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Final Technical Report, October 1, 1993–September 30, 1994

SPECTRUM ALLOCATION STRATEGIES
FOR COMMUNICATION NETWORKS
(AFOSR Grant F49620-94-1-0005)

Robert J. McEliece
Department of Electrical Engineering
California Institute of Technology
Pasadena, CA 91125

The long-term goal of this project has been to obtain a basic mathematical understanding of the problems associated with communication in the presence of severe noise, e.g., fading, jamming or interference from other (friendly) signals. Our basic approach has always been to apply the techniques and insights of *information theory* to these problems. In the period covered by this report, we continued, and greatly extended, our study of models for *multi-user* communication systems, i.e., systems in which many simultaneous two-way conversations must share a common band of frequencies. We have shown (refs. [4],[5],[6],[7],[9]) that the ultimate limits for such systems (measured by the number of conversations per unit of available bandwidth) can, in some cases, be computed by a fairly simple linear program. Later, we extended this work (ref. [16]) to show that it applies to the more general class of *blocking service networks*, i.e, networks which provide many kinds of service to many customers simultaneously. Besides “cellular” communication networks, we have already shown that our new theory also applied to ordinary telephone networks, and to stochastic “bin packing” TDMA communication networks. Most recently, we studied the performance of a class of practical bandwidth allocation algorithms, the “distributed dynamic” algorithms, and showed (ref. [21]) that in many cases they are nearly optimal.

In the past year, we continued, to explore this extremely fertile research area. Our most important result was a proof that the distributed dynamic algorithms referred to above are asymptotically optimal in a very strong sense, viz., for any value of the (normalized) offered traffic, as the number of channels becomes large, the carried traffic for these algorithms equals or exceeds that of any other algorithm (ref. [25]). We also found a class of modified algorithms which are a bit more complex, but which achieve optimality “faster” than the timid algorithm (refs. [23] and [24].)

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