Session Announcements
(SAP, RFC 2974)

Session Description
(SDP, RFC 2327)
(SDP, RFC 4566)

Slide contributions by Dirk Kutscher (Uni Bremen TZI)

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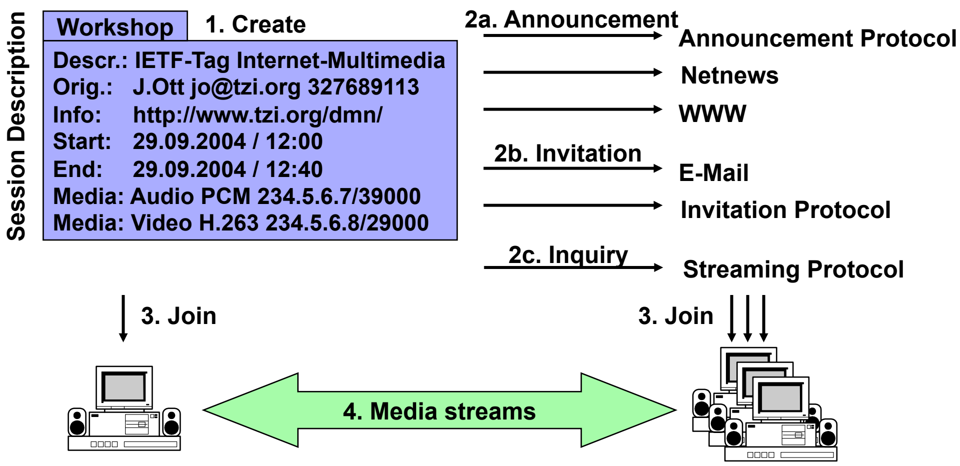
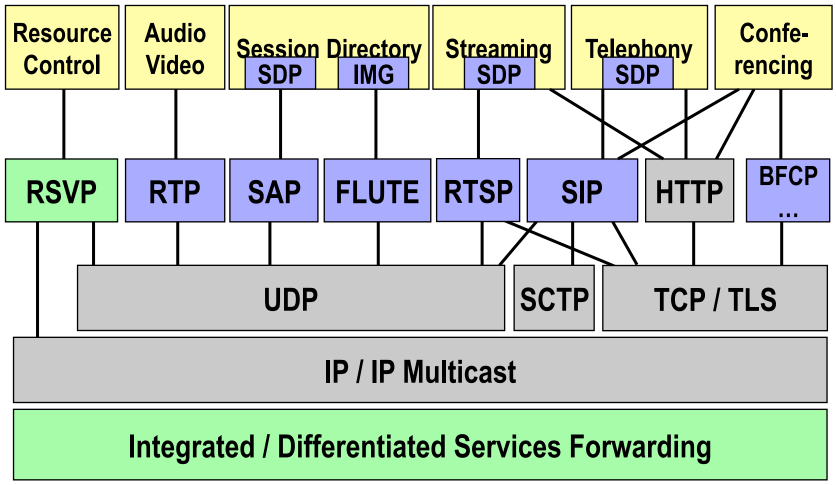
Conference Establishment & Control



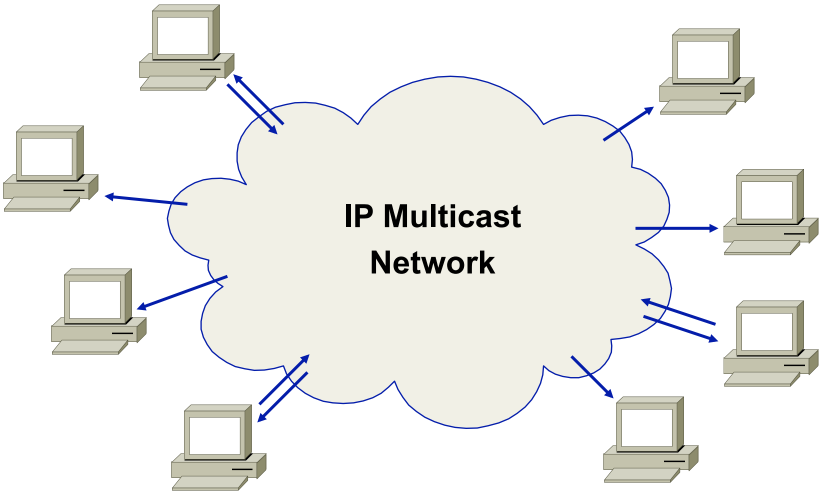
IETF Multimedia (Conferencing) Architecture



Session Announcement Protocol (SAP)

- Announcing multimedia sessions to a broad audience
- Session announcements contain SDP
  - Subject of the session
  - Date(s) and time(s)
  - Media streams and addresses
  - Further information
- SAP Functions
  - New session announcements
  - Modify announcements
  - Delete announcements
  - Support for relays
- Earlier: Coordinate use of multicast address space

SAP Scenario



Dissemination of SAP Announcements

- Scope of Announcements
  - Per (administratively defined) multicast address scope
  - Local: 239.255.0.0/16
  - Organization local: 239.192.0.0/14
  - SAP conferences: 224.2.0.0 – 224.2.127.253
  - Other: Global
  - Similar considerations for IPv6
    - Scope identifier built-in into the IPv6 address structure
- SDP descriptions should use addresses of same scope
  - To ensure that receivers can also receive the media streams if they can receive the announcements

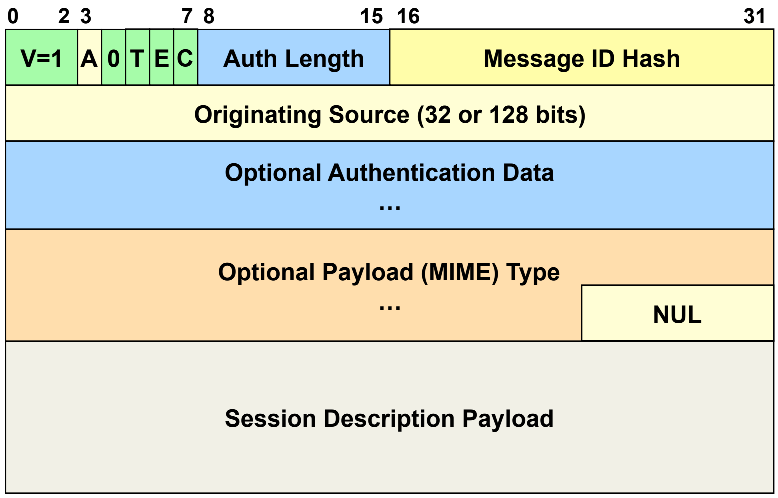
SAP Features

- Limited announcement bandwidth per scope
  - e.g. 4000 bit/s (defined per scope)
- Calculation algorithm roughly similar to RTCP
  - Measure incoming SAP packets per scope
    - Sizes, number of announcements
  - Calculate size of own announcements
  - Estimate available share of bandwidth
  - Calculate own transmission interval
    - Use dithering (± 1/3 of the interval)
    - Timer reconsideration before transmitting

(New) Announcements

- SAP uses UDP/IP: no reliability
- Repeat announcements in “regular” intervals
- Intervals: in the order of minutes
  - e.g. minimum 5 min
- Announcements for easy comparison identified by
  - Source IP address (of the creator)
  - 16 bit hash value
- May be authenticated (creator authentication)
- May be encrypted
- May be compressed
- May contain different payload types (SDP is just one)

SAP Packet Format



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SAP Header Fields (1)

V: Version — =1 for SAPv2

A: Address type — =0 IPv4 source address
=1 IPv6 source address

T: Type — =0 Announcement packet
=1 Deletion packet

E: Encrypted — indicates encryption of the

C: Compressed — indicates that the announcement packet is compressed

Auth Length — Length of the authentication header (0 = no authentication)

SAP Header Fields (2)

Message ID Hash	—	Unique value per session creator
Originating Source	—	IP address of session creator
Authentication Data	—	Source Authentication information (PGP and CMS formats defined so far)
Payload MIME Type	—	NUL-terminated text string indicating the MIME type of the payload Default: application/sdp

Deleting Announcements

- Explicit Timeout
  - No need to announce sessions after the “end time” in SDP
  - Caveat: the SAP receivers and relays need to understand SDP
- Implicit Timeout
  - Receiver observe repetition of announcement
  - After 10 times the announcement interval (or one hours) with re-announcement the session is removed
- Explicit Deletion
  - Send Deletion packet for a session
  - Message ID Hash and Originating Source must match
  - SHOULD be authenticated (match the original announcement)

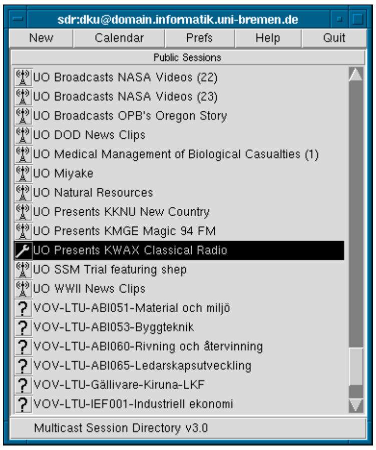
Modifying Announcements

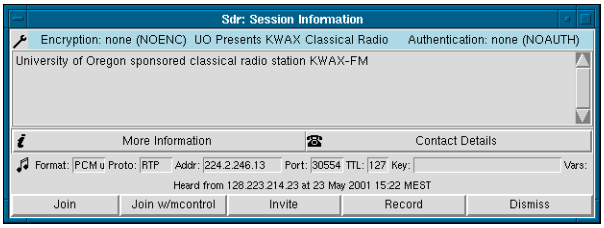
- Replace an existing session description
  - E.g. modify media or start / end times
  - Update description
- Message ID Hash MUST change
- Modifying announcement MUST be authenticated if and only if the original announcement was
- If in doubt, a new session is "created"
  - Prevent denial-of-service attacks
- If proper match is found, the old session information is simply replaced by the new one

SAP Security

- Encrypted messages for secure information distribution
  - Should be only used with limited size receiver groups
  - Avoid waste of computation resource if many receivers cannot decrypt the message
  - Key distribution out-of-scope
  - Limited applicability, limited usefulness
- Authentication
  - SHOULD always be done
  - Enables at least to verify that two messages are from the same source
  - Proper source authentication requires PKI
- General observation
  - Both is rarely used in practice
  - Current use of SAP in the Internet does not justify the effort...

Session Announcement Tool: SDR





Session Description Protocol (SDP)

- All you need to know about a session to join
  - who? — convener of the session + contact information
  - what about? — name and informal subject description
  - when? — date and time
  - where? — multicast addresses, port numbers
  - which media? — capability requirements
  - how much? — required bandwidth
- Grouped into three categories
  - 1 x session, m x time, n x media

Session Level Description

v=0 Version
o= Owner / creator of the session + unique identifier + version
u= URL for further information
e= Contact email address
p= Contact phone number
b= Bitrate information
k= Encryption key information
z= Time zone adjustment
a= Attribute lines (for extensions)
c= Connection (=address) information

Time Description

- Start and end time(s) of a session
  - Plus time zone adjustment
- Regular repetitions
  - Every Tuesday and Thursday, 10 – 12
  - Every day
- Arbitrary repetitions
  - Repeated specification of t= lines

t= Start, end time (NTP seconds, special case: 0, 0)
r= Repetitions (interval, duration, offsets)

Media Description

- Define the media streams comprising a conference
  - Media type (audio, video, text, tones, application, ...)
    - Only audio, video, text, tones are well-defined
  - (multicast) address(es) + port number
  - Maps RTP payload types for media to encoding formats
  - Other media level attributes

m=	Media and port specification
c=	IP address specification (inherited from session)
a=	Attributes for this media stream rtpmap:, fmtp:, recvonly, portrait | landscape

SDP Example

Length of Time represented by Media in a single Packet

(In SIP: address where originator wants to receive data)

```
v=0
o=llynch 3117798688 3117798739 IN IP4 128.223.214.23
s=UO Presents KWAX Classical Radio
i=University of Oregon sponsored classical radio station KWAX-FM
u=http://darkwing.uoregon.edu/~uocomm/
e=UO Multicasters multicast@lists.uoregon.edu
p=Lucy Lynch (University of Oregon) (541) 346-1774
t=0 0
a=tool:sdr v2.4a6
a=type:test
m=audio 30554 RTP/AVP 0
c=IN IP4 224.2.246.13/127
a=ptime:40
```

Session Level

Media Level

Session Management Attributes

- Signaling the RTCP port (RFC 3605)
  - Motivation: RTP and RTCP port number may not be adjacent
  - `a=rtcp:<port> [<nettype> <addrtype> <addr>]`
  - `a=rtcp:60004 [IN IP4 192.168.11.12]`
- Signaling multicast sources (IMGPv3, SSM)
  - `a=src-filter:incl IN IP4 232.3.4.5 192.168.1.89`
  - `a=src-filter:excl IN IP4 225.3.4.5 192.168.1.89 192.168.6.66`
- Session bandwidth (independent of lower layers, RFC 3890)
  - `b=TIAS:64000`
  - `a=maxprate:40.0`
- RTCP bandwidth (modify sender/receiver share, RFC3556)
  - `b=RS:1600`
  - `b=RR:14400`

Session Description and Capability Negotiation

From Session Announcement
to Session Invitation

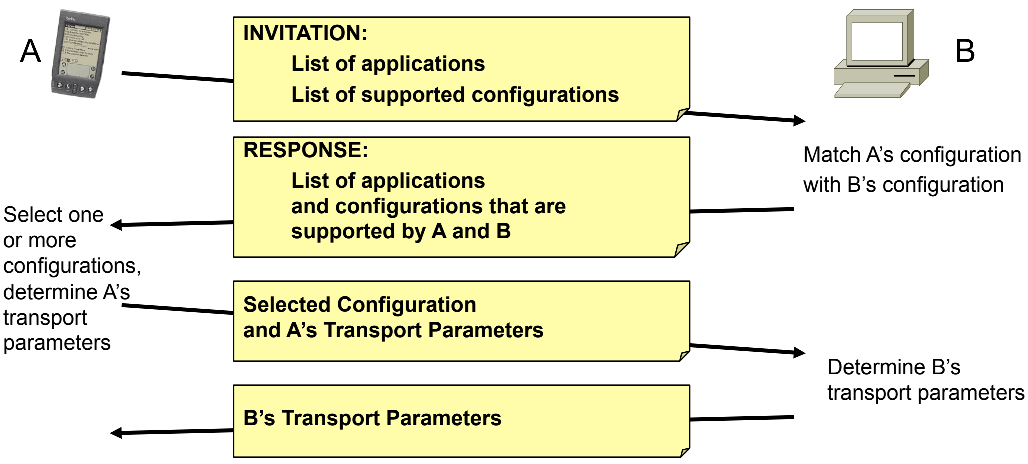
Characteristics of SAP Announcements

- Common view
  - Every SAP-receiver sees the same description
    - Session meta information & scheduling
    - Media description & transport parameters
- Identical transport parameters for all participants
  - IP-Multicast service model:
    - Senders send to a multicast group (IP address)
    - Receivers join ("tune into") a multicast group

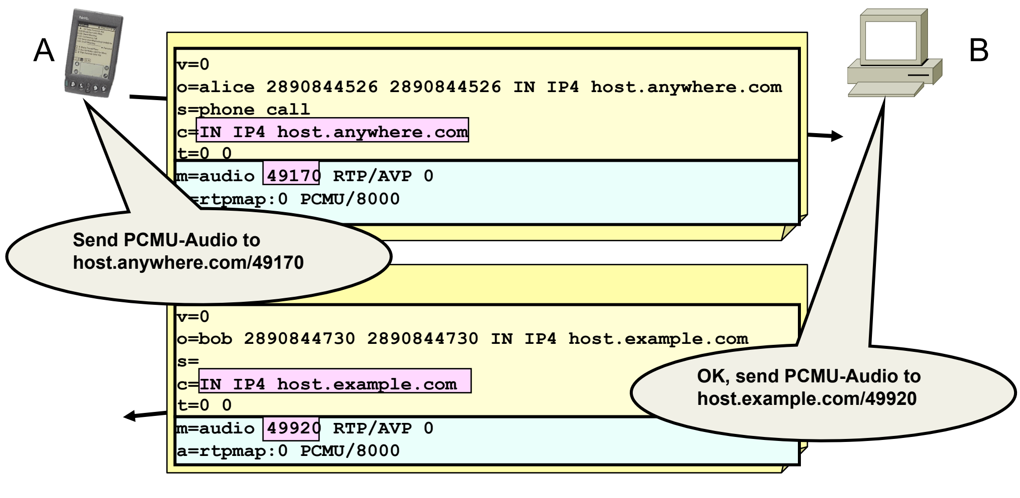
Session Initiation

- Distribute conference configuration
  - Applications
    - Media types, media format parameters
  - Transport Parameters
    - IP addresses, transport protocols, protocol parameters
- Negotiate Parameters!
  - Heterogeneous end systems
    - Different hardware and software capabilities
  - User preferences
- SDP provides syntax mechanisms to express parameters
  - Procedural model for initiation required

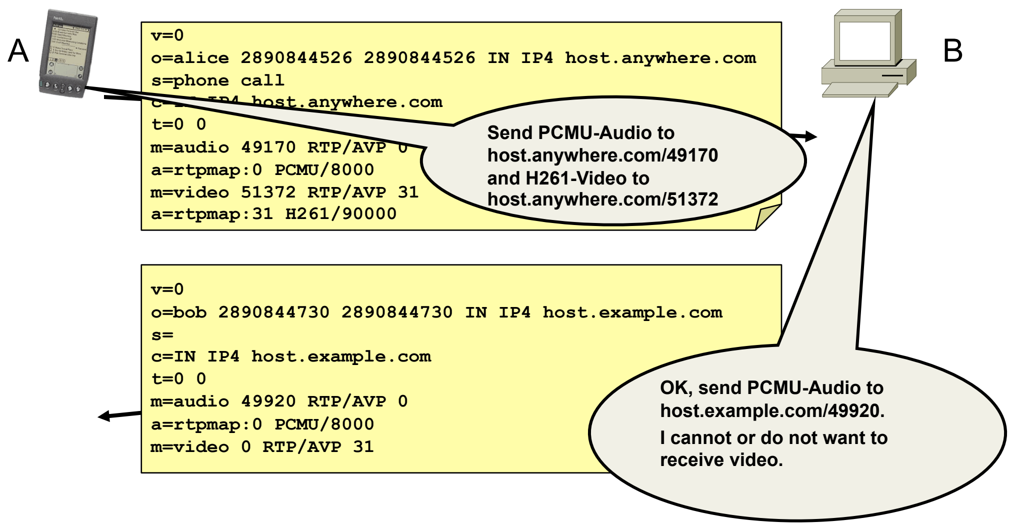
Invitation: Conceptual Model



Session Initiation with SDP (1)



Session Initiation with SDP (2)

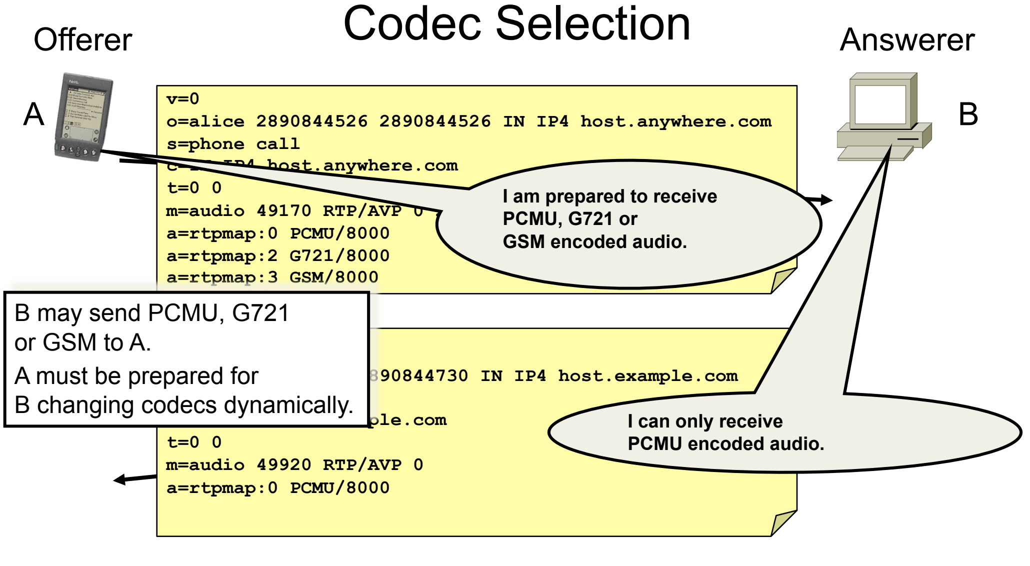


SDP Offer/Answer Model (RFC 3264)

- For initiation of unicast sessions
- Objective: generate common view of session configuration
- Simple exchange of capability descriptions

- Basic Model:
  - A sends offer to B, including
    - Set of media streams and codecs A wishes to use
    - Transport parameters (where A wants to *receive* data)
  - B sends answer to A
    - For each stream in offer, indicating whether stream is accepted or not
    - For each stream add transport parameters (where B wants to *receive* data)

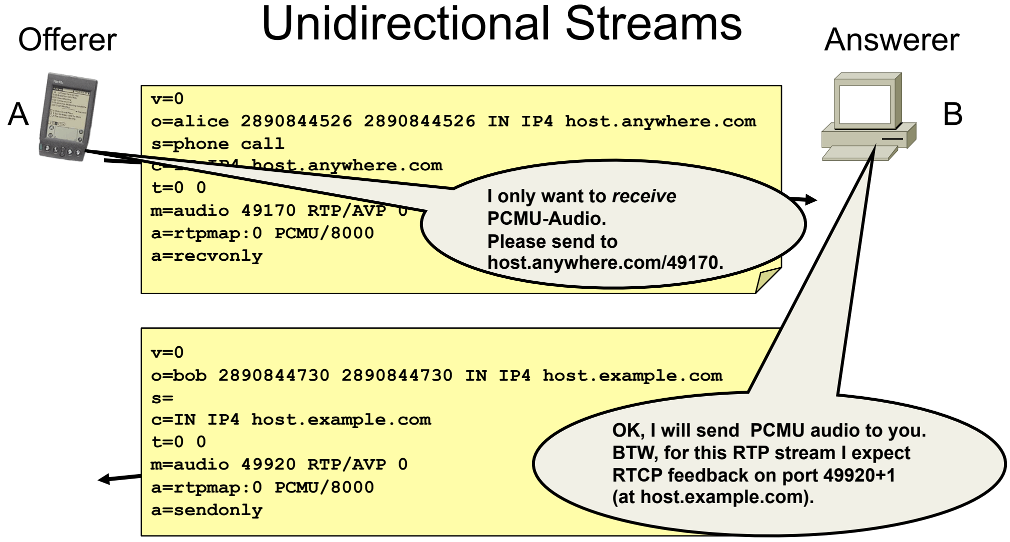
Codec Selection



Codec Selection

- Offer can provide multiple codecs for a media stream.
  - Ordered by preference
  - Offerer commits to support all codecs (one at a time)
  - Answerer should generate list of codecs for each stream, maintaining payload type mapping
  - New codecs may be added
- One of N codec selection
  - Offer multiple codecs, but cannot change dynamically
  - Offerer sends codec list “with reservation”
  - Answerer sends back subset
  - Offerer “locks” one codec for session
  - Implemented with `a=inactive` media level attribute…

Unidirectional Streams



Send/Receive Only

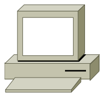
- Media streams may be unidirectional
  - Indicated by *a=sendonly*, *a=recvonly*
- Attributes are interpreted from sender's view
- sendonly
  - Recipient of SDP description should not send data
  - Connection address indicates where to send RTCP receiver reports
  - Multicast session: recipient sends to specified address
- recvonly
  - Sender lists supported codecs
  - Receiver chooses the subset he intends to use
  - Multicast session: recipient listens on specified address
- inactive
  - To pause a media stream (rather than deleting it)

Codec Selection

Offerer

A 

Answerer

 B

```
v=0
o=alice 2890844526 2890844526 IN IP4 host.anywhere.com
s=phone call
c=IN IP4 host.anywhere.com
t=0 0
m=audio 49170 RTP/AVP 0 2 3
a=rtpmap:0 PCMU/8000
a=rtpmap:2 G721/8000
a=rtpmap:3 GSM/8000
```

```
v=0
o=bob 2890844730 2890844730 IN IP4 host.example.com
s=
c=IN IP4 host.example.com
t=0 0
m=audio 49920 RTP/AVP 0
a=rtpmap:0 PCMU/8000
```


Example SDP Alignment

```
v=0
o=jo 7849 2873246 IN IP4 ruin.inf…
s=SIP call
t=0 0
c=IN IP4 134.102.218.1
m=audio 52392 RTP/AVP 98 99
a=rtpmap:98 L8/8000
a=rtpmap:99 L16/8000
m=video 59485 RTP/AVP 31
a=rtpmap:31 H261/90000
```

```
v=0
o=cabo 82347 283498 IN IP4 dmn.inf…
s=SIP call
t=0 0
c=IN IP4 134.102.218.46
m=audio 49823 RTP/AVP 98
a=rtpmap:98 L8/8000
m=video 0 RTP/AVP 31
```

Resulting configuration:

Grouping of m= lines in SDP

- Observation:
  - Multiple m= lines in SDP have no relationship to each other
    - Independent media streams
    - usually different media types
- Problem:
  - Want to express synchronization relationship
    - Lip synchronization
  - Concept of "flows" that consist of several media streams
    - Streams encoded in several formats
    - May be streamed from different hosts/ports
    - Useful application in some IP telephony scenarios

Example for Lip Synchronization

Stream 1 and 2 should be synchronized.

```
v=0
o=Laura 289083124 289083124 IN IP4 one.example.com
t=0 0
c=IN IP4 224.2.17.12/127
a=group:LS 1 2
m=audio 30000 RTP/AVP 0
a=mid:1
m=video 30002 RTP/AVP 31
a=mid:2
m=audio 30004 RTP/AVP 0
i=This media stream contains the Spanish translation
a=mid:3
```

ANAT Grouping

- Alternative Network Address Types (RFC 4091)
  - Allows expressing IPv4 and IPv6 address alternatives

```
v=0
o=bob 280744730 28977631 IN IP4 host.example.com
s=
t=0 0
a=group:ANAT 1 2
m=audio 25000 RTP/AVP 0
c=IN IP6 2001:DB8::1
a=mid:1
m=audio 22334 RTP/AVP 0
c=IN IP4 192.0.2.1
a=mid:2
```


FEC Grouping

- Group basic and FEC data (draft-ietf-mmusic-fec-grouping-05.txt)

```
v=0
o=adam 289083124 289083124 IN IP4 host.example.com
s=ULP FEC Seminar
t=0 0
c=IN IP4 224.2.17.12/127
a=group:FEC 1 2
a=group:FEC 3 4
m=audio 30000 RTP/AVP 0
a=mid:1
m=application 30002 RTP/AVP 100
a=rtpmap:100 ulpfec/8000
a=mid:2
m=video 30004 RTP/AVP 31
a=mid:3
m=application 30004 RTP/AVP 101
c=IN IP4 224.2.17.13/127
a=rtpmap:101 ulpfec/8000
a=mid:4
```

Further Groupings

- Alternative RTP profiles
  - Dealing with combinatorial explosion of options
  - E.g. AVP and AVPF, AVP and SAVP
- Layered coding and scalable (video) coding
  - Convey dependencies across different RTP sessions
- …

Simple Capability Declaration in SDP

- Observation:
  - Capability negotiation/declaration in SDP too limited
  - Session description describe both session parameters and capabilities without clear distinction
  - Simultaneous capability restrictions cannot be expressed
    - *“Supporting multiple codecs for one media type, but only one per session”*
- Simcap: add SDP attributes to explicitly express capabilities

Simcap Example

Sender is willing
to receive and send
G.729 (18)
and telephone-events.

Additionally, it declares the following capabilities:

- PCMU-Audio (0)
- telephone-events (different events)
- Fax-Relay over UDP and TCP

```
v=0
o=- 25678 753849 IN IP4 128.96.41.1
s=
c=IN IP4 128.96.41.1
t=0 0
m=audio 3456 RTP/AVP 18 96
a=rtpmap:96 telephone-event
a=fmtp:96 0-15,32-35
a=sqn: 0
a=cdsc: 1 audio RTP/AVP 0 18 96
a=cpar: a=fmtp:96 0-16,32-35
a=cdsc: 4 image udptl t38
a=cdsc: 5 image tcp t38
```


Simcap Example

Semantics:

- a=sqn: declares a sequence number
- a=cdsc: declare one or more capabilities
- a=cpar: additional parameters for a declaration


```
v=0
o=- 25678 753849 IN IP4 128.96.41.1
s=
c=IN IP4 128.96.41.1
t=0 0
m=audio 3456 RTP/AVP 18 96
a=rtpmap:96 telephone-event
a=fmtp:96 0-15,32-35
a=sqn: 0
a=cdsc: 1 audio RTP/AVP 0 18 96
a=cpar: a=fmtp:96 0-16,32-35
a=cdsc: 4 image udptl t38
a=cdsc: 5 image tcp t38
```

Connection-oriented Media with SDP

- Focus on TCP (RFC 4145) and TLS (RFC 4572)
- In contrast to UDP, a connection must be established
  - Who is to initiate setup, who is to listen?
    - `a=setup: active | passive | actpass | holdconn`
  - What if a connection already exists (e.g., when renegotiating)
    - Keep the existing connection?
    - Set up a new one?
    - `a=connection: new | existing`
  - When to tear down a connection?
    - If a "new" one is specified, close an existing one
- Relies on interactive agreement on how to proceed

Labeling media streams

- Unique identification
  - Across SDP session descriptions
    - Contrast to mid (which is valid within a session only)
  - `a=label:<token>`
  - No semantics
- Attaching stream semantics
  - Usually relevant within an SDP session
  - Hint at stream semantics
    - E.g., if multiple media streams are received: which is which?
  - `a=content:<token>`
  - `token=slides | speaker | sl | main | alt | user-floor | …`

SDP Extensions: There is more…

- Precondition signaling for media streams
  - Security
  - QoS
  - Connectivity
- Key management (fixing k=)
  - End-to-end key negotiation
  - End-to-end key distribution (via a protected channel)
- And support for further media types
  - Multicast file distribution, application sharing, …
- Will be discussed in the context of signaling protocols

Summary So Far

- SDP syntax can be used for session initiation
  - But requires additional specification of procedures: Offer/Answer
- SDP & Offer/Answer not appropriate for all usage scenarios
  - Fundamental SDP problem of combining configuration descriptions with capability declaration
  - Lack of expressiveness: grouping of media streams
  - “a=“ only a limited extension mechanism
- SDP Syntax
  - Limited expressiveness and cumbersome extensibility

SDP Syntax Issues

- Basic set of description elements for media sessions
  - IP addresses, port numbers, RTP payload types, parameters
- Extensibility: new session / media level attributes
  - `a=<keyword>:<value> ...`
  - Senders can use arbitrary attributes:
    - Important attributes cannot be distinguished from unimportant ones
    - Name clashes (misinterpretation) cannot be excluded
  - In principle, allows for any kind of extension
    - Grouping, constraints, …
- SDP workarounds rather clumsy, inefficient, …

Fixing SDP…

- The grand idea (in 1999): SDPng
  - More expressiveness
    - For individual media and their combination
    - Often only very basic media descriptions available
  - Real negotiation functionality
  - Extensibility
  - More explicit (e.g., semantics for media sessions)
- Major issue: syntax choice (XML)
  - Not backwards-compatible (deployment, vendor know-how, code re-use)
  - Back in the late 1990s, XML considered “too expensive” for endpoints
- Result: no buy-in from vendors → little motivation → dead
- But: conceptual elements survived

Intelligent Endpoints

- Intelligent endpoints with support for
  - Multiple codecs and format parameters
  - Different applications (e.g., audio, DTMF, video, games)
  - Many transport parameters
    - RTP/UDP/IPv4, RTP/UDP/IPv6, Security, Source-Specific-Multicast…
  - AAA & security parameters

Must be expressible in configuration descriptions!

Intelligent Endpoints

- Heterogeneous end systems
  - Different capabilities
  - Different user preferences
  - Dynamic configuration

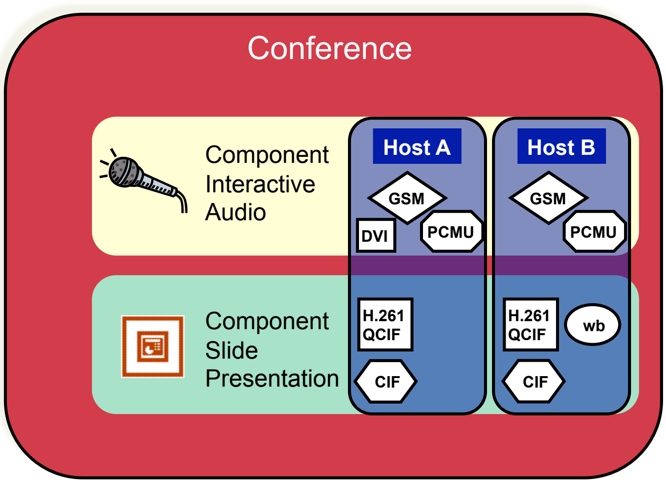
Interoperability requires dynamic negotiations of parameters!

Specific Requirements

- Expressiveness
  - Describe all required configuration parameters
- Extensibility
  - No fixed parameter set
  - Profiles (“packages”) for new configuration parameters
- Support for Negotiation
  - Derive commonly supported configurations from individual configuration descriptions (for n ≥ 2)
- Compatibility
  - Drop-in replacement for SDP in SIP applications

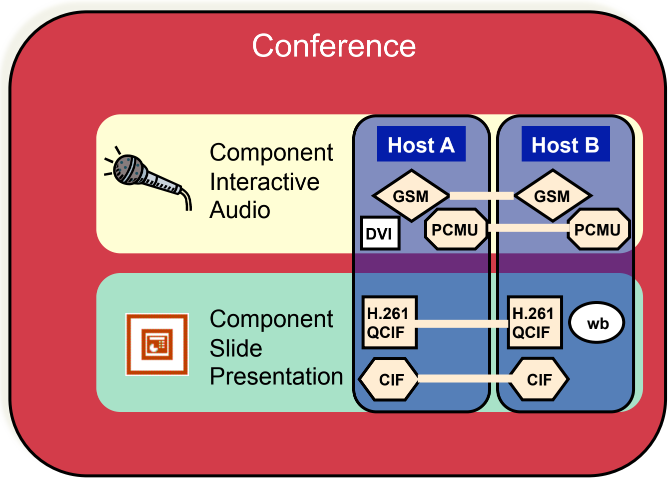
SDPng’s Conference Model

- Components in a conference
  - Individual cooperation functions
  - Characterized by the service they provide (not by their technical implementation)
- Implementations of components
  - Depend on endpoint capabilities and user preferences
  - Use of implementations must be configured or negotiated



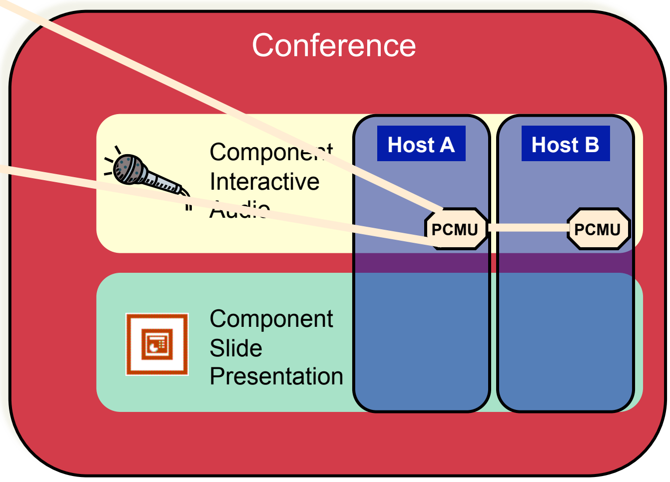
Potential Configurations

- Configurations for implementing a component
  - Common capabilities
  - Not a complete conference description, e.g., no transport parameters
  - Dynamic set of parameters
    - Can change over the course of a conference



Actual Configurations

```
address=192.168.1.1
port=37000
codec-type=PCMU
payload-type=0
…
```

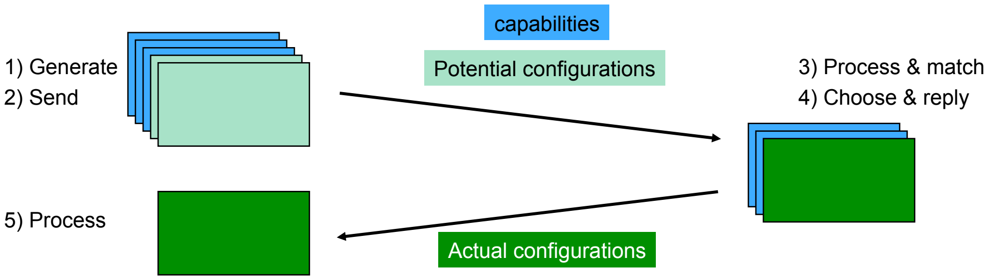


- Complete specification of conference parameters
  - Selected subset of potential configurations
  - Complemented with
    - Media format parameters
    - Transport parameters

SDP Capability Negotiation

draft-ietf-mmusic-sdp-capability-negotiation-09.txt

- Four elements
  - Definition of capabilities
  - Proposing potential configurations
  - Agreeing on actual configurations
  - Negotiation process
    - Based upon the SDP offer/answer model



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Mapping to SDP…

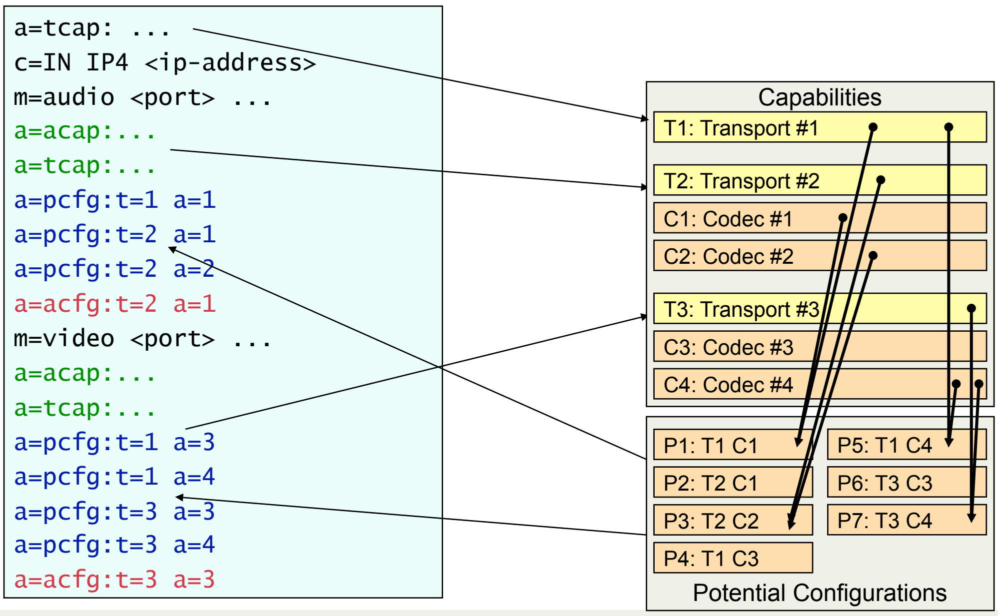
- Reminder

```
m=audio 54321 AVP/RTP 0 8 96
a=rtpmap:96 g729
a=...
m=video 54545 AVP/RTP 32
a=...
```

- Requirements
  - Must be expressed in SDP syntax
  - Backwards compatibility
  - Operate in one round-trip (offer/answer exchange)
  - Extensible
  - Not too verbose (messages can already grow quite large)
  - …

Basic Approach and Syntactic Elements

- Backwards compatibility leaves SDP attributes as the only option
- Extensibility: feature tags
  - Supported: `a=csup:foo,bar,crunch`
  - Required: `a=creq:zompel`
- Capability descriptions
  - Transport capability: `a=tcap:<n> RTP/AVP`
  - Media level attribute: `a=acap:<m> rtpmap …`
- Configuration negotiation
  - Potential configuration: a=pcfg:<k> <n> <m>
  - Actual configuration: a=acfg:<k> <n> <m>
- Offer/answer extension allowing to include capabilities



Litmus Test Example: Optional Security

- Offerer supports secure media streams (preferred)
  - Yet, wants to allow fallback to insecure communications for compatibility
  - Does not want to wait for an extra round-trip

Offer

```
v=0
o=- 25678 753849 IN IP4 192.0.2.1
s=
c=IN IP4 192.0.2.1
t=0 0
m=audio 53456 RTP/AVP 0 1
a=tcap:1 RTP/SAVP
a=acap:1 crypto:1 AES_CM_
   inline:NzB4d1BINUAvLEw
a=pcfg:1 t=1 a=1
```

Answer

```
v=0
o=- 24351 621814 IN IP4 192.0.2.2
s=
c=IN IP4 192.0.2.2
t=0 0
m=audio 54568 RTP/SAVP 0 18
a=crypto:1 AES_CM_128_HMAC_SHA1_80
      inline:PS1uQCVeeCFCanVm...|2^20|1:4
a=acfg:1 t=1 a=1
```

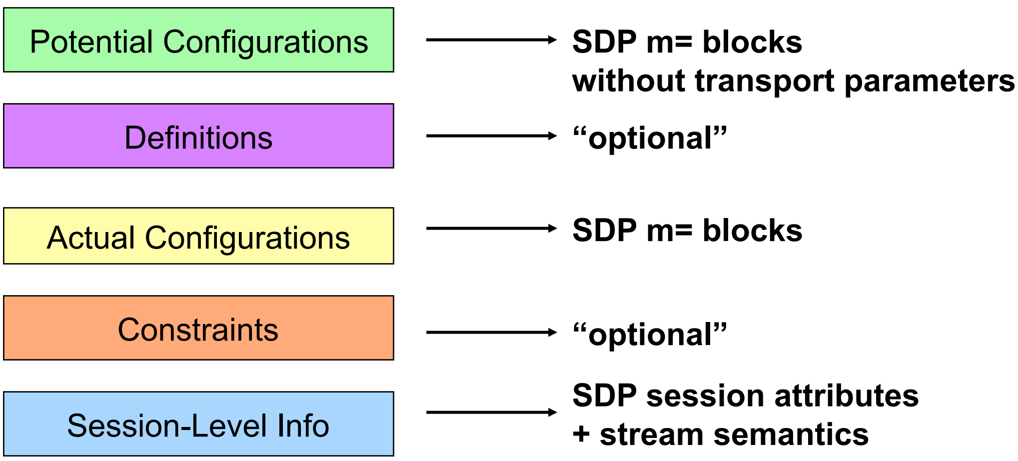

More Syntax and Semantics

- Multiple transport mechanisms in the order of preference
  - a=tcap:SAVP/RTP AVP/RTP
- Referring to multiple attributes
  - a=pcfg:t=1 a=1,3,4,5,6,8
- Alternatives in potential configurations
  - a=pcfg:t=3|4 a=1|2
- Optional capabilities
  - a=pcfg:t=1 a=1,[2],3
- Inheritance: all attributes specified per m= line without [at]cap
  - Become part of all potential and actual configurations of this media stream

Capability Negotiation Status

- To become RFC shortly
  - With the IESG for publication.
- Coverage
  - Basic negotiation mechanisms
  - Essential feature set for alternative transports a basic parameters
  - Particularly security
- Complementary specifications
  - Media attribute sets for capability specifications
    - Do not want to inherit all the baggage from SDP
  - Discussion of further capability representation mechanisms
    - So far, all attributes are additive (to the basic attribute set)
    - Deleting or replacing attributes?
    - Syntax and interpretation are easy; generation is hard.

General SDPng Model



SDPng Structure

Potential Configurations	List of capabilities as XML elements. Only these are are processed by capability negotiation.
Definitions	Define commonly used parameters for later referencing.
Actual Configurations	Actual configurations as alternatives for each component.
Constraints	Reference configurations and express constraints on combinations
Session-Level Info	Elements for meta information on individual applications (i.e., streams, sessions), referencing configuration definitions.

SPDng: An Extensible Framework

SDPng consists of

- Base specification
  - Overall structure of SDPng documents
  - Common data types and element types
- Basic rules packages ("profiles")
  - Define how to express commonly used parameters
    - Codecs, RTP parameters etc.

} **Formally specified**

- Basic definitions ("libraries")
  - Specific codec definitions, RTP payload type definitions etc.

} **SDPng description instances**

Capability Model

- Three different types
  - Tokens:
    - `encoding=PCMU`
    - Ascertain identity || fail
  - Token lists:
    - `sampling-rate=8000,16000, 44000`
    - Determine common subset || fail
  - Numerical Ranges
    - `6 <= bitrate <= 64`
    - Determine common sub-range || fail

- Distinguish *optional* capabilities
    - `silence-suppression supported`
    - Applicable to each type, failing results in removing the capability, interoperability still possible

XML Syntax (1)

- Feature independent negotiation
  - Process capability descriptions without knowing semantics
  - Access to schema definition not required

XML Syntax (2)

- Capabilities
  - A collection of independent definitions
  - Each definition is processed independently
  - Every property is a single XML element
    - Tokens and token lists as element content
    - Numerical ranges with explicit XML attributes
    - No further substructure
    - Descriptions are still standalone

```
<audio:codec name="avp:pcmu">
  <audio:encoding>PCMU</audio:encoding>
  <audio:channels>1 2</audio:channels>
  <audio:sampling>8000 16000</audio:sampling>
  <audio:bitrate min="6" max="64"/>
  <audio:silence-suppression status="opt"/>
</audio:codec>
```


Formal Schema Definition

- Base specification
  - SDPng XML document structure
  - Basic data types (token, token lists, ranges)
  - XML-Schema as a definition mechanism

- Package definitions
  - Application specific vocabulary
  - Each package definition in unique XML namespace
  - XML-Schema as a definition mechanism

Sample Package Definition

```
<xsd:complexType name="audio:CodecT">
  <xsd:complexContent>
    <xsd:extension base="sdpng:Definition">
     <xsd:sequence>
       <xsd:element name="encoding" type="sdpng:token"/>
       <xsd:element minOccurs="0" name="channels"
                    type="sdpng:tokenlist"/>
       <xsd:element minOccurs="0" name="sampling"
                    type="sdpng:tokenlist"/>
       <xsd:element minOccurs="0" name="bitrate"
                    type="sdpng:range"/>
       <xsd:element minOccurs="0" name="silenceSuppression"
                    type="sdpng:optToken"/>
     </xsd:sequence>
    </xsd:extension>
  </xsd:complexContent>
</xsd:complexType>

<xsd:element name="audio:codec" type="audio:CodecT"
             substitutionGroup="sdpng:definition"/>
```


Specifying Configurations (1)

```
<cap>
  <audio:codec name="avp:pcmu">
    <audio:encoding>PCMU</audio:encoding>
    <audio:channels>1 2</audio:channels>
    <audio:sampling>8000 16000</audio:sampling>
    <audio:bitrate min="6" max="64"/>
    <audio:silence-suppression status="opt"/>
  </audio:codec>
  <rtp:udp name="rtpudpip6">
    <rtp:network>IP6</rtp:network>
  </rtp:udp>
</cap>
```

Specifying Configurations (2)

```
<cap>
  <audio:codec name="avp:pcmu"> […]</audio:codec>
  <rtp:udp name="rtpudpip6"> […] </rtp:udp>
</cap>

<def>
 <rtp:udp name="rtp-cfg1" ref="rtp:rtpudpip6">
   <rtp:ip-addr>::1</rtp:ip-addr>
   <rtp:port>9456</rtp:port>
   <rtp:pt>1</rtp:pt>
 </rtp:udp>
</def>
```


Specifying Configurations (3)

```
<cap>
  <audio:codec name="avp:pcmu"> […] </audio:codec>
  <rtp:udp name="rtpudpip6"> […] </rtp:udp>
</cap>
<def>
 <rtp:udp name="rtp-cfg1">[…]</rtp:udp>
</def>

<cfg>
  <component name="interactive-audio" media="audio">
     <alt name="alt1">
       <audio:codec ref="avp:pcmu"/>
       <rtp:udp ref="rtp-cfg1"/>
     </alt>
   </component>
</cfg>
```

Specifying Configurations (4)

- Each *component* (application session) element provides list of alternatives
- Each *alternative* provides definitions for the *component*
  - Referencing definitions from the capability section
    - Providing additional parameters, where required
    - Alternatives that reference non-interoperable definitions are discarded
  - List of definitions
    - No nesting of elements from different packages
  - Semantics are application-specific
    - Applications MUST know how to interpret definitions
  - No restrictions on quantity or order

Libraries

- Libraries:
  - Pre-defined definitions, e.g., a set of audio codec definitions
  - Referenced from a description document
- Semantics difficult to get right
  - Application-independent negotiation would require access to library definitions
    - Requirement to *include* library definitions into description document
    - Capability negotiation has to consider *all* definitions

➔ Forego libraries, include definitions inline

Summary

- Extensibility and dynamic negotiation are key to interoperability
  - Intelligent endpoints and new services require a capable and flexible description mechanism
- SDPng to provide interoperability *and* extensibility
  - Simple applications stay simple
  - Innovation is possible through structured extensibility
- Smooth migration from SDP to SDPng is possible
  - “Bi-lingual” endpoints and mapping of SDP to SDPng