Context as an IMS Service

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Abstract — **The worldwide spread of mobile phones and its increasing trend makes them the main vehicle for mobile communications. Mobile Operators can provide valuable services to their clients by using context information to personalize multimedia content distribution. The knowledge of users' situations shall guide applications to select the most helpful content in each specific instant. This paper proposes IMS (IP Multimedia Subsystem) as a context service enabler allowing Mobile Operators to offer more useful services to their clients by applying the Internet of Things vision into the telecommunications world.**

Keywords: Context; IMS; IoT; Mobile; Services.

I. INTRODUCTION

A core challenge to Mobile Operators is to afford clever services based on the user's current situation in order to make them cheaper and useful. The mobile devices explosion and the wireless networks diffusion allow users to be always connected enabling a ubiquitous access. Furthermore, it is expectable that sensor networks technologies will be fast widened all over the world fostering the Internet of Things (IoT) accomplishment. The information gathered from these sensors networks can be treated as context information, which enables the usage of intelligent models that can be employed by context-aware services to improve their utility. Mobile Operators require an effective communication framework that allows context information to flow from their providers towards the context consumers making possible to get better services and personalized contents distribution.

This paper devises IMS (IP Multimedia Subsystem) as a context service facilitator enabling Mobile Operators to provide valuable services to end-users. It is here proposed context as an IMS service that instead of delivering multimedia content makes available context information to context-aware services allowing Mobile Operators to offer the right content to the right client.

The rest of the paper is as follows: in Section II the main motivations for context usage are referred; Section III presents the devised framework that allows Mobile Operators to use context information to provide useful services to their clients; in Section IV is introduced the procedures that enable the context exchange between interested entities by showing the proposed demonstration scenario. Finally, Section V summarizes the main conclusions.

II. MOTIVATION

A. Context in Mobile Services

Context can be understood as sensed information that changes over time, which can be used by context-aware systems to improve their performance. Nowadays, Mobile Operators are already offering some context-aware services based on users' location by selecting the content that best fits the user position. But Mobile Operators can go further since they are in a privileged position to collect information about their clients' situation. They can bring together statistics on their clients most accessed web pages or their favorite programs and channels; they can even collect figures about their online shopping profile. Furthermore, following the IoT fashion, through the use of external sensoring, it is possible to collect extra context information, like noise, temperature or movement. All this information is critical to Mobile Operators since it allows them to offer useful services through optimized networks to end-users. Figure 1 presents possible sources of context information.

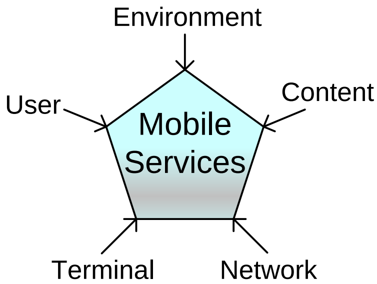

Figure 1. Possible Context Sources

B. Service Scenario

This is the raining season. A huge storm is flooding the regional roads letting the population out-of-the-way. Unhappily, there is often a lot of kills victims of these natural catastrophes and, most of them, are tourists caught napping in the storm. In order to reduce their impact, the Government is funding Mobile Operators to offer a service that streams videos indicating to each of their clients in critical situation the best way to reach a shelter having food and potable water. The name of the service is: Get safe.

Mobile Operators using their native capabilities can imprecisely check their clients location based on their attached antennas. If they are nearby a flooding area, Mobile Operators check which ones have on their terminals the Global

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Positioning System (GPS) and try to immediately get the right users' location in order to provide the most accurate location-based helping video. Due to those users, Mobile Operators require context information and, consequently, they become context consumers of a context service that converts user geographic coordinates into user street location. The geographic coordinates are supplied to the Context Service by the context provider based on the clients GPS information. Furthermore, Mobile Operators makes even use on their clients profile in order to check their native language.

Based on users' location and using their specific language, Mobile Operators can offer understandable videos with clear indications about the way to reach a shelter saving hundreds of lives.

C. Related Work

The use of context in mobile networks is nowadays a key research topic in scientific community. Its usage in telecommunications systems allows the service personalization over optimized networks.

The FP7 (Framework Program 7) SENSEI (Integrating the Physical with the Digital World of the Network of the Future) project aimed to provide the necessary network and information management services to enable consistent and accurate context information retrieval and interaction with the physical environment [1]. The work carried out in [2] has proposed a set of interfaces enabling Applications and Services to access real world information.

PERSIST (Personal Self-Improving Smart Spaces) was a FP7 project intending to develop Personal Smart Spaces (PSS) that were able to learn and reason about users, their intentions, preferences and context [3]. The PSS was enabled to extend and enhance as the user meets other smart spaces. In [4] is presented the overall design of the main components supporting the operation of Personal Smart Spaces.

The FP7 C-CAST (Context Casting) project aimed at evolving mobile multimedia multicasting to exploit the increasing integration of mobile devices with our everyday physical world and environment [5]. Furthermore, it has designed an innovative approach allowing personalized content delivery to multiple mobile users independently of the underlying networks. In [6] and [7] was defined an architecture to support a complete context management functionality along with service components like group management and content selection. The work carried out in [8] and [9] has defined a framework to collect sensor data, distribute context information and manage efficiently context aware multiparty data distribution. In [10] and [11] were developed a set of mechanisms for autonomous context driven content creation, adaptation and media delivery.

The research presented in [12] demonstrates the usefulness of context-awareness usage to improve the interface between the user and the mobile devices. The context is derived from the fusion of multiple sensors. The article also proposes a hierarchically working model to structure the context concept.

In [13] was proposed a layered conceptual architecture where the layers were increased with interpreting and reasoning functionalities, which allows the detection and the context usage.

Another research has been carried out in [14] where a layered conceptual design framework was proposed highlighting the different elements common to most context-aware architectures.

The research done in [15] has studied the impact of context, sensors and wireless networks in the telecommunications field. Several scenarios were suggested stressing the possible synergies between the defined areas.

In [16] is devised a convergent context-aware architecture where IMS is used to convey context information and to control MBMS (Multimedia Broadcast and Multicast Service) and E-MBMS (Evolved MBMS) multimedia channels allowing Mobile Operators to easily offer innovative services over efficient networks.

The work introduced in [17] exposes the benefits of using context information for the vertical handover decision procedures. It devises a context-aware information server skilled to manage dynamic information retrieved from both the network and the terminal side entities, which leads to an improved handover process.

III. IMS AS A CONTEXT FACILITATOR

A. IMS Architecture

3GPP (3rd Generation Partnership Project) Release 5 has introduced IMS as an extension of the UMTS (Universal Mobile Telecommunication System) architecture [18]. It has added a set of new functions linked by new standardized interfaces. IMS uses the IETF (Internet Engineering Task Force) SIP (Session Initiation Protocol) in order to manage multimedia sessions [19]. It provides QoS (Quality of Service) by means of resource reservation and allows operators new charging schemes for multimedia sessions. Finally, IMS makes possible fast service deployment enabling more and better services to end customers. The IMS architecture, as defined by 3GPP in [18], is presented in Figure 2.

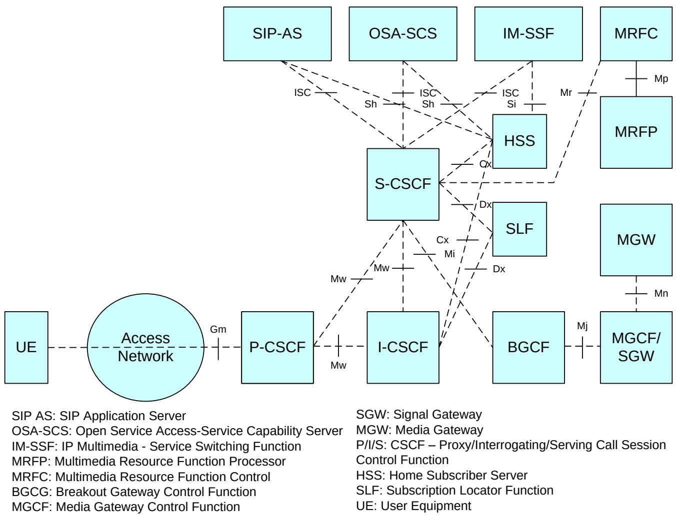

Figure 2. 3GPP Release 5 IMS Architecture

B. *Context as a Service*

Context is defined in [20] as the information employed to characterize the situation of entities. A situation is defined in [21] as the state of a context at a certain point in space at a certain point in time, identified by a name. A situation is even matched up to a snapshot taken by a camera where it captures the momentary profile of the context attributes. A service can be considered context-aware if it uses context information to adapt its behavior to optimally perform its tasks.

Context-aware services require services that provide context-aware information. Consequently, context-aware services need context services to afford users' situation information. A Context Service (CxS) can be defined as a service that makes available context information to context-aware systems [16]. CxS uses context information provided by Context Producers (CxP) and presents users' related situation to Context Consumers (CxC). So, CxSs gather context information from CxPs and make it available to CxCs.

CxS can have different complexity behaviours. It can just bypass basic sensor information, such as the user location, or it can apply demanding algorithms based on mixed context sources in order to get more complex information such as users' wishes or needs.

CxS can collect context information from different sources. The information can then be filtered to select only the valid data. Additionally, fusion processes can be applied enabling the consistent values attainment through the integration of similar data sources. Aggregation mechanisms can run over heterogeneous sources of information to obtain higher level context data. As a final point, reasoning mechanisms allow CxS to wrap up users' situation by applying logical rules over collected context information.

CxC, CxS and CxP can exchange context information by request (where is the client now?), periodically, (where is the client in each 5 minutes?) or on an event-based (let me know when the client leaves the train station). The functional interaction can be seen in Figure 3.

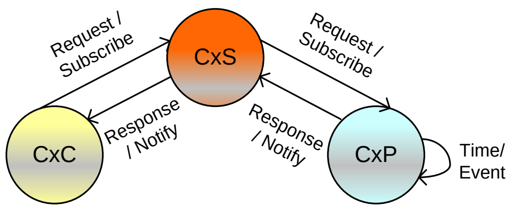

Figure 3. CxC, CxS and CxP interactions

C. *Context as an IMS Service*

One of the main IMS advantages is the easy development of multimedia services. Following the same approach, IMS can be very useful as a context service facilitator enabling awareness in mobile services. This analogy is presented in Figure 4.

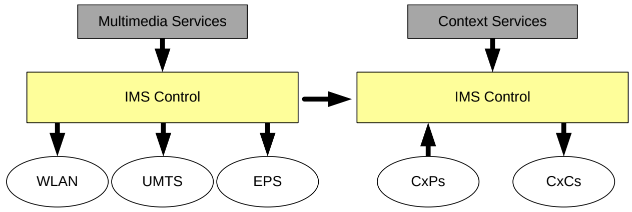

Figure 4. IMS Moving Towards a Context Enabler

This paper proposes to have Context Services playing de role of IMS specific applications that make the bridge between context producers and context consumers. It is here devised IMS as a context facilitator in which the IMS Application Servers are used to manage context instead of the standard multimedia services. The proposed framework is context agnostic being capable of controlling all types of context information. CxS shall collect context information from CxP, then they shall apply their own logic and finally they shall provide inferred context information to CxC. This process shall take place independently of the type of information exchanged between all context entities.

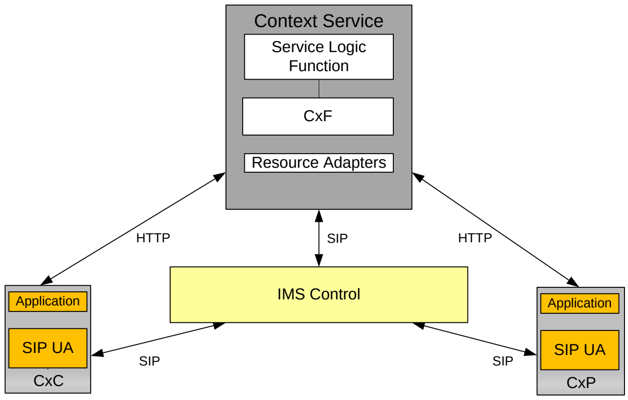

Figure 5. Context Framework

CxS can be further elaborated by splitting the application logic from the Context Function (CxF) that has functional roles allowing applications to bypass the details of communications with CxC and CxP. For instance, all the management of context dialogs established between CxP, CxS and CxC shall be transparent to applications. Also, Resources Adapters are fundamental since they hide the signaling details to the higher layers. Consequently they enable both SIP signaling for context transfer and HTTP for, for instance, service generic information presentation or subscription purposes.

CxP and CxC shall be considered as SIP UA (User Agents) that are able to register under IMS networks and to manage SIP specific signaling. They shall have their own logic allowing the context information transfer between involved entities. As stated in [18], SIP is the protocol adopted for session control in the IMS systems. Therefore, it makes sense to use it for an IMS-based context management. The context framework can be seen above in Figure 5.

IV. SCENARIO DEMONSTRATION

The use of IMS as a context enabler allows the fast context services creation. An instance of the signaling procedures for

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the scenario suggested in Section II.B using the framework proposed in this paper can be seen in Figure 6. The signaling is detailed below.

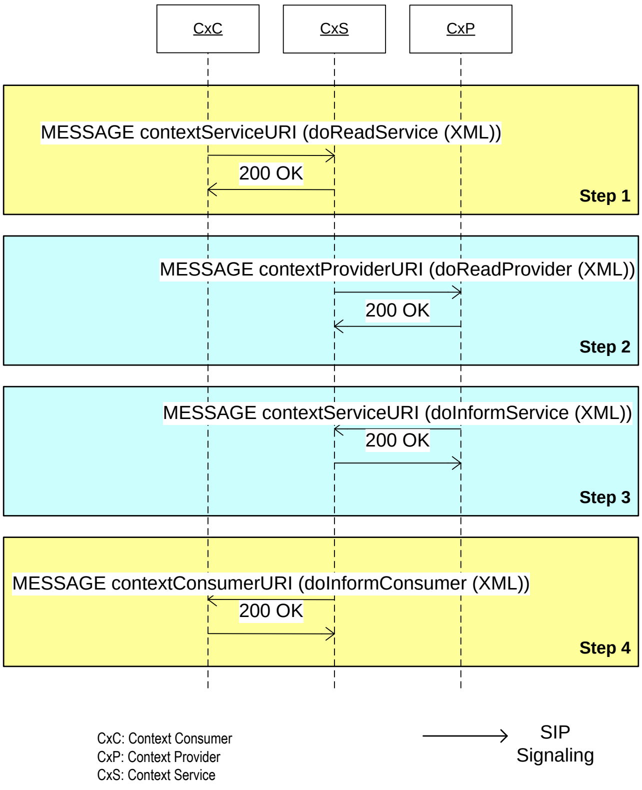

Figure 6. Signalling Flows

A. Step 1

A Mobile Operator (CxC) providing the "Get Safe" service intends to obtain immediately the exact street address of one of its clients in order to provide him the most appropriated video to let him reach the shelter. For that it sends a SIP MESSAGE towards the CxS encompassing a XML file describing the user identification, which in this case is the user SIP address. The XML file sent by the Mobile Operator is presented in Figure 7.

```
<?xml version="1.0" ?>
<!DOCTYPE hdr SYSTEM "MLP_HDR_200.DTD">
<svc_init>
    <hdr ver="2.0.0">
        <client>
            <id>ptin</id>
            <pwd>test</pwd>
            <serviceid>Get Safe</serviceid>
            <servicetype type="PASSIVE"/>
        </client>
    </hdr>
    <slir ver="2.0.0" res_type="PERSISTENT">
      <msids>
        <msid type="URI">bob@ptin.pt</msid>
      </msids>
    </slir>
</svc_init>
```

Figure 7. Request XML file sent from CxC towards CxS

B. Step 2

The CxS after validating the request coming from the CxC forwards it towards the CxP using a SIP MESSAGE where the XML file is included, but instead of requesting the street address, it will request the geographic location.

C. Step 3

The CxP checks the mobile identity and uses its own mechanisms to get the user geographic location. The information is compiled in the XML file which is sent towards the CxS inside a SIP MESSAGE, as presented in Figure 8.

```
<svc_result>
  <slia ver="2.0.0">
    <pos>
      <gsm_net_param>
        <cgi>
          <cellid>35086</cellid>
          <lac>305</lac>
        </cgi>
      </gsm_net_param>
      <msid type="URI">bob@ptin.pt</msid>
      <pd>
        <alt>87.145419</alt>
        <shape>
          <circle>
            <point>
              <ll_point>
                <lat>38.741602</lat>
                <long>-9.197874</long>
              </ll_point>
            </point>
            <rad>791.795320536137</rad>
          </circle>
        </shape>
        <time utc_off="+0000">20101215152929</time>
      </pd>
    </pos>
    <result resid="0">OK</result>
  </slia>
</svc_result>
```

Figure 8. XML file sent from CxP to CxS including user geographic location

D. Step 4

The CxS shall use its own mechanisms to translate geographic location into addresses location. After doing the conversion, CxS sends the answer back towards the CxC, which in this case is the Mobile Operator, providing the Get Safe service. A SIP MESSAGE is sent containing the XML file described in Figure 9. Having the right user location, Mobile Operators can now select the video that best helps the user running away from the flood.

```
<?xml version="1.0" ?>
<get_place_result>
     <content type=street>
       Avenida Comandante Jika
     </content>
</get_place_result>
```

Figure 9. XML file sent from CxS towards CxC including the street address

V. CONCLUSIONS AND FUTURE WORK

This paper has devised a framework where IMS works as a context enabler allowing Mobile Operators to offer useful services to their end-clients. The context information usage enables the selection of content that best matches the user situation making possible to have personalized content distribution. A service scenario was here presented exposing the potentialities of the Internet of Things usage in the mobile services domain.

System performance evaluation is envisaged as future work. A particular attention will be given to the delays introduced by the context management. Moreover, the impact of the additional signaling introduced by the context information transport will be analyzed in the IMS-based context-aware system.

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