# Proposal of an IVR Solution and Granting of Credit With Asterisk's AGI and a Flask RESTFul Framework in an IMS Network: Case of an Advertisement

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***Abstract*— The need to communicate has become a necessity in Africa today, particularly in Senegalese families whose income level is low. The implementation of Interactive Voice Mailboxes (IVR) in an Internet Multimedia Sybsystem (IMS) environment increases communication services for 4G or even 5G.**

**In this article, we propose an innovative Interactive Voice Response (IVR) solution in an IMS network. The goal is to have a network user, the ad or an audio ad listen to the end, in order to benefit from a phone credit rate without hanging up the phone. IVRs are implemented with Asterisk's Asterisk Gateway Interface (AGI). Once the call is launched, a check of its balance is carried out, if the person has credit allowing him to make a call, the announcement will not be played for him, but as soon as one notes a lack of credit, we propose to listen to the announcement until the end to grant him a sum allowing him to continue his call. Automatic credit reloading at the end of the ad is ensured by a Flask RESTFul Framework which is responsible for connecting to the MySQL database on the account of the user in question to credit his balance with a fixed sum.**

**This solution will have a major impact on the current population and also on the level of research in general. It will make it possible to communicate even if one does not have money, the essential thing is to listen to an advertisement or a publicity until its end. As part of the research, it will allow researchers who are in areas where access to credit becomes very difficult and the need to want to exchange feels.**

***Keywords*__ IVR, IMS, AGI, Flask RESTFul, MySQL, Asterisk**

## I. Introduction

The evolution of mobile networks is seen today in the world and particularly in Africa. This development is also noted in Senegal with the arrival of the fourth generation. This results in the implementation of innovative IVRs in an IMS network environment.

Today, the trend is to go to rich communication platforms due to the evolution of mobile networks. Rich Communication Services (RCS) defines a set of services that network operators can provide using the IMS. Telephone services must be implemented continuously even if the technology evolves.

To have a converged telecom network offering both high-speed mobility for data and quality voice services, we need an IMS network. The IMS network defines the routing of the telephone signaling, the access to databases where the profile and the secret of the subscriber are stored, as well as the specific processing of the voice. In recent years a lot of research has been done around the IMS architecture. To do this, researchers rely on or develop free platforms implementing the core of the IMS network.

In its architecture, IMS relies on HSS to store user profiles and service profiles. The HSS entity contains information to locate the user but also to associate the service profiles. The malfunction of the HSS entity will have a negative impact on the quality of service but also on the profits of the telecom operators. To locate a user, the HSS entity communicates with the Call Session Control Function (CSCF) functions through the DIAMETER protocol.

IMS provides entities that provide protocol conversion and interconnection of fixed and mobile networks. Signal and voice flows are anchored using the Single Voice Voice Continuity (SRVCC) mechanism [1] [2].

The HSS plays an important role in providing the Access Point Name (APN) and also provides access to mobile profile and security data. The HSS entity is a database that stores data specific to each user. The stored data includes user identities, access parameters, and application server invocation rules by the S-CSCF.

In addition, online or offline charging is based on the DIAMETER protocol. DIAMETER is the exchange protocol between the key entities of the IMS network. Therefore, the mechanisms implemented in the exchanges must be reliable to ensure the reliability of the data stored or processed by the core entities of the IMS network [3] [4].

The authors in [5] proposed IVRs for online training systems. The IVR application is integrated into the Moodle online training platform. The application of the IVR is designed and implemented in the Electronic Commerce Laboratory of the University of Belgrade.

Those in [6] treated IVRs with an application that interacts with a database containing all the vocal files. This application reads the voice files of the question and receives the answers from users to perform the appropriate processing of the user.

The authors in [7] discussed the contribution of IVR applications to IMS network subscribers compared to value-added services. They also performed problem analysis, architecture design, application implementation and solution evaluation.

RESTful and SOAP services are the two major web provisioning services today, RESTful services are gaining popularity over time and replacing SOAP-based Web services in many areas due to ease of use, deployment and deployment. in lightness, a question of vital interest arises regarding better performance between RESTful and SOAP-based services [8].

The authors in [9,10] have changed the performance of the service individually and collectively RESTFul web services and also have conducted experiments on use in different circumstances.

Our article is structured according to the following plan: in the second part we studied the technologies used for the implementation of the system, in the third part, we talked about the proposed architecture, in the fourth part, we presented the results obtained and to finish with a conclusion.

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It is for this reason that we have proposed a platform of solutions with a Session Initiation Protocol (SIP) application server implementing telephone services initially coupled to a core of the Internet Multimedia Subsystem (IMS), Clearwater and a second time coupled to two IMS network cores, Clearwaters.

Telephone services must be implemented continuously even if the technology evolves. It is for this reason that we have found it necessary to implement all the services in an application server (AS) such as Asterisk and to make the coupling with the IMS network to allow a continuation of the implementation of the innovative services. .

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To manage billing, we have interconnected Asterisk and A2billing, which will allow us to manage IVR billing.

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## II. Technologies Used

To implement this solution, we will use the following technologies:

### *A. Clearwater*

Clearwater was designed from the ground up to be optimized for deployment in virtualized and cloud environments. It relies heavily on established design models for building and deploying highly scalable Web applications, adapting these design models to SIP and IMS constraints. The Clearwater architecture therefore has some similarities to the traditional IMS architecture, but it is not identical. [11]

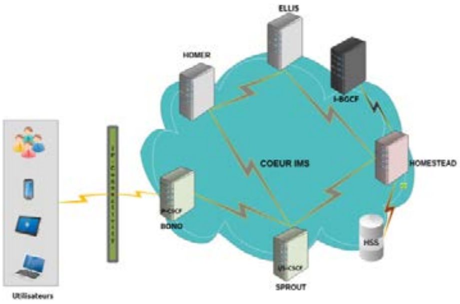



**Figure 1.** Clearwater Deployment Architecture

***Bono (Proxy Edge)***

Bono nodes form a horizontally scalable SIP edge proxy, providing both an IMS Gm SIP-compliant interface and a WebRTC interface to clients. The client connections are balanced between the nodes. The Bono node provides the anchor point for the client's connection to the Clearwater system, including support for various NAT traversal mechanisms. A client is therefore anchored to a particular Bono node for the duration of its registration, but can move to another Bono node if the connection or client fails. Customers can connect to Bono via SIP / UDP or SIP / TCP. Bono supports any WebRTC client that performs call setup signaling using SIP on WebSocket. Clearwater can also be deployed with a third party P-CSCF or an edge session controller implementing the P-CSCF function. In this case, Bono nodes are not required.

***Sprout***

Sprout nodes act as an authoritative, horizontally scalable SIP registration server and routing proxy, and manage client authentication and the ISC interface with the application servers. Sprout nodes also contain the integrated MMTEL application server. SIP transactions are balanced on the Sprout cluster, so there is no long-term association between a client and a particular Sprout node. Sprout does not store any long-lived data, but uses.

- Web services interfaces with Homestead and Homer to retrieve the HSS configuration such as authentication data / user profiles and MMTEL service settings
- API for Vellum to store subscriber registration data and run timers.

Germination is the core of the I-CSCF and S-CSCF function, with the rest being provided by Dime (and supported by long-lived Vellum data stores).

***Homestead***

Homestead provides Sprout with a Web services interface that retrieves authentication information and user profile information. It can either control the data (in which case it exposes a web services provisioning interface), or extract the data from an IMS-compliant HSS via the Cx interface. The Homestead nodes themselves are stateless - mastered / cached subscriber data is all stored on Vellum - mastered data is stored in Cassandra via the Thrift interface, cached data is stored in the Memcached cluster. In the IMS architecture, the HSS mirror function is considered part of the I-CSCF and S-CSCF components. Therefore, in Clearwater, the I-CSCF and S-CSCF functions are implemented with a combination of Sprout and Dime clusters.

***Ralf***

Ralf provides an HTTP API that Bono and Sprout can use to report billable events to be transmitted to the Data Load Function (CDF) via the Rf Billing Interface. Ralf is stateless and uses Vellum to maintain the long-running session state and run the necessary timers to comply with the Rf protocol.

***Vellum***

As described above, Vellum is used to maintain all states of long duration in the deployment. To do this, it runs a number of distributed storage clusters optimized for the cloud.

***Homer***

Homer is a standard XDMS used to store the MMTEL service parameter documents for each user of the system. Documents are created, read, updated, and deleted using a standard XCAP interface. As with Homestead, Homer nodes use Vellum as the data store for all long-lived data.

***Ellis***

Ellis is an example of a provisioning portal for self-registration, password management, line management, and control of MMTEL service settings. It is not intended to be part of Clearwater's production deployments (it is not easy to scale it horizontally because of MySQL basics) but to make the system easy to use.

### *B. HSS (Home Subscriber Server)*

As a central provisioning and authorization element on LTE networks, the Home Subscriber Server (HSS) defines the access levels to the services available on your LTE network for your permanent or occasional users. [12]

The characteristics are:

- Provision and management of subscription data
- Processing user identification
- Access authorization
- Support for encryption and authentication based on the USIM module
- User Registration Management
- IRAT mobility processing between LTE 2G / 3G ports
- Flexible deployment (frontal or monolithic)
- Support for operation and maintenance

### *C. Asterisk*

Asterisk is a free and proprietary private branch exchange (licensed under GPL and proprietary license) for GNU / Linux systems. It allows, among other things, voicemail, queues, call agents, standby music and call cautions, call distribution etc. [13]. It is also possible to add the use of conferences through the installation of additional modules. Asterisk includes a very large number of features allowing full integration to meet the majority of telephony needs. It allows to completely replace, through FXO (Foreign eXchange Subscriber) / FXS (Foreign eXchange Office) cards, a proprietary Private Automatic Branch Exchange (PABX), and to add VoIP features to transform it into PBX (Private Branch eXchange) IP. It also makes it possible to work completely in VoIP, through SIP or IAX phones on the market. Finally, call routing features, voice menu and voice boxes among others, place it at the level of the most complex PBX.

### *D. Imsdroid*

IMSdroid is the first full open source SIP / IMS client for Anroid. It is also the only free Android SIP client that supports direct audio / video calls.

### *E. A2billing*

A2Billing is a complete solution for any telecommunications company wishing to provide residential, professional and wholesale voice over IP services, calling card services, call back and resale services. A2Billing is a free downloadable open source software that relies on a professional development and support network, giving business users the confidence they need to build their telecom business around A2Billing.[14]

### *F. Flask Restful*

Flask-RESTful provides an extension to Flask for building REST APIs. Flask-RESTful was originally developed as an internal project at Twilio, designed to power their public and internal APIs. Flask-RESTful promotes best practices with minimal configuration. [15]

## III. PROPOSED ARCHITECTURE

In this architecture we are the clients who must connect to the Bono node which represents here the IMS P-CSCF. The heart of the IMS network is Clearwater, which is interconnected with an Asterisk application server. This application server will be used to implement advertising IVRs using Asterisk AGI. To manage the billing side, we used A2billing. This billing of an advertisement is managed by a Flask RESTFul API which will allow us to recover the credit of the MySQL database of a user who wants to communicate, but also will serve us to add the sum to the account of the user

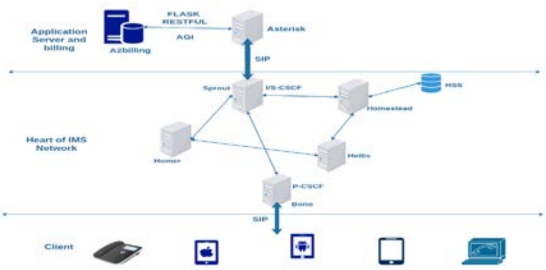



**Figure 2.** Proposed architecture

### *A. Sequence diagram*

The following sequence diagram shows the different phases of establishing a call and checking the balance of the sender of the call. If he has sufficient credit to make this call, the communication is simply established if not, an advertisement is proposed that he is required to listen to the end of the audio to benefit from the fixed sum that goes him to allow him to continue his call without having to hang up his phone.

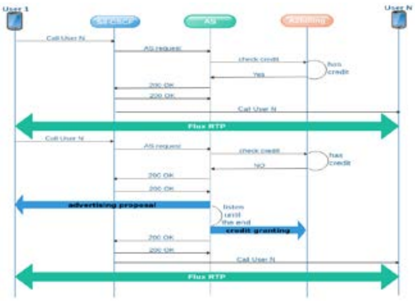


**Figure 3.** Sequence diagram of establishing a communication

### *B. Setting up the Flask RESTFul API*

This API (Application Programming Interface) will allow us to query the user balance database, it has two resources, one to retrieve the credit and another to add credit as the following shows:


**Figure 4**. The interface of the FLASK RESTFul API

### *C. A2billing Configuration*

A2billing is the platform that will allow us to implement the billing of calls but also it will allow us to settle the account of a user who has listened to all the announcement. It has the MySQL database of user accounts. To do this, configurations have been made at this billing server for this implementation.

### *D. Application Server Configuration (AS)*

*We will perform the application server (AS) configurations where we will implement the advertisement or advertisement IVRs. The AS will be interconnected at the heart of the IMS network. To set up this interconnection, we will proceed as shown in the following figures.*


**Figure 5.** Creating Application Server

After creating the AS, we must now create the Trigger Point where we will define the dial plan for users who are put in the AS.

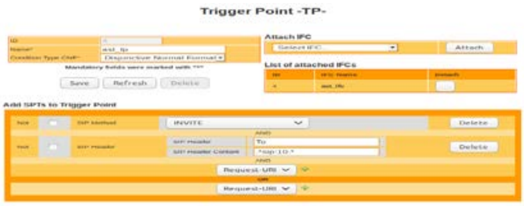



**Figure 6.** Creation of the Trigger Point

Then we will go to the creation of the Initial Filter Criteria (IFC), in this part, it is a question of associating the Trigger Point and the AS which is created after giving a name to the IFC.

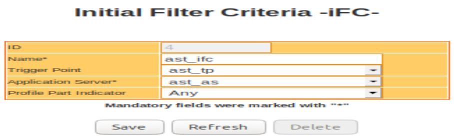



**Figure 7.** Creation of IFC

All that remains is to associate the created AS with the Profile Service (SP) by default.


**Figure 8.** Creating the SP

### E. *Customer configuration*

We will create two users who will serve us for the implementation of the tests of the solution.

A user 1000 whose creation is as follows:

We will create the user 1000 and the creation of the other users respects the same process.

For that we will create the Private User Identity -IMPI-:

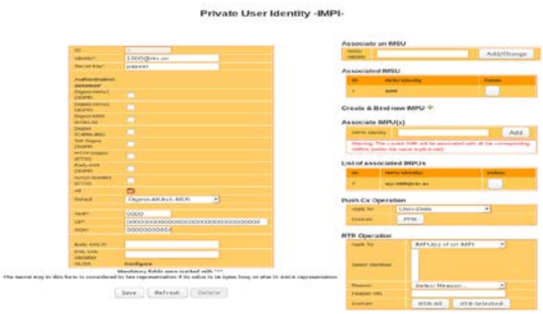



**Figure 9**. Creation of the IMPI

Then create the Public User Identity -IMPU-:

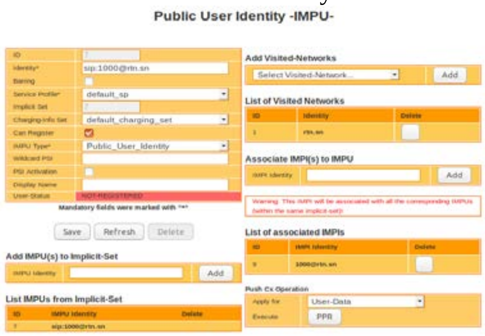



**Figure 10**. Creation of IMPU

For after create the IMS Subscription -IMSU-:


**Figure 11**. Creation of the IMSU

### F. *Application Server Configuration (Asterisk)*

The configuration of the application server is done in two files, which are the sip.conf file and the extensions.conf file.

In the sip.conf file we have:

```
[asterisk]
username=asterisk
type=peer
secret=passer
host=192.168.1.213
context=a2billing
allow=all
insecure=port,invite
careinvite=yes
qualify=yes
dtmfmod=rfc2833
allowguest=yes

[1000]
username=1000
type=friend
context=test
secret=passer
host=dynamic
port=5060
callerid=1000 <1000>
language=fr

[1001]
username=1001
type=friend
context=test
secret=passer
host=dynamic
port=5060
callerid=1001 <1001>
language=fr
```

**Figure 12.** Configuring the sip.conf file

In the extensions.conf file the configurations are:

```
[test]
exten => _2XXX,1,Dial(SIP/asterisk/${EXTEN})

[a2billing]
exten => _2XXX,1,Dial(SIP/1${EXTEN:1})
```

**Figure 13**. Configuring the extensions.conf file

## IV. RESULTS OBTAINED

The results obtained are presented in the following sections. We will view the database of users to see the availability of credit. We get the following figure:

```
mysql> use mya2billing
Reading table information for completion of table and column names
You can turn off this feature to get a quicker startup with -A

Database changed
mysql> select username, useralias, credit from cc_card;
+------------+-----------+------------+
| username   | useralias | credit     |
+------------+-----------+------------+
| 8987344413 | 1000      | 2000.00000 |
| 9700203963 | 1001      | 1812.08333 |
| 3377949903 | 1002      | 1999.75000 |
+------------+-----------+------------+
3 rows in set (0.00 sec)

mysql>
```

**Figure 14**. The state of the database of users before the call

In this figure, we find the availability of credit for the customer 1000 worth 2000fcfa. He must make the call.
To make a call, the user 1000 who wants to call the user 1001, he must dial 2001 and we will have to remove the 2 to replace it with 1 to allow A2billing to perform the billing without having a problem of dialed number.

- User 1000 dials the number 2001 to call the user 1001

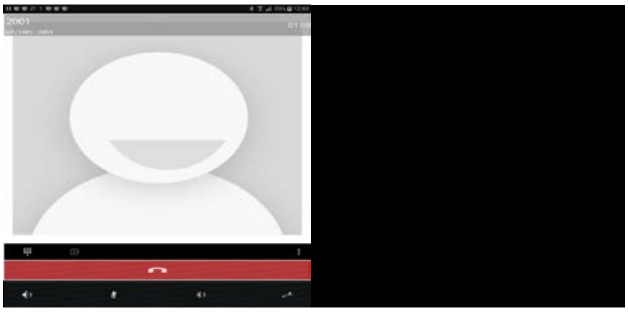
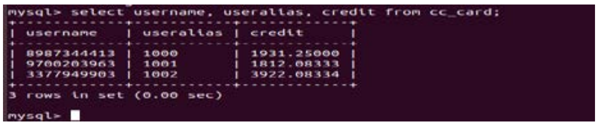


**Figure 15**. Communication between 1000 and 1001

Once the call is made, the call is directly established as shown in the following figure:

**Figure 16.** Asterisk server messages

At the end of the communication, we can view again the database of users to see if the billing is done well, we find:



mysql> select username, useralias, credit from cc_card;

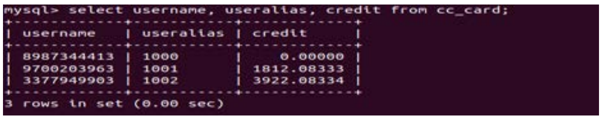
| username | useralias | credit |
|---|---|---|
| 8987344413 | 1000 | 1931.25000 |
| 9700203963 | 1001 | 1812.08333 |
| 3377949903 | 1002 | 3922.08334 |

3 rows in set (0.00 sec)

mysql>

**Figure 17**. The state of the base after communication for the account 1000

Now, we will empty the credit for this same customer and repeat the tests.



mysql> select username, useralias, credit from cc_card;

| username | useralias | credit |
|---|---|---|
| 8987344413 | 1000 | 0.00000 |
| 9700203963 | 1001 | 1812.08333 |
| 3377949903 | 1002 | 3922.08334 |

3 rows in set (0.00 sec)

**Figure 18.** Database emptied

The user 1000 who no longer has credit will issue the call to 1001.


**Figure 19**. Play audio ad file

The audio instruction demo advertisement file named "demo-instruct" is read when the user makes the call.

If the reading is finished, a sum is added to his account and without hanging up, the call continues. We notice an advertisement which is proposed to him that he listened until the end to see his paid account of a sum fixed at 2000 fcfa.

**Figure 20**. A2billing server side

After adding the sum at the end of the audio, the call is automatically triggered. The following figure shows this:

**Figure 21**. Triggering the call

The API that is responsible for recovering credit availability is started and we find that it has launched the resource recovers credit.


**Figure 22**. The API recovers the balance

After reading the audio, the API adds the sum to the client's 1000 account.


**Figure 23**. The API adds the sum of 2000 Fcfa to the account 1000

## V. CONCLUSION

This article is set up allows access to communication for everything and without exception. It allows people in remote areas whose access to credit is a huge problem to be able to reach their communication needs.
In a world where the development of the telecommunications sector is growing, the implementation of innovative solutions has become a necessity.
The solution implementation requires a good knowledge of Asterisk's AGI as it forms the basis of this implementation.
For this solution it is to make listen to an advertisement until its end to a person who does not have credit in his account to benefit from a sum allowing him to communicate.
The article also allows companies to be able to pass their products or publicity of their activities. It also allows politicians during the campaign period to get their programs through advertisements at the level of telecommunications operators.
A deeper implementation is envisaged to put restrictions on the user modes of the solution to avoid misuse.

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