Session Initiation Protocol (SIP)
Introduction

- A powerful alternative to H.323
- More flexible, simpler
- Easier to implement
  - Advanced features
- Better suited to the support of intelligent user devices
- A part of IETF multimedia data and control architecture
  - SDP, RTSP (Real-Time Streaming Protocol), SAP (Session Announcement Protocol)
The Popularity of SIP

- Originally Developed in the MMUSIC (Multiparty Multimedia Session Control)
  - A separate SIP working group
  - RFC 2543
  - Many developers
  - The latest version: RFC 3261 (June 2002)

- SIP + MGCP/MEGACO
  - The VoIP signaling in the future

- “bake-offs” or SIP Interoperability Tests
  - The development of SIP and its implementation by system developers has involved a number of events.
  - Various vendors come together and test their products against each other
    - to ensure that they have implemented the specification correctly
    - to ensure compatibility with other implementations
**SIP Architecture**

- A signaling protocol
  - The setup, modification, and tear-down of multimedia sessions
- SIP + SDP
  - Describe the session characteristics to potential session participants
- Separate signaling and media streams
  - Signaling may pass via one or more proxy or redirect servers
  - Media stream takes a more direct path.
SIP Network Entities [1/4]

- Clients
  - User agent clients
  - Application programs sending SIP requests

- Servers
  - Responds to clients’ requests

- Clients and servers may be in the same platform.
  - Proxy acts as both clients and servers
SIP Network Entities [2/4]

- **Four types of servers**
  - **Proxy servers**
    - Act in a similar way to a proxy server used for web access
    - Handle requests or forward requests to other servers after some translation
    - Can be used for call forwarding, time-of-day routing, or follow-me services

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**Example Scenario**

1. Request  
   Collins@work.com

2. Request  
   Collins@home.net

3. Response

4. Response

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**Call Flow Diagram**

- **Caller@work.com** to **Collins@home.net**
- **SIP Proxy**
SIP Network Entities [3/4]

Redirect servers

- Accept SIP requests
- Map the destination address to zero or more new addresses
- Return the new address(es) to the originator of the request

1. Request
   Collins@work.com

2. Moved temporarily
   Contact: Collins@home.net

3. ACK

4. Request
   Collins@home.net

5. Response

Redirect Server
SIP Network Entities [4/4]

- A user agent server
  - Accepts SIP requests and contacts the user
  - The user responds → an SIP response
  - A SIP device
    - E.g., a SIP-enabled telephone

- A registrar (location server)
  - Accepts SIP REGISTER requests
    - Indicating that the user is at a particular address
    - Personal mobility
  - Typically combined with a proxy or redirect server
SIP Call Establishment

- A SIP call establishment is simple.
- A number of interim responses may be made to the INVITE prior to the called party accepting the call.
SIP Advantages

- Attempt to keep the signaling as simple as possible
- Offer a great deal of flexibility
  - Does not care what type of media is to be exchanged during a session or the type of transport to be used for the media
- Various pieces of information can be included within the messages
  - Including non-standard information
    - Text-based encoding
  - Enable the users to make intelligent decisions
    - The control of the intelligent features is placed in the hands of the customer, not the network operator.
  - E.g., SUBJECT header
Call Completion to Busy Subscriber Service

INVITE

Busy (Try at 4pm)

ACK

INVITE

Ringing

ACK

Conversation

BYE

OK

OK
Overview of SIP Messaging Syntax

- Text-based
  - Similar to HTTP
  - Disadvantage – more bandwidth consumption

- SIP messages
  - message = start-line
    - *message-header CRLF
    - [message-body]
  - start-line = request-line | status-line

- Request-line specifies the type of request
- The response line indicates the success or failure of a given request.
Message headers
- Additional information of the request or response
- E.g.,
  - The originator and recipient
  - Retry-after header
  - Subject header

Message body
- Describe the type of session
- The most common structure for the message body is SDP (Session Description Protocol).
- Could include an ISDN User Part message
- Examined only at the two ends
SIP Requests [1/2]

- **Method**: SP Request-URI  SP SIP-version CRLF
- **Request-URI**
  - The SIP address of the destination
- **Methods**
  - INVITE, ACK, OPTIONS, BYE, CANCEL, REGISTER
  - INVITE
    - Initiate a session
    - Information of the calling and called parties
    - The type of media
    - ~IAM (initial address message) of ISUP
    - ACK only when receiving the final response
SIP Requests [2/2]

- **BYE**
  - Terminate a session
  - Can be issued by either the calling or called party

- **OPTIONS**
  - Query a server as to its capabilities
    - To support a particular type of media

- **CANCEL**
  - Terminate a pending request
  - Pending Request: an INVITE did not receive a final response

- **REGISTER**
  - Log in and register the address with a SIP server
  - “all SIP servers” – multicast address (224.0.1.175)
  - Can register with multiple servers
  - Can have several registrations with one server
"One Number" Service

User at Address 2  User at Address 1  Registrar/Proxy  Caller

Register (address 2)  Register (address 1)  OK

INVITE

INVITE

INVITE

INVITE

Trying

CANCEL

OK (for CANCEL)

OK (for INVITE)

ACK

Conversation

OK
SIP INFO Method

- Specified in RFC 2976
  - For transferring information during an ongoing session
- The transfer of DTMF digits
- The transfer of account balance information
  - Pre-paid service
- The transfer of mid-call signaling information
SIP Responses

SIP Version SP Status Code SP Reason-Phrase CRLF

Reason-Phrase
- A textual description of the outcome
- Could be presented to the user

Status code
- A three-digit number
- 1XX Informational
- 2XX Success (only 200 is defined: the request has been understood and has been performed)
- 3XX Redirection (302: the called party is not available at the address used in the request, and the request should be reissued to a new address included with the response)
- 4XX Request Failure (401: the client is not authorized to make the request)
- 5XX Server Failure (505: the server does not support the SIP version specified in the request)
- 6XX Global Failure (600: busy)
- All responses, except for 1XX, are considered final
  - Should be ACKed if the original message happened to be an INVITE
SIP Addressing

SIP URIs (Uniform Resource Indicators)

- user@host
- sip:collins@home.net
- sip:3344556789@telco.net
Message Headers

- Provide further information about the message

  E.g.,

  - To: header in an INVITE
    - The called party
  - From: header
    - The calling party
  - M (mandatory), M* (the header field should be present in the request, but a receiver should be prepared to process the request even if the header is absent), O (optional), T (the header should be included in the request if a stream-based transport is used), C (the presence of the header depends on the context of the message), N/A (the header should not be sent in the request)

- Four main categories
  - General, Request, Response, and Entity headers
General Headers

- Used in both requests and responses
- Basic information
  - E.g., To:, From:, Call-ID: (uniquely identifies a specific invitation to a session),…
- Contact:
  - Provides a URL for use in future communication regarding a particular session
  - Examples 1: In a SIP INVITE, the Contact header might be different from the From header.
    - An third-party administrator initiates a multiparty session.
  - Example 2: Used in response, it is useful for directing further requests directly to the called user.
  - Example 3: It is used to indicate a more appropriate address if an INVITE issued to a given URI failed to reach the user.
- Request Headers
  - Apply only to SIP requests
  - Addition information about the request or the client
  - E.g.,
    - Subject:
    - Priority: urgency of the request (emergency, urgent, normal, or non-urgent)

- Response Headers
  - Further information about the response that cannot be included in the status line
  - E.g.,
    - Unsupported
    - Retry-After
Entity Headers

- Indicate the type and format of information included in the message body

- Content-Length: the length of the message body

- Content-Type: the media type of the message body
  - E.g., application/sdp

- Content-Encoding: for message compression

- Content Disposition: how a message part should be interpreted
  - session, alert, render ...