NEED OF CONSTRUCTION OF A NEW RAILWAY TRACK

Strategic reasons

Connecting trade centers

Political demand

Developing a backward area

Shortening the existing route

REQUIREME NTS OF A GOOD ALIGNMENT

- Purpose of a track
  - Transportation services
  - Political and strategic considerations
  - To connect industrial towns
  - To open up new track
  - Shortening the existing track

REQUIREMENT OF GOOD ALIGNMENT CONTINUED

- Feasibility
- Economy
  - Distance
  - Cost of construction
  - Maintenance cost
  - Operation cost

Contd….2

- Safety
  - Aesthetic aspects

FACTORS AFFECTING THE SELECTION OF GOOD ALIGNMENT

- Obligatory points

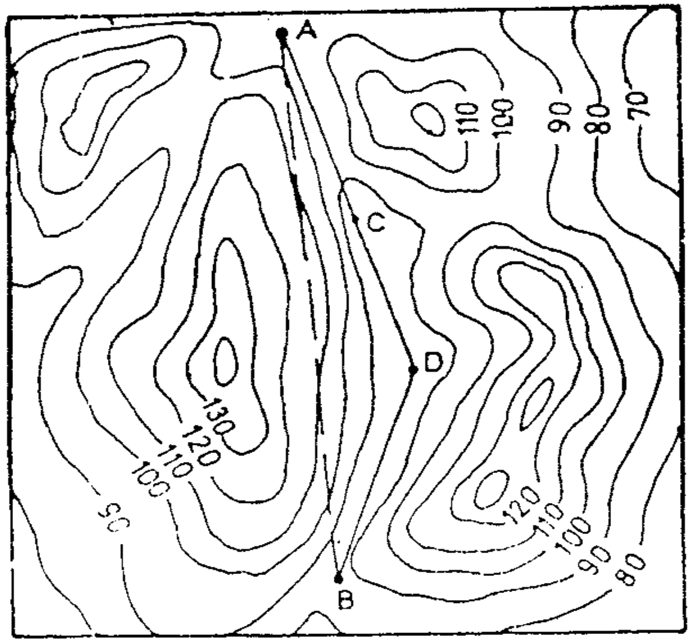


Figure 2.1. Connecting Obligatory Points

FACTORS AFFECTING THE SELECTION OF GOOD ALIGNMENT

- Important cities and towns

FACTORS AFFECTING THE SELECTION OF GOOD ALIGNMENT - **OBLIGATORY POINTS**

- River crossings

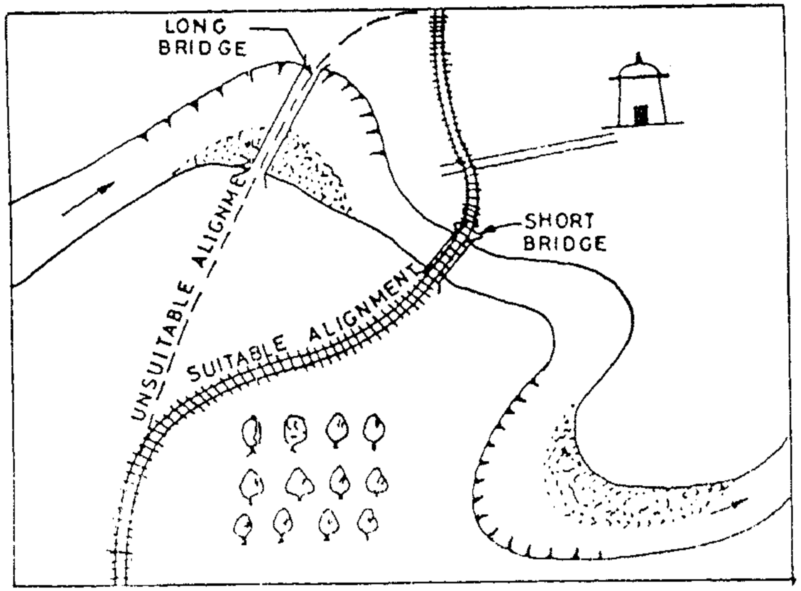


Figure 2.2. Crossing a River over a Bridge

FACTORS AFFECTING THE SELECTION OF GOOD ALIGNMENT - **OBLIGATORY POINTS**

- Hill passes

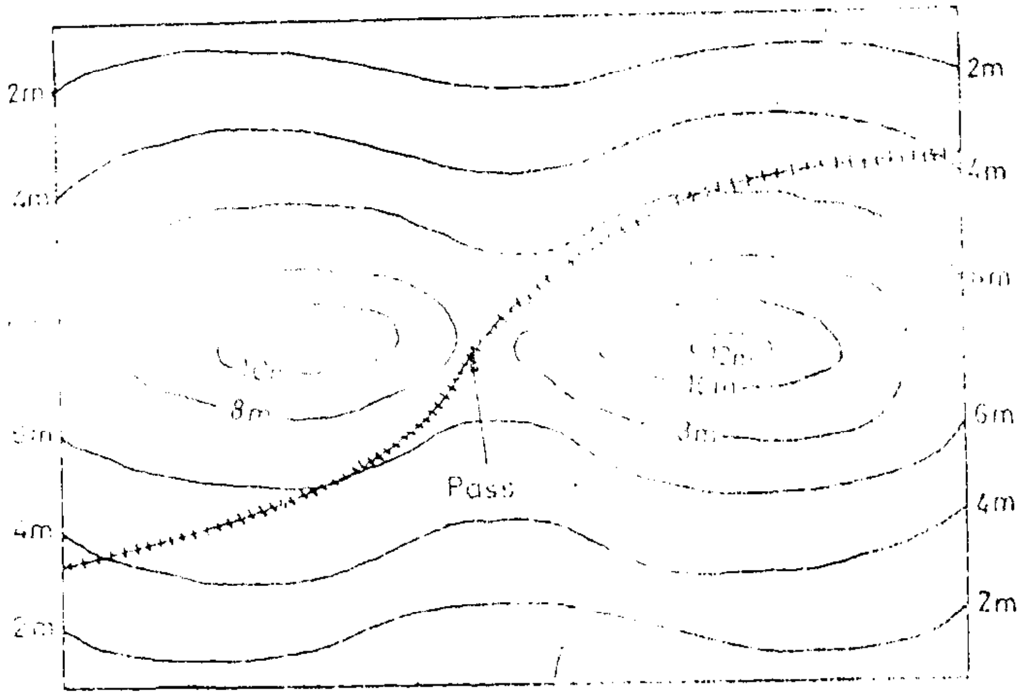


Figure 2.3. Crossing a Hill Range through a Pass

FACTORS AFFECTING THE SELECTION OF GOOD ALIGNMENT

- Site of tunnels

LOCATION FROM WHICH THE ALIGNMENT SHOULD NOT PASS

- Costly land
- Religious places
- Water logged areas
- Rich agricultural areas
- Sites earmarked for other projects like housing, industry etc.
- Long stretches of filled up areas

LOCATION FROM WHICH THE ALIGNMENT SHOULD NOT PASS

- Grave yards
- Stretches containing a rich mineral deposits

OTHER FACTORS AFFECTING THE SELECTION OF GOOD ALIGNMENT

- Population of the area
- Revenue
- Corridor

TYPICAL CONTOURS FOR A CONICAL HILL

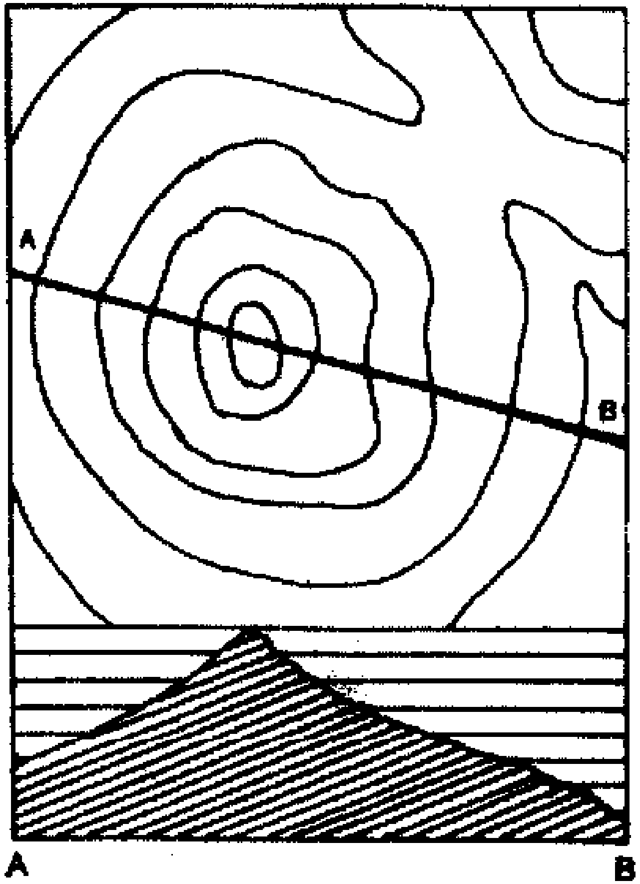


Fig. 34.2 A conical hills

TYPICAL CONTOUR OF PLATEAU

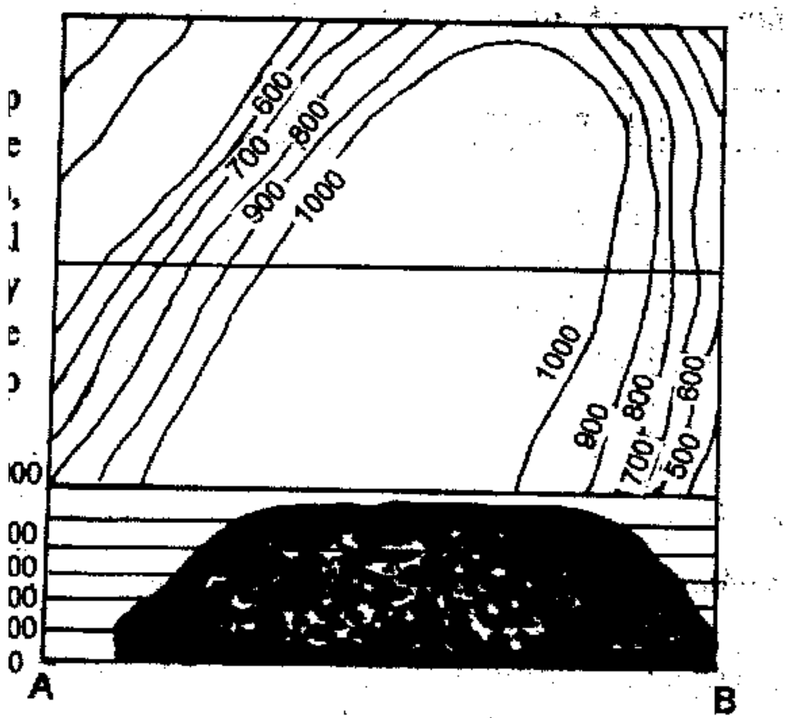


Fig. 34.3 A Plateau

TYPICAL CONTOURS FOR RIDGES

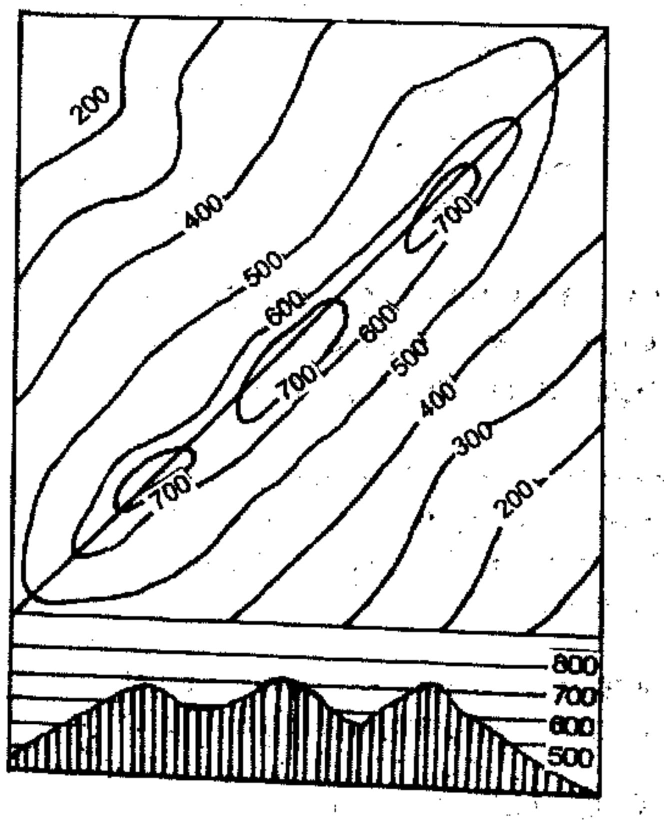


Fig. 34.4 A Ridge

TYPICAL CONTOURS FOR A VALLEY

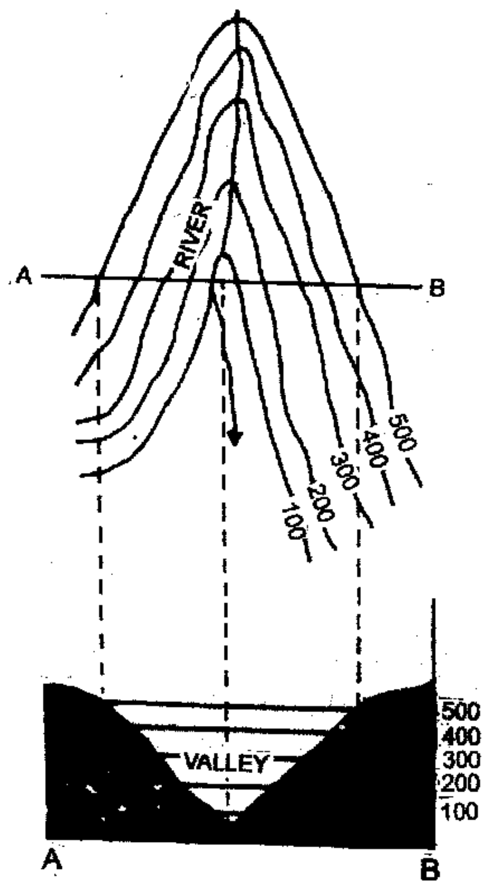


Fig. 34.5 A 'V' shaped valley

TYPICAL CONTOURS FOR CLIFFS

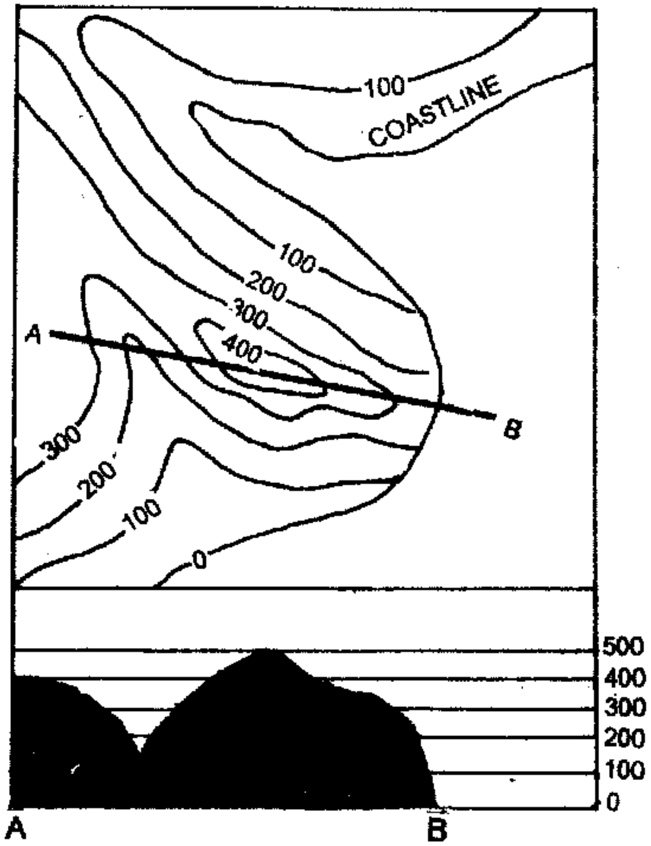


Fig. 34.6 A cliff

TYPICAL CONTOUR DEPICTING WATER FALL

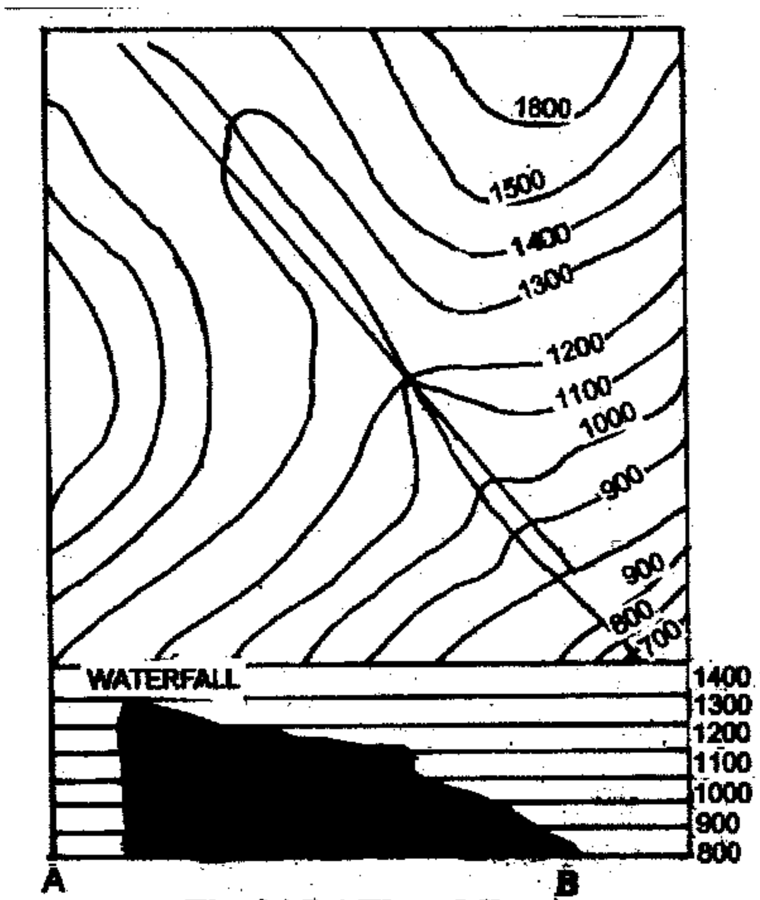


Fig. 34.7 A Waterfall

TYPICAL CONTOURS SHOWING THE SLOPE

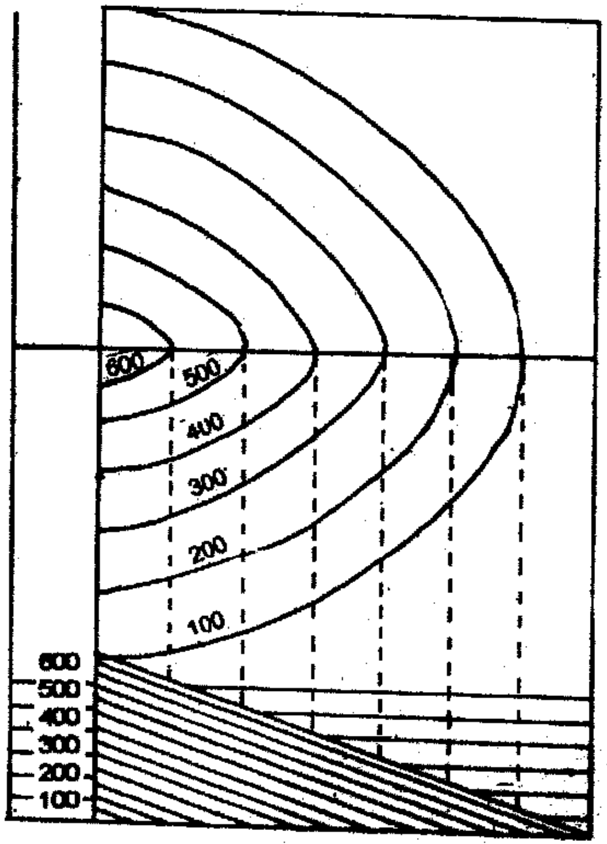


Fig. 34.8 A Uniform slope

TYPICAL CONTOURS SHOWING UNDULATING SLOPE

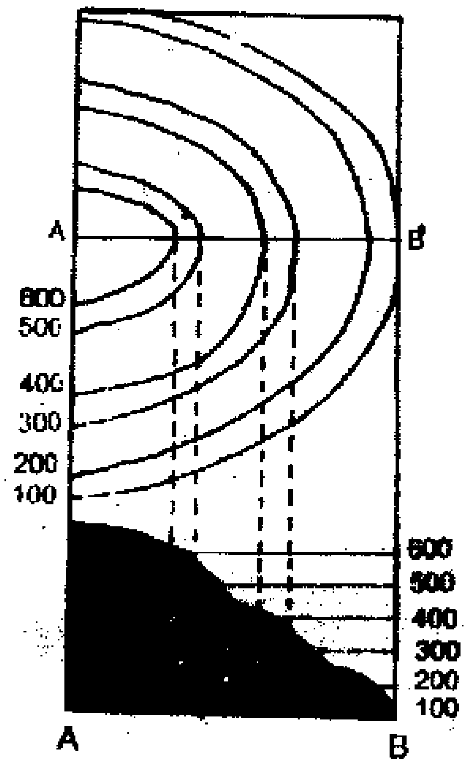


Fig. 34.9 A Undutaling slope

TYPICAL CONTOURS SHOWING COVE SLOPE

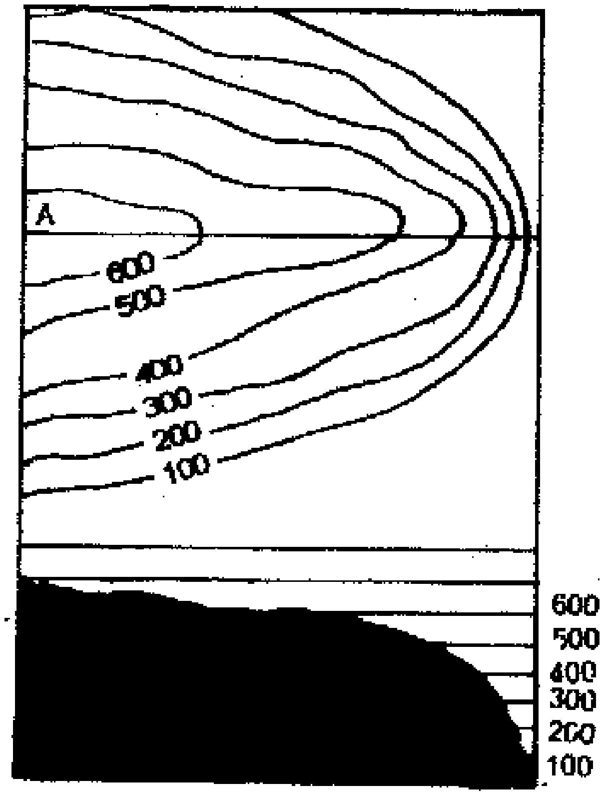


Fig. 34.10 A Cove slope

TYPICAL CONTOURS SHOWING GENTLE AND STEEP SLOPE

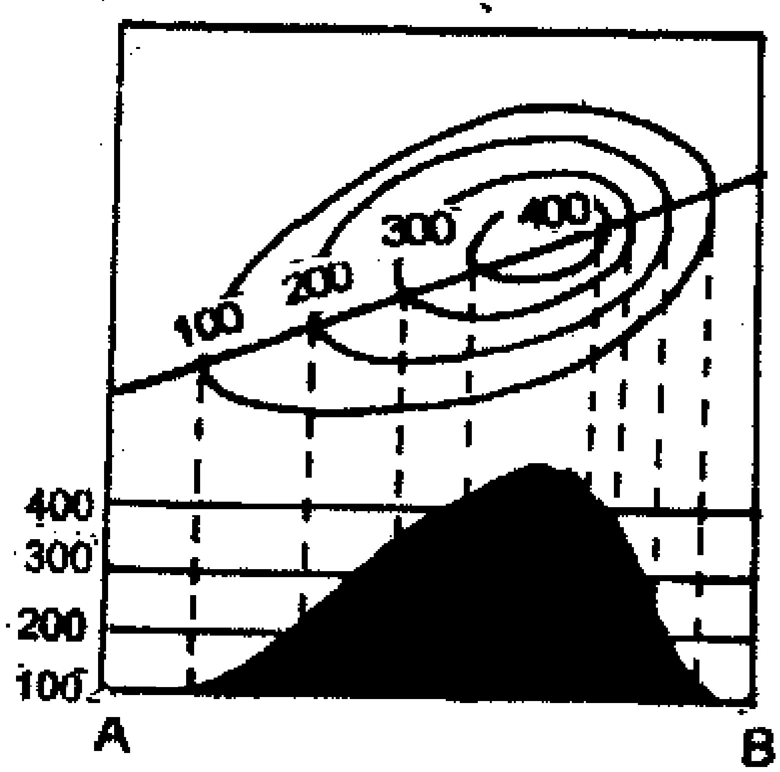


Fig. 34.11 A Gentle & Steep slope

TYPICAL CONTOURS SHOWING CONCAVE SLOPE

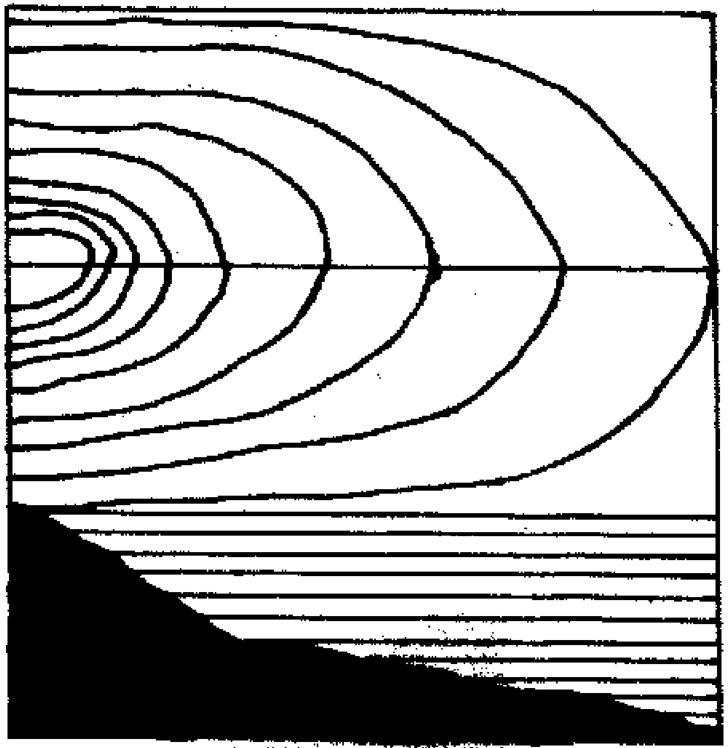


Fig. 34.12 A Concave slope

TYPICAL CONTOUR SHOWING SECTION PROFILE

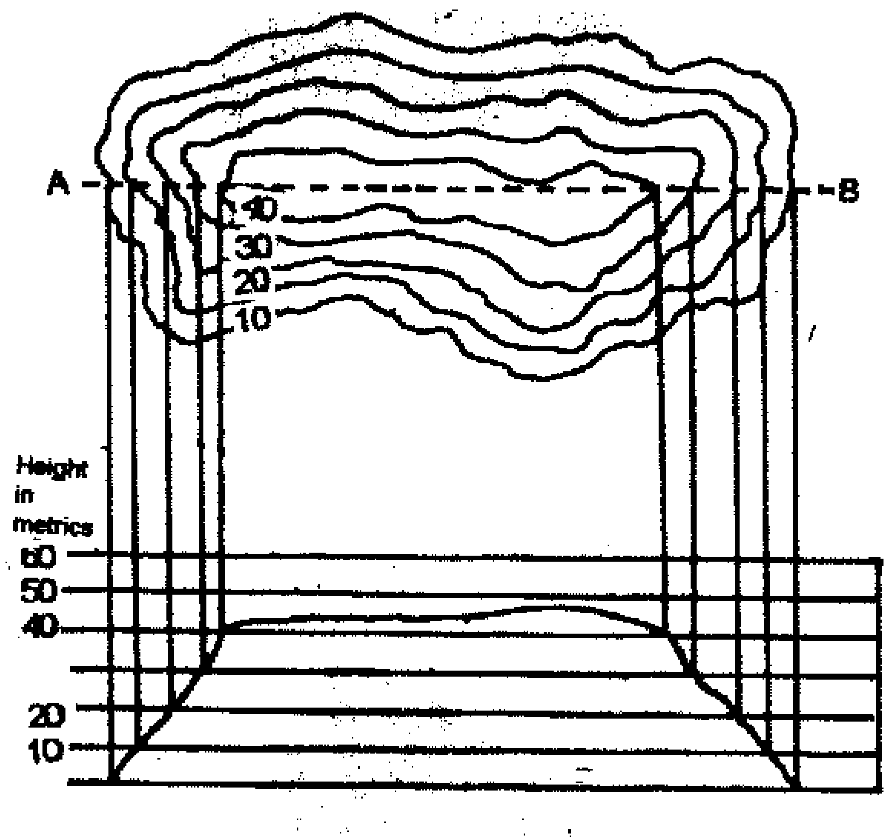


Fig. 34.13 A cross section profile

STANDARD SYMBOLS OF THE TOPOSHEETS

Road, metalled: according to importance: milestone..........................

Road, unmetalled: according to importance: milestone......................

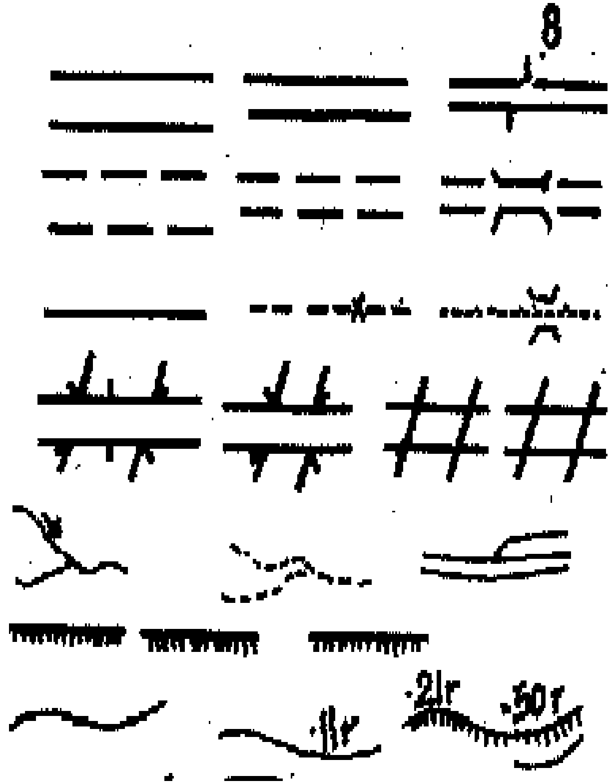
Cart-truck, Pack - track and pass...Foot-path with bridge...................

Bridges with piers without. Causeway, Ford or Ferry...........................

Sreams:withtrack in bed: undefined, Canal...

Dams: masonry or Rockfilled earthwork. Weir/Anicut in Madras.........

River banks. shelving: steep.10 to 19ft.: over19ft................................



STANDARD SYMBOLS OF THE TOPOSHEETS

River dry with water channel with island & rocks. Tidel river................

Submerged rocks. Shoal. Swamp. Reeds..

Wells: lined, unlined Spring, Tanks:perenniel dry..............................

Embankments: road or rail, tank Broken ground...................................

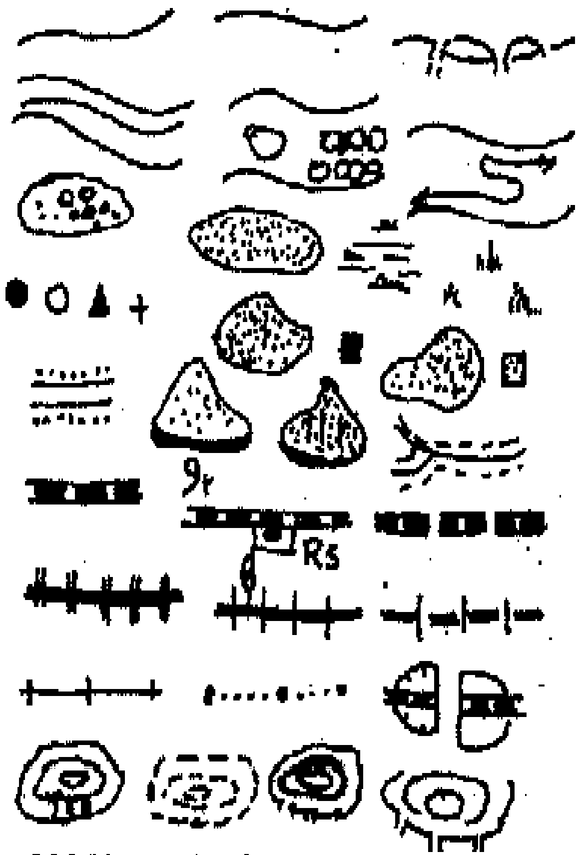
Railways. Broad gauge: Double/Single with station: under constrn.....

Railways. other gauges: Double/Single with milestone: under constrn

Light Railway or tramway. Telegragh line. Cutting with Tunnel...........

Contours, Formlines , Rocky slopes Cliffs..

Sand features:(1) flat (2)sand hills(permanent)(3)...



STANDARD SYMBOLS OF THE TOPOSHEETS

Sand features,(1) flat (2)sand-hills(permanent)(3) dunes, (shifting).....

Towns or villages: inhabited: deserted Fort...........................

Huts, permanent, temporary. Tower, Antiquities...........................

Temple. Chhatri Church. Mosque, Idgah, Tomb. Graves....................

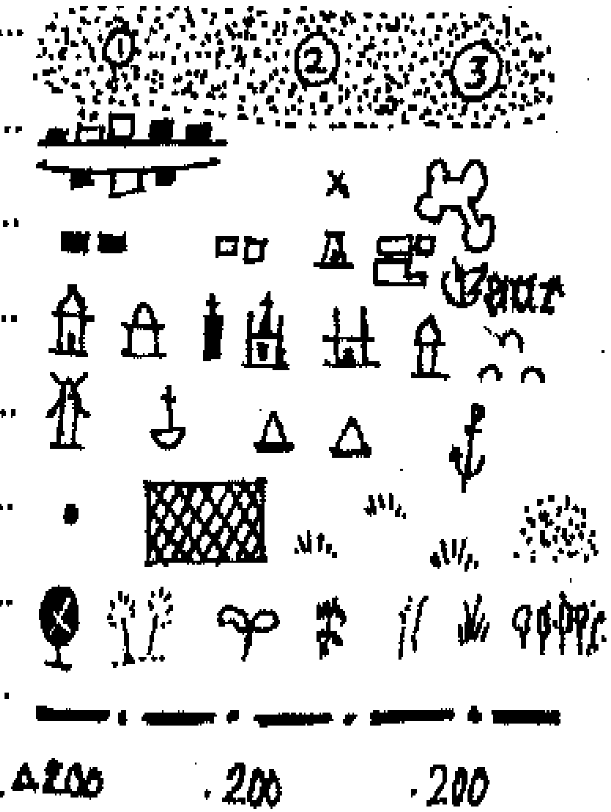
Light house, Lightship, Bouys: lighted, unlighted, anchorage.............

Mine, Vine on trellis. Grass, Scrub..

Palms, palmyra.other Plantain. Conifer. Bamboo Other trees............

Boundary pillers surveyed. unlocated. vilaget trijunction....................

Heights. triangulated: station: point Approximate..............................



STANDARD SYMBOLS OF THE TOPOSHEETS

Bench = mark: geodatic: tertiary. canal. other...................................	BM 200 .BM 200 .200 .200
Post office, Combined office. Police Station...................................	PO TO PTO PS
Bunglows:dak or travellers: inspection. Rest house...........................	DB IB(CANAL) RH (FOREST)
Circuit House. Camping ground. Forest: reserved: protected.............	CH CG RF PF
Space names: administrative :locality or tribal...................................	KIKRI NAGA

SYSTEM OF NUMBERING OF TOPOSHEETS OF SURVEY OF INDIA

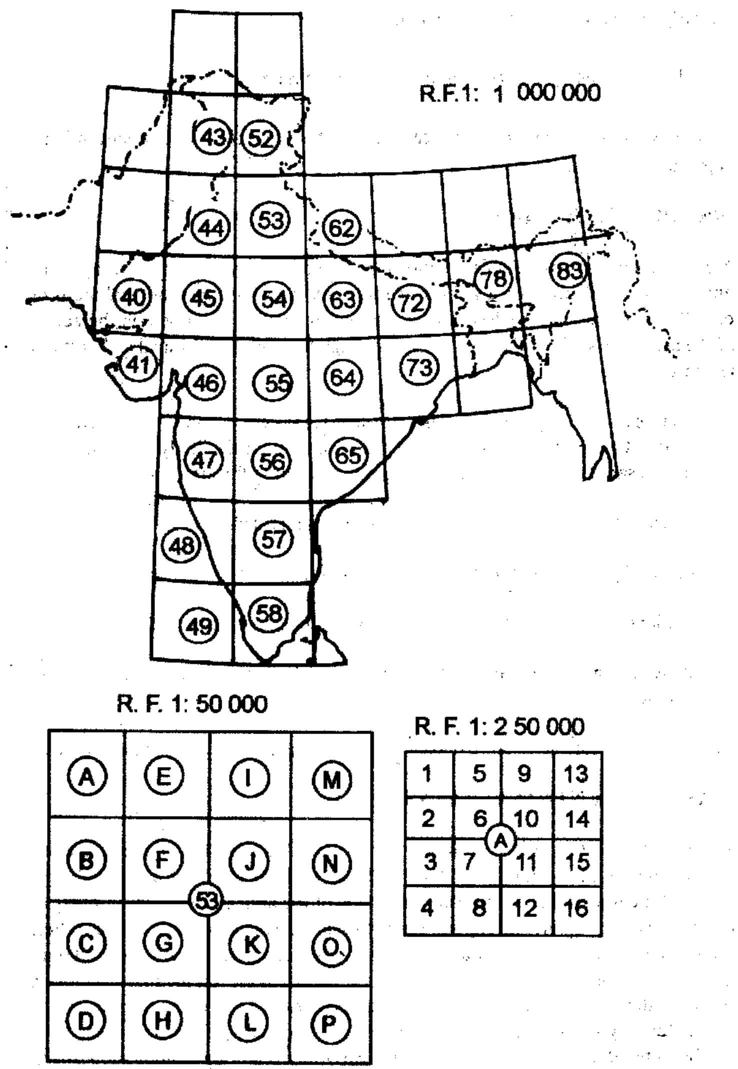


Fig. 34.1 Arrangement of Sheets

CLASSIFICATION OF ALIGNMENTS ACCORDING TO GRADIENT

- Alignments having ruling gradient of less than 3% are normal alignments
- Alignments with ruling gradient of 3% and above are called mountainous alignments
-

COLOUR SCHEME USED FOR SURVEY OF INDIA TOPOSHEETS

- Road and railway alignments – Black colour
- Area shown for cultivation – Yellow
- Forest cover – Dark green
- Agricultural land – Light green
- Habitation – Red
- Contours – Brown

TERMS OF REFERENCE OF THE SURVEY

- Ruling gradient
- Maximum degree of curve

TERMS OF REFERENCE OF THE SURVEY - contd

- Ruling gradient is the maximum gradient permissible for the alignment. However, there can be exceptions to negotiate isolated difficult patches.
- The maximum curvature chosen for the alignment should be such that it should not result in imposition of speed restrictions on the curves but at the same time it should not be so flat so as to increase the length of the total alignment.

TERMS OF REFERENCE OF THE SURVEY – Contd.

- Both these terms of reference have a profound effect on the utility of the alignment as also the time required for construction, the maintenance of the line and the difficulty in operation of the line. As such, the terms of reference are decided by the client in advance.

Type of Railway surveys

- Reconnaissance Survey
- Preliminary survey
- Final location Survey
- Construction Survey

Reconnaissance Survey

- Commencement of the reconnaissance survey is done by procuring the correct topo sheets of preferably 1:25,000 scale.
- Alternative routes(both straights and curves of proper degree) are then marked on the alignment as per the terms of reference given by the client.

Purpose of Reconnaissance Survey

- Familiarize with the topography of the area
- Know precisely the towns, Roads, river crossings, ghat sections requiring tunnels and other special strategies for negotiation.
- Geological characteristics likely to affect the choice of foundations.
- Width of waterway required for drainages coming in the way

Purpose of reconnaissance survey contd-

- Maximum flood levels of the intercepting drainages.
- Availability of building material and labour
- Total length of the route.
- Rough assessment of the earthwork.
- Approximate cost of construction
- Approximate time of construction.
- Identification of water logged areas.
- Rainfall in the areas in question.

Purpose of Reconnaissance Survey-contd.

- Available working months due to non availability of labour and rainfall pattern in the areas in question.
- Approximate length and location of the tunnels.
- Difficulty if any likely to be encountered for land acquisition.

Reconnaissance Survey
Role of satellite imagery

- In the recent years, due to availability of satellite imagery, the time and the number of filed visits have drastically come down.

Preliminary survey

- After deciding on the best route out of the existing alternatives, a detailed survey is done on the ground covering approximately 100 mtr on either side of the center line of the proposed route.
- This survey is carried out in the following manner:
- The old methodology has mainly been replaced after advent of Total Station theodolite which has made surveying very easy in the field.

Preliminary survey contd.

- To start with, a peg is driven indicating the starting point of the alignment.
- A suitable base line is than fixed on the ground and measured very accurately with the help of Total Station theodolite.
- A grid of triangles is now marked on the ground fixing the triangulation stations so as to avoid too obtuse / acute angles. Generally angles between 30 degree to 60 degree are considered to be suitable.

Preliminary survey contd.

- The detailed ground features are then collected.
- Quality of survey is decided by the extent of details collected during the preliminary survey.
- Inadequate data can lead to choosing of wrong alignment resulting and has a potential of delaying the construction.

Preliminary survey contd.

- It is good engineering practice to simultaneously to go on ploting each day’s work so as to decipher the missing links and inaccuracies in the survey.
- After the preliminary survey, the final alignment after considering all the factors is then drawn in the office.
- The profile is drawn to a scale of 1:2000 horizontal and 1:200 vertical.

FACTORS TO BE KEPT IN MIND WHILE DECIDING THE FINAL ALIGNMENT

- While deciding the final alignment in the office, following items are kept in mind :
  - Minimum gradient
  - Minimum curvature
  - Equalization of the earthwork
  - Heavy Earthwork
  - Minimum number of expensive bridges
  - Minimum number of retaining and breast walls

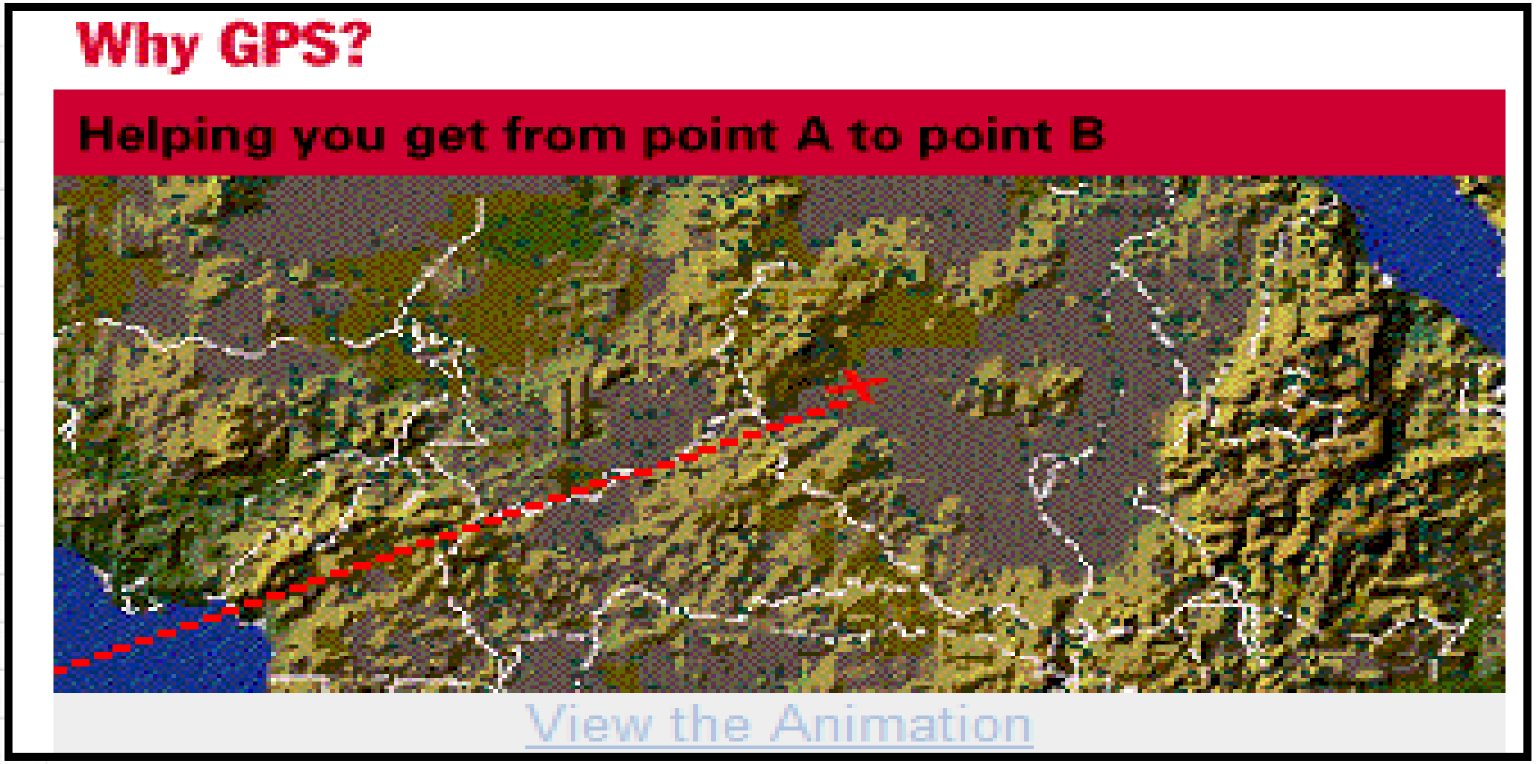
FACTORS TO BE KEPT IN MIND WHILE DECIDING THE FINAL ALIGNMENT – contd.

- As far as possible the alignment of a significant water course should be perpendicular to the flow of the river.
- Avoid curves in the approach of such bridges.
- Since the ground generally starts falling rapidly towards a water course, most of the bridges have high approaches the height of bank on such approaches must be studied to keep it within limits.

FINAL LOCATION SURVEY

- The alignment so chosen in the office is then transferred to the ground in the final location survey.
- Normally no changes in the alignment are permitted during the final location survey unless there are very pressing reasons for the same.

GPS Instruments



Why GPS?

Trying to figure out where you are and where you're going is probably one of man's oldest pastimes.

Navigation and positioning are crucial to so many activities and yet the process has always been quite cumbersome.

Over the years all kinds of technologies have tried to simplify the task but every one has had some disadvantage. [view other Positining Systems]

What is GPS?

A constellation of 24 satellites

What is GPS?

The Global Positioning System (GPS) is a worldwide radio-navigation system formed from a constellation of 24 satellites and their ground stations.

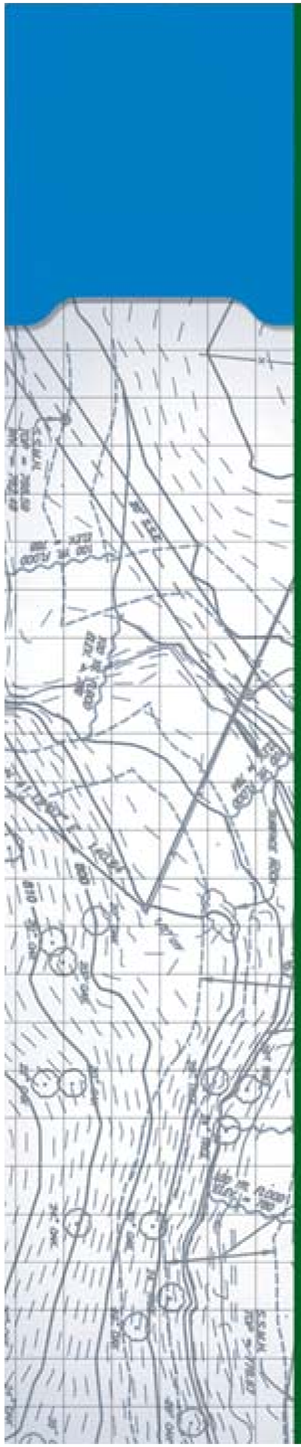
GPS uses these "man-made stars" as reference points to calculate positions accurate to a matter of meters. In fact, with advanced forms of GPS you can make measurements to better than a centimeter!

In a sense it's like giving every square meter on the planet a unique address.

GPS receivers have been miniaturized to just a few integrated circuits and so are becoming very economical. And that makes the technology accessible to virtually everyone.

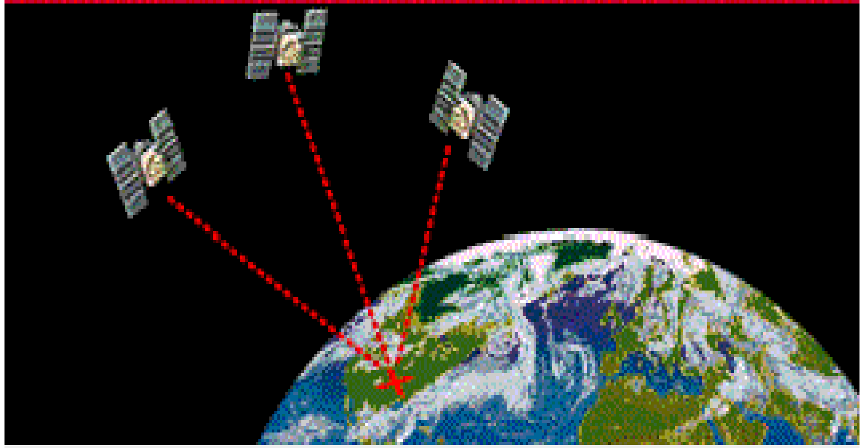
These days GPS is finding its way into cars, boats, planes, construction equipment, movie making gear, farm machinery, even laptop computers.

Soon GPS will become almost as basic as the telephone. Indeed, at Trimble, we think it just may become a universal utility.



How it works

Satellites are reference points for locations on earth



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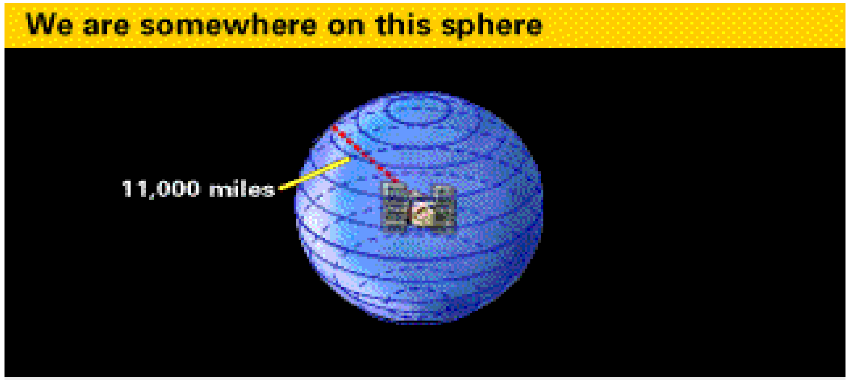
How GPS works?

Here's how GPS works in five logical steps:

1. The basis of GPS is "triangulation" from satellites.
2. To "triangulate," a GPS receiver measures distance using the travel time of radio signals.
3. To measure travel time, GPS needs very accurate timing which it achieves with some tricks.
4. Along with distance, you need to know exactly where the satellites are in space. High orbits and careful monitoring are the secret.
5. Finally you must correct for any delays the signal experiences as it travels through the atmosphere.

We'll explain each of these points in the next five sections of the tutorial. We recommend you follow the tutorial in order. Remember, science is a step-by-step discipline!

Step 1: Triangulating from Satellites



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Triangulating from Satellites

Improbable as it may seem, the whole idea behind GPS is to use satellites in space as reference points for locations here on earth.

That's right, by very, very accurately measuring our distance from three satellites we can "triangulate" our position anywhere on earth.

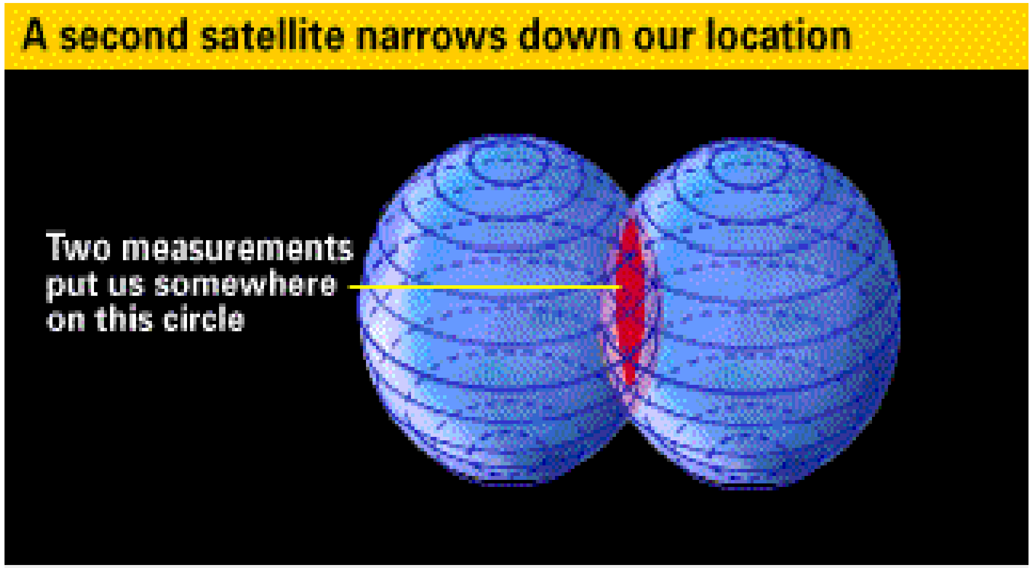
Forget for a moment how our receiver measures this distance. We'll get to that later. First consider how distance measurements from three satellites can pinpoint you in space.

The Big Idea Geometrically:

Step One:

> Suppose we measure our distance from a satellite and find it to be 11,000 miles.
>
> Knowing that we're 11,000 miles from a particular satellite narrows down all the possible locations we could be in the whole universe to the surface of a sphere that is centered on this satellite and has a radius of 11,000 miles.

Step 1: Triangulating from Satellites



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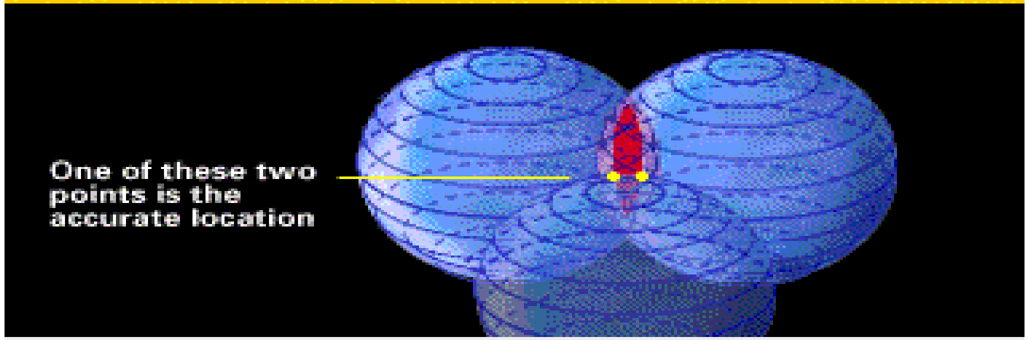
Step Two:

Next, say we measure our distance to a second satellite and find out that it's 12,000 miles away.

That tells us that we're not only on the first sphere but we're also on a sphere that's 12,000 miles from the second satellite. Or in other words, we're somewhere on the circle where these two spheres intersect.

Step 1: Triangulating from Satellites

A third satellite puts us at either two points



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Step Three:

If we then make a measurement from a third satellite and find that we're 13,000 miles from that one, that narrows our position down even further, to the two points where the 13,000 mile sphere cuts through the circle that's the intersection of the first two spheres.

So by ranging from three satellites we can narrow our position to just two points in space.

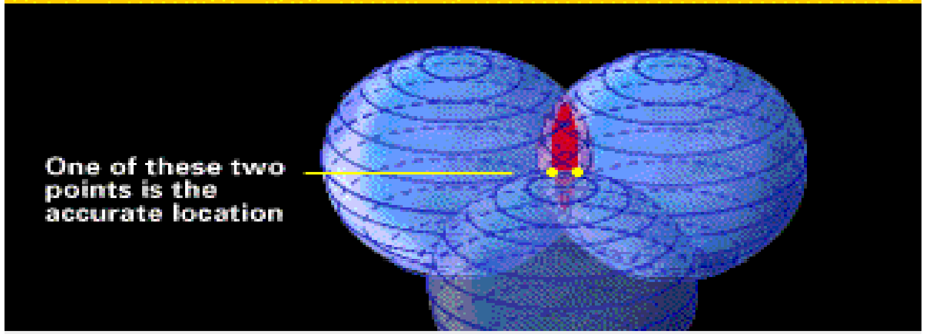
To decide which one is our true location we could make a fourth measurement. But usually one of the two points is a ridiculous answer (either too far from Earth or moving at an impossible velocity) and can be rejected without a measurement.

A fourth measurement does come in very handy for another reason however, but we'll tell you about that later.

Next we'll see how the system measures distances to satellites.

Step 1: Triangulating from Satellites

In Review: Triangulating



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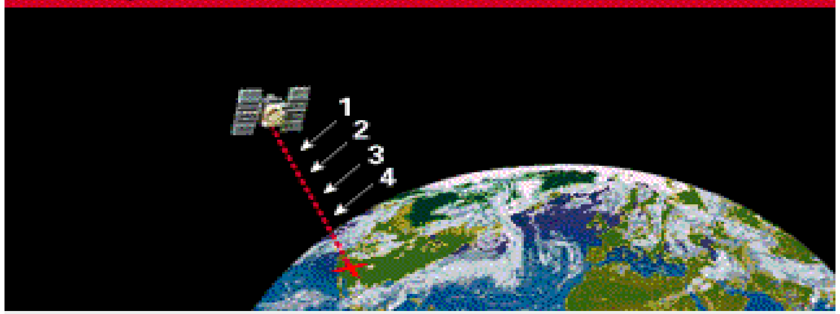
In Review:

- Position is calculated from distance measurements (ranges) to satellites.
- Mathematically we need four satellite ranges to determine exact position.
- Three ranges are enough if we reject ridiculous answers or use other tricks.
- Another range is required for technical reasons to be discussed later.

Step 2: Measuring distance from a satellite

velocity x time = distance



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Measuring distance from a satellite

We saw in the last section that a position is calculated from distance measurements to at least three satellites.

Step 2: Measuring distance from a satellite

Synchronizing our watches

- Timing is tricky
- We need precise clocks to measure travel time
- The travel time for a satellite right overhead is about 0.06 seconds.
- The difference in sync of the receiver time minus the satellite time is equal to the travel time

View the Animation

The Big Idea Mathematically:

In a sense, the whole thing boils down to those "velocity times travel time" math problems we did in high school. Remember the old: "If a car goes 60 miles per hour for two hours, how far does it travel?"

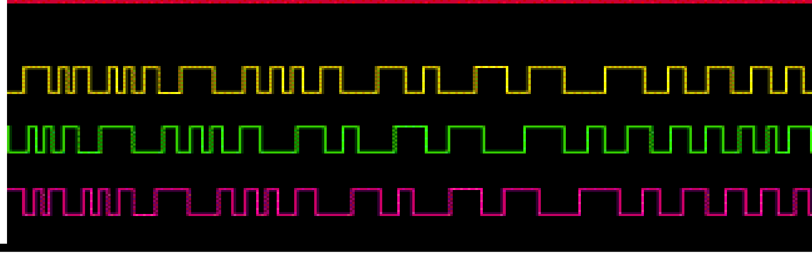
Velocity (60 mph) x Time (2 hours) = Distance (120 miles)

In the case of GPS we're measuring a radio signal so the velocity is going to be the speed of light or roughly 186,000 miles per second.

The problem is measuring the travel time.

Step 2: Measuring distance from a satellite

Each satellite has a unique Pseudo Random Code



- Timing is tricky
- We need precise clocks to measure travel time
- The travel time for a satellite right overhead is about 0.06 seconds
- The difference in sync of the receiver time minus the satellite time is equal to the travel time

The timing problem is tricky. First, the times are going to be awfully short. If a satellite were right overhead the travel time would be something like 0.06 seconds. So we're going to need some really precise clocks. We'll talk about those soon.

But assuming we have precise clocks, how do we measure travel time? To explain it let's use a goofy analogy:

Suppose there was a way to get both the satellite and the receiver to start playing "The Star Spangled Banner" at precisely 12 noon. If sound could reach us from space (which, of course, is ridiculous) then standing at the receiver we'd hear two versions of the Star Spangled Banner, one from our receiver and one from the satellite.

These two versions would be out of sync. The version coming from the satellite would be a little delayed because it had to travel more than 11,000 miles.

If we wanted to see just how delayed the satellite's version was, we could start delaying the receiver's version until they fell into perfect sync.

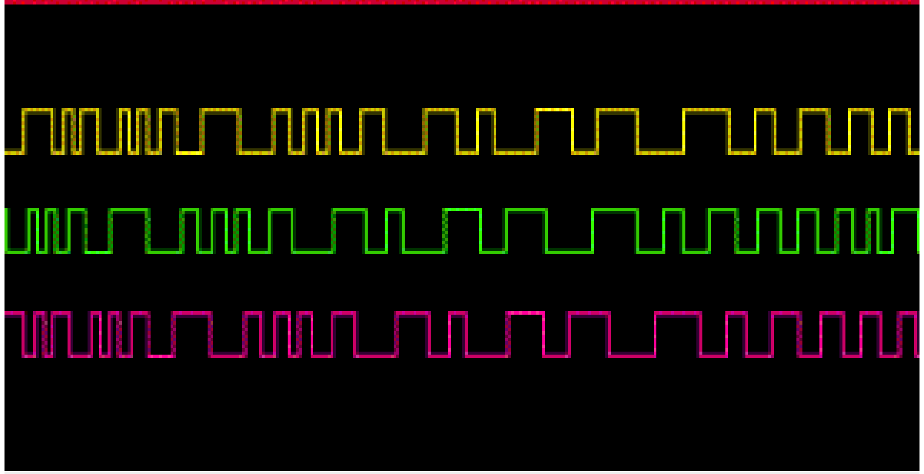
The amount we have to shift back the receiver's version is equal to the travel time of the satellite's version. So we just multiply that time times the speed of light and BINGO! we've got our distance to the satellite.

That's basically how GPS works.

Only instead of the Star Spangled Banner the satellites and receivers use something called a "Pseudo Random Code" - which is probably easier to sing than the Star Spangled Banner.

Step 2: Measuring distance from a satellite

In Review: Measuring Distance



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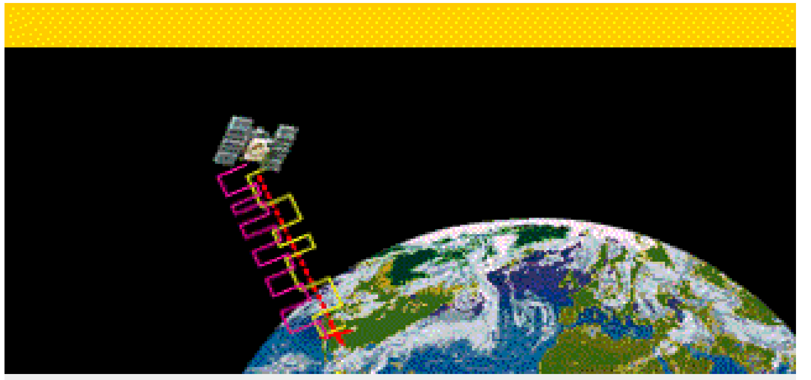
In Review:

1. Distance to a satellite is determined by measuring how long a radio signal takes to reach us from that satellite.
2. To make the measurement we assume that both the satellite and our receiver are generating the same pseudo-random codes at exactly the same time.
3. By comparing how late the satellite's pseudo-random code appears compared to our receiver's code, we determine how long it took to reach us.
4. Multiply that travel time by the speed of light and you've got distance.

TETRA TECH

Step 3: Getting perfect timing



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Getting perfect timing

If measuring the travel time of a radio signal is the key to GPS, then our stop watches had better be darn good, because if their timing is off by just a thousandth of a second, at the speed of light, that translates into almost 200 miles of error!

On the satellite side, timing is almost perfect because they have incredibly precise atomic clocks on board.

But what about our receivers here on the ground?

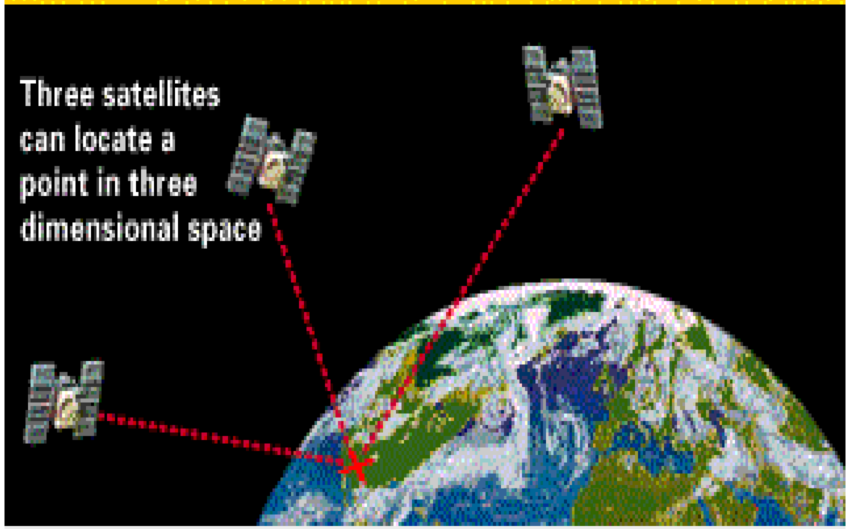
Remember that both the satellite and the receiver need to be able to precisely synchronize their pseudo-random codes to make the system work. (to review this point click here)

If our receivers needed atomic clocks (which cost upwards of $50K to $100K) GPS would be a lame duck technology. Nobody could afford it.

Luckily the designers of GPS came up with a brilliant little trick that lets us get by with much less accurate clocks in our receivers. This trick is one of the key elements of GPS and as an added side benefit it means that every GPS receiver is essentially an atomic-accuracy clock.

Step 3: Getting perfect timing

Means synchronizing the satellite and the receiver



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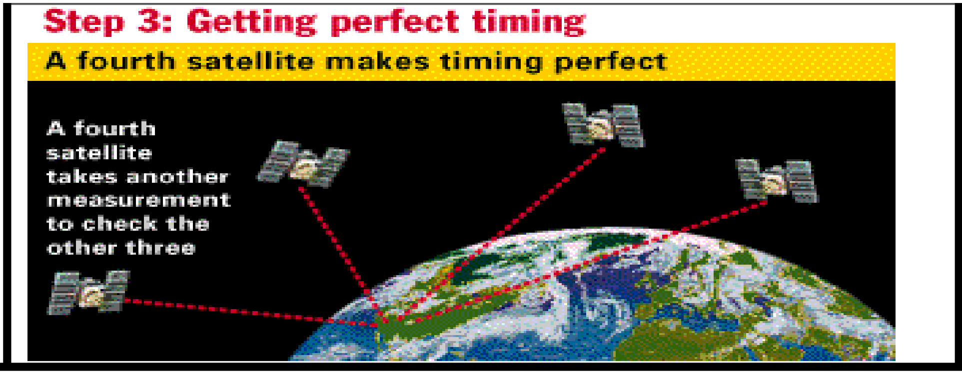
The secret to perfect timing is to make an extra satellite measurement.

That's right, if three perfect measurements can locate a point in 3-dimensional space, then four imperfect measurements can do the same thing.

This idea is so fundamental to the working of GPS that we have a separate illustrated section that shows how it works. If you have time, cruise through that.



Getting perfect timing

Extra Measurement Cures Timing Offset

If our receiver's clocks were perfect, then all our satellite ranges would intersect at a single point (which is our position). But with imperfect clocks, a fourth measurement, done as a cross-check, will NOT intersect with the first three.

So the receiver's computer says "Uh-oh! there is a discrepancy in my measurements. I must not be perfectly synced with universal time."

Since any offset from universal time will affect all of our measurements, the receiver looks for a single correction factor that it can subtract from all its timing measurements that would cause them all to intersect at a single point.

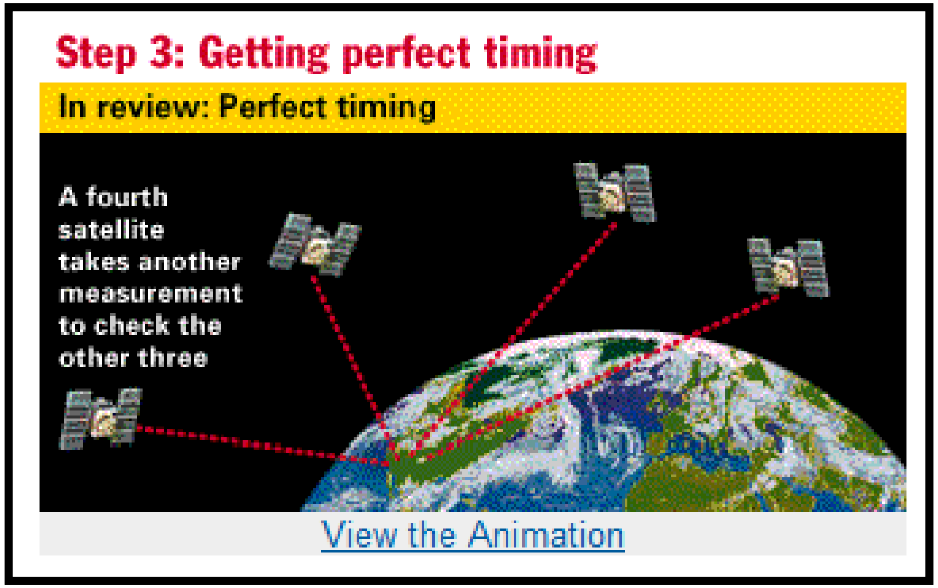
That correction brings the receiver's clock back into sync with universal time, and bingo! - you've got atomic accuracy time right in the palm of your hand.

Once it has that correction it applies to all the rest of its measurements and now we've got precise positioning.

One consequence of this principle is that any decent GPS receiver will need to have at least four channels so that it can make the four measurements simultaneously.

With the pseudo-random code as a rock solid timing sync pulse, and this extra measurement trick to get us perfectly synced to universal time, we have got everything we need to measure our distance to a satellite in space.

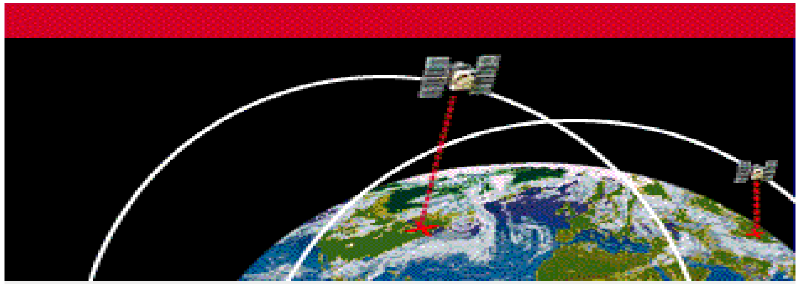
But for the triangulation to work we not only need to know distance, we also need to know exactly where the satellites are.



1. Accurate timing is the key to measuring distance to satellites.
2. Satellites are accurate because they have atomic clocks on board.
3. Receiver clocks don't have to be too accurate because an extra satellite range measurement can remove errors.

TETRA TECH

Step 4: Knowing where a satellite is in space



View the Animation

Satellite Positions

Knowing where a satellite is in space

In this tutorial we've been assuming that we know where the GPS satellites are so we can use them as reference points.

But how do we know exactly where they are? After all they're floating around 11,000 miles up in space.

A high satellite gathers no moss

That 11,000 mile altitude is actually a benefit in this case, because something that high is well clear of the atmosphere. And that means it will orbit according to very simple mathematics.

The Air Force has injected each GPS satellite into a very precise orbit, according to the GPS master plan.

Satellite Positions

Getting the message out

Once the DoD has measured a satellite's exact position, they relay that information back up to the satellite itself. The satellite then includes this new corrected position information in the timing signals it's broadcasting.

So a GPS signal is more than just pseudo-random code for timing purposes. It also contains a navigation message with ephemeris information as well.

With perfect timing and the satellite's exact position you'd think we'd be ready to make perfect position calculations. But there's trouble afoot. Check out the next section to see what's up.