

**Capturing, managing and  
disseminating large point clouds**

**Martin Kodde – Fugro-Inpark B.V.**

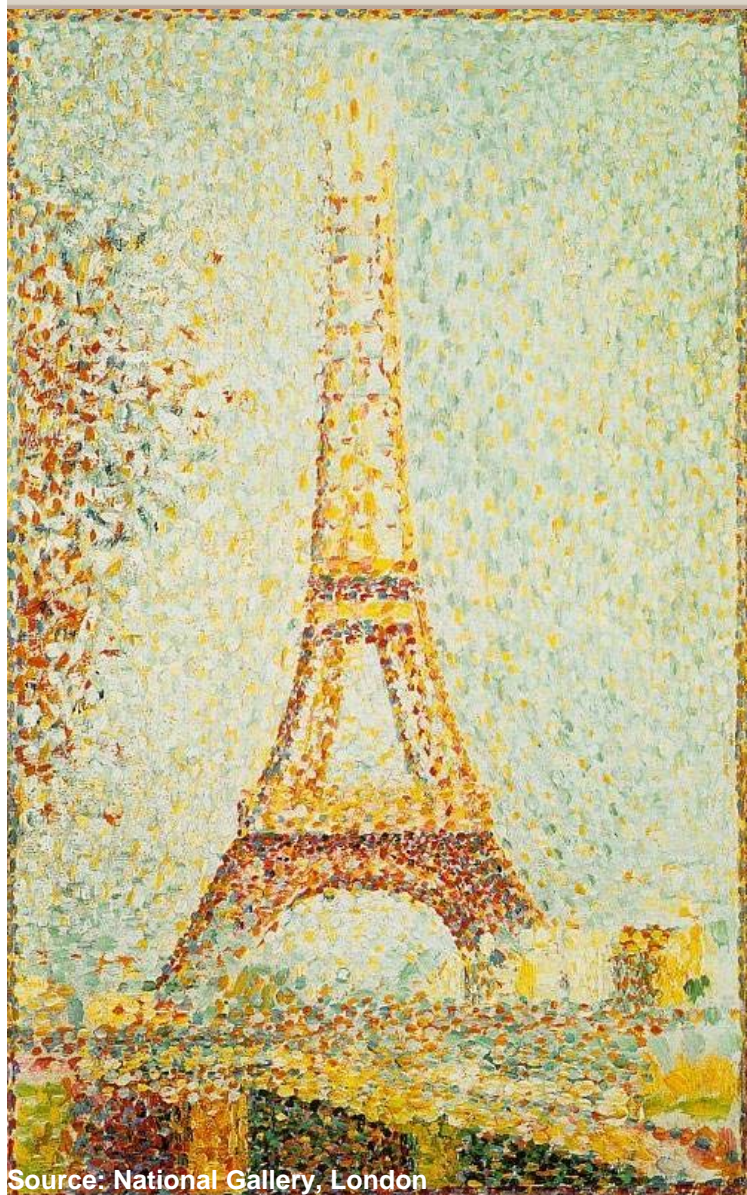


- About Fugro
  - Strategy
  - Products and services
  - Client portfolio
  - Etc.
- Point Clouds & Fugro
- Methods for capturing point clouds
- Challenges in processing point clouds
- Challenges in disseminating point clouds



## What is a point cloud?

- A surface representation by means of individual points
- They're cool!
- Innovative
- A source for 3D topographic data
- An intermediate product
- A lot of data



Source: National Gallery, London



## Why are point clouds a problem?

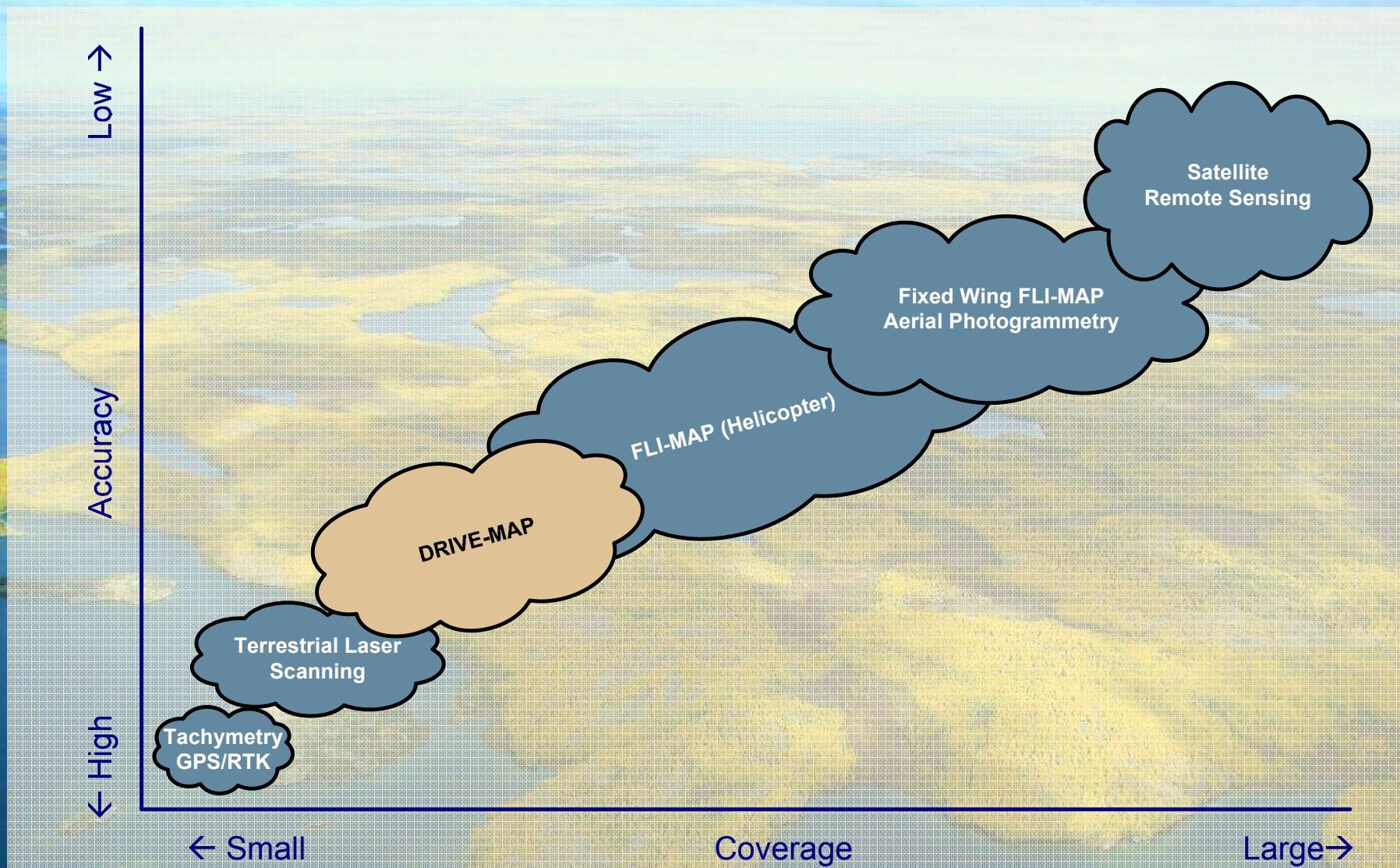
“This building can only be fully understood when viewed from the air”

Source: UNCP

[www.fugro.com](http://www.fugro.com)



# Fugro and point clouds





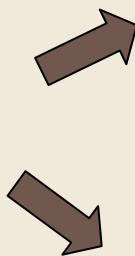
# How to get a point cloud?



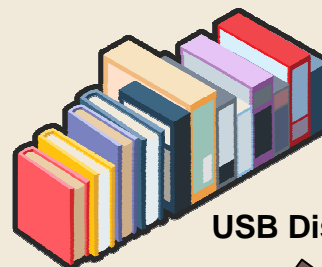
Measurement



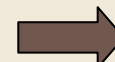
Processing



Server



USB Disks



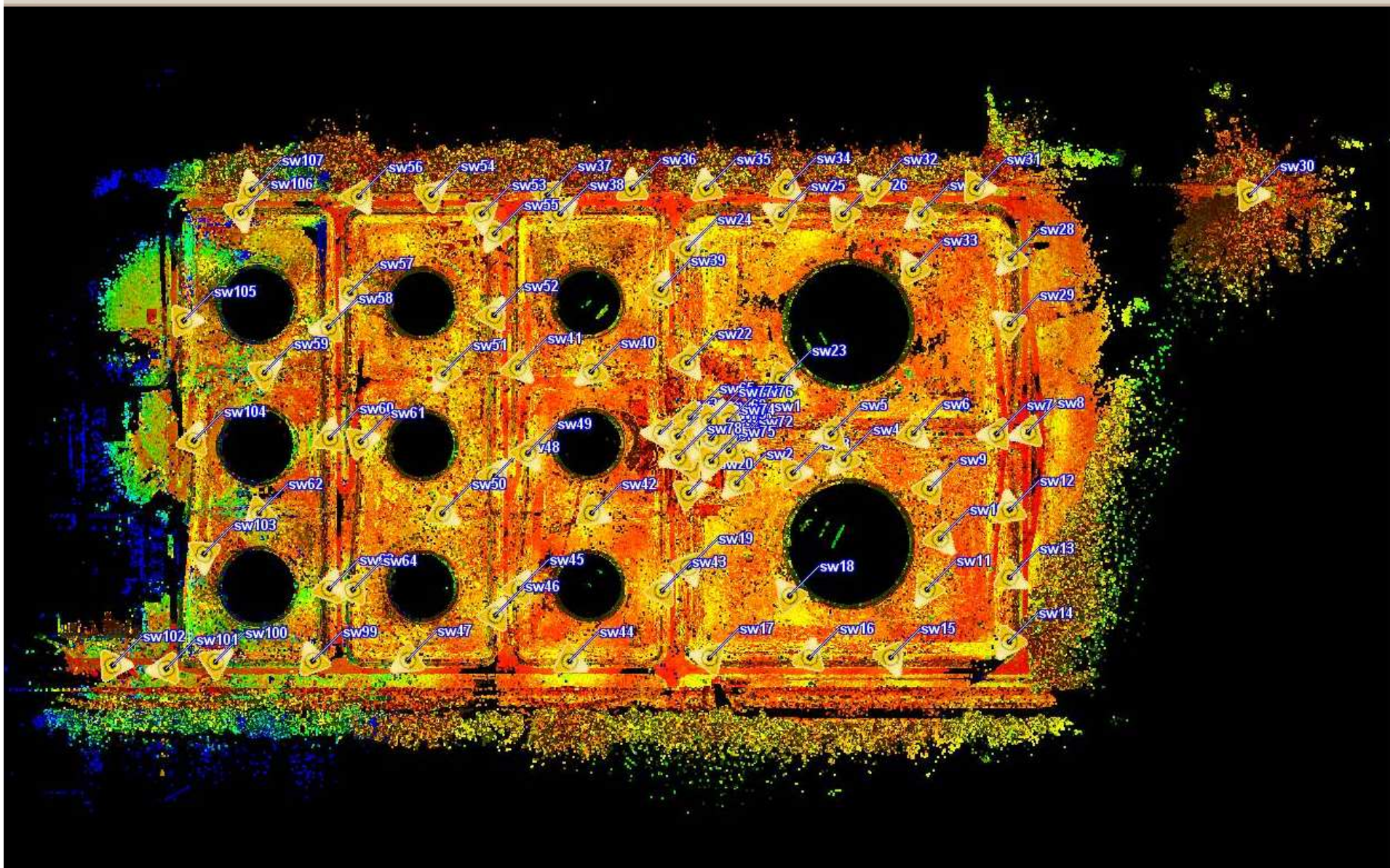
- Data acquisition
- Lidar processing
- The Client



- **Laser Scanning**
  - Measurement of phase or Time of Flight
  - Terrestrial
  - Aerial
  - Mobile
- **Acoustic Remote Sensing**
  - Multi Beam Echosounding
- **Image Matching**
  - Correlation of two or more images



# Terrestrial Laser Scanning





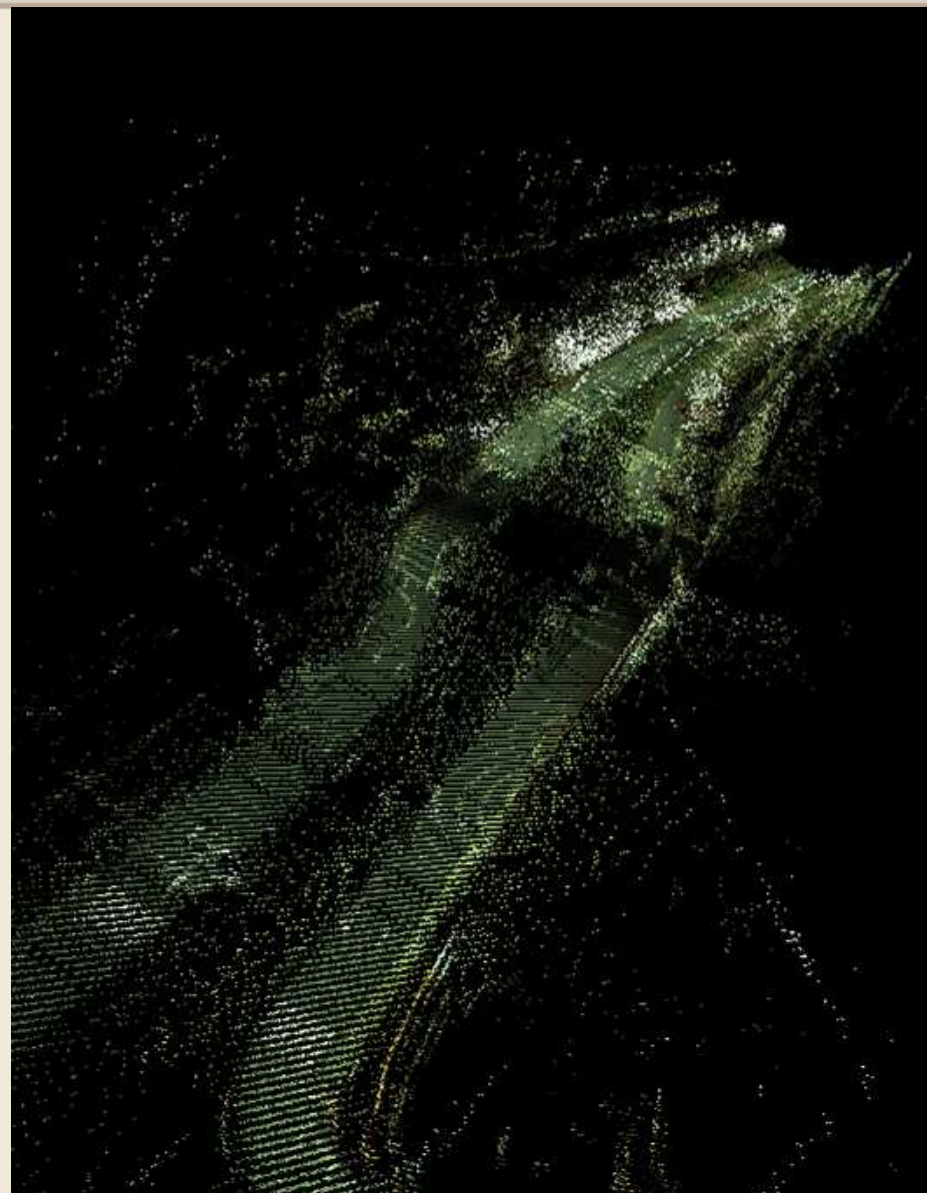
- Laser scanning
  - From helicopter
  - From Airplane
- 250.000 Hz scanning
- Automatic colouring of laser points
- High resolution cameras for aerial photographs
- Corridor scanning or wide area scanning.





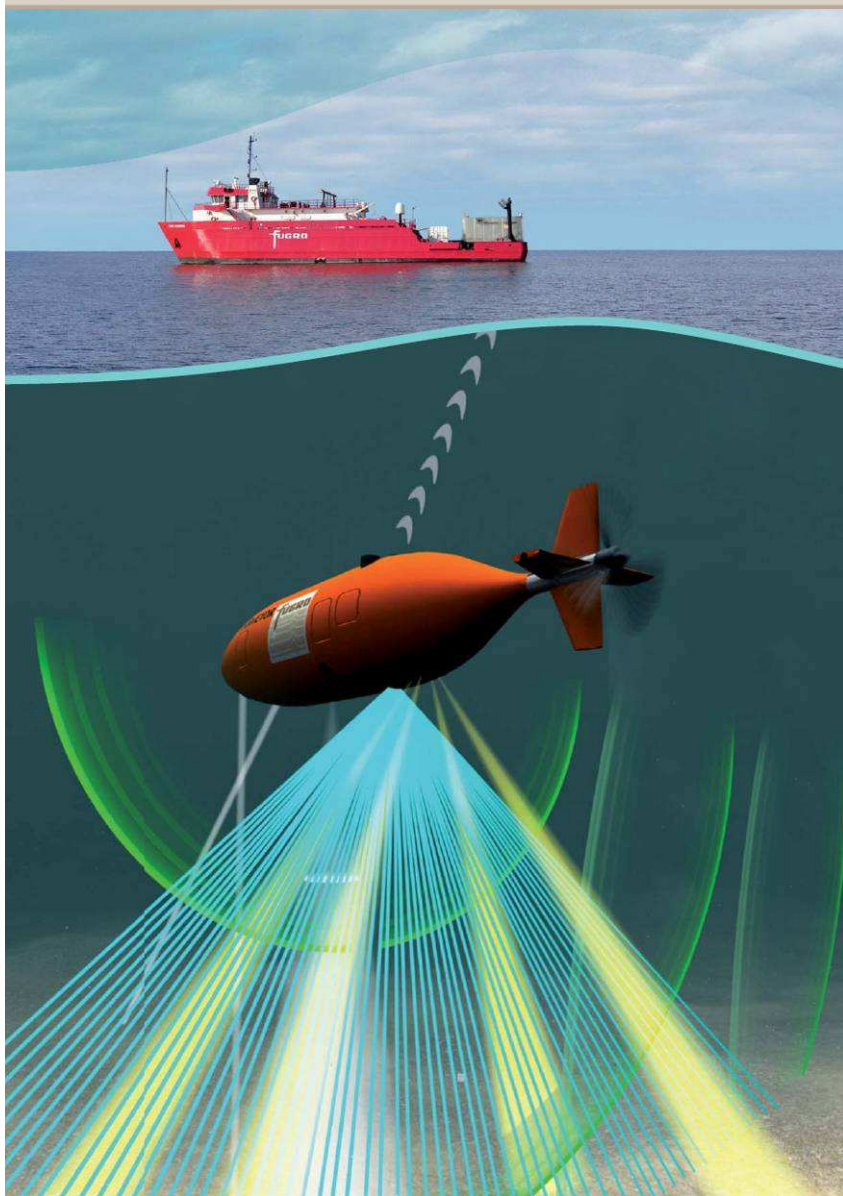
## DRIVE-MAP

- Very high accuracy mapping from a mobile platform
- Sensors include:
  - Lidar
  - Panoramic imagery
  - High resolution cameras
- Applications:
  - Large scale base map updating
  - Asset inventory
  - 3D modelling





## Multi Beam Echo Sounding

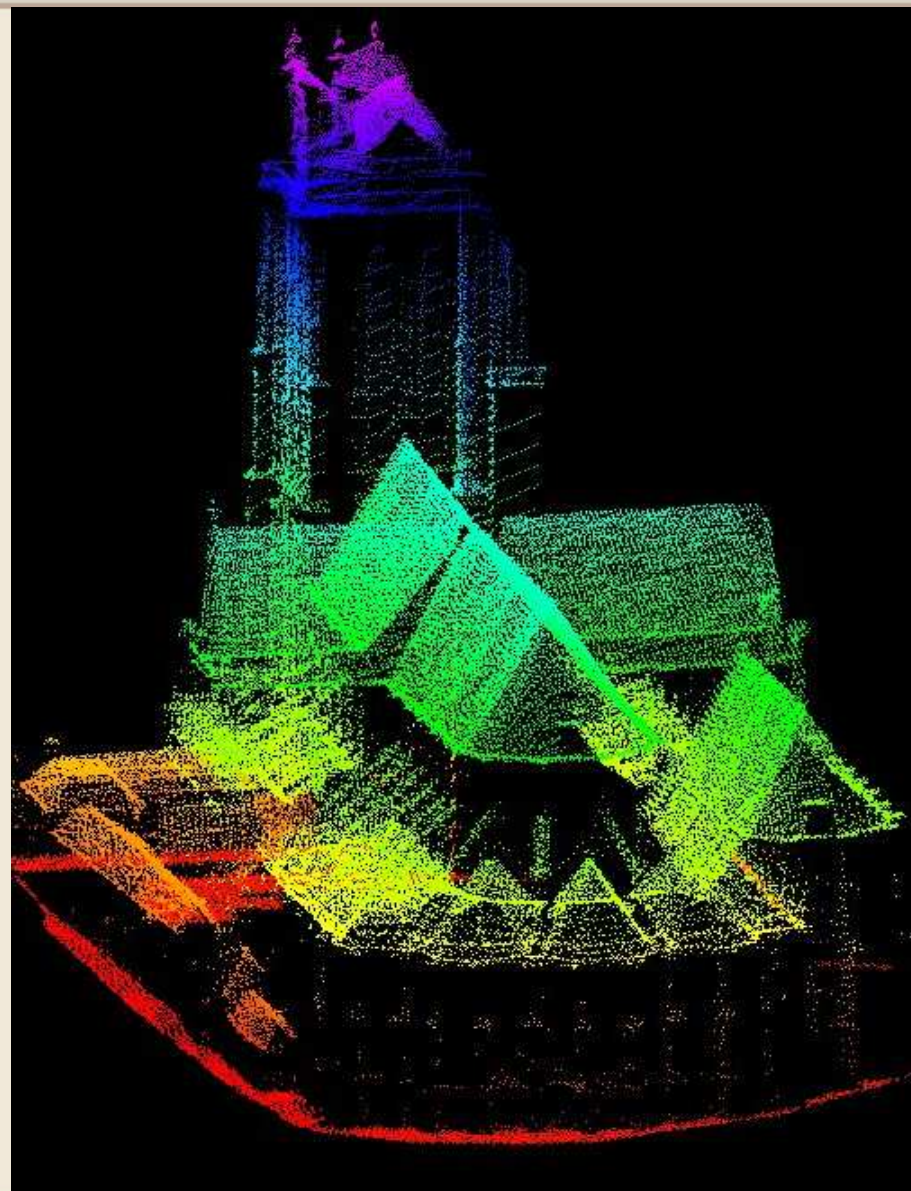


- Single beam and multi beam echo sounding
- Goal: mapping of the seabed and the layers just beneath
- Design for subsea facilities, cable and pipe line routing.
- Deep sea (3000 m) surveys
- Experimental: point clouds from image matching



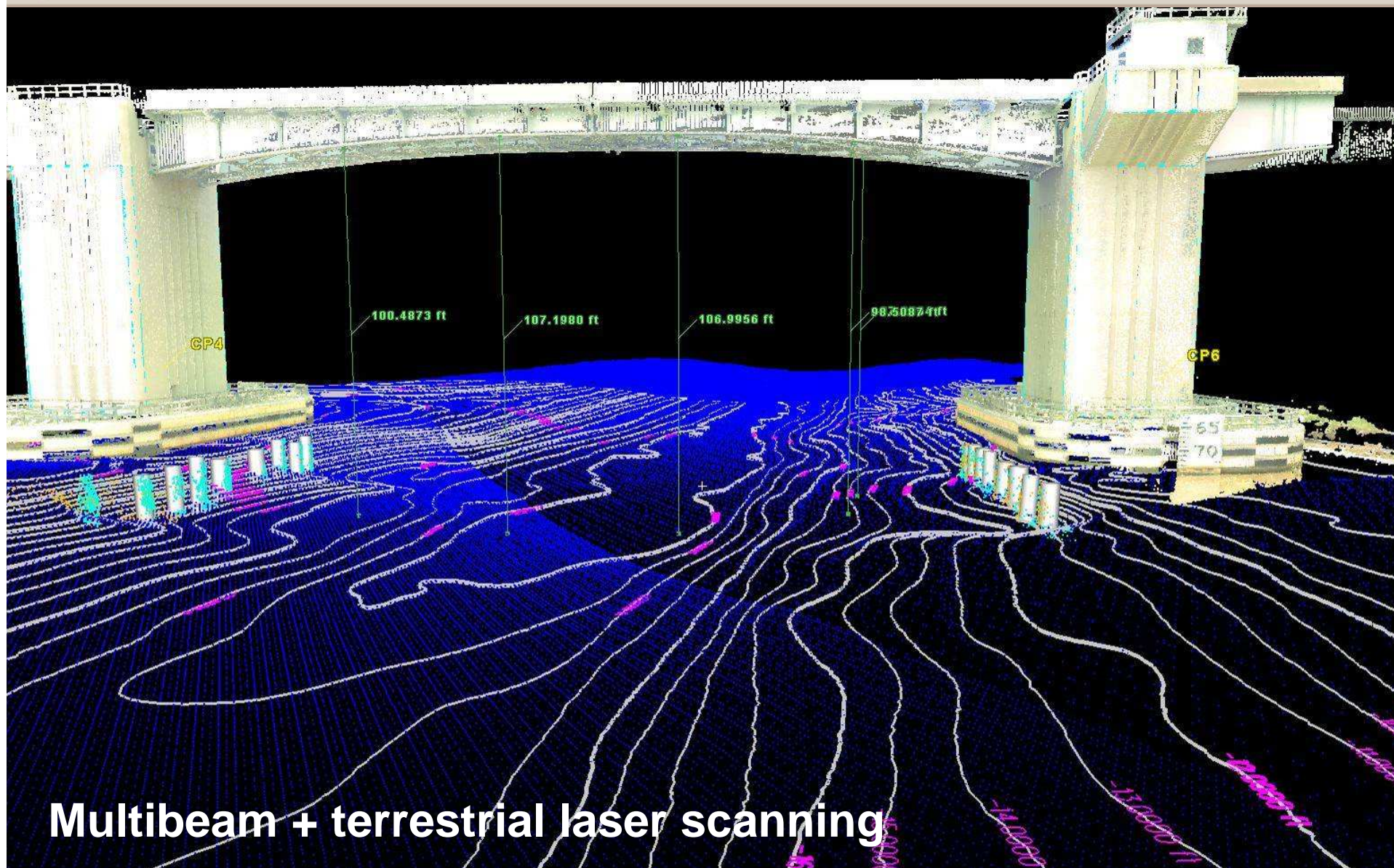
## A massive point cloud

- AHN2 Zeeland
  - 20 billion points
  - 10 points / m<sup>2</sup>
- TLS scan of an industrial site
  - 147 scans positions
  - 1.8 billion points
  - 100 x 100 points / m<sup>2</sup>
- DRIVE-MAP survey of 300 km of road
  - 3.6 billion points
  - 50 points / m<sup>2</sup>





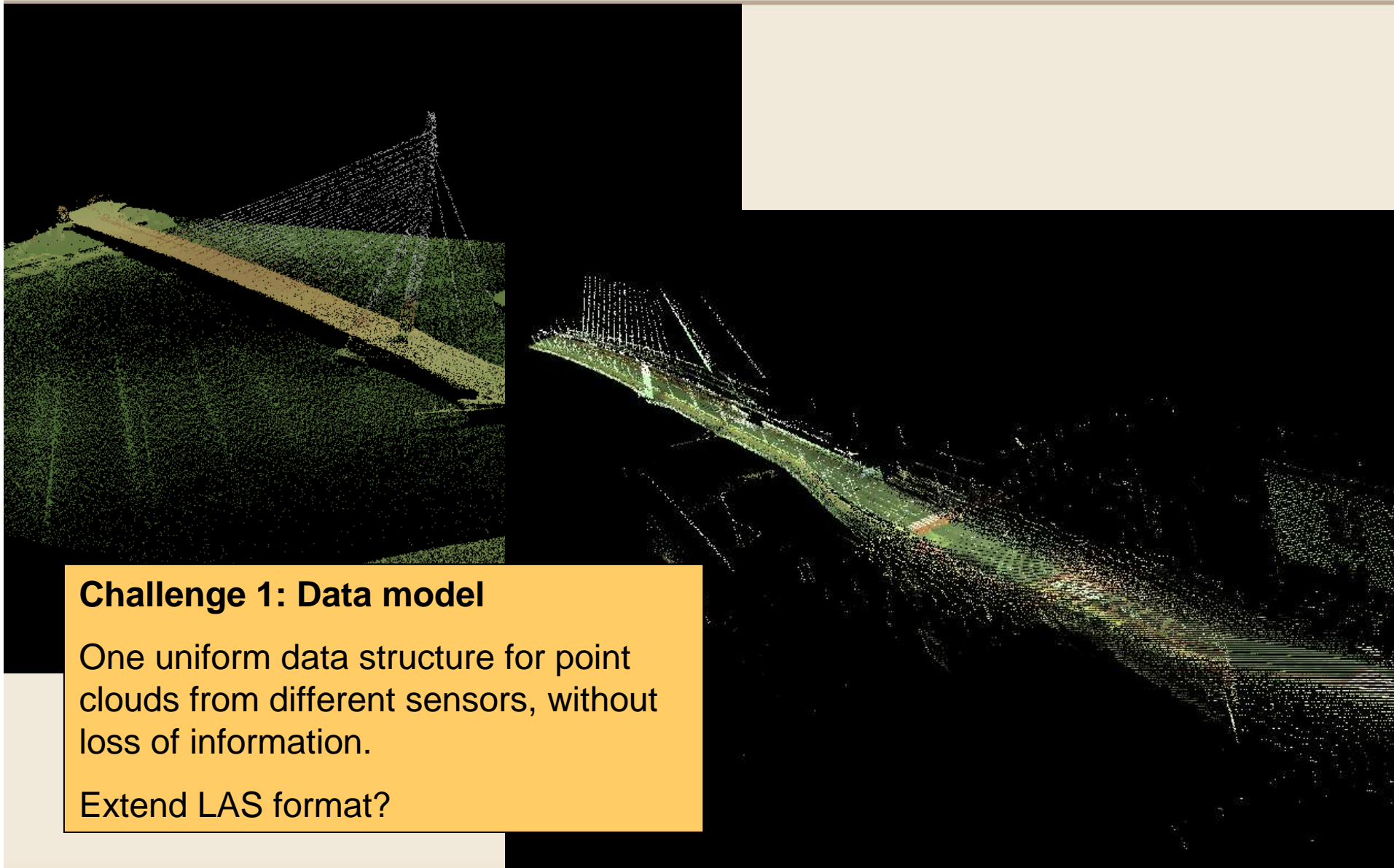
## Integration of datasets



**Multibeam + terrestrial laser scanning**



## Integration of datasets



### Challenge 1: Data model

One uniform data structure for point clouds from different sensors, without loss of information.

Extend LAS format?



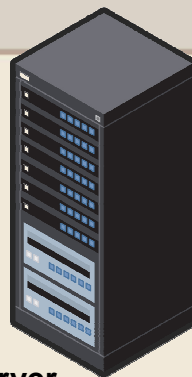
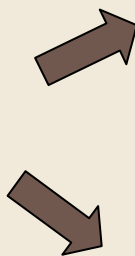
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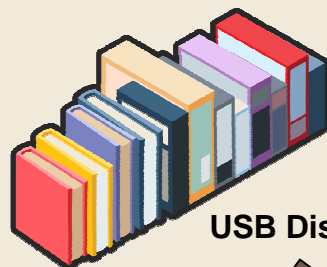
Measurement



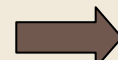
Processing



Server



USB Disks



- Data acquisition
- Lidar processing
- Client



## Deliverables

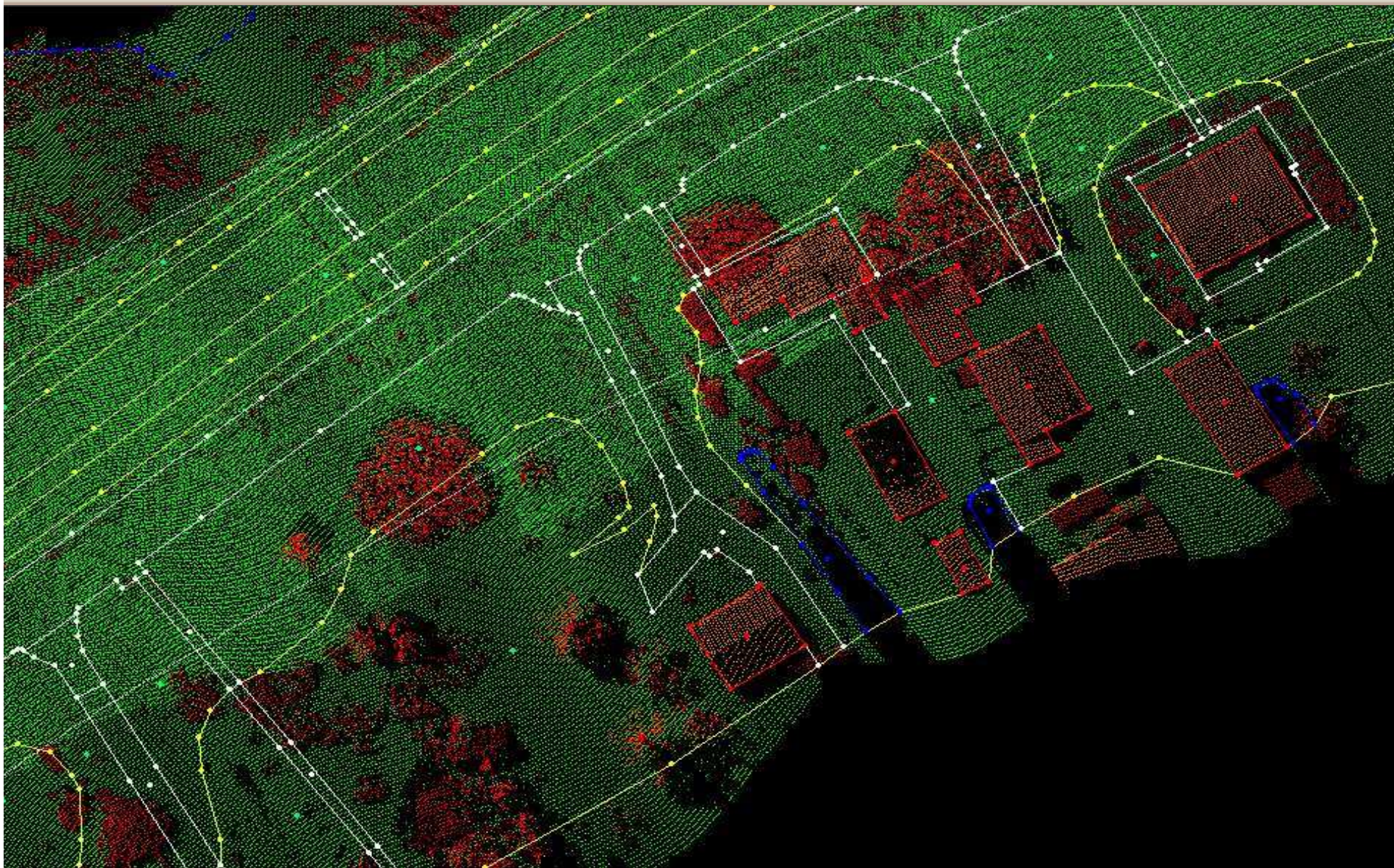


**Point Clouds are  
not an end product!**





## Interpreted end product



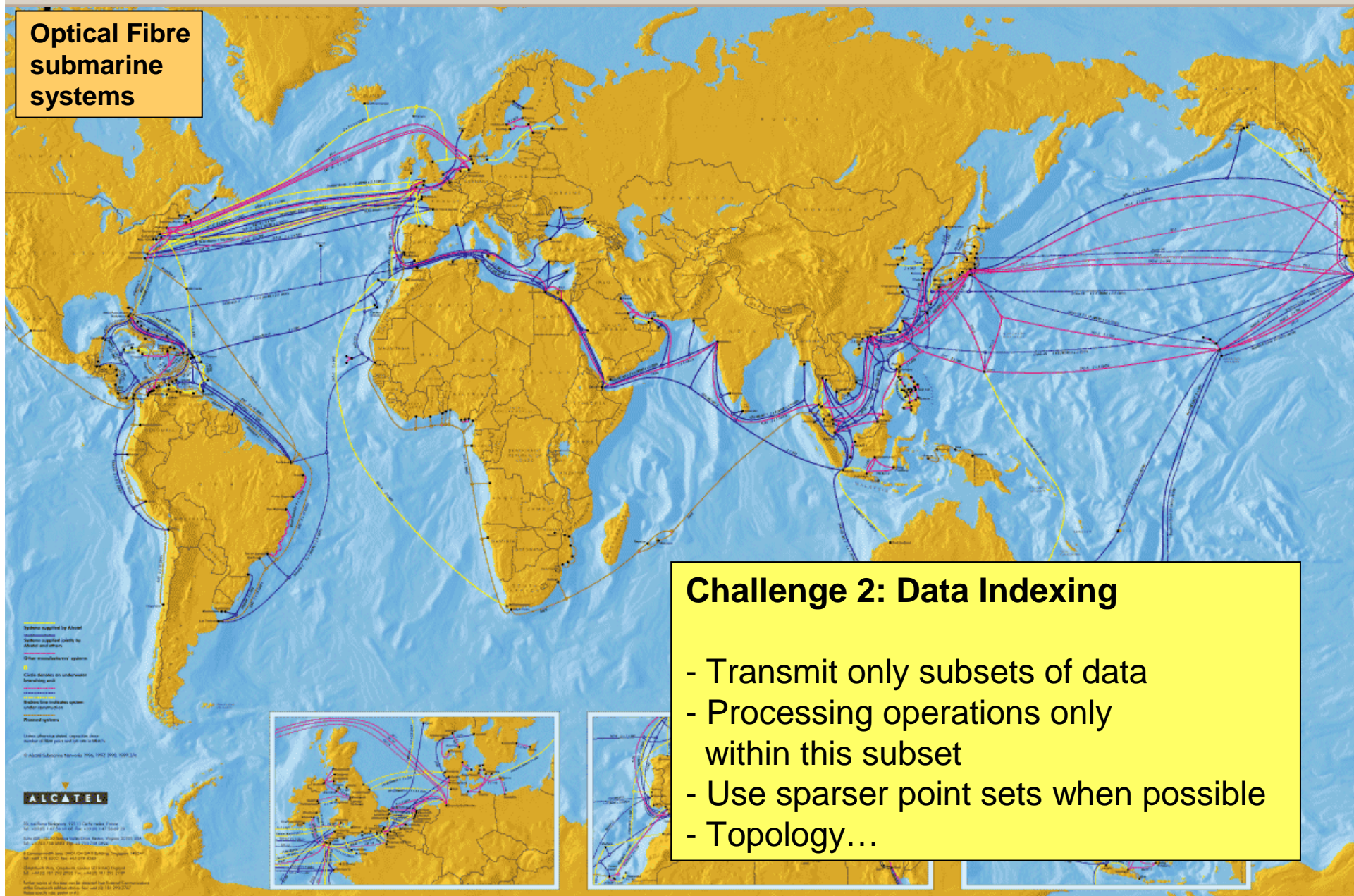


# Processing around the world

Optical Fibre submarine systems

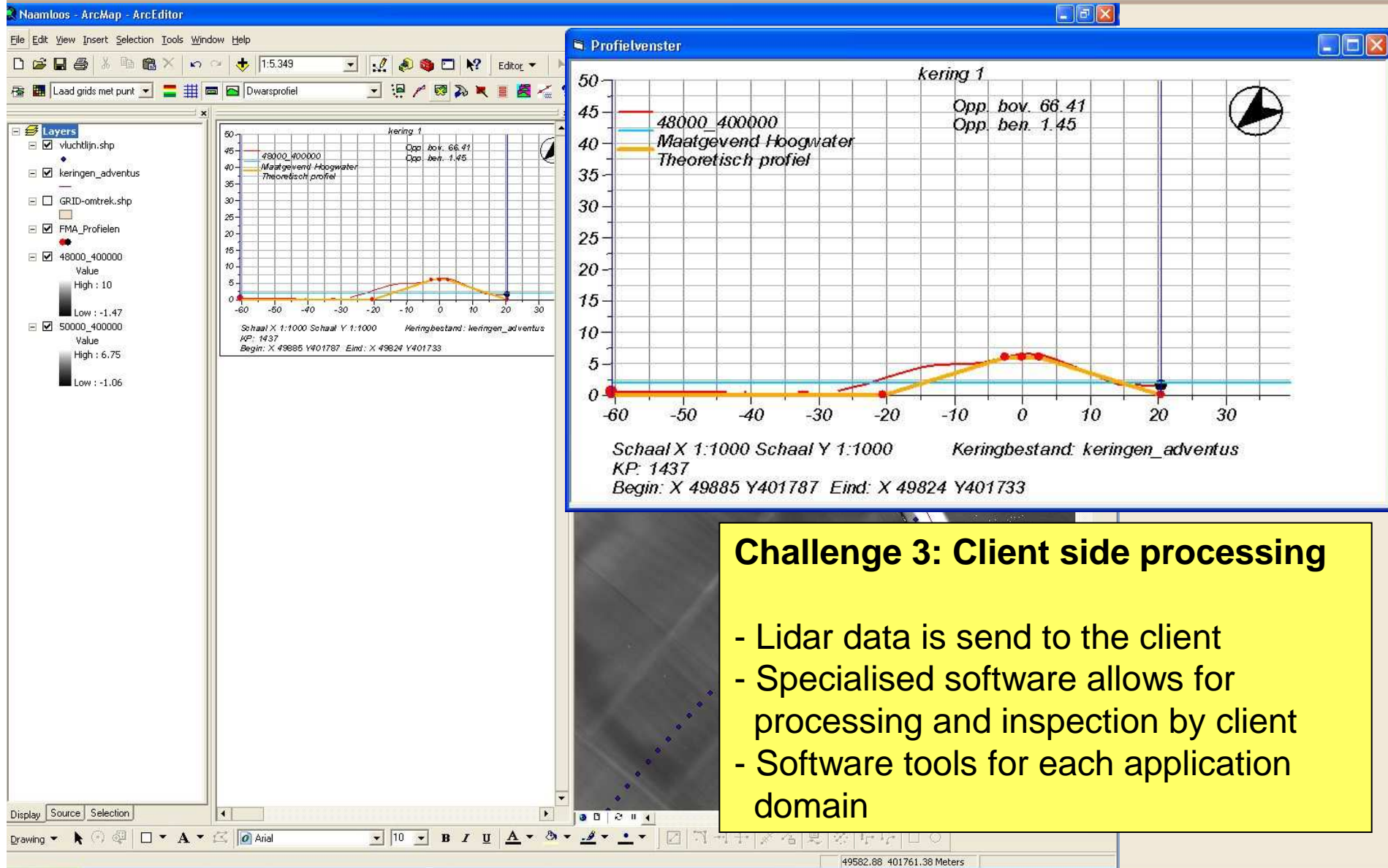
## Challenge 2: Data Indexing

- Transmit only subsets of data
- Processing operations only within this subset
- Use sparser point sets when possible
- Topology...





# FLI-MAP Analyst

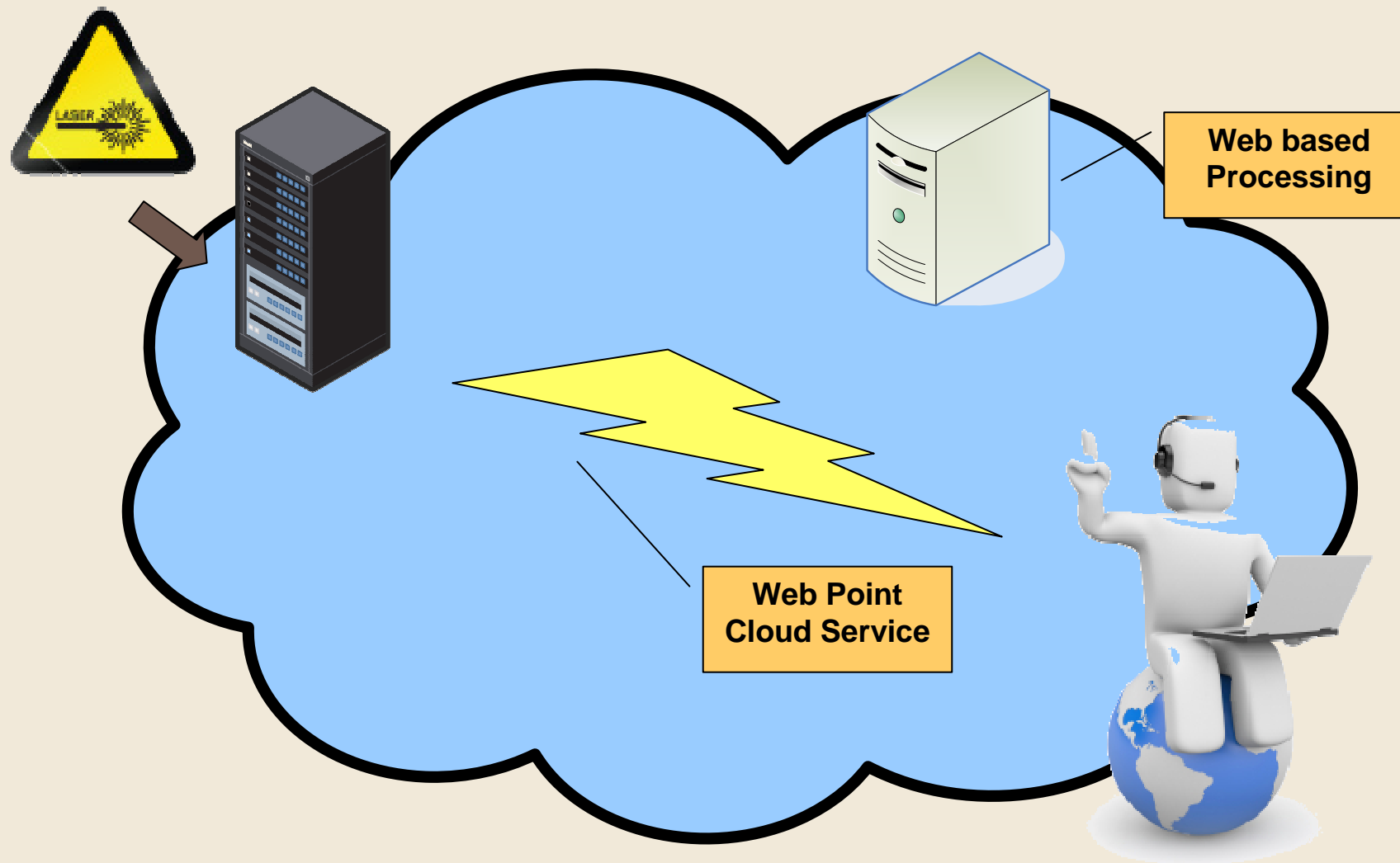


**Challenge 3: Client side processing**

- Lidar data is send to the client
- Specialised software allows for processing and inspection by client
- Software tools for each application domain



# Point clouds “in the cloud”





## Point Clouds “in the cloud”

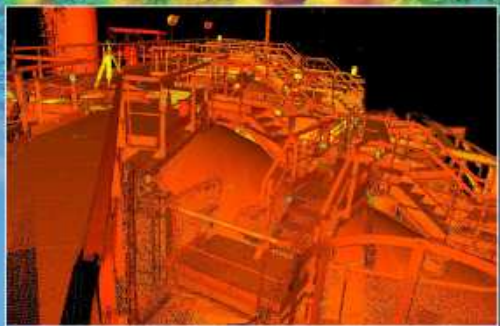
- Point Cloud Storage Server
  - Store all point cloud data and imagery
  - No more need to send HDs with data to clients
  - Web Point Cloud Service
  - Unified data model for point clouds?
- Processing software
  - Either locally installed or web based
  - Provide analysis tools to the client
  - If web based:
    - Moderate specs for client’s pc
    - Simple processing locally on pc (profiles, viewing, ...)
    - Computationally intense processing on server (segmentation, ...)
    - Pre-processed data (normal vectors, ...)



## The art of disseminating point clouds?

In the cloud?





**THANK YOU FOR YOUR ATTENTION**

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Satellite Remote Sensing

Airborne Laser Scanning  
Aerial Photogrammetry  
GeoSAR

FLI-MAP

Mobile Mapping

Terrestrial Laser Scanning

Tachymetry  
GPS/RTK

Detection  
GPR

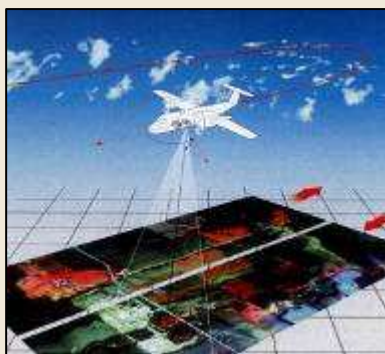
Geospatial Services



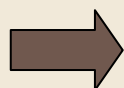


## Deliver disciplinary end-to-end solutions

ACQUISITION



Advanced collection technologies



PROCESSING



Sophisticated processing systems delivering high accuracy, quality, and fast turnaround



PRODUCT & APPLICATION DEVELOPMENT



Turnkey functionality to meet a multitude of needs

ISO 9001:2000 CERTIFIED and/or COMPLIANT SYSTEMS



# Activities

- Aerial Sensing and Mapping Services
- Terrestrial Survey services
- Geospatial Information Services



GEOSPATIAL SERVICES

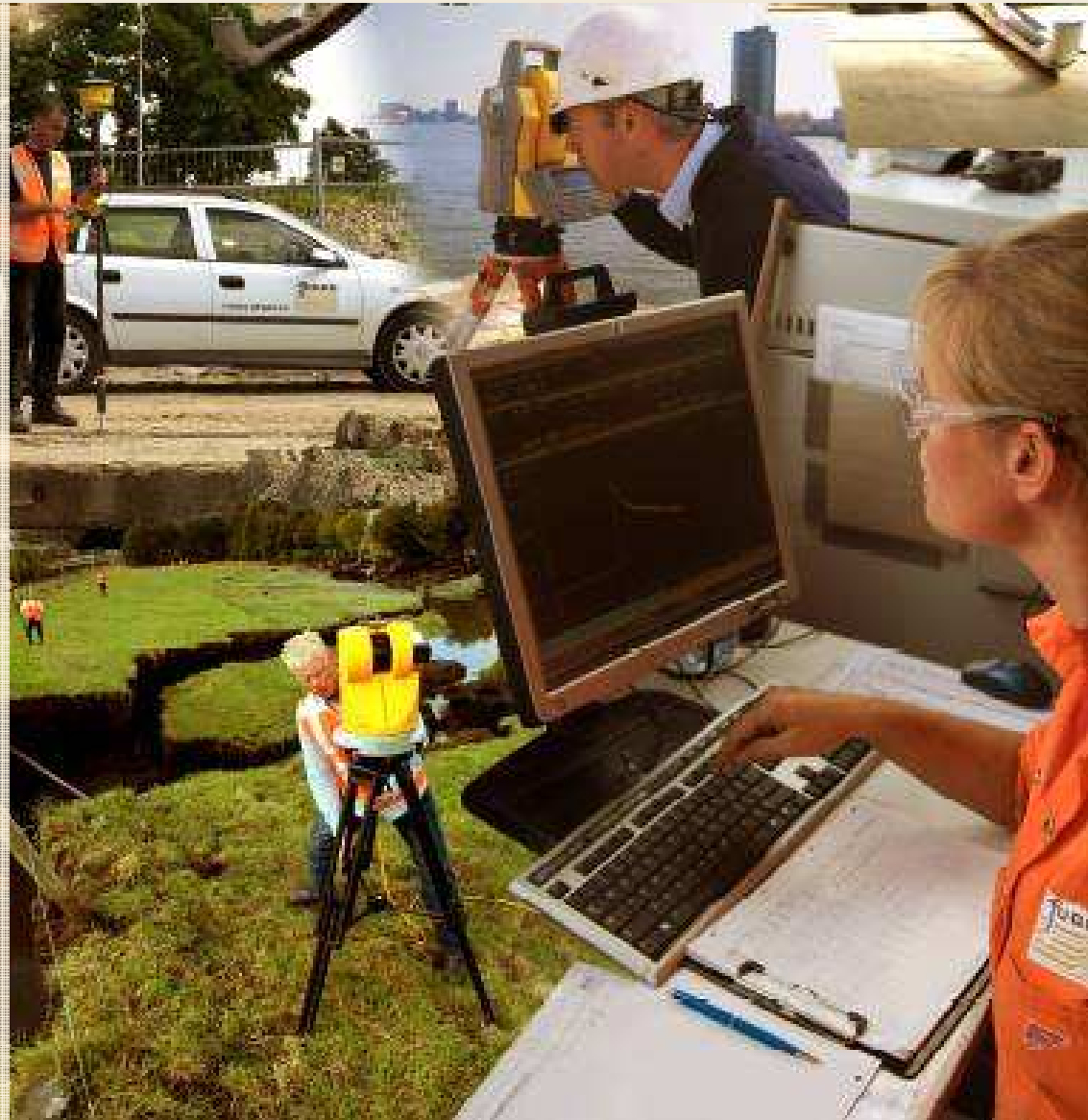




# Terrestrial Survey Services



- Regular Survey Services
- Special Field Services
- Data Services





FUGRO-INPARK B.V.

## Profile



Drachten



Amsterdam



Leidschendam



Arnhem



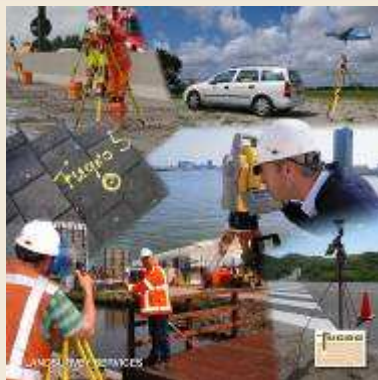
Breda



Fugro-Inpark B.V.

is a survey specialist in data collection, processing, interpretation and management of geographical information.

Our 200 employees work in 5 regional offices scattered over the Netherlands



- Regular Survey Services
  - Building measurements
  - Topographical measurements
  - Levelling
  - Technical measurements
  - Cadastral survey
- Special Field Services
  - Subsurface infrastructure
  - GPR
  - Railroad surveys
  - Laser scanning and Dimension Control
  - Drive-Map
  - Machine guidance
  - Geo-Monitoring
  - DTB's
  - Civil engineering
- Data Services
  - Geo-ICT services
  - Geo-ICT products





FUGRO-INPARK B.V.\_ACTIVITIES

# Regular Survey Services



LANDSURVEY SERVICES



## Regular Survey Services

- Building measurements
- Topographical measurements
- Levelling
- Technical measurements
- Cadastral

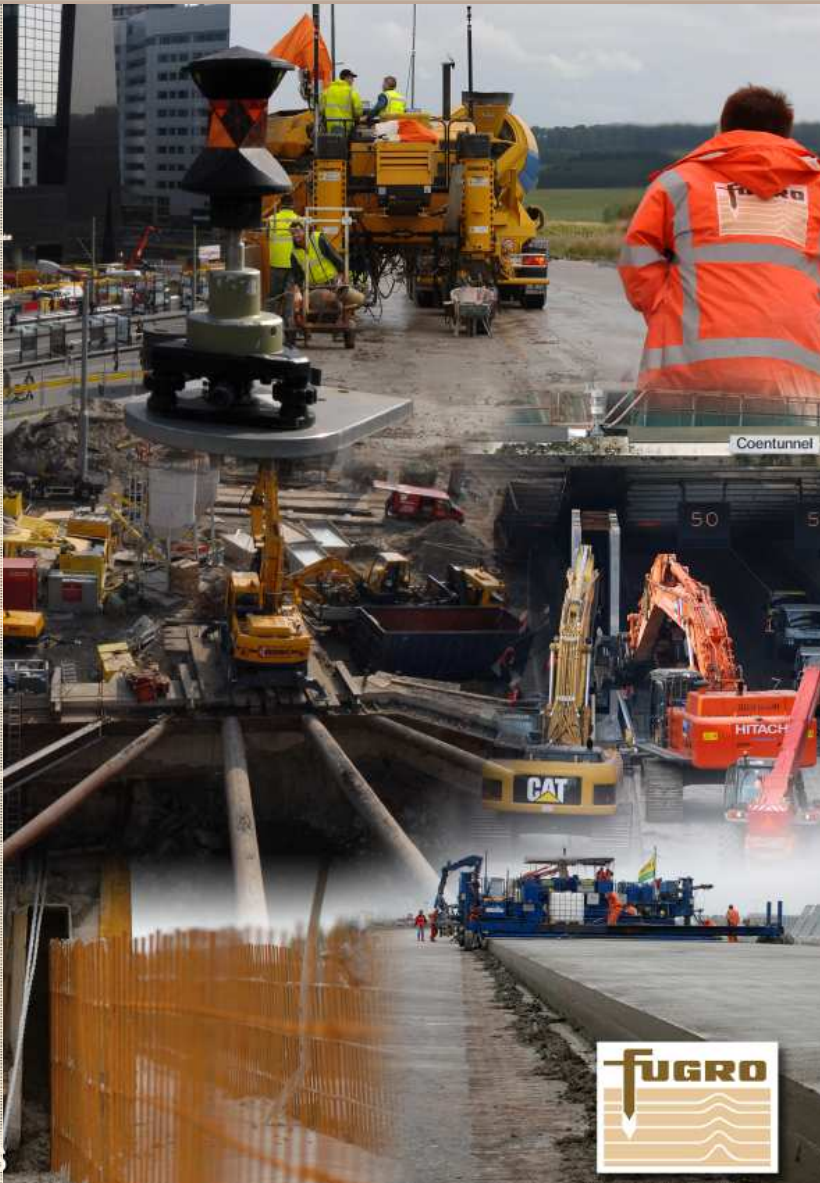




# Special Field Services

- Subsurface infrastructure
- GPR
- Railroad surveys
- Laser scanning and Dimensional Control
- Machine guidance
- Geo-Monitoring
- DTB's
- Civil engineering

SPECIAL FIELD SERVICES

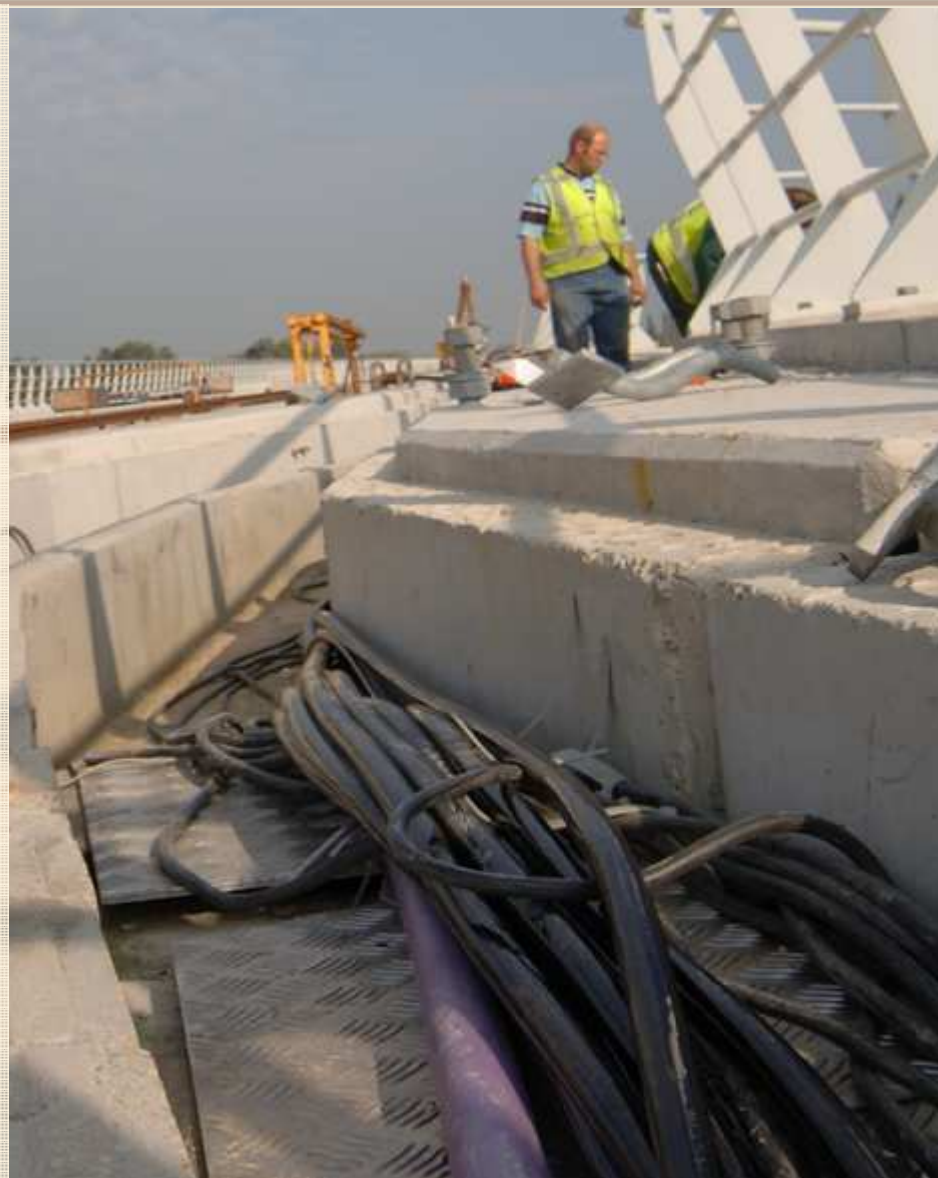






## Subsurface Infrastructure

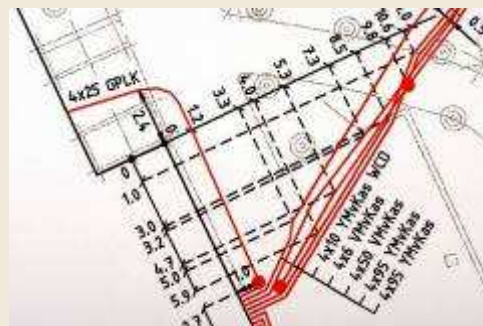
- Mapping and Detection (GPR)
- Advising external contacts
- Specific investigations
- Detail engineering and calculation
- Preparation arrangements



- Determining

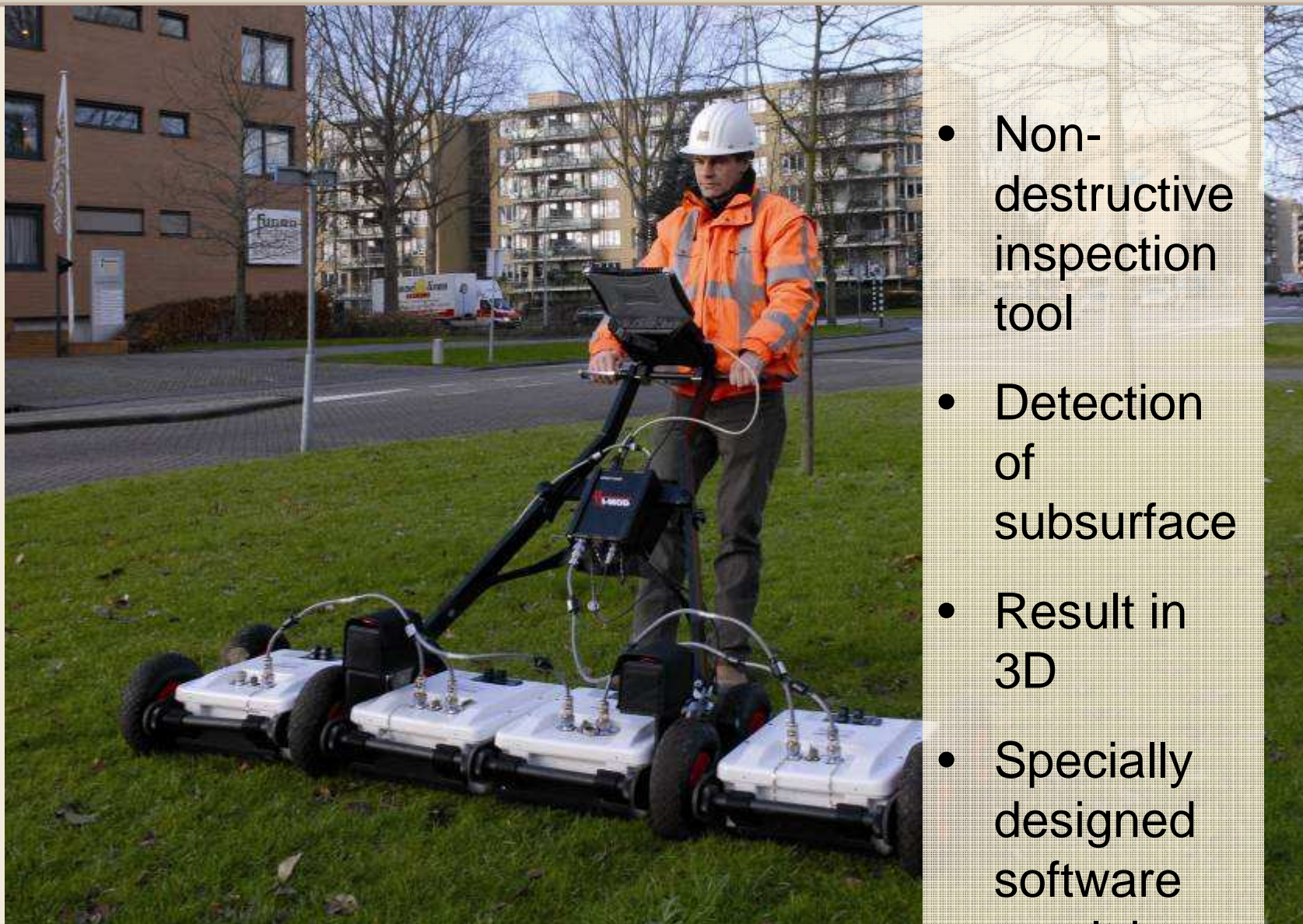
# Subsurface Infrastructure

- Stake-out and measurements
- Revisions
- Data conversions
- Geo data services





## GPR (Ground Penetrating Radar)

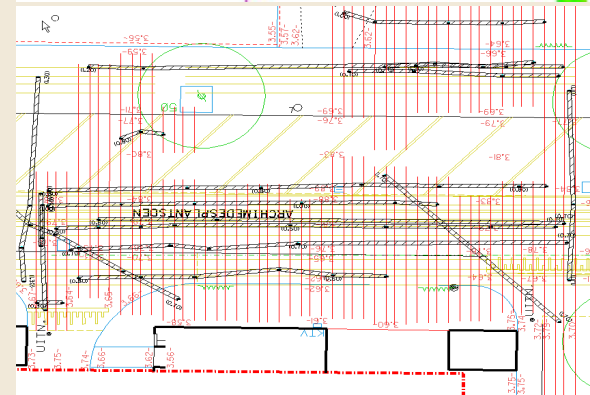
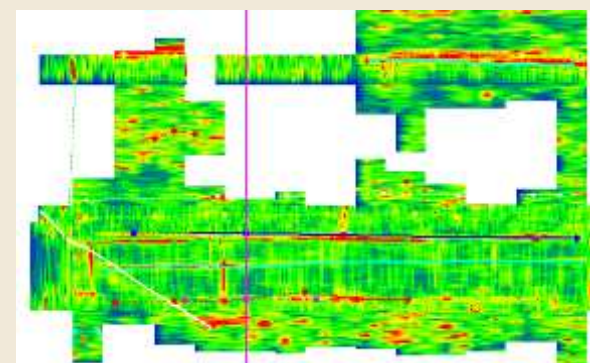
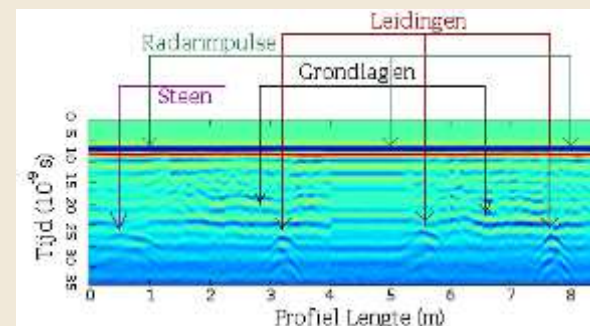


- Non-destructive inspection tool
- Detection of subsurface
- Result in 3D
- Specially designed software result in as

# GPR (Ground Penetrating Radar)

## When to apply

- Detailed detection of subsurface cables and utilities as preliminary activities for civil engineering and construction works in public terrains
- Mapping instrument for (very) large terrains
- As a second technology to verify the quality of the detection and/or registration of the subsurface infrastructure
- Detailed detection of subsurface transport utilities,





## Traditional methodology:

- Primary geometric reference network
- Detail measurements along railways
- Machine guidance of Georog system

## Safety:

- Laser scanning



## Measurements of Rail Geometry:

- Measurements of reference bolts in portals
- Comparison of as-built situation with design
- As-built drawings



# Laser Scanning



## Laser Scanning

### Processes:

- Data Acquisition
- Registration
- Processing
- Deliverables

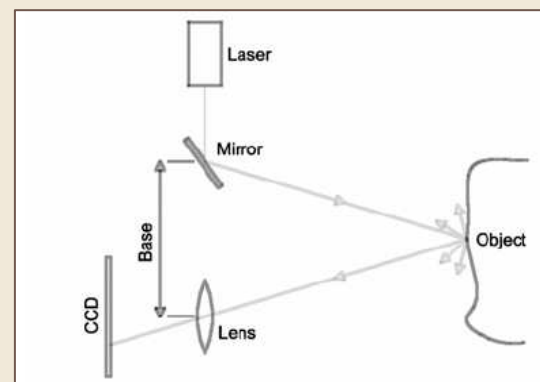
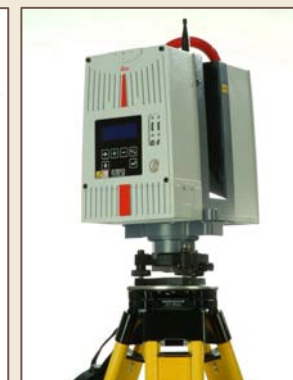
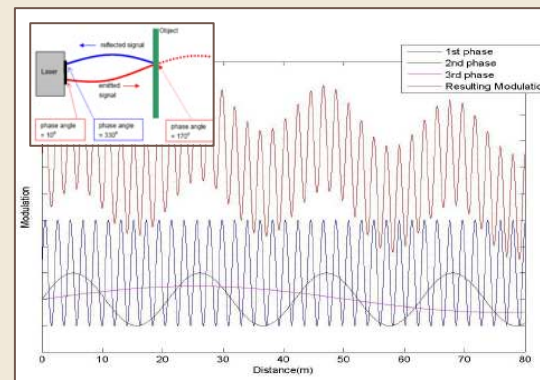
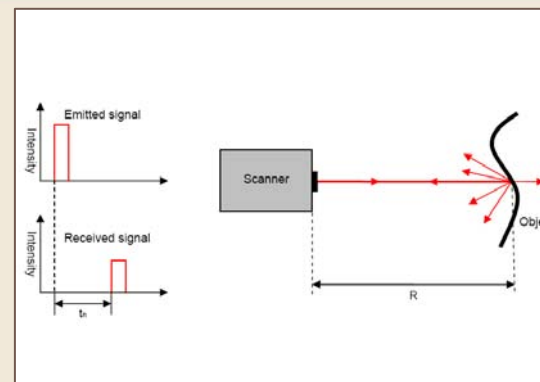
### Software:

- Cyclone
- Cloudworx
- I FM

# Laser Scanning

## Types of scanners:

- Long range: time of flight
  - High range
  - Constant accuracy
  
- Mid range: phase modulation
  - Short measure time
  - 360° Field of view





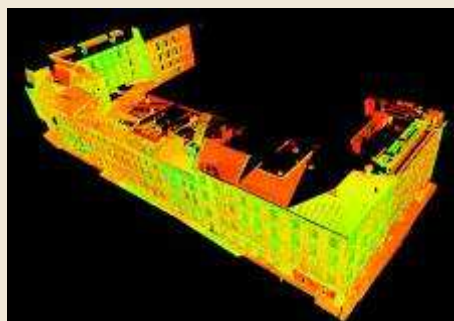
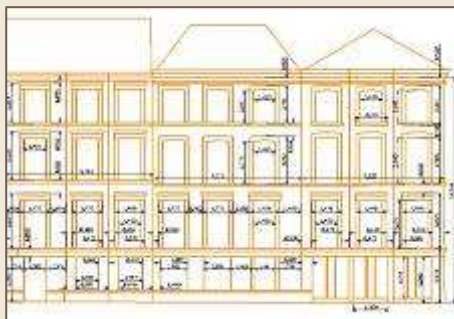
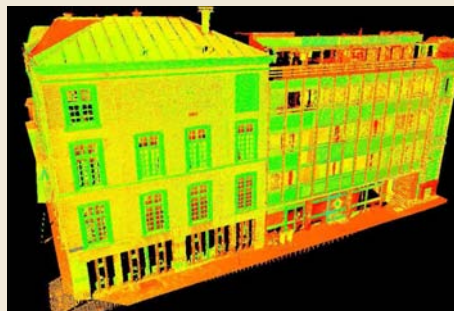
## Applications of 3D Laser scanning

- **Architecture**
  - Facades
  - Cultural heritage
- **Industry**
  - Piping
  - Process industry
- **Civil engineering**
  - Mapping
  - Infrastructure
- **Other areas**
  - Archaeology
  - Art



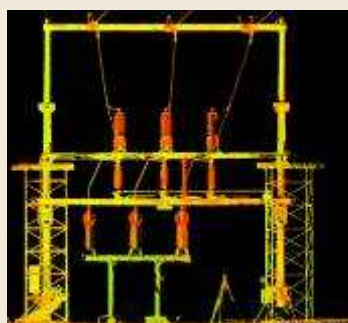
## 3D laser scanning of Architectural Objects

- Facades
- Cultural heritage



## 3D laser scanning of Power lines

- Hanging
- Safe zones
- Dimension control

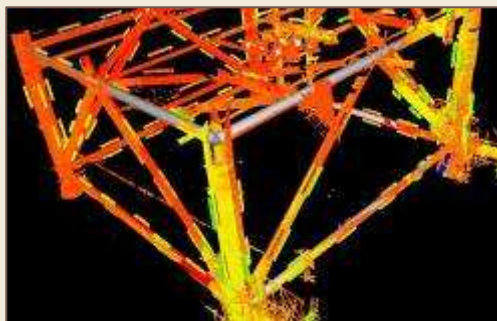


## Dimension Control

- Consistent
- Complete
- Correct

## Analysis

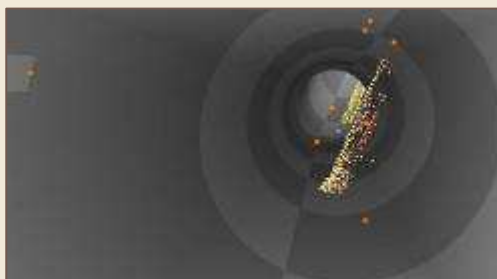
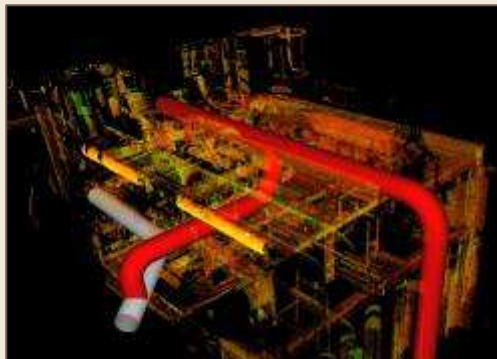
## Reports



# Laser Scanning

## Dimension Control

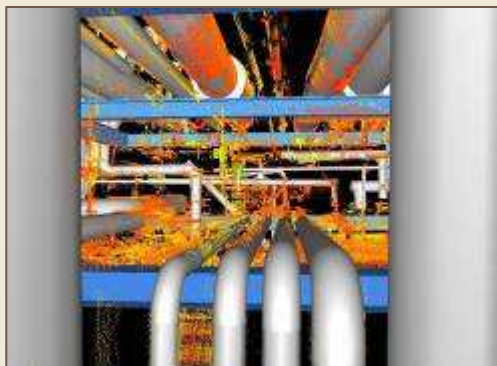
- accurate
- reliable
- complete



## Pipe routing

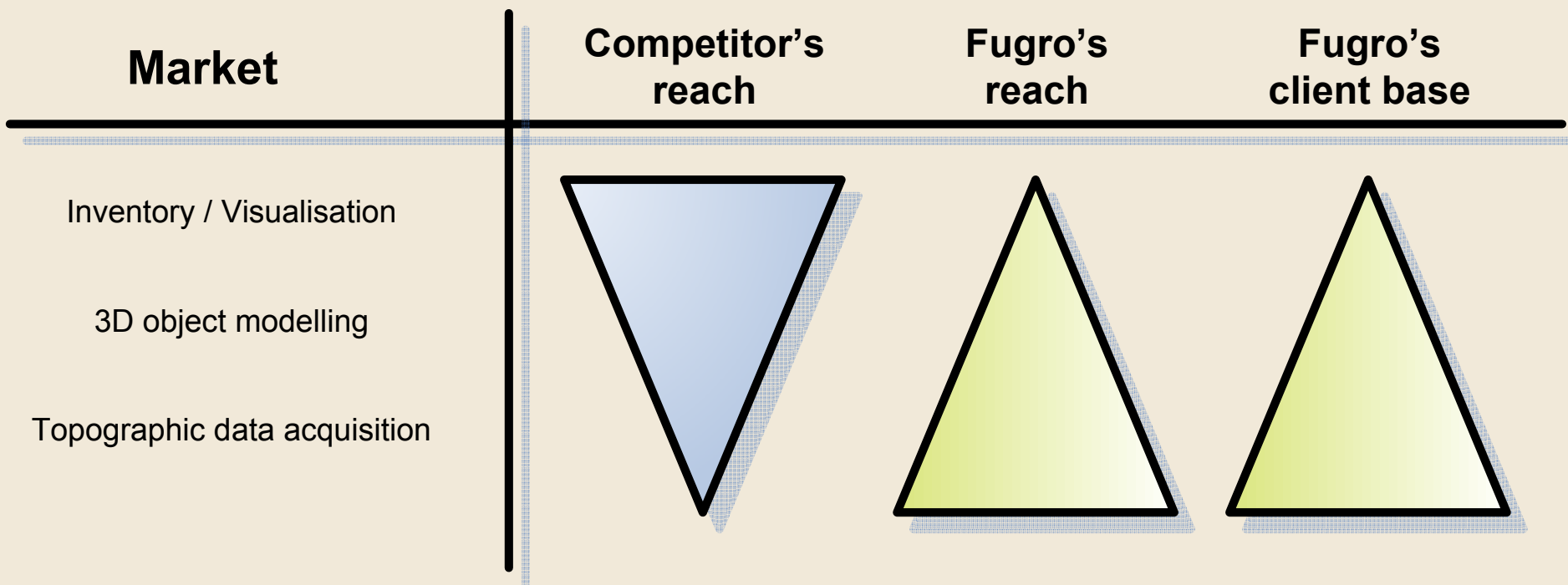
## Clash detection

## Conceptual design





# Mobile Mapping: Drive-Map





## Machine Guidance



Current operating systems such as slip form pavers, asphalt spreading machines and graders can be fully automated, making it



Advantages in comparison to traditional

methods:

- Cost effective and more efficient
- operational machines of 24 hours a day
- less traffic jams
- improved traffic safety
- Quality guaranteed by consistent use of three dimensional design data throughout the whole process







## Geo-Monitoring



Monitoring the  
behaviour of  
the surface  
and  
constructions  
makes it  
possible to  
prevent,  
minimize or at  
least manage

The different kind of measurements that we can execute for you, can be divided in:

- Monitoring of the surface, the underground and constructions
- Control measurements
- Geophysical measurements
- Tailor made specialist measurements



Depending on the objective of the measurements and the required accuracy Fugro makes use of several techniques like:

- (Digital) spirit levelling
- Automatic data collection
- Crack measurements
- Photo reports
- Laser scanning

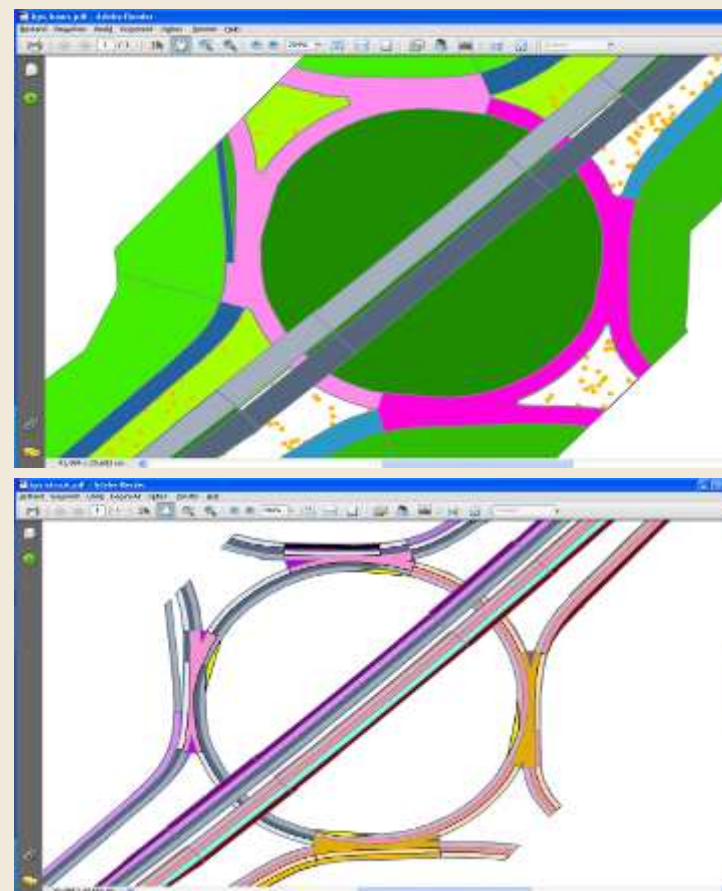




Supplying  
geodata  
highroads with  
high accuracy  
and high level  
of detail using  
specialist  
software,  
developed or  
customized in



- DTB
  - Photogrammetric points and covered situations
  - Tachymetry's
  - Laser scanning
- KernGIS
  - Geometric out of DTB
  - Administrative specifications of contractor
- BPS
  - Geometric out of KernGIS



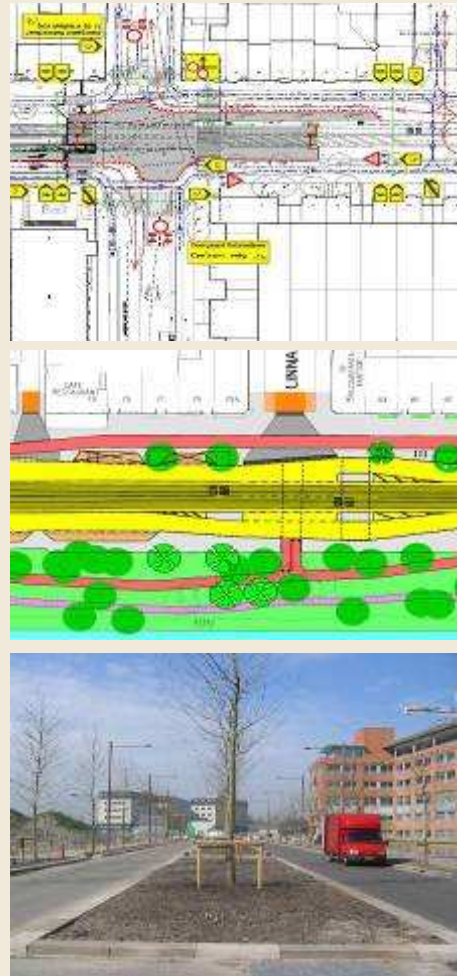


## Civil Engineering

Support  
realization of  
civil-technical  
projects in the  
field of  
renovation,  
reconstruction  
roads,  
sewerage,  
preparing for



- Project management and advise
- Stocktaking of the project
- Support during the phase of designing
- as-built drawings
- Supervision and managing of the project





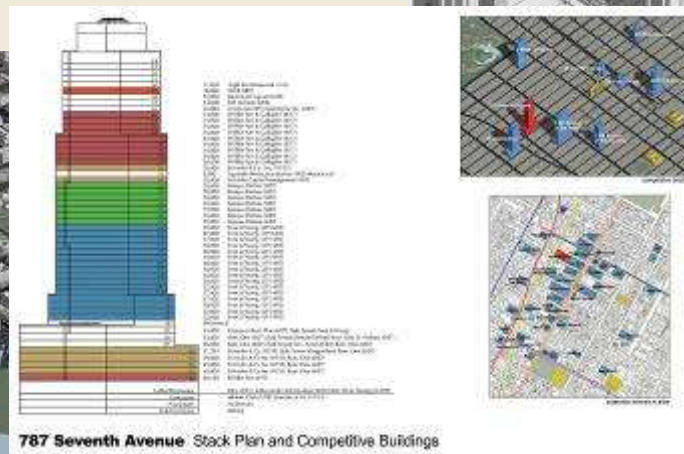
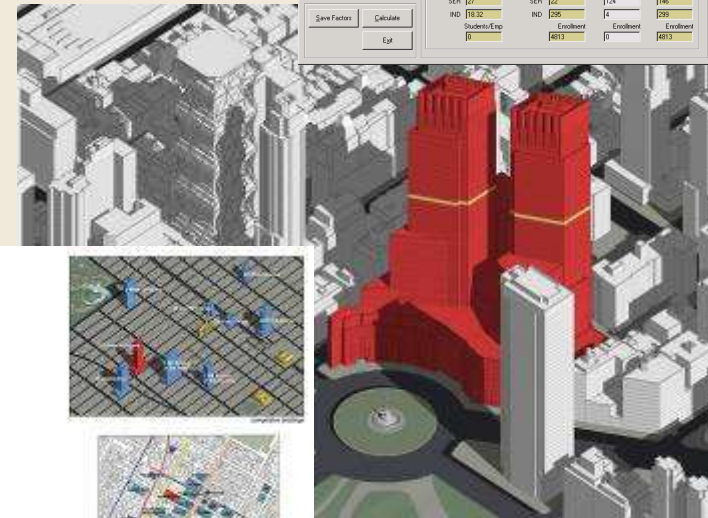
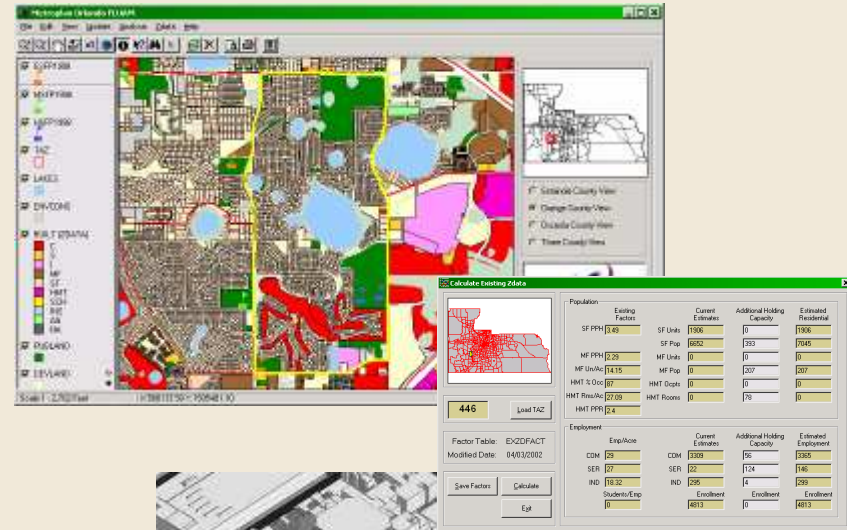
FUGRO-INPARK B.V.\_ACTIVITIES  
Data Services





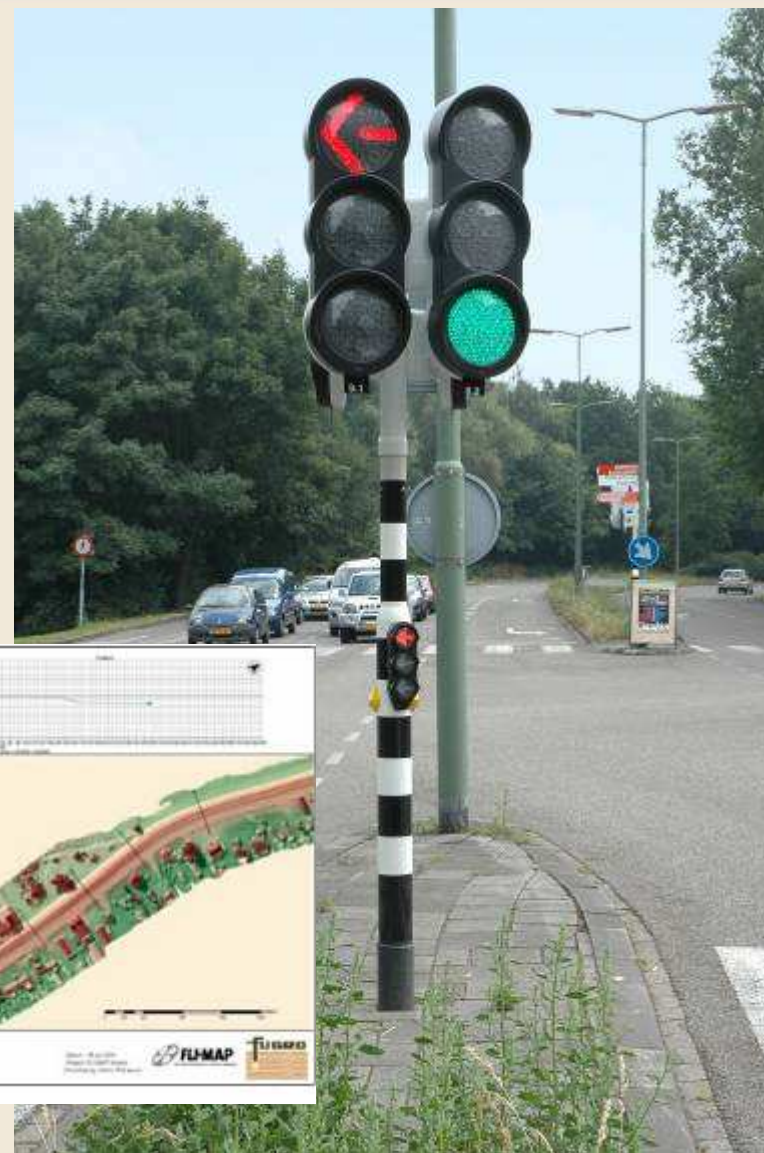
## Custom made GIS solutions

- Applications for:
  - Regional planning
  - KLIC reports
  - VRI
  - Traffic junction



## Products:

- INCA
  - INCA VRI
- INFRA
- FLI-MAP Analyst



## Specialist techniques

- Web services
- Mobile GIS
- Knowledge of several software packages:
  - ArcGIS
  - Geomedia
  - FME
  - MicroStation

