RESEARCH ARTICLE OPEN ACCESS

Delay Limited Transmission Techniques with Low Density Parity Check Method of Quasi Stationary Sources Over Block Fading Channels

Dr. T. V. S. Prasad Gupta, A. SrinivasaRao, J. Anusha,
Head of ECE Department, MVR College of Engineering and Technology
M.Tech, Assistant Professor, MVR College of Engineering & Technology
M.Tech Student, MVR College of Engineering & Technology

Abstract
In a Quasi stationary sources time utilization takes a major role. To implement the delay limited transmission of Quasi stationary sources over block fading channels is considered. Here to reduce the delay we propose the power adaption schemes here we can implement the analytical distortion outage probability as performance measure and also derive the power of each transmission scheme.transmission are presented. The first one is optimizedfor fixed rate transmission, and hence enjoys simplicity of implementation. The second one is a high performance scheme, which also benefits from optimized rate adaptation with respect to source and channel states.for High SNR regime ,the asymptotic outage distortion gain are derived.here another two schemes with fixed transmission powers and adaptive rates are consider for comparisions here source and channel coded optimized power adaption scheme outperforms compare to other schemes,by adding the low density parity check method the delay can be reduced rapidly by using the proposed method.
Keywords:Quasi stationary sources, Channel coding ,Block fading channels

I. INTRODUCTION

Shannon's source-channel separation theorem states that, in point-to-point communicationsystems, a source can be reliably transmitted over a channel if and only if the minimum source coding rate is below the channel capacity [1]. This means that a simple comparison of the rates of the optimal source and channel codes for the underlying source and channel distributions, respectively, suffices to conclude whether reliable transmission is possible or not. Furthermore, the separation theorem dictates that the source and channel codes can be designed independently without loss of optimality. This theoretical optimality of modularity has reinforced the notion of network layers, leading to the separate development of source and channel coding aspects of a communication system. The separation theorem holds for stationary and ergodic sources and channels under the usual information theoretic assumptions of infinite delay and complexity (see [2] for more general conditions under which separation holds). However, Shannon's source channel separation theorem does not generalize to multiuser networksSuboptimality of separation for multiuser systems was first shown by Shannon in [3], where an example of correlated source transmission over the two-way channel was provided. Later, a similar observation was made for transmitting correlated sources over multiple access channels (MACs) in [4]. The example provided in [4] reveals that comparison of the Slepian-Wolf source coding region [5] with the capacity region of the underlying MAC is not sufficient to decide whether reliable transmission can be realized. In general communication networks have multiple sources available at the network nodes, where the source data must be transmitted to its destination in a lossless or lossy fashion. Some (potentially all) of the nodes can transmit while some (potentially all) of the nodes can receive noisy observations of the transmitted signals. The communication channel is characterized by a probability transition matrix from the inputs of the transmitting terminals to the outputs of the receiving terminals. We assume that all the transmissions share a common communications medium; special cases such as orthogonal transmission can be specified through the channel transition matrix. The sources come from an arbitrary joint distribution, that is, they might be correlated. For this general model, the problem we address is to determine whether thesourcescan be transmitted losslessly or within the required fidelity to their destinations for a given number of channel uses per source sample (cupss), which is defined to be the *source-channelrate*of the joint source channel code. Equivalently, we might want to find the minimum sourcechannelrate that can be achieved either reliably (for lossless reconstruction) or with the required reconstruction fidelity (for lossy reconstruction). The problem of jointly optimizing source coding along with the multiuser channel coding in this very general setting is extremely complicated. If the channels are assumed to be noisefreefinite capacity links, the problem reduces to a multiterminal source coding problem [1]; alternatively, if the sources are independent, then we must find the capacity region of a general communication network. Furthermore, considering that we do not have a separation result for source and channel coding even in the case of very simple networks, the hope for solving thisproblem in the general setting is slight.

The paper is organized as follows. Following the proposed method in Section II, Section III presents the design based on fixed source coding rate for minimized distortion outage probability. Next, in Section IV, we present the adaptive rate and power source and channel coding design. Finally performance evaluations and comparisons are presented in Section V

II. PROPOSED METHOD

We consider the transmission of a quasi-stationary source over a block fading channel. Specifically, the source is finite state quasi-stationary Gaussian with zero mean and variance$\sigma 2$ s in a given block, where $s \in S$:$S = \{1, 2, ...,Ns\}$[18]. The source state s from the set S is a discrete random variable with the probability mass function (pmf) $P(s)$. The source coding rate in a block in state s, is denoted by Rs bits per source sample. Hence, according to the distortion-rate function of a Gaussian source [18][19], the instantaneous distortion in a block in state s is given by $D = \sigma 2s\ 2{-}2Rs$. We consider a point to point wireless block fading channel for transmitting the source information to the destination. Let X, Y and Z, respectively indicate channel input, output and additive noise, where Z is an i.i.d Gaussian noise $\sim N(0, 1)$. Therefore, we have $Y = \sqrt{\alpha}X + Z$, where$\sqrt{\alpha}$ is the multiplicative fading. The channel gain α is constant across one block and independently varies from one block to anotheraccording to the continuous probability density function $f(\alpha)$. For a Rayleigh fading channel,$\sqrt{\alpha}$ is a Rayleigh distributed random variable and consequently, the channel gain α is an exponentially distributed random variable, where we here consider $E[\alpha] = 1$. The block diagram of the system is depicted in Fig. 1. We consider K source samples spanning one source block coded into a finite index by the source encoder. This index is transmitted in N channel uses spanning one fading block (bandwidth expansion ratio $b = NK$, where $b \geq 1$). We assume that K and N are large enough such that, over a given state of source and channel, the rate distortion function of the quasistationary source and the instantaneous capacity of the block fading channel may be achieved. The source coding rate Rs in bits per source sample and channel coding rate R in bits per channel use are related by $Rs= bR$. Note that in general $Rs$and$R$may be both designed to depend on source and channel states, i.e., $Rs= Rs(\sigma s, \alpha)$ and $R =$

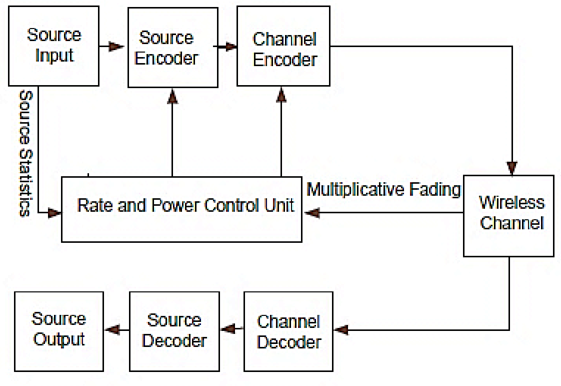


Fig. 1. Block diagram of the system.

$R(\sigma s, \alpha)$. The instantaneous capacity of the fading Gaussian channel [3] over one block (in bits per channel use) is defined as

$$C(\alpha,\gamma) = \frac{1}{2}\log_2(1+\alpha\gamma), \quad (1)$$

The outage distortion exponent is defined as

$$\Delta_{OD} = \lim_{\bar{P}\to\infty} -\frac{\ln \mathrm{P_{Dout}}}{\ln P}. \quad (2)$$

Let $P1$ and $P2$ be the average powers transmitted to asymptotically achieve a specific distortion outage probability by two different schemes. We define the asymptotic outage distortion gain as follows

$$G_{OD} = 10\log_{10}\bar{P}_2 - 10\log_{10}\bar{P}_1. \quad (3)$$

III. CHANNEL OPTIMIZED POWER ADAPTATION SCHEMES

In this section, the aim is to find the optimized powerallocation strategy and fixed rate such that the distortion outage probability for communication of a quasi-stationary source over a wireless fading channel is minimized. With a fixed rate (R does not change from one block to another), the encoders do not need to be rate adaptive which simplifies the design and implementation of transceivers. Noting (3) the distortion outage probability is computed as follows

$$\begin{aligned}\mathrm{P_{Dout}} =& \Pr(R > C(\alpha,\gamma))\Pr(\sigma_s^2 > D_m) + \\ & (1-\Pr(R > C(\alpha,\gamma)))\Pr(\sigma_s^2 2^{-2bR} > D_m)\end{aligned} \quad (4)$$

The power allocation in this setting may be interpreted as water-filling with respect to the channel state and the source and channel statistics. The next two Propositions quantify the performance of the proposed COPA-MDO scheme in terms of the resulting distortion outage probability and outage distortion exponent, respectively.

The distortion outage probability obtained by COPA-MDO scheme for transmission of a quasi-stationary source over a Rayleigh block fading channel is given by Thus, we have

$$\mathrm{P_{Dout}} \cong \Pr\left(\sigma_s^2 > D_m\right)\exp\left(\frac{-\bar{P}}{\left(\frac{\max_s\{\sigma_s^2\}}{D_m}\right)^{\frac{1}{b}} - 1}\right) \quad (5)$$

And therefore,

$$\Delta_{OD} = \lim_{\bar{P}\to\infty}\frac{\frac{\bar{P}}{\left(\frac{\max_s\{\sigma_s^2\}}{D_m}\right)^{\frac{1}{b}}-1} - \ln\Pr\left(\sigma_s^2 > D_m\right)}{\ln \bar{P}} \quad (6)$$

Hence, the proof is complete. For the optimized fixed rate $R*$, the distortion outage exponent enhances when the average power limit $\bar{P}$ increases. In the following three Corollaries, we summarize the implications of the COPA-MDO design for transmission of stationary sources over block fading channels. The stationary source is a Gaussian with zero mean and variance $\sigma 2 \geq Dm$. Obviously, with $\sigma 2 < Dm$, the distortion outage probability is equal to zero. The results are directly obtained from Propositions 1, 2, 3 and 4 and allows for insights into the system performance as it relates to source statistical characteristics.

Corollary 1: The optimum power adaptation and channel coding rate prescribed by COPA-MDO for transmission of a stationary source over a block fading channel are given by

$$R^* = \frac{1}{2b}\log_2\frac{\sigma^2}{D_m} \quad (7)$$

and

$$\gamma^* = \begin{cases} \frac{\left(\frac{\sigma^2}{D_m}\right)^{\frac{1}{b}}-1}{\alpha} & \text{if } \alpha \geq \frac{\left(\frac{\sigma^2}{D_m}\right)^{\frac{1}{b}}-1}{q_1^*} \\ 0 & \text{otherwise} \end{cases} \quad (8)$$

Corollary 2: The distortion outage probability obtained by COPA-MDO for transmission of a stationary source over anRayleigh block fading channel is given by

$$\mathrm{P_{Dout}} = 1 - \exp\left(-\frac{\left(\frac{\sigma^2}{D_m}\right)^{\frac{1}{b}} - 1}{q_1^*}\right) \quad (9)$$

with$q*1$ satisfying the following equationThe results in Corollary 2 is obtained noting that $\sigma 2 > Dm$andPr($\sigma 2s2-2bR*>Dm$) = 0 for stationary sources.

Corollary 3: For communication of a stationary source over a Rayleigh block fading channel and with large average power limit P, the COPA-MDO scheme achieves the outage distortion exponent.

IV. SOURCE AND CHANNEL OPTIMIZED POWER ANDRATE ADAPTATION

In this section, we consider power and rate adaptation with regard to source and channel states for improved performance of communications of a quasi-stationary source over a wireless block fading channel. Thus, the objective in this section is to devise power and rate adaptation strategies for each state (s, α) such that the distortion outage probability is minimized, when the average power is constrained to $\bar{P}$. We have the following design problem.

Problem: The problem of delay-limited source and channel optimized power adaptation for transmission of a quasistationary source with minimum distortionoutage probability (SCOPA-MDO) over a block fading channel is formulated as follows

$$\min_{\gamma,R}\ \mathrm{P_{Dout}} = \Pr\left(D(\sigma_s,\alpha,\gamma) > D_m\right)$$
$$\text{subject to } \mathrm{E}[\gamma] \leq \bar{P}, \quad (10)$$

The distortion outage probability for transmission of a quasi-stationary source using the SCOPA-MDO scheme over a Rayleigh block fading channel is given by

$$\mathrm{P_{Dout}} = \Pr(\sigma_s^2 > D_m) - \sum_{s:\sigma_s^2 > D_m}\exp\left(-\frac{\left(\frac{\sigma_s^2}{D_m}\right)^{\frac{1}{b}}-1}{q_2^*}\right)P(s) \quad (11)$$

Hence, noting for $q*2\to\infty$ we obtain

$$\Delta_{OD} = \lim_{\bar{P}\to\infty}\frac{\bar{P}}{\ln\bar{P}\sum_{s:\sigma_s^2>D_m}\left(\left(\frac{\sigma_s^2}{D_m}\right)^{\frac{1}{b}}-1\right)P(s)} \quad (12)$$

Thus, the proof is completed. The following Corollary expresses the implication of the SCOPA-MDO design for transmission of a stationary sourceover block fading channels. This is directly obtained from Proposition 5 when a stationary source is assumed.

In the case of a stationary source, the optimized source coding rate in SCOPA-MDO reduces to 12b log2($\sigma 2Dm$), which is fixed and equal to that of COPAMDO. The power adaptation in both schemes now coincide as they both depend on the same source coding rates and the power constraints. Hence, both schemes provide the same performance with stationary sources.

4.1 Low Density parity check Method:

A parity check matrix is an r-row by n-column binary matrix. Remember k=n-r.Therowsrepresent the equationsand the columnsrepresent the digitsinthe code word.There is a 1in the i-th row and j-thcolumnif and only if the i-th code digitis contained in the j-th equation.

For a code word of the form c1, c2, c3, c4, c5, c6, c7, the equations are:

c1 +c2 +c3 +c5= 0

c1 +c2 +c4 +c6= 0

c1 +c3 +c4 +c7 = 0.

The inherent parallelismin decoding LDPC codes suggests their use in high data ratesystemsThe performance of SCOPA-MDO scheme is studied in Section V.

V. PERFORMANCE EVALUATION

In this section, we first present two constant power transmission schemes as benchmarks for comparisons. Next, we consider analytical performance comparison of different schemes followed by numerical results. To this end, we consider three quasi-stationary sources, with $Ns = 25$ where the variance of the source in the state s is given by $\sigma 2s$ (s) = (1+ s−16)2 : ∀s ∈{1, ...,Ns}. For two of the sources, labeled as G1 and G2, the probability of being in different states follows a discrete Gaussian distribution with means 14.34, 13.89 and variances 2, 19, respectively. For the third source, U, the said distribution is considered uniform with mean 13 and a variance of 52. We also consider an stationary source S with $\sigma 2$ = 10.44 for a meaningful comparison. Unless otherwise mentioned, we consider the source G2 for the following results and simulations.

Two constant power schemes for transmission of a quasistationary source over a block fading channel are considered as benchmarks for comparisons. In the first scheme, the channel coding rate is adjusted based on the channel state to minimize the distortion outage probability; hence the scheme is labeled as Channel Optimized Rate Adaptation with Constant Power (CORACP). In the second scheme with Constant Rate and Constant Power (CRCP), the aim is to find the optimized fixed rate such that the distortion outage probability is minimized.

51. Channel Optimized Rate Adaptation with ConstantPower:

With CORACP and constant transmission power P, the instantaneous capacity is given by $C(\alpha)$ =12 log2_ 1 + α ¯¯P; and hence to minimize PDout it is logical to consider the rate adaptation strategy of $R(\alpha)$ = $C(\alpha)$. The source coding rate is then set as Rs= bR. The next two Propositions quantify the distortion outage performance of CORACP.

The distortion outage probability for transmission of a quasi-stationary source over a Rayleigh block fading channel using CORACP is given by

$$\Delta_{OD} = \lim_{\bar{P}\to\infty} \frac{\ln \bar{P} - \ln \sum_{s:\sigma_s^2 > D_m} \left(\left(\frac{\sigma_s^2}{D_m} \right)^{\frac{1}{b}} - 1 \right) P(s)}{\ln \bar{P}} = 1$$

It is evident in Proposition 10 that the optimized fixed rate R with CRCP is related to the source statistics and equals 1 2b log2($\sigma 2s{*}Dm$), where $s{*}$is given in (64). Therefore, the distortion outage probability is

$$P_{Dout} = \Pr\left(C(\alpha) < \frac{1}{2b} \log_2\left(\frac{\sigma_{s^*}^2}{D_m}\right) \right) \Pr(\sigma_s^2 > D_m) + \Pr\left(C(\alpha) \geq \frac{1}{2b} \log_2\left(\frac{\sigma_{s^*}^2}{D_m}\right) \right) \Pr\left(\frac{\sigma_s^2 D_m}{\sigma_{s^*}^2} > D_m\right) \quad (13)$$

the CRCP scheme achieves the distortion outage probability of

$$\Delta_{OD} = \lim_{\bar{P}\to\infty} - \frac{-\ln(\bar{P})}{\ln \bar{P}} = 1. \quad (14)$$

For communication of a stationary source over a Rayleigh block fading channel, the CRCP scheme achieves a distortion outage probability of

$$P_{Dout} = 1 - \exp\left(- \frac{\left(\frac{\sigma^2}{D_m}\right)^{\frac{1}{b}} - 1}{\bar{P}} \right) \quad (15)$$

and an outage distortion exponent of ΔOD of the order O (1).

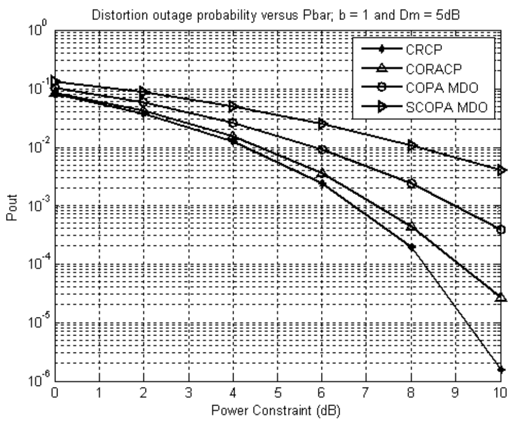
5.2Analytical Performance Comparison:

In the sequel, we quantify the respective asymptotic outage distortion gain GOD of SCOPA-MDO, COPA-MDO, CORACP and CRCP for transmission of a quasi-stationary source over a block fading channel.

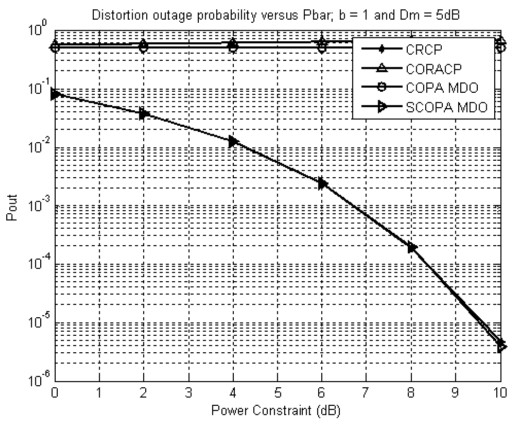
Proposition 12: In transmission of a quasi-stationary source over a Rayleigh block fading channel, the asymptotic outage distortion gain obtained by scheme 1 with respect to scheme 2 (see Table I) is given by

$$G_{OD}^3 = 10 \log_{10} \left(\left(\left(\frac{\max_s\{\sigma_s^2\}}{D_m} \right)^{\frac{1}{b}} - 1 \right) \Pr\left(\sigma_s^2 > D_m\right) \right) - 10 \log_{10} \sum_{s:\sigma_s^2 > D_m} \left(\left(\frac{\sigma_s^2}{D_m} \right)^{\frac{1}{b}} - 1 \right) P(s).$$

The distortion outage exponent ΔOD of the COPA-MDO and SCOPA-MDO schemes which are derived in line with the proofs of the Propositions 4 and 7, are quantified in Table II. As denoted in Propositions 9 and 11, CORACP.

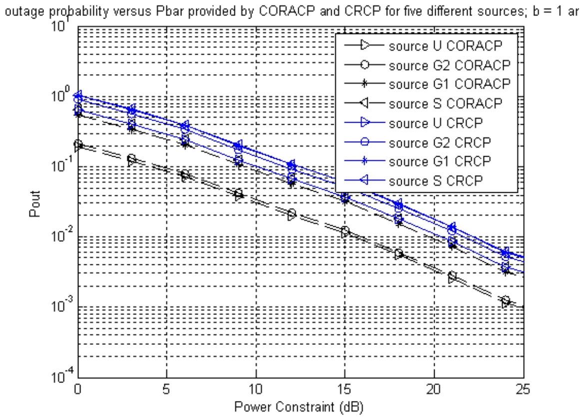


CRCP schemes give $\Delta OD = 1$. The distortion outage exponent indicates the speed at which the distortion outage (dB) reduces as the average power (limit) (dB) increases. Therefore, as evident, this speed is noticeably high with SCOPA-MDO and very low with CORACP and CRCP. Furthermore, the ΔOD obtained by SCOPA-MDO and COPA-MDO depends on the average power limit $\bar{P}$, maximum allowable distortion *Dm* and bandwidth expansion ratio *b*. It is observed that with SCOPA-MDO and COPA-MDO, ΔOD improves as *b*, $\bar{P}$ or *Dm* increase.



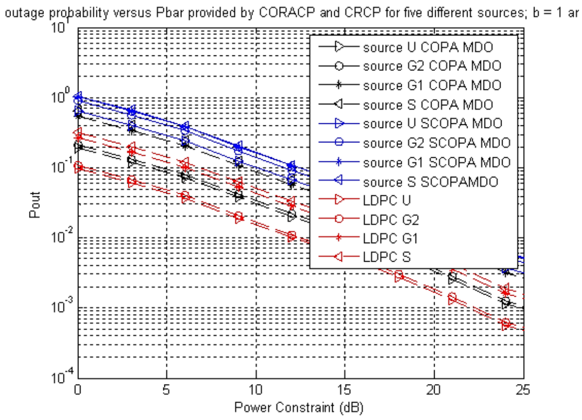
In fact, for a given value of *N*, a larger *b* implies a more finely encoded source that is more sensitive to channel errors and hence can more greatly benefit from increased power. The results in Tables I and II indicate that from the perspective of probability of distortion outage, for delay limited communication of quasi-stationary sources, CORACP and CRCP schemes may not be appropriate designs. The following three Corollaries quantify the asymptotic outage distortion gain in transmission of a stationary source over block fading channels. These are directly obtained from Proposition 12 when a stationary source is considered.

Corollary 8: In transmission of a stationary source over a Rayleigh block fading channel, the asymptotic outage distortion gain obtained by SCOPA-MDO with respect to COPAMDO is equal to zero



C. Numerical Results

Figs. 2 and 3 depict the distortion outage probability performance of the presented schemes as a function of the power constraint $\bar{P}$ for *Dm* = 8dBand *Dm* = 5dB, respectively. As expected, for a given $\bar{P}$, PDout decreases as *Dm*increases. It is evident that the proposed SCOPA-MDO scheme achieves an asymptotic outage distortion gain of about 6.25 dB



Corollary 9: In transmission of a stationary source over a Rayleigh block fading channel, the asymptotic outage distortion gain of COPA-MDO with respect to CORACP is equal to

$$G_{OD} = 10 \log_{10} \frac{T}{\ln T}, \quad (16)$$

and5dB with respect to COPA-MDO, for $\bar{P}$ = 20dB and *Dm* = 8dB and *Dm* = 5dB, respectively. In the same settings, the COPAMDO scheme achieves asymptotic outage distortion gains of about 8.4dB and 6.4dB with respect to CORACP; and CORACP achieves gains of 5dB and 4.6dB with respect to CRCP. The results obtained from simulations and what is reported in Table I from analyses match reasonably well given the assumption of very high average SNR considered in the analytical performance evaluations. The analytical results in Table II for Δ*OD* performance, may also be observed in numerical results of Figs. 2 and 3. Specifically, at each point on the curves, the corresponding value in the vertical coordinate in dB, i.e., 10 log10 PDout divided by the value in the horizontal coordinate, i.e., $\bar{P}$(dB), indicates −Δ*OD*. For example, as seen in Fig. 2, Δ*OD* for SCOPA-MDO is almost equal to 30.86 at $\bar{P}$ = 20dB with *Dm* = 8dB. It is noteworthy that the four methods discussed, ondifferent levels of source and channel state information (SSI and CSI). Specifically, it can be verified that three schemes of SCOPA-MDO, COPA-MDO and CORACP require instantaneous CSI for rate and/or power adaptation, while CRCP needs CSI statistics. The SCOPA-MDO scheme also needs instantaneous SSI, while COPA-MDO and CRCP simply need SSI statistics.

VI. CONCLUSION

In this paper, delay-limited transmission of a quasistationary source over a block fading channel was considered. Aiming at minimizing the distortion outage probability, two transmission strategies namely channel-optimized power adaptation with fixed rate (COPA-MDO) and source and channel optimized power (and rate) adaptation (SCOPA-MDO) were introduced. The SCOPA-MDO scheme provides a superior performance, while the COPA-MDO scheme enjoys the simplicity of single rate transmission. In high SNR regime, different scaling laws involving outage distortion exponent and asymptotic outage distortion gain were derived. Ourstudies confirm the benefit of power adaption from a distortion outage perspective and for delay-limited transmission of quasistationary sources over wireless block fading channels. The analyses of the presented schemes in the case of stationary sources indicate the same outage distortion performance with or without rate adaptation.here we addind low density parity check metyhod for reducing delay.

VII. APPENDIXPROOF OF PROPOSITION

Noting (42) for $\gamma = \bar{P}$, distortion can be written as follows

$$D(\sigma_s, \alpha, \gamma = \bar{P}) = \sigma_s^2 2^{-2bR} = \frac{\sigma_s^2}{(1+\alpha\bar{P})^b} \quad (17)$$

and then we can derive

$$P_{\mathrm{Dout}} = \Pr\left(\frac{\sigma_s^2}{(1+\alpha\bar{P})^b} > D_m, \sigma_s^2 > D_m\right) = \Pr\left(\alpha < \frac{1}{\bar{P}}\left(\left(\frac{\sigma_s^2}{D_m}\right)^{\frac{1}{b}} - 1\right), \sigma_s^2 > D_m\right). \quad (18)$$

REFERENCES

[1] V. Hanly and D. Tse, "Multiaccess fading channels. Part II: Delaylimited capacities," *IEEE Trans. Inf. Theory*, vol. 44, pp. 2816–2831, Nov. 1998.

[2] L. Li and A. J. Goldsmith, "Capacity and optimal resource allocation for fading broadcast channels. Part II: Outage capacity," *IEEE Trans.Inf. Theory*, vol. 47, pp. 1103–1127, Mar. 2001.

[3] G. Caire, G. Taricco, and E. Biglieri, "Optimum power control over fading channels," *IEEE Trans. Inf. Theory*, vol. 45, pp. 1468–1489, July1999.

[4] L. Li, N. Jindal, and A. Goldsmith, "Outage capacities and optimal power allocation for fading multiple-access channels," *IEEE Trans. Inf.Theory*, vol. 51, pp. 1326–1347, Nov. 2005.

[5] J. N. Laneman, D. N. C. Tse, and G. W. Wornell, "Cooperative diversity in wireless networks: Efficient protocols and outage behavior," *IEEETrans. Inf. Theory*, vol. 50, pp. 3062–3080, Nov. 2004.

[6] Y. Liang, V. V. Veeravalli, and H. V. Poor, "Resource allocation for wireless fading relay channels: Max-min solution," *IEEE Trans. Inf.Theory*, vol. 53, pp. 3432–3453, Oct. 2007.

[7] D. Gunduz and E. Erkip, "Opportunistic cooperation by dynamic resource allocation," *IEEE Trans. Wireless Commun.*, vol. 6, pp. 1446–1454, Oct. 2007.

AUTHORS PROFILE:

Dr.T.V.S.Prasad Gupta, is the Head of ECE Department in MVR College of Engineering and Technology

A. SrinivasaRao,M.Tech is an Assistant Professor in MVR College of Engineering & Technology.

J.Anusha is pursuing M.Tech in MVR College of Engineering & Technology.