Session Initiation Protocol

INSE 7110 – Winter 2004
Value Added Services Engineering in Next Generation Networks
Week #3
Outline

1. Introduction to Next Generation Networks
2. Core SIP
3. Selected Extensions
4. Third Generation Cellular Networks
Introduction to Next Generation Networks …

1. Distinctive characteristics

2. A brief history

3. Some of the protocols
Distinctive characteristics …

Loosely used to refer to:

- Internet Telephony
- 3G
- 3G and Beyond

Distinctive characteristics

- Packet switching (instead of circuit switching in today’s 2G networks)
- QoS enabled (unlike the Internet best effort)
- Voice + data (unlike today’s 2G networks which focus on voice)
-
## Circuit switching vs. packet switching

<table>
<thead>
<tr>
<th>Principal Criteria</th>
<th>Circuit switched</th>
<th>Packet switched</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dedicated Physical path</td>
<td>Yes/No</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Derived criteria</td>
<td>Circuit switched</td>
<td>Packet switched</td>
</tr>
<tr>
<td>Call set up required</td>
<td>Yes/No</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Possibility of congestion during</td>
<td>Yes/No</td>
<td>Yes/No</td>
</tr>
<tr>
<td>communication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fixed bandwidth available</td>
<td>Yes/No</td>
<td>Yes/No</td>
</tr>
<tr>
<td>Non optimal usage of bandwidth</td>
<td>Yes/No</td>
<td>Yes/No</td>
</tr>
</tbody>
</table>
A brief history …

**Milestones**

- **Late 70s:**
  - First two party voice calls over Internet (Network Voice Protocol (NVP - RFC 741 - November 1977)

- **80s:**
  - Emergence of proprietary systems for Internet Telephony

- **90s:**
  - Emergence of standards (e.g. SIP, H.323)

- **00s:**
  - Backing by telcos (e.g. 3GPP specifications)
  - Backing by other new players (e.g. cable industry)
Some of the protocols ...
Session Initiation Protocol (SIP) - Core

1. Introduction
2. Functional entities
3. Messages
4. A digression on SDP
5. Examples
SIP: Introduction

A set of IETF specifications including:

- SIP core signalling:
  - RFC 2543, March 1999
  - RFC 3261, June 2002 (Obsoletes RFC 2543)

- SIP extensions (e.g. RFC 3265, June 2002 - Event notification)

- Used in conjunction with other IETF protocols
  - QOS related protocol (e.g. RSVP)
  - Media transportation related protocol (e.g. RTP - RFC 1889)
  - Others (e.g. SDP - RFC 2327)
SIP: Introduction

**SIP core Signaling**
- A signalling protocol for the establishment, modification and tear down of multimedia sessions
- Based on HTTP

**A few key features**
- Text based protocol
- Client/server protocol (request/response protocol)
SIP: The functional entities

User agents
- End points, can act as both user agent client and as user agent server
  - User Agent Client: Create new SIP requests
  - User Agent Server: Generate responses to SIP requests
- Dialog: Peer to peer relationship between two user agents, established by specific methods

Proxy servers
- Application level routers

Redirect servers
- Redirect clients to alternate servers

Registrars
- Keep tracks of users
SIP: The functional entities

**State-full proxy**
- Keep track of all transactions between the initiation and the end of a transaction
- Transactions:
  - Requests sent by a client along with all the responses sent back by the server to the client

**Stateless proxy**
- Fire and forget
SIP: The messages

Generic structure
- Start-line
- Header field(s)
- Optional message body

Request message
- Request line as start line
  . Method name
  . Request URI
  . Protocol version

Response message
- Status line as start line
  . Protocol version
  . Status code
  . Reason phrase (Textual description of the code)
SIP: The messages

Request messages
- Methods for setting up sessions
  . INVITE
  . ACK
  . CANCEL
  . BYE

- Others
  . REGISTER (Registration of contact information)
  . OPTIONS (Querying servers about their capabilities)
SIP: The messages

Response message

- Provisional
- Final

Examples of status code
1xx: Provisional
2xx: Success
6xx: Global failure
A digression on SDP …

Session Description Protocol
- Convey the information necessary to allow a party to join a multimedia session
  - Session related information
  - Media related information
- Text based protocol
- No specified transport
  - Messages are embedded in the messages of the protocol used for the session
    - Session Announcement Protocol (SAP)
    - Session Initiation Protocol (SIP)
A digression on SDP …

**Session Description Protocol**

- `<Type> = <Value>`
- Some examples
  
  **Session related**
  
  v= (protocol version)
  s= (Session name)
  
  **Media related**
  
  m= (media name and transport address)
  b= (bandwidth information)
A digression on SDP …

**Session Description Protocol**

**Use with SIP**

- Negotiation follows offer / response model
- Message put in the body of pertinent SIP messages
  - INVITE Request / response
  - OPTIONS Request / response
SIP: A simplified call case

CALLER

INVITE (1)

100 TRYING (3)

180 RINGING (8)

200 OK (11)

PROXY A

INVITE (2)

100 TRYING (5)

180 RINGING (7)

200 OK (10)

ACK (12)

MEDIA SESSION

PROXY B

INVITE (4)

100 TRYING (5)

180 RINGING (6)

200 OK (9)

CALLEE

200 OK (14)

BYE (13)
SIP: Examples of messages from the RFC

An example of an INVITE

INVITE sip:bob@biloxi.com SIP/2.0
Via: SIP/2.0/UDP pc33.atlanta.com;branch=z9hG4bK776asdhds
Max-Forwards: 70
To: Bob <sip:bob@biloxi.com>
From: Alice <sip:alice@atlanta.com>;tag=1928301774
Call-ID: a84b4c76e66710@pc33.atlanta.com
CSeq: 314159 INVITE
Contact: <sip:alice@pc33.atlanta.com>
Content-Type: application/sdp
Content-Length: 142
SIP: Examples of messages from the RFC

An example of an OPTIONS message

OPTIONS sip:carol@chicago.com SIP/2.0
    Via: SIP/2.0/UDP
    pc33.atlanta.com;branch=z9hG4bKhjhs8ass877
    Max-Forwards: 70
    To: <sip:carol@chicago.com>
    From: Alice <sip:alice@atlanta.com>;tag=1928301774
    Call-ID: a84b4c76e66710
    CSeq: 63104 OPTIONS
    Contact: <sip:alice@pc33.atlanta.com>
    Accept: application/sdp
    Content-Length: 0
SIP: Examples of messages from the RFC

An example of RESPONSE to the OPTIONS request

SIP/2.0 200 OK
Via: SIP/2.0/UDP pc33.atlanta.com;branch=z9hG4bKhjhs8ass877
;received=192.0.2.4
To: <sip:carol@chicago.com>;tag=93810874
From: Alice <sip:alice@atlanta.com>;tag=1928301774
Call-ID: a84b4c76e66710
CSeq: 63104 OPTIONS
Contact: <sip:carol@chicago.com>
Contact: <mailto:carol@chicago.com>
Allow: INVITE, ACK, CANCEL, OPTIONS, BYE
Accept: application/sdp
Accept-Encoding: gzip
Accept-Language: en
Supported: foo
Content-Type: application/sdp
Session Description Protocol
An example from the RFC ...

v=0 
o=mhandley 2890844526 2890842807 IN IP4 126.16.64.4 
s=SDP Seminar 
i=A Seminar on the session description protocol 
u=http://www.cs.ucl.ac.uk/staff/M.Handley/sdp.03.ps 
e=mjh@isi.edu (Mark Handley) 
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 
m=application 32416 udp wb 
a=orient:portrait
SIP – Selected Extensions

1. Event framework
2. Others
Event Notification

Motivation

- Necessity for a node to be asynchronously notified of happening(s) in other nodes
  - Busy / not busy (SIP phones)
    - A client A can call again a client B when notified that B is now not busy
  - On-line / Off-line
    - Buddy list
Event Notification

Conceptual framework

Requestor

Subscribe (specific event(s))

Notify (specific event)

Notify (specific event)

Notify (specific event)

Un-subscribe (specific event(s))

Provider
Event Notification

The SIP Event Notification Framework

- Terminology
  - Event package:
    - Events a node can report
    - Not part of the framework – Part of other RFCs
  - Subscriber
  - Notifier

- New Messages
  - Subscribe
    - Need to be refreshed
    - Used as well for un-subscribing (expiry value put to zero)
  - Notify
Event Notification

The SIP Event Notification Framework

- More on the methods
  - New headers
    - Event
    - Allow-Events
    - Subscription state
Event Notification

An example of use: REFER Method
- Recipient should contact a third party using the URI provided in the CONTACT field
  - Call transfer
  - Third party call control
- Handled as Subscribe / notify
  - REFER request is considered an implicit subscription to REFER event
    - Refer-TO: URI to be contacted
    - Expiry determined by recipient and communicated to sender in the first NOTIFY
    - Recipient needs to inform sender of the success / failure in contacting the third party
Event Notification

Another example of use: Presence

- Dissemination/consumption of presence information (e.g. on/off, willingness to communicate, device capabilities, preferences)
  - Numerous applications
    - Multiparty sessions initiated when a quorum is on-line
    - News adapted to device capabilities
  - Several standards including SIMPLE (SIP based)
    - Handled as Subscribe / notify in SIMPLE
      - Watchers / presentities
        - Explicit subscriptions
        - Explicit notifications
INFO Method

Allow the exchange of non signalling related information during a SIP dialog
- Semantic defined at application level
- Mid-call signalling information
  - DTMF digits with SIP phones
- Info carried as
  - Headers and/or
  - Message body
3GPP networks

1. Essentials
2. Key definitions
3. Call cases
3GPP networks

**Essentials**

- **Made of:**
  - Legacy
    - Circuit switched part (GSM)
    - Packet switched (GPRS)
  - Next generation part (IP multimedia (IM))
  - Inter-working
  - Some of the functional entities are common to both legacy and NGN (e.g. Home Subscriber Server)

- Adoption/extension of existing NGN specifications:
  - SIP instead of H.323
  - H.248/Megaco
IP multimedia portion

IP Multimedia Networks

PSTN

IM Multimedia Networks

Mg

Mk

Mm

Mw

C, D, Gc, Gr

IM Subsystem

AS

CSCF

BGCF

MRFC

PDF

MRFP

MGCF

HSS

SLF

UE

ISC

A S

PSTN

CSCFMGCF

HSS

IP Multimedia portion
IP Multimedia portion

Some of the functional entities

Call Session Control Function (CSCF)
- Proxy-CSCF: First contact point in the IM network – Accepts requests and proxies them
- Serving-CSCF: Perform session control for all user entities in the networks including visitors
- Interrogating CSCF: Contact point in an operator domain for all users (home users, and visiting users)

Home Subscriber Server (HSS)
- Master data base – subscription / location information
IP Multimedia portion – Registration

1. Register
2. Register
3. Cx-Query
4. Cx-Query Resp
5. Cx-Select-pull
6. Cx-Select-pull Resp
7. Register
8. Cx-put
9. Cx-put Resp
10. Cx-Pull
11. Cx-Pull Resp
12. Service Control
13. 200 OK
14. 200 OK
15. 200 OK
IP Multimedia portion – De-Registration

Visited Network

<table>
<thead>
<tr>
<th>UE</th>
<th>P-CSCF</th>
</tr>
</thead>
</table>

| 1. REGISTER |

Home Network

<table>
<thead>
<tr>
<th>I-CSCF</th>
<th>HSS</th>
<th>S-CSCF</th>
</tr>
</thead>
</table>

| 3. Cx-Query |
| 4. Cx-Query-Resp |
| 5. REGISTER |
| 6. Service Control |
| 7. Cx-Put |
| 8. Cx-Put Resp |
| 9. 200 OK |
| 10. 200 OK |
| 11. 200 OK |
IP Multimedia portion – Call initiation - Same operator

1. Invite (Initial SDP Offer)
2. Service Control
3. Invite (Initial SDP Offer)
4. Location Query
5. Invite (Initial SDP Offer)
6. Invite (Initial SDP Offer)
7. Service Control
8. Invite (Initial SDP Offer)
9. Offer Response
10. Offer Response
11a. Offer Response
11b. Offer Response
11c. Offer Response
12. Offer Response
13. Response Conf (Opt SDP)
14. Response Conf (Opt SDP)
15. Response Conf (Opt SDP)
16. Response Conf (Opt SDP)
17. Conf Ack (Opt SDP)
18. Conf Ack (Opt SDP)
19. Conf Ack (Opt SDP)
20. Conf Ack (Opt SDP)
21. Reservation Conf
22. Reservation Conf
23. Reservation Conf
24. Reservation Conf
25. Reservation Conf
26. Reservation Conf
27. Reservation Conf
28. Reservation Conf
29. Ringing
30. Ringing
31. Ringing
32. Ringing
33. 200 OK
34. 200 OK
35. 200 OK
36. 200 OK
37. ACK
38. ACK
39. ACK
40. ACK
41. 200 OK
42. ACK
43. ACK
44. ACK
45. ACK
46. ACK
47. ACK
48. ACK
49. ACK
50. ACK
IP Multimedia portion – Call initiation - Different operators

1. Invite (Initial SDP Offer)
2. Service Control
3a. Invite (Initial SDP Offer)
3b1. Invite (Initial SDP Offer)
3b2. Invite (Initial SDP Offer)
4. Location Query
5. Response
6. Invite (Initial SDP Offer)
7. Service Control
8. Invite (Initial SDP Offer)
9. Offer Response
10. Offer Response
11a. Offer Response
11b1. Offer Response
11b2. Offer Response
12. Offer Response
13. Response Conf (Opt SDP)
14. Response Conf (Opt SDP)
15. Response Conf (Opt SDP)
16. Response Conf (Opt SDP)
17. Conf Ack (Opt SDP)
18. Conf Ack (Opt SDP)
19. Conf Ack (Opt SDP)
20. Conf Ack (Opt SDP)
21. Reservation Conf
22. Reservation Conf
23. Reservation Conf
24. Reservation Conf
25. Reservation Conf
26. Reservation Conf
27. Reservation Conf
28. Reservation Conf
29. Ringing
30. Ringing
31. Ringing
32. Ringing
33. 200 OK
34. 200 OK
35. 200 OK
36. 200 OK
37. ACK
38. ACK
39. ACK
40. ACK

Roch H. Glitho - Ericsson/Concordia University

January 2004
References

Core SIP

- SIP core signalling:
  - H. Schulzrinne, an J. Rosenberg, SIP: Internet Centric Signaling, IEEE Communications Magazine, October 2000
  - RFC 3261, June 2002 (Obsoletes RFC 2543)
  - RFC 2327 (SDP)

- SIP extensions
  No overview paper
  - RFC 3265, 3515 (Event framework)
  - RFC 2976 (INFO Method)

- 3GPP
  - No overview paper
  - 3GPP TS 23.228
  - 3GPP TS 2302