_GPS SURVEYING

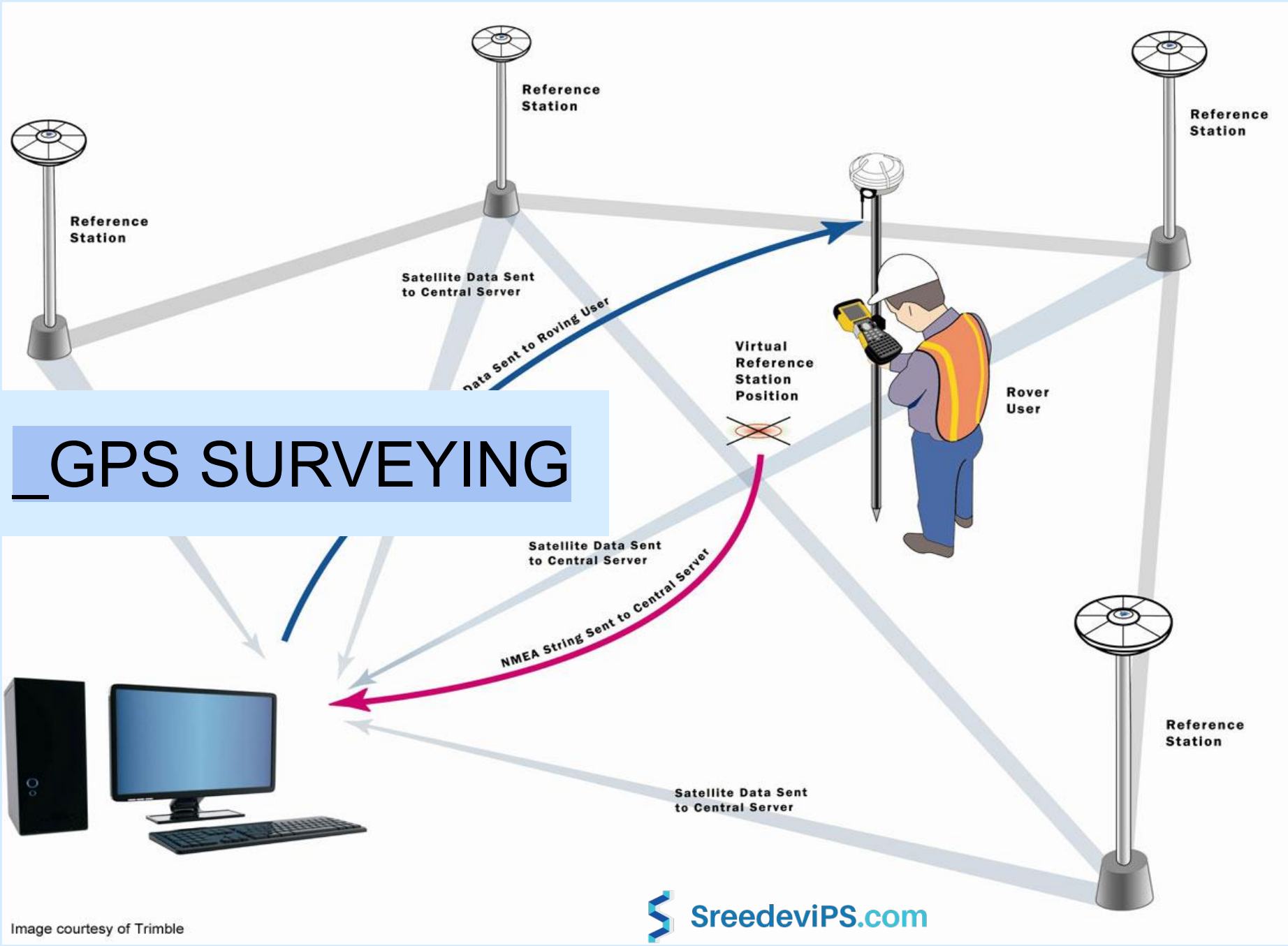


Image courtesy of Trimble

SreedeviPS.com

MODULE IV - GPS SURVEYING

SYLLABUS

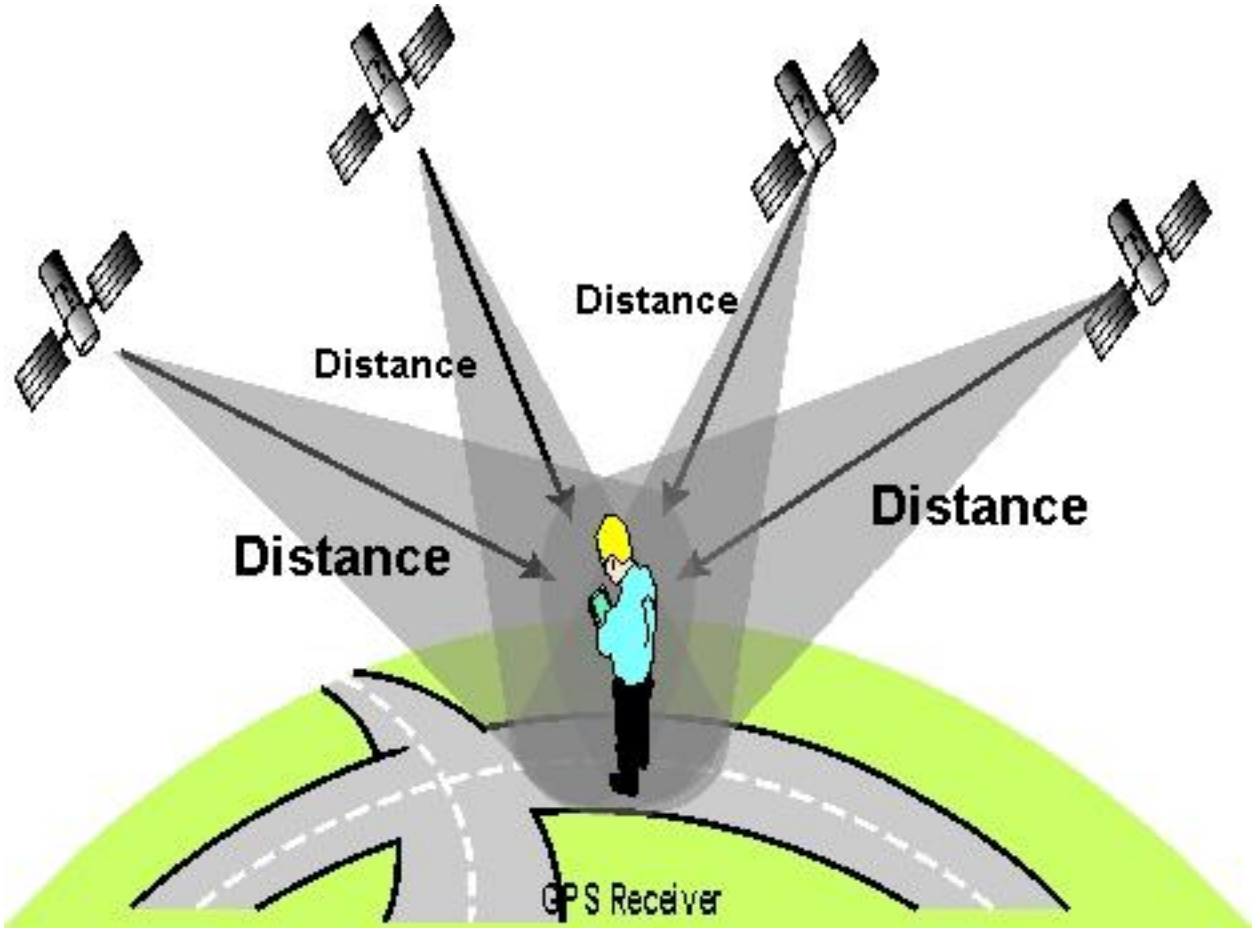
- GPS Surveying methods-Static, Rapid static , Kinematic methods – DGPS,
- Phases of GPS Survey -Planning and preparation,
- Field operation-horizontal and vertical control,
- data sheet, visibility diagram, Processing and report preparation,

GPS SURVEYING TECHNIQUES

- GPS – determine position of stationary or moving object
- Position w r t
  - coordinate (x,y,z)
  - Single GPS receiver
  - 4 satellites

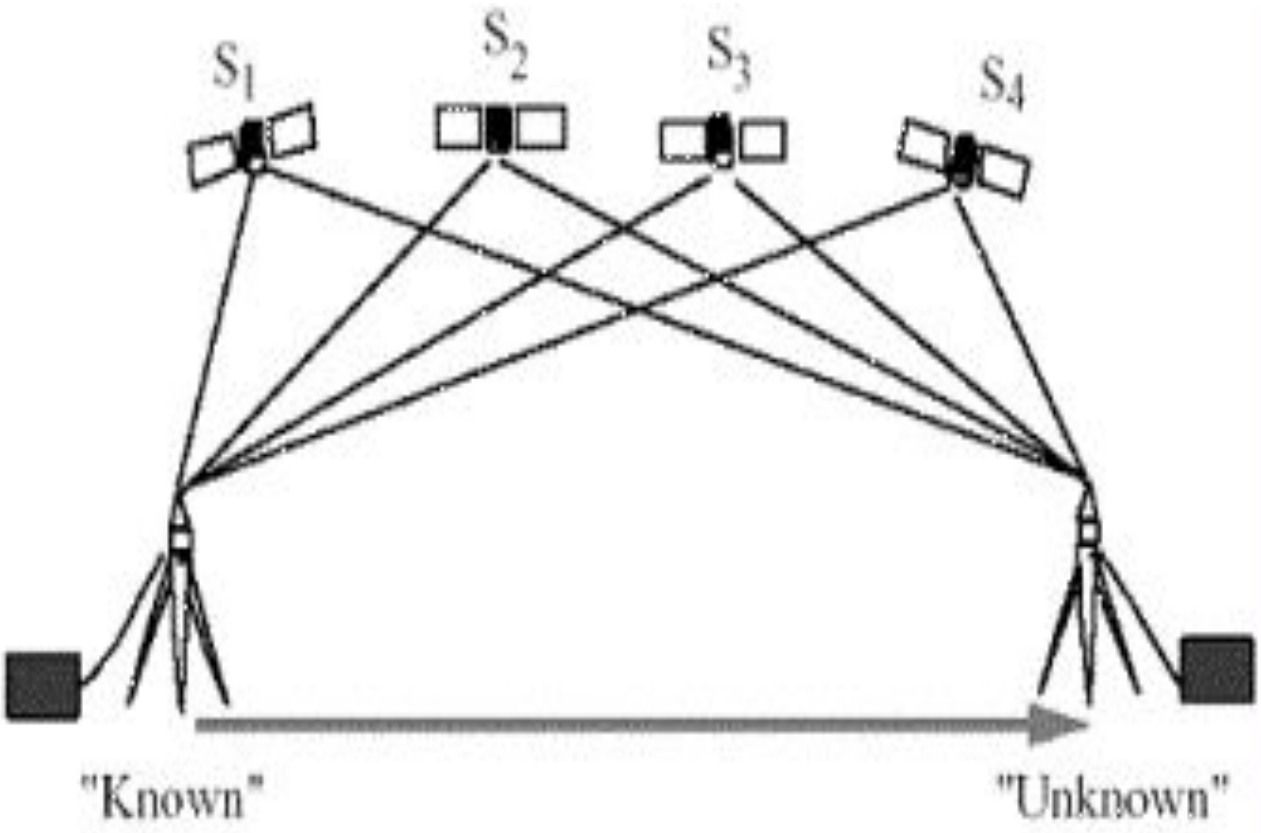
Point positioning or absolute positioning

Point positioning or absolute positioning



RELATIVE POSITIONING

- objective of the work is the determination of the position of the other point
- 2 GPS receivers
- One known point (coordinates known)
- Distance between 2 receivers – baseline
- Both receivers observe the same constellation of satellites at the same time
- Object stationary – static positioning
- Moving object – kinematic positioning



Relative Positioning

GPS SURVEYS

- GPS surveying implies the precise measurement of the vector between two instrument stations
- Static surveying
  - Traditional static surveying
  - Rapid static surveying
  - Pseudo static surveying
  - Pseudo Kinematic method

  } Reoccupation Mode
- Dynamic surveying
  - Stop and Go Method
  - Traditional Kinematic surveying
  - Kinematic on the fly (KOTF)
  - Real time kinematic or real time differential

STATIC SURVEYING TECHNIQUE

Traditional static surveying

- First high precision method
- 2 GPS receiver – fixed position
- One base receiver – placed over known coordinates
- Second receiver – new permanent station to be positioned

- Involves long observation time (1-2 hrs depending on number of visible satellites) in order to resolve the integer ambiguities between the satellite and the receiver
- At least two receivers collect carrier-phase data in stationary or static mode for a long duration of time
- One of the receivers is placed on point whose coordinates are known (reference receiver)
- Second one is positioned over the point whose coordinate is unknown (rover)

- Both receivers must receive signals from the same four or more satellites for a period of time (few minutes to several hours)
- Session's duration depends on:
  - length of baseline
  - geometry of satellites
  - Precision of result required
- Larger the constellation of satellites, lower the session duration

- Post processing software analyzes all data from the receivers simultaneously and obtains the differential position between the receivers
- Used for long lines, geodetic networks, tectonic plate studies
- Offers high accuracy of 1cm to 0.1cm over long distances like 10km

APPLICATIONS OF STATIC METHOD

- Geodetic control over large areas
- National and conventional networks
- Monitoring tectonic movements
- High accuracy survey networks

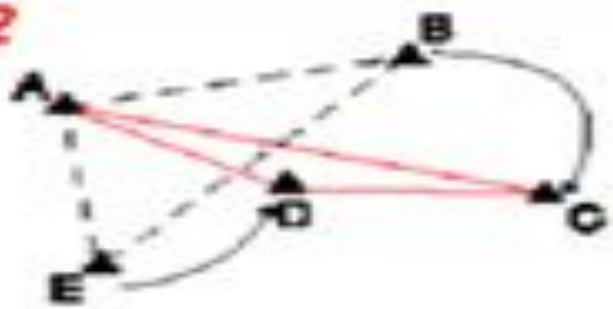
Disadvantages

- Time consuming
  - d/p on receiver
  - Satellite configuration
  - Length of base
  - Atmospheric condition

EXAMPLE

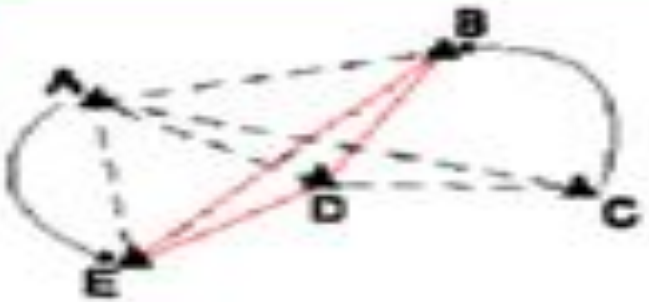
- A network ABCDE is to be measured.
- Coordinates of Point A are known
- Initial set up of receivers at A,B and E
- Triangle ABE is measured

2



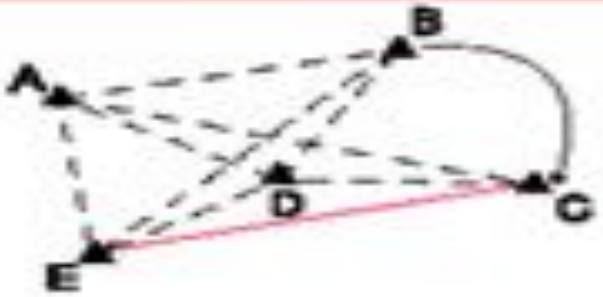
After the required length of time, the receiver that was at E moves to D and B moves to C. The triangle ACD is measured.

3



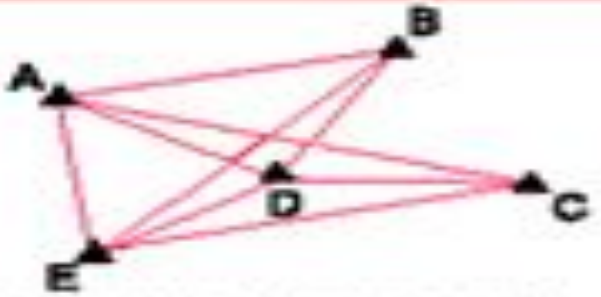
Then A moves to E and C moves to B. The triangle BDE is measured.

4



Finally, B moves back to C and the line EC is measured.

5



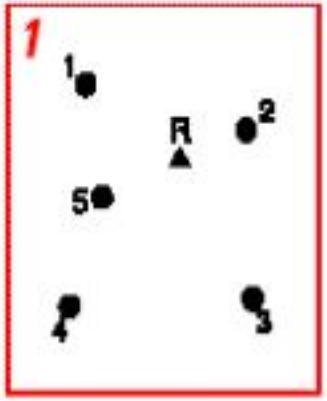
The end result is the measured network ABCDE. One point is measured three times and every point has been measured at least twice. This provides redundancy. Any gross errors will be highlighted and the offending measurement can be removed.

RAPID STATIC SURVEYING

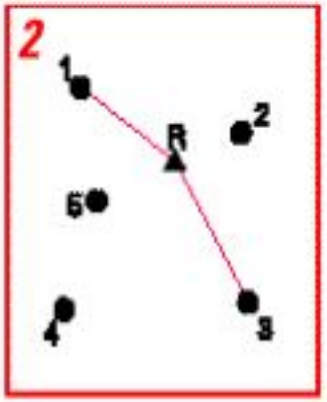
- To measure baselines and determine positions up to centimeter level with short observation time of about 5-20 min
- A reference point is chosen and one or more rovers operate with respect to it
- Used for detailing the existing network, establishing control points etc..
- Reference receiver is set up at a known point
- Rover receivers are moved to each of the required points

- When working with more than one rover, it is essential to ensure that all rovers operate at each occupied point simultaneously
- Rapid static technique provide the same accuracy available from 1-2 hr session of static positioning with observations of 5-20 min
- It uses a technique called ***wide laning***

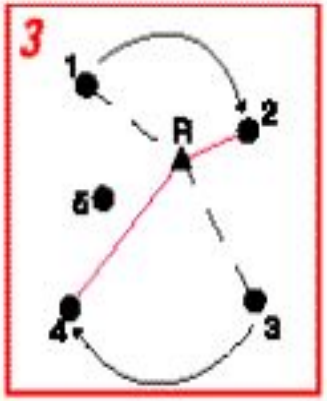
Rapid Static survey



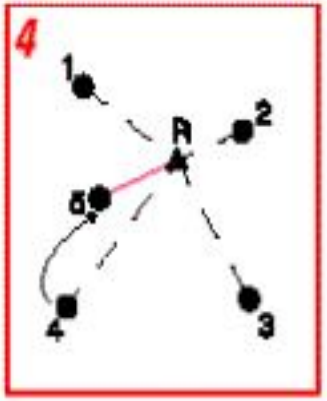
The network 1,2,3,4,5 has to be measured from Reference station R with three GPS receivers.



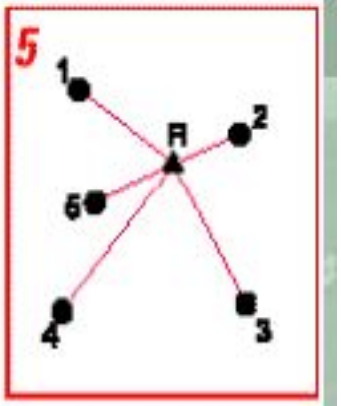
The reference station is set up. One Rover occupies point 1 whilst the other occupies point 3.



After the required length of time, one Rover moves to point 2 whilst the other moves to point 4.

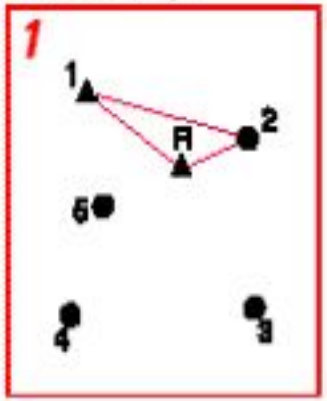


Then, one Rover can return to the office whilst the other measures point 5.

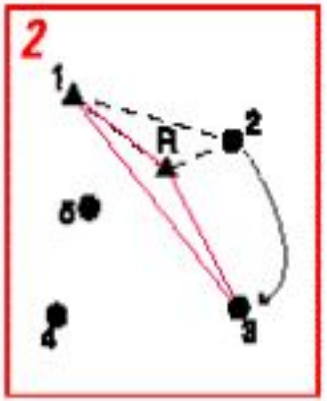


The end result is as above. On a subsequent day, the operation will be repeated in order to check for gross errors.

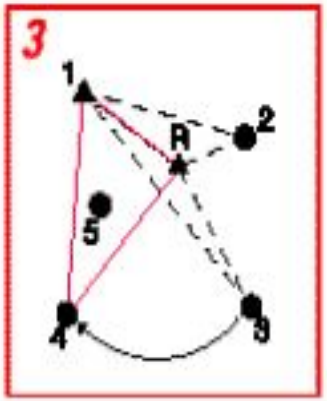
Alternatively...



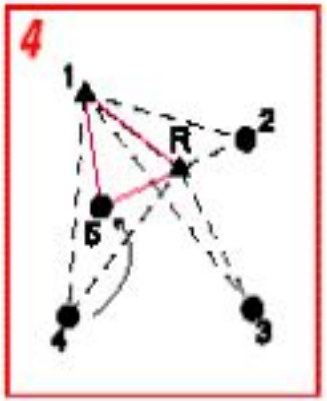
Reference stations are set up at R and point 1. The Rover occupies point 2.



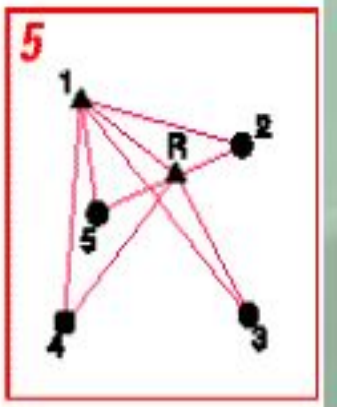
After the required length of time, the Rover moves to point 3.



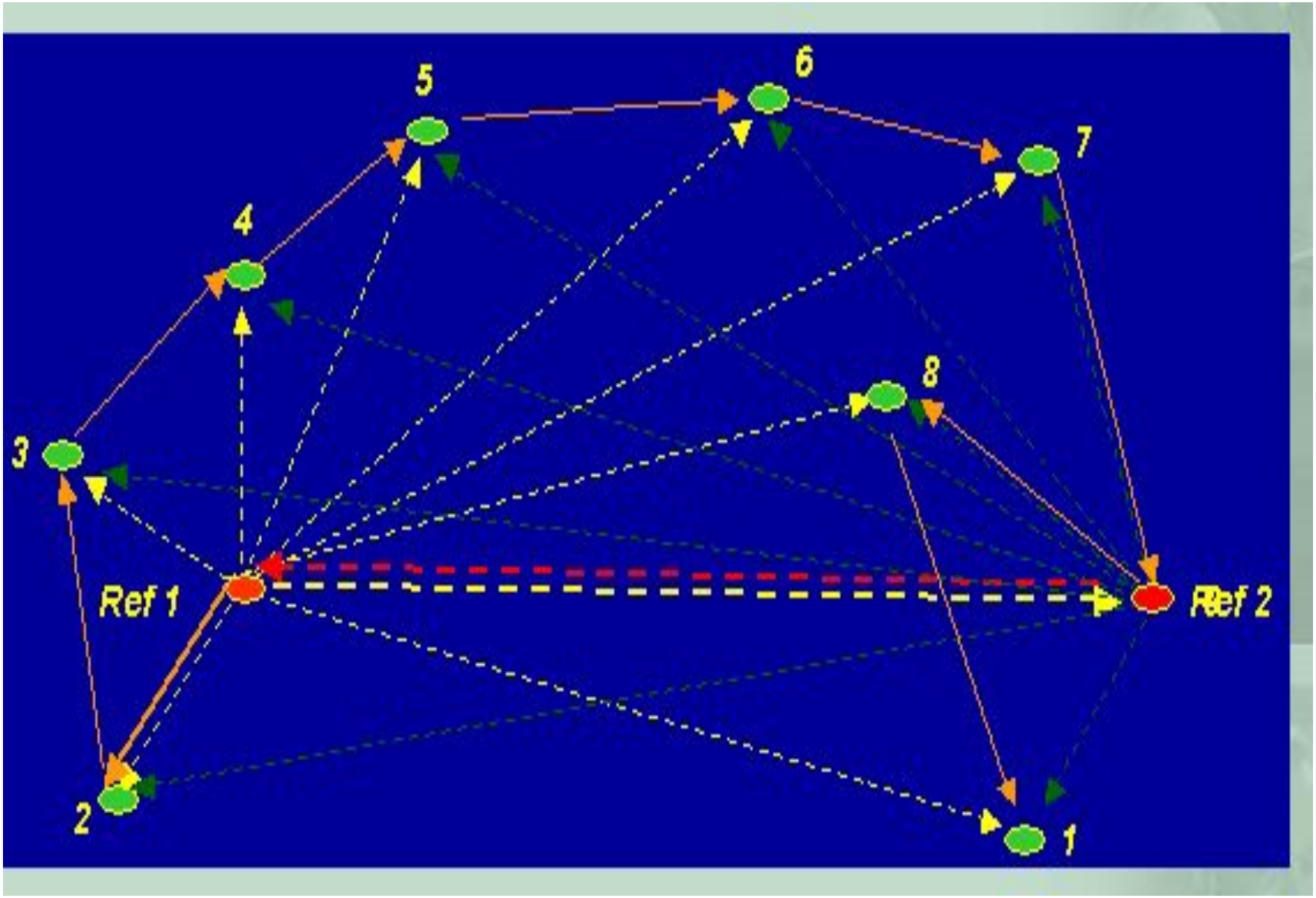
Similarly, the Rover then progresses to point 4...



...and then point 5.



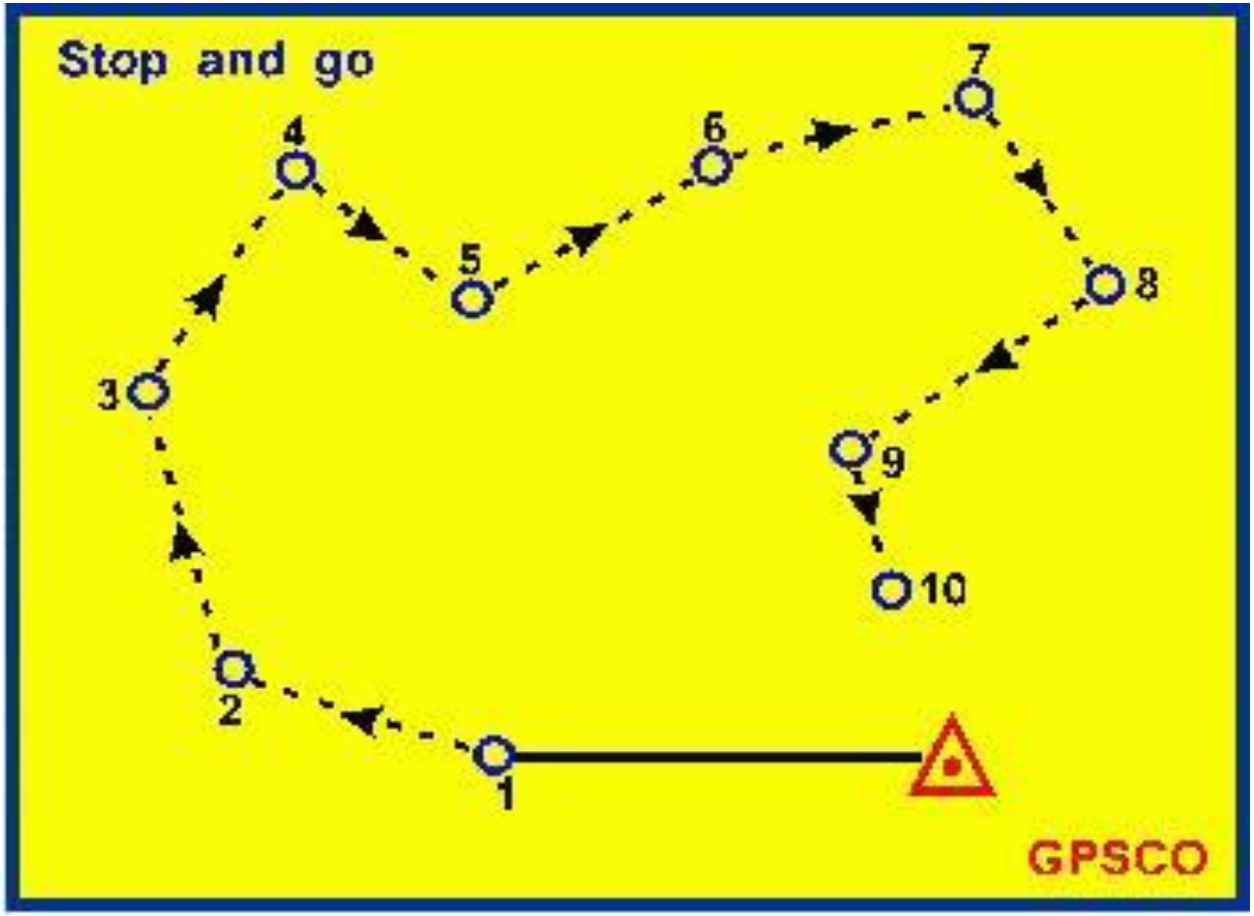
The end result is a measured network with built-in redundancy.


5
6
7
4
8
3
Ref 1
Ref 2
2
1

PSEUDO – STATIC SURVEYING
(STOP-AND-GO TECHNIQUE)

- A reference station is established
- At least four satellites have to be tracked without loss of signal
- The roving receiver starts from the known position coordinates
- Then it moves to other points maintaining lock on the satellites
- Rover maintains only for a small time for two epochs on each detail point
- Epoch is a particular fixed instant of time used as a reference point on a time scale

- Similar to rapid static method in which,
  - All receivers observe the same satellites simultaneously
  - Reference receiver occupy the same control point throughout the survey
- Kinematic method differs in the movement of rovers from point to point
- Stop momentarily at each new point for a short period
- Data provides vectors between themselves and reference receivers


Stop and go
1
2
3
4
5
6
7
8
9
10
GPSCO

APPLICATIONS

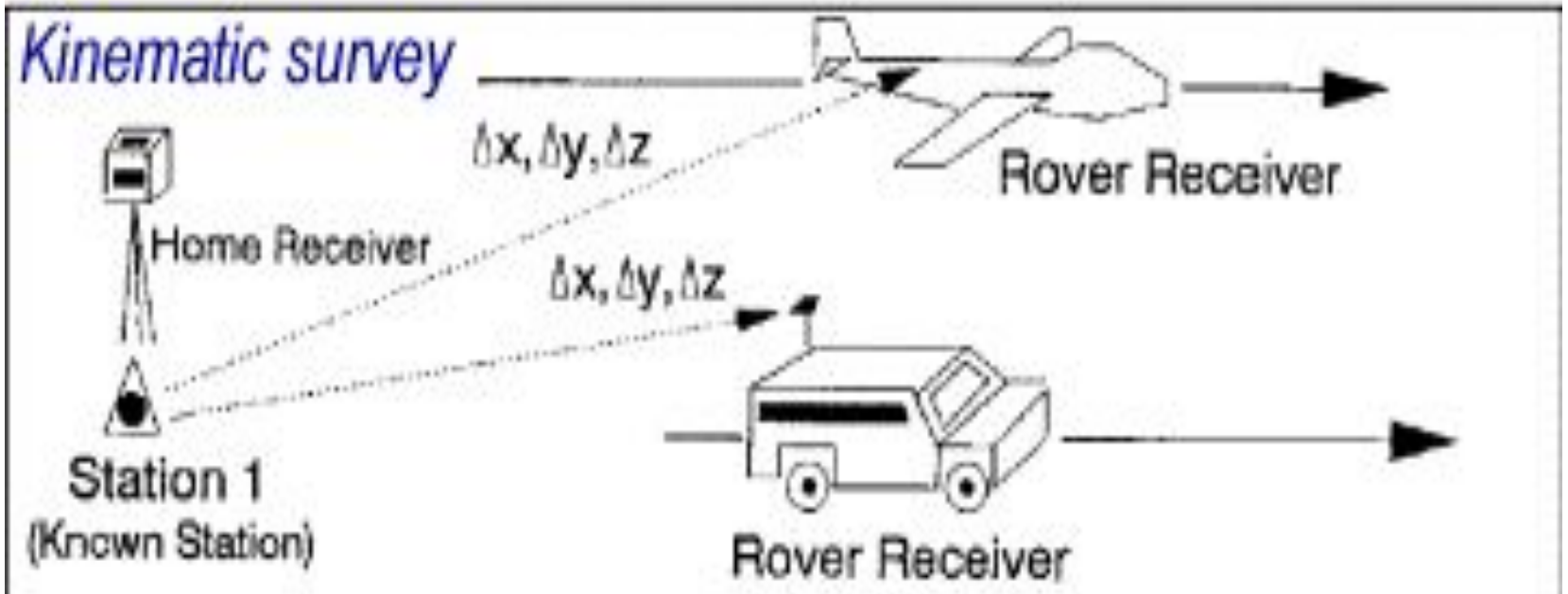
- Used for detailed and engineering surveys in open areas
- Used where points are close together

ADVANTAGES AND DISADVANTAGES

- Advantages
  - Fast and economical
  - Fastest way to survey detail points
- Disadvantages
  - New static or rapid static fix is needed if complete loss of satellite lock occurs
  - Must maintain phase lock of at least four satellites for a successful survey

TRUE KINEMATIC METHOD

- Uses differential carrier phase tracking
- Requires two receivers for recording observations simultaneously
- Referred as dynamic surveying
- Reference receiver remains fixed on a known control point
- Roving receiver collects data on a moving platform (vehicle, vessel, aircraft etc.)



- Based on pseudo–range(lower precision) and/or carrier phase(higher precision) observations.
- Positions determined with respect to the fixed station.
- No intermediate stops required for moving receiver.
- Either real-time or postmission processing possible.

TRUE KINEMATIC METHOD (Contd.)

- The reference and rover are switched on and remain stationary for 5-20 min for collecting data
- After this period, the rover may move freely
- While the rover moves, the user can record its positions at a predefined recording rate (say 1, 2, 3,4,5 seconds)
- If loss of satellite lock occurs, a new period of static initialization must take place

TRUE KINEMATIC METHOD (Contd.)

- Advantages
  - Very short sessions
  - Fast and economical
  - Produce largest number of positions in least time
  - Continuous measurements
- Disadvantages
  - Slight degradation in the accuracy of work
  - Needs initialization in the case of complete loss of satellite lock
  - Occupied stations should be free of overhead obstructions
  - Route between stations must be clear

TRUE KINEMATIC METHOD (Contd.)

- Applications
  - Measuring trajectory of moving objects
  - In hydrographic surveys
  - In surveying centre of road
  - Photogrammetry with ground control
  - For preparation of topographic maps

DIFFERENTIAL GPS (DGPS) (ASSIGNMENT - II)

- Improves accuracy
- Reference receiver computes the error and transmits to the rover
- Radio data link between reference and rover
- Rover applies correction
- No post processing required

PLANNING OF GPS SURVEYING

- Fundamentally carried out in four phases

(a) Planning and preparation

(b) Field operations

(c) Post processing and data generation

(d) Report preparation

PLANNING AND PREPARATION

PLANNING

- Selection of station points
- Field reconnaissance
- Monumentation
- Selection of Observation window
- Selection of observation session
- Selection of positioning technique
- Selection of receiver type
- Survey design

Selection of station points

- Points to be positioned and their accuracy requirement should be identified
- Site to be positioned and control points available should be plotted
- Serves as a reference throughout the planning, project execution and final reporting stage

Field reconnaissance

- It gives informations like

(a) Set of point required for GPS observations

(b) Current description of the site

(c) Access information

(d) Description of any special steps which need to be taken

- Site should be checked for suitability for GPS survey, availability of control points and logistical requirements
  - Site should be free from obstructions and interferences
  - Obstructions may be avoided by establishment of eccentric stations
  - Site should be free from obstruction in all direction above 15˚ elevation
  - Interference to GPS signal due to electrical and multipath interference should also be considered

Monumentation

- Points/Stations are required to be marked properly
- Standard specification to be followed
- Objectives to find the points easily and station may be placed properly

Selection of Observation window

- To determine optimum daily observation period and to decide how to subdivide
- Factors considered

(a) Visibility – by observing azimuth elevation chart

(b) Geometry of satellites- by comparing GDOP(Geometrical Dilution of Precision) values

(c) Ionospheric refraction

Selection of observation session

- Depends on

(a) Length of baseline

(b) Number of visible satellites

(c) Relative geometry of satellites

(d) Signal to Noise Ratio of received satellite signal

Selection of positioning technique

- By considering aspects like

(a) Accuracy requirement

(b) Geographical environment

(c) Distance between points to be positioned

(d) cost

Selection of receiver type

- Receivers should be of same make for relative positioning
- Technical considerations for receiver selection are

(a) Methods of collection of L2 carrier

(b) Number of channels

(c) Measurement accuracies

Survey design

- It includes control requirements, network configuration and redundancy
- survey design will vary greatly depending on the accuracy sought and the GPS positioning technique employed

Preparation

- To determine and decide the best window to be used to collect GPS data
- To decide the optimal number of GPS receivers and personnel for the project and make the necessary arrangements
- To plot the survey design, taking into account control requirements, network configuration, travel time between sites, satellite window and logistical constraints

- To arrange transportation between sites
- To establish unique numbering system to clearly identify all sites positioned on the ground with their related computer data files and other associated attribute
- To train personals
- To organize accommodation for field
- To organize all requirements and supplies to support GPS field activities

Validation of plan for execution

- The procedure and equipment to be used, from data collection to final product should be checked to ensure they are reliably satisfy the desired accuracy requirements
- Positioning method chosen, equipment used and processing method adopted are checked

FIELD OPERATION

- Responsibilities in field are divided among a part chief, observer and a processor
- These responsibility may be assigned to one person or shared amongst many

Party chief responsibility

- To ensure all crew members have the training and information required to carry out observations according to plan
- Daily duties includes
  - (a) Scheduling who should observe at what station
  - (b) Keeping informed of any satellite problem/ geometric storms
  - (c) Accessing results on daily basis and modifying plans as required
  - (d) Handling any logistical difficulties

Observers responsibility

- Observer should know where when and for how long GPS observation should be collected
- Field responsibility can be broken down into four stages
  - (a) Preparation for observations
  - (b) Set up in field
  - (c) Monitoring receiver station
  - (d) Terminating observations

- A comprehensive field log for each site should be maintained by observer
- The following informations should be documented
  - Site name and identifier for receiver data file
  - Observer's name
  - Receiver and antenna types and serial number
  - Data collection start and stop time
  - Satellites tracked
  - Problems experienced and actions taken

Processor's responsibility

- Data submitted should be verified to ensure they are clear, complete and accurate
- Data should be downloaded to computer
- Processing should be carried out to judge if the collected data is of adequate quality
- Analyze processing results to access the goodness of the data and pass results to party chief
- Notes on data processed, difficulties experienced and action taken to be kept

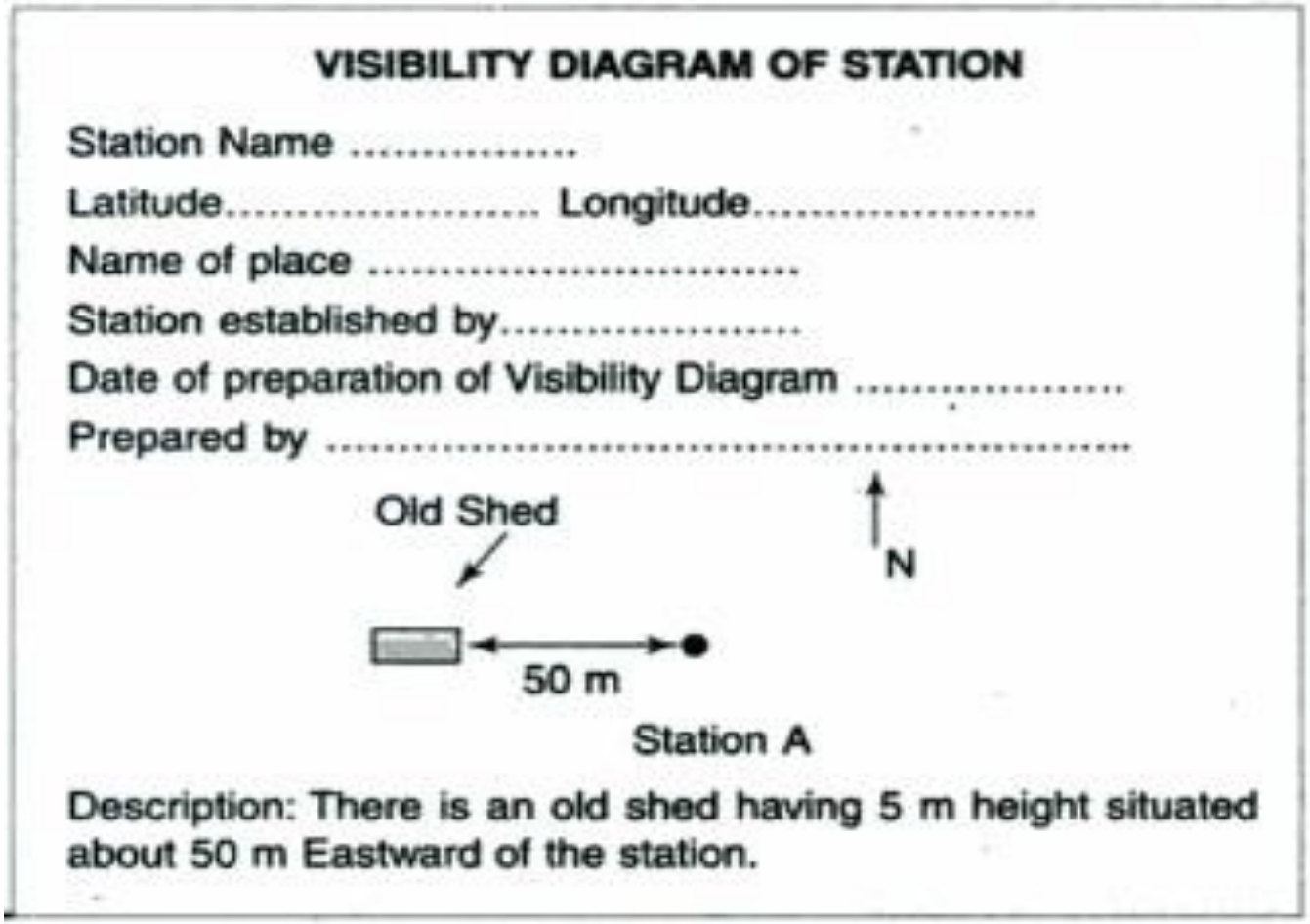
DATA SHEET

DATA SHEET
STATION

Name of the station.....*A* .....
Name of place : *XXXXXXXXXXXX*
Established by : *Hydrographic Survey Wing*
Latitude.....*XX...XXX.XX*
Longitude.....*XXX....XXX.XX*.....
Spheroid... *Everest 1953 India*
Projection .. *Universal Traverse Mercator projection*
Zone .... *Zone No. 43* State.. *Kerala*
Ellipsoidal Height - *175 meters*
Northing- *xxxxx.xxx N* Easting- *xxxxxx.xxxE*
Description- *The station is located* .....
.....
.....
Station Identification ... *The station is constructed with Plain Cement Concrete 30 cm x 30 cm x 50 cm above ground. A station mark is provided with a metal disk embedded on the top of the concrete post. The disk is stamped as 'A' —'HSW'*

VISIBILITY DIAGRAM

Obstruction above 15° angle around station is noted in visibility diagram



POST PROCESSING & DATA GENERATION

- Observed data needs to be transferred, processed and tested for quality
- As per requirement the observed data is processed further to carry datum transformation, computation of coordinates

REPORT PREPARATION

A project report must address the

following topics:

1. Location and description of project area
2. Purpose of survey and achievements in comparison to standard specifications
3. Description of monumentation
4. Instruments used and their detail specification
5. Computation scheme for the project and processing software
6. Datum transformation parameters and their source, computation of coordinates and sketch of control points
7. Problems encountered during survey work

8.Following list must be included

- List of loop closures
- Occupation schedule
- Vector statistics
- List of adjusted positions and plane coordinates
- Project statistics
- Copies of original site occupation log
- Equipments malfunctioning log
- Project sketch showing all points and control points

9. Copy of original observation should be transmitted