

Global Positioning System

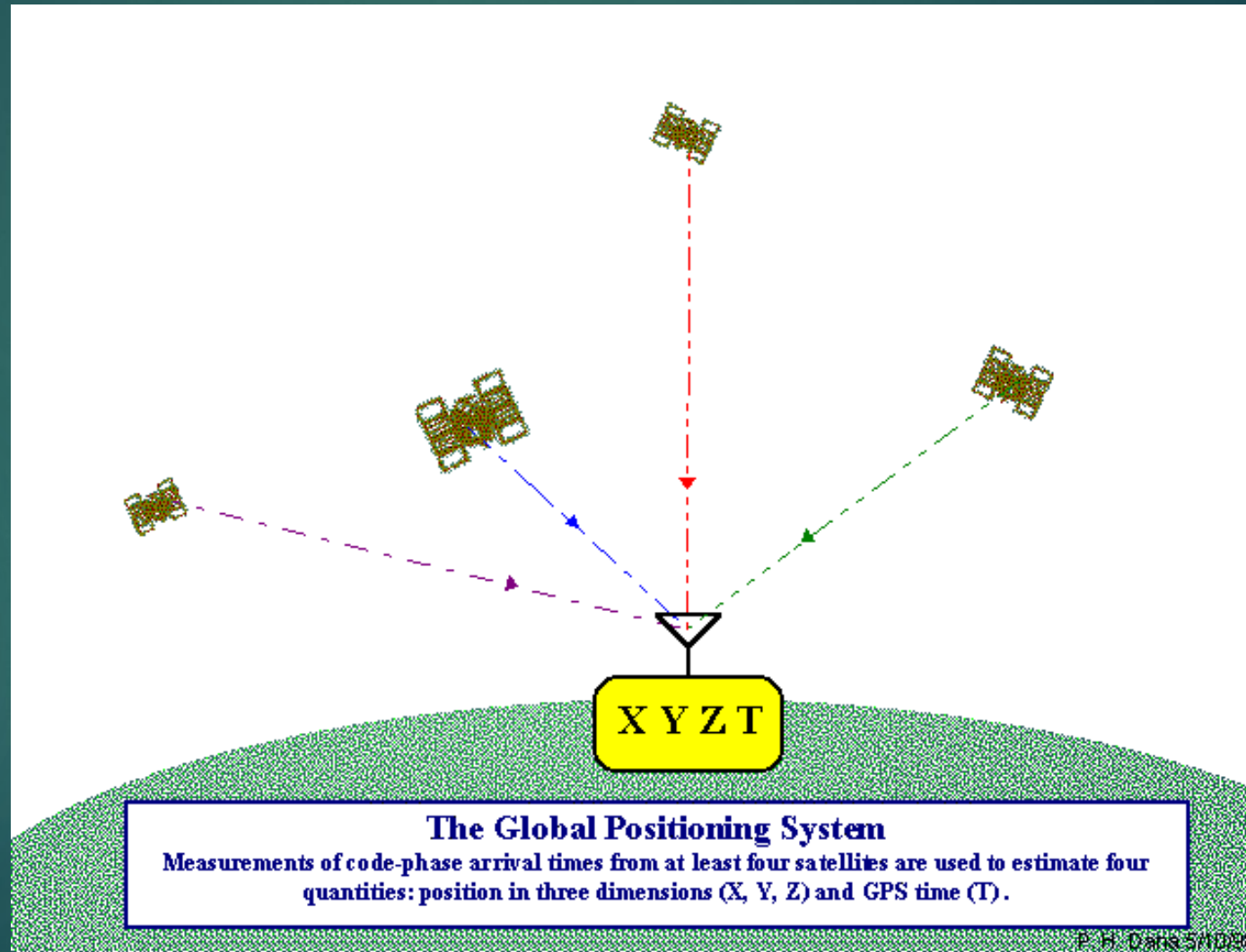
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Introduction

- ▶ GPS is funded and controlled by U. S. Department of Defense (DOD).
- ▶ GPS provides specially coded satellite signals that can be processed in a GPS receiver.
- ▶ Four GPS satellite signals - to compute positions in three dimensions and the time offset in the receiver clock.

- ▶ Space segment
- ▶ Control segment
- ▶ User segment

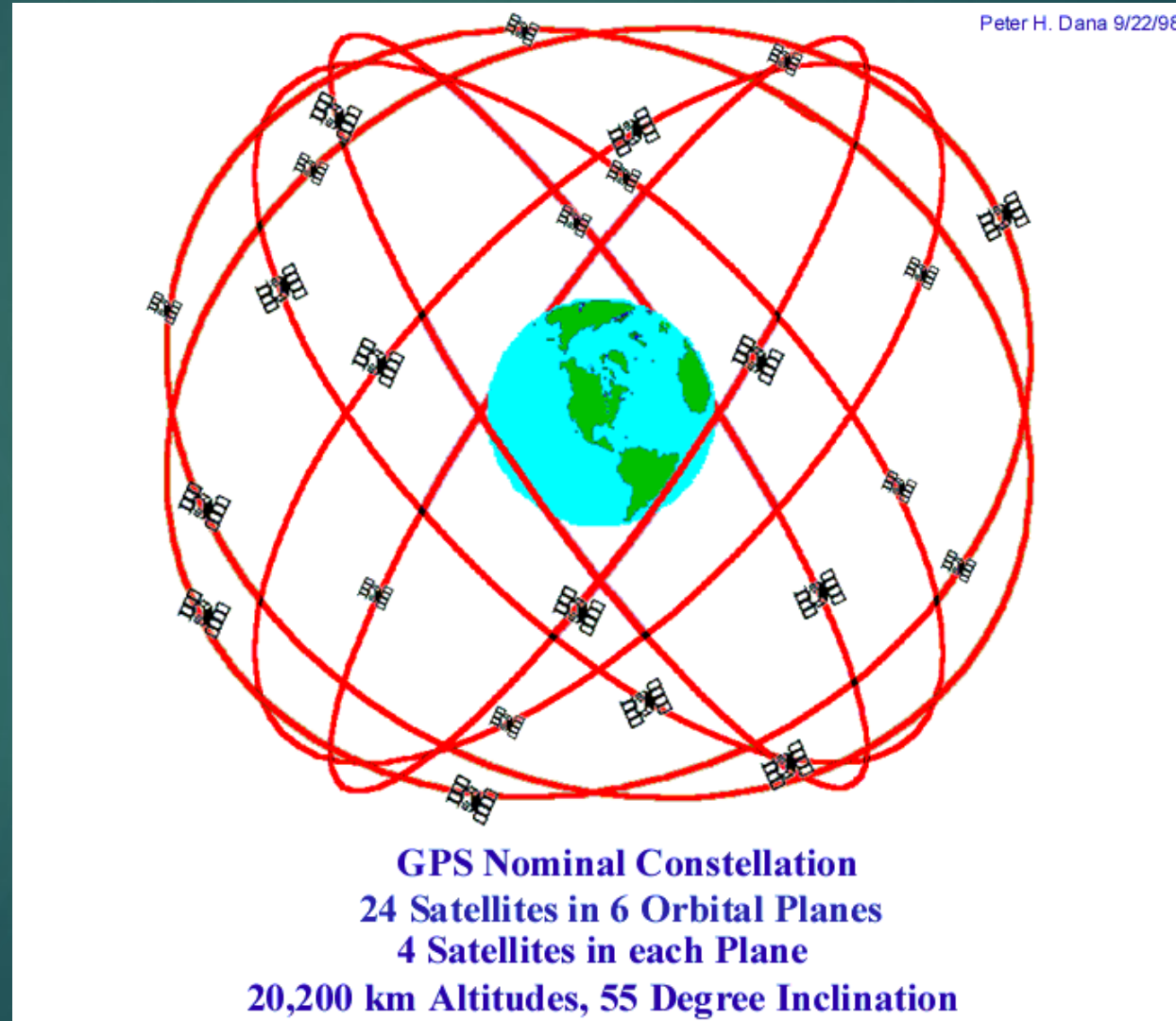
GPS - Intro



Space Segment

- ▶ GPS satellites - Space vehicles (SVs) send radio signals from space
- ▶ Nominal GPS Operational Constellation consists of 24 satellites that orbit the earth in 12 hours
- ▶ 6 orbital planes (4 SVs in each), equally spaced (60° apart), and inclined at about 55° to equatorial plane
- ▶ This constellation provides the user with between five and eight SVs visible from any point on the earth

GPS Nominal Constellation



Control Segment

- ▶ The Master Control facility is located at Schriever Air Force Base (formerly Falcon AFB) in Colorado, USA
- ▶ Monitor stations measure signals from the SVs which are incorporated into orbital models for each satellite
- ▶ Models compute precise orbital data (ephemeris) and SV clock corrections for each satellite
- ▶ Master Control station uploads precise ephemeris and clock data to the SVs
- ▶ SVs then send subsets of the orbital ephemeris data to GPS receivers over radio signals

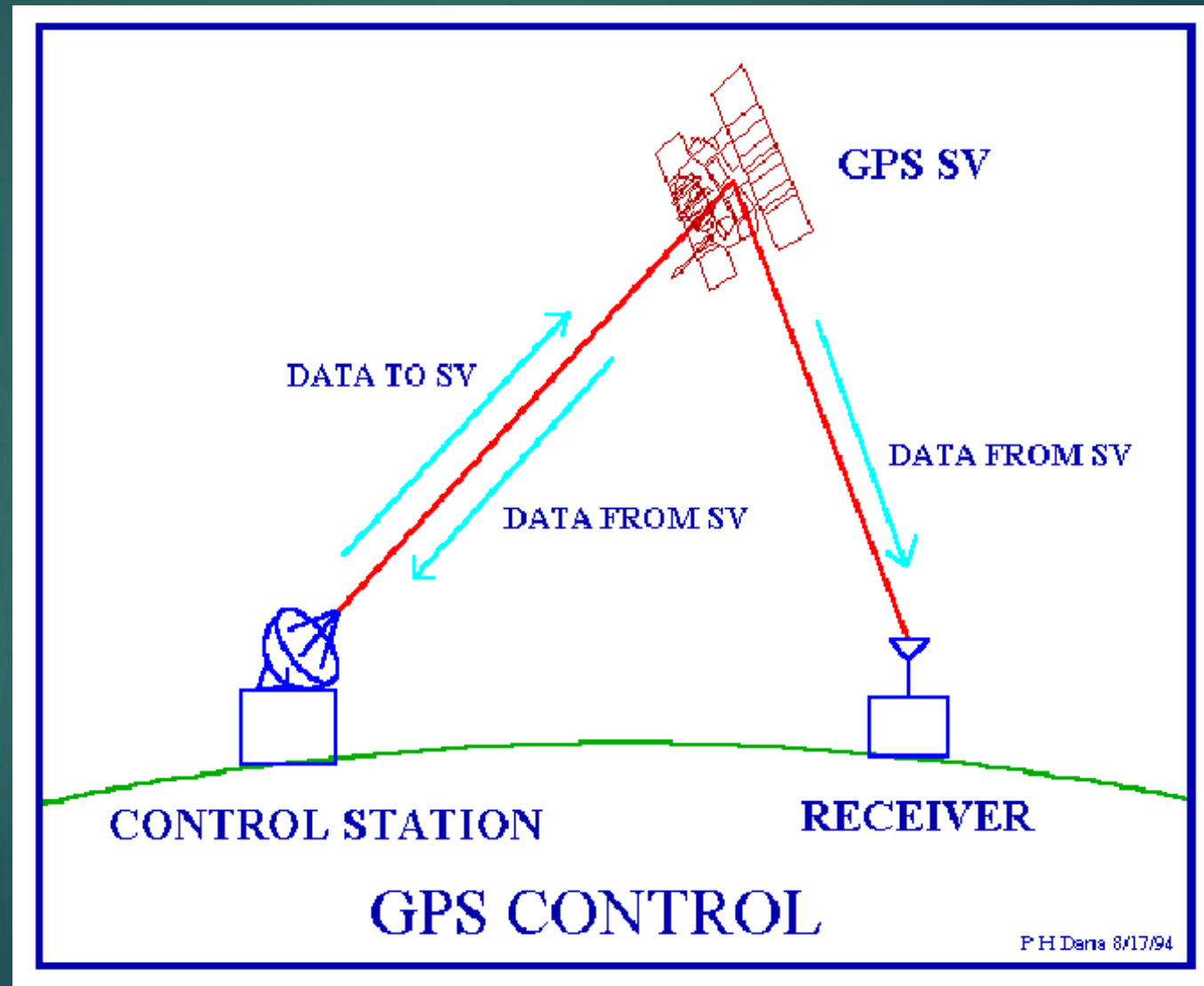
Control Segment

Peter H. Dana 5/27/95



Global Positioning System (GPS) Master Control and Monitor Station Network

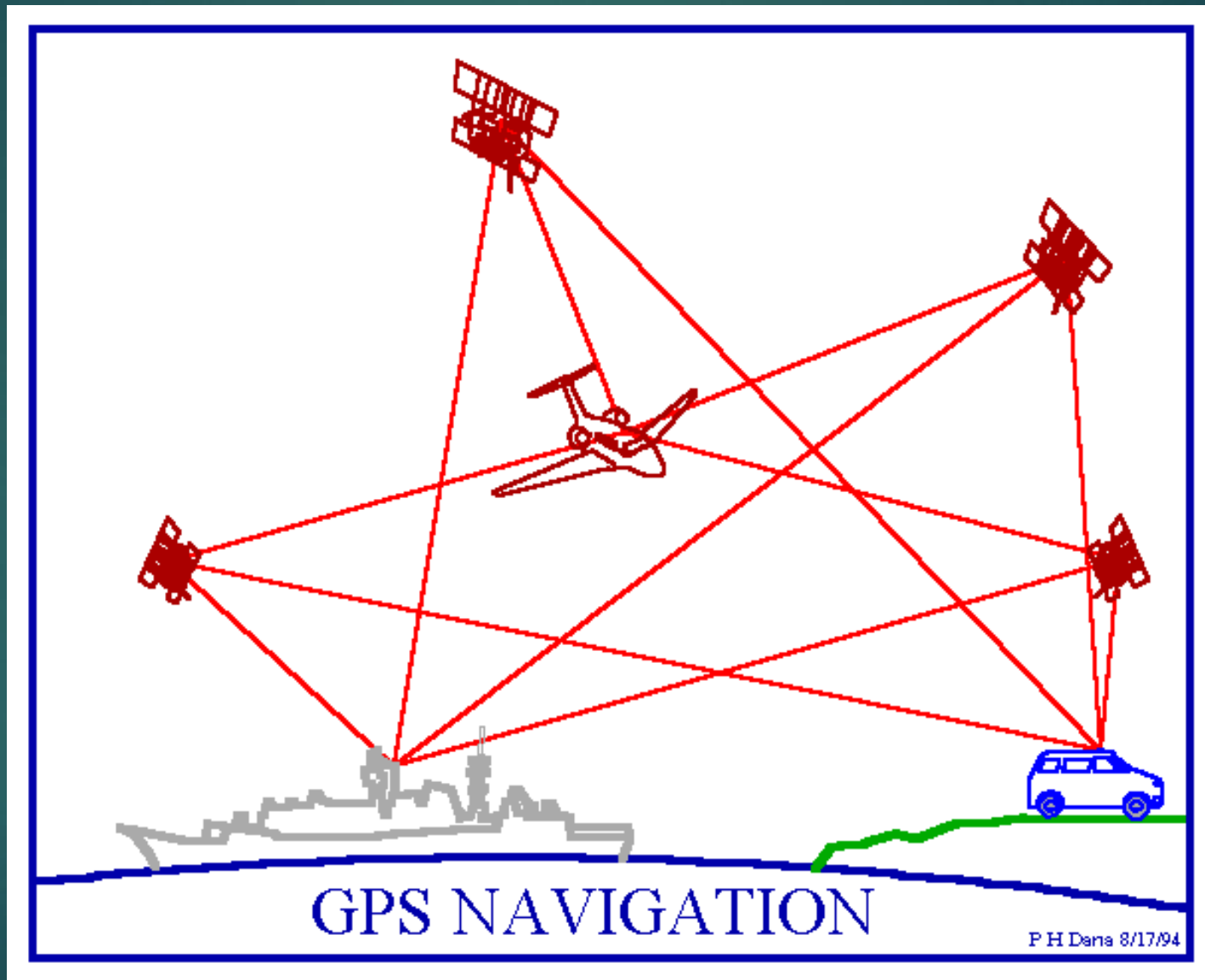
Control Segment



User Segment

- ▶ GPS receivers and the user community
- ▶ GPS receivers convert SV signals into position, velocity and time estimates
- ▶ Four satellites are required to compute the four dimensions of X, Y, Z (position) and Time
- ▶ Used for Navigation, Positioning, Time Dissemination etc.,
- ▶ Navigation receivers are made for aircraft, ships, ground vehicles and for hand carrying by individuals
- ▶ Precise positioning at reference locations for Surveying, geodetic control, and plate tectonic studies
- ▶ Time and frequency dissemination (Based on Precise clocks): Astronomical Observatories, Telecommunications Facilities and Laboratory Standards can be set to Precise Time Signals

User Segment



GPS Positioning Services

- ▶ Precise Positioning Service (PPS)
- ▶ Standard Positioning Service (SPS)

Precise Positioning Service

Authorized users with cryptographic equipment and keys and specially equipped receivers

PPS Predictable Accuracy

22 meter Horizontal accuracy

27.7 meter vertical accuracy

200 nanosecond time (UTC) accuracy

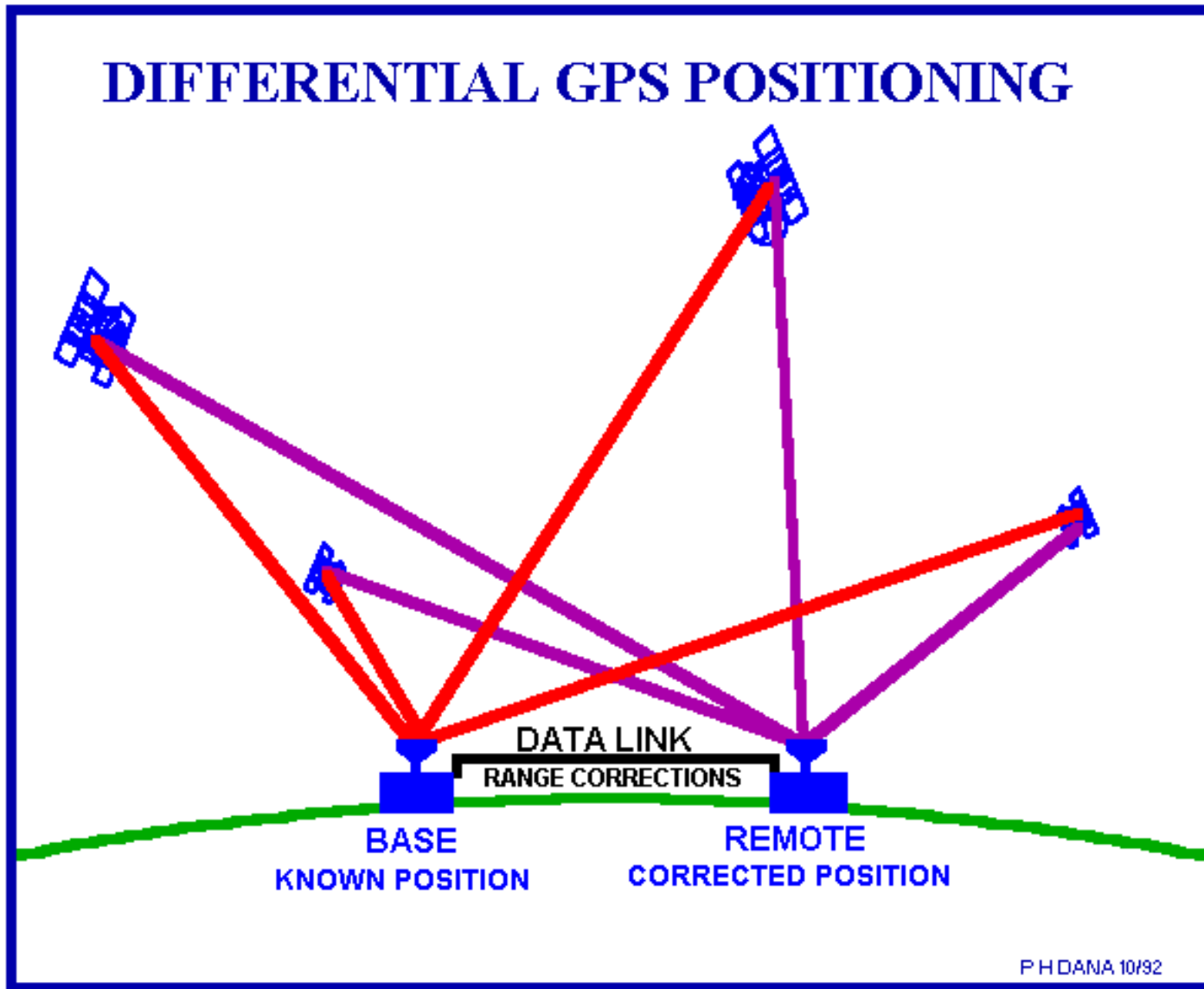
Standard Positioning Service

Civil users worldwide use the SPS without charge or restrictions

SPS Predictable Accuracy

- 100 meter horizontal accuracy
- 156 meter vertical accuracy
- 340 nanoseconds time accuracy

Differential GPS (DGPS)



GPS Error Sources

GPS ERROR SOURCES

ERROR SOURCE	TYPICAL RANGE ERROR	DGPS (CODE) RANGE ERROR <100 KM REF-REMOTE
SV CLOCK	1 M	
SV EPHEMERIS	1 M	
SELECTIVE AVAILABILITY	10 M	
TROPOSPHERE	1 M	
IONOSPHERE	10 M	
PSEUDO-RANGE NOISE	1 M	1 M
RECEIVER NOISE	1 M	1 M
MULTIPATH	0.5 M	0.5 M
RMS ERROR	15 M	1.6 M
ERROR * PDOP=4	60 M	6 M

PDOP=Position Dilution of Precision (3-D) 4.0 is typical

GPS

Handheld



Bluetooth
Module



Car
navigation

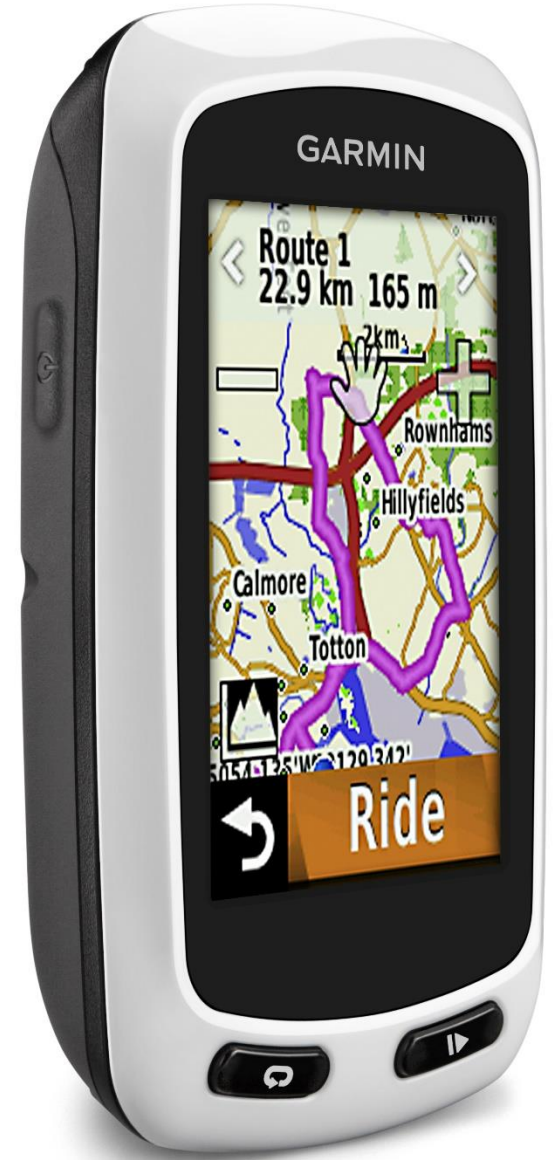


PDA



Garmin 60cx – 2m & Etrex – 5m





Reference Material

- ▶ Dr. T.V. Ramachandra, Principles of remote sensing in environmental Management, IISc
- ▶ Dr. Nagesh Kumar, Notes of Principles of remote sensing in water resources, IISc
- ▶ Landsat.org
- ▶ Tutorials, CCRS, Canada
- ▶ ITC, netherlands