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THE WIRELESS WORLD

Modem Technology

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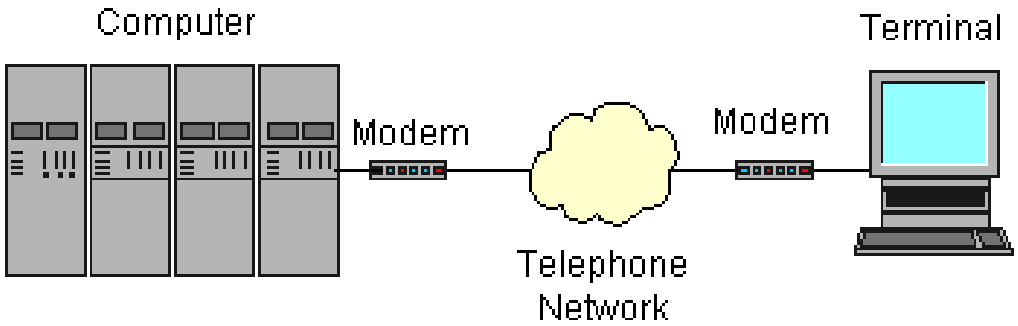
Origins of Modems

The Origin of Modems

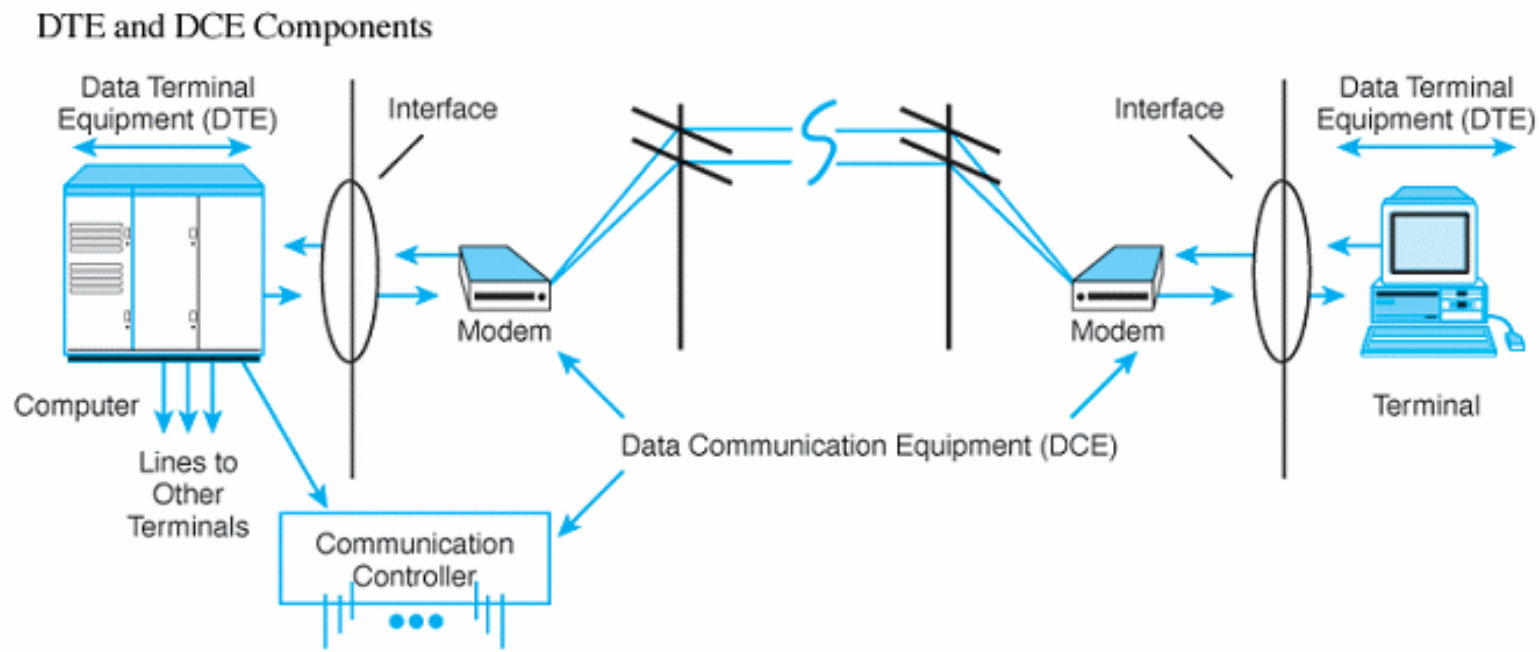
The word "modem" is a contraction of the words **modulator-demodulator**.

- A modem is typically used to send digital data over a phone line. The sending modem **modulates** the data into a signal that is compatible with the phone line, and the receiving modem **demodulates** the signal back into digital data.
- **Wireless modems** convert digital data into radio signals and back.

Modems came into existence in the 1960s as a way to allow terminals to connect to computers over the phone lines. A typical arrangement is shown below:



What is a MODEM?



•A modem is a device to convert digital information from your computer into audible tones. A modem on the other end of the phone line changes these tones back into digital signals that your equipment can understand.

•Modems are used to send and deliver electronic mail, to transfer data and program files, to access bulletin board systems, and to access networks.

Wireless Data Overview

Circuit Switched vs. Packet Switched

There are two types of data transmission - Circuit Switched and Packet switched.

Circuit switched actually takes over a voice channel to transmit and receive data, essentially keeping a phone line open during the entire session. Cellular and PCS modems use circuit switched transmission, allowing you to dial up over your wireless phone just like you would using a landline connection.

Packet switched data transmission compresses the data and sends short data bursts between conversations or during gaps in conversations on the voice channels. Packet data transmission is ideal for short messages, including E-mail, news headlines, and stock quotes.

PPP Protocol

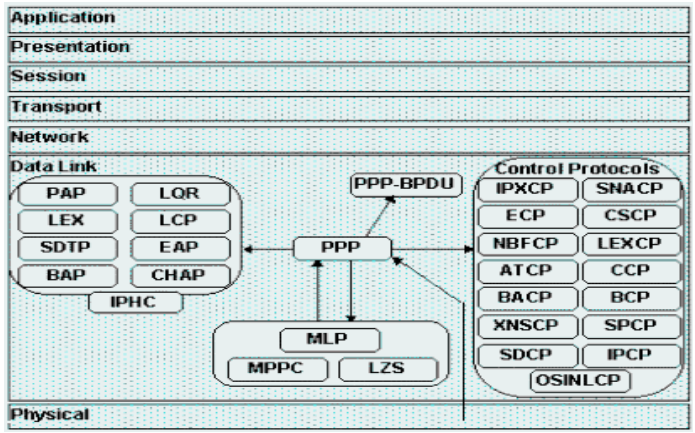
PPP (Point-to-Point Protocol) is a protocol for communication between two computers using a serial interface, typically a personal computer connected by phone line to a server. For example, your Internet server provider may provide you with a PPP connection so that the provider's server can respond to your requests, pass them on to the Internet, and forward your requested Internet responses back to you. PPP uses the Internet protocol (IP) (and is designed to handle others). It is sometimes considered a member of the TCP/IP suite of protocols.

PPP is a full-duplex protocol that can be used on various physical media, including twisted pair or fiber optic lines or satellite transmission. It uses a variation of High Speed Data Link Control (HDLC) for packet encapsulation.

PPP is usually preferred over the earlier de facto standard Serial Line Internet Protocol (SLIP) because it can handle synchronous as well as asynchronous communication. PPP can share a line with other users and it has error detection that SLIP lacks. Where a choice is possible, PPP is preferred.

Some examples of what a PPP connection allows:

- **Telnet:**
- **FTP:**
- **World Wide Web:**
- **Usenet:**
- **Ping:**
- **Microsoft Networking:**
- **AppleShare/IP:**
- **E-mail:**



3G In Context

3G cellular technology is a huge technological and market phenomenon, but it needs to be understood in the context of other developments.

•The control network used in telephone networks today is called Signaling System 7 (SS7). This system will evolve into an IP-based system, increasing the importance for IP-based control mechanisms in wireless networks.

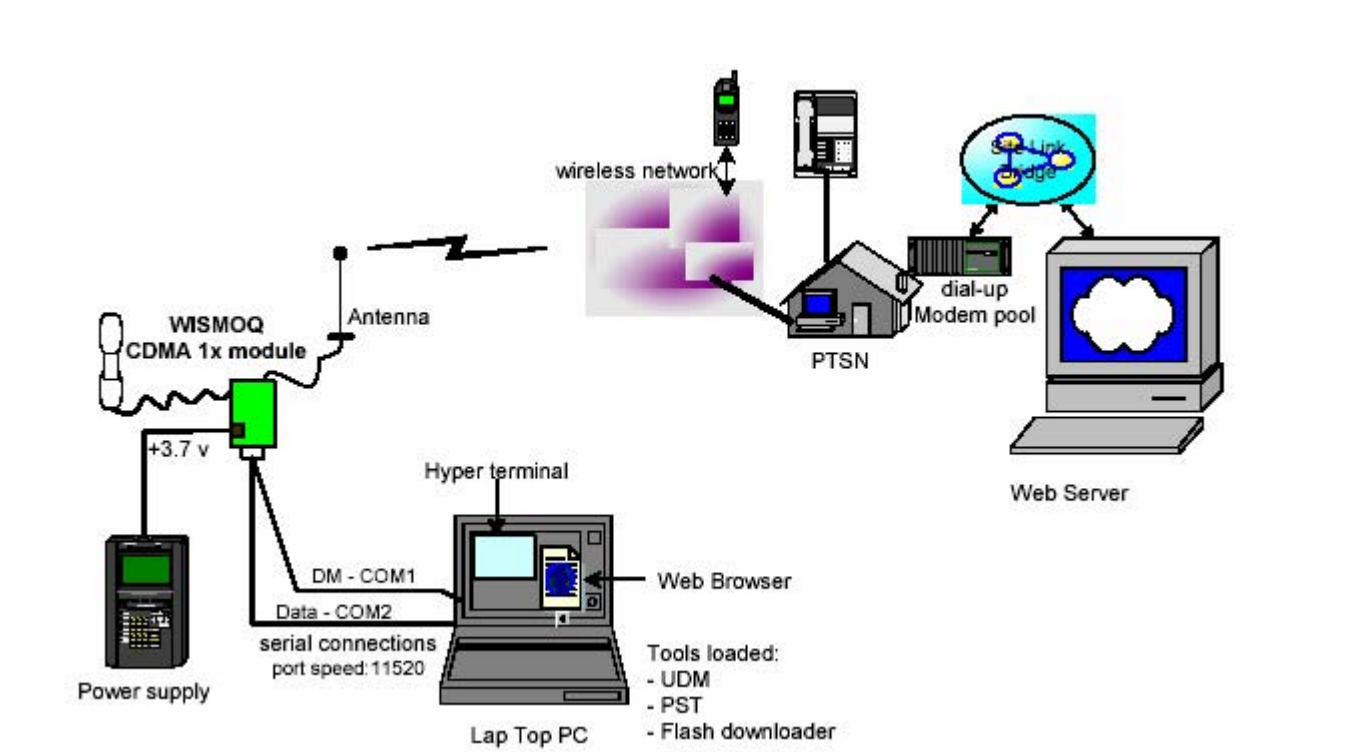
•IP will increasingly be used for voice communications, so delivery of IP-based voice to cellphones will be critical. This will require the resolution of difficult, quality-of-service issues in wireless networks.
•As E-commerce becomes common, users will want to safely conduct transactions from their mobile terminals. Such use will make robust security protocols a must for wireless networks.

•Mobile users will want to access private information from anywhere, driving the demand for secure communications and related technologies such as virtual private networks (VPNs).

•As a huge population of mobile-data users emerges, content developers will start producing material specifically for these users, including items related to travel, entertainment, news, weather, and recreation. Though such developments are already underway, they are still in their infancy.

There is no question that a myriad of new applications will be possible with next-generation, wireless-data networks. But keep in mind that these are massively complex networks, and it will take both time and large investments to develop and deploy the technology. Many of the advantages that these networks will offer are already available using existing data services. Organizations that gain experience with wireless technologies today will be the ones best positioned to take advantage of new networks tomorrow.

Network Arcetecture



GSM & IS-136 Infrastructure

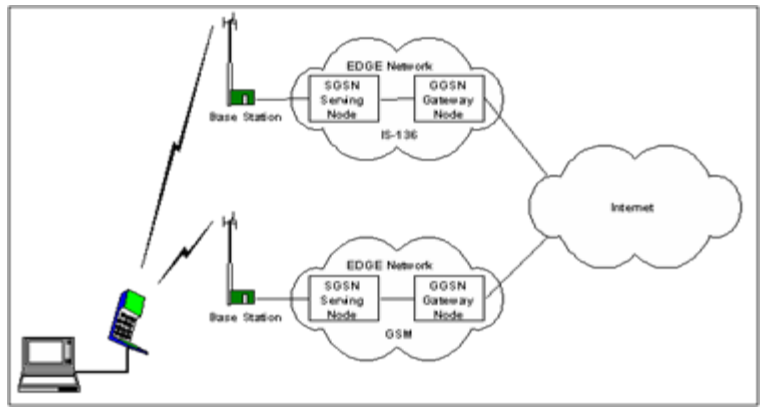
GSM dominates the world today, with over 200 million users in over a hundred countries.

General Packet Radio Service (GPRS), a 2.5G technology. GPRS can combine up to 8 (out of 8 available) time slots in each time interval for IP-based packet data speeds up to a maximum theoretical rate of 160 Kbps. Four time slots (80 Kbps maximum, 56 Kbps typical) for the downlink and one timeslot (20 Kbps maximum, 14.4 Kbps typical) for the uplink. GPRS supports both IP and X.25 networking.

GPRS can be added to GSM infrastructures quite readily. It takes advantage of existing 200 kHz radio channels and does not require new radio spectrum. The principal new infrastructure elements are called the Gateway GPRS Support Node (GGSN) and the Serving GPRS Support Node (SGSN). The GGSN provides the interconnection to other networks such as the Internet or private networks, while the SGSN tracks the location of mobile devices and routes packet traffic to them. Packet service allows constant "virtual" connections without the need to constantly "dial" into the network.

The phase after GPRS is called Enhanced Data Rates for GSM Evolution (EDGE). EDGE, generally considered a 3G technology, introduces new methods at the physical layer, including a new form of modulation (8 PSK) and different ways of encoding data to protect against errors. Meanwhile, higher layer protocols, such as those used by the GGSN and SGSN, stay the same. The result is that EDGE will deliver data rates up to 500 Kbps using the same GPRS infrastructure. Keep in mind though that 500 Kbps represents a best case scenario, with a strong signal, no interference, and a user device accessing the entire 200 kHz radio channel. In addition, this radio channel must also be shared by multiple users in that sector of the cell site. Consequently, practical throughputs may be only half the maximum rate.

Though developed initially for GSM, the Universal Wireless Communications Consortium (UWCC), an organization that represents IS-136 carriers and vendors worldwide, has decided to embrace EDGE for IS-136 networks. The tricky part of adopting EDGE is that IS-136 networks use 30 kHz radio channels. Deploying EDGE will require new radios in base stations to support the 200 kHz data channels. The GGSN and SGSN will be virtually the same for both GSM and IS-136 networks. EDGE data users will eventually be able to roam between IS-136 and GSM networks around the world. EDGE data services for IS-136 networks will probably roll out shortly after EDGE for GSM networks, possibly in 2002 or 2003. Figure 2 shows the common network technology used by both GSM and IS-136 networks.



CDMA Infrastructure

CDMAOne

IS-95A standard. A refinement of this standard, IS-95B, allows packet-data rates as high as 64 Kbps. Japanese CDMA carriers, IDO and DDI, are planning on deploying this higher-speed service by early 2000.

CDMA2000

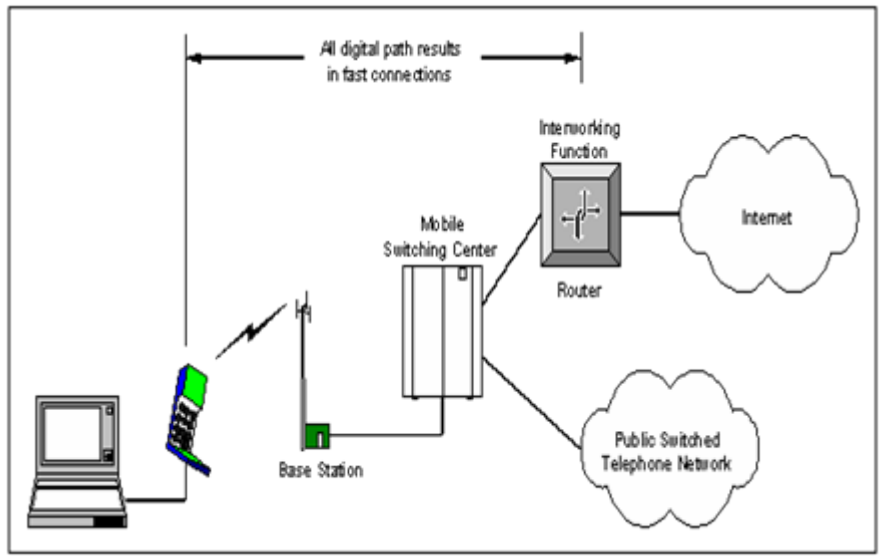
Has many advantages over IS-95A, including more sophisticated power control, new modulation on the reverse channels, and improved data encoding methods. The result is significantly higher capacity for the same amount of spectrum, and indoor data rates up to 2Mbps that meet the IMT-2000 requirements

1XRTT technology is thus a convenient stepping stone for CDMA carriers moving to 3G, and it can also be thought of as a 2.5G technology.

1XRTT can be deployed in existing spectrum to double voice capacity, and requires only a modest investment in infrastructure. It will provide IP-based packet-data rates of up to 144 Kbps.

Initial deployment of 1XRTT is expected by US CDMA carriers in 2001, with 3XRTT following a year or two behind, depending on whether new spectrum becomes available.

The full-blown 3XRTT implementation of CDMA requires a 5MHz spectrum commitment for both forward and reverse links.



Cellular Data Perfomance

Core Technology	Service	Data Capability
GSM	Circuit-switched data based on the standard GSM 07.07	9.6 Kbps or 14.4 Kbps
	High-speed circuit-switched data (HSCSD)	28.8 to 56 Kbps service likely
	General Packet Radio Service (GPRS)	IP and X.25 communications over Kbps
	Enhanced Data Rates for GSM Evolution (EDGE)	IP communications to 384 Kbps. Roaming with IS-136 networks possible.
	Wideband CDMA (WCDMA)	Similar to EDGE but adds 2Mbps indoor capability. Increased capacity for voice.
IS-136	Circuit-switched data based on the standard IS-135	9.6 Kbps
	EDGE	IP communications to 384 Kbps. Roaming with GSM networks possible.
	WCDMA or Wideband TDMA (WTDMA)	Similar to EDGE but adds 2Mbps indoor capability
CDMA	Circuit-switched data based on the standard IS-707	9.6 Kbps or 14.4 Kbps
	IS-95B	IP communications to 64 Kbps
	CDMA2000 - 1XRTT	IP communications to 144 Kbps
	CDMA2000 - 3XRTT	IP communications to 384 Kbps outdoors and 2 Mbps indoors