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Theory of Network Communication

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Assignment 4

Problem 11 (3 points)**:**
Suppose we have a network G with unit edge capacities, $n = 2^d$ nodes for some integer d, and flow number F. One way to design a deterministic, adaptive routing algorithm for G is to simulate a multibutterfly by G. Imagine that we want to use the strategy to map all nodes in $\{(i,\alpha) \mid i \in [d+1]\}$ of the d-dimensional multibutterfly to node α in G for every $\alpha \in [2]^d$. If we then want to simulate a communication step of the multibutterfly, we have to be able to send in the worst case a packet (or equivalently, a demand of 1) for every pair of nodes in G that represent a pair of nodes in the multibutterfly that is connected by an edge. To come up with good paths for this in G, we have to solve a suitable concurrent multicommodity flow problem. Specify an upper bound on the total demand that has to leave or reach any node in G for that problem, and give upper bounds on the congestion and dilation of a system of flow paths for the multicommodity flow problem. (Hint: look at Theorems 1.10 and 1.14 to see how the flow number can be used for this.)

Problem 12 (5 points)**:**
Specify what type of control packets are needed for each of the three routing algorithms presented in Section 4 (1 point for each). Think about a way of sending control information for the T-balancing algorithm in Section 4.3 so that the communication overhead caused by the control information is as small as possible. (Suppose for this that the network is static, i.e. the neighborhood of a node does not change over time.)