Finding the size and the diameter of a radio network using short labels. (English) 

Summary: The number of nodes of a network, called its size, and the largest distance between nodes of a network, called its diameter, are among the most important network parameters. Knowing the size and/or diameter (or a good upper bound on those parameters) is a prerequisite of many distributed network algorithms, ranging from broadcasting and gossiping, through leader election, to rendezvous and exploration. A radio network is a collection of stations, called nodes, with wireless transmission and receiving capabilities. It is modeled as a simple connected undirected graph whose nodes communicate in synchronous rounds. In each round, a node can either transmit a message to all its neighbors, or stay silent and listen. At the receiving end, a node $v$ hears a message from a neighbor $w$ in a given round, if $v$ listens in this round, and if $w$ is its only neighbor that transmits in this round. If $v$ listens in a round, and two or more neighbors of $v$ transmit in this round, a collision occurs at $v$. If $v$ transmits in a round, it does not hear anything in this round. Two scenarios are considered in the literature: if listening nodes can distinguish collision from silence (the latter occurs when no neighbor transmits), we say that the network has the collision detection capability, otherwise there is no collision detection.

We consider the tasks of size discovery and diameter discovery: finding the size (resp. the diameter) of an unknown radio network with collision detection. All nodes have to output the size (resp. the diameter) of the network, using a deterministic algorithm. Nodes have labels which are (not necessarily distinct) binary strings. The length of a labeling scheme is the largest length of a label. We concentrate on the following problems:

What is the shortest labeling scheme that permits size discovery in all radio networks of maximum degree $\Delta$? What is the shortest labeling scheme that permits diameter discovery in all radio networks?

Our main result states that the minimum length of a labeling scheme that permits size discovery is $\Theta(\log \log \Delta)$. The upper bound is proven by designing a size discovery algorithm using a labeling scheme of length $O(\log \log \Delta)$, for all networks of maximum degree $\Delta$. The matching lower bound is proven by constructing a class of graphs (in fact even of trees) of maximum degree $\Delta$, for which any size discovery algorithm must use a labeling scheme of length at least $\Omega(\log \log \Delta)$ on some graph of this class. By contrast, we show that diameter discovery can be done in all radio networks using a labeling scheme of constant length.

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radio network; collision detection; network size; network diameter; labeling scheme

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References:


