A Mechanism of Applying Human Intelligence to Future Generation Network

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***Abstract*—To entertain network users, service operators have released a number of innovative services and many new features for the basic services. However, their efforts still cannot greatly satisfy the network users because the network users would like to make the services to their own appetite instead of use the ones created by the service operators. Upon that, this research proposes to apply intelligence to the network so that the network is able to develop services according to the users' preferences. The approach is to let a virtual user in the network to work for a real user in a communication session. The virtual person makes appropriate decisions on how to perform a service according the real user's preference. Moreover, with the help of the virtual buddy, not only will the communication session most likely succeed but also the real user have fewer jobs in a service session.**

Keywords-intelligence; network; service; virtual user

I. INTRODUCTION

Next Generation Network (NGN) aims to accommodate all types of service on heterogeneous access networks [1] with its four-layer architecture, including the access layer, the transport layer, the control layer, and the application/service layer [2].

To provide network users with multifarious types of services anywhere and anytime, service operators have addressed a number of essential topics such as service-type conversion, service delivery, and service invention [3]-[6]. Even so, still some important issues concerned with service management are ignored in the current networks:

- users' social relations with other users, which play an essential role in a communication session because communications happen between at least two related people, and
- heavy communication burden to the network users due to more available communication terminals.

Taking into considerations of these two issues, we propose a mechanism for applying intelligence to the NGN to improve its service performance and service management. We call the NGN with the intelligence Future Generation Network (FGN).

In this paper we will first position the network intelligence in the FGN. Next, we will define the network intelligence at a high level and then give the functional design of the network intelligence in order to realize it in a technical way. Finally, we realize the network intelligence on the FGN by embedding its functional entities on an IMS testbed.

II. POSITION OF FUTURE NETWORK INTELLIGENCE

Using the NGN architecture as a background, we insert the intelligence mechanism between the application/service level of the NGN architecture and the real user as in Figure 1. The intelligence mechanism and the NGN then work together as the advanced FGN to help the network users with their busy modern communications.

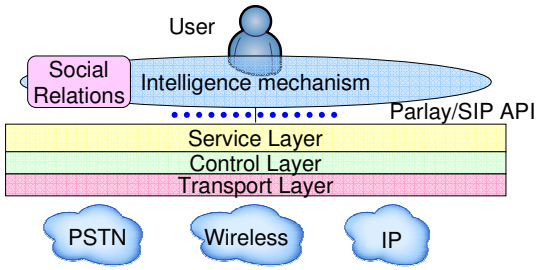

Figure 1. Architecture of Future Generation Network.

As can be obtained from the Figure 1, the FGN is able to partake in the network users' communications and thus extend the function of the network to the users. It also creates an interface for the network users so that the users can make their own preferred services. Moreover, the intelligence mechanism enables the FGN to treat network users in a friendly way by utilizing the real users' social relations with other users.

The network intelligence is also expected compatible with the current NGN using the Parlay or Session Initiation Protocol (SIP) interface [7]-[8]. At present, we may implement the network intelligence as a part of application/service level of the NGN architecture. While with time going on, when to technically realize a communication idea does not count a problem any longer, the focus of network operators will turn to the user part. Not only is the network supposed to provide the network users with the friendly interfaces to make their favorite services, but also it is supposed to intelligently administrate these services newly created either by service operators or the users. Thus we can realize the network intelligence as an independent level of the current NGN architecture. The five-layer network is exactly what we call the FGN.

III. HIGH-LEVEL FUTURE NETWORK INTELLIGENCE

We establish a virtual person in the FGN to take over part of the task of a real person during a communication session. We call the virtual person the secretary of the real person.

We assume the virtual person has the intellectual abilities that a real person has. Namely, the virtual person is able to recognize an existing problem, analyze and troubleshot the problem, forecast an emerging problem, express its thoughts, speak in a generally understandable language, and learn new things like a real person usually does in communications.

The virtual person completely reflects the personal communication profile of the real person in terms of personal information, present communication status, and the social relations of the real person with other people.

Figure 2 visualizes the virtual people in the FGN. In this figure, the caller, the callee, and the assistant callee are real network users. They all have their virtual network secretaries who are the virtual caller, the virtual callee, and the virtual assistant callee respectively. Each real user talks to one's virtual buddy frequently by updating the database of the virtual user every time the real user interacts with the network.

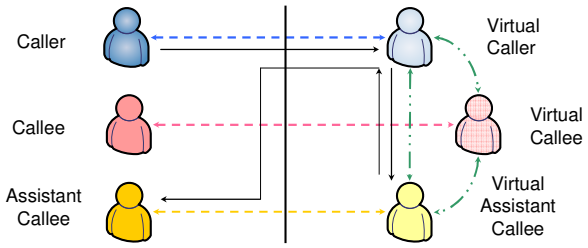

Figure 2. High-level design of Future Generation Network Intelligence.

When initiating a service, the caller first connects to the virtual caller. The virtual caller negotiates with the virtual callee on whether the callee is able to receive this service session. If the callee is technically available such as being with proper and free terminal and at the proper time, a successful service session between the caller and the callee will be set up.

However, if the virtual callee finds that the callee is not available in terms of proper communication manner and proper answering time, it will further search its socially related parties on whether other people are available and able to provide the service. After the virtual callee finds an appropriate virtual assistant callee, it authorizes the virtual assistant callee to handle the service after a successful negotiation. Thus a connection will be set up between the virtual caller and the virtual assistant callee.

After these virtual people have eventually finished all the negotiations and choices, the network indicates the final callee who is finally decided to receive the service to receive this service session and communicate directly with the caller.

In the entire procedure of setting up and running a service session, only two real people are involved in the session. They are the caller and the final callee, and they are only respectively responsible for initiating a service session and receiving a successful incoming service. All the rest of the work such as looking for and setting up an appropriate connection between two appropriate people is conducted by the intelligent network.

IV. FUNCTIONAL FUTURE NETWORK INTELLIGENCE

For the easier view and realization of network intelligence in a technical way, we describe the functional design of the network intelligence in the horizontal orientation of the FGN architecture as in Figure 3:

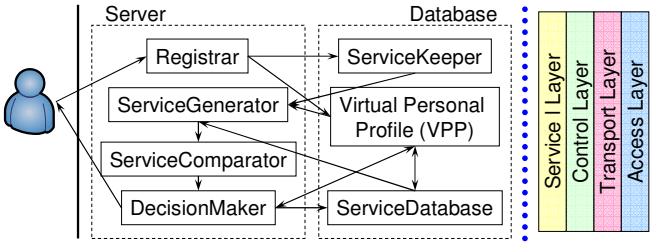

Figure 3. Functional design of Future Generation Network Intelligence. The main functional entities are the rectangle marked with strips.

We will introduce the intelligence mechanism at length following by defining its function entities and analyzing the function of each functional entity in a service session.

A. *Definition of functional entities*

Registrar divides a service into three parts: the part of service-characteristics and corresponding service-requirements, the part of the caller's personal information, and the part of the callee's personal information.

Service Keeper keeps the temporary services, which are to be performed in the network, in form of service characteristics.

Virtual Personal Profiles (VPP) stores the users' personal communication profiles such as their current communication status and their social relations.

Service Generator generates a type of service by combining the needed service characteristics and the requirements on each characteristic.

Service Comparator compares the performance of two services by comparing each service characteristic of the two services on the requirement level, which is marked as different scores when at different levels.

Decision Maker decides whether to immediately deliver a service, or wait for further demands from the VPPs.

Service Database temporarily keeps the services that cannot meet the requirements of immediate delivery by the network and the VPP information of the relevant users.

B. *Procedure of a service session*

A service separates into three parts at the Registrar. The part of service characteristics is kept in the Service Keeper. The parts of the caller's and callee's communication information are sent to the VPP of the caller and the callee respectively.

Then the Service Generator will separately generate an "original service" based on the caller's communication status and a "new service" based on the callee's status.

Once these services are ready, the Service Comparator will compare all service characteristic of them on the requirements.

If the "new service" has a satisfying service performance, the Decision Maker will set up a successful service session for the caller and the callee.

If the "new service" cannot meet the requirements of the "original service", the Decision Maker will make decisions according to the caller's VPP and the service status. Thus the service will either be immediately delivered with a less qualified performance, or be postponed till the callee changes to be available, or be performed after the virtual callee finds a virtual assistant callee to help with the service.

Finally a real communication will be set up between the caller and the final callee (either the callee or the assistant callee) after these three extra tries.

V. FUTURE NETWORK INTELLIGENCE ON TESTBED

To prove the practicability and the acuity of the future-network-intelligence concept, we plan to apply the intelligence mechanism on a testbed and use a typical experiment to test it.

If this trial succeeds, the theory of applying intelligence on network proves correct and feasible in a testbed environment. Then the mechanism of network intelligence is expected to be able to fit into the FGN in principle.

We choose the IMS testbed because (1) the IMS is generally taken as a reality of the NGN, (2) the IMS testbed is technically strong to provide a global service delivery platform to supply high-QoS and low-cost multimedia services in NGN, and (3) the Open IMS playground at FOKUS has successfully prototyped and validated an IMS simulation environment on testbeds for all types of experiments.

We place the intelligence mechanism between the real user and the IMS as what we have done in NGN in Figure 1. This intelligence mechanism can then work with the IMS to serve the users. We then realize the future network intelligence as functional entities in the IMS testbed in Figure 4:

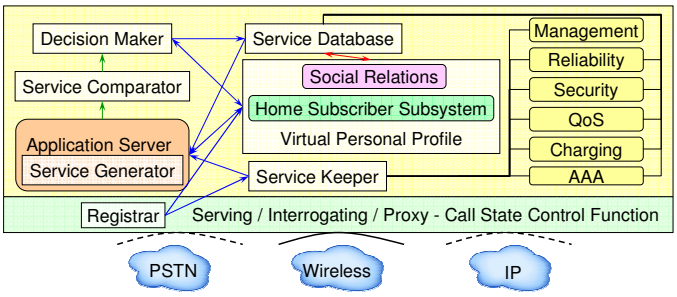

Figure 4. Network intelligence on IMS testbed. The rounded rectangles wihout strips are the elementary units of the IMS. Home Subscriber Subsystem (HSS) keeps users' profiles such as location. Application Server (AS) is in charge of the service part of multimedia applications. Service characteristics such as reliability are kept separately in categorized Service Libraries. Serving Call State Control Function (S-CSCF) registers a user and interacts with the service part of the IMS. Interrogatin Call State Control Function (I-CSCF) responds for the interworking between different S-CSCFs. Proxy Call State Control Function (P-CSCF) starts the operations in the IMS.

Figure 4 shows how the future network intelligence is realized within the IMS testbed. The network intelligence is primarily represented by the cooperation of many functional entities in Figure 3. An intelligence functional entity may be supplementary to the existing testbed entities such as the Registrar. It may also work together with an IMS testbed entity to behave as one extended function entity such as the VPP. Still, it may also be implemented as a characteristic of the existing IMS function entity such as the Service Generator.

VI. FUTURE NETWORK INTELLIGENCE

The current convergent NGN only creates new features for the existing basic services by bringing in value-added services. However, it cannot satisfy the customers' increasing service requirements on brand-new and stylish services according to their individual preferences.

This research pre-establishes a virtual user in the FGN to work on behalf of a real user under specific situations. The virtual user is able to automatically provide the most appropriate solution for the real user according to the real user's VPP, which is composed of the real user's current communication status and social relations

Considering users' social relations in communications is one of the major features of personal communication system but has been long-time ignored. In the future research, we need to develop a well-organized structure of social relations among communicating individuals [9]. Thus the choice of how to perform a service as successfully as possible may be decided by the network according to the network users' social relations and the characteristics of the service, such as the priority and delivering time of the service.

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