Code Division Multiple Access Channel Resources Allocation with Applied Token Sub-Queuing for Wireless Multi-Service Packet Switch Traffics

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Code Division Multiple Access Channel Resources Allocation with Applied Token Sub-Queuing for Wireless Multi-Service Packet Switch Traffics

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Abstract. The purpose of this paper is to determine the method of Channel Resources Allocation of wireless Multi-Service Packet Switch CDMA based. As it has been known, CDMA cell has a fluctuated capacity mainly due to its varying co-channel interference. The simulation is performed to shows the characteristic for Multi-Service Packet Switch traffic such combine CBR, VBR, and ABR users is applied on CDMA system. The idea is to deliver the traffics when capacity increase from assigned minimum value, by implementing Proposed Token Sub-Queue and Multi-Service Traffic Channel Resources Algorithm. In the first time, this method is aim for non-real time traffic such ABR traffic, but the simulation shows that it can be applied further to the real-time connection by prioritizing delaying the drop calls of certain agreed QoS values to re-seize into services. The simulation of proposed method shows better CDMA channel or bandwidth utilization, and suppresses drop call probability for real-time traffic.

1. Introduction

The wireless Multi-rate Packet Switched has become the major services to deliver broadband traffic today. An efficient use of the available spectrum is achieved by finding ways to allow multiple users to share the available spectrum simultaneously. The Code Division Multiple Access (CDMA) was designed to achieve this feet [1]. To have wireless or mobile Multi-Service Packet Switched CDMA based, will form broadband wireless access cellular system that has better capacity with extra advantage that is more secure connection due to CDMA low probability to intercept property [2]. Efficient scheduling and resource allocation are essential components for enabling high-speed data access in wireless networks [3]. The resource allocation in CDMA systems has captured considerable attention during the past years. Hanly and Tse provided a survey in [4] on the characterization of the capacity region, i.e., the capacity vector consisting of the achievable throughput for each user, and the corresponding power control. Fixed dedicated allocation is assigned to constant-bit-rate (CBR) traffic. For variable-bit-rate (VBR) traffic, combination of fixed allocation and the sharing of unused slots were used. In the case of available-bit-rate (ABR) and unspecified-bit-rate (UBR) traffic, such as non-time-critical data and applications like file transfer and e-mail, dynamic allocation is used, whereby any unused slots left over from CBR and VBR traffic can be used [5]. This paper proposes the method of Channel Resources Allocation of wireless Multi-Service Packet Switch CDMA based. As have been known CDMA cell has a fluctuated capacity mainly due to its varying co-channel interference.

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2. Method

Refer to [6] the signal to noise ratio of received uplink signal of each user can be approach by equation (1).

$$\frac{S}{N} = \left\{ \left(\frac{E_b}{N_o} \right)^{-1} + \frac{m\,\alpha_{ma}}{PG} \right\}^{-1} \tag{1}$$

The probability of bit error can be approach by equation (2):

$$P_e = Q\left(\sqrt{\frac{2S}{N}} \right) \tag{2}$$

Note:

- $\frac{E_b}{N_o}$: Ratio of energy bit signal to thermal noise
- m : Number of overlapped packets.
- α_{ma} : Cross correlation inter code coefficient.
- PG : Processing Gain

Processing gain can be approach by equation (3).

$$PG \triangleq \frac{B_{ss}}{B_s} \approx \frac{T_b}{T_c} \tag{3}$$

Where T_b is a bit timing, and T_c is chip timing.

Capacity of CDMA cellular network in equation (4) is depend on probability or bit error (BER) that will be given as CDMA network services. From equation (2) this certain BER average can be obtain from certain S/N or E_b/I_o.

$$N = \frac{PG}{E_b/(N_o + \text{Interference})} \tag{4}$$

This capacity will undulate to certain average and deviation depends on interference, noise and signal power received.

3. Results and Discussion

The simulation in this paper assumes CBR and VBR traffic arrival was generated as Poisson process, VBR cells or packets are generated as MMPP models [7], and ABR traffic modelled as IBP (Interrupted Bernoulli Process) [8] (see Figure 1).

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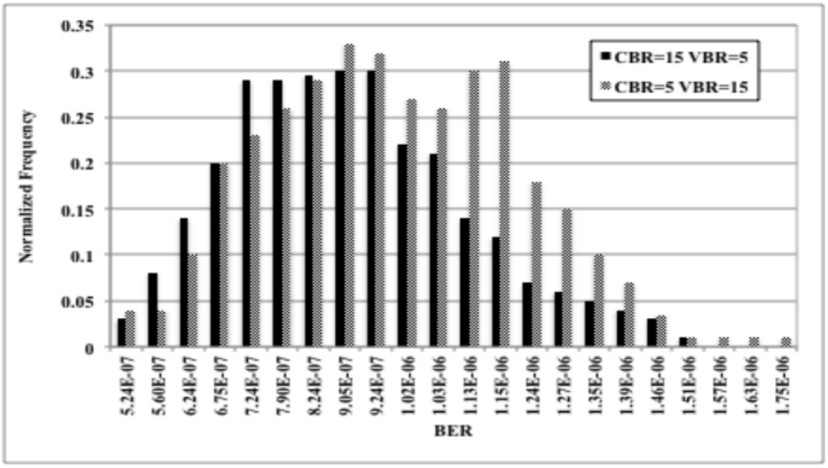

Figure 1. Simulation Result of BER distribution of 15 CBR users and 5 VBR users compare to 5 CBR users and 15 VBR users.

The traffic parameter assumptions of the simulation are: Access rate 2 Mbps, CBR rate 64 kbps, VBR active rate 1.2 Mbps, VBR idle rate 100 kbps, VBR active period 15 ms, VBR idle period 35 ms, and ABR active rate 50 ms, idle rate ms. Average (m) CDMA channel resources capacity is set to be 40 and deviation standard (σ=1). Initial parameters of users are concurrent active 20 CBR users, 5 VBR users, and 15 ABR users.

The simulation result as it shown in Figure 1, has average of BER =7.99 x 10^{-8} and variance 9.31 x 10^{-14} for 15 CBR and 5 VBR users, and average of BER=9.15x10^{-8} and variance 1.51x10^{-15} for 5 CBR and 15 VBR users. The simulation results show an increasing average (m) and deviation standard (σ) of BER and for increasing VBR terminal users due to its higher m and σ bit-rate compare to CBR traffic. The basic idea of the channel resources allocation algorithm is to utilize CDMA unused capacity to deliver ABR/UBR traffic. The further enhancement of the idea is that to utilize fluctuated CDMA capacity for real-time traffic.

At it shows in Figure 2, the traffic is modelled to 3 (three) main services, that we CBR, VBR, and ABR traffic. The CBR and VBR traffic are represent the real-time traffic, while ABR represent non real-time traffic. The Multi-Services traffics handling will be modelled as queuing system.

The active wireless/mobile users population is represented by active terminals tokens queuing. The active terminals tokens queuing system is modelled to have service rate (μ) $\mu = \mu 1 + \mu 2 + \mu 3$ which is representing the number of incoming traffic rate. The incoming real-time Traffic call request will be served directly if the maximum capacity number (M) is not exceeded. If the maximum capacity has already reached the incoming call request will be delay to certain value. This value is depended on Contract Traffic standard parameter. On the other hand, the incoming non real time (ABR) call requests will be served if there's available resource or channel capacity. In the case of out of resources or channels, the call requests will be delayed until there is an available channel. The delayed incoming calls are modelled as another queue. According to there kinds of traffic sources (CBR, VBR and ABR)[9], there are three incoming request traffic tokens queue for each kind of traffic. The in-service connections are also modelled as a queuing system (Tokens Queue).

These incoming traffics are handled separately by each queuing system (Token Calling Queue), the rate successfully served incoming called token request is represented by µtd1 for CBR, µtd2 for VBR and µtd3 for ABR. The µtd1, µtd2 and µtd3 can be considered as service rate of delayed token queuing systems of its traffic. For real-time connection (CBR or real-time VBR) will blocked call rate (µtb1 and µtb2) will be applied. The blocked calls happen when the allowable delay (based on contract

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traffic parameters) call request token is exceeded. For non real-time (ABR) call requests, blocked of the calls can be considered not happened in normal condition, this is because the acceptable delay of the call request token is unlimited or the acceptable delay is more than maximum delay of the incoming traffic token is served, but in not normal condition such there is overflow traffic is occurred, then the users can be blocked.

Each service rates µtd1 of CBR, µtd2 of VBR and µtd3 of ABR deliver each tokens to the each Tokens Queuing system, which are representing the connections in service. Once the connections stated to be served, or active, the packets or cells that contain information traffic are generated, this mechanism depict after the connections setup is confirmed then is followed by data transfer. In the case of non real-time traffic (ABR), the packets or cells might be has already generated, the packets or cells might be buffered at mobile station or base station.

In the case of real time connection (CBR and VBR) the blocked and drop call rate will be depend on the CDMA capacity fluctuation. The conventional channel resources algorithm will allow token to be served to certain value which agreed blocked call rate and acceptable drop rate frequency, which means the channels resources algorithm will not allow channel/resources allocation to exceed certain value, that optimally refer to CDMA capacity average.

The performance parameters to be simulated and analyzed on implementation of the Channel Resource Allocation Method and Algorithm are Delay Packet, Probability of Drop Calls, and Channel Resources Utilization.

1. Delay Packets Analysis.
   The simulation in Figure 2, shows delay packets impact on Sub-Queue implementation is bigger on ABR than CBR, due to the CBR (real-time) traffic priority on the Algorithm.

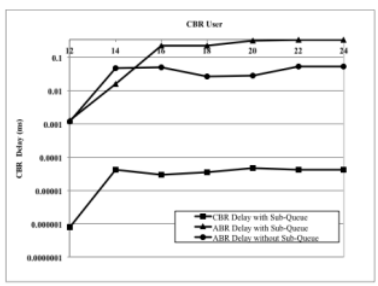
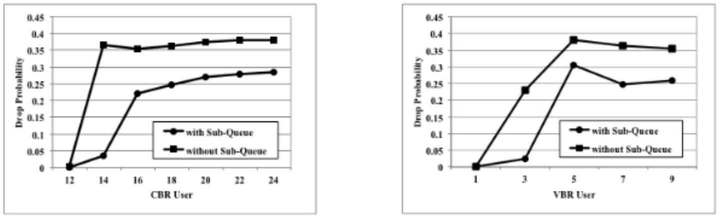


Figure 2. Packets Delay of CBR and ABR traffic on Channel Resources Algorithm and Sub-Queue Implementation.

   The implementation of Token Sub-Queue with CBR priority, increase delay of the CBR packets from 0 ms to around $4x10^{-5}$ ms, this number is still acceptable for voice delay traffic constraint [10].

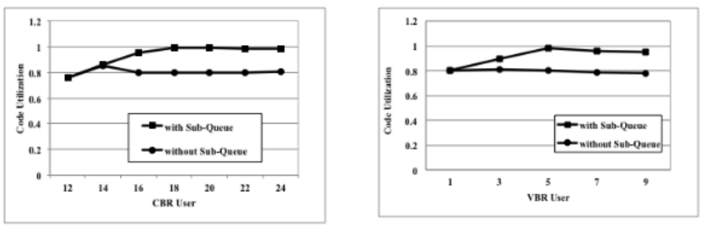
2. Probability of Drop Calls Analysis.
   The simulation in Figure 3, shows improvement of Probability of Drop Call for both real-time traffic CBR and VBR.



(a) (b)

Figure 3. Simulation of Probability Drop Call on Channel Allocation Method (a) CBR Traffic (b) VBR Traffic.

3. Utilization of Channel Resources Analysis
The simulation result in Figure 4, shows that implementation of the Token Sub-Queue with Algorithm will increase the Channel Resources Utilization from about 80% to almost 100%.



(a) (b)

Figure 4. Simulation of Channel Utilization (a) CBR Traffic (b) VBR Traffic.

4. Conclusion

The CDMA capacity that based on bit error rate (BER) performance will be fluctuated for any combination of wireless Multi-Service Packet Switched traffic, depends on number of users and traffic characteristic. The Token Sub-Queue implementation combines with Prioritized Channel Resource Algorithm on Real-Time Traffic for Wireless Multi-Services Packet Switch CDMA based, shows better channel resource utilization, hence better traffic capacity to be transferred, and better Probability of Drop Call for real-time traffic (CBR and VBR), while still have acceptable packets delay on real-time traffic services.

Acknowledgments
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