InsideGNSS
GPS | GALILEO | GLONASS | BEIDOU

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UNMANNED SYSTEMS WEEK

WELCOME TO
UNMANNED SOLUTIONS & APPLICATIONS DAY

Friday, June 6, 2014
11 am–12:30 PDT
Noon–1:30 pm Mountain
1 pm–2:30 pm Central
2 pm–3:30 pm Eastern

WELCOME TO
Unmanned Solutions & Applications Day

Jeff Fagerman
CEO
Fagerman
Techonologies, Inc

Blyth Gill
Commercialization Manager
Clearpath Robotics

Chris Day
Head of Capability
Engineering
Schiebel

Co-Moderator: Lori Dearman, Sr. Webinar Producer

Who's In the Audience?

A diverse audience of professionals registered from 34 countries, 29 states and provinces representing the following industries:

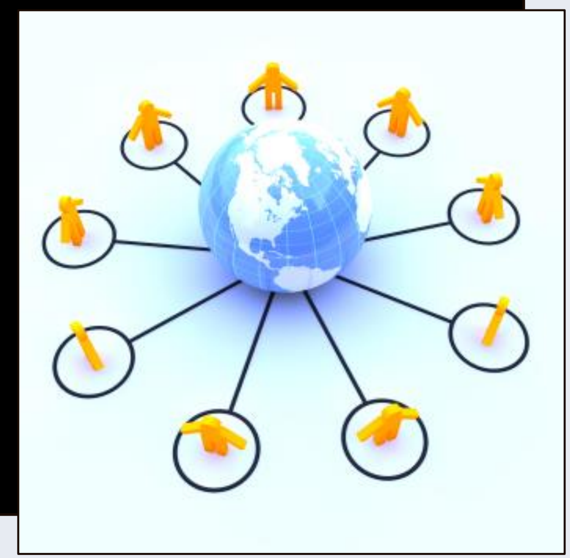
21% GNSS Equipment Manufacturer

17% Professional User

17% System Integrator

17% Product/Application Designer

28% Other

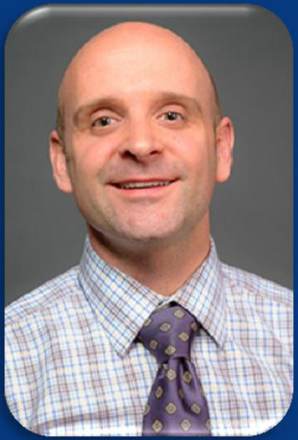


Welcome from *Inside GNSS*

Glen Gibbons

Editor and Publisher
Inside GNSS

Unmanned Solutions & Applications Day



Mark Petovello
Geomatics Engineering
University of Calgary
Contributing Editor
Inside GNSS

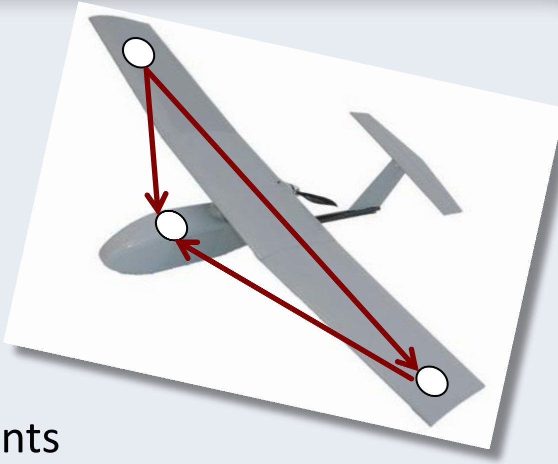
Poll #1

What are the top two applications that you are interested in using unmanned systems for? (Select two)

- *Mapping and surveying*
- *Precision agriculture*
- *Mining*
- *Environmental monitoring*
- *Security and surveillance*

Overview of June 2

- Overview of unmanned systems
  - Applications
  - Appropriate metrics
- Positioning requirements
  - Key challenges/issues of GNSS in different environments
  - Role of multi-GNSS systems
  - Importance of having a reliable system
- GNSS accuracy requirements
  - Standalone & differential processing
  - Attitude systems
- Application to aerial and marine systems

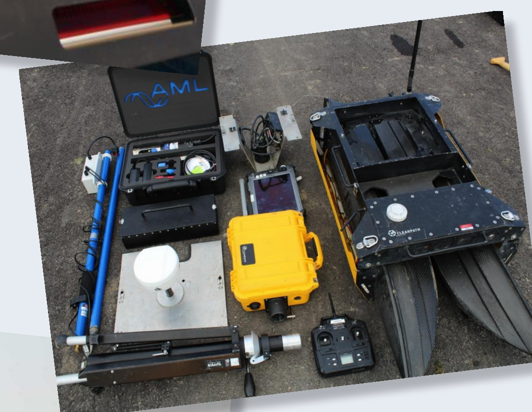


Overview of June 4

- GNSS/INS+ systems
  - Role of GNSS & inertial
  - Typical other sensors
  - Possible operating environments
- Integration approaches
  - Limitations of GNSS/INS
  - How to include other sensors + examples
  - Plug & play capability
- Product development
  - Practical considerations for developing and testing
    - IMU & sensor selection, processing options, etc.

What to expect today…

- Focus more on unmanned applications
- Mobile mapping
  - System configurations
  - Example results
- Bathymetric data collection
  - Comparison with traditional method
  - Cost/time benefits
  - Example applications
- Airborne systems
  - Specific challenges
  - Importance of reliability



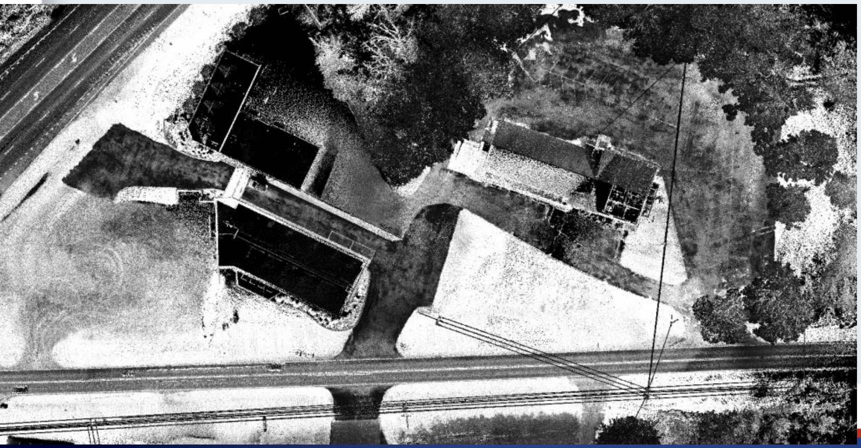
Mobile Mapping

Jeff Fagerman
CEO
Fagerman
Techonologies, Inc

Applications using GNSS and Inertial Systems
Mobile Mapping – from ground, water, or low-altitude aerial

Requirements for success:

- Sufficient positioning and orientation
- Appropriate size and weight
- Cost effective
- Reliable
- Durable
- Environmentally safe and friendly



Applications:

- Accident scene reconstruction
- Disaster relief
- Surveying
- Engineering and planning
- GIS & Mapping
- Forestry
- Agriculture
- Oil & Gas
- Mining
- Movies
- Video Games
- Simulations
- BIM
- Tourism

ScanLook Snoopy – a complete miniature mobile mapping system

Constituent parts:

- INS
- Antenna
- Scanner
- Video

Key features:

- Small
- Light
- Rigid
- Rapid Deployment
- Easy transport

Higher Accuracy INS, More Scanners

ITAR restricted INS

Added second scanner (FARO)
- Higher quality scans
- Single line
- Detachable
- Bigger but still small and light

Suitable for subway/tunnel scanning:
- Setup time is crucial
- No GPS
- Accuracy is crucial
- Failure is unacceptable

Proof of concept – completely legal (in US) helicopter deployment

Mounting
- Quick
- Simple
- Secure

Viable option worldwide today

Cost effective

Using appropriate components

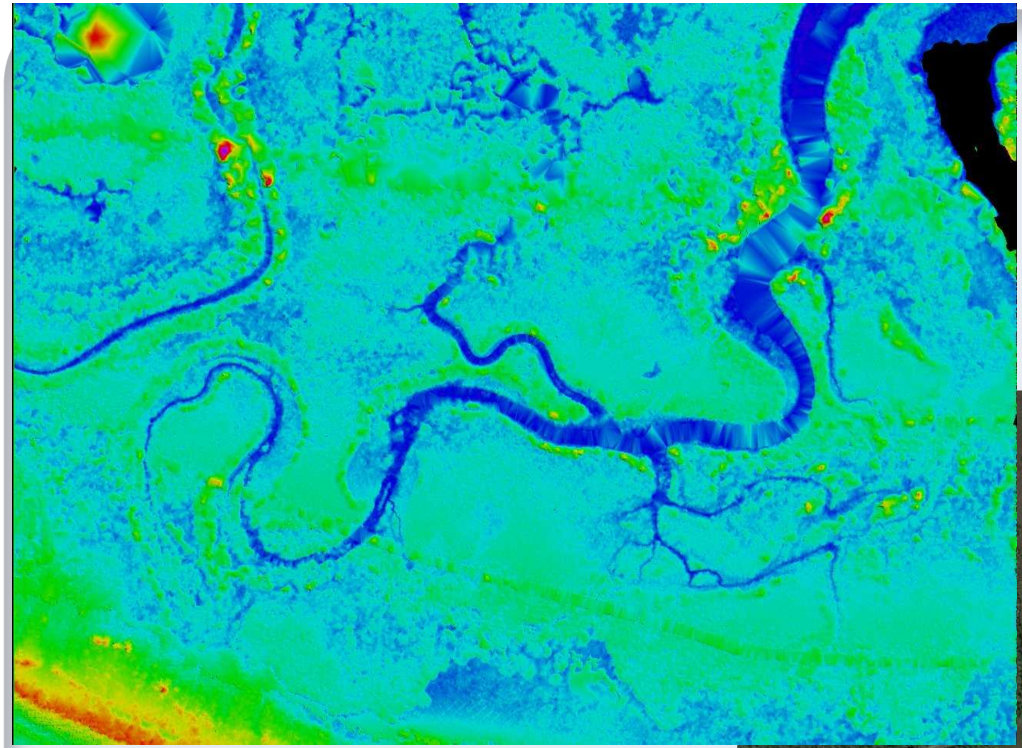
Key concerns:
- Size
- Cost
- Performance

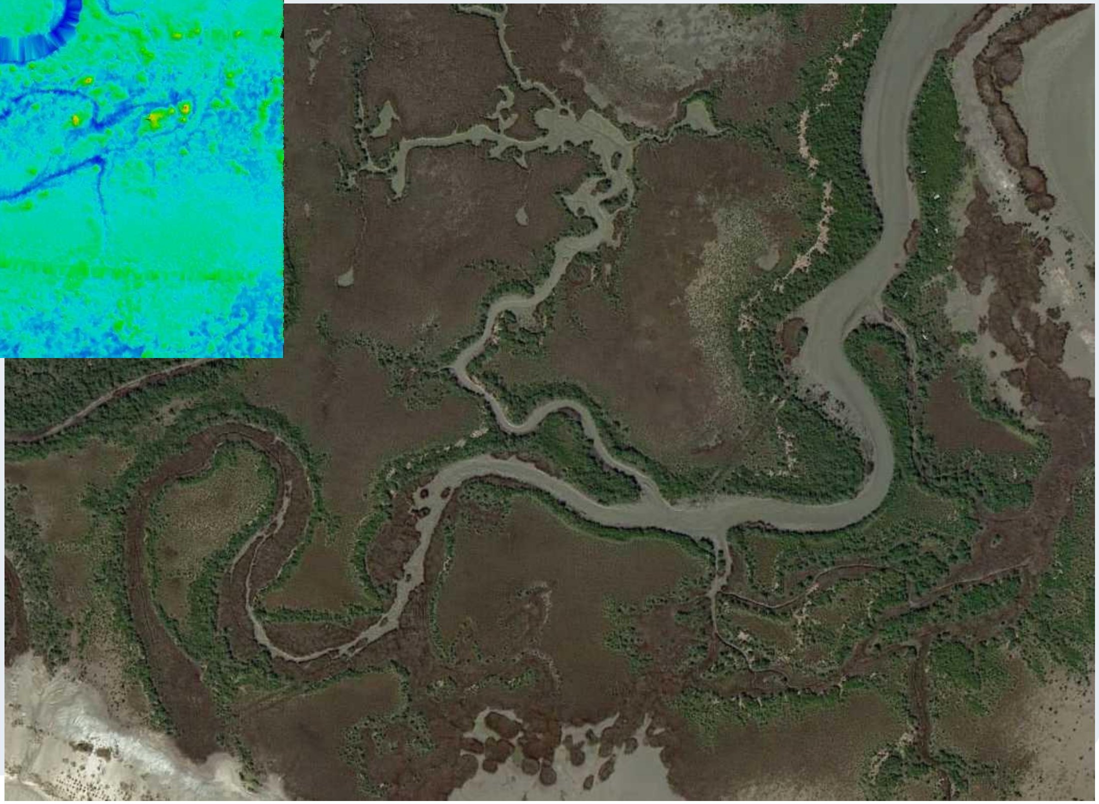
UAV is just another option. It must be competitive.

Aerial view of system and landscape

- Under 10 pounds
- 15 to 20 mm LiDAR scanning with 80 meter range
- Cables for power and laptop viewing.
- UAV would be completely localized.

Surface model of helicopter scan and RGB image





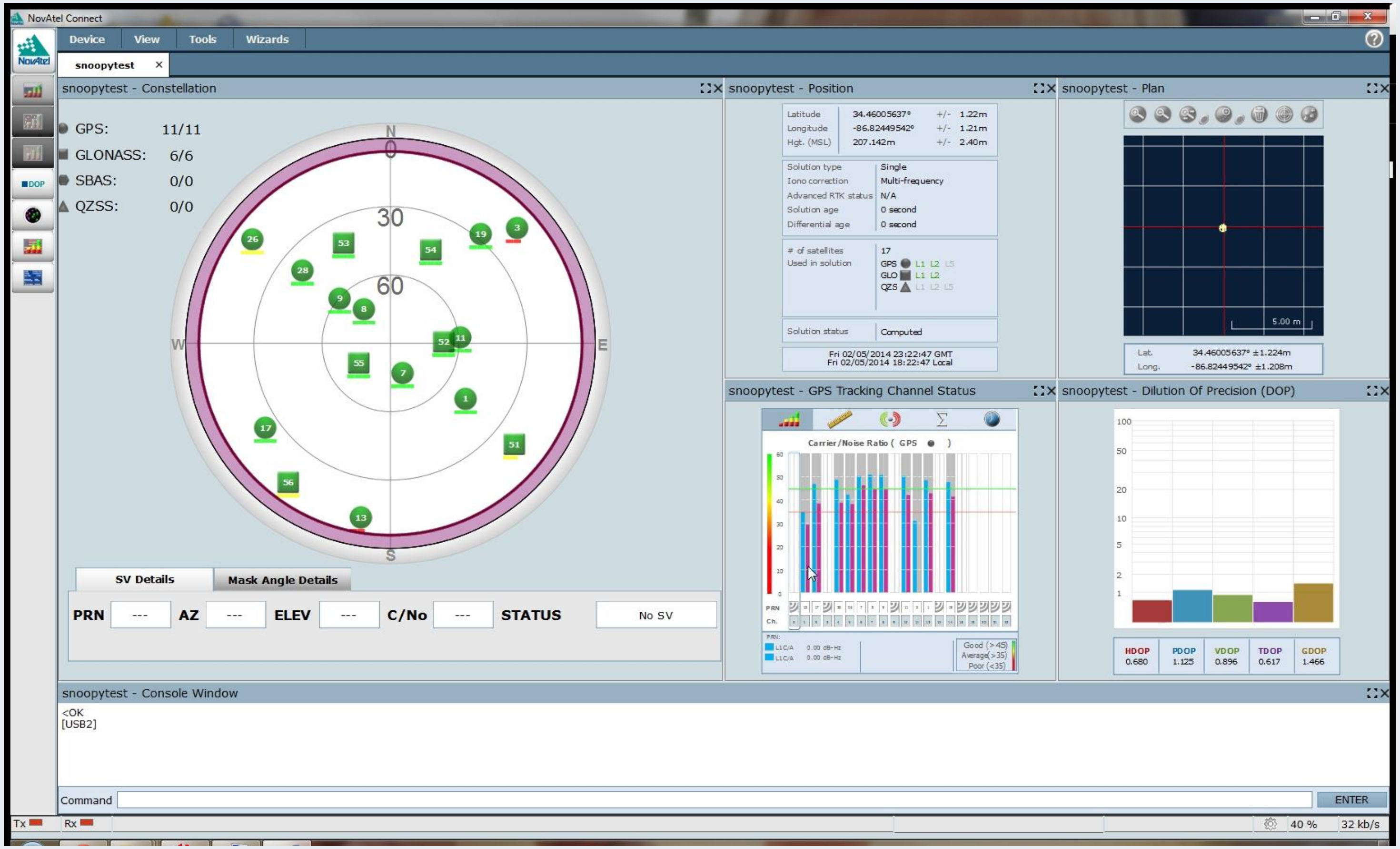
Gyroplane implementation

- Small, light, simple.
- Scanner must have suitable viewing.
- Antenna must be placed with view to open sky.

A larger, potentially more robust INS

- Same system EXCEPT a different INS.
- It’s a bit bigger and more costly but has advantages.
- Still quite compact.
- Versatility of swapping INS and sensors
- Easily adapts to various platforms and mounts.

Run-time Feedback



- Constellation configuration
- DOPs

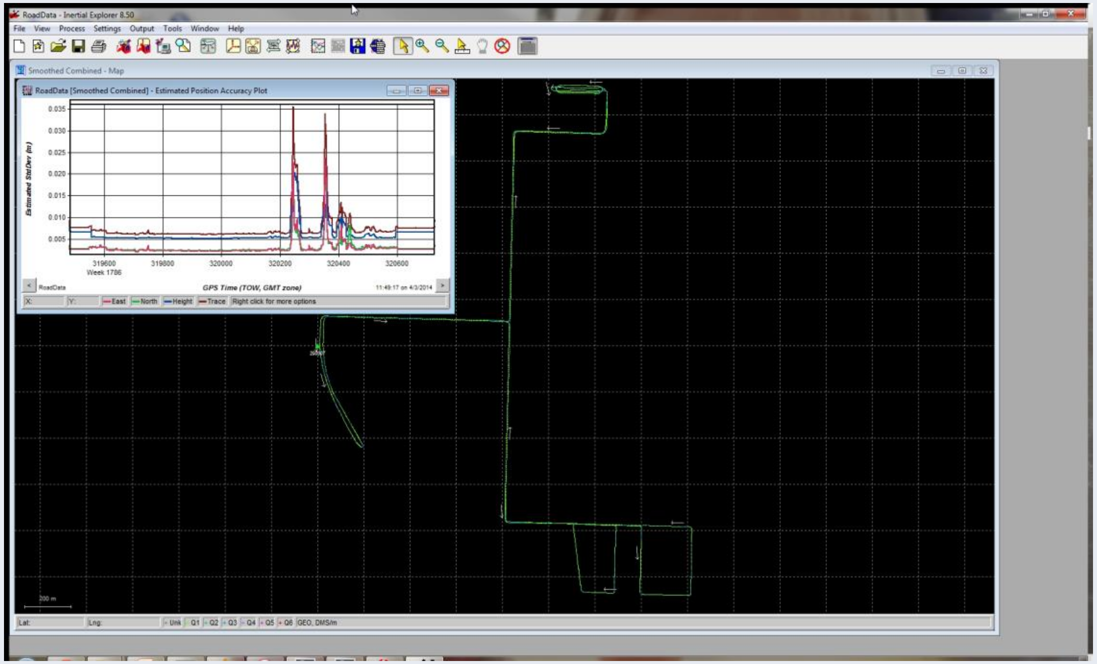
Post processing Analytics

Processing involves:

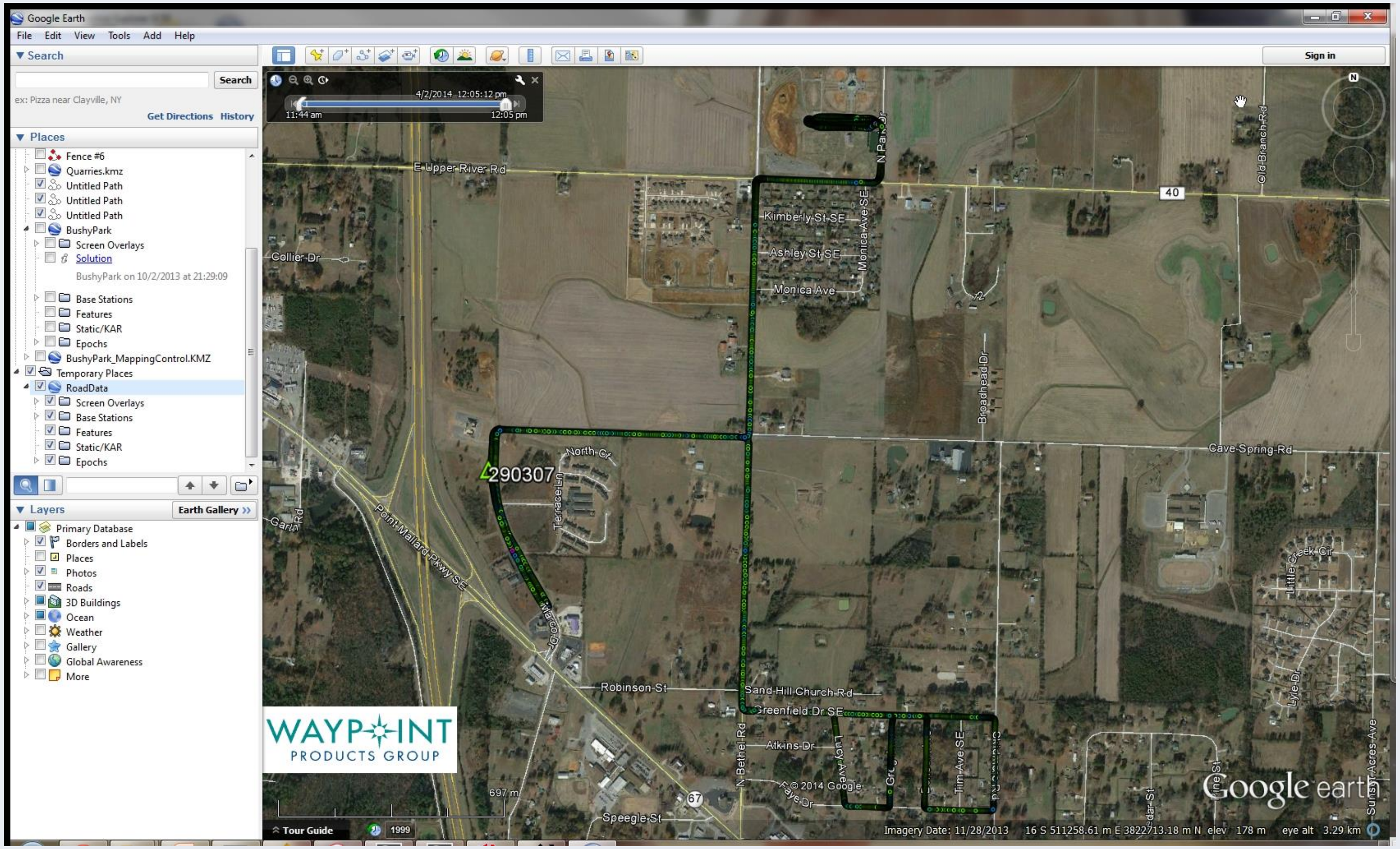
- Lever arms and orientation
- Base stations
- Mission duration
- Accuracy required

The above determines which solution is appropriate for the project:

- RTK
- Post Processed PPP
- Post Processed DGPS
- LC/TC/Combined/Smoothed



Mapping


Google Earth
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Places
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Quarries.kmz
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Epochs
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RoadData
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Features
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Borders and Labels
Places
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Roads
3D Buildings
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Weather
Gallery
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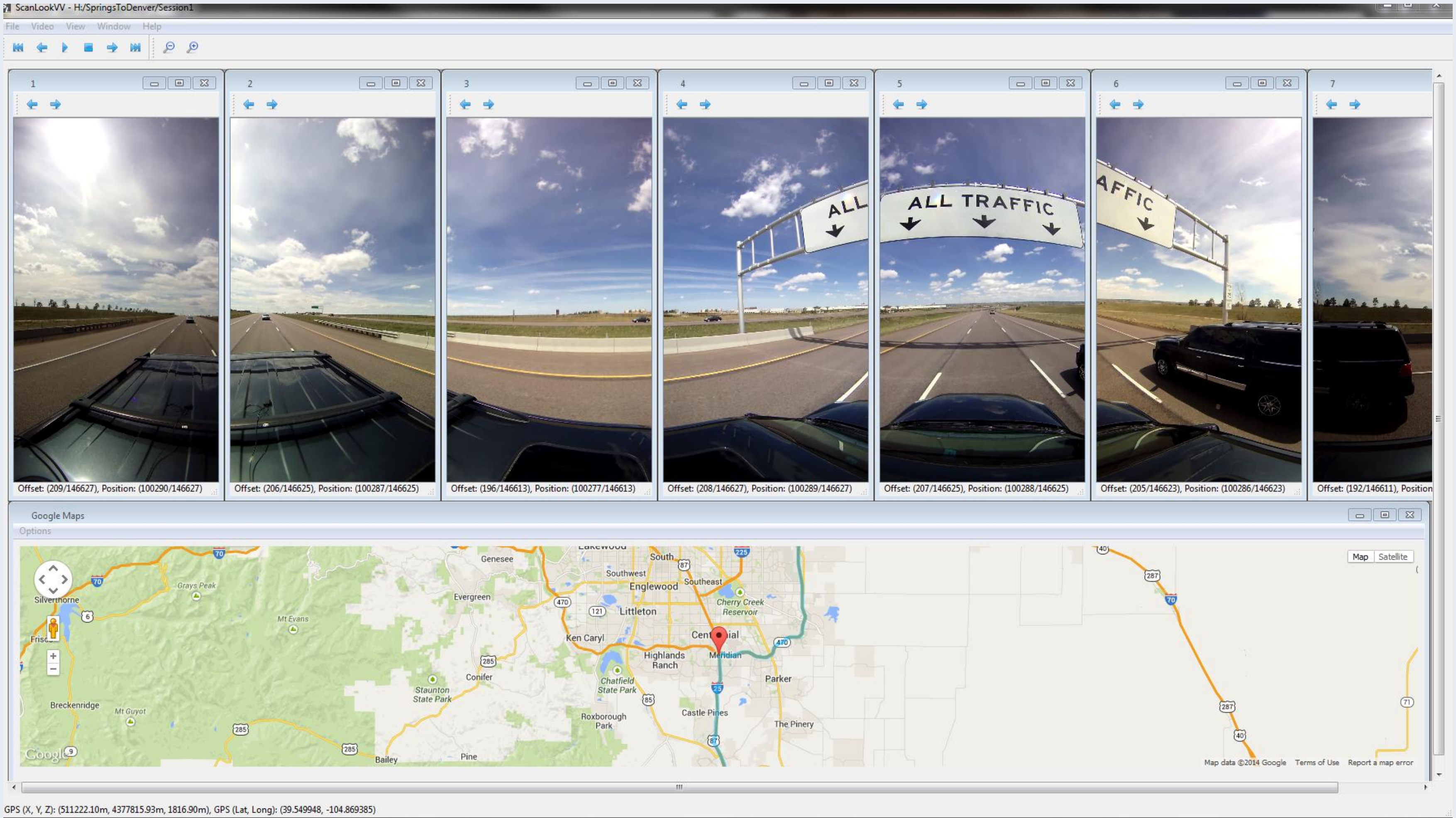
Robinson St
Sand Hill Church Rd
Greenfield Dr SE
Atkins Dr
Speegle St
WAYPOINT
PRODUCTS GROUP
© 2014 Google
Google earth
Tour Guide
Imagery Date: 11/28/2013 16 S 511258.61 m E 3822713.18 m N elev 178 m eye alt 3.29 km

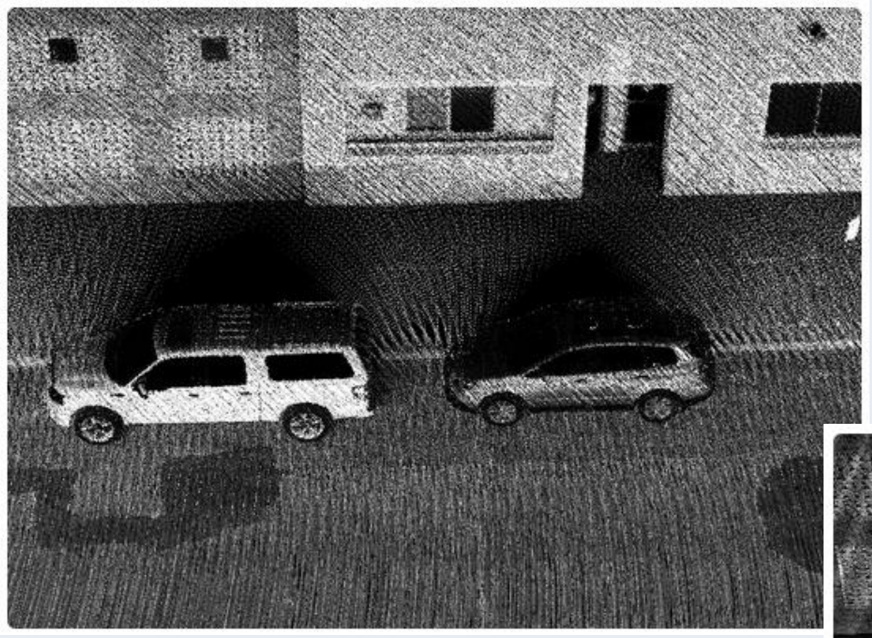
Street view Video Imaging

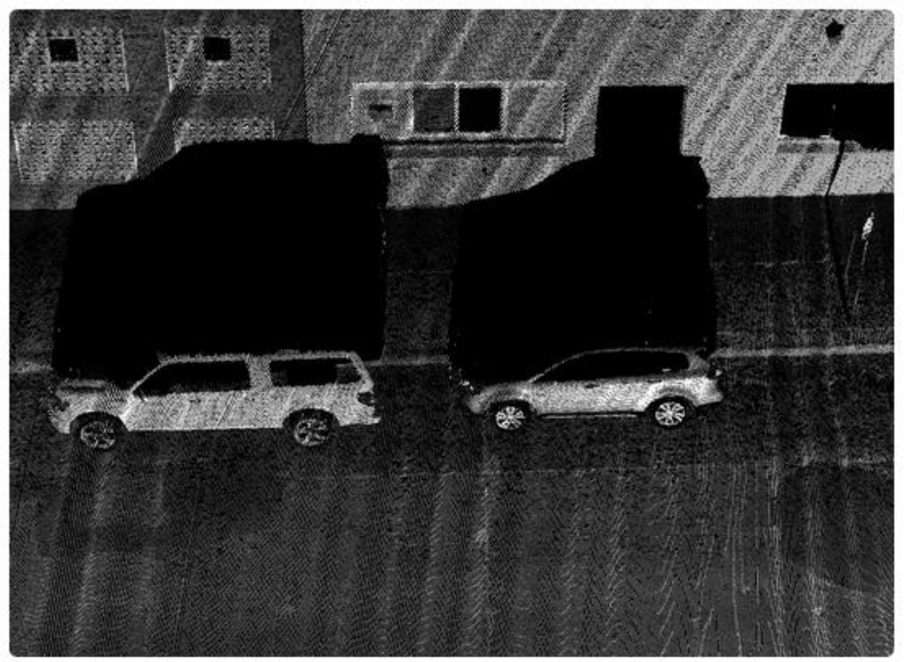
ere would Google Earth, Streetview imaging, etc. be without GNSS and Inertial?

Where would Google Earth, Street view imaging, etc. be without GNSS and Inertial?

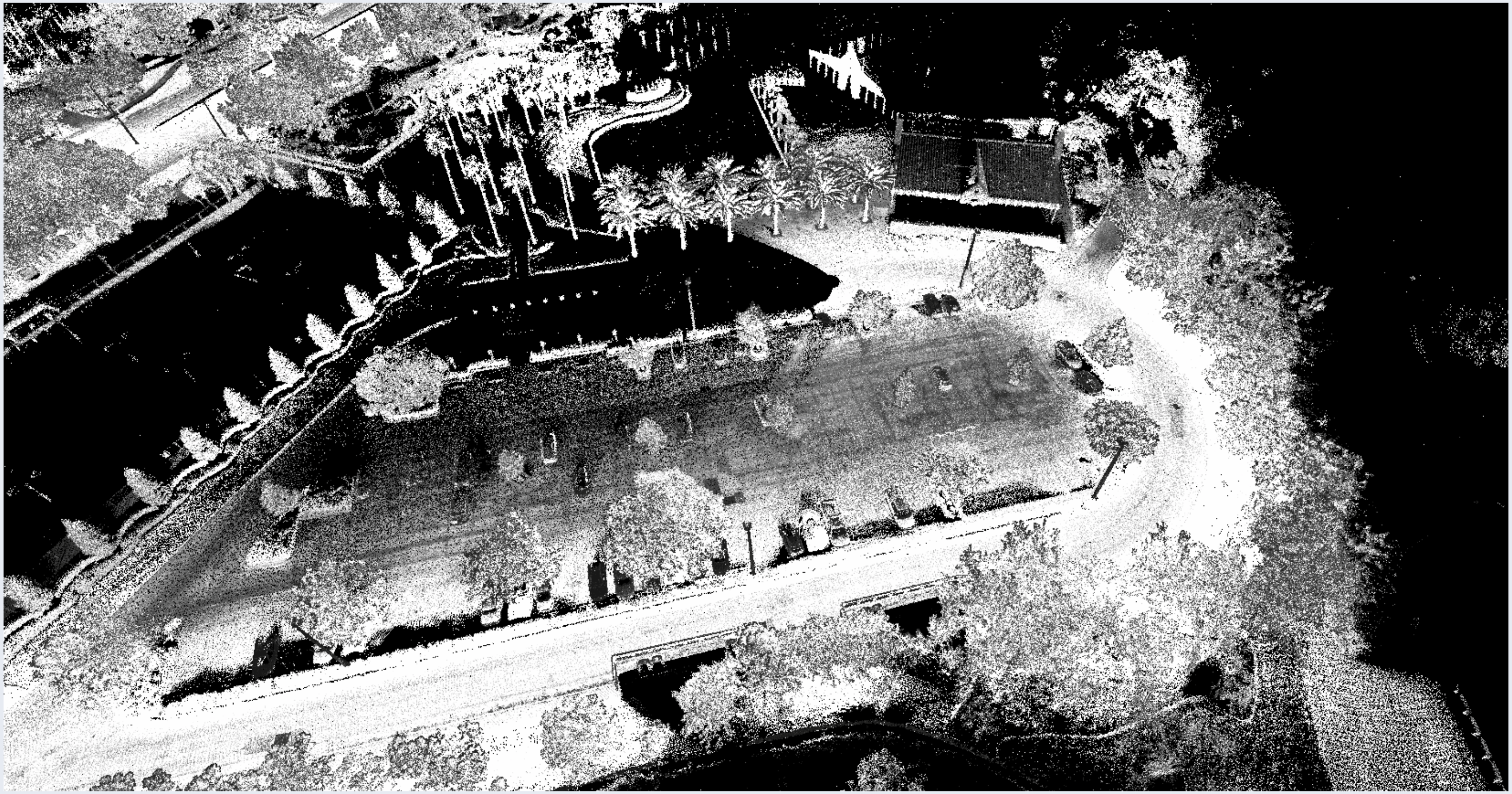


Differing sensors affect output

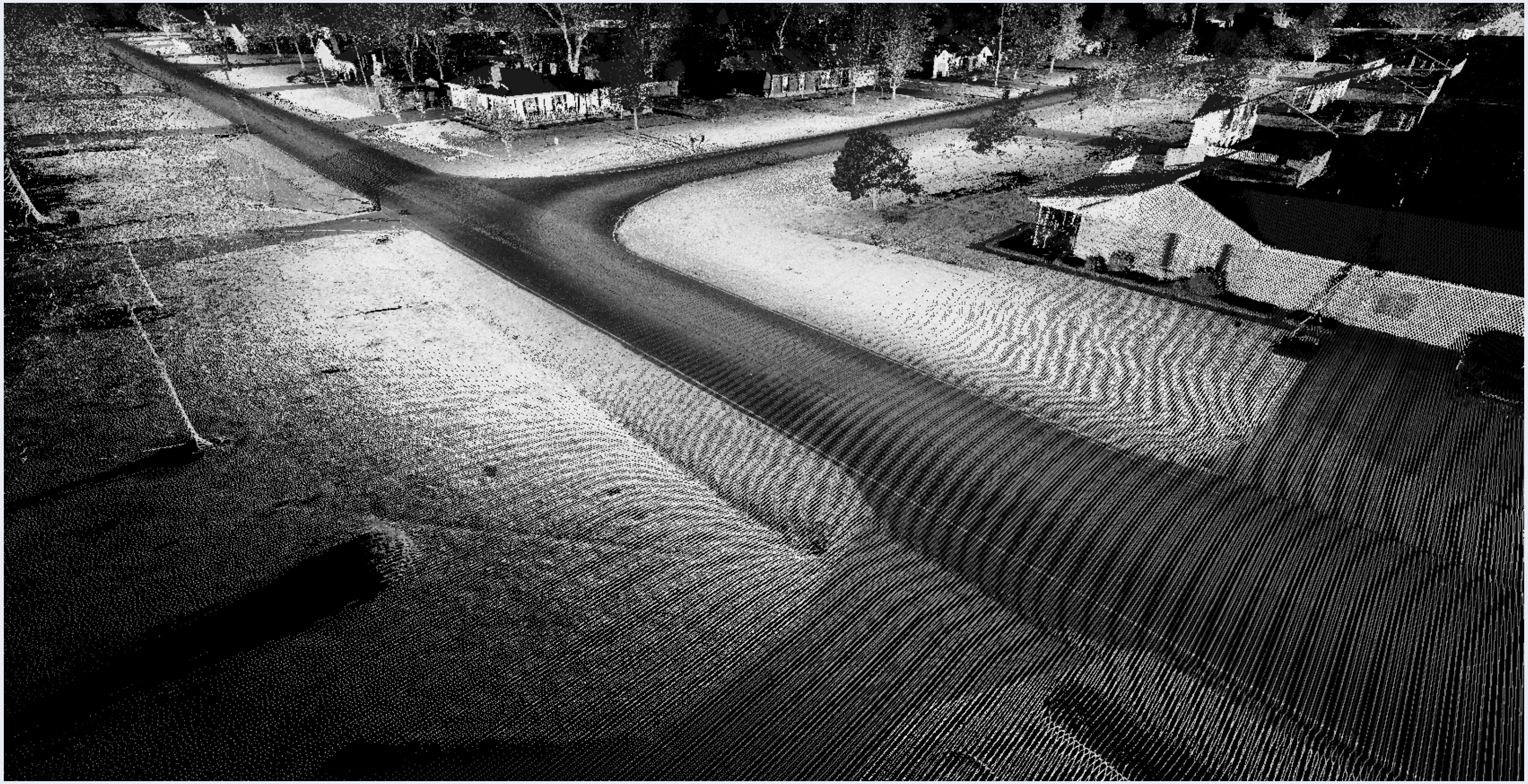




Mobile scan of Disney area hotel entrance

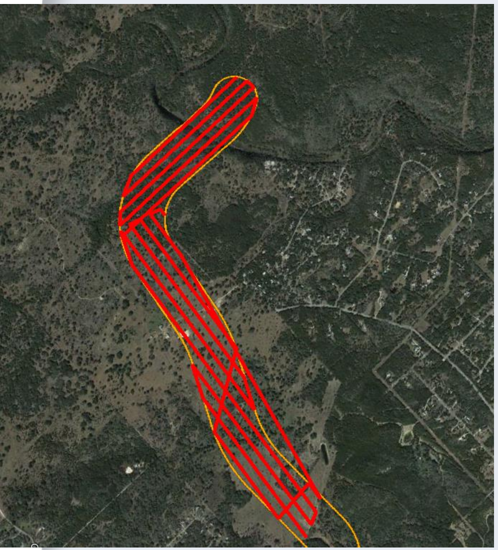


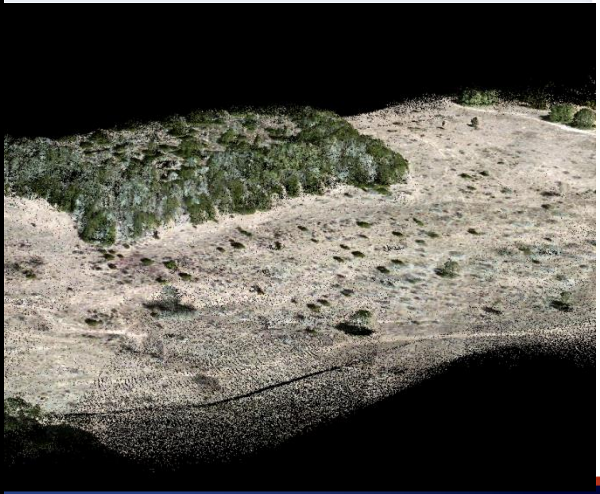
Residential neighborhood scan



Some suitable UAV’s

Point Cloud data from an altitude of 70 meters

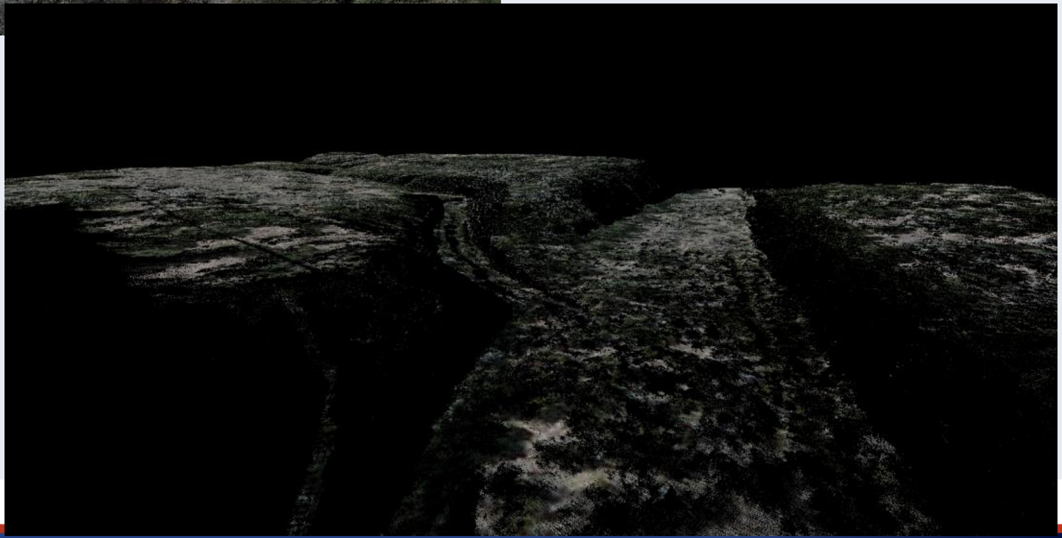




Raw vs processed LiDAR

Full point cloud, including ground and vegetation

Ground Only



Location, location, location

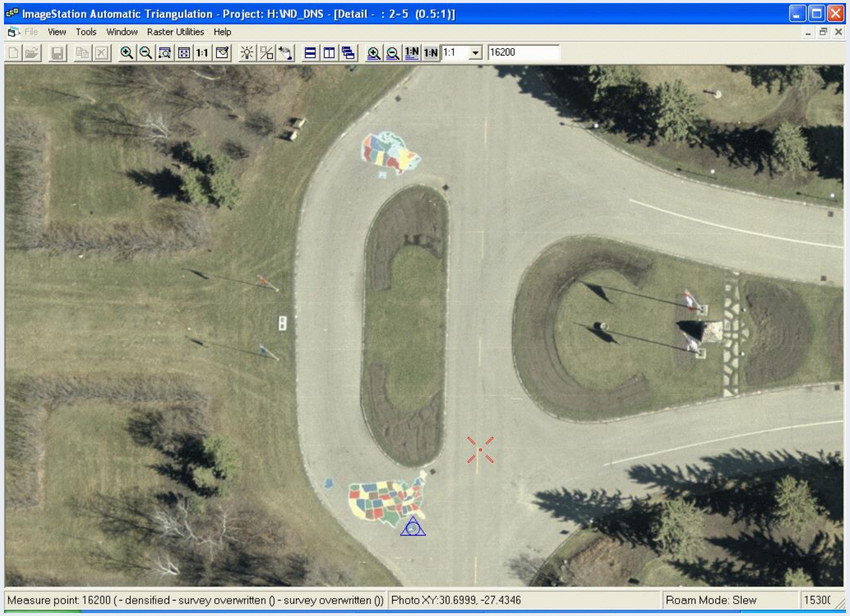
Mobile mapping would be nowhere without GNSS and IMU support.
The key is knowing position, orientation and time.
The solution is global.

There are a lot of areas needing attention where this doesn't work.

- Indoors
- Anywhere without clear sky access to GNSS
- Areas with jamming or interference

Fortunately, there are other localized solutions:

- Locata
- Cell towers
- UWB, RF, etc
- SLAM
- Surveying



Better Data Starts with Better Data Collection Methods

Blyth Gill
Commercialization Manager
Clearpath Robotics

YOUR UNMANNED EXPERTS ™

CLEARPATH ROBOTICS™

ECHOSTREAM
ENVIRONMENTAL DATA SYSTEMS ®

Automated Bathymetric Survey Tools for Water Resource Professionals ™

COMPANY SNAPSHOT

Mission: Automate worlds dullest, dirtiest and deadliest jobs

Specialty: Unmanned Vehicle Systems

Founded: 2009 as a University of Waterloo Spin-off

Employees: 40 and growing….quickly!

Markets Served:

WHAT WE DO BEST

Clearpath Robotics delivers **proven unmanned vehicle products** and services to help large R&D departments get **complex robotics projects to market faster** with less risk.

Products:

Ground

Husky UGV

Grizzly RUV

Water

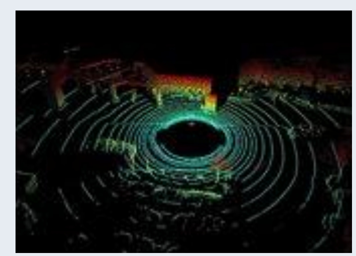
Kingfisher USV

Custom Vehicles

Services:

Sensor Fusion

Autonomous Software



Advanced Mapping & Navigation

WE WORK WITH WORLD LEADERS

BMW

Google

NASA

NATIONAL INSTRUMENTS

3M

MDA

intel

MIT Massachusetts Institute of Technology

CSA ASC

QinetiQ

U.S. AIR FORCE

NovAtel

Leland Stanford Junior University — Die Luft der Freiheit weht — 1891

UNIVERSITY OF WATERLOO

Sandia National Laboratories

McGill

Carnegie Mellon University

Argonne NATIONAL LABORATORY

Cal

Queen's UNIVERSITY

National Defence | Défense nationale

Fraunhofer

UNIVERSITY OF CALGARY

KINGFISHER M200™

UNMANNED SURFACE VESSEL

UTILITY VEHICLE

CONFIGURED FOR TRANSPORT, NO SENSORS

EQUIPPED WITH SENSOR

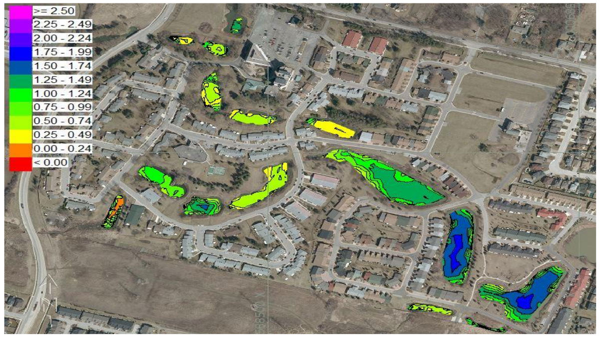
WHAT WE DO BEST

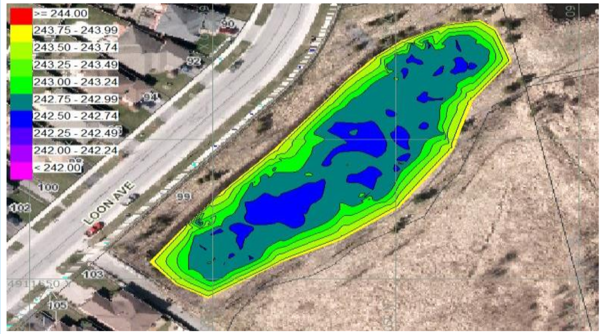
CUSTOM AUTOMATION- Mining Applications

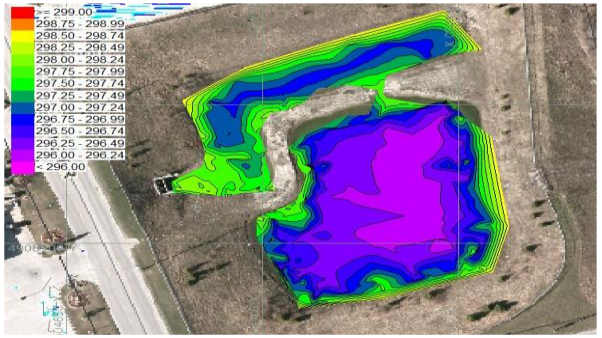
ECHOSTREAM
ENVIRONMENTAL DATA SYSTEMS ®

Better Bathymetric Data

Starts with Better Collection Methods







Automated Bathymetric Survey Tools for Water Resource Professionals ™

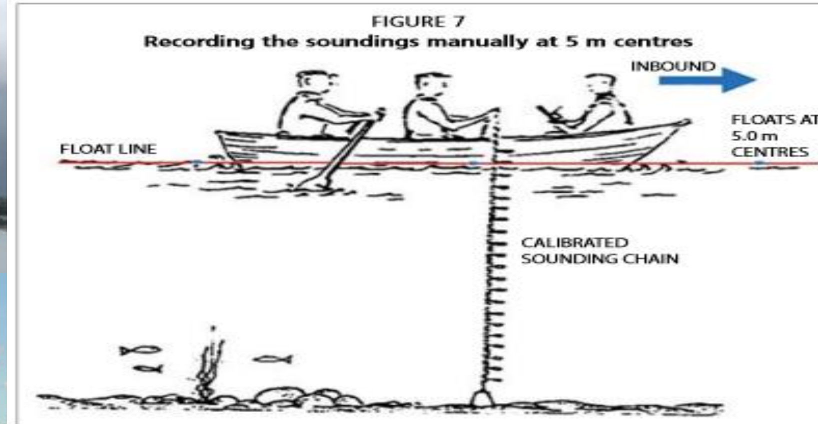
Data

- Consistency critical to quality
- Collection Speed/ Cost a challenge
- Digitization
- Accuracy

Problems

- Unsafe
- Slow
- Expensive
- Non-repeatable
- Inaccurate

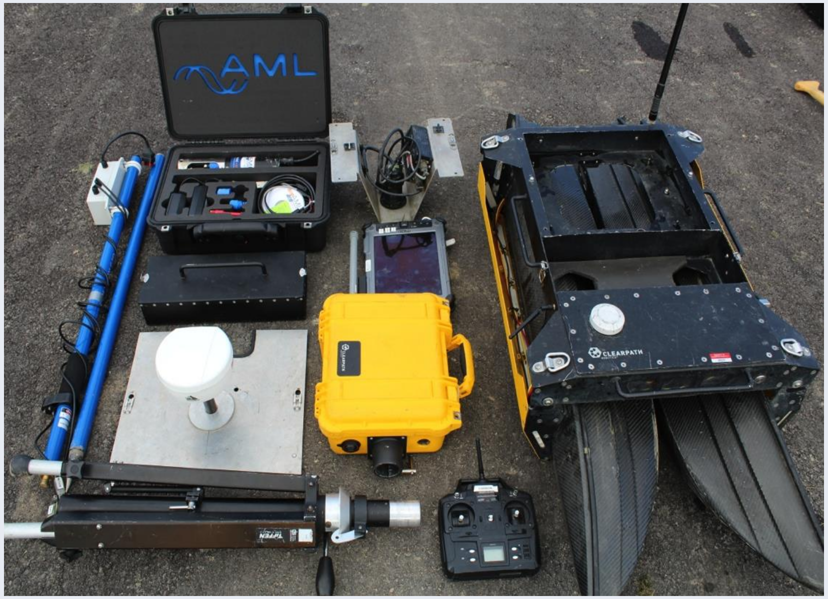
Traditional Methods



OLD WAY VS. NEW WAY

THE TECHNOLOGY

TM TM



Ask the Experts – Part 1

Jeff Fagerman
CEO
Fagerman
Techonologies, Inc

Blyth Gill
Commercialization Manager
Clearpath Robotics

Chris Day
Head of Capability
Engineering
Schiebel

Poll #2

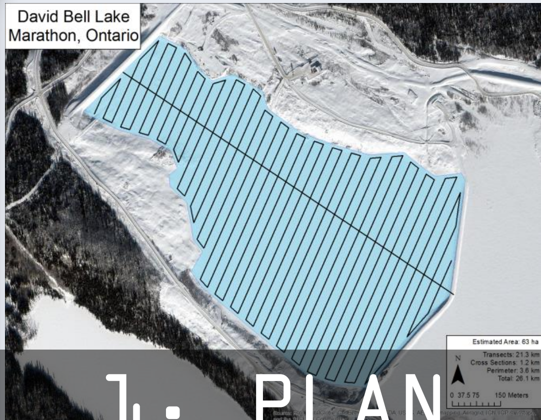
What are your accuracy requirements for the uses that you have in mind?

- *Centimeter level*
- *Decimeter level*
- *Meter level*

Proven Success: Faster, Cheaper, Safer

Blyth Gill
Commercialization Manager
Clearpath Robotics

HOW IT WORKS

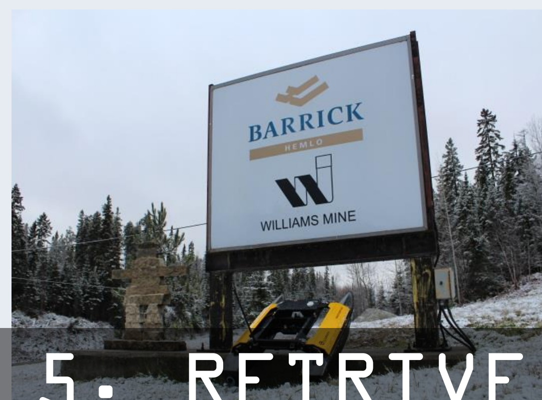


1. PLAN

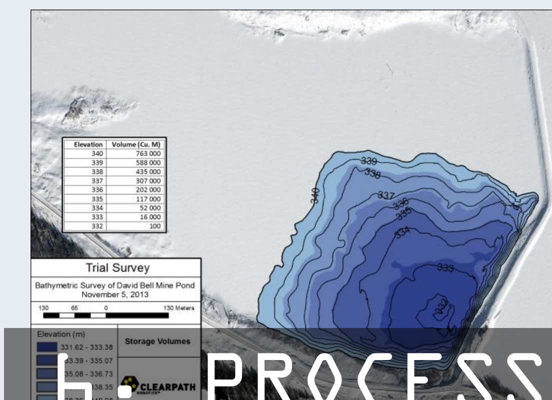
2. ARRIVE

3. DEPLOY

4. COLLECT



5. RETRIVE



6. PROCESS

Comparison Study

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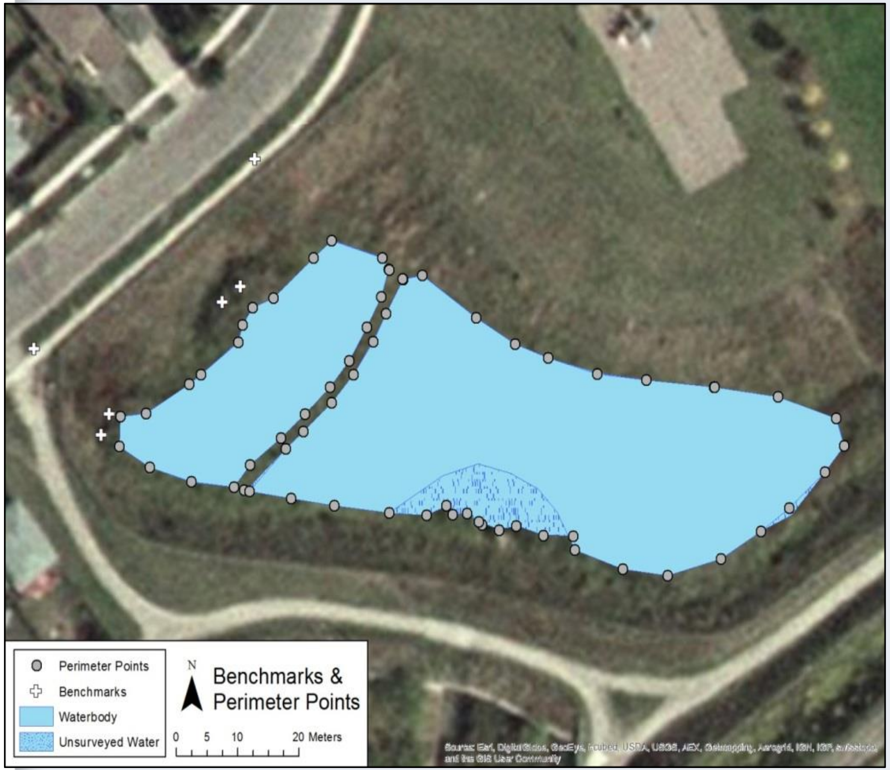
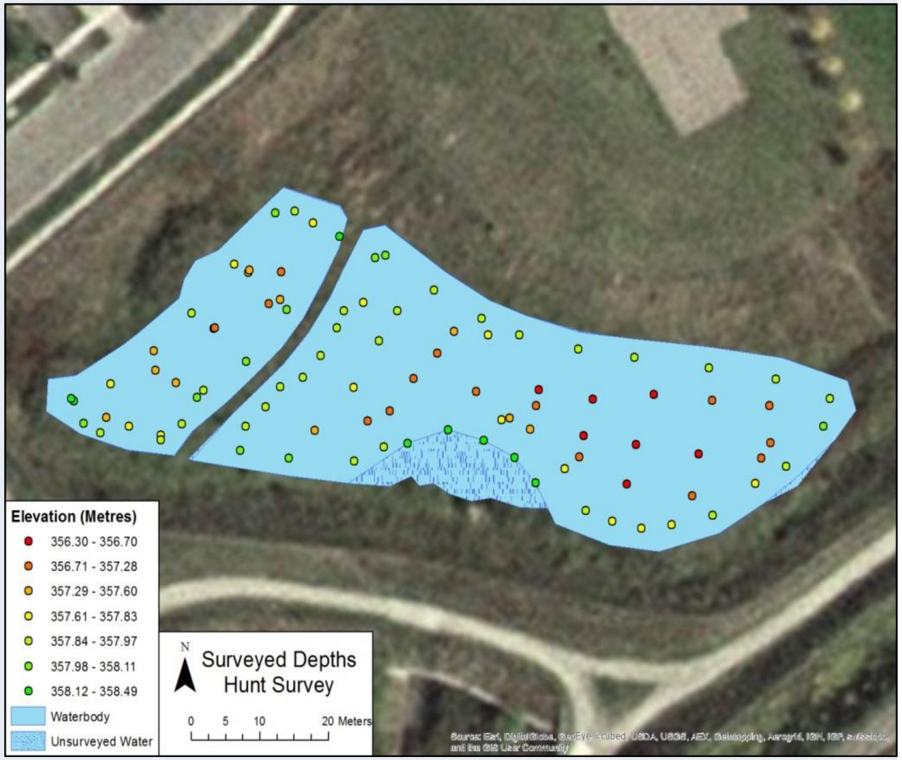
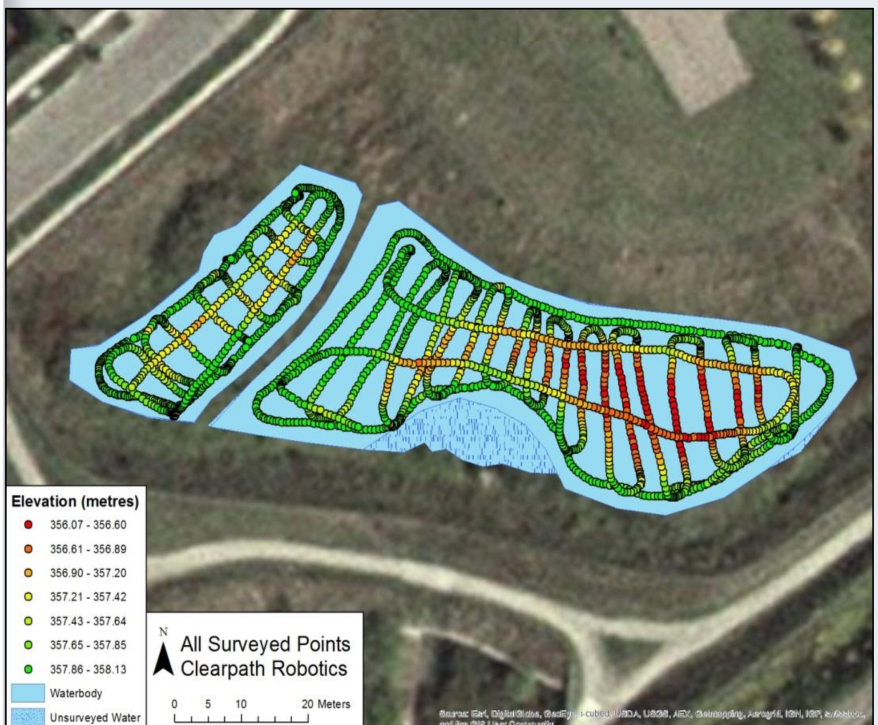
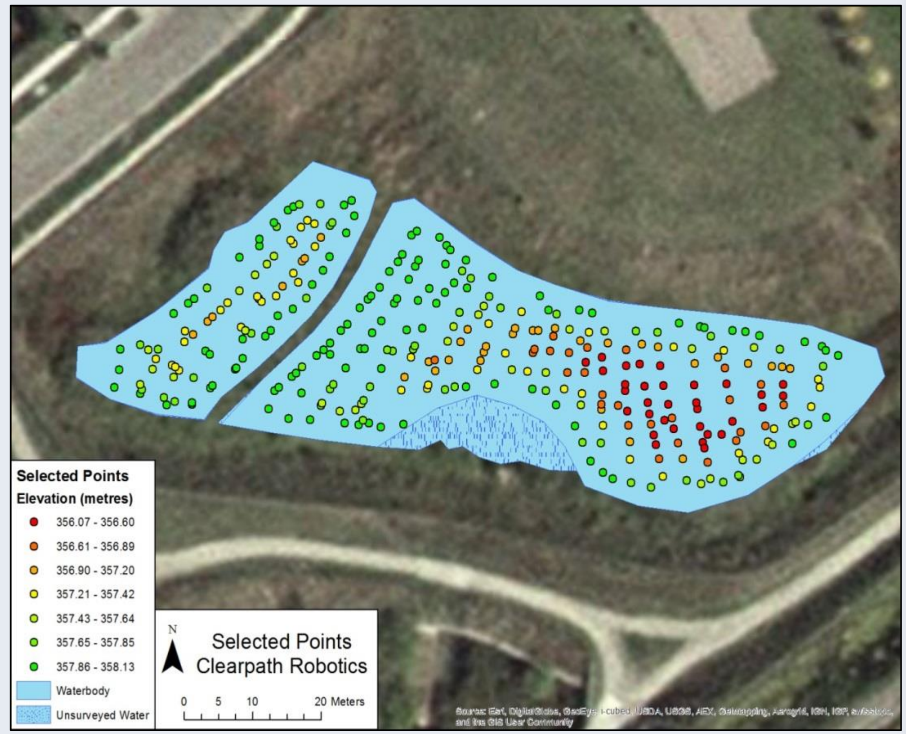
Benchmark Survey



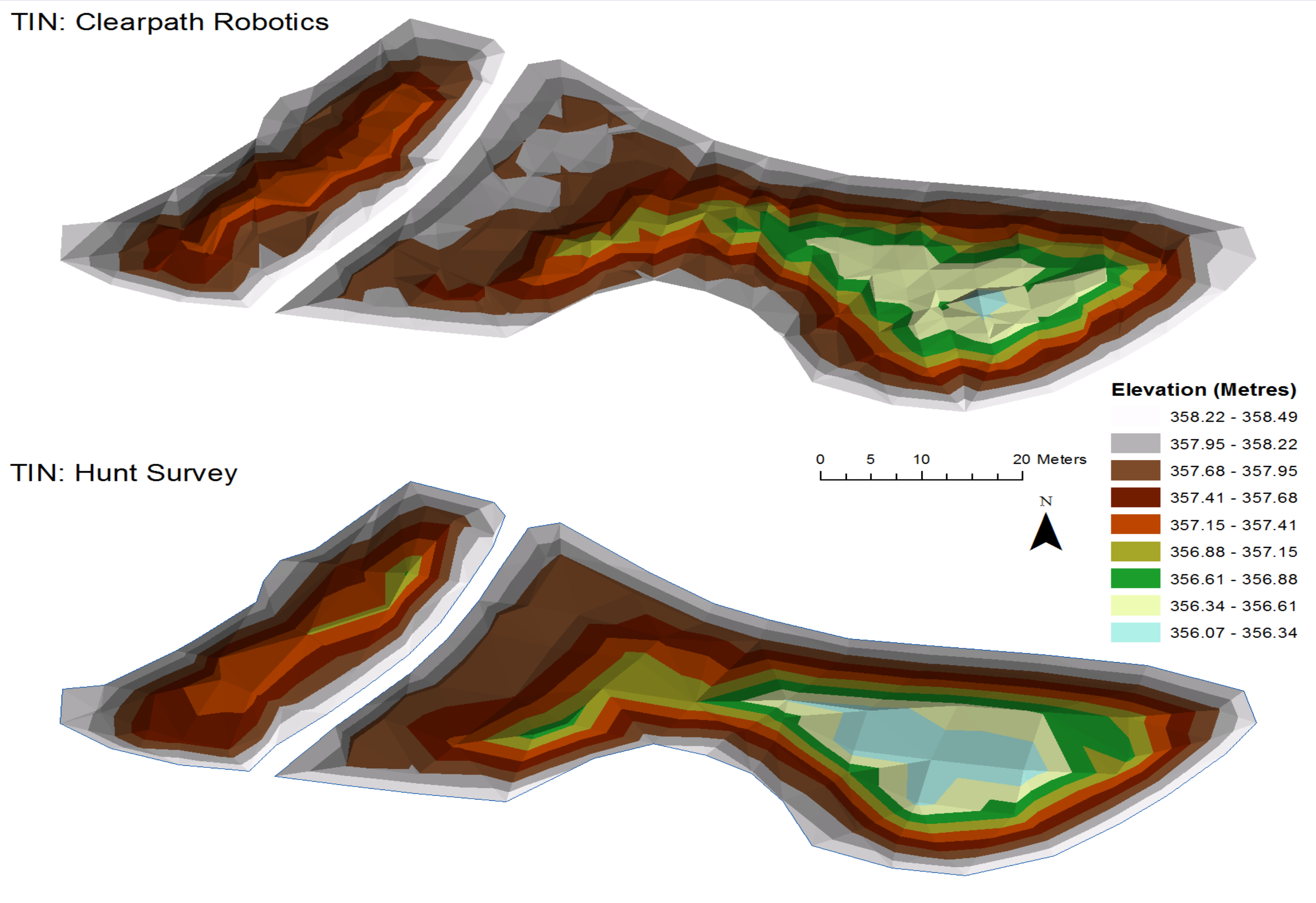


Echostream Survey

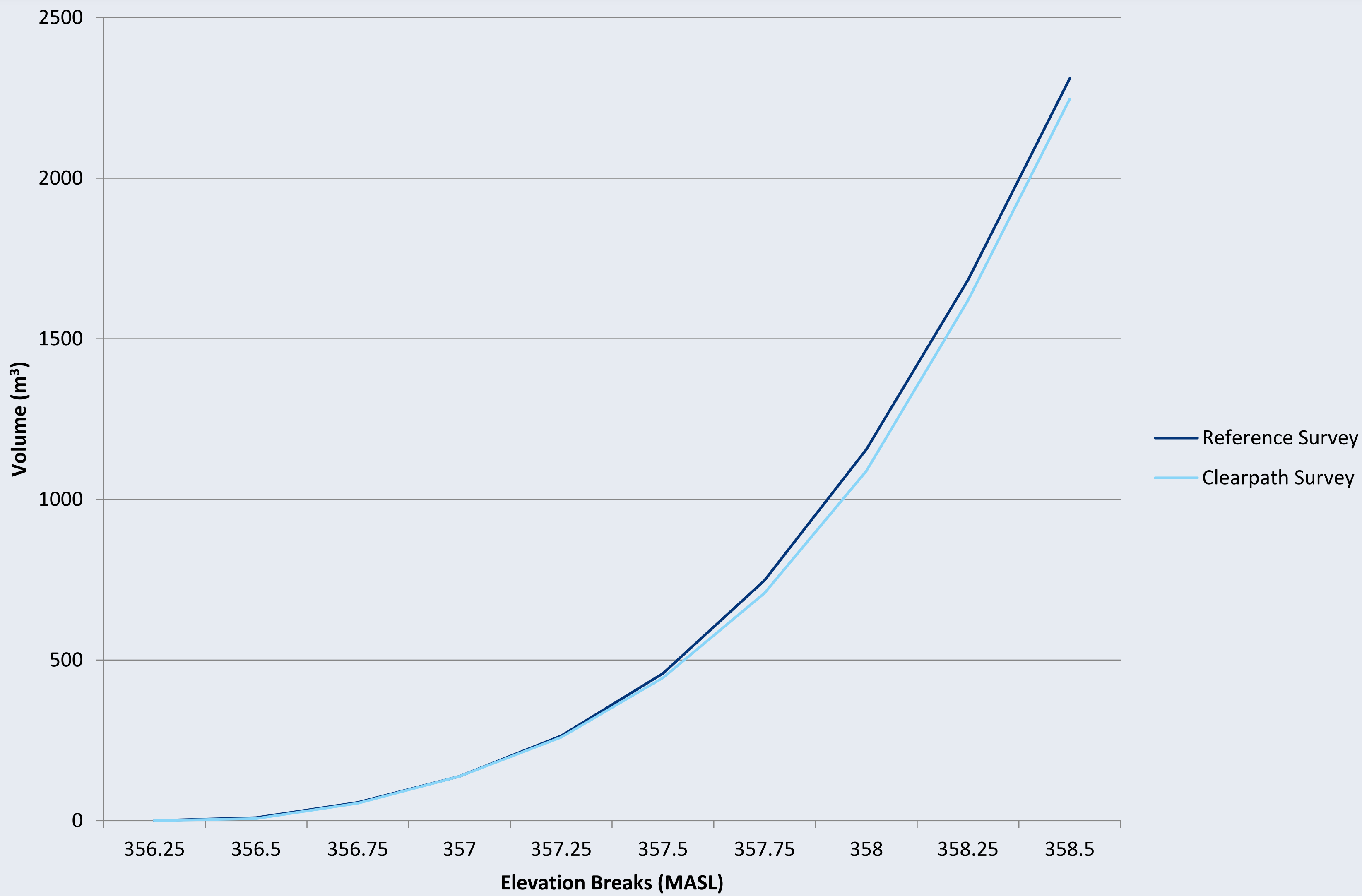




TIN Maps


TIN: Clearpath Robotics
TIN: Hunt Survey
Elevation (Metres)
358.22 - 358.49
357.95 - 358.22
357.68 - 357.95
357.41 - 357.68
357.15 - 357.41
356.88 - 357.15
356.61 - 356.88
356.34 - 356.61
356.07 - 356.34
0 5 10 20 Meters
N

Storage Curves



Time Savings

Table 2: Elapsed time summary

Stage	Element	Echostream	Hunt Surveys
Perimeter Points (minutes)	Set-up	15	10
	Survey	50	45
Water Points (minutes)	Set-up	15	20
	Forebay	10	40
	Main Cell	17	70
Total	-	122	200

*Note that robotic survey can be completed with one individual, traditional methods with at least two

APPLICATIONS

Stormwater Management

Tailings Storage Facilities

Hydro Dams and Reservoirs

Streams, Creeks and Rivers

Coastal and Shoreline

Ports and Harbors

PROVEN SUCCESS:

Faster, Cheaper, Safer

PotashCorp

12 vs.
300 man-hours

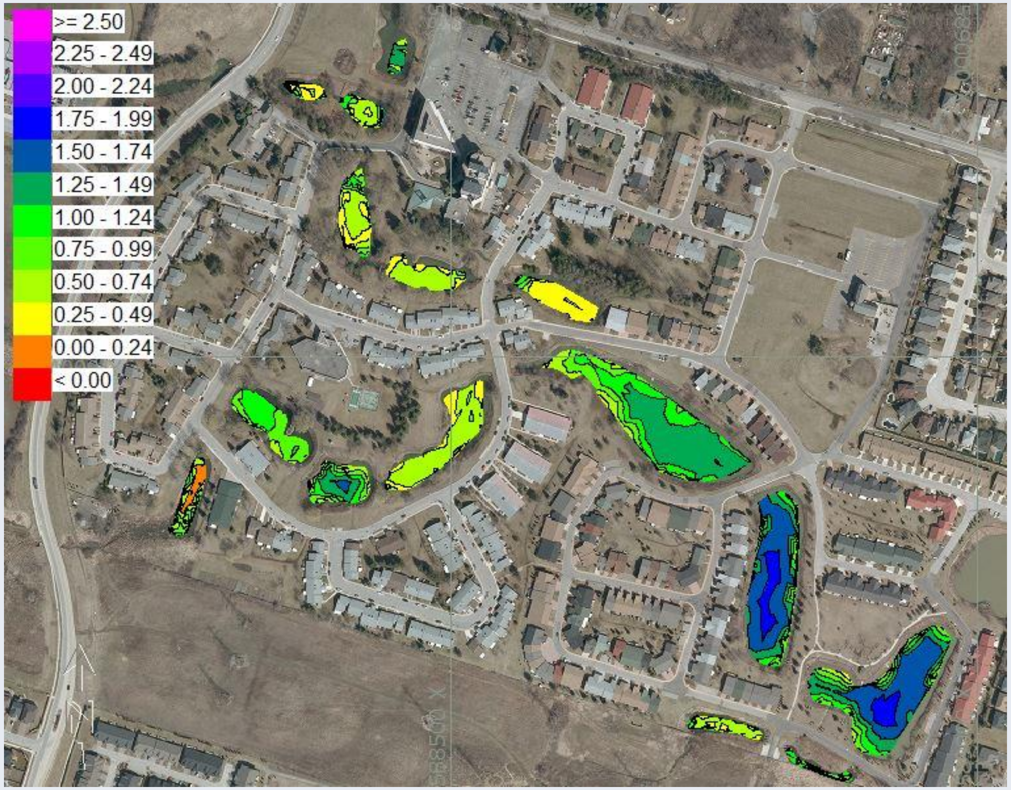
89,000 data points

33% cost

Zero risk to workers

Stormwater Management (SWM) Ponds

AECOM



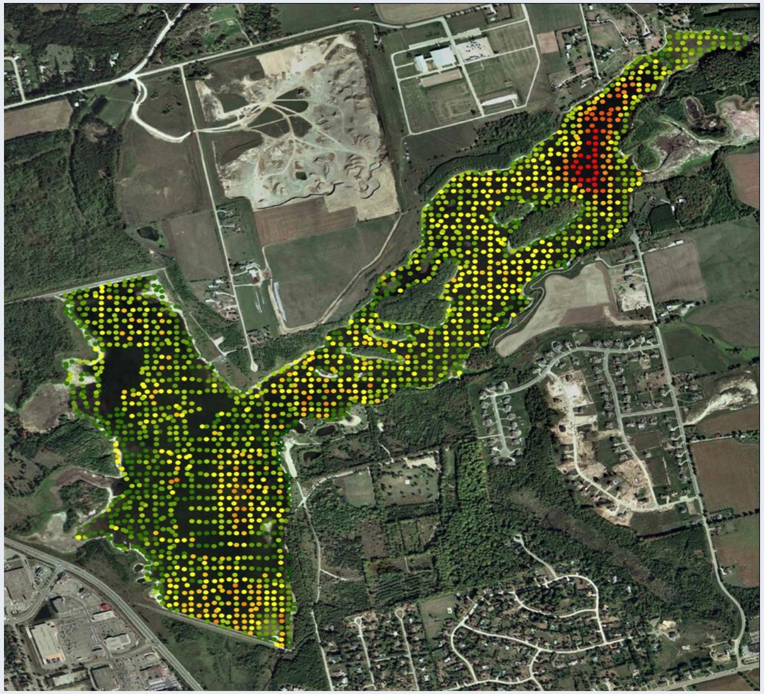
1.5 days vs.
5 days

50 % cost

Zero risk to workers

PROVEN SUCCESS:

Dams & Reservoirs



Island Lake Reservoir
Orangeville, ON

Woolwich Dam
Elmira, ON

Kelso Lake Reservoir
Milton, ON

PROVEN SUCCESS: Tailings Ponds

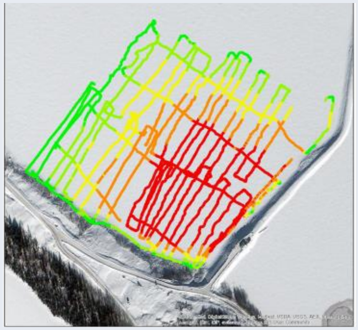
BARRICK

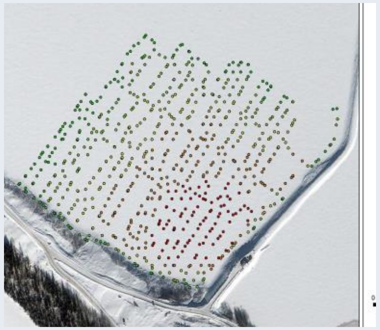
PotashCorp

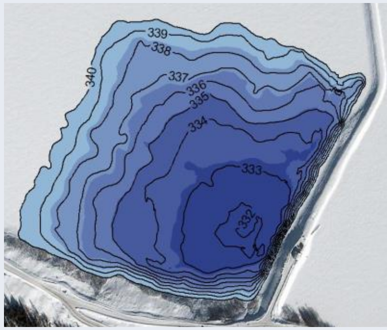
Kirkland Lake Gold Inc.

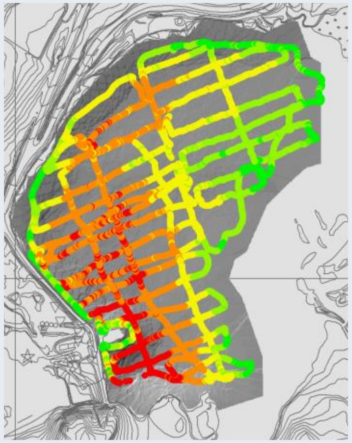
AECOM

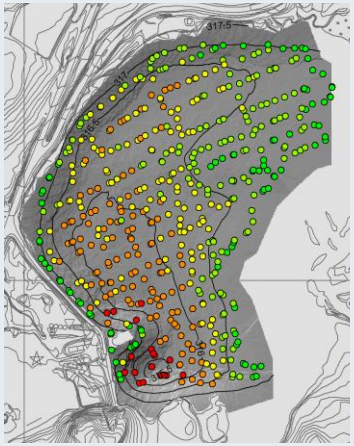
amec

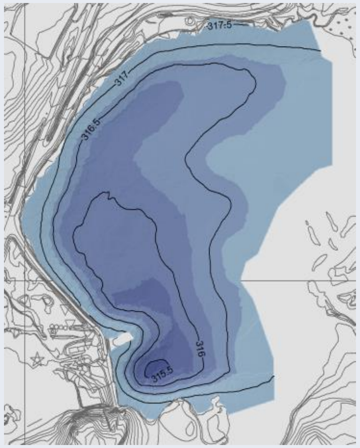












Storage Curves Contour Maps

CALL TO ACTION:

Be safe… use robots!

Field Experience and Considerations

Chris Day
Head of Capability Engineering
Schiebel

CAMCOPTER® S-100 UNMANNED AIR SYSTEM

SCHIEBEL

CAMCOPTER® S-100 CAPABILITIES

Operational on:

- ✓ **3 Oceans**
- ✓ **Artic, Mountain, Desert, Rainforest Environments**
- ✓ **Automatic Launch and Recovery – Sea-state 5, Wind Gusts Over 25 Knots.**

Each Environment presents it own unique set of challenges for the air vehicle and its systems

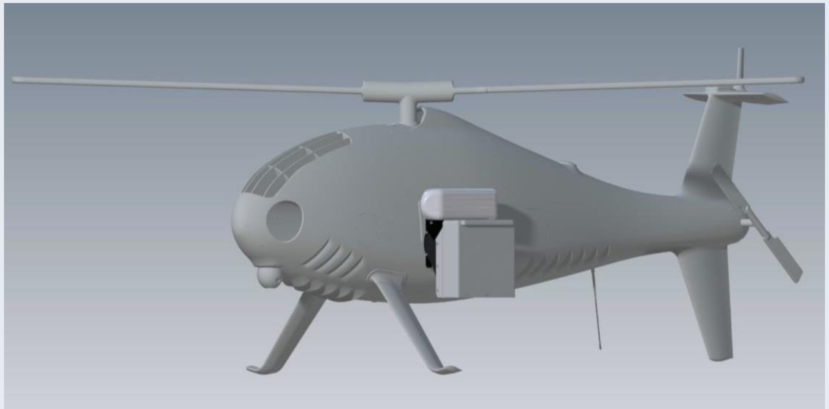
Operational Challenges

- ✓ Duplex navigation system - redundancy
- ✓ Additional high accuracy navigation system(s) required for
  - ✓Sensors –
    - ✓Geolocation accuracy
    - ✓Pointing accuracy
  - ✓Shipboard auto-recovery system

Operational Challenges

- ✓ Independence from GPS is becoming ever more important
- ✓ GPS resilience – Essential
- ✓ Point recovery is demanding on GPS service

Operational Challenges



- ✓ Many countries have developed independent satellite navigation systems:
  - ✓USA - GPS,
  - ✓Europe - Galileo,
  - ✓Russia - GLONASS,
  - ✓China - Beidou or COMPASS,
  - ✓ India - Indian Regional Navigation Satellite System (IRNSS),
  - ✓France - Doppler Orbitography and Radio (DORIS)
  - ✓Japan - Quazi Zenith Satellite System (QZSS).
- ✓ Different Customers require different solutions – The system has to be flexible to cope with all possible solutions

Operational Experience

- ✓ Denial of service becoming an ever more frequent problem.
- ✓ Instances occurring world-wide
- ✓ Unpredictable
- ✓ Capability leveller
- ✓ Significant threat to growth of unmanned systems

Next Steps

Visit www.insidegnss.com/webinars for a PDF of Presentations

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Poll #3

What are the limitations to adopting an unmanned system? (Select your top two)

- *Cost/Return on investment*
- *Learning curve*
- *Familiarity with technology*
- *Regulatory concerns*
- *Data accuracy*

Ask the Experts – Part 2

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