Technical Article

Low-power Wi-Fi®: How Environment Properties Impact an Application's Energy Consumption

Asaf Even Chen

In real-life conditions the environment's properties have a large impact over an application's energy consumption. These factors include, for instance, access point (AP) behavior, network performance, network capacity and load, as well as link quality. While control over environment-related behavior is often limited, our SimpleLink™ Wi-Fi® devices utilize advanced algorithms to learn and adapt to the environment in order to achieve increased performance and decreased energy consumption while still maintaining a robust system. In addition, our SimpleLink Wi-Fi CC3100 and CC3200 devices have been tested with more than 200 APs to ensure robustness and optimal performance. The following blog includes advanced information on how the AP and network behavior impact application energy consumption.

Impact of Access Point Behavior on Energy Consumption:

Wi-Fi connection sequence– The time to complete the connection to the AP (and energy consumption thereof) may vary from one AP to another. This could be a significant part of the overall solution's energy consumption for applications that frequently disconnect and reconnect to the AP, such as a sensor application. For applications that stay connected to the access point, this could be considered as negligible.

Idle connected mode ("beacon reception") – In this mode the Wi-Fi device maintains a connection to the AP for the purpose of listening to network beacons. The energy consumption in this mode depends on the specific AP behavior to which the device is connected, and may vary up to 300% across different APs. The SimpleLink Wi-Fi device implements a unique algorithm which limits the energy consumption variance to a factor no greater than 50% for most APs. The algorithm is enabled automatically and does not consume extra energy.

Link quality - The quality of the Wi-Fi connection directly impacts the energy consumption. A low-quality link results in higher retransmission likelihood, hence, the number of times packet need to be sent increases. The transmitted packet output power, number of retransmissions and its transmission rate define the packet error rate over a channel and the resulting energy consumption. The rate is usually determined by the AP's policy and the SimpleLink Wi-Fi device in the link layer, for reducing packet error rate, achieving optimal energy consumption and throughput performance; thus uncontrollable by the application. When using a local network, the AP and stations' deployment could be defined to achieve optimal link quality.

Network Behavior Impact on Energy Consumption:

Network capacity and load – Network capacity is a measure of the maximum amount of data that can be transferred between network clients over a link. The number of clients over the network and the required throughput affects the network load and the response time, and therefore its capacity. An increase in network usage increases the communication period over the network and the overall device energy consumption thereof. A reduction of the network usage for a specific throughput can be done by reducing the number of transmissions and their duration. The number of transmissions is reduced by aggregating data, which can be employed up to the maximum allowed packet size and as long as the system latency demand is kept . The transmission duration can be reduced by using a higher Wi-Fi rate as described above (see section on link quality).

Round trip time (RTT) – The RTT is the time measured from the moment a request has been sent by a server/ client until response has been received. This time is affected by the data transfer rate, the physical distance, the number of nodes between the source and destination and the number of other requests being handled by the server. The RTT is one of the main factors affecting the application latency. Larger RTT results in higher energy consumption owning to the need for a prolonged waiting time.

IP acquisition method –There are two distinct methods for obtaining an address in an IP-based system. Either dynamically, from a DHCP server, which may consume a significant amount of energy due to the energy attributed to the DHCP exchange involved. Dynamic IP acquisition process can be bypassed by defining in advance the IP address that the system should use; this is known as static IP definition. Using static IP is relevant for systems where the control over the IP network topology is possible. In which case, static IP configuration is favorable from energy consumption perspective. This is achievable by configuring the IP acquisition method on the device (see sl_NetCfgSet described in the SimpleLink Wi-Fi CC3100 API / SimpleLink Wi-Fi CC3200 API).

More details on low-power Wi-Fi development and how to optimize your designs can be found at: SimpleLink Wi-Fi CC3100/CC3200 Internet-on-a-chip™ networking sub-system power management application note as well as previous posts of our low-power Wi-Fi blog series. We hope this blog series has been helpful – please let us know what you think and what additional topics you'd like us to discuss!

Read Our White Paper on Low-power Wi-Fi Connectivity:

- Low-power Internet connectivity over Wi-Fi®

IMPORTANT NOTICE AND DISCLAIMER

TI PROVIDES TECHNICAL AND RELIABILITY DATA (INCLUDING DATA SHEETS), DESIGN RESOURCES (INCLUDING REFERENCE DESIGNS), APPLICATION OR OTHER DESIGN ADVICE, WEB TOOLS, SAFETY INFORMATION, AND OTHER RESOURCES “AS IS” AND WITH ALL FAULTS, AND DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, INCLUDING WITHOUT LIMITATION ANY IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE OR NON-INFRINGEMENT OF THIRD PARTY INTELLECTUAL PROPERTY RIGHTS.

These resources are intended for skilled developers designing with TI products. You are solely responsible for (1) selecting the appropriate TI products for your application, (2) designing, validating and testing your application, and (3) ensuring your application meets applicable standards, and any other safety, security, regulatory or other requirements.

These resources are subject to change without notice. TI grants you permission to use these resources only for development of an application that uses the TI products described in the resource. Other reproduction and display of these resources is prohibited. No license is granted to any other TI intellectual property right or to any third party intellectual property right. TI disclaims responsibility for, and you will fully indemnify TI and its representatives against, any claims, damages, costs, losses, and liabilities arising out of your use of these resources.

TI’s products are provided subject to TI’s Terms of Sale or other applicable terms available either on ti.com or provided in conjunction with such TI products. TI’s provision of these resources does not expand or otherwise alter TI’s applicable warranties or warranty disclaimers for TI products.

TI objects to and rejects any additional or different terms you may have proposed.

Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265