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(54) METHOD AND SYSTEM FOR IMPLEMENTING A SYSTEM ACQUISITION FUNCTION FOR USE WITH A COMMUNICATION DEVICE

(75) Inventors: **Ghobad Heidari**, San Diego, CA (US); **Kuor-Hsin Chang**, Sunnyvale, CA (US); **Paul L. Master**, Sunnyvale, CA (US); **Eugene B. Hogenauer**, San Carlos, CA (US); **Walter James Scheuermann**, Saratoga, CA (US)

Correspondence Address:
NIXON PEABODY LLP
401 9TH STREET, N.W.
WASHINGTON, DC 20004 (US)

(73) Assignee: **QST Holdings, LLC**, Palo Alto, CA (US)

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(63) Continuation of application No. 10/067,496, filed on Feb. 4, 2002, now Pat. No. 7,400,668, which is a continuation-in-part of application No. 09/815,122, filed on Mar. 22, 2001, now Pat. No. 6,836,839.

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(57) **ABSTRACT**

A system acquisition module and corresponding method for facilitating PN code searching which has a PN sequence generator configurable to generate a plurality of PN sequences. The module and method also includes computational units configurable to correlate each received signal sample of a plurality of received signal samples with a corresponding PN sequence of the plurality of PN sequences, and further configurable to provide other hardware resources. A number of computational units from the plurality of computational units are selectively configured to correlate the received signal samples with the PN sequences—the number depending upon availability of the plurality of computational units from providing the other hardware resources. In another embodiment, a communication device having a system acquisition function is provided which includes the system acquisition module and a receiver configured to receive signals, where a plurality of configurable computational units are selectively configurable to implement the PN sequence generator.

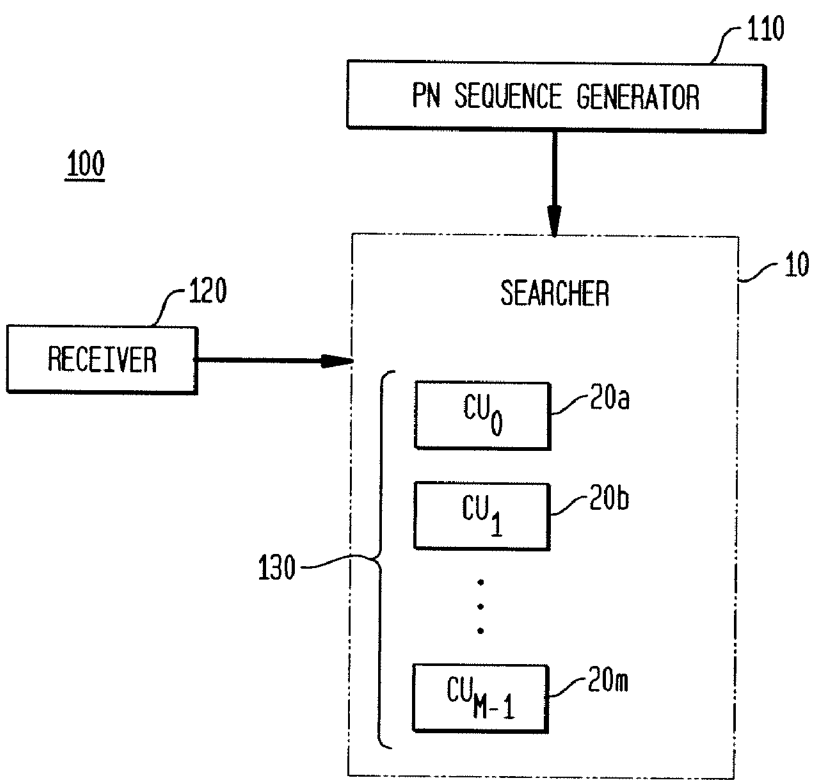


FIG. 1

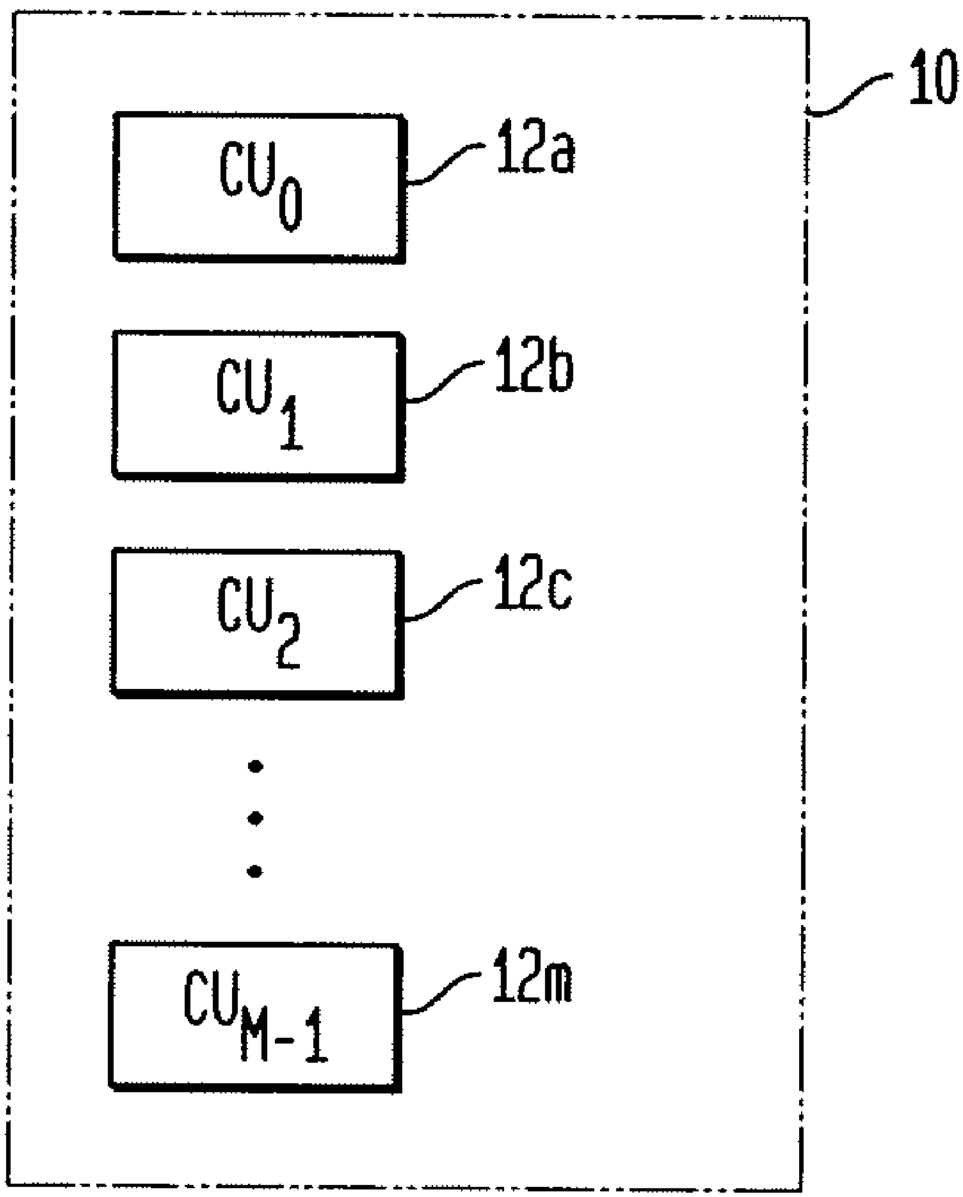


FIG. 2

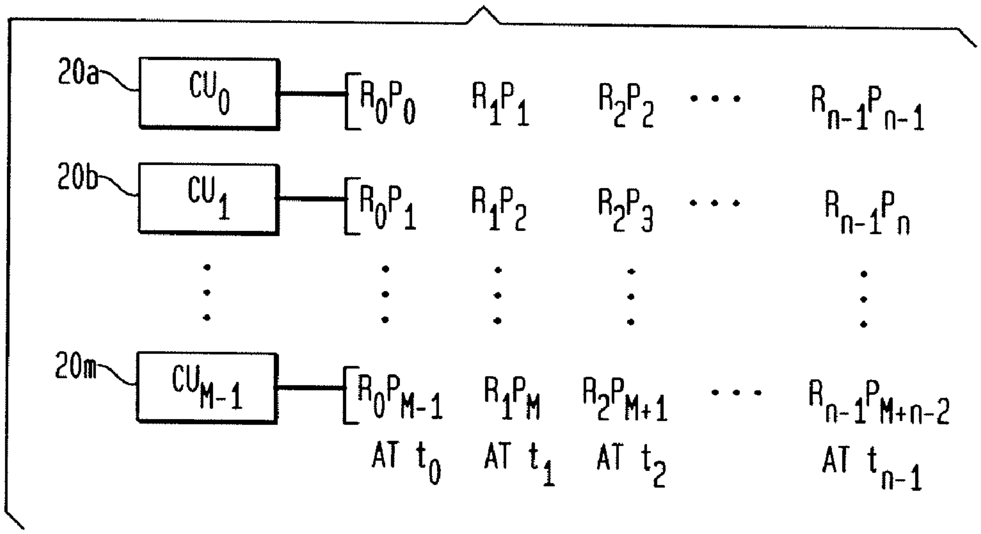

20a
CU_0
R_0P_0 R_1P_1 R_2P_2 ··· $R_{n-1}P_{n-1}$
20b
CU_1
R_0P_1 R_1P_2 R_2P_3 ··· $R_{n-1}P_n$
20m
CU_{M-1}
R_0P_{M-1} R_1P_M R_2P_{M+1} ··· $R_{n-1}P_{M+n-2}$
AT t_0 AT t_1 AT t_2 AT t_{n-1}

FIG. 3

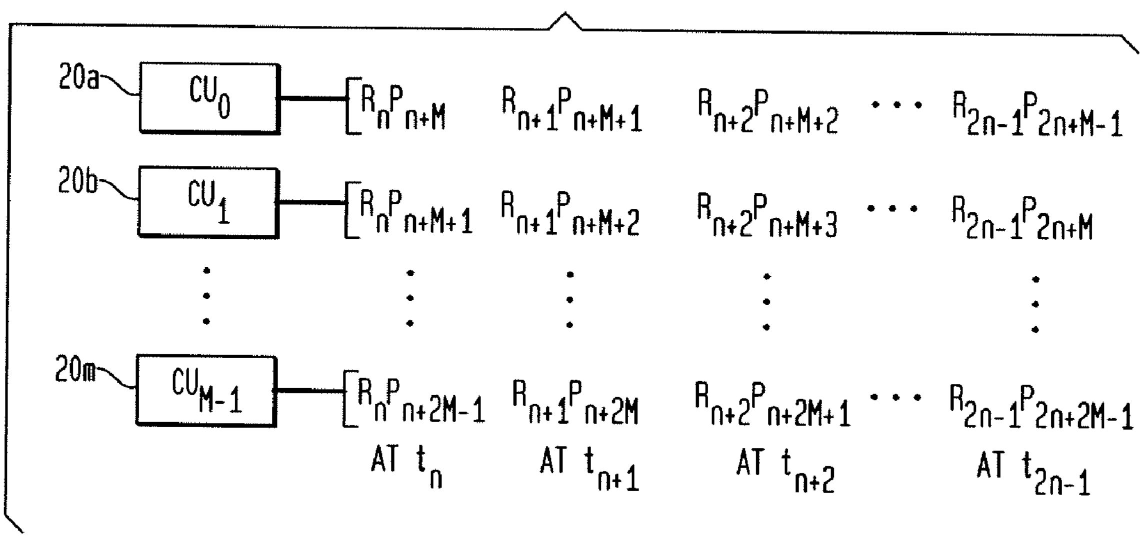

20a
CU_0
R_nP_{n+M} $R_{n+1}P_{n+M+1}$ $R_{n+2}P_{n+M+2}$ ··· $R_{2n-1}P_{2n+M-1}$
20b
CU_1
R_nP_{n+M+1} $R_{n+1}P_{n+M+2}$ $R_{n+2}P_{n+M+3}$ ··· $R_{2n-1}P_{2n+M}$
20m
CU_{M-1}
R_nP_{n+2M-1} $R_{n+1}P_{n+2M}$ $R_{n+2}P_{n+2M+1}$ ··· $R_{2n-1}P_{2n+2M-1}$
AT t_n AT t_{n+1} AT t_{n+2} AT t_{2n-1}

FIG. 4

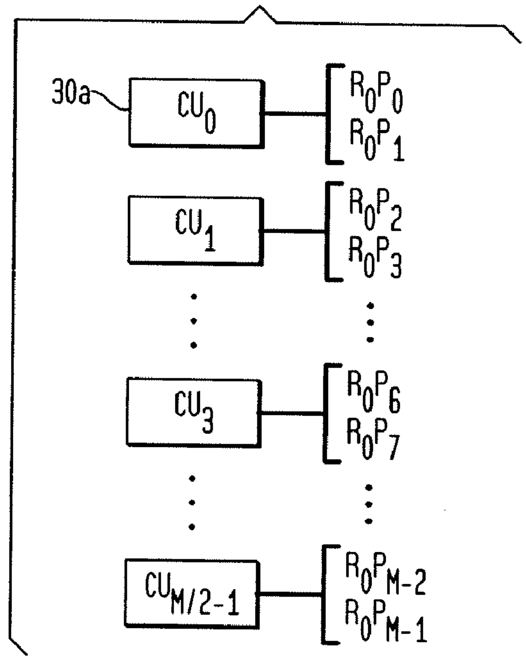

30a
CU_0
R_0P_0
R_0P_1
CU_1
R_0P_2
R_0P_3
CU_3
R_0P_6
R_0P_7
$CU_{M/2-1}$
R_0P_{M-2}
R_0P_{M-1}

FIG. 5

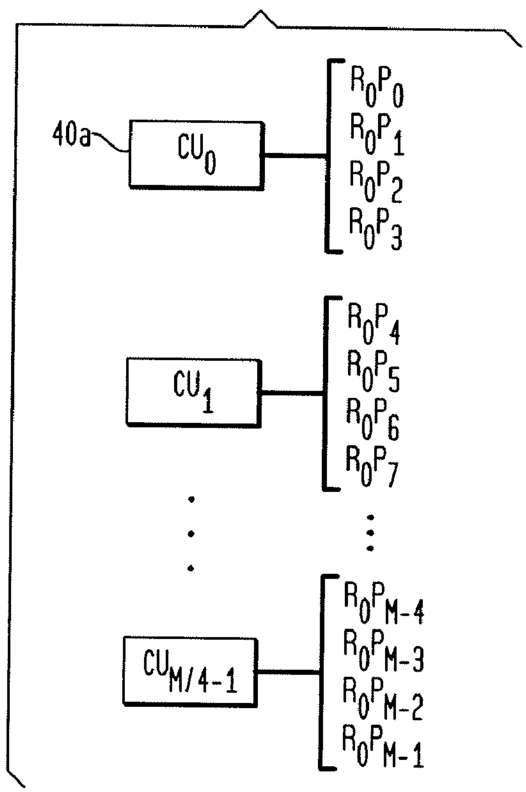

40a
CU_0
R_0P_0
R_0P_1
R_0P_2
R_0P_3
CU_1
R_0P_4
R_0P_5
R_0P_6
R_0P_7
$CU_{M/4-1}$
R_0P_{M-4}
R_0P_{M-3}
R_0P_{M-2}
R_0P_{M-1}

FIG. 6

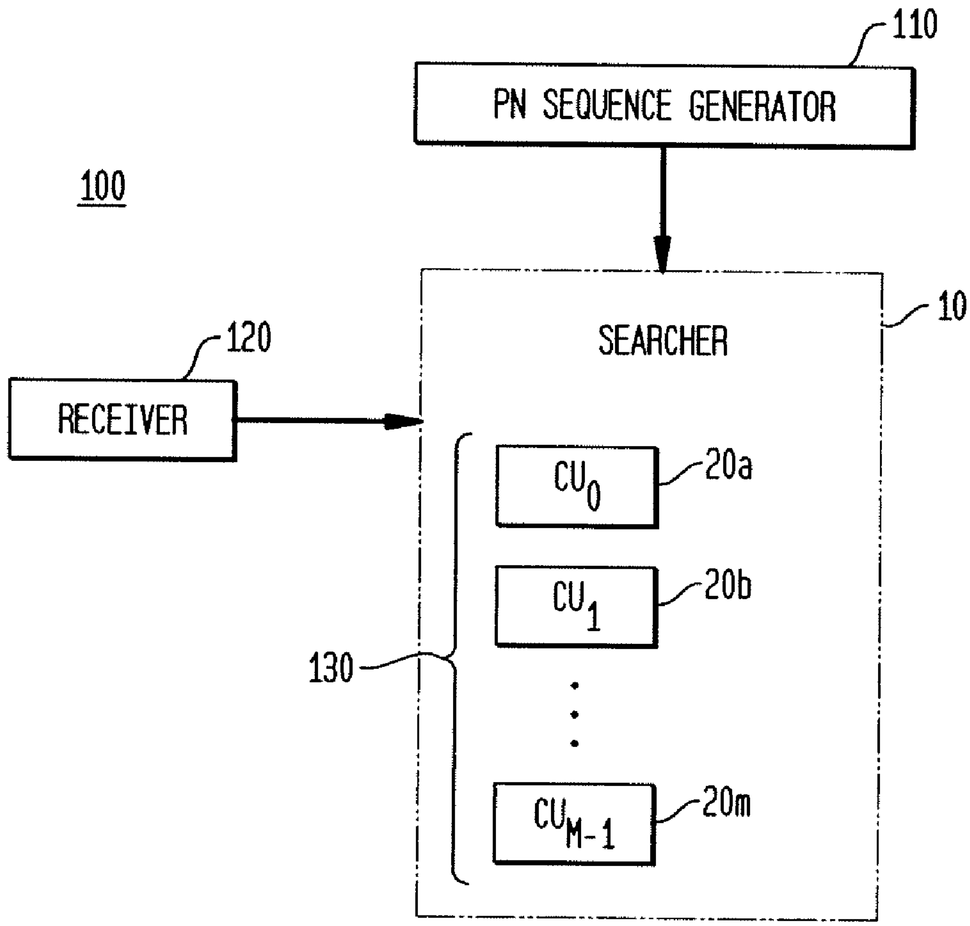

110
PN SEQUENCE GENERATOR
100
10
SEARCHER
120
RECEIVER
CU0
20a
CU1
20b
130
CUM-1
20m

FIG. 7

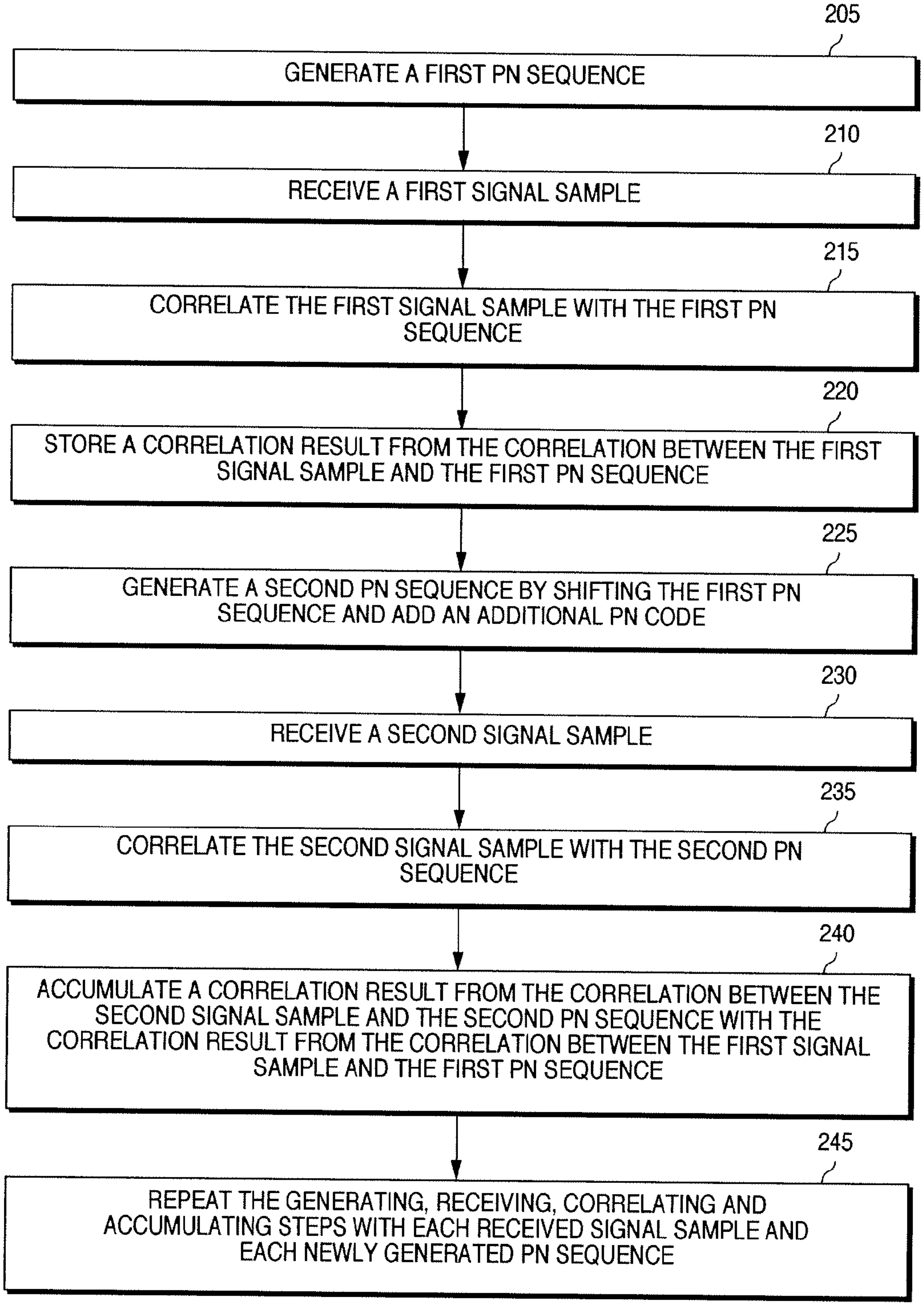
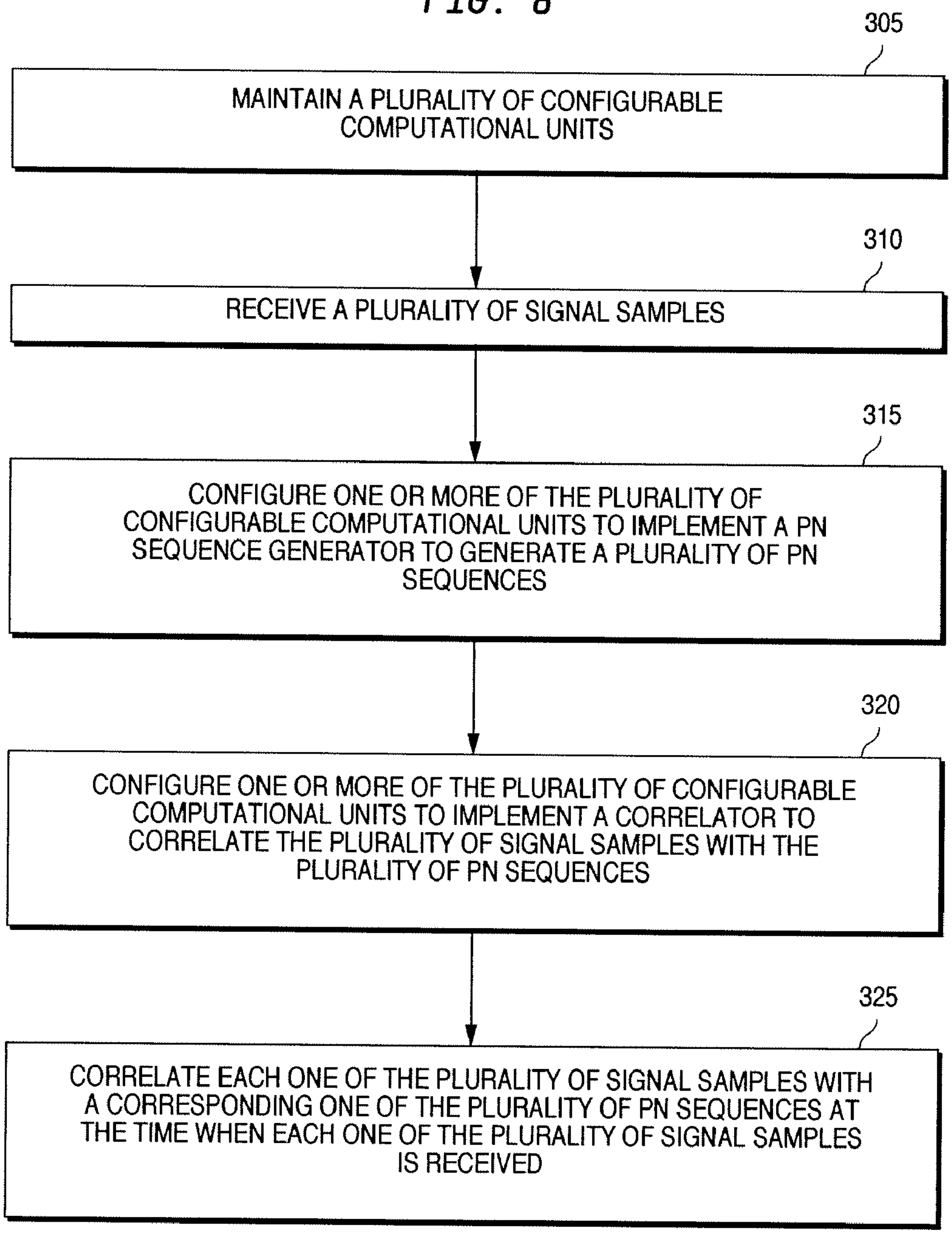

205
GENERATE A FIRST PN SEQUENCE
210
RECEIVE A FIRST SIGNAL SAMPLE
215
CORRELATE THE FIRST SIGNAL SAMPLE WITH THE FIRST PN SEQUENCE
220
STORE A CORRELATION RESULT FROM THE CORRELATION BETWEEN THE FIRST SIGNAL SAMPLE AND THE FIRST PN SEQUENCE
225
GENERATE A SECOND PN SEQUENCE BY SHIFTING THE FIRST PN SEQUENCE AND ADD AN ADDITIONAL PN CODE
230
RECEIVE A SECOND SIGNAL SAMPLE
235
CORRELATE THE SECOND SIGNAL SAMPLE WITH THE SECOND PN SEQUENCE
240
ACCUMULATE A CORRELATION RESULT FROM THE CORRELATION BETWEEN THE SECOND SIGNAL SAMPLE AND THE SECOND PN SEQUENCE WITH THE CORRELATION RESULT FROM THE CORRELATION BETWEEN THE FIRST SIGNAL SAMPLE AND THE FIRST PN SEQUENCE
245
REPEAT THE GENERATING, RECEIVING, CORRELATING AND ACCUMULATING STEPS WITH EACH RECEIVED SIGNAL SAMPLE AND EACH NEWLY GENERATED PN SEQUENCE

FIG. 8


305
MAINTAIN A PLURALITY OF CONFIGURABLE COMPUTATIONAL UNITS
310
RECEIVE A PLURALITY OF SIGNAL SAMPLES
315
CONFIGURE ONE OR MORE OF THE PLURALITY OF CONFIGURABLE COMPUTATIONAL UNITS TO IMPLEMENT A PN SEQUENCE GENERATOR TO GENERATE A PLURALITY OF PN SEQUENCES
320
CONFIGURE ONE OR MORE OF THE PLURALITY OF CONFIGURABLE COMPUTATIONAL UNITS TO IMPLEMENT A CORRELATOR TO CORRELATE THE PLURALITY OF SIGNAL SAMPLES WITH THE PLURALITY OF PN SEQUENCES
325
CORRELATE EACH ONE OF THE PLURALITY OF SIGNAL SAMPLES WITH A CORRESPONDING ONE OF THE PLURALITY OF PN SEQUENCES AT THE TIME WHEN EACH ONE OF THE PLURALITY OF SIGNAL SAMPLES IS RECEIVED

METHOD AND SYSTEM FOR IMPLEMENTING A SYSTEM ACQUISITION FUNCTION FOR USE WITH A COMMUNICATION DEVICE

CROSS-REFERENCES TO RELATED APPLICATION(S)

[0001] This application is a continuation of U.S. patent application Ser. No. 10/067,496, filed Feb. 4, 2002, which is a continuation-in-part application of U.S. patent application Ser. No. 09/815,122, filed on Mar. 22, 2001, now U.S. Pat. No. 6,836,839, issued Dec. 28, 2004, the disclosures of each of the aforementioned applications are hereby incorporated by reference in their entirety as if set forth in full herein for all purposes.

BACKGROUND OF THE INVENTION

[0002] The present invention generally relates to a system acquisition function. More specifically, the present invention relates to a method and system for implementing a system acquisition function for use with a communication device.

[0003] In CDMA communication systems, each base station differentiates amongst one another by using an unique PN code. A communication device, such as a mobile phone, is equipped with a system acquisition function, typically embodied in a searcher, to search for and locate the PN codes of the base stations within the vicinity of the mobile phone. Upon power-on, one of the initial tasks of the mobile phone is to find the strongest pilot signal from the nearby base stations as soon as possible. The task of finding the strongest pilot signal is commonly known as system or pilot acquisition and is usually performed by a searcher within the mobile phone.

[0004] Under one conventional approach, the system acquisition function within the mobile phone is implemented in the form of the searcher using a serial search technique that only utilizes a set of complex correlators to search for the correlation peak from one PN code offset to another. This approach consumes less power and requires less hardware; however, the search for the correlation peak may take longer.

[0005] Under another conventional approach, the searcher within the mobile phone is implemented using a traditional parallel search technique that utilizes several sets of fixed, dedicated correlators to compute the correlation peak in a concurrent manner. This other approach may shorten the search time but it does so at cost of incurring more hardware and power consumption. Furthermore, since the acquisition mode is typically less active than other modes, the exclusive use of fixed, dedicated correlators often results in a waste of hardware resources within the mobile phone.

[0006] More specifically, system or pilot acquisition in a CDMA communication system is typically performed as follows. Each base station continually broadcasts its own unique PN code in a periodic manner. One PN code from one base station differs from another PN code from another base station by an offset. Before a PN code can be identified by the mobile phone, the mobile phone first searches for signals at a particular frequency. As a result, only signals from base stations transmitting at that particular frequency are received by the mobile phone.

[0007] Next, the PN code of the base station which transmits the strongest pilot signal is identified and synchronized. The mobile phone receives signals from different base stations and these received signals are added up. Typically, the received signals are stored by the mobile phone before the correlation process begins. The mobile phone has a local PN sequence generator which is capable of generating sequences of PN codes. Initially, before the PN code of the base station which transmits the strongest pilot signal is identified, the PN sequence generator generates an initial PN code. This initial PN code is correlated with the received signals by a correlator residing in the mobile phone. Correlation is done to determine the power level of the received signals. The correlation results are examined to determine if the received signals representing the PN code of the transmitting base station fall within an acceptable time delay from the initial PN code to qualify as the strongest pilot signal. If the correlation results are below a predetermined threshold, i.e., the initial PN code generated by the local PN sequence generator does not qualify as the strongest pilot signal, then the local PN sequence generator shifts by one chip to generate another PN code and this other PN code is correlated with the received signals. The generation of PN codes and the correlation of these codes with the received signals continue until the strongest pilot signal is identified.

[0008] When the strongest pilot signal is identified, the PN code generated by the PN sequence generator and used to identify the strongest pilot signal is synchronized with the PN code of the base station which transmits the strongest pilot signal. Once the synchronization of the PN code is achieved, the mobile phone is able to communicate with the base station.

[0009] Furthermore, after pilot acquisition is completed, the mobile phone continues searching for nearby strong pilot signals and maintains a list to keep track of such signals. This process is commonly called set maintenance. That is, in addition to the strongest pilot signal, the mobile phone also searches for and keeps track of a number of additional pilot signals (and their associated PN codes) with different levels of signal strength. For example, the mobile phone may maintain an active set which keeps track of additional multipaths associated with the pilot signal of the base station that the mobile phone is currently communicating with, a candidate set with pilot signals whose strengths exceed certain threshold, and a neighbor set that includes pilot signals from cells that are in the vicinity of the cells that the mobile phone is communicating with. Maintaining a number of additional pilot signals (and their associated PN codes) facilitates the handoff process. A handoff typically occurs when a mobile phone is roaming from one area to another. This happens when a pilot signal transmitted from another base station is stronger than the one that the mobile phone is currently communicating with. The candidate set may be used to more efficiently identify the new base station transmitting the strongest pilot signal. This is because the strongest pilot signal is more likely to be one of the signals included in the candidate set. Hence, the associated PN code can be retrieved more quickly and communication with the new base station likewise can be established in a shorter period of time.

[0010] As can be seen above, the received signals need to be stored by the mobile phone so they can be subsequently used for correlation purposes. Furthermore, generation of the PN codes by the PN sequence generator is done in a sequential manner by shifting the current PN code.

[0011] Hence, it would be desirable to provide a method and system to implement a searcher for use with a mobile phone to more efficiently identify the PN code of the base station which transmits the strongest pilot signal.

SUMMARY OF THE INVENTION

[0012] A method and system for implementing a system acquisition function for use with a communication device is provided. According to one exemplary embodiment of the system, the system acquisition function is embodied in a searcher. The searcher is embedded in the communication device, such as, a mobile phone. The searcher includes one or more computational units which are used to perform a PN sequence generation function to generate PN sequences. Each PN sequence is comprised of a number of PN chips. The searcher further includes a number of computational units which are used to correlate received signal samples with the PN chips generated by the PN sequence generation function. As each signal sample is received by the communication device, the received signal sample is correlated (complex multiplied) with a PN sequence in a parallel manner using the computational units. The sample correlation results are then respectively accumulated within each computational unit that conducts the corresponding sample correlation. As the next signal sample is received, this newly received signal sample is similarly correlated with the next PN sequence in a parallel manner. Likewise, the sample correlation results are also accumulated. The foregoing process is repeated until all the signal samples needed to complete a signal correlation are received and correlated with the PN sequences. The number of PN chips within a PN sequence used to correlate with each received signal sample is equivalent to a correlation length chosen such that the correlation results between each received signal sample and the locally generated PN sequence are sufficiently reliable to determine whether the strongest pilot is found.

[0013] According to another aspect of the system, the computational units are implemented using adaptive hardware resources. The number of computational units which are used to implement the PN sequence generation function and the correlation function are adjustable depending on, for example, the amount of available adaptive hardware resources.

[0014] Reference to the remaining portions of the specification, including the drawings and claims, will realize other features and advantages of the present invention. Further features and advantages of the present invention, as well as the structure and operation of various embodiments of the present invention, are described in detail below with respect to accompanying drawings, like reference numbers indicate identical or functionally similar elements.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] FIG. **1** is a simplified diagram illustrating an exemplary embodiment of an M-node having four (4) computational units in accordance with the present invention;

[0016] FIG. **2** is a simplified diagram illustrating an exemplary method for performing correlations in accordance with the present invention;

[0017] FIG. **3** is a simplified diagram illustrating the exemplary method as shown in FIG. **2** for performing an additional round of correlations in accordance with the present invention;

[0018] FIG. **4** is a simplified diagram illustrating a second exemplary method for performing correlations in accordance with the present invention;

[0019] FIG. **5** is a simplified diagram illustrating a third exemplary method for performing correlations in accordance with the present invention;

[0020] FIG. **6** is a block diagram illustrating an exemplary system embodiment in accordance with the present invention;

[0021] FIG. **7** is a flow diagram illustrating a first exemplary method embodiment in accordance with the present invention; and

[0022] FIG. **8** is a flow diagram illustrating a second exemplary method embodiment in accordance with the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0023] The present invention in the form of one or more exemplary embodiments will now be described. FIG. **1** is a simplified diagram illustrating an exemplary embodiment of the present invention. Referring to FIG. **1**, there is shown a searcher **10** having a number of computational units **12***a-m*. The searcher **10** can be located in any type of communication device, such as a mobile phone. As will be further demonstrated below, each computational unit **12***a-m* correlates the received signal samples with a corresponding PN code. In an exemplary embodiment, these computational units **12***a-m* are implemented using reconfigurable hardware resources within an adaptive computing architecture. Details relating to the adaptive computing architecture and how reconfigurable hardware resources are used to implement functions on an on-demand basis are disclosed in U.S. Pat. No. 6,836,839, issued Dec. 28, 2004, the disclosure of which is hereby incorporated by reference in their entirety as if set forth in full herein for all purposes. It should be understood that while the present invention is described as being in the searcher **10**, it will be appreciated by a person of ordinary skill in the art that the present invention can be implemented in other manners within a communication device. For example, some or all of the functionality of the present invention as described herein may be implemented outside of the searcher **10** in other parts of the communication device.

[0024] In an exemplary embodiment, the computational units **12***a-m* are arranged in a sequential order and configured to calculate the correlations between the received signal samples and a number of PN sequences. The start of any two adjacent PN sequences is offset by one chip. More specifically, the computational units **12***a-m* correlate each received signal sample with their corresponding components of a PN sequence in a parallel manner.

[0025] The PN sequences used by the computational units **12***a-m* are generated in a successive, offset order. The starting position of each successive PN sequence is only one chip off from the preceding PN sequence. The PN chips of each PN sequence can be provided to the computational units **12***a-m* in a number of ways. For example, the PN chips can be generated by either a PN sequence generator implemented in the form of another computational unit (not shown) or a RISC processor. As will be described further below, each PN chip is shifted into a corresponding computational unit **12***a-m*. Each computational unit **12***a-m* includes a local memory for storing its corresponding PN chip.

[0026] FIG. **2** illustrates an exemplary method for performing correlations in accordance with the present invention. Assume the time duration of a received signal sample is T_d, that is, one signal sample is received every Td. Then, conversely, the frequency of the received signal sample is $1/T_d=f_d$.

[0027] Referring to FIG. **2**, there are m computational units **20***a-m* within the searcher **10**. At time to, signal sample R_0 is received by a receiver (not shown) located within the communication device. Signal sample R_0 is then correlated with the PN sequence, $P_0P_1 \ldots P_{M-1}$. The PN sequence, $P_0P_1 \ldots P_{M-1}$, is generated by a PN sequence generator (as shown in FIG. **6**) located within the communication device. Since there are M PN chips within the PN sequence, M computational units **20***a-m* are used to do the correlations in parallel. Hence, each computational unit **20***a-m* correlates the signal sample R_0 with one PN chip. For example, computational unit **20***a* correlates R_0 with P_0 to generate correlation result R_0P_0. The collective correlation results generated by the computational units **20***a-m* are as follows: $R_0P_0, R_0P_1, \ldots, R_0P_{M-1}$. The correlations are performed and the correlation results are respectively accumulated into the computational units **20***a-m* before the next signal sample R_1 is received at time t_1. The signal sample R_0 may then be discarded after the correlations are performed.

[0028] At time t_1, signal sample R_1 is received. Signal sample R_1 is then correlated with a second PN sequence, $P_1P_2 \ldots P_M$. The PN sequence, $P_1P_2 \ldots P_M$, is only a shift of the PN sequence used at time t_0 plus a newly generated PN chip P_M. That is, the start of the new PN sequence is offset by one chip from the preceding PN sequence. Consequently, the new PN sequence can be supplied to or propagated through the computational units **20***a-m* as follows. Except for the last computational unit **20***m*, each computational unit **20***a*-**1** receives its corresponding PN chip for the next correlation from its neighbor. The last computational unit **20***m* receives its corresponding PN chip P_M from the PN sequence generator. In other words, except for the first computational unit **20***a*, each remaining computational unit **20***b-m* passes its current PN chip to its neighbor in the same direction. As to the first computational unit **20***a*, its current PN chip is discarded; and as to the last computational unit **20***m*, as mentioned above, the PN sequence generator provides the next PN chip. For example, after the correlations are completed for the received signal sample R_0 (which is some time before time t_1), computational unit **20***a* discards its current PN chip P_0 and receives its next PN chip (which will be P_1) from computational unit **20***b*; computational unit **20***m* passes its current PN chip P_{M-1} to its neighboring computational unit **201** (not shown) and receives its next PN chip P_M from the PN sequence generator; and the remaining computational units **20***b*-**1** pass their current PN chips respectively to their neighbors in one direction and receive their next PN chips respectively from their neighbors in the other direction.

[0029] Again, since there are M PN codes within a PN sequence, M computational units **20***a-m* are used to do the correlations in parallel. This time around, the collective correlation results generated by the computational units **20***a-m* are as follows: $R_1P_1R_1P_2, \ldots, R_1P_M$. The correlations are performed and the results are accumulated with the correlation results that were done at time t_0 before the next signal sample R_2 is received at time t_2. Hence, for example, before time t_2, computational unit **20***a* contains correlation results R_0P_0 and R_1P_1. The foregoing process is repeated until the last signal sample R_{n-1} is received at time t_{n-1} and then correlated with the PN sequence, $P_{n-1}P_n \ldots P_{M+n-2}$ generating the following collective correlation results: $R_{n-1}P_{n-1}, R_{n-1}P_n, \ldots, R_{n-1}P_{M+n-2}$.

[0030] At the end of the time period, $t_{n-1}+T_d$, the correlation results for the received signal samples, $R_0R_1 \ldots R_{n-1}$, with n different PN sequences that are offset by one chip between the start of any two adjacent PN sequences, are then obtained. For example, $R_0P_0+R_1P_1+\ldots+R_{n-1}P_{n-l}$ represent the correlation results accumulated at computational unit **20***a*. Also, at the end of the time period, $t_{n-1}+T_d$, M different PN code offsets have been searched. If the number of PN codes that need to be searched is M or fewer, then the entire search process is completed at the end of the time period $t_{n-1}+T_d$.

[0031] If the number of PN codes that need to be searched is more than M, then a second round of search or correlations (or additional rounds if necessary) may be performed. The length (time-wise) of a round of correlations is the time period $t_{n-1}+T_d$. For example, FIG. **3** illustrates this second round of correlations. Before the second round of correlations begins, the accumulated correlation results in each of the computational unit **20***a-m* are transferred and stored in other memory locations and then cleared. Referring to FIG. **3**, in the second round of correlations, the received signal sample R_n is correlated by the computational units **20***a-m* with the PN sequence, $P_{n+M}P_{n+M+1} \ldots P_{n+2M-1}$ at time t_n. The correlation results are then accumulated at each of the computational unit **20**-*a-m*.

[0032] At time t_{n+1}, the signal sample R_{n+1} is correlated with the next PN sequence, $P_{n+M+1}P_{n+M+2} \ldots P_{n+2M}$. Similarly, the start of this next PN sequence is offset from the preceding PN sequence by one chip and a new PN chip is added at the end. This process will continue until the second round of correlations is completed. For the second round of real-time correlations, another M PN offsets ($P_M, P_{M+1}, \ldots, P_{2M+1}$) are searched. The correlation results are then stored and cleared from each computational unit **20***a-m* before the next round of correlations starts.

[0033] According to the exemplary method shown in FIG. **2**, all the received signal samples R_x are not stored first and then later used for correlation purposes. Instead, as each signal sample R_x is received, the signal sample R_x is correlated with M PN codes and then accumulated. The collective correlation results for all the received signal samples R_x are then examined to identify the PN sequence which corresponds to the strongest pilot signal. Hence, the collective correlation results for the received signal samples R_x can be derived much faster. In addition, since all the received signal samples R_x need not be stored before the correlation function is performed, the memory overhead and hardware requirements and costs correspondingly become less.

[0034] As can be seen from FIG. **2**, for each time period T_d, M computational units **20***a-m* are used to correlate a received signal sample R_x with a PN sequence which has M PN codes. For each time period T_d, each computational unit **20***a-m* performs one correlation. As a result, with M computational units **20***a-m*, M correlations are collectively performed. As will be further described below, the number of computational units **20***a-m* which are used to perform the correlations is scalable. That is, the number of computational units **20***a-m* may vary depending on the amount of hardware resources available and the clock rate that is used to drive each computational unit.

[0035] Referring back to FIG. **2**, for each time period T_d and a PN sequence with M PN codes, each computational unit performs one correlation thereby resulting in M correlations being performed. However, each computational unit is not necessarily restricted to performing one correlation during each time period T_d.

[0036] Each computational unit may perform two or more correlations per time period T_d. While M correlations are to be performed per time period T_d, these M correlations may be collectively performed by a fewer number of computational units. For example, referring to FIG. **4**, there are M/2 computational units. In this case, each of the M/2 computational units is driven to perform two (2) correlations within the time period T_d; for instance, computational unit **30***a* performs two (2) correlations and generates correlation results R_0P_0 and R_0P_1. In order to perform two (2) correlations with the time period T_d, each computational unit is driven at a higher clock rate to increase the speed of execution.

[0037] In another example, as shown in FIG. **5**, there are M/4 computational units. In this case, each of the M/4 computational units is driven to perform four (4) correlations within the time period T_d; for instance, computational unit **40***a* performs four (4) correlations and generates correlation results R_0P_0, R_0P_1, R_0P_2 and R_0P_3. In order to perform four (4) correlations with the time period T_d, each computational unit is driven at an even higher clock rate to increase the speed of execution.

[0038] FIG. **6** is a block diagram illustrating an exemplary system **100** embodiment in accordance with the present invention. As illustrated, an exemplary system **100**, for implementing a system acquisition function to facilitate PN code searching, comprises: a PN sequence generator **110** configured to generate a plurality of PN sequences; and a searcher **10** having a plurality of computational units **20***a*-**20***m* forming a correlator **130** and configurable to correlate a received signal sample (from receiver **120**) with a PN sequence generated by the PN sequence generator, the correlations being executed in a parallel manner. As discussed above, the plurality of PN sequences are generated in a sequential manner; the plurality of PN sequences includes a first PN sequence and a second PN sequence, the second PN sequence immediately following the first PN sequence; and the start of the second PN sequence is determined by shifting the first PN sequence. In addition, a number of computational units from the plurality of computational units are selectively configured to correlate the received signal sample with the PN sequence, with the number of computational units which are selectively configured to correlate the received signal with the PN sequence depending on availability of the plurality of computational units.

[0039] FIG. **7** is a flow diagram illustrating a first exemplary method embodiment for implementing a system acquisition function to facilitate the PN code searching in accordance with the present invention. The first exemplary method begins with generating a first PN sequence, the first PN sequence being made up of a plurality of PN chips, step **205**, and receiving a first signal sample, step **210**. The first signal sample is correlated with the first PN sequence upon receiving the first signal sample, step **215**, and a correlation result from the correlation between the first signal sample and the first PN sequence is stored, step **220**. A second PN sequence is generated by shifting the first PN sequence and adding an additional PN chip, step **225**, and a second signal sample is received, step **230**. The second signal sample is correlated with the second PN sequence, step **235**, and the methodology accumulates a correlation result from the correlation between the second signal sample and the second PN sequence with the correlation result from the correlation between the first signal sample and the first PN sequence, step **240**. The method then repeats the above generating, receiving, correlating and accumulating steps with each received signal and each newly generated PN sequence, step **245**.

[0040] FIG. **8** is a flow diagram illustrating a second exemplary method embodiment for implementing a system acquisition function to facilitate PN code searching in accordance with the present invention. The second exemplary method begins with maintaining a plurality of configurable computational units, step **305**, and receiving a plurality of signal samples, step **310**. One or more of the plurality of configurable computational units are configured to implement a PN sequence generator to generate a plurality of PN sequences, step **315**. One or more of the plurality of configurable computational units are configured to implement a correlator to correlate the plurality of signal samples with the plurality of PN sequences, step **320**. Each one of the plurality of signal samples is correlated with a corresponding one of the plurality of PN sequences at the time when each one of the plurality of signal samples is received, step **325**. As discussed above, the number of configurable computational units used to implement the correlator depends on availability of the plurality of configurable computational units. In addition, the method may also provide for generating the plurality of PN sequences in a sequential manner, wherein the plurality of PN sequences includes a first PN sequence and second PN sequence, the second PN sequence immediately following the first PN sequence, and wherein the start of the second PN sequence is determined by shifting the first PN sequence.

[0041] Based on the disclosure provided herein, a person of ordinary skill in the art should be able to determine the appropriate number of computational units to be used to implement the PN sequence generation function and the correlation function in accordance with the present invention. The number of computational units which can be used depends on a number of factors, such as the availability of the configurable hardware resources, the incoming signal rate or, conversely, the signal period, and the available clock rates, etc. For instance, if only a limited number of computational units can be used, then the clock rate may need to be driven higher in order to perform the requisite number of correlations. Conversely, if additional hardware resources are available, additional computational units driven at a lower clock rate may be implemented to perform the same number of correlations. For another instance, if the signal period is shortened, then additional computational units may be needed to perform the requisite number of correlations within the signal period.

[0042] The present invention as described above can also be used to provide more efficient set maintenance. Signals from the base station which previously transmitted the strongest pilot signal can be searched and correlated more quickly to confirm that this base station continues to be the one transmitting the strongest pilot signal. Likewise, signals from the base stations which correspond to the candidate set and the neighbor set respectively can also be searched and correlated more quickly to update the status of the neighbor set and the neighbor set. A candidate set may be searched more frequently than a neighbor set. As a result, the set maintenance update cycle is reduced.

[0043] Moreover, while the above disclosure provided above is described in connection with a searcher **10**, it should be understood that the present invention is not restricted to use with a searcher and that the present invention is applicable to and can be used with any communication devices which are capable of performing a system acquisition function.

[0044] It is understood that the present invention as described above is applicable to a CDMA communication system but that a person of ordinary skill in the art should know of other ways and/or methods to apply the present invention to other types of communication systems.

[0045] Furthermore, it is to be understood that the present invention as described above can be implemented in the form of control logic using software, hardware or a combination of both. Based on the disclosure provided herein, a person of ordinary skill in the art will know of other ways and/or methods to implement the present invention.

[0046] It is further understood that the examples and embodiments described herein are for illustrative purposes only and that various modifications or changes in light thereof will be suggested to persons skilled in the art and are to be included within the spirit and purview of this application and scope of the appended claims. All publications, patents, and patent applications cited herein are hereby incorporated by reference for all purposes in their entirety.

What is claimed is:

1. A system for implementing a system acquisition function to facilitate PN code searching, comprising:
- a PN sequence generator configured to generate a plurality of PN sequences; and
- a plurality of computational units configurable to correlate a received signal sample with a PN sequence generated by the PN sequence generator, the correlation being executed in a parallel manner;
- wherein a number of computational units from the plurality of computational units are selectively configured to correlate the received signal sample with the PN sequence, the number of computational units which are selectively configured to correlate the received signal with the PN sequence depends on availability of the plurality of computational units.

2. The system according to claim **1** wherein the plurality of PN sequences are generated in a sequential manner;
- wherein the plurality of PN sequences includes a first PN sequence and a second PN sequence, the second PN sequence immediately following the first PN sequence; and
- wherein the start of the second PN sequence is determined by shifting the first PN sequence.

3. The system according to claim **1** wherein the PN sequence has M components; and
- wherein the number of computational units selectively configured to correlate the received signal sample with the PN sequence is M or smaller.

4. The system according to claim **3** wherein the number of computational units selectively configured to correlate the received signal sample with the PN sequence is capable of being reduced if a clock rate driving the plurality of computational units is increased.

5. The system according to claim **3** wherein the number of computational units selectively configured to correlate the received signal with the PN sequence is capable of being reduced if the availability of the plurality of computational units is reduced.

6. The system according to claim **1** wherein the received signal sample is correlated with the PN sequence as soon as the received signal sample is received.

7. The system according to claim **6** wherein after correlating the received signal sample with the PN sequence, the received signal sample is discarded.

8. The system according to claim **1** wherein one or more of the plurality of computational units are configurable to implement another function when the PN code searching is not needed.

9. The system according to claim **1** wherein the system acquisition function is performed by a communication device.

10. The system according to claim **9** wherein the communication device is a mobile phone for use in a CDMA communication system.

11. A system acquisition module for facilitating PN code searching, comprising:
- a PN sequence generator configured to generate a plurality of PN sequences; and
- a plurality of computational units configurable to correlate a plurality of received signal samples with the plurality of PN sequences;
- wherein each of the plurality of received signal samples is correlated with a corresponding one of the plurality of PN sequences; and
- wherein a number of computational units from the plurality of computational units are selectively configured to correlate the plurality of received signal samples with the plurality of PN sequences, the number of computational units which are selectively configured to correlate the plurality of received signal samples with the plurality of PN sequences depends on availability of the plurality of computational units.

12. The system acquisition module according to claim **11** wherein the plurality of received signal samples is received in a sequential manner;
- wherein the plurality of PN sequences is generated in a sequential order and starting positions of any two adjacent PN sequences are offset by a chip.

13. The system acquisition module according to claim **12** wherein the plurality of PN sequences includes a first PN sequence and a second PN sequence, the second PN sequence immediately following the first PN sequence; and
- wherein the start of the second PN sequence is determined by shifting the first PN sequence.

14. The system acquisition module according to claim **12** wherein each of the plurality of received signal samples is correlated with the corresponding one of the plurality of PN sequences as soon as each of the plurality of received signal samples is received.

15. The system acquisition module according to claim **14** wherein after correlating a received signal sample with a corresponding PN sequence, the received signal sample is discarded.

16. The system acquisition module according to claim **11** wherein each of the plurality of PN sequences has M components; and
- wherein the number of computational units selectively configured to correlate the plurality of received signal samples with the plurality of PN sequences is M.

17. The system acquisition module according to claim **11** wherein the number of computational units which are selectively configured to correlate the plurality of received signal samples with the plurality of PN sequences is capable of being reduced if a clock rate driving the plurality of computational units is increased.

18. The system acquisition module according to claim **11** wherein the number of computational units which are selectively configured to correlate the plurality of received signal samples with the plurality of PN sequences is capable of being reduced if the availability of the plurality of computational units is reduced.

19. The system acquisition module according to claim **11** wherein one or more of the plurality of computational units are configurable to implement another function when the PN code searching is not needed.

20. The system acquisition module according to claim **11** wherein the system acquisition module is located in a communication device.

21. The system acquisition module according to claim **20** wherein the communication device is a mobile phone for use in a CDMA communication system.

22. A communication device having a system acquisition function, comprising:

a receiver configured to receive a plurality of signal samples;

a PN sequence generator configured to generate a plurality of PN sequences, the PN sequence generator being implemented by selectively using one or more of a first plurality of configurable computational units; and

a correlator configured to correlate the plurality of signal samples with the plurality of PN sequences, the correlator being implemented by selectively using one or more of a second plurality of configurable computational units, the number of configurable computational units to be selectively used to implement the correlator depending on availability of the second plurality of configurable computational units.

23. The communication device according to claim **22** wherein the plurality of signal samples is received in a sequential manner;

wherein the plurality of PN sequences is generated in a sequential order; and

wherein each of the plurality of signal samples is correlated with a corresponding one of the plurality of PN sequences.

24. The communication device according to claim **23** wherein the plurality of PN sequences includes a first PN sequence and a second PN sequence, the second PN sequence immediately following the first PN sequence; and

wherein the start of the second PN sequence is determined by shifting the first PN sequence.

25. The communication device according to claim **23** wherein each of the plurality of signal samples is correlated with the corresponding one of the plurality of PN sequences as soon as each of the plurality of signal samples is received.

26. The communication device according to claim **25** wherein after correlating a signal sample with a corresponding PN sequence, the signal sample is discarded.

27. The communication device according to claim **22** wherein each of the plurality of PN sequences has M components; and

wherein the number of configurable computational units to be selectively used to implement the correlator to correlate the plurality of signal samples with the plurality of PN sequences is M.

28. The communication device according to claim **22** wherein the number of configurable computational units which are to be selectively used to implement the correlator to correlate the plurality of signal samples with the plurality of PN sequences is capable of being reduced if a clock rate driving the second plurality of configurable computational units is increased.

29. The communication device according to claim **22** wherein the number of configurable computational units which are to be selectively used to implement the correlator to correlate the plurality of signal samples with the plurality of PN sequences is capable of being reduced if the availability of the second plurality of configurable computational units is reduced.

30. The communication device according to claim **22** wherein one or more of the second plurality of configurable computational units are configurable to implement another function when the system acquisition function is not needed.

31. The communication device according to claim **22** wherein the communication device is a mobile phone for use in a CDMA communication system.

32. A communication device having a system acquisition function, comprising:

a receiver configured to receive a plurality of signals;

a PN sequence generator configured to generate a plurality of PN sequences, the PN sequence generator being implemented by selectively using one or more of a plurality of configurable computational units; and

a correlator configured to correlate the plurality of signals with the plurality of PN sequences, the correlator being implemented by selectively using one or more of the plurality of configurable computational units;

wherein the number of configurable computational units to be selectively used to implement the correlator depend on availability of the plurality of configurable computational units.

33. The communication device according to claim **32** wherein the plurality of signals is received in a sequential manner;

wherein the plurality of PN sequences is generated in a sequential order; and

wherein each of the plurality of signals is correlated with a corresponding one of the plurality of PN sequences.

34. The communication device according to claim **33** wherein the plurality of PN sequences includes a first PN sequence and a second PN sequence, the second PN sequence immediately following the first PN sequence; and

wherein the start of the second PN sequence is determined by shifting the first PN sequence.

35. The communication device according to claim **32** wherein each of the plurality of signals is correlated with the corresponding one of the plurality of PN sequences as soon as each of the plurality of signals is received.

36. The communication device according to claim **35** wherein after correlating a signal with a corresponding PN sequence, the signal is discarded.

37. The communication device according to claim **32** wherein each of the plurality of PN sequences has M components; and

wherein the number of configurable computational units to be selectively used to implement the correlator to correlate the plurality of signals with the plurality of PN sequences is M or smaller.

38. The communication device according to claim **32** wherein the number of configurable computational units which are to be selectively used to implement the correlator to correlate the plurality of signals with the plurality of PN sequences is capable of being reduced if a clock rate driving the plurality of configurable computational units is increased.

39. The communication device according to claim **32** wherein the number of configurable computational units which are to be selectively used to implement the correlator to correlate the plurality of signals with the plurality of PN sequences is capable of being reduced if the availability of the plurality of configurable computational units is reduced.

40. The communication device according to claim **32** wherein one or more of the plurality of configurable computational units are configurable to implement another function when the system acquisition function is not needed.

41. The communication device according to claim **32** wherein the communication device is a mobile phone for use in a CDMA communication system.

42. A system for implementing a system acquisition function to facilitate PN code searching, comprising:

a PN sequence generator configured to generate a plurality of PN codes, one or more PN codes making up a PN sequence; and

a plurality of computational units configurable to correlate a plurality of received signals with a plurality of PN sequences;

wherein a number of computational units from the plurality of computational units are selectively configured to correlate the plurality of received signals;

wherein for each received signal, each configured computational unit correlates the received signal with a corresponding PN code of a first PN sequence and stores a correlation result, all the configured computational units perform their respective correlations upon receiving the received signal and in a parallel manner.

43. The system of claim **42** wherein after each received signal is correlated, a second PN sequence is generated by shifting the first PN sequence and adding an additional PN code; and

wherein upon receiving a next received signal, each configured computational unit correlates the next received signal with a corresponding PN code of the second PN sequence and accumulates a correlation result with the correlation result from the previously correlated received signal.

44. The system of claim **42** wherein the number of configured computational units is scalable.

45. The system of claim **42** wherein the number of configured computational units is capable of being reduced if performance of the plurality of computational units is increased.

46. The system of claim **42** wherein after each received signal is correlated, the received signal is discarded.

47. A method for implementing a system acquisition function to facilitate PN code searching, comprising:

maintaining a plurality of configurable computational units;

receiving a plurality of signals;

configuring one or more of the plurality of configurable computational units to implement a PN sequence generator to generate a plurality of PN sequences;

configuring one or more of the plurality of configurable computational units to implement a correlator to correlate the plurality of signals with the plurality of PN sequences; and

correlating each one of the plurality of signals with a corresponding one of the plurality of PN sequences at the time when each one of the plurality of signals is received;

wherein the number of configurable computational units used to implement the correlator depends on availability of the plurality of configurable computational units.

48. The method of claim **47** further comprising:

generating the plurality of PN sequences in a sequential manner, wherein the plurality of PN sequences include a first PN sequence and second PN sequence, the second PN sequence immediately following the first PN sequence, and wherein the start of the second PN sequence is determined by shifting the first PN sequence.

49. The method of claim **47** wherein the number of configurable computational units used to implement the correlator is capable of being reduced if a clock rate driving the plurality of configurable computational units is increased.

50. The method of claim **47** wherein the number of configurable computational units used to implement the correlator is capable of being reduced if the availability of the plurality of configurable computational units is reduced.

51. The method of claim **47** wherein one or more of the plurality of configurable computational units are configurable to implement another function when the system acquisition function is not needed.

52. A communication device utilizing the method of claim **47**.

53. The method of claim **52** wherein the communication device is a mobile phone for use in a CDMA communication system.

54. A method for implementing a system acquisition function to facilitate PN code searching, comprising:

generating a first PN sequence, the first PN sequence being made up of a plurality of PN codes;

receiving a first signal;

correlating the first signal with the first PN sequence upon receiving the first signal;

storing a correlation result from the correlation between the first signal and the first PN sequence;

generating a second PN sequence by shifting the first PN sequence and adding an additional PN code;

receiving a second signal;

correlating the second signal with the second PN sequence;

accumulating a correlation result from the correlation between the second signal and the second PN sequence with the correlation result from the correlation between the first signal and the first PN sequence; and

repeating the above generating, receiving, correlating and accumulating steps with each received signal and each newly generated PN sequence.

55. The method of claim **54** wherein the generating step further comprises:

configuring one or more of a plurality of configurable computational units to implement the generation function; and

wherein the correlating step further comprises:

configuring one or more of the plurality of configurable computational units to implement the correlation function, the number of configurable computational units to be configured to implement the correlation function depends on the availability of the plurality of configurable computational units.

56. The method of claim **55** wherein the number of configurable computational units to be configured to implement the correlation function is capable of being reduced if a clock rate driving the plurality of configurable computational units is increased.

57. The method of claim **55** wherein the number of configurable computational units to be configured to implement the correlation function is capable of being reduced if the availability of the plurality of configurable computational units is reduced.

58. The method of claim **55** wherein one or more of the plurality of configurable computational units are configurable to implement another function when the system acquisition function is not needed.

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