4.6 RAKE RECEIVER

RAKE receiver is used in CDMA-based Code Division Multiple Access systems and can combine multipath components, which are time-delayed versions of the original signal transmission.

Combining is done in order to improve the signal to noise ratio at the receiver.

RAKE receiver attempts to collect the time-shifted versions of the original signal by providing a separate correlation receiver for each of the multipath signals. This can be done due to multipath components are practically uncorrelated from another when their relative propagation delay exceeds a chip period.

The basic idea of a RAKE receiver was first proposed by Price and Green (1956).

Due to reflections from obstacles a radio channel can consist of many copies of originally transmitted signals having different amplitudes, phases, and delays.

If the signal components arrive more than duration of one chip apart from each other, a RAKE receiver can be used to resolve and combine them.

The RAKE receiver uses a multipath diversity principle.Multipath can occur in radio channel in various ways such as, reflection and diffraction from buildings, and scattering from trees .

M-finger RAKE Receiver

A RAKE receiver utilizes (shown in figure 4.6.1) multiple correlators to separately detect M strongest multipath components. The outputs of each correlator are weighted to provide better estimate of the transmitted signal than is provided by a single component.

Demodulation and bit decisions are then based on the weighted outputs of the M correlators.

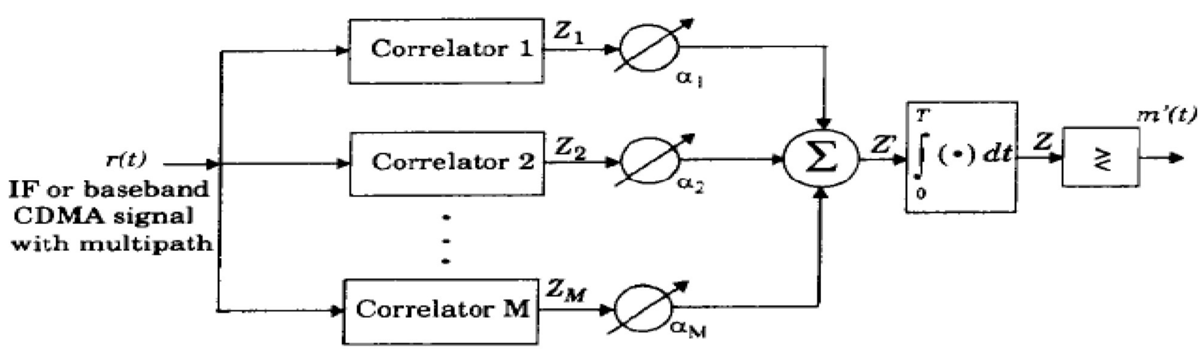

Fig4.6.1: RAKE Receiver Implementation

Source : "Wireless communications" by Theodore S. Rappaport,Page-336]

Each correlator detects a time-shifted version of the original CDMA transmission, and each finger of the RAKE correlates to a portion of the signal, which is delayed by at least one chip in time from the other fingers.

Assume M correlators are used in a CDMA receiver to capture M strongest multipath components. A weighting network is used to provide a linear combination of the correlator output for bit decision. Correlator 1 is synchronized to the strongest multipath m1. Multipath component m2 arrived t1 later than m1 but has low correlation with m1.

The RAKE receiver uses several baseband correlators to individually process several signal multipath components.The correlator outputs are combined to achieve improved communications reliability and performance.

Bit decisions based only a single correlation may produce a large bit error rate as the multipath component processed in that correlator can be corrupted by fading.

In a RAKE receiver, if the output from one correlator is corrupted by fading, the others may not be, and the corrupted signal may be discounted through the weighting process.

The M decision statistics are weighted to form an overall decision statistics.

The outputs of the M correlators are denoted as Z**1**, Z**2**,…, and Z**M**.

They are weighted by α**1**, α **2….** and α **M**, respectively.

The weighting coefficients are based on the power or the SNR (Signal-toNoise Ratio) from each correlator output.

If the power or SNR is small out of a particular correlator, it will be assigned a small weighting factor, α.

$$Z' = \sum_{m=1}^{M} \alpha_m Z_m$$

The weighting coefficients, $\propto_m$ are normalized to the output signal power of the correlator in such a way that the coefficients sum to unity.

$$\alpha_m = \frac{Z_m^2}{\sum_{m=1}^{M} Z_m^2}$$

Due to Multiple Access Interference (MAI), RAKE fingers with strong multipath amplitudes will not necessarily provide strong output after correlation.

Choosing weighting coefficients based on the actual outputs of the correlator yields better RAKE performance.