



Saving Lives and Property Through Improved Interoperability

***Commercial Services Report #2:
Wireless Data Communications Assessment***

Final

December 2001

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Foreword...

THE WIRELESS DATA COMMUNICATIONS ASSESSMENT REPORT PROVIDES AN UPDATE ON THE STATUS OF VARIOUS WIRELESS-BASED DATA TECHNOLOGIES

- This report is part of a three-report series targeting commercial services and their applicability to public safety missions
 - Provides a broad assessment of the current state of the wireless data industry
 - Does not reflect a government position, nor does it offer the Public Safety Wireless Network (PSWN) Program's endorsement for any particular service provider or vendor
- This single, consolidated report serves as an update and replacement for four PSWN Program Year 1 (1997) documents that addressed cellular digital packet data (CDPD), global positioning system (GPS), computer-aided dispatch (CAD), and other mobile data technology. Note, however, where industry information reported in the earlier documents is unchanged, but still relevant, that information is included in this report for ease of reference
- Comments regarding the information provided in this document may be directed to the PSWN Program Management Office (PMO) at 1-(800)-565-PSWN, or by e-mail to information@pswn.gov
- For additional PSWN Program information and research, visit the home page at <http://www.pswn.gov>

Outline of Contents

Executive Summary

- I. Introduction
- II. Background
- III. Methodology
- IV. Wireless Data Public Safety Requirements
- V. Current Wireless Data Technologies
- VI. Commercial Wireless Data Services
- VII. Public Safety Wireless Data System Example - Computer Aided Dispatch
- VIII. Summary
 - A. Bibliography
 - B. Acronyms

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EXECUTIVE SUMMARY

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Executive Summary...

THE WIRELESS DATA COMMERCIAL SERVICES REPORT EXAMINES SEVERAL METHODS FOR CONSERVING PUBLIC SAFETY AGENCY-OWNED SPECTRUM THROUGH USE OF COMMERCIAL DATA SERVICES

- Available wireless data services that strengthen public safety agency capabilities in a mobile environment use two main transmission techniques: packet-switched and circuit-switched data
 - Packet-Switched Data—“Packet-switched” describes a network over which relatively small units of data, called packets, are routed over a network (wireless or wired) based on the destination address contained within each packet
 - Circuit-Switched Data—“Circuit-switched” describes a network, such as the standard cellular network, in which the communication circuit path for the call is set up and dedicated to the participants in that call. For the duration of the connection, all resources on that circuit are unavailable to other users
- This report provides information on technologies utilizing both techniques, and focuses on the following wireless data services:
 - Cellular Digital Packet Data (CDPD)—CDPD is a widely used packet-switched technology. It is one of the main types of data communications used by public safety agencies. It uses existing, but unused, portions of analog cellular 800 megahertz (MHz) channels as the system’s local area network (LAN)
 - Paging Services — One-way pagers such as voice, numerical, and alphanumeric pagers are discussed, as well as two-way text messaging pagers
 - Global Positioning System (GPS)—GPS is a satellite system that orbits the Earth, making it possible for users with ground receivers to pinpoint their geographic location
 - Computer aided dispatch (CAD)— CAD systems combine different commercial service technologies and agency-owned radio infrastructure with a vast assortment of tools to improve public safety’s mission performance. It allows for quick and accurate incident entry, provides access to information such as databases, and fosters two-way communications between the dispatcher and mobile units.
 - CAD systems provide capabilities in supporting a dispatcher’s work and can be tailored to specific operational needs. Capabilities include graphical user interfacing, records management, mapping, AVL, entry and display of incident information, incident dispatch, unit tracking, time stamping, address verification, and report generation

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Executive Summary...

THE WIRELESS DATA COMMERCIAL SERVICES REPORT EXAMINES SEVERAL METHODS FOR CONSERVING PUBLIC SAFETY AGENCY-OWNED SPECTRUM THROUGH USE OF COMMERCIAL DATA SERVICES (CONT'D)

- Commercial wireless data services can deliver invaluable information to public safety personnel in the field while, at the same time, conserving the limited amount of spectrum that each agency must share; however, agencies must consider several factors when planning to implement wireless data technologies
 - A wireless link is required, either through a packet-switched data network or a circuit-switched data network
 - Communications must be established using equipment that can receive data according to an agency's needs, such as a mobile data terminal (MDT), a personal digital assistant (PDA), a pager, a GPS receiver, etc.
 - Data equipment can all be linked together at a communications center, using multiple offices and/or using databases in other areas of the country
 - CAD systems provide an integrated solution bridging agency-owned infrastructure with commercially available wireless data services
 - Beyond the general overview this report provides, the reader is encouraged to conduct further reading and research according to the highlighted considerations

- Several data points were analyzed in developing this report, leading to an assessment based on key findings. The analysis followed the process outlined below:
 - Data gathering— Included performing a gap analysis on the PSWN Program's Year 1 reports on Commercial services, and then gathering input from professional societies, textbooks, technology forums and vendor web sites
 - Analysis—Packet-switched and circuit switched technologies then were assessed relative to the CARTS (Cost, Accessibility, Reliability, Technology, and Security) model
 - Results—Results from the analysis reflect the primary factors that local, state and federal users should consider when weighing options for implementing commercial wireless data solutions

- Listed on the next page is a chart summarizing the results of the assessment of each technology, relative to CARTS. Results are shown with shaded circles, ranging from fully shaded to fully empty. Full (or filled in) circles indicate the most favorable condition, compared to empty circles, which indicate the least favorable condition

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Executive Summary...

THE WIRELESS DATA COMMERCIAL SERVICES REPORT EXAMINES SEVERAL METHODS FOR CONSERVING PUBLIC SAFETY AGENCY-OWNED SPECTRUM THROUGH USE OF COMMERCIAL DATA SERVICES (CONT'D)

Technology	Cost	Accessibility	Reliability	Technology	Security	Overall Rating	Comments
Packet-Switched Data Access (CDPD)	2	2	4	4	4	3	CDPD service can be easy to use, although coverage can suffer in certain areas and the speed and cost is a disadvantage
Digital phones or analog phones with modems	4	2	2	4	2	3	Circuit-switched service can be easy to use, although the service may be affected in the same areas, as is CDPD. The service may not be as secure
Voice pagers	4	4	4	2	0	3	Voice pages are very simple to use; however there is little to no security and the amount of information sent through a pager is limited
Alphanumeric pagers	4	4	4	4	4	4	Alphanumeric pagers are of great importance to public safety personnel. The units are relatively inexpensive, very accessible in a large coverage area, easy to use, and have encryption capabilities
Two-way pagers	4	2	1	2	4	3	Two-way pagers are useful tools at times; however there are limitations to the technology such as coverage, accessibility, ease-of-use, and how proven a technology it is so far
Handheld GPS units	4	0	2	2	4	2	Handheld units provide the same data as other GPS units; however the connectivity to other devices may be limited
In-vehicle GPS	2	2	2	0	4	2	In-vehicle GPS units provide the added usefulness of viewing a map in an automobile. However, the car-mounted equipment may not have external data connectivity
Computer/MDT equipped GPS	4	2	2	2	4	3	Computer and MDTs equipped with GPS can combine the uses of GPS handhelds, AVL, and mapping into the MDT
Automatic Vehicle Locator equipped GPS*	2	2	2	4	4	3	AVL GPS antennas can be installed in an automobile to provide a stand-alone unit for command and control activities using an antenna, an interface, and a transponder. No user intervention is usually required

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I. INTRODUCTION

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Introduction...

PUBLIC SAFETY AGENCIES HAVE DEMONSTRATED AN INHERENT NEED FOR COMMUNICATIONS IN EMERGENCY SITUATIONS

- The public safety community takes great interest in improving its ability to complete its mission to save lives, fight crime, and serve the public in the most efficient manner possible. Wireless data services are essential components of public safety communications that assist in pursuing this goal. In particular—
 - Public safety personnel are likely to have an increased intake of information before arriving at an emergency when using wireless data
 - Wireless data services have proven to help public safety agencies to maintain a greater supply of critical information exchange for field personnel at any given time
- This report serves as a guide to help public safety coordinators understand wireless data systems and technologies. The report can also serve as a primer for a coordinator to use in understanding plans to purchase a new system or to improve or assess an existing system
- Wireless data technology makes it possible to give officers tools for executing aspects of their mission that may not have been as easy without this technology
 - Wireless services can essentially create a mobile office for uniformed personnel to perform desk work while in the field
 - Commercially available wireless data services can provide the ability to link local, state, and federal databases to all personnel in the field
 - Hardware and software tools can be used in conjunction with wireless data services to further enhance the field personnel performance

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Introduction...

IN RECOGNIZING THE PUBLIC SAFETY MISSION, THE PUBLIC SAFETY WIRELESS NETWORK (PSWN) PROGRAM TAKES A GREAT INTEREST IN EVALUATING WIRELESS DATA AND WIRELESS DATA SYSTEMS

- The PSWN Program's main goals center on interoperable communications, including interoperability among wireless data systems
- Wireless data services provide connectivity to many different databases in different areas of the country, as well as the ability to connect users to handheld devices, mobile computers, and dispatch systems. Thus, interoperable communications greatly impact the effectiveness of a wireless data system

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II. BACKGROUND

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Background...Benefits of Wireless Data...

WIRELESS DATA SERVICES CAN ENABLE A PERSON OR AN AGENCY TO TRANSFER INFORMATION MORE EFFICIENTLY AND EFFECTIVELY COMPARED WITH CONVENTIONAL VOICE COMMUNICATIONS

- Wireless data communications can be defined as the transfer of text, pictures, fingerprints, or any non-voice information over radio frequency (RF) communications technology
- Wireless voice communications are very effective in communicating messages; however, today's wireless voice communications systems have several disadvantages
 - Because of a combination of limited radio spectrum and a large number of users, wireless voice systems tend to have a high level of congestion
 - A user can view a large amount of information all at once, rather than listening for specific information from a dispatcher, another user, or multiple users, thus reducing the probability of errors or misunderstandings
- The use of wireless data technology has many benefits
 - Users can transfer information at a greater speed and density compared with voice communications
 - Potentially life-saving information, such as maps, mug shots, fingerprints, traffic information, weather reports, and many other data sources, are available to a public safety official during an emergency
 - Seamless data transfer between mobile and command and control centers supports an increasingly paperless environment
 - Field personnel can enter reports or access information just as though they were located at the office
 - Users can acknowledge information in real time without answering a telephone or a page
 - Errors, such as misinterpretation of information because of illegible handwritten notes or dialects, are reduced or eliminated
- Wireless data services offer functions similar to wireline data services, such as e-mail, Internet access, remote database lookups, mapping and location information, dispatch services, and Public Switched Telephone Network (PSTN) access
- Mobile data systems use a similar data transfer protocol to that used for Internet communications; therefore users can access information in the same way they do with wired networks

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Background... History of Wireless Data...

FOR MORE THAN A CENTURY, WIRELESS DATA TECHNOLOGIES HAVE PROVEN TO BE AN EFFECTIVE MEANS OF COMMUNICATION

- In 1895, Guglielmo Marconi invented the world's first wireless data device, the telegraph
 - Similar to today's data communications, it transmitted a coded sequence that was then translated by the receiving operator
 - Military demands drove further wireless data innovations. Radio Telegraph Stations spurred an expanded use worldwide, including battlefield support and use in air-to-ground communications in the 1920s
 - During World War II, the United States and Germany communicated with their fleets using a wireless data system
- In the late 1950s, wireless Teletype units were developed for military use. Operators used these units to send latitude and longitude coordinates for radar location within the data transmissions. These manageable transmission segments were the forerunners of packet data technology
- In 1972, IBM introduced a mobile data radio system for public safety use. This system, known as the 2976 Mobile Terminal System, worked well for its time, but was later withdrawn from the market because of its size, lack of dispatch software, and a lack of acceptance by the public safety community
 - Throughout the 1970s, many prototype systems followed
 - Attention finally focused on a Federal Express system developed by Mobile Data International. A count of 25,000 units within Federal Express' system spurred Motorola and IBM to develop public packet-switched data networks known as the Digital Communication System (DCS) and the Digital Radio Network (DRN), for use in corporations worldwide
- Meanwhile, the first pager was introduced in 1974. It delivered an audio tone when a page was sent. The user then called in to receive the message. This system is still in use by many public safety agencies
 - By 1980, there were 3.2 million pager users worldwide. Pagers had a limited range and were used in campus environments, such as hospital and universities
 - By 1990, wide-area paging was established, and more than 22 million pagers were in use
 - By 1994, more than 61 million pagers were operating worldwide¹

¹ DeRose, James, *Wireless Data Handbook*, 4th Edition, Wiley & Sons, 1999

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III. METHODOLOGY

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Methodology...

COMMERCIALLY AVAILABLE WIRELESS DATA SERVICES DISCUSSED IN THIS REPORT ARE BASED ON MANY DIFFERENT RESOURCES

- The report was created using the following five-step process:
 - Data gathering
 - Analysts used initial PSWN Program Year 1 reports for initial subject matter
 - Analysts filled information gaps and gathered technology updates for each subject from various professional societies, textbooks, technology forums, and vendor Web sites
 - Analysis of wireless data technology
 - This report assessed two wireless data technologies, packet-switched and circuit-switched transmission, based on their relevance to the public safety community
 - Analysis of wireless data services
 - This report discusses and assesses, in detail, data services that use packet-switched and circuit-switched technologies either directly or indirectly
 - Each wireless data service review includes public safety applications
 - Discussion of how wireless services play a role in public safety
 - This report analyzes requirements local, state, and federal public safety agencies have relative to wireless data applications
 - The report presents examples of systems that public safety agencies use. Specifically, the report includes a discussion of a computer-aided dispatch (CAD) system that uses many of the wireless data services described elsewhere in this report
 - Develop wireless data communications assessment
 - The report assess wireless data services based on potential public safety needs and requirements
 - The wireless data report summarizes key findings in a one-page outline

**IV. WIRELESS DATA PUBLIC SAFETY
REQUIREMENTS**

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Wireless Data Public Safety Requirements...Considerations...User Requirements...

OVERALL, PUBLIC SAFETY PLANNERS SHOULD ADDRESS FIVE KEY CRITERIA WHEN CONSIDERING COMMERCIAL SERVICES FOR USE IN PUBLIC SAFETY MISSIONS—COST, AVAILABILITY, RELIABILITY, TECHNOLOGY, AND SECURITY

- This section examines each of the wireless data services described in this report
- Each identified wireless data service is evaluated based on the five key criteria
- Shown below is a table of keys used to rate each requirement and a chart evaluating how well each technology would satisfy each requirement in a public safety environment

Cost —User equipment, service fees, and the public safety communications center’s equipment costs are the first barrier to implementing a system. The user’s operational needs define the system requirements and thus define the cost of an overall system. A three-level cost analysis is used to assess each service. The analysis is based on a relative estimate of low, medium, or high. System planners should consider a full cost benefit analysis before procuring such services	
⁴	Low Cost—The equipment is low in cost (approximately \$1,000 or lower in cost) with minimal recurring maintenance fees per user
²	Medium Cost—The equipment is somewhat expensive (in the range of \$1,000 to \$2,500)
⁰	High Cost—The equipment tends to be quite expensive (\$2,500 and above)

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Wireless Data Public Safety Requirements...Considerations...User Requirements...

OVERALL, PUBLIC SAFETY PLANNERS SHOULD ADDRESS FIVE KEY CRITERIA WHEN CONSIDERING COMMERCIAL SERVICES FOR USE IN PUBLIC SAFETY MISSIONS—COST, AVAILABILITY, RELIABILITY, TECHNOLOGY, AND SECURITY (CONT'D)

<p>Availability—If a public safety agency has the funding available to purchase a new technology product, the technology must be readily available and must be able to sustain a public safety operation. These technologies must also use integrated hardware and software that can interoperate effectively with other systems, according to each user’s needs. However, there are some applications that a majority of the users will need and that should be implemented throughout an entire system. Less-frequently used applications and peripheral tools can be added in a later phase. The availability of required applications dictates the value of the service to the public safety community, thus each service is assessed based on the following categories:</p>	
4	High—A system can pass all pertinent data seamlessly between communication centers and a mobile unit. The hardware and needed software is likely to be available nationwide
2	Medium—The technology is very helpful but somewhat antiquated and will likely be outdated in the next 5 to 10 years
0	Low—The technology has limited use when compared with current technology standards. Few connections exist between communication centers and the mobile terminals, in terms of interoperability. This system is a last resort, backup, or a “quick fix” type of unit
<p>Reliability— Wireless data technologies must endure many environments and conditions in a mobile environment. A public safety user may be operating in an indoor or an outdoor environment. With reliability also comes the durability of user equipment, such as the ability to receive an adequate signal at any given moment and the ability to maintain operations with a stable operating system. All these factors must be considered when purchasing equipment and services. Therefore, each of the identified services is assessed based on the following categories:</p>	
4	High—A technology that has proven reliable, has redundancy, and has proven capabilities in the public safety community
2	Medium—A technology that has some reliability, redundancy, and trustworthiness, however can encounter some degradations
0	Low—A technology that has not been proven in the field, especially in public safety missions

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Wireless Data Public Safety Requirements...Considerations...User Requirements...

OVERALL, PUBLIC SAFETY PLANNER SHOULD ADDRESS FIVE KEY CRITERIA WHEN CONSIDERING COMMERCIAL SERVICES FOR USE IN PUBLIC SAFETY MISSIONS ARE COST, AVAILABILITY, RELIABILITY, TECHNOLOGY, AND SECURITY (CONT'D)

Technology —The overall usefulness of a given technology for public safety operations is an important factor. A new technology must be effective and reliable for use in emergency incident response. Further, a technology must add value to mission requirements. The technology must not hinder, but rather, it must enhance job performance. Therefore, each of the identified services were assessed based on the following categories:	
4	Favorable—A powerful technology that serves many applications. The technology is easy to use or requires no human interaction
2	Neutral—The technology is useful, however may require training or need an on-site expert
0	Unfavorable—The technology may be difficult to learn or to use. Extensive training may be needed to use this technology
Security —The ability to mitigate communication path vulnerabilities is one of the most important requirements of any system. An agency must understand that with a wireless system there are many paths between two communicating devices. At any point between these devices, a message has the potential of being intercepted, spoofed, or eavesdropped upon. A public safety agency must take every precaution to eliminate interception, especially when a system is connected to proprietary or confidential databases	
4	High—One of the best encryption standards available
2	Medium—Security is encoded; however it is relatively easy to intercept
0	Low—Little to no security is available

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Wireless Data Public Safety Requirements...Considerations...User Requirements...

THE FOLLOWING CHART SUMMARIZES THE ASSESSMENT OF EACH SERVICE AGAINST EACH REQUIREMENT BASED ON THE KEYS LISTED ABOVE

Technology	Cost	Accessibility	Reliability	Technology	Security	Overall Rating	Comments
Packet-Switched Data Access (CDPD)	2	2	4	4	4	3	CDPD service can be easy to use, although coverage can suffer in certain areas and the speed and cost is a disadvantage
Digital phones or analog phones with modems	4	2	2	4	2	3	Circuit-switched service can be easy to use, although the service may be affected in the same areas, as is CDPD. The service may not be as secure
Voice pagers	4	4	4	2	0	3	Voice pages are very simple to use; however there is little to no security and the amount of information sent through a pager is limited
Alphanumeric pagers	4	4	4	4	4	4	Alphanumeric pagers are of great importance to public safety personnel. The units are relatively inexpensive, very accessible in a large coverage area, easy to use, and have encryption capabilities
Two-way pagers	4	2	1	2	4	3	Two-way pagers are useful tools at times; however there are limitations to the technology such as coverage, accessibility, ease-of-use, and how proven a technology it is so far
Handheld GPS units	4	0	2	2	4	2	Handheld units provide the same data as other GPS units; however the connectivity to other devices may be limited
In-vehicle GPS	2	2	2	0	4	2	In-vehicle GPS units provide the added usefulness of viewing a map in an automobile. However, the car-mounted equipment may not have external data connectivity
Computer/MDT equipped GPS	4	2	2	2	4	3	Computer and MDTs equipped with GPS can combine the uses of GPS handhelds, AVL, and mapping into the MDT
Automatic Vehicle Locator equipped GPS*	2	2	2	4	4	3	AVL GPS antennas can be installed in an automobile to provide a stand-alone unit for command and control activities using an antenna, an interface, and a transponder. No user intervention is usually required

* A description of the AVL service can be found in the Computer-Aided Dispatch section later in this report

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System Considerations...User Checklist...

THE FOLLOWING USER CHECKLIST IS INTENDED FOR RADIO MANAGERS OR SYSTEM ADMINISTRATORS INVESTIGATING A WIRELESS DATA SYSTEM PURCHASE.

- This checklist should be used only as a preliminary guideline for covering the most important services

<u>WIRELESS DATA CHECKLIST</u>	
<input checked="" type="checkbox"/>	Do I need the wireless data services and to what extent?
<input checked="" type="checkbox"/>	Where do I need the service? Locally? Regionally? Nationally?
<input checked="" type="checkbox"/>	Will the wireless data services work in my operational environment?
<input checked="" type="checkbox"/>	Will it support mission critical requirements?
<input checked="" type="checkbox"/>	What type of service and pricing plans does the service provider offer?
<input checked="" type="checkbox"/>	Does the carrier provide packet switched or circuit switched data?
<input checked="" type="checkbox"/>	What is the coverage area of the particular service provider?
<input checked="" type="checkbox"/>	What coverage does the service provider offer with roaming agreements?
<input checked="" type="checkbox"/>	What type of value added service options does the service providers?
<input checked="" type="checkbox"/>	How can encryption be added to the handset to support operations?
<input checked="" type="checkbox"/>	What type of modem do I need and does the service provider support it?
<input checked="" type="checkbox"/>	What happens if the wireless data equipment was lost, stolen, or damaged?

V. CURRENT WIRELESS DATA TECHNOLOGIES

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Current Wireless Data Technologies...

TODAY THE AVAILABLE WIRELESS DATA SERVICES THAT STRENGTHEN PUBLIC SAFETY AGENCY CAPABILITIES IN A MOBILE ENVIRONMENT USE TWO MAIN TRANSMISSION TECHNIQUES

- Packet-Switched Data—“Packet-switched” describes a network over which relatively small units of data, called packets, are routed over a network (wireless or wired) based on the destination address contained within each packet. Information is sent in packets and bundled with overhead information. This overhead data includes routing and destination information as well as error correction data to ensure correct transmission in case of poor signal quality
 - Dividing a message into packets allows many network users to share the same data path²
 - This type of communication between sender and receiver is known as connectionless (rather than dedicated) communications. Most traffic over the wired Internet relies on a packet-switching type protocol
 - Cellular digital packet data (CDPD), a wireless data service, is an example of a widely used packet-switched technology. This type of packet-switched data service is the main type of data communications used by public safety agencies
 - Packet-switched based data services allow for the use of special data applications to assess central databases owned by the agency or remotely maintained by a state or a federal agency, i.e., National Crime Information Center (NCIC), National Law Enforcement Telecommunications System (NLETS), Washington Area Law Enforcement System (WALES), etc.
 - Packet data architecture is normally based on open architecture, which allows for continuous upgrades and enhancements to keep it current with advancing technology. The openness of the architecture allows use of a wide variety of computing devices and modems

² Packet-Switched Data Technology <<http://www.whatis.com>> August, 2001

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Current Wireless Data Technologies...

TODAY THE AVAILABLE WIRELESS DATA SERVICES THAT STRENGTHEN PUBLIC SAFETY AGENCY CAPABILITIES IN A MOBILE ENVIRONMENT USE TWO MAIN TRANSMISSION TECHNIQUES (CONT'D)

- Circuit-Switched Data—“Circuit-switched” describes a network, such as the standard cellular network, in which the communication circuit path for the call is set up and dedicated to the participants in that call. For the duration of the connection, all resources on that circuit are unavailable to other users³
 - Data transferred through this type of circuit passes through a digital cellular telephone with a built-in modem, or through an analog telephone with an attached analog-to-digital modem. This type of communication relies on the quality of the cellular providers service
 - Users can connect to a data service by using a cellular telephone as a modem to connect to an Internet service provider, or to a business local area network (LAN) using a dial-up networking type of model
 - » Cellular and personal communications services (PCS) providers have lately offered services that enable data-capable digital telephones to send and receive data from and to a laptop or personal digital assistant (PDA)
 - » Similar to packet-switched service, users can access information such as e-mail, Internet data, or query databases
 - » The cellular telephone user dials in to either an Internet service provider or a business LAN, depending on the type of connection that is arranged ahead of time
 - » A business LAN can consist of a public safety agency’s own central office LAN with a server or workstation connected to a dial-up networking modem or a modem pool, which would answer one or many calls, depending on the number of modems present
 - » Users can employ either analog or digital voice channels to access data; however, digital telephones have built-in modems, thus eliminating the need for an additional modem. Analog telephones require a modem in order to encode or decode digital information

³ Circuit-Switched Data Technology <<http://www.whatis.com>> August 2001

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Current Wireless Data Technologies...

TODAY THE AVAILABLE WIRELESS DATA SERVICES THAT STRENGTHEN PUBLIC SAFETY AGENCY CAPABILITIES IN A MOBILE ENVIRONMENT USE TWO MAIN TRANSMISSION TECHNIQUES (CONT'D)

- Because the cellular and PCS providers supply the connectivity and data-capable telephones, the infrastructure is identical to that of PCS and cellular infrastructures. The PSWN Program *Commercial Services Report #1: Cellular Telephone and Personal Communications Service Assessment* contains an in-depth description of these services
 - » Coverage of a circuit-switched network is identical to the coverage of the specific service provider's network
 - » Users must employ specific telephones and cables to connect to a laptop or PDA
 - » As with voice calls, subscribers share the airwaves and compete for capacity on the network. Note, however, sometimes the demand at a site will exceed available capacity, rendering the service useless

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VI. COMMERCIAL WIRELESS DATA SERVICES

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Commercial Wireless Data Services...Introduction...

TODAY SEVERAL WIRELESS DATA SERVICES ARE AVAILABLE TO STRENGTHEN PUBLIC SAFETY AGENCY CAPABILITIES IN A MOBILE ENVIRONMENT

- Cellular Digital Packet Data (CDPD)
 - CDPD is a widely used packet-switched technology. It is one of the main types of data communications used by public safety agencies
 - CDPD services use existing, but unused, portions of analog cellular 800 megahertz (MHz) channels as the system's local area network (LAN)
- Paging Services
 - One-way paging—A one-way pager is a short-range wireless receiver that captures multiple messages
 - » One of the simplest types of pagers, a tone pager, sounds a tone when its own telephone number is called. The user then calls in to a voice-mail type of service
 - » Another type of one-way pager displays the return-call telephone number of the person who sent the message
 - » Sophisticated one-way pagers can display short alpha-numeric messages
 - Two-way paging—Two-way paging or two-way messaging relies on a technology that employs large numbers of repeaters, allowing low-power transmitters with subminiature antennas to reach at least one repeater from any location within the service coverage area.
 - » This technology allows the receipt and transmission of short alpha-numeric messages
 - » A typical unit is about the size of a pocket calculator and has a built-in, miniature keyboard and liquid crystal display (LCD) screen that can display several lines of text or even simple graphics
- Global Positioning System (GPS)
 - GPS is a satellite system that orbits the Earth, making it possible for users with ground receivers to pinpoint their geographic location
 - The Department of Defense (DoD) developed and currently owns and operates the GPS, which has allowed for use of this technology by the public
 - Benefits of this technology are far reaching, with uses in public safety, science, recreation, construction, traffic, and weather, to name a few

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Commercial Wireless Data Services...CDPD Services...Introduction...

THE FOLLOWING SECTION ANALYZES KEY PARAMETERS OF PACKET-SWITCHED WIRELESS DATA SERVICES TO ASSESS THEIR ABILITY IN SUPPORTING PUBLIC SAFETY MISSIONS

- This section describes network perspectives and service characteristics to establish a knowledge base when designing a system for a specific agency's operational requirements. Included here is a discussion on the following subjects, as they relate to CDPD, paging, and GPS:
 - Network Perspective
 - Availability and Coverage
 - Mobility
 - Reliability
 - Transmission Speeds and Set-Up Times
 - Security
 - Sample Costs

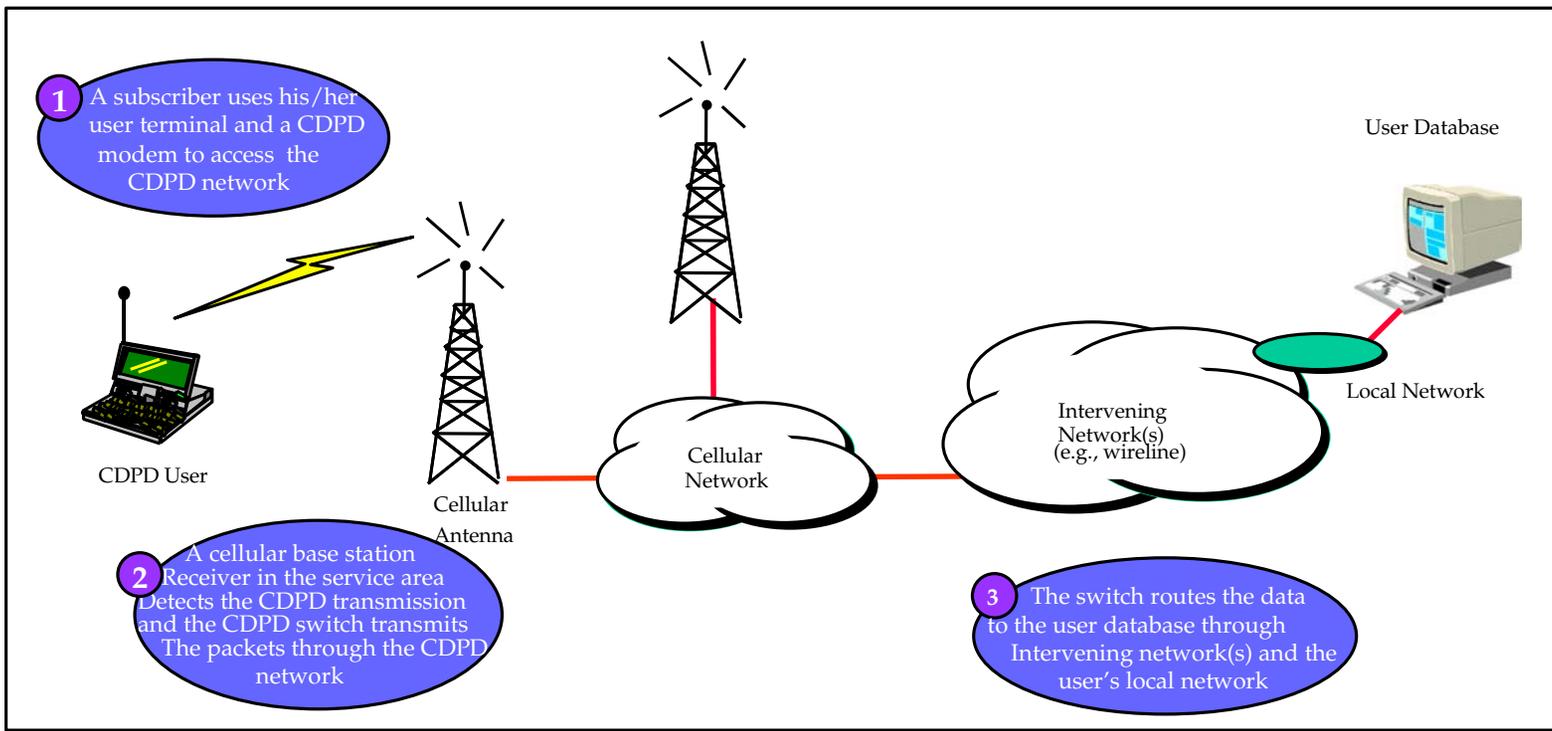
- Many types of user equipment are available for field personnel to access data in a mobile environment. Depending on the specific operational requirements, a specific type of unit can be chosen, either as a mobile unit (automobile equipped) or as a portable unit (handheld device). This section then also discusses the following technologies, as they relate to CDPD, paging, and GPS:
 - Mobile Data Terminals (MDT) and Mobile Data Computers (MDC)
 - Additional Equipment and Interfaces
 - Software
 - Handheld Devices

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Commercial Wireless Data Services...CDPD Services...Characteristics...Network Perspective...

SHOWN BELOW IS AN EXAMPLE OF A CDPD NETWORK FROM THE END USER TO THE OFFICE

- Data packets travel wirelessly from the user's MDT or MDC to a nearby cellular site, where they enter the CDPD network
- From the base station, the CDPD switch routes the packets based on the header routing information contained within the packet, directing the data to the user's local network or to any other targeted destination
- Information sent to the user would generally be routed through the same path, but in the reverse direction



Draft—Do Not Quote or Cite

Commercial Wireless Data Services...CDPD Services...Characteristics...Availability and Coverage...

CDPD SERVICE COVERS A LARGE PORTION OF METROPOLITAN AREAS IN THE CONTINENTAL UNITED STATES, ALTHOUGH SUBSCRIBERS MAY EXPERIENCE SERVICE GAPS

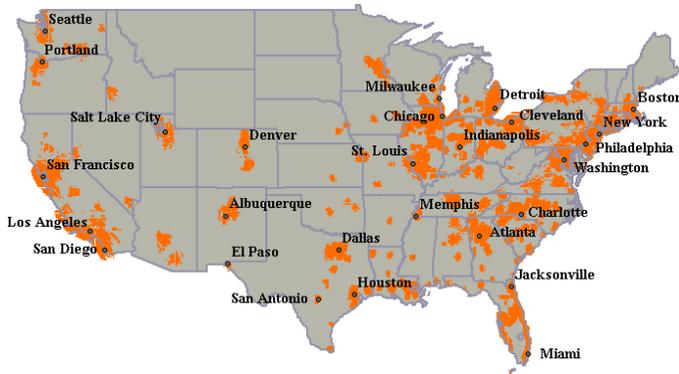
- Coverage, or a subscriber's home area, can be provided in a local, metropolitan, or nationwide setting, depending on the service provider. Service providers may not provide coverage in rural areas away from major roadways because of low population density and hence low potential revenue
- Coverage gaps may exist within the network for many reasons
 - Natural and manmade obstacles, such as terrain or buildings can weaken or block signals
 - Users of other nearby transmitter frequencies, power relays, or other natural occurrences can cause interference
 - As networks and services mature, the occurrence of these coverage gaps may diminish
- The CDPD network currently covers approximately 3,000 cities and 167 major metropolitan areas serving more than 172 million people⁴
- CDPD service providers use roaming agreements to extend their local and metropolitan services to other metropolitan areas outside their region, allowing subscribers to use the service as they change local service areas or travel to different parts of the country

⁴ AT&T Wireless “CDPD Information” <http://www.attws.com/general/our_company/tech/mobility.shtml> August 2001

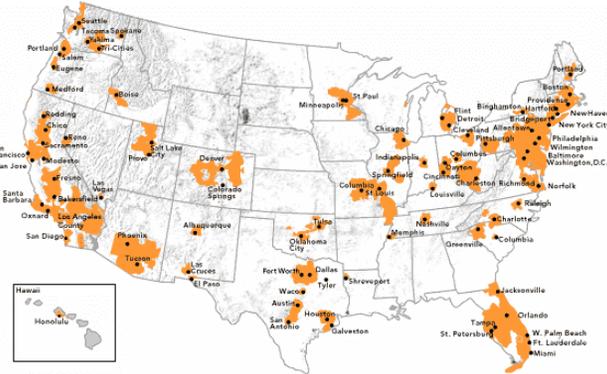
Draft—Do Not Quote or Cite

Commercial Wireless Data Services...CDPD Services...Characteristics...Availability and Coverage...

SHOWN BELOW ARE EXAMPLES OF CDPD COVERAGE IN THE UNITED STATES PROVIDED BY SEVERAL DIFFERENT SERVICE PROVIDERS



- Courtesy of Cingular Wireless, "CDPD Coverage"

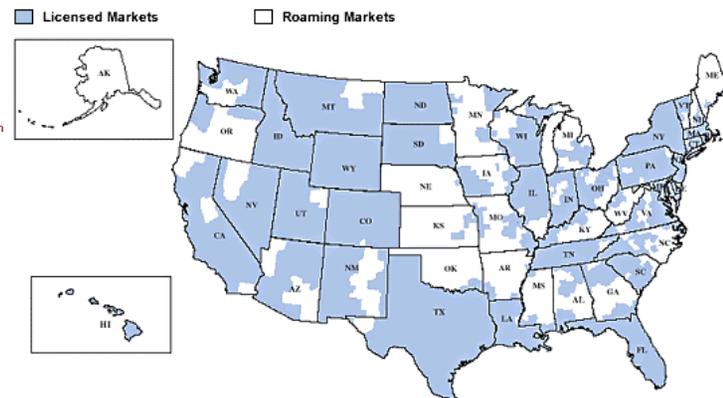


-Courtesy of Omnisky Corporation, "CDPD Coverage"



- Courtesy of Verizon, "Mobile IP / CDPD Service"

Nationwide Licensed Service Areas



- Courtesy of Verizon, "U.S. Nationwide Service Areas"

Draft—Do Not Quote or Cite

Commercial Wireless Data Services...CDPD Services...Characteristics...Mobility...

CERTAIN THRESHOLDS INHIBIT USE OF CDPD SERVICE WHILE TRAVELING IN AUTOMOBILES

- Similar to the technology in cellular systems, packet-switched data systems rely on multiple base stations to maintain a large coverage area. When the user travels through a metropolitan area, he/she may pass through several base station coverage areas, requiring handoff between the CDPD modem and multiple base stations
- To allow a wireless CDPD modem to function properly, the wireless protocols are designed to prevent handoffs and poor signal quality from disabling a link. These protocols include error correction and packet transmission retry functions, and permit longer delays between packet transmission
- Using data services while traveling in automobiles can also invite multipath interference caused by objects such as other cars and trucks. The result can be a received signal that varies greatly in strength over a short period of time, creating a highly variable signal quality and thus ineffective throughput
- CDPD protocols, however, do not eliminate dropped calls and slow transmission rates; these protocols only reduce the unwanted results. The best use of CDPD and other packet data transmission services is in a relatively stationary environment

Draft—Do Not Quote or Cite

Commercial Wireless Data Services...CDPD Services...Characteristics...Reliability...

USERS OF CDPD SYSTEMS SHARE THE AIRWAVES WITH ONE ANOTHER, AND AS WITH MOST WIRELESS SYSTEMS, ISSUES SUCH AS CONGESTION MAY HINDER SYSTEM PERFORMANCE

- Users may experience congestion if there is more demand than the network capacity can handle. Congestion within CDPD networks will cause delays in setting up a connection and transmission of data
- The amount of congestion depends, in part, on the type of CDPD network used
 - Non-dedicated channels take advantage of unused spectrum in cellular systems. CDPD customers receive channels on demand, and users remain in a queue if the system is full
 - Dedicated channels are available to subscribers at a premium cost. This technique dedicates capacity on a portion of the cellular network for CDPD use only. These channels have a guaranteed speed and availability at all times
 - In certain situations, CDPD congestion may be associated with the number of cellular calls. During peak hours or emergencies, when voice traffic on cellular networks tends to increase significantly, the likelihood of CDPD users experiencing congestion may increase significantly
- In the unlikely event of a transmission loss, the network automatically re-transmits and receives the lost message in its entirety. This approach, in conjunction with the use of advanced verification technology, helps create a reliable environment for data transmission

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Commercial Wireless Data Services...CDPD Services...Characteristics...Transmission Speed and Set-Up Times...

THE SPEED OF A CDPD NETWORK IS SLOW COMPARED WITH A STANDARD WIRED OFFICE NETWORK; HOWEVER, VENDORS BUILD APPLICATIONS FOR MOBILE ENVIRONMENT TO USE SMALL FILE SIZES AND A QUICK TRANSFER RATE

- CDPD provides a maximum data rate of 19.2 kilobits per second (kbps). The actual transmission speeds are slower—typically from 10 to 12 kbps
 - The exact transmission speed varies among service providers and is also affected by the level of traffic on the network
 - In general, a 10-kilobyte file, containing 1,500 words or 3 pages of text, takes approximately 15 seconds to transmit
- Call set-up time depends on the routine required to connect to a local base station. The set-up time may range from 1 to 4 seconds, depending on the type of terminal accessing the network and the ability to access the network itself (influence of congestion)
- From the user's point of view, the overall time to transmit data is equal to the call set-up time plus the transmission duration
- Applications used in a mobile environment for equipment such as an MDT, use software geared specifically for users with a slow connection. These types of applications include online forms for writing reports, gray-scale mug shot queries, license plate queries, fingerprint queries, 911 dispatch information, maps, directions, etc. These data transactions usually consist of a page or less of data

Draft—Do Not Quote or Cite

Commercial Wireless Data Services...CDPD Services...Characteristics...Security...

CDPD USES SEVERAL SECURITY FEATURES TO LIMIT UNAUTHORIZED, FRAUDULENT ACCESS AND DATA INTERCEPTION

- CDPD privacy features include automatic identification, authentication and packet transmissions. The packet burst transfer method allows the CDPD system to change channels intermittently. This is the first line of defense against a security breach because the entire set of data is not sent through the same channel
- CDPD also uses a standard form of encryption to protect the information sent over the air. In North America, CDPD encryption is generally applied using a 128-bit private key; it can be as low as 40 bit in other parts of the world
- Several security guidelines exist for users wanting access to federal criminal databases. According to the National Crime Information Center (NCIC), public systems implemented after January 1, 2001, must employ at least 128-bit encryption keys. In addition, all new wireless upgrades to a system implemented after October 30, 2002, must also support a minimum of 128-bit encryption

Draft—Do Not Quote or Cite

Commercial Wireless Data Services...CDPD Services...Characteristics...Sample Costs...

SERVICE PRICING STRUCTURES AND RATES VARY BY CARRIER, THE PARTICULAR PRICING PLAN, AND THE NUMBER OF USERS IN AN AGENCY

- Shown below is an example of a pricing list for CDPD customers. The publicly available list below shows standard pricing. Costs may differ for agencies with many users or special needs

	CDPD Internet Access	CDPD Internet Access (2-year)	CDPD Internet Access Traveler	CDPD Internet Access Traveler (2-year)	CDPD Internet Access for Palms and Handhelds	CDPD Internet Access Traveler for Palms and Handhelds
Contract term	1 year	2 years	1 year	2 years	1 year	1 year
Monthly access fee	\$54.95	\$39.95	\$64.95	\$49.95	\$24.95	\$34.95
Activation fee	\$25	\$25	\$25	\$25	\$25	\$25
Usage inside service provider markets	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited	Unlimited
Usage outside service provider markets	\$0.08/kb	\$0.06/kb	\$0.06/kb	\$0.06/kb	\$0.08/kb	\$0.06/kb

Courtesy of Verizon Wireless Services

	Plan 1	Plan 2	Plan 3	Plan 4	Plan 5	Plan 6
Monthly access fee	\$25.00	\$35.00	\$90.00	\$140.00	\$200.00	\$300.00
Kilobytes included per month	50	200	1,000	3,000	5,000	10,000
Extra kilobyte rate	\$0.20	\$0.10	\$0.07	\$0.04	\$0.03	\$0.02
Activation fee per unit	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00	\$60.00
System access fee	Included	Included	Included	Included	Included	Included
Roaming kilobyte rate	\$0.10	\$0.10	\$0.10	\$0.10	\$0.10	\$0.10

Courtesy of Tellus Mobility

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Commercial Wireless Data Services...CDPD Services...User Equipment...MDT/MDC...

TYPICAL MDTs or MDCs HAVE THE SAME CHARACTERISTICS AND CONFIGURATIONS AS PERSONAL COMPUTERS WITH ADDITIONAL FEATURES SUITED FOR PUBLIC SAFETY USE

- MDTs come in a variety of configurations, but all have the same basic components: a processor, memory, hard drive, power supply, monitor, keyboard (or touch screen), and mouse. Some examples of MDTs are shown below
 - MDTs can also have the acronym MDC, or mobile data computer. For simplicity, all terminals are to be referred to as MDTs in this report
- The MDTs are installed in many different ways, depending on the environment in which they will be used
 - Patrol cars typically have a laptop or desktop configuration
 - » The laptop is an all-in-one, ruggedized unit mounted in the midsection of the front seat. It can provide a user with greater portability outside the patrol car
 - » The desktop configuration can be set up in many different ways. The main processor, memory, hard drive, and power supply can be housed in the glove compartment or the trunk of the vehicle, with a monitor or touch screen, keyboard, and mouse in the center dashboard area
 - Some agencies may need smaller, more portable units. An emergency medical services (EMS) responder, for example, may use a handheld type device outside of a vehicle or in a building



Draft—Do Not Quote or Cite

Wireless Data Services...CDPD Services...User Equipment...Additional Equipment and Interfaces...

A RADIO FREQUENCY (RF) MODEM (CDPD MODEM) CONNECTED TO THE MDT PROVIDES CONNECTIONS TO A CDPD SERVICE

- A CDPD modem is a small unit capable of modulating outgoing digital signals from a MDT or other mobile computer to analog signals for RF transmission. The modem also demodulates any incoming analog signals and converts them to a digital signal for the MDT
 - A modem can be pre-packaged into the device, or it can be purchased separately as an add-on—as a PCMCIA card in a laptop, or as a COM port connection for a desktop
 - Because CDPD modems are based on personal computer standards, brand-name products are not specific to a particular carrier or manufacturer—any CDPD modem should work with any computer

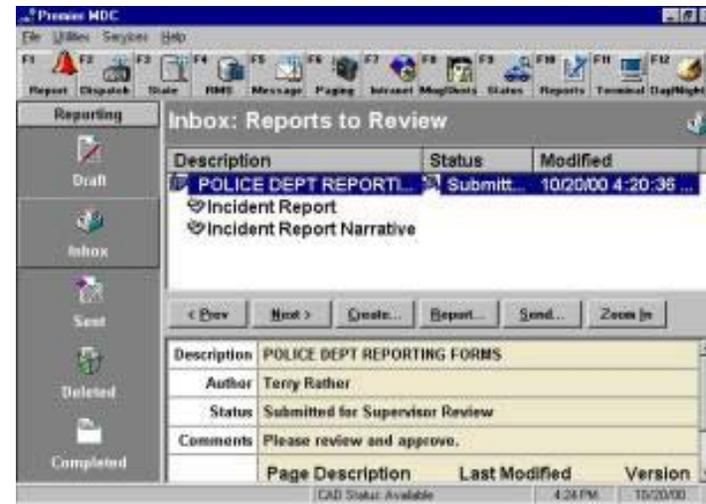
- Additional equipment can be interfaced with a MDT and used to send additional data to the public safety headquarters
 - Monitors—Dashboard-mounted touch-screen monitors have become a helpful addition for public safety use. Because free space in an emergency vehicle is limited, eliminating the keyboard and mouse is an added benefit
 - Digital Cameras—Officers can use digital cameras to send photos or mug shots from the scene of a crime
 - Fingerprint Scanners—Portable fingerprint scanners are available in various sizes for instant criminal checks
 - Printers—Users often need a printers for quick mug shot copies or mapping
 - GPS terminals and antennas—GPS units can be added as mapping accessories, although GPS units can be used separately for computer-aided dispatch (CAD) or automatic vehicle location (AVL) systems
 - Video Cameras—For some advanced uses of an MDT, a full-motion camera can be integrated using the video card and monitor. This equipment is not intended for transmitting data but simply for local viewing and recording. A trunk-mounted videocassette recorder (VCR) records the video, and the tape is later delivered to the public safety agency's headquarters

Draft—Do Not Quote or Cite

Commercial Wireless Data Services...CDPD Services...User Equipment...Software...

TYPICAL MDTs RUN ON THE SAME OPERATING SYSTEMS AND SOFTWARE AS PERSONAL COMPUTERS; HOWEVER, SOME APPLICATIONS FOR MDTs MAY MINIMIZE CDPD DATA TRANSFER THROUGH THE RF LINKS

- Most MDTs normally run the Microsoft Windows operating system software. This permits the user to employ any applications that run under that operating system
 - A Web-enabled browser can use forms designed for specific agencies, which allow users to send in reports as well as additional text and graphics
 - Users can employ query tools to access databases such as the NCIC database or records management systems (RMS), or state databases such as Department of Motor Vehicles (DMV) license plate information
 - Peripherals that normally work under a Windows environment should be able to connect easily to a mobile data terminal, assuming a proper connection to the computer is available. This allows for the integration of a printer, bar reader/scanner, fingerprint reader, etc., with the MDT device
- Shown below are examples of screens that agencies may use in the field



Courtesy of Motorola

Draft—Do Not Quote or Cite

Commercial Wireless Data Services...CDPD Services...User Equipment...PDA Equipment...

OFFICERS OPERATING OUTSIDE OF AN AUTOMOBILE HAVE THE ABILITY TO USE A PERSONAL DIGITAL ASSISTANT (PDA) TO CONNECT TO A CDPD NETWORK

- Using a Palm-type device, an internal CDPD modem, and custom software, an officer can connect to the same network as with MDTs
- This kind of system can include any number of PDAs, a standard commercial CDPD service, and a server network in the public safety headquarters that provides connectivity to all pertinent databases, such as vehicle identification numbers (VIN), registration numbers, and DMV records, NCIC, NLETs, etc.
- A PDA can perform all the basic functions of an MDT, such as form writing, database queries, messaging, and e-mail. It cannot connect to all the peripherals such as fingerprint scanners, printers, video cameras, and bar code readers unless they are built into the PDA itself

Draft—Do Not Quote or Cite

Commercial Wireless Data Services...CDPD Services...Updates and Changes in Technology...

SINCE THE PUBLIC SAFETY WIRELESS NETWORK (PSWN) PROGRAM PUBLISHED THE YEAR 1 CDPD REPORT, THERE HAVE BEEN SEVERAL CHANGES AND IMPROVEMENTS IN CDPD TECHNOLOGY

- In recent years, providers have installed many base stations throughout the United States to supply a larger base of customers and a higher capacity, thus increasing coverage and quality of service
- CDPD mobility has improved in recent years. Many service providers have merged into one corporation to provide larger home coverage areas. Other service providers have made mutual agreements for roaming to other home areas. These mergers and agreements have made it more convenient to access services while traveling from city to city
- User equipment size, speed, and reliability have improved in recent years. The improved user equipment is able to serve agencies with immediate needs, usually in small working space

Draft—Do Not Quote or Cite

Commercial Wireless Data Services...CDPD Services...User Checklists...

PUBLIC SAFETY AGENCIES SHOULD USE THE FOLLOWING USER CHECKLIST TO DETERMINE WHETHER THEY SHOULD SUBSCRIBE TO A PARTICULAR CDPD SERVICE

- The checklist below will assist system administrators or radio managers in investigating a CDPD lease. Agencies should use this checklist only as a preliminary guideline for covering the most important services

<u>CDPD CHECKLIST</u>	
<input checked="" type="checkbox"/>	Do I need a mobile data service?
<input checked="" type="checkbox"/>	Where do I need mobile data services? Locally? Regionally? Nationally?
<input checked="" type="checkbox"/>	What data services are available to meet my needs? Will this work in my current operational environment?
<input checked="" type="checkbox"/>	Will it support mission-critical requirements?
<input checked="" type="checkbox"/>	What is the coverage of the carrier's CDPD network?
<input checked="" type="checkbox"/>	Do known coverage gaps exist? Where?
<input checked="" type="checkbox"/>	Will the provider address my coverage gaps in areas where I know I will need CDPD services?
<input checked="" type="checkbox"/>	Are there regional or nationwide roaming agreements? With whom?
<input checked="" type="checkbox"/>	Is the provider's network a dedicated or a channel-hopping network?
<input checked="" type="checkbox"/>	What is the average transmission speed?
<input checked="" type="checkbox"/>	What maximum delay in accessing the network will the carrier guarantee?
<input checked="" type="checkbox"/>	What type of service and pricing plans are offered?
<input checked="" type="checkbox"/>	How do the service plans rate against my needs?
<input checked="" type="checkbox"/>	Are volume discounts or flat-rate pricing plans available?

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Commercial Wireless Data Services ...Paging...Introduction...

PUBLIC SAFETY AGENCIES THROUGHOUT THE UNITED STATES USE COMMERCIAL PAGING SERVICES TO SUPPLEMENT THEIR LAND MOBILE RADIO (LMR) SYSTEMS

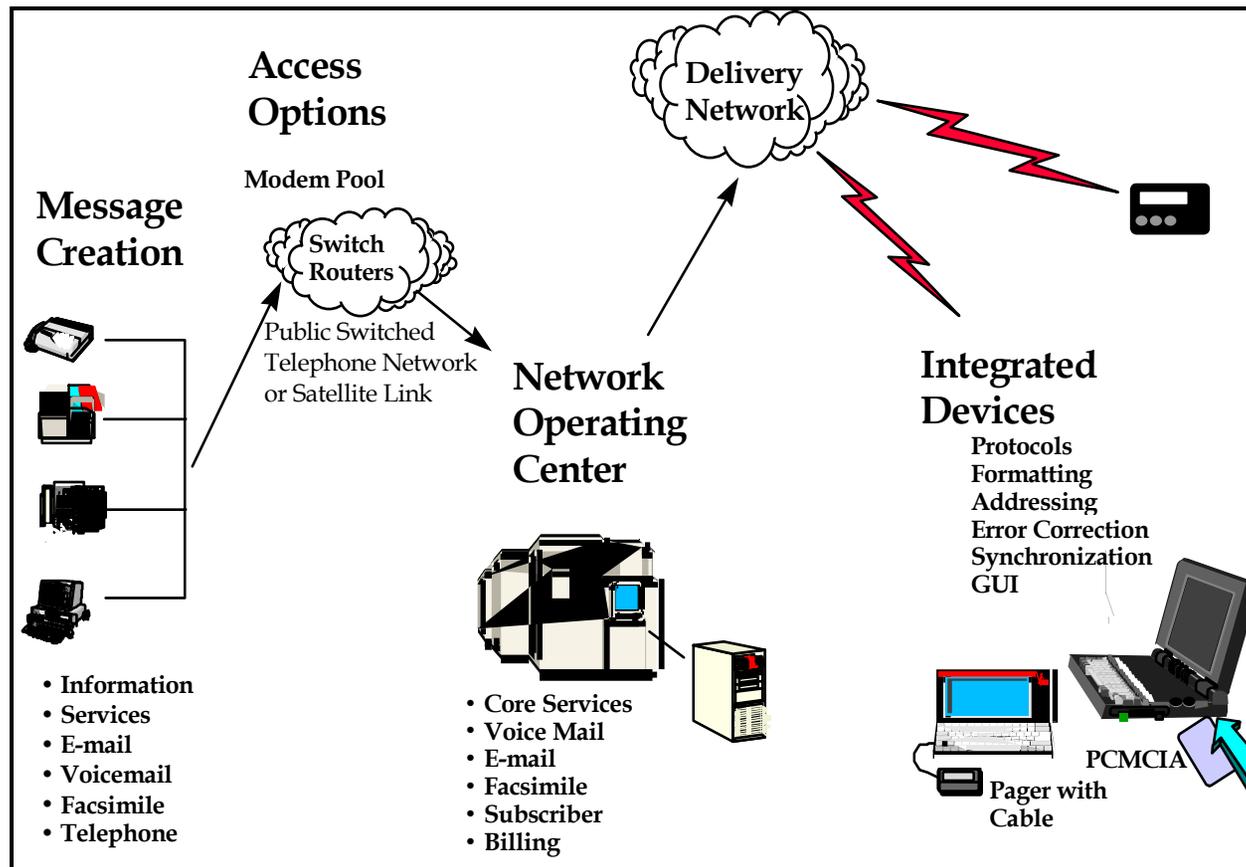
- A pager is a small telecommunications device that receives (and, in some cases, transmits) alert signals and/or brief messages
 - Depending on the type of the service, the message may be a numeric message, an alphanumeric message, or a voice message
 - Paging systems typically notify a subscriber of the need to call a particular telephone number or travel to a known location to receive further instructions
 - Modern paging systems may also include capabilities to deliver news headlines, stock quotations, and faxes
 - The caller normally sends a message to a paging subscriber by calling a paging system access number (usually a toll-free number) using a telephone keypad or modem
- Paging systems vary widely in complexity and coverage area
 - Paging systems may cover a limited range of 2 to 5 kilometers (km) or may even be confined to within individual buildings. Wide area paging systems can provide worldwide coverage
 - Although paging receivers are usually simple and inexpensive, the required transmission system is quite sophisticated
 - Wide area paging systems consist of a network of telephone lines, many base station transmitters, and large radio towers that simultaneously broadcast a page from each base station (known as simulcasting). Simulcast transmitters may be located within the same service area or in different cities or countries
 - Paging systems are generally designed to provide reliable communication to subscribers wherever they are—in a building, driving on a highway, or in the air. This ubiquitous service necessitates large transmit power (on the order of kilowatts) and low data sizes
- Pagers are convenient for agency personnel who expect telephone calls, but who are not near a wireline or cellular telephone, or are in an off-duty environment
- Pagers also provide on-call officers with the added convenience of not having to carry a two-way portable radio at all times

Draft—Do Not Quote or Cite

Commercial Wireless Data Services ...Paging...Network Perspective...

PAGING SYSTEMS ARE WIRELESS DATA NETWORKS COMPOSED OF HIGH-POWER TRANSMITTER SITES WITH LARGE COVERAGE FOOTPRINTS

- Wide area paging networks generally consist of a network operating center connected to a paging terminal through a landline or satellite link as shown below



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Commercial Wireless Data Services ...Paging...Network Perspective...

TWO-WAY TEXT PAGING INCLUDES SEVERAL FORMS OF ADVANCED PAGING

- Introduced in 1995, two-way text paging was initially created to allow subscribers to send acknowledgements of pages received, as well as the ability to respond with one of a selection of preset responses. Pagers such as these are still available in certain locations
- A more recently created two-way instant messenger allows the user to create and send short messages using the keyboard embedded in the subscriber unit
- Additionally, two-way paging capabilities have been included in mobile telephones. Mobile telephone two-way messaging, however, uses the same infrastructure as voice communications. The service provider's specific design architecture designates what paths a message will travel. If a system planner decides to this kind of system, it is important to know what the messaging options are, such as Internet messaging, mobile-to-mobile messaging, or mobile-to-two-way pager messaging
 - Internet messaging essentially relays messages from a pager, through the paging wireless link, to the Internet, and on to the intended recipient
 - Mobile-to-mobile messaging relays messages from mobile telephone to mobile telephone in the same route as that of mobile telephone voice communications
 - Mobile-to-two-way pager messaging resembles mobile-to-mobile messaging, except a two-way pager replaces one of the mobile telephones

Draft—Do Not Quote or Cite

Commercial Wireless Data Services...Paging...Characteristics...

AGENCIES SHOULD EXAMINE KEY PARAMETERS IMPORTANT TO THE PUBLIC SAFETY COMMUNITY WHEN ANALYZING THE ABILITY OF PAGING SERVICES TO SUPPORT THEIR MISSION. * THESE PARAMETERS MAY INCLUDE THE FOLLOWING

- Hardware
- Coverage
- Connectivity
- Cost

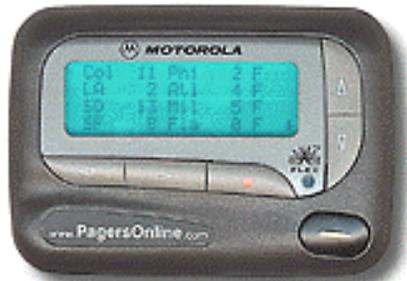
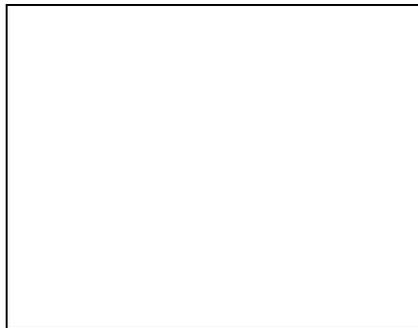
**The Public Safety Wireless Network Paging Services Report (July 1997) provides an in-depth explanation of service characteristics*

Draft—Do Not Quote or Cite

Commercial Wireless Data Services...Paging...Characteristics...Hardware...

CURRENTLY THE PUBLIC SAFETY COMMUNITY MAINLY USES THREE TYPES OF PAGERS

- One-way numeric pagers—This type of pager displays the phone number of a person or agency requesting a return call
- One-way alphanumeric pagers—This type of pager displays a short message from the sending person, agency, or dispatch service about any news, emergencies, or telephone numbers to call
- Two-way text pagers—These pagers have a built-in, miniature keyboard and a LCD screen that can display several lines of text and/or simple graphics. These pagers allow the user to communicate in a near-real-time environment with another user, or they can also act as alphanumeric pagers^{5,6}



⁵ www.pageronline.com

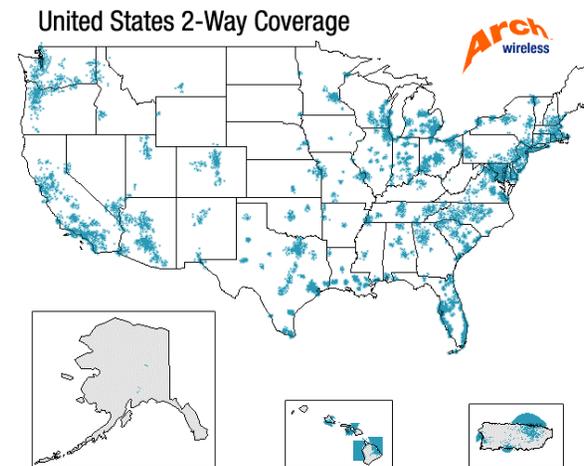
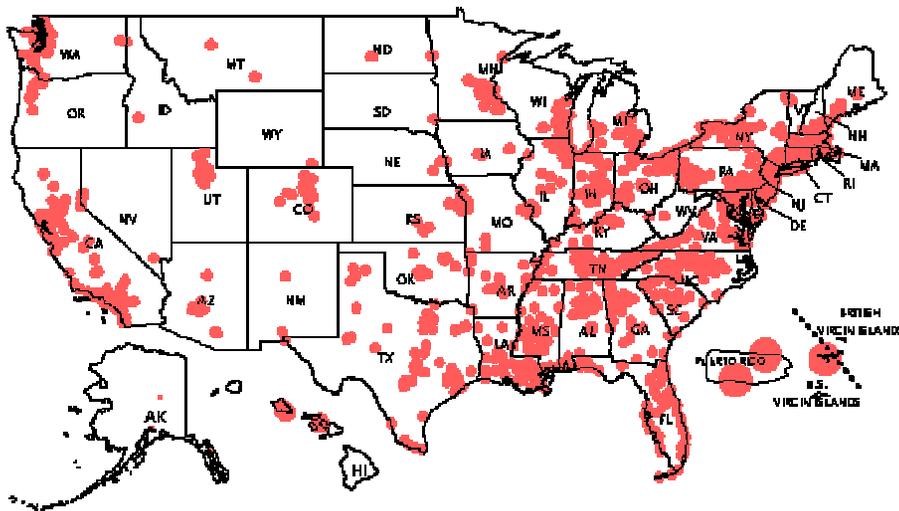
⁶ Blackberry Corporation <<http://www.rim.com/products/handhelds.shtml>>

Draft—Do Not Quote or Cite

Commercial Wireless Data Services...Paging...Characteristics...Coverage...

PAGER COVERAGE AREAS, ALTHOUGH DEPENDENT UPON THE SPECIFIC CARRIER, INCLUDE A LARGE PORTION OF THE UNITED STATES

- Most paging service providers operate in the 900 MHz frequency band. This higher frequency band provides in-building penetration similar to that offered by the 800 MHz public safety radio systems. However, some paging vendors still operate at the lower frequencies. The Federal Communications Commission (FCC) lists several networks operating in the low and high very high frequency (VHF) bands and the 450 MHz ultra high frequency (UHF) band
- Two-way pagers transmit at a significantly lower power when sending reply messages via the “reply channel.” In order for the return channel to mirror the outbound footprint, providers must use multiple receivers strategically located within the outbound transmitter’s footprint. Two-way pager coverage is typically limited to a 5-mile radius
- Shown below are examples of one-way and two-way paging coverage maps*



Because wireless services use radio transmission waves, various factors can affect signal strength in an area. These may include locations within a building, topography, weather and other environmental conditions. Therefore your actual coverage may vary from the detailed coverage illustrated on the map.

*Coverage maps courtesy of Arch Wireless

Draft—Do Not Quote or Cite

Commercial Wireless Data Services...Paging...Characteristics...Connectivity...

THE FOLLOWING ARE THE MOST POPULAR METHODS FOR SENDING A MESSAGE TO A PAGER USER; HOWEVER, ALL VENDORS MAY NOT OFFER ALL THESE METHODS

- Internet—A user can send a text message through a Web browser from anywhere in the world. The Web message travels through the Internet to a paging dispatch center and on, wirelessly, through to the recipient
- Telephone—A sender can call a paging number and dial a return number using a touch-tone key pad for the recipient to call
- Telephone message—A telephone message can be recorded and typed back to the pager unit through a paging dispatch center, which interprets the message
- Group messages—A dispatch unit can send a message to alert predetermined subscribers simultaneously

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Commercial Wireless Data Services...Paging...Characteristics...Cost...

PAGERS CONTINUE TO PROVIDE ONE OF THE MOST INEXPENSIVE WAYS TO RECEIVE EFFICIENT DATA COMMUNICATIONS

- The following are several examples of individual pager costs
 - Numeric pagers are the least expensive, with costs ranging from approximately \$20 to \$30
 - Alphanumeric pagers range in cost from approximately \$40 to \$80, depending on hardware enhancement options. Some hardware enhancements include—
 - » Increased memory for more message storage space
 - » Backlit displays
 - » Text zooming capabilities
 - Two-way pager costs range from \$170 to \$500
 - Two-way pagers vary greatly with regard to their hardware elements. These elements may include—
 - » Display features
 - » Indicators and alert functions
 - » Memory
 - » Messaging features
 - » Productivity suite application
 - » Personal control features
- Service providers may also offer special package deals for public safety agencies, which may result in a lower average cost per user

Draft—Do Not Quote or Cite

Commercial Wireless Data Services...GPS...Introduction...

THE GPS IS A SATELLITE-BASED NAVIGATION SERVICE THAT PROVIDES USERS WITH PRECISE POSITION, VELOCITY, HEADING, AND ELEVATION DATA USING GPS RECEIVER EQUIPMENT

- GPS can be a helpful tool in assisting public safety agencies with many command and control tasks. When GPS technology is combined with dispatch center communications equipment such as computer-aided dispatch (more specifically AVL), GPS can enable agencies to view in real time the fleet of mobile personnel in the field. It is important to have an understanding of GPS to imagine the full potential of the technology
- Originally called Navstar, GPS was developed by the DoD for use in guiding missiles, ships, and aircraft to their targets
- Today, a wide variety of industries use GPS, including transportation, aviation, civil engineering and construction, sport and recreation, and mobile telephone networks. GPS has become successful because it provides a direct readout of the present position of a GPS receiver with an accuracy of approximately 10 meters (m). Other position location systems, such as Long Range Navigation (LORAN) can also provide direct readout of position, but not with the accuracy and reliability of GPS
- GPS has many tiers of uses, ranging from a single stand-alone user acquiring one unit's position data to a fleet of users charting many receivers on the Earth in a real-time setting

Draft—Do Not Quote or Cite

Commercial Wireless Data Services...GPS...Network Perspective...

GPS IS A SOPHISTICATED NETWORK OF SATELLITES AND GROUND STATIONS OPERATED CONTINUOUSLY AND SEAMLESSLY, AT MANY LOCATIONS ON THE GLOBE

- The DoD controls and owns the 24 satellites circumnavigating the globe in a medium Earth orbit (MEO)
 - GPS is designed for an unlimited number of receivers. A receiver needs only four satellites in a line-of-sight (LOS) area to locate itself. Up to 10 satellites may be visible at some times, and more than 4 satellites are visible nearly all of the time
 - In 2000, 30 GPS satellites were actually in orbit, some of which were spares. Because GPS is an integral part of the U.S. satellite-based defense systems, spare satellites are kept in orbit, and more are ready for immediate launch
 - The satellites weigh 4,138 pounds at launch and have a lifetime of 10 years
 - » The satellites operate at a nominal altitude of 12,552 miles, with an orbital inclination of 55 degrees
 - » The satellites are clustered in groups of four, called constellations, with each constellation separated by 60 degrees in longitude
 - The orbital period is approximately 11 hours and 58 minutes, so the same satellites appear in the same position in the sky twice each day
- The U.S. Air Force operates the GPS from the Master Control Station (MCS) at Falcon Air Force Base in Colorado Springs, Colorado
 - The MCS, and a series of four subsidiary control stations around the globe, continuously monitor all GPS satellites as they come into view
 - The MCS and the other stations calculate celestial coordinate data for each satellite, atomic clock error, and other parameters needed for the navigation message
 - Data is then transmitted to the satellite using a secure S-band link to update onboard data
- The four subsidiary control stations (in addition to the MCS) are located in Hawaii, Ascension Island in the Atlantic Ocean, Diego Garcia in the Indian Ocean, and the Kwajalein Atoll in the Pacific Ocean
 - The monitor stations have precise cesium time standards and make continuous measurements of range to all visible satellites
 - Measurements are conducted every 1.5 seconds to provide updates to the navigation messages

Draft—Do Not Quote or Cite

Commercial Wireless Data Services...GPS...Network Perspective...

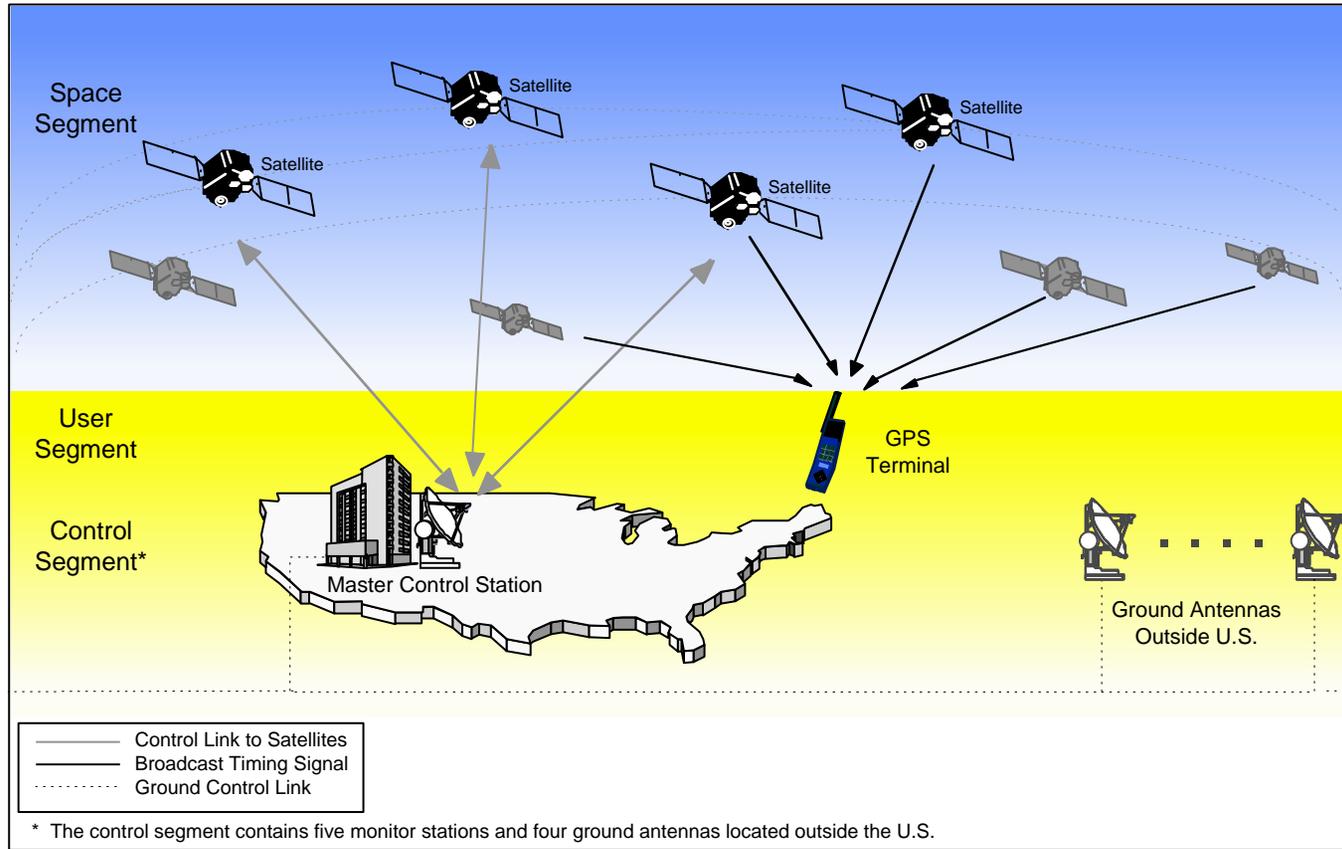
GPS REAL-TIME POSITIONING IS ACCOMPLISHED USING TRILATERATION, ONE OF THE SIMPLEST AND MOST ACCURATE METHODS OF LOCATING AN UNKNOWN POSITION

- Trilateration measures the distance of an unknown point from three known points
 - The intersection of arcs corresponding to three distances defines the unknown point relative to the known points because three measurements can be used to solve three equations to give the latitude, longitude, and elevation of the receiver
 - The distance between a transmitter and a receiver can be computed by measuring the time it takes for a pulse of RF energy to travel between them
 - » The distance an electromagnetic wave travels is assumed to be equal to the velocity of light, which is 3×10^8 meters per second
 - » Time can be measured most precisely by using atomic clocks. Using this capability, GPS can achieve a measurement accuracy of 3.28 feet in a distance of 12,427 miles
 - » To achieve a position location accuracy of 3.28 feet, timing measurements must have accuracy better than 3 nanoseconds (ns), which is possible with modern digital circuitry
- A GPS receiver contains a clock synchronized, in turn, to the clock on each satellite from which it is receiving
 - The receiver simply measures the time delay of the arrival of the bit sequence, which is proportional to the distance between the satellite and the GPS receiver
 - Once the distance of a GPS receiver from the three satellites is known, the only remaining information required is the position of each satellite. This location is calculated in the receiver using celestial coordinate data for the satellite orbits that is broadcast from each respective satellite in its navigation message
 - Because the start time at which each bit sequence was transmitted is known at the receiver, the position of the satellite at that time can be calculated from its orbital data
 - Making the calculation for four satellites provides the receiver with sufficient information to determine its position with a very high accuracy
 - » Four satellites, rather than three, are needed because the clock in the receiver is not inherently accurate enough
 - » The fourth distance measurement provides information from which clock errors in the receiver can be corrected and the receiver clock synchronized to GPS time with an accuracy better than 100 ns

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Commercial Wireless Data Services...GPS...Network Perspective...

THE FOLLOWING DIAGRAMS DEPICT VIEWS OF THE GPS ABOVE THE EARTH (CONT'D)



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Commercial Wireless Data Services...GPS...Characteristics...Introduction...

THE FOLLOWING SECTION ANALYZES KEY PARAMETERS OF GPS SERVICES TO ASSESS THEIR ABILITY TO SUPPORT PUBLIC SAFETY MISSIONS

- Service Characteristics
 - Types of Services and Costs—describes access to civilian grade or military grade (now available to anyone) location information accuracy at any given time. Costs are given in terms of the equipment needed for connection to the satellite signals
 - Coverage and Reliability—illustrates the type of environment needed to view the satellites effectively and how susceptible the system is to an outage
 - Time and Navigation Synchronization—explains the accuracy of the atomic clocks and how they are used to effectively calculate a user's position information on the ground
 - Security—clarifies security issues relative to communications between a user terminal and GPS satellites
- User Equipment
 - Receivers—lists the different types of receiver technology
 - Products—explains the types of equipment available for purchase among the receiver technologies and how they can be connected to a user's dispatch center
 - Costs—explains the associated, per-user, costs

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Commercial Wireless Data Services...GPS...Characteristics...Types of Services and Costs...

GPS PROVIDES TWO CATEGORIES OF SERVICE: PRECISE POSITIONING SERVICE (PPS) AND STANDARD POSITIONING SERVICE (SPS)

- GPS satellites transmit two signals at different frequencies known as L1 and L2
 - The L2 signal is modulated with a 10.23 megabit per second (Mbps) Pseudorandom Noise (PN) bit sequence called the Precise (P) code, which is used by military positioning systems. The P code is transmitted in an encrypted form known as the Y code, which restricts the use of the P code to authorized users
 - The L1 frequency carrier is modulated by a 1.023 Mbps PN sequence called the Coarse Acquisition (C/A) code, which is available for public use. The C/A code also carries the P code as a quadrature modulation, although the higher bit rate of the P code provides better measurement accuracy than the C/A code
 - GPS units using the secure Y code require the C/A code as an intermediate step in making high-accuracy distance measurements
 - Until May 2000, the accuracy of a receiver using the C/A code was deliberately degraded using a process known as selective availability (SA). SA caused variations in the C/A code satellite transmissions that resulted in less than accurate calculation of position. Although use of SA has been discontinued, it could be reinstated if the President of the United States declared a national emergency
- PPS receivers track both P code and C/A code on L1 and L2 frequencies. PPS is used mainly by military users, because the P code is encrypted into the Y code before transmission and requires decryption equipment in the receiver
- SPS receivers track the C/A code on L1, which is used by the general public. The P(Y) and C/A codes transmitted by each satellite create Direct Sequence Spread Spectrum (DSSS) signals that occupy the same frequency bands
 - Both the C/A codes and the P codes are publicly available, but the P code cannot be recovered in a GPS receiver without knowledge of the Y code decryption algorithm
- Unlike other commercial services, receipt of GPS signals is free. GPS users do, however, incur costs associated with the initial purchase of the equipment

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Commercial Wireless Data Services...GPS...Characteristics...Coverage and Reliability...

GPS IS AVAILABLE AT ALL TIMES TO ANYONE IN THE WORLD BECAUSE 4 OR MORE OF THE 24 SATELLITES ARE IN A CONSTANT LINE OF SIGHT AT ANY POINT ON THE GLOBE

- GPS coverage is available for use in any environment that has a clear view of the sky
 - GPS receivers must have a direct LOS view with at least four satellites to function properly
 - Positioning information could be difficult to obtain when the receiver is in a dense urban high-rise environment, thick vegetation, deep within canyons, next to mountains, or inside buildings
- GPS system components, i.e., satellites, ground control stations, and user receivers, are susceptible to rare service interruptions
 - Receivers share the network infrastructure when making position determinations; however, unlike other commercial wireless data services, GPS is not a duplex service. Satellites only transmit information and do not receive signals from user terminals. Thus, when considering reliability, user congestion is not an issue as it is with other wireless devices, such as cellular telephony
 - GPS satellites, however, are susceptible to system-level service outages. Although rare, when a satellite malfunctions, a user terminal may have to wait for an operational satellite to move into position overhead before calculating its position precisely again. Satellite outages may affect some GPS terminals more than others
 - » Specifically, service outages will affect older single processing terminals more than parallel multichannel terminals
 - » Parallel multichannel terminals can scan up to 12 satellites, simultaneously reducing the vulnerability to satellite outages
 - Astronomical occurrences are also possible. Because satellites are not under Earth's protective atmosphere, they are more vulnerable to the Sun's solar flares or damaging debris in orbit around the Earth

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Commercial Wireless Data Services...GPS...Characteristics...Time and Navigation Synchronization...

GPS TERMINALS, COMBINING BOTH INTERNAL TIMING AND SATELLITE TIMING, PROVIDE A SOPHISTICATED METHOD FOR CALCULATING POSITION AND VELOCITY

- GPS satellites carry four atomic clocks that are calibrated against time standards in the GPS control stations around the world, the result being GPS Time. This time standard is available in every GPS satellite
- The accuracy of an atomic clock is approximately 1 part in 100 billion. This accuracy provides ground users with the ability to calculate their position with extreme accuracy, based on the differences in time of the satellites. Essentially, the user's receiver performs a triangulation calculation in relation to the positions of the four or more satellites viewed from Earth
- An average receiver would not include an atomic clock because of the cost and size, but a standard crystal oscillator is built into a receiver with an accuracy of approximately 1 in 10,000. This oscillator gives a receiver the ability to retune its clock to the GPS time without an effect on calculating position
- The receiver clock is allowed to have an offset relative to GPS time, so when a time delay measurement is made, the measurement will have an error caused by the clock offset
- To minimize this error, C/A code receivers can synchronize their internal GPS time within 170 ns of the original signal, which corresponds to a distance measurement accuracy of 50 m
- Repeated measurements and time averaging improve this position location error to well below 50 m

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Commercial Wireless Data Services ...GPS...Characteristics...Security...

GPS POSITION AND VELOCITY IDENTIFICATION PROCESSES POSE NO THREAT TO A USER'S SECURITY BECAUSE OF THE SIMPLEX TRANSMISSION OF INFORMATION

- Because user terminals do not transmit any data to a satellite, a user's privacy is completely ensured
- GPS signals are transmitted without any specific recipient and can be received by any user with a GPS terminal
- Any position or location information originating from a GPS receiver could be intercepted once that information was sent outside the initial set of GPS components, such as to an AVL
- Ultimately, the security of any GPS information sent beyond the GPS receiver becomes the responsibility of the user's security built around the equipment using the specific GPS location information

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Commercial Wireless Data Services...GPS...User Equipment...Receivers...

THERE ARE THREE MAIN TYPES OF GPS RECEIVERS: SINGLE-PROCESSING, PARALLEL-PROCESSING, AND DIFFERENTIAL GPS (DGPS) PROCESSING UNITS

- Single processing refers to a handset's ability to process only a single GPS satellite's transmission at a time. Thus, these receivers scan sequentially through all possible satellites and risk losing a signal lock as they switch channels. This slows down the positioning process and drastically limits accuracy
- Parallel processing enables a receiver to track 4 to 12 satellites at once. Parallel processing receivers also have the capability to track both the L1 and L2 signals for a satellite at the same time for greater accuracy. A standard parallel processing unit is 12 channels, tracking only 1 channel per satellite at a time
- Using terrestrial base stations, DGPS tracks the GPS satellite signals and then compares and averages the location signals with a stationary signal nearby on the ground. This equipment is primarily used for surveying in civil engineering scenarios

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Commercial Wireless Data Services...GPS...User Equipment...Products...

GPS TERMINALS COME IN A VARIETY OF PACKAGES—SELF SUSTAINING, SELF SUSTAINING WITH ADVANCED FEATURES, AND INTERFACED WITH OTHER EQUIPMENT

- A self-sustaining GPS terminal, or a handheld device, is useful in applications such as outdoor sporting events or for site surveying purposes. Public safety could potentially use this type of device for recording crime scene locations
- Advanced handheld devices may have features such as larger screens displaying detailed maps and other terrestrial information in addition to the self-sustaining features of a normal handheld unit. These devices may also have data output terminals to interface with a personal computer (PC) or palm device
- In-vehicle GPS terminals are used primarily for navigation on streets. In-car units are very user friendly with easy-to-operate functions and can have voice-activated controls
- GPS antennas can be connected to a PC for integration with mapping software, or an antenna could be used to connect to AVL services as shown below in the photograph on the right



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Commercial Wireless Data Services...GPS...User Equipment...Cost...

THERE IS A WIDE RANGE OF COSTS ASSOCIATED WITH GPS EQUIPMENT

- Handheld receivers can range from \$100 to approximately \$500. The complexity of the individual unit determines the price. Many factors, such as the number of tracked channels, mapping software, data output, screen size, and ruggedness, can influence the cost
- Vehicle-mounted units can cost as much as \$2,000
- GPS antennas suited for use with PCs or integrated devices can cost between \$150 and \$400
- Prices may be different when purchased through a government supplier

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Commercial Wireless Data Services...GPS...Updates and Changes in Technology...

IN RECENT YEARS, SEVRAL ADVANCES IN PRODUCTS AND SERVICES HAVE IMPROVED THE OVERALL RELIABILITY, COST EFFECTIVENESS, AND USEFULNESS OF GPS

- User equipment has recently improved due to semiconductor technology, storage space, and RF receivers
 - Typical GPS units now have 12 to 16 channels built in to continuously monitor all available satellites in range
 - Improved receivers also have a greater sensitivity to a GPS signal, which allows greater reception under a car windshield
 - Reduction in the size of semiconductor chips allows a unit to be constructed in a smaller amount of space, allowing for more storage, such as ground maps, points of interest, and other similar databases
- GPS products have become very popular throughout the world for many uses. With that, the market has decreased the cost for all types of units. In the future, more products will likely use GPS, resulting in an even more consumer-friendly price
- DoD has released a new standard, which will become available for use in 2003, with full completion in 2014. The standard will improve horizontal accuracy and add a new baseline transmission protocol that circumvents ionic interference. Current uses of the GPS are not expected to require an upgrade. Readers can find the full standard at the Web site: <http://www.navcen.uscg.gov/gps/geninfo/2001SPSPPerformanceStandardFINAL.pdf>
- The FCC has instructed mobile telephone manufacturers to install location-finding devices within mobile telephones or mobile telephone infrastructures by October 31, 2001. This technology will enable public safety agencies to locate any mobile telephone user in the United States
 - This technology is possible because of the atomic clock accuracy of the GPS. As GPS relays the time signal to Earth, a telephone or a base station will use the time signal to home in on a mobile user within seconds
 - Location-finding technology will also be helpful outside of public safety emergencies. Mobile telephones may soon allow users to find their location and get directions to a desired destination

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Commercial Wireless Data Services...GPS...User Considerations...

BEFORE ACQUIRING GPS SERVICES, POTENTIAL USERS SHOULD USE THE LIST SHOWN BELOW TO ASSIST IN DETERMINING WHETHER GPS MEETS THEIR AGENCY'S NEEDS

- Like all evolving technologies, there are benefits and limitations of using the GPS service, so it is important to identify all the operational requirements related to this service before selecting an appropriate GPS terminal for each individual

<u>GPS CHECKLIST</u>	
<input checked="" type="checkbox"/>	Do I need GPS service?
<input checked="" type="checkbox"/>	Where do I need GPS service? Locally? Regionally? Nationally?
<input checked="" type="checkbox"/>	Will GPS work in my operational environment?
<input checked="" type="checkbox"/>	How much does the terminal cost?
<input checked="" type="checkbox"/>	Is the terminal single-channel or multi-channel capable? How many channels can it scan in parallel?
<input checked="" type="checkbox"/>	What accuracy is specified for this terminal?
<input checked="" type="checkbox"/>	What power requirements does the terminal have?
<input checked="" type="checkbox"/>	How much storage capacity is available?
<input checked="" type="checkbox"/>	Are attachments available for in-vehicle use? Can an external antenna be used?
<input checked="" type="checkbox"/>	Can the terminal be used with a personal computer in real-time mode? What additional software is required?
<input checked="" type="checkbox"/>	What additional cables are necessary to link the terminal to a computer?
<input checked="" type="checkbox"/>	What software is preprogrammed into the terminal?
<input checked="" type="checkbox"/>	What internal mapping features or Geographic Information System capabilities does the terminal have?
<input checked="" type="checkbox"/>	Is additional hardware or software required to use DGPS with this terminal?
<input checked="" type="checkbox"/>	What type of service and pricing plans does the DGPS provider offer?
<input checked="" type="checkbox"/>	What is the coverage area of the DGPS service provider?

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**VII. PUBLIC SAFETY WIRELESS DATA SYSTEM
EXAMPLE—COMPUTER AIDED DISPATCH**

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Computer-Aided Dispatch...Introduction...

COMPUTER AIDED DISPATCH (CAD) SYSTEMS COMBINE DIFFERENT COMMERCIAL SERVICE TECHNOLOGIES AND AGENCY-OWNED RADIO INFRASTRUCTURE WITH A VAST ASSORTMENT OF TOOLS TO IMPROVE PUBLIC SAFETY'S MISSION PERFORMANCE

- CAD is a management software tool that automates and refines dispatching functions. It allows for quick and accurate incident entry, provides access to information such as databases, and fosters two-way communications between the dispatcher and mobile units. CAD enables a dispatch center to integrate all communications and information processing into one system
- Although the CAD technologies described in this section are proprietary in nature, it is important to detail their functionality because several of the commercial services discussed in this report, such as mobile data and AVL, are routinely interfaced with CAD systems
- For public safety communications, CAD provides the ability to dispatch law enforcement, fire, and emergency medical services (EMS) units from one central computer, allowing dispatchers to coordinate public safety responses and activities
- CAD also integrates interactive mapping capabilities to allow dispatchers to use geographic representation to help the dispatcher locate emergencies and incident scenes. Specifically, CAD systems functionality includes—
 - Displaying pending calls, active calls, and active units
 - Tracking the location of response vehicles
 - Helping dispatchers determine the best resources to dispatch based on vehicle location and status

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Computer-Aided Dispatch...Capabilities...

TYPICAL CAD SYSTEMS PROVIDE SEVERAL CAPABILITIES THAT SUPPORT A DISPATCHER'S WORK AND CAN BE TAILORED TO A SPECIFIC OPERATIONAL NEED

- Graphical User Interface (GUI)—A GUI is a Windows-based graphical application software tool that supports easy selection among different processing functions. CAD provides similar functionality as is provided in many personal computer (PC) applications. A GUI features pull-down menus, transaction icons, and hot keys to eliminate unnecessary keystrokes, and offers flexibility in screen presentation. Organizations can customize displays and features to enhance their specific operational needs
- Records Management System (RMS)—These systems are typically configured with CAD systems to provide fast and easy access to historical and recent information. They provide relational database capabilities that allow users to store historical data, interrelate data, and conduct data searches. Both the CAD operator and mobile units can easily access and retrieve information from the RMS via wireless links to the CAD
- Mapping—CAD systems can include a mapping subsystem that displays geographic information, status information and location of E911 incident calls to the dispatcher based on the entered location, or units based on data from an automatic vehicle locator (AVL) system. By viewing a map on the screen that shows current call location, pending calls, and active units, dispatchers can access incident information and identify which units should be dispatched to the scene. Mapping systems are commonly referred to as geographic information systems (GIS) and use commercially available mapping software
- AVL—AVL is a wireless radio technology for tracking vehicles. AVL systems provide a means to electronically locate units and communicate their locations to a control center. The majority of AVL systems use GPS based services to locate and monitor vehicles
- Entry of incident information—Essentially, CAD can collect a database of incident data, including the address, caller information, and details gathered by the dispatcher. The software alerts the dispatcher if a new incident might be related to an incident already entered, based on the proximity of the two incidents

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Computer-Aided Dispatch...Capabilities...

TYPICAL CAD SYSTEMS PROVIDE SEVERAL CAPABILITIES THAT SUPPORT A DISPATCHER'S WORK AND CAN BE TAILORED TO A SPECIFIC OPERATIONAL NEED (CONT'D)

- Display of incident information—Once incident information is entered, the CAD system can display a list of the pending, current, and past incidents at the command of the dispatcher, usually sorted on the screen by date, time, location, type of incident, or other criteria
- Incident dispatch—Incident dispatch allows the dispatcher to link, or assign, an incident to one or more field units. Most CAD software also recommends which units should respond, according to a built-in database of the units' geographic assignments (e.g., beats, districts, precincts, etc.), the type of incident (e.g., high danger, low danger), and type of unit (e.g., patrol, supervisor, canine)
- Unit tracking database—This database tracks field units, their assigned personnel, and what incidents they handled and when. The software can display any combination of units by their status or location. Some programs use a command line to change unit status, while others can perform drag-and-drop status changes
- Time stamping—Whenever a dispatcher takes an action (i.e., enters a new incident, dispatches a unit, learns that unit arrives on-scene, etc.), the computer records that time and links it to the incident and unit records for later review
- Address verification—Most CAD programs have some method of standardizing address entries, usually from a list of the jurisdiction's streets and block ranges, which is called a geofile. This feature helps ensure that the computer files the address and makes it easier to retrieve address-based information. The geofile also contains commonplace names, landmarks, and other points of interest that can be used by the dispatcher to enter an incident location when a traditional house number/street name is not available
- Report generation—This function helps to analyze incident and unit activity, and allows production of reports listing all types of information, by ranges of date and time, and sorted by various fields⁷

⁷ *Dispatch Monthly Magazine* Web page, 2001: CAD Information Sheet, <http://www.911dispatch.com>

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Computer-Aided Dispatch...Capabilities...

TYPICAL CAD SYSTEMS PROVIDE SEVERAL CAPABILITIES THAT SUPPORT A DISPATCHER'S WORK AND CAN BE TAILORED TO A SPECIFIC INDUSTRY OR OPERATIONAL NEED (CONT'D)

- External links—The CAD computer and software can be linked to other useful computer systems
 - E-911 system—to automatically fill in the caller's name, address and telephone number
 - Local, county, state, and federal law enforcement databases—to access wants and warrants, vehicle registration, driver's license, stolen vehicle and property, and other useful features
 - Master clock synchronization—to allow a standard time tracking system for reporting and filing of incidents
 - Radio systems—to show last unit that broadcast, or unit that pressed "emergency" button
 - Mobile data, records management, paging, etc.
- The CAD software can be set up to automatically route license plates entered from vehicle stops into the law enforcement databases, and to allow manual entry of other inquiries
- Maintenance—the CAD system allows access to various support files, user authorizations, security, and system files

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Computer Aided Dispatch...Operation...

CAD SYSTEMS ARE DESIGNED TO PROVIDE AN EASY-TO-USE AND EFFICIENT DISPATCHING CAPABILITY

- When an emergency call comes into a CAD-enabled communications center, the dispatching screen immediately displays the caller's name and location on the dispatching screen as the dispatcher speaks to the caller over a telephone line. This feature will also be available for cellular telephone-initiated calls using the E-911 enhancement
- Using the CAD computer terminal, a dispatcher can add details concerning the emergency situation and the type of help required. Dispatchers can determine which units should be sent to the emergency scene by viewing electronic maps of the area showing the locations of active response units
- Through a combination of mouse and keyboard inputs, the dispatcher can then send text dispatch orders to a nearby mobile unit via two-way radio to the MDT. If MDTs are not in use, the dispatcher can switch to a land mobile radio (LMR) voice connection to audibly dispatch appropriate mobile emergency units. The figure on the next page displays an example of a currently available and typical CAD software-dispatching screen. All data is displayed on one screen, allowing the user to have more information at his or her disposal

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Computer Aided Dispatch...Operation...

THE FIGURES BELOW ARE SCREEN SHOTS OF A CAD SYSTEM.

- The screenshot displays an AVL mapping routine with a list of vehicles at or near the scene. A typical CAD system generally has multiple screens for viewing several different applications at once

The screenshot shows the RightCAD Computer Aided Dispatch System interface. The main window is titled "RightCAD: Computer Aided Dispatch System - Open Work". The interface is divided into several panes:

- Open Work (1 Trip):** A table showing the current trip details.
- Map - Los Angeles:** A map showing the current location and route.
- Vehicle Information:** A table listing 6 vehicles with their status, location, time, and type.
- Candidate Rankings:** A table showing the ETA, vehicle, and status for candidate vehicles.
- Route Detail (1 Trip):** A table showing the trip details, including the trip number, status, pick-up, and drop-off locations.
- Trip Summary:** A summary of the trip, including the status and the pick-up and drop-off locations.

Vehicle	Status	Location	Time	Type
701	At Scene	W 5TH ST & S MAIN	10:47	ALS
702	En Route	W 9TH ST & S MAIN	10:33	ALS
706	At Post	MANHATTAN BEAC	18:39	BLS
710	At Post	LONG BEACH	13:33	BLS
712	EnR Post	11467 S BROADWAY	17:39	BLS
743	At Destin	208 N REESE PL	10:32	ALS

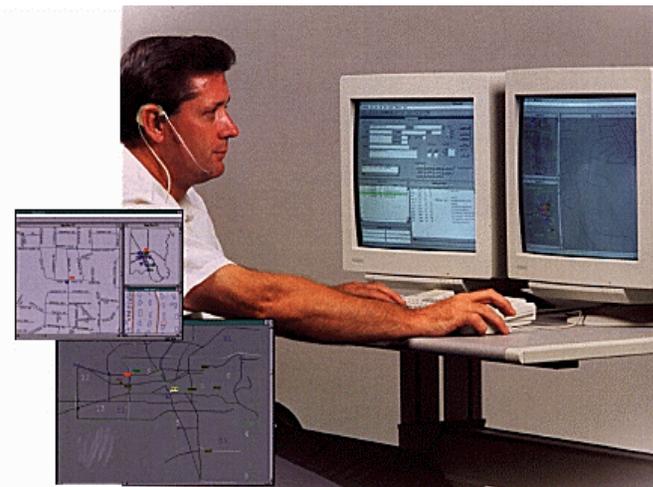
ETA	Vehicle	Status
00:03	701	At Scene 2
00:17	743	At Destin: 11
00:18	702	En Route 11

Trip#	Status	Pick-Up	Pick-Up	Drop
0001-A	At Scene	10:27	W 5TH ST & S MAIN	208 N

Trip Summary
<Unknown>, Trip#0003-A on 11/03/1996, Status: Open
ALS, Emergency, Heart Attack

Pick-Up
10:27 at
3414 S MAIN ST
LOS ANGELES

Drop-Off
BRANDYWINE HOSPITAL
208 N REESE PL
EMERGENCY
BURBANK, (000) 651-6545 Ext.



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Computer Aided Dispatch...Considerations...

THE FOLLOWING USER CHECKLIST WILL ALLOW PUBLIC SAFETY AGENCIES TO BETTER DETERMINE WHETHER THEY SHOULD USE CAD SYSTEMS

- The table shown below describes several considerations for using CAD system. Before acquiring CAD system, potential users may choose to ask questions such as those listed to better understand the attributes and costs of specific services. These considerations should assist planners in determining whether CAD system can meet user requirements

<i>CAD Considerations</i>	
<ul style="list-style-type: none">• Efficiency — CAD systems reduce effort and increase productivity. CAD capabilities allow quick access information, improving response and decision• Interface to Databases (Internal and Third-Party) CAD is able to perform database searches and create detailed reports, and provide accurate and timely information to the user.• Standard Forms for Information Structure — The graphical nature of GUI within the CAD system users to easily enter and access dispatch historical information for storage into a• Incorporation of Enhanced Systems Most CAD system vendors make interfaces that allow it to connect to or incorporate enhanced features such as AVL, GPS, NCIC databases, and commercial wireless services.• Automated Error-Checking and Validation The computerization of dispatch through CAD technology and software allows for automated error-checking and data validation.	<ul style="list-style-type: none">• Cost — The high cost of CAD is the most deterrent to utilizing its capabilities and features. abundance of optional features and enhanced add-ons such as linking to GPS, LMR, NCIC, etc. can drive the cost of a CAD system to levels beyond what some safety agencies and private corporations are able to afford.• Transition and Training — Moving from a non-computerized dispatching environment to a CAD system requires time for both system testing and staff training. When MDTs are used, individual field users must also be trained, demanding both time and money during a transition period.

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VIII. SUMMARY

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Summary...

ALTHOUGH COMMERCIAL WIRELESS DATA SERVICES CAN DELIVER INVALUABLE INFORMATION TO PUBLIC SAFETY PERSONNEL IN THE FIELD, WHILE AT THE SAME TIME CONSERVING THE LIMITED AMOUNT OF SPECTRUM THAT EACH AGENCY MUST SHARE; HOWEVER, SEVERAL FACTORS MUST BE CONSIDERED WHEN PLANNING TO IMPLEMENT WIRELESS DATA TECHNOLOGIES

- A wireless link is required, either through a packet-switched data network or a circuit-switched data network
- Communications must be established using equipment that can receive data according to an agency's needs, such as a MDT, a PDA, a pager, a GPS receiver, etc.
- Data equipment can all be linked together at a communications center, using multiple offices, and/or using databases in other areas of the country
- CAD systems provide an integrated solution bridging agency-owned infrastructure with commercially available wireless data services
- Beyond the general overview this report provides, the reader is encouraged to conduct further reading and research according to the considerations highlighted

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APPENDIX A—BIBLIOGRAPHY

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Appendix A...Bibliography...

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APPENDIX B—ACRONYMS

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Appendix B...Acronyms...

ARQ	Automatic Repeat Request
AVL	Automatic Vehicle Location
C/A	Coarse Acquisition
CAD	Computer-Aided Dispatch
CDPD	Cellular Digital Packet Data
DCS	Digital Communication System
DGPS	Differential GPS
DMV	Department of Motor Vehicles
DoD	Department of Defense
DRN	Digital Radio Network
DSSS	Direct Sequence Spread Spectrum
EMS	Emergency Medical Services
FCC	Federal Communications Commission
GIS	Geographic Information System
GPS	Global Positioning System
GUI	Graphical User Interface
kbps	Kilobits Per Second
km	Kilometer
LAN	Local Area Network
LCD	Liquid Crystal Display
LMR	Land Mobile Radio
LORAN	Long Range Navigation
LOS	Line of Sight
m	Meter
Mbps	Megabits per second
MCS	Master Control Station
MDT	Mobile Data Terminal
MEO	Medium Earth Orbit
MHz	Megahertz
NCIC	National Crime Information Center
NLETS	National Law Enforcement Telecommunications System

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ns	Nanosecond
P	Precise
PC	Personal Computer
PCS	Personal Communications Services
PDA	Personal Digital Assistant
PMO	Program Management Office
PN	Pseudorandom Noise
PPS	Precise Positioning Service
PSTN	Public Switched Telephone Network
PSWN	Public Safety Wireless Network
RF	Radio Frequency
RMS	Records Management System
SA	Selective Availability
SPS	Standard Positioning Service
UHF	Ultra High Frequency
VCR	Videocassette Recorder
VHF	Very High Frequency
WALES	Washington Area Law Enforcement System