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DYNAMICS OF LARGE SCALE DISTRIBUTED NETWORKS

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ABSTRACT

This talk addresses the question of robustness for large scale, distributed communications networks from a dynamical standpoint. In particular, we are interested in maximizing call throughput (carried load) subject to varying levels of localized congestion and network node and link outages. The networks considered use alternate routing and crankback control to route calls. A set of approximately one hundred Public Switched Network (PSN) switching systems, together with a subset of PSN facility and trunk interconnectivity, are used to generate several network designs. Trunk to facility assignments are included in the design process, so that the effect of correlated trunk failures is properly taken into account.

Two networks having different types of connectivity are discussed. The first network possesses "nearest neighbor" connectivity in which each node is connected by trunk groups to its nearest neighbors only ("nearest" referring to the physical proximity of nodes). The second network incorporates a "route-around" capability in which node pairs are interconnected by facility paths around interveining nodes. The route-around connectivity is extracted from PSN trunk groups, and hence is not considered to be costly augmentation. Route-around allows an alternate routing plan, perhaps used in conjunction with an adaptive routing algorithm, to route calls around trouble spots in the network.

Using a network model to evaluate network performance, it is shown that these two networks (i.e., the nodes together with their trunk group connectivity) have very different performance characteristics when subjected to congestion and node and link outages. Furthermore, it is seen that the network with bypass connectivity not only maintains a higher call-carrying capacity than the nearest neighbor network, under local congestion and node outage, but also has a lower average call set-up time. The data and algorithms used for network design and performance evaluation will be discussed. Through the use of simulation it is shown that the "nearest neighbor" topology exhibits natural high usage routes with the attendant robustness concerns. The question of how to increase trunk connectivity so as to improve robustness without significantly affecting network cost is investigated.