CC4IMS: A Mobile-based Open-Source Call Center for IMS

Harilaos Koumaras, Christos Sakkas, Michael-Alexandros Kourtis, Jose Oscar Fajardo, Fidel Liberal

Abstract — **This paper presents a novel open-source implementation of a call center, which is compatible with the IP Multimedia Subsystem (IMS) platform, supporting call forwarding and dispatching services, along with video call and chat with file transfer. The proposed solution is called Call Center for IMS (CC4IMS) and following a requirement analysis, the paper discusses the overall architecture and design of the proposed Call Center, focusing on the IMS compatibility and mobility of the implementation. Then, an open-source prototype implementation is presented, which was designed for mobile devices in order to be suitable for distributed and ad-hoc launch at emergency situations by first responder teams near to the location of the emergency incident. Finally, a protocol and message illustration between the CC4IMS and the IMS modules is presented, based on messages that have been actually captured by the CC4IMS prototype and the Open IMS Core, showing that the proposed Call Center confronts with the IMS signaling.**

Index Terms— **Call Center, Open Source, IMS, SIP**

I. Introduction

TODAY, the users of first responder communication systems are aware of the benefits that the interconnection between different Professional Mobile Radio (PMR) and the integration of new advanced data services could bring to their professional sectors. Considering the current multimedia capabilities of both emergency and general purpose mobile terminals, it is just a matter of time that we see police or fire-fighter units transmitting image-based vital information in real time to central stations or to other mobile units in order to assure quick and expert responses to critical incidents.

In order to satisfy this need for broadband data services, different PMR technologies have tried to improve data transmission capabilities. For example, TETRA Enhanced Data Service (TEDS), standardized with TETRA Relase 2 at the end of 2005, has been considered as a suitable alternative for advanced security services, such as video surveillance and extensive image sharing or positioning services. However, TEDS technology is getting obsolete for the requirements of new security applications and the need for upgrading to broadband is a recognized fact. Thus, the discussion in the TETRA Association has been lately focused on which kind of broadband solution should be adopted: integration of other broadband technologies or evolution of TEDS technology [1].

At the same time, commercial wireless technologies have been evolving from traditional GSM/GPRS/UMTS services towards more advanced wideband solutions such as WiMAX or LTE, trying to support wider coverage and higher data rates (up to 50-100Mbps). The future of mobile communications seems to be directed towards an all-IP world, which has raised considerable discussion regarding the provision of multimedia services. During 2010, the GSM Association (GSMA) adopted IP Multimedia Subsystem (IMS) as the key driver technology to support voice services over LTE [2]. Thus, IMS can be considered as the candidate for the provision and management of multimedia services of future 4G networks and the most promising platform for the expected future convergence of PMR and LTE.

In such a converged and IMS-based infrastructure, a crucial role for the provision of emergency services is the existence of a call center, which answers all the incoming emergency calls and according to the incident forwards the caller to the most appropriate first responder (similar to 911 or 112 emergency numbers for the States and Europe today) [3].

However, the current requirement for faster and more optimal coordination of each emergency incident, creates new demands for more advanced features and services. More specifically, the next generation Call Center should be able to inform the operator about the location and the availability of each first responder team. Moreover, for better coordination of the incident, software-based with mobile capabilities call center implementations are expected, which will leverage the high investment costs that are currently required for a call center deployment and will also support closer to the emergency-event coordination.

Thus, this paper presents a Call Center for IMS (CC4IMS), an open source implementation of a mobile Call Center, compatible with the IMS that supports an interactive map for depicting the location and the status of the first responder teams. The CC4IMS is especially designed for installation at mobile Android devices in order to be possible the mobility of the call center near the incident, without being limited only to in-house operation, lowering both the operational and investment cost for Call Center installation and deployment.

The rest of the paper is organized as follows: Section II provides a brief information of the IMS basic architectural

H. Koumaras, Ch. Sakkas, M-A Kourtis are with the National Center for Scientific Research DEMOKRITOS, Institute of Informatics and Telecommunications, Agia Paraskevi, 15310, Greece (e-mail: {koumaras, chsakkas, akis.kourtis}@ iit.demokritos.gr).

J. O. Fajardo and F. Liberal are with the Department of Electronics and Telecommunications,ETSI Bilbao, Alameda Urquijo s/n, 48013 Bilbao, Spain (e-mail: {fidel.liberal, joseoscar.fajardo}@ehu.es).

elements. Then, Section III discusses a brief requirement analysis of the presented Call Center. Section IV analyses the design and architecture of the Call Center, discussing also its Graphical User Interface (GUI) structure. Section V presents the open source (i.e. the CC4IMS) prototype implementation of the proposed Call Center. Section VI presents the SIP protocol and messaging illustration of the CC4IMS implementation in relevance to the IMS and finally Section VII concludes paper.

II. The IP Multimedia Subsystem

The CC4IMS is based on a Next Generation Network IMS infrastructure [4] and aims at developing within this NGN environment a mobile-based Call Center, which will be able to optimize the response time of the first responder teams.

CC4IMS is fully IMS compliant, composed of modules based on IMS signaling (SIP/SDP) for communication, processing and interaction with the rest IMS modules and interfaces.

The control layer of the IMS infrastructure consists of nodes for managing call establishment, management and release, which are called Call Session Control Functions (CSCF). The CSCF inspects each SIP/SDP message and determines if the signaling should visit one or more application servers en route to its final destination. More specifically, the CSCF is a distributed entity comprised of three different components:

- The Proxy CSCF (P-CSCF), which acts as the entry point for any service invocation within IMS and grants appropriate access rights after successful user authentication. The P-CSCF is tasked to relay session and therefore is the module with which the CC4IMS will interact with for the session and call management.
- The Interrogating CSCF (I-CSCF) acts as a topology-hiding gateway between the P-CSCF and the S-CSCF, by determining the S-CSCF or the Application Server (AS) to which an end-user should register. I-CSCF is a contact point within an operator's network for all connections destined to a subscriber of that network operator.
- The Serving CSCF (S-CSCF) is responsible for key routing decisions as it receives all the User Equipment (UE)-originated and UE-terminated sessions and transactions. Therefore it is also responsible for handling registration processes, maintaining session states and storing the service profiles. CC4IMS will interact with S-CSCF via its interaction with the P-CSCF.
- The Home Subscriber Server (HSS) is the main data storage component for all subscriber and service-related data of the IMS. The main data stored in HSS include user identities, registration information, access parameters and service-triggering information. HSS contains IMS access parameters which include parameters like user authentication, roaming authorization and allocated S-CSCF names.

For the functional needs of the CC4IMS, the following Application Servers are also required:

- The XML (Extensible Markup Language) Document Management Server (XDMS Server) defines a common mechanism that makes user-specific service-related information accessible to the service enablers (e.g., CC4IMS, IM (Instant Messaging), Conferencing, etc.) that need them. Such information is stored in the network at the IMS Application Layer on an XDMS server where it can be located, accessed and manipulated.
- The Presence Server, which supports one of the most well known and used services in today's real time media applications as it has an enabler service role for many applications like Instant Messaging, Push To Talk over Cellular, Video Calls/Conferences and many others by providing the status of the registered users. The CC4IMS retrieves this information for the relative map representation of the registered users (along with the users status).

Following this section, the requirements analysis is discussed in the next section.

III. Requirements Analysis

The CC4IMS, in order to be able to fulfill the challenges and expectations of a modern call center, should fulfill the following Functional and Non-Functional requirements:

A. *IMS Compatibility*

The CC4IMS should be compatible with the IMS framework and capable of interacting with the CSCFs modules.

B. *Mobility*

The CC4IMS should be developed on a mobile platform (e.g. Android), which will make possible the mobile deployment of the call center near to emergency incidents.

C. *Voice Call/Video Call*

The CC4IMS should support basic voice service and video call for providing on sight coverage to the emergency incident and give to the Call Center operator an objective assessment of the emergency incident.

D. *Call Management - Call Dispatching*

The CC4IMS should be capable of handling call forwarding and dispatching of incoming calls to the appropriate first responder, who is closer to the area of the incident. The call management and dispatching should be performed utilizing SIP-based and IMS compatible signaling messages.

E. *Interactive Map*

The CC4IMS should be capable of offering to the call center operator an interactive map utility, which will provide a general view of the situation in the field, including the position and the status of the first responders.

F. *MSRP Chat and File Transfer*

The CC4IMS should be capable of offering advanced chat services to the callers and able of handling MSRP chat sessions and messages. This service should be capable of handling file transfers, image sharing and text chatting,

facilitating the actions of the first responders by providing on-site photos and other media related content.

G. *Grouping Users – Static/Dynamic*

Static predefined groups of users will be available to the CC4IMS. Having grouped in advance different users together (e.g. group1 a police station and group2 a fire station) improves the communication time, when mass communication may be needed. Except from those group though, the CC4IMS operator will have the ability to create dynamic groups on-the-fly with users of his choice, depending on the incident.

IV. Overall Architecture of CC4IMS

The CC4IMS is a self sufficient Call Center and capable of managing many organizations and users. The overall architecture of the CC4IMS is depicted on Figure 1.

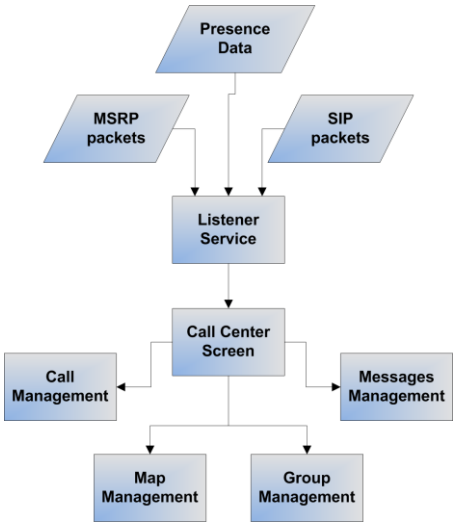

Figure 1 - CC4IMS Architecture

The core module of the CC4IMS is a Listener Service, which concentrates the SIP messages from the call-related IMS signaling, the MSRP messages for the chat related content and finally the Presence messages from the XDMS and Presence server of the IMS.

The Listener service interacts with the CC4IMS GUI either in standby or active mode, which in turn further manages the calls, the messages, the map or the group by the user interaction.

The CC4IMS aims to provide an efficient interface for the call center operators, so they are able to easily receive/initiate emergency calls, process these calls and perform required actions, control and manage the set of emergency sessions currently being processed in the system, etc. Thus, the CC4IMS will be available to the user via an easy to operate intuitive graphical user interface.

On the login screen, the operator will be able to provide his/her credentials. This ensures reliable and high-quality call-taking and processing in emergency situations. CC4IMS's functions (forms, maps, schematics) will be depicted in separate frames.

The mobility and compactness of the control room allows reliable and organized communications suitable for environments that require fast and dynamic group deployment, with communication needs. As Figure 2 depicts, the map is a fragment of the main UI and its data are being refreshed periodically. Presence data are being transmitted with XML files and the parsing of these files is handled by a background thread in order to avoid performance issues in the application's user interface.

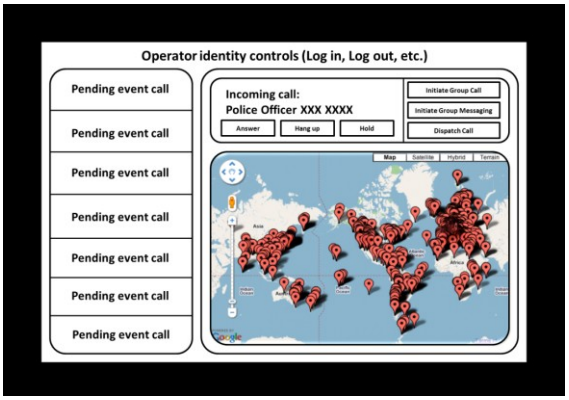

Figure 2 - CC4IMS Mock-up design of GUI

The Incoming Call list is updated dynamically and has options, like holding and resuming calls, as well as, transferring the current call to another person. Thus, fast and efficient call management is achieved.

Each new incoming call is shown in the map with different icon in order to distinguish them, from other users' calls. This functionality is available at presence-enabled IMS clients.

Groups can be divided in two modes, dynamic and static. Static groups are predefined and are served by the XDMS server. Static group for example it can be a police precinct or a fire department, or even an elite team, which is part of the police precinct. On the other hand dynamic groups will be created on the fly to cover the needs at a given time, like when different organizations or different teams participate at a common operation.

In case of video call, the caller sends video feed to the CC4IMS, which is displayed on the top left corner of the GUI and if needed can be switched to full screen by the operator. The CC4IMS by default does not send back a video feed of CC4IMS operator to the callee, though if needed it is able to support it.

V. CC4IMS Prototype Implementation

A prototype implementation of the CC4IMS has been developed within the framework of this paper and is currently available as open source project at [5]. The CC4IMS implementation has utilized the Doubango opensource framework [6] for reassuring compatibility with IMS/SIP functions. For the mobility purposes of the CC4IMS, the Android 4.1.2 and Google Maps v2 for Android have been utilized, providing a lightweight implementation. The prototype is fully operational, supporting: Login Screen for registering the CC4IMS operator to IMS, Call Center Screen that has all the functionalities of the application in a well defined GUI, a Listener Service that handles incoming requests and sessions from the IMS server and its modules (e.g. Presence and XDMS Server).

A. *Login Screen*

The Login Screen of the CC4IMS is depicted in Figure 3. The user through the log in screen is able to register at the IMS and initiate the interaction with the IMS modules.

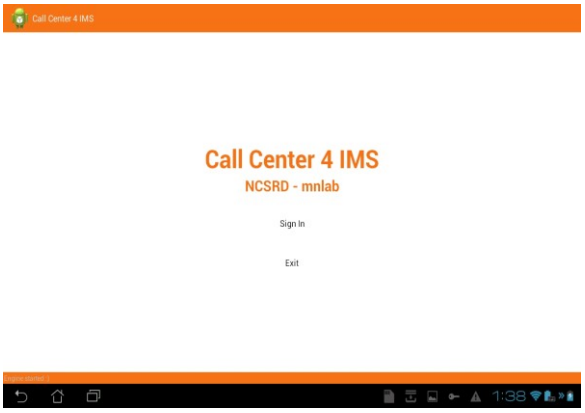

Figure 3 CC4IMS Login Screen

B. CC4IMS Standby mode

Following a successful IMS registration, the standby screen of the CC4IMS provides to the operator the capability to monitor the position of all the IMS registered first responder users on the interactive map utility. The CC4IMS operator can retrieve additional info for the depicted/monitored users on the map by clicking on them. Then additional information appears on the top right area of the standby screen (See Figure 4).

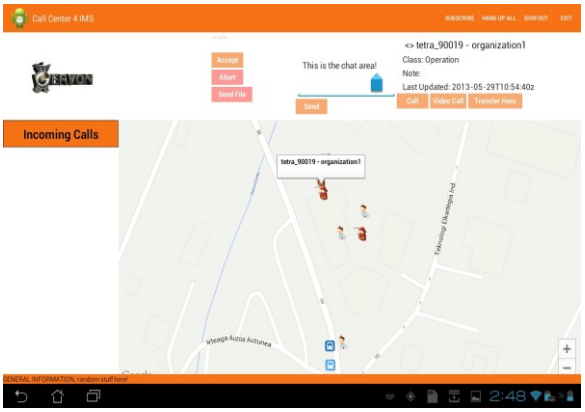

Figure 4 CC4IMS Standby mode with Presence information

C. *CC4IMS Active Mode*

Once an incoming call arrives at call center, then a popup window appears asking from the operator to answer the call. Once the call has been answered by the operator, the CC4IMS switches to Active mode.

In active mode, the CC4IMS screen displays the video stream of the incoming call on the upper left of the screen and the voice part of the incoming call is also served by the speakers of the mobile device. Additionally, the option of call forwarding/dispatching to another registered user is also available and the operator can interact with the appropriate screen button or the interactive map in order to complete this action.

As seen on Figure 5, a chat area is also available for sending and receiving multimedia content (i.e. text and/or media files) to the session participants.

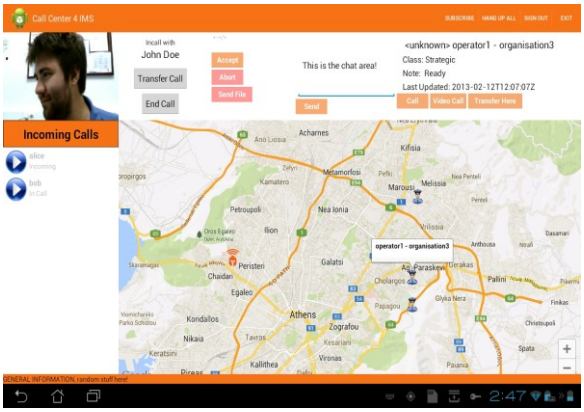

Figure 5 CC4IMS Active Mode with a video call and a new incoming call

Finally, more options for call management are available (e.g. hold) with a press and hold action by the operator on the call session button at the incoming calls list.

VI. Protocol and Messages Illustration

CC4IMS is an open-source implementation of a call center, which is compatible with the IMS platform, thus interacts with the IMS that is registered to, utilizing IMS compatible SIP-based messages [7]. In this section the basic messages/protocol illustrations of the CC4IMS and the P-CSCF are presented, based on actually captured messages between the CC4IMS prototype and Open IMS Core [8].

A. *Call Session Establishment and Termination*

A Call Session is established between a user (Alice) and the CC4IMS through the P-CSCF as Figure 6 illustrates.

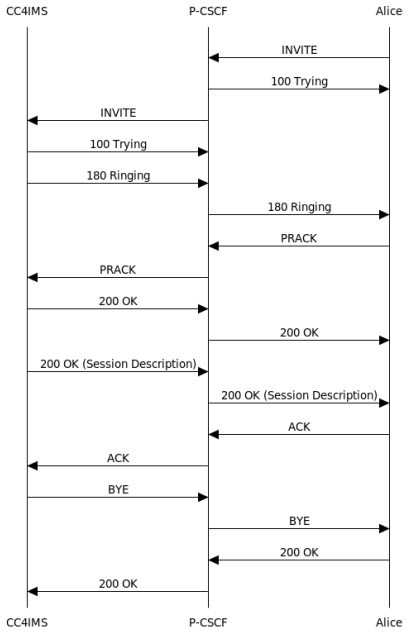

Figure 6 Call Session between user (Alice) and CC4IMS

Alice sends an INVITE message and the CC4IMS responds with 100 Trying and 180 Ringing. Then a PRACK message is generated from Alice. When the CC4IMS operator answers the call, a 200 OK message, containing the Session Description is sent back to Alice. Alice confirms with an ACK message and the session is established. When the CC4IMS operator decides to hang up the call, a BYE message is sent. Alice responds with 200 OK and the call session is terminated successfully.

B. Subscribing CC4IMS for Presence Information

For retrieving the presence information the CC4IMS sends a SUBSCRIBE message per group to P-CSCF. Then P-CSCF sends a 202 OK, indicating that it has successfully received the SUBSCRIBE message. Then the XML files containing the presence information are sent back to the CC4IMS as a payload within a NOTIFY message. Figure 7 illustrates a subscription example of CC4IMS to three groups for retrieving their presence information.

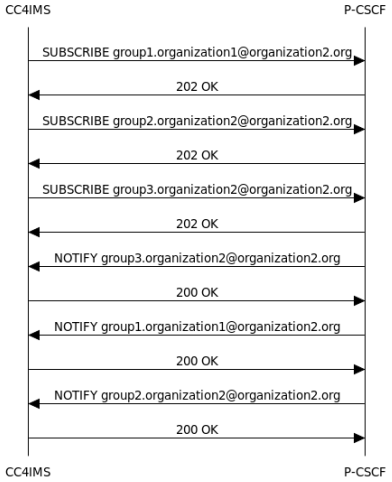

Figure 7 Subscribing CC4IMS to 3 groups for presence information

C. Call Transfer

A Call Transfer can occur when there is already a call session established. The CC4IMS operator speaks with Alice and then he decides that Alice needs to speak with Bob. So when the operator presses the Transfer Call button, then a REFER message is sent to Alice with the SIP URI of Bob as Figure 8 depicts. Alice then accepts the transfer and an INVITE message is sent to Bob in order to initiate the new call session between Alice and Bob. Status messages are being exchanged from CC4IMS, Alice, Bob and P-CSCF. Then a new call session is established between Alice and Bob. When Bob answers the call from Alice, the CC4IMS is released from the call session with Alice.

VII. CONCLUSION

This paper has presented the design and open-source implementation of the CC4IMS, an IMS compatible Call Center, with call session management, multimedia chat and interactive map capabilities. The presented Call Center implementation has been publicly released by the authors as an open source project. The presented implementation has been especially designed for mobile devices in order to be suitable for near-site initiation by the first responder teams. The paper has also presented the messages illustration of the CC4IMS with the IMS modules for its basic functionalities.

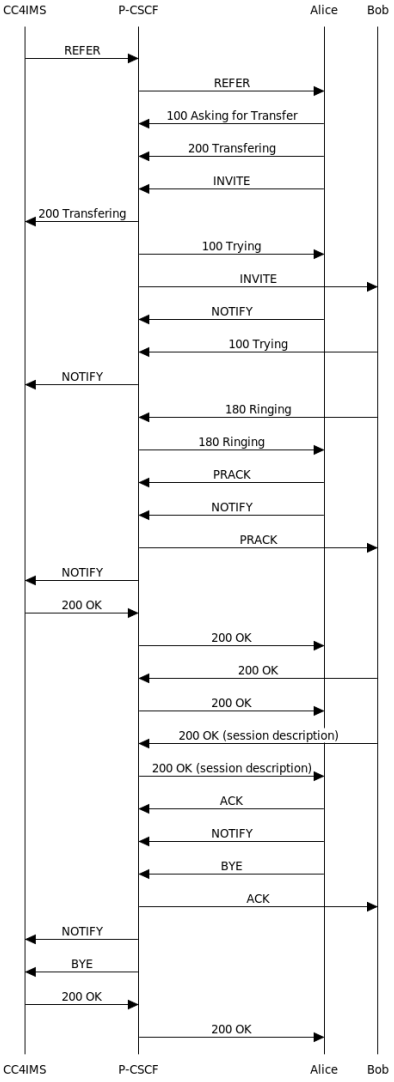

Figure 8 Call Transfer messaging betweem CC4IMS, Alice and Bob

ACKNOWLEDGMENT

The work of this paper has been supported by the EU-funded GERYON project (SEC-284863).

REFERENCES

[1] "Selection of a Broadband Technology for TETRA". Mehdi Nouri. Chairman of TC TETRA Working Group 4 (High-Speed Data) Tetra. Association, 2009.
[2] GSMA Leads Mobile Industry Towards a Single, Global Solution for Voice over LTE http://www.gsmworld.com/newsroom/press-releases/2010/4634.htm
[3] 3GPP: IP Multimedia Subsystem (IMS) emergency sessions, TS 23.167, V11.6.0, Dec 2012
[4] 3GPP: Technical specification group services and system aspects. IP Multimedia Subsystem (IMS), Stage 2. TS 23.28 V8.5.0, Jun 2008
[5] CC4IMS Open-source project at http://code.google.com/p/cc4ims
[6] Doubango, http://www.doubango.org/
[7] 3GPP: Signalling flows for the IP multimedia call control based on Session Initiation Protocol (SIP) and Session Description Protocol (SDP); Stage 3. TS 24.228, Oct 2006
[8] Open IMS Core, http://www.openimscore.org/