Merging Geospatial Technologies to Improve the Bottom Line

John Whitehead

Trimble Navigation Limited

Trimble:
Data Collection to Decision Making

This talk will explore how the mergers of geospatial technologies provide practical, efficient solutions for today's surveyor while holding the potential to dramatically improve the bottom line.

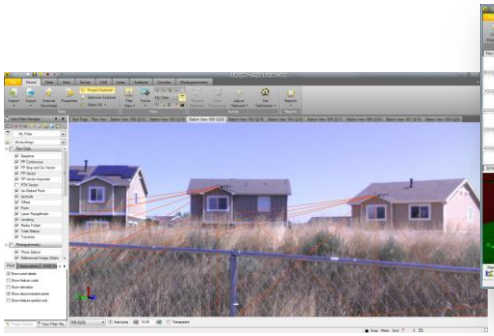
Key Drivers of Change

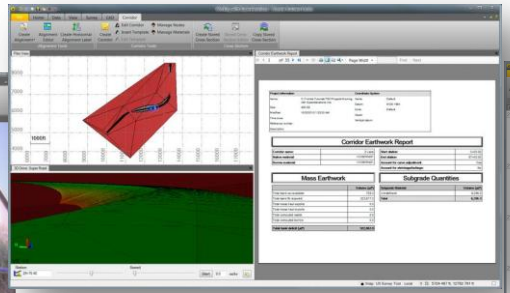
- Customers are demanding more from their geospatial data
- Data Collection Solutions are rapidly changing and improving efficiency
- Survey Professionals are searching for ways to provide more value to their customers at multiple levels
  - One organization, multiple departments
  - One project, multiple organizations
  - Present and future value of collected data

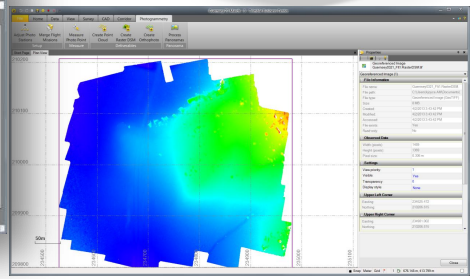
Trimble V10 Imaging Rover

Trimble UX5 Aerial Imaging Rover

Trimble Business Center







Both the V10 and UX5 combine photogrammetry principles with survey and mapping data collection workflows…..

So what can surveyors get from pictures?

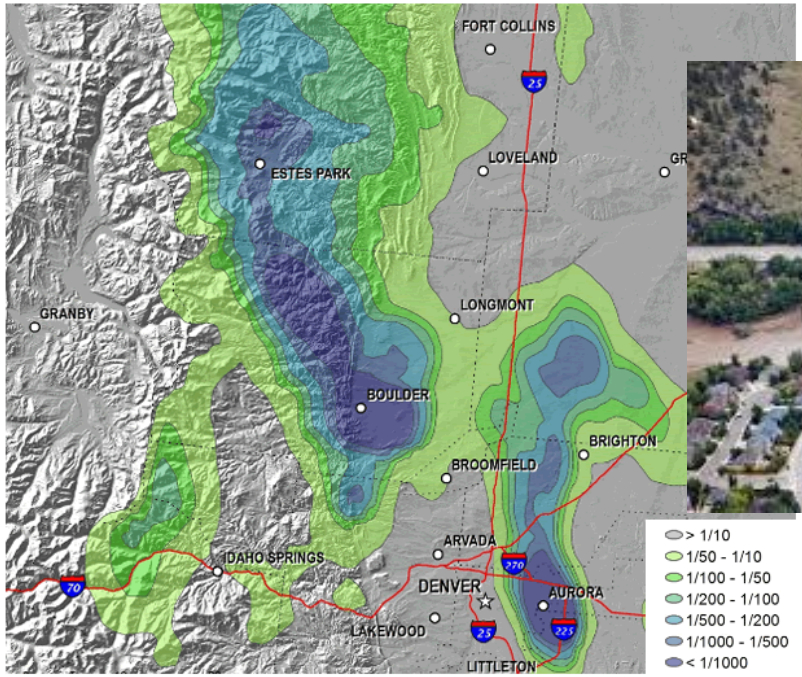
Colorado Floods

Colorado's exceedingly rare flood in 3 maps

By Jason Samenow, Published: September 19 at 1:56 pm E-mail the writer

New visuals from the National Oceanic and Atmospheric Administration reveal the exceptional nature of rainfall that flooded parts of 17 counties in Colorado last week.

The map below – as an example – shows the likelihood of the maximum 24-hour rainfall totals (in any given year) that occurred along the Colorado Front Range between September 9 and 16.

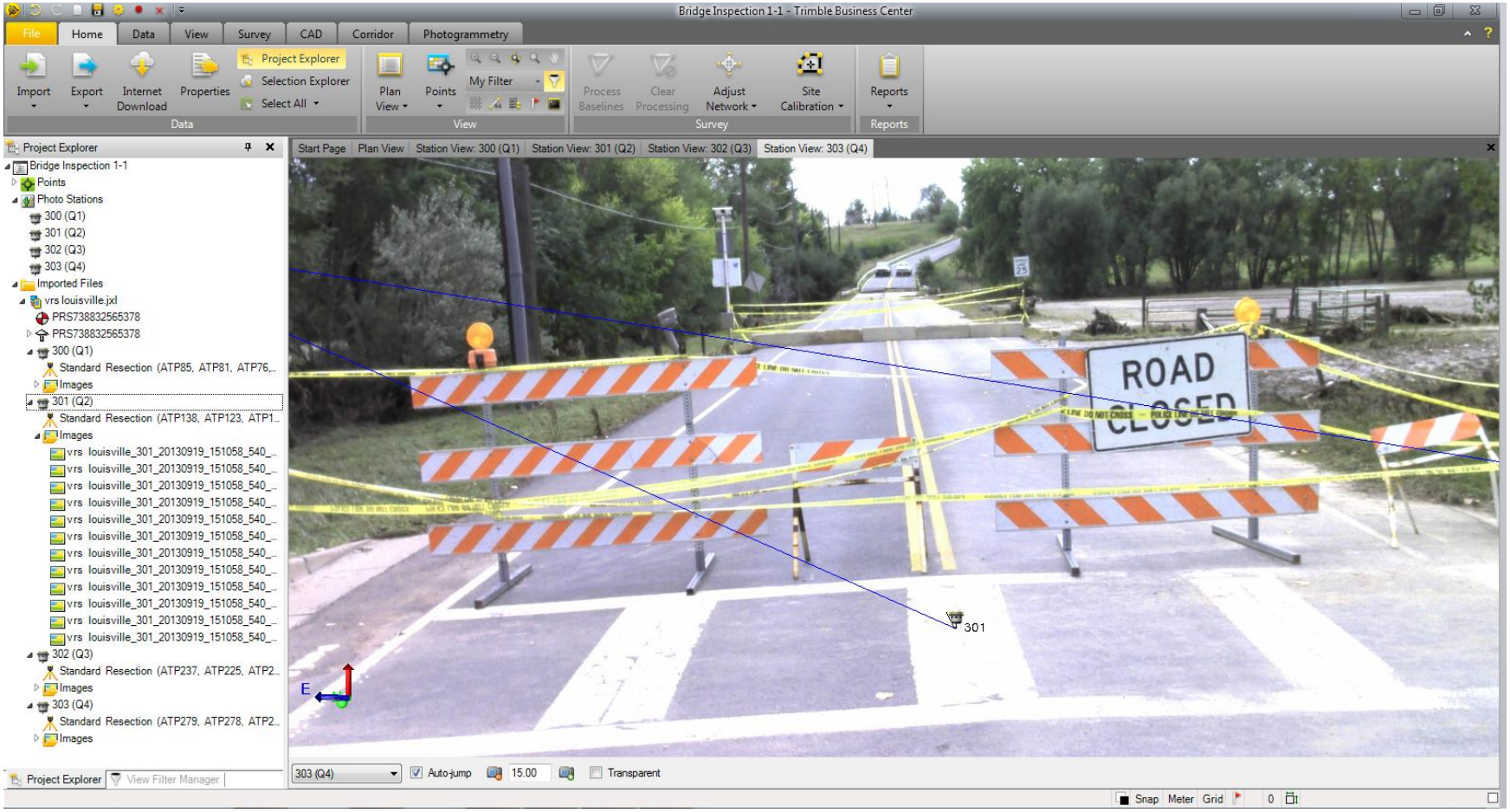


Annual exceedance probabilities for the worst case 24-hour rainfall. (NOAA)

Rain slows rescue efforts amid deadly Colorado floods

Join the conversation
CNN iReport

By David Simpson, Nick Valencia and Emma Lacey-Bordeaux, CNN
updated 12:33 AM EDT, Mon September 16, 2013


Bridge Inspection 1-1 - Trimble Business Center
File
Home
Data
View
Survey
CAD
Corridor
Photogrammetry
Import
Export
Internet Download
Properties
Project Explorer
Selection Explorer
Select All
Data
Plan View
Points
My Filter
View
Process Baselines
Clear Processing
Adjust Network
Site Calibration
Survey
Reports
Reports
Project Explorer
Bridge Inspection 1-1
Points
Photo Stations
300 (Q1)
301 (Q2)
302 (Q3)
303 (Q4)
Imported Files
vrs louisville.jxl
PRS738832565378
PRS738832565378
300 (Q1)
Standard Resection (ATP85, ATP81, ATP76,...
Images
301 (Q2)
Standard Resection (ATP138, ATP123, ATP1...
Images
vrs louisville_301_20130919_151058_540_...
302 (Q3)
Standard Resection (ATP237, ATP225, ATP2...
Images
303 (Q4)
Standard Resection (ATP279, ATP278, ATP2...
Images
Project Explorer
View Filter Manager
Start Page
Plan View
Station View: 300 (Q1)
Station View: 301 (Q2)
Station View: 302 (Q3)
Station View: 303 (Q4)
ROAD
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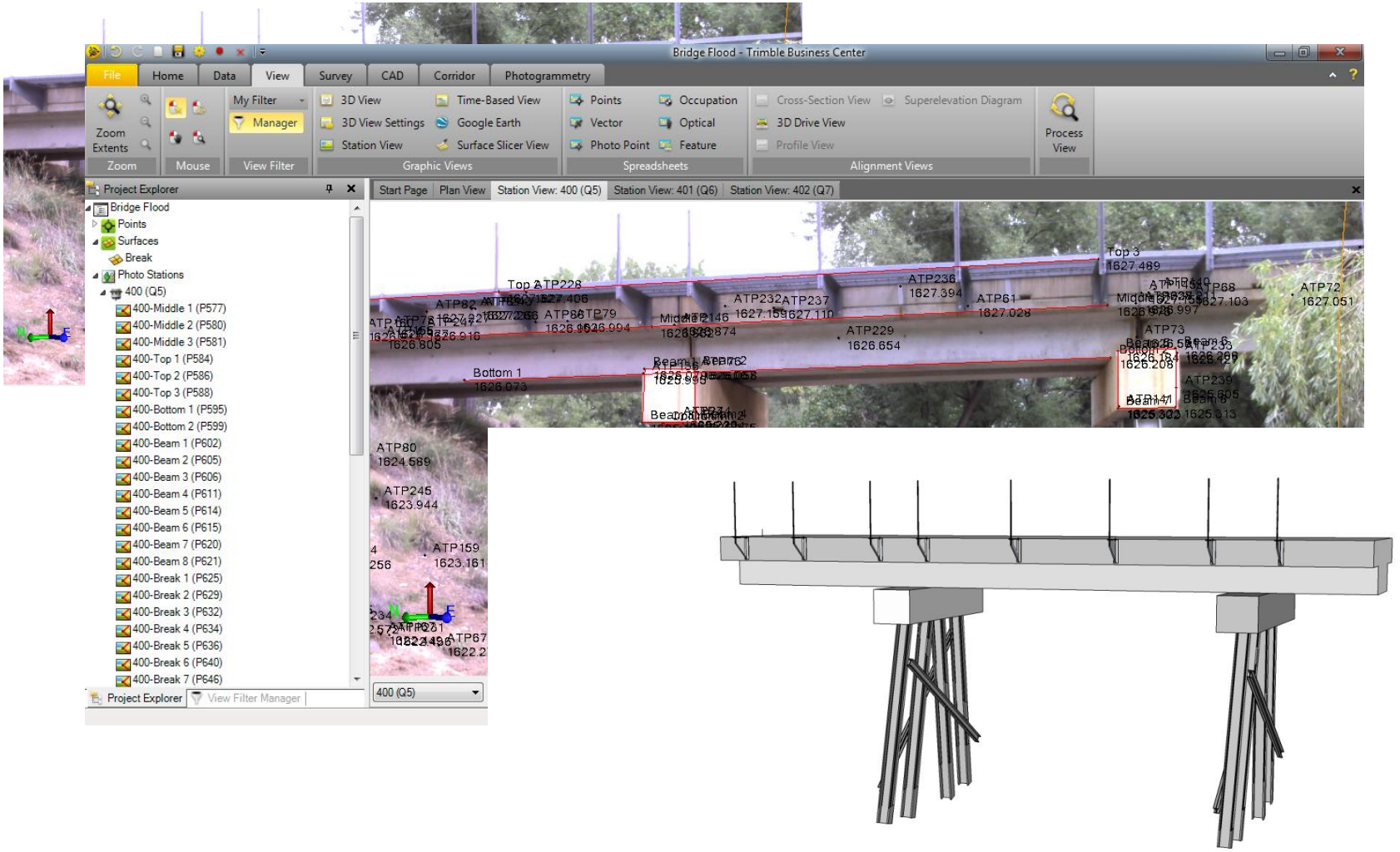
Positions from Pictures



The Technology….

Product Vision Statement

The Trimble V10 Imaging Rover is an integrated camera system that precisely captures 360° digital panoramas used to visually document and measure the surrounding environment.

Trimble V10 – ***Positions from Pictures***

Positioning Sensor

- Integrates seamlessly with R10 GNSS receiver and S-Series total station positioning sensors.

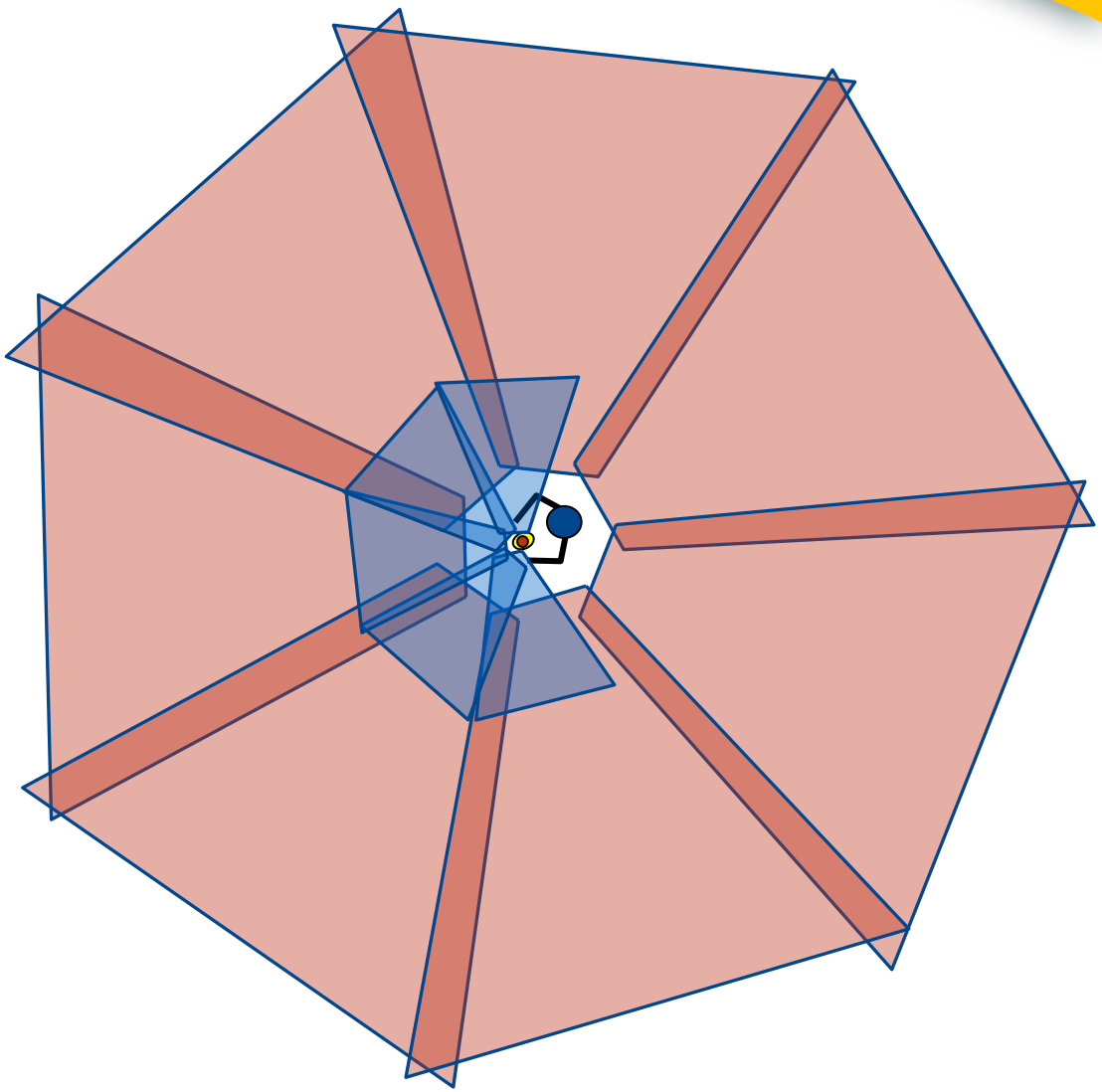
- Panoramas may also be captured standalone pre- or post- survey of occupied points

Camera System

- 12 calibrated cameras
- 60 Megapixel 360° panorama
- Sequential image capture
- Tilt sensors
- Magnetic compass
- Gyrometers and accelerometers
- On-board data storage
- USB communications
- 2m pole drop tested
- IP 54 environmentally protected

Camera System

- 7 panoramic cameras
- 5 downward-looking cameras



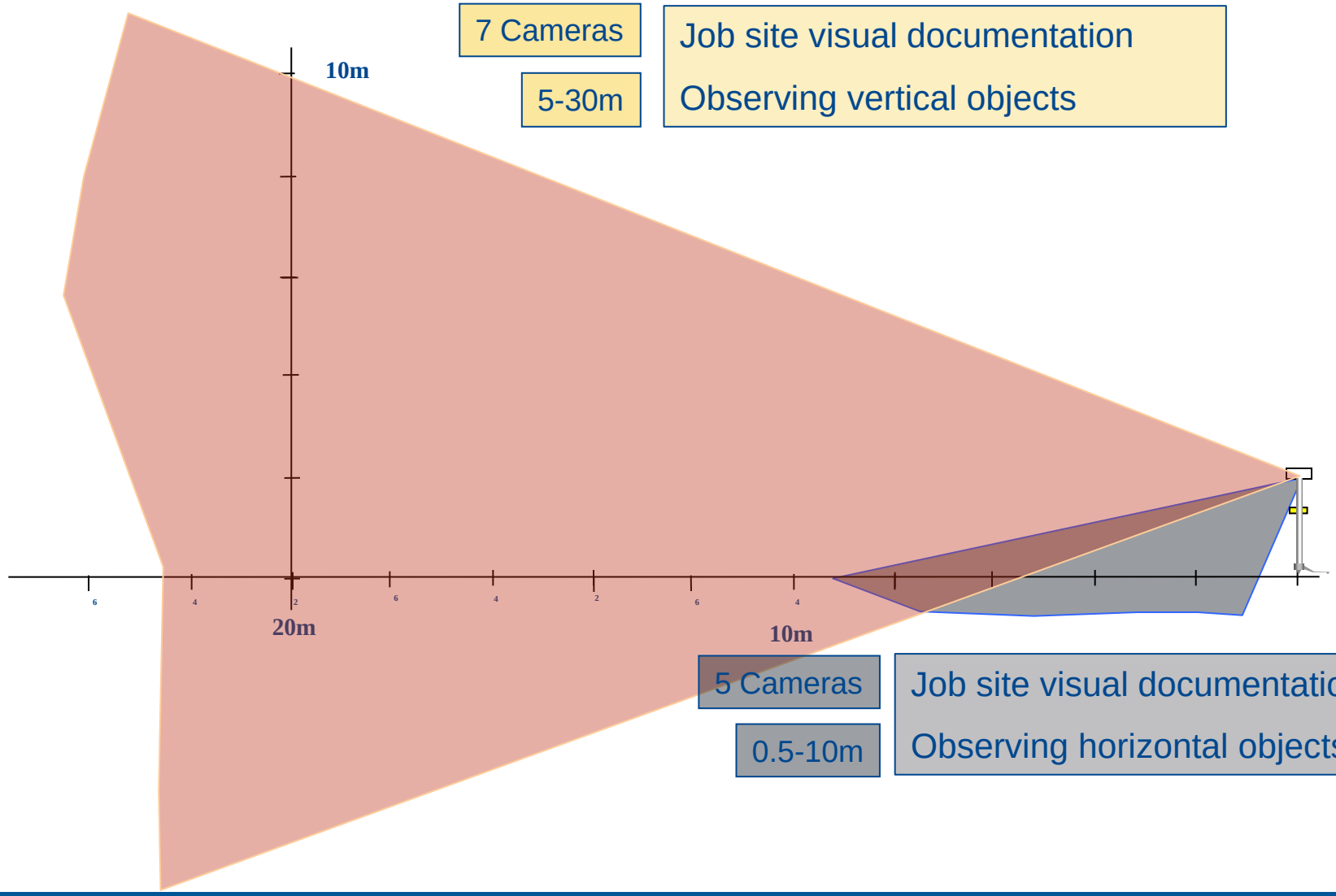
Camera System

7 Cameras

5-30m

Job site visual documentation

Observing vertical objects



5 Cameras

0.5-10m

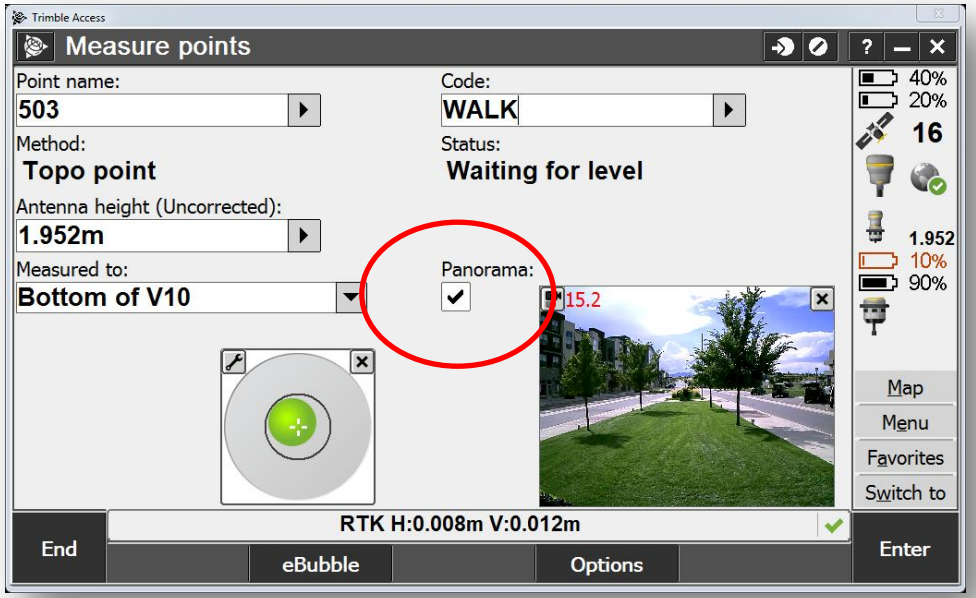
Job site visual documentation

Observing horizontal objects

Field Software

Trimble Access

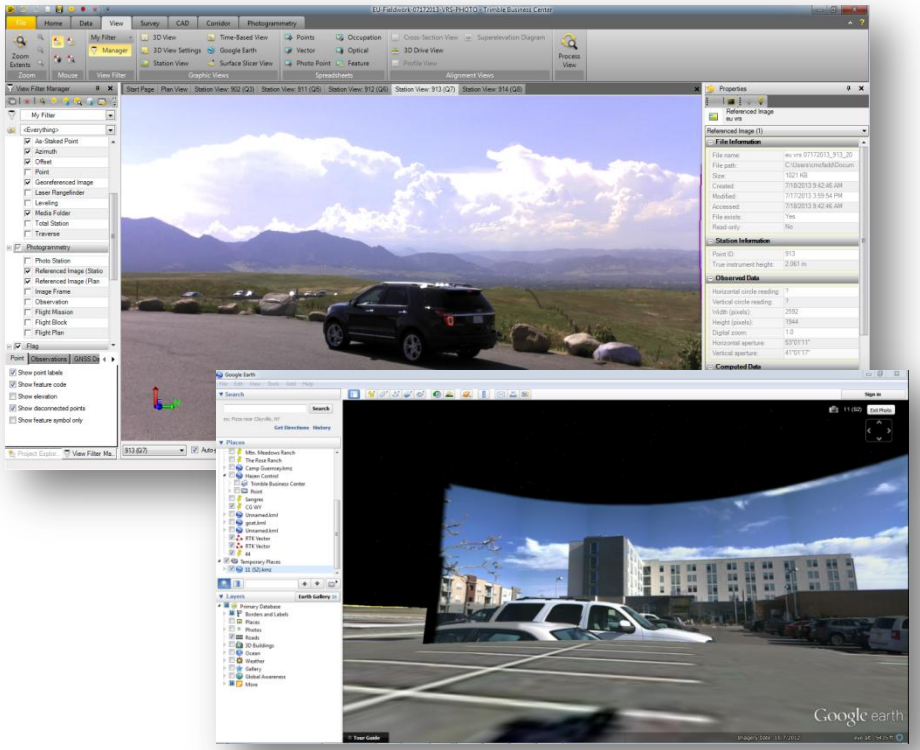
1. Streaming video
2. Capture and store panoramas simultaneously with points or standalone
3. Review thumb-nail images
4. Review Panoramas



Office Software

Trimble Business Center

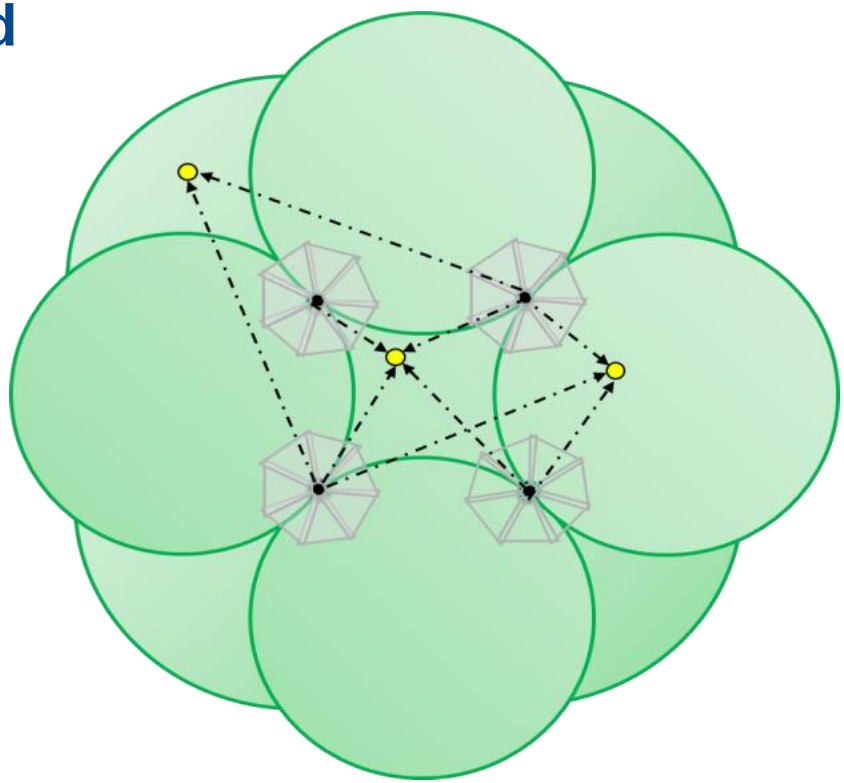
1. Network adjustment of panoramas
2. Measure photo points
3. Panoramic review with data overlay
4. Export panoramas (jpeg, html, kmz)
5. Export deliverables (CAD, GIS)

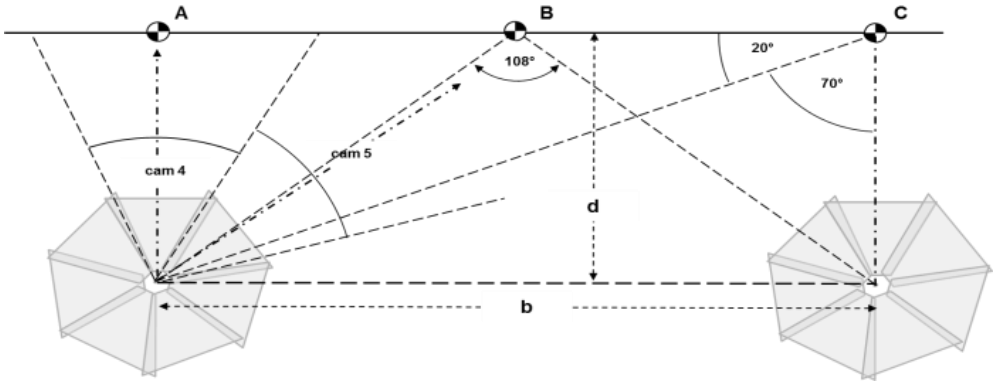


How Does It Work?

How do I get Positions from Pictures?

- Capture panoramas in the field using Trimble Access
- Process the data in Trimble Business Center
- Measure objects in the photos in TBC to create positions
- Prepare deliverables in TBC from the positions

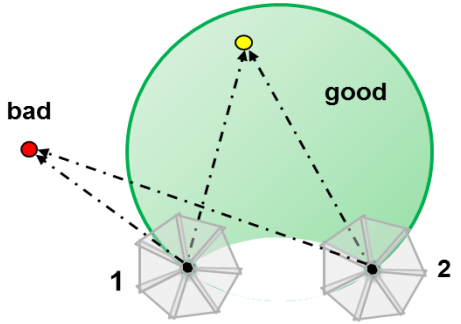




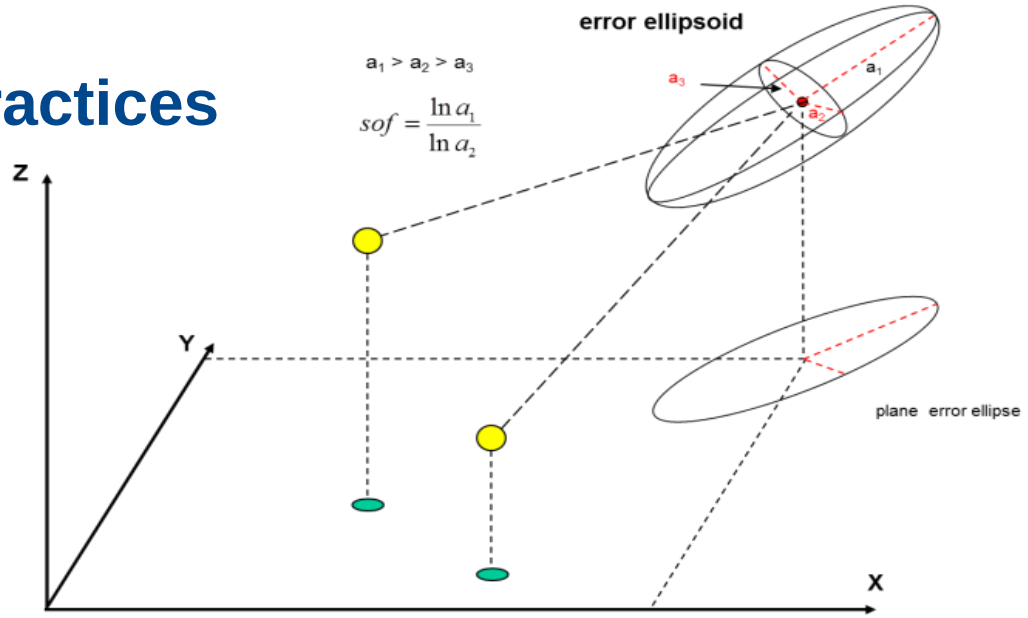
How Accurate is it?

How accurate are the positions produced by the system?

- **1 Centimeter sample distance @ 10 meters from object with good network geometry (2cm @ 20m, 3cm @ 30m)**



- **Dependent of field practices**
  - **Distance to object of interest**
  - **Distance between stations**
  - **Site geometry**



Old Design Survey Workflow

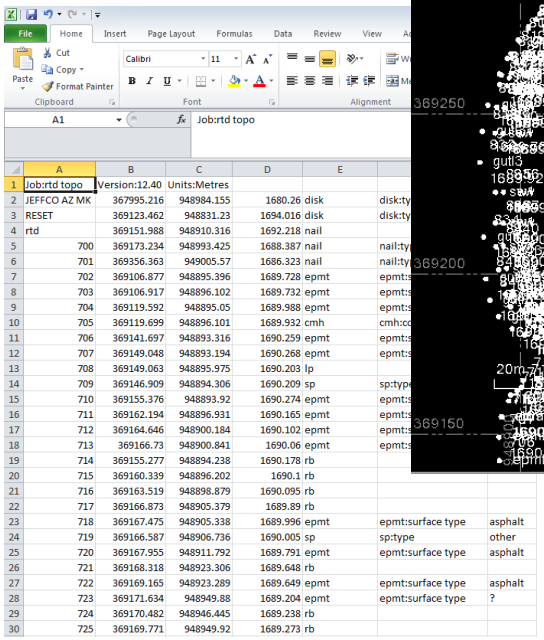
Capture points in the field

Download CSV file

Import to CAD

Connect the dots

Publish 2D+ Paper



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3	RESET	369123.462	948831.23	1694.016	disk	disk:ty	
4	rtd	369151.988	948910.316	1692.218	nail		
5	700	369173.234	948993.425	1688.387	nail	nail:ty	
6	701	369356.363	949005.57	1686.323	nail	nail:ty	
7	702	369106.877	948895.396	1689.728	epmt	epmt:s	
8	703	369106.917	948896.102	1689.732	epmt	epmt:s	
9	704	369119.592	948895.05	1689.988	epmt	epmt:s	
10	705	369119.699	948896.101	1689.932	cmh	cmh:co	
11	706	369141.697	948893.316	1690.259	epmt	epmt:s	
12	707	369149.048	948893.194	1690.268	epmt	epmt:s	
13	708	369149.063	948895.975	1690.203	lp		
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18	713	369166.73	948900.841	1690.06	epmt	epmt:s	
19	714	369155.277	948894.238	1690.178	rb		
20	715	369160.339	948896.202	1690.1	rb		
21	716	369163.519	948898.879	1690.095	rb		
22	717	369166.873	948905.379	1689.89	rb		
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27	722	369169.165	948923.289	1689.649	epmt	epmt:surface type	asphalt
28	723	369171.634	948949.88	1689.204	epmt	epmt:surface type	?
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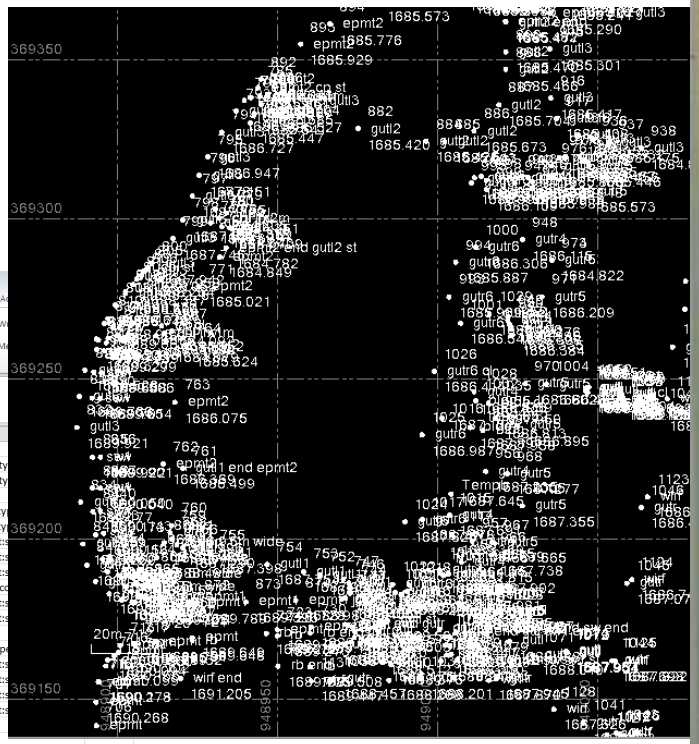
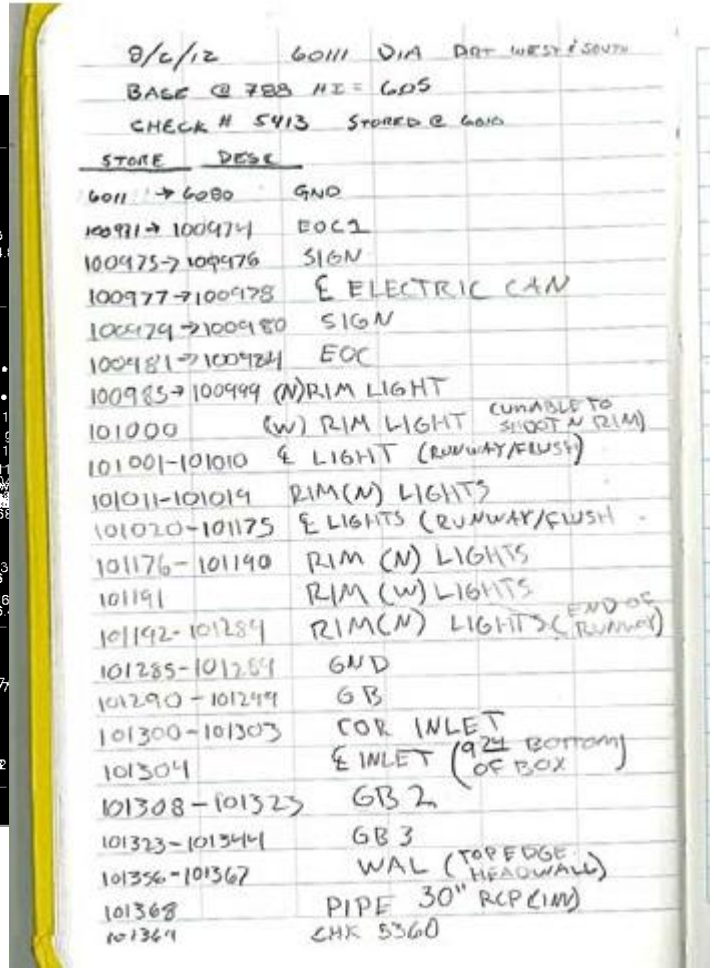
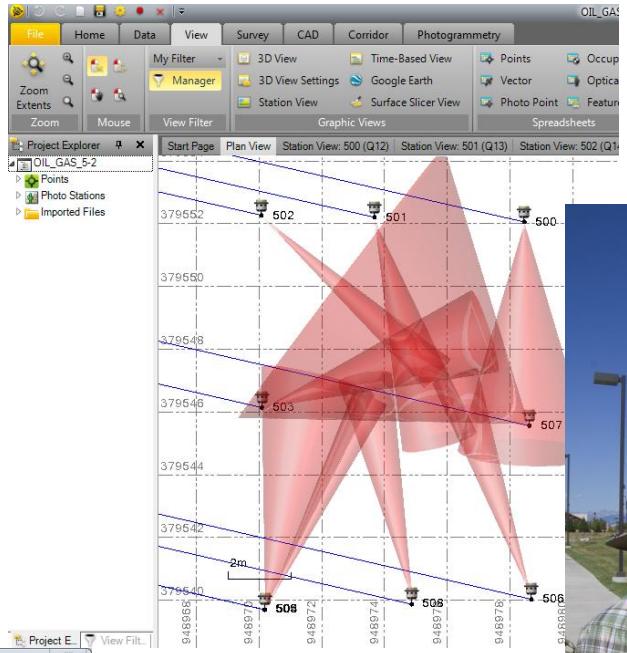
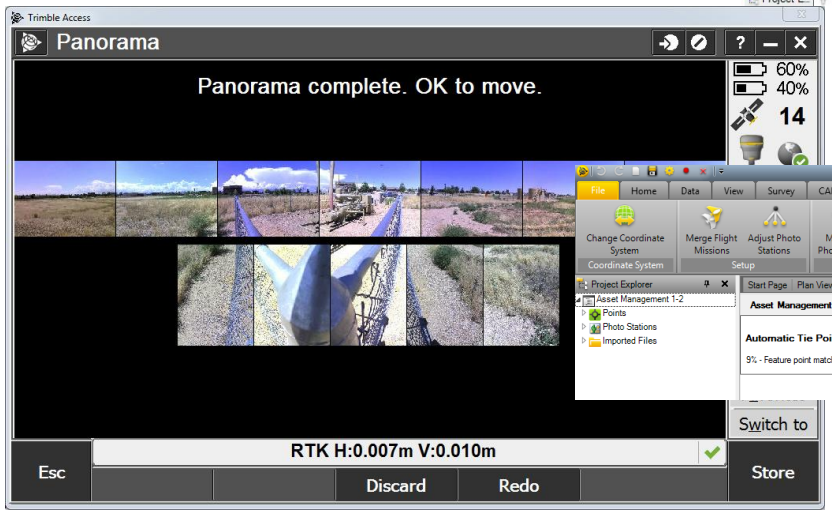


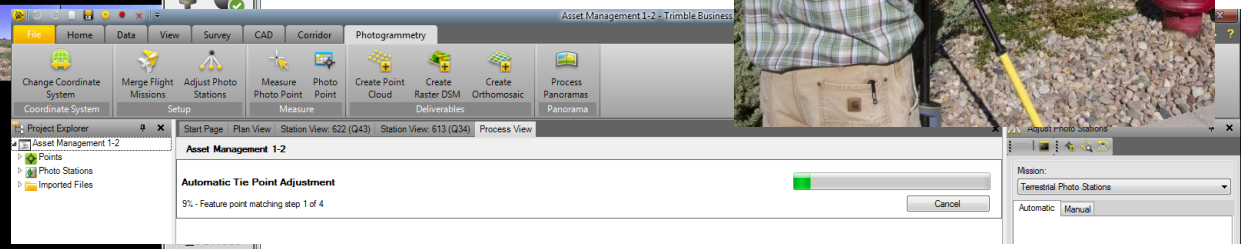


Trimble V10 Design Survey Workflow

- Mission planning
- Capture panoramas
- Process photo stations
- Measure objects in the photos
- Prepare new deliverables
- Reduce field time by ~30%







Trimble UX5 Specifications

- Weight: 2.5 kg
- Wingspan: 100 cm
- Launch Type: Catapult
- Cruise Speed: 80 km/h
- Endurance (flight time): 50 min
- Flight Height (AGL): 75-750 m
- Coverage (@ 5 cm GSD): 2.19 km^2
- Coverage (@ 10 cm GSD): 4.94 km^2
- GSD: 2.4-24 cm
- Flight Ceiling: 5000 m
- Wind Speed: 65 km/h
- Landing Type: Belly
- Camera: Sony NEX5R (16.1 MP)

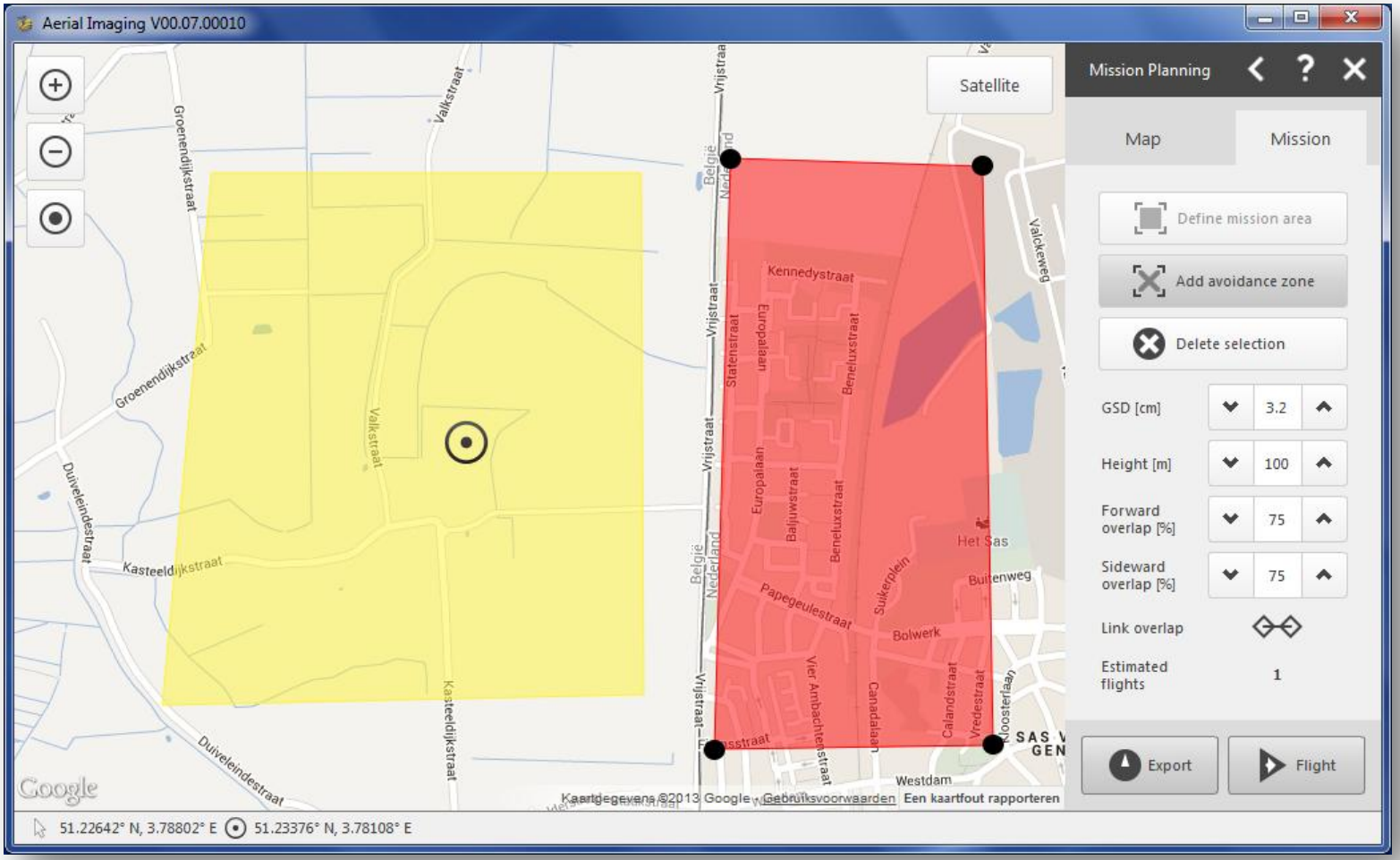
Trimble UX5 Aerial Imaging Process

- **Mission & flight planning**
  - Trimble Access Aerial Imaging application

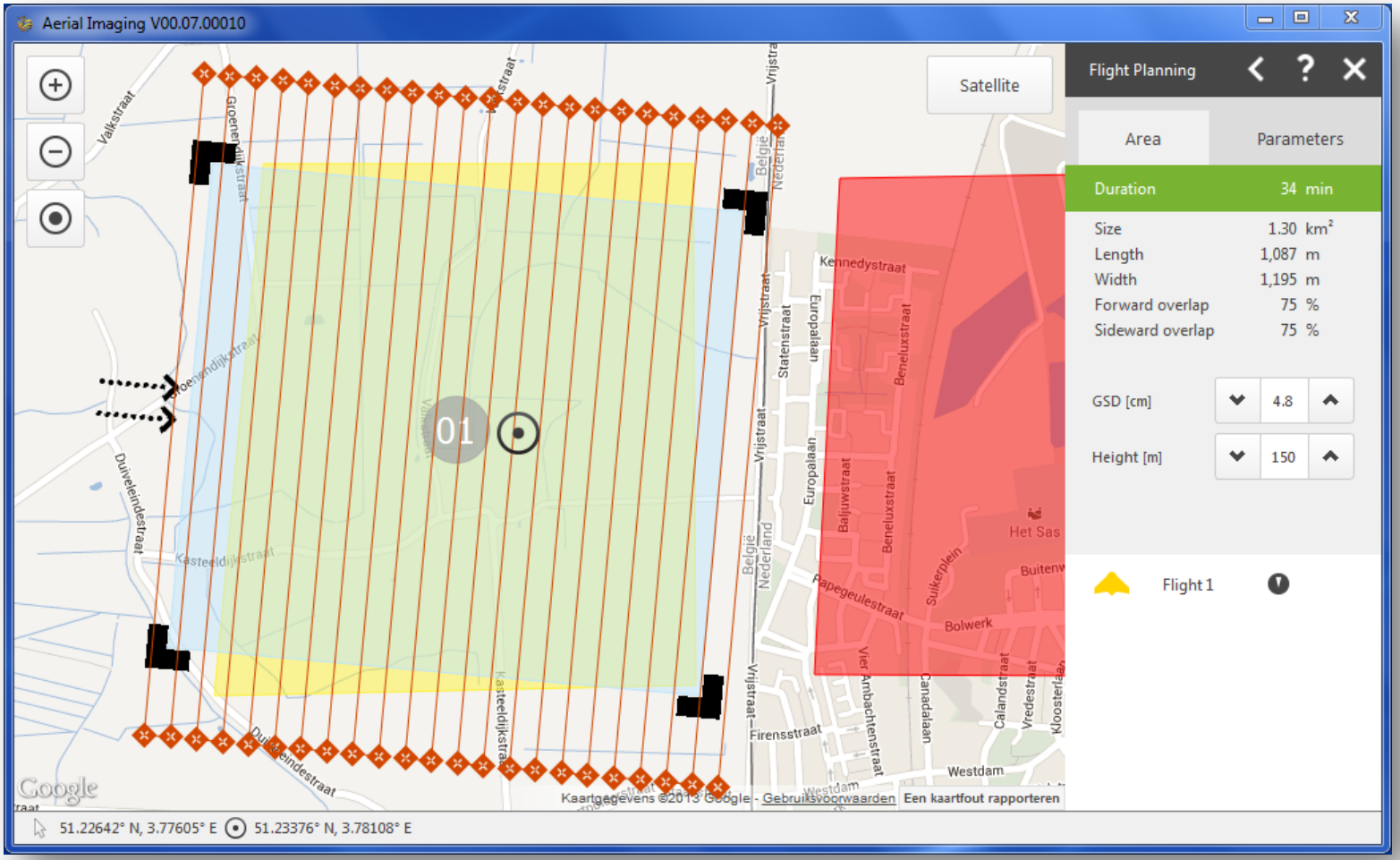
- **Image acquisition & flight monitoring**
  - Trimble UX5 Aerial Imaging Rover
  - Trimble Access Aerial Imaging application

- **Image processing & creating deliverables**
  - Trimble Business Center Photogrammetry Module

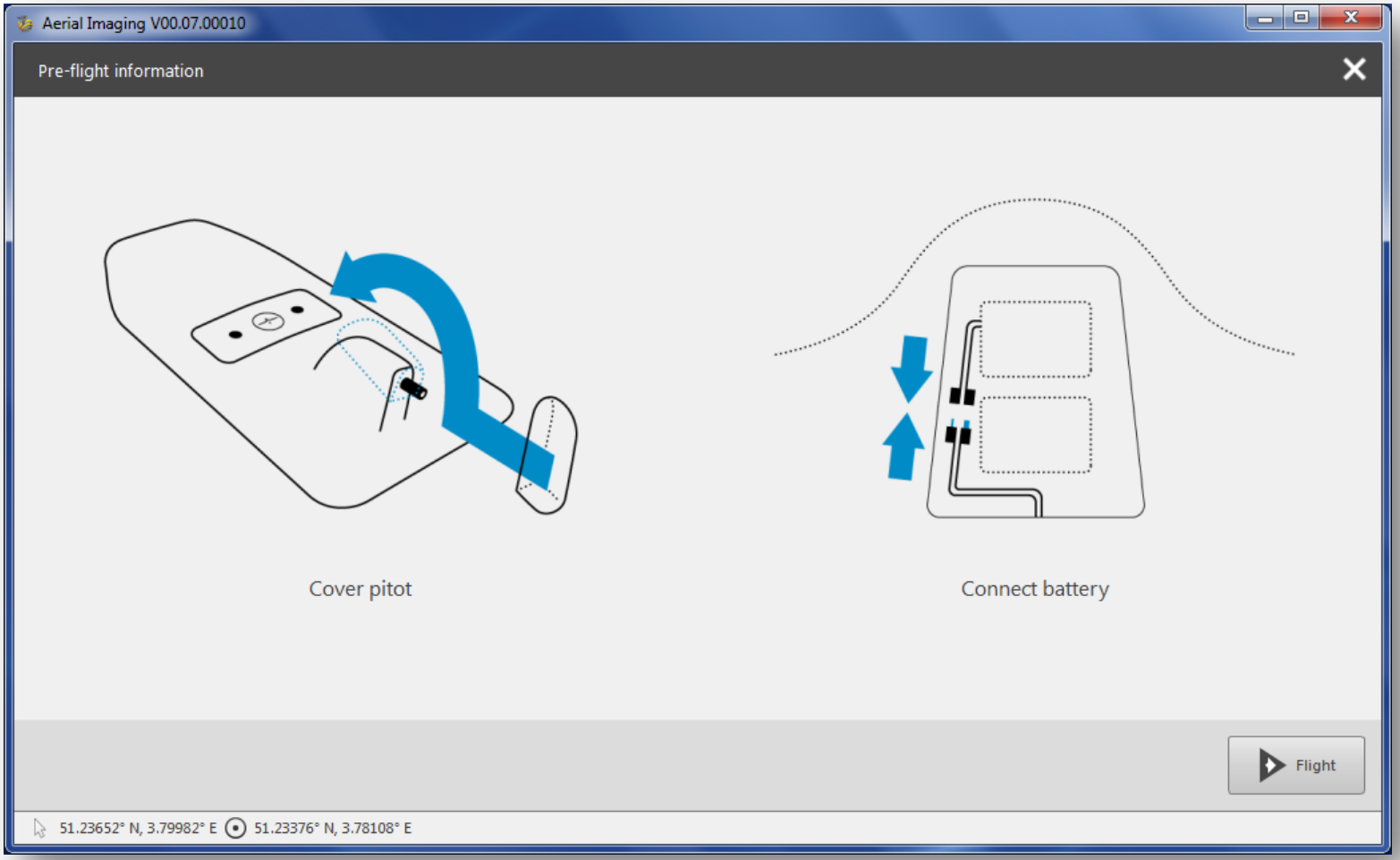
Defining the Project Area



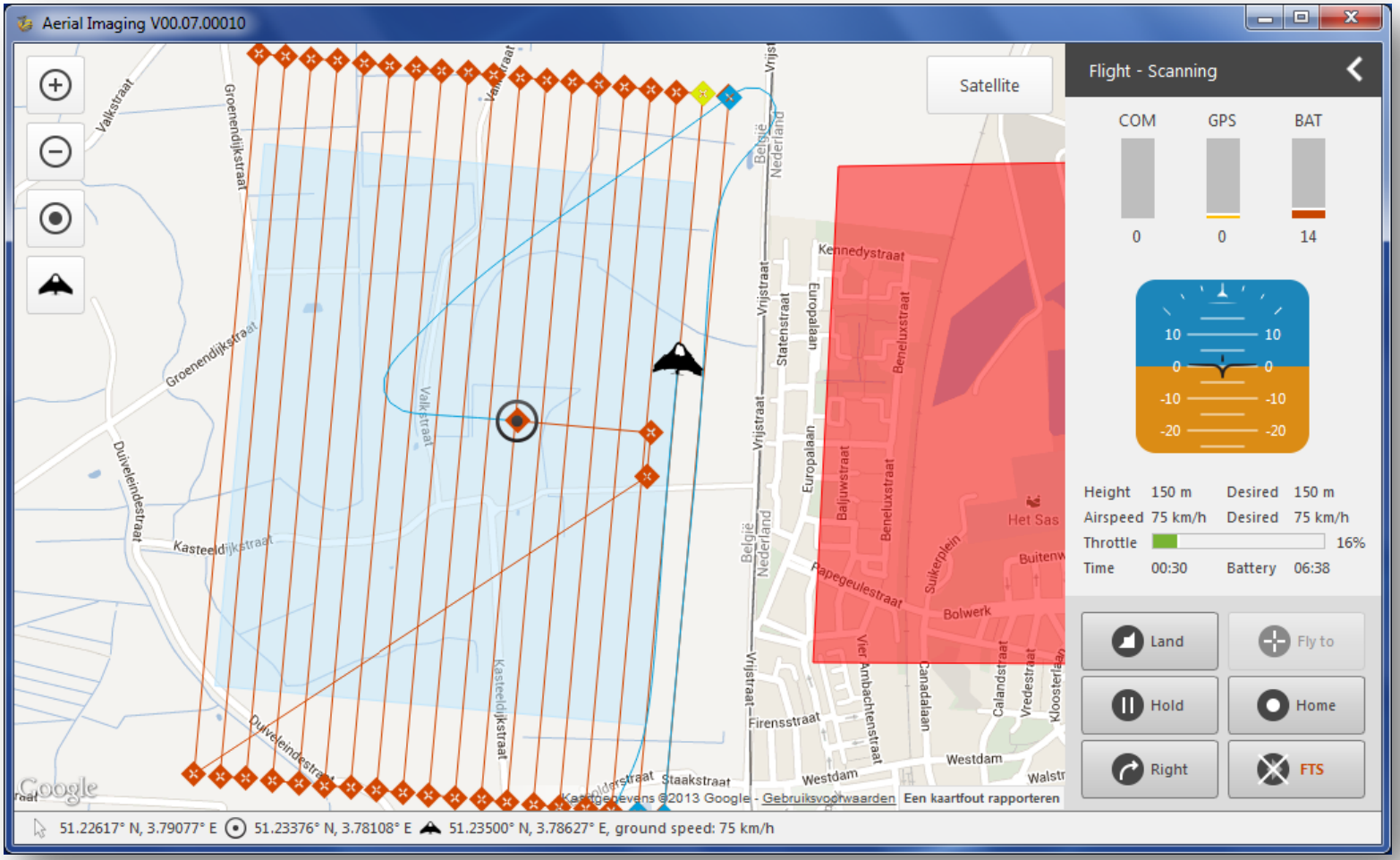
Defining the Flight



Pre-Flight Checklist

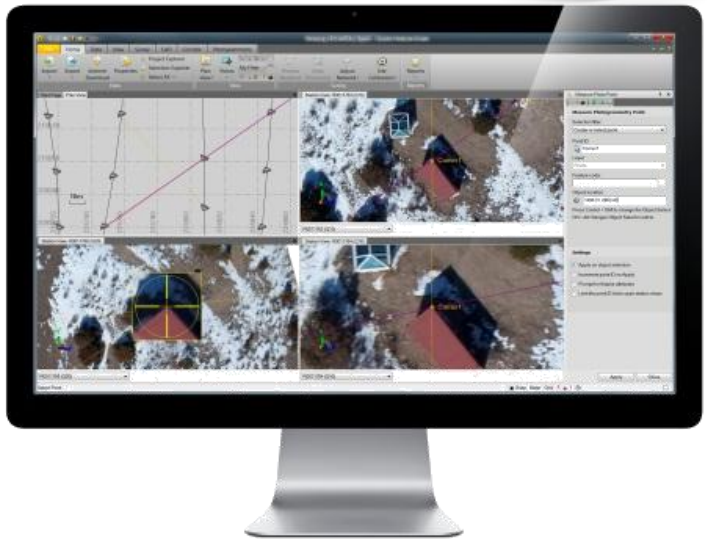


Flight Operation

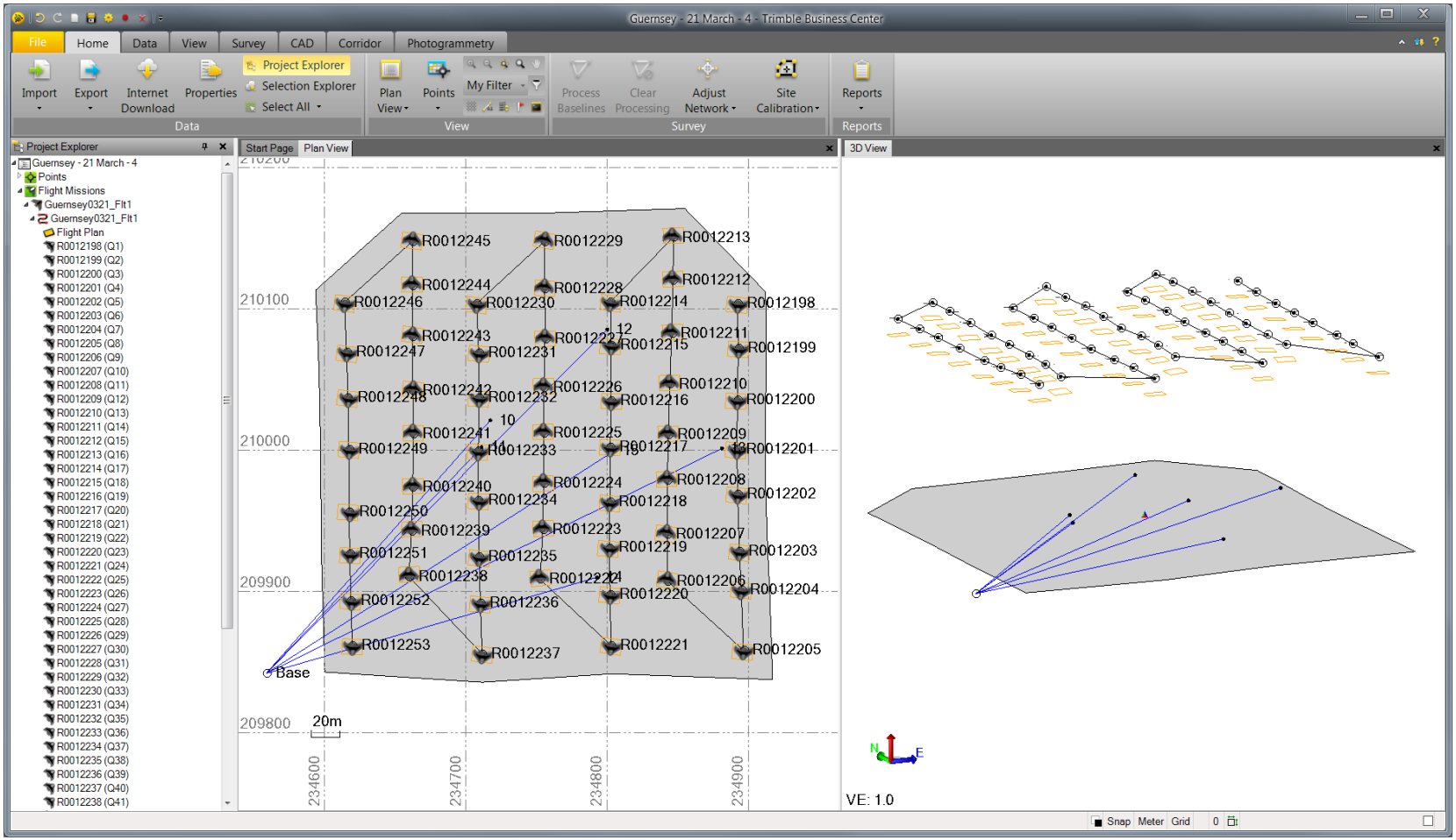


Trimble Business Center Photogrammetry Module

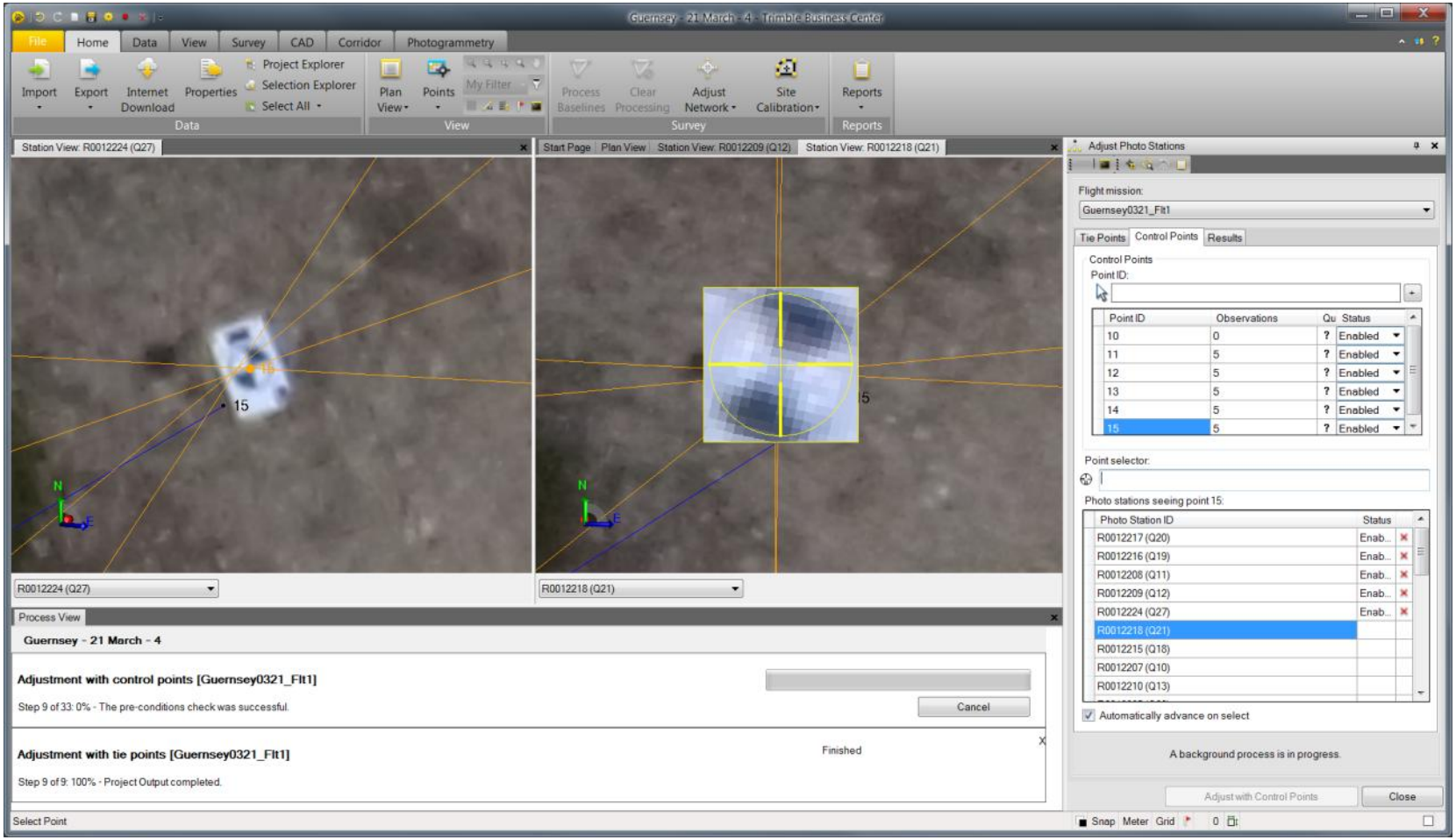
- Office application for processing traditional and Trimble UAS survey data
- 64-bit processor / operating system requirement
- Photogrammetry processing using technology from Inpho
- Simple workflows for importing flight data, stitching images, identifying ground control points, producing deliverables, and measuring features



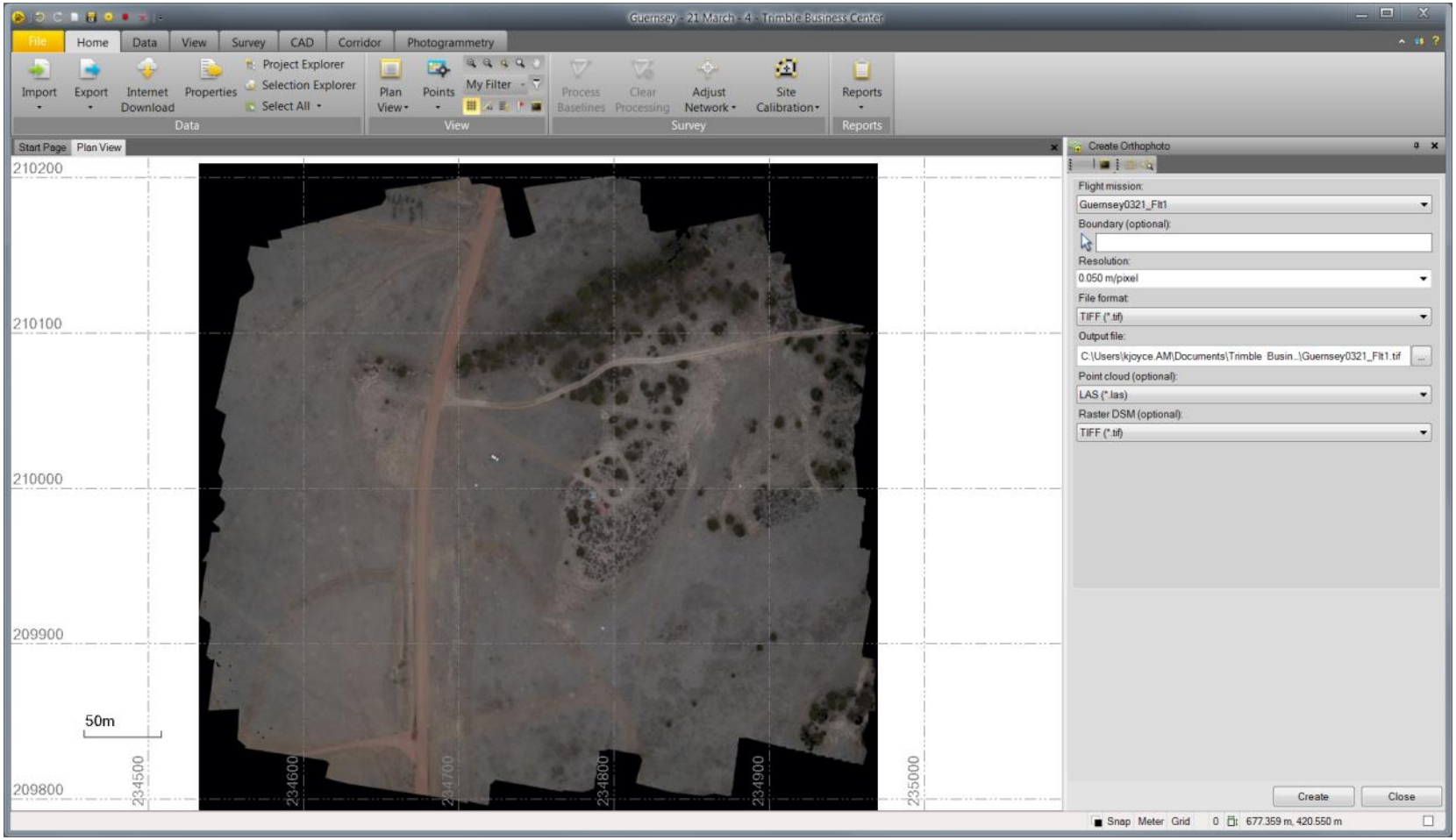
Import Flight Data



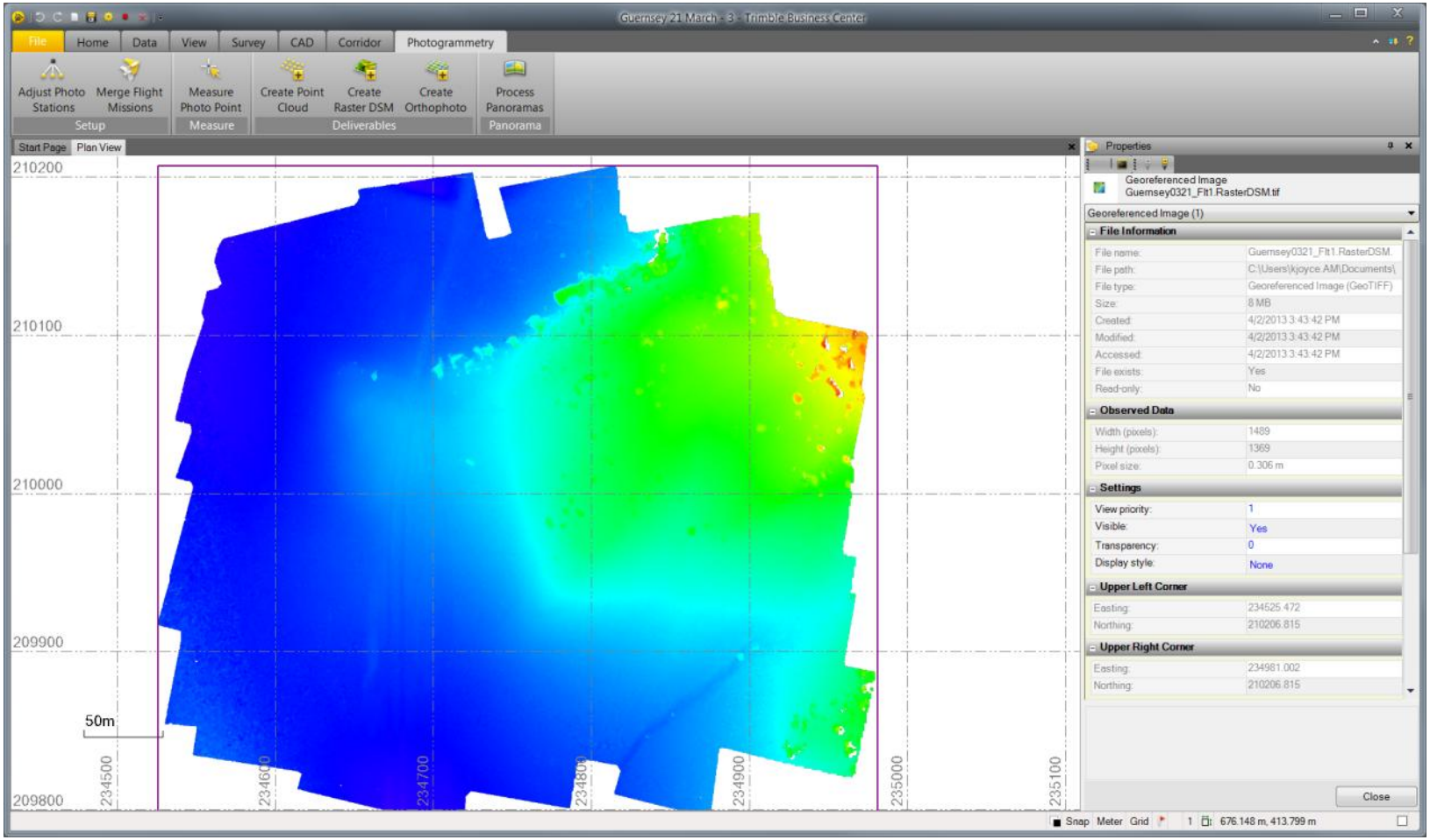
Identify Ground Control Points



Create Orthophotos



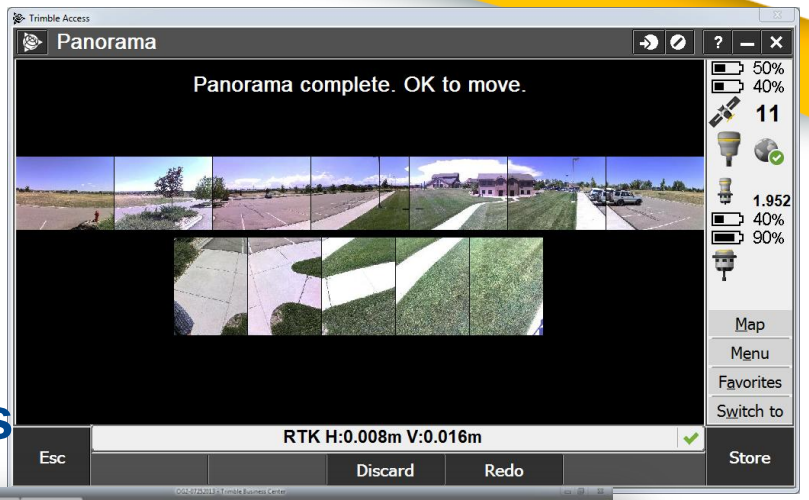
Create Digital Surface Models

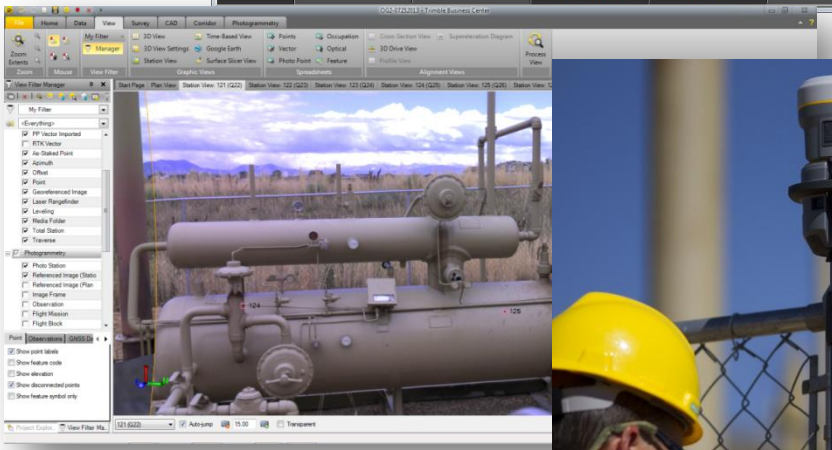


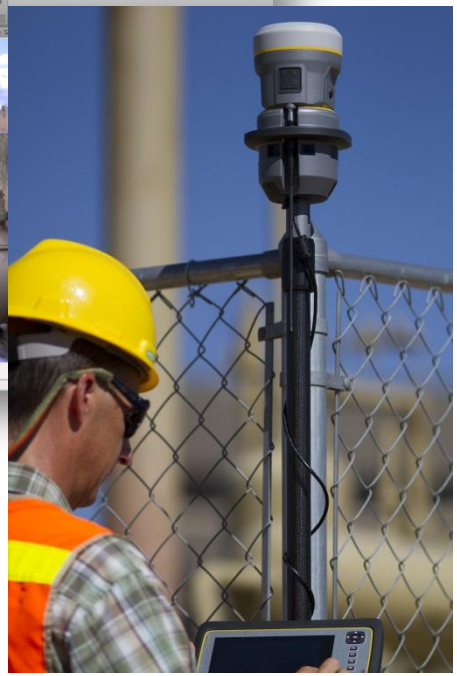
Applications….

V10 Applications

- Land Surveying
  - Design Surveys
  - As-Builts
  - Facades
- Geographic Information Systems
  - 3D Cities
  - Asset Management
  - Data Inventory
- Oil & Gas
- Property Management
- Environmental
- Mining
- Site Visualization
  - Accident Investigation
  - Job Planning
  - Inspections

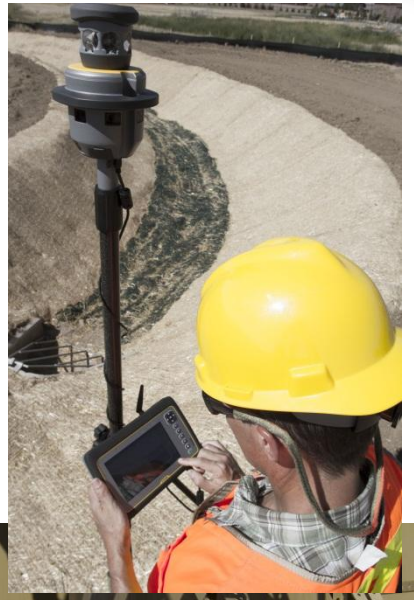


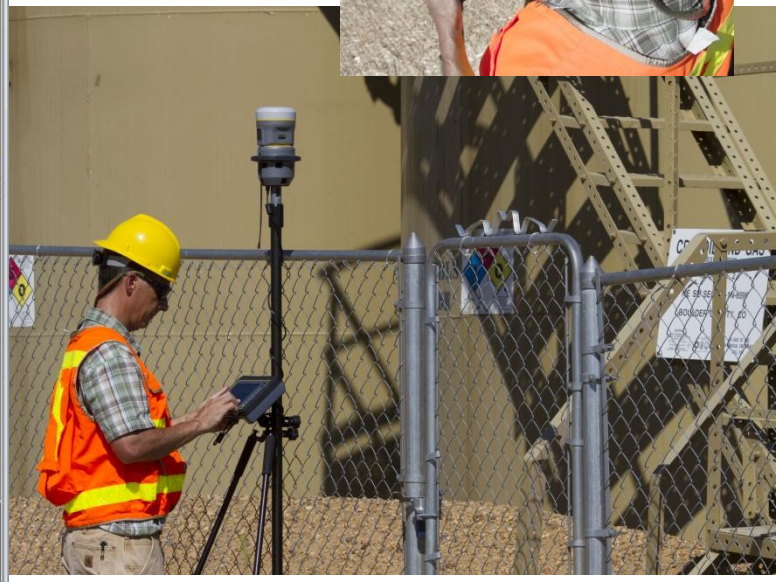


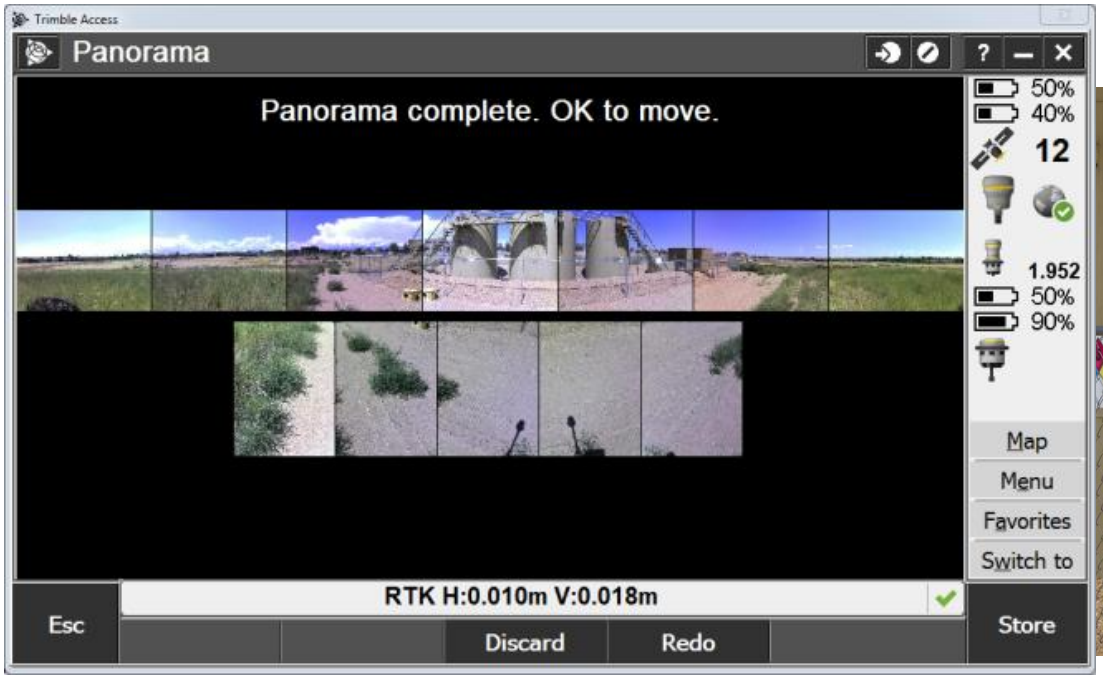


V10 Applications

- Europe – Rail (Netherlands) – Asset Management
- China – Utilities – Transformer Inspections
- North America – Oil & Gas (Texas, Global) – Facilities Management







V10 Applications continued...

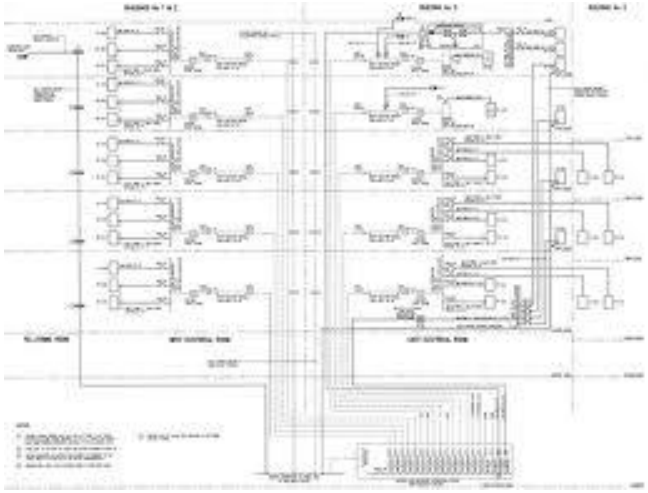
Retrofit Dredging Machines - Netherlands

- Machines must be rebuilt or retrofitted between projects
- Estimated savings was 25% faster project completion

V10 Applications continued...

Electrical Plants

- Virtual Site Visit
- Work Planning
  - determine the conditions
  - Allocate crews and equipment
  - Budgeting, procurement and planning



V10 Applications continued...

Cemetery Headstone Survey - USA

- **The V10 could be used to inventory and locate headstones at military cemeteries.**

WASHINGTON — Estimates of the number of graves that might be affected by mix-ups at Arlington National Cemetery grew from hundreds to as many as 6,600 on Thursday, as the cemetery's former superintendent blamed his staff and a lack of resources for the scandal that forced his ouster.

John Metzler, who ran the historic military burial ground for 19 years, said he accepts "full responsibility" for the problems.

But he also denied some of the findings by Army investigators and **suggested cemetery employees and poor technology were to blame** for remains that may have been misidentified or misplaced. He said the system used to track grave sites relied mostly on a complicated paper trail vulnerable to error.

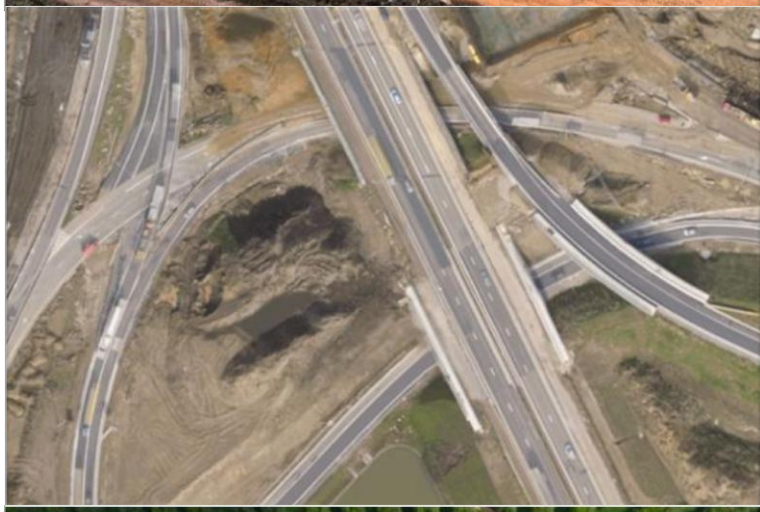
V10 Applications continued...

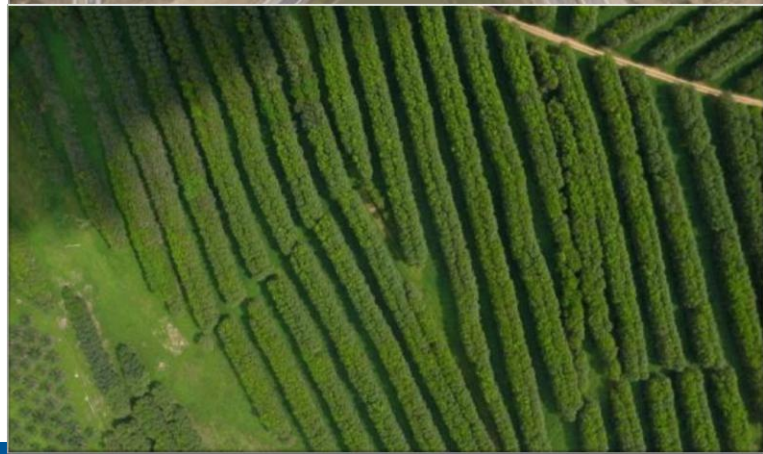
Mine Site Survey - Bulgaria

- Customer issue - Surveyors are not always available when Geologist require them

UX5 Applications

- Engineering & Surveying
- Mining
- Civil & Heavy Earthworks Construction
- Oil & Gas
- Environmental & Landfill
- Public Agencies
- Agriculture & Forestry

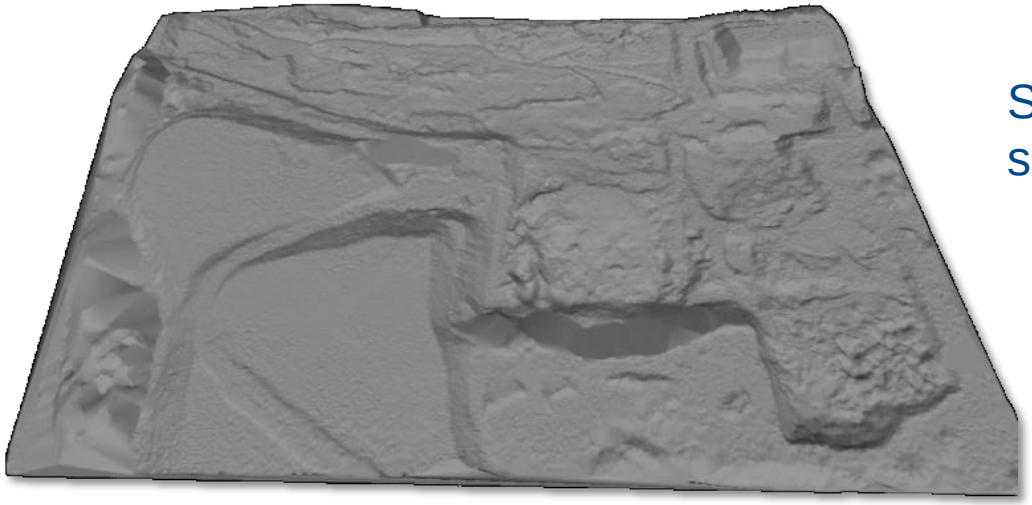




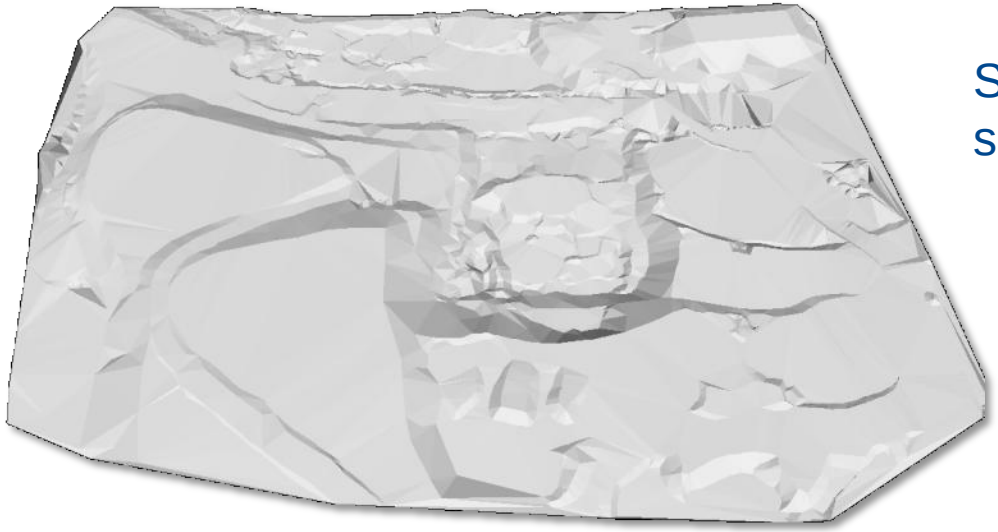
Topographic Survey Example

Switzerland
510 Images
400 m Flight Height
11 cm GSD
3.12 km^2

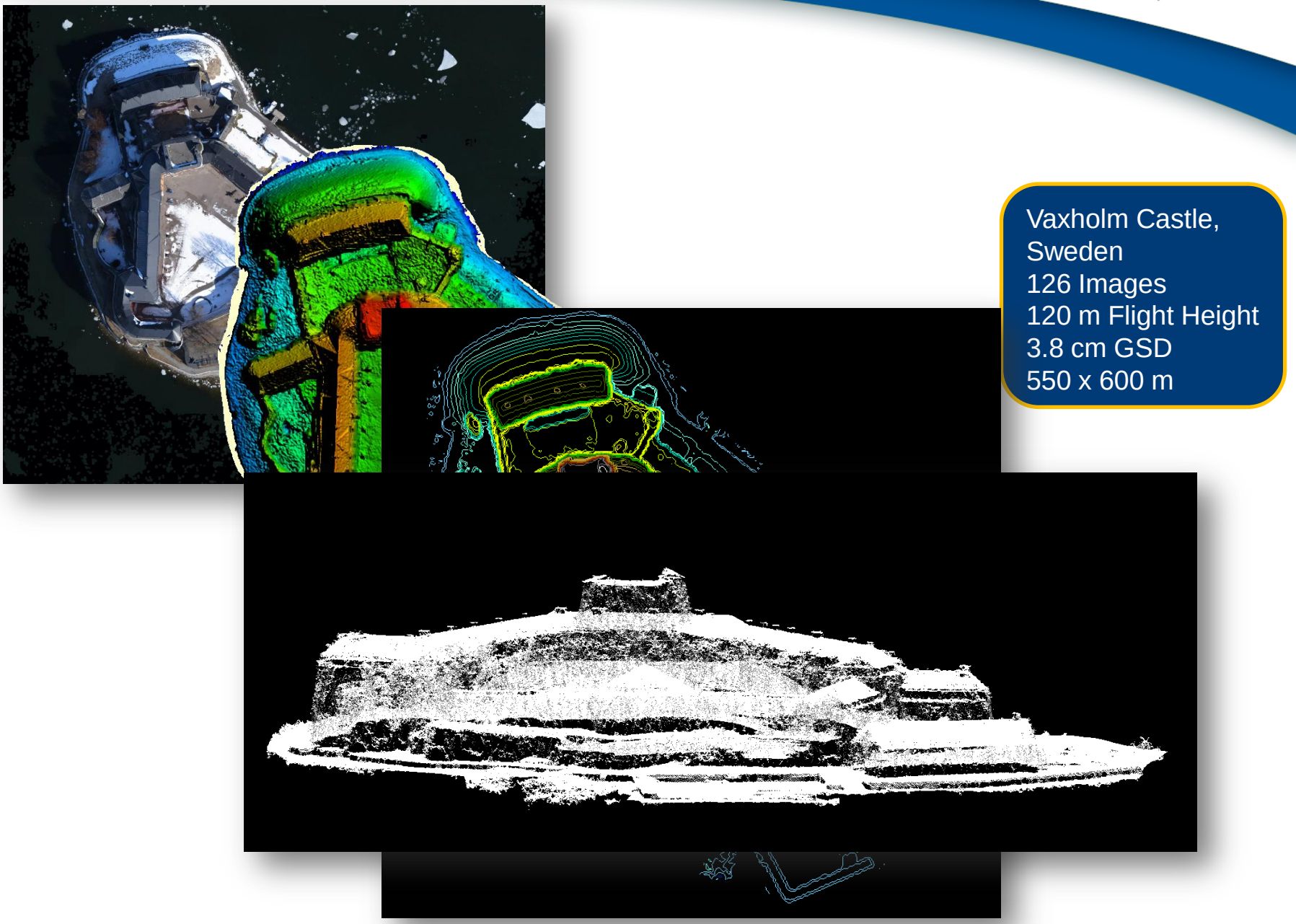
Topographic Survey Example



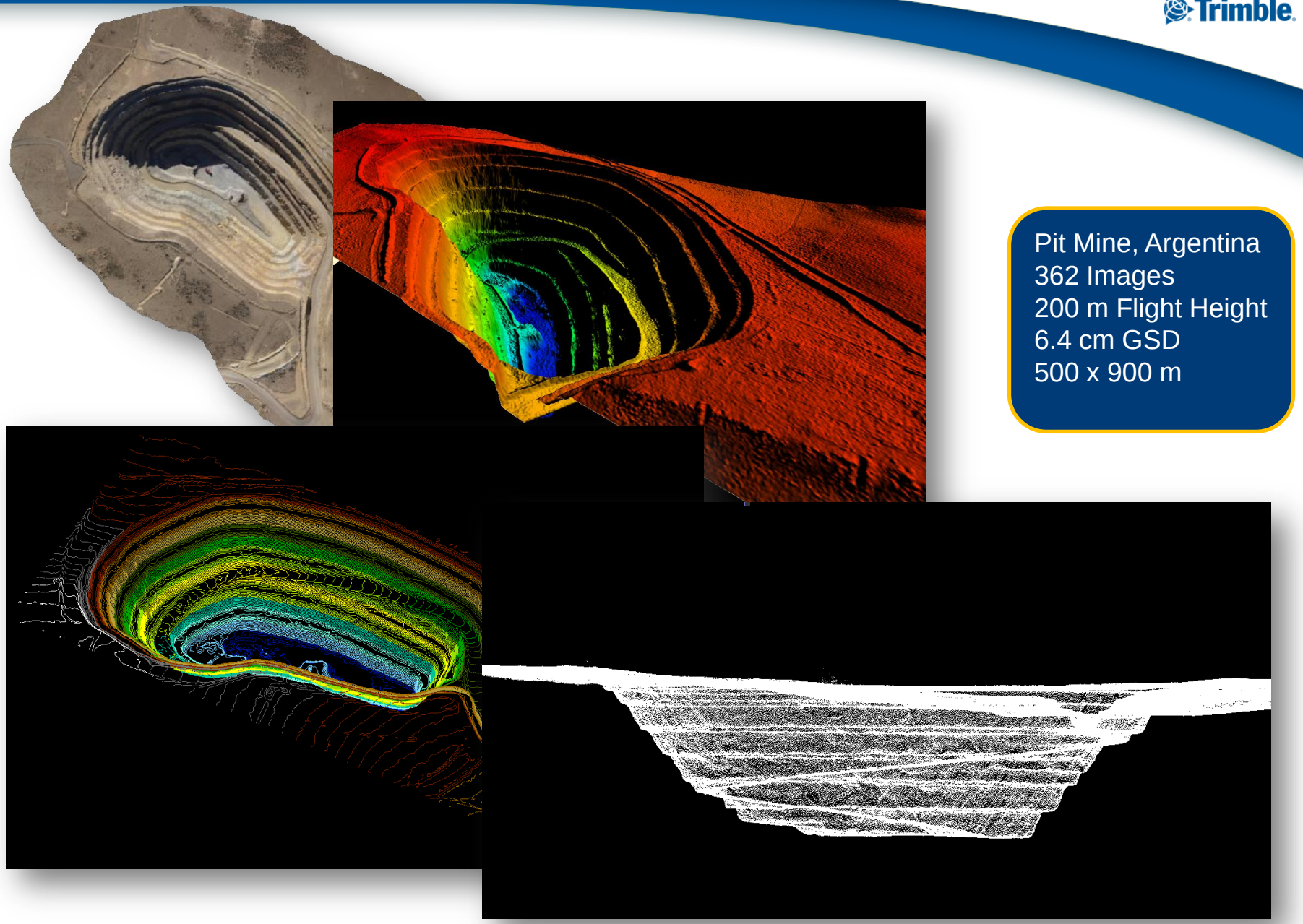
Surface model generated from UAS survey (300,000 measurements)



Surface model generated from GNSS survey (1,000 measurements)



Vaxholm Castle,
Sweden
126 Images
120 m Flight Height
3.8 cm GSD
550 x 600 m



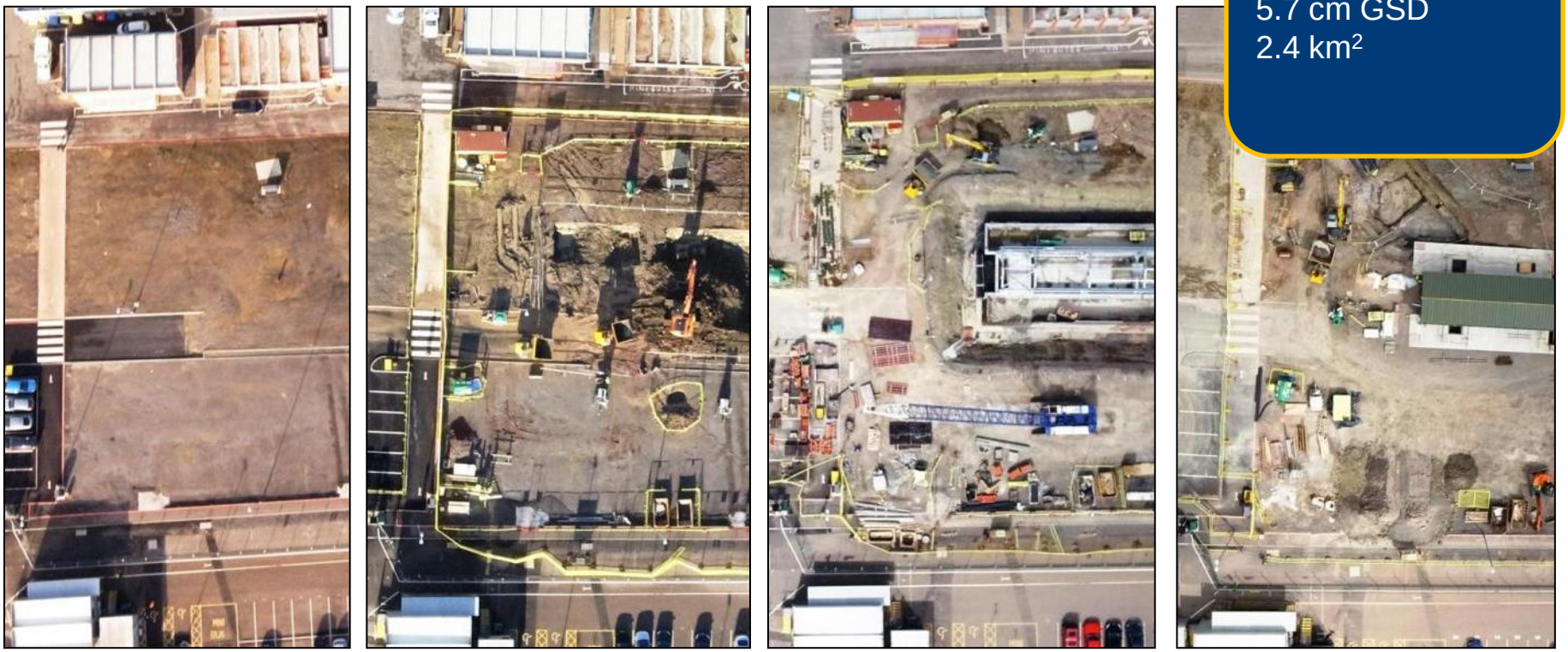
Pit Mine, Argentina
362 Images
200 m Flight Height
6.4 cm GSD
500 x 900 m

Route Planning Example

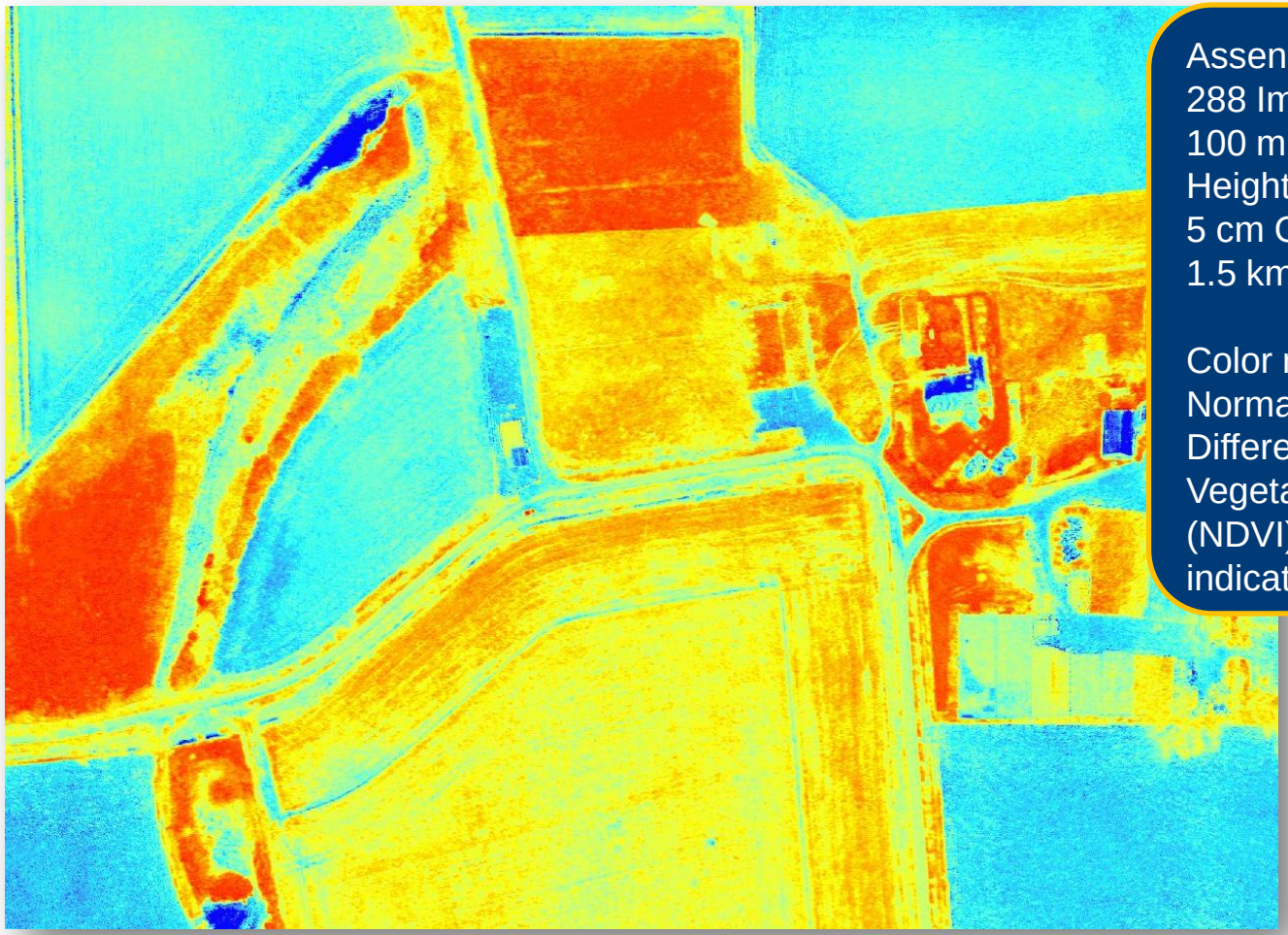
Belgium
462 Images
150 m Flight Height
5 cm GSD
0.8 km^2

Progress Monitoring Example

United Kingdom
150 m Flight Height
5.7 cm GSD
2.4 km^2



Vegetation Health Example



Assenede
288 Images
100 m Flight Height
5 cm GSD
1.5 km2

Color relates to Normalized Difference Vegetation Index (NDVI) value - indication of health

Return on Investment….

V10 Customer ROI

Cost Estimate for 5 day survey project with 2-man field crew, 1 draftsman and 1 professional land surveyor working on the project.

Traditional Survey Workflow			**Trimble V10 Imaging Rover Workflow**		
Item	**Cost**	**Fee**	**Item**	**Cost**	**Fee**
Setting Control	$ 180	$ 600	Setting Control	$ 180	$ 600
Boundary Solution (Office and Field)	$ 1,180	$ 2,200	Boundary Solution (Office and Field)	$ 860	$ 2,200
Locate Improvements	$ 1,800	$ 2,400	Locate Improvements	$ 720	$ 2,400
Capture Topography	$ 1,080	$ 1,800	Capture Topography	$ 720	$ 1,800
Drafting	$ 1,200	$ 1,920	Drafting	$ 1,200	$ 1,920
Deliverables	$ 400	$ 640	Deliverables	$ 400	$ 1,640
Total	**$ 5,840**	**$ 9,560**		**$ 4,080**	**$ 10,560**

UX5 Topographic Survey ROI

	UAS	GNSS	Comments
Area	1.5 km^2	1.5 km^2	
Ground control setup & measurement	1 ¼ hr	---	Ground control not required for all applications
Setup time	15 min	15 min (per day)	
Survey time	45 min	30 ½ hr (4 days)	
Tear-down time	15 min	15 min (per day)	
Data processing time	4 hrs	---	Data can be processed overnight
Total time	6 hr 30 min	32 hr 30 min	5x faster than GNSS
Measurement sampling	3.8 cm (at 120 m flight altitude)	15 m	Minimum sampling size is 2.4 cm
Horizontal accuracy	2 cm	1 cm	
Vertical accuracy	4 cm	2 cm	

But there is more hidden value…

- **Economic solution** – multiple data sets extracted from one trip to the field, reduces repeat trips. Different parties have interest in different data, so users can capitalize on multiple deliverables from one trip to the field
- **Safety**
- **Efficient process** – in addition to reduced field time, data processing time is cut down
- **Workflow dependent** – the workflow dictates everything, so as long as the user follows a well planned work flow, strong results will follow
- **Versatility** – a technology that can be used to serve numerous professional markets and applications
- **Diversification** – opens up new applications and new business opportunities for users

Trimble

transforming the way the world works

Thank You!

Terima Kasih!