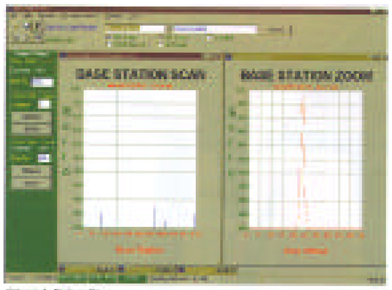

Figure 1. FalconEye

CDMA Pilot Scanner Data Capture and Presentation Software

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Introduction

CDMA(Code Division Multiple Access) networks require tools for the planning and optimization stages of development. Network Base Stations must be placed at locations that maximize coverage based on environmental concerns. In a perfect wireless world, the earth would contain only flat ground without any mountains, buildings, tunnels, trees, etc. It would be very easy to plan a CDMAnetwork of base stations. There would only be direct paths to any receiving subscriber units (phones). Since we do not live in a perfect world, transmitted signals from Base Stations will reflect off of obstructions such as mountains to create a great number of signal paths, also known as multipath. Planning and maintaining CDMA networks becomes increasingly more difficult in areas where multipaths are prevalent. Pilot Signal pollution due to multipaths may interfere with Base Station identification. The identification process is hampered when multipaths from one Base Station are offset enough so that they appear as other Base Stations. Multipath information at the planners' disposal would assist in calculating the PN offsets which are to be used for each Base Station in a network. Offsets are chosen so that any confusion due to multipath pollution is minimized.

Equipment has been developed to address the headaches associated with the prediction of multipaths in a network. These devices home in on Pilot Signals that are emitted from all IS-95 type CDMA Base Stations. A network planner would use this device, known as a Pilot Scanner, to record information on Base Station signal strengths throughout the network. A Pilot Scanner would be placed in a vehicle and driven throughout the entire coverage area to be assessed. This information can be processed to ultimately make optimization decisions.

Falcon Description

The Falcon is a compact, lightweight unit that is powered by 12VDC. It is available at Cellular (869.04-893.97 MHz) and Personal Communication Services (PCS) (1930.0-1990.0 MHz) frequencies.

A good field instrument uses information acquired through the GPS antenna to synchronize its circuits with Base Station transmissions for proper PN offset identification. This is a powerful feature in that it is completely independent of the CDMA network. A pilot scanning system that uses a phone is compromised in that it is dependent on Base Station search suggestions. The Base Station suggests the neighboring stations that are available to scan (also known as a neighborlist). The Falcon Scanner is independent of these suggestions and can identify Base Stations not in the neighbor list.

The Falcon reports power profiles on Base Stations, RSSI spectrumanalyzer like information, unit information and GPS data. This data is transferred via the serial port for storage on the PC at 115kBaud. Single Base Station (zoom mode) information can be updated up to 37 times a second. Top Stations for the search of all Base Stations (Base Station Data screen) are updated up to 6 times a second.

FalconEye Overview

FalconEye is the companion software for the Falcon Scanner. It is primarily a high speed data collection application. The user interface allows the modification of parameters which define the data being retrieved. FalconEye also displays the retrieved data on data grids for immediate inspection. The data is stored in a compact binary format that can then be exported to an ASCII format or to popular mapping software formats such as MapInfo® and Maptitude®.

FalconEye sends lowlevel commands to the Falcon through the serial port to retrieve different types of data. FalconEye provides the user with five information screens. These screens are Base Station Data, Base Station Zoom, RSSI (Received Signal Strength Indicator) Sweep, Top Base Stations, and the GPS Information screen. Figure I shows FalconEye with the Base Station and Zoom screens visible.

The Base Station Data screen displays all 512 Base Station locations. These correspond to PN chip values between 0 and 32,768. Each Base Station is separated by

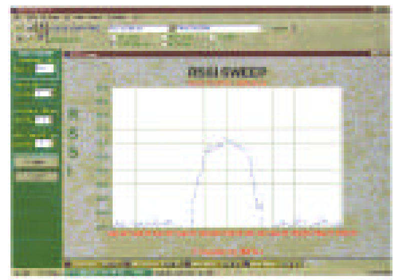

Figure 2. RSSI Sweep Screen

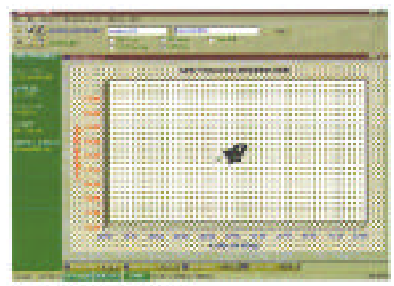
Figure 3. GPS Information Screen

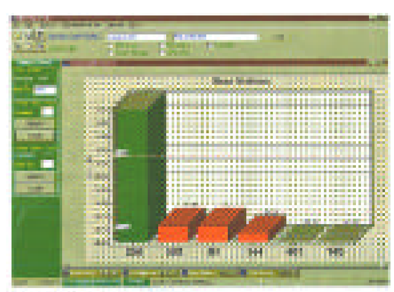
Figure 4. Top Base Stations

Table 1. Sample Output Data Records

Base Station Data	1950,1,–18.75,–112.34, . . .,5/22/98,12:34:56,–74.361,42.935
Base Station Zoom	1950,–15.98,-110.95, . . .,5/22/98,12:34:56,–74.361,42.935
RSSI Sweep	1950,10,100,0.05,–87.45,-82.64, . . .,5/22/98,12:34:56,–74.3,42.9
Top Base Stations	1950.0,208,–5.43,–107.98, . . .,5/22/98,12:34:56,–74.361,42.935

64 chips. The Base Station Zoom screen displays a closeup of the 64 chips associated with a specific Base Station. Note that in Figure 1, Base Station 256 is in the Zoom screen. The same Base Station is highlighted in red on the Base Station Data screen to denote that it is indeed the Station being spotlighted. The values being displayed are Ec/lo (in dB).

The RSSI Sweep screen (shown here in Figure 2) displays the RSSI value for the frequency range specified by the user. Resolution Bandwidth and Amplitude may also be modified. The GPS Information screen (Figure 3) displays the drive pattern of the current drive test. It also displays location and heading information as well as date and time.

The Top Base Station screen (Figure 4) displays the top six The Stations at any given time. The information can be ordered by Ec/lo, Base Station numbers, or a fixed format which keeps the Base Station displayed at the location at which it entered the screen. The dashed lines on the display represent user selectable TAdd and TDrop thresholds. These lines are for reference only and visually simulate the thresholds where a Base Station becomes a candidate for handoff (TAdd) and where it is no longer considered a candidate (TDrop).

The control panel on the left of the main screen (see Figure 1) allows the user to set certain parameters and to start or stop different types of scans. The START buttons start the data stream for the particular screen that is denoted by the group box that surrounds the button. Other parameters such as frequency and reuse factor can be set. The Reuse factor allows the user to scan through Base Stations that are divisible by this factor. For instance, if the Reuse factor is set to 4, the Falcon will only search Base Stations 0,4,8, etc...

The taskbar at the top of the application allows the users to select screens to be displayed, and provides choices for logging data. The status bar on the bottom of the screen displays system status, including the conditions of GPS lock, Generator lock, and system synchronization to the GPS second. The visible and tracked satellites are also shown in the GPS lock box.

Types of Data

FalconEye stores data in different files for the different data types. The different files include Base Station Data, Base Station Zoom, RSSI Sweep, and Top Base Stations. GPS information is matched with records in each of these files for postprocessing efforts. These different data streams will be discussed one at a time.

The Base Station Data will contain continuous streams of Ec/lo values for all 512 Base Stations. At the end of every record is a GPS information packet including date/time and positioning information. This GPS information is critical in plotting the network. A sample of this data is shown in Table 1. The data shown is after export to an ASCII comma delimited file.

Both Ec/lo and True Signal Power (in dBm) are logged to the data file. Each record begins with the frequency and the reuse factor. The FalconEve application puts the highest priority on logging data to the hard drive. It has been developed so that the data display does not slow down the data storage.

The Base Station Zoom data (as shown in ASCII output form in Table 1) stores all 64 chips of information for the particular Base Station. This data is extremely useful for detecting multi-paths for the same Base Station. The direct path is usually the closest to the 0-chip offset. Multi-paths would then follow at higher chip offsets. Since the chip calculations are time-based, the delay of multi-paths reflecting off of different surfaces creates higher chip offsets when plotted.

The Top Base Station data is similar to the Base Station Data format with the exception that the Base Station number is now included with the Ec/Io and True Power. The top six Stations will be placed in a record that is again headed by frequency and trailed by GPS information. A sample record is shown in Table 1.

RSSI Sweep data contains the RSSI values for the whole range specified by the user. This record is headed by the center frequency, the span, the resolution bandwidth, and the step-size. Using these parameters, the RSSI values are listed in order from lowest to highest frequency. The record is trailed by GPS information and is shown in Table 1.

The Next Step : Post-Processing

After the data has been massaged and formatted according to the user's requirements, import into a post-processing software package is the next logical step. The use of GPS tracking information provided by the Falcon allows the engineer to plot a map of network coverage.

Data retrieved can be used for various efforts in network optimization. The coverage area of each of the Base Stations surveyed may be recorded. When data from each of the Base Stations are combined, coverage holes that exist will appear and can then be corrected.

Base Station data may also be compared against neighbor lists supplied by Base Stations to suggest candidate stations for hand-off. Since a PN scanner operates independent of the network, it stores data on Base Stations from which it is able to retrieve information.

There are instances where the scanner will 'see' Base Stations which are not in the neighbor list. Neighbor lists could be adjusted accordingly to reflect the information found by the scanner.

There are many other post-processing applications of the data retrieved from PN scanners including pilot pollution studies and time-lapse studies if the given network adjusts cell coverage based on phone demand during different time periods.

The End Result: CDMA Network Optimization

Data collection from high-speed PN scanners such as the Falcon serve many purposes. Data on multi-path pilot pollution is used to eliminate Base Station conflicts which may arise by allowing the user to specify PN offsets which are not in conflict with multi-path components of other Base Stations. Network coverage holes where there is a potential for dropped calls are also exposed by the PN scanner. Alterations may need to be made to neighbor lists after the PN scanner identifies differences between available candidate Base Stations in a particular area and the neighbor list being transmitted by the active Base Station. PN scanners are also used to continually tweek (update) the network as operating conditions (such as environmental) change. PN scanners can also be used repeatedly to adjust the system periodically over time after the network has been up and running. The race continues to blanket the entire country with digital wireless phone networks. PN scanners such as the Falcon are invaluable in construction and optimization of these networks.

For more information on the Falcon or any other Berkeley Varitronics Systems products, please call (732) 548-3737 or E-mail to Info @bvsystems.com. You can also visit their web site at www.bvsystems.com

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