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We consider a complete graph of n nodes, any pair of which can communicate with each other directly through one of $\mathcal{F}$ available wireless channels. n is not known to the nodes. Time is divided into synchronous rounds. In each round, a node can select at most one channel to listen to or transmit on. Transmission is successful if there is exactly one node transmitting on a channel (and one or more nodes listening). If two or more nodes transmit on the same channel, a collision occurs and their transmissions fail. Nodes can detect collisions, i.e., can distinguish collision from silence. We study distributed solutions to the *information exchange problem*: given initially k nodes each holding a packet, the task is to disseminate these k packets to all n nodes as quickly as possible. We assume that multiple packets can be packed in a single message.

Recently, due to the advent of mobile devices that can operate on multiple channels, some attention has been given to studying the effect of multiple channels on improving communication [1, 2, 4–6]. Daum et al. [2] proposed a randomized algorithm that accomplishes information exchange in $O(k + \log^2 n/\mathcal{F} + \log n \log\log n)$ rounds with high probability. With collision detection, Wang et al. [5] proposed a protocol that can disseminate all the packets in $O(k/\mathcal{F} + \mathcal{F} \cdot \log^2 n)$ rounds with high probability. However, all existing works require prior knowledge of n. In ad hoc networks, to make n known to all the nodes in fact can be a tough task. Moreover, in ad hoc networks, the value of n could change sporadically or even frequently due to nodes leaving and joining. Hence, there is practical need for designing *uniform* protocols that do not require any prior information about the network including n and k. Not knowing the parameters n or k greatly increases the difficulty of designing fast algorithms, especially in this case where different nodes can operate on different channels, as it is hard to manage the transmission probabilities over the distributed set of nodes.

⋆ The details of this work can be found in [7].

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Uniform Information Exchange Protocol

Given $\mathcal{F}$ available channels, our protocol applies a very intuitive rule for the nodes to select a channel: in each round, a node selects one channel uniformly at random, and then transmits or listens on the selected channel. If a node listens and detects that the selected channel is *idle*, it doubles its transmission probability, or otherwise, it halves the probability. To achieve the desired efficiency in using the channels, the total transmission probability of all the nodes should be in a "safe range", $[\alpha_1 \cdot \mathcal{F}, \alpha_2 \cdot \mathcal{F}]$ with constants $\alpha_2 > \alpha_1 > 0$. Since the nodes distributedly and independently select their channels, the per-channel total transmission probability of nodes selecting a channel may vary substantially from channel to channel. This causes difficulties in analyzing whether the safe range is still guaranteed after an update (halving or doubling). In our protocol, the nodes selecting the same channel update their transmission probabilities consistently, and we show that whenever the total transmission probability of all the nodes falls outside the safe range, there are enough channels where the nodes would behave consistently to pull the total transmission probability back to be within the safe range. Our protocol also applies the technique of *indirection*: "if your message is received by another transmitter, then you need never to transmit again." With this in place, transmitting nodes become fewer and fewer as the protocol executes. When the number of transmitting nodes becomes rather small, using all $\mathcal{F} > 1$ channels is not beneficial, as it is harder for these nodes to meet each other over a randomly selected channel. In our solution, when there are only a few transmitting nodes remaining, they stop selecting a random channel but would operate on a pre-defined channel.

Main Results. The proposed protocol can accomplish the dissemination in $O(k/\mathcal{F}+\mathcal{F}\cdot\log n)$ rounds with high probability, assuming collision detection. This result is asymptotically optimal when k is large ($k \geq \mathcal{F}^2 \cdot \log n$). Furthermore, our protocol can handle dynamic joining and leaving of nodes efficiently. After a node joining or leaving, the existing nodes will adapt quickly to a state of "safe range", in which the $\mathcal{F}$ channels will continue to be made full use of. Our protocol is probably the first known *uniform* protocol for information exchange.

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