AN02 Network Assistance

Introduction

In normal GPS receivers, when a positional computation is required the receiver needs to have the following data available in order to gain a rapid fix;

(1) An up to date almanac
(2) Rough estimates of receiver location and velocity
(3) An estimate of GPS time
(4) Valid satellite ephemeris for satellites in view

Almanac

The almanac is required to let the receiver know where the satellites will be in the sky for any given geographical location at any particular point in time. The almanac is valid for some time but needs to be downloaded from the satellites if the receiver has been powered down for long periods.

Positional, Velocity and GPS Time Estimates

If the estimates of receiver location, velocity and time are known then the receiver can perform a specific limited sky search for satellites as it knows where to look in the sky relative to the almanac. If these estimates are not available or valid, then the satellite sky search has to be opened up to acquire satellites with an associated increase in Time To First Fix (TTFF), as the receiver has to search the sky for all possible PRN codes, in all possible Doppler bins and for all possible code states.

Satellite Ephemeris

Once the receiver has located satellites, it needs to have an up to date ephemeris for each satellite so that each satellite can be used in performing a positional fix. Satellite ephemeris is automatically downloaded during satellite acquisition but takes approximately 30 seconds, and the ephemeris data itself is only valid whilst the specific satellites are still in view (the ephemeris data also starts to degrade after about 3 hours).

Therefore in summary, in order to achieve a rapid TTFF the receiver needs to have access to all of the above data in order to avoid having to perform a full sky search with associated degradation of TTFF.

Network Assistance

Assisted GPS, or A-GPS, is a technique whereby the receiver can be supplied with all or some of the above items of data to allow the receiver to obtain a rapid TTFF.

This data is normally provided to the receiver via some form of communications link from a remote server and is not downloaded from the satellites as in the normal satellite acquisition process. A-GPS can therefore provide the receiver with the ability to achieve a much faster TTFF than relying on the normal satellite acquisition process.

Much more importantly, if the receiver itself has high sensitivity then the receiver can cold start and provide a positional fix even with satellite signal levels lower than that required to cold start in the normal satellite acquisition process (this is largely because download of ephemeris data from the satellites normally requires reasonably strong signal levels of around at least –130dBm).

This also means that the receiver can maintain positional fixes by being able to acquire new satellites as old ones disappear from view, as A-GPS provides ephemeris data for satellites whose signals are below the limit for autonomous acquisition.

CW25 GPS Receiver with Network Assistance

The CW25 GPS receiver not only has the ability to perform positional fixes by using Network Assistance techniques, but the receiver also has the ability to acquire and track satellite signals down to –155dBm in this mode of operation. This means that the CW25 can perform assisted cold starts right down to satellite signal strengths of –155dBm (specific details of how the CW25 achieves this level of sensitivity can be found in AN01 Indoor GPS).

Satellite signal levels of –155dBm relate to signal levels typically seen in severe urban canyons, under dense foliage and even deep inside buildings. Normal GPS receivers cannot track satellites at such low levels or perform cold starts with such signals, and therefore using the CW25 with network assistance hugely increases the range of locations where positional fixes can be performed.

Network Assist Data

The network assist data that the CW25 can accept is as follows;

(1) Time

(2) Position

(3) Ephemeris

(4) Almanac

(5) Klobuchar Ionospheric parameters

(6) UTC corrections

The application of accurate time relies on the time data being accurate to below a few ms and therefore if the time data is sent over a communications link then the latency of the link may degrade the time data beyond useful limits. CDMA wireless systems for example are GPS synchronised and therefore able to provide accurate time to the CW25 whereas a GSM link could prove problematical. It is therefore important to consider the communications link to be used in providing accurate time data, and it is often better to concentrate more on providing data such as ephemeris, almanac, position etc. This will have a slight impact on the achieved TTFF but will still allow the CW25 to be able to acquire satellites down to signal levels of –155dBm.

Sources of Network Assist Data

Network assist data can be collected from all satellites remotely or from specialist websites, and then collated on a server that in turn transmits the data to the CW25 receivers. This technique needs to be used if receivers are to be tracked in locations all over the globe and at large distances from the network assistance server due to the fact that the receivers and server will see different satellites.

In the situation where the server is within a few hundred kilometres of all CW25 receivers being served with network assistance data, where there is commonality of satellites in view, then a server that includes a GPS receiver to collect the required assistance data can be used. NavSync can provide such a server in the form of the CW55 (see www.navsync.com for further details). The CW55 can also be used as a source of network assistance to a centralised server collating data from geographically diverse CW55 units.

CW25 Performance with Network Assistance

The TTFF performance of the CW25 GPS receiver when operating with network assistance was measured with the test set up shown in Figure 1. Although the CW25 receiver and the rest of the test set up was located in the laboratory completely inside the building, the CW25 antenna itself could be located either outside the building with a clear view of the sky, or completely inside the laboratory to demonstrate the ability to acquire satellite signals under very poor signal conditions.

The CW55 Network Assistance Server had its own antenna located outdoors to allow the CW55 to provide the required network assistance data to be supplied to the CW25 receiver under test. In this test, the communications link between the CW55 and the CW25 was a standard RS232 serial link. The TTFF performance of the CW25 receiver was measured from the standard NMEA datastream output from the CW25 receiver with test software located on a PC

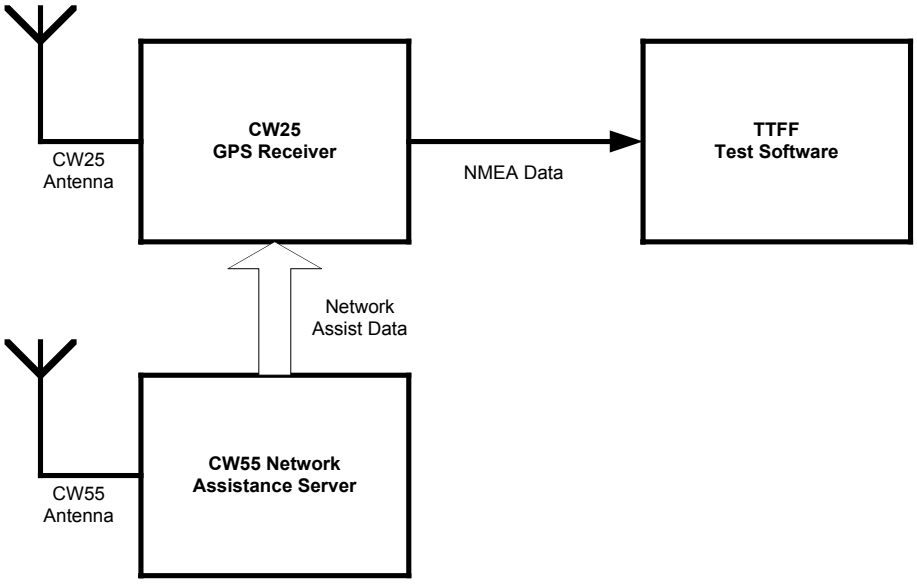
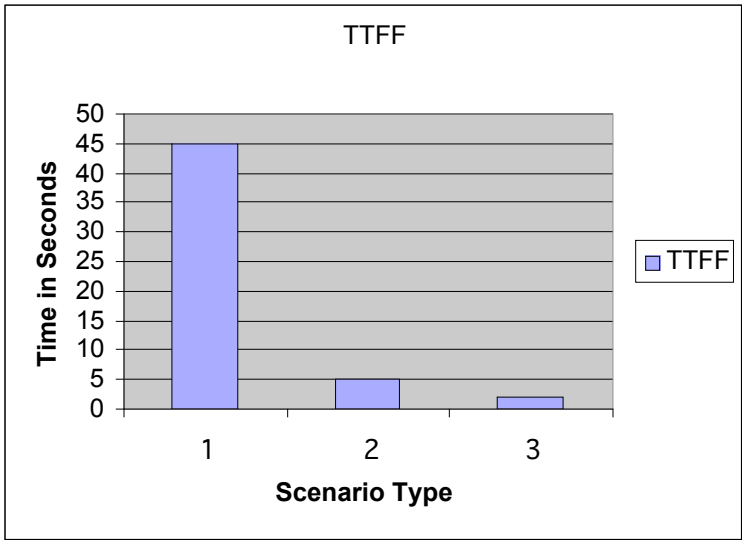


Figure1

Test Results



Scenario Type	Description
1	Autonomous outdoor cold start (no network assistance)
2	Indoor acquisition with network assistance
3	Outdoor acquisition with network assistance
Note	Full GPS engine software build in baseband processor

The test data shows that the CW25 receiver would achieve an autonomous outdoor cold start TTFF of 45 seconds (meaning that the CW25 receiver was working in the normal way of acquiring a positional fix without any network assistance data, and this TTFF figure was used as the benchmark for A-GPS operation).

The CW25 receiver would achieve an outdoor TTFF of < 2 seconds when supplied with network assist data and when the same test was performed with the CW25 antenna placed entirely within the building the TTFF performance was <5 seconds.

All of these tests were performed with the CW25 receiver software configured with the maximum build of number of taps and points on the FFT which allows the maximum TTFF performance. This maximum software build uses the highest level of power consumption and lower power consumptions can be realised by reducing the software build levels with associated increases in TTFF performance.

Lower overall power consumption can also be realised by allowing the CW25 to get a positional fix, writing accurate time to its on board Real Time Clock (RTC) and then putting the receiver to sleep until the next positional fix requirement, whereby the RTC is used to wake up the receiver with accurate time information.

The data shown in Table 1 shows the tracking performance of the CW25 receiver supplied with network assistance data, with the antenna connected to the CW25 located completely within the building some metres from any windows.

The CW25 achieved a positional fix with satellite signal strengths in the region of –150dBm to –155dBm by utilising the network assistance data, and then maintained tracking of the satellites with the same signal strength (without network assistance data, the CW25 would not be able to achieve the acquisition of satellites at such signal levels). The CW25 was able to maintain an estimated accuracy of <20m under such conditions.

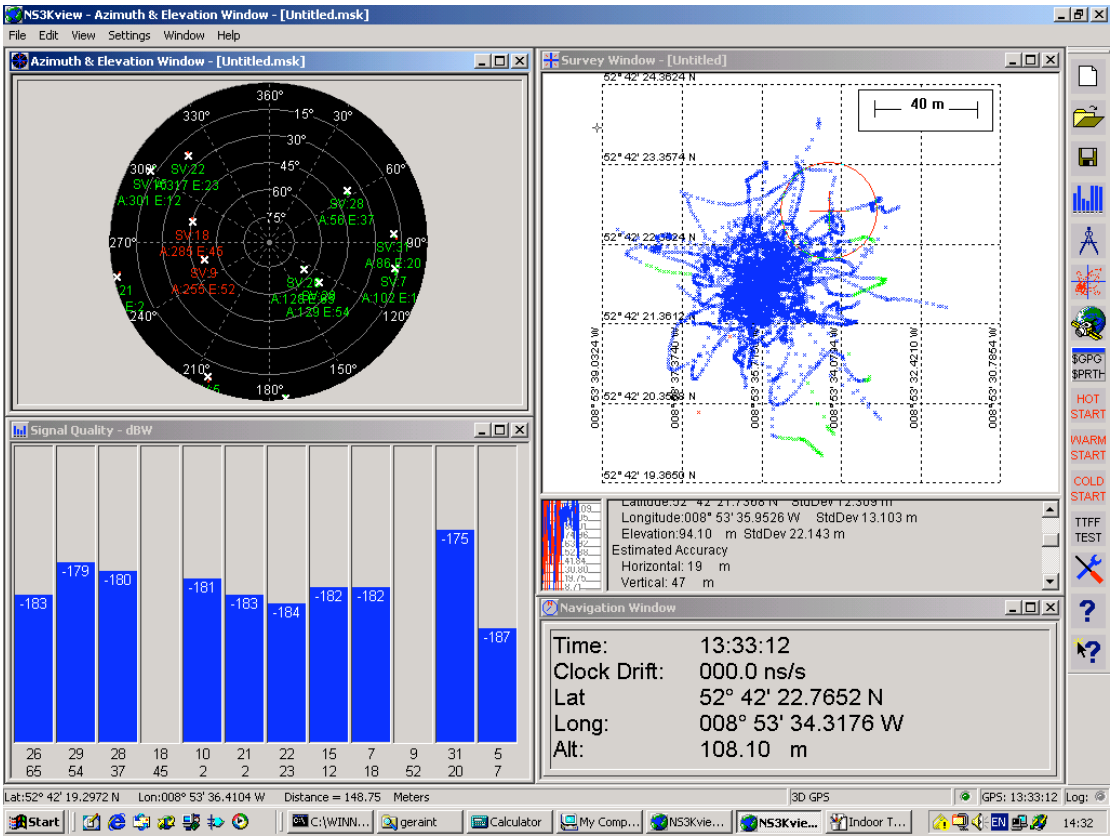


Table 1

Figure 2 shows the location of the antenna during the test. The antenna was located in the laboratory which is entirely inside a building with one small window to the outside some metres from the placement of the antenna.

The picture also shows the CW55 Network Assistance Base Station placed next to the CW25 receiver, which provided the assist data to allow the CW25 to acquire satellites under such conditions.

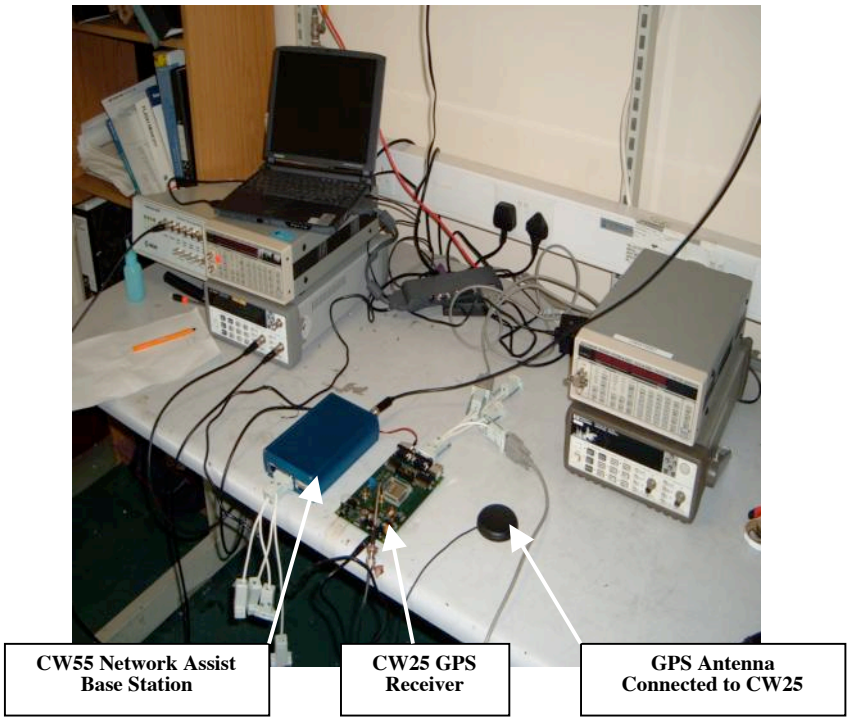


Figure 2

Conclusions

From the descriptions and test data presented in this application note, it can be seen that Network Assistance techniques can significantly reduce the TTFF for applications with normal signal strengths.

More importantly, it can be seen that the CW25 GPS receiver can utilise Network Assistance to perform very rapid TTFF figures for applications with very low signal strengths down to levels of –155dBm.

Under very low signal strength conditions, assisted CW25 operation will also allow continuous satellite tracking which would not be possible without network assistance, where the signal levels would be lower than that required to autonomously download satellite ephemeris data.

Therefore the combination of network assistance with the extremely high sensitivity of the CW25 enables GPS positional fixes and continuous tracking in extremely poor signal strength areas including locations deep inside buildings.

For further details of the CW25 GPS receiver and all other GPS products, please contact NavSync (contact details are available on www.navsync.com).