Market Opportunities in the Age of Seamless Mobility

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Abstract

The next wave of mobile handsets will provide a continuity of user experience that was previously not possible. Whether at work, in the automobile or at home, the ability to provide a seamless transition across heterogeneous networks will enable a new level of consumer experience and efficiency. In order to provide this capability mobile device architectures and related infrastructure will become more complex. This complexity will create opportunities for component suppliers to innovate new solutions that will lower costs and size while improving performance for seamless mobility devices similar to that found in the evolution of UMTS devices.

AN OVERVIEW OF SEAMLESS MOBILITY

The Goal of seamless mobility is to put people in control of technology --letting you access and control everything that is important to you from anywhere you happen to be.
The technological obstacles that would separate you from what you value most disappear. Instead, millions of networks, people and intelligent devices work together. So all you have to worry about is enjoying the experience or getting work done. For a corporate user, seamless mobility will provide boundary-less communications, where capabilities normally available only inside the walls of an enterprise such as email, meeting calendars, and corporate directories will available wherever the user goes. Users will be able to start a call on their enterprise network and seamlessly transition to the cellular network as they leave the office. They can be reached via one number while on the go. One example solution ties together WLAN and cellular technologies in a single device for easier, more efficient access to voice and data networks whether inside or outside of the enterprise. For the personal user seamless mobility will help you whether you are in your car, in your home, at work or out in the world. Phones that pay for parking without touching a key. Cars that know where you're supposed to be and how to get there. Homes that record your favorite tunes and movies and share them with your friends. Seamless mobility will enable products and systems that carry intelligence into your life. Into the next thing you'll want to do.

SEAMLESS MOBILITY FOR MOBILE DEVICE AND INFRASTREUCTURE MANUFACTURERS

For mobile device and infrastructure manufacturers creating seamless mobility solutions there is work to be done in many areas of the architectures and ecosystems before seamless mobility will become ubiquitous. The mobile devices transition from a single air interface to multiple interfaces. Likewise multiple types of basestations or "fixed" nodes will enter into the solution as well as a more complex infrastructure to handle the hand-offs and solution of the best type of network to use at a given point of time, whether the optimization of the best network is based on bandwidth requirements, cost minimization, existing network load, etc. Figure 1 shows an expected architecture for the seamless mobility ecosystem. Notice that the core is centered around the internet protocol and encompasses the home, the office and the automobile in additional to the traditional cellular components.

A further complication not found in single air interface networks today and increasing the complexity of the architecture is the expectation that there will be multiple partially overlapping networks. This will help provide an increased bandwidth capability in "hot spots" while still maintaining an overall network coverage. This is shown schematically in Figure 2.

In the broadest sense, seamless mobility can entail communication among devices without the use of a traditional network backbone through the use of so-called ad-hoc communications between devices themselves or a hybrid where a mobile device may use another mobile device as an intermediary to help extend its range or performance into the traditional network.

THE MARKET OPPORTUNITY

In essence, in order to simplify the life of the consumer, the tools provided to the consumer are becoming more complex. In the first generation architectures, this complexity is adding to the cost of the solution. As in any consumer electronics space, there are market opportunities for component manufactures who are able to innovate and deliver solutions for the next generation architectures that improve performance, and reduce risk, size or cost to the mobile device manufactures. The areas of innovation possibilities encompass almost every aspect of the mobile device architecture including displays, user input methods, memory optimization, applications processor performance as well as the RF sections. This paper will concentrate on the RF portions of the seamless mobility architecture which is of interest to the CS MANTECH community.

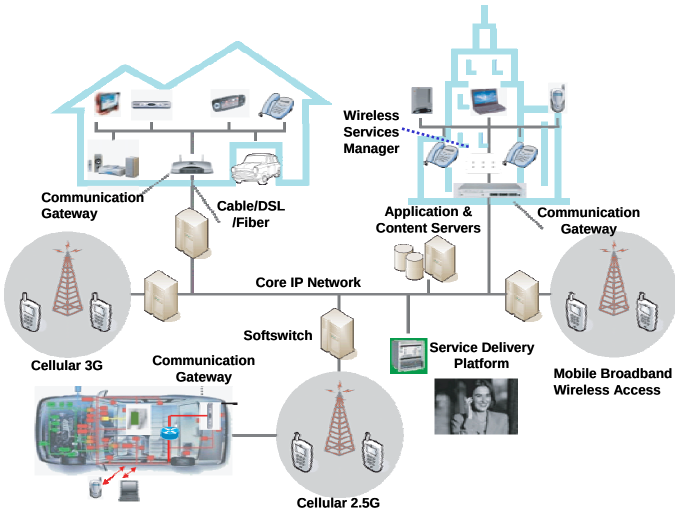

Figure 1. Seamless Mobility Architecture.

HYBRID RF

Although the fundamental definition of seamless mobility is air interface agnostic, the majority of the work today is typically centered around one of the cellular interfaces coupled with WiFi. WiFi is becoming more prevalent within an enterprise's network, within homes and at "hotspots" in many communities. However, WiMAX may also become a contender in the seamless mobility interface space based on its larger coverage area and efficient use of spectrum. Table 1 provides a comparison of the main performance differentiators between WiFi and WiMAX. Table 2 provides a more complete set of the range of possibilities for frequency combinations based on the cellular standards, WiFi/WiMAX possibilities, Bluetooth and ultrawide broadband configurations. Some sections in the 802.16e proposal extend the frequency range up to 11GHz. The 3GPP efforts work to define interoperability across the major standards. The Global Navigation Satellite Systems (GNSS) receivers which are comprised of GPS now and will include the Galileo system when deployed, increasingly found in mobile handsets, operate at 1575 MHz.

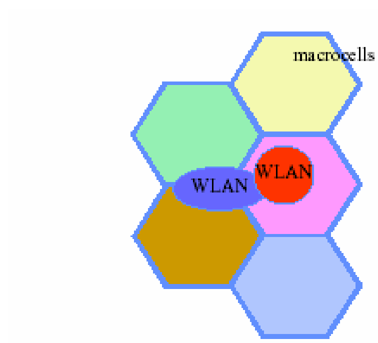

Figure 2. Hybrid System with Overlapping Technologies. Ref: Jiang, et al, Seamless mobility Management Based on Proxy Servers.

Table 1. A comparison of features between WiFi and WiMAX.

	802.11 WiFi	802.16 WiMAX
Range	Optimized for users within 100m radius Access points or high gain antenna can be added for greater coverage	Optimized for typical cell size of 7-10 km Up to 50km range
Coverage	Optimized for indoor environments	Optimized for outdoor environments
Scalability	Channel bandwidth for 20 MHz is fixed	Channel B/W is flexible from 1.5 MHz to 20 MHz for both licensed and license-exempt bands Frequency re-use Enables Cell planning for commercial service providers
Mobility	Some mobility	Fixed. 802.16e Expected to offer portability in 2005
Bit Rate	2.7 bps/Hz peak data rate; Up to 54 Mbps in 20 MHz channel	3.8 bps/Hz peak data rate; Up to 75 Mbps in a 20 MHz channel 5 bps/Hz bit rate; 100 Mbps in 20 MHz channel
QoS	No QoS suport today -> 802.11e working to standardize	QoS designed in for voice/video, differentiated services
Frequency	2.4 GHz, 5.8 GHz	2-11 GHz
Use Case	Local Area broadband, Wireless Ethernet	Wide Area Backhaul, ISP

Table 2. Possible Frequency Bands Utilized for Seamless Mobility.

Freq Band (MHz)	Designator	GSM	CDMA	WCDMA	GNSS	802.11 WLAN	802.16e WiMAX	Bluetooth	3GPP evolution	UWB
800	Cell	Deployed	Deployed	Deployed					Possible	
900	GSM	Deployed		Expected					Possible	
1575	GPS/Gallileo				Deployed					
1800	DCS	Deployed		Expected					Possible	
1900	PCS	Deployed	Deployed	Deployed					Possible	
1700/2100	USAWS		Expected	Expected			Possible		Possible	
1900/2100	ITU1		Deployed	Deployed					Possible	
2010-2025	2010								Possible	
2300-2400	2300					Deployed	Possible	Deployed		
2500-2690	2500		Possible	Possible			Possible		Possible	
3-5 GHz										Expected
3.3-3.7 GHz	3000						Possible			
5.25-5.85 GHz	5000					Deployed				
6-9.5 GHz										Expected

Legend =Deployed =Expected = Possible

As can be seen by the frequency bands shown in Table 2, the introduction of interfaces beyond the traditional cellular networks broadens the frequency range required of the front end components. The solution today is to have duplicate hardware for each air interface and is akin to the initial architectures in UMTS. The evolution of UMTS architectures can provide insight into the opportunities for vendors of chipsets targeted for seamless mobility and is described in the next section.

UMTS Evolution Example

UMTS handsets combine WCDMA and GSM air interfaces in one handset to provide higher speed data capabilities with world wide roaming access. Figure 4 shows a schematic of a first generation architecture for a tri-band GSM and a single band WCDMA UMTS handset. This design has 8 IC's, 3 PA's and 9 filters for Class 10 GPRS and 384 kbps receive / 128 kbps transmit operation over WCDMA.

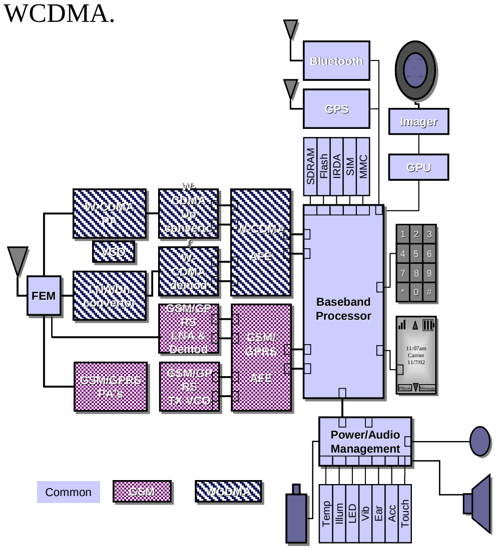

Figure 3. First Generation UMTS Architecture consisting of 3 bands GSM (900/1800/1900) and 1 band WCDMA Band I (1900UL/2100DL).

The second generation reduced the parts count to 5 IC's, 3 PA's and 7 filters for the same data rates, as shown in Figure 3. Two RF-IC's are shared between the GSM and WCDMA sections providing cost, size and power consumption reduction.

The third generation UMTS architecture further reduces size and power consumption while increasing the bands to four GSM and three WCDMA with 3.6 Mbps HSDPA, Class 12 EDGE capability and 384 kbps in both uplink and downlink for WCDMA. Size and cost reductions are achieved by further integration of components into modules as shown in Figure 5.

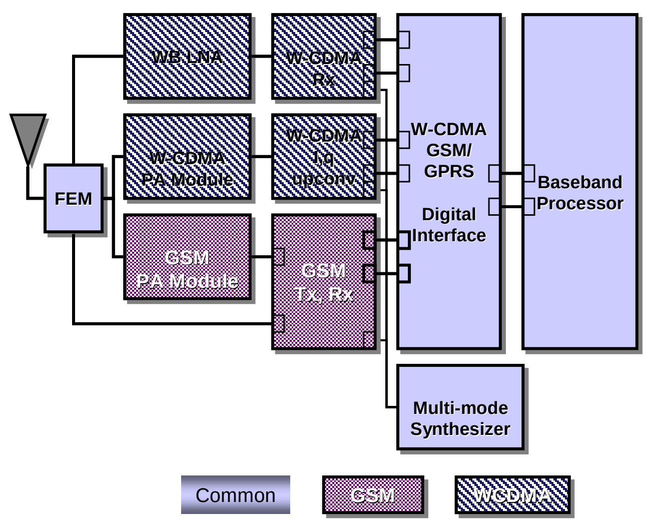

Figure 4. A Second Generation UMTS Architecture. The non RF and non-cellular RF sections from Figure 3 are removed to simplify the schematic.

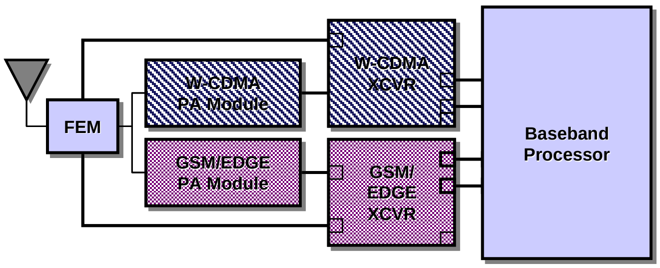

Figure 5. Third generation UMTS RF Front-end Architecture with 4 bands of GSM/EDGE and 3 bands of WCDMA/HSPDA.

DISCUSSION

The implications of achieving the same types of evolution in the seamless mobility spaces as demonstrated in UMTS touch every aspect of the RF architecture from the antenna performance requirements through to the digital interface. From the current multiple antenna solutions there is potential for developing lower cost electronic tuning capabilities that would support the broader spectrum. This would extend to tunable filters and improved isolation technologies to mitigate the interference from the multiple bands. For the power amplifier a greater gain-bandwidth product or the ability to tune the amplifier for optimum power and efficiency into a selected band would be advantageous. This may necessitate new A/D & D/A converters capable of responding over a greater dynamic range. With shrinking process technologies earlier conversion to a digitized signal offers opportunities to provide a re-configurable architecture to support multiple air interfaces and optimize the performance of the system by shaping the waveform. An example of the emerging capabilities to develop such an architecture can be found in the Digital Radio Process (DRP) announced by Texas Instruments[2].

With so many different frequency bands possible in a seamless mobility handset the loss associated with multiple filters and switches along the RF path quickly mounts up. MEMs switches have long been known to offer an advantage in this area, but have traditionally been too expensive when compared to existing solutions. An example of a seamless mobility handset front-end for a Quad-Band GSM with 802.11 and GNSS is shown in Figure 6.

CONCLUSION

The next wave of mobile handsets will have more complex RF architectures encompassing a greater frequency range of operation and multiple air interfaces. This provides a market opportunity for innovative component suppliers similar to what has occurred in the UMTS handset, but at higher data rates and frequencies.

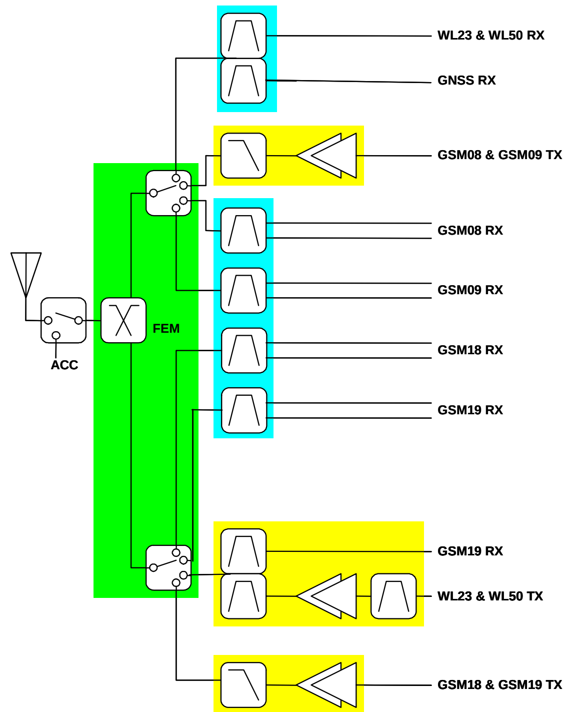

Figure 6. An Example RF Front End for a Seamless Mobility Handset.

ACKNOWLEDGEMENTS

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ACRONYMS

GSM: Global System for Mobile Communications.
GPRS: General Packet Radio Service.
UMTS: Universal Mobile Telecommunications System
WCDMA: Wideband Code Division Multiple Access
GNSS: Global Navigation Satellite Systems
GPS Global Positioning System
USAWS: USA Wireless Services
ITU: International Telecommunication Union