Advanced Dial Plan Design

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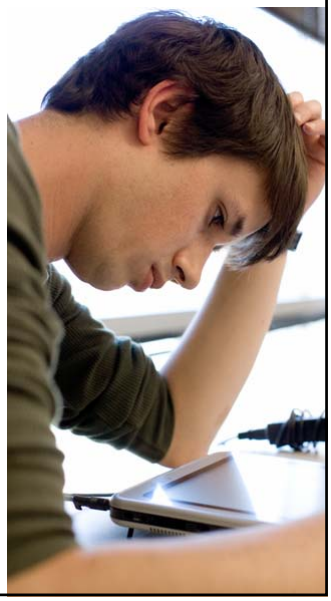
Scope and Objectives

- 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 Cisco Unified Communications Manager 4.X, 5.X and 6.X
- Aspects we will cover:
  - Design guidelines (Classes of service, multisite deployments, extension mobility…)
  - Integration of multiple UCMs in a single system (e.g. inter-UCM call routing, device mobility)



Overall Agenda

- Planning Considerations
- Design Guidelines
- Conclusions

Planning Considerations

Planning Considerations
The Fundamentals

A few things we all like in a good dial plan:

- Not reprinting business cards (i.e. not changing numbers because we change phone systems)
- Having abbreviated dialing within a site (e.g. five 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 five digits to reach colleagues)

Planning Considerations
The Fundamentals (Cont.)

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 redo it all
- Have a good user experience (e.g. not having to wait for interdigit timeout when calling the guy in the next cube over)

Remember: The best tool to start with is this:

Planning Considerations

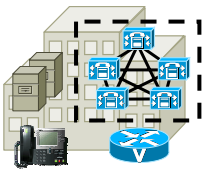
Uniform Dial Plans Are Simple

Q: Could this system use a **uniform** three digit dial plan?

A: No! Chicago and Dallas' DID ranges overlap in the last three digits

Q: Ok, how about four digit uniform dial plan?

A: No! overlaps again!



Anchorage
907 507 18XX

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 interdigit timeout, even when calling from Anchorage!

New York
212 555 75XX

Chicago
708 552 91XX

Birmingham
205 937 54XX

Dallas
972 553 11XX

Planning Considerations

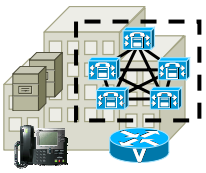
Uniform Dial Plans Are Simple (2)

Q: Fine! How about a five 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…



Anchorage
907 507 18XX

New York
212 555 75XX

Chicago
708 552 91XX

Birmingham
205 937 54XX

Dallas
972 553 11XX

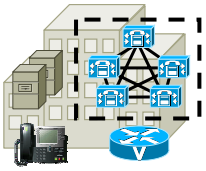
Hawaii
808 ??? ????

Planning Considerations

Uniform Dial Plans Are Simple (3)

Q: If all I could get from Hawaii's telco is a DID range of 808 557 54XX, could I not dial six digits to reach a Hawaii phone, and five 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 interdigit timeout to occur before the call is routed (and a few other reasons: can you spot them?)



Anchorage
907 507 18XX

Q: What do I do now? Go to six digits?

A: No: Anchorage's second NXX digit is 0. Overlaps with the operator code…

Q: Seven digits?

A: No: Birmingham starts with a 9!

New York
212 555 75XX

Chicago
708 552 91XX

Birmingham
205 937 54XX

Dallas
972 553 11XX

Hawaii
808 557 54XX

Planning Considerations

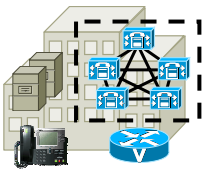
Uniform Dial Plans Are Simple (or So We Hoped)

Q: Eight digits?

A: Ok for now: but you'll never open an office in Raleigh (area code 919)

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

Q: Ten digits?



Anchorage
907 507 18XX

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…

New York
212 555 75XX

Chicago
708 552 91XX

Birmingham
205 937 54XX

Dallas
972 553 11XX

Hawaii
808 557 54XX

Planning Considerations

How About an On-Net, Intersite Access Code?

Q: What about 0 for operator, 9 for outside line, and 8 for intersite calls?

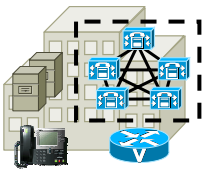
A: Great idea

Q: How many digits for intrasite calls, though?

A: Not 3 (4XX and 1XX overlap)

Not 4 either (911!)

5 would work!



Anchorage
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New York
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Chicago
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808 557 54XX

Planning Considerations

How About an On-Net, Intersite Access Code?

Q: Ok: now I have it:

0 = operator

8 + 5 digits: intersite on-net

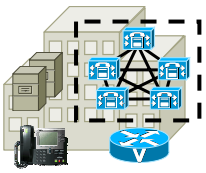
9 + 7 digits, 9 + 10 digits , 9 + 1 + 10 digits, 9 + 011… all off-net patterns

And then any five digits that begin with 1 though 7 is an on-net, intrasite call

Am I good to go?

A: Yes

…for now



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205 937 54XX

Dallas
972 553 11XX

Hawaii
808 557 54XX

Planning Considerations

What If I Have Many, Many More Sites? More Users?

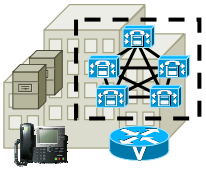
Q: I have 250 branches, with over 90 with 100+ users, and a dozen with more than 1000 users, and a headquarter with 12000 users. Can I still use eight + five digits for on-net, intersite calls?

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 five digit range for a single site, and dividing the rest into 250 unequal 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

Planning Considerations

What if I Have Many, Many More Sites? More Users? (2)

Q: What to do?

A: Site codes are a good idea

0 = operator

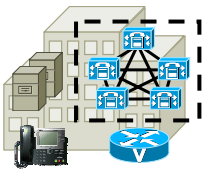
9 = outside line, all combinations

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

[1-7]XXX: on-net, intrasite dialing

Q: But I have a site with more than 10000 users?

A: Would you be OK with using two site codes for that site? And having that site use five digit on-net?



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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

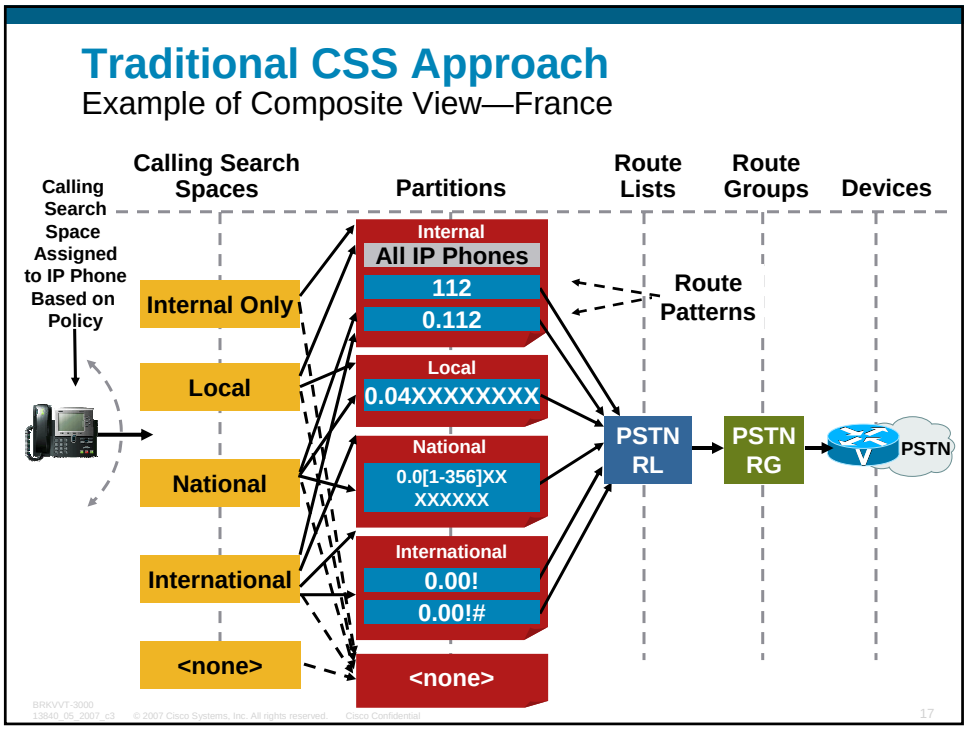
Philadelphia
267 555 1XXX
Site Code 390

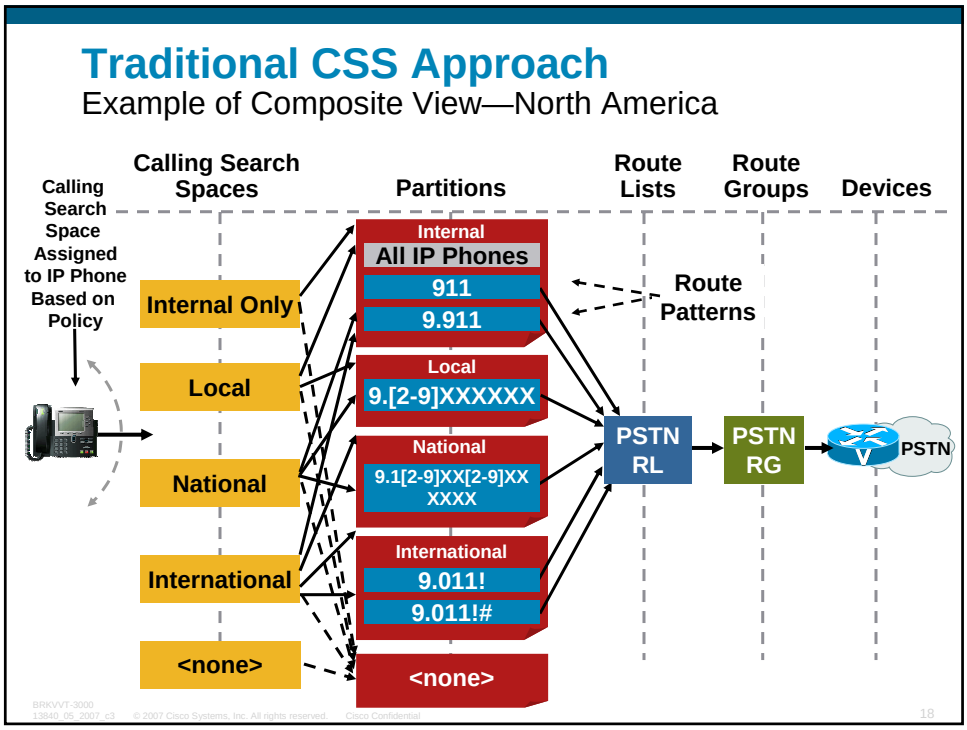
Hawaii
808 557 54XX
Site Code 822

Design Guidelines

Design Guidelines Agenda

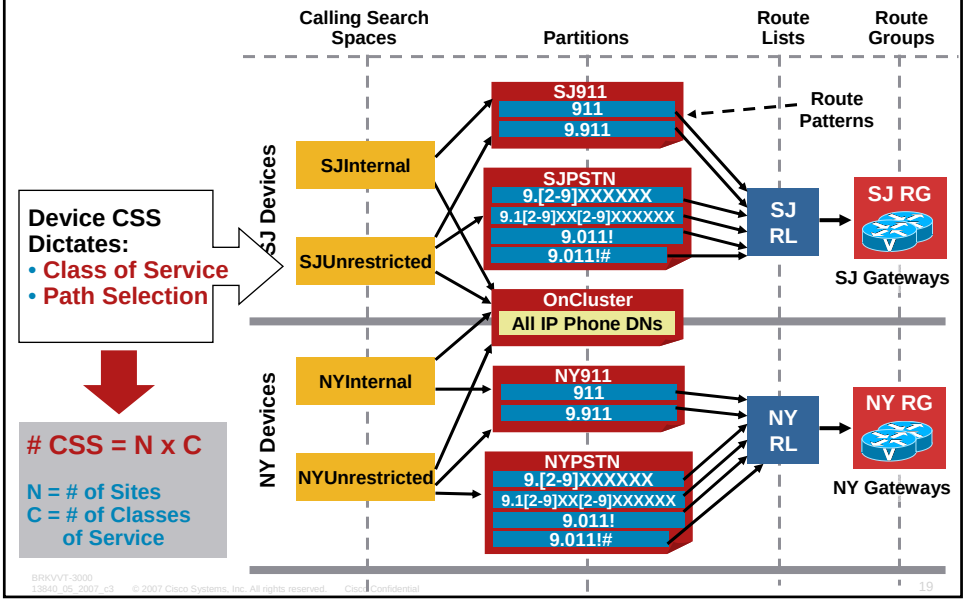
- Building Classes of Service
  - Traditional CSS Approach
  - Line/Device CSS Approach
- Multisite Deployments
- Mobility Considerations





Traditional CSS Approach

Scalability for Centralized Deployments

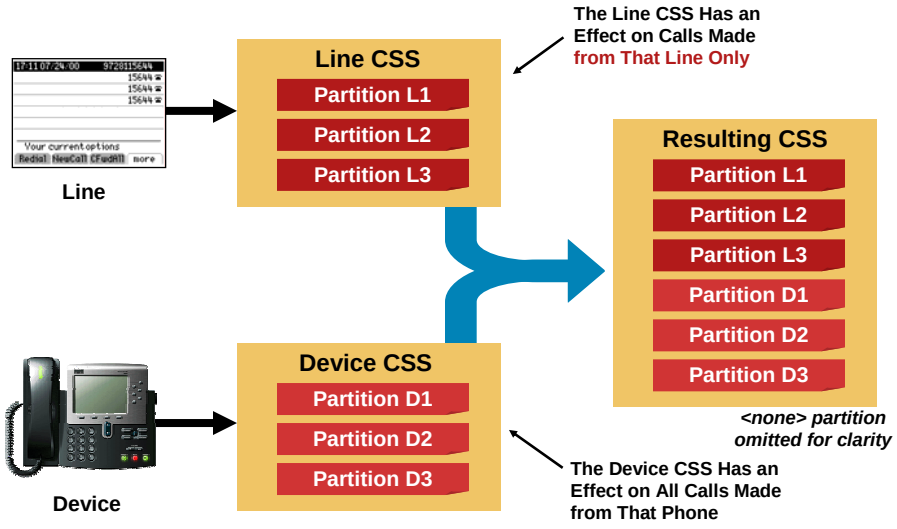


Design Best Practices Agenda

- Building Classes of Service
  - Traditional CSS Approach
  - Line/Device CSS Approach
- Multisite Deployments
- Mobility Considerations

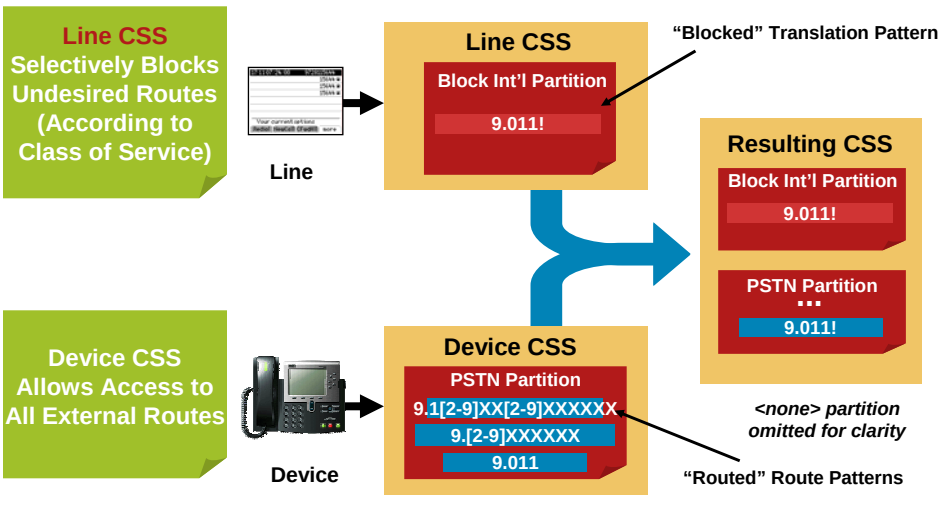
The Line/Device CSS Approach

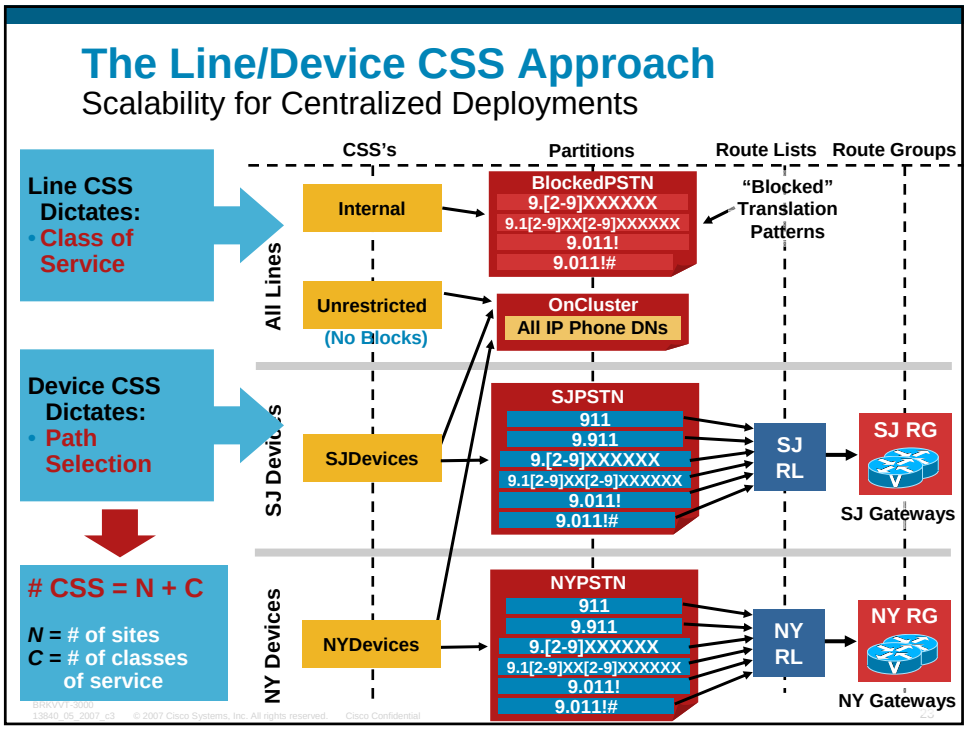
Line CSS vs. Device CSS

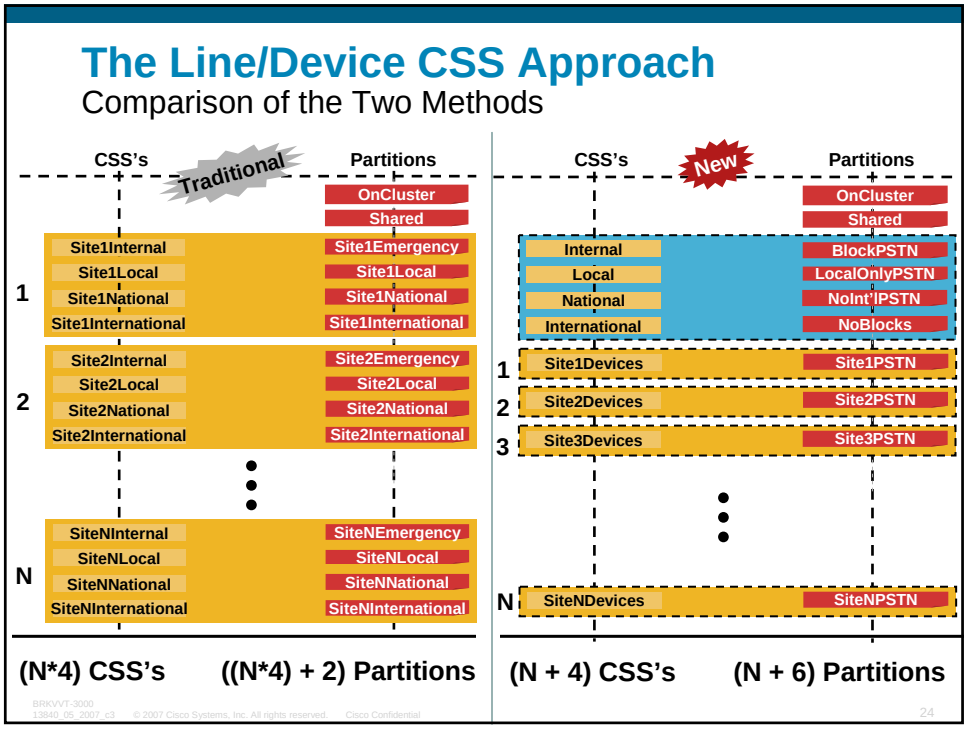


The Line/Device CSS Approach

Key Idea







The Line/Device CSS Approach

CallForward Caveats (1 of 2)

- Forwarded calls use the CallFwdxxx CSS's only; these values are not concatenated with Line or Device CSS
- If forwarded calls must have unrestricted privileges, set the CallFwdxxx CSS's to the site-specific Device CSS
- If forwarded calls must be restricted to internal numbers only, set the CallFwdxxx CSS's to a single, global CSS with only internal partitions
- In 4.X, If forwarded calls must have some intermediate restriction (e.g., no international calls), this approach may lose efficiency, as additional site-specific CSS's will be needed

New In CUCM 5.X and 6.X, a new CSS [Secondary Calling Search Space for CallForwardAll] has been added, allowing for CFA to have all the classes of service afforded by the line/device approach

The Line/Device CSS Approach

CallForward Caveats (2 of 2)

New
- Calling Search Space Activation policy (6.X only)

  Use system Default

  the CFA CSS Activation Policy cluster-wide service parameter determines which Forward All Calling Search space will be used.

  With Configured CSS

  The configured CFAll and Secondary CSS for CFAll are used

  With Activating Device/Line CSS

  the Forward All Calling Search Space and Secondary Calling Search Space for Forward All automatically gets populated with the Directory Number Calling Search Space and Device Calling Search Space for the activating device.
- When a device is roaming in the same device mobility group, Cisco Unified Communications Manager uses the Device Mobility CSS to reach the local gateway. If a user sets Call Forward All at the phone, the CFA CSS is set to None, and the CFA CSS Activation Policy is set to With Activating Device/Line CSS, then:

  The Device CSS and Line CSS get used as the CFA CSS when the device is in its home location.

  If the device is roaming within the same device mobility group, the Device Mobility CSS from the Roaming Device Pool and the Line CSS get used as the CFA CSS.

  If the device is roaming within a different device mobility group, the Device CSS and Line CSS get used as the CFA CSS.

The Line/Device CSS Approach
Other Caveats

- Blocking translation patterns configured within the Line CSS must be **at least as specific** as the route patterns configured within the Device CSS
  - (Watch for the "@" wildcard, as its patterns are very specific)
- AAR uses a different CSS for rerouted calls; in most cases, this CSS can be the same as the unrestricted site-specific Device CSS
- Priority order between line and device is reversed for CTI route points and CTI ports; therefore, the Line/Device CSS approach cannot be *directly* applied to CTI devices, such as Softphone (not Communicator)
  - In this case, it is viable only if blocked patterns are more specific than the routed ones (i.e. not relying on order of the partitions)

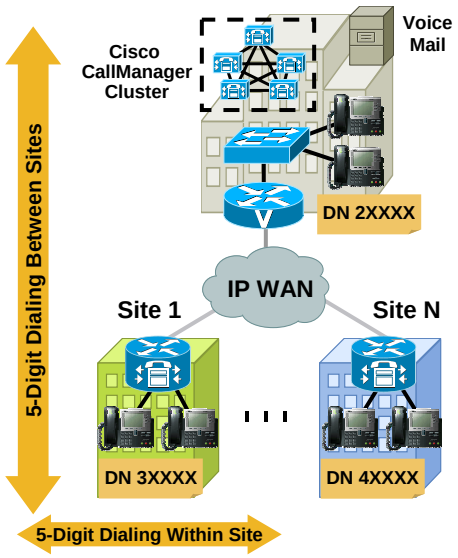
Design Best Practices Agenda

- Building Classes of Service
- Multisite Deployments
  - Choosing a Dial Plan Approach
  - Uniform On-Net Dialing
  - Variable-Length On-Net Dialing with Partitioned Addressing
  - Variable-Length On-Net Dialing with Flat Addressing
  - VoPSTN
  - Tail End Hop Off (a.k.a. toll bypass)
- Mobility Considerations

Choosing a Dial Plan Approach

Uniform On-Net Dialing

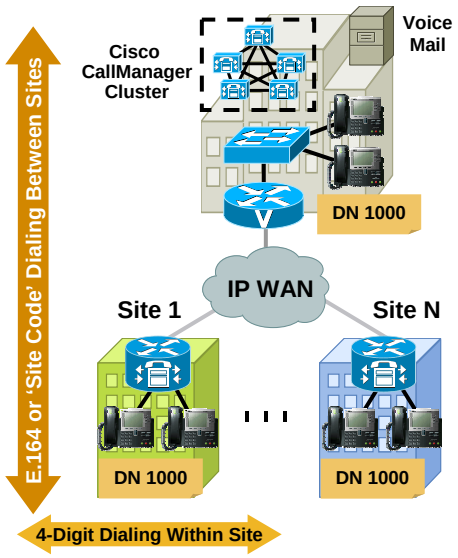
- Dialing within a site and across sites with same number of digits (e.g., 5)
- Extensions are globally unique
- Easy to design and configure
- Limited scalability of the addressing method (number of sites, number of extensions)



Choosing a Dial Plan Approach

Variable-Length On-Net Dialing (VLOD)

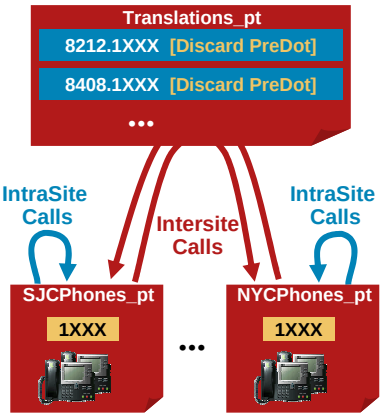
- Abbreviated dialing within a site (four or five digits)
- Identical extensions (e.g., 1000) may appear at different sites
- Intersite calls use an "escape code" (e.g., "9 + full E.164", or "8 + site code + extension")
- Easier scalability for large numbers of extensions and sites



Choosing a Dial Plan Approach

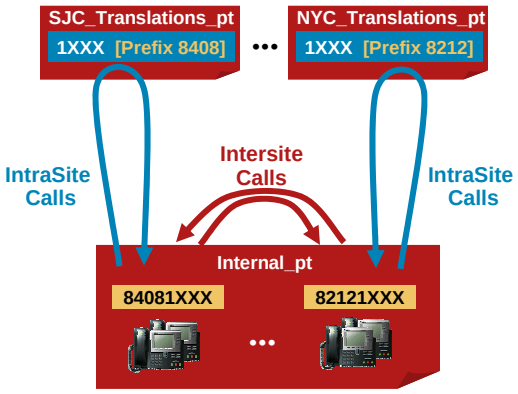
Addressing Methods for VLOD

Partitioned Addressing



- Phone DN's in different partitions
- Global Xlations for intersite calls

Flat Addressing



- Phone DN's in same global partition
- Per-site translations for intrasite calls

Choosing a Dial Plan Approach

Preliminary Design Questions

- How many sites are going to be part of the system?
- What are the calling patterns between sites?
- What do users dial within a site and to reach another site?
- What transport network is going to be used for intersite calls (PSTN or IP WAN)?
- What (if any) CTI applications are being used?
- Is there a desire for a standardized on-net dialing structure (e.g., using site codes)?

Design Best Practices Agenda

- Building Classes of Service
- MultiSite Deployments
  - Choosing a Dial Plan Approach
  - Uniform On-Net Dialing
  - Variable-Length On-Net Dialing with Partitioned Addressing
  - Variable-Length On-Net Dialing with Flat Addressing
  - VoPSTN
  - Tail End Hop Off (a.k.a. toll bypass)
- Mobility Considerations

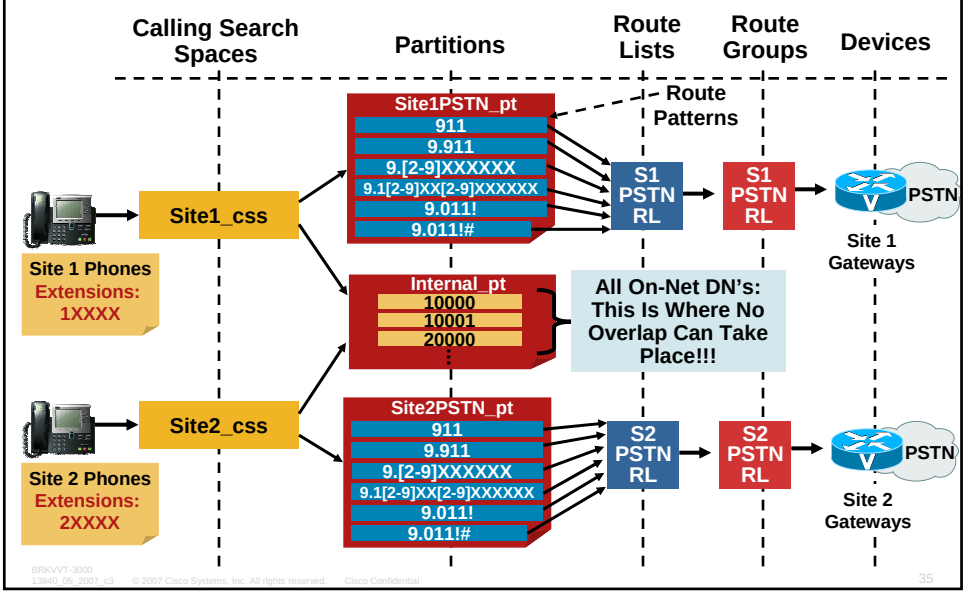
Uniform On-Net Dialing

Use This Model If…

- DID ranges do not overlap (based on chosen quantity of digits for internal calls)
- Number of sites is small
- Number of sites is not expected to grow significantly in the future
- DID ranges are deemed to be predictable (can anyone make that assumption??? One area code split, and you may be back to the drawing board!!!)

Uniform On-Net Dialing

Composite View



Design Best Practices Agenda

- Building Classes of Service
- MultiSite Deployments
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- Mobility Considerations

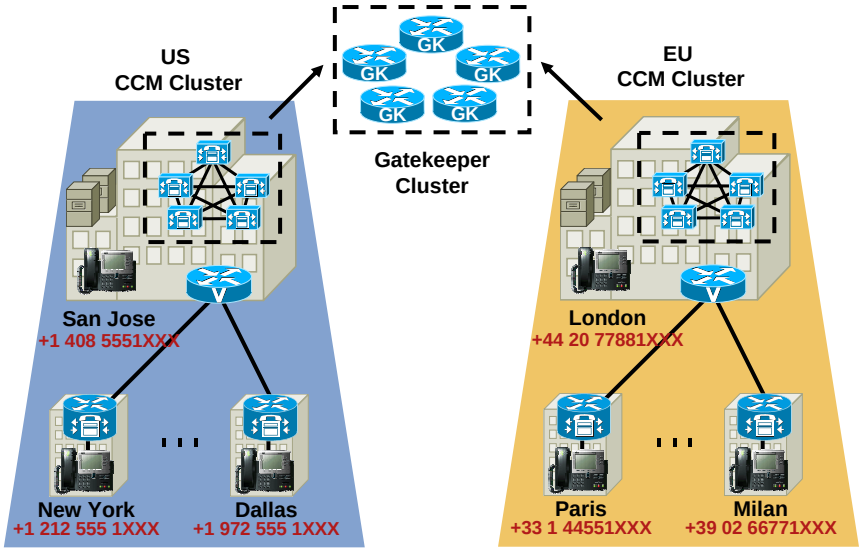
VLOD with Partitioned Addressing

Use This Model If…

- A global on-net numbering plan using site codes is not desired (or possible)
- Policy restrictions must be applied to on-net intersite calls (that is, some or all users are not allowed to dial other sites on-net)
- Intersite calls are always routed over the PSTN
- CTI applications are not used across sites
- You have to because the system was built this way from the start…

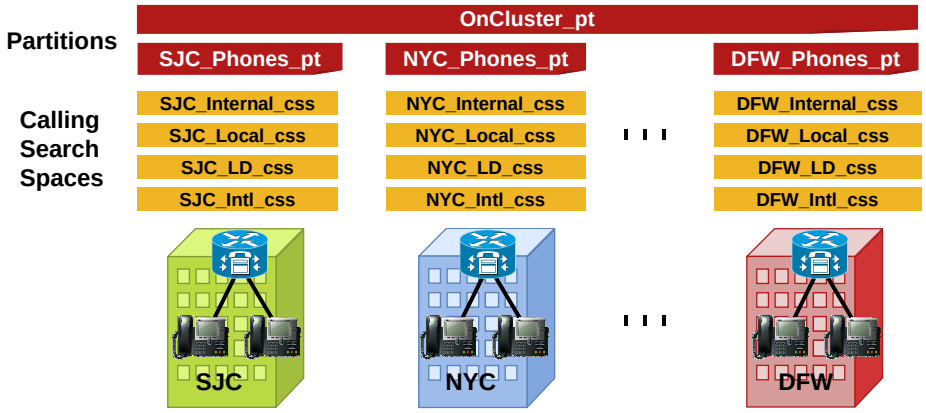
VLOD with Partitioned Addressing

Hypothetical Customer Example



VLOD with Partitioned Addressing

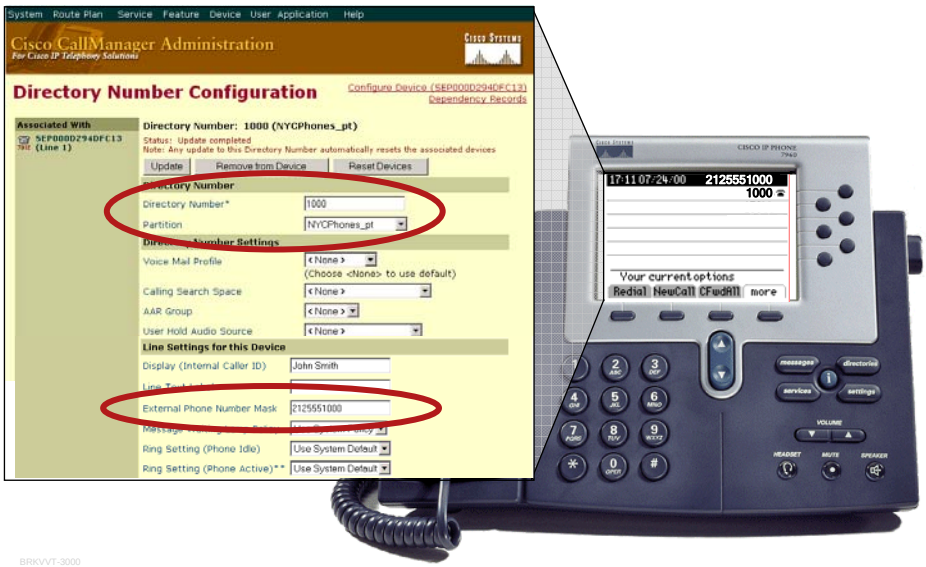
Partitions and Calling Search Spaces

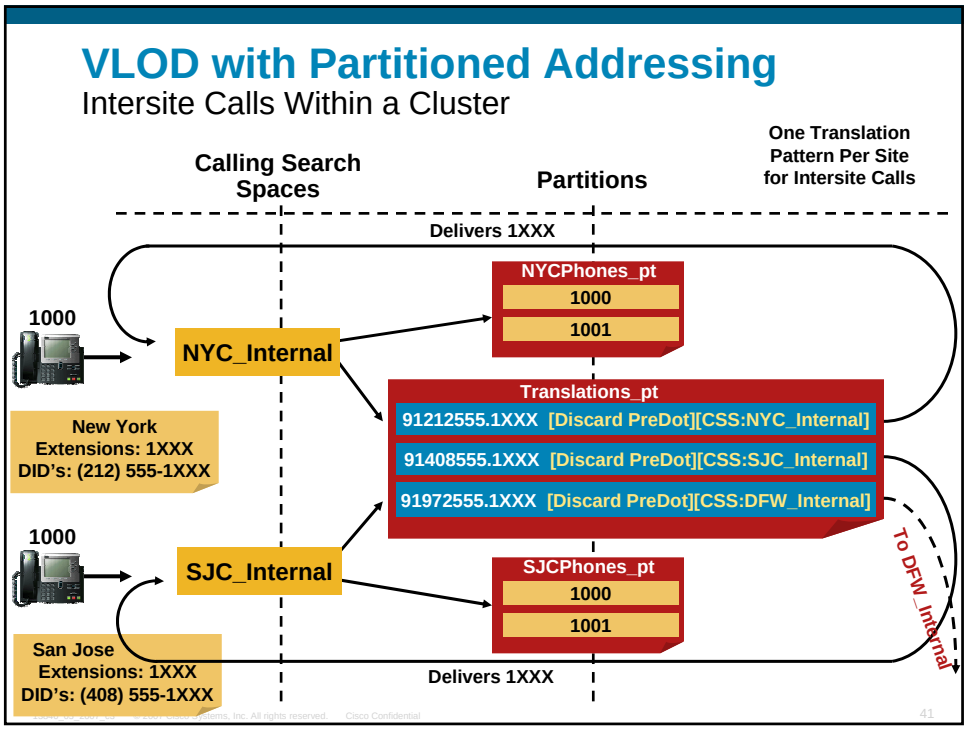


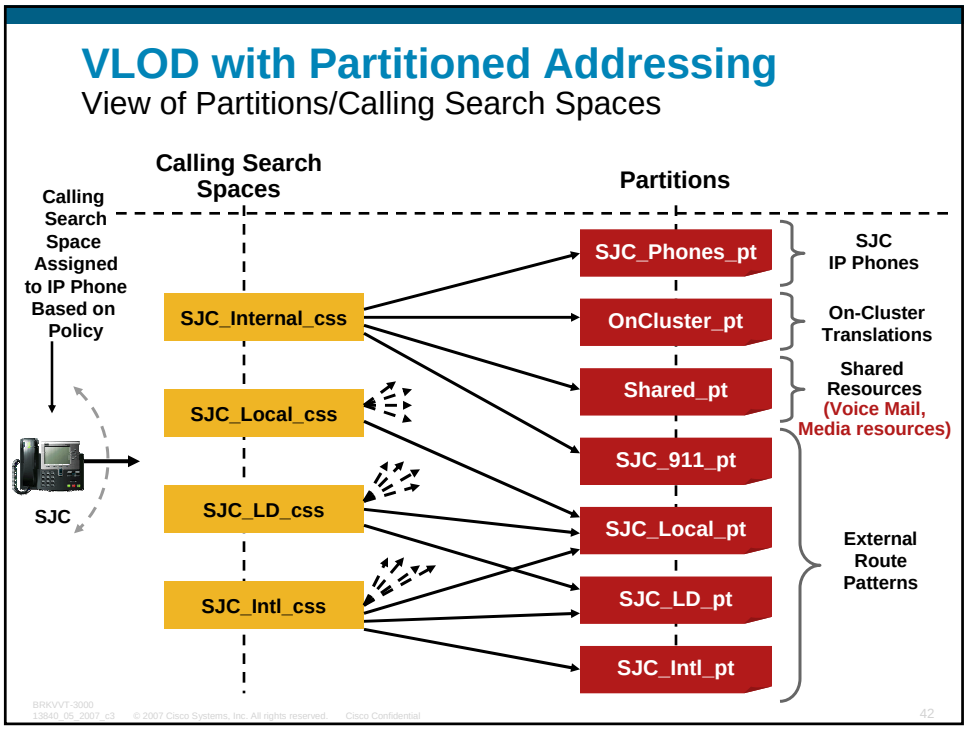
* **Note: If Using the Line/Device CSS Approach, the Number of CSS's Can Be Reduced**

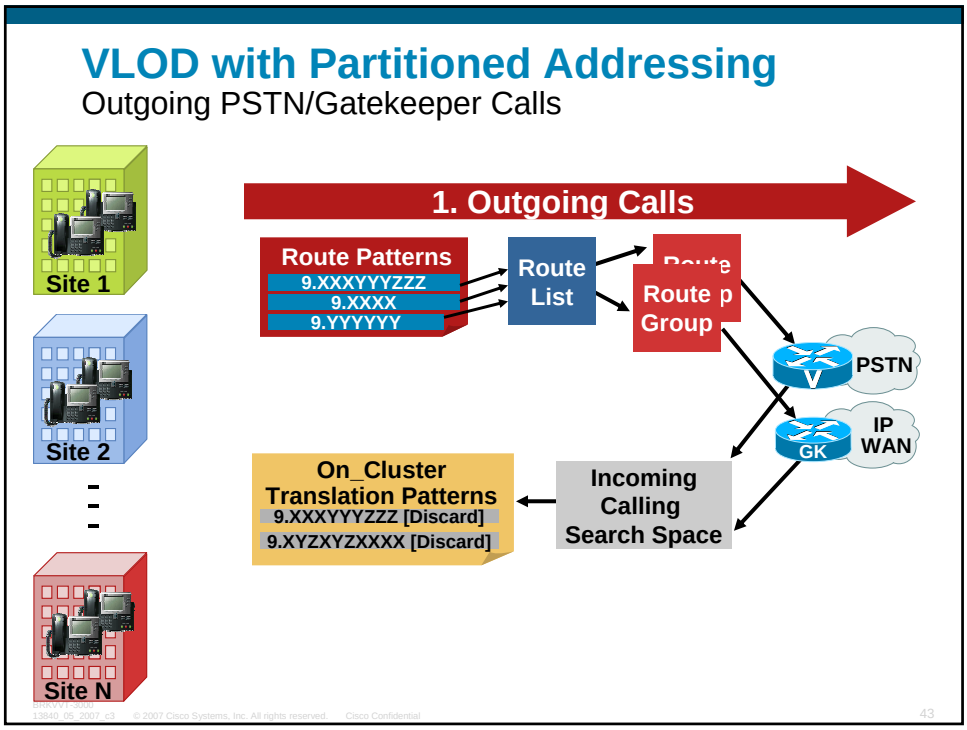
VLOD with Partitioned Addressing

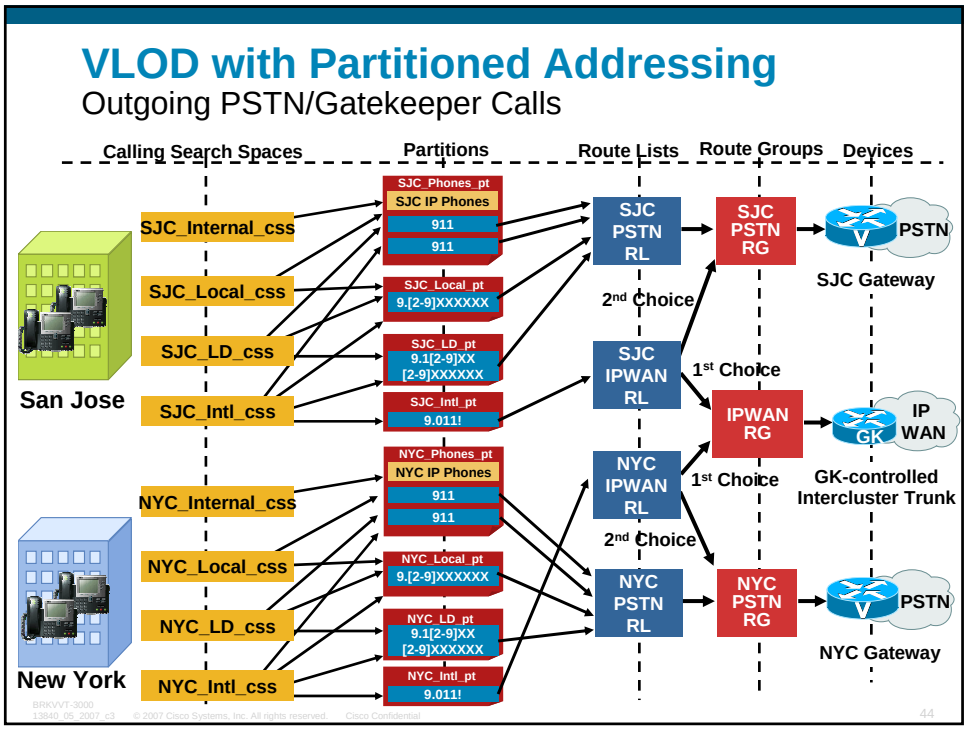
Line Configuration

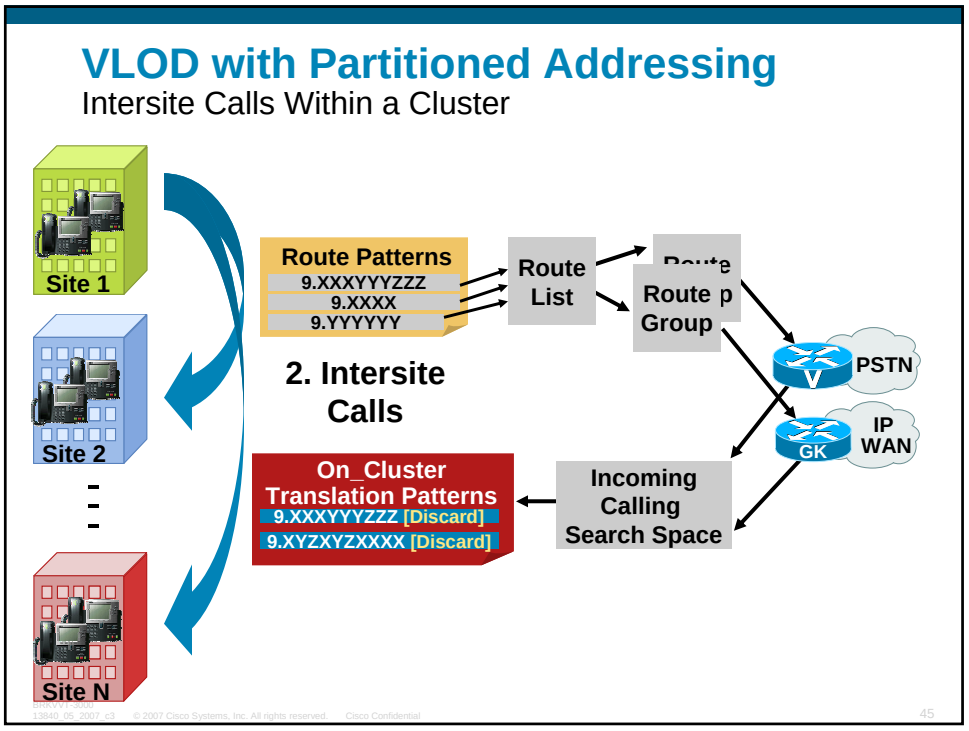


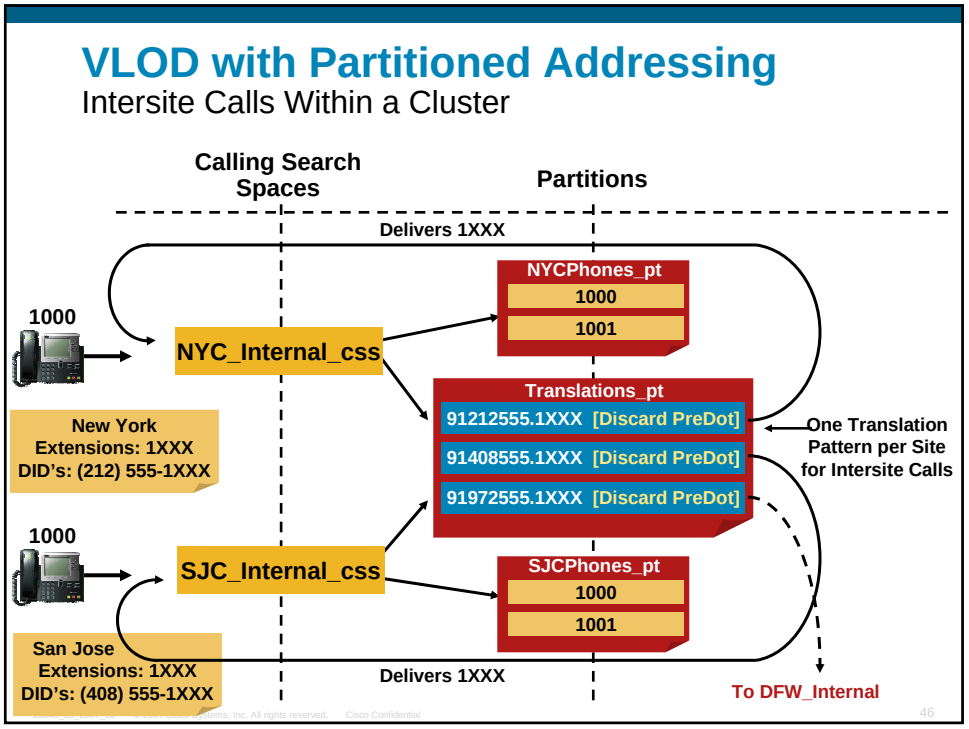


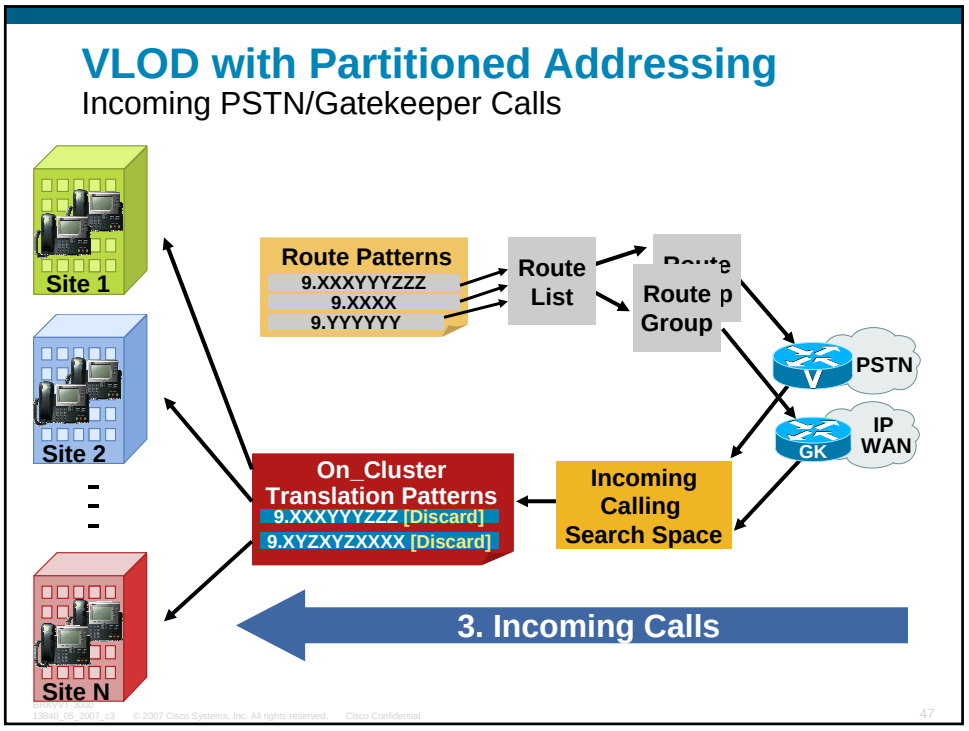


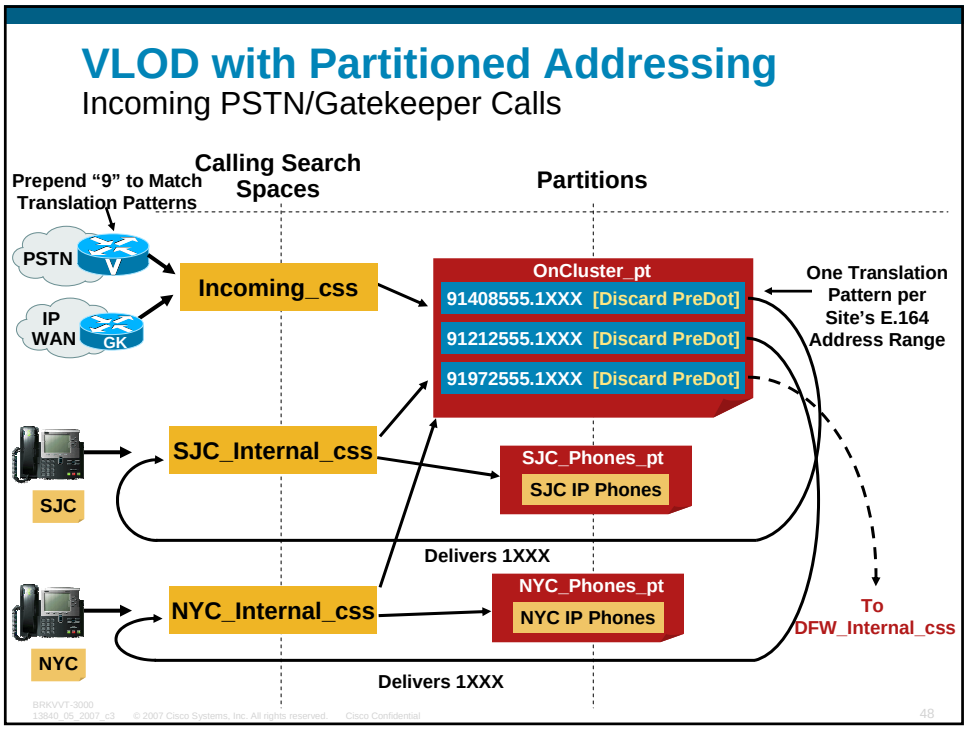








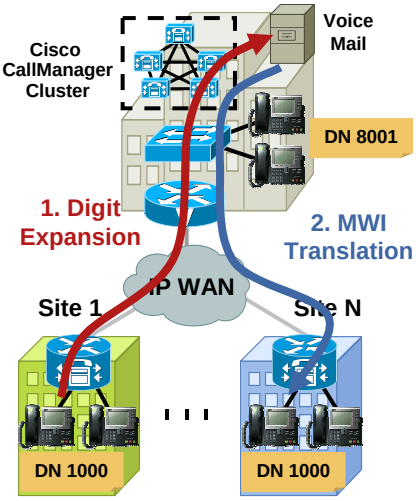




VLOD with Partitioned Addressing

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



VLOD with Partitioned Addressing

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

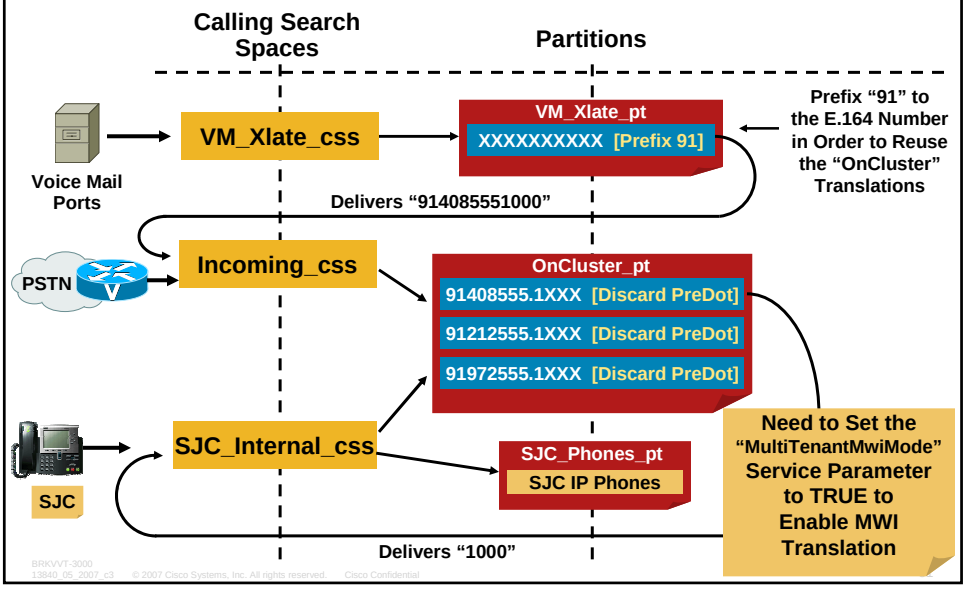
* indicates required item

** 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)

VLOD with Partitioned Addressing

Voice-Mail Integration: MWI Translation



Design Best Practices Agenda

- Building Classes of Service
- MultiSite Deployments
  - Choosing a Dial Plan Approach
  - Uniform On-Net Dialing
  - Variable-Length On-Net Dialing with Partitioned Addressing
  - Variable-Length On-Net Dialing with Flat Addressing
  - Tail End Hop Off (a.k.a. toll bypass)
- Mobility Considerations

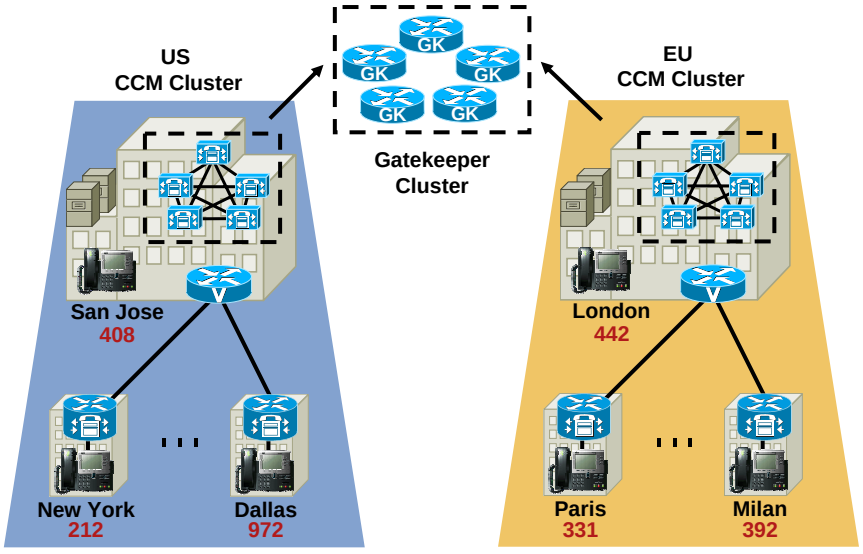
VLOD with Flat Addressing

Use This Model If…

- Branches interact often
- Users dial a ‘site code’ for intersite calls
- Intersite calls go over IP WAN
- CTI applications are used across sites
- International deployment
- A global on-net dial plan is needed
- This approach is presumed by many upcoming features’ design guidance. *If you can start with this approach, you will most likely be future-proofed.*

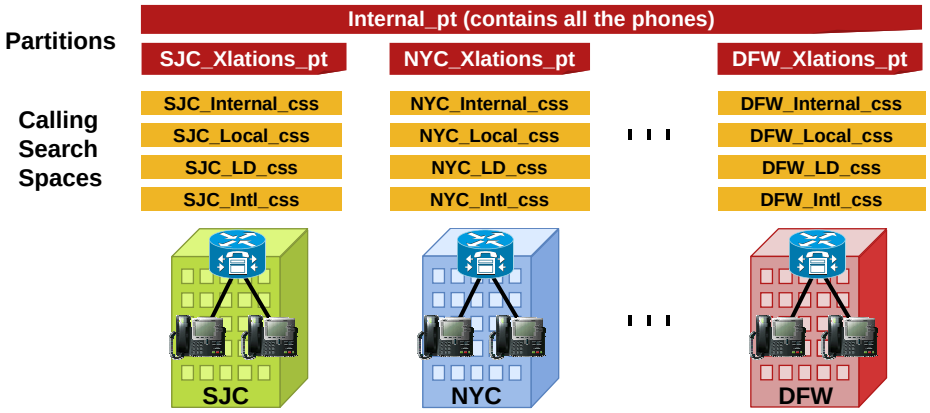
VLOD with Flat Addressing

Site Code Assignment



VLOD with Flat Addressing

Partitions and Calling Search Spaces



* **Note: If Using the Line/Device CSS Approach, the Number of CSS's Can Be Reduced**

VLOD with Flat Addressing

Line Configuration

*Note: Line Text Label Is Not Preserved in SRST Mode

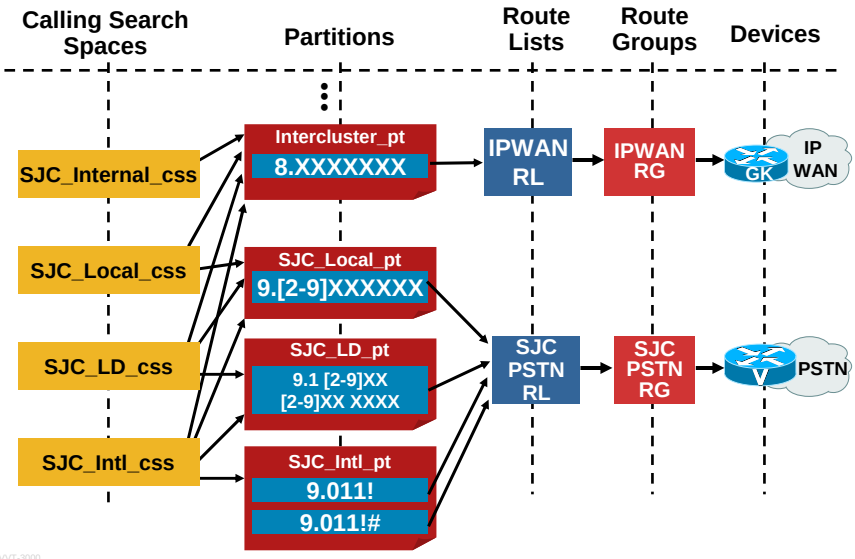
VLOD with Flat Addressing

Outgoing Inter-cluster WAN/PSTN Calls

- Option 1: Eight digit only
  - Simple, easy to maintain
  - No automatic PSTN failover (manual redial)
- Option 2: Eight digit + E.164 with centralized PSTN failover
  - A little more configuration and maintenance
  - Automatic PSTN failover using central gateway
    - (**SJC in our example**)
  - Possibility to place calls on-net even when dialed as PSTN
- Option 3: Eight digit + E.164 with distributed PSTN failover
  - A lot more configuration and maintenance
  - Automatic PSTN failover using local gateway

VLOD with Flat Addressing

Outgoing PSTN/IP WAN Calls: Option 1



Design Best Practices Agenda

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Design Best Practices Agenda

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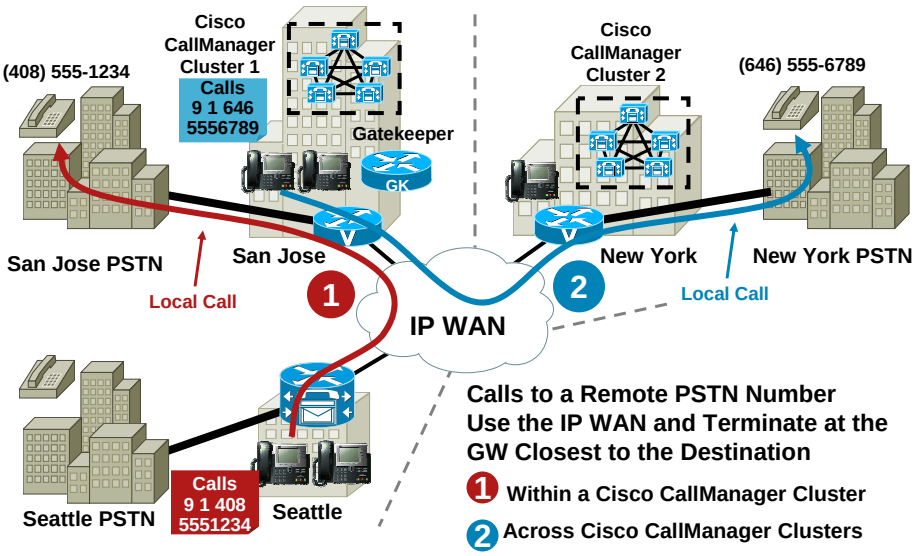
Tail-End Hop-Off (TEHO)

What Is It?

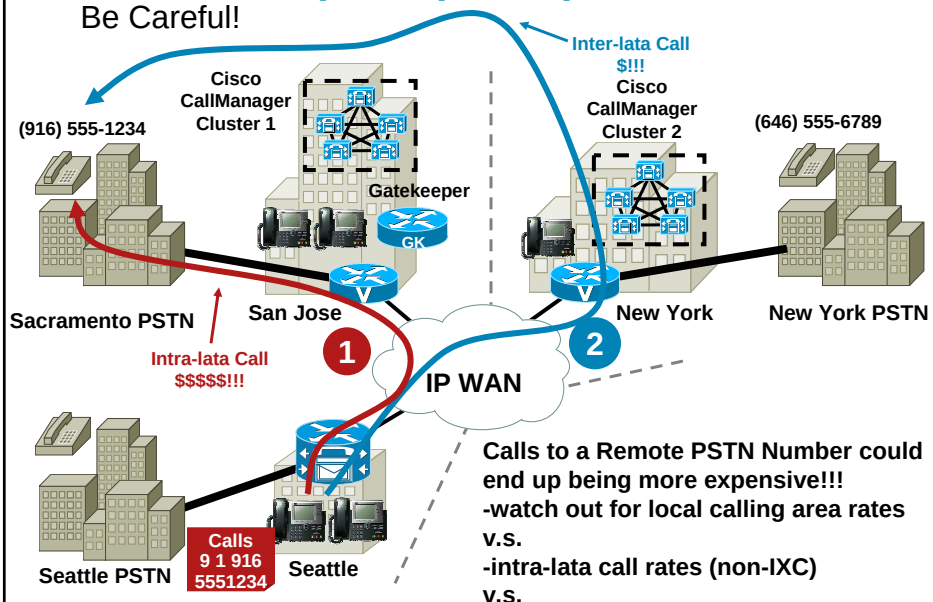


Calls to a Remote PSTN Number Use the IP WAN and Terminate at the GW Closest to the Destination

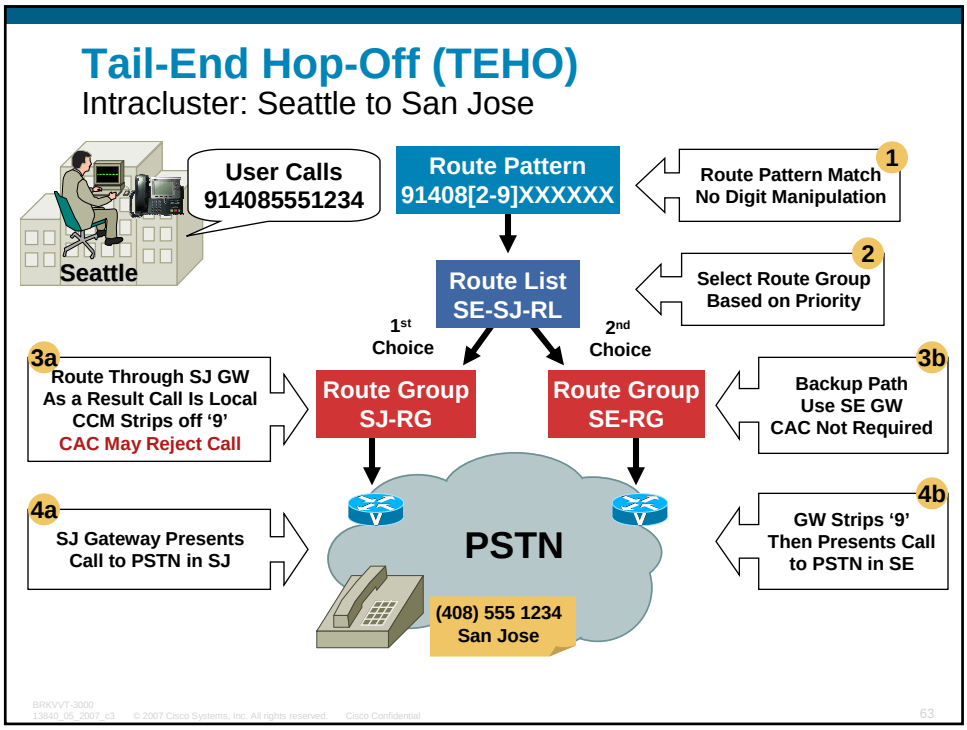
1. Within a Cisco CallManager Cluster
2. Across Cisco CallManager Clusters

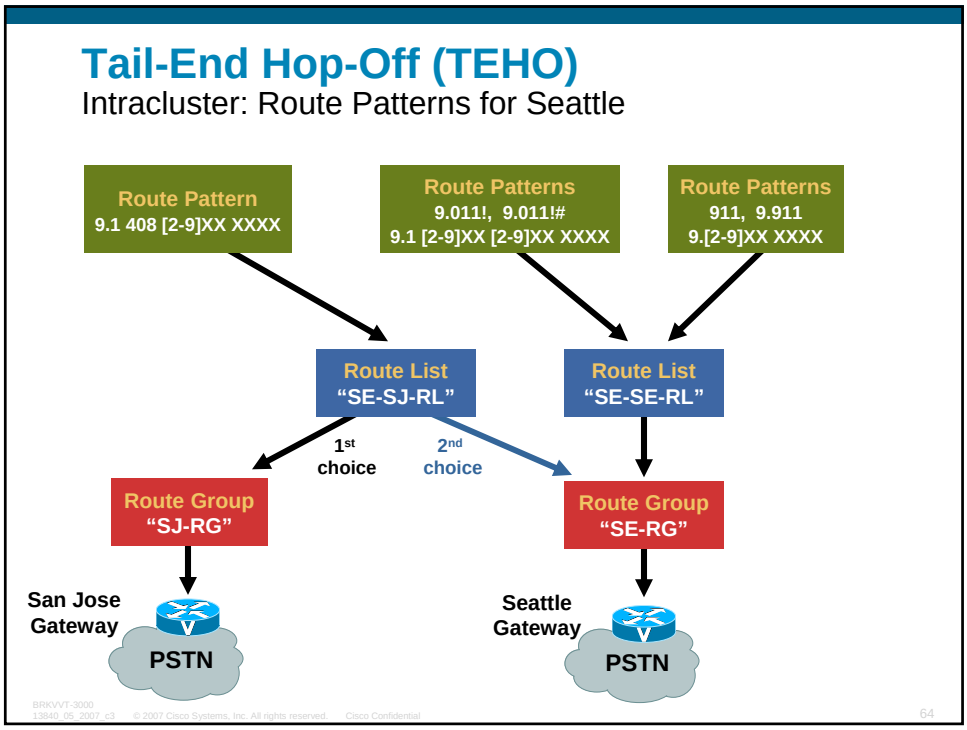
Tail-End Hop-Off (TEHO)

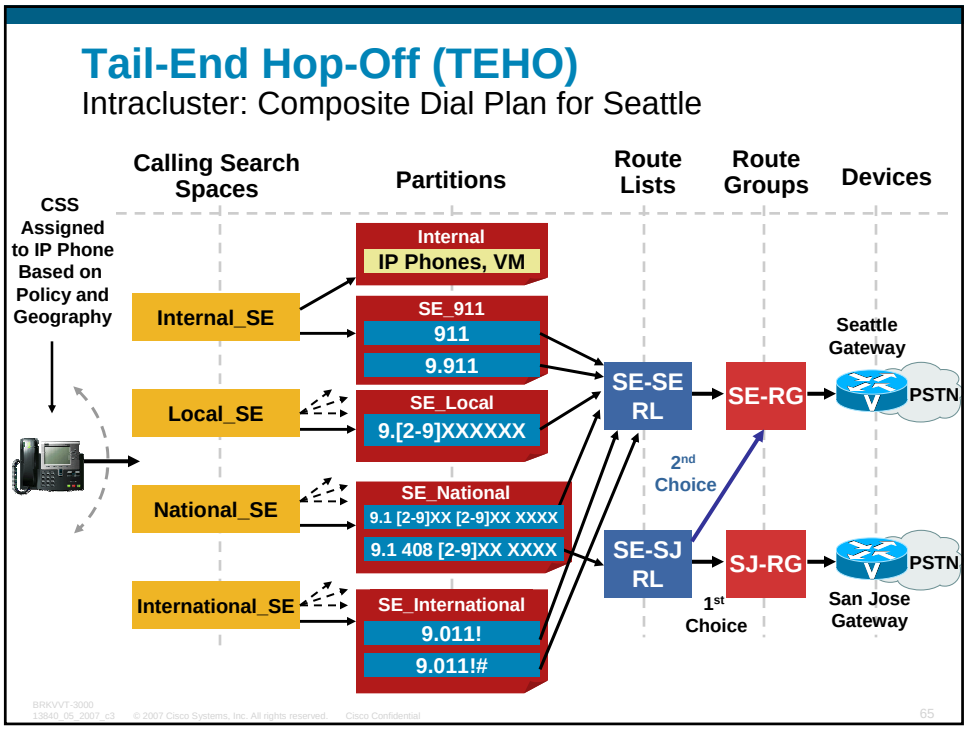
Be Careful!

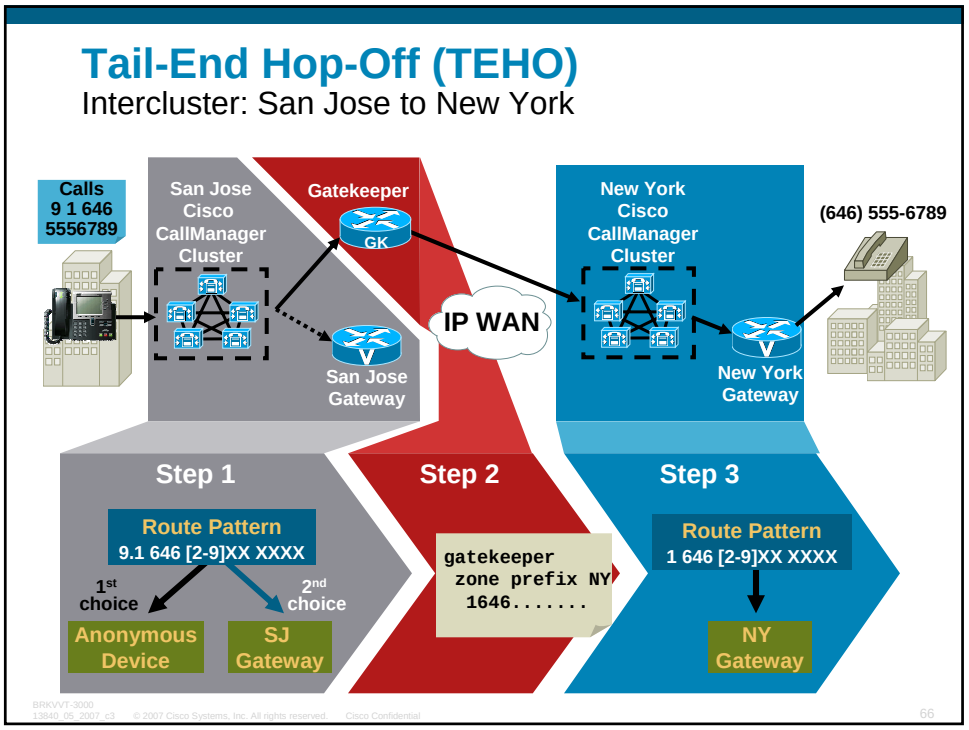


Calls to a Remote PSTN Number could end up being more expensive!!!
-watch out for local calling area rates
v.s.
-intra-lata call rates (non-IXC)
v.s.
-inter-lata call rates (IXC)



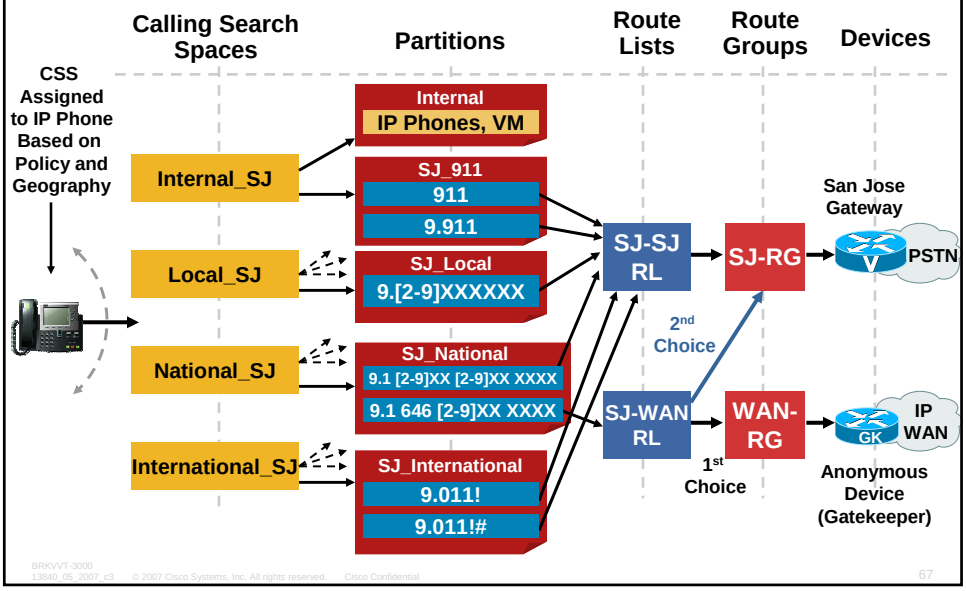






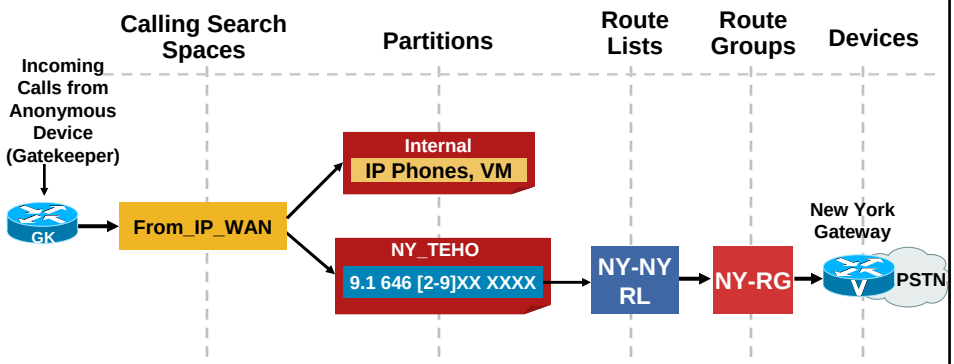
Tail-End Hop-Off (TEHO)

Intercluster: Composite Dial Plan for San Jose



Tail-End Hop-Off (TEHO)

Intercluster: Dial Plan for New York



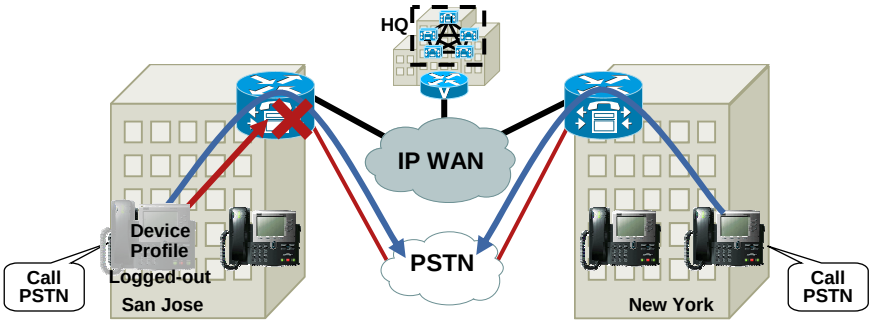
Note: To Avoid Routing Loops, Do Not Include Partitions That Contain IP WAN Routes in the "From_IP_WAN" Calling Search Space

Design Best Practices Agenda

- Building Classes of Service
- MultiSite Deployments
- Mobility Considerations
  - Extension mobility
  - Device Mobility
  - Mobility Manager

Extension Mobility Considerations

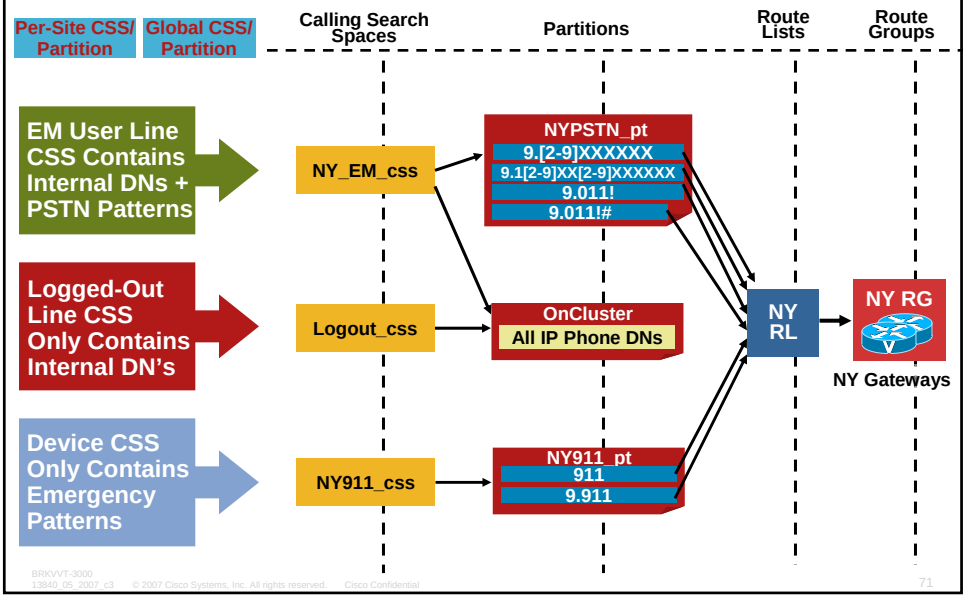
Requirements



- Allow users to log in at different sites with a single device profile
- Restrict PSTN calls when logged out
- Always route emergency calls via local gateway
- Optional: route all PSTN calls via local gateway

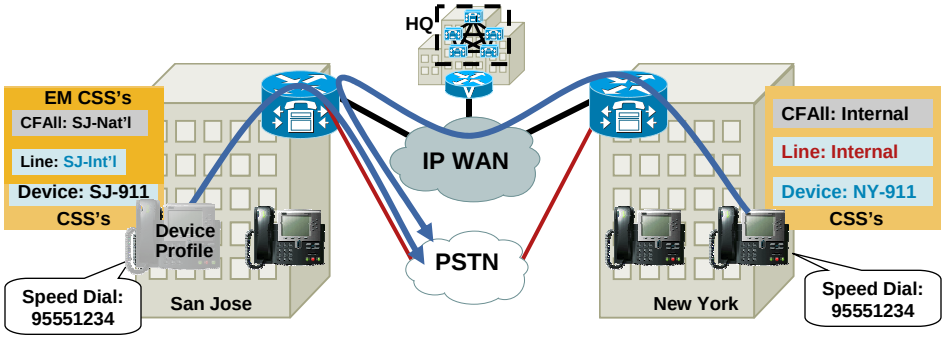
Extension Mobility Considerations

Traditional Dial Plan Approach



Extension Mobility Considerations

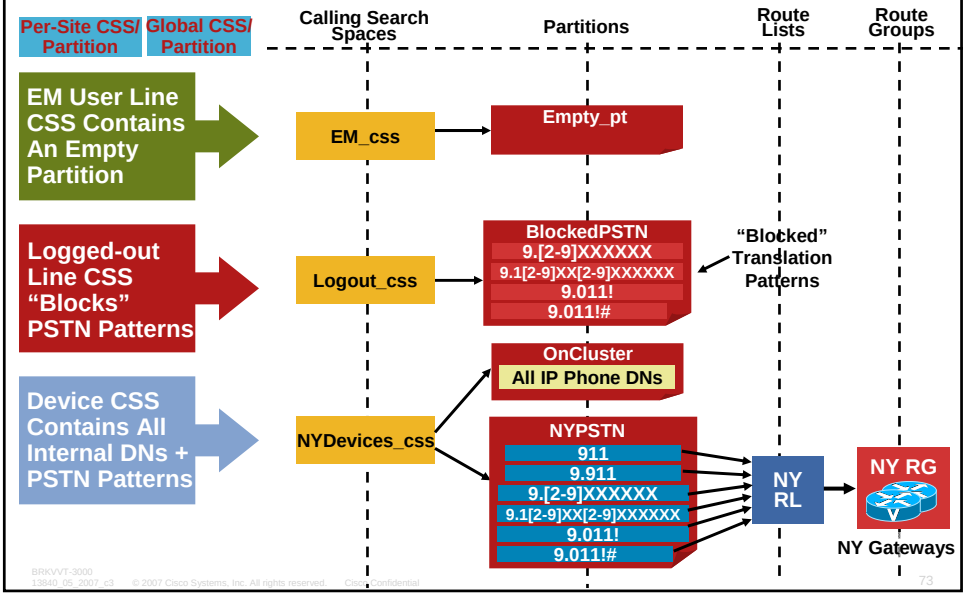
Traditional Dial Plan Approach: Behavior



- Emergency calls routed via local gateway
- Other PSTN calls routed via "home" gateway
- User dialing habits and speed dials are automatically preserved

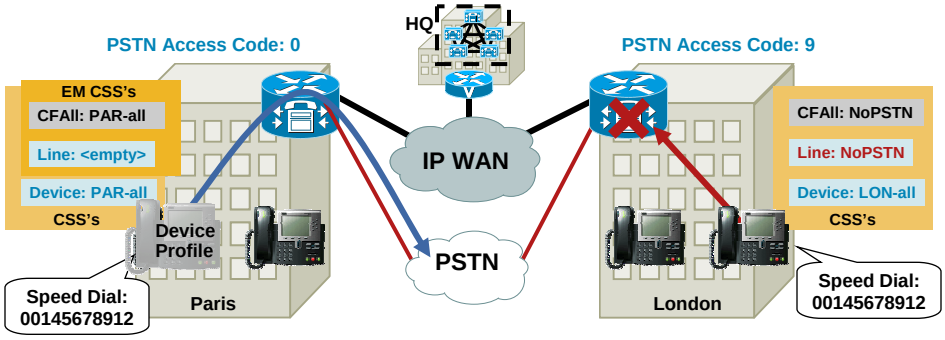
Extension Mobility Considerations

Line/Device Dial Plan Approach



Extension Mobility Considerations

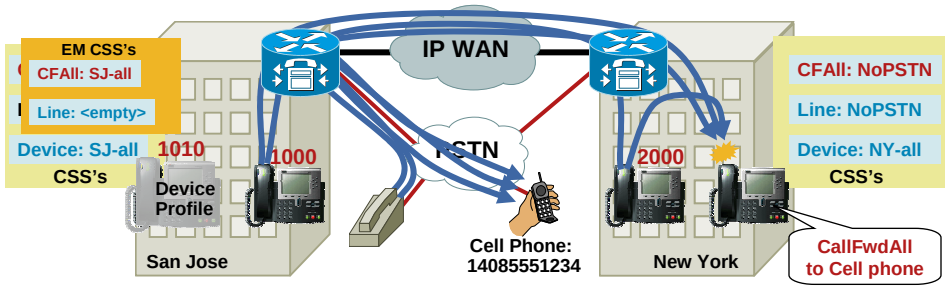
Line/Device Dial Plan Approach: Behavior



- All PSTN calls are routed via local gateway
- User dialing habits and speed dials are not preserved across different dialing "domains"
- Forwarded calls are routed via "home" gateway

Extension Mobility Considerations

Line/Device Dial Plan Approach: Forwarded Calls

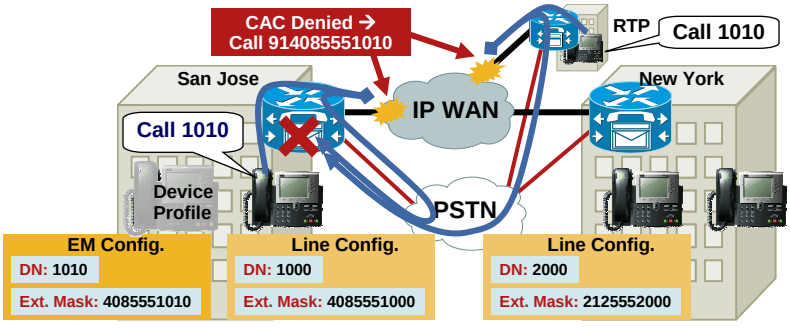


When a SJ User Logs in at NY Site and Forwards His Phone to a PSTN Number:

- Calls from SJ IP phones use SJ PSTN GW
- Calls from PSTN users get hairpinned at the SJ PSTN GW
- Calls from NY IP phones cross the WAN and use SJ PSTN GW

Extension Mobility Considerations

AAR Interaction



- AAR is inherently incompatible with EM users moving across branch sites (regardless of approach)
- When EM users log in at a different site, they cannot be reached via AAR from other sites (DIDs don't move!)
- Ensure that GW CSS's contain internal numbers only to prevent routing loops

Conclusions

Conclusions
General Recommendations

- **Keep It Simple!**