CE103: Surveying (4 cr. Hr.)
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CE103: Syllabus

- Curve Setting
  - Horizontal Curve
    - Circular Curve
    - Transition Curve
  - Vertical Curve
- Remote Sensing, GIS and GPS
- Reconnaissance and Project Surveying

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The Global Positioning System (GPS)

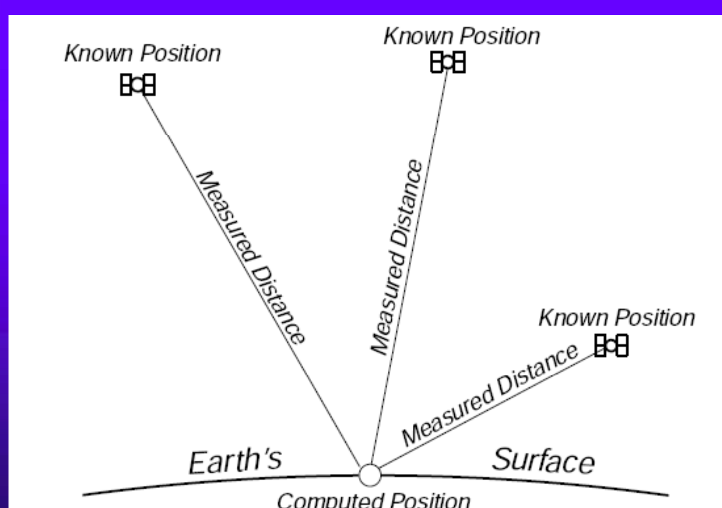
The Global Positioning System *(GPS) is a navigational or positioning system developed by the United States Department of Defense. It was designed as a fast positioning system for 24 hour a day, three dimensional coverage worldwide.*

It is based on a constellation of 21 active and 3 spare satellites orbiting 10,900 miles above the earth. The GPS *(NAVSTAR) satellites have an orbital period of 12 hours and are not in geosynchronous orbit (they are not stationary over a point on the earth). They maintain a very precise orbit and their position is known at any given moment in time. This constellation could allow a GPS user access to up to a maximum of 8 satellites anywhere in the world.*

GPS provides *Point Position (Latitude/Longitude) and Relative Position (Vector). GPS can differentiate between every square meter on the earth's surface thus allowing a new international standard for defining locations and directions.*

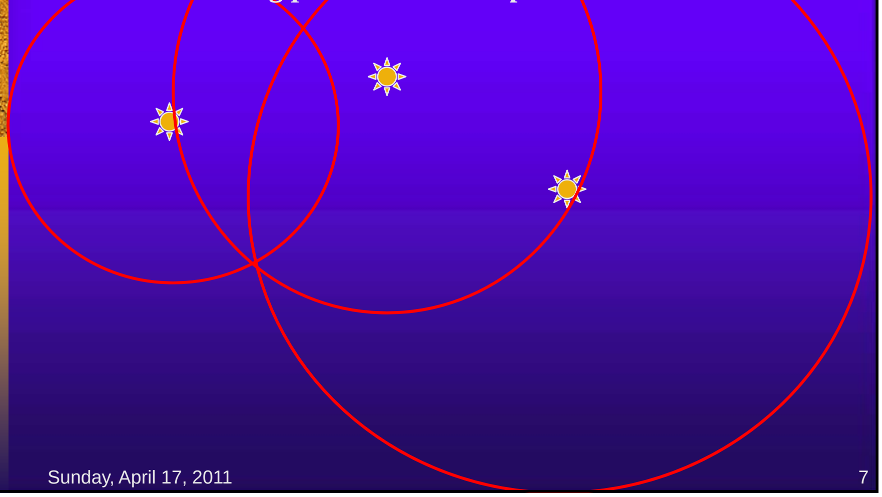
The applications (military or civilian) for GPS are almost limitless, from guiding a missile to a target with incredible accuracy or tracking and monitoring the location of a city's emergency vehicles or providing a zero visibility landing and air collision avoidance system to a variety of surveying applications.

The Basic Principles of GPS



How positions are computed

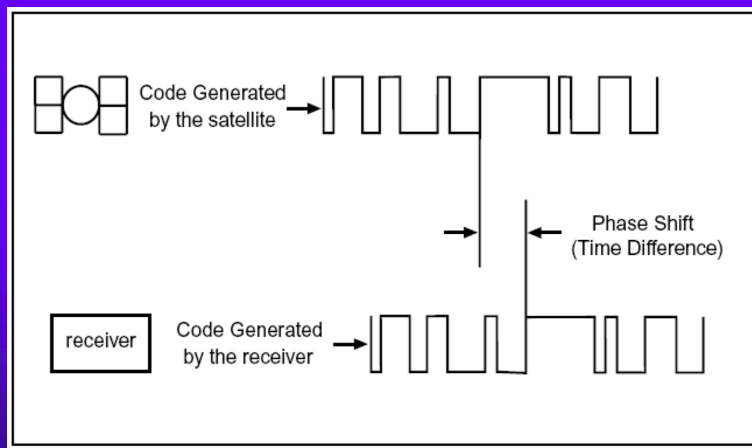
Distance of GPS reciever is measured from each satellite
If we draw 3 sphere around 3 satellite
Then the intersecting point is the exact position of GPS reciever



How satellite distance is measured

Each GPS satellite continually broadcasts a radio signal. Radio waves travel at the speed of light (186,000 miles per second) and if we measure how long it took for the signal to reach us we could compute the distance by multiplying the time in seconds by 186,000 miles per second.

In order to measure the travel time of the radio signal, the satellite broadcasts a very complicated digital code. The receiver on the ground generates the same code at the exact time and when the signal is received from the satellite, the receiver compares the two and measures the phase shift to determine the time difference.



If the satellites are orbiting about 10,900 miles above the surface of the earth and the radio signal travels at 186,000 miles per second, a satellite directly above takes about 0.06 seconds to transmit its signal to earth. To be able to measure the distance to the accuracy needed, the satellite and the receiver must be perfectly in sync and we must have the ability to measure time with extreme accuracy.

Each satellite is equipped with 4 atomic clocks which keep almost perfect time and the receivers that we use can measure time to an accuracy of 0.000000001 of a second. The problem is that the receivers are not in sync with the atomic clocks. If the receiver is out of sync with the satellite by even 0.001 of a second, the computed distance would be off by 186 miles!

To solve this problem we include the measurement to an extra satellite. The added sphere to the equation would intersect at the same point as before *if the receiver were in perfect sync with the satellite. If the added sphere does not intersect at the same point, then the clocks are not in perfect sync and a clock offset for the receiver can be calculated. For accurate 3D positions, 4 satellites must be in view of the receiver.*

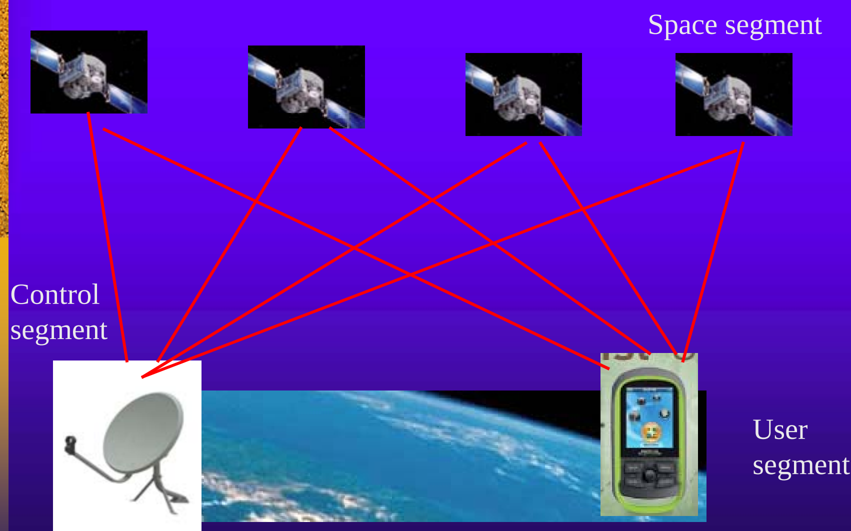
The Ephemeris

table of values that gives the positions of astronomical objects in the sky at a given time or times.

Once we know the distance to the satellite, we need to know exactly where the satellite was at the moment of the measurement. Receivers have an almanac stored in their memory which gives each satellite's position in the sky at any given time. Contradicting what was mentioned earlier, the satellite's orbit does decay changing its position, altitude and speed.

This change is extremely minuscule and is monitored by the Department of Defense every 12 hours and these variations (ephemeris errors) are transmitted back to the satellite. The satellite transmits a data message along with its pseudo-random code. The data message contains information about its exact orbital location (with the ephemeris error corrections) and its system's health.

3 Segments of GPS



Differential GPS (DGPS)

To achieve sub-centimeter accuracies in positions, we need a survey grade receiver and a technique called *Differential GPS. By placing a receiver at a known location, a total error factor which accounts for all the possible errors in the system, can be computed which can be applied to the position data of the other receivers in the same locale. The satellites are so high-up that any errors measured by one receiver could be considered to be exactly the same for all others in the immediate area.*

The Nuclear Detection System (NDS or NUDET)

Since 1980, GPS satellites have carried a secondary payload consisting of nuclear detonation sensors that provide worldwide, near-real-time, threedimensional location of nuclear detonations.

The GPS Nuclear Detonation Detection System is managed as a joint program of the U.S. Air Force and the Department of Energy (DoE).

Remote sensing

Remote sensing is simply measuring objects from a distance, where the measuring device is not in direct contact with the object being measured. Remote sensing devices can be active or passive. Active devices emit electromagnetic radiation and measure reflectance (or lack of reflectance) from an object. These include active radar (LIDAR), sonar devices that detect fish or water depth, and medical imaging devices. Passive systems measure ambient electromagnetic radiation emitted from an object. Passive devices include airborne photography, most satellite-based sensors, and photography (without a flash).

Most broadly defined, remotely sensed data includes any measurement made from a distance. This definition can include sounds, smells, and other types of observations, but this site focuses on data that can usually be displayed as an image.

Geographic Information System (GIS)

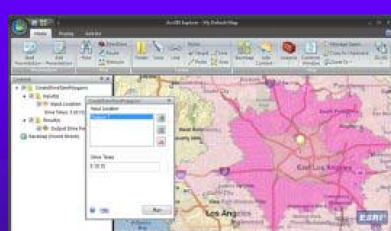
A geographic information system (GIS) integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information.

GIS allows us to view, understand, question, interpret, and visualize data in many ways that reveal relationships, patterns, and trends in the form of maps, globes, reports, and charts.

A GIS helps you answer questions and solve problems by looking at your data in a way that is quickly understood and easily shared.

GIS technology can be integrated into any enterprise information system framework.

ArcView is a GIS software



A **geographic information system (GIS)**, **geographical information system**, or **geospatial information system** is the system that captures, stores, analyzes, manages, and presents data with reference to geographic location data. In the simplest terms, GIS is the merging of cartography, statistical analysis, and database technology.

GIS may be used in archaeology, geography, cartography, remote sensing, land surveying, public utility management, natural resource management, precision agriculture, photogrammetry, urban planning, emergency management, landscape architecture, navigation, aerial video, and localized search engines.

What goes beyond a GIS is a spatial data infrastructure (SDI), a concept that has no such restrictive boundaries.

Therefore, in a general sense, the term describes any information system that integrates, stores, edits, analyzes, shares, and displays geographic information for informing decision making.

GIS applications/softwares are tools that allow users to create interactive queries (user-created searches), analyze spatial information, edit data, maps, and present the results of all these operations

The year 1960 was the development of the world's first true operational GIS in Ottawa, Ontario, Canada by the federal Department of Forestry and Rural Development. Developed by Dr. Roger Tomlinson, it was called the "Canada Geographic Information System" (CGIS) and was used to store, analyze, and manipulate data collected for the Canada Land Inventory (CLI) – an effort to determine the land capability for rural Canada by mapping information about soils, agriculture, recreation, wildlife, waterfall, forestry, and land use at a scale of 1:50,000.