A Framework to Provide Charging for Composite Services

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***Abstract*— Changing telecommunications market trends calls for the evolution of service creation and delivery by network operators. They need to maximize on any available form of revenue creation to avoid becoming "bit-pipes" and can achieve this by creating interfaces for 3rd party service and content providers to offer applications and services to their users. Composing and bundling of these services will create new services for the user and achieve rapid deployment of enhanced services. Effective accounting of service usage requires mechanisms for billing and charging of these services. Achieving this in an environment where the network operator interacts directly with the 3rd party providers may become complicated. This paper proposes the use of a service composer who mediates between an IMS network operator and many content providers to create new services that are composed from independent applications; the composer simplifies the technical and business aspects of service provision.**

Keywords- Charging, Service Composition, IMS, Multi-provider Composed Services.

I. INTRODUCTION

The last few years has seen the telecommunications industry go through a number of fundamental changes. These can be seen from maturing telecommunications markets and rising competitive pressures amongst network operators as well as against the emergence of Web 2.0 services. End users are no longer providing revenue through the use of legacy services like voice calling and text messaging as we have seen decreased pricing for these basic services. The evolution of packet switched networks has also contributed to vanishing revenue streams.

One of the more significant changes also reflects the way in which revenue is created and distributed within the industry. Services have become the main differentiator, thus revenue creation is highly dependent on the ability of network operators to deliver new and exciting services to their customers [1]. This means that network operators need to have effective service creation and deployment capabilities; alternatively they would form business partnerships with service and content providers to offer some of these services. This implication greatly fragments and complicates the service environment and calls for key issues to be addressed to cater for new business partnerships.

The IP Multimedia Subsystem (IMS) is a next generation networking architecture that provides for interoperability between existing mobile networks and the Internet; it provides a platform for which multimedia services can be developed and deployed for fixed and mobile operators. The IMS enables network operators to offer services that will enable them to remain key role players within the industry. However, deploying the IMS faces business challenges due to existence of multiple key players in the service value chain. These include: the network operator, the service retailer and the content provider. Apportioning of revenue among these parties becomes complicated. Mechanisms are required to accurately achieve charging, billing and accounting for IMS networks when multiple administrative domains are involved.

The key issues that need to be investigated can then be summed up as follows:

- How can network operators maximize profit? How can they achieve this by forming partnerships with 3rd party service and content providers?
- How can current systems that are outdated in the face of emerging NGNs and related charging and billing mechanisms be improved upon?
- Can charging be handled by the charging systems in an efficient and effective manner?

In this paper, we propose the use of a platform that allows for the composition of services offered by service providers not residing in the network operator's administrative domain. Furthermore it also highlights the additional steps that need to be followed in order to achieve charging and billing for these composite services. The framework is designed to use open API standards to allow for the charging of composed services from different service providers to be deployed over the IMS.

The remainder of this paper is structured as follows. Section II discusses existing work and related work. Section III highlights the requirements of the different role players in this service environment. Section IV describes the overall architecture for which the platform was designed. Section V presents testing and validation procedures. Finally, Section VI briefly discusses the advantages of the platform and concludes the paper.

II. RELATED WORK

Composite services are services created from independent applications and services. This is as opposed to an atomic service, whose implementation is self-contained and does not invoke any other service. Network operators may provide interfaces based on frameworks like the Open Services Architecture (OSA) that can be mapped onto telecom specific protocols like the Customized Applications for Mobile Enhanced Logic (CAMEL) Application Part (CAP) and the Mobile Application Part (MAP), to provide listener-controller capabilities for different services [2]. However, extensions are required this framework to add network reconfigurability for QoS, user customization, and support of adaptable service provision and flexible charging schemes.

Composed services can be offered by a service provider that does not reside in the same administrative domain as the network operator. Mobile Virtual Network Operator (MVNO) may be seen as service composers, since they reside between service providers and Mobile Network infrastructure Operators (MNO). However, they also manage user subscriptions and profiles etc. Thus to users the MVNO appears like a conventional MNO. In addition to working with MVNO, conventional operators need to deal with non-competitor service composers to gain a stronger edge in the business. The composer would simplify the requirements of apportioning revenue amongst involved parties.

The 3rd Generation Partnership Project has released charging specifications for the IMS [3] [4] [5]. We note that the specifications fail to give insight of charging for services that are offered by 3rd party service providers as well as for composed services.

Xu et al. [6] propose an architecture for automating the deployment and application of charging schemes for composed services in the IMS. They use a Domain Specific Language (DSL) to develop an Accounting Logic Generator (ALG) that achieves this. This work however does not take into account the implications of real-time charging on services.

Bhushan et el. [7] propose a framework for Federated Accounting which addresses the complex aspects of charging for composed services. The key issues addressed are the exchange of service usage records in a multi-domain environment considering Service Level Agreements (SLA). However, this work however is done in a non-IMS context.

Ooms et el. [8] investigate an effective way to provide Authentication, Authorization and Accounting (AAA) for composed services in a multi-domain IMS using the Diameter protocol [9]. However, the focus is on the security aspects of a multi-domain environment.

III. REQUIREMENTS FOR CHARGING OF COMPOSED SERVICES

The main focus in this work is to consider the business relationship between a network operator and multiple service providers. The Network operators would implement the charging system and the Service Composer within its domain. The service providers would then reside in the application layer as depicted in Fig 1.

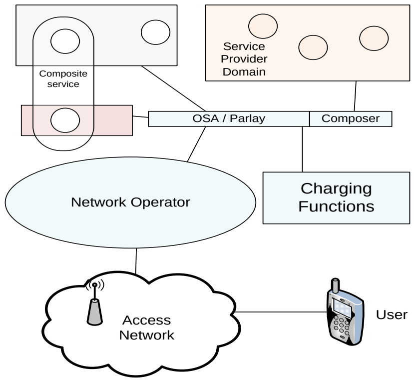

Figure 1. Muilti-domain services scenario

The nature of the proposed environment means that there will be a number of business entities that cooperate to provide services to the end user. Each role player will have different requirements to allow for such partnerships.

A. User Requirements

The contract between the user and the network operator as well as the service and content providers will require for the specification of Service Level Agreements. Tariff information at all times for all services in the network should also be available to the user upon request. Ultimately, to provide an improved user Quality of Experience the user would want to receive a combined bill of all service usage regardless of which organization supplies the service or content to the user.

B. Network Operator Requirements

For our framework we propose the adoption of a Network Operator Centric Business Model [10]. Adoption of this model ensures that the network operator be able to provide comprehensive user management so as to be able to redirect service delivery to the users as well as maintaining a centralized charging framework. As the Charging Functions will operate in the domain of the network operator, the operator will provide either postpaid or prepaid charging as is selected by the end user. The network operator will need to be in possession of all information on chargeable events that occur in order to enforce settlement between the different parties involved. For this to be administered effectively the network operator needs to receive all service requests to be able to keep track of all service invocations from users. Should a user opt for prepaid charging, the network operator would need to keep live records of the user's credit balance and monitor credit during service usage. This will allow the network operator to end or deny services to users with insufficient credit.

C. Service Provider and Content Provider Requirements

As the network operator is the central entity of our framework, service and content providers need transparency in the revenue apportioning process. The network operator needs to inform the service providers on service invocations and charging operations that occur and relate to the specific service and content providers. The network operator should aim to achieve fair allocation of revenue obtained from service usage. If dynamic pricing applies the network operator would need real-time tariff information updates from the service providers for effective enforcement. The operator should also provide an interface to the service providers and also have the capabilities to compose services as required by users and perform charging of the services.

IV. Implementation Considerations

The platform proposed is designed to use existing network elements that have been defined by the 3GPP and the Parlay Group standardization bodies. It defines new entities to allow for the composition of services and the interfacing of service providers and the network operator.

A. *OSA Parlay Gateway:*

To enable the rapid creation of value added services by independent third party service providers the OSA/Parlay provides a framework that specifies an open set of standards and network-independent APIs that enable authorized service providers to control a selected range of network capabilities. The open network services offered to authorized entities concern mobility and location information management, call control, and content-based charging. The gateway provides an interface for communication between the third party application servers and the IMS control plane. In this architecture it is the composer that takes on the additional functions that do not currently exist in the IMS network or in the OSA/Parlay.

B. *Composer:*

In this architecture the composer would take on the additional roles required by the gateway. These include modules to complement the functions of the gateway so as to provide the lacking mechanisms in the system for charging of third party services to take place

1) *Service mediator*

This entity oversees the formation and management of composite services from other base services, depending on the requirements of the user. The mediator acts as an orchestration engine for the implementation of the service compositions. Each service can be viewed as a process that awaits requests from the mediator and responds accordingly

Each atomic service needs a high-level description that can be used to advertise the features of that service to users. This abstraction is contained in the *ServiceProfile*. The profile contains information about what kind of service it is and which service operator the service belongs to (*ServiceProvider* and *ServiceProviderID*).

TABLE I. Service Profile

Model component	Component type
ServiceProvider	String type
ServiceProviderID	Interger type
ServiceType	Interger type
DiscountSPPartners	Interger contioner
RatingModel	Interger type

All the services that are available to the user would be stored in a database along with the service profile information so as to allow for seamless composition by the service mediator. When a user requests a third party service or services the mediator would retrieve the service profiles to gather all the required information on these services. To complete the composition process, it would create a *ServiceSession* object that contains the service profile information about all the services that belong to a unique user session as well as the number of services belonging to that *ServiceSession* (*SessionID*) and the user that is using that service composition group (*UserID*).

2) *Service composition algorithm*

The process of forming a composite service is represented in the following pseudo function:

```
Wait for external event
    If (event = service request) {
        If initial request
            Create ServiceSession object
            Attach UserID and SessionID
        Else subsequent request
        Find ServiceSession related to request
        Then for all requested services
            Retrieve  ServiceProfile
            Attach ServiceProfile to object
        }
    If (event = terminate service){
        Find ServiceSession related to request
            Remove   ServiceProfile   from
            object
            If no more services in object
                Terminate object
        }
```

3) *Charging invoker (CTF) and Diameter interface*

The Charging Trigger Function (CTF) is integrated to the composer as it would to any other IMS Application Server (AS). Normally an AS will start to send charging information to the offline charging function or the online charging function whenever a service has been requested by a user. In the case of offline charging the CTF would pass on information that maps the captured resource usage so that subsequent billing can be performed. To perform offline functions the composer would have to implement the Rf reference point and relay messages using the Diameter protocol. In the case of online charging a service needs to be authorized by the charging functions before it can be accessed by the user. This requires credit control to enforce, in real time, service usage. The CTF would then send requests to the online charging function and await positive response before the service can be delivered. To perform online functions the composer would have to implement the Ro reference point and relay messages using the Diameter protocol and more specifically the Diameter Credit Control Application [11]. The IMS uses the Diameter protocol to transport all AAA messages between functions.

C. *Charging system*

The charging system is comprised of two charging functions, namely the Charging Data Function (CDF) and the Online Charging System (OCS). These are in accordance with the ability of the system to perform offline charging and online charging. In addition to these function, there are two types of charging functionalities within the charging system, these are event based charging and session based charging.

V. Testbed Validation and Evaluation

The implementation of a prototype charging system within the IMS was developed for the purposes of testing. It utilizes the open source software released by the Franhoer Fokus institute in Germany, as part of the Open Source IMS (OSIMS) project [14]. The testbed is built on the Linux operating system; it uses open source libraries to achieve high extensibility and customization.

A. The Service Delivery Platform

The Communications Research Group (CRG) at the University of Cape Town (UCT) is actively involved in IMS research. Certain IMS nodes have been implemented by the research group for the purpose of continued research into the IMS

1) UCT IMS Client

The UCT IMS client [12] was developed to provide an easily configurable real IMS user agent. It performs registration with the IMS core, voice and video calling, and IPTV viewing. It implements signaling according to IETF and 3GPP standards. For the purpose of charging, we extend the client to allow users to select usage of a pre-paid or post paid billing account. Usually network operators assign account types at subscription time; such information is mapped to the user's Universal Subscriber Identity Module (USIM).

2) UCT Charging System

The UCT charging system performs IMS level offline charging and online charging as well as flow level charging and volume based charging. The charging system achieves session based charging using a dedicated charging server; charging for services invoked through application servers involves the use of a CTF integrated in each server. For the case of composite services the CTF is located in the Service Composer function.

3) Service Composer

The SP Database was implemented using an Apache Mysql database. The Service Composer is implemented as a redirection application server. When a user requests a service, the Service Composer first retrieves the service profile information from the Service provider database and then sends a message to receive authorization from the charging system to allow service usage to the user. It then sends a message to the specific third party application server to provide the service to the user

4) Third Party Application Servers

The JAIN Service Logic Execution Environment (SLEE) was used as a portal to implement services that can represent 3rd party service and content provider application servers [13]. The JAIN SLEE provides a highly scalable event-driven module with a robust component model and fault-tolerance execution environment. Services can be preloaded onto the SLEE application server such that if a request is received by the SLEE it can be redirected to the specific service.

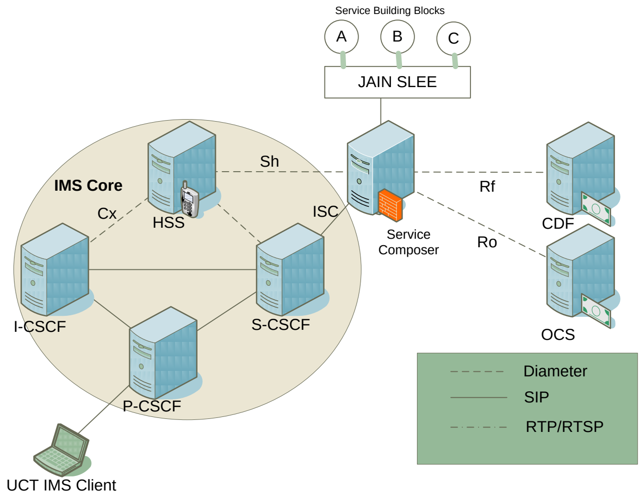

Figure 2. Testbed Setup

B. Tests and Results

Tests were conducted on the testbed to provide a motivation for the use of a composer to act as an intermediary between a network operator and multiple service providers. Additionally the composer was also the relay between the IMS network and the Charging Functions. The scenario tested the functionality of a user using the prepaid charging thus the OCS was contacted for charging purposes.

1) Proof of Concept Tests

For online charging once the Service Composer receives a request from a user, it performs the information retrieval from the SP Database and requests credit from the OCS by sending a CCR message, within the message the server embedded a *Multiple-Service-Indicator* AVP in the initial CCR request which informs the OCS that the credit needs to be allocated for multiple services. The OCS would then perform rating on the services and reserve quota for each service provided that the user has sufficient credit for the requested service. It then responds to the CTF with a CCA() with the amount of quota allocated for each service. The Service mediator contacts the service providers of the respective services to provide services to the user. This is illustrated in Fig 3.

2) Composition Tests

Subsequently the system was tested to see how service composition affected the performance of the system and given the additional framework components. These results are preliminary and further implementation and testing is required to evaluate the system for complex service composition scenarios as well as fault tolerance of the system as we would expect that certain service compositions would be invalid and have the potential to cause deadlocks in the system.

C. Discussions

The following table indicates the average time for each function to occur with the framework:

TABLE II. DELAYS CAUSED BY SERVICE COMPOSITIONS

Function	Delay (seconds)
EU Registration	0.8
SP Database Retrieval	0.24
OCS authorization	0.48
JAIN SLEE invocation	1.4

In our scenario one user requests a maximum of three services. The SP Database contains 20 records with 5 data entries each. The information contained is as shown in table 1. We expect that the average time for service composition to increase as the number of users increase and the number of services/service providers' increase.

VI. CONCLUSIONS

Composed services provide an opportunistic way for network operators to create revenue from existing services offered by service providers. This paper outlined the need for a service composer to create simplified mechanisms for IMS network operators to meet service provision, billing and accounting requirements of users and 3rd party providers. The architecture is based on the Parlay and 3GPP frameworks and introduces extensions that allow for the identified requirements to be met within the system. In the proposed framework usage-based charging and complex business models can be reflected as well as incorporating revenue sharing models.

Further work includes the completion of implementation and testing of the framework to allow for scalability testing as well and fault tolerance of service compositions. In this paper we have made apparent the need for network operators to investigate new and rapid service provisioning strategies and we investigate how this can be achieved with the partnership of existing third party service and content providers.

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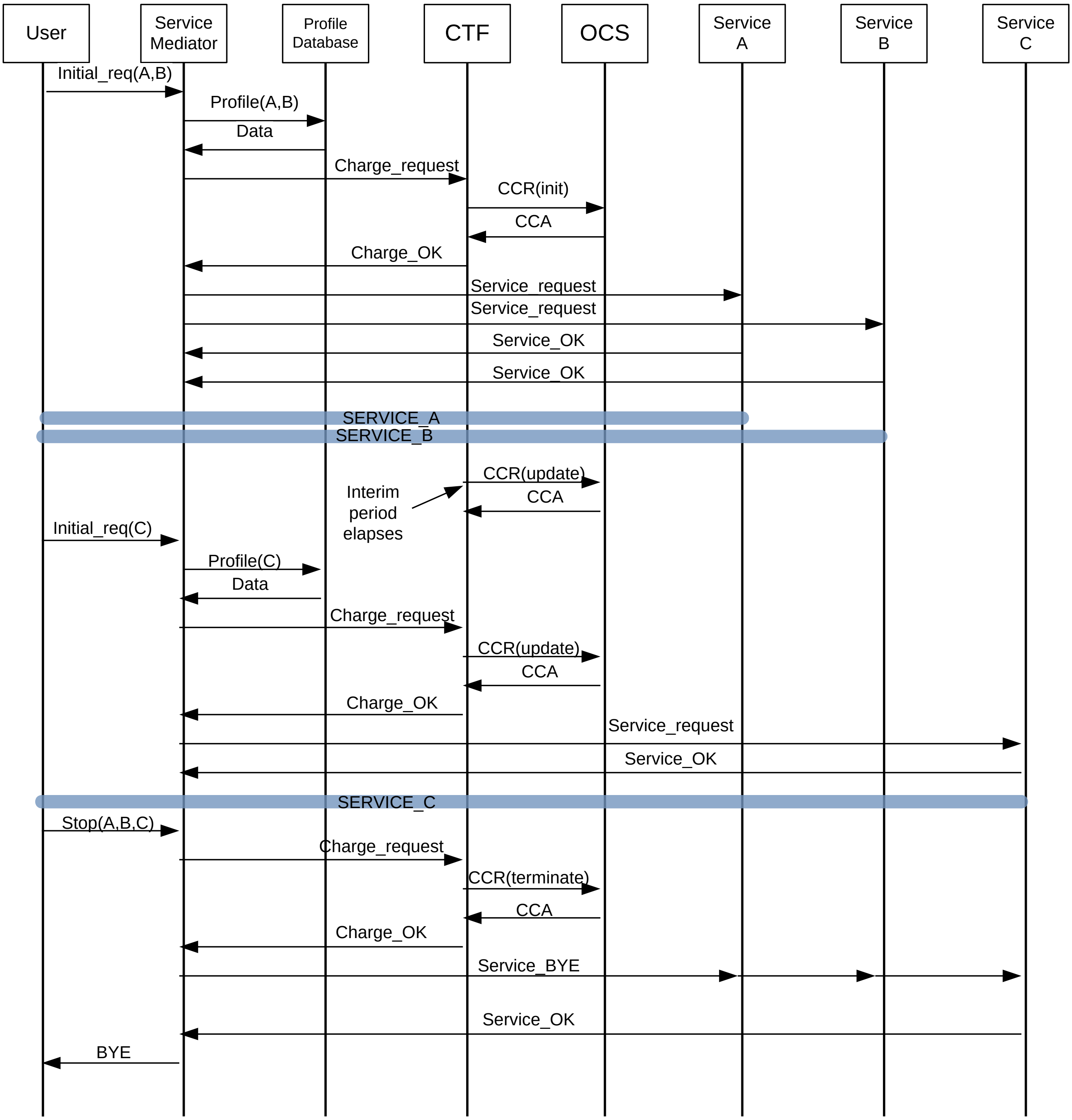

Figure 3. Compositions and Charging flow Diagram