Technical Brief
How Quickly Should a GPS Receiver achieve an RTK Fixed Solution by Evan Bollard Utility Magazine August 2014

How Quickly Should a GPS Receiver achieve an RTK Fixed Solution

This is the proverbial "how long is a piece of string" in the use of satellite positioning systems equipment for high accuracy work. Based on my experience, it depends on the type of equipment being used. In general terms the first thing is that the receiver must be capable of carrier phase observations and be looking to fix the integer ambiguity of the carrier wave for each signal to each satellite that is being observed. (As we are only considering RTK fixed solutions in this particular response)

This type of equipment is often termed survey or professional grade.

Type of equipment and ballpark performance.

Open sky ballpark performances baseline less than 10Km's	**Single Constellation eg.GPS**	**Dual Constellation eg.GPS/Glonass**	**Multi Constellation eg. GPS/Glonass/ Galileo/BeiDou**
Single Frequency	1-10 minutes	30 seconds to 5 minutes	Under 3 minutes
Dual Frequency	10-seconds to 1 minute	10 seconds	1 second
Triple/Multi frequency	tbd	1 second	<1 second

Many combinations of the above are possible, however as a general statement the performance and cost increase as you move to the bottom right of the table.

If we simplify this analysis by stating that the "matching" base station (meaning similar, or better configuration, compared to the rover) is in a clear location with no restrictions. (As should be the goal with all base stations whether temporary or fixed – we are also not considering moving base stations in this response) This is stated as, in any RTK solution the base station or network of base stations is very relevant to the solution provided at the roving receiver. As an example if a rover unit was in an open sky environment and was using a poorly sited base station then an RTK fixed solution might never be possible no matter what type of roving receiver was being deployed.

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The next broad comment is the number of frequencies used by the system.

If it is a single frequency, single constellation receiver, some can produce reliable RTK fixed solutions in periods of 1 to 10 minutes depending on the environment the roving receiver is being used in. When in an open sky environment with no multipath (reflected signals) and sufficient satellites (7-9) with a suitable PDOP (<4) you will be closer to the lower end of the initialisation times. In a restricted environment (buildings, trees, high multipath, etc.) or a lower number of satellites (min. 5) then the initialisation may take quite a bit longer and is likely not to be achievable at all in difficult circumstances. Base line lengths (the distance from the base to the rover) should be less than 10Km for this outline to apply in the case of single frequency.

With dual frequency receivers the first advantage is that the RTK fixed solution is achieved faster than for single frequency. In an open environment from about 10 seconds to 1 minute. Next the baseline length can be much greater (30 to 40km) as when using a dual frequency configuration propagation variations of the various signals can be more effectively modelled and corrected for. Although the length of this base line will impact on the speed of initialisation. As a general rule the longer the baseline the longer the initialisation time.

Triple frequency receivers will have the advantage of different combinations to resolve the integer ambiguities when sufficient satellites provide these signals. This will lead to faster initialisations and more robust solutions. As yet these signals are not available on most satellites or have no published details for the third frequency signal that does exist. (ie. BeiDou B3 signal)

Next the use of more than one constellation of satellites can greatly enhance performance in any sort of restricted environment. For Single, Dual or Triple frequency receivers the addition of one or more extra satellite constellations allows the number and type of observations to increase and hence faster initialisation and better robustness for any solution.

Using a Dual frequency Dual constellation receiver in open conditions initialisation should be around 10 seconds at baseline lengths up to about 20Km's.

With multi-constellation, multi-frequency receivers virtually instantaneous initialisation is possible in an open environment and on heavily restricted sites caused by obstructions , provided sufficient satellites with an acceptable PDOP are available, reliable robust RTK solutions can be determined which are not possible with lower level receivers.

When using an RTK network based solution for base station information it is possible to get faster initialisations due to the advanced modelling of signal propagation variations associated with longer baseline lengths. Although there are many methodologies for network base station data provision, generally the intention is to provide corrections for a “location” close to the rover receiver. In essence making the baseline as short as practical. This also allows rover receiver operation at much larger distances from physical base stations without a significant degradation in performance.

In general, more satellites, more signals, from a closer or “network base station” leads to faster and more reliable, robust RTK fixed solutions.