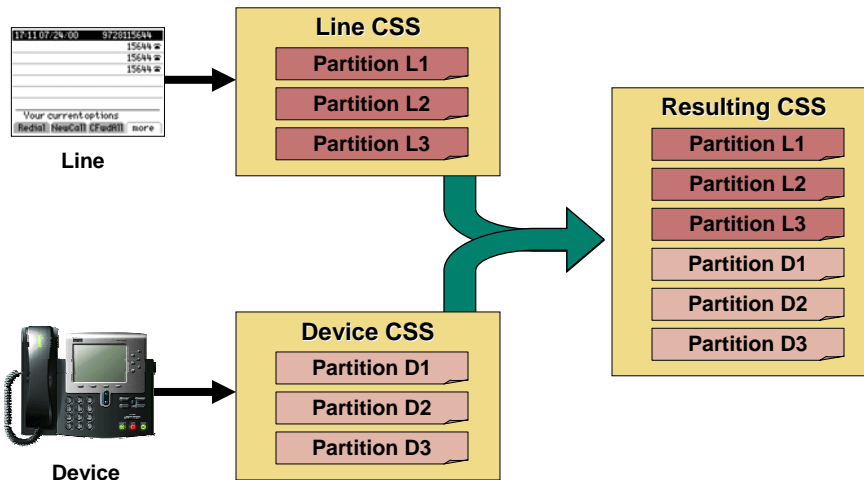
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Partitions and Calling Search Spaces Device CSS-Line CSS Interaction

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Resulting CSS is concatenation of Line CSS and Device CSS

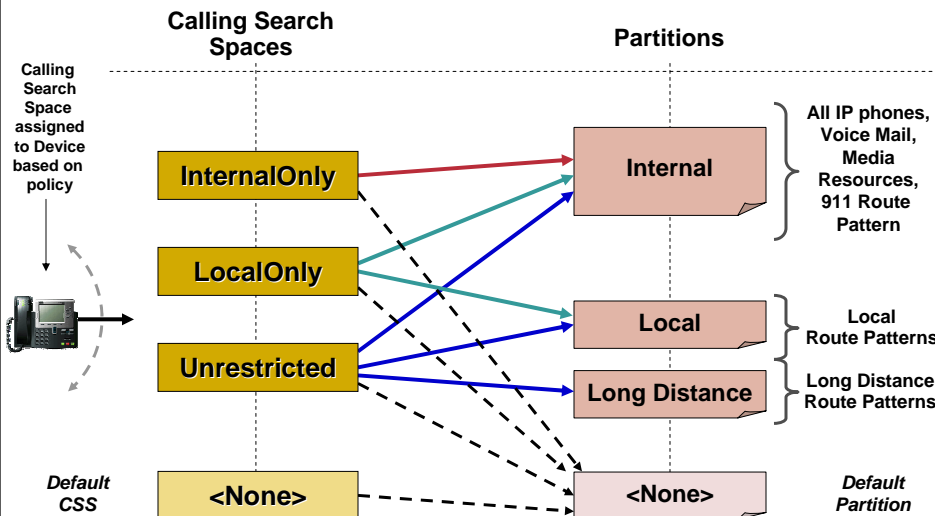
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Partitions and Calling Search Spaces Typical Use and Default Values

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