

An Update on 4G Wireless: Identifying the Capabilities Required in a 4G Handset

From December 2007 *High Frequency Electronics*
Copyright © 2007 Summit Technical Media, LLC

Fourth Generation wireless (4G) has been touted as either the full emergence of mobile broadband services, the first major step toward convergence, or both. As 2008 unfolds, we should get a good idea whether the first statement is correct, but convergence does not appear to have an imminent arrival. The only place where functions are converging is inside the handset, where a growing variety of functions are being combined—some might say forced to coexist—in very small space!

If personal wireless telecommunications evolves into 4G as industry analysts are currently saying, the handsets will be very impressive engineering accomplishments. To illustrate what level of performance and complexity is expected in a 4G handset, let's look at the range of functionality that is now being, or soon will be, implemented in the wireless arena.

Narrow Bandwidth Services: Voice and Data

Voice—The original mobile telephone concept remains the primary use for a wireless handset. Like many new technologies that dramatically alter the way we live, it may require time for younger users to “grow up with wireless” and make more extensive use of the additional capabilities.

Low-speed data—These services include text messaging, ring tone downloads and message services such as news headlines, weather or stock market reports. The number of text messages is growing exponentially, much like wireless phone usage itself in the 1980s and 1990s. With low-cost bundled rates that included unlimited text messages, this use will continue indefinitely, and will be part of all new 4G handsets.

Wide Bandwidth Services

At present, industry association CTIA reports that less than 9 percent of wireless handset users have high-speed service. While there are certainly many users who would like to have improved mobile services, there may be greater urgency in industry to develop 4G for its potential to increase revenues with premium broadband services.

Service	Frequency & Type	
General:		
Wireless provider	900/1900MHz	(voice, low rate data)
Broadband:		
Wireless provider	2.1-2.3 GHz	(broadband)
WiMAX	3.5 GHz	(broadband, video)
WiFi	2.4/5 GHz	(broadband)
Digital Television*	VHF/UHF	(video programming, broadband downlink)
Re-farmed TV	700 MHz	(broadband)
Short-range:		
Bluetooth	2.4 GHz	(voice, low rate data)
Ultra Wideband	3-10 GHz	(broadband, video)
Accessory:		
GPS*	1.5/1.6 GHz	(location, navigation)
RFID	various	(security, SmartCard)
*receive only		
Note: These are U.S. frequencies only, worldwide allocations for some services may vary.		

Radio services that a 4G handset may potentially be required to support.

Internet access—Beyond the factor of increased bandwidth, A 4G handset must deal with the practical user issues of screen and keyboard size. The example of the Apple iPhone suggests that innovative design may provide a solution. Some of the expandable folding handsets offer additional possibilities. These are very important matters, because the early response to scaled-down internet page formats formatted especially for mobile users has not been strong.

Broadband portal—The wireless network as a modem for the user's portable computer has shown significant value, especially when the user understands the nature of system operation, including WiFi. We have not seen much discussion of this part of wireless handset use, but expect it to be available along with internal broadband capabilities.

Subscription services—Movies, audio downloads, sporting events, and other services have excellent revenue potential if the number of users is sufficient. Like cable television's pay-per-view, the numbers will be likely be a small fraction of the user base, but rates can be established that are acceptable to the user and profitable to the service provider.

Other Functions and Services

At a minimum, a 4G handset will still have a range of additional functions, including GPS navigation with related location-based information services, plus Bluetooth personal area connectivity.

As we have already seen, still and video cameras are an accepted part of a handset, along with MP3 audio players. 4G will add video players and improved video sharing. Full-feature GPS-linked maps and navigation should be typical, as well.

A wide range of specialized capabilities may be offered, since the available bandwidth will be much greater. Any conceivable broadcast, cable or Internet-based service is potentially a built-in feature on some version of a 4G handset.

Capabilities of the Radio Circuits

To connect with the services noted above (and new ones yet to be imagined), a 4G handset will require much more radio capability than a current 2.5G or 3G handset. Current radio technology includes the 900/1900 MHz wireless channels, plus GPS and Bluetooth. This will change dramatically with 4G. As shown in Table 1, here are the RF functions that a handset may be required to perform:

Wireless provider channels—Both the current 900/1900 MHz and wide bandwidth "3G" 2.1 GHz channels licensed by the customers' wireless provider need to be supported.

WiMAX—3.5 GHz (and possibly higher frequency bands in the future) is the location of WiMAX, which will provide some of the broadband capability in 4G. This system is beginning deployment, which will proceed in tandem with mobile wireless services as they move toward 4G capabilities.

WiFi—The Apple iPhone includes WiFi access as a means of obtaining wireless Internet access. It is possible that handsets may be offered that are WiFi and WiMAX based without a normal wireless provider, using voice-over-IP as the base telephone service.

Digital Television transmissions—There has been little publicity in the area, but there are efforts underway to use DTV transmissions to deliver broadband services to mobile handsets. As a one-way service, this will require the uplink via the wireless provider's lower bandwidth. This may be a relatively minor issue, since DSL and cable modem services are

also asymmetrical with respect to uplink/downlink data rates. With a television tuner in place for data services, it will take only a small additional effort to include broadcast DTV reception capabilities in a 4G handset, a function that may appeal to a significant number of users.

Re-farmed TV channels—Spectrum in the 700 MHz region will be auctioned off by the FCC, with the anticipated use being wireless broadband access. This spectrum will become available after the transition to digital is completed for major TV stations. It is still unknown exactly what type of systems will be developed, but they should be accommodated in 4G.

Bluetooth—This system is already in use for connection to wireless headsets and other accessories. With the automotive industry developing Bluetooth-based applications, related features may be offered in 4G handsets.

Ultra Wideband—UWB has the potential to become the primary high bandwidth transmission medium for wireless household networks, providing entertainment, security, and other communications. As with Bluetooth, most 4G architects envision greater connectivity to other wireless services, so UWB is a candidate for inclusion in a handset when the technology becomes widely used.

GPS—Currently, GPS is mainly used for E-911 services and other law enforcement activities, but there are many possibilities for expanding its functionality. Personnel tracking, location-based information services, and navigation assistance are well-known GPS applications. Technical advances have recently been made in GPS receiver technology to increase indoor sensitivity. In addition, GPS repeaters are available for providing GPS access in structures where GPS signals cannot otherwise be received.

RFID—Another valuable accessory function is RFID, another means of connectivity to functions and services outside the normal wireless handset realm. RFID and the related SmartCard technology can, in effect, place security tags, credit cards, asset tracking and other functions in the user's handset.

Summary

This look at the scope of RF functions is sufficient to show how complex 4G can be. When you add non-wireless functions that will also be expanded in their number and capabilities, the complexity grows. On top of that, we must consider other necessary improvements, such as secure user access, battery life and mechanical robustness.

It is impossible to guess exactly how these potential capabilities and features will be combined as the market evolves, but from a technical perspective, it will be a fascinating story!