Chapter 112
Contention Window Adjustment Strategy for IEEE 802.11 WLAN

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Abstract The IEEE 802.11 DCF in the original study, based on proposed based on the contention window adjustment strategy (CWAS). The algorithm idea is that each site slot utilization and optimal utilization of theoretical comparison, the minimum periodic dynamic adjust its contention window to adapt to different network congestion conditions. Simulation results show that the algorithm improves the IEEE 802.11 LAN performance under congestion, the saturation throughput and latency on varying degrees of improvement.

Keywords IEEE 802.11 • Contention window • Network congestion • Saturation throughput

112.1 Introduction

IEEE802.11 standard defines the MAC protocol Distributed Association Function (DCF) time slot as the unit of discrete time scale and binary exponential back off strategy (BEB) [1]. As MAC access mechanism for wireless network performance has a significant impact, there are a variety of improved algorithms, such as a new back off process of replacing BEB back off strategy [2]. Proposed a multiplicative increase linear decrease although the improved node fairness, but a longer times to make the nodes of greater competition in the state of the window, but may reduce the network throughput. For its shortcomings, the literature [3] proposed the exponential increase exponentially (EIED) algorithm, the increment and decrement index flexible configuration parameters, but how to choose the best index of the network state parameters requires further study [4]. The double collision and

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successful half of the strategy can be seen as EIED a special case, referred to here as MIMD algorithms. In addition, there are different network performance indicators to adjust the RTS threshold, the minimum contention window and other DCF parameters to improve network performance. In by modeling analysis of mixed mode frame transmission delay obtained under the optimal input RTS threshold [5]. Through the collection of network time and idle time of conflict to derive the ratio of maximum throughput. But the downside is that they need to estimate or assumption that the number of known sites in the network. Substitution to avoid the use of formulas to estimate directly the number of sites in the network, but from one node to calculate the average number of retransmissions mixed mode energy consumption at least the RTS threshold.

112.2 Measure of Network Congestion Situation

Adaptive algorithm to dynamically according to network conditions need to adjust its parameters to achieve optimal network performance [5]. Proposed the concept of slot utilization can be a good reflection of the current network congestion level, which is defined as follows:

$$Slot_{uti} = \frac{Slot_{busy}}{Slot_{all}} = \frac{Slot_{collide} + Slot_{success}}{Slot_{all}} = 1 - (1 - \tau)^n \tag{112.1}$$

τ is the beginning of each time slot to send the site in the probability, n is the number of sites in the network. When the network is busy, busy channel time slot number of time slots in the proportion of the total increase, increase the utilization of real-time gap. The network is idle, an increase in the number of idle slots, instant gap utilization decreases. But how to find optimal slot utilization as a measure of network congestion situation is critical.

Gives the WLAN in the case of site saturation send the best probability of [3]:

$$\tau = \frac{\sqrt{[n + 2(n-1)(T_c^* - 1)]/n} - 1}{(n-1)(T_c^* - 1)} \tag{112.2}$$

Where i Where T_c^* is the slot number of units, the average duration of the conflict. This is the site number and average duration of the conflict under certain circumstances, in order to obtain a theoretical maximum saturation throughput, the transmission probability of the site need to meet, it has nothing to do with what kind of back off algorithm. Therefore, you can type (112.2) into (112.1) find the number of different sites under the theory of optimal slot utilization value.

We found that either mode, the network theory, optimal slot utilization increases with little change in the number of sites, approximately constant. The nature of our adaptive algorithm provides a good reference to the optimal value. The theoretical optimal value as the number of cases in different sites of a network congestion measure.

112.3 CWAS Algorithm Description

112.3.1 CWAS Algorithm Design

Because the characteristics of 802.11 back off process, the minimum contention window size on network performance have a huge impact. Analysis shows that [3], in the case of network congestion, increasing the value of the minimum contention window will significantly improve network throughput and reduce conflict. In the case of the network is idle, the contention window is too large it will increase the network idle time slot count, lower throughput. This shows that to obtain optimal network performance needs to dynamically adjust according to network conditions the value of the minimum contention window. And network congestion can be used to measure proposed slot utilization [5], the network benefits of each site can be calculated independently distributed. Because the shared nature of wireless channels, WLAN each node can listen to the single-hop range of frames of other sites. According to statistics of the network time slot utilization and the actual sections drawn on the optimal utilization of time slots can be drawn comparing the best position relative to the current network is congested or idle, and then adjust the value to the minimum contention window The adjustment to the whole network broadcast to all sites updated simultaneously. To minimize the algorithm overhead, update the data frame incidentally.

As the network congestion is not an instant lift at a time, to improve the fairness between the nodes, the dynamic adjustment of the minimum contention window based backoff process, we further optimized. BEB and MILD in the back window of a compromise between speed, using the window half way to success. This better balance between fairness and network bandwidth utilization problems, and easier to process a simple model analysis.

112.4 CWAS Algorithm Implementations

Set the minimum contention window CWmin value, Sbusy busy for the time slot number, Sall update cycle for the experience of the gap number, S_Uopt optimal slot utilization.

Define a new frame type. 802.11 standard MAC frame header type field of 6bit, identify the type of the current frame. Said data frame in which the value of 0×20, $0 \times 28 \sim 0 \times 3F$ is reserved. 0×30 is a good definition of the network data frame, data frame for the network is idle, 0×32 frame for network congestion.

This does not change the frame format in the case of algorithm, the algorithm can not only eliminate the extra cost but also to the original 802.11 network compatibility.

Update cycle Tperiod time, it made the frame of the site. Sent successfully or if the site of conflict (including himself), then Sbusy increase.

To reach the update cycle, the first channel to its competitive success of the site statistics of Sbusy and Sall ratio as the current time slot utilization S_U, compared with the optimal slot utilization. S_U > S_Uopt + Dsu network congestion; the other hand, the network is idle; Otherwise, the network in good condition. According to the current network state selection of the appropriate type of custom data frame to send data frames. If a conflict occurs, this conflict will be included in the statistics, calculate the new time slot utilization and network status, operating above until the next retransmission sent or received successfully update issued by other sites.

Sites, such as listening to the above-defined type of data frame, regardless of whether sent to their own, according to the type specified by the network status to adjust their CWmin value. Network congestion is CWmin doubled, then CWmin half idle, good will remain unchanged. Then, Sbusy and Sall counter is cleared to start the next counter is cleared to begin the next cycle of the update process.

112.5 Simulation and Analysis

112.5.1 Simulation Model

Using NS2 simulation tool, using 802.1 lb the DSSS transmission type, all sites are in the single-hop communication within the transmission range of 200 m and purpose of each site were randomly selected sites to communicate. Data frame payload 1000 byte, made the frame interval of 0.025 s. Using the method described in Sect. 112. 2 to be the optimal time slot CWAS utilization, and reference [3] to select the slot utilization of the specific parameters of the floating threshold of tolerance. In order to assess the scale of the different network performance under the agreement, we are the number of sites for the eight groups of 10–80 this simulation scenario, in which each scene to take measurements of different random seeds 10 times the average.

112.5.2 Simulation

First select a more reasonable minimum contention window update, the update cycle is not too small nor too big. Update cycle is too small, the required network adaptive algorithm does not accurately reflect the state statistics network

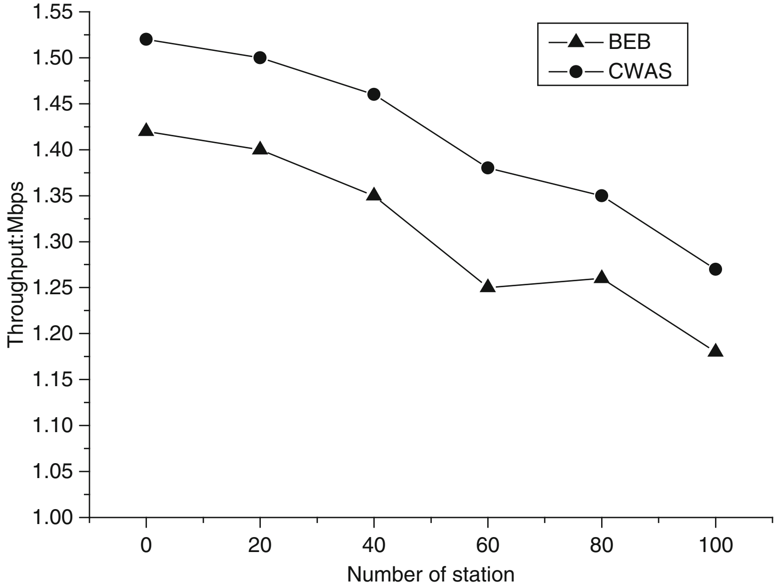

Fig. 112.1 The performance in the RTS mode

conditions: the update cycle is too long, the adaptive algorithm cannot adjust the contention window, the effect is decreased. By selecting different update cycle simulation test comparison, we used 0.58 for the update cycle. The following Figs. 112.1 and 112.2, that CWAS under different network size and two access modes with BEB and MIMD algorithms performance comparison.

Figures 112.1 and 112.2 in the RTS/CTS mode, the performance comparison. CWAS frame delay and MIMD or less, slightly larger than BEB. This is because the RTS/CTS mode, the probability of conflict and conflict lead to greatly reduce the time, compromise the window back rate has actually increased latency. The saturation throughput, the number of sites of 15 lower than the performance of the following BEB, which is due to the utilization of the best slot number on the site for more than 15 or 15 of age and have a relatively large change, and our best slot utilization is taking more than 15 sites of approximately the same number of fixed values, combined with our tolerance of the selected time slot usage threshold see floating. Reference value is not the best, resulting in fewer sites to determine the network status at a certain bias, making the site larger minimum contention window. But as the number of sites increases, competition, CWAS began better than these two algorithms.

The above analysis shows that, CWAS algorithm in Basic mode and frame delay on the full amount of the relative BEB, MIMD has greatly improved, and close to the theoretical maximum throughput; in the RTS/CTS mode with the network scale, the throughput improvement is gradually revealed. This shows that the CWAS

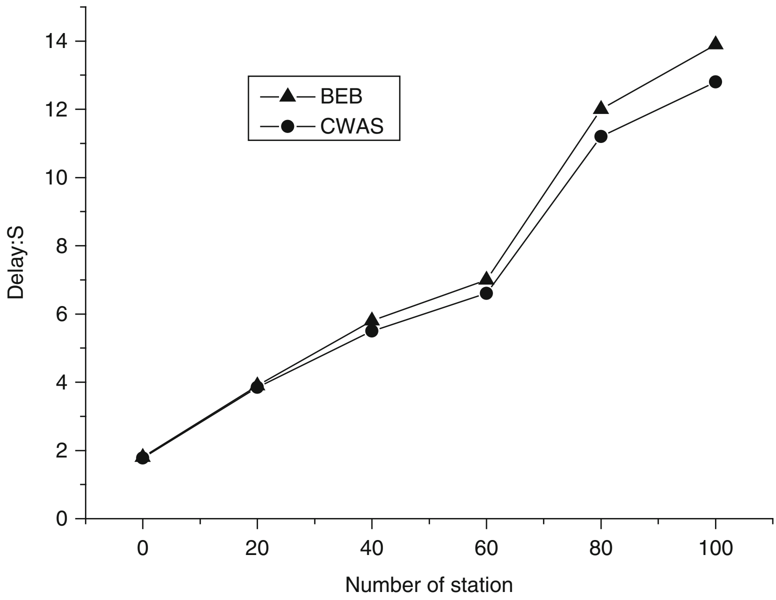

Fig. 112.2 The performance in the CTS mode

adaptive algorithm used in the smallest window adjustment mechanisms and conflict halving strategy is efficient windows. Future improvements are expected to scale according to different network adaptive update cycle and the selection of optimal utilization of floating time slot tolerance threshold. And consider the case of the station points lower values of the best slot utilization problem, further improvement of RTS/CTS mode, the throughput and latency.

112.6 Conclusion

Theory of network parameters using the best case the number of slot utilization increases with approximately the same site characteristics, proposed CWAS contention window adjustment algorithm and its theoretical model. The algorithm uses the adaptive mechanism is simple and effective, according to current network conditions to adjust the minimum contention window value, largely reducing the potential for conflict. With the BEB algorithm, MIMD algorithm the number of cases in different sites compare simulation results show that, CWAS algorithm in Basic mode, the throughput and delay performance have greatly improved, RTS/CTS mode, the performance remains to be further improved.

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