GPS NAVIGATION APPLICATIONS IN ANTARCTICA

GPS was originally designed as military global navigation. It was subsequently made available to civilian users with guaranteed accuracy of position after a signal degradation termed Selective Availability had been applied.

Provided best practice was observed, the original GPS specifications stated that under conditions of Selective availability a single horizontal GPS position would have an uncertainty of 100 metres at 95 % confidence increasing to 300 metres at 99% confidence. This meant that 95% of the time the position obtained would be within 100 metres of the "true" (but generally unknown) position and 99% of the time it will be within 300 metres. However, as the position displayed by GPS receivers is often an average of a number of positions, it could be within about 30 metres of the "true" position. The height determined from a GPS receiver in point position mode is even more uncertain. According to the specifications the height will be within 156 metres at 95% confidence, rising to 500 metres at 99.99% confidence.

This type of position could be obtained from simple hand-held GPS receivers costing a few hundred dollars, or from more sophisticated (and expensive) surveying. However the consistency of the result can be affected by the hardware (e.g. clock, number of channels) and the firmware (i.e. the filtering and processing used). The achievable accuracy at that time is shown in the table below.

Technique	**Receivers required**	**Coverage**	**Observation Time**	**Accuracy**
Point positioning & navigation	1	Anywhere	Seconds	50-100 m
Differential navigation (DGPS)	2	100s km	Seconds	1 - 10 m
Static differential	2	~100 km	Hours	1 - 10 cm
Psuedo-kinematic	2	~20 km	Minutes	2 - 5 cm
Regional solutions	1	1,000s km	Days	1 - 5 cm

Static differential precise survey

Static Differential GPS, typically used for accurate surveying measurements, determines the difference in position between a GPS receiver on a known position and another GPS receiver at an unknown position. This technique uses the phase of the GPS signal, rather than the observed satellite-receiver distance (the pseudo-range), giving at least an order of magnitude increase in accuracy compared to the DGPS technique. By observing simultaneously for a few hours and with appropriate post-processing of the data, this technique can be used over distances up to several hundred kilometres to produce a relative accuracy of about a part per million (1 part per million = 1 mm per kilometre). This requires sophisticated GPS receivers, typically costing $20,000 or more each.

Differential navigation (DGPS)

To eliminate the effects of Selective Availability and other uncertainties, differential corrections can be applied to the observed position at a remote site. These corrections are calculated at one or more base stations by comparing the observed position with the known position at those base stations. The base stations may be a permanent service, or setup specifically for a project. When applied at the remote site these corrections greatly enhance its positional accuracy. The correction can be in terms of position, or more often in terms of the

observed satellite-receiver distance (the pseudo-range). The corrections may be collected and applied at a later time, or they may be broadcast immediately to the remote site by mobile phone, radio or satellite communications.
DGPS positioning can be carried out with some simple hand held receivers over a few 10s of kilometres, or it may be done with sophisticated multi-basestation systems integrated with satellite communications, to cover a region of thousands of kilometres (wide area differential navigation). The accuracy of DGPS, of the order of a few metres, generally degrades with increased distance from the nearest base station.

In Antarctic a network of GPS base stations has been built up from within the GIANT program for static survey purposes and these could be used to develop and transmit DGPS corrections to shipping or Aviation to give positions to a few metres.

Removal of selective availability

On May 1, 2000 The President of the United States announced a decision to end selective availability:
"Today, I am pleased to announce that the United States will stop the intentional degradation of the Global Positioning System (GPS) signals available to the public beginning at midnight tonight. We call this degradation feature Selective Availability (SA). This will mean that civilian users of GPS will be able to pinpoint locations up to ten times more accurately than they do now. GPS is a dual-use, satellite-based system that provides accurate location and timing data to users worldwide. My March 1996 Presidential Decision Directive included in the goals for GPS to: "encourage acceptance and integration of GPS into peaceful civil, commercial and scientific applications worldwide; and to encourage private sector investment in and use of U.S. GPS technologies and services." To meet these goals, I committed the U.S. to discontinuing the use of SA by 2006 with an annual assessment of its continued use beginning this year. The decision to discontinue SA is the latest measure in an on-going effort to make GPS more responsive to civil and commercial users worldwide. Last year, Vice President Gore announced our plans to modernize GPS by adding two new civilian signals to enhance the civil and commercial service. This initiative is on-track and the budget further advances modernization by incorporating some of the new features on up to 18 additional satellites that are already awaiting launch or are in production. We will continue to provide all of these capabilities to worldwide users free of charge. My decision to discontinue SA was based upon a recommendation by the Secretary of Defense in coordination with the Departments of State, Transportation, Commerce, the Director of Central Intelligence, and other Executive Branch Departments and Agencies. They realized that worldwide transportation safety, scientific, and commercial interests could best be served by discontinuation of SA. Along with our commitment to enhance GPS for peaceful applications, my administration is committed to preserving fully the military utility of GPS. The decision to discontinue SA is coupled with our continuing efforts to upgrade the military utility of our systems that use GPS, and is supported by threat assessments which conclude that setting SA to zero at this time would have minimal impact on national security. Additionally, we have demonstrated the capability to selectively deny GPS signals on a regional basis when our national security is threatened. This regional approach to denying navigation services is consistent with the 1996 plan to discontinue the degradation of civil and commercial GPS service globally through the SA technique. Originally developed by the Department of Defense as a military system, GPS has become a global utility. It benefits users around the world in many different applications, including air, road, marine, and rail navigation, telecommunications, emergency response, oil exploration, mining, and many more. Civilian users will realize a dramatic improvement in GPS accuracy with the discontinuation of SA. For example, emergency teams responding to a cry for help can now determine what side of the highway they must respond to, thereby saving precious minutes. This increase in accuracy will allow new GPS applications to emerge and continue to enhance the lives of people around the world. 30-30-30

Comment
The impact of this action is that GPS users inn Antarctica can now reliably expect positional accuracies of better than 30 metres , in most cases this will be in the order of 10 metres. This has a potential benefit on Antarctic users and will reduce the need for DPGS for some operations.

There is also the prospect of using GLONASS for navigation in Antarctic which when combined with GPS can be a distinct benefit.

Future initiatives

WG-GGI will look at the accuracies likely to be achieved from the improved system. However where greater accuracies are required in real time for scientists or logistics DGPS technology will still be required. Indeed centimetre accuracy in near real time is achievable using RTK techniques for local areas of about 10 km or more for special purposes.

WG-GGI and the GIANT program would like to work closely with COMNAP to rationalise the use of GPS position applications for logistics and scientific use.

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