MASTER'S THESIS

Performance analysis and improvement of IEEE 802.11 protocols

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Abstract

With the rapid expansion of wireless network coverage, IEEE 802.11 based wireless services have brought convenience to more and more people's everyday life. Along with the adoption of WiFi networks in most of public areas, there comes the issue of network performance degradation as the number of users in the same area increases. The coexistence of more wireless stations always leads to slower network speed because of channel competition and interference.

Access points, or APs, have been playing an important role in infrastructure wireless LANs. An important functionality of an AP is to relay messages among wireless stations inside the same wireless cell. In current implementations, an AP needs to compete for the wireless channel with all other wireless stations using DCF protocol. The first objective of this thesis is to design systematic and reproducible experiments to show that, with uncontrolled UDP traffic in the network, the AP becomes the system bottleneck and the system goodput could drop to an unacceptable level, mainly due to buffer overflow at the AP. Even worse, TCP connections can be easily choked by UDP traffic for a long duration. We think this observation is important because UDP traffic volume is growing rapidly with the widely-deployed Voice over WiFi, wireless surveillance system, digital games, multimedia streaming applications, etc. For a research of improvement methods, we resort to simulation analysis to compare two schemes: either let the AP waits for shorter time or, add rate control scheme at the MAC layer to slow down all stations when AP becomes too busy. Our simulation shows that both methods can alleviate the UDP traffic's impact to TCP services. In particular, by reducing the contention window size of AP, the performance of TCP throughput is slightly better than that of giving a fixed shortest SIFS to AP.

Wireless mesh networks have attracted extensive research interests in recent years. With the maturity and pervasive deployment of IEEE 802.11a/b/g technology, 802.11 DCF protocol is considered as a promising candidate for constructing the backbone of wireless mesh networks. In a multi-channel multi-interface wireless mesh

network, point-to-point 802.11 wireless link can provide the highest throughput; hence it is critical to understand the 802.11 throughput performance in a point-to-point configuration. The second target of this thesis is to present a simple yet precise Markov model for the analysis of point-to-point 802.11 link performances in terms of saturation throughput. Different from previously proposed analytical models, our model does not assume a constant and independent collision probability. Our analytical model is validated by computer simulations for both 802.11b and 802.11g configurations.

Finally, in order to achieve best service to different kinds of traffic, it is imperative to support quality of service (QoS) in wireless mesh networks. In the last part of this thesis, we design a framework to provide parameterized QoS in 802.11e based wireless mesh networks. Our framework consists of admission control algorithms and scheduling algorithms, which aim at supporting constant bit-rate (CBR) traffic flows, as well as variable bit-rate (VBR) traffic flows. We study the proposed different admission control algorithms for VBR traffic by simulations and the results show that, by taking advantage of statistical multiplexing, much more traffic flows can be admitted.

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