Tik-109.350 Televerkon signalointiprotokollat
Assignment 2

Cellular Digital Packet Data

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Abstract

This paper discusses the the North American wireless packet data service Cellular Digital Packet Data (CDPD). Cellular Digital Packet Data is a data transmission technology developed for use on cellular phone frequencies. It uses unused cellular channels (in the 800 to 900 MHz range) to transmit data in packets and offers data transfer rates up to 19.2 Kbps, quicker call set up, and better error correction than using modems on analog cellular channel.

1 Introduction

The global wireless telecommunications market has grown from 40 billion dollars in 1993 to 200 billion in year 2000. Today's market conditions therefore require that managers evaluate cellular technology as an alternative to traditional wireline telecommunications services to make their corporations more competitive. [7]

There are many benefits to utilizing wireless data. Some organizations have recognized increased productivity, efficiency and mobility in the sales and service operations. Other organizations have realized greater customer satisfaction by empowering their field personnel with real time information access. Many companies want to reduce operating expenses with wireless data services. [3]

Cellular Digital Packet Data is a technique used for transmitting small chunks of data, commonly referred to as packets, over the cellular network in a reliable manner. It allows users to send and receive data from anywhere in the cellular coverage area at any time, quickly and efficiently. CDPD technology provides extensive, high speed (data can be sent over an airlink at a rate of 19.2 kilobits per second), high capacity, cost effective data services to mobile users. With this technology, both voice and data can be transmitted over existing cellular channels. [1, 10]

The structure of this paper is the following:

Chapter 2 begins with the description of the origins of CDPD, after which it gives a general description of the CDPD and compares the CDPD with analog data transmission. The chapter ends by giving a brief look to the CDPD markets today.

Chapter 3 describes the structure of the CDPD network, defines what channel hopping means and describes the encryption technique used in CDPD.

Chapter 4 describes what kinds of equipment are needed to be able to use a CDPD network. It also contains some example services which could be used with a CDPD network.

2 Cellular Digital Packet Data

2.1 Origin of CDPD

In 1992, a CDPD development consortium was formed with key industry leadership from Ameritech Mobile Communications Inc., Bell Atlantic Mobile Systems, GTE Mobilnet Inc., McCaw Cellular Communications Inc., NYNEX Mobile Communications Inc., Pactel Cellular and Southwestern Bell Mobile Systems, with the goal of creating a uniform standard for sending data over existing cellular telephone channels. They wanted to find a cost-effective, reliable, flexible, two-way wireless data communications service for mobile professionals which could compete with all digital voice and data services. In 1993, they published the Cellular Digital Packet Data System Specification Release 1.0 guidelines which enabled modem and network providers to build compatible and competitive products which would function on the CDPD network. [1]

In December 1996 the CDPD Forum passed the CDPD Specification to the Telecommunications Industry Association (TIA). The TIA has formed TIA TR45.6 Subcommittee to maintain and enhance CDPD technology via the CDPD Specification. A TIA Interim Standard (IS) on CDPD was published near the end of 1997. [4]

The CDPD Forum has emerged as a trade association for wireless data services providers, equipment manufacturers, software developers and information providers who are shaping the technology and supporting the development of the CDPD commercial marketplace. It currently has in excess of 88 members representing all areas of the wireless data communications industry. [1]

2.2 General description of CDPD

The Cellular Digital Packet Data service is popular in North America, but it has not yet gained worldwide success. The types of network accesses in the United States are advanced mobile phones systems (AMPS), time division multiple access (TDMA), and code division multiple access (CDMA). CDPD is available over all of those network types. [7, 4]

The cellular technology allows two different methods of transmitting data over air links. A user may transmit data using CDPD or switched cellular. CDPD is a packet overlay on the existing cellular network that needs no call setup or tear down. Data packets are transmitted over the idle capacity. The packet overlay is based on transmission control protocol/internet protocol (TCP/IP) and does not need the call setup procedures required for switched voice calls. This allows users to transmit data packets that are routed to their destinations. Switched cellular uses the network the same way a voice call would except data is transmitted and received over the switched, dial-up connection. [6, 7, 9]

CDPD service is the only fully defined open standard for packet data services available to mobile users today. There are other packet data services available from RAM (based on Ericsson technology) and Ardis (based on Motorola technology), but the standards defining these services are proprietary. [4]

Because the CDPD network is connectionless, each unit of user data (a packet) is a self-contained entity. The network routes and handles each packet independently of every other packet in the network. In the event that the network loses a packet, the end-to-end connections are able to recover the packet, just as they do in current wired networks. CDPD allows packets to be of variable size. The maximum packet size is 2000 characters. [5]

By building CDPD as an overlay to the existing cellular infrastructure, and using the same frequencies as cellular voice, carriers are able to minimize the capital expenditures required to offer the service while offering the same coverage area their customer base has grown accustomed to. In comparison, it costs approximately $1 million to build out a new cellular cellsite and only about $50,000 to build the CDPD overlay to an existing site. [1]

2.3 Differences Between CDPD and Analog Data Transmission

Table 1 from [5] shows some major differences that exist between sending data over the Public Switched Telephone Network (PSTN) or the analog cellular network and CDPD.

Function	CDPD	Circuit Switched Network
Packet data	Yes	No
Phone number required	No	Yes
IP address required	Yes	No
Open phone line required	No	Yes
Modems required on both devices	No	Yes
Charges accumulated by	Data Volume	Time of usage
Connect time charges	No	Yes

Table 1: Differences between CDPD and circuit switched networks

Figure 1 on page 5 is from [7] and shows results from a cost analysis of two methods of data transport, circuit switched call and CDPD service. The amount of data to transmit is on the x-axis and the cost of the transmission is on the y-axis. This particular analysis assumes that the switched call has a ten second setup time, a forty cents per minute charge, transmits data at 9600 bits/second, and has a one minute minimum charge. The CDPD assumes nineteen cents per Kbyte usage charge. [7]

According to this data analysis, files greater than 2 Kbytes should be sent over cellular switched communication, if the goal is to minimize the cost of transmission. As a rule, CDPD should be used for data transmission of fewer than 5 Kbytes of data and switched cellular for applications transmitting more than 5 Kbytes. [7]

CDPD is the optimal solution for a customer who is sending information which is both short and bursty. On the other hand, the circuit switch solution would be optimal when sending a large data transmission. Another important difference is that CDPD uses less power than circuit switching. Since the information is sent in short bursts, the device only has to be at high levels of power for short intervals. Additionally, CDPD has a sleep mode which allows the device to conserve power when not in use, without logging off of the network. [1]

2.4 State of the Market

CDPD technology is now available in 39 of the top 50 Metropolitan Serving Areas (MSAs) within the United States and is also spreading outside USA,

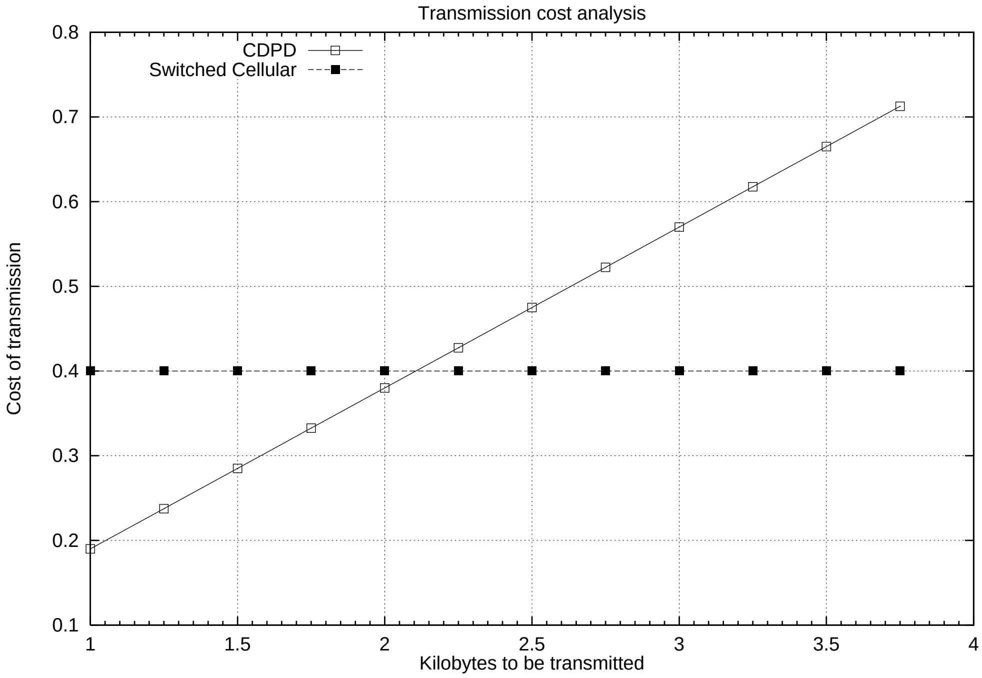

Figure 1: Transmission cost analysis

with introductions in four cities in Ecuador. [1]

3 Structure of Cellular Digital Packet Data Network

Figure 2 is from [4], and shows the interfaces and functional entities used to define CDPD infrastructure. Each functional entity is briefly described below.

The Intermediate System (IS) provides a network relay function between other network ISs. Its main function is to route packets of data into and out of the CDPD Service Provider network. ISs are commonly viewed as routers although they may also perform gateway and protocol conversion functions in order to aid in network interconnection. Usually, the Intermediate System (IS) is made up of off-the-shelf routers which are CDPD compatible. [1, 4, 8]

The Mobile End System (M-ES) is the device used by a subscriber to access wireless data communication services offered by a CDPD service. The M-ES could be a modem type device which connects to a variety of computer or communications equipment offering wireless data communications. Examples of an M-ES are laptop computers, and personal digital assistants (PDA). Unlike voice cellular phones, the decision to initiate a transfer, or hand-off from one cell to another cell is under the control of the CDPD M-ES itself, as it is the M-ES

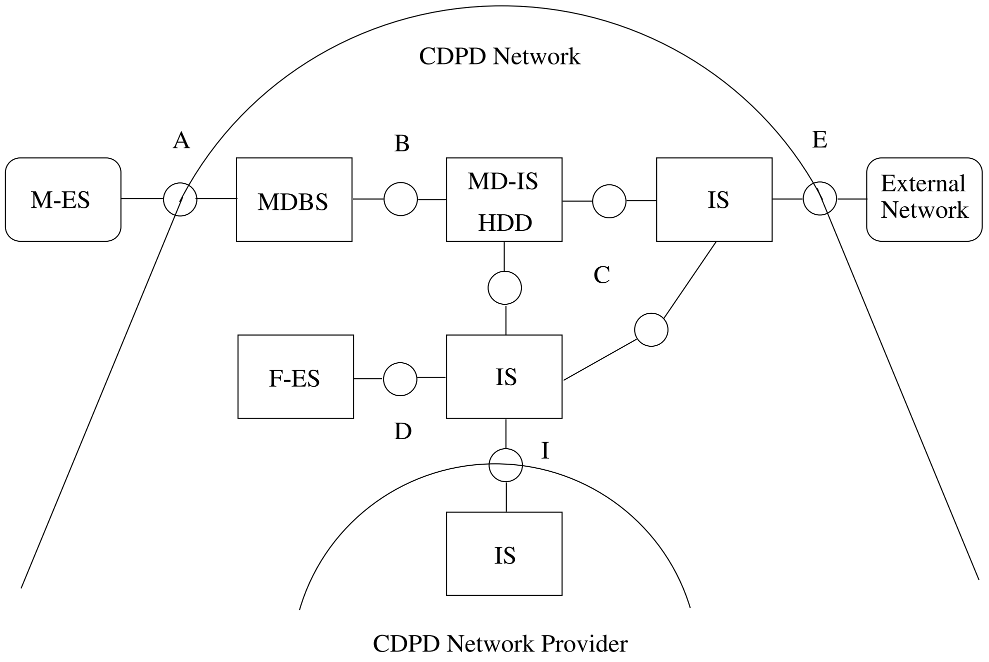

Figure 2: CDPD reference points and functional entities

which is responsible for monitoring the received signal strength of the cellular channel being used. [1, 4, 8]

The Mobile Data Intermediate System (MD-IS) performs routing functions based on the current location of the M-ES. All mobility management functions are performed by the MD-IS. The MD-IS uses a Home Domain Directory (HDD) to maintain the location of all M-ESs that are homed to it. In addition, MD-IS is responsible for routing data packets to and from the CDPD network and M-ES appropriately. The Mobile Data Intermediate System is a stationary network component. It has been referred to as the brain of the network because of its functionality. Not only is it responsible for ensuring that an M-ES is allowed to log on the network, but it also stores information on the M-ES's last known location, traffic statistics and billing information. [1, 4, 8]

The Mobile Data Base Station (MDBS) is primaly responsible for Radio Frequency (RF) channel management. It is located at the voice cell sites and is responsible of instructing the M-ES to hop to new channels for continued communication in the event voice communication (which is the priority traffic) is detected. It also handles the leg work for the M-ES in locating new channels when a hand off is required between cell sites. [1, 4, 8]

The Fixed End Systems (F-ES) are traditional data applications operating on stationary computer systems connected to landline networks. These could be any types of data applications from Internet web pages to customized systems for private business. [1, 4, 8]

3.1 Channel Hopping

To effectively integrate voice and data traffic on the cellular system without degrading the level of service provided to the voice customer, the CDPD network employs a technique called channel hopping. The way this works is that when a CDPD mobile data unit desires to initiate data transmission, it will check for availability of a cellular channel. If an available channel is located, the data link is established. As long as the assigned cellular channel is not needed for voice communications, the mobile data unit can continue to transmit data packet bursts on it. However, if a cellular voice customer initiates voice communication, it will take priority over the data transmission. At such time, the mobile data unit will be advised by the Mobile Data Base Station to hop to another available channel. In the event that there are no other available channels, the data transmission will be temporarily discontinued. [1]

Channel hops are completely transparent to the mobile data user. As far as the user can see, there is only one data stream being used to complete the entire transmission. [1]

3.2 Encryption in the CDPD Network

The CDPD Specification provides for the security of all data transmitted over the air between the M-ES and the MD-IS [5].

This security is built in to the network and is transparent to any CDPD application. Security is controlled by off-the-shelf security software developed by, and licensed through, RSA Data security. [5]

Site access to the Remote Operations Controllers (ROC) also requires site specific address and group numbers to be broadcasted before a response is transmitted. Additionally, security is provided by the nature of the ROC protocol and special features of software to RTU (Right To Use) matching that can be implemented. [5]

4 Cellular Digital Packet Data services

4.1 Using CDPD Network

When using the CDPD network the user needs a cellular data modem. A wireless modem costs between $400 and $800 [2]. There are a number of companies that manufacture cellular data modems. Some of the leading modem manufacturers are Mitsubishi, Uniden, Motorola, Novatel, INET and Sierra Wireless. In addition the host computer system needs to be connected to a network that provides IP routing. [3]

4.2 Description of CDPD Services

The fact that CDPD does not need the call setup procedures required for switched voice calls makes it ideal for short bursty message applications such as point-of-sales (POS) credit card verification, vehicle dispatch, package tracking and e-mail [7].

Since CDPD is an integrated technology, it can be used in a variety of applications, and is designed to maximize utilization of the existing cellular infrastructure. In broad terms, the applications could fall into the categories of transaction, batch or broadcast applications and be developed on the basis of specific business solutions for specific industries such as transportation or packet delivery, security, public safety, retailing, etc. [1]

Transaction applications Transaction applications are designed to provide communication between two network users, and often involve two way messaging in the form of an inquiry and response.

Some typical transaction applications for CDPD networks are [1]:

Credit Card Verification A credit card number is entered at the point of sale and an inquiry is sent to authorize the purchase.

Point of sale Messages can be exchanged to query individual prices of items as well as to report the transaction total. In addition to credit verification, point of sale transaction may include inventory control information, price updates, etc. Hand held registers could be introduced to eliminate the need for some check-out counters, saving floor space and putting sales people on the floor with customers.

Fleet Management Messages could be sent to specific mobile computing devices in a vehicle to direct it toward a destination for a pickup or next job. The response would acknowledge receipt of the dispatch message.

Package Pickup, Delivery and Tracking Messages could be sent to specific mobile computing devices to direct it to pick up or deliver packages. The response message would confirm receipt of the dispatch message. At delivery, the package tracking number and disposition may be registered with the package tracking system.

Electronic Mail Notification and Delivery When a message is delivered to a mail server, the server could generate a message notifying the subscriber of the receipt of the message. Delivery of the message could also be accomplished by sending the message directly to the mobile computing device.

Telemetry Information is periodically sent from wireless data acquisition equipment to a collector or user of the data. The type of data acquired may include approximate subscriber location, engine or vehicle statistics (mileage, speed, oil pressure, temperature, voltage, etc.), burglar or fire alarm reporting, vending machine status (temperature, sales, location, etc.), weather statistics, vehicular traffic statistics.

Information Retrieval Services Transaction interfaces to other information services, such as a restaurant reservation service, weather service, directory assistance, driving instructions, travel reservations etc.

File Transfers Copying of complete files from an external system to a mobile subscriber's system or visa versa.

Statistical Information Transfers The collection of telemetry information that might be deemed less critical than that used in the earlier example. For instance, the collection of billing information from utility meters in an apartment complex.

Broadcast applications Some typical broadcast applications are [1]:

General Information Services This might include national, state or local news, international news, advertising, etc.

Weather Advisories

Traffic Advisories

Advertising

Private Bulletin Boards

In CDPD networks prising is on per packet basis which means the user pays only for the data that is sent, whereas cellular voice and circuit switched data subscribers are charged for usage of the channel, regardless of whether there is communications present or not. [1]

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