The surveyor 4.0

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International Federation of Surveyors
Féderation Internationale des Géomètres
Internationale Vereinigung der Vermessungsingenieure

Content

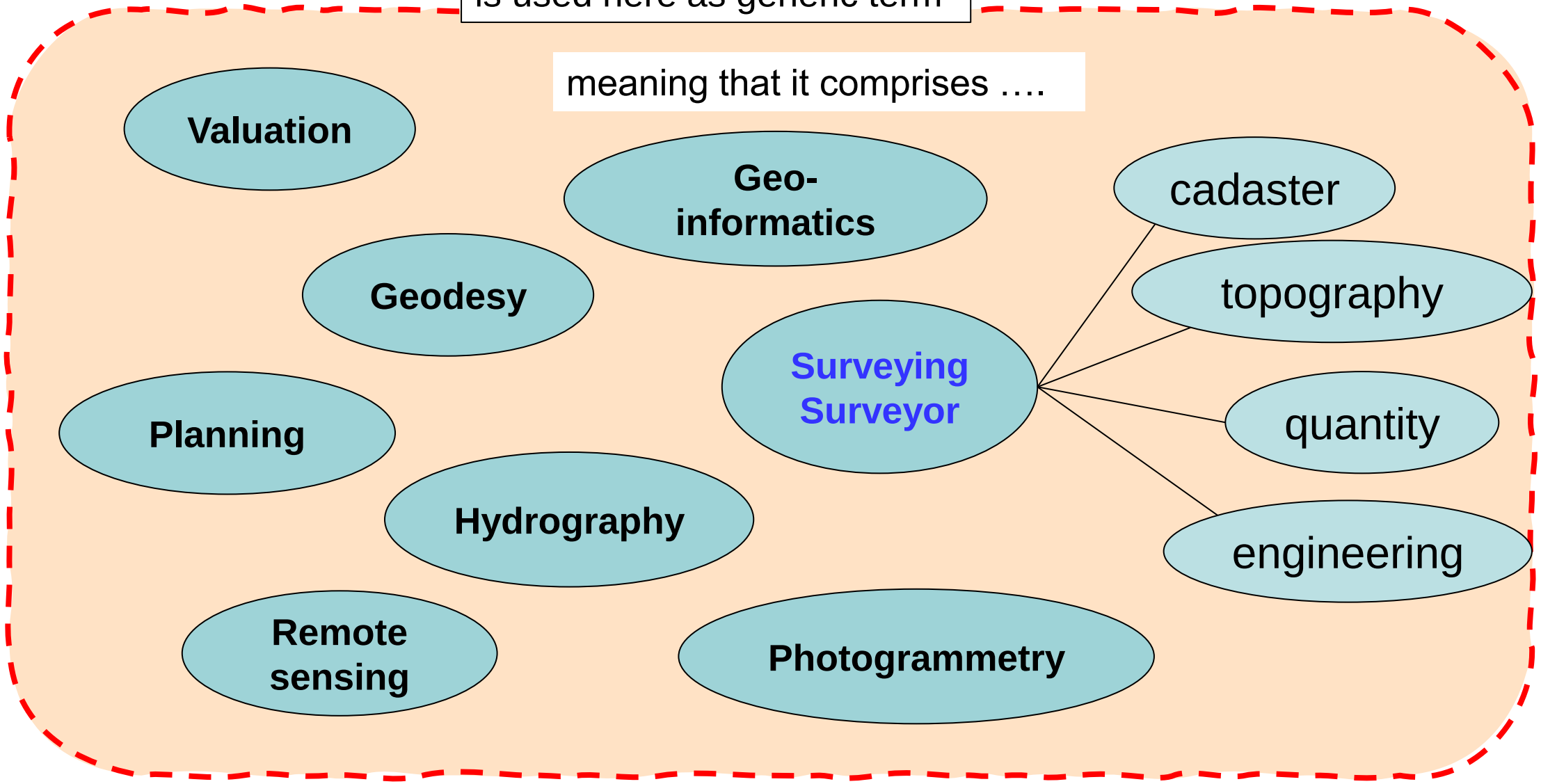
- Introduction – some definitions
- History – geodetic measurements
- Present - Measurements / Profession / Society
- Future
  - 4th Industrial Revolution
  - Surveying 4.0
- Conclusions

The expression

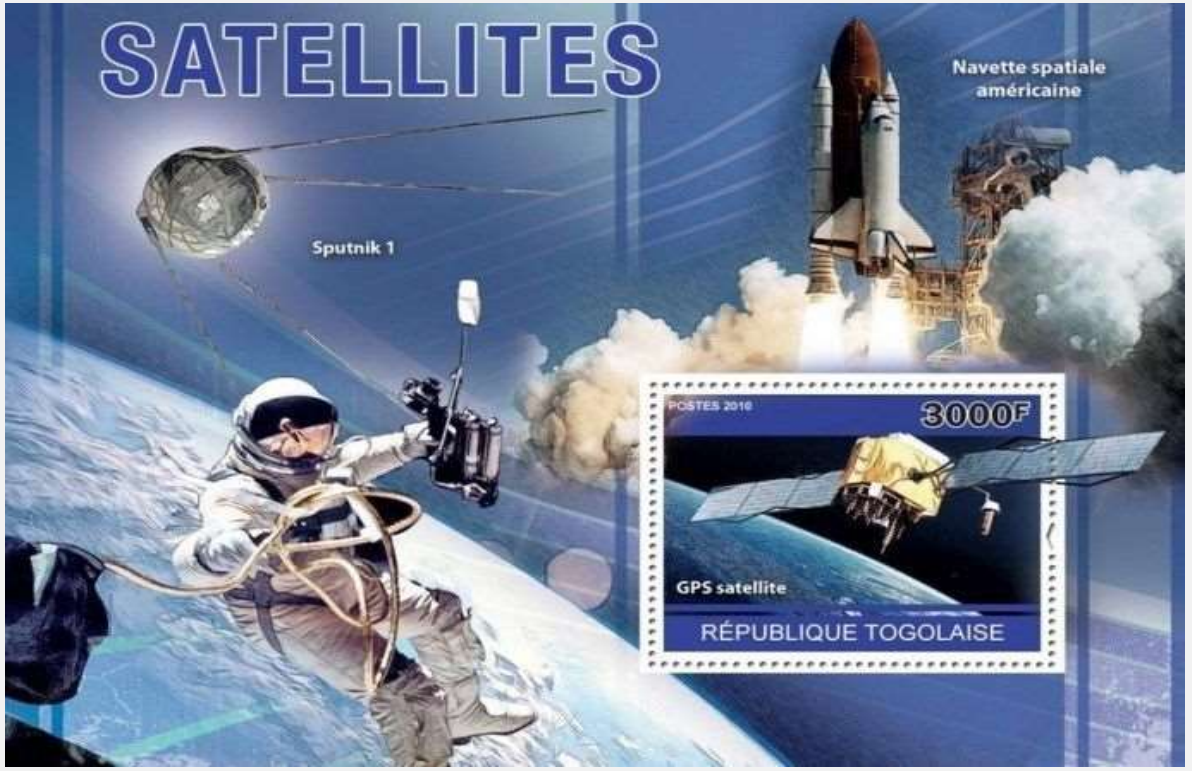
Surveyor / surveying

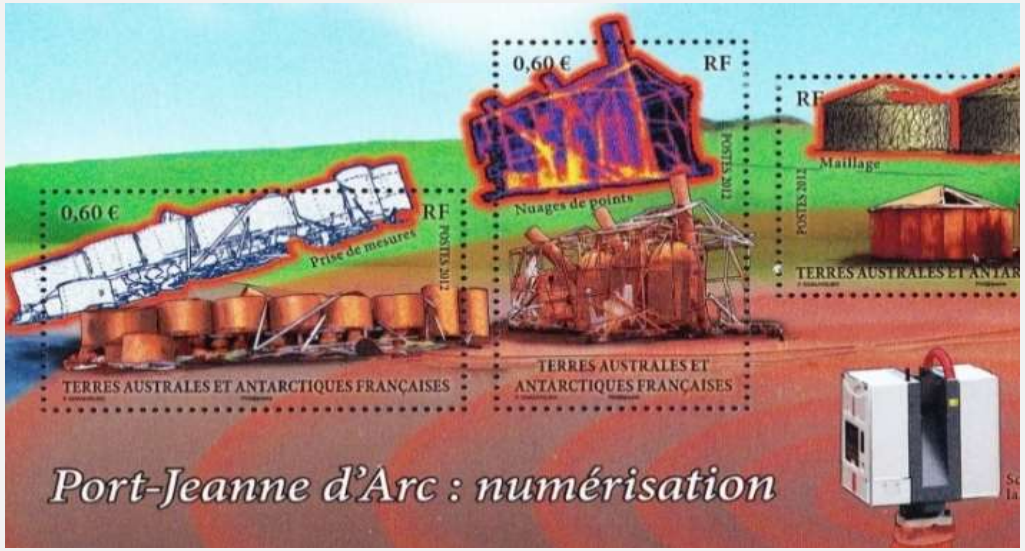
is used here as generic term

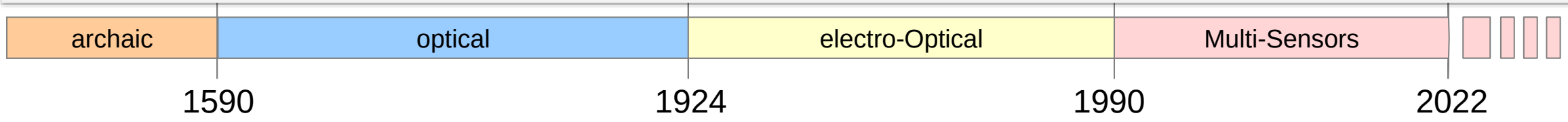
meaning that it comprises ….



Geodetic Instruments – Technical development in 4 phases







Industrial Revolutions (IR)

1. Slaughter house

second

electricity -> mass production
forms of energy: oil + gas

1. Programable
Micro-Controller

Third

Electronic + Information-technology
automatized production
nuclear energy

First

Water + Steampower

1. mechanical
loom

Foundation of FIG

1786

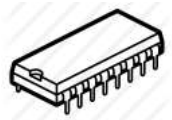
1870

1878

1969

time

Archaic	Optical	Electro-Optical	Multi-Sensors
1590	1924	1990	2022

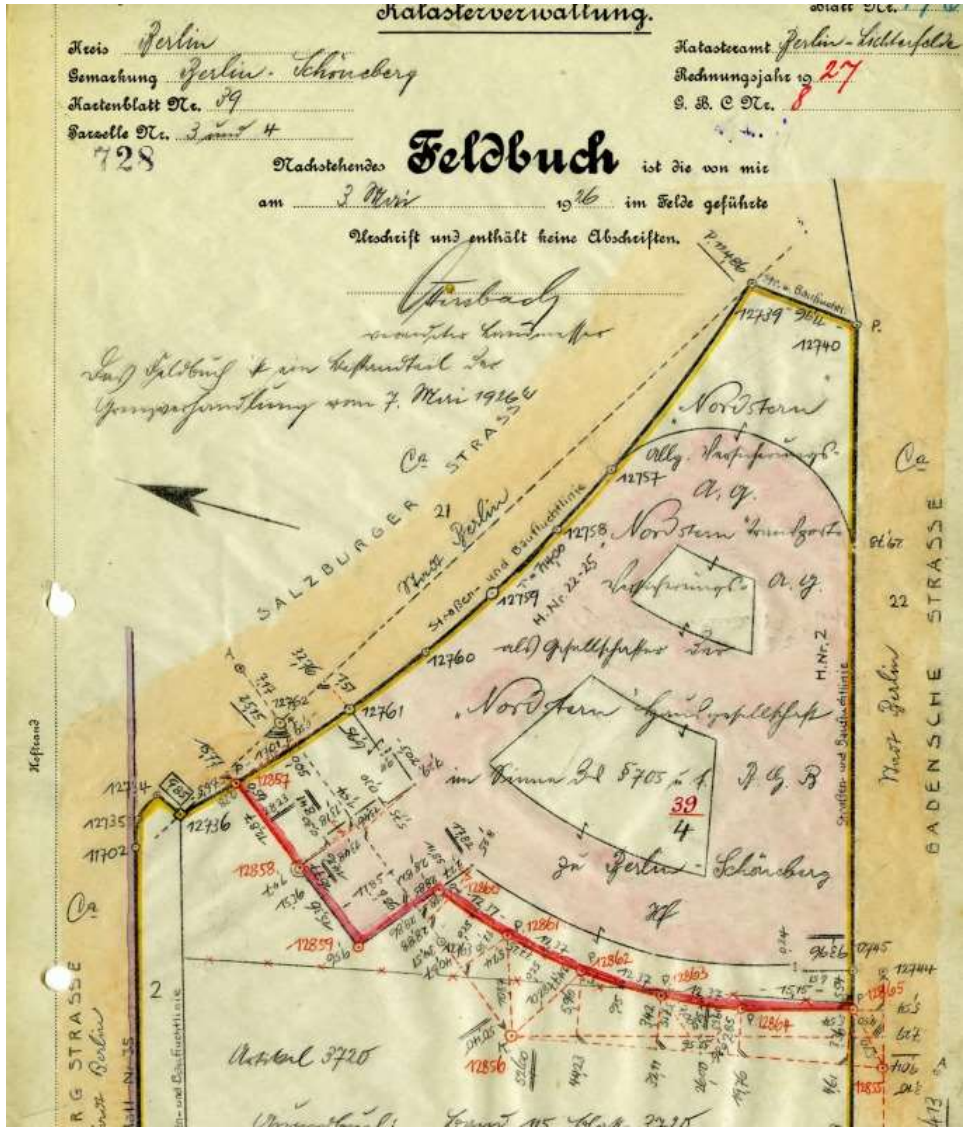


3. Industrial revolution (IR)

EDM = **E**lectronic **D**istance **M**easurement

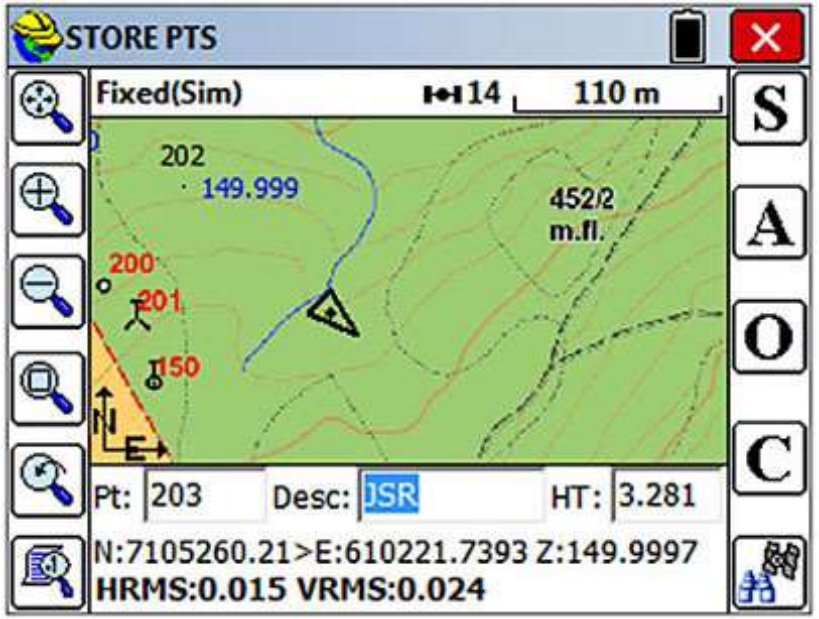
3. Industrial revolution (IR)

Digital storage + Visualisation



source: www.berlin.de

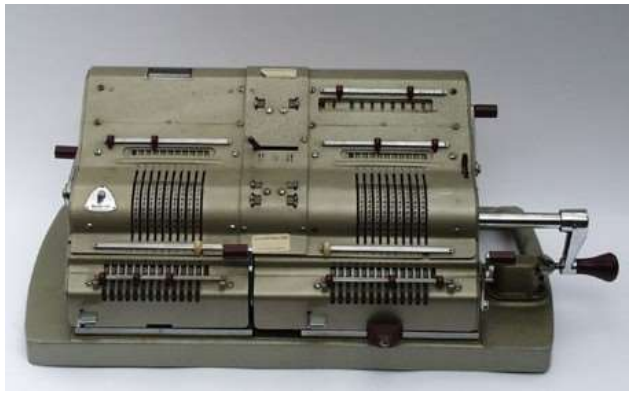
Electronic fieldbook



source: CARLSON CURVE

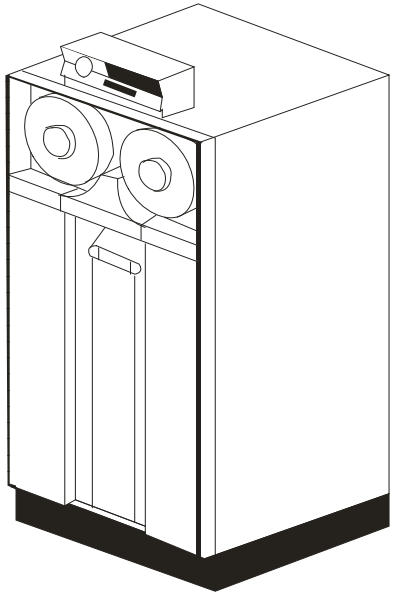
3. Industrial revolution (IR)

Pocket calculator programable

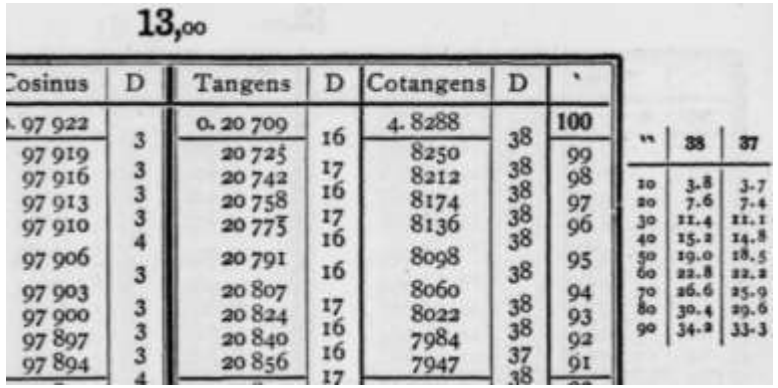


calculations

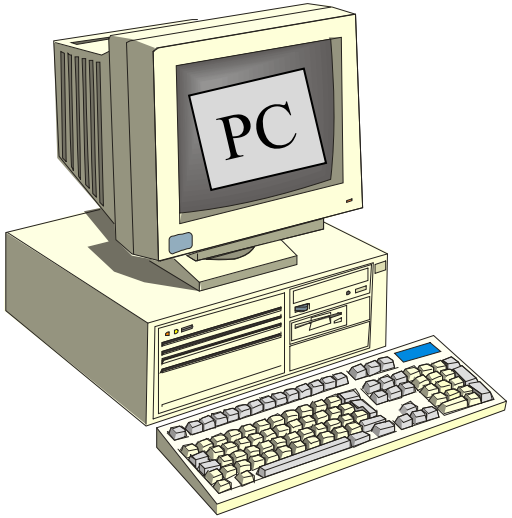
Mechnical Calculation engine



Main Frame



Logarithm table



Presence

- Measurements -

1990 – Start of the Multi-Sensor-Phase

GPS

Digital level

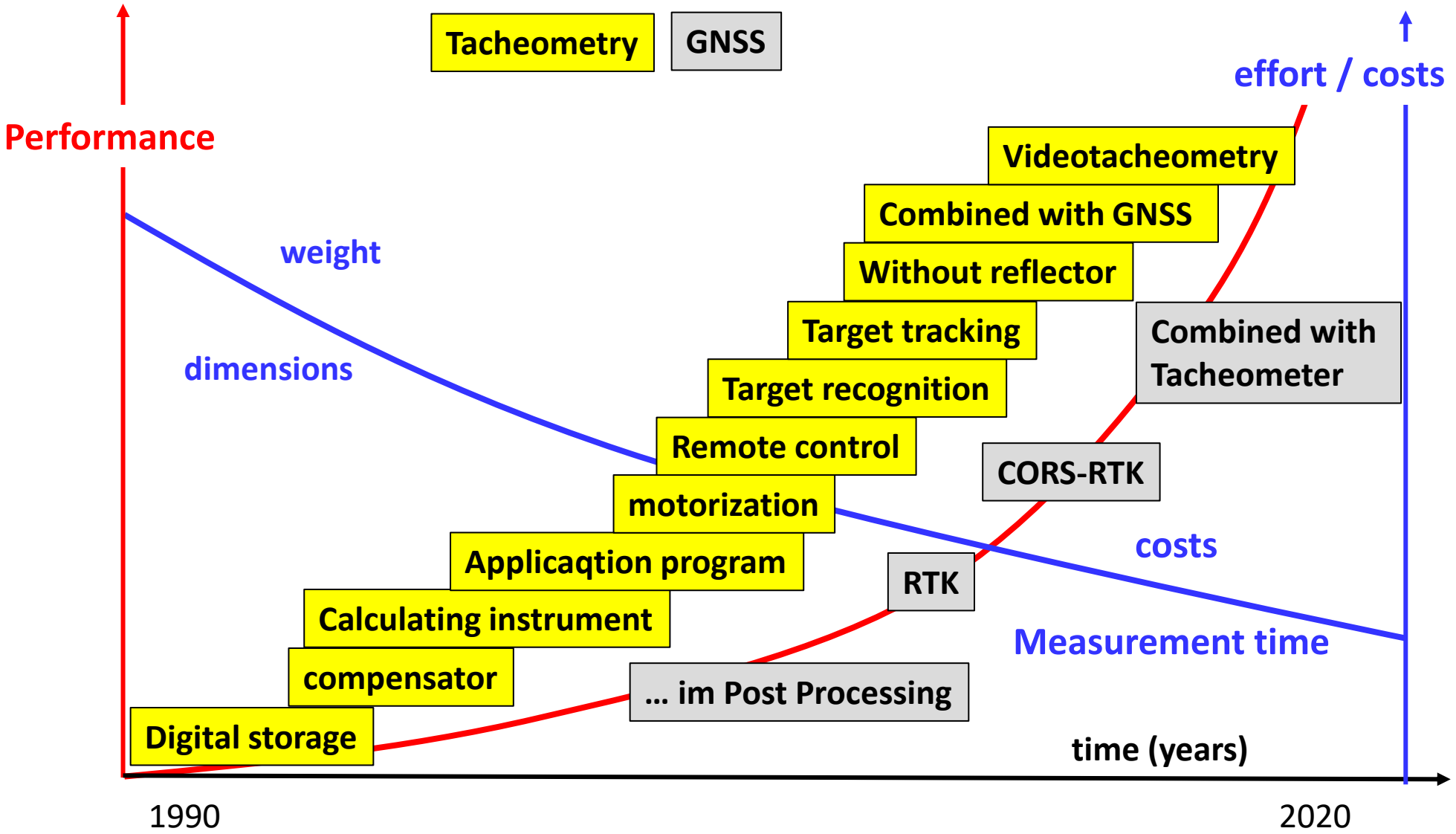
Leica NA 2000

Total Station

1-Person-Total Station

Geodimeter 4000

Technical progress since 1990



Measurement equipment – today - single points

Tacheometry

Totalstation

Laser Tracker

Laser Radar

Fernglas
+ EDM
+ Kompass

Handstrecken-
messer

GNSS

GNSS-Rover

Smartphone

GNSS-
Base station

height measurements

Digital level

Rotating laser

Measurement equipment – today – point clouds

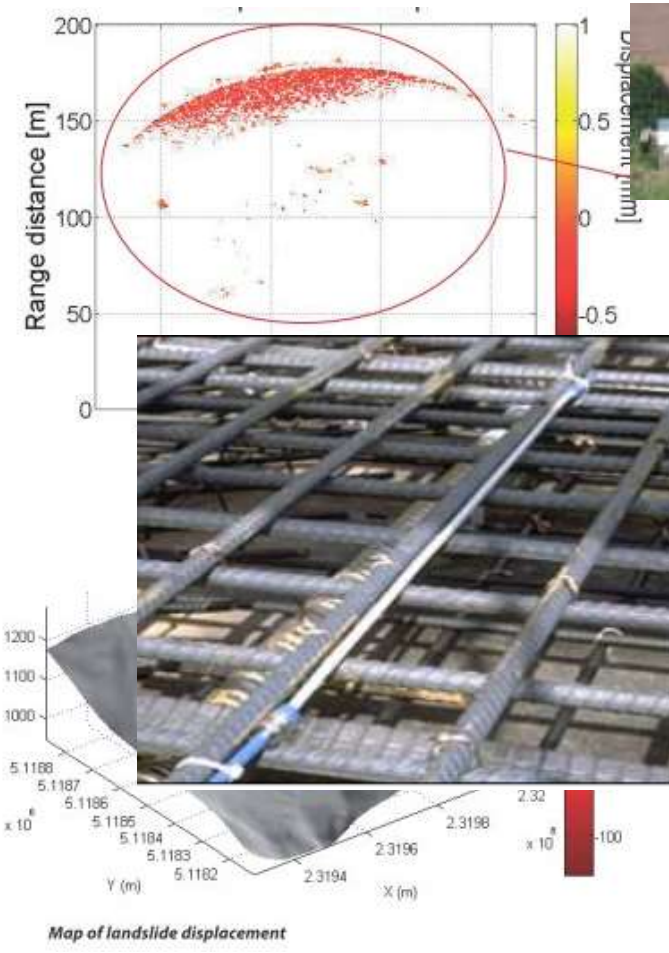
Laser Scanner

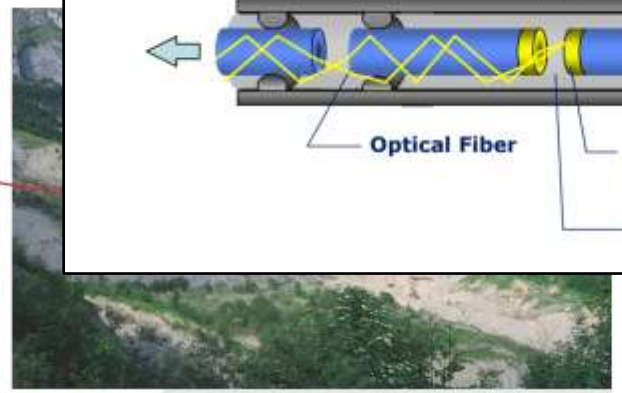
- TLS — **T**errestrial
- MLS — **M**obile
- ULS — **U**nmar
- ALS — **A**uton

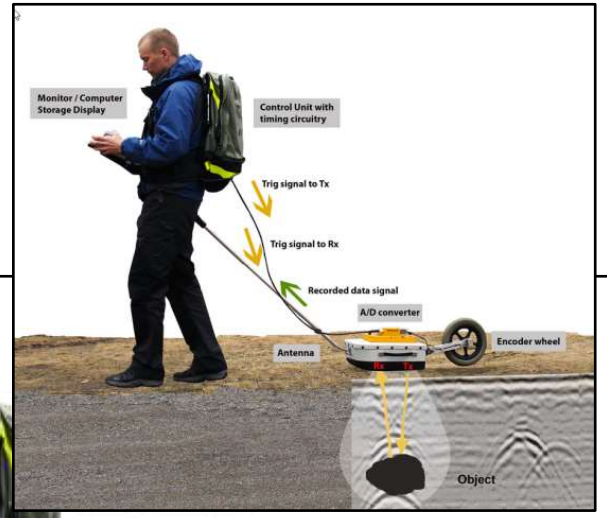
Leica BLK 360

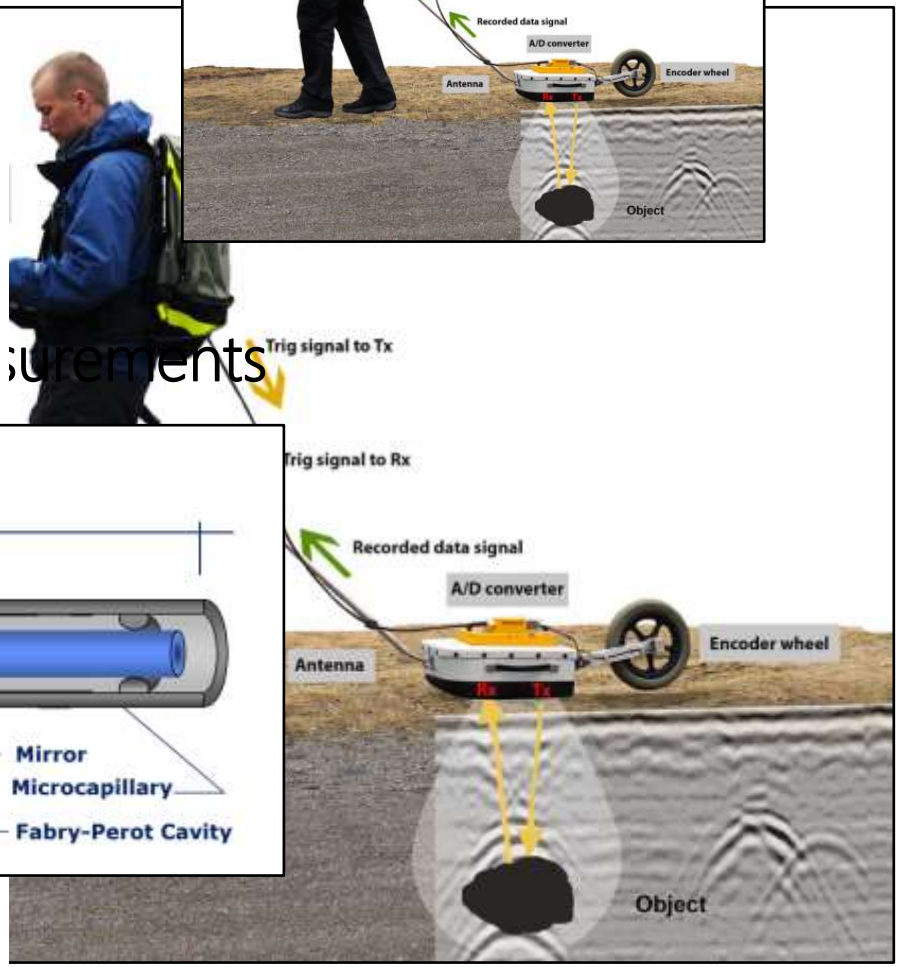
New measurement technologies

- GPR- Ground Penetrating Radar (Bodenradar)
- RI- Radar Interferometrie









??- GNSS-Pole with compensation of the inclination - ??

+ fast setup – without horizontalization
+ hidden points can be measured
+ Secure places for the operators
+ solution more precise through the „moving“ -pole

UAV 1 – Unmanned Aerial Vehicle

UAV 1 – Unmanned Aerial Vehicle

What is a **UAV**….. ? From the technical point of view?

Is it a measurement system …? **No !!**

Is it a sensor …. ? **No !!**

Actually a UAV is just a flying tripod!!

UAV 2 – Unmanned Aerial Vehicle

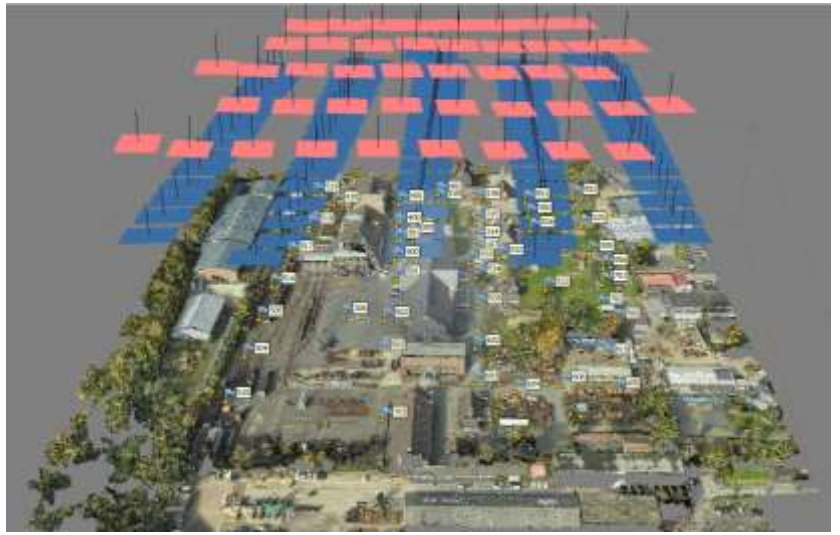
We have to see the entire combination, consisting of …. …..

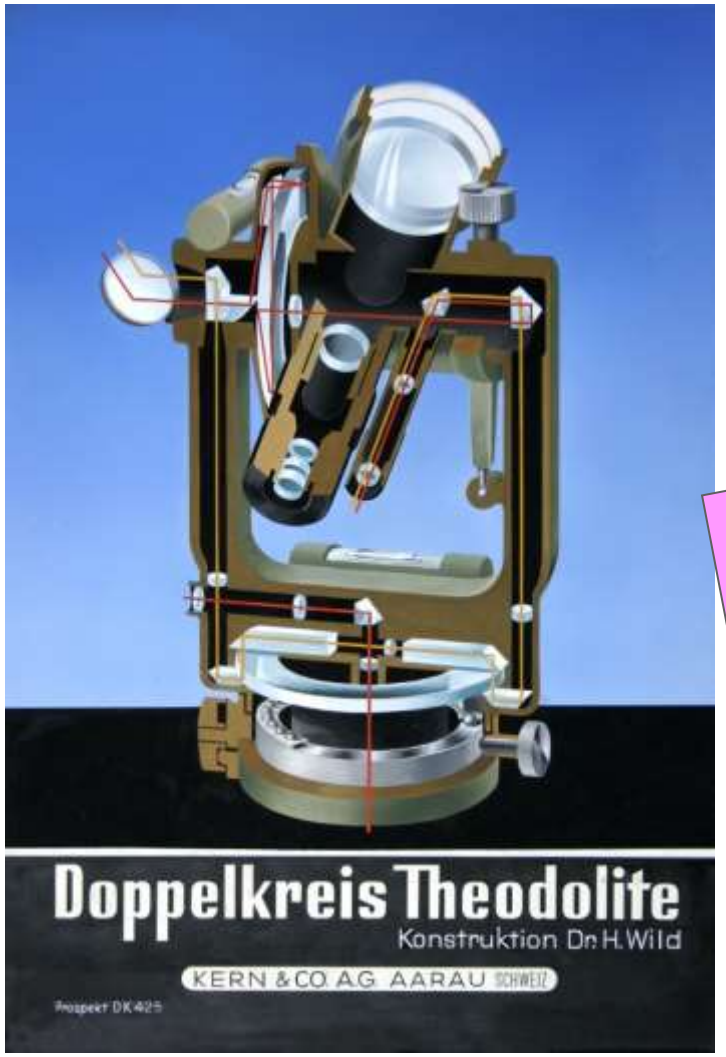
UAV

Digital camera

SLAM
Simultaneous **L**ocalization
and **M**apping - algorithm

Software





View of the users

From „Observer“ to a User

No original measurement values anymore!

Read-the-Manual-error!

easy-to-use
Today we use our equipment …
… like a big OFFICE-software-package

Black box

Life time cycles of a product are very short !! (3-5 years)

WILD T2
1921-1996

User believes that the results are TRUE and free of deviations and that a regular check of the equipment is not necessary!

View of the manufacturer

Push the button

Measurements are easy

Leica Geosystems · Trimble · TOPCON · GEOMAX · SPECTRA PRECISION · SOKKIA

Reasons for a new product...?

- New / improved functionality
- Components no longer available!
- Cost reduction

Not all what is technically possible ... becomes a product!

fully automatic levelling system

Precise distance meter

Kern Mekometer ME 5000

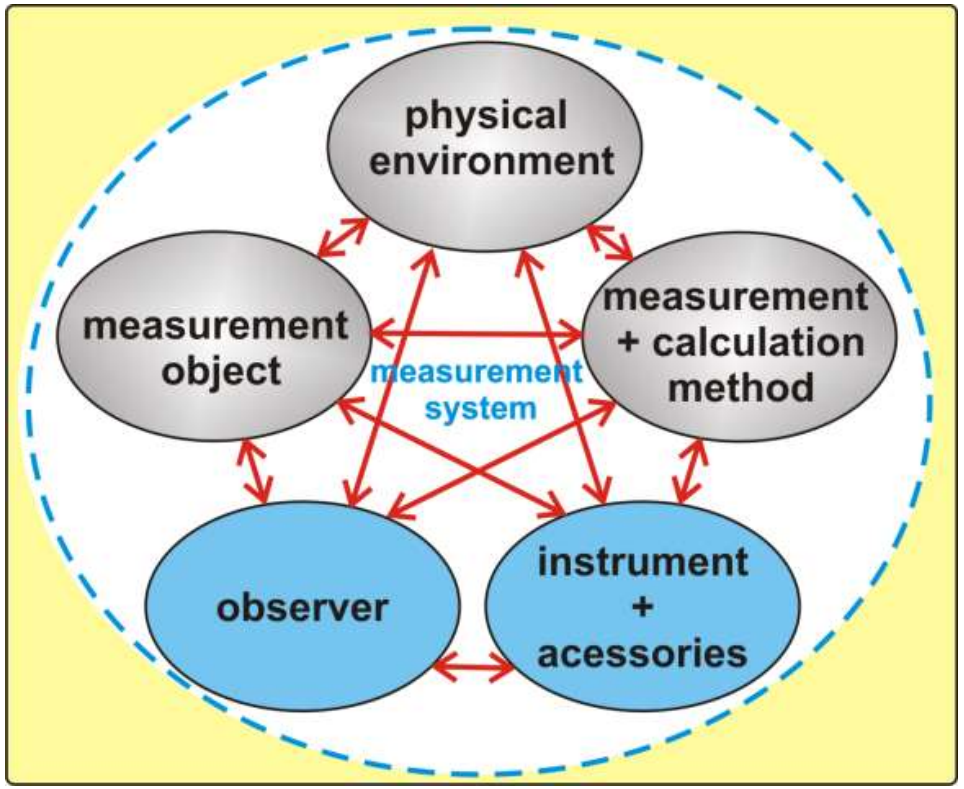
View of metrology

All instruments fulfil their specifications

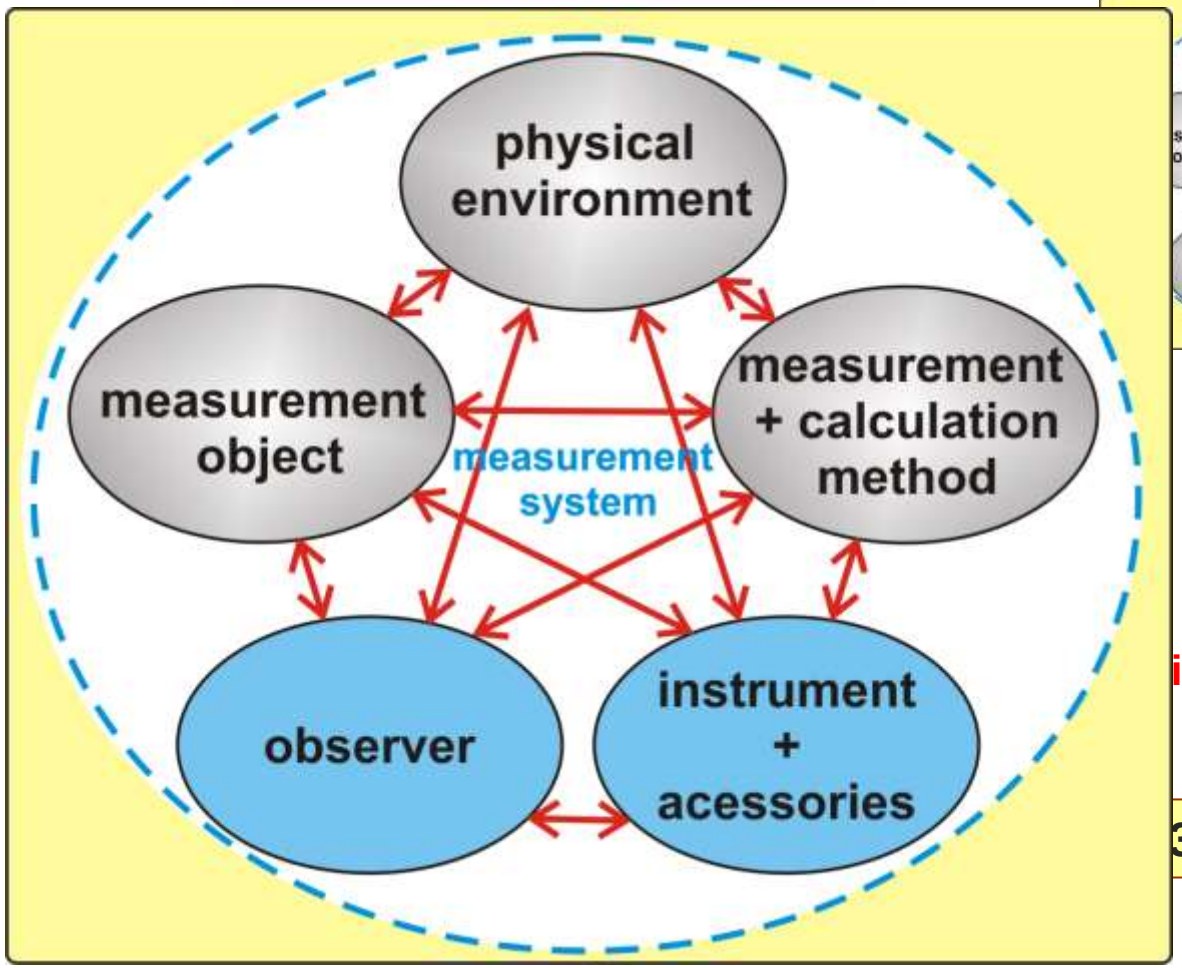
The traceability of geodetic measurements down to the national standards is not always given

The limitations of accuracy - in the past

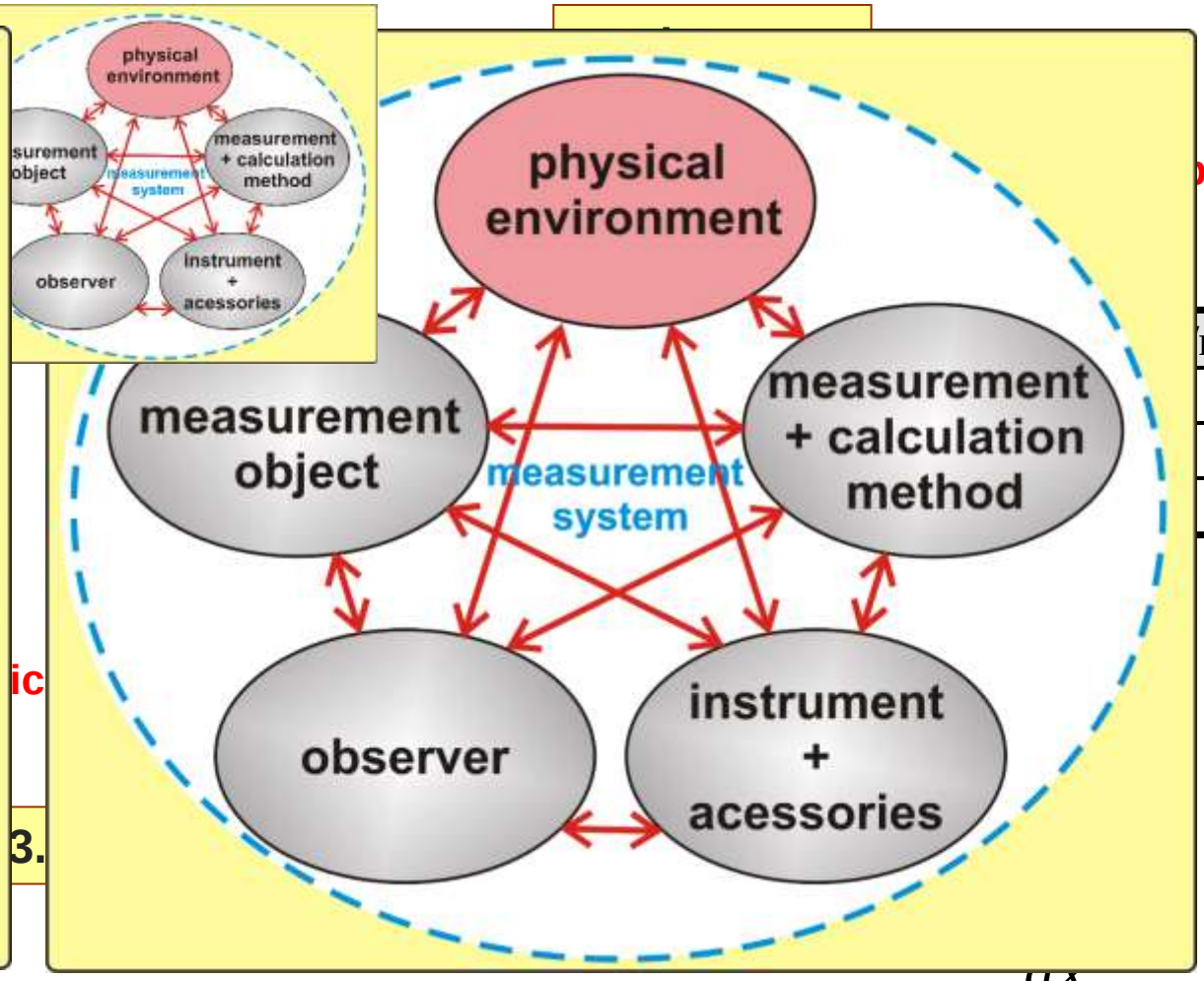
- **multiple measurements**
- **the observer had a direct influence onto the measurements**



limitations today - accuracy



limitations in the past

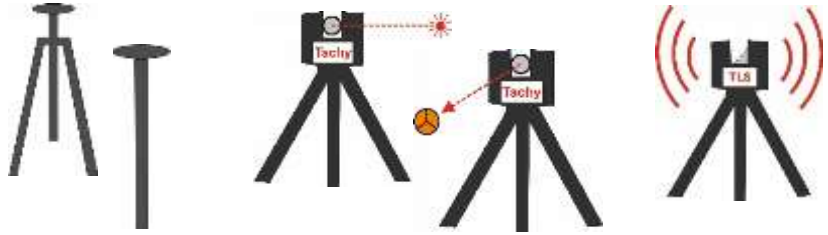


$$\delta(T)[\mathrm{mgon}] = 0{,}033 \cdot D[\mathrm{m}] \cdot grd\,T[\mathrm{K/m}]$$

Bsp.: grd T = 0,5 K/m, D = 500m -> **δ = 8,2 mgon**

summary – state of the art - geodetic measurements (GMT)

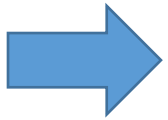
GMT today is richer and bigger compared to 20 years ago



Laser Scanner: Software  **<> Hardware** 

close range photogrammetry = Standard tool also for non-specialists

core competence of the surveyor remains unchanged!



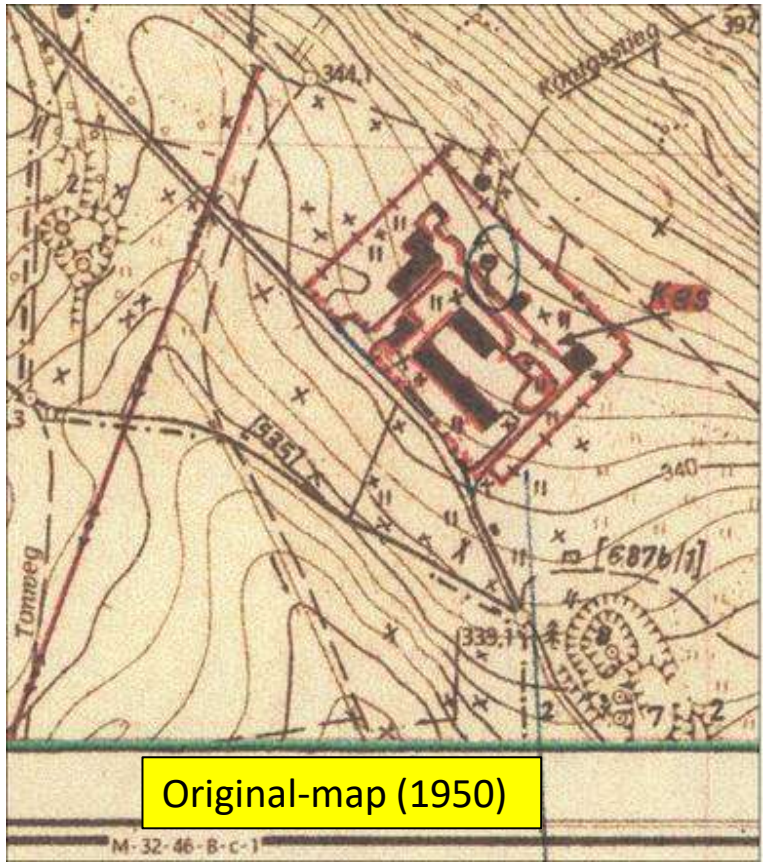
precise and detailed acquisition of large objects

Presence

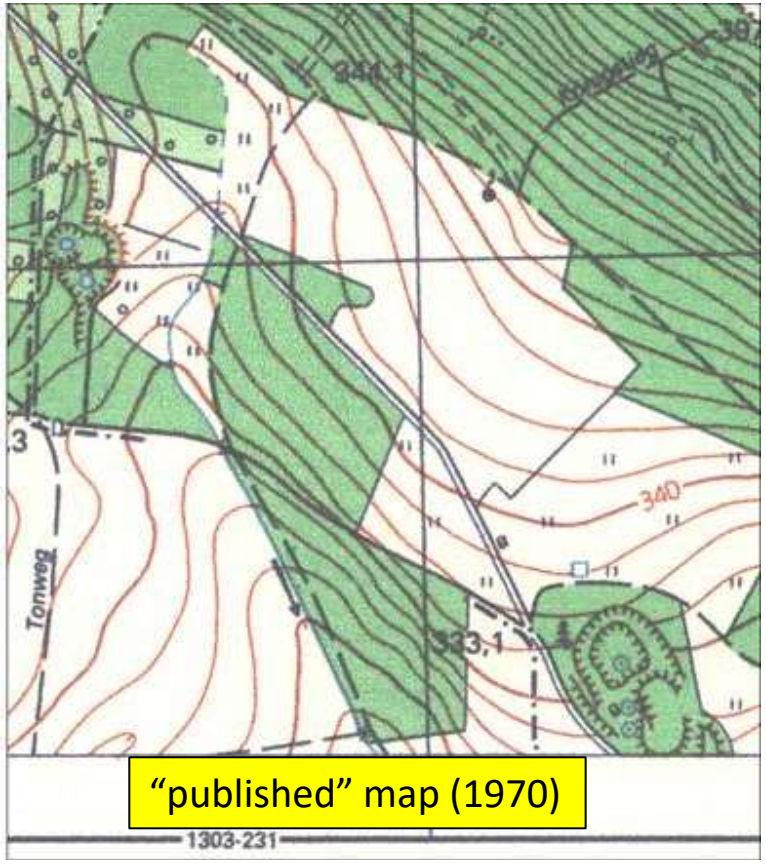
- description of our profession -

topographical map from German Democratic Republic (GDR)

Google Maps (2019)



Original-map (1950)



"published" map (1970)

source: K. Brunner, UniBw Munich

our profession … yesterday <> today

	2020	*1990 and before*
Geo data	**Geo data is a public good with a significant economical value!**	**Geo data with restricted access!**
surveyor	**important for the infrastructure of the entire society**	**„main customers“ state administration / military**

Presence

- Society -


1989

1994

IBM “SIMON”
1st smartphone


2007
cingular
9:41 AM
Text
Calendar
Photos
Camera
Calculator
Stocks
Maps
Weather
Notes
Clock
Settings


2013


We are accessible…
always and everywhere
Social Networks
Facebook
Instagram
Twitter
Tumblr
Pinterest
Google+
LinkedIn
WhatsApp
Messenger
….
sms
www
email
skype
…

The 4th Industrial revolution

Industrial Revolutions (IR)

1. Programable Micro-Controller

1. Slaughter house

second

electricity -> mass production
forms of energy: oil + gas

Third

Elektronic + Information-technology
automatized production
nuclear energy

Fourth

Fusion of technologies
physical / digital / biological
Spheres

First

Water + Steampower

1. mechanical loom

1786

1870

1969

2005

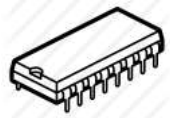
time

Archaic | Optical | Electro-Optical | Multi-Sensors

1590

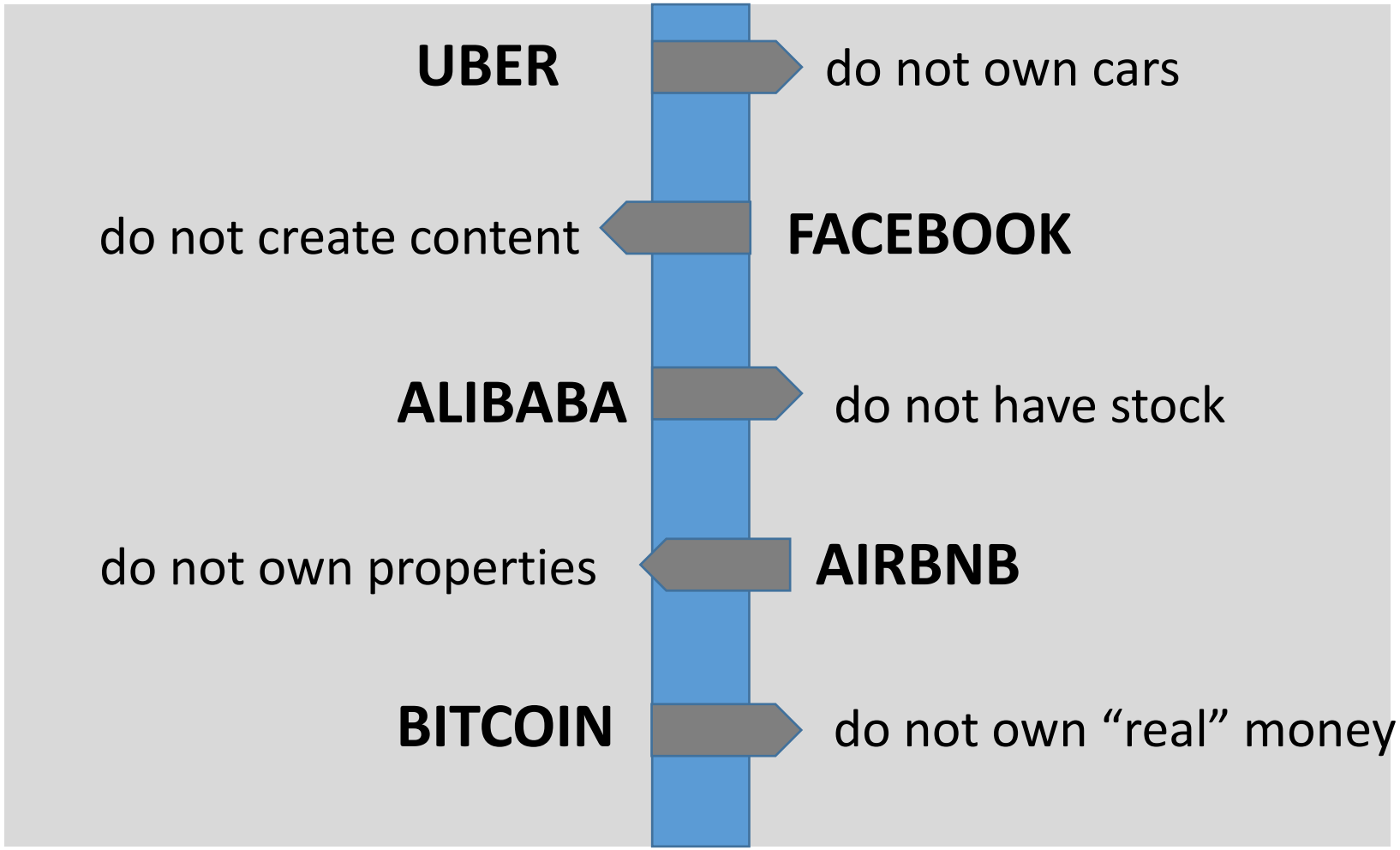
1924

1990



2021

4. Industrial revolutions – some “observations”



source: Tom Goodwin, 2015

4. Industrial Revolution

Transformation through Digitalisation

Digitisation

Transformation from analogue to digital …. *maps*, *drawings*, *field books*….

Digitalisation

use digital information!!

Smart data

Digital Transformation

use digitalisation for new business models

UBER **AIRBNB**

FACEBOOK **BITCOIN**

ALIBABA

Surveying 4.0

Surveying project

UAV

Data

Laser Scanner

GNSS

acquisition → treatment → analysis → Presentation final result

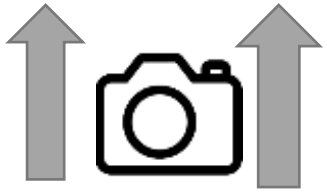
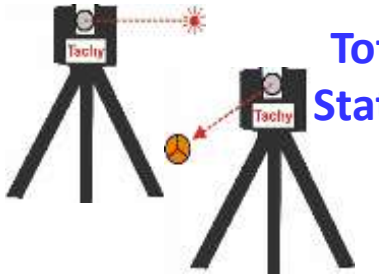


image based systems

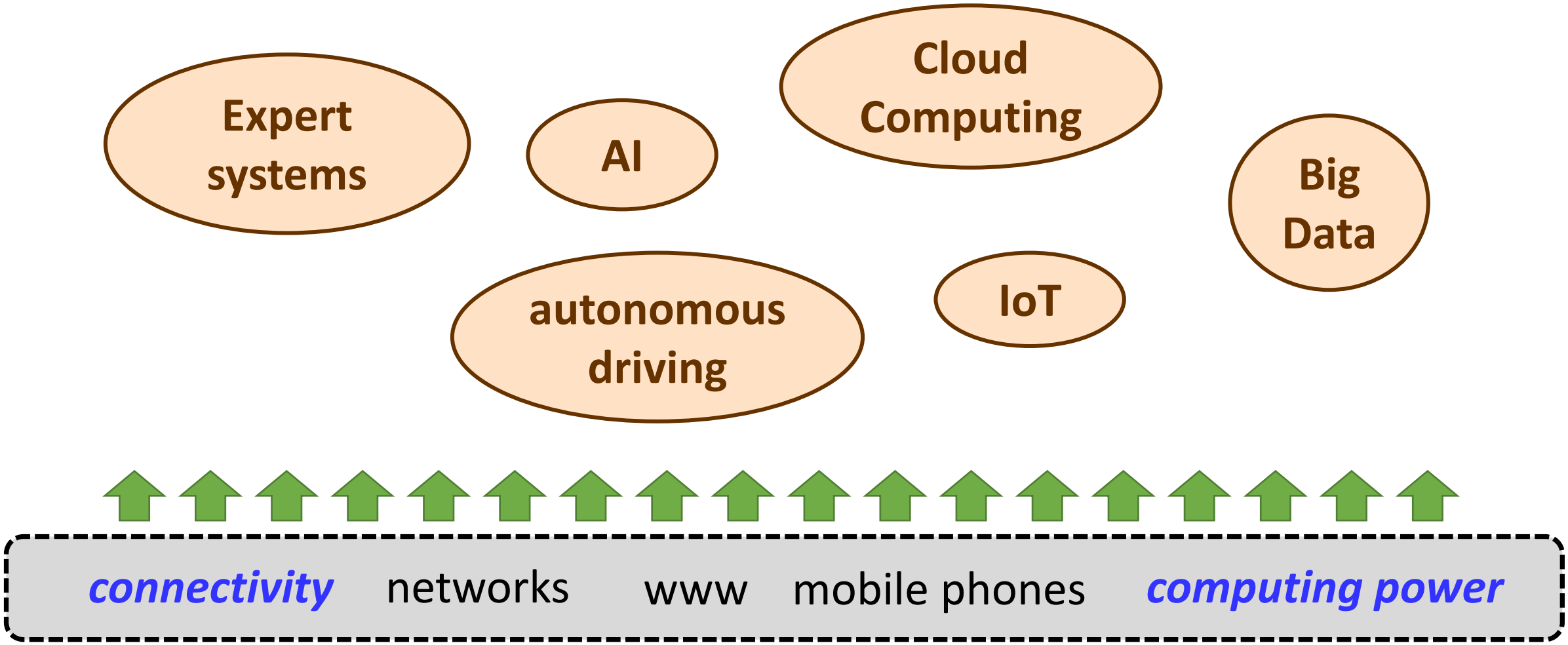


Total Station

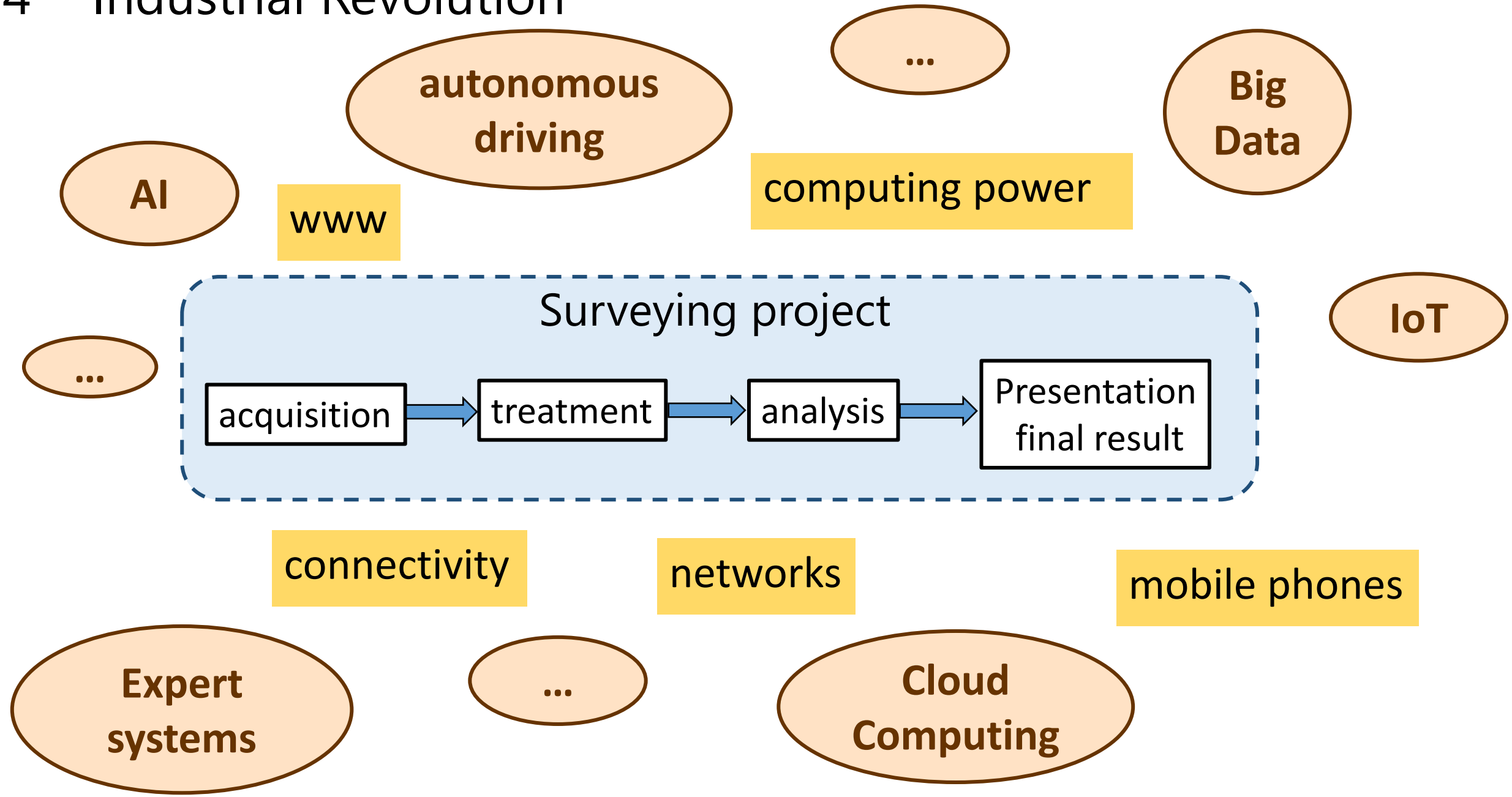
Valid for all type of projects

- Positioning
- Valuation
- Construction surveying
- Cadaster
- Land Management
- Mapping
- Geo-information
- Building surveying
- Land Administration
- Spatial Planning
- Marine
- Real Estate Management
- Property surveying
- Quantity surveying
- Land surveying
- Geodesy

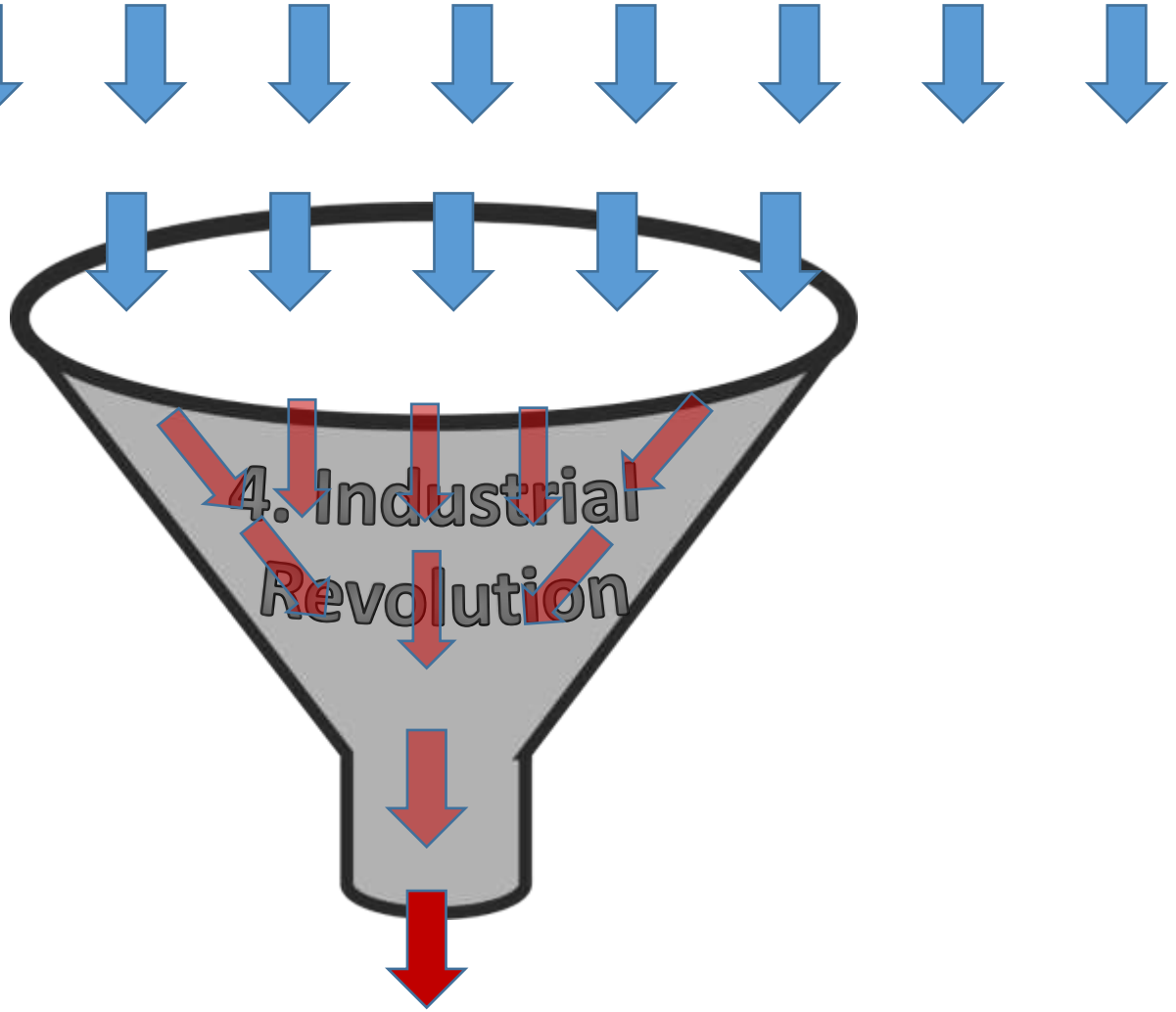
4th Industrial Revolution



4th Industrial Revolution



… measurements … profession society Technical progress …



Surveyor 4.0

Which **skills** are needed today?

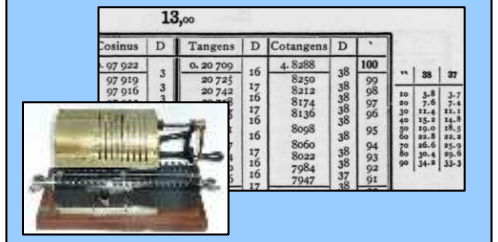
surveyor 1.0

Optical

precision mechanic!

to be sharp-eyed!

good calculator!



weather proofed!

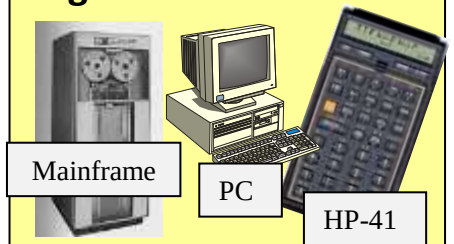
surveyor 2.0

Electro-optical

~~precision mechanic!~~

sharp-eyed!

good calculator!



weather proofed!

surveyor 3.0

Multi-sensor

~~precision mechanic!~~

~~sharp-eyed!~~

~~good calculator!~~

~~weather proofed!~~

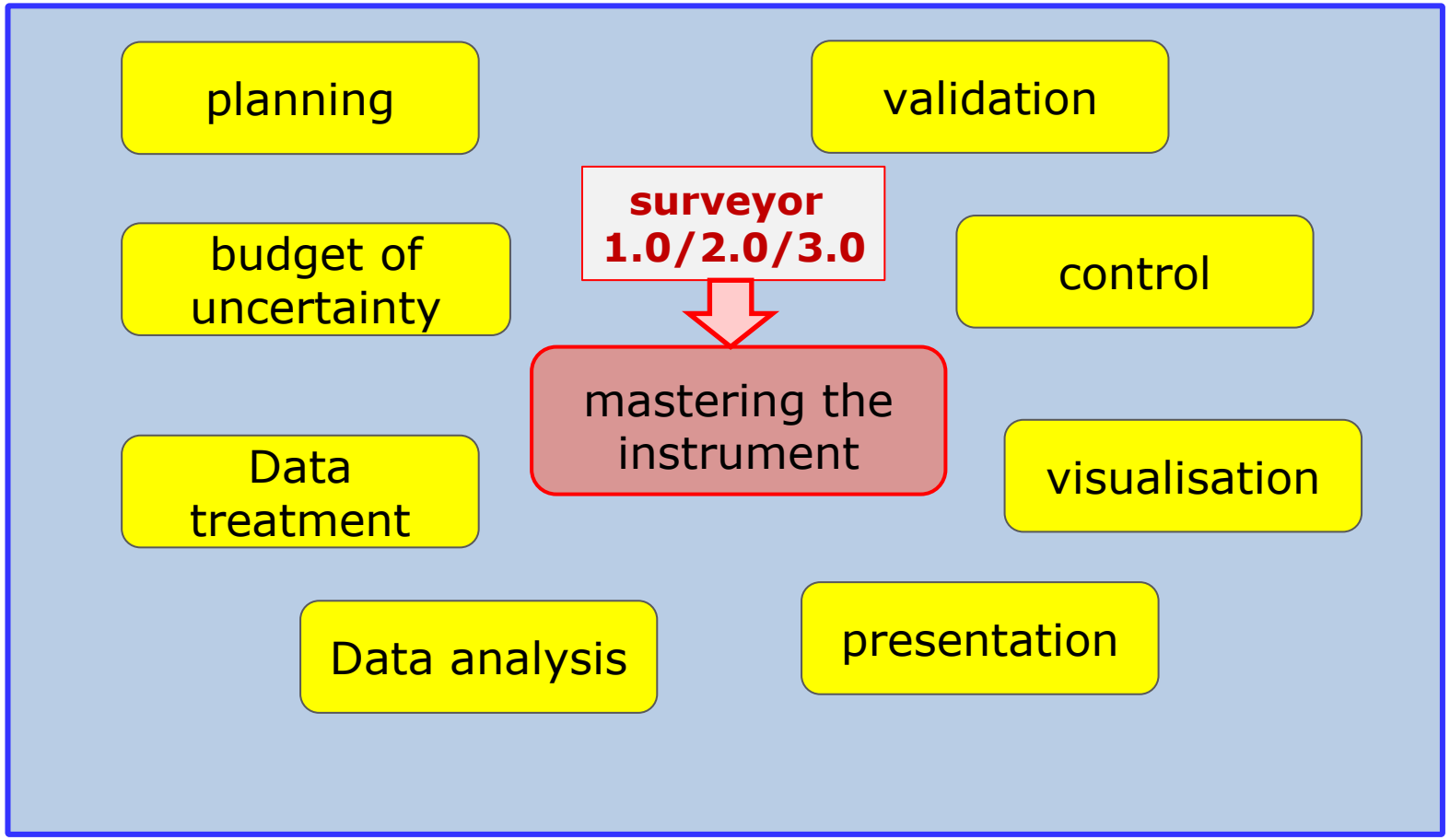
surveyor 4.0

1590 → 1924 → 1990 → 2022

1. conclusion

surveyor 4.0

mastering the whole processs



skills of the surveyor 4.0

detailed knowledge about the different measurement technologies

- *framing conditions*
- *restrictions*
- *safety*

capable … to develop an entire measurement concept!

- *data acquisition*
- *data analysis*
- *presentation of the results*

…. estimate uncertainties!

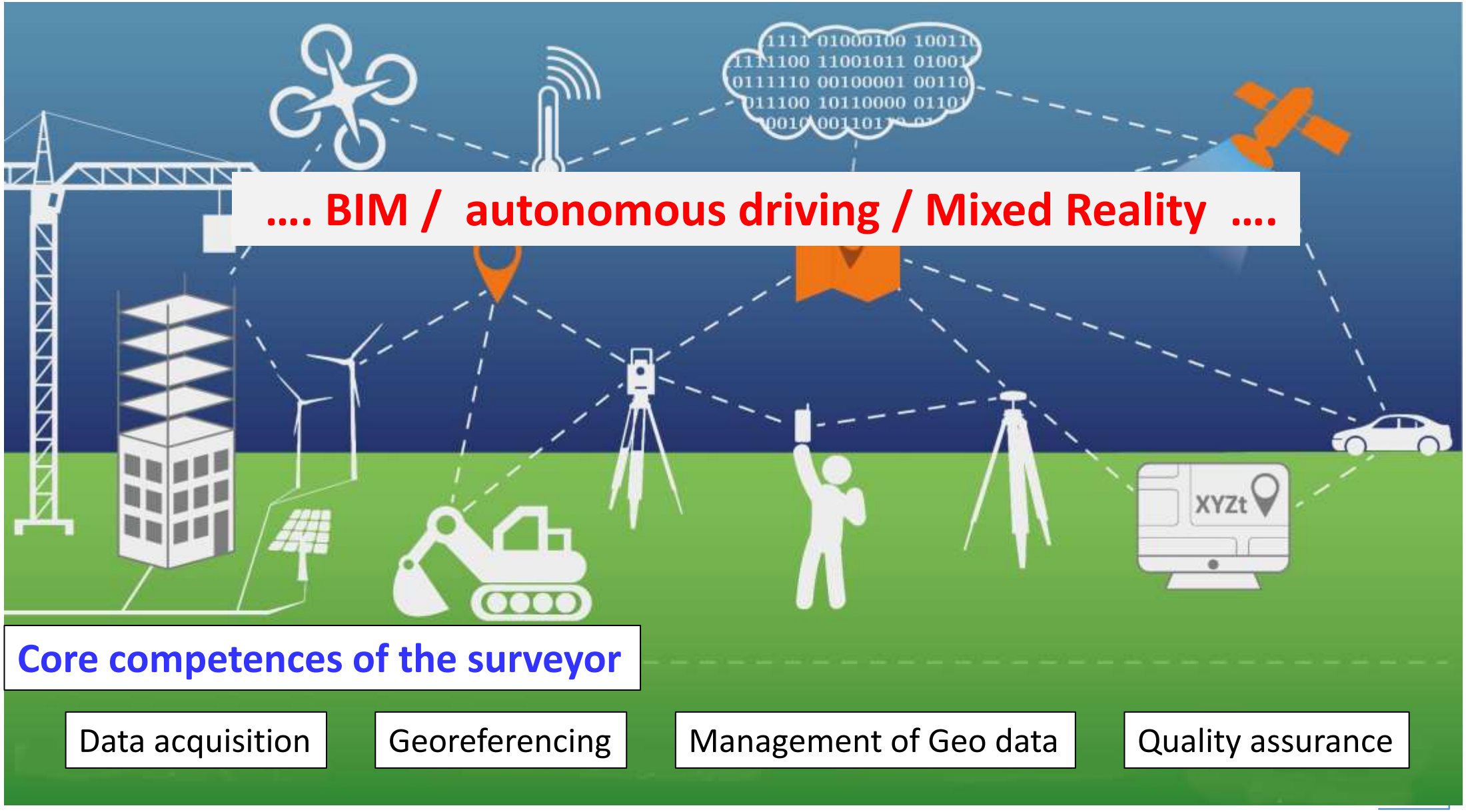
…. validate the measurements !

…. Prepare profitability analysis!

…. do the data treatment and the analysis!

Big Data !!

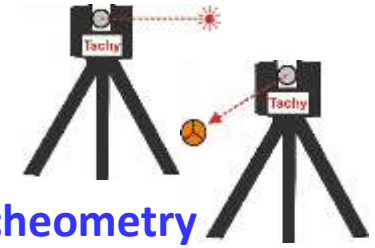
Surveying 4.0 → DIGEOtalisierung DIGEOtalisation



How does the measurement technology of tomorrow look-like??

principal instruments

GNSS



Tacheometry

Laser Scanner

image based systems

Leica BLK 360

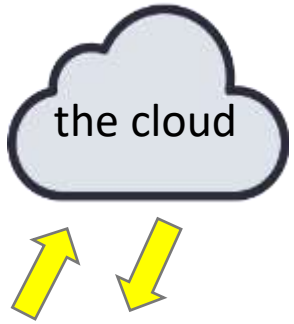
Leica BLK 3D

Tendencies

measurement systems become
- smaller
- lighter
- faster and
consume less energy!

but also ….

- **individually configurable**
- **modular**
- **programmable**
- **automatised ->> autonomous**
- **data storage and data treatment in**



Thank you very much for your attention