

**Node-Based Distributed Channel Access With Enhanced Delay Characteristics**

**Abstract:**

Recent studies in wireless scheduling have shown that carrier-sense multiple access (CSMA) can be made throughput optimal by optimizing over activation rates. However, those throughput optimal CSMA algorithms were found to suffer from poor delay performance, especially at high throughputs where the delay can potentially grow exponentially in the size of the network. Motivated by these shortcomings, in this paper we propose a node-based version of the throughput optimal CSMA (NB-CSMA) as opposed to traditional link-based CSMA algorithms, where links were treated as separate entities. Our algorithm is fully distributed and corresponds to Glauber dynamics with “Block updates”. We show analytically and via simulations that NB-CSMA outperforms conventional link-based CSMA in terms of delay for any fixed-size network. We also characterize the fraction of the capacity region for which the average queue lengths (and the average delay) grow polynomially in the size of the network, for networks with bounded-degree conflict graphs. This fraction is no smaller than the fraction known for link-based CSMA, and is significantly larger for many instances of practical wireless ad-hoc networks. Finally, we restrict our focus to the special case of collocated networks, analyze the mean starvation time using a Markov chain with rewards framework and use the results to quantitatively demonstrate the improvement of NB-CSMA over the baseline link-based algorithm.

**Existing System:**

The seminal work is the first example of a throughputoptimal scheduling algorithm, which can support any arrival rate vector within the network capacity region without any of the link queues growing to infinity. It was shown that if the interference relationships of the network is modeled by a conflict graph, the max-weight algorithm, where the weight of the link is taken to be the queue size, is throughput optimal. However, max-weight based algorithms suffer from

high complexity: In general networks, determining the maximum weight independent set is NP-hard.

**Proposed System:**

We propose a new throughput-optimal distributed Node-Based CSMA (NB-CSMA) algorithm, where the scheduling decisions are made on a node level rather than a link level.

We compare the Node-Based CSMA (NB-CSMA) to the link based CSMA (Q-CSMA) in terms of expected delay for any fixed network. We show analytically and via simulations that NB-CSMA performs no worse than Q-CSMA for any network setting.

We use mixing time analysis to characterize the fraction of the capacity region where under the NB-CSMA algorithm, the expected queue lengths and expected delay can be bounded by a polynomial in the size of the network (as opposed to exponential mixing). We show that this fraction is no smaller than the known fraction of capacity region under Q-CSMA.

For a special class of networks, namely, collocated networks, we derive analytically a closed-form for the link mean starvation time using a Markov chain with rewards framework. We then use the results in the case where all link throughputs are equal to quantitatively demonstrate the improvement of NB-CSMA over Q-CSMA as a function of both topology and network load.