

# **IMS Tutorial**

## **Examples based in SDS Ericsson tool**

### **Basic level course.**

#### **Lesson one.**

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#### **1. IMS Overview – Why talk about IMS?**

The IMS Multimedia Telephony service is seen as the next step in telecommunications and the services which would finally harmonize telephony with data communications.

The development of the Multimedia Telephony service is driven by the fact that end-users desire to communicate in new ways, while still requiring a telecom grade service for the traditional real-time voice and video telephony service components, i.e. the same quality, reliability and security. For enterprise users, Multimedia Telephony will also offer integration of email, support for remote workers, conferencing and collaboration features. Another important property of Multimedia Telephony is personal mobility. Professional users want to use the telephony and data communication services in the same way while traveling as when being in the office. A third important feature for enterprise users is the possibility to control what calls and sessions should be allowed at any given point in time. For example, when attending a business meeting or a conference, the users may want to allow only the most important calls or sessions to reach the receiver. Other, less important, calls may be routed to an answering machine where the sound is recorded and attached in an e-mail to the subscriber's e-mail address.

IMS and the IMS Multimedia Telephony service are interesting also for the operators for several reasons. The IMS system incorporates the control mechanisms that are required in order to ensure that they can meet the users' expectations on quality of the service, reliability and security. The generic architecture and flexibility of the IMS platform also offers simple development and deployment of new services that can be added to the existing services, which gives the operators new revenue opportunities. In addition, the operator also requires an efficiency that is on a par with existing circuit switched systems and also interoperability with legacy systems. IMS also supports developing

standardized services, such as IMS Multimedia Telephony. The standardization is required to make the core set of service components behave the same for all operators since a user visiting another country still expects the same service behavior as in his or her home network.

Another attractive property of the IMS is that it allows for operating a single all-IP network, thereby removing the need for maintaining a circuit switched system in parallel with the IP network. This reduces the need for capital expenditure (CAPEX) as well as the operational expenditure (OPEX).

The Multimedia Telephony service is also transport “agnostic”. This means that service providers only need to implement one version of the service, which significantly reduces the implementation, testing and verification efforts and allows for faster time to market.

## 1.1 Some necessary Definitions:

**CAPEX: (CAPital EXpenditure)** Funds used by a company to acquire or upgrade physical assets such as property, industrial buildings or equipment. This type of outlay is made by companies to maintain or increase the scope of their operations. These expenditures can include everything from repairing a roof to building a brand new factory. <sup>1</sup>

**OPEX: (OPerational EXpenditure)** is an on-going cost for running a product, business, or system. Its counterpart, a CAPEX, is the cost of developing or providing non-consumable parts for the product or system.

### 1.1.1 IMS Definition

*“The IP Multimedia Core Network Subsystem (IMS) is an architecture designed to let telecom operators provide IP multimedia communication services to their customers. [3GPP TS 22.228] defines the service requirements for the IMS.”*

When all think about IMS services, we think about multimedia sessions consisting of video, audio, and voice and talk too about mixing all of these media types in a single session, being able to use these services while roaming the network. This is absolutely true, and is what makes the IMS different from the current telecommunications networks.

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<sup>1</sup> <http://investopedia.com>

Taking the definition from the book “*The IMS: IP multimedia concepts and services*”[1] :

**IMS is a global, access-independent and standard-based IP connectivity and service control architecture that enables various types of multimedia services to end-users using common Internet-based protocols.**

The real integration of voice and data services will be increase the productivity while the development of innovative applications integrating voice, data and multimedia will create demands for new services, such as presence, multimedia chat, push to talk and conferencing.

This is the key for IMS success, the skill to combine mobility and the IP network, find the kill application that permit the services success.

The figure 1 shows a converged communication network for the fixed mobile environment. It is the IMS which introduces multimedia session control in the packet-switched domain and at the same time brings circuit-switched functionality in the packet switched domain

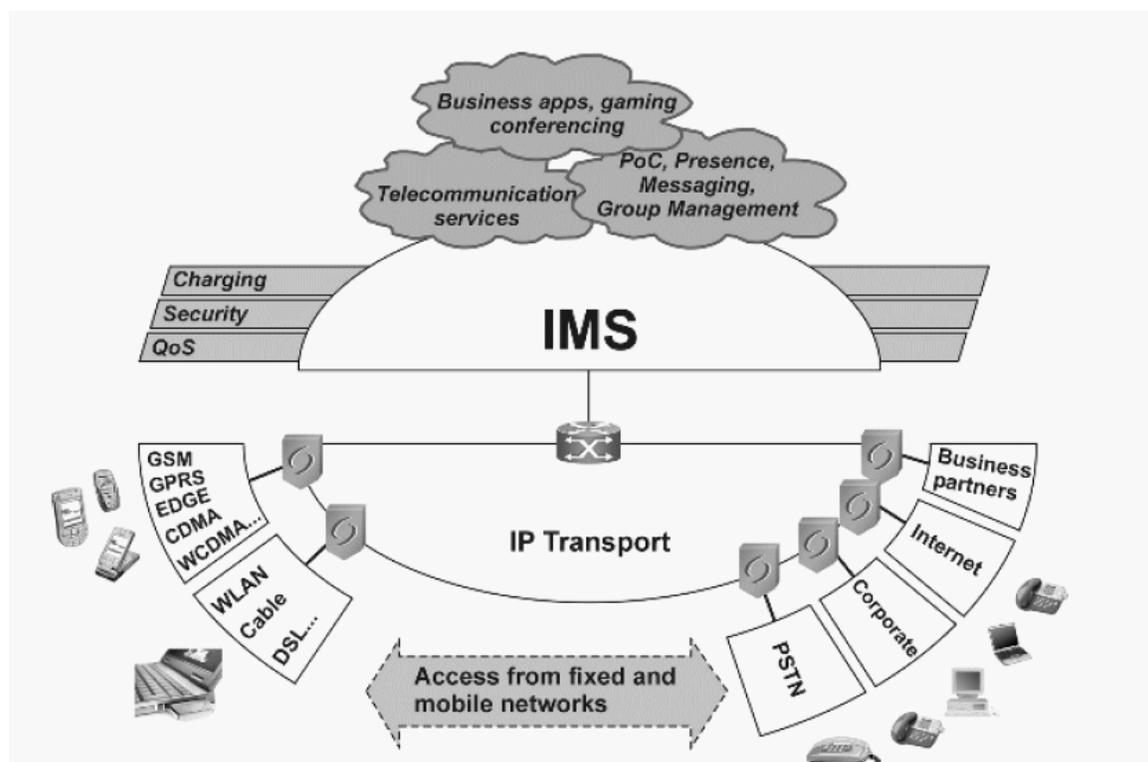


Figure 1: Converged communication network, taked from [2]

## **2. IMS Network Architecture:**

IMS is primarily based on IP protocols, with some legacy protocols used for compatibility with the PSTN and other traditional telecommunications networks. The IP family of protocols has been developed by the Internet Engineering Task Force (IETF). Since IMS utilizes several different access technologies, such as GSM, UMTS, etc. many additional protocols are also necessary. Rather than inventing new protocols, 3GPP decided to reuse protocols that had already been developed in other organizations, such as the IETF and the International Telecommunication Union–Telecommunications (ITU-T). Figure 2 shows the main protocols used between the basic elements of IMS. Each of the elements of this figure will be described in conjunction with the relevant protocol(s) . In this figure shows too the nodes included in the so-called IP Multimedia Core Network Subsystem. These nodes are:

- one or more user databases, called HSSs (Home Subscriber Servers) and SLFs
- (Subscriber Location Functions);
- one or more SIP servers, collectively known as CSCFs (Call/Session Control Functions);
- one or more ASs (Application Servers);
- one or more MRFs (Media Resource Functions), each one further divided into MRFC (Media Resource Function Controllers) and MRFP (Media Resource Function Processors);
- one or more BGCFs (Breakout Gateway Control Functions);
- one or more PSTN gateways, each one decomposed into an SGW (Signaling Gateway),
- an MGCF (Media Gateway Controller Function), and an MGW (Media Gateway).

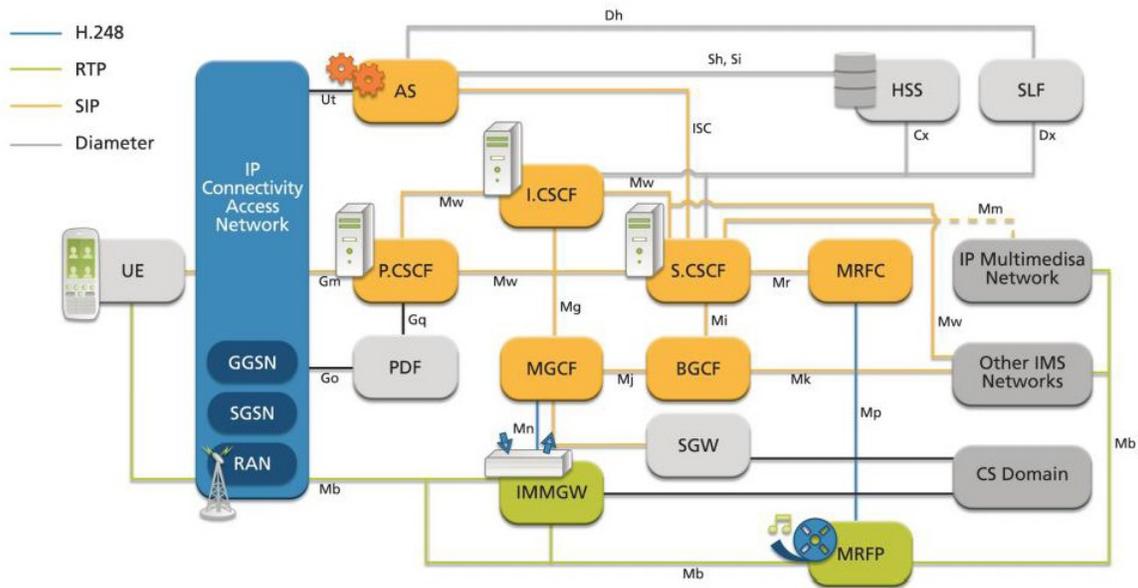


Figure 2. Copy from: Radvision, “IMS SIP and Signaling, The Radvision perspective – A technology overview”, Radvision, Technical Report, 2006.

## 2.1 HSS [2]

The Home Subscriber Server (HSS) is the central repository for user-related information.

Technically, the HSS is an evolution of the HLR (Home Location Register), which is a GSM node. The HSS contains all the user-related subscription data required to handle multimedia sessions. These data include, among other items, location information, security information (including both authentication and authorization information), user profile information (including the services that the user is subscribed to), and the S-CSCF (Serving-CSCF) allocated to the user.

A network may contain more than one HSS, in case the number of subscribers is too high to be handled by a single HSS. In any case, all the data related to a particular user are stored in a single HSS.

Networks with a single HSS do not need a Subscription Locator Function (SLF).

On the other hand, networks with more than one HSS do require an SLF.

The SLF is a simple database that maps users' addresses to HSS's. A node that queries the SLF, with a user's address as the input, obtains the HSS that contains all the information related to that user as the output. Both the HSS and the SLF implement the Diameter protocol (RFC 3588) with an IMS-specific Diameter application..

## 2.2 CSCF

The CSCF (Call/Session Control Function), which is a SIP server, is an essential node in the IMS. The CSCF processes SIP signaling in the IMS. There are three types of CSCFs, depending on the functionality they provide. All of them are collectively known as CSCFs, but any CSCF belongs to one of the following three categories.

- P-CSCF (Proxy-CSCF).
- I-CSCF (Interrogating-CSCF).
- S-CSCF (Serving-CSCF).

### 2.2.1 P-CSCF

Proxy Call Session Control Function (P-CSCF) is the first contact point for users within the IMS. It means that all SIP signalling traffic from the UE will be sent to the P-CSCF. Similarly, all terminating SIP signalling from the network is sent from the P-CSCF to the UE. The P-CSCF have four unique task:

- SIP compression
- IPsec security association, interaction with
- Policy Decision Function (PDF)
- emergency session detection.

As the SIP protocol is a text-based signalling protocol, it contains a large number of headers and header parameters, including extensions and security-related information which means that their message sizes are larger than with binary-encoded protocols.

For speeding up the session establishment 3GPP has mandated the support of SIP compression<sup>2</sup> between the UE and P-CSCF. The P-CSCF needs to compress messages if the UE has indicated that it wants to receive signalling messages compressed.

P-CSCF is responsible for maintaining Security Associations (SA) and applying integrity and confidential protection for SIP signalling. This is achieved during SIP registration as the UE and P-CSCF negotiate IPsec SA. After the initial registration the P-CSCF is able to apply integrity and confidential protection of SIP signalling.

The P-CSCF may include a PDF (Policy Decision Function). The PDF may be integrated with the P-CSCF or be implemented as a stand-alone unit. The PDF authorizes media plane resources and manages Quality of Service over the media plane.

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<sup>2</sup> SIP compression only reduces a time connection, not save bandwidth.

### **2.2.2 I-CSCF**

Interrogating Call Session Control Function (I-CSCF) is a contact point within an operator's network for all connections destined to a subscriber of that network operator. There are 3 unique tasks assigned for the I-CSCF:

- Obtaining the name of the next hop (either S-CSCF or application server) from the Home Subscriber Server (HSS).
- Assigning an S-CSCF based on received capabilities from the HSS. The assignment of the S-CSCF will take place when a user is registering with the network or a user receives a SIP request while she is unregistered from the network but has services related to an unregistered state (e.g., voice mail).
- Routing incoming requests further to an assigned S-CSCF or the application server Providing Topology Hiding Inter-network Gateway (THIG) functionality.

### **2.2.3 S-CSCF**

Serving Call Session Control Function (S-CSCF) is the focal point of the IMS as it is responsible for handling registration processes, making routing decisions and maintaining session states, and storing the service profiles. When a user sends a registration request it will be routed to the S-CSCF, which downloads authentication data from the HSS. Based on the authentication data it generates a challenge to the UE. After receiving the response and verifying it the S-CSCF accepts the registration and starts supervising the registration status. After this procedure the user is able to initiate and receive IMS services. Moreover, the S-CSCF downloads a service profile from the HSS as part of the registration process.

A service profile is a collection of user-specific information that is permanently stored in the HSS. The S-CSCF downloads the service profile associated with a particular public user identity (e.g., joe.doe@ims.example.com) when this particular public user identity is registered in the IMS. The S-CSCF uses information included in the service profile to decide when and, in particular, which application server is contacted when a user sends a SIP request or receives a request from somebody. Moreover, the service profile may contain further instructions about what kind of media policy the S-CSCF needs to apply – for example, it may indicate that a user is only allowed to use audio and application media components but not video media components.

The S-CSCF is responsible for key routing decisions as it receives all UE-originated and UE terminated sessions and transactions. When the S-CSCF receives a UE originating request via the P-CSCF it needs to decide if application servers are contacted prior to sending the request further on. After possible application server interaction the S-CSCF either continues a session in IMS or breaks to other domains (CS or another IP network). Moreover, if the UE uses a Mobile Station ISDN (MSISDN) number to address a called party then the S-CSCF converts the MSISDN number (i.e., a tel URL) to SIP Universal Resource Identifier (URI) format prior to sending the request further, as the IMS does not route requests based on MSISDN numbers. Similarly, the S-CSCF receives all requests which will be terminated at the UE. Although, the S-CSCF knows the IP address of the UE from the registration it routes all requests via the P-CSCF, as the P-CSCF takes care of SIP compression and security functions. Prior to sending a request to the P-CSCF, the S-CSCF may route the request to an application server, for instance, checking possible redirection instructions.

## **2.4 The Application Server AS**

The AS (Application Server) is a SIP entity that hosts and executes services. Depending on the actual service the AS can operate in SIP proxy mode, SIP UA (User Agent) mode (i.e., endpoint), or SIP B2BUA (Back-to-Back User Agent) mode (i.e., a concatenation of two SIP User Agents). The AS interfaces the S-CSCF using SIP.

There are 3 types of AS: See Figure 3

**2.4.1 OSA-SCS (Open Service Access-Service Capability Server):** this application server provides an interface to the OSA framework Application Server. It inherits all the OSA capabilities, especially the capability to access the IMS securely from external networks. This node acts as an Application Server on one side (interfacing the S-CSCF with SIP) and as an interface between the OSA Application Server and the OSA Application Programming Interface (API, described in 3GPP TS 29.198).

**2.4.2 IM-SSF (IP Multimedia Service Switching Function):** this specialized application server allows us to reuse CAMEL (Customized Applications for Mobile network Enhanced Logic) services that were developed for GSM in the IMS. The IM-SSF allows a gsmSCF (GSM Service Control Function) to control an IMS session. The IM-SSF acts as an Application Server on one side (interfacing the S-CSCF with SIP). On the other side, it acts as an SSF (Service Switching Function), interfacing the gsmSCF with a protocol based on CAP (CAMEL Application Part, defined in 3GPP TS 29.278). All three types of

application servers behave as SIP application servers toward the IMS network (i.e., they act as either a SIP proxy server, a SIP User Agent, a SIP redirect server, or a SIP Back-to-back User Agent). The IM-SSF AS and the OSA-SCS AS have other roles when interfacing CAMEL or OSA, respectively. In addition to the SIP interface the AS may optionally provide an interface to the HSS. The SIP-AS and OSA-SCS interfaces toward the HSS are based on the Diameter protocol (RFC 3588) and are used to download or upload data related to a user stored in the HSS. The IM-SSF interface toward the HSS is based on MAP (Mobile Application Part, defined in 3GPP TS 29.002 ).

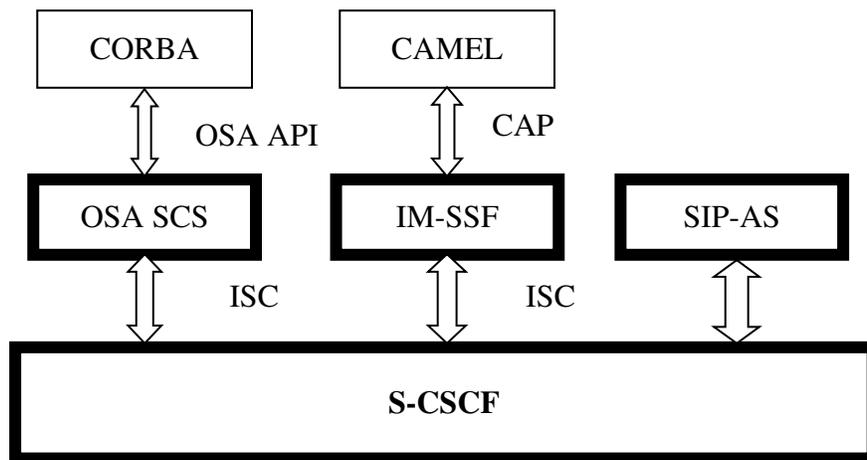


Figure 3: The different types of Application Services.

### 3. Call path in the SIP Application Server.

#### 3.1 First step. User registration

IMS-level authentication is basically the procedure by which the network authenticates the user and then authorizes them to access the IMS services. The user is authenticated by means of a SIP REGISTER message sent to the P-CSCF this is similar to a standard SIP Registration but modified by 3GPP and containing many extra pieces of information in an attempt to speed up the whole process and save round trip SIP messages.

The IMS registration allows the UE to use IMS services, the UE must obtain an IP connectivity bearer and discover an IMS entry point (i.e., the P-CSCF).

IMS registration contains two phases: Follow the Figure 4a and ab.

- The first phase – how the network challenges the UE.
- The second phase – how the UE responds to the challenge and completes the registration.

### **3.1.1 First phase**

1. The UE sends a SIP REGISTER request to the discovered P-CSCF. This request would contain, say, an identity to be registered and a home domain name (address of the I-CSCF).
2. The P-CSCF processes the REGISTER request and uses the provided home domain name to resolve the IP address of the I-CSCF.
3. The I-CSCF, in turn, will contact the Home Subscriber Server (HSS) to fetch the required capabilities for S-CSCF selection.
4. After S-CSCF selection the I-CSCF forwards the REGISTER request to the S-CSCF.
5. The S-CSCF realizes that the user is not authorized and, therefore, retrieves authentication data from the HSS
6. and challenges the user with a 401 Unauthorized response.

### **3.1.2 Second phase:**

7. The UE will calculate a response to the challenge and send another REGISTER request to the P-CSCF.
8. Again the P-CSCF finds the I-CSCF
9. and the I-CSCF, in turn, will find the S-CSCF.
10. Finally, the S-CSCF checks the response
11. and, if it is correct, downloads a user profile from the HSS
12. and accepts the registration with a 200 OK response.

Once the UE is successfully authorized, the UE is able to initiate and receive sessions. During the registration procedure both the UE and the P-CSCF learn which S-CSCF in the network will be serving the UE.

It is the UE's responsibility to keep its registration active by periodically refreshing its registration. If the UE does not refresh its registration, then the S-CSCF will silently remove the registration when the registration timer lapses. When the UE wants to de-register from the IMS it sets a registration timer to 0 and sends a REGISTER request.

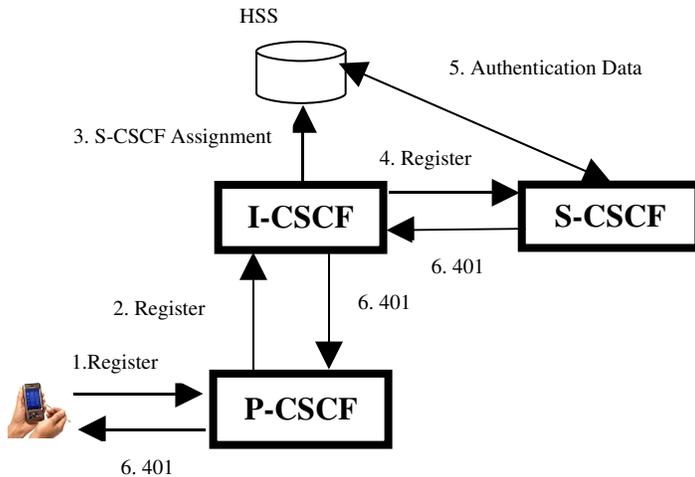


Figure 4a: First Registration phase

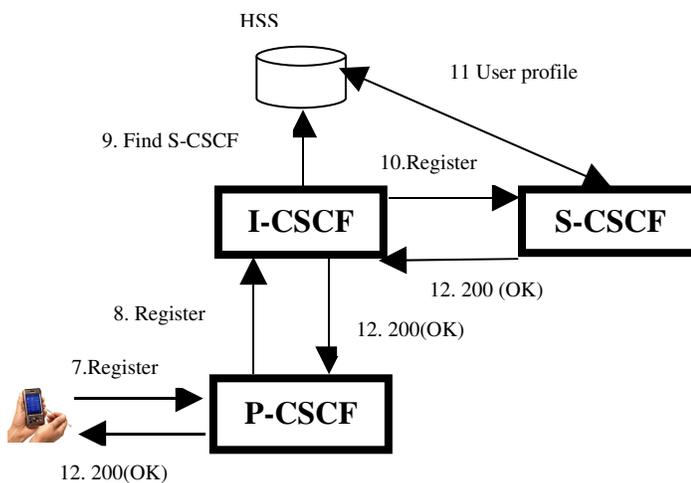


Figure 4B: Second Registration Phase.

### 3.2 Trigger a services from a AS (Application Server)

Each SIP request that passes through a S-CSCF is evaluated against a series of filter criteria and, if a match is found, the SIP message is proxied to the AS. In real terms this means every INVITE, REGISTER, SUBSCRIBE (see later) and OPTIONS message and not PRACK, NOTIFY, UPDATE or BYE message. In fact the most important are REGISTER and INVITE. The filter criteria (Known as IFC Initial Filter Criteria) are downloaded from the HSS as part of the registration

phase. At typical filter might look (logically) like this (each line being known as a trigger point):

```
IF (method = INVITE) AND (Request-URI = sip: greetings@fg.com)
THEN FORWARD TO (AServer1@fg.com)
```

#### 4. The example to understand this.

For explain the call path into IMS, we uses the SDS tool provided by Ericsson<sup>3</sup> and take the example form SDS tutorial Sip Servlet.

We use as example the first example used in the sds ericsson tutorial, you can download the program and documentation from.

[http://www.ericsson.com/developer/sub/open/technologies/ims\\_poc/tools/sds\\_40](http://www.ericsson.com/developer/sub/open/technologies/ims_poc/tools/sds_40)

Please open the document [SDS 4.1 Tutorial](#) and go to the section to execute the example.

Here S-CSCF contains the service profile of the users and PSI's. The service profile links a user or PSI with one or many Initial Filter Criteria IFC. An IFC is used to tell the S-CSCF to forward all request to an application server if they match certain Service Point Trigger (SPT's). SPR's can be matched on the RequestUri, the SIP method session case or any header in the message . In this example:

```
IF (method = Message) and (RequestUri = sip:greetings@ericsson.com)
THEN FORWARD to (AS)
```

Using the IP address 192.168.0.5 to work (see section 9.1.2.1 to set the IP address in document SDS 4.1 tutorial) we have a network as can see in the figure 5, that must be completed. (Homework!!!!!!).

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<sup>3</sup> Ericsson is the trademark or registered trademark of Telefonaktiebolaget LM Ericsson.

IP=192.68.0.5

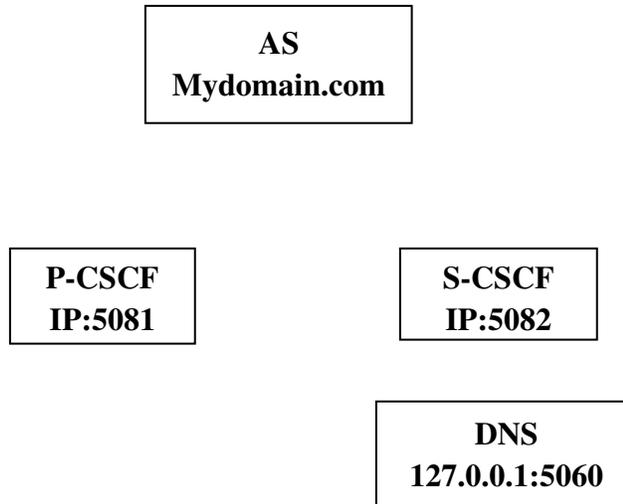


Figure 5. **Complete the sequence following the HelloWorldServlet example.**

We assume that the user Coco is registered.

1. The User "Coco" send the message to P-CSCF
2. P-CSCF send the request to S-CSCF. S-CSCF contain the service profile of the user, the service profile link a user with one or more iFC (initial filter criteria).In the example

Request message is received in S-CSCF

Request-Uri = sip:[greetings@ericsson.com](mailto:greetings@ericsson.com)

Then match with the iFC then.

3. The S-CSCF ask to the DNS wich adrres correspond to the site mydomain.com
4. DNS Respond to S-CSCF
5. S-CSCF forward the request to AS.
6. The servlet must send a SIP **200 OK** message in response to acknowledge request was received.

If you see the code that correspond to the Servlet in the example, you can see:

```
// This servlet is triggered by a MESSAGE to
// sip:greetings@ericsson.com. Ignore the request if
// URI is not sip:greetings@ericsson.com.
if (!"sip:greetings@ericsson.com"\
.equals(req.getRequestURI().toString())) {
return;
}
}
```

**The above code ignores the request if the MESSAGE URI is not sip:greetings@ericsson.com.**

Now the servlet should create the SIP MESSAGE, specifying the expected SIP headers.

```
// Create a greeting MESSAGE to send back to the user.
SipServletRequest messageRequest = sipFactory\
.createRequest(req.getSession(), "MESSAGE", \
req.getTo(), req.getFrom());
messageRequest.pushRoute(sipFactory\
.createSipURI(null, "127.0.0.1:5082"));
messageRequest.addHeader("Accept-Contact", req\
.getHeader("Accept-Contact"));
messageRequest.addHeader("User-Agent", req.getHeader\
("User-Agent"));
```

The above code creates the MESSAGE with its required headers.

## 7. Send the message to “Hello World” include.

```
// Create a greeting MESSAGE to send back to the user.
SipServletRequest messageRequest =
sipFactory.createRequest(req.getSession(), \
"MESSAGE", req.getTo(), req.getFrom());
messageRequest.pushRoute(sipFactory.createSipURI(null, "127.0.0.1:5082"));
messageRequest.addHeader("Accept-Contact", req.getHeader("Accept-Contact"));
messageRequest.addHeader("User-Agent", req.getHeader("User-Agent"));
// Set the message content.
messageRequest.setContent("Hello, World!", "text/plain");
// S-CSCF processes only asserted requests. When a request is sent
// without a P-Asserted-Identity header, it is rejected with a
// 403 Forbidden. This header asserts that the request comes from a
// trusted domain.
messageRequest.addHeader("p-asserted-identity", "sip:helloworld@ericsson.com");
// Send the request
messageRequest.send();
```

See also articles:

- ***Application Server examples in SDS***
- ***Using asynchronous HTTP***
- ***Charging for IMS, examples and analysis.***
- ***SIP SERVLET a tutorial (Level: Beginners, Expert).***

For more information and suggest please send me a mail to [dansebus@gmail.com](mailto:dansebus@gmail.com)

References:

- [1] The IMS: IP Multimedia concepts and services in the mobile domain. Miika Poikselkä, Goerg Mayer, Hisham Khartabil, Aki Niemi. John Wiley & Sons.
- [2] *3G IP multimedia subsystem IMS*, Gonzalo Camarillo, Miguel A. Garcia-Martin.-2nd ed. John Wiley & Sons