

APPENDIX F

Surveying Terms and Glossary

Superseded

Glossary (Edited from <http://www.auslig.gov.au/corpinfo/info/glossary.htm>)

AMI Active Microwave Instrument - active sensing system on-board ERS-1 and ERS-2 satellites which consists of two separate radars, operating at a frequency of 5.3ghz (c-band) with three modes of operation - a Synthetic Aperture Radar (SAR) for image and wave mode and a three antenna Wind Scatterometer.

AOS - Acquisition of Signal.

ARC/INFO - GIS Software.

Array Sensor - an imaging device employing an array of electronically sampled detectors in the focal plane.

Ascending node - the point on a satellite's orbit when a satellite crosses the Earth's Equatorial plane from South to North.

Atmospheric correction - image processing procedure that compensates for the effects of scattered and absorbed radiation by the atmosphere.

Attribute accuracy - component of data quality describing the likelihood of an attribute of a spatial feature being erroneous.

AUTOCAD - Drafting Software.

Automated cartography - the preparation and presentation of maps using machines controlled by computers.

AVHRR Advanced Very High Resolution Radiometer - sensor on-board the NOAA series of satellites.

Azimuth - geographic orientation of a line given as an angle measurement in degrees clockwise from north.

Azimuth range - for radar images this term represents the distance measured along a line between the limits of the radar beam in the direction of the satellite or aircraft.

Band - a selection of a wavelength interval in the electromagnetic spectrum.

Band-pass filter - a wave filter that has a single transmission band extending from a lower cutoff frequency greater than zero to a finite upper cutoff frequency.

Bandwidth - the number of cycles per second between the limits of a frequency band. usually associated with topographic mapping covering country or region at different scales.

Bathymetric surveying - is the measure of the depth and shape of the ocean floor. Usually associated with the mapping of the resources of the sea bed.

BMP - an abbreviation for Windows Bitmap. BMP is a common raster data format supported by many Microsoft Windows products and applications.

Brightness - the attribute of visual perception in accordance with which an area appears to emit more or less light.

Cadastral survey - a survey of the boundaries of land parcels.

Cadastre - a public register usually recording the quantity, value and ownership of land parcels in a country or jurisdiction.

Calibration - the act or process of comparing certain specific measurements in an instrument with a standard.

Cartography - the art and science of producing maps, charts and other representations to spatial relationships.

CCD Charged Coupled Device - a device in which electrons are stored at the surface of a semiconductor.

CCRS Canadian Centre for Remote Sensing

Cell - an area on the ground from which electromagnetic radiation is emitted or reflected.

CEOS Committee on Earth Observation Satellites

Change detection - sensing of environmental changes.

Characteristic curve - a curve showing the relationship between exposure and resulting density in a photograph image, usually plotted as density (D) against the logarithm of the exposure (log E) in candela- meter-seconds. It is also called the H and D curve, the sensitometric curve, and the D log E.

Chemical fog - density produced on photographic paper or films by chemical means, such as too energetic or contaminated developer.

CNES Centre National d'Etudes Spatiales (French Space Agency)

Completeness - component of data quality describing the completeness of coverage within a data set(s).

Contour - an imaginary line drawn on a map joining all the points on the earth that are the same height above sea level.

Control - a system of points which are used as fixed references for positioning other surveyed features.

Control, ground - control obtained by ground surveys as distinguished from control obtained by photogrammetric methods; may be for horizontal or vertical control, or both. Ground (in-situ) observations to aid in the interpretation of remote sensing data.

Control point - any station in a horizontal and/or vertical control system that is identified on a photograph and used for correlating the data shown on that photograph.

Coordinates - linear or angular quantities which designate the position of a point in a given reference or grid system.

Coordinate, geographic - a system of spherical coordinates for describing the positions of points on the earth. The declinations and polar bearings in this system are the latitudes and longitudes respectively.

Coordinates, grid - a plane-rectangular coordinate system based on and mathematically adjusted to a map projection in order that geographic positions (latitudes and longitudes) may be readily transformed into plane coordinates and the computations relating to them made by the ordinary methods of plane surveying.

COPYFILE - shareware software owned and copyright by Informatix Inc, USA. Used by GEODATA RASTER-250K to reformat the raster data.

CP Centering Point or Control Point

CSA Canadian Space Agency

DCX - a raster image format, and is a variation of PCX file. DCX is used by many MS-DOS fax boards.

DEM Digital Elevation Model - a geographic grid of an area where the contents of each grid cell represents the height of the terrain in that cell. Consists of X, Y and Z coordinates.

Descending node - point on the orbit of a satellite when a satellite crosses the Earth's equatorial plane while moving from north to south. Using two GPS satellite receivers with one at a known position it is possible to increase the accuracy from a roving receiver by applying corrections derived from the fixed receiver.

DIGEST Digital Geographic Information Exchange Standard; a system for compiling spatial data directly in digital form.

Distortion - any shift in the position of an image on a photograph which alters the perspective characteristics of the photograph. Compression or expansion of the scale of the imagery in the azimuth direction. Change in scale from one part of the imagery to another.

DMA Defense Mapping Agency - United States of America

Downlink - a communication link between a satellite and a ground station.

DORIS Doplar Orbitography and Radiopositioning Integrated by Satellite

DPI - dots per inch.

Dynamic range - the ratio of maximum measurable signal to minimum detectable signal.

EDM Electronic Distance Measurement - measurement of distance by means of electromagnetic transmissions, including radio, visible high, laser and infrared light.

Elevation - the angle above the horizon, measured from the horizontal plane.

EMR Electromagnetic Radiation - energy propagated through space or through material media in the form of an advancing interaction between electric and magnetic fields.

Engineering surveying - surveying associated with the setting out and monitoring of engineering or construction works.

Enhancement, image - the process of altering the appearance of an image to extract additional information. It may be accomplished by digital or photographic (optical) methods.

ERC Earth Rotation Correction

ERS European Remote Sensing Satellite - ERS-1 was launched 17 July 1991 and operates in a near circular sun synchronous orbit with a period of 100 minutes. The satellite altitude is 785km. The repeat coverage cycle varies, depending on mission requirements, and includes 3, 35 and 168 day cycles. ERS-2 was launched 20 April 1995 and has the same orbit parameters as ERS-1.

ESA European Space Agency

FIG Federation Internationale des Geometres or International Federation of Surveyors

Frequency - the number of oscillations per unit time or number of wavelengths that pass a point per time.

Geocentric Datum**Error! Reference source not found.** - a datum based on the Earth's centre of mass (or geocentre); as distinct from a regional datum, such as the AGD, whose origin does not coincide with the Earth's centre of mass.

GEODATA products - comprise map information converted into digital format. Used in conjunction with geographic information systems GEODATA products assist applications such as resource management, environmental assessment, mineral prospecting, communications and transportation planning.

Geodesy - the study of the size and shape of the Earth's surface, the measurement of the position and motion of points on the surface and the configuration and area of large portions of its surface.

Geodetic control**Error! Reference source not found.** - a network of sites for which precise positions and/or heights are known and for which the shape and size of the Earth are taken into account.

Geodetic surveying - surveying which takes into account the shape and size of the earth. The result of a geodetic survey is a continuous series of accurately marked points on the ground, to which topographic, land and engineering surveys can be related to provide additional coordinated points for mapping and other purposes.

Geographical Grid - grid derived from geographical coordinates (commonly referred to as longitude and latitude).

Geometric correction - the removal of sensor, platform, or scene induced geometric errors such that the data conforms to a desired projection. This involves the creation of a new digital image by resampling the input digital image.

GEOREFERENCED - digital spatial data (and non-digital map features) for which the coordinates or location can be determined.

GICS Geocoded Image Correction System - an image processing system employed at ACRES.

GIF Graphics Interchange Format - the image file format originally developed by CompuServe as a machine-independent image file format. GIF files are a popular way of storing 8 bit, scanned or digitised images, and the compression ratios achieved are commonly better than other 8 bit formats. This format is commonly used in Internet applications.

GIS Geographic Information System - a computer-based system used to capture, create, maintain, display and analyze spatially-related information.

GPS Global Positioning SystemError! Reference source not found. - is a satellite based navigation system developed by the United States Department of Defense and widely used for civilian navigation and positioning.

Grey scale - a monochrome strip of tones ranging from white to black with intermediate shades of gray. The scale is placed in a setup for a color photograph and serves as a means of balancing the separation negatives and color dye images.

Ground Station - a facility capable of receiving signals from earth observation satellites such as LANDSAT, SPOT, ERS, JERS and MOS.

Ground Resolution Cell - the area on the ground that is covered by the **IFOV** of a detector.

GRS Grille de Reference SPOT - the system of using a path and row combination to identify nominal scene positioning for data from the SPOT satellites.

HDDT High Density Digital Tape - one inch magnetic tape containing data from a remote sensing satellite and recorded in a compressed format.

HRV Haute Resolution dans le Visible - the name given to the multispectral radiometer designed for SPOT spacecraft and offering high resolution in the visible and near-infrared. The first three SPOT spacecraft (SPOT-1,-2,-3) carry two identical HRVs designed for operation in a number of viewing configurations and in different spectral modes.

HRVIR Haute Resolution Visible Infra Rouge (proposed SPOT4).

Hydrographic surveying - the measurement and description of the physical features offshore and adjoining coastal areas with special reference to their use for the purpose of navigation.

Hypsometric tints - colors on a map depicting variations in the height of the earth's surface above sea level.

IFOV Instantaneous Field Of View - is the pixel dimensions of the bulk (Level 1) product not the pixel dimensions of the resampled product.

IGAE Intergovernmental Agreement on the Environment

IMAGINE - software owned and copyright to ERDAS, USA. Used to update RASTER-250K map images.

IR Infra-Red

LANDSAT - earth resources satellites operated by NOAA, United States. LANDSAT 5 was launched 1 March 1994 and operates in a near polar sun synchronous orbit at an altitude of 705km. Repeat cycle is 16 days.

Legal cadastre - a cadastre compiled so that the jurisdiction may have a record of ownership of all land parcels.

Lineage - component of data quality describing the history or origin of features within the described data set.

LIS Land Information System - synonymous with GIS although more often associated with cadastral based systems.

Look angle (radar) - the direction of the look, or direction, in which the antenna is pointing when transmitting and receiving from a particular cell.

LOS Loss of Signal

LUT Look-Up Table

LZW compression - a compression routine for raster data, patented and owned by Unisys Corporation of the United States of America.

Map - a representation of the earth's surface. A cadastral map is one showing the land subdivided into units of ownership; a topographic map is one showing the physical and superficial features as they appear on the ground; a thematic map displays a particular theme, such as vegetation or population density.

Mbps Megabits per second - the rate of transfer of binary information in millions of bits per second and commonly referred to in data transmission rates from satellites to ground stations.

Metadata - summary information describing the content of a dataset.

Mining surveying - associated with the construction, monitoring and mapping of mines and associated works.

MLA Multispectral Linear Array

MMOFE Mission Management Organization Front End - NASDA's mission management computer.

MOS Marine Observation Satellite (Japan)

Mosaicing - the assembling of photographs or other images whose edges are cut and matched to form a continuous photographic representation of a portion of the earth's surface.

MOSS Modelling of Surface Systems

MQS Microimage Quicklook System - image cataloguing system employed at ACRES.

MSS Multi-spectral Scanning System - a scanner on board LANDSAT 4 and 5 that records four bands of digital data.

Multipurpose cadastre - a cadastre containing a variety of parcel-based information considered necessary for good land administration.

Multispectral - generally used for acquisition of remote sensing data in two or more spectral bands.

MW Microwave

Nadir - that point on the ground vertically beneath the perspective centre of the camera lens.

NASA National Aeronautics and Space Administration

NIR Near Infra-Red

NOAA National Oceanic and Atmospheric Administration

Number of looks (radar) - this term refers to the successive observations of the same area as the antenna moves along its designated path. Many observations may be required in order to characterize the backscatter properties of a surface.

Orbit - path of a satellite around the earth.

Orbital elements - a set of parameters defining the orbit of a satellite. Also called orbital parameters.

Orbital period - the time taken by a satellite to make one revolution around the earth. Also referred to as the anomalous or nodal period.

Orthographic projection - the projection by parallel rays onto a plane at right angles to the rays.

Orthophotomaps - aerial maps, true to scale.

Path - the number of the north/south track of the satellite in its specific satellite grid. LANDSAT uses the WRS and SPOT the GRS. For LANDSAT, in the visibility circle for the Alice Springs receiving station, the path range is 84 to 117, from east to west.

PC - IBM or compatible personal computer.

PCX - raster data format originally developed by Zsoft and extensively used in IBM PC computer applications.

Photogrammetry - the science and art of obtaining measurements from photographs.

PHOTOSHOP - software owned and copyright to ADOBE, USA. Used to edit and enhance GEODATA RASTER-250K map images.

Pixel - a contraction of the words 'picture element'. A data element having both spatial and spectral aspects. The spatial variable defines the size of the resolution cell (i.e. the area on the ground represented by the data values), and the spectral variable defines the intensity of the spectral response for that cell in a particular channel.

PLA Panchromatic Linear Array - the single band sensor onboard the SPOT 1, 2, and 3 spacecraft.

Polarisation - the direction of vibration of the electrical field vector of **electromagnetic radiation**.

Positional Accuracy - component of data quality describing the planimetric accuracy of features

PSMA Public Sector Mapping Agencies

Quantization - the process of converting from continuous values of information to a finite number of discrete values.

RADARSAT - the earth observation satellite launched 4 November 1995 and operated by the Canadian Space Agency (CSA). RADARSAT is equipped with a C-band SAR which can be operated in a variety of modes with swath widths ranging from 35 kilometers to 500 kilometers and with resolutions from 10 meters to 100 meters respectively.

Radiance - a measure of the energy radiated by an object together with the frequency distribution of that radiation.

Raster Data - a picture or image composed of rows and columns of data cells (pixels). Satellite data and GEODATA RASTER-250K are examples of raster data.

Raster Image - a cellular data structure composed of rows and columns. Each cell has a value which represents an attribute value for the feature represented by that group of cells.

Relief Displacement - a shift in position of the optical image of an object caused by the height of the object above or depth below a datum plane.

Remote sensing - the acquisition of information about an object without physical contact. Usually associated with the acquisition of information about the Earth's surface by electronic and/or optical instruments from satellites, airborne platforms or ground observation.

Repeat Cycle - cycle time for a satellite to pass over a given point on the earth.

Row - the number of the east/west grid line in the specific satellite grid. LANDSAT uses the WRS and SPOT the GRS. For LANDSAT, in the visibility circle for the Alice Springs receiving station, the row range is 61 to 91, from north to south.

SAR Synthetic Aperture Radar - type of instrument on recently launched satellites which can "see" through clouds and make it possible to acquire satellite imagery day and night.

SATOPS Satellite Operations Section (ACRES) - the primary responsibilities include the management of all client future acquisition requests and also long and short term acquisition planning for the ACRES archive program.

Scale - the indication given on a map, either as a linear scale or representative fraction, of the ratio between a given distance on the map and the corresponding distance on the earth's surface.

SDTS Spatial Data Transfer Standard

Sensor - any device which gathers EMR or other energy and presents it in a form suitable for obtaining information about the environment.

Slant Range - for radar images this term represents the distance measured along a line between the antenna and the target.

SLR Satellite Laser Ranging - the measurement of the distance to a satellite fitted with retro-reflectors, by measuring the time taken for a laser beam to travel to the satellite and back. These measurements are used to determine satellite orbits and to monitor the movement of the earth.

Spectral band - an interval in the electromagnetic spectrum defined by two wavelengths, frequencies, or wave numbers.

SPOT Satellite Pour L'Observation de la Terre - the SPOT series of earth observation satellites are operated by CNES, France. SPOT 1 was launched 22 February 1986, SPOT 2 was launched 21 January 1990 and is currently operational and SPOT 3 was launched 26 September 1993 and is currently fully operational. SPOT satellites are operated in a sun synchronous near polar orbit. Satellite altitude is 830km and the repeat cycle is 26 days. SPOT 4 is proposed for launch in December 1997.

Stereoscopic pair - two images of the same area taken from different camera stations so as to afford stereoscopic vision; frequently called stereopair.

Stereoscopic plotting instrument - an instrument for plotting a map or obtaining spatial solutions by observation of stereoscopic models formed by stereopairs of images.

Sun synchronous - earth satellite orbit in which the orbital plane is near polar and the satellite passes over points on the earth at the same latitude at the same local sun time.

Surveying - measurement of dimensions (contour, position, boundaries, area, height etc.) of any part of the earth's surface (land or water) or any cultural feature. Depending on the type of survey undertaken and the degree of accuracy required, "surveys" may involve the application of the theory, principles and techniques of geodesy, photogrammetry and cartography.

SWIR Short Wave Infra-Red

Telemetry - radio signals transmitted between satellites and ground stations.

TIFF Tagged Information File Format - raster image format created by Aldus and Microsoft Corporations and designed to be a universal format. It is used extensively in desktop publishing packages. TIFF can be compressed using a wide range of compression routines. The most common of these is LZW.

Title - the evidence of a person's right to land.

TM Thematic Mapper - a scanner on-board the LANDSAT 4 and 5 satellites that records seven bands of digital data.

Topographic surveying - involves establishing the contour level and interval of the earth's surface above and below sea level based on a particular control survey system. These surveys may be done by aerial, photogrammetric and ground survey and involves recording of natural features such as hills, streams, valleys and cultural features, such as roads, bridges, railways, etc. These surveys are used to produce topographic maps.

Topography - description or representation on a map of the physical and cultural surface features.

UV Ultra-Violet

Vector data - spatial data in which the location of features is defined by points and straight lines (vectors). A road network would be described by vector data.

VLBI Very Long Baseline Interferometry

Wavelength - the least distance between particles moving in the same phase of oscillation in a wave disturbance. For electromagnetic waves wavelength is influenced by the environment in which the waves are propagating (e.g. air versus a vacuum).

WGS84 World Geodetic System 1984 Geocentric datum used by GPS systems.

WRS World Reference System - the system of using a path and row combination to identify nominal scene positioning for data from the MSS and TM sensors on the LANDSAT satellite.

GPS/GIS/LIS Glossary of Terms

FROM ASHTECH <http://www.ashtech.com/pages/gps/glossary.html>

Aerotriangulation (phototriangulation) - a complex process vital to aerial photogrammetry that involves extending vertical and/or horizontal control so that the measurements of angles and/or distances on overlapping photographs are related to a spatial solution using the perspective principles of the photographs. Aerotriangulation consists of mathematically extending the vectors/angles of a triangular pattern of known reference points on or near the designated photo-block terrain upward through a rectangle representing the area of the photo-block (as seen by the camera's optical center) in such a way that the three-point terrain triangle and the camera's eye three-point triangle (within the photographic frame) are analogous.

Almanac - a set of parameters used by a GPS receiver to predict the approximate locations of a GPS satellite and the expected satellite clock offset. Each GPS satellite contains and transmits the almanac data for all GPS satellites. (See ephemeris **Error! Reference source not found.**)

Ambiguity - the initial bias in a carrier-phase observation of an arbitrary number of cycles; the uncertainty of the number of cycles a receiver is attempting to count. If wavelength is known, the distance to a satellite can be computed once the number of cycles is established via carrier-phase processing.

Antenna - a variety of GPS antennas ranging from simpler microstrip devices to complex choke ring antennas that mitigate the effects of multipath scattering.

Anti-Spoofing (AS) - the process of encrypting the P-Code modulation sequence so that the code cannot be replicated by hostile forces. When encrypted, the P-Code is referred to as the Y-Code (see Y-Code & Spoofing). **Error! Reference source not found.**

Atomic clock - a clock whose frequency is maintained using electromagnetic waves that are emitted or absorbed in the transition of atomic particles between energy states. The frequency of an atomic transition is very precise, resulting in very stable clocks. A cesium clock has an error of about one second in one million years. For redundancy purposes, GPS satellites carry multiple atomic clocks. GPS satellites have used rubidium clocks as well as cesium clocks. The GPS Master Control Station uses cesium clocks and a hydrogen maser clock.

Baseline - the measured distance between two receivers or two antennas.

Bipolar biphase shift key (BPSK) - the modulation technique used on GPS satellites. In this method, a binary bit transition results in a 180-degree shift of the carrier.

Cadastral survey - a survey that defines boundaries, property lines, etc., and pertains to cadastre, an official register of ownership, the extent and value of real property. Cadastral surveys usually determine taxation.

Carrier frequency - the basic frequency of an unmodulated radio signal. GPS satellite navigation signals are broadcast on two L-band frequencies, L1 and L2. L1 is at 1575.42 Mhz, and L2 is at 1227.6 Mhz.

Carrier phase - the fraction of a cycle, often expressed in degrees, where 360 degrees equals a complete cycle. Carrier phase can also mean the number of complete cycles plus a fractional cycle. In a survey-grade GPS receiver, the receiver can lock on to a satellite and, keeping track of the number of whole cycles of the carrier, creates a cumulative phase of the signal which is often referred to as integrated Doppler.

C/A (clear acquisition) Code - consists of a sequence of 1023 bits (0 or 1) that repeats every millisecond. Each satellite broadcasts a unique 1023-bit sequence that allows a receiver to distinguish between various satellites. The C/A-Code modulates only the L1 carrier frequency on GPS satellites. The C/A-Code allows a receiver to quickly lock on to a satellite.

Carrier phase - the cumulative phase of either the L1 or L2 carrier of a GPS signal, measured by a receiver while locked-on to the signal (also known as integrated Doppler).

Channel - refers to the hardware in a receiver that allows the receiver to detect, lock-on and continuously track the signal from a single satellite. The more receiver channels available, the greater number of satellite signals a receiver can simultaneously lock-on and track.

Circular Error Probable (CEP) - the radius of a circle, centered at the true location, within which 50% of position solutions fall. CEP is used for horizontal accuracy (see SEP).

Constellation - refers to the collection of orbiting GPS satellites. The GPS constellation consists of 24 satellites in 12-hour circular orbits at an altitude of 20,200 kilometers. In the nominal constellation, four satellites are spaced in each of six orbital planes. The constellation was selected to provide a very high probability of satellite coverage even in the event of satellite outages.

Conventional Terrestrial System (CTS) - a standardized reference system, originating at the planet's center of mass, that is designed to allow uniformity in geodetic measurements and computations.

Cycle slip - a loss of count of carrier cycles as they are being measured by a GPS receiver. Loss of signal, ionospheric interference and other forms of interference cause cycle slips to occur (see carrier phase).

Differential GPS (DGPS) - a technique whereby data from a receiver at a known location is used to correct the data from a receiver at an unknown location. Differential corrections can be applied in either real-time (see RTCM SC-104 format) or by post-processing. Since most of the errors in GPS are common to users in a wide area, the DGPS-corrected solution is significantly more accurate than a normal SPS solution.

Dilution of Precision (DOP) - a measure of the receiver-satellite(s) geometry. DOP relates the statistical accuracy of the GPS measurements to the statistical accuracy of the solution. Geometric Dilution of Precision (GDOP) is composed of Time Dilution of Precision (TDOP) & Position Dilution of Precision (PDOP), which are composed of Horizontal Dilution of Precision (HDOP) & Vertical Dilution of Precision (VDOP).

Doppler shift - a shift similar to that experienced by audio phenomena, except occurring in the electromagnetic spectrum, where an apparent change in signal frequency occurs as the transmitter and receiver move toward or away from one another.

Double difference - (see single difference **Error! Reference source not found.**) the arithmetic differencing of carrier phases measured simultaneously by a pair of receivers tracking the same pair of satellites. Single differences are obtained by each receiver from each satellite; these differences are then differenced in turn, which essentially deletes all satellite and receiver clock errors.

Earth Centered, Earth Fixed (ECEF) - a Cartesian coordinate system centered at the earth's center of mass. The Z-axis is aligned with the earth's mean spin axis. The X-axis is aligned with the zero meridian. The Y-axis is 90 degrees west of the X-axis, forming a right-handed coordinate system.

Elevation mask - an adjustable feature of GPS receivers that specifies that a satellite must be at least a specified number of degrees above the horizon before the signals from the satellite are to be used. Satellites at low elevation angles (five degrees or less) have lower signal strengths and are more prone to loss of lock thus causing noisy solutions.

Ellipsoid of revolution (often referred to simply as ellipsoid) - a mathematical representation of the earth that is an ellipse that is rotated about its minor axis. An ellipsoid is an equipotential surface of a rotating, homogeneous body. Various ellipsoid models have been determined to approximate the geoid in local areas and in a global sense. GPS uses the WGS84 earth model which is based on the GRS80 ellipsoid.

Ephemeris (plural: ephemerides) - a set of parameters used by a GPS receiver to predict the location of a GPS satellite and its clock behavior. Each GPS satellite contains and transmits ephemeris data its own orbit and clock. Ephemeris data is more accurate than the almanac data but is applicable over a short time frame (four to six hours). Ephemeris data is transmitted by the satellite, every 30 seconds. (See almanac **Error! Reference source not found.**).

Firmware - the electronic 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.

Frequency - the number of times that a periodic event occurs per unit of time. For GPS, frequency usually refers to the radio frequency, in Hz, of either of two basic carriers transmitted by each satellite (see L1 & L2 **Error! Reference source not found.**).

Geodetic coordinates - a coordinate system whose elements are latitude, longitude and geodetic height. The latitude is an angle based on the perpendicular to the ellipsoid. Longitude is the angle measured in the XY plane (see ECEF **Error! Reference source not found.**).

Geodetic datum (horizontal datum) - a specifically oriented ellipsoid typically defined by eight parameters which establish its dimensions, define its center with respect to Earth's center of mass and specify its orientation in relation to the Earth's average spin axis and Greenwich reference meridian.

Geodetic height (ellipsoidal height) - the height of a point above an ellipsoidal surface. The difference between a point's geodetic height and its orthometric height equals the geoidal height.

Geoid - the equipotential surface of the Earth's gravity field which best fits mean sea level. Geoids currently in use are GEOID84 and GEOID90.

Geoidal height (geoidal separation; undulation) - the height of a point on the geoid above the ellipsoid measured along a perpendicular to the ellipsoid.

Global Orbiting Navigation Satellite System (GLONASS) - the Russian version of GPS.

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.

Gravity - a force that is the vector sum of gravitational attraction of the various masses within the planet (gravitation) plus the centrifugal force caused by the rotation of the Earth. Unit of measurement: the gal = 1 cm per m/sec².

Hydrographic and bathymetric surveying - surveying or mapping of harbors, inlets or deep water locations. Hydrography is the study of the physical characteristics of oceans, lakes and rivers as well as the elements affecting safe navigation. Bathymetry is the measurement and study of water depths.

Ionosphere - refers to the layers of ionized air in the atmosphere extending from 70 kilometers to 700 kilometers and higher. Depending on frequency, the ionosphere can either block radio signals completely or change the propagation speed. GPS signals penetrate the ionosphere but are delayed. The ionospheric delays can be either predicted using models, though with relatively poor accuracy, or measured using two frequency receivers.

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.

Kinematic surveying - a method which initially solves wavelength ambiguities and retains the resulting measurements by maintaining a lock on a specific number of satellites throughout the entire surveying period.

L1 & L2 - designations of the two basic carrier frequencies transmitted by GPS satellites that contain the navigation signals. L1 is 1,575.42 Mhz and L2 is 1,227.60 Mhz.

L-band - a nominal portion of the microwave electromagnetic spectrum ranging from 1 to 2 Ghz.

Multipath - the reception of a signal both along a direct path and along one or more reflected paths. The resulting signal results in an incorrect pseudorange measurement. The classical example of multipath is the "ghosting" that appears on television when an airplane passes overhead.

Multiplexing - a technique used in some GPS receivers to sequence the signals of two or more satellites through a single hardware channel. Multiplexing allows a receiver to track

more satellites than the number of hardware channels at the cost of lower effective signal strength.

Navigation messages - data modulated onto the satellite's signals. The navigation data is transmitted 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.

NAVigation Satellite for Timing And Ranging (NAVSTAR) - Another term for GPS or sometimes used in conjunction with GPS as in "NAVSTAR GPS."

On-the-Fly (OTF) - a term used to describe the technique of resolving differential carrier-phase integer ambiguities without requiring a GPS receiver to remain stationary.

Orbit - the path a satellite takes in space.

Orthometric height (orthometric elevation) - the height of a point above the geoid.

P-Code - "precise" or "protected" code which is bi-phase shift modulated on both the L1 and L2 carrier frequencies. P-code has a 10.23MHz bit rate and, as implemented in GPS, has a period of one week. Each satellite has a unique P-code that is used to distinguish the satellite from all other GPS satellites.

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 endeavors.

Post-processing - the reduction and processing of GPS data after the data was actually collected in the field. Post-processing is usually accomplished on a computer in an office environment where appropriate software is employed to achieve optimum position solutions.

Precise Positioning System (PPS) - the more accurate GPS capability that is restricted to authorized, typically military, users.

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

Pseudorandom noise (PRN) - the P(Y) and C/A codes are pseudo-random noise sequences which modulate the navigation signals. The modulation appears to be random noise but is, in fact, predictable hence the term "pseudo"random. Use of this technique allows the use of a single frequency by all GPS satellites and also permits the satellites to broadcast a low power signal.

Pseudorange - the measured distance between the GPS receiver antenna and the GPS satellite. The pseudorange is approximately the geometric range biased by the offset of the receiver clock from the satellite clock. The receiver actually measures a time difference which is related to distance (range) by the speed of propagation.

Quartz oscillator - the timing device within a receiver that synchronizes the receiver's operation and maintains time for the receiver.

Ratio - a measure of the precision of observations that takes into account the resolution of ambiguities and arrives at an RMS value during the processing computations.

Real-time - refers to immediate, "on the spot," GPS data collection, processing and position determination (usually) within a receiver's firmware, rather than post-processing "after the fact" via a computer in an office environment.

Real-time kinematic (RTK) - a DGPS process where carrier-phase corrections are transmitted in real-time from a reference receiver at a known location to one or more remote "rover" receiver(s).

Reference Network - a series of monuments or reference points with accurately measured mutual vectors/distances that is used as a reference basis for cadastral and other types of survey.

Reference Station - a point (site) where crustal stability, or tidal current constants, have been determined through accurate observations, and which is then used as a standard for the comparison of simultaneous observations at one or more subordinate stations. Certain of these are known as Continuous Operating Reference Stations (CORS), and transmit reference data on a 24-hour basis.

RINEX - the Receiver-INdependent EXchange format for GPS data, which includes provisions for pseudorange, carrier-phase, and Doppler observations.

Root mean squared (RMS) - a statistical measure of the scatter of computed positions about a "best fit" position solution. RMS can be applied to any random variable.

RTCM SC-104 format - a standard format used in the transmission of differential corrections.

Satellite Image Mapping (SIM) - a product of remote sensing where discrete blocks of orbital photography are "mosaicked" into a comprehensive whole, then "geocoded" or computer-linked to specific Mercator, Lambert Conformal, or other types of projections that include a scale factor and reference geoid, with each pixel related to a specific latitude and longitude.

Selective Availability (SA) - the process whereby DoD "dithers" the satellite clock and/or broadcasts erroneous orbital ephemeris data to create a pseudorange error (see Standard Positioning System **Error! Reference source not found.**).

Spherical Error Probable (SEP) - a navigational measure of accuracy equaling the radius of a sphere, centered on the true location, inside which 50% of the computed solutions lie. (See CEP.)

Sidereal Time - is defined by the hour angle of the vernal equinox. Taking the mean equinox as the reference yields true or apparent Sidereal Time. Neither Solar nor Sidereal Time are constant, since angular velocity vary due to fluctuations caused by the Earth's polar moment of inertia as exerted through tidal deformation and other mass transports.

Single difference - the arithmetic "differencing" of carrier phases simultaneously measured by a pair of receivers tracking the same satellite (between-receivers and satellite), or by a single receiver tracking two satellites (between-satellite and receivers); the former essentially deletes all satellite clock errors, while the latter essentially deletes all receiver errors.

Software - usually refers to a set of advanced modules, such as Ashtech's PRISM II Package, that allows the user to plan efficient surveys, organize and acquire GPS data, verify and download GPS data into a computer, process and analyze the measurements, perform a network adjustment, and report/archive the final results.

Spoofing - the process of replicating the GPS code in such a way that the user computes incorrect position solutions.

Standard Positioning System - the less accurate GPS capability which is available to all. (See Anti-Spoofing and Selective Availability **Error! Reference source not found.**)
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Static observations - a GPS survey technique that requires roughly one hour of observation, with two or more receivers observing simultaneously, and results in high accuracies and vector measurements.

Triple difference - the arithmetic difference of sequential, doubly-differenced carrier-phase observations that are free of integer ambiguities, and therefore useful for determining initial, approximate coordinates of a site in relative GPS positioning, and for detecting cycle slips in carrier-phase data. (See single difference & double difference **Error! Reference source not found.**)

Universal Time Coordinated (UTC) - time as maintained by the U.S. Naval Observatory. Because of variations in the Earth's rotation, UTC is sometimes adjusted by an integer second. The accumulation of these adjustments compared to GPS time, which runs continuously, has resulted in an 11 second offset between GPS time and UTC at the start of 1996. After accounting for leap seconds and using adjustments contained in the navigation message, GPS time can be related to UTC within 20 nanoseconds or better.

World Geodetic System 1984 (WGS 84) - a set of U.S. Defense Mapping Agency parameters for determining global geometric and physical geodetic relationships. Parameters include a geocentric reference ellipsoid; a coordinate system; and a gravity field model. GPS satellite orbital information in the navigation message is referenced to WGS 84.

Y-Code - the designation for the end result of P-Code during Anti-Spoofing (AS) activation by DoD.

Y-Code tracking, civilian - several methods of obtaining valid data from encrypted Y-code are available:

1. Signal squaring (now obsolete) multiplies the signal by itself, thus deleting the carrier's code information and making distance measurement (ranging) impossible. Carrier phase measurements can still be accomplished, although doubling the carrier frequency halves the

wavelength, further weakening an already weak signal. This method required collecting data over a much longer period.

2. Cross correlation, where no local (receiver) code is generated to match the L1 & L2 encrypted Y-codes. The ionosphere "slows" the L2 Y-code slightly in respect to the L1 Y-code, hence the difference between these distances can be measured and, once known, matched and multiplied to remove the codes and leave pure carrier frequencies for measurement. This does away with the half-wavelength problem, but again results in a weakened signal that necessitates longer observation periods.

3. Code correlation & squaring. Here, the L1 & L2 Y-Codes are compared against a locally generated P-Code; the difference (the encrypting Y-code signal) is thus revealed, measured and squared so that pure carrier frequencies can be measured. Squaring once again weakens the resulting half-wavelengths of both carrier frequencies, and once again requires longer observation periods.

4. Ashtech's "Z-Technique" (see Z-Tracking TM).

Z count - a 29-bit binary number consisting of the fundamental GPS time unit. The (10) most significant bits carry the GPS week number, and the (19) least significant bits give the time of week (TOW) count in units of 1.5 seconds.