Abstract

The dissertation proposes a series of new acquisition techniques -- namely the distributed sample acquisition (DSA), batch DSA (BDSA), parallel DSA (PDSA), DPSK-based DSA (D³SA), and correlation-aided DSA (CDSA) -- which are applicable to the DS/CDMA system with long-period PN sequence.

In the DSA scheme, acquisition is done in two steps: First, the short-period igniter sequence is synchronized, which normally takes very short time due to its short length. Then, the state samples of the long-period PN sequence generator (or, the main SRG) in the transmitter, which are conveyed to the receiver over the igniter sequence stream, are determined out of the synchronized igniter sequence and provided to the main SRG synchronization block. The long-period PN sequence (or, the main sequence) is synchronized by applying the state sample based comparison-correction process to the main SRG in the receiver. Since the operation of each step takes very short time, the overall acquisition is done very fast. The acquisition time performance of the proposed scheme, analyzed by taking the transform domain approach, confirms that the resulting mean acquisition time is dramatically reduced. Nonetheless, the additional circuit complexity for its implementation is very small.

Then, the binary signaling DSA scheme is extended to the BDSA and the PDSA
schemes such that the fast acquisition principle can be efficiently applicable to the general M-ary signaling or multi-carrier DS/CDMA systems. Since the BDSA and the PDSA contain the primitive DSA as a special case of \( M=2 \), they may be regarded as generalized DSA schemes. For the construction of the BDSA and the PDSA schemes, several SRG synchronization principles such as the generalized non-uniform sampling and correction theory and the parallel sampling and correction theory are derived. Next, to reduce the receiver hardware complexity and improve the acquisition performance, the \( D^2 \)SA scheme is proposed as a novel variant of the DSA. The \( D^2 \)SA employs differentially-coherent phase shift keying (DPSK) to convey the SRG state samples and the pre-rotation of the data constellation to realize the coherent demodulation of the data stream. The use of DPSK instead of orthogonal modulation as the means of the state sample conveyance improves the system performance in terms of both system complexity and acquisition time. The number of correlators required for acquisition, which used to be \( 2^b \) for the DSA schemes when \( b \) state samples are conveyed per state symbol, always reduces to one.

Finally, the CDSA scheme is proposed to improve the robustness of the DSA schemes to the worst-case channel environment: fading, shadowing, and frequency offset. The CDSA scheme incorporates the state symbol correlation process in the DSA process to maintain the fast acquisition performance even under very poor channel environment. In the first stage of the synchronization procedure, the MS attempts to acquire the PN sequence by taking the comparison-correction based synchronization approach of the original DSA scheme. However, if it cannot acquire the synchronization until it collects a pre-determined number of state symbols (e.g., a period of the state symbol sequence), the MS stops the comparison-correction process and determines the PN sequence timing by correlating the received symbol
sequence with each shift of the pre-stored state symbol sequences. As the state symbol-SNR is relatively high, the state symbol correlation process enables reliable synchronization even in very low chip-SNR environment. The CDSA-based inter-cell synchronous and asynchronous DS/CDMA cellular systems are introduced and their performances are compared with those of the IS-95 and the IMT-2000 W-CDMA systems. Performance results confirm the superiority of the CDSA-based systems to the conventional systems in terms of acquisition time, robustness, and system complexity.

**Keywords:** Distributed sample acquisition (DSA), igniter sequence, shift register generator (SRG), serial search acquisition (SSA), parallel search acquisition (PSA), batch DSA (BDSA), parallel DSA (PDSA), state sample/symbol, DPSK-based DSA (D²SA), data constellation pre-rotation, correlation-aided DSA (CDSA), state symbol correlation process, comparison-correction based synchronization, primary synchronization code (PSC), secondary synchronization code (SSC), 3GPP 3-step synchronization approach