# Efficient Resource Allocation in Next Generation Cellular Networks to Support Multimedia Traffic

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***Abstract*:- The rapid growth in mobile applications such as wireless web browsing, real-time multimedia streaming, and interactive applications has necessitated the development of the next-generation broadband mobile wireless networks. High data rate transmission over wide band wireless channels is extensively limited by inter-symbol interference (ISI) because of inherent channel characteristics like multi path fading, and limited band width. To contend with ISI, multi-carrier communication techniques, which is based on modulating a large number of narrow band data streams over closely spaced subcarriers has become a most accepted wireless access technique today.**

**The objective of the research carried out here is to develop an efficient and dynamic resource allocation technique for the next generation cellular mobile communication system to support high quality multimedia applications. First, a study of multimedia services and its support by multi carrier communication is carried out. The two broad categories of multi carrier communication systems viz. MC-CDMA and OFDMA are investigated to find support for adaptive protocols. As the time division duplexing (TDD) technique is more flexible and spectrally more efficient than frequency division duplexing (FDD), the research work focuses on resource allocation in TDD based MC-CDMA and OFDMA systems. System modeling, simulation and analysis were done for these two schemes to estimate various performance parameters such as signal to interfering noise(SINR), bit error rate (BER), capacity and delay. A highly adaptive and efficient resource allocation method viz., Two Stage Rate Adaptive (TSRA) algorithm for OFDMA systems was developed. TSRA was simulated under two categories: with and without a water filled radio channel. The OFDMA system employing TSRA algorithm achieves 6.5 bit/sec/Hz (against theoretical capacity of 7.0 bit/sec/Hz) under higher traffic load in Rayleigh channel mixed with additive white Gaussian noise (AWGN). An M-ary quadrature amplitude modulation (M-QAM) with a maximum order of modulation (M) of 128 was used to adaptively modulate the data stream. The observed system capacity employing TSRA algorithm is 27.4% higher than the algorithm of Ian Wong et al (2004).**

**TSRA with water filled channel performs better than without water filled channel under medium as well as high traffic load. Apart from capacity, other system parameters like throughput, delay, and BER were simulated and analyzed for the TSRA protocol and the results meet the quality of service (QoS) requirements for multimedia services.**

## MOBILE MULTIMEDIA SERVICES

The mobile multimedia applications are characterized by large variations in bit rate. The requirement for the data rate is directly governed by the quality of multimedia services. As shown in Figure 1.1, the video related multimedia services occupy more bandwidth. Also, the remote medical services demand increased bandwidth as it consists of high resolution images. Other applications like Internet access and information distribution services require variable data rate support. The bit rate requirements are rising exponentially day by day with the new multimedia services with higher quality. The QoS requirement and reliable delivery of content for these multimedia applications pose a greater design challenges on MAC protocol development.

## SUPPORTS FOR MULTIMEDIA IN CELLULAR SYSTEMS

The simplest forms of mobile multimedia are already provided by GSM mobile telephones delivering audio and basic data services. However, they remain in the dark ages when compared to the multimedia applications one has grown accustomed to using over fixed data networks. Nextgeneration mobile multimedia services, such as instant messaging, push to talk over cellular (PoC), video sharing, presence and online gaming, need to be universally available regardless of platform, network or terminal type – fixed or mobile. The GSM association (GSMA) recommends the following arrangement for these services: IMS (IP Multimedia Subsystem) as the platform, SIP (Session Initiation Protocol) to create, modify and terminate sessions, and evolved GPRS roaming exchange (GRX) networks to carry the traffic (Bernd Hoogkamp 2006). Interworking of new multimedia services requires the development of new technologies. However, there is no need to extend networks, as there is already a strong technology platform available to carry these services – GRX networks. Usually, the GRX is based on a private or public IP backbone and uses GPRS tunneling protocol on the session layer between the visited PLMN (Public Land Mobile Network) and the home PLMN. The GRX is an open standard, eliminating the risk of islands of connectivity forming. The standard is IP based and thus already prepared for mobile data communication. SIP is the preferred control plane to manage session-based IP communication services and applications. SIP was chosen by the third generation partnership project (3GPP) to support multimedia platforms such as IMS, and is widely used by fixed operators to carry, for example, VoIP. SIP is fit to be used for a variety of new mobile multimedia services. It is also part of the NGN (Next Generation Network) developed by the European telecommunications standards institute (ETSI) to provide access to the services like VoIP independently, which is important from the convergence point of view. The IMS is an architectural framework for delivering internet protocol (IP) multimedia services. It was originally designed by the 3GPP, as a part of the vision for evolving mobile networks beyond GSM. To facilitate the integration with the internet, IMS uses IETF protocols wherever possible, e.g. SIP. The IMS platform is designed to allow seamless use of IP-services across the fixed–mobile boundary without compromising service quality. Although 3G networks can support many multimedia applications, it has some limitations as follows:

i. The difficulty of moving across different wireless networks seamlessly
ii. The limitation of the spectrum and its allocation
iii. Data and multimedia transport at high speeds between fixed networks and sub-networks

## THE MIGRATION TO THE NEXT GENERATION NETWORKS

The transition from first generation (1G) networks to the third generation (3G) networks being deployed today is a clear indication that satisfying consumer demands for better and improved systems, and generating more revenue for the operator are the main areas of focus. 3G provide services that help transfer simultaneously both voice data (a telephone call) and non-voice data (such as downloading information, exchanging email, instant messaging). Compared to 2G, these networks are in the higher frequency band (2 GHz and beyond) with larger bandwidth (around 5MHz). They can also provide higher speeds up to 2 Mbps in a fixed or stationary wireless environment and at 384 Kbps in a mobile environment (White Paper, Motorola 2008). The migration to 4G Networks are reflected in comparison with the features as shown in Figure 1.2. 3G and 4G networks differ in many features. Some of these are
i. Data rates
ii. Services
iii. Transmission ways
iv. Access technology
v. Quality of service and security
vi. The compatibility to interface with wired backbone network

The speed of 3G can be upto 2Mbps,which is much slower than 4G which should support atleast 100Mbps peak rates in full mobility wide area coverage and 1Gbps in low mobility local area coverage (Recommendation ITU-R M.1645, 2003). 4G will be a global standard that provides global service and service portability. 4G is expected to provide global smooth roaming ubiquitously with lower cost. 3G applies the concept of circuit and packet switching for transmission with limited access technology such as WCDMA,CDMA and TD-SCDMA. However the 4G standard based on broadband IP entirely apply packet switching method of transmission with seemles access convergence (Toshio Miki et al 2005, Hidekazu Taoka and Kenichi Higuchi 2007). At 100 Mbps, almost all multimedia services existing today can be served by 4G, but the major issue is: design of air interface that efficiently support such high bandwidth requirement. Due to the very high efficiency and adaptiveness, the multi-carrier systems are the obvious choice for the next generation systems.

## MOTIVATION

The development of an adaptive resource allocation algorithm for the next-generation broadband mobile wireless networks is a highly demanding task that efficiently utilizes wireless resources and supports a variety of services. The following are the major motivation points for carrying out research on this.

i. **No ultimate medium access control protocol**: There is always room for improvement in the efficient resource allocation techniques. Every existing protocol for the next generation systems has its own limitations. Optimizing major system parameters still needs further research.
ii. **Support for high quality multimedia**: The QoS requirements for high quality multimedia are so stringent that very often the available system resources are inadequate to serve it.
iii. **The multi carrier communication systems**: The multi carrier communication technique can not only optimize the system resource, but also permit flexible and dynamic resource allocation.
iv. **The MC-CDMA / OFDMA systems**: The two broader categories of multi carrier system projected for the next generation system offer a high degree of flexibility in resource management. The MC-CDMA and OFDMA systems can support a highly adaptive and efficient medium access control protocol to optimize system resources while supporting large variety of applications.