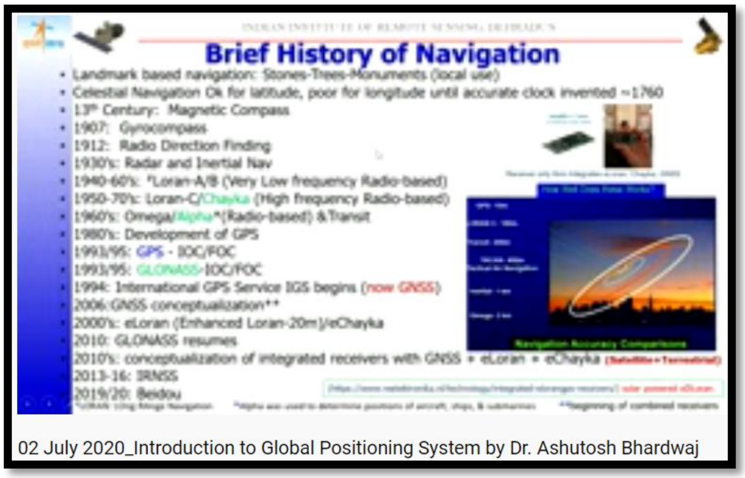
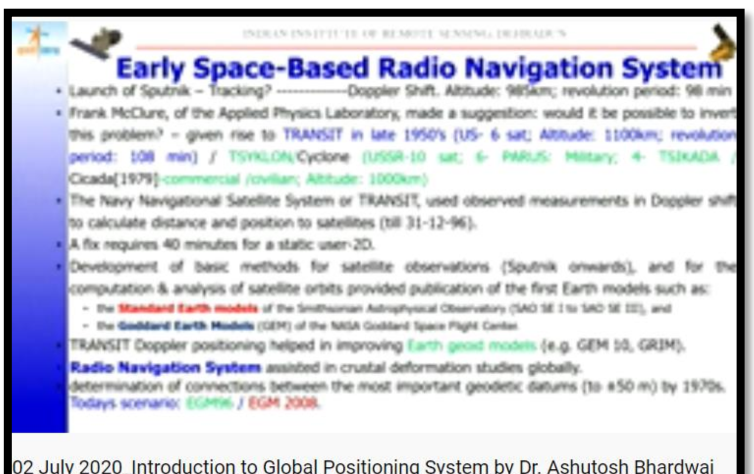
DAILY ASSESSMENT

Date:	**02/07/2020**	**Name:**	**Davis S. Patel**
Course:	**IIRS Outreach Programme on "Satellite Photogrammetry and its Applications"**	**USN:**	**4AL16EC045**
Topic:	**Introduction to Global Positioning System**	**Semester & Section:**	**8th - A**
GitHub Repository:	**Davis**		

AFTERNOON SESSION DETAILS
Image of session



02 July 2020_Introduction to Global Positioning System by Dr. Ashutosh Bhardwaj



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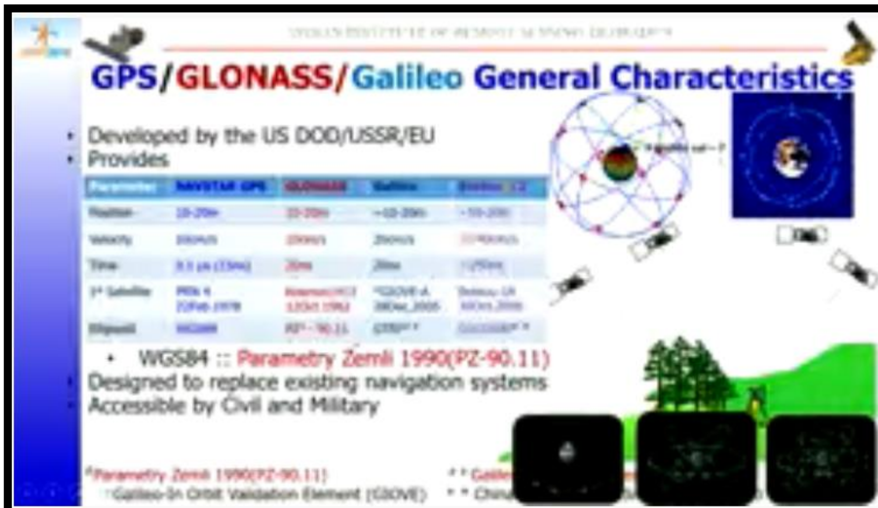

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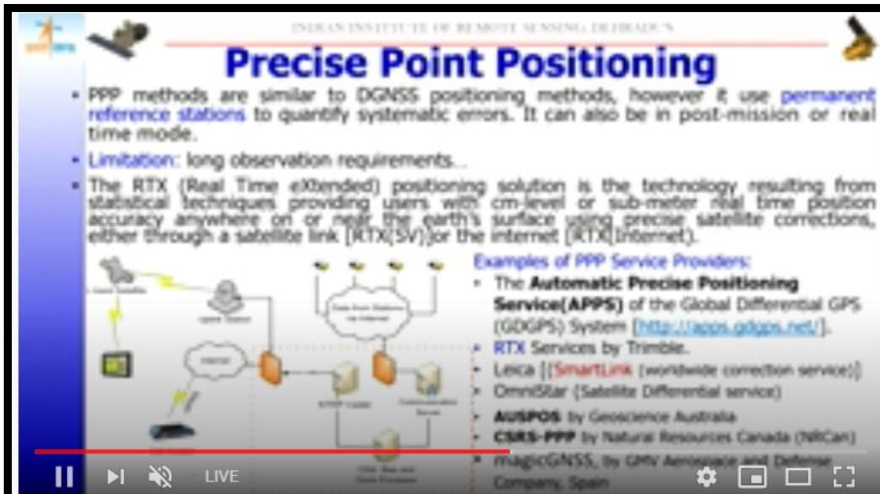

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REPORT –

The Global Positioning System (GPS) is a satellite-based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defense. GPS was originally intended for military applications, but in the 1980's, the government made the system available for civilian use. GPS works in any weather conditions, anywhere in the world, 24 hours a day, 365 days a year. The 24 satellites that make up the GPS space segment are orbiting the earth about 12,000 miles above us. These satellites are travelling at speeds of roughly 7,000 miles an hour. GPS satellites are powered by solar energy. They have backup batteries onboard to keep them running in the event of a solar eclipse, when there's no solar power. Small rocket boosters on each satellite keep them flying in the correct path. Each satellite weighs about 2,000 pounds and is built to last about ten years.

GPS satellites circle the earth twice a day in a very precise orbit and transmit signal information to earth. GPS receivers take this information and use triangulation to calculate the user's exact location. Essentially, the GPS receiver compares the time a signal was transmitted by a satellite with the time it was received. The time difference tells the GPS receiver how far away the satellite is. Now, with distance measurements from a few more satellites, the receiver can determine the user's position and display it on the user's electronic map. A GPS receiver must be locked on to the signal of at least three satellites to calculate a 2D position (latitude and longitude) and track movement. With four more satellites in view, the receiver can determine the user's 3D position (latitude, longitude and altitude). Once the user's position has been determined, the GPS unit can calculate other information, such as speed, bearing, track, trip distance, distance to destination, sunrise and sunset time and more.

The first satellite navigation system was Transit, a system deployed by the US military in the 1960s. Transit's operation was based on the Doppler Effect: the satellites travelled on well-known paths and broadcast their signals on a well-known radio frequency. The received frequency will differ slightly from the broadcast frequency because of the movement of the satellite with respect to the receiver. By monitoring this frequency shift over a short time interval, the receiver can determine its location to one side or the other of the satellite, and several such measurements combined with a precise knowledge of the satellite's orbit can fix a particular position. Satellite orbital position errors are caused by radio-wave refraction, gravity field changes (as the Earth's gravitational field is not uniform), and other phenomena. A team, led by Harold L Jury of Pan Am Aerospace Division in Florida from 1970-1973, found solutions and/or corrections for many error sources. Using real-time data and recursive estimation, the systematic and residual errors were narrowed down to accuracy sufficient for navigation.

Currently, there are mainly four Global Navigation Satellite System (GNSS) systems, including the United Stated (US) Global Positioning System (GPS), the Russian GLONASS System, the future European GALILEO System and Chinese COMPASS System. GPS is a line-of–sight, all weather, world-wide continuously available satellite based radio frequency system that is capable of providing three-dimensional position, velocity and time to users with an appropriate receiving equipment [1]. The nominal GPS constellation consists of 24 satellites, operated in six orbital planes. The orbital radius is about 26,560km and the inclination is 55° [2]. In each plane there are four operational satellites and the satellites are not evenly distributed within the planes. At present the constellation actually consists of 30 operational satellites. For the moment we assume that the nominal 24-satellite constellation will be maintained. Currently, GPS transmits on the L1 and L2 frequency. Future satellites will also transmit on the L5 frequency.

GLONASS is a satellite navigation system operated by Russia’s Ministry of Defense. The system consists of a 21 active satellites, operated in 3 orbital planes and nominally inclined at 64.8° to the equator. Each orbital plane also contains a spare constellation, thus there are 8 satellites in each orbital plane placed orbiting at an altitude of 25500Km from the mean surface of the earth, with a period of approximately 11 hours 15 minutes. GALILEO is a joint initiative of the European Commission and the European Space Agency. GALILEO will be put into operation by 2013 under the agreement signed by the EU transport ministers in November 2007.

The designed GALILEO constellation consists of 30 satellites, and the satellites are evenly divided within three orbital planes with an orbital radius of 29,994 km and an inclination of 56°. However, we will only consider the 27-satellite constellation here. GALILEO signals will be transmitted on the E2-L1-E1, E5a-E5b and E6 frequencies. The COMPASS navigation system is China’s entry into the realm of GNSS. The current design is to have a system comprised of 5 Geostationary Earth Orbit (GEO) satellites and 30 Non-GEO satellites (Inclined Geosynchronous

Earth Orbit satellites and Medium Earth Orbit satellites). The Medium Earth Orbit (MEO) satellites will operate in six orbital planes to provide global positioning coverage.

Precise Point Positioning (PPP) is a positioning technique that removes or models GNSS system errors to provide a high level of position accuracy from a single receiver. A PPP solution depends on GNSS satellite clock and orbit corrections, generated from a network of global reference stations. Once the corrections are calculated, they are delivered to the end user via satellite or over the Internet. These corrections are used by the receiver, resulting in decimeter-level or better positioning with no base station required.

PPP delivers accuracy up to 3 centimeters. A typical PPP solution requires a period of time to converge to decimeter accuracy in order to resolve any local biases such as the atmospheric conditions, multipath environment and satellite geometry. The actual accuracy achieved and the convergence time required is dependent on the quality of the corrections and how they are applied in the receiver.

Similar in structure to an SBAS system, a PPP system provides corrections to a receiver to increase position accuracy. However, PPP systems typically provide a greater level of accuracy and charge a fee to access the corrections. PPP systems also allow a single correction stream to be used worldwide, while SBAS systems are regional.

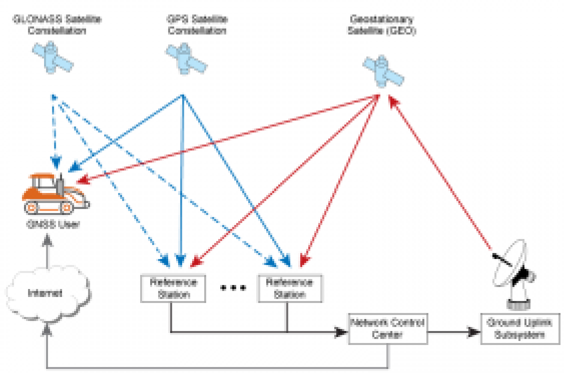

Figure 43 Precise Point Positioning (PPP) System Overview

PPP is able to provide position solutions at centimeter to decimeter level by combining precise satellite positions and clocks with un-differenced, dual-frequency (to remove the first order effect of the ionosphere), pseudo range and carrier-phase GNSS observables. In static mode, PPP can provide even sub-centimeter positioning precision. PPP differs from traditional Double-Difference (DD) relative baseline positioning (e.g., Real Time Kinematics, RTK) in the sense that it does not require access to simultaneous observations from one or more close reference stations accurately-surveyed As a result, PPP provides absolute positioning information, contrarily to RTK, which instead provides relative positioning information with respect to a reference station. PPP just requires precise orbit and clock data, which are computed by a processing center with measurements coming from reference stations belonging to a relatively sparse network (i.e., thousands of km apart would suffice). This makes PPP a very attractive alternative to RTK for those areas where RTK coverage is limited or not available.