

An Analytical Energy Consumption Model for Packet Transfer over Wireless Links

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Energy-efficient data communication is an important requirement in wireless networks. Reducing energy consumption in transceivers during data communication can extend the operational lifetime of battery-powered devices and save energy in a global scale. A fundamental step, however, is to accurately model the energy consumption for data communication over a wireless link. Without the use of such a model, any mechanism designed to be energy-efficient may not be optimal, and any analysis of energy-efficiency may only be a poor approximation. In this article, the authors provide a comprehensive analytical model for estimating the total energy consumed when exchanging data over a wireless link. The model improves previous models by considering many pertinent details, such as link reliability, data packet size, acknowledgment packet size, wireless link data rate, and energy consumed by processing elements in wireless devices. To develop the model, the authors use experimental results and discover that the energy consumed for receiving erroneous data is comparable to the energy consumed for receiving error-free data. A high volume of data reported as lost during the wireless transmission is actually received completely (like error-free data), but is discarded at the receiver due to erroneous bits. The experimental results also verify that even if there is practically no wireless link between two devices (due to very low link quality), up to 60% of transmitted data is completely received and discarded. In other words, wireless devices consume energy not only to receive correct data but also to receive and process data that will be reported as lost to the application layer. This is an important finding that should be taken into account when designing energy-efficient wireless networks.

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