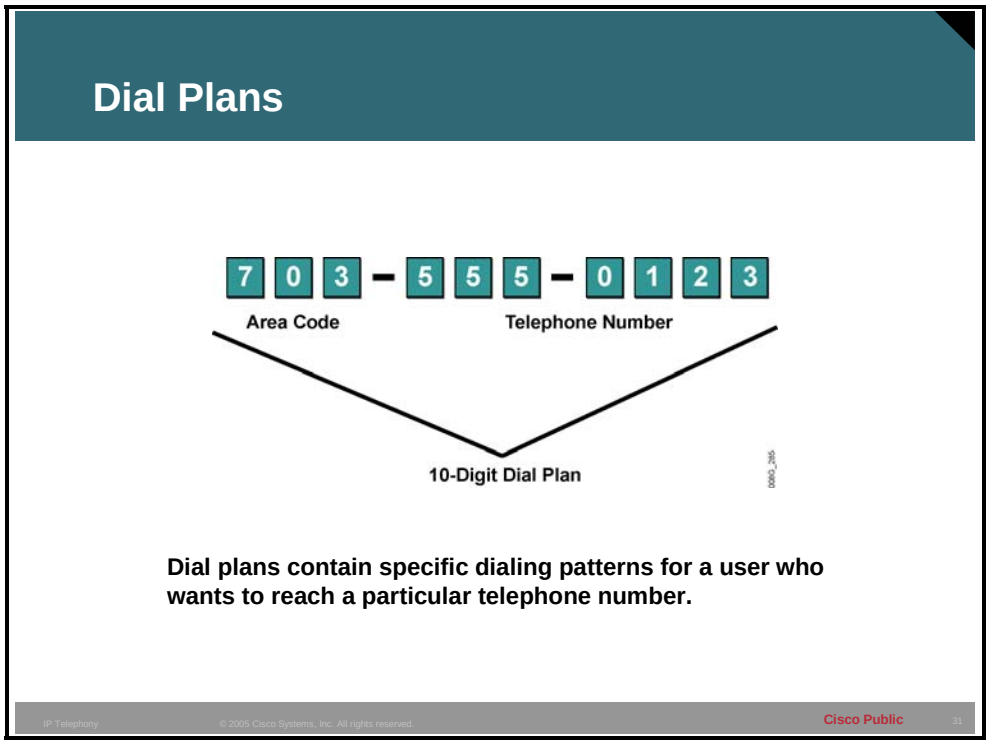
Building a Scalable Numbering Plan

Scalable Numbering Plan

This topic describes the need for a scalable numbering plan in a VoIP network.



Although most people are not acquainted with dial plans by name, they use them daily.

Example: Dial Plan Implementations

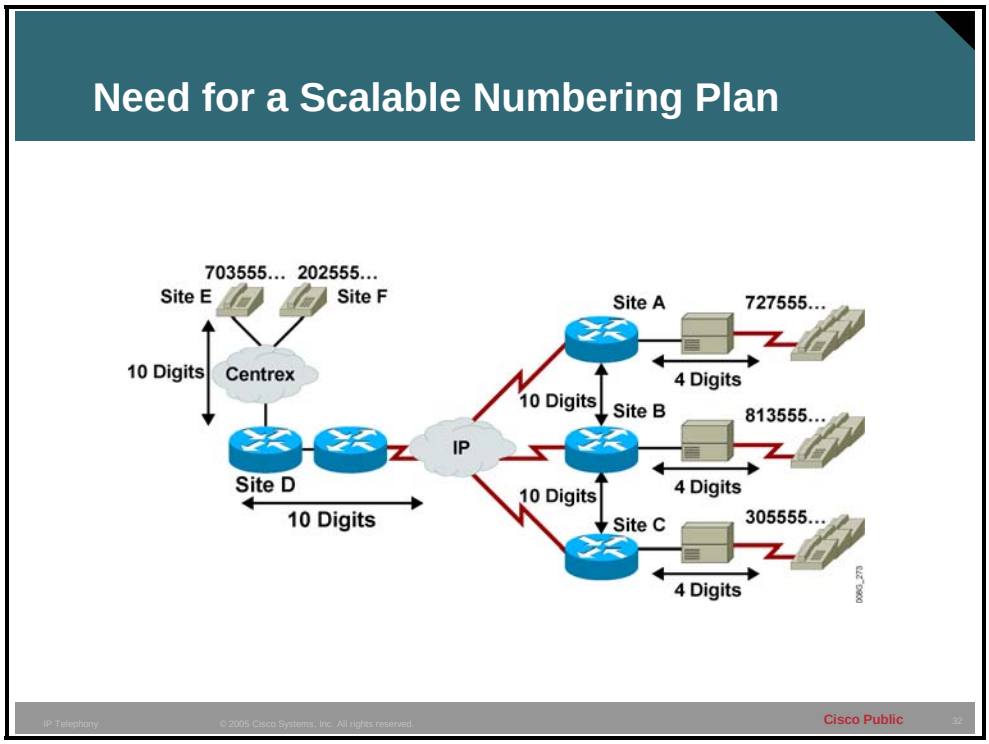
The North American telephone network is designed around a 10-digit dial plan that consists of 3-digit area codes and 7-digit telephone numbers. For telephone numbers that are located within an area code, the PSTN uses a 7-digit dial plan. Features within a CO-based PBX, such as Centrex, allow the use of a custom 5-digit dial plan for customers who subscribe to that service. PBXs are more flexible and allow for variable-length dial plans containing 3 to 11 digits.

Dial plans contain specific dialing patterns for a user who wants to reach a particular telephone number. Dial plans also contain access codes, area codes, specialized codes, and combinations of the numbers of digits dialed.

Dial plans require knowledge of the customer network topology, current telephone number dialing patterns, proposed router and gateway locations, and traffic-routing requirements. If the dial plans are for a private internal voice network that is not accessed by the outside voice network, the telephone numbers can be any number of digits.

Typically, companies that implement VoIP networks carry voice traffic within the least expensive systems and paths. Implementing this type of system involves routing calls through IP networks, private trunks, PBXs, key systems, and the PSTN. The numbering plan to support

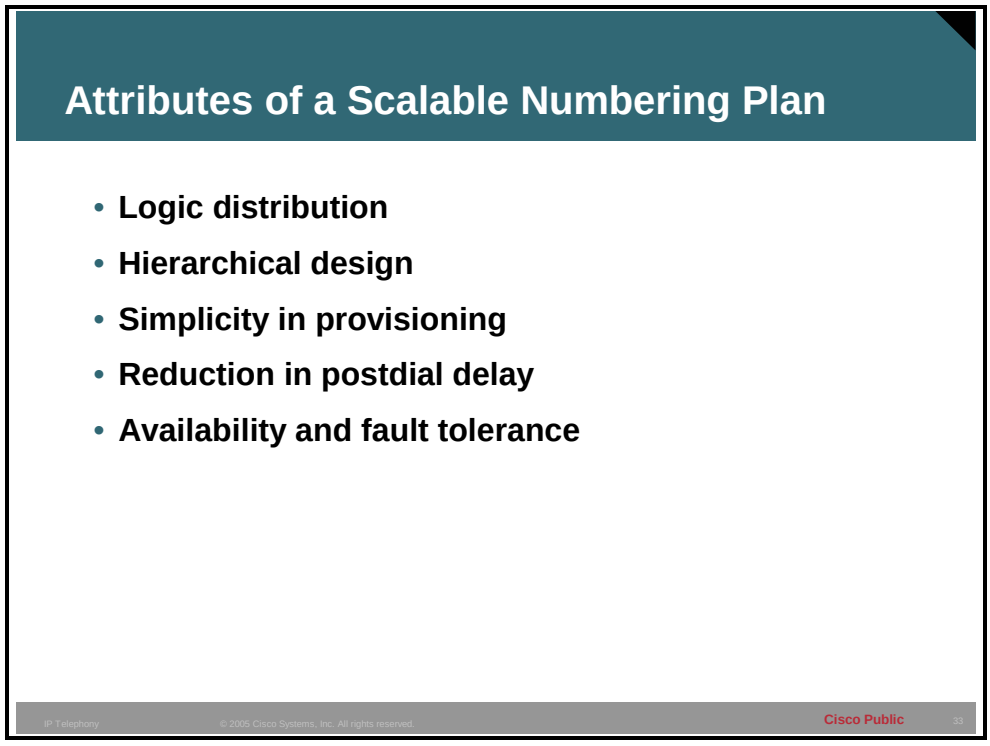
the system is scalable, easily understood by the user, and transportable between all of the system components. The use of alternate path components reduces instances of call failure. Finally, the numbering plan conforms to all applicable standards and formats for all of the systems involved.



This figure illustrates a complex voice network that consists of the components discussed in this topic. A comprehensive and scalable numbering plan must be well-planned and well-implemented on networks such as this. The Centrex service requires 7-digit dialing between itself and site D; the IP network requires 7-digit dialing toward sites A, B, and C; and each of the PBXs requires 3-digit dialing.

Scalable Numbering Plan Attributes

This topic describes the attributes of a scalable numbering plan.



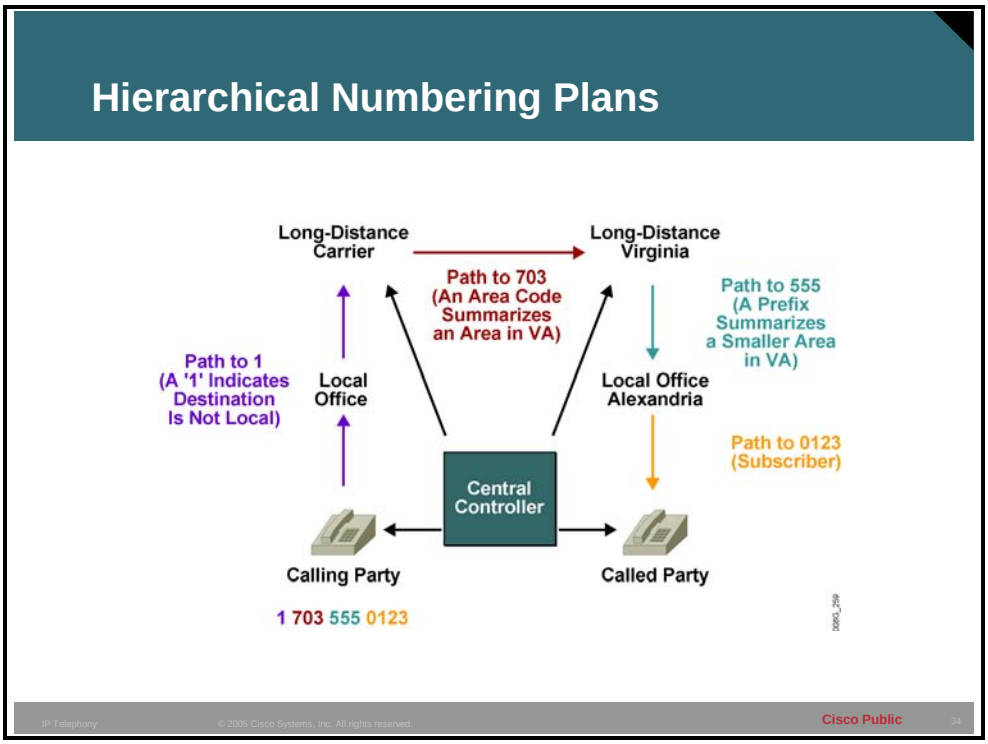
When designing a large-scale numbering plan, you must adhere to the following attributes:

- **Logic distribution:** Good dial plan architecture relies on the effective distribution of the dial plan logic among the various components. Devices that are isolated to a specific portion of the dial plan reduce the complexity of the configuration. Each component focuses on a specific task accomplishment. Generally, the local switch or gateway handles details that are specific to the local point of presence (POP). Higher-level routing decisions are passed along to the gatekeepers and PBXs. A well-designed network places the majority of the dial plan logic at the gatekeeper devices.
- **Hierarchical design (scalability):** You must strive to keep the majority of the dial plan logic (routing decisions and failover) at the highest-component level. Maintaining a hierarchical design makes the addition and deletion of number groups more manageable. Scaling the overall network is much easier when configuration changes are made to a single component.
- **Simplicity in provisioning:** Keep the dial plan simple and symmetrical when designing a network. Try to keep consistent dial plans on the network by using translation rules to manipulate the local digit dialing patterns. These number patterns are normalized into a standard format or pattern before the digits enter the VoIP core. Putting digits into a standard format simplifies provisioning and dial-peer management.

- **Reduction in postdial delay:** Consider the effects of postdial delay in the network when you design a large-scale dial plan. Postdial delay is the time between the last digit dialed and the moment the phone rings at the receiving location. In the PSTN, people expect a short postdial delay and to hear ringback within seconds. The more translations and lookups that take place, the longer the postdial delay becomes. Overall network design, translation rules, and alternate pathing affect postdial delay. You must strive to use these tools most efficiently to reduce postdial delay.
- **Availability and fault tolerance:** Consider overall network availability and call success rate when you design a dial plan. Fault tolerance and redundancy within VoIP networks are most important at the gatekeeper level. By using an alternate path you help provide redundancy and fault tolerance in the network.

Hierarchical Numbering Plans

This topic describes the advantages and attributes of hierarchical numbering plans.



Scalable telephony networks require telephone-numbering plans that are hierarchical. A hierarchical design has the following advantages:

- **Simplified provisioning:** Provides the ability to easily add new groups and modify existing groups
- **Simplified routing:** Keeps local calls local and uses a specialized number key, such as an area code, for long-distance calls
- **Summarization:** Establishes groups of numbers in a specific geographical area or functional group
- **Scalability:** Adds scalability to the number plan by adding additional high-level number groups
- **Management:** Controls number groups from a single point in the overall network

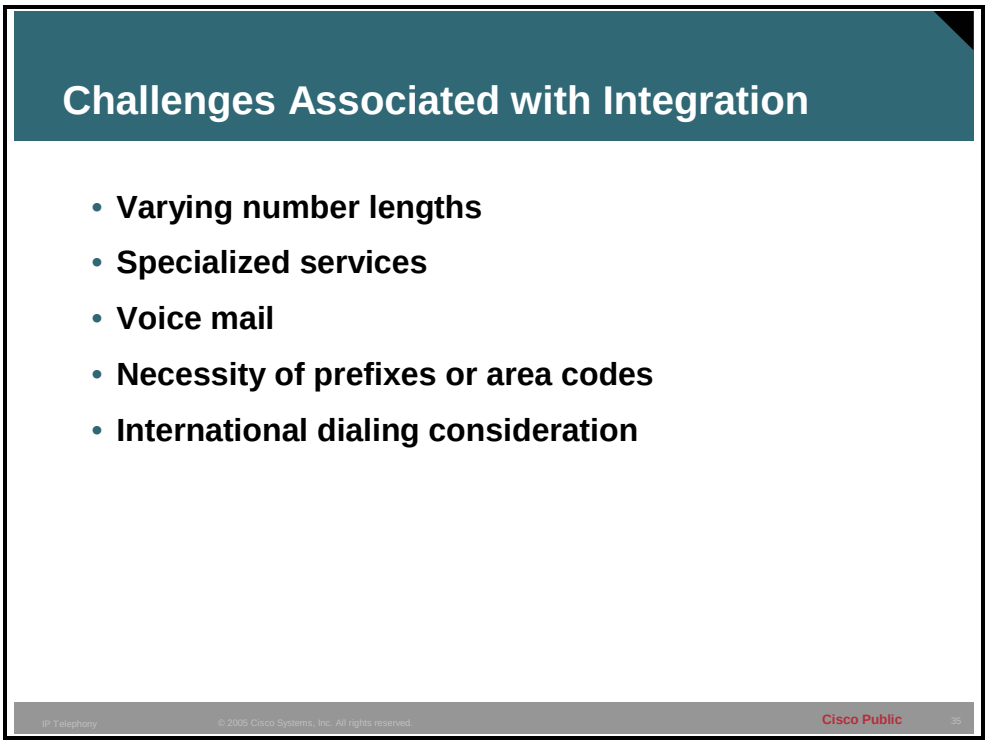
It is not easy to design a hierarchical numbering plan. Existing numbering plans in the network (such as proprietary PBXs, key systems, and telephony services such as Centrex), and the necessity to conform to the PSTN at gateways, all contribute to the complexity of the design. Translation between these systems is a difficult task. If possible, avoid retraining system users. The goal is to design a numbering plan that has the following attributes:

- Minimal impact on existing systems
- Minimal impact on users of the system
- Minimal translation configuration
- Consideration of anticipated growth

- Conformance to public standards, where applicable

Internal Numbering and Public Numbering Plan Integration

This topic describes the challenges associated with integrating internal numbering with the public numbering plan.



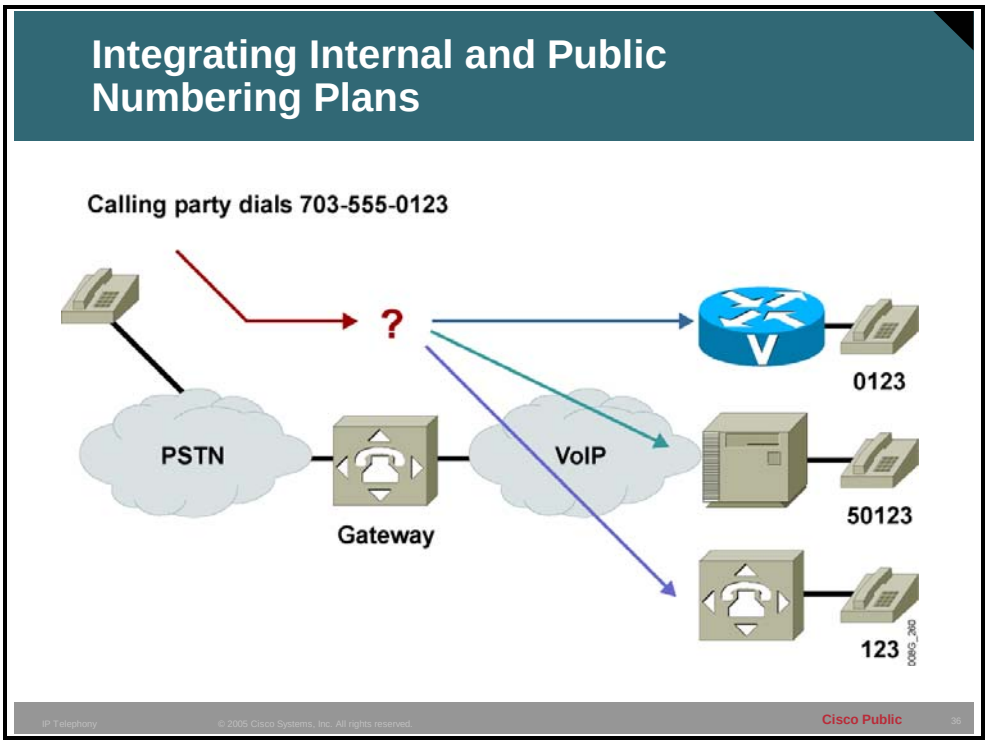
Numbering plans vary greatly throughout the world. Different countries use different number lengths and hierarchical plans within their borders. Telephony equipment manufacturers and service providers use nonstandard numbering. In an attempt to standardize numbering plans, the International Telecommunication Union (ITU) developed the E.164 worldwide prefix scheme.

Number plan integration from an internal system such as a VoIP and PBX system to the PSTN requires careful planning. The hierarchical structure of the number plan and the problems associated with varying number lengths in different systems make number plan integration complex.

The challenges that you face with number plan integration include the following:

- **Varying number lengths:** Within the IP network, consideration is given to varying number lengths that exist outside the IP network. Local, long-distance, key system, and Centrex dialing from within the IP network may require digit manipulation.
- **Specialized services:** Services such as Centrex and their equivalents typically have 4- or 5-digit numbers. Dialing from the PSTN into a private VoIP network and then out to a Centrex extension can also require extensive digit manipulation.
- **Voice mail:** When a called party cannot be reached, the network may have to redirect the call to voice mail. Since the voice-mail system can require a completely different number plan than the endpoint telephones, translation is necessary.

- **Necessity of prefixes or area codes:** It can be necessary to strip or add area codes, or prepend or replace prefixes. Rerouting calls from the IP network to the PSTN for failure recovery can require extra digits.
- **International dialing consideration:** Country codes and number plans vary in length within countries. Dialing through an IP network to another country requires careful consideration.

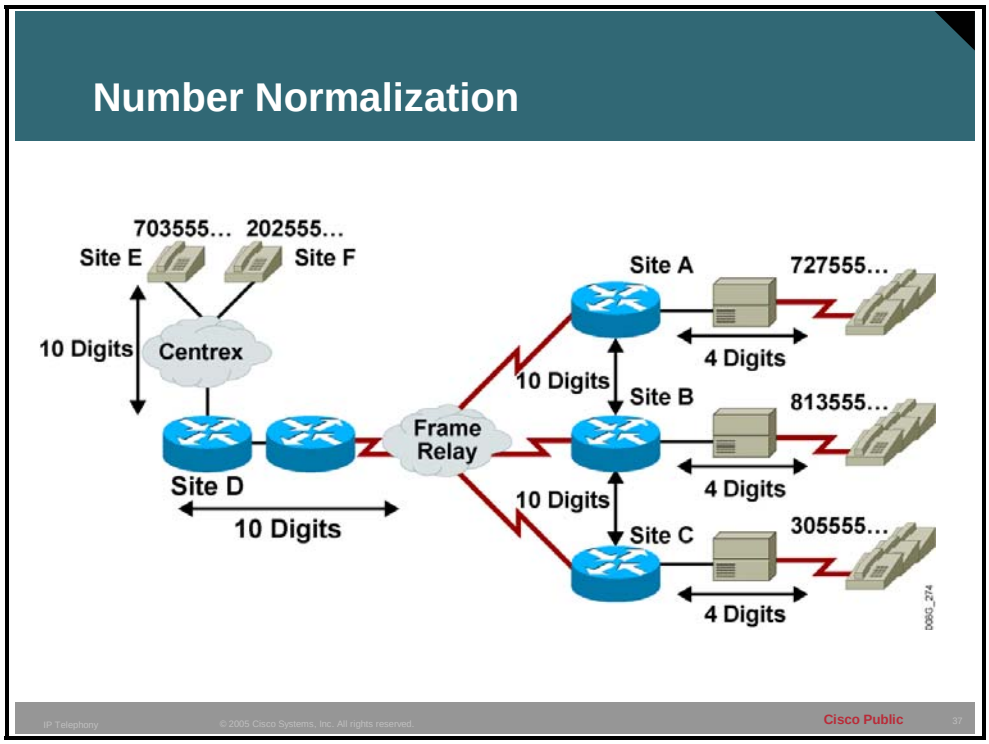


This figure shows a call from the PSTN destined for 1-703-555-0123. The gateway must realize the true destination. All endpoints end with the correct digit sequence, but which is the correct endpoint? Should the gateway append or prepend digits to the dialed number? Should it strip and omit digits?

Different PBXs support variable-length dial plans that contain 3 to 11 digits. The length variations present challenges when private plans merge with public number plans. Issues also arise when no one answers a number and the call is forwarded to a voice-mail system.

Enhancing and Extending an Existing Plan to Accommodate VoIP

This topic describes methods for integrating existing number plans into a VoIP network.



There are many ways that you can enhance and extend an existing number plan to accommodate the VoIP network; all of them require careful planning and consideration. This lesson will discuss two of these ways: number normalization and technology prefixes.

Example: Number Normalization

When site E (703555….) dials 7275550199, the full 10-digit dialed string is passed through the Centrex to the router at site D. Router D matches the destination pattern 7275550199 and forwards the 10-digit dial string to router A. Router A matches the destination pattern 727555…., strips off the matching 727555, and forwards the remaining 4-digit dial string to the PBX. The PBX matches the correct station and completes the call to the proper extension.

Calls in the reverse direction are handled similarly. However, because the Centrex service requires the full 10-digit dial string to complete calls, the POTS dial peer at router D is configured with digit stripping disabled. An alternate solution involves enabling digit stripping and configuring the dial peer with a 6-digit prefix (in this case 703555), which results in forwarding the full dial string to the Centrex service.

Router Digit Stripping Comparison

Router A	Router D
dial-peer voice 1 pots	dial-peer voice 4 pots
destination-pattern 727555….	destination-pattern 703555….
port 1/0:1	**no digit-strip**
!	port 1/0:1
dial-peer voice 4 voip	!
destination-pattern 703555….	dial-peer voice 5 pots
session target ipv4:10.10.10.2	destination-pattern 202555….
!	**no digit-strip**
dial-peer voice 5 voip	port 1/0:1
destination-pattern 202555….	!
session target ipv4:10.10.10.3	dial-peer voice 1 voip
!	destination-pattern 727555….
	session target ipv4:10.10.10.1
	!

Another method, called “technology prefixes,” allows you to include special characters in the called number. These special characters (most commonly designated as 1#, 2#, 3#, etc.) are prepended to the called number on the outgoing VoIP dial peer. The gatekeeper then checks its gateway technology prefix table for gateways that are registered with that particular technology prefix. Technology prefixes also identify a type, class, or pool of gateways.

Example: Technology Prefixes Applied

Voice gateways can register with technology prefix 1#; H.320 gateways with technology prefix 2#; and voice-mail gateways with technology prefix 3#. Multiple gateways can register with the same type prefix. When this happens, the gatekeeper makes a random selection among gateways of the same type.

If the callers know the type of device that they are trying to reach, they can include the technology prefix in the destination address to indicate the type of gateway to use to get to the destination. For example, if a caller knows that address 7275550111 belongs to a regular telephone, the caller can use the destination address of 1#7275550111, where 1# indicates that the address should be resolved by a voice gateway. When the voice gateway receives the call for 1#7275550111, it strips off the technology prefix and routes the next leg of the call to the telephone at 7275550111.

You can enter technology prefix commands on gateways and gatekeepers in two places, depending on how you want to design the technology prefix decision intelligence: the gateway VoIP interface or the gateway dial peer.

You can implement this type of digit manipulation and management of dialed numbers in various ways, depending on the infrastructure of the network. All of the components, including

the gatekeepers, gateways, Cisco CallManagers, PBXs, key systems, and other systems, may need to be included in the process.

