Management of User Generated Multicast Sessions in IMS-based Networks

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Abstract

Factors such as the growing number of multimedia terminals, the constant increase of bandwidth available per user, and the large number of existing data sharing applications, are compelling users to generate and distribute their own content to restricted groups of other users. Inorder to support such scenario, we present an IMS-based solution that enables content distribution, in multicast, to groups of users, where the source of the content is also an end-user. The proposed solution allows the source of content to configure the service, indicating a list of authorized receivers and both the transmission date and duration. Moreover, the proposed solution also allows the operator to manage the registered user profiles, to impose access control and to validate the configurations submitted by the users.

1 Introduction

Considering the growing usage of multimedia mobile terminals accessing the Internet, the increase of the bandwidth available per user, and the low prices of data services in mobile networks, the development of frameworks enabling the creation of services sourced and controlled by the user seems to be opportune. The work presented in this paper assumes this paradigm; it addresses a service where a user could transmit live or recorded contents to a selected group of receivers, while enabling operators to control users and transmissions. Using the IP Multimedia Subsystem (IMS) [10] and a set of service enablers, the operator can control user, service and transmission profiles. The C-Mobile project has specified a platform of service enablers which are based on IMS and on Open Mobile Alliance - Service Environment (OMA-OSE) [8] standards. The C-Mobile project also integrates the Multimedia Broadcast Multicast Service (MBMS) - Release 6 [1] functional blocs for access network resource optimization. However, in order to create a service for the presented scenario it was necessary to develop a new set of service enablers. These complementary service enablers and their working logic constitute the original contribution of the work presented.

The remainder of this paper is structured as follows: Chapter 2 presents the C-Mobile platform and related technologies, Chapter 3 presents the architecture of the proposed solution, Chapter 4 details the implementation of the proposed solution and presents the developed prototype, and Chapter 5 draws the conclusions of the work.

2 C-Mobile project

The objective of the C-Mobile project (IST-2005-27423) is to evolve the broadcast and multicast technologies of the 3G networks [2]. It aims to go beyond the vision of a converged global network based on the usage of multiple broadcast transport bearers, and it is also focused on re-

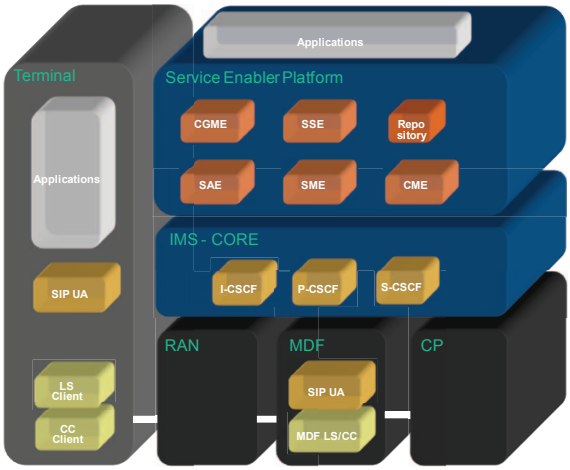

Figure 1. C-Mobile Architecture

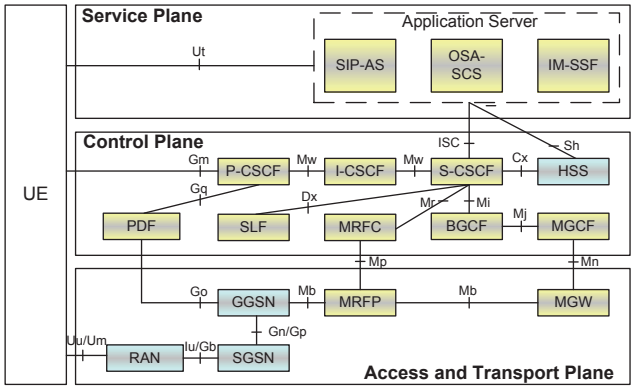

Figure 2. IMS Architecture

source efficiency, service flexibility and smooth migration for MBMS by creating broadcast and multicast communication capabilities on all communication layers across multiple technologies. IMS is used by C-Mobile's service enablers as the overlay control layer that provides a common platform for multiple access technologies. On the other hand, MBMS is used as the bearer technology to be integrated with IMS. The service enablers, which follow OMA-OSE standard, enable rapid service development and deployment by providing the basis for a flexible service oriented platform.

The C-Mobile architecture is shown in Figure 1 and it comprises the Service Enabler Platform (SEP), the IMS Core, the Access Networks (AN), the Radio Access Network (RAN), the Media Delivery Framework (MDF), the Content Provider (CP), and the Terminal. The SEP [3] constitutes a cooperative platform between the service provider, content provider, network operator and the end-user, which comprises a set of enablers: the Service Announcement Enabler (SAE), the Session Management Enabler (SME), the Context Group Management Enabler (CGME), the Content Management Enabler (CME), the Scheduling Service Enabler (SSE), and the repository.

SAE refers to the methods used by the MBMS service provider, to announce services and service packages to the terminal. The SME [6] is the contact point for the end user and it is responsible for all signaling flows between the SEP and the terminal. The SME Interacts with the IMS Core and it is responsible for access and session duration control. The CGME manages groups based on context-awareness, gathering context information and, based on that information (e.g. terminal capacity, location, user preference), it creates groups of receivers. The SSE is responsible for content delivery scheduling in order to efficiently use the available resources in the Core network and in the RAN. The CGME works in the carousel mode. The CME serves as a communication interface between the service provider (SP) and the content provider (CP); it provides control and policy enforcement of both type and amount of content a terminal is allowed access.

The IMS is used as the common control layer to converge heterogeneous multicast/broadcast access networks and the service logic. On the media delivery plane, the MDF is used to control the media processing functions and it enables the SEP use of such media processing functions via Session Initiation Protocol (SIP) protocol [12]. The media delivery functions include content streaming (MDF Live Content), e.g. Live TV, content casting (MDF Content Casting) and user generated content. The user generated content uses FLUTE [9] protocol for files upload, e.g. upload of media files for a podcast, streaming from the user equipment was not implemented. Therefore, the C-MOBILE integrated architecture allows mobile TV services and Web 2.0 content to be efficiently distributed to mobile communities over unicast, multicast or broadcast bearers.

2.1 IMS and MBMS

Release 5 of 3GPP introduced IMS as an extension of the UMTS architecture. It adds a set of new functions linked by new standard interfaces. IMS uses the SIP in order to manage multimedia sessions. It provides Quality of Service (QoS) by means of resource reservation and allows operators to adopt new charging schemes for multimedia sessions. Accordingly, the core IMS functionalities include management of multimedia sessions, encompassing registration, session establishment and teardown, bearer control, including end-to-end quality of service, authentication, authorization and charging, and service provisioning on the application server facilitating the introduction of innovative services. The IMS architecture is presented in Figure 2.

Brought in under R6 of 3GPP, the Multimedia Broadcast and Multicast Service (MBMS) [1] is used to broadcast and

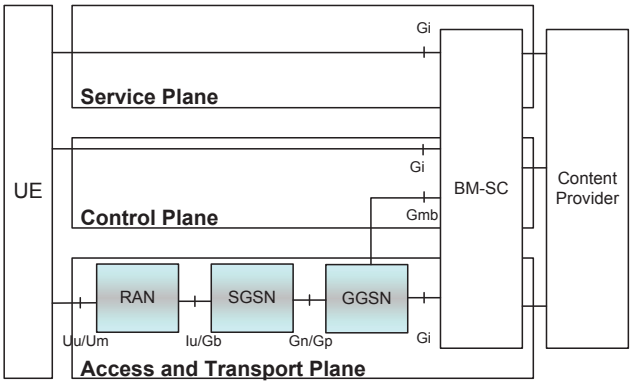

Figure 3. MBMS Architecture

multicast packet data on UMTS networks to large groups of users. MBMS allows the unidirectional transportation of information from a single source to multiple receivers (point-to-multipoint). This architecture allows an efficient use of the network resources, by sending the same information to all MBMS users simultaneously. The introduction of MBMS into the UMTS network has forced the modification of several network elements and, as a result, new interfaces and protocols were defined. Also, a new entity was presented: the Broadcast Multicast Service Centre (BM-SC). BM-SC is the platform responsible for the management of the broadcast and multicast content that is inserted into the UMTS network. It provides functionalities for the provision and delivery of MBMS user services. The reference architecture is illustrated in Figure 3.

2.2 OMA-OSE

In order to ease software reuse in the mobile world, the OMA specifies a number of architectural guidelines, whose main entity is the service enabler [7]. These architectural guidelines are described in the OSE specification, whose main objectives are to control resource exposure to application developers, and to integrate and manage resources towards a globally integrated and coordinated service environment [8]. Furthermore, the OMA also defines a number of service enablers to ease mobile application development.

3 Proposed solution

The solution proposed to support the management of user generated multicast sessions in IMS-based networks consists in 3 new service enablers for the C-Mobile service platform: the Booking Service Enabler (BSE), the User Group Creation Enabler (UGCE), and the Announcement Enabler (AE). Besides, this solution allows content transmission to groups of users, where the users can be both content providers and consumers. The user which generates the content must be able to define the set of allowed receivers, and to schedule real-time or recorded content transmissions. This user interacts with the BSE, using a web browser, in order to configure the user generated content transmission. In turn, the BSE interacts with the UGCE for group definition and management functions, and with the AE to announce the availability of the content to the group users. The C-Mobile architecture comprising the new service enablers is shown in Figure 4.

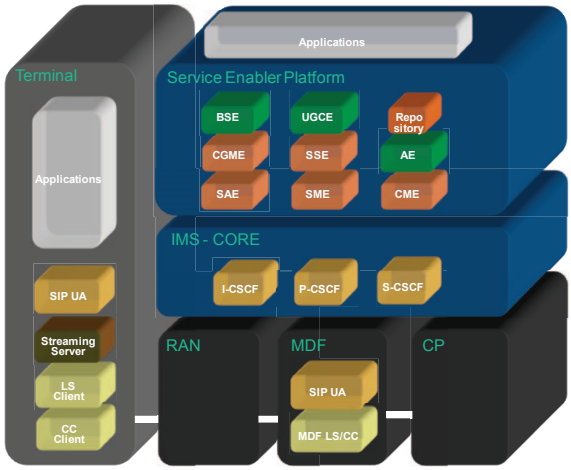

Figure 4. C-Mobile Architecture including the new service enablers

3.1 Booking Service Enabler

The BSE is responsible for the creation, removal and management of user generated content bookings. The user interacts with the BSE by means of a web browser in order to create a new booking. Bookings consist in information such as the transmission date, duration, and the group of receivers. Through this enabler, a user may reserve a time slot to transmit its content, indicating the date and duration of the given transmission. The booking will be passed to the CME, where it is stored as a new content.

3.2 User Group Service Enabler

UGCE is the enabler responsible for the creation, removal and management of groups of receivers. A receiver groups is associated to a booking in a one-to-one relation, i.e. each receiver group has a single booking and each booking has a single receiver group. Additionally, receiver groups are defined based on contact lists, created to ease the selection of groups of receivers. Both types of groups are created and managed by the user. Receiver groups are cre-

ated upon a booking, while contact groups may be created by the user at any time.

3.3 Announcement Enabler

The AE is the enabler responsible for the creation of a set of announcements for each reservation. Since a booking may occur some time before the actual transmission, it may be required to signal content availability to the receiver group, remembering them that a transmission is scheduled for a given time. For each booking three announcements are sent at different periods of time. The last announcement, which the one closest to the transmission date, marks the beginning of the transmission. An announcement is implemented as an XML formated file and consists of specific tags. These tags include the information required by a receiver to access the content, namely the service Uniform Resource Identifier (URI), the content description, the Electronic Program Guide (EPG), and the content Uniform Resource Locater (URL). The first announcement occurs upon the reservation confirmation, and the second occurs some time between the reservation confirmation and the transmission date. The last announcement is triggered two minutes before the start of the transmission.

4 Implementation

The proposed solution was implemented over the C-Mobile prototype. The C-Mobile prototype, shown in Figure 5, consists in multiple virtual machines interconnected through virtual IP connections. It comprises an IMS Core, an Application Server (AS), a Media Delivery Function (MDF), a User Equipment (UE), and a Multicast Router. For convenience, the IMS Core machine is also responsible for running the prototype's DNS server.

The IMS Core was implemented using the Open IMS Core and it is responsible for the SIP signaling management. The AS uses SailFin Application Server and it supports both the C-Mobile and the proposed service enablers. The included MDF was developed in the context of the C-Mobile project and the SIP support is provided by the Sofia-SIP stack; it provides media processing capabilities, such as media relaying between the source user and the group of receivers, and media transcoding. The MDF may use RTP [13], HTTP [4], FTP [11] or FLUTE [9] as transport protocols. The end user application was written in C language and it consists of three modules: the graphical user interface (GUI), the Sofia-sip communication protocol module, and the media module. It was deployed in the Nokia N800 Tablet device, which is capable of browsing HTML pages and of playing and recording multimedia content.

Figure 6 shows user subscription and registration. Both types of users (source and receiver) must, previously to using the service, register in the platform and subscribe to the booking service. To do so, the users must generate and transmit the message 1 shown in 6. The source user then becomes an owner of one reserved transmission service (message 2). An user willing to receive the transmission must, at this point, subscribe to the source user's service (message 3).

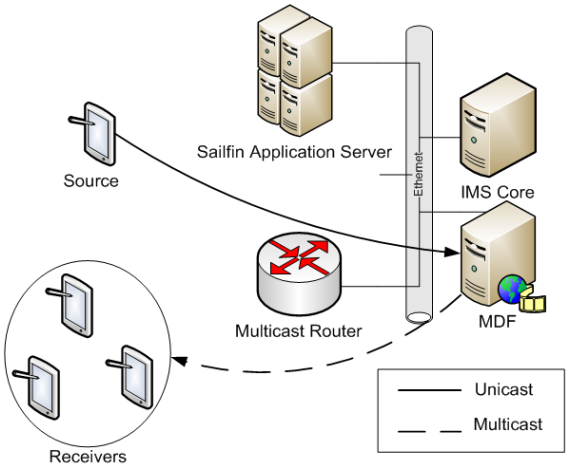

Figure 5. Proposed solution prototype

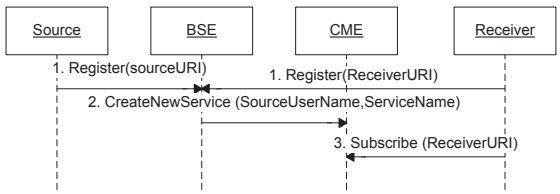

Figure 6. Service registration and subscription

Figure 7 represents an user creating a new booking. Bookings are accepted only if there is at least one receiver subscribed. Messages 1 to 3 are used to inform the relevant service enablers of the characteristics of the new reservation. The transmission date, duration and URI are sent to the BSE; the list of subscribed receivers is obtained from the CME, and the request for the creation of a new receiver group for the reservation is sent to the UGCE. Upon the creation of a new receiver group, the announcements are created (messages 4 and 5). The first announcement is triggered upon the reservation, and messages 6 to 9 represent such announcement. The announcements (message 8) are sent by SME, but triggered by AE (message 6), using the functions provided by the existing C-Mobile SAE (messages 7 and 8).

Figure 8 represents the beginning of the content trans-

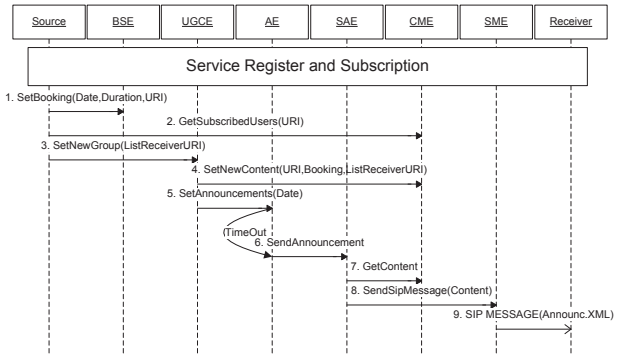

Figure 7. New booking

mission by the source user. A transmittion time window of four minutes was specified, not allowing source users to start streaming the content earlier than two minutes before the reserved time, nor later than two minutes after the reserved time. Message 1 triggers the source session initiation (SIP INVITE), using the service URI as its destiny and the Session Description Protocol (SDP) [5]. Message 1 will be processed by the IMS Core, forwarding it to the SME (message 2). The CME then verifies if the user is registered, subscribed, source of content and if it has an reservation scheduled for the specific time (Message 3). Message 4 is sent by the SME upon successful user validation, triggering the MDF to prepare the reception of the stream for latter distribution. The SDP is used with an extra attribute field (named crid) that will enable rapid stream differentiation. On prepare relay, the MDF negotiates the possible codecs, using function of the SME (messages 5 to 10), and indicates the IP address and port to be used. Upon the acknowledgment of the source's streaming (messages 11 to 14), one of the possible codecs for the session is adopted and the source starts streaming the content, in unicast, to the MDF. Such ends the prepare relay phase.

Figure 9 represents the signalling required for the first receiver session establishment. Messages 1 and 2, sent to the SME, trigger the user validation (message 3), which is analogous to the source user validation. The CME verifies if the user is registered, subscribed and if the user is not the source of the content, but has subscribed to the requested service, then the session initiation is accepted. Message 4 is sent by the SME upon successful user validation, triggering the MDF to start relaying the content's stream Messages 5 to 14, are analogous to the source users stream initiation and codec negotiation, with the difference that the realyed stream is in multicast. Such requires receivers to join the multicast session. The invite sent by the SME (message 5) also comprises the extra attribute crid; such attribute will allow MDF to verify if the stream with that attribute is being

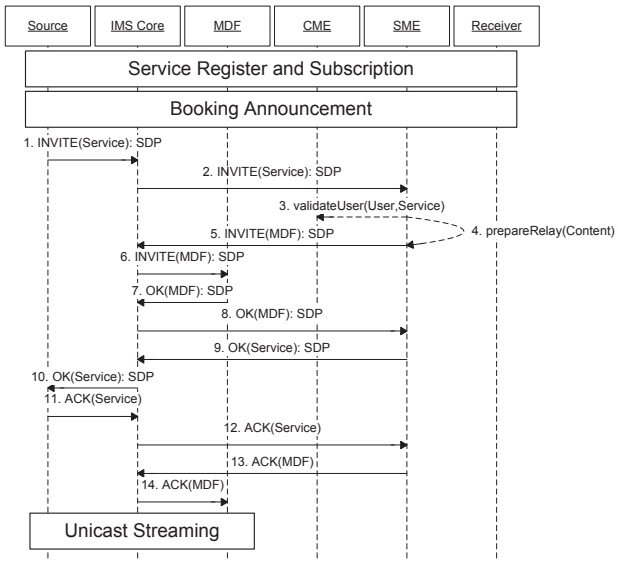

Figure 8. Source content transmission

received, if the requested codec is compatible and, if not, tries to transcode the stream. If the transcoding is possible, the sequence continues and the MDF responds with message 7. Message 7 carries the multicast group address and port number. Upon session acknowledgment by the IMS Core (message 14), the multicast group is created and the MDF starts streaming to the group of receivers sharing the same codec, in multicast.

5 Conclusions

In this paper we proposed a solution for IMS-based management of user generated multicast sessions. This solution allows users to generate and distribute their own content to groups of other users. The proposed solution also allows users to configure real-time transmissions of their content, specifying the transmission date, duration and the desired set of receivers. The new functionalities are provided by three new service enablers for the C-Mobile platform, which are used to create transmission bookings (BSE), to create and manage user groups (UGCE) and announcements of available transmissions (AE) to valid users. The proposed solution also enables service providers to control user, service and transmission profiles. The user, source of content, identifies the users allowed to access the content (receivers) and the SEP imposes access control based on that information.

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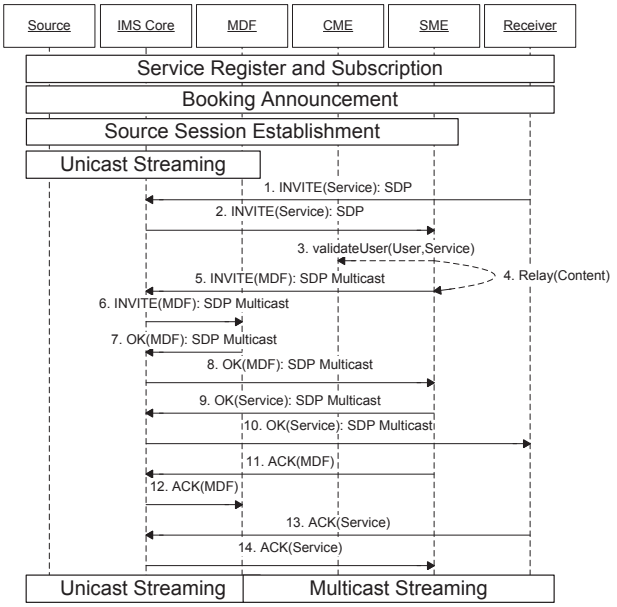

Figure 9. Receiver content access

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