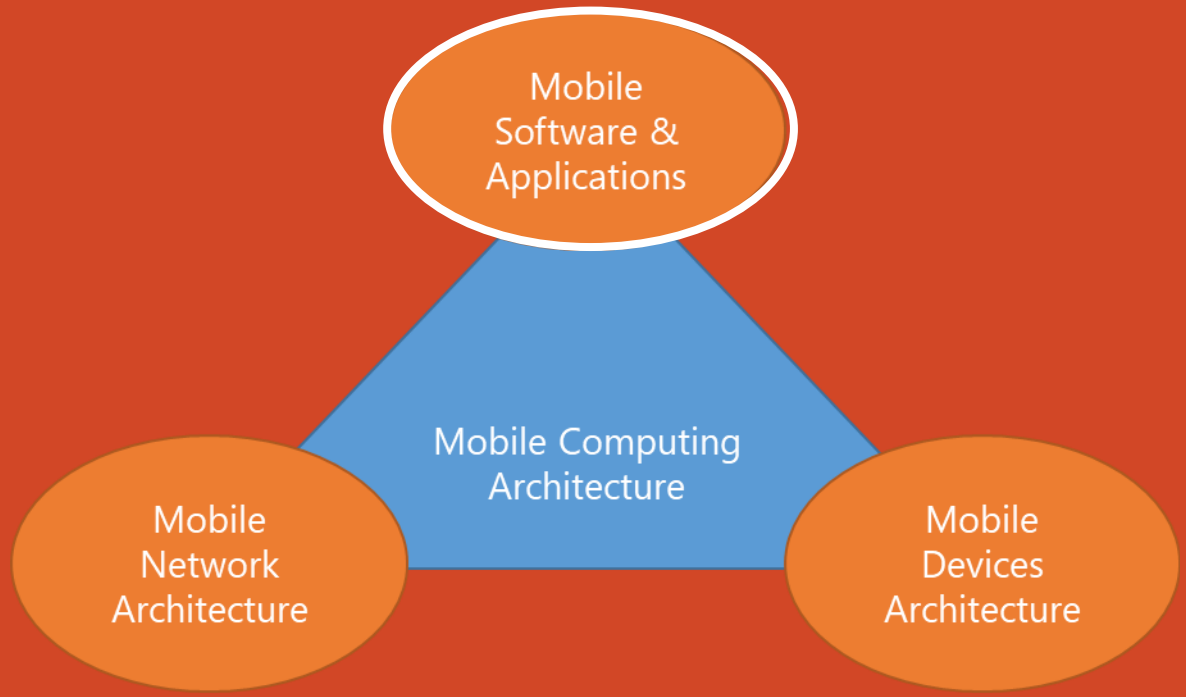
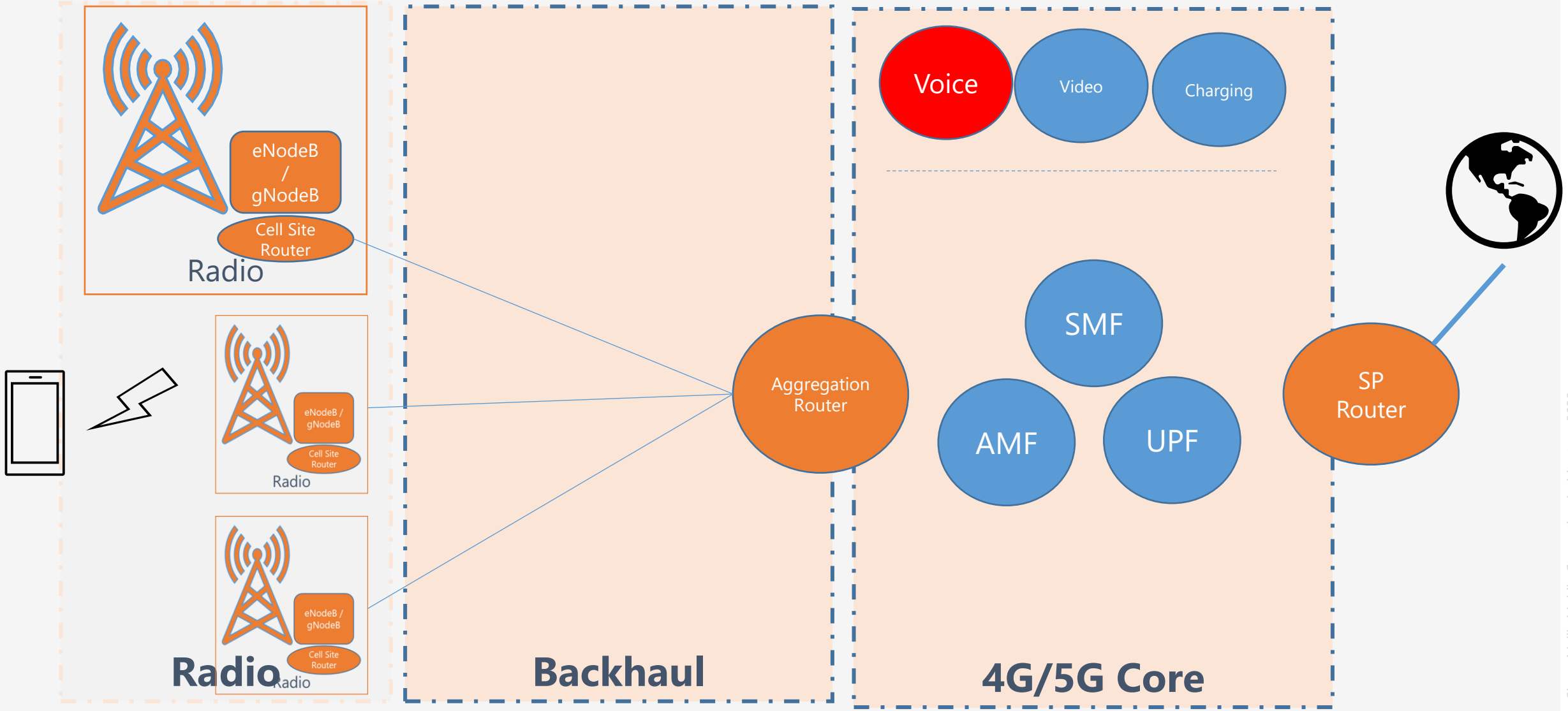
Mobile Computing Architecture

UW Bothell, WA

Voice Over IP over 5G (and 4G)



How do we put those applications on a 5G Mobile Network?



Brief History of Session Initiation Protocol (SIP)

Developed by Handley, Schulzrinne, Schooler, and Rosenberg

- Submitted as Internet-Draft 7/97 to IETF
- Assigned RFC 2543 in 3/99
- Updated to RFC 3261 in 6/02
- Now comprises more than 215 RFCs

Application-layer (signaling) control protocol for initiating and controlling a session and related media among users. Covers point-to-point sessions (calls), conferences and multimedia distribution.

- Re-use of & Maximum Interoperability with existing protocols
- Reuse Internet addressing (URLs, DNS, proxies)
- Utilize rich Internet feature set
- Reuse HTTP (Text based) coding and use client-server model
- Make no assumptions about underlying protocol: TCP, UDP, SCTP, etc.

Components of Session Initiation Protocol (SIP)

Users

- Users are identified by unique addresses.
  - sip:userID@gateway.com
  - tel:+19725551212

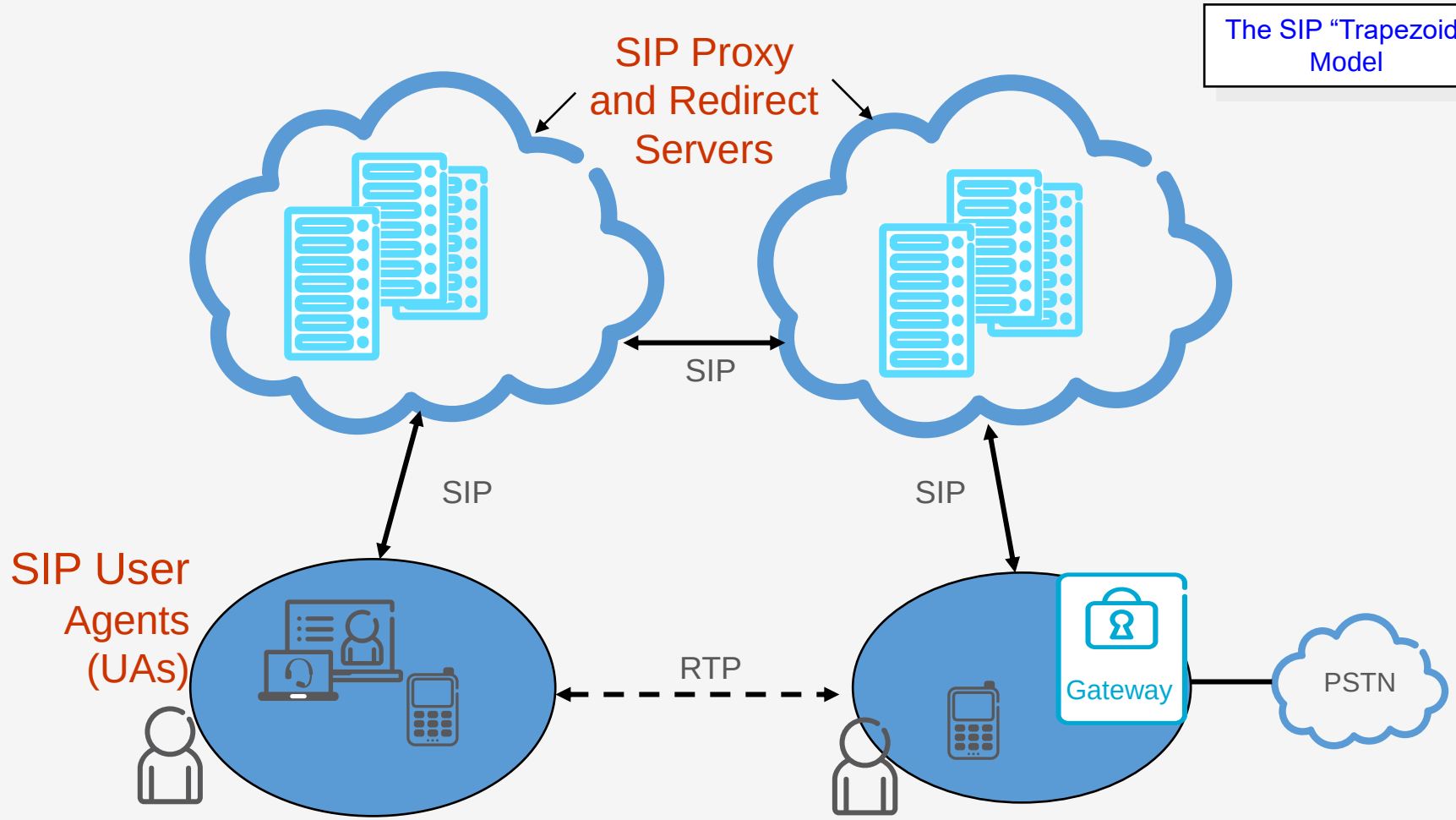
User Agents:

- SIP is a peer-to-peer protocol between User Agents (UAs):
  - User agent client (UAC)
  - User agent server (UAS)
  - A device may function as both → But only one or the other per transaction.

Servers:

- Proxy Server – "routes" a request to another server
- Redirect Server – UAS that redirects to other URIs, and sends address of next hop back to client/requestor
- Registrar – handles registration and maintains users' whereabouts (via database)
- Network Servers – support tasks (location, database, telephony, directory)

SIP Architecture

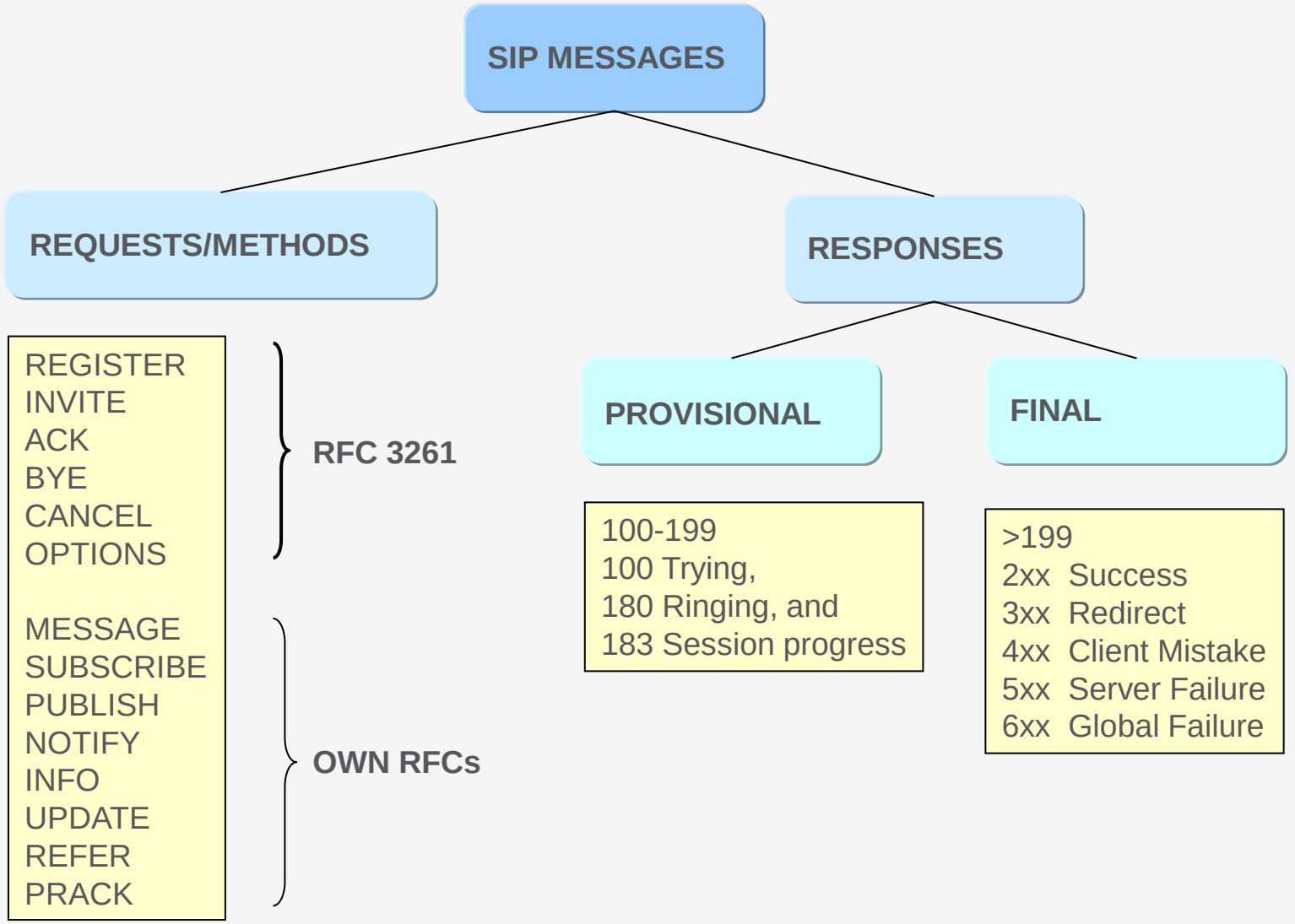


SIP Address – Uniform Resource Identifier

Uses internet Uniform Resource Locators URLs

- Supports both Internet and PSTN addresses
- General form of a SIP URL is **name@domain** **(e.g. Bob@telco.com)**
- Examples:

SIP Messages



SIP Requests / Responses

SIP **Requests** (also called Methods / Messages) are defined as:

- Method SP Request-URI SP SIP-Version CRLF (SP=Space, CRLF=Carriage Return and Line Feed)
- Example: INVITE sip:picard@telco1.com SIP/2.0
- Other Methods: REGISTER, CANCEL, BYE, ACK, OPTIONS, …

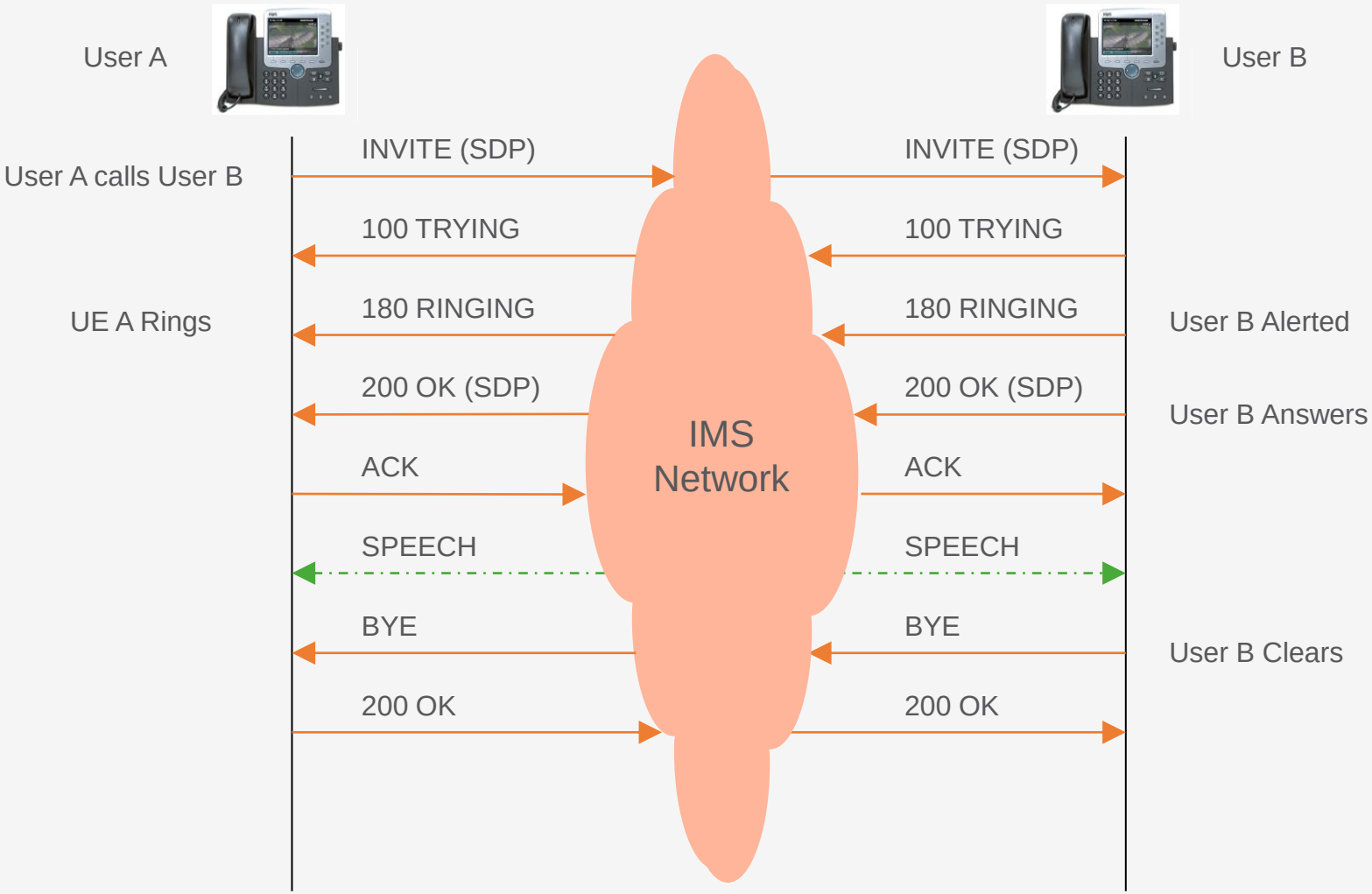
SIP **Responses** are defined as:

- SIP-Version SP Status-Code SP Reason-Phrase CRLF (SP=Space, CRLF=Carriage Return Line Feed)
- Example: `SIP/2.0 404 Not Found`

First digit of the Status-Code gives Class of response:

- 1xx - Informational – request received, continuing to process.
- 2xx - Success – Action was successfully received, understood and accepted.
- 3xx - Redirection – Further action needs to be taken to complete the request
- 4xx - Client Error – Request contains bad syntax, or cannot be fulfilled by this server
- 5xx - Server Error – Server failed to fulfill an otherwise valid request
- 6xx - Global Failure – Request is invalid at any server

Simplified SIP Sequence



SIP Request Example

Typical SIP Request:

Request line

```
INVITE sip:picard@telco2.com SIP/2.0
```

SIP Headers

```
Via: SIP/2.0/UDP host.telco1.com:5060
From: Alan Johnston <sip:alan.johnston@telco1.com>;tag=a4e2
To: Jean Luc Picard <sip:picard@telco2.com>
Call-ID: 314159@host.telco1.com
CSeq: 1 INVITE
Contact: sip:alan.johnston@telco1.com
Content-Type: application/sdp
Content-Length: 124
```

space

SDP

```
v=0
o=ajohnston 5462346 332134 IN IP4 host.telco1.com
s=Let's Talk
c=IN IP4 10.64.1.1
t=0 0
m=audio 49170 RTP/AVP 0 3
```

The relative order of header fields (with different field names) is not significant. However, it is recommended that header fields used for proxy processing (e.g. Via, Route, Record-Route, Proxy-Require, and Max-Forwards) appear towards the top of the message.

SIP Response Example

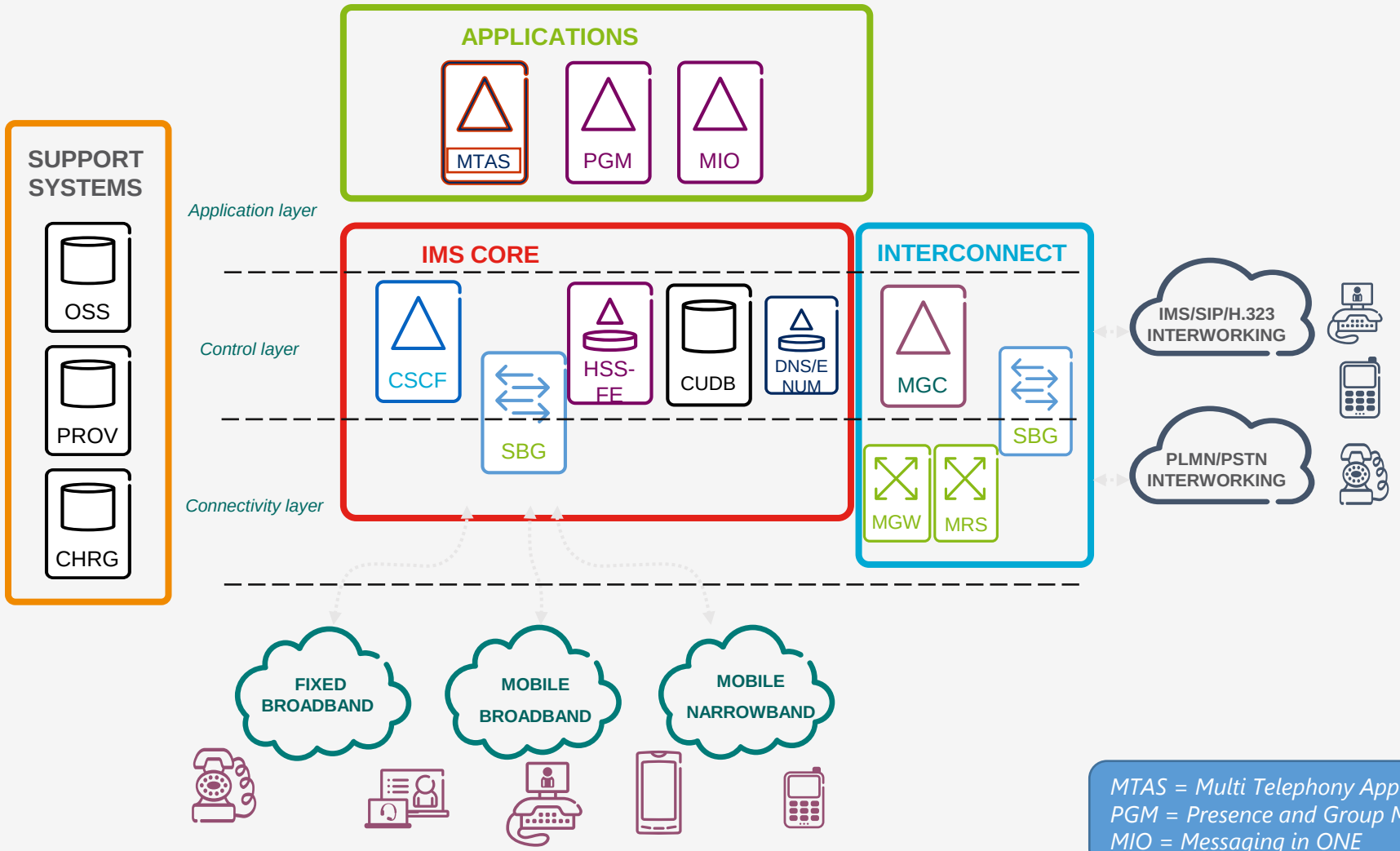
- **Via**, **From**, **To**, **Call-ID**, and **CSeq** are copied exactly from Request (and To tag added).
- **To** and **From** are NOT swapped!

IP Multimedia System (IMS)

BASIC CONCEPTS AND PROCEDURES

[Voice over LTE (VOLTE) and Voice over 5G]

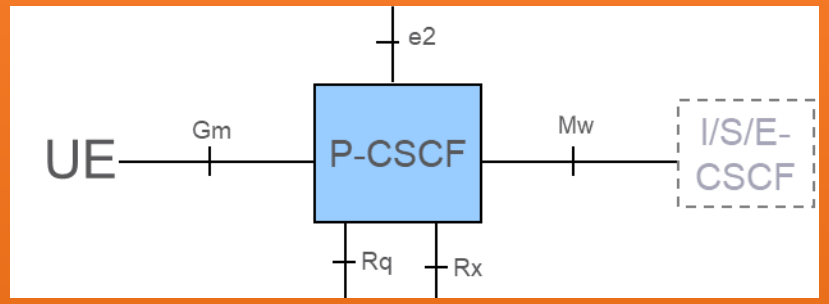
IMS Layered Architecture



MTAS = Multi Telephony App Server
PGM = Presence and Group Management
MIO = Messaging in ONE

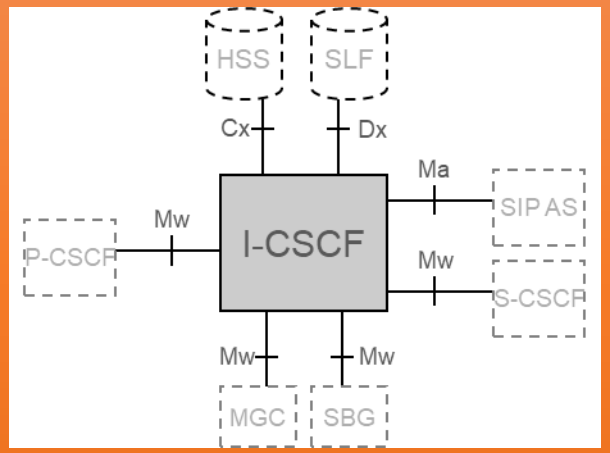
IMS Core
Proxy- Call Session Control Function (CSCF)

- Proxy - the first point of contact between the IMS terminal and the IMS network (signaling plane)
- Allocated to the IMS terminal during the registration (and does NOT change during the registration period)
- Includes security/authentication related functions, (charging), signaling compression, policy decision functions, etc.



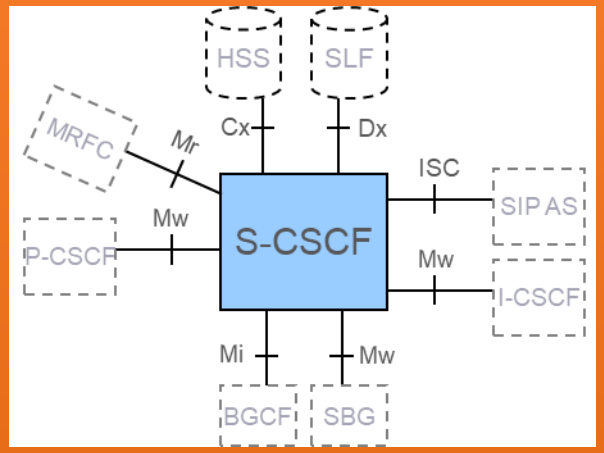
IMS Core
I-CSCF (interrogating)

- I-CSCF is a SIP stateless proxy located at the edge of IMS domain
- I-CSCF is involved to find the S-CSCF at;
  - Registration
  - Terminating requests
- The address of the I-CSCF is listed in the DNS records of the domain
- I-CSCF has an interface to HSS (to be able to find the S-CSCF for a specific user)
- Proxies SIP requests to S-CSCF or Application Servers



IMS core
S-CSCF (serving)

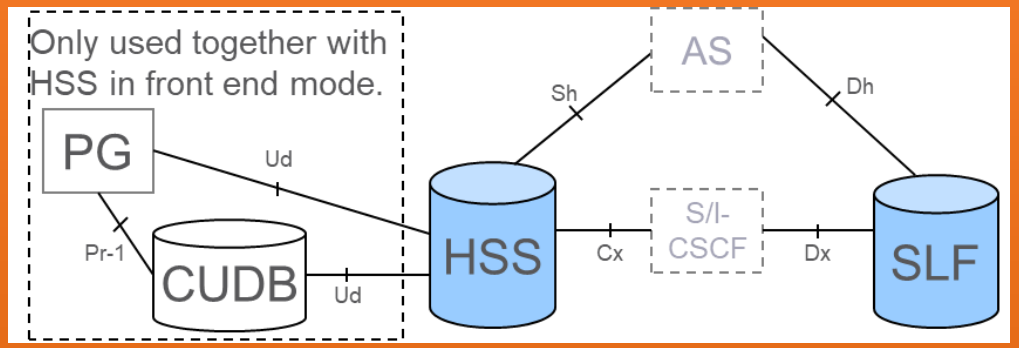
- The central node of the signaling plane
- SIP registrar (maintains a binding between the user location (IP address of user terminal) and the Public User Identity) i.e. creates and stores user ”contact” information
- Has an interface to HSS/CUDB (authentication and user profiles)
- Performs user service triggering (Filter Criteria)
- Based on user specific information downloaded at registration, the S-CSCF invokes application servers for end users service handling.
- ALL the SIP signaling related to an IMS device will traverse the allocated S-CSCF (except for Emergency calls)



IMS Core

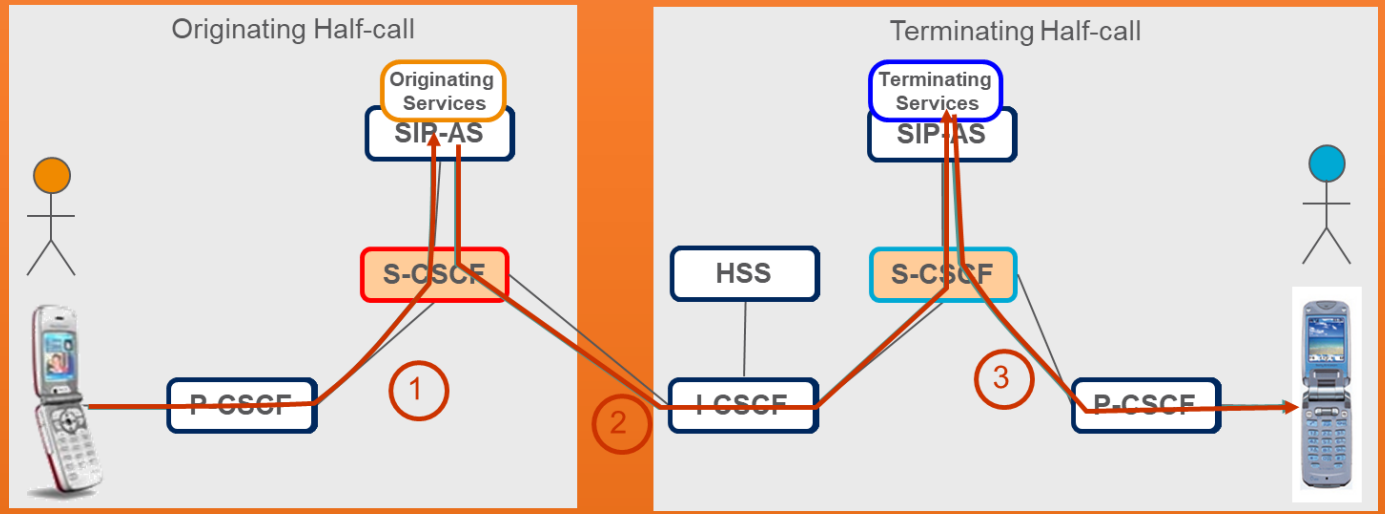
Home Subscriber Server (HSS) and Centralized User Database (CUDB)

- HSS is a database for user related information.
- HSS in the **classic mode** uses an HSS internal database.
- HSS in **front end mode** uses an UDR, an external database (the Ericsson CUDB implements the UDR).
- HSS implements the Diameter protocol (not SIP)
- The Provisioning Gateway handles the provisioning interfaces and the provisioning logic between the HSS Front End and the CUDB.



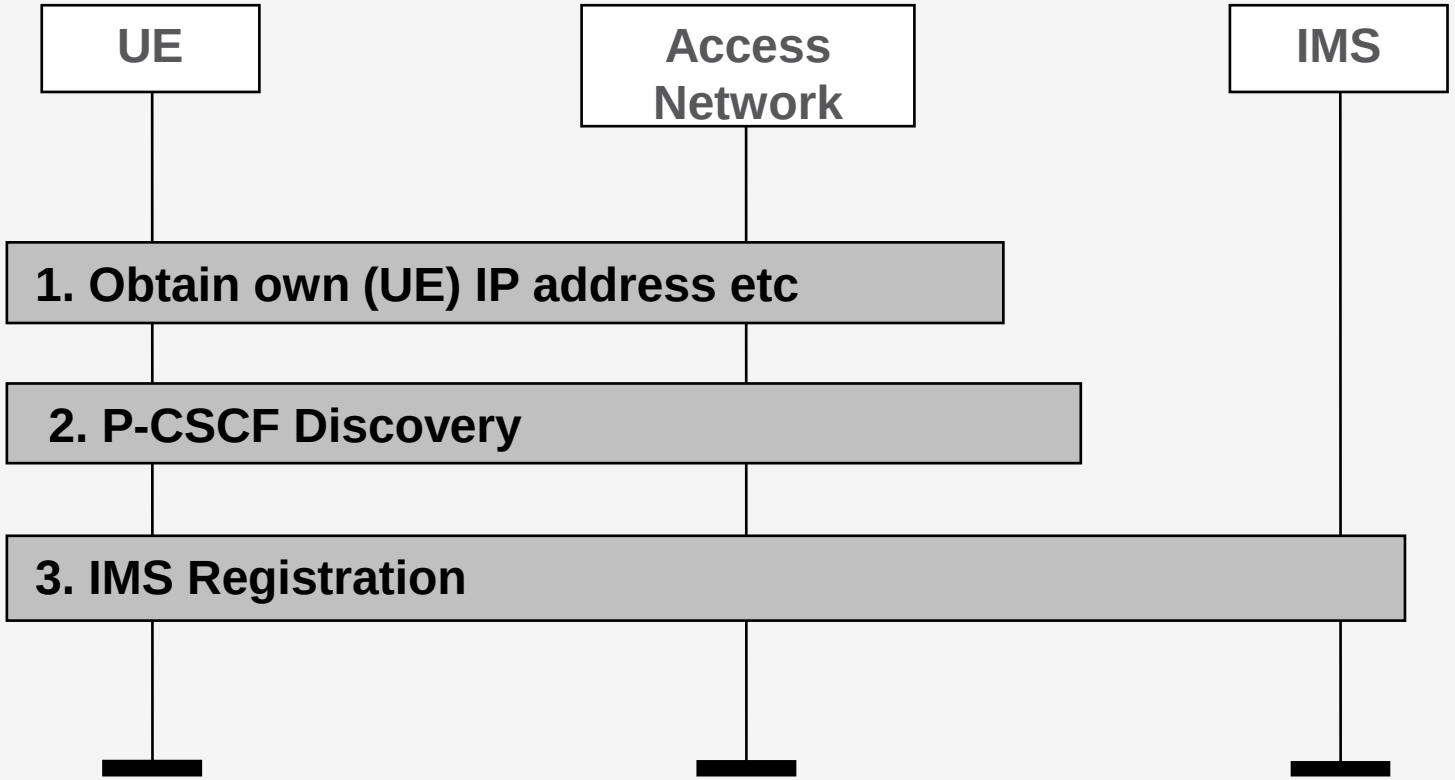
Telephony Application server- TAS

- IMS Service Centralization and Continuity Application Server (SCC-AS).
- *Multi-user and One-number Subscriptions*
- Scheduled Conference Application Server



Note: If the SIP-AS is a B2BUA, e.g., MTAS, there are three dialogs in the session

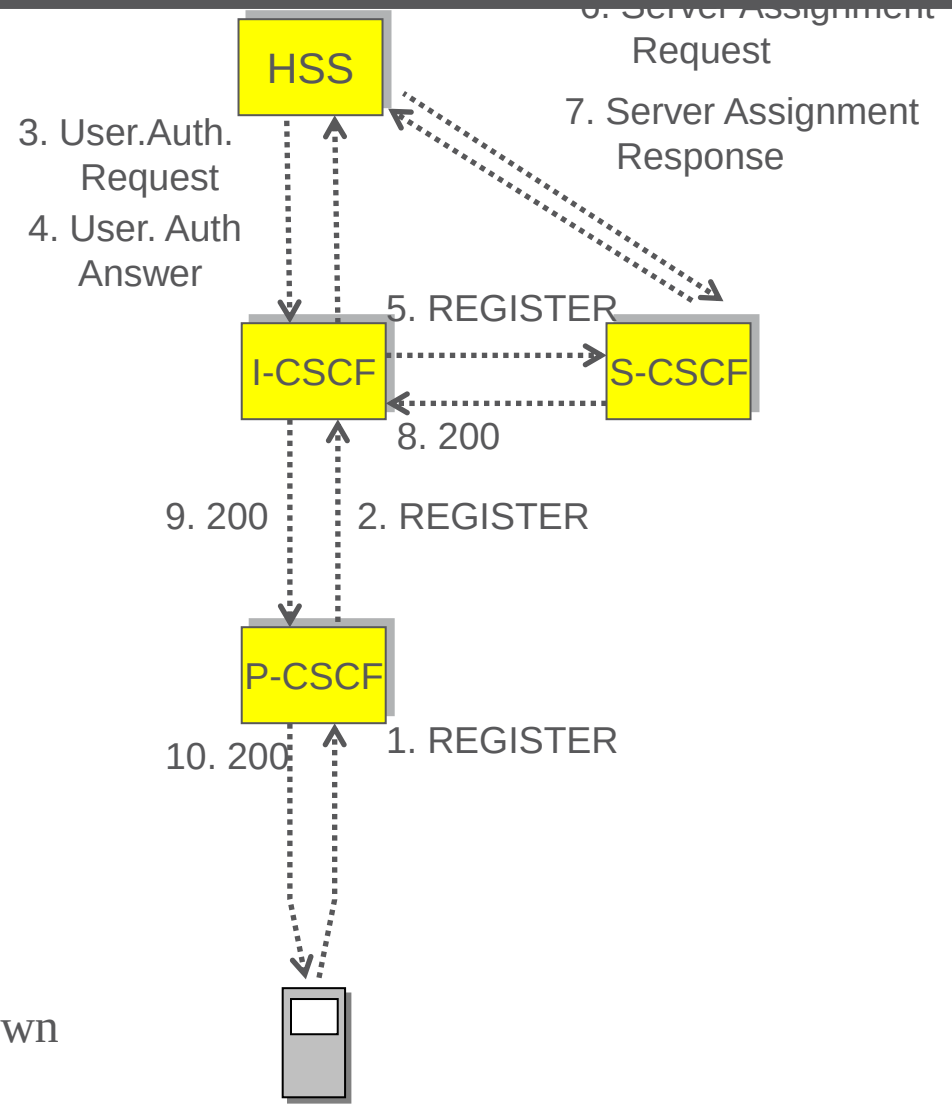
PRE-Registration Procedures



Initial Registration procedure

200 OK

The S-CSCF indicates that registration was successful with the 200 OK message



Note: Service, Security and SLF Aspects Not shown

After Registration

HSS

The HSS remembers where the S-CSCF for the user is

S-CSCF

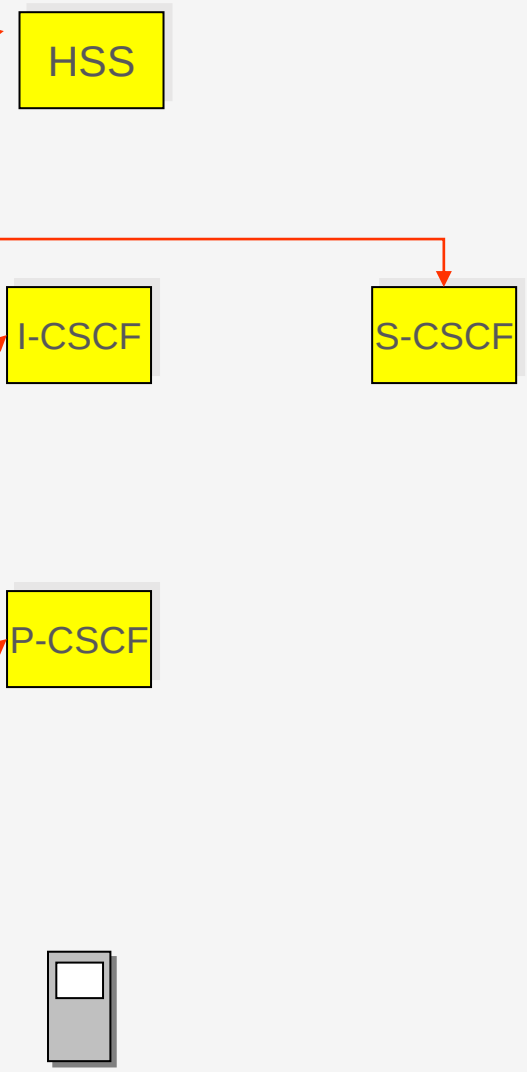
The S-CSCF remembers the user profile of the user, including the service triggers

I-CSCF

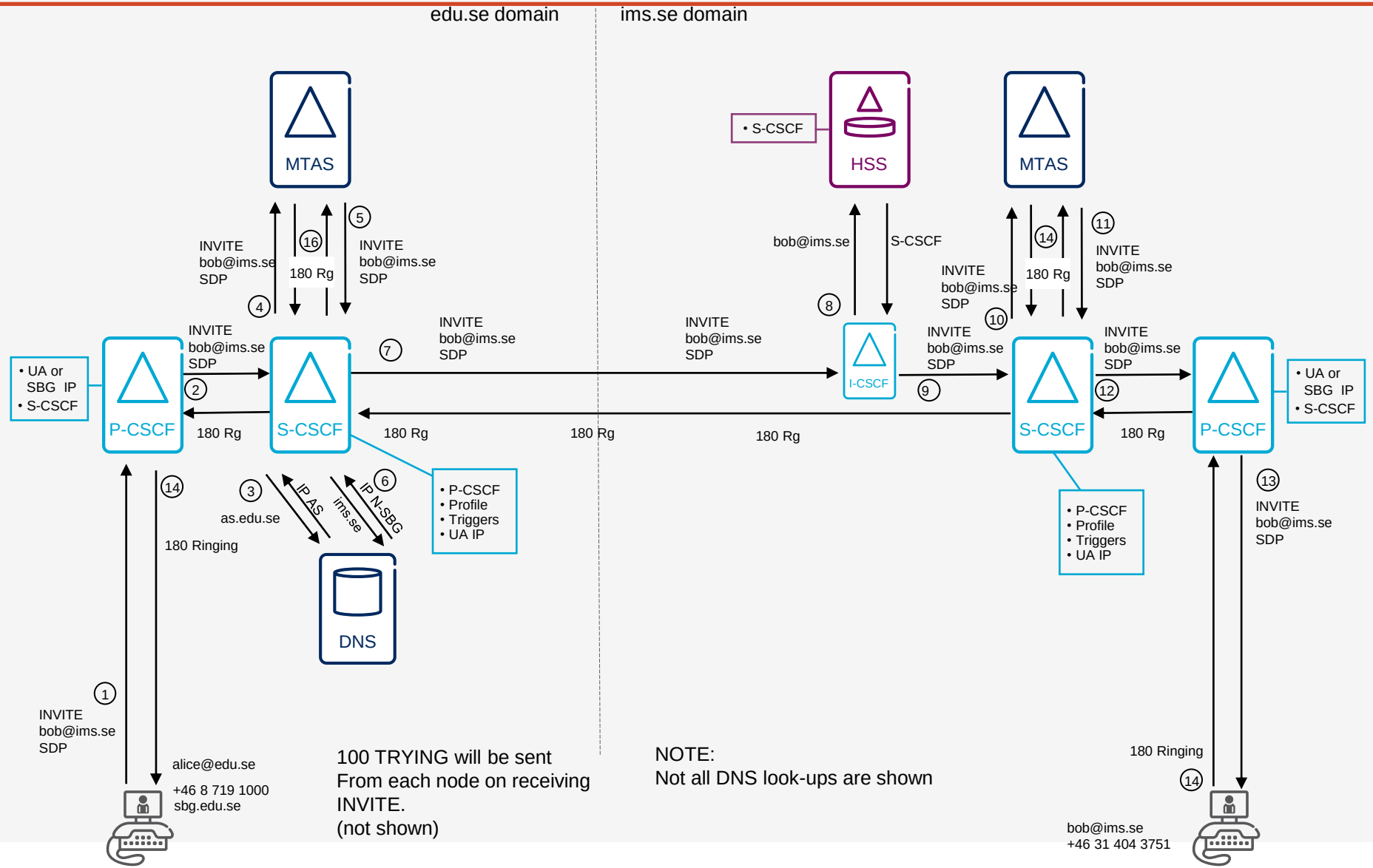
The I-CSCF does not remember anything

P-CSCF

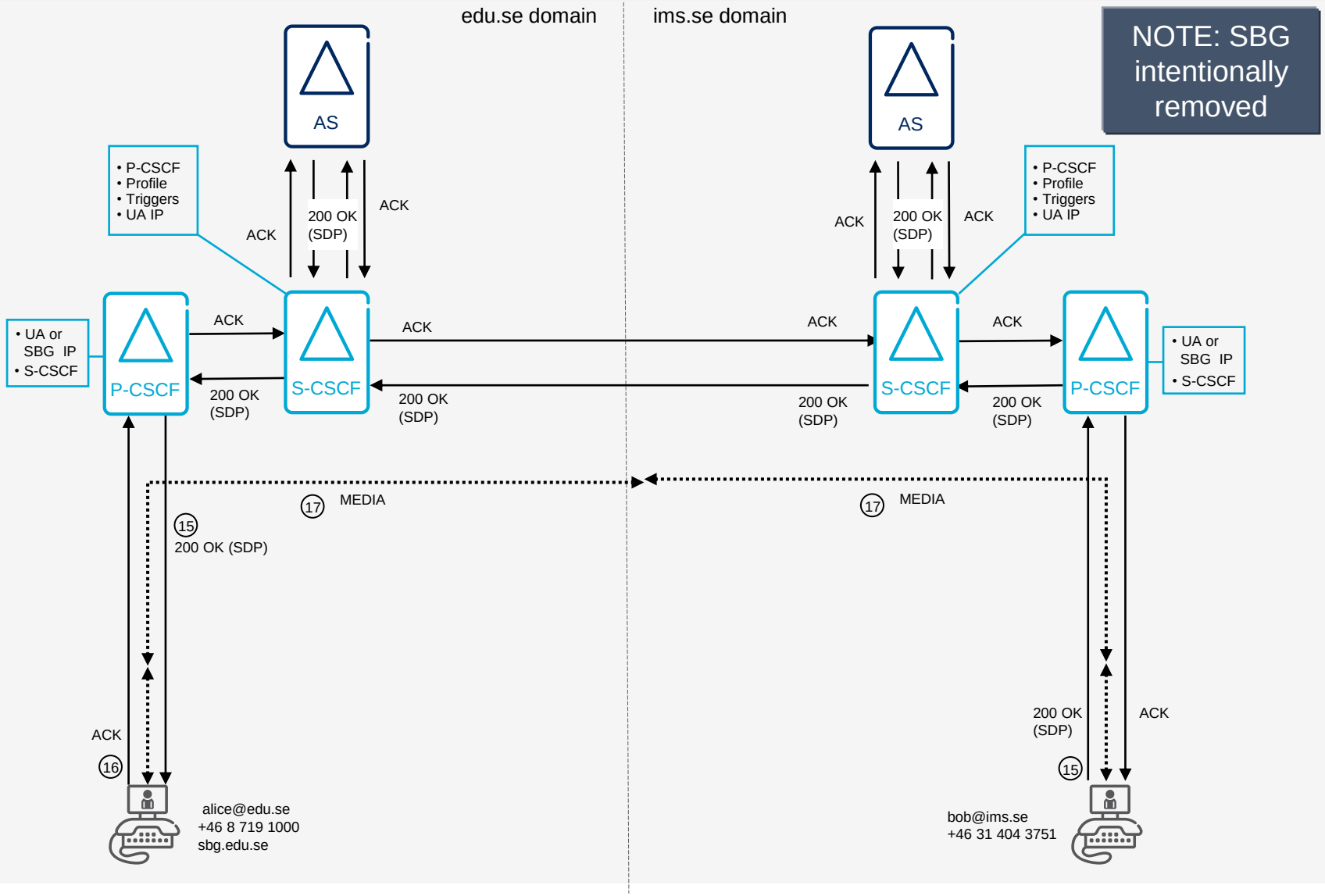
The P-CSCF remembers how to route the SIP signaling to the S-CSCF of the user



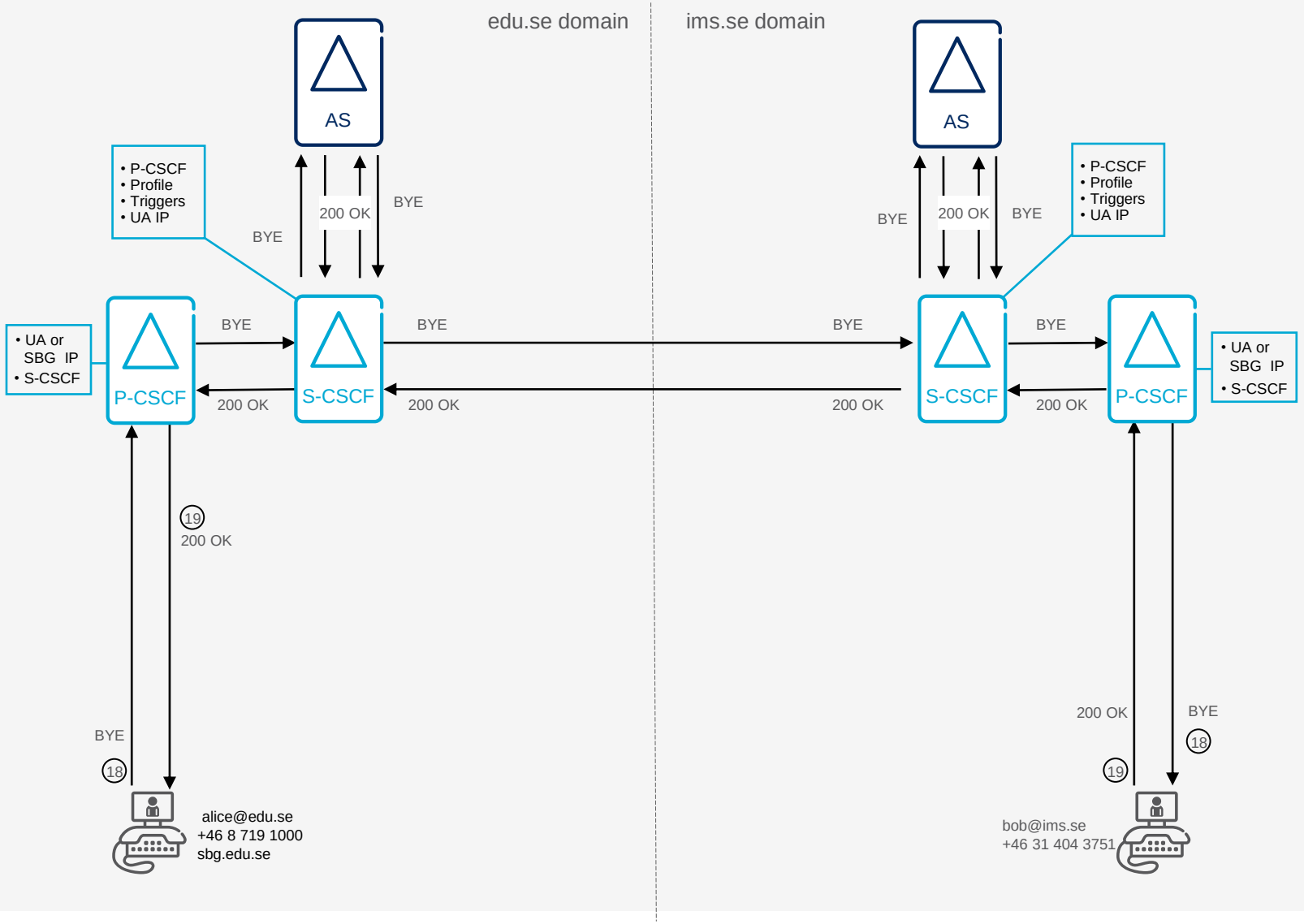
SIP to SIP Session (1/3)



SIP to SIP Session (2/3)

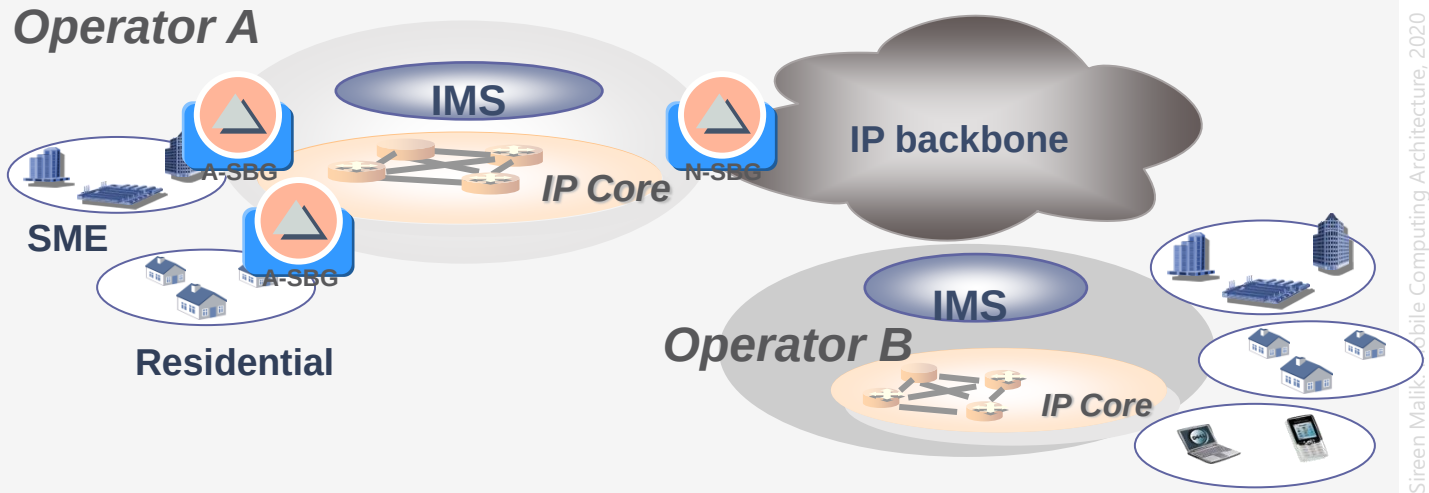


SIP to SIP Session (3/3)



Session Border Gateway (SBG)

- Protects the IMS core both from users in access network as well as other operators
- “N-SBG”, at the NNI (Network to Network Interface)
- “A-SBG”, at the UNI (User to Network Interface)



SBG Security Functionality

- DoS protection
  - Most common IP attacks, SIP flood attacks
- Message validation
  - Syntax, valid SIP clients
- Topology hiding
  - NAPT with SDP rewrite, SIP header stripping
- Bandwidth theft protection, dynamic pinhole FW with bandwidth policing
  - open/close media ports dynamically correlated to SDP
  - police bandwidth according to SDP payload type (codec)
- Hosted NAT/FW
- Lawful Intercept

SBG in IMS Network