Integrating WLAN into Mobile Handsets

Introduction

The growth of wireless networks based on the IEEE 802.11 Wireless LAN family of standards has been one of the most outstanding success stories of the technology industry in recent years.

The initial growth of WLAN, also commonly referred to as Wi-Fi thanks to the certification efforts of the Wi-Fi Alliance, was in its intended role of providing a wireless data networking capability as a replacement to a wired LAN connection; but as its capabilities grew – with the standards being enhanced to offer higher data rates, better quality of service, and special modes such as power-save – it quickly became an integral part of a large variety of electronic devices including phones, gaming devices, music players, sensors, and other consumer devices. In this article, we look at the factors to be considered while integrating WLAN into mobile handsets. The handsets utilize WLAN connectivity for a wide array of purposes – including Voice-over-Wi-Fi (VoWiFi) calls, web browsing, email, data download, audio and video streaming, and file synchronization.

Integration Considerations

The most common method of bringing in WLAN functionality into a handset is through the integration of a self-contained WLAN module offering a low load on the host processor. This approach minimizes integration effort, as we elaborate further on. Figure 1 shows the typical constituent blocks of such a WLAN module. The Host Interface is usually SDIO or SPI, or sometimes a memory-mapped interface or USB. The module shares a frequency reference with the handset's communication blocks, and also a low frequency clock used in sleep modes.

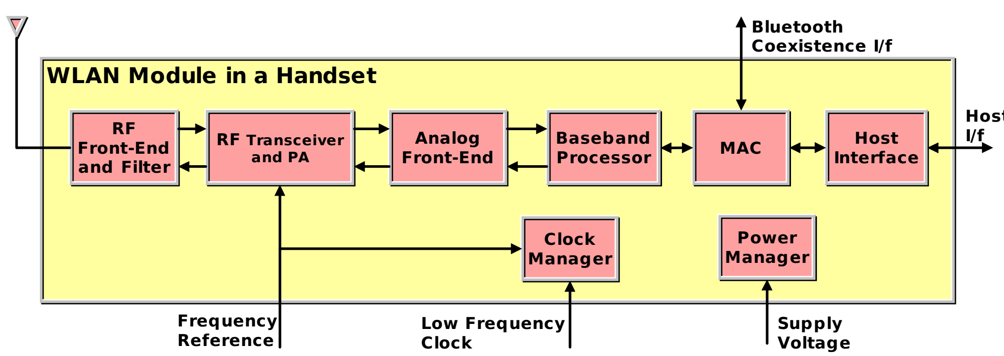

Figure 1: The Components of a WLAN Module

There are several considerations influencing the integration of this module into the handset, as listed below.

Physical and Electrical considerations: Size and weight are primary concerns because of their influence on a consumer's choice of a mobile phone. State of the art WLAN modules are typically smaller than 10 mm by 10 mm.

The high level of integration within the WLAN module drives a need for several voltages. To cater to this, and to the stringent power-save considerations, the modules include a full featured power-management block.

Coexistence: Since the modern full-featured handset includes a myriad functional blocks, with many of them communicating wirelessly – like GPS, Bluetooth, FM radio, etc., coexistence issues become prominent. Among these, Bluetooth requires special handling since it occupies the same frequency band of 2.4 GHz as WLAN. Bluetooth coexistence is handled usually by exchanging hardware signals in real time with the Bluetooth module, through which it is ensured that their transmission and reception are spaced apart in time and frequency. With some bands of the cellular spectrum being relatively close to the WLAN operational frequencies, handsets also require a measure of filtering in front of the WLAN module to curb mutual interference between the cellular RF and the WLAN RF.

Software Integration: The WLAN module is expected to take care of the majority of protocol specific tasks. The host application processor normally integrates a network driver that configures the WLAN hardware and provides for command and control functionality. The host may also include a supplicant taking care of enterprise mode authentication requirements.

In summary, the integration of WLAN via a self-contained module is the preferred approach for the following reasons:

- No WLAN related protocol load in the host processor.
- No critical RF design and integration necessary.
- Independently Wi-Fi certified – low risk in re-certification on the platform.
- Minimum time-to-market.
- Potentially simple upgrade path.

Performance and Power Consumption Considerations

The primary consideration here is that of power consumption. The WLAN functionality would be used for a variety of purposes, and each of the applications would require a separate analysis of performance requirements and power consumption. We elucidate this for a couple of few key applications below.

Voice Calls

VoWiFi is a potential 'killer application' in mobile handsets. The widespread availability of WLAN connectivity in public places, at home, and in the office means that a potentially large percentage of voice communication can take place through low-cost VoIP services. For the user to experience a satisfactory call quality, the WLAN connection would need to ensure performance in terms of low jitter, low packet loss, and low latency. Meeting these requires, in addition to basic wireless performance, the provision of standards-compliant QoS mechanisms. Additionally, the WLAN client would have to implement a robust and quick roaming mechanism to ensure that voice calls are carried over smoothly when the client roams from one AP to another.

There are two functional modes related to VoWiFi from the power consumption point of view. The first is during the state when a phone is kept 'ON' and is waiting for a call. The power consumed in this mode will determine the standby time of the phone. The second mode is during an active call – this would determine the talk time of the phone. Active voice calls use standards-compliant power-save modes such as U-APSD, where the WLAN device enters a low-power state in the duration between transmissions of voice packets.

Data Download and Upload

The performance metric of data transfer applications is primarily the transfer speed. This data rate is influenced by the location of the handset with respect to the Access Point, the performance of the receiver in its ability to handle weak and distorted signals, and the power and quality of its transmitted signals. Interestingly, the higher the performance, the lower is the energy consumed for transferring a desired amount of data. This is because the WLAN client typically resumes a low-power sleep state upon entering an idle period – and it can enter this state more quickly if the performance of the system permits the transfer of data faster.

802.11n Benefits

The IEEE 802.11n standard primarily provides for high throughput, high-efficiency, and long range data connectivity, and includes the use of multiple antennas and transmit-receive chains. However, the standard also includes a single-stream mode that is intended to provide the benefits of 11n to low-power small form-factor devices like handheld phones. The use of single-stream 802.11n WLAN in mobile handsets provides the following benefits:

- Higher throughput – achieved through better efficiency in PHY and MAC. Higher throughput also brings in lower power consumption.
- Longer range – through use of diversity schemes such as STBC
- Preservation of 802.11n network capacity – the presence of legacy 802.11a/b/g clients forces the 11n nodes to use protection mechanisms and results in overall drop in network capacity. 802.11n helps avoid this.

Certifications

Interoperability of WLAN devices is mainly ensured through the certification facility provided by the Wi-Fi Alliance. Relevant certifications for the handset include WPA2, 802.11n Draft 2.0, WMM,

WMM-PS, WPS, and Voice-Personal. State of the art WLAN modules, include Redpine Signals' Lite-Fi™, are certified for all of these.