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EMERGING TECHNOLOGIES

Wireless Networks

One of the most striking changes in the use of technology in the last year or so has been the explosive growth in the use of wireless networks for Internet and local network access. We will be looking in this column at the varieties of wireless connectivity now in use, including infrared, cellular, and Wi-Fi (802.11b), as well as those just now arriving on the scene, such as Bluetooth and 3G. The promise of ubiquitous wireless networks dramatically enhances the usefulness of small Internet-capable devices.

Infrared

Infrared (IR) ports have been standard on most laptops and PDA's ("personal digital assistants") for quite some time. Some printers and cell phones come equipped with infrared ports as well. The principal use has been to provide a communication channel between devices for synchronization, backup, or file transfer. The transfer rate is not as fast (4 Mbps or megabits per second) as wired connections (such as USB), although now some IR ports can transfer at a zippier 16 Mbps. IR ports are also used to transfer contact information or calendar entries between hand-held devices. This use is quite popular in Japan and Europe, particularly for exchanging business cards and downloading short messages. Utilities are available which allow for IR interoperability among Palms, WindowsCE/PocketPC devices, and even older Newton Messagepads (JetSend, Peacemaker, BackTalk). While IR is the granddaddy of wireless protocols, new applications continue to be developed for the its use, including InfoPort, a product for beaming large documents to Palm devices from kiosks or other public terminals (being used at the University of South Dakota for transferring documents to students), and Infrared Financial Messaging (IrFM), a new "point and pay" wireless payment standard. Financial transactions, in fact, are seen as a major future use of IR, as it is a more secure means of communication than other wireless protocols, since devices have to be lined up in close proximity to one another.

What allows communication among digital devices through infrared is a common set of specifications developed by the Infrared Data Association (IrDA) and first published in 1994, the most significant of which is the Object Exchange protocol or OBEX. A project is underway at the University of Tromsø (Norway) to develop an open source implementation of OBEX which promises to make available OBEX functionality without license fees (to Extended Systems). In a rare example of not re-inventing the wheel with each new technological advance, OBEX has been selected as the standard for file exchange on the new Bluetooth wireless protocol. IrDA capability is built into mainstream operating systems including MS Windows, Linux, and MacOS. But IrDA compatible ports are also being added to devices such as cameras (the Casio WQV3 cameras) and scanners (Hewlett-Packard CapShare and the QuickLink Pen from WizCom). Scanning text or images into a hand-held scanner, which can then be beamed and stored on a hand-held computer offers interesting possibilities for collecting such materials as newspaper clippings or realia for language learning purposes.

Bluetooth

A wireless protocol which has been highly touted in the last several years is Bluetooth, developed originally by Ericsson in Sweden in 1994 and named for Harald Bluetooth, the Viking king who united Denmark and Norway in the 10th century. Bluetooth uses a short-wave, always-on radio signal that lets devices of all kinds communicate with one another, including cell phones, printers, laptops, and hand-held computers. Since it uses RF (radio frequency) waves, communication does not require a line-of-sight connection between devices, as does IR. Like IR, Bluetooth is short range (the normal limit is 10 meters) but is also omnidirectional and can travel through non-metal obstructions (clothes, furniture, walls). Longer range transmitters, capable of sending signals up to 100 meters, are also being developed. Bluetooth transmits at a maximum rate of 1 Mbps.

There has been quite a buzz about Bluetooth and the era of "personal area networks" (also being called "piconets") or "information clouds" this wireless technology promises to create. The idea is that once Bluetooth components become inexpensive enough (from the current US $20 to US $5), they will become embedded in all kinds of

machines, including VCRs, washer-dryers, stoves, microwaves, and CD-players, all of which could be monitored and controlled by Bluetooth. Ericsson envisions a scenario in which mall shoppers would access sales information on their PDAs as they stroll, or cameras might send instantly pictures to relatives as they are taken. For some, this kind of all-encompassing network is more threatening than enticing. Of interest to language teachers is the fact that Bluetooth supports voice as well as data.

Others see a more modest role for Bluetooth principally as a cable replacement technology, taking over the role of wired serial or USB connections. In contrast to IR, Bluetooth allows point-to-multi-point connections, thus creating an ad-hoc wireless connection of "master" and (up to seven) "slaves." Also, as opposed to IR, Bluetooth communication can be initiated by the devices themselves, allowing for self-monitoring and automated interactions. Given the proliferation of cell phones in Europe, Bluetooth is expected to gain a foothold there first. It is already incorporated into a variety of phones available in Europe.

Wi-Fi

If Bluetooth is being promoted as a cable replacement technology, Wi-Fi is seen widely as a replacement of wired Ethernet. Actually wireless LAN (local area network) technology has been around since the late 1980's. However, different proprietary approaches were used, and the networks operated at low-speed (1-2 Mbps). In 1997, the standards setting body, IEEE, released the 802.11 standard for wireless local area networking using the unlicensed 2.4 GHz frequency band (as opposed to the 900 MHz band used previously). This standard was later updated to 802.11b, which raised the transmission speed from 2 to 11 Mbps, or approximately the same transmission speed as traditional wired Ethernet connections. This is the standard generally referred to today as Wi-Fi ("wireless fidelity") or wireless LAN. As opposed to Bluetooth, Wi-Fi requires use of a "base station" or "access point" for transmitting signals to clients, which generally use Wi-Fi PC cards or desktop adapters to connect to the base station. Like Bluetooth (which also transmits at 2.4 GHz), Wi-Fi signals can travel through solid objects, although they traverse better through wood or drywall than through stone and brick. Transmission distances vary from 50 to 300 feet, depending on equipment and configuration, and can be extended up to 20 miles through the use of high gain antennas.

Wi-Fi began to be widely used when in 1999 Apple introduced its "Airport" wireless networking technology which uses the 802.11b standard. Apple integrated antennas for Wi-Fi into all of its laptops and offered an attractively priced base station capable of communicating with up to 10 clients (the latest version serves 50 clients). Today many Wi-Fi base stations and adapters are available from a variety of vendors. As prices have dropped and vendors multiplied in the past year, wireless networks have sprouted throughout the US in homes, schools, and offices. The home growth in the US has been driven in part by the increasing popularity of higher-speed Internet access through cable and DSL ("digital subscriber line") modems. Base stations such as Apple's Airport allow sharing of an Internet line by multiple users. Since DHCP ("dynamic host configuration protocol") is built into the Airport hub, all devices can share just one IP number. The base station can be connected to a dial-up or Ethernet Internet connection. Some base stations (such as those from D-Link, Linksys or Nokia) incorporate firewall support.

Mixed networks of Windows, Mac and/or Linux computers can co-exist quite comfortably and easily on the same Wi-Fi network, along with network-capable printers and mobile devices equipped with Wi-Fi cards. Individual configuration of Wi-Fi connections is not difficult; MacOS and WindowsXP automatically detect the presence of Wi-Fi signals (assuming a Wi-Fi client card is installed) and walk the user through set-up of the network for Internet access. Some Wi-Fi enthusiasts have taken to trolling urban areas for available Wi-Fi networks (comprehensive world-wide guides are also available). In fact, the ease and power of Wi-Fi networks has led to the establishment of wireless freenets in several urban areas in North American and elsewhere. With a series of base stations and antennae, it is not difficult to set up such a network, which some dub "parasitic grids." In the aftermath of the September 11 tragedy several such networks were quickly established in Manhattan (such as NYCWireless). Others see such "renegade wlans" as a way to bridge the "digital divide", bringing Internet access to the inner city. Commercial Internet providers are also now beginning to offer Internet access (for a fee) through Wi-Fi, especially in smaller communities. Wi-Fi connections are also showing up in public and commercial spaces such as airports or coffee shops, where connections are available for a fee.

Despite Wi-Fi's popularity there are several concerns in its use voiced by users and system administrators, namely limited bandwidth, radio interference from other devices, and security. A revision of the specification called 802.11a addresses these issues, at least in part. Although Wi-Fi runs at about the same speed as 10 Mbps wired Ethernet, configuration and security concerns usually reduce throughput to something more like 5-7 Mbps. 802.11a runs at the higher speed of 54 Mbps, although real-world use will be lower. This is still a significant increase for applications needing higher bandwidth such as streaming media. Wi-Fi runs on a radio frequency (2.4 GHz) shared by microwave ovens, most cordless phones, and Bluetooth devices, creating the potential for serious interference problems. 802.11a runs at 5.4 GHz, thus avoiding that conflict. Both wireless standards have a built-in security protocol called WEP ("Wireless Encryption Protocol") which allows for encrypted transmissions. Often, however, WEP has not been used on Wi-Fi networks out of concern that throughput will be negatively effected. The higher bandwidth of 802.11a may encourage greater use of WEP. Security experts, however, point out that WEP is not impenetrable and recommend use of VPN ("Virtual Private Network") software for secure network access with wireless clients. A new security protocol, 802.1x, is just being added to Wi-Fi setups (and is supported in WindowsXP).

Products based on 802.11a, or Wi-Fi5 as it is being called, are now being marketed in the US. However, since 802.11a transmits at a different frequency, it is incompatible with existing Wi-Fi networks. In other words, new base stations and client cards will be needed. It's likely that vendors will offer dual-standard products, but they are not yet available. It is possible, however, for both standards to co-exist in the same environment. Due to the incompatibility issue, another revision of the standard has been proposed but not yet finalized. 802.11g runs also at 54 Mbps but operates in the same 2.4 GHz frequency as Wi-Fi, thus allowing for backwards compatibility with existing Wi-Fi networks. Stay tuned, since there is yet another new protocol being discussed, 802.11e, which adds QoS ("quality of service") to high-speed bandwidth, guaranteeing a reliable stream of data transmission to individual clients, vital for effective video streaming.

It should also be noted that there are several other standards for wireless local networks. HomeRF, developed by Proxim (and marketed under the "Symphony" name), combines the 802.11b and the Digital Enhanced Cordless Telecommunications (DECT) portable phone standards into a single system. The latest version (HomeRF 2.0) increments throughput from 1.6 to 10 Mbps. It is not compatible with Wi-Fi. Given Intel's recent drop of support for HomeRF, its future appears uncertain. A wireless standard just emerging which looks more promising is HiperLAN2, developed by Nokia and Ericsson, and approved by the European Telecommunication Standardization Institute (ETSI). It is similar to, but not compatible with, 802.11a in that it uses the 5.4 GHz frequency with a throughput of 54Mbps. However, while 802.11a is primarily a data-delivery protocol, HiperLAN2 offers built in support for voice and video and allows for QoS transmissions. HiperLAN2 also provides for unicast, multicast, and broadcast transmissions. Most experts see it as the most advanced wireless standard currently available.

Alternatives and Outlook

It seems likely that Europe and North America will travel different paths to wireless local networks, with North America embracing 802.11x and Europe tilting towards HiperLAN2. This leaves the rest of the world to choose one of the two or (God forbid) come up with a different standard. This mirrors the unfortunate state of affairs in cellular phones, with Europe (and most of the rest of the world except Japan) using GSM ("Global System for Mobile Communications") while North America has gone its own way with analog (AMPS -- "Advanced Mobile Phone Service") and digital (CDMA -- "Code Division Multiple Access"; TDMA -- "Time Division Multiple Access"). Actually, GSM is also available in the US and Canada but coverage is far from universal. Interest in GSM is being driven in part out of interest in world-wide compatibility and in part due to an add-on/successor to GSM called GPRS ("General Packet Radio Service") which provides always-on, higher-bandwidth data transmissions/Internet access. A similar data enhancement to CDMA is known as "1xRTT" and is just beginning to reach the market in North America.

The data transmission service of analog cellular in North America (CDPD -- "Cellular Digital Packet Data"), which enables Internet access, has been available for some time and enjoys wide coverage in the US, but suffers from a slow transmission rate of 19.2 kbps (kilobits per second), suitable for e-mail but painfully slow for Web browsing (landline modems typically operate at 56 kbps). It is available for both hand-helds and laptops through PC cards such as Novatel's Merlin series. Some more expensive PC cards, such as Sierra Wireless' AirCard, use compression

software to enhance considerably access speed. A faster alternative in the US has been the Ricochet network, which operates at 128 kbps. Unfortunately for subscribers, the network's parent company, Metricom, went bankrupt in August, 2001. However, Aerie Networks purchased the Ricochet network and has announced plans to resume service in the US.

Much of the news in the mobile phone world for the past several years has centered around 3G, the third-generation cellular network, combining high speed mobile access with Internet Protocol (IP)-based services, which proponents have hailed as the future of Internet access, with fast, reliable, always-on connections. Anticipated data transfer rates range from 144 kbps to 2 Mbps. It is based on a revised version of CDMA called Wideband-CDMA (with several different implementations in the works including CDMA2000 and 3GPP). Telecommunication companies have spent billions of dollars to purchase licenses to operate 3G networks and since then have invested billions more in developing the technology and buying the hardware to build the needed new infrastructure. So far, no 3G systems have seen the light of day, except in experimental trials, and it seems likely that in 3G implementation North America and Europe may again go their separate ways. Once they arrive on the scene, 3G networks promise to deliver broadband access through cell phones, allowing for applications such as videoconferencing and multimedia-on-demand. The arrival of MPEG-4, with its dramatically enhanced compression codecs, will help considerably in making this a reality. This is likely to accelerate the development of so-called convergence devices, which combine the functions of cell phones, personal organizers, hand-held computers, and even video players. Smartphones from Nokia and Ericsson, the forthcoming "Stinger" phone line from Microsoft, and the recently announced "Treo" Palm devices from Handspring are examples of this trend.

While 3G is still a vision waiting to be fulfilled, it seems likely that for most mobile network users, wireless LAN solutions will provide the principal means of Internet access. Wi-Fi is not likely to show up as an add-on to cell phones due to excessive power requirements of PC cards. But cards are available for both Palm devices and PocketPCs, the two dominant hand-held platforms. More applications are being developed that enhance Internet use on such devices. AvantGo, for example, uses a "store and forward" model to sync up Web-based content on hand-helds. Many periodicals in a variety of languages are available for (free) subscription through AvantGo. Blackboard, a widely used course management system, has recently released a plug-in for Blackboard 5.5 which allows users to view course site content on Palms and PocketPCs through AvantGo. The University of South Dakota has been experimenting with universal ownership of Palm devices for its freshman class, with learning software specifically designed for hand-held use. East Carolina University has been using hand-helds and AvantGo in several humanities classes. St. Olaf College (Minnesota) has been using Palm devices with AvantGo and KingKanji software to help students with Japanese reading and writing skills. Participants found the devices especially helpful in practicing stroke order in writing. Given price reductions, color screens, and emerging high-speed wireless Internet access (through Wi-Fi5 or HiperLAN2), hand-held computers seem poised to become popular choices for Internet access. Such a development may open the door for development of new multimedia language learning applications, designed to run on mobile devices accessing the Internet from wherever they may be.

In North America, one other wireless Internet option is a satellite connection, offered by vendors such as Starband, DirecPC, or Earthlink. Satellite access is particularly attractive in areas not served by cable or DSL service, but hardware costs are considerably higher than for other broadband services. The U.S. Federal Communications Commission (FCC) recently awarded licenses to 11 satellite vendors to provide new satellite telecom services including high-speed Internet. These systems will be using satellites in geostationary orbit broadcasting "spot beams" in the "Ka-band" of 20/30 GHz. The promise is for faster, more affordable service throughout the US (beginning in 2002/2003). Vendors such as WildBlue are planning to enable easy sharing of the satellite Internet connection with multiple users in a home, office, or school.

Resource List

Organizations, Standards, and General Information on Wireless Networking

- WLANA - Wireless Network Association
- Infrared Data Association
- MPEG home page with wealth of links to info on MPEG-4

- MPEG4 Industry Forum
- Wi-Fi, Bluetooth beating up on 3G from ZDNet News
- Bluetooth home page
- IEEE international standards setting body
- ETSI European Telecommunication Standardization Institute

Infrared and Bluetooth

- Point and Shoot: Infrared-enabled proximity payments are here about IrFM applications
- Hewlett-Packards CapShare 910 review of the hand-held scanner in PC Magazine
- Pocket Scanner for Your PocketPC review of the QuickLink Scanner Pen from PocketPC Magazine
- Open Obex open source OBEX development project from the University of Tromsø
- I talk to the Palm guide to software for moving data between hand-held devices (PocketPC Magazine)
- Can Bluetooth live up to the hype? from CNN

Wireless LANs

- IEEE 802.11B WIRELESS LAN STANDARD brief introduction to Wi-Fi
- The Wireless LAN Revolution from the Portland Community LAN Resource Guide
- 802.11b Tips, Tricks, and Facts from O'Reilly
- Getting Started with Lucent's 802.11b Wireless LAN Card popular PC card for Wi-Fi in laptops (now called Orinoco)
- Agere Plugs XP article on the "enhanced media sense" built into WindowsXP, allowing automatic detection of Wi-Fi networks
- Wireless Comes Home review of 12 different Wi-Fi access points in PC World
- Performance Test: 802.11b Takes a Lickin' and Keeps on Tickin' practical tips on Wi-Fi use, including interference issues (such as microwave ovens)
- 802.11a - Fast Wireless Networking comprehensive overview of the new Wi-Fi5 standard from ExtremeTech
- HomeRF
- Proxim Symphony review of Symphony cards for use on HomeRF networks
- Hiperlan2
- about HiperLAN2 from the HiperLAN Resource Center
- A Wireless Neighborhood Freenet article by Moshe Bar on setting up a Wi-Fi network in Isreal
- 'Parasitic grid' wireless movement may threaten telecom profits from InfoWorld
- Renegade WLANs: Pararsitic or Free-Spirited Anarchistic

Mobile Phones and Hand-helds

- Blackberry hand-held device for viewing e-mail (uses CDPD network)
- Handspring unveils wireless triplets from Cnet, on Handspring "Treo" convergence phones
- An Introdcution to General Packet Radio Service from GSMWorld, detailed information on GPRS
- 3G or not 3G discussion of pros and cons of 3G
- 3G Cometh not so fast discussion of implementation issues with 3G
- Sendo Stinger phone coming this spring news release on new smartphone using Microsoft's Stinger technology
- Palm devices in Higher Ed article highlighting use of Palm devices on campuses