Improvement of QoS for General Packet Radio Service

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Abstract

Having frameworks that allow the implementation of personal agents on mobile devices, such as JADE- LEAP, is essential towards a future massive deployment of service-providing agents and their widespread social acceptance. This paper presents how JADE-LEAP may be used to implement a personal agent on a Mobile device. This agent belongs to a multi-agent system that allows the user to request a URL. The personal agent communicates wirelessly, via Wi-Fi, with the rest of the agents of the multi-agent system, in order to serve the user the required files. This work produces better quality in performance through the reduction of over-head traffic by localizing data transfer. The localization will affect the total bit rate, increase the availability and reduce latency.

Key words: General Packet Radio Service , QoS , JADE-LEAP

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1. Introduction

As the Internet is becoming more and more mobile, it is important for cellular network operators to improve the performance of their networks in order to achieve a better performance of Internet applications that mobile users can access. The reason to perform these improvements is the growing user demand on the Quality of Service (QoS) of these applications [1].

The first generation of cellular mobile data communication systems arose. These were analogous systems constrained to different national standards. The second generation Global System for Mobile Communication (GSM) cellular system provides digital switches circuits that were not suited for Internet traffic and data services. The allocation of channels for the entire period was not efficient at all. It is obvious that for burst traffic, packet switched bearer services have better utilization of physical channels. This is because a channel will be allocated when needed and will be released immediately after the transmission of the data. Therefore multiple users can share the same physical channel to transmit and receive their packets [2]. In order to address these inefficiencies in the GSM networks, General Packet Radio Service (GPRS), as the 2.5G cellular packet data network was developed for GSM. With GPRS, user's packets will be directly routed from the mobile network to packet switched network. However, GPRS became more and more popular among GSM subscribers, and this fact resulted in setting certain QoS requirements for packet data services. But the priority of packet data is still lower than of conventional circuit switched voice communication in GSM networks today.

On the other hand the increase of GPRS users will increase the demand on performance QoS of GPRS-based Internet applications that nowadays become more and more mobile-oriented. This is a challenge for GSM operators to improve their GPRS performance, so that it could meet end-user QoS requirements. But there are certain obstacles that operators will face when they try to make these improvements [3]. In the past, mobile phones had limited memory, limited data communication capabilities, and closed, proprietary operating systems; for these reasons, they seemed almost immune to file sharing applications. However, with current memory-intensive

smart phones, endowed with several connectivity options (i.e., GSM, GPRS, Wi-Fi and Bluetooth) and running open software platforms like Symbian and Windows Mobile, Peer-to-Peer systems are ready to colonize even the mobile realm [3].

2 .Global System for Mobile communication etwork

The GSM is a second generation (2G) network, is the largest existing 2G cellular network and employs circuit switched technology to transmit voice. Second generation refers to the fact that the system uses digital signals in contrast to first generation networks, where analogue signals were used [1]. GSM network is made up of geographic areas. As shown in Figure (1), these areas include cells, Location Area (LAs), Mobile Switching Center/Visitor Location Register (MSC/VLR) service areas, and Public Land Mobile Network (PLMN) areas. The cell is the area, where radio coverage is given by one Base Transceiver Station. The GSM network identifies each cell via the Cell Global Identity (CGI) number assigned to each cell. The Location Area is a group of cells. It is the area in which the subscriber will be paged. Each LA is served by one or more Base Station Controllers, but only by a single MSC. Each LA is assigned a Location Area Identity (LAI) number. A MSC/VLR the service area represents the part of the GSM network that is covered by one MSC and which is reachable, as it is registered in the VLR of the MSC. The PLMN service area is an area served by one network operator [2]. GSM employs a combination of Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA) schemes to access the radio channels. With FDMA, the available frequency is divided into channels of equal bandwidth. This concept is shown in Figure (2 (a)). In a TDMA, the frequency channel is divided up into a number of slices of time, as shown in Figure (2 (b))[3,4].

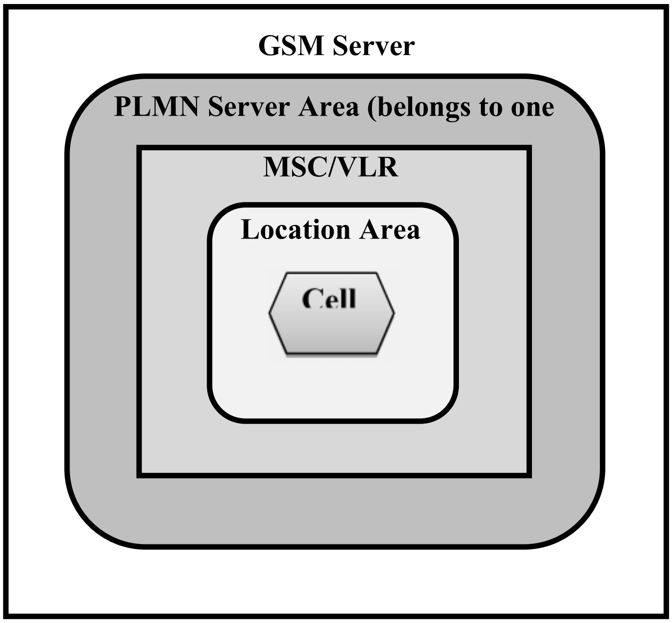

Figure 1: GSM Network Areas

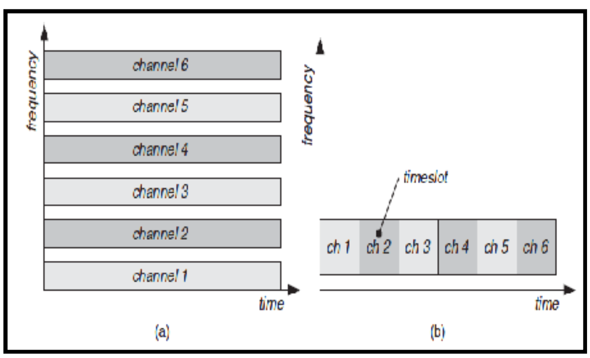

Figure 2: Frequency and Time Division Multiple Access

3. GPRS Network

GPRS offers efficient bandwidth utilization over GSM by allocating channels only when needed and by releasing them immediately after their use. GPRS also offers data service at a lower cost because billing is based on the quantity of data transmitted rather than the connection time and the negotiated quality of service. GPRS and GSM networks make use of the same infrastructure and share the same radio resources. GPRS attempts to reuse the existing GSM network elements as much as possible [6].

In order to effectively build a packet-based mobile cellular network, some new network elements, interfaces, and protocols that handle packet traffic are required. Therefore, GPRS requires modifications to numerous network elements. However, the integration of GPRS into an existing GSM network requires the addition of only two GPRS Supporting Nodes (GSNs) and modifications to several existing nodes. The two GSNs form the core network of GPRS. These two nodes were added to GPRS in order to provide an end-to-end packet transfer and they called the Serving GPRS Support Node (SGSN) and Gateway GPRS Support Node (GGSN) [7] as shown in Figure (3).

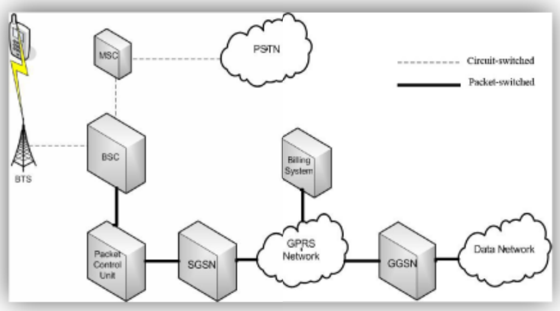

Figure 3: GPRS Architecture

The SGSN is a node that routes packet to and from terminals within its service area and it obtains the GPRS subscriber profile and it is responsible for the mobile subscribers' location, mobility management, link management, security and authentication [8].The GGSN acts as a logical interface to external Packet Data Networks (PDNs) such as Internet. It converts GPRS packets coming from the SGSN into the appropriate Packet Data Protocol (PDP) format (i.e. IP or X.25) and sends them out on the corresponding external network. In the other direction, the PDP address of incoming data packets (e.g. the IP destination address) is converted into the GSM address of the destination user. The readdressed packets are sent to the responsible SGSN [9]. For this purpose, the GGSN stores the current SGSN addresses and profiles of registered users in its location register. Some existing GSM network elements must also be enhanced in order to support packet data. Base Station Subsystem (BSS) system needs enhancement to recognize and send packet data. This includes BTS upgrade to allow transportation of user data to the SGSN. Also, a new functional component, called Packet Control Unit (PCU) was added to the BSS in the GPRS standard to support the handling of data packets. HLR (Home Location Register) needs enhancement to register GPRS user profile and respond to queries originating from GSNs regarding these profiles. The mobile station for GPRS is different from that of GSM.

GPRS has minor impact on the existing GSM making it easy to reuse existing component and links without major modifications. This is possible because GPRS uses the same frequency bands and hopping techniques, the same TDMA frame structure, the same radio modulation and burst structure as GSM [9].

4. Simulation

In this section the multi agent system is discussed as implemented.

4.1 Multi-agent system architecture

A key problem in supporting applications is managing their different requirements of QoS. Here, the proposed solution is presented through the development of multi agent system in mobile network. The main idea is that the user will request a file from his mobile phone. This request will reach wirelessly the Base Station that will

forward it to GGSN to get the request from the server. The BSC (Base Station Controller) will register this request in its local data base with agent ID. If another Agent request the same URL the BSC will search for URL in its data base and respond to that request by sending the ID of agent whose own that URL and send it to the user's mobile device.

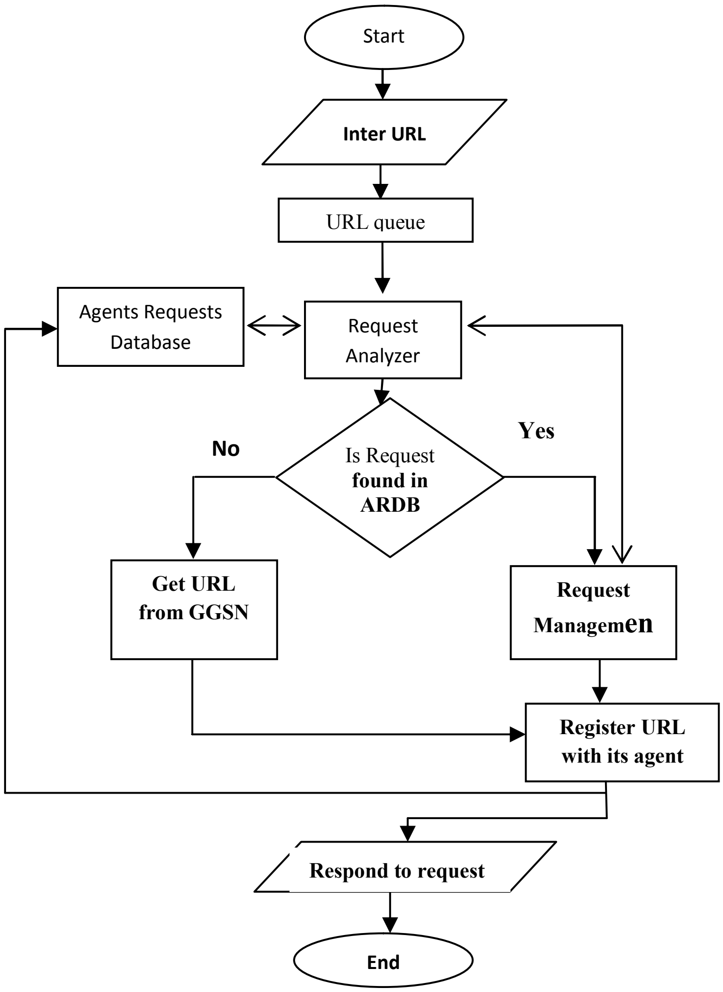

Figure 4: BSC Agent Flowchart

Figure 4 show the flowchart of the agent that will be implemented in BSC. The architecture of multi-agent system is composed of three types of agents:

- **BSC Agent: it is running on Base Station Controller with data base connection has been needed to support BSC Agent, this data base will provide efficient access to records stored in BSC. BSC records are a relational data base representing the material being requested (URLs), mobile stations holding the instance of that material and the time stamp.**
- **GPRS Agent: The Agent installed at GGSN that represents the point through which GPRS domain attached to external data networks (i.e., Internet and corporate Intranets) to simulate the real Internet.**
- **MS Agent: The software package installed in each mobile station is composing of four software components: Agent Midlet, Welcome, Simple Agent GUI and Agent GPRS. These software components are interacted with each other to produce the mobile station side of the proposed system.**

4.2 Requesting URL

This section will describe how the system works by following all the messages that are exchanged between the agents when a URL is requested.

First of all, the mobile agents must register itself with the main container of the Base Station Controller. Figure (5) shows containers on the system. The main container and Base Station Controller container hold agents of the same platform. After initializing BSC Agent and GGSN Agent then the basic network architecture will be ready to accept incoming GPRS Agents joined the platform.

Two agents (Agent GPRS and Agent GPRS002) can request for URL as normal activity in interacting the Internet. GPRS Agents started in mobile device will pass through two important stages; first stage is the initialization stage where Agent will register itself into the platform, second stage when Agent is interacting the user and start communicating BSC Agent trying to fulfill the request by locating local host having requested resources.

BSC Agent will record this request in its internal table, where the AID (Agent Identifier) and time for the request and the requested URL are the main fields composing the record. The record inserted in BSC table will be used later to forward requests for the same URL to AID associated with that URL.

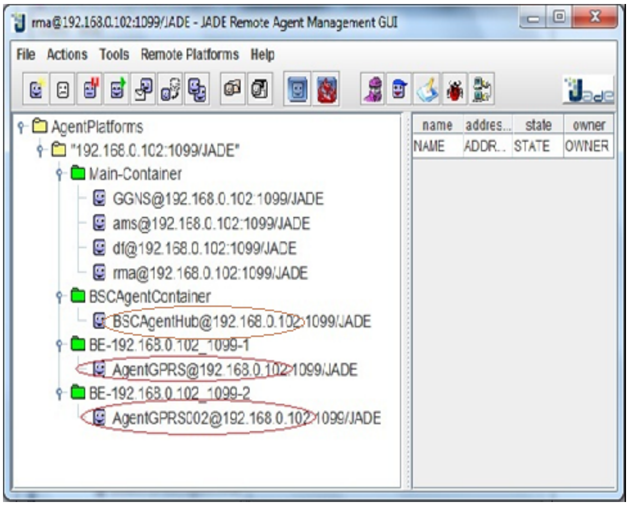

Figure 5: Distribution of agents in containers.

BSC local table will be increased with continues requests for URLs, normally some requests will be repeated where surfing the internet tends to cluster around specific document which grant this approach much credit.

The sniffer Agent provided by JADE environment was used to monitor complete session. At the first stage of the session the URL resources is located in global source (i.e., at GGSN) and second stage when URL resources located in local mobile station. within the same BSC. Figure 5 presents screen shot of the sniffing tool and two GPRS Agents were selected beside GGSN Agent and BSC Agent.

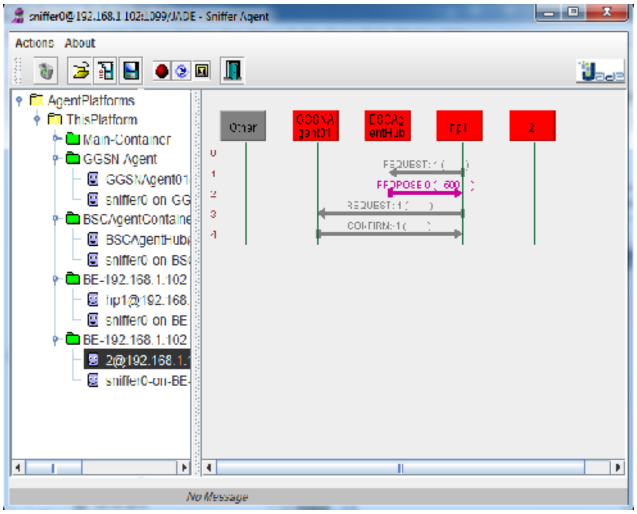

Figure 6: Requesting URL that Located Through GGSN

As Figure 6 presents; the first call for a URL that does not located in local cell (i.e., within the same BSC of the requester) will be managed as there is no Agent platform and four messages will be transferred over the GPRS network. The requested URL will be downloaded through GGSN to local cache server as the same time will be streamed to the requester. Next request from clients requesting for certain URL resources located in the cache server will affect the traffic of the entire GPRS network and eventually affect the overall through put and QoS. Figure (7) depicts that next request to URL required time to download file from GGSN that has been downloaded by one of Agents within mobile station and this does not affect the traffic on the GGSN, thus, no bottle neck will exist and the traffic will highly be localized. The next URL not require to send the request to the GGSN, the BSC index server would respond to the request. This URL needed less amount of time to download it from GPRS Agent within mobile station. This time appear on the screen of the mobile device as shown in figure 7.

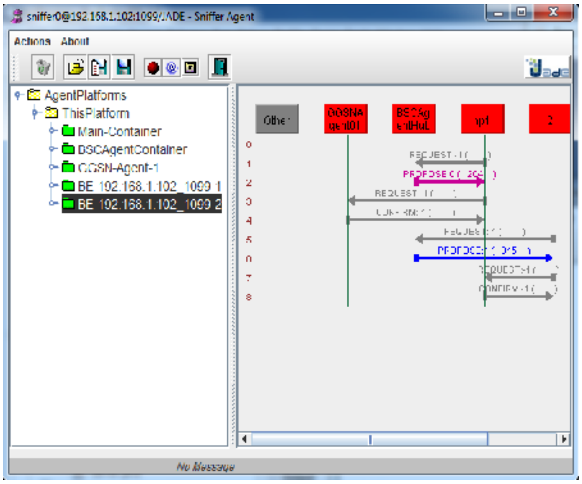

Figure 7: Request to URL Located within the Same BSC

5 .Conclusions

In the development of this proposal, JADE-LEAP has been successfully used to implement a personal agent on a mobile device. This framework opens the way towards any kind of distributed multi-agent systems, in which personal agents may be smoothly running on mobile devices (mobile phones with enough resources) and can communicate wirelessly with agents that may provide any kind of services available in a city. This kind of frameworks, linked with the standardization efforts in the multi-agent field lead by organizations such as FIPA, are quickly paving the way towards a near future in which personal assistants, which will know everything about the user's needs and preferences, will provide all kinds of personalized information and services to the user and will soon become indispensable to many citizens.

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تحسين جودة الخدمة في شبكة خدمة حزمة الراديو العامة

أ.م.د.جين جليل اسطيفان * نور وليد حنا**

المستخلص

ان جودة اطر العمل التي تسمح بتنفيذ الوكلاء على الأجهزة المحمولة ، مثل JADE LEAPامر اساسي في الأنتشار الواسع النطاق في المستقبللتقديم خدمة الوكلآء وقبولها الأجتماعي على نطاق واسع . في هذا البحث تم البحث عن كيفية الستخدام JADE LEAP ، لتمثيل الوكليل على جهاز محمول . ان الوكيل ينتمي الى نظام متعدد الوكلاء والّذي يسمح للمستخدم بطلب URLوتواصل الوكيل لاسلكياً عبر(واي فاي)، مع بقية عناصر النظاممتعدد الوكلاء.

ان برنامج الوكيل لأجهزة النقال هو برنامج تم بناءه باستخدام بيئة برامجيات تطوير جافا (JADE) مع التوسع باستخدام (LEAP) . ينتج عن النظام المقترح نزعية اداء افضل من خلال تفليل كمية معلومات السيطرة المظافة للبيانات وبالتالي اثر هذا على المعدل الكلي لنقل البيانات ، زيادة التوفرية و تقليل التأخير.

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