Reference Document

The GPS Dictionary

Acronyms, Abbreviations and Glossary related to GPS

u-blox

Content

THE GPS DICTIONARY

0 thru 9

1 PPS (1 Pulse Per Second)
Generally a GPS receiver gives out a precise 1 PPS pulse (1 pulse per second) to mark exact second intervals (1 s). This signal is used for precise timing and synchronization. The GPS receiver produces a 1PPS pulse with a defined level (e.g. TTL level) and a defined pulse length.

2D (Two Dimensional)
The horizontal position with latitude/longitude (or northing/easting or X/Y) is called 2D coordinate.

2D Coverage
The number of hours-per-day with three or more satellites visible. Three visible satellites can be used to determine location (longitude and latitude) if the GPS receiver is designed to accept an external altitude input (Altitude Hold).

2D Mode
A 2D (two dimensional) position fix that includes only horizontal coordinates. It requires a minimum of three visible satellites.).

2D Navigation
Navigation Mode in which a fixed value of altitude is used for one or more position calculations while horizontal (2-D) position can vary freely based on satellite range measurements. It requires a minimum of three visible satellites.

2drms (Two Distance RMS Error)
A position accuracy measure defined as twice the RMS of the horizontal error. This approximately corresponds to the 95% confidence interval, or "two sigma standard deviation" value.

3D (Three Dimensional)
The horizontal and vertical position with latitude/longitude/altitude (northing/easting/altitude or X/Y/Z) is called 3D coordinate.

3D Coverage
The number of hours-per-day with four or more satellites visible. At least four visible satellites are required to determine longitude, latitude and altitude, with the receiver clock error as a fourth parameter to be determined.

3D Mode
A 3D (three dimensional) position fix that includes horizontal coordinates plus altitude. It requires a minimum of four visible satellites.

3D Navigation
Navigation mode in which altitude and horizontal position (longitude and latitude) are determined from satellite range measurements.

50BPS (50 Bit Per Second)
The usable data stream transmitted by a GPS-Satellite.

A thru B

A/D (Analog to Digital)
The conversion from analog to digital. The conversion is done by a converter (ADC: Analog-Digital-Converter).

Absolute Positioning
Positioning mode in which a position is identified with respect to a well-defined coordinate system, commonly a geocentric system (i.e., a system whose point of origin coincides with the center of mass of the earth).

Accuracy
The degree of conformance between the estimated or measured position, time, and/or velocity of a GPS receiver and its true time, position, and/or velocity as compared with a constant standard. Radio navigation system accuracy is usually presented as a statistical measure of system error and is characterized as follows:
Predictable - The accuracy of a radio navigation system's position solution with respect to the charted solution. Both the position solution and the chart must be based upon the same geodetic datum.
Repeatable - The accuracy by which a user can return to a position, whose coordinates have been measured previously with the same navigation system.
Relative - The accuracy with which a user can measure position relative to that of another user of the same navigation system at the same time.

Acquisition Time
The time it takes a GPS Receiver to acquire a lock onto enough satellites for a position fix (three satellites for a 2D and four satellites for a 3D solution).

Active Antenna
A GPS-Antenna with an integrated low noise amplifier (LNA).

ALI
→ see Automatic Location Identification.

Almanac
Data transmitted by a GPS satellite which includes orbit information on all the satellites and health of satellites, satellite clock correction, and atmospheric delay parameters. These data are used to facilitate rapid SV acquisition. The orbit information is a subset of the ephemeris data with reduced accuracy. Information on the entire GPS constellation is transmitted by each GPS satellite. For reading a complete new almanac it takes 12.5 minutes. There are two different Almanac formats: the SEM format and the YUMA format
The YUMA format, which is used by a variety of satellite tracking programs, defines 13 parameters:
ID: PRN of the SVN
Health: 000=usable
Eccentricity: This shows the amount of the orbit deviation from circular (orbit). It is the distance between the foci divided by the length of the semi-major axis (our orbits are very circular).
Time of Applicability: The number of seconds in the orbit when the almanac was generated.
Orbital Inclination: The angle to which the SV orbit meets the equator (GPS is at approx. 55 degrees). Roughly, the SV's orbit will not rise above approx. 55 degrees latitude. The number is part of an equation: #= pi/180 = the true inclination.
Rate of Right Ascension: Rate of change of the angle of right ascension as defined in the Right Ascension mnemonic.

SQRT(A) Square Root of Semi-Major Axis: This is defined as the measurement from the center of the orbit to either the point of apogee or the point of perigee.
Right Ascension at Time of Almanac (TOA): Right Ascension is the angle □ between the vernal equinox and the ascending node.
Argument of Perigee: An angular measurement along the orbital path measured from the ascending node to the point of perigee, measured in the direction of the SV's motion.
Mean Anomaly: Angle (arc) traveled past the longitude of ascending node (value= 0-180 degrees or 0-negative 180 degrees). If the value exceeds 180 degrees, subtract 360 degrees to find the mean anomaly. When the SV has
passed perigee and heading towards apogee, the mean anomaly is positive. After the point of apogee, the mean anomaly value will be negative to the point of perigee.
Af(0): SV clock bias in seconds
Af(1): SV clock Drift in seconds per seconds
week: GPS week (0000-1024), every 7 days since 6 Jan 1980/0000z

Altitude
The distance between the current position and the nearest point on WGS84 reference ellipsoid (→ see Height above Ellipsoid) or the geoid (→ see Height Above Sea Level) . Altitude is usually expressed in meters and is positive outside the ellipsoid or above the geoid.

Altitude Hold
A technique that allows navigation using measurements from three GPS satellites plus an independently obtained value of altitude (→ see also 2D Navigation).

Altitude Hold Mode
A navigation mode during which a value of altitude is processed by the Kalman Filter as if it were a range measurement from a satellite at the Earth's center (WGS-84 reference ellipsoid center).

Ambiguity
The unknown number of complete wavelengths (cycles) of the carrier phase contained in a measurement between a single satellite and a single receiver.

Ambiguity Resolution
If the initial integer ambiguity value for each satellite-receiver pair can be determined, then the integrated carrier phase measurement can be used as a precise (millimeter observation accuracy) receiver-satellite distance measurement. A solution using the carrier phase observations is known as an "ambiguity-fixed" solution. The mathematical process or algorithm for determining the value for the ambiguities is Ambiguity Resolution.

Analog
A type of transmission characterized by variable waveforms representing information, contrasted with digital.

Antenna
That part of the GPS receiver hardware, which receives (and sometimes amplifies → see Active Antenna) the incoming L-Band signal. Antennas come in all shapes and sizes, but most these days use so-called "microstrip" or "patch" antenna elements. Microstrip antenna: "An antenna which consists of a thin metallic conductor bonded to a thin grounded dielectric substrate". An example of such antennas is the microstrip patch. The geodetic antennas, on the other hand, may use a "choke-ring" to mitigate any multipath signals.

Antenna gain

The maximum gain of an antenna is simply defined as the product of the directivity by efficiency. If the efficiency is not 100 percent, the gain is less than the directivity. When the reference is a loss less isotropic antenna, the gain is expressed in dBi. When the reference is a half wave dipole antenna, the gain is expressed in dBd (1 dBd = 2.15 dBi)

Antenna Splitter

An attachment which can be used to split the antenna signal into two or more, so that it may be fed to several GPS receivers. Such a configuration forms the basis of a zero baseline test.

Anti-Spoofing (A-S)

Anti-spoofing (A-S) is the process whereby the P-code used for the precise positioning service is encrypted. The resulting encrypted code is called the Y-code. The encryption data can only be decoded by GPS receivers with special decryption circuitry, guarding against fake transmissions of satellite data.

Apogee

On an elliptical orbit path, point at which a satellite is farthest from the Earth.

Application Software

These programs accomplish the specialized tasks of the user, while operating system software allows the computer to work. A computer-aided dispatch system is application software, as is each word processing program.

Argument of Perigee

The angle or arc from the ascending node to the perigee closest approach of the orbiting body to the focus, as measured at the focus of an elliptical orbit, in the orbital plane in the direction of motion of the orbiting body.

A-S

→ see Anti-Spoofing

Ascending Node

The point at which an object's orbit crosses the reference plane (ie., the equatorial plane) from south to north.

AT Command Set (Hayes Command Set)

The modem initialization string consists of a series of commands. It prepares the modem for communications, setting such features as dialing mode, waits, detection of the busy signal and many other settings. Newer modem communications programs reset the initializations string for you according to which menu options you select, which features you enable, etc.
The AT Command Set can be divided into four groups:
Basic Command Set
Extended Command Set
Proprietary Command Set
Register Commands

Atomic Clock

A very precise clock that operates using the elements Cesium or Rubidium. A Cesium clock has an error of one second per million years. GPS satellites contain multiple Cesium and Rubidium clocks.

Automatic Location Identification (ALI)

Means the automatic display at a public safety answering point of the subscriber telephone number, the service address for the telephone, the position and supplementary information.

Automatic Vehicle Location (AVL)

A type of system using any sort of technology to track or locate a vehicle.

Availability

The percentage of time that the services of a navigation system can be used within a particular coverage area. Signal availability is the percentage of time that navigational signals transmitted from external sources are available for use. Availability is a function of both the physical characteristics of the operational environment and the technical capabilities of the transmitter facilities.

AVL

→ see Automatic Vehicle Location

Azimuth

A horizontal direction expressed as an angle between a referenced direction, and the direction of the object. The referenced direction is normally true North.

Bandwidth

A measure of the capacity of a signal to carry information. It is expressed as the width of the spectrum of that signal (frequency domain representation) in Hertz (Hz), Kilo-Hertz (kHz) or Mega-Hertz (MHz). The bandwidth of the GPS-Standard-Signal is 2,046MHz.

Base Station

A base station or reference station is a GPS receiver set up on a location with known position specifically to collect data for differentially correcting data of other GPS receivers. Base station data is used to calculate errors relative to its known position. The "relative difference" between the base station's known position and the position calculated from GPS satellite signals become the correction factor for other GPS receivers collecting data during the same time period. Corrections can be transmitted in real-time, or used during later post-processing. Also called a reference station.

Baseline

A baseline consists of the resultant three dimensional vector between a pair of stations for which simultaneous GPS data is collected.

Baud

A unit of signaling speed equal to the number of discrete signal conditions, variations, or events (bits) per second. If the duration of the unit interval is 20 milliseconds, the signaling speed is 50 bauds. In a bit stream, the number of bits occurring per unit time is usually expressed in bits per second or baud.

Beacon

Stationary transmitter that emits signals in all directions also called a non-directional beacon. In DGPS, the beacon transmitter broadcasts pseudorange correction data to nearby GPS receivers for greater accuracy.

Bearing

The compass direction from a position to a destination. In a GPS receiver, bearing usually refers to the direction to a waypoint.

Bias

All GPS measurements are affected by biases and errors. Their combined magnitudes will affect the accuracy of the positioning results (they will bias the position or baseline solution). Biases may be defined as being those systematic errors that cause the true measurements to be different from observed measurements by a "constant, predictable or systematic amount", such as, for example, all distances being measured too short, or too long. Biases must somehow be accounted for in the measurement model used for data processing if high accuracy is sought. There are several sources of biases with varying characteristics, such as magnitude, periodicity, satellite or receiver dependency, etc. Biases may have physical bases, such as atmospheric effects on signal propagation or ambiguities in the carrier phase measurements, but may also enter at the data processing stage through imperfect knowledge of constants, for example any "fixed" parameters such as the satellite ephemeris information, station coordinates, velocity of light, antenna height errors, etc. Random errors will not bias a solution. However, outlier measurements, or measurements significantly affected by multipath disturbance (which may be considered a transient, unmodelled bias), will bias a solution if the proportion of affected measurements is relatively high compared to the number of unaffected measurements. For this reason, long period static GPS Surveying is more accurate (less likely to be biased) than "rapid static surveying" or kinematic (single-epoch) positioning.

Binary Biphase Modulation

Phase changes of either 0 or 180 degrees on a constant frequency carrier (representing a binary 0 or 1, respectively). GPS signals are biphase modulated.

Binary Phase Shift-Key Modulation (BPSK)

BSK is a modulation technique by which a binary message, such the Navigation Message or the PRN codes (consisting of 0's and 1's), is imprinted on the carrier wave. Unlike Amplitude Modulation (AM) and Frequency Modulation (FM), BSK Modulation does not alter the signal level (the "amplitude") or the carrier wavelength (the "frequency"). At a change in value of the message from 0 or 1, or from 1 to 0, the carrier wave is reversed (the phase is "flipped" by 180°). All reversals take place at the zero-crossings of the carrier (sine) wave (i.e., where the phase is zero).

Binary Pulse Code Modulation

Pulse modulation using a string of binary numbers (codes). This coding is usually represented by 1's and 0's with definite meanings assigned to them. Examples include changes in phase or direction of a wave.

Block I, II, IIR, IIF Satellites

The various generations of GPS satellites: Block I were prototype satellites that began being launched in 1978; 24 Block II satellites made up the fully operational GPS constellation declared in 1995; Block IIR are replenishment satellites; and Block IIF refers to the follow-on generation.

Bps (Bit per Second)

→ see Baud

BPSK

→ see Binary Phase Shift Key Modulation

C thru D

C/A Code
→ see Coarse Acquisition Code

C/No
Carrier-to-Noise ratio. The ratio of the received carrier power and the noise power in a given bandwidth, expressed in dB. If the bandwidth is not defined C/No is expressed in dBHz. The higher the C/No-value is, the better is the strength, and therefore the quality of the received signal.

Carrier
A radio wave having at least one characteristic, such as frequency, amplitude or phase that may be varied from a known reference value by modulation.

Carrier Frequency
The frequency of the unmodulated fundamental output of a radio transmitter. The GPS L1 carrier frequency is 1575.42 MHz.

Carrier Phase
GPS measurements based on the L1 or L2 carrier signal.

Carrier-Aided Tracking
A signal processing strategy that uses the GPS carrier signal to achieve an exact lock on the pseudorandom code.

Carrier-smoothed code
Most GPS-receivers use a technique which is called "carrier-smoothed code" to increase the accuracy of the C/A code. This involves measuring the distance from the receiver to the satellites by counting the number of waves that carry the C/A code signal. This information is then used to smoothen the received code phase.

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 (the axis trough the north-pole) of rotation (→ see also ECEF).

CDMA
→ see code division multiple access

CEP
→ see circular error probable

CH1903 and CH1903+
CH1903 is the old Swiss geodetic datum based on the Bessel-Ellipsoid and CH1903+ is the newer geodetic datum, in use since 1995.

Channel
A channel of a GPS receiver consists of the circuitry necessary to receive the signal from a single GPS satellite.

Chip
The length of time to transmit either a "0" or a "1" in a binary pulse code. The transition time for individual bits in the pseudo-random sequence. Also, an integrated circuit.

Chip Rate
Number of chips per second. For example, C/A code = 1.023 MHz.

Circular Error Probable (CEP)
In a circular normal distribution, the radius of the circle containing 50 percent of the individual measurements being made, or the radius of the circle within which there is a 50 percent probability of being located.

Civilian Code
→ see Coarse Acquisition Code.

Clock Bias
The difference between the clock's indicated time and true universal time.

Clock Error
The uncompensated difference between synchronous GPS system time and time best known within the GPS receiver.

Clock Offset
Constant difference in the time reading between two clocks.

Coarse Acquisition Code (C/A Code)
The standard positioning signal the GPS satellite transmits to the civilian user. It contains the information the GPS receiver uses to fix its position and time. Accurate to 24 meter. This code is a sequence of 1023 pseudorandom binary biphase modulations on the GPS carrier (L1) at a chipping rate of 1.023 MHz, thus having a code repetition period of 1 millisecond. The code was selected to provide good acquisition properties. Also known as the "civilian code.".
COCOM (Coordinating Committee for Multilateral Export Controls)
All commercially available GPS-receivers have to conform to guidelines known as the COCOM-limits or restrictions. Those receivers will operate only at velocities less than 1,854 kilometers per hour (1,000 knots) and/or at altitudes of less than 18,300 meters (60,000 feet).
Code Division Multiple Access (CDMA)
A method of frequency reuse whereby many radios use the same frequency but each one has a unique code. GPS uses CDMA techniques with Gold's codes for their unique cross-correlation properties.

Code Phase GPS
GPS measurements based on the pseudo random code (C/A or P) as opposed to the carrier of that code.

Code Search
The purpose of searching is to search for C/A Code alignment and once found, change to a tracking mode on the found code.

Cold Start

Powering up a unit after it has been turned off for an extended period of time and no longer contains current ephemeris data. In Cold Start Scenario, the receiver has no knowledge on last position, approximate time or satellite constellation. The receiver starts to search for signals blindly. This is normal behavior, if no backup battery is connected. Cold Start time is the longest startup time for GPS receivers and can be several minutes.

Constellation

Refers to either the specific set of satellites used in calculating a position, or all the satellites visible to a GPS receiver at one time, or the entire ensemble of GPS satellites comprising the Space Segment.

Control Point

A point at which coordinates have been assigned. These coordinates are held fixed and used in other dependent surveys

Control Segment

A world-wide network of GPS monitor and control stations that ensure the accuracy of satellite positions and their clocks.

Coordinates

A unique description of a geographic position using numeric or alphanumeric characters.

Correlation Channel

A GPS receiver channel that uses a delay lock loop to maintain an alignment (correlation peak) between the copy of the GPS code generated by the receiver and the received GPS code.

Correlator

The GPS receiver "software" or electronic means, implemented in some fashion (either analogue or digital) within a Tracking Channel, used to shift or compare the incoming signal with an internally generated signal. This operation is performed on the PRN codes, but may be used for more "exotic" mixed signals in the case of L2 measurements, where under the policy of Anti-Spoofing (AS) the L2 PRN code is not known. Correlator design may be influenced such that it is optimized for accuracy, mitigation of multipath, acquisition of signal under foliage, etc.

Course

The direction from the beginning landmark of a course to its destination (measured in degrees or radians).

CRC

→ see Cyclic Redundancy Check

Cross Correlation

The signal derived from correlating the L1 frequency with the L2 frequency. This is a method for countering the encryption of the P-Code to the secret Y code as it allows the reconstruction of the carrier wave on L2. The resultant carrier has a much reduced signal quality when compared to the unencrypted signal.

Cutoff Angle
The minimum acceptable satellite elevation angle (above the horizon) to avoid blockage of line-of-sight, multipath errors or too high Tropospheric or Ionospheric Delay values. May be preset in the receiver, or applied during data post-processing. For navigation receivers may be set as low as 5°, while for GPS Surveying typically a cutoff angle of 15° is used.

Cycle Slip
A discontinuity in the carrier phase measurement resulting from a temporary loss of lock in the carrier tracking loop of a GPS receiver. It indicates that a receiver has momentarily lost the signal from a satellite.

Cyclic Redundancy Check (CRC)
This is a byte added to the end of a data packet that is used to verify the data preceding it is valid.

Data Message
A message included in the GPS signal that reports the satellite's location, clock corrections, and health. Information on the status of other satellites in the constellation is included (→ see also Navigation Message).

Datalogger
Also known as a Data Recorder. A handheld, lightweight data entry computer. It can be used to store additional data obtained by a GPS receiver, such as attribute information on a feature whose coordinates are captured for a project.

Datum
A geographic model obtained by referencing the earth's sea level surface area and applying theoretical mathematical calculations. Map datums may vary from chart to chart. The map datum for your GPS unit should match the datum listed on the corresponding chart. Refer to the map legend to find the specific datum for your chart.

dB (Decibel)
dB is the abbreviation for decibel(s). The decibel is the conventional relative power ratio for expressing relative powers. The ratio in dB is given by:

$$\text{for power}: \quad dB = 10 \cdot \log_{10}\left(\frac{P_1}{P_2}\right) \qquad \text{for voltage}: \quad dB = 20 \cdot \log_{10}\left(\frac{U_1}{U_2}\right)$$

dBHz (Decibel per Hertz)
A voltage or power magnitude expressed in dB referenced for a bandwidth of 1 hertz

dBiC (Decibel-Isometric-Circular)
Measure of power relative to an isometric antenna with circular polarization.

dBm (Decibel per Milliwatt.)
dB referenced to one milliwatt (the received GPS-signal on the earth-surface has a magnitude of about –133dBm).

dBW (Decibel per Watt)
dB referenced to one watt (the emitted power from a GPS-Satellite is +13,4dBW and the received GPS-signal on the earth-surface has a magnitude of about –163dBW).

DC (Direct Current)
Abbreviation for direct current.

Dead reckoning (DR)
Dead reckoning is the navigation of a vehicle exclusively by means of computations based on airspeed, course, heading, wind direction, and speed, ground speed, and elapsed time. A technique that calculates the current location of a vehicle by measuring the distance and direction that the vehicle has traveled since leaving a known starting point

Delay Lock
The technique whereby the received code (generated by the satellite clock) is compared with the internal code (generated by the receiver clock) and the latter is shifted in time until the two codes match.

Delta Pseudorange
→ see reconstructed carrier phase.

Desired Track (DTK)
The compass course between the "from" and "to" waypoints.

DGPS
→ see Differential GPS

Differential Correction
A process for cancelling out man-made and natural errors in the GPS signal. Requires the use of another GPS receiver set up on a position with known location. The receiver on the known location computes its location with the GPS satellite data and compares this position with the known value for is actual, known, position. This difference (hence differential) is the error in the transmitted GPS signal. The differential value is then used for correcting, either in real-time or during post processing, the positions collected by other GPS receivers during the same time period, observing the same satellites.

Differential GPS (DGPS)
A technique used to improve positioning or navigation accuracy by determining the positioning error at a known location (→ see Base Station or Reference Station) and subsequently incorporating a corrective factor (by real-time transmission of corrections or by post processing) into the position calculations of another receiver operating in the same area and simultaneously tracking the same satellites. Also a system of beacons which broadcasts signals to help increase the accuracy of GPS positioning.

Digit
A symbol, numeral, or graphic character that represents an integer. Examples of digits include any one of the decimal characters "0" through "9" and either of the binary characters "0" or "1". In a given numeration system, the number of allowable different digits, including zero, is always equal to the base (radix).

Digital
Generally, information is expressed, stored and transmitted by either analog or digital means. In a digital form, this information is seen in a binary state as either a one or a zero, a plus or a minus. The computer uses digital technology for most actions.

Dilution of Precision (DOP)

A description of the purely geometrical contribution to the uncertainty in a position fix. Standard terms for the GPS application are:
GDOP: Geometric (3 position coordinates plus clock offset in the solution)
PDOP: Position (3 coordinates)
HDOP: Horizontal (2 horizontal coordinates)
VDOP: Vertical (height only)
TDOP: Time (clock offset only)
RDOP: Relative (normalized to 60 seconds and based on a change in geometry)
DOP is a function expressing the mathematical quality of solutions based on the geometry of the satellites. Position dilution of precision (PDOP), the most common such value, has a best case value of 1, higher numbers being worse. A low number of DOP (2) is good, a high number (>7) is considered to be bad. The best PDOP would occur with one satellite directly overhead and three others evenly spaced about the horizon.. PDOP could theoretically be infinite, if all the satellites were in the same plane.
PDOP has a multiplicative effect on the user range error (URE) value. A URE of 32 meters with a PDOP of one would give a user an assumed best accuracy of 32 meters. A PDOP of 2 would result in an assumed accuracy of 64 meters. Many receivers can be programmed to stop providing position solutions above a specific PDOP level (6 is common).

Direct Sequence Spread Spectrum (DSSS)

The most practical, all digital version of Spread Spectrum (SS) is the direct sequence. A direct sequence system uses a locally generated pseudo noise code to encode digital data to be transmitted. The local code runs at much higher rate than the data rate. Data for transmission is simply logically modulo-2 added (an EXOR operation) with the faster pseudo noise code. The composite pseudo noise and data can be passed through a data scrambler to randomize the output spectrum (and thereby remove discrete spectral lines). A direct sequence modulator is then used to double sideband suppressed carrier modulate the carrier frequency to be transmitted. The resultant DSB suppressed carrier AM modulation can also be thought of as binary phase shift keying (BPSK). Carrier modulation other than BPSK is possible with direct sequence.
However, binary phase shift keying is the simplest and most often used SS modulation technique.

Distance Root Mean Square (drms)

The root-mean-square value of the distances from the true location point of the position fixes in a collection of measurements. As typically used in GPS positioning, 2drms (→ see 2drms) is the radius of a circle that contains at least 95 percent of all possible fixes that can be obtained with a system at any one place.

Dithering

The deliberate introduction of digital noise. This is the process the DoD used to add inaccuracy to GPS signals to induce Selective Availability.

DoD (Department of Defense)

The Department of Defense of the United States of America is a Cabinet-level Organization. Reporting to it are the three military departments (Army, Navy and Air Force) and 14 defense agencies. The four armed services are subordinate to their military departments. The Marine Corps is a second armed service in the Department of the Navy.

DOP

→ see dilution of precision

Doppler Search

GPS signal acquisition is a search process. This search process, like the tracking process, requires replication of both the code and the carrier of the SV to acquire the SV signal (i.e., the signal match for success is two-dimensional). The range dimension is associated with the replica code. The Doppler dimension is associated with the replica carrier. From the user velocity and the SV line-of-sight Doppler, the total line-of-sight Doppler can be determined. This is used in the Doppler search pattern for the SV.

Doppler Shift (Doppler Offset)

The apparent change in the frequency of a signal caused by the relative motion of the transmitter and receiver.

Doppler-Aiding

A signal processing strategy that uses a measured Doppler shift to help the receiver smoothly track the GPS signal. Allows more precise velocity and position measurement.

Double-Difference

A data processing procedure by which the pseudo-range or carrier phase measurements made simultaneously by two GPS receivers are combined so that, for any measurement epoch, the observations from one receiver to two satellites are subtracted from each other (in a so-called "between-satellite single-difference") to remove that receiver's clock error (or bias). (Similarly for the other receiver's observations to the same two satellites.) Then the two single-differences are subtracted so as to eliminate the satellite clock errors as well as to reduce significantly the effect of unmodeled atmospheric biases and orbit errors. (The order may be reversed, i.e., take "between-receiver single-differences" to each satellite in turn, and then difference between the single-differences.) The resulting set of Double-Differenced observables (for all independent combinations of two-satellite-two-receiver combinations) can be processed to solve for the baseline (linking the two receivers) components and, in the case of ambiguous carrier phase measurements, the integer ambiguity parameters. All high precision positioning techniques use some form of Double-Difference processing: pseudo-range, unambiguous carrier phase within a "bias-fixed" solution (i.e., after the double-differenced ambiguity values have been estimated and applied to the original carrier measurements), or ambiguous carrier phase data within a "bias-free" solution.

DR

→ see Dead reckoning

drms

→ see distance root mean square

DSP (Digital Signal Processor)

DSP stands for digital signal processor, a special type of coprocessor designed for performing the mathematics involved in signal processing. Most DSP's are programmable, which means that they can be used for manipulating different types of information, including sound, images, and video.

DSSS

→ see Direct Sequence Spread Spectrum

DTK

→ see desired track

DTR (Data Terminal Ready)

A signal from a communications program to a modem, which means the program is loaded and ready to run.

Dual-Frequency

Refers to the instrumentation that can make measurements on both L-Band frequencies, or to the measurements themselves (e.g., L1 and L2 pseudo-range or carrier phase measurements). Dual-frequency measurements are useful for high precision (pseudo-range-based) navigation because the Ionospheric Delay bias can be determined, and the data corrected for it. In the case of Double-Differenced carrier phase, dual-frequency observations can account for the residual ionospheric bias (for case of long baselines), or aid Ambiguity Resolution for "rapid static" or "kinematic" baseline determination. All high precision GPS receivers are of the dual-frequency variety, and are comparatively expensive because of the special signal processing techniques that must be implemented to make measurements on the L2 carrier under the policy of Anti-Spoofing.

E thru G

E911 (Enhanced 911)
911 service becomes E911 when automatic number identification and automatic location information is provided to the 911 operator. In the USA the phone number 911 is a nationwide universal telephone number which provides the public with direct access to a Public Safety Answering Point (PSAP).

Earth Centered Earth Fixed (ECEF)
Cartesian coordinate system where the origin is nominally the center of the earth. It is actually the center of a datum, which is thought to best fit the size and shape of the earth. For GPS calculations it is defined and named WGS 84. The X direction is the intersection of the prime meridian (Greenwich) with the equator. The vectors rotate with the earth. The Z direction is from the center of the earth to the north pole.

Earth-Centered Inertial coordinate system (ECI)
The ECI coordinate system is typically defined as a Cartesian coordinate system, where the coordinates (position) are defined as the distance from the origin along the three orthogonal (mutually perpendicular) axes. The z axis runs along the Earth's rotational axis pointing North, the x axis points in the direction of the vernal equinox and the y axis completes the right-handed orthogonal system. The vernal equinox is an imaginary point in space which lies along the line representing the intersection of the Earth's equatorial plane and the plane of the Earth's orbit around the Sun or the ecliptic. Another way of thinking of the x axis is that it is the line segment pointing from the center of the Earth towards the center of the Sun at the beginning of Spring, when the Sun crosses the Earth's equator moving North. The x axis, therefore, lies in both the equatorial plane and the ecliptic. These three axes defining the Earth-Centered Inertial coordinate system are 'fixed' in space and do not rotate with the Earth.

Eccentric Anomaly E
The regularizing variable in the two-body problem. E is related to the mean anomaly M by Keeper's equation: $M = E - e \cdot \sin(E)$ (e stands for eccentricity).

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

$e = \sqrt{\frac{a^2 - b^2}{a^2}}$ where a and b are the semi-major and semi-minor axes of the ellipse respectively.

ECEF
→ see Earth Centered Earth fixed

ECI
→ see Earth-Centered Inertial coordinate system

EEPROM (Electrically Erasable Programmable Read Only Memory)
A memory chip that can be recorded or erased electrically, but that does not lose its content when electrical power is removed. It is called ROM even though it can be recorded, because it takes a lot longer to record than RAM and is only practical for recording data which is not changed often.

Effective radiated power (ERP)
In a given direction, the relative gain of a transmitting antenna with respect to the maximum directivity of a half-wave dipole multiplied by the net power accepted by the antenna from the connected transmitter.

EGNOS (European Geostationary Navigation Overlay Service)
GPS and GLONASS system augmentation through geostationary satellites.

EHPE (Expected Horizontal Position Error)
The error in position which is expected under certain given condition

Elevation
Height above or below mean sea level or vertical distance above the geoid.

Elevation Mask Angle (Cut-Off Angle)
That angle below satellites should not be tracked. Normally set to 7.5 …15 degrees to avoid interference problems caused by buildings and trees and multipath errors.

Ellipsoid
A mathematical figure formed by revolving an ellipse about its minor axis. It is often used interchangeably with spheroid. Two quantities define an ellipsoid; these are usually given as the length of the semi-major axis a , and the flattening, f = (a - b) / a, where b is the length of the semi-minor axis.

Ellipsoid Height
The height (vertical distance) above an ellipsoid. Not the same as elevation above sea level. GPS receivers output positions and heights above the WGS84 datum.

EMC (Electromagnetic Compatibility)
The ability of a device or system to function without error in its intended electromagnetic environment.

EMI (Electromagnetic Interference)
Electromagnetic emissions from a device or system that interfere with the normal operation of another device or system.

Encryption
Encryption is the process of changing data into a form that can be read only by the intended receiver. To decipher the message, the receiver of the encrypted data must have the proper decryption key. In GPS, the military P code is encrypted with a key so that civilian users cannot make use of it and so that it has "anti spoofing" qualities. This means that it is difficult for an unfriendly force to interfere with the signal or transmit a false signal. When encrypted, it is called the Y code. The P code has been permanently encrypted since March 1994.

Endianess
In computer systems, there are two different architectures for handling memory storage. They are called Big Endian and Little Endian and refer to the order in which the bytes are stored in memory. On a Little Endian system, the little end is stored first. This means a Hex word like 0x1234 is stored in memory as (0x34 0x12). The little end, or lower end, is stored first. The same is true for a four-byte value; for example, 0x12345678 would be stored as (0x78 0x56 0x34 0x12). A Big Endian system does this in the reverse fashion, so 0x1234 would be stored as (0x12 0x34) in memory.

EOW
→ see Week Number Rollover

EPE
→ see Estimated Position Error

Ephemeris
A list of accurate positions or locations of a celestial object as a function of time. Available as "broadcast ephemeris" or as postprocessed "precise ephemeris." The predictions of current satellite position that are transmitted to the user in the data message.

Ephemeris Errors
Errors (or "biases") which are present in the (Broadcast or Precise) Ephemeris data. Broadcast Ephemeris errors are typically at the few meter level, while Precise Ephemeris errors are at the decimeter-level. Ephemeris errors are largely mitigated by differential correction (in DGPS Positioning) or in double-differenced observables (formed from carrier phase measurements) when the receivers are not up to a few tens of kilometres apart. In very high precision applications and/or where the baseline lengths are hundreds or thousands of kilometers, residual Ephemeris Errors may limit the accuracy of the baseline solution.

Epoch
An instant in time. In GPS, an epoch is the moment a measurement is made by a receiver. The epoch rate is the measurement interval, observation interval or recording rate used by a receiver when recording data. e.g. making observations every 15 seconds.

EPROM (Erasable Programmable Read Only Memory)
Unlike dynamic and static RAM, EPROM chips do not require power to retain their data. Consequently, EPROM chips are commonly used to store long term information and basic software for modems, video cards, and other peripherals. EPROMs can be erased by exposure to ultraviolet light and then reprogrammed using a device called a PROM burner.

ERP
→ see Effective radiated power

Estimated Position Error (EPE)
A measurement of horizontal position error in feet or meters based upon a variety of factors including DOP and satellite signal quality.

Estimated Time Enroute (ETE)
The time left to your destination based upon your present speed and course.

Estimated Time of Arrival (ETA)
The time of day of your arrival at a destination.

ETA
→ see Estimated Time of Arrival

ETE
→ see Estimated Time Enroute

EVPE (Expected Vertical Position Error)

Fast Fourier Transform (FFT)
A procedure for calculating discrete frequency components from sampled time data.

Fast-Multiplexing Channel
→ see fast-switching channel

Fast-Switching Channel

A single channel which rapidly samples a number of satellite ranges. "Fast" means that the switching time is sufficiently fast (2 to 5 milliseconds) to recover the data message.

FFT

→ see Fast Fourier Transform

Firmware

The software heart of a receiver, where coded instructions relating to receiver function, and (sometimes) data processing algorithms, are embedded as integral portions of the internal circuitry.

Flash memory

Flash memory is a non-volatile memory device that retains its data when the power is removed. The device is similar to EPROM with the exception that it can be electrically erased, whereas an EPROM must be exposed to ultra-violet light to erase. A Flash Memory can be erased and reprogrammed in blocks instead of one byte at a time. Many modern receivers have their program stored on a flash memory chip so that it can easily be updated if necessary. Flash memory is also popular in GPS-receivers because it enables the manufacturer to support new features as they become standardized.

Flattening

$$f = \frac{a-b}{a} = 1-\sqrt{1-e^2}$$

a = semi-major axis
b = semi-minor axis
e = eccentricity

FP (Floating-Point)

Mathematics: as opposed to fixed point. FP is accomplished by using coefficients, a base, and exponents (E) to specify the scale, range, or magnitude of numbers. An example of floating-point coding is using 119.8 × 106 or 119.8E6 to represent 119,800,000. If the number is rounded to 120,000,000, it might be written as 120E6 or 12E7 in which the last digit is the number of zeros to be appended to the preceding digits. IEEE Standard 754 floating point is the most common representation today for real numbers on computers.

Frame and Subframes

The GPS Navigation Message consists of time-tagged data bits marking the time of transmission of each subframe at the time they are transmitted by the SV. A data bit frame consists of 1500 bits divided into five 300-bit subframes. A data frame is transmitted every thirty seconds. Three six-second subframes contain orbital and clock data. SV Clock corrections are sent in subframe one and precise SV orbital data sets (ephemeris data parameters) for the transmitting SV are sent in subframes two and three. Subframes four and five are used to transmit different pages of system data. An entire set of twenty-five frames (125 subframes) makes up the complete Navigation Message that is sent over a 12.5 minute period. Data frames (1500 bits) are sent every thirty seconds. Each frame consists of five subframes. Data bit subframes (300 bits transmitted over six seconds) contain parity bits that allow for data checking and limited error correction.

Frequency Band

A range of frequencies in a particular region of the electromagnetic spectrum.

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

FRP (Federal Radionavigation Plan)
The U.S. Government document that contains the official policy on the commercial use of GPS.

Full Operational Capability
For NAVSTAR, defined as the capability that will occur when 24 operational GPS satellites (Block II/IIA) are operating in their assigned orbits and are available for navigation use.

Fundamental Frequency
The fundamental frequency used in GPS is 10.23 MHz. The carrier frequencies L1 and L2 are integer multiples of this fundamental frequency.
L1 = 154F = 1575.42MHz
L2 = 120F = 1227.60 MHz

GaAs (Gallium Arsenide)
A semiconductor material which is used in high-frequency circuits.

Galileo
Galileo, the European challenge to GPS, is a world-wide satellite-based network devoted to precise positioning and timing and will enhance the integrity of satellite-based navigation. The European Space Agency (ESA) will be responsible for the definition of the space segment and related ground segment required for the navigation satellites and their operation. Galileo is expected to be fully functional in 2007 ….2008.

GDOP
(→ see Dilution of Precision).

General Purpose Input/Output (GPIO)
Some GPS-Receiver provide a set of flexible I/O control functions to the system designer through a set of General Purpose I/O ports. These GPIO ports may serve as simple I/O or may be individually configured to provide a predefined alternate function.

Geocenter
The center of the earth.

Geodesy
The science related to the determination of the size and shape of the Earth (geoid) by direct measurements.

Geodetic Datum
A mathematical model designed to best fit part or all of the geoid. GPS uses WGS 84. A model is defined by an ellipsoid together with the relationship between the ellipsoid and a point on the topographic surface established as the origin of datum. This relationship can be defined by several quantities, one method is to define the geodetic latitude, longitude, and the height of the origin, the two components of the deflection of the vertical at the origin, and the geodetic azimuth of a line from the origin to some other point. Another is to define differences with respect to WGS 84 in the position of its center (dy, dy, dz), its rotations (ex, ey, ez) and any error in scale.

Geodetic Surveys
Global surveys done to establish control networks (comprised of reference or control points) as a basis for accurate land mapping.

Geo-fencing
The action of creating an invisible boundary in which a vehicle is authorized to travel, alarms are generated if the area is lost et cetera.

Geographic Information System (GIS)
A computer-based system that is capable of collecting, managing and analyzing geospatial data. This capability includes storing and utilizing maps, displaying the results of data queries and conducting spatial analysis.

Geographic Information Systems (GIS)
In the strictest sense, a GIS is a computer system capable of assembling, storing, manipulating, and displaying geographically referenced information , i.e. data identified according to their locations. Practitioners also regard the total GIS as including operating personnel and the data that go into the system.

Geoid
The particular equipotential surface that coincides with mean sea level and that may be imagined to extend through the continents. This surface is everywhere perpendicular to the force of gravity.

Geoid Ondulation
The height of the geoid (reference surface for orthometric or MSL heights) relative to an ellipsoid. It is a positive value when the geoid is above the ellipsoid, and negative when it is below. The value is used to convert an MSL elevation (→ see Height above mean sea level) to an ellipsoidal height - the height above ellipsoid (→ see. Height above Ellipsoid)

Geometric Dilution of Precision (GDOP)
→ see Dilution of Precision

Geometric Quality
The probable accuracy of a position fix found by taking into consideration the relative position of satellites.

GIS
→ see Geographic Information Systems

Global Navigation Satellite System (GLONASS)
The Russian equivalent to the American NAVSTAR GPS. GLONASS was designed to provide worldwide coverage. GLONASS has three orbital planes containing eight satellites each, when all slots are filled. GLONASS satellites are failing at a much higher rate than they are being replenished, leaving the system operating a diminishing capacity.

Global Navigation Satellite System (GNSS)
Organizing concept of a system that would incorporate GPS, GLONASS, and other space-based and ground-based segments to support all forms of navigation.

Global System for Mobile communication (GSM)

The Global System for Mobile communication (GSM) is a digital mobile telephone system widely used in Europe and other parts of the world. It operates at either the 900MHz or 1800MHz frequency band.

GLONASS

→ see Global Navigation Satellite System.

GMT

→ see Greenwich Mean Time.

GNSS (Global Navigation Satellite System)

→ see Global Navigation Satellite System.

GPIO

→ see General Purpose Input/Output

GPS

The U.S. Department of Defense Global Positioning System: A constellation of 24 … 30 satellites orbiting the earth at a very high altitude. GPS satellites transmit signals that allow one to determine, with great accuracy, the locations of GPS receivers. The receivers can be fixed on the Earth, in moving vehicles, aircraft, or in low-Earth orbiting satellites. GPS is used in air, land and sea navigation, mapping, surveying and other applications where precise positioning is necessary.
The Global Positioning System consist of :
The space segment (24 … 30 NAVSTAR satellites in six different orbits)
The control segment (five monitor stations, one master control station, and three upload stations).
The user segment (GPS receivers).
NAVSTAR satellites carry extremely accurate atomic clocks and broadcast coherent simultaneous signals.

GPS ICD-200

The GPS interface Control Document is a government document that contains the full technical description of the interface between the satellites and the user. GPS receivers must comply with this specification if they are to receive and process GPS signals properly.

GPS Time

GPS Time is a uniformly counting time scale beginning at the January 5, 1980 to January 6, 1980 midnight. January 6, 1980 is a Sunday. GPS Time counts in weeks and seconds of a week from this instant. The weeks begin at the Saturday/Sunday transition. The days of the week are numbered, with Sunday being 0, 1 Monday, etc. The work "uniformly" is used above to indicate that there are no "leap seconds" in this time system. The world does not rotate smoothly. This can easily be measured with atomic clocks. A plot of the difference between atomic clock time and "earth" time shows a slow drift with some small irregularities. Because GPS time does not have leap seconds, it will change by 1 second with respect to UTC whenever a leap second is inserted. The two time scales were aligned when GPS time began on January 6, 1980. With the next insertion of a leap second, on July 1, 1981, the UTC time scale began reporting a number 1 second smaller than GPS time. In January 2001 GPS Time was 13 seconds ahead to UTC Time. The navigation message of the GPS satellites contains the number of seconds offset between GPS and UTC time.

GPS Week

GPS time started at Saturday/Sunday midnight, January 6, 1980. The GPS week is the number of whole weeks since GPS time zero (→ see also Week Number Rollover).

Great circle

A circle defined by the intersection of the surface of the earth and any plane that passes through the center of the Earth. On the idealized surface of the Earth, the shortest distance between two points lies along a great circle.

Greenwich Mean Time (GMT)

→ see Universal Time. This is a few seconds different to GPS time. GMT and Universal time are often used interchangeably.

Grid

A pattern of regularly spaced horizontal and vertical lines forming square zones on a map used as a reference for establishing points.

Ground Speed

The velocity you are traveling relative to a ground position. Typically measured in "knots" (nautical miles per hour), but may be expressed in km/hr or m/s.

GSM

→ see Global System for Mobile communication.

Gyroscope (gyro).

An inertial device for measuring change of attitude (pitch rate, roll rate, and yaw rate); gyroscopes usually consist of a gimbled, rotating mass; gyroscopes are usually included in inertial sensors. A rotating wheel inside a frame that lets its axis turn in any direction. When the wheel is spinning, it is able to maintain the same absolute direction in space.

H thru M

HAE
→ see Height above Ellipsoid.

Handover Word (HOW)
The word in the GPS message that contains synchronization information for the transfer of tracking from the C/A to the P-code.

Hardware
The physical components of a system that uses coded instructions to accomplish a task or operation. Reference is often made to computer "hardware" and "software"; in that context, "hardware" consists of the computer (case, motherboard, etc) input and output devices and other peripheral equipment.

Hayes Command Set
→ see AT Command Set.

HDOP
Horizontal Dilution of Precision. (→ see Dilution of Precision).

Heading
The direction in which a ship or an aircraft is moving. This may differ from actual COG due to winds, sea conditions, etc.

Height above Ellipsoid (HAE)
The height coordinate determined from GPS observations is related to the surface of a Reference Ellipsoid (WGS84). The coordinates are derived initially in the 3-D Cartesian system (as XYZ values), and then for display/output purposes they are transformed to Latitude, Longitude and (Ellipsoidal) Height using well known formulae to an ellipsoid such as that associated with the WGS84 Datum (semi-major axis: 6378137m; inverse flattening: 298.257223563). The surface of the ellipsoid is the zero ellipsoidal height datum. In Relative Positioning, the height component of the receiver whose coordinates are being determined relative to the Base Station can also be related to an ellipsoid by transforming the baseline vector from the 3-D form (DXDYDZ) to a change in Latitude, change in Longitude, and change in Ellipsoidal Height.

Height above Mean Sea Level (MSL)
The Height above mean sea level or Orthometric Height is the height of a station on the earth's surface, measured along the local plumbline direction through that station, above the Geoid surface. It is approximated by the "Height Above Mean Sea Level", where the MSL Datum is assumed to be defined by the mean tide gauge observations over several years. The relationship between Orthometric Height (MSL) and Ellipsoidal Height (HAE) is:Orthometric Height (MSL) = HAE - Geoid Undulation, Orthometric Height is traditionally derived from geodetic leveling (using such techniques as optical leveling, trigonometrical leveling, barometric leveling).

Held Altitude
The altitude value that will be sent to the Kalman filter as a measurement when set in Altitude Hold Mode. It is an Auto Hold Altitude unless an amended Altitude is supplied by the application processor.

Hot Start
Start mode of the GPS receiver when current position, clock offset, approximate GPS time and current ephemeris data are all available. In Hot Start Scenario, the receiver was off for less than 2 hours. It uses its last Ephemeris data to calculate a position fix.

HOW
→ see Handover Word.

Hz (Hertz)
A unit of frequency [1/s].

I/O (Input/ Output)
Transfer of data into and from an electronic system to the outside world.

I-DGPS
→ see Inverse DGPS.

IF (Intermediate Frequency)
A frequency with a carrier frequency is shifted as an intermediate step in transmission or reception.
IGRF (International Geomagnetic Reference Field).
The International Geomagnetic Reference Field (IGRF) model is the empirical representation of the Earth's magnetic field recommended for scientific use by the International Association of Geomagnetism and Aeronomy (IAGA). The IGRF model represents the main (core) field without external sources. The model employs the usual spherical harmonics expansion of the scalar potential in geocentric coordinates. The IGRF model coefficients are based on all available data sources including geomagnetic measurements from observatories, ships, aircrafts and satellites.

Inclination
The angle between the orbital plane of a body and some reference plane (e.g. Equatorial plane).

Initial Acquisition
→ see Initialization.

Initial Operating Capability
For NAVSTAR, defined as the capability that will occur when 24 GPS satellites (Block I/II/IIA) are operating in their assigned orbits and are available for navigation use.

Initialization
The first time a GPS receiver orients itself to its current location. After initialization has occurred, the receiver remembers its location and acquires a position more quickly because it doesn't need a large amount of satellite information.
Initialization is necessary under any of the following conditions:
The first time a GPS-receiver is used.
After a large displacement (>500km) of the receiver while power was turned off.
If the receiver's memory has been cleared.

Integer Ambiguity

Bias term: the receiver counts the radio waves from the satellite, as they pass the antenna, to a high degree of accuracy. However, it has no information on the number of waves (complete wavelengths) there were between the satellite and the antenna when it started counting. This unknown number of wavelengths between the satellite and the antenna is the integer ambiguity. Resolving the integer ambiguity for each satellite is an essential part of differential processing for land surveying applications.

Integrity

The ability of a system to provide timely warnings to users when the system should not be used for navigation as a result of errors or failures in the system.

Intelligent Transport System (ITS)

System to help improve the safety, efficiency, capacity and environmental quality of the existing public and private transportation systems.

Interface

A shared boundary between various systems or programs. An interface is also the equipment or device that facilitates the interoperation of two or more systems.

International Atomic Time (TAI)

TAI (Temps Atomique International), is the international atomic time scale based on a continuous counting of the SI second. TAI is currently (year 2001) ahead of UTC by 32 seconds.The International Atomic Time (TAI) is calculated by the BIPM (Bureau International des Poids et Mesures) from the readings of more than 200 atomic clocks located in metrology institutes and observatories in more than 30 countries around the world.

Inverse DGPS (I-DGPS)

Inverse DGPS can be performed either real–time or post–processed. In this method, the mobile receiver reports to a base station its navigation solution and which satellites IDs were used to create it. The base station also maintains a record of pseudorange corrections and associated TOA (time-of-applicability) from a reference receiver. The base station then selects the pseudorange corrections corresponding to the satellite IDs used in the navigation solution and time-propagates then to agree with the TOA of each mobile receiver's navigation solution.

Invert Route

To display and navigate a route from end to beginning for purposes of returning back to the route's starting point.

IODE (Issue of Data Ephemeris)

IODE is a part of the Navigation Message Data Structure. The navigation message is transmitted by the satellite on the L1 data link at a rate of 50 Bps. The Issue of Data, Ephemeris (IODE) is an 8 bit number equal to the 8 LSBs of the 10 bit IODC of the same data set. The issue of ephemeris data (IODE) term will provide the user with a convenient means for detecting any change in the ephemeris representation parameters. The IODE is provided in both subframes 2 and 3 for the purpose of comparison with the 8 LSBs of the IODC term in subframe 1. Whenever these three terms do not match, a data set cutover has occurred and new data must be collected. The transmitted IODE will be different from any value transmitted by the satellite during the preceding six hours.

Ionosphere
The band of electrically charged particles 80 to 120 miles above the earth's surface, which represent a nonhomogeneous and dispersive medium for radio signals.

Ionospheric Delay
A wave passing through the ionosphere is held up or "delayed" for various reasons. Phase delay depends on the electron content of the atmosphere and therefore this affects the carrier signals. Group delay additionally depends on dispersion in the ionosphere and this affects signal modulation (code signals). The phase and group delay are of the same magnitude but opposite sign. In practice ionospheric disturbance such as delays can affect the accuracy of GPS measurements when measuring at long range.

Ionospheric Refraction
The change in the propagation speed of a signal as it passes through the ionosphere.

ITS
→ see Intelligent Transport System.

JPO (Joint Program Office)
An office within the U.S. Air Force Systems Command, Space Systems Division. The JPO is responsible of managing the development and production aspect of the GPS system and is staffed by representatives from each branch of the U.S. military, the U.S. Department of transportation, Defense Mapping Agency, NATO member nations, and Australia.

Julian date
The number of days that have elapsed since 1 January 4713 B.C. in the Julian calendar. GPS time zero is defined to be midnight UTC, Saturday/Sunday, 6 January 1980 at Greenwich. The Julian date for GPS time zero is 2,444,244.5.

Kalman Filter
A numerical method used to track a time varying signal in the presence of noise. If the signal can be characterized by some number of parameters that vary slowly with time, then Kalman Filtering can be used to tell how incoming raw measurements should be processed to best estimate those parameters as a function of time.

Keplerian Orbital Elements
The set of six independent constants which define an orbit-named for Johannes Kepler (1571-1630). The constants define the shape of an ellipse or hyperbola, orient it around its central body and define the position of a satellite on the orbit. The classical orbital elements used in the GPS navigation message are:
a: semi-major axis, gives the size of the orbit,
e: eccentricity, gives the shape of the orbit,
i: inclination angle, gives the angle of the orbit plane to the central body's equator
☐: right ascension of the ascending node, which gives the rotation of the orbit plane from reference axis,
☐: argument of perigee is the angle from the ascending nodes to perigee point, measured along the orbit in the direction of the satellites motion
ν: true anomaly gives the location of the satellite on the orbit

L1 and L2
L1 is the primary L band signal radiated by each NAVSTAR satellite at 1575.42 MHz. The L1 signal is modulated to transmit the civilian C/A code, military P codes and the NAV message.
L2 has a frequency of 1227.60 MHz and is modulated with the military P-Code and the NAV message.

L1 Frequency
One of the two radio frequencies (1575.42 MHz) transmitted by the NAVSTAR satellites. Unlike GLONASS satellites, all NAVSTAR satellites transmit on the same frequencies. This frequency carries the C/A code used for the standard positioning service (SPS) and the P code used for the precise positioning service (PPS).

L1 Frequency Band
One of the two radio frequency bands (1602.5625 MHz - 1615.5000 MHz) transmitted by the GLONASS satellites. Unlike NAVSTAR satellites, each GLONASS satellite transmits on a separate frequency within this band.

L1 Signal
The primary L-band signal transmitted by each GPS satellite at 1572.42 MHz. The L1 broadcast is modulated with the C/A and P-codes and with the navigation message.

L2 Frequency
One of the two radio frequencies (1227.6 MHz) transmitted by the NAVSTAR satellites. This frequency carries only the P code used for the precise positioning service (PPS).

L2 Frequency Band
One of the two radio frequency bands (1246.4375 MHz - 1256.5000 MHz) transmitted by the GLONASS satellites. Unlike NAVSTAR satellites, each GLONASS satellite transmits on a separate frequency within this band.

L2 Signal
The second L-band signal is centered at 1227.60 MHz and carries the P-code and navigation message.

LAAS
→ see Local Area Augmentation System

Latitude
A position's distance north or south of the equator measured by degrees (°)from -90° to +90° or 0° to 90° (N or S).

L-Band
The group of radio frequencies extending from 390 MHz to 1550 MHz. The GPS carrier frequencies (1227.6 MHz and 1575.42 MHz) are in the L-band.

LBS
→ see Location Based Service

Line-of-sight
In order for the GPS receiver to receive signals from the satellites, it must have an unobstructed view to them. Objects such as tall buildings and bridges can block the line-of-sight needed by the receiver to obtain a position solution.

Liquid Crystal Display (LCD)

Produced by applying an electric field to liquid crystal molecules and arranging them to act as light filters.

LLA (Latitude, Longitude, Altitude)

Geographical coordinate system used for locating places on the surface of the Earth. Latitude and longitude are angular measurements, expressed as degrees of a circle measured from the center of the Earth. The Earth spins on its axis, which intersects the surface at the north and south poles. The poles are the natural starting place for the graticule, a spherical grid of latitude and longitude lines.

LNA

→ see Low Noise Amplifier

Local Area Augmentation System (LAAS)

Plan by which Local Area Differential GPS (LADGPS), which generates and transmits differential corrections to appropriately equipped aircraft users, is augmented with integrity messages transmitted from the ground and additional ranging signals. LAAS is set up near a major airport, and consists of the DGPS reference station, the integrity monitoring receiver and a pseudolite which transmits "satellite-like" PRN-coded signals to incoming aircraft.

Location Based Service (LBS)

One of the ways to deliver highly personalized services. There are four major categories of Location Based Services (LBS):
Location based information
Location sensitive billing
Emergency services
Tracking
One of the most obvious technologies behind LBS is positioning, with the most widely recognized system being the Global Positioning System (GPS). There are however, other means of positioning in addition to GPS. These other technologies are network based positioning and typically rely on various means of triangulation of the signal from cell sites serving a mobile phone. In addition, the serving cell site can be used as a fix for location of the user.

Long Range Navigation System (LORAN)

A long-distance radio navigation system by which a ship or aircraft determines its position using radio signals sent out by two terrestrial stations. The system is operated and maintained by the U.S. Coast Guard.

Longitude

A position's distance east or west of the prime meridian, usually measured in degrees (°) which runs from the North to South Pole through Greenwich, England. Longitude is expressed from -180° to +180° or 0° to 180° (W or E).

LORAN

→ see Long Range Radio Navigation System

Low Noise Amplifier (LNA)
This is the preamplifier between the antenna and the GPS-Receiver. For maximum effectiveness, it must be located as near the antenna as possible, and is usually attached directly to the antenna receive port. The LNA is especially designed to contribute the least amount of thermal noise to the received signal.
LSB (Least Significant Bit or Least Significant Byte)
The Bit or Byte with the smallest significance

LTP (Local Tangent Plane)
Coordinate system: in the Local Tangent Plane coordinate system are the coordinates supplied in a North, East, down sense. The North will be in degrees or radians, East in same units and Down will be height below WGS84 ellipsoid in meters.

m/sec (Meters per Second)
Unit of velocity

m/sec/sec (m/s2) (Meters per Second per Second)
Unit of acceleration

m/sec/sec/sec (m/s3) (Meters per second per second per second)
Unit of impulse or jerk

Magnetic North
Represents the direction of the north magnetic pole from the observer's position. The direction a compass points.

Magnetic Variation
Errors in magnetic compass readings caused by variance in the earth's magnetic field at different locations on the planet. Navigational charts list the variation and a yearly level of increase.

Mask Angle
The minimum GPS satellite elevation angle permitted by a particular GPS receiver design.

MDT (Mobile Data Terminal)
A device, typically installed in a vehicle consisting of a small screen, a keyboard or other operator interface, and various amounts of memory and processing capabilities.

Mean Time Between Failure (MTBF)
An indicator of expected system reliabilty calculated on a statistical basis from the known failure rates of various components of the system. MTBF is typically expressed in hours. The hours are calculated by dividing the total number of failures into the total number of operating hours observed.

Measurement
The square of the standard deviation of a measurement quality. The standard deviation Error Variance is representative of the error typically expected in a measured value of the quantity.

MHz (Megahertz)
A unit of frequency (1MHz = 1’000’000 Hz).

Microstrip Antenna
A two dimensional. flat, precisely cut piece of metal foil glued to a substrate.

MID (Message Identifier)
This is a unique number or a sequence of characters identifying a message of a protocol.

MO and MT
Abbreviations for mobile (GSM-telephone) originated (MO) and mobile terminated (MT). Calls or data generated by the mobile telephone are MO (e.g. a SM (short message), which is sent by the mobile telephone, is MO).
Calls and data arriving to the mobile telephone are MT (e.g. a calling for the Handy is thus MT).

Modem
MOdulator DEModulator. Used to allow computers and terminals to send data over telephone lines using audible tones. Often mounted internally in a PC and connected to the telephone line. The modem may also be an external unit which connects to the computer via the serial port. → see also wireless modem.

Monitor Stations
World-wide group of stations used in the GPS control segment to monitor satellite clock and orbital parameters. Data collected here is linked to a master station where corrections are calculated and controlled. This data is uploaded to each satellite at least once per day from an upload station.

Moving Map
The actual position is always displayed in the middle of the screen-map

MSB (Most Significant Bit or Most Significant Byte)
The Bit or Byte with the highest significance

MSL
→ see Height Above Sea Level

MTBF
→ see Mean Time Between Failure

Multichannel Receiver
A receiver containing multiple independent channels, each of which tracks one satellite continuously, so that position solutions are derived from simultaneous calculations of pseudoranges.

Multipath
Interference of the GPS signal often caused by the bouncing or reflecting of the signals from surrounding objects. Its effect is similar to "ghosting" on a television screen. It occurs when some of the signals arriving at an antenna have followed an indirect path. A signal taking the longer path gives a larger distance measurement to the satellite. This means that it also gives an inaccurate carrier phase value. It can be the most serious error to affect GPS surveying. Whilst some multipath conditions cause errors of a few centimeters, others cause errors of a few meters. Bad multipath conditions can cause a short static session to fail completely.

Multipath error
Errors caused by the interference of a signal that has reached the receiver antenna by two or more different paths. Usually caused by one path being bounced or reflected.

Multiplexing Channel

A receiver channel that is sequenced through several satellite signals (each from a specific satellite and at a specific frequency) at a rate that is synchronous with the satellite message bit rate (50 bits per second, or 20 milliseconds per bit). Thus, one complete sequence is completed in a multiple of 20 milliseconds.

mV (Millivolt)

mW (Milliwatt)

N thru Q

NAD-27
North American Datum of 1927. Obsolete horizontal datum of North America. NAD 27 depends upon an early approximation of the shape of the earth, known as the Clarke Spheroid of 1866, designed to fit only the shape of the conterminous United States, and utilizing a specific Earth surface coordinate pair as its center of reference.

NAD-83
North American Datum of 1983. NAD 83 relies on the more precise Geodetic Reference System of 1980 (GRS 80).

Nanosecond (ns)
One billionth of a second.

NANU
Notice Advisory to NAVSTAR Users - a periodic bulletin alerting users to changes in system performance.

National Marine Electronics Association (NMEA)
A U.S. standards committee that defines data message structure, contents, and protocols to allow the GPS receiver to communicate with other pieces of electronic equipment. NMEA 0183 is the standard data communication protocol used by GPS receivers and other types of navigation and marine electronics.

Nautical Mile
A unit of length used in sea and air navigation, based on the length of one minute of arc of a great circle, especially an international and U.S. unit equal to 1,852 meters (about 6,076 feet).

NAVD-88
North American Vertical Datum of 1988. Effort underway by the National Geodetic Survey (NGS) to readjust the North American Vertical Datum. The NAVD 88 readjustment will remove distortions from the continent-wide vertical geodetic (height) reference system.

NAVDATA
The 1500 bit navigation message (NAV message) broadcast by each satellite at 50 bps on both L1 and L2 frequencies. This message contains system time, clock correction parameters, ionospheric delay model parameters, the satellite's ephemeris and it's health. This information is used to process GPS signals to obtain user position and velocity. It is also used when processing precise surveying data.

Navigation
The act of determining the course or heading of movement. This movement could be for a plane, ship, automobile, person on foot, or any other similar means.

Navigation Message (Nav Message)
The navigation data is transmitted on the L1 and L2 signals at 50 bits per second and contains ephemeris and clock data for that particular satellite, other data required by a receiver to compute position velocity and time and almanac data for all NAVSTAR satellites. The data is transmitted in 1500 bit frames, each requiring 30 seconds to transmit. A complete set of data to include all almanacs, timing information, ionospheric information and other data requires 12-1/2 minutes to transmit. This message contains also system time, clock correction parameters, ionospheric delay model parameters, and the vehicle's ephemeris and health. The information is used to process GPS signals to give user time, position, and velocity.

NAVSTAR
The name given to GPS satellites, built by Rockwell International, that is an acronym formed from NAVigation System with Time And Ranging.

NED (North, East, Down)
Coordinate system. → see LTP.

Network-assisted GPS location
There are different solutions to assist GPS
A network-driven approach places a minimal GPS front end in the handset and transfers the partially processed GPS satellite data back to the GSM-base station. The position is then determined in the base station.
A second network-assisted method uses a more complete GPS subsystem in the handset, but enhances its operation by downloading from the base station some GPS start-up information to accelerate position calculation. The position is calculated in the handset.

NMEA
→ see National Marine Electronics Association.

NVRAM (Non-Volatile RAM)
Non-volatile RAM, portion of the SRAM that is powered by a backup battery power supply when prime power is removed. It is used to preserve important data and allow faster entry into the Navigation Mode when prime power is restored. (sometimes also referred to as keep-alive SRAM).

Obscuration
Term used to describe periods of time when a GPS receiver's line-of-sight to GPS satellites is blocked by natural or man-made objects.

Observation
The period of time over which GPS data is collected simultaneously by two or more receivers.

Observation Interval
The rate at which a receiver samples and stores the observation data transmitted by a satellite. It is sometimes called the epoch rate.

Observing Session
The period of time over which GPS data is collected simultaneously by two or more receivers.

Odometer
An instrument for measuring the distance traveled by a vehicle.

OEM (Original Equipment Manufacturer)

Original Equipment Manufacturer. Typically GPS receiver "modules" or "engines" that an end user product developer can embed within some application or hardware package.

On-The-Fly (OTF)

This is a form of Ambiguity Resolution (AR), which does not require that the receivers remain stationary for any length of time. Hence this AR technique is suitable for initializing carrier phase-based Kinematic Positioning. For many applications this introduces considerable flexibility. For example, aircraft do not have to be parked on the ground in order to resolve the carrier cycle ambiguities, and then require that signal lock-on be maintained throughout the kinematic survey. However, dual-frequency instrumentation capable of making both carrier phase and precise (P-Code level) pseudo-range measurements is required.

Order of Survey

In an analogous manner to "Class of Survey", Order of Survey is a means of categorizing the quality, or precision, of a static survey. However, it relates to the external quality, and is influenced by the quality of the "external" network information. If the existing geodetic control is of a lower quality to what can be achieved using modern GPS Surveying techniques, then the geodetic control network must be upgraded or "renovated" using more precise GPS Geodesy techniques.

Orthometric Height

→ see Height Above Sea Level

Outage

Defined as a loss of availability, due to either there not being enough satellites visible to calculate a position, or the value of the DOP indicator is greater than some specified value (implying that the accuracy of the position is unreliable).

Over Determined Solution

The solution of a system of equations containing more equations than unknowns. The GPS receiver computers, when possible, an over determined solution using the measurements from five or more GPS satellites, instead of the four necessary for a three-dimensional position solution (longitude, latitude, altitude and the receiver clock bias).

Parallel Channel Receiver

A receiver employing multiple receiver circuits, each dedicated to receiving and processing the signal from a single satellite.

Parity Error

A digital message is composed of 1's and 0's. Parity can be defined as the sum of these bits within a word unit (8 bits) and the "parity bit" of a word is set to be even or odd accordingly. When data has been transmitted to another electronic system, the receiving computer recalculates the sum then compares its result with the transmitted parity bit. A parity error exists when there is a discrepancy in this comparison. It shows that the data transmission has errors.

Passive Antenna

→ see Antenna

Patch Antenna

→ see Antenna

P-Code

The protected or precise code transmitted on both L1 and L2 by GPS satellites. This code is now encrypted and in not available to any civilian user and is typically used alone by U.S. and allied military receivers. A very long sequence of pseudo-random binary biphase modulations on the GPS carrier at a chip rate of 10.23 MHz which repeats about every 267 days(=38 weeks). Each satellite uses a 1 week segment of this code that is unique to each GPS satellite and is reset each week.

PDOP

Position Dilution Of Precision, a unitless figure of merit expressing the relationship between the error in user position and the error in satellite position. Geometrically, PDOP is proportional to 1 divided by the volume of the pyramid formed by lines running from receiver to 4 satellites observed. Small values of PDOP (< 3) are to be considered "good" for positioning. Large values (> 7) are considered poor. Thus, small PDOP is associated with widely separated satellites. PDOP is related to Horizontal and vertical DOP by: PDOP2 = HDOP2 + VDOP2.

PDOP Mask

Usually a user-definable upper limit for the PDOP you will tolerate during collection of a dataset. If PDOP rises above the pre-set limit, GPS data collection will be suspended until the PDOP decreases below the limit.

Perigee

That point in a geocentric orbit when the geometric distance is a minimum.

Phase Lock

The technique whereby the phase of an oscillator signal is made to follow exactly the phase of a reference signal. The receiver first compares the phases of the two signals, then uses the resulting phase difference signal to adjust the reference oscillator frequency. This eliminates phase difference when the two signals are next compared.

Phase Observable

→ see reconstructed carrier phase.

Photogrammetry

An aerial remote sensing technique whose latest innovations employ a high-resolution aerial camera with forward motion compensation and uses GPS technology for pilot guidance over the designated photo block(s). Photogrammetry forms the baseline of many Geographic Information Systems (GIS) and Land Information System (LIS) studies and endeavours.

Pi

The mathematical constant (□) having a value of approximately 3.14159.

Pixel

A single display element (picture element) of an LCD screen. The more pixels, the higher the resolution and definition.

Point Positioning

A geographic position produced from one receiver located at a single point. At best, the position accuracy obtained from a receiver using the C/A code is 15 to 25 meters, depending on the constellation of the satellites. However the USDoD degrade the accuracy through Selective Availability so that the positions are at best
+/–100 meters in horizontal, +/–180 meters in vertical.
A position calculated as a mean of point positions during an observation session is often called single point position calculation and will have a higher accuracy than an instantaneous point position.

Poor Man's DGPS

Two different GPS receivers are used and one of them is fixed to a known location. The change in position is watched, and is computed as latitude and longitude error, or offset from the known location. The bias is sent (typically via VHF or UHF radio link) to a mobile receiver, which simply subtracts it out of its own latitude and longitude measurements. The problem is that the two GPS units (even if they're identical models) can use very different data to calculate the position solution. The biggest single problem is that they are each likely to use a different set of GPS satellites. The fixed receiver has a stationary view of the sky, probably a good one. The mobile receiver is cruising around with a changing collection of satellites that are in-view. As the receiver uses different satellites, it has a very different collection of error factors. All this makes the bias on one receiver almost unrelated to the bias on another, enough so that the "corrected" position is likely to be less accurate than the mobile receiver alone.

Position

A geographic location on or near the earth, commonly measured in latitude and longitude.

Position Dilution of Precision

→ see PDOP

Position Fix

The GPS receiver's computed position coordinates.

Position Format

The way in which the GPS receiver's position will be displayed on the screen. Commonly displayed as degrees and minutes, with options for degrees, minutes, and seconds, degrees only, or one of several grid formats.

Post-Processed Differential GPS

Using post-processed differential GPS data collection techniques, base and roving receivers have no data link between them. Each receiver independently records data that will allow differential correction when processed with data from other receivers collecting during the same time period. During collection, the same set of satellites must be in view of all receivers collecting data for later combined processing. Differential correction software is used to combine and process the data collected.

PPS

→ see Precise Positioning Service or
→ see Pulse per Second

Precise Positioning Service (PPS)

The highest level of military dynamic positioning accuracy provided by GPS, using the dual-frequency P-code. PPS is the most accurate positioning, velocity, and timing information continuously available, worldwide, from the basic GPS. This service is limited to authorized U.S. and allied Federal Governments; authorized foreign and military users; and eligible civil users. PPS information is usually (but not always) encrypted to prevent use by unauthorized users. The encryption process is known as Anti-Spoofing. GPS receivers that can use the P code provide a predictable positioning accuracy of at least 22 meters (2 drms) horizontally and 27.7 meters (2 sigma) vertically. They can also provide timing/time interval accuracy within 90 nanoseconds (95 percent probability). This improved accuracy is provided in two ways. First, P-code users are not subjected to Selective Availability. Second, access to the L2 channel allows the user to correct for atmospheric propagation errors. Equipment that uses the P code is available for civilian use; however, The capability is useless when Anti-Spoofing is active. Access to GPS receivers that can decrypt the Y code is tightly controlled and is subject to National Security considerations. If you are a civilian user, you will need a really good excuse to get one.

Prime Meridian

The zero meridian (0), used as a reference line from which longitude east and west is measured. It passes through Greenwich, England.

PRN

→ see Pseudorandom Noise

Pseudo-kinematic surveying

A variation of the kinematic method where roughly five-minute site occupations are repeated at a minimum of once each hour.

Pseudolite

Shortened form of pseudo-satellite. A ground-based differential GPS receiver that simulates the signal of a GPS satellite and can be used for ranging. The data portion of the signal may also contain differential corrections that can be used by receivers to correct for GPS errors.

Pseudorandom Code

The identifying signature signal transmitted by each GPS satellite and mirrored by the GPS receiver, in order to separate and retrieve the signal from background noise. A signal with random noise-like properties. It is a very complicated but repeating pattern of 1's and 0's.

Pseudorandom Noise (PRN)

Pseudorandom noise, a sequence of digital 1's and 0's that appear to be randomly distributed like noise, but which can be exactly reproduced. The important property of PRN codes is that they have a low autocorrelation value for all delays or lags except when they are exactly coincident. Each NAVSTAR satellite has its own unique C / A and P pseudorandom noise codes.

Pseudorange

The approximate distance, measured by a receiver, between a satellite and a receiver antenna. Pseudorange is obtained by multiplying the wavelength of the GPS signal by the time it took the signal to travel between the satellite and the receiver. Major sources of error include the clock offset and the atmosphere which delays the signals, an error in time measurement causes an error in the distance measurement.

Pseudorange Difference

→ see reconstructed carrier phase.

Pulse per Second (PPS)

→ see 1 PPS

PVT (Position, Velocity and Time)

Global Positioning Systems (GPS) are space-based radio positioning systems that provide 24 hour, three dimensional position, velocity and time (PVT) information to suitably equipped users.

R thru S

R95
A position accuracy measure. The R95 value is defined as a circle's radius, when centered at the true position, encloses 95% of the data points in a horizontal scatter plot.

Radio Data System (RDS)
The radio data system is an auxiliary data channel on a FM-radio signal. The primary purpose of RDS is to provide radio station, program information and DGPS error correction.

Radio Technical Commission for Maritime Services (RTCM)
→ see RTCM

Radionavigation
The determination of position, or the obtaining of information relative to position, for the purpose of navigation by means of the propagation properties of radio waves. GPS is a method of radionavigation.

RAM (Random Access Memory)

Range Rate
The range change rate (distance) between the satellite and receiver. The distance to a satellite changes because the satellites are moving across the sky and the earth is rotating. Range rate is determined by measuring the Doppler shift of the satellite signal.

RDOP
Relative dilution of precision. →see DOP.

RDS
→ see Radio Data System

Reacquisition
The reacquisition figure gives the time required to get lock on a satellite if the signal has been blocked for a short time (e.g. due to buildings). This is most important in urban areas. Reacquisition time is not related with TTFF.

Real Time Clock (RTC)
An Integrated circuit which keeps the time on a GPS-Receiver. The RTC chip is battery powered to ensure it can keep time even when the PC is turned off. The chip itself updates time, day, month, and year.

Real Time Kinematic (RTK)
Real time processing of kinematic data. If the code and carrier data collected at a base station is transmitted in real time to one or more roving receivers, then a computer at the roving receiver calculates the carrier differential processing in real time, results will be available in real time. Such a system is called Real time Kinematic. Although RTCM data formats exist, most manufacturers use proprietary formats.

Real-Time Differential GPS

A data collection process whereby a GPS receiver gets real-time correction data from another source in order to filter out the effects of SA and other sources of error. One way to get correction data is from a GPS receiver located at a known position (known as a base station). The GPS receiver at the known position computes, formats, and transmits corrections usually through a data link (e.g., VHF radio or cellular telephone) with each new GPS observation. The roving unit requires some sort of data link equipment to receive the GPS corrections so that the correction factor can be applied to its current observations. Other sources of correction data are Satellite-based systems (like OMNISTAR), CORS stations, etc.

Receiver Autonomous Integrity Monitoring (RAIM)

A form of receiver self-checking in which redundant pseudo-range observations are used to detect if there is a problem or "failure" with any of the measurements -- only four measurements are needed to derive 3-D coordinates and the receiver clock error, hence any extra measurements can be used for checking. Once the failed measurements have been identified they may be eliminated from the navigation fix. RAIM is a concept that has been introduced by aviation users who are concerned that GPS does not have the level of Integrity necessary for non-precision airport approaches or GPS-aided landing.

Receiver Channels

A GPS receiver specification which indicates the number of independent hardware signal processing channels included in the receiver design.

Receiver Independent Exchange Format (RINEX)

A set of standard definitions and formats to promote the free exchange of GPS data and facilitate the use of data from any GPS receiver with any postprocessing software package. The format includes definitions for three fundamental GPS observables: time, phase, and range.

Reconstructed Carrier Phase

The difference between the phase of the incoming GPS carrier, corrected for Doppler shift, and the phase of a nominally constant reference frequency generated in the receiver.
For static positioning, the reconstructed carrier phase is sampled at epochs determined by a clock in the receiver. A change in the satellite to receiver distance of one wavelength of the GPS carrier (19cm for L1) results in a one cycle change in the phase of the reconstructed carrier.

Reference Station

→ see Base Station

Relative Navigation

A technique similar to relative positioning, except that one or both of the points may be moving. A data link is used to relay error terms to the moving vessel or aircraft to improve real-time navigation.

Relative Positioning

The process of determining the relative difference in position between two marks. This can be done with a much greater precision than absolute, single point positioning. A receiver (antenna) is placed over each spot and measurements are made by observing the same satellites with each receiver at exactly the same observation interval and with overlapping times. This technique allows the cancellation (during computations) of all errors that are common to both receivers. These include satellite clock errors, propagation delays, etc. See also translocation and differential navigation.

Reliability
The probability of performing a specified function without failure under given conditions for a specified period of time.

RF (Radio Frequency)
Any frequency within the electromagnetic spectrum normally associated with radio wave propagation.

RFI (Radio Frequency Interference)
Any electromagnetic disturbance that interrupts, obstructs, or otherwise degrades or limits the effective performance of electronics/electrical equipment. It can be induced intentionally, as in some forms of electronics warfare, or unintentionally, as a result of spurious emissions and responses, intermodulation products.

RINEX
→ see Receiver Independent Exchange format.

RMS
→ see Root Mean Squared

ROM (Read Only Memory)
A memory in which data, under normal conditions, can only be read.

Root Mean Squared (RMS)
A statistical measure of the scatter of computed positions about a true position solution. RMS can be applied to any random variable.

Route
A planned course of travel that is defined by a sequence of waypoints.

Rover
Any mobile GPS receiver used during a data collection session. The receiver's position can be computed relative to one or more stationary GPS receivers.

RS-232C
Serial interface used by computers. Also known under the name V.24.

RTC
→ see Real Time Clock

RTCA (Radio Technical Commission of Aeronautics)

RTCM (Radio Technical Commission for Maritime Services)
A special committee of the commission (Special Committee 104) was set up to define a differential data link to be used to relay GPS correction messages from a monitor (Reference) station to a field user. RTCM SC-104 recommendations define the correction message format and 16 different correction message types.

RTK
→ see Real Time Kinematic

SA
→ see selective availability

Satellite constellation
The arrangement in space of a set of satellites. In the case of GPS, the fully operational constellation is composed of six orbital planes, each containing four satellites. GLONASS has three orbital planes containing eight satellites each.

Satellite Elevation Mask
Usually a user-definable elevation mask (in degrees) that a the Satellite Vehicles (SV) must be above the horizon before your receiver will allow it's data to be used as part of the position calculation. SV's at an elevation below the mask value will be tracked, but data from them will not be used to compute positions. This is done because SV's near the horizon have larger error potentials due to atmospheric sources.

Satellite-Based Augmentation Systems (SBAS)
The various Satellite-Based Augmentation Systems (SBASs) currently under development utilize Geostationary Earth Orbit (GEO) satellites to provide ranging signals to the end user that also contain integrity data on GPS, GLONASS, and/or Galileo satellites. This signal is generated on the ground and provided via C-band (or K-band) uplink to the GEO, whose navigation transponder frequency translates it to L1 and C-band (or K-band) downlink frequencies, then broadcasts the signals throughout the GEO's edge of coverage footprint.

SATNAV
A local term referring to use of the older TRANSIT system for satellite navigation. One major difference between TRANSIT and GPS is that TRANSIT satellites are in a low altitude Polar orbit with a 90 minute period.

SBAS
→ see Satellite-Based Augmentation Systems

Selective Availability (SA)
Selective availability is the name of a process that allows the DoD to limit the accuracy available to users of Navstar's Standard Positioning Service. It is accomplished by manipulating navigation message orbit data (epsilon) and/or the satellite clock frequency (dither) This process is intended to prevent potential adversaries of the United States from using low-cost GPS receivers for certain military functions. Differential GPS techniques can be used to reduce these effects for local applications. The United States stopped the intentional degradation (SA) of the Global Positioning System (GPS) signals available to the public (SPS) at midnight on May 1, 2000. The United States has no intent to ever use SA again. To ensure that potential adversaries do not use GPS, the military is dedicated to the development and deployment of regional denial capabilities in lieu of global degradation.

SEM Almanac
→ see Almanac

Semi-major axis
One half of the major axis of an ellipse.

SEP
→ see spherical error probable.

Sequential Receiver
A GPS receiver in which the number of satellite signals to be tracked exceeds the number of available hardware channels. Sequential receivers periodically reassign hardware channels to particular satellite signals in a predetermined sequence.

Short Message Service (SMS)
The Short Message Service , part of GSM, is the ability to send and receive alphanumeric text messages (up to 160 characters long) to and from mobile telephones.

Sideral Day
Time taken for a complete rotation of the earth. Note that this is approximately 4 minutes less than 24 hours (a solar day). The solar day is longer because it additionally takes account to the movement of the earth around the sun.

SIM-Card
A SIM-Card is used in wireless telephones (GSM) and is a Subscriber Identity Module. Basically, it is used to store : the subscriber profile some subscriber data (phonebooks, SMS) some applets (only possible with SIM Tool Kit compatible SIM cards) Moreover, the SIM card includes some security features to avoid fraud and to guarantee the confidentiality of the communications.

Simultaneous Measurements
Measurements made with two or more receivers over the same period of time, at exactly the same epochs. Alternatively, the epochs could be so closely matched in time that any time misalignment can be accommodated by correction terms in the observation equation.

SINEX (Solution Independent Exchange Format)
A solution output format recently developed by geodesists to permit the exchange of solution information between organizations, from which the original normal equation systems for precise GPS adjustments can be reconstructed. These reconstructed equation systems can be combined with other normal equation systems to create new GPS baseline solutions.

SMS
→ see Short Message Service

SNR
Signal to Noise Ratio. A measure of the information content of the signal relative to the signal's noise. A higher number is desirable.

Solar Day
24 hours. Time between two successive upper transits of the sun or two successive midday's.

Space Segment
The part of the whole GPS system that is in space (i.e. the satellites).

Speed Over Ground (SOG)
The actual speed the GPS unit is moving over the ground. This may differ from airspeed or nautical speed due to such things as sea conditions or head winds. For example, a plane that is going 120 knots into a 10-knot head wind may have a SOG of 110 knots.

Spherical Error Probable (SEP)
SEP is the three-dimensional analogue of → CEP. A statistical measure of precision defined as the 50th percentile value of the three dimensional position error statistics. Thus, half of the results are within a 3D SEP value.

Spheroid
→ see ellipsoid.

Spoofing
The deliberate transmission of fake signals to fool a GPS receiver. Spoofer must mimic a GPS satellite, rather like a pseudolite but with disruptive intent.

Spread Spectrum (SS)
The received GPS signal is a wide-bandwidth, low-power signal (-160 dBW). This property results from modulating the L-band signal with a PRN code to spread the signal energy over a bandwidth that is much greater than the signal information bandwidth. This is done to provide the ability to receive all satellites unambiguously and to provide some resistance to noise and multipath.

Spread Spectrum System
A system in which the transmitted signal is spread over a frequency band much wider than the minimum bandwidth needed to transmit the information being sent. This is done by modulating with a pseudo random code, for GPS.

SPS
→ see Standard Positioning Service

Squaring-Type Channel
A GPS receiver channel that multiplies the received signal by itself to obtain a second harmonic of the carrier. It does not contain the code modulation and is called codeless. Note that the resultant signals are much weaker and much noisier than either the original signal or a cross correlated signal. They have a half cycle carrier, (12 cm) which makes rapid ambiguity fixing much more difficult.

SRAM (Static Random Access Memory)
A static read/write, nonsequential-access memory used for the storage of instructions and data.

Standard Deviation (sigma)
A measure of the dispersion of random errors about the mean value. If a large number of measurements or observations of the same quantity are made, the standard deviation is the square root of the sum of the squares of deviations from the mean value divided by the number of observations less one.

Standard Error Ellipsoid
An ellipsoid in which position measurements have a 20% chance of being located.

Standard Positioning Service (SPS)

The normal civilian positioning accuracy obtained by using the single frequency C/A code. Under selective availability conditions, guaranteed to be no worse than 100 meters 95 percent of the time (2 drms). SPS is the standard specified level of positioning and timing accuracy that is available, without qualification or restrictions, to any user on a continuous worldwide basis. The accuracy of this service is established by the U.S. Department of Defense based on U.S. security interests. Navstar currently provides horizontal positioning accuracy within 100 meters (2 drms) and 300 meters with 99.99 percent probability. The signals providing standard positioning service are inherently capable of greater accuracy than this. The accuracy of the system is limited through the application of a process called Selective Availability.

Static Positioning

Location determination accomplished with a stationary receiver. This allows the use of various averaging or differential techniques

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Statue Mile

A unit of length equal to 5,280 feet or 1,760 yards (1,609 meters) used in the U.S. and other English-speaking countries.

Straight Line Navigation

The act of going from one waypoint to another in the most direct line and with no turns.

Subframes

→ see Frame and Subframes

SV

Satellite vehicle or space vehicle.

Switching Channel

A receiver channel that is sequenced through a number of satellite signals (each from a specific satellite and at a specific frequency) at a rate that is slower than, and asynchronous with, the message data rate.

T thru Z

TAI
→ see International Atomic Time

TDOP
Time dilution of precision, → see DOP.

Telemetry
Telemetry is remote measurement or the remote collection of data. Telemetered data can be physical, environmental or biological data. Telemetry is typically used to gather data from distant, inaccessible locations, or when data collection would be dangerous or difficult for a variety of reasons.

Time of Arrival (TOA)
The differences between the times of arrival of the signal from a handset at three GSM-Basestations is used to calculate the location of the handset. This requires that either the mobile network or the GSM-Network is synchronized using atomic or GPS clocks at every cell site.

Time of Ephemeris (TOE)
An information given by the RINEX navigation message file.

Time of Perigee (Perihelion) Passage:
The time at which a satellite last passed perigee (or perihelion).

Time-To-First-Fix (TTFF)
The actual time required by a GPS receiver to achieve a position solution. This specification will vary with the operating state of the receiver, the length of time since the last position fix, the location of the last fix, and the specific receiver design. See also Hot Start, Warm Start and Cold Start mode descriptions.

TOA
→ see Time of Arrival

TOE
→ see Time of Ephemeris

TOW (Time of Week)
In seconds from Sunday 0.00h.

Track (TRK)
Your current direction of travel relative to a ground position (same as COG).

Translocation
A version of relative positioning that makes use of a known position, such as a National survey station, to aid in the accurate positioning of a desired new point. The initial position (coordinates) is used as a starting point, then the three-dimensional differences measured by GPS are used to calculate the position (coordinates) of the second point.

Triangulation
The location of an unknown point, as in GPS navigation, found by using the laws of plane trigonometry.

Trickle Power Mode™

In Trickle Power Mode, Vcc is continuously supplied to the module. A software configurable internal timer periodically forces the module to acquire a position fix. Between the fixes, the module remains in an ultra-low power sleep mode. This mode is recommended for applications where lowest power consumption and a periodical position up-date are of primary concern. A backup battery must be connected to enable the module to reduce startup times when recovering from a Vcc supply interruption.

Tropospheric Correction

The correction applied to the measurement to account for tropospheric delay.

True North

The direction of the North Pole from your current position. Magnetic compasses are slightly incorrect due to effects of the Earth's magnetic field. GPS units are not affected by magnetic influences.

TTFF

→ see Time to First Fix

UART (Universal Asynchronous Receiver/Transmitter)

The UART produces an electrical signal and timing for transmission of data over a communications path, and circuitry for detection and capture of such data transmitted from another UART.

UDRE (User Differential Range Error)

A measure of error in range measurement to each satellite as seen by the receiver.

UI

→ see User Interface

Universal Time (UT)

Local solar mean time at Greenwich meridian. Some commonly used versions of universal time are:
UT0: Universal time as deduced directly from observations. The fixed numerical relationship between universal and sidereal time is 3 minutes 56.555 seconds.
UT1: UT0 corrected for polar motion.
UT2: UT1 corrected for seasonal variations in the earth's rotation rate.
UTC: Universal time coordinated; uniform atomic time system kept very close to UT2 by offsets. Maintained by the U.S. Naval Observatory.
GPS time (→ see GPS Time) is relatable directly to UTC:

Universal Time Coordinated (UTC and UTC (USNO)

A universal time standard, referencing the time at Greenwich, England. Also referred to as GMT or Zulu time. An international, highly accurate and stable uniform atomic time system kept very close, by offsets, to the universal time corrected for seasonal variations in the earth's rotation rate. Maintained by the U.S. Naval Observatory (USNO). GPS time (→ see GPS Time) is directly relatable to UTC.

Universal Transverse Mercator (UTM)

A worldwide coordinate projection system utilizing north and east distance measurements from reference point(s). UTM is the primary coordinate system used on United States Geological Survey topographic maps. The UTM Grid consists of 60 north-south zones, each 6 degrees wide in longitude.

Update Rate
The GPS receiver specification which indicates the solution rate provided by the receiver when operating normally. It is typically once per second.

URA
→ see user range accuracy

User Interface (UI)
The hardware and operating software by which a receiver operator executes procedures on equipment (such as a GPS receiver) and the means by which the equipment conveys information to the person using it: the controls and displays.

User Range Accuracy (URA)
The contribution to the range-measurement error from an individual error source (apparent clock and ephemeris prediction accuracy's), converted into range units, assuming that that error source is uncorrelated with all other error sources. Values of 32 indicate that Selective Availability is active. Values less than 10 generally indicate that SA is inactive.

User Range Error (URE)
Estimated error in range due to factors such as unmodeled atmospheric effects, orbital calculation errors, satellite clock bias, multipath and selective availability. This value is transmitted by the NAVSTAR satellites and may be displayed by some GPS receivers. The number is expressed in meters.

User Segment
The part of the whole GPS system that includes the receivers of GPS signals.

UTC or UTC (USNO)
→ see Universal Time Coordinated

UTM
→ see Universal Transverse Mercator Map Projection.

VCO (Voltage Controlled Oscillator)
A voltage-controlled oscillator (VCO) is an electronic circuit that generates an oscillating signal at a frequency proportional to an externally applied voltage. These types of circuits are useful for tracking and matching signal frequencies as they shift due to thermal variations, power supply fluctuations, and other sources of frequency phase-shifts. VCO's are found particularly often in phase-locked loops (PLLs) used for clock generation and synchronization. PLLs combine the variable frequency characteristics of the VCO with a phase detector circuit in order to track a signal as it changes frequency.

VDOP (Vertical dilution of precision)
→ see DOP and PDOP.

Velocity Made Good (VMG)
The rate at which you are approaching a destination, based upon your current speed and course.

Vernal Equinox
The intersection of the celestial equator with the ecliptic, with the positive sense being from the Earth to the sun, as the sun crosses the equator from south to north.

Vertical
The line perpendicular to the geoid at any point. The direction of the force of gravity at that point.

VSWR (Voltage Standing Wave Ratio)
In a transmission line, the ratio of maximum to minimum voltage in a standing wave pattern: The VSWR is a measure of impedance mismatch between the transmission line and its load. The higher the VSWR, the greater the mismatch. The minimum VSWR, i.e., that which corresponds to a perfect impedance match, is unity.

WAAS
→ see Wide Area Augmentation Service

Warm Start
Start mode of a GPS receiver when current position, clock offset and approximate GPS time are known. Almanac data is retained, but the ephemeris data is cleared. In Warm Start Scenario, the receiver knows - due to a backup battery or by other techniques – his last position, approximate time and almanac. Thanks to this, it can quickly acquire satellites and get a position fix faster than in cold start mode.

Waypoint
A permanently stored and named position in the GPS receiver's memory.

WDGPS
Wide area Differential GPS - A real-time DGPS system that is made available over a large area - possibly global.

Week Number Rollover (WNRO)
The Global Positioning System (GPS) has experienced the first rollover of its internal clock, termed the End of Week (EOW) Rollover, August 21, 1999. The EOW rollover exists because the large increment for counting GPS system time is one week, and weeks are accumulated in a 10-bit register (decimal values: from "0000" to "1023"). GPS time started Jan. 6, 1980 with week "0000" and continues until 23:59:47 Universal Time Coordinated (UTC), Aug. 21 with week "1023" . After the rollover the GPS clock will reset itself to week "0000" This was the first EOW rollover since the GPS constellation was established.

WGS-72
World Geodetic System (1972); the mathematical reference ellipsoid previously used by GPS, having a semi-major axis of 6378.135 km and a flattening of 1/298.26.

WGS-84 (World Geodetic System 1984)
The mathematical ellipsoid used by GPS since January, 1987.

Wide Area Augmentation System (WAAS)
WAAS is a US Federal Aviation Authority (FAA) funded system of equipment and software that augments GPS accuracy, availability and integrity. The WAAS provides a satellite signal for WAAS users to support enroute and precision approach aircraft navigation. Similar systems are under development in Europe (where it is known as EGNOS – European Geostationary Navigation Overlay System) and Japan (where it is known as "MT-SAT Based Satellite Augmentation System" (MSAS).)

Wireless Modem

A wireless modem is a device that accepts data (typically through RS-232, RS-422, or RS-485 interfaces) and transmits it without wires to another device that also has a serial port. Data is sent from one end to the other as if there were a cable.

WNRO

→ see Week Number Rollover

World geodetic system

A consistent set of parameters describing the size and shape of the Earth, the positions of a network of points with respect to the center of mass of the Earth, transformations from major geodetic datum's, and the potential of the Earth (usually in terms of harmonic coefficients).

Y-Code

A name given to the P code when it has been encrypted. Encryption of the P code became permanent in March 1994.

YUMA Almanac

→ see Almanac

Z-Count

The GPS satellite clock time at the leading edge of the next data subframe of the transmitted GPS message (usually expressed as an integer number of 6 seconds).

Zero Baseline

A Zero Baseline test can be used to study the precision of receiver measurements (and hence its correct operation), as well as the data processing software. The experimental setup, as the name implies, involves connecting two GPS receivers to the same antenna. When two receivers share the same antenna, biases such as those which are satellite (clock and ephemeris) and atmospheric path (troposphere and ionosphere) dependent, as well as errors such as multipath CANCEL during data processing. The quality of the resulting "zero baseline" is therefore a function of random observation error (or noise), and the propagation of any receiver biases that do not cancel in double-differencing.

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