

第20章 多媒体的传输





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20.1.1 多媒体应用协议套

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第20章 多媒体的传输

- 在IP网上传输声音和影视的研究和开发已成为网络应用的重要方向。
- 多媒体应用的主要问题是**如何保障实时多媒体数据的传输质量**，尤其是对那些实时互动的应用。
- 保障传输质量的技术集中体现在多媒体传输协议和控制协议上



20.1 多媒体应用协议套

- 在IP网上的多媒体应用有两种类型的协议
 - 会话协议
两台设备或两个站点之间的持续连接和多媒体数据交换
 - 信令协议
通信双方建立和控制连接所需信息的交换方法



20.1 多媒体应用协议套

■ 20.1.1 多媒体应用协议套

- 数据传送服务：对数据的时延要求不高
- 多媒体应用：时延短和抖动小

在IP网络上，支持实时视听数据传输的协议构成了多媒体应用协议套



20.1 多媒体应用协议套

- (1) 实时传输协议(Real-time Transport Protocol, RTP)
 - ◆ 位于应用层和UDP之间, 用于传输包括声音和影视等实时数据的协议。

- (2) 实时控制协议(Real-Time Control Protocol, RTCP)
 - ◆ 与实时协议(RTP)一起工作的传输控制协议, 用于在发送者和接收者之间交换控制实时数据传输的消息。

- (3) 实时流播协议(Real-Time Streaming Protocol, RTSP)
 - ◆ 网上传输实时、现场的或存储的声音、影视和三维动画的控制协议



20.1 多媒体应用协议套

- (4) 资源保留协议(Resource Reservation Protocol, RSVP)
 - ◆ IETF核准的为“带宽按需调配”开发的传输协议。

- (5) 会话启动协议(Session Initiation Protocol, SIP)
 - ◆ 在IP网上建立呼叫的协议。

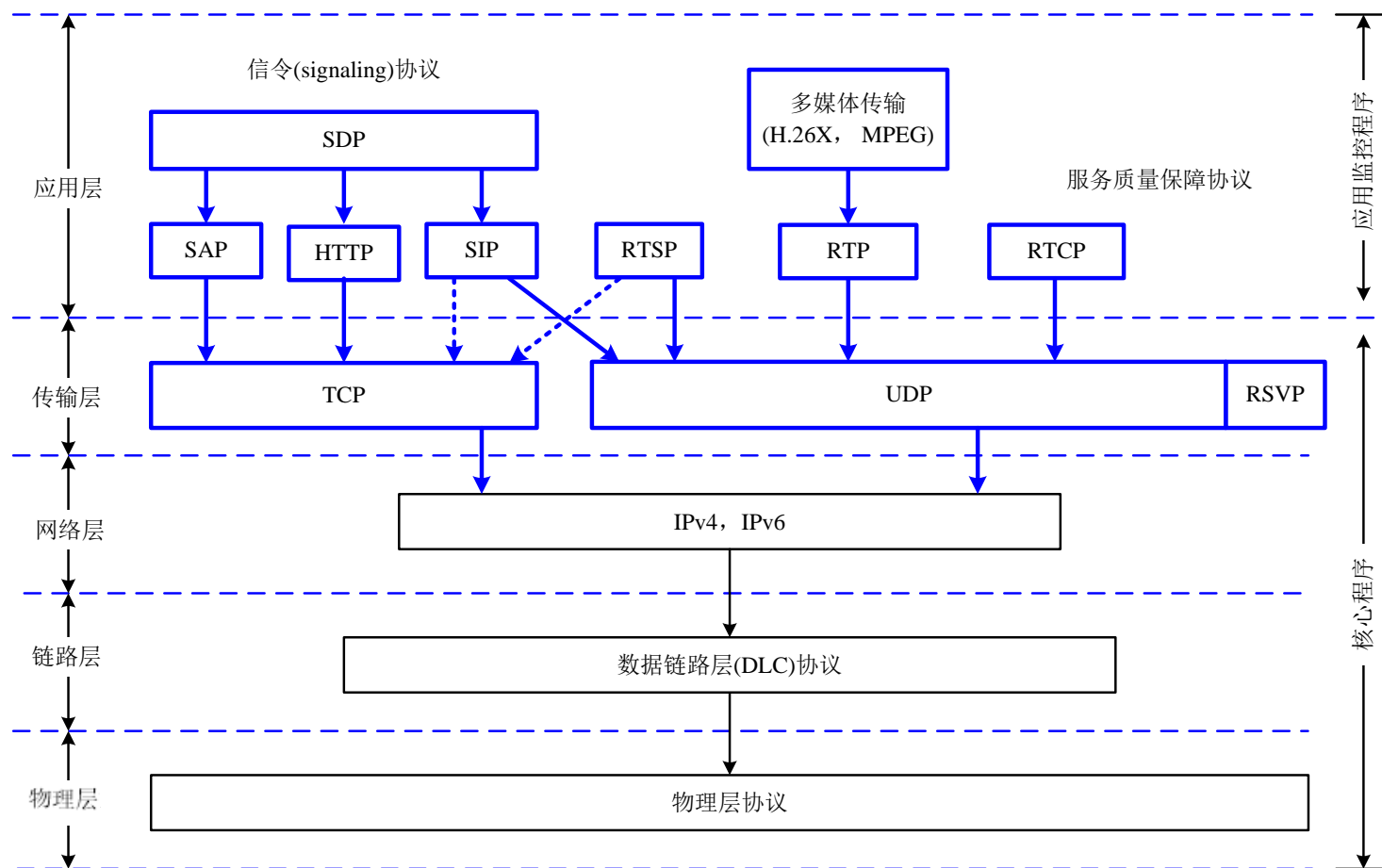
- (6) 会话描述协议(Session Description Protocol, SDP)
 - ◆ 描述流媒体初始化参数的格式



20.1 多媒体应用协议套

- (7) 会话通告协议(Session Announcement Protocol, SAP)
 - ◆ 用于向参与多目标广播(multicast)的潜在主机发布广播会话消息。
- 以上这些重要协议构成的协议套也称互联网多媒体协议套(Internet multimedia protocol stack)

多媒体应用协议套



多媒体应用协议套是TCP/IP协议套中的一部分



20.2 实时传输和控制协议

- 实时传输协议(RTP)和实时控制协议(RTCP)是为网上传送实时多媒体数据开发的协议
 - RTP提供端对端的实时数据传输服务
 - RTCP协议用于监视和控制实时数据的传输
- RTP和RTCP协议的详细规范定义在RFC 3550(2003)中，并取代1996年发布的RFC 1889



20.2.1 实时传输协议(RTP)

- **实时传输协议(Real-time Transport Protocol, RTP)**
 - 用于通过IP网络传送音频和视频的网络协议，定义了标准的数据包
 - 应用:声音点播(AoD)、影视点播(VoD)、因特网电话和电视会议等
 - 提供端对端的实时声音和视像数据的传输，而对声音和视像数据的压缩和编码格式没有限制。

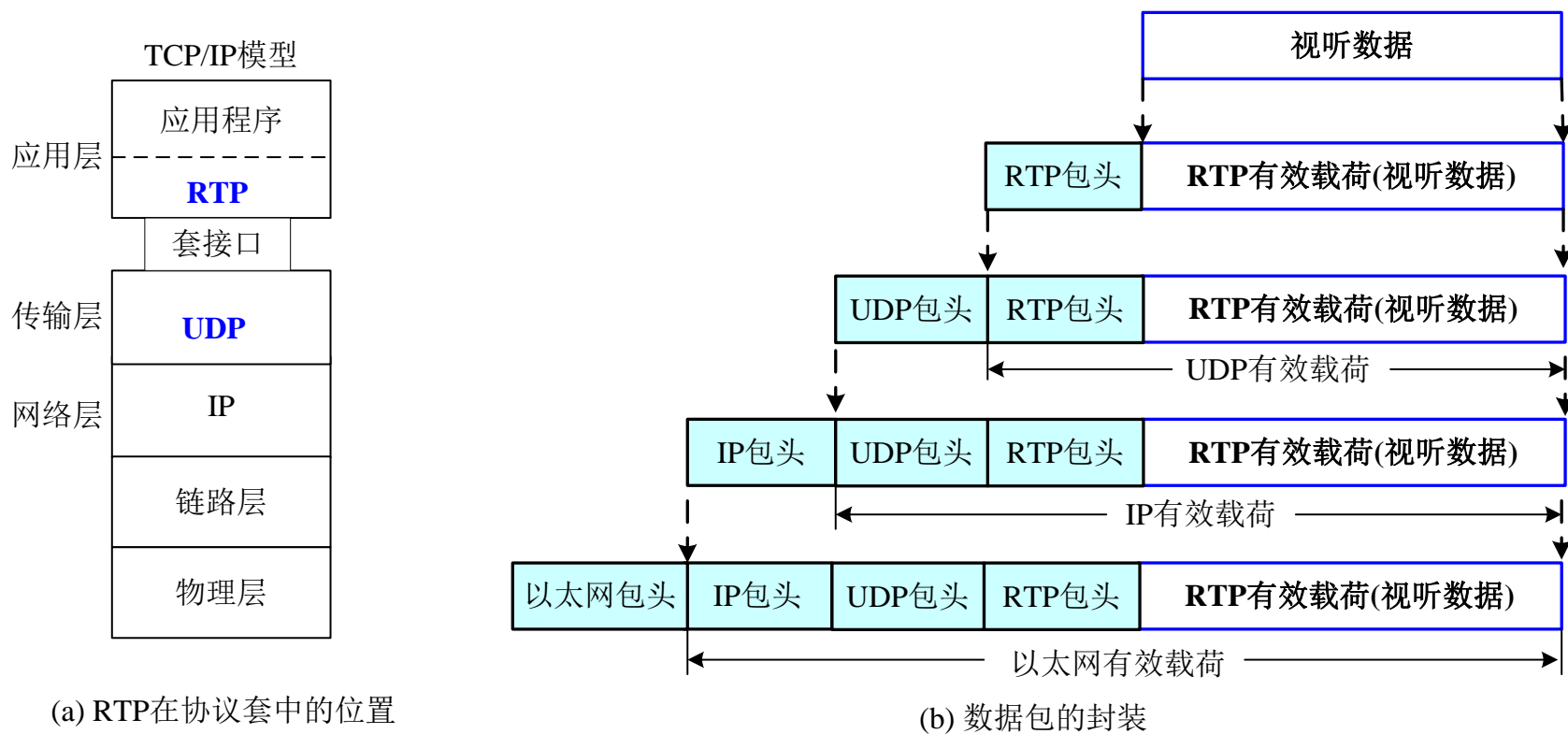


20.2.1 实时传输协议(RTP)

- RTP 为 “实时数据” 的传输协议。
 - 本身不提供任何机制来确保把实时数据及时送到接收端，不保证在递送过程中不丢失数据包，也没有使用防止数据包次序被打乱的方法
 - 提供了减少或消除抖动、视听数据同步和视听数据流复合的方法。
 - RTP协议需要使用RTCP来提高服务质量

20.2.1 实时传输协议(RTP)

➤ RTP协议原理



20.2.1 实时传输协议(RTP)

- RTP包头组成：有效载荷类型、顺序号、时间戳和同步源标识符

0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
V=2	P	X	CC				M	Payload Type(载荷类)								Sequence Number(顺序号)															
Timestamp(时间戳)																															
Synchronization Source (SSRC) Identifier (同步源标识符)																															
Contributing Source (CSRC) Identifiers(贡献源标识符)																															
...																															
Contributing Source (CSRC) Identifiers(贡献源标识符)																															

20.2.1 实时传输协议(RTP)

表20-2 RFC 3551指定的部分声音有效载荷类型

PT	编码名称	*时钟率(Hz)	PT	编码名称	时钟率(Hz)
0	PCM-μ率	8,000	10	L16	44,100
1	保留		11	L16	44,100
2	保留		12	QCELP	8,000
3	GSM	8,000	13	CN	8,000
4	G723	8,000	14	MPEG-Audio	90,000
5	DVI4	8,000	15	G728	8,000
6	DVI4	16,000	16	DVI4	11,025
7	LPC	8,000	17	DVI4	22,050
8	PCM-A率	8,000	18	G729	8,000
9	G722	8,000	19	保留	

* 时钟率用于产生时间戳

20.2.1 实时传输协议(RTP)

表20-3 RFC 3551指定的部分视像有效载荷类型

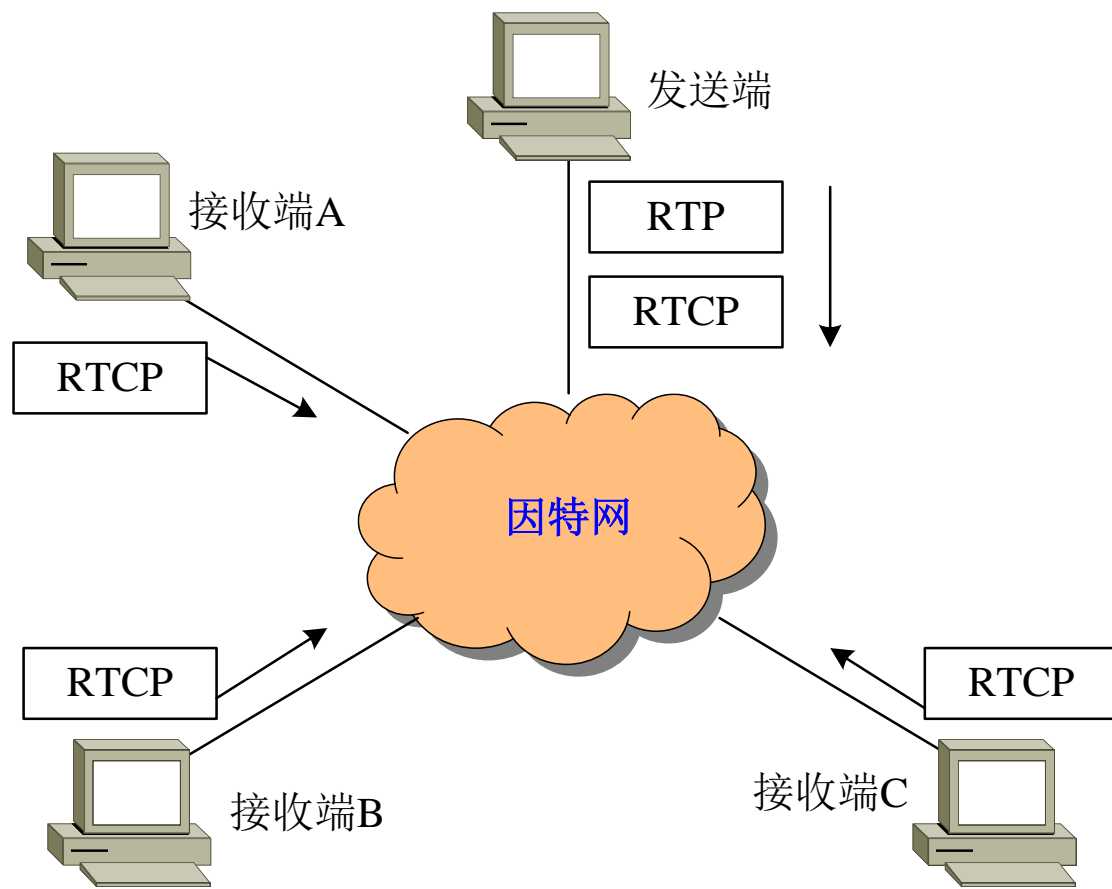
PT	编码名称	媒体类型	时钟率(Hz)	注释
26	JPEG	V	90,000	
27	未指定	V		
28	nv	V	90,000	Sun公司的专有格式
29	未指定	V		
30	未指定	V		
31	H261	V	90,000	
32	MPV	V	90,000	MPEG-1和-2
33	MP2T	AV	90,000	MPEG-2传输流
34	H263	V	90,000	
* 在35-127中, 有些作为保留、未指定或动态指定				



20.2.2 实时控制协议(RTCP)

- **实时控制协议(Real-Time Control Protocol, RTCP)**
 - 主要功能:为收发两端的应用程序提供有关会话传送质量的数据包
 - 每个RTCP数据包不是封装声音数据或视像数据，而是封装收发两端的统计信息。
 - RTCP规范没有指定应用程序如何使用控制数据包中的信息，这完全取决于应用程序开发人员

20.2.2 实时控制协议(RTCP)



每个参与者周期性地发送RTCP控制数据包



20.2.2 实时控制协议(RTCP)

- RTCP数据包的5种类型
 - (1) SR(Sender report)—发送者报告
 - ◆ 实时数据的传送摘要，包括RTP流的同步源标识符，当前的时间，发送的数据包数目和发送的字节数等
 - (2) RR(Receiver report)—接收者报告
 - ◆ 包括丢失的数据包、最后接收到的顺序号和平均的抖动间隔等统计信息



20.2.2 实时控制协议(RTCP)

- (3) SDES(Source description items)—RTP源描述项
 - ◆ 包含标识RTP源的标识符，称为“规范名称(canonical name，简称为CNAME)”。
- (4) BYE(Goodbye)—再见；
- (5) APP(Application-specific functions)—特定应用功能。



20.3 实时流播协议 (RTSP)

- **实时流播协议(Real-Time Streaming Protocol, RTSP)**
 - 在应用层用来控制RTP会话的协议，用于控制实时多媒体数据在网上的传输
 - 可为客户端的媒体播放器提供远程控制功能，如暂停、快播和从头开始播放。
 - 大多数情况下，RTSP使用TCP协议传送播放器的控制消息，使用UDP协议传送视听数据。

20.3 实时流播协议

- RTSP协议定义了控制媒体流的方法(method), 包括
 - (1) SETUP(设置): 服务器为媒体流配置资源(如存放媒体流的URL), 并启动RTSP会话
 - (2) PLAY(播放): 根据SETUP设置的资源启动数据传输, 开始播放一个或多个媒体流
 - (3) PAUSE(暂停): 暂停播放一个或多个媒体流, 但不释放服务器资源
 - (4) TEARDOWN(终止): 用于终止会话, 释放与流播有关的所有资源。
 - (5) DESCRIBE(描述): 描述视听媒体流。
 - (6) RECORD(录制): 启动流媒体录制功能;
 - (7) ANNOUNCE(通告): 改变媒体对象的描述;
 - (8) REDIRECT(重定向): 告诉客户需要连接到另一个服务器地址



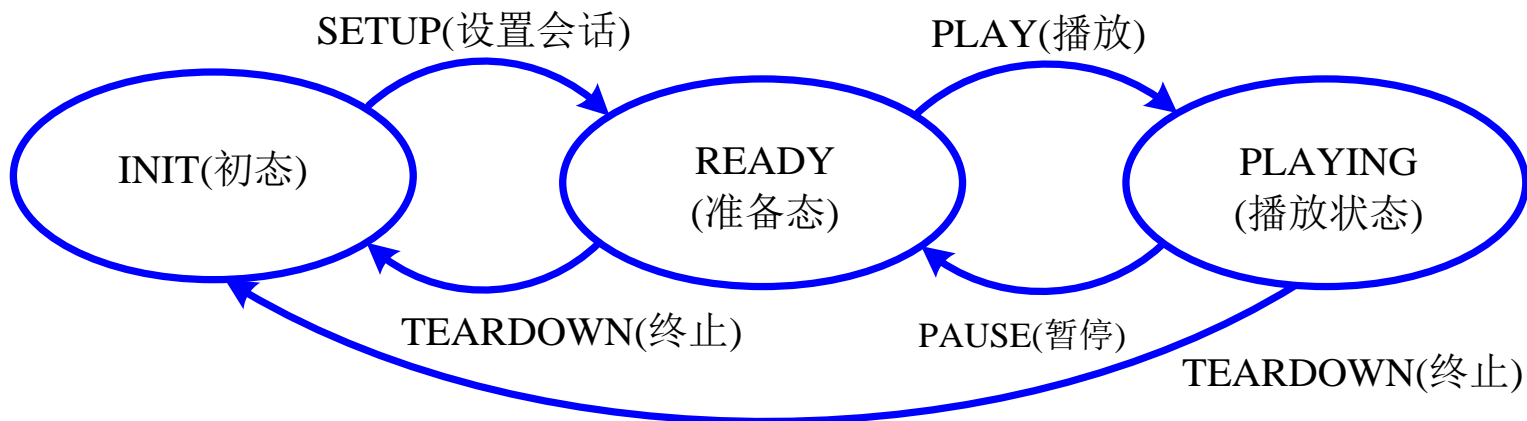
20.3 实时流播协议

■ RTSP协议原理

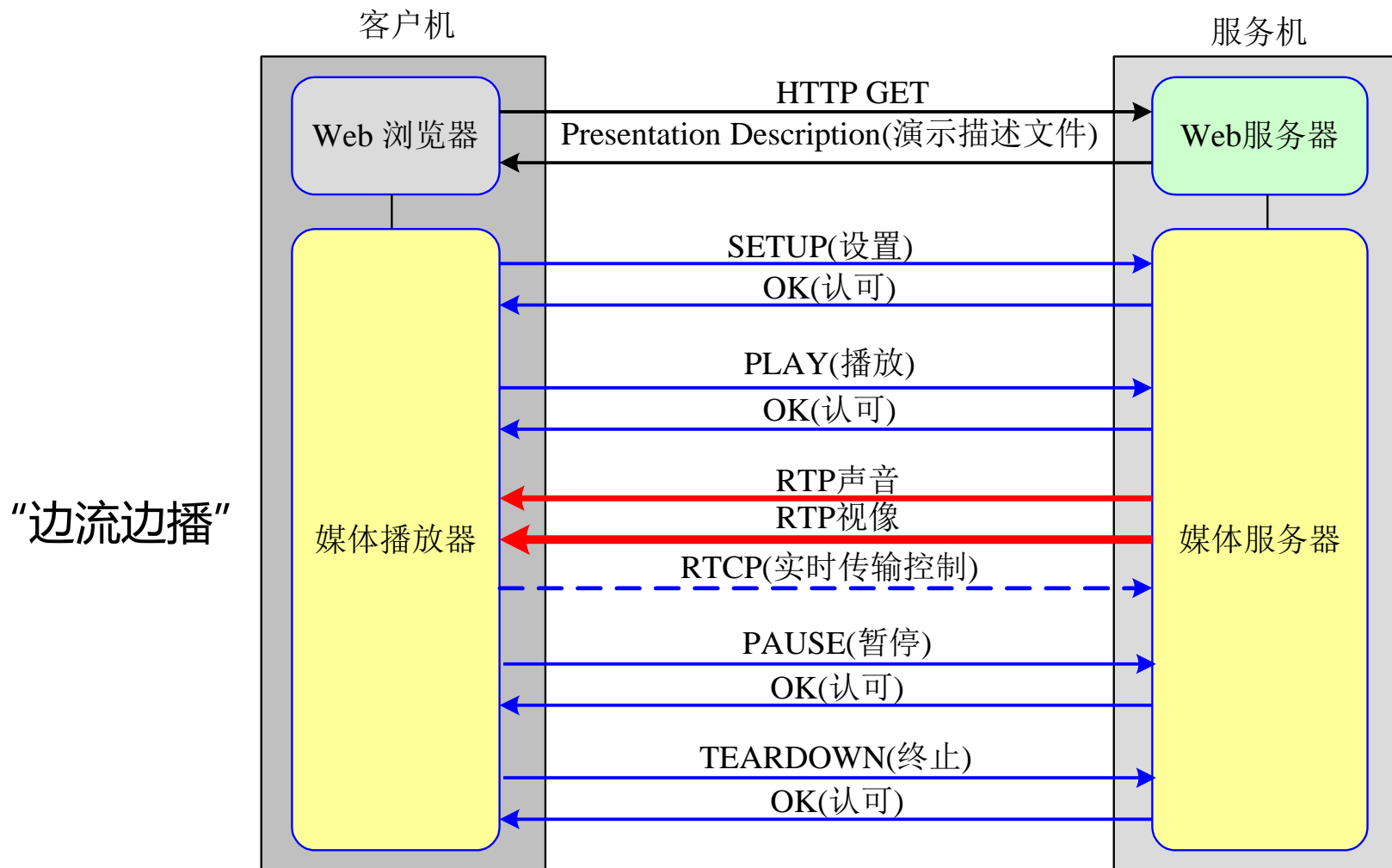
- 执行RTSP协议的程序实际上就是维护客户机和服务机的状态。
- 客户机和服务机都有三个状态
 - (1) INIT(初态): 在客户机和服务机之间没有RTSP会话
 - (2) READY(准备态): 创建RTSP会话, 准备传输数据
 - (3) PLAYING(播放态): 传输和播放流媒体

这些状态之间的转换是通过执行各种方法实现的

20.3 实时流播协议



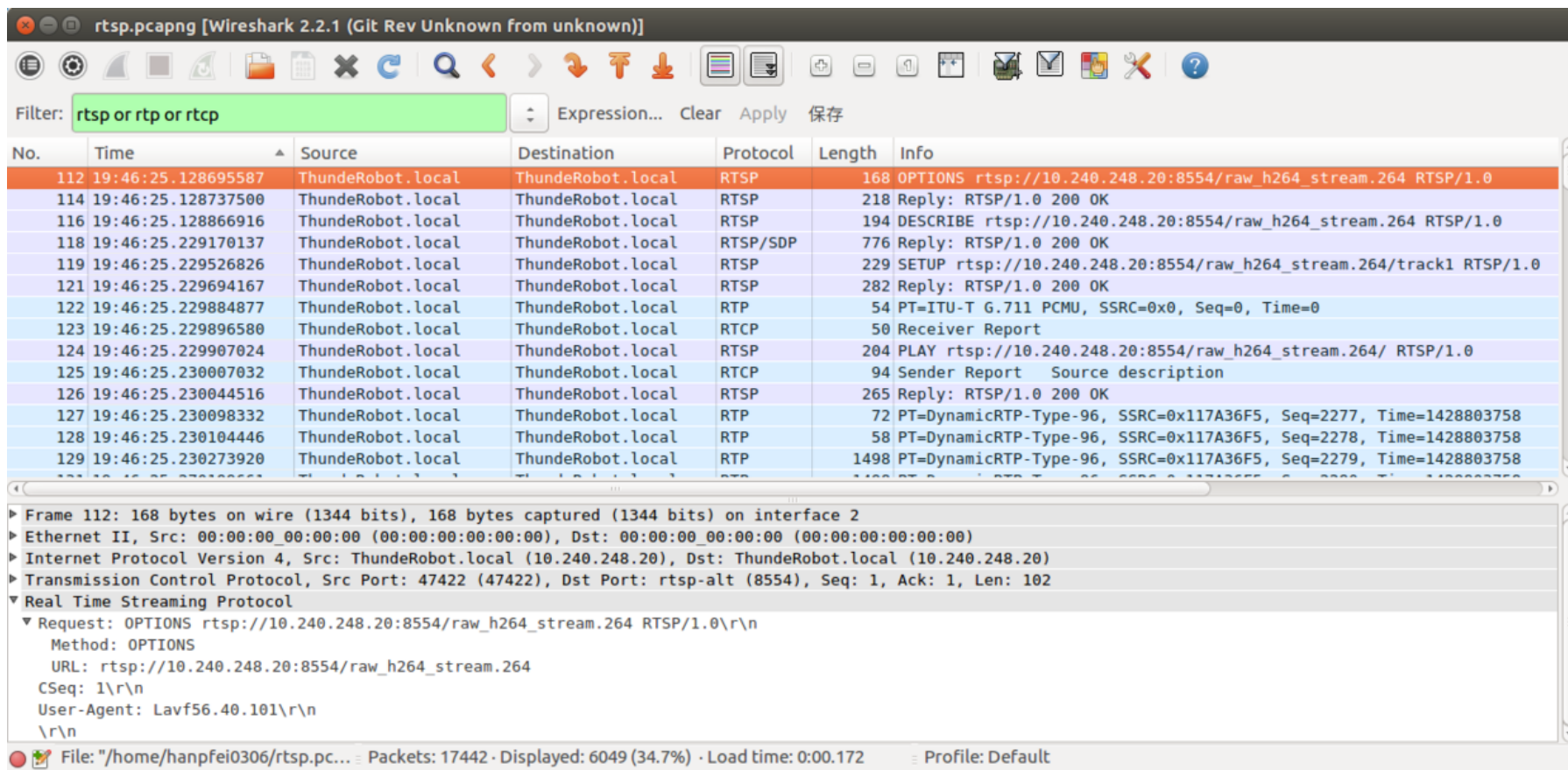
20.3 实时流播协议



20.3 实时流播协议

- (1) 用户通过Web浏览器向Web服务器发送HTTP GET消息, 请求提供视听媒体, 而Web服务器把描述媒体流的“演示描述(presentation description)”文件发送给Web浏览器
- (2) Web浏览器得到响应后打开媒体播放器, 并将描述文件转发给媒体播放器
- (3) 媒体播放器向媒体服务器发送SETUP(设置)请求消息
- (4) 媒体播放器得到媒体服务器的响应后发送PLAY请求消息
- (5) 媒体服务器发送认可消息, 并用RTP/RTCP向媒体播放器发送视听数据
- (6) 如果媒体播放器向媒体服务器发送暂停PAUSE请求, 媒体服务器就暂停传输数据
-
- (n) 媒体播放器发送TEARDOWN请求, 终止RTSP会话

Wireshark 抓包分析 RTSP/RTP/RTCP



启动 Wireshark 抓包。然后通过 ffplay 请求 live555MediaServer 并播放 raw_h264_stream.264, 通过 Display Filter 过滤仅显示 RTSP/RTP/RTCP 包

首先是 RTSP 数据的交互, 建立媒体传输会话, 随后开始通过 RTP/RTCP 传输数据。

来自csdn hanpei's blog

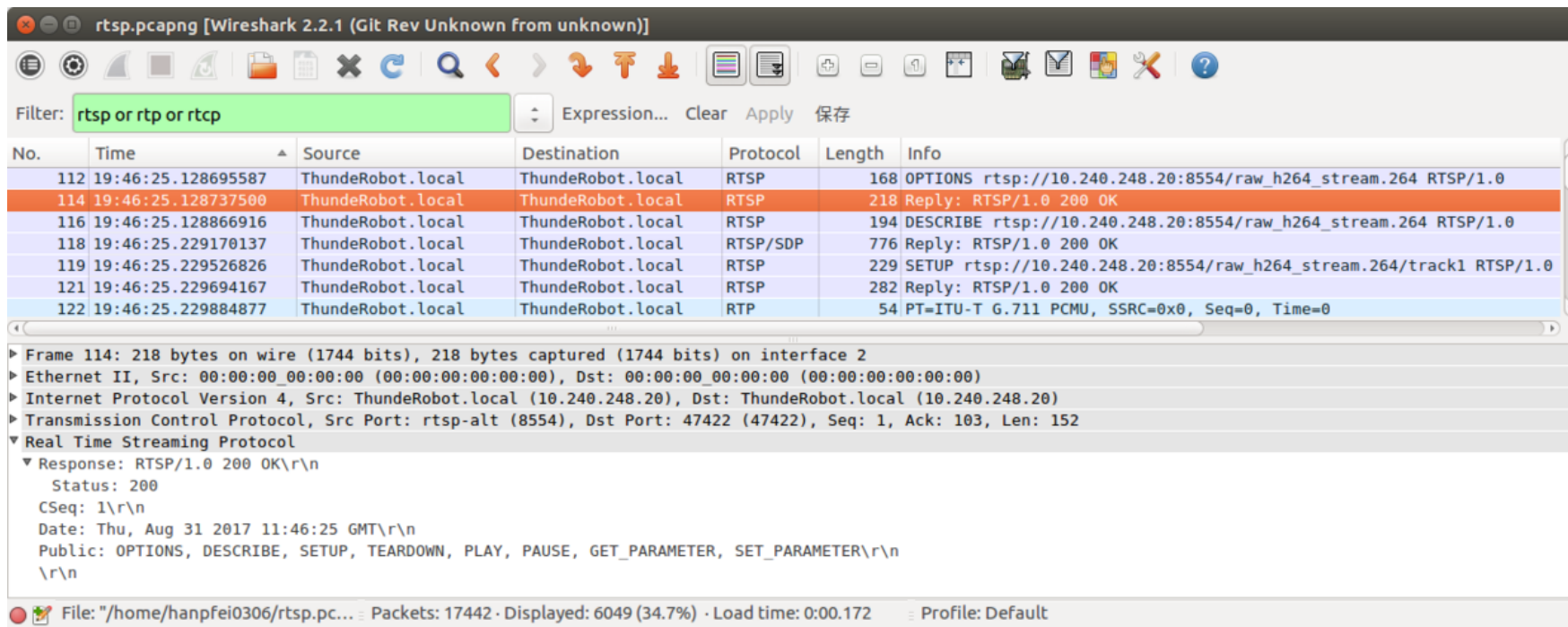
Wireshark 抓包分析 RTSP/RTP/RTCP

RTSP 具体定义的方法

1	method	direction	object	requirement
2	DESCRIBE	C->S	P,S	recommended
3	ANNOUNCE	C->S, S->C	P,S	optional
4	GET_PARAMETER	C->S, S->C	P,S	optional
5	OPTIONS	C->S, S->C	P,S	required
6				(S->C: optional)
7	PAUSE	C->S	P,S	recommended
8	PLAY	C->S	P,S	required
9	RECORD	C->S	P,S	optional
10	REDIRECT	S->C	P,S	optional
11	SETUP	C->S	S	required
12	SET_PARAMETER	C->S, S->C	P,S	optional
13	TEARDOWN	C->S	P,S	required

Wireshark 抓包分析 RTSP/RTP/RTCP

1.客户端首先向服务器发送了一个方法为 OPTIONS 的请求, 如第 112 号包, 携带有 URL, RTSP 版本号, User-Agent 等信息。



The screenshot shows the Wireshark interface with a packet capture filter set to 'rtsp or rtp or rtcp'. The packet list displays several packets, with packet 114 (RTSP Reply: 200 OK) selected. The packet details pane shows the structure of the RTSP response, including status, CSeq, Date, and supported methods.

No.	Time	Source	Destination	Protocol	Length	Info
112	19:46:25.128695587	ThundeRobot.local	ThundeRobot.local	RTSP	168	OPTIONS rtsp://10.240.248.20:8554/raw_h264_stream.264 RTSP/1.0
114	19:46:25.128737500	ThundeRobot.local	ThundeRobot.local	RTSP	218	Reply: RTSP/1.0 200 OK
116	19:46:25.128866916	ThundeRobot.local	ThundeRobot.local	RTSP	194	DESCRIBE rtsp://10.240.248.20:8554/raw_h264_stream.264 RTSP/1.0
118	19:46:25.229170137	ThundeRobot.local	ThundeRobot.local	RTSP/SDP	776	Reply: RTSP/1.0 200 OK
119	19:46:25.229526826	ThundeRobot.local	ThundeRobot.local	RTSP	229	SETUP rtsp://10.240.248.20:8554/raw_h264_stream.264/track1 RTSP/1.0
121	19:46:25.229694167	ThundeRobot.local	ThundeRobot.local	RTSP	282	Reply: RTSP/1.0 200 OK
122	19:46:25.229884877	ThundeRobot.local	ThundeRobot.local	RTP	54	PT=ITU-T G.711 PCMU, SSRC=0x0, Seq=0, Time=0

Frame 114: 218 bytes on wire (1744 bits), 218 bytes captured (1744 bits) on interface 2

- Ethernet II, Src: 00:00:00_00:00:00 (00:00:00:00:00:00), Dst: 00:00:00_00:00:00 (00:00:00:00:00:00)
- Internet Protocol Version 4, Src: ThundeRobot.local (10.240.248.20), Dst: ThundeRobot.local (10.240.248.20)
- Transmission Control Protocol, Src Port: rtsp-alt (8554), Dst Port: 47422 (47422), Seq: 1, Ack: 103, Len: 152
- Real Time Streaming Protocol
 - Response: RTSP/1.0 200 OK\r\n
 - Status: 200
 - CSeq: 1\r\n
 - Date: Thu, Aug 31 2017 11:46:25 GMT\r\n
 - Public: OPTIONS, DESCRIBE, SETUP, TEARDOWN, PLAY, PAUSE, GET_PARAMETER, SET_PARAMETER\r\n\r\n

File: "/home/hanpei0306/rtsp.pc... Packets: 17442 · Displayed: 6049 (34.7%) · Load time: 0:00.172 Profile: Default

2.服务器将该 URL 支持的方法的列表返回给客户端, 即OPTIONS, DESCRIBE, SETUP, TEARDOWN, PLAY, PAUSE, GET_PARAMETER, SET_PARAMETER

Wireshark 抓包分析 RTSP/RTP/RTCP

3.客户端向服务器发送了一个 DESCRIBE 请求，即第 116 号包

rtsp.pcapng [Wireshark 2.2.1 (Git Rev Unknown from unknown)]

Filter: `rtsp or rtp or rtcp` Expression... Clear Apply 保存

No.	Time	Source	Destination	Protocol	Length	Info
112	19:46:25.128695587	ThundeRobot.local	ThundeRobot.local	RTSP	168	OPTIONS rtsp://10.240.248.20:8554/raw_h264_stream.264 RTSP/1.0
114	19:46:25.128737500	ThundeRobot.local	ThundeRobot.local	RTSP	218	Reply: RTSP/1.0 200 OK
116	19:46:25.128866916	ThundeRobot.local	ThundeRobot.local	RTSP	194	DESCRIBE rtsp://10.240.248.20:8554/raw_h264_stream.264 RTSP/1.0
118	19:46:25.229170137	ThundeRobot.local	ThundeRobot.local	RTSP/SDP	776	Reply: RTSP/1.0 200 OK
119	19:46:25.229526826	ThundeRobot.local	ThundeRobot.local	RTSP	229	SETUP rtsp://10.240.248.20:8554/raw_h264_stream.264/track1 RTSP/1.0
121	19:46:25.229694167	ThundeRobot.local	ThundeRobot.local	RTSP	282	Reply: RTSP/1.0 200 OK
122	19:46:25.229884877	ThundeRobot.local	ThundeRobot.local	RTP	54	PT=ITU-T G.711 PCMU, SSRC=0x0, Seq=0, Time=0

Frame 116: 194 bytes on wire (1552 bits), 194 bytes captured (1552 bits) on interface 2

- Ethernet II, Src: 00:00:00_00:00:00 (00:00:00:00:00:00), Dst: 00:00:00_00:00:00 (00:00:00:00:00:00)
- Internet Protocol Version 4, Src: ThundeRobot.local (10.240.248.20), Dst: ThundeRobot.local (10.240.248.20)
- Transmission Control Protocol, Src Port: 47422 (47422), Dst Port: rtsp-alt (8554), Seq: 103, Ack: 153, Len: 128
- Real Time Streaming Protocol
 - Request: DESCRIBE rtsp://10.240.248.20:8554/raw_h264_stream.264 RTSP/1.0\r\n
 - Method: DESCRIBE
 - URL: rtsp://10.240.248.20:8554/raw_h264_stream.264
 - Accept: application/sdp\r\n
 - CSeq: 2\r\n
 - User-Agent: Lavf56.40.101\r\n
 - \r\n

File: "/home/hanpei0306/rtsp.pc... Packets: 17442 · Displayed: 6049 (34.7%) · Load time: 0:00.172 Profile: Default

DESCRIBE 请求的 Accept 头部值为 application/sdp，表示客户端希望收到 SDP 格式的媒体表示。

4.服务器以一个 RTSP/SDP 包作为响应

Wireshark 抓包分析 RTSP/RTP/RTCP

rtsp.pcapng [Wireshark 2.2.1 (Git Rev Unknown from unknown)]

Filter: **rtsp or rtp or rtcp** Expression... Clear Apply 保存

No.	Time	Source	Destination	Protocol	Length	Info
112	19:46:25.128695587	ThundeRobot.local	ThundeRobot.local	RTSP	168	OPTIONS rtsp://10.240.248.20:8554/raw_h264_stream.264 RTSP/1.0
114	19:46:25.128737500	ThundeRobot.local	ThundeRobot.local	RTSP	218	Reply: RTSP/1.0 200 OK
116	19:46:25.128866916	ThundeRobot.local	ThundeRobot.local	RTSP	194	DESCRIBE rtsp://10.240.248.20:8554/raw_h264_stream.264 RTSP/1.0
118	19:46:25.229170137	ThundeRobot.local	ThundeRobot.local	RTSP/SDP	776	Reply: RTSP/1.0 200 OK
119	19:46:25.229526826	ThundeRobot.local	ThundeRobot.local	RTSP	229	SETUP rtsp://10.240.248.20:8554/raw_h264_stream.264/track1 RTSP/1.0
121	19:46:25.229694167	ThundeRobot.local	ThundeRobot.local	RTSP	282	Reply: RTSP/1.0 200 OK
122	19:46:25.229884877	ThundeRobot.local	ThundeRobot.local	RTP	54	PT=ITU-T G.711 PCMU, SSRC=0x0, Seq=0, Time=0

Frame 118: 776 bytes on wire (6208 bits), 776 bytes captured (6208 bits) on interface 2

Ethernet II, Src: 00:00:00:00:00:00 (00:00:00:00:00:00), Dst: 00:00:00:00:00:00 (00:00:00:00:00:00)

Internet Protocol Version 4, Src: ThundeRobot.local (10.240.248.20), Dst: ThundeRobot.local (10.240.248.20)

Transmission Control Protocol, Src Port: rtsp-alt (8554), Dst Port: 47422 (47422), Seq: 153, Ack: 231, Len: 710

Real Time Streaming Protocol

- Response: RTSP/1.0 200 OK\r\n
 - Status: 200
 - CSeq: 2\r\n
 - Date: Thu, Aug 31 2017 11:46:25 GMT\r\n
 - Content-Base: rtsp://10.240.248.20:8554/raw_h264_stream.264/\r\n
 - Content-type: application/sdp
 - Content-length: 531
 - \r\n

Session Description Protocol

- Session Description Protocol Version (v): 0
- Owner/Creator, Session Id (o): - 1504179985128927 1 IN IP4 10.240.248.20
- Session Name (s): H.264 Video, streamed by the LIVE555 Media Server
- Session Information (i): raw_h264_stream.264
- Time Description, active time (t): 0 0
- Session Attribute (a): tool:LIVE555 Streaming Media v2017.07.18
- Session Attribute (a): type:broadcast
- Session Attribute (a): control:*
- Session Attribute (a): range:npt=0-
- Session Attribute (a): x-qt-text-nam:H.264 Video, streamed by the LIVE555 Media Server
- Session Attribute (a): x-qt-text-inf:raw_h264_stream.264

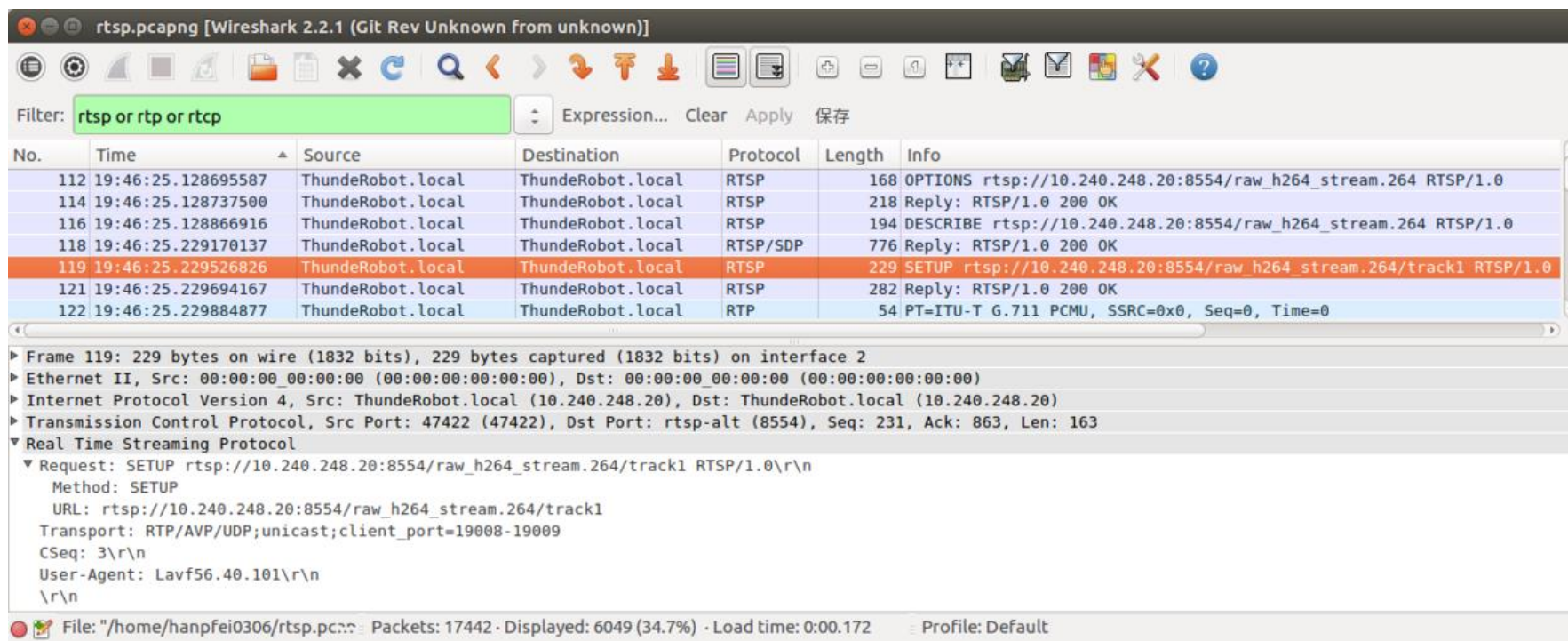
Media Description, name and address (m): video 0 RTP/AVP 96

- Connection Information (c): IN IP4 0.0.0.0
- Bandwidth Information (b): AS:500
- Media Attribute (a): rtpmap:96 H264/90000
- Media Attribute (a): fmp:96 packetization-mode=1;profile-level-id=42802A;sprop-parameter-sets=Z0KAKtoBEA8eXlIKDAoNoUJq,aM4G4g==
- Media Attribute (a): control:track1

Media Description, name and add... Packets: 17442 · Displayed: 6049 (34.7%) · Load time: 0:00.172 Profile: Default

Wireshark 抓包分析 RTSP/RTP/RTCP

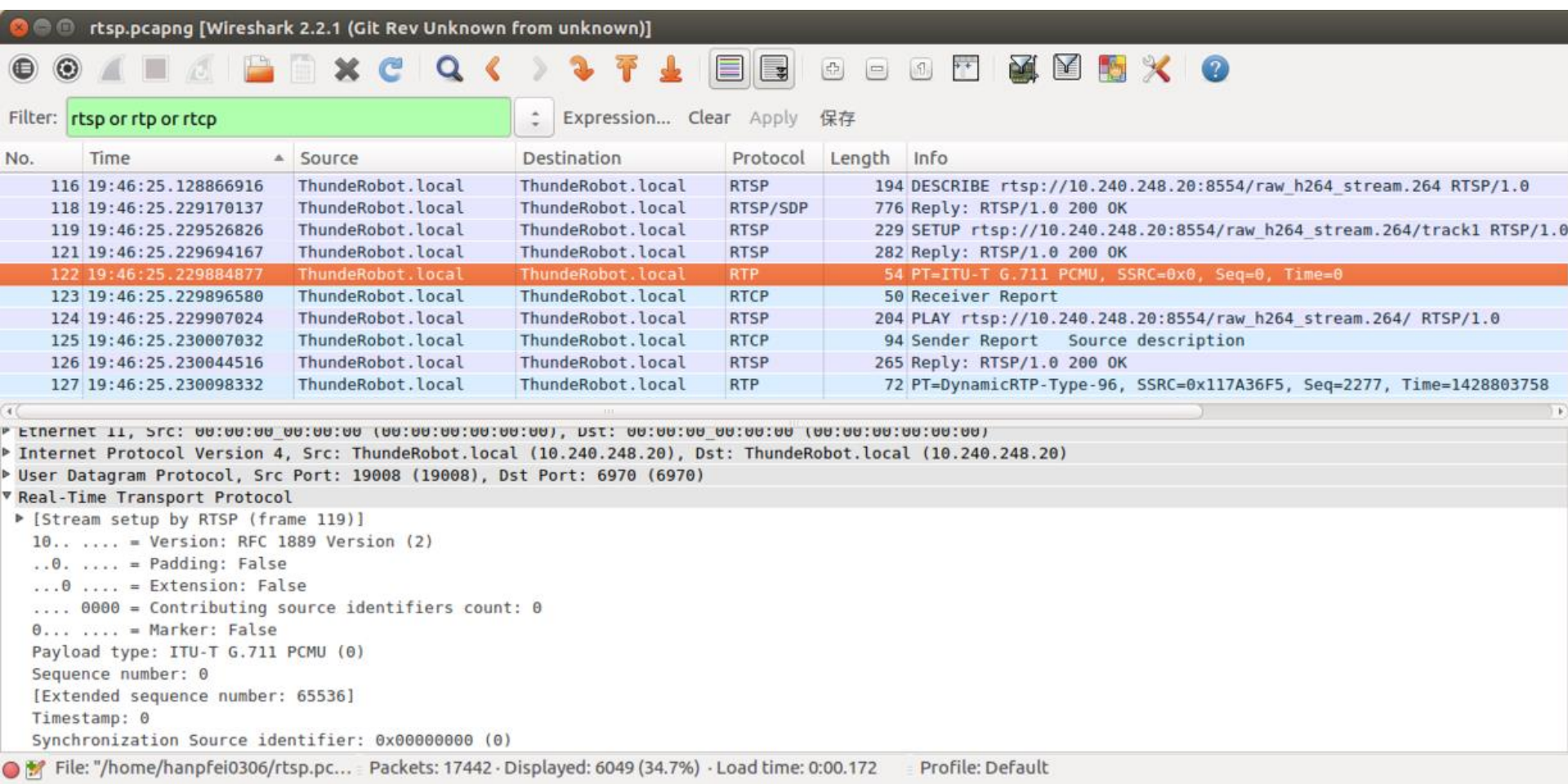
5. 客户端在收到服务器发来的 SDP 包之后，会选择两个端口，分别用于 RTP 和 RTCP 包的收发，并发送了一个 SETUP 请求用于建立媒体会话



6. 服务器对 SETUP 请求做出了响应，如第121 号包，把它为媒体会话开启的用于收发 RTP、RTCP 包的端口，会话的标识符，超时时间等信息通知给客户端

Wireshark 抓包分析 RTSP/RTP/RTCP

7. 客户端分别在 RTP 和 RTCP 的端口上，向服务器的 RTP 和 RTCP 端口上发送了两个包，如第 122 号包和第 123 号包



Filter: `rtsp or rtp or rtcp` Expression... Clear Apply 保存

No.	Time	Source	Destination	Protocol	Length	Info
116	19:46:25.128866916	ThundeRobot.local	ThundeRobot.local	RTSP	194	DESCRIBE rtsp://10.240.248.20:8554/raw_h264_stream.264 RTSP/1.0
118	19:46:25.229170137	ThundeRobot.local	ThundeRobot.local	RTSP/SDP	776	Reply: RTSP/1.0 200 OK
119	19:46:25.229526826	ThundeRobot.local	ThundeRobot.local	RTSP	229	SETUP rtsp://10.240.248.20:8554/raw_h264_stream.264/track1 RTSP/1.0
121	19:46:25.229694167	ThundeRobot.local	ThundeRobot.local	RTSP	282	Reply: RTSP/1.0 200 OK
122	19:46:25.229884877	ThundeRobot.local	ThundeRobot.local	RTP	54	PT=ITU-T G.711 PCMU, SSRC=0x0, Seq=0, Time=0
123	19:46:25.229896580	ThundeRobot.local	ThundeRobot.local	RTCP	50	Receiver Report
124	19:46:25.229907024	ThundeRobot.local	ThundeRobot.local	RTSP	204	PLAY rtsp://10.240.248.20:8554/raw_h264_stream.264/ RTSP/1.0
125	19:46:25.230007032	ThundeRobot.local	ThundeRobot.local	RTCP	94	Sender Report Source description
126	19:46:25.230044516	ThundeRobot.local	ThundeRobot.local	RTSP	265	Reply: RTSP/1.0 200 OK
127	19:46:25.230098332	ThundeRobot.local	ThundeRobot.local	RTP	72	PT=DynamicRTP-Type-96, SSRC=0x117A36F5, Seq=2277, Time=1428803758

Packet 122 details:

- Ethernet II, Src: 00:00:00:00:00:00 (00:00:00:00:00:00), Dst: 00:00:00:00:00:00 (00:00:00:00:00:00)
- Internet Protocol Version 4, Src: ThundeRobot.local (10.240.248.20), Dst: ThundeRobot.local (10.240.248.20)
- User Datagram Protocol, Src Port: 19008 (19008), Dst Port: 6970 (6970)
- Real-Time Transport Protocol
 - [Stream setup by RTSP (frame 119)]
 - 10... = Version: RFC 1889 Version (2)
 - ..0. = Padding: False
 - ...0 = Extension: False
 - 0000 = Contributing source identifiers count: 0
 - 0... = Marker: False
 - Payload type: ITU-T G.711 PCMU (0)
 - Sequence number: 0
 - [Extended sequence number: 65536]
 - Timestamp: 0
 - Synchronization Source identifier: 0x00000000 (0)

File: "/home/hanpei0306/rtsp.pc... Packets: 17442 - Displayed: 6049 (34.7%) - Load time: 0:00.172 Profile: Default

Wireshark 抓包分析 RTSP/RTP/RTCP

rtsp.pcapng [Wireshark 2.2.1 (Git Rev Unknown from unknown)]

Filter: **rtsp or rtp or rtcp** Expression... Clear Apply 保存

No.	Time	Source	Destination	Protocol	Length	Info
116	19:46:25.128866916	ThundeRobot.local	ThundeRobot.local	RTSP	194	DESCRIBE rtsp://10.240.248.20:8554/raw_h264_stream.264 RTSP/1.0
118	19:46:25.229170137	ThundeRobot.local	ThundeRobot.local	RTSP/SDP	776	Reply: RTSP/1.0 200 OK
119	19:46:25.229526826	ThundeRobot.local	ThundeRobot.local	RTSP	229	SETUP rtsp://10.240.248.20:8554/raw_h264_stream.264/track1 RTSP/1.0
121	19:46:25.229694167	ThundeRobot.local	ThundeRobot.local	RTSP	282	Reply: RTSP/1.0 200 OK
122	19:46:25.229884877	ThundeRobot.local	ThundeRobot.local	RTP	54	PT=ITU-T G.711 PCMU, SSRC=0x0, Seq=0, Time=0
123	19:46:25.229896580	ThundeRobot.local	ThundeRobot.local	RTCP	50	Receiver Report
124	19:46:25.229907024	ThundeRobot.local	ThundeRobot.local	RTSP	204	PLAY rtsp://10.240.248.20:8554/raw_h264_stream.264/ RTSP/1.0
125	19:46:25.230007032	ThundeRobot.local	ThundeRobot.local	RTCP	94	Sender Report Source description
126	19:46:25.230044516	ThundeRobot.local	ThundeRobot.local	RTSP	265	Reply: RTSP/1.0 200 OK
127	19:46:25.230098332	ThundeRobot.local	ThundeRobot.local	RTP	72	PT=DynamicRTP-Type-96, SSRC=0x117A36F5, Seq=2277, Time=1428803758

Frame 123: 50 bytes on wire (400 bits), 50 bytes captured (400 bits) on interface 2

Ethernet II, Src: 00:00:00_00:00:00 (00:00:00:00:00:00), Dst: 00:00:00_00:00:00 (00:00:00:00:00:00)

Internet Protocol Version 4, Src: ThundeRobot.local (10.240.248.20), Dst: ThundeRobot.local (10.240.248.20)

User Datagram Protocol, Src Port: 19009 (19009), Dst Port: 6971 (6971)

Real-time Transport Control Protocol (Receiver Report)

[Stream setup by RTSP (frame 121)]

- 10.. = Version: RFC 1889 Version (2)
- ..0. = Padding: False
- ...0 0000 = Reception report count: 0

Packet type: Receiver Report (201)

Length: 1 (8 bytes)

Sender SSRC: 0x00000000 (0)

[RTCP frame length check: OK - 8 bytes]

Real-time Transport Control Prot... Packets: 17442 · Displayed: 6049 (34.7%) · Load time: 0:00.172 Profile: Default

Wireshark 抓包分析 RTSP/RTP/RTCP

8.客户端向服务器发送了一个 PLAY 请求，来启动播放

The image shows a Wireshark packet capture of an RTSP session. The filter is set to 'rtsp or rtp or rtcp'. The packet list shows a sequence of RTSP and RTP/RTCP packets. Packet 124 is highlighted, showing a 'PLAY' request from ThundeRobot.local to ThundeRobot.local. The packet details pane shows the 'Real Time Streaming Protocol' section expanded, displaying the 'Request' details: 'PLAY rtsp://10.240.248.20:8554/raw_h264_stream.264/ RTSP/1.0\r\n', 'Method: PLAY', 'URL: rtsp://10.240.248.20:8554/raw_h264_stream.264/', 'Range: npt=0.000-\r\n', 'CSeq: 4\r\n', 'User-Agent: Lavf56.40.101\r\n', and 'Session: D491FF5F\r\n'.

No.	Time	Source	Destination	Protocol	Length	Info
119	19:46:25.229526826	ThundeRobot.local	ThundeRobot.local	RTSP	229	SETUP rtsp://10.240.248.20:8554/raw_h264_stream.264/track1 RTSP/1.0
121	19:46:25.229694167	ThundeRobot.local	ThundeRobot.local	RTSP	282	Reply: RTSP/1.0 200 OK
122	19:46:25.229884877	ThundeRobot.local	ThundeRobot.local	RTP	54	PT=ITU-T G.711 PCMU, SSRC=0x0, Seq=0, Time=0
123	19:46:25.229896580	ThundeRobot.local	ThundeRobot.local	RTCP	50	Receiver Report
124	19:46:25.229907024	ThundeRobot.local	ThundeRobot.local	RTSP	204	PLAY rtsp://10.240.248.20:8554/raw_h264_stream.264/ RTSP/1.0
125	19:46:25.230007032	ThundeRobot.local	ThundeRobot.local	RTCP	94	Sender Report Source description
126	19:46:25.230044516	ThundeRobot.local	ThundeRobot.local	RTSP	265	Reply: RTSP/1.0 200 OK
127	19:46:25.230098332	ThundeRobot.local	ThundeRobot.local	RTP	72	PT=DynamicRTP-Type-96, SSRC=0x117A36F5, Seq=2277, Time=1428803758
128	19:46:25.230104446	ThundeRobot.local	ThundeRobot.local	RTP	58	PT=DynamicRTP-Type-96, SSRC=0x117A36F5, Seq=2278, Time=1428803758
129	19:46:25.230273920	ThundeRobot.local	ThundeRobot.local	RTP	1498	PT=DynamicRTP-Type-96, SSRC=0x117A36F5, Seq=2279, Time=1428803758
131	19:46:25.270199661	ThundeRobot.local	ThundeRobot.local	RTP	1498	PT=DynamicRTP-Type-96, SSRC=0x117A36F5, Seq=2280, Time=1428803758

Transmission Control Protocol, Src Port: 47422 (47422), Dst Port: rtsp-alt (8554), Seq: 394, Ack: 1079, Len: 138

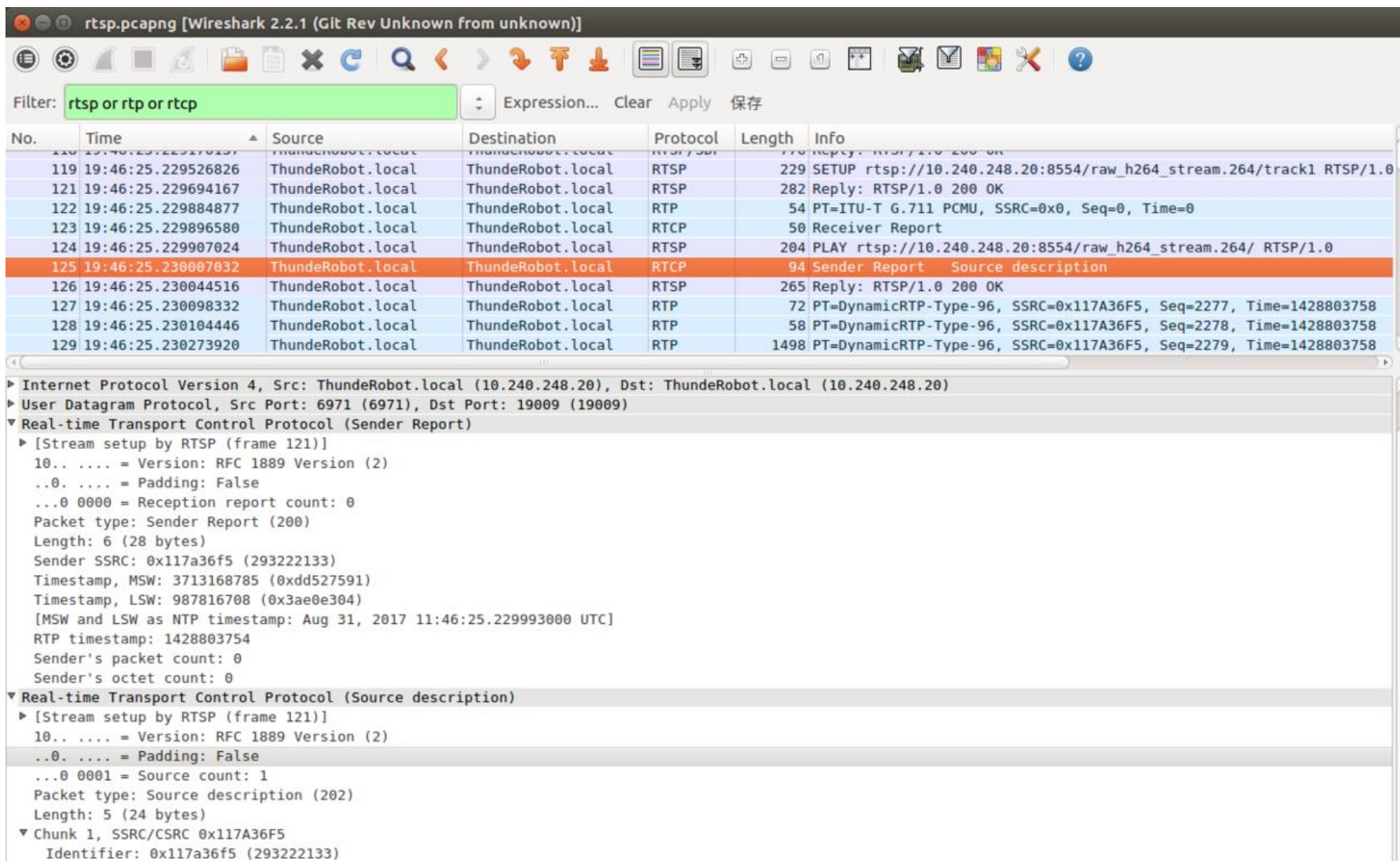
Real Time Streaming Protocol

- Request: PLAY rtsp://10.240.248.20:8554/raw_h264_stream.264/ RTSP/1.0\r\n
 - Method: PLAY
 - URL: rtsp://10.240.248.20:8554/raw_h264_stream.264/
 - Range: npt=0.000-\r\n
 - CSeq: 4\r\n
 - User-Agent: Lavf56.40.101\r\n
 - Session: D491FF5F\r\n

File: "/home/hanpei0306/rtsp.pcap" Packets: 17442 · Displayed: 6049 (34.7%) · Load time: 0:00.172 · Profile: Default

Wireshark 抓包分析 RTSP/RTP/RTCP

9.服务器向客户端发送了一个 RTCP 包，把 RTP 时间戳，服务器的 SSRC，服务器的 CNAME 等信息发送给客户端



rtsp.pcapng [Wireshark 2.2.1 (Git Rev Unknown from unknown)]

Filter: `rtsp or rtp or rtcp` Expression... Clear Apply 保存

No.	Time	Source	Destination	Protocol	Length	Info
119	19:46:25.229526826	ThundeRobot.local	ThundeRobot.local	RTSP	229	SETUP rtsp://10.240.248.20:8554/raw_h264_stream.264/track1 RTSP/1.0
121	19:46:25.229694167	ThundeRobot.local	ThundeRobot.local	RTSP	282	Reply: RTSP/1.0 200 OK
122	19:46:25.229884877	ThundeRobot.local	ThundeRobot.local	RTP	54	PT=ITU-T G.711 PCMU, SSRC=0x0, Seq=0, Time=0
123	19:46:25.229896580	ThundeRobot.local	ThundeRobot.local	RTCP	50	Receiver Report
124	19:46:25.229907024	ThundeRobot.local	ThundeRobot.local	RTSP	204	PLAY rtsp://10.240.248.20:8554/raw_h264_stream.264/ RTSP/1.0
125	19:46:25.230007032	ThundeRobot.local	ThundeRobot.local	RTCP	94	Sender Report Source description
126	19:46:25.230044516	ThundeRobot.local	ThundeRobot.local	RTSP	265	Reply: RTSP/1.0 200 OK
127	19:46:25.230098332	ThundeRobot.local	ThundeRobot.local	RTP	72	PT=DynamicRTP-Type-96, SSRC=0x117A36F5, Seq=2277, Time=1428803758
128	19:46:25.230104446	ThundeRobot.local	ThundeRobot.local	RTP	58	PT=DynamicRTP-Type-96, SSRC=0x117A36F5, Seq=2278, Time=1428803758
129	19:46:25.230273920	ThundeRobot.local	ThundeRobot.local	RTP	1498	PT=DynamicRTP-Type-96, SSRC=0x117A36F5, Seq=2279, Time=1428803758

Internet Protocol Version 4, Src: ThundeRobot.local (10.240.248.20), Dst: ThundeRobot.local (10.240.248.20)

User Datagram Protocol, Src Port: 6971 (6971), Dst Port: 19009 (19009)

Real-time Transport Control Protocol (Sender Report)

- [Stream setup by RTSP (frame 121)]
- 10.. = Version: RFC 1889 Version (2)
- ..0. = Padding: False
- ...0 0000 = Reception report count: 0
- Packet type: Sender Report (200)
- Length: 6 (28 bytes)
- Sender SSRC: 0x117a36f5 (293222133)
- Timestamp, MSW: 3713168785 (0xdd527591)
- Timestamp, LSW: 987816708 (0x3ae0e304)
- [MSW and LSW as NTP timestamp: Aug 31, 2017 11:46:25.229993000 UTC]
- RTP timestamp: 1428803754
- Sender's packet count: 0
- Sender's octet count: 0

Real-time Transport Control Protocol (Source description)

- [Stream setup by RTSP (frame 121)]
- 10.. = Version: RFC 1889 Version (2)
- ..0. = Padding: False
- ...0 0001 = Source count: 1
- Packet type: Source description (202)
- Length: 5 (24 bytes)
- Chunk 1, SSRC/CSRC 0x117A36F5
- Identifier: 0x117a36f5 (293222133)

Wireshark 抓包分析 RTSP/RTP/RTCP

10. 服务器发送 PLAY 请求的响应，其中包含 RTP 包的初始序列号，RTP 时间等重要信息。至此媒体会话最终建立完成。

rtsp.pcapng [Wireshark 2.2.1 (Git Rev Unknown from unknown)]

Filter: `rtsp or rtp or rtcp` Expression... Clear Apply 保存

No.	Time	Source	Destination	Protocol	Length	Info
123	19:46:25.229896580	ThundeRobot.local	ThundeRobot.local	RTCP	50	Receiver Report
124	19:46:25.229907024	ThundeRobot.local	ThundeRobot.local	RTSP	204	PLAY rtsp://10.240.248.20:8554/raw_h264_stream.264/ RTSP/1.0
125	19:46:25.230007032	ThundeRobot.local	ThundeRobot.local	RTCP	94	Sender Report Source description
126	19:46:25.230044516	ThundeRobot.local	ThundeRobot.local	RTSP	265	Reply: RTSP/1.0 200 OK
127	19:46:25.230098332	ThundeRobot.local	ThundeRobot.local	RTP	72	PT=DynamicRTP-Type-96, SSRC=0x117A36F5, Seq=2277, Time=1428803758
128	19:46:25.230104446	ThundeRobot.local	ThundeRobot.local	RTP	58	PT=DynamicRTP-Type-96, SSRC=0x117A36F5, Seq=2278, Time=1428803758
129	19:46:25.230273920	ThundeRobot.local	ThundeRobot.local	RTP	1498	PT=DynamicRTP-Type-96, SSRC=0x117A36F5, Seq=2279, Time=1428803758
131	19:46:25.270199661	ThundeRobot.local	ThundeRobot.local	RTP	1498	PT=DynamicRTP-Type-96, SSRC=0x117A36F5, Seq=2280, Time=1428803758

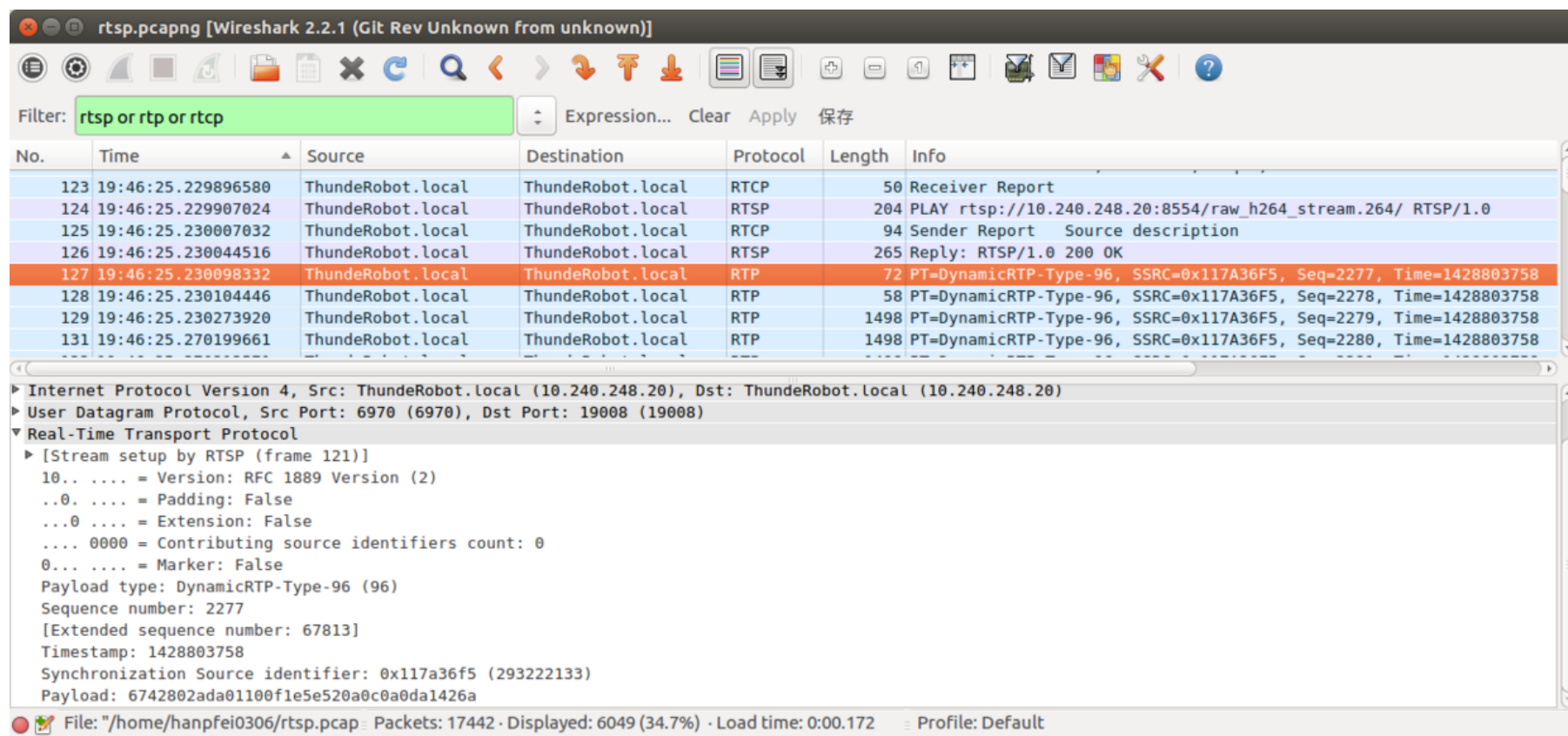
Frame 126: 265 bytes on wire (2120 bits), 265 bytes captured (2120 bits) on interface 2

- Ethernet II, Src: 00:00:00_00:00:00 (00:00:00:00:00:00), Dst: 00:00:00_00:00:00 (00:00:00:00:00:00)
- Internet Protocol Version 4, Src: ThundeRobot.local (10.240.248.20), Dst: ThundeRobot.local (10.240.248.20)
- Transmission Control Protocol, Src Port: rtsp-alt (8554), Dst Port: 47422 (47422), Seq: 1079, Ack: 532, Len: 199
- Real Time Streaming Protocol
 - Response: RTSP/1.0 200 OK\r\n
 - Status: 200
 - CSeq: 4\r\n
 - Date: Thu, Aug 31 2017 11:46:25 GMT\r\n
 - Range: npt=0.000-\r\n
 - Session: D491FF5F
 - RTP-Info: url=rtsp://10.240.248.20:8554/raw_h264_stream.264/track1;seq=2277;rtptime=1428803758\r\n
 - \r\n

Text item (text), 19 bytes Packets: 17442 · Displayed: 6049 (34.7%) · Load time: 0:00.172 Profile: Default

Wireshark 抓包分析 RTSP/RTP/RTCP

11. 通过 RTP/RTCP 发送流媒体数据。



rtsp.pcapng [Wireshark 2.2.1 (Git Rev Unknown from unknown)]

Filter: `rtsp or rtp or rtcp` Expression... Clear Apply 保存

No.	Time	Source	Destination	Protocol	Length	Info
123	19:46:25.229896580	ThundeRobot.local	ThundeRobot.local	RTCP	50	Receiver Report
124	19:46:25.229907024	ThundeRobot.local	ThundeRobot.local	RTSP	204	PLAY rtsp://10.240.248.20:8554/raw_h264_stream.264/ RTSP/1.0
125	19:46:25.230007032	ThundeRobot.local	ThundeRobot.local	RTCP	94	Sender Report Source description
126	19:46:25.230044516	ThundeRobot.local	ThundeRobot.local	RTSP	265	Reply: RTSP/1.0 200 OK
127	19:46:25.230098332	ThundeRobot.local	ThundeRobot.local	RTP	72	PT=DynamicRTP-Type-96, SSRC=0x117a36f5, Seq=2277, Time=1428803758
128	19:46:25.230104446	ThundeRobot.local	ThundeRobot.local	RTP	58	PT=DynamicRTP-Type-96, SSRC=0x117a36f5, Seq=2278, Time=1428803758
129	19:46:25.230273920	ThundeRobot.local	ThundeRobot.local	RTP	1498	PT=DynamicRTP-Type-96, SSRC=0x117a36f5, Seq=2279, Time=1428803758
131	19:46:25.270199661	ThundeRobot.local	ThundeRobot.local	RTP	1498	PT=DynamicRTP-Type-96, SSRC=0x117a36f5, Seq=2280, Time=1428803758

Internet Protocol Version 4, Src: ThundeRobot.local (10.240.248.20), Dst: ThundeRobot.local (10.240.248.20)

User Datagram Protocol, Src Port: 6970 (6970), Dst Port: 19008 (19008)

Real-Time Transport Protocol

[Stream setup by RTSP (frame 121)]

10... .. = Version: RFC 1889 Version (2)

..0... .. = Padding: False

...0... .. = Extension: False

.... 0000 = Contributing source identifiers count: 0

0... .. = Marker: False

Payload type: DynamicRTP-Type-96 (96)

Sequence number: 2277

[Extended sequence number: 67813]

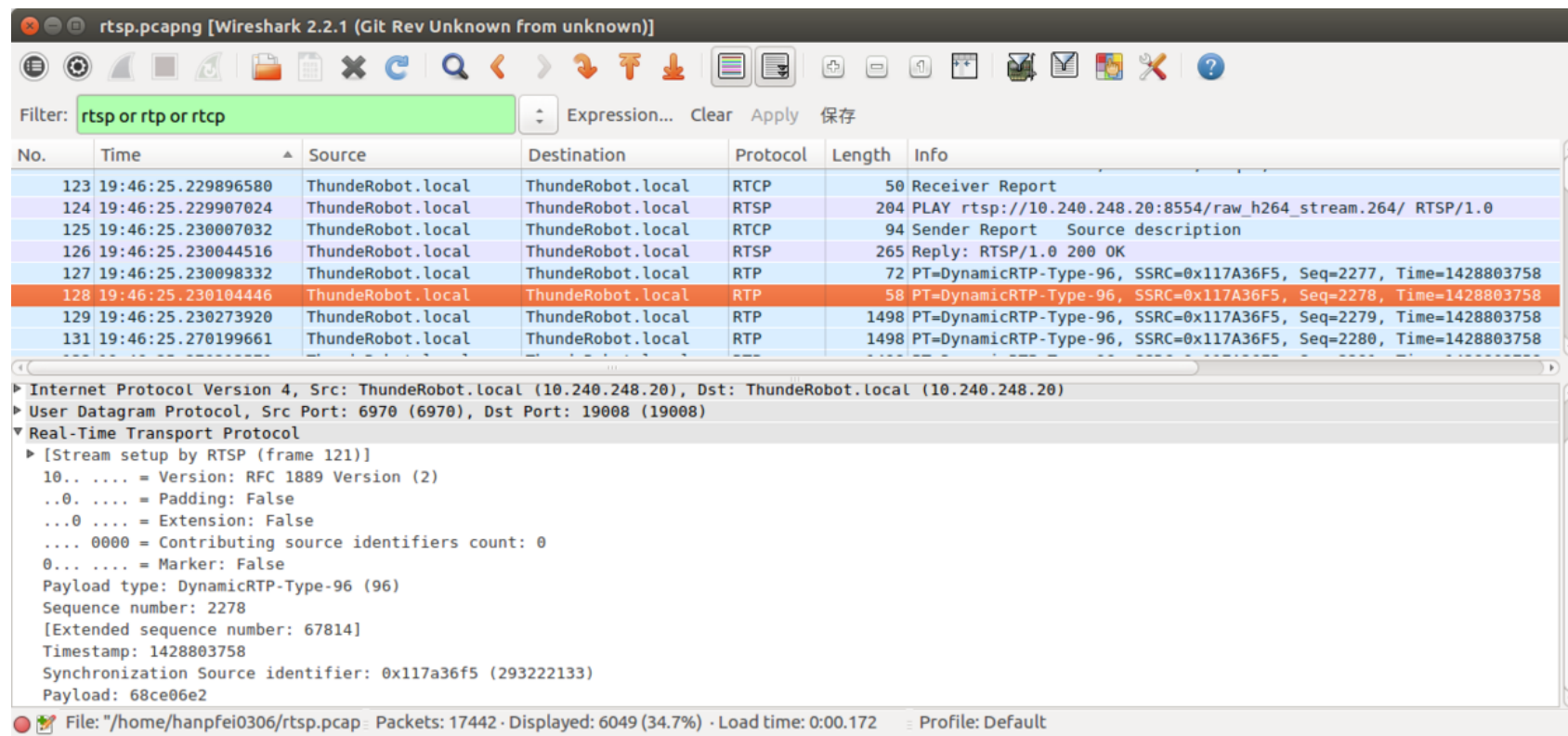
Timestamp: 1428803758

Synchronization Source identifier: 0x117a36f5 (293222133)

Payload: 6742802ada01100f1e5e520a0c0a0da1426a

File: "/home/hanpei0306/rtsp.pcap" Packets: 17442 - Displayed: 6049 (34.7%) - Load time: 0:00.172 Profile: Default

Wireshark 抓包分析 RTSP/RTP/RTCP



127, 128号包的内容与 H.264 视频文件的前两个 NALU 的内容完全吻合。

从 RTSP 的 OPTIONS 请求开始，到首个视频数据 NALU 开始发送，经过了总共大概 102 ms 的时间，媒体会话完全建立完成。

来自csdn hanpei's blog

Wireshark 抓包分析 RTSP/RTP/RTCP

12. 视频数据经过一段时间的稳定传输，最终以服务器向客户端发送的一个 RTCP BYE 包而结束，如第 6451 号包：

rtsp.pcapng [Wireshark 2.2.1 (Git Rev Unknown from unknown)]

Filter: **rtsp or rtp or rtcp** Expression... Clear Apply 保存

No.	Time	Source	Destination	Protocol	Length	Info
6447	19:46:59.230184213	ThundeRobot.local	ThundeRobot.local	RTP	394	PT=DynamicRTP-Type-96, SSRC=0x117A36F5, Seq=8274, Time=1431860145
6448	19:46:59.230220709	ThundeRobot.local	ThundeRobot.local	RTP	1498	PT=DynamicRTP-Type-96, SSRC=0x117A36F5, Seq=8275, Time=1431863745
6449	19:46:59.270248423	ThundeRobot.local	ThundeRobot.local	RTP	1498	PT=DynamicRTP-Type-96, SSRC=0x117A36F5, Seq=8276, Time=1431863745
6450	19:46:59.270269663	ThundeRobot.local	ThundeRobot.local	RTP	873	PT=DynamicRTP-Type-96, SSRC=0x117A36F5, Seq=8277, Time=1431863745
6451	19:46:59.270329455	ThundeRobot.local	ThundeRobot.local	RTCP	78	Sender Report Goodbye

Frame 6451: 78 bytes on wire (624 bits), 78 bytes captured (624 bits) on interface 2

Ethernet II, Src: 00:00:00_00:00:00 (00:00:00:00:00:00), Dst: 00:00:00_00:00:00 (00:00:00:00:00:00)

Internet Protocol Version 4, Src: ThundeRobot.local (10.240.248.20), Dst: ThundeRobot.local (10.240.248.20)

User Datagram Protocol, Src Port: 6971 (6971), Dst Port: 19009 (19009)

Real-time Transport Control Protocol (Sender Report)

- [Stream setup by RTSP (frame 121)]
 - [Setup frame: 121]
 - [Setup Method: RTSP]
 - 10.. = Version: RFC 1889 Version (2)
 - ..0. = Padding: False
 - ...0 0000 = Reception report count: 0
 - Packet type: Sender Report (200)
 - Length: 6 (28 bytes)
 - Sender SSRC: 0x117a36f5 (293222133)
 - Timestamp, MSW: 3713168819 (0xdd5275b3)
 - Timestamp, LSW: 1161028444 (0x4533e35c)
 - [MSW and LSW as NTP timestamp: Aug 31, 2017 11:46:59.270322000 UTC]
 - RTP timestamp: 1431867418
 - Sender's packet count: 6001
 - Sender's octet count: 8036970

Real-time Transport Control Protocol (Goodbye)

- [Stream setup by RTSP (frame 121)]
 - [Setup frame: 121]

Wireshark 抓包分析 RTSP/RTP/RTCP

总结一下这个过程：

1. 客户端首先向服务器发送一个方法为 OPTIONS 的请求，了解服务器为 URL 提供了哪些方法的支持。
2. 服务器将该 URL 支持的方法的列表返回给客户端。
3. 客户端向服务器发送了一个 DESCRIBE 请求，提取由所请求的 URL 标识的表示或媒体对象的描述信息。
4. 服务器通过 SDP 包，告知流媒体数据传输所用的协议，以及流媒体本身的一些信息。
5. 客户端在收到服务器发来的 SDP 包之后，会选择两个端口，分别用于 RTP 和 RTCP 包的收发，并发送了一个 SETUP 请求用于建立媒体会话。
6. 服务器发回 SETUP 响应，把它为媒体会话开启的用于收发 RTP、RTCP 包的端口，会话的标识符，超时时间等信息通知给客户端

Wireshark 抓包分析 RTSP/RTP/RTCP

7. 客户端分别在 RTP 和 RTCP 的端口上，向服务器的 RTP 和 RTCP 端口上发送了两个包。
8. 客户端向服务器发送一个 PLAY 请求，来启动播放。
9. 服务器向客户端发送一个 RTCP 包，把 RTP 时间戳，服务器的 SSRC，服务器的 CNAME 等信息发送给客户端。
10. 服务器发送 PLAY 请求的响应，其中包含 RTP 包的初始序列号，RTP 时间等重要信息。至此媒体会话最终建立完成。
11. 通过 RTP/RTCP 发送流媒体数据。
12. 服务器向客户端发送一个 RTCP BYE 包结束会话。

END

第20章 多媒体的传输

