"From Geodesy and Mapping to Geospatial Information Management - the Future of Geoinformation"

by
Gottfried Konecny
Emeritus Professor
Leibniz University Hannover, Germany

1. **Geodesy is the art and science to determine size and shape of the earth**

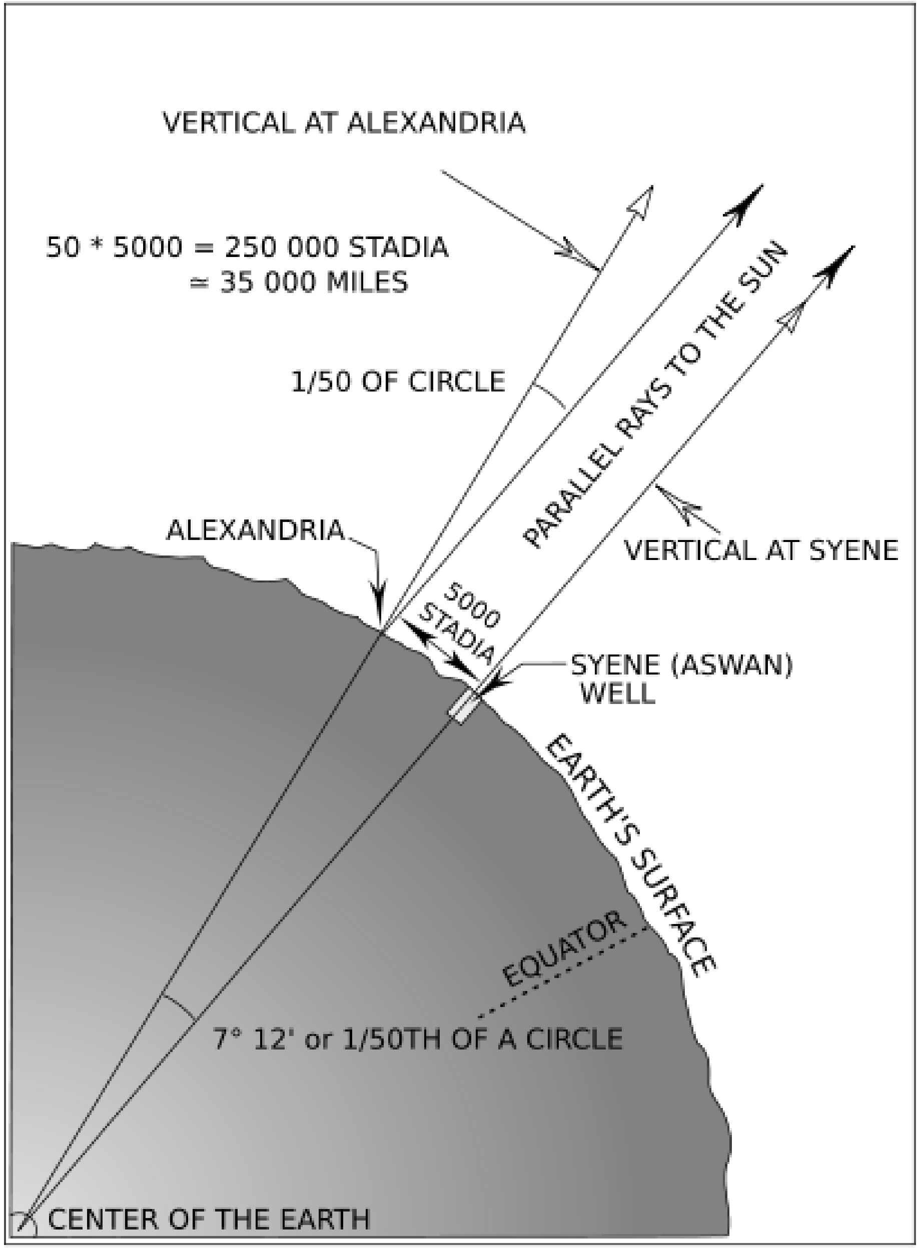
   (C.F. Helmert, 1880)

2. **and to map the earth´s surface**

3..... and to manage it for sustainable development

1. Geodesy

ERATOSTHENES METHOD FOR DETERMINING THE SIZE OF THE EARTH

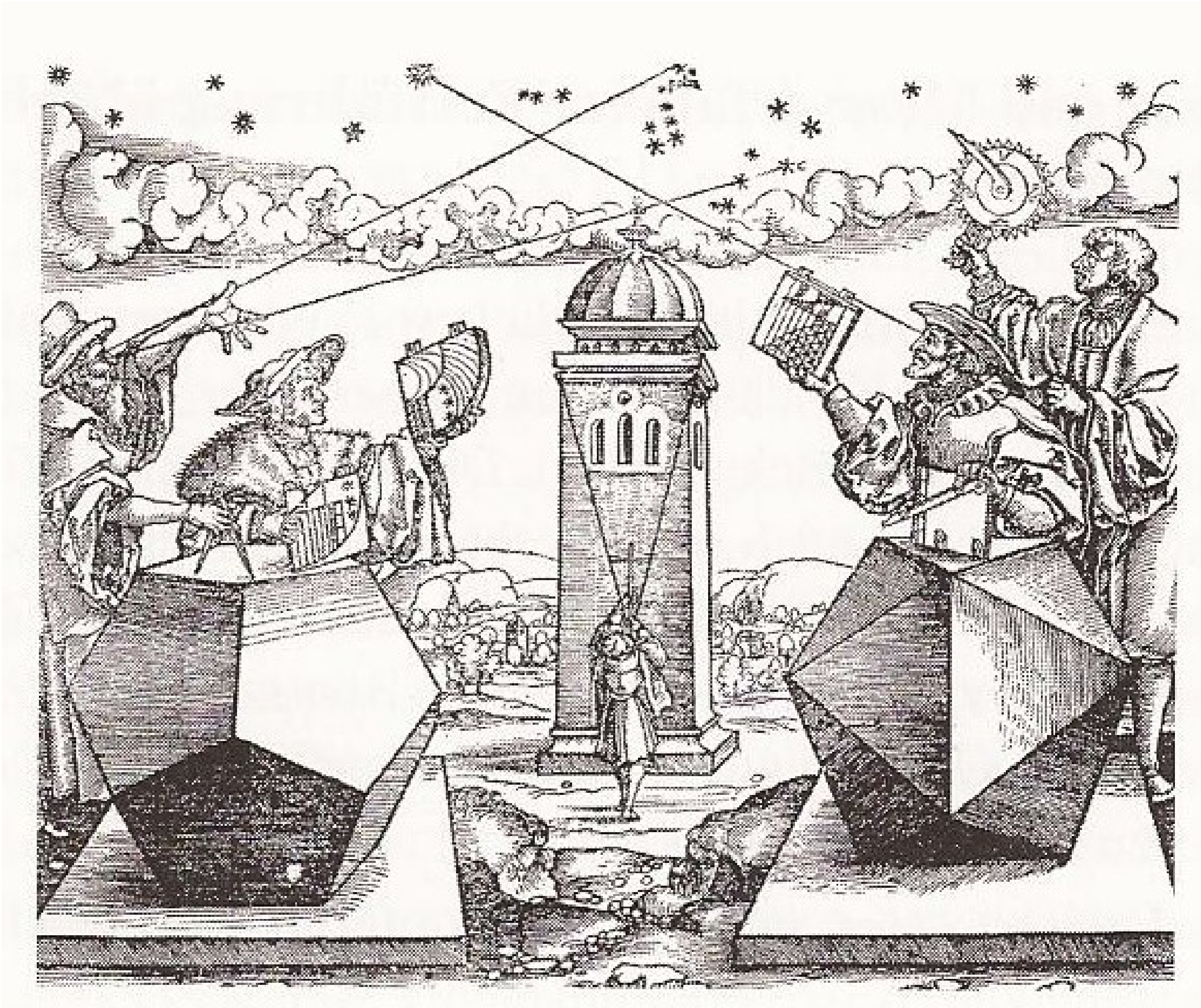


Eratosthenes

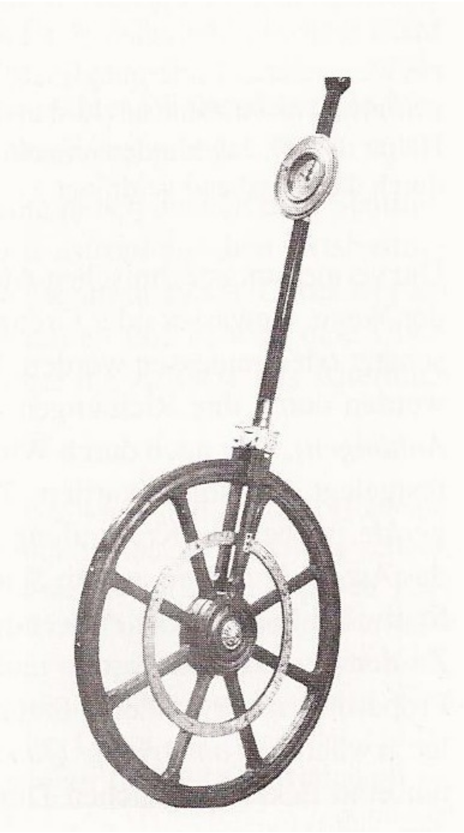
born 276 B.C. in Cyrene
died 194 B.C. im Alexandria

first determination of the size of a sherical earth

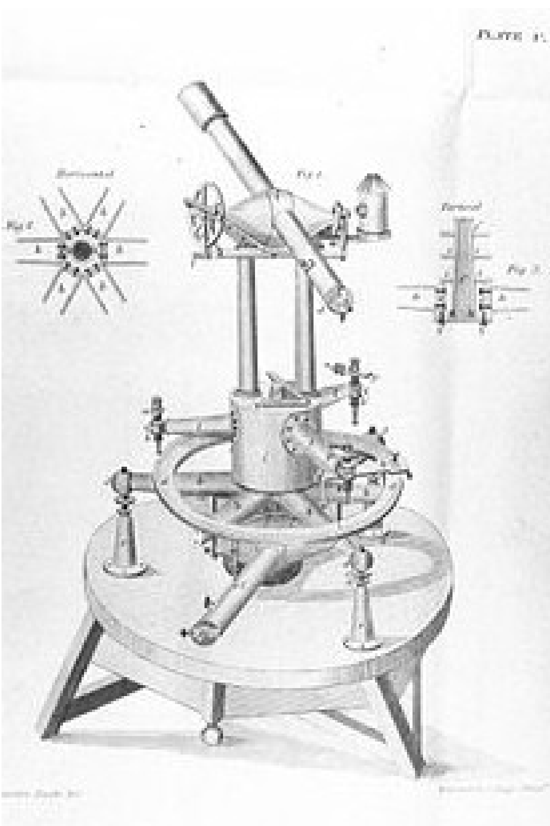
Astronomic Positioning at sea and on land in the age of exploration

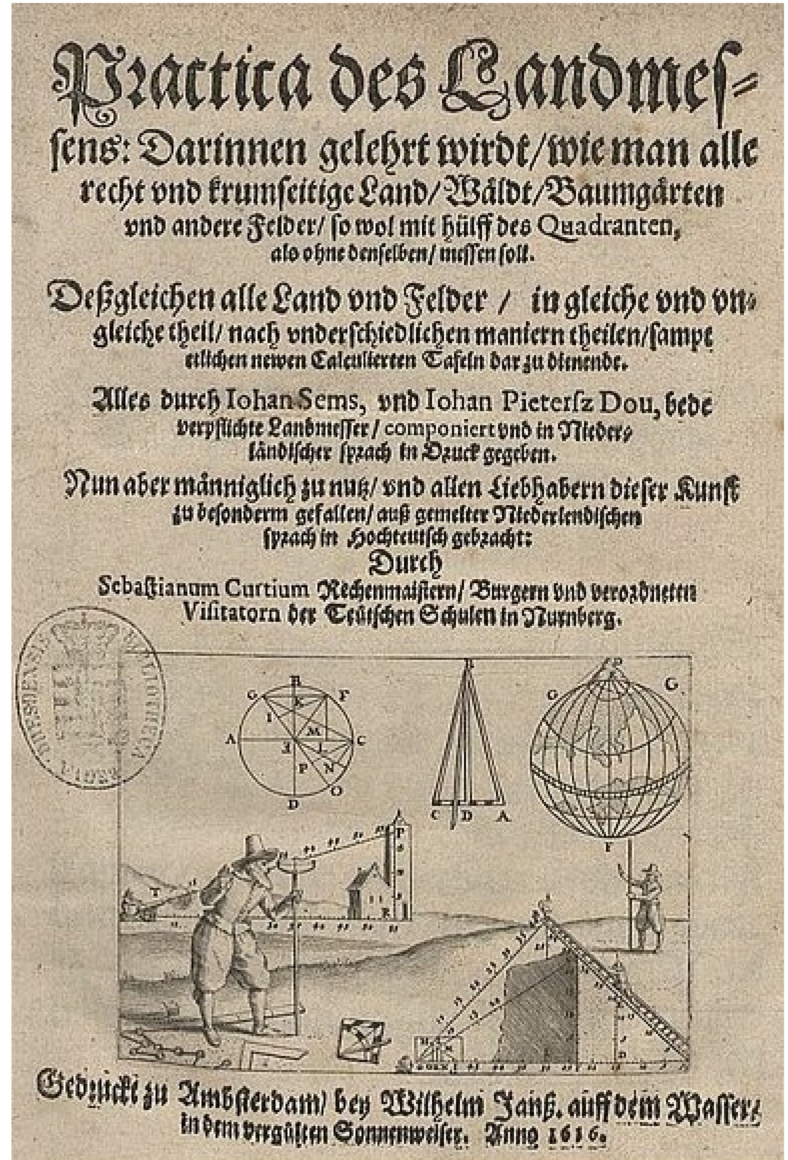


time consuming measurement of distances



New tools: measurement of angles
1500 the theodolite
1533 Gemma Frisius
principle of triangulation
1615 Willebrord Snellius
first triangulation in Holland





Practica des Landmessens: Darinnen gelehrt wirdt/ wie man alle recht vnd krumseitige Land/ Wäldt/ Baumgärten vnd andere Felder/ so wol mit hülff des Quadranten, als ohne denselben/ messen soll.

Deßgleichen alle Land vnd Felder / in gleiche vnd vngleiche theil/ nach vnderschiedlichen maniern theilen/ sampt etlichen newen Calculierten Tafeln dar zu dienende.

Alles durch Iohan Sems, vnd Iohan Pietersz Dou, bede verpflichte Landmesser / componiert vnd in Niederländischer sprach in Druck gegeben.

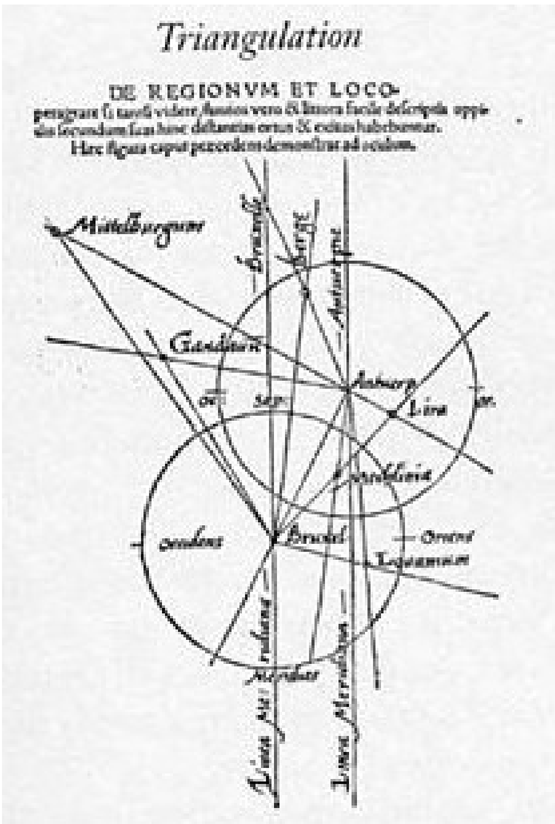
Nun aber männiglich zu nutz/ vnd allen Liebhabern dieser Kunst zu besonderm gefallen/ auß gemelter Niederlendischen sprach in Hochteutsch gebracht:

Durch

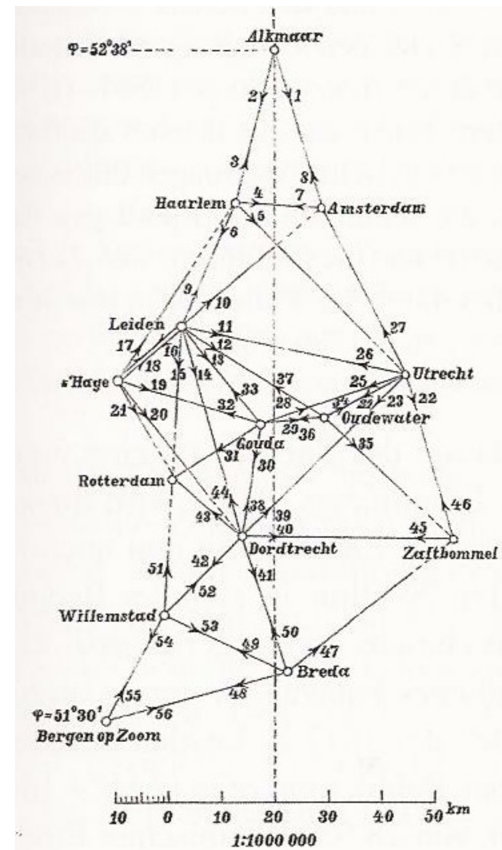
Sebastianum Curtium Rechenmaistern/ Burgern vnd verordneten Visitatorn der Teütschen Schulen in Nurnberg.

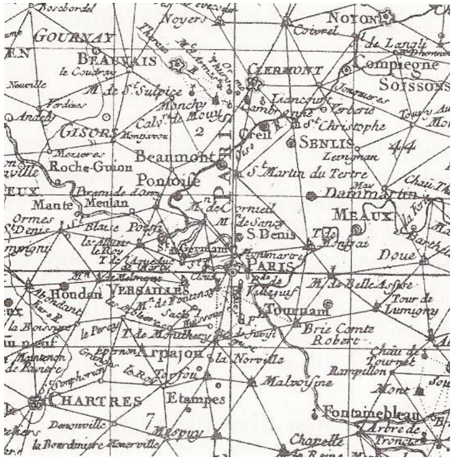
Gedruckt zu Ambsterdam/ bey Wilhelm Janß. auff dem Wasser/ in dem vergülten Sonnenweiser. Anno 1616.

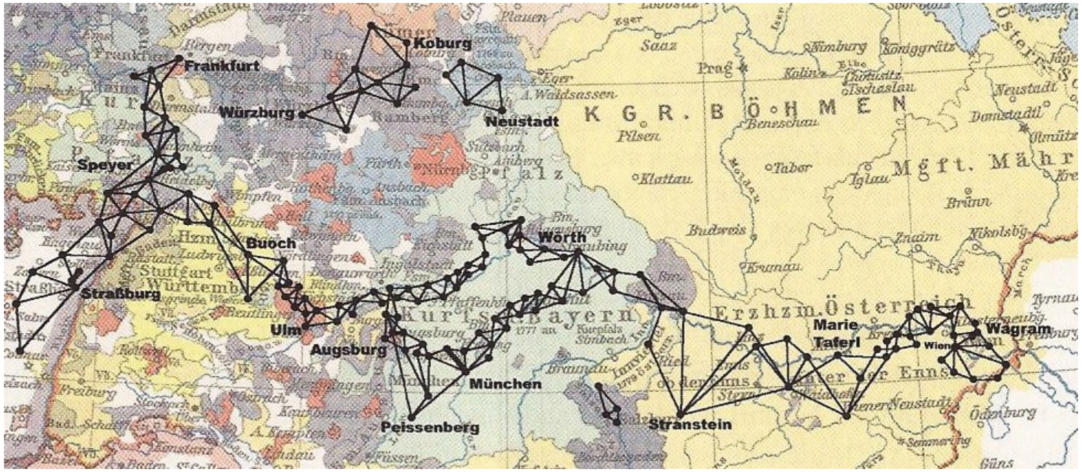
Explanation of Technology by Gemma Frisius 1533



Willebrord Snellius 1615
First triangulation network







French triangulation 1744

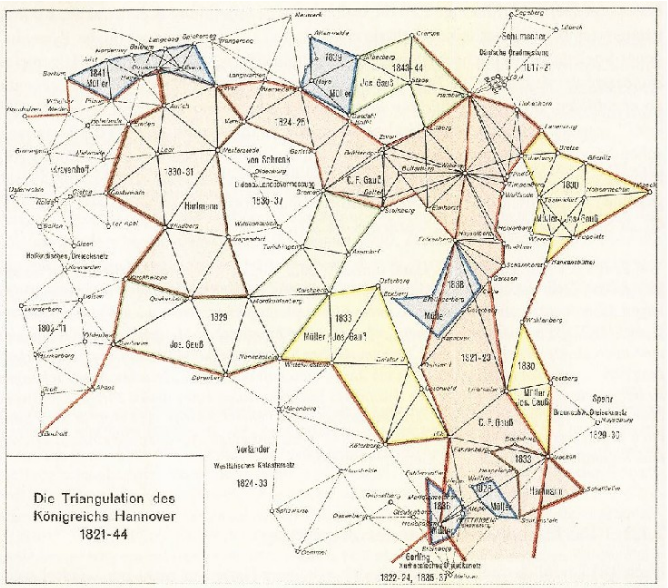
French- Austrian triangulation chain 1761 – 1762

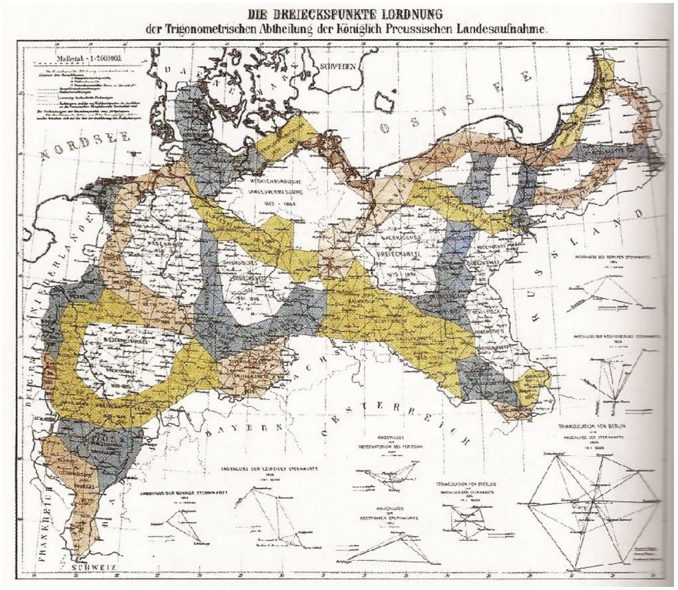
C.F.Gauss triangulation of the Kingdom of Hannover

first triangulation net adjusted by least squares 1828 - 1844

Prussian triangulation network

completed 1899



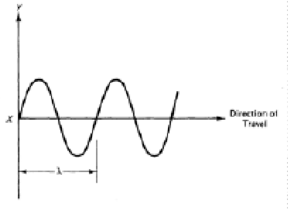


Electronic Distance Measurement

PRINCIPLES

- Wave – travels along x-axis at velocity of 299,792.5 ± 0.4 km/s
- Frequency – time taken for one complete wavelength
- Relationship:

$$\lambda = \frac{c}{f}$$



  - λ = wavelength in meters
  - c = velocity, in km/s
  - f = frequency, in hertz (one cycle per second)

PRINCIPLES

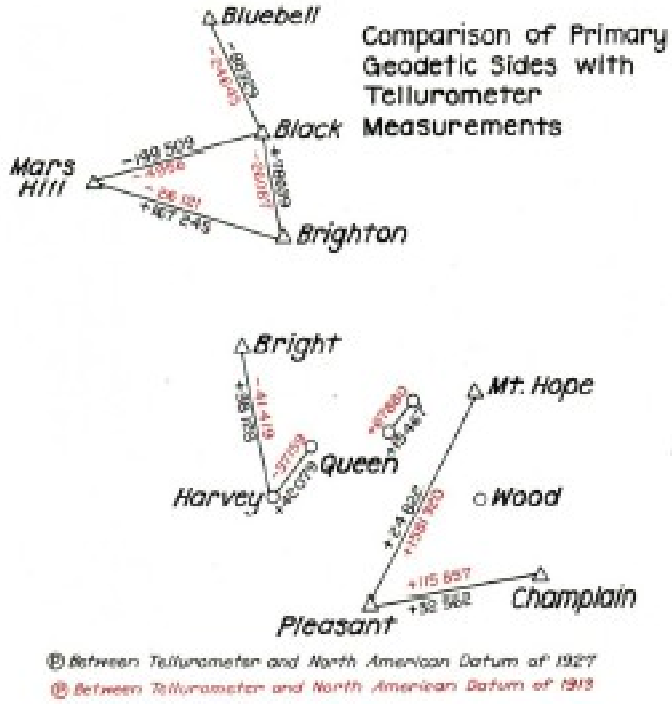
- Modulated wave leaves EDM then reflected back to instrument – measures double distance (2L)
- Partial wavelength measured from phase delay between transmitted and reflected

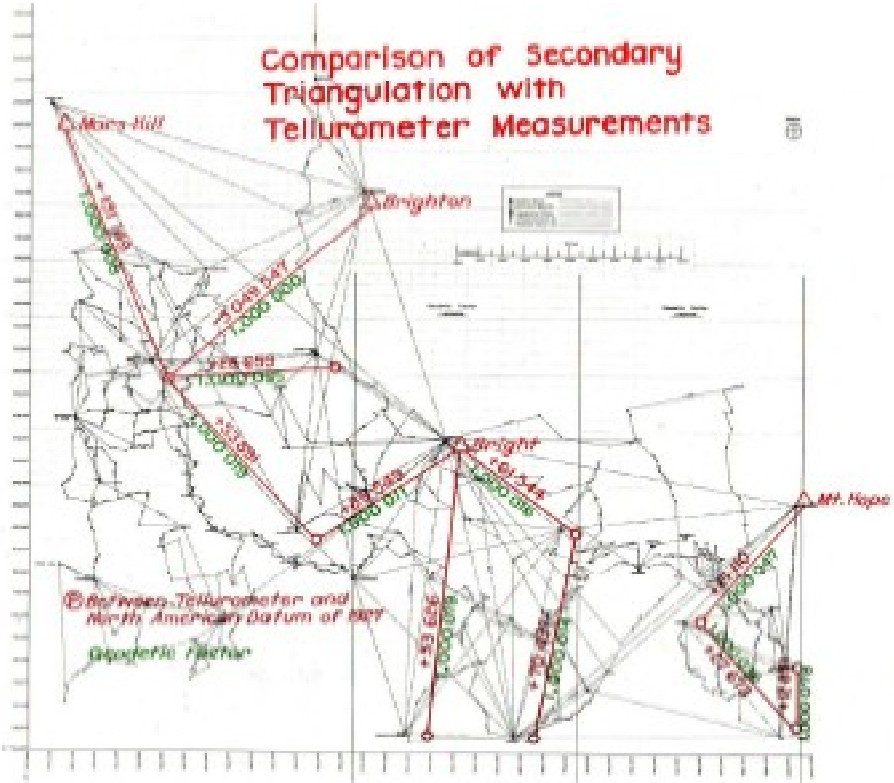
$$L = \frac{n\lambda + \varphi}{2} \text{ meters}$$

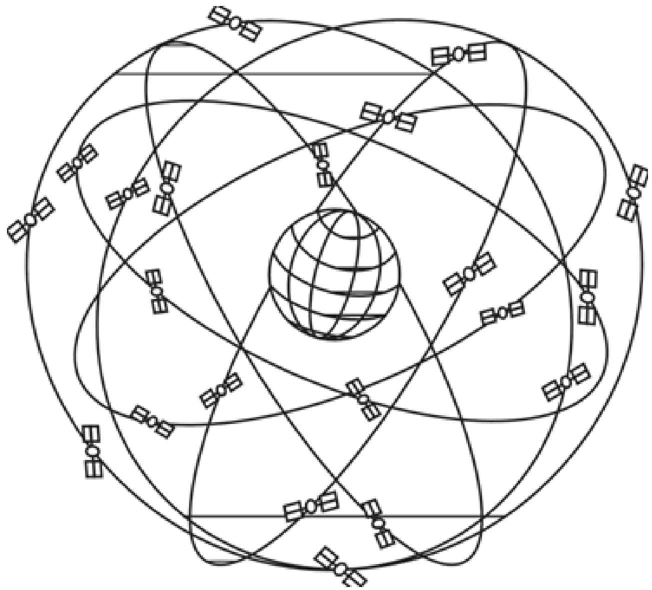
- $n\lambda$ whole number of wavelengths
- φ partial wavelength

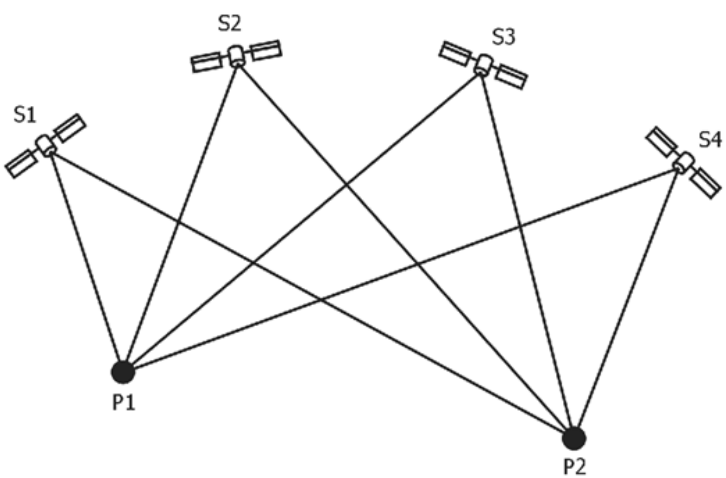
In the late 1950´s Electronic Distance Measurement permitted to extend control over large areas

The more efficient and more accurate EDM began to be a new survey tool in the 1960´s







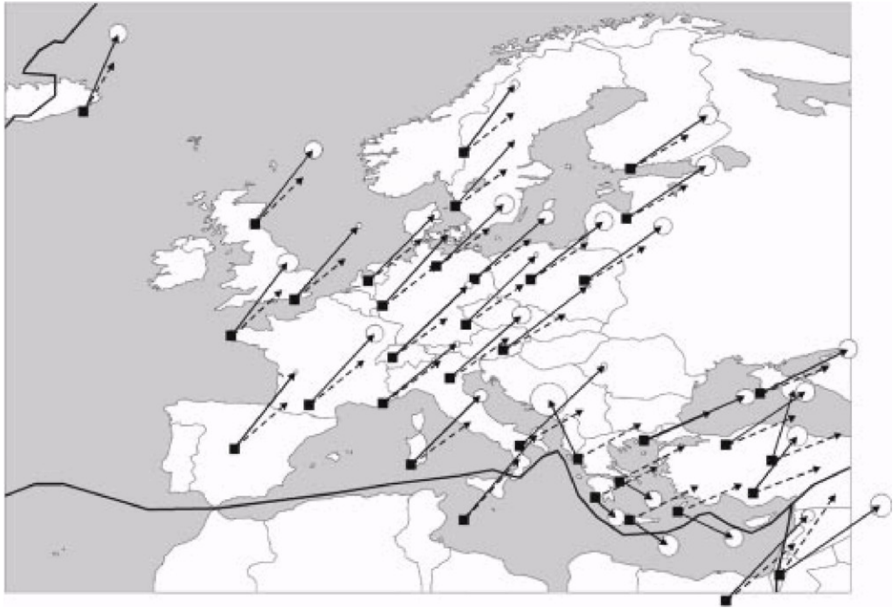


GNSS
became a new revolution in the 1990´s

With GNSS geodesy became an indispensable earth science tool

CORS

IREF



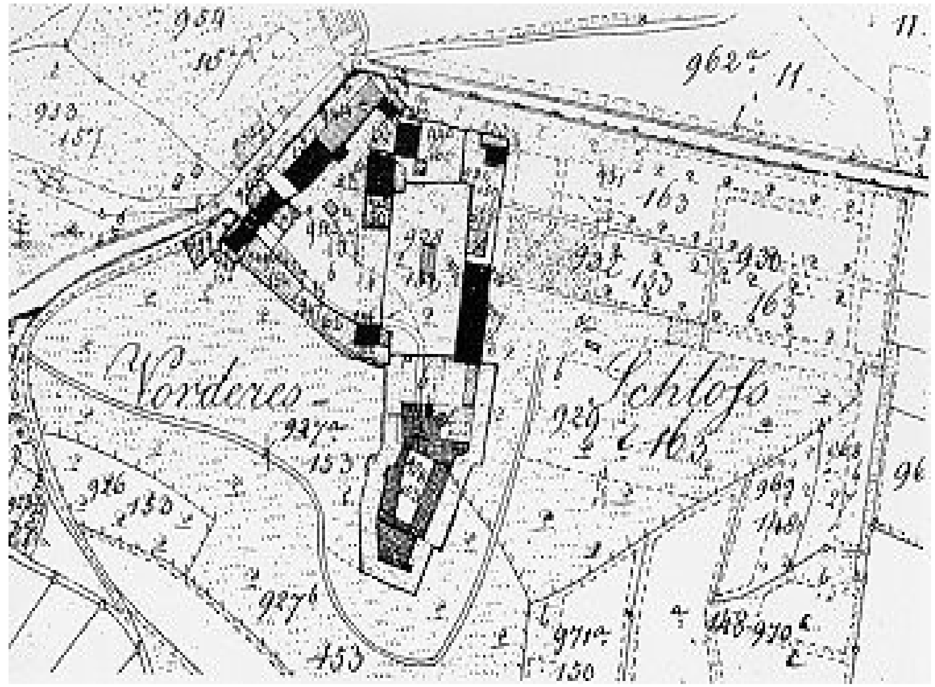
2. Mapping

Explorer Maps around 1500 were descriptions and described relative geographic locations determined by astronomic positions

The first map series based on astronomic positioning was Apian´s Map of Bavaria of 1570

Napoleon used it to conquer Bavaria from the Habsburgs in 1810

In the early 19th century Topographic Mapping was based on Triangulation Networks and Plane Table Surveying



Starting with Emperor Joseph of Austria in 1770 most mapping at larger scale was introduced for property taxation at the scale 1:2880

The Tax Cadastre also permitted to base some topographic objects on the property map (buildings, pastures, creeks, forests)

Aimé Laussedat
1819/1907 Paris Mapping

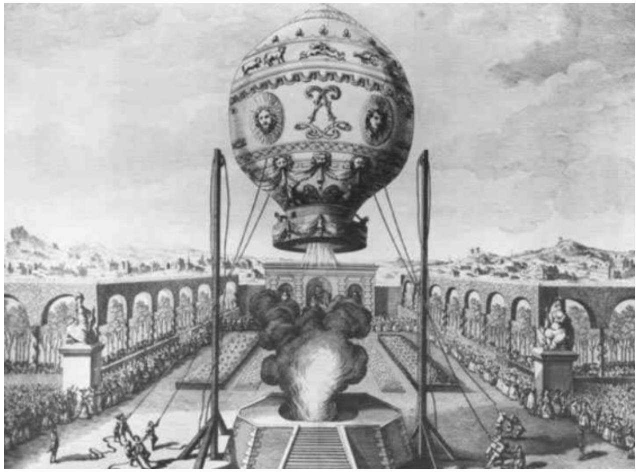
Albrecht Meydenbauer
1858/1865 Architectural Documentation

Iconometry

Photogrammetry

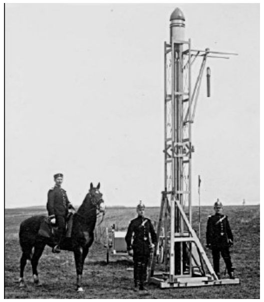
the use of photographs became a tool for the survey of all objects with the start in the 1850´s and with a global impact in the 1950´s

Aerial Platforms

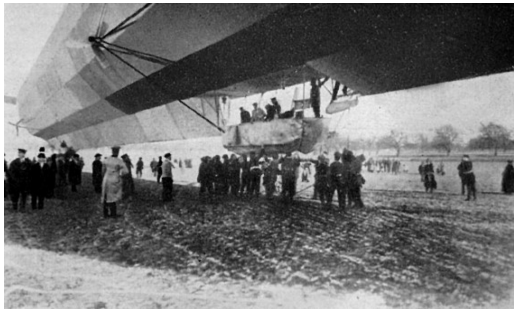


Jacques Etiene & Joseph Michel Montgolfier 1783

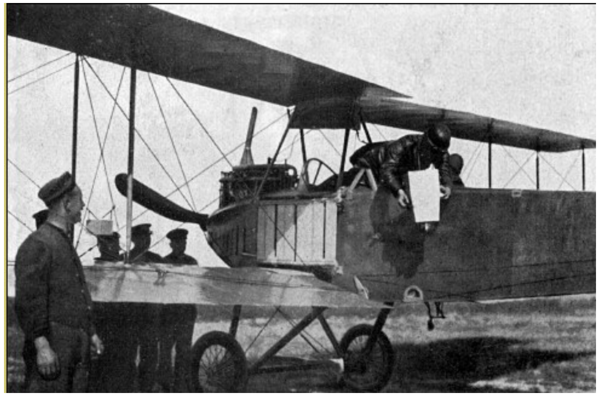
Gaspard-Felix Tournachon (Nadar)
balloon photography 1863



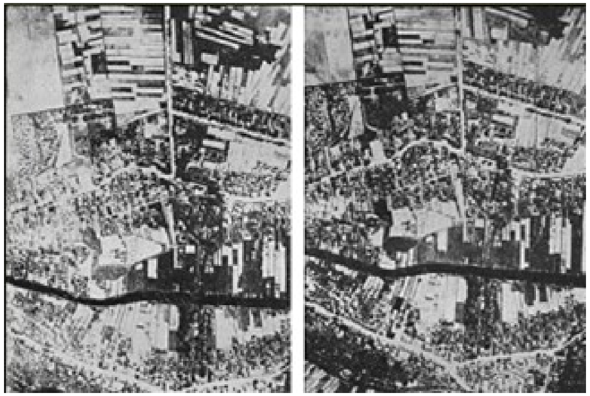
Rockets 1906

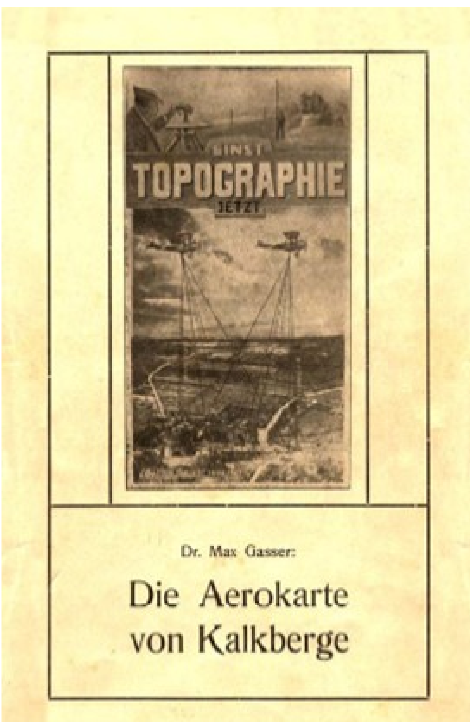


Zeppelin 1909



Aircraft 1914





Widmung.

Denjenigen Hochschulgeodäten gewidmet, die
durch Empfehlung Anderer
zur Unterdrückung Anderer
für Firmeninteressen
frei von jedem Forschungstriebe
von staatlichen Gehältern
leben.

Dr. Gasser.
1907 bis 1920 Dozent für Aero-Geodäsie
und Photogrammetrie an der Technischen
Hochschule zu Darmstadt.

Max Gasser invented the Gasser Projector (Multiplex) in 1915, for which he obtained a war patent.

1925 the Zeiss Company made the Stereoplanigraph

Gasser made a restitution of two stereo images taken from the Zeppelin over Kalkberge.

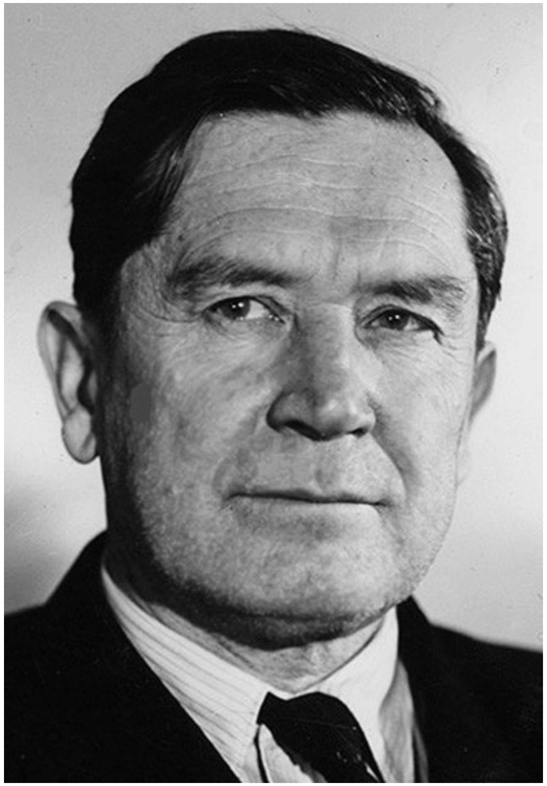
He published a book and dedicated it to those

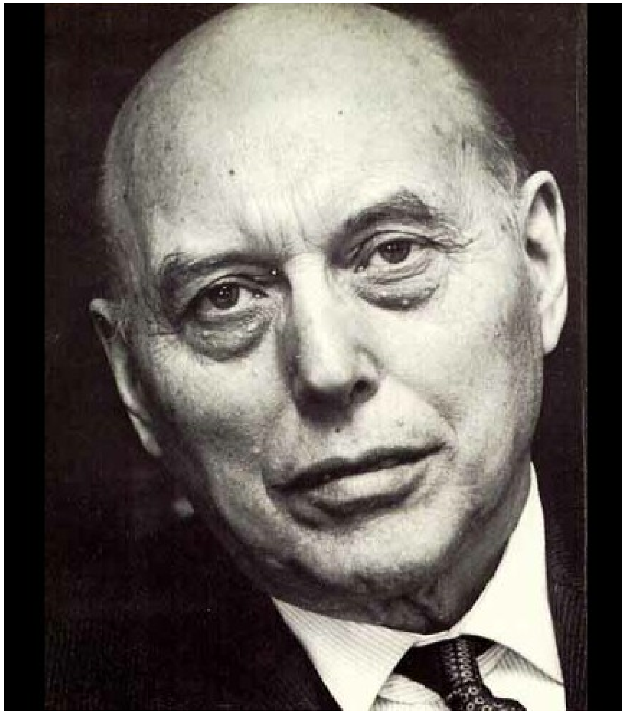
„University Geodesists, who by recommendation of others, for oppression of others, for company interests, free from research motivation, live from salaries of the Government“

F. V. Drobyshev
1894 - 1986

Professor of Photogrammetry
MIIGAIK   1941 – 1971

MIIGAiK was responsible for developing mapping technology in the socialist Countries, the USSR and China

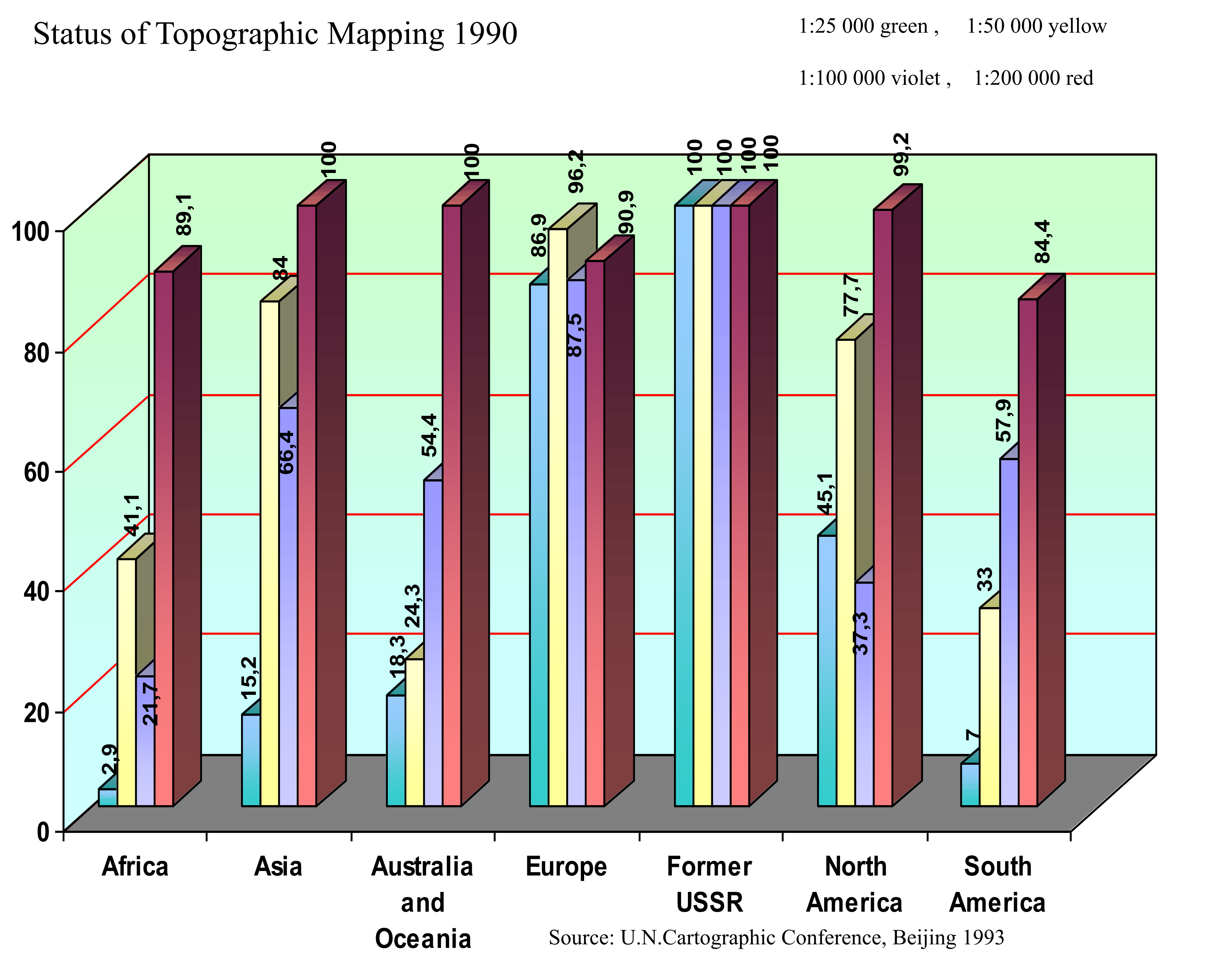




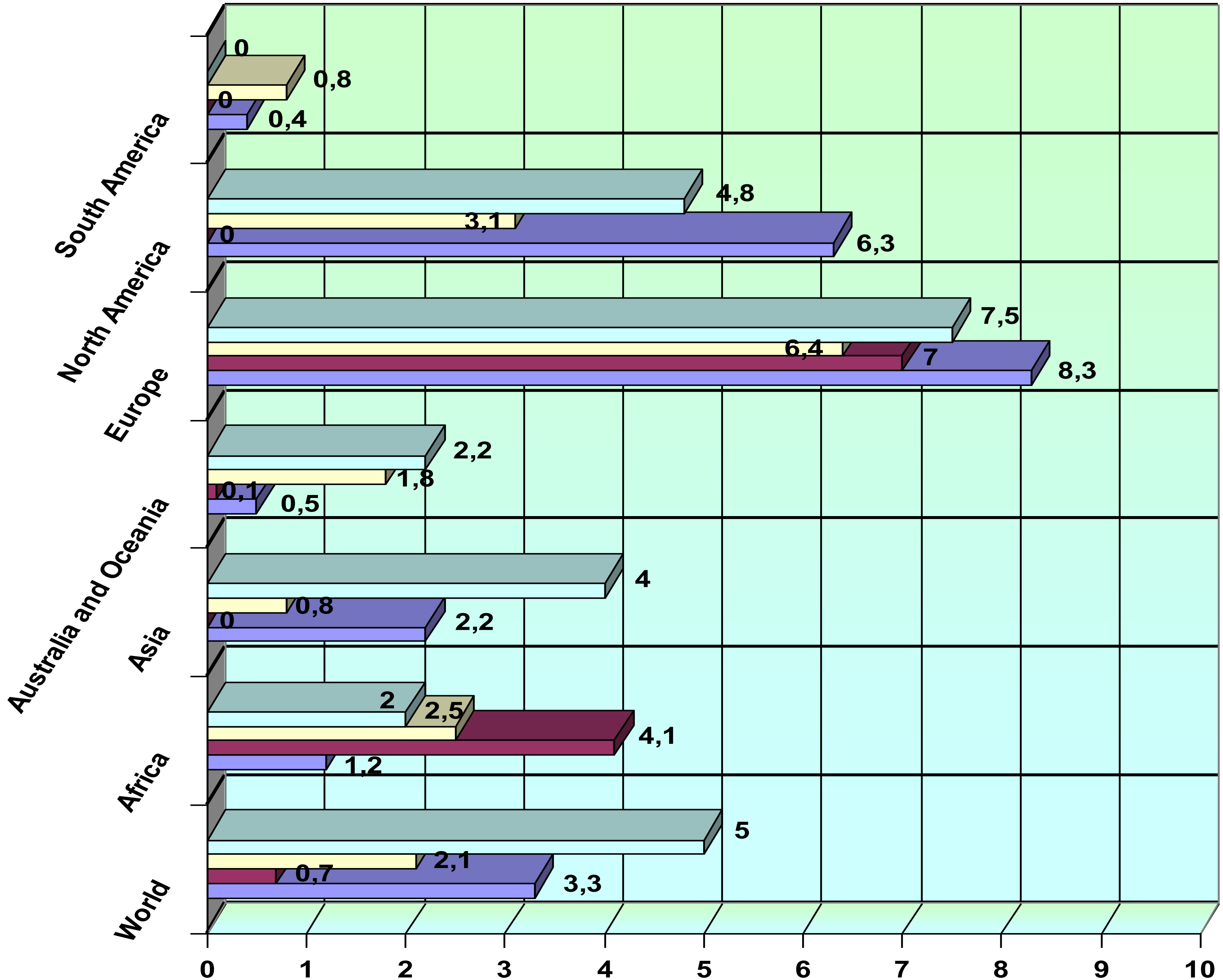
Willem Schermerhorn
Professor, Technical University Delft
President ISP 1938-1948
Prime Minister of the Netherlands
1946 – 1947
Founder of the ITC

spread the use of Photogrammetry
to the developing world

Status of Topographic Mapping 1990

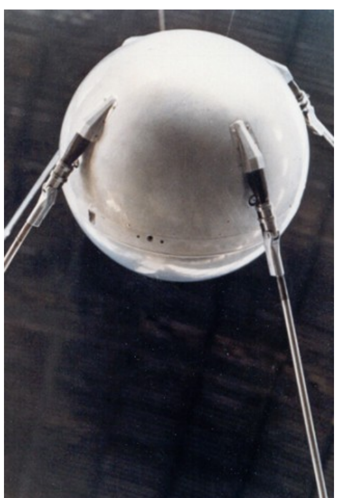


Source: U.N.Cartographic Conference, Beijing 1993



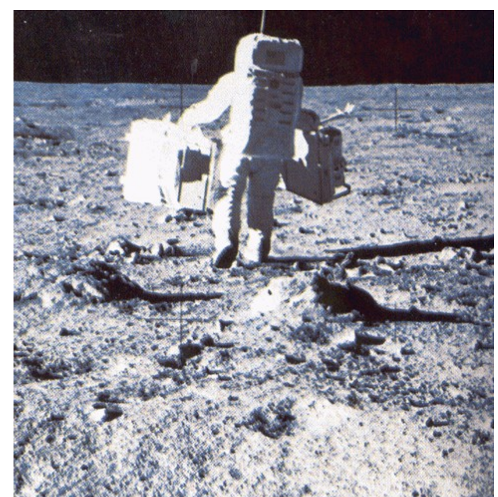
Map Updating Source: U.N. Cartographic Conference Bangkok, 1990

Koroljov Wernher von Braun

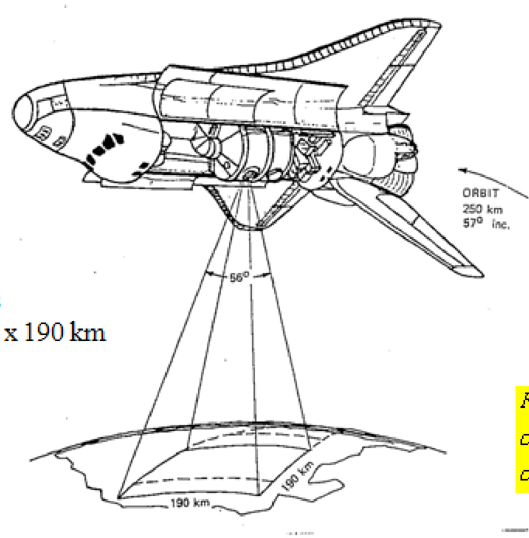


Sputnik 1957

Space Platforms



Man on the Moon 1969



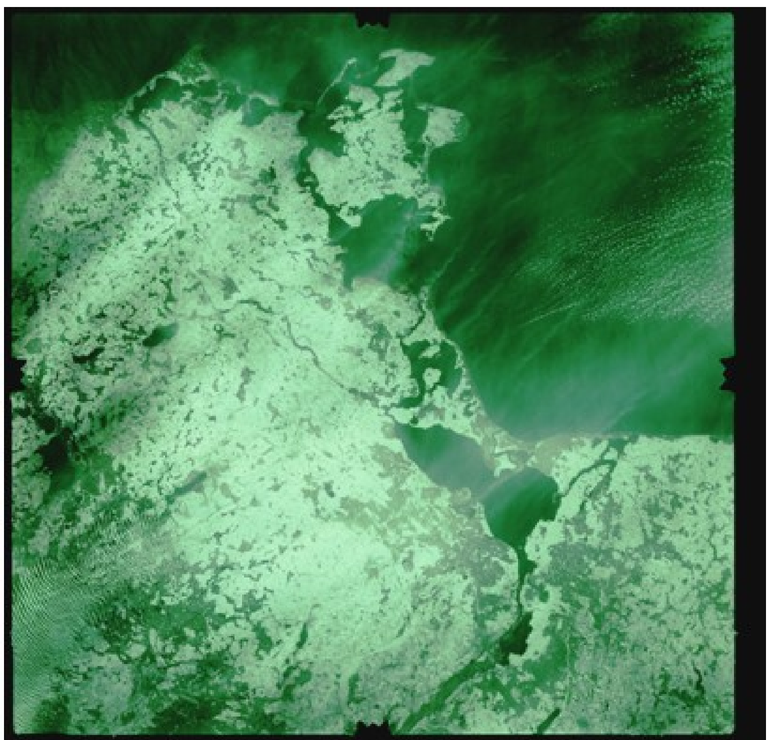
1000 Images
each 190 km x 190 km

$R_g \approx 15m$
$\sigma_z \approx 15-20m$
$\sigma_{xy} \approx 10m$

Project Scientist: Gottfried Konecny, University Hannover
Project Engineer: Manfred Schroeder, DLR-Oberpfaffenhofen
Project Manager: Arndt Langner, DLR-Cologne
Industrial Contractor: T. Miski, ERNO, Bremen
K Meier,C.Zeiss, Oberkochen
ESA-Project Coordinator: Mike Reynolds, ESTEC, Nordwigk
ESA-Metric Camera Working Groups
Gottfried Konecny, University Hannover, Chair
Jan Dowmann, University College, London
Guy Ducher, IGN, Paris
Giovanna Togliatti, Politecnico, Milano

Before the 1980´s
high resolution images from
Space were
Considered secret
in 1983 the German Government
and ESA financed the
„Metric Camera Experiment“
from Space Shuttle

10% of the earth´s land mass
was covered in stereo in the
9 day mission

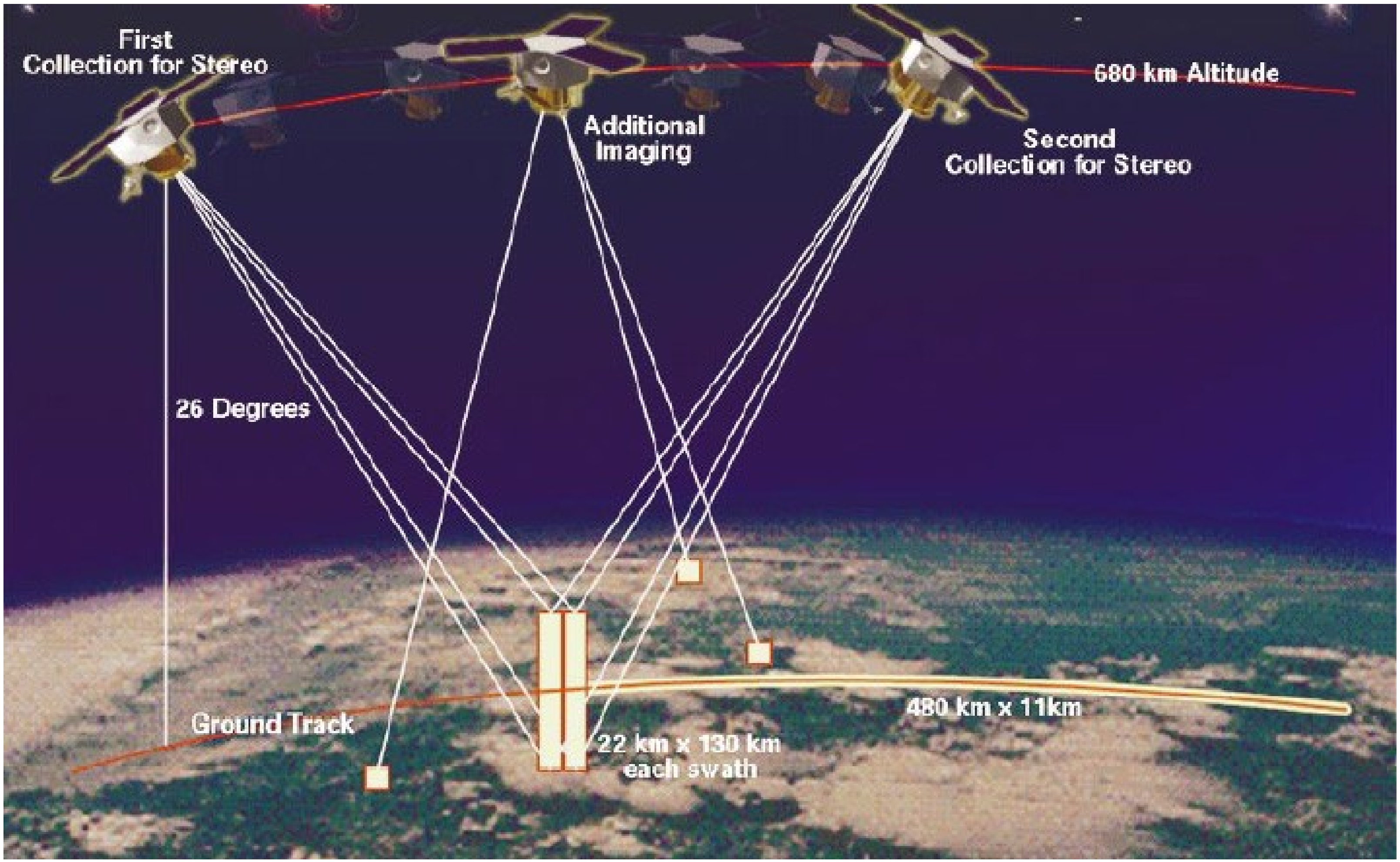


the film was developed at DLR or IGN. A beautiful strip was taken over the GDR. The Government, not wanting to admit that imagery had been taken 0ver a socialist country, did not include the images in the catalogue.

Instead, copies of these images were taken informally to our ISPRS friends in the GDR by car

the favourable response came later in 1987, when ISPRS was brought to Leipzig for a meeting, where the collegues of the Sovjet Union (Kienko and Drazhniuk) openly showed us their KFA 1000 images.

Stereo Image Collection from Space as it is practised today



Current Status of Satellite Imaging

GeoEye 1   0.5m GSD

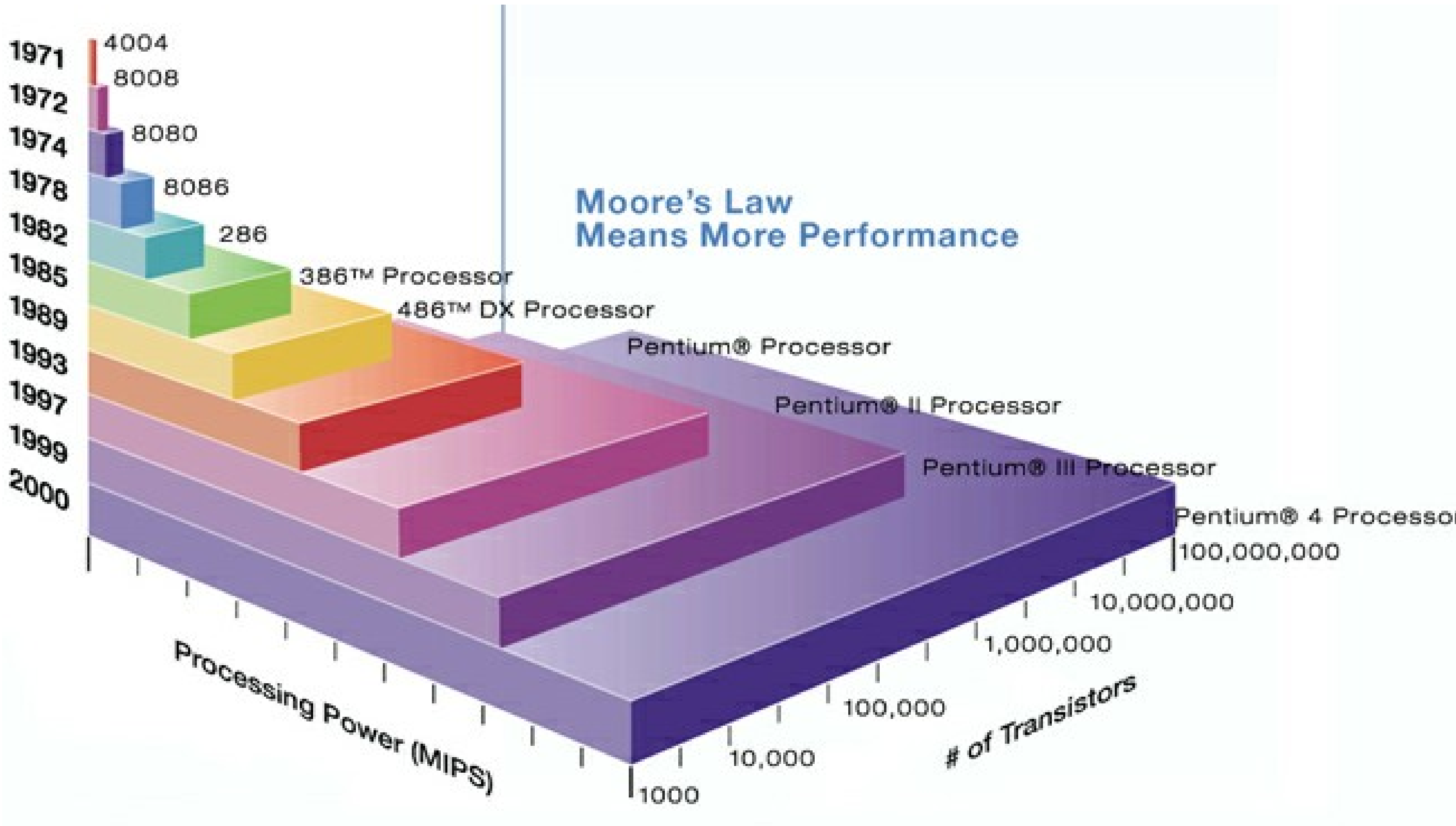
WorldView 2   0.5m GSD

Pleiades 1
0.5m GSD

TerraSar X
1m GSD

3. Databases

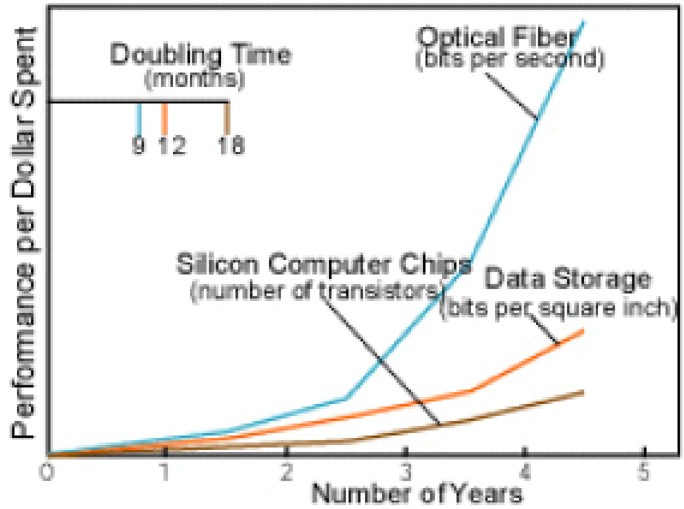
Exponential Growth of Computer Technology



Exponential Growth in Network Performance

Network exponentials

- Network vs. computer performance
  - computer speed doubles every 18 months
  - network speed doubles every 9 months
  - difference: order of magnitude per 5 years
- 1986 to 2000
  - computers: x 500
  - networks: x 340,000; factor 1000
- 2001 to 2010
  - computers: x 60
  - networks: x 4000; factor: 100



Moore's Law vs. storage improvements vs. optical improvements. Graph from **Scientific American** 2001) by Cleo Vilett, source Vined Khoslan, Kleiner, Caufield and Perkins

6. GIS and Database Technology

an example: ArcGIS

Software components in ArcGIS (1)

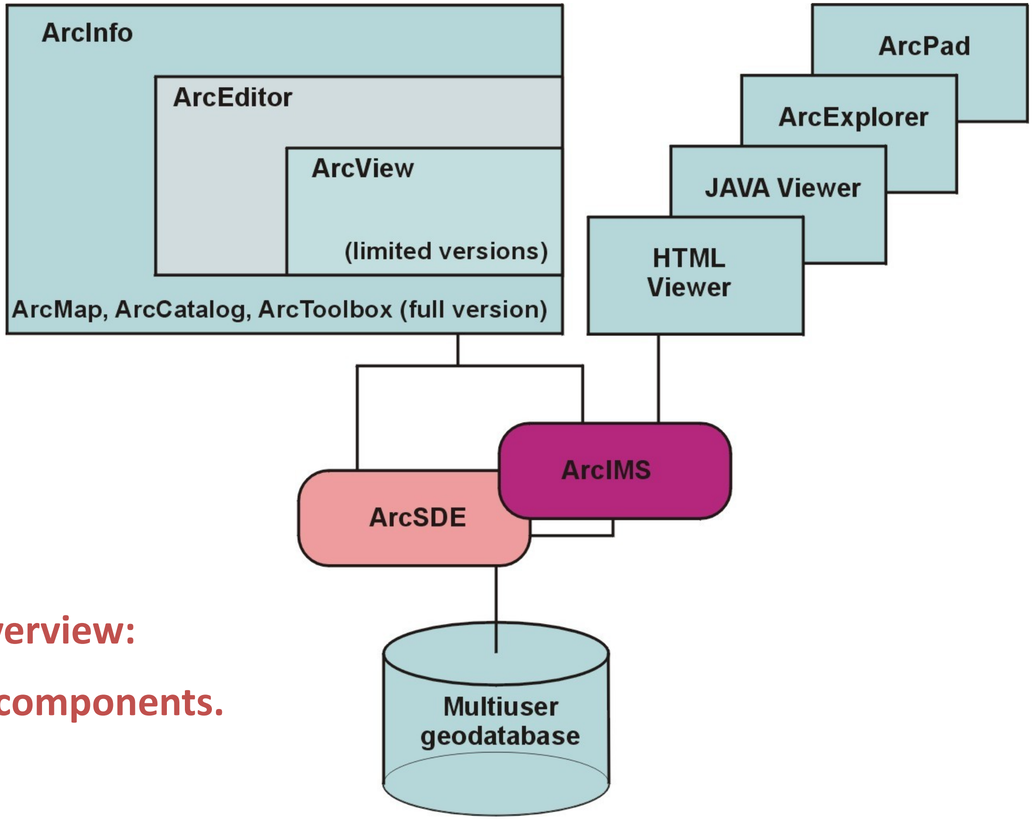
Introduction

Objectives

Materials & Methods

Results

Conclusions / Outlook



Overview:

ArcGIS components.

Test Plots - Level 1 Map

Introduction

Objectives

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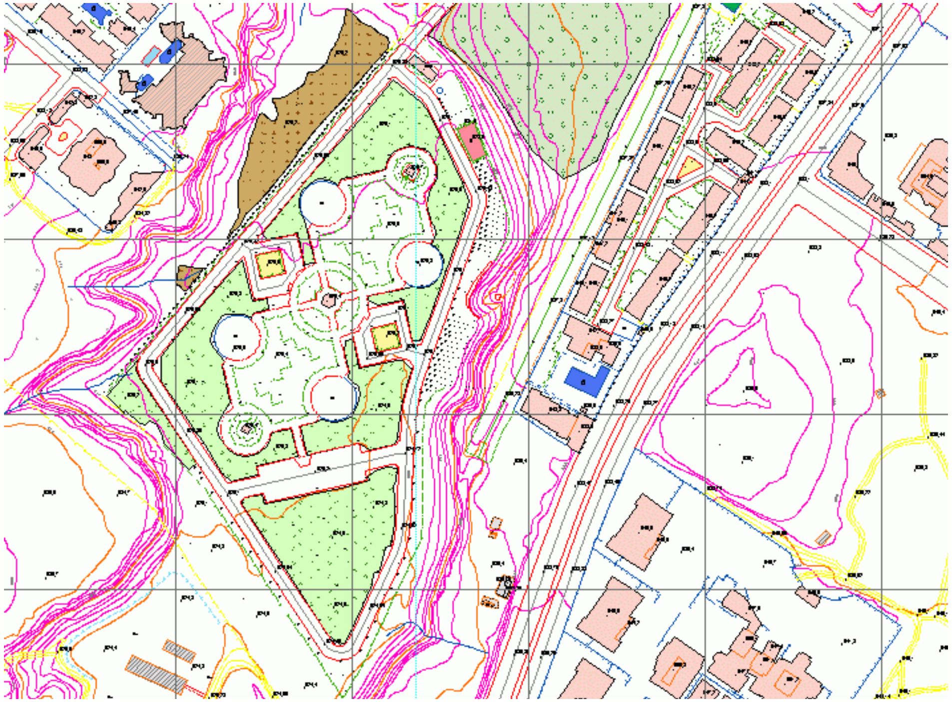


Result of import into ArcGIS/ArcInfo and automated polygon closure & attribute allocation.

Test Plots - Level 2 Map

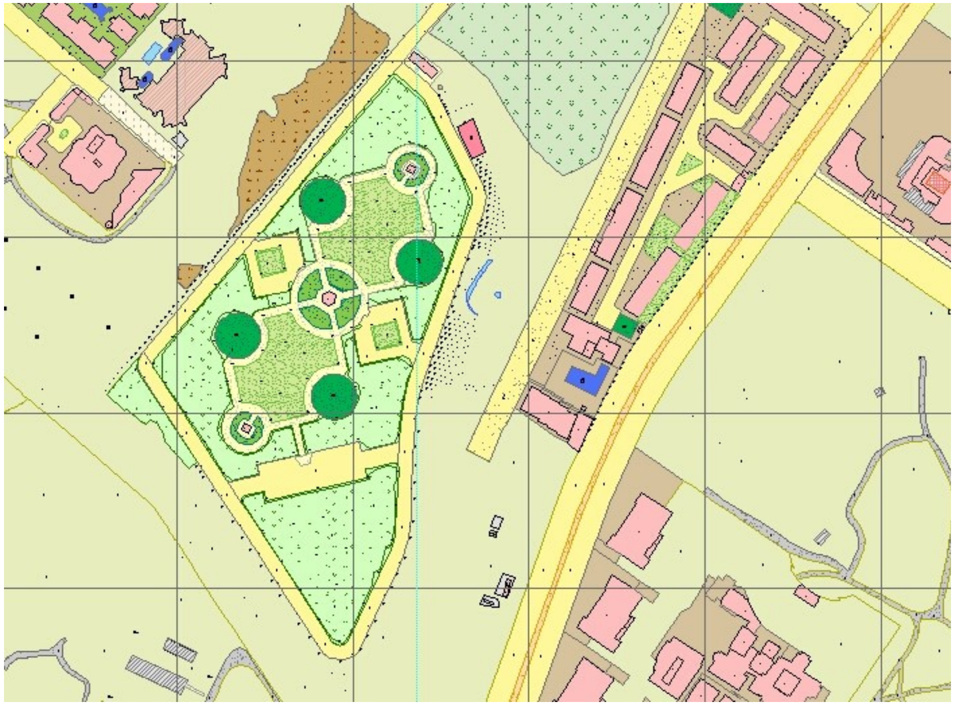
Introduction

Objectives

Materials & Methods

Results

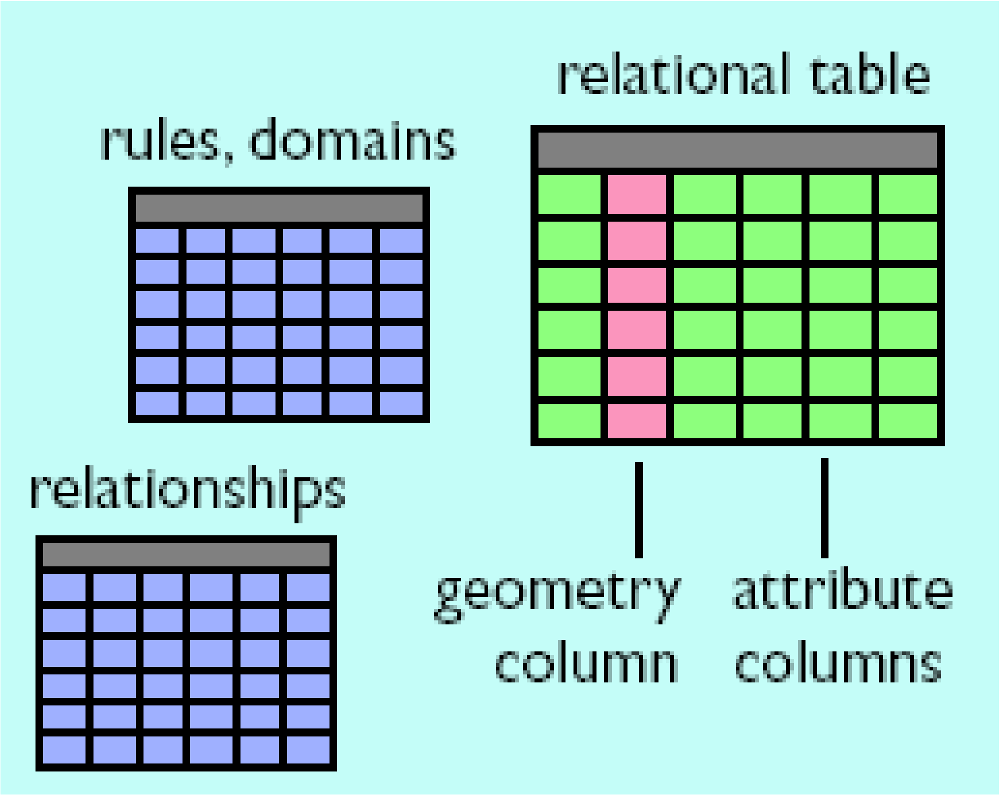
Conclusions / Outlook



Result of import into ArcGIS/ArcInfo and manual polygon closure & attribute allocation.

The geodatabase data model

(3rd generation)



3.1.1.1 Administrative Borders:

FEATURE DATASET	FEATURE CLASS	ATTRIBUTE	SUB-TYPE	DOMAIN
ADMINISTRATIVE BOUNDARIES	Communa (Polygon)	-OBJECTID	–	–
		-SHAPE	–	–
		-SHAPE_Length (m)	–	–
		-SHAPE_Area (m^2)	–	–
		-Name	–	–
	Mini-Municipality (Polygon)	-OBJECTID	–	–
		-SHAPE	–	–
		-SHAPE_Length (m)	–	–
		-SHAPE_Area (m^2)	–	–
		-Mini_Municipality_ID **Use existing 11 mini-municipality inside 30 km2. Outwards, use one compact region i.e Minimunicipality # 12**	–	–
		-Name **Numeric data from1 to 12**	–	–
	Village (Polygon)	-OBJECTID	–	–
		-SHAPE	–	–
		-SHAPE_Length (m)	–	–
		-SHAPE_Area (m^2)	–	–
		-Name	–	–

3.1.1.2 Blocks:

FEATURE DATASET	FEATURE CLASS	ATTRIBUTE	SUB-TYPE	DOMAIN
BLOCKS **Iprs cadastral blocks are used for geometry**	Block (Polygon)	-OBJECTID	–	–
		-SHAPE **IPRS blocks are used within 30 km2, outwards preliminary blocks are drawn**	–	–
		-Block_ID **New Numbering** **(Described in detail under Section 2.3.1 above)**	–	–
		-Population_Density (person/m^2) **Spatial query between BLOCK and centroid of INSTAT BUILDING, calculate SUM of POPULATION within the same BLOCK. After then, divide by the AREA of BLOCK FC.**	–	–
		-Builtup_Area_Ratio (($m*m^2$)/m^2) **Spatial query between BLOCK and centroid of BUILDING FC, calculate SUM of (HEIGHT*AREA) of each BUILDING within the same BLOCK. After then, divide by the AREA of BLOCK FC.**	–	–
		-Floor_Area_Ratio (m^2/m^2) **Spatial query between BLOCK and centroid of BUILDING FC, calculate SUM of (AREA) of each BUILDING within the same BLOCK. After then, divide by the AREA of BLOCK FC.**	–	–
		-Hours_of_Water_Supply*	–	–
		-Hours_of_Electricity_Supply*	–	–
		-Office_Space*	–	–
		-SHAPE_Length (m)	–	–
		-SHAPE_Area (m^2)	–	–
: Reserve a space for these items, however it'll be filled out by Bashkia in future due to lack of existing information				

3.1.1.3 Buildings

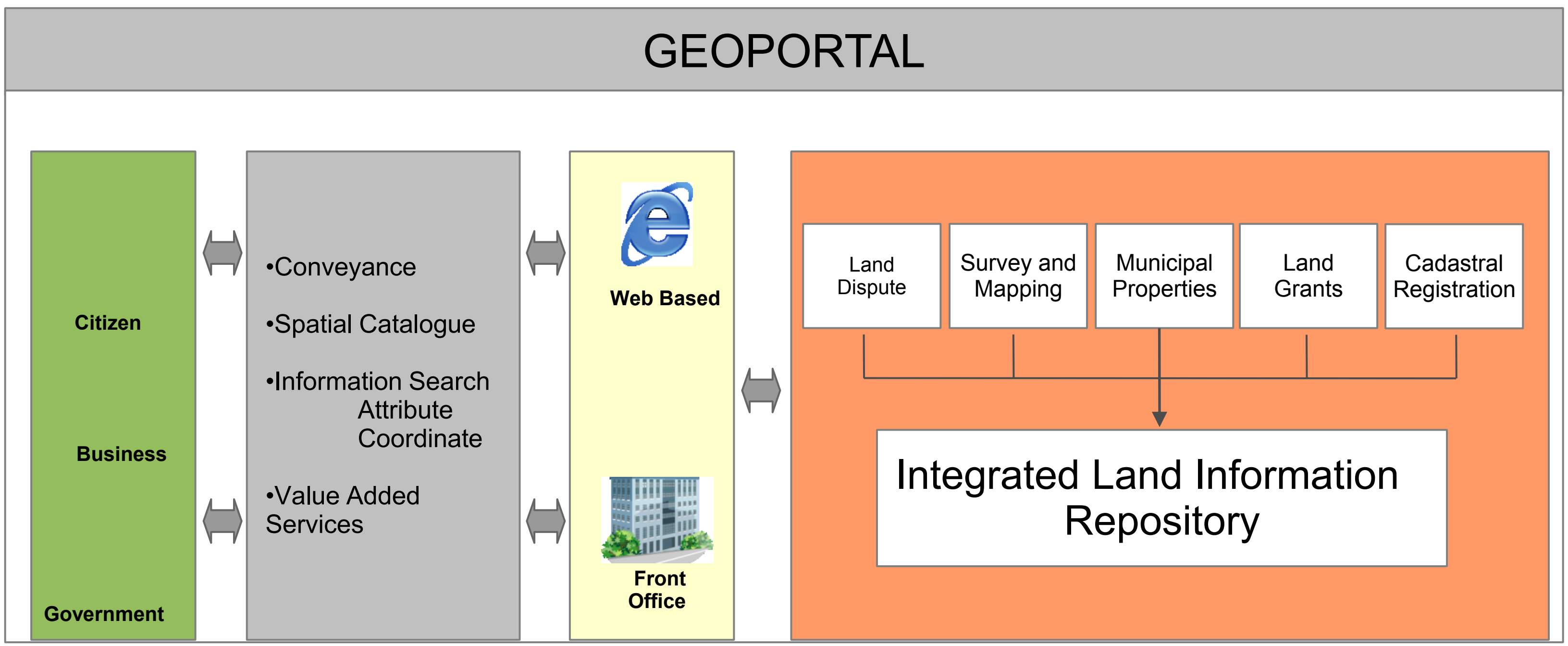
FEATURE DATASET	FEATURE CLASS	ATTRIBUTE	SUB-TYPE	DOMAIN
BUILDINGS	Building (Polygon)	-OBJECTID	–	–
		-SHAPE **Drawn from QB satellite image**	–	–
		-SHAPE_Length (m)	–	–
		-SHAPE_Area (m^2)	–	–
		-Center **Geodetic centroid in UTM projection**	–	–
		-Height **Found via field study, exceptions: construction in process, military areas took "0"**	–	–
		-Building_ID **New Numbering (Described in detail under Section 2.3.1 above)**	–	–
		-Parcel_ID **New Numbering (Described in detail under Section 2.3.1 above)**	–	–
		-Municipality_ID **Spatial query between centroid of BUILDING FC & MINIMUNICIPALITY FC.**	–	–
		-Block_ID **Spatial query between centroid of BUILDING FC & BLOCKS FC**		

3.1.1.4 Land-use:

FEATURE DATASET	FEATURE CLASS	ATTRIBUTE	SUB-TYPE	DOMAIN
LANDUSE	Agriculture (Polygon)	-OBJECTID	–	–
		-SHAPE	–	–
		-SHAPE_Length (m)	–	–
		-SHAPE_Area (m^2)	–	–
		-Type	-Green House -Cultivated Area	–
	Empty_Areas (areas that do not have a landuse property) (Polygon)	-OBJECTID	–	–
		-SHAPE	–	–
		-SHAPE_Length (m)	–	–
		-SHAPE_Area (m^2)	–	–
	Cemeteries (Polygon)	-OBJECTID	–	–
		-SHAPE	–	–
		-SHAPE_Length (m)	–	–
		-SHAPE_Area (m^2)	–	–
	Commercial (Polygon)	-OBJECTID	–	–
		-SHAPE	–	–

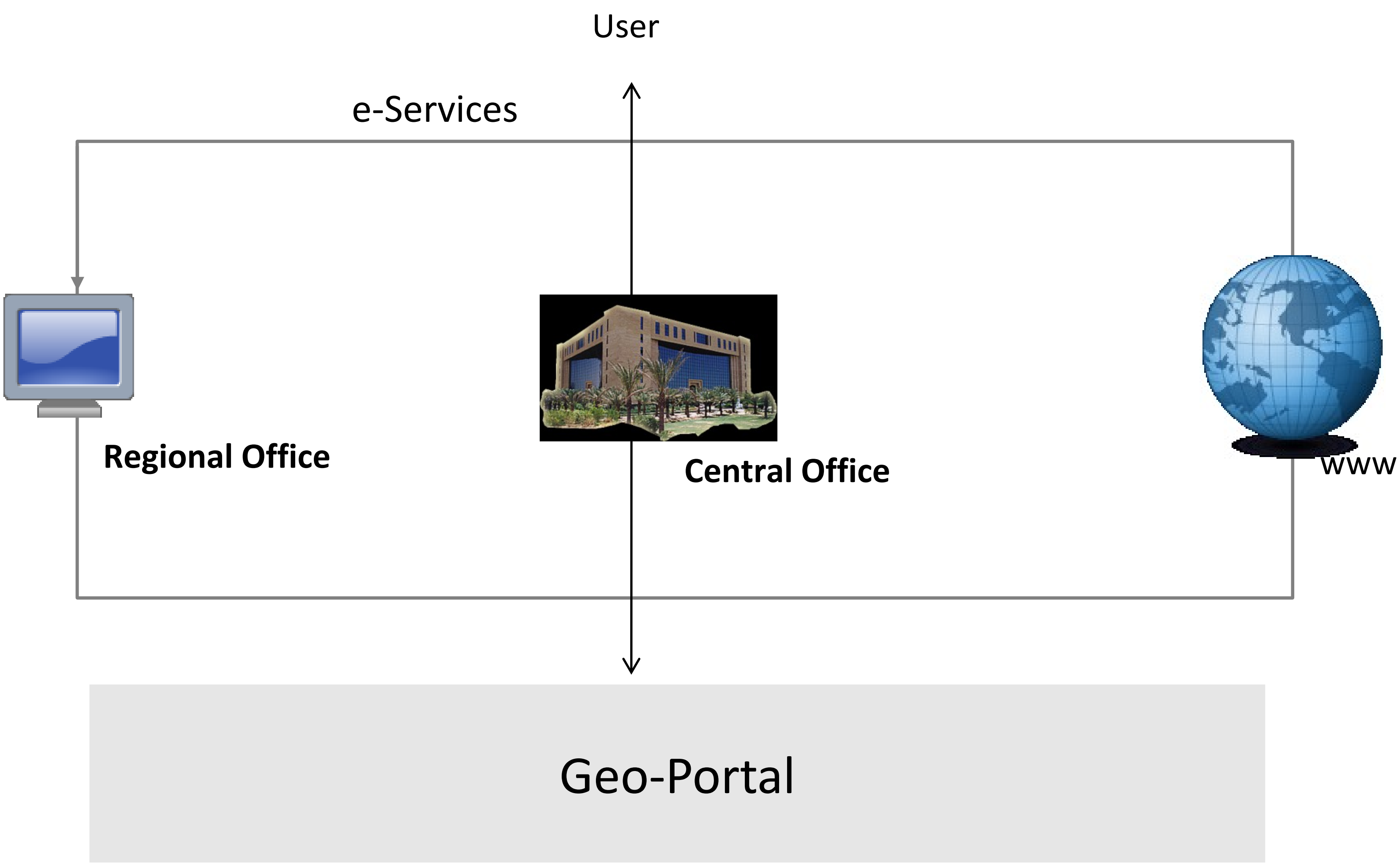
VISION

‘To design, implement and manage a comprehensive and sustainable GEOPORTAL, which serves as an “One Stop” source of land information and services in an integrated, efficient and cost effective manner.’

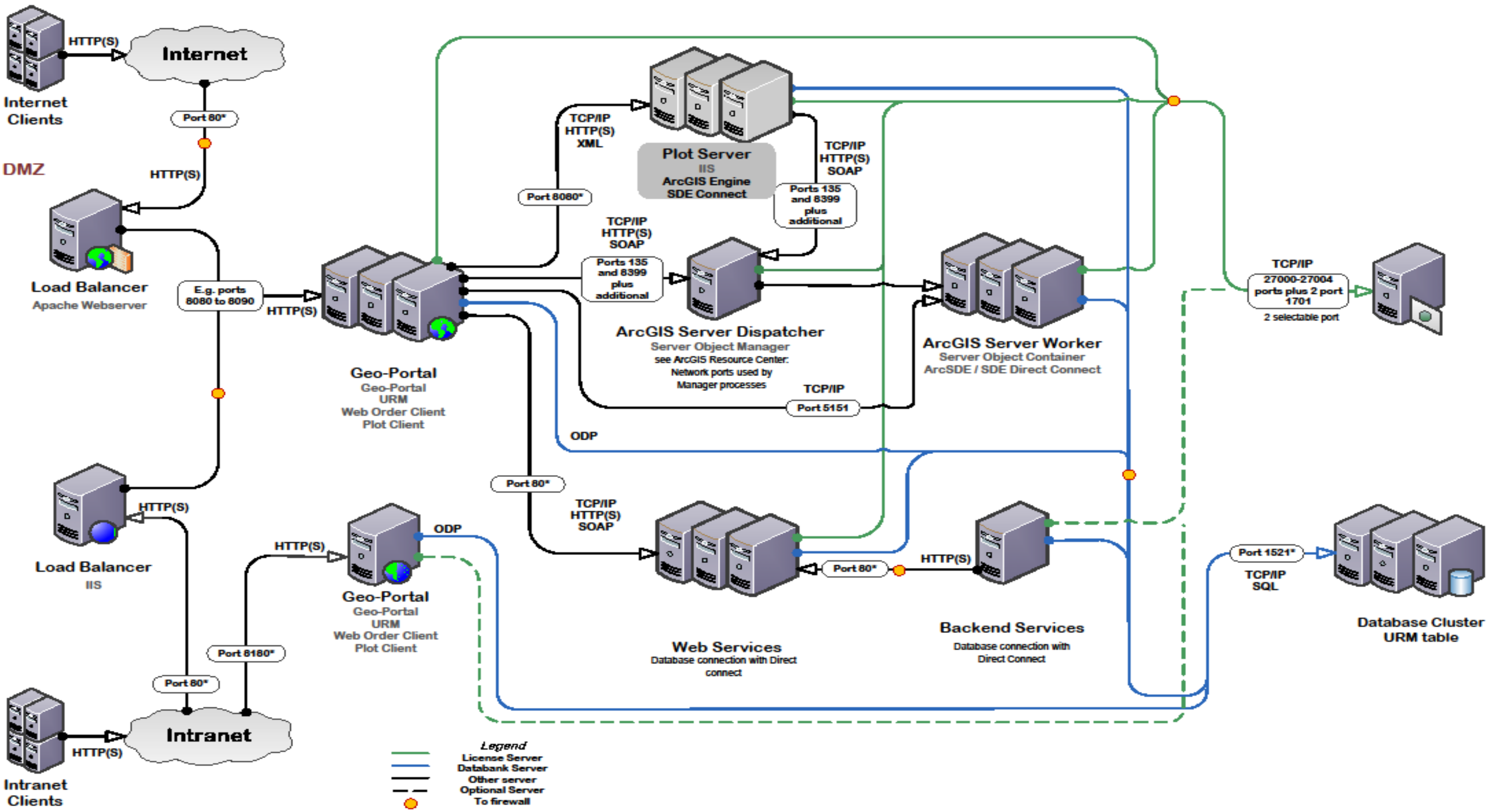


STRUCTURE

Components	Element	Environment	Functions
Web-Portal	Web Site,Web Control	.NET	Search, Map Viewer, Publish, Administrate Query, Gazetteer, Mapping, Edit, Geo-coding
Web-services	Geographical Web-services	XML, SOAP, WSDL, WMS, WFS	Query, Map render/feature, Transaction, Geocode
Data Management	DBMS	Oracle	Raster,vector, Tabular


User
e-Services
Regional Office
Central Office
www
Geo-Portal

ARCHITECTURE

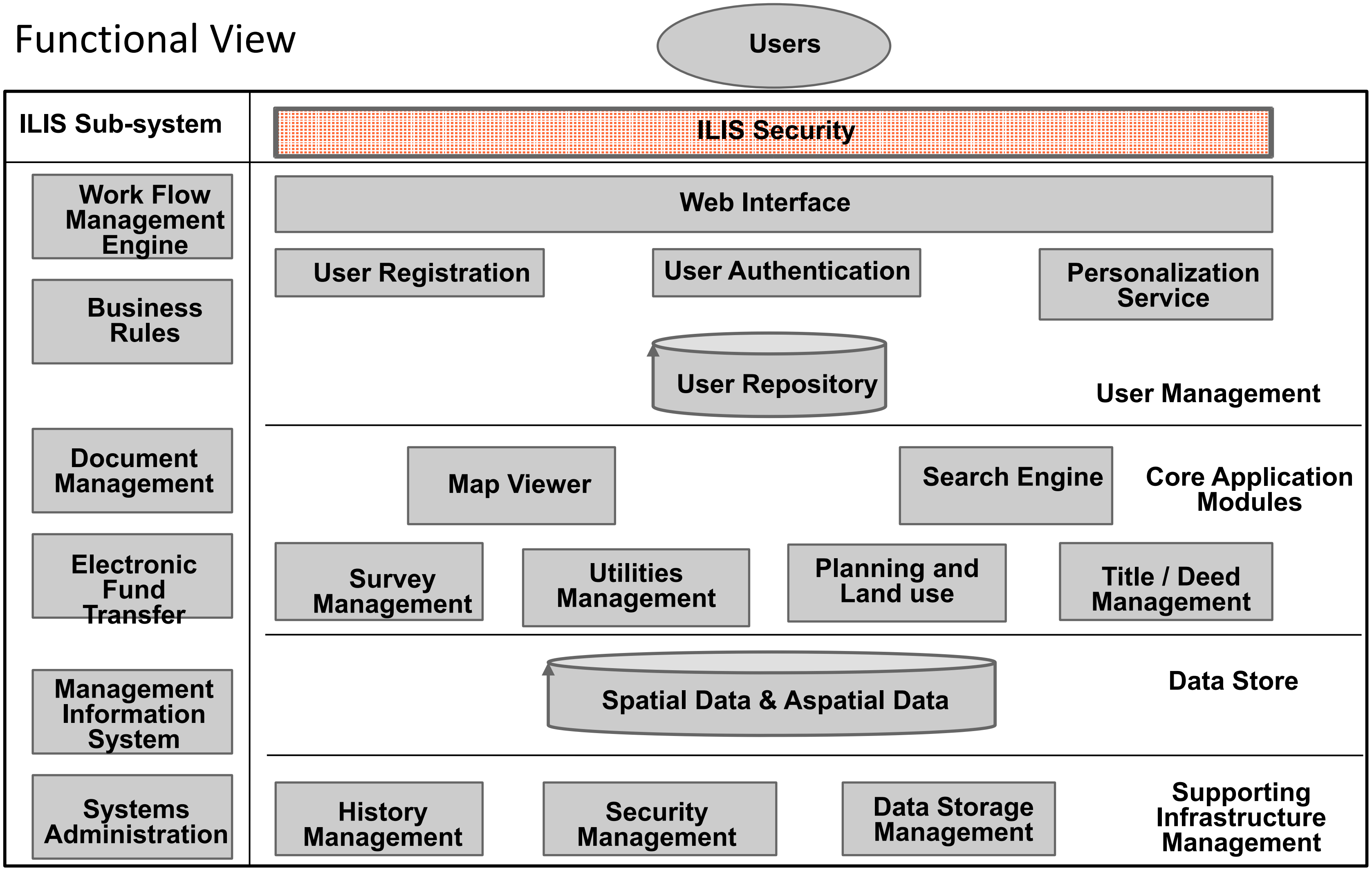


FUNCTIOINAL REQUIRMENTS

Functional Requirements

- Multiple Service Delivery Channel and Integration
- User services
- Management Services
- Map Viewer
- Document Management System
- Information Access and Search
- e-Acceptance of Transaction Documents
- Information Security
- Bilingual Language Support (Arabic and English)
- MIS and Reports
- Integration with other entities

Functional View



8. Smart Phones permit GIS to become mobile

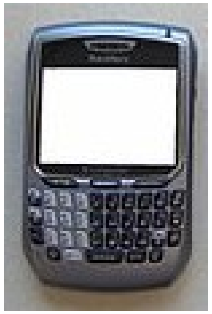
Apple

I Pod

I Pad

I Phone

I Phone G3



Blackberry

Samsung Omni

Smartphone

Ein Samsung I8910HD (Symbian S60)

Versatility
lies in the
downloadable
„Apps“
making the
Smartphone

a Navigation Device
(Google Maps, Navtech, Tom Tom)
an Internet Browser
a phone
a data base