MATHEMATICAL MODEL OF SPATIAL COMMUNICATION NETWORK FLOW

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ABSTRACT

A behavior of a communication network can be modeled as a network flow where the traffic units flow along links connected by nodes. We describe an approach to packet flow that derives a node/link network model and connects it to a fluid-like model of traffic flow. The discrete node/link model emphasizes packet queuing and the flow of packets from spatial point to spatial point. The model assumes that packets reside in buffers at each node, and are classified by their destination and the length of time they have resided in the buffer. An algorithm was created for packets to exit the buffer at each node according to their age and travel to the next node along a predetermined path to their destination. This algorithm calculates the rate at which packets distribute themselves to the next link in the route to their destination, assumes a source of packets originating at the node, and subtracts packets whose destination is that particular node. The continuum model derived from this discrete flow model leads to a flow continuity equation. The continuity equation describes the density of packets as a function of time and space, so that we are able to predict changes in global flow patterns and optimal paths in the network. Solutions to the flow equations in one dimension show that if the sources are too strong or the flow is restricted, the packet density grows at the nearest upstream node. When the source strength is reduced, or when flow is restored, the buffered packets flow at capacity until the density has been reduced.