A Novel Mobile Communication for the Future Internet

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Abstract — **In this paper, Organic Mobile Communication (OMC) is defined as a Mobile Communication (MC) system operating organically as a body. As smart phones, for example, the I-phone, become more popular, Internet services are becoming more intelligent and diversified. Internet traffic is also expected to increase explosively, with much variation. In the future Internet, MC is expected to play a key role. Therefore, the future MC needs to have more capabilities in capacity, function, etc. Especially, considering traffic requirements and limited radio resources, flexible operation of MC will be more important. OMC is an alternative to meet these requirements. In this paper, the architecture of OMC is analyzed with the service requirements from the system design point of view. OMC consists of the handsets, Base Stations (BS's) and the Core Networks (CN's) of the present MC system. However, the routing in the air is quite different. In OMC, all the wireless equipment, such as handsets and the BS's, are regarded as nodes, of which the states are ABLE or UNABLE. The routes among nodes are constituted by the ABLE nodes and are changed dynamically. An optimal route between two nodes is determined with aids of the Radio Routing Agent (RRA) of the CN. With OMC, we can increase the system capacity significantly and thus satisfy the future Internet requirements.**

Keywords – mobile; communication service; Internet; organic communication.

I. INTRODUCTION

As more convenient telecommunication services are required, the need for the Internet and MC also increases. Particularly, ubiquitous and intelligent services including convergence are very important for the future of MC [1]. Mobile Internet (MI) services are main services in the future of MC. The MI services require various levels of Quality of Service (QoS). The MC systems supporting these MI services are also varied. A user in the future will adopt the various MC systems. Direct radio paths will be also needed to support MI services efficiently. Considering the increased traffic in the future due to the ever-rising popularity of intelligent phones, it is important to improve the radio resource efficiency. Although the Universal Access (UA) with cognitive radio is proposed to improve the radio resource efficiency [2]-[3], it is difficult for UA alone to meet future MI requirements.

The Future MC System (FMCS) is expected to consist of several types of the MC systems, such as LTE, WiMax, WiFi, etc. The ad-hoc network [4] may also be a part of the FMCS. In the future, MC companies will serve their customers well with the required MI services, regardless of the supporting system. Also, as the smart phone becomes more intelligent, an MC system needs to be more intelligent. The FMCS needs to have the capability to support future MC users efficiently with MI services.

In this paper, a novel FMCS is proposed as an alternative to meet future MI requirements. In the proposed FMCS, each piece of wireless equipment, such as a handset or BS, is regarded as a node. Every node is available or unavailable. The route between two nodes consists of available nodes. The RRA maintains the status data about all of the nodes and the handsets. If a call is attempted, the RRA determines the optimal route for the call and informs the caller. The assigned route is changed dynamically, like an organism. With the proposed **Organic Mobile Communication** (OMC), radio resource efficiency is significantly increased by the flexible use of the resources.

This paper is organized as follows. In Section II, the life style of a future user and future MC services are discussed briefly. Section III presents an example of a part of the OMC architecture and its concept. A call processing procedure is also illustrated. Section IV is concerned with the wireless and mobile technologies required for the OMC. Finally, Section V concludes this paper.

II. MOBILE COMMUNICATION SERVICES

To extract the requirements for future MC services, , we briefly consider some aspects of life in the future . Compared to the present, the following kinds of people and other rising social phenomena are expected to be more common in the future.

- Lonely single
- Older women socializing with younger men
- Mobile couples from the weekend couples.
- Retired worker
- Extreme commuter
- Person who sleeps less
- DIY (do-it-yourself) doctors
- Learning requirements for teenagers
- Knitting youngster
- Adult video game
- Home schooling
- Easily and fast transportation

Considering the above, future life will be more personalized and more intelligent. In future society, human's existing problems will be solved. Such biological problems as illness, death, and pain will be relieved. Human and cyber space will be connected with special equipment to the human body. Artificial machines, such as artificial material, artificial software, artificial infra, and robot replace human's brain work as well as

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human's physical work. The care economy will rise jointly with the artificial society, since the care for human themselves in terms of mental and physical activity will be more important.

In the future, the advent of super brains will open the Artificial Intelligent (AI) society and thus an ideal society will be come into being. Humans will be able to reach self-realization through proxy experience, services, travel, games, leisure, stories, poems, novels, plays, movies, etc. Nano-technology will also be popularized and thus equipment will be minuscule. In addition, a large portion of human manual labor and mental work will be done by small robots and AI. In industry, humans will cooperate with robots. The trends of future life can be summarized by the terms 'carbon-reducer', 'sweet-interlude', 'communion-machine' and 'big-brain'.

To cope with the trend, MC is expected to play a key role with MI. Considering future life styles and trends, future MC services will be 'green-mobile', 'relaxation-mobile', 'communion-mobile', and 'brain-mobile'. The All Things on Network (ATON) including the machine to machine (M2M) is also a key service for the FMCS, with location-based-service (LBS). Therefore, future MC services are summarized as group communication (conference-call), community services (cyber-society), multimedia-query (specific-conversation), value-added data goods (including sight, auditory, smell, touch, etc.), and green transportation. Fig.1 shows an example of future MC services.

III. OMC ARCHITECTURE

The major service of the FMCS is MI service with M2M service. Since MI service and M2M service are provided at the present time, the continuous support of MI service and M2M service provided by existing systems, such as LTE, WiMax, and WiFi, is very important. Therefore, the existing systems, including the Intelligent Transportation System (ITS) and the Ubiquitous Sensor Network (USN), need to be adopted efficiently. Considering these, the FMCS is expected to consist of the existing systems as well as the new FMCS components. Furthermore, considering limited radio resources, the FMCS is required to increase the frequency-use efficiency significantly.

To meet the requirements, OMC is proposed. Fig. 2 shows the concept of OMC. OMC is a novel FMCS characterized by key words like 'informative', 'green', 'cognitive', 'self-organized', etc. Existing MC systems and the new FMCS components constitute the proposed OMC. In this OMC, all network components and radio resources are organically combined without any human control to provide the services optimally matched with the users' needs. OMC evolves by itself to adapt dynamically to the varying environments. Hence, with OMC, we can support future MI services as well as conventional MC services efficiently and can relieve the limitations of radio resources.

Fig. 3 shows an example of an MC part of OMC architecture. In Fig. 3, terminal A, base station A, and the core network A constitute the system A. System B consists of terminal B, base station B and, core network B. OMC may include other systems available in the operating company. In OMC, all wireless equipment, such as handsets and BSs, are regarded as nodes. The state of a node is described as either available (ABLE) or unavailable (UNABLE). Direct communication between any two nodes is possible, and the route consists of the ABLE nodes. The optimal route between two nodes is determined with the aid of the RRA of the CN A and is changed dynamically by the environment. In the figure, system A is assumed to be the main operating system. The RRA maintains all the status data about all the nodes of the handsets and the BSs. Hence, OMC is self-organized and operates organically.

Fig. 4 shows an example of a call processsing flow. If subscriber A makes a call, this message is transferred to the call processsor (CP) A of the CN A. If the CP A receives the call attempt message, the CP A requests the optimal route to the RRA. The RRA determines the optimal route for the call and informs the CP A. The CP A transfers the call attempt message to the CP B of the called subscriber. If there is no problem in the received response, the CP A informs the caller of the optimal route. With the informed route, the caller communicates with the callee. During the call, the route may be changed by the RRA like a handoff.

Fig. 5 shows the uplink channel architecture proposed for OMC. The basic channel architecture is the same as for LTE. In Fig. 5, a new channel, the Dedicated Access CHannel (DACH) is included to improve access efficiency. During the call processing procedure, the identification number for the DACH is informed by the network.

IV. WIRELESS AND MOBILE TECHNOLOGIES

OMC is proposed to efficiently support future MC services with MI services. Considering future MC requirements, radio resource efficiency is a key parameter for the system. Although a number of technologies are proposed to improve radio resource efficiency, it would be difficult to meet the requirements of MC in the future with the proposed technologies. However, the technologies could still utilized for OMC if they were improved, and here they are introduced.

- Multiple-Input Multiple-Output (MIMO). MIMO shares the communication resources by means of distributed transmission and signal processsing. Neighboring infra-structure stations as BSs or Relay Stations (RSs) are for utilization.
- CoOrdinated Multi-Point (COMP). COMP transmission is used with coordinated scheduling/beamforming and joint transmission.
- Cooperative Processing (CP). CP overcomes the limits on spectral efficiency imposed by inter-cell interference. Between BSs and RSs, as well as among RSs, it extends the coverage and capacity of point-to-multi-point links.
- Multi-Hop Relay (MHR). A relay path is a concatenation of consecutive relay links between the source and the designated access relay station. The

relay normally works in half-duplex mode. Three schemes, amplifying and forwarding (AF), the decoding and forwarding (DF), and estimating and forwarding (EF), are used.

- Cooperative relaying is a source node multi-casting a message to a number of cooperative relays which in turn resend a processed version to the intended destination node. The destination node combines the signals received from the relays and recovers the source signal
- Cognitive Radio (CR) allows universal access to the less-loaded-station. The traffic load is distributed among the MC systems available.
- Femtocell is an MC system for a small area, such as a home or the SOHO. In a femtocell, a compact BS is connected to the operator's network via the Internet. The operations of femtocells are controlled by the Self Organizing Network (SON).
- SON is a set of use-cases covering all the fields of network operation from network planning to maintenance activities. The self-optimization is also done in the SON. Plug and play technology is applied to the compact BSs to achieve the SON functions in conjunction with the CN.

V. CONCLUSION

Future communication services are expected to be more intelligent and convenient. MI services are the main services of the FMCS. Hence, a large capacity, a number of functions, and various levels of QoS are required for the FMCS. Although many wireless/mobile technologies, such as the MIMO, the CR, etc. are proposed to overcome the limited radio resources, it is difficult to meet the FMCS requirements only with the technologies. The proposed OMC in this paper is an alternative to meet future MC requirements.

OMC consists of handsets, BSs, and CNs. Unlike in current MC systems, direct communications among handsets are possible in OMC. In OMC, the different types of wireless equipment are regarded as nodes. The optimal route between two nodes is constituted by available nodes and is assigned with the aid of the RRA of the CN. The RRA maintains the status data about all nodes. The assigned route is changed dynamically, as if it were an organism. With the proposed OMC, radio resource efficiency is significantly increased by flexible use of resources.

ACKNOWLEDGMENT

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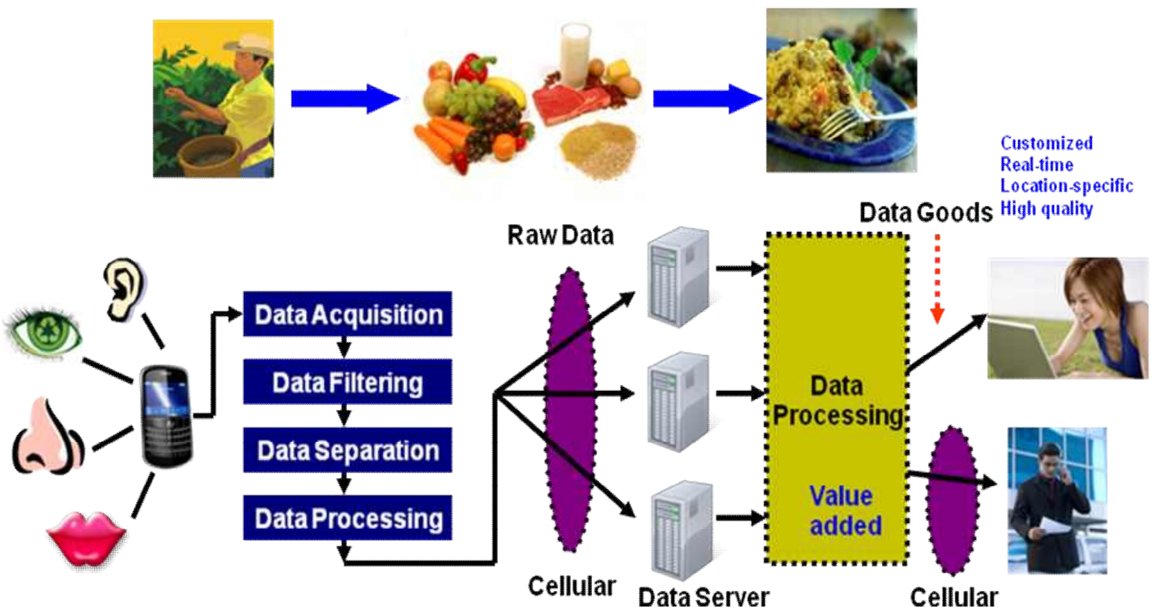

Figure 1. An example of the future MC services

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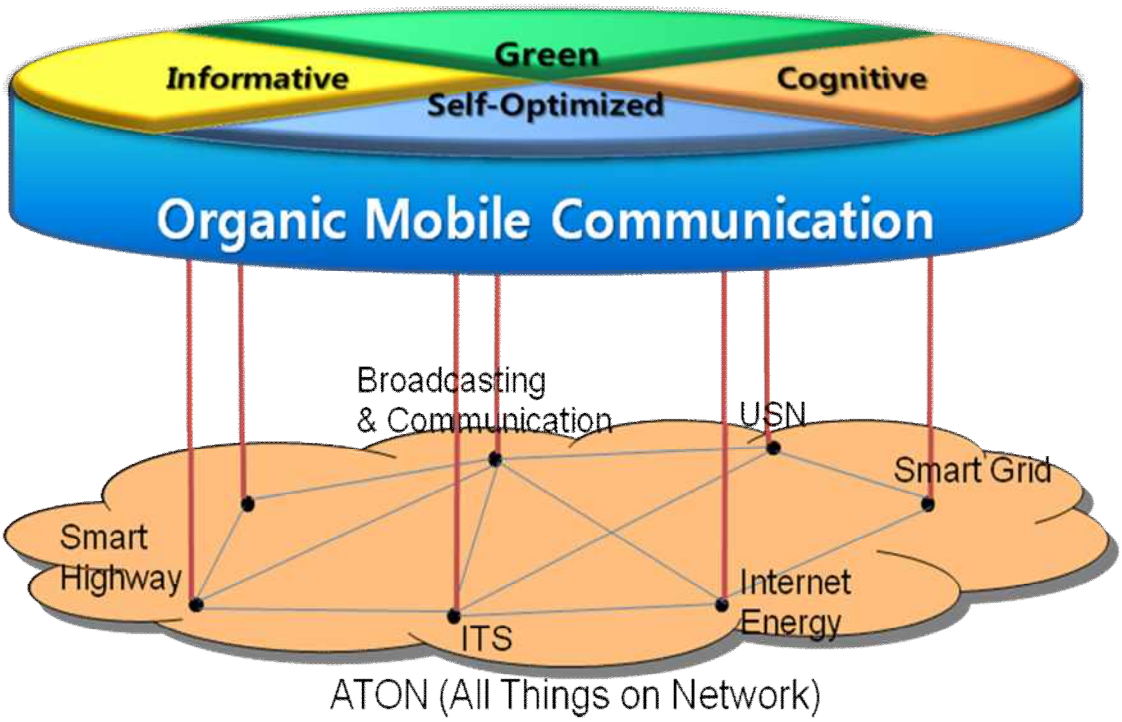

Figure 2. The concept for the organic mobile communication

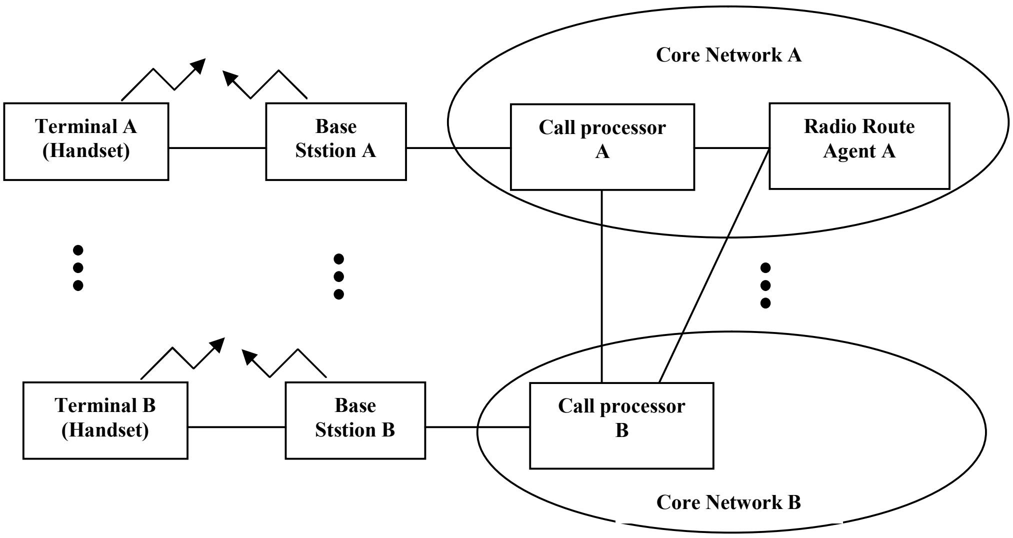

Figure 3. An example of a MC part of the OMC architecture

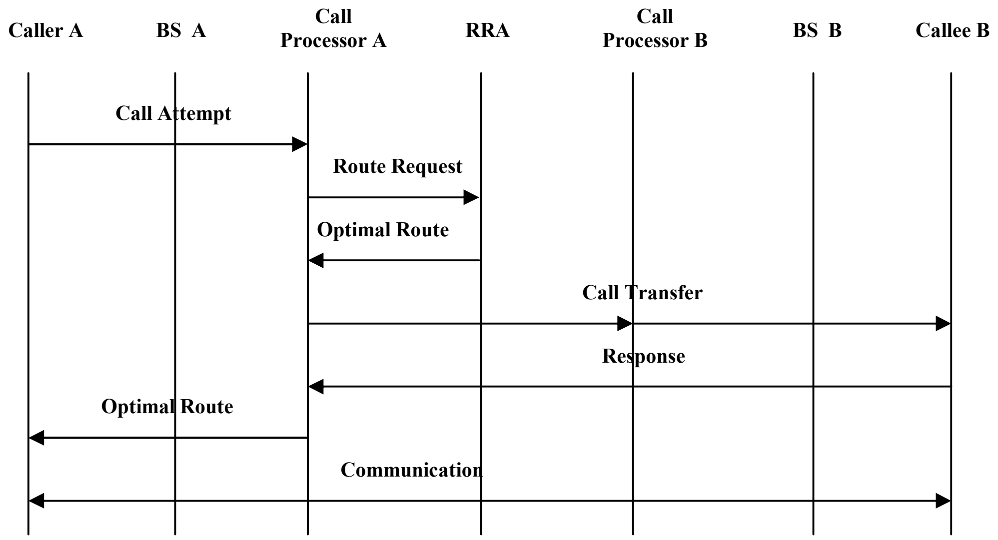

Figure 4. An example of a call processing flow of OMC.

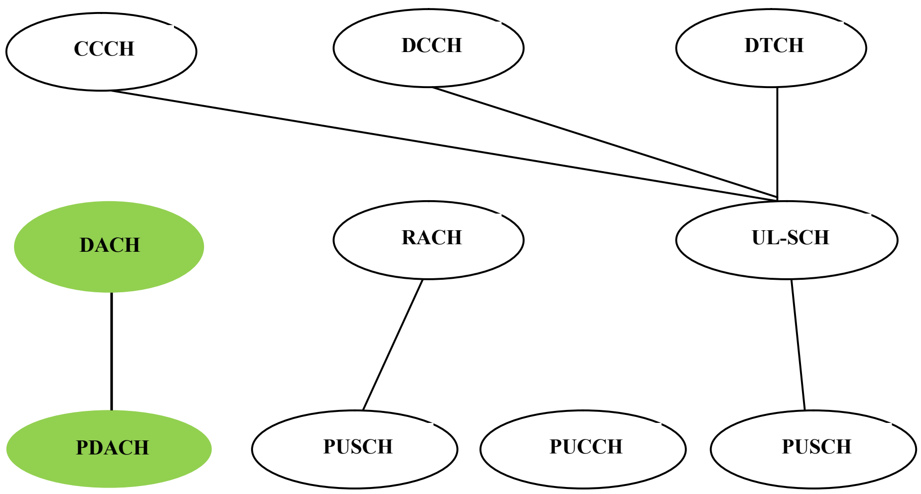

Figure 5. The uplink channel architecture for the OMC.

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