Scout CDMA Pilot Scanner

Pitfalls of CDMA Deployment

One of the chief advantages of Code Division Multiple Access (CDMA) is capacity. Unfortunately, it is also the most difficult attribute to optimize if the system parameters and configuration are not correctly implemented. "Pilot pollution", caused by excessive overlap of coverage contours, can rob CDMA designs of capacity. From a practical point of view, placement of the base stations is dependent on tower space availability, and is very terrain dependent. Since many traffic channels can share the same RF channel, digital codes are used to separate the various voices. Sometimes, too many codes radiate in one area and cause interference because it reduces the ratio of signal to noise, often referred to as Ec/lo (energy in a correlated bit to that of total RF channel energy).

Propagation and Coverage Analysis of CDMA Signals

Multiple CDMA-modulated signals sharing the same RF channel have unique characteristics when signal reflections are encountered. These reflections cause unphased additions of data symbols which can cause bit errors in the received data. Paradoxically, unmodulated signal strength measurements (using narrow bandwidth stimulus signals such as CW) can be misleading. The signal appears to be strong (these unphased callers add to each other, making them measure stronger), although in actuality they often have poor Bit Error Rate performance. The reason for this is often multipath reflections, better known as time dispersion of the RF carrier.

Time dispersion or delay spreading is induced when signals from the same origin encounter reflections. The signal breaks into several paths with some components being delayed because they travel a longer path and arrive at the receiver at different phases. The modulated symbols add and subtract from each other, and this mixing action destroys the integrity of the original digitally-modulated signal. These potential distortions must be considered when planning and optimizing high-rate digital radio systems.

In almost all cases, short-term fading is caused by the environment, where two or more copies of the originally authored signal arrive at the receiver, but at different times. These radio waves are then combined at the antenna and vary widely in both phase and amplitude. There are generally three properties that affect the character of the RF waves that arrive at the antenna. They are distance, propagation time, and bandwidth of the transmitted signal. Simple RF signal strength has been the most traditional measurement for quality of the link. In an ideal environment, it has a predictable relationship to distance, and has been used almost exclusively to determine overall coverage in analog communication system designs.
With digitally-modulated signals, the adverse effects of multipath reception are:

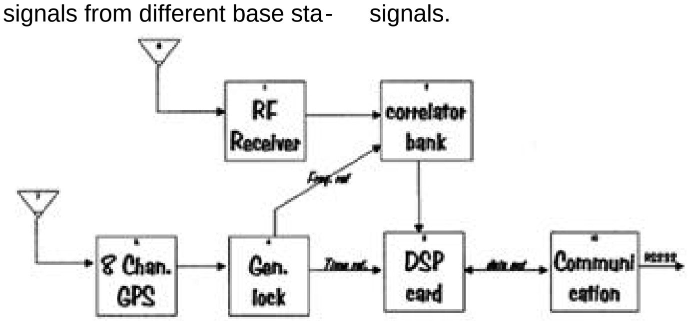
(i) rapid variations in the received RF amplitude
(ii) some FM of the original signal caused by the Doppler shifts on more than one path
(iii) echoes (time dispersion) causing the carriers to add and subtract (vectorially in amplitude and phase) from each other causing data symbols to cancel

CDMA's Subtle Problems Create the Rational for Advanced Tools

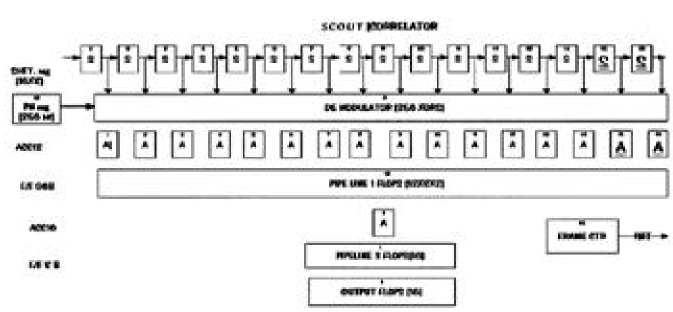
CDMA telephones have limited ability to find the best base station to communicate with because they lack the required processing power to search all available stations. There are up to 512 such stations, and a CDMA phone must correlate signal strength - a process which integrates over time, symbols to derive the traffic information. In order to get around this problem, each IS-95 serving base station downloads a list of best candidate stations to communicate with to each subscriber's telephone (in case a handoff to another station is needed). These lists are compiled largely on a theoretical basis, often by proximity assumptions, and do not account for stations in certain parts of the service territory that may from time to time, be stronger or better candidates to receive a handoff because of their terrain advantages. Distant base stations that repeat the same PN code as the local station become another source of interference to the telephone. Also, since signals from different base stations are only separated by delayed PN codes (64 chips per station), a base station signal that travels too far may be received by a phone in another base' s offset, confusing or unsynchronizing the phone from the network.

BVS Scout

The Scout is a mobile measurement system which continuously surveys all Cellular or PCS CDMA Pilot channel signals and reports every possible power profile. These measured profiles indicate the correlated power for each received pilot as well as the distributions of interference and multipath components as a function of delay spread. The system employs an eight-channel GPS system to synchronize and track the CDMA signals.



Functional Block Diagram of the SCOUT



SCOUT Correlator

The Scout can be configured to continuously survey all or just specific base stations. The ability of the Scout to scan every frame [26.6 msec] of all 512 base stations, and the associated multipaths at each base station, exceeds all existing data collecting tools for CDMApropagation analysis. The Scout excels in conducting accurate CDMA coverage studies, base station transmitter testing and setting- hand-off thresholds. The heavily parallel, expandable, high speed time multiplexed architecture and DSP downloadable PN phases allow the capture of realtime co-channel interference and multipath analysis. The optional output of raw data may be coupled to any standard propagation and multipath fading analysis software. The standard equipment complies with IS-95/IS-97 and PCS JED008 standards.

The equipment can be customized to meet any CDMA standards with short turn around times because the customizing parameters are DSP downloadable. The Scout increases CDMA network capacity, transmission quality and security.

The main blocks of the Scout are the RF receiver, correlator bank, GPS module, reference generator, DSP module and communication control processor. The fig,ure above shows the functional block diagram of these salient elements of the hardware design. In addition to the CDMA wideband receiver, a narrowband, high selectivity RF receiver covers the cellular or PCS frequencies and supports a 20 to 60 MHz tuning range. The receiver scans 15 ms per channel and measures the Received Signal Strength Indicator [RSSI]. The dynamic range of the receiver is -118 to -30 dBm with a 10 kHz bandwidth and better than -50 dB adjacent channel rejection at ±30 kHz. The time base stability is ±2.5 ppm and less than -80 dBc/Hz phase noise at 1 kHz.

At the front end of the correlator bank, the demodulated in-phase and quad-phase baseband signals from the RF modules are sampled(I by 8-bit ADCs at 16 times the chip) rate of 1.2288 MHz. The correlation consists of four banks of ASICs to compute correlation power in parallel with a chip resolution. Each bank consists of two ASICs implementing a bank of 256 8-bit shift registers to store the last 256 phases of the input, a DSP loadable 256-bit shift register to store PN phases, and 17 16-bit accumulators to compute correlation power every chip period.

The correlators are initially synchronized to GPS. The input samples to correlators are software selectable. Hence, by selecting the first sample for the first bank and the eighth sample for second bank the correlation power resolution will be half chip. With optional add-on boards, resolution of the correlation power can he improved up to 1/16th of the chip. The Genlock board extends the frequency reference for the correlator banks and time reference to DSP card from the 8-channel differential GPS. The DSP card consists of a high speed TI DSP and a dual UART to download power profile to the external device.

The DSP computes the optimum 256 PN phases and downloads to the PN shift register and continuously reads the correlation power from the ASICs and the timing reference from the genlock board. In a standard unit, the time tags and correlation power above a configurable threshold value are downloaded through an RS-232 port. The instrument can be programmed to interface to a variety of external devices for fast, synchronous downloading of raw data.

Applications

The Scout is a portable, high-speed field measurement device that continuously surveys all the Cellular or PCS CDMA Pilot channel signals and reports their power profiles and multipaths. Measuring Ec/Io total power (dBm) in the CDMA channel as well as absolute power (dBm) profiles from each CDMA base station, The Scout generates these correlations using internal, high-speed parallel architecture in real-time. These profiles indicate the distribution of interference and multipath components as a function of relative power and delay. The system also employs an 8-channel differential GPS system. The system provides the following functions:

• Survey Cellular/PCS Base station, Code Domain, and continuous wave power and update base station lists.

• Computation, setting, and regular update of the multipath combining thresholds and hand-off thresholds from the real time data from the Scout.

• Coverage studies for Cellular and PCS CDMA systems.

• Analysis of co-channel interference or multipath components.

• Data for statistical characterization of multipath propagation and interference for analysis of antenna performance.

• Channel modeling and analysis of multipath fading.

For more information on the Scout, contact Berkeley Varitronics Systems, Liberty Corporate Park, Metuchen, NJ 08840, or call (908) 548-3737.