“Roadmap” for Multimedia Networking

1. Introduction
   — why QoS?
   — what are the problems?

2. Basic operations
   — jitter buffers (at hosts)
   — task scheduling (at hosts)
   — packet shaping (at hosts)
   — packet dropping (at routers)
   — packet scheduling (at routers)

3. Types of service
   — Integrated Services (IntServ) and Resource Reservation Protocol (RSVP)
   — Differentiated Services (DiffServ)

4. Application-level feedback and control
   — Real-time Protocol (RTP), Real-time Control Protocol (RTCP)

5. Application signaling and device control
   — Session Description Protocol (SDP)
   — Real-time Streaming Protocol (RTSP)
   — Session Initiation Protocol (SIP)
   — Media Gateway Control Protocol (MGCP)

6. Routing
   — multicasting
   — Multi-protocol Label Switching (MPLS)
MGCP (Media Gateway Control Protocol)

- Master-slave protocol between Media Gateway Controllers (MGC) and Media Gateways (MG)
  - maintains close control over devices such as telephones
  - supports users and their subscribed features
- Main function: create, modify, and delete media streams across a gateway

MGCP (cont'd)

1. Media transformations
   — negotiate media stream formats
   — specify transformations to be applied at gateway

2. Events / actions
   — notify the MGC of events in the media stream (on-hook, etc.)
   — specify action MG should take in response to events

3. QoS
   — configure MG to provide QoS
   — report QoS from MG to MGC

4. Subscriber management
   — report billing / accounting information

5. Fault tolerance
   — provide recovery in event of MGC failure
Properties of MGCP

- Text-based protocol, for simplicity
- “Stateless” protocol
  - the MGC tracks the call state, but there is no transaction state
Megaco

- Megaco/H.248: a single, unified protocol developed by IETF and ITU for call control and signaling

- Alternate protocol to do same thing as MGCP
  — coexist at present; Megaco will take over?
Endpoints

• Types
  — single digital channel (DS0) or multiplexed digital channel (DS1)
  — analog phone circuit
  — announcement server
  — interactive voice response server
  — conference bridge access point
  — wiretap access point
  — packet relay (firewall or security gateway)
  — etc.
Endpoints (cont’d)

• Each endpoint associated with endpoint identifier
  — ex.: DS0 #7 within DW1 #12 within DS3 #4 = trunk_4/12/7@gateway.somenetwork.net
  — endpoint identifier can include * (wildcard) to control group of endpoints, or get response from a group of endpoints
Terminology

- **Connection** = relationship between an endpoint and an RTP/IP session
- **Call** = group of connections between endpoints

*Figure 6-6*
Relationship between calls and connections

*Source: Carrier Grade Voice Over IP, D. Collins, McGraw-Hill, 2001*
Commands

• 9 commands between MGC and MG

• Command headers
  — action
  — transaction Identifier
    • also put in the response header to correlate with command
  — name of target endpoint
  — protocol version

• Can encapsulate one command inside another
  — encapsulated command only executed in conjunction with outer command
Some Response Parameters

- **CallID (C)**: generated by MGC, identifies call (involving one or more connections)

- **ConnectionMode (M)**: sent by MGC to endpoint to establish connection state (normal, send only, receive only, loopback, etc.)

- **ConnectionID (I)**: generated by endpoint in response to CRCX command

- **RequestIdentifier (X)**: generated by MGC as part of notification request

- **DigitMap (D)**: rules about combinations of digits that can be dialed and how to interpret them
Parameters (cont’d)

- **RequestedEvents (R)**: list of events for which endpoint must watch

- **ObservedEvents (O)**: events detected by endpoint for which notification has been requested

- **LocalConnectionOptions (L)**: encoding method, packetization interval, bandwidth, type of service, echo cancellation indicator

- **ConnectionParameters (P)**: statistics sent by endpoint to MGC when connection deleted
  - packets sent and received, bytes sent and received, packets lost, average jitter, average latency

- **RequestedInfo (F)**: return a local connection descriptor
Commands

- **Endpoint Configuration (EPCF)**
  - sent from MGC to MG; inform of "line-side" characteristics
  - parameters: BearerInformation

- **Create Connection (CRCX)**
  - create a connection to an endpoint
  - mandatory parameters: CallID ConnectionMode
  - SDP description may be part of the message body

- **Modify Connection (MDCX)**
  - change characteristics of an existing connection
  - mandatory parameters: CallID ConnectionID
  - SDP description may be part of the message body
Commands (cont’d)

• **Delete Connection (DLCX)**
  — terminate the connection
  — mandatory parameters: CallID ConnectionID

• **Request Notification (RQNT)**
  — issued by MGC to MG; alert MGC when event has been detected in media stream
  — mandatory parameters: RequestIdentifier

• **Notify (NTFY)**
  — notification from MG to MGC that an event has occurred
  — mandatory parameters: RequestIdentifier ObservedEvents
Commands (cont’d)

• Audit Endpoint (AUEP)
  — request the capabilities and state of an endpoint
  — mandatory parameters: (none)

• Audit Connections (AUCX)
  — request the capabilities and state of a connection
  — mandatory parameters: ConnectionID RequestedInfo
“Digit Maps”

- A pattern specifying particular sequences of keypresses and what they mean

- The MG collects and analyzes digits to see if a complete number has been dialed
  - saves communication (keypress by keypress) with the MGC

- Examples:
  - [2-9]xxxxxx = normal 7 digit number for local call
  - *xx = request for a feature
  - etc.
Return Codes

• 100-199  Provisional response, final response follows later

• 200-299  Success

• 400-499  Failure due to temporary error
  — ex.: phone already off hook, insufficient bandwidth available

• 500-599  Failure due to permanent error
  — Ex.: endpoint unknown, protocol error, gateway does not support request, unknown call-ID, hardware failure, ...
Figure 6-7
MGCP call-establishment overview

Call Setup

Figure 6-8
MGCP call setup between two gateways

Figure 6-9
MGCP call setup between residential
and trunking
gateways

Source: Carrier Grade Voice Over IP,

Call Setup
When User
Picks Up
Phone
Call Setup Using MGCP and SIP

Call Release

Figure 6-11
MGCP call release

Sources of Info

• Recommended Books
  — D. Collins, *Carrier-Grade Voice over IP*, 2001
    • Chapter 6

• Other books
  — O. Hersent et al., *IP Telephony*, 2000
    • Chapter 2

• RFCs
  — [Media Gateway Control Protocol Version 1.0](http://reeves.csc.ncsu.edu)