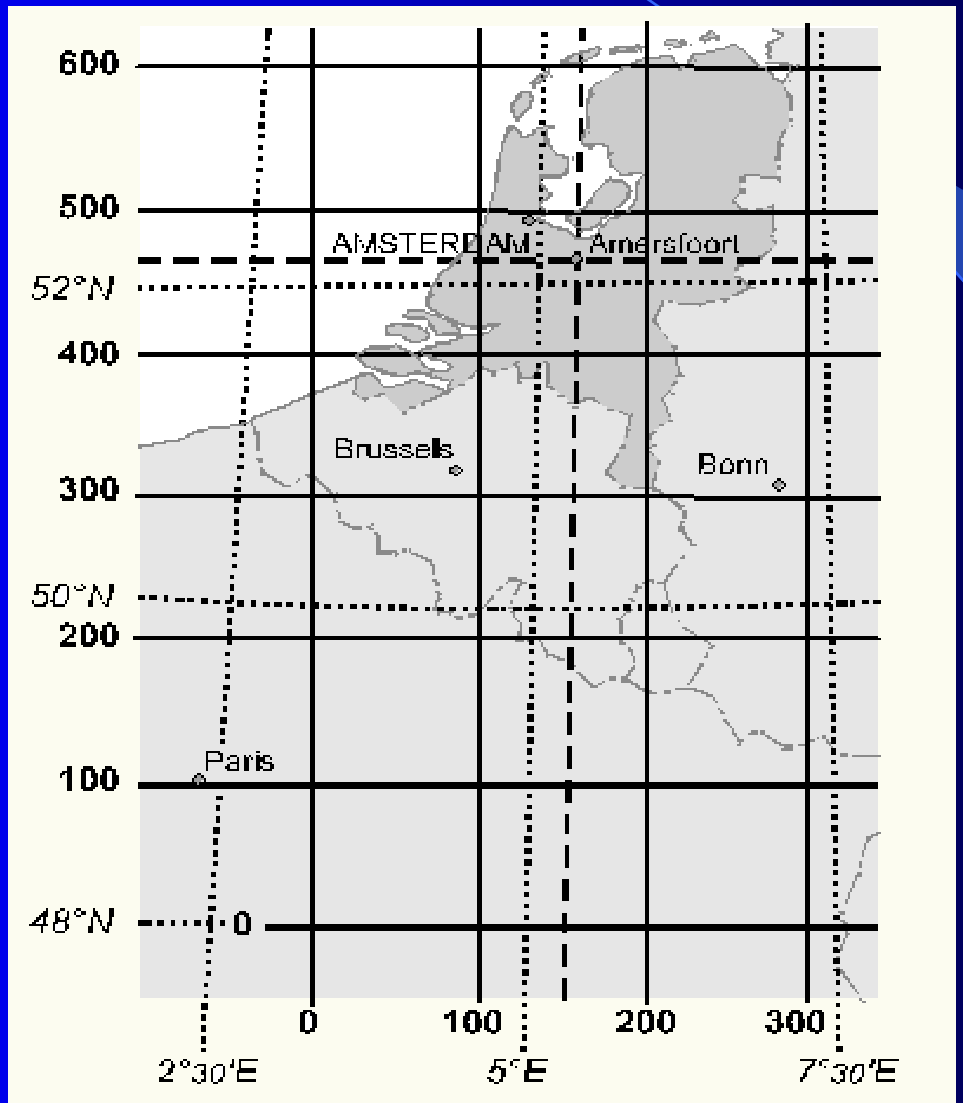
# Toponymy course
# 6. Maps, Geodetic and cartographic reference systems

Richard Knippers

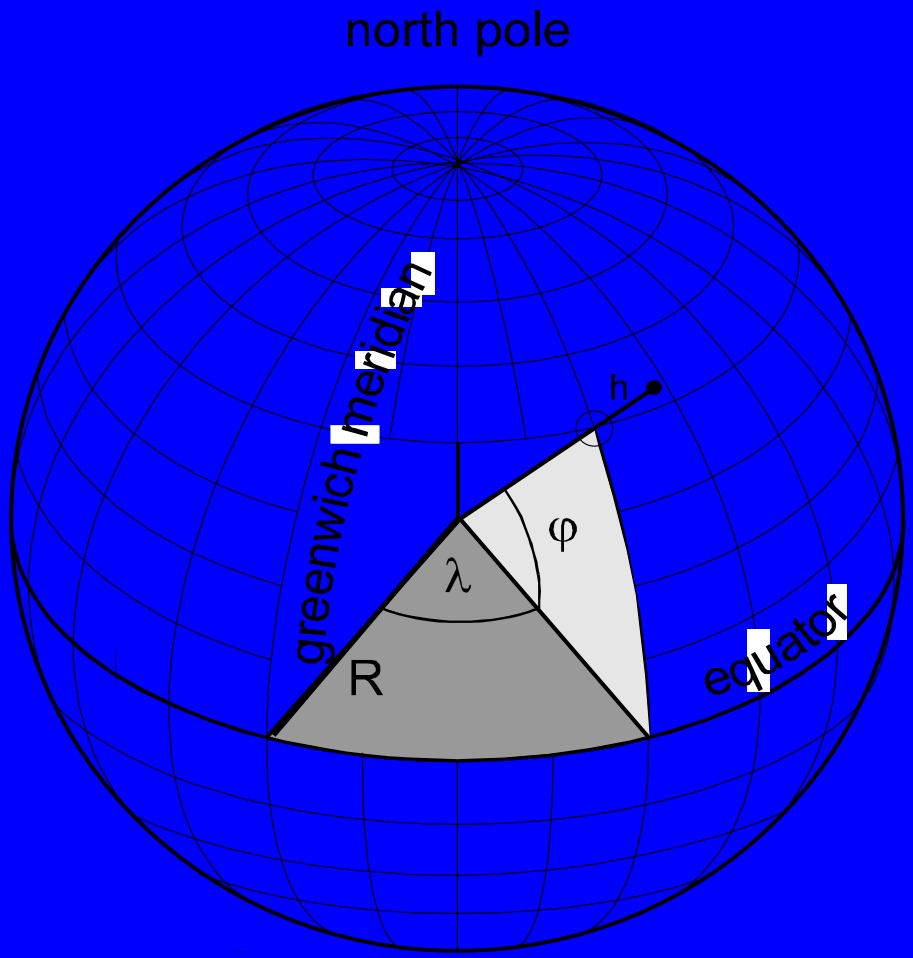
# What methods are available to indicate the location of geographic features?

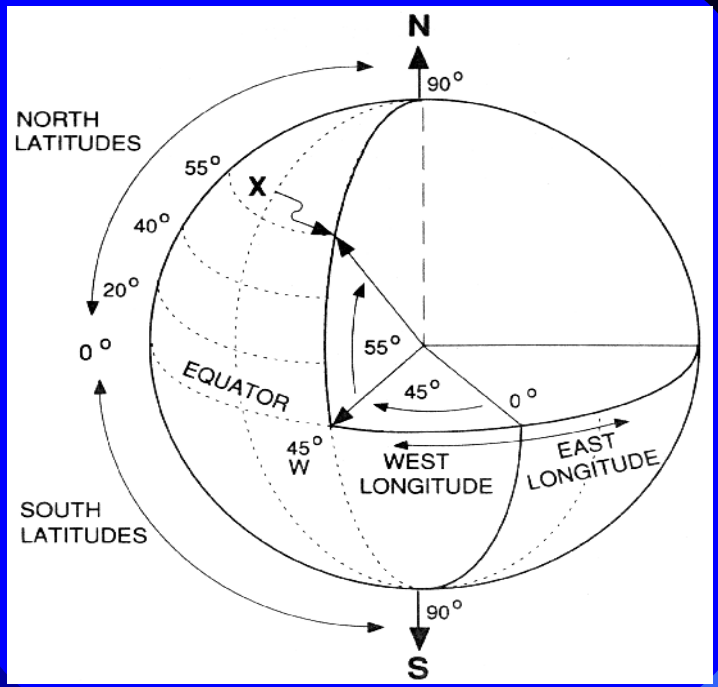
- ✓ ***Name***
- ✓ ***Topology***
- ✓ ***Address and street codes***
- ✓ ***Postal codes***
- ✓ ***Statistical units and other administrative zones***
- ✓ ***Discrete grid system***
- ✓ ***Local coordinates***
- ✓ ***Global coordinates***

# Geographical and Plane rectangular coordinates

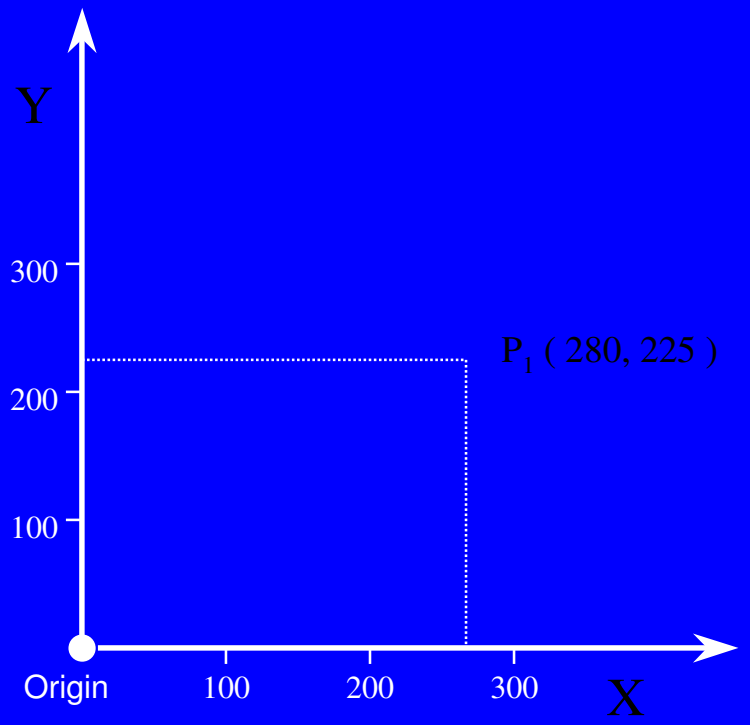


# Geographical coordinates

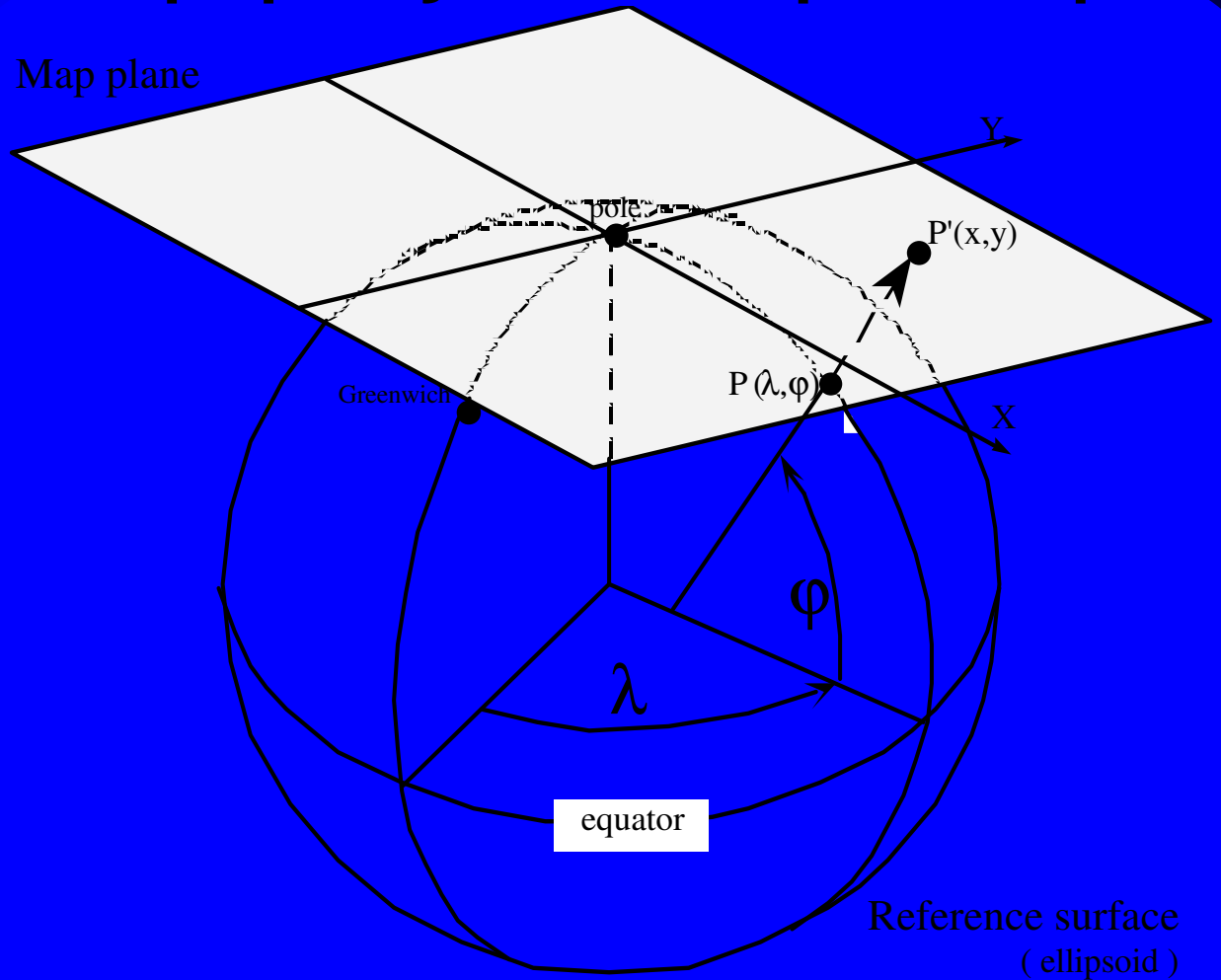


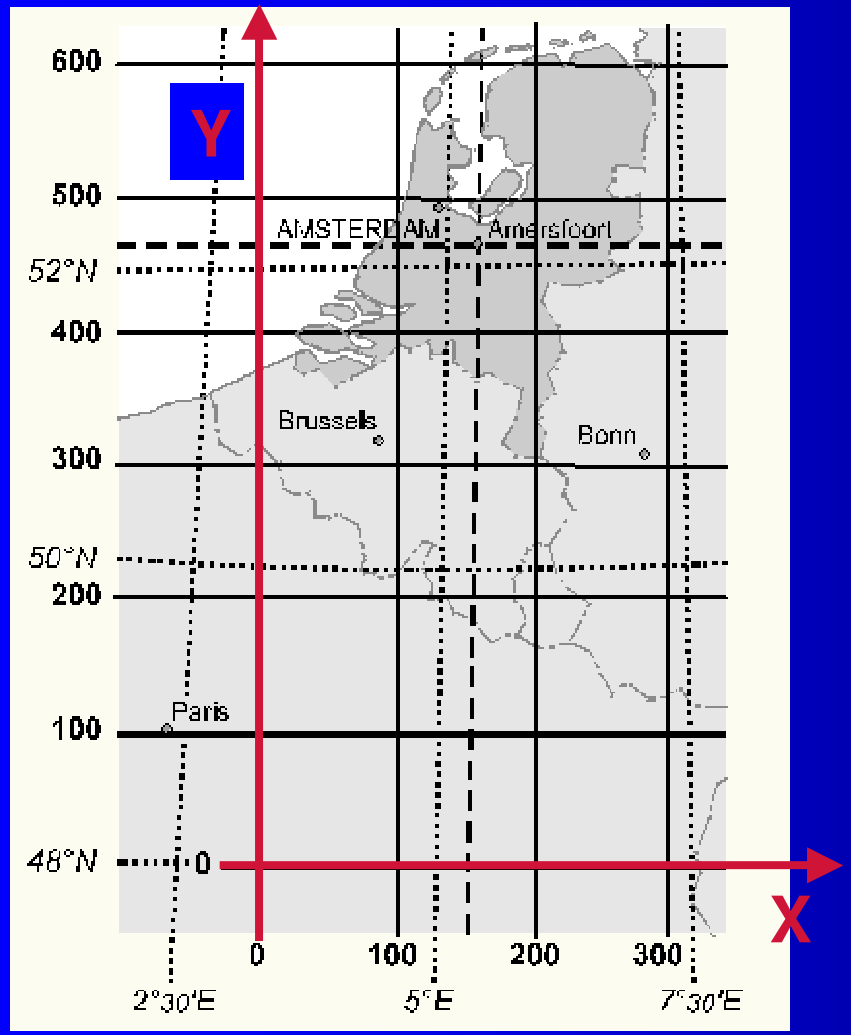
# Plane rectangular coordinates (Cartesian coordinates)



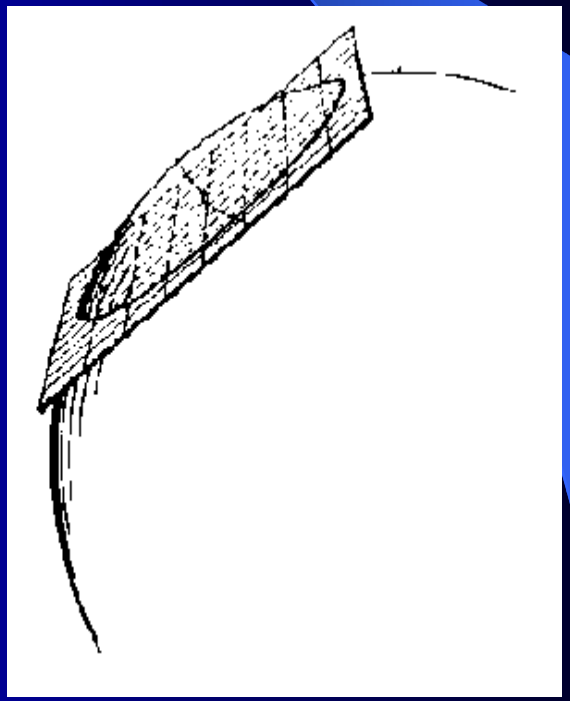
# Map projection principle



# National Grid System of the Netherlands




***Map projection: Oblique azimuthal Stereographic projection***

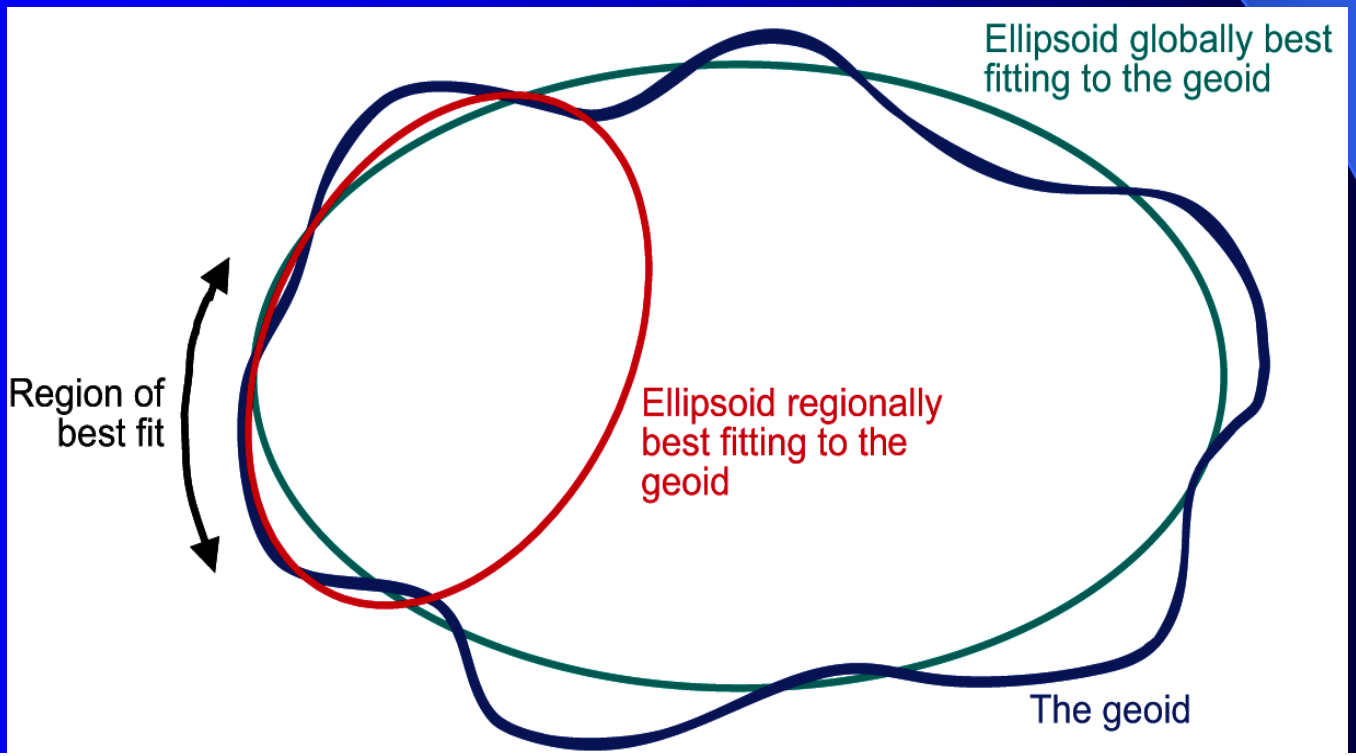


# National Grid system

- Reference surface (geodetic datum)
- Map projection
- Projection parameters

# Horizontal (geodetic) datum

Countries establish a *horizontal* (or geodetic) *datum*, which is an ellipsoid with a fixed position, so that the ellipsoid best fits the surface of the area of interest (the country)



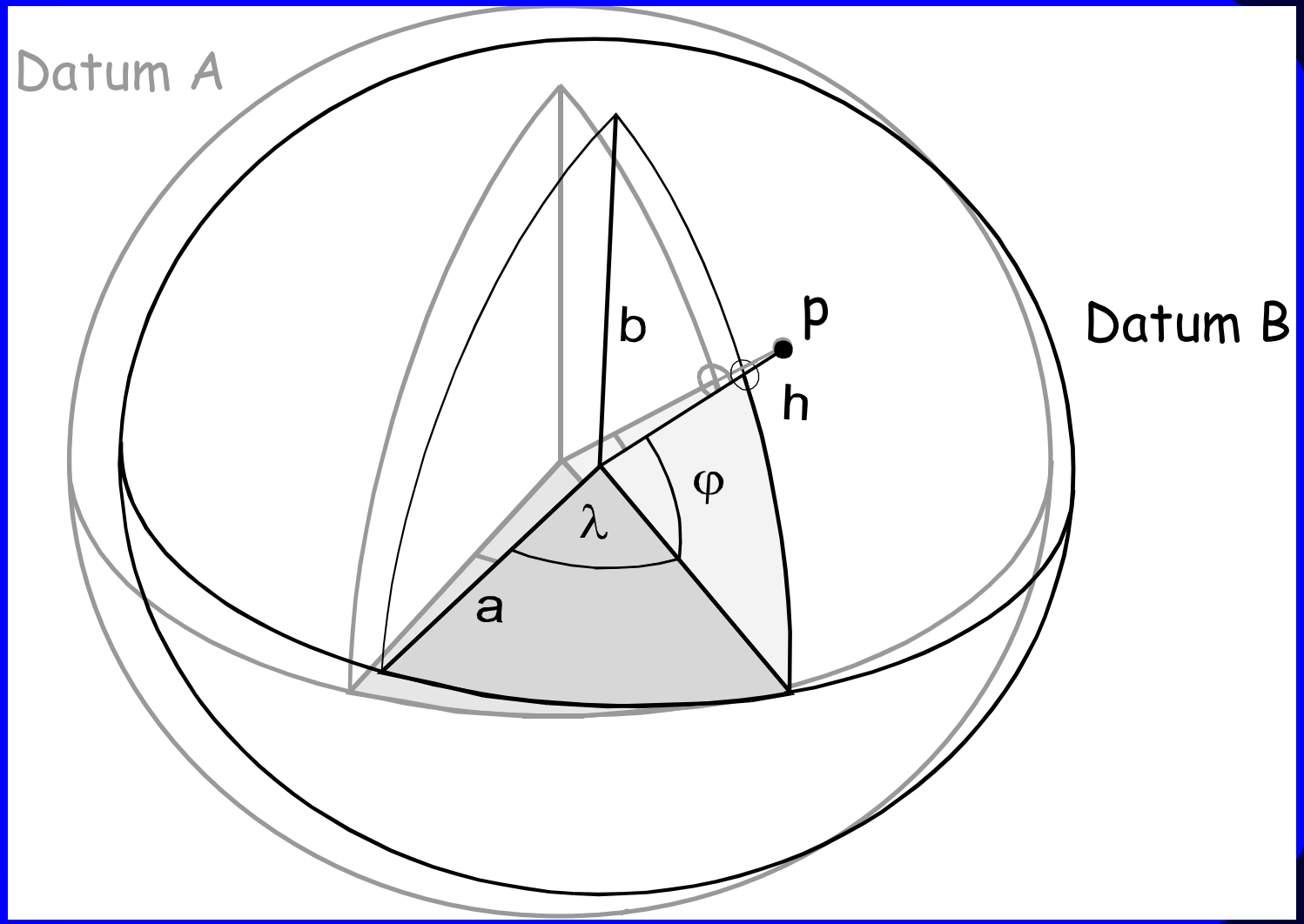
# Commonly used ellipsoids

| *Name* | *Date* | *a (m)* | *b (m)* | *Use* |
|---|---|---|---|---|
| **Everest** | 1830 | 6377276 | 6356079 | India, Burma, Sri Lanka |
| **Bessel** | 1841 | 6377397 | 6356079 | Central Europe, Chile, Indonesia |
| **Airy** | 1849 | 6377563 | 6356257 | Great brittain |
| **Clarke** | 1866 | 6378206 | 6356584 | North America, Philippines |
| **Clarke** | 1880 | 6378249 | 6356515 | France, Africa (parts) |
| **Helmert** | 1907 | 6378200 | 6256818 | Africa (parts) |
| **International (or Hayford)** | 1924 | 6378388 | 6356912 | World |
| **Krasovsky** | 1940 | 6378245 | 6356863 | Russia, Eastern Europe |
| **GRS80** | 1980 | 6378137 | 6356752 | North America |
| **WGS84** | 1984 | 6378137 | 6356752 | World (GPS measurements) |

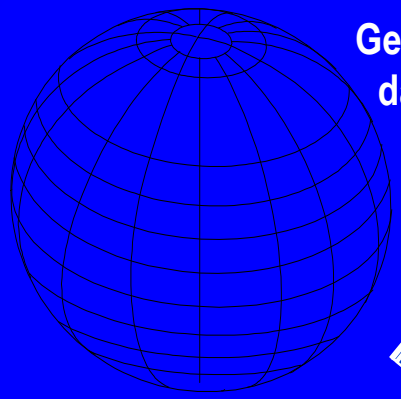
# Geodetic datums using the same ellipsoid

| Datum | Ellipsoid | Datum shift (m) ( Dx, Dy, Dz ) |
|---|---|---|
| Alaska (NAD-27) | Clarke 1866 | -5, 135, 172 |
| Bahamas (NAD-27) | Clarke 1866 | -4, 154, 178 |
| Bermuda 1957 | Clarke 1866 | -73, 213, 296 |
| Central America (NAD-27) | Clarke 1866 | 0, 125, 194 |
| Bellevue (IGN) | Hayford | -127, -769, 472 |
| Campo Inchauspe | Hayford | -148, 136, 90 |
| Hong Kong 1963 | Hayford | -156, -271, -189 |
| Iran | Hayford | -117, -132, -164 |

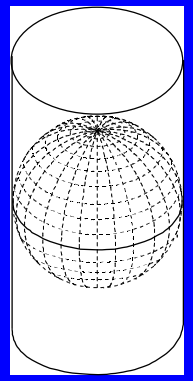
# Datum shift



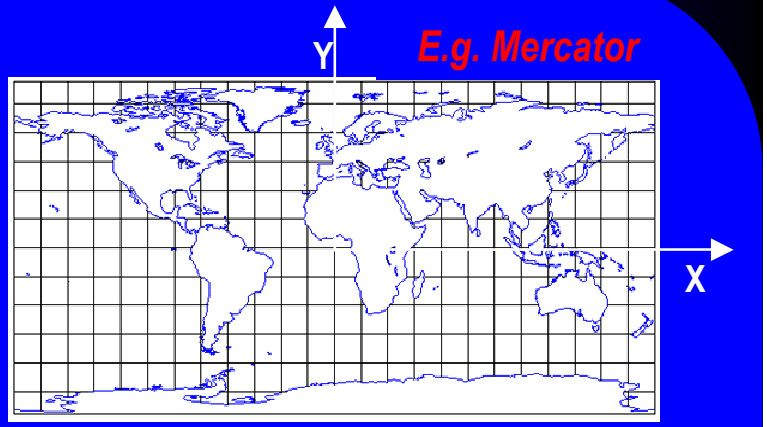
# Map projections



Geodetic datum

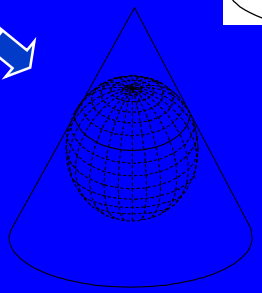


Cylinder



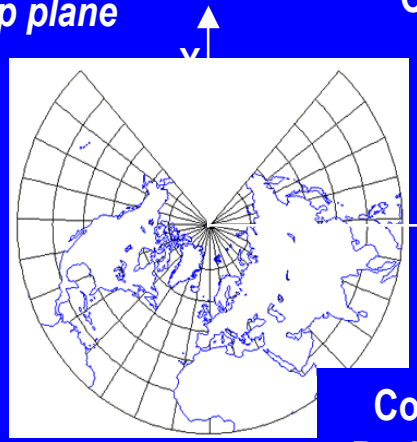

*E.g. Mercator*

Cylindrical Projection



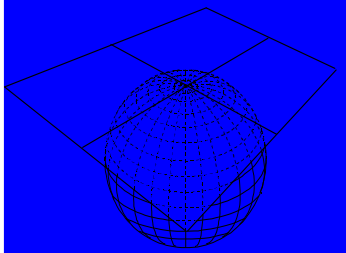
Cone

*Projection on the map plane*

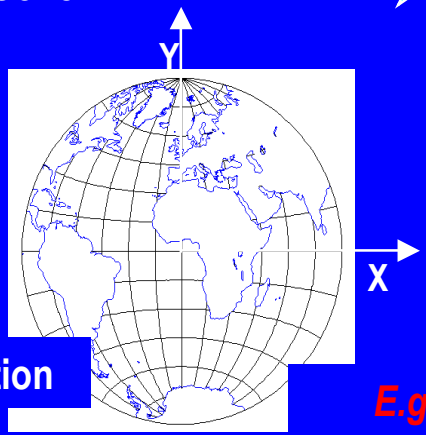



*E.g. Lambert Conformal Conical projection*

Conical Projection



Plane




Azimuthal Projection

*E.g. Stereographic projection*

# Map projection parameters

***A reference surface and a map projection by itself isn't enough to define a national grid system. One has to define the projection parameters***

***For example:***

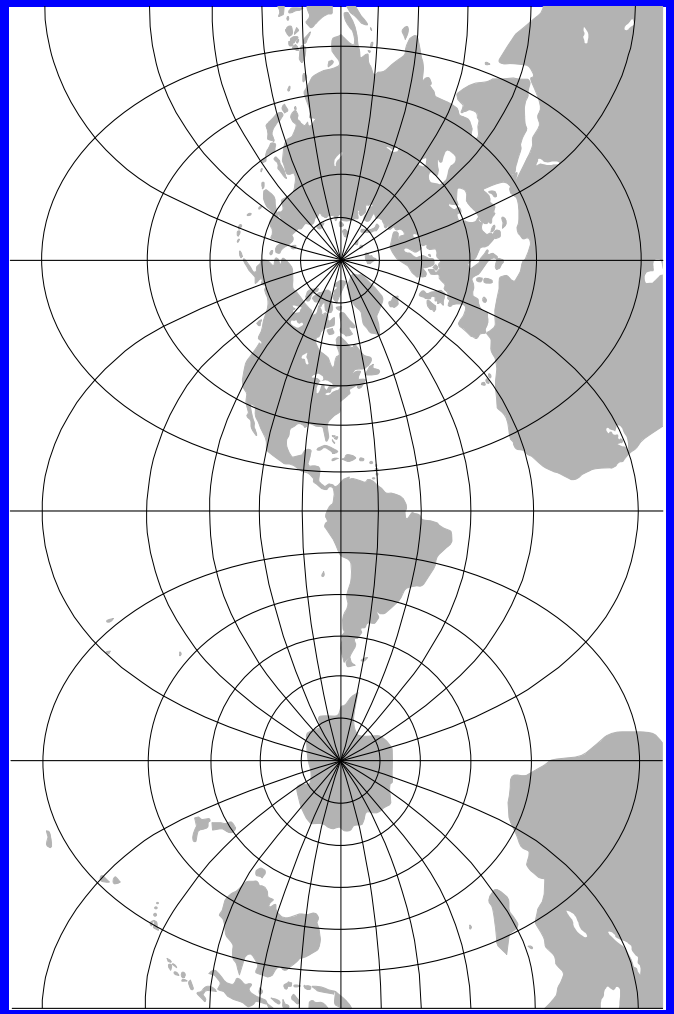
- ***Origin of the coordinate system ( latitude and longitude of origin )***
- ***False Easting and False Northing***
- ***Central Meridian ($\lambda_0$) or the standard parallels***
- ***Scale factor at CM or standard parallels***
- ***…***

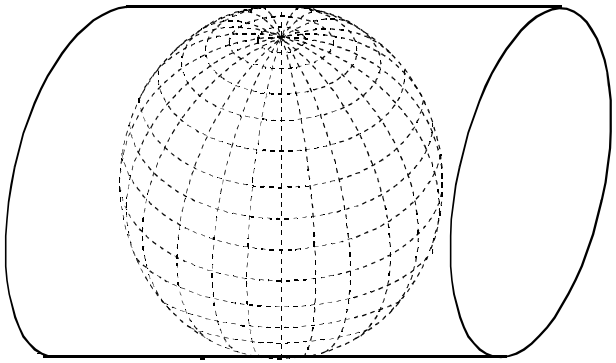
# Map Projections used in the World

The most widely used grid system is the UTM system

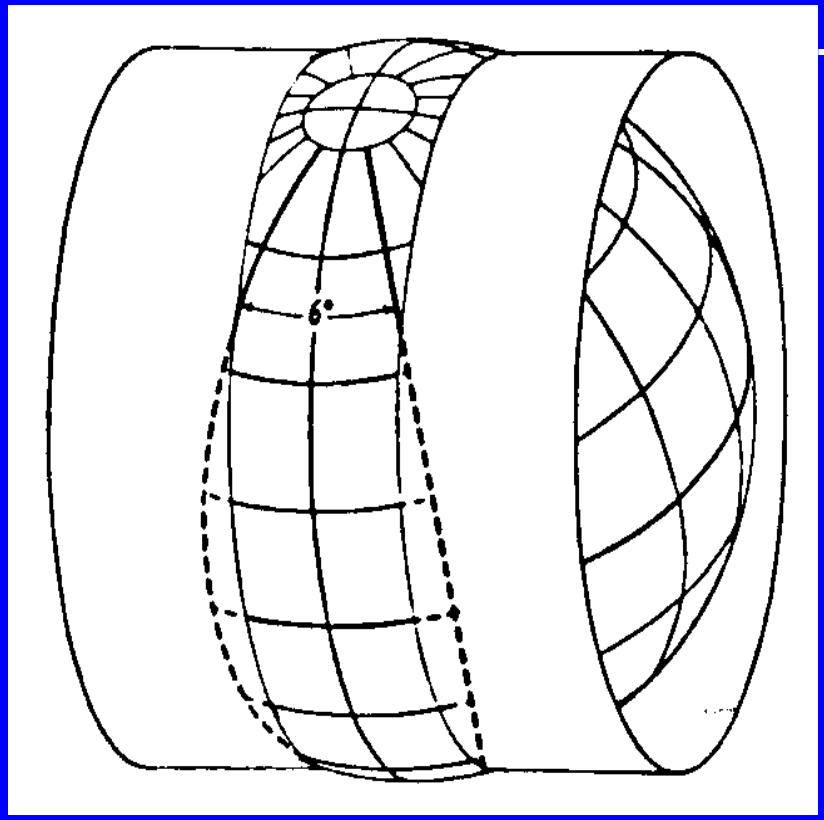
| Projection | Areas |
|---|---|
| UTM | 42 % |
| TM ( Gauss-Kruger ) | 37 % |
| Polyconic | 10 % |
| Lambert Conformal Conical | 5 % |
| Others | 6 % |

# Transverse Mercator projection





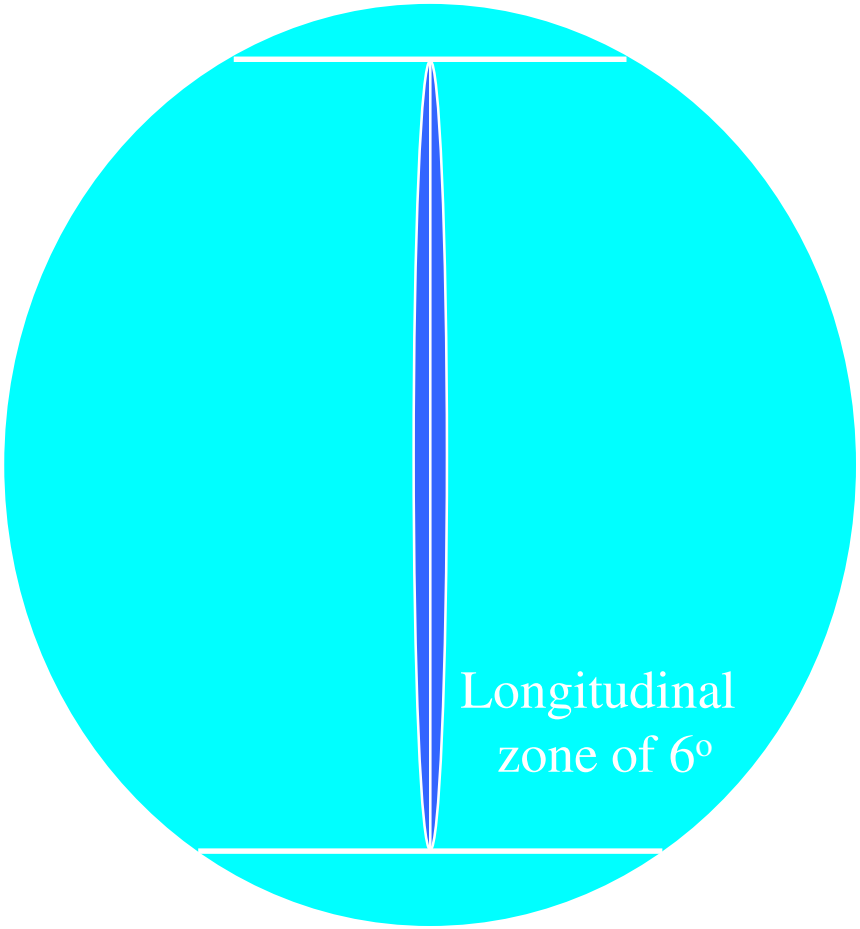
# UTM-projection



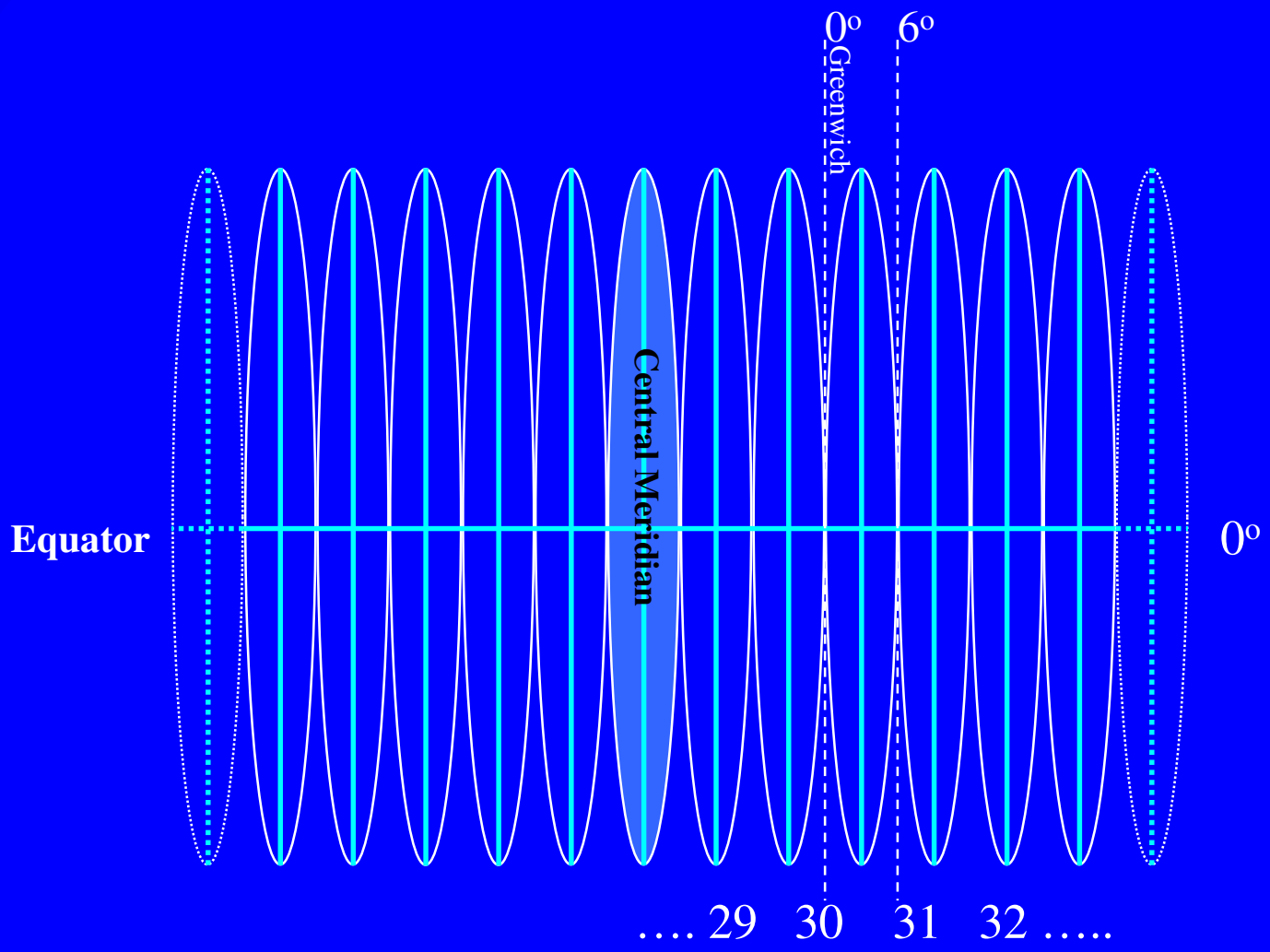

Transverse secant Cylinder
( 6° zones )

**( UTM ) Universal Transverse Mercator**

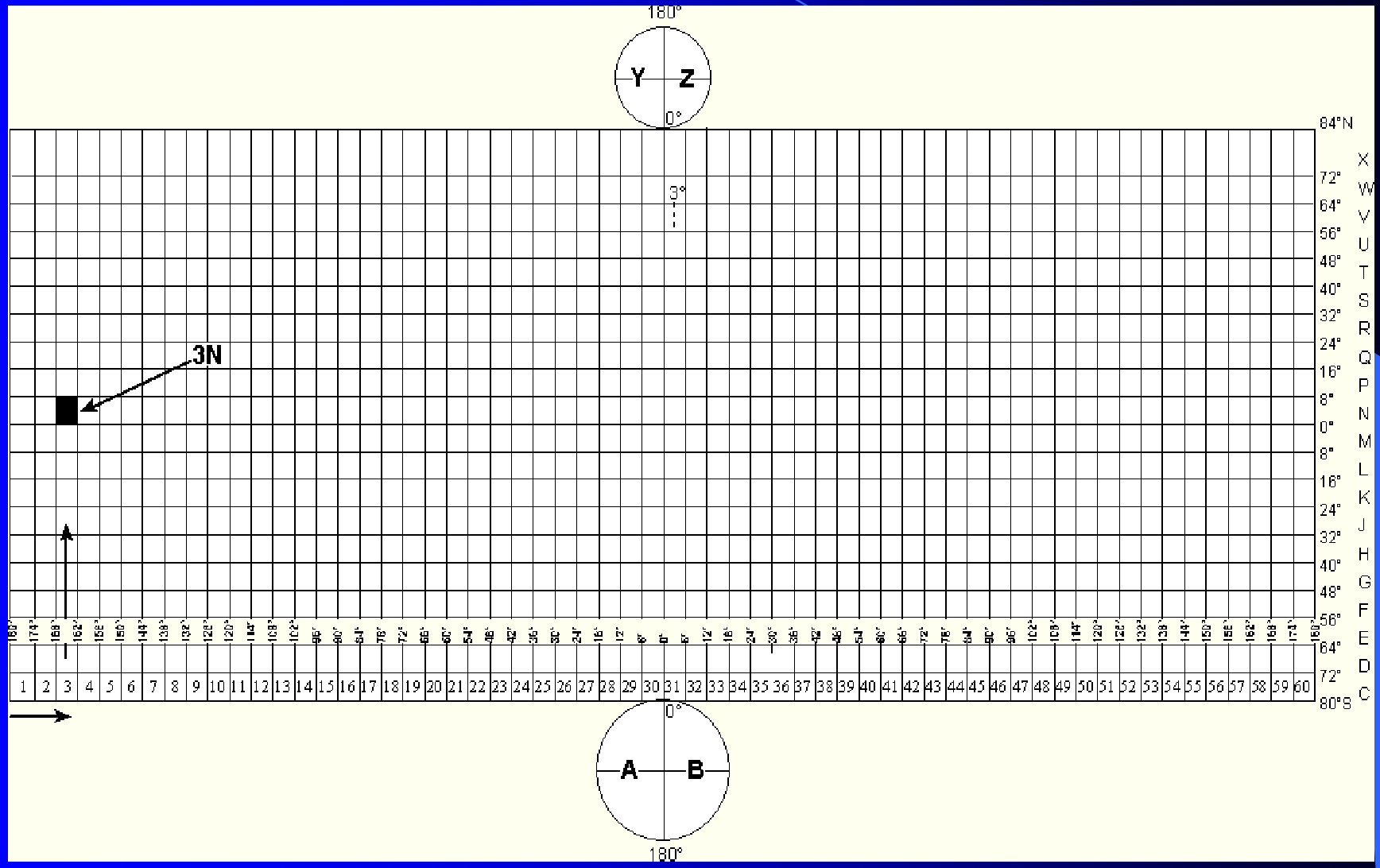
# Organisation into UTM-zones



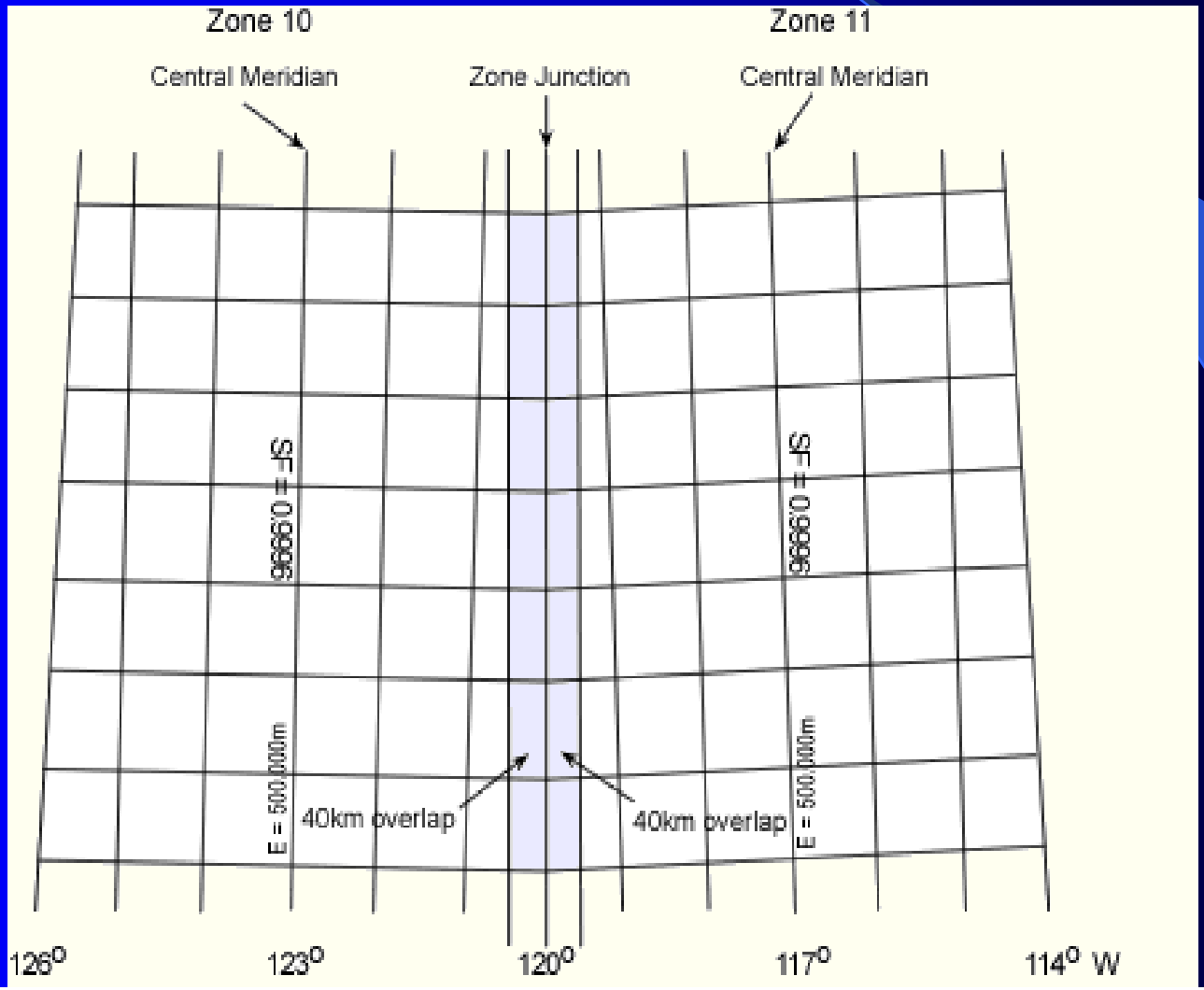
# UTM-Zones



# UTM zone numbering system



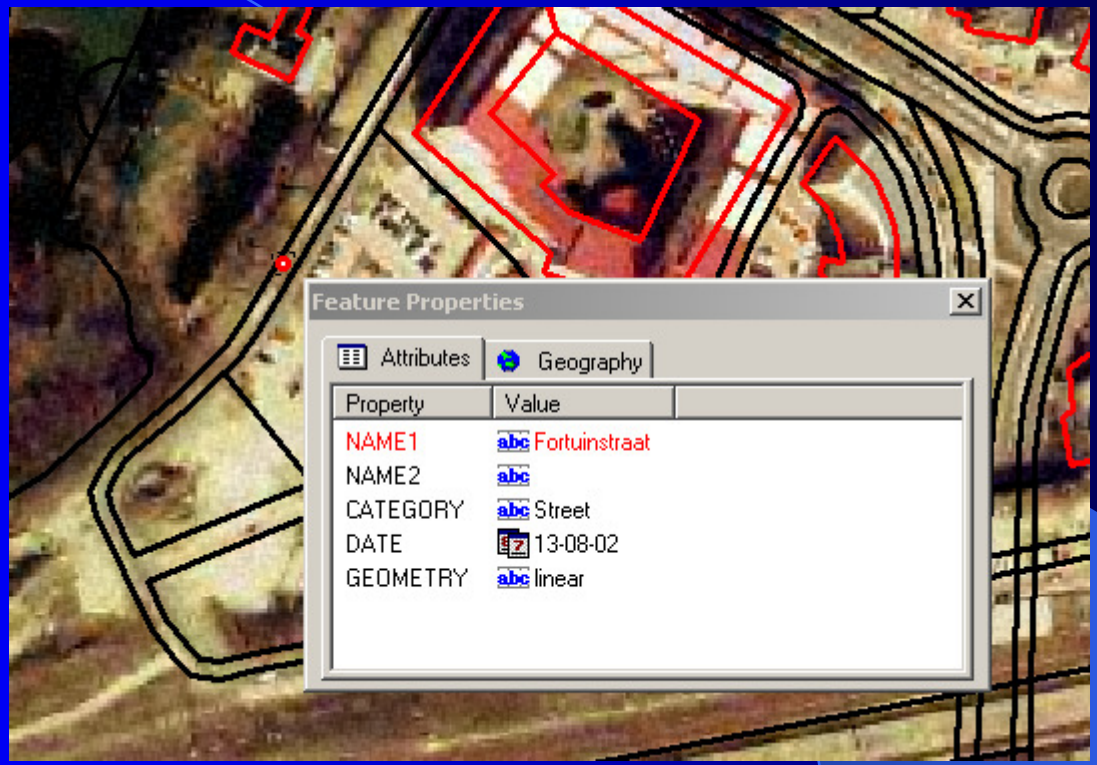
# Two adjacent UTM zones



# *Unfortunately, not all countries adopted the UTM grid and the WGS84 datum*

| Country: *The Netherlands* | |
|---|---|
| **Projection system** | |
| Projection: | **Double stereographic (of Schreiber)** ***(Rijksdriehoeksstelsel)*** |
| Zone(s) (if applicable): | N/a |
| Limits of zone(s) (if applicable): | N/a |
| Latitude of projection origin ($\varphi_0$): | 52:09:22.178 d:m:s |
| Longitude of projection origin ($\lambda_0$): | *5:23:15.500 d:m:s* |
| Scale factor at projection origin: | 0.9999079 |
| False easting (m): | 155 000m |
| False northing (m): | 463 000m |
| **Geodetic datum** | |
| Datum name: | Rijksdriehoeksmeting |
| Ellipsoid name: | Bessel 1841 |
| Semi-major axis of ellipsoid (a): | 637739.155000m |
| Semi-minor axis of ellipsoid (b): | - |
| Flattening of ellipsoid: | 1/299.152813 |
| Fundamental point: | Amersfoort $\varphi$?= $52^0$ 09' 22".178 $\lambda$ = $5^0$23' 15".500 |
| Orientation: | Not known |
| Datum shift in X (m): | 565.04m |
| Datum shift in Y (m): | 49.91m |
| Datum shift in Z (m): | 465.84m |
| Rotation in X ($\alpha$): | *0.4094"* |
| Rotation in Y ($\beta$): | *0.3597"* |
| Rotation in Z ($\gamma$): | *1.8685"* |
| Scale (s): | *4.0772 ppm* |
| **Vertical datum** | |
| Datum name: | Normaal Amsterdam Peil (NAP), Mean Sea Level at Amsterdam |

# Mobile GPS/GIS mapping technology



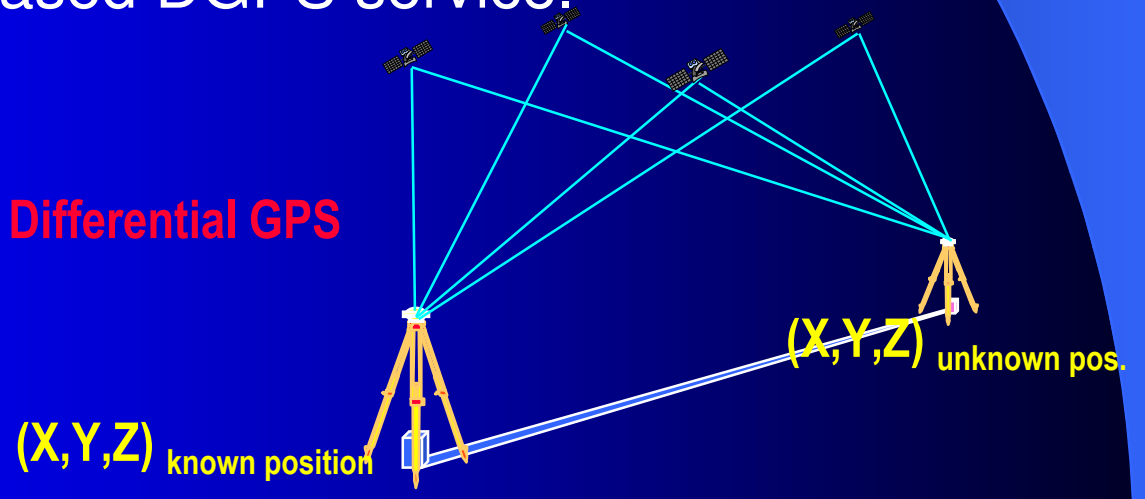
# Mobile GIS

***Mobile GIS is a growing technology. More and more choices are becoming available for field spatial data collection.***

- *GPS*
  ***Global Positioning System (GPS) is a technology that uses the locations satellites to determine locations on earth. GPS is an essential tool for GIS because it allows for the gathering of data that locationwise is highly accurate.***
- *Location Based Services (LBS)*
  ***Location Based Services is a growing technology field that focuses on providing GIS and spatial information via mobile and field units.***

# GPS receivers


- With the elimination of Selective Availability (SA), autonomous accuracy is much better. Today, a single stand alone receiver can provide an accuracy of between 5 - 15 meters.
- It is also now possible with the use of DGPS service to obtain sub meter accuracy in real time. (This eliminates the need for post processing). This DGPS service is available through the use of coast guard beacon receivers and satellite based DGPS service.

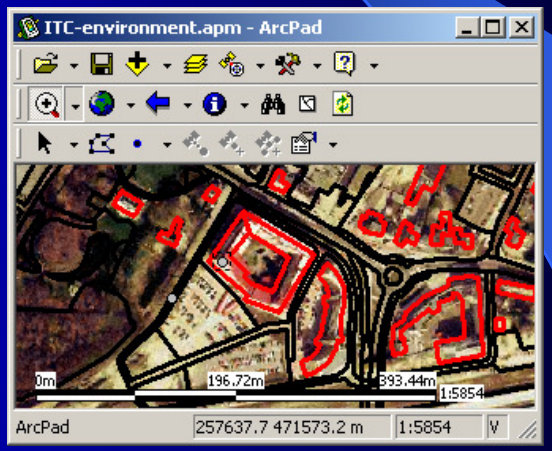


# Data collectors

- With the introduction of Palm Pilots followed by Microsoft's launch of a pocket PC operating system, a new generation of handheld Personal Digital Assistants (PDA's) have flooded the market. It is now possible to use these lightweight handheld PDA's , with GPS/GIS data collection software, for field applications.
- They have a longer battery life, 14-16 hours, and are lightweight. In addition, most data collectors have touch screens and come with a color display. Almost all have voice activated systems which comes in handy if one wants to dictate notes.

# Software

- The new generation of software offers the user various options that can be used for his or her applications. The software is very economically priced, between $50-$3000, and has the capability to add background maps or digital orthophotos.




- Once the location, features and attribute data have been collected, all of the data can be exported in different GIS formats, such as ArcView shape files.

# Mobile GIS systems


GPS-receiver


Portable PC
(PDA)

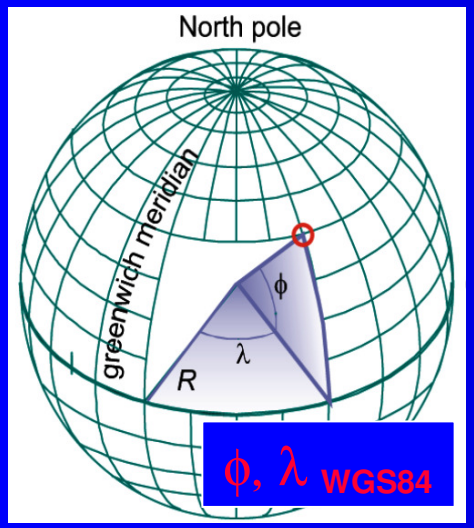

GPS-receiver
and
Portable PC

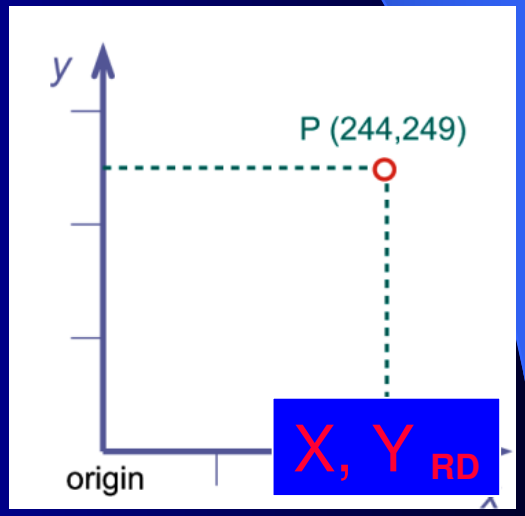
# Coordinate transformations

- Often field data projects are handled in different datums and projections, and as a result, one should take care that the projection and datum are correctly set

GPS-receiver

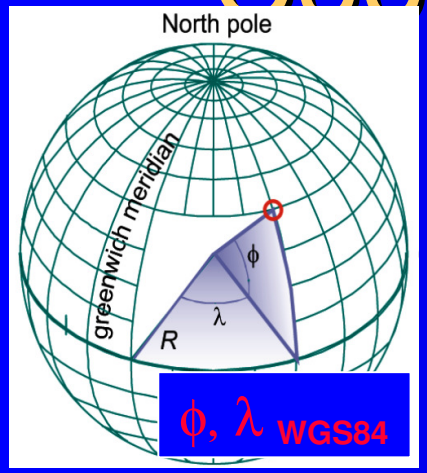
Portable PC
(PDA)



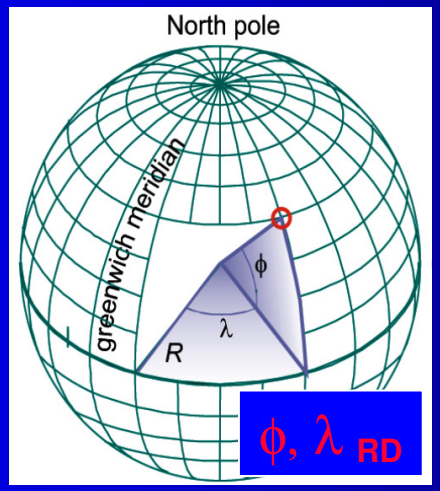



# Coordinate transformations

GPS-receiver

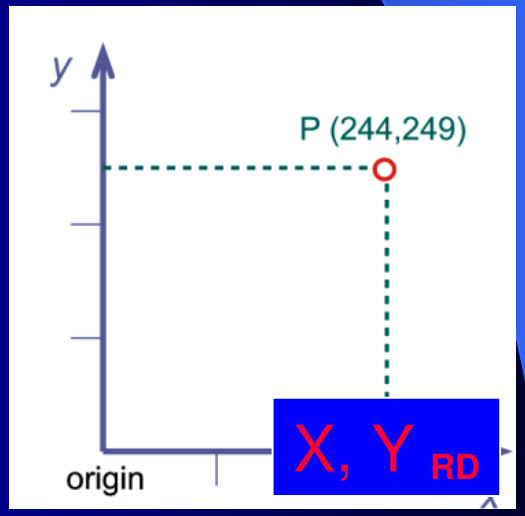



Datum transformation



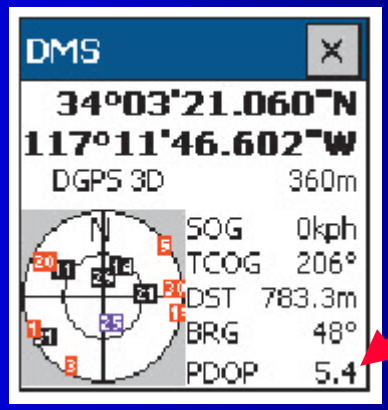

Projection transformation

Portable PC (PDA)

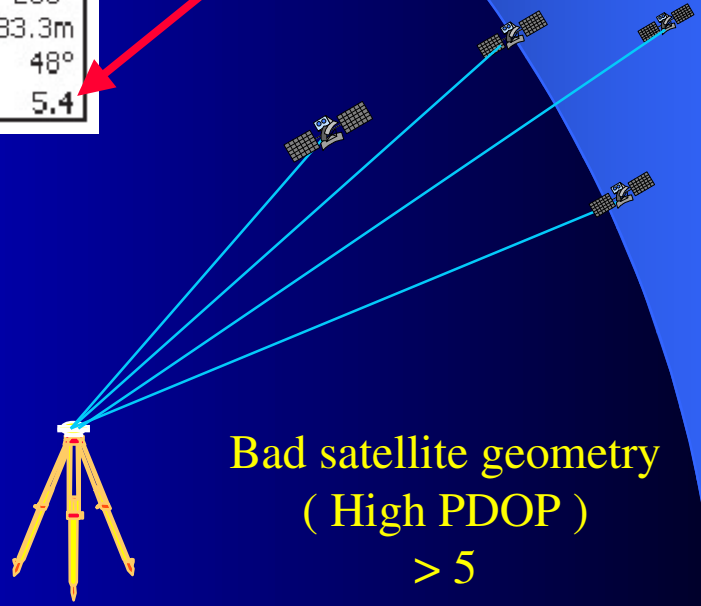


# Satellite geometry

- It is good practice to view the quality of GPS data collected by viewing the PDOP number.



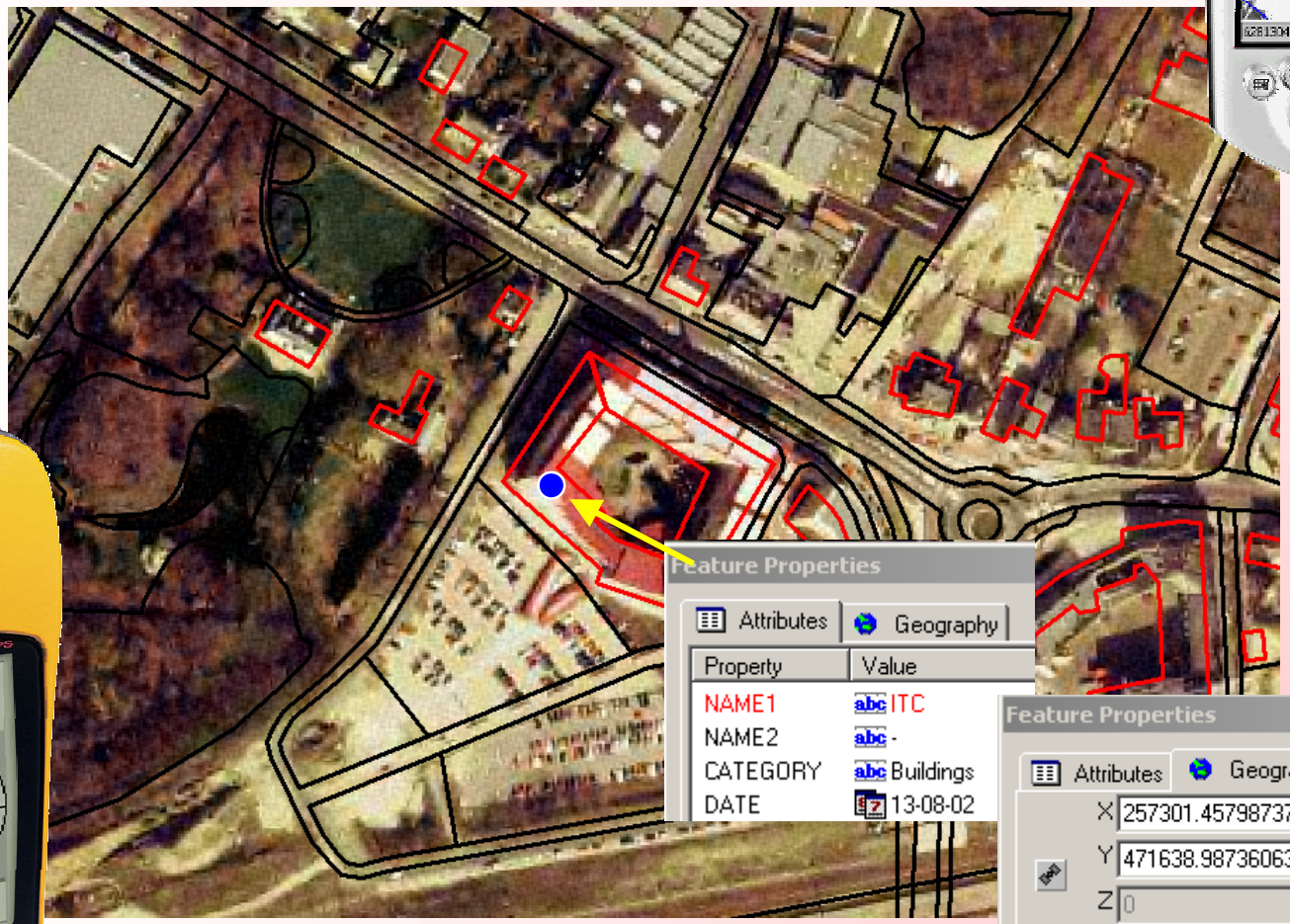

Good satellite geometry
( Low PDOP )
< 5



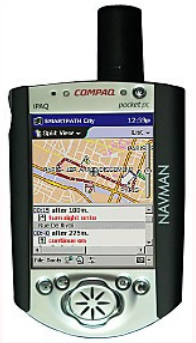
Bad satellite geometry
( High PDOP )
> 5

# Mobiel GIS

# Field exercise


# Some relevant information…




## GPS receiver (NAVMAN)

**12-channel; horizontal accuracy 5.0 meters (95% probable); battery life 1.5 –2.2 hours**

## Data collector (Compaq iPAQ)

**64 MB memory version, running at 200 Mhz under MS-Windows-CE is able to run ArcPad and to connect to a GPS.**

**The Pocket PC has backlight-features so that in bright sun the screen is still readable.**

## ArcPad Software

**Arc-Pad is able to convert GPS readings 'on-the-fly' to the required coordinate system.**

**The user can save the use the GPS to prepare shapefiles (containing either point, line, or polygon features). The software allows to prepare forms (questionnaires), and to draw points, lines, or polygons directly by hand on the screen.**

**Images are SID files**

# MrSID compression .....

Aerial photograph of Enschede reduced from van 25Mb to 1 Mb)

# The field exercise ....

## Tasks

- Prepare  a ‘point and polygon layer’ with an attribute form in ArcPad
- Collect a number of names of geographic features in this neighbourhood