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Understanding H.323 Gatekeepers

Introduction

The ITU−T H.323 standard specifies four components:

- gateway
- gatekeeper
- terminal
- multipoint control unit (MCU)

This document provides a comprehensive introduction to the functionality and operation of the gatekeeper in H.323 Voice over IP (VoIP) networks.

For an more information on H.323 refer to the H.323 Tutorial .

Prerequisites

Requirements

Ensure that you use the H.323 Gatekeeper functionality feature, which is denoted as **x−** on the Software Center (registered customers only) . For example, a valid Cisco IOS® for the Cisco 2600 to act as a gatekeeper is c2600−ix−mz.122−11.

Components Used

This document is not restricted to specific software and hardware versions.

Conventions

For more information on document conventions, see the Cisco Technical Tips Conventions.

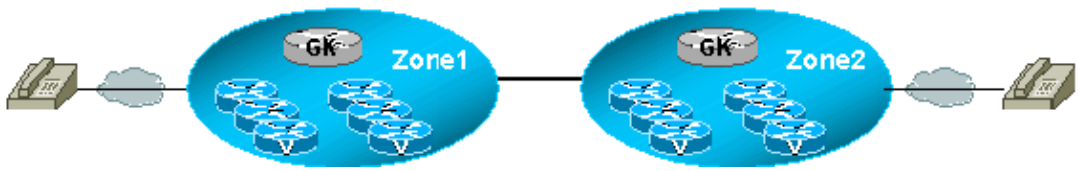
Gatekeeper Definition

A gatekeeper is an H.323 entity on the network that provides services such as address translation and network access control for H.323 terminals, gateways, and MCUs. Also, they can provide other services such as bandwidth management, accounting, and dial plans that can be centralized to provide salability.

Gatekeepers are logically separated from H.323 endpoints such as terminals and gateways. They are optional in an H.323 network, but if a gatekeeper is present, endpoints must use the services provided.

Gatekeeper Zones and Subnets

A zone is the collection of H.323 nodes such as gateways, terminals, and MCUs registered with the gatekeeper. There can only be one active gatekeeper per zone. These zones can overlay subnets and one gatekeeper can manage gateways in one or more of these subnets.



Gatekeeper Functionality

The H.323 standard defines mandatory and optional gatekeeper functions as described below:

Mandatory Gatekeeper Functions

- **Address Translation** − Translates H.323 IDs (such as gwy1@domain.com) and E.164 numbers (standard telephone numbers) to endpoint IP addresses.
- **Admission Control** − Controls endpoint admission into the H.323 network. To achieve this, the gatekeeper uses the following:

    - H.225 Registration, Admission, and Status (RAS) messages

For more information about RAS Signaling, see H.225 RAS Signaling: Gatekeepers and Gateways section.
    - ♦ Admission Request (ARQ)
    - ♦ Admission Confirm (ACF)
    - ♦ Admission Reject (ARJ)
- **Bandwidth Control** − Consists of managing endpoint bandwidth requirements. To achieve this, the gatekeeper uses these H.225 RAS messages:
    - ♦ Bandwidth Request (BRQ)
    - ♦ Bandwidth Confirm (BCF)
    - ♦ Bandwidth Reject (BRJ)
- **Zone Management** − The gatekeeper provides zone management for all registered endpoints in the zone. For example, controlling the endpoint registration process.

Optional Gatekeeper Functions

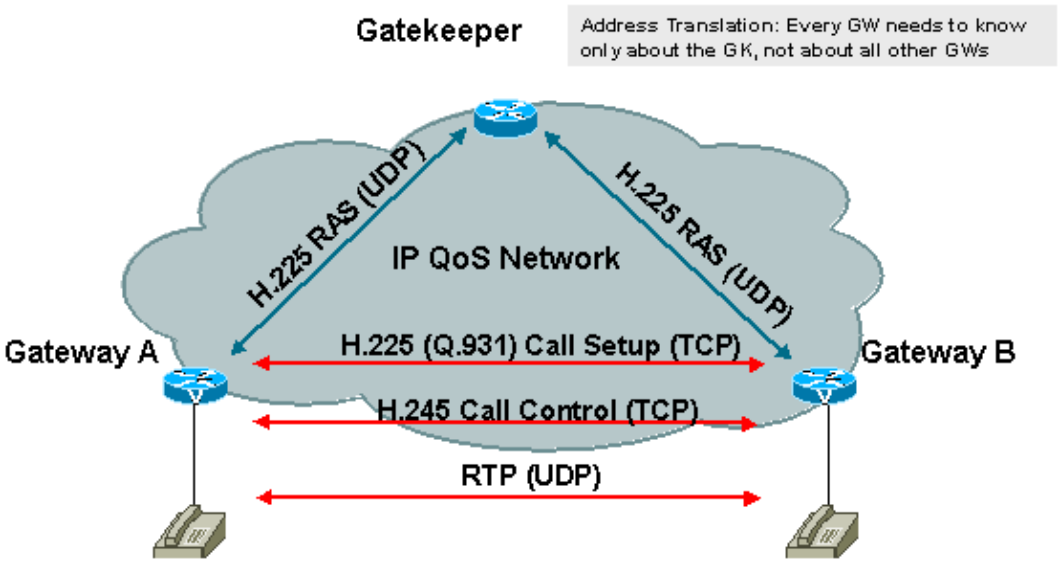
- **Call Authorization** − With this option, the gatekeeper can restrict access to certain terminals or gateways and/or have time−of−day policies restrict access.
- **Call Management** − With this option, the gatekeeper maintains active call information and uses it to indicate busy endpoints or redirect calls.
- **Bandwidth Management** − With this option, the gatekeeper can reject admission when the required bandwidth is not available.
- **Call Control Signaling** − With this option, the gatekeeper can route call−signaling messages between H.323 endpoints using the Gatekeeper−Routed Call Signaling (GKRCS) model. Alternatively, it allows endpoints to send H.225 call−signaling messages directly to each other.

Note: Cisco IOS gatekeepers are Direct Endpoint Signaling based. They do not support GKRCS. See the Gatekeeper−Routed Call Signaling vs Direct Endpoint Signaling section of this document.

H.323 Protocol Suite

The H.323 protocol suite is split into three main areas of control:

- RAS (H.225) signaling
- Call Control/Call Setup (H.225)
- Media Control and Transport (H.245) signaling



H.225 RAS Signaling

RAS is the signaling protocol used between gateways and gatekeepers. The RAS channel is opened before any other channel and is independent of the call setup and media transport channels.

- RAS uses User Datagram Protocol (UDP) ports 1719 (H.225 RAS messages) and 1718 (unicast gatekeeper discovery).

For more detailed information, see the H.225 RAS Signaling: Gatekeepers and Gateways section of this document.

H.225 Call Control (Setup) Signaling

H.225 call control signaling is used to setup connections between H.323 endpoints. The ITU H.225 recommendation specifies the use and support of Q.931 signaling messages.

A reliable (TCP) call control channel is created across an IP network on TCP port 1720. This port initiates the Q.931 call control messages for the purpose of connecting, maintaining, and disconnecting calls.

When a gatekeeper is present in the network zone, H.225 call setup messages are exchanged either via Direct Call Signaling or GKRCS. See the Gatekeeper−Routed Call Signaling vs Direct Endpoint Signaling section of this document for more information. The method chosen is decided by the gatekeeper during the RAS admission message exchange.

If no gatekeeper is present, H.225 messages are exchanged directly between the endpoints.

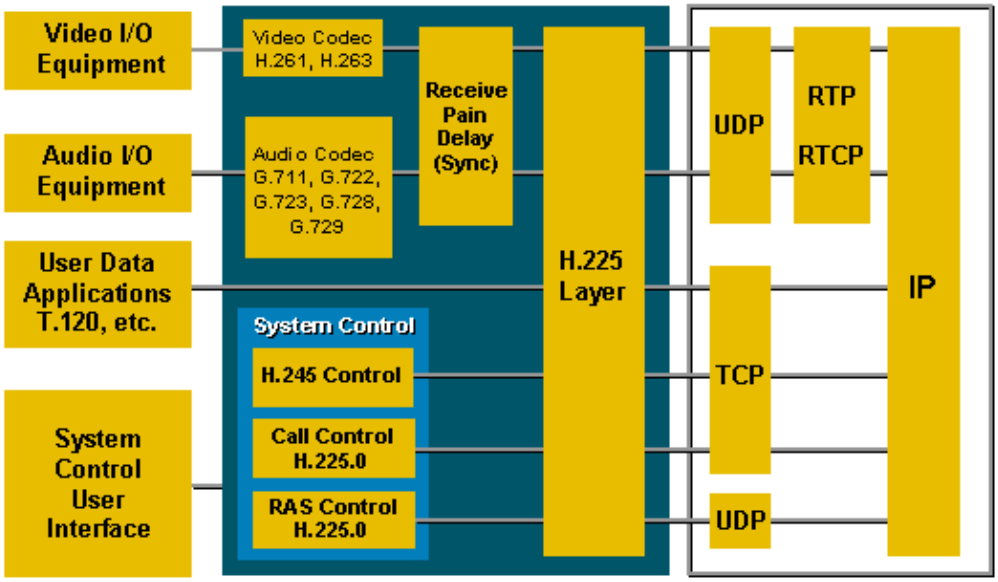
H.245 Media Control and Transport

H.245 handles end−to−end control messages between H.323 entities. H.245 procedures establish logical channels for transmission of audio, video, data, and control channel information. It is used to negotiate channel usage and capabilities such as:

- flow control
- capabilities exchange messages

A detailed explanation of H.245 is beyond the scope of this document.

H.323 Protocol Suite Overview



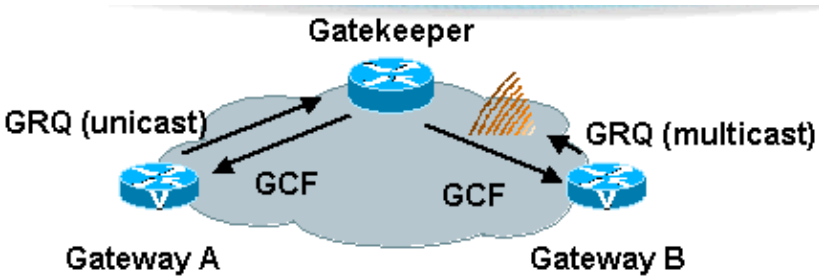
H.225 RAS Signaling: Gatekeepers and Gateways

RAS Gatekeeper Discovery

There are two processes by which H.323 terminals/gateways discover their zone gatekeepers:

- **Unicast Discovery (manual method)** − Uses UDP port 1718. In this process, endpoints are configured with the gatekeeper IP address and can attempt registration immediately. The gatekeeper replies with a gatekeeper confirm (GCF) or gatekeeper rejection (GRJ) message.
- **Multicast Discovery (auto−discovery)** − Uses UDP multicast address 224.0.1.41. Auto discovery enables an endpoint to discover its gatekeeper through a multicast message. Because endpoints do not have to be statically configured for gatekeepers, this method has less administrative overhead. A gatekeeper replies with a GCF message or remains silent. A gatekeeper can be configured to respond only to certain subnets.

If a gatekeeper is not available, the gateway periodically attempts to rediscover a gatekeeper. If a gateway discovers the gatekeeper has gone off−line, it stops accepting new calls and attempts to rediscover a gatekeeper. Active calls are not affected.



The following table defines the RAS gatekeeper discovery messages:

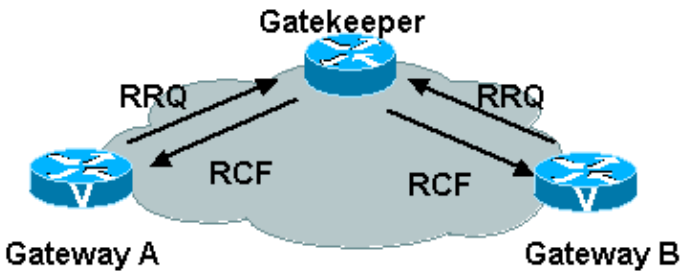
Gatekeeper Discovery	
GRQ (Gatekeeper_Request)	Message sent by endpoint to gatekeeper.
GCF (Gatekeeper_Confirm)	Reply from gatekeeper to endpoint indicating the transport address of the gatekeeper RAS channel.
GRJ (Gatekeeper_Reject)	Reply from gatekeeper to endpoint rejecting the endpoint's request for registration. Usually due to gateway or gatekeeper configuration error.

RAS Registration and Unregistration

Registration is the process by which gateways, terminals, and/or MCUs join a zone and inform the gatekeeper of their IP and alias addresses. Registration occurs after the discovery process. Every gateway can register with only one active gatekeeper. There is only one active gatekeeper per zone.

The H.323 gateway registers with an H.323 ID (email ID) or an E.164 address. For example:

- **EmailID (H.323 ID):** gwy−01@domain.com
- **E.164 Address:** 5125551212



The following table defines the RAS gatekeeper registration and unregistration messages:

Gatekeeper Discovery	
RRQ (Registration_Request)	Sent from an endpoint to a gatekeeper RAS channel address.
RCF (Registration_Confirm)	Reply from the gatekeeper confirming endpoint registration.
RRJ (Registration_Reject)	Reply from the gatekeeper rejecting endpoint registration.
URQ (Unregister_Request)	Sent from endpoint or gatekeeper to cancel registration.
UCF (Unregister_Confirm)	Sent from endpoint or gatekeeper to confirm an unregistration.
URJ (Unregister_Reject)	Indicates that endpoint was not preregistered with the gatekeeper.

RAS Admissions

Admission messages between endpoints and gatekeepers provide the basis for call admissions and bandwidth control. Gatekeepers authorize access to H.323 networks by confirming or rejecting an admission request.

The following table defines the RAS admission messages:

Admission Messages	
ARQ (Admission_Request)	An attempt by an endpoint to initiate a call.
ACF (Admission_Confirm)	An authorization by the gatekeeper to admit the call. This message contains the IP address of the terminating gateway or gatekeeper and enables the originating gateway to initiate call control signaling procedures.
ARJ (Admission_Reject)	Denies the endpoint's request to gain access to the network for this particular call.

For more information see the Gatekeeper to Gateways Call Flow section.

RAS Endpoint Location

Location Request messages are commonly used between inter−zone gatekeepers to get the IP addresses of different zone endpoints. The following table defines the RAS location request messages:

Location Request	
LRQ (Location_Request)	Sent to request the gatekeeper contact information for one or more E.164 addresses.
LCF (Location_Confirm)	Sent by the gatekeeper and contains the call signaling channel or RAS channel address of itself or the requested endpoint. It uses its own address when GKRCS is used. It uses the requested endpoint address when Directed Endpoint Call Signaling is used.
LRJ (Location_Reject)	Sent by gatekeepers that received an LRQ for which the requested endpoint is not registered or has unavailable resources.

For more information refer to the Gatekeeper to Gateways Call Flow section.

RAS Status Information

The gatekeeper can use the RAS channel to obtain status information from endpoints. This can be used to monitor whether the endpoint is online or off−line. The following table defines the RAS status information messages:

Status Information	
IRQ (Information_Request)	Sent from gatekeeper to endpoint requesting status.
IRR (Information_Request_Response)	Sent from endpoint to gatekeeper in response to IRQ. This message is also sent from endpoint to gatekeeper if the gatekeeper requests periodic status updates. The IRR is used by gateways to inform the gatekeeper about the active calls.
IACK (Info_Request_Acknowledge)	Used by the gatekeeper to respond to IRR messages.
INACK (Info_Request_Neg_Acknowledge)	Used by the gatekeeper to respond to IRR messages.

RAS Bandwidth Control

Bandwidth control is initially managed through the Admission Messages (ARQ/ACF/ARJ) sequence. However, bandwidth can change during the call. The following table defines the RAS bandwidth control messages:

Bandwidth Control	
BRQ (Bandwidth_Request)	Sent by the endpoint to the gatekeeper requesting an increase/decrease in call bandwidth.
BCF (Bandwidth_Confirm)	Sent by the gatekeeper confirming acceptance of the bandwidth change request.
BRJ (Bandwith_Reject)	Sent by the gatekeeper rejecting bandwidth change request.
RAI (Resource Availability Indicator)	This is used by gateways to inform the gatekeeper whether resources are available in the gateway to take on additional calls.
RAC (Resource Availability Confirm)	Notification from the gatekeeper to the gateway acknowledging

	reception of the RAI message.

For more information about RAI, refer to Understanding, Configuring, and Troubleshooting Resource Allocation Indication.

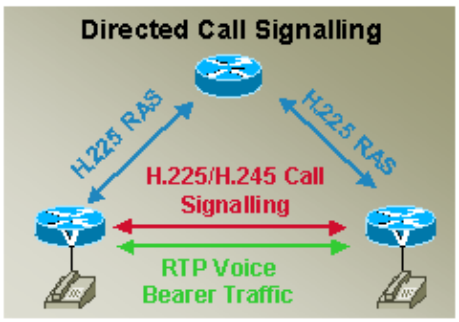
Gatekeeper−Routed Call Signaling vs Direct Endpoint Signaling

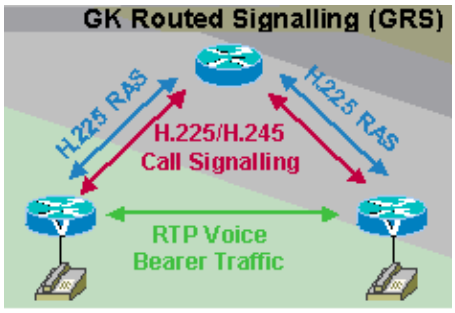
There are two types of gatekeeper call signaling methods:

- **Direct Endpoint Signaling** − With this method, call setup messages are directed to the terminating gateway or endpoint.
- **Gatekeeper−Routed Call Signaling (GKRCS)** − With this method, the call setup messages are directed through the gatekeeper.

Note: Cisco IOS gatekeepers are Direct Endpoint signaling based and do not support GKRCS.

The following diagram illustrates the differences between these two methods:

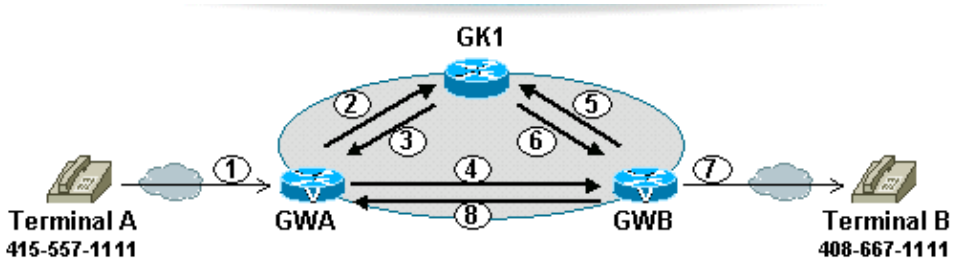




Gatekeeper to Gateways Call Flow

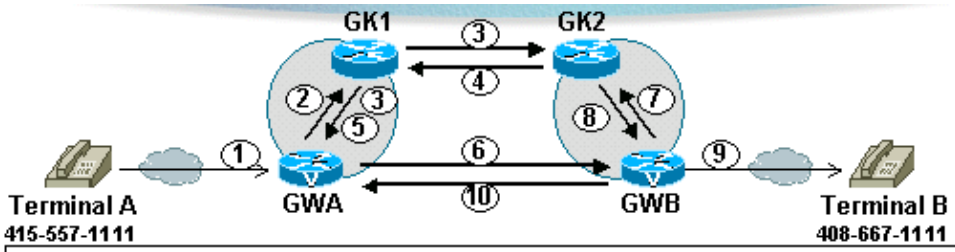
In the following sections, only Directed Call Signaling call flow scenarios are presented. Also, assume the gateways have already completed discovery and registration with their gatekeepers.

Intra−Zone Call Setup



1) Terminal A dials the phone number 408-667-1111 for Terminal B
2) GWA sends GK1 an ARQ, asking permission to call Terminal B
3) GK1 does a look-up and finds Terminal B registered; returns an ACF with the IP address of GWB
4) GWA sends a Q.931 Call-Setup to GWB with Terminal B's phone number
5) GWB sends GK1 an ARQ, asking permission to answer GWA's call
6) GK1 returns an ACF with the IP address of GWA
7) GWB sets up a POTS call to Terminal B at 408-667-1111
8) When Terminal B answers, GWB sends Q.931 Connect to GWA
9) GWs sends IRR to GK after call is setup

Inter−Zone Call Setup



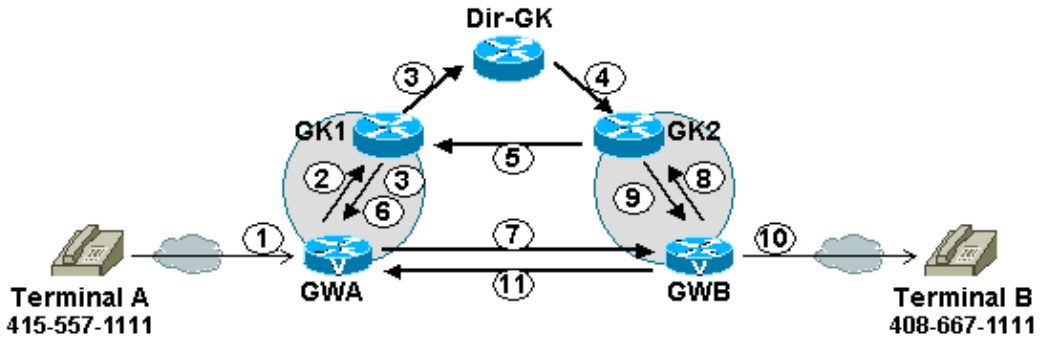
1) Terminal A dials the phone number 408-667-1111 for Terminal B
2) GWA sends GK1 an ARQ, asking permission to call Terminal B
3) GK1 does a look-up and does NOT find Terminal B registered; GK1 does a prefix look-up and finds a match with GK2; GK1 sends an LRQ GK2, and RIP (Request In Progress) to GWA
4) GK2 does a look-up and finds Terminal B registered; returns an LCF with the IP address of GWB
5) GK1 returns an ACF with the IP address of GWB
6) GWA sends a Q.931 Call-Setup to GWB with Terminal B's phone number
7) GWB sends GK2 an ARQ, asking permission to answer GWA's call
8) GK2 returns an ACF with the IP address of GWA
9) GWB sets up a POTS call to Terminal B at 408-667-1111
10) When Terminal B answers, GWB sends Q.931 Connect to GWA

Inter−Zone Call Setup with a Directory Gatekeeper

A major functionality of gatekeepers is to keep track of other H.323 zones and forward calls appropriately. When many H.323 zones are present, gatekeeper configurations can become administratively intensive. In such large VoIP installations it is possible to configure a centralized directory gatekeeper that contains a registry of all the different zones and coordinates LRQ−forwarding processes. With directory gatekeepers, no full mesh is needed between inter−zone gatekeepers.

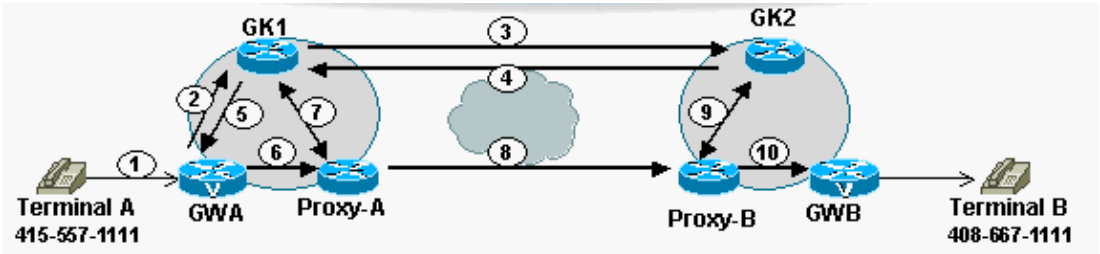
Note: A directory gatekeeper is not an industry standard, but is a Cisco implementation.

For more information see the H.323 Network Scaling with Gatekeepers section.



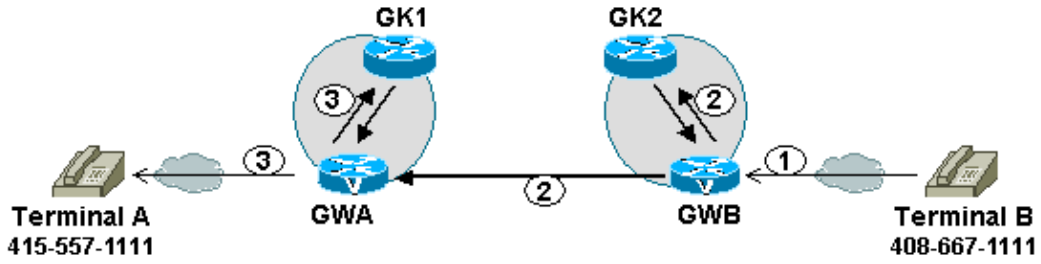
1) Terminal A dials the phone number 408-667-1111 for Terminal B
2) GWA sends GK1 an ARQ, asking permission to call Terminal B
3) GK1 does a look-up and does NOT find Terminal B registered; GK1 does a prefix look-up and finds a wildcard match with Dir-GK; GK1 sends LRQ to Dir-GK, and RIP to GWA
4) Dir-GK does a prefix look-up and finds GK2; Forwards the LRQ to GK2
5-11) Same as steps 4-10 in previous scenario

Proxy−Assisted Call Setup



1) Terminal A dials Terminal B
2) GWA sends ARQ to GK1
3) GK1 sends LRQ to GK2
4) GK2 returns Proxy-B's address, hiding GWB's identity
5) GK1 knows to get to Proxy-B, it must go through Proxy-A, so GK1 returns Proxy-A's address to GWA
6) GWA calls Proxy-A
7) Proxy-A consults GK1 to find the true destination, GK1 tells it to call Proxy-B
8) Proxy-A calls Proxy-B
9) Proxy-B consults GK2 for the true destination, which is GWB; GK2 gives GWB's address to Proxy-B
10) Proxy-B completes the call to GWB
From here the call proceeds as before...

Call Disconnect

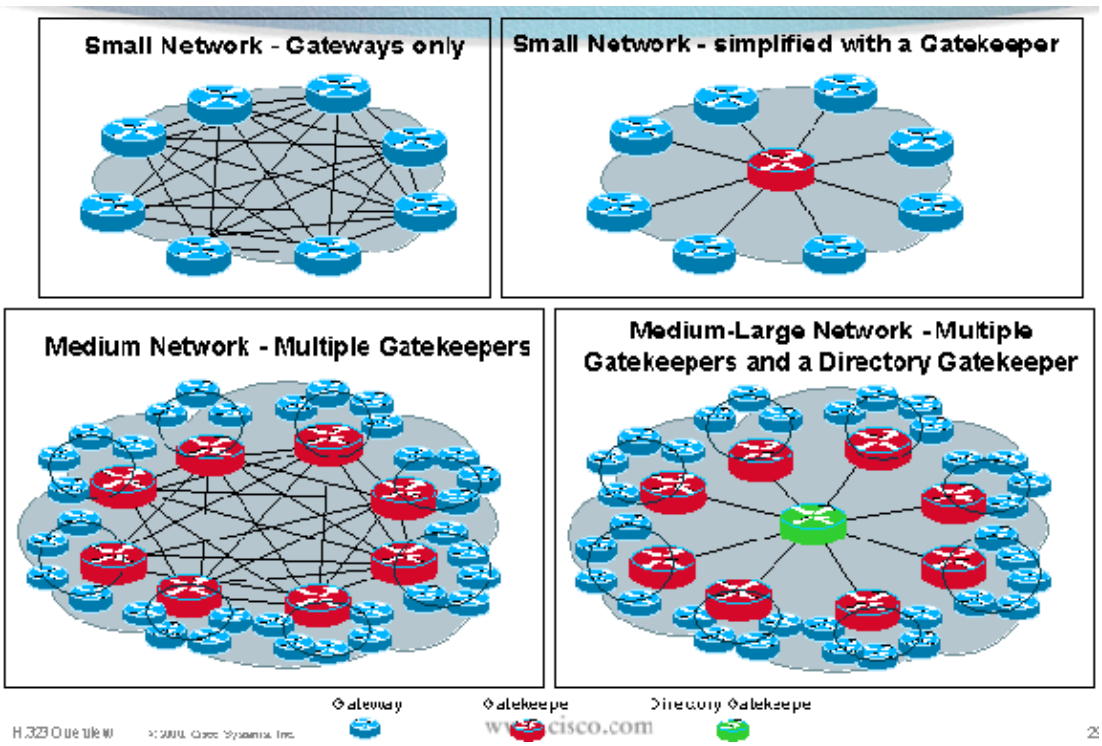


Terminals A and B are in active conversation...

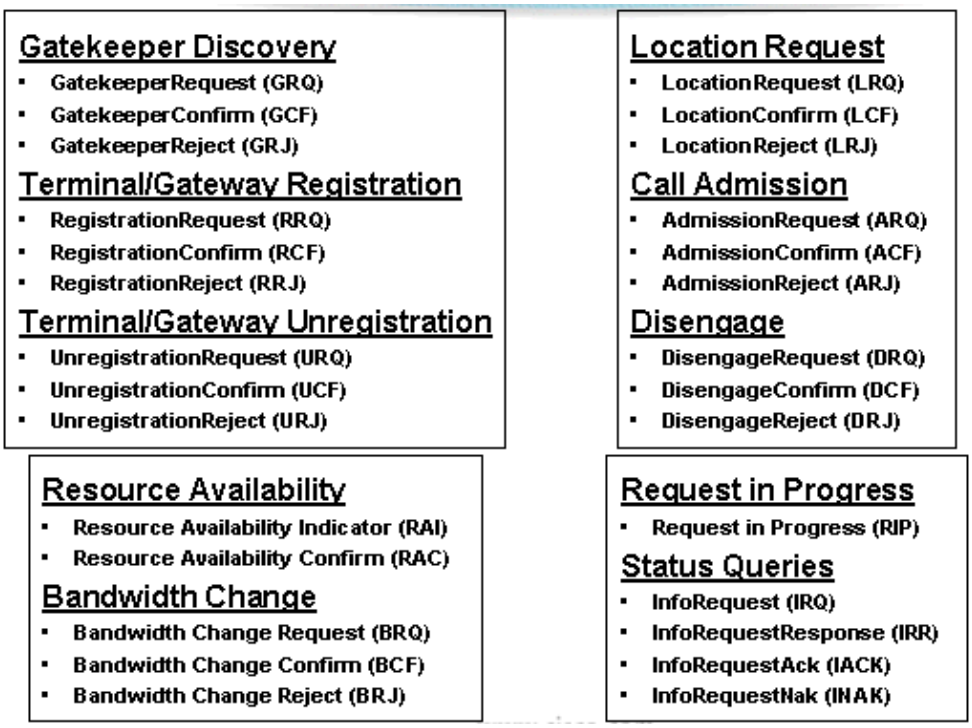
1) Terminal B hangs up
2) GWB sends DRQ to GK2, disconnecting the call between Terminals A and B. A DCF is received some time later.
3) GWB sends a Q.931 Release Complete to GWA
4) GWA sends DRQ to GK1, disconnecting the call between Terminals A and B. A DCF is received some time later.
5) GWA signals a call disconnect to the voice network (the mechanism differs depending on the trunk used on GWA. If it is a phone set (FXS), then there is no mechanism to signal the disconnect.

H.323 Network Scaling with Gatekeepers

The following diagram illustrates the concept of VoIP Network scaling with gatekeepers and directory gatekeepers:



H.225 RAS Protocol Elements Table



Note: For gatekeeper sample configurations refer to Understanding Cisco IOS Gatekeeper Call Routing.

Related Information

- **Troubleshooting Gatekeeper Registration Issues**
- **Understanding and Troubleshooting Gatekeeper TTL and Aging out Process**
- **Conferencing Software**
- **Voice Technologies**
- **Voice, Telephony and Messaging Devices**
- **Voice Software**
- **Voice, Telephony and Messaging TAC eLearning Solutions**
- **Recommended Reading: Troubleshooting Cisco IP Telephony Cisco Press, ISBN 1587050757**
- **Technical Support − Cisco Systems**