GLOSSARY

Terms

Absolute Positioning
The unique ability of a GPS receiver to produce positional values without another receiver for reference.

Ambiguity
The unknown number of whole carrier wavelengths between the satellite and the receiver. Also called cycle ambiguity.

Anywhere Fix
Receiver with unique ability to calculate positions without being given an approximate location and time.

Antispoofing (A/S)
An encryption technique developed by the US Department of Defense (DoD) that when implemented, denies access to the P-code by any unauthorized users. With antispoofing on, the user will need a DoD-issued "key" in order to gain access to the P-code.

Apogee
The point in the orbit of a satellite about the earth that is the greatest distance from the center of the earth.

Autocorrelation
In reference to code, a plot of the scalar product of the noise sequence with a delayed copy of itself.

Bandwidth
A measure of the width of the frequency spectrum of a signal expressed in Hertz.

Baseline
The resultant three-dimensional vector V between any two stations from which simultaneous GPS data have been collected and processed. Generally given in earth-centered Cartesian coordinates where:

$$V = (\Delta x, \Delta y, \Delta z)$$

Beat Frequency
Either of the two additional frequencies obtained when two signals of two frequencies are mixed, equal to the sum or difference of the original frequencies.

Binary Pulse Code Modulation
A two-state pulse modulation using a string of binary numbers or codes. The coding is generally represented by 1 and 0 with definite meanings attached to each.

Binary Biphase Modulation
Phase changes on a constant frequency carrier of either 0 or 180 degrees. These represent the binary digits 0 and 1, respectively.

Binary Code
A system used in communication where selected strings of 0's and 1's are assigned definite meanings.

Broadcast Ephemeris
The ephemeris broadcast by the GPS satellites.

Canadian National Convention (CNT)
The Canadian standard transformation program for converting between NAD 27 and NAD 83. Accuracy is often in the range of 0.10 meter and it predicts to within 0.50 meter for 93 percents of all cases.

C/A-Code
The standard Course/Acquisition GPS code, sometimes referred to as the Clear Access Code, also known as the S- or Standard Code. This code contains a sequence of 1023 pseudo-random binary biphase modulations on the GPS carrier at a chipping rate of 1.023 MHz, thus having a period of 1 ms.

Carrier
A high-frequency radio wave having at least one characteristic (frequency, amplitude, or phase) which may be varied by modulation from an accepted value. In general, the carrier wavelength is much shorter than the wavelength of the codes.

Carrier Beat Phase
The difference between the phase of the incoming Doppler shifted satellite carrier signal and the phase of the nominally constant reference frequency generated in the receiver.

Carrier Phase
The phase measurement of the carrier wave. The percentage value is usually converted to millimeters.

Carrier Frequency
The frequency of the unmodulated fundamental output of a radio transmitter.

Cartesian/Geocentric Coordinates
A system of defining position which has its origin at the center of the earth with the x- and y-axes in the plane of the equator. Typically, the x-axis passes through the meridian of Greenwich, and the z-axis coincides with the earth's axis of rotation. The three axes are mutually orthogonal and form a right-handed system.

Channel
A channel of a GPS receiver consists of the hardware and the software to track the signal from one satellite at one of the two carrier frequencies.

Chip
a. The minimum transition time interval for individual bits of either a 0 or a 1 in a binary pulse code, usually transmitted in a pseudo-random sequence. b. A tiny square piece of thin semiconductor material on which an integrated circuit is formed or to be formed.

Clock Bias
Difference between clock's indicated time and true universal time.

Code
A system for representing information, together with rules for using the system.

Code Receiver
An instrument that requires a knowledge of the P- or C/A-code to complete its measurements. This type of receiver will also record the broadcast ephemeris.

Codeless Receiver
An instrument that does not require a knowledge of the P- or C/A-codes to perform measurements. This type of receiver does not record any ephemeris data. Therefore, before a baseline solution is computed, an ephemeris file must be obtained from another source.

Collimate
To physically align a survey target or antenna over a mark.

Complete Instantaneous Phase Measurement
A measurement of carrier beat phase which includes the integer number of cycles of phase since the initial measurement. See *Fractional Instantaneous Phase Measurement; Integer-cycle Ambiguity*.

Control Points
A point to which coordinates have been assigned. These coordinates can then be held fixed and are used in other dependent surveys.

Control Segment
A worldwide network of GPS monitoring and control stations that ensure the accuracy of the GPS satellite orbits and operations of their atomic clocks. The original control segment consists of control facilities in Diego Garcia, Ascension Island, Kwajalein, and Hawaii, with a master control station at the Consolidated Space Operations Center (CSPOC) at Colorado Springs, Colorado.

Correlation Type Channel
A channel that uses a correlator to maintain alignment between a receiver generated code and/or carrier frequency and the incoming satellite code and/or carrier frequency.

Cycle Ambiguity
See Ambiguity.

Cycle Slip
A discontinuity in measured carrier beat phase resulting from a temporary loss of lock in the carrier tracking loop of a GPS receiver.

D-code (Data Message)
A 1500-bit message included in the GPS signal which reports the satellite's location, clock corrections, and health. Included is rough information on the other satellites in the constellation.

Datum
A horizontal or vertical reference system for making survey measurements and computations. A set parameters and control points used to accurately define the three-dimensional shape of the earth. The datum defines parts of a geographic coordinate system that is the basis for a planar coordinate system. Horizontal datums are typically referred to ellipsoids, the State Plane Coordinate System, or the Universal Transverse Mercator Grid System. Vertical datums are typically referred to the geoid. The vertical datum used in the United States is the National Geodetic Vertical Datum of 1929 (NGVD 29), formerly referred to as the Sea Level Datum of 1929. This datum has been upgraded to the North American Vertical Datum of 1988 (NAVD 88).

Datum transformation, geographic transformation
A method that converts data between two geographic coordinate systems (datum).

Deflection of the Vertical
The angle between the perpendicular to the geoid (plumb line) and the perpendicular to an ellipsoid.

Delay Lock
A code correlation technique where the code received from a satellite is compared with "early" and "late" versions of the reference code generated by the receiver to obtain a bipolar discrimination function.

DSARC
Defense System Acquisition Review Council, the DoD body which must authorize any major defense system acquisition.

Delta Pseudo-range
See *Reconstructed Carrier Phase.*

Differencing
A technique used in baseline processing to resolve the integer cycle ambiguity and to reduce a number of error sources including oscillator variations and atmospheric and orbital modeling errors. This technique "differences" the measurement of the carrier beat phase across time, frequency, receivers, satellites, or any combination of these. The most popular differences are described below:

A single difference between receivers is the instantaneous difference in the complete carrier beat phase measurements made at two receivers simultaneously observing the same signal.

A double difference between receivers and between satellites is found by differencing the single difference for one satellite with the single difference for another satellite where both single differences are from the same epoch.

A triple difference between receivers, between satellites, and between epochs (time) is the difference between a double difference at one epoch and the same double difference at the following epoch.

Differential Positioning
The determination of the position of an object station relative to a reference station when receivers at each station are simultaneously tracking the same signals.

Dilution of Precision (DOP)
A measure of the geometric contribution to the uncertainty of a position fix. The more popular terms are given below:

GDOP - Geometric Dilution of Precision - measurement accuracy in three-dimensional position and time.

PDOP - Position Dilution of Precision (PDOP) - measurement accuracy in three-dimensional position.

HDOP - Horizontal Dilution of Precision (HDOP) - measurement accuracy in two-dimensional horizontal position.

VDOP - Vertical Dilution of Precision (VDOP) - measurement accuracy as standard deviation of vertical height.

RDOP - Relative Dilution of Precision (RDOP) - measurement of the quality of baseline reductions.

Doppler-aiding
Signal processing strategy that uses a measured Doppler shift to help the receiver smoothly track the GPS signal, allowing more precise velocity and position measurement.

Doppler Shift
The apparent change in frequency of a received signal due to the rate of change of the distance between the transmitter and receiver.

Dynamic Positioning
Determination of the position of a moving receiver such as one mounted in a boat. Generally, each set of coordinates is computed from a single data sample. The GPS was originally conceived for

dynamic positioning of a single receiver; however, it may be used in a differential mode to increase relative accuracy. Also, referred to as kinematic positioning.

Eccentricity
The ratio of the distance from the center of an ellipse to its focus on the semi-major axis.

Elevation
The height of an object above some reference datum.

Ellipsoid
A geometric shape formed by revolving an ellipse about its minor axis. The term is used interchangeably with spheroid. An ellipsoid is defined by the length of its semi-major axis a and its flattening f, where:

$$f = (a - b)/a$$

and b = length of the semi-minor axis.

The most commonly used ellipsoids in North America are:

Clarke 1866
Geodetic Reference System of 1980 (GRS 80)
World Geodetic System of 1972 (WGS 72)
World Geodetic System of 1984 (WGS 84)

Prior to January 1987, the GPS operated with reference to WGS 72. Since January 1987, it has been referenced to WGS 84. For most purposes, the GRS 80 and WGS 84 can be considered identical.

Ellipsoid Height
The elevation h of a point above or below the ellipsoid.

Ephemeris
A tabular statement of the positions of a celestial body (satellite) at regular intervals.

Epoch
A period of time or a date selected as a point of reference.

Fast Switching Channel
A switching channel with a time sequence short enough to recover the integer part of the carrier beat phase. The switching time is generally between 2 to 5 ms.

Flattening
See Ellipsoid.

Fractional Instantaneous Phase Measurement
A measurement of the carrier beat phase that does not include any integer cycle count.

Frequency Band
A range of frequencies in a region of the electromagnetic spectrum.

Frequency Spectrum
The distribution of signal amplitudes as a function of frequency of the constituent signal waves.

Fundamental Frequency
The GPS fundamental frequency *F* is 10.23 MHz. The carrier frequencies are:

L1 = 154 * F = 1575.42 MHz
L2 = 120 * F = 1227.60 MHz

Geographic coordinates
A measurement of a location of the earth's surface expressed in degrees of latitude and longitude. See also projected coordinates.

Geoid
An equipotential surface approximating the earth's surface and corresponding with mean sea level in the oceans and its extension through the continents. In other words, the geoid would coincide with the surface to which the oceans would conform over the entire earth if the oceans were set free to adjust to the combined effect of the earth's mass attraction and the centrifugal force of the earth's rotation.

Geodetic Leveling Network
A network of vertical control or benchmarks whose heights are known as accurately as possible, and whose horizontal position are known only approximately.

Geoid Height
The elevation *N* of the geoid above or below the reference ellipsoid.

GNSS
Global Navigation Satellite System.

GPS
Global Positioning System. The GPS consists of the NAVSTAR satellites in six different orbits, five monitor stations, and the user community.

GPS Time
The broadcast GPS time signals are synchronized with atomic clocks at the GPS Master Control Station. These clocks are in turn periodically synchronized with Coordinated Universal Time (UTC). However, UTC is incremented by "leap seconds" to correct for the slowing of the earth's rotation with respect to the sun; GPS time is not. As of July 1990:

GPS time = UTC + 4 seconds

The fundamental time scale for all the earth's timekeeping is International Atomic Time (TAI). It is a continuous time scale not corrected by "leap seconds." There is a constant offset of 10 seconds between GPS time and TAI such that:

GPS time = TAI - 10 seconds

Handover Word
The word in the GPS message that contains time synchronization information for the transfer from the C/A-code to the P-code.

Horizontal Geodetic Network
A network for which the horizontal coordinate, latitude, and longitude of the control points in the network are determined as accurately as possible, and heights are known only approximately.

Independent Baseline
Those baselines that provide a unique position solution for a given station.

INS
Inertial Navigation System, which contains an Inertial Measurement Unit (IMU).

Integer-cycle Ambiguity
The unknown integer number of whole carrier cycles between the satellite and receiver.

Integrated Doppler
The accumulation of measured Doppler frequency multiplied by the time interval of measurement, so as to approximate the integral over time of the Doppler frequency.

Interferometry
See Differential Positioning.

Ionosphere
Region of the earth's atmosphere between the stratosphere and the exosphere approximately 50 to 250 miles above the surface of the earth.

Ionospheric Refraction Delay
A delay in the propagation of the GPS signal caused by the signal traveling through the ionosphere.

IRON
Inter Range Operation Number. A random number assigned to various orbiting objects assigned by the joint US/Canadian North American Air Defense Command (NORAD). Each of the GPS satellites has an individual IRON.

JPO
GPS Joint Program Office, originally located at the US Air Force Space Division at El Segundo, California. The JPO consists of the US Air Force Program Manager and Deputy Program Managers representing the Army, Navy, Marine Corps, Coast Guard, Defense Mapping Agency, and NATO.

Kinematic Positioning
Often used to describe dynamic positioning. A GPS differential surveying technique, whereby one GPS unit, the fixed receiver, stays fixed on a known control point, while another GPS unit, the rover, collects data on a constantly moving vehicle, all the time continually tracking four or more satellites during the observation period. This process is done in an effort to ascertain the location or position of the rover receiver.

L-band
The radio frequency band from 390 MHz to 1550 MHz. The primary L-band signal radiated by each NAVSTAR satellite is L1 at 1575.42 MHz. The L1 beacon is modulated with the C/A- and P-codes, and with the NAV message. The L1 carrier frequency has a wavelength of approximately 19 centimeters (cm). The L2 carrier frequency is 1227.60 MHz and has a wavelength of approximately 24 cm. The L5 carrier frequency is 1176.45 MHz and has a wavelength of approximately 26 cm.

L1
See L-band.

L2
See L-band.

L5
See L-band.

Lock
The state of noninterruption in the reception of a radio signal.

Monitor Station
One of five worldwide stations maintained by the DoD and used in the GPS control segment to monitor and control satellite clock and orbital parameters. Corrections are calculated and uploaded to each satellite at least once per day. See Control Segment.

Multipath
A phenomenon similar to "ghosts" on a television screen whereby GPS signals from a satellite arrive at an antenna having traversed different paths. The signal traversing the longer path may

have been reflected off one or more objects--the ground, a vehicle, boat, building or some other surface--and once received by the antenna, will yield a larger pseudo-range estimate and increase the error. Multipath usually results in multipath error.

Multipath Error
A positioning error resulting from radio signals traveling from the transmitter to the receiver by two paths of different electrical lengths.

Multichannel Receiver
A receiver containing multiple channels.

Multiplexing Channel
A receiver channel that is sequenced through a number of satellite signals, each from a specific satellite.

NAD 27
The North American Datum of 1927 uses the Clarke 1866 spheroid to represent the shape of the earth. The origin of this datum is a point on the earth referred to as Meades Ranch in Kansas. Many NAD 1927 control points were calculated from observations taken in the 1800. These calculations were done manually and in sections over many years. Therefore, errors vary from station to station.

NAD 83
Many technological advances in surveying and geodesy since the establishment of NAD 27-electronics theodolites, GPS satellites, very Long Baseline Interferometry, and Doppler systems-revealed weaknesses in the existing network of control points. Differences became particularly noticeable when linking existing control with newly established surveys. To address these problems, the North American Datum of 1983 was developed. It consistently covers North America and surroundings areas and is based upon both earth and satellite observations using the GRS 80 spheroid. The origin for this datum is the earth's center of mass rather than the point on the earth (as with NAD 27), which causes the locations of previous control points in North America to shift, sometimes as much as 500 feet. A 10-year multinational effort tied together a network of control points for the United States, Canada, Mexico, Greenland, Central America, and the Caribbean. Because NAD 83 is an earth-centered coordinate system, it is compatible with GPS data. The raw GPS data is actually reported in the World Geodetic System 1984 (WGS 1984) coordinate system.

NADCON (North American Datum CONversion)
The standard NAD 27-NAD 83 datum transformations program, created by the United States National Geodetic Survey. Transformation is derived from a minimum curvature surface from the National Geodetic Reference System. Approximate accuracy of 0.15-0.50 meter. NADCON is the fastest, simplest, and most accurate datum transformation for mapping at scale of 1:200 and smaller and is intended for conversion of NAD 27 to NAD 83 in the continental United States, Puerto Rico, and the Virgin Islands.

NAV Data
The 1500-bit NAVigation message broadcast by each satellite at 50 bps on both L1 or L2 beacons. This message contains system time, clock correction parameters, ionospheric delay model parameters, and the vehicle's ephemeris and health. This information is used to process GPS signal to obtain user position and velocity. Sometimes referred to as the Navigation message.

Navigation Message
See NAV data.

NAVSTAR
NAVSTAR is the name given to GPS satellites, originally manufactured by Rockwell International.

Observing Session
The period of time over which data are collected.

Orthometric Height
The elevation H of a point above or below the geoid. A relationship between ellipsoid heights and orthometric heights is obtained from the following equation:

$$h = H + N$$

where

h = ellipsoidal height

H = orthometric height

N = geoidal height

Outage
The period of time when a Dilution of Precision exceeds a specified maximum.

Precise or Protected Code (P-Code)
A sequence of pseudo-random binary biphase modulations on the GPS carrier at a chip rate of 10.23 MHz which repeats once every 267 days. Each 1-week segment of code is unique to a particular GPS satellite and is generally reset each week.

Perigee
The point in the orbit of a satellite about the earth that is the least distant from the center of the earth.

Phase Lock
The technique where the phase of a signal is set to replicate the phase of a reference signal by comparing the phase of the two signals and then using the resultant phase difference to adjust the reference oscillator to eliminate the difference.

Phase Measurement
A measurement expressed as a percentage of a portion of a wave (e.g., a sine wave). For example, a complete wavelength is 100 percent; one-half is 50 percent; etc.

Phase Observable
See Reconstructed Carrier Phase.

Polar Plot
A circular plot in which elevation and azimuth as a function of time for each satellite, with respect to a specified location, are predicted and plotted.

Positioning
Determination of a position (usually a GPS antenna) with respect to a coordinate system (WGS 84, UTM, State Plane, etc.).

Precise Ephemeris
The ephemeris computed after the transmission of the satellite signal and based on satellite tracking information.

Precise Positioning Service (PPS)
Dynamic positioning of a single receiver based on the P-code. Currently, the PPS is the most accurate dynamic positioning service offered with GPS.

Projected coordinates
A measurement of locations on the earth's surface in a two-dimensional system that locates features based on their distance from an origin (0,0) along two axes, a horizontal *x*-axis representing east-west and a vertical *y*-axis representing north-south. A map projection transforms latitude and longitude to *x*,*y* coordinates in a projected coordinate system. See also geographic coordinates.

Projected coordinate system

1. A reference system used to measured horizontal and vertical distances of a planimetric map. A coordinate system is usually define by a map projection, a spheroid of references, a datum, one or more standard parallels, a central meridian, and possible shifts in the x-and y-directions to locate x,y positions of points, line, and area features.

2. In ArcInfo, a system with units and characteristics defined by a map projection. A common coordinate system is used to spatially register geographic data for a given area.

3. A reference system consisting of a set of points, lines and/or surfaces and a set of rules used to define the position of points in space either in two or three dimensions.

Projection
A mathematical formula that transforms feature locations between the earth's curved surface and a map's flat surface. A projected coordinate system includes the information needed to transform locations expressed as latitude values to x,y coordinates. Projections cause distortion in one or more of these spatial properties-distance, area, shape, and direction.

Pseudolite
A ground-based GPS station that can be used in a ranging solution. The station transmits a signal with a structure similar to that of an actual GPS satellite.

Pseudo-Random Noise (PRN)
When used as a description of code, it indicates that the code has some random noise-like properties. Each GPS satellite has a unique PRN number assigned to it.

Pseudorange
The time shift required to a align a replica of the GPS code generated in the receiver with the code received from the satellite, scaled into distance by the speed of light. The time shift is the difference between the time of signal of reception and the time of signal transmission where the reception is measured in the receiver time reference and the transmission is measured in the satellite time reference. Therefore, the pseudo-range contains several errors including satellite/receiver time offset, and satellite ephemeris error.

Pseudorange Difference
See Reconstructed Carrier Phase.

Pseudorange Observable
The difference between the time of transmission and the time of arrival of a particular signal transmitted by the satellite.

Reconstructed Carrier Phase
The difference between the incoming Doppler-shifted carrier phase and the phase of a nominally constant reference frequency generated in the receiver. In dynamic applications, the reconstructed carrier phase is sampled at epochs of the received message code, and the difference in reconstructed carrier phase between consecutive code epochs is a measure of the change in satellite-to-receiver range between epochs. This is referred to as the pseudo-range difference, or the delta pseudo-range. In static positioning, the reconstructed carrier phase is sampled at epochs determined by the receiver clock. The reconstructed carrier phase changes according to the continuously integrated Doppler shift of the incoming signal, biased by the integral of the frequency offset between the satellite and receiver oscillators. The reconstructed carrier phase can be referred to the range between satellite and receiver once the phase ambiguity has been resolved. One cycle change in the reconstructed carrier phase is one wavelength of the carrier signal change in the range from satellite to receiver.

Relative Positioning
See Differential Positioning.

S-Code
Another name for the C/A-Code.

Satellite Constellation
The arrangement of a set of satellites in space.

Satellite Message
Sometimes, referred to as the Data (D) code. A low-frequency (50 Hz) stream of data on both carriers (L1 and L2) of the satellite signal. The stream of data is designed to inform the user about the health and position of the satellite. The satellite message can be decoded by the receiver and used for positioning in real time.

Selective Availability (S/A)
The policy of the DoD to intentionally degrade the accuracy obtainable from GPS by civilian users.

Simultaneous Measurements
A measurement or set of measurements referred to the same epoch.

Slow Switching Channel
A channel that switches with a period too long to recover the integer part of the carrier phase.

Space Segment
The portion of the GPS system with major components in space (e.g., GPS satellites).

Spheroid
Used interchangeably with ellipsoid.

Squaring-type channel
A receiver channel that multiplies the received signal by itself to obtain a second harmonic of the carrier which does not contain the code modulation.

Standard Positioning Service (SPS)
Positioning of a single receiver based on the C/A-Code. Also see PPS.

Static Positioning
Determination of the position of a stationary receiver.

Stop-and-Go Kinematic Surveying
A GPS differential survey technique whereby one GPS unit, the fixed receiver, remains fixed on a known control point, while the other, a rover receiver, collects signals on a point of unknown position for a short period of time, usually minutes, and then moves to subsequent points to collect signals for a few more minutes, all the time continually tracking four or more satellites during the observation period. This process is done in an effort to ascertain the position of the object stations occupied by the rover receiver.

Switching Channel
A channel that is sequenced through a number of satellite signals at a rate that is slower than and asynchronous with the message data rate.

Time Tag
The time appended to an actual measurement.

Translocation
See Differential Positioning.

Troposphere
Inner layer of the atmosphere, located between 6 and 12 miles above the earth's surface.

User Equivalent Range Error (UERE)
A term for GPS measurement accuracy which represents the combined effects of ephemeris uncertainties, propagation errors, clock and timing errors, and receiver noise. A high UERE may indicate that S/A has been imposed on the satellite used.

User Segment
The portion of the GPS with major components that can be directly interfaced by the user (e.g., GPS receivers).

Visibility Plot
A plot against time of day of the number of satellites which are visible from a specified location.

Y-code
The P-code after encryption.

Z-count Word
The GPS satellite clock time at the leading edge of the data subframe of the transmitted GPS message.