

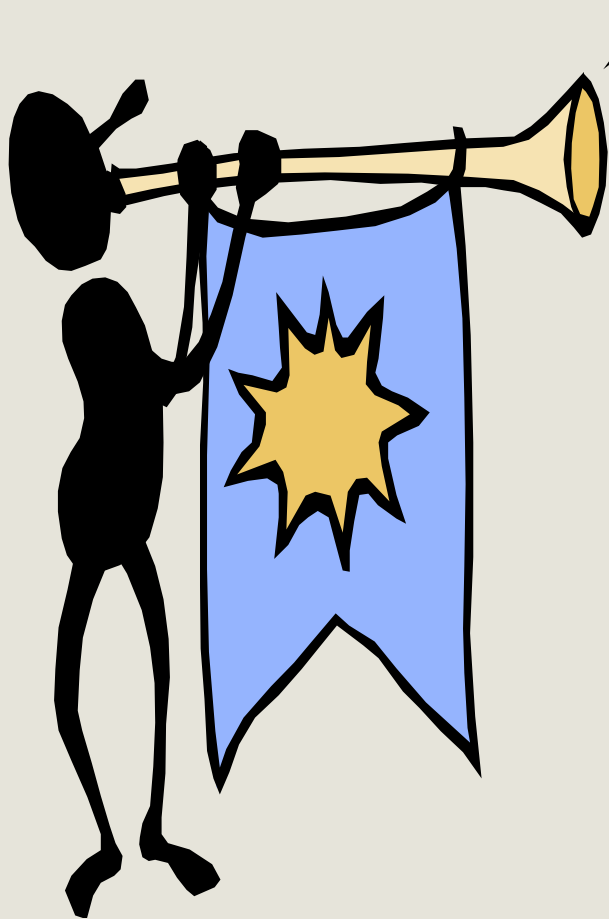
# Session Initiation Protocol

**INSE 7110 – Winter 2009**

**Value Added Services Engineering in Next Generation Networks**

**Lecture 3, Week #3**

# Outline



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

## **SIP: Introduction**

### **A set of IETF specifications including:**

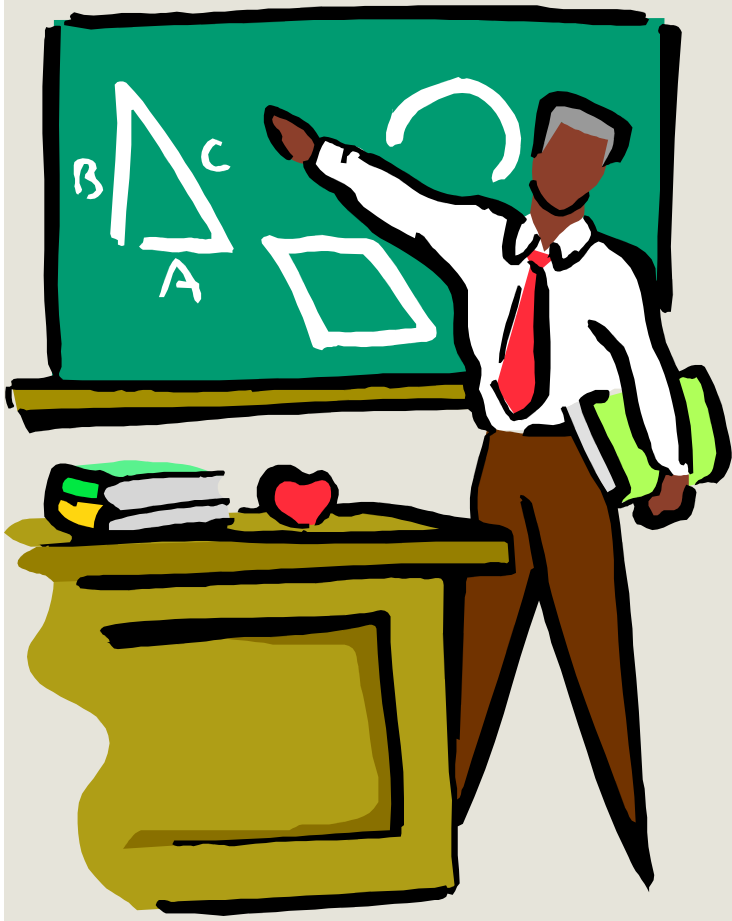
- **SIP core signalling:**
  - RFC 2543, March 1999
  - RFC 3261, June 2002 (Obsoletes RFC 2543)
  
- **SIP extensions (e.g. RFC 3265, June 2002 - Event notification)**
  - May have nothing to do with signalling
  
- **Used in conjunction with other IETF protocols**
  - QOS related protocol (e.g. RSVP)
  - 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:

# Session Initiation Protocol (SIP) - Core



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

# 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)

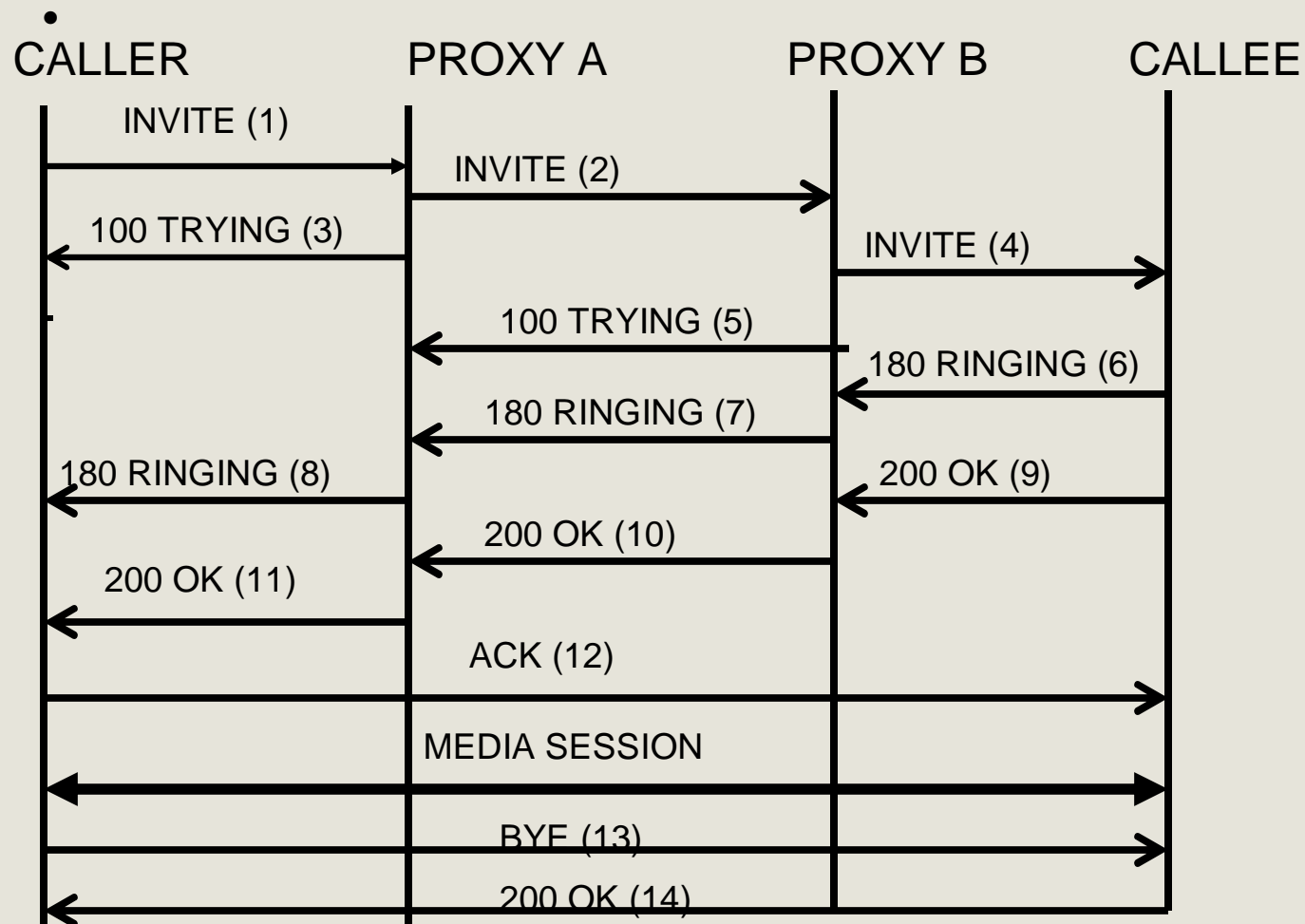
## A digression on SDP ...

### 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



## 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

# 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

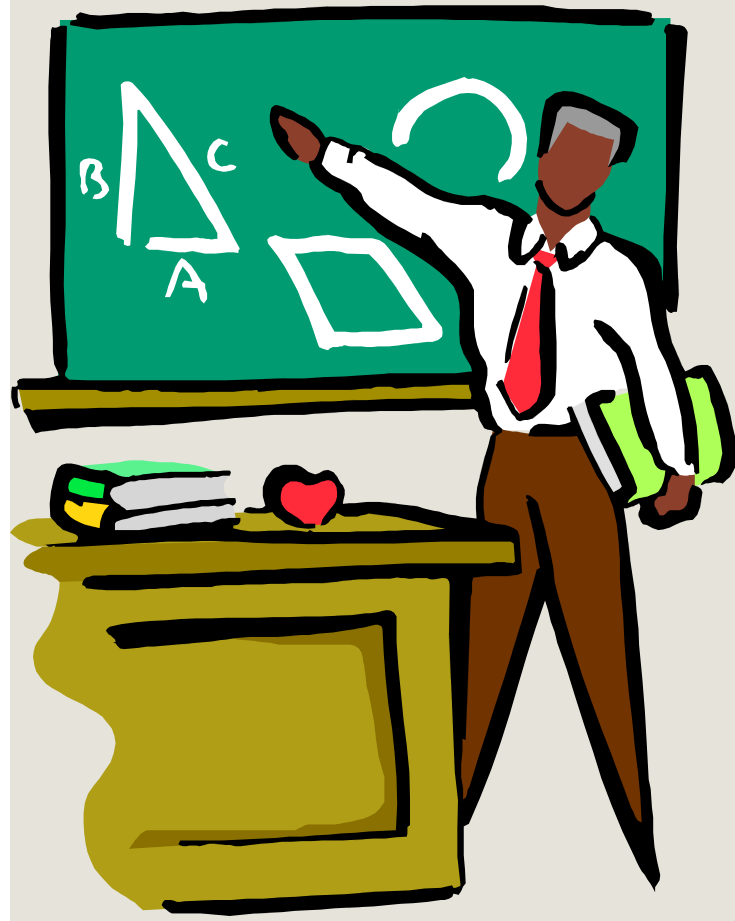
m=audio 49170 RTP/AVP 0

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

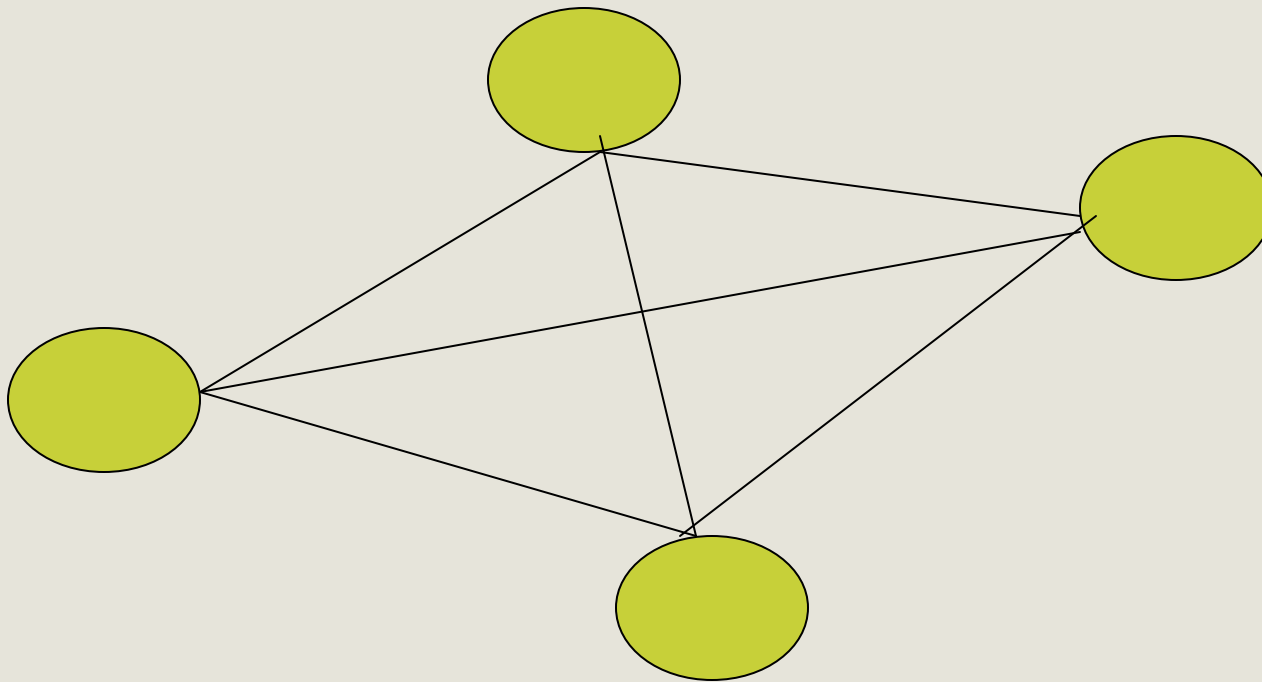
## Signalling

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

## 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



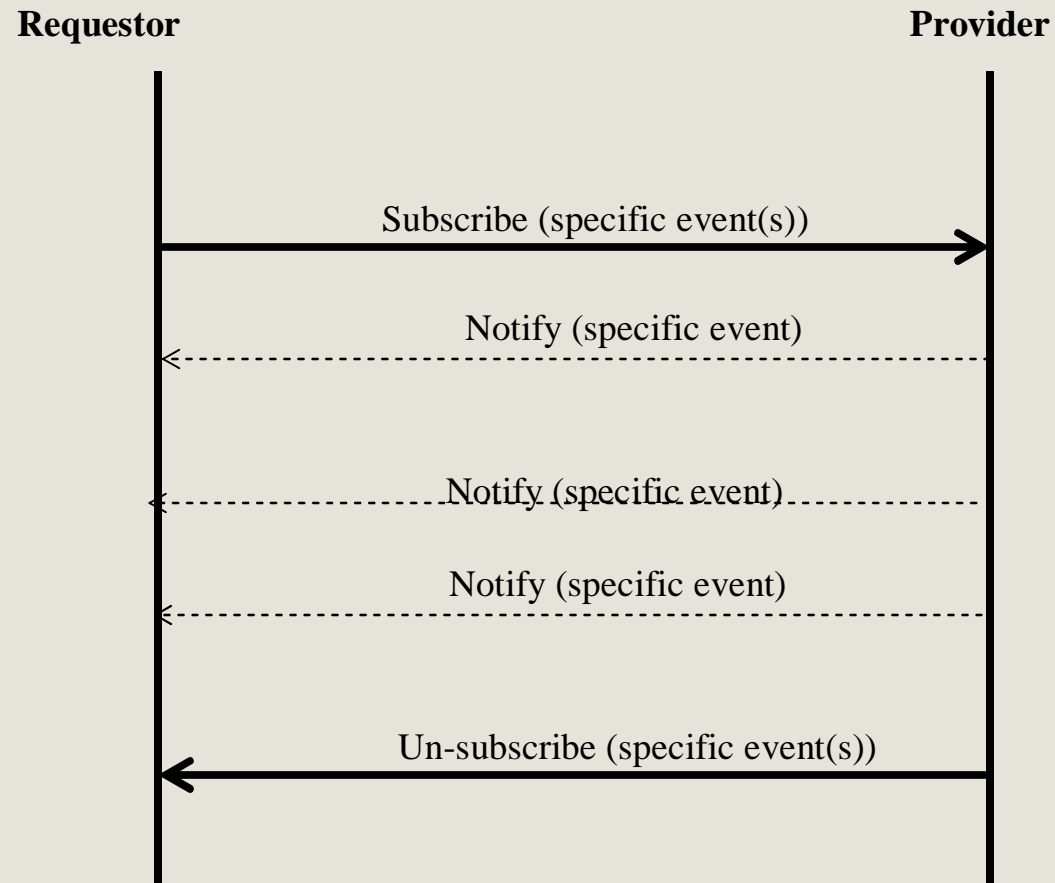
# Event Notification

## 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



# 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

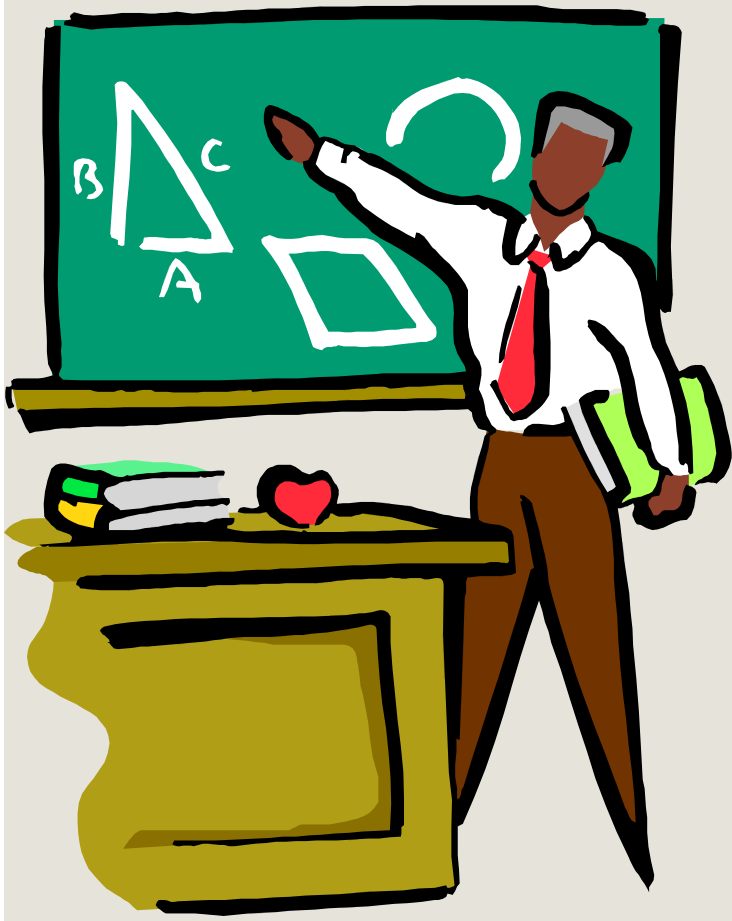
- Dissemination/consumption of presence information (e.g. on/off, willingness to communicate, device capabilities, preferences)
  - Numerous applications
    - Multiparty sessions initiated when a quorum is on-line
    - News adapted to device capabilities
- Several standards including SIMPLE (SIP based)
  - 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

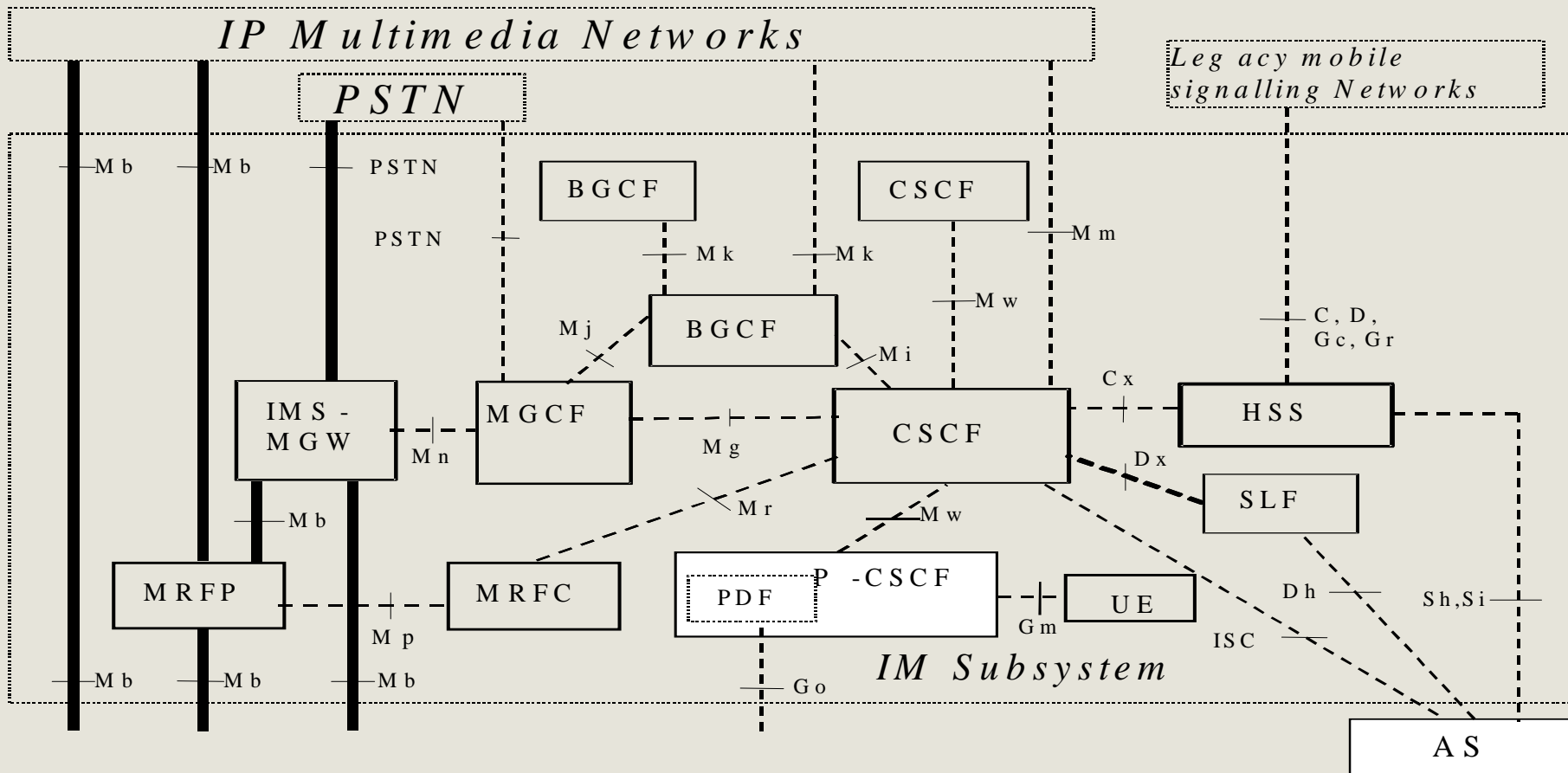


# 3GPP networks

## 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
  - Compression 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 administrative 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

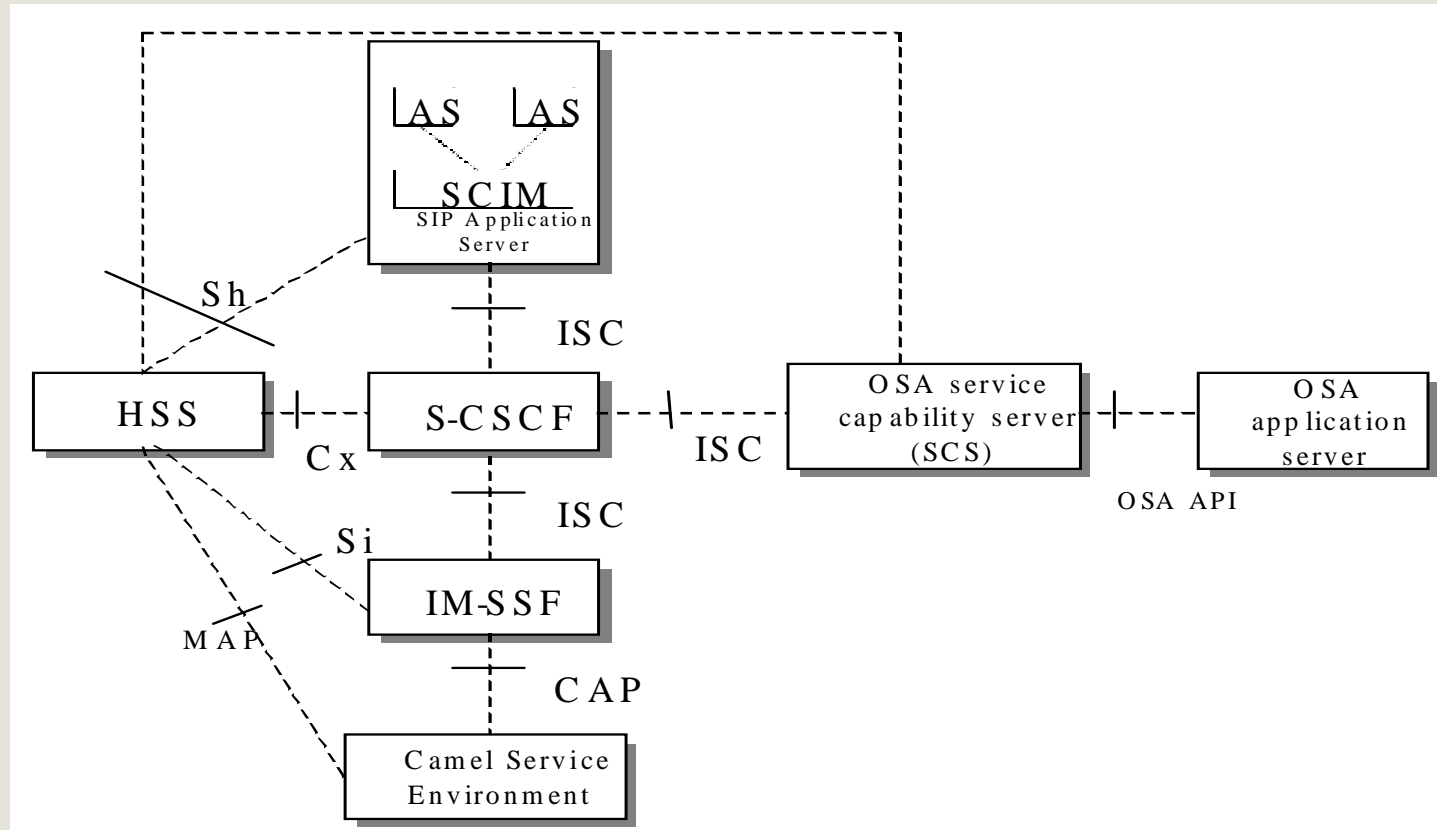
SIP AS: Signaling specific architecture (Services can work only in SIP environment)

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

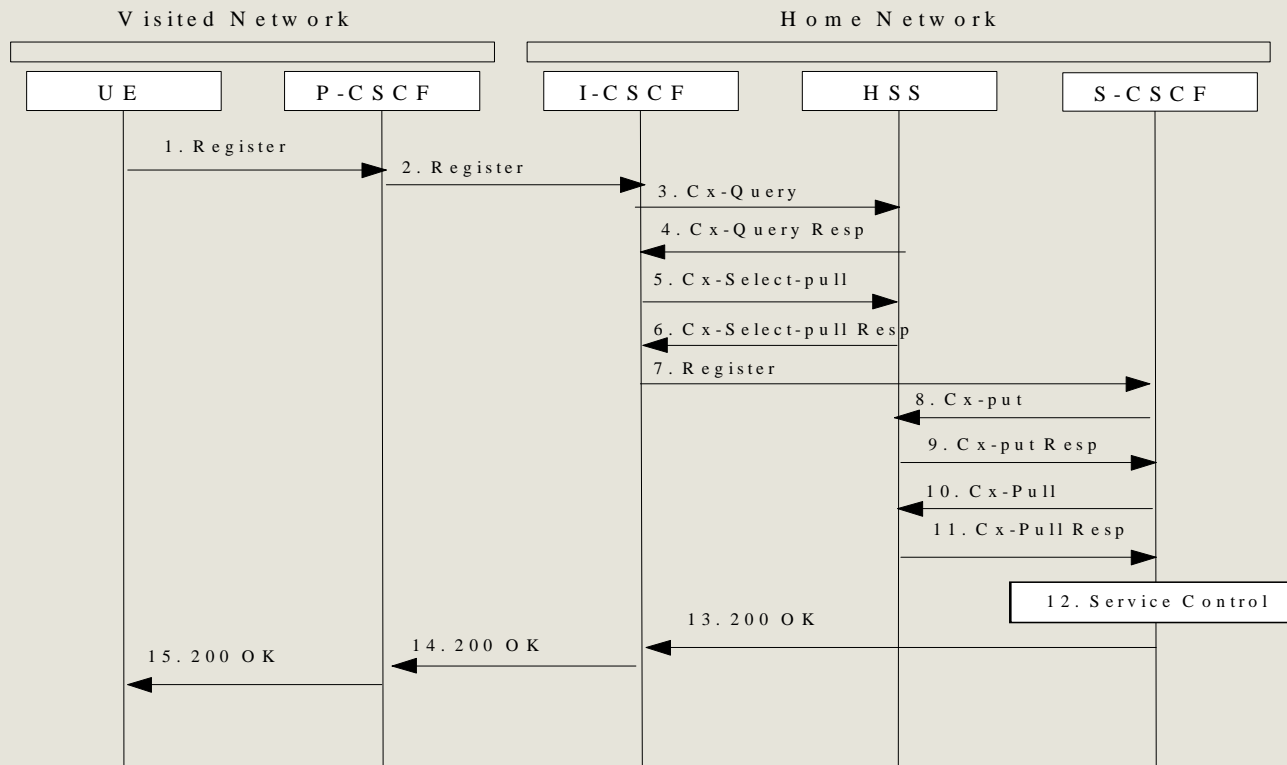
- Signaling neutral architecture
- Happens to work in a SIP environment, but can work in other environments



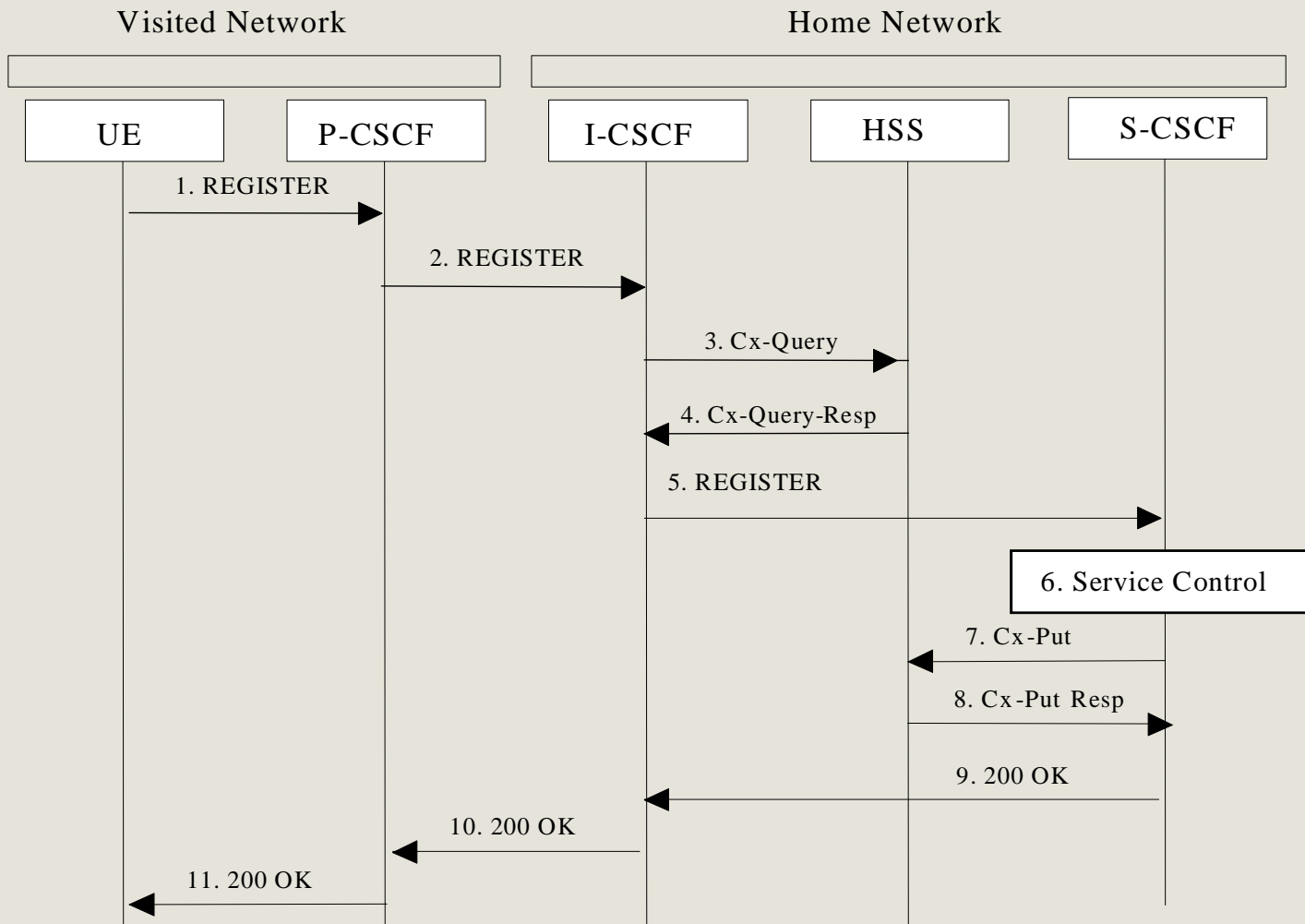
# IP multimedia portion



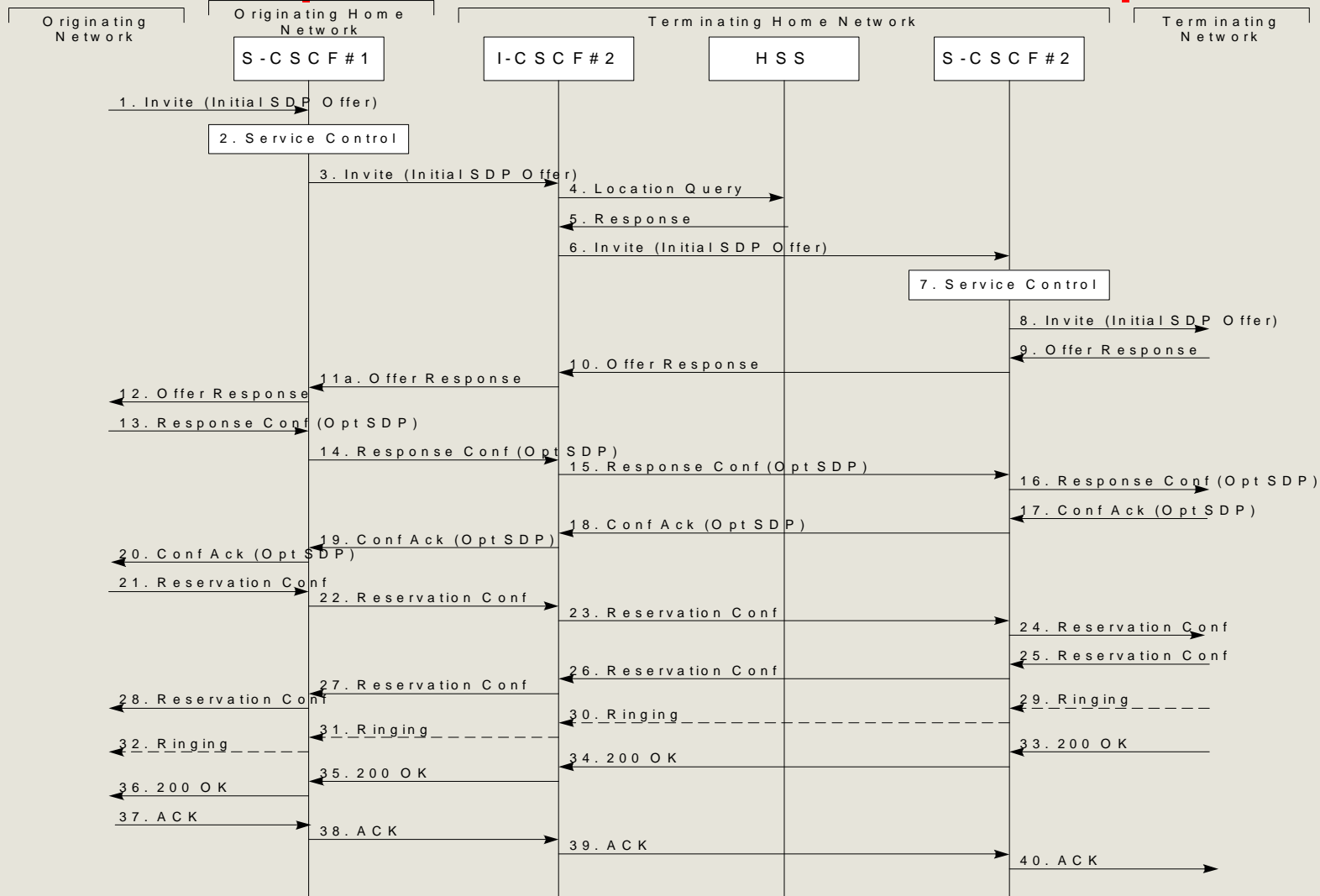
# IP Multimedia portion – Registration



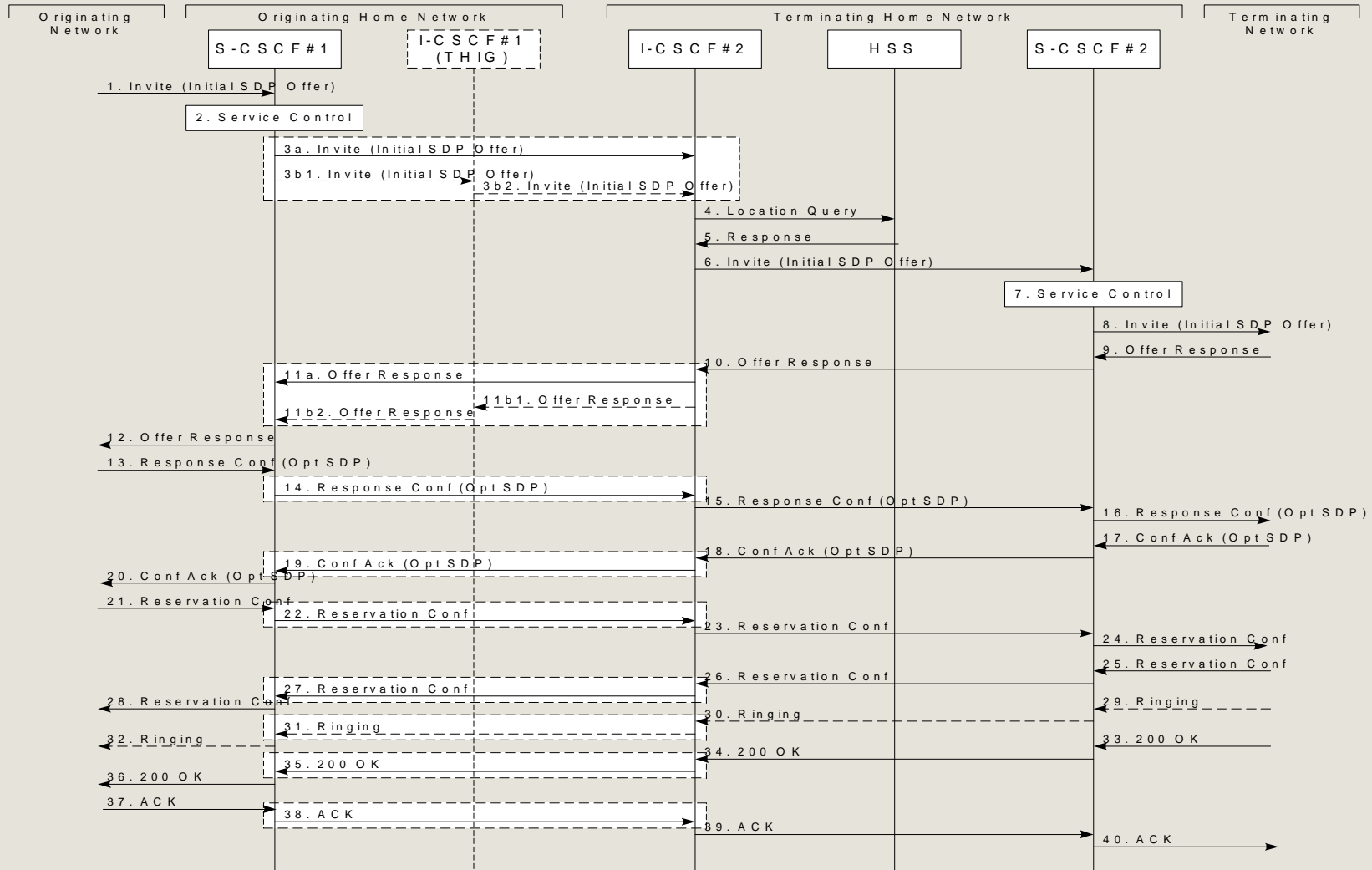
# IP Multimedia portion – De-Registration



# IP Multimedia portion – Call initiation - Same operator



# IP Multimedia portion – Call initiation - Different operators



# References

## Core SIP

- SIP core signalling:
- H. Schulzrinne, and 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 , October 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