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UNIVERSITY OF CALIFORNIA

Los Angeles

Packet Switching in a Multi-Access Broadcast Channel with Application to Satellite Communication in a Computer Network

A dissertation submitted in partial satisfaction of the requirements for the degree Doctor of Philosophy in Engineering

by

Simon Sin-Sing Lam

1974

The dissertation of Simon Sin-Sing Lam is approved, and it is acceptable in quality for publication on microfilm.

Wesley W. Chu

James R. Jackson

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Leonard Kleinrock, Committee Chairman

University of California, Los Angeles

1974

To my mother, brother and sisters

and to my wife Amy

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PUBLICATIONS

Kleinrock, Leonard and Simon S. Lam. "Packet-Switching in a Slotted Satellite Channel," National Computer Conference, New York, June 4-8, 1973, AFIPS Conference Proceedings, 1973, Vol. 42, pp. 703-710.

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ABSTRACT OF THE DISSERTATION

Packet Switching in a Multi-Access Broadcast Channel
with Application to
Satellite Communication in a Computer Network

by

Simon Sin-Sing Lam
Doctor of Philosophy in Engineering
University of California, Los Angeles, 1974
Professor Leonard Kleinrock, Chairman

This dissertation considers a packet switching technique applicable to packet communication using a satellite or ground radio channel. The objective of this research is to develop analytic models for the evaluation and optimization of the system performance in terms of stability, throughput and delay.

Advantages of packet switched satellite and ground radio systems over conventional wire communications for large computer-communication networks are discussed. The emphasis of this research is on a high-speed channel shared by a large population of "small" users. The channel behavior is typical of "contention" systems in which the throughput vanishes to zero as the load on the system increases. This phenomenon is called channel saturation. The channel may go into saturation as a result of (a) time fluctuations, and (b) stochastic fluctuations in the channel input. The channel response to time varying inputs is first studied using a deterministic approximation analysis. The effect of (b) is then studied through probabilistic models. In this case, contributions of this research may be classified into three categories:

(1) a coherent theory of channel behavior in which the key result is the characterization of stable and unstable channels

(2) evaluation of channel performance such as equilibrium throughput-delay tradeoffs for stable channels and stability-throughput-delay tradeoffs for unstable channels

(3) dynamic channel control and estimation procedures for optimal control of unstable channels.

This study has several implications. First, a coherent theory of channel behavior has been developed, system design variables have been identified and operational strategies for the optimization of channel performance have been evaluated. These results suggest a system design methodology. Second, the techniques employed in characterizing the stability behavior and evaluating dynamic channel control schemes may profitably be applied to probabilistic models of other contention systems.