

Dial Plan Design for IP Telephony Networks

(Based on Networkers 2003 Session VVT-4010)

Q³: Quick Quiz Question

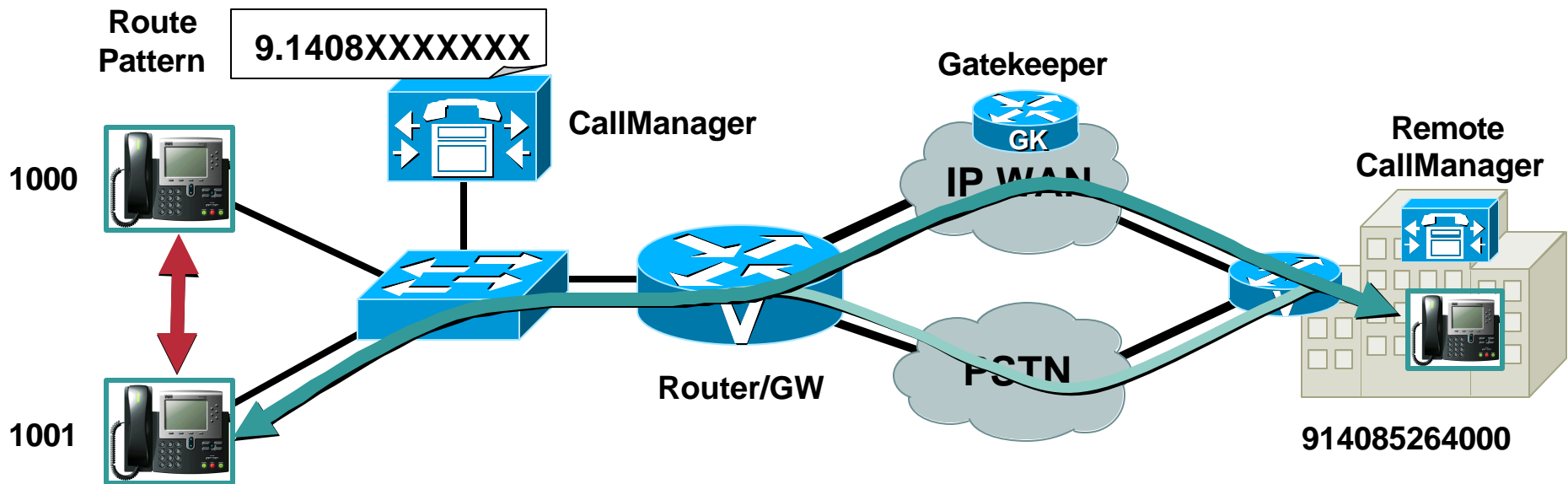
- **Please try to answer for yourself the following question**
- **We will immediately give you the answer**
- **And the rest of the presentation contains the information to back up our answer!**

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

Cisco.com



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

Session Scope and Objectives

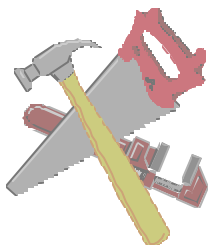
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- **Learn how to build an enterprise IP telephony dial plan**
- **Design based on CallManager 3.2 or higher**
- **Aspects we will cover:**
 - Dial plan operation**
 - Design best practices**
 - Caveats and recommendations**
- **Many US/Canada based examples were left in the preso (e.g. 911 v.s.: 080). We will highlight the differences as applicable.**

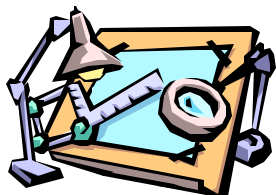
Agenda



- **IP Telephony Deployment Models**



- **Cisco CallManager Dial Plan Toolkit**



- **Dial Plan Design Guidelines**



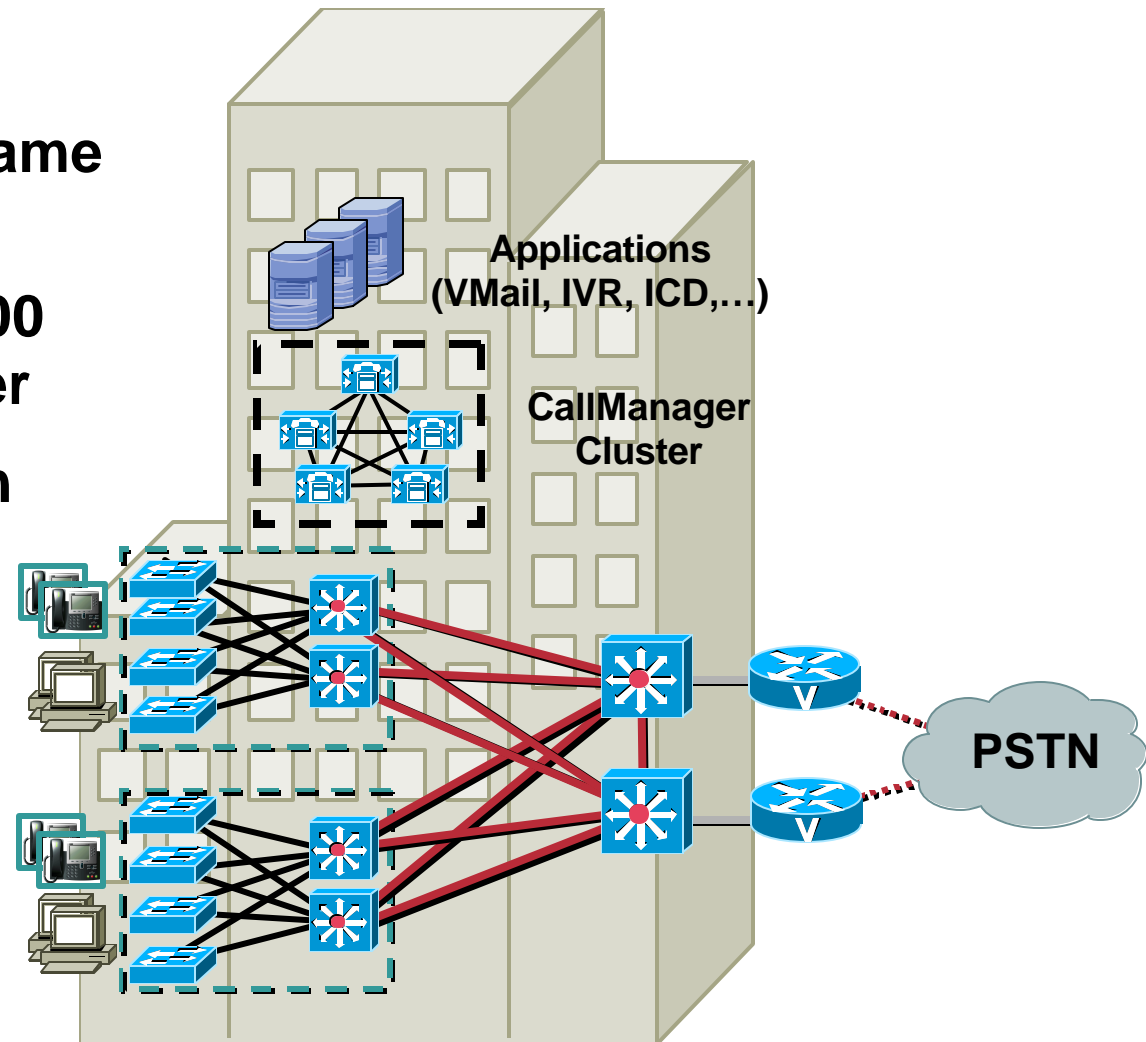
- **Conclusions**

IP Telephony Deployment Models

Single Site

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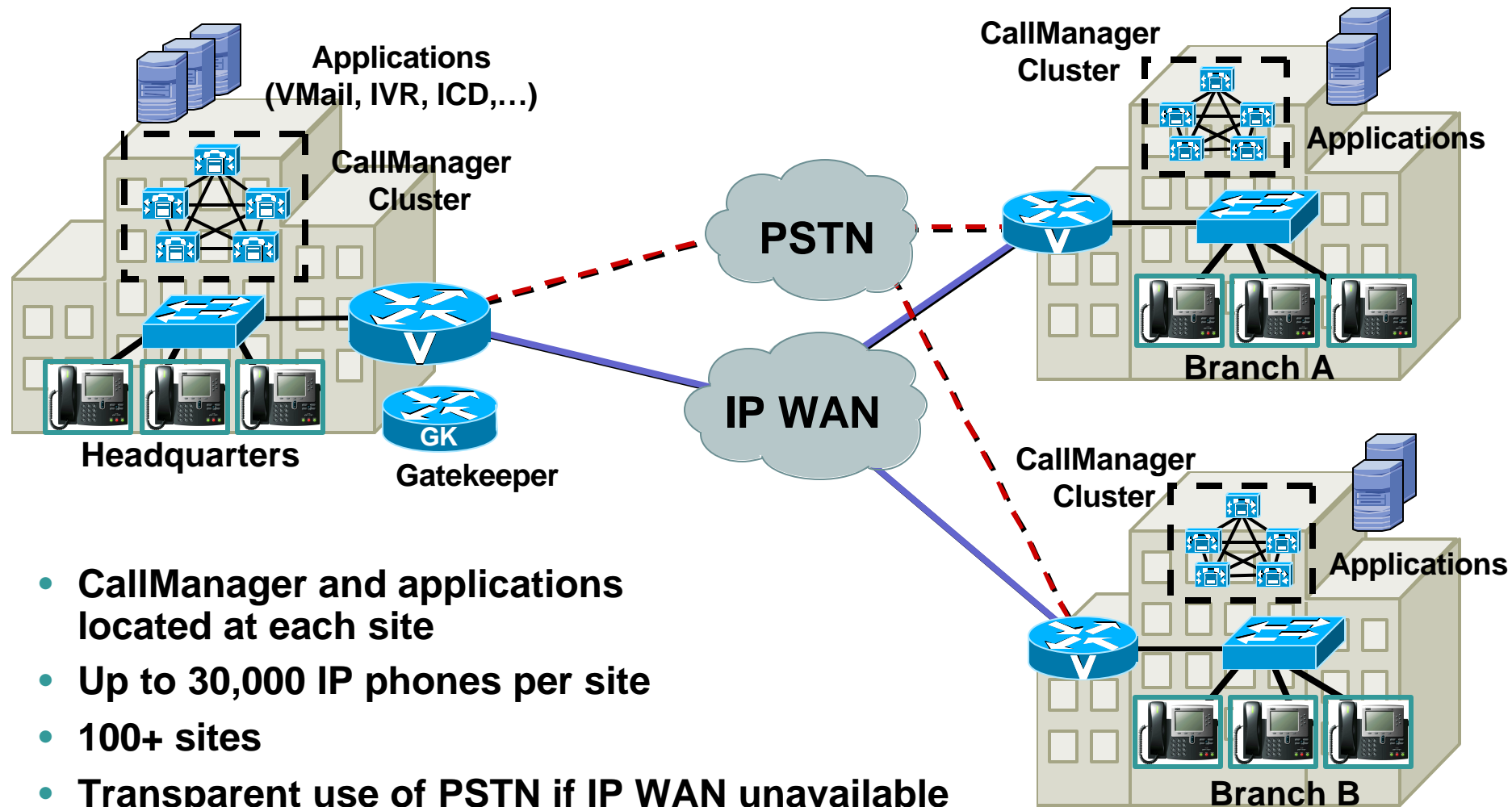
- Cisco CallManager, Applications and DSP Resources at same physical location
- Supports up to 30,000 IP phones per cluster
- Multiple clusters can be interconnected via Inter-Cluster trunks
- PSTN used for all external calls



IP Telephony Deployment Models

Distributed Call Processing

Cisco.com

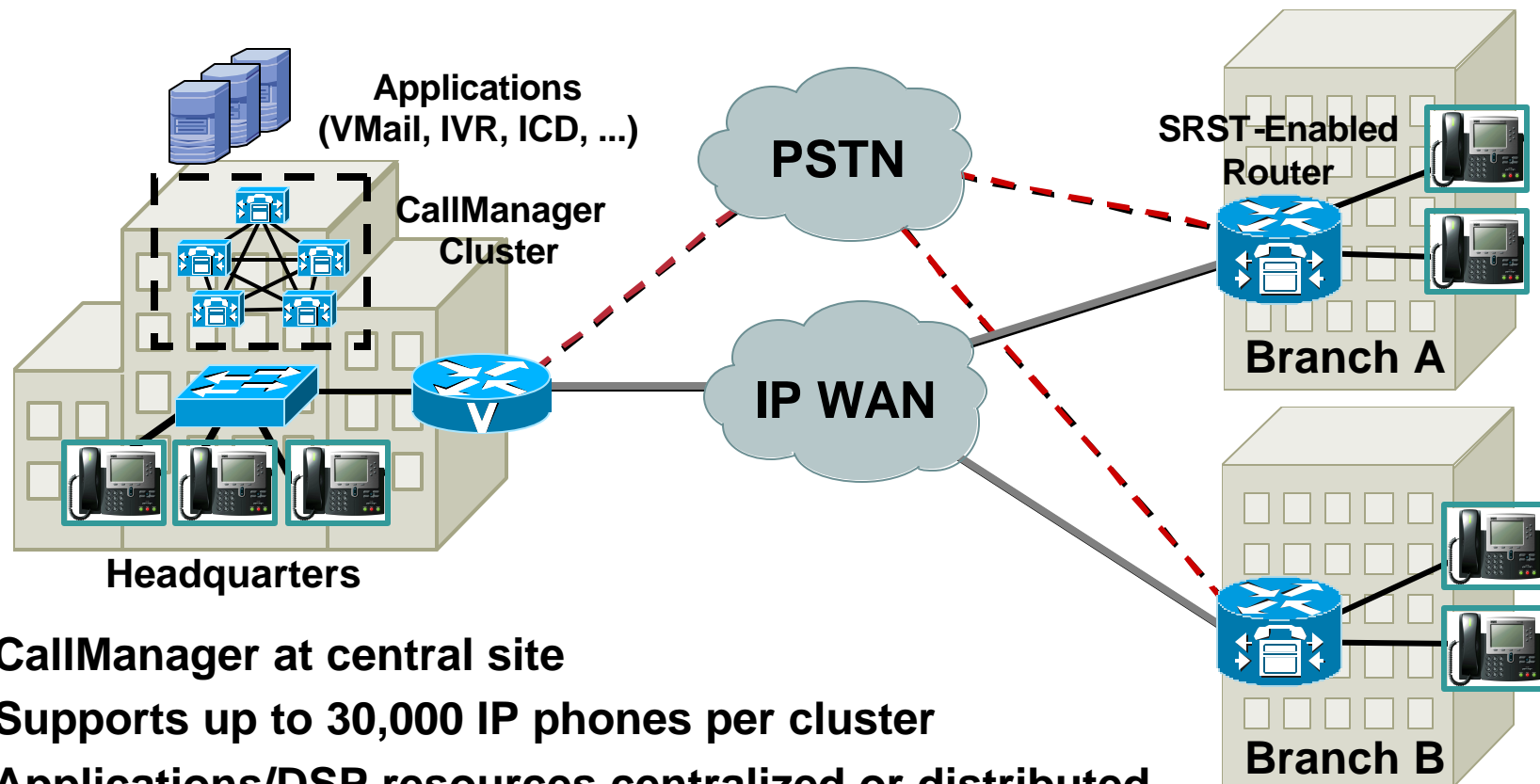


- CallManager and applications located at each site
- Up to 30,000 IP phones per site
- 100+ sites
- Transparent use of PSTN if IP WAN unavailable

IP Telephony Deployment Models

Centralized Call Processing

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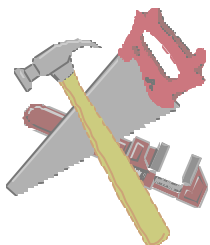


- **CallManager at central site**
- **Supports up to 30,000 IP phones per cluster**
- **Applications/DSP resources centralized or distributed**
- **Survivable Remote Site Telephony for remote branches**
- **PSTN access at each remote branch and/or central site**
- **Transparent use of PSTN if IP WAN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

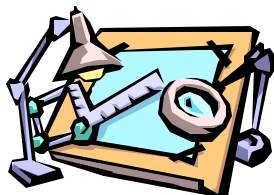
Agenda



- **IP Telephony Deployment Models**



- **Cisco CallManager Dial Plan Toolkit**



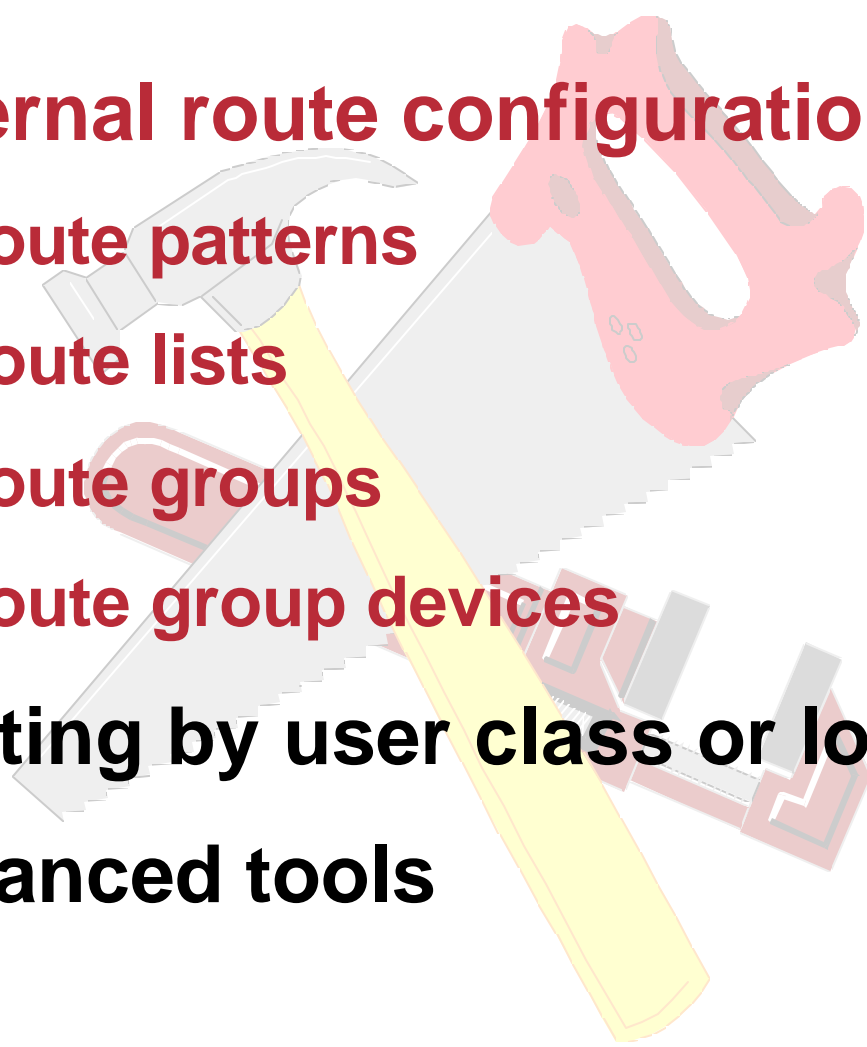
- **Dial Plan Design Guidelines**



- **Conclusions**

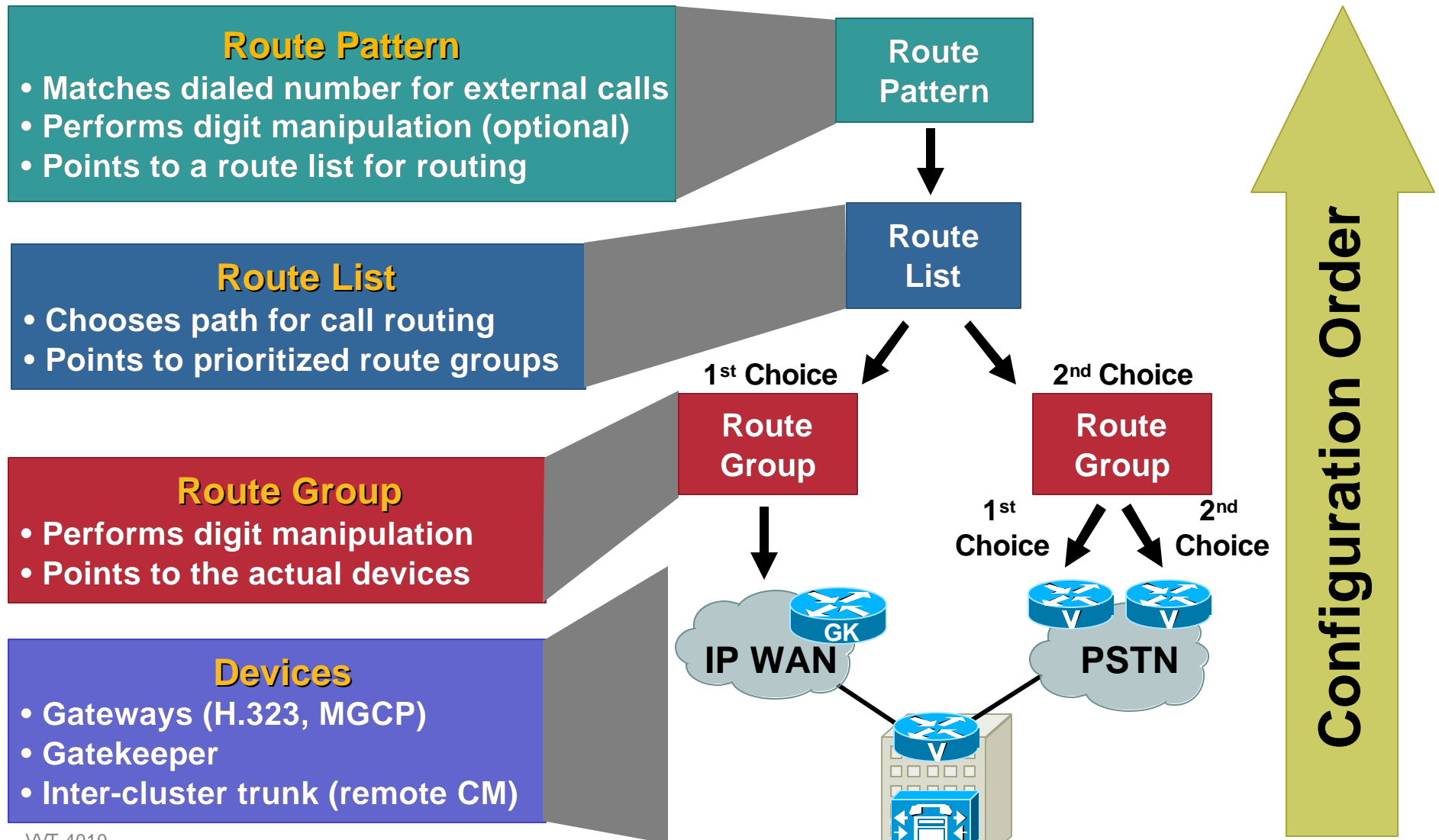
CallManager Dial Plan Toolkit

Cisco.com

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

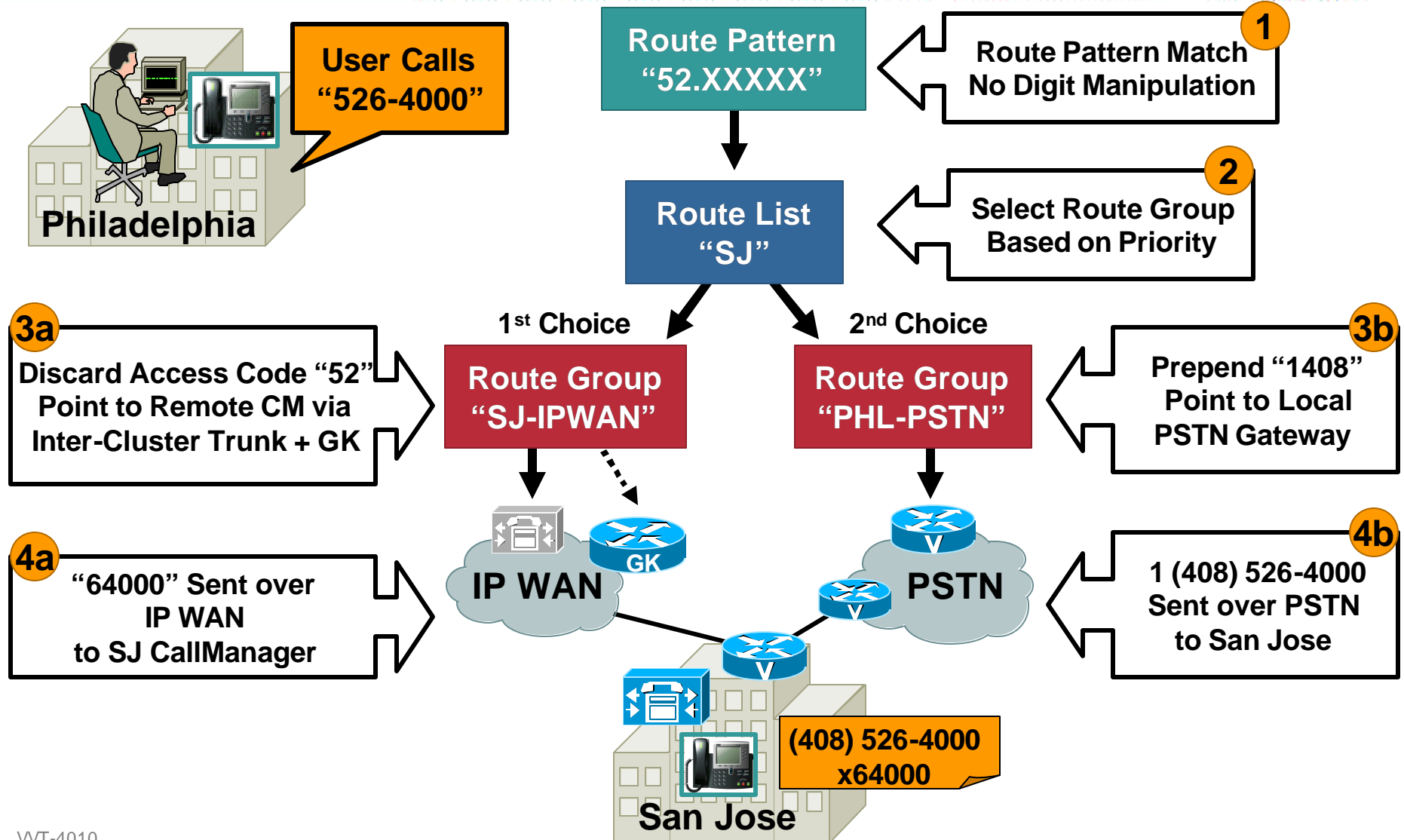
External Route Elements in CallManager

Cisco.com

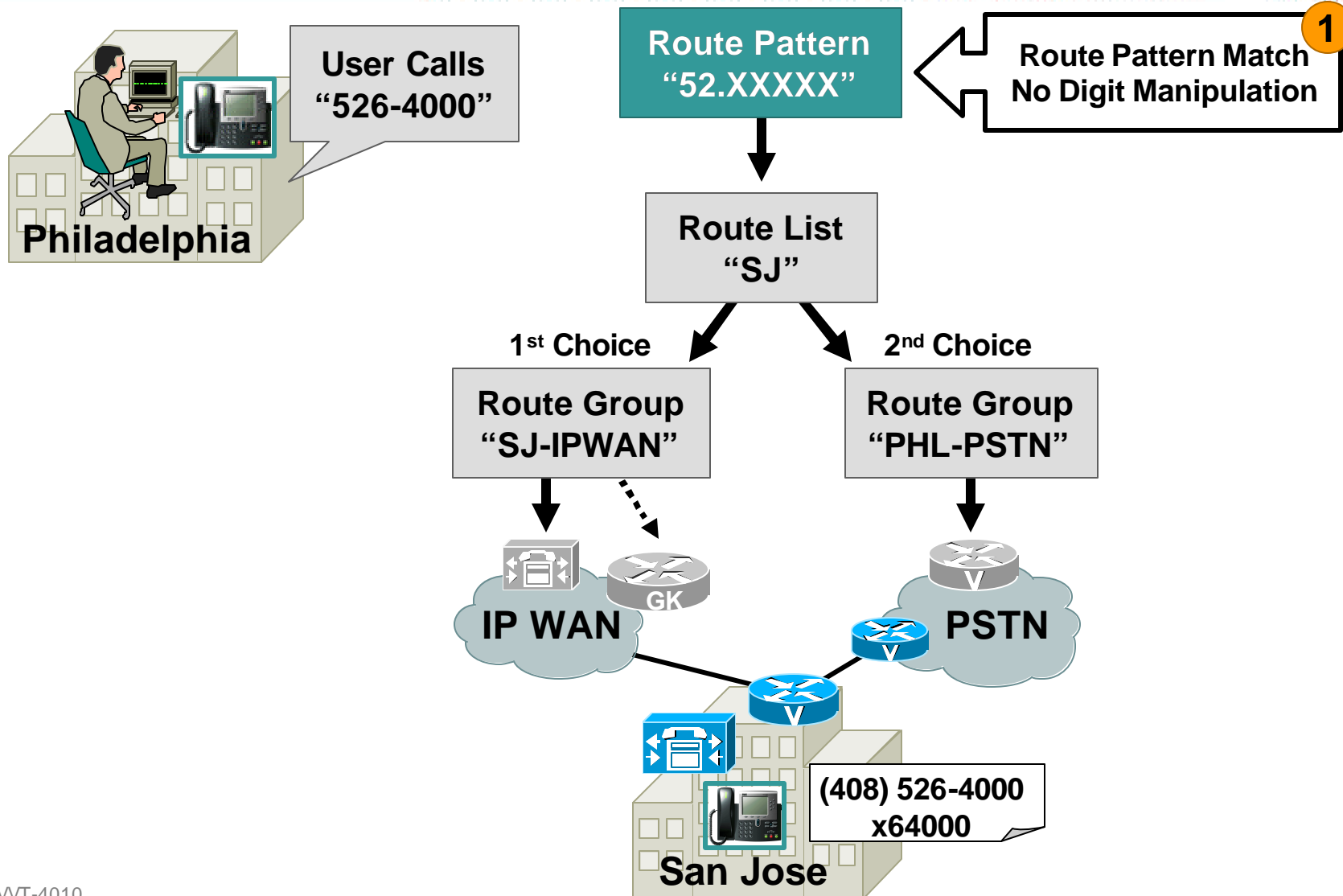


External Route Example: PHL to SJ

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Route Patterns



Route Pattern Configuration

SystemRoute PlanServiceFeatureDeviceUserApplicationHelpLogout

Cisco CallManager Administration
For Cisco IP Telephony Solutions

CISCO SYSTEMS

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

Pattern Definition

Route Pattern*	52.XXXXXX
Partition	IPWAN
Description	San Jose off-net
Numbering Plan*	North American Numbering Plan
Route Filter	< None >
Gateway/Route List*	SJ
Route Option	<input checked="" type="radio"/> Route this pattern <input type="radio"/> Block this pattern
<input checked="" type="checkbox"/> Provide Outside Dial Tone	<input type="checkbox"/> Urgent Priority

Calling Party Transformations

Use Calling Party's External Phone Number Mask

Calling Party Transform Mask

Prefix Digits (Outgoing Calls)

Calling Party Presentation

Called Party Transformations

Discard Digits

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

Partition
Determines WHO Can Reach 52.XXXXXX

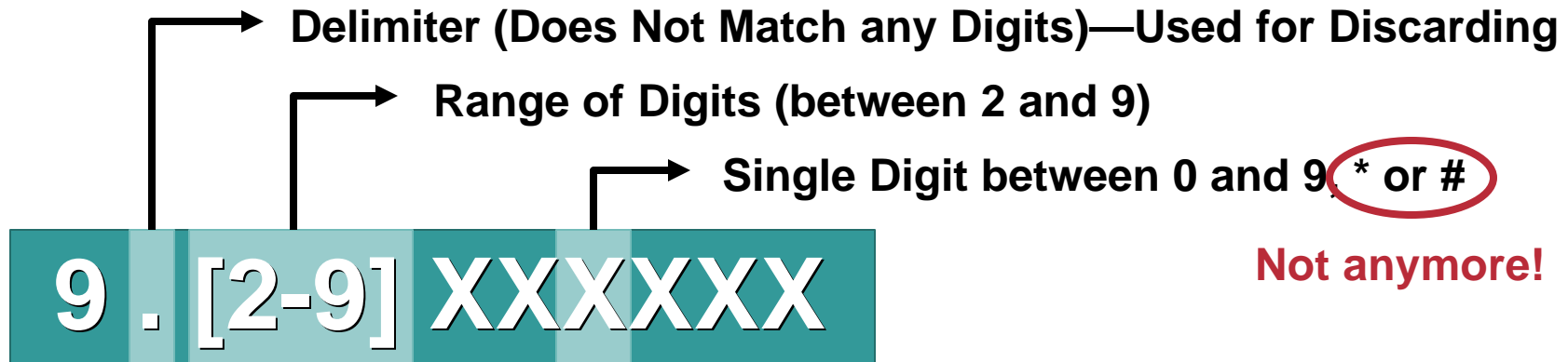
Route List
Defines HOW to Reach 52.XXXXXX

Digit Manipulation
Not Recommended in Route Pattern

Route Patterns

Commonly Used Wildcards

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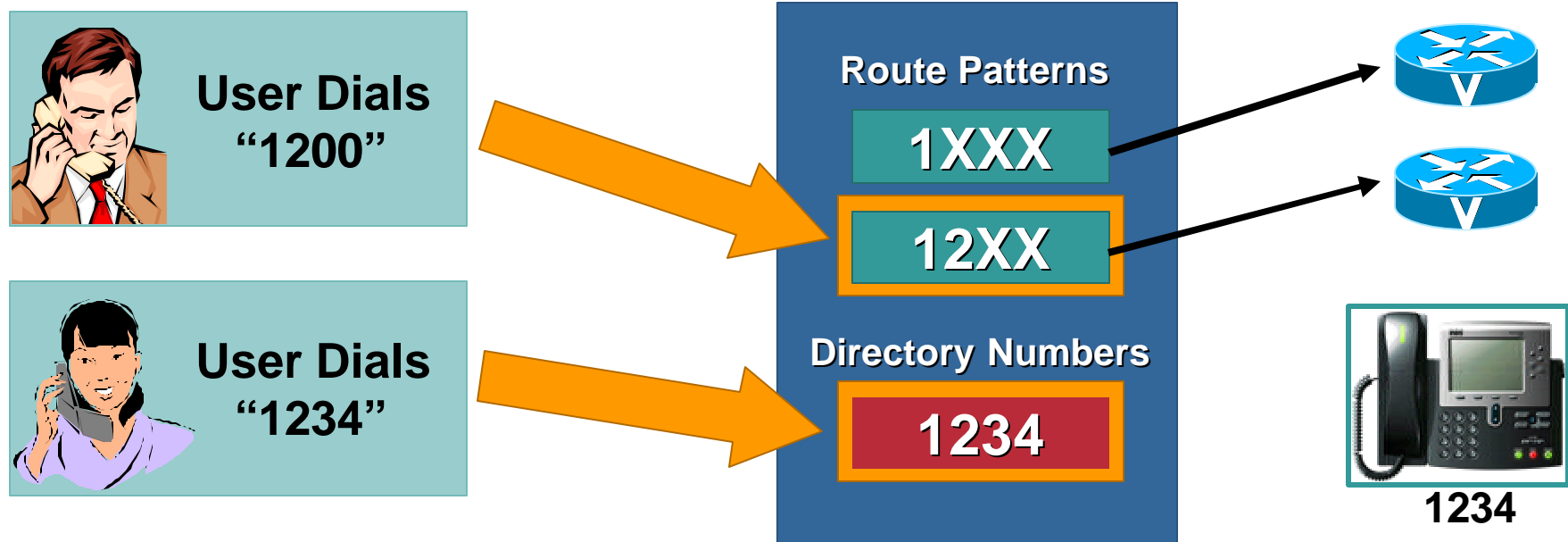


Route Patterns

CallManager Call Routing Logic

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CallManager Call Routing Logic



- **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**

Route Patterns

CallManager Call Routing Logic

Cisco.com

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

Cisco.com

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

Cisco.com

Configured Route Patterns

User's Dial String:

1

CallManager Actions:

Break 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="1")  
Digit analysis: potentialMatches=PotentialMatchesExist
```

Route Patterns

CallManager Call Routing Logic

Cisco.com

Configured Route Patterns

User's Dial String:

13

CallManager Actions:

Wait

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

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

Route Patterns

CallManager Call Routing Logic

Cisco.com

Configured Route Patterns

User's Dial String:

131

CallManager Actions:

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

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

```
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

CallManager Actions:

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

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

```
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>

CallManager Actions:

Extend Call to the **Best Match**

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

Route Patterns

CallManager Call Routing Logic

Cisco.com

Configured Route Patterns

User's Dial String:

1311<Timeout>

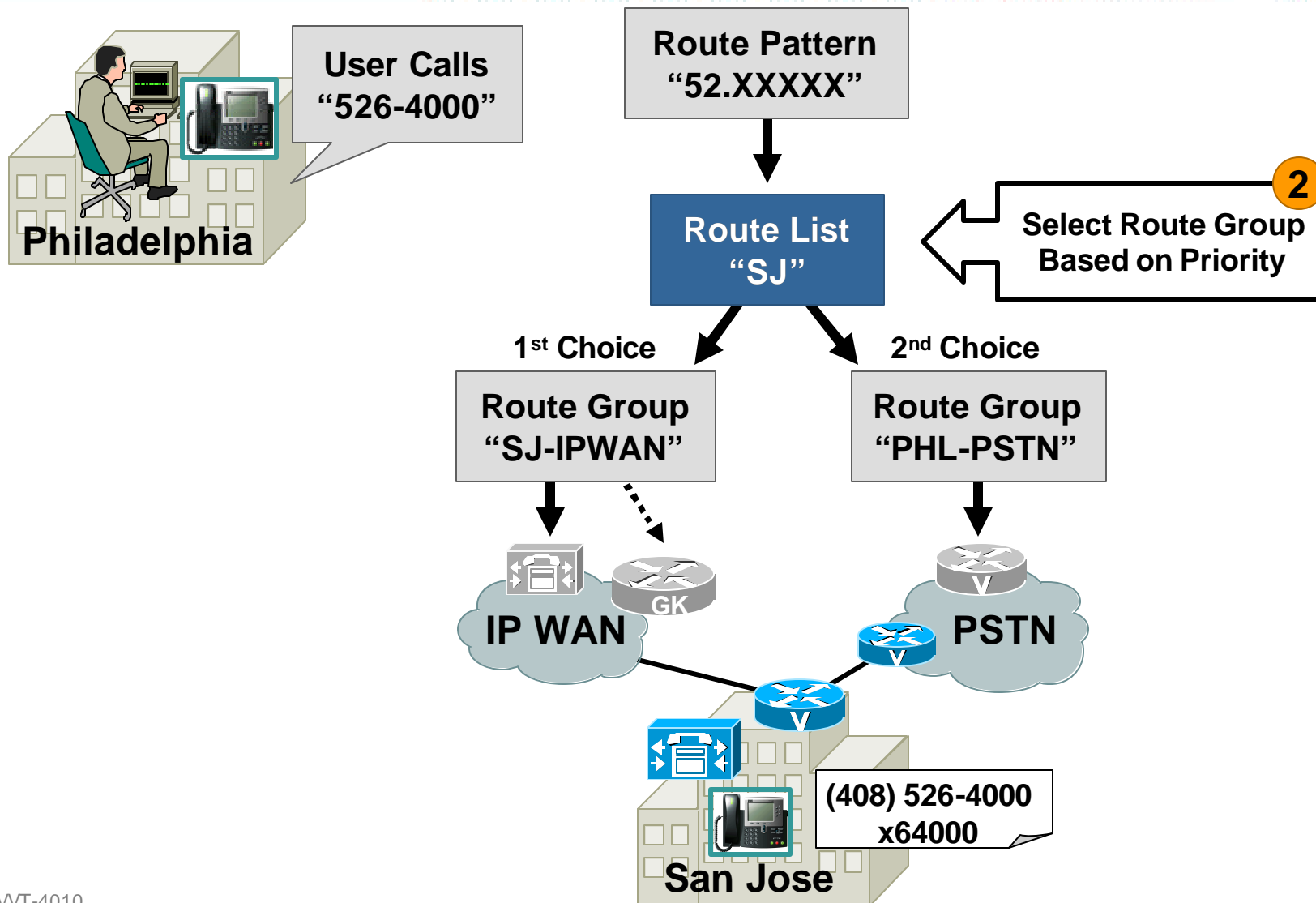
Matches 200 Digit Strings

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 Given the Number of Digits Dialed

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

Route Lists

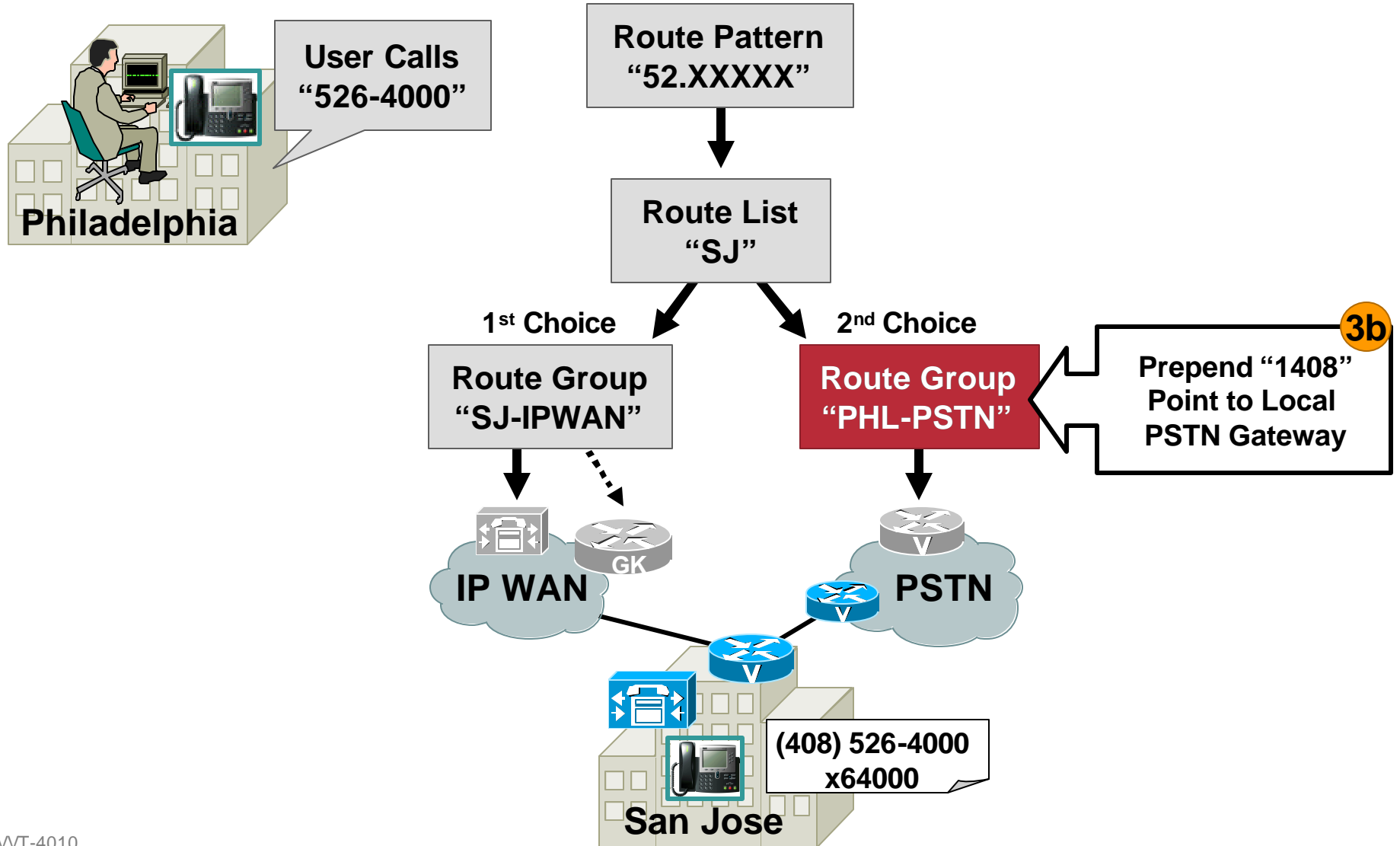


Route Lists Configuration

The screenshot displays the Cisco CallManager Administration web interface. At the top, there is a navigation menu with options: System, Route Plan, Service, Feature, Device, User, Application, and Help. Below the menu is a header bar with the Cisco CallManager Administration logo and the Cisco Systems logo. The main content area is titled "Route List Configuration". On the left, there is a tree view showing various route lists: gearanto-PSTN, PHL, and PIT. The "SJ" route list is selected and highlighted with a red box. The main configuration area for "Route List: SJ" shows its status as "Ready". There are buttons for "New", "Update", "Delete", and "Cancel". Below these are input fields for "Route List Name*" (containing "SJ") and "Description". There are also buttons for "Add Route Group" and "Remove Route Group(s)". A list box shows "Route Groups selected ordered by highest priority" with "SJ IPWAN" and "PHL PSTN" listed. A red arrow points from a callout box to the "Remove Route Group(s)" button.

- 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 Groups

Viewed from within the Route List

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The screenshot displays the Cisco CallManager Administration interface. The top banner includes the Cisco logo and the text "Cisco CallManager Administration For Cisco IP Telephony Solutions". The main heading is "Route Details Configuration". On the left, a sidebar lists various route groups, with "Route Details for PHL PSTN" highlighted in a red box. The main content area shows configuration for "Route List: SJ" and "Route Group: PHL PSTN", with a status of "Ready". Below this are sections for "Calling Party Transformations" and "Called Party Transformations". The "Called Party Transformations" section includes a "Prefix Digits" field containing "1408". A red arrow points from a callout box to this field.

Note:

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

Digit Manipulation
Prepend "1408"

Route Groups

Digit Manipulation Notes

Cisco.com

The screenshot shows the configuration page for Route Groups, divided into two sections: **Calling Party Transformations** and **Called Party Transformations**. In the **Calling Party Transformations** section, the checkbox **Use Calling Party's External Phone Number Mask** is checked. Below it is a text input field for **Calling Party Transform Mask**. In the **Called Party Transformations** section, the **Discard Digits** dropdown menu is set to **PreDot 11D->10D**. Below it are text input fields for **Called Party Transform Mask** and **Prefix Digits (Outgoing Calls)**. Three red arrows point from callout boxes on the right to these specific fields: the top arrow points to the checked checkbox, the middle arrow points to the **Calling Party Transform Mask** field, and the bottom arrow points to the **Called Party Transform Mask** field.

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)

Callouts:

- 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**

Route Groups Standalone View

System Route Plan Service Feature Device User Application Help

Cisco CallManager Administration
For Cisco IP Telephony Solutions

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Route Group Configuration

Route Group Name : SJ IPWAN
Status: Ready

New Update Delete Cancel

Route Group Name* SJ IPWAN

Add Device Remove Device

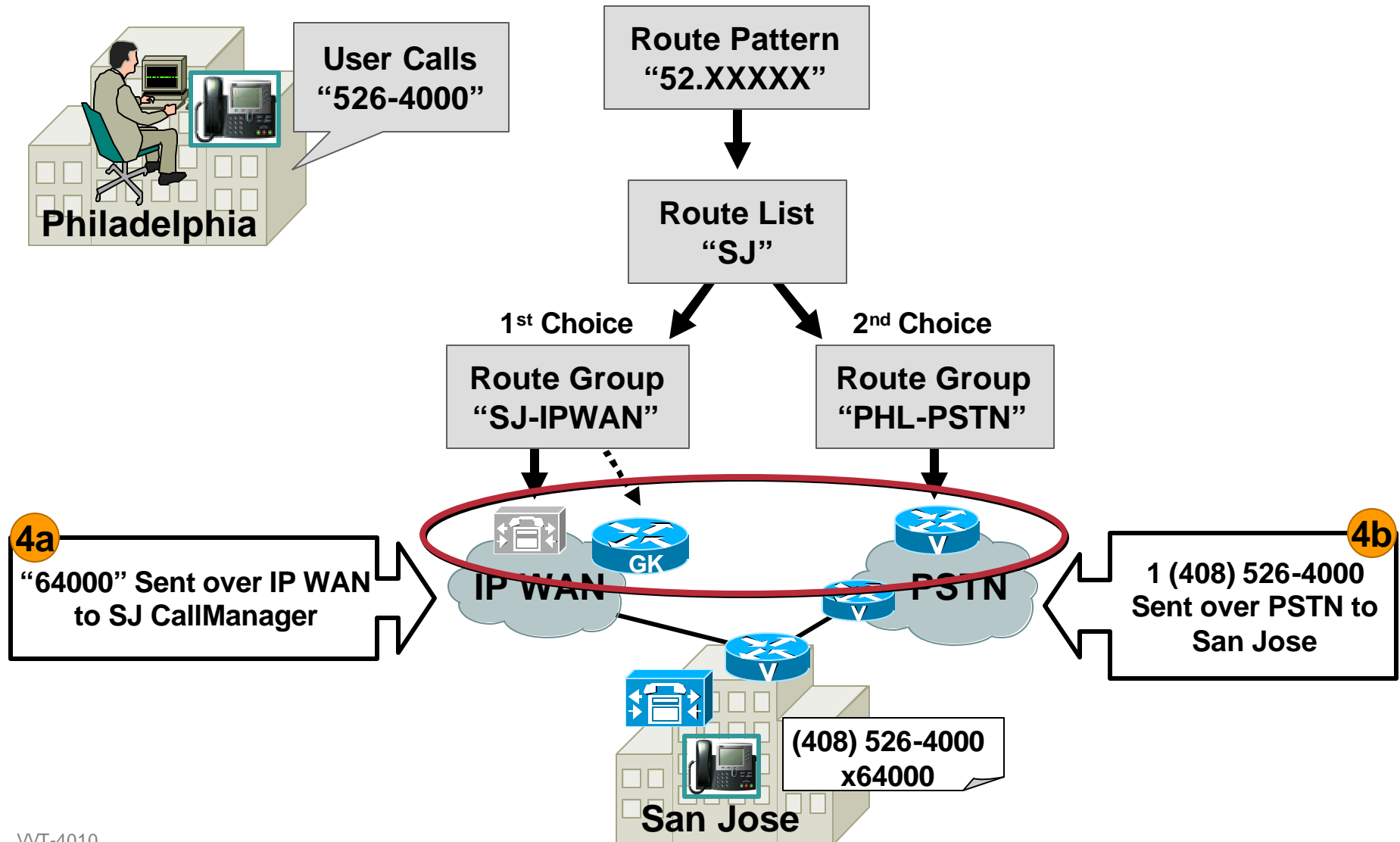
Devices for SJ IPWAN

Device	Port	Order
<input type="checkbox"/> 10.1.20.1	All	1

* indicates required item

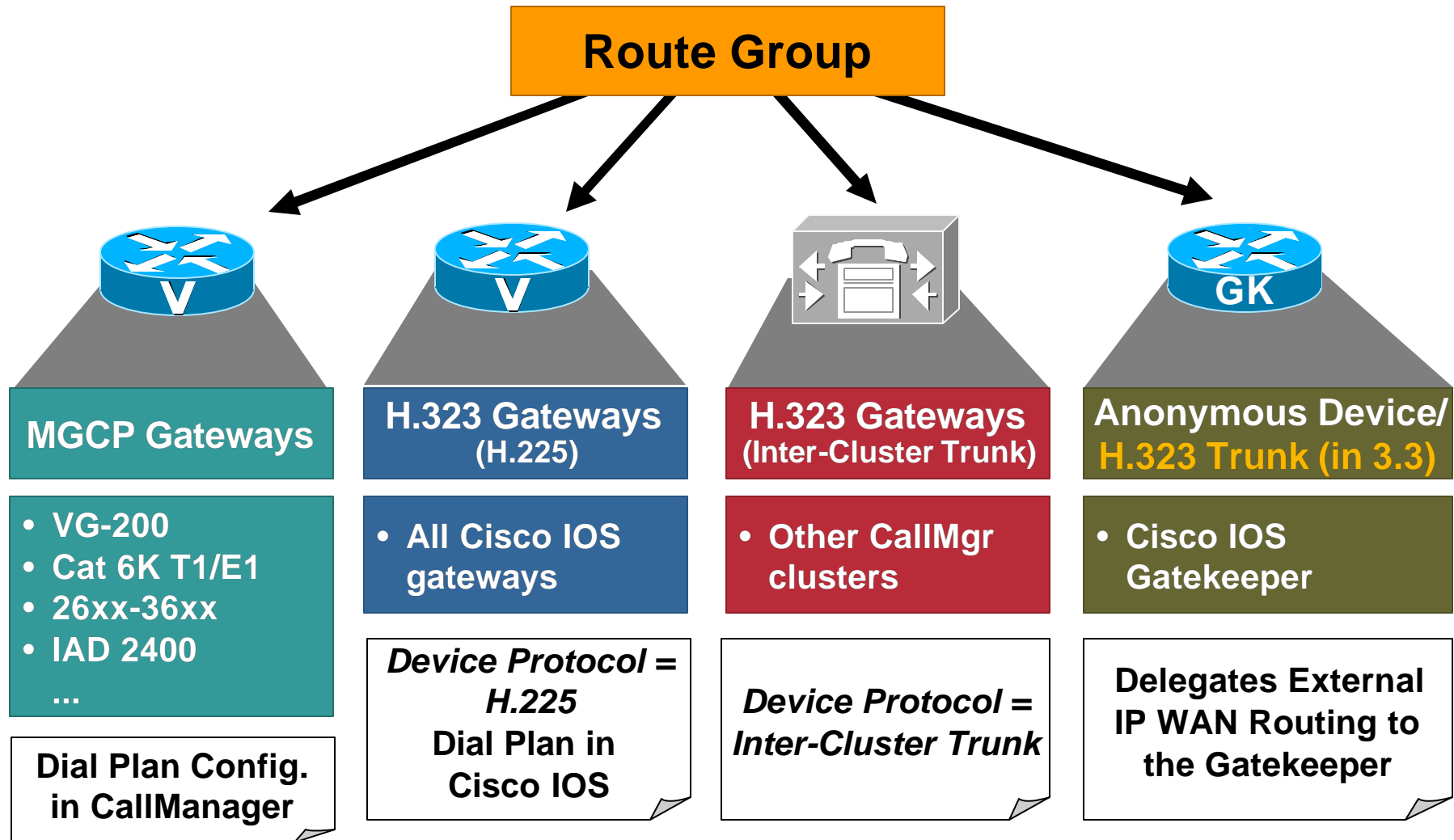
Actual Device(s) Pointed by the Route Group

Route Group Devices



Route Group Devices

Device Types



Route Group Devices

H.323 Gateway Configuration (CallManager)

Cisco.com

Gateway Configuration

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	<input type="checkbox"/>
Gatekeeper Name	< None >
Media Termination Point Required	<input type="checkbox"/>
Num Digits*	23
Sig Digits	<input type="checkbox"/>
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

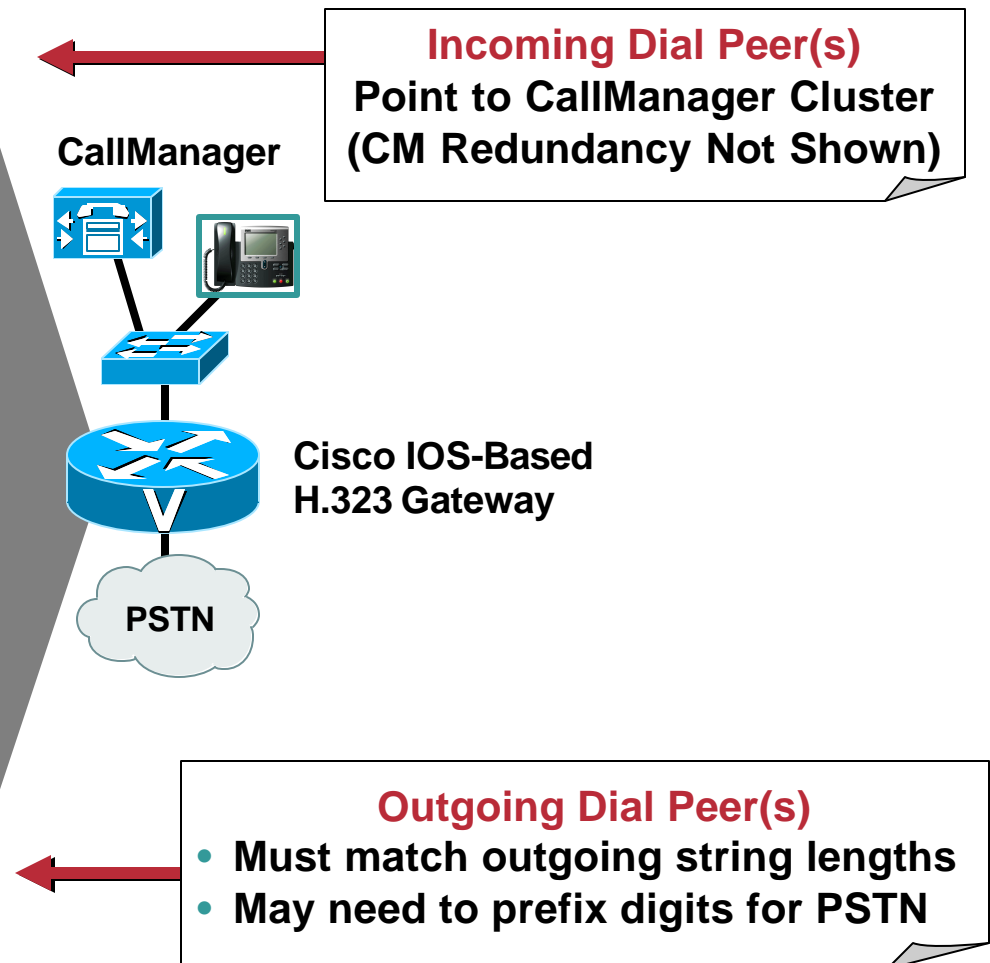
To Prefix Incoming Calls

Route Group Devices

H.323 Gateway Configuration (Cisco IOS)

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```
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)
```



Route Group Devices

“Anonymous Device” Configuration (Pre-3.3)

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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 selected

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”

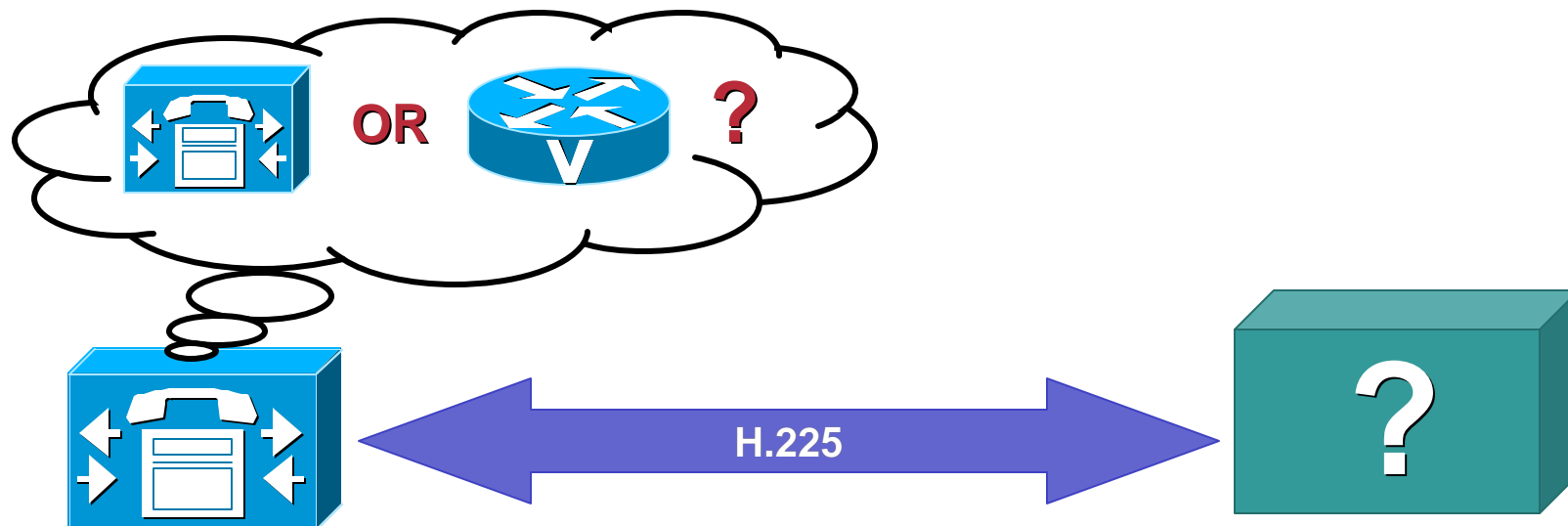
Device Protocol
In CallManager 3.2, this Is the
DEFAULT Device Protocol

Route Group Devices

Anonymous Device—Auto-Discovery

Cisco.com

- 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

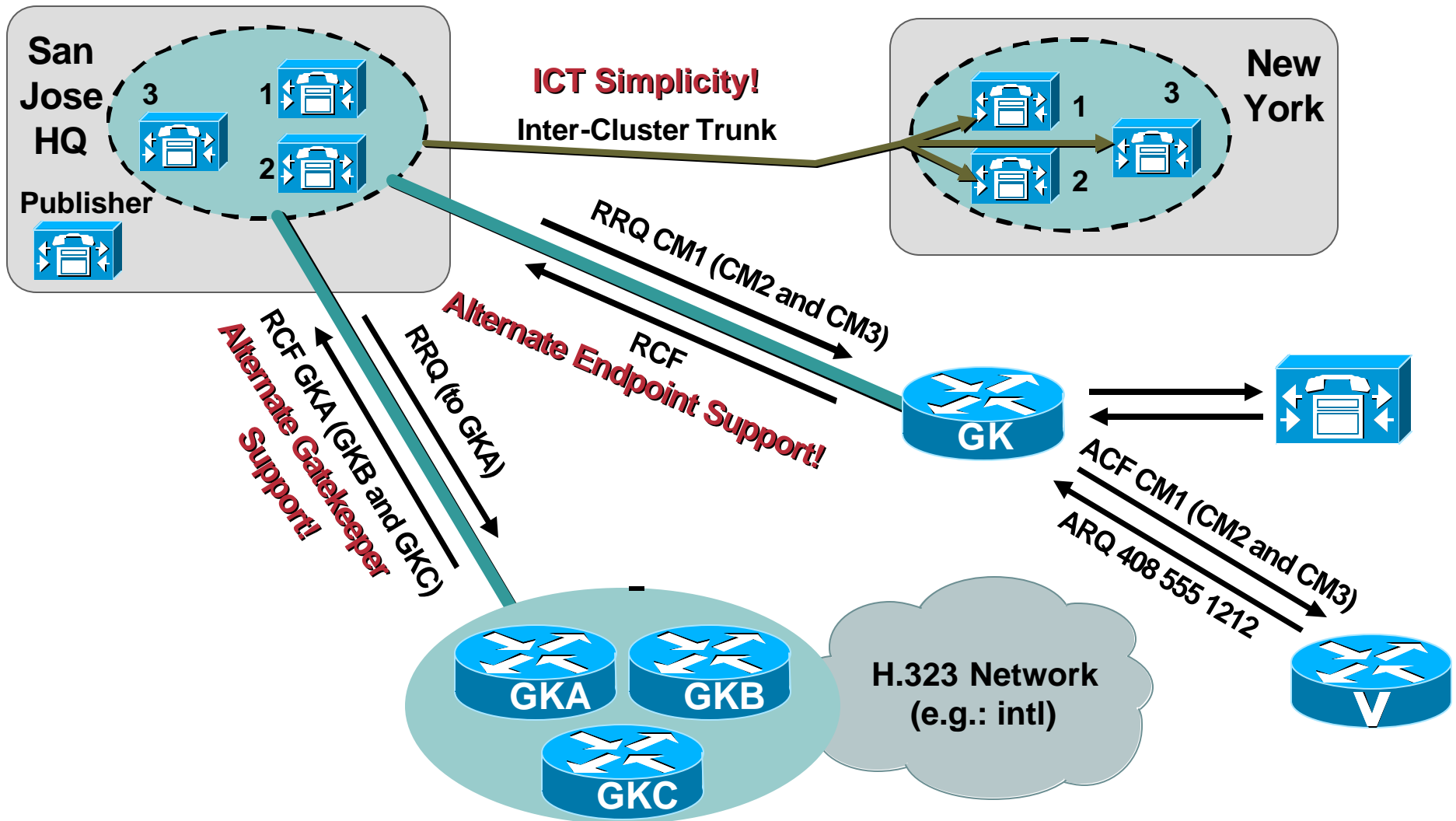


Use H.225 as Default Device Protocol if all CallManagers Are 3.2 or Later

Route Group Devices

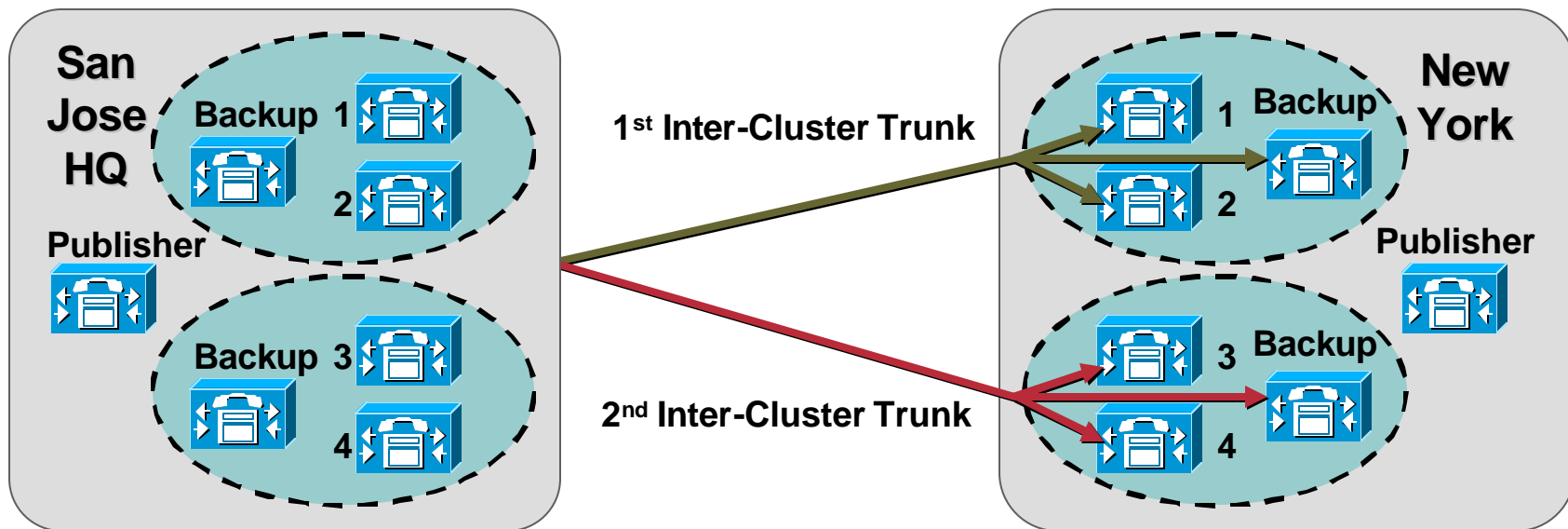
H.323 Trunks (3.3)—New Simplicity and Possibilities

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Inter-Cluster Trunks—Redundancy

Cisco.com



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)

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

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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

Device Information

Device Name*	<input type="text" value="EMEA_Trunk"/>
Description	<input type="text" value="EMEA_Trunk from SF"/>
Device Pool*	<input type="text" value="SF"/>
Media Resource Group List	<input type="text" value=" < None >"/>
Location	<input type="text" value=" < None >"/>
AAR Group	<input type="text" value="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

SystemRoute PlanServiceFeatureDeviceUserApplicationHelpLogout

Cisco CallManager Administration
For Cisco IP Telephony Solutions

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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
Description	EMEA Gatekeeper
Registration Request Time To Live	60
Registration Retry Timeout	300
Enable Device	<input checked="" type="checkbox"/>

* indicates required item

Up to 10 Gatekeepers Can Be Defined in CallManager 3.3

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

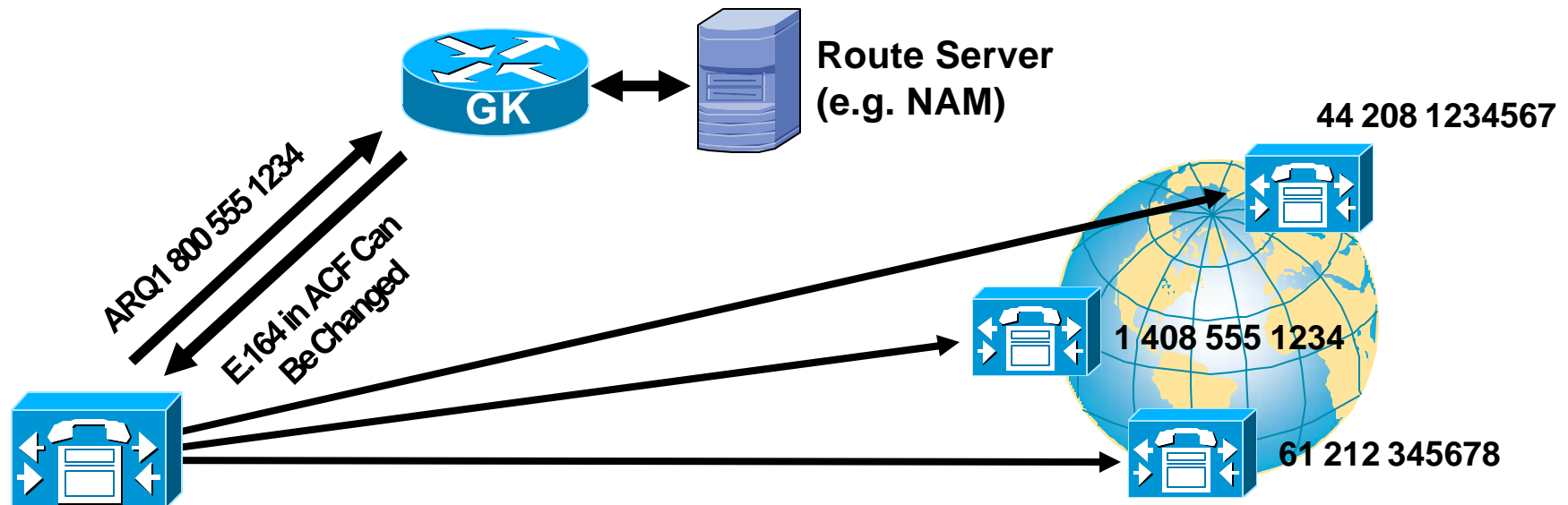
H.323 Trunk Possibilities

- **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**

H.323 Enhancements

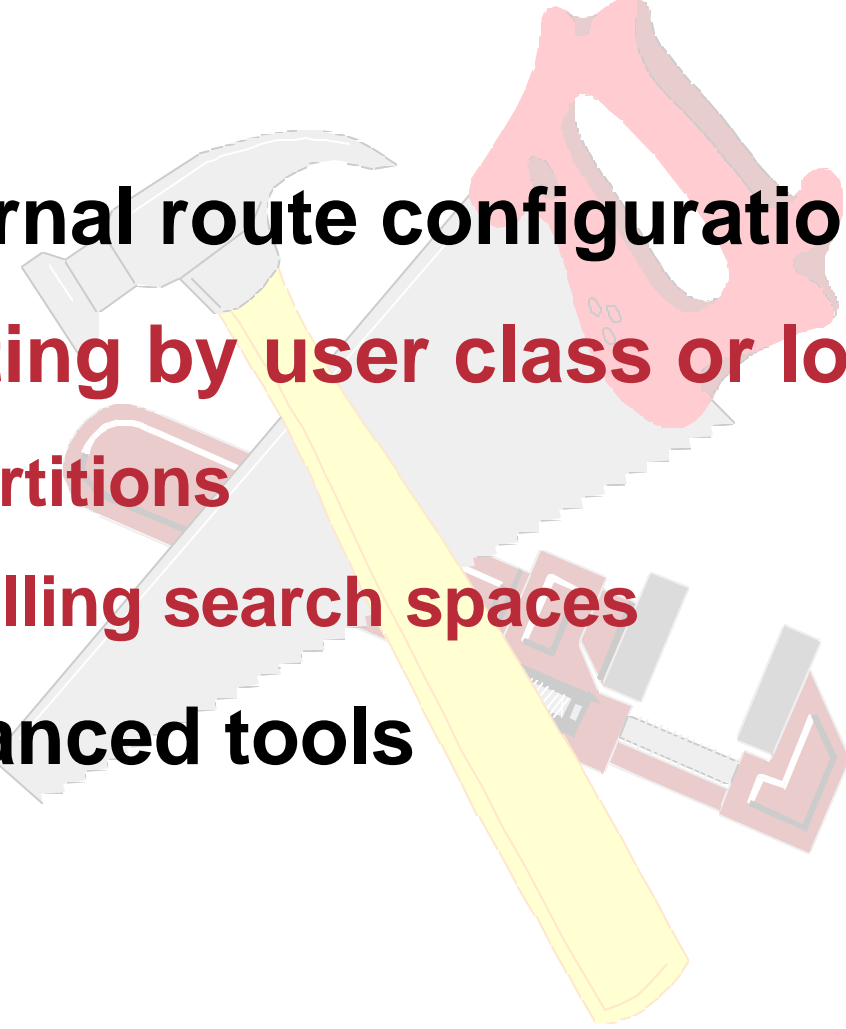
CanMapAlias

- 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



CallManager Dial Plan Tool Kit

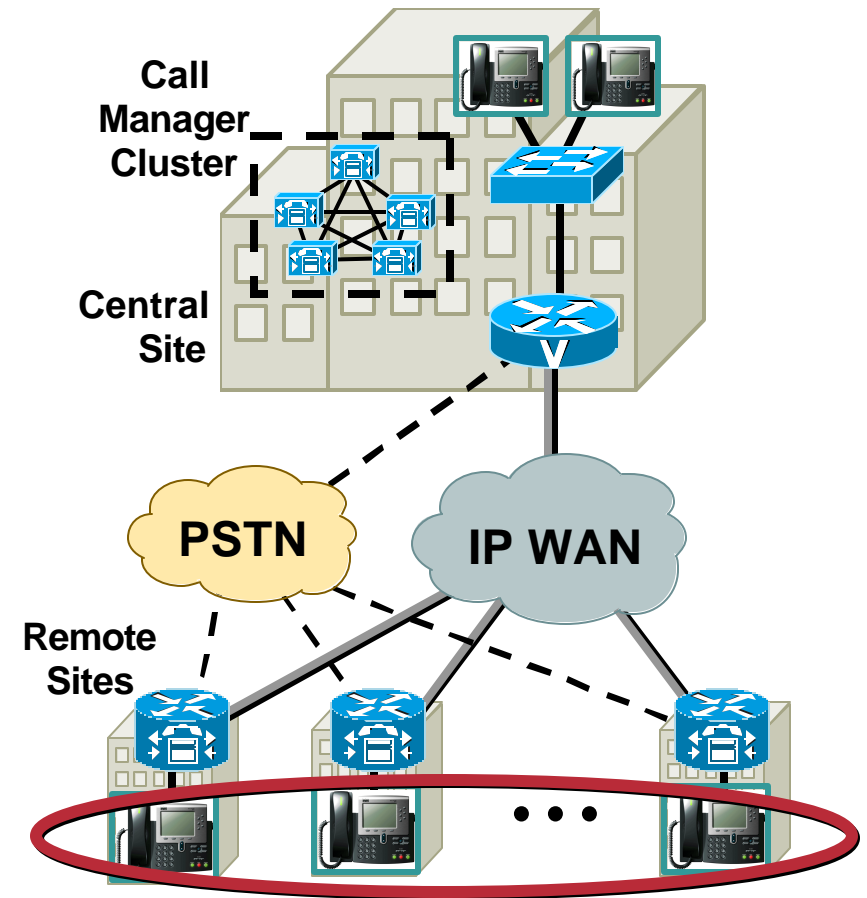
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- 
- **External route configuration**
 - **Routing by user class or location**
 - Partitions**
 - Calling search spaces**
 - **Advanced tools**

Routing by User Class or Location



**Create “Classes of Service”
to Define Calling Restrictions**

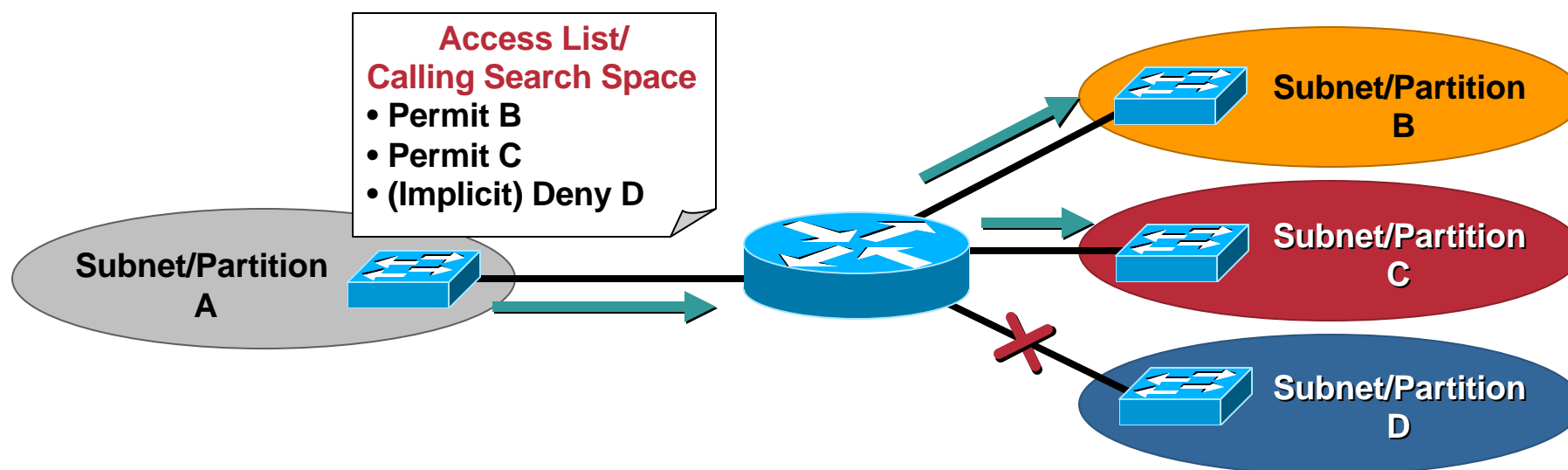


**Instruct Remote Phones to Use Their
Local Gateway for PSTN Access**

Partitions and Calling Search Spaces

Analogy with Subnets/Access Lists

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- **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

Partitions and Calling Search Spaces

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- **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

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

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



Rita

...the Call Will Go Through



Dave

305 555 5000

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

Partitions and Calling Search Spaces

Definition

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- **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

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**

Partitions and Calling Search Spaces Configuration

The screenshot shows the Cisco CallManager Administration interface. At the top, there is a navigation menu with options: System, Route Plan, Service, Feature, Device, User, Application, and Help. Below the menu is the Cisco CallManager Administration logo and the text 'For Cisco IP Telephony Solutions'. The main heading is 'Calling Search Space Configuration'. Underneath, it displays 'Calling Search Space: SJCExecutiveCS (in use)' with a status of 'Ready'. There are buttons for 'Copy', 'Update', 'Delete', 'Restart Devices', and 'Cancel Changes'. The 'Calling Search Space Information' section includes 'Calling Search Space Name*' (SJCInternationalCSS) and 'Description' (Allows International Calls). The 'Route Partitions for this Calling Search Space' section has two lists: 'Available Partitions' (ICDAgentsPartition, InboundTranslations, MILInternationalPartition, MILLocalPartition, MILNationalPartition) and 'Selected Partitions*' (ordered by highest priority) (InternalPartition, OnNetRoutes, SJCNationalPartition, SJCLocalPartition, SJCServicePartition). A red arrow points from a note box to the 'Selected Partitions*' list.

NOTE:

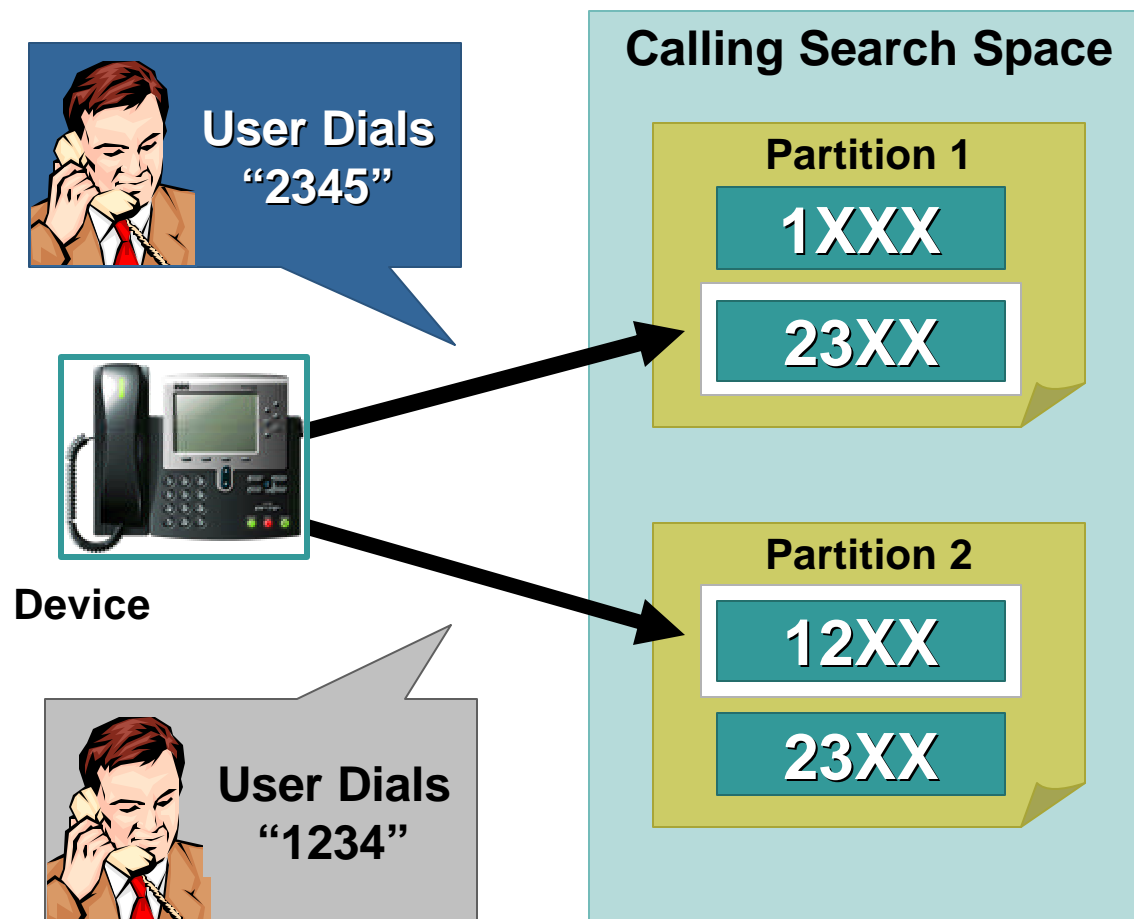
- CallManager Stores a CSS as colon-separated list of partitions
- Maximum length of CSS Is 512 bytes

List of Partitions that Can Be "Seen" by this Calling Search Space

Partitions and Calling Search Spaces

Impact of Partition Order

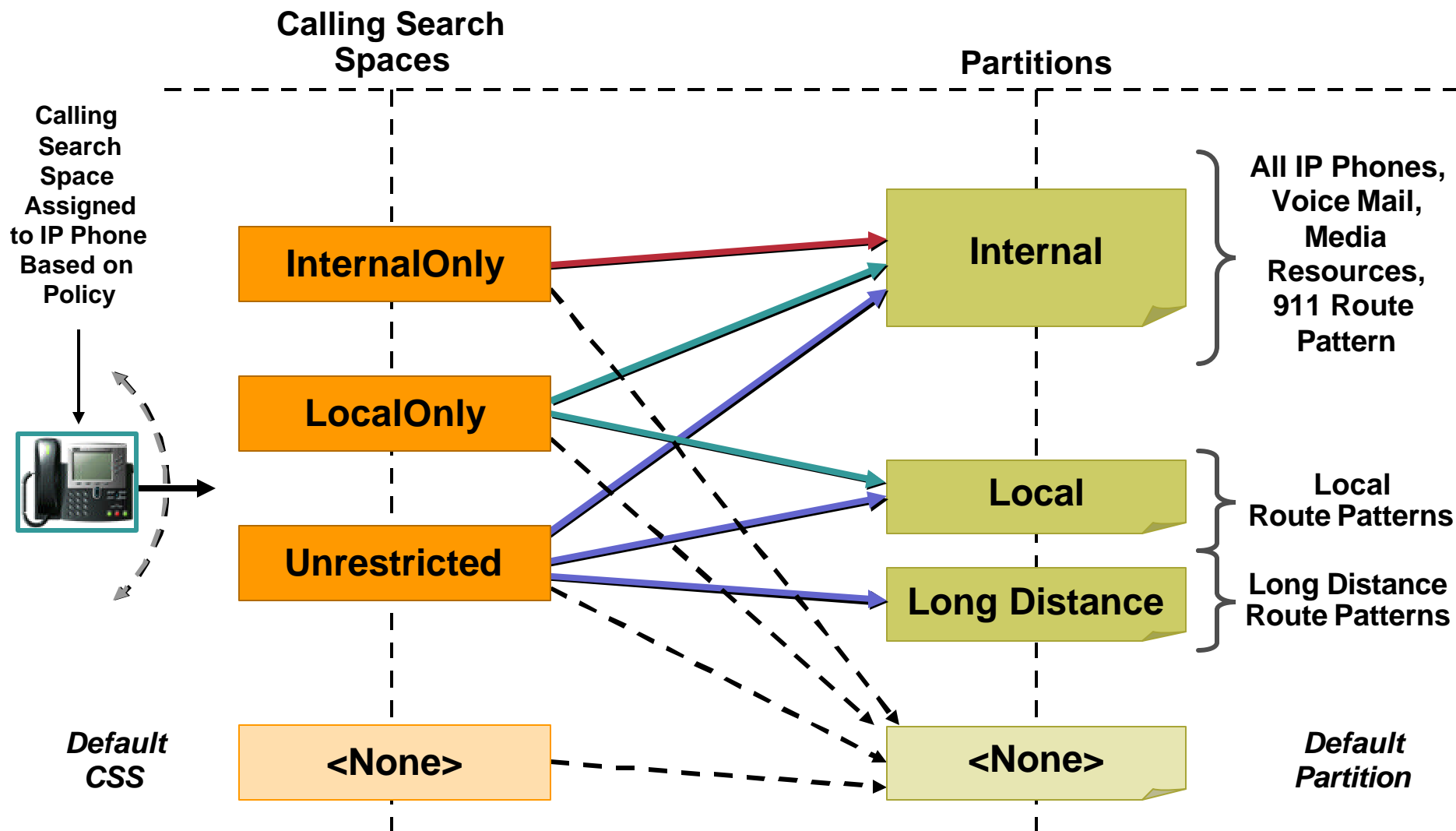
Cisco.com



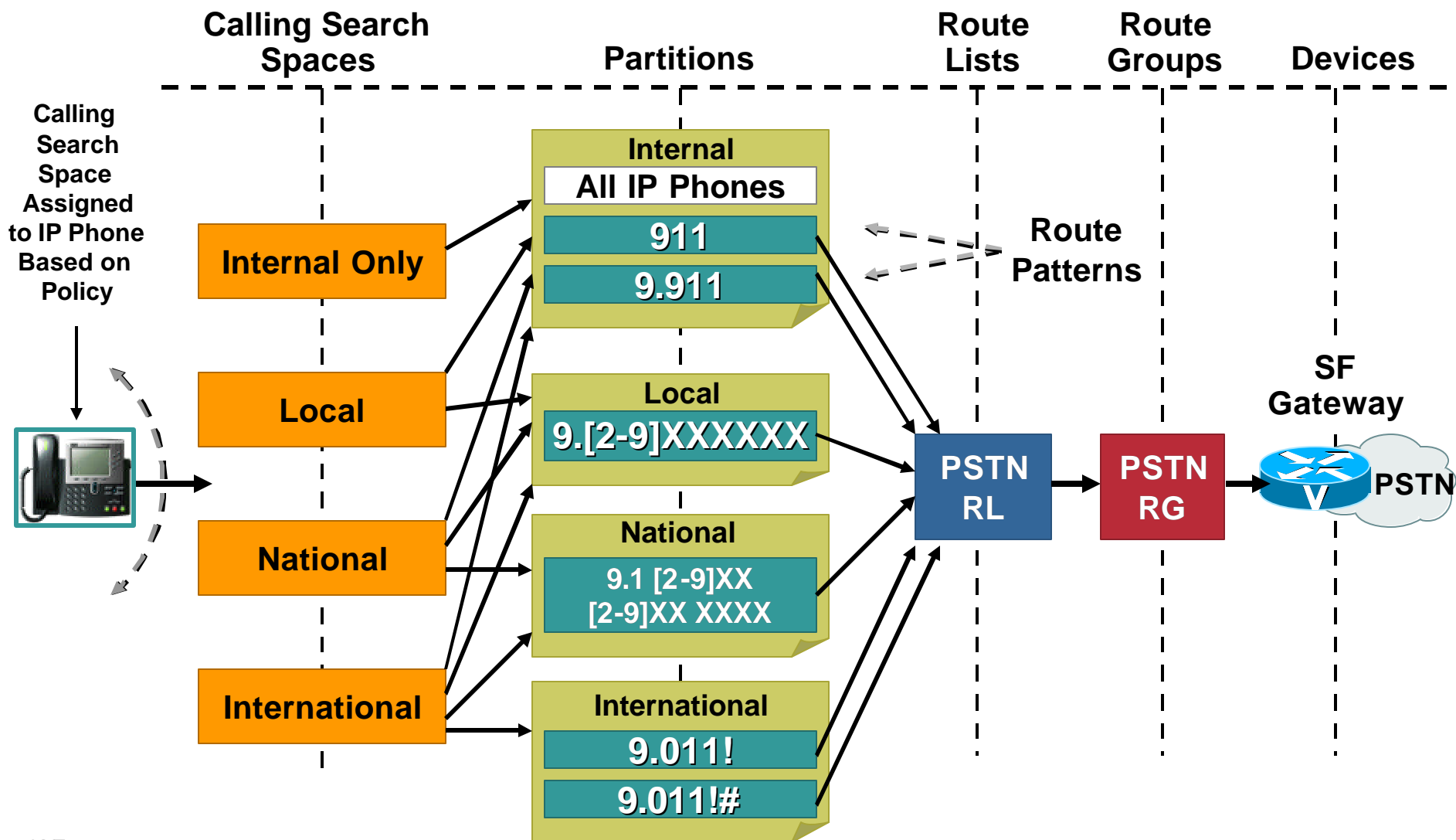
- Most specific patterns are chosen irrespective of partition order
- Partition order is only used as a **tie-breaker** in case of equal matches

Partitions and Calling Search Spaces

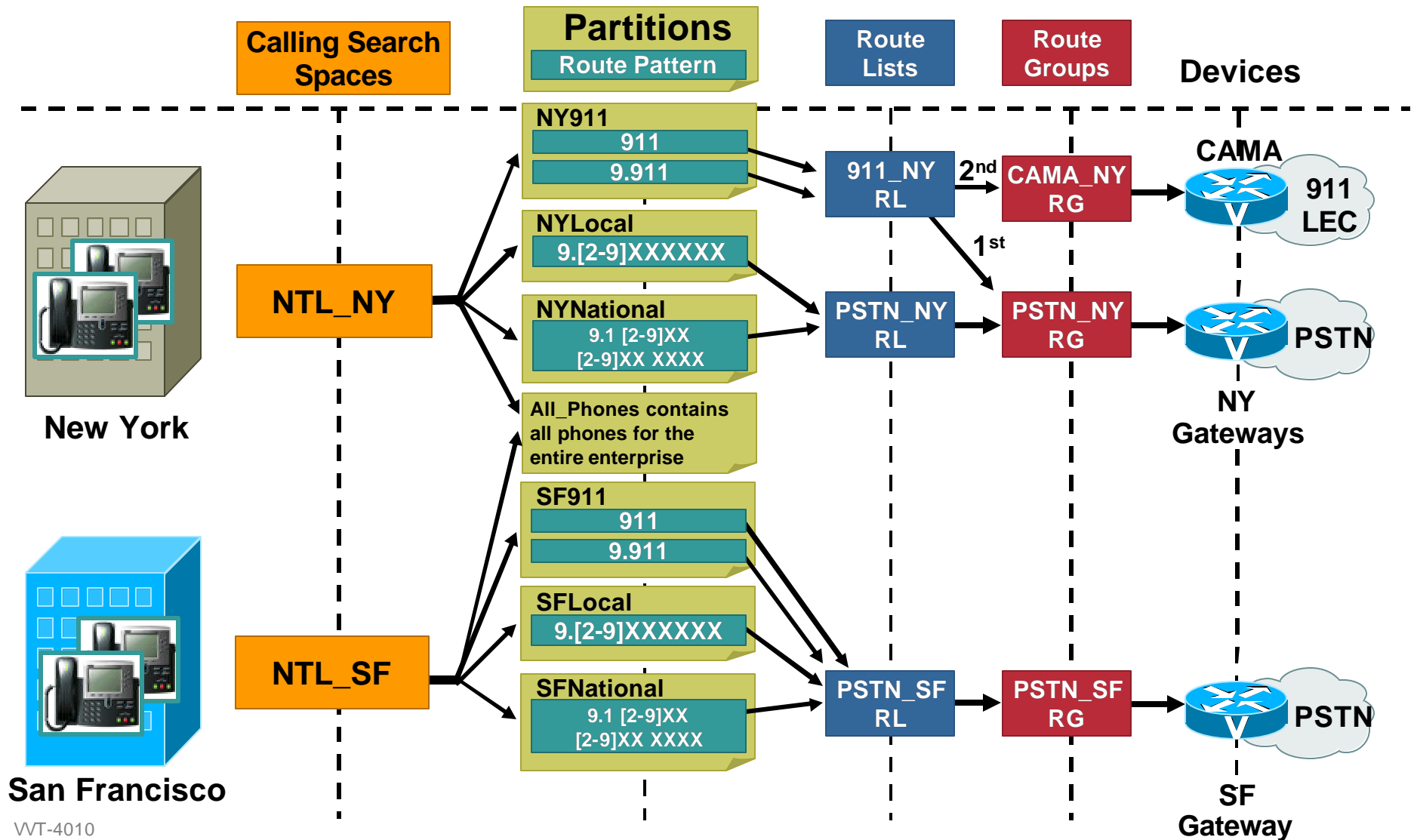
How to Build Classes of Service



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



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...).

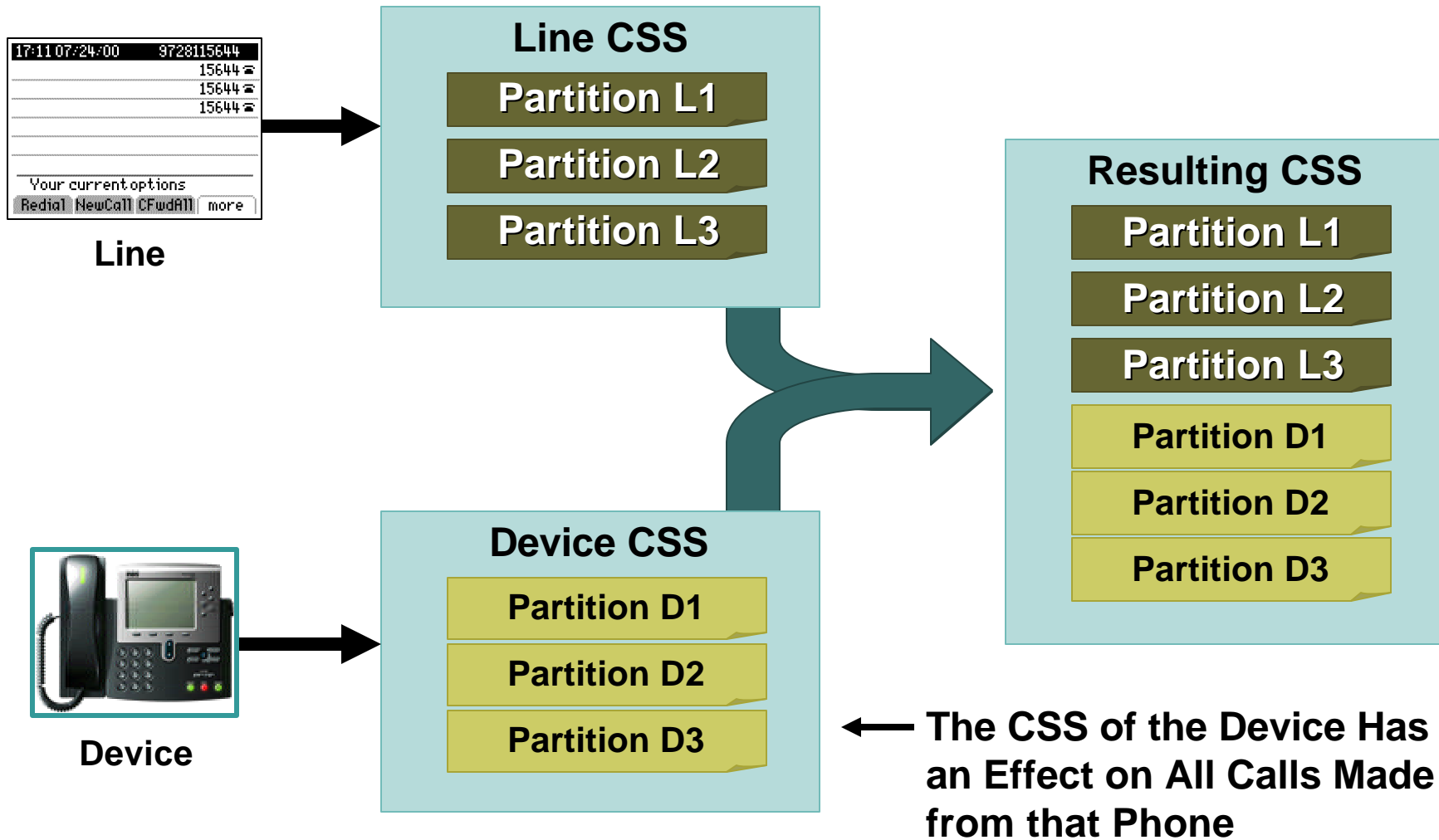
AND

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

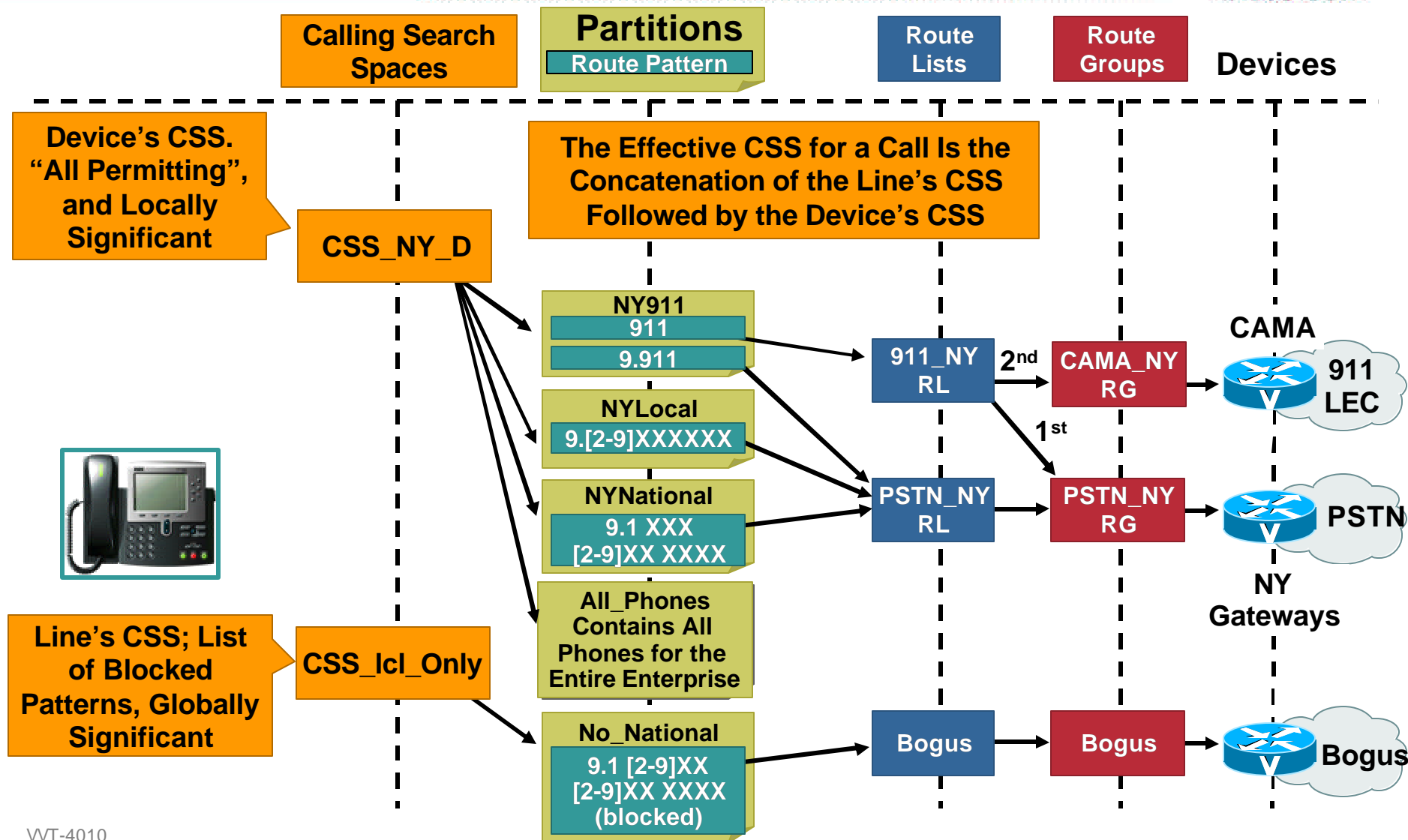
Device-Line CSS Interaction



Partitions and Calling Search Spaces

An Alternative Approach

Cisco.com



Partitions and Calling Search Spaces

An Alternative Approach (Summary)

Cisco.com

- **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)

Cisco.com

- **This approach 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**
- **Call Forward functionality only uses a single CSS (no concatenation with the device's CSS): if you have specific CFNA, CFB or CFA needs, you may need to create more CSSes.**

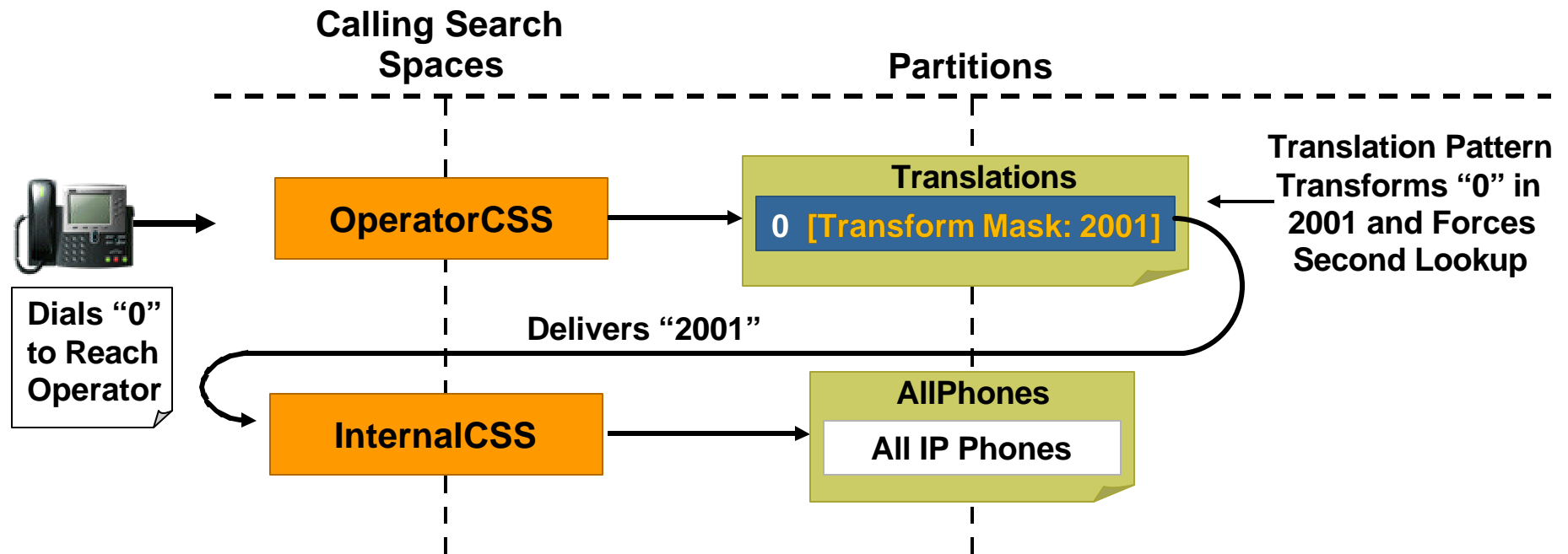
CallManager Dial Plan Tool Kit

Cisco.com

- **External route configuration**
- **Routing by user class or location**
- **Advanced tools**
 - Translation patterns**
 - Route filters**
 - Automated alternate routing**

Translation Patterns

The Basics



- 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,
900X
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): []

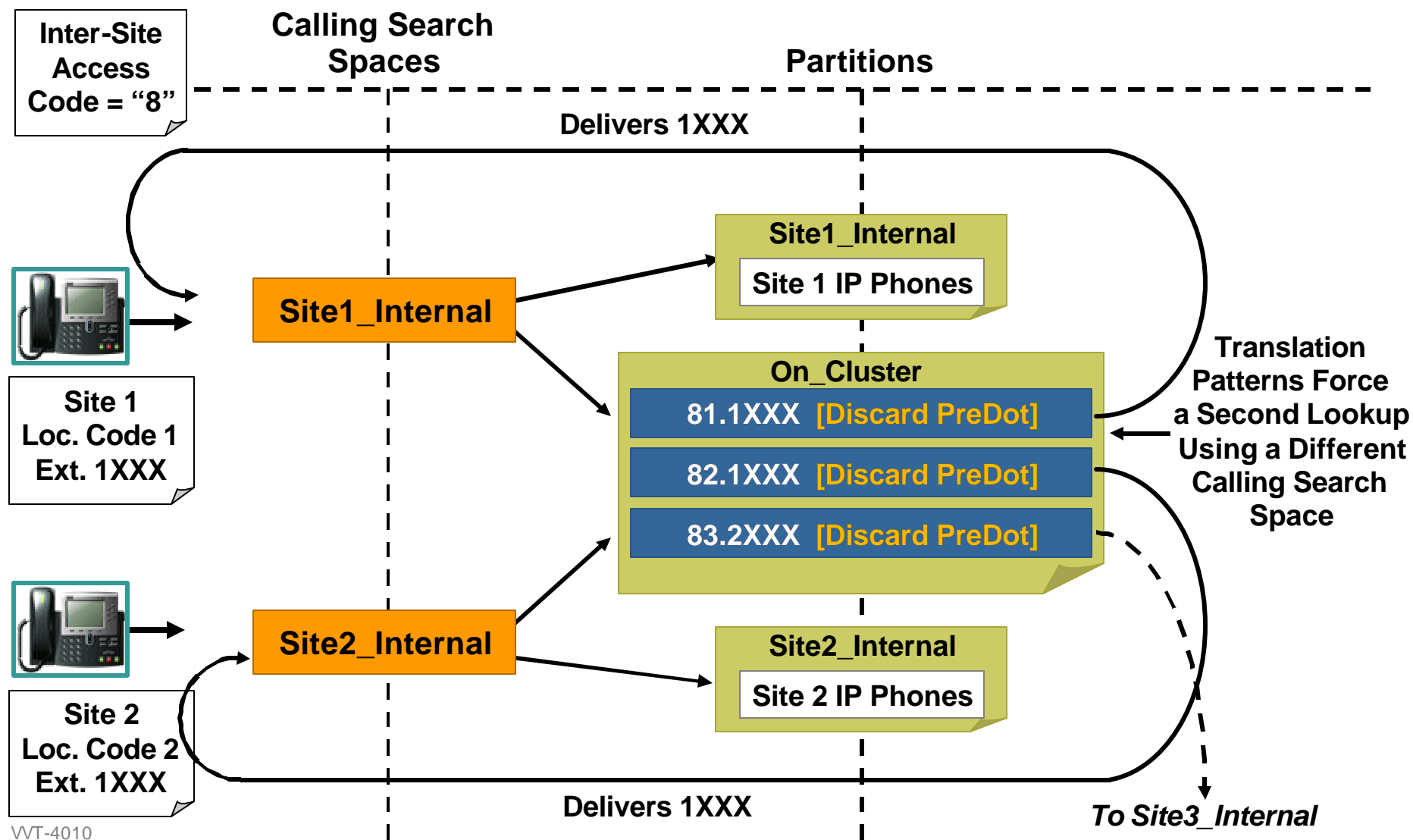
Partition where Translation Pattern Resides

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

Translation Patterns

Example—Overlapping Extensions

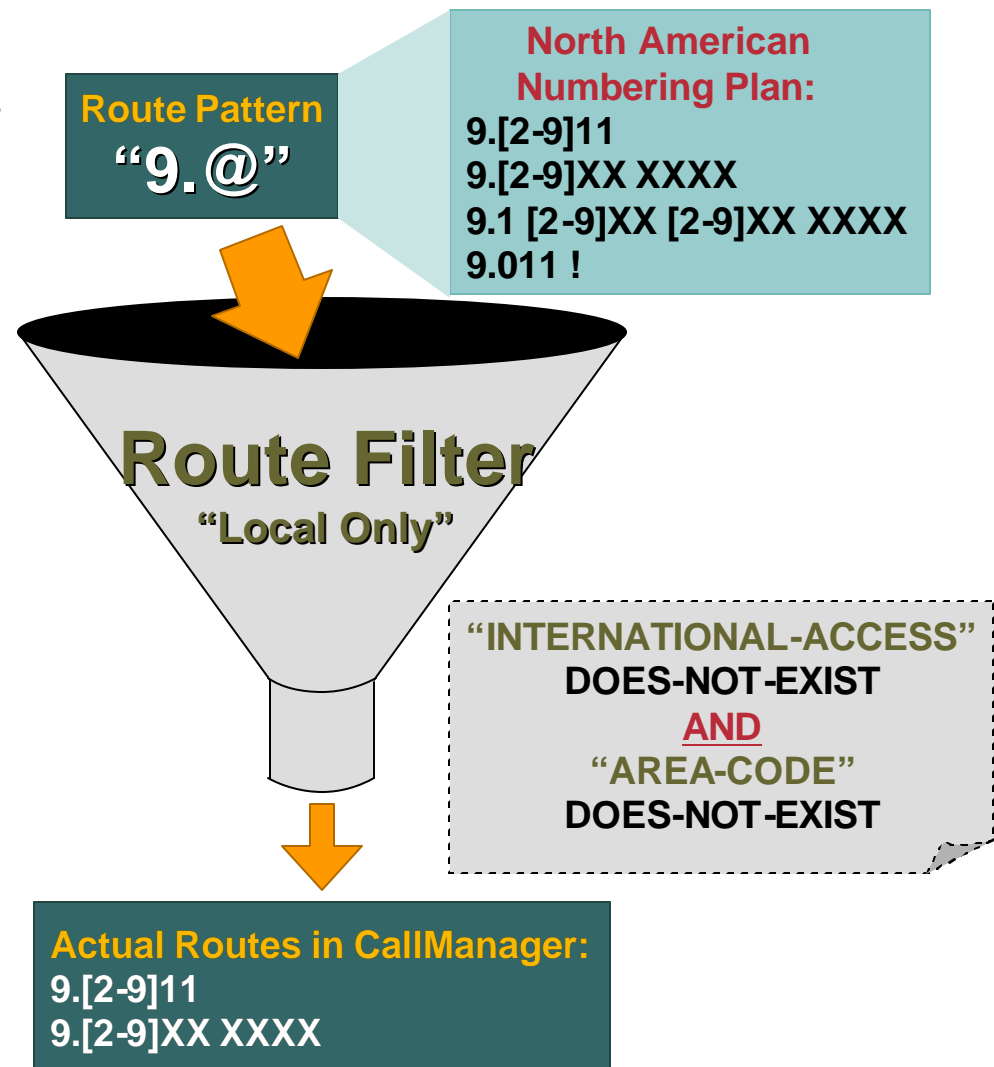


Route Filters

The Basics—“9.@” Route Pattern

Cisco.com

- The “@” wildcard represents all the routes defined in the national numbering plan
- CallManager identifies **tags** 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 Filters Configuration

Route Filter Configuration

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

Choose a Dial Plan*

Route Filter Name: Domestic calls

Clause: (AREA-CODE EXISTS AND INTERNATIONAL-ACCESS DOES-NOT-EXIST)

Status: Ready

Route Filter Name*

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

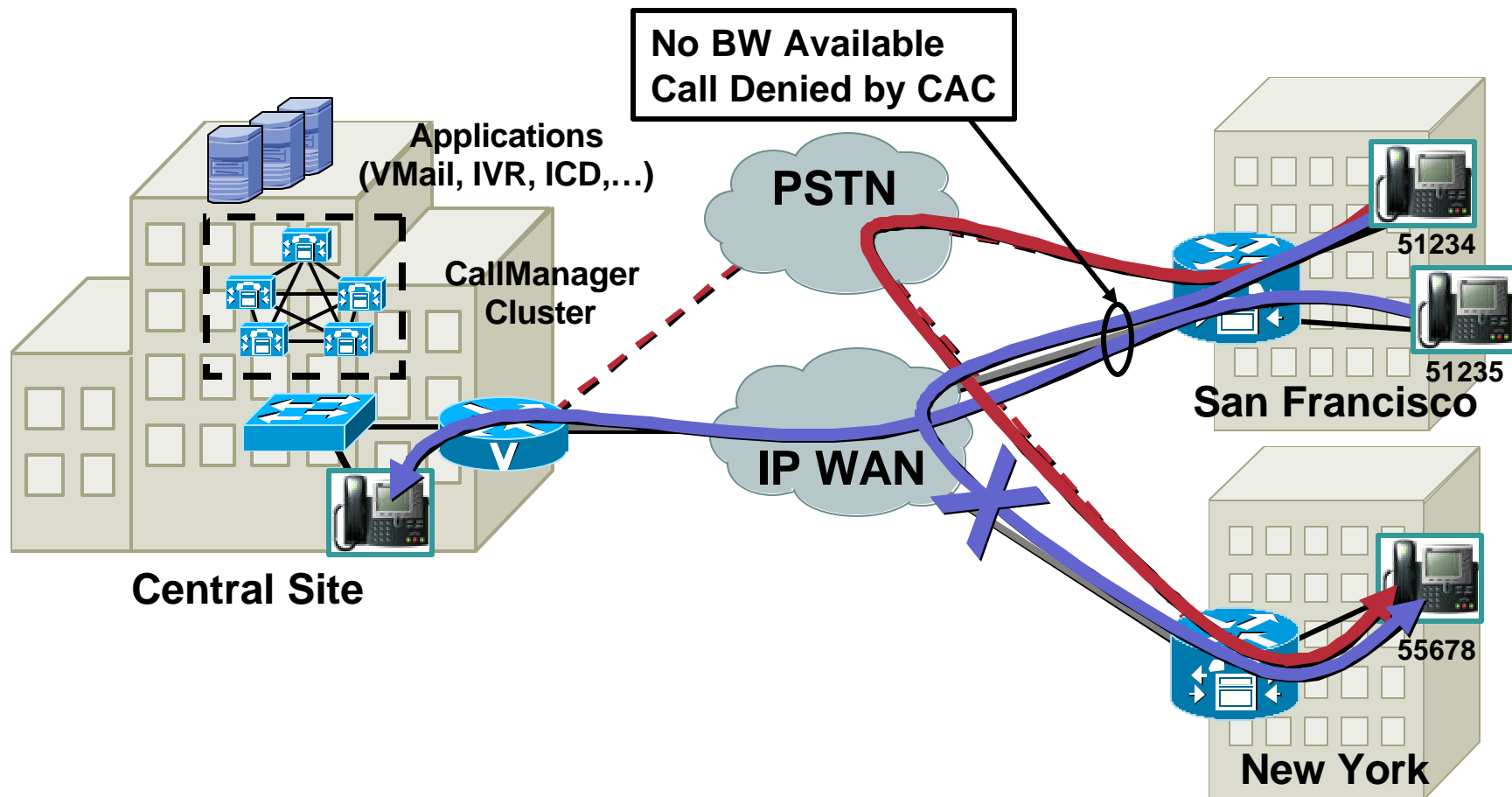
AAR—Automated Alternate Routing

Cisco.com

- **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!



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?

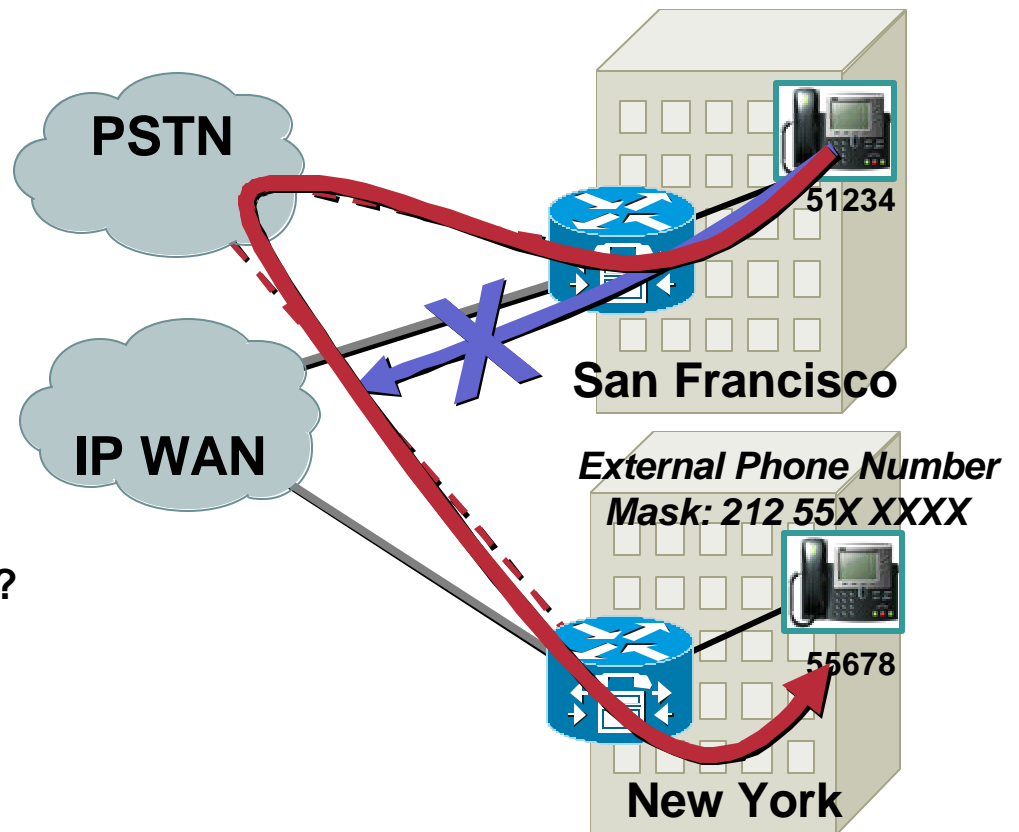
Called phone's External Phone Number Mask: 212 555 5678!

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!



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

Cisco.com

- 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

SystemRoute PlanServiceFeatureDeviceUserApplicationHelpLogout

Cisco CallManager Administration
For Cisco IP Telephony Solutions

CISCO SYSTEMS

[Add a New AAR Group](#)
[Back to Find/List AAR Groups](#)

Automated Alternate Routing Group Configuration

AAR Group: San Francisco
Status: Update completed

AAR Group Name*

Prefix digits within San Francisco

Prefix Digits

San Francisco

Prefix digits between San Francisco and other AAR groups

	Prefix Digits (From San Francisco)	Prefix Digits (To San Francisco)
Dallas	<input type="text" value="91"/>	<input type="text" value="91"/>
New York	<input type="text" value="91"/>	<input type="text" value="91"/>
San Jose	<input type="text" value="91"/>	<input type="text" value="91"/>

First Previous Next Last

Page of 1

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)

SystemRoute PlanServiceFeatureDeviceUserApplicationHelpLogout

Cisco CallManager Administration
For Cisco IP Telephony Solutions

CISCO SYSTEMS

Directory Number Configuration

[Configure Device \(SEPABC123ABC123\)](#)

Devices using this Directory Number

SEPABC123ABC123
7960 (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

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

The screenshot displays the Cisco CallManager Administration web interface. At the top, there is a navigation bar with links: SystemRoute, PlanServiceFeatureDeviceUserApplicationHelpLogout. Below this is the page title "Cisco CallManager Administration" and the Cisco Systems logo. The main heading is "Phone Configuration" in red. To the right of the heading are several links: "Add a new phone", "Add/Update Speed Dials", "Subscribe/Unsubscribe Services", and "Back to Find/List Phones".

On the left side, there is a "Directory Numbers" section with a "Base Phone" sub-section. It lists two lines: "Line 1 - 55678 in ALL_IPPHONES" and "Line 2 - Add new DN".

The main configuration area shows the following details for the phone:

- Phone: SEPABC123ABC123 (SF reception)
- Registration: Unknown
- IP Address:
- Status: Ready

Below these details are four buttons: "Copy", "Update", "Delete", and "Reset Phone".

The "Phone Configuration (Model = Cisco 7960)" section is expanded to show "Device Information":

- MAC Address*: ABC123ABC123
- Description: SF reception
- Device Pool*: SF (with a "(View details)" link)
- 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 >

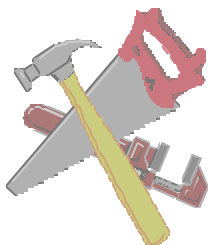
AAR Rules and Caveats

- **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**

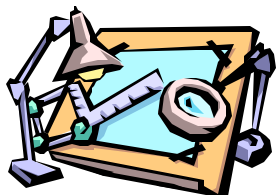
Agenda



- **IP Telephony Deployment Models**



- **Cisco CallManager Dial Plan Toolkit**



- **Dial Plan Design Guidelines**



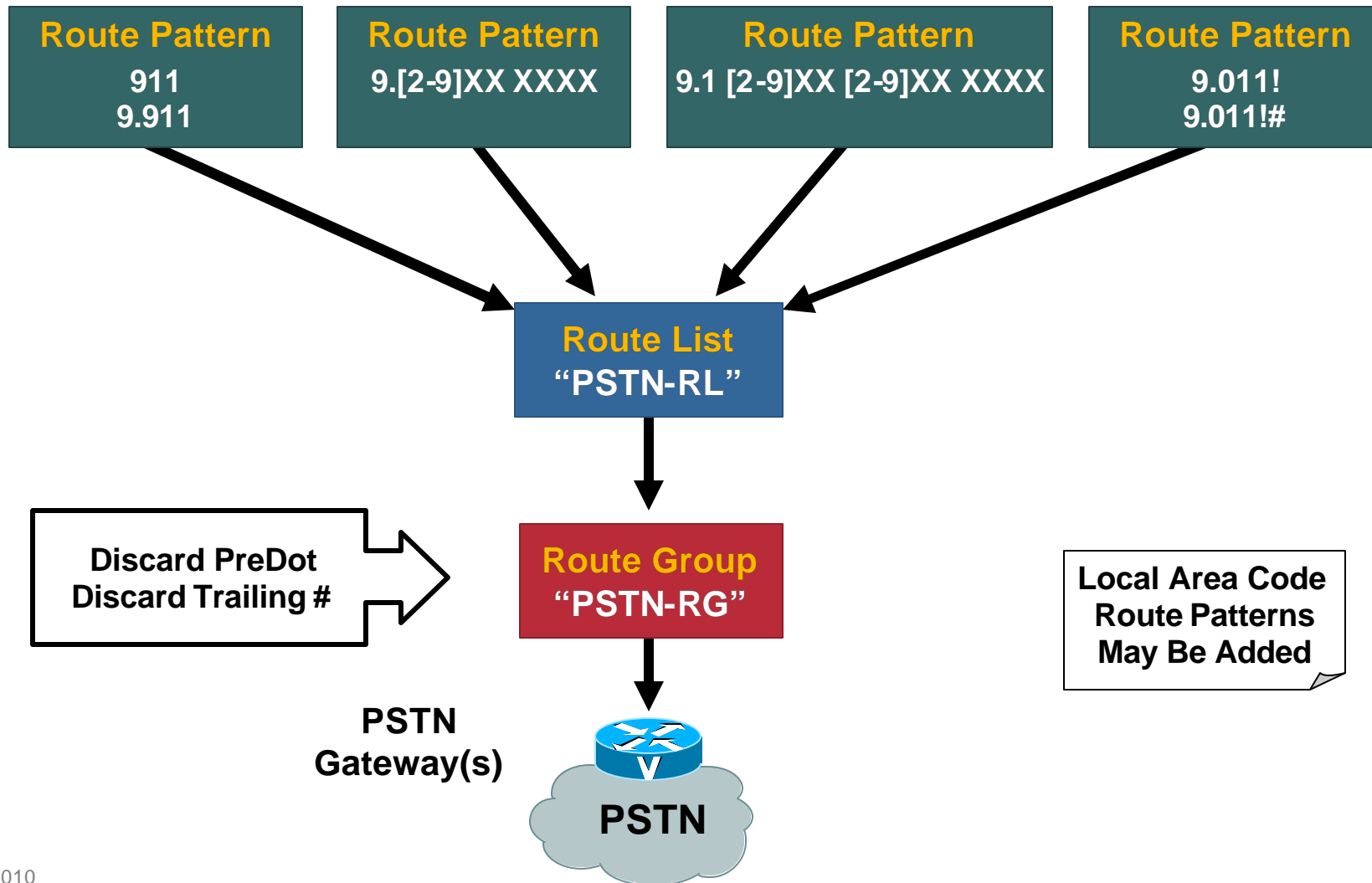
- **Conclusions**

Dial Plan Design Guidelines Agenda

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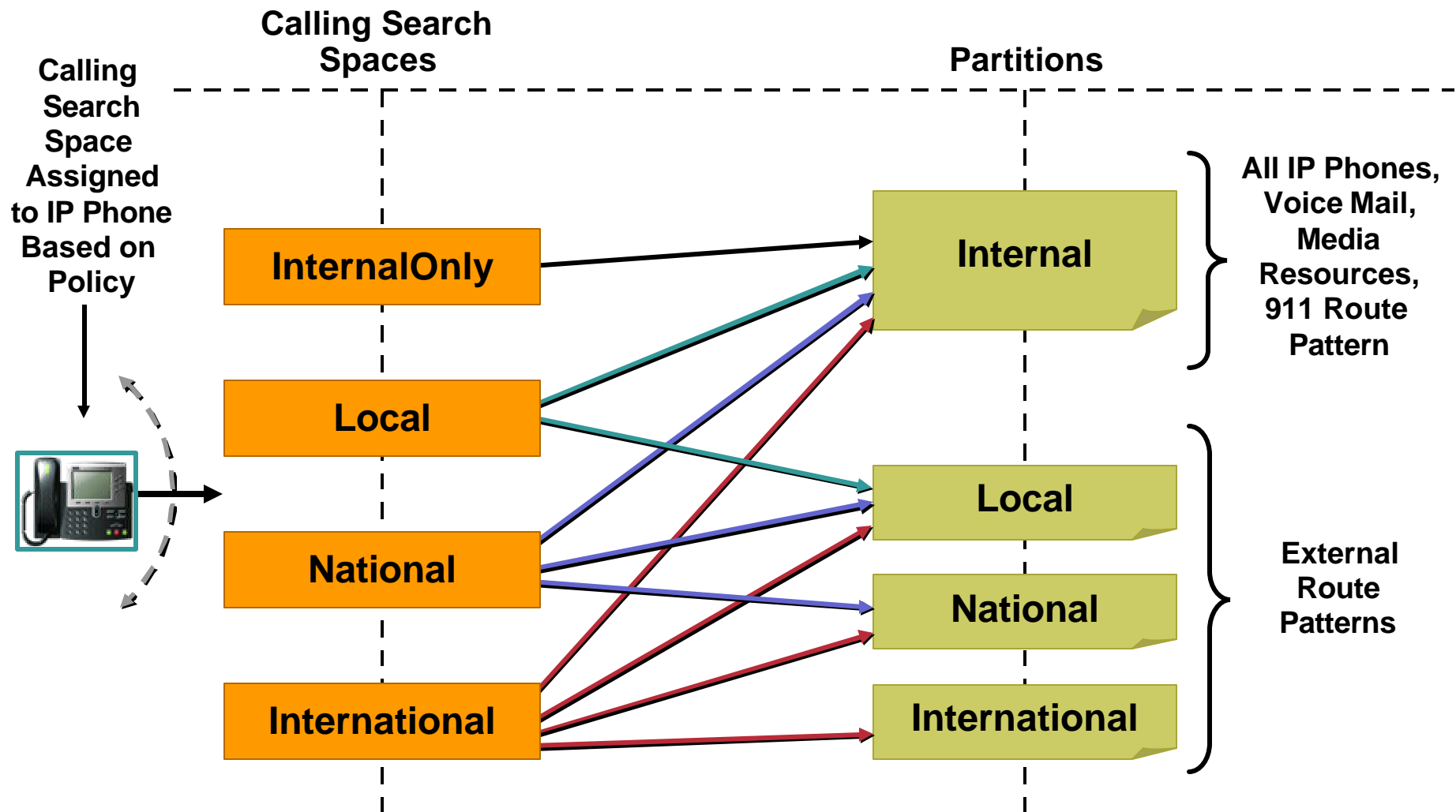
- **Single Site Enterprise**
- **Multi-Site with Distributed Call Processing**
- **Multi-Site with Centralized Call Processing**
- **Tail-End Hop-Off (TEHO)**
- **Useful Tidbits**

Single Site Typical Route Patterns

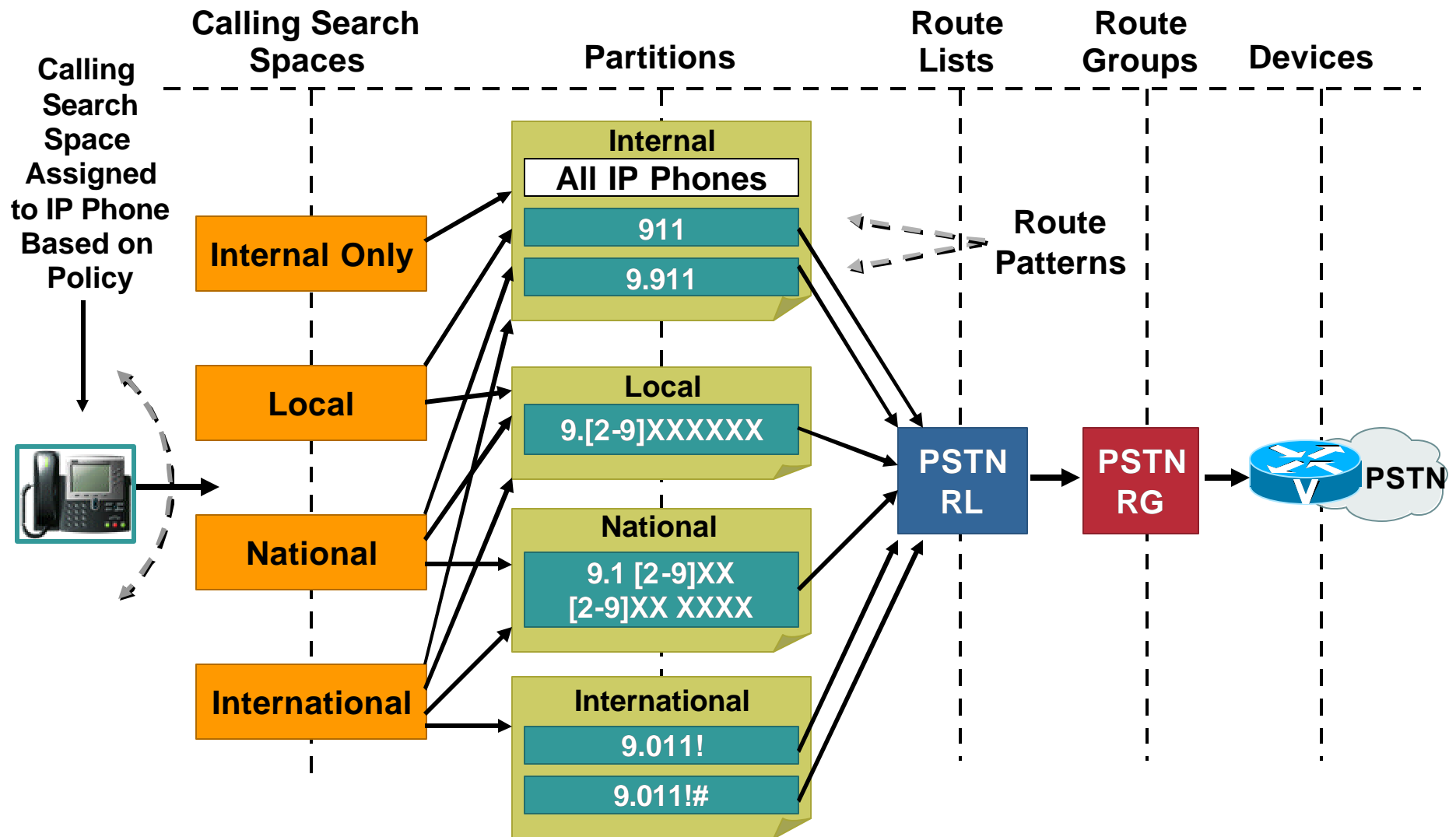


Single Site View of Partitions/Calling Search Spaces

Cisco.com



Single Site Composite Dial Plan View



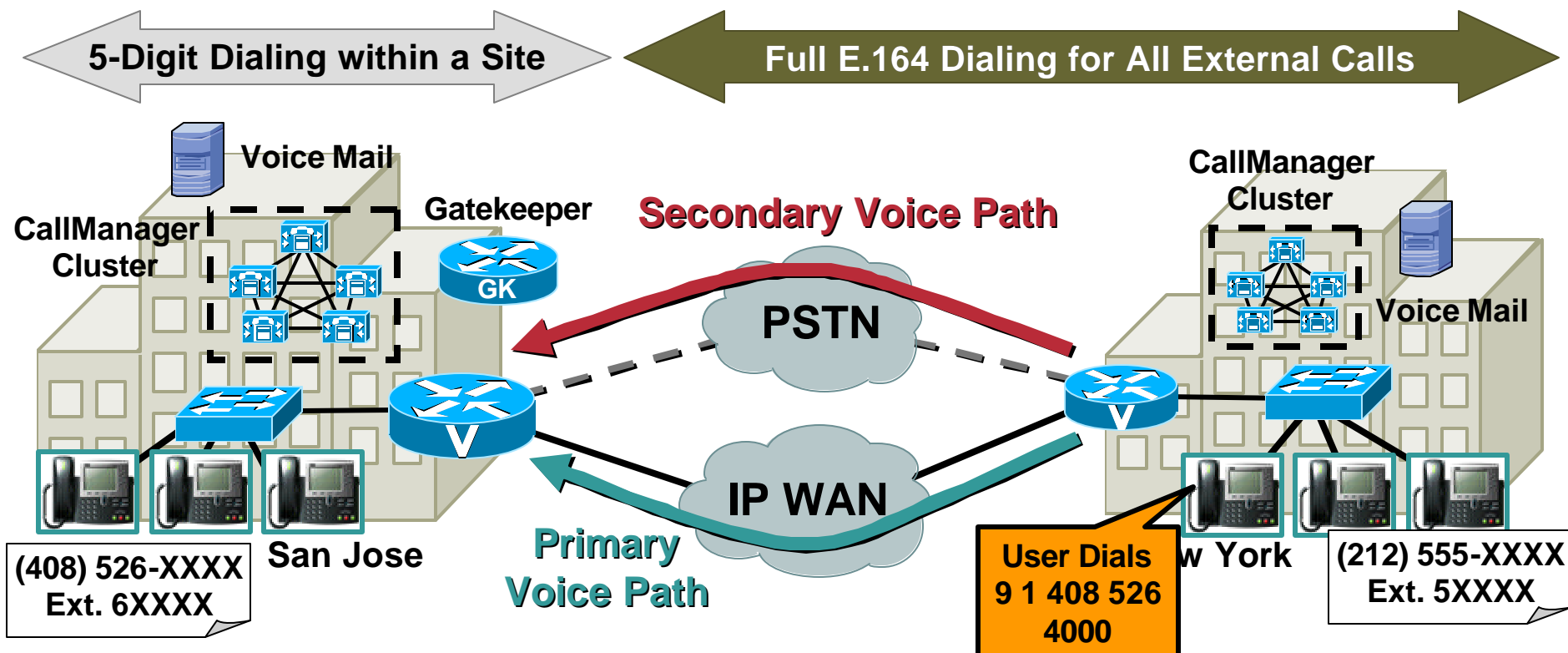
Dial Plan Design Guidelines Agenda

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- **Single Site Enterprise**
- **Multi-Site with Distributed Call Processing**
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- **Useful Tidbits**

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

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Primary Voice Path: IP WAN

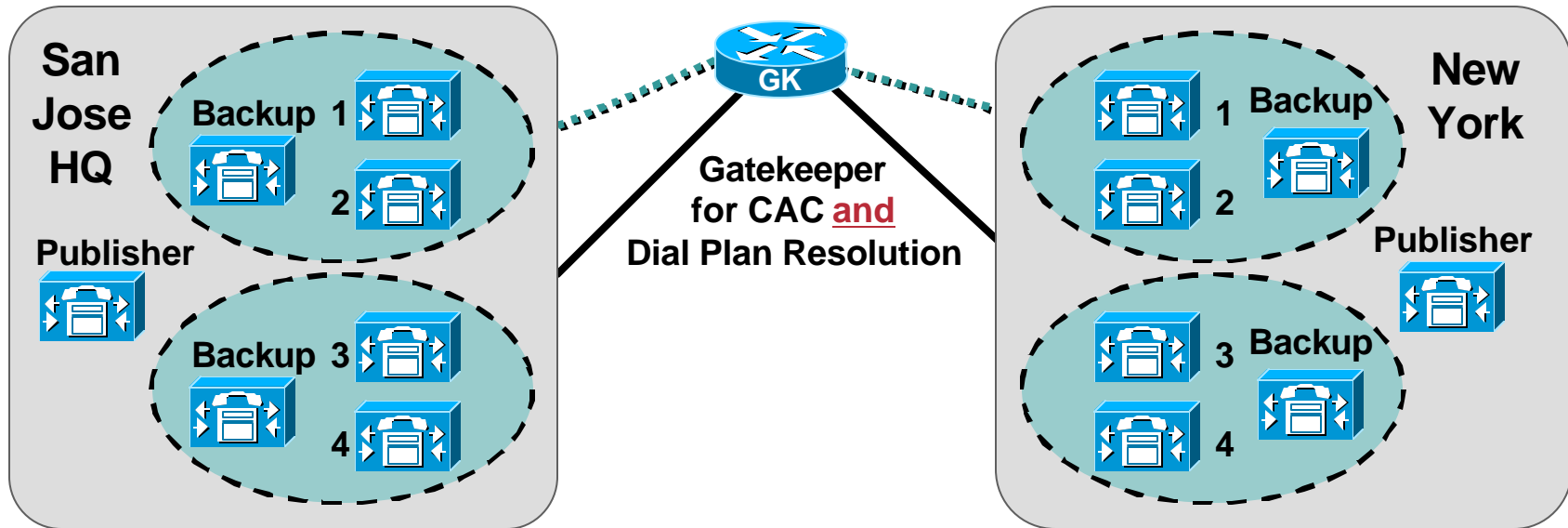
- **Outgoing** (NY cluster): Strip "9" and deliver "14085264000" to Gatekeeper
- **Incoming** (SJ cluster): Strip all but significant 5 digits

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

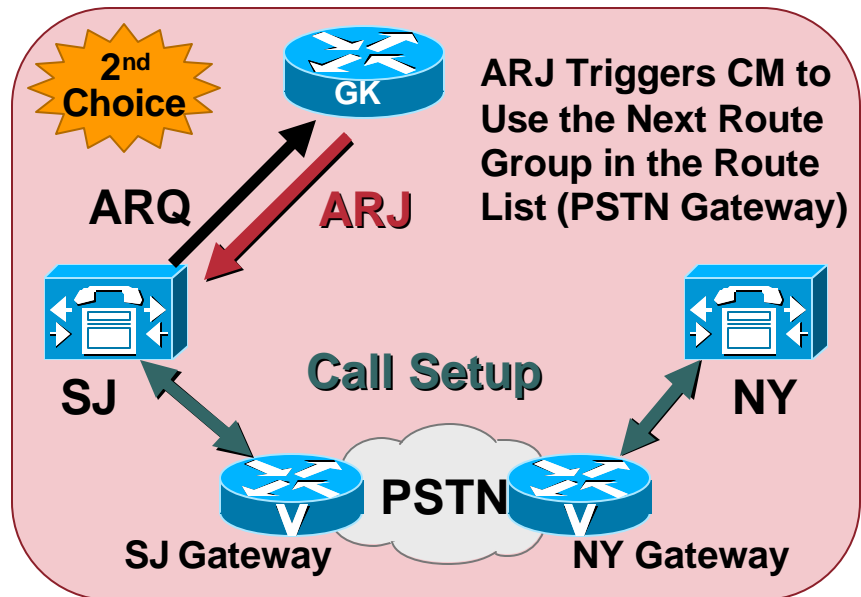
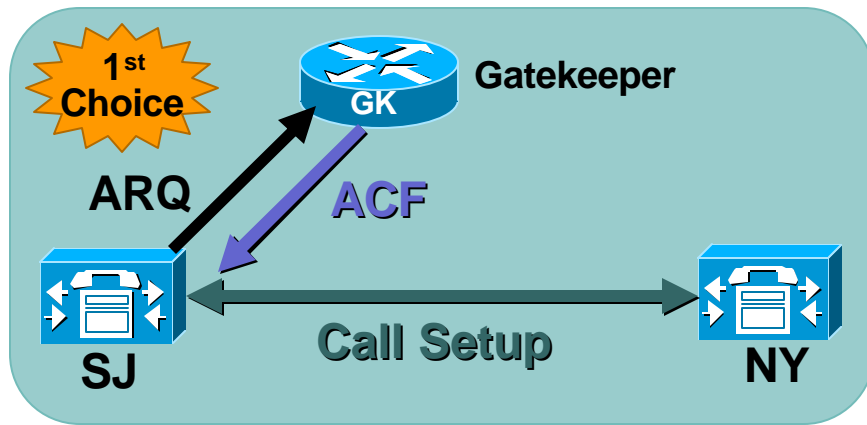
Cisco.com



- 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

Cisco.com



```
gatekeeper
  zone local SJC cisco.com
  zone local NYC cisco.com
  zone prefix SJC 140855534..
  zone prefix SJC 14085557...
  zone prefix SJC 131055598..

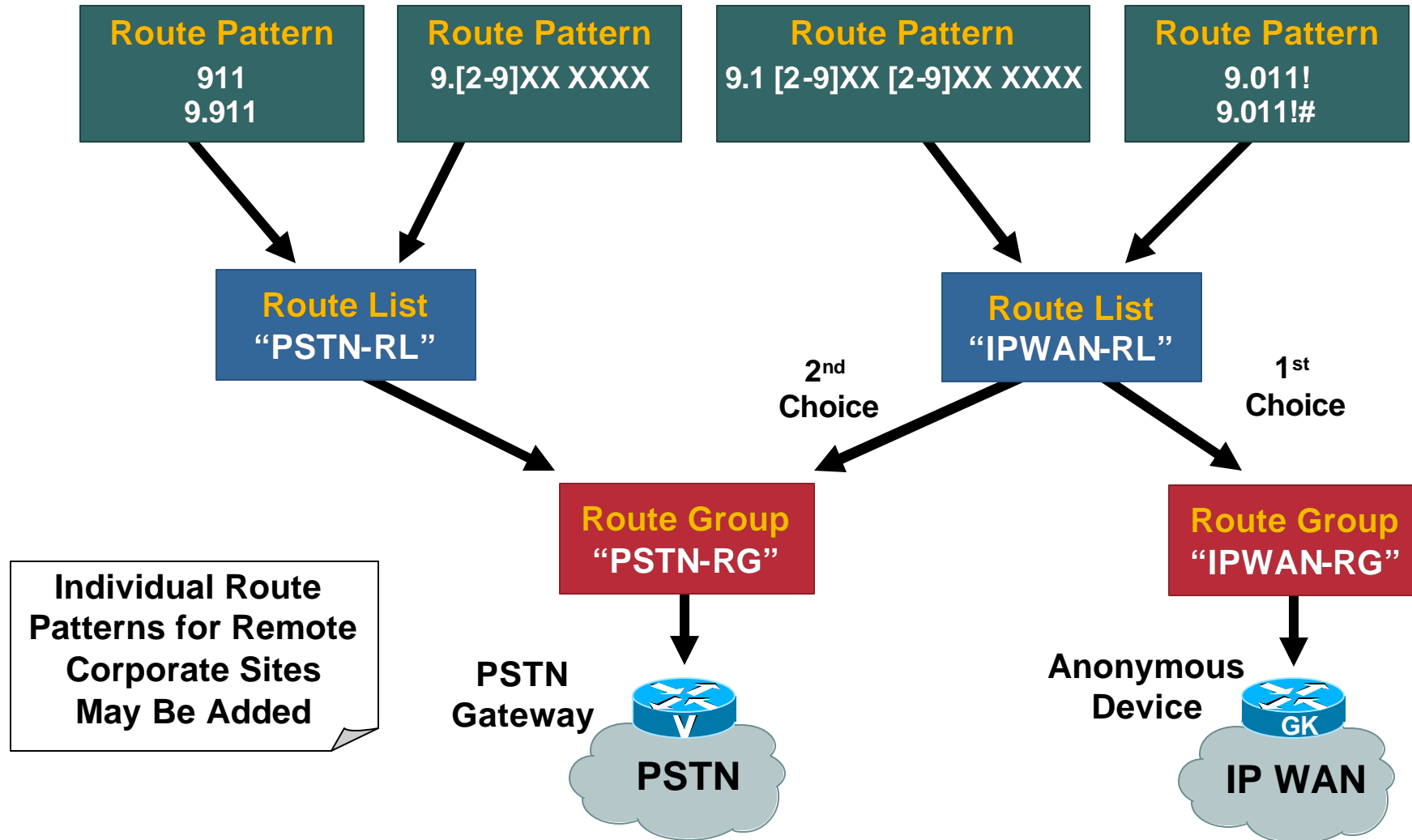
[...]
```

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

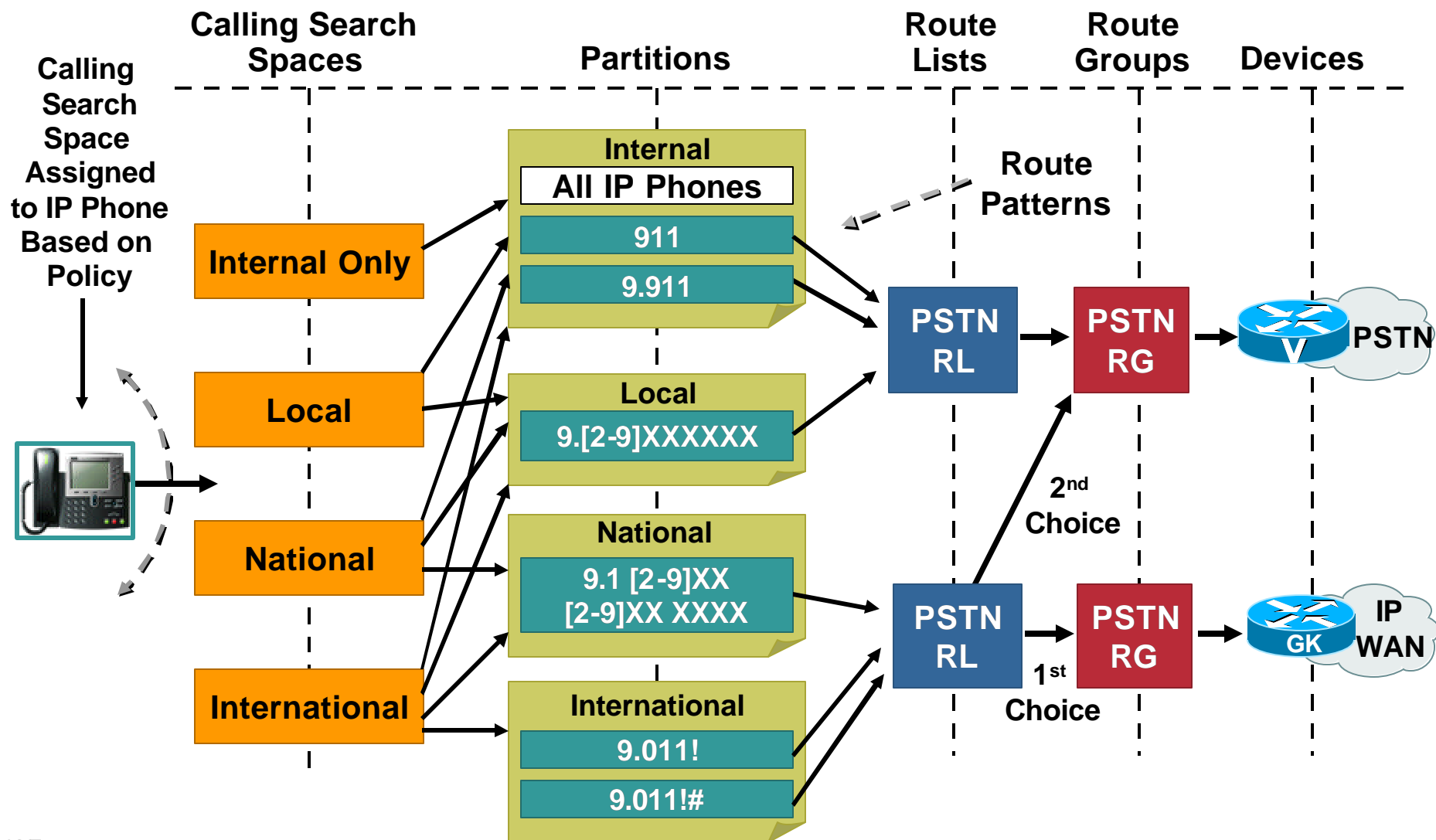
[...]
```

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

Multi-Site with Distributed Call Processing Typical Route Patterns



Multi-Site with Distributed Call Processing Composite Dial Plan View



Dial Plan Design Guidelines Agenda

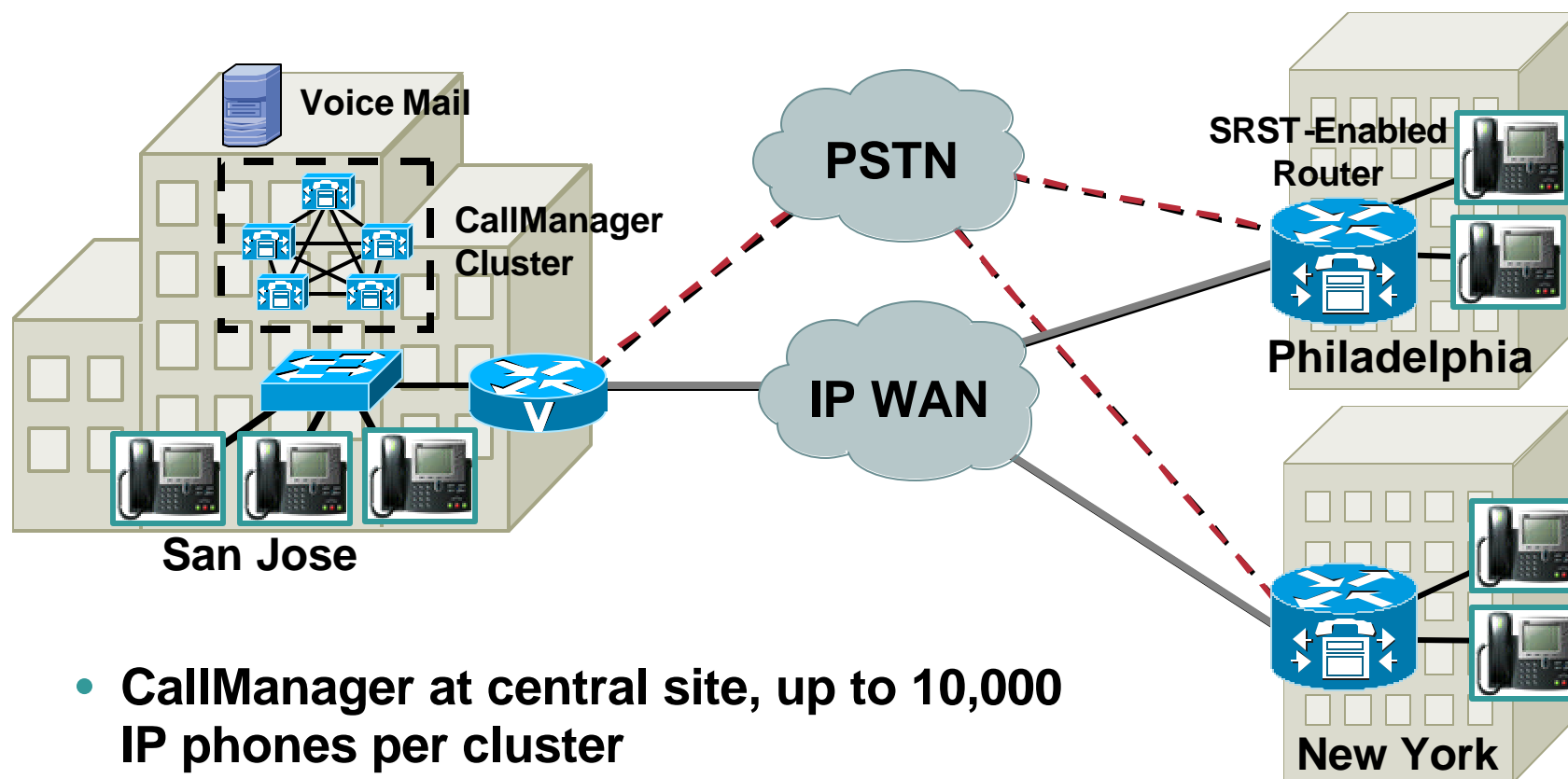
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- **Single Site Enterprise**
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Multi-Site with Centralized Call Processing

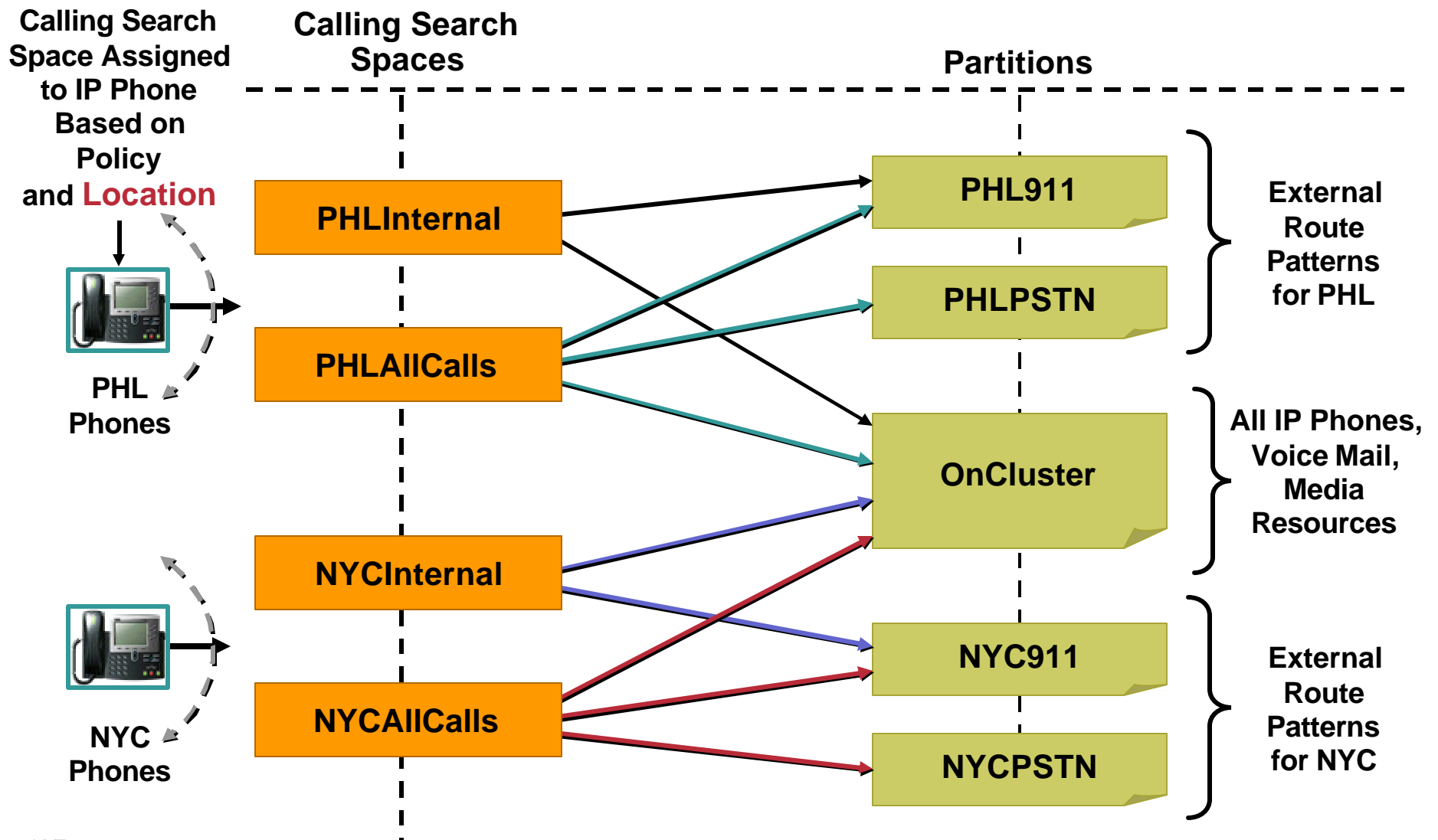
Example of Dial Plan Requirements

Cisco.com

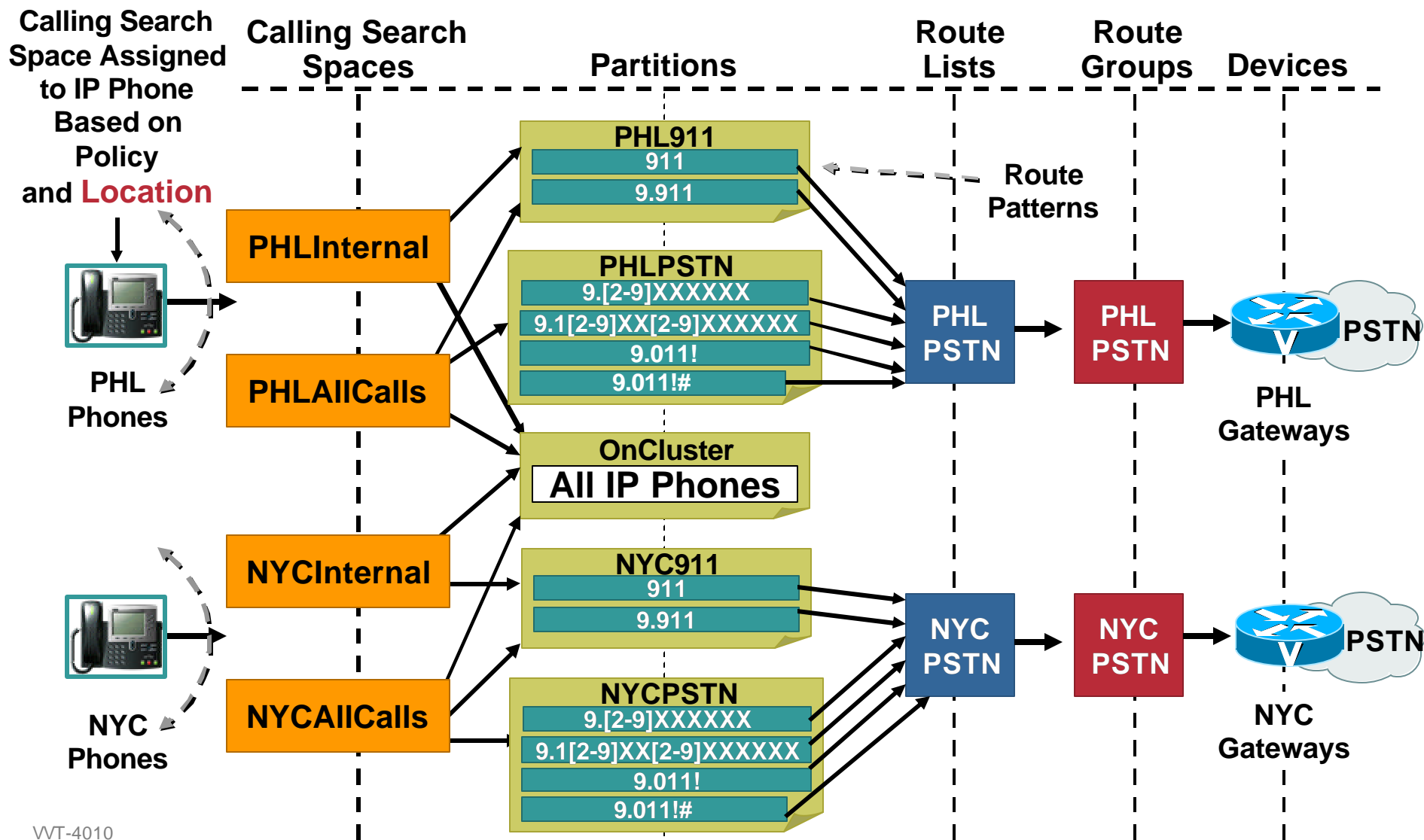


- CallManager at central site, up to 10,000 IP phones per cluster
- Common PSTN access code (“9”)
- 911 and PSTN calls use each site’s local gateway
- Non-overlapping extensions (*overlapping case covered later*)

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



Multi-Site with Centralized Call Processing Composite Dial Plan View

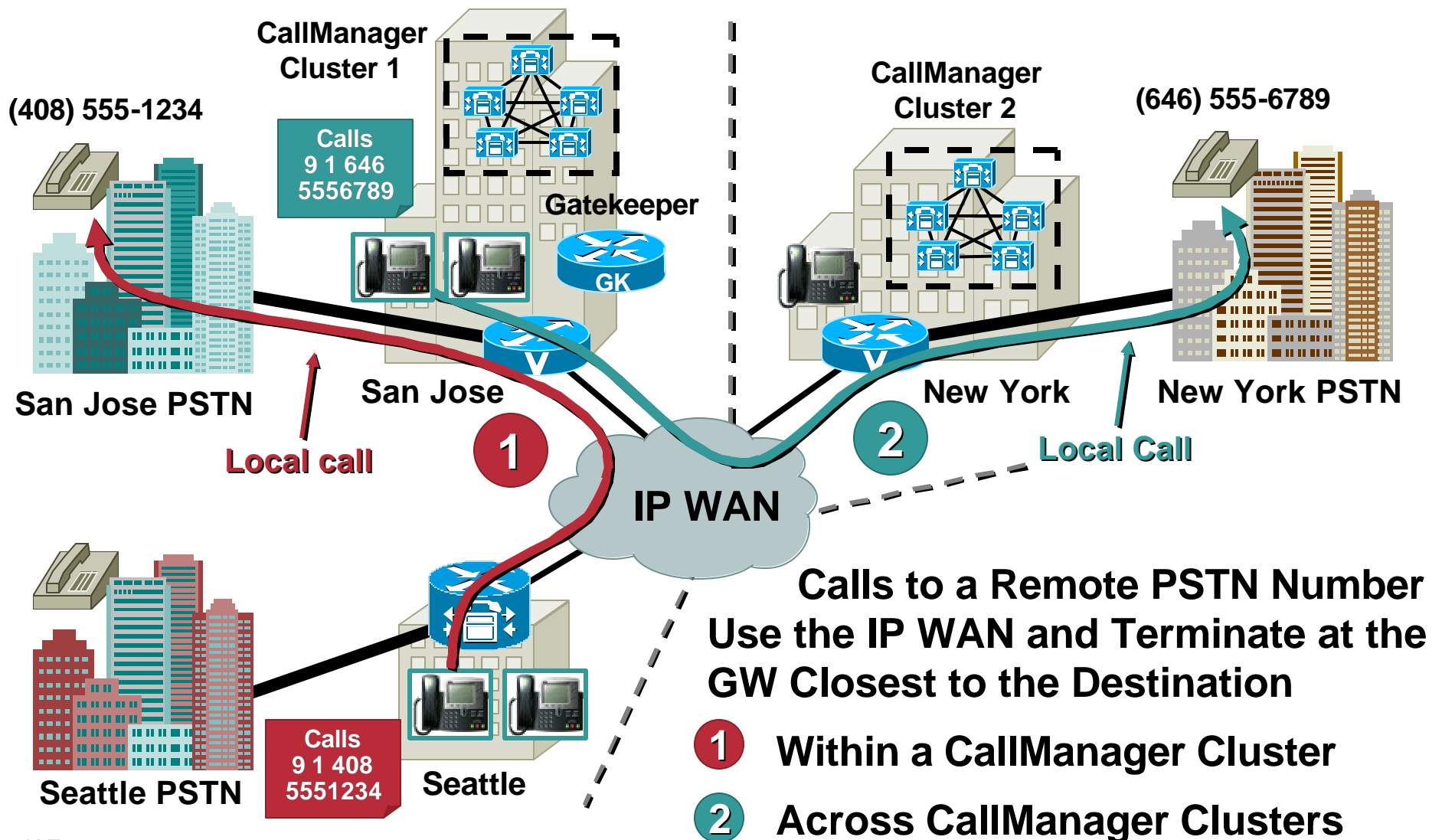


Dial Plan Design Guidelines Agenda

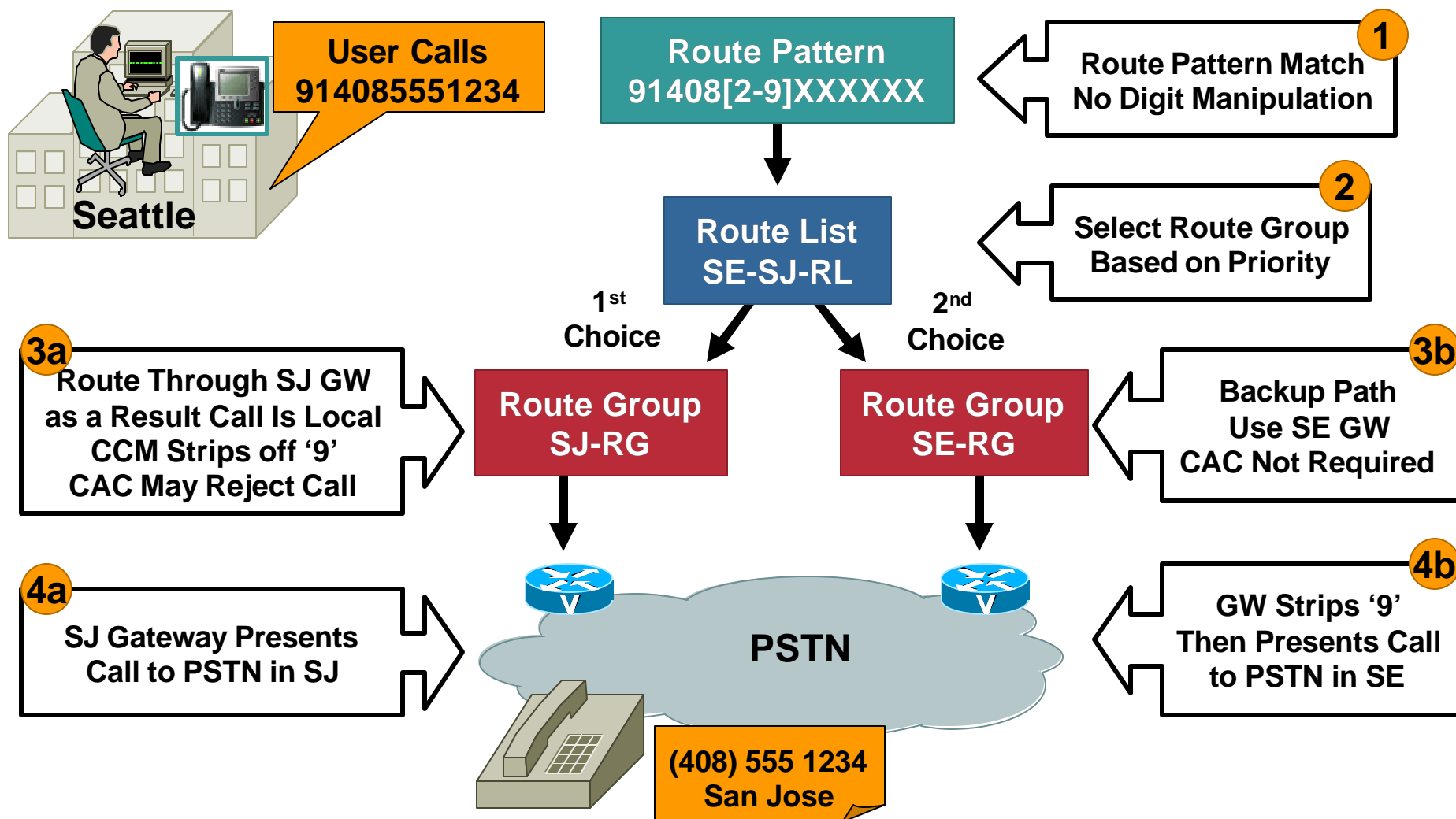
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- **Single Site Enterprise**
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Tail-End Hop-Off (TEHO) What Is it?

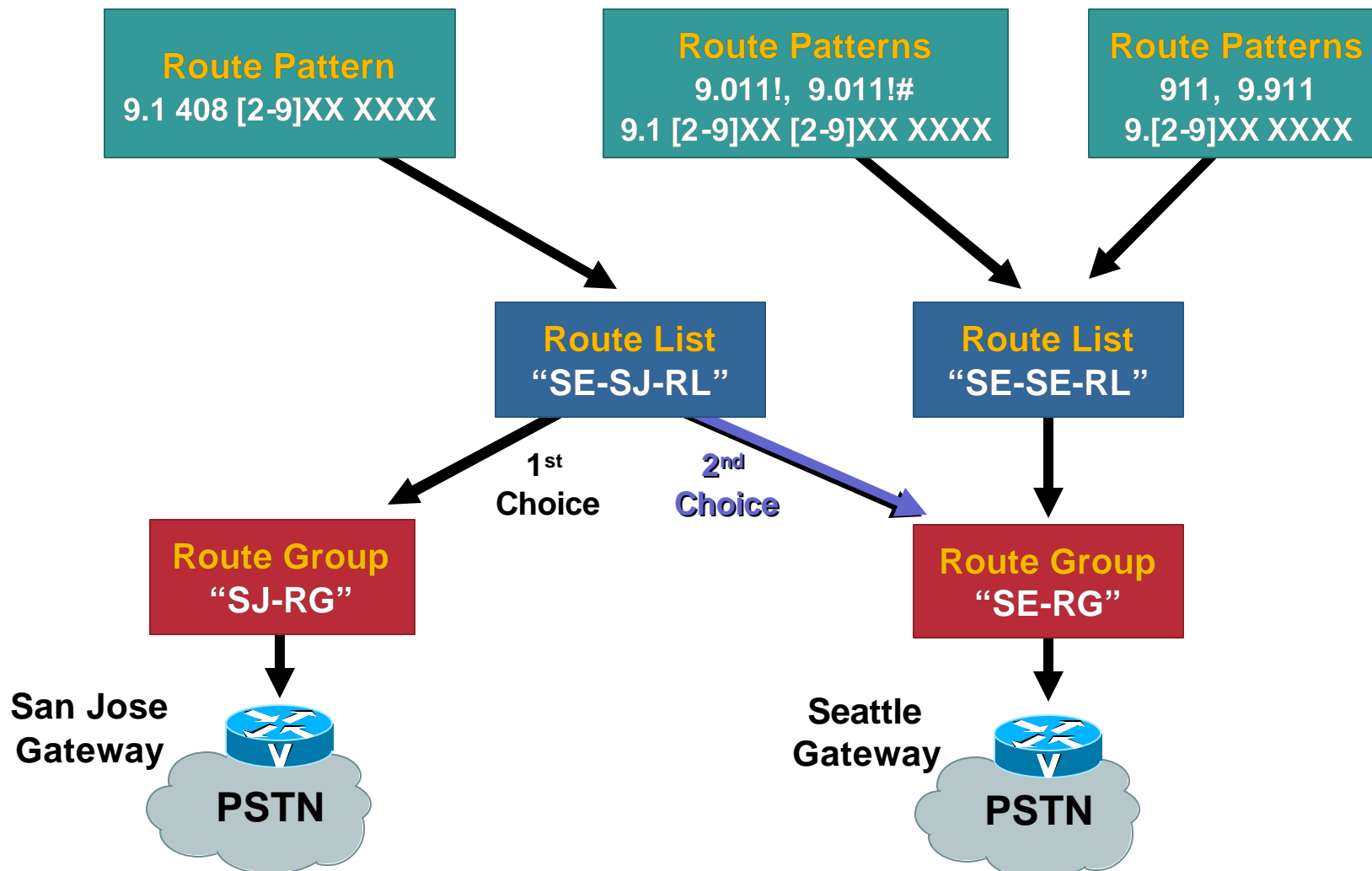


Tail-End Hop-Off (TEHO) Intra-Cluster—Seattle to San Jose



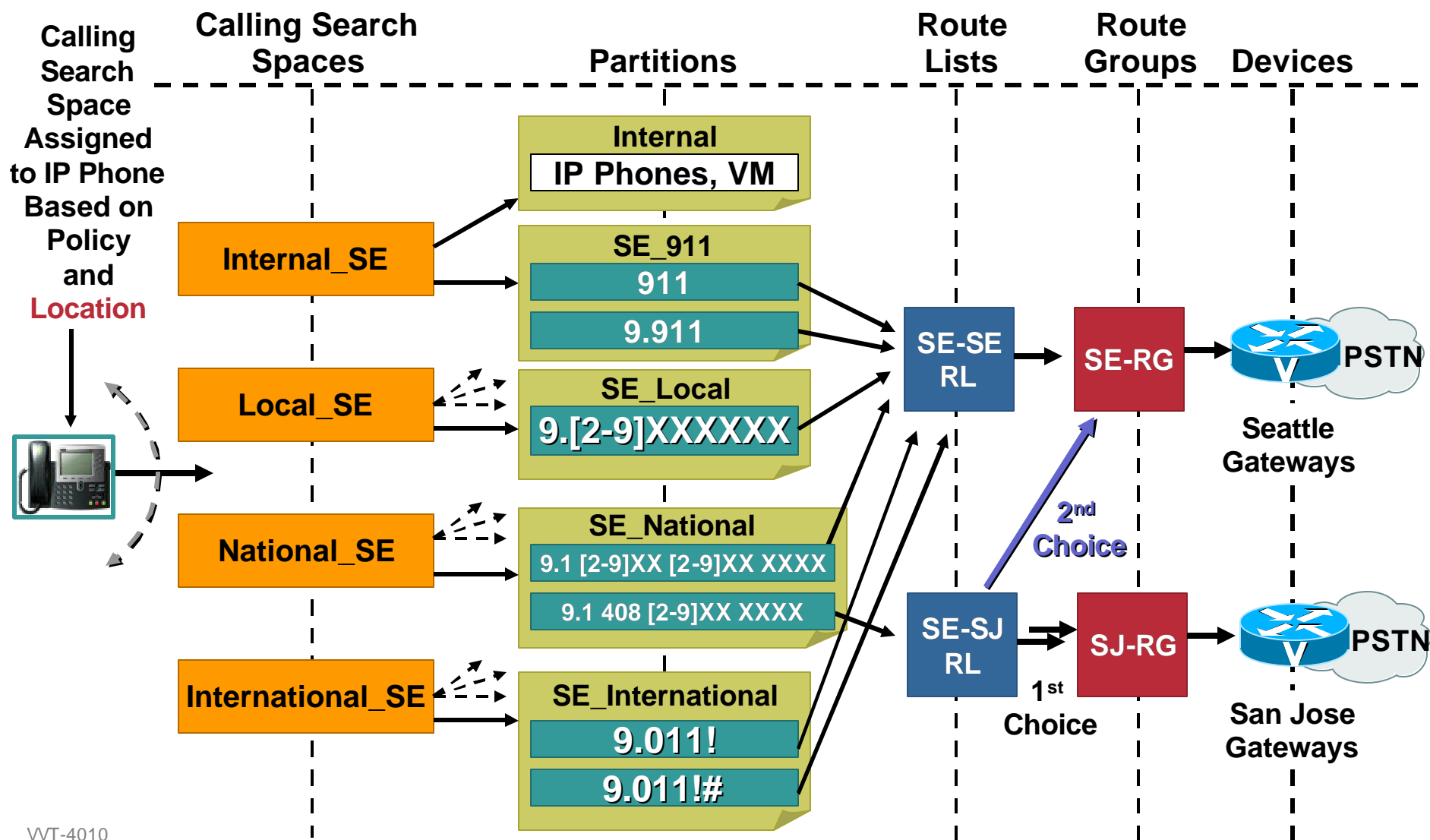
Tail-End Hop-Off (TEHO) Intra-Cluster—Route Patterns for Seattle

Cisco.com

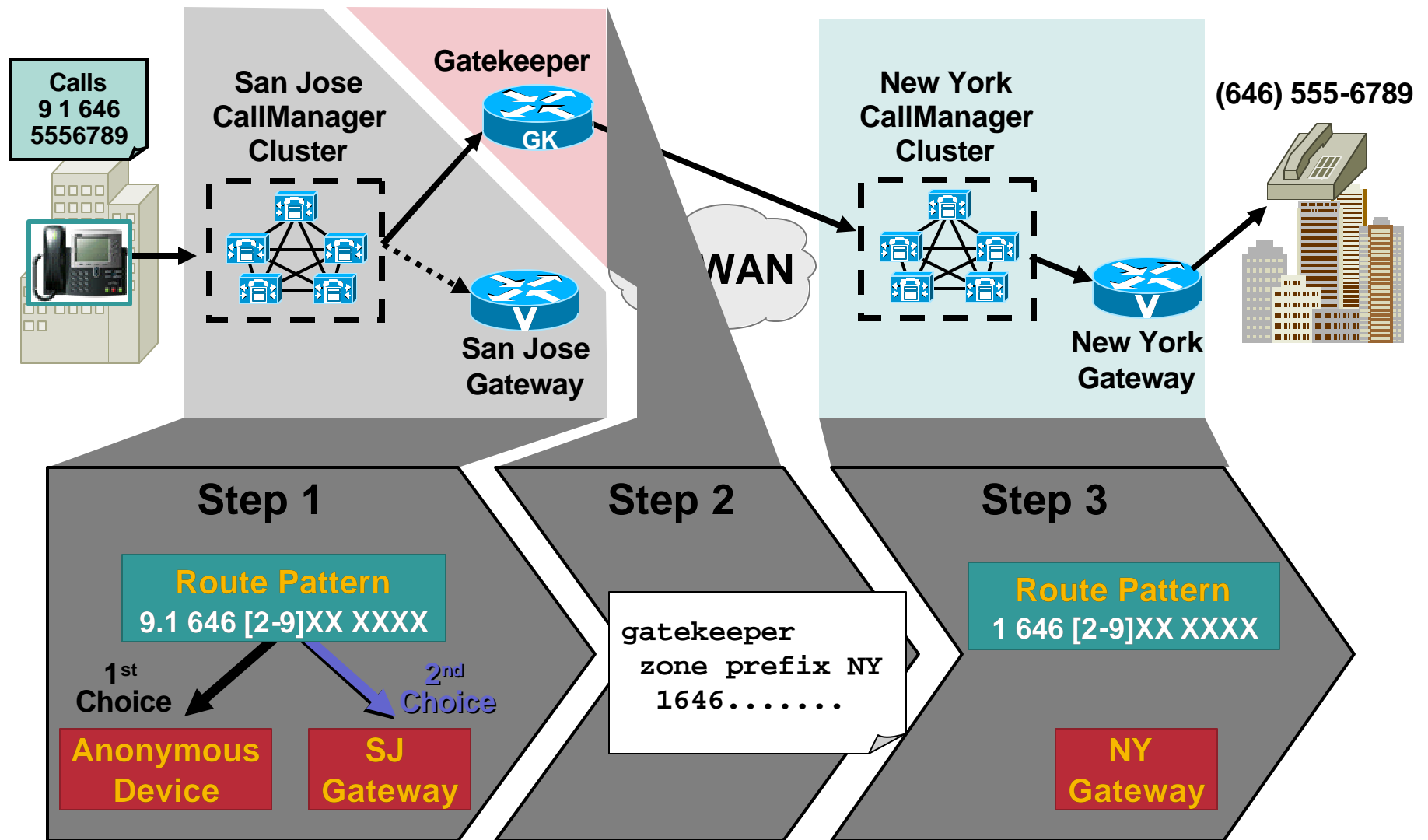


Tail-End Hop-Off (TEHO) Intra-Cluster—Composite Dial Plan for Seattle

Cisco.com

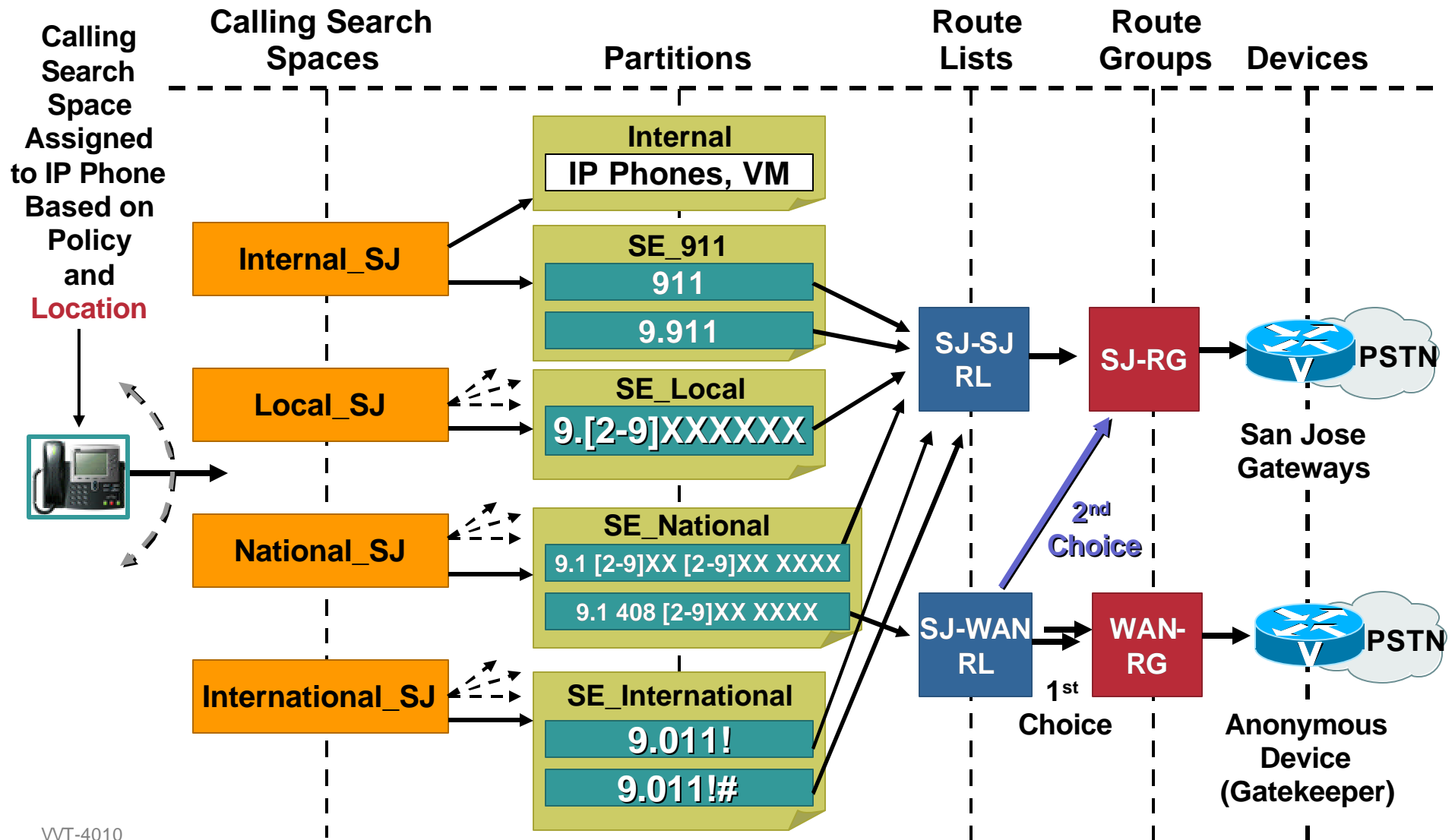


Tail-End Hop-Off (TEHO) Inter-Cluster—San Jose to New York



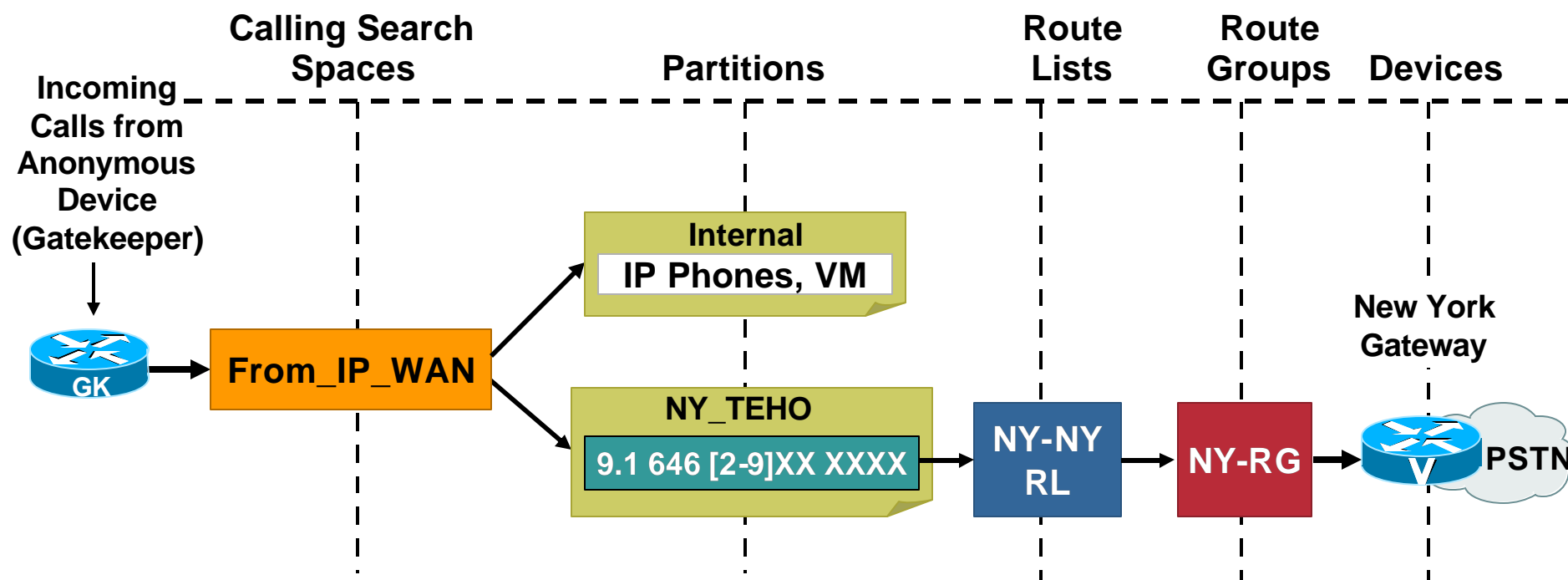
Tail-End Hop-Off (TEHO) Inter-Cluster—Composite Dial Plan for San Jose

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Tail-End Hop-Off (TEHO) Inter-Cluster—Dial Plan for New York

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- **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

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- **Single Site Enterprise**
- **Multi-Site with Distributed Call Processing**
- **Multi-Site with Centralized Call Processing**
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- **Useful Tidbits**

Dial Plan Design Guidelines Agenda

Cisco.com

- **Single Site Enterprise**
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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

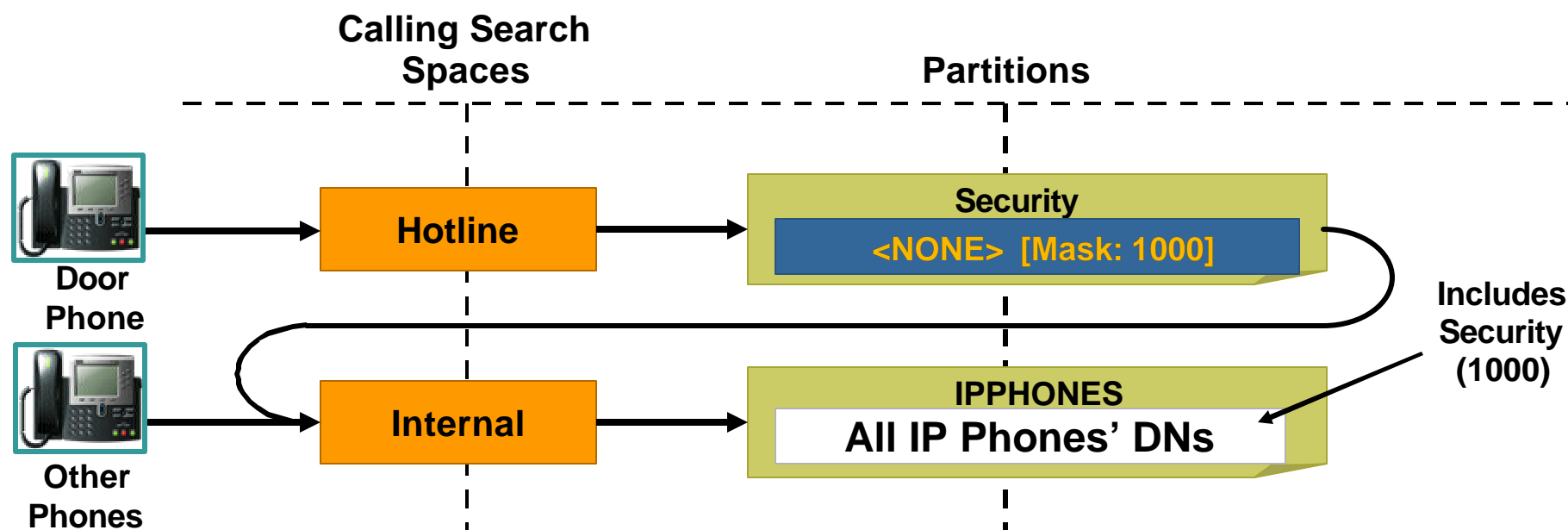
Cisco.com

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)

Cisco.com



Create Partition **SECURITY**

Create **HOTLINE** CSS Containing **SECURITY** Partition

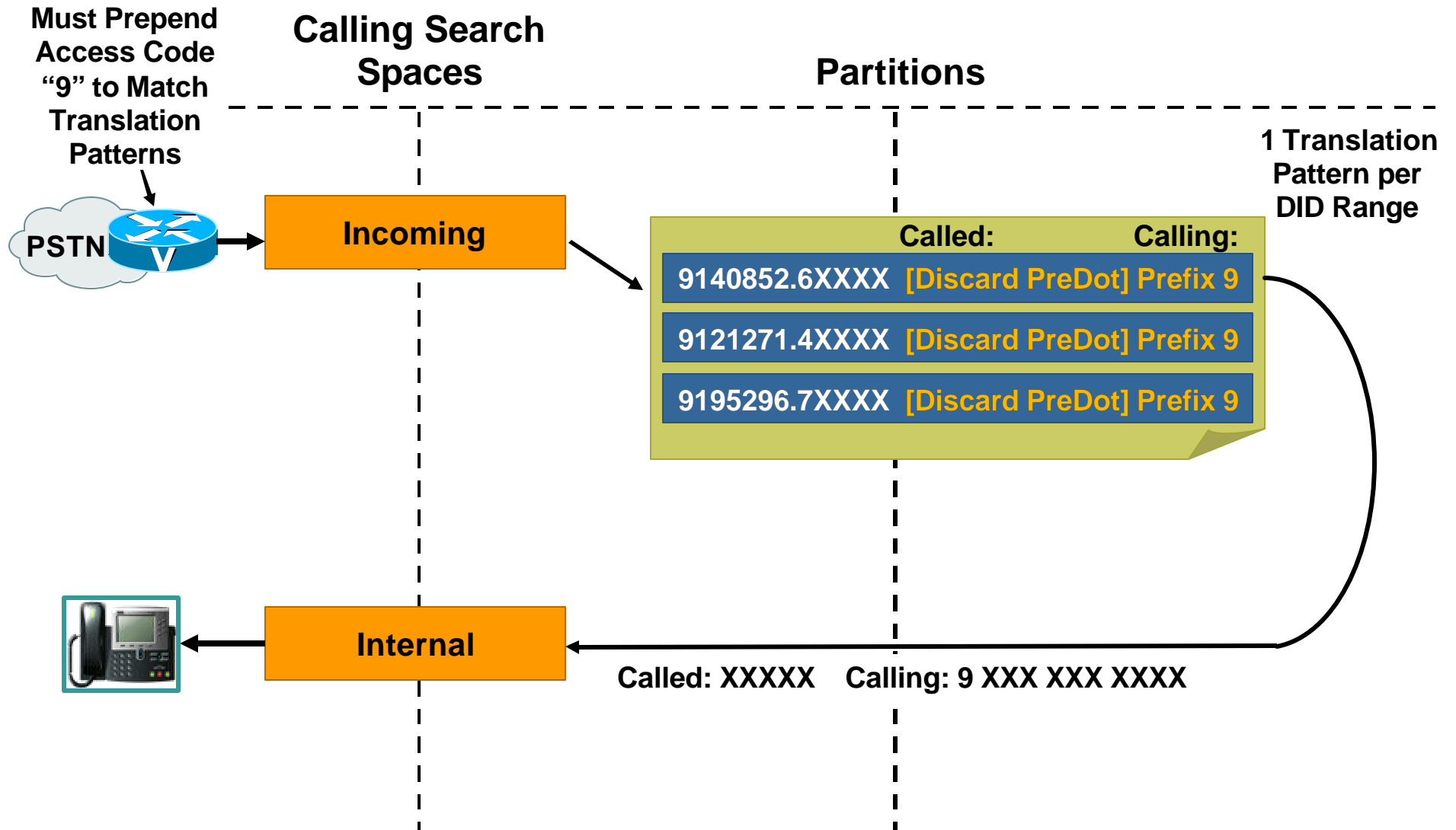
Create Translation Pattern Matching `<NONE>`, Called Party Transformation Mask Equal to 1000, CSS Set for Internal. (Contains Partition with Security Phone)

Create Door Phone with CSS set to **HOTLINE**

Useful Tidbits

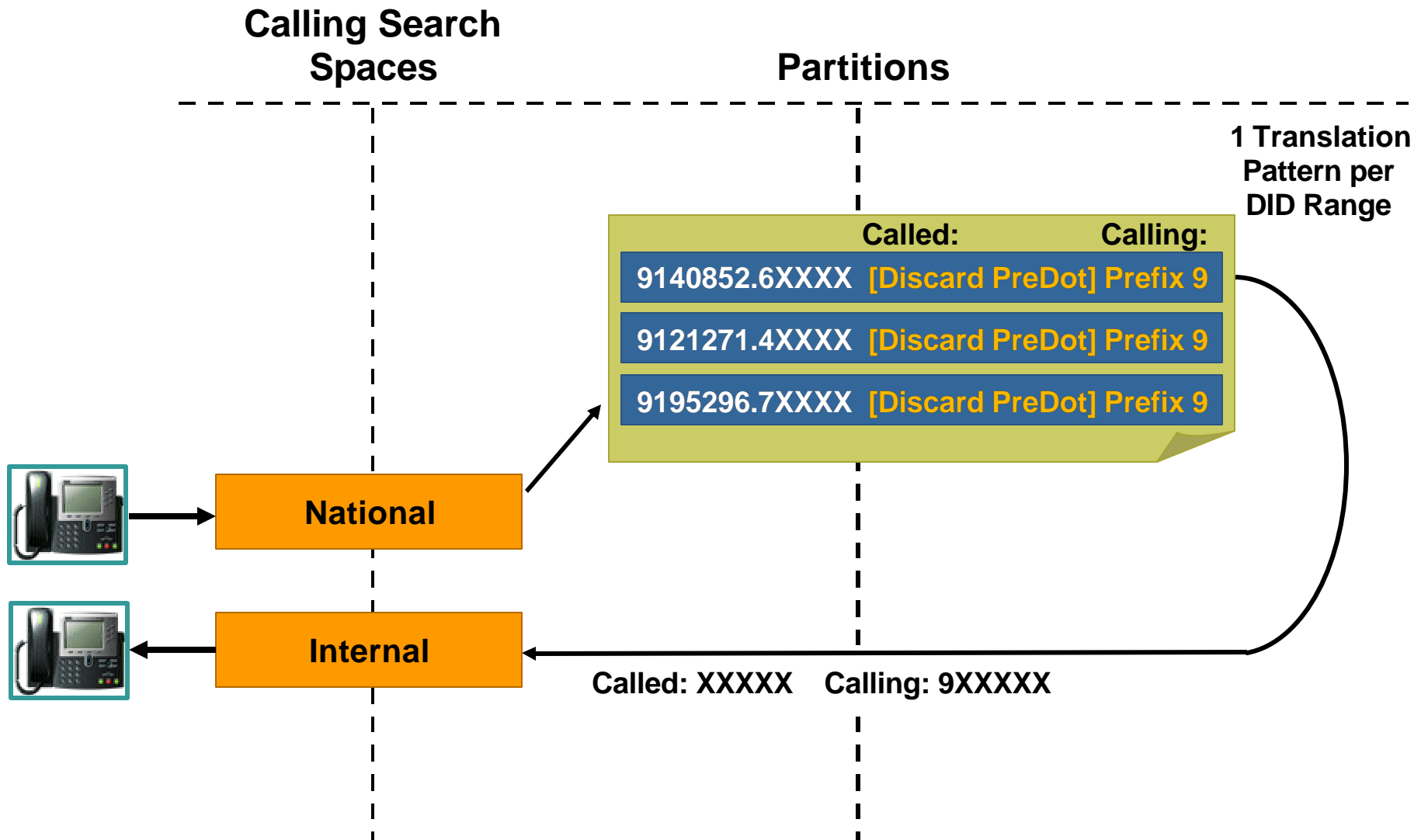
Mapping DID to 5 Digit Extension—Prefix Calling # with 9

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Useful Tidbits

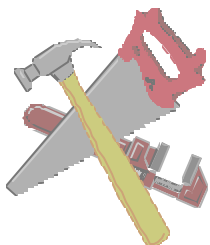
Staff Calls Other Internal Staff Member via DID



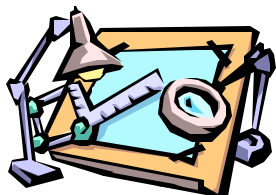
Agenda



- **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?

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- **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:
www.cisco.com/go/srnd

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

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SOLUTION REFERENCE NETWORK DESIGNS

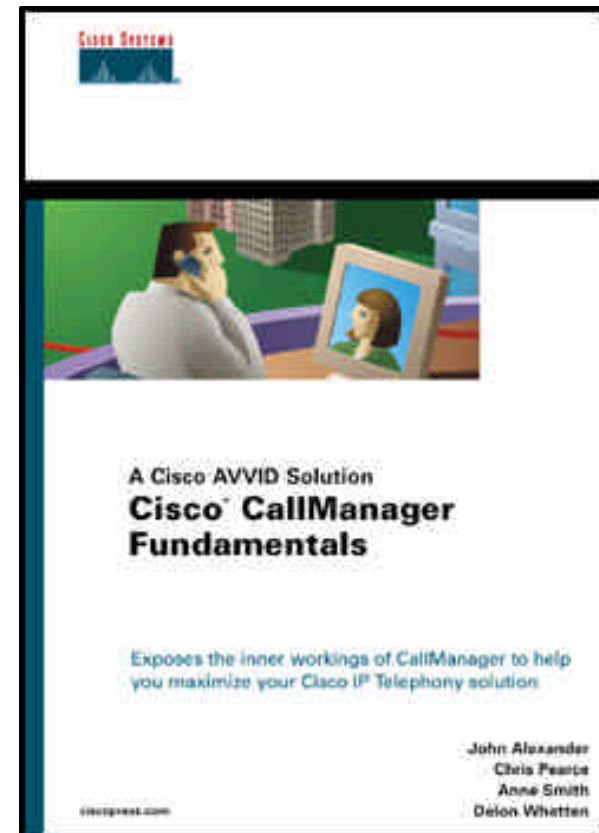
In order to assist enterprise customers in building an efficient, reliable, and scalable network, Cisco has developed a set of documents with detailed design and implementation guidance for various Cisco networking solutions. These Solution Reference Network Design Guides (SRNDs) provide proven best practices to build out a Cisco AVID 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 - 7 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)

Recommended Reading

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



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Dial Plan Design

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