Next Generation Session Announcements:

Internet Media Guides (IMGs)

(work in progress)

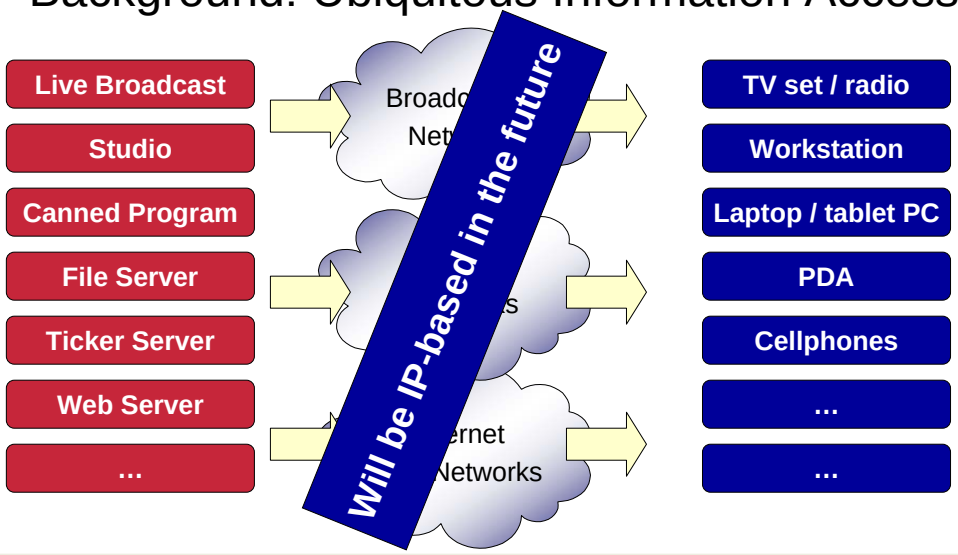
Observations

- SAP/SDP tied to IP-Multicast-based session model
- Only one distribution scheme: announcement
- Only one type of service: convey multimedia session information

- (Global) IP-Multicast has not prevailed as a distribution platform
- SAP rather experimental
- Was often used for debugging Mbone connectivity

- Summary
  - SAP/SDP too limited
  - Not appropriate as a general solution for distributing session information
  - Traditionally linked to IP-only (and Multicast-only)

Background: Ubiquitous Information Access



"Classic" Broadcasting & Internet Multimedia

- Broadcasting still a different world today
  (including customer expectations, philosophy)
  - Encodings
    - Audio/Video largely compatible (but different quality expectations)
    - Image/text formats/HTML vs. Videotex, MHP, specific markups, tables
  - Data transmission
    - IP + UDP/TCP + RTP/… vs. MPEG multiplex (or even analog)
  - Addressing
    - IP addresses + ports vs. frequency/channel, PID, satellite position, pol., …
  - Interaction & control
    - RTSP, HTTP, SIP, … vs. MHP, …
- But there is a migration towards IP in various areas
  - Content providers, transmission technologies, consumer equipment

Platform/Network-Independent Content Provision

- The same content shall be available via different networks
  - Pref
- "Conte
  - Orig
  - Sup
- Conte
- Conte
  - Des
  - Ava
- Altern
  - Netw

Application areas:
- **Digital Video Broadcasting (incl. DVB-T/H)**
- **3G / 4G wireless communication systems**
- **Wireless LAN Hot-Spots**
- **Regular Internet**

Content is a special case of "services"…!
- **Internet access**
- **File distribution**
- **"e/m-Commerce"**

Internet Media Guides (IMG)

Definition of an IMG (from MMUSIC Charter)

Content:
- A **collection of multimedia session descriptions**
- Expressed using SDP, SDPng or other metadata formats
- It is used to describe a collection of multimedia sessions (e.g. television programme schedules).

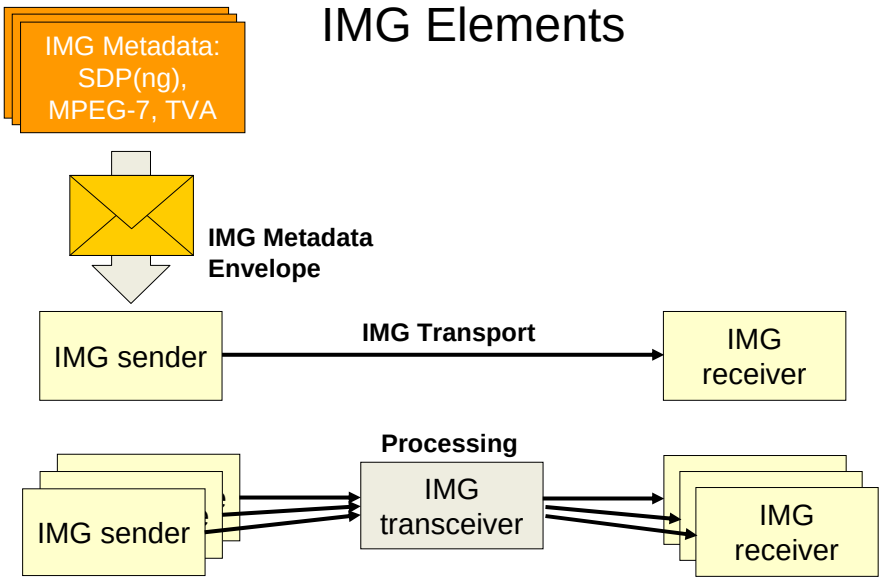
Distribution:
- The IMG must be **delivered to a potentially large audience (push or pull)**, who use it to join a subset of the sessions described, and who may need to be **notified of changes** to the IMG.

IMG ≈ EPG

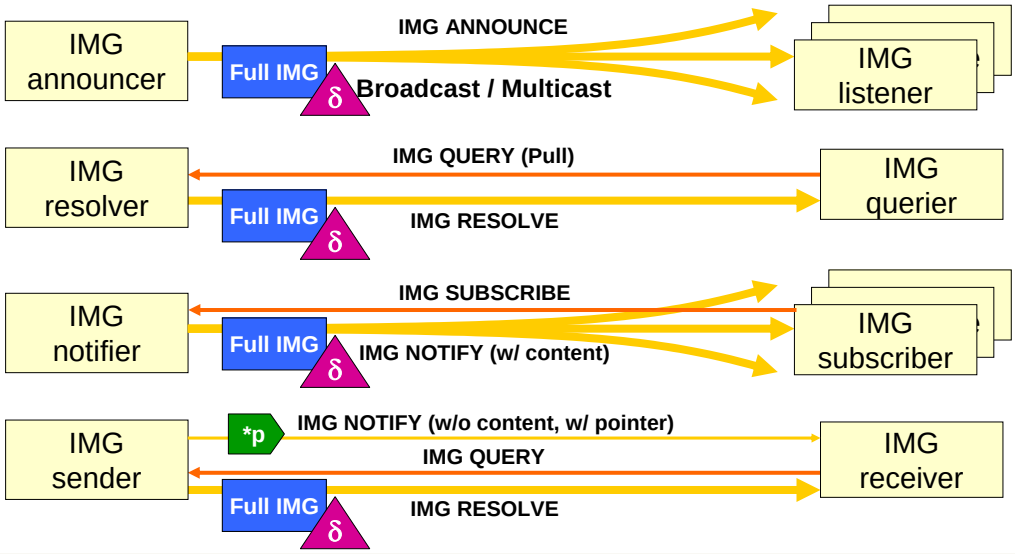
- Generalized for arbitrary...
  - Types of media
  - Types of sessions and interactions: services!
  - Classes of devices
- Plurality of access methods
  - Physical delivery
  - (Reliable) Broadcast / multicast (push)
  - Interactive retrieval (pull)
  - Provision of full IMGs and of deltas
  - Notification about changes
- Network-independent
  - For the delivery of IMGs
  - For the (request and) transmission of actual media in sessions

The same IMGs should be usable everywhere.

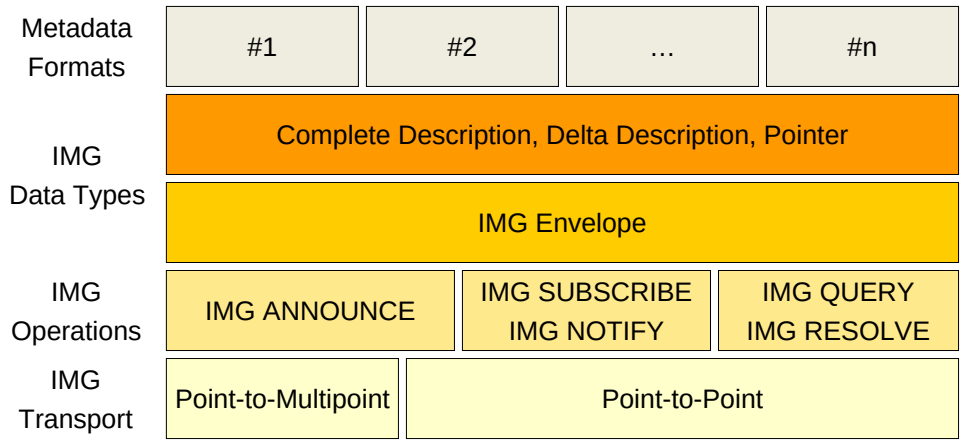
IMG Elements



IMG Delivery Models / Operations



IMG Architecture



IMG Envelope: Security Requirements

- Authentication + Integrity validation of contained metadata
  - Must work for complete and delta information
  - Must work across IMG transceivers
    - Aggregation, splitting, filtering of pieces of metadata
- Privacy
  - Must be able to protect (parts of) contained metadata
    - User protection + access control
  - Enable (limited) IMG transceiver functionality
- Interdependency with metadata formats
  - What to expect from metadata?
  - Granularity of embedded metadata objects
  - DRM? ➔ metadata formats

IMG Envelope

- Container for metadata
  - Complete, delta, pointers
  - Independent of metadata
  - Likely to become some kind of wrapper mechanism
  - Metadata itself defined by other bodies
- Generic management information
  - Identification + version + validity information
  - Content-Type: to identify metadata format
  - Support for security?
    - authentication + integrity information
    - Privacy of content

Current debate:

MIME vs. XML

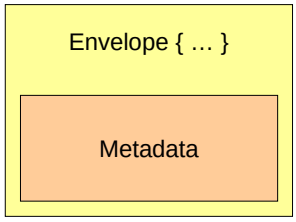
Envelope Features (1)

- Container for metadata (independent of these)
  - Complete, delta, pointers
  - Metadata itself defined by other bodies
- Version number
  - Determine the most recent (i.e., valid) copy
  - Referenced as basis for delta encoding
- Validity time
  - Period: from, to
- Metadata URI
  - Identifies the metadata element contained in the envelope
  - Helps to deal with fragments
- Content-Type
  - Defines the type of metadata contents

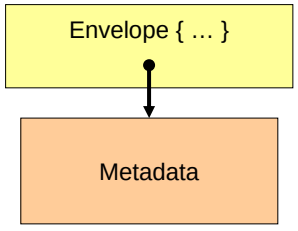
Envelope Features (2)

- Support for digital signatures (on parts of the envelope)
- Support for encryption
  - Only partly specified so far
  - May use S/MIME
- Metadata contents:

Inline



External (via pointer)



Envelope Encoding: XML vs. MIME

- **Present focus: XML (also used by 3GPP MBMS)**
- **Example (with SDP as metadata)**

```
<?xml version="1.0" encoding="UTF-8"?>
       <metadataEnvelope
         xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
         xsi:noNamespaceSchemaLocation="envelope.xsd"
         metadataURI="http/www.example.com/img001/session001.sdp"
         version="1"
         validFrom="2003-12-17T09:30:47-05:00"
         validUntil="2003-12-17T09:30:47-05:00"
         contentType="application/sdp">
         <metadataFragment>
           v=0
           o=jo 2890844526 2890842807 IN IP4 10.33.57.27
           s=SDP Seminar
           c=IN IP4 224.2.17.12/127
           t=2873397496 2873404696
           a=recvonly
           m=audio 49170 RTP/AVP 0
           m=video 51372 RTP/AVP 31
         </metadataFragment>
       </metadataEnvelope>
```


IMG Metadata

- Past focus on traditional contents
  - Conveying plain TV-schedules
  - Streaming in 3GPP Release 6
- Broadening the scope
  - Cover services in a more general fashion
  - Provide region/location information
  - Support personalized inquiries
  - Address issues of cost
    - Make offers automatically comparable
- Technical level: enable service discovery (and location)
- Business level: support adequate service selection

IMG URN

- IMGs need to be identified globally
  - In particular, across different networks and providers
- Motivates the use of IMG URNs
- Format

  urn:img: ProviderId : DateId : IMGResourceId [: FragmentId]
  - ProviderId: domain name
  - DateId: Point in time when the domain name was owned by the entity
  - IMGResourceId: provider-selected string
  - FragmentId: some identifier for a piece of an IMG
- Examples
  - urn:img:example.org:20051021:my-img
  - urn:img:example.org:20051021:my-img:subset
- Mapping to URIs (e.g., HTTP, SIP) to be defined

IN PROGRESS

IMG Transports

- Need to provide mechanisms for IMG Operations
- ANNOUNCE
  - Reliable multicast transport protocol: FLUTE + MUPPET
- SUBSCRIBE / NOTIFY
  - Session Initiation Protocol (SIP): Extensions for Subscription/Notification
- QUERY / RESOLVE
  - HTTP
- Identify IMGs properly across protocols: IMG URN (yet tbd.)
  - Mappings to individual protocols for actual processing

IMG ANNOUNCE: Reliable Multicast

- Layered Coding Transport (LCT)
  - Single sender multicast transport
  - Defines single or multi-object delivery across an LCT session
    - Provides identifiers for objects (TOI)
    - Provides session identification (TSI)
  - LCT session comprises a group of channels
    - Each identified by the respective (multicast) transport address
- Forward Error Correction (FEC)
  - General container for various FEC schemes
  - Alows to identify payload + provides in-band signaling of FEC parameters
- Asynchronous Layered Coding (ALC)
  - Simple combination of LCT and FEC

IMG ANNOUNCE: FLUTE Basics

- File Delivery over Unidirectional Transport
- Uses ALC (= LCT + FEC)
  - Fixed parameter sets for the protocol instantiation
- Specifies semantics of objects
  - Files
  - File Delivery Table (FDT)
- FDT
  - XML-based format to carry file attributes (name, location, size, etc.)
    - Carried as Transport Object ID = 0
  - Transmitted in a carrousel style together with files

IMG ANNOUNCE: FLUTE FDT

- XML-based structured information
- Example

```
<FDT-Payload Expires="<date>" complete="true">
    <File
                Content-Location=
                TOI=
                Content-Length=
                Transfer-Length=
                Content-Type=
                Content-Encoding=
                Content-MD5=
                ... plus some FEC stuff ... >
    <File ...>
    ...
</FDT-Payload>
```


IMG ANNOUNCE: MUPPET

- Specific usage of FLUTE for carrying IMG envelopes
- Defines various lower layer parameters
- Defines usage of multiple layers

IMG QUERY / RESOLVE

- "Naturally" maps to HTTP GET + 200 OK
- HTTP URI: http://<hostname>/<resource>?param1&param2&...
  - Parameters identify IMG version
    - type: full or delta IMG, pointer
    - version requested
    - diffVersion: base for delta IMG
- Querier response format selection
  - Accept: application/img-envelope+xml
    - Provide IMG in envelope format
  - Accept: text/plain, text/html
    - Provide a human-readable description of an IMG as optional fallback
  - Allow for directly returning the plain metadata without envelope?
- 200 OK carries response in body
- HTTP headers used accordingly

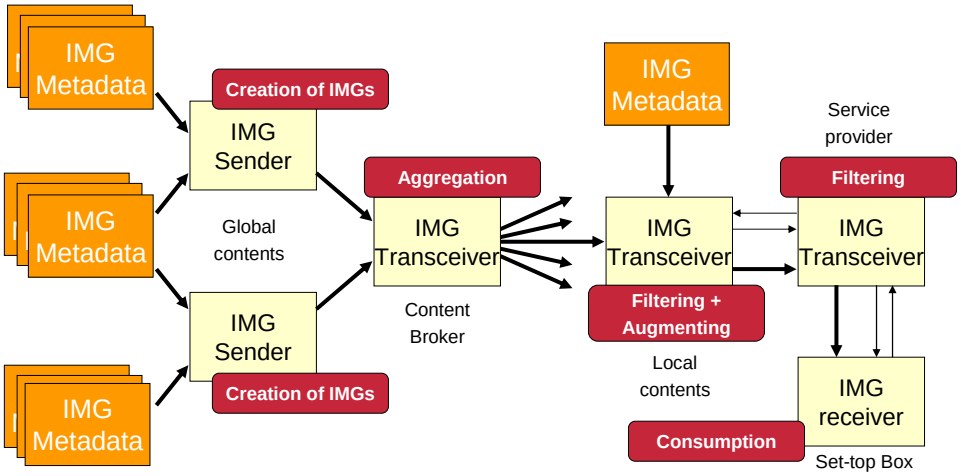
IN PROGRESS

IMG SUBSCRIBE / NOTIFY

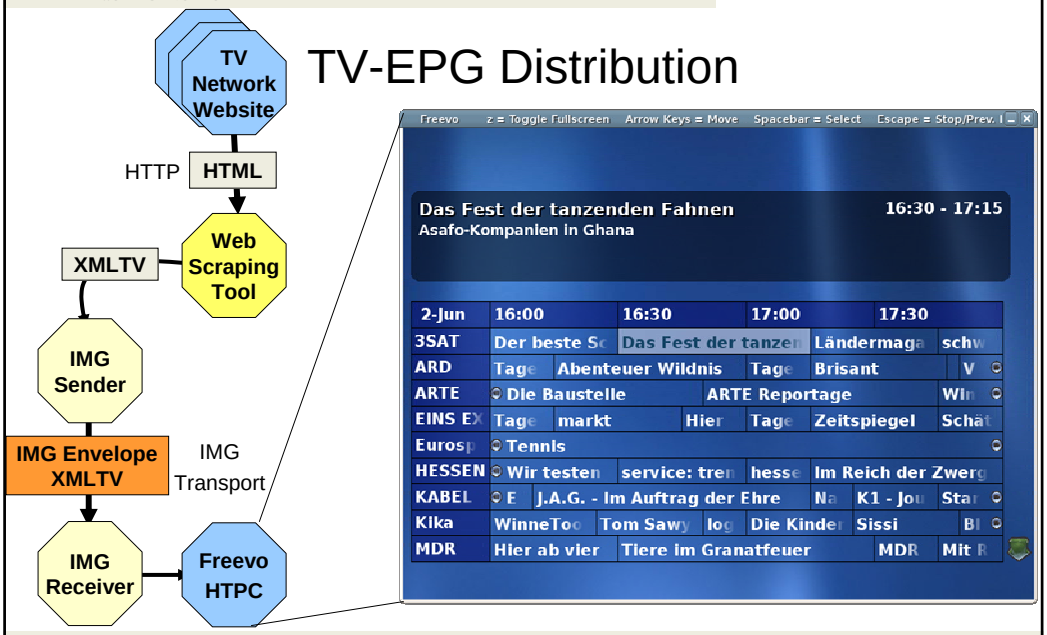
- Based upon the Session Initiation Protocol (SIP)
  - Particularly its SUBSCRIBE / NOTIFY mechanism
  - Details to be discussed
- SUBSCRIBE / NOTIFY
  - Register interest in (part of) an IMG
  - Receive an immediate response and updates upon changes
  - Soft-state based: subscription times out and needs refreshing
- IMG usage of SIP SUBSCRIBE / NOTIFY
  - Define SIP event package: img
  - Presently suggests a MIME-based IMG envelope
    - Natural choice for SIP
  - Content-Type:, Content-Location:
  - Content-ID: major.minor, Expires: valid-until

IN PROGRESS

Regionalization & Personalization with IMGs



TV-EPG Distribution



Media Streaming in the Internet

- Introduction to Media Streaming
- Real-time Streaming Protocol (RTSP)
- HTTP-based Streaming

Real-time Media Streaming

Retrieving content from a source where

- the content is continuous in nature (e.g. audio, video),
- the content is (potentially) presented to the user before it has been downloaded entirely, and
- there is no human-to-human interaction involved (i.e. latencies are acceptable to a certain degree).

Contrast: interactive, interpersonal communications

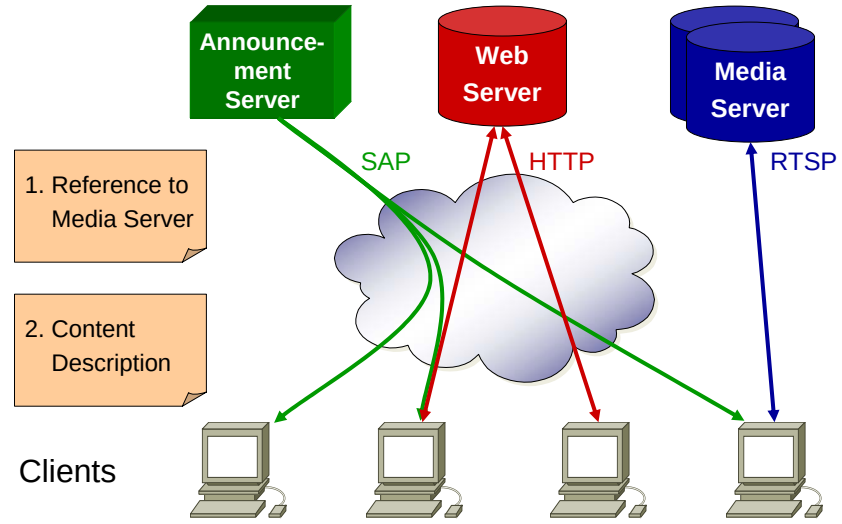
Two Types of Streaming

- Broadcast streaming (non-interactive)
  - Sender transmits media stream according to its own schedule
  - Receivers “tune into a media stream” of interested
  - Receivers have no means to influence the transmission
  - Suitable for multicast / broadcast networks
- Interactive streaming
  - Sender provides media stream to receivers “on demand”
  - Receivers may start / stop transmission
  - Receivers may invoke further operations
    - Fast forward, search, play offset, …
  - Suitable for P2P sessions or coordinated small groups

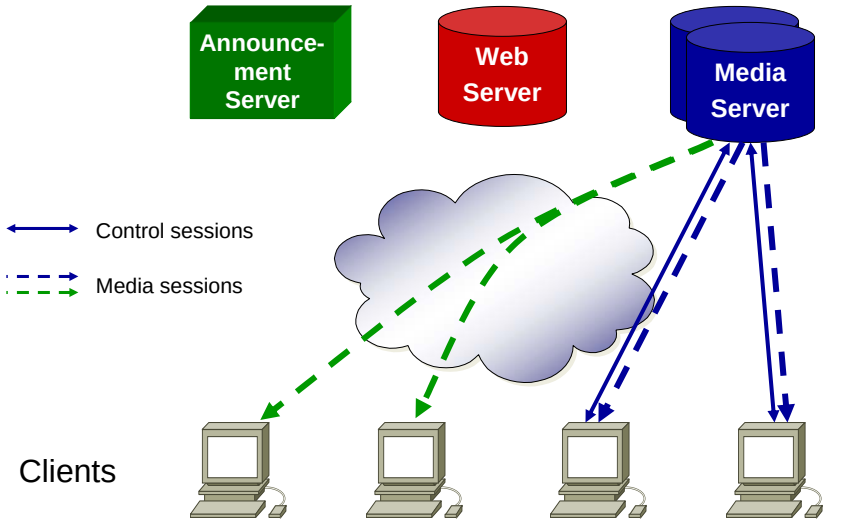
Architectural Components

- Content Description
  - Describe type of content, format, access methods, ...
  - SDP, SDPng, ...
- Content Description Delivery / Access Protocol
  - Delivers Content Description
  - HTTP, SMTP, NNTP, SAP, ...
- Content Access (= Media Streaming) Protocol
  - Initiates, controls, and terminates media streams
  - RTSP, proprietary protocols, ...
- Content Delivery (= Media Transport) Protocol
  - Carries the actual content
  - RTP/RTCP, proprietary protocols, ...

Conceptual Overview



Conceptual Overview

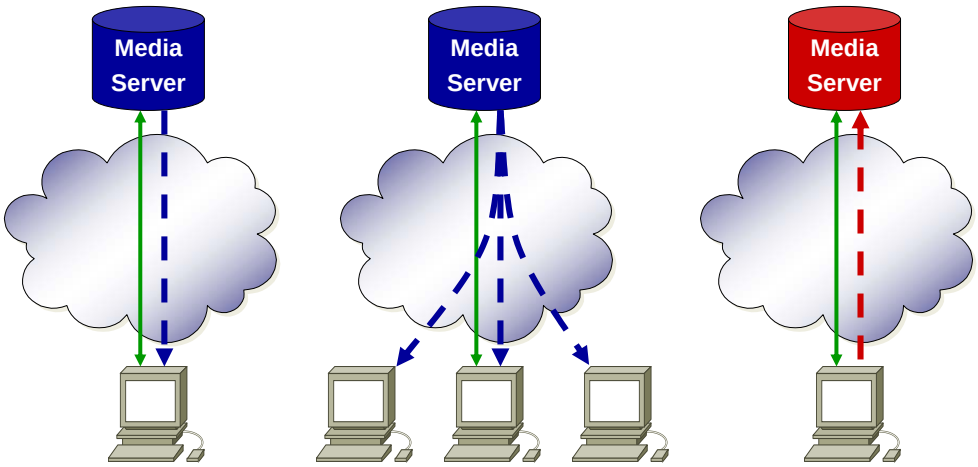


Real-Time Streaming Protocol (RTSP)

- RFC 2326 (“buggy”, “underspecified”)
- draft-ietf-mmusic-rfc2326bis-11.txt

- Interactive streaming control in the Internet
  - Media servers provide media streams to users on demand
  - Content described by presentation descriptions
- “Network Remote Control” of a media server
  - PLAY [and RECORD]
  - Numerous options for media control
    - PAUSE, faster / slower playback, selection of ranges from a stream, ...

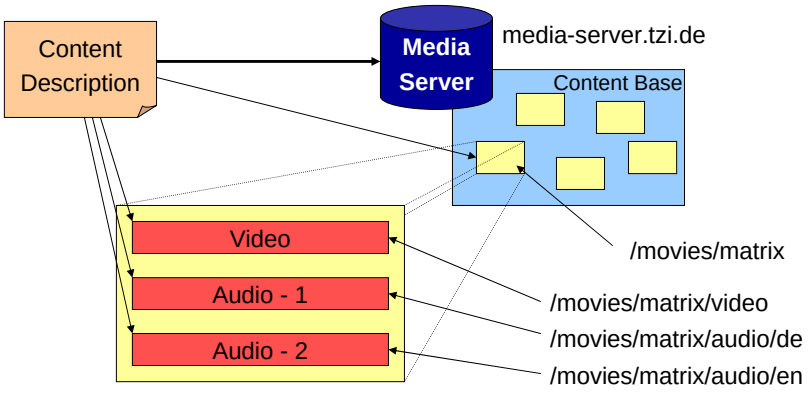
RTSP Scenarios



Protocol Characteristics

- Borrows heavily from HTTP
  - Syntax, quite a bit of semantics, parts of the architecture
- Important differences
  - Servers may issue requests, too!
    - Symmetric communication
  - Servers are stateful
  - Different methods
  - Different headers
    - But many HTTP headers re-used
  - Entities (=request/response bodies) only describe content
  - Content itself (=media) is carried out of band
    - e.g. in RTP; also support for interleaving of media with RTSP connection
- Transport: TCP [or UDP]
  - Reliability handled at the RTSP level

RTSP Components



rtsp://media-server.hut.fi/movies/matrix/audio/en

RTSP URLs

- Schemes:
  - rtsp: reliable, connection-oriented (TCP)
  - rtspu: potentially unreliable, connectionless (UDP)
  - rtsps: secure, reliable, connection-oriented (TLS)
- General scheme:
  - rtsp:// host / local identifier
- Host
  - Should be DNS name
  - Support for IPv4; IPv6 now being added
- Local Identifier
  - Opaque; may be used for aggregate / non-aggregate control

Time in RTSP

- SMPTE Timestamps
  - SMPTE = Society of Motion Picture Television Engineers
  - Measured in hours, minutes, seconds, frames, fractions (subframes)
    - 29.97 or 25 frames per second (default: 29.97)
  - Human readable HHH:MM:SS:FF.ff 3:47:09:10.25
- Normal Play Time (NPT ≠ NTP)
  - Relative to beginning of stream
  - In seconds: SS.fff 10.74
  - In human readable time: HHH:MM:SS.fff 3:47:09.314159
- Absolute Time
  - Using ISO 8601 format
  - 20021211T101435.89Z
- (RTP Media Time)
  - Media-specific clock for the RTP timestamp
  - Synchronized with absolute time via RTCP

RTSP Sessions

- Shared state between RTSP client and server
- Establish by SETUP message
- Removed by TEARDOWN
  - Or due to some timeout
- Independent of underlying TCP connections
  - TCP connections may be closed and re-opened during a single RTSP session
- Typically bound to a single presentation
  - in case of SDP, valid for one SDP session (description)
- May contain several RTP sessions
  - e.g. one per media stream

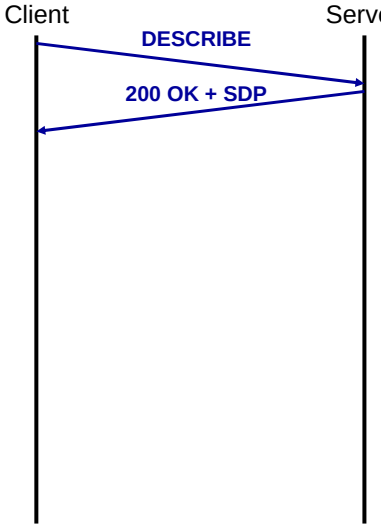
RTSP Request Message

SETUP rtsp://ms.hut.fi/movies/matrix RTSP/1.0
CSeq: 302
Date: 10 Dec 2002 15:35:06 GMT
Session: 47112344
Transport: RTP/AVP;unicast;
  client_port=4588-4589
<CRLF>
[Optional Message Body]

RTSP Response Message

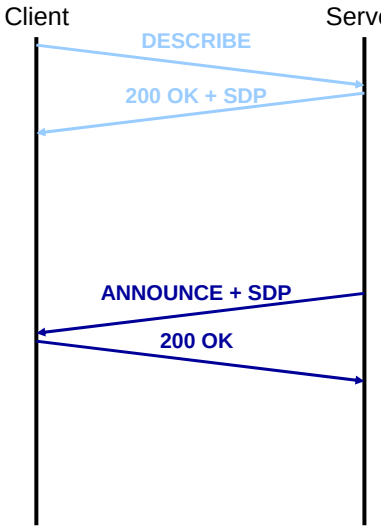
RTSP/1.0 200 OK
CSeq: 302
Date: 10 Dec 2002 15:35:07 GMT
Server: Matrix-Server 0.4.2
Session: 47112344
Transport: RTP/AVP;unicast;
client_port=4588-4589;server_port=6256-6257
<CRLF>
[Optional Message Body]

RTSP Protocol Operation: DESCRIBE



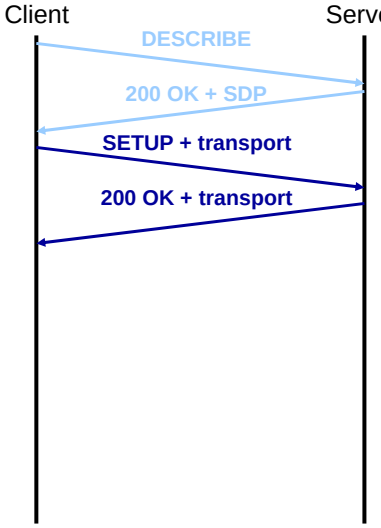
- Obtain presentation description from server
  - e.g. SDP
- Media initialization
  - Contains information about all embbeded media streams
  - Support for aggregate / non-aggregate control
  - Allows a client to determine suitability of content
  - Choose encoding if possible
- Optional: description may be obtained out-of-band

RTSP Protocol Operation: ANNOUNCE



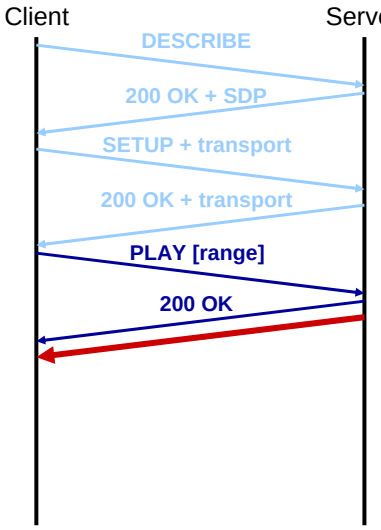
- Updates the presentation description actively from the server
  - e.g. add or remove media streams
- May be issued at any time

RTSP Protocol Operation: SETUP



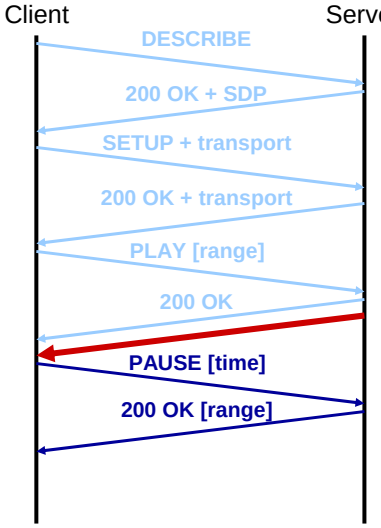
- Initiate an RTSP session
- Reserve resources at the server
  - Server may redirect to other servers (e.g. if busy)
- Convey transport parameters for media sessions
  - Negotiate transport protocol
  - e.g. RTP/UDP vs. tunneling
  - Enable firewalls to open holes

RTSP Protocol Operation: PLAY



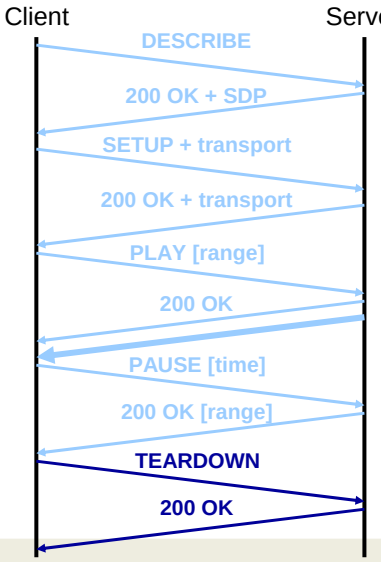
- Start streaming
- Allows to specify a variety of streaming operations
  - Range(s) to play
    - = seek operation
    - E.g. 10-20s; 30-45s; 60s-
  - Forward / backward
  - Speed
    - +3.0
    - - 2.5

RTSP Protocol Operation: PAUSE



- Interrupt streaming
  - But keep resources allocated
- May take effect
  - Immediately or
  - At a specified point in time
- PLAY may be used to resume streaming

RTSP Protocol Operation: TEARDOWN



- Stop streaming
- Terminate RTSP session
  - Free resources
- Takes effect immediately

RTSP Methods

- OPTIONS
- DESCRIBE, ANNOUNCE
- SETUP, TEARDOWN
- PLAY, PAUSE
- REDIRECT
  - May be used by a server to refer a client to a different location
- GET_PARAMETER
  - Retrieve parameter value specified in the header (in the Session: context)
    - Returned in 200 OK response body as “Name: value” pairs
  - May be used for keep-alive purposes
- SET_PARAMETER
  - Set value of parameter(s) per response body (“Name: value” pairs)
- [RECORD]
  - Record a media stream at a server
  - Underspecified, not really suppored, now removed from base spec

RTSP General Header Fields

(For reference only)

- Cache-Control:
- Connection:
- CSeq:
- Date:
- Timestamp:
- Via:

RTSP Request Header Fields

(For reference only)

- Accept:, Accept-Encoding:, Accept-Language:
- Authorization:
- Bandwidth:
- Blocksize:
- From:
- If-Modified-Since:
- Require:, Proxy-Require:, Supported:
- Referer:
- Scale:, Speed:, Range:
- Session:
- Transport:
- User-Agent:

Some Response Status Codes

- 100 Continue
- 200 OK / 201 Created
- 300 Multiple Choices
- 301 Moved Permanently / 302 Moved Temporarily
- 304 Not Modified
- 305 Use Proxy
- 400 Bad Request
- 401 Unauthorized / 407 Proxy Authentication Required
- 403 Forbidden
- 404 Not Found
- 405 Method Not Allowed / 406 Not Acceptable / 408 Request Timeout
- 451 Parameter Not Understood
- 454 Session Not Found
- 455 Method vot valid in this State / 457 Invalid Range
- 461 Unsupported Transport
- 500 Internal Server Error / 501 Not Implemented / 551 Option not Supported

Response Header Fields

(For reference only)

- Accept-Ranges:
- Proxy-Authenticate: / WWW-Authenticate:
- Public:
- Location:
- Range: / Scale: / Speed:
- Retry-After:
- RTP-Info:
- Transport:
- Unsupported:
- Vary:
- Session:

Entities

- Entities contained in RTSP messages are typically presentation descriptions
  - e.g. an SDP message
    (Content-Type: application/sdp)
  - Should always fully specify the media stream(s)
- Header fields:
  - Content-Length:, Content-Type:, Content-Encoding:, Content-Base:, Content-Location:, Content-Language:
  - Allow:
  - Last-Modified:, Expires:

Interleaving

- RTSP should use RTP/UDP for media streaming
  - Not always feasible (e.g. firewall, see next slide)
- Interleaving of RTSP and media data
  - Escape binary data (“$”)
  - Define multiple “channels”
  - Specify packet length in binary
  - Yields a four byte header:

$	ch	length

    - Interleaved with RTSP messages
    - Starts right after previous message
    - Length used to determine how many bytes to skip / pass

RTSP 2.0

- Presently under development (well advanced)
- draft-ietf-mmusic-rfc2326bis-11.txt
- Tons of editorial changes (readability, coherence, …!)
- Better state machine descriptions
- Updated (more coherent) semantics for various header fields
  - Significant alignment with SIP based upon experience gained there
- RECORD disappeared from base spec
  - Was underspecified anyway
- Support for NAT traversal upcoming
  - draft-ietf-mmusic-rtsp-nat-04.txt

Firewall Friendliness

- Several means to support RTSP across firewalls
  - Interleaving support
  - Transport: header indicates port numbers, IP addresses, …
    - Firewall logic does not need to parse SDP format
  - SOCKS support
- Still may be insufficient
  - Firewalls may block RTSP in the first place
  - “Last resort”: HTTP tunneling
    - Really bad (dubious!)
    - Boils down to a competition between firewall vendors and application developers
    - Defeats the purpose of a firewall in the first place
  - Nevertheless: widely deployed (“HTTP streaming”)
    - Apple, Microsoft, …

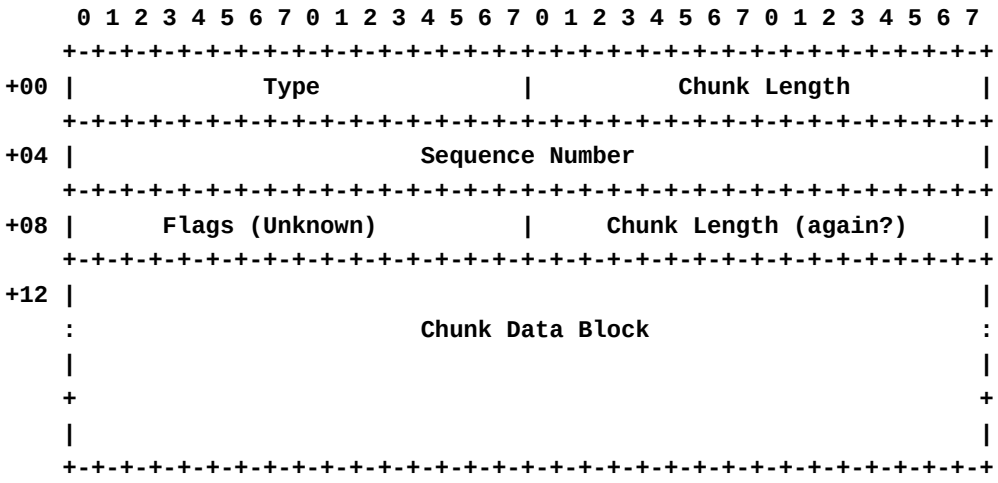
RTSP: Implications for Session Descriptions

- Session Announcements (SAP)
  - Session Descriptions (SDP) specifies fixed parameter set
  - May be updated by the server later on
- HTTP-based retrieval of session information
  - SDP specifies fixed parameter set or alternatives
  - Client gets to choose one of these
- RTSP-based session initiation
  - SDP from server describes set of alternatives
  - Clients may choose which one to use
  - Both sides may update their offering / choice later
- Need for negotiating session parameters
  - Both side may provide suggestions, make choices, and update these
  - Particularly relevant for interactive communications
- Generalized Offer/Answer model for SDP + negotiation with SDPng

“HTTP Streaming”

- Tunneling media and control in an HTTP connection
- Simplest case
  - Start replay before download is complete
  - No extensions needed
  - Mainly client-side operation
  - But: server needs to use appropriate media file format
- Alternative: add additional headers (MS)
  - Preserve packetization of media within a TCP connection

MS HTTP Streaming Format



Sample Request Header (1/2)

GET test.asf HTTP/1.0
Accept: */*
User-Agent: NSPlayer/4.1.0.3856“
Host: media_host
Pragma: no-cache,rate=1.000000,stream-time=0,stream-offset=0:0,
request-context=1,max-duration=0
Pragma: xClientGUID={c77e7400-738a-11d2-9add-0020af0a3278}
Connection: Close

Sample Request Header (2/2)

GET test.asf HTTP/1.0
Accept: */*
User-Agent: NSPlayer/4.1.0.3856
Host: media_host
Pragma: no-cache,rate=1.000000,stream-time=0,
stream-offset=0:0,request-context=2,max-duration=40“
Pragma: xPlayStrm=1
Pragma: xClientGUID={c77e7400-738a-11d2-9add-0020af0a3278}
Pragma: stream-switch-count=1
Pragma: stream-switch-entry=ffff:1:0
Connection: Close

Sample Response Header

HTTP/1.1 200 OK
Content-Type: application/octet-stream
Server: Cougar 4.1.0.3920
Cache-Control: no-cache
Pragma: no-cache
Pragma: features="stridable"