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The Wireless World in 2012:
A Day at the London Olympics 2012

Introduction

The year is 2012, and you have the good fortune to be in London for the Olympic Games. Some of your friends are along for the trip, too, compliments of Lily, who has invited you to stay at her flat. You're excited about checking out all of the new advanced wireless communications at the games.

In a digital world already dominated by advanced, innovative wireless equipment, this fictitious scenario forces us to imagine: ***What will you be able to do in the wireless world of 2012?***

Today, in 2009, the great ambition of the wireless industry is to not only make the various types of voice, video and data applications available through all air interfaces, but also to make access transparent to the user. Essentially, all telephone calls, the Internet, TV and data services can be accessible for users to enjoy on their PC, mobile phone, PDA or any other wireless device that may eventually appear.

Although this convergence is not likely to be complete in the next few years, 2012 is a good checkpoint to gauge the direction and progress of tomorrow's wireless world. Wireless developments that are just beginning to appear today will be in full deployment by then. Technical issues that seem daunting right now will likely be resolved. Even more interesting to consider are the changes in business models that will take place as channel bandwidths increase in scale and more content providers have ready access to them.

The wireless technology for the early part of the next decade already exists, and we are familiar with its promises:

- Hundreds of kilobits to tens of megabits per second on cell phones, sufficient for extremely compressed low-definition TV broadcasts
- Up to hundreds of megabits per second for wireless LANs (WLANs), sufficient for highly compressed, high-definition TV
- Metropolitan-area networks (MANs) with bit rates approaching WLANs and coverage over several miles

These numbers may sound impressive, but there are still significant issues that remain for seamless application convergence. Voice, data and broadcast networks are designed to address several different purposes, and it will take considerable alterations before each device can work together as compatible pieces of a larger mixed network.

Today, the various interactive networks compete rather than complement one another. Multiple, largely parallel wireless networks exist. These networks can be grouped into two categories:

- Voice-centric cellular, with circuit-switched delivery in real time
- Data-centric WLAN, with IP-based, best-effort packet-switched delivery

The most significant change to the overall wireless network in the next few years will be the merger of these two networks into a single data network. The application-agnostic world of IP delivery will be tempered with a desire to support multiple applications, some of which with no real-time constraints and others that will have significant real-time constraints in a wireless environment. (Radio and TV broadcast networks are not interactive, although it is important to realize that these traditional sources of digital content will continue to play a major role in shaping user demand, with different packaging.)

A Day at the London Olympics 2012

You begin the day on your 4G cell phone/PDA by confirming the schedule of events and activating your electronic tickets so you can use the express line at the security gate. While you've been on hold, waiting for confirmation, you've used your PC to check the weather (a sunny day, of course) and searched for the least-congested route to Wembley Stadium. The satellite-tracked site you view gives 15-second traffic updates in any area of the city and constantly updates the suggested route.

Realizing that today you'll never get through all the traffic, you decide instead to hop the Tube (which you still want to call the subway). Your friends are also attending their events or still arriving in London. Lily, your host, has given you security clearance to her home so that you can come and go at will. Ali, your athlete friend from Dubai, has some preliminary events in the discuss throw. You are anxious to see his real-time video update.

Key to bringing about the convergence of voice and data is the implementation of IMS (IP Multimedia Subsystem), a standardized architecture to support IP-based applications in a standard way independent of the capabilities of user terminals. Using a standard Internet protocol called Session Initiation Protocol (SIP), IMS delivers a consistent network architecture view to the application, and allows it to negotiate with the user terminal to define how the data should be transferred. As this negotiation occurs at the start of every new user interaction, the application developer does not need to know the capabilities of the network or the user when developing the application program. For instance, the same e-mail server can be installed on a cellular network, a WLAN network, or even a wired cable-modem network.

Different networks interoperate seamlessly with each other when supporting wireless applications. The user has a consistent experience with the application regardless of which network they are on. For example, users can check the weather on a home laptop and then recheck it using a PDA at the game. This also makes it easier to develop and deploy applications quickly, driving the variety and relevance of the services available on wireless networks.

Although IMS offers the delivery framework for a merged network, there is still a need to work out some of the details, particularly when supporting real-time transmissions. Existing voice over IP (VoIP) implementations tend to operate within defined boundaries, typically in an enterprise or subscriber network, where quality of service (QoS) mechanisms guarantee real-time delivery. In the open Internet, such mechanisms are supported sporadically or not at all, allowing latencies in packet delivery that tend to make voice calls and interactive video less than satisfactory. For the merged wireless network to work, QoS support will have to be extended over a wider coverage area.

QoS issues have been around since users began trying to stretch the Internet beyond its original data applications. What has changed, however, are the wireless networks, which are diverse enough to test the limitations of existing delivery mechanisms. The cellular legacy of voice means that it will take some time to make the changeover. By 2012, cellular networks may not have merged all services and handsets may have separate frequencies for voice and data. Eventually, though, QoS and latency issues will be resolved for all wireless networks that operate within an IMS framework.

One basic trade-off will be in system capacity. Cellular networks are designed to support voice very efficiently, whereas VoIP will not perform as well on wireless. However, as voice becomes a smaller part of the total data bandwidth and the capacity of wireless networks increases, voice will become just another application. It will be more convenient to support voice in the all-encompassing IP framework used for other applications. Network providers are also putting a lot of thought into how to support VoIP; the performance difference is shrinking.

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Once inside the stadium, you have a variety of wireless access points available to enhance your enjoyment of the spectacle. The stadium network provides ongoing close-ups and replays, as well as several channels broadcasting events taking place at other sites in and around London's Olympic venues. At any time, you can direct your attention to worldwide news or other programming that is broadcast on the Internet. And since every portable unit has a hard drive with huge capacity, you can record your favorite TV show for later viewing while you watch a live event.

You receive a message on your handheld that a security alert has been issued at Gatwick, so Gustavo's flight from Brazil is delayed. You quickly access Gustavo's Olympic itinerary and change his tickets for later in the afternoon. They will be ready for him to activate when he lands.

Both network topologies and delivery protocols will change. Some of today's wireless networks route data through a cluster of WLANs, in which user data enters a network that is flat, not hierarchical, and through which there may be several paths from the user to the Internet access point. These flat mesh networks can form their own intranets with only a single (or at most a few) connections to the wide-area network and Internet. These networks are easier to deploy and extend because the topology is very flexible and often redundant. Traffic flow through the network is dealt with locally in an ad hoc manner; hence congestion in a particular link, or even the loss of a particular link, does not necessarily bring the network down.

Already being deployed by governments, businesses and academia, in upcoming years mesh networks will continue to grow. As they do, they will be used to support a wider range of applications for an array of organizations such as government municipalities, political activist groups and even large sporting events.

Nobody knows yet how WiMAX will fit into this network scenario, but there is no doubt it will play a role. Perhaps it will be widely used for backhauling from mesh networks, especially when these are set up ad hoc for special events. Certainly WiMAX has a role to play in rural areas where it may be difficult to supply wired services. In cities, WiMAX may sit side-by-side with WLANs and mesh networks, providing an alternate access that can fill dead spots in reception, avoid transmission interference and perhaps offer different services. Or instead of playing these supporting roles, WiMAX may take the lead. Why bother to set up your own WLAN when you can rely on something already deployed? All we can say today is that WiMAX and mesh networks will both be present in future topologies. Their functionality, however, could take many forms.

A similar outcome is true for cellular networks, which continue to grow and offer new ways to provide increased bandwidth to their subscribers. These networks are best established over wide areas and their voice services are indispensable to most customers, making it unlikely that their importance will diminish soon. Cellular networks have also (for the most part) solved the problem of supporting a massive network of users with coverage and decent QoS.

Future networks will require an even better level of QoS, demanding solutions to trickier coverage problems such as video gaming applications in higher frequency bands. Only cellular systems have proven themselves in this arena. Nevertheless, of all the connectivity options, cellular networks have the most progress to make in changing delivery mechanisms, and they will have to do so to remain competitive in the future.

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You keep in constant touch with your companions via phone, PDA, laptop and interactive stations at the various venues. Gustavo has arrived and is on his way to the Velodrome. Ali has also scored an impressive 68.5-meter throw – just shy of the Olympic record. Izumi has been keeping track of the swim-meet scores while attending the table tennis finals. Sanjay, Kay and the rest of their friends are creating their own Olympic webcast; two of them are in a booth providing commentary and editing the low-resolution images you are all continually forwarding.

In the days to come, you will all be reporting on different events from widely separated locations as part of the growing band of amateur webcasters, whose diverse commentaries on wide-ranging topics have grown out of the text blogosphere into a video blogosphere. Sporting and music venues have struggled to control this new trend, but for the Olympics the organizers have decided to allow such behavior in the hopes that it will actually encourage commercial viewing. It is certainly true that the video blogosphere has become a gold mine for network operators and equipment manufacturers.

Wireless handsets continue to evolve, and they will become even more personalized in the future. Some will be smaller, some will offer larger displays with higher resolutions, and some will integrate video cameras and other specialized inputs. Miniaturized hard disk drives with capacities in the hundreds of gigabytes will provide TiVo®-like features, and large buffer memories will help enhance picture quality by optimizing compression and smoothing latency jitter. Many of these devices will communicate with each other, making personal networking much easier.

These advances will be enabled by new generations of highly integrated digital signal processors (DSPs) and analog radio components, which continue to offer higher performance with lower power consumption at affordable costs. DSPs make it possible to compress, decompress and reformat highly encoded audio, video and voice data – all in real time. Technology advances such as digital radios minimize the power and space required for transmission and reception, making it possible to introduce wireless capabilities inexpensively in handsets with new form factors. Device techniques for power management continue to improve as well, helping to stretch the life of batteries between charges as long as possible. Improved display technology will enhance everyone's experience – whether on a handheld, computer or TV screen.

Perhaps the most interesting change in the wireless network will be in who provides the content. As bandwidth increases and compression improves, more and more video will be transmitted. Although a great deal of this digital content will come from the television and film industries, much of it will be delivered from more advanced sources. YouTube and similar streaming video Web sites have already shown the popularity of uploading personal videos, and the availability of real-time delivery will encourage personal broadcasts that appeal to specialized groups. Much of this digital content is very narrow in interest, but what seems trivial to some viewers may be vital to others, and there is always some content that pushes communications and entertainment in important new directions. Some of these new content providers are finding sponsorship from advertising or other sources, and they are forming the core of a new industry.

As content becomes increasingly diverse in its sources, network providers may become more transparent as the source of services. Once any type of data can travel over any air link and any business can set up an IMS-based service, it will become less obvious that network providers should also be the supplier of phone, Internet and IPTV services. Traditional carriers will continue to enhance their service offerings in order to retain subscribers, but they will also let new service providers set up shop on their IMS networks to provide niche content. This is similar to how mobile virtual network operators are leasing network capacity and setting up niche cellular services. The carrier that can balance their own service provisioning while still letting outside service providers flourish on their networks will be the most successful.

By 2012, the business model for network services will be different from what it is today, just as the network topology and delivery framework will also change. Getting from today's individual digital equipment to tomorrow's converged communications devices will not require a technology revolution – just a steady evolution based on technology that already exists and is continually deployed. Eventually, all air interfaces will support general voice, video and data applications. Range, bandwidth and available service offerings will make the difference as to which type of network works best for a specific use. The networks probably won't be fully merged by 2012, but they will be well on their way. One thing is certain about the wireless services available during the London Olympics: they will undoubtedly be more advanced than what was available in Athens in 2004 and Beijing in 2008.

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Your group has arranged to meet at the main Olympic stadium when the day is over. How can you possibly find each other in the midst of such a crowd? A locater service on your phone, using a combination of a wireless network and GPS, amplifies voices as you approach each other, making the process much easier for you and your friends. Although interoperable locator services are offered by your cellular service providers, you choose to use the same sort of capabilities provided by the stadium's wireless mesh network free of charge, because the stadium has found it actually saves them money in crowd control.

Then you all head off to Lily's house, where Kay has arranged for groceries to be delivered via Lily's automatic account. The oven has been turned on, the beverage cooler has been set to chill and the temperature in the flat is moving to a comfortable setting. Everything is ready for a lovely evening spent reviewing each other's personal webcasts and discussing the day's events with friends around the world.

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