An Overview of Network Architecture for 4G Mobile Communication Systems

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Abstract
This short term paper is a summary for network architecture for the 4G mobile communications system. Because of the fast development of the mobile communication services, increasing number of people start to use their mobile phones not only as a telephone, but also a wireless assistant. As a result, data traffic used by mobile devices is increasing significantly. Using an article published in IEEE Personal Communications Journal [1], the term paper briefly estimates the future demand of mobile communications and then introduces a network architecture which will satisfy the requirements of this feature demand.

Introduction
In the past years, when the mobile communication was first introduced, only a small number of people were using mobile telephones. Moreover, thedevices were only used for a voice communication. Due to the development of the mobile technologies, service areas was expanded and cost of the technology is reduced. Thus, the number of people using mobile communication systems increased. Later on, these mobile systems started to be used for connecting the Internet with some data communication services. Further developments of the technology are expected to be resulted in some services, which will change the people's lifestyles dramatically. The paper first accommodates the future market trends in mobile communications to analyze the future requirements, and then suggests 4G network architecture to serve these requirements.

Market Trends of Mobile Communications
It is known that first and second generation of the mobile systems is mostly used for the voice communications. The next generation (3G) system enhances the support given for data communication services of 2G system and offers package-switched multimedia services in addition to the circuit switched voice systems. Because of the increasing demand for multimedia content for mobile devices, 4G system should offer higher bitrates than 3G system.

The forecast about the market trend is done for 2010 and 2015 and compared to the 1999. In 2010, it is expected that the amount of traffic of the voice services would increase twofold compared to that of 1999. However, multimedia services will start to dominate the market and the multimedia traffic will become twice the traffic of voice services. In 2015, voice traffic is expected to be 23 times larger than the voice traffic in 1999, and the multimedia traffic constitutes 90 percent of the overall mobile traffic.

Network Requirements
Compared to the 3G and broadband wireless access systems, transmission bit rate of the 4G system should be more than 20 Mb/s in an outdoor or vehicular environment. It is clear that this bit rate eventually accommodates a large amount of traffic. Therefore, higher frequency bands than mobile communications should be used. Providing three orders of magnitude greater than the bit rate of the 2G system, the cell radius covered by a base station will eventually decrease. The calculations in [1] show that covering the same area as the 3G system will require 4 times the number of base stations than those of 3G systems. Another thing is that small mobile devices need a miniature base station which will be used as a mobile terminal for the 4G system, as a result of the difficulties such as power consumption and antenna size. Supplying these configuration needs having multiple overlapping cells in the service areas.

Considering the characteristics given above, many requirements for 4G system are needed. First, it is known that customers of all systems have a limit for paying the system. Due to

decreasing base cell sizes and the large amount of the base stations needed for 4G systems, economic coverage of the system can be facilitated with the use of other wireless systems and reducing system costs. To accomplish this task, a clever system design, interconnection and capability of handover between wireless access networks and security mechanisms across these networks are needed. Also, because of the increasing bit rates and decreasing coverage areas of base stations, the number of handovers and error bit packets will increase. As a result, the number of control messages and the duration of the handovers should be decreased. Another requirement is the native internet support. For this reason, 4G system should support IP protocols. Lastly, it is stated that 4G system will enable high speed wireless connections. By establishing a LAN, people can use the same mobile device as a gateway to connect more than one device to the Internet and use the LAN in a moving system, such as cars. Thus, the system should enable this kind of movable networks.

Network Architecture

Similar to the 3G structure, there are two main parts that constitutes the 4G system. These are core network (CN) and radio access network (RAN). For establishing an economical 4G background, RAN physical link configuration and the network architecture should be revised.

In 4G system, since there will be more base stations than the other systems, and more data to be transmitted, the work of the radio network controller (RNC), which is mainly responsible for connecting data taken from different base stations (BS) for the same mobile phone (MP) and transmitting them to CN, will increase, which will bring a serious cost increase. The RAN structure given here can be called as a “cluster-type” RAN. In this structure, BSs are grouped and connected as clusters. There is a cluster head which connects the cluster to the CN. The difference is that there is no need for a RNC in this structure. When there is a transmission using more than one BS, one BS eventually gets all data, connects and sends it to the cluster head. Since the amount of traffic is shared through BSs, the cost can be remained low. Also, when a MP can use multiple BSs at the same time, the quality of the connection for each BS can be monitored and a BS can automatically choose not to transmit. This reduces the unnecessary power consumption and increases the capacity, which also affects the overall cost.

To explain the network architecture and give an exampe of the mobility control, two different cases are considered. The first case is the movement of mobile host (MH), such as cell phones, in a static network. Mobility control is done with home agents (HA) and mobile agents (MA) in the network. When the MH moves into a new area, foreign link assigns it a new temporary address and gives the MA address. To request the packages of itself, MH notifies the MA and HA. When a package is first sent to MH by an outher host, the packet first arrives to the HA, then MA, and then MH. After that, MH informs the outer host of MA and HA. The other packages sent to MH first arrives MA, then MH, without the need of HA. The other case is the movement of MH into a movable network. Similar to this communication, with notifications of hosts and agents, a mobile device in a mobile environment can get its packages with a small number of forwards.

Conclusion

In this paper, market trends of mobile communication are analyzed and then the requirements for 4G communication system is clarified. Based on the requiremens stated in the article, a network architecture is presented and the ability of the architecture to satisfy the requiremens is explained. The article explained the mobility control of the 4G network. A future work might be developing other functions of cellular network using this network.

References

[1] Otsu, T.; Okajima, I.; Umeda, N.; Yamao, Y.; Network architecture for mobile communications systems beyond IMT-2000; Personal Communications, IEEE Volume 8, Issue 5, Oct. 2001 Page(s):31 - 37