ISSN: 2250–3676

[IJESAT] INTERNATIONAL JOURNAL OF ENGINEERING SCIENCE & ADVANCED TECHNOLOGY Volume-2, Issue-4, 1066 – 1075

A NOVEL METHOD FOR DETERMINING CELLULAR ACCESS IN MOBILE COMMUNICATIONS

M. L. S. N. S. Lakshmi[1], S.Gopi Krishna[2]

[1]*M.tech(communication and radars), Department of Electronics, Koneru Lakshmaiah University, Andhra Pradesh, India,*
lalli0690@gmail.com

[2]*Associate professor,Department of Electronics ,Koneru Lakshmaih University, Andhra Pradesh, India,*
gopi.seemala@gmail.com

Abstract

The paper presents a new cellular architecture for radio access, CDPA that can be applied to present and future cellular systems, independently of the cell size. It poses as an appealing alternative to systems based on classical bandwidth subdivision methods, namely TDMA, FDMA or CDMA. In these systems, parallelism of communications is achieved by subdividing the band width "a priori" among cells. In CDPA no bandwidth sub division is operated. All cells and terminals use a single frequency channel and transmit packets on a slotted channel. Parallel transmission in different cells is achieved through the "capture" capability. A dynamic polling mechanism, C-PRMA, managed by the base station, guarantees almost immediate re transmission of packets that are not captured, thus assuring that packets are eventually correctly received. Analytical evaluations show that CDPA has the potential to provide larger capacity than the other cited systems in the case of continuous traffic sources. Furthermore, as C-PRMA is inherently apt to sustain bursty traffic, the system capacity is easily doubled in the case of packetized voice transmission using silence suppression. The paper compares the performance of two channel access schemes suitable for the cellular environment, which, in particular allow the packet capture and can deal with inter-cell interference.

Index Terms: *Packet access, c-prma, multiple access ,polling request, channel access schemes*

--- *** ---

1. INTRODUCTION

Recently, a new method for achieving spectrum reuse in cellular systems, called Capture-Division Packetized Access (CDPA), has been introduced CDPA is, in fact, a novel cellular architecture for wireless communications between Mobile Stations (MS) and Base Stations (BS), which exploits at three different levels the benefits of packet switching. The first level is the channel reuse technique, which is the method by which the same channel can be reused in different cells. The second level concerns the channel transmission scheme within a cell and the third level is the type of wireless-channel procedure to connect to the Base Stations. Two different approaches to channel reuse are currently proposed.

The first one is adopted in narrowband systems, e.g., GSM, where the system bandwidth is divided into a number of channels, and the same channel is assigned for use to a fraction of cells in such a way that the distance between cells that use the same channel is maximized and the interference is reduced to a tolerable level. The second solution is CDMA, where interference from adjacent cells is dealt with by Spread-Spectrum techniques. The price to be paid is a bandwidth subdivision in the first case, and the need for a bandwidth spreading in the second. The CDPA channel reuse technique is based on packetized transmission and the receiver capture, which is the ability of the receiver to detect a signal in the presence of interference noise. The same channel is used in all cells and transmissions in each cell occur independently of those in other cells. Since the interference from other cells changes rapidly with time because of changes in traffic conditions, transmitters and channel attenuation, packet transmission can statistically take advantage of periods in which the interference is low and the capture of packets is possible. When this happens, packets are correctly received, and parallel transmission is achieved. Otherwise, packets are retransmitted. In practice, an ALOHA retransmission scheme is used to solve "contentions" among transmissions (of different cells. If the traffic is adequately low, and a retransmission scheme is implemented, a complete reuse of the bandwidtlh does not inhibit system operation . The advantage of this approach is that the bandwidth is wasted only when necessary (i.e., to retransmit erroneous packets), as opposed to an "a priori " protection strategy, where the waste of bandwidth is always incurred. As a matter of fact, the analytical models presented in the paper show that the CDPA presents a throughput gain over classic schemes as FDMA with a 7 cell reuse pattern. The channel transrnission scheme used by CDPA within the cell, is a polling-like mechanism, C-PRMA which is very efficient because of the short propagation delays and can easily integrate different types of traffic. This access method, if coupled with a smart scheduling strategy, allows a prompt retransmission of erroneous packets, so that the total packet delay can be kept within acceptable values. This feature makes CDPA an attractive system even for delay-sensitive traffic, such as voice. Finally, the packet switching technology allows to use connection-less comrnunication between MSs and BSs. This, combined with the use of the same frequency in all cells, is expected to drastically reduce the hand-over traffic on the radio links. Capture is the capability that receivers have to detect a signal in the presence of other signals, provided that the signal to interference ratio exceeds the capture threshold.

In the cellular environment, received signal levels are strongly influenced by the near far effect and the fading phenomenon, which make the signal levels randomly vary. Thus capture becomes a probabilistic phenomenon, whose failure is naturally handled by retransmission techniques.

The mobile radio system is demanded to offer radio access to the wide area network services, which is traditionally provided by local networks. The huge amount of bandwidth required is obtained by organizing a geographical distribution of base stations that collect and administer the traffic from their surrounding region, called cell, and by providing means for getting transmission parallelism among different cells. In the following introductory discussion, we ignore the transmission from many terminals to the base station, i.e., the multiple-access problem, and concentrate on the transmission parallelism, or bandwidth reuse problem, which occurs when several transmitter receiver pairs communicate to each other using the techniques provide the same reuse factor of l/f = 1/1.CDMA operates in a different way. All cells are assigned the whole spectrum and the required SIR is achieved by using appropriate coding (spread spectrum). Usually, CDMA also provides the multiple access and the code protects against interference from terminals inside the cell as well. Here the reuse1/c is due to the fraction c of the whole bandwidth reduction needed to protect against interference from outside the cell. In practice, the bandwidth reuse obtained by CDMA is comparable to that of FDMA and TDMA. Once a technique for bandwidth reuse is adopted, the bandwidth available at a cell can be shared among terminals with different access methods, that can be still based on FDMA, TDMA and CDMA. For example, TDMA has been proposed as access method in conjunction with a FDMA reuse method, while a unique CDMA system can provide both access and bandwidth reuse and benefits from advantages offered by this integrated solution, as, for example, flexibility in using some of the bandwidth unused by other cells. If packet switching is used instead of circuit switching, a correct transmission can be achieved even if capture is not always successful. In fact, when this is the case, recovery can be obtained by retransmitting the incorrectly received packet. Therefore, packet switching offers an alternative to obtain bandwidth reuse. In this paper we show that capture can be effectively used in conjunction with packet switching to obtain a new frequency reuse method, that we call Capture-Division Packetized Access (CDPA).

This technique can provide better bandwidth efficiency than classical methods and is suitable for both data and voice. The parallelism is achieved when different overlapping transmissions are captured by different receivers. Unlike FDMA, TDMA and CDMA, that require an “a priori“ bandwidth pattern subdivision to reduce interference and provide safe communications, CDPA operates “a posteriori”, since it uses packet retransmissions to recover from collisions due to interference from other cells. The packets which get lost because of insufficient power discrimination are retransmitted until they are successfully received.

The retransmission strategy is expected to be effective because of the high probability that the effect of interference changes from slot to slot due to changes of transmitting terminals and/or changes of fading conditions. Further provisions, such as the selection among different transmitting power levels, can also be adopted to facilitate capture. The retransmission processor however, wastes bandwidth and the proposed method is advantageous if the loss in capacity does not exceed the fraction of bandwidth assigned to adjacent cells in classical systems, which amounts to 6/7 times, in a FDMA cellular pattern with 7 cells. CDPA spends bandwidth resources to coordinate transmissions only when needed and this should grant greater efficiency than the systems in which such an overhead is always wasted.

Recently, a cellular system that uses capture division associated with the Slotted ALOHA has been studied in the previous versions. In this system, retransmissions are used to achieve both the radio access within the cells and the bandwidth reuse. It is shown that the transmission parallelism achieved by the capture division compensates the bandwidth wasted by retransmissions and that a throughput increase is obtained in the case of speech sources with silence suppression.

In this work we present a preliminary throughput analysis of the terminal-to-base channel (inbound channel) obtained by CDPA, while the reverse base-to terminal channel is supposed ideal and capable to provide immediate base responses to inbound transmissions. The access protocol that we assume in CDPA is the Centralized packet reservation multiple access(C-PRMA), introduced in as a more dynamic version of packet reservation multiple access(PRMA) . In this new protocol the base station acts as a centralized scheduler, so that collisions among terminals in the same cell are avoided. The central scheduler is very effective and flexible in assigning transmission time slots and it allows for immediate retransmission of packets, which is a key issue for real-time data and voice transmission. The analysis refers to continuous sources and does not take into account packet losses due to expiration of the maximum allowable delay. In this analysis we present CDPA Is a suitable access scheme for this architecture.

2. CDPA

The Capture Division Packetized-Access is a cellular access architecture where the same frequency is used in all cells and information is transmitted in packets. In this work we examine the terminal-to-base channel only and suppose that the base-to-terminal communication is such as to provide immediate and error free feedback to inbound transmissions. In particular, we assume that the time axis is subdivided into time slots equal to the packet transmission time and that slots are aligned in all cells. The terminal access to the inbound channel is obtained according to the C-PRMA protocol that, apart from slot synchronization, is asynchronously run in each cell. Packets that are transmitted in the same slot in different cells overlap and may cause incorrect packet detection at the receiver if capture is unsuccessful. CPRMA guarantees that the packet transmissions from terminals in the same cell do not overlap. The time slots are in fact marked by the base station as available or reserved. A terminal is allowed to transmit a packet only when polled, i.e., in a reserved slot. Available slots are used to transmit signalling mini packets for call set-up and tear-down, for the execution of handoffs, and to signal the beginning of transmission bursts (e.g., voice talkspurts). In this paper we are concerned with a preliminary evaluation of the CDPA capacity, directly comparable with the capacity assumed for classical cellular schemes. Thus, we assume continuous traffic sources, so that the impact of the signalling traffic, as a first approximation, can be neglected.

Reserved slots are scheduled by the base station according to a Scheduling Algorithm (SA), thoroughly described in .In the simplified version in which reservation traffic is absent the SA operates as a queue which is fed by polling requests as soon as packets become ready for transmission at the terminals. The polling requests are ordered in the queue, according to the time the packets can wait before being discarded, and are served by releasing reserved slots. The polling requests of unsuccessfully transmitted packets immediately re enter the queue. Polling requests of discarded packets are also discarded.

The effectiveness of C-PRMA in recovering unsuccessful packet transmissions is the key issue for its utilization in CDPA architecture. Note that the potential of C-PRMA as a protocol to manage reservations in a cellular environment is fully exploited in this situation, where other commonly considered schemes, such as classic TDMA/FDMA or even PRMA, cannot operate properly, due to exceedingly large interference. Infact, even though the SA described was designed for a single cell environment, in which retransmissions are rare, it basically applies with minor changes also to the CDPA multi cell system. The differences are due to the increased retransmission rate, especially by terminals suffering higher interference because of their position in the cell, and the need for a control mechanism that assures a system operation in optimal conditions.

The first problem is solved by introducing, in the polling-queue ordering mechanism, a further dominating priority arrangement in which highest priority is given to the first transmission, second highest priority to the second transmission of the same packet and so on. The control mechanism may be obtained, as in ALOHA protocols, by issuing reserved slots with a given probability, which in our case is equal to the value G of the offered traffic per cell that maximizes the throughput. Note that more sophisticated traffic control techniques can be used because, unlike in ALOHA, the terminal transmissions are under the complete control of the base station. To this goal, a coordination among the surrounding base stations can be acheived. Surrounding base stations can be easily achieved.

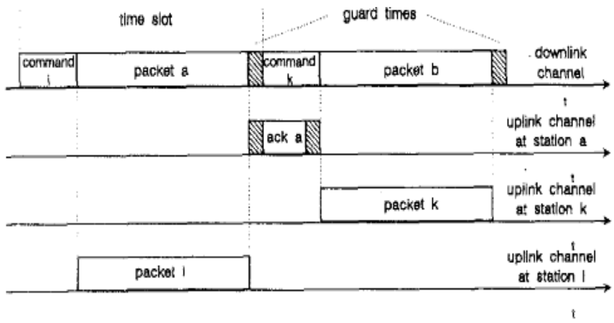

Fig. 1. Uplink and downlink-channel time relationship.

The Capture-Division Packetized Access is a cellular access architecture that operates on a packet switching basis. Transmissions from Mobile Stations (MS) to Base Stations (BS) use the uplink channel, while transmissions from BSs to MSs Use the downlink channel. For sake of simplicity, in the following we assume that two disjoint frequency bands are assigned to these channels for narrowband transmission. The implementation of each channel uses the same frequency in all cells. The transmissions on both channels are temporally and logically driven by the BS, which periodically releases commands on the downlink channel. The time between consecutive commands is constant and defines the channel slot as a logical entity that can be usefully referred to in the sequel.

Uplink packet transmissions occur as depicted in Fig 1, where all signals are observed by three MSs, assumed at the same distance from the BS. Commands, like in polling systems, trigger the immediate response of the polled station (processing times are ignored). The time between two consecutive commands is set equal to the packet transmission time plus the maximum round trip delay, 2r. This guard time is needed, in order to allow the complete reception of uplink packets before a new command is issued. An unsuccessful MS transmission is promptly recognized by the BS, which can reschedule a new attempt by issuing the appropriate command. In the downlink channel, packets are transmitted by the BS after the command. This transmission, however, requires an explicit acknowledgment, which is transmitted by the MS starting 2r seconds after the BS packet has been received, to avoid overlapping with the packet transmission from another MS. The above procedure, which manages the packet transmissions on the radio channel, allows the immediate retransmission of corrupted packets. It is used in CDPA, together with a scheduling algorithm, to overcome the packet errors due to collisions among transmissions in different cells. A key role in accomplishing prompt retransmissions is played by the scheduling algorithm, which must be flexible enough to efficiently integrate transmissions and retransmissions, according to the specific needs of each source. In particular, it must be able to support constant rate traffic, such as voice with or without silence suppression, and data traffic with different constraints. We remark that an algorithm with these features will make possible packet voice transmission with retransmission recovery, a technique usually not considered due to delay constraints. A possible implementation of such a algorithm is C-PRMA, . However, in this paper we will refer to simplified versions of the algorithm, suitable for constant rate traffic only. The effective multiplexing of discontinuous sources requires an MS to be polled only when ready to transmit. While the polling mechanism can be interrupted simply by a flag in the MS packet header, the polling resume requires a further signaling channel from MS to BS to transmit a connection request (CR). Such a signal is also used to start a new connection set up. Therefore, besides uplink reserved slots, i.e. slots dedicated to packet transmissions, some uplink slots are dedicated to the transmission of CRs. These slots, signalling slots, are declared by appropriate commands in the downlink channel and can be used by all MSs willing to send CRs. A possibility is to subdivide the signalling slot into several mini-slots that can be used by MSs according to some random access technique. As in this paper we are only interested in the performance evaluation of the channel reuse technique, this issue will no longer be considered.

In this paper, we ignore the errors in ACK and command transmissions, caused by co channel interference. As these errors drastically reduce the system throughput, the adequate protection of ACKs and commands is to be accomplished by means of specific transmission techniques. The effectiveness of specific coding techniques and the impact on system performance are discussed in this paper, we also assume that the transmissions of commands at different BSs are synchronized. This assumption, although not strictly required for system operation, positively affects the system performance, as in the case of Pure and Slotted Aloha, and simplifies the performance analysis.

3. THROUGHPUT ANALYSIS IN CDPA

In this section we derive the throughput of the inbound channel of a cellular system operating under the CDPA technique. To carry out the analysis we make the following assumptions. The terminals are geographically distributed on the plane according to a Poisson point process of intensity A terminals/m2. The base stations are evenly spaced on the plane, at the centre of ideal cells (assumed of unit radius), and operate with omni-directional antennas. Each terminal is supposed to talk to the nearest base station and to transmit using a unique carrier frequency, thus achieving a complete frequency reuse. Packet transmissions are synchronized on a unique slotted time basis, so that multiple transmissions overlap completely.

The power R_i, received at the base station from terminal i, located at distance r_j, is computed assuming a propagation model that takes into account Rayleigh fading, due to multipath, log-normal shadowing, due to the terrain irregularities, and a 77-th power loss law. The propagation loss exponent 77 typically takes values close to 4. The received power R_i is therefore given by

$$R_i = \alpha_i^2 e^{\xi_i} K r_i^{-\eta} P_T, \qquad (1)$$

where α^2_i is an exponentially distributed random variable with unit mean, is a Gaussian random variable, with zero mean and variance σ^2, $Kr^{-\eta}_i$ " accounts for the power loss law, and P_T is the transmitted power, assumed the same for all terminals.

The probability, P,, that the packet transmitted by terminal "0" is successfully received when N ≥ 1 other packets are overlapping at the base station is given by

$$P_s = P\left[\frac{\alpha_0^2 e^{\xi_0} K r_0^{-\eta} P_T}{\sum_{i=1}^{N} \alpha_i^2 e^{\xi_i} K r_i^{-\eta} P_T} > b\right], \qquad (2)$$

where b is the capture ratio. Depending on the distribution of the r_i's in (2), different situations can be taken into account. Note that, since in the present context we are focusing only on reserved slots, the N + 1 transmitters are located in different cells. Packets that have failed transmission (with probability 1 - P_s) join the new ones in attempting transmission and constitute the offered traffic, which we characterize by the steady-state intensity G packets per slot per cell. As the probability P_s depends on T_O, the density of packets to be transmitted, i.e., the offered traffic in an elementary area at distance r , g(r) ,rdr $d\theta$ packets/slot, also depends on T (note that, due to the circular symmetry, there is no dependence on 0). The total offered traffic in a cell can thus be expressed as

$$G = \int_0^1 2\pi r g(r) dr. \qquad (3)$$

Similarly, the throughput is given by

$$S = \int_0^1 2\pi r s(r) dr \qquad (4)$$

where s(r) is the throughput density.

$$P_s(G, r_0) = \int_{-\infty}^{\infty} d\xi \frac{e^{-\frac{\xi^2}{2\sigma^2}}}{\sqrt{2\pi}\sigma} e^{-GJ(\xi, r_0)}, \qquad (5)$$

The success probability P_s depends in turn on the density law g (z , y) that the offered traffic presents on the plane. Even with the Poisson assumption for the terminal locations, g(z, y) is not uniform because of the argument exposed above and this introduces an intractable complexity. Moreover, in CDPA the interfering transmissions come from other cells and they can be at most one per cell, which further complicates the model. To proceed with the analysis we make the following assumptions:

I. The terminals generating interfering transmissions are uniformly distributed outside the cell according to the spatial Poisson model.

II. The interfering transmissions are generated by each terminal independently of other terminals and from slot to slot in such a way that they collectively obey to a Poisson model of intensity G packets per slot per cell.

III. The variables $\alpha^2_i$and ε_i are drawn independently at each transmission.

The rationale of assumption III stems from the fact that fading conditions, in narrowband transmissions, can be assumed independent from slot to slot. The above assumptions simplify the analysis as they lead to ignore the spatial and time correlations and cross correlations that exist in real systems. As a consequence, the distribution of the interference power and the capture process depend only on G. The evaluation of P_s is obtained by evaluating the probability (2), where N is a Poisson random variable and r_i,i = 1,. , N , are linearly distributed on the plane (i.e., the users locations are uniformly distributed), according to the Poisson assumptions I and .At the end of the averaging process, that includes averages on $\alpha^2_i$and ε_i, we obtain

Where

$$J(\xi, r_0) = \int_{-\infty}^{\infty} dx \frac{e^{-\frac{x^2}{2\sigma^2}}}{\sqrt{2\pi}\sigma} \int_1^{\infty} \frac{2r dr}{1 + b^{-1} e^{\xi - x} \left(\frac{r_0}{r}\right)^{\eta}} \qquad (6)$$

The throughput is then evaluated assuming that there is equilibrium between the newly generated traffic and the traffic that is correctly transmitted, i.e.:

$$S(r)=P_s(G,r)g(r) \qquad (7)$$

The above equation represents a generalization eq. No general solution has been found. Fortunately, a simple solution exists for the practical case in which a uniform throughput is required. In this case, s(r) ≡ s and S =πs, where π is the area of the cell. Thus, substituting in (3) g(r) obtained from (7), we have

$$G = \int_0^1 2\pi r dr \frac{s}{P_s(G, r)}, \qquad (8)$$

and therefore, the throughput as function of G can be derived by (7) as:

$$S(G) = \pi s = G\left(\int_0^1 \frac{2r dr}{P_s(G, r)}\right)^{-1}. \qquad (9)$$

In the following Section we present some numerical results for the throughput in CDPA, with different system parameters. For comparison reasons, we will show also the results obtained when S-ALOHA is used as access method instead of C-PRMA. The analysis carried out so far also applies to S-ALOHA. The only difference is that in the latter system interfering transmissions can also be generated by terminals within the same cell of terminal 0. This is simply taken into account by changing from 1 to 0 the inferior limit of the inner integral . Note that, even in this case, the intended user is located according to the function g(r), whereas all interferers (even those in the test cell, whose presence is not excluded under S-ALOHA) are assumed to follow the Poisson distribution. Although approximate, this comparison directly shows the effect of having no intra cell collisions, as guaranteed by C-PRMA. Of course, the Ps for the S-ALOHA turns out to be smaller than that for CDPA.

ISSN: 2250–3676
[IJESAT] INTERNATIONAL JOURNAL OF ENGINEERING SCIENCE & ADVANCED TECHNOLOGY Volume-2, Issue-4, 1066 – 1075

4. NUMERICAL RESULTS

The approximate analysis presented in the previous section provides a first-order evaluation of the throughput in CDPA and S-ALOHA systems. Fig 2 and 3 summarize the numerical results as function of G for $\eta = 4$ and for different values of the capture ratio b and the shadowing parameter σ. The offered traffic is limited to G = 1, which is the maximum possible value in CDPA since no more than a single packet transmission per cell can be attempted in a slot. The curves confirm that CDPA always behaves better than S-ALOHA and show that the congestion problem is present also in CDPA, though to a less extent than in S-ALOHA. The control needed to achieve the maximum performance is easily implemented in CDPA because the throughput and the offered traffic G are completely under control of the base stations, which can easily exchange information and take control measures collectively.

In all the examined cases, the maximum throughput of CDPA is comparable or even superior to the throughput of the classic cellular pattern with 7 frequencies, which would be equal to 1/7 = 0.143 if this cellular reuse scheme guaranteed zero interference. Even though this is often assumed, recent studies have shown that the interference with this frequency reuse pattern is not negligible, and a probability of outage of 10-20% is realistic, even for small values of the outage threshold (capture ratio), b 11, 121. Therefore, with a more precise assessment of the performance of cellular systems of this sort, CDPA would gain even further over classic schemes. Note from Fig 1 that the throughput of CDPA can be as high as 0.335, which represents a gain factor of 2.3 over cellular FDMA.

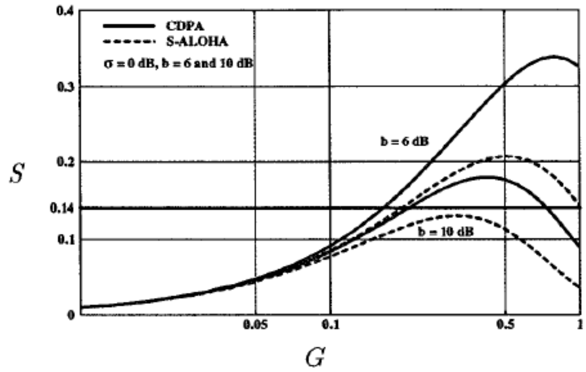

Fig. 2. Average throughput per cell, S, vs. the offered loadper cell, G: Slotted ALOHA (dotted) and CDPA (solid) compared; σ = 0 dB, b = 6 and 10 dB.

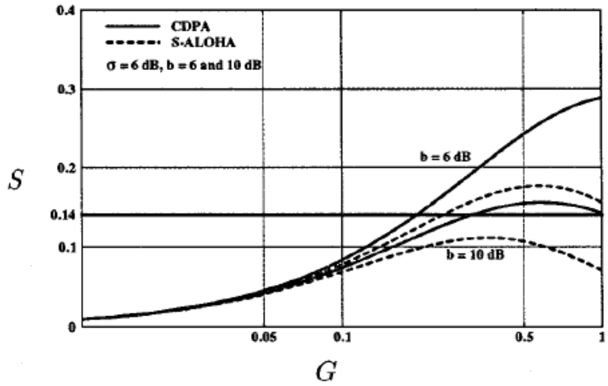

Fig. 3. Average throughput per cell, S, vs. the offered load per cell, G: Slotted ALOHA (dotted) and CDPA (solid) compared; σ = 6 dB, b = 6 and 10 dB.

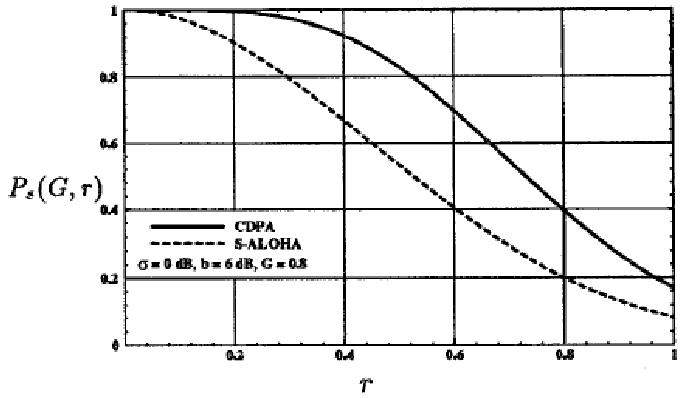

Fig. 4. Success probability, P,(G, T) , vs. the distance T , for G = 0.8: Slotted ALOHA (dotted) and CDPA (solid) compared; σ= 0 dB, b = 6 dB.

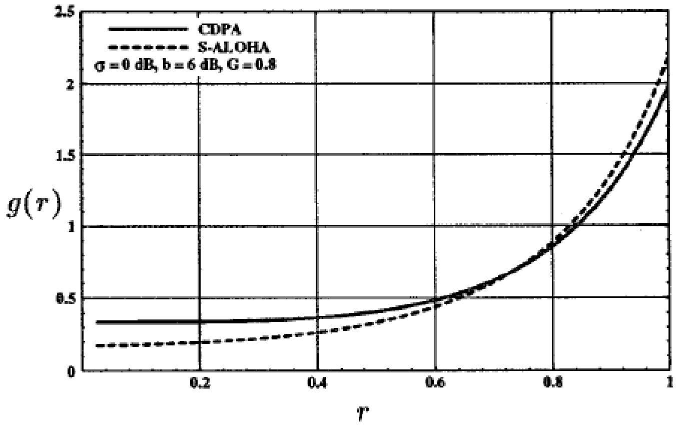

Fig.5. Density of offered traffic, g(T), vs. the distance T , for G = 0.8: Slotted ALOHA (dotted) and CDPA (solid) compared; σ = 0 dB, b = 6 dB.

Fig 4 shows, for the case of σ = 0 dB, b = 6 dB and G = 0.8 (corresponding to maximum S, see Fig. 2), the probability P_s that a packet is successfully received vs. the distance F of the intended terminal from the base station. For the same set of parameters as above, Fig 5 shows the behaviour of the offered traffic distribution g(r) vs. T. For F = 0, a packet is always correctly received and thus g = s. The ratio between g(r) and g(0) represents the average number of transmissions needed to get a successful packet transmission at the edge of the cell, which corresponds to the worst case, g(1)/g(0) ~ 6 The results presented above confirm that CDPA has the potential to outperform the classic systems as far as the traffic capacity is concerned. However, we are aware that other issues, neglected in this preliminary analysis, must be thoroughly investigated.

Among these, we must consider the interference correlation among transmissions by the same terminal. More detailed issues may concern the implementation of the signaling channel that in C-PRMA requires high protection. Also, migration of users toward the edge could cause too impaired transmission conditions and perhaps some mixed Capture-Division/Time-Division technique, with coordination among the base stations, could be adopted to face these situations.

5. SLOTTED ALOHA ANALYSIS

Here we assume that the signals that reach the BS are all generated by MSs within the considered cell, which all transmit according to the S-ALOHA protocol. If required condition is not met, the packet transmission fails, and a retransmission is scheduled. We also assume that the successfully transmitted packets are acknowledged by the BS and that the acknowledgments are always correctly received. The S-ALOHA analysis is based on the "infinite population model" which assumes that transmission attem ts in a cell are Poisson distributed with a spatial density gr), being r the distance from the BS. More precisely, the offered number of transmissions generated in the circular ring of radii r and r + dr is a Poisson random variable with mean 2πg(r)dr. Here and in the rest of the paper we assume, for analytical convenience and without loss in generality, that the hexagonal cell is approximated by a circle of unit radius, so that, due to the circular symmetry, the angular component is irrelevant. The probability of successful transmission P, depends on the intended user's location and the location of the interfering sources. If we consider a single cell S-ALOHA system with a single class of users, the possible interfering users are the MSs in the cell and the probability of successful transmission P_{sc}, which is averaged over the interfering users locations, now depends on the density g(r) . Then the total offered traffic in a cell can be expressed as

$$G = \int_0^1 2\pi r dr g(r) \tag{10}$$

and the probability of a successful transmission P_s, which is the average of (4) with respect to the number $k_1$of interfering packets all of the same class (k_2 = 0), is

$$P_s(r_0, g(.)) = \sum_{k_1=0}^{\infty} \frac{e^{-G} G^{k_1}}{k_1!} [I_1(r_0, g(.))]^{k_1} = e^{-J_1(r_0, g(.))} \tag{11}$$

Where

$$J_1(r_0) = G\left(1 - E\left[\frac{1}{1 + b\left(\frac{r}{r_0}\right)^{-\eta}}\right]\right) = = \int_0^1 \frac{2rdr\pi g(r)}{1 + b^{-1}\left(\frac{r}{r_0}\right)^{\eta}}. \tag{12}$$

The throughput spatial density can then be written as

$$s(r) = P_s(r, g(.))g(r). \tag{13}$$

As usual, if equilibrium is assumed between the newly generated traffic s(r) and the throughput, then g(r) is the steady state density of the sum of the newly generated packets and the backlog packets.

Equation (13) represents a generalization, which admits no general solution.

Fortunately, a simple solution exists for the practical case, assumed in this paper, in which a uniform throughput is required. If S denotes the throughput of the cell, the throughput density is S/π and the curve g(r) can be computed from

$$g(r_0) = \frac{S}{\pi P_s(r_0, g(.))} = \frac{S}{\pi} \exp\left(\int_0^1 \frac{2rdr\pi g(r)}{1 + b^{-1}\left(\frac{r}{r_0}\right)^{\eta}}\right) \tag{14}$$

Eq. (14) cannot be easily solved to find the function g(r). A possibility, suggested is to iterative1 find the function g(r), by starting, for example, from g(r) ≡ S/π. We found by direct computation that there exists a value, SO, such that the iterative procedure converges if S < SO and, after a sufficient number of steps, the solution g(r) is found. We also observed that the initial distribution of traffic does not affect the final solution, provided that the algorithm converges. If the initial traffic load (or the required throughput, S) is larger than SO, the algorithm does not converge. The latter behaviour reflects the operation of the system in the unstable region and therefore SO is interpreted as the maximum throughput.

A further interesting issue is the effect of power control on the system performance. In fact, on one side the system so far considered is unbalanced because users closer to cell border experience higher collision probability and must attempt transmission more often. Since we require uniform throughput, performance is dominated by the worst case. Thus, if the performance of the far users is improved, we expect an overall performance increase. Controlling the transmitted power in such a way that, on the average, the signal of all users are received with the same power is a simple way to eliminate this performance unbalancing. On the other hand, eliminating the differences in the received power is expected to degrade the capture effect, and it is not clear which of the two conflicting effects will prevail. The extension of the analysis to perfect power control is very simple. In this case, the transmitted power, W_T,is inversely proportional to the path loss, $r^{-\eta}$ and the received power varies only because of fading. The probability of success, which is now equal for all users, is found as

$$P_s = \exp\left[-G\left(1-\frac{1}{1+b}\right)\right] = \exp\left(-\frac{bG}{1+b}\right) \qquad (15)$$

and the average throughput is

$$S = P_s G = G\exp\left(-\frac{bG}{1+b}\right) \qquad (16)$$

which reaches the maximum S* = (1 +b)/b e^{-1} for G = 1 +l/b.

The throughput results are shown in Fig 1 as function of the global channel load G for two values of the capture threshold, namely b= 6dBandb= 10dB.The curves with no power control are reported only for those values of S that assure the convergence of the evaluation procedure. The maximum observed throughput is 0.54 pkt/slot for b = 6 dB and 0.46 pkt/slot for b = 10 dB. If power control is used the performance slightly decreases, showing that the advantage of having a performance balance among users is

Over weighed by the reduced capture effect due to the more uniform power received. Note also that in this case the fading is crucial to the performance. Otherwise the analysis reduces to the classical case and throughput drops to 0.36.

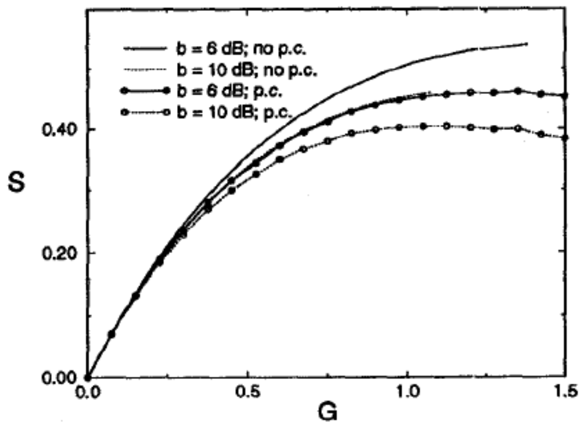

Fig. 6: Throughput S versus the offered load G for single cell S-ALOHA with and without power control.

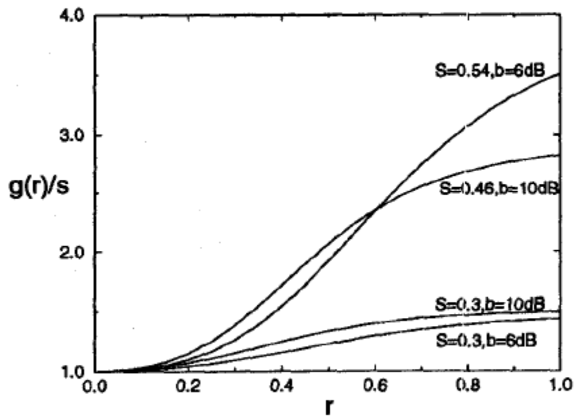

Fig. 7: Normalized channel-traffic density g(r)/s vs. the distance r for single cell S-ALOHA without power control.

In Fig 7 we show the normalized channel load density g(r)/s as function of the distance P from BS and for the two values of the capture threshold already cited, Only the case without power control is plotted, since with power control g(r) is independent of r.

6. ANALYSIS OF CDPA AND SLOTTED ALOHA

As already mentioned in the introductory section, the Capture-Division Packetized Access assumes a protocol that coordinates the transmission of MSs within the same cell, whereas no attempt is made to coordinate the transmission of MSs belonging to different cells 124. In CDPA the uplink transmission is logically driven by the BS, which at each slot releases commands, on the downlink channel, that specify the use of that slot. This technique can be implemented in different ways. One is exemplified in Fig 7, where all signals are observed by three MSs, assumed at the same distance from the BS. Commands are used like in polling systems and trigger the immediate response of the polled station (processing times are ignored). An unsuccessful MS transmission is promptly recognized by the BS, which can reschedule a new attempt by issuing the appropriate command. Note that, since the whole systems may operate under strong co-channel interference, commands too could be incorrectly received if no means to protect them from the co-channel interference is assumed. However, to be consistent with the the S-ALOHA model, in which acknowledgments are assumed error-free, here too we assume that commands are always correctly received. Commands, in fact, carry out the same function as acknowledgments in S-ALOHA: they confirm the correct reception of previously transmitted packets and solicit the transmission of the next one. The difference is that in commands the address of the next transmission is specified instead of the address of the previous transmission.

The CDPA analysis is simpler than in the multi-cellular S-ALOHA case because at most one user at a time can be transmitting in each cell and an unsuccessful reception is caused only by inter-cell interfering transmissions. This also changes the interfering traffic from outside, since now it consists of at most one packet per cell. However, due to the fact that interference is caused by a great number of cells, the approximation made by assuming the uniform Poisson model for the interfering traffic is still acceptable, as proven by the simulation results presented With this assumption, the probability of success can be derived by setting ,k_1 = 0 in below equation.

$$P_s^{(a)}(r_0, g(.)) = \sum_{k_1=0}^{\infty} \frac{e^{-G}G^{k_1}}{k_1!}[I_1(r_0, g(.))]^{k_1} \times \times \sum_{k_2=0}^{\infty} \frac{e^{-G(a^2-1)}(G(a^2-1))^{k_2}}{k_2!}[I_2^{(a)}(r_0)]^{k_2} = = e^{-J_1(r_0,g(.))-GJ_2^{(a)}(r_0)} \quad (18)$$

Thus, the result depends on g(r) only through its integral, G, and we obtain

$$G = \int_0^1 \frac{2\pi r drs}{P_s(G,r)}, \quad (19)$$

from which s can be derived to give the throughput as function of G:

$$S(G) = \pi s = G\left(\int_0^1 \frac{2rdr}{P_s(G,r)}\right)^{-1} \quad (20)$$

Therefore, in this case no recursion is needed.

If power control is used, again g(r) becomes constant and the same procedure used in multi-cellular S-ALOHA provides P_s (G) and S(G). The throughput results for the multiple cell environment are reported in Fig 6. Note that with CDPA the channel load G cannot be increased beyond G = 1 because no more than one station per cell can be transmitting at the same time. The maximum attainable throughput is 0.34 pkt/slot for b = 6 dB and0.18pkt/slot for b = l0dB, which denotes are markable throughput increase with respect to multiple cell S-ALOHA (note that the single cell S-ALOHA should be compared with a single cell CDPA, which has a maximum throughput of 1 pkt/slot). The improvement of CDPA with respect to the multiple cell S-ALOHA is to be ascribed to the complete removal of the intra-cell interference. This removal also eliminates the negative effect of power control, which now offers improved performance.

7. CONCLUSION

In this paper we have introduced capture division as a means to get bandwidth reuse in cellular systems. We have proposed an access architecture and performed a throughput analysis for the case in which the technique is applied to the terminal-to-base channel only. More important, our results prove the validity of the approach that privileges retransmission as opposed to an a priori bandwidth subdivision. This philosophy promises further bandwidth advantages if applied extensively to radio channels. Among other relevant advantages that CDPA offers, we point out the single frequency operation which allows, as in CDMA, to reduce the complexity of transmitters and receivers, and to simplify the handover procedures at the physical level. Also the use of power control, which enables a terminal to reduce its transmitting power as it gets closer to its base station, is a further means to increase the efficiency, due to the decreased interference. We have shown that, besides providing more throughput than S-ALOHA, CDPA presents additional advantages, such as stable operation, the effective ability to deliver uniform throughput and to guarantee a bounded delay, which make this system suitable for time constrained service such as voice. Moreover, CDPA can integrate S-ALOHA to provide signalling and single packet transmission.

These results encourage a deeper investigation that can take into account additional issues, neglected in the present analysis, such as a more precise model of the propagation effects and the access protocol, a delay analysis, the inclusion of signalling channels, and the extension of the technique to the base-to-terminal channel. The model must be refined to take into account the possible fragility of acknowledgments and commands, to model additional propagation effects such as lognormal shadowing, and to investigate other transmission strategies, such as, for example, the introduction of a random component in the transmitted levels.

REFERENCES

[1] Zorzi, "C-PRMA: the Centralized Packet Reservation Multiple Access for local wireless communications", to be presented at IEEE GLOBECOM. 2010.

[2] K. S. Gilhousen, I. M. Jacobs, R. Padovani, A. J. Viterbi, L. A. Weaver, Jr, and C. E. Wheatley 111, "On the capacity of a cellular CDMA system", IEEE Trans. Veh. Tech., vol. VT-40, pp. 303-312, May 2007

[3] M. Zorzi, S. Pupolin, "Outage probability in multiple access packet radio networks in the presence of fading", to appear on IEEE Trans. Veh. Tech 2006

ISSN: 2250–3676
[IJESAT] INTERNATIONAL JOURNAL OF ENGINEERING SCIENCE & ADVANCED TECHNOLOGY Volume-2, Issue-4, 1066 – 1075

[4] C.K. Siew, D.J. Goodman, "Packet data transmission over mobile radio chanels", IEEE Trans. Veh. Tech., vol. VT-38, pp. 95-101, May 2006.

[5] M. Zorzi, L. Tomba, "A comparison of CDMA, TDMA and Slotted ALOHA multiple access schemes in cellular mobile radio systems", in Proc. ICCC WCN'94, The Hague, Netherlands, 21-23 Sep. 2005.

[6] C.T. Lau and C. bung, ''Capture models for mobile packet radio networks", IEEE Trans. Comm., vol. COM-40, pp. 917-925, May2002

[7] N. Abramson, "The throughput of packet broadcasting channels",IEEE Trans. on C o m , vol. COM-25, pp. 117-128, Jan. 2007

[8] J.C. Arnbakand W. van Blitterswijk, "Capacity of slotted ALOHA in Rayleigh-fading channels", IEEE Journal on Select. Areas in CO", vol. SAC-5, pp. 261-269, Feb. 2004.

[9] J. E. Padgett, C. G. Gunther, and T. Hattori, "Overview of wireless personalcommunications",IEEECommunM.a g., vol. 33, Jan. 1999.

AUTHORS BIBILOGRAPHY

M.L.S.N.S Lakshmi received her diploma in Electronics and Communications in Govt. Polytechnic for Women Guntur (Andhra Pradesh) in (2008),B.Tech degree in Electronics And Communication Engineering from Vignan's Engineering college affiliated to JNTU Kakinada, (in 2011) and presently doing her M.Tech in Communications and Radars from Koneru Lakshmaiah University (KLU) situated in Vaddeswaram near to Vijayawada (Andhra Pradesh). Currently she is doing research at the laboratories of mobile and wireless communications in the Department of Electronics and Communication Engineering at KL University. Her research interests lie in channel allocation strategies, assignment schemes, hand off techniques, call blocking probabilities, access techniques& queuing techniques, related to mobile and wireless communications.

Gopi Krishna.Seemala received B.S.C electronics degree from Andhra university Visakhapatnam (Andhra pradesh) in 1999.and M.S.C electronics in 2001,and doctorate in physics(phd)from same university in 2002.from 2002-2007 he worked as a senior research fellow in Andhra University under the Guidance of PROF.P.V.S RAMA RAO Physics Dept, Andhra University and from 2007 he worked as a research scientist in Institute For scientific research ,Boston college, Boston U.S.A. later he worked as a post doctoral research scientist (2007-2009) in the same college .having Hands on experience on Real time monitoring TEC, and scintillations using the LISN(low latitude ionospheric sensor network)producing TEC maps and possible prediction of scintillations. He published more than 20 research publications in territial atmospheric, and oceanic sciences journal of geophysical research, Journal of earth planets and sciences, journal of atmospheric and solar territial physics and presented papers on communication journals. Presently he is working as a associate professor in Koneru Lakshmaiah university.