



# GIS och Positionering

GIS 101

Satellit/GPS

Mobil positionering

Windows Sensor and Location Platform

W3C Geolocation

Google Street View

# General GIS Concepts 1

- **What is GIS?**

- Geographic Information System offer a dynamic digital environment for visualizing and analyzing geographic information
- A GIS is constituted by the interaction between tabular and spatial data, where the tables contain information related to map features
- For this reason, one often speak of *Relational Databases* when discussing GIS

- **When to use it?**

- To find spatial data
- To analyze data using geospatial methods
- To map information

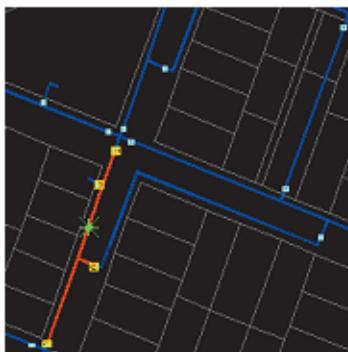
# What can you do with GIS 1?



A tax assessor's office produces land use maps for appraisers and planners.



An engineering department monitors the condition of roads and bridges and produces planning maps for natural disasters.



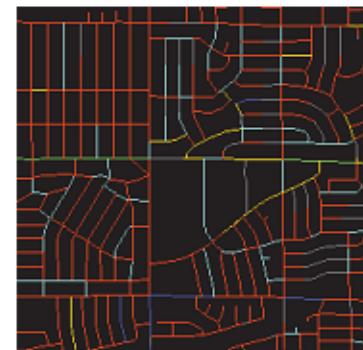
A water department finds the valves to isolate a ruptured water main.



A transit department produces maps of bicycle paths for commuters.

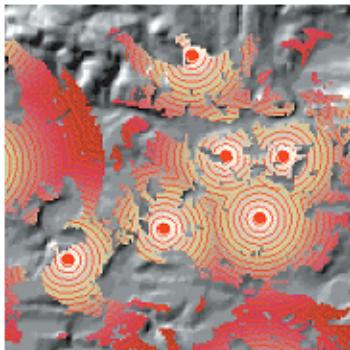


A police department studies crime patterns to intelligently deploy its personnel and to monitor the effectiveness of neighborhood watch programs.



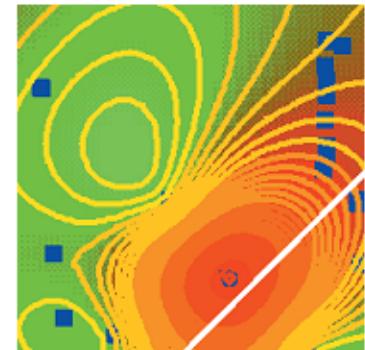
A wastewater department prioritizes areas for repairs after an earthquake.

# What can you do with GIS 2?

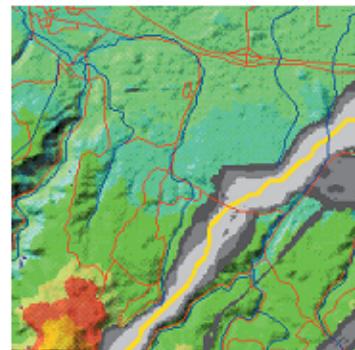


A telecommunication company studies the terrain to find locations for new cell phone antennae.

A hydrologist monitors water quality to protect public health.



A pipeline company finds the least-cost path for a new pipeline.

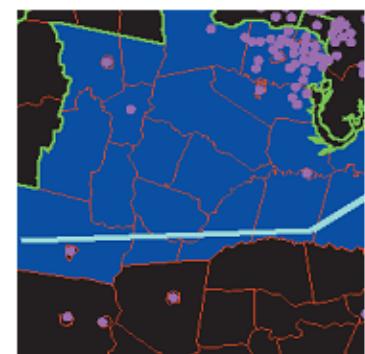


A biologist studies the impact of construction plans on a watershed.



An electric utility models its circuits to minimize power loss and to plan the placement of new devices.

A meteorologist issues warnings for counties in the path of a severe storm.



# GIS example 1

Brottsplasskartan - se var ... 

brottsplasskartan.se

Freja och Embla - iGoogle SY Synonymer.se - Lexi... Språkrådet - Lexin xda-developers Android Developers Metasploit Unleashe...

Other bookmarks

Din plats: Borlänge Åndra Gå direkt till län... Ok

Om webbplatsen API Statistik Andra länkar om brott

Google Anpassad sökning Sök

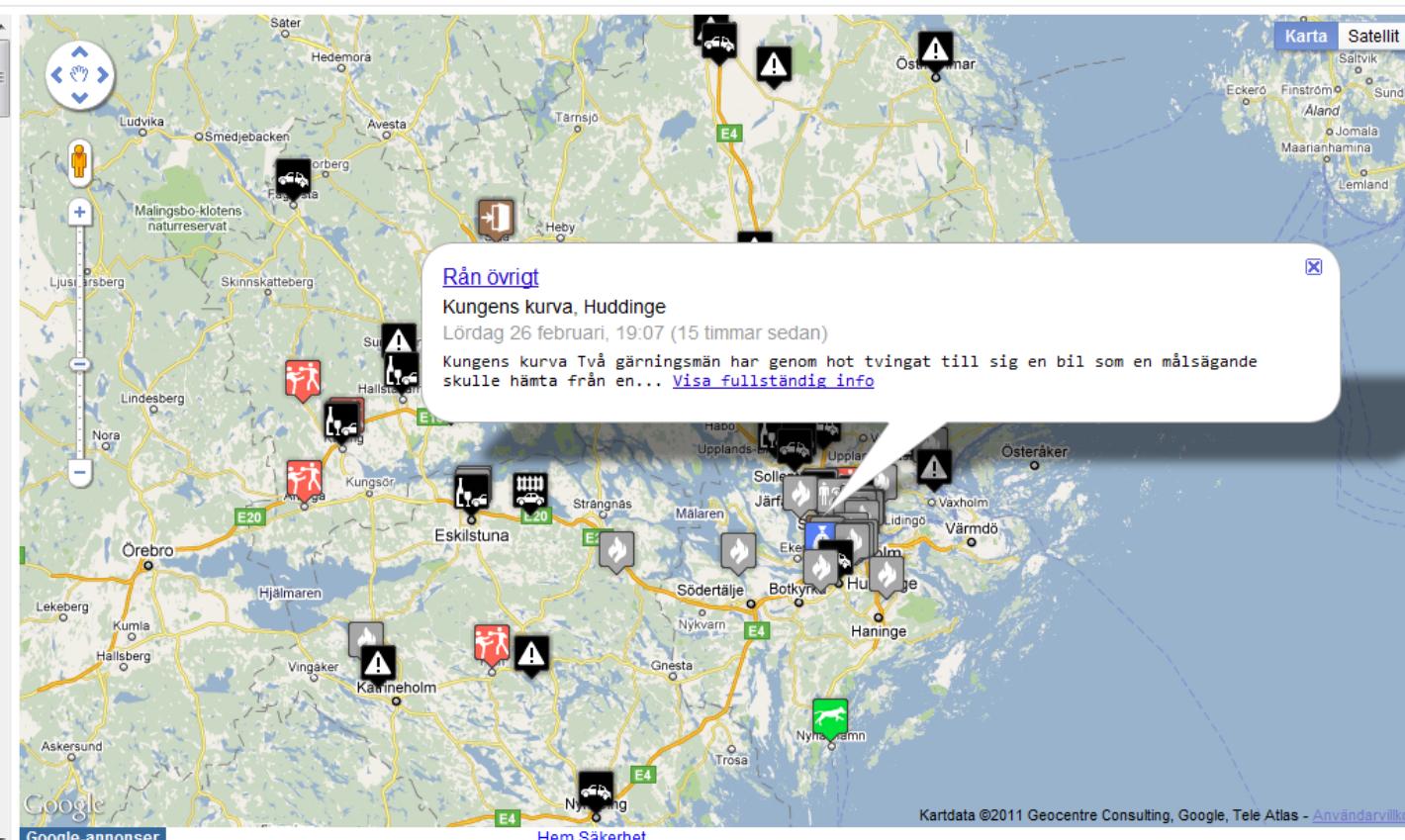
DELA Flattr this! Recommend 282

1 dag | 3 dagar | 7 dagar | 30 dagar | Alla typer

83 händelser:

- Brand** Götgatan, Stockholm  
Sön 27 feb, 09:27 (1 timme sedan) [Visa »](#)
- Rattfylleri** Hultgrensgatan, Köping  
Sön 27 feb, 09:00 (1 timme sedan) [Visa »](#)
- Kontroll person/fordon** Hamngatan, Sundbyberg  
Sön 27 feb, 08:19 (2 timmar sedan) [Visa »](#)
- Skadegörelse** Västerås  
Sön 27 feb, 08:00 (2 timmar sedan) [Visa »](#)
- Brand** Länna Norrvywagen, Norrtälje  
Sön 27 feb, 07:54 (3 timmar sedan) [Visa »](#)
- Övrigt** Uppsala län  
Sön 27 feb, 07:42 (3 timmar sedan) [Visa »](#)
- Sammanfattning natt** Södermanland  
Sön 27 feb, 06:22 (4 timmar sedan) [Visa »](#)
- Skadegörelse** Patrull, Västerås  
Sön 27 feb, 04:28 (6 timmar sedan) [Visa »](#)

**Rån övrigt**  
Kungens kurva, Huddinge  
Lördag 26 februari, 19:07 (15 timmar sedan)  
Kungens kurva Två gärningsmän har genom hot tvingat till sig en bil som en mälsägande skulle hämta från en... [Visa fullständig info](#)

The map displays various crime incidents marked with icons such as a car, a person, a flame, and a warning sign. Labels on the map include Säter, Hedemora, Tärnström, Österåker, Ekerö, Finström, Sund, Aland, Jomala, Maarianhamina, Lemland, Ludvika, Smedjebacken, Borlänge, Fagersta, Heby, Malingsbo-klotrens naturreservat, Skinnskatteberg, Ljusnarsberg, Hallstahammar, Su, Kungsör, Eskilstuna, Strängnäs, Mälaren, Habo, Upplands-Bro, Söderköping, Botkyrka, Haninge, Växholm, Värmdö, Järfälla, Sollentuna, Upplands-Väsby, Österåker, Askeröd, Kumla, Hallsberg, Lekeberg, Askersund, Vingåker, Karlskrona, Nyköping, Trosa, Nynäshamn, and Älvkarleby.

Google-annonser

Hem Säkerhet

Kartdata ©2011 Geocentre Consulting, Google, Tele Atlas - [Användarvillkor](#)

# GIS example 2

Geodataportalen 

www.geodata.se/GeodataExplorer/index.jsp

Freja och Embla - iGoogle SY Synonymer.se - Lexi... Språkrådet - Lexin xda-developers Android Developers Metasploit Unleashes...

Other bookmarks

Sökpanel

**Geodata**  
SVERIGE BIT FÖR BIT

Välkommen Hans Jones

Fritextsökning...

Sök Rensa Visa Enkel Utökad

Ämne Ansvarig Resurstyp

Ordningsföljd på kategorier se (nedan)

- » Ämne
- » Ansvarig
- » Resurstyp

Kategorier att söka på

- Positionering
- Samhälle
- Transporter
- Ej angivet
  - Botkyrka kommun
  - Göteborgs stad Stadsbyggnadskontore
  - Lantmäteriet
  - Naturstyrelsen
  - Naturvårdsverket
  - Riksantikvarieämbetet
  - SCB
    - Tjänst
    - SMHI
    - Sveriges geologiska undersökning

Koordinater Tidsbaserade

Sök ortnamn

www.geodata.se/GeodataExplorer/index.jsp#

**Resultat**

Lägg förfrågan Visa förfrågan Karta Hjälp

Länkar	Titel
	Småorter
	B3: Befolning efter civilstånd
	IB7: Befolning (20+ år) efter disponibel inkomst
	B1: Befolning efter ålder
	Tätorter
	A4: Förvärvsarbetande Dagbefolkning (16+ år)
	IF1: Familjer efter förvärvsinkomst (20+ år)
	Fritidshusområden

Producent: SCB

Länk:  
[http://www.gis.scb.se/b/cgi-bin/mapserv.exe?map=pp%2Fscb\\_wms%2FFritidshusomraden.map&](http://www.gis.scb.se/b/cgi-bin/mapserv.exe?map=pp%2Fscb_wms%2FFritidshusomraden.map&)

**Sammanfattning:**  
Fritidshusområden är koncentrationer av fritidshus med minst 50 fritidshus och högst 150 meter mellan husen. De avgränsas för områden utanför tätorter. SCB avgränsar polygoner för fritidshusområden och beräknar sedan statistik för dessa utgående från registerdata. De kan överlappa småorter. Nyckelord 2.3 Områdesindelning för statistiska undersökningar

Länkar	Titel
	Arbetsplatssområden utanför tätorter
	B6: Befolning efter födelseland
	A9: Befolning (25-64 år) efter utbildning
	B7: Befolning efter flyttning
	A2: Förvärvsarbetande Nattbefolkning (20-64 år)
	B2: Befolning efter kön
	A7: Befolning (20-64 år) efter sysselsättning

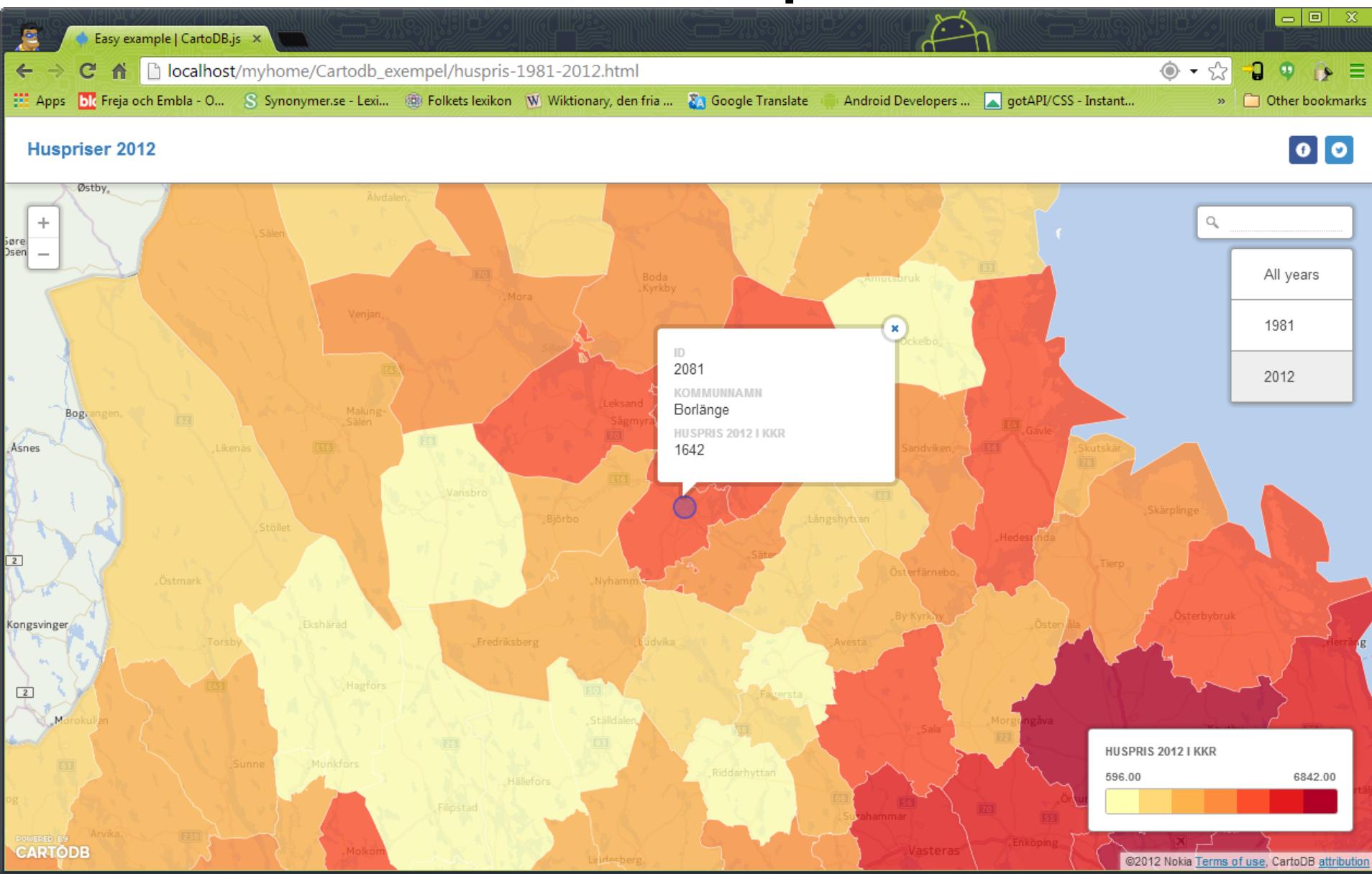
Karta

1 : 5805369



Visar resultat 1 - 15 av 15

# GIS example 3



# General GIS Concepts 2

- **Tabular Data**
  - Tabular data consists of ***attribute tables*** that define the parameters of the map features
  - There is really no limit to what the tables can contain, whether boolean values, text, or numeric data
    - A text entry may have the city's name, or some other description etc.
    - A numeric entry could have population figures, lat/long coordinates or date time
  - The advantage of the relational database system is that the different columns can be sorted and selected according to the user's need
    - These selections then appear highlighted on the map

# General GIS Concepts 3

- **Spatial Data**
  - Spatial data places the features on the map
  - The coordinates of a point are the most obvious example of this, but it also incorporates projection systems, line and polygon attributes, and other information
  - There are two main classes of spatial data: **vector** and **raster**
  - If not DBMS is spatially enabled (support for spatial data types and functions) data is usually stored in the database as a “BLOB” (Binary Large OBject)
    - BlobDataName varBinary(n)

# General GIS Concepts 4

- **Spatial Vector Data**
  - Most work developers do in GIS is based on vector data
  - This system of recording features is based on the interaction between arcs and nodes, represented by ***points, lines (or polylines), and polygons***
  - A point is a single node, a line is two nodes (points) with an arc between them (a polyline got more than 2 nodes), and a polygon is a closed group of three or more arcs
  - With these three elements, it is possible to record most or all necessary information

# General GIS Concepts 5

- **Spatial Raster Data**

- Raster data is characterized by pixel values
- Basically, a raster file is a giant table, where each pixel is assigned a specific value from 0 to 255
- The meaning behind these values is specified by the user, they can represent elevations, temperatures, water, etc.
- Raster data is advantageous to vector data in constructing 3D images, as the values for every pixel are calculated through a process called ***interpolation*** – for example: oceans in Google Earth
- Can be images as well (raster images), .jpg, .tif etc.

# General GIS Concepts 6

- **Layer** – A slice of the geography of a particular area. On a paper map, one layer could be the roads, another could be water, another could be places of interest etc.
- **Base Map** – A layer that lends context to your data
- **Geocoding** – Converting street addresses etc. into spatial data that can be displayed on a map (usually latitude and longitude)
  - Reverse geocoding is more or less **Geolocation**
- **Shapefiles** – A data format that stores a particular geographic feature of a certain area and is almost the de-facto standard
- **KML/KMZ** – an XML based language schema for expressing geographic visualization. It is an official open standard for all geobrowsers
- **Projection** – transformation of a map from a spherical object with a certain "camera view" to a flat sheet of paper

KML - Google Code

code.google.com/apis/kml/

Freja och Embla · iGoogle · Synonymer.se - Lexi... · Språkrådet - Lexin · xda-developers · Metasploit Unleashe... · Other bookmarks · My favorites · English · Sign in

# Google code

e.g. "adwords" or "open source"

Search

## KML

Home Docs FAQ Articles Blog Forum

### What is KML?

KML is a file format used to display geographic data in an Earth browser, such as Google Earth, Google Maps, and Google Maps for mobile. You can create KML files to pinpoint locations, add image overlays, and expose rich data in new ways. KML is an international standard maintained by the [Open Geospatial Consortium, Inc. \(OGC\)](#).

Google Earth 6 supports elements in the Google extension namespace. These elements include [dual-colored line strings](#), [GPS tracks](#), [underwater altitude modes](#), [time support for AbstractViews](#), and [touring](#). [Download](#) Google Earth 6 now!

### Who uses KML?

**Casual users**  
Placemark homes, plan and document journeys.  
[Everytrail Half Dome Hike](#)

**Scientists**  
See detailed mappings of natural resources and trends.  
[USGS Earthquakes](#)

**Non-Profits**  
Highlight problems and advocate change.  
[Crisis in Darfur](#)

**Students and Educators**  
Explore historic and current places, people and events.  
[City of London Timeline](#)

### How do I start?

1. Learn the [basics of KML](#).
2. Explore the [Developer's Guide](#).
3. Try out the [KML Interactive Sampler](#).
4. Find more answers in the [KML Reference](#).

### Featured Project

[2010 Hurricane Season Visualization](#)



by [Geodesic Development](#)

## View KML in Google Earth (Maps) and Mobile

<http://code.google.com/apis/kml/documentation/whatiskml.html>

# KML (Keyhole Markup Language) vs. ESRI Shapefile

- 3 shapefiles are mandatory, may contain optional files as: prj, xml, sbx/sbn, ...
  - **.shp** - shape format; the feature geometry itself
  - **.shx** - shape index format; a positional index of the feature geometry to allow seeking forwards and backwards quickly
  - **.dbf** - attribute format; columnar attributes for each shape, in dBase III format
  - Each shape record index in a file correspond to other files records in sequence
  - [http://en.wikipedia.org/wiki/ESRI\\_shape](http://en.wikipedia.org/wiki/ESRI_shape)
- KML, KMZ = Zipped KML
  - XML based file
  - Placemark – point
  - Path – line
  - Polygon
  - Images (3D)
  - Etc.

```
<?xml version="1.0" encoding="UTF-8"?>
<kml xmlns="http://www.opengis.net/kml/2.2">
<Placemark>
  <name>New York City</name>
  <description>New York City</description>
  <Point>
    <coordinates>-74.006393,40.714172,0</coordinates>
  </Point>
</Placemark>
</kml>
```

<http://code.google.com/apis/kml/documentation/>

[http://en.wikipedia.org/wiki/Keyhole\\_Markup\\_Language](http://en.wikipedia.org/wiki/Keyhole_Markup_Language)

Shp2kml, kml2shp, online KML Toolbox  
<http://www.zonums.com/>

# ShapeUp GIS tool

Base map

Tabular data

The screenshot displays the ShapeUp GIS tool interface. On the left, the 'Themes' panel lists several layers: 'blg\_wgs.shp' (selected), 'C:\data\NMC\shapeup\g', 'C:\data\NMC\shapeup\g', 'C:\data\NMC\shapeup\g', and 'C:\data\NMC\shapeup\g'. The main workspace shows a base map with blue lines representing water bodies and land parcels. Overlaid on this are several colored lines (red, yellow, green) representing spatial vector data, which appear to be projections or specific paths. A legend in the top right corner identifies these colors. In the bottom right, a table titled 'Attributes' shows tabular data with columns for Date/Time, Coordinates, Statistics, Bookmarks, and Fields 1 through 4. One row in the table is highlighted with a red box, corresponding to a specific point on the map. The bottom status bar indicates coordinates (15.363865, 60.490813) and a projection (WGS 84).

ShapeUp - [ShapeUp3.sup]

File Edit View Insert Theme Table Tools Window Help

Themes

- blg\_wgs.shp
- C:\data\NMC\shapeup\g
- C:\data\NMC\shapeup\g
- C:\data\NMC\shapeup\g
- C:\data\NMC\shapeup\g

1:24513

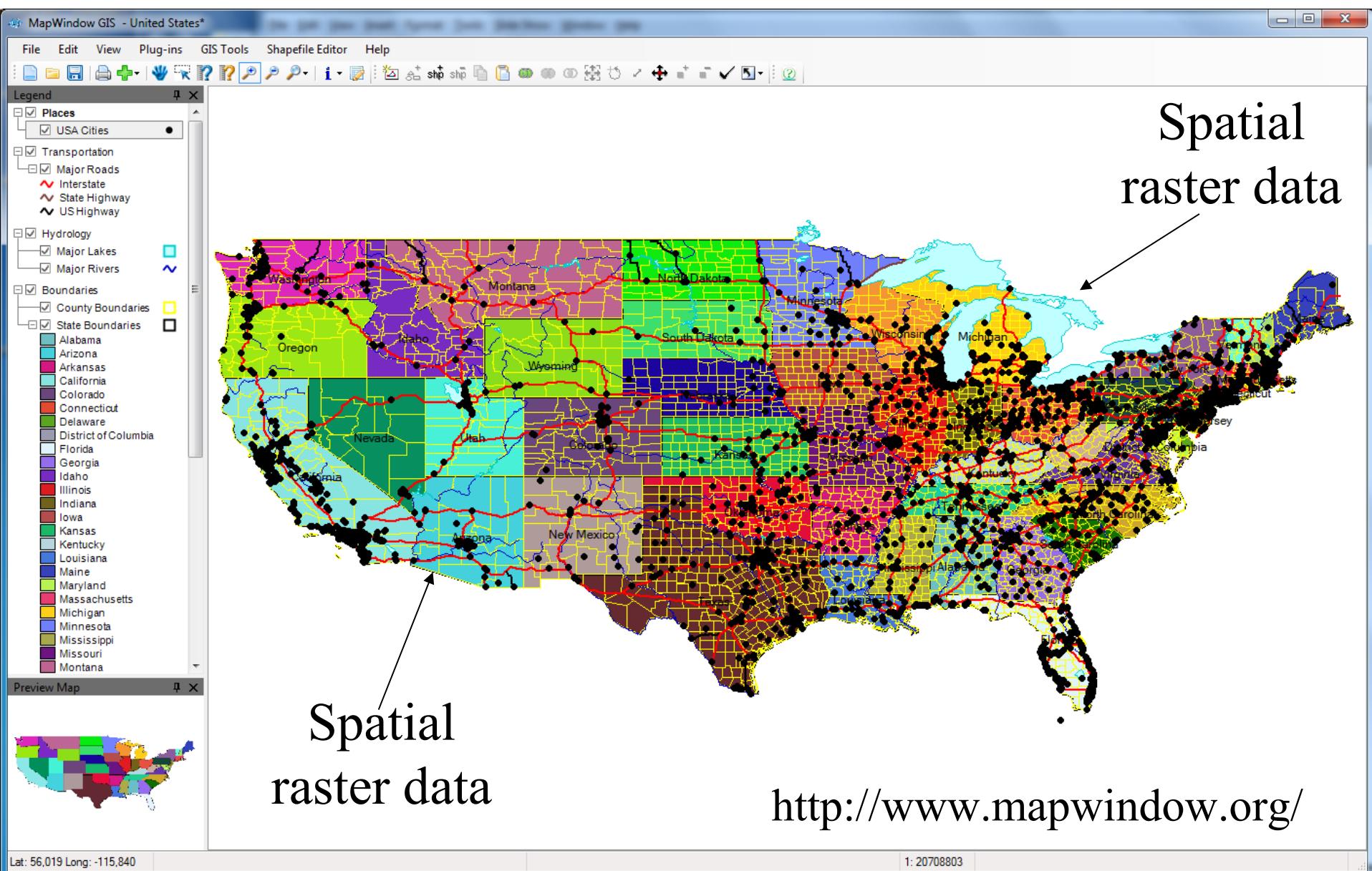
Attributes Coordinates Statistics Bookmarks

Field 1	Field 2	Field 3	Field 4	Field 5
2008-11-13 20:17:55	92.241.204.254	15.39405...	60.49113...	hjo
2008-11-13 20:17:53	92.241.204.254	15.39425...	60.49138...	hjo
2008-11-13 20:17:51	92.241.204.254	15.39447...	60.49161...	hjo
2008-11-13 20:17:48	92.241.204.254	15.39484...	60.49197...	hjo
2008-11-13 20:17:45	92.241.204.254	15.39531...	60.49233...	hjo
2008-11-13 20:17:41	92.241.204.254	15.39588...	60.49266...	hjo
2008-11-13 20:17:38	92.241.204.254	15.39674...	60.49309...	hjo
2008-11-13 20:17:34	92.241.204.254	15.39722...	60.49328...	hjo
2008-11-13 20:17:32	92.241.204.254	15.39856...	60.49373...	hjo
2008-11-13 20:17:26	92.241.204.254	15.39909...	60.49390...	hjo
2008-11-13 20:17:24	92.241.204.254	15.40006...	60.49427...	hjo
2008-11-13 20:17:20	92.241.204.254	15.40048...	60.49448...	hjo
2008-11-13 20:17:18	92.241.204.254	15.40134...	60.49491...	hjo
2008-11-13 20:17:14	92.241.204.254	15.40172...	60.49508...	hjo
2008-11-13 20:17:11	92.241.204.254	15.40190...	60.49515...	hjo
2008-11-13 20:17:11	92.241.204.254	15.40204...	60.49523...	hjo
2008-11-13 20:17:09	92.241.204.254	15.40207...	60.49539...	hjo
2008-11-13 20:17:07	92.241.204.254	15.40198...	60.4954809	hjo
2008-11-13 20:17:06	92.241.204.254	15.40162...	60.49565...	hjo
2008-11-13 20:17:03	92.241.204.254	15.40100...	60.49595...	hjo
2008-11-13 20:17:00	92.241.204.254	15.40061...	60.49619...	hjo
2008-11-13 20:16:58	92.241.204.254	15.40022...	60.49644...	hjo
2008-11-13 20:16:57	92.241.204.254	15.40002...	60.4965806	hjo
2008-11-13 20:16:55	92.241.204.254	15.3996402	60.49684...	hjo
2008-11-13 20:16:53	92.241.204.254	15.39945...	60.4969883	hjo
2008-11-13 20:16:51	92.241.204.254	15.39891...	60.49742...	hjo
2008-11-13 20:16:49	92.241.204.254	15.39853...	60.49771...	hjo
2008-11-13 20:16:46	92.241.204.254	15.39812...	60.49800...	hjo
2008-11-13 20:16:45	92.241.204.254	15.39791...	60.49813...	hjo
2008-11-13 20:16:43	92.241.204.254	15.39701...	60.49866...	hjo
2008-11-13 20:16:39	92.241.204.254	15.39679...	60.49878...	hjo
2008-11-13 20:16:38	92.241.204.254	15.30557	60.49880	hjo

Ready

15.363865 60.490813 WGS 84

# MapWindow GIS tool



# QGIS GIS tool



- Probably the most open and best free GIS tool

The screenshot displays the QGIS interface. On the left, the 'Layer Properties - Pano\_Lines | Style' dialog is open, showing settings for a 'Single Symbol' style. It includes options for Unit (Millimeter), Transparency (0%), Width (0.05000), Color, and a 'Symbols in group' section with various line patterns like Bridlew, Canal, and Cycle. Below this is the 'Select Color' dialog, which shows a color picker and numerical controls for Hue, Red, Green, Blue, Saturation, and Alpha channel. The main window shows a grayscale topographic map with contour lines. A URL 'http://www.qgis.org/' is overlaid on the map.

Layer Properties - Pano\_Lines | Style

General

Style

Labels

Fields

Rendering

Display

Actions

Joins

Diagrams

Metadata

Unit: Millimeter

Transparency: 0%

Width: 0.05000

Color:

Symbols in group: [Open Library]

Line

Simple line

Bridlew Canal Canal Constr Crossir Cycle |

Dam Ditch Drain Floodw Footpa Jetty

Layer rendering

Layer transparency: 0

Load Style ... Save As Default Restore Default Style Save Style Advanced

OK Cancel Apply Help

Select Color

Basic colors

Custom colors

Hue: 0 Red: 148  
Sat: 0 Green: 148  
Val: 148 Blue: 148  
Alpha channel: 200

OK Cancel

Toggles the editing state of the current layer

Coordinate: 226270,347968 Scale: 1:177,246 Render: USER:100001

<http://www.qgis.org/>

# Vector vs. Raster

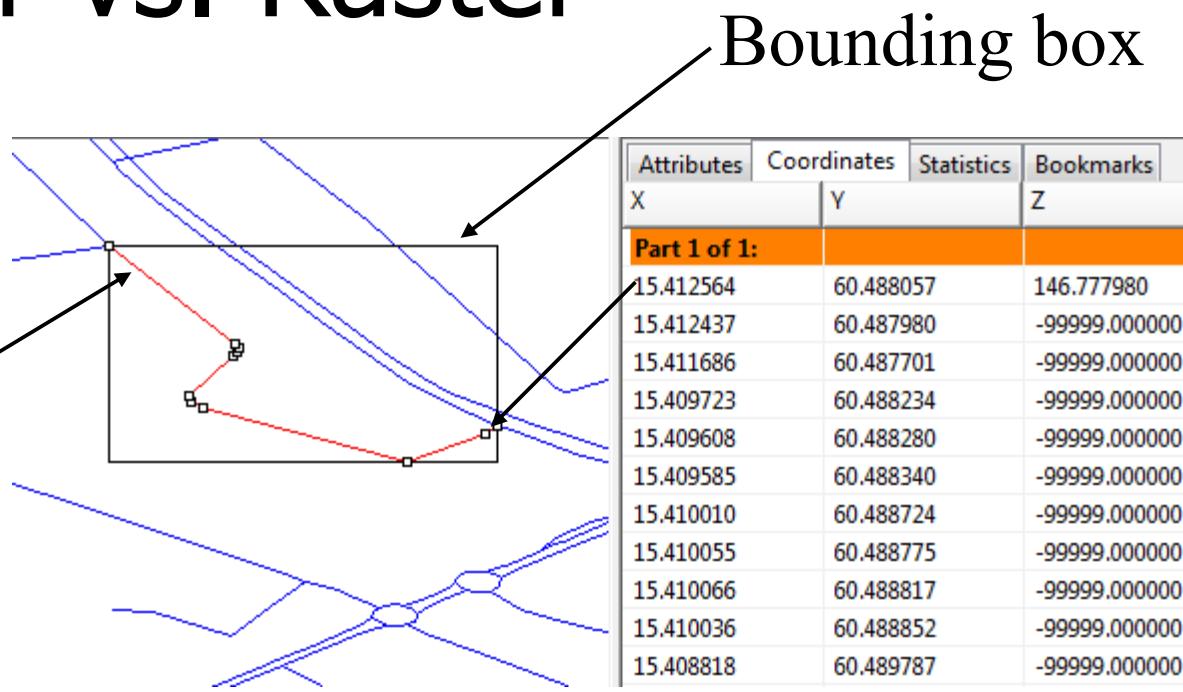
- ShapeUp
  - .shp

raster representation

A	A	A	A	0	0	0	0
A	A	A	A	A	0	0	0
A	A	A	A	0	B	0	0
A	A	A	A	0	0	0	0
A	A	A	0	0	0	C	C
0	0	0	0	0	C	0	0
C	C	C	C	C	0	0	0
0	0	0	0	0	0	0	0

Arc

pixel	value
1	A
2	A
3	A
4	A
5	0
6	0
7	0
8	0
9	A
10	A
11	A
12	A
13	A
14	0
15	0
16	0
.	.
.	.
62	0
63	0
64	0



raster representation

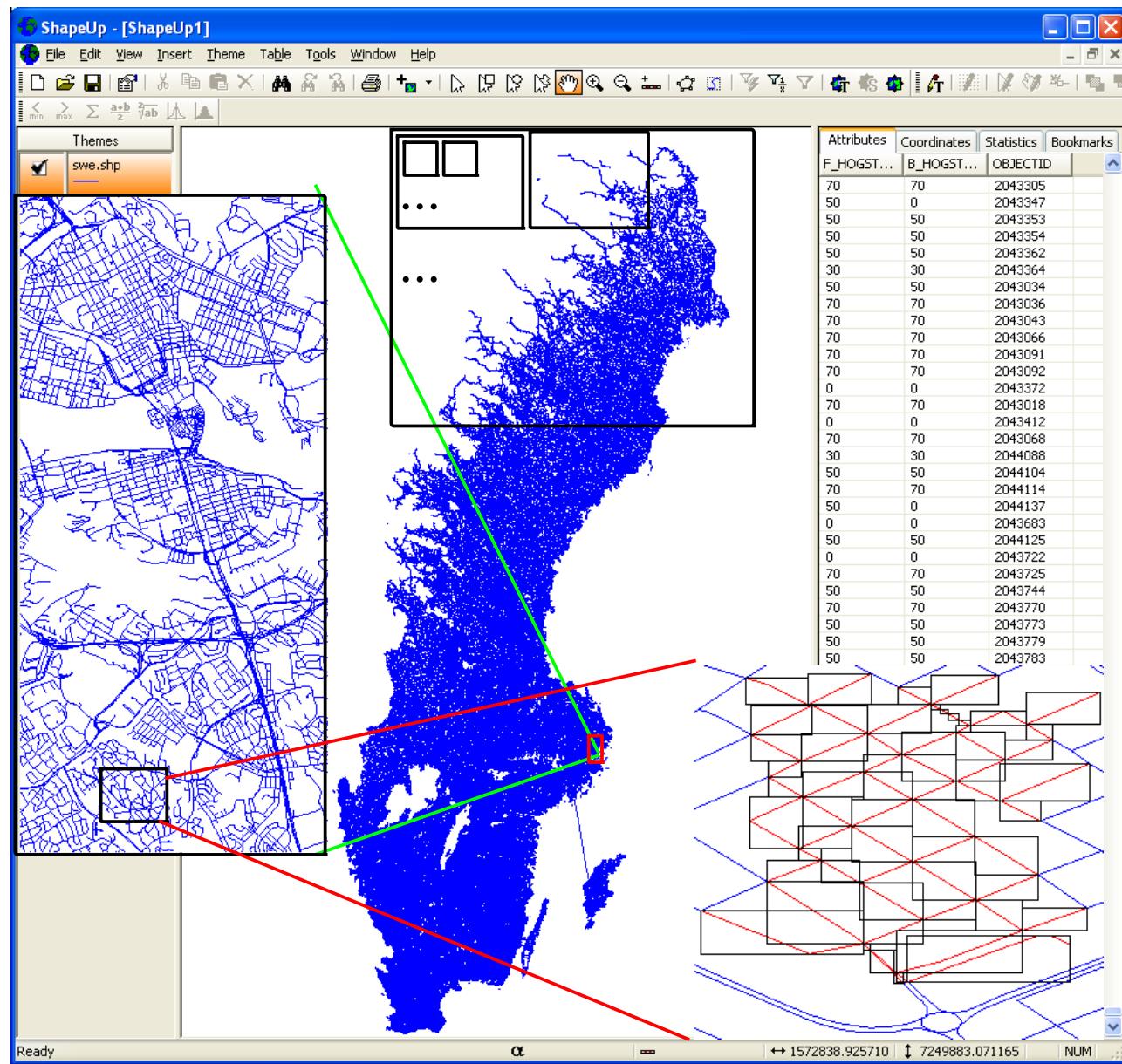
A	A	A	A	0	0	0	0
A	A	A	A	A	0	0	0
A	A	A	A	0	B	0	0
A	A	A	A	0	0	0	0
A	A	A	0	0	0	C	C
0	0	0	0	0	C	0	0
C	C	C	C	C	0	0	0
0	0	0	0	0	0	0	0

Run-length encoded raster

A,	4	0,	8
A,	5	0,	8
A,	4	0,	5
A,	4	0,	8
A,	3	0,	6
0,	5	C,	6
C,	5	0,	8
0,	8		

# Spatial index and Geolocation

- Swedish roads =  $2.1 \times 10^6$  polylines
- Makes queries on vector data very fast!
- Usually 3 or 4 spatial levels is followed by a bounding box
- Selection is made upon best probability of a candidate according to a certain algorithm





# Google Earth

The screenshot shows the Google Earth application window. On the left, there are four panels: a Search Panel, a Places Panel, a Transparency Control and Play Tour panel, and a Layers Panel. The main area is the 3D Viewer showing a satellite view of Europe. Navigation controls are located on the right side of the viewer. Callout boxes with arrows point from the labels to their respective parts of the interface.

Labels and their corresponding components:

- Search Panel: Points to the search bar in the top-left corner of the interface.
- Places Panel: Points to the "Platser" (Places) panel on the left, which lists saved locations like "Mina platser" and "blg-leksand".
- Transparency Control and Play Tour: Points to the "Lager" (Layers) panel on the left, which includes options for "Geografi på webben" (Web Geography) and "Vägar" (Roads).
- Layers Panel: Points to the "Lager" (Layers) panel on the left, listing various geographical layers such as "Geografi på webben", "Vägar", "3D-byggnader", "Gatuvy", "Gränser och etiketter", "Trafik", "Väder", "Galleri", "Ocean", "Global Awareness", "Intressanta platser", "Mer", and "Terräng".
- Toggle Sidebar: Points to the "Toggle Sidebar" button in the top menu bar.
- 3D Viewer: Points to the central 3D globe view of the Earth.
- Navigation Controls: Points to the navigation controls on the right side of the viewer, including zoom and orientation buttons.

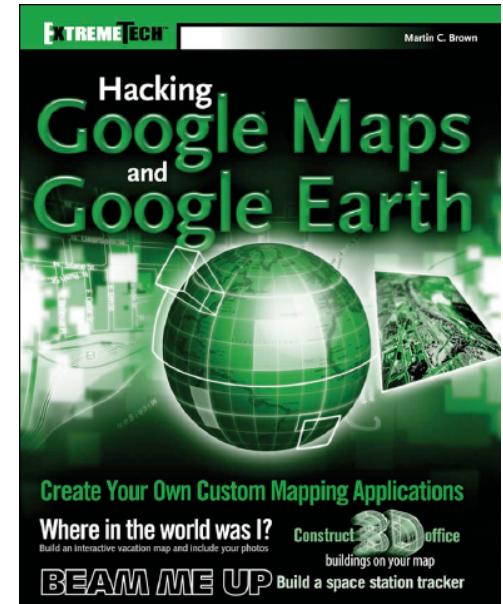
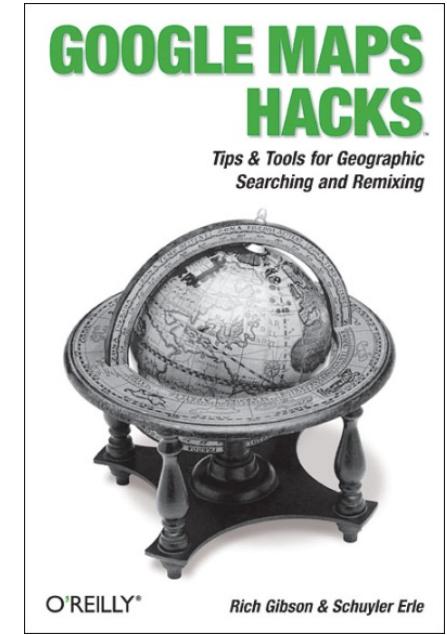
# Google Maps API etc.

- Maps API and sign up for API key etc.
  - Maps JavaScript API currently in version 3
  - Static Maps API
  - <https://developers.google.com/maps/>
- Further reading
  - <http://googlemapsmania.blogspot.com/>
  - <http://www.postneo.com/2007/09/10/google-maps-geoxml-crash-course>
- Test Google API functions
  - <http://hobbiton.thisside.net/advmap.html>
  - <http://koti.mbnet.fi/ojalesa/exam/index.html>



GPSBabel converts waypoints, tracks, and routes between popular GPS receivers and mapping programs

<http://www.gpsbabel.org/>



# View on a map

Personal GPS Tracker - Windows Internet Explorer  
http://users.du.se/~hjo/lbs/latng/wpt\_track.html

Personal GPS Tracker (click on a pushpin to see more detail) Refresh

[#4] WPT4  
Datetime: 2007/02/14 17:17:02  
GPS: 60.4903 / 15.4089  
Speed: 67.0 km/h  
Direction: 151.0 deg  
Altitude: 141.0 m

Karta Satellit Hybrid

5 decimals degrees (0.00001)  
give the precision  
Long/X: 0,88 meters  
Lat/Y: 1,11 meters

POWERED BY Google 2 mi 2 km Floda

Kartdata ©2008 Tele Atlas - AnyÄndringar saknas

GPS Data (scroll to view)

#	Code	Date/Time	Lat/Long	km/h	Dir	Alt
1	WPT1	2007/02/14 17:14:41	60.4884/15.3886	3.0	116.0	168.0
2	WPT2	2007/02/14 17:15:03	60.4886/15.3912	39.0	106.0	173.0
3	WPT3	2007/02/14 17:16:03	60.4939/15.3994	58.0	54.0	158.0
4	WPT4	2007/02/14 17:17:02	60.4903/15.4089	67.0	151.0	141.0

Done Internet | Protected Mode: Off 100%

# The Geospatial Desktop

From Google Maps to iPhone apps, geographic data and visualization is quickly becoming a standard part of life.

The Geospatial Desktop (former Desktop GIS) shows you how to assemble and use an Open Source GIS toolkit. You'll find strategies for choosing a platform, selecting the right tools, integration, managing change, and getting support.

You'll get a good introduction to using the many tools available so you can visualize, digitize, and analyze your own mapping data.

<http://geospatialdesktop.com/>



## Desktop GIS

Mapping the Planet  
with Open Source Tools



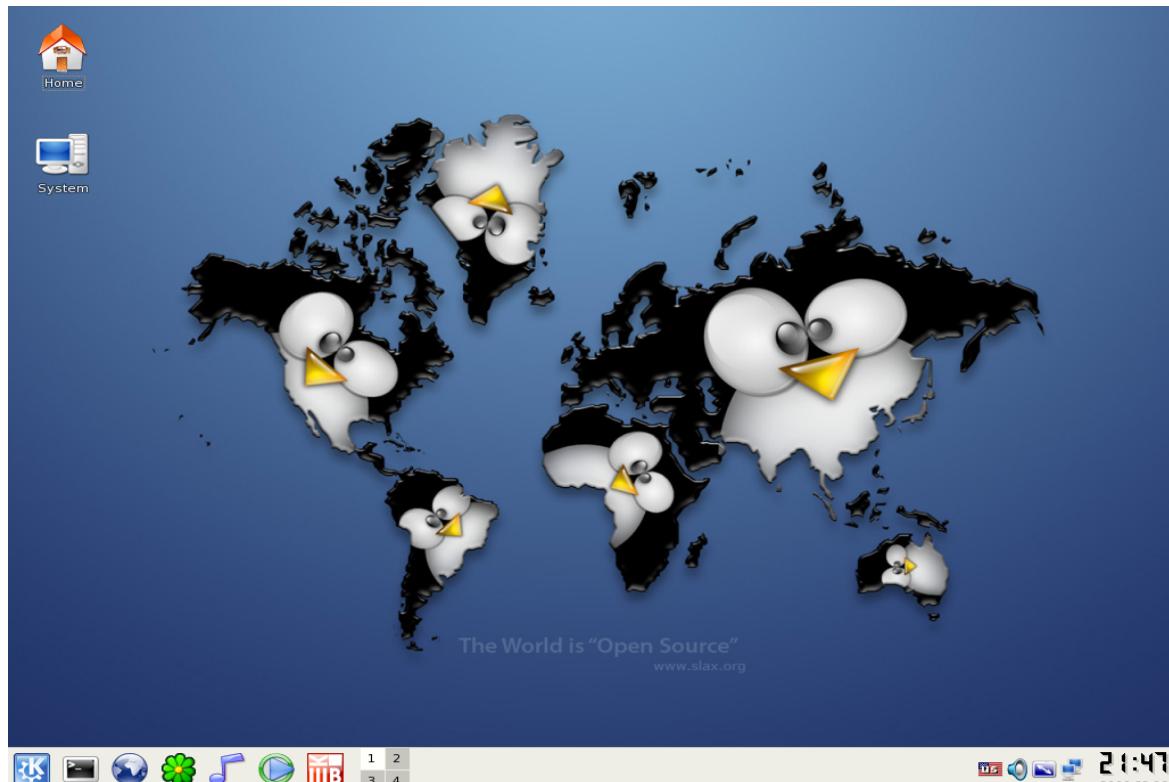
Gary E. Sherman

# VigerGIS

VigerGIS is a collection of GIS software packages which you can run from a VM as VirtualBox

slaxGIS includes the following software:

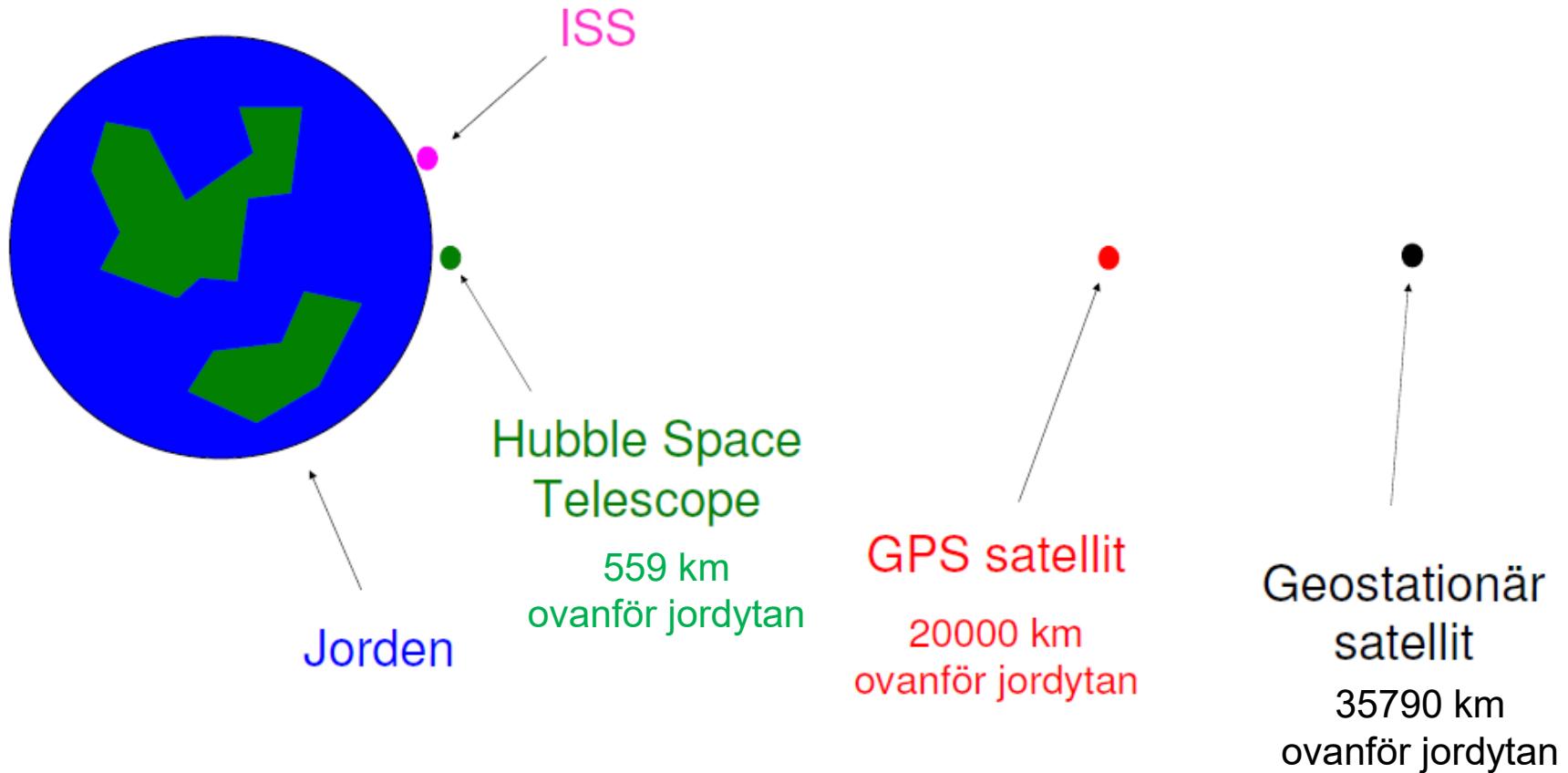
- MapServer
- OpenLayers
- uDig
- OpenJUMP PIROL
- PostgreSQL
- PostGIS
- Grass
- ...

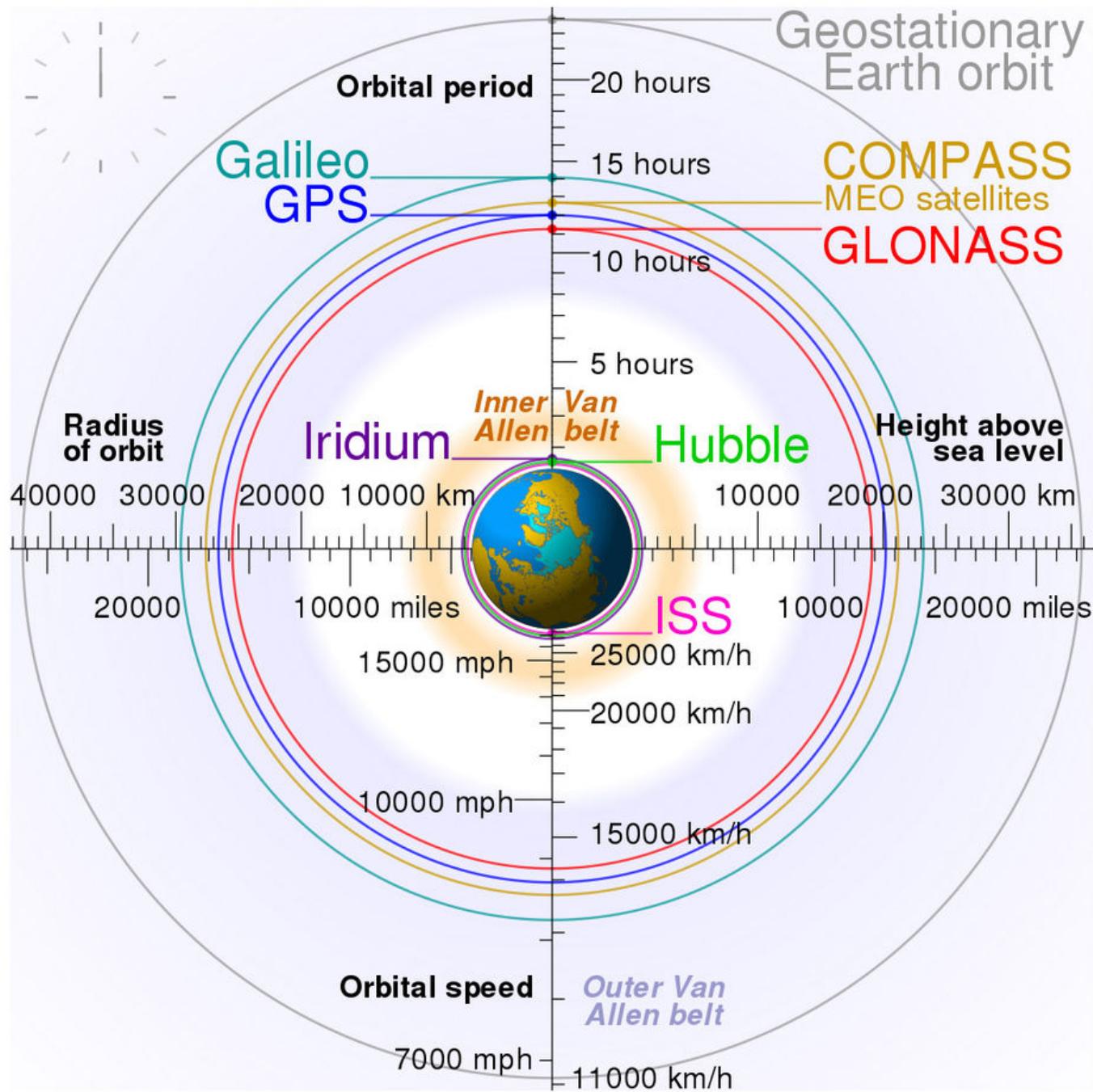


<http://geomatica.como.polimi.it/software/vigerGIS/index.php?lang=en>

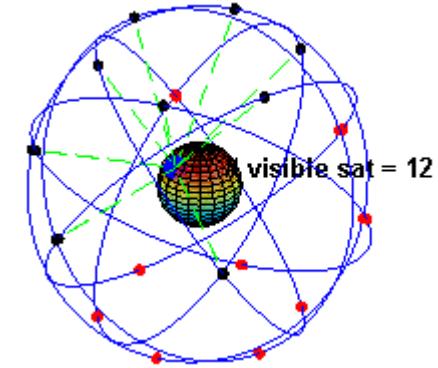
# Satellitbaserade positioneringssystem

- [http://sv.wikipedia.org/wiki/Geostation%C3%A4r\\_omloppsbana](http://sv.wikipedia.org/wiki/Geostation%C3%A4r_omloppsbana)

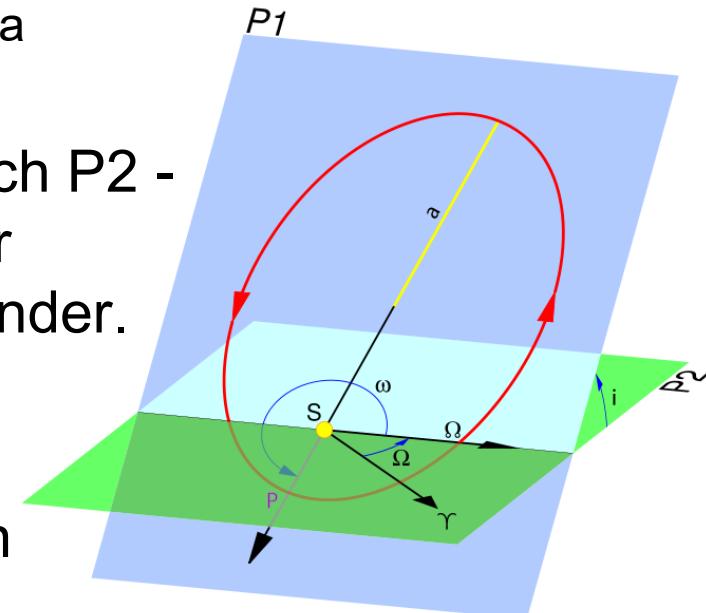




# Satellitbaserade positioneringssystem



- Interactive Satellite Tracker - Science @ NASA
  - <http://science.nasa.gov/iSat/>
- Global Navigation Satellite Systems (GNSS)
  - GPS (Global Positioning System), USA
  - GLONASS (GLObal Navigation Satellite System), Ryssland
  - Compass (Beidou Navigation System), Kina
  - Galileo, (efter Galileo Galilei), EU mfl.
- Inklinationen (vinkel "i" mellan P1 och P2 - tilt relativt ekvatorn) är den latitud där satelliternas banor (6 st. för GPS) vänder. Över denna latitud (ca: 55° för GPS) minskar noggrannheten
- <http://en.wikipedia.org/wiki/Inclination>



# GPS

- Tänkt som ett militärt system från början, störnings signal borta 2000
- Första satelliten skickades upp 1978
- 1994 hade alla 24 satelliter samt tre reservsatelliter skickats upp
- För närvarande (dec 2012) 32 satelliter
- En ny per år har sänts upp 2010 - 2013
- Noggrannheten är ca: 2 - 8 m (stand alone)
- Inklination, 55 grader
- [http://en.wikipedia.org/wiki/Global\\_Positioning\\_System](http://en.wikipedia.org/wiki/Global_Positioning_System)

# GLONASS

- Startade 1982 som ett militärt projekt, fritt 2007
- Alla 24 satelliterna i omlopp 1996, sedan sönderfall
- För närvarande (2013) är 29 satelliter i bruk
- Noggrannhet 4 – 8 m, bättre närmare polerna än GPS
- Kraftig restaurering sedan 2010  
vilket pågår ännu
- Så här har ryska försvarets  
apparater sett ut...  
Förmodligen kan den köras  
över med stridsvagn ☺
- Inklination, 64.8 grader över 3  
omloppsbanor
- <http://en.wikipedia.org/wiki/GLONASS>



# GALILEO

- Första testsatelliten skickades upp 2005 (första skarpa 2011)
- Alla 30 satelliterna (inklusive tre i reserv) planeras vara uppe 2020
  - 18 st. uppe hittills (dec -16)
  - Finansieringsproblem
- Utlovar (mycket) bättre noggrannhet än GPS
- Förmodas ge 150 000 nya jobb i Europa
- Kompatibelt med GPS och GLONASS
- Inklination, 56 grader
- 3 omloppsbanor (9 st. + 1 reserv per bana)
- [http://en.wikipedia.org/wiki/Galileo\\_\(satellite\\_navigation\)](http://en.wikipedia.org/wiki/Galileo_(satellite_navigation))



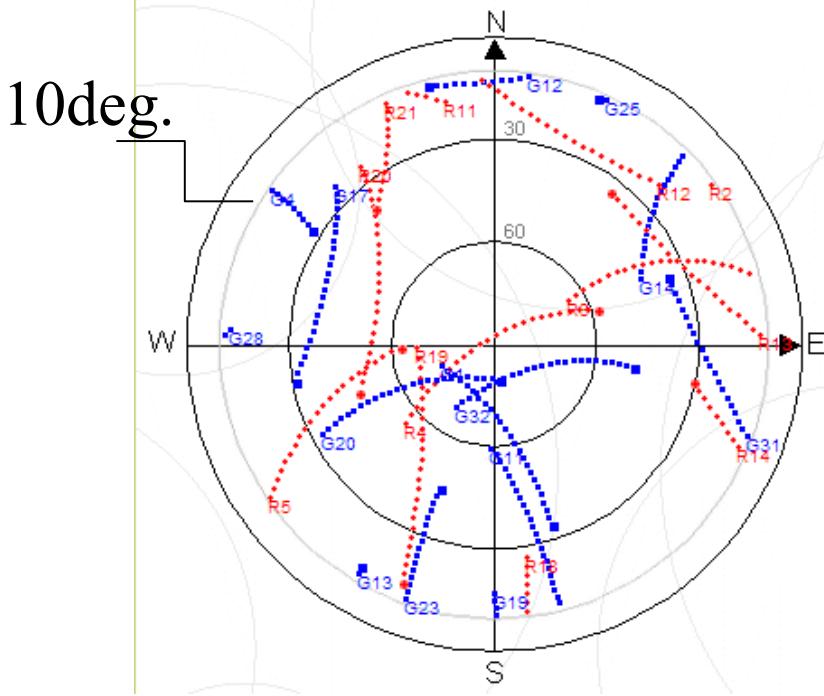
# BeiDou Navigation Satellite System

- BeiDou 1
  - Tänkt som ett militärt system från början men är öppet från 2008 ->
  - Första satelliten skickades upp 2000
  - 2007 hade 5 satelliter skickats upp
  - Satelliterna befinner sig i geostationär bana ca: 35000 km över jordytan
  - Noggrannheten är ca: 10 m
- BeiDou 2
  - Globalt system med 35 satelliter, 10 st. uppe 2011
  - Fungerar i asien sedan dec 2012, ska vara klart 2020
- [http://en.wikipedia.org/wiki/Beidou\\_Navigation\\_Satellite\\_System](http://en.wikipedia.org/wiki/Beidou_Navigation_Satellite_System)

# Precision och tillgänglighet

- 1D (no fix), 2D or 3D Fix
  - At least 4 satellites is necessary to have a 3D position fix
- Satellitprediktering
  - <http://swepos.lmv.lm.se/predop/in.asp>

"Skyplot" för satelliter med elevationsvinkel större än 10°  
Stor prick anger satellitpositionen för sluttiden  
GPS = G GLONASS = R



## Stationsinformation

### Koordinater

Geografiska: 60°29' N, Lon=15°27' E

### Datum/Tid

Startdatum = 2013-12-11, GPS-dag=345, GPS-vecka=1770, Svensk tid: 13:00 - 15:00

### Övrigt

Intervall: 5min. Elevationsmask: 10°

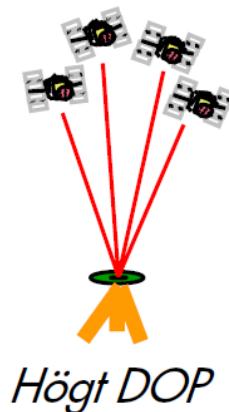
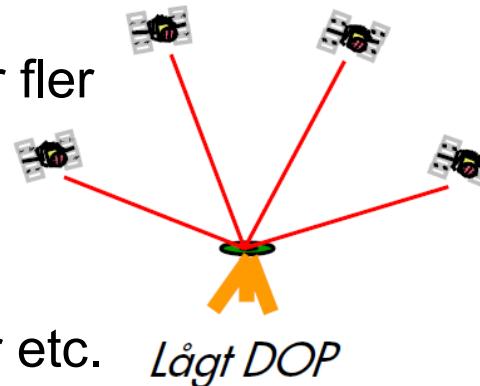
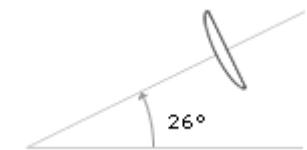
## Antal satelliter samt PDOP vid en elevationsvinkel större än 10°

Tid	GPS	GLONASS	PDOP
13:00	16 (8/8)		1,2
13:05	15 (8/7)		1,3
13:10	14 (7/7)		1,3
13:15	15 (7/8)		1,2
13:20	16 (7/9)		1,1
13:25	15 (7/8)		1,3
13:30	15 (7/8)		1,3
13:35	14 (7/7)		1,5
13:40	14 (7/7)		1,6
13:45	15 (8/7)		1,4
13:50	15 (8/7)		1,4
13:55	15 (8/7)		1,4
14:00	18 (8/8)		1,3
14:05	17 (9/8)		1,3
14:10	17 (9/8)		1,3
14:15	17 (9/8)		1,4
14:20	19 (10/9)		1,2
14:25	19 (10/9)		1,2
14:30	19 (10/9)		1,2
14:35	18 (9/9)		1,2
14:40		18 (9/9)	1,2
14:45		17 (9/8)	1,2
14:50		16 (9/7)	1,3
14:55		17 (10/7)	1,2
15:00		17 (10/7)	1,3

# Satellitplanera

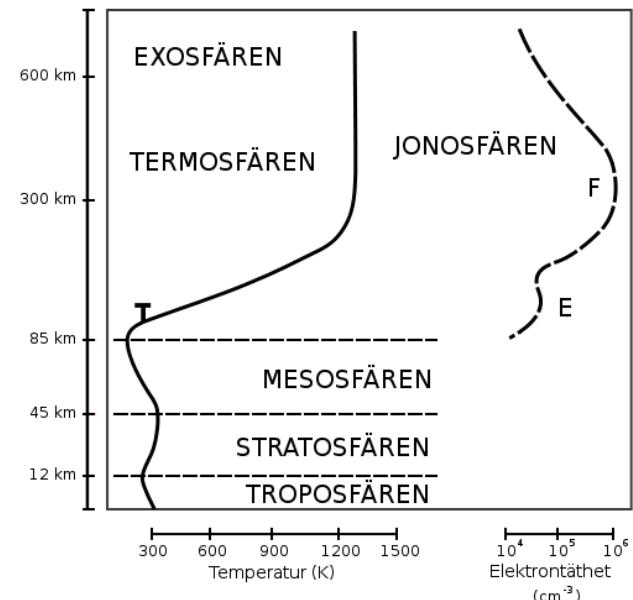
- DOP = Mått på geometrisk spridning
  - Diluton Of Precision
  - HDOP, VDOP, PDOP, TDOP, GDOP ...
  - [http://en.wikipedia.org/wiki/Dilution\\_of\\_precision\\_\(GPS\)](http://en.wikipedia.org/wiki/Dilution_of_precision_(GPS))
- Ju lägre DOP-tal-desto bättre geometrisk spridning
  - PDOP (position 3D) bör inte överstiga 4 - 5
- Elevationsmask bör vara 10-15 grader
  - 0 – 89 grader är teoretiskt
  - En lägre elevationsmask ger fler satelliter och ett bättre lägre DOP värde
  - Men ofta också ett högre "brus", reflektioner, atmosfär etc.

Elevationsvinkel =  
vinkeln från markplan



# Felkällor och felreducering

- Klockfel
  - Tidstolerans ca: 1-50 ns/dygn
  - Allmänna relativitets teorin - tiden går snabbare med låg gravitation, 16s sedan start
  - Gravitationen är proportionell mot tiden
  - [http://www.youtube.com/watch?v=Ev50\\_rFGFs8](http://www.youtube.com/watch?v=Ev50_rFGFs8)
  - <http://www.imdb.com/title/tt2364345/>
- Osäkerhet i satellits position i satellitbana
- Jonosfären
  - <http://sv.wikipedia.org/wiki/Jonosf%C3%A4ren>
- Troposfären
- Studsande signaler
- Dåliga mottagare/antenner
- Systematiska fel reduceras genom att "rättad" data skickas till GPS-mottagare från platser med kända positioner
  - Felen kan reduceras från 10-15 m till 1-2 m

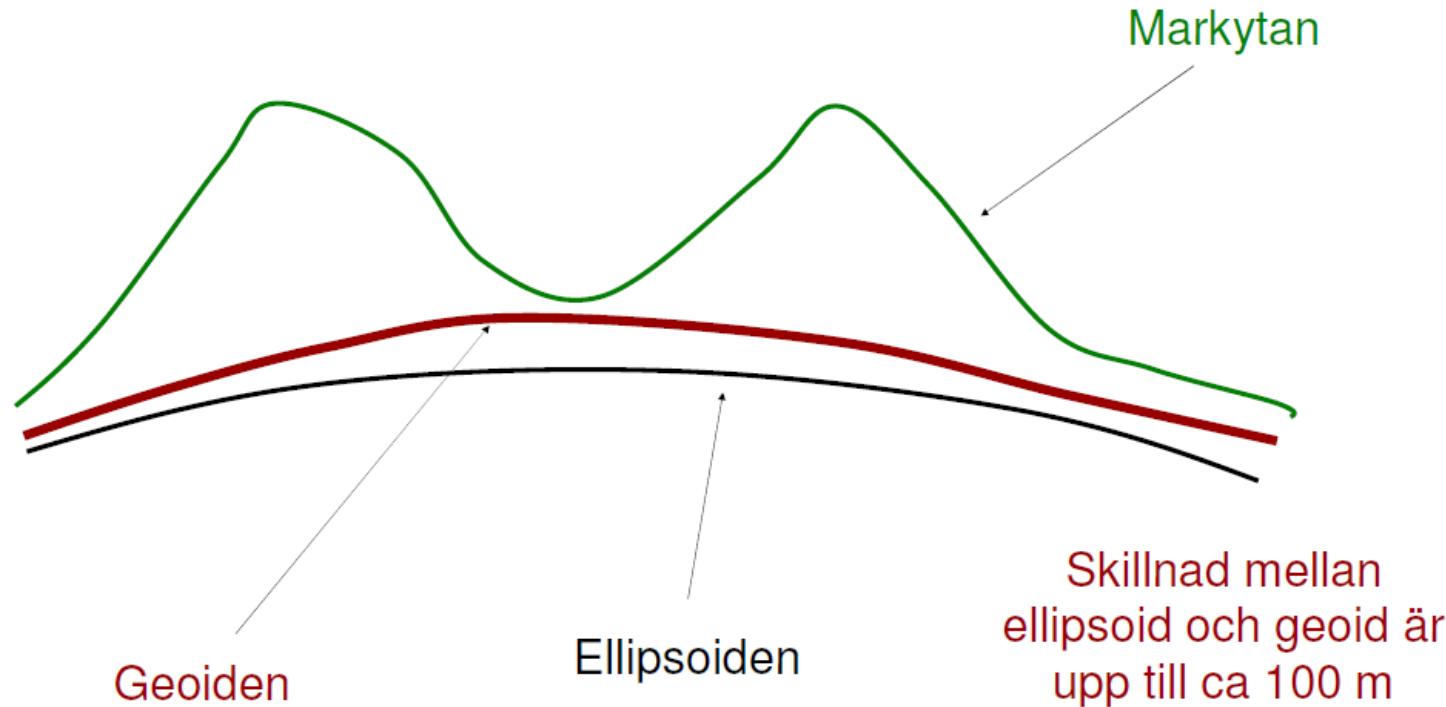


# Augmentation

- Systemlösningen kontrollerar integritetsgränser och beräknar korrektionsfaktorer för att slutligen sända rättad positionsdata till GPS-mottagaren (på samma frekvens) endera via markstationer (GBAS) eller via satellitstationer (SBAS)
- GBAS (Ground Based Augmentation System)
  - SWEPOS (LMV) och EPOS (Teracoms dGPS tjänst)
  - Förbättrar precisionen ner mot centimetern
  - <http://swepos.lmv.lm.se/>
- SBAS (Satellite Based Augmentation System), geostationära
  - WAAS (Wide Area Augmentation System, USA)
  - MSAS (Multi-functional Satellite Augmentation System, Asien)
  - EGNOS (European Geostationary Navigation Overlay Service)
    - Förbättrar precisionen - bättre än 2 meter fel
    - EGNOS är påslaget sedan 2005 men kan ha problem i norrland

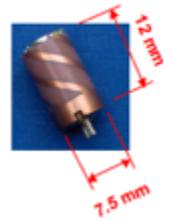
# Geoiden och ellipsoiden

- Jordens form approximeras med en ellipsoid, dvs. en roterande ellips
- GPS mottagaren ger höjden relativt ellipsoiden
- "Höjd över havet" beräknas relativt geoiden (jorden är inte en exakt ellips)



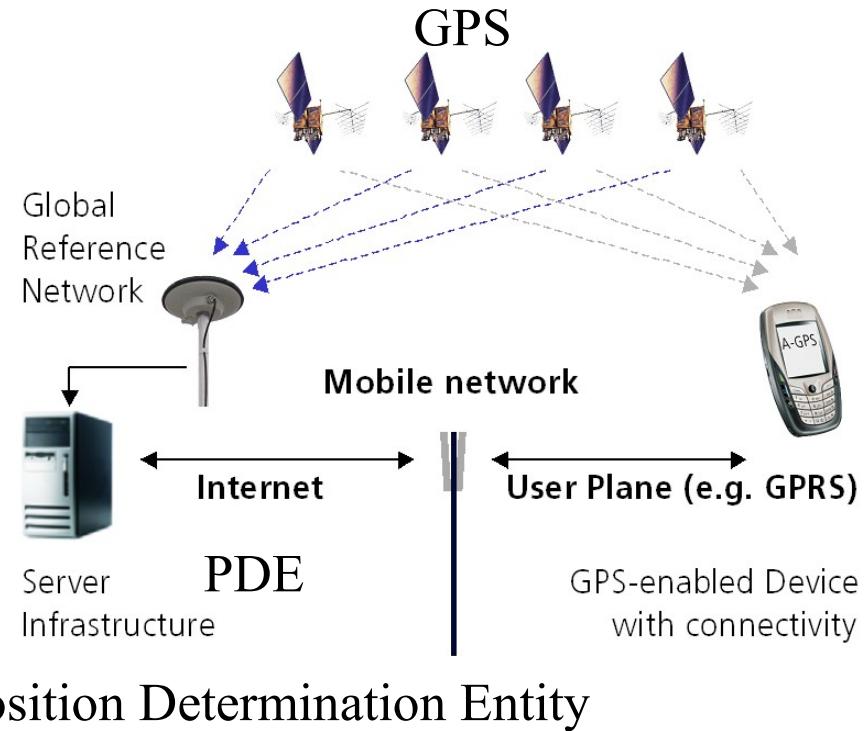
# GPS devices & phones 1

- Built-in
  - Qualcomm gpsOne and other proprietary solutions
  - <http://www.prisjakt.nu/kategori.php?k=v615>
- Bluetooth (GPS chipsets)
  - U-blox, SiRF, RFMD and MTK etc.
- Static navigation filter
  - Bad for pedestrian mode
  - <http://etn.se/index.php?view=article&catid=27%3Aprodukt&id=47540%3Aantenn-fo>
- Almanac
  - En förutsägelse om alla satelliternas bana och position runt jorden
  - Giltig uppemot flera månader
- Ephemeris
  - Innehåller enskilda satellitens exakta positionsdata vid given tid och annan information nödvändig för positionering, uppdateras var 30 sec.
  - Max uppemot 2-4h timmar gammal, 30 minuter i praktiken
  - [http://www.satellitetrackingsystem.co.uk/satellite\\_tracking\\_software.htm](http://www.satellitetrackingsystem.co.uk/satellite_tracking_software.htm)



# GPS devices & phones 2

- User plane vs. Control plane
- A-GPS (Assisted)
  - Hjälper till med att få igång positioneringen genom att ge bla. aktuell GPS **Almanac** och **Ephemeris** via nätet
  - Mobilnäts data (almanac)
  - Många fler parametrar kan ges:  
[http://en.wikipedia.org/wiki/GPS\\_Phone](http://en.wikipedia.org/wiki/GPS_Phone)
- TTFF (Time To First Fix)
- Cold start vs. warm start
  - Super cold start
- Qualcomm Snapdragon gpsone gen8 supports Glonass as well
  - <http://en.wikipedia.org/wiki/GpsOne>

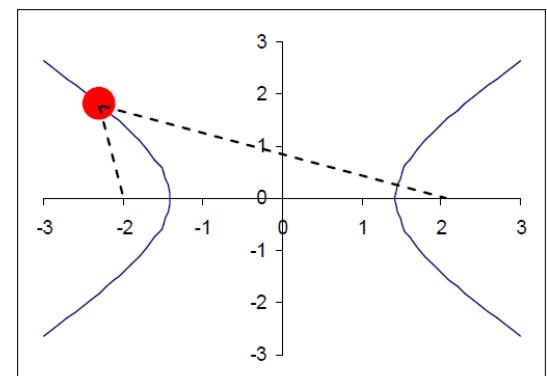
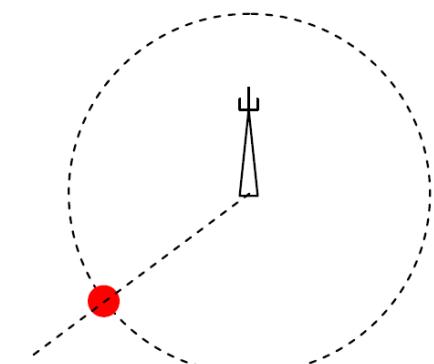
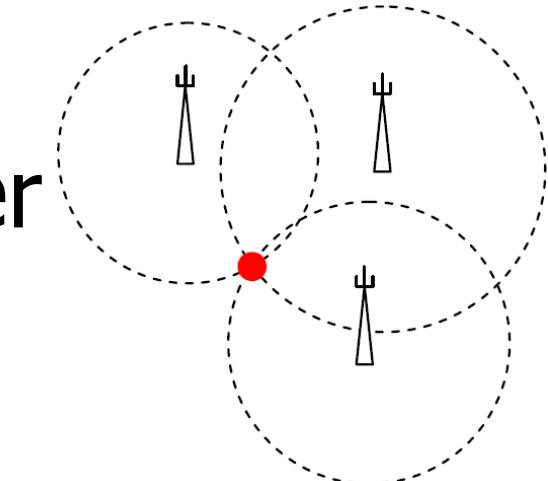


# Mobile Positioning Methods

- Mobile-based positioning
  - The mobile phone receives signals from position-specified base stations and positions itself with the help of the information
- Network-based positioning
  - The mobile network performs the positioning for the most part passively using the mobile phone
- Assisted mobile positioning
  - The mobile phone performs all measurements itself but sends measurement signals to the network for calculation

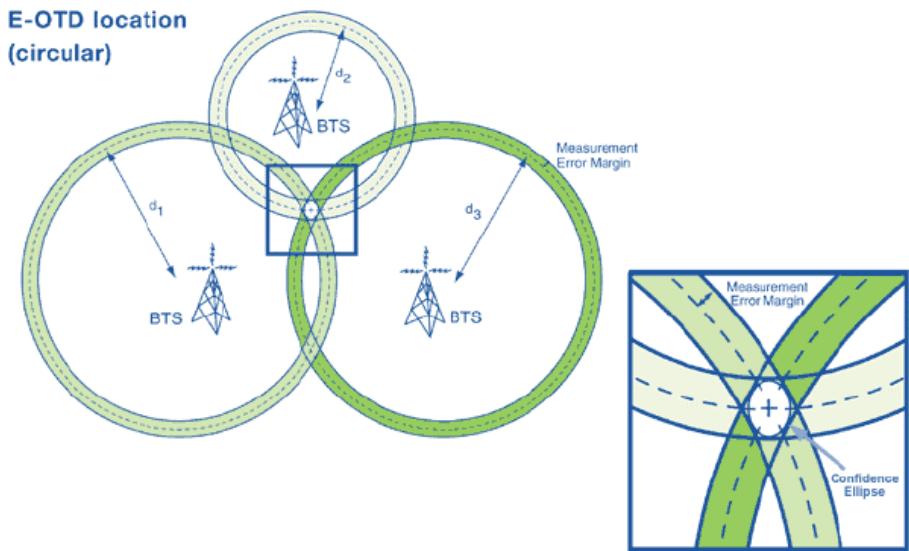
# Mobila Positioneringsmetoder

- Radiell-radiell metoden
  - Avståndsmätningar kombineras
- Vinkel-radiell metoden
  - Avståndsmätningar och vinkelmätningar kombineras
- Hyperbolisk-Hyperbolisk metoden
  - Avancerad radiell-radiell metod
    - TOA (Time of Arrival)
    - Time Difference Of Arrival (TDOA)
  - BTSer på x-axel vid -2 och 2



# Triangulation

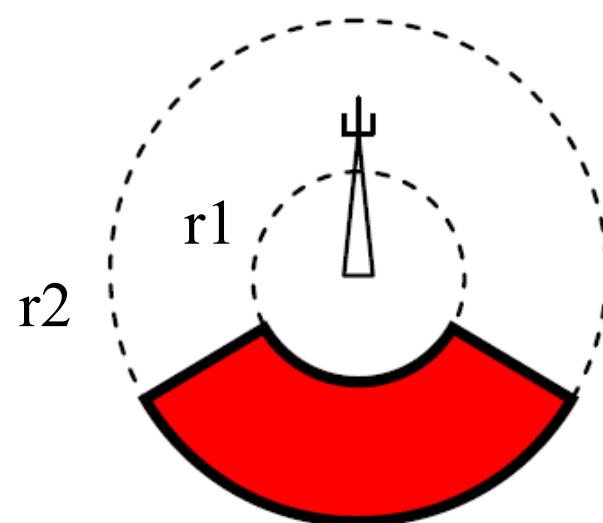
- OTDOA (Observed Time Difference Of Arrival), WCDMA
- AFLT (Advanced Forward Link Trilateration), CDMA
- E-OTD (Enhanced Observed Time Difference of arrival), GSM
- TTFF around 6-8 sec
- Precision 100-1000 meters
  - Hur korrekt är PDE:ns (Position Determination Entity) almanac för alla basstationer?
  - Terminalens kalibrering
  - Antalet pilotkanaler från basstationer som är synliga för terminal som skall positioneras
  - Basstationers cellstorlek



# Cell ID

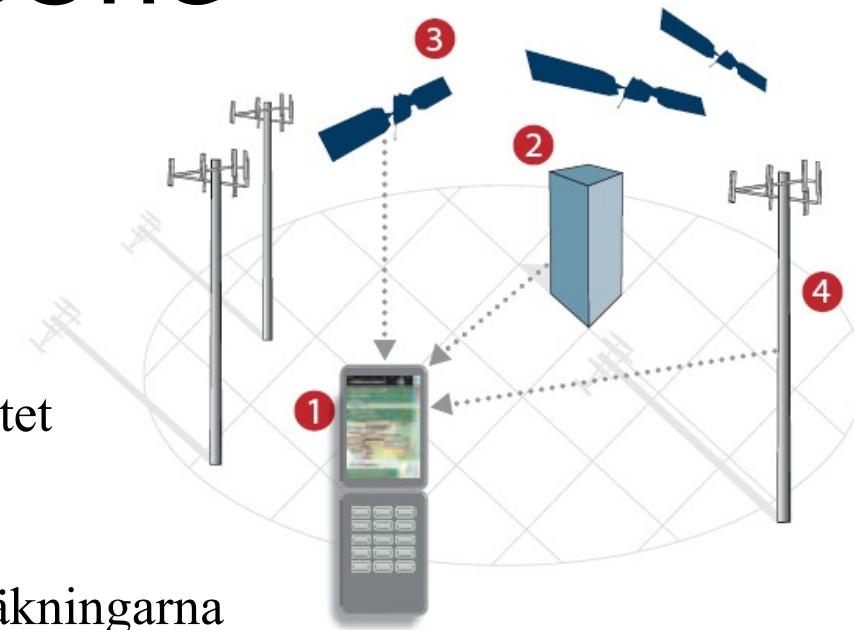
- Med Cell ID menas täckningsområdet av basstationens antenn/antenner (sektorer)
  - Stort om den är rundstrålande
- CGI-TA
  - Cell Global Identity-Timing Advance
  - Del av sektor i basstationen vilka för det mesta strålar 120 grader
  - I GSM kan  $r_2 - r_1$  som lägst bli 550 m, om inte cellen är mindre än 550 m
- Angel of Arrival (AOA)
  - Vinkel-radiell metod, kräver antenner som strålar mycket snävt

Frequency (MHz)	Cell radius (km)	Cell area (km <sup>2</sup> )	Relative cell count
450	50	7521	1
950	26.9	2269	3
1800	14.0	618	12
2100	12	449	16



# Qualcomm gpsOne

- Helt integrerad i chipset
- Kan arbeta i 4 lägen
  - Fristående GPS
  - MS (Mobile Station) baserad
    - GPS och location signal från nätet
  - MS assisted
    - Samma som ovan samt att en PDE server hjälper till med beräkningarna
  - MS assisted/hybrid
    - Samma som ovan men Internet funktionen består
    - Eliminerar fördröjningen för första ”fixen”
    - Finns i över 300 miljoner telefoner och +40 operatörer - 2009
      - <http://en.wikipedia.org/wiki/GpsOne>
- Qualcomm Snapdragon SoC sitter i många smartphones
  - [http://en.wikipedia.org/wiki/Snapdragon\\_%28processor%29](http://en.wikipedia.org/wiki/Snapdragon_%28processor%29)

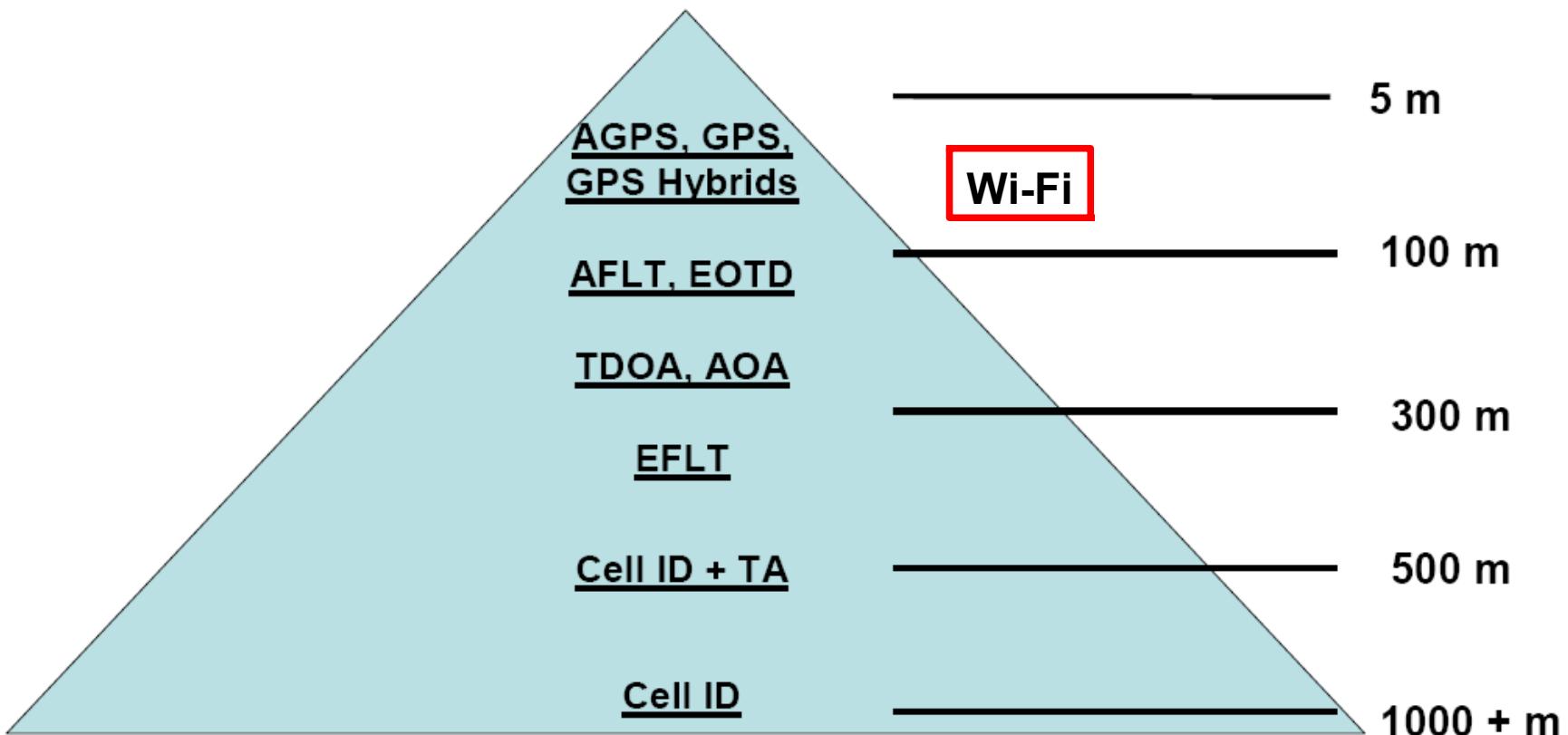


# Sammanfattning positionering 1

Technique	Method and strengths	Examples
Data-based	Location calculated with reference to a single base station. Fast and cheap but reliant on density of base station distribution and provide limited accuracy	Cell-ID, Time Advance, MAHO/NMR.
Network-based	Location calculated based on triangulation of three base stations. Fast and accurate, but increased overheads	TOA, TDOA, AOA
Handset-based	Location calculated by handset based GPS receiver or packet switching capabilities. Very accurate position fix, increasingly affordable and GPS technology costs drop	GPS, A-GPS, E-OTD

# Sammanfattning positionering 2

Network-based, handset-based, and hybrid solutions are available



# Sampling GPS, NMEA 0183

- The National Marine Electronics Association (NMEA)
  - [http://en.wikipedia.org/wiki/NMEA\\_0183](http://en.wikipedia.org/wiki/NMEA_0183)
- **GGA** - Essential fix data which provide 3D location and accuracy data
- **GSA** - GPS \*DOP (dilution of precision) values and active satellites
- **GSV** - Satellites in view - 1 sentence data = max 4 satellites
- **RMC** - NMEA has its own version of essential GPS PVT (position, velocity, time) data
  - <http://www.gpsinformation.org/dale/nmea.htm#nmea>
- Draw a track on Google Map from a NMEA GPS log file
  - [http://franson.com/forum/topic.asp?TOPIC\\_ID=4058](http://franson.com/forum/topic.asp?TOPIC_ID=4058) (GPS Visualizer)
- Example, 1 sec

\$GPGLL,133851.996,A,6046.3885,N,01501.1250,E,1,04,04.1,00172.3,M,30.0,M,,\*63

\$GPGLL,133851.996,A,6046.3885,N,01501.1250,E,1,04,04.1,00172.3,M,30.0,M,,\*63

\$GPGLL,133851.996,A,6046.3885,N,01501.1250,E,1,04,04.1,00172.3,M,30.0,M,,\*63

\$GPGLL,133851.996,A,6046.3885,N,01501.1250,E,1,04,04.1,00172.3,M,30.0,M,,\*63

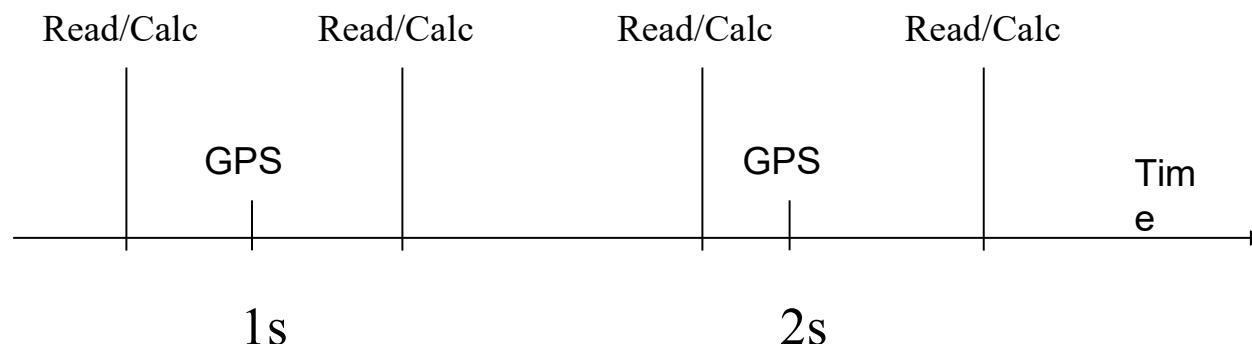
\$GPGLL,133851.996,A,6046.3885,N,01501.1250,E,1,04,04.1,00172.3,M,30.0,M,,\*63

\$GPRMC,133851.996,A,6046.3885,N,01501.1250,E,064.7,194.4,131105,003.1,E\*6<sup>a</sup>

} Max 12 sat.

# Sampling GPS

- Principle for sampling of GPS with at least the double speed to ensure that a valid sample is obtained in the software (sampling theorem)
  - If read/Calc is done in one thread and GPS is a callback
- GPS problems?
  - A number of!
- Solutions
  - Prediction
  - Dead reckoning (accelerometer, gyro, step counter sensors)
  - Magnetic electronic compass (not dependent of GPS)





# Projections, reference systems

- WGS 84 (World Geodetic System 1984)
  - Decimal Degrees
    - Lat/Long: 60.483494, 15.411272
  - Degrees/Minutes/Seconds
    - Lat/Long: N 60° 29' 0.58", E 15° 24' 40.58"
  - Degrees/Decimalminutes
    - Lat/Long: 6029.3240,N,01523.3028,E
  - UTM (meters)
    - Cylindric map projection in 60 zones, SE=32-35
    - [http://en.wikipedia.org/wiki/Transverse\\_Mercator\\_projection](http://en.wikipedia.org/wiki/Transverse_Mercator_projection)
    - <http://sv.wikipedia.org/wiki/UTM>
- RT90 - Swedish grid
  - X= 6707377 , Y= 1478345
- SWEREF 99 TM (använder UTM zon 33)
  - SWEdish REference Frame 1999
  - N: 6705329.393, E: 522604.151
- [http://sv.wikipedia.org/wiki/WGS\\_84](http://sv.wikipedia.org/wiki/WGS_84)

Visa lat/long

- Decimalgrader
- Grader, minuter, sekunder
- Grader, decimalminuter
- Universal Transverse Mercator

To convert coordinates from degrees, minutes, seconds format to decimal format, use this formula:  
 $\text{degrees} + (\text{minutes}/60) + (\text{seconds}/3600)$

To convert coordinates from degrees, decimal minutes format to decimal format, use this formula:  
 $\text{degrees} + (\text{decimal minutes}/60)$

 Windows | Dev Center - Hardware ▾

DASHBOARD GET STARTED DESIGN DEVELOP CERTIFY

Systems Devices Drivers Debugging Downloads Samples Community Archives

- Sensor and Location Platform
  - Integrating Motion and Orientation Sensors
  - Implementing Light-Aware UI in Windows 7
  - Integrating Ambient Light Sensors in Windows 7
  - Introducing the Windows Sensor and Location Platform
  - Visual Variable Guidelines for Light-Aware UI
  - Graphing Accelerometer Data in Windows 7: Sample Code
  - Monitoring a Motion Sensor with Windows 7
  - GNSS (GPS) Test Guidance
  - Integrating Ambient Light Sensors with Computers Running Windows 8
  - Windows 8 Sensor Calibration and Configuration Persistence

# Windows Sensor and Location Platform

The Windows Sensor and Location platform simplifies the integration and use of sensors. The platform consists of a driver component and a client component. For Windows 8, the platform includes the following new features for hardware engineers and driver developers:

- An inbox class driver for sensors that supports the Human Interface Device (HID) protocol.
- Reference code for this class driver which ships as a sample in the Windows Driver Kit.
- Inbox support for screen rotation and brightness adjustments.
- Support for the Windows Location Provider which is capable of retrieving location data using Wi-Fi triangulation or IP addresses.
- Support for GPS devices.
- A sample Geolocation driver that demonstrates a simulated GPS device.
- A new Sensor Diagnostic Tool for testing your hardware and device-driver.

The platform includes the following new features for modern-sensor app developers:

- A Sensors namespace (Windows.Devices.Sensors) that includes support for a variety of motion, device-orientation, and light sensors. (The output for one motion, and one device-orientation, sensor is the result of sensor fusion—the combining of data from multiple sensors.)
- Support for Javascript/HTML apps
- Support for VB/C#/C++ XAML apps

The platform includes the following new features for modern-location app developers:

- A Geolocation namespace (Windows.Devices.Geolocation) that is capable of retrieving the computer's location using either the Windows Location Provider or GPS input.
- Support for Javascript/HTML apps
- Support for VB/C#/C++ XAML apps

Note that Microsoft is shipping a number of apps that use the Windows Sensor and Location platform. For an example, see the [Star Chart](#) app that is available on the store.

## Windows 8 topics for hardware engineers and driver developers

- Integrating Motion and Orientation Sensors
- Integrating Ambient Light Sensors with Computers Running Windows 8
- GNSS (GPS) Test Guidance
- HID Sensors Usages
- The HID Class Driver for Sensors
- Sensors driver sample for geolocation
- Sensor Diagnostic Tool

## Windows 8 topics for modern sensor-app developers

- Windows.Devices.Sensors namespace
- Responding to motion and orientation-sensor quickstarts
- Responding to light sensors quickstarts

## Windows 8 topics for modern location-app developers

- Windows.Devices.Geolocation namespace
- Detecting geolocation quickstarts

## Windows 7 topics for the sensor and location platform

- Sensors HID driver sample
- Implementing Light-Aware UI in Windows 7
- Integrating Ambient Light Sensors in Windows 7
- Introducing the Windows Sensor and Location Platform
- Visual Variable Guidelines for Light-Aware UI

## Windows 7 desktop sample code

- Build Your Own Game Controller
- Graphing Accelerometer Data in Windows 7
- Monitoring a Motion Sensor with Windows 7
- Sensor Video-Capture Solution

<http://msdn.microsoft.com/en-us/library/windows/hardware/gg463473.aspx>

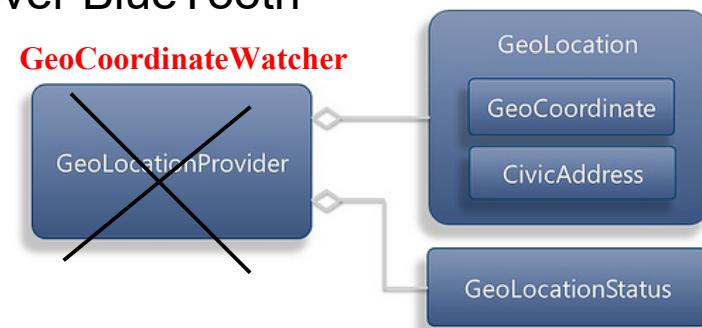
## Sensors measure a physical phenomenon or a physical interaction

### Sensor Types

- Ambient Light Sensors (ALS)
- Accelerometers
- Location Sensors
- GPS, Wi-Fi /cell tower triangulation, IP Geolocation
- Proximity Sensors
- Temperature Sensors
- Biometric Sensor\*
- Others (Human presence, RFID)

# Windows Sensor and Location Platform

- GPS enabled mobile phone supporting development and Bluetooth
- Symarctic ExtGPS - Android program
  - Sample phone GPS and sends NMEA data over BlueTooth
- GPS Direct Virtual Sensor Driver
  - Read a COM port that contains GPS NMEA data and map it to a Windows 7 GPS Sensor
  - <http://www.turboirc.com/gps7/>
- LocationConsoleApp (Visual Studio 2010)
  - Simple console application that outputs Lat/Long values from Windows 7 GPS Sensor
  - <http://msdn.microsoft.com/en-us/library/system.device.location.geocoordinatewatcher%28VS.100%29.aspx>
- Sensor API: Make your Windows applications environment-aware in Windows 7
  - <http://www.codeproject.com/KB/winsdk/sensor.aspx>





# W3C Geolocation API demo

- Geolocation API Specification – **included in HTML5**
  - <http://dev.w3.org/geo/api/spec-source.html>
- Websites can request for "your location" if you got a supported web browser supporting HTML5 Geolocation API
  - All web browsers (IE from v9), also mobile browsers
- Using the Geolocation API
  - [http://www.w3schools.com/html/html5\\_geolocation.asp](http://www.w3schools.com/html/html5_geolocation.asp)
- The Geolocation API defines a high-level interface to location information associated only with the device hosting the implementation, such as latitude and longitude. The API itself is agnostic of the underlying location information sources
- Common sources of location information include **Global Positioning System (GPS)** and location inferred from network signals such as **IP address**, **RFID**, **WiFi** and **Bluetooth MAC addresses**, and **GSM/CDMA cell IDs**, as well as **user input**. No guarantee is given that the API returns the device's actual location

# W3C Geolocation API example

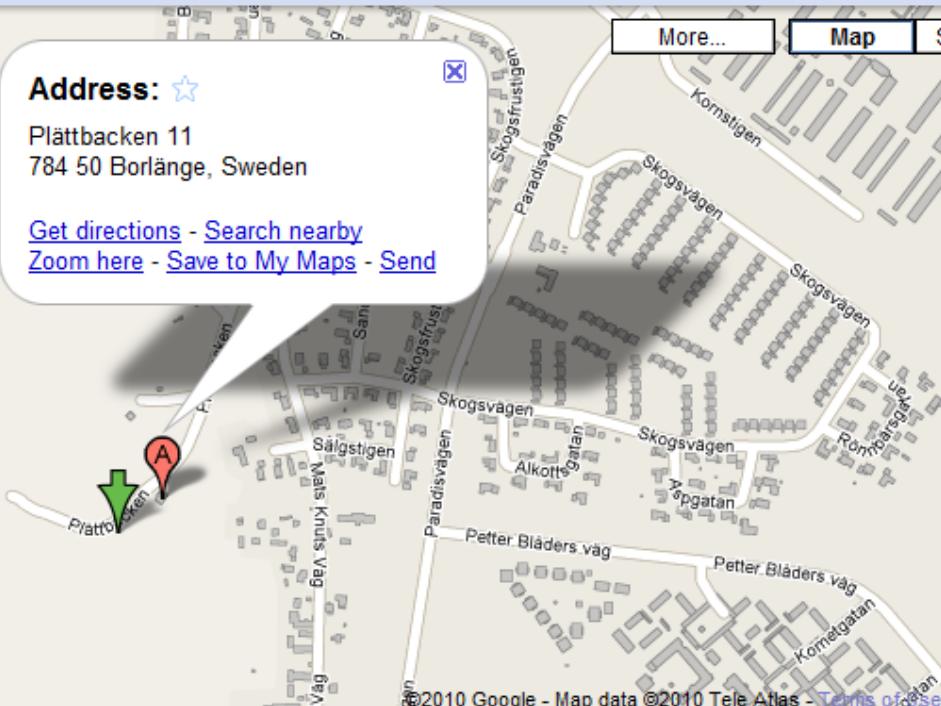
<http://users.du.se/~hjo/lbs/geolocation/geolocationapi.html>

60.487051 15.384473 - Google Maps - Mozilla Firefox

File Edit View History Bookmarks ScrapBook Tools Help  
Back Forward Stop Home http://maps.google.com/maps?geocode=&q=60.487051+15.384473  
Most Visited Getting Started Latest Headlines Freja och Embla - Ofelias blogg  
60.487051 15.384473 - Google Maps  
Web Images Videos Maps News Shopping Gmail more My Profile | My Account

Google maps 60.487051 15.384473  
Find businesses, addresses and places of interest.

Address: ★  
Plättbacken 11  
784 50 Borlänge, Sweden  
[Get directions](#) - [Search nearby](#)  
[Zoom here](#) - [Save to My Maps](#) - [Send](#)



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Most Visited Getting Started  
http://users.du.se/~hjo/lbs/geolocation/geolocationapi.html

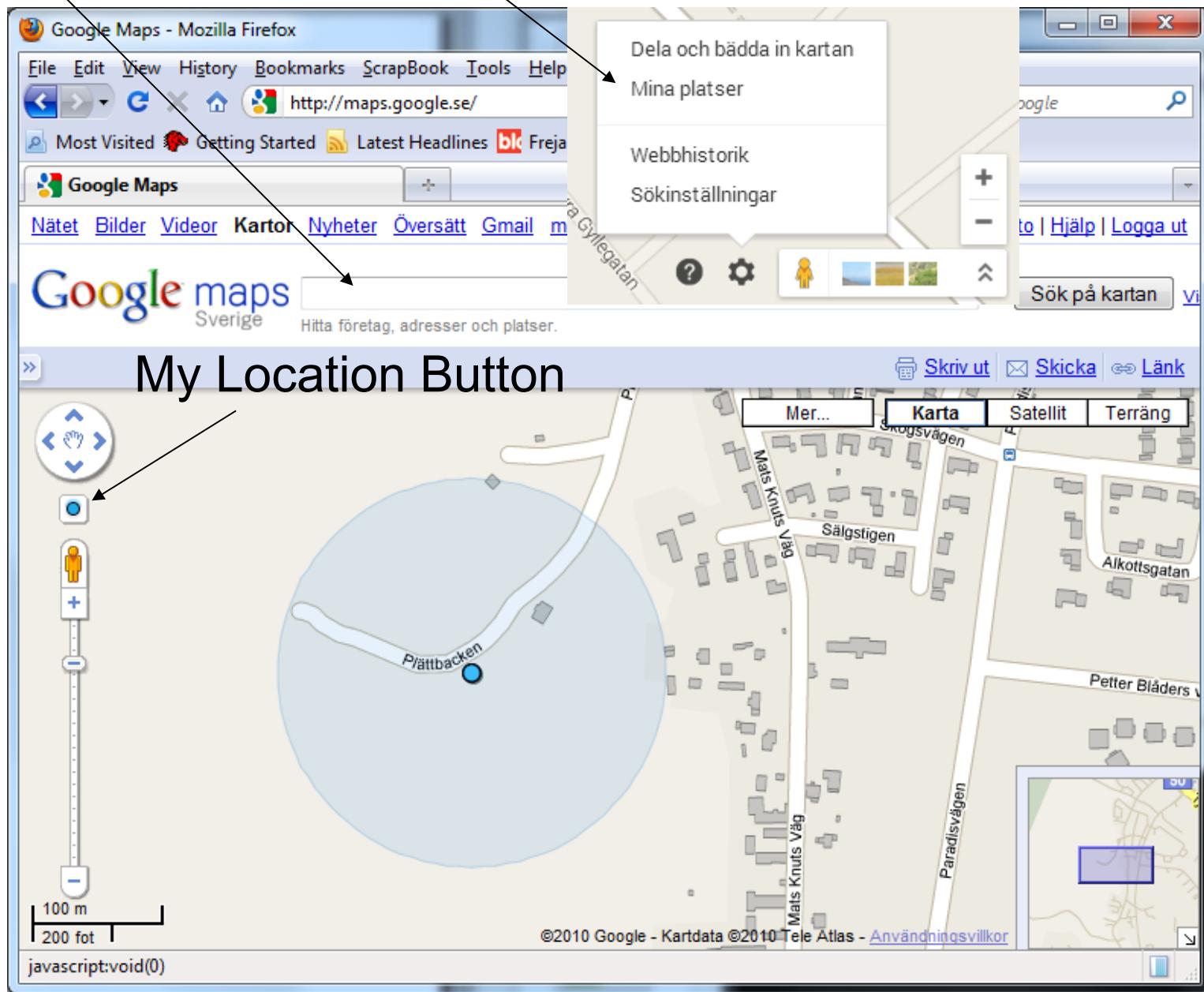
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accuracy = 150 m

streetNumber: 11  
street: Plättbacken  
premises: null  
city: null  
county: null  
region: null  
country: Sweden  
countryCode: SE  
postalCode: 78450

[View your location on Google maps](#)

Done

First goto my places with in the new Google maps design, then put address to file in search field: <http://users.du.se/~hjo/cs/dt2016/GIS/lecture-cellid.kml>



# Google Street View

The screenshot shows a map of a coastal area with a highlighted path. The path starts at a location labeled "Dunluce Castle" and follows a winding road along the coastline. The path is marked with blue segments and red dots, and points A through U are labeled along its course. A yellow dotted line continues the path further down the coast. The background features a large, craggy cliff face overlooking the ocean under a clear blue sky.

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Help ▶

+ -

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# GIS, kartor och GPS länkar

- Rapport öppna kartjänster
  - <http://users.du.se/~hjo/cs/dt2011/GIS/Rapport%20Kartl%C3%A4ggning%20av%20c3%b6ppna%20kartj%C3%A4nster.pdf>
- GIS self learning tool
  - <http://www.geogra.uah.es/patxi/gisweb/menu.html>
- <http://libraries.mit.edu/gis/>
- <http://www.lantmateriet.se/>
- <http://www.utsidan.se>
- <http://www.gpspassion.com>
- <http://www.nvdb.se/>