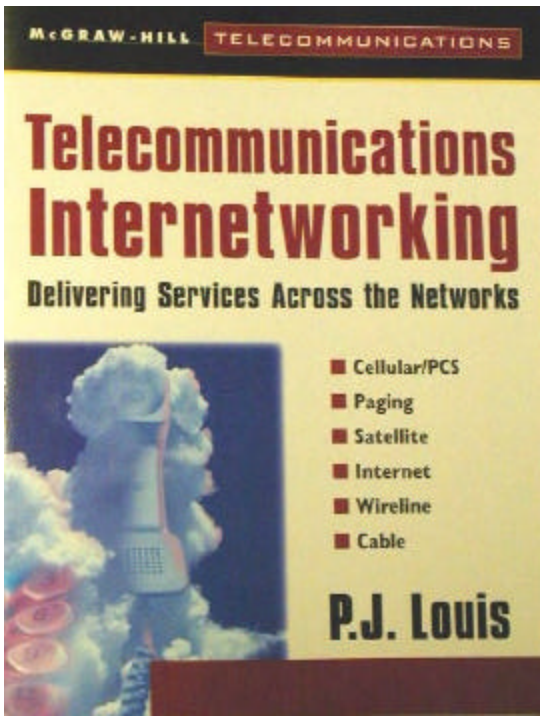
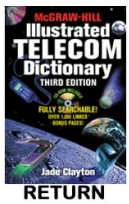
FURTHER READING

As a preview for further reading, the following reference has been provided from the pages of the book below:

Title: Telecommunications Internetworking
Author: P.J. Louis
Publisher: McGraw-Hill

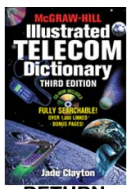
ISBN: 0071356541





CHAPTER 8

Paging Systems



Paging is usually considered to be the "low end" of mobile communications or the "poor man's mobile communications." The paging concept was first conceived in 1939. The first practical and commercial unit was created in 1950 by Al Gross. The first commercial unit was licensed by the FCC in 1952. Paging is less expensive than other mobile communications systems because it was and still is primarily a one-way system. The paging receiver alerts the user to the call but does not verify or respond in any way to the base station. The cost and bulk of a typical mobile transceiver is due to the transmit portion, which is missing from a paging receiver; therefore, it can be small and cheap.

Paging has become a part of the mainstream consumer market. Executives and teenagers alike now use pagers that allow them to communicate wherever they are. This trend has given paging service providers cause to feverishly increase their subscriber base at a faster pace. Paging systems to date have satisfied most requirements for tone, numeric, and short alphanumeric messaging with sufficient subscriber capacity for the service providers. Cellular and PCS service providers are already integrating paging capabilities into their handsets. The challenge facing paging service providers is differentiating themselves. Pagers can either integrate low-quality voice messaging or expand their existing messaging and data capabilities. Figure 8-1 is a rendering of the Paging network.

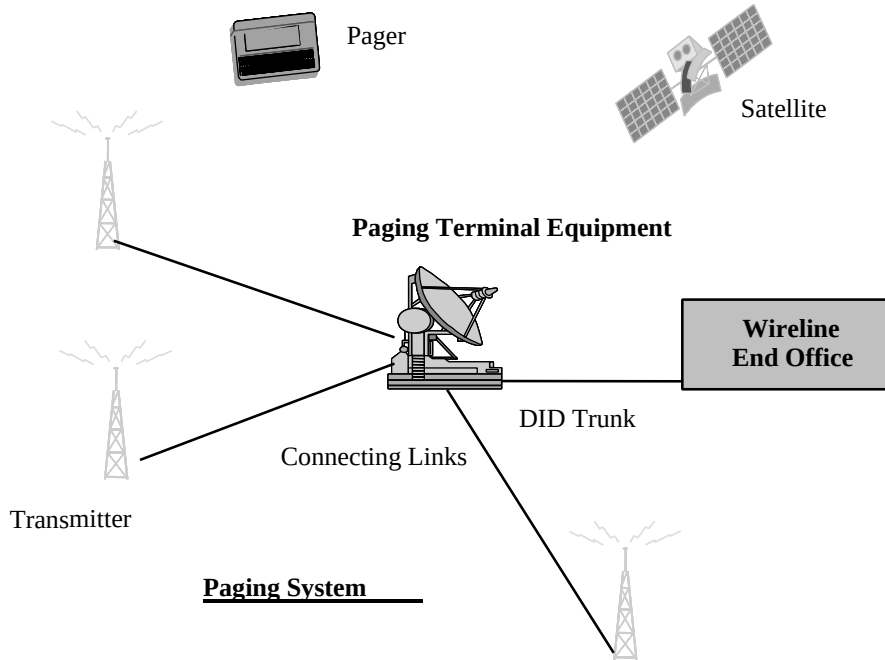
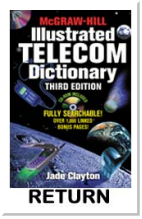


Figure 8-1
Paging network



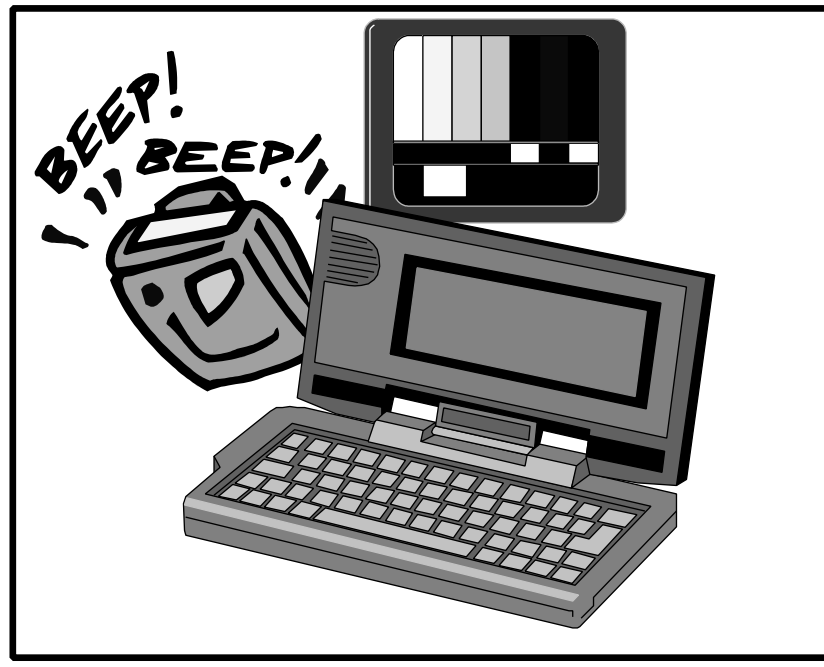


Figure 8-2
Paging and the Internet

New types of paging devices and enhanced protocols have led to a dazzling array of new paging services involving messaging and low speed data. The services themselves may involve partnering with another provider of telecommunications services. For example, a paging provider decides that they will partner with an Internet service provider. The partnership results in a small handheld paging device/computer that serves as both a messaging device and an Internet access device. Figure 8-2 is a rendering of the integration of paging and the Internet.

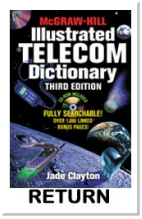
Fewer pagers exist today than cellular and PCS devices, but they are still widespread.

Paging Radio Frequency Spectrum Requirements

The FCC has allocated multiple frequency bands to paging service providers. These bands are

- 35 MHz
- 43 MHz

- 150 MHz
- 450 MHz
- 931 MHz



These frequencies are licensed as paging frequencies. These bands were allocated over a period of 50 years starting in 1952. The 931 MHz band was allocated specifically for nationwide use only. The FCC has licensed only three nationwide carriers for this purpose. The frequencies list in Table 8-1 can also be used for paging services.

Wireless carriers, especially PCS carriers, have taken a broader interpretation of paging and are providing paging services in the narrowband PCS frequencies. These PCS carriers are marketing their services as two-way messaging services. Although these service providers are not FCC-licensed paging service providers, they are marketing themselves as such. There is no prohibition on selling paging services. These types of carriers are in fact selling and marketing the short message service capability as paging. The subscribers do not know the technical difference, regulatory difference, or marketing difference between a paging company and a cellular carrier or between a paging company and a PCS carrier. The subscriber attaches labels and names to things and businesses all the time. The word paging brings to mind images of little devices that beep or vibrate and are stored on a belt or in a pocket or purse. These devices light up or display a alphanumeric message. If a PCS license holder attacks the paging market by announcing that they will provide a new kind of paging to the subscriber base, that paging company has found a market differentiator. As competition in the traditional cellular and PCS markets heats up, they will be entering the paging marketplace. The narrowband PCS carriers have an advantage because they have more spectrum with which to work. The frequency blocks allotted to the traditional paging carriers are only one or two

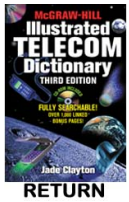
Table 8-1

PCS Band

PCS Band	Spectrum Block	Frequency Range (MHz)	Coverage Area
A	30 MHz	1850–1865/1930 –1945	Major trading area
B	30 MHz	1870–1885/1950 –1965	Major trading area
C	30 MHz	1895–1910/1975 –1990	Basic trading area
D	10 MHz	1865–1870/1945 –1950	Basic trading area
E	10 MHz	1885–1895/1965 –1970	Basic trading area
F	10 MHz	1890–1910/1975 –1990	Basic trading area

MHz in each of the previous traditional bands. This does not mean that the traditional paging service providers cannot compete. The various advancements in device design and radio design are enabling the traditional players to remain competitive.

For illustrative purposes, I will explicitly differentiate the PCS carriers in the paging market and the traditional paging service providers.



Paging Architecture

The network architecture of a paging system is not unlike that of any other type of wireless telecommunications network. A paging network has a switching element, transmission facility element, and a radio component. In reality there is far more complexity to what I have described. However, what is important to remember is that one should not get intimidated with telecommunications network technology. All networks can be dissected in a way to better understand the technology.

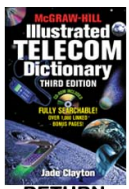
Paging Network Elements

To understand traditional paging, you must gain a basic understanding of what comprises a paging system. A typical paging system is comprised of the following:

- *Paging control terminal* The paging service provider's switch
- Transmitter
- Paging device

Paging Control Terminal The paging control terminal is typically interconnected to the ILEC (that is, the PSTN). The paging control terminal is similar to a large piece of customer premise equipment. The paging control terminal receives the call and associates the telephone number or *personal identification number* (PIN) with a specific paging device. The paging control terminal is interconnected to the ILEC/PSTN via a *Direct Inward Dialing* (DID) trunk or a common two-way Type 2A trunk. The control terminal's interconnect point in the PSTN is a Class 5 end office.

Unlike the cellular, wireline, or PCS industry segments, the paging industry's switching technology is not as complex. The typical small controller is a 6,000 line controller with two RF channels and eight trunks. The control



terminals vary in size and may even have a voice messaging system. Larger control terminals will support millions of subscribers and hundreds of RF channels. The paging systems are not as complex. The complexity is in the feature set offered by the typical paging service provider, not the size of the system. As I write this chapter, the paging industry is undergoing changes that will keep it competitive to cellular and PCS. Figure 8-3a is an illustration of how the paging network is currently configured and interconnected. Figure 8-3b is an illustration of how a Type 2A transmission facility is used in the interconnection of a paging terminal and the PSTN.

Transmitter The transmitter is comprised of two components: modulator and carrier. A radio frequency generator generates the radio energy that will carry the signal. This generally consists of an oscillator (which produces the initial signal) and a number of amplifier stages (which amplify the level to that required at the antenna). A modulator mixes the signal to be transmitted with the radio frequency signal (called the carrier) in such a way that the signal can be decoded at a distant receiver. Figure 8-4a is a block diagram of a paging transmitter. The antennas used in the base station are typically simple high gain omnidirectional dipole antennas. As noted in Figure 8-4b, omnidirectional antennas can assume a variety of different shapes. The thing to remember is that the omnidirectional antennas radiate radio energy in a uniform pattern outward from the antenna.

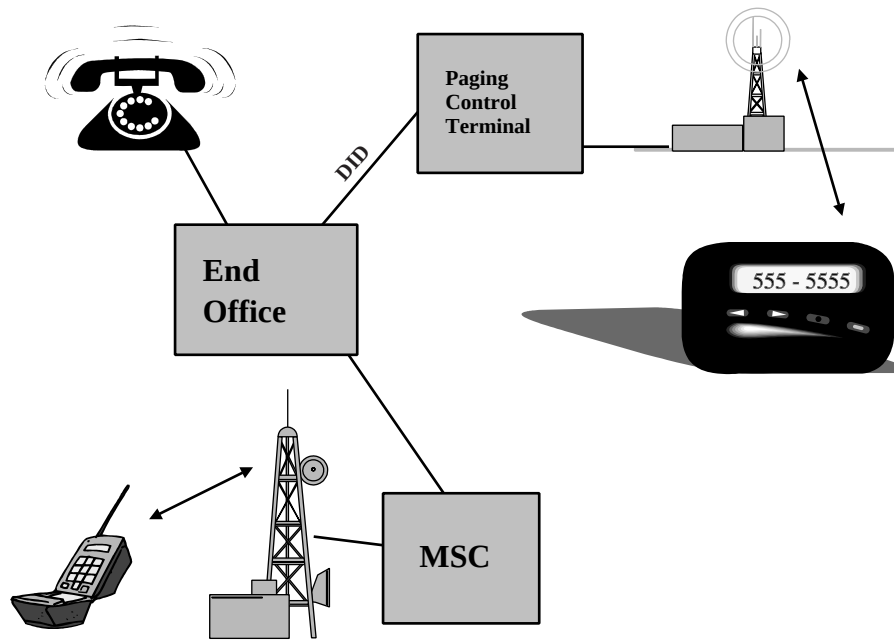


Figure 8-3a
Paging control terminal interconnected at the LEC end office

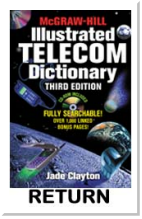


Figure 8-3b
Paging control terminal interconnected via a type 2A facility

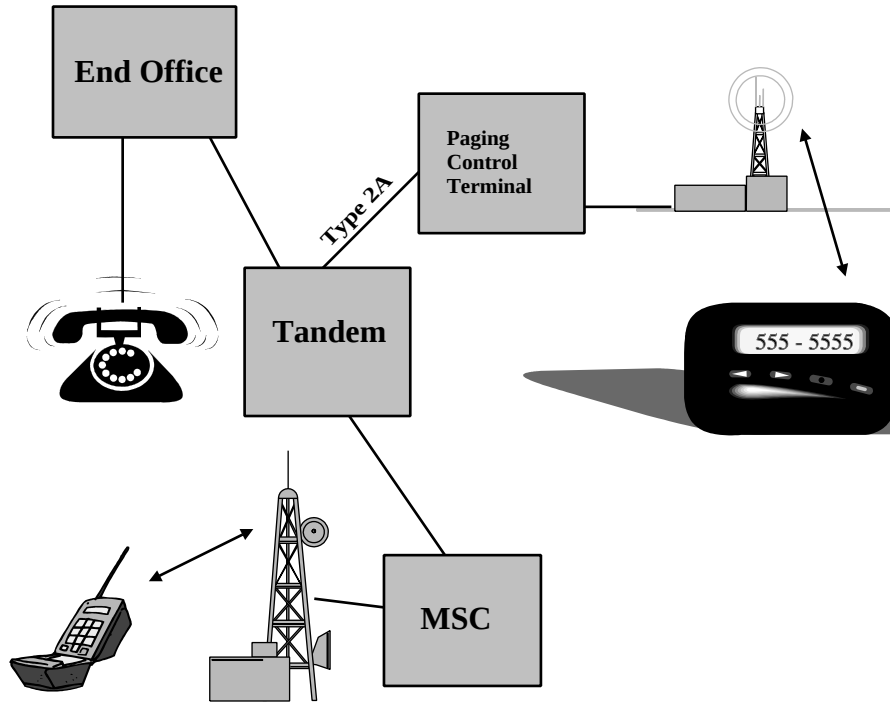
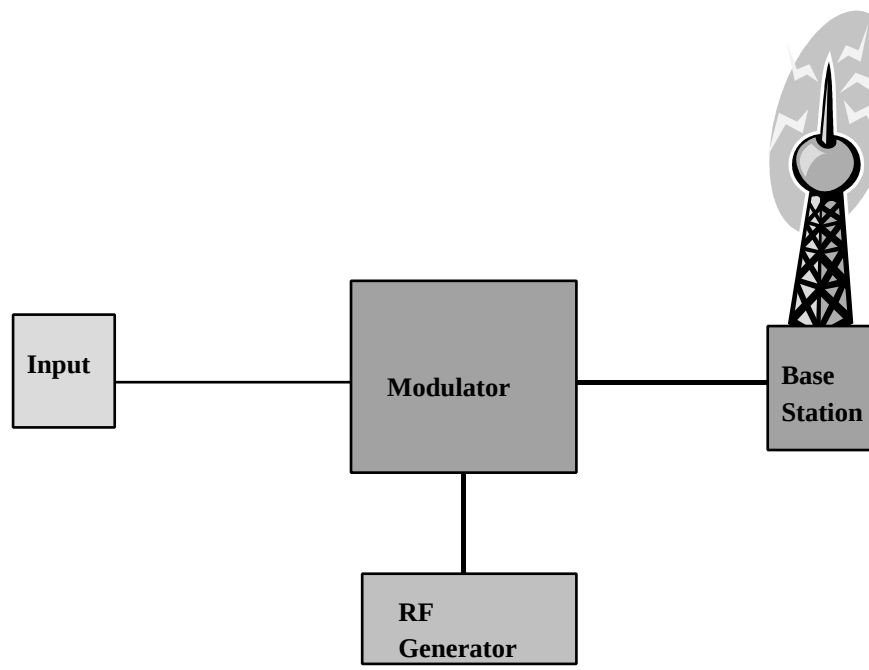


Figure 8-4a
Basic paging transmitter



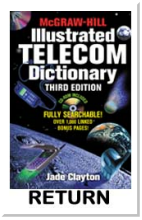
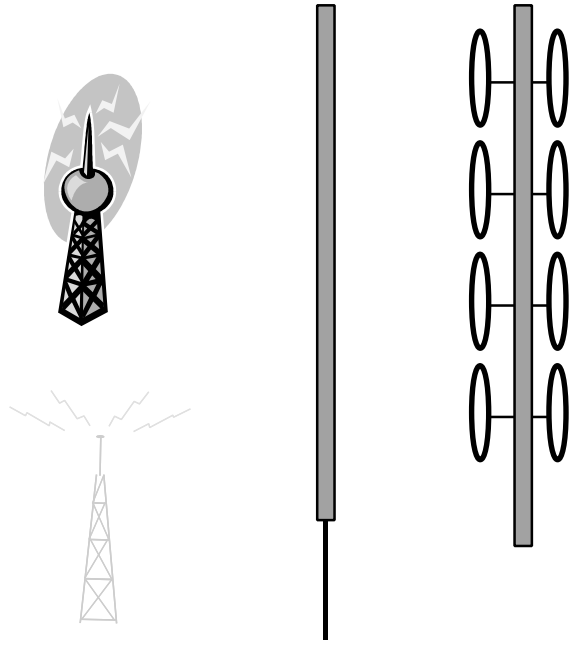


Figure 8-4b
Omnidirectional antennas



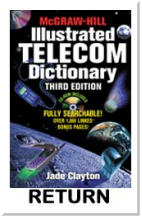
Omnidirectional antennas can assume a variety of configurations.

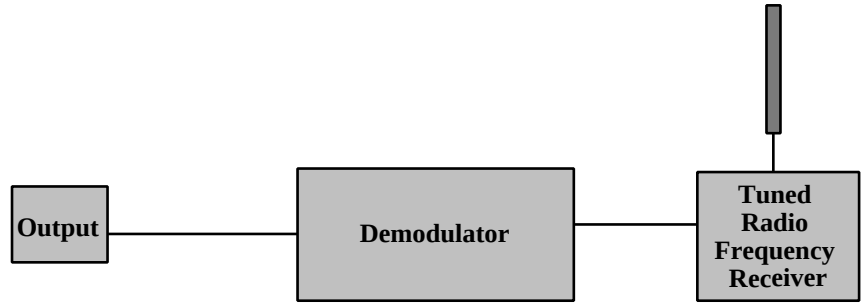
Traditional paging service providers are allowed to transmit at effective radiated power levels of up to 500 watts. This is a transmission level far greater than cellular or PCS, which do not transmit above 100 watts. Cellular and PCS are prohibited from transmitting at such power levels. The reader should note the various antennas described are utilized in the cellular and PCS industry segments. Unlike cellular and PCS, tower siting for paging is not as a laborious and arduous experience. Given, the transmit power levels, lower subscriber density, and message packet size, transmit antenna design in the paging industry presents less tasking challenges.

Receiver—Paging Device The receiver gets a signal from its antenna, which also receives a number of unwanted signals. The tuned circuit tunes out all but the wanted signal, which is then demodulated (decoded) by the demodulator.

The very simple receiver (which consists only of a tuned section and a demodulator) is known as a *tuned radio frequency* (TRF) receiver. The term *tuned radio frequency* (TRF) is out of date today. Several years ago the TRF was replaced by the superheterodyne. In the case of the paging device, the receiver is in the pager. The pager is a small, pocket-sized, two ounce device. The receiver antenna needs to be installed in the aforementioned device. Figure 8-5 is a block diagram of a paging receiver.

Figure 8-5
Paging receiver





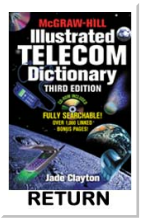
Pagers normally use a single loop antenna. Pagers come in a variety of different flavors:

- *Tone only* The original pagers supported only tone, which was a single "soft beep tone." Today pagers will beep, chirp, or even blip.
- *Alphanumeric* The alphanumeric pagers today display telephone numbers, stock reports, and the news. The alphanumeric paging systems utilize digital radio technology. More on this later in the chapter.
- *Vibrating* The paging system emits a signal that instructs the pager to vibrate instead of emitting a tone or lighting up. The pager has a mechanism that causes the paging device to vibrate.
- *Visual* The visual indication is a *light emitting diode* (LED) or a flashing icon.
- Combinations of the above

The original pagers were tone only and were fixed to react to a specific frequency. Most pagers today are still designed to operate on one frequency. However, newer pagers are being manufactured so the user can enable the pager to operate on different frequencies. Given the enhancements being made to the pagers, they are not just simple paging devices, but more like messaging devices capable of communicating more than just a number or a name. Pagers can be leased from a paging service provider or purchased through various retailers.

Typical Architectural Configurations

There are two basic configurations used in the paging network. One supports the original and still dominant one-way paging system. The second configuration supports two-way paging. Figure 8-6 is a rendering of a one way paging network configuration. Figure 8-7 is an illustration of a two way paging network configuration.



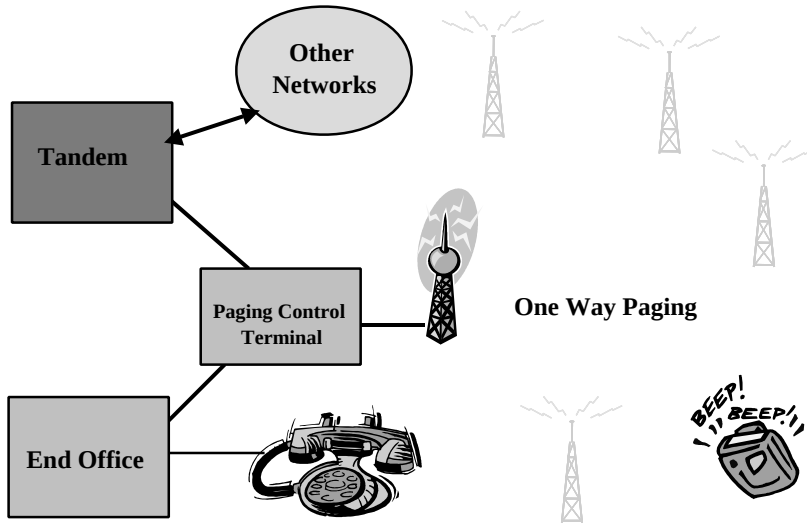


Figure 8-6
One way paging network—configuration 1

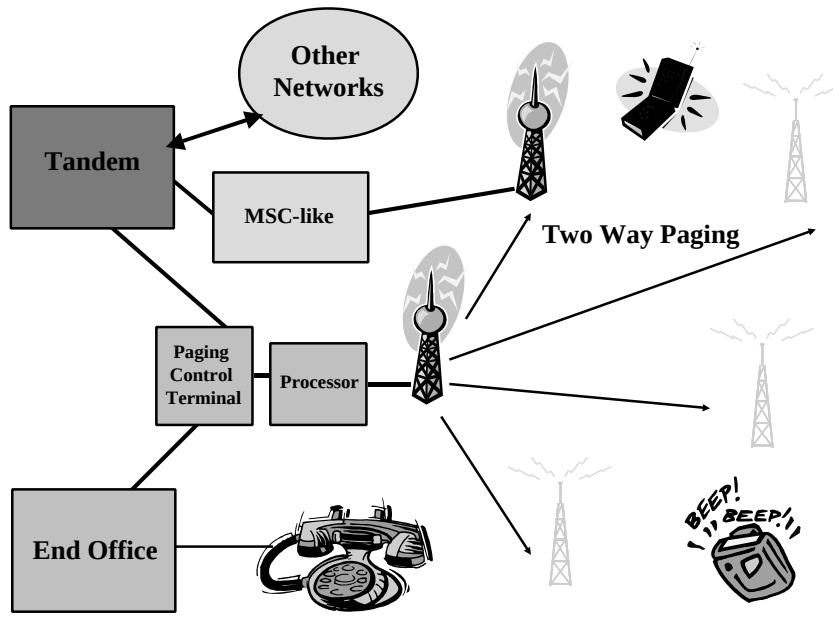
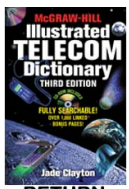


Figure 8-7
Two way paging network—configuration 2

In the first configuration, the paging device is a simple receiver. In the second configuration, the paging device is a transceiver (receiving and transmitting data). Two-way paging or, more accurately, the two-way messaging device is capable of supporting alphanumeric responses to incoming messages, sending voice messages to the paging subscriber, voice between parties,



stock reports, the latest news, and so on. The second configuration requires the use of a paging switch and base station that can accept transmission from the paging device. The two-way paging system can assume one of two types of network switching architectures. The first type utilizes the same paging control terminal with an adjunct device for processing messages from the paging devices. The second type of architecture uses a MSC class switch that is capable of processing messages from mobile devices. In both configurations, satellite transmission may be used to support nationwide broadcasting. The satellite transmits the paging information to a terrestrial network for the actual paging broadcast.

From the perspective of the ILEC/PSTN, the traditional paging terminal is like a cellular switch or a piece of customer premise equipment. The PSTN interconnect is critical because without the PSTN/ILEC interface, the paging service provider does not have visibility to its own customers. At this time, traditional paging service providers do not enable their subscribers to dial out telephone numbers from their paging devices.

The traditional paging terminal is responsible for receiving, processing, storing, and forwarding information from the caller. The paging terminal validates the type of call, determines the authenticity of the subscriber, and serves as the interface to the *radio frequency* (RF) network or to other paging terminals within a multi-city paging network. The RF network accepts the data from the paging terminal via telephone lines, RF link, or satellite and decodes the data streams containing the paging data. Upon decoding

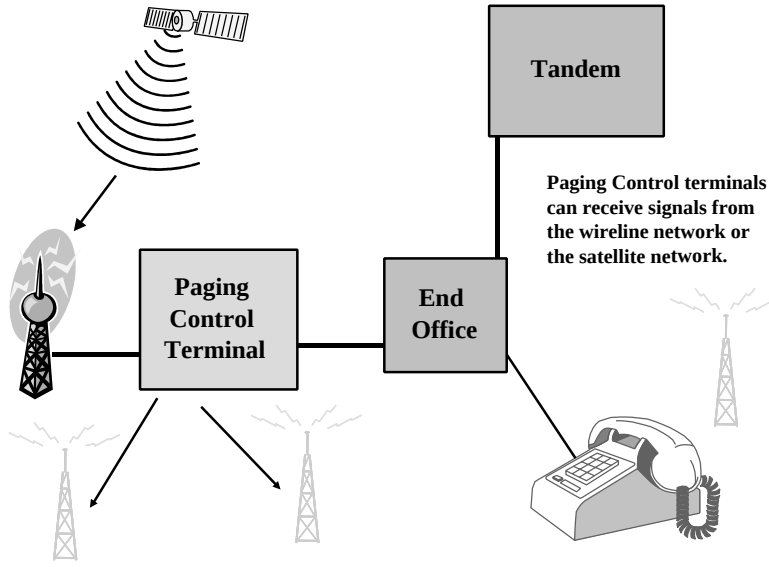
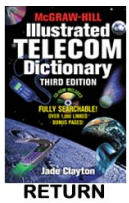


Figure 8-8
Traditional paging configuration



RETURN

the data, the transmitter translates the paging data into signals that modulate the RF paging signal at the desired transmit frequency. Figure 8-8 is an illustration of the traditional paging network configuration.

Paging Company Types and Numbering

This section will cover numbering and its application in the paging industry. This section will also describe the types of traditional paging companies in operation. There is a relationship between the numbering schemas used and the types of traditional paging companies. The relationship is partially technically- and business-driven.

Addressing in Traditional Paging

Traditional paging companies are either assigned a single telephone number or a block of telephone numbers. The telephone numbers conform to the *North American Numbering Plan* (NANP). These telephone numbers are used by calling parties to send a page or message to a paging subscriber. The telephone numbers are the method of access to the paging company. The telephone numbers may be of the following format types:

NPA-NXX-XXXX The NPA (area code) may be a local area code. The NXX-XXXX part of the number may be assigned specifically to the pager or may be assigned to the entire paging company. In the case where the telephone number is assigned to the paging device, a calling party will be able to call the paging carrier. Because the telephone number is assigned to the paging device, the calling party will be able to simply enter their message.

In the case where a single telephone number (NXX-XXXX) is assigned to the paging carrier only, the paging subscriber has a unique *personal identification number* (PIN) assigned to them. In the PIN case, the calling party calls the paging carrier and is asked to enter a PIN before sending the alphanumeric message. This case usually means that the paging carrier is sharing the NXX (exchange) with the ILEC's subscribers. Remember the ILEC assigns the local telephone number in their areas. Figure 8-9 is a chart of the typical numbering schema used by the paging carriers.

888-NXX-XXXX, 800-NXX-XXX, 877-NXX-XXXX This numbering format is typically used by the large nationwide carriers to provide toll free (no

Figure 8-9
Numbering scheme

NPA-NXX-XXXX

- NPA = Area Code
- NXX = Exchange usually shared with other subscribers or carriers
- XXXX = Assigned to either the Paging carrier or subscriber

❖ PIN = Personal Identification Number sometimes assigned

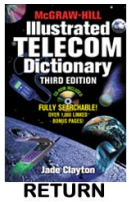


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Figure 8-10
Numbering scheme—toll free

888-NXX-XXXX

800-NXX-XXXX

877-NXX-XXXX

telephone access charges) service to calling parties wishing to page the carrier's subscribers. Nationwide paging carriers utilize PINs to identify individual paging units. Nationwide paging carriers are normally given a single NXX-XXXX to identify itself—this is why the use of PINs is so important. PINs can range from 6 to 20 numerical characters. Figure 8-10 illustrates the free charge numbering scheme.

Both nationwide paging carriers and local paging carriers support autonomous communication and service bureau communication to the paging device. In autonomous communication, the calling party simply enters the telephone number associated with the paging device. In the service bureau scenario, the calling party calls a service bureau and identifies the paging subscriber by name and sometimes by company. The service bureau alerts the paging subscriber via a tone and the subscriber calls the service bureau for the message. The service bureau was the predecessor of the alphanumeric paging device. The paging service bureau is still very much active within the paging industry. Figure 8-11 is a rendering of how a paging service bureau can be used.

Traditional nationwide paging carriers and local paging carriers are very similar. The only apparent difference is in the coverage of the carrier. Like cellular and PCS, even nationwide paging carriers do not have complete coverage. Paging carriers have the advantages of greater transmission power levels and minimal overhead setup messaging. The perceived differences between cellular, PCS, and paging are rapidly disappearing. The following section will take a more in-depth look at network deployment and operations. Figure 8-12 is a rendering depicting the benefits/advantages of Paging.

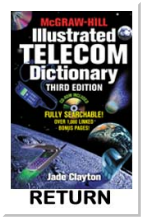


Figure 8-11
Paging service bureaus

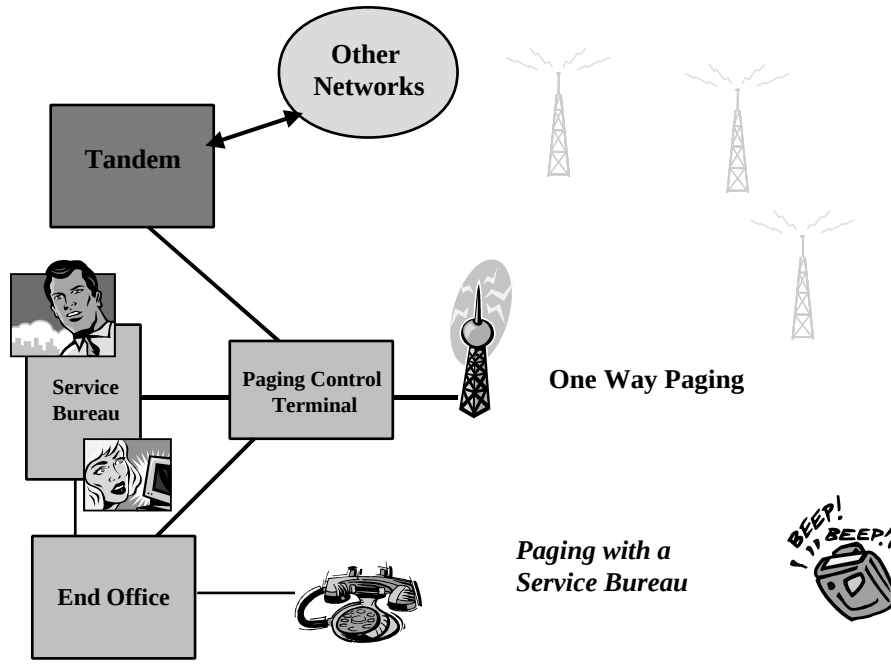
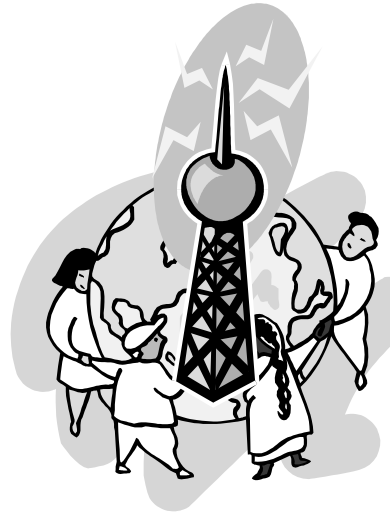
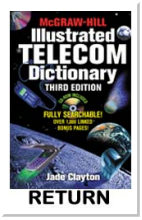


Figure 8-12
Paging advantages



- ***Greater Power Transmission levels***
- ***Less Overhead Messaging than Cellular or PCS***
- ***Coverage is better than Cellular or PCS***

Traditional Paging Network and Interconnection



When an individual contacts a paging device, the device is called with a telephone number and probably some type of *personal identification number* (PIN). You can use almost any kind of terminal device or even service bureau provided it has access to the paging network. The calling device can be a personal computer, telephone, or an operator dispatch (service bureau) where someone takes and enters a message or sends and alerting tone.

Paging is different than either cellular or PCS service. In a cellular and PCS system, a calling party dials a number, the call is processed through the a service provider's network, and then probably through the PSTN to the wireless service provider's network. As soon as the call gets to the wireless service provider's network, the calling party is connected to the wireless called party. A real-time conversation connection is established. In the case of paging, communication does not occur in real-time. Communication is stored and forwarded. Up until recently, paging was strictly a one-way service: calling party to called party only. The reader should note that the stored-and-forward nature of a paging call tends to have an effect on the types of services that are offered. Two-way paging/messaging is entering the marketplace. I will discuss this more later. Figure 8-13 is a rendering of paging's strengths.

A sender uses one of the previously mentioned input sources to send the message or page through the local phone system, or PSTN. The PSTN "switches" the page to a carrier paging terminal. After the paging control

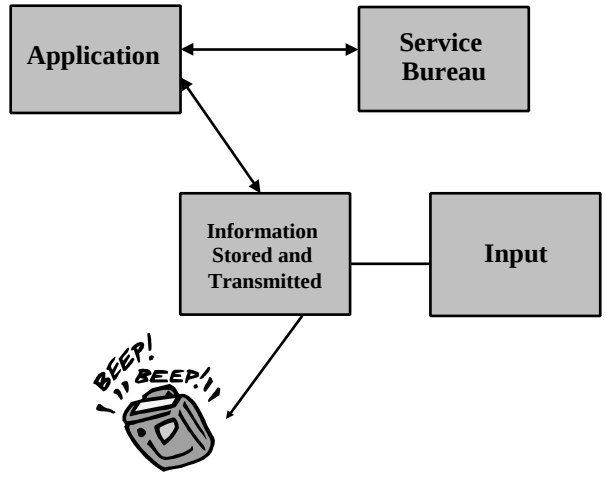


Figure 8-13
Paging—information storage is a strength.

Storage of information facilitates the use of data for a variety of applications that do not require real time processing

terminal receives the page, the terminal processes, stores, and forwards information from the caller. Additionally, it encodes the page for transmission through the carrier paging system. Typically, an encoder accepts the incoming page, validates the pager address, and "encodes" the address and page into the appropriate paging signaling protocol. After the page is encoded, it is sent to the RF link system, which includes the link transmitter and link receiver. The link transmitter sends the page to the link receiver, which is located at the various paging transmitter sites along the channel. The transmitter then broadcasts the page across the coverage area on the specified carrier frequency.

The interconnection through the PSTN (that is, ILEC) is critical in the paging carrier's operations. Without the ILEC interconnection, the paging carrier cannot be reached. The paging carrier obtains its PSTN interconnection from the wireline *local exchange carrier* (LEC). The dominant interconnection used by the paging carrier is the *Direct Inward Dialing* (DID) connection. The *Direct Inward Dialing* (DID) connection is a trunk-side wireline carrier end office connection. The DID connection is a two-wire circuit limited to one-way incoming service (LEC to other carrier). The DID connection gives the wireline local exchange carrier the perception that the paging control terminal is a customer premise equipment terminal. DID connections support DTMF address pulsing. Although the DID is a one-way interconnection type, it can support signaling back to the paging control terminal. The reader should note that the one-way nature of the DID connection prohibits outbound (from the paging carrier) calls to the LEC. The DID interconnection also does not support power ringing, also known as alerting ringing. The DID connection was one of the earliest interconnection types offered by the PSTN; hence, the DID is the dominant connection types used by the paging carrier. Figure 8-14 depicts paging's basic interconnection type with the PSTN.

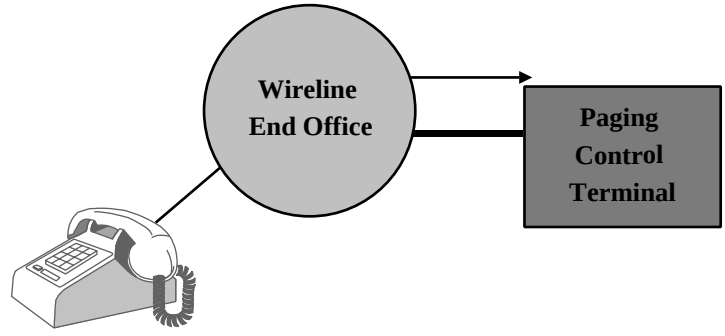


Figure 8-14
Paging interconnect—DID is the most basic interconnect type.