

**METHOD FOR MINIMIZING THE MAXIMUM SYSTEM TIME
UNCERTAINTY FOR A MOBILE STATION**

[0001] This application claims priority from copending United States provisional patent application serial number 60/500,432, filed September 5, 2003.

[0002] This invention relates generally to improvements in wireless communications systems. More particularly, the invention relates to improvements in methods and apparatus for position location of a mobile station in a wireless communication system.

[0003] Wireless communication systems typically include a plurality of mobile stations operating in a wireless network that includes a number of base stations through which the mobile stations communicate. "Mobile station" is the term used to describe a mobile communication device, such as a cellular telephone, PDA, pager, mobile computer, or the like. A base station typically includes a base station controller and one or more associated base transceiver station. The base station provides the functionality that enables a mobile station to access network services over the air interface.

[0004] Recently, in addition to the communication functionality of mobile stations, there has been increased interest in applications for accurately locating the position of the mobile stations. This desire has been driven in large part by regulatory forces. In June 1996, the Federal Communications Commission (FCC) mandated support for enhanced 911 (E-911) service with planned phased implementations by the first decade of the 21st century.

[0005] A common method of locating a mobile station is to determine the amount of time it takes for signals transmitted by known sources to reach the receiver of the mobile station to be located. One such source of transmitted signals is the Global Positioning Satellite (GPS) system. The GPS system has a constellation of 24 satellites (plus other spare satellites) circling the earth every 12 hours at an altitude of 20,200 km. Each GPS satellite transmits a unique message that identifies its position at a particular time. Multiple GPS signals at any particular time enable reference points to be developed from which the location of a GPS receiver can be determined. By measuring the distance from at least four GPS satellites, the GPS receiver can calculate its position anywhere on the earth. The distances can be determined by measuring the time delays required for the GPS signals to travel from the GPS satellites to the receiver.

[0006] However, mobile stations designs are extremely sensitive to power consumption, and added GPS circuitry for performing position determination decreases the battery operating time (i.e., the time between recharging) proportionally to its operational usage (i.e., duty factor). Nevertheless, mobile stations generally have limited battery capacity and must conserve power consumption. Therefore, it advantageous to minimize the operational power usage of the GPS circuitry to minimize the power consumption of the mobile station.

[0007] Power consumption is of particular concern during initial GPS signal acquisition, because of the relatively long operating time that is required to acquire the GPS signals. If power consumption were not a concern, the time to acquire a GPS signal would not be critical, and the GPS circuitry could be left on operational mode indefinitely.

[0008] However, initially, the position of the mobile station is unknown, both within the GPS system and with respect to the base station network in which the mobile system operates. All base stations are synchronized to the same network system time (i.e., all base station clocks are adjusted precisely to the same reference time, which is typically based on GPS time). When a signal is transmitted by a base station and received by the mobile station, there is an associated unknown propagation delay.

[0009] Thus, GPS signal acquisition duration is proportional to both the system time uncertainty and the position uncertainty of the mobile station. However, in some applications, time uncertainty is the dominant parameter. To acquire the GPS signal, the mobile station must turn on its GPS circuitry for a time period proportional to the maximum propagation delay between a base station in a known location and the mobile station, plus a time period proportional to the position uncertainty of the mobile station. Without further information, the maximum propagation delay is based on the worst case distance between a base station and the mobile station within its cell coverage (i.e., the maximum cell size).

[0010] Accordingly, to conserve power, the GPS circuitry should only be activated during a minimal search time window, for example, using methods for minimizing the search time window for the mobile station to acquire the GPS signals.

SUMMARY

[0011] The embodiments described herein provide methods for minimizing the search time window for the mobile station to acquire GPS signals. Thus, according to

one aspect of the invention, a method for minimizing maximum system time uncertainty uses a neighbor search window size (NSWS) parameter. The NSWS parameter is received in a message transmitted from a base station and a conversion table is used to match the NSWS parameter with a corresponding maximum antenna range (MAR). In one embodiment, the maximum propagation delay is calculated based on the MAR and propagation speed. Then, the search time window is set proportionally to the sum of the maximum propagation delay and a compensation for the position uncertainty of the mobile station.

[0012] In another broad aspect, a method for minimizing maximum system time uncertainty uses neighbor pilot measurements (NPM). A serving base station (SBS) is determined, and SBS multipath signals are received from SBS pilots transmitted by the serving base station. An earliest SBS multipath signal is selected from the SBS multipath signals, and N alternate base stations (ABSs) are determined. N sets of ABS multipath signals are received from N sets of ABS pilots transmitted by the N ABSs, and N earliest ABS multipath signals are selected from the N sets of ABS multipath signals. N time delays are determined with each of the N time delays being a time delay between each of the N earliest ABS multipath signals and the earliest SBS multipath signal. A maximum antenna range (MAR) is estimated, based on the N time delays. In one embodiment, the maximum propagation delay is calculated based on the MAR and propagation speed. Then, the search time window is set proportionally to the sum of the maximum propagation delay and a compensation for the position uncertainty of the mobile station.

[0013] In yet another aspect, a method for minimizing a maximum system time uncertainty uses a last successful position determination fix (LSPDF). The last successful position determination fix is determined, and a new fix is determined as the position of the mobile station at a current time. The time difference, t_d , is calculated from the last successful position determination fix to the new fix. The speed of the mobile station is determined, and the maximum distance d_{max} that the mobile station has moved since the last successful position determination fix based on the time difference, t_d , and the speed of the mobile station is determined. The maximum antenna range (MAR) is set to equal the sum of the maximum distance d_{max} and the serving base station distance d_{sbs} . In one embodiment, the maximum propagation delay is calculated based on the MAR and propagation speed. Then, the search time window is set

proportionally to the sum of the maximum propagation delay and a compensation for the position uncertainty of the mobile station.

[0014] In yet another aspect, in a method for minimizing maximum system time uncertainty a NSWS parameter is received in a message transmitted from a base station. MARNSWS is determined by using a conversion table to match the NSWS parameter, and the SBS is determined. SBS multipath signals are received from SBS pilots transmitted by the serving base station, and an earliest SBS multipath signal is selected from the SBS multipath signals. N ABSs are determined, and N sets of ABS multipath signals are received from N sets of ABS pilots transmitted by the N alternate base stations (ABS). N earliest ABS multipath signals are selected from the N sets of ABS multipath signals, and N time delays are determined with each of the N time delays being a time delay between each of the N earliest ABS multipath signals and the earliest SBS multipath signal. MARNPM is estimated, based on the N time delays, and the last successful position determination fix is determined. A new fix is defined as the position of the mobile station at the current time, and a time difference, t_d , from the last successful position determination fix to the new fix is determined. The speed of the mobile station is determined, and a MARLSPDF based on the time difference, t_d , and the speed of the mobile station is estimated. Finally, MAR is calculated, based on a weighted combination of MARNSWS, MARNPM and MARLSPDF. In one embodiment, the maximum propagation delay is calculated based on the MAR and propagation speed. Then, the search time window is set proportionally to the sum of the maximum propagation delay and a compensation for the position uncertainty of the mobile station.

BRIEF DESCRIPTION OF THE DRAWINGS

[0015] Figure 1 is simplified diagram of a wireless communication system.

[0016] Figure 2 is a flow diagram illustrating a method using neighbor search window size (NSWS).

[0017] Figure 3 is a flow diagram illustrating a method using neighbor pilot measurements.

[0018] Figure 4 is a flow diagram illustrating a method using a last successful position determination fix.

DETAILED DESCRIPTION

[0019] FIG. 1 is a simplified diagram of a wireless communication system in which mobile station 10, such as wireless telephones 10A or wireless PCs 10B, are located within the cell coverage of base stations 12. The base stations 12 are coupled to base station controllers (BSC) 14 which are coupled to a public switched telephone network (PSTN) 16.

[0020] At any one time during operation, some mobile stations 10 may be exchanging data with the base stations 12, while other mobile stations 10 may be on standby mode. In the embodiment illustrated, messages communicated from the base station 12 contain "aiding information" that allows the mobile stations 10 to speed up their acquisition of the GPS signal for a position determination fix. The aiding information may include, for example, neighbor search window size (NSWS) parameters, neighboring pilot measurements (NPM) from various base stations 12, or the like.

[0021] The mobile stations 10 use the aiding information to narrow the search time window (i.e., minimize the maximum system time uncertainty/maximum propagation delay), compensate for Doppler effects, and tune to the GPS frequency to begin correlating the received GPS signal. Upon receipt of the GPS signal, the mobile stations 10 can then determine their respective position locations using various known techniques.

[0022] During initial GPS signal acquisition, the position of the mobile station is unknown. If power consumption were not a concern, the time to acquire a GPS signal would not be critical, and the GPS circuitry could be left on operational mode indefinitely. However, as mentioned, mobile stations 10 have limited battery capacity and must conserve power consumption. Thus, to conserve power, the GPS circuitry should only be activated during a minimal search time window.

[0023] One method of minimizing the search window for acquiring the GPS signals is to include a highly accurate clock in the mobile station 10 that is synchronized to GPS time so that an appropriate time can be determined to search for the GPS signal. However, including a highly accurate clock in each mobile station 10 that can establish and maintain synchronization with GPS time may not be cost effective. Also, accommodating the volume and power requirements of such highly accurate clock within a mobile station 10 may be difficult.

[0024] Alternatively, all base stations are synchronized to the same network system time. That is, all base station clocks are adjusted precisely to the same reference time, which is typically based on GPS time. By including a highly accurate clock synchronized to GPS time, clock information of the base stations 12 can be transmitted to the mobile station 10 to minimize the search window for the GPS signals for position location.

[0025] Since the mobile station 10 and the base station 12 are typically not at the same location, there is a propagation delay in the clock information received by the mobile station 10 from the base station 12. Without auxiliary information, the maximum propagation delay in a wireless communication system is based on the worst case distance between a base station 12 and the mobile station 10 within its cell coverage. This is the largest possible cell size. This establishes the maximum system time uncertainty, and hence, the maximum search time window for the mobile station 10. If the maximum propagation delay can be refined to a value less than the worst case propagation delay, then the search time window, and hence, mobile station power consumption, are minimized. With the search time window minimized, the mobile station 10 can turn on its GPS circuitry to receive the GPS signal during the appropriate time window.

[0026] Figure 2 is a flow diagram illustrating a method using neighbor search window size (NSWS) for minimizing the maximum system time uncertainty (i.e., maximum propagation delay) for improving duration and accuracy of a position determination fix using GPS. In step 200, the mobile station 10 receives the NSWS parameter in a message transmitted from the base station 12. The (NSWS) parameter may be used to estimate maximum propagation delay due to the cell size of the serving base station. The NSWS parameter is deployed in such a way to be as large as possible to allow a successful handoff to a neighboring base station. At the same time, the NSWS should be as small as possible to reduce the neighboring pilot search time (this reduces power consumption and probability of neighbor base station pilot detection false alarm).

[0027] In one embodiment, a conversion table listing NSWS parameters and their corresponding maximum antenna range (MAR) is embedded in the memory of the mobile station 10. MAR is equal to the maximum propagation delay (which is equal to the maximum system time uncertainty) times the propagation speed c (i.e., speed of light). Using the received NSWS parameter, the mobile station 10 looks up the

corresponding MAR from the conversion table in step 210. The corresponding MAR using this method is denoted by MARNSWS.

[0028] In step 220, the maximum propagation delay is determined. Maximum propagation delay equals MAR (i.e., MARNSWS) divided by propagation speed c (i.e., speed of light). In step 230, the search time window is set proportionally to the sum of the maximum propagation delay and a compensation for the position uncertainty of the mobile station.

[0029] Figure 3 is a flow diagram illustrating a method using neighbor pilot measurements (NPM) for minimizing the maximum system time uncertainty for improving duration and accuracy of a position determination fix using GPS. In step 300, the mobile station 10 determines the SBS based on known techniques. Once the serving base station is determined, the mobile station 10 can receive valid SBS multipath signals from all usable SBS pilots transmitted by the serving base station in step 310.

[0030] From the received valid SBS multipath signals, in step 320, the mobile station 10 selects the earliest SBS multipath signal received from the serving base station. In step 330, the mobile station 10 receives valid ABS multipath signals from all usable ABS pilots transmitted by alternate base stations (ABS) other than the serving base station. In one embodiment, the alternate base stations are base stations (other than the serving base station) within the mobile communications network that are closest to the mobile station 10. Although the number of alternate base stations N is a design choice, the number of alternate base stations N may conveniently be three.

[0031] In step 340, for each alternate base station, the mobile station 10 selects the earliest ABS multipath signal from the received valid ABS multipath signals. Thus, for each alternate base station, there is a corresponding earliest ABS multipath signal. In step 350, the mobile station 10 estimates the MAR based on delays between the earliest ABS multipath signals from the alternate base stations and the earliest SBS multipath signal from the serving base station.

[0032] In one embodiment, the mobile station 10 determines the time delay associated with each of the earliest ABS multipath signals from the alternate base stations relative to the earliest SBS multipath signal from the serving base station. The mobile station 10 selects the earliest ABS multipath signal from the alternate base stations with the largest time delay ($\tau_{\max}$). Similarly, it selects the earliest ABS multipath signal from the alternate base stations with the smallest time delay ($\tau_{\min}$). In ideal base station deployment geometry and RF conditions, the estimated MAR should

be approximately be between 0.7 times propagation speed c times $(\tau_{\max} - \tau_{\min})$ and 1.6 times propagation speed c times $(\tau_{\max} - \tau_{\min})$. To account for non-ideal deployment geometry and/or RF conditions, conservatively estimate MAR using equation 1.

$$\text{MARNPM} = 2 \times c \times (\tau_{\max} - \tau_{\min}) \quad (1)$$

where c is the propagation speed

The MAR using this method is denoted by MARNPM.

[0033] An alternative way of describing the above is to select the largest time delay $\tau_{\max}$ from N time delays corresponding to the N alternate base stations, and to select the smallest time delay $\tau_{\min}$ from the same N time delays. Then, estimate MAR to be a constant K times propagation speed c times the difference between $\tau_{\max}$ and $\tau_{\min}$. In ideal conditions, the constant K is approximately between 0.7 and 1.6. In non-ideal conditions, a conservative estimate for K is 2.

[0034] In step 360, the maximum propagation delay is determined. Maximum propagation delay equals MAR (i.e., MARNPM) divided by propagation speed c (i.e., speed of light). In step 370, the search time window is set proportionally to the sum of the maximum propagation delay and a compensation for the position uncertainty of the mobile station.

[0035] Figure 4 is a flow diagram illustrating a method using last successful position determination fix (LSPDF) for minimizing the maximum system time uncertainty for improving duration and accuracy of a position determination fix using GPS. In this method, the current serving base station must be the same as the serving base station that determined the last successful position determination fix.

[0036] In step 400, the mobile station 10 calculates the time difference t_d between the last successful position determination fix and the new fix (i.e., the current time). In step 410, the mobile station 10 estimates the maximum distance $d_{\max}$ that the mobile station 10 has moved since the last successful position determination fix. In one embodiment, the maximum distance $d_{\max}$ is based on a predetermined maximum speed $V_{\max}$ of the mobile station 10 which may be recorded in the memory of the mobile station 10.

[0037] In another embodiment, the predetermined maximum speed $V_{\max}$ of the mobile station 10 may be entered by the user of the mobile station 10. In yet another embodiment, the predetermined maximum speed $V_{\max}$ of the mobile station 10 may be dynamically determined based on sensor measurements or the last successful GPS

measurements. The maximum distance $d_{\max}$ is based on the predetermined maximum speed $V_{\max}$ of the mobile station 10 and the time difference t_d . In step 420, MAR is set to equal the sum of the maximum distance $d_{\max}$ and the serving base station distance d_{sbs} . The serving base station distance d_{sbs} is the distance between the serving base station (during the last successful position determination fix) and the last successful position determination fix.

[0038] In step 430, the maximum propagation delay between the last successful position determination fix and the new fix is determined. Maximum propagation delay equals maximum distance $d_{\max}$ (i.e., MAR) divided by propagation speed c (i.e., speed of light). In step 440, the search time window is set proportionally to the sum of the maximum propagation delay and a compensation for the position uncertainty of the mobile station. The MAR using this method is denoted by MARLSPDF.

[0039] In an alternative method, the MAR can be estimated based on a weighted combination of MARNSWS, MARNPM and MARLSPDF. In one embodiment, the MAR is the minimum of MARNSWS, MARNPM and MARLSPDF. Once the MAR is estimated, it can be used to calculate maximum propagation delay, since the maximum propagation delay is equal to MAR divided by the propagation speed c . Then, the search time window is set proportionally to the sum of the maximum propagation delay and a compensation for the position uncertainty of the mobile station.

[0040] The description of various embodiments herein is not intended to represent the only embodiments in which the invention may be practiced, but are provided as examples or illustrations, and should not necessarily be construed as preferred or advantageous over other embodiments. The detailed description includes specific details for the purpose of providing a thorough understanding of the embodiments. However, it will be apparent to those skilled in the art that the invention may be practiced without these specific details. In some instances, well-known structures and devices are shown in block diagram form in order to avoid obscuring the concepts of the invention. Acronyms and other descriptive terminology may be used merely for convenience and clarity and are not intended to limit the scope of the invention. In addition, for the purposes of this disclosure, the term "coupled" means "connected to" and such connection can either be direct or, where appropriate in the context, can be indirect, e.g., through intervening or intermediary devices or other means.

[0041] Other embodiments will become readily apparent to those skilled in the art from the following detailed description and accompanying drawing, showing various illustrative embodiments. Of course, the invention is capable of other and different embodiments and its several details are capable of modification in various other respects, all without departing from the spirit and scope of the invention. Accordingly, the drawings and detailed description are to be regarded as illustrative in nature and not as restrictive.

CLAIMSWHAT IS CLAIMED IS:

1. A method of minimizing a maximum system time uncertainty using a neighbor search window size (NSWS) parameter for a mobile station in a wireless communications system, comprising:

receiving the NSWS parameter in a message transmitted from a base station; and
using a conversion table to match the NSWS parameter with a corresponding maximum antenna range (MAR).

2. The method of claim 1 further comprising:

calculating a maximum propagation delay based on the MAR and propagation speed;

and setting a search time window proportional to the sum of the maximum propagation delay and a position uncertainty.

3. The method of claim 1 wherein the conversion table is stored in a memory within the mobile station.

4. A method of minimizing a maximum system time uncertainty using neighbor pilot measurements (NPM) for a mobile station in a wireless communications system comprising:

determining a serving base station (SBS);
receiving a plurality of SBS multipath signals from a plurality of SBS pilots transmitted by the serving base station;

selecting an earliest SBS multipath signal from the plurality of SBS multipath signals;

determining N alternate base stations (ABS);
receiving N plurality of ABS multipath signals from N plurality of ABS pilots transmitted by the N alternate base stations (ABS);

selecting N earliest ABS multipath signals from the N plurality of ABS multipath signals;

determining N time delays with each of the N time delays being between each of the N earliest ABS multipath signals and the earliest SBS multipath signal; and
estimating a maximum antenna range (MAR) based on the N time delays.

5. The method of claim 4 further comprising:
calculating a maximum propagation delay based on the MAR and propagation speed;
and setting a search time window proportional to the sum of the maximum propagation delay and a position uncertainty.
6. The method of claim 4 wherein N is 3.
7. The method of claim 4 wherein the N alternate base stations are base stations within the wireless communications system other than the serving base station that are closest in distance to the mobile station.
8. The method of claim 4 further comprising:
selecting a largest time delay $\tau_{\max}$ from the N time delays;
selecting a smallest time delay $\tau_{\min}$ from the N time delays; and
estimating MAR to be K times propagation speed c times the difference between $\tau_{\max}$ and $\tau_{\min}$.
9. The method of claim 8 wherein K is 2.
10. The method of claim 8 wherein K is a constant between 0.7 and 1.6.
11. A method of minimizing a maximum system time uncertainty using a last successful position determination fix (LSPDF) for a mobile station in a wireless communications system comprising:
determining the last successful position determination fix;
defining a new fix as the position of the mobile station at a current time;
calculating a time difference, t_d , from the last successful position determination fix to the new fix;
determining a speed of the mobile station;

estimating a maximum distance, $d_{\max}$, that the mobile station has moved since the last successful position determination fix based on the time difference, t_d , and the speed of the mobile station;

estimating a serving base station distance d_{sbs} ; and

setting a maximum antenna range (MAR) to equal the maximum distance $d_{\max}$ and the serving base station distance d_{sbs} at the time of the last successful fix.

12. The method of claim 11 further comprising:

calculating a maximum propagation delay based on the MAR and propagation speed; and

setting a search time window proportional to the sum of the maximum propagation delay and a position uncertainty.

13. The method of claim 11 wherein the speed of the mobile station equals a predetermined maximum speed $V_{\max}$.

14. The method of claim 13 wherein the predetermined maximum speed $V_{\max}$ is stored in a memory of the mobile station.

15. The method of claim 13 wherein the predetermined maximum speed $V_{\max}$ is entered by a user of the mobile station.

16. The method of claim 11 wherein the speed of the mobile station is entered by a user of the mobile station.

17. A method of minimizing a maximum system time uncertainty for a mobile station in a wireless communications system comprising:

receiving a NSW parameter in a message transmitted from a base station, and determining a MARNSWS by using a conversion table to match the NSW parameter;

determining a serving base station (SBS), receiving a plurality of SBS multipath signals from a plurality of SBS pilots transmitted by the serving base station, selecting an earliest SBS multipath signal from the plurality of SBS multipath signals, determining N alternate base stations (ABS), receiving N plurality of ABS multipath signals from N plurality of ABS pilots transmitted by the N alternate base stations

(ABS), selecting N earliest ABS multipath signals from the N plurality of ABS multipath signals, determining N time delays with each of the N time delays being between each of the N earliest ABS multipath signals and the earliest SBS multipath signal, and estimating a MARNPM based on the N time delays;

determining a last successful position determination fix, defining a new fix as the position of the mobile station at a current time, calculating a time difference, t_d , from the last successful position determination fix to the new fix, determining a speed of the mobile station and estimating a MARLSPDF based on the time difference, t_d , the speed of the mobile station and a serving base station distance d_{sbs} at the time of the last successful fix; and

calculating a maximum antenna range (MAR) based on a weighted combination of MARNSWS, MARNPM and MARLSPDF.

18. The method of claim 17 wherein the weighted combination is the minimum of MARNSWS, MARNPM and MARLSPDF.

19. The method of claim 17 further comprising:

calculating a maximum propagation delay based on the MAR and propagation speed;

and setting a search time window proportional to the sum of the maximum propagation delay and a position uncertainty.

20. Computer readable media embodying a program of instructions executable by a computer program to perform a method for minimizing a maximum system time uncertainty using a neighbor search window size (NSWS) parameter for a mobile station in a wireless communications system, the method comprising:

receiving the NSWS parameter in a message transmitted from a base station; and

using a conversion table to match the NSWS parameter with a corresponding maximum antenna range (MAR).

21. The computer readable media of claim 20 wherein the method further comprises:

calculating a maximum propagation delay based on the MAR and propagation speed;

and setting a search time window proportional to the sum of the maximum propagation delay and a position uncertainty.

22. Computer readable media embodying a program of instructions executable by a computer program to perform a method for minimizing a maximum system time uncertainty using neighbor pilot measurements (NPM) for a mobile station in a wireless communications system, the method comprising:

determining a serving base station (SBS);

receiving a plurality of SBS multipath signals from a plurality of SBS pilots transmitted by the serving base station;

selecting an earliest SBS multipath signal from the plurality of SBS multipath signals;

determining N alternate base stations (ABS);

receiving N plurality of ABS multipath signals from N plurality of ABS pilots transmitted by the N alternate base stations (ABS);

selecting N earliest ABS multipath signals from the N plurality of ABS multipath signals;

determining N time delays with each of the N time delays being between each of the N earliest ABS multipath signals and the earliest SBS multipath signal; and

estimating a maximum antenna range (MAR) based on the N time delays.

23. The computer readable media of claim 22 wherein the method further comprises:

calculating a maximum propagation delay based on the MAR and propagation speed;

and setting a search time window proportional to the sum of the maximum propagation delay and a position uncertainty.

24. Computer readable media embodying a program of instructions executable by a computer program to perform a method for minimizing a maximum system time uncertainty using a last successful position determination fix (LSPDF) for a mobile station in a wireless communications system, the method comprising:

determining the last successful position determination fix;

defining a new fix as the position of the mobile station at a current time;

calculating a time difference, t_d , from the last successful position determination fix to the new fix;

determining a speed of the mobile station;

estimating a maximum distance $d_{\max}$ that the mobile station has moved since the last successful position determination fix based on the time difference, t_d , and the speed of the mobile station;

estimating a serving base station distance d_{sbs} ; and

setting a maximum antenna range (MAR) to equal the maximum distance $d_{\max}$ and the serving base station distance d_{sbs} at the time of the last successful fix.

25. The computer readable media of claim 24 wherein the method further comprises:

calculating a maximum propagation delay based on the MAR and propagation speed; and

setting a search time window proportional to the sum of the maximum propagation delay and a position uncertainty.

26. Computer readable media embodying a program of instructions executable by a computer program to perform a method for minimizing a maximum system time uncertainty for a mobile station in a wireless communications system, the method comprising:

receiving a NSWS parameter in a message transmitted from a base station, and determining a MARNSWS by using a conversion table to match the NSWS parameter;

determining a serving base station (SBS), receiving a plurality of SBS multipath signals from a plurality of SBS pilots transmitted by the serving base station, selecting an earliest SBS multipath signal from the plurality of SBS multipath signals, determining N alternate base stations (ABS), receiving N plurality of ABS multipath signals from N plurality of ABS pilots transmitted by the N alternate base stations (ABS), selecting N earliest ABS multipath signals from the N plurality of ABS multipath signals, determining N time delays with each of the N time delays being between each of the N earliest ABS multipath signals and the earliest SBS multipath signal, and estimating a MARNPM based on the N time delays;

determining a last successful position determination fix, defining a new fix as the position of the mobile station at a current time, calculating a time difference, t_d , from the last successful position determination fix to the new fix, determining a speed of the

mobile station and estimating a MARLSPDF based on the time difference t_d , the speed of the mobile station and a serving base station distance d_{sbs} at the time of the last successful fix; and

calculating a maximum antenna range (MAR) based on a weighted combination of MARNSWS, MARNPM and MARLSPDF.

27. The computer readable media of claim 26 wherein the method further comprising:

calculating a maximum propagation delay based on the MAR and propagation speed;

and setting a search time window proportional to the sum of the maximum propagation delay and a position uncertainty.