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GPS and Property Surveying

In 2010 the Global Positioning System (GPS) developed by the United States military was still the best known Global Navigation Satellite System (GNSS). Others included Russia's GLONASS, China's COMPASS and Europe's GALILEO systems. Fully developed, each supported its own constellation of twenty to thirty radio transmitting, Earth orbiting satellites. Although military satellite navigation systems can be traced back to the 1960s, their civilian uses emerged in the 1980s, initially limited to navigation positioning, not property surveying.

In conventional property surveying, the point of interest is a property marker, a point on a property boundary, a control point from which detailed measurements to property features can be made, or a control point for the photogrammetric mapping of property. The typical accuracy required of such points is 2-5cm. As late as the 1990s, the basic tools used in property surveying were a tape measure for determining shorter distances, a level to determine height or elevation differences, and a theodolite, set on a tripod, to measure horizontal and vertical angles. At the end of the century, theodolites were largely replaced by total station surveying instruments that combined the theodolite with an electronic distance measurement device (EDM) to measure both the angle and distance to a point simultaneously. Starting from a position with known location and elevation, the coordinates of an unknown point were computed from the measured angles and distances using the triangulation method.

By 2010, GNSS receivers were increasingly replacing the triangulation method and associated equipment for determining the coordinates of unknown locations in property surveying. Receivers use the mathematical method of trilateration from range distances between the receiver and at least four satellites to calculate the coordinate of a survey point. Early GNSS receivers processed transmissions from only one satellite constellation, but by 2008 they increasingly processed transmissions from all systems, enabling surveying throughout the day.

For U.S. security reasons, an intentional degradation (called selective availability) of GPS transmissions to civilian users was implemented in 1985, when the technology was made available for civilian uses. This led to horizontal accuracies of only about 100m, although differential correction procedures were soon developed to overcome the degraded signals, realizing 20cm accuracies, or better. Low cost hand-held GPS receivers with accuracies of about 60m, when used without differential correction, were marketed in the 1990s and soon captured the public's imagination. For many involved in resource mapping, these were adequate, providing much needed data for geographic information systems. But the accuracies were not sufficient for conventional property surveying.

Accuracies improved the longer the receiver remained stationary; for example, sub-centimeter accuracies could be achieved at points occupied for three days (Abidin et al. 2006). But this was not practical for property surveying, and real-time kinematic procedures were preferred where a single reference station provided the real-time corrections, providing up to centimeter-level accuracy.

In May 2000 selective availability was discontinued, and GPS reverted to a user friendly technology where expensive survey-grade instruments were capable of meeting the needs of conventional property surveying. Cheaper handheld GPS results also improved, achieving accuracies of 10-20m.

The period of selective availability implementation coincided with major investments worldwide in cadastral mapping systems (World Bank 1999), driven by the understanding that accurate land information encouraged economic development. For example, property mapping projects in South Africa used GPS-enabled palmtop computers to produce title plans, with accuracies of about 2m, in areas undergoing extremely rapid settlement (Barry and Ruther 2001). But for its conventional cadastre South Africa aimed for greater accuracies. Although methods to be used in cadastral surveying were not specified in the country's survey legislation, and any recognised methods were acceptable, most cadastral surveys used total station or GNSS methods. For South Africa, the accuracies of property surveying were specified in three classes, ranging from about 4cm to 12cm.

In the United Kingdom the largest available scale topographic maps were the legislated basis of title plans. However, in remote areas the largest scale maps inadequately distinguished small parcels and the need for higher accuracy property surveying was recognised by 2002. Historic errors in British mapping appeared when GPS surveying commenced, so software and an on-line converter were made available by the country's national mapping organisation for transforming new GPS-based property surveys to the existing National Spatial Data Infrastructure (NSDI).

Property surveying methods have varied both between and within nations. However, GPS surveying with some supporting legislation, had, by the early years of the 21st century, sufficiently developed to meet the needs of the property sector.

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