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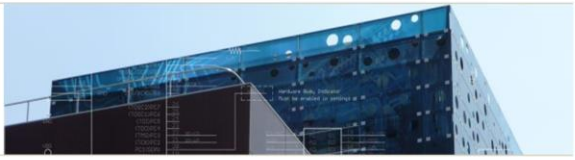
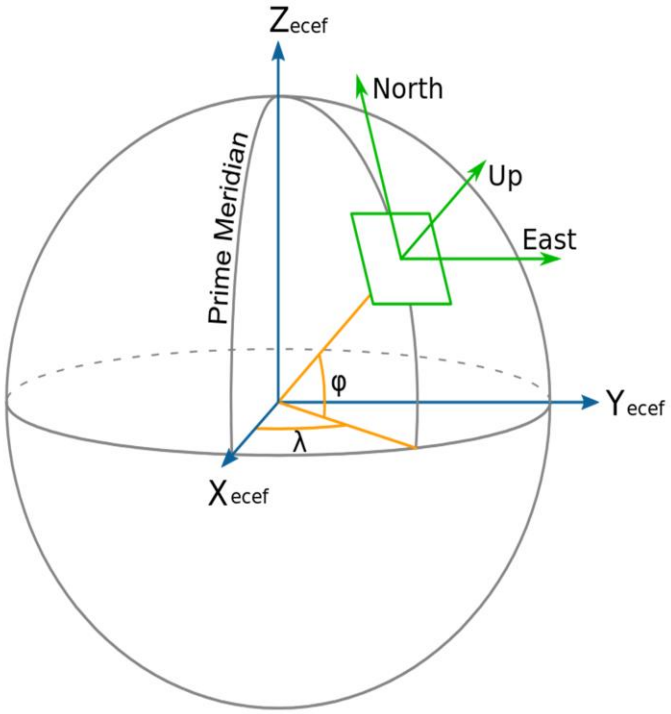


Wireless Computing

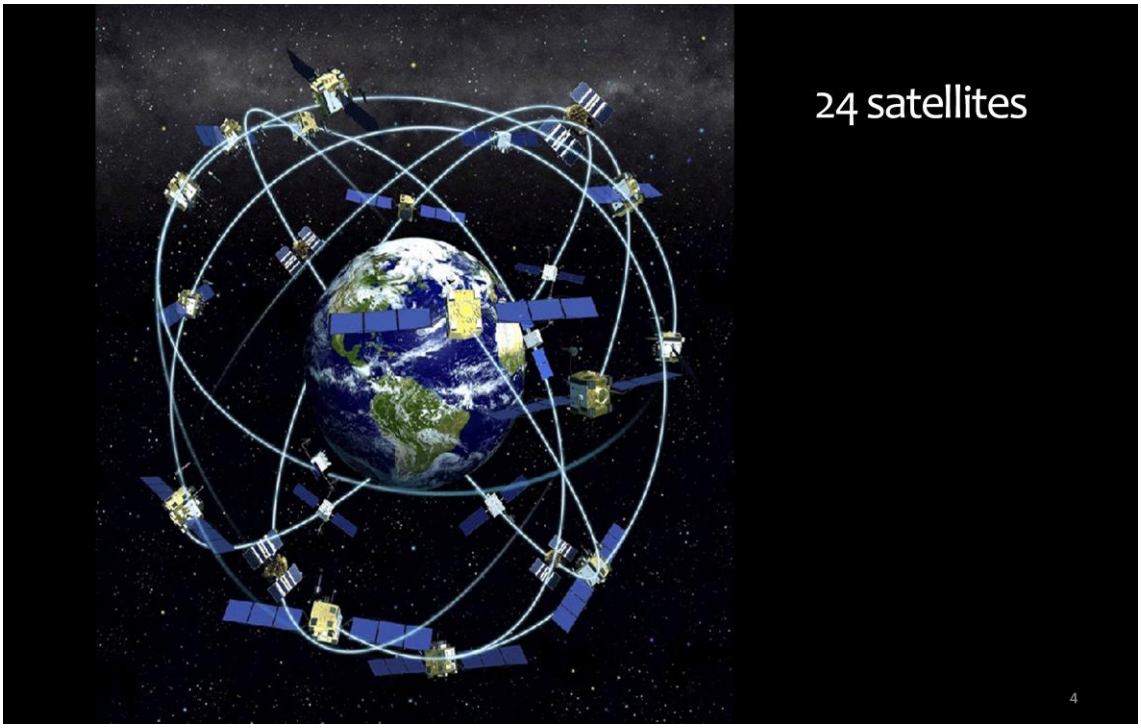
GPS. Geopositioning

The topic we are going to see in this unit, the global positioning system, is not directly related with the computer networks we use everyday, but it is indeed a kind of computer network, as the specialised satellite network it uses and the devices that receive its signal use computer communications to work.

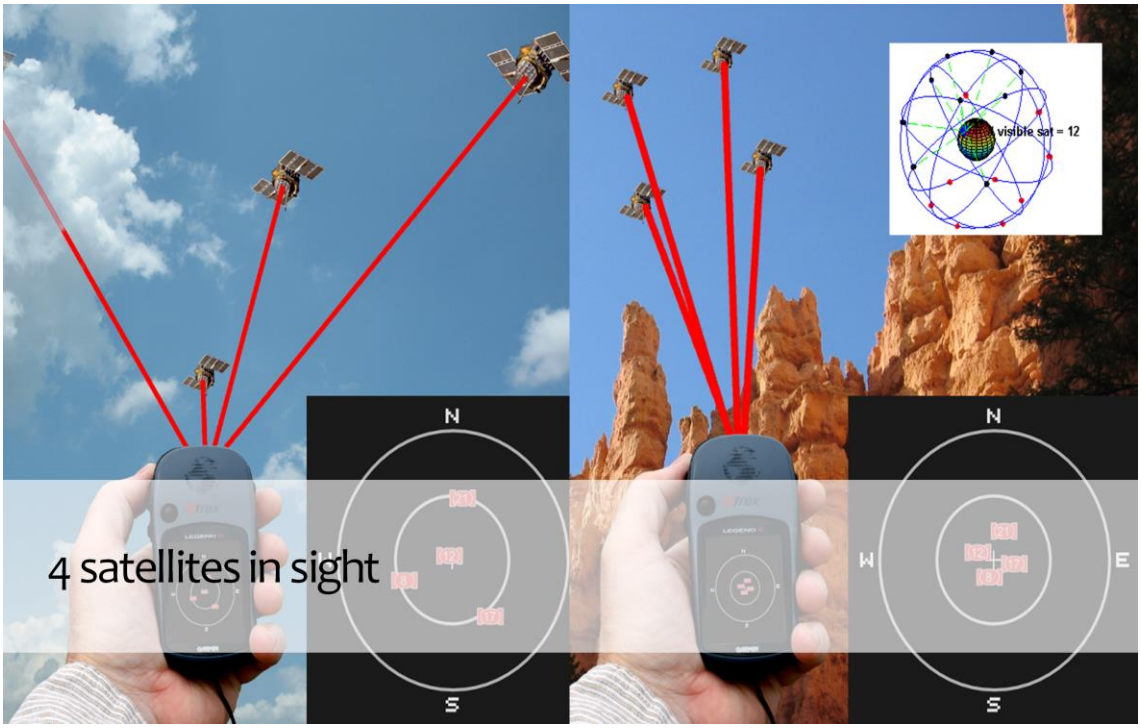
The GPS system allows the location of an object on the surface of the Earth with high precision.



To locate a point on the surface of the Earth, 3 coordinates are needed: latitude, longitude and altitude.



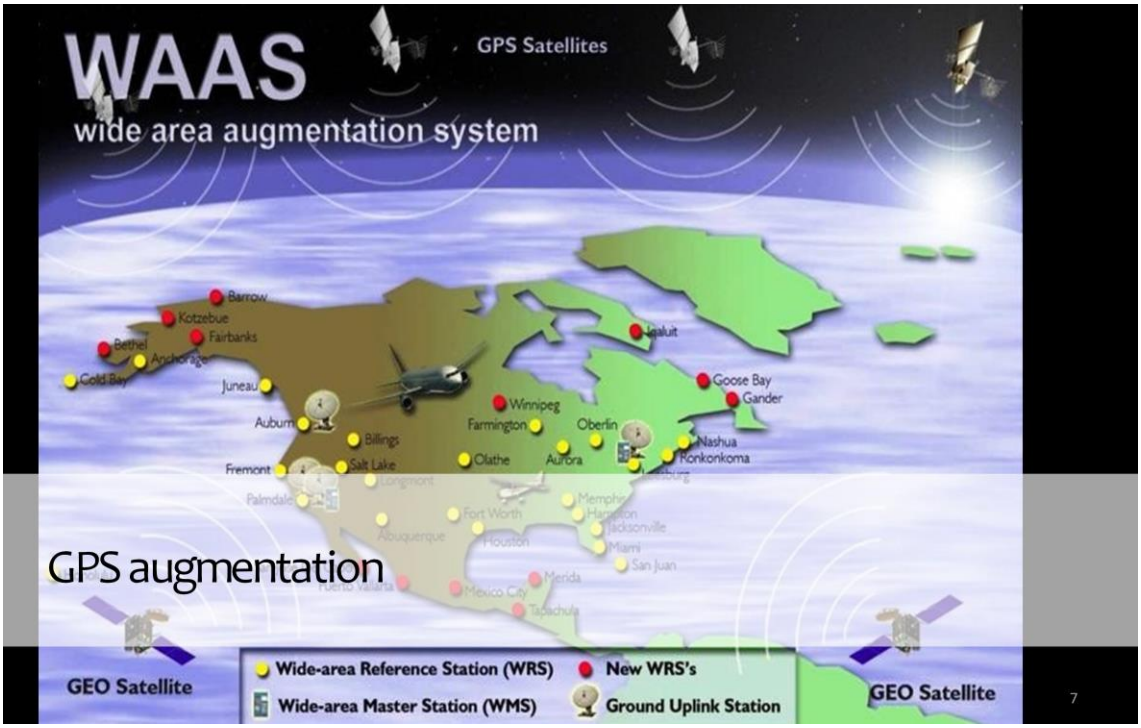
To be able to calculate its coordinates a receiver gets the signal of several of the satellites of a network orbiting around the planet. The main GPS system, NAVSTAR, relies on a network composed of 24 satellites that fly at 20,000 kilometres over sea level with synchronised trajectories.
They broadcast a signal based in a very accurate on-board atomic clock using mainly 2 radio-frequencies around 1 GHz, L1 (1575.42 MHz) and L2 (1227.60 MHz).
Their system has 3 elements, a space segment (the satellites), a control segment and a user segment (the receivers).



As a position is determined by 3 coordinates, direct vision of at least 4 satellites is needed to triangulate our position in 3D. If we know that we are on the Surface level, we may do that with just three and discard altitude information.

However, the accuracy increases with the number of satellites in sight, so the more the better.

Nowadays, there are 4 main systems. GPS usually refers to the U.S.A network, NAVSTAR. The Soviet union began the development of its own system: GLONASS, but it wasn't finished until mid-2000. The Chinese navigation system BeiDou began being operational in 2011 and it has main coverage over continental China. Galileo is the system created in the european union. The first satellite was launched in 2011 and in 2016 it will begin to offer its services.
Japan is also creating a regional GPS system called QZSS to complement and enhance the Navstar coverage over Japan. They launched its first satellite in 2010.



The signal transmitted by the satellites gets distorted by atmosphere propagation, introducing errors in the calculated position. These errors can be ignored for most user applications, but they are important in some others, such as airplane navigation and landing or land measurements, for example.

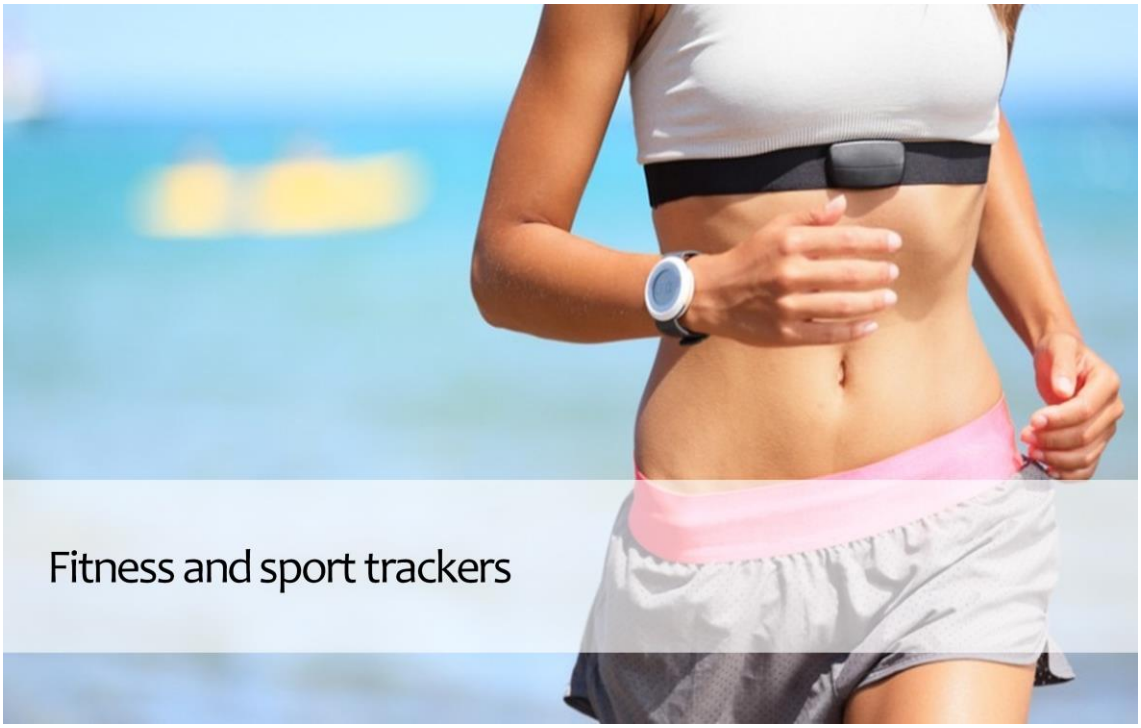
A mechanism called augmentation has been devised to correct these errors. It consists in receiving the GPS position at locations of known positions and calculating the error in real time, to send it to one or more geostationary satellites that broadcast the errors, so receiving stations can correct the GPS position in real time.

The network of receiving points and the infrastructure needed to broadcast the errors are collectively know as SBAS network (for *Satellite Based Augmentation System)* . There are several augmentation systems in place in the world, the one deployed by the U.S. is called WASS for *Wide Area Augmentation System*, the one from Europe is called EGNOS and the one from Japan MSAS, for example.

Vehicle GPS

GPS' has several uses, all related with location. Probably the most extended one is its functions to assist vehicles in their routes, as a guidance system that has replaced the maps on paper in a lot of situations.

Outdoor activities have different necessities, since the coverage is worse in mountains and similar spaces that obscure the vision of multiple satellites. Usually the outdoor receivers include maps with level curves and altitudes.



Sport activities also benefit from the track a receiver can generate of the user's activities. Receivers are used to record and review the activity once it has finished or to allow other persons to follow the position on-line.

In all these activities, specialised devices are used. But more and more smartphones include an integrated GPS, so in many cases they are being replaced by them.

Attribution

The sources of some of these figures are :

- https://en.wikipedia.org/wiki/File:ECEF_ENU_Longitude_Latitude_relationships.svg
- https://en.wikipedia.org/wiki/Space_and_Missile_Systems_Center#/media/File:GPS-constellation-3D-NOAA.jpg
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