The MAHO lists and cell site information are delivered to a processor that can determine mobile location with either, or a combination, of two techniques. AT&T Wireless will initially utilize the second ("contour matching") technique, but will investigate the possibility of using the first ("triangulation") technique, either in place of or in combination with triangulation, as a means for improving accuracy.

In the first technique, termed "triangulation", the signal strength from multiple MAHO channels is associated to their cell site location. This then produces a geometric triangulation mathematical problem that can be solved to determine the mobile's location.

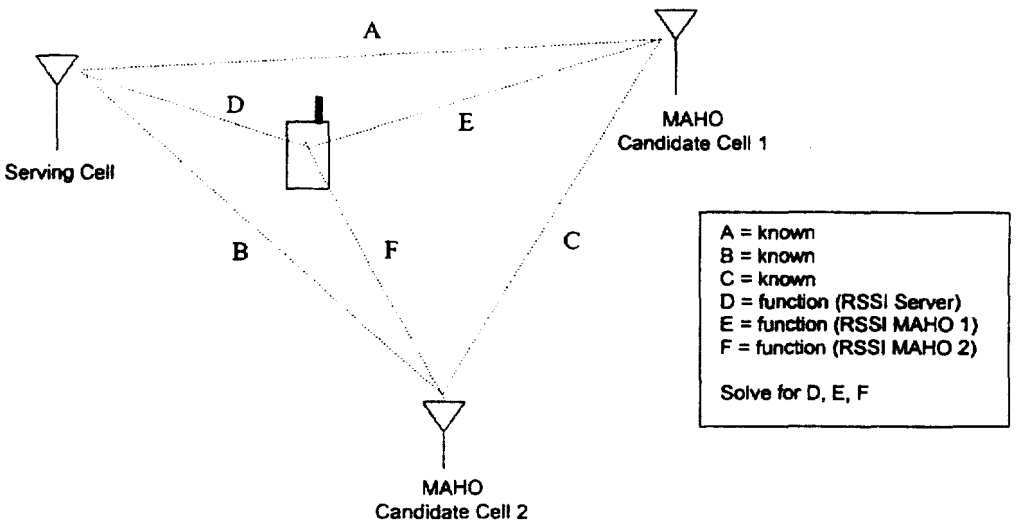


Figure 3: Example of "triangulation" to determine location, 3 site example.

In the second technique, termed "contour matching", the wireless system receives these measurements and compares these relative signal strength measurements to a specially-developed database of stored relative signal strength measurements within the cell serving the call. The wireless system will then determine the location of the mobile by matching it to one of these predetermined grid locations in the database.

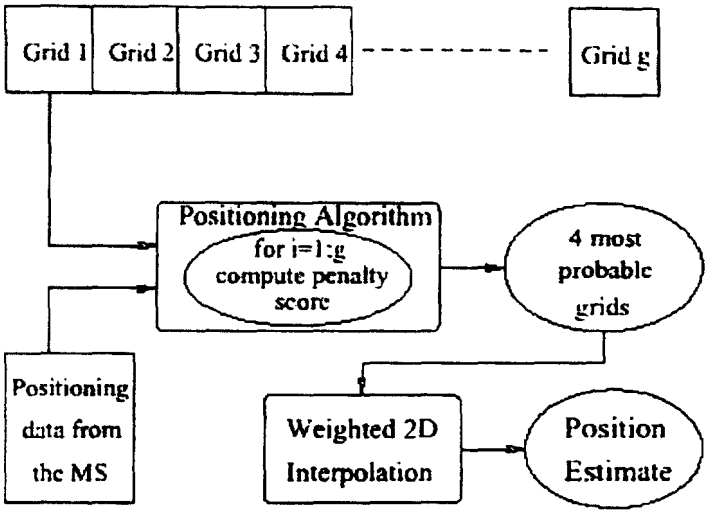


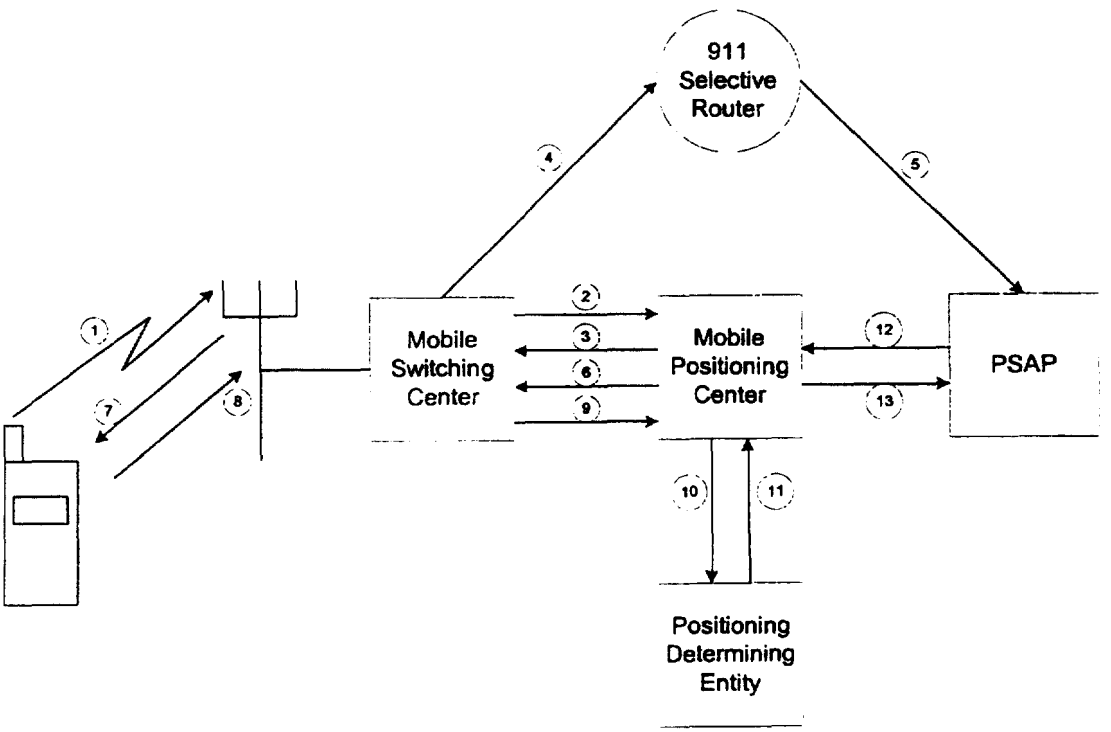
Figure 4: Wireless system determines location by matching DB grids to mobile report

The database for the grid measurements can be created in several different methods. The best method is to use available RF engineering tools to predict the expected received signal strength (RSS) measurements within grids as small as 50 meters. These engineering tools take into account antenna height and type, down-tilt, beam width, effective radiated power, and ground clutter. These predictive measurements can then also be augmented with real world measurements to increase accuracy in difficult areas.

It is possible to use both the triangulation and contour match techniques in combination. In combination, it would allow for the most flexibility.

Overall Location Processing Flow:

The following is the flow of the call through the network.



1. The mobiles places a call to 911
2. The MSC sends a J-STD-036 compliant message to the MPC indicating that a 911 call was placed, that the MSC is capable of doing MNLS and that the mobile is TDMA.
3. The MPC returns routing instructions to the MSC directing the call to the proper PSAP.
4. The MSC routes the voice portion of the call to the Selective router.
5. The selective router routes the call to the proper PSAP.
6. The MPC queries the MSC for the signal strength measurements, using a J-STD-036 compliant message, necessary for MNLS.

7. The MSC commands the mobile to make the measurements.
8. The mobile responds with the measurement report.
9. The MSC forwards the measurement report to the MPC.
10. The MPC sends the measurement report to the PDE to compute the exact location.
11. The PDE matches the location of the caller within the grid of the serving cell and returns the X/Y of the caller to the MPC.
12. The PSAP queries the MPC for the location of the call that it has just received.
13. The MPC returns the location of the caller to the PSAP.

(Steps 6-13 can be repeated for additional updated locations. Note: One of the advantages of the MNLS system is the fact that locates can be completed repeatedly on the same 911 call, in order to allow PSAPs additional information, such as direction of travel, etc.)

Status of Standards Efforts:

MNLS is a fully standards-compliant solution that is currently being adopted by TR45.2 AHES (Ad-Hoc on Emergency Services), the industry-PSAP body overseeing wireless E911 standards.

Advantages:

The MNLS has many advantages over other alternate solutions investigated. These advantages include:

1. Legacy handsets – The systems works with all TDMA handsets in the AWS ANSI-41 network. No changes, upgrades or replacements are necessary to these handsets.
2. Roaming support – MNLS will support all TDMA handsets roaming into our network.
3. Non-valid/uninitialized handsets – MNLS will support TDMA phones that do not have a valid account or phone number.
4. High Reliability – MNLS is using the same functionality normally required by the network. Therefore, if problems arise, they will be detected immediately. The integral nature of the MNLS solution to the overall network dramatically increases the reliability of the system. [Note: Conversely, network-overlay solutions, which by definition are independent from the normal call flow, make problems very hard to detect due of very low 911 call volume (relative to non-emergency calls). Trial experience has demonstrated that a complex low traffic system is extremely difficult to properly maintain and in which to detect problems.]
5. Standards compliant – MNLS is a fully standards compliant (see above).
6. Updated Location – One of the advantages of the MNLS system is the fact that locates can be completed repeatedly on the same 911 call, in order to allow PSAPs additional information, such as direction of travel, etc.

7. Improvement – The accuracy of the system can most likely be improved with ongoing enhancements to the algorithms, and to the location grid database.
8. One of the advantages of the MNLS system is the fact that locates can be completed repeatedly on the same 911 call, in order to allow PSAPs additional information, such as direction of travel, etc.

Trials:

AWS has been investigating MNLS since early 1997 as a possible solution to locating E911 callers. We have conducted, participated in or reviewed multiple trials including the following:

1. Trial in Kirkland, WA by AT&T Wireless in 1997
2. Trial by Nortel Networks in 1998
3. Trial in Stockholm by Ericsson in 2000
4. Trial in Redmond, WA by AT&T Wireless in 2001

Accuracy:

The following are the approximate accuracies expected:

All Environments	67%	95%
All Calls	Approx. 250 meters	Approx. 750 meters

CERTIFICATE OF SERVICE

I, Andrea Willis, hereby certify that on this 4th day of April 2001, I caused copies of the foregoing "AT&T Wireless Services, Inc. Request For Waiver Of The E911 Phase II Location Technology Implementation Rules" to be sent to the following by hand delivery:

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