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QoS for Fourth Generation Mobile Communication System

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Abstract:
As with time activity in 4G (fourth generation)/ NG (Next Generation) mobile communication systems have steeped the race in its implementation at the earliest. 4G wireless being an upcoming standard witness burgeoning interest amongst researchers and vendor. It is being designed to allow seamless integration and communication between wireless devices across diverse wireless standards as well as broadband networks wirelessly. Access to different radio technologies is facilitated with the IP-based approach of next generation mobile communication system for huge number of user connectivity. It is anticipated that packet transmission services getting popular for information transfer, but it suffers from packet losses due to inadequate received signal quality or forced by protocol in signalling domain of mobile infrastructure. To reduce the occurrence of packet losses and hence to improve the quality of transmission in mobile communication network, a quantitative analysis of QoS (Quality of service) in signalling domain is mandatory. With this information, we propose some QoS parameter monitoring and how they help to maintain QoS and to control mobility during high-speed traveling. This paper attempts to make an assessment in fourth generation mobile communication system with a perspective of wireless QoS with packets and Mobility control. Keyword Ubiquitous environment, QoS unit, turns around time, ISDN number, point-to-point delivery time, MR movement. 1. Introduction The number of mobile users has rapidly increased worldwide. In terms of services, the demand for high-resolution video services is expected to increase in mobile communications, as indicated by the high popularity of Hi-Vision images. It is important that communications carriers reduce their communications charges on a sound management basis, rather than engage in a cut- throat price war [1]. This requires reduction of capital investment

Keywords: Ubiquitous environment, QoS unit, turns around time, ISDN number, point-to-point delivery time, MR movement.

1. INTRODUCTION

The number of mobile users has rapidly increased worldwide. In terms of services, the demand for high-resolution video services is expected to increase in mobile communications, as indicated by the high popularity of Hi-Vision images. It is important that communications carriers reduce their communications charges on a sound management basis, rather than engage in a cut-throat price war [1]. This requires reduction of capital investment costs by expanding system capacity. 4G/NG system architecture design holds an extremely important position as a wireless infrastructure in the broadband multimedia information society. The reduction of system costs resulting in the construction of an economical system is a top-priority issue. Other important themes in light of making services seamless include not only accelerated radio transmission speed but also improved user convenience, by constructing and operating a system that integrates IMT-2000 (International mobile telecommunication–2000) networks, fixed wireless access networks, wireless LAN (Local area network), and so forth. Another key issue is to build a ubiquitous information environment surrounding humans at home or in the office so that information can be obtained in various forms according to individual need. It is anticipated that 4G systems have to satisfy some of the objectives, which are mentioned as follows [1] [2]:

- High Speed Transmission (peak 50 100 mbps)
- Larger capacity 10 times greater than 3G
- Neat-generation Internet support IPV6 QoS
- Seamless service
- Flexible network architecture
- Use of microwave band (3 – 6 GHz)

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- Low System cost (1/10 – 1/100 of 3G system)

Above listed objectives show the main technological requirements of NG systems. The system capacity must be around 10 times greater than its 3G counterpart, and the cost per bit must be decreased to 1/10 to 1/100 of 3G, in order to avoid imposing a heavier burden on users associated with the expansion of information volume. Additionally, NG must introduce various Grades of service (GoS) levels to provide many kinds of best effort multimedia services corresponding to user demand. Furthermore, Internet Protocol version 6 (IPv6) should be supported in IP networks so that a huge number of IP addresses of mobile terminals, especially in person-machine and machine-machine communications, can be accommodated. In terms of user friendliness, the issue will be to offer seamless services by radically shortening the time consumed in accessing servers, which is slightly not enough in 3G systems. In the area of networking, the key will be to provide an IP network with sufficient reliability and construct a flexible network configuration that enables seamless connections with the use of various accessing methods, which will be required, as the number of mobile user increased in future [1][3][4].

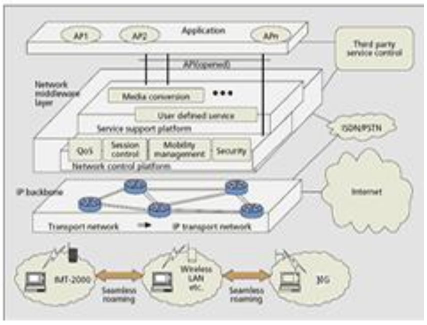

Figure 1. Architecture of NG system

Figure 1 shows the configuration of a next-generation mobile network. IP over everything is believed to make progress, As IP packets are processed based on various transport technologies (from asynchronous transfer mode to optical routers). In the next-generation IP network, the control and packet forwarding functions will evolve independent of each other, and the functional configuration of the IP transport network and middleware will be separated logically [5][6]. Figure 2 shows example of IP based networks.

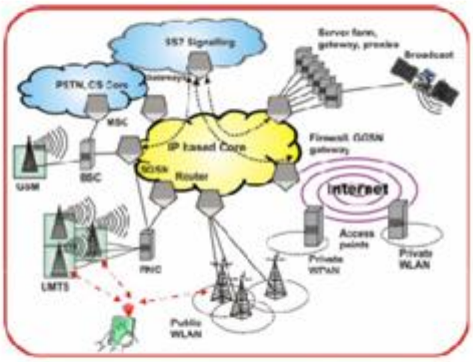

Figure 2. Example of IP network

The middleware will consist of two platforms the network control platform (NCPF) and the service support platform (SSPF). NCPF functions include mobility management, session management, QoS management (Grade of service monitoring unit), authentication/admission, and common radio resource management required for mobile communications management. Standardized network control authority is considering architecture for common mobility management that does not depend on a radio system, so services can be sustained seamlessly across different types of access systems. SSPF consists of service function groups exemplified by content conversion/distribution. SSPF functions include the provision of services unique to mobile communications, such as location services support. As for terminals, limited functionality chip-type terminals (so small that they cannot provide any services by themselves) are expected to emerge and form a ubiquitous environment, in addition to the generic all-in-one mobile terminals serving as the evolved version of existing terminals. Furthermore, connections between terminals are expected to be based primarily on local networks, such as ad hoc networks. In this manner, an extremely broad range of access and networking capabilities will be provided in NG systems.

1. GoS monitoring

As the requirement of future generation mobile to handle large capacity user and provide high Grade of service levels, we are solving the issue of large capacity user with the above-described technological profile. Now for maintaining high GoS level of large user we must have way to measure the GoS of the system, solution for this is QoS unit available in NG architecture (Above explained configuration). We know packet transmission services have continuously gained importance in mobile communications. Such services include e.g. the SMS (Short Message Service), first introduced in GSM (Global System for Mobile Communications) [7] [8], and TCP/IP services. In mobile communications, the SMS used in GSM and in GPRS (General Packet Radio Service) [9] mobile communications networks has become the most important economic success during the past decade. To enable the deployment of packet services like SMS in professional environments, complying with sustained high Grade of Service (GoS) levels is mandatory [10]. GoS levels are measured by evaluating GoS parameters, like a predetermined level of reliability and well-defined attributes for precedence and delay of the service. Depend on this for NG we proposed unit that is QoS unit in NG architecture, which is used to monitor and control high GoS level. Unfortunately, sustained high GoS levels can usually not be guaranteed for the SMS, and SMS Centers therefore cannot provide a high service quality in all cases, today. SMS suffers from packet losses due to e.g. inadequate received signal quality, which is caused by the time and frequency selectivity of the mobile radio channel and by imperfections of mobile terminals. However, packet losses are also produced by time-outs, entailing forced packet deletions. These forced packet deletions are the consequences of protocols in the signaling domain of the infrastructure of a mobile communications network, including the Base Station System Application Part (BSSAP+) and the Mobile Application Part (MAP) protocols [10]. The mentioned time outs occur for various reasons. For instance, when a mobile terminal, which shall be contacted by means of SMS, stays outside the coverage area or has been switched off for a certain period, the allocated Mobile Switching Center (MSC) will detect an absent subscriber and may force the deletion of packets. When SMS is used for non-professional, i.e. private, communication from one subscriber to another, the lack of sustained high GoS levels may be acceptable. However, this is no longer the case for the deployment of SMS in professional scenarios. To reduce the effect of packet losses and, hence, to improve the quality of the packet transmission service, a quantitative analysis of the GoS in the signalling domain is a must [11] [12]. Definitions are tailored for the point-to-point transmissions, including Delivery Time and Success Rate as GoS parameters. After modification, they can be used to observe the quality from the SMS Center's point of view for packet transmission. As we know in SMS transmission procedure, assuming successful SMS delivery from the Short Message Service Center (SMSC) to the Mobile Station (MS), the Mobile Application Part (MAP) commands of the SS7 (Signalling System # 7) protocols are applied with details statistical modelling of the packet traffic can be done, which will present results related to efficiency parameters [13] [14]. The forced packet deletions mentioned above have not been taken into consideration yet. Also, the defined GoS parameters do not completely fulfill the needs arising from a professional SMS. Therefore, additional GoS parameters, which complement the presently existing, set of GoS parameters defined by standardized bodies is required.

2.1 GoS parameters

There are different parameters, which help decide QoS LEVEL of communicating environment some of them are as follows.

Faithful Ratio # SMS (FT#): It is the ratio of the number of MAP commands reached to destination. faithfully to the total number of MAP commands **•Failed Ratios # SMS (FL#):** It is the ratio of the number of failed MAP commands of the SS7 protocol to the total number of MAP commands. **•Average# SMS (AR#):** It is the average number of protocol commands to transmit a short message. Since SMS Centers communicate with service providers' infrastructures by using the SS7 (Signaling System 7) protocol. The additional

GoS parameters consider the signaling domain explicitly. The additional GoS parameters have been applied to the SMS in real GSM networks. To quantify the corresponding GoS levels, the signals and error acknowledgements, made available through the SS7 protocol, have been evaluated. These signals and error acknowledgements also cover SMS related services, which use signals from the MAP layer of the SS7 protocol. The system framework for GoS monitoring, alerting and reconfiguring an SMS Center, which makes use of the additional GoS parameters monitored by QoS unit, has been implemented at the SMS Center of proposed system. The system framework is based on programs and databases. Therefore, it facilitates the reduction of the turn-around time for necessary reconfigurations at the SMS Center, which shall sustain high GoS levels. In case the value of a certain GoS parameter drops below or exceeds a preset threshold, the system framework generates an alerting message, which can be exploited for the reconfigurations. The information gained by applying the system framework reflects the type of traffic. Therefore, this information can be used for traffic shaping and tailoring billing strategies.

2. ROUTING ADDRESS

As already mentioned, MAP command is used to deliver a particular short message to a customer, i.e. the owner of a SIM inside a mobile station, via its Servicing MSC. To locate the mentioned customer, the ISDN number of the Servicing MSC must be known. This ISDN number is considered as the routing address, which is obtained by evaluating the report associated with MAP command, which transit between gateways MSC (Mobile Switching Center) and servicing MSC. When the network operator owning the Servicing MSC and the network operator owning the Gateway MSC do not have any roaming agreement for the SMS, a subscriber will not be reachable for the delivery of a short message. In this case, the provision of the SMS may be possible through a different network operator who also provides service at the temporary location of the subscriber.

3. ROLE OF SMS CENTER (SMSC) IN PACKET TRANSMISSION

In successful transmission of a packet containing a short message from the SMSC to the Mobile Station only three commands are used, namely:

3.1 SEND-ROUTING-INFO-FOR SM (short message) (msris)

This command is used between the gateway MSC (Mobile Switching Center) and the HLR (Home Location Register) to retrieve the routing information needed for routing the short message to the servicing MSC, where the subscriber roams. The above-mentioned command is the required request for routing information from the SMS Gateway. MSC contains the MSISDN (Mobile Subscriber ISDN) of the subscriber, while the result contains the ISDN number (routing address) of the Servicing MSC. This address is used to forward the short message in a forward SM (short message) process.

3.2 FORWARD-SHORT-MESSAGE (mfsm)

This command is used to forward mobile originated or mobile terminated short messages between the SMS Gateway MSC, which has a connection to the SMS Center, and the Servicing MSC, where the subscriber roams. mapping of error codes to their verbose description has not been standardized. Since the error standardized, code descriptions are not yet, other error descriptions are conceivable, as well. 5. Standardized GoS Parameters Codes There exist several standardized GoS parameters for the SMS, namely ¬ Service Accessibility SMS MO (mobile originated)

3.3 MAP – REPORT – SM – DELIVERY STATUS (rsds)

This command is used between the Gateway MSC and the HLR. When the transmission of a short message from the SMS Service Center to the MS is unsuccessful, e.g. because the subscriber was absent, the MSC returns a negative response to the Gateway MSC and the Gateway MSC sends a mrsds to the HLR to allow for a delayed delivery of the short message. MAP – REPORT – SM DELIVERY – STATUS is used to set the

Message Waiting Data flag into the HLR or to inform the HLR of successful SM transfer after polling. Every command delivers a status report. The interpretation of these status reports at the SMS Center facilitates the generation of various error codes, including the acknowledgement of the successful delivery of the SMS. The mapping of error codes to their verbose description has not been standardized. Since the error standardized, code descriptions are not yet, other error descriptions are conceivable, as well.

4. STANDARDIZED GoS PARAMETERS

There exist several standardized GoS parameters for the SMS, namely

- Service Accessibility SMS MO (mobile originated)
- Access Delay SMS MO
- Point-to-point Delivery Time SMS
- Success Rate SMS (SRSMS)

The first two GoS parameters, i.e. Service Accessibility SMS MO and access delay SMS MO, are not applicable to the GoS evaluation in an SMSC because they are tailored to the mobile originated SMS, so we are not considering them for our GoS study. The other two GoS parameters are applicable, however, after modifications, as there is a problem of exact time of SMS sent i..e. from customer to customer, as point-to point delivery time depends on the time that the SMS has successfully reached and on the time that first MAP command associated with the same SMS. With this we can modify point-to-point delivery time as follows:

$$t_{\text{point-to-point SMS}} = t_{\text{mfsm}} - t_{\text{msris}}$$

For success rate SMS time we don't have information

faithfully reached SMS failed, corrupted and duplicated, so for this SRSMS is modified as say NmfsmSUCbeing the number of successful mfsm commands and with Nmfsm. ALL denoting the total number of all mfsm commands, having mutually different message IDs, we define the new GoS parameter Success Rate SMS (SR SMS) in the following way:

$$\eta_{\text{SR SMS}} = \frac{N_{\text{mf sm suc}}}{N_{\text{mfsm ALL}}}$$

4.1 New Additional GoS Parameters

To improve the GoS level and to simplify the measuring process of the GoS parameters, the error codes (Information in the form of failed SMS to reach other end user, time counter out of send SMS, absent subscriber, all this information maintain in database), resulting from the interpretation of status reports, are analyzed. As already mentioned above, these error codes can be measured and the ratio to the total number of error codes can be calculated. With reference to initially discussed GoS parameters FT# SMS and FL# SMS which can be presented as NMAP-SUCbeing the number of successful MAP commands and with NMAP-ALLdenoting the number of all MAP commands, the FT# SMS is defined as

$$\eta_{\text{FT\# SMS}} = \frac{N_{\text{MAP suc}}}{N_{\text{MAP ALL}}}$$

With NMAP-ERROR# being the number of failed MAP commands and with NMAP-ALL denoting the number of all MAP commands, theFL# SMS is defined as

$$\eta_{\text{FL\# SMS}} = \frac{N_{\text{MAP error\#}}}{N_{\text{MAP ALL}}}$$

A further GoS parameter is called AR# SMS, cf. first discussed. Under ideal circumstances, only two MAP commands are needed for a successful delivery of a short new message: First msris command is sent which is followed by an mfsm command. When an error code other than faithfully reached SMS then more MAP commands are required for the service completion or success rate completion. The delivery of short messages therefore requires various sequences of MAP commands. Now, let nSEQ, nSEQ € N, be the number of a particular sequence of MAP commands, which are required for the delivery of short messages. With pnSEQ, nSEQ € N , being the probability of sequence nSEQ of MAP commands, with NnSEQ denoting the number of

MAP commands in the said sequence and with KSEQ ' KSEQ € N, Representing the total number of different sequences of MAP commands, the GoS parameter AR# SMS is defined as

$$AR\# = \sum_{n_{SEQ}=1}^{K_{SEQ}} N_{n_{SEQ}} \cdot P_{n_{SEQ}}$$

Thus, AR# is the average number of MAP commands needed to transmit the short messages. The ideal value for the SMS transmission is 2. Measurements show that the value usually is greater and around 3. The QoS system has inbuilt intelligence to analyze stored information which helps to maintain the desired QoS/GoS level during communication. 6. Mobility control Figure 3 shows the basic concept behind the network configuration of the 4G systems. Like the 3G systems, it comprises a core network (CN), which performs location control, call control, and service control; and the radio access network (RAN), which performs radio transmission and radio resource control. Mobility control is performed through cooperation between the CN and RAN. The information transportation in the 4G system (CN and RAN) is based on IP protocols. Each MT has its own IP address. Therefore, the 4G networks directly connect with the Internet, but connect with ISDN or PSTN through gateways. Contrarily, traditional mobile systems connect to the Internet through gateways. In order to make seamless connections, multiple types of RANs are connected to a common CN.

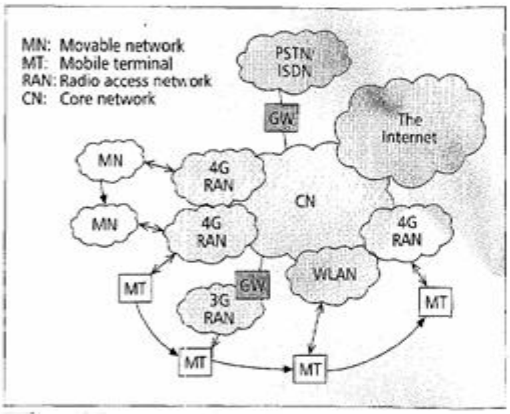

Figure 3. Basic concept of network architecture

Following figure 4(a) and 4(b) shows the network architecture considered in this article and examples of mobility control. From the viewpoint of the network layer, RANs and the CN can be considered as one IP transport network when each BS has its own IP address and data packets are transferred based on IP protocols. Therefore, BSs are shown as wireless routers (WRs) and the RAN and CN are not labeled in Fig.4. As a difference from conventional cellular mobile systems, which accommodate only customer terminals as MTs, there are movable networks that are movable as whole sub-networks. Since IP based transportation is considered in this architecture, a MT (which does not contain routers) is denoted as a mobile host (MH) and a router in the movable network is denoted as a mobile router (MR) in thearchitecture model. Mobility control is performed by home agents (HA) and mobility agents (MA) with packet tunneling technology as proposed in [15]. When there is movement of the MH (Fig. 4a): When the MH moves into a new foreign link area, the MH obtains a temporary address (hereafter care of address: CoA) and the MA address through the foreign link, and notifies the MA of the HA address and the CoA (control packet flow 1) in order to request that packets for the MH be forwarded to the CoA. The MH also notifies the HA of the MA address and its (home) address (control packet flow 2) in order to request that packets for the MH be forwarded When a corresponding host (CH) sends a packet to the MH (data packet flow 3), the packet is first sent to the HA, then it is forwarded to the MA using tunnel 4, and the MA in turn forwards it to the MH using the CoA (tunnel 5). When the MH receives the first packet from the CH, it notifies the CH of the home address and the MA address (control packet flow 6). Then the CH can directly transmit data packets for the MH to the MA (tunnel 7) and the MA forwards them to the CoA (MH). When there is movement of a mobile host into a movable network (Fig. 4 b):

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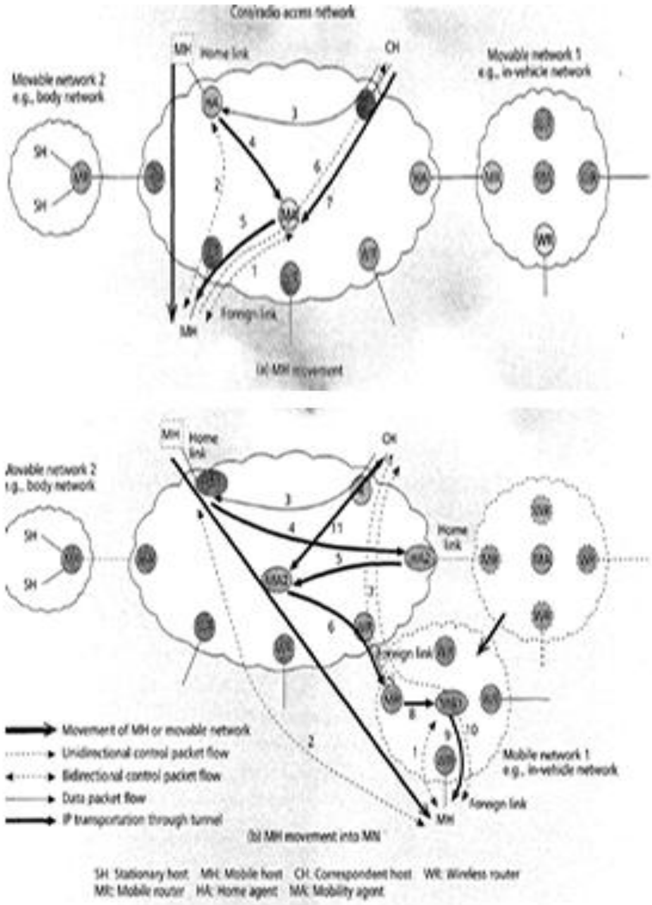

Figure 4. Network architecture and mobility control

When the MH moves into a new foreign link area in movable network 1, the MH obtains a CoA and the address of the MA (MA1) through the foreign link, and notifies the MA1 of the HA address and the CoA (control packet flow 1) in order to request that packets for the MH be forwarded to the CoA. The MH also notifies HA1 of the MA1 address and its (home) address (control packet flow 2) in order to request tha, packets for the MH be forwarded toMA1. When a corresponding host (CH) sends a packet to the MH (data packet flow 3), the packet is first sent to HA1, then it is forwarded to HA2 (tunnel 4) because the CoA of the MH is the address of a sub network of the MR in movable network 1, and HA1 in turn forwards the packet to MA2 using the CoA assigned to the MR (tunnel 5). MA2 also forwards the packet to the MR (tunnel 6). When the MR receives the first packet from the CH, it notifies the CH of the address prefix of the movable network 1 and MA2 address (control packet flow 7). Then the CH can directly transmit data packets to MA2 for movable network 1 (tunnel 11). Packets that arrive at the MR having a MA1 addresses are forwarded to MA1 (tunnel 8) and MA1 forwards the packets to the MH (tunnel 9). When the MH receives the first packet from the CH, it notifies the CH of the home address and the MA1 address (control packet flow 10). With the two requests from MR and MH (control packet flow 7 and lo), the CH can directly transmit data packets for the MH to the MA2 (tunnel 11) and the MA2 forwards them to the MA1. Based on this control, although the movable network moves into another area, handover control packets for MHs in movable network 1 are not required but only control packets for MR movement are exchanged. By deploying the MAs in networks that temporarily accommodate MTs or movable networks from other networks and by deploying the HAs in a network that accommodates terminals and networks as in a home environment, mobility control can be performed even though the networks are composed of layered sub-networks, and the number of control signals concerning the mobility control can be reduced. In movable networks, if MTs do not leave the movable network at all, mobility control is required only for the movable network, but not for individual MTs in the movable network. This consequently should reduce the number of control messages. **7.**

CONCLUSION

By properly monitoring the QoS /GoS parameter for QoS unit together with a mobility control unit in new configuration of the transmission systems, we serve for large user with higher grade of service.

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