



**Data Communications
and Networking**

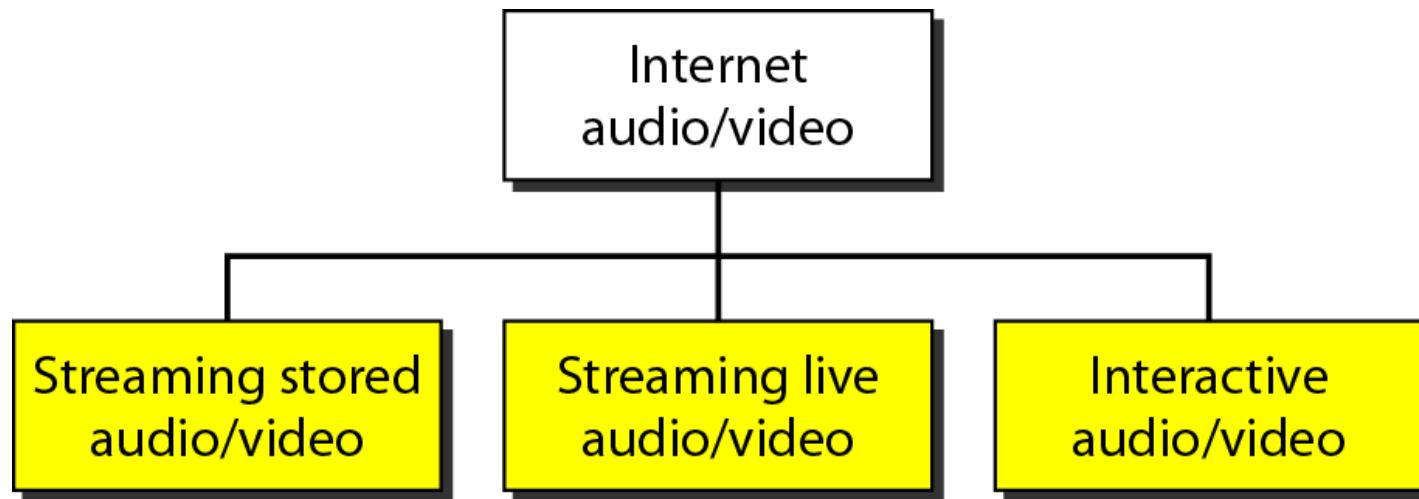
Fourth Edition

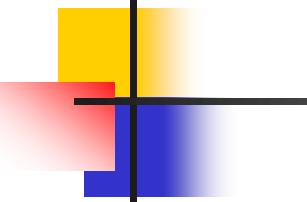
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Chapter 29

Multimedia

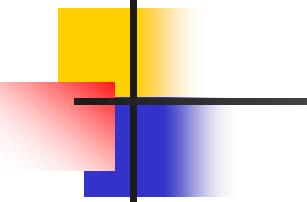
Figure 29.1 *Internet audio/video*





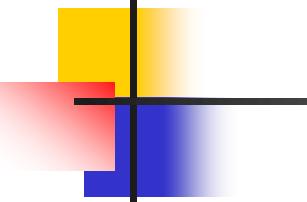
Note

Streaming stored audio/video refers to on-demand requests for compressed audio/video files.



Note

Streaming live audio/video refers to the broadcasting of radio and TV programs through the Internet.



Note

Interactive audio/video refers to the use of the Internet for interactive audio/video applications.

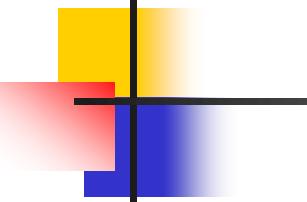
29-1 DIGITIZING AUDIO AND VIDEO

Before audio or video signals can be sent on the Internet, they need to be digitized. We discuss audio and video separately.

Topics discussed in this section:

Digitizing Audio

Digitizing Video



Note

Compression is needed to send video over the Internet.

29-2 AUDIO AND VIDEO COMPRESSION

To send audio or video over the Internet requires compression. In this section, we discuss audio compression first and then video compression.

Topics discussed in this section:

Audio Compression

Video Compression

Figure 29.2 *JPEG gray scale*

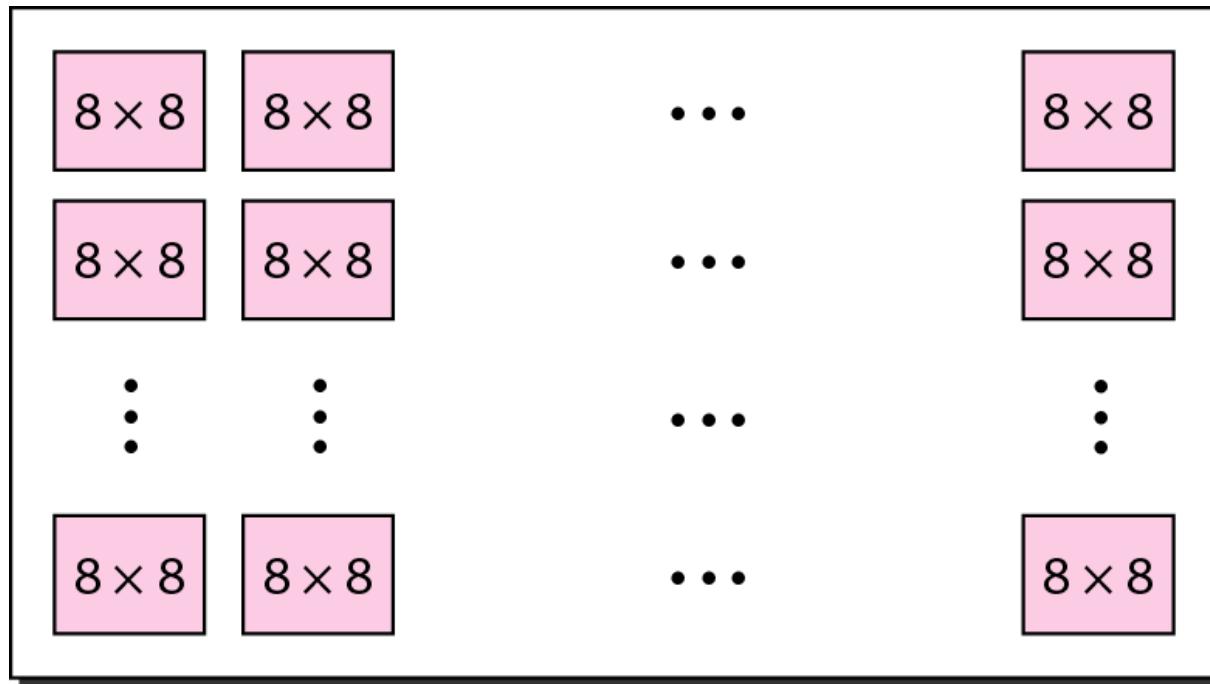


Figure 29.3 *JPEG process*

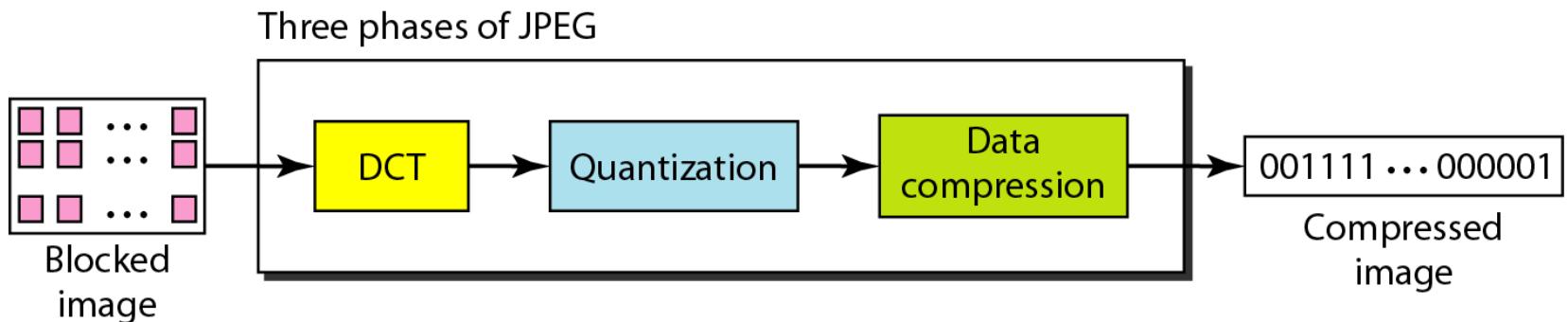


Figure 29.4 Case 1: uniform gray scale

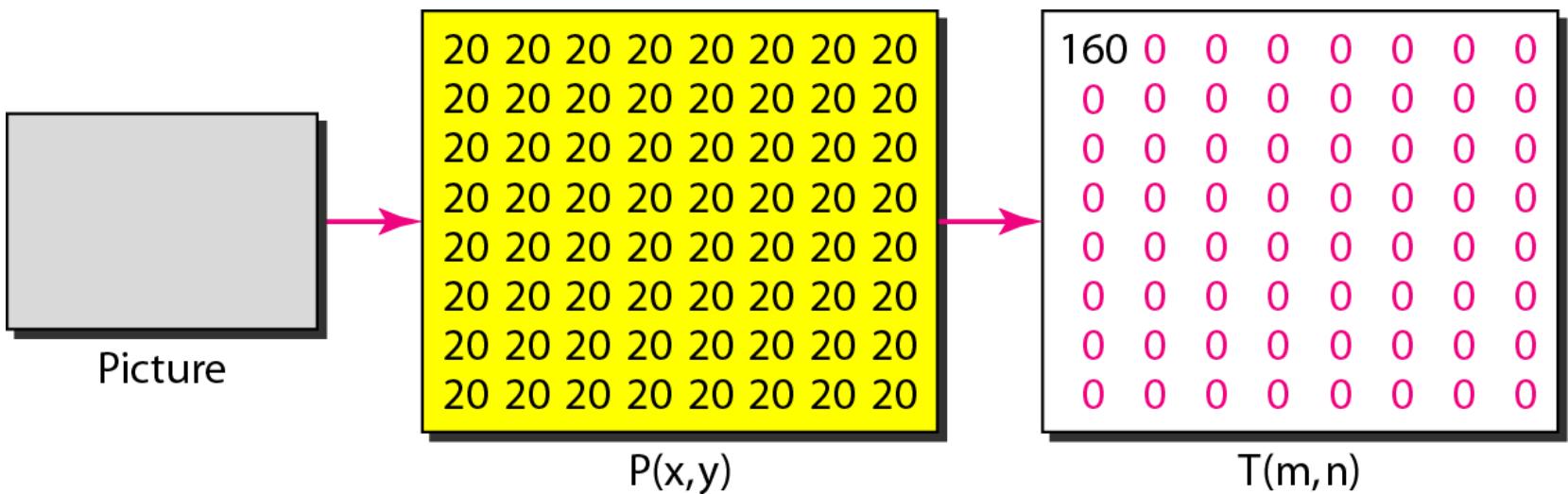


Figure 29.5 Case 2: two sections

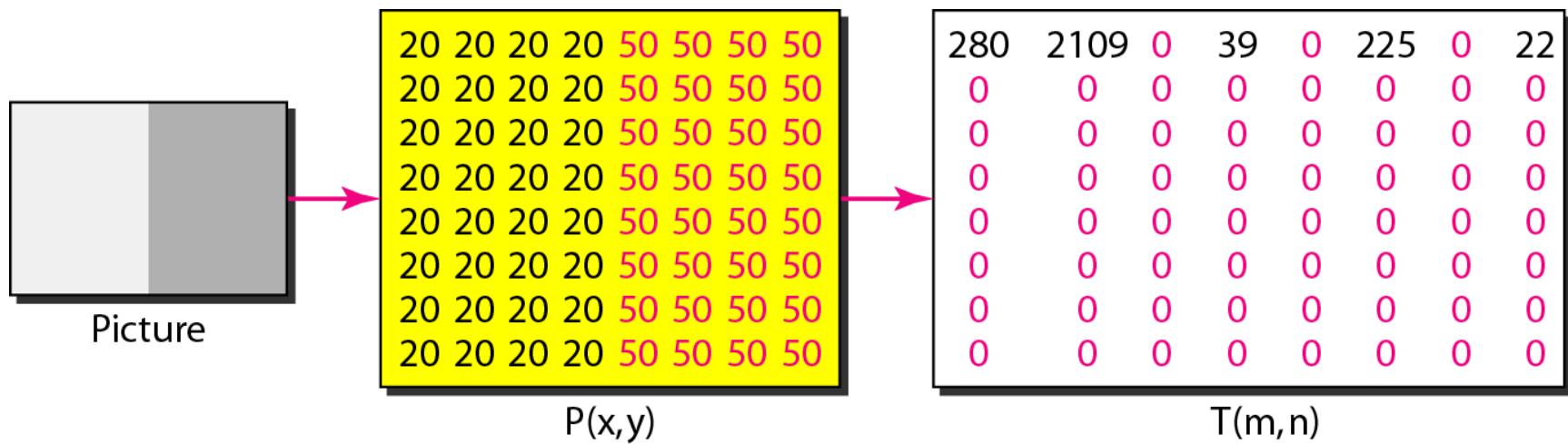


Figure 29.6 Case 3: gradient gray scale

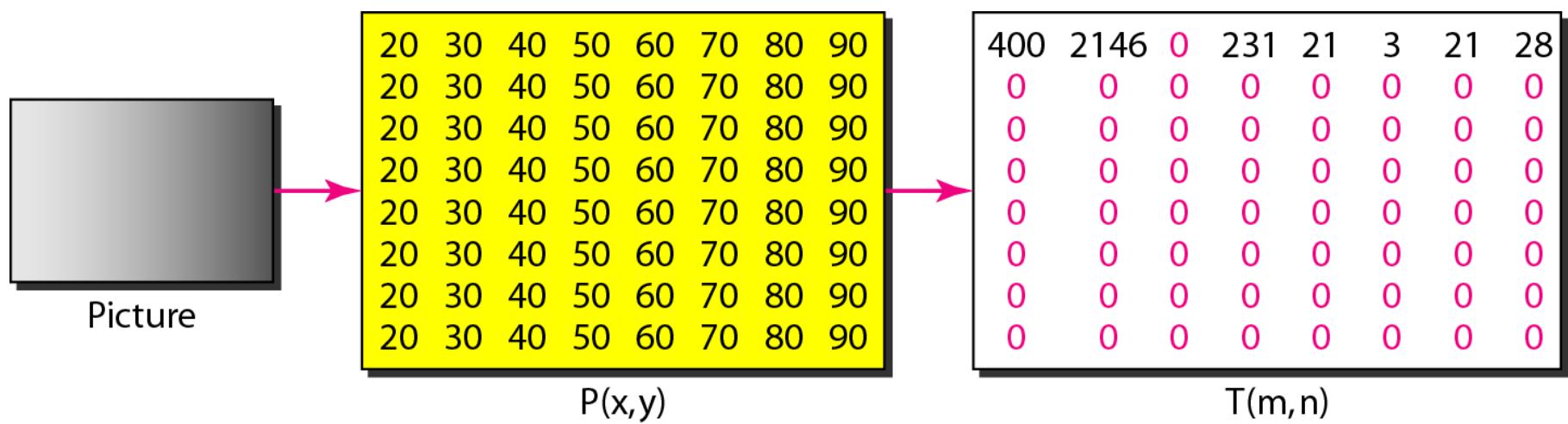


Figure 29.7 *Reading the table*

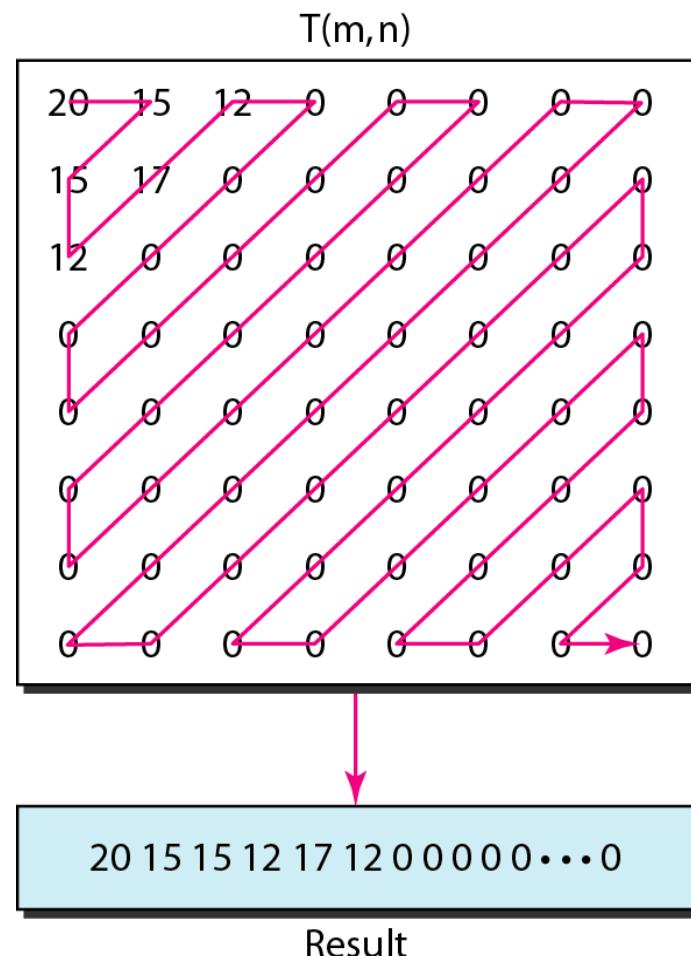


Figure 29.8 *MPEG frames*

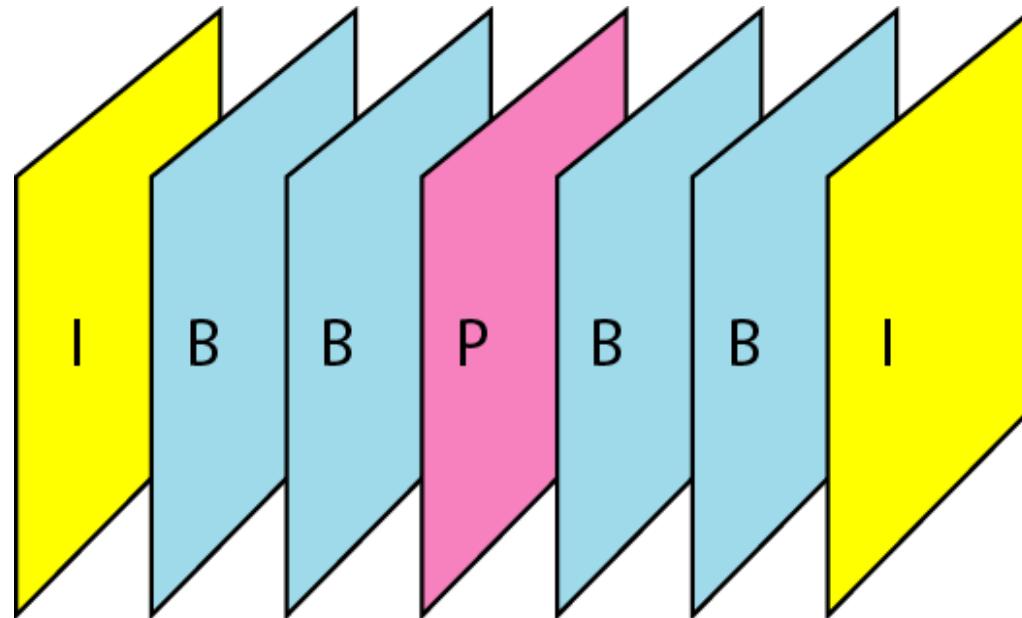
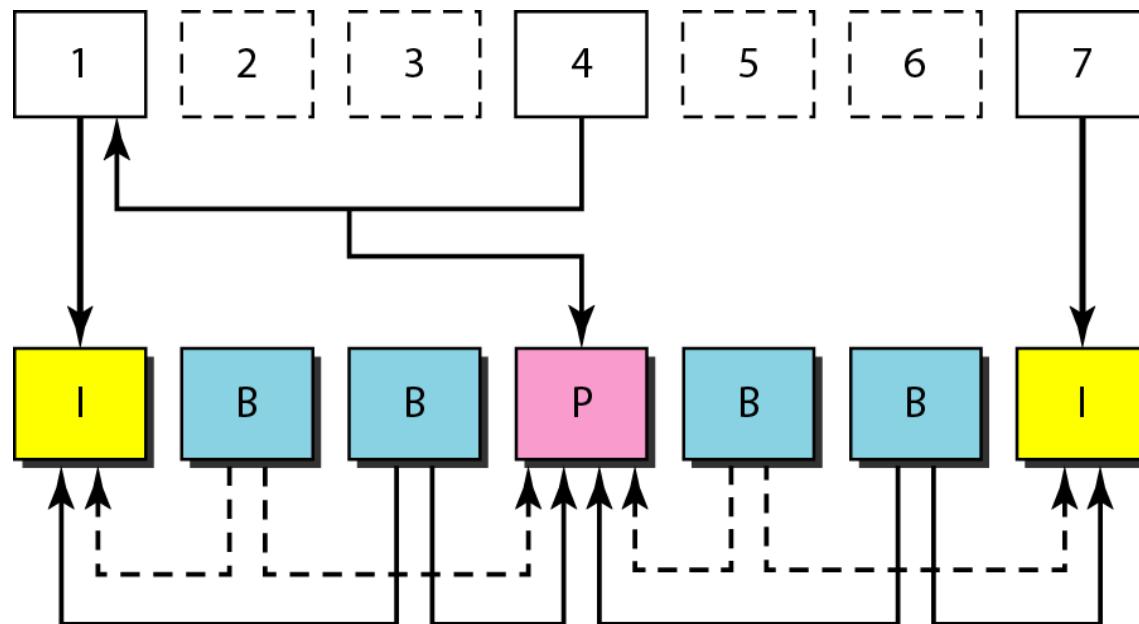


Figure 29.9 *MPEG frame construction*



29-3 STREAMING STORED AUDIO/VIDEO

Now that we have discussed digitizing and compressing audio/video, we turn our attention to specific applications. The first is streaming stored audio and video.

Topics discussed in this section:

First Approach: Using a Web Server

Second Approach: Using a Web Server with a Metafile

Third Approach: Using a Media Server

Fourth Approach: Using a Media Server and RTSP

Figure 29.10 *Using a Web server*

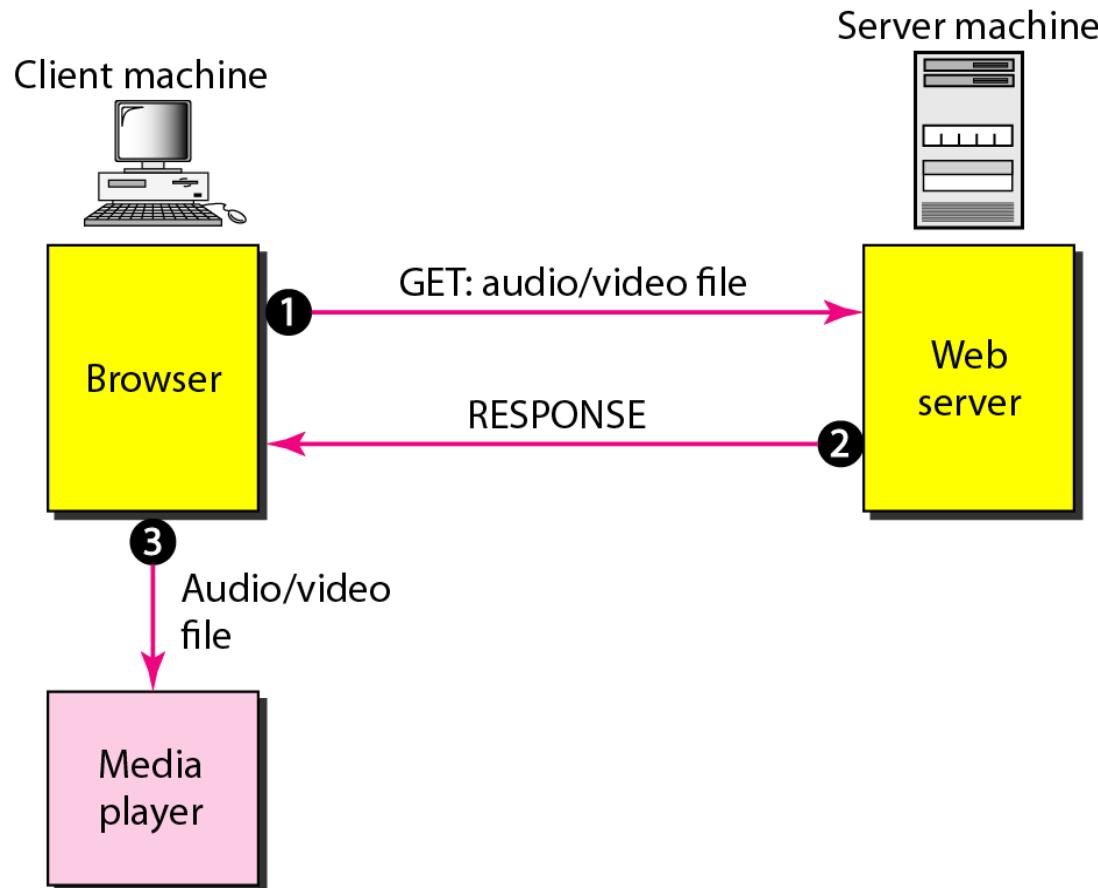


Figure 29.11 *Using a Web server with a metafile*

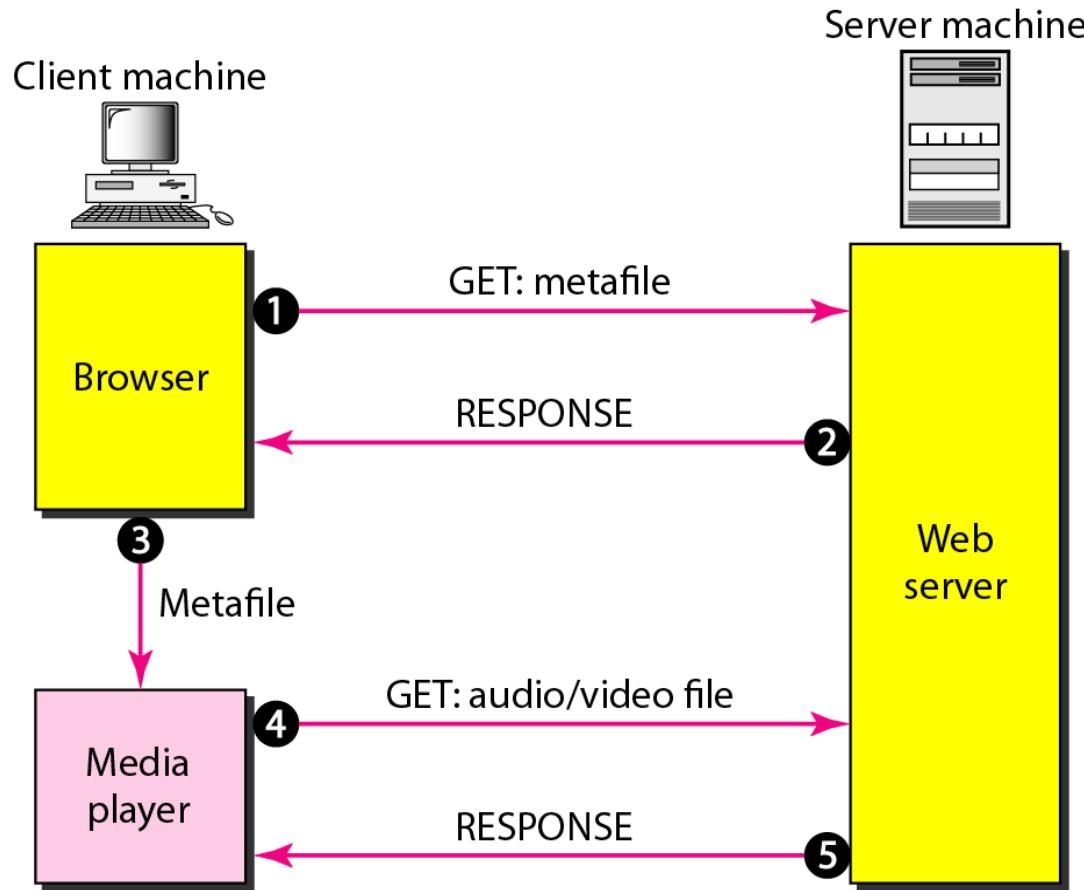


Figure 29.12 Using a media server

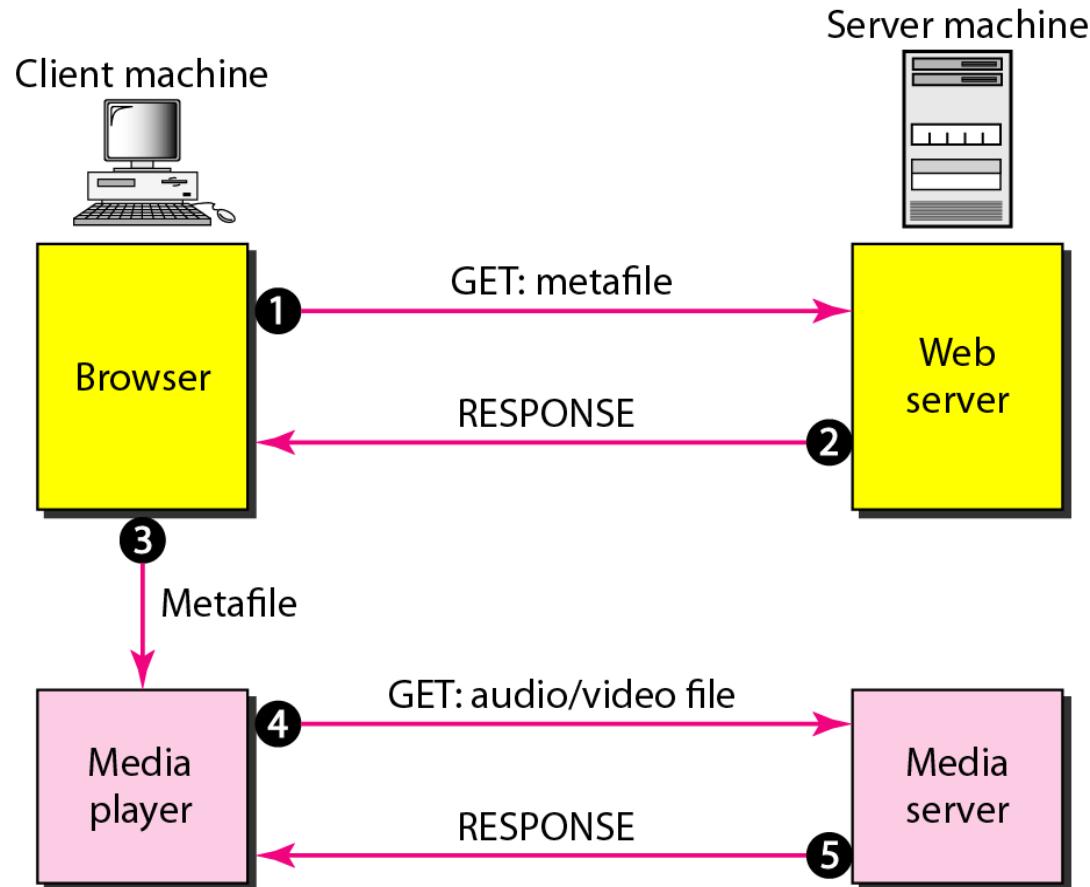
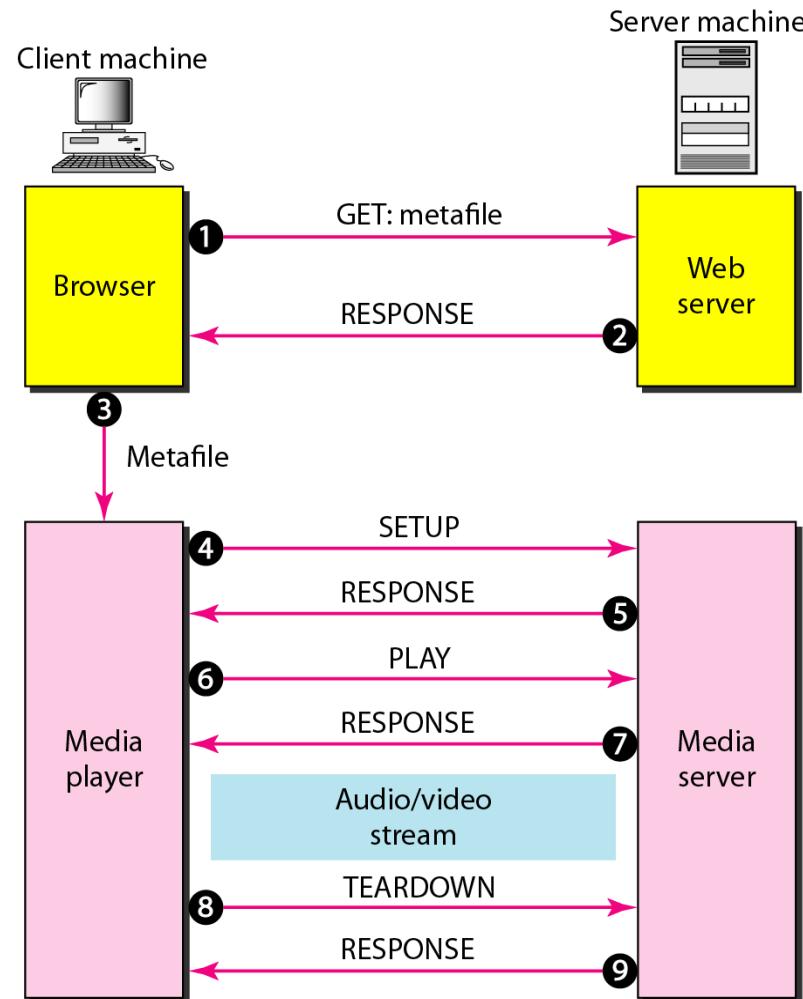


Figure 29.13 Using a media server and RTSP



29-4 STREAMING LIVE AUDIO/VIDEO

Streaming live audio/video is similar to the broadcasting of audio and video by radio and TV stations. Instead of broadcasting to the air, the stations broadcast through the Internet. There are several similarities between streaming stored audio/video and streaming live audio/video. They are both sensitive to delay; neither can accept retransmission. However, there is a difference. In the first application, the communication is unicast and on-demand. In the second, the communication is multicast and live.

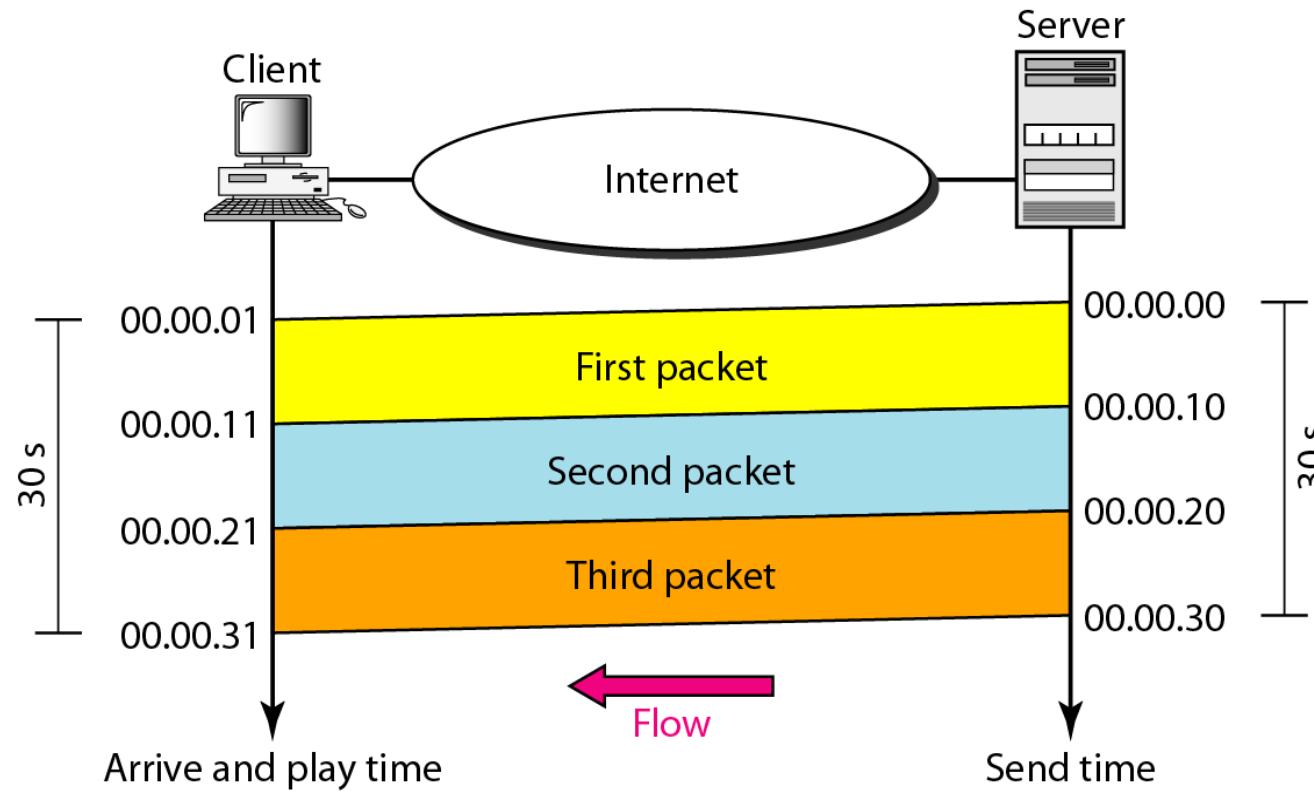
29-5 REAL-TIME INTERACTIVE AUDIO/VIDEO

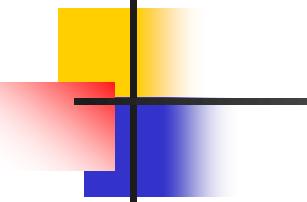
In real-time interactive audio/video, people communicate with one another in real time. The Internet phone or voice over IP is an example of this type of application. Video conferencing is another example that allows people to communicate visually and orally.

Topics discussed in this section:

Characteristics

Figure 29.14 Time relationship





Note

Jitter is introduced in real-time data by the delay between packets.

Figure 29.15 Jitter

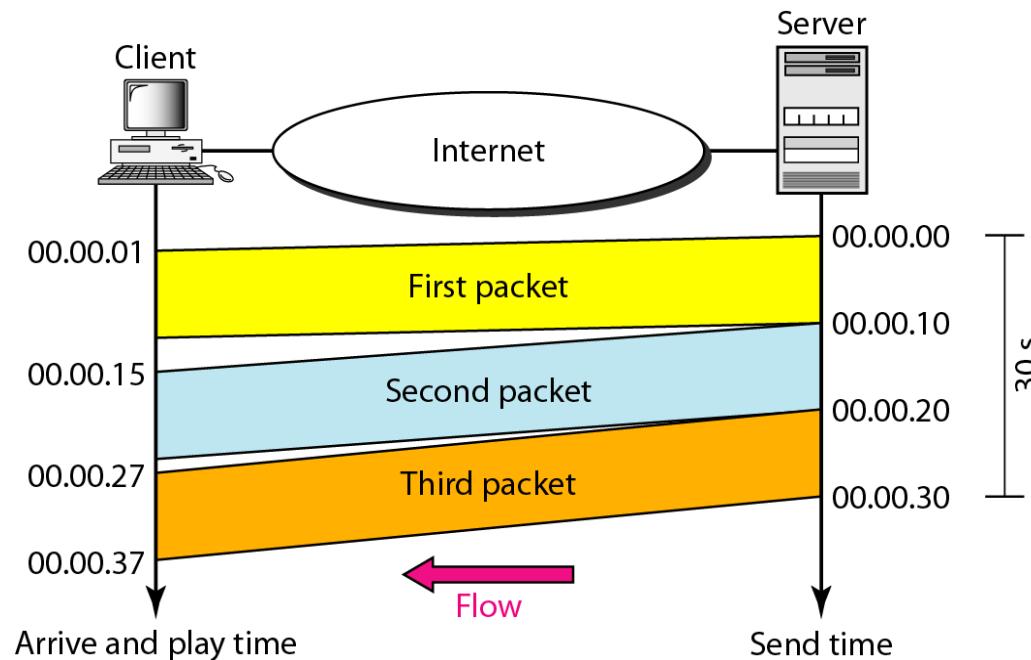
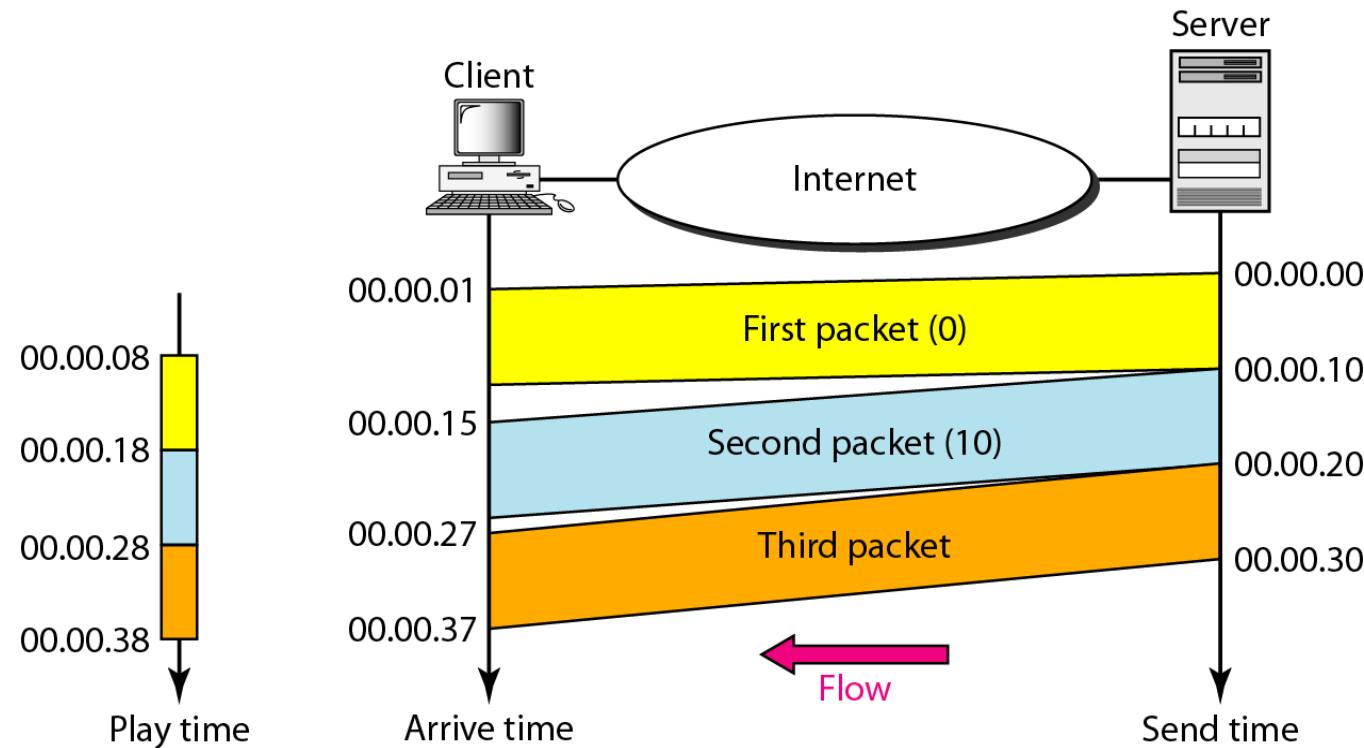
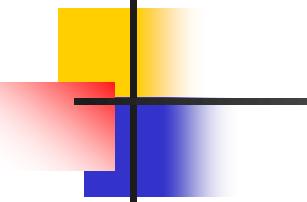


Figure 29.16 Timestamp

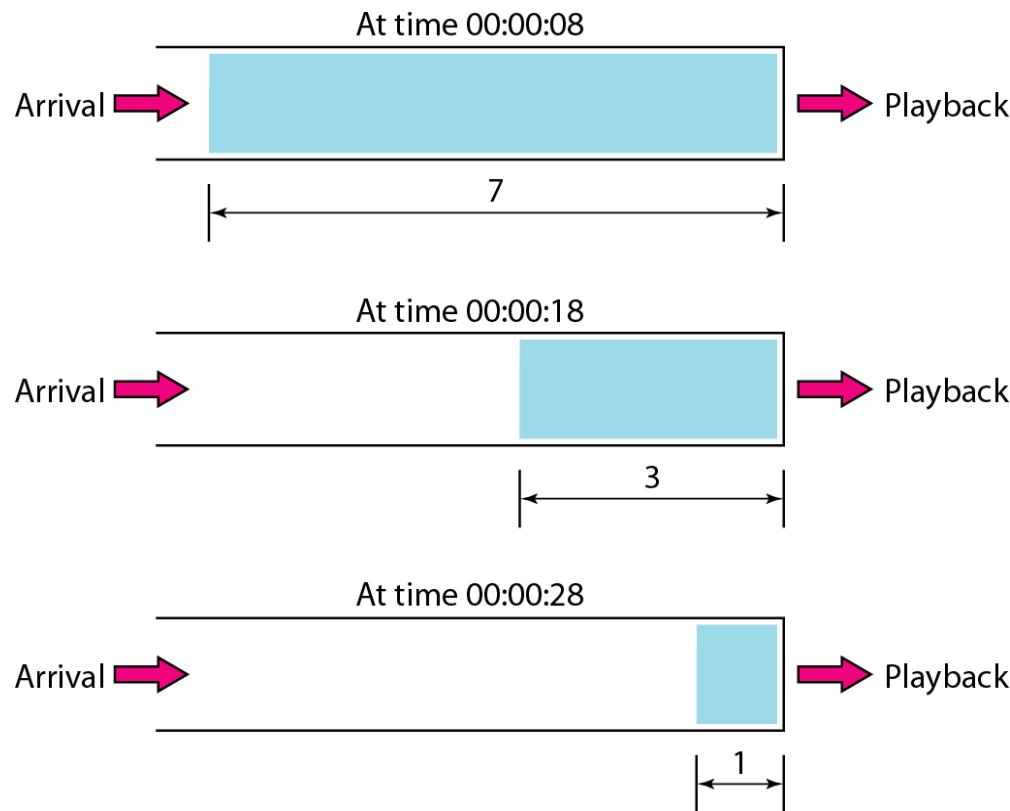


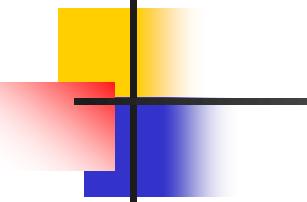


Note

To prevent jitter, we can time-stamp the packets and separate the arrival time from the playback time.

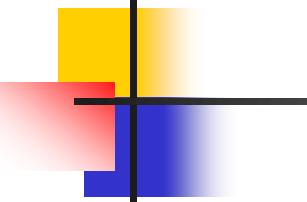
Figure 29.17 *Playback buffer*





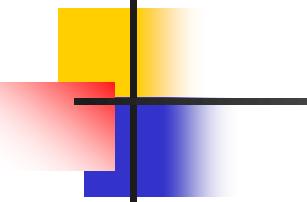
Note

A playback buffer is required for real-time traffic.



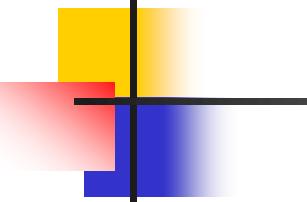
Note

A sequence number on each packet is required for real-time traffic.



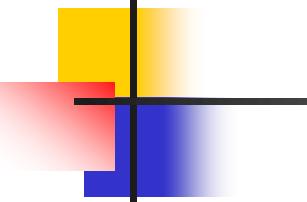
Note

**Real-time traffic needs the support of
multicasting.**



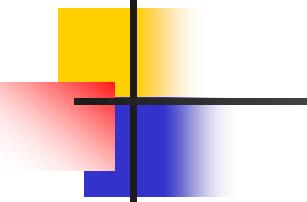
Note

Translation means changing the encoding of a payload to a lower quality to match the bandwidth of the receiving network.



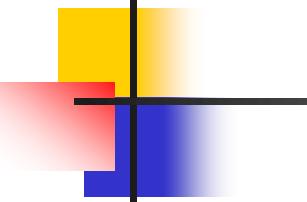
Note

Mixing means combining several streams of traffic into one stream.



Note

TCP, with all its sophistication, is not suitable for interactive multimedia traffic because we cannot allow retransmission of packets.



Note

UDP is more suitable than TCP for interactive traffic. However, we need the services of RTP, another transport layer protocol, to make up for the deficiencies of UDP.

29-6 RTP

Real-time Transport Protocol (RTP) is the protocol designed to handle real-time traffic on the Internet. RTP does not have a delivery mechanism; it must be used with UDP. RTP stands between UDP and the application program. The main contributions of RTP are time-stamping, sequencing, and mixing facilities.

Topics discussed in this section:

RTP Packet Format

UDP Port

Figure 29.18 RTP

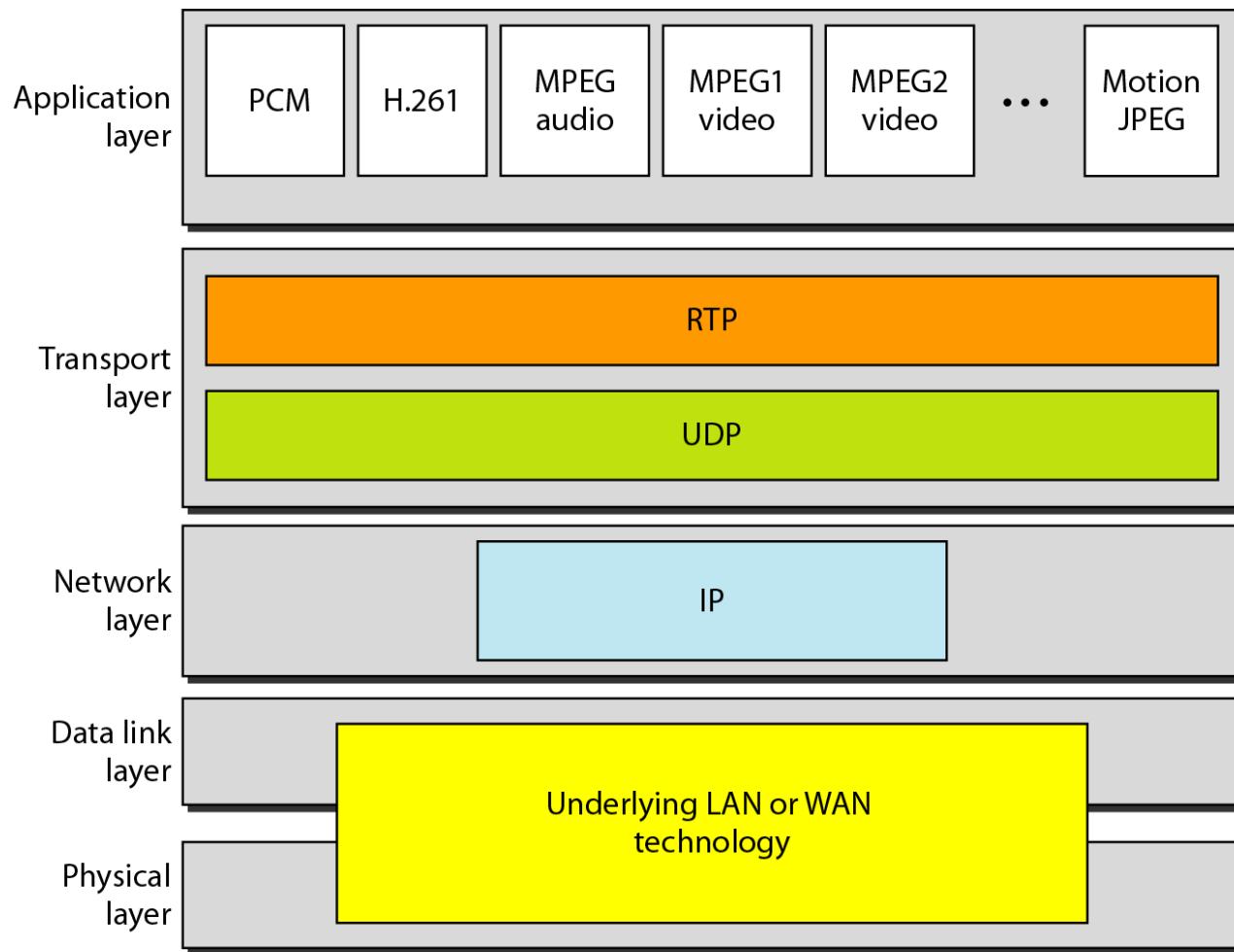


Figure 29.19 RTP packet header format

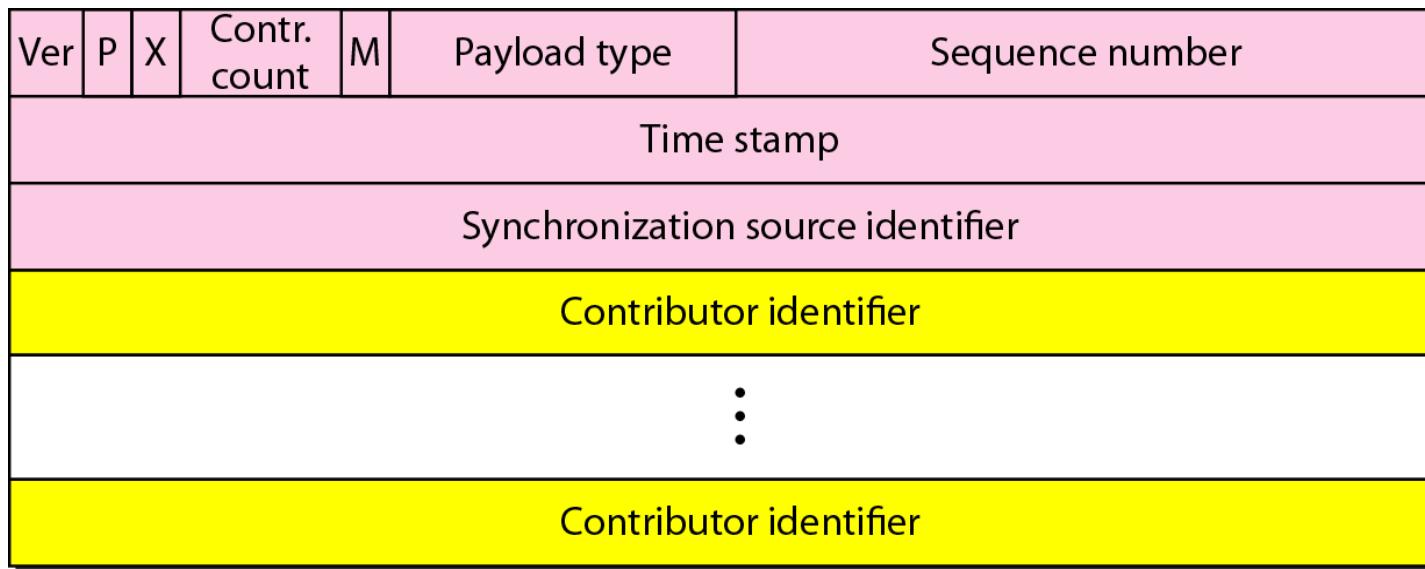
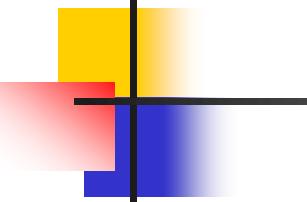


Table 20.1 *Payload types*

Type	Application	Type	Application	Type	Application
0	PCM μ Audio	7	LPC audio	15	G728 audio
1	1016	8	PCMA audio	26	Motion JPEG
2	G721 audio	9	G722 audio	31	H.261
3	GSM audio	10–11	L16 audio	32	MPEG1 video
5–6	DV14 audio	14	MPEG audio	33	MPEG2 video



Note

RTP uses a temporary even-numbered UDP port.

29-7 RTCP

RTP allows only one type of message, one that carries data from the source to the destination. In many cases, there is a need for other messages in a session. These messages control the flow and quality of data and allow the recipient to send feedback to the source or sources. Real-time Transport Control Protocol (RTCP) is a protocol designed for this purpose.

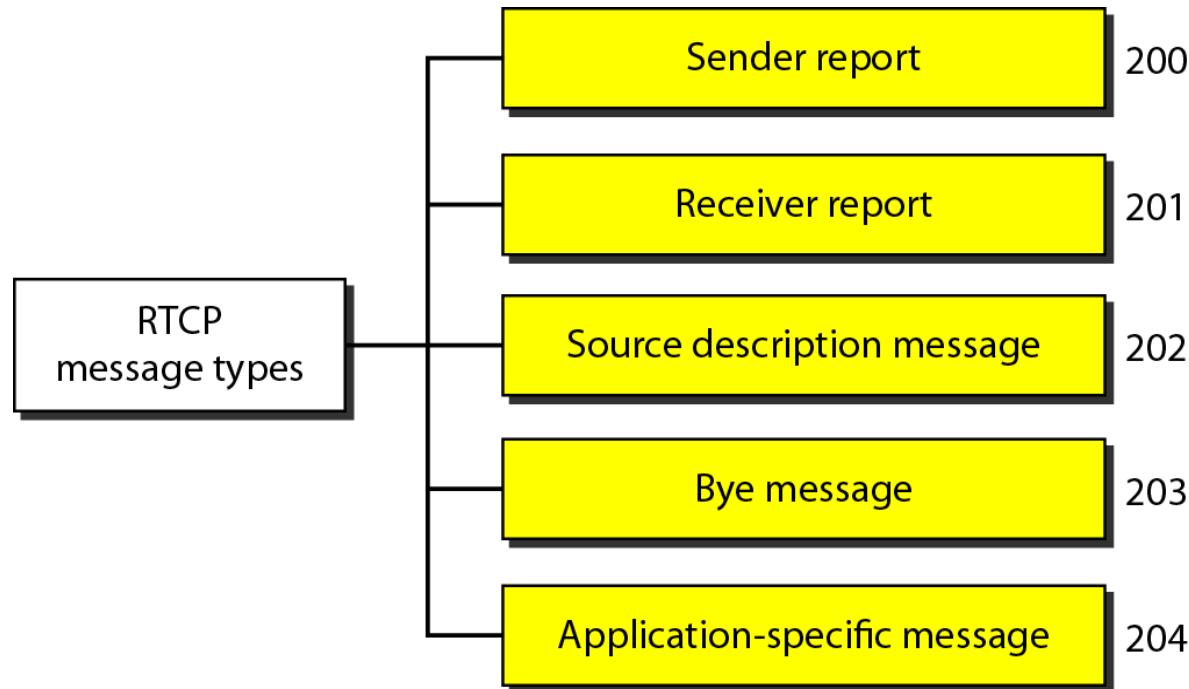
Topics discussed in this section:

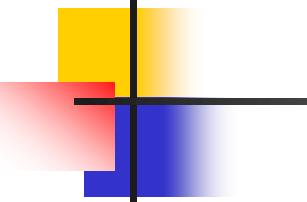
Sender Report and Receiver Report

Messages

UDP Port

Figure 29.20 *RTCP message types*





Note

RTCP uses an odd-numbered UDP port number that follows the port number selected for RTP.

29-8 VOICE OVER IP

Let us concentrate on one real-time interactive audio/video application: voice over IP, or Internet telephony. The idea is to use the Internet as a telephone network with some additional capabilities. Two protocols have been designed to handle this type of communication: SIP and H.323.

Topics discussed in this section:

SIP

H.323

Figure 29.21 *SIP messages*

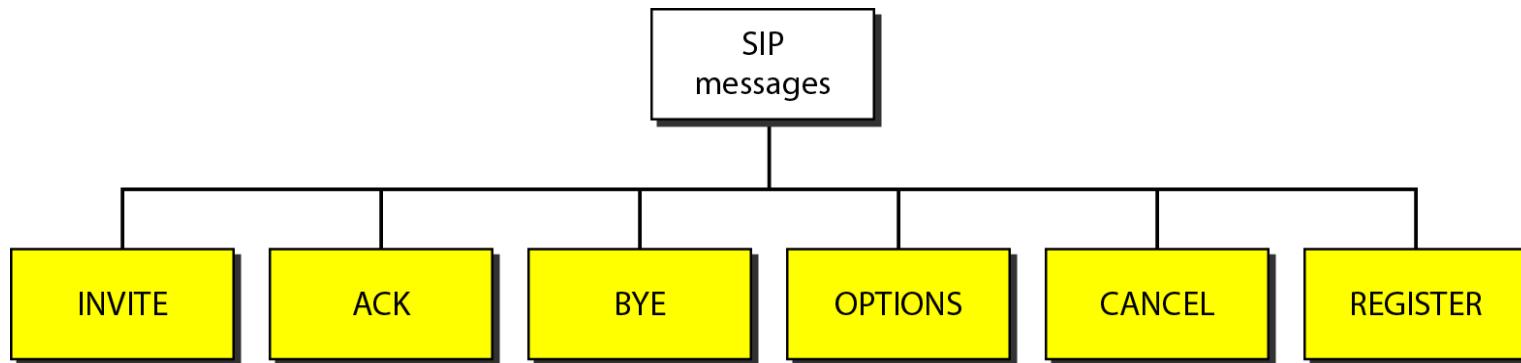


Figure 29.22 SIP formats



Figure 29.23 SIP simple session

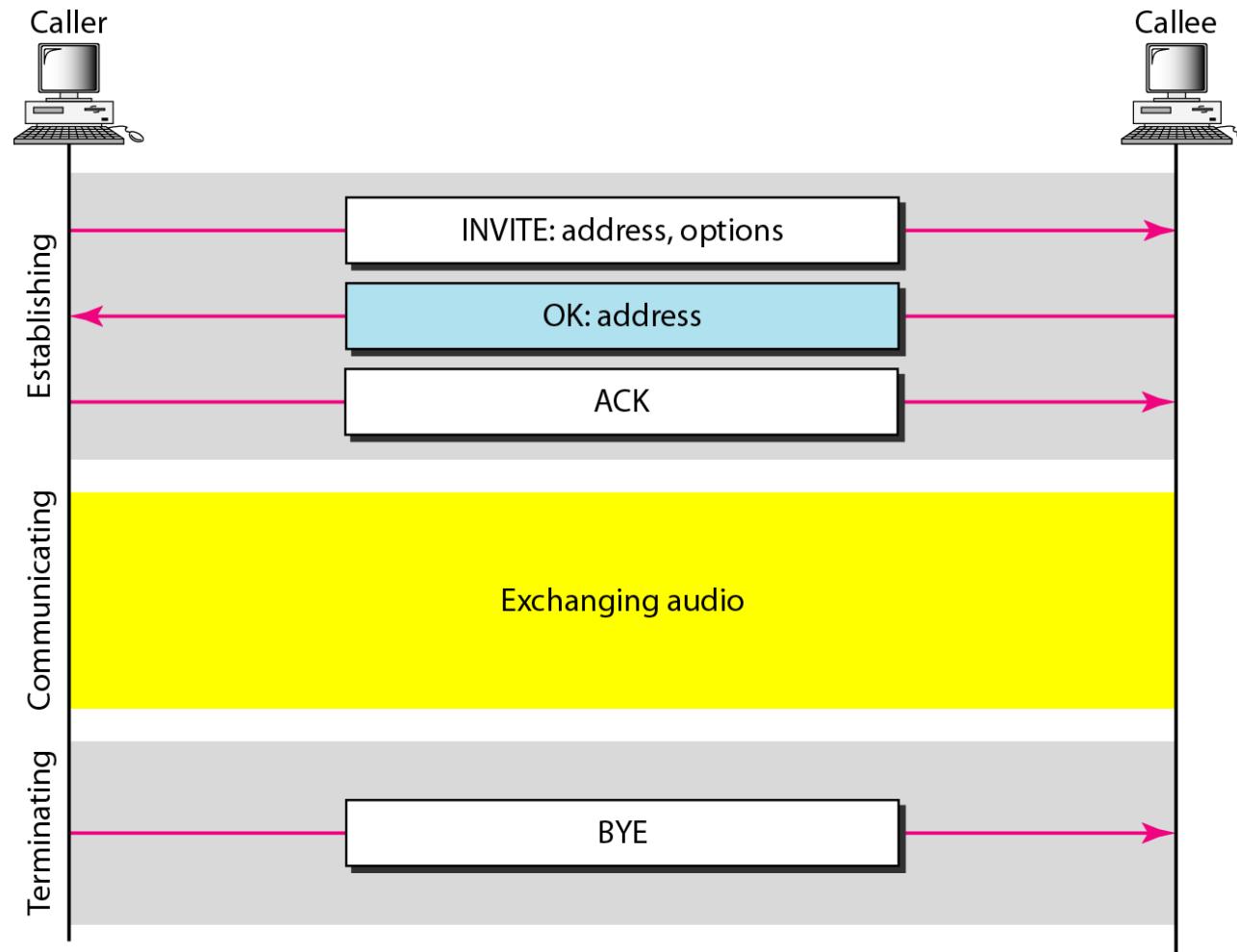


Figure 29.24 Tracking the callee

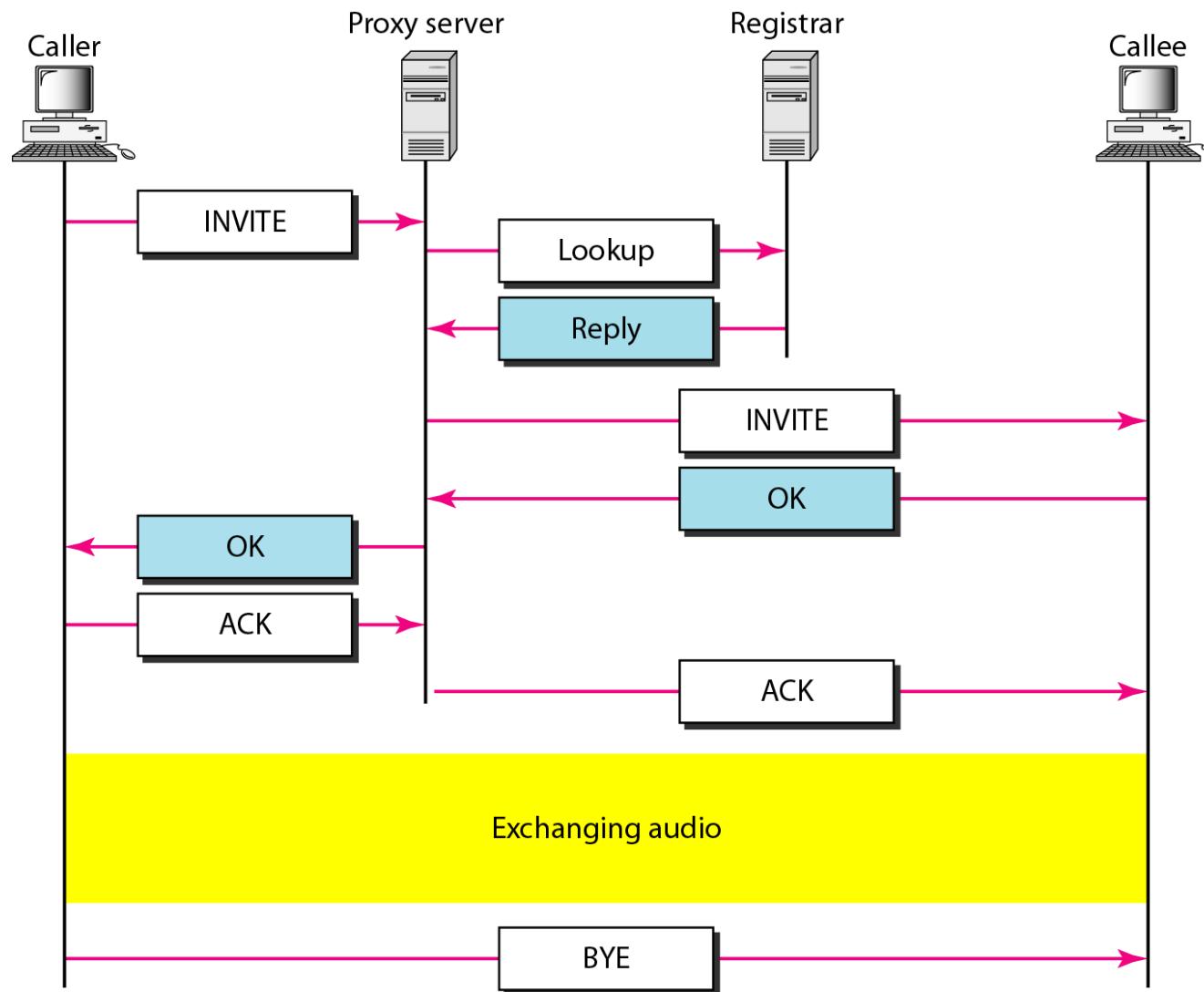


Figure 29.25 H.323 architecture

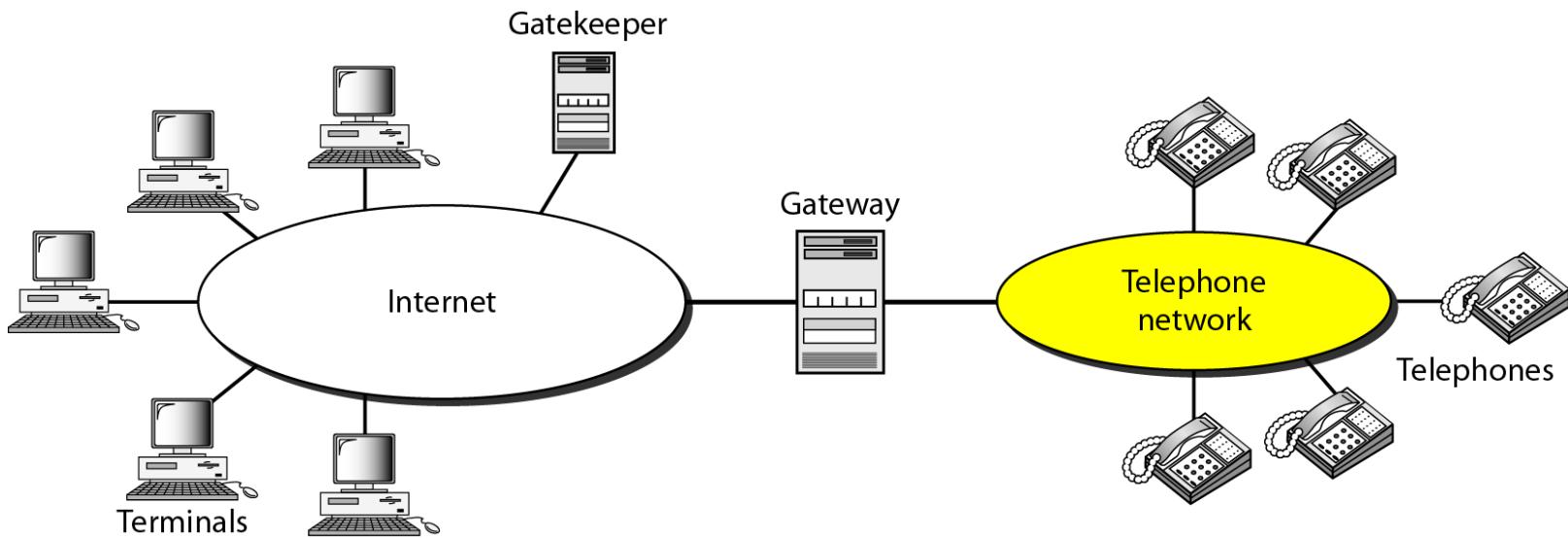


Figure 29.26 *H.323 protocols*

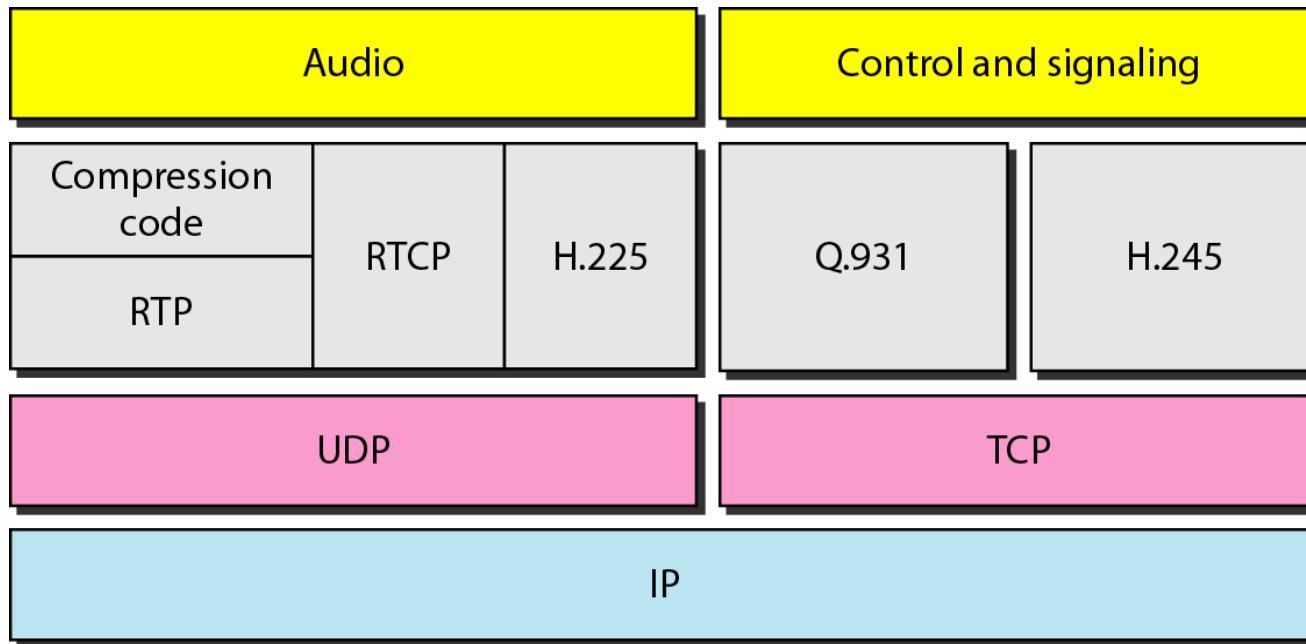


Figure 29.27 H.323 example

