

# Combo Chips Pack a Punch

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The ongoing convergence of communications technologies and proliferation of digital media is introducing radical changes to the consumer electronic market. These changes are redefining our traditional ideas of what we can expect from familiar products such as televisions, personal computers and cellphones. Advances in semiconductor technology are driving this transformation by bringing capabilities to which we are already accustomed (such as Web browsing, recording video, and getting driving directions) into new device contexts. Mobile handsets are a good example of this trend, with the newest models providing advanced multimedia and Internet features that were previously limited to other devices.

Key to this convergence is the ability for mobile devices to connect to multiple networks, including those powered by Wi-Fi, Bluetooth, cellular and other radio technologies. These connectivity options greatly extend the usefulness of a mobile phone by enabling commerce and communication (via high-speed Internet access), delivering real-time sports and news broadcasts, and extending their interfaces with wireless headsets and other peripherals. Each radio technology performs a specific function, but the sum represents a significant transformation of the role of these devices in our lives.

## Wi-Fi IN MOBILE DEVICES

While Bluetooth is already a mainstay feature of mobile phones, Wi-Fi is a relative newcomer to these devices. But with the skyrocketing demand for mobile data, location-based services and multimedia content on any device, both wireless carriers and consumers are now seeing significant value in having Wi-Fi on the handset.

For mobile users, Wi-Fi provides a high-speed link to the Internet and the endless array of digital music, video and games. But since most consumers won't pay much for content that is confined to a single device, tying the mobile phone (and its contents) into the larger Wi-Fi ecosystem makes sense. Imagine downloading songs onto your phone while traveling and adding them to the music library on your PC when you arrive home, or transmitting photos and videos between your phone and television.

For cellular carriers, Wi-Fi is a technology that can offload data traffic from a 3G network, which frees up bandwidth and reduces the cost of adding infrastructure to support the growing number of customers looking to use these new applications. Additionally, it can turn a wireless handset into a

multimedia center, spurring new usage models and revenue streams for service providers.

The additional bandwidth and coverage of the new 802.11n standard will enable even more multimedia applications on mobile devices. This will accelerate Wi-Fi's transition from high-end smartphones into media-centric mid-range phones, and is expected to drive Wi-Fi attach rates from 10 percent of phones in 2009 to 20 percent by 2012, according to ABI Research.

## COMBO CHIPS: A WINNING APPROACH

Given the growing demand for Bluetooth, Wi-Fi and other connectivity technologies in mobile devices, manufacturers are looking for ways to add these features in smaller and smaller products. However, adding multiple radios to mobile phones and other compact devices brings several design challenges – more cost, more drain on battery life, more space, and more radio interference.

Just as various wireless technologies are converging to meet new consumer demands and create new usage models, chip companies are bringing them together at the silicon level to address the technical challenges presented by wireless convergence. Rather than supplying several discrete components, chipmakers are now integrating multiple wireless technologies (such as Wi-Fi, Bluetooth, FM radio, and GPS) onto a single die. Such "combo chips" offer significant advantages that overcome the challenges of designing small mobile devices with the latest connectivity features. Because of these advantages, IDC predicts that combo chips will account for nearly two-thirds of all wireless connectivity solutions shipped into mobile phones by 2012 – demonstrating the strength of this approach.

Manufacturers evaluating discrete wireless solutions versus combo chips must consider the following design criteria:

### Performance

To compete in the cut-throat handset market, vendors are constantly striving to offer the latest features and a better user experience. Both of these are critical to attracting new customers and maintaining brand loyalty. If a wireless feature fails to work as expected, consumers will become frustrated and may stop using the feature altogether – or worse yet, switch to another handset brand.

When adding multiple wireless technologies to a mobile handset, manufacturers will not settle for sub-par performance. New devices must perform as

good or better than previous generations. Since the Bluetooth and Wi-Fi technologies are constantly evolving, integrating the most advanced features into combo chips is an arduous task. Therefore, handset makers must look for silicon vendors that not only have well-rounded wireless portfolios, but also those with a proven track record of combining technologies for mobile designs.

### Coexistence and Interference

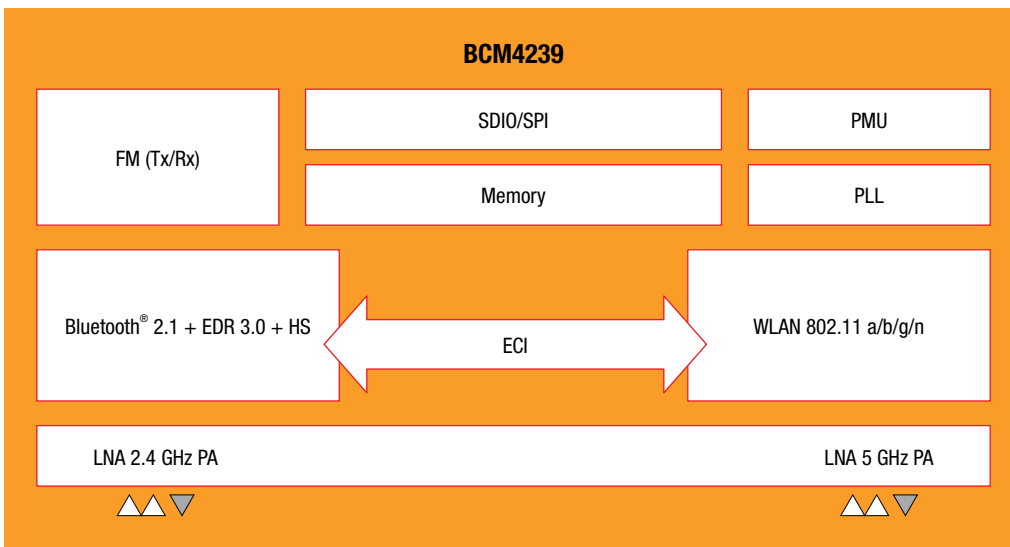
Multi-radio coexistence is also critical to ensuring the best possible user experience for devices with Wi-Fi and Bluetooth. Since both technologies operate in the 2.4GHz frequency band, concurrent transmissions can severely degrade performance and render both radios useless. Although Bluetooth uses an adaptive frequency-hopping (AFH) scheme to mitigate radio interference in the 2.4GHz band, AFH is insufficient when there is little isolation between the Bluetooth and Wi-Fi radios – as is the case in a handheld device.

As you can imagine, the coexistence problem is even worse when both radios are found on the same silicon die. To mitigate interference in close proximity, most chipmakers employ a standard three-wire coexistence interface between the Bluetooth and Wi-Fi chips. However, cutting-edge vendors have developed unique algorithms and hardware mechanisms that intelligently manage the 2.4GHz band. This advanced approach is used to synchronize transmissions, avoid collisions, and find the clearest channel and time slot for Bluetooth and Wi-Fi operation. As a result, today's combo chips can provide better performance than discrete solutions.

### Component Size and Cost

As mobile designs get smaller and less expensive, the size and cost of every component is critical. Wireless combination chips are not only smaller than multiple standalone chips, but they require fewer external components to complete the system. For example, discrete Wi-Fi and Bluetooth systems typically require approximately 200 components, including power amplifiers, baluns, low-noise amplifiers, etc. Combo solutions can cut that number to 40 – by sharing many of the redundant components between the Bluetooth and Wi-Fi systems and integrating others on-chip.

When you map these components to a board layout, the footprint of the discrete solutions is approximately 200mm<sup>2</sup> of board area, versus 75mm<sup>2</sup> for the combo chip. In addition to saving



**Figure 1:** One of Broadcom's latest combo chips combines 802.11n Wi-Fi, Bluetooth, and an FM radio, as shown in this functional block diagram. The chip is unique for its integrated CMOS power amplifiers, among other things.

board space, fewer components obviously reduces the bill-of-material cost for manufacturers. One semiconductor supplier has integrated high-power CMOS power amplifiers into its combo chip, which eliminates the cost of an external PA without sacrificing the system's performance. Innovations like these will continue to make it more cost-effective for handset makers to add combo chips to multiple phone categories.

#### Antenna Placement

With multiple radio technologies come multiple antennas. In addition to one or more cellular antennas, today's more advanced handsets must

accommodate separate antennas for Bluetooth, Wi-Fi, FM and GPS. This not only adds to the system cost, but poses considerable challenges for board layout. Some combo chips can help to alleviate these challenges by sharing an antenna system between the Bluetooth and Wi-Fi radios.

#### Power Management

The more components on the board, the more power it consumes and the more heat it generates – all factors that impact battery life. We've already mentioned that combo chips require fewer components, which reduces overall power consumption. But even more important is the process technology that

chipmakers use when designing combo chips. The leading vendors are using the 65nm process node, which enables greater efficiency, tighter silicon integration, and lower power consumption. As a result, manufacturers can add Wi-Fi and Bluetooth to their devices without concerns over unacceptable battery life.

To further address the complex power requirements of mobile handsets and other portable devices, some combo chips integrate a power management unit (PMU). Such PMUs can monitor usage patterns and optimize system operation to maximize battery life. For example, intelligent "sleep" and "wake" modes can power-down components to minimize wasted power when not in use. Some PMUs are offered with a complete set of software and device drivers to enable the integrated linear and switching regulator output voltages to be programmed, or for start-up sequencing, providing a fast and efficient correlation between the power source and integrated components.

Driven by the functional consolidation in mobile devices, combo chips are the next big wave of semiconductor design. Such highly-integrated solutions offer lower power, a smaller footprint, more cost-effective design options, and better performance than discrete wireless solutions – making them ideal for portable devices like mobile phones. As these mobile devices become more media-centric, consumers demand more connectivity features that enable them to access, enjoy and share digital content among devices. To meet this demand, device manufacturers are looking to the leading chipmakers to provide combo solutions that reflect this new reality. W

(Continued from page 5)

## Revolutionary Broadband Wireless Technology

Ubiquiti Networks has launched a disruptive global outdoor broadband wireless technology called AirMax.

The technology enables real outdoor TCP/IP speeds of 150Mbps+ and consists of radio hardware design, carrier class basestation MIMO antennas, and a powerful TDMA protocol that enables speed and network scalability over multi-km link distances. Most importantly, the solution delivers a price/performance combination that will redefine the economics of outdoor broadband wireless network deployments around the world.

The AirMax TDMA protocol was designed with speed and scalability in mind. Traditionally, the most cost-effective unlicensed band outdoor radio solutions have been based on the 802.11 (or Wi-Fi) standard. While these solutions can provide good results in small scale deployments, they typically degrade exponentially in performance as

more clients are added and cause collisions and retransmissions. The AirMax technology solves these problems through the use of a hardware accelerated TDMA protocol consisting of a smart polling coordinator with smart scheduling and native VOIP packet detection. The result is a network that can scale to hundreds of clients per basestation while maintaining low latency, high throughput, and uninterrupted voice quality.

Along with this next-generation TDMA protocol implementation, Ubiquiti has introduced a MIMO antenna technology portfolio featuring carrier-class performance with return loss, cross-polar isolation, gain, electrical downtilt, and beam width characteristics typically found in only the highest quality of cellular basestation antennas. The antennas have been designed and field tested to ensure optimized throughput performance while using both the AirMax protocol and 2x2 MIMO

radio AirMax hardware.

Ubiquiti has also introduced several AirMax based radio products that allow for powerful and flexible deployment options. The BaseStation platform called The Rocket consists of a rugged, hi-power, wide operating temperature, 802.11n based 2x2 outdoor device which was designed to instantly mate to any of Ubiquiti's AirMax Antennas. For the station side, Ubiquiti has released the next-generation version of their well-received NanoStation. The product called NanoStation M is a compact 2x2 MIMO indoor/outdoor CPE capable of 150Mbps+ TCP/IP throughput and can link distances up to 15km. Additionally, Ubiquiti offers the flexible Bullet M radio which can instantly pair to any outdoor antenna to provide link distances beyond 30km and throughput greater than 100Mbps TCP/IP. W