A STUDY ON THE MAC TECHNOLOGY AND ACCESS NETWORK OVER 3G SYSTEMS

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ABSTRACT

Access network architecture and media access control technique are the requirements of beyond 3G mobile communication systems for B3G systems [1]. The proposed novel access network architecture is that the network complexity is minimized and maximizes system performance. The Centralized mini-slot packet reservation multiple access (CMPRMA based on OFDMA is proposed which not only can acquire the advantages or good assets of MPRMA and support or guide Real-time traffic in well manner but can also give the resource reservation scheme for data traffic and support transmission for data traffic efficiently.

KEYWORDS

B3G System, CMPRMA, OFDMA, MAC Protocol, MPRMA.

1.INTRODUCTION

In this era the third-generation (3G) mobile communications systems are in commercial operation in several parts of many countries around all over the world. If we compared traditional mobile communication systems to 3G systems, it offers highest transmission rates and also supports many multimedia services. However, in this time users and operators are continuously increasing, for the same reason there is a needs of best support for reduced network architecture, several quality of service (QoS), higher spectral efficiency and higher data rates for packet-switched services hugely increase in order to further enlarge user experience while maintaining efficient performance of system resources. It is defined that the characteristics of 3G techniques demands cannot be gratified [2]. As a result most of the researchers are researching apart from 3G systems which are assumed to be suitable wideband wireless communication systems.

The future B3G project for advanced wireless systems financed by the Chinese government is sponsored to examine and determine key technologies for air interface and novel network architectures beyond 2G/3G systems and its getting most of the attention from operating companies, customers, communication device providers, and subscribers [1]. The target is to cover the full 3G environment and provide 100 Mb/s–1 Gb/s peak data rates. So by following multiple-input multiple output (MIMO) and orthogonal frequency-division multiplexing (OFDM), In first release, peak data rate has achieved 100 Mb/s in downlink and 50 Mb/s in uplink within the 20 MHz frequency band, and the spectrum efficiency is 2–10 b/s/Hz. The system should be supportive to vehicular speed of 250 km/h and Quality of service guarantee for multi- traffic transmission [2, 3]. If we compare higher transmission rates, to current 3G systems, the key characteristics of the Future B3G system are define as follows:

- An open platform provides subscribers or users the capability to openly choose different

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communication protocols, device applications and networks. In addition, this architecture can also permits application service providers and application content providers topresent services,facilities and contents independent of operation.

- B3G systems can support IPv6 multimedia services at minimum transmission power and system latency.

- It is well known that the International Telecommunication Union (ITU) has take up CDMA2000, wideband code-division multiple access (WCDMA) and time-division/synchronous CDMA (TDSCDMA) as the standards for 3G systems. So it is assumed that B3G will have a uniform standard to remove all the compatibility problem in the system.

- As we can add something what we discussed above to higher transmission, the system promises to give different services accept multimedia broadcast multicast service (MBMS) traffic with the QoS guarantee scheme.

Its gives highly efficient authority and security mechanism. It give the guarantees for the security of a user's personal information and data transmission. This is very important for the Third Generation Partnership Project (3GPP) and 3GPP2 to consider taking efficient measures in 3G long-term evolution (LTE) and air interface evolution (AIE), respectively, to evolve to B3G systems in order to give high-data-rate services with minimum cost, minimum latency and maximum coverage and capacity [4, 5]. The requirements of the future B3G project is the Universal Mobile Telecommunications System (UMTS) terrestrial radio access network (UTRAN) architecture cannot adapt to the trend toward an access network that should not only divide the control plane and traffic plane to decrease transmission delays but also be adoptable with multiple radio access systems including WLANs and wireless personal access networks (WPANs).When it comes to the related protocol stack, media access control (MAC) techniques based on physical (PHY) layer techniques including orthogonal frequency-division multiple access (OFDMA), MIMO, and other techniques should support that how to provide resources among all the users and promote or give the knowledge about all resource utilization.

- However, most MAC protocols, including packet reservation multiple access (PRMA) and mini- PRMA (MPRMA), are based on time-division multiple access (TDMA).The PRMA combines a reservation mechanism with classical slotted ALOHA and grants mobile terminals (MTs) to contend for uplink slots with slotted ALOHA; however, a defined reservation mechanism is only attractive for voice users so PRMA is bad for data users who should deny for slots with packets each time [6]. Although both voice and data users are applicable to define further reservations in MPRM. The protocol is not supportive in an OFDMA system and cannot support dynamic resource allocation greatly in an integrated traffic environment [7]. As a consequence, innovative access network architecture and a novel MAC protocol based on OFDMA are studied, examined and discussed in this article.

2. A NOVEL ACCESS NETWORK ARCHITECTURE

In order to achieve the working target of the Future B3G project, minimizing the number of network nodes along the data path has been considered to minimize the interface delay. Figure 1 defines the novel access network architecture of a B3G system.

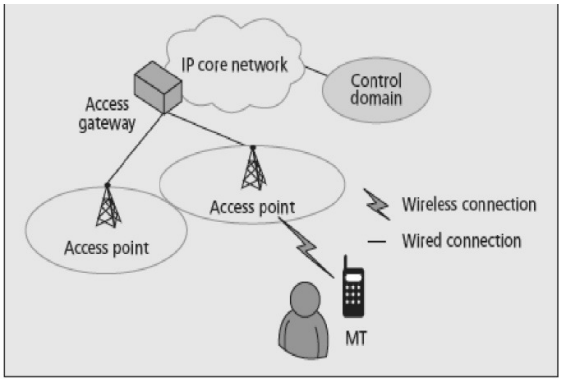

Fig. 1: An architecture of Access Network

On the network side, the access system is characterised into two parts: access point (AP) and control domain (CD). The AP combines the functions of Node B or the radio network controller (RNC) in release 99 and divides this into a user plane and a control plane to give services to the MT. The AP connects to the IP core network directly via an access gateway and can avoid the complexity of the access network induced by the RNC in charge of multiple nodes Bs and thus minimize the time delay for traffic flow. The AP is applicable to transform the data format between wireless and wired networks and packet IP flows into wireless frames then transmit them on the air interface. The objective of the CD is to achieve a programmable service control and mobility management platform to load or extend services and add new services flexibly, and to fulfil corresponding management functions. The CD can communicate with the control plane in the AP through control signals via the IP core network and has functionalities including cooperative radio resource management (CRRM) spectrum sharing and load balance for different access systems .The AP can co-operate with the CD to finish related control operations in a subsystem, such as radio resource management, mobility management, packet scheduling, and QoS guarantee. To improve reliability, the CD entity can be a server connected to the IP core network, or share the same entity with the AP in the network.

3. MEDIA ACCESS CONTROL PROTOCOL

In future B3G systems, the mobile communications system will not only adopt the advanced techniques in the PHY layer, but will also need new MAC protocols that should take the techniques of the PHY layer into consideration and support the system to achieve the goal of dynamic transmission rate change and QoS guarantee for multitraffic [3]. In this time OFDMA is becoming a promising technology in the PHY layer. It is not only a modulation scheme, but also a multiple access technology.

In an OFDMA system, every user is allocated/distributed a set of orthogonal subcarriers. In addition to overcoming inter symbol interference; an OFDMA system can mitigate multiple access interference due to orthogonality among subcarriers. In contrast to static multiple access schemes, OFDMA considers the channel information and allows multiple users to transmit concurrently on different subcarriers per OFDM symbol. Thus an OFDMA system can fulfil

access for multiple users and satisfy the QoS requirements for multitraffic. There have been some studies on the media access protocol [6–9].

The Mini-Packet Reservation Multiple Access (MPRMA) protocol is proposed in [7]. Although

this protocol can give the surety connectivity for a voice user and also support efficient transmission for a data user.

It is only used in TDMA systems, which cannot be applied in an OFDMA system to make full use of time and frequency resources. For current research on the future B3G system, there are two research branches, one for frequency- division duplex (FDD) and the other for time-division duplex (TDD). TDD is a very promising and attractive duplex mode for rare frequency spectrum, and can utilize radio frequency more flexibly and effectively. Moreover, TDD is more appropriate for asymmetrical services because radio resources can be allocated flexibly between uplink and downlink. Besides these superiorities, TDD also makes it possible to widen coverage with multiple transmitting antennas deployed in AP. Therefore, a new MAC protocol is based on OFDMA/TDD techniques called Centralized Mini-slot Packet Reservation Multiple Access (CMPRMA) is introduced in this article. The proposed protocol divides radio resources into mini time-frequency blocks which are the basic transmission units. As the central controller, an AP controls resource allocation dynamically and provides a flexible access scheme for both voice and data users. It not only inherits or derives the good properties of MPRMA, which can support real-time traffic in very well manner, but can also transfer the resource reservation scheme for the data traffic, and also take care of healthy transmission for multi-users and multitraffics. The protocol adopts a dynamic threshold scheme for the access probability of MTs, allows AP to take control of data users' access dynamically, and improves system performance effectively.

4. MAC FRAME STRUCTURE

In Figure 2, In OFDMA/TDD systems, it shows the MAC frame structure of CMPRMA, as it is used in this. To define uplink stage, one random access slot and *Lu* uplink transmission slots should be composed. The access requests and data packets in the access slot and uplink transmission slots send by MTs respectively. In order to allocate resources dynamically, the protocol divides each regular slot into *Lm* mini-slots, which is regarded as the basic transmission unit in the time domain. From the characteristics of an OFDMA system into consideration, the mini-time-frequency block composed of radio resources in the time and frequency domains is defined as the base unit for packet transmission. As shown in Fig. 2, the downlink channels are composed of one broadcast slot and *Ld* downlink transmission slots. An AP broadcasts an acknowledge (ACK) message for users' access requests and the results of resource allocation, and sends the data packets in downlink transmission slots. Moreover, there is a guard time between uplink and downlink.

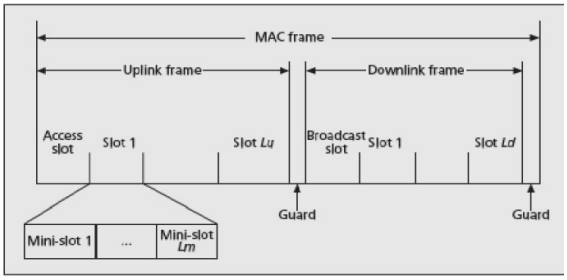

Fig. 2: Slot Structure in Uplink and Downlink

5. SIMULATION RESULTS AND PERFORMANCE ANALYSIS

In simulations, we noticed that two types of users are present in the system: voice users and data

users. The system adopts a fixed modulation mode. The access of user is delay, of a voice user is less than 8 ms and less than 12 ms for data user when the number of users in the system is less than 80. Even when the number of users reaches 130, the access delay of a voice user is less than 10 ms and that of a data user less than 24 ms . The simulation curves totally indicate that CMPRMA not only gives superb transmission quality guarantee for voice traffic, which has higher priority, but also take care of data traffic transmission efficiently in the integrated traffic environment. The access delay increases as the fixed threshold increases. When $Pc = 0.3$ and $Pc = 0.4$, the access delay is nearly three times that with a dynamic threshold. When $Pc = 0.03$ and $Pc = 0.1$, although there are only minimum distinctions in access delay compared to dynamic threshold when the system is in light load, access delay rises rapidly with increasing users. The reason is that the system will not do effective admission control for data users when the fixed probability threshold is too small which leads to a mass of collisions. It is obvious that the system capacity of CMPRMA is nearly twice that of MPRMA and four times that of PRMA. The simulation curves indicate that CMPRMA can make full use of the resources provided by an OFDMA system to increase system capacity and can guarantee QoS for voice traffic and make more efficient transmission for data traffic with a flexible access scheme and resource allocation mechanism.

6. CONCLUSION

In the area of universal network and multitraffic transmission, the future access network architecture and CMPRMA are advised and studied in this article. The novel flat network composed of an AP and a control domain can maximize system latency, combining the nodes in the current network and fulfilling wireless network functions efficiently. The proposed MAC protocol utilizes the primary characteristics of OFDMA and categorizes resources into mini-time frequency blocks, which makes the resource allocation more adjustable. Meanwhile, the adaptive permission probability threshold policy and resource reservation scheme can maximize system capacity and radio resource utilization to promote system performance. The simulation results fully imply the advantages of an AP as a central controller, and reflect that CMPRMA not only gives good transmission quality surity for higher-priority traffic, but also supports lower-priority traffic transmission efficiently in an integrated traffic environment. Thus, we see that the proposed protocol can satisfy the requirements of multi-users and multitraffic in future mobile communication networks. With the building of communication technologies and the boost of new traffic, the network architecture and responding protocol stack design will draw most of the attention attention from researchers, and we will add something in future into our work in related fields.

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