



Media Gateway Control and the Softswitch Architecture

Chapter 6



Introduction

- Voice over IP
 - Lower cost of network implementation
 - Integration of voice and data applications
 - New service features
 - Reduced bandwidth
- Replacing all traditional circuit-switched networks is not feasible.
- VoIP and circuit-switching networks coexist
 - Interoperation
 - Seamless interworking

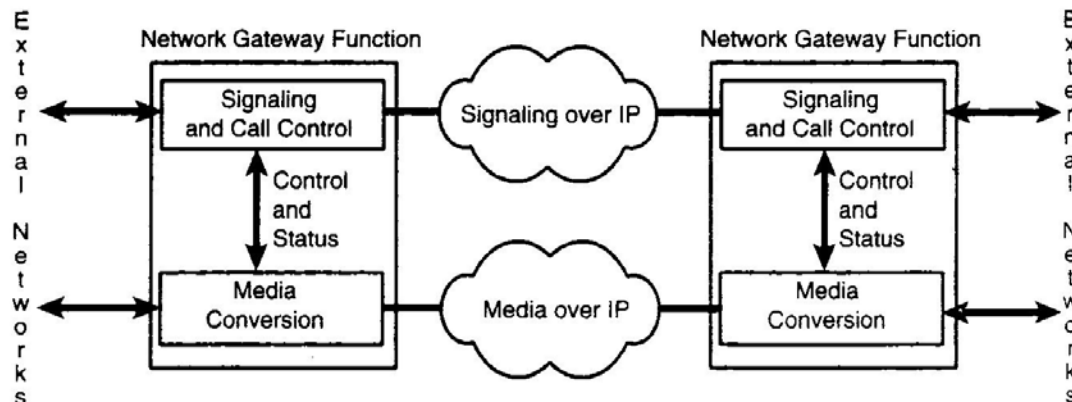


Separation of Media and Call Control

- Gateways
 - Interworking
 - To make the VoIP network appear to the circuit switched network as a native circuit-switched system and vice versa
- Signaling path and media path are different in VoIP systems.
 - Media – directly (end-to-end)
 - Signaling – through H.323 gatekeepers (or SIP proxies)
- SS7, Signaling System 7
 - The logical separation of signaling and media

Separation of Media and Call Control

- A network gateway has two related but separate functions.
 - Signaling conversion
 - The call-control entities use signaling to communicate.
 - Media conversion
 - A slave function (mastered by call-control entities)
- Figure 6-1 illustrates the separation of call control and signaling from the media path.

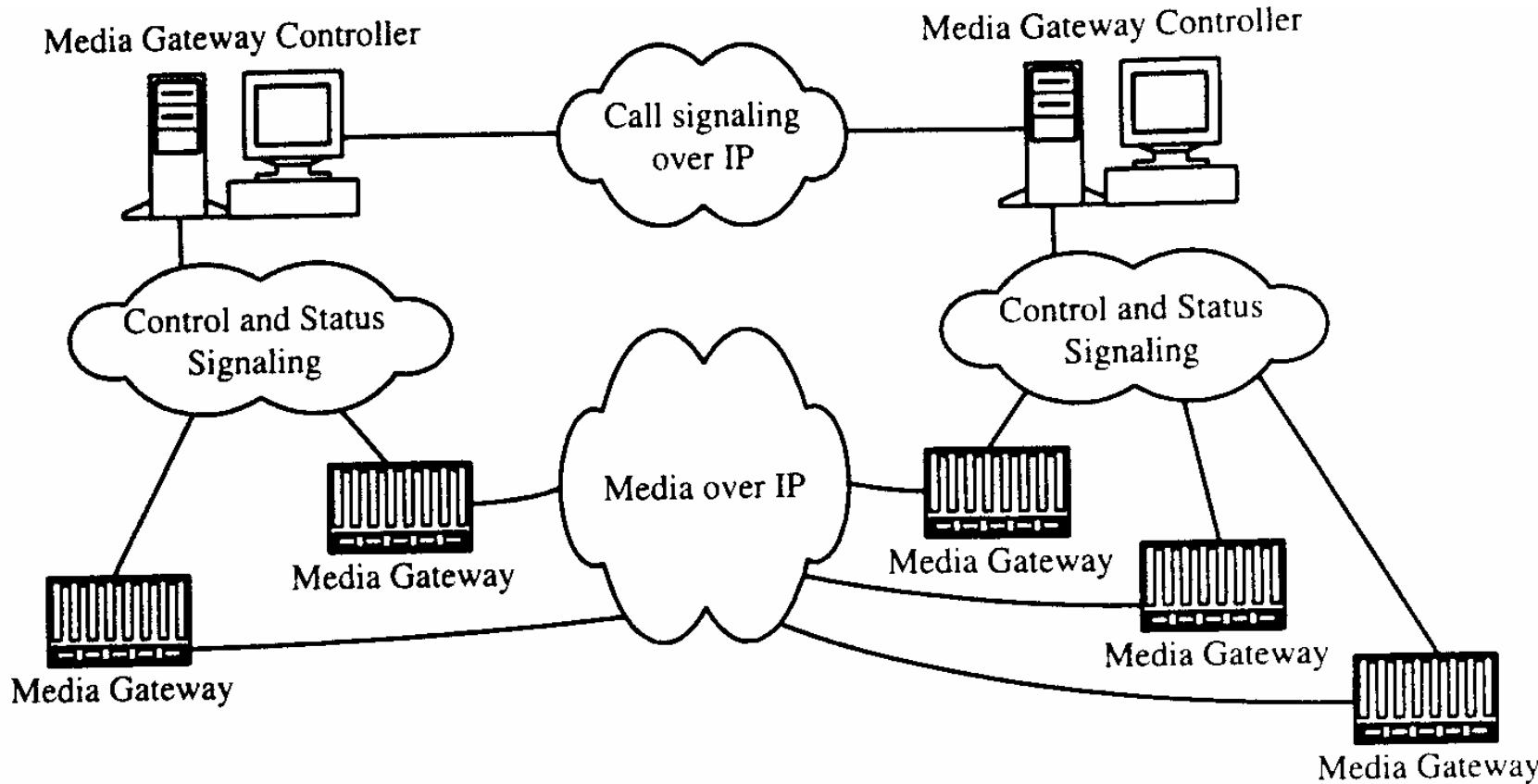




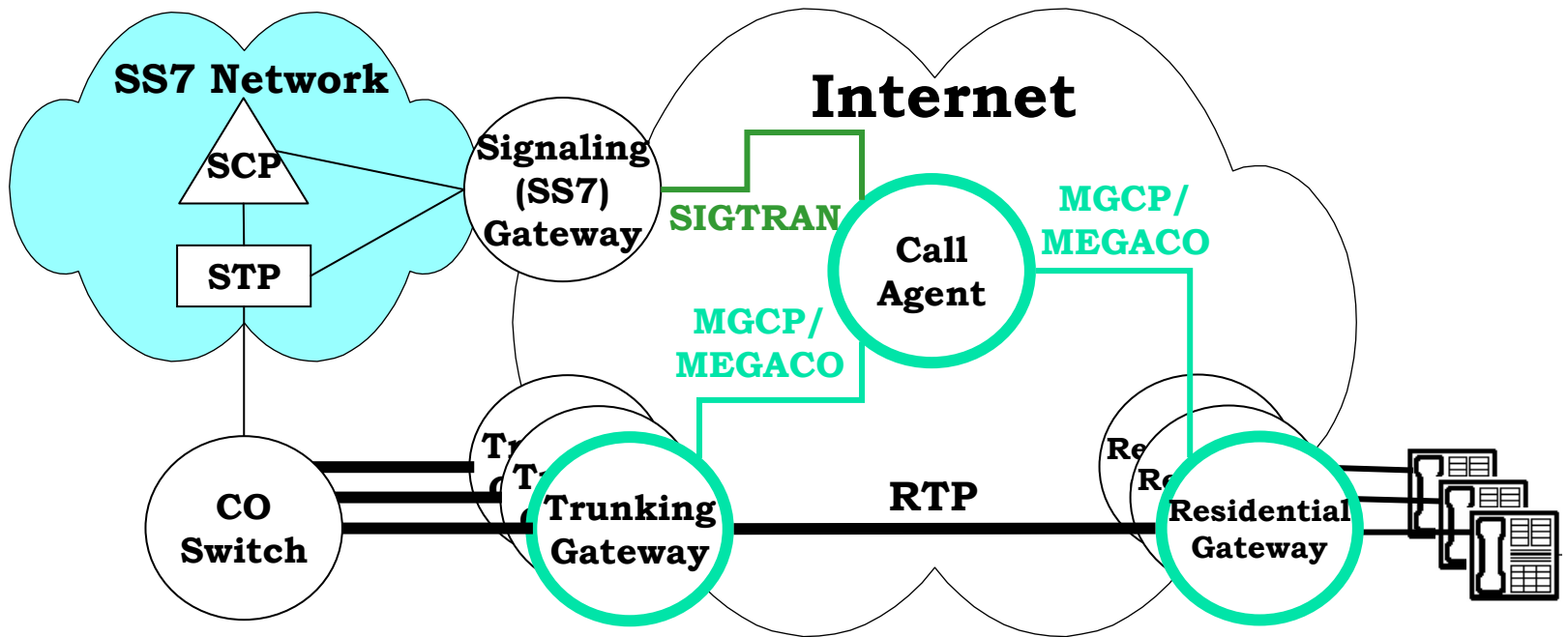
Separation of Media and Call Control

- Advantages of Separation
 - Media conversion close to the traffic source and sink
 - The call-handling functions is centralized.
 - A call agent (media gateway controller - MGC) can control multiple gateways.
 - New features can be added more quickly.
- MGCP, Media Gateway Control Protocol
 - IETF
- MEGACO/H.248
 - IETF and ITU-T Study Group 16

Softswitch Architecture [1/2]



Softswitch Architecture [2/2]



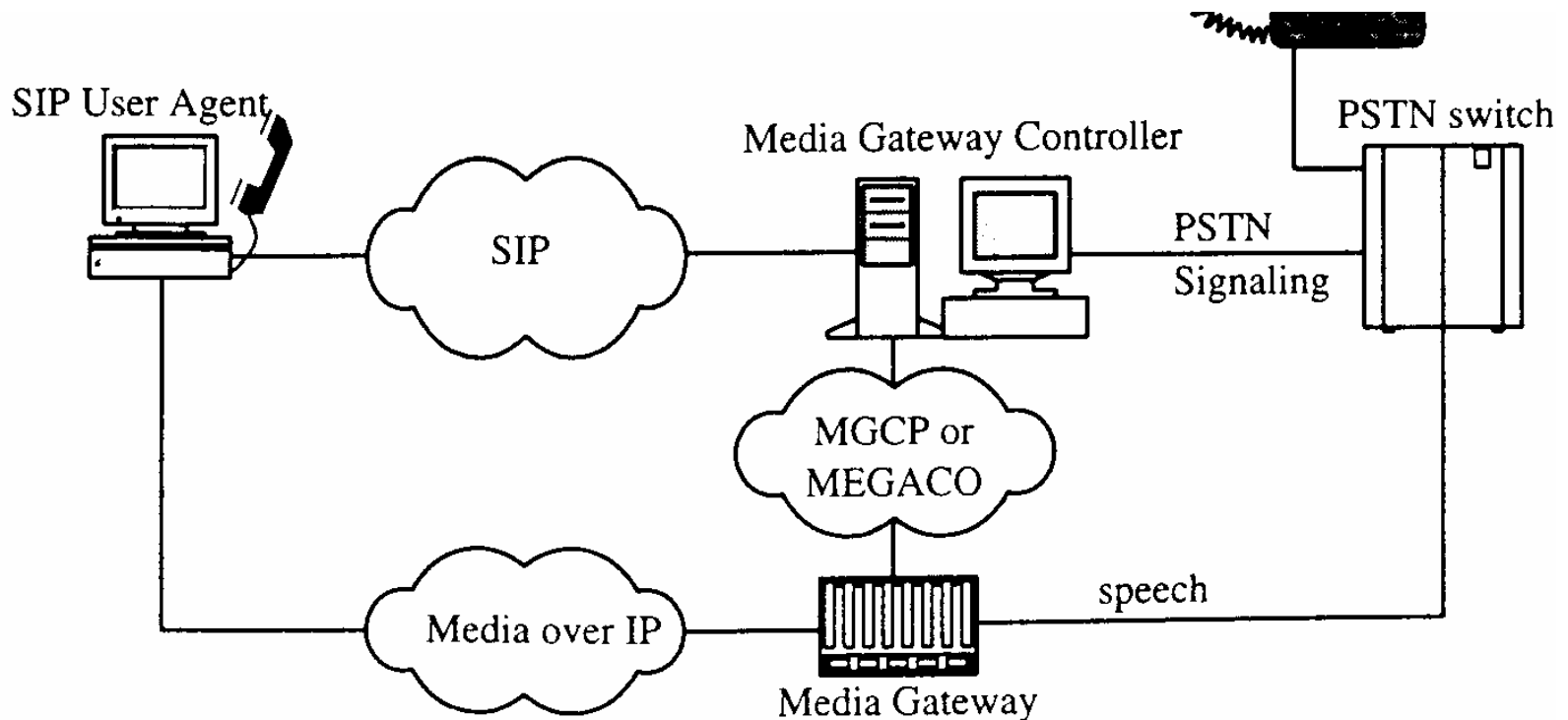


Softswitch

- The switching functions are handled by software
- International Softswitch Consortium (ISC)
 - www.softswitch.org
 - To promote the softswitch concept and related technologies
- Why the softswitch approach is popular?
 - A distributed architecture
 - For network operators
 - It is possible to use different network components from different vendors.
 - For equipment vendors
 - It is possible to focus on one area.

Softswitch/PSTN Interworking

- SIP is often used as the signaling protocol between the MGCs.



Requirements for Media Gateway Control

[1/2]

- RFC 2895
 - Media Gateway Control Protocol Architecture and Requirements
- Requirement
 - The creation, modification and deletion of media streams
 - Including the capability to negotiate the media formats
 - The specification of the transformations applied to media streams
 - Request the MG to report the occurrence of specified events within the media streams, and the corresponding actions

Requirements for Media Gateway Control

[2/2]

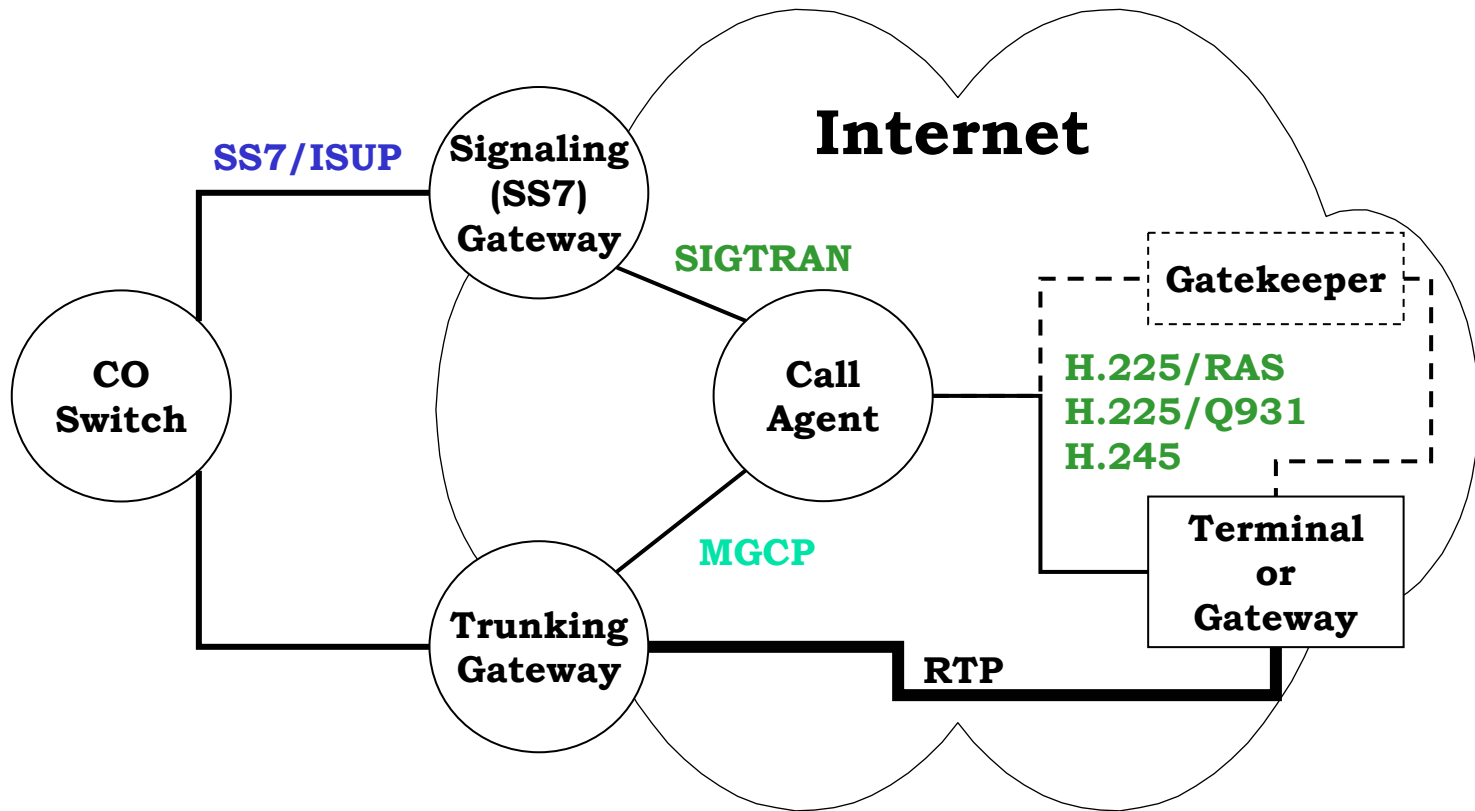
- Request the MG to apply tones or announcements
- The establishment of media streams according to certain QoS requirements
- Reporting QoS and billing/accounting statistics from an MG to an MGC
- The management of associations between an MG and an MGC
 - In the case of failure of a primary MGC
- A flexible and scalable architecture in which an MGC can control different MGs
- Facilitate the independent upgrade of MGs and MGCs



Protocols for Media Gateway Control

- The first protocol is MGCP
 - RFC 2705, informational
 - To be succeeded by MEGACO/H.248
 - Has be included in several product developments
- MEGACO/H.248
 - A standards-track protocol
 - RFC 3015 is now the official version.

Relation with H.323 Standards





H323, SIP & MGCP/MEGACO

■ H.323 , SIP

- peer-to-peer
- internet oriented
- intelligent endpoint
 - optional GK
- decentralized

■ Problems

- maintenance
 - cost & scalability of large systems
- signaling & media control are coupled
- interoperability with SS7

■ MGCP/MEGACO

- client-server
- traditional telephony
- intelligent server
 - “dumb” terminal
- centralized

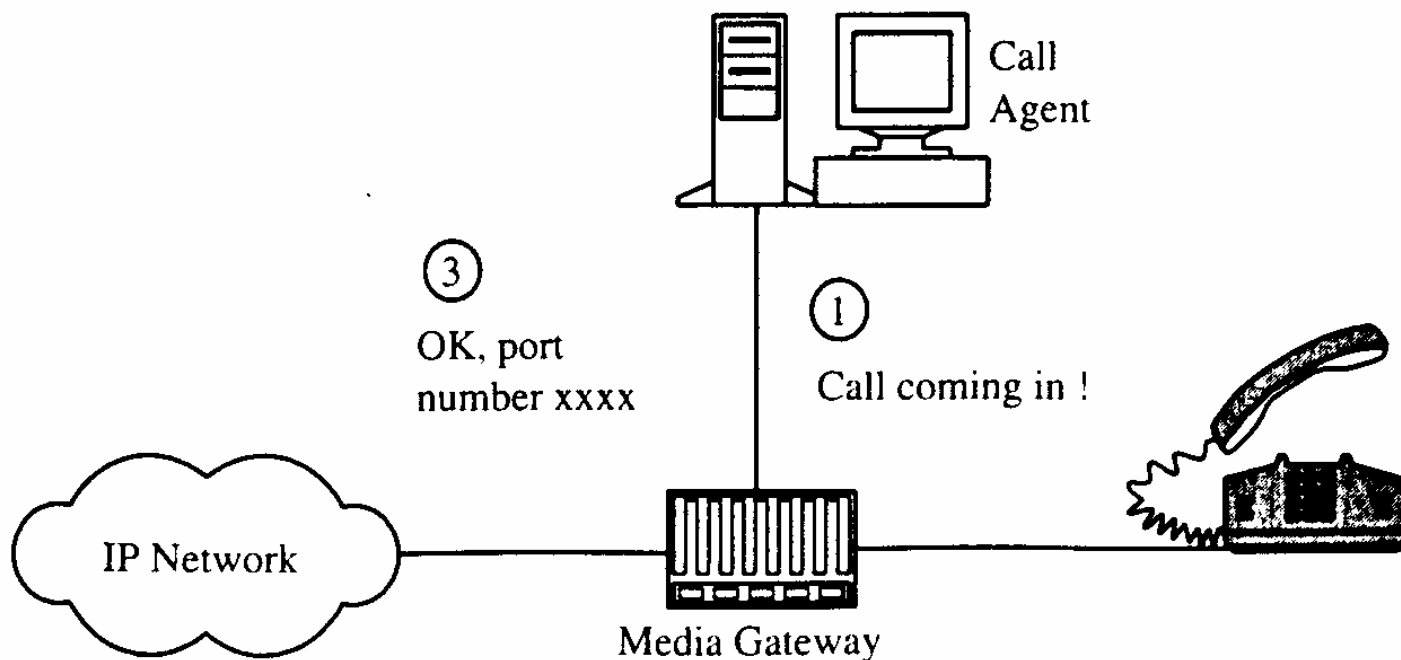
■ Concept

- gateway decomposed
 - separate call control from media ports
 - CA, MG, SG
- interoperability with PSTN

MGCP Connection Establishment

②

Select an RTP port
and connect



- A master-slave protocol
 - Call agents (MGCs) control the operation of MGs
 - Call-control intelligence
 - Related call signaling
 - MGs
 - Do what the CA instructs
 - A line or trunk on circuit-switched side to an RTP port on the IP side
- Types of Media Gateway
 - Trunking Gateway to CO/Switches
 - Residential Gateway to PSTN Phones
 - Access Gateway
- Communication between call agents
 - Likely to be the SIP



The MGCP Model

- Endpoints
 - Sources or sinks of media
 - Trunk interfaces
 - POTS line interfaces
 - Announcement endpoint
- Connections
 - Allocation of IP resources to an endpoint
 - An ad hoc relationship is established from a circuited-switched line and an RTP port on the IP side.
 - A single endpoint can have several connections



MGCP Endpoints [1/3]

- DS0 channel
 - A digital channel operates at 64kbps.
 - Multiplexed within a larger transmission facility such as DS1 (1.544 Mbps) or E1 (2.048 Mbps)
 - G.711 (u-law or A-law)
- Analog line
 - To a standard telephone line
 - An analog voice stream
 - Could also be audio-encoded data from a modem
 - The gateway shall be required to extract the data and forward it as IP packets.



MGCP Endpoints [2/3]

- Announcement server access point
 - Provide access to a single announcement
 - One-way
 - No external circuit-switched channels
- Interactive voice response (IVR) access point
 - Provide access to an IVR system
- Conference bridge access point
 - Media streams from multiple callers can be mixed
- Packet relay
 - A firewall between an open and a protected networks



MGCP Endpoints [3/3]

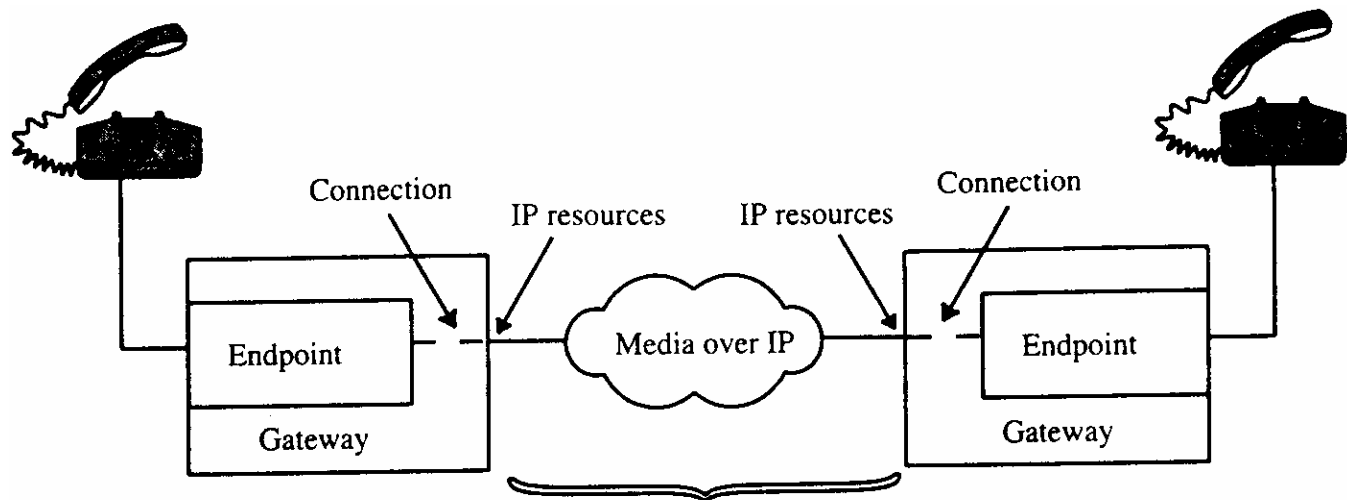
- Wiretap access point
 - For listening to the media transmitted
 - One way
- ATM trunk-side interface
 - The termination of an ATM trunk
 - May be an ATM virtual circuit

Endpoint Identifier

- GW's Domain Name + Local Name
- Local Name
 - A hierarchical form: X/Y/Z
- trunk4/12/7@gateway.somenetwork.net
 - To identify DS0 number 7 within DS1 number 12 on DS3 number 4 at gateway.somenetwork.net
- Wild-cards
 - \$, any; *, all
 - e.g., trunk1/5/\$@gateway.somenetwork.net
 - CA wants to create a connection on an endpoint in a gateway and does not really care which endpoint is used.
 - e.g., trunk1/5/*@gateway.somenetwork.net
 - CA requests statistical information related to all endpoints on a gateway.

MGCP Calls and Connections

- A connection
 - Relationship established between a given endpoint and an RTP/IP session
- A call
 - A group of connections
- The primary function of MGCP is to enable
 - The connections to be created
 - The session descriptions to be exchanged between the connections





MGCP Commands

- 9 commands to handle Connection/Endpoints

- EPCF** ■ EndpointConfiguration (coding characteristics)
 - RQNT** ■ NotificationRequest (requested events)
 - NTFY** ■ Notify (GW: detected events)
 - CRCX** ■ CreateConnection
 - MDCX** ■ ModifyConnection
 - DLCX** ■ DeleteConnection
 - AUEP** ■ AuditEndpoint
 - AUCX** ■ AuditConnection
 - RSIP** ■ RestartInProgress (GW : taken in/out of service)
- All commands are acknowledged.



MGCP Command Format

- A command line
 - Request verb (the name of the command)
 - Transaction id
 - Endpoint id (for which the command applies)
 - Protocol version
- A number of parameter lines
- An optional session description (SDP)
 - Separated by a single empty line
- Command Encapsulation
 - One command can be included within another
 - Only one level of encapsulation
 - E.g., when instructing a gateway to create a connection, CA can simultaneously instruct the gateway to notify the CA of certain events.



MGCP Parameters [1/6]

- BearInformation (B)
 - The line-side encoding
 - B:e:mu
- CallId (C)
 - Comprised of hexadecimal digits
- Capabilities (A)
 - In response to an audit
- ConnectionId (I)
 - Comprised of hexadecimal digits
- ConnectionMode (M)
 - Send only, receive only and send-receive

MGCP Parameters [2/6]

- ConnectionParameters (P)
 - Connection-related statistical information
 - Average latency, jitter, packets sent/received/lost
 - GW -> CA
- DetectEvents (T)
 - That an endpoint should detect during quarantine period
 - E.g., off-hook, on-hook, hook-flash, DTMF digits...
- LocalConnectionDescriptor (LC)
 - An SDP session description
- LocalConnectionOptions (L)
 - Bandwidth, packetization period, silence suppression, gain control, echo cancellation...
 - L: e:off, s:on
 - To turn echo cancellation off and to turn silence suppression on

MGCP Parameters [3/6]

- EventStates (ES)
 - In response to an audit command
 - A list of events associated with the current state
- MaxMGCPDatagram (MD)
 - To indicate the maximum size MGCP packet supported by an MG
 - Included in the response to an AUEP command
- NotifiedEntity (N)
 - An address for the CA
- ObservedEvents (O)
 - Detected by an endpoint
- PackageList (PL)
 - Supported by an endpoint
 - Events and signals are grouped into packages
 - Analog line endpoint

MGCP Packages

- Group events and signals into packages
- Generic Media (G)
- DTMF (D)
- MF (M)
- Trunk (T)
- Line (L)
- Handset (H)
- RTP (R)
- Network Access Server (N)
- Announcement Server (A)
- The experimental packages have names beginning with the two character “x-”.

Gateway	Supported packages
Trunk GW (ISUP)	G, D, T, R
Trunk GW (MF)	G, M, D, T, R
Network Access Server	G, M, T, N
Combined NAS/VOIP GW	G, M, D, T, N, R
Access GW (VOIP)	G, M, D, R
Access GW (VOIP + NAS)	G, M, D, N, R
Residential GW	G, D, L, R
Announcement GW	A, R

MGCP Parameters [4/6]

- QuarantineHandling (Q)
 - Events that occur during the period in which the GW is waiting for a response to a Notify command
 - Process the events or discard them
- ReasonCode (E)
 - When a GW deletes/restarts a connection
- RemoteConnectionDescriptor (RC)
 - An SDP session description
- RequestEvents (R)
 - A list of events that an endpoint is to watch for
 - Associated with each event, the endpoint can be instructed to perform actions
 - E.g., collect digits, or apply a signal



MGCP Parameters [5/6]

- RequestInfo (F)
 - In response to audit requests
 - The current values of RequestEvents, DigitMap, NotifiedEntity
- RequestIdentifier (X)
 - To correlate a given notification from a GW
- RestartDelay (RD)
 - A number of seconds indicating when an endpoint will be brought back into service
- RestartMethod (RM)
 - Graceful or Forced

MGCP Parameters [6/6]

- SecondConnectionId (I2)
 - The connection on a second endpoint
- SpecificEndpointID (Z)
 - A response to a command using a wild card
- SecondEndpointID (Z2)
 - A connection between two endpoints on the same GW
- SignalRequests (S)
 - Signals to be applied by an endpoint
- SpecificEndpointID (Z)
 - Used to indicate a single endpoint

Digit Map

- CA ask GW to collect user dialed digits
 - Created by CA

- Usage

- Gateways detect a set of digits.
 - e.g., (11x|080xxxxxx|03xxxxxxx|002x.T)
- Match accumulated digits
 - under-qualified, do nothing further
 - matched, send the collected digits to CA
 - over-qualified, send the digits to CA

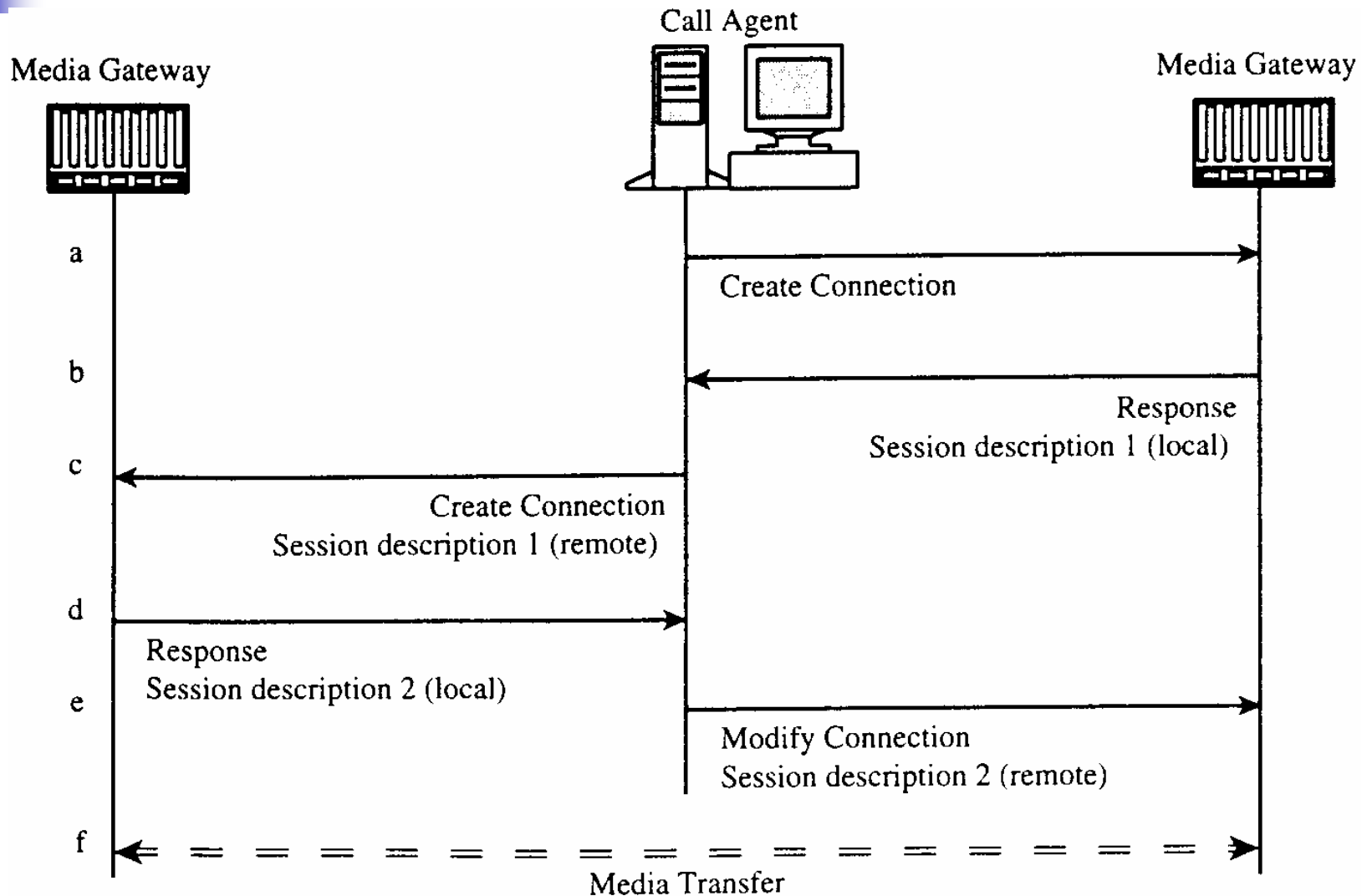
Inter-digit Timer

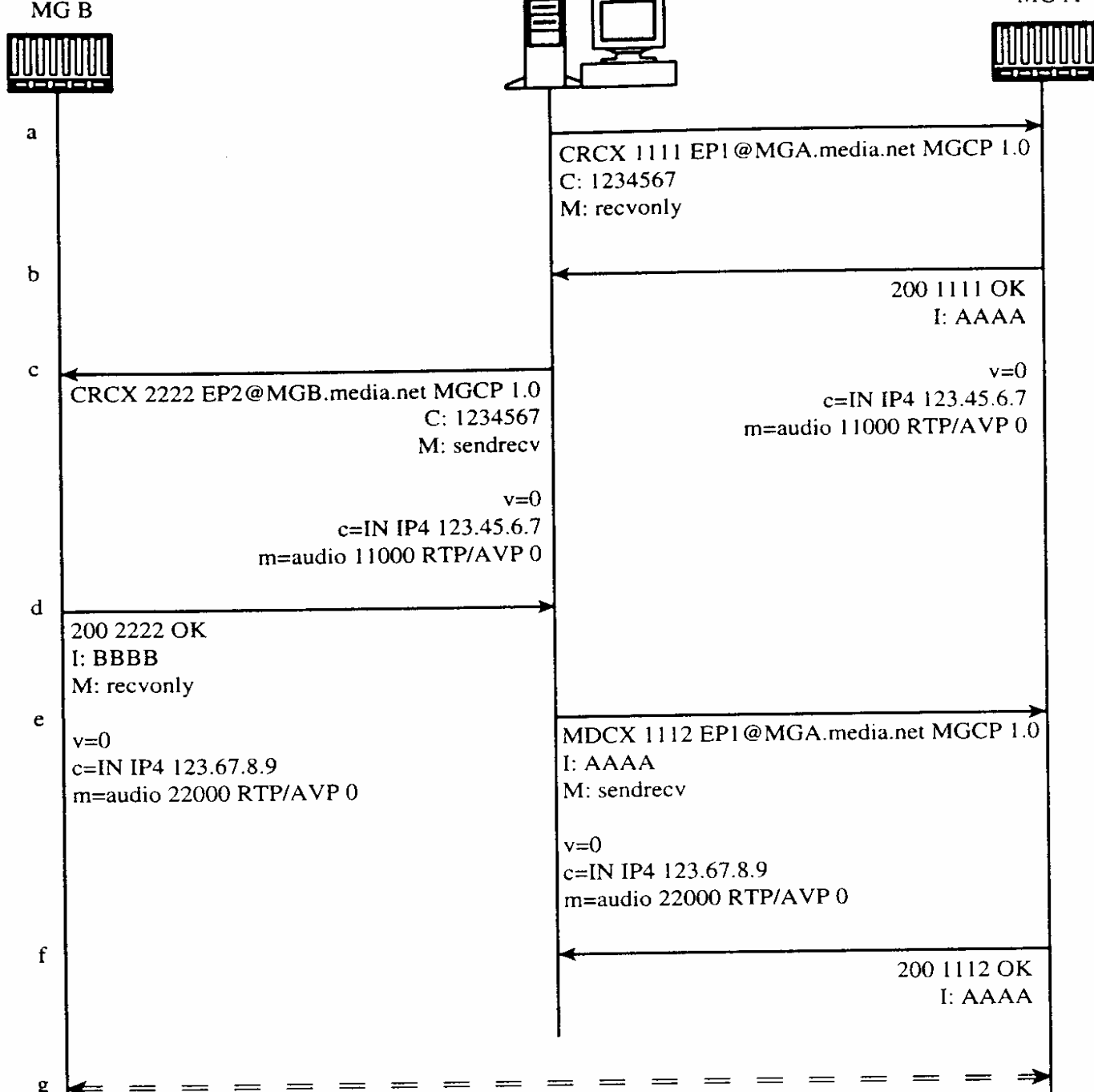


MGCP Response

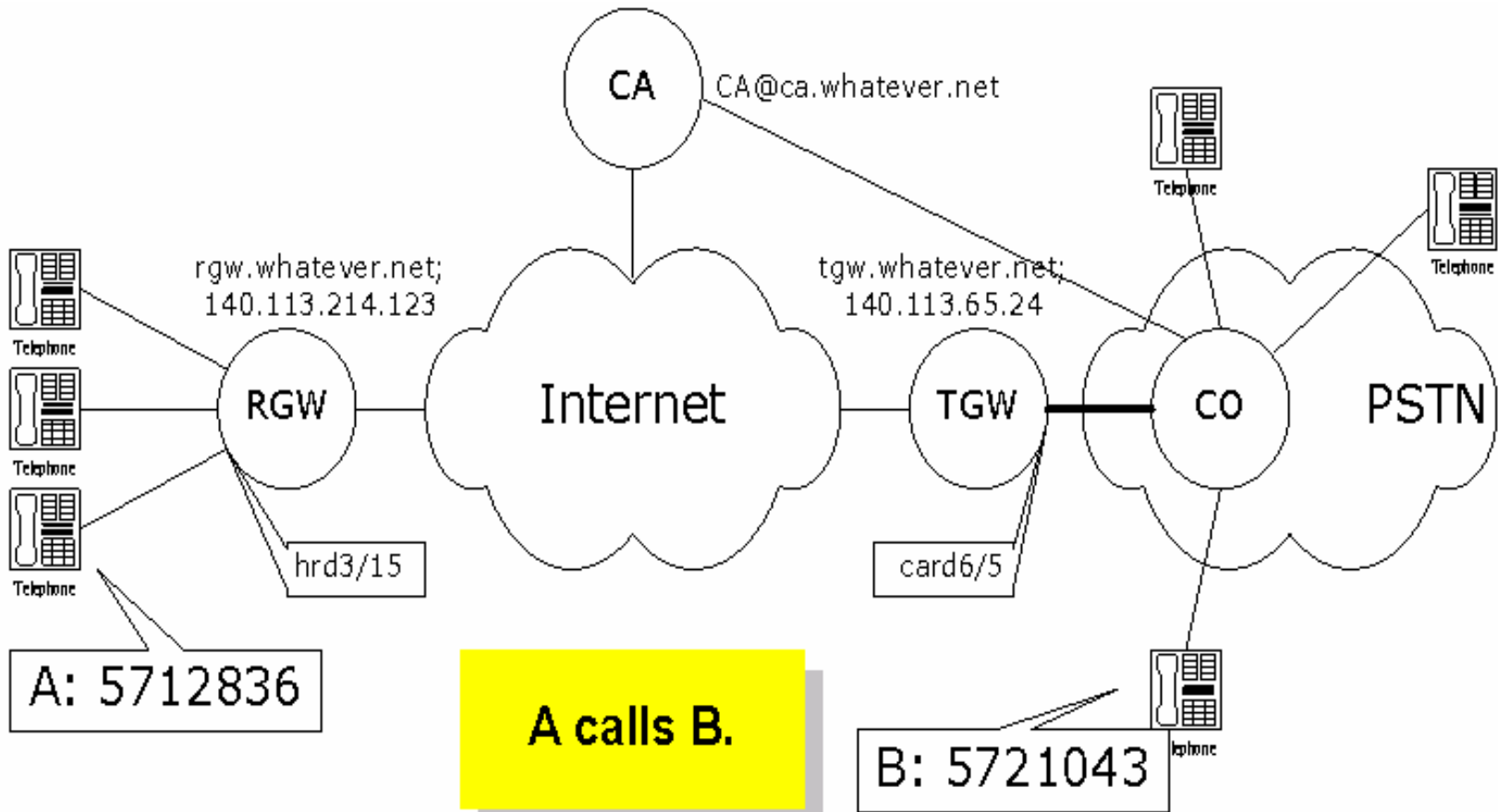
- Header
 - a response line
 - return code + TransID + Commentary
 - a set of parameter lines (optional)
 - E.g., I: A3C47F21456789F0 (ConnectionId)
- Session Description
 - Session Description Protocol
 - separated from header by an empty line

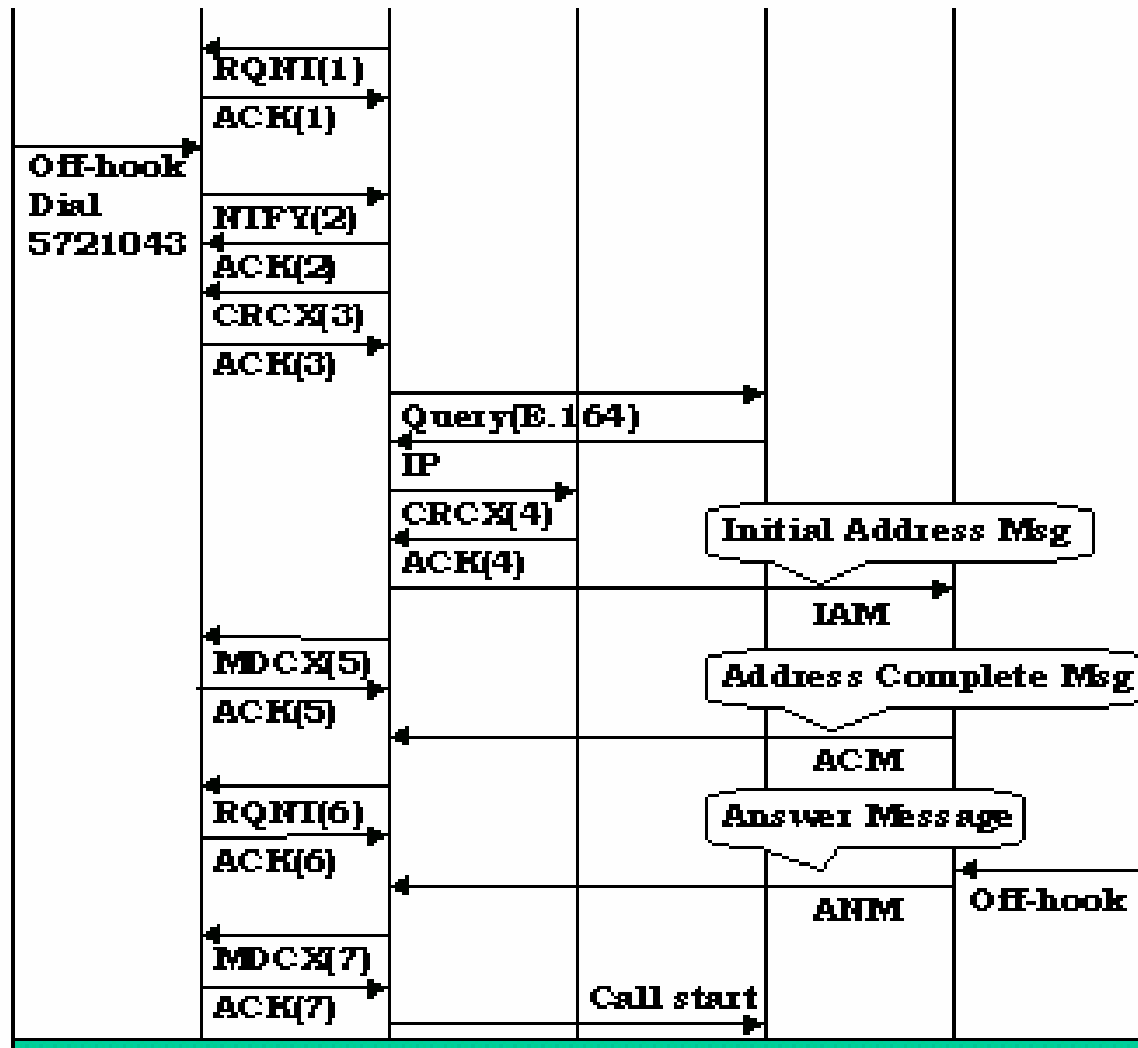
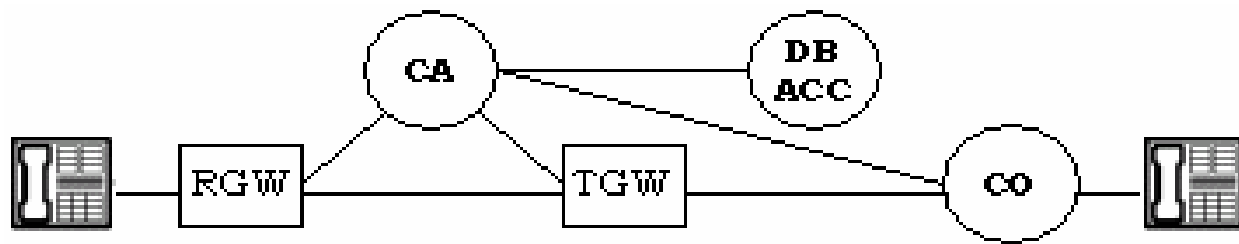
Call Setup Using MGCP

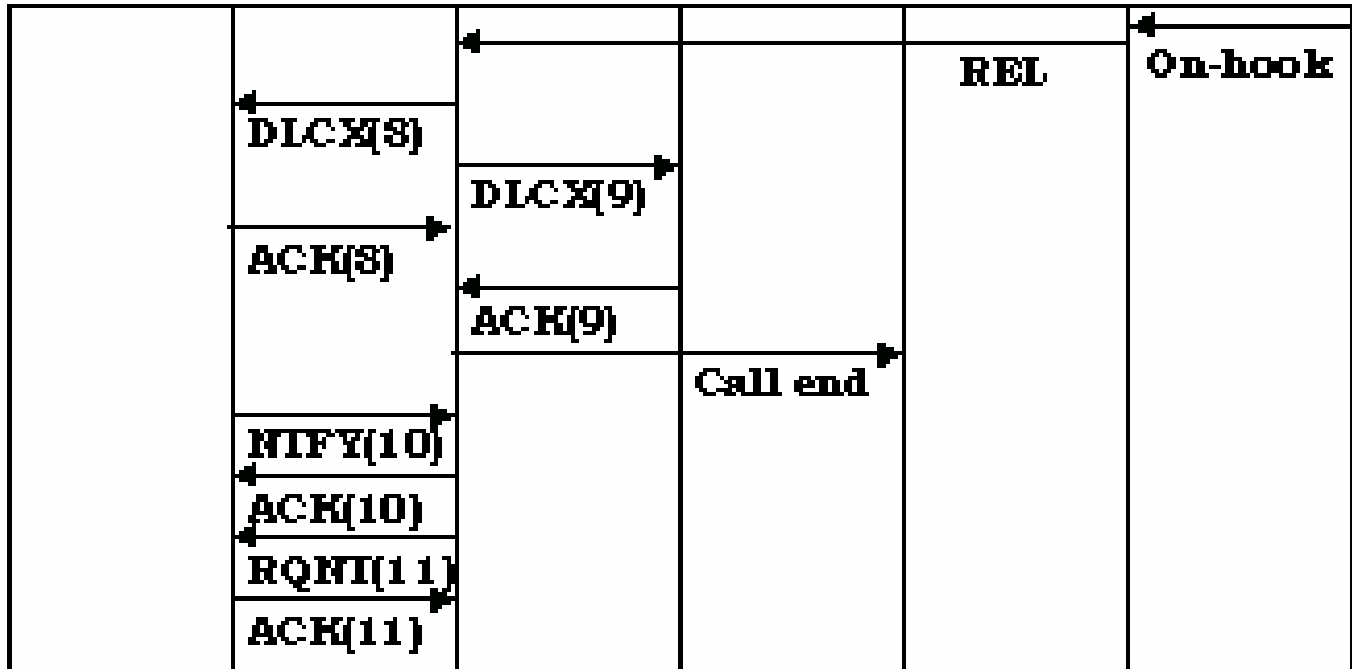
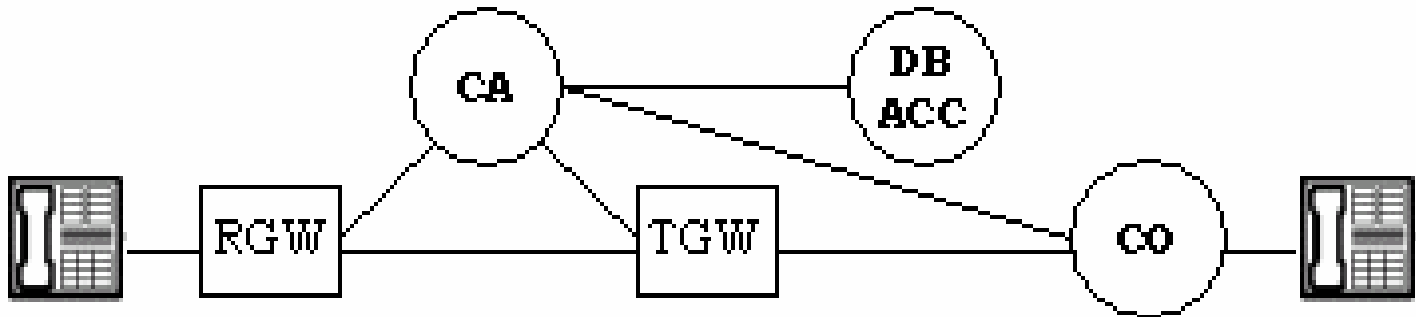




Call Flow for RGW to TGW







Call Flow for RGW to TGW

■ RQNT(1) : NotificationRequest

- RQNT 1201 hrd3/15@rgw.whatever.net MGCP 1.0
- N: CA@ca.whatever.net:5678
- X: 0123456789AC
- R: hd(E(R(hu(N)),S(dl),D/(D)))
- D: (11x|080xxxxxx|57xxxxx|002x.T)

```
N: NotifyEntity
X: RequestIdentifier
R: RequestEvents
D: DigitMap
```

■ ACK to RQNT(1)

- 200 1201 OK

```
E: Embedded Request
R: Notification Request
N: Notify immediately
S: Signal Request
D: Digit Map
```

Call Flow for RGW to TGW

- NTFY(2) : Notify from RGW
 - NTFY 2002 hrd3/15@rgw.whatever.net MGCP 1.0
 - N: CA@ca.whatever.net:5678
 - X: 0123456789AC
 - O: 5721043
- ACK to NTFY(2)
 - 200 2002 OK

```
N: NotifyEntity
X: RequestIdentifier
O: ObservedEvent
```


Call Flow for RGW to TGW

■ CRCX(3) : CreateConnection

- CRCX 1204 hrd3/15@rgw.whatever.net MGCP 1.0
- C: A3C47F21456789F0
- L: p:10, a: G.711; G.726-32
- M: recvonly
- X: 0123456789AD
- R: hu

■ ACK to CRCX(3)

- 200 1204 OK
- I: FDE234C8
- Session Description

```
C: CallId
L: LocalCXOptions
   p: packetize period(ms)
   a: Compression Algo.
M: Mode
X: RequestIdentifier
R: RequestEvents
I: ConnectionId
```

Call Flow for RGW to TGW

- ACK to CRCX(3) Session Description
 - v=0
 - c=IN IP4 140.96.102.166
 - m=audio 3456 RTP/AVP 0 96
 - a=rtpmap:96 G726-32/8000

**G726~G732 encoded
audio sample at 8 kHz**

```
v: protocol version
c: connection information
m: media name and transport address
a: more media attribute line
```

Call Flow for RGW to TGW

- CRCX(4) : CreateConnection
 - CRCX 1205 card6/5@tgw.whatever.net MGCP 1.0
 - C: A3C47F21456789F0
 - L: p:10, a: G.711; G.726-32
 - M: sendrecv
 - Session Description from ACK(3)
- ACK to CRCX(4)
 - 200 1205 OK
 - I: 32F345E2
 - Session Description

```
C: CallId
M: Mode
I: ConnectionId
```

Call Flow for RGW to TGW

■ MDCX(5) : ModifyConnection

- MDCX 1206 hrd3/15@rgw.whatever.net MGCP 1.0
- C: A3C47F21456789F0
- I: FDE234C8
- M: recvonly
- Session Description from ACK(4)

```
C: CallId  
I: ConnectionId  
M: Mode
```

■ ACK to MDCX(5)

- 200 1206 OK

Call Flow for RGW to TGW

- RQNT(6) : NotificationRequest

- RQNT 1207 hrd3/15@rgw.whatever.net MGCP 1.0
- N: CA@ca.whatever.net:5678
- X: 012345789AE
- R: hu
- S: v (alerting)

- ACK to RQNT(6)

- 200 1207 OK

```
N: NotifyEntity
X: RequestIdentifier
R: RequestEvents
S: SignalRequests
```

Call Flow for RGW to TGW

- MDCX(7) : ModifyConnection

- MDCX 1209 hrd3/15@rgw.whatever.net MGCP 1.0
- C: A3C47F21456789F0
- I: FDE234C8
- M: sendrecv
- X: 012345789AF
- R: hu

```
C: CallId
I: ConnectionId
M: Mode
```

- ACK to MDCX(7)

- 200 1209 OK

Call Flow for RGW to TGW

■ DLCX(8) : DeleteConnection

- DLCX 1210 hrd3/15@rgw.whatever.net MGCP 1.0
- C: A3C47F21456789F0
- I: FDE234C8

C: CallId

I: ConnectionId

■ ACK to DLCX(8)

- 200 1210 OK
- P: PS=1245, OS=62345, PR=780, OR=45123, PL=10, JI=27, LA=48

PS: Packets sent

OS: Octets sent

PR: Packets received

OR: Octets received

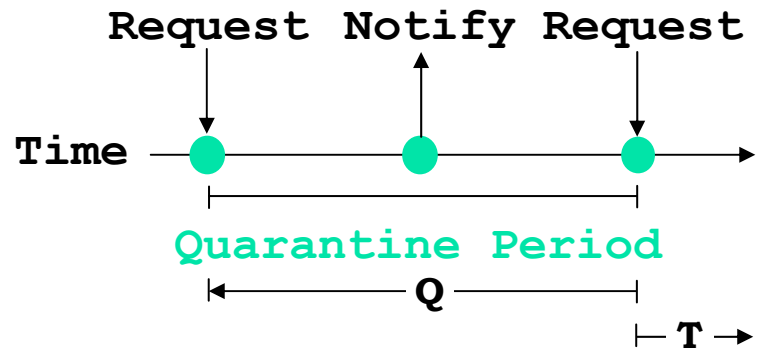
PL: Packets lost

JI: Average Jitter (ms)

LA: Average Latency (ms)

Usage of Commands

- NotificationRequest()
 - EndpointId,
 - [NotifiedEntity,]
 - [RequestedEvents,]
 - RequestIdentifier,
 - [DigitMap,]
 - [SignalRequests,]
 - [QuarantineHandling,]
 - [DetectEvents,]
 - [encapsulated EndpointConfiguration]



Q: **process**/discard
step/loop (notify)

T: events to detect
during quarantine

Usage of Commands

- CreateConnection()
 - CallId,
 - EndpointId,
 - [NotifiedEntity,]
 - [LocalConnectionOption,]
 - Mode,
 - [{RemoteConnectDescriptor | **SecondEndpointId**}]
 - [Encapsulated NotificationRequest,]
 - [Encapsulated EndpointConfiguration]

Hairpin Connection



Usage of Commands

- DeleteConnection()
 - Delete one connection from Call Agent
 - ConnectionId in the parameter line
 - GW responds with Connection parameters
 - Multiple connections from Call agent
 - only EndpontId (and CallId) in the parameter line
 - GW does not respond with Connection parameters
 - From gateway
 - Reason-Code & Connection-Parameters in Command

Usage of Commands

- RestartInProgress()
 - EndPointId
 - RestartMethod
 - [RestartDelay]
 - [Reason-code]
- ReturnCode
 - [NotifiedEntity]

RestartMethod

- **Forced**
- **Restart**
- **Disconnected**
- ...

Usage of Commands

- AuditEndPoint()

- EndpointId
- [RequestedInfo]

- ReturnCode

- EndPointIdList

**If EndpointId is
“wildcard”,
EndPointIdList is returned**

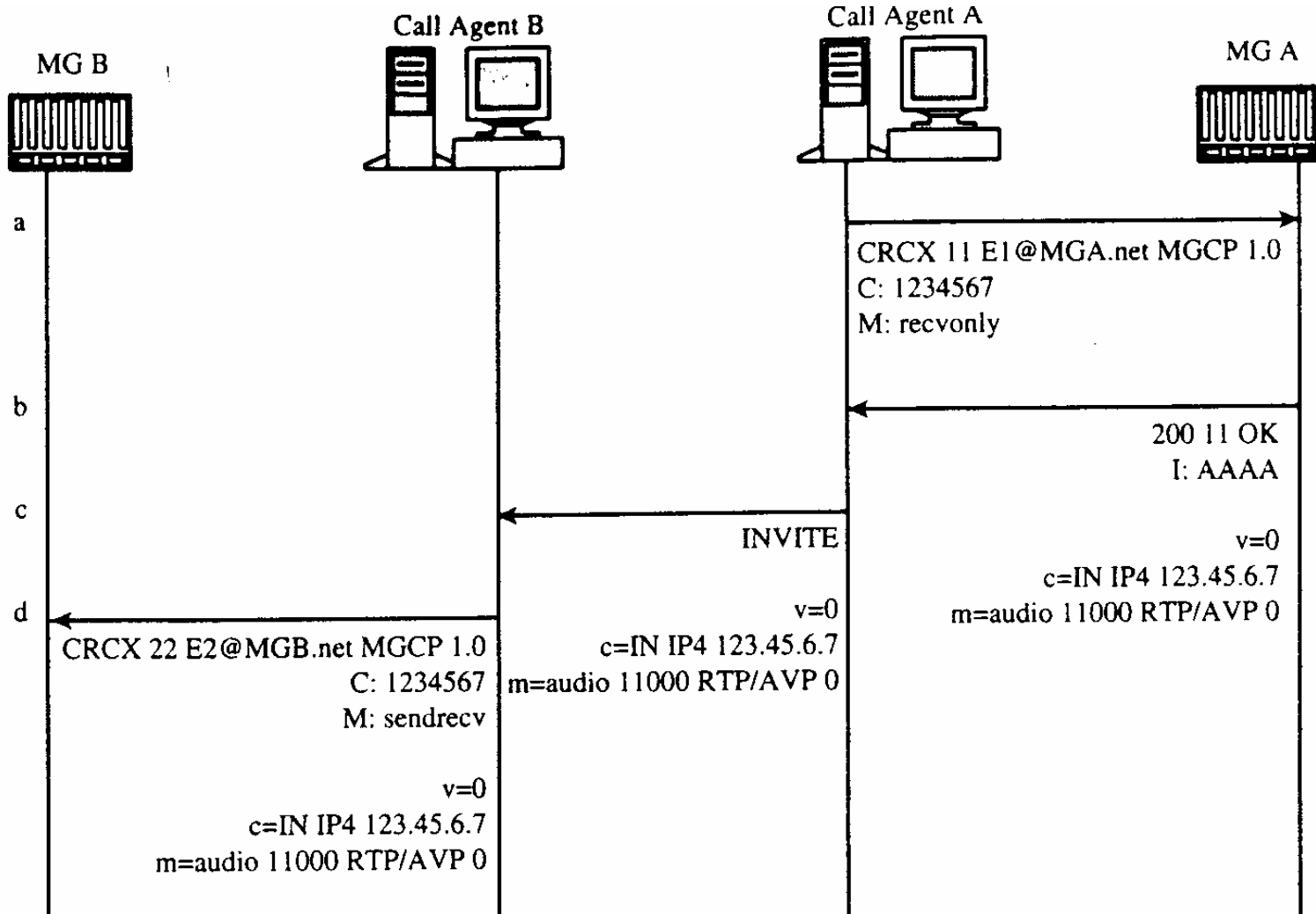
{RequestedEvents
DigitMap
SignalRequests
RequestIdentifier, ... }

Usage of Commands

- AuditConnection()
 - ConnectionId
 - RequestedInfo
- ReturnCode
 - CallId
 - NotifiedEntity
 - LocalConnectionOptions ...

“Wildcard” shall not be used

Interworking between MGCP and SIP



Interworking between MGCP and SIP

