End user functionality for QoS provision in a context aware medical network environment

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Abstract— Nowadays, context awareness seems to be the key factor in providing personalized services. The quality of the provided service is determined by considering several features of the whole individual environment. In this paper, we introduce a communication model that approaches mobility and connectivity, from the view point of context-awareness. In that perspective we define “Context-Aware Mobility” and “Context-Aware QoS Connectivity”. Context aware motivates the creation and organization of I-spaces for handling cases of emergency in daily activity that can be characterized of great interest. E-health services have been designed, in the vision of handling emergency situation. So, it seems to us ideal to apply the above communication model into telemedicine domain.

Index Terms—context-oriented mobility, context-aware QoS connectivity, patient-centric e-health

I. INTRODUCTION

NGN considers user’s mobility as a seamless transition from one network to another. Nowadays, network users are not anymore a communication point but a set of contexts that can produce information. In this perspective mobility should be considered as context-oriented.

In this paper, we propose a procedure of dynamic determination of user’s QoS requirements for connectivity. This is accomplished by taking into consideration a number of contexts that specify the user himself and a number of contexts that describe the “space” in which a user would move. An ideal area of implementing this kind of technology is telemedicine domain due to the nature of its services [1]. In this paper we propose a new context aware infrastructure which enables QoS provision in tele-monitoring health care service.

II. STATE OF THE ART

Despite the numerous implementations and proposals of context-awareness and QoS provisioning, found in literature, only a few works include both. Context-aware computing acquires and utilizes information concerning the context of a device to provide services that are appropriate to particular people, place time, events etc [8]. That revolution shifted communication paradigm from any place and any time into the right time in the right way. Networks used to satisfy dump users with best effort service delivery. On the other hand, NGN fulfills modern, demanding and moving end-user functions thanks to categorization of services into classes, following Differentiated Service structure.
III. A DIFFERENT APPROACH ON CONTEXT-ORIENTED MOBILITY AND QOS-ORIENTED CONNECTIVITY

Context is a theme that has numerous approaches, accordingly to the implementation area. Dye defined context as any information that can be used to characterize the situation of an entity, where entity can be a person, place, physical or computation object and is considered relevant to the interaction between entities [4].

It seems that context is the key for user-centric applications. For instance, as Figure 1 shows, in telemedicine domain, user-patient is characterized by the terms of:

- **Natural Context** handing geographical position and time.
- **Clinical Context** is created by measurements of biomedical signals such as heart rate (ECG), blood pressure (ESP), temperature, brain’s wave activity (EEG) etc.
- **Task Context** describes with explicit goals, tasks and actions what user is doing.
- **Close Computing Context** refers to any type of devices that could characterized as Mobile Transfer Units (smart phones, PDAs) and Gateways that could placed on his body (BAN’s gateway–BGW, GPS module).
- **Close Communicating Context** handling information that characterizes any type of networks in which is subscribed to have access to, including links between close computing context’s elements.

The group of above contexts is referred as “personal context”. Obviously it constitutes user’s integral part, since in modern telecommunications, user is considered as a point of reference placed on his head and the rest of his body is his inseparable personal context.

User describes world that surrounds him, using the following terms:

- **Physical Context** handling measurements of physical constants such as temperature, pressure, humidity, lighting, noise levels, traffic conditions, etc.
- **Social Context** refers to nearby people and their special features and capabilities.
- **Computing Context** includes all surroundings devices and their features and capabilities.
- **Communicating Context** consists of nearby resources, types of network connectivity and communication bandwidth.

That set of contexts, contained in Figure 2, is thereafter referred as “environmental context”. In a daily base, user could move from area to area where each area can be described by an environmental context; we call this area as “space”. Each user influences space’s ambience and vice versa. For that reason we define the set of user’s personal and environmental contexts as “I-space”.

We also consider the user as a “voyager” which has the ability of moving seamlessly from space to space (Fig. 3). We consider a two states model that delimits the users’ behavior; the Transition and the Connectivity states.

**Transition state**: Each context is described by quantitative parameters; some of which we define as critical. The change of one or more critical parameters marks the event of voyagers’ abandonment of the current space and his transition to a new space. For instance, a man is walking in a warm sunny day when an increase of high heart rate is detected. This event causes the rise of a health alarm indicating the transition to a new I-space.

We define that movement as Transition state and we approach his demand for seamless transition as “context-oriented mobility”.

**Connectivity state**: On arriving in the new space, the voyager’s personal context and the environmental context (space) are interrelated, creating a new I-space. Thanks to that I-space structure, voyager is gradually enabled to:

- derive his current communication needs based on the Transition state mentioned above, e.g. the alarm requires a fast and loss free connection with predefined communication points.
- translate the communication needs into concrete data delivering QoS parameters, e.g. set the range of tolerance in delay, packet loss and throughput per path.
- match the customized QoS subsets into the proper network offered in I-space, e.g. selection of the mobile network for sending the warning alarms and the WLAN for transferring the rest information.

We define the above three step procedure as “Context Aware QoS Connectivity”. Communication’s quality depends on the percentage of voyager’s awareness about his space. In that sense, we propose levels of awareness, that show in what degree voyager is authenticated and authorized by the space to have access to its elementary contextual information. A voyager could be to a space:

- “Familiar”, so he is permitted to have access in any kind of contextual information.
- “Recognizable”, so he is aware of some features and capabilities of its entourage.
- “Guest”, so he knows only the necessary environmental context information.

Thanks to that ability user reacts in a dynamically changed environment whose capabilities takes profit of.
both end-user and space contexts. In this paper, we examine this new reality, in tele-medicine domain. An important application theme is patient-voyager moving between more or less familiar spaces and demanding continuous and seamless delivery of tele-monitoring service that satisfy his needs.

IV. I-SPACE ORIENTED NETWORK INFRASTRUCTURE

In our telecommunication point of view, I-space is translated to a peer ad-hoc network which is controlled by voyager’s node. Following that argument, we present the structure of that network which enables voyager’s node control functionalities.

I-Space Manager - We assign MBU [5] as the I-space manager making it responsible for handling, organizing and assessing the gathering contextual information. Because of RACF and NACF capabilities, MBU controls the layered ad-hoc network. In that way end-user functions get node’s structure, for enabling attachment with any type of network and setting of QoS requirements. Also it is the point where internal and the chosen as proper external networks are connected.

Voyager’s Network Infrastructure - User, as spatiotemporal reference point is recognized in I-space, the moment that his natural contextual information is assigned. A GPS module scans and declares the position that voyager holds in a certain time. Voyager’s reference point gets human form when his clinical context is detected. The voyager’s BAN collects the proper vital signs. Finally his existence is completed by his activities clearly described in task context and confirmed by an activity detection sensor. GPS, BAN’s sensors and GPS module are always connected to BGW through Zigbee protocol. BGW has a stable Bluetooth link with MBU. Finally, MBU has protocol network interfaces so that it can connect to any type of NGN access network in which is subscribed to.

Space’s Network Infrastructure: - Voyager is aware of its physical context by sensor networks that measure the level of important natural constants. MBU is continuously computing and communicating aware, thanks to MANET neighbor discovery protocol’s mechanisms. Most of the times, social and computing contexts are interrelated, because voyager’s surrounding subjects declare their existence through devices they carry. MBU is aware of voyager’s social context thanks to updated membership lists that are located into his close computing context. The elements of environmental context, essentially, construct an ad-hoc network which is based on Bluetooth or Wi-Fi protocol depending on the area’s range.

V. I-SPACE RESOURCE MANAGEMENT FOR QoS PROVISION

The enhancement of MBU with network selection and attachment and resource allocation capabilities, transforms it to a real NGN peer node. That goal motivated us to begin that kind of research. In order for the user to be upgraded into peer, he must get node structure. So, following the modern network design, user must be able to set his own requirements for service delivery, select the resources that satisfy his needs and allocate them. Essentially, we upgrade end-user functions introducing RACF and NACF NGN like capabilities.

Following the above definition, both Transition and Context-Aware QoS Connectivity states are context-oriented. We consider I-space, as a layered network infrastructure aiming to offer this kind of knowledge to user. We approached it, in that way, because we like to make user capable to understand his temporary needs for communications and set them in a clear way. Moreover we enable him with close and environmental computing and communicating awareness in order to give him the capability of selecting, in first place, and in second allocating the resources that can satisfy its needs.

MBU plays the double role of I-space’s manager and connecting link between internal and external network. Performed steps in Context-Aware QoS Connectivity state, shall apply in MBU through the following functions:

- Assignment of service, in current state, to a notational area of quality behavior. For example, in service delivery, VoIP uses the Classes of Service EF (46) and AF31 for transferring voice data and call signaling, respectively. In I-space case, VoIP does not belong exclusively to the above classes, but driven by its personal context, it may employ a personalized extended group of classes. Essentially service Quality Limitations constitute a notational area of behavior.
- Determination of QoS requirements taking account QoS specification of service domain and I-space’s contextual information (personal and environmental contexts) except for communicating context. For instance, alarm service delivery has a range of tolerance in delay, packet loss and through which limits are set according to individual’s health state, position and the possible social environment that can be seem helpful.
- Detection and identification of available resources within the I-space included in close and environmental computing and communicating contexts. For example, MBU checks the availability of its own access networks and the types of networks that its neighbor has access to.
- Specification of the permissible ways of using the available I-space resources, by updates concerning Transport Profiles, SLAs and general regulatory frameworks availability and use of. For example, communicating neighborhood informs MBU for the offering of usage of QoS resources.
- Classification of the above resources in relation with the QoS that can be provided, in order to be awarded at service delivery in Classes of Service with respectively requirements. For instance, WLAN’s and neighbors mobile resources are antiquate for delay less data transfer. On the other hand other neighbor’s optical resources are characterized as high capacity’s and can be used for transportation of great amount contextual data.
- Match of notational area of quality behavior to Class of Service, e.g. Alarm’s fast and loss free transfer is matched to Differentiated Services Code Point that assures that kind of transition.
• Selection of proper resources and allocation in order to accomplish service’s QoS requirements. e.g. selection of the mobile network for sending the warning alarms and the WLAN for transferring the rest information.

The above analysis shows that context constitutes an extra, but the most important, input on extraction QoS requirements transfer function. As figure 4 shows, we formulate the above procedure into a three steps function of QoS requirements exportation, which goes as follows:

• **Step 1**: MBU gets personal context information that BGW has send through the Bluetooth link and derives the clinical context-ones. In second place, sets clinical contextual data and QoS specifications in $G_1$ in order to determine individual’s personal QoS requirements.

In e-Health services, clinical data are the most important and for that reason they constitute the input that combined with service’s QoS specification define individual’s QoS requirements.

• **Step 2**: That output is applied as input in $G_2$ that extracts individual’s QoS requirements. It is a closed loop system that also gets as inputs physical, social, task and natural contextual data. Because of the effect that natural and social contextual data have on the procedure of defining QoS requirements, the system multiples them with proper weights. The contextual data determine user’s current situation, and that’s why they are used, in second place. Physical context information is weighted because it constitutes the key information that combines mobility and connectivity. On the hand social context information are characterized as important because, in many ways, have a great influence on system’s choice for proper path for data transfer.

• **Step 3**: The final Transfer Function, $G_3$, matches user’s QoS requirements to network infrastructure QoS. This can be done through a close loop system that gets as inputs, individual’s QoS requirements combined with feedback, close communication contextual information and time delayed communication context information.

Close and environmental Communicating Context information is used, so the system has a full view of its communicating environment. Thanks to them it is able to choose the proper network for service delivery. It checks first his possible network attachments and then its neighbor, and for that reason environmental communicating context information gets in system in delay.

The above described system enables end-user functions with NACF and RACF capabilities.

**VI. Future Work**

The next step is the definition of all critical quantitative parameters and their threshold that indicate changes in any type of context. Our main goal is the definition of notational quality service behavior that would facilitate the mapping procedure. We want to express user’s QoS requirements in specific QoS factors in order to produce new classes of services, if needed. Our research concludes with a range of simulation that will approve our approach.

**Conclusions**

This paper is an effort to formulate a context-aware medical network environment with efficiency in assigning and allocating dynamically resources, in need. We propose a new communication model that takes account Contextual Mobility and QoS Provisioning in service delivery that is adequate in e-Health domain.

**References**


