Lecture Summary 2: Mobile Data Access

In the wireless world, in addition to cellular networks, many wireless technologies have emerged and matured. Figure 1 shows existing and emerging wireless technologies with respect to data-rate and range. Cellular systems are positioned in a grid of low data rate and high signal range. Wireless LANs (the 802.11 family) provide medium and high data rates. Within personal area network (PAN) range UWB delivers at a high data rate (but failed commercially), Bluetooth, NFC, and infrared are low energy and low data rate range. The WiMax (802.16a and 802.16e), and LTE Advanced, represent fourth generation (4G) of mobile wireless-communication that aims to provide future cellular connectivity across metropolitan areas, and countries.

Cellular Networks

Communication by wireless media has existed since the invention of the radio (late 19th century), and many mobile radio systems have existed through the 20th century, such as the VHF radio. Different radio frequencies serve better for different uses, VHS (300 MHz) works well in the countryside and on the ocean, they are low energy and bounce around obstacles giving them wider range. Higher frequencies have higher data-capacity but more limited ranges because more susceptible to interference by reflection and diffraction (which weakens the signal). Cellular frequencies vary significantly between different countries, but for all cellular networks today radioband frequencies are used. UHF (800MHz) frequencies were used for the first commercial mobile systems (1G) which were for urban purposes and relatively short range. The system was analogue and shared access by TDMA (time division multiple-access), which divides a band into multiple time-divided channels. Much of the infrastructural support required by cellular networks was developed during the time of the first generation phones.

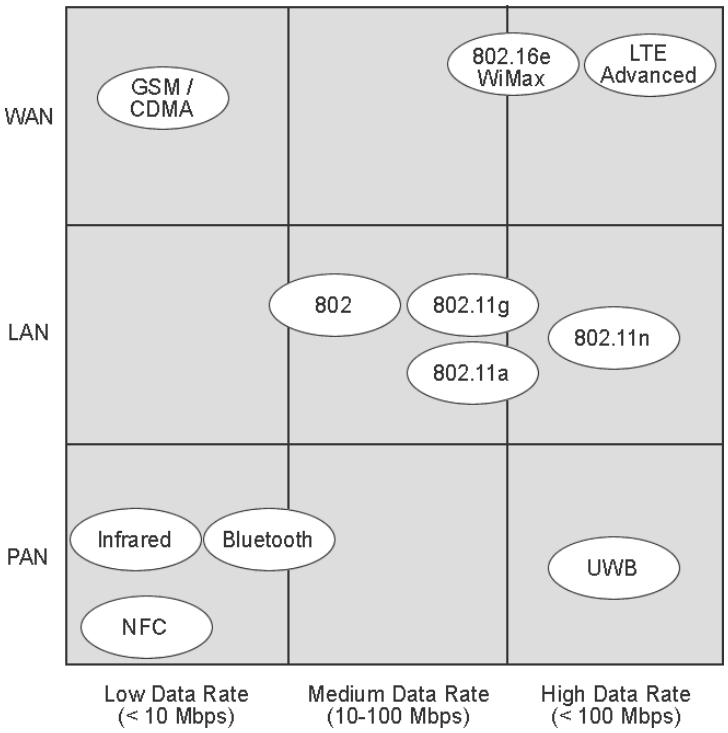

Figure 1: An overview of wireless communication technologies (image courtesy [1])

In the early 90s phones 2G phones emerged based on digital transmission, two protocols were introduced in different places of the world that were incompatible and still in contention today. CDMA is used in many parts of the US, and GSM which approximately covers the rest of the world. The two technologies use CDMA (code division MS) and TDMA (time-division, like the analogue predecessor) respectively. CDMA digitizes calls over one another and unpacks them on the back end with sequence codes.

Since the branching of GSM and CDMA, several protocol upgrades (relating to more bandwidth or better coding) have occurred along each route, which have resulted in many different current and legacy protocols. GPRS and EDGE are GSM based, while the 3G upgrade UMTS converged on CDMA for media access, but still incompatible with cdma2000 as a standard. The third generation of mobile was primarily defined with demands for mobile internet access.

802.11 Family

The 802.11 set of standards are designed to be the wireless equivalent of wired LANs such as Ethernet. Consequently, similar to other 802 LAN standards, the physical and medium access layers hide the details of data transmission and supplies the same interface to the logical link control (LLC) sublayer. Hence, applications will not detect any difference when running in wired LAN or wireless LAN.

LAN has a different approach to sharing the radioband compared to cellular networks. The MAC layer of 802.11 employs the carrier sense multiple access/collision avoidance (CSMA/CA) medium access mechanism. If the channel is idle a node can begin to transmit, otherwise it will wait for a random amount of time with a contention window, and sense the channel again. This mechanism causes congestion as number of nodes increases. Another problem is due to spatial limitations of signal strength, a station may not draw a correct conclusion on channel usage leading to signal interference or channel underutilization. Collisions may occur in the hidden node problem when a station is receiving two signals at the same time. The MAC layer of 802.11 solves the problem by a handshake protocol with small RTS and CTS frames. A request-to-send (RTS) frame is first sent from the source to the destination. Then, if the destination is not receiving, it replies with a clear-to-send (CTS) frame, upon data transmission can begin.

4G Networks

The 3G networks will soon be followed by 4G, which refers to all-IP packet-switched networks that support mobile bandwidths up to 100 Mb/s. The LTE Advanced infrastructure is taking place in many parts of the world. Phones within 1-2 years are expected to support the technology.

NFC

NFC[1], is currently in use on security access systems (such as University cards), and in public payment systems (e.g. Oystercard for the London Underground). Newest phones are shipped with NFC, this technology is expect that these enable a new generation of convenient low-charge payment systems, the action of paying would just requires the close vicinity of the phone.

Summary

Mobile wireless is one of the most active area in the domain of computing and communications. Mobile voice communication, which has been dominant for many years will be replaced by voice over IP systems. In addition, mobile communications and computing are taking place in many forms, including interperson, intrasystem, and person to system. This implies ubiquitous mobile access to a converged mobile wireless infrastructure which will eventually become completely pervasive.

References

[1] Zheng P. and Ni M.L. Smart phone & next generation mobile computing. *Morgan Kaufmann*, 2006.

[1] http://en.wikipedia.org/wiki/Near_field_communication