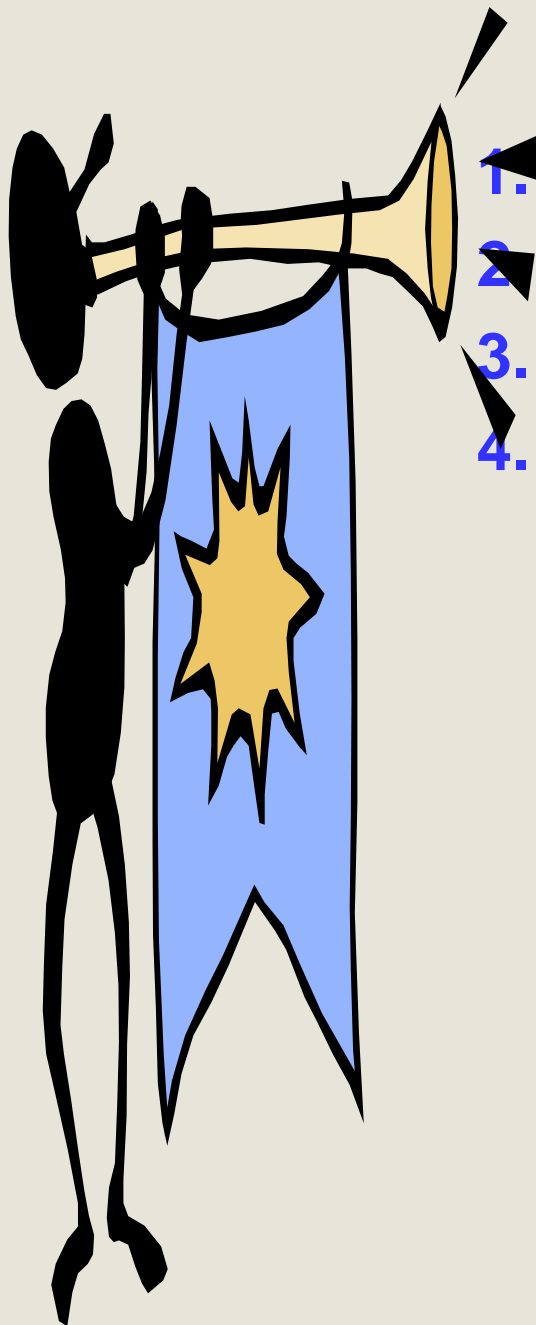# Session Initiation Protocol

**INSE 7110 – Winter 2008**
**Added Services Engineering in Next Generation Net**
**Lecture 3, Week #3**

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# Outline

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

# 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)**
  - May have nothing to do with signalling

- **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

## Prime signaling system because adopted by all key next generation networks:

- 3GPP
- 3GPP2
- PacketCable:

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# Session Initiation Protocol (SIP) - Core

# 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)

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# 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

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# 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)**

ERICSSON

# 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)**

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# SIP: The messages

### Response message
- - Provisional
- - Final

Examples of status code
1xx: Provisional
2xx: Success
6xx: Global failure

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**ERICSSON**

# 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)

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# A digression on SDP …

**Session Description Protocol**

- **-** &lt;Type&gt; = &lt;Value&gt;
- - Some examples

    Session related

    v= (protocol version)

    s= (Session name)

    Media related

    m= (media name and transport address)
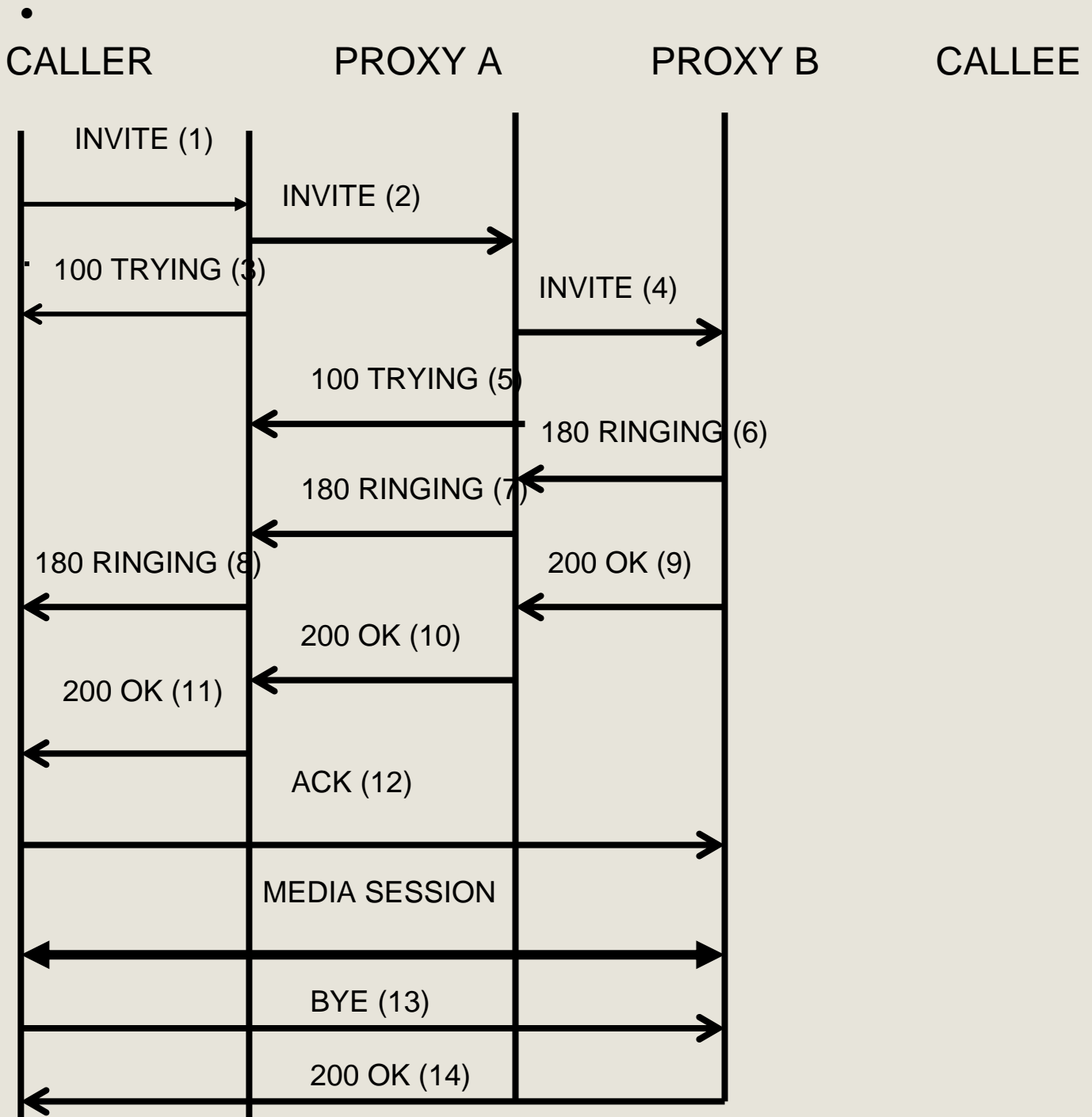
    b= (bandwidth information)

.

# 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

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# SIP: A simplified call case



- 

| CALLER | PROXY A | PROXY B | CALLEE |
| --- | --- | --- | --- |

- INVITE (1)
- INVITE (2)
- 100 TRYING (3)
- INVITE (4)
- 100 TRYING (5)
- 180 RINGING (6)
- 180 RINGING (7)
- 180 RINGING (8)
- 200 OK (9)
- 200 OK (10)
- 200 OK (11)
- ACK (12)
- MEDIA SESSION
- BYE (13)
- 200 OK (14)

# 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

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# 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=z9hG4bKhjhs8ass
   877
    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

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# 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

# SDP: Examples of messages from the RFC …

**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. Extensions for ad hoc networks

2. Event framework

3. Others

# Ad hoc networks

**(Possibly mobile) heterogeneous nodes communicating without fixed infrastructure and pre-set organization of available links**

- Wireless technologies (e.g. Bluetooth, IEEE 802.11)
- Used in scenarios such as:
    - Disaster relief operations
    - Military operations
    - Hot spots …
- Considered a a new network of 4G
- 4G
    - Co-existing and cooperating networks

# Ad hoc networks
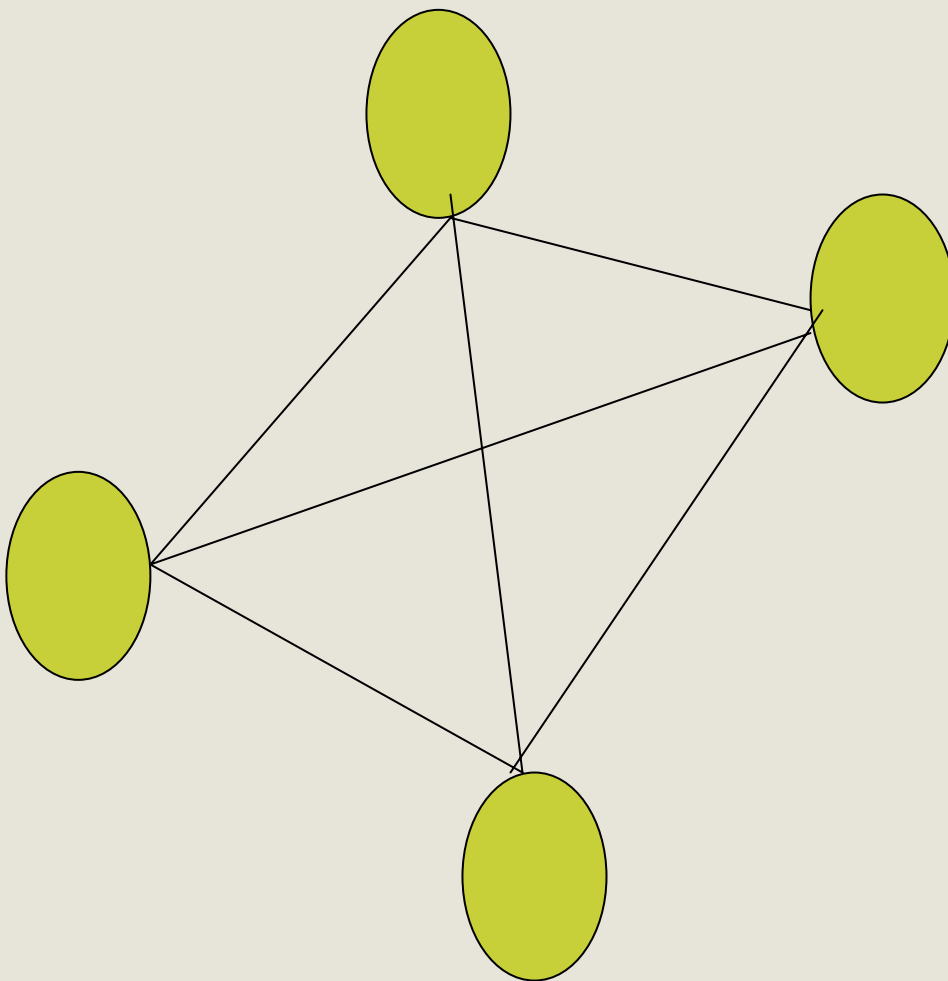
## Signalling

- No centralized entity
- Dynamic propagation of session related information
- Scalability
- Lightweight
- Optimal usage of resources

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# Ad hoc networks

## Signalling

- Possible, but not optimal implementation: Full-mesh

# Ad hoc networks

## Signalling – Extensions made to SIP

- Expired IETF drafts
  - Example of new headers
    - Also: List the participants already connected to the session or trying to connect to it
    - Replace: use in split / merge operation
      - Listed participants should be treated as if they have sent a BYE to the recipient of the message
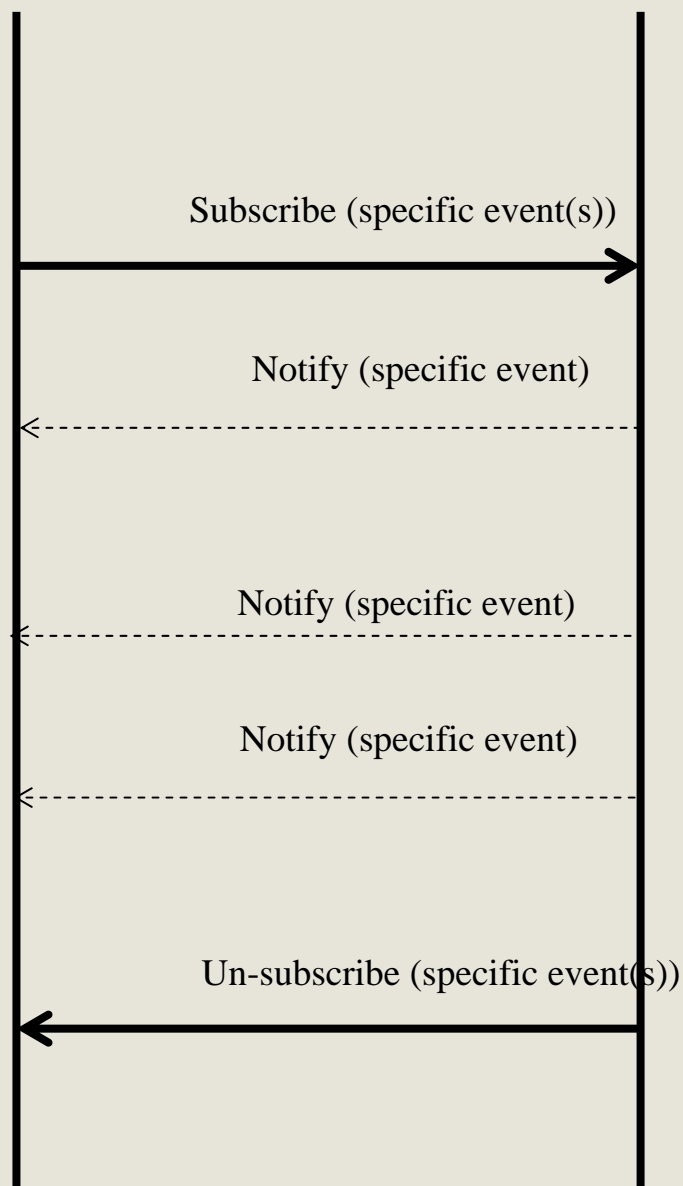
# Event Notification

## 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                                                          Provider

Subscribe (specific event(s))

Notify (specific event)

Notify (specific event)

Notify (specific event)

Un-subscribe (specific event(s))

# 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
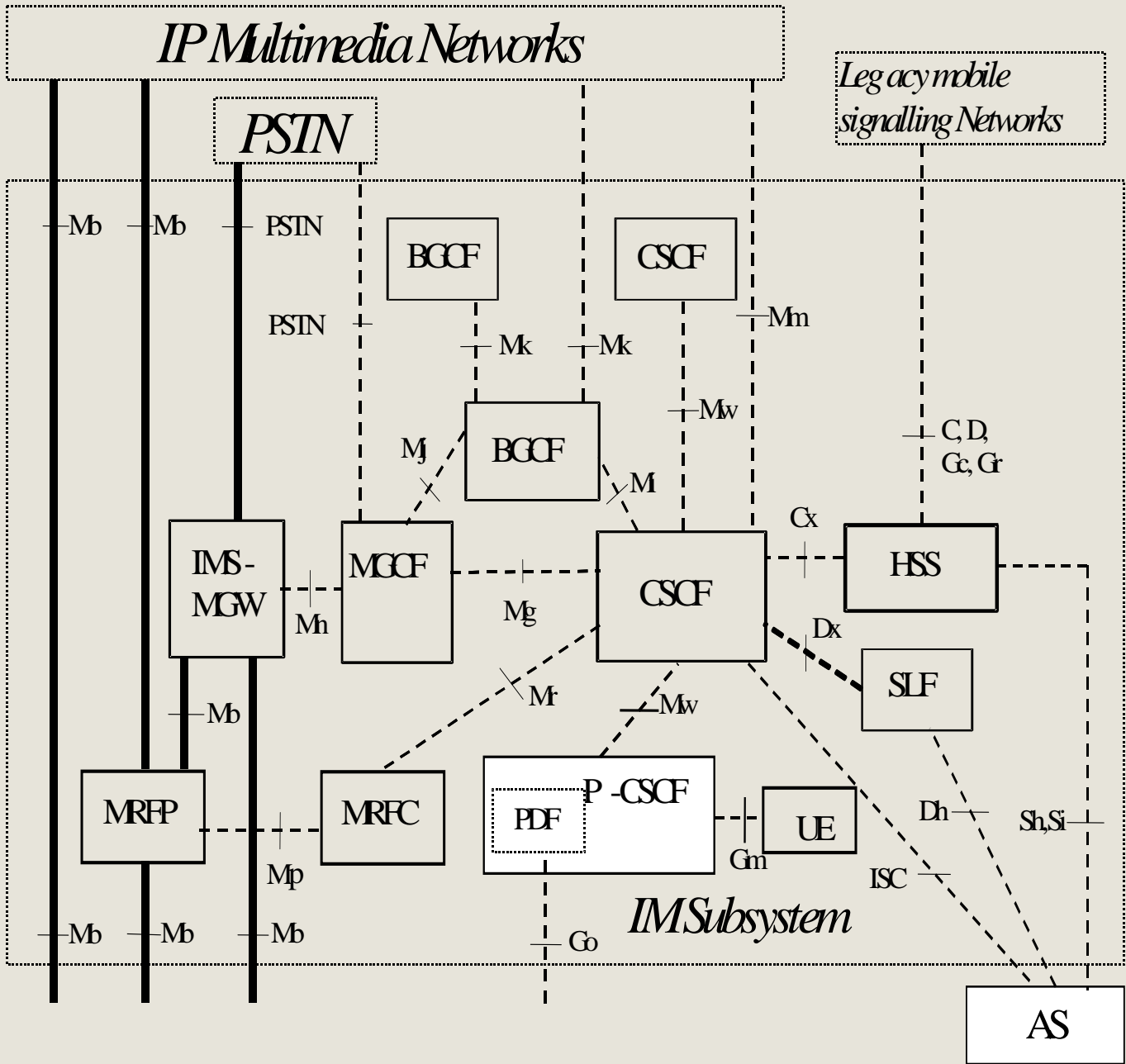
# IP Multimedia portion

**Some of the functional entities**

Home Subscriber Server (HSS)

- Evolution of the HLR

- All user related subscription data (e.g. profile)

- A network may contain one or several

- Subscriber Location Function (SLF) maps users to specific HSS

.

# IP Multimedia portion

Media Resource Function (MRF)
- Source of media (media mixing, announcement playing)
- Two parts
    - Control part: MRFC
    - Media Part: MRFP
        - Megaco / H.248: Protocol used between the two

Media Gateway Function (MGF):
    Signaling conversion between PSTN/2G and IMS
Media Gateway (MG)
    Media conversion between PSTN/2G and IMS
            Megaco / H.248: Protocol used between the two

.

# IP Multimedia portion

**Some of the functional entities**

Call Session Control Function (CSCF) "The switch"

Proxy-CSCF:

- Location

Either visited network or home network

- First contact point in the IM network

- Outbound / In-bound SIP proxy (All requests from/to IMS    terminals go through it)

- Forward SIP requests in the appropriate direction (Terminals or IMS network)

- Several functions

- Security

- Generation of charging information

- Compresssion and decompression of messages

# IP Multimedia portion

## Some of the functional entities

Call Session Control Function (CSCF)

Interrogating CSCF (I-CSCF):

SIP proxy located at the edge of an admnistrative domain

- **Listed in the domain name server (DNS)**
- **There may be several in the same network for scalability reasons**

.

# IP Multimedia portion

## Some of the functional entities

Call Session Control Function (CSCF)

Serving  CSCF (S-CSCF):

Always located in home domain

**SIP proxy + SIP registrar with possibility of performing session control**

- **Binding between IP address (terminal location) and user SIP address**
- **Interacts with application servers for value added service purpose**
- **Translation services (Telephone number / Sip URIs)**
- **Routing**

# IP Multimedia portion

**Some of the functional entities**

Application server (AS)

Most relevant functional entity in the context of this course

Host services and execute services

Communicate using SIP

Two types

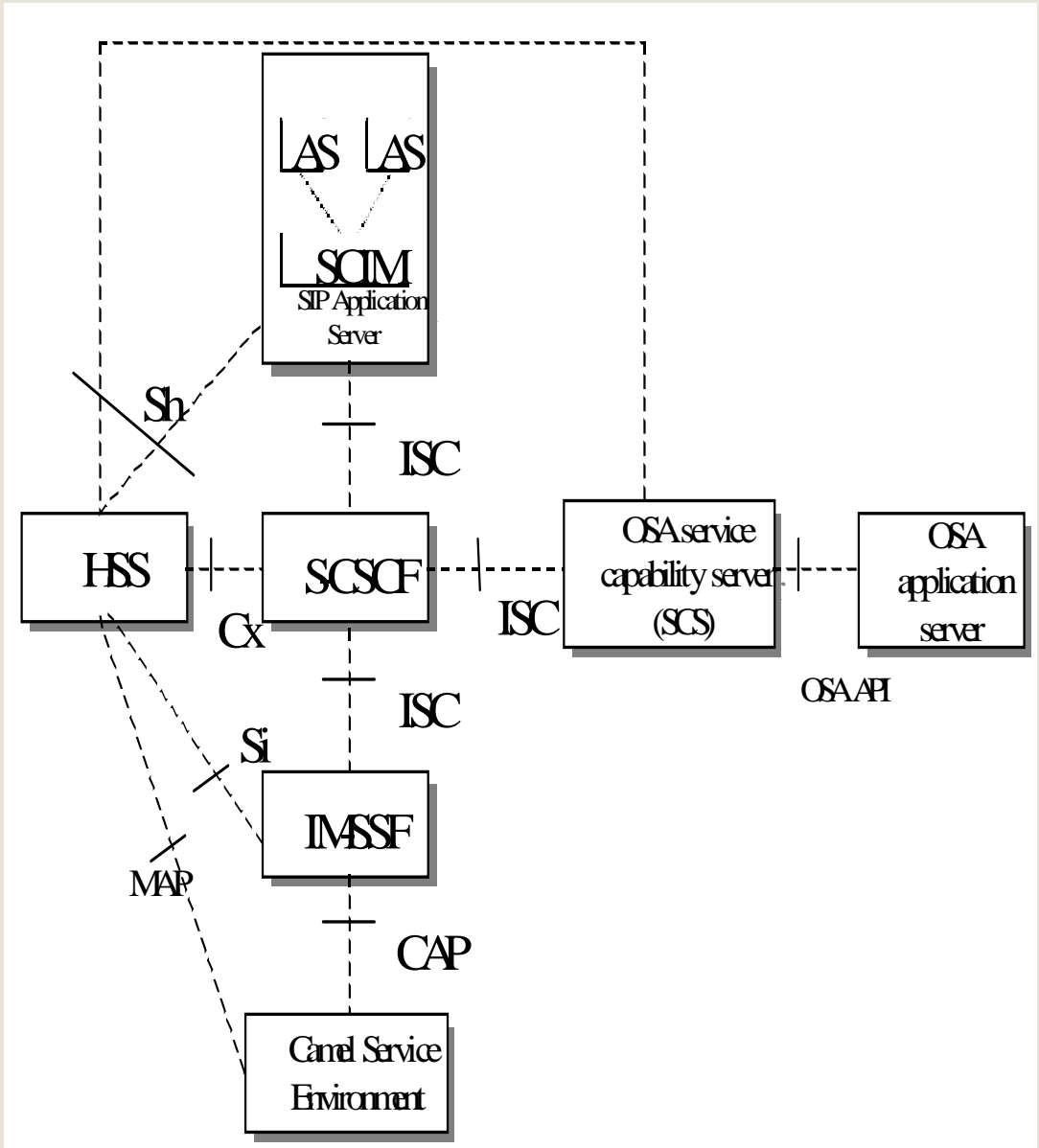SIP AS: Signaling specific architecture (Services can work only        in SIP environment

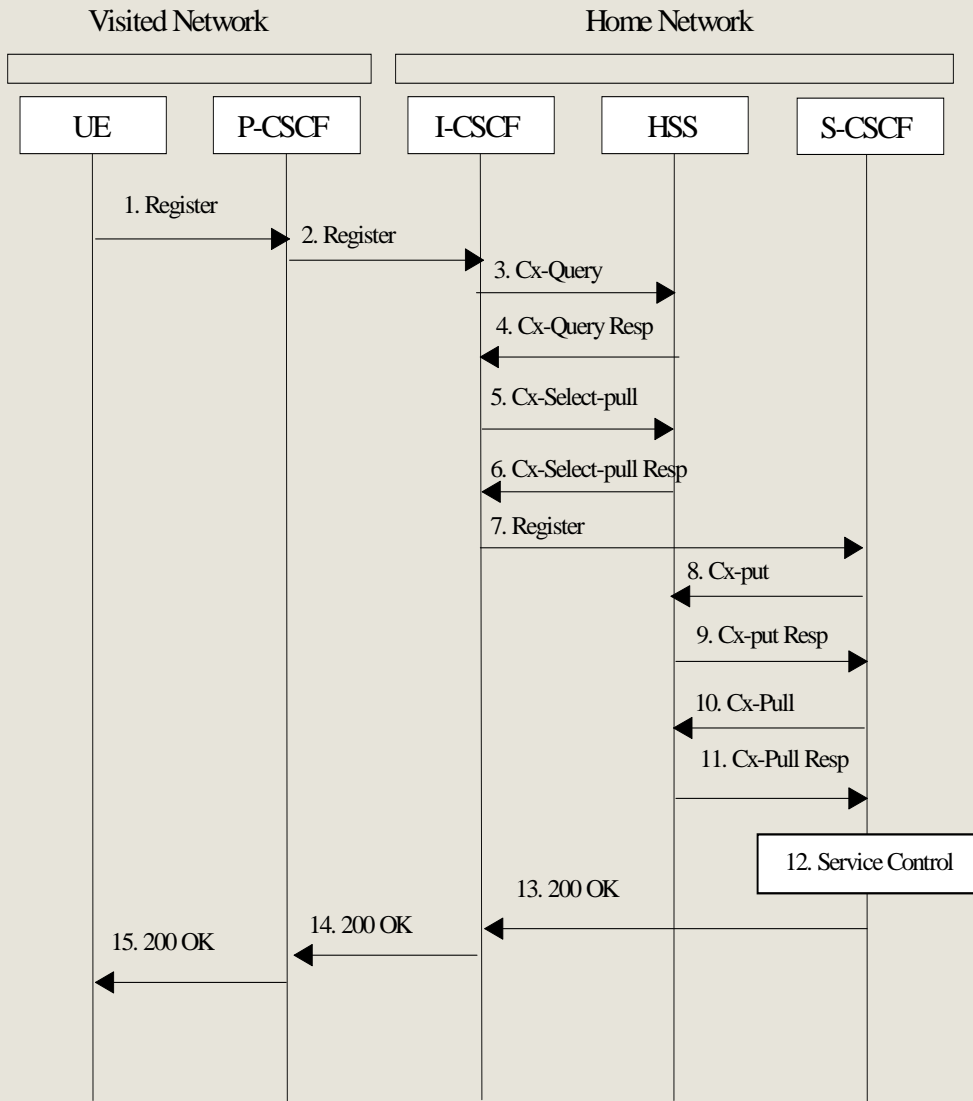Open Service Architecture – Service Capability Server (OSA/SCS)

- Signaling neutral architecture
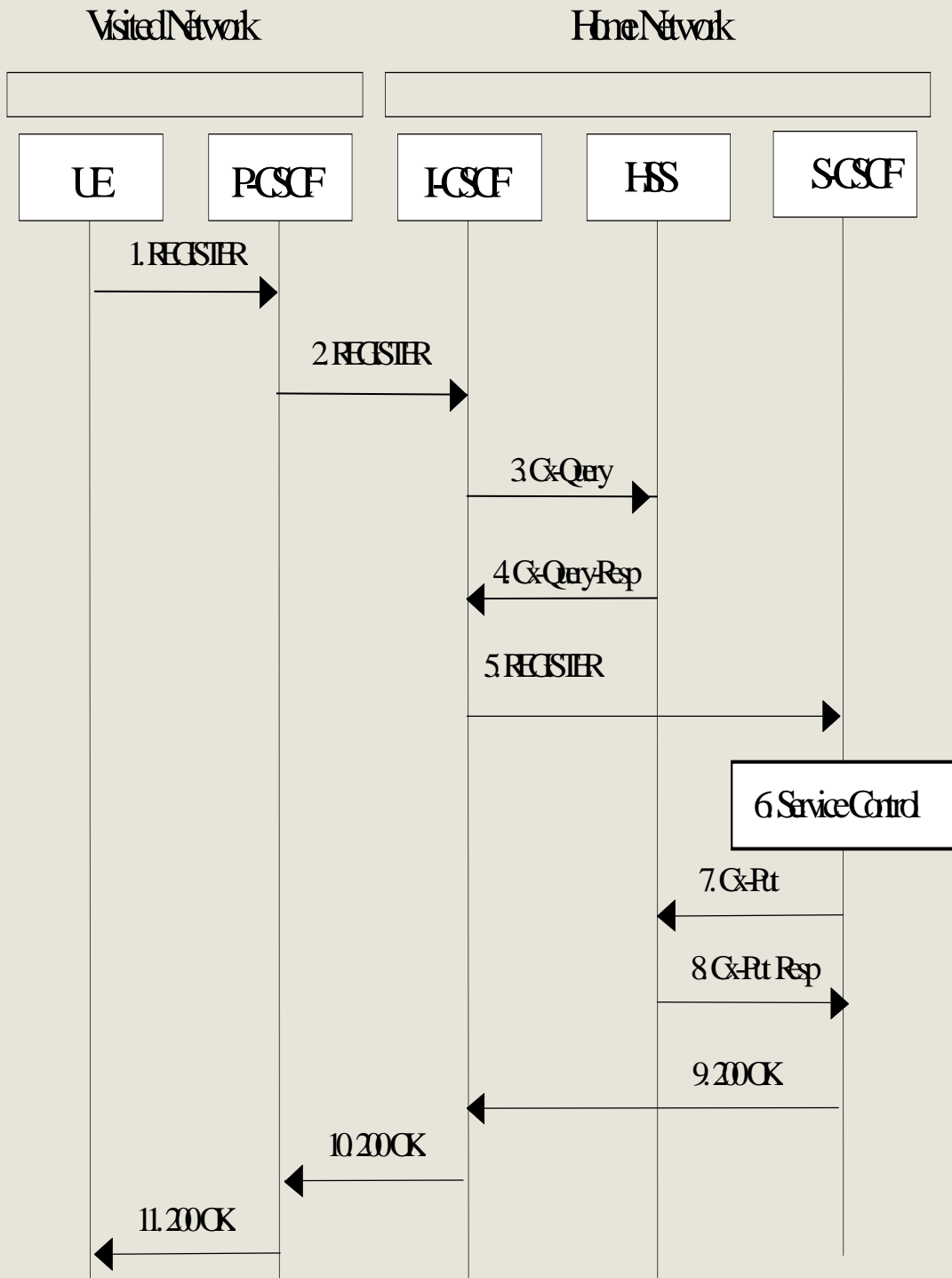- Happens to work in a SIP environment, but can work in other environments
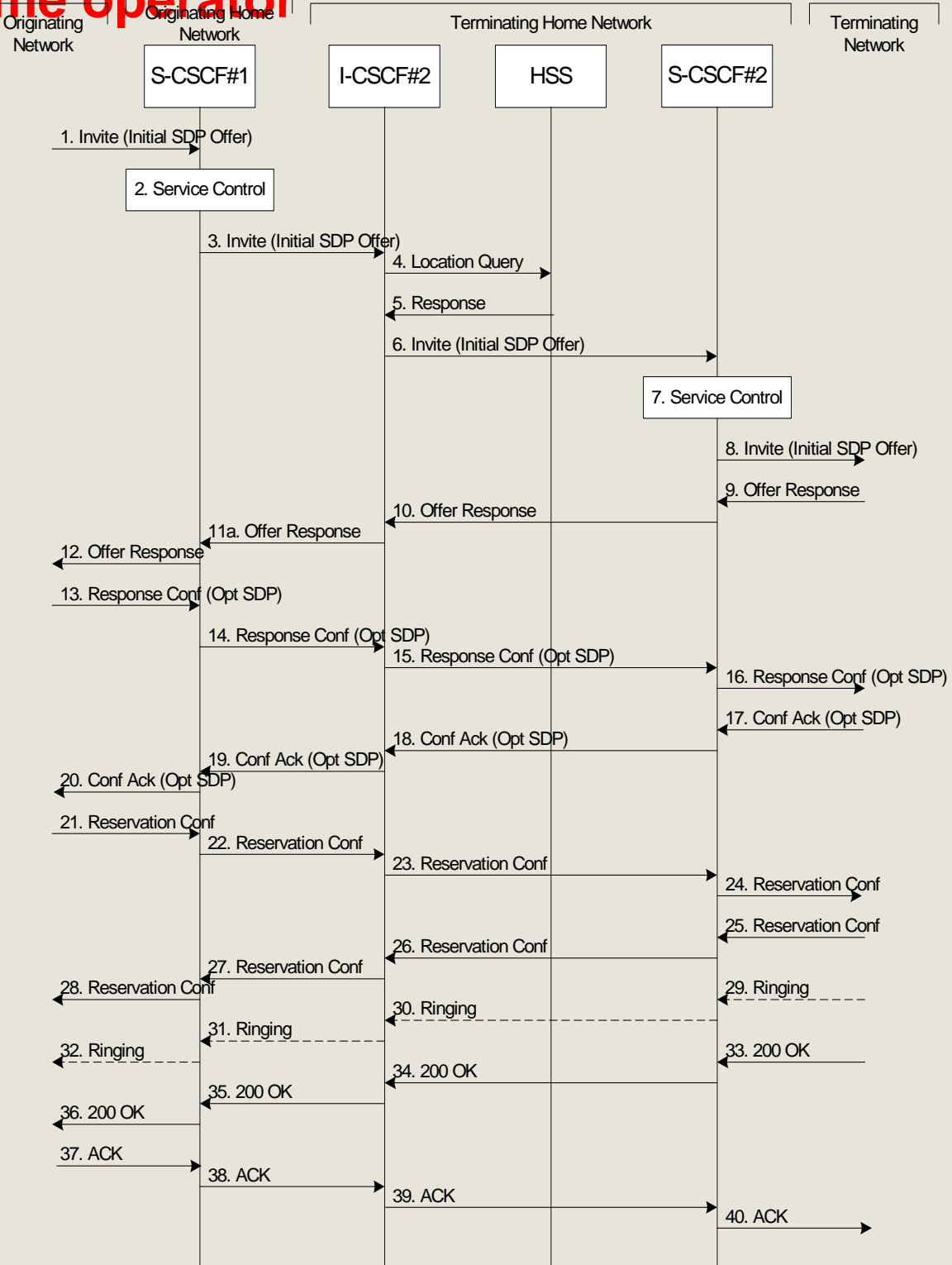
# IP multimedia portion
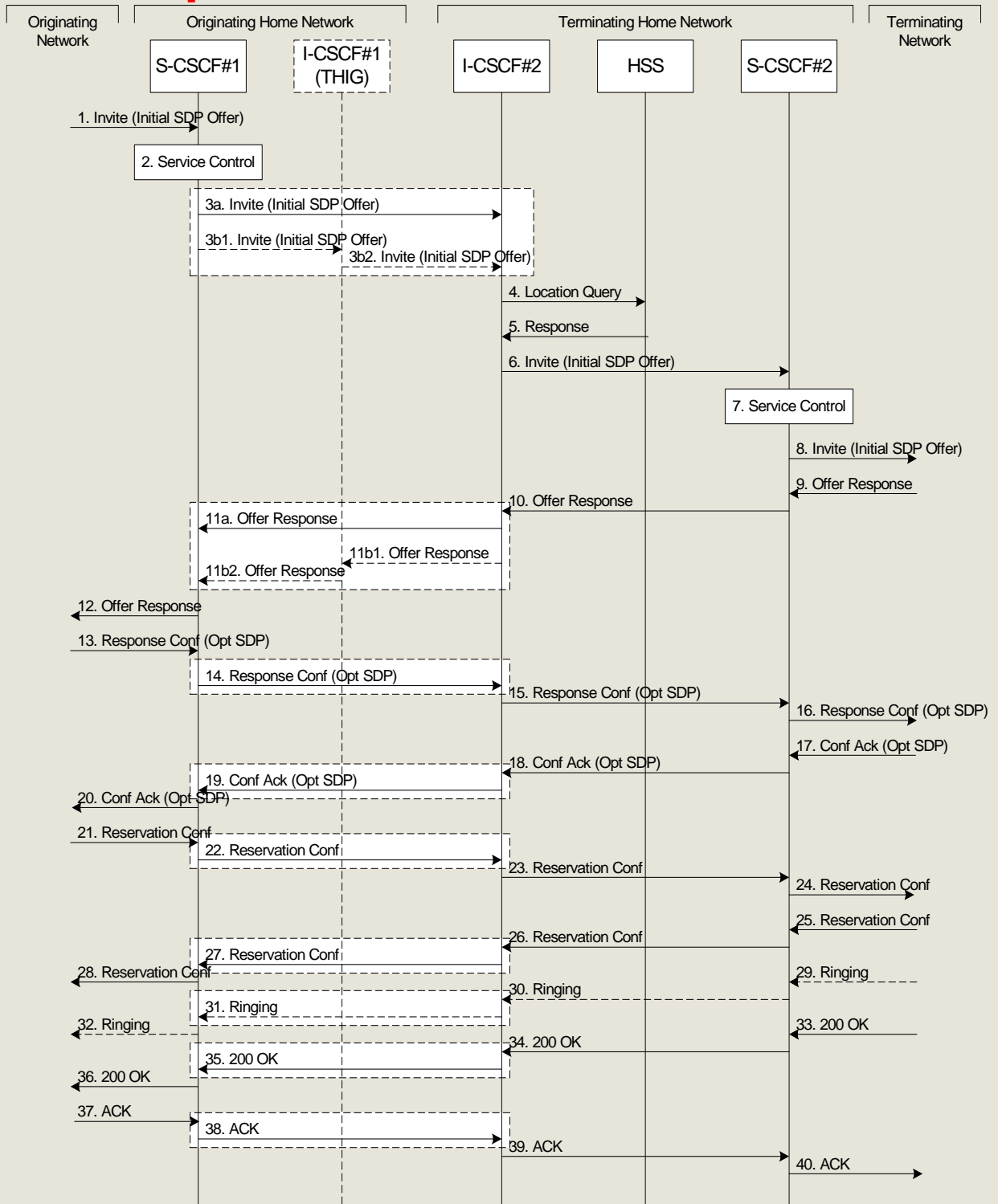
# IP Multimedia portion – Registration

# IP Multimedia portion – De-Registration

# IP Multimedia portion – Call initiation - Same operator

# IP Multimedia portion – Call initiation - Different operators

# 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

- **K. Knightson, N. Morita and T. Towle, NGN Architecture: General Principles, Functional Architecture and Implementation, IEEE Communications Magazine , Ocotber 2005, Vol.43, No10**
- **G. Camarillo and M. Garcia-Martin, The 3G IP Multimedia Subsystem, Wiley, 2004 , Part II**
- **3GPP TS 23.228**
- **3GPP TS 2302**