

INTERMOUNTAIN REGION GPS PURCHASING OPTIONS

Global Positioning System (GPS) technology has tremendous potential applications throughout the United States Government. Today's demands for information about natural or cultural resources requires precise locations, described in relation to each other, and employing the concept of direction and distance.

This paper was developed to serve as a guide to the some of the models of GPS equipment available as of May 2000. Because of the wide range of units that are available for varying purposes this list is not all-inclusive, but rather reflect GPS units that are used by personnel of the National Park Service. It is the intent of the Intermountain Region to periodically update this document as changes occur.

The Intermountain GIS Center will support and train purchasers in the Intermountain Region, if desired, on Trimble Navigation Limited products (not including the Trimble Centurion). Other products are also on the list, but this office will not do training to support them. The names and phone of parks that have purchased units other than Trimble are included for your information.

A Definition of the Global Positioning System

Tim Smith, <http://165.83.119.44/npsgps/>

GPS (Global Positioning System) is a constellation of, now, 25 Department of Defense satellites that orbit the earth approximately every 12 hours. The position and time information transmitted by these satellites is used by a GPS receiver to trilaterate a location on the earth.

GPS was developed to provide a continuous, 24 hour, 3D (position and elevation) coverage anywhere on the earth. It provides reliable, repeatable information that is unaffected by rough terrain and bad weather, and is highly resistant to multipath errors and interference.

The satellites broadcast on two carrier frequencies in the L-band of the electromagnetic spectrum. One is the "L1" or 1575.42MHz and the other is "L2" or 1227.6MHz. On these carrier frequencies are broadcast codes, much like a radio or television station broadcast information on their channels (frequencies). The satellites broadcast two codes, a military-only encrypted code (PPS) and a civil-access or Standard Positioning (SPS) code.

All commercial and consumer GPS receivers are SPS receivers. There are two basic types of SPS receivers, those that use the broadcasted code to do their positioning (code-phase) and those that do carrier phase measurements (carrier-phase). PPS, Precision-code or P(Y)-Code (PLGR's) receivers utilize the P(Y)-code broadcast on the L1, L2 carrier frequencies for positioning. These type of receivers are only available to the military and some government agencies.

Positional accuracies for the code-phase, resource grade or C/A-code receivers range from 10 meters to less than 1 meter. Accuracy for carrier-phase units (commonly referred to as geodetic receivers) can be measured in millimeters. Positional accuracy for both types of receivers strongly depends on a process called differential correction. In the past, the Department of Defense has maintained a control over autonomous receiver accuracies though Selective

Availability (SA), an information degradation procedure. With SA implemented, civilian receivers received information adequate for positioning within 100 meters, 95 percent of the time. In order to achieve greater accuracies, one must have a procedure for limiting the SA and other errors in their GPS positional data. Therefore, differential corrections were necessary.

TURNING OFF SELECTIVE AVAILABILITY:

PRESIDENT BILL CLINTON announced May 1, 2000 the ending of the intentional degrading of the Global Positioning System (GPS) signals available to the public.

THE DECISION TO DROP S/A was based on a recommendation from the Secretary of Defense in coordination with the Departments of State, Transportation, Commerce, the Director of Central Intelligence, and other departments and agencies. The military agreed to the decision after demonstrating the ability to selectively deny GPS signals--which guide many weapons systems-- on a regional basis when national security is threatened. The White House statement said that "GPS has become a global utility...This increase in accuracy will allow new GPS applications to emerge and continue to enhance the lives of people around the world." Full text of the statement and other information is on the Web at the Interagency GPS Executive Board (<http://www.igeb.gov>)

With SA gone, do I still need differential GPS (DGPS)?

It depends on your specific user requirements. If you are using GPS for safety-critical navigation, you will still need to use the Coast Guard DGPS or Nationwide DGPS to get the higher accuracy (1-3 meter) and the integrity monitoring/warning service. If you are a surveyor requiring sub-meter positioning, you will still need some form of DGPS to achieve that level of precision.

On the other hand, if you are a trucking company using GPS to track and manage assets, the <20 meter accuracy now available from the basic civil signal may be sufficient to meet your needs without DGPS augmentations.

Will the Coast Guard continue to operate its DGPS services?

Yes. The U.S. Coast Guard will continue to run the maritime DGPS network to provide the higher accuracy and integrity monitoring/warning service required for safety-critical navigation. In fact, efforts are currently under way to expand the Coast Guard DGPS network across the continental United States to provide the same GPS augmentation service to terrestrial users on railroads and highways. The expanded network is known as the Nationwide DGPS, or NDGPS, service.

Is DGPS more accurate now?

No. There should not be much change in the accuracy of DGPS. However, DGPS corrections may not need to be broadcast as frequently any more. As a result, we may see future commercial DGPS services that use less radio bandwidth and thus cost less to the end user.

Tim Smith recommends differentially correcting GPS data, in order to remove any atmospheric effects, multipath and such. Ten meter accuracy is much better for navigation, but not quite good enough for most mapping applications.

For more information, see <http://www.igeb.gov/sa/faq.shtml>

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Hurn, Jeff. 1989. GPS: A Guide to the Next Utility. Trimble Navigation. Sunnyvale, CA.

Peter Dana of the U. of Texas at Austin, Dept. of Geography: [An Overview of GPS](#)

John Beadle's [Introduction to GPS Applications](#)

NOAA: [National Geodetic Survey Division](#)

NOAA: [Determining Heights with GPS](#)

Please check <http://www.navcen.uscg.mil/ADO/DgpsSelectStatus.asp> for current status of Coast Guard real-time beacon expansions.

PRODUCTS:

TRIMBLE GEOEXPLORER 3: A small, handheld, 12-channel receiver with menu-driven user interface. Accuracy is 1-5 meters with differential correction. Performance (as with just about any receiver) can be enhanced by using an external antenna. The GeoExplorer 3 will do submeter measurements if proper data collection (high accuracy carrier phase processing) and base file is used. It can use real-time differential correction from a beacon receiver such as CSI's MBX-3 or the Trimble's cable-free Beacon-on-a-Belt System (BoB) to provide about 1-4 meters in the field. Trimble products come bundled with Pathfinder Office correction software, which also provides data dictionary development (Geo 3 can have >1 data dictionary, an improvement from the GeoII), data processing, and GIS and mapping system data export.

Pros/cons: Small size is handy and portable, can throw in backpack for use on longer trips. The 3 has a real-time map display now, and graphical satellite skyplot and navigation screens. The internal battery has improved, so that it should last through a day of data collection. Tim Smith has reported position spikes in the 10 to 30 meter range under certain circumstances, particularly under canopy. Trimble engineers and technicians are working to isolate the spiking issue and provide a fix. However, under most circumstances the GeoExplorer 3 seems to provide reliable data within specifications.

Pricing:	GeoExplorer 3	PN 39100-00-Eng	\$4090.00
	120V External Power Kit	PN 39001-00	\$359.00
	External Antenna Kit	PN 39002-00	\$177.00
	1 year software/firmware	PN 40004-61	\$625.00

Source: see Trimble representatives on ProXR/XRS page.

TRIMBLE PATHFINDER PRO XR/XRS: A larger, backpack, 12-channel receiver with sub-meter accuracy (post-processed or real-time), or 1 to 25 cm with Carrier Phase Processing. Comes bundled with Pathfinder Office correction software, which also provides data dictionary development, data processing, and GIS and mapping system data export. The XR can operate as Integrated GPS, to be post-processed with the Pathfinder Office correction software, or with a Coast Guard Beacon receiver for real-time differential capabilities. The XRS combines the Integrated GPS receiver, a Coast Guard beacon differential receiver, and a satellite differential receiver, allowing for a choice in real-time differential corrections. (Coast Guard Beacons are FREE, real-time broadcast corrections, but are not available in all areas. The satellite differential receiver requires a subscription-based satellite correction service.) The data logger has 2 mg of memory.

Pros/Cons: The ProXR is a great unit, easy to learn and use, with very good accuracy and utility. The only problem may be its size on longer backcountry hikes. Because it originally came with a hip pack, now backpack, it would be difficult to use and also wear a backpack. It works well under canopy. The datalogger (TSC1) keypad is easy to use, has a good menu, and text entry is easy. Having multiple data dictionaries loaded on the unit at once is great and makes it possible to collect data for multiple projects at once. Or it makes it possible to have smaller, more focused data dictionaries rather than an all encompassing one which, in a GeoExplorer, eats into the disk space for data storage.

Cons: Expense. Is the expanded data collecting abilities worth the extra \$6 grand? You need to look at what your upcoming projects are in order to answer that and who will be using the unit. Dave Hammond says, "I've trained some folks here (GRTE) who were totally inexperienced with GPS and, for the most part, they've been collecting the data that they need for their projects."

Joel Cusick from Alaska comments:

Pros: A great receiver. Take some training to get a good kick start. Be very mindful of at least the SNR and PDOP settings. Remove the XR hip and shoulder belt system and attach the small pack to your backpack or packboard with the snap buckles. Make sure you have at least one extra set of external batteries with you. I get about 8 hours of on/off use per twin battery pack. QuickPlan is a great tool to plan your GPS survey. If you're planning a weeks worth of work, be sure to print out the PDOP chart to see when signals will have an effect on your data collection. Effective data dictionary creation is critical for ease of data entry. Test the dictionary BEFORE the job. Collecting data with one dictionary and trying to combine those data with a modified dictionary is VERY DIFFICULT.

Cons: The XR's firmware uses "Everest Technology" that is supposed to minimize multipath errors. I think it does a great job there, but in the wet or dry canopy (wet conifers especially) you may sit 20-30 minutes to get one point!!! There will be in-field decisions to "at least get a point" which may then compromise your points accuracy, but if you're not getting data.... Its tough to get a good answer on which settings to compromise to get data from Trimble, major choices being PDOP or SNR. Read all you can on this. Give yourself plenty of extra time conducting GPS surveys under thick canopy.

Pricing:	12-Channel ProXR GPS/TSC1	P/N 29756-85-eng	\$9550.45
	12-Channel ProXRS GPS/TSC1	P/N 29756-87-eng	\$10915.45
	1 yr Software/Firmware Update ProXR/TSC1	P/N 37095-61	\$750.00
	1 yr Software/Firmware Update ProXRS/TSC1	P/N 37096-61	\$750.00

The ProXRS series requires a satellite corrections data subscription active to produce realtime differential corrections, like an Omnistar L-band subscription. The one-year subscription requires a separate purchase order, and will be activated upon telephone notification supplying your serial number to Omnistar.

1 yr Omnistar Data Subscription, ProXRS	\$800.00
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Source: CEA Inc.
 Bill Ewin
 P.O. Box 25696
 Tempe, AZ 85285-5696
 (480) 820-1127
 (480) 820-1128 Fax
ceagps@aol.com
http://www.trimble.com/products/pd_dm.htm

Source: Frontier Precision Inc.
 Ron Davis
 2322 East 13th St
 Loveland, CO 80537
 (800) 652-1522
 (970) 663-7529 Fax

Source: CompassCom
 6770 S. Dawson Circle Unit 1A
 Englewood, CO 80112-4224
 (303) 680-3221
 (303) 680-2488 Fax
<http://www.compasscom.com>

Source: Inland GPS
 Guner Gardenhire
 P.O. Box 1525
 406.453.7733
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www.inlandgps.com

SATLOC REAL-TIME ATTRIBUTE MAPPING (RAM) SYSTEM: a real-time, sub-meter hip-pack unit. Satloc has a real-time L-Band frequency that is broadcast from 3 geo-synchronous satellites. This setup uses an Apple Newton or similar message pad for data logger with FieldWorker software. Parks that utilize this unit are Carlsbad Caverns, Dave Roemer (505) 785-2232 ext 373, and Fossil Butte, Arvid Aase (307) 877-4455.

Pros/Cons:

Comments from Dave:

I happen to like the Apple Newton datalogger, but they have been discontinued. FieldWorker has been porting the software to Palm Pilots and Windows CE portables, but I haven't really kept up with the changes (<http://www.fieldworker.com>). If someone were to purchase the SatLoc system today, they would have lots of options for which Palm Pilot-type thing (and operating system) to consider.

The FieldWorker software looks powerful. A real plus is having multiple projects loaded up at once, solving the one data dictionary at a time limitation of a GeoExplorer II. You can also edit project controls of the FieldWorker software so that no one accidentally makes changes to it. It's easy to do offshoots too, either by triangulation or distance and azimuth to what you want coordinates for.

The SatLoc unit itself comes with no useful documentation. It's kinda heavy so most people headed for the backcountry would probably prefer to slip a GeoExplorer II in their jacket pocket instead. But if you're working from a vehicle or the office then the SatLoc is great. Did I mention that it looks really cool?

Comments from Aarvid:

FieldWorker has been very good to work with. The Newton interface is easy to use. The Windows-like menus make it easy to choose options. It downloads points, lines, and polygons into Arcview rather easily. I have been unable to download in decimal degrees, and it is not overlaying other GIS data. I have not found it explained in the book nor has Scientific Technologies responded to my inquiry into how this can be accomplished.

Pricing: (estimated, no formal quote)

Unit	\$5700
Backpack	\$650
Apple data logger	\$1800

Source: Scientific Technologies Corporation

4400 East Broadway, Suite 705

Tucson, Arizona 85711

(520) 202-3333

(520) 202-3340 fax

stc@rtd.com

<http://www.satloc.com/backpack.stm>

COMMUNICATION SYSTEMS INTERNATIONAL INC (CSI) MBX-3/MGL-3 BEACON RECEIVER SYSTEM: An add-on beacon receiver that works with any differentially capable GPS receiver, will yield 2-5 meter real-time accuracy. A park that utilizes this unit is San Antonio Missions, Rich Arias (210) 534-8833.

Pros/Cons: Rich uses the MBX3 to get real-time data with the Trimble GeoExplorer. He says he needs to use both the external antenna for the GeoExplorer and the real-time antenna, and the antenna needs to be up high to receive the real-time signals (he is close to the edge of the range of the Coast Guard Beacon). He is happy with the receiver and says it is easy to use.

Tim Smith says “it has some strong pluses for it over other beacon receivers including Trimble’s. The MBX-3 has a front panel display for trouble shooting and picking the beacon you want to use. This is a big plus if you are having trouble receiving signals. MBX-3 has a Garmin engine and can be controlled from Garmin GPS receivers that are plugged into it. The receiver will run for about ten hours on one charge of a Multiplier (lead-acid type) battery. Batteries cost \$35 with charger. GOOD buy. CSI makes cheaper receivers but I would not recommend buying cheaper if you can afford it. The advantages of the front panel display are great.”

Joel Cusick says “ In my humble opinion, spending the extra money, carrying the extra gear (two antennas...in alders???) for real-time is not justified. You’re going to get a better point (most likely) post-processing, and don’t have to worry about VHF reception in addition to satellite geometry. Stick with a full post-process differential unit for serious GIS level mapping.

Pricing:

MBX-3

300 KHz Beacon Receiver Complete with Mounting Bracket, 1 Meter Power Cable, 3 Meter Data Cable, 3, 5, or 10 Meter Antenna Cable, and User Manual:

System Price with MBA-3 E-Field Antenna	\$ 950.00
With MBL-3 H-Field Loop Antenna	\$ 1,075.00
With MGL-3 Combination GPS/Loop Ant.	\$ 1,250.00
With ABL-1 Aircraft Loop Antenna	\$ 1,550.00

Source: Communication Systems International Inc.

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GARMIN GPS III Plus: (Review by Tim Smith). The onboard maps, size and cost of this receiver could have some very good applications for law enforcement / search and rescue operations and anyone wanting to be able to navigate to within 100 meters of locations. It can do a lot including have 1:100,000 topos loaded up to it—"The topos are an incredible feature!" Accuracies are what one might expect from a 12 channel, undifferentiated receiver and it seems to work very well under canopy. It can only be relied on to 100 meters (**written before S/A turned to 0, now should be less than 10 meters**), but quite often it is better than that. All this for around \$360 at Wal-Mart (not an endorsement). You can use a Coast Guard beacon receiver with the GPS III for accuracies of two to five meters realtime. Garmin sells the beacon receiver GBR 21 for about \$400. Tim is testing it out in conjunction with a CSI beacon receiver at this time. Watch the NPS GPS website for test results of the Garmin GPS III Plus and CSI realtime differential receiver combination compared to a PLGR.
(http://165.83.119.44/npsgps/garmin_test/test.html)

<http://www.garmin.com/outdoor.html>